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On some recent optimizations in EUROPLEXUS numerical simulations of urban blast events

Casadei, F., Larcher, M., Markovic, D.

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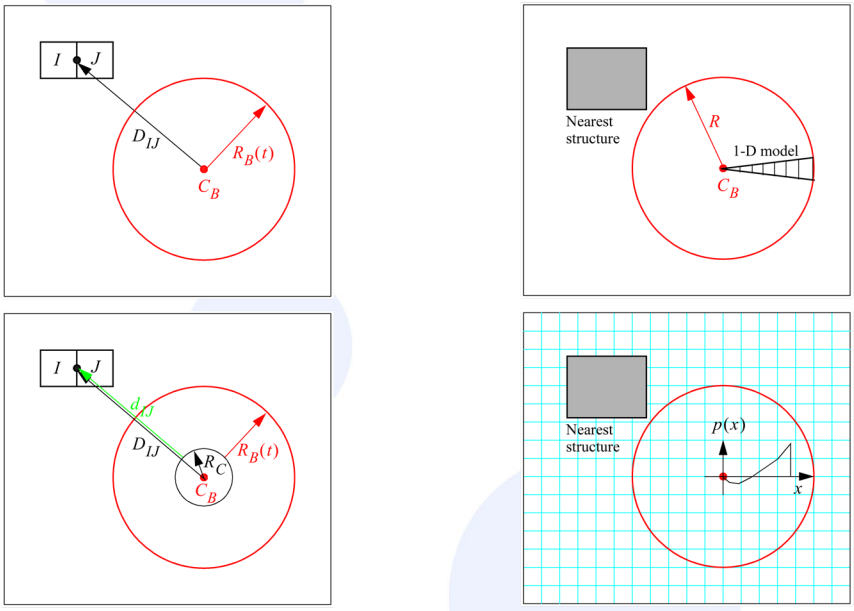

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Contents

Abstract

This report presents some optimizations that have been recently introduced in the EUROPLEXUS code for the numerical simulation of blast events in urban environments. The optimizations are focused on reducing CPU load and time in transient dynamic simulations of blasts offering technical support to EC policies concerning the security of critical infrastructures and the protection of public spaces, two subjects which have become more and more sensible over the last years.

Two (alternative) types of optimization are considered. In the first type, the calculation of numerical fluxes in the Cell-Centered Finite Volume (CCFV) discrete model used to represent the fluid sub-domain is skipped for all portions of the model that have not yet possibly been reached by the blast wave resulting from the explosion. This is simply derived from the distance between the charge and the fluid FV (or FV interface) under consideration, and from the propagation speed of the blast wave, assumed constant for simplicity.

In the second type of optimization, which is outlined but not yet implemented, a combined 1-D/multi-D fluid model would be set up. The 1-D model is similar to that used to produce a so-called map file, i.e. to compute the numerical solution from the detonation instant until the instant in which the blast wave encounters the first obstacle, typically a structure. During this time period, the blast wave is typically spherical or hemispherical and may be represented by a 1-D model instead of a (typically) 3-D one, thus saving a substantial amount of CPU time.

Then, the solution would be stored on a map file. In a subsequent simulation, the (1-D) solution would be read back from the map file and mapped onto the real 3D mesh, containing also the structures to be tested. Finally, the 3-D simulation would be carried on until the desired final time.

Keywords: *Fast transient dynamics, explicit code, FSI, urban blast events, critical infrastructures, public spaces*.

Foreword

This report is part of a large series of scientific-technical documents that are meant to provide essential information and documentation to users and developers of the EUROPLEXUS code. EUROPLEXUS (also abbreviated as EPX) is a computer code jointly developed by the French Commissariat à l'Energie Atomique (CEA DMT Saclay) and by EC-Joint Research Centre (JRC Ispra) within the framework of contractual agreements between the two research bodies.

EPX is a mature, general-purpose Finite Element and Finite Volume explicit code under active development since 1999, for the simulation of fast transient dynamic events in complex fluid-structure systems. It is an evolution of its ancestor PLEXIS-3C, which was also jointly developed by CEA and JRC in the 1980s and early '90s.

The code has been traditionally used in safety studies, ranging from nuclear reactors, to energy plants, to chemical and industrial plants, off-shore structures, car and road barrier crashes, among others. More recently it has proven a very useful tool in providing certified and independent numerical solutions in support of EC policies regarding the security of critical infrastructures and public spaces (like buildings, train and metro stations and carriages, etc.), which may be vulnerable to terrorist attacks or to natural disasters.

While being mainly of technical nature, the information contained in this series of reports is an invaluable source of reference for the users (as a complement to the User's manual) but also in particular for the developers of EPX. New models made available in the code are described in detail from the theoretical viewpoint. Several verification and application examples are also usually provided, in order to illustrate the practical use and to verify the correct functioning of the models.

Usually, at the end of each report an Annex lists the input files that were used to produce the examples presented in the report. This allows users to re-run the test cases with EPX at any time and to use them as a basis for their own numerical simulations.

A complete list of the reports (produced both at JRC and at CEA) in this series can be found in the Bibliography section of the EPX User's manual [1].

Acknowledgements and Authors

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1 Introduction

This report presents some optimizations that have been recently introduced in the EUROPLEXUS code for the numerical simulation of blast events in urban environments. The optimizations are focused on reducing CPU load and time in transient dynamic simulations of blasts offering technical support to EC policies concerning the security of critical infrastructures and the protection of public spaces, two subjects which have become more and more sensible over the last years.

EUROPLEXUS [1] (also abbreviated as EPX) is a computer code jointly developed by the French Commissariat à l'Energie Atomique (CEA DMT Saclay) and by EC-JRC. The code application domain is the numerical simulation of fast transient phenomena such as explosions, crashes and impacts in complex three-dimensional fluid-structure systems. The Cast3m [2] software from CEA is used as a pre-processor to EPX when it is necessary to generate complex meshes.

Two (alternative) types of optimization are considered. In the first type, the calculation of numerical fluxes in the Cell-Centered Finite Volume (CCFV) discrete model used to represent the fluid sub-domain is skipped for all portions of the model that have not yet possibly been reached by the blast wave resulting from the explosion. This is simply derived from the distance between the charge and the fluid FV (or FV interface) under consideration, and from the propagation speed of the blast wave, assumed constant for simplicity.

In the second type of optimization, a combined 1-D/multi-D fluid model is set up. The 1-D model is similar to that used to produce a so-called map file, i.e. to compute the numerical solution from the detonation instant until the instant in which the blast wave encounters the first obstacle, typically a structure. During this time period, the blast wave is typically spherical or hemispherical and may be represented by a 1-D model instead of a (typically) 3-D one, thus saving a substantial amount of CPU time.

Then, the solution would be stored on a map file. In a subsequent simulation, the (1-D) solution would be read back from the map file and mapped onto the real 3D mesh, containing also the structures to be tested. Finally, the 3-D simulation would be carried on until the desired final time.

This two-step process may result cumbersome in practice because it requires running the EPX code twice. However, this is not strictly necessary because EPX can deal with a fluid model containing both 1-D and 3-D parts at the same time. Therefore, the idea is to build a mixed numerical model. Initially, the 3D volumes would be excluded from the simulation, thus saving computer time. Once reached the desired map time (as the blast wave impinges on the first structure) the 1-D part of the model would be disabled, while the 3D part would instantly become active, starting with "initial" conditions derived (mapped0)from the 1-D solution.

In this way, by using a simple activation/deactivation mechanism, a single (monolithic) EPX simulation would suffice to perform the complete analysis. Moreover, the map time could be determined automatically by the code instead of requiring an estimation by the user.

1.1 Motivation and intended audience

The present developments are related to the validation of JRCs computational tools for the numerical simulation of explosive events. These simulations provide technical support to EC policies concerning the security of critical infrastructures and the protection of public spaces, two subjects which have become more and more sensible over the last years. Readers should be warned that the report is very technical and the intended audience is primarily developers and users of the EPX code. For such categories, this type of report provides critical information and documentation.

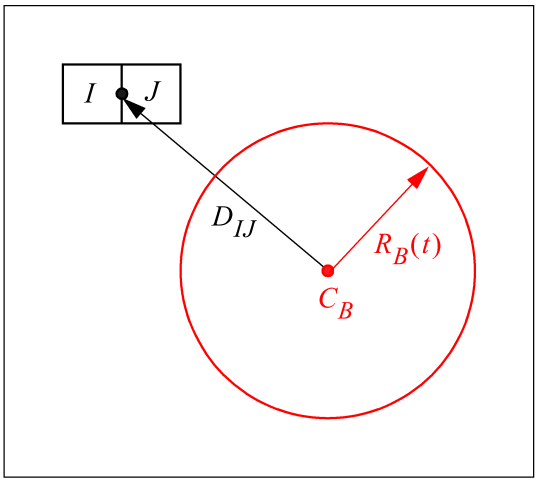
2 Skipping mesh portions not yet reached by the blast wave

2.1 Interface skipping strategy

The strategy adopted for the mesh skipping strategy is depicted in Figure 1. Assume that a detonation occurs at point $\boldsymbol{C}_B$ and at time t_B. As long as no obstacles are hit, this will produce a spherical wave of radius $R_B(t)$ at time t. If we assume for simplicity that the propagation speed s_B of the wavefront is constant, we have, at the generic time $t > t_B$:

$$R_B(t) = s_B(t - t_B) \tag{1}$$

Figure 1: The skipping strategy.



Sources: JRC analysis.

2.1.1 Interface blast time

Consider a couple of neighboring FVs I and J, separated by an interface (face) IJ, with center at $\boldsymbol{C}_{IJ}$, located at a distance D_{IJ} from the explosive:

$$D_{IJ} = ||\boldsymbol{C}_{IJ} - \boldsymbol{C}_B|| \tag{2}$$

The numerical fluxes across IJ need not be computed, i.e. the interface may be skipped, until the blast has a chance to reach it, i.e. not earlier than a time t_{JJ} given by:

$$t_{IJ} = D_{IJ}/s_B \tag{3}$$

Assuming first for simplicity that the fluid mesh is static (in other words, that there is no adaptivity), the time t_{IJ} can be evaluated once and for all for each interface IJ at the beginning of the calculation and stored in an array dimensioned upon the total number of interfaces. Then, during the transient simulation, the interface IJ would simply be skipped as long as $t < t_{IJ}$.

If there are several charges at different positions, each one possibly detonating at a different time and with a different estimated wavefront speed, then the activation time t_{IJ} wouuld be determined separately for each charge, and the minimum value would be retained.

2.1.2 Volume blast time

Besides the interface-related blast time t outlined in the previous paragraph, one should also consider a volume-related blast time τ. In fact, it seems reasonable that the state (conserved variables) of a finite volume should not be updated until all its interfaces have become active. Otherwise, i.e. in the presence of a mixture of active and inactive interfaces for a volume, some of the flux contributions for the volume under consideration would be missing, thus leading to erroneous results.

If a volume I has n interfaces F_k, $k = 1, \cdots, n$ with corresponding blast times t_k, then:

$$\tau_I = \max_k(t_k) \tag{4}$$

This means that volume I should not be updated until all its faces have become active. By considering first for simplicity the case without adaptivity in the fluid mesh, just like the interface blast times t, the volume blast times τ need be computed only once, at the beginning of the transient calculation, immediately after the calculation of t.

2.2 Input syntax

To activate the skipping strategy, a new optional `BLAS` sub-directive is implemented in the `INIT` directive [1], namely:

```
INIT BLAS nblas * ( POIN x y <z> VELO v T0 t0 < DMIN dmin > /LECT/ )
```

where:

`nblas`

Number of blasts to be defined next.

`POIN x y z`

Point (center) at which the charge detonates. In 2D only two coordinates should be specifiued.

`VELO v`

Speed of propagation of the wave front, assumed constant for simplicity. To be on the safe side, the user may want to specify a speed slightly larger than the estimated (maximum) speed of the blast wavefront.

`T0 t0`

Time at which the charge detonation begins.

`DMIN dmin`

Minimum distance $D_{\min}$ from the charge point specified by `POIN` below which the finite volume interfaces are always computed (never skipped). If omitted, the code assumes $D_{\min} = 0$.

`/LECT/`

List of concerned elements (Finite Volumes).

If more than one blast is specified, the minimum hit time of all blasts is retained for each Finite Volume considered.

2.3 Numerical examples with the skipping strategy

We present some simple numerical examples to verify the skipping model. They are summarized in Table 1 and are described in detail in the next paragraphs.

Table 1: Simulations to verify the skipping model.

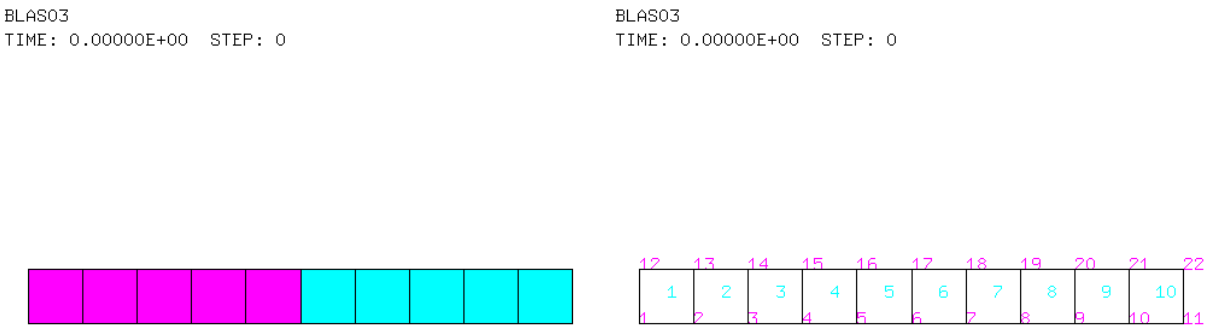
Case	Elements	Model	t_f [ms]	Steps	Els*Steps	CPU [s]
BLAS03	10 Q4VF	Reference solution (no skip), coarse mesh	0.6	7	80	—
BLAS04	10 Q4VF	Same as 03 but with skip, `VELO 650`	0.6	7	44	—
BLAS05	10 Q4VF	Same as 03 but with skip, `VELO 1200`	0.6	7	62	—
BLAS06	10 Q4VF	Same as 03 but with skip, `VELO 900`	0.6	7	54	—
BLAS01	800 Q4VF	Reference solution (no skip), fine mesh	0.6	733	587 200	1.0
BLAS02	800 Q4VF	Same as 01 but with skip, `VELO 650`	0.6	733	230 789	0.7
BLAS07	800 Q4VF	Same as 01 but with skip, `VELO 1200`	0.6	733	386 211	0.9
BLAS11	6 400 Q4VF	Reference solution (no skip), 2D box	0.8	147	947 200	1.4
BLAS12	6 400 Q4VF	Same as 11 but with skip, `VELO 1667`	0.8	122	444 540	0.8
BLAS13	6 400 Q4VF	Same as 11 but with skip, `VELO 3000`	0.8	136	637 452	1.1
BLAS14	6 400 Q4VF	Same as 11 but `FCON 3` instead of 6	0.8	144	928 000	1.3
BLAS15	6 400 Q4VF	Same as 12 but `FCON 3` instead of 6	0.8	119	433 896	1.3
BLAS21	800 Q4VF	Same as 01 but tube along y	0.6	1 460	2 337 600	2.9
BLAS22	800 Q4VF	Same as 02 but tube along y	0.6	1 459	230 789	0.6
BLAS16	6 400 Q4VF	Same as 12 but corrected distance eqn.	0.8	147	613 892	1.1
BLAS17	6 400 Q4VF	Same as 13 but corrected distance eqn.	0.8	147	739 000	1.2
BLAS31	512 000 CUVF	Reference solution (no skip), 3D box	0.8	560	287 232 000	705.7
BLAS32	512 000 CUVF	Same as 31 but with skip, `VELO 3333`	0.8	524	193 471 488	526.2
BLAS33	512 000 CUVF	Same as 32 but `DMIN 0.20`	0.8	560	228 074 296	600.3
BLAS40	10 Q4VF	Same as 03 but with `BUBB` conditions	0.08	8	90	—
BLAS41	512 000 CUVF	Same as 31 but instrumented for velocity	0.8	560	287 232 000	703.1

Sources: JRC analysis.

2.3.1 Case BLAS03

A simple shock tube is considered in 2D. The tube is 1 m long and consists of two equal parts, the left one initially at high pressure and the right one at low pressure. The mesh is very coarse and uses only 10 Q4VF quadrangles, see Figure 2.

Figure 2: Model of test BLAS03.

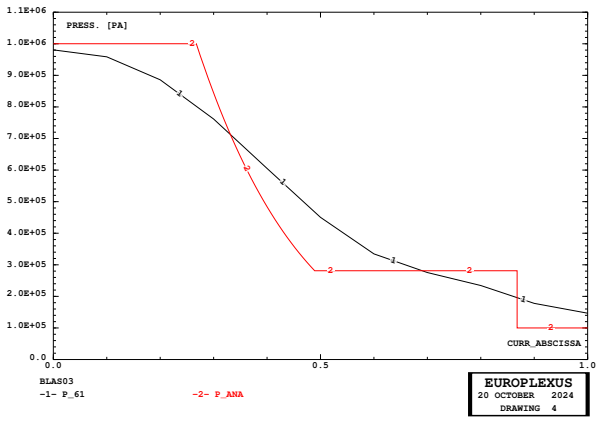


(a) Mesh (b) Nodes and elements

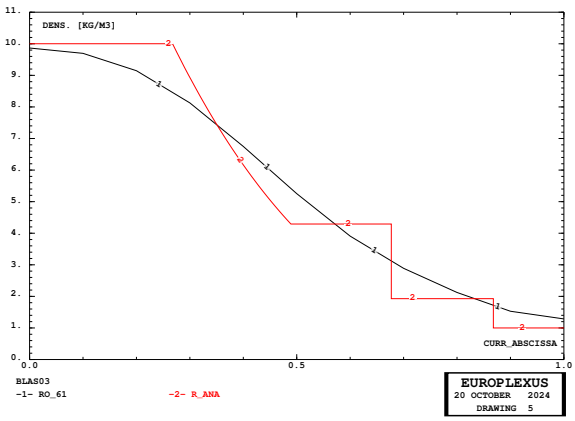
Sources: JRC analysis.

This is the reference solution, i.e. without activating the `INIT BLAS` mesh skipping directive. The solution is illustrated in Figure 3, showing the pressure, density and velocity distributions along the tube at the final time. The red curves are the analytical solution. The agreement with the numerical solution (black curves) is poor, due to the extreme coarseness of the mesh.

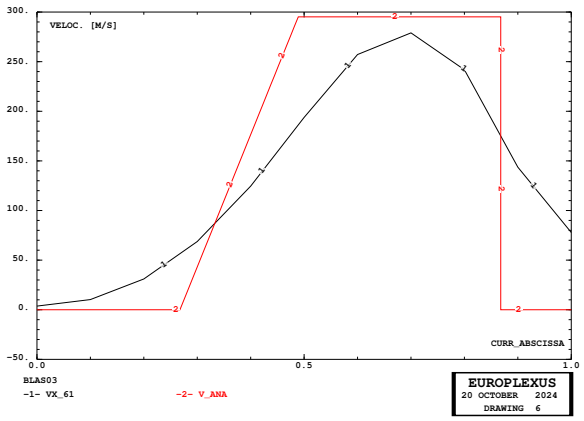
Figure 3: Solution of test BLAS03.



(a) Pressure



(b) Density



(c) Velocity

Sources: JRC analysis.

2.3.2 Case BLAS04

This test is identical to BLAS03 but we add the INIT BLAS mesh skipping directive:

```
BLAS04
ECHO
!CONV win
EULE DPLA
GEOM LIBR POIN 22 Q4VF 10 TERM
 0.0 0.0  0.1 0.0  0.2 0.0  0.3 0.0  0.4 0.0  0.5 0.0
          0.6 0.0  0.7 0.0  0.8 0.0  0.9 0.0  1.0 0.0
 0.0 0.1  0.1 0.1  0.2 0.1  0.3 0.1  0.4 0.1  0.5 0.1
          0.6 0.1  0.7 0.1  0.8 0.1  0.9 0.1  1.0 0.1
  1  2 13 12
  2  3 14 13
  3  4 15 14
  4  5 16 15
  5  6 17 16
  6  7 18 17
  7  8 19 18
  8  9 20 19
  9 10 21 20
 10 11 22 21
COMP GROU 3 'bar1' LECT 1 2 3 4 5 TERM
           'bar2' LECT 6 7 8 9 10 TERM
           'bar'  LECT bar1 bar2 TERM
     NGRO 1 'xaxo' LECT 1 PAS 1 11 TERM
     COUL ROSE LECT bar1 TERM
          TURQ LECT bar2 TERM
MATE GAZP RO 10 GAMM 1.5 PINI 1.E6 PREF 1.E5
          LECT bar1 TERM
     GAZP RO  1 GAMM 1.5 PINI 1.E5 PREF 1.E5
          LECT bar2 TERM
INIT BLAS 1
          POIN 0.5 0.05
          VELO 650.0
          TO 0.0
          DMIN 0.25
          LECT bar TERM
ECRI COOR DEPL VITE ACCE FINT FEXT CONT ECRO VFCC FREQ 1
!    FICH ALIC TEMP FREQ 1
!         POIN LECT pa pmid pb TERM
!         ELEM LECT ea eb TERM
     FICH ALIC FREQ 1
OPTI NOTE STEP IO
 csta 0.5
 log 1
!VFCC FCON 1              ! OK
!VFCC FCON 2 VISC 0.75    ! OK
 VFCC FCON 3              ! OK
!VFCC FCON 4              ! OK
!VFCC FCON 5              ! OK
!VFCC FCON 6              ! OK
!VFCC FCON 7              ! OK
!VFCC FCON 8              ! OK
!VFCC FCON 9              ! OK
!VFCC FCON 10             ! OK
!VFCC FCON 11             ! OK
!VFCC FCON 12             ! OK
      dump
CALC TINI 0. TEND 0.60E-3 ! nmax 1
*=============================================================
SUIT
Post-treatment (space curves from alice file)
ECHO
RESU ALIC GARD PSCR
SORT GRAP
PERF 'blas04.pun'
AXTE 1.0 'Time [s]'
*
SCOU 21 'p_2'  NSTO 3 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      ECRO COMP 1
SCOU 22 'ro_2' NSTO 3 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      ECRO COMP 2
SCOU 23 'vx_2' NSTO 3 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      VCVI COMP 1
DCOU 26 'pa_2' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.2199655E-3 NRAR 30 VARI 1
DCOU 27 'ra_2' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.2199655E-3 NRAR 30 VARI 2
DCOU 28 'va_2' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.2199655E-3 NRAR 30 VARI 5
RCOU 121 'p_2'  FICH 'blas03.pun' RENA 'p_2_03'
RCOU 122 'ro_2' FICH 'blas03.pun' RENA 'ro_2_03'
RCOU 123 'vx_2' FICH 'blas03.pun' RENA 'vx_2_03'
TRAC 21 26 121 AXES 1.0 'PRESS. [PA]' SYMB
COLO NOIR ROUG VERT
TRAC 22 27 122 AXES 1.0 'DENS. [KG/M3]' SYMB
COLO NOIR ROUG VERT
TRAC 23 28 123 AXES 1.0 'VELOC. [M/S]' SYMB
COLO NOIR ROUG VERT
*
SCOU 31 'p_3'  NSTO 4 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      ECRO COMP 1
SCOU 32 'ro_3' NSTO 4 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      ECRO COMP 2
SCOU 33 'vx_3' NSTO 4 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      VCVI COMP 1
DCOU 36 'pa_3' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.3060051E-3 NRAR 30 VARI 1
DCOU 37 'ra_3' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.3060051E-3 NRAR 30 VARI 2
DCOU 38 'va_3' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.3060051E-3 NRAR 30 VARI 5
RCOU 131 'p_3'  FICH 'blas03.pun' RENA 'p_3_03'
RCOU 132 'ro_3' FICH 'blas03.pun' RENA 'ro_3_03'
RCOU 133 'vx_3' FICH 'blas03.pun' RENA 'vx_3_03'
TRAC 31 36 131 AXES 1.0 'PRESS. [PA]' SYMB
COLO NOIR ROUG VERT
TRAC 32 37 132 AXES 1.0 'DENS. [KG/M3]' SYMB
COLO NOIR ROUG VERT
TRAC 33 38 133 AXES 1.0 'VELOC. [M/S]' SYMB
COLO NOIR ROUG VERT
*
SCOU 71 'p_7'  NSTO 8 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      ECRO COMP 1
SCOU 72 'ro_7' NSTO 8 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      ECRO COMP 2
SCOU 73 'vx_7' NSTO 8 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      VCVI COMP 1
DCOU 76 'pa_7' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.6E-3 NRAR 30 VARI 1
DCOU 77 'ra_7' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.6E-3 NRAR 30 VARI 2
DCOU 78 'va_7' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.6E-3 NRAR 30 VARI 5
RCOU 171 'p_7'  FICH 'blas03.pun' RENA 'p_7_03'
RCOU 172 'ro_7' FICH 'blas03.pun' RENA 'ro_7_03'
RCOU 173 'vx_7' FICH 'blas03.pun' RENA 'vx_7_03'
TRAC 71 76 171 AXES 1.0 'PRESS. [PA]' SYMB
COLO NOIR ROUG VERT
TRAC 72 77 172 AXES 1.0 'DENS. [KG/M3]' SYMB
COLO NOIR ROUG VERT
TRAC 73 78 173 AXES 1.0 'VELOC. [M/S]' SYMB
COLO NOIR ROUG VERT
*
!QUAL VCVI COMP 1 LECT ea   TERM REFE  3.50414E+0 TOLE 2.E-2
!     VCVI COMP 1 LECT eb   TERM REFE  2.95375E+2 TOLE 2.E-2
!     ECRO COMP 1 LECT ea   TERM REFE  9.86505E+5 TOLE 2.E-2
!     ECRO COMP 1 LECT eb   TERM REFE  2.81254E+5 TOLE 2.E-2
!     ECRO COMP 2 LECT ea   TERM REFE  9.90980E+0 TOLE 2.E-2
!     ECRO COMP 2 LECT eb   TERM REFE  1.92767E+0 TOLE 2.E-2
*=============================================================
SUIT
Post treatment (BMPs from alice file)
ECHO
RESU ALIC GARD PSCR
OPTI PRIN
SORT VISU NSTO 61
PLAY
CAME   1 EYE   5.00000E-01  5.00000E-03  3.00015E-01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   5.25000E+01
SCEN GEOM NAVI FREE
          LINE HEOU
     ISO  FILL FIEL VCVI SCAL USER PROG 20 PAS 20 280 TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1400 400 FICH BMP REND
SCEN GEOM NAVI FREE
          LINE HEOU
     ISO  FILL FIEL ECRO 2 SCAL USER PROG 1 PAS 0.6 8.8 TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1400 400 FICH BMP REND
ENDPLAY
*=============================================================
FIN
```

The POIN is set at the center of the shock tube, on the interface that separates the two zones. The VELO parameter is tentatively set to 650 m/s. This number is extracted from the listing of case BLAS03 when the space plots are produced including the analytical curves (DCOU SHTU commands) and corresponds to the theoretical speed of the shock wave front (VS). A slightly larger value is used for safety reasons.

```
HARLOW & AMSDEN SHOCK TUBE : INPUT DATA
=======================================
GAMA   =   1.50000000000000
ROM    =   10.0000000000000
ROP    =   1.00000000000000
AIO    =   200000.000000000

LENM   =  0.500000000000000
LENP   =  0.500000000000000
TUBLEN=   1.00000000000000
TIM    =  6.0000000000000002E-004
NCSI   =          30

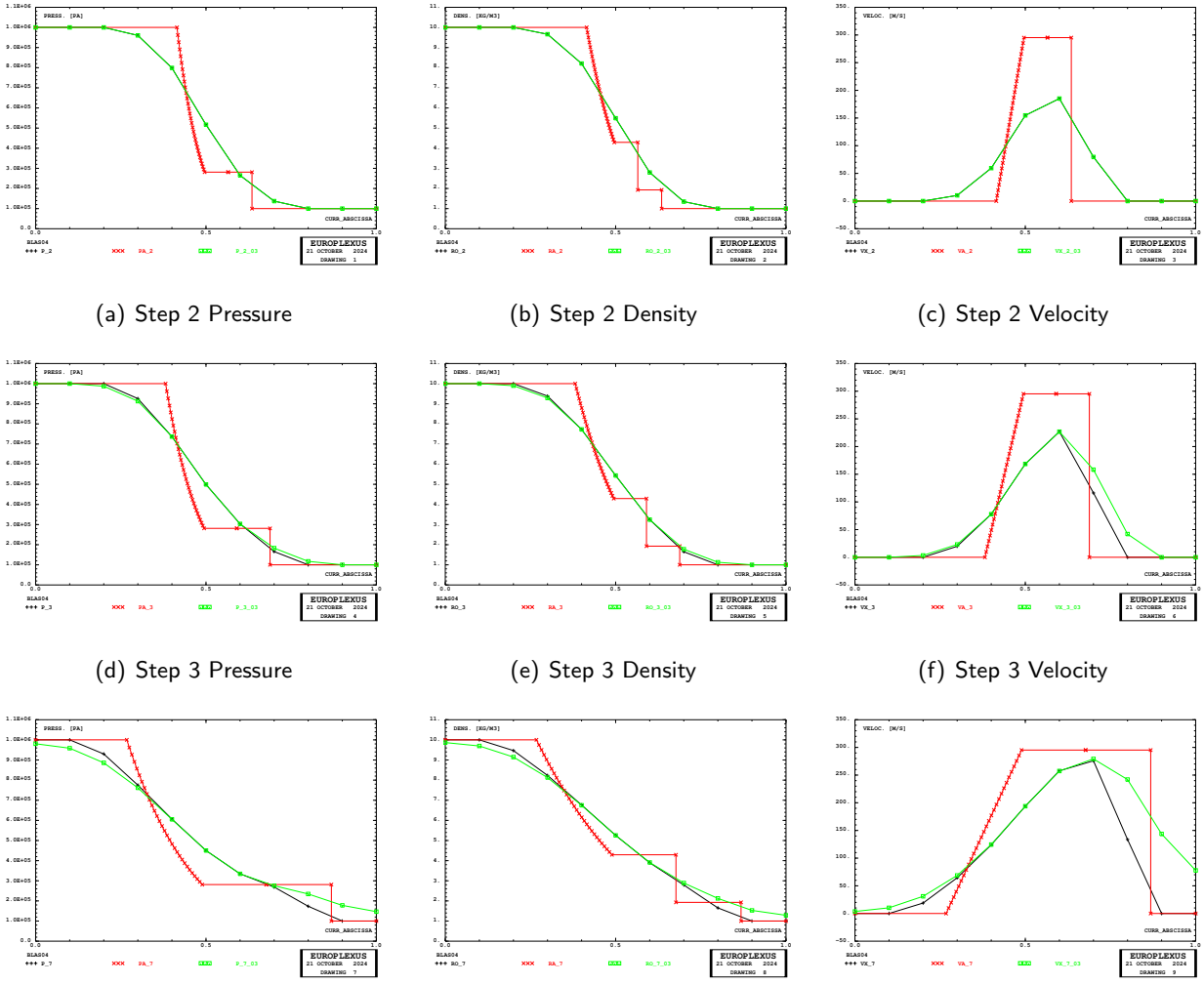
IVAR   =           5

RESULTS
=======
PIM    =   1000000.00000000
PIP    =   100000.000000000
ALAM   =   10.0000000000000
P      =   2.81173872299326
PIC    =   281173.872299327
ROR    =   1.92770062452834
ROL    =   4.29190375717491
AIR    =   291719.438922860
AIL    =   131025.245768514
UC     =   295.278289836459
VS     =   613.568783589856
VA     =  -18.2004723251679
VB     =  -387.298334620742
C0     =   387.298334620742
CA     =   313.478762161627
CB=C0  =   387.298334620742
CL=CA  =   313.478762161627
CR     =   467.749483369191
```

CSI	C	RHO	P	I	V
0.000	3.87298D+02	1.00000D+01	1.00000D+06	2.00000D+05	0.00000D+00
0.033	3.84838D+02	9.74828D+00	9.62480D+05	1.97467D+05	9.84261D+00
0.067	3.82377D+02	9.50134D+00	9.26141D+05	1.94950D+05	1.96852D+01
0.100	3.79916D+02	9.25912D+00	8.90952D+05	1.92449D+05	2.95278D+01
0.133	3.77456D+02	9.02156D+00	8.56885D+05	1.89964D+05	3.93704D+01
0.167	3.74995D+02	8.78860D+00	8.23910D+05	1.87495D+05	4.92130D+01
0.200	3.72534D+02	8.56018D+00	7.91999D+05	1.85043D+05	5.90557D+01
0.233	3.70074D+02	8.33625D+00	7.61125D+05	1.82606D+05	6.88983D+01
0.267	3.67613D+02	8.11674D+00	7.31261D+05	1.80186D+05	7.87409D+01
0.300	3.65152D+02	7.90159D+00	7.02379D+05	1.77782D+05	8.85835D+01
0.333	3.62692D+02	7.69075D+00	6.74455D+05	1.75394D+05	9.84261D+01
0.367	3.60231D+02	7.48415D+00	6.47461D+05	1.73022D+05	1.08269D+02
0.400	3.57771D+02	7.28175D+00	6.21375D+05	1.70666D+05	1.18111D+02
0.433	3.55310D+02	7.08348D+00	5.96169D+05	1.68327D+05	1.27954D+02
0.467	3.52849D+02	6.88928D+00	5.71822D+05	1.66003D+05	1.37797D+02
0.500	3.50389D+02	6.69911D+00	5.48309D+05	1.63696D+05	1.47639D+02
0.533	3.47928D+02	6.51290D+00	5.25608D+05	1.61405D+05	1.57482D+02
0.567	3.45467D+02	6.33060D+00	5.03695D+05	1.59130D+05	1.67324D+02
0.600	3.43007D+02	6.15216D+00	4.82549D+05	1.56871D+05	1.77167D+02
0.633	3.40546D+02	5.97751D+00	4.62147D+05	1.54629D+05	1.87010D+02
0.667	3.38085D+02	5.80661D+00	4.42470D+05	1.52402D+05	1.96852D+02
0.700	3.35625D+02	5.63940D+00	4.23496D+05	1.50192D+05	2.06695D+02
0.733	3.33164D+02	5.47583D+00	4.05205D+05	1.47998D+05	2.16537D+02
0.767	3.30703D+02	5.31584D+00	3.87577D+05	1.45820D+05	2.26380D+02
0.800	3.28243D+02	5.15938D+00	3.70592D+05	1.43658D+05	2.36223D+02
0.833	3.25782D+02	5.00640D+00	3.54233D+05	1.41512D+05	2.46065D+02
0.867	3.23321D+02	4.85685D+00	3.38480D+05	1.39382D+05	2.55908D+02
0.900	3.20861D+02	4.71068D+00	3.23315D+05	1.37269D+05	2.65750D+02
0.933	3.18400D+02	4.56783D+00	3.08720D+05	1.35171D+05	2.75593D+02
0.967	3.15939D+02	4.42826D+00	2.94679D+05	1.33090D+05	2.85436D+02
1.000	3.13479D+02	4.29190D+00	2.81174D+05	1.31025D+05	2.95278D+02

The results are compared against those of the reference solution BLAS03 in Figure 4.

Figure 4: Solution of test BLAS04 compared with BLAS03.



(a) Step 2 Pressure (b) Step 2 Density (c) Step 2 Velocity

(d) Step 3 Pressure (e) Step 3 Density (f) Step 3 Velocity

(g) Step 7 Pressure (h) Step 7 Density (i) Step 7 Velocity

Sources: JRC analysis.

The two solutions are identical until step 2 (the black and green curves are superposed). Then, from step 3 on the solution with skipping (black curves) progressively deviates from the reference (green curve). The deviation is particularly evident on the velocity.

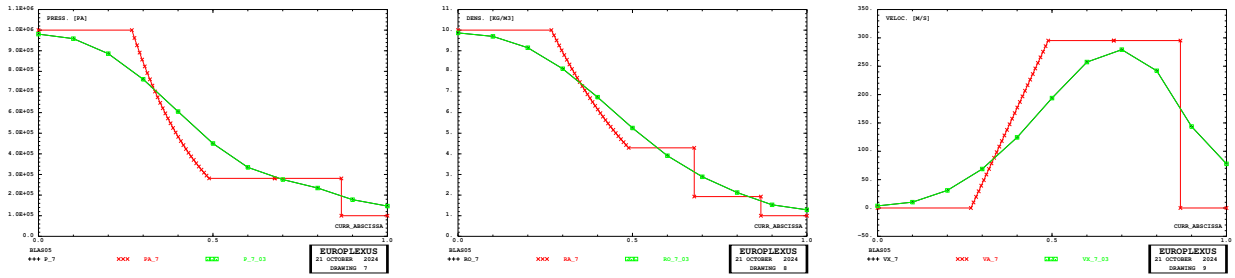
2.3.3 Case BLAS05

Inspection of case BLAS04 reveals that the `VELO` parameter (estimated shock wave speed) used in the simulation to skip the still unaffected mesh parts may have been too low. In fact, it was taken only slightly larger than the analytical speed ($v_S = 613.57$ m/s). However, in a numerical solution there is a so-called numerical precursor, which extends beyond the analytical wavefront, and which is related to the spatial discretization. In this example, the discretization is extremely (unrealistically) coarse.

From the reference solution case BLAS03 (Figure 3) one can see that the perturbed region extends far beyond the analytical one, due to the numerical precursor. Therefore, in the present test BLAS05 we tentatively take a larger value for `VELO`, almost twice the analytical value (1200 m/s).

The solution obtained is compared against the reference in Figure 5. The agreement is now perfect until the final time (step 7). The solution used more elements*step than in case BLAS04 (62 instead of 44), but still less than the reference (80), indicating that some interfaces/elements were indeed skipped. This test is too small to get any conclusions about CPU time saving with the skip option.

Figure 5: Solution of test BLAS05 compared with BLAS03.



(a) Step 7 Pressure (b) Step 7 Density (c) Step 7 Velocity

Sources: JRC analysis.

2.3.4 Case BLAS06

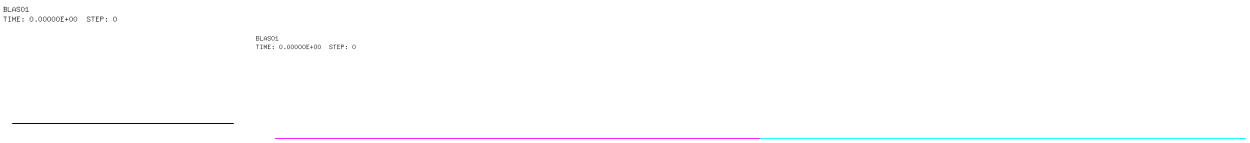
This test is similar to BLAS05 but uses an intermediate value of the blast speed (900 m/s). The solution deviates from the reference, although less than in case DRAW04, and is not shown for brevity.

Therefore, in this example with a very coarse mesh, it seems that a safe value for the blast speed for the skipping mechanism is about twice the analytical wavefront speed. The number of elements*step in this solution is 54, an intermediate value between cases BLAS04 ($v_S = 650$) and BLAS05 ($v_S = 1200$).

2.3.5 Case BLAS01

This test is similar to the previous ones but uses a much finer (more realistic) discretization of 800 elements in the shock tube, see Figure 6. The lateral dimension of the tube is 1.25×10^{-3} m instead of the 0.1 m used in the previous examples. The result is independent from the lateral dimension and the particular value used is chosen in order to have regular elements (perfect squares).

Figure 6: Model of test BLAS01.

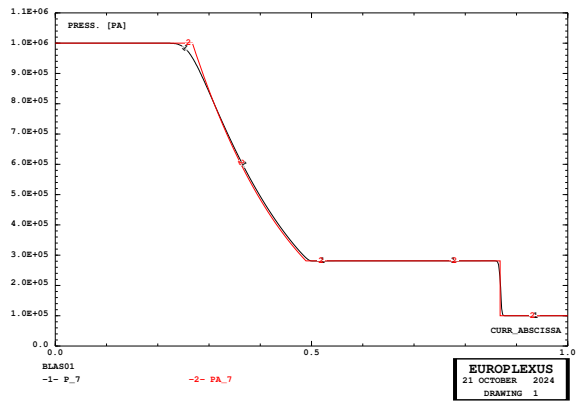


(a) Mesh (b) Without element outlines

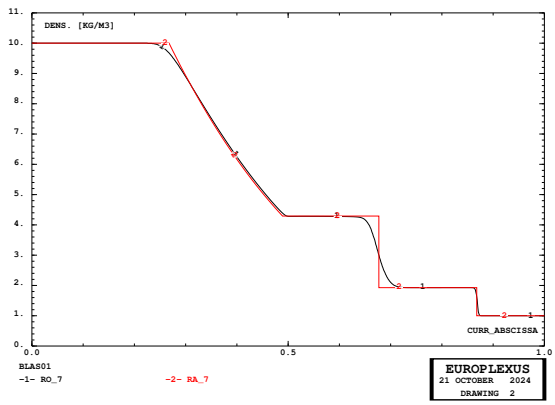
Sources: JRC analysis.

This is the reference solution, i.e. without activating the `INIT BLAS` mesh skipping directive. The solution is illustrated in Figure 7, showing the pressure, density and velocity distributions along the tube at the final time. The red curves are the analytical solution. The agreement with the numerical solution (black curves) is much better than in the previous test BLAS03, thanks to the finer mesh.

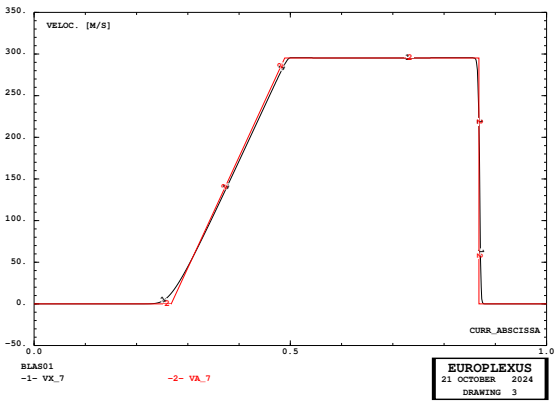
Figure 7: Solution of test BLAS01.



(a) Pressure



(b) Density



(c) Velocity

Sources: JRC analysis.

2.3.6 Case BLAS02

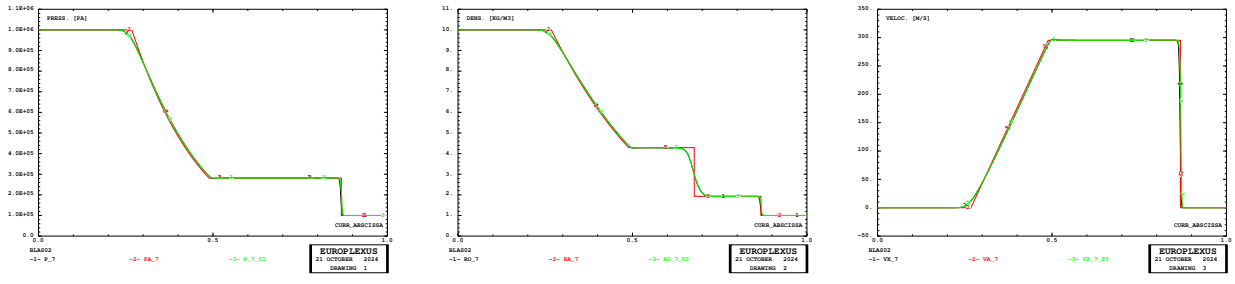
This test is identical to BLAS01 but we add the `INIT BLAS` mesh skipping directive:

```
BLAS02
ECHO
!CONV win
CAST mesh
EULE DPLA
GEOM Q4VF bar TERM
COMP COUL ROSE LECT bar1 TERM
          TURQ LECT bar2 TERM
MATE GAZP RO 10 GAMM 1.5 PINI 1.E6 PREF 1.E5
          LECT bar1 TERM
     GAZP RO  1 GAMM 1.5 PINI 1.E5 PREF 1.E5
          LECT bar2 TERM
INIT BLAS 1
          POIN 0.5 6.25E-4
          VELO 650.0
          TO 0.0
          DMIN 2.5E-3
          LECT bar TERM
ECRI COOR DEPL VITE ACCE FINT FEXT CONT ECRO TFRE 0.3E-3
     FICH ALIC TEMP FREQ 1
          POIN LECT pa pmid pb TERM
          ELEM LECT ea eb TERM
     FICH ALIC TFRE 1.0E-4
OPTI NOTE STEP IO
 csta 0.5
 log 1
!VFCC FCON 1              ! OK
!VFCC FCON 2 VISC 0.75    ! OK
 VFCC FCON 3              ! OK
!VFCC FCON 4              ! OK
!VFCC FCON 5              ! OK
!VFCC FCON 6              ! OK
!VFCC FCON 7              ! OK
!VFCC FCON 8              ! OK
!VFCC FCON 9              ! OK
!VFCC FCON 10             ! OK
!VFCC FCON 11             ! OK
!VFCC FCON 12             ! OK
CALC TINI 0. TEND 0.60E-3
*=================================================================
SUIT
Post-treatment (space curves from alice file)
ECHO
RESU ALIC GARD PSCR
SORT GRAP
PERF 'blas02.pun'
AXTE 1.0 'Time [s]'
SCOU 71 'p_7'  NSTO 7 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      ECRO COMP 1
SCOU 72 'ro_7' NSTO 7 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      ECRO COMP 2
SCOU 73 'vx_7' NSTO 7 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      VCVI COMP 1
DCOU 76 'pa_7' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.6E-3 NRAR 30 VARI 1
DCOU 77 'ra_7' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.6E-3 NRAR 30 VARI 2
DCOU 78 'va_7' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.6E-3 NRAR 30 VARI 5
RCOU 171 'p_7'  FICH 'blas01.pun' RENA 'p_7_01'
RCOU 172 'ro_7' FICH 'blas01.pun' RENA 'ro_7_03'
RCOU 173 'vx_7' FICH 'blas01.pun' RENA 'vx_7_03'
TRAC 71 76 171 AXES 1.0 'PRESS. [PA]'
COLO NOIR ROUG VERT
TRAC 72 77 172 AXES 1.0 'DENS. [KG/M3]'
COLO NOIR ROUG VERT
TRAC 73 78 173 AXES 1.0 'VELOC. [M/S]'
COLO NOIR ROUG VERT
*
QUAL VCVI COMP 1 LECT ea   TERM REFE  3.45909E+0 TOLE 1.E-1
     VCVI COMP 1 LECT eb   TERM REFE  2.95372E+2 TOLE 2.E-2
     ECRO COMP 1 LECT ea   TERM REFE  9.86677E+5 TOLE 2.E-2
     ECRO COMP 1 LECT eb   TERM REFE  2.81256E+5 TOLE 2.E-2
     ECRO COMP 2 LECT ea   TERM REFE  9.91096E+0 TOLE 2.E-2
     ECRO COMP 2 LECT eb   TERM REFE  1.92768E+0 TOLE 2.E-2
*=================================================================
SUIT
Post treatment (BMPs from alice file)
ECHO
RESU ALIC GARD PSCR
OPTI PRIN
SORT VISU NSTO 61
PLAY
CAME   1 EYE   5.00000E-01  5.00000E-03  3.00015E-01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   5.25000E+01
SCEN GEOM NAVI FREE
          LINE HEOU
     ISO  FILL FIEL VCVI SCAL USER PROG 20 PAS 20 280 TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1400 400 FICH BMP REND
SCEN GEOM NAVI FREE
          LINE HEOU
     ISO  FILL FIEL ECRO 2 SCAL USER PROG 1 PAS 0.6 8.8 TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1400 400 FICH BMP REND
ENDPLAY
*=================================================================
FIN
```

From test BLAS01 (Figure 7) we see that the numerical precursor, although present, is much less pronounced than in the tests with coarse mesh. Therefore, we tentatively choose for the `VELO` parameter a value only slightly higher than the theoretical value, i.e. 650 m/s, like in test BLAS04.

In the present case, this speed is sufficient to guarantee a correct solution with skipping. In fact, from Figure 8 one can see that the present solution with skipping (black curve) is in very good agreement with the analytical solution (red curve) and is almost exactly superposed to the reference solution without skipping (green curve).

Figure 8: Solution of test BLAS02 compared with BLAS01.



(a) Final Pressure (b) Final Density (c) Final Velocity

Sources: JRC analysis.

From Table 1 we can see that there is a substantial reduction in the number of elements*step and

also a small saving of CPU with the skipping option. However, the test case is still too small for an accurate evaluation of the saving and more realistic tests will have to be carried out to this end.

2.3.7 Case BLAS07

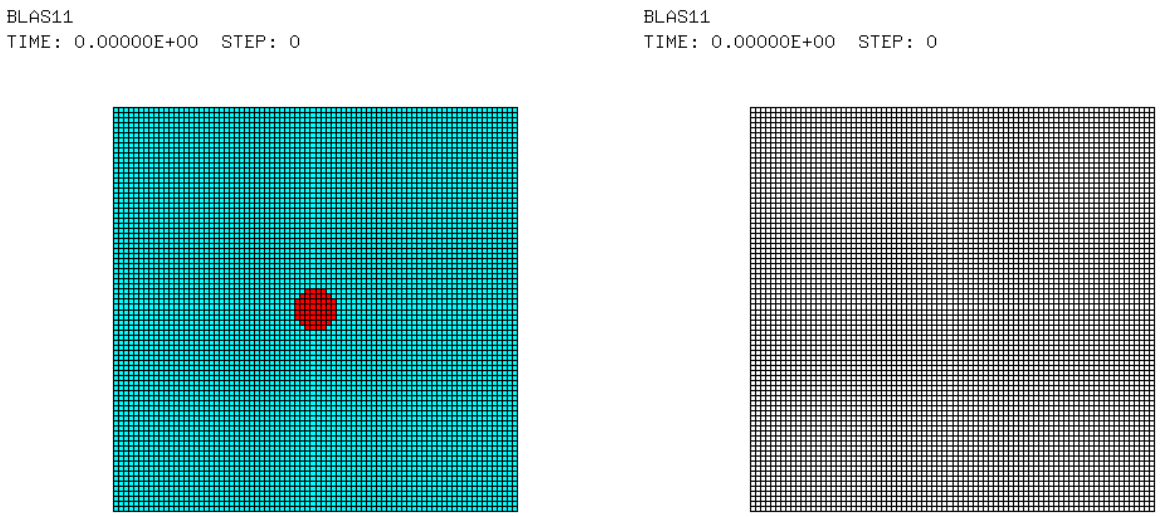
This test is identical to BLAS02 but we raise the `VELO` parameter to 1200 m/s. The solution becomes practically identical to the reference case BLAS01 and is not shown for brevity. However, note that in this case the previous solution with 650 m/s (BLAS02) was already almost perfect.

This shows that in a realistic case a value of `VELO` just slightly above the analytical value should suffice to obtain an accurate solution (that is, a solution very similar to the one without skipping).

2.3.8 Case BLAS11

This test is a more realistic one, although still in 2D. The problem is an explosion in a square cavity of 1×1 m with rigid walls. The mesh is relatively fine and consists of $80 \times 80 = 6\,400$ square volumes of type Q4VF, as shown in Figure 9. The final time is set at 0.8 ms, i.e. shortly after the moment when the blast wave has reached the four corners of the box.

Figure 9: Model of test BLAS11.



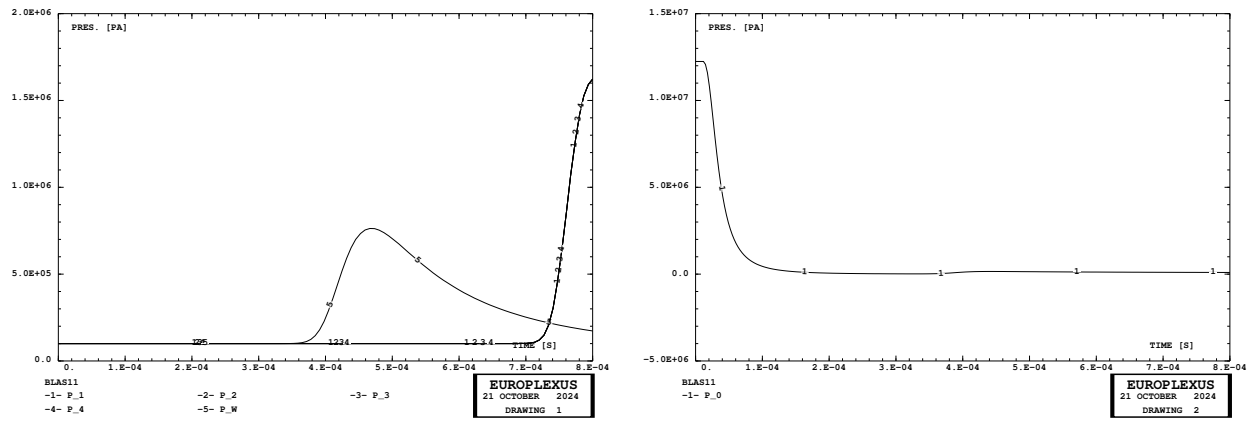
(a) Mesh with zones (b) Element outlines

Sources: JRC analysis.

The box walls are considered rigid. The explosion takes place at the box center and is represented by a compressed gas bubble of radius 0.05 m. The BUBB material is assigned to the initial charge region, with a mass of 0.04 kg of TNT.

The solution, considered as the reference, is presented in Figures 10 (pressure time curves at characteristic locations) and 11 (pressure maps at representative time instants).

Figure 10: Solution (pressure time curves) of test BLAS11.

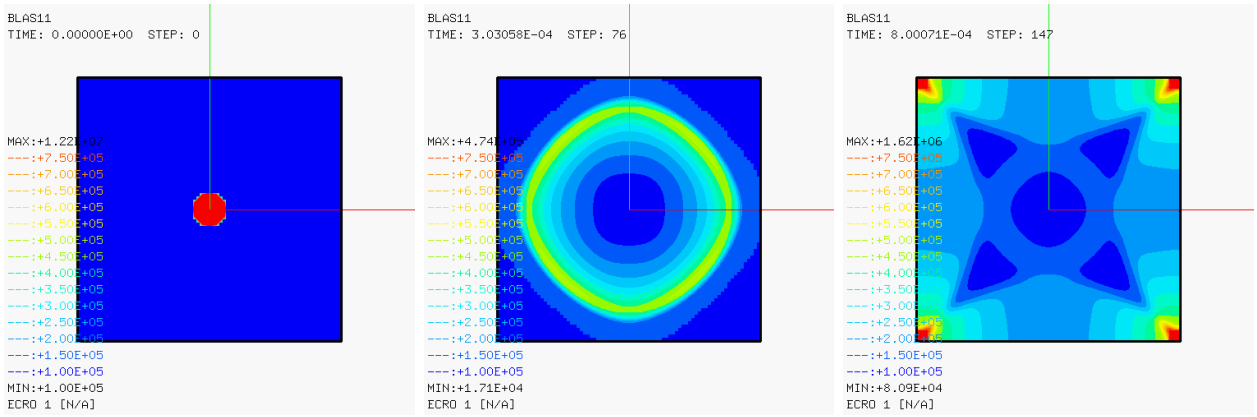


(a) Pressures at the corners and mid-wall (b) Pressure at the box center

Sources: JRC analysis.

From Figure 11(a) we may estimate (on the safe side) that the propagation speed of the blast wavefront is about $L/t = 0.5/3 \times 10^{-4} = 1\,667$ m/s. This value is obtained from the 5-th curve in the

Figure 11: Solution (pressure maps) of test BLAS11.



(a) $t = 0$ (b) $t = 0.3$ ms (c) $t = 0.8$ ms

Sources: JRC analysis.

diagram (labeled P_W), which is the pressure at the mid-side of the box, i.e. at the first boundary to be reached by the blast. The actual pressure rise time from the curve is at about 0.35 ms, but we use the smaller value 0.30 ms to avoid problems with the numeric precursor.

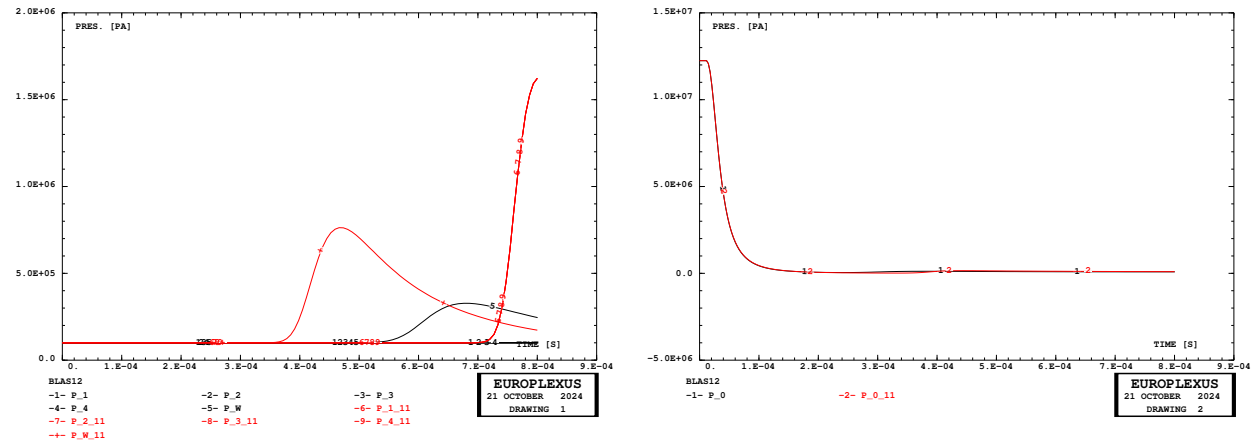
2.3.9 Case BLAS12

This test is similar to BLAS11 but we activate the skipping mechanism:

```
BLAS12
 . . .
INIT BLAS 1
          POIN 0.0 0.0
          VELO 1667.0
          TO 0.0
          DMIN 0.07
          LECT flui TERM
 . . .
```

The solution is smooth and symmetric but weird. The wave propagates more slowly and less intensely than in the reference. See Figures 12 for the pressure time curves and 13 for the pressure maps. Also strangely, the pressure at the center of the charge is in good agreement with the reference.

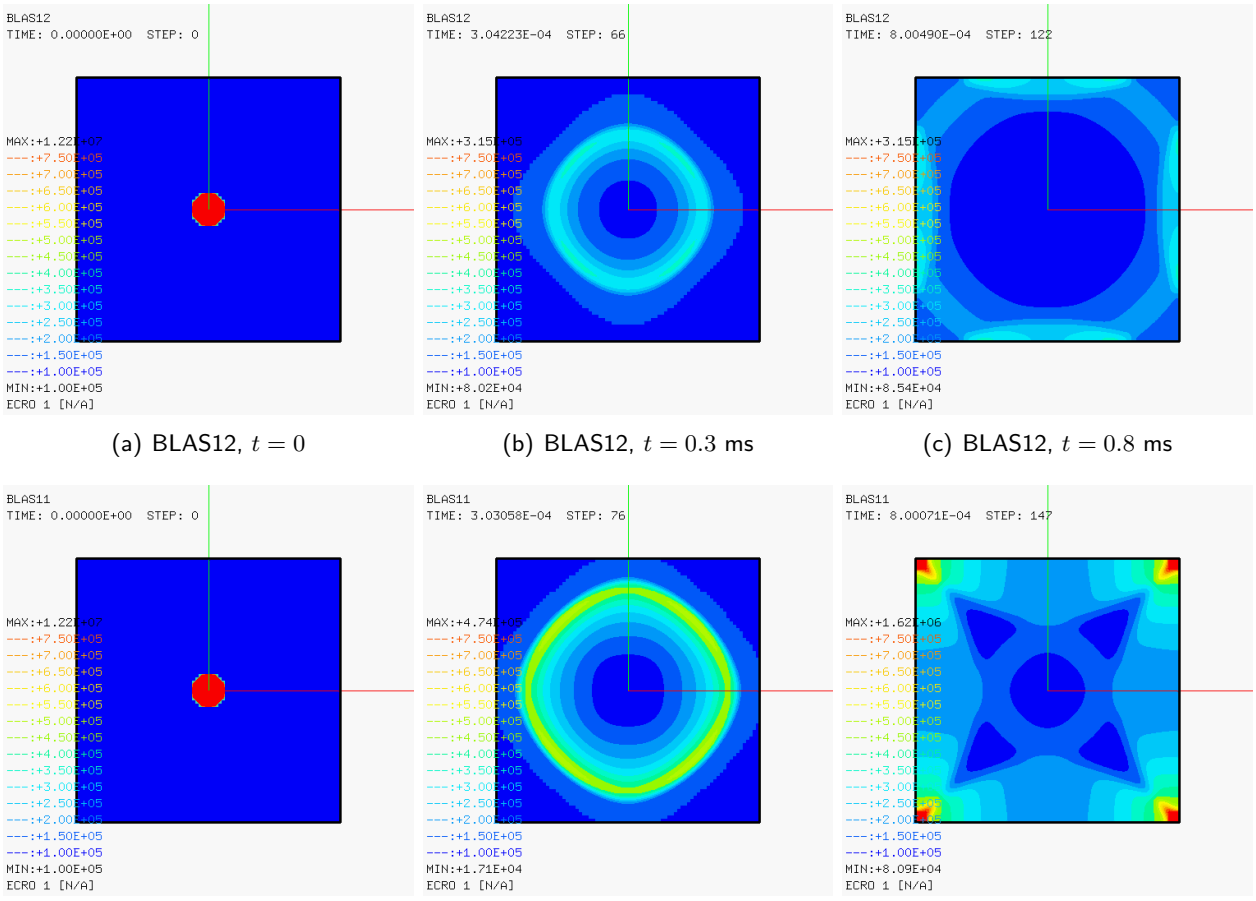
Figure 12: Solution (pressure time curves) of test BLAS12 compared with BLAS11.



(a) Pressures at the corners and mid-wall (b) Pressure at the box center

Sources: JRC analysis.

Figure 13: Solution (pressure maps) of test BLAS12 (top) compared with BLAS11 (bottom).



(a) BLAS12, $t = 0$ (b) BLAS12, $t = 0.3$ ms (c) BLAS12, $t = 0.8$ ms

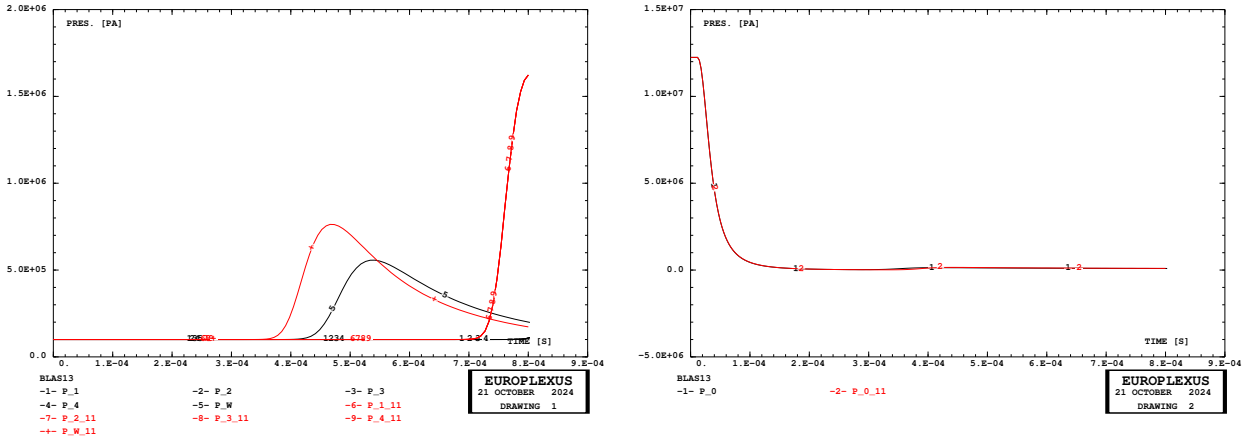
(d) BLAS11, $t = 0$ (e) BLAS11, $t = 0.3$ ms (f) BLAS11, $t = 0.8$ ms

Sources: JRC analysis.

2.3.10 Case BLAS13

This test is similar to BLAS12 but uses a higher propagation velocity for the skipping operation ($v_S = 3000$ m/s). The solution is in slightly better agreement with the reference, but still quite weird, see Figures 14 and 15.

Figure 14: Solution (pressure time curves) of test BLAS13 compared with BLAS11.

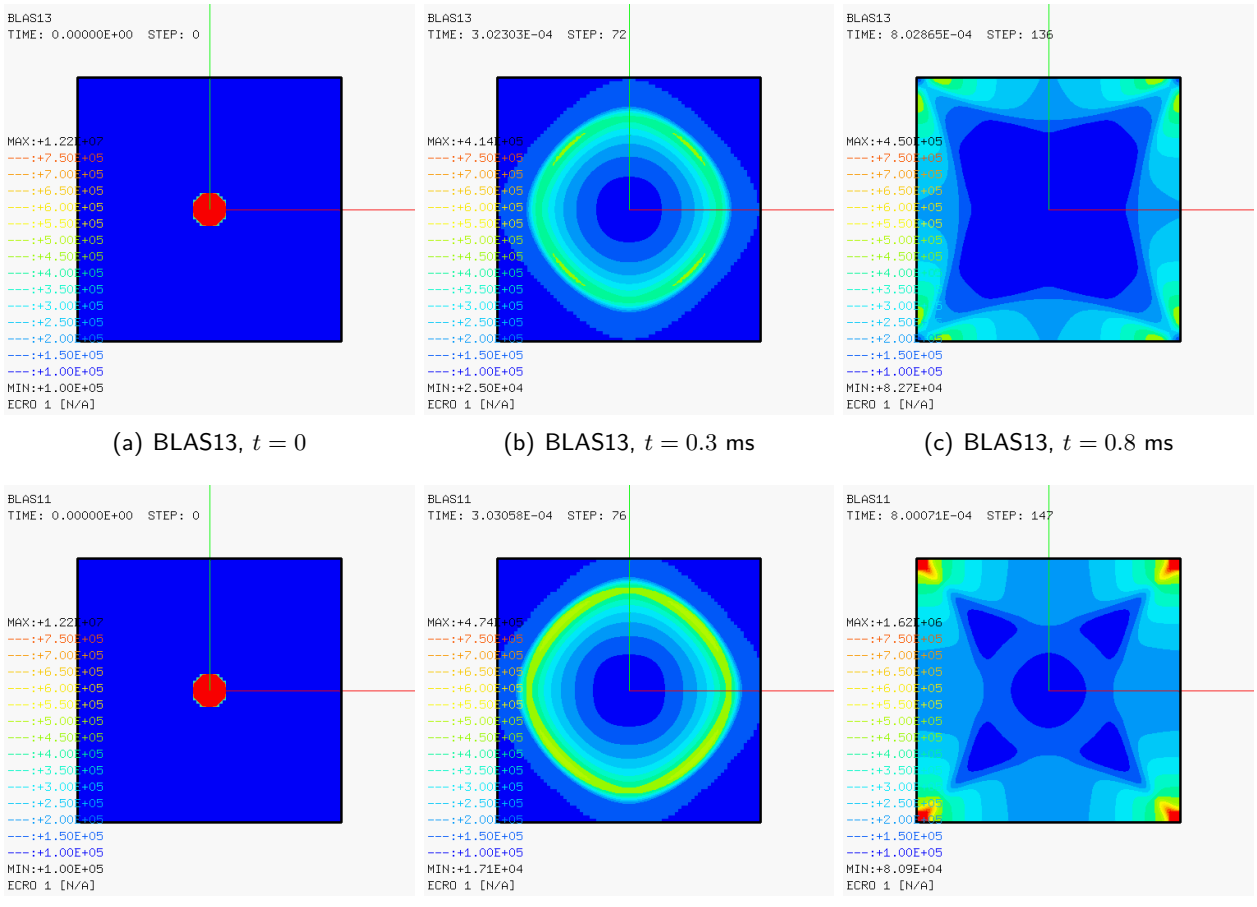


(a) Pressures at the corners and mid-wall

(b) Pressure at the box center

Sources: JRC analysis.

Figure 15: Solution (pressure maps) of test BLAS13 (top) compared with BLAS11 (bottom).



(a) BLAS13, $t = 0$

(b) BLAS13, $t = 0.3$ ms

(c) BLAS13, $t = 0.8$ ms

(d) BLAS11, $t = 0$

(e) BLAS11, $t = 0.3$ ms

(f) BLAS11, $t = 0.8$ ms

Sources: JRC analysis.

2.3.11 Cases BLAS14 and BLAS15

The tests BLAS01 to BLAS07 used `FCON 3`, i.e. the HLLE solver, while the cases BLAS11 to BLAS13 use the default flux solver (`FCON 6`, HLLC solver). To exclude any influence of the flux solver on the weird results of tests BLAS11 and BLAS12, these are re-run with `FCON 3`, i.e. the HLLE solver, namely tests BLAS14 and BLAS15, respectively.

The results obtained are very similar to those of tests BLAS11 and BLAS12, respectively (the latter being weird) and are not shown for brevity. Therefore, influence of the flux solver on the weird results seems to be excluded.

2.3.12 Cases BLAS21 and BLAS22

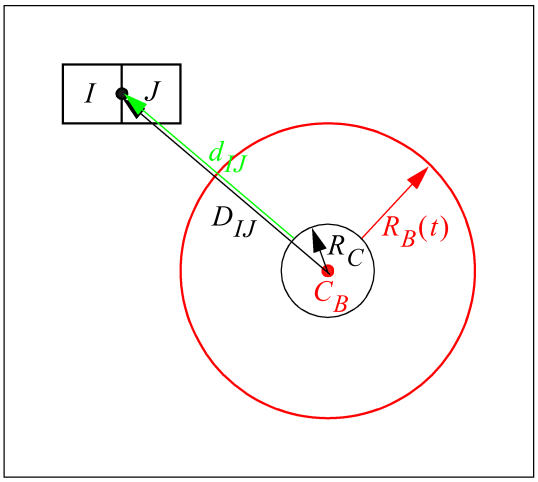
These tests are sinilar to cases BLAS01 and BLAS02, respectively, but the shock tube is oriented vertically (along y) rather than horizontally. The results obtained are quite similar to cases BLAS01 and BLAS02 (although strangely case BLAS21 took a lot more steps and CPU time: to be checked). It seems therefore that the orientation is not the reason for the weird results obtained.

2.3.13 Correction of the distance formula

It is suspected that the malfunctioning of the skipping strategy observed in the square box tests BLAS11 to BLAS22 might be due to the presence of the balloon model. In other words, the charge is not punctual and located at the center $\boldsymbol{C}_B$, but it has a finite radius R_C, which is non-negligible with respect to the size of the model.

In other words the situation is not the one depicted in Figure 1, but rather that of Figure 16.

Figure 16: The skipping strategy with a balloon charge.



Sources: JRC analysis.

Under these circumstances, the shock wave originates at the surface of the bubble, i.e. on a sphere of radius R_C centered on point $\boldsymbol{C}_B$. Then, instead of the distance D_{IJ} given by eqn. (2), one should consider the distance d_{IJ}:

$$d_{IJ} = D_{IJ} - R_C = ||\boldsymbol{C}_{IJ} - \boldsymbol{C}_B|| - R_C \tag{5}$$

and the skip time is not given by eqn. (3), but by:

$$t_{IJ} = d_{IJ}/s_B \tag{6}$$

Note that, for interface points IJ located within the balloon, eqn. (5) would give a negative distance d_{IJ}. To avoid the problem, the equation is modified as follows:

$$d_{IJ} = \max((D_{IJ} - R_C), 0) = \max((||\boldsymbol{C}_{IJ} - \boldsymbol{C}_B|| - R_C), 0) \tag{7}$$

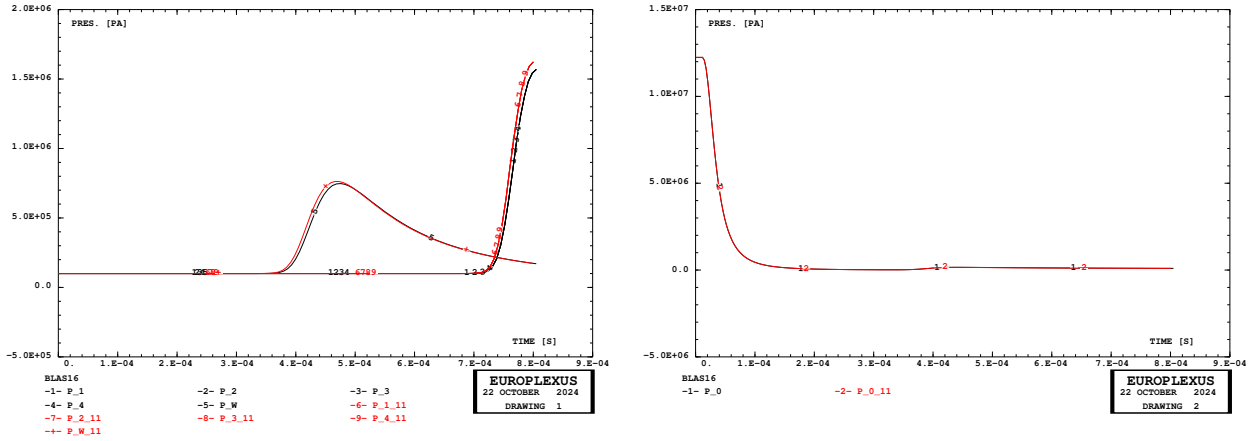
In the case of a balloon charge model, the role of R_C is played by the `DMIN` input parameter. In other words, if a balloon charge is used, the user should specify `DMIN` equal (or even better slightly larger, by one or two element sizes) than the balloon radius R_C.

The eqn. (4) for the calculation of the volume blast time need not be corrected.

2.3.14 Case BLAS16

This is the case BLAS12 repeated as such after the correction of the distance formula. The results are shown in Figures 17 and 18. They are not perfect, but in much better agreement with the reference solution BLAS11.

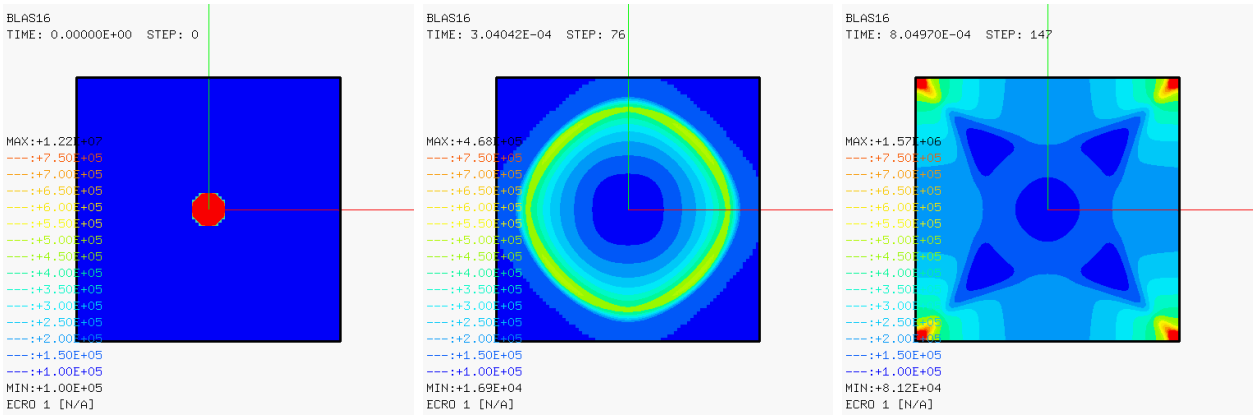
Figure 17: Solution (pressure time curves) of test BLAS16 compared with BLAS11.



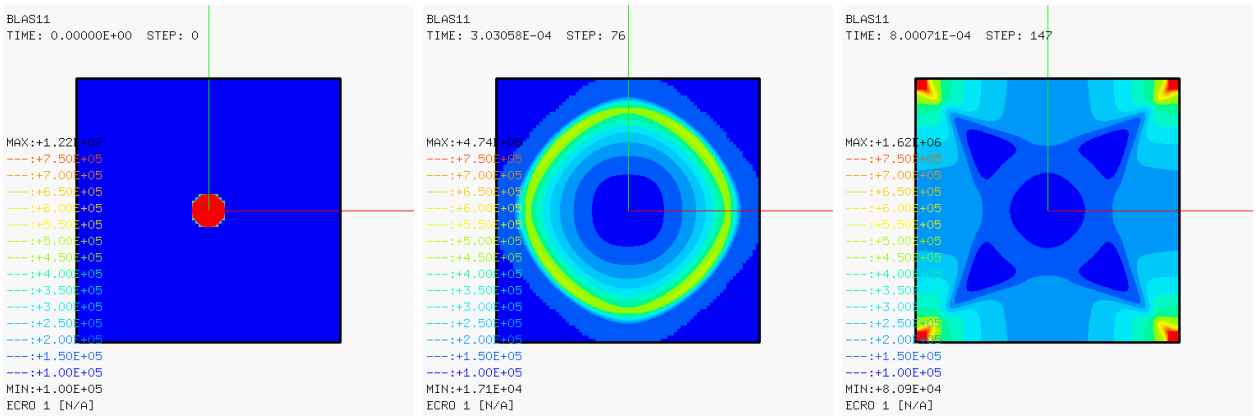
(a) Pressures at the corners and mid-wall (b) Pressure at the box center

Sources: JRC analysis.

Figure 18: Solution (pressure maps) of test BLAS16 (top) compared with BLAS11 (bottom).



(a) BLAS16, $t = 0$ (b) BLAS16, $t = 0.3$ ms (c) BLAS16, $t = 0.8$ ms



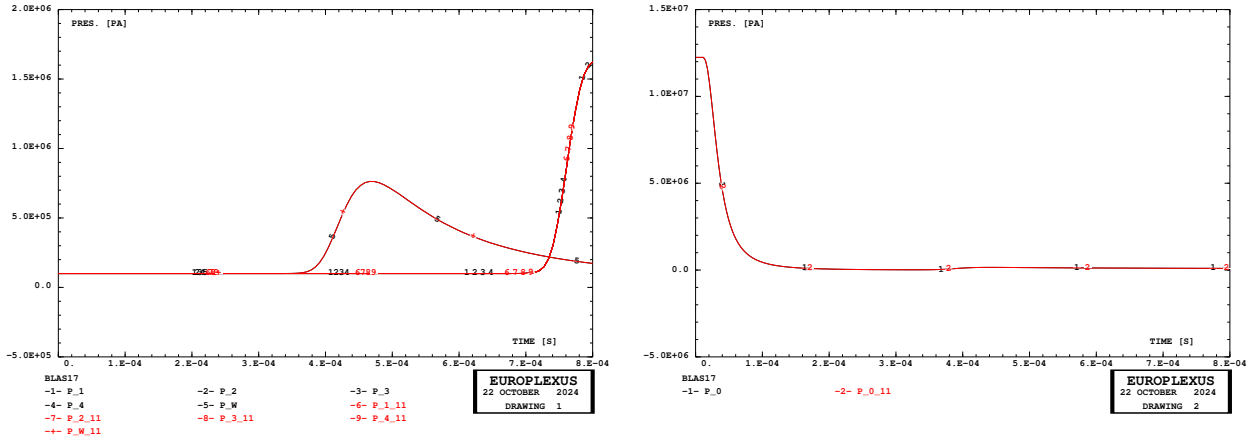
(d) BLAS11, $t = 0$ (e) BLAS11, $t = 0.3$ ms (f) BLAS11, $t = 0.8$ ms

Sources: JRC analysis.

2.3.15 Case BLAS17

This is the case BLAS13 (`VELO 3000`) repeated as such after the correction of the distance formula. The results are shown in Figures 19 and 20. They are in perfect agreement with the reference solution BLAS11.

Figure 19: Solution (pressure time curves) of test BLAS17 compared with BLAS11.

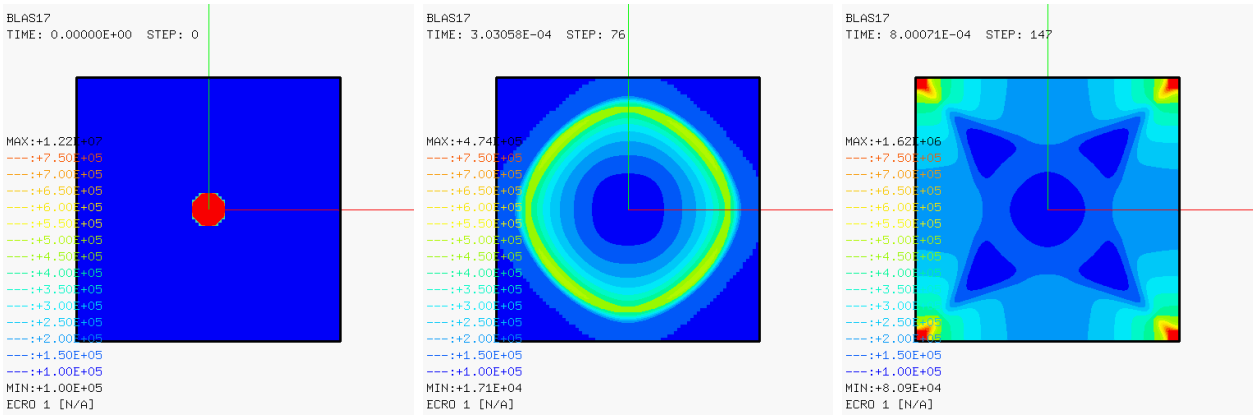


(a) Pressures at the corners and mid-wall

(b) Pressure at the box center

Sources: JRC analysis.

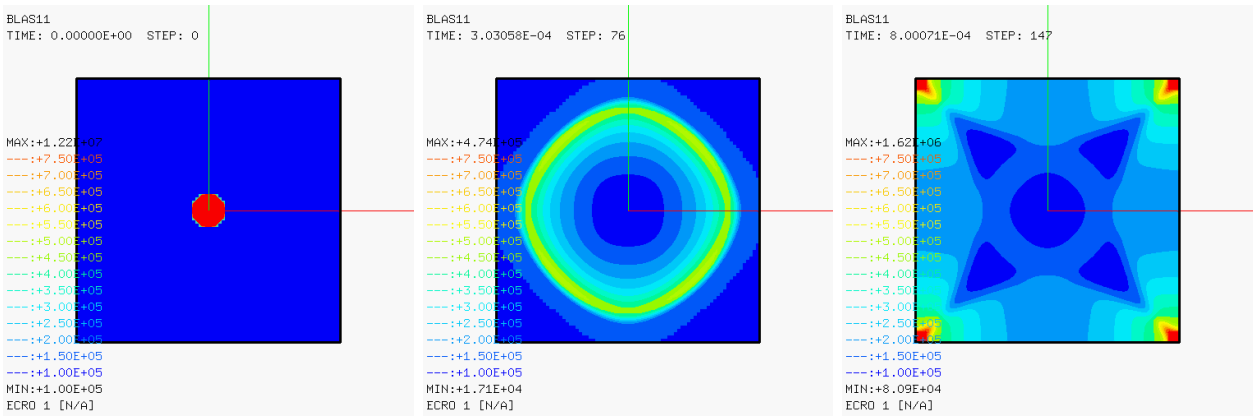
Figure 20: Solution (pressure maps) of test BLAS17 (top) compared with BLAS11 (bottom).



(a) BLAS17, $t = 0$

(b) BLAS17, $t = 0.3$ ms

(c) BLAS17, $t = 0.8$ ms



(d) BLAS11, $t = 0$

(e) BLAS11, $t = 0.3$ ms

(f) BLAS11, $t = 0.8$ ms

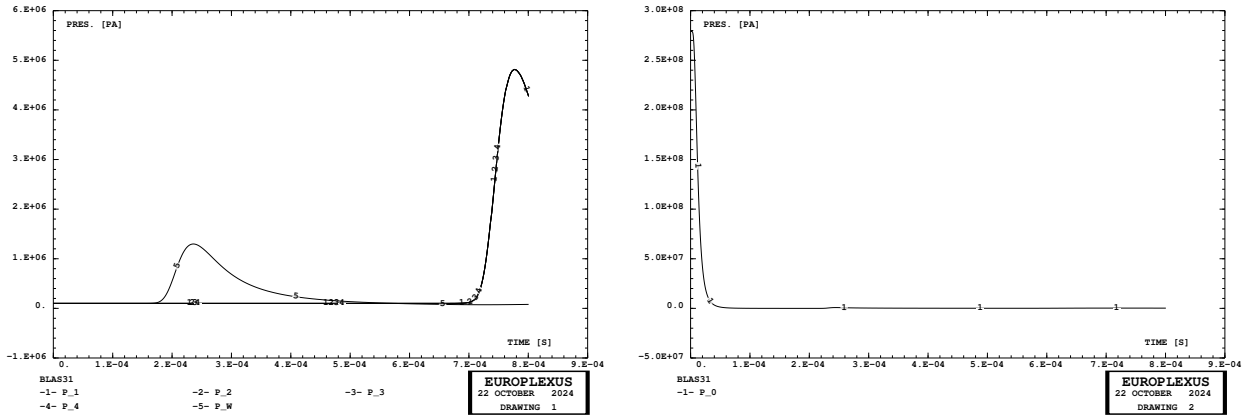
Sources: JRC analysis.

2.3.16 Case BLAS31

This is the 3D version of case BLAS11. A cubic box of 1 m side is considered, with an explosion at the center. The mesh consists of $80 \times 80 \times 80 = 512\,000$ CUVF volumes. This is the reference solution, without skipping, and is carried on until 0.8 ms. The test was tentatively run with a stability safety factor `CSTA 0.5` but it became unstable. By reducing the safety factor to `CSTA 0.25` a complete solution could be obtained.

The solution is presented in Figures 21 and 22.

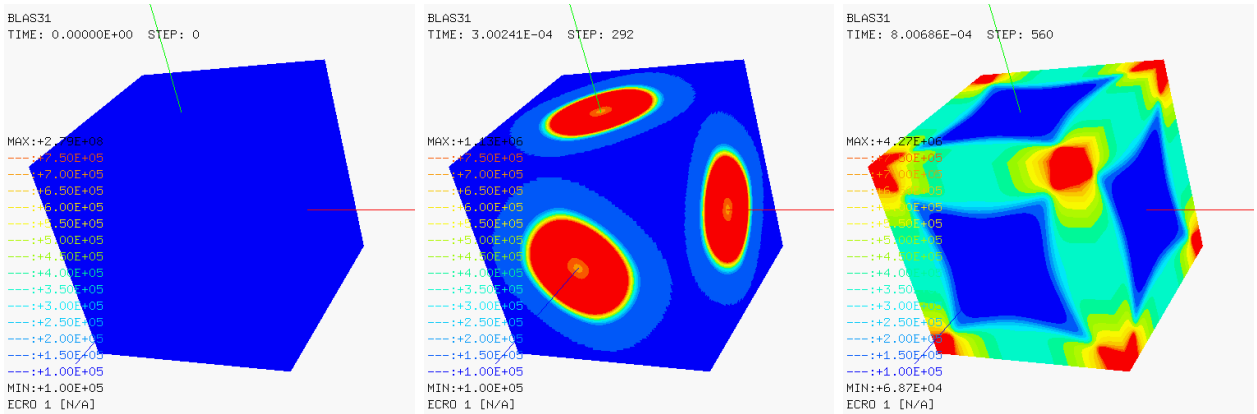
Figure 21: Solution (pressure time curves) of test BLAS31.



(a) Pressures at the corners and mid-wall (b) Pressure at the box center

Sources: JRC analysis.

Figure 22: Solution (pressure maps) of test BLAS31.



(a) $t = 0$ (b) $t = 0.3$ ms (c) $t = 0.8$ ms

Sources: JRC analysis.

From Figure 22(a) we may estimate (on the safe side) that the propagation speed of the blast wavefront is about $L/t = 0.5/1.5 \times 10^{-4} = 3\,333$ m/s. This value,which is roughly double that of the corresponding 2-D case BLAS11, is obtained from the 5-th curve in the diagram (labeled `P_W`), which is the pressure at the mid-face of the box, i.e. at the first boundary to be reached by the blast. The actual pressure rise time from the curve is at about 0.175 ms, but we use the smaller value 0.150 ms to avoid problems with the numeric precursor.

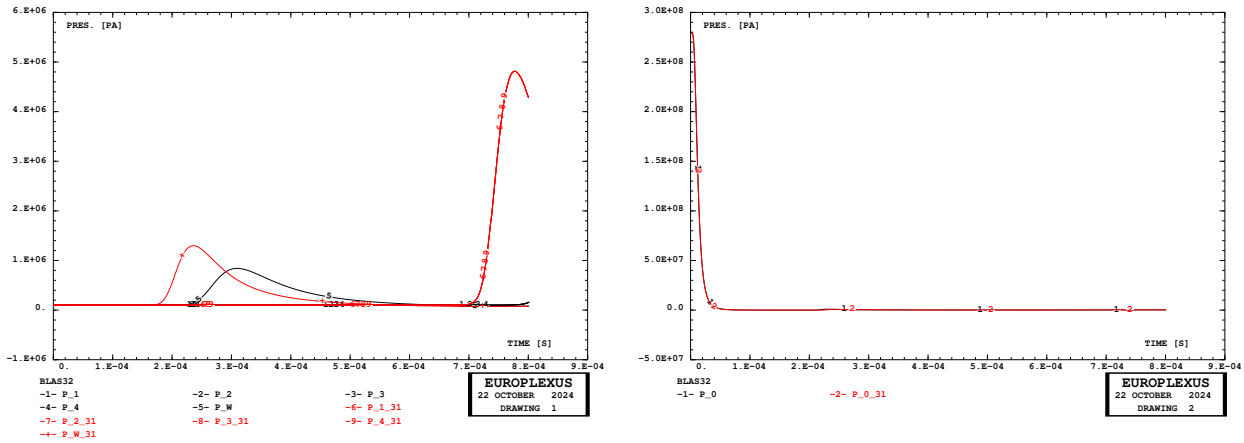
2.3.17 Case BLAS32

This test is similar to BLAS31 but we activate the skipping mechanism:

```
BLAS32
 . . .
INIT BLAS 1
          POIN 0.0 0.0 0.0
          VELO 3333.0
          TO 0.0
          DMIN 0.07
          LECT flui TERM
 . . .
```

The solution is smooth and symmetric but weird. The wave propagates more slowly and less intensely than in the reference. See Figures 23 for the pressure time curves and 24 for the pressure maps. The pressure at the center of the charge is in good agreement with the reference.

Figure 23: Solution (pressure time curves) of test BLAS32 compared with BLAS31.

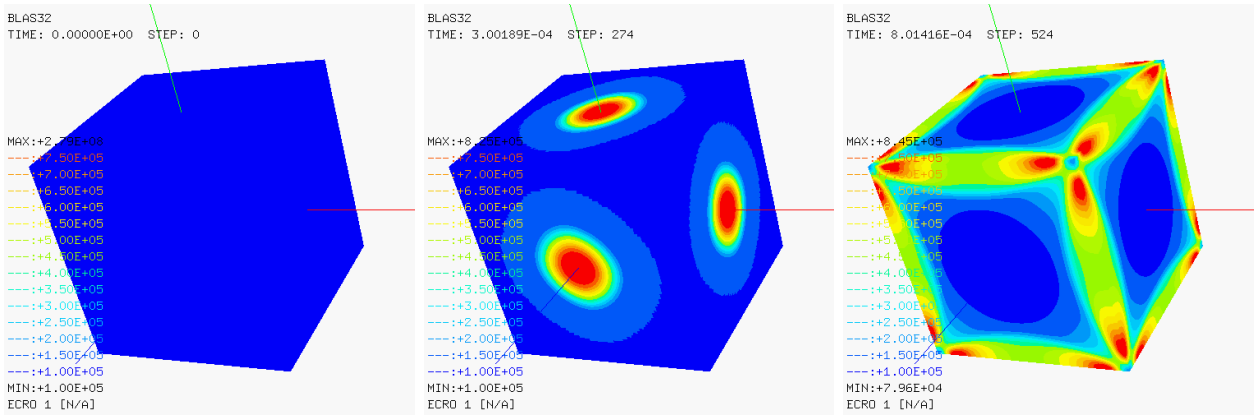


(a) Pressures at the corners and mid-wall

(b) Pressure at the box center

Sources: JRC analysis.

Figure 24: Solution (pressure maps) of test BLAS32 (top) compared with BLAS31 (bottom).



(a) BLAS32, $t = 0$ (b) BLAS32, $t = 0.3$ ms (c) BLAS32, $t = 0.8$ ms

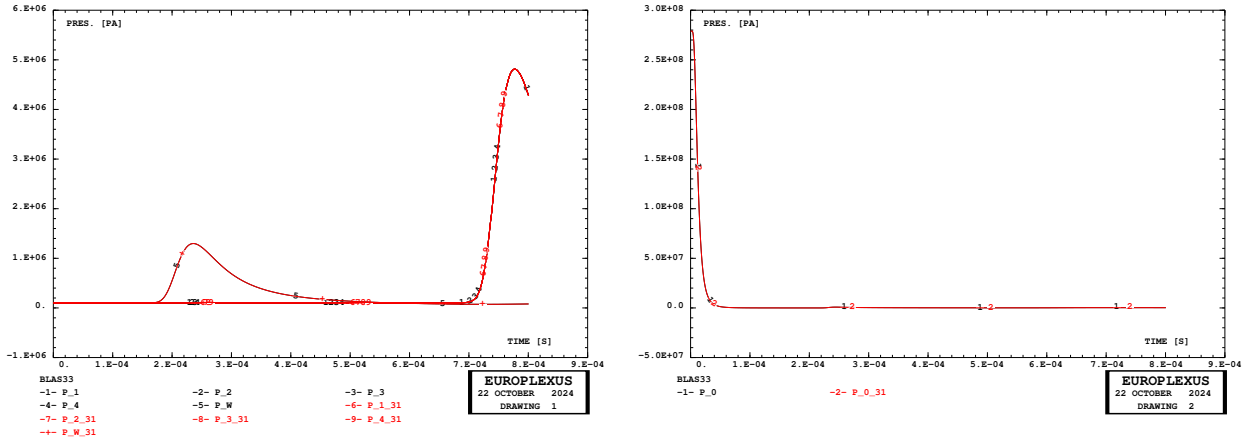
(d) BLAS31, $t = 0$ (e) BLAS31, $t = 0.3$ ms (f) BLAS31, $t = 0.8$ ms

Sources: JRC analysis.

2.3.18 Case BLAS33

This test is similar to BLAS32 but we increase the minimum distance parameter by taking `DMIN 0.20` instead of `DMIN 0.07`. The solution is in very good agreement with the reference, see Figures 25 and 26. However, the gain of CPU becomes very low, reaching only a modest and disappointing 15%.

Figure 25: Solution (pressure time curves) of test BLAS33 compared with BLAS31.

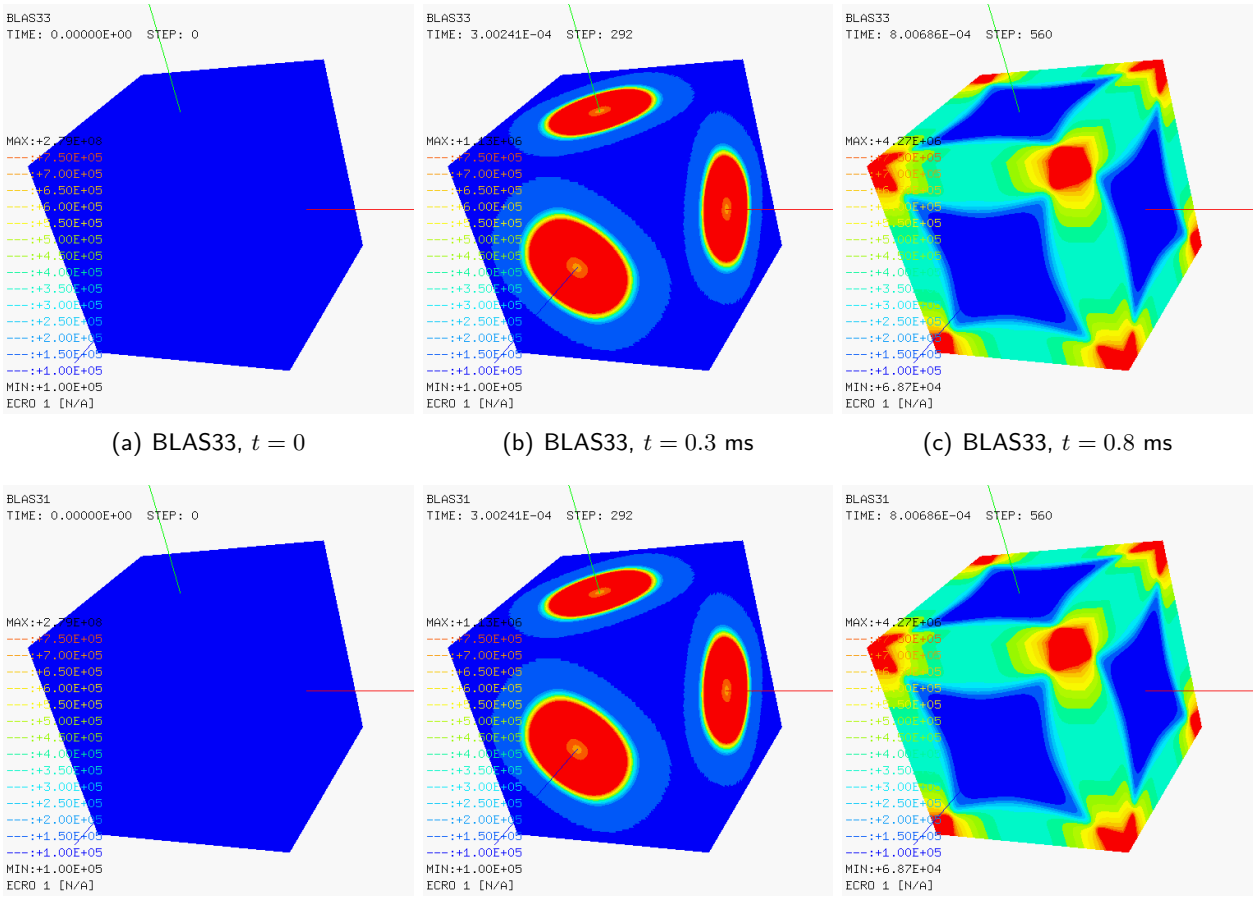


(a) Pressures at the corners and mid-wall

(b) Pressure at the box center

Sources: JRC analysis.

Figure 26: Solution (pressure maps) of test BLAS33 (top) compared with BLAS31 (bottom).



(a) BLAS33, $t = 0$

(b) BLAS33, $t = 0.3$ ms

(c) BLAS33, $t = 0.8$ ms

(d) BLAS31, $t = 0$

(e) BLAS31, $t = 0.3$ ms

(f) BLAS31, $t = 0.8$ ms

Sources: JRC analysis.

2.4 Analysis of results with the skipping strategy

The skipping strategy has been tested in Section 2.3, for the moment only in simulations using a first-order in space formulation of the FV. The functioning in the second-order case remains to be verified (see Section 2.5).

The strategy yields correct results, but at the expense of a relatively cumbersome choice of the skipping parameters, in particular the propagation speed of the shock wave front `VELO` (assumed constant) and the minimum distance `DMIN`. Unfortunately, an inaccurate choice of these parameters yields smooth and apparently plausible solutions which, however, may be under-estimating (by far) the true propagation speed and the true intensity of the shock.

These drawbacks are more evident in cases with a spherical explosion (which are the ones of interest in practice) than in academic shock tube examples, because in the latter the shock wave is planar and not spherical, and the shock wave speed is actually constant.

On the contrary, in a spherical geometry the actual shock wave propagation speed is not constant but diminishes as the blast wave expands. Taking an average speed over the domain under consideration may be on the wrong side during the first part of the simulation and may lead to losing part of the blast energy during the early phases of the blast wave expansion. This effect may be compensated by assuming a larger minimum distance than theoretically necessary, but at the expense of reducing the speed-up with respect to a solution without the skipping mechanism. Specifying a larger propagation speed than the average one in the input data set may also serve to avoid the mentioned problems but, again, is detrimental for the speed-up.

All in all, the obtainable speed-up is disappointingly low. Improving the model by using a variable wave speed would perhaps slightly increase the efficiency, but at the expense of having to estimate the wave speed variation, which is even more complicated for the user than figuring out a constant (average) wave speed.

The next couple of tests are dedicated at investigating the variation of the blast wave shock front velocity in a 3D spherical explosion,

2.4.1 Case BLAS40

This test is a 2D shock tube similar to case BLAS03 but with the same initial conditions as those in the explosive bubble for 3-D case SHOC31. The aim is to obtain the analytical value of the shock wave speed v_S which, in this case, is constant (plane wave):

```
BLAS40
 . . .
MATE GAZP RO 52.8159 GAMM 1.4 PINI 2.78952E8 PREF 1.E5
          LECT bar1 TERM
     GAZP RO  1 GAMM 1.4 PINI 1.E5 PREF 1.E5
          LECT bar2 TERM
 . . .
FIN
```

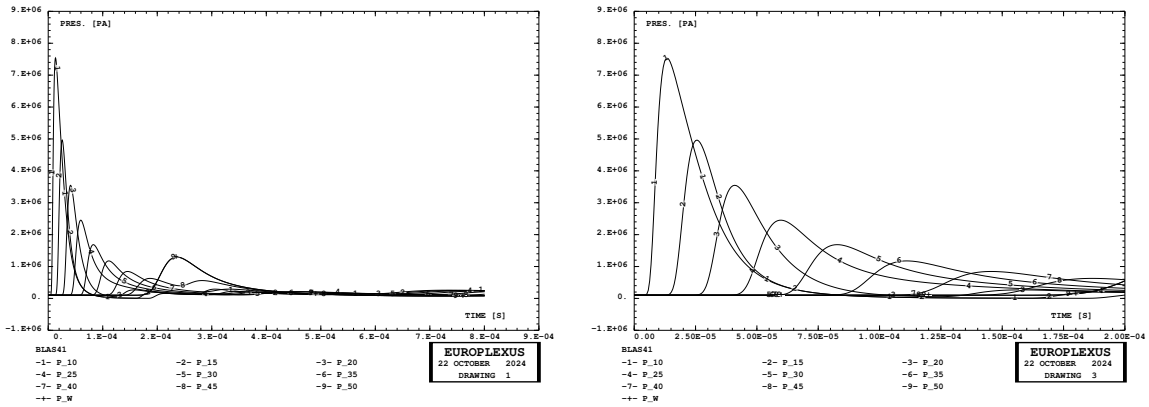
Note that in this case it is `GAMM 1.4` instead of 1.5. From the `DCOU SHTU` command for space plotting of the analytical solution, we obtain in the listing: $v_S = 5851.615$ m/s. We expect this to be also the initial shock wave speed for the spherical bubble expansion.

2.4.2 Case BLAS41

This test is identical to BLAS32 (3-D box with spherical charge, no skipping), but we add the storage of a series of element results along a radius at distances of 0.10 to 0.50 m from the center at regular intervals of 5 mm in order to be able to estimate the propagation speed of the spherical shock. Recall that the initial diameter of the bubble is 10 cm, i.e. the initial interface is at a distance of 5 cm from the center.

Next, we plot the stored pressure signals vs. time as in Figure 27 and use the `FVAL` command to extract (on the listing) the values (times) at which the pressure reaches 1.1 bar at each monitored location. From these data, the (average) propagation velocity in each interval may be evaluated. The results obtained are summarized in Table 2.

Figure 27: Pressure time curves at various locations in test BLAS41.



(a) Whole time interval (b) Zoom over the first 0.2 ms

Sources: JRC analysis.

Table 2: Estimation of the wave front speed vs. space in test BLAS41.

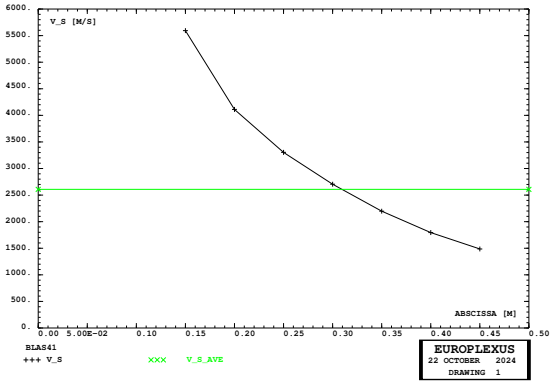
x [cm]	$t_{p=1.1E5}$ [μs]	Δt [μs]	$v_S = \Delta x/\Delta t$ [m/s]	$\overline{v}_S$ [m/s]
5	0.0	—	—	
10	4.6539	4.6539	10743.70	
15	13.5953	8.9414	5591.97	
20	25.7584	12.1631	4110.79	
25	40.8959	15.1375	3303.06	
30	59.3813	18.4854	2704.84	
35	82.1299	22.7486	2197.94	
40	109.9850	27.8551	1795.00	
45	143.6120	33.6270	1486.90	
50	172.5500	28.9380	1727.83	2607.94

Sources: JRC analysis.

The first and last values obtained (shown in red) may be inaccurate for various reasons and are ignored. The average speed over the entire model (shown in green) is $\overline{v}_S = 0.45/172.55 \times 10^{-6} = 2607.94$ m/s. We see that the average velocity in the first interval is similar to the analytical one computed for the shock tube in case BLAS40, as expected. As the wave propagates, the shock speed slows down and its velocity is greatly reduced (almost by four times) when it reaches the end of the model, after a displacement of only 0.45 m.

The data are represented graphically in Figure 28, with the average speed in green. The shock wave speed decreases non-linearly as the wave expands. This shows that considering a constant propagation speed in the skipping strategy may be very inappropriate for the expansion of a spherical bubble in 3-D.

Figure 28: Spatial variation of the shock speed in test BLAS41.



Sources: JRC analysis.

2.5 Numerical examples at second order

All the numerical examples presented so far used first order formulation in space and in time for the Finite Volumes solution of the fluid sub-domain. In this Section we verify the functioning of the skipping procedure also with full second-order in space and in time.

The numerical simulations performed are summarized in Table 3 and are detailed in the following paragraphs.

Table 3: Simulations to verify the skipping model with second-order VFCC in space and time.

Case	Elements	Model	t_f [ms]	Steps	Els*Steps	CPU [s]
BLAS51	6 400 Q4VF	Reference solution (no skip), 2D box, 2nd order	0.8	147	947 200	1.4
BLAS57	6 400 Q4VF	Same as 51 but with skip, VELO 3000	0.8	136	637 452	1.1

Sources: JRC analysis.

2.5.1 Case BLAS51

This test is similar to case BLAS11 but uses full second-order formulation in space and in time. No skip is prescribed, so this is the reference solution for the following test with skip.

```
BLAS51
 . . .
OPTI PAS AUTO NOTE STEP LIBR
     CSTA 0.5
     LOG 1
     VFCC FCON 6 ! HLLC flux solver
          STPS 2 ! In time
          ORDR 2 ! In space
          RECO 1 ! For true 2nd order in space
 . . .
FIN
```

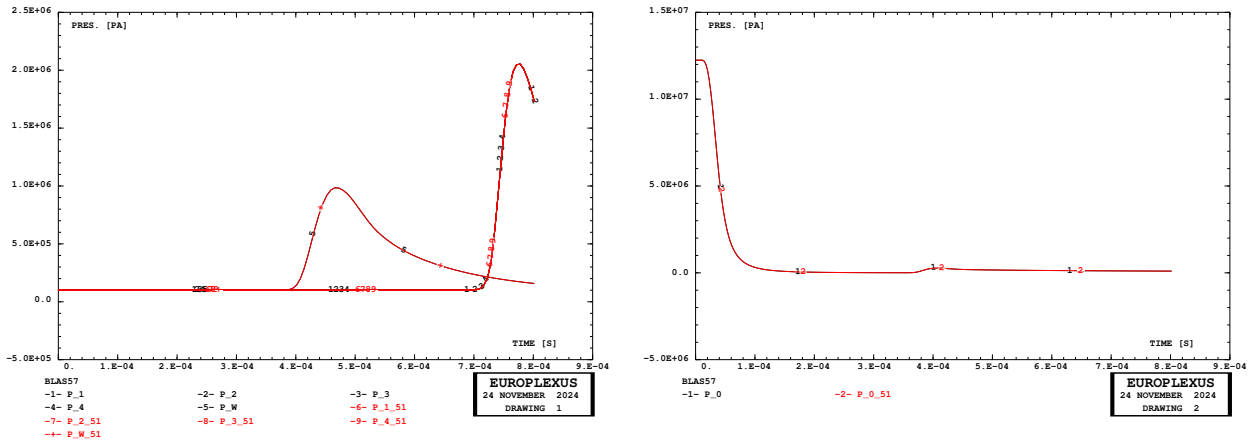
2.5.2 Case BLAS57

This test is similar to case BLAS51 but we activate the skipping command, like in case BLAS17, with a wave front velocity (VELO) of 3000 m/s.

```
BLAS57
 . . .
INIT BLAS 1
          POIN 0.0 0.0
          VELO 3000.0
          TO 0.0
          DMIN 0.07
          LECT flui TERM
 . . .
FIN
```

The solution obtained is practically identical to that without skipping of the reference case BLAS51, as shown in Figures 29 and 30. It seems therefore that no further modifications in the code are needed in order to use full second-order formulation in the VFCC fluid solver.

Figure 29: Solution (pressure time curves) of test BLAS57 compared with BLAS51.

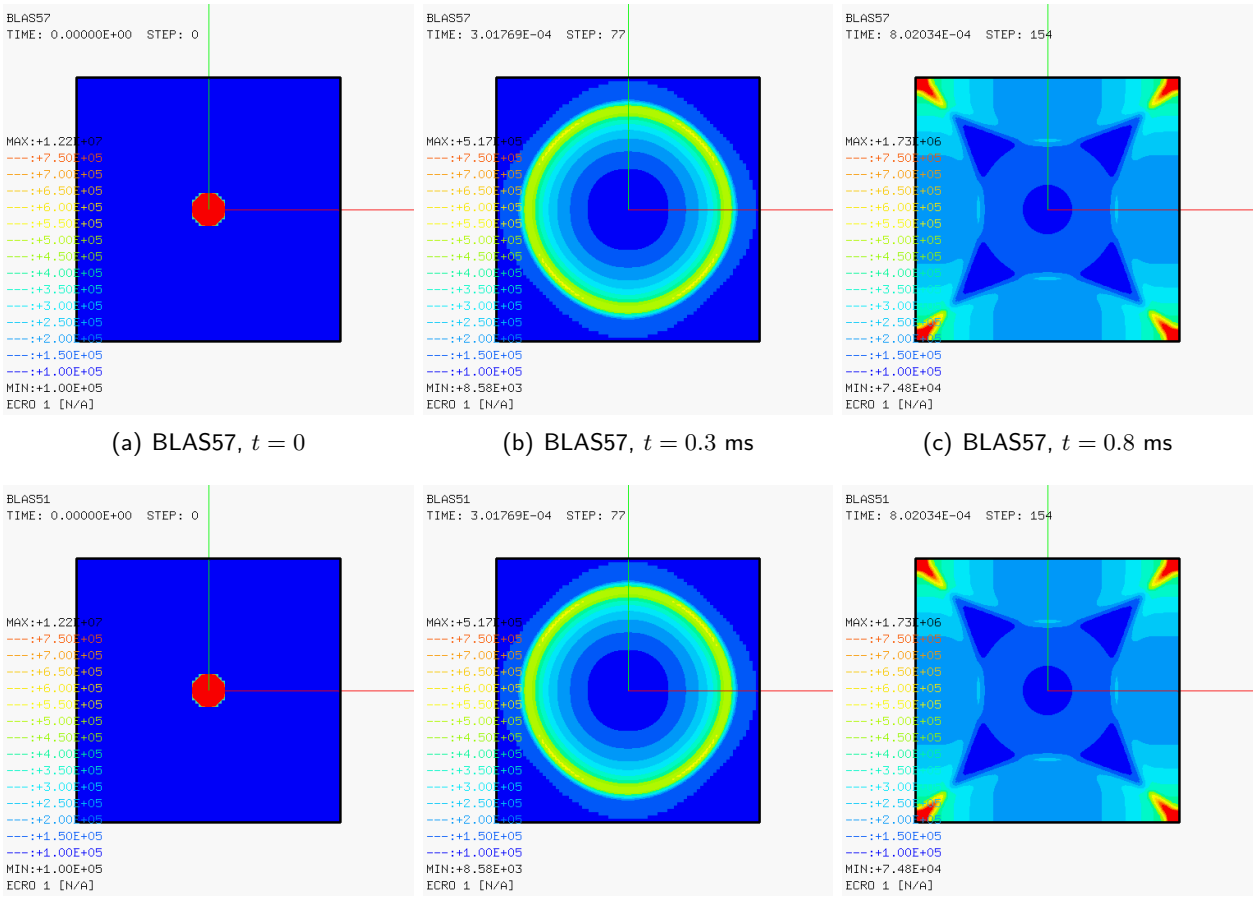


(a) Pressures at the corners and mid-wall

(b) Pressure at the box center

Sources: JRC analysis.

Figure 30: Solution (pressure maps) of test BLAS57 (top) compared with BLAS51 (bottom).



(a) BLAS57, $t = 0$

(b) BLAS57, $t = 0.3$ ms

(c) BLAS57, $t = 0.8$ ms

(d) BLAS51, $t = 0$

(e) BLAS51, $t = 0.3$ ms

(f) BLAS51, $t = 0.8$ ms

Sources: JRC analysis.

2.6 Accounting for a variable shock wave speed

The relatively low and disappointing speed ups obtained in the previous examples with the element skipping procedure are due to the necessity of using an upper bound of the wave speed if such speed is considered as constant in the skipping model.

The assumption of a constant wave speed is very penalizing, if one considers that in practice such speed decreases rapidly as the blast wave expands, as shown e.g. in the practical example of Figure 28. Therefore, if more interesting speed-ups are to be obtained, the skipping procedure should be modified so that a variable wave speed may be prescribed.

Before proposing a way to achieve this goal, we consider another practical example, a medium-sized model which could be typical of simulations of a blast in an urban environment. The simulations performed are summarized in Table 4 and are detailed in the following paragraphs.

Table 4: Simulations to study the variable blast wave speed.

Case	Elements	Model	t_f [ms]	Steps	Els*Steps	CPU [s]
BLAS61	200 000 Q4VF 18 000 CL3D	Reference solution (no skip)	100.0	429	86 000 000	272
BLAS62	200 000 Q4VF 18 000 CL3D	With skip, `VELO 3000`	100.0	429	72 049 920	243
BLAS62	200 000 Q4VF 18 000 CL3D	With skip, `DFUN`	100.0			

Sources: JRC analysis.

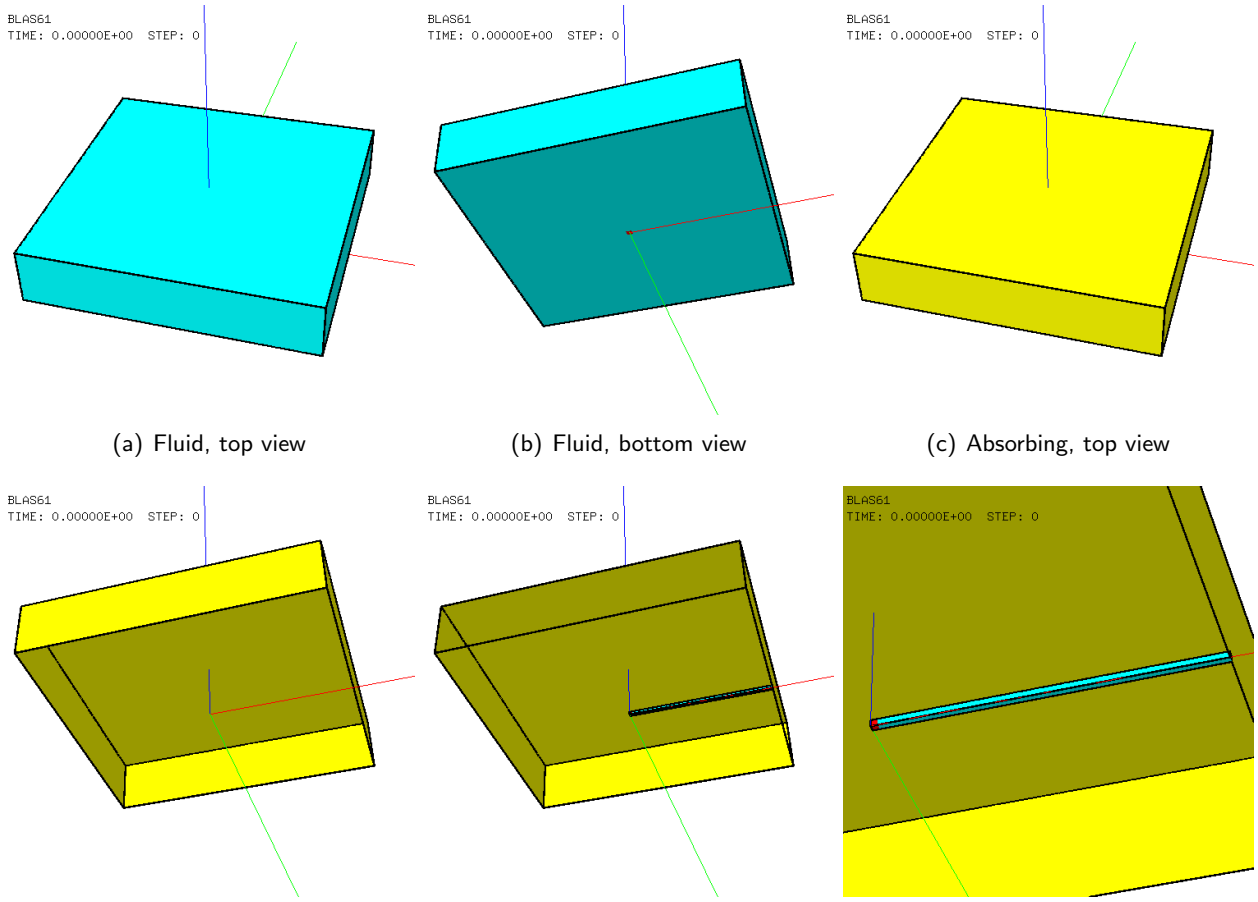
2.6.1 Case BLAS61

The model, shown in Figure 31, is a $100 \times 100 \times 20$ m fluid domain, meshed by regular CUVF cubes of size $h_F = 1.0$ m, with an explosive bubble modelled by the BUBB model simulating a 100 kg TNT-equivalent charge at the bottom-center of the fluid domain (adjacent to the ground), in the origin of the global reference frame. The initial bubble volume is 4.0 m^3 and the bubble is composed of 4 volumes.

The Cast3m mesh generation file is:

```
opti echo 1;
opti dime 3 elem cub8;
opti trac psc ftra 'blas61_mesh.ps';
opti sauv form 'blas61.msh';
*
lx = 100.0;
ly = 100.0;
lz = 20.0;
lx2 = lx / 2.0;
ly2 = ly / 2.0;
tol = lx / 1.E5;
*
* Fluid mesh
*
den = 1.0;
dens den;
p0 = 0 0 0;
p1 = (0 - lx2) (0 - ly2) 0;
p2 =      lx2  (0 - ly2) 0;
p3 =      lx2       ly2  0;
p4 = (0 - lx2)      ly2  0;
c1 = p1 d p2;
c2 = p2 d p3;
c3 = p3 d p4;
c4 = p4 d p1;
base = dall c1 c2 c3 c4 plan;
elim tol (base et p0);
flui = base volu tran (0 0 lz);
expl = flui elem appu larg p0;
air = flui diff expl;
*
* Absorbing boundaries
*
abs1 = c1 tran (0 0 lz);
abs2 = c2 tran (0 0 lz);
abs3 = c3 tran (0 0 lz);
abs4 = c4 tran (0 0 lz);
abs5 = base plus (0 0 lz);
abso = abs1 et abs2 et abs3 et abs4 et abs5;
elim tol (flui et abso);
*
* Pressure sensors
*
p01 = manu cub8 (0 0 0) (den 0 0) (den den 0) (0 den 0)
                (0 0 den) (den 0 den) (den den den) (0 den den);
p02 = p01 plus (den 0 0);
p03 = p02 plus (den 0 0);
p04 = p03 plus (den 0 0);
p05 = p04 plus (den 0 0);
p06 = p05 plus (den 0 0);
p07 = p06 plus (den 0 0);
p08 = p07 plus (den 0 0);
p09 = p08 plus (den 0 0);
p10 = p09 plus (den 0 0);
p11 = p10 plus (den 0 0);
p12 = p11 plus (den 0 0);
p13 = p12 plus (den 0 0);
p14 = p13 plus (den 0 0);
p15 = p14 plus (den 0 0);
p16 = p15 plus (den 0 0);
p17 = p16 plus (den 0 0);
p18 = p17 plus (den 0 0);
p19 = p18 plus (den 0 0);
p20 = p19 plus (den 0 0);
p21 = p20 plus (den 0 0);
p22 = p21 plus (den 0 0);
p23 = p22 plus (den 0 0);
p24 = p23 plus (den 0 0);
p25 = p24 plus (den 0 0);
p26 = p25 plus (den 0 0);
p27 = p26 plus (den 0 0);
p28 = p27 plus (den 0 0);
p29 = p28 plus (den 0 0);
p30 = p29 plus (den 0 0);
p31 = p30 plus (den 0 0);
p32 = p31 plus (den 0 0);
p33 = p32 plus (den 0 0);
p34 = p33 plus (den 0 0);
p35 = p34 plus (den 0 0);
p36 = p35 plus (den 0 0);
p37 = p36 plus (den 0 0);
p38 = p37 plus (den 0 0);
p39 = p38 plus (den 0 0);
p40 = p39 plus (den 0 0);
p41 = p40 plus (den 0 0);
p42 = p41 plus (den 0 0);
p43 = p42 plus (den 0 0);
p44 = p43 plus (den 0 0);
p45 = p44 plus (den 0 0);
p46 = p45 plus (den 0 0);
p47 = p46 plus (den 0 0);
p48 = p47 plus (den 0 0);
p49 = p48 plus (den 0 0);
p50 = p49 plus (den 0 0);
pxx = p01 et p02 et p03 et p04 et p05 et p06 et p07 et p08 et p09 et p10
   et p11 et p12 et p13 et p14 et p15 et p16 et p17 et p18 et p19 et p20
   et p21 et p22 et p23 et p24 et p25 et p26 et p27 et p28 et p29 et p30
   et p31 et p32 et p33 et p34 et p35 et p36 et p37 et p38 et p39 et p40
```

Figure 31: Model for test BLAS61.



(a) Fluid, top view (b) Fluid, bottom view (c) Absorbing, top view

(d) Absorbing, bottom view (e) Absorbing and sensors row (f) Zoom on the sensors row

Sources: JRC analysis.

```
   et p41 et p42 et p43 et p44 et p45 et p46 et p47 et p48 et p49 et p50;
elim tol (flui et pxx);
trac cach qual expl;
trac cach qual flui;
trac cach qual abso;
trac cach qual pxx;
```

```
*
mesh = flui et abso;
tass mesh noop;
sauv form mesh;
*
fin;
```

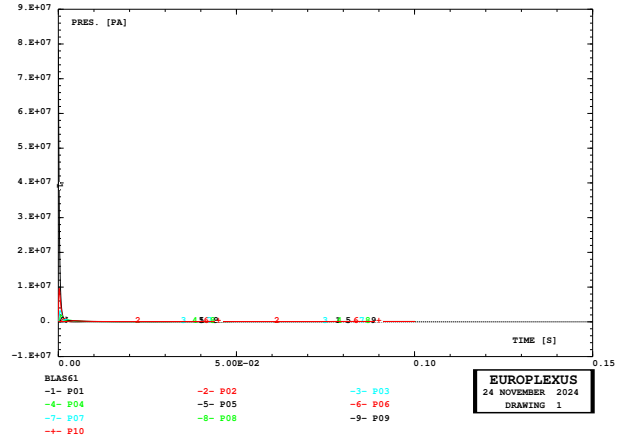
and the EPX input file:

```
BLAS61
ECHO
!CONV WIN
CAST mesh
TRID EULE
GEOM CUVF flui CL3D abso TERM
COMP COUL TURQ LECT air TERM
          ROUG LECT expl TERM
          JAUN LECT abso TERM
MATE GAZP RO 1.0 GAMM 1.4 PINI 1.E5 PREF 1.E5
          LECT flui TERM
     BUBB MASS 100.0
          LECT expl TERM
          CLVF ABSO RO 1.0 LECT abso TERM
ECRI ECRO TFRE 1.0E-3
     NOPO
     ELEM LECT pxx TERM
     FICH SPLI ALIC TFRE 1.0E-3
     FICH ALIC TEMP FREQ 1
          ELEM LECT pxx TERM
OPTI PAS AUTO NOTE STEP LIBR
 CSTA 0.25
 LOG 1
CALC TINI 0. TEND 100.0E-3
FIN
```

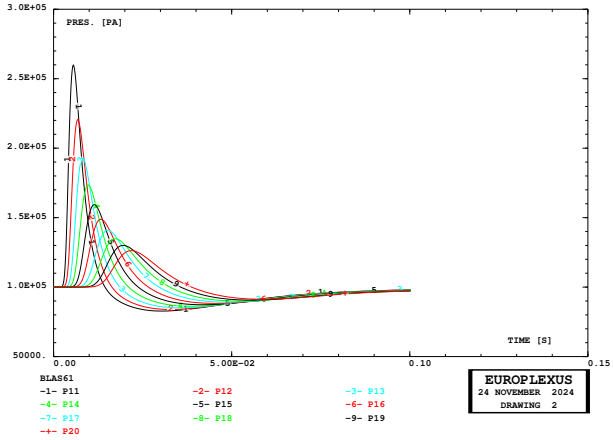
A row of pressure sensors is embedded in the model along the positive x-axis. One sensor is placed in each volume, for a total of 50 sensors. The first sensor is inside the compressed bubble.

Some results of this test are shown in Figures 32 (pressure signals at the sensors) and 33 (pressure maps at some selected times). At the chosen final time $t = 100$ ms the blast wave has just reached the lateral absorbing boundaries.

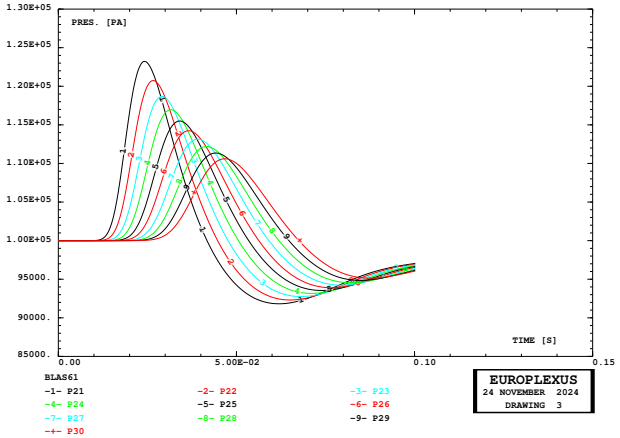
Figure 32: Pressure signals at the sensors in test BLAS61.



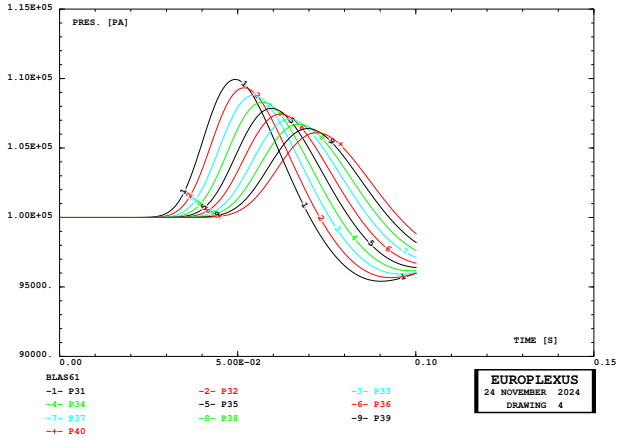
(a) Sensors 1-10



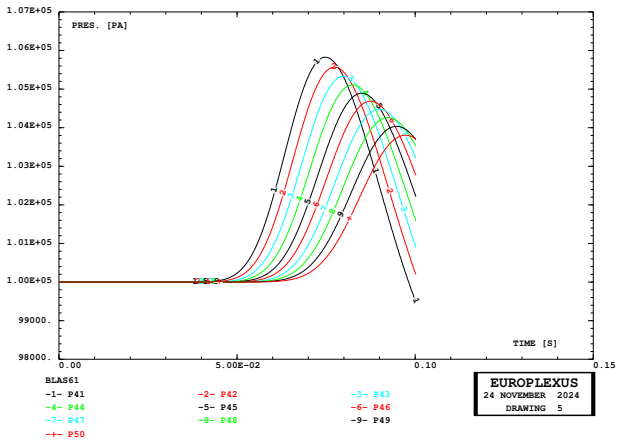
(b) Sensors 11-20



(c) Sensors 21-30



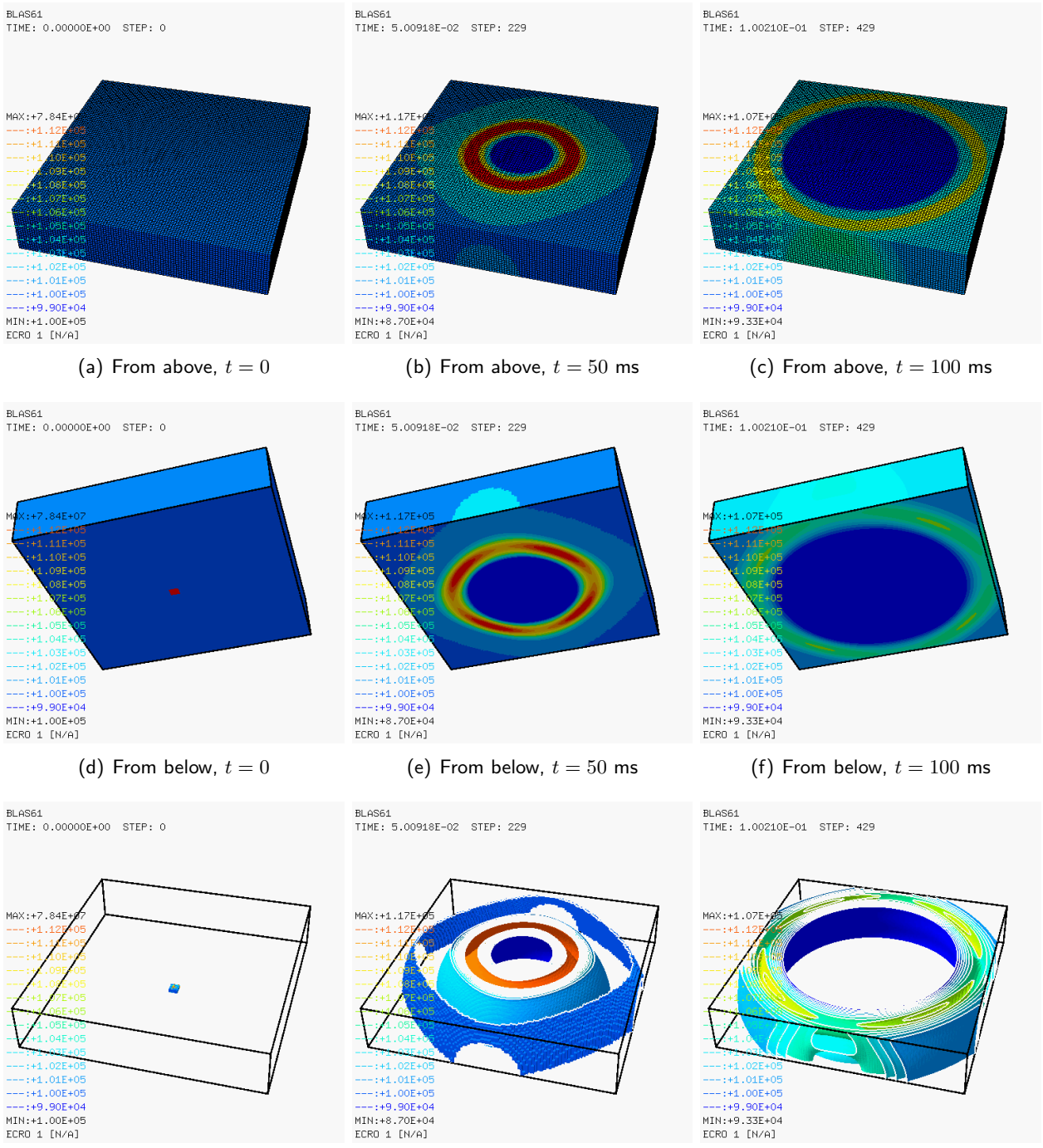
(d) Sensors 31-40



(e) Sensors 41-50

Sources: JRC analysis.

Figure 33: Pressure maps in test BLAS61.



(a) From above, $t = 0$ (b) From above, $t = 50$ ms (c) From above, $t = 100$ ms

(d) From below, $t = 0$ (e) From below, $t = 50$ ms (f) From below, $t = 100$ ms

(g) Iso-surfaces, $t = 0$ (h) Iso-surfaces, $t = 0$ (i) Iso-surfaces, $t = 0$

Sources: JRC analysis.

From the 50 pressure signals, by using the `FVAL` command, we (manually) extract the times at which the pressure reaches 1.001 bar at each pressure sensor:

```
BLAS61P
ECHO
OPTI PRIN
RESU ALIC TEMP 'blas61.alt' GARD PSCR
SORT GRAP
AXTE 1.0 'Time [s]'
COUR  1 'p01' ECRO COMP 1 ELEM LECT p01 TERM
COUR  2 'p02' ECRO COMP 1 ELEM LECT p02 TERM
COUR  3 'p03' ECRO COMP 1 ELEM LECT p03 TERM
COUR  4 'p04' ECRO COMP 1 ELEM LECT p04 TERM
COUR  5 'p05' ECRO COMP 1 ELEM LECT p05 TERM
COUR  6 'p06' ECRO COMP 1 ELEM LECT p06 TERM
COUR  7 'p07' ECRO COMP 1 ELEM LECT p07 TERM
COUR  8 'p08' ECRO COMP 1 ELEM LECT p08 TERM
COUR  9 'p09' ECRO COMP 1 ELEM LECT p09 TERM
COUR 10 'p10' ECRO COMP 1 ELEM LECT p10 TERM
COUR 11 'p11' ECRO COMP 1 ELEM LECT p11 TERM
COUR 12 'p12' ECRO COMP 1 ELEM LECT p12 TERM
COUR 13 'p13' ECRO COMP 1 ELEM LECT p13 TERM
COUR 14 'p14' ECRO COMP 1 ELEM LECT p14 TERM
COUR 15 'p15' ECRO COMP 1 ELEM LECT p15 TERM
COUR 16 'p16' ECRO COMP 1 ELEM LECT p16 TERM
COUR 17 'p17' ECRO COMP 1 ELEM LECT p17 TERM
COUR 18 'p18' ECRO COMP 1 ELEM LECT p18 TERM
COUR 19 'p19' ECRO COMP 1 ELEM LECT p19 TERM
COUR 20 'p20' ECRO COMP 1 ELEM LECT p20 TERM
COUR 21 'p21' ECRO COMP 1 ELEM LECT p21 TERM
COUR 22 'p22' ECRO COMP 1 ELEM LECT p22 TERM
COUR 23 'p23' ECRO COMP 1 ELEM LECT p23 TERM
COUR 24 'p24' ECRO COMP 1 ELEM LECT p24 TERM
COUR 25 'p25' ECRO COMP 1 ELEM LECT p25 TERM
COUR 26 'p26' ECRO COMP 1 ELEM LECT p26 TERM
COUR 27 'p27' ECRO COMP 1 ELEM LECT p27 TERM
COUR 28 'p28' ECRO COMP 1 ELEM LECT p28 TERM
COUR 29 'p29' ECRO COMP 1 ELEM LECT p29 TERM
COUR 30 'p30' ECRO COMP 1 ELEM LECT p30 TERM
COUR 31 'p31' ECRO COMP 1 ELEM LECT p31 TERM
COUR 32 'p32' ECRO COMP 1 ELEM LECT p32 TERM
COUR 33 'p33' ECRO COMP 1 ELEM LECT p33 TERM
COUR 34 'p34' ECRO COMP 1 ELEM LECT p34 TERM
COUR 35 'p35' ECRO COMP 1 ELEM LECT p35 TERM
COUR 36 'p36' ECRO COMP 1 ELEM LECT p36 TERM
COUR 37 'p37' ECRO COMP 1 ELEM LECT p37 TERM
COUR 38 'p38' ECRO COMP 1 ELEM LECT p38 TERM
COUR 39 'p39' ECRO COMP 1 ELEM LECT p39 TERM
COUR 40 'p40' ECRO COMP 1 ELEM LECT p40 TERM
COUR 41 'p41' ECRO COMP 1 ELEM LECT p41 TERM
COUR 42 'p42' ECRO COMP 1 ELEM LECT p42 TERM
COUR 43 'p43' ECRO COMP 1 ELEM LECT p43 TERM
COUR 44 'p44' ECRO COMP 1 ELEM LECT p44 TERM
COUR 45 'p45' ECRO COMP 1 ELEM LECT p45 TERM
COUR 46 'p46' ECRO COMP 1 ELEM LECT p46 TERM
COUR 47 'p47' ECRO COMP 1 ELEM LECT p47 TERM
COUR 48 'p48' ECRO COMP 1 ELEM LECT p48 TERM
COUR 49 'p49' ECRO COMP 1 ELEM LECT p49 TERM
COUR 50 'p50' ECRO COMP 1 ELEM LECT p50 TERM
!TRAC 1 5 10 15 20 25 30 35 40 45 50 AXES 1.0 'PRES. [Pa]' YZER
!COLO NOIR ROUG TURQ VERT NOIR ROUG TURQ VERT NOIR ROUG TURQ
!LIST 1 5 10 15 20 25 30 35 40 45 50 AXES 1.0 'PRES. [Pa]' YZER
!TRAC   5 10 15 20 25 30 35 40 45 50 AXES 1.0 'PRES. [Pa]' YZER
!COLO      ROUG TURQ VERT NOIR ROUG TURQ VERT NOIR ROUG TURQ
!TRAC     10 15 20 25 30 35 40 45 50 AXES 1.0 'PRES. [Pa]' YZER
!COLO           TURQ VERT NOIR ROUG TURQ VERT NOIR ROUG TURQ
FVAL  1 1.001E5
FVAL  2 1.001E5
FVAL  3 1.001E5
FVAL  4 1.001E5
FVAL  5 1.001E5
FVAL  6 1.001E5
FVAL  7 1.001E5
FVAL  8 1.001E5
FVAL  9 1.001E5
FVAL 10 1.001E5
FVAL 11 1.001E5
FVAL 12 1.001E5
FVAL 13 1.001E5
FVAL 14 1.001E5
FVAL 15 1.001E5
FVAL 16 1.001E5
FVAL 17 1.001E5
FVAL 18 1.001E5
FVAL 19 1.001E5
FVAL 20 1.001E5
FVAL 21 1.001E5
FVAL 22 1.001E5
FVAL 23 1.001E5
FVAL 24 1.001E5
FVAL 25 1.001E5
FVAL 26 1.001E5
FVAL 27 1.001E5
FVAL 28 1.001E5
FVAL 29 1.001E5
FVAL 30 1.001E5
FVAL 31 1.001E5
FVAL 32 1.001E5
FVAL 33 1.001E5
FVAL 34 1.001E5
FVAL 35 1.001E5
FVAL 36 1.001E5
FVAL 37 1.001E5
FVAL 38 1.001E5
FVAL 39 1.001E5
FVAL 40 1.001E5
FVAL 41 1.001E5
FVAL 42 1.001E5
FVAL 43 1.001E5
FVAL 44 1.001E5
FVAL 45 1.001E5
FVAL 46 1.001E5
FVAL 47 1.001E5
FVAL 48 1.001E5
FVAL 49 1.001E5
FVAL 50 1.001E5
TRAC  1  2  3  4  5  6  7  8  9 10 AXES 1.0 'PRES. [Pa]' YZER
COLO NOIR ROUG TURQ VERT NOIR ROUG TURQ VERT NOIR ROUG
TRAC 11 12 13 14 15 16 17 18 19 20 AXES 1.0 'PRES. [Pa]' YZER
COLO NOIR ROUG TURQ VERT NOIR ROUG TURQ VERT NOIR ROUG
TRAC 21 22 23 24 25 26 27 28 29 30 AXES 1.0 'PRES. [Pa]' YZER
COLO NOIR ROUG TURQ VERT NOIR ROUG TURQ VERT NOIR ROUG
TRAC 31 32 33 34 35 36 37 38 39 40 AXES 1.0 'PRES. [Pa]' YZER
COLO NOIR ROUG TURQ VERT NOIR ROUG TURQ VERT NOIR ROUG
TRAC 41 42 43 44 45 46 47 48 49 50 AXES 1.0 'PRES. [Pa]' YZER
COLO NOIR ROUG TURQ VERT NOIR ROUG TURQ VERT NOIR ROUG
LIST  1  2  3  4  5  6  7  8  9 10 AXES 1.0 'PRES. [Pa]' YZER
LIST 11 12 13 14 15 16 17 18 19 20 AXES 1.0 'PRES. [Pa]' YZER
LIST 21 22 23 24 25 26 27 28 29 30 AXES 1.0 'PRES. [Pa]' YZER
LIST 31 32 33 34 35 36 37 38 39 40 AXES 1.0 'PRES. [Pa]' YZER
LIST 41 42 43 44 45 46 47 48 49 50 AXES 1.0 'PRES. [Pa]' YZER
FIN
```

This allows to (manually) build up a table X-t (file `wave61.txt`) where X is the distance of the sensor from the center of the pressurized bubble, and t is the time at which the blast wave reaches the sensor:

```
0.000000000    1.0
0.000010000    1.5
0.000126265    2.5
0.000218291    3.5
0.000303681    4.5
0.000453831    5.5
0.000652466    6.5
0.000927883    7.5
0.00125604     8.5
0.00164243     9.5
0.00211007    10.5
0.00265619    11.5
0.00329081    12.5
0.00400837    13.5
0.00481838    14.5
0.00572335    15.5
0.00671387    16.5
0.00780492    17.5
0.00896870    18.5
0.0102228     19.5
0.0115575     20.5
0.0129424     21.5
0.0143960     22.5
0.0159097     23.5
0.0174780     24.5
0.0190987     25.5
0.0207639     26.5
0.0224731     27.5
0.0242193     28.5
0.0260043     29.5
0.0278238     30.5
0.0296763     31.5
0.0315569     32.5
0.0334638     33.5
0.0353990     34.5
0.0373571     35.5
0.0393367     36.5
0.0413384     37.5
0.0433603     38.5
0.0454010     39.5
0.0474597     40.5
0.0495358     41.5
0.0516282     42.5
0.0537334     43.5
```

```
0.0558556     44.5
0.0579903     45.5
0.0601397     46.5
0.0623021     47.5
0.0644868     48.5
0.0667163     49.5
```

Then, with the help of a small ad-hoc program `wave61.F90`:

```
PROGRAM wave61
IMPLICIT NONE
INTEGER, PARAMETER :: NP = 50
REAL(8) :: T(NP), X(NP), V(NP), DT, DX
INTEGER :: I
DO I = 1, NP
  READ (5, *) T(I), X(I)
END DO
V(1) = 0.D0
DO I = 2, NP
  DX = X(I) - X(I-1)
  DT = T(I) - T(I-1)
  V(I) = DX / DT
END DO
DO I = 1, NP
  WRITE (6, 1001) I, T(I), X(I), V(I)
1001  FORMAT ('I=',I2,' T=',1PD13.5,' X=',1PD13.5,' V=',1PD13.5)
END DO
WRITE (6, *) ' '
DO I = 1, NP
  WRITE (6, 1002) T(I), X(I)
1002  FORMAT (1P2D13.5)
END DO
WRITE (6, *) ' '
DO I = 1, NP
  WRITE (6, 1002) T(I), V(I)
END DO
STOP 'NORMAL END'
END PROGRAM wave61
```

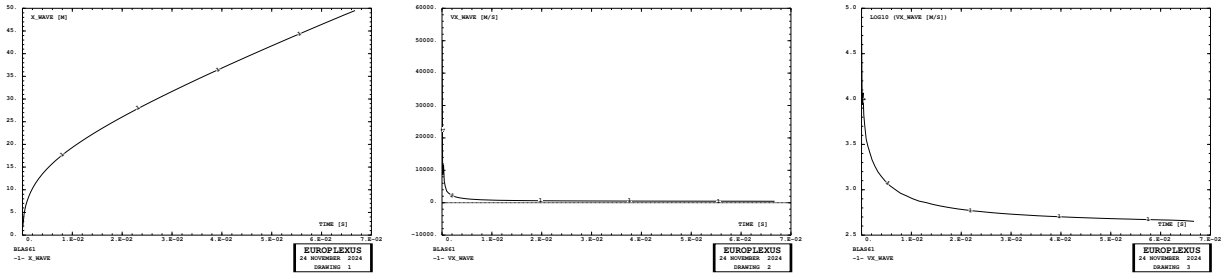
we also obtain the velocity of the wave fronts (see file `wave61.out`):

```
I= 1 T=  0.00000D+00 X=  1.00000D+00 V=  0.00000D+00
I= 2 T=  1.00000D-05 X=  1.50000D+00 V=  5.00000D+04
I= 3 T=  1.26265D-04 X=  2.50000D+00 V=  8.60104D+03
I= 4 T=  2.18291D-04 X=  3.50000D+00 V=  1.08665D+04
I= 5 T=  3.03681D-04 X=  4.50000D+00 V=  1.17110D+04
I= 6 T=  4.53831D-04 X=  5.50000D+00 V=  6.66001D+03
I= 7 T=  6.52466D-04 X=  6.50000D+00 V=  5.03436D+03
I= 8 T=  9.27883D-04 X=  7.50000D+00 V=  3.63086D+03
I= 9 T=  1.25604D-03 X=  8.50000D+00 V=  3.04732D+03
I=10 T=  1.64243D-03 X=  9.50000D+00 V=  2.58806D+03
I=11 T=  2.11007D-03 X=  1.05000D+01 V=  2.13840D+03
I=12 T=  2.65619D-03 X=  1.15000D+01 V=  1.83110D+03
I=13 T=  3.29081D-03 X=  1.25000D+01 V=  1.57575D+03
I=14 T=  4.00837D-03 X=  1.35000D+01 V=  1.39361D+03
I=15 T=  4.81838D-03 X=  1.45000D+01 V=  1.23455D+03
I=16 T=  5.72335D-03 X=  1.55000D+01 V=  1.10501D+03
I=17 T=  6.71387D-03 X=  1.65000D+01 V=  1.00957D+03
I=18 T=  7.80492D-03 X=  1.75000D+01 V=  9.16548D+02
I=19 T=  8.96870D-03 X=  1.85000D+01 V=  8.59269D+02
I=20 T=  1.02228D-02 X=  1.95000D+01 V=  7.97385D+02
I=21 T=  1.15575D-02 X=  2.05000D+01 V=  7.49232D+02
I=22 T=  1.29424D-02 X=  2.15000D+01 V=  7.22074D+02
I=23 T=  1.43960D-02 X=  2.25000D+01 V=  6.87947D+02
I=24 T=  1.59097D-02 X=  2.35000D+01 V=  6.60633D+02
I=25 T=  1.74780D-02 X=  2.45000D+01 V=  6.37633D+02
I=26 T=  1.90987D-02 X=  2.55000D+01 V=  6.17017D+02
I=27 T=  2.07639D-02 X=  2.65000D+01 V=  6.00528D+02
I=28 T=  2.24731D-02 X=  2.75000D+01 V=  5.85069D+02
I=29 T=  2.42193D-02 X=  2.85000D+01 V=  5.72672D+02
I=30 T=  2.60043D-02 X=  2.95000D+01 V=  5.60224D+02
I=31 T=  2.78238D-02 X=  3.05000D+01 V=  5.49602D+02
I=32 T=  2.96763D-02 X=  3.15000D+01 V=  5.39811D+02
I=33 T=  3.15569D-02 X=  3.25000D+01 V=  5.31745D+02
I=34 T=  3.34638D-02 X=  3.35000D+01 V=  5.24411D+02
I=35 T=  3.53990D-02 X=  3.45000D+01 V=  5.16742D+02
I=36 T=  3.73571D-02 X=  3.55000D+01 V=  5.10699D+02
I=37 T=  3.93367D-02 X=  3.65000D+01 V=  5.05153D+02
I=38 T=  4.13384D-02 X=  3.75000D+01 V=  4.99575D+02
I=39 T=  4.33603D-02 X=  3.85000D+01 V=  4.94584D+02
I=40 T=  4.54010D-02 X=  3.95000D+01 V=  4.90028D+02
I=41 T=  4.74597D-02 X=  4.05000D+01 V=  4.85743D+02
I=42 T=  4.95358D-02 X=  4.15000D+01 V=  4.81672D+02
I=43 T=  5.16282D-02 X=  4.25000D+01 V=  4.77920D+02
I=44 T=  5.37334D-02 X=  4.35000D+01 V=  4.75014D+02
I=45 T=  5.58556D-02 X=  4.45000D+01 V=  4.71209D+02
I=46 T=  5.79903D-02 X=  4.55000D+01 V=  4.68450D+02
I=47 T=  6.01397D-02 X=  4.65000D+01 V=  4.65246D+02
I=48 T=  6.23021D-02 X=  4.75000D+01 V=  4.62449D+02
I=49 T=  6.44868D-02 X=  4.85000D+01 V=  4.57729D+02
I=50 T=  6.67163D-02 X=  4.95000D+01 V=  4.48531D+02
```

The obtained position and velocity data can be plotted by EPX obtaining the curves in Figure 34. The values in the first couple of points in the Table (shown in red in the above lists) are slightly adapted because the values read from the FVAL command can be inaccurate at such small distances from the bubble.

As expected, the wave speed decreases drastically, from several thousand m/s at the beginning of the transient, to only about 450 m/s after about 66 ms (or after a propagation distance of 50 m. This confirms the importance of taking into account the variability of the wave speed in the element skipping procedure.

Figure 34: Wave front position and velocity in test BLAS61.



(a) X-Position (from bubble center) (b) Velocity (c) Velocity (log scale)

Sources: JRC analysis.

2.7 Input syntax including variable wave speed

To allow the specification of a variable wave speed, the INIT BLAS EPX input directive introduced in Section 2.2 is modified as follows:

```
INIT BLAS nblas * ( POIN x y <z>
                    $ VELO v ; DFUN dfun $
                    TO t0 < DMIN dmin > /LECT/ )
```

where:

nblas

Number of blasts to be defined next.

POIN x y z

Point (center) at which the charge detonates. In 2D only two coordinates should be specifiued.

VELO v

Speed of propagation of the wave front, assumed constant for simplicity. To be on the safe side, the user may want to specify a speed slightly larger than the estimated (maximum) speed of the blast wavefront.

DFUN dfun

The radial position of the wave front measured from the explosion center (typically the center of the explosive charge, or the center of the pressurized bubble if the BUBB model is adopted) is prescribed by the user in a tabular function of index dfun. The function contains couples of values (t, d) where t is time and d the distance.

TO t0

Time at which the charge detonation begins.

DMIN dmin

Minimum distance $D_{\min}$ from the charge point specified by POIN below which the finite volume interfaces are always computed (never skipped). If omitted, the code assumes $D_{\min} = 0$.

/LECT/

List of concerned elements (Finite Volumes).

The model simply assumes that:

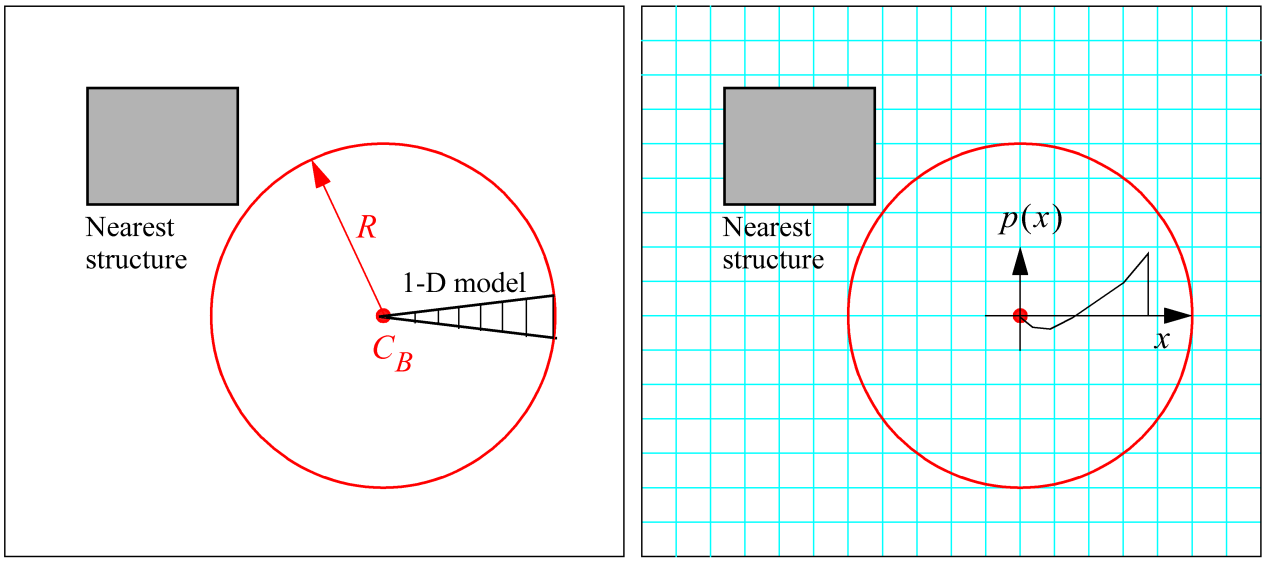
1. Either the blast wave front propagates spherically at constant speed.
2. Or, the radial position of the wave front from the explosion center is a given function of time.

If more than one blast is specified, the minimum hit time of all blasts is retained for each Finite Volume considered.

3 Using a 1-D/3-D model to perform a monolithic simulation

The strategy for this second approach is sketched in Figure 35. A mixed-dimension model is built up consisting of a 1-D fluid model superposed to the normal multi-D fluid (and structure) model.

Figure 35: Mixed-dimension model for a monolithic simulation.



(a) 1-D simulation (b) multi-D simulation

Sources: JRC analysis.

As shown in Figure 36(a), the 1-D model is composed of conical 1-D finite volumes. It has the narrow extremity on the center of the explosive charge C_B and extends up to the nearest structure, i.e. over the fluid region where the blast wave expansion is undisturbed (spherical). The radius R of the spherical region (length of the 1-D fluid model) extents up to the nearest structure or obstacle that would perturb the fluid flow during the expansion of the blast wave.

Figure 36(b) shows the multi-D fluid grid (in cyan) which is superposed to the 1-D fluid model. Both models are set up from the beginning of the calculation and are read in by EPX.

During the first part of the simulation, only the 1-D fluid model is activated. The multi-D fluid model and the structural model are de-activated and are just skipped in the calculation. The code monitors the motion of the shock wave front. As this wave reaches the end of the 1-D model (with a small safety margin), the code automatically switches to the second part of the simulation.

The 1-D fluid model is then disabled and is no longer considered in the rest of the simulation. The multi-D fluid model is activated and the 1-D solution is mapped onto the multi-D mesh to provide suitable "initial" conditions of pressure, density, velocity etc. Then the simulation is continued until the final time by considering only the multi-D fluid mesh and the structure.

A minor drawback of this second strategy with respect to the first one is that for practical reasons it is limited to just one blast source. The advantage is that it is not necessary for the user to estimate the wave front speed (nor to assume it as constant), since this is dealt with by the code itself. In fact, the code performs the switch between the two phases automatically at the correct time. Furthermore, since the 1-D part of the model is relatively inexpensive, a very fine 1-D mesh can be used to achieve optimal accuracy in the early phase of the blast.

Implementation and testing of the second strategy detailed above are left for a subsequent report.

4 Conclusions

This report has presented some optimizations recently introduced in the EUROPLEXUS code for the numerical simulation of blast events in urban environments. The optimizations are focused on reducing CPU load and time in transient dynamic simulations of blasts offering technical support to EC policies concerning the security of critical infrastructures and the protection of public spaces, two subjects which have become more and more sensible over the last years.

Two (alternative) types of optimization were considered. In the first type, the calculation of numerical fluxes in the Cell-Centered Finite Volume (CCFV) discrete model used to represent the fluid subdomain is skipped for all portions of the model that have not yet possibly been reached by the blast wave resulting from the explosion.

In the second type of optimization, which is designed but whose implementation is left for a subsequent work, a combined 1-D/multi-D fluid model would be set up.

References

[1] EUROPLEXUS User's Manual, on-line version: http://europlexus.jrc.ec.europa.eu.

[2] Cast3m Software: http://www-cast3m.cea.fr/.

List of abbreviations and definitions

ALE Arbitrary Lagrangian Eulerian formulation
AMR Adaptive Mesh Refinement and un-refinement (adaptivity)
CCFV Cell Centred Finite Volumes (also indicated as VFCC)
CEA Commissariat à l'Energie Atomique
EC European Commission
EL Euler Lagrange formulation
EPX EUROPLEXUS software [1]
FE Finite Elements
FSI Fluid Structure Interaction
IBM Immersed Boundary Method
JRC Joint Research Centre

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Annex — Input files

All the input files used in the previous Sections are listed below.

blas01.dgibi

```
opti echo 0;
opti donn 'pxordpoi.proc';
opti echo 1;
opti dime 2 elem qua4;
opti sauv form 'blas01.msh';
opti trac psc ftra 'blas01_mesh.ps';
p0 = 0 0;
p0p = p0 plus (0 0.00125);
pmid = 0.5 0;
p1 = 1 0;
p1p = p1 plus (0 0.00125);
pa = 0.25 0;
pb = 0.75 0;
tol = 1.E-5;
n = 800;
n2 = n / 2;
n4 = n2 / 2;
c11 = p0 d n4 pa;
c12 = pa d n4 pmid;
c1 = c11 et c12;
c21 = pmid d n4 pb;
c22 = pb d n4 p1;
c2 = c21 et c22;
bar11 = c11 tran 1 (0 0.00125);
bar12 = c12 tran 1 (0 0.00125);
bar1 = bar11 et bar12;
bar21 = c21 tran 1 (0 0.00125);
bar22 = c22 tran 1 (0 0.00125);
bar2 = bar21 et bar22;
bar = bar1 et bar2;
elim tol (bar et p0p et p1p et pa et pb);
ea = bar12 elem cont pa;
eb = bar21 elem cont pb;
xax = chan 'POI1' (c1 et c2);
xaxo = pxordpoi xax p0;
mesh = bar et ea et eb et xaxo;
tass mesh;
sauv form mesh;
trac qual mesh;
trac ((cont mesh) et ea et eb);
fin;
```

blas01.epx

```
BLAS01
ECHO
!CONV win
CAST mesh
EULE DPLA
GEOM Q4VF bar TERM
COMP COUL ROSE LECT bar1 TERM
          TURQ LECT bar2 TERM
MATE GAZP RO 10 GAMM 1.5 PINI 1.E6 PREF 1.E5
          LECT bar1 TERM
     GAZP RO  1 GAMM 1.5 PINI 1.E5 PREF 1.E5
          LECT bar2 TERM
ECRI COOR DEPL VITE ACCE FINT FEXT CONT ECRO TFRE 0.3E-3
     FICH ALIC TEMP FREQ 1
          POIN LECT pa pmid pb TERM
          ELEM LECT ea eb TERM
     FICH ALIC TFRE 1.0E-4
OPTI NOTE STEP IO
 csta 0.5
 log 1
!VFCC FCON 1              ! OK
!VFCC FCON 2 VISC 0.75    ! OK
 VFCC FCON 3              ! OK
!VFCC FCON 4              ! OK
!VFCC FCON 5              ! OK
!VFCC FCON 6              ! OK
!VFCC FCON 7              ! OK
!VFCC FCON 8              ! OK
!VFCC FCON 9              ! OK
!VFCC FCON 10             ! OK
!VFCC FCON 11             ! OK
!VFCC FCON 12             ! OK
CALC TINI 0. TEND 0.60E-3
*=============================================================
SUIT
Post-treatment (space curves from alice file)
ECHO
RESU ALIC GARD PSCR
SORT GRAP
PERF 'blas01.pun'
AXTE 1.0 'Time [s]'
SCOU 71 'p_7'  NSTO 7 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      ECRO COMP 1
SCOU 72 'ro_7' NSTO 7 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      ECRO COMP 2
SCOU 73 'vx_7' NSTO 7 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      VCVI COMP 1
DCOU 76 'pa_7' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.6E-3 NRAR 30 VARI 1
DCOU 77 'ra_7' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.6E-3 NRAR 30 VARI 2
DCOU 78 'va_7' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.6E-3 NRAR 30 VARI 5
TRAC 71 76 AXES 1.0 'PRESS. [PA]'
COLO NOIR ROUG
LIST 71 76 AXES 1.0 'PRESS. [PA]'
TRAC 72 77 AXES 1.0 'DENS. [KG/M3]'
COLO NOIR ROUG
LIST 72 77 AXES 1.0 'DENS. [KG/M3]'
TRAC 73 78 AXES 1.0 'VELOC. [M/S]'
COLO NOIR ROUG
LIST 73 78 AXES 1.0 'VELOC. [M/S]'
*
QUAL VCVI COMP 1 LECT ea   TERM REFE  3.45909E+0 TOLE 2.E-2
     VCVI COMP 1 LECT eb   TERM REFE  2.95372E+2 TOLE 2.E-2
     ECRO COMP 1 LECT ea   TERM REFE  9.86677E+5 TOLE 2.E-2
     ECRO COMP 1 LECT eb   TERM REFE  2.81256E+5 TOLE 2.E-2
     ECRO COMP 2 LECT ea   TERM REFE  9.91096E+0 TOLE 2.E-2
     ECRO COMP 2 LECT eb   TERM REFE  1.92768E+0 TOLE 2.E-2
*=============================================================
SUIT
Post treatment (BMPs from alice file)
ECHO
RESU ALIC GARD PSCR
OPTI PRIN
SORT VISU NSTO 61
PLAY
CAME   1 EYE   5.00000E-01  5.00000E-03  3.00015E-01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   5.25000E+01
SCEN GEOM NAVI FREE
          LINE HEOU
     ISO  FILL FIEL VCVI SCAL USER PROG 20 PAS 20 280 TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1400 400 FICH BMP REND
SCEN GEOM NAVI FREE
          LINE HEOU
     ISO  FILL FIEL ECRO 2 SCAL USER PROG 1 PAS 0.6 8.8 TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1400 400 FICH BMP REND
ENDPLAY
*=============================================================
FIN
```

blas02.dgibi

```
opti echo 0;
opti donn 'pxordpoi.proc';
opti echo 1;
opti dime 2 elem qua4;
opti sauv form 'blas02.msh';
opti trac psc ftra 'blas02_mesh.ps';
p0 = 0 0;
p0p = p0 plus (0 0.00125);
pmid = 0.5 0;
p1 = 1 0;
p1p = p1 plus (0 0.00125);
pa = 0.25 0;
pb = 0.75 0;
tol = 1.E-5;
n = 800;
n2 = n / 2;
n4 = n2 / 2;
c11 = p0 d n4 pa;
c12 = pa d n4 pmid;
c1 = c11 et c12;
c21 = pmid d n4 pb;
c22 = pb d n4 p1;
c2 = c21 et c22;
bar11 = c11 tran 1 (0 0.00125);
bar12 = c12 tran 1 (0 0.00125);
bar1 = bar11 et bar12;
bar21 = c21 tran 1 (0 0.00125);
bar22 = c22 tran 1 (0 0.00125);
bar2 = bar21 et bar22;
```

```
bar = bar1 et bar2;
elim tol (bar et p0p et p1p et pa et pb);
ea = bar12 elem cont pa;
eb = bar21 elem cont pb;
xax = chan 'POI1' (c1 et c2);
xaxo = pxordpoi xax p0;
mesh = bar et ea et eb et xaxo;
tass mesh;
sauv form mesh;
trac qual mesh;
trac ((cont mesh) et ea et eb);
fin;
```

blas02.epx

```
BLAS02
ECHO
!CONV win
CAST mesh
EULE DPLA
GEOM Q4VF bar TERM
COMP COUL ROSE LECT bar1 TERM
          TURQ LECT bar2 TERM
MATE GAZP RO 10 GAMM 1.5 PINI 1.E6 PREF 1.E5
          LECT bar1 TERM
     GAZP RO  1 GAMM 1.5 PINI 1.E5 PREF 1.E5
          LECT bar2 TERM
INIT BLAS 1
          POIN 0.5 6.25E-4
          VELO 650.0
          TO 0.0
          DMIN 2.5E-3
          LECT bar TERM
ECRI COOR DEPL VITE ACCE FINT FEXT CONT ECRO TFRE 0.3E-3
     FICH ALIC TEMP FREQ 1
          POIN LECT pa pmid pb TERM
          ELEM LECT ea eb TERM
     FICH ALIC TFRE 1.0E-4
OPTI NOTE STEP IO
 csta 0.5
 log 1
!VFCC FCON 1              ! OK
!VFCC FCON 2 VISC 0.75    ! OK
 VFCC FCON 3              ! OK
!VFCC FCON 4              ! OK
!VFCC FCON 5              ! OK
!VFCC FCON 6              ! OK
!VFCC FCON 7              ! OK
!VFCC FCON 8              ! OK
!VFCC FCON 9              ! OK
!VFCC FCON 10             ! OK
!VFCC FCON 11             ! OK
!VFCC FCON 12             ! OK
CALC TINI 0. TEND 0.60E-3
*===============================================================
SUIT
Post-treatment (space curves from alice file)
ECHO
RESU ALIC GARD PSCR
SORT GRAP
PERF 'blas02.pun'
AXTE 1.0 'Time [s]'
SCOU 71 'p_7'  NSTO 7 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      ECRO COMP 1
SCOU 72 'ro_7' NSTO 7 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      ECRO COMP 2
SCOU 73 'vx_7' NSTO 7 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      VCVI COMP 1
DCOU 76 'pa_7' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.6E-3 NRAR 30 VARI 1
DCOU 77 'ra_7' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.6E-3 NRAR 30 VARI 2
DCOU 78 'va_7' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.6E-3 NRAR 30 VARI 5
RCOU 171 'p_7'  FICH 'blas01.pun' RENA 'p_7_01'
RCOU 172 'ro_7' FICH 'blas01.pun' RENA 'ro_7_01'
RCOU 173 'vx_7' FICH 'blas01.pun' RENA 'vx_7_01'
TRAC 71 76 171 AXES 1.0 'PRESS. [PA]'
COLO NOIR ROUG VERT
TRAC 72 77 172 AXES 1.0 'DENS. [KG/M3]'
COLO NOIR ROUG VERT
TRAC 73 78 173 AXES 1.0 'VELOC. [M/S]'
COLO NOIR ROUG VERT
*
QUAL VCVI COMP 1 LECT ea   TERM REFE  3.45909E+0 TOLE 1.E-1
     VCVI COMP 1 LECT eb   TERM REFE  2.95372E+2 TOLE 2.E-2
     ECRO COMP 1 LECT ea   TERM REFE  9.86677E+5 TOLE 2.E-2
     ECRO COMP 1 LECT eb   TERM REFE  2.81256E+5 TOLE 2.E-2
     ECRO COMP 2 LECT ea   TERM REFE  9.91096E+0 TOLE 2.E-2
     ECRO COMP 2 LECT eb   TERM REFE  1.92768E+0 TOLE 2.E-2
*===============================================================
SUIT
Post treatment (BMPs from alice file)
ECHO
RESU ALIC GARD PSCR
OPTI PRIN
SORT VISU NSTO 61
PLAY
CAME   1 EYE   5.00000E-01  5.00000E-03  3.00015E-01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   5.25000E+01
SCEN GEOM NAVI FREE
          LINE HEOU
     ISO  FILL FIEL VCVI SCAL USER PROG 20 PAS 20 280 TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1400 400 FICH BMP REND
SCEN GEOM NAVI FREE
          LINE HEOU
     ISO  FILL FIEL ECRO 2 SCAL USER PROG 1 PAS 0.6 8.8 TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1400 400 FICH BMP REND
ENDPLAY
*===============================================================
FIN
```

blas03.epx

```
BLAS03
ECHO
!CONV win
EULE DPLA
GEOM LIBR POIN 22 Q4VF 10 TERM
 0.0 0.0  0.1 0.0  0.2 0.0  0.3 0.0  0.4 0.0  0.5 0.0
          0.6 0.0  0.7 0.0  0.8 0.0  0.9 0.0  1.0 0.0
 0.0 0.1  0.1 0.1  0.2 0.1  0.3 0.1  0.4 0.1  0.5 0.1
          0.6 0.1  0.7 0.1  0.8 0.1  0.9 0.1  1.0 0.1
  1  2 13 12
  2  3 14 13
  3  4 15 14
  4  5 16 15
  5  6 17 16
  6  7 18 17
  7  8 19 18
  8  9 20 19
  9 10 21 20
 10 11 22 21
COMP GROU 2 'bar1' LECT 1 2 3 4 5 TERM
           'bar2' LECT 6 7 8 9 10 TERM
     NGRO 1 'xaxo' LECT 1 PAS 1 11 TERM
     COUL ROSE LECT bar1 TERM
          TURQ LECT bar2 TERM
MATE GAZP RO 10 GAMM 1.5 PINI 1.E6 PREF 1.E5
          LECT bar1 TERM
     GAZP RO  1 GAMM 1.5 PINI 1.E5 PREF 1.E5
          LECT bar2 TERM
ECRI COOR DEPL VITE ACCE FINT FEXT CONT ECRO VFCC FREQ 1
!    FICH ALIC TEMP FREQ 1
!         POIN LECT pa pmid pb TERM
!         ELEM LECT ea eb TERM
     FICH ALIC FREQ 1
OPTI NOTE STEP IO
 csta 0.5
 log 1
!VFCC FCON 1              ! OK
!VFCC FCON 2 VISC 0.75    ! OK
 VFCC FCON 3              ! OK
!VFCC FCON 4              ! OK
!VFCC FCON 5              ! OK
!VFCC FCON 6              ! OK
!VFCC FCON 7              ! OK
!VFCC FCON 8              ! OK
!VFCC FCON 9              ! OK
!VFCC FCON 10             ! OK
!VFCC FCON 11             ! OK
!VFCC FCON 12             ! OK
      dump
CALC TINI 0. TEND 0.60E-3 ! nmax 1
*===============================================================
SUIT
Post-treatment (space curves from alice file)
ECHO
RESU ALIC GARD PSCR
SORT GRAP
PERF 'blas03.pun'
AXTE 1.0 'Time [s]'
*
SCOU 21 'p_2'  NSTO 3 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      ECRO COMP 1
SCOU 22 'ro_2' NSTO 3 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      ECRO COMP 2
SCOU 23 'vx_2' NSTO 3 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      VCVI COMP 1
DCOU 26 'pa_2' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.2199655E-3 NRAR 30 VARI 1
DCOU 27 'ra_2' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.2199655E-3 NRAR 30 VARI 2
DCOU 28 'va_2' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.2199655E-3 NRAR 30 VARI 5
TRAC 21 26 AXES 1.0 'PRESS. [PA]' SYMB
COLO NOIR ROUG
LIST 21 26 AXES 1.0 'PRESS. [PA]' SYMB
TRAC 22 27 AXES 1.0 'DENS. [KG/M3]' SYMB
COLO NOIR ROUG
LIST 22 27 AXES 1.0 'DENS. [KG/M3]' SYMB
TRAC 23 28 AXES 1.0 'VELOC. [M/S]' SYMB
COLO NOIR ROUG
```

```
LIST 23 28 AXES 1.0 'VELOC. [M/S]' SYMB
*
SCOU 31 'p_3'  NSTO 4 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      ECRO COMP 1
SCOU 32 'ro_3' NSTO 4 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      ECRO COMP 2
SCOU 33 'vx_3' NSTO 4 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      VCVI COMP 1
DCOU 36 'pa_3' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.3060051E-3 NRAR 30 VARI 1
DCOU 37 'ra_3' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.3060051E-3 NRAR 30 VARI 2
DCOU 38 'va_3' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.3060051E-3 NRAR 30 VARI 5
TRAC 31 36 AXES 1.0 'PRESS. [PA]' SYMB
COLO NOIR ROUG
LIST 31 36 AXES 1.0 'PRESS. [PA]' SYMB
TRAC 32 37 AXES 1.0 'DENS. [KG/M3]' SYMB
COLO NOIR ROUG
LIST 32 37 AXES 1.0 'DENS. [KG/M3]' SYMB
TRAC 33 38 AXES 1.0 'VELOC. [M/S]' SYMB
COLO NOIR ROUG
LIST 33 38 AXES 1.0 'VELOC. [M/S]' SYMB
*
SCOU 71 'p_7'  NSTO 8 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      ECRO COMP 1
SCOU 72 'ro_7' NSTO 8 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      ECRO COMP 2
SCOU 73 'vx_7' NSTO 8 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      VCVI COMP 1
DCOU 76 'pa_7' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.6E-3 NRAR 30 VARI 1
DCOU 77 'ra_7' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.6E-3 NRAR 30 VARI 2
DCOU 78 'va_7' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.6E-3 NRAR 30 VARI 5
TRAC 71 76 AXES 1.0 'PRESS. [PA]' SYMB
COLO NOIR ROUG
LIST 71 76 AXES 1.0 'PRESS. [PA]' SYMB
TRAC 72 77 AXES 1.0 'DENS. [KG/M3]' SYMB
COLO NOIR ROUG
LIST 72 77 AXES 1.0 'DENS. [KG/M3]' SYMB
TRAC 73 78 AXES 1.0 'VELOC. [M/S]' SYMB
COLO NOIR ROUG
LIST 73 78 AXES 1.0 'VELOC. [M/S]' SYMB
*
!QUAL VCVI COMP 1 LECT ea   TERM REFE  3.50414E+0 TOLE 2.E-2
!     VCVI COMP 1 LECT eb   TERM REFE  2.95375E+2 TOLE 2.E-2
!     ECRO COMP 1 LECT ea   TERM REFE  9.86505E+5 TOLE 2.E-2
!     ECRO COMP 1 LECT eb   TERM REFE  2.81254E+5 TOLE 2.E-2
!     ECRO COMP 2 LECT ea   TERM REFE  9.90980E+0 TOLE 2.E-2
!     ECRO COMP 2 LECT eb   TERM REFE  1.92767E+0 TOLE 2.E-2
*===============================================================
SUIT
Post treatment (BMPs from alice file)
ECHO
RESU ALIC GARD PSCR
OPTI PRIN
SORT VISU NSTO 61
PLAY
CAME   1 EYE   5.00000E-01  5.00000E-03  3.00015E-01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   5.25000E+01
SCEN GEOM NAVI FREE
          LINE HEOU
     ISO  FILL FIEL VCVI SCAL USER PROG 20 PAS 20 280 TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1400 400 FICH BMP REND
SCEN GEOM NAVI FREE
          LINE HEOU
     ISO  FILL FIEL ECRO 2 SCAL USER PROG 1 PAS 0.6 8.8 TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1400 400 FICH BMP REND
ENDPLAY
*===============================================================
FIN
```

blas04.epx

```
BLAS04
ECHO
!CONV win
EULE DPLA
GEOM LIBR POIN 22 Q4VF 10 TERM
 0.0 0.0  0.1 0.0  0.2 0.0  0.3 0.0  0.4 0.0  0.5 0.0
          0.6 0.0  0.7 0.0  0.8 0.0  0.9 0.0  1.0 0.0
 0.0 0.1  0.1 0.1  0.2 0.1  0.3 0.1  0.4 0.1  0.5 0.1
          0.6 0.1  0.7 0.1  0.8 0.1  0.9 0.1  1.0 0.1
  1  2 13 12
  2  3 14 13
  3  4 15 14
  4  5 16 15
  5  6 17 16
  6  7 18 17
  7  8 19 18
  8  9 20 19
  9 10 21 20
 10 11 22 21
COMP GROU 3 'bar1' LECT 1 2 3 4 5 TERM
            'bar2' LECT 6 7 8 9 10 TERM
            'bar'  LECT bar1 bar2 TERM
     NGRO 1 'xaxo' LECT 1 PAS 1 11 TERM
     COUL ROSE LECT bar1 TERM
          TURQ LECT bar2 TERM
MATE GAZP RO 10 GAMM 1.5 PINI 1.E6 PREF 1.E5
          LECT bar1 TERM
     GAZP RO  1 GAMM 1.5 PINI 1.E5 PREF 1.E5
          LECT bar2 TERM
INIT BLAS 1
          POIN 0.5 0.05
          VELO 650.0
          T0 0.0
          DMIN 0.25
          LECT bar TERM
ECRI COOR DEPL VITE ACCE FINT FEXT CONT ECRO VFCC FREQ 1
!    FICH ALIC TEMP FREQ 1
!         POIN LECT pa pmid pb TERM
!         ELEM LECT ea eb TERM
     FICH ALIC FREQ 1
OPTI NOTE STEP IO
 csta 0.5
 log 1
!VFCC FCON 1              ! OK
!VFCC FCON 2 VISC 0.75    ! OK
 VFCC FCON 3              ! OK
!VFCC FCON 4              ! OK
!VFCC FCON 5              ! OK
!VFCC FCON 6              ! OK
!VFCC FCON 7              ! OK
!VFCC FCON 8              ! OK
!VFCC FCON 9              ! OK
!VFCC FCON 10             ! OK
!VFCC FCON 11             ! OK
!VFCC FCON 12             ! OK
      dump
CALC TINI 0. TEND 0.60E-3 ! nmax 1
*===============================================================
SUIT
Post-treatment (space curves from alice file)
ECHO
RESU ALIC GARD PSCR
SORT GRAP
PERF 'blas04.pun'
AXTE 1.0 'Time [s]'
*
SCOU 21 'p_2'  NSTO 3 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      ECRO COMP 1
SCOU 22 'ro_2' NSTO 3 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      ECRO COMP 2
SCOU 23 'vx_2' NSTO 3 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      VCVI COMP 1
DCOU 26 'pa_2' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.2199655E-3 NRAR 30 VARI 1
DCOU 27 'ra_2' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.2199655E-3 NRAR 30 VARI 2
DCOU 28 'va_2' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.2199655E-3 NRAR 30 VARI 5
RCOU 121 'p_2'  FICH 'blas03.pun' RENA 'p_2_03'
RCOU 122 'ro_2' FICH 'blas03.pun' RENA 'ro_2_03'
RCOU 123 'vx_2' FICH 'blas03.pun' RENA 'vx_2_03'
TRAC 21 26 121 AXES 1.0 'PRESS. [PA]' SYMB
COLO NOIR ROUG VERT
TRAC 22 27 122 AXES 1.0 'DENS. [KG/M3]' SYMB
COLO NOIR ROUG VERT
TRAC 23 28 123 AXES 1.0 'VELOC. [M/S]' SYMB
COLO NOIR ROUG VERT
*
SCOU 31 'p_3'  NSTO 4 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      ECRO COMP 1
SCOU 32 'ro_3' NSTO 4 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      ECRO COMP 2
SCOU 33 'vx_3' NSTO 4 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      VCVI COMP 1
DCOU 36 'pa_3' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.3060051E-3 NRAR 30 VARI 1
DCOU 37 'ra_3' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.3060051E-3 NRAR 30 VARI 2
DCOU 38 'va_3' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.3060051E-3 NRAR 30 VARI 5
RCOU 131 'p_3'  FICH 'blas03.pun' RENA 'p_3_03'
RCOU 132 'ro_3' FICH 'blas03.pun' RENA 'ro_3_03'
RCOU 133 'vx_3' FICH 'blas03.pun' RENA 'vx_3_03'
TRAC 31 36 131 AXES 1.0 'PRESS. [PA]' SYMB
COLO NOIR ROUG VERT
TRAC 32 37 132 AXES 1.0 'DENS. [KG/M3]' SYMB
COLO NOIR ROUG VERT
TRAC 33 38 133 AXES 1.0 'VELOC. [M/S]' SYMB
COLO NOIR ROUG VERT
*
SCOU 71 'p_7'  NSTO 8 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      ECRO COMP 1
SCOU 72 'ro_7' NSTO 8 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      ECRO COMP 2
SCOU 73 'vx_7' NSTO 8 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      VCVI COMP 1
DCOU 76 'pa_7' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
```

```
                    TIME 0.6E-3 NRAR 30 VARI 1
DCOU 77 'ra_7' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.6E-3 NRAR 30 VARI 2
DCOU 78 'va_7' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.6E-3 NRAR 30 VARI 5
RCOU 171 'p_7'  FICH 'blas03.pun' RENA 'p_7_03'
RCOU 172 'ro_7' FICH 'blas03.pun' RENA 'ro_7_03'
RCOU 173 'vx_7' FICH 'blas03.pun' RENA 'vx_7_03'
TRAC 71 76 171 AXES 1.0 'PRESS. [PA]' SYMB
COLO NOIR ROUG VERT
TRAC 72 77 172 AXES 1.0 'DENS. [KG/M3]' SYMB
COLO NOIR ROUG VERT
TRAC 73 78 173 AXES 1.0 'VELOC. [M/S]' SYMB
COLO NOIR ROUG VERT
*
!QUAL VCVI COMP 1 LECT ea   TERM REFE  3.50414E+0 TOLE 2.E-2
!     VCVI COMP 1 LECT eb   TERM REFE  2.95375E+2 TOLE 2.E-2
!     ECRO COMP 1 LECT ea   TERM REFE  9.86505E+5 TOLE 2.E-2
!     ECRO COMP 1 LECT eb   TERM REFE  2.81254E+5 TOLE 2.E-2
!     ECRO COMP 2 LECT ea   TERM REFE  9.90980E+0 TOLE 2.E-2
!     ECRO COMP 2 LECT eb   TERM REFE  1.92767E+0 TOLE 2.E-2
*===============================================================
SUIT
Post treatment (BMPs from alice file)
ECHO
RESU ALIC GARD PSCR
OPTI PRIN
SORT VISU NSTO 61
PLAY
CAME   1 EYE   5.00000E-01  5.00000E-03  3.00015E-01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   5.25000E+01
SCEN GEOM NAVI FREE
          LINE HEOU
     ISO  FILL FIEL VCVI SCAL USER PROG 20 PAS 20 280 TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1400 400 FICH BMP REND
SCEN GEOM NAVI FREE
          LINE HEOU
     ISO  FILL FIEL ECRO 2 SCAL USER PROG 1 PAS 0.6 8.8 TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1400 400 FICH BMP REND
ENDPLAY
*===============================================================
FIN
```

blas05.epx

```
BLAS05
ECHO
!CONV win
EULE DPLA
GEOM LIBR POIN 22 Q4VF 10 TERM
 0.0 0.0  0.1 0.0  0.2 0.0  0.3 0.0  0.4 0.0  0.5 0.0
          0.6 0.0  0.7 0.0  0.8 0.0  0.9 0.0  1.0 0.0
 0.0 0.1  0.1 0.1  0.2 0.1  0.3 0.1  0.4 0.1  0.5 0.1
          0.6 0.1  0.7 0.1  0.8 0.1  0.9 0.1  1.0 0.1
  1  2 13 12
  2  3 14 13
  3  4 15 14
  4  5 16 15
  5  6 17 16
  6  7 18 17
  7  8 19 18
  8  9 20 19
  9 10 21 20
 10 11 22 21
COMP GROU 3 'bar1' LECT 1 2 3 4 5 TERM
           'bar2' LECT 6 7 8 9 10 TERM
           'bar'  LECT bar1 bar2 TERM
     NGRO 1 'xaxo' LECT 1 PAS 1 11 TERM
     COUL ROSE LECT bar1 TERM
          TURQ LECT bar2 TERM
MATE GAZP RO 10 GAMM 1.5 PINI 1.E6 PREF 1.E5
          LECT bar1 TERM
     GAZP RO  1 GAMM 1.5 PINI 1.E5 PREF 1.E5
          LECT bar2 TERM
INIT BLAS 1
          POIN 0.5 0.05
          VELO 1200.0
          TO 0.0
          DMIN 0.25
          LECT bar TERM
ECRI COOR DEPL VITE ACCE FINT FEXT CONT ECRO VFCC FREQ 1
!    FICH ALIC TEMP FREQ 1
!         POIN LECT pa pmid pb TERM
!         ELEM LECT ea eb TERM
     FICH ALIC FREQ 1
OPTI NOTE STEP IO
 csta 0.5
 log 1
!VFCC FCON 1              ! OK
!VFCC FCON 2 VISC 0.75    ! OK
 VFCC FCON 3              ! OK
!VFCC FCON 4              ! OK
!VFCC FCON 5              ! OK
!VFCC FCON 6              ! OK
!VFCC FCON 7              ! OK
!VFCC FCON 8              ! OK
!VFCC FCON 9              ! OK
!VFCC FCON 10             ! OK
!VFCC FCON 11             ! OK
!VFCC FCON 12             ! OK
     dump
CALC TINI 0. TEND 0.60E-3 ! nmax 1
*===============================================================
SUIT
Post-treatment (space curves from alice file)
ECHO
RESU ALIC GARD PSCR
SORT GRAP
PERF 'blas05.pun'
AXTE 1.0 'Time [s]'
*
SCOU 21 'p_2'  NSTO 3 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      ECRO COMP 1
SCOU 22 'ro_2' NSTO 3 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      ECRO COMP 2
SCOU 23 'vx_2' NSTO 3 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      VCVI COMP 1
DCOU 26 'pa_2' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.2199655E-3 NRAR 30 VARI 1
DCOU 27 'ra_2' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.2199655E-3 NRAR 30 VARI 2
DCOU 28 'va_2' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.2199655E-3 NRAR 30 VARI 5
RCOU 121 'p_2'  FICH 'blas03.pun' RENA 'p_2_03'
RCOU 122 'ro_2' FICH 'blas03.pun' RENA 'ro_2_03'
RCOU 123 'vx_2' FICH 'blas03.pun' RENA 'vx_2_03'
TRAC 21 26 121 AXES 1.0 'PRESS. [PA]' SYMB
COLO NOIR ROUG VERT
TRAC 22 27 122 AXES 1.0 'DENS. [KG/M3]' SYMB
COLO NOIR ROUG VERT
TRAC 23 28 123 AXES 1.0 'VELOC. [M/S]' SYMB
COLO NOIR ROUG VERT
*
SCOU 31 'p_3'  NSTO 4 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      ECRO COMP 1
SCOU 32 'ro_3' NSTO 4 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      ECRO COMP 2
SCOU 33 'vx_3' NSTO 4 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      VCVI COMP 1
DCOU 36 'pa_3' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.3060051E-3 NRAR 30 VARI 1
DCOU 37 'ra_3' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.3060051E-3 NRAR 30 VARI 2
DCOU 38 'va_3' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.3060051E-3 NRAR 30 VARI 5
RCOU 131 'p_3'  FICH 'blas03.pun' RENA 'p_3_03'
RCOU 132 'ro_3' FICH 'blas03.pun' RENA 'ro_3_03'
RCOU 133 'vx_3' FICH 'blas03.pun' RENA 'vx_3_03'
TRAC 31 36 131 AXES 1.0 'PRESS. [PA]' SYMB
COLO NOIR ROUG VERT
TRAC 32 37 132 AXES 1.0 'DENS. [KG/M3]' SYMB
COLO NOIR ROUG VERT
TRAC 33 38 133 AXES 1.0 'VELOC. [M/S]' SYMB
COLO NOIR ROUG VERT
*
SCOU 71 'p_7'  NSTO 8 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      ECRO COMP 1
SCOU 72 'ro_7' NSTO 8 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      ECRO COMP 2
SCOU 73 'vx_7' NSTO 8 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      VCVI COMP 1
DCOU 76 'pa_7' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.6E-3 NRAR 30 VARI 1
DCOU 77 'ra_7' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.6E-3 NRAR 30 VARI 2
DCOU 78 'va_7' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.6E-3 NRAR 30 VARI 5
RCOU 171 'p_7'  FICH 'blas03.pun' RENA 'p_7_03'
RCOU 172 'ro_7' FICH 'blas03.pun' RENA 'ro_7_03'
RCOU 173 'vx_7' FICH 'blas03.pun' RENA 'vx_7_03'
TRAC 71 76 171 AXES 1.0 'PRESS. [PA]' SYMB
COLO NOIR ROUG VERT
TRAC 72 77 172 AXES 1.0 'DENS. [KG/M3]' SYMB
COLO NOIR ROUG VERT
TRAC 73 78 173 AXES 1.0 'VELOC. [M/S]' SYMB
COLO NOIR ROUG VERT
*
!QUAL VCVI COMP 1 LECT ea   TERM REFE  3.50414E+0 TOLE 2.E-2
!     VCVI COMP 1 LECT eb   TERM REFE  2.95375E+2 TOLE 2.E-2
!     ECRO COMP 1 LECT ea   TERM REFE  9.86505E+5 TOLE 2.E-2
!     ECRO COMP 1 LECT eb   TERM REFE  2.81254E+5 TOLE 2.E-2
!     ECRO COMP 2 LECT ea   TERM REFE  9.90980E+0 TOLE 2.E-2
!     ECRO COMP 2 LECT eb   TERM REFE  1.92767E+0 TOLE 2.E-2
*===============================================================
SUIT
Post treatment (BMPs from alice file)
ECHO
RESU ALIC GARD PSCR
OPTI PRIN
SORT VISU NSTO 61
PLAY
CAME   1 EYE   5.00000E-01  5.00000E-03  3.00015E-01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
```

```
        VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
        RIGH  1.00000E+00  0.00000E+00  0.00000E+00
        UP    0.00000E+00  1.00000E+00  0.00000E+00
        FOV   5.25000E+01
SCEN GEOM NAVI FREE
         LINE HEOU
     ISO  FILL FIEL VCVI SCAL USER PROG 20 PAS 20 280 TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1400 400 FICH BMP REND
SCEN GEOM NAVI FREE
         LINE HEOU
     ISO  FILL FIEL ECRO 2 SCAL USER PROG 1 PAS 0.6 8.8 TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1400 400 FICH BMP REND
ENDPLAY
*=============================================================
FIN
```

blas06.epx

```
BLAS06
ECHO
!CONV win
EULE DPLA
GEOM LIBR POIN 22 Q4VF 10 TERM
 0.0 0.0  0.1 0.0  0.2 0.0  0.3 0.0  0.4 0.0  0.5 0.0
          0.6 0.0  0.7 0.0  0.8 0.0  0.9 0.0  1.0 0.0
 0.0 0.1  0.1 0.1  0.2 0.1  0.3 0.1  0.4 0.1  0.5 0.1
          0.6 0.1  0.7 0.1  0.8 0.1  0.9 0.1  1.0 0.1
  1  2 13 12
  2  3 14 13
  3  4 15 14
  4  5 16 15
  5  6 17 16
  6  7 18 17
  7  8 19 18
  8  9 20 19
  9 10 21 20
 10 11 22 21
COMP GROU 3 'bar1' LECT 1 2 3 4 5 TERM
           'bar2' LECT 6 7 8 9 10 TERM
           'bar'  LECT bar1 bar2 TERM
     NGRO 1 'xaxo' LECT 1 PAS 1 11 TERM
     COUL ROSE LECT bar1 TERM
          TURQ LECT bar2 TERM
MATE GAZP RO 10 GAMM 1.5 PINI 1.E6 PREF 1.E5
          LECT bar1 TERM
     GAZP RO  1 GAMM 1.5 PINI 1.E5 PREF 1.E5
          LECT bar2 TERM
INIT BLAS 1
          POIN 0.5 0.05
          VELO 900.0
          TO 0.0
          DMIN 0.25
          LECT bar TERM
ECRI COOR DEPL VITE ACCE FINT FEXT CONT ECRO VFCC FREQ 1
!    FICH ALIC TEMP FREQ 1
!         POIN LECT pa pmid pb TERM
!         ELEM LECT ea eb TERM
     FICH ALIC FREQ 1
OPTI NOTE STEP IO
 csta 0.5
 log 1
!VFCC FCON 1              ! OK
!VFCC FCON 2 VISC 0.75    ! OK
 VFCC FCON 3              ! OK
!VFCC FCON 4              ! OK
!VFCC FCON 5              ! OK
!VFCC FCON 6              ! OK
!VFCC FCON 7              ! OK
!VFCC FCON 8              ! OK
!VFCC FCON 9              ! OK
!VFCC FCON 10             ! OK
!VFCC FCON 11             ! OK
!VFCC FCON 12             ! OK
      dump
CALC TINI 0. TEND 0.60E-3 ! nmax 1
*=============================================================
SUIT
Post-treatment (space curves from alice file)
ECHO
RESU ALIC GARD PSCR
SORT GRAP
PERF 'blas06.pun'
AXTE 1.0 'Time [s]'
*
SCOU 21 'p_2'  NSTO 3 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      ECRO COMP 1
SCOU 22 'ro_2' NSTO 3 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      ECRO COMP 2
SCOU 23 'vx_2' NSTO 3 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      VCVI COMP 1
DCOU 26 'pa_2' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.2199655E-3 NRAR 30 VARI 1
DCOU 27 'ra_2' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.2199655E-3 NRAR 30 VARI 2
DCOU 28 'va_2' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.2199655E-3 NRAR 30 VARI 5
RCOU 121 'p_2'  FICH 'blas03.pun' RENA 'p_2_03'
RCOU 122 'ro_2' FICH 'blas03.pun' RENA 'ro_2_03'
RCOU 123 'vx_2' FICH 'blas03.pun' RENA 'vx_2_03'
TRAC 21 26 121 AXES 1.0 'PRESS. [PA]' SYMB
COLO NOIR ROUG VERT
TRAC 22 27 122 AXES 1.0 'DENS. [KG/M3]' SYMB
COLO NOIR ROUG VERT
TRAC 23 28 123 AXES 1.0 'VELOC. [M/S]' SYMB
COLO NOIR ROUG VERT
*
SCOU 31 'p_3'  NSTO 4 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      ECRO COMP 1
SCOU 32 'ro_3' NSTO 4 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      ECRO COMP 2
SCOU 33 'vx_3' NSTO 4 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      VCVI COMP 1
DCOU 36 'pa_3' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.3060051E-3 NRAR 30 VARI 1
DCOU 37 'ra_3' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.3060051E-3 NRAR 30 VARI 2
DCOU 38 'va_3' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.3060051E-3 NRAR 30 VARI 5
RCOU 131 'p_3'  FICH 'blas03.pun' RENA 'p_3_03'
RCOU 132 'ro_3' FICH 'blas03.pun' RENA 'ro_3_03'
RCOU 133 'vx_3' FICH 'blas03.pun' RENA 'vx_3_03'
TRAC 31 36 131 AXES 1.0 'PRESS. [PA]' SYMB
COLO NOIR ROUG VERT
TRAC 32 37 132 AXES 1.0 'DENS. [KG/M3]' SYMB
COLO NOIR ROUG VERT
TRAC 33 38 133 AXES 1.0 'VELOC. [M/S]' SYMB
COLO NOIR ROUG VERT
*
SCOU 71 'p_7'  NSTO 8 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      ECRO COMP 1
SCOU 72 'ro_7' NSTO 8 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      ECRO COMP 2
SCOU 73 'vx_7' NSTO 8 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      VCVI COMP 1
DCOU 76 'pa_7' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.6E-3 NRAR 30 VARI 1
DCOU 77 'ra_7' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.6E-3 NRAR 30 VARI 2
DCOU 78 'va_7' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.6E-3 NRAR 30 VARI 5
RCOU 171 'p_7'  FICH 'blas03.pun' RENA 'p_7_03'
RCOU 172 'ro_7' FICH 'blas03.pun' RENA 'ro_7_03'
RCOU 173 'vx_7' FICH 'blas03.pun' RENA 'vx_7_03'
TRAC 71 76 171 AXES 1.0 'PRESS. [PA]' SYMB
COLO NOIR ROUG VERT
TRAC 72 77 172 AXES 1.0 'DENS. [KG/M3]' SYMB
COLO NOIR ROUG VERT
TRAC 73 78 173 AXES 1.0 'VELOC. [M/S]' SYMB
COLO NOIR ROUG VERT
*
!QUAL VCVI COMP 1 LECT ea   TERM REFE  3.50414E+0 TOLE 2.E-2
!     VCVI COMP 1 LECT eb   TERM REFE  2.95375E+2 TOLE 2.E-2
!     ECRO COMP 1 LECT ea   TERM REFE  9.86505E+5 TOLE 2.E-2
!     ECRO COMP 1 LECT eb   TERM REFE  2.81254E+5 TOLE 2.E-2
!     ECRO COMP 2 LECT ea   TERM REFE  9.90980E+0 TOLE 2.E-2
!     ECRO COMP 2 LECT eb   TERM REFE  1.92767E+0 TOLE 2.E-2
*=============================================================
SUIT
Post treatment (BMPs from alice file)
ECHO
RESU ALIC GARD PSCR
OPTI PRIN
SORT VISU NSTO 61
PLAY
CAME   1 EYE   5.00000E-01  5.00000E-03  3.00015E-01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   5.25000E+01
SCEN GEOM NAVI FREE
         LINE HEOU
     ISO  FILL FIEL VCVI SCAL USER PROG 20 PAS 20 280 TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1400 400 FICH BMP REND
SCEN GEOM NAVI FREE
         LINE HEOU
     ISO  FILL FIEL ECRO 2 SCAL USER PROG 1 PAS 0.6 8.8 TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1400 400 FICH BMP REND
ENDPLAY
*=============================================================
FIN
```

blas07.dgibi

```
opti echo 0;
opti donn 'pxordpoi.proc';
opti echo 1;
opti dime 2 elem qua4;
opti sauv form 'blas07.msh';
opti trac psc ftra 'blas07_mesh.ps';
p0 = 0 0;
```

```
p0p = p0 plus (0 0.00125);
pmid = 0.5 0;
p1 = 1 0;
p1p = p1 plus (0 0.00125);
pa = 0.25 0;
pb = 0.75 0;
tol = 1.E-5;
n = 800;
n2 = n / 2;
n4 = n2 / 2;
c11 = p0 d n4 pa;
c12 = pa d n4 pmid;
c1 = c11 et c12;
c21 = pmid d n4 pb;
c22 = pb d n4 p1;
c2 = c21 et c22;
bar11 = c11 tran 1 (0 0.00125);
bar12 = c12 tran 1 (0 0.00125);
bar1 = bar11 et bar12;
bar21 = c21 tran 1 (0 0.00125);
bar22 = c22 tran 1 (0 0.00125);
bar2 = bar21 et bar22;
bar = bar1 et bar2;
elim tol (bar et p0p et p1p et pa et pb);
ea = bar12 elem cont pa;
eb = bar21 elem cont pb;
xax = chan 'POI1' (c1 et c2);
xaxo = pxordpoi xax p0;
mesh = bar et ea et eb et xaxo;
tass mesh;
sauv form mesh;
trac qual mesh;
trac ((cont mesh) et ea et eb);
fin;
```

blas07.epx

```
BLAS07
ECHO
!CONV win
CAST mesh
EULE DPLA
GEOM Q4VF bar TERM
COMP COUL ROSE LECT bar1 TERM
          TURQ LECT bar2 TERM
MATE GAZP RO 10 GAMM 1.5 PINI 1.E6 PREF 1.E5
          LECT bar1 TERM
     GAZP RO  1 GAMM 1.5 PINI 1.E5 PREF 1.E5
          LECT bar2 TERM
INIT BLAS 1
          POIN 0.5 6.25E-4
          VELO 1200.0
          TO 0.0
          DMIN 2.5E-3
          LECT bar TERM
ECRI COOR DEPL VITE ACCE FINT FEXT CONT ECRO TFRE 0.3E-3
     FICH ALIC TEMP FREQ 1
          POIN LECT pa pmid pb TERM
          ELEM LECT ea eb TERM
     FICH ALIC TFRE 1.0E-4
OPTI NOTE STEP IO
 csta 0.5
 log 1
!VFCC FCON 1              ! OK
!VFCC FCON 2 VISC 0.75    ! OK
 VFCC FCON 3              ! OK
!VFCC FCON 4              ! OK
!VFCC FCON 5              ! OK
!VFCC FCON 6              ! OK
!VFCC FCON 7              ! OK
!VFCC FCON 8              ! OK
!VFCC FCON 9              ! OK
!VFCC FCON 10             ! OK
!VFCC FCON 11             ! OK
!VFCC FCON 12             ! OK
CALC TINI 0. TEND 0.60E-3
*=============================================================
SUIT
Post-treatment (space curves from alice file)
ECHO
RESU ALIC GARD PSCR
SORT GRAP
PERF 'blas07.pun'
AXTE 1.0 'Time [s]'
SCOU 71 'p_7'  NSTO 7 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      ECRO COMP 1
SCOU 72 'ro_7' NSTO 7 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      ECRO COMP 2
SCOU 73 'vx_7' NSTO 7 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      VCVI COMP 1
DCOU 76 'pa_7' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.6E-3 NRAR 30 VARI 1
DCOU 77 'ra_7' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.6E-3 NRAR 30 VARI 2
DCOU 78 'va_7' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.6E-3 NRAR 30 VARI 5
RCOU 171 'p_7'  FICH 'blas01.pun' RENA 'p_7_01'
RCOU 172 'ro_7' FICH 'blas01.pun' RENA 'ro_7_03'
RCOU 173 'vx_7' FICH 'blas01.pun' RENA 'vx_7_03'
TRAC 71 76 171 AXES 1.0 'PRESS. [PA]'
COLO NOIR ROUG VERT
TRAC 72 77 172 AXES 1.0 'DENS. [KG/M3]'
COLO NOIR ROUG VERT
TRAC 73 78 173 AXES 1.0 'VELOC. [M/S]'
COLO NOIR ROUG VERT
*
QUAL VCVI COMP 1 LECT ea   TERM REFE  3.45909E+0 TOLE 2.E-2
     VCVI COMP 1 LECT eb   TERM REFE  2.95372E+2 TOLE 2.E-2
     ECRO COMP 1 LECT ea   TERM REFE  9.86677E+5 TOLE 2.E-2
     ECRO COMP 1 LECT eb   TERM REFE  2.81256E+5 TOLE 2.E-2
     ECRO COMP 2 LECT ea   TERM REFE  9.91096E+0 TOLE 2.E-2
     ECRO COMP 2 LECT eb   TERM REFE  1.92768E+0 TOLE 2.E-2
*=============================================================
SUIT
Post treatment (BMPs from alice file)
ECHO
RESU ALIC GARD PSCR
OPTI PRIN
SORT VISU NSTO 61
PLAY
CAME   1 EYE   5.00000E-01  5.00000E-03  3.00015E-01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   5.25000E+01
SCEN GEOM NAVI FREE
          LINE HEOU
     ISO  FILL FIEL VCVI SCAL USER PROG 20 PAS 20 280 TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1400 400 FICH BMP REND
SCEN GEOM NAVI FREE
          LINE HEOU
     ISO  FILL FIEL ECRO 2 SCAL USER PROG 1 PAS 0.6 8.8 TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1400 400 FICH BMP REND
ENDPLAY
*=============================================================
FIN
```

blas11.dgibi

```
opti echo 1;
opti dime 2 elem qua4;
opti sauv form 'blas11.msh';
opti trac psc ftra 'blas11_mesh.ps';
p0 = 0 0;
p1 = -0.5 -0.5;
p2 =  0.5 -0.5;
p3 =  0.5  0.5;
p4 = -0.5  0.5;
c1 = p1 d 80 p2;
flui = c1 tran 80 (0 1);
tol = 0.01;
elim tol (flui et p0 et p3 et p4);
trac cach flui;
mesh = flui;
sauv form mesh;
trac mesh;
fin;
```

blas11.epx

```
BLAS11
ECHO
!CONV WIN
CAST mesh
DPLA EULE
GEOM Q4VF flui TERM
COMP GROU 7 'e1' LECT flui TERM COND NEAR NODE LECT p1 TERM
            'e2' LECT flui TERM COND NEAR NODE LECT p2 TERM
            'e3' LECT flui TERM COND NEAR NODE LECT p3 TERM
            'e4' LECT flui TERM COND NEAR NODE LECT p4 TERM
            'e0' LECT flui TERM COND NEAR NODE LECT p0 TERM
            'bomb' LECT flui TERM COND SPHE XC 0 YC 0 R 0.05
            'ew' LECT flui TERM COND NEAR POIN -0.5 0.0
     COUL TURQ LECT flui DIFF bomb TERM
          ROUG LECT bomb TERM
MATE GAZP RO 1.0 GAMM 1.4 PINI 1.E5 PREF 1.E5
          LECT flui TERM
     BUBB MASS 0.04
          LECT bomb TERM
ECRI COOR DEPL VITE ACCE ECRO TFRE 0.6E-3
     NOPO
     ELEM LECT e1 e2 e3 e4 e0 TERM
     FICH SPLI ALIC TFRE 0.1E-3
     FICH ALIC TEMP FREQ 1
          ELEM LECT e1 e2 e3 e4 e0 ew TERM
OPTI PAS AUTO NOTE STEP LIBR
 CSTA 0.5
 LOG 1
CALC TINI 0. TEND 0.8E-3
SUIT
BLAS11A
ECHO
RESU ALIC TEMP GARD PSCR
OPTI PRIN
SORT GRAP
```

```
AXTE 1.0 'Time [s]'
COUR 1 'p_1' ECRO COMP 1 ELEM LECT e1 TERM
COUR 2 'p_2' ECRO COMP 1 ELEM LECT e2 TERM
COUR 3 'p_3' ECRO COMP 1 ELEM LECT e3 TERM
COUR 4 'p_4' ECRO COMP 1 ELEM LECT e4 TERM
COUR 5 'p_w' ECRO COMP 1 ELEM LECT ew TERM
COUR 10 'p_0' ECRO COMP 1 ELEM LECT e0 TERM
TRAC 1 2 3 4 5 AXES 1.0 'PRES. [PA]'
LIST 1 2 3 4 5 AXES 1.0 'PRES. [PA]'
TRAC 10 AXES 1.0 'PRES. [PA]'
LIST 10 AXES 1.0 'PRES. [PA]'
QUAL COUR  1 REFE  1.62235E+06 TOLE 1.E-3
     COUR  2 REFE  1.62235E+06 TOLE 1.E-3
     COUR  3 REFE  1.62235E+06 TOLE 1.E-3
     COUR  4 REFE  1.62235E+06 TOLE 1.E-3
     COUR 10 REFE  9.67298E+04 TOLE 1.E-3
SUIT
BLAS11Z
ECHO
 CONV WIN
RESU SPLI ALIC GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
PLAY
CAME   1 EYE   0.00000E+00  0.00000E+00  3.53553E+00
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  0.00000E+00  0.00000E+00  0.00000E+00
!RSPHERE:  7.07107E-01
!RADIUS :  3.53553E+00
!ASPECT :  1.00000E+00
!NEAR   :  2.75772E+00
!FAR    :  4.94975E+00
SCEN GEOM NAVI FREE
          LINE HEOU SFRE
          REFE FRAM
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.E5 PAS 0.5E5 7.5E5
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 9 FPS 5 KFRE 5 COMP -1
                  OBJE LECT flui TERM REND
FREQ 1
GOTR LOOP 7 OFFS FICH AVI CONT NOCL
                  OBJE LECT flui TERM REND
GO
TRAC OFFS FICH AVI CONT
                  OBJE LECT flui TERM REND
ENDPLAY
SUIT
BLAS11Y
ECHO
 CONV WIN
RESU SPLI ALIC GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
PLAY
CAME   1 EYE   0.00000E+00  0.00000E+00  3.53553E+00
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  0.00000E+00  0.00000E+00  0.00000E+00
!RSPHERE:  7.07107E-01
!RADIUS :  3.53553E+00
!ASPECT :  1.00000E+00
!NEAR   :  2.75772E+00
!FAR    :  4.94975E+00
SCEN GEOM NAVI FREE
        ! LINE HEOU SFRE
          REFE FRAM
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.E5 PAS 0.5E5 7.5E5
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 9 FPS 5 KFRE 5 COMP -1
                  OBJE LECT flui TERM REND
FREQ 1
GOTR LOOP 7 OFFS FICH AVI CONT NOCL
                  OBJE LECT flui TERM REND
GO
TRAC OFFS FICH AVI CONT
                  OBJE LECT flui TERM REND
ENDPLAY
FIN
```

blas12.dgibi

```
opti echo 1;
opti dime 2 elem qua4;
opti sauv form 'blas12.msh';
opti trac psc ftra 'blas12_mesh.ps';
p0 = 0 0;
p1 = -0.5 -0.5;
p2 =  0.5 -0.5;
p3 =  0.5  0.5;
p4 = -0.5  0.5;
c1 = p1 d 80 p2;
flui = c1 tran 80 (0 1);
tol = 0.01;
elim tol (flui et p0 et p3 et p4);
trac cach flui;
mesh = flui;
sauv form mesh;
trac mesh;
fin;
```

blas12.epx

```
BLAS12
ECHO
!CONV WIN
CAST mesh
DPLA EULE
GEOM Q4VF flui TERM
COMP GROU 7 'e1' LECT flui TERM COND NEAR NODE LECT p1 TERM
            'e2' LECT flui TERM COND NEAR NODE LECT p2 TERM
            'e3' LECT flui TERM COND NEAR NODE LECT p3 TERM
            'e4' LECT flui TERM COND NEAR NODE LECT p4 TERM
            'e0' LECT flui TERM COND NEAR NODE LECT p0 TERM
            'bomb' LECT flui TERM COND SPHE XC 0 YC 0 R 0.05
            'ew' LECT flui TERM COND NEAR POIN -0.5 0.0
     COUL TURQ LECT flui DIFF bomb TERM
          ROUG LECT bomb TERM
MATE GAZP RO 1.0 GAMM 1.4 PINI 1.E5 PREF 1.E5
          LECT flui TERM
     BUBB MASS 0.04
          LECT bomb TERM
INIT BLAS 1
          POIN 0.0 0.0
          VELO 1667.0
          T0 0.0
          DMIN 0.07
          LECT flui TERM
ECRI COOR DEPL VITE ACCE ECRO TFRE 0.6E-3
     NOPO
     ELEM LECT e1 e2 e3 e4 e0 TERM
     FICH SPLI ALIC TFRE 0.1E-3
     FICH ALIC TEMP FREQ 1
          ELEM LECT e1 e2 e3 e4 e0 ew TERM
OPTI PAS AUTO NOTE STEP LIBR
 CSTA 0.5
 LOG 1
CALC TINI 0. TEND 0.8E-3
SUIT
BLAS12A
ECHO
RESU ALIC TEMP GARD PSCR
OPTI PRIN
SORT GRAP
AXTE 1.0 'Time [s]'
COUR 1 'p_1' ECRO COMP 1 ELEM LECT e1 TERM
COUR 2 'p_2' ECRO COMP 1 ELEM LECT e2 TERM
COUR 3 'p_3' ECRO COMP 1 ELEM LECT e3 TERM
COUR 4 'p_4' ECRO COMP 1 ELEM LECT e4 TERM
COUR 5 'p_w' ECRO COMP 1 ELEM LECT ew TERM
COUR 10 'p_0' ECRO COMP 1 ELEM LECT e0 TERM
RCOU 11 'p_1' FICH 'blas11.pun' RENA 'p_1_11'
RCOU 12 'p_2' FICH 'blas11.pun' RENA 'p_2_11'
RCOU 13 'p_3' FICH 'blas11.pun' RENA 'p_3_11'
RCOU 14 'p_4' FICH 'blas11.pun' RENA 'p_4_11'
RCOU 15 'p_w' FICH 'blas11.pun' RENA 'p_w_11'
RCOU 20 'p_0' FICH 'blas11.pun' RENA 'p_0_11'
TRAC 1 2 3 4 5 11 12 13 14 15 AXES 1.0 'PRES. [PA]'
COLO NOIR NOIR NOIR NOIR NOIR ROUG ROUG ROUG ROUG ROUG
LIST 1 2 3 4 5 AXES 1.0 'PRES. [PA]'
TRAC 10 20 AXES 1.0 'PRES. [PA]'
COLO NOIR ROUG
LIST 10 AXES 1.0 'PRES. [PA]'
QUAL COUR  1 REFE  1.62235E+06 TOLE 1.E-3
     COUR  2 REFE  1.62235E+06 TOLE 1.E-3
     COUR  3 REFE  1.62235E+06 TOLE 1.E-3
     COUR  4 REFE  1.62235E+06 TOLE 1.E-3
     COUR 10 REFE  9.67298E+04 TOLE 1.E-3
SUIT
BLAS12Z
ECHO
 CONV WIN
RESU SPLI ALIC GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
PLAY
CAME   1 EYE   0.00000E+00  0.00000E+00  3.53553E+00
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  0.00000E+00  0.00000E+00  0.00000E+00
!RSPHERE:  7.07107E-01
!RADIUS :  3.53553E+00
!ASPECT :  1.00000E+00
!NEAR   :  2.75772E+00
!FAR    :  4.94975E+00
SCEN GEOM NAVI FREE
          LINE HEOU SFRE
          REFE FRAM
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.E5 PAS 0.5E5 7.5E5
```

```
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 9 FPS 5 KFRE 5 COMP -1
                  OBJE LECT flui TERM REND
FREQ 1
GOTR LOOP 7 OFFS FICH AVI CONT NOCL
                  OBJE LECT flui TERM REND
GO
TRAC OFFS FICH AVI CONT
                  OBJE LECT flui TERM REND
ENDPLAY
SUIT
BLAS12Y
ECHO
 CONV WIN
RESU SPLI ALIC GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
PLAY
CAME   1 EYE   0.00000E+00  0.00000E+00  3.53553E+00
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  0.00000E+00  0.00000E+00  0.00000E+00
!RSPHERE:  7.07107E-01
!RADIUS :  3.53553E+00
!ASPECT :  1.00000E+00
!NEAR   :  2.75772E+00
!FAR    :  4.94975E+00
SCEN GEOM NAVI FREE
        ! LINE HEOU SFRE
          REFE FRAM
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.E5 PAS 0.5E5 7.5E5
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 9 FPS 5 KFRE 5 COMP -1
                  OBJE LECT flui TERM REND
FREQ 1
GOTR LOOP 7 OFFS FICH AVI CONT NOCL
                  OBJE LECT flui TERM REND
GO
TRAC OFFS FICH AVI CONT
                  OBJE LECT flui TERM REND
ENDPLAY
FIN
```

blas13.dgibi

```
opti echo 1;
opti dime 2 elem qua4;
opti sauv form 'blas13.msh';
opti trac psc ftra 'blas13_mesh.ps';
p0 = 0 0;
p1 = -0.5 -0.5;
p2 =  0.5 -0.5;
p3 =  0.5  0.5;
p4 = -0.5  0.5;
c1 = p1 d 80 p2;
flui = c1 tran 80 (0 1);
tol = 0.01;
elim tol (flui et p0 et p3 et p4);
trac cach flui;
mesh = flui;
sauv form mesh;
trac mesh;
fin;
```

blas13.epx

```
BLAS13
ECHO
!CONV WIN
CAST mesh
DPLA EULE
GEOM Q4VF flui TERM
COMP GROU 7 'e1' LECT flui TERM COND NEAR NODE LECT p1 TERM
           'e2' LECT flui TERM COND NEAR NODE LECT p2 TERM
           'e3' LECT flui TERM COND NEAR NODE LECT p3 TERM
           'e4' LECT flui TERM COND NEAR NODE LECT p4 TERM
           'e0' LECT flui TERM COND NEAR NODE LECT p0 TERM
           'bomb' LECT flui TERM COND SPHE XC 0 YC 0 R 0.05
           'ew' LECT flui TERM COND NEAR POIN -0.5 0.0
     COUL TURQ LECT flui DIFF bomb TERM
          ROUG LECT bomb TERM
MATE GAZP RO 1.0 GAMM 1.4 PINI 1.E5 PREF 1.E5
          LECT flui TERM
     BUBB MASS 0.04
          LECT bomb TERM
INIT BLAS 1
          POIN 0.0 0.0
          VELO 3000.0
          TO 0.0
          DMIN 0.07
          LECT flui TERM
ECRI COOR DEPL VITE ACCE ECRO TFRE 0.6E-3
     NOPO
     ELEM LECT e1 e2 e3 e4 e0 TERM
     FICH SPLI ALIC TFRE 0.1E-3
     FICH ALIC TEMP FREQ 1
          ELEM LECT e1 e2 e3 e4 e0 ew TERM
OPTI PAS AUTO NOTE STEP LIBR
 CSTA 0.5
 LOG 1
CALC TINI 0. TEND 0.8E-3
SUIT
BLAS13A
ECHO
RESU ALIC TEMP GARD PSCR
OPTI PRIN
SORT GRAP
AXTE 1.0 'Time [s]'
COUR 1 'p_1' ECRO COMP 1 ELEM LECT e1 TERM
COUR 2 'p_2' ECRO COMP 1 ELEM LECT e2 TERM
COUR 3 'p_3' ECRO COMP 1 ELEM LECT e3 TERM
COUR 4 'p_4' ECRO COMP 1 ELEM LECT e4 TERM
COUR 5 'p_w' ECRO COMP 1 ELEM LECT ew TERM
COUR 10 'p_0' ECRO COMP 1 ELEM LECT e0 TERM
RCOU 11 'p_1' FICH 'blas11.pun' RENA 'p_1_11'
RCOU 12 'p_2' FICH 'blas11.pun' RENA 'p_2_11'
RCOU 13 'p_3' FICH 'blas11.pun' RENA 'p_3_11'
RCOU 14 'p_4' FICH 'blas11.pun' RENA 'p_4_11'
RCOU 15 'p_w' FICH 'blas11.pun' RENA 'p_w_11'
RCOU 20 'p_0' FICH 'blas11.pun' RENA 'p_0_11'
TRAC 1 2 3 4 5 11 12 13 14 15 AXES 1.0 'PRES. [PA]'
COLO NOIR NOIR NOIR NOIR NOIR ROUG ROUG ROUG ROUG ROUG
LIST 1 2 3 4 5 AXES 1.0 'PRES. [PA]'
TRAC 10 20 AXES 1.0 'PRES. [PA]'
COLO NOIR ROUG
LIST 10 AXES 1.0 'PRES. [PA]'
QUAL COUR  1 REFE  1.62235E+06 TOLE 1.E-3
     COUR  2 REFE  1.62235E+06 TOLE 1.E-3
     COUR  3 REFE  1.62235E+06 TOLE 1.E-3
     COUR  4 REFE  1.62235E+06 TOLE 1.E-3
     COUR 10 REFE  9.67298E+04 TOLE 1.E-3
SUIT
BLAS13Z
ECHO
 CONV WIN
RESU SPLI ALIC GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
PLAY
CAME   1 EYE   0.00000E+00  0.00000E+00  3.53553E+00
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  0.00000E+00  0.00000E+00  0.00000E+00
!RSPHERE:  7.07107E-01
!RADIUS :  3.53553E+00
!ASPECT :  1.00000E+00
!NEAR   :  2.75772E+00
!FAR    :  4.94975E+00
SCEN GEOM NAVI FREE
          LINE HEOU SFRE
          REFE FRAM
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.E5 PAS 0.5E5 7.5E5
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 9 FPS 5 KFRE 5 COMP -1
                  OBJE LECT flui TERM REND
FREQ 1
GOTR LOOP 7 OFFS FICH AVI CONT NOCL
                  OBJE LECT flui TERM REND
GO
TRAC OFFS FICH AVI CONT
                  OBJE LECT flui TERM REND
ENDPLAY
SUIT
BLAS13Y
ECHO
 CONV WIN
RESU SPLI ALIC GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
PLAY
CAME   1 EYE   0.00000E+00  0.00000E+00  3.53553E+00
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  0.00000E+00  0.00000E+00  0.00000E+00
!RSPHERE:  7.07107E-01
!RADIUS :  3.53553E+00
!ASPECT :  1.00000E+00
!NEAR   :  2.75772E+00
!FAR    :  4.94975E+00
SCEN GEOM NAVI FREE
        ! LINE HEOU SFRE
          REFE FRAM
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.E5 PAS 0.5E5 7.5E5
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 9 FPS 5 KFRE 5 COMP -1
                  OBJE LECT flui TERM REND
FREQ 1
GOTR LOOP 7 OFFS FICH AVI CONT NOCL
                  OBJE LECT flui TERM REND
```

```
GO
TRAC OFFS FICH AVI CONT
                  OBJE LECT flui TERM REND
ENDPLAY
FIN
```

blas14.dgibi

```
opti echo 1;
opti dime 2 elem qua4;
opti sauv form 'blas14.msh';
opti trac psc ftra 'blas14_mesh.ps';
p0 = 0 0;
p1 = -0.5 -0.5;
p2 =  0.5 -0.5;
p3 =  0.5  0.5;
p4 = -0.5  0.5;
c1 = p1 d 80 p2;
flui = c1 tran 80 (0 1);
tol = 0.01;
elim tol (flui et p0 et p3 et p4);
trac cach flui;
mesh = flui;
sauv form mesh;
trac mesh;
fin;
```

blas14.epx

```
BLAS14
ECHO
!CONV WIN
CAST mesh
DPLA EULE
GEOM Q4VF flui TERM
COMP GROU 7 'e1' LECT flui TERM COND NEAR NODE LECT p1 TERM
           'e2' LECT flui TERM COND NEAR NODE LECT p2 TERM
           'e3' LECT flui TERM COND NEAR NODE LECT p3 TERM
           'e4' LECT flui TERM COND NEAR NODE LECT p4 TERM
           'e0' LECT flui TERM COND NEAR NODE LECT p0 TERM
           'bomb' LECT flui TERM COND SPHE XC 0 YC 0 R 0.05
           'ew' LECT flui TERM COND NEAR POIN -0.5 0.0
     COUL TURQ LECT flui DIFF bomb TERM
          ROUG LECT bomb TERM
MATE GAZP RO 1.0 GAMM 1.4 PINI 1.E5 PREF 1.E5
          LECT flui TERM
     BUBB MASS 0.04
          LECT bomb TERM
ECRI COOR DEPL VITE ACCE ECRO TFRE 0.6E-3
     NOPO
     ELEM LECT e1 e2 e3 e4 e0 TERM
     FICH SPLI ALIC TFRE 0.1E-3
     FICH ALIC TEMP FREQ 1
          ELEM LECT e1 e2 e3 e4 e0 ew TERM
OPTI PAS AUTO NOTE STEP LIBR
 CSTA 0.5
 LOG 1
 VFCC FCON 3
CALC TINI 0. TEND 0.8E-3
SUIT
BLAS14A
ECHO
RESU ALIC TEMP GARD PSCR
OPTI PRIN
SORT GRAP
AXTE 1.0 'Time [s]'
COUR 1 'p_1' ECRO COMP 1 ELEM LECT e1 TERM
COUR 2 'p_2' ECRO COMP 1 ELEM LECT e2 TERM
COUR 3 'p_3' ECRO COMP 1 ELEM LECT e3 TERM
COUR 4 'p_4' ECRO COMP 1 ELEM LECT e4 TERM
COUR 5 'p_w' ECRO COMP 1 ELEM LECT ew TERM
COUR 10 'p_0' ECRO COMP 1 ELEM LECT e0 TERM
TRAC 1 2 3 4 5 AXES 1.0 'PRES. [PA]'
LIST 1 2 3 4 5 AXES 1.0 'PRES. [PA]'
TRAC 10 AXES 1.0 'PRES. [PA]'
LIST 10 AXES 1.0 'PRES. [PA]'
QUAL COUR  1 REFE  1.62235E+06 TOLE 1.E-3
     COUR  2 REFE  1.62235E+06 TOLE 1.E-3
     COUR  3 REFE  1.62235E+06 TOLE 1.E-3
     COUR  4 REFE  1.62235E+06 TOLE 1.E-3
     COUR 10 REFE  9.67298E+04 TOLE 1.E-3
SUIT
BLAS14Z
ECHO
 CONV WIN
RESU SPLI ALIC GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
PLAY
CAME   1 EYE   0.00000E+00  0.00000E+00  3.53553E+00
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  0.00000E+00  0.00000E+00  0.00000E+00
!RSPHERE:  7.07107E-01
!RADIUS :  3.53553E+00
!ASPECT :  1.00000E+00
!NEAR   :  2.75772E+00
!FAR    :  4.94975E+00
SCEN GEOM NAVI FREE
          LINE HEOU SFRE
          REFE FRAM
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.E5 PAS 0.5E5 7.5E5
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 9 FPS 5 KFRE 5 COMP -1
                  OBJE LECT flui TERM REND
FREQ 1
GOTR LOOP 7 OFFS FICH AVI CONT NOCL
                  OBJE LECT flui TERM REND
GO
TRAC OFFS FICH AVI CONT
                  OBJE LECT flui TERM REND
ENDPLAY
SUIT
BLAS14Y
ECHO
 CONV WIN
RESU SPLI ALIC GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
PLAY
CAME   1 EYE   0.00000E+00  0.00000E+00  3.53553E+00
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  0.00000E+00  0.00000E+00  0.00000E+00
!RSPHERE:  7.07107E-01
!RADIUS :  3.53553E+00
!ASPECT :  1.00000E+00
!NEAR   :  2.75772E+00
!FAR    :  4.94975E+00
SCEN GEOM NAVI FREE
         ! LINE HEOU SFRE
           REFE FRAM
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.E5 PAS 0.5E5 7.5E5
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 9 FPS 5 KFRE 5 COMP -1
                  OBJE LECT flui TERM REND
FREQ 1
GOTR LOOP 7 OFFS FICH AVI CONT NOCL
                  OBJE LECT flui TERM REND
GO
TRAC OFFS FICH AVI CONT
                  OBJE LECT flui TERM REND
ENDPLAY
FIN
```

blas15.dgibi

```
opti echo 1;
opti dime 2 elem qua4;
opti sauv form 'blas15.msh';
opti trac psc ftra 'blas15_mesh.ps';
p0 = 0 0;
p1 = -0.5 -0.5;
p2 =  0.5 -0.5;
p3 =  0.5  0.5;
p4 = -0.5  0.5;
c1 = p1 d 80 p2;
flui = c1 tran 80 (0 1);
tol = 0.01;
elim tol (flui et p0 et p3 et p4);
trac cach flui;
mesh = flui;
sauv form mesh;
trac mesh;
fin;
```

blas15.epx

```
BLAS15
ECHO
!CONV WIN
CAST mesh
DPLA EULE
GEOM Q4VF flui TERM
COMP GROU 7 'e1' LECT flui TERM COND NEAR NODE LECT p1 TERM
           'e2' LECT flui TERM COND NEAR NODE LECT p2 TERM
           'e3' LECT flui TERM COND NEAR NODE LECT p3 TERM
           'e4' LECT flui TERM COND NEAR NODE LECT p4 TERM
           'e0' LECT flui TERM COND NEAR NODE LECT p0 TERM
           'bomb' LECT flui TERM COND SPHE XC 0 YC 0 R 0.05
           'ew' LECT flui TERM COND NEAR POIN -0.5 0.0
     COUL TURQ LECT flui DIFF bomb TERM
          ROUG LECT bomb TERM
MATE GAZP RO 1.0 GAMM 1.4 PINI 1.E5 PREF 1.E5
          LECT flui TERM
     BUBB MASS 0.04
          LECT bomb TERM
INIT BLAS 1
          POIN 0.0 0.0
          VELO 1667.0
          T0 0.0
          DMIN 0.07
          LECT flui TERM
```

```
ECRI COOR DEPL VITE ACCE ECRO TFRE 0.6E-3
     NOPO
     ELEM LECT e1 e2 e3 e4 e0 TERM
     FICH SPLI ALIC TFRE 0.1E-3
     FICH ALIC TEMP FREQ 1
          ELEM LECT e1 e2 e3 e4 e0 ew TERM
OPTI PAS AUTO NOTE STEP LIBR
 CSTA 0.5
 LOG 1
 VFCC FCON 3
CALC TINI 0. TEND 0.8E-3
SUIT
BLAS15A
ECHO
RESU ALIC TEMP GARD PSCR
OPTI PRIN
SORT GRAP
AXTE 1.0 'Time [s]'
COUR 1 'p_1' ECRO COMP 1 ELEM LECT e1 TERM
COUR 2 'p_2' ECRO COMP 1 ELEM LECT e2 TERM
COUR 3 'p_3' ECRO COMP 1 ELEM LECT e3 TERM
COUR 4 'p_4' ECRO COMP 1 ELEM LECT e4 TERM
COUR 5 'p_w' ECRO COMP 1 ELEM LECT ew TERM
COUR 10 'p_0' ECRO COMP 1 ELEM LECT e0 TERM
RCOU 11 'p_1' FICH 'blas14.pun' RENA 'p_1_14'
RCOU 12 'p_2' FICH 'blas14.pun' RENA 'p_2_14'
RCOU 13 'p_3' FICH 'blas14.pun' RENA 'p_3_14'
RCOU 14 'p_4' FICH 'blas14.pun' RENA 'p_4_14'
RCOU 15 'p_w' FICH 'blas14.pun' RENA 'p_w_14'
RCOU 20 'p_0' FICH 'blas14.pun' RENA 'p_0_14'
TRAC 1 2 3 4 5 11 12 13 14 15 AXES 1.0 'PRES. [PA]'
COLO NOIR NOIR NOIR NOIR NOIR ROUG ROUG ROUG ROUG ROUG
LIST 1 2 3 4 5 AXES 1.0 'PRES. [PA]'
TRAC 10 20 AXES 1.0 'PRES. [PA]'
COLO NOIR ROUG
LIST 10 AXES 1.0 'PRES. [PA]'
QUAL COUR  1 REFE  1.62235E+06 TOLE 1.E-3
     COUR  2 REFE  1.62235E+06 TOLE 1.E-3
     COUR  3 REFE  1.62235E+06 TOLE 1.E-3
     COUR  4 REFE  1.62235E+06 TOLE 1.E-3
     COUR 10 REFE  9.67298E+04 TOLE 1.E-3
SUIT
BLAS15Z
ECHO
 CONV WIN
RESU SPLI ALIC GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
PLAY
CAME   1 EYE   0.00000E+00  0.00000E+00  3.53553E+00
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  0.00000E+00  0.00000E+00  0.00000E+00
!RSPHERE:  7.07107E-01
!RADIUS :  3.53553E+00
!ASPECT :  1.00000E+00
!NEAR   :  2.75772E+00
!FAR    :  4.94975E+00
SCEN GEOM NAVI FREE
          LINE HEOU SFRE
          REFE FRAM
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.E5 PAS 0.5E5 7.5E5
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 9 FPS 5 KFRE 5 COMP -1
                  OBJE LECT flui TERM REND
FREQ 1
GOTR LOOP 7 OFFS FICH AVI CONT NOCL
                  OBJE LECT flui TERM REND
GO
TRAC OFFS FICH AVI CONT
                  OBJE LECT flui TERM REND
ENDPLAY
SUIT
BLAS15Y
ECHO
 CONV WIN
RESU SPLI ALIC GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
PLAY
CAME   1 EYE   0.00000E+00  0.00000E+00  3.53553E+00
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  0.00000E+00  0.00000E+00  0.00000E+00
!RSPHERE:  7.07107E-01
!RADIUS :  3.53553E+00
!ASPECT :  1.00000E+00
!NEAR   :  2.75772E+00
!FAR    :  4.94975E+00
SCEN GEOM NAVI FREE
        ! LINE HEOU SFRE
          REFE FRAM
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.E5 PAS 0.5E5 7.5E5
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 9 FPS 5 KFRE 5 COMP -1
                  OBJE LECT flui TERM REND
FREQ 1
GOTR LOOP 7 OFFS FICH AVI CONT NOCL
                  OBJE LECT flui TERM REND
GO
TRAC OFFS FICH AVI CONT
                  OBJE LECT flui TERM REND
ENDPLAY
FIN
```

blas16.dgibi

```
opti echo 1;
opti dime 2 elem qua4;
opti sauv form 'blas16.msh';
opti trac psc ftra 'blas16_mesh.ps';
p0 = 0 0;
p1 = -0.5 -0.5;
p2 =  0.5 -0.5;
p3 =  0.5  0.5;
p4 = -0.5  0.5;
c1 = p1 d 80 p2;
flui = c1 tran 80 (0 1);
tol = 0.01;
elim tol (flui et p0 et p3 et p4);
trac cach flui;
mesh = flui;
sauv form mesh;
trac mesh;
fin;
```

blas16.epx

```
BLAS16
ECHO
!CONV WIN
CAST mesh
DPLA EULE
GEOM Q4VF flui TERM
COMP GROU 7 'e1' LECT flui TERM COND NEAR NODE LECT p1 TERM
            'e2' LECT flui TERM COND NEAR NODE LECT p2 TERM
            'e3' LECT flui TERM COND NEAR NODE LECT p3 TERM
            'e4' LECT flui TERM COND NEAR NODE LECT p4 TERM
            'e0' LECT flui TERM COND NEAR NODE LECT p0 TERM
            'bomb' LECT flui TERM COND SPHE XC 0 YC 0 R 0.05
            'ew' LECT flui TERM COND NEAR POIN -0.5 0.0
     COUL TURQ LECT flui DIFF bomb TERM
          ROUG LECT bomb TERM
MATE GAZP RO 1.0 GAMM 1.4 PINI 1.E5 PREF 1.E5
          LECT flui TERM
     BUBB MASS 0.04
          LECT bomb TERM
INIT BLAS 1
          POIN 0.0 0.0
          VELO 1667.0
          T0 0.0
          DMIN 0.07
          LECT flui TERM
ECRI COOR DEPL VITE ACCE ECRO TFRE 0.6E-3
     NOPO
     ELEM LECT e1 e2 e3 e4 e0 TERM
     FICH SPLI ALIC TFRE 0.1E-3
     FICH ALIC TEMP FREQ 1
          ELEM LECT e1 e2 e3 e4 e0 ew TERM
OPTI PAS AUTO NOTE STEP LIBR
 CSTA 0.5
 LOG 1
CALC TINI 0. TEND 0.8E-3
SUIT
BLAS16A
ECHO
RESU ALIC TEMP GARD PSCR
OPTI PRIN
SORT GRAP
AXTE 1.0 'Time [s]'
COUR 1 'p_1' ECRO COMP 1 ELEM LECT e1 TERM
COUR 2 'p_2' ECRO COMP 1 ELEM LECT e2 TERM
COUR 3 'p_3' ECRO COMP 1 ELEM LECT e3 TERM
COUR 4 'p_4' ECRO COMP 1 ELEM LECT e4 TERM
COUR 5 'p_w' ECRO COMP 1 ELEM LECT ew TERM
COUR 10 'p_0' ECRO COMP 1 ELEM LECT e0 TERM
RCOU 11 'p_1' FICH 'blas11.pun' RENA 'p_1_11'
RCOU 12 'p_2' FICH 'blas11.pun' RENA 'p_2_11'
RCOU 13 'p_3' FICH 'blas11.pun' RENA 'p_3_11'
RCOU 14 'p_4' FICH 'blas11.pun' RENA 'p_4_11'
RCOU 15 'p_w' FICH 'blas11.pun' RENA 'p_w_11'
RCOU 20 'p_0' FICH 'blas11.pun' RENA 'p_0_11'
TRAC 1 2 3 4 5 11 12 13 14 15 AXES 1.0 'PRES. [PA]'
COLO NOIR NOIR NOIR NOIR NOIR ROUG ROUG ROUG ROUG ROUG
LIST 1 2 3 4 5 AXES 1.0 'PRES. [PA]'
TRAC 10 20 AXES 1.0 'PRES. [PA]'
COLO NOIR ROUG
LIST 10 AXES 1.0 'PRES. [PA]'
QUAL COUR  1 REFE  1.62235E+06 TOLE 1.E-3
     COUR  2 REFE  1.62235E+06 TOLE 1.E-3
     COUR  3 REFE  1.62235E+06 TOLE 1.E-3
     COUR  4 REFE  1.62235E+06 TOLE 1.E-3
     COUR 10 REFE  9.67298E+04 TOLE 1.E-3
SUIT
BLAS16Z
ECHO
```

```
 CONV WIN
RESU SPLI ALIC GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
PLAY
CAME   1 EYE   0.00000E+00  0.00000E+00  3.53553E+00
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  0.00000E+00  0.00000E+00  0.00000E+00
!RSPHERE:  7.07107E-01
!RADIUS :  3.53553E+00
!ASPECT :  1.00000E+00
!NEAR   :  2.75772E+00
!FAR    :  4.94975E+00
SCEN GEOM NAVI FREE
          LINE HEOU SFRE
          REFE FRAM
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.E5 PAS 0.5E5 7.5E5
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 9 FPS 5 KFRE 5 COMP -1
                   OBJE LECT flui TERM REND
FREQ 1
GOTR LOOP 7 OFFS FICH AVI CONT NOCL
                   OBJE LECT flui TERM REND
GO
TRAC OFFS FICH AVI CONT
                   OBJE LECT flui TERM REND
ENDPLAY
SUIT
BLAS16Y
ECHO
 CONV WIN
RESU SPLI ALIC GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
PLAY
CAME   1 EYE   0.00000E+00  0.00000E+00  3.53553E+00
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  0.00000E+00  0.00000E+00  0.00000E+00
!RSPHERE:  7.07107E-01
!RADIUS :  3.53553E+00
!ASPECT :  1.00000E+00
!NEAR   :  2.75772E+00
!FAR    :  4.94975E+00
SCEN GEOM NAVI FREE
       ! LINE HEOU SFRE
         REFE FRAM
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.E5 PAS 0.5E5 7.5E5
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 9 FPS 5 KFRE 5 COMP -1
                   OBJE LECT flui TERM REND
FREQ 1
GOTR LOOP 7 OFFS FICH AVI CONT NOCL
                   OBJE LECT flui TERM REND
GO
TRAC OFFS FICH AVI CONT
                   OBJE LECT flui TERM REND
ENDPLAY
FIN
```

blas17.dgibi

```
opti echo 1;
opti dime 2 elem qua4;
opti sauv form 'blas17.msh';
opti trac psc ftra 'blas17_mesh.ps';
p0 = 0 0;
p1 = -0.5 -0.5;
p2 =  0.5 -0.5;
p3 =  0.5  0.5;
p4 = -0.5  0.5;
c1 = p1 d 80 p2;
flui = c1 tran 80 (0 1);
tol = 0.01;
elim tol (flui et p0 et p3 et p4);
trac cach flui;
mesh = flui;
sauv form mesh;
trac mesh;
fin;
```

blas17.epx

```
BLAS17
ECHO
!CONV WIN
CAST mesh
DPLA EULE
GEOM Q4VF flui TERM
COMP GROU 7 'e1' LECT flui TERM COND NEAR NODE LECT p1 TERM
            'e2' LECT flui TERM COND NEAR NODE LECT p2 TERM
            'e3' LECT flui TERM COND NEAR NODE LECT p3 TERM
            'e4' LECT flui TERM COND NEAR NODE LECT p4 TERM
            'e0' LECT flui TERM COND NEAR NODE LECT p0 TERM
            'bomb' LECT flui TERM COND SPHE XC 0 YC 0 R 0.05
            'ew' LECT flui TERM COND NEAR POIN -0.5 0.0
     COUL TURQ LECT flui DIFF bomb TERM
          ROUG LECT bomb TERM
MATE GAZP RO 1.0 GAMM 1.4 PINI 1.E5 PREF 1.E5
          LECT flui TERM
     BUBB MASS 0.04
          LECT bomb TERM
INIT BLAS 1
          POIN 0.0 0.0
          VELO 3000.0
          T0 0.0
          DMIN 0.07
          LECT flui TERM
ECRI COOR DEPL VITE ACCE ECRO TFRE 0.6E-3
     NOPO
     ELEM LECT e1 e2 e3 e4 e0 TERM
     FICH SPLI ALIC TFRE 0.1E-3
     FICH ALIC TEMP FREQ 1
          ELEM LECT e1 e2 e3 e4 e0 ew TERM
OPTI PAS AUTO NOTE STEP LIBR
 CSTA 0.5
 LOG 1
CALC TINI 0. TEND 0.8E-3
SUIT
BLAS17A
ECHO
RESU ALIC TEMP GARD PSCR
OPTI PRIN
SORT GRAP
AXTE 1.0 'Time [s]'
COUR 1 'p_1' ECRO COMP 1 ELEM LECT e1 TERM
COUR 2 'p_2' ECRO COMP 1 ELEM LECT e2 TERM
COUR 3 'p_3' ECRO COMP 1 ELEM LECT e3 TERM
COUR 4 'p_4' ECRO COMP 1 ELEM LECT e4 TERM
COUR 5 'p_w' ECRO COMP 1 ELEM LECT ew TERM
COUR 10 'p_0' ECRO COMP 1 ELEM LECT e0 TERM
RCOU 11 'p_1' FICH 'blas11.pun' RENA 'p_1_11'
RCOU 12 'p_2' FICH 'blas11.pun' RENA 'p_2_11'
RCOU 13 'p_3' FICH 'blas11.pun' RENA 'p_3_11'
RCOU 14 'p_4' FICH 'blas11.pun' RENA 'p_4_11'
RCOU 15 'p_w' FICH 'blas11.pun' RENA 'p_w_11'
RCOU 20 'p_0' FICH 'blas11.pun' RENA 'p_0_11'
TRAC 1 2 3 4 5 11 12 13 14 15 AXES 1.0 'PRES. [PA]'
COLO NOIR NOIR NOIR NOIR NOIR ROUG ROUG ROUG ROUG ROUG
LIST 1 2 3 4 5 AXES 1.0 'PRES. [PA]'
TRAC 10 20 AXES 1.0 'PRES. [PA]'
COLO NOIR ROUG
LIST 10 AXES 1.0 'PRES. [PA]'
QUAL COUR  1 REFE  1.62235E+06 TOLE 1.E-3
     COUR  2 REFE  1.62235E+06 TOLE 1.E-3
     COUR  3 REFE  1.62235E+06 TOLE 1.E-3
     COUR  4 REFE  1.62235E+06 TOLE 1.E-3
     COUR 10 REFE  9.67298E+04 TOLE 1.E-3
SUIT
BLAS17Z
ECHO
 CONV WIN
RESU SPLI ALIC GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
PLAY
CAME   1 EYE   0.00000E+00  0.00000E+00  3.53553E+00
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  0.00000E+00  0.00000E+00  0.00000E+00
!RSPHERE:  7.07107E-01
!RADIUS :  3.53553E+00
!ASPECT :  1.00000E+00
!NEAR   :  2.75772E+00
!FAR    :  4.94975E+00
SCEN GEOM NAVI FREE
          LINE HEOU SFRE
          REFE FRAM
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.E5 PAS 0.5E5 7.5E5
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 9 FPS 5 KFRE 5 COMP -1
                   OBJE LECT flui TERM REND
FREQ 1
GOTR LOOP 7 OFFS FICH AVI CONT NOCL
                   OBJE LECT flui TERM REND
GO
TRAC OFFS FICH AVI CONT
                   OBJE LECT flui TERM REND
ENDPLAY
SUIT
BLAS17Y
ECHO
 CONV WIN
RESU SPLI ALIC GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
PLAY
CAME   1 EYE   0.00000E+00  0.00000E+00  3.53553E+00
```

```
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  0.00000E+00  0.00000E+00  0.00000E+00
!RSPHERE:  7.07107E-01
!RADIUS :  3.53553E+00
!ASPECT :  1.00000E+00
!NEAR   :  2.75772E+00
!FAR    :  4.94975E+00
SCEN GEOM NAVI FREE
       ! LINE HEOU SFRE
         REFE FRAM
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.E5 PAS 0.5E5 7.5E5
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 9 FPS 5 KFRE 5 COMP -1
                  OBJE LECT flui TERM REND
FREQ 1
GOTR LOOP 7 OFFS FICH AVI CONT NOCL
                  OBJE LECT flui TERM REND
GO
TRAC OFFS FICH AVI CONT
                  OBJE LECT flui TERM REND
ENDPLAY
FIN
```

blas21.dgibi

```
opti echo 0;
opti donn 'pxordpoi.proc';
opti echo 1;
opti dime 2 elem qua4;
opti sauv form 'blas21.msh';
opti trac psc ftra 'blas21_mesh.ps';
p0 = 0 0;
p0p = p0 plus (-0.00125 0.0);
pmid = 0 0.5;
p1 = 0 1;
p1p = p1 plus (-0.00125 0.0);
pa = 0 0.25;
pb = 0 0.75;
tol = 1.E-5;
n = 800;
n2 = n / 2;
n4 = n2 / 2;
c11 = p0 d n4 pa;
c12 = pa d n4 pmid;
c1 = c11 et c12;
c21 = pmid d n4 pb;
c22 = pb d n4 p1;
c2 = c21 et c22;
bar11 = c11 tran 2 (-0.00125 0.0);
bar12 = c12 tran 2 (-0.00125 0.0);
bar1 = bar11 et bar12;
bar21 = c21 tran 2 (-0.00125 0.0);
bar22 = c22 tran 2 (-0.00125 0.0);
bar2 = bar21 et bar22;
bar = bar1 et bar2;
elim tol (bar et p0p et p1p et pa et pb);
ea = bar12 elem cont pa;
eb = bar21 elem cont pb;
xax = chan 'POI1' (c1 et c2);
xaxo = pxordpoi xax p0;
mesh = bar et ea et eb et xaxo;
tass mesh;
sauv form mesh;
trac qual mesh;
trac ((cont mesh) et ea et eb);
fin;
```

blas21.epx

```
BLAS21
ECHO
!CONV win
CAST mesh
EULE DPLA
GEOM Q4VF bar TERM
COMP COUL ROSE LECT bar1 TERM
          TURQ LECT bar2 TERM
MATE GAZP RO 10 GAMM 1.5 PINI 1.E6 PREF 1.E5
          LECT bar1 TERM
     GAZP RO  1 GAMM 1.5 PINI 1.E5 PREF 1.E5
          LECT bar2 TERM
ECRI COOR DEPL VITE ACCE FINT FEXT CONT ECRO TFRE 0.3E-3
     FICH ALIC TEMP FREQ 1
          POIN LECT pa pmid pb TERM
          ELEM LECT ea eb TERM
     FICH ALIC TFRE 1.0E-4
OPTI NOTE STEP IO
 csta 0.5
 log 1
!VFCC FCON 1              ! OK
!VFCC FCON 2 VISC 0.75    ! OK
 VFCC FCON 3              ! OK
!VFCC FCON 4              ! OK
!VFCC FCON 5              ! OK
!VFCC FCON 6              ! OK
!VFCC FCON 7              ! OK
!VFCC FCON 8              ! OK
!VFCC FCON 9              ! OK
!VFCC FCON 10             ! OK
!VFCC FCON 11             ! OK
!VFCC FCON 12             ! OK
CALC TINI 0. TEND 0.60E-3
*============================================================
SUIT
Post-treatment (space curves from alice file)
ECHO
RESU ALIC GARD PSCR
SORT GRAP
PERF 'blas21.pun'
AXTE 1.0 'Time [s]'
SCOU 71 'p_7'  NSTO 7 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      ECRO COMP 1
SCOU 72 'ro_7' NSTO 7 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      ECRO COMP 2
SCOU 73 'vy_7' NSTO 7 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      VCVI COMP 2
DCOU 76 'pa_7' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                     TIME 0.6E-3 NRAR 30 VARI 1
DCOU 77 'ra_7' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                     TIME 0.6E-3 NRAR 30 VARI 2
DCOU 78 'va_7' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                     TIME 0.6E-3 NRAR 30 VARI 5
TRAC 71 76 AXES 1.0 'PRESS. [PA]'
COLO NOIR ROUG
LIST 71 76 AXES 1.0 'PRESS. [PA]'
TRAC 72 77 AXES 1.0 'DENS. [KG/M3]'
COLO NOIR ROUG
LIST 72 77 AXES 1.0 'DENS. [KG/M3]'
TRAC 73 78 AXES 1.0 'VELOC. [M/S]'
COLO NOIR ROUG
LIST 73 78 AXES 1.0 'VELOC. [M/S]'
*
QUAL VCVI COMP 2 LECT ea   TERM REFE  3.45909E+0 TOLE 2.E-2
     VCVI COMP 2 LECT eb   TERM REFE  2.95372E+2 TOLE 2.E-2
     ECRO COMP 1 LECT ea   TERM REFE  9.86677E+5 TOLE 2.E-2
     ECRO COMP 1 LECT eb   TERM REFE  2.81256E+5 TOLE 2.E-2
     ECRO COMP 2 LECT ea   TERM REFE  9.91096E+0 TOLE 2.E-2
     ECRO COMP 2 LECT eb   TERM REFE  1.92768E+0 TOLE 2.E-2
*============================================================
SUIT
Post treatment (BMPs from alice file)
ECHO
RESU ALIC GARD PSCR
OPTI PRIN
SORT VISU NSTO 61
PLAY
CAME   1 EYE   5.00000E-01  5.00000E-03  3.00015E-01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   5.25000E+01
SCEN GEOM NAVI FREE
          LINE HEOU
     ISO  FILL FIEL VCVI SCAL USER PROG 20 PAS 20 280 TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1400 400 FICH BMP REND
SCEN GEOM NAVI FREE
          LINE HEOU
     ISO  FILL FIEL ECRO 2 SCAL USER PROG 1 PAS 0.6 8.8 TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1400 400 FICH BMP REND
ENDPLAY
*============================================================
FIN
```

blas22.dgibi

```
opti echo 0;
opti donn 'pxordpoi.proc';
opti echo 1;
opti dime 2 elem qua4;
opti sauv form 'blas22.msh';
opti trac psc ftra 'blas22_mesh.ps';
p0 = 0 0;
p0p = p0 plus (-0.00125 0.0);
pmid = 0 0.5;
p1 = 0 1;
p1p = p1 plus (-0.00125 0.0);
pa = 0 0.25;
pb = 0 0.75;
tol = 1.E-5;
n = 800;
n2 = n / 2;
n4 = n2 / 2;
c11 = p0 d n4 pa;
c12 = pa d n4 pmid;
c1 = c11 et c12;
c21 = pmid d n4 pb;
c22 = pb d n4 p1;
c2 = c21 et c22;
bar11 = c11 tran 2 (-0.00125 0.0);
```

```
bar12 = c12 tran 2 (-0.00125 0.0);
bar1 = bar11 et bar12;
bar21 = c21 tran 2 (-0.00125 0.0);
bar22 = c22 tran 2 (-0.00125 0.0);
bar2 = bar21 et bar22;
bar = bar1 et bar2;
elim tol (bar et p0p et p1p et pa et pb);
ea = bar12 elem cont pa;
eb = bar21 elem cont pb;
xax = chan 'POI1' (c1 et c2);
xaxo = pxordpoi xax p0;
mesh = bar et ea et eb et xaxo;
tass mesh;
sauv form mesh;
trac qual mesh;
trac ((cont mesh) et ea et eb);
fin;
```

blas22.epx

```
BLAS22
ECHO
!CONV win
CAST mesh
EULE DPLA
GEOM Q4VF bar TERM
COMP COUL ROSE LECT bar1 TERM
          TURQ LECT bar2 TERM
MATE GAZP RO 10 GAMM 1.5 PINI 1.E6 PREF 1.E5
          LECT bar1 TERM
     GAZP RO  1 GAMM 1.5 PINI 1.E5 PREF 1.E5
          LECT bar2 TERM
INIT BLAS 1
          POIN -6.25E-4 0.5
          VELO 650.0
          TO 0.0
          DMIN 2.5E-3
          LECT bar TERM
ECRI COOR DEPL VITE ACCE FINT FEXT CONT ECRO TFRE 0.3E-3
     FICH ALIC TEMP FREQ 1
          POIN LECT pa pmid pb TERM
          ELEM LECT ea eb TERM
     FICH ALIC TFRE 1.0E-4
OPTI NOTE STEP IO
 csta 0.5
 log 1
!VFCC FCON 1              ! OK
!VFCC FCON 2 VISC 0.75    ! OK
 VFCC FCON 3              ! OK
!VFCC FCON 4              ! OK
!VFCC FCON 5              ! OK
!VFCC FCON 6              ! OK
!VFCC FCON 7              ! OK
!VFCC FCON 8              ! OK
!VFCC FCON 9              ! OK
!VFCC FCON 10             ! OK
!VFCC FCON 11             ! OK
!VFCC FCON 12             ! OK
CALC TINI 0. TEND 0.60E-3
*===============================================================
SUIT
Post-treatment (space curves from alice file)
ECHO
RESU ALIC GARD PSCR
SORT GRAP
PERF 'blas22.pun'
AXTE 1.0 'Time [s]'
SCOU 71 'p_7'  NSTO 7 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      ECRO COMP 1
SCOU 72 'ro_7' NSTO 7 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      ECRO COMP 2
SCOU 73 'vy_7' NSTO 7 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      VCVI COMP 2
DCOU 76 'pa_7' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.6E-3 NRAR 30 VARI 1
DCOU 77 'ra_7' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.6E-3 NRAR 30 VARI 2
DCOU 78 'va_7' SHTU GAMM 1.5 ROM 10 ROP 1 EINT 2.0E5 LENM 0.5 LENP 0.5
                    TIME 0.6E-3 NRAR 30 VARI 5
RCOU 171 'p_7'  FICH 'blas21.pun' RENA 'p_7_21'
RCOU 172 'ro_7' FICH 'blas21.pun' RENA 'ro_7_21'
RCOU 173 'vy_7' FICH 'blas21.pun' RENA 'vx_7_21'
TRAC 71 76 171 AXES 1.0 'PRESS. [PA]'
COLO NOIR ROUG VERT
TRAC 72 77 172 AXES 1.0 'DENS. [KG/M3]'
COLO NOIR ROUG VERT
TRAC 73 78 173 AXES 1.0 'VELOC. [M/S]'
COLO NOIR ROUG VERT
*
QUAL VCVI COMP 2 LECT ea   TERM REFE  3.45909E+0 TOLE 2.E-2
     VCVI COMP 2 LECT eb   TERM REFE  2.95372E+2 TOLE 2.E-2
     ECRO COMP 1 LECT ea   TERM REFE  9.86677E+5 TOLE 2.E-2
     ECRO COMP 1 LECT eb   TERM REFE  2.81256E+5 TOLE 2.E-2
     ECRO COMP 2 LECT ea   TERM REFE  9.91096E+0 TOLE 2.E-2
     ECRO COMP 2 LECT eb   TERM REFE  1.92768E+0 TOLE 2.E-2
*===============================================================
SUIT
Post treatment (BMPs from alice file)
ECHO
RESU ALIC GARD PSCR
OPTI PRIN
SORT VISU NSTO 61
PLAY
CAME   1 EYE   5.00000E-01  5.00000E-03  3.00015E-01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   5.25000E+01
SCEN GEOM NAVI FREE
          LINE HEOU
     ISO  FILL FIEL VCVI SCAL USER PROG 20 PAS 20 280 TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1400 400 FICH BMP REND
SCEN GEOM NAVI FREE
          LINE HEOU
     ISO  FILL FIEL ECRO 2 SCAL USER PROG 1 PAS 0.6 8.8 TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1400 400 FICH BMP REND
ENDPLAY
*===============================================================
FIN
```

blas31.dgibi

```
opti echo 1;
opti dime 3 elem cub8;
opti sauv form 'blas31.msh';
opti trac psc ftra 'blas31_mesh.ps';
p0 = 0 0 0;
p1 = -0.5 -0.5 -0.5;
p2 =  0.5 -0.5 -0.5;
p3 =  0.5  0.5 -0.5;
p4 = -0.5  0.5 -0.5;
c1 = p1 d 80 p2;
base = c1 tran 80 (0 1 0);
flui = base volu 80 tran (0 0 1);
tol = 0.01;
elim tol (flui et p0 et p3 et p4);
trac cach flui;
mesh = flui;
tass mesh noop;
sauv form mesh;
trac cach mesh;
fin;
```

blas31.epx

```
BLAS31
ECHO
!CONV WIN
CAST mesh
TRID EULE
GEOM CUVF flui TERM
COMP GROU 7 'e1' LECT flui TERM COND NEAR NODE LECT p1 TERM
            'e2' LECT flui TERM COND NEAR NODE LECT p2 TERM
            'e3' LECT flui TERM COND NEAR NODE LECT p3 TERM
            'e4' LECT flui TERM COND NEAR NODE LECT p4 TERM
            'e0' LECT flui TERM COND NEAR NODE LECT p0 TERM
            'bomb' LECT flui TERM COND SPHE XC 0 YC 0 ZC 0 R 0.05
            'ew' LECT flui TERM COND NEAR POIN -0.5 0.0 0.0
     COUL TURQ LECT flui DIFF bomb TERM
          ROUG LECT bomb TERM
MATE GAZP RO 1.0 GAMM 1.4 PINI 1.E5 PREF 1.E5
          LECT flui TERM
     BUBB MASS 0.04
          LECT bomb TERM
ECRI COOR DEPL VITE ACCE ECRO TFRE 0.8E-3
     NOPO
     ELEM LECT e1 e2 e3 e4 e0 TERM
     FICH SPLI ALIC TFRE 0.1E-3
     FICH ALIC TEMP FREQ 1
          ELEM LECT e1 e2 e3 e4 e0 ew TERM
OPTI PAS AUTO NOTE STEP LIBR
 CSTA 0.25
 LOG 1
CALC TINI 0. TEND 0.8E-3
SUIT
BLAS31A
ECHO
RESU ALIC TEMP GARD PSCR
OPTI PRIN
SORT GRAP
AXTE 1.0 'Time [s]'
COUR 1 'p_1' ECRO COMP 1 ELEM LECT e1 TERM
COUR 2 'p_2' ECRO COMP 1 ELEM LECT e2 TERM
COUR 3 'p_3' ECRO COMP 1 ELEM LECT e3 TERM
COUR 4 'p_4' ECRO COMP 1 ELEM LECT e4 TERM
COUR 5 'p_w' ECRO COMP 1 ELEM LECT ew TERM
COUR 10 'p_0' ECRO COMP 1 ELEM LECT e0 TERM
TRAC 1 2 3 4 5 AXES 1.0 'PRES. [PA]'
LIST 1 2 3 4 5 AXES 1.0 'PRES. [PA]'
TRAC 10 AXES 1.0 'PRES. [PA]'
LIST 10 AXES 1.0 'PRES. [PA]'
QUAL COUR  1 REFE  4.27481E+06 TOLE 1.E-3
     COUR  2 REFE  4.27481E+06 TOLE 1.E-3
     COUR  3 REFE  4.27481E+06 TOLE 1.E-3
     COUR  4 REFE  4.27481E+06 TOLE 1.E-3
```

```
     COUR 10 REFE  2.45215E+05 TOLE 1.E-3
SUIT
BLAS31Z
ECHO
 CONV WIN
RESU SPLI ALIC GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
PLAY
CAME   1 EYE   2.16506E+00  1.87500E+00  3.24760E+00
!        Q     9.33013E-01 -2.50000E-01  2.50000E-01 -6.69873E-02
         VIEW -5.00000E-01 -4.33013E-01 -7.50000E-01
         RIGH  8.66025E-01 -2.50000E-01 -4.33013E-01
         UP   -2.77556E-17  8.66025E-01 -5.00000E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  0.00000E+00  0.00000E+00  0.00000E+00
!RSPHERE:  8.66025E-01
!RADIUS :  4.33013E+00
!ASPECT :  1.00000E+00
!NEAR   :  3.37750E+00
!FAR    :  6.06218E+00
SCEN GEOM NAVI FREE
          LINE HEOU SFRE
          REFE FRAM
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.E5 PAS 0.5E5 7.5E5
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 9 FPS 5 KFRE 5 COMP -1
                  OBJE LECT flui TERM REND
FREQ 1
GOTR LOOP 7 OFFS FICH AVI CONT NOCL
                  OBJE LECT flui TERM REND
GO
TRAC OFFS FICH AVI CONT
                  OBJE LECT flui TERM REND
ENDPLAY
SUIT
BLAS31Y
ECHO
 CONV WIN
RESU SPLI ALIC GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
PLAY
CAME   1 EYE   2.16506E+00  1.87500E+00  3.24760E+00
!        Q     9.33013E-01 -2.50000E-01  2.50000E-01 -6.69873E-02
         VIEW -5.00000E-01 -4.33013E-01 -7.50000E-01
         RIGH  8.66025E-01 -2.50000E-01 -4.33013E-01
         UP   -2.77556E-17  8.66025E-01 -5.00000E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  0.00000E+00  0.00000E+00  0.00000E+00
!RSPHERE:  8.66025E-01
!RADIUS :  4.33013E+00
!ASPECT :  1.00000E+00
!NEAR   :  3.37750E+00
!FAR    :  6.06218E+00
SCEN GEOM NAVI FREE
        ! LINE HEOU SFRE
          REFE FRAM
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.E5 PAS 0.5E5 7.5E5
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 9 FPS 5 KFRE 5 COMP -1
                  OBJE LECT flui TERM REND
FREQ 1
GOTR LOOP 7 OFFS FICH AVI CONT NOCL
                  OBJE LECT flui TERM REND
GO
TRAC OFFS FICH AVI CONT
                  OBJE LECT flui TERM REND
ENDPLAY
FIN
```

blas32.dgibi

```
opti echo 1;
opti dime 3 elem cub8;
opti sauv form 'blas32.msh';
opti trac psc ftra 'blas32_mesh.ps';
p0 = 0 0 0;
p1 = -0.5 -0.5 -0.5;
p2 =  0.5 -0.5 -0.5;
p3 =  0.5  0.5 -0.5;
p4 = -0.5  0.5 -0.5;
c1 = p1 d 80 p2;
base = c1 tran 80 (0 1 0);
flui = base volu 80 tran (0 0 1);
tol = 0.01;
elim tol (flui et p0 et p3 et p4);
trac cach flui;
mesh = flui;
tass mesh noop;
sauv form mesh;
trac cach mesh;
fin;
```

blas32.epx

```
BLAS32
ECHO
!CONV WIN
CAST mesh
TRID EULE
GEOM CUVF flui TERM
COMP GROU 7 'e1' LECT flui TERM COND NEAR NODE LECT p1 TERM
            'e2' LECT flui TERM COND NEAR NODE LECT p2 TERM
            'e3' LECT flui TERM COND NEAR NODE LECT p3 TERM
            'e4' LECT flui TERM COND NEAR NODE LECT p4 TERM
            'e0' LECT flui TERM COND NEAR NODE LECT p0 TERM
            'bomb' LECT flui TERM COND SPHE XC 0 YC 0 ZC 0 R 0.05
            'ew' LECT flui TERM COND NEAR POIN -0.5 0.0 0.0
     COUL TURQ LECT flui DIFF bomb TERM
          ROUG LECT bomb TERM
MATE GAZP RO 1.0 GAMM 1.4 PINI 1.E5 PREF 1.E5
          LECT flui TERM
     BUBB MASS 0.04
          LECT bomb TERM
INIT BLAS 1
          POIN 0.0 0.0 0.0
          VELO 3333.0
          T0 0.0
          DMIN 0.07
          LECT flui TERM
ECRI COOR DEPL VITE ACCE ECRO TFRE 0.8E-3
     NOPO
     ELEM LECT e1 e2 e3 e4 e0 TERM
     FICH SPLI ALIC TFRE 0.1E-3
     FICH ALIC TEMP FREQ 1
          ELEM LECT e1 e2 e3 e4 e0 ew TERM
OPTI PAS AUTO NOTE STEP LIBR
 CSTA 0.25
 LOG 1
CALC TINI 0. TEND 0.8E-3
SUIT
BLAS32A
ECHO
RESU ALIC TEMP GARD PSCR
OPTI PRIN
SORT GRAP
AXTE 1.0 'Time [s]'
COUR 1 'p_1' ECRO COMP 1 ELEM LECT e1 TERM
COUR 2 'p_2' ECRO COMP 1 ELEM LECT e2 TERM
COUR 3 'p_3' ECRO COMP 1 ELEM LECT e3 TERM
COUR 4 'p_4' ECRO COMP 1 ELEM LECT e4 TERM
COUR 5 'p_w' ECRO COMP 1 ELEM LECT ew TERM
COUR 10 'p_0' ECRO COMP 1 ELEM LECT e0 TERM
RCOU 11 'p_1' FICH 'blas31.pun' RENA 'p_1_31'
RCOU 12 'p_2' FICH 'blas31.pun' RENA 'p_2_31'
RCOU 13 'p_3' FICH 'blas31.pun' RENA 'p_3_31'
RCOU 14 'p_4' FICH 'blas31.pun' RENA 'p_4_31'
RCOU 15 'p_w' FICH 'blas31.pun' RENA 'p_w_31'
RCOU 20 'p_0' FICH 'blas31.pun' RENA 'p_0_31'
TRAC 1 2 3 4 5 11 12 13 14 15 AXES 1.0 'PRES. [PA]'
COLO NOIR NOIR NOIR NOIR NOIR ROUG ROUG ROUG ROUG ROUG
LIST 1 2 3 4 5 AXES 1.0 'PRES. [PA]'
TRAC 10 20 AXES 1.0 'PRES. [PA]'
COLO NOIR ROUG
LIST 10 AXES 1.0 'PRES. [PA]'
QUAL COUR  1 REFE  4.27481E+06 TOLE 2.E-2
     COUR  2 REFE  4.27481E+06 TOLE 2.E-2
     COUR  3 REFE  4.27481E+06 TOLE 2.E-2
     COUR  4 REFE  4.27481E+06 TOLE 2.E-2
     COUR 10 REFE  2.45215E+05 TOLE 2.E-2
SUIT
BLAS32Z
ECHO
 CONV WIN
RESU SPLI ALIC GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
PLAY
CAME   1 EYE   2.16506E+00  1.87500E+00  3.24760E+00
!        Q     9.33013E-01 -2.50000E-01  2.50000E-01 -6.69873E-02
         VIEW -5.00000E-01 -4.33013E-01 -7.50000E-01
         RIGH  8.66025E-01 -2.50000E-01 -4.33013E-01
         UP   -2.77556E-17  8.66025E-01 -5.00000E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  0.00000E+00  0.00000E+00  0.00000E+00
!RSPHERE:  8.66025E-01
!RADIUS :  4.33013E+00
!ASPECT :  1.00000E+00
!NEAR   :  3.37750E+00
!FAR    :  6.06218E+00
SCEN GEOM NAVI FREE
          LINE HEOU SFRE
          REFE FRAM
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.E5 PAS 0.5E5 7.5E5
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 9 FPS 5 KFRE 5 COMP -1
                  OBJE LECT flui TERM REND
FREQ 1
GOTR LOOP 7 OFFS FICH AVI CONT NOCL
                  OBJE LECT flui TERM REND
GO
TRAC OFFS FICH AVI CONT
                  OBJE LECT flui TERM REND
ENDPLAY
SUIT
BLAS32Y
ECHO
```

```
 CONV WIN
RESU SPLI ALIC GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
PLAY
CAME   1 EYE   2.16506E+00  1.87500E+00  3.24760E+00
!        Q     9.33013E-01 -2.50000E-01  2.50000E-01 -6.69873E-02
         VIEW -5.00000E-01 -4.33013E-01 -7.50000E-01
         RIGH  8.66025E-01 -2.50000E-01 -4.33013E-01
         UP   -2.77556E-17  8.66025E-01 -5.00000E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  0.00000E+00  0.00000E+00  0.00000E+00
!RSPHERE:  8.66025E-01
!RADIUS :  4.33013E+00
!ASPECT :  1.00000E+00
!NEAR   :  3.37750E+00
!FAR    :  6.06218E+00
SCEN GEOM NAVI FREE
       ! LINE HEOU SFRE
         REFE FRAM
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.E5 PAS 0.5E5 7.5E5
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 9 FPS 5 KFRE 5 COMP -1
                  OBJE LECT flui TERM REND
FREQ 1
GOTR LOOP 7 OFFS FICH AVI CONT NOCL
                  OBJE LECT flui TERM REND
GO
TRAC OFFS FICH AVI CONT
                  OBJE LECT flui TERM REND
ENDPLAY
FIN
```

blas33.dgibi

```
opti echo 1;
opti dime 3 elem cub8;
opti sauv form 'blas33.msh';
opti trac psc ftra 'blas33_mesh.ps';
p0 = 0 0 0;
p1 = -0.5 -0.5 -0.5;
p2 =  0.5 -0.5 -0.5;
p3 =  0.5  0.5 -0.5;
p4 = -0.5  0.5 -0.5;
c1 = p1 d 80 p2;
base = c1 tran 80 (0 1 0);
flui = base volu 80 tran (0 0 1);
tol = 0.01;
elim tol (flui et p0 et p3 et p4);
trac cach flui;
mesh = flui;
tass mesh noop;
sauv form mesh;
trac cach mesh;
fin;
```

blas33.epx

```
BLAS33
ECHO
!CONV WIN
CAST mesh
TRID EULE
GEOM CUVF flui TERM
COMP GROU 7 'e1' LECT flui TERM COND NEAR NODE LECT p1 TERM
           'e2' LECT flui TERM COND NEAR NODE LECT p2 TERM
           'e3' LECT flui TERM COND NEAR NODE LECT p3 TERM
           'e4' LECT flui TERM COND NEAR NODE LECT p4 TERM
           'e0' LECT flui TERM COND NEAR NODE LECT p0 TERM
           'bomb' LECT flui TERM COND SPHE XC 0 YC 0 ZC 0 R 0.05
           'ew' LECT flui TERM COND NEAR POIN -0.5 0.0 0.0
     COUL TURQ LECT flui DIFF bomb TERM
          ROUG LECT bomb TERM
MATE GAZP RO 1.0 GAMM 1.4 PINI 1.E5 PREF 1.E5
          LECT flui TERM
     BUBB MASS 0.04
          LECT bomb TERM
INIT BLAS 1
          POIN 0.0 0.0 0.0
          VELO 3333.0
          TO 0.0
          DMIN 0.20
          LECT flui TERM
ECRI COOR DEPL VITE ACCE ECRO TFRE 0.8E-3
     NOPO
     ELEM LECT e1 e2 e3 e4 e0 TERM
     FICH SPLI ALIC TFRE 0.1E-3
     FICH ALIC TEMP FREQ 1
          ELEM LECT e1 e2 e3 e4 e0 ew TERM
OPTI PAS AUTO NOTE STEP LIBR
 CSTA 0.25
 LOG 1
CALC TINI 0. TEND 0.8E-3
SUIT
BLAS33A
ECHO
RESU ALIC TEMP GARD PSCR
OPTI PRIN
SORT GRAP
AXTE 1.0 'Time [s]'
COUR 1 'p_1' ECRO COMP 1 ELEM LECT e1 TERM
COUR 2 'p_2' ECRO COMP 1 ELEM LECT e2 TERM
COUR 3 'p_3' ECRO COMP 1 ELEM LECT e3 TERM
COUR 4 'p_4' ECRO COMP 1 ELEM LECT e4 TERM
COUR 5 'p_w' ECRO COMP 1 ELEM LECT ew TERM
COUR 10 'p_0' ECRO COMP 1 ELEM LECT e0 TERM
RCOU 11 'p_1' FICH 'blas31.pun' RENA 'p_1_31'
RCOU 12 'p_2' FICH 'blas31.pun' RENA 'p_2_31'
RCOU 13 'p_3' FICH 'blas31.pun' RENA 'p_3_31'
RCOU 14 'p_4' FICH 'blas31.pun' RENA 'p_4_31'
RCOU 15 'p_w' FICH 'blas31.pun' RENA 'p_w_31'
RCOU 20 'p_0' FICH 'blas31.pun' RENA 'p_0_31'
TRAC 1 2 3 4 5 11 12 13 14 15 AXES 1.0 'PRES. [PA]'
COLO NOIR NOIR NOIR NOIR NOIR ROUG ROUG ROUG ROUG ROUG
LIST 1 2 3 4 5 AXES 1.0 'PRES. [PA]'
TRAC 10 20 AXES 1.0 'PRES. [PA]'
COLO NOIR ROUG
LIST 10 AXES 1.0 'PRES. [PA]'
QUAL COUR  1 REFE  4.27481E+06 TOLE 2.E-2
     COUR  2 REFE  4.27481E+06 TOLE 2.E-2
     COUR  3 REFE  4.27481E+06 TOLE 2.E-2
     COUR  4 REFE  4.27481E+06 TOLE 2.E-2
     COUR 10 REFE  2.45215E+05 TOLE 2.E-2
SUIT
BLAS33Z
ECHO
 CONV WIN
RESU SPLI ALIC GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
PLAY
CAME   1 EYE   2.16506E+00  1.87500E+00  3.24760E+00
!        Q     9.33013E-01 -2.50000E-01  2.50000E-01 -6.69873E-02
         VIEW -5.00000E-01 -4.33013E-01 -7.50000E-01
         RIGH  8.66025E-01 -2.50000E-01 -4.33013E-01
         UP   -2.77556E-17  8.66025E-01 -5.00000E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  0.00000E+00  0.00000E+00  0.00000E+00
!RSPHERE:  8.66025E-01
!RADIUS :  4.33013E+00
!ASPECT :  1.00000E+00
!NEAR   :  3.37750E+00
!FAR    :  6.06218E+00
SCEN GEOM NAVI FREE
          LINE HEOU SFRE
          REFE FRAM
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.E5 PAS 0.5E5 7.5E5
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 9 FPS 5 KFRE 5 COMP -1
                  OBJE LECT flui TERM REND
FREQ 1
GOTR LOOP 7 OFFS FICH AVI CONT NOCL
                  OBJE LECT flui TERM REND
GO
TRAC OFFS FICH AVI CONT
                  OBJE LECT flui TERM REND
ENDPLAY
SUIT
BLAS33Y
ECHO
 CONV WIN
RESU SPLI ALIC GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
PLAY
CAME   1 EYE   2.16506E+00  1.87500E+00  3.24760E+00
!        Q     9.33013E-01 -2.50000E-01  2.50000E-01 -6.69873E-02
         VIEW -5.00000E-01 -4.33013E-01 -7.50000E-01
         RIGH  8.66025E-01 -2.50000E-01 -4.33013E-01
         UP   -2.77556E-17  8.66025E-01 -5.00000E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  0.00000E+00  0.00000E+00  0.00000E+00
!RSPHERE:  8.66025E-01
!RADIUS :  4.33013E+00
!ASPECT :  1.00000E+00
!NEAR   :  3.37750E+00
!FAR    :  6.06218E+00
SCEN GEOM NAVI FREE
       ! LINE HEOU SFRE
         REFE FRAM
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.E5 PAS 0.5E5 7.5E5
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 9 FPS 5 KFRE 5 COMP -1
                  OBJE LECT flui TERM REND
FREQ 1
GOTR LOOP 7 OFFS FICH AVI CONT NOCL
                  OBJE LECT flui TERM REND
GO
TRAC OFFS FICH AVI CONT
                  OBJE LECT flui TERM REND
ENDPLAY
FIN
```

blas40.epx

```
BLAS40
ECHO
!CONV win
```

```
EULE DPLA
GEOM LIBR POIN 22 Q4VF 10 TERM
 0.0 0.0  0.1 0.0  0.2 0.0  0.3 0.0  0.4 0.0  0.5 0.0
          0.6 0.0  0.7 0.0  0.8 0.0  0.9 0.0  1.0 0.0
 0.0 0.1  0.1 0.1  0.2 0.1  0.3 0.1  0.4 0.1  0.5 0.1
          0.6 0.1  0.7 0.1  0.8 0.1  0.9 0.1  1.0 0.1
  1  2 13 12
  2  3 14 13
  3  4 15 14
  4  5 16 15
  5  6 17 16
  6  7 18 17
  7  8 19 18
  8  9 20 19
  9 10 21 20
 10 11 22 21
COMP GROU 2 'bar1' LECT 1 2 3 4 5 TERM
           'bar2' LECT 6 7 8 9 10 TERM
     NGRO 1 'xaxo' LECT 1 PAS 1 11 TERM
     COUL ROSE LECT bar1 TERM
          TURQ LECT bar2 TERM
MATE GAZP RO 52.8159 GAMM 1.4 PINI 2.78952E8 PREF 1.E5
          LECT bar1 TERM
     GAZP RO  1 GAMM 1.4 PINI 1.E5 PREF 1.E5
          LECT bar2 TERM
ECRI COOR DEPL VITE ACCE FINT FEXT CONT ECRO VFCC FREQ 1
!    FICH ALIC TEMP FREQ 1
!         POIN LECT pa pmid pb TERM
!         ELEM LECT ea eb TERM
     FICH ALIC FREQ 1
OPTI NOTE STEP IO
 csta 0.5
 log 1
      dump
CALC TINI 0. TEND 0.08E-3 ! nmax 1
*=============================================================
SUIT
Post-treatment (space curves from alice file)
ECHO
RESU ALIC GARD PSCR
SORT GRAP
PERF 'blas40.pun'
AXTE 1.0 'Time [s]'
*
SCOU 21 'p_f'  NSTO 9 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      ECRO COMP 1
SCOU 22 'ro_f' NSTO 9 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      ECRO COMP 2
SCOU 23 'vx_f' NSTO 9 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                      VCVI COMP 1
DCOU 26 'pa_f' SHTU GAMM 1.4 ROM 52.8159 ROP 1 EINT 1.32040E7
                    LENM 0.5 LENP 0.5
                    TIME 0.08E-3 NRAR 30 VARI 1
DCOU 27 'ra_f' SHTU GAMM 1.4 ROM 52.8159 ROP 1 EINT 1.32040E7
                    LENM 0.5 LENP 0.5
                    TIME 0.08E-3 NRAR 30 VARI 2
DCOU 28 'va_f' SHTU GAMM 1.4 ROM 52.8159 ROP 1 EINT 1.32040E7
                    LENM 0.5 LENP 0.5
                    TIME 0.08E-3 NRAR 30 VARI 5
TRAC 21 26 AXES 1.0 'PRESS. [PA]' SYMB
COLO NOIR ROUG
LIST 21 26 AXES 1.0 'PRESS. [PA]' SYMB
TRAC 22 27 AXES 1.0 'DENS. [KG/M3]' SYMB
COLO NOIR ROUG
LIST 22 27 AXES 1.0 'DENS. [KG/M3]' SYMB
TRAC 23 28 AXES 1.0 'VELOC. [M/S]' SYMB
COLO NOIR ROUG
LIST 23 28 AXES 1.0 'VELOC. [M/S]' SYMB
*
!QUAL VCVI COMP 1 LECT ea   TERM REFE  3.50414E+0 TOLE 2.E-2
!     VCVI COMP 1 LECT eb   TERM REFE  2.95375E+2 TOLE 2.E-2
!     ECRO COMP 1 LECT ea   TERM REFE  9.86505E+5 TOLE 2.E-2
!     ECRO COMP 1 LECT eb   TERM REFE  2.81254E+5 TOLE 2.E-2
!     ECRO COMP 2 LECT ea   TERM REFE  9.90980E+0 TOLE 2.E-2
!     ECRO COMP 2 LECT eb   TERM REFE  1.92767E+0 TOLE 2.E-2
*=============================================================
FIN
```

blas41.dgibi

```
opti echo 1;
opti dime 3 elem cub8;
opti sauv form 'blas41.msh';
opti trac psc ftra 'blas41_mesh.ps';
p0 = 0 0 0;
p1 = -0.5 -0.5 -0.5;
p2 =  0.5 -0.5 -0.5;
p3 =  0.5  0.5 -0.5;
p4 = -0.5  0.5 -0.5;
c1 = p1 d 80 p2;
base = c1 tran 80 (0 1 0);
flui = base volu 80 tran (0 0 1);
tol = 0.01;
elim tol (flui et p0 et p3 et p4);
trac cach flui;
mesh = flui;
tass mesh noop;
sauv form mesh;
trac cach mesh;
fin;
```

blas41.epx

```
BLAS41
ECHO
!CONV WIN
CAST mesh
TRID EULE
GEOM CUVF flui TERM
COMP GROU 16 'e1' LECT flui TERM COND NEAR NODE LECT p1 TERM
             'e2' LECT flui TERM COND NEAR NODE LECT p2 TERM
             'e3' LECT flui TERM COND NEAR NODE LECT p3 TERM
             'e4' LECT flui TERM COND NEAR NODE LECT p4 TERM
             'e0' LECT flui TERM COND NEAR NODE LECT p0 TERM
             'bomb' LECT flui TERM COND SPHE XC 0 YC 0 ZC 0 R 0.05
             'ew' LECT flui TERM COND NEAR POIN -0.5 0.0 0.0
             'p10' LECT flui TERM COND NEAR POIN 0.10 0.0 0.0
             'p15' LECT flui TERM COND NEAR POIN 0.15 0.0 0.0
             'p20' LECT flui TERM COND NEAR POIN 0.20 0.0 0.0
             'p25' LECT flui TERM COND NEAR POIN 0.25 0.0 0.0
             'p30' LECT flui TERM COND NEAR POIN 0.30 0.0 0.0
             'p35' LECT flui TERM COND NEAR POIN 0.35 0.0 0.0
             'p40' LECT flui TERM COND NEAR POIN 0.40 0.0 0.0
             'p45' LECT flui TERM COND NEAR POIN 0.45 0.0 0.0
             'p50' LECT flui TERM COND NEAR POIN 0.50 0.0 0.0
     COUL TURQ LECT flui DIFF bomb TERM
          ROUG LECT bomb TERM
MATE GAZP RO 1.0 GAMM 1.4 PINI 1.E5 PREF 1.E5
          LECT flui TERM
     BUBB MASS 0.04
          LECT bomb TERM
ECRI COOR DEPL VITE ACCE ECRO TFRE 0.8E-3
     NOPO
     ELEM LECT e1 e2 e3 e4 e0 TERM
     FICH SPLI ALIC TFRE 0.1E-3
     FICH ALIC TEMP FREQ 1
          ELEM LECT e1 e2 e3 e4 e0 ew
                    p10 p15 p20 p25 p30 p35 p40 p45 p50 TERM
OPTI PAS AUTO NOTE STEP LIBR
 CSTA 0.25
 LOG 1
CALC TINI 0. TEND 0.8E-3
SUIT
BLAS41A
ECHO
RESU ALIC TEMP GARD PSCR
OPTI PRIN
SORT GRAP
AXTE 1.0 'Time [s]'
COUR 1 'p_1' ECRO COMP 1 ELEM LECT e1 TERM
COUR 2 'p_2' ECRO COMP 1 ELEM LECT e2 TERM
COUR 3 'p_3' ECRO COMP 1 ELEM LECT e3 TERM
COUR 4 'p_4' ECRO COMP 1 ELEM LECT e4 TERM
COUR 5 'p_w' ECRO COMP 1 ELEM LECT ew TERM
COUR 10 'p_0' ECRO COMP 1 ELEM LECT e0 TERM
TRAC 1 2 3 4 5 AXES 1.0 'PRES. [PA]'
LIST 1 2 3 4 5 AXES 1.0 'PRES. [PA]'
TRAC 10 AXES 1.0 'PRES. [PA]'
LIST 10 AXES 1.0 'PRES. [PA]'
QUAL COUR  1 REFE  4.27481E+06 TOLE 1.E-3
     COUR  2 REFE  4.27481E+06 TOLE 1.E-3
     COUR  3 REFE  4.27481E+06 TOLE 1.E-3
     COUR  4 REFE  4.27481E+06 TOLE 1.E-3
     COUR 10 REFE  2.45215E+05 TOLE 1.E-3
SUIT
BLAS41Z
ECHO
 CONV WIN
RESU SPLI ALIC GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
PLAY
CAME   1 EYE   2.16506E+00  1.87500E+00  3.24760E+00
!        Q     9.33013E-01 -2.50000E-01  2.50000E-01 -6.69873E-02
         VIEW -5.00000E-01 -4.33013E-01 -7.50000E-01
         RIGH  8.66025E-01 -2.50000E-01 -4.33013E-01
         UP   -2.77556E-17  8.66025E-01 -5.00000E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  0.00000E+00  0.00000E+00  0.00000E+00
!RSPHERE:  8.66025E-01
!RADIUS :  4.33013E+00
!ASPECT :  1.00000E+00
!NEAR   :  3.37750E+00
!FAR    :  6.06218E+00
SCEN GEOM NAVI FREE
          LINE HEOU SFRE
          REFE FRAM
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.E5 PAS 0.5E5 7.5E5
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 9 FPS 5 KFRE 5 COMP -1
                  OBJE LECT flui TERM REND
FREQ 1
GOTR LOOP 7 OFFS FICH AVI CONT NOCL
                  OBJE LECT flui TERM REND
GO
TRAC OFFS FICH AVI CONT
                  OBJE LECT flui TERM REND
ENDPLAY
SUIT
BLAS41Y
ECHO
 CONV WIN
RESU SPLI ALIC GARD PSCR
```

```
OPTI PRIN
SORT VISU NSTO 1
PLAY
CAME   1 EYE   2.16506E+00  1.87500E+00  3.24760E+00
!        Q     9.33013E-01 -2.50000E-01  2.50000E-01 -6.69873E-02
         VIEW -5.00000E-01 -4.33013E-01 -7.50000E-01
         RIGH  8.66025E-01 -2.50000E-01 -4.33013E-01
         UP   -2.77556E-17  8.66025E-01 -5.00000E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  0.00000E+00  0.00000E+00  0.00000E+00
!RSPHERE:  8.66025E-01
!RADIUS :  4.33013E+00
!ASPECT :  1.00000E+00
!NEAR   :  3.37750E+00
!FAR    :  6.06218E+00
SCEN GEOM NAVI FREE
        ! LINE HEOU SFRE
          REFE FRAM
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.E5 PAS 0.5E5 7.5E5
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 9 FPS 5 KFRE 5 COMP -1
                  OBJE LECT flui TERM REND
FREQ 1
GOTR LOOP 7 OFFS FICH AVI CONT NOCL
                  OBJE LECT flui TERM REND
GO
TRAC OFFS FICH AVI CONT
                  OBJE LECT flui TERM REND
ENDPLAY
FIN
```

blas41a.epx

```
BLAS41A
ECHO
RESU ALIC TEMP 'blas41.alt' GARD PSCR
OPTI PRIN
SORT GRAP
AXTE 1.0 'Time [s]'
COUR 10 'p_10' ECRO COMP 1 ELEM LECT p10 TERM
COUR 15 'p_15' ECRO COMP 1 ELEM LECT p15 TERM
COUR 20 'p_20' ECRO COMP 1 ELEM LECT p20 TERM
COUR 25 'p_25' ECRO COMP 1 ELEM LECT p25 TERM
COUR 30 'p_30' ECRO COMP 1 ELEM LECT p30 TERM
COUR 35 'p_35' ECRO COMP 1 ELEM LECT p35 TERM
COUR 40 'p_40' ECRO COMP 1 ELEM LECT p40 TERM
COUR 45 'p_45' ECRO COMP 1 ELEM LECT p45 TERM
COUR 50 'p_50' ECRO COMP 1 ELEM LECT p50 TERM
COUR  5 'p_w'  ECRO COMP 1 ELEM LECT  ew TERM
FVAL 10 1.1E5
FVAL 15 1.1E5
FVAL 20 1.1E5
FVAL 25 1.1E5
FVAL 30 1.1E5
FVAL 35 1.1E5
FVAL 40 1.1E5
FVAL 45 1.1E5
FVAL 50 1.1E5
FVAL  5 1.1E5
TRAC 10 15 20 25 30 35 40 45 50 5 AXES 1.0 'PRES. [PA]'
TRAC 10 15 20 25 30 35 40 45 50 5 AXES 1.0 'PRES. [PA]'
     XMIN 0.0 XMAX 4.E-4 NX 8
TRAC 10 15 20 25 30 35 40 45 50 5 AXES 1.0 'PRES. [PA]'
     XMIN 0.0 XMAX 2.E-4 NX 8
FIN
```

blas41b.epx

```
BLAS41B
ECHO
RESU ALIC TEMP 'blas41.alt' GARD PSCR
OPTI PRIN
SORT GRAP
AXTE 1.0 'Abscissa [m]'
DCOU 1 'v_s' 7
             0.15 5591.97
             0.20 4110.79
             0.25 3303.06
             0.30 2704.84
             0.35 2197.94
             0.40 1795.00
             0.45 1486.90
DCOU 2 'v_s_ave' 2
             0.00 2607.94
             0.50 2607.94
TRAC 1 2 AXES 1.0 'V_S [M/S]' SYMB XMIN 0.0 XMAX 0.5 NX 10
                                YMIN 0.0 YMAX 6000 NY 12
COLO NOIR VERT
FIN
```

blas51.dgibi

```
opti echo 1;
opti dime 2 elem qua4;
opti sauv form 'blas51.msh';
opti trac psc ftra 'blas51_mesh.ps';
p0 = 0 0;
p1 = -0.5 -0.5;
p2 =  0.5 -0.5;
p3 =  0.5  0.5;
p4 = -0.5  0.5;
c1 = p1 d 80 p2;
flui = c1 tran 80 (0 1);
tol = 0.01;
elim tol (flui et p0 et p3 et p4);
trac cach flui;
mesh = flui;
sauv form mesh;
trac mesh;
fin;
```

blas51.epx

```
BLAS51
ECHO
!CONV WIN
CAST mesh
DPLA EULE
GEOM Q4VF flui TERM
COMP GROU 7 'e1' LECT flui TERM COND NEAR NODE LECT p1 TERM
           'e2' LECT flui TERM COND NEAR NODE LECT p2 TERM
           'e3' LECT flui TERM COND NEAR NODE LECT p3 TERM
           'e4' LECT flui TERM COND NEAR NODE LECT p4 TERM
           'e0' LECT flui TERM COND NEAR NODE LECT p0 TERM
           'bomb' LECT flui TERM COND SPHE XC 0 YC 0 R 0.05
           'ew' LECT flui TERM COND NEAR POIN -0.5 0.0
     COUL TURQ LECT flui DIFF bomb TERM
          ROUG LECT bomb TERM
MATE GAZP RO 1.0 GAMM 1.4 PINI 1.E5 PREF 1.E5
          LECT flui TERM
     BUBB MASS 0.04
          LECT bomb TERM
ECRI COOR DEPL VITE ACCE ECRO TFRE 0.6E-3
     NOPO
     ELEM LECT e1 e2 e3 e4 e0 TERM
     FICH SPLI ALIC TFRE 0.1E-3
     FICH ALIC TEMP FREQ 1
          ELEM LECT e1 e2 e3 e4 e0 ew TERM
OPTI PAS AUTO NOTE STEP LIBR
     CSTA 0.5
     LOG 1
     VFCC FCON 6 ! HLLC flux solver
          STPS 2 ! In time
          ORDR 2 ! In space
          RECO 1 ! For true 2nd order in space
CALC TINI 0. TEND 0.8E-3
SUIT
BLAS51A
ECHO
RESU ALIC TEMP GARD PSCR
OPTI PRIN
SORT GRAP
AXTE 1.0 'Time [s]'
COUR 1 'p_1' ECRO COMP 1 ELEM LECT e1 TERM
COUR 2 'p_2' ECRO COMP 1 ELEM LECT e2 TERM
COUR 3 'p_3' ECRO COMP 1 ELEM LECT e3 TERM
COUR 4 'p_4' ECRO COMP 1 ELEM LECT e4 TERM
COUR 5 'p_w' ECRO COMP 1 ELEM LECT ew TERM
COUR 10 'p_0' ECRO COMP 1 ELEM LECT e0 TERM
TRAC 1 2 3 4 5 AXES 1.0 'PRES. [PA]'
LIST 1 2 3 4 5 AXES 1.0 'PRES. [PA]'
TRAC 10 AXES 1.0 'PRES. [PA]'
LIST 10 AXES 1.0 'PRES. [PA]'
QUAL COUR  1 REFE  1.72753E+06 TOLE 1.E-3
     COUR  2 REFE  1.72753E+06 TOLE 1.E-3
     COUR  3 REFE  1.72753E+06 TOLE 1.E-3
     COUR  4 REFE  1.72753E+06 TOLE 1.E-3
     COUR 10 REFE  9.82726E+04 TOLE 1.E-3
SUIT
BLAS51Z
ECHO
 CONV WIN
RESU SPLI ALIC GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
PLAY
CAME   1 EYE   0.00000E+00  0.00000E+00  3.53553E+00
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  0.00000E+00  0.00000E+00  0.00000E+00
!RSPHERE:  7.07107E-01
!RADIUS :  3.53553E+00
!ASPECT :  1.00000E+00
!NEAR   :  2.75772E+00
!FAR    :  4.94975E+00
SCEN GEOM NAVI FREE
          LINE HEOU SFRE
          REFE FRAM
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.E5 PAS 0.5E5 7.5E5
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 9 FPS 5 KFRE 5 COMP -1
                  OBJE LECT flui TERM REND
```

```
FREQ 1
GOTR LOOP 7 OFFS FICH AVI CONT NOCL
                  OBJE LECT flui TERM REND
GO
TRAC OFFS FICH AVI CONT
                  OBJE LECT flui TERM REND
ENDPLAY
SUIT
BLAS51Y
ECHO
 CONV WIN
RESU SPLI ALIC GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
PLAY
CAME   1 EYE   0.00000E+00  0.00000E+00  3.53553E+00
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  0.00000E+00  0.00000E+00  0.00000E+00
!RSPHERE:  7.07107E-01
!RADIUS :  3.53553E+00
!ASPECT :  1.00000E+00
!NEAR   :  2.75772E+00
!FAR    :  4.94975E+00
SCEN GEOM NAVI FREE
        ! LINE HEOU SFRE
          REFE FRAM
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.E5 PAS 0.5E5 7.5E5
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 9 FPS 5 KFRE 5 COMP -1
                  OBJE LECT flui TERM REND
FREQ 1
GOTR LOOP 7 OFFS FICH AVI CONT NOCL
                  OBJE LECT flui TERM REND
GO
TRAC OFFS FICH AVI CONT
                  OBJE LECT flui TERM REND
ENDPLAY
FIN
```

blas57.dgibi

```
opti echo 1;
opti dime 2 elem qua4;
opti sauv form 'blas57.msh';
opti trac psc ftra 'blas57_mesh.ps';
p0 = 0 0;
p1 = -0.5 -0.5;
p2 =  0.5 -0.5;
p3 =  0.5  0.5;
p4 = -0.5  0.5;
c1 = p1 d 80 p2;
flui = c1 tran 80 (0 1);
tol = 0.01;
elim tol (flui et p0 et p3 et p4);
trac cach flui;
mesh = flui;
sauv form mesh;
trac mesh;
fin;
```

blas57.epx

```
BLAS57
ECHO
!CONV WIN
CAST mesh
DPLA EULE
GEOM Q4VF flui TERM
COMP GROU 7 'e1' LECT flui TERM COND NEAR NODE LECT p1 TERM
            'e2' LECT flui TERM COND NEAR NODE LECT p2 TERM
            'e3' LECT flui TERM COND NEAR NODE LECT p3 TERM
            'e4' LECT flui TERM COND NEAR NODE LECT p4 TERM
            'e0' LECT flui TERM COND NEAR NODE LECT p0 TERM
            'bomb' LECT flui TERM COND SPHE XC 0 YC 0 R 0.05
            'ew' LECT flui TERM COND NEAR POIN -0.5 0.0
     COUL TURQ LECT flui DIFF bomb TERM
          ROUG LECT bomb TERM
MATE GAZP RO 1.0 GAMM 1.4 PINI 1.E5 PREF 1.E5
          LECT flui TERM
     BUBB MASS 0.04
          LECT bomb TERM
INIT BLAS 1
          POIN 0.0 0.0
          VELO 3000.0
          TO 0.0
          DMIN 0.07
          LECT flui TERM
ECRI COOR DEPL VITE ACCE ECRO TFRE 0.6E-3
     NOPO
     ELEM LECT e1 e2 e3 e4 e0 TERM
     FICH SPLI ALIC TFRE 0.1E-3
     FICH ALIC TEMP FREQ 1
          ELEM LECT e1 e2 e3 e4 e0 ew TERM
OPTI PAS AUTO NOTE STEP LIBR
     CSTA 0.5
     LOG 1
     VFCC FCON 6 ! HLLC flux solver
          STPS 2 ! In time
          ORDR 2 ! In space
          RECO 1 ! For true 2nd order in space
CALC TINI 0. TEND 0.8E-3
SUIT
BLAS57A
ECHO
RESU ALIC TEMP GARD PSCR
OPTI PRIN
SORT GRAP
AXTE 1.0 'Time [s]'
COUR 1 'p_1' ECRO COMP 1 ELEM LECT e1 TERM
COUR 2 'p_2' ECRO COMP 1 ELEM LECT e2 TERM
COUR 3 'p_3' ECRO COMP 1 ELEM LECT e3 TERM
COUR 4 'p_4' ECRO COMP 1 ELEM LECT e4 TERM
COUR 5 'p_w' ECRO COMP 1 ELEM LECT ew TERM
COUR 10 'p_0' ECRO COMP 1 ELEM LECT e0 TERM
RCOU 11 'p_1' FICH 'blas51.pun' RENA 'p_1_51'
RCOU 12 'p_2' FICH 'blas51.pun' RENA 'p_2_51'
RCOU 13 'p_3' FICH 'blas51.pun' RENA 'p_3_51'
RCOU 14 'p_4' FICH 'blas51.pun' RENA 'p_4_51'
RCOU 15 'p_w' FICH 'blas51.pun' RENA 'p_w_51'
RCOU 20 'p_0' FICH 'blas51.pun' RENA 'p_0_51'
TRAC 1 2 3 4 5 11 12 13 14 15 AXES 1.0 'PRES. [PA]'
COLO NOIR NOIR NOIR NOIR NOIR ROUG ROUG ROUG ROUG ROUG
LIST 1 2 3 4 5 AXES 1.0 'PRES. [PA]'
TRAC 10 20 AXES 1.0 'PRES. [PA]'
COLO NOIR ROUG
LIST 10 AXES 1.0 'PRES. [PA]'
QUAL COUR  1 REFE  1.72753E+06 TOLE 1.E-3
     COUR  2 REFE  1.72753E+06 TOLE 1.E-3
     COUR  3 REFE  1.72753E+06 TOLE 1.E-3
     COUR  4 REFE  1.72753E+06 TOLE 1.E-3
     COUR 10 REFE  9.82726E+04 TOLE 1.E-3
SUIT
BLAS57Z
ECHO
 CONV WIN
RESU SPLI ALIC GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
PLAY
CAME   1 EYE   0.00000E+00  0.00000E+00  3.53553E+00
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  0.00000E+00  0.00000E+00  0.00000E+00
!RSPHERE:  7.07107E-01
!RADIUS :  3.53553E+00
!ASPECT :  1.00000E+00
!NEAR   :  2.75772E+00
!FAR    :  4.94975E+00
SCEN GEOM NAVI FREE
          LINE HEOU SFRE
          REFE FRAM
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.E5 PAS 0.5E5 7.5E5
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 9 FPS 5 KFRE 5 COMP -1
                  OBJE LECT flui TERM REND
FREQ 1
GOTR LOOP 7 OFFS FICH AVI CONT NOCL
                  OBJE LECT flui TERM REND
GO
TRAC OFFS FICH AVI CONT
                  OBJE LECT flui TERM REND
ENDPLAY
SUIT
BLAS57Y
ECHO
 CONV WIN
RESU SPLI ALIC GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
PLAY
CAME   1 EYE   0.00000E+00  0.00000E+00  3.53553E+00
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  0.00000E+00  0.00000E+00  0.00000E+00
!RSPHERE:  7.07107E-01
!RADIUS :  3.53553E+00
!ASPECT :  1.00000E+00
!NEAR   :  2.75772E+00
!FAR    :  4.94975E+00
SCEN GEOM NAVI FREE
        ! LINE HEOU SFRE
          REFE FRAM
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.E5 PAS 0.5E5 7.5E5
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 9 FPS 5 KFRE 5 COMP -1
                  OBJE LECT flui TERM REND
FREQ 1
GOTR LOOP 7 OFFS FICH AVI CONT NOCL
```

```
                  OBJE LECT flui TERM REND
GO
TRAC OFFS FICH AVI CONT
                  OBJE LECT flui TERM REND
ENDPLAY
FIN
```

blas61.dgibi

```
opti echo 1;
opti dime 3 elem cub8;
opti trac psc ftra 'blas61_mesh.ps';
opti sauv form 'blas61.msh';
*
lx = 100.0;
ly = 100.0;
lz = 20.0;
lx2 = lx / 2.0;
ly2 = ly / 2.0;
tol = lx / 1.E5;
*
* Fluid mesh
*
den = 1.0;
dens den;
p0 = 0 0 0;
p1 = (0 - lx2) (0 - ly2) 0;
p2 =      lx2  (0 - ly2) 0;
p3 =      lx2       ly2  0;
p4 = (0 - lx2)      ly2  0;
c1 = p1 d p2;
c2 = p2 d p3;
c3 = p3 d p4;
c4 = p4 d p1;
base = dall c1 c2 c3 c4 plan;
elim tol (base et p0);
flui = base volu tran (0 0 lz);
expl = flui elem appu larg p0;
air = flui diff expl;
*
* Absorbing boundaries
*
abs1 = c1 tran (0 0 lz);
abs2 = c2 tran (0 0 lz);
abs3 = c3 tran (0 0 lz);
abs4 = c4 tran (0 0 lz);
abs5 = base plus (0 0 lz);
abso = abs1 et abs2 et abs3 et abs4 et abs5;
elim tol (flui et abso);
*
* Pressure sensors
*
p01 = manu cub8 (0 0 0) (den 0 0) (den den 0) (0 den 0)
                (0 0 den) (den 0 den) (den den den) (0 den den);
p02 = p01 plus (den 0 0);
p03 = p02 plus (den 0 0);
p04 = p03 plus (den 0 0);
p05 = p04 plus (den 0 0);
p06 = p05 plus (den 0 0);
p07 = p06 plus (den 0 0);
p08 = p07 plus (den 0 0);
p09 = p08 plus (den 0 0);
p10 = p09 plus (den 0 0);
p11 = p10 plus (den 0 0);
p12 = p11 plus (den 0 0);
p13 = p12 plus (den 0 0);
p14 = p13 plus (den 0 0);
p15 = p14 plus (den 0 0);
p16 = p15 plus (den 0 0);
p17 = p16 plus (den 0 0);
p18 = p17 plus (den 0 0);
p19 = p18 plus (den 0 0);
p20 = p19 plus (den 0 0);
p21 = p20 plus (den 0 0);
p22 = p21 plus (den 0 0);
p23 = p22 plus (den 0 0);
p24 = p23 plus (den 0 0);
p25 = p24 plus (den 0 0);
p26 = p25 plus (den 0 0);
p27 = p26 plus (den 0 0);
p28 = p27 plus (den 0 0);
p29 = p28 plus (den 0 0);
p30 = p29 plus (den 0 0);
p31 = p30 plus (den 0 0);
p32 = p31 plus (den 0 0);
p33 = p32 plus (den 0 0);
p34 = p33 plus (den 0 0);
p35 = p34 plus (den 0 0);
p36 = p35 plus (den 0 0);
p37 = p36 plus (den 0 0);
p38 = p37 plus (den 0 0);
p39 = p38 plus (den 0 0);
p40 = p39 plus (den 0 0);
p41 = p40 plus (den 0 0);
p42 = p41 plus (den 0 0);
p43 = p42 plus (den 0 0);
p44 = p43 plus (den 0 0);
p45 = p44 plus (den 0 0);
p46 = p45 plus (den 0 0);
p47 = p46 plus (den 0 0);
p48 = p47 plus (den 0 0);
p49 = p48 plus (den 0 0);
p50 = p49 plus (den 0 0);
pxx = p01 et p02 et p03 et p04 et p05 et p06 et p07 et p08 et p09 et p10
   et p11 et p12 et p13 et p14 et p15 et p16 et p17 et p18 et p19 et p20
   et p21 et p22 et p23 et p24 et p25 et p26 et p27 et p28 et p29 et p30
   et p31 et p32 et p33 et p34 et p35 et p36 et p37 et p38 et p39 et p40
   et p41 et p42 et p43 et p44 et p45 et p46 et p47 et p48 et p49 et p50;
elim tol (flui et pxx);
trac cach qual expl;
trac cach qual flui;
trac cach qual abso;
trac cach qual pxx;
*
mesh = flui et abso;
tass mesh noop;
sauv form mesh;
*
fin;
```

blas61.epx

```
BLAS61
ECHO
!CONV WIN
CAST mesh
TRID EULE
GEOM CUVF flui CL3D abso TERM
COMP COUL TURQ LECT air TERM
          ROUG LECT expl TERM
          JAUN LECT abso TERM
MATE GAZP RO 1.0 GAMM 1.4 PINI 1.E5 PREF 1.E5
          LECT flui TERM
     BUBB MASS 100.0
          LECT expl TERM
     CLVF ABSO RO 1.0 LECT abso TERM
ECRI ECRO TFRE 1.0E-3
     NOPO
     ELEM LECT pxx TERM
     FICH SPLI ALIC TFRE 1.0E-3
     FICH ALIC TEMP FREQ 1
          ELEM LECT pxx TERM
OPTI PAS AUTO NOTE STEP LIBR
 CSTA 0.25
 LOG 1
CALC TINI 0. TEND 100.0E-3
FIN
```

blas61a.epx

```
BLAS61A
ECHO
 CONV WIN
OPTI PRIN
RESU SPLI ALIC 'blas61.ali' GARD PSCR
SORT VISU NSTO 1
PLAY
CAME   1 EYE   7.58567E+01 -2.50532E+02  2.08483E+02 ! Fluid from above
!        Q     8.87589E-01  4.39167E-01  7.09425E-02  1.19521E-01
         VIEW -2.30915E-01  7.62641E-01 -6.04199E-01
         RIGH  9.61364E-01  2.74482E-01 -2.09566E-02
         UP   -1.49859E-01  5.85695E-01  7.96558E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  0.00000E+00  0.00000E+00  1.00000E+01
!RSPHERE:  7.14143E+01
!RADIUS :  3.28506E+02
!ASPECT :  1.00000E+00
!NEAR   :  2.57091E+02
!FAR    :  4.71334E+02
CAME   2 EYE   6.71853E+01 -2.50690E+02 -1.91386E+02 ! Fluid from below
!        Q     4.36824E-01  8.88745E-01  1.29042E-01  5.16350E-02
         VIEW -2.04518E-01  7.63124E-01  6.13037E-01
         RIGH  9.61364E-01  2.74482E-01 -2.09566E-02
         UP    1.84260E-01 -5.85066E-01  7.89776E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  0.00000E+00  0.00000E+00  1.00000E+01
!RSPHERE:  7.14143E+01
!RADIUS :  3.28506E+02
!ASPECT :  1.00000E+00
!NEAR   :  2.57091E+02
!FAR    :  4.71334E+02
SCEN GEOM NAVI FREE
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 0.99E5 PAS 0.01E5 1.12E5 TERM
          SUPP LECT flui TERM
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS FICH AVI NOCL NFTO 101 FPS 15 KFRE 10 COMP -1
          OBJE LECT flui TERM REND
GOTR LOOP 99 OFFS FICH AVI CONT NOCL
          OBJE LECT flui TERM REND
GO
TRAC OFFS FICH AVI CONT
          OBJE LECT flui TERM REND
ENDPLAY
FIN
```

blas61b.epx

```
BLAS61B
ECHO
 CONV WIN
OPTI PRIN
RESU SPLI ALIC 'blas61.ali' GARD PSCR
SORT VISU NSTO 1
PLAY
CAME   1 EYE   7.58567E+01 -2.50532E+02  2.08483E+02 ! Fluid from above
!        Q     8.87589E-01  4.39167E-01  7.09425E-02  1.19521E-01
         VIEW -2.30915E-01  7.62641E-01 -6.04199E-01
         RIGH  9.61364E-01  2.74482E-01 -2.09566E-02
         UP   -1.49859E-01  5.85695E-01  7.96558E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  0.00000E+00  0.00000E+00  1.00000E+01
!RSPHERE:  7.14143E+01
!RADIUS :  3.28506E+02
!ASPECT :  1.00000E+00
!NEAR   :  2.57091E+02
!FAR    :  4.71334E+02
CAME   2 EYE   6.71853E+01 -2.50690E+02 -1.91386E+02 ! Fluid from below
!        Q     4.36824E-01  8.88745E-01  1.29042E-01  5.16350E-02
         VIEW -2.04518E-01  7.63124E-01  6.13037E-01
         RIGH  9.61364E-01  2.74482E-01 -2.09566E-02
         UP    1.84260E-01 -5.85066E-01  7.89776E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  0.00000E+00  0.00000E+00  1.00000E+01
!RSPHERE:  7.14143E+01
!RADIUS :  3.28506E+02
!ASPECT :  1.00000E+00
!NEAR   :  2.57091E+02
!FAR    :  4.71334E+02
SCEN GEOM NAVI FREE
         LINE HEOU SSHA
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 0.99E5 PAS 0.01E5 1.12E5 TERM
         SUPP LECT flui TERM
     LIMA ON
SLER CAM1 2 NFRA 1
FREQ 1
TRAC OFFS FICH AVI NOCL NFTO 101 FPS 15 KFRE 10 COMP -1
         OBJE LECT flui TERM REND
GOTR LOOP 99 OFFS FICH AVI CONT NOCL
         OBJE LECT flui TERM REND
GO
TRAC OFFS FICH AVI CONT
         OBJE LECT flui TERM REND
ENDPLAY
FIN
```

blas61c.epx

```
BLAS61C
ECHO
 CONV WIN
OPTI PRIN
RESU SPLI ALIC 'blas61.ali' GARD PSCR
SORT VISU NSTO 1
PLAY
CAME   1 EYE   7.58567E+01 -2.50532E+02  2.08483E+02 ! Fluid from above
!        Q     8.87589E-01  4.39167E-01  7.09425E-02  1.19521E-01
         VIEW -2.30915E-01  7.62641E-01 -6.04199E-01
         RIGH  9.61364E-01  2.74482E-01 -2.09566E-02
         UP   -1.49859E-01  5.85695E-01  7.96558E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  0.00000E+00  0.00000E+00  1.00000E+01
!RSPHERE:  7.14143E+01
!RADIUS :  3.28506E+02
!ASPECT :  1.00000E+00
!NEAR   :  2.57091E+02
!FAR    :  4.71334E+02
CAME   2 EYE   6.71853E+01 -2.50690E+02 -1.91386E+02 ! Fluid from below
!        Q     4.36824E-01  8.88745E-01  1.29042E-01  5.16350E-02
         VIEW -2.04518E-01  7.63124E-01  6.13037E-01
         RIGH  9.61364E-01  2.74482E-01 -2.09566E-02
         UP    1.84260E-01 -5.85066E-01  7.89776E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  0.00000E+00  0.00000E+00  1.00000E+01
!RSPHERE:  7.14143E+01
!RADIUS :  3.28506E+02
!ASPECT :  1.00000E+00
!NEAR   :  2.57091E+02
!FAR    :  4.71334E+02
SCEN GEOM NAVI FREE
         LINE HEOU SSHA
     ISO  SULI FIEL ECRO 1 SCAL USER PROG 0.99E5 PAS 0.01E5 1.12E5 TERM
         SUPP LECT flui TERM
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS FICH AVI NOCL NFTO 101 FPS 15 KFRE 10 COMP -1
         OBJE LECT flui TERM REND
GOTR LOOP 99 OFFS FICH AVI CONT NOCL
         OBJE LECT flui TERM REND
GO
TRAC OFFS FICH AVI CONT
         OBJE LECT flui TERM REND
ENDPLAY
FIN
```

blas61p.epx

```
BLAS61P
ECHO
OPTI PRIN
RESU ALIC TEMP 'blas61.alt' GARD PSCR
SORT GRAP
AXTE 1.0 'Time [s]'
COUR  1 'p01' ECRO COMP 1 ELEM LECT p01 TERM
COUR  2 'p02' ECRO COMP 1 ELEM LECT p02 TERM
COUR  3 'p03' ECRO COMP 1 ELEM LECT p03 TERM
COUR  4 'p04' ECRO COMP 1 ELEM LECT p04 TERM
COUR  5 'p05' ECRO COMP 1 ELEM LECT p05 TERM
COUR  6 'p06' ECRO COMP 1 ELEM LECT p06 TERM
COUR  7 'p07' ECRO COMP 1 ELEM LECT p07 TERM
COUR  8 'p08' ECRO COMP 1 ELEM LECT p08 TERM
COUR  9 'p09' ECRO COMP 1 ELEM LECT p09 TERM
COUR 10 'p10' ECRO COMP 1 ELEM LECT p10 TERM
COUR 11 'p11' ECRO COMP 1 ELEM LECT p11 TERM
COUR 12 'p12' ECRO COMP 1 ELEM LECT p12 TERM
COUR 13 'p13' ECRO COMP 1 ELEM LECT p13 TERM
COUR 14 'p14' ECRO COMP 1 ELEM LECT p14 TERM
COUR 15 'p15' ECRO COMP 1 ELEM LECT p15 TERM
COUR 16 'p16' ECRO COMP 1 ELEM LECT p16 TERM
COUR 17 'p17' ECRO COMP 1 ELEM LECT p17 TERM
COUR 18 'p18' ECRO COMP 1 ELEM LECT p18 TERM
COUR 19 'p19' ECRO COMP 1 ELEM LECT p19 TERM
COUR 20 'p20' ECRO COMP 1 ELEM LECT p20 TERM
COUR 21 'p21' ECRO COMP 1 ELEM LECT p21 TERM
COUR 22 'p22' ECRO COMP 1 ELEM LECT p22 TERM
COUR 23 'p23' ECRO COMP 1 ELEM LECT p23 TERM
COUR 24 'p24' ECRO COMP 1 ELEM LECT p24 TERM
COUR 25 'p25' ECRO COMP 1 ELEM LECT p25 TERM
COUR 26 'p26' ECRO COMP 1 ELEM LECT p26 TERM
COUR 27 'p27' ECRO COMP 1 ELEM LECT p27 TERM
COUR 28 'p28' ECRO COMP 1 ELEM LECT p28 TERM
COUR 29 'p29' ECRO COMP 1 ELEM LECT p29 TERM
COUR 30 'p30' ECRO COMP 1 ELEM LECT p30 TERM
COUR 31 'p31' ECRO COMP 1 ELEM LECT p31 TERM
COUR 32 'p32' ECRO COMP 1 ELEM LECT p32 TERM
COUR 33 'p33' ECRO COMP 1 ELEM LECT p33 TERM
COUR 34 'p34' ECRO COMP 1 ELEM LECT p34 TERM
COUR 35 'p35' ECRO COMP 1 ELEM LECT p35 TERM
COUR 36 'p36' ECRO COMP 1 ELEM LECT p36 TERM
COUR 37 'p37' ECRO COMP 1 ELEM LECT p37 TERM
COUR 38 'p38' ECRO COMP 1 ELEM LECT p38 TERM
COUR 39 'p39' ECRO COMP 1 ELEM LECT p39 TERM
COUR 40 'p40' ECRO COMP 1 ELEM LECT p40 TERM
COUR 41 'p41' ECRO COMP 1 ELEM LECT p41 TERM
COUR 42 'p42' ECRO COMP 1 ELEM LECT p42 TERM
COUR 43 'p43' ECRO COMP 1 ELEM LECT p43 TERM
COUR 44 'p44' ECRO COMP 1 ELEM LECT p44 TERM
COUR 45 'p45' ECRO COMP 1 ELEM LECT p45 TERM
COUR 46 'p46' ECRO COMP 1 ELEM LECT p46 TERM
COUR 47 'p47' ECRO COMP 1 ELEM LECT p47 TERM
COUR 48 'p48' ECRO COMP 1 ELEM LECT p48 TERM
COUR 49 'p49' ECRO COMP 1 ELEM LECT p49 TERM
COUR 50 'p50' ECRO COMP 1 ELEM LECT p50 TERM
!TRAC 1 5 10 15 20 25 30 35 40 45 50 AXES 1.0 'PRES. [Pa]' YZER
!COLO NOIR ROUG TURQ VERT NOIR ROUG TURQ VERT NOIR ROUG TURQ
!LIST 1 5 10 15 20 25 30 35 40 45 50 AXES 1.0 'PRES. [Pa]' YZER
!TRAC   5 10 15 20 25 30 35 40 45 50 AXES 1.0 'PRES. [Pa]' YZER
!COLO      ROUG TURQ VERT NOIR ROUG TURQ VERT NOIR ROUG TURQ
!TRAC     10 15 20 25 30 35 40 45 50 AXES 1.0 'PRES. [Pa]' YZER
!COLO           TURQ VERT NOIR ROUG TURQ VERT NOIR ROUG TURQ
FVAL  1 1.001E5
FVAL  2 1.001E5
FVAL  3 1.001E5
FVAL  4 1.001E5
FVAL  5 1.001E5
FVAL  6 1.001E5
FVAL  7 1.001E5
FVAL  8 1.001E5
FVAL  9 1.001E5
FVAL 10 1.001E5
FVAL 11 1.001E5
FVAL 12 1.001E5
FVAL 13 1.001E5
FVAL 14 1.001E5
FVAL 15 1.001E5
FVAL 16 1.001E5
FVAL 17 1.001E5
FVAL 18 1.001E5
FVAL 19 1.001E5
FVAL 20 1.001E5
FVAL 21 1.001E5
FVAL 22 1.001E5
FVAL 23 1.001E5
FVAL 24 1.001E5
FVAL 25 1.001E5
FVAL 26 1.001E5
FVAL 27 1.001E5
FVAL 28 1.001E5
FVAL 29 1.001E5
FVAL 30 1.001E5
FVAL 31 1.001E5
FVAL 32 1.001E5
FVAL 33 1.001E5
FVAL 34 1.001E5
FVAL 35 1.001E5
FVAL 36 1.001E5
```

```
FVAL 37 1.001E5
FVAL 38 1.001E5
FVAL 39 1.001E5
FVAL 40 1.001E5
FVAL 41 1.001E5
FVAL 42 1.001E5
FVAL 43 1.001E5
FVAL 44 1.001E5
FVAL 45 1.001E5
FVAL 46 1.001E5
FVAL 47 1.001E5
FVAL 48 1.001E5
FVAL 49 1.001E5
FVAL 50 1.001E5
TRAC  1  2  3  4  5  6  7  8  9 10 AXES 1.0 'PRES. [Pa]' YZER
COLO NOIR ROUG TURQ VERT NOIR ROUG TURQ VERT NOIR ROUG
TRAC 11 12 13 14 15 16 17 18 19 20 AXES 1.0 'PRES. [Pa]' YZER
COLO NOIR ROUG TURQ VERT NOIR ROUG TURQ VERT NOIR ROUG
TRAC 21 22 23 24 25 26 27 28 29 30 AXES 1.0 'PRES. [Pa]' YZER
COLO NOIR ROUG TURQ VERT NOIR ROUG TURQ VERT NOIR ROUG
TRAC 31 32 33 34 35 36 37 38 39 40 AXES 1.0 'PRES. [Pa]' YZER
COLO NOIR ROUG TURQ VERT NOIR ROUG TURQ VERT NOIR ROUG
TRAC 41 42 43 44 45 46 47 48 49 50 AXES 1.0 'PRES. [Pa]' YZER
COLO NOIR ROUG TURQ VERT NOIR ROUG TURQ VERT NOIR ROUG
LIST  1  2  3  4  5  6  7  8  9 10 AXES 1.0 'PRES. [Pa]' YZER
LIST 11 12 13 14 15 16 17 18 19 20 AXES 1.0 'PRES. [Pa]' YZER
LIST 21 22 23 24 25 26 27 28 29 30 AXES 1.0 'PRES. [Pa]' YZER
LIST 31 32 33 34 35 36 37 38 39 40 AXES 1.0 'PRES. [Pa]' YZER
LIST 41 42 43 44 45 46 47 48 49 50 AXES 1.0 'PRES. [Pa]' YZER
FIN
```

blas61q.epx

```
BLAS61$
ECHO
OPTI PRIN
RESU ALIC TEMP 'blas61.alt' GARD PSCR
SORT GRAP
AXTE 1.0 'Time [s]'
*
DCOU 101 'X_WAVE' 50
  0.00000D+00  1.00000D+00
  1.00000D-05  1.50000D+00
  1.26265D-04  2.50000D+00
  2.18291D-04  3.50000D+00
  3.03681D-04  4.50000D+00
  4.53831D-04  5.50000D+00
  6.52466D-04  6.50000D+00
  9.27883D-04  7.50000D+00
  1.25604D-03  8.50000D+00
  1.64243D-03  9.50000D+00
  2.11007D-03  1.05000D+01
  2.65619D-03  1.15000D+01
  3.29081D-03  1.25000D+01
  4.00837D-03  1.35000D+01
  4.81838D-03  1.45000D+01
  5.72335D-03  1.55000D+01
  6.71387D-03  1.65000D+01
  7.80492D-03  1.75000D+01
  8.96870D-03  1.85000D+01
  1.02228D-02  1.95000D+01
  1.15575D-02  2.05000D+01
  1.29424D-02  2.15000D+01
  1.43960D-02  2.25000D+01
  1.59097D-02  2.35000D+01
  1.74780D-02  2.45000D+01
  1.90987D-02  2.55000D+01
  2.07639D-02  2.65000D+01
  2.24731D-02  2.75000D+01
  2.42193D-02  2.85000D+01
  2.60043D-02  2.95000D+01
  2.78238D-02  3.05000D+01
  2.96763D-02  3.15000D+01
  3.15569D-02  3.25000D+01
  3.34638D-02  3.35000D+01
  3.53990D-02  3.45000D+01
  3.73571D-02  3.55000D+01
  3.93367D-02  3.65000D+01
  4.13384D-02  3.75000D+01
  4.33603D-02  3.85000D+01
  4.54010D-02  3.95000D+01
  4.74597D-02  4.05000D+01
  4.95358D-02  4.15000D+01
  5.16282D-02  4.25000D+01
  5.37334D-02  4.35000D+01
  5.58556D-02  4.45000D+01
  5.79903D-02  4.55000D+01
  6.01397D-02  4.65000D+01
  6.23021D-02  4.75000D+01
  6.44868D-02  4.85000D+01
  6.67163D-02  4.95000D+01
DCOU 102 'VX_WAVE' 49
  1.00000D-05  5.00000D+04
  1.26265D-04  8.60104D+03
  2.18291D-04  1.08665D+04
  3.03681D-04  1.17110D+04
  4.53831D-04  6.66001D+03
  6.52466D-04  5.03436D+03
  9.27883D-04  3.63086D+03
  1.25604D-03  3.04732D+03
  1.64243D-03  2.58806D+03
  2.11007D-03  2.13840D+03
  2.65619D-03  1.83110D+03
  3.29081D-03  1.57575D+03
  4.00837D-03  1.39361D+03
  4.81838D-03  1.23455D+03
  5.72335D-03  1.10501D+03
  6.71387D-03  1.00957D+03
  7.80492D-03  9.16548D+02
  8.96870D-03  8.59269D+02
  1.02228D-02  7.97385D+02
  1.15575D-02  7.49232D+02
  1.29424D-02  7.22074D+02
  1.43960D-02  6.87947D+02
  1.59097D-02  6.60633D+02
  1.74780D-02  6.37633D+02
  1.90987D-02  6.17017D+02
  2.07639D-02  6.00528D+02
  2.24731D-02  5.85069D+02
  2.42193D-02  5.72672D+02
  2.60043D-02  5.60224D+02
  2.78238D-02  5.49602D+02
  2.96763D-02  5.39811D+02
  3.15569D-02  5.31745D+02
  3.34638D-02  5.24411D+02
  3.53990D-02  5.16742D+02
  3.73571D-02  5.10699D+02
  3.93367D-02  5.05153D+02
  4.13384D-02  4.99575D+02
  4.33603D-02  4.94584D+02
  4.54010D-02  4.90028D+02
  4.74597D-02  4.85743D+02
  4.95358D-02  4.81672D+02
  5.16282D-02  4.77920D+02
  5.37334D-02  4.75014D+02
  5.58556D-02  4.71209D+02
  5.79903D-02  4.68450D+02
  6.01397D-02  4.65246D+02
  6.23021D-02  4.62449D+02
  6.44868D-02  4.57729D+02
  6.67163D-02  4.48531D+02
TRAC 101 AXES 1.0 'X_WAVE [m]' YZER
TRAC 102 AXES 1.0 'VX_WAVE [m/s]' YZER
TRAC 102 AXES 1.0 'VX_WAVE [m/s]' YLOG
FIN
```

blas62.dgibi

```
opti echo 1;
opti dime 3 elem cub8;
opti trac psc ftra 'blas62_mesh.ps';
opti sauv form 'blas62.msh';
*
lx = 100.0;
ly = 100.0;
lz = 20.0;
lx2 = lx / 2.0;
ly2 = ly / 2.0;
tol = lx / 1.E5;
*
* Fluid mesh
*
den = 1.0;
dens den;
p0 = 0 0 0;
p1 = (0 - lx2) (0 - ly2) 0;
p2 =      lx2  (0 - ly2) 0;
p3 =      lx2       ly2  0;
p4 = (0 - lx2)      ly2  0;
c1 = p1 d p2;
c2 = p2 d p3;
c3 = p3 d p4;
c4 = p4 d p1;
base = dall c1 c2 c3 c4 plan;
elim tol (base et p0);
flui = base volu tran (0 0 lz);
expl = flui elem appu larg p0;
air = flui diff expl;
*
* Absorbing boundaries
*
abs1 = c1 tran (0 0 lz);
abs2 = c2 tran (0 0 lz);
abs3 = c3 tran (0 0 lz);
abs4 = c4 tran (0 0 lz);
abs5 = base plus (0 0 lz);
abso = abs1 et abs2 et abs3 et abs4 et abs5;
elim tol (flui et abso);
*
* Pressure sensors
*
p01 = manu cub8 (0 0 0) (den 0 0) (den den 0) (0 den 0)
                (0 0 den) (den 0 den) (den den den) (0 den den);
p02 = p01 plus (den 0 0);
p03 = p02 plus (den 0 0);
p04 = p03 plus (den 0 0);
p05 = p04 plus (den 0 0);
p06 = p05 plus (den 0 0);
p07 = p06 plus (den 0 0);
p08 = p07 plus (den 0 0);
p09 = p08 plus (den 0 0);
```

```
p10 = p09 plus (den 0 0);
p11 = p10 plus (den 0 0);
p12 = p11 plus (den 0 0);
p13 = p12 plus (den 0 0);
p14 = p13 plus (den 0 0);
p15 = p14 plus (den 0 0);
p16 = p15 plus (den 0 0);
p17 = p16 plus (den 0 0);
p18 = p17 plus (den 0 0);
p19 = p18 plus (den 0 0);
p20 = p19 plus (den 0 0);
p21 = p20 plus (den 0 0);
p22 = p21 plus (den 0 0);
p23 = p22 plus (den 0 0);
p24 = p23 plus (den 0 0);
p25 = p24 plus (den 0 0);
p26 = p25 plus (den 0 0);
p27 = p26 plus (den 0 0);
p28 = p27 plus (den 0 0);
p29 = p28 plus (den 0 0);
p30 = p29 plus (den 0 0);
p31 = p30 plus (den 0 0);
p32 = p31 plus (den 0 0);
p33 = p32 plus (den 0 0);
p34 = p33 plus (den 0 0);
p35 = p34 plus (den 0 0);
p36 = p35 plus (den 0 0);
p37 = p36 plus (den 0 0);
p38 = p37 plus (den 0 0);
p39 = p38 plus (den 0 0);
p40 = p39 plus (den 0 0);
p41 = p40 plus (den 0 0);
p42 = p41 plus (den 0 0);
p43 = p42 plus (den 0 0);
p44 = p43 plus (den 0 0);
p45 = p44 plus (den 0 0);
p46 = p45 plus (den 0 0);
p47 = p46 plus (den 0 0);
p48 = p47 plus (den 0 0);
p49 = p48 plus (den 0 0);
p50 = p49 plus (den 0 0);
pxx = p01 et p02 et p03 et p04 et p05 et p06 et p07 et p08 et p09 et p10
   et p11 et p12 et p13 et p14 et p15 et p16 et p17 et p18 et p19 et p20
   et p21 et p22 et p23 et p24 et p25 et p26 et p27 et p28 et p29 et p30
   et p31 et p32 et p33 et p34 et p35 et p36 et p37 et p38 et p39 et p40
   et p41 et p42 et p43 et p44 et p45 et p46 et p47 et p48 et p49 et p50;
elim tol (flui et pxx);
trac cach qual expl;
trac cach qual flui;
trac cach qual abso;
trac cach qual pxx;
*
mesh = flui et abso;
tass mesh noop;
sauv form mesh;
*
fin;
```

blas62.epx

```
BLAS62
ECHO
!CONV WIN
CAST mesh
TRID EULE
GEOM CUVF flui CL3D abso TERM
COMP COUL TURQ LECT air TERM
          ROUG LECT expl TERM
          JAUN LECT abso TERM
MATE GAZP RO 1.0 GAMM 1.4 PINI 1.E5 PREF 1.E5
          LECT flui TERM
     BUBB MASS 100.0
          LECT expl TERM
     CLVF ABSO RO 1.0 LECT abso TERM
INIT BLAS 1
          POIN 0.0 0.0 0.0
          VELO 3000
          TO 0.0
          DMIN 10.0
          LECT flui TERM
ECRI ECRO TFRE 1.0E-3
     NOPO
     ELEM LECT pxx TERM
     FICH SPLI ALIC TFRE 1.0E-3
     FICH ALIC TEMP FREQ 1
          ELEM LECT pxx TERM
OPTI PAS AUTO NOTE STEP LIBR
 CSTA 0.25
 LOG 1
CALC TINI 0. TEND 100.0E-3
FIN
```

blas62a.epx

```
BLAS62A
ECHO
 CONV WIN
OPTI PRIN
RESU SPLI ALIC 'blas62.ali' GARD PSCR
SORT VISU NSTO 1
PLAY
CAME   1 EYE   7.58567E+01 -2.50532E+02  2.08483E+02 ! Fluid from above
!        Q     8.87589E-01  4.39167E-01  7.09425E-02  1.19521E-01
         VIEW -2.30915E-01  7.62641E-01 -6.04199E-01
         RIGH  9.61364E-01  2.74482E-01 -2.09566E-02
         UP   -1.49859E-01  5.85695E-01  7.96558E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  0.00000E+00  0.00000E+00  1.00000E+01
!RSPHERE:  7.14143E+01
!RADIUS :  3.28506E+02
!ASPECT :  1.00000E+00
!NEAR   :  2.57091E+02
!FAR    :  4.71334E+02
CAME   2 EYE   6.71853E+01 -2.50690E+02 -1.91386E+02 ! Fluid from below
!        Q     4.36824E-01  8.88745E-01  1.29042E-01  5.16350E-02
         VIEW -2.04518E-01  7.63124E-01  6.13037E-01
         RIGH  9.61364E-01  2.74482E-01 -2.09566E-02
         UP    1.84260E-01 -5.85066E-01  7.89776E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  0.00000E+00  0.00000E+00  1.00000E+01
!RSPHERE:  7.14143E+01
!RADIUS :  3.28506E+02
!ASPECT :  1.00000E+00
!NEAR   :  2.57091E+02
!FAR    :  4.71334E+02
SCEN GEOM NAVI FREE
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 0.99E5 PAS 0.01E5 1.12E5 TERM
          SUPP LECT flui TERM
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS FICH AVI NOCL NFTO 101 FPS 15 KFRE 10 COMP -1
          OBJE LECT flui TERM REND
GOTR LOOP 99 OFFS FICH AVI CONT NOCL
          OBJE LECT flui TERM REND
GO
TRAC OFFS FICH AVI CONT
          OBJE LECT flui TERM REND
ENDPLAY
FIN
```

blas62b.epx

```
BLAS62B
ECHO
 CONV WIN
OPTI PRIN
RESU SPLI ALIC 'blas62.ali' GARD PSCR
SORT VISU NSTO 1
PLAY
CAME   1 EYE   7.58567E+01 -2.50532E+02  2.08483E+02 ! Fluid from above
!        Q     8.87589E-01  4.39167E-01  7.09425E-02  1.19521E-01
         VIEW -2.30915E-01  7.62641E-01 -6.04199E-01
         RIGH  9.61364E-01  2.74482E-01 -2.09566E-02
         UP   -1.49859E-01  5.85695E-01  7.96558E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  0.00000E+00  0.00000E+00  1.00000E+01
!RSPHERE:  7.14143E+01
!RADIUS :  3.28506E+02
!ASPECT :  1.00000E+00
!NEAR   :  2.57091E+02
!FAR    :  4.71334E+02
CAME   2 EYE   6.71853E+01 -2.50690E+02 -1.91386E+02 ! Fluid from below
!        Q     4.36824E-01  8.88745E-01  1.29042E-01  5.16350E-02
         VIEW -2.04518E-01  7.63124E-01  6.13037E-01
         RIGH  9.61364E-01  2.74482E-01 -2.09566E-02
         UP    1.84260E-01 -5.85066E-01  7.89776E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  0.00000E+00  0.00000E+00  1.00000E+01
!RSPHERE:  7.14143E+01
!RADIUS :  3.28506E+02
!ASPECT :  1.00000E+00
!NEAR   :  2.57091E+02
!FAR    :  4.71334E+02
SCEN GEOM NAVI FREE
          LINE HEOU SSHA
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 0.99E5 PAS 0.01E5 1.12E5 TERM
          SUPP LECT flui TERM
     LIMA ON
SLER CAM1 2 NFRA 1
FREQ 1
TRAC OFFS FICH AVI NOCL NFTO 101 FPS 15 KFRE 10 COMP -1
          OBJE LECT flui TERM REND
GOTR LOOP 99 OFFS FICH AVI CONT NOCL
          OBJE LECT flui TERM REND
GO
TRAC OFFS FICH AVI CONT
          OBJE LECT flui TERM REND
ENDPLAY
FIN
```

blas62c.epx

```
BLAS62C
ECHO
 CONV WIN
OPTI PRIN
RESU SPLI ALIC 'blas62.ali' GARD PSCR
SORT VISU NSTO 1
PLAY
CAME   1 EYE   7.58567E+01 -2.50532E+02  2.08483E+02 ! Fluid from above
!        Q     8.87589E-01  4.39167E-01  7.09425E-02  1.19521E-01
         VIEW -2.30915E-01  7.62641E-01 -6.04199E-01
         RIGH  9.61364E-01  2.74482E-01 -2.09566E-02
         UP   -1.49859E-01  5.85695E-01  7.96558E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  0.00000E+00  0.00000E+00  1.00000E+01
!RSPHERE:  7.14143E+01
!RADIUS :  3.28506E+02
!ASPECT :  1.00000E+00
!NEAR   :  2.57091E+02
!FAR    :  4.71334E+02
CAME   2 EYE   6.71853E+01 -2.50690E+02 -1.91386E+02 ! Fluid from below
!        Q     4.36824E-01  8.88745E-01  1.29042E-01  5.16350E-02
         VIEW -2.04518E-01  7.63124E-01  6.13037E-01
         RIGH  9.61364E-01  2.74482E-01 -2.09566E-02
         UP    1.84260E-01 -5.85066E-01  7.89776E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  0.00000E+00  0.00000E+00  1.00000E+01
!RSPHERE:  7.14143E+01
!RADIUS :  3.28506E+02
!ASPECT :  1.00000E+00
!NEAR   :  2.57091E+02
!FAR    :  4.71334E+02
SCEN GEOM NAVI FREE
         LINE HEOU SSHA
     ISO  SULI FIEL ECRO 1 SCAL USER PROG 0.99E5 PAS 0.01E5 1.12E5 TERM
         SUPP LECT flui TERM
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS FICH AVI NOCL NFTO 101 FPS 15 KFRE 10 COMP -1
         OBJE LECT flui TERM REND
GOTR LOOP 99 OFFS FICH AVI CONT NOCL
         OBJE LECT flui TERM REND
GO
TRAC OFFS FICH AVI CONT
         OBJE LECT flui TERM REND
ENDPLAY
FIN
```

blas62p.epx

```
BLAS62P
ECHO
OPTI PRIN
RESU ALIC TEMP 'blas62.alt' GARD PSCR
SORT GRAP
AXTE 1.0 'Time [s]'
COUR  1 'p01' ECRO COMP 1 ELEM LECT p01 TERM
COUR  2 'p02' ECRO COMP 1 ELEM LECT p02 TERM
COUR  3 'p03' ECRO COMP 1 ELEM LECT p03 TERM
COUR  4 'p04' ECRO COMP 1 ELEM LECT p04 TERM
COUR  5 'p05' ECRO COMP 1 ELEM LECT p05 TERM
COUR  6 'p06' ECRO COMP 1 ELEM LECT p06 TERM
COUR  7 'p07' ECRO COMP 1 ELEM LECT p07 TERM
COUR  8 'p08' ECRO COMP 1 ELEM LECT p08 TERM
COUR  9 'p09' ECRO COMP 1 ELEM LECT p09 TERM
COUR 10 'p10' ECRO COMP 1 ELEM LECT p10 TERM
COUR 11 'p11' ECRO COMP 1 ELEM LECT p11 TERM
COUR 12 'p12' ECRO COMP 1 ELEM LECT p12 TERM
COUR 13 'p13' ECRO COMP 1 ELEM LECT p13 TERM
COUR 14 'p14' ECRO COMP 1 ELEM LECT p14 TERM
COUR 15 'p15' ECRO COMP 1 ELEM LECT p15 TERM
COUR 16 'p16' ECRO COMP 1 ELEM LECT p16 TERM
COUR 17 'p17' ECRO COMP 1 ELEM LECT p17 TERM
COUR 18 'p18' ECRO COMP 1 ELEM LECT p18 TERM
COUR 19 'p19' ECRO COMP 1 ELEM LECT p19 TERM
COUR 20 'p20' ECRO COMP 1 ELEM LECT p20 TERM
COUR 21 'p21' ECRO COMP 1 ELEM LECT p21 TERM
COUR 22 'p22' ECRO COMP 1 ELEM LECT p22 TERM
COUR 23 'p23' ECRO COMP 1 ELEM LECT p23 TERM
COUR 24 'p24' ECRO COMP 1 ELEM LECT p24 TERM
COUR 25 'p25' ECRO COMP 1 ELEM LECT p25 TERM
COUR 26 'p26' ECRO COMP 1 ELEM LECT p26 TERM
COUR 27 'p27' ECRO COMP 1 ELEM LECT p27 TERM
COUR 28 'p28' ECRO COMP 1 ELEM LECT p28 TERM
COUR 29 'p29' ECRO COMP 1 ELEM LECT p29 TERM
COUR 30 'p30' ECRO COMP 1 ELEM LECT p30 TERM
COUR 31 'p31' ECRO COMP 1 ELEM LECT p31 TERM
COUR 32 'p32' ECRO COMP 1 ELEM LECT p32 TERM
COUR 33 'p33' ECRO COMP 1 ELEM LECT p33 TERM
COUR 34 'p34' ECRO COMP 1 ELEM LECT p34 TERM
COUR 35 'p35' ECRO COMP 1 ELEM LECT p35 TERM
COUR 36 'p36' ECRO COMP 1 ELEM LECT p36 TERM
COUR 37 'p37' ECRO COMP 1 ELEM LECT p37 TERM
COUR 38 'p38' ECRO COMP 1 ELEM LECT p38 TERM
COUR 39 'p39' ECRO COMP 1 ELEM LECT p39 TERM
COUR 40 'p40' ECRO COMP 1 ELEM LECT p40 TERM
COUR 41 'p41' ECRO COMP 1 ELEM LECT p41 TERM
COUR 42 'p42' ECRO COMP 1 ELEM LECT p42 TERM
COUR 43 'p43' ECRO COMP 1 ELEM LECT p43 TERM
COUR 44 'p44' ECRO COMP 1 ELEM LECT p44 TERM
COUR 45 'p45' ECRO COMP 1 ELEM LECT p45 TERM
COUR 46 'p46' ECRO COMP 1 ELEM LECT p46 TERM
COUR 47 'p47' ECRO COMP 1 ELEM LECT p47 TERM
COUR 48 'p48' ECRO COMP 1 ELEM LECT p48 TERM
COUR 49 'p49' ECRO COMP 1 ELEM LECT p49 TERM
COUR 50 'p50' ECRO COMP 1 ELEM LECT p50 TERM
!TRAC 1 5 10 15 20 25 30 35 40 45 50 AXES 1.0 'PRES. [Pa]' YZER
!COLO NOIR ROUG TURQ VERT NOIR ROUG TURQ VERT NOIR ROUG TURQ
!LIST 1 5 10 15 20 25 30 35 40 45 50 AXES 1.0 'PRES. [Pa]' YZER
!TRAC   5 10 15 20 25 30 35 40 45 50 AXES 1.0 'PRES. [Pa]' YZER
!COLO      ROUG TURQ VERT NOIR ROUG TURQ VERT NOIR ROUG TURQ
!TRAC     10 15 20 25 30 35 40 45 50 AXES 1.0 'PRES. [Pa]' YZER
!COLO           TURQ VERT NOIR ROUG TURQ VERT NOIR ROUG TURQ
FVAL  1 1.001E5
FVAL  2 1.001E5
FVAL  3 1.001E5
FVAL  4 1.001E5
FVAL  5 1.001E5
FVAL  6 1.001E5
FVAL  7 1.001E5
FVAL  8 1.001E5
FVAL  9 1.001E5
FVAL 10 1.001E5
FVAL 11 1.001E5
FVAL 12 1.001E5
FVAL 13 1.001E5
FVAL 14 1.001E5
FVAL 15 1.001E5
FVAL 16 1.001E5
FVAL 17 1.001E5
FVAL 18 1.001E5
FVAL 19 1.001E5
FVAL 20 1.001E5
FVAL 21 1.001E5
FVAL 22 1.001E5
FVAL 23 1.001E5
FVAL 24 1.001E5
FVAL 25 1.001E5
FVAL 26 1.001E5
FVAL 27 1.001E5
FVAL 28 1.001E5
FVAL 29 1.001E5
FVAL 30 1.001E5
FVAL 31 1.001E5
FVAL 32 1.001E5
FVAL 33 1.001E5
FVAL 34 1.001E5
FVAL 35 1.001E5
FVAL 36 1.001E5
FVAL 37 1.001E5
FVAL 38 1.001E5
FVAL 39 1.001E5
FVAL 40 1.001E5
FVAL 41 1.001E5
FVAL 42 1.001E5
FVAL 43 1.001E5
FVAL 44 1.001E5
FVAL 45 1.001E5
FVAL 46 1.001E5
FVAL 47 1.001E5
FVAL 48 1.001E5
FVAL 49 1.001E5
FVAL 50 1.001E5
TRAC  1  2  3  4  5  6  7  8  9 10 AXES 1.0 'PRES. [Pa]' YZER
COLO NOIR ROUG TURQ VERT NOIR ROUG TURQ VERT NOIR ROUG
TRAC 11 12 13 14 15 16 17 18 19 20 AXES 1.0 'PRES. [Pa]' YZER
COLO NOIR ROUG TURQ VERT NOIR ROUG TURQ VERT NOIR ROUG
TRAC 21 22 23 24 25 26 27 28 29 30 AXES 1.0 'PRES. [Pa]' YZER
COLO NOIR ROUG TURQ VERT NOIR ROUG TURQ VERT NOIR ROUG
TRAC 31 32 33 34 35 36 37 38 39 40 AXES 1.0 'PRES. [Pa]' YZER
COLO NOIR ROUG TURQ VERT NOIR ROUG TURQ VERT NOIR ROUG
TRAC 41 42 43 44 45 46 47 48 49 50 AXES 1.0 'PRES. [Pa]' YZER
COLO NOIR ROUG TURQ VERT NOIR ROUG TURQ VERT NOIR ROUG
LIST  1  2  3  4  5  6  7  8  9 10 AXES 1.0 'PRES. [Pa]' YZER
LIST 11 12 13 14 15 16 17 18 19 20 AXES 1.0 'PRES. [Pa]' YZER
LIST 21 22 23 24 25 26 27 28 29 30 AXES 1.0 'PRES. [Pa]' YZER
LIST 31 32 33 34 35 36 37 38 39 40 AXES 1.0 'PRES. [Pa]' YZER
LIST 41 42 43 44 45 46 47 48 49 50 AXES 1.0 'PRES. [Pa]' YZER
FIN
```

blas62q.epx

```
BLAS62$
ECHO
OPTI PRIN
RESU ALIC TEMP 'blas62.alt' GARD PSCR
SORT GRAP
AXTE 1.0 'Time [s]'
*
DCOU 101 'X_WAVE' 50
  0.00000D+00  1.00000D+00
  1.00000D-05  1.50000D+00
  1.26265D-04  2.50000D+00
  2.18291D-04  3.50000D+00
  3.03681D-04  4.50000D+00
  4.53831D-04  5.50000D+00
  6.52466D-04  6.50000D+00
  9.27883D-04  7.50000D+00
```

```
  1.25604D-03  8.50000D+00
  1.64243D-03  9.50000D+00
  2.11007D-03  1.05000D+01
  2.65619D-03  1.15000D+01
  3.29081D-03  1.25000D+01
  4.00837D-03  1.35000D+01
  4.81838D-03  1.45000D+01
  5.72335D-03  1.55000D+01
  6.71387D-03  1.65000D+01
  7.80492D-03  1.75000D+01
  8.96870D-03  1.85000D+01
  1.02228D-02  1.95000D+01
  1.15575D-02  2.05000D+01
  1.29424D-02  2.15000D+01
  1.43960D-02  2.25000D+01
  1.59097D-02  2.35000D+01
  1.74780D-02  2.45000D+01
  1.90987D-02  2.55000D+01
  2.07639D-02  2.65000D+01
  2.24731D-02  2.75000D+01
  2.42193D-02  2.85000D+01
  2.60043D-02  2.95000D+01
  2.78238D-02  3.05000D+01
  2.96763D-02  3.15000D+01
  3.15569D-02  3.25000D+01
  3.34638D-02  3.35000D+01
  3.53990D-02  3.45000D+01
  3.73571D-02  3.55000D+01
  3.93367D-02  3.65000D+01
  4.13384D-02  3.75000D+01
  4.33603D-02  3.85000D+01
  4.54010D-02  3.95000D+01
  4.74597D-02  4.05000D+01
  4.95358D-02  4.15000D+01
  5.16282D-02  4.25000D+01
  5.37334D-02  4.35000D+01
  5.58556D-02  4.45000D+01
  5.79903D-02  4.55000D+01
  6.01397D-02  4.65000D+01
  6.23021D-02  4.75000D+01
  6.44868D-02  4.85000D+01
  6.67163D-02  4.95000D+01
DCOU 102 'VX_WAVE' 49
  1.00000D-05  5.00000D+04
  1.26265D-04  8.60104D+03
  2.18291D-04  1.08665D+04
  3.03681D-04  1.17110D+04
  4.53831D-04  6.66001D+03
  6.52466D-04  5.03436D+03
  9.27883D-04  3.63086D+03
  1.25604D-03  3.04732D+03
  1.64243D-03  2.58806D+03
  2.11007D-03  2.13840D+03
  2.65619D-03  1.83110D+03
  3.29081D-03  1.57575D+03
  4.00837D-03  1.39361D+03
  4.81838D-03  1.23455D+03
  5.72335D-03  1.10501D+03
  6.71387D-03  1.00957D+03
  7.80492D-03  9.16548D+02
  8.96870D-03  8.59269D+02
  1.02228D-02  7.97385D+02
  1.15575D-02  7.49232D+02
  1.29424D-02  7.22074D+02
  1.43960D-02  6.87947D+02
  1.59097D-02  6.60633D+02
  1.74780D-02  6.37633D+02
  1.90987D-02  6.17017D+02
  2.07639D-02  6.00528D+02
  2.24731D-02  5.85069D+02
  2.42193D-02  5.72672D+02
  2.60043D-02  5.60224D+02
  2.78238D-02  5.49602D+02
  2.96763D-02  5.39811D+02
  3.15569D-02  5.31745D+02
  3.34638D-02  5.24411D+02
  3.53990D-02  5.16742D+02
  3.73571D-02  5.10699D+02
  3.93367D-02  5.05153D+02
  4.13384D-02  4.99575D+02
  4.33603D-02  4.94584D+02
  4.54010D-02  4.90028D+02
  4.74597D-02  4.85743D+02
  4.95358D-02  4.81672D+02
  5.16282D-02  4.77920D+02
  5.37334D-02  4.75014D+02
  5.58556D-02  4.71209D+02
  5.79903D-02  4.68450D+02
  6.01397D-02  4.65246D+02
  6.23021D-02  4.62449D+02
  6.44868D-02  4.57729D+02
  6.67163D-02  4.48531D+02
TRAC 101 AXES 1.0 'X_WAVE [m]' YZER
TRAC 102 AXES 1.0 'VX_WAVE [m/s]' YZER
TRAC 102 AXES 1.0 'VX_WAVE [m/s]' YLOG
FIN
```

blas63.dgibi

```
opti echo 1;
opti dime 3 elem cub8;
opti trac psc ftra 'blas63_mesh.ps';
opti sauv form 'blas63.msh';
*
lx = 100.0;
ly = 100.0;
lz = 20.0;
lx2 = lx / 2.0;
ly2 = ly / 2.0;
tol = lx / 1.E5;
*
* Fluid mesh
*
den = 1.0;
dens den;
p0 = 0 0 0;
p1 = (0 - lx2) (0 - ly2) 0;
p2 =      lx2  (0 - ly2) 0;
p3 =      lx2       ly2  0;
p4 = (0 - lx2)      ly2  0;
c1 = p1 d p2;
c2 = p2 d p3;
c3 = p3 d p4;
c4 = p4 d p1;
base = dall c1 c2 c3 c4 plan;
elim tol (base et p0);
flui = base volu tran (0 0 lz);
expl = flui elem appu larg p0;
air = flui diff expl;
*
* Absorbing boundaries
*
abs1 = c1 tran (0 0 lz);
abs2 = c2 tran (0 0 lz);
abs3 = c3 tran (0 0 lz);
abs4 = c4 tran (0 0 lz);
abs5 = base plus (0 0 lz);
abso = abs1 et abs2 et abs3 et abs4 et abs5;
elim tol (flui et abso);
*
* Pressure sensors
*
p01 = manu cub8 (0 0 0) (den 0 0) (den den 0) (0 den 0)
                (0 0 den) (den 0 den) (den den den) (0 den den);
p02 = p01 plus (den 0 0);
p03 = p02 plus (den 0 0);
p04 = p03 plus (den 0 0);
p05 = p04 plus (den 0 0);
p06 = p05 plus (den 0 0);
p07 = p06 plus (den 0 0);
p08 = p07 plus (den 0 0);
p09 = p08 plus (den 0 0);
p10 = p09 plus (den 0 0);
p11 = p10 plus (den 0 0);
p12 = p11 plus (den 0 0);
p13 = p12 plus (den 0 0);
p14 = p13 plus (den 0 0);
p15 = p14 plus (den 0 0);
p16 = p15 plus (den 0 0);
p17 = p16 plus (den 0 0);
p18 = p17 plus (den 0 0);
p19 = p18 plus (den 0 0);
p20 = p19 plus (den 0 0);
p21 = p20 plus (den 0 0);
p22 = p21 plus (den 0 0);
p23 = p22 plus (den 0 0);
p24 = p23 plus (den 0 0);
p25 = p24 plus (den 0 0);
p26 = p25 plus (den 0 0);
p27 = p26 plus (den 0 0);
p28 = p27 plus (den 0 0);
p29 = p28 plus (den 0 0);
p30 = p29 plus (den 0 0);
p31 = p30 plus (den 0 0);
p32 = p31 plus (den 0 0);
p33 = p32 plus (den 0 0);
p34 = p33 plus (den 0 0);
p35 = p34 plus (den 0 0);
p36 = p35 plus (den 0 0);
p37 = p36 plus (den 0 0);
p38 = p37 plus (den 0 0);
p39 = p38 plus (den 0 0);
p40 = p39 plus (den 0 0);
p41 = p40 plus (den 0 0);
p42 = p41 plus (den 0 0);
p43 = p42 plus (den 0 0);
p44 = p43 plus (den 0 0);
p45 = p44 plus (den 0 0);
p46 = p45 plus (den 0 0);
p47 = p46 plus (den 0 0);
p48 = p47 plus (den 0 0);
p49 = p48 plus (den 0 0);
p50 = p49 plus (den 0 0);
pxx = p01 et p02 et p03 et p04 et p05 et p06 et p07 et p08 et p09 et p10
   et p11 et p12 et p13 et p14 et p15 et p16 et p17 et p18 et p19 et p20
   et p21 et p22 et p23 et p24 et p25 et p26 et p27 et p28 et p29 et p30
   et p31 et p32 et p33 et p34 et p35 et p36 et p37 et p38 et p39 et p40
   et p41 et p42 et p43 et p44 et p45 et p46 et p47 et p48 et p49 et p50;
elim tol (flui et pxx);
trac cach qual expl;
trac cach qual flui;
trac cach qual abso;
trac cach qual pxx;
```

```
*
mesh = flui et abso;
tass mesh noop;
sauv form mesh;
*
fin;
```

blas63.epx

```
BLAS63
ECHO
!CONV WIN
CAST mesh
TRID EULE
GEOM CUVF flui CL3D abso TERM
COMP COUL TURQ LECT air TERM
          ROUG LECT expl TERM
          JAUN LECT abso TERM
MATE GAZP RO 1.0 GAMM 1.4 PINI 1.E5 PREF 1.E5
          LECT flui TERM
     BUBB MASS 100.0
          LECT expl TERM
     CLVF ABSO RO 1.0 LECT abso TERM
FONC 1 TABL 53
!     d             t
    0.0    0.000000000
    1.0    0.000000000
    1.5    0.000010000
    2.5    0.000126265
    3.5    0.000218291
    4.5    0.000303681
    5.5    0.000453831
    6.5    0.000652466
    7.5    0.000927883
    8.5    0.00125604
    9.5    0.00164243
   10.5    0.00211007
   11.5    0.00265619
   12.5    0.00329081
   13.5    0.00400837
   14.5    0.00481838
   15.5    0.00572335
   16.5    0.00671387
   17.5    0.00780492
   18.5    0.00896870
   19.5    0.0102228
   20.5    0.0115575
   21.5    0.0129424
   22.5    0.0143960
   23.5    0.0159097
   24.5    0.0174780
   25.5    0.0190987
   26.5    0.0207639
   27.5    0.0224731
   28.5    0.0242193
   29.5    0.0260043
   30.5    0.0278238
   31.5    0.0296763
   32.5    0.0315569
   33.5    0.0334638
   34.5    0.0353990
   35.5    0.0373571
   36.5    0.0393367
   37.5    0.0413384
   38.5    0.0433603
   39.5    0.0454010
   40.5    0.0474597
   41.5    0.0495358
   42.5    0.0516282
   43.5    0.0537334
   44.5    0.0558556
   45.5    0.0579903
   46.5    0.0601397
   47.5    0.0623021
   48.5    0.0644868
   49.5    0.0667163 ! v ~ 450 m/s
   50.5    0.1000000 ! Extrapolate with v = cost. = 450 m/s
   95.5    0.2000000
INIT BLAS 1
          POIN 0.0 0.0 0.0
          DFUN 1
          TO 0.0
          DMIN 10.0
          LECT flui TERM
ECRI ECRO TFRE 1.0E-3
     NOPO
     ELEM LECT pxx TERM
     FICH SPLI ALIC TFRE 1.0E-3
     FICH ALIC TEMP FREQ 1
          ELEM LECT pxx TERM
OPTI PAS AUTO NOTE STEP LIBR
 CSTA 0.25
 LOG 1
CALC TINI 0. TEND 100.0E-3
FIN
```

blas63a.epx

```
BLAS63A
ECHO
 CONV WIN
OPTI PRIN
RESU SPLI ALIC 'blas63.ali' GARD PSCR
SORT VISU NSTO 1
PLAY
CAME   1 EYE   7.58567E+01 -2.50532E+02  2.08483E+02 ! Fluid from above
!        Q     8.87589E-01  4.39167E-01  7.09425E-02  1.19521E-01
         VIEW -2.30915E-01  7.62641E-01 -6.04199E-01
         RIGH  9.61364E-01  2.74482E-01 -2.09566E-02
         UP   -1.49859E-01  5.85695E-01  7.96558E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  0.00000E+00  0.00000E+00  1.00000E+01
!RSPHERE:  7.14143E+01
!RADIUS :  3.28506E+02
!ASPECT :  1.00000E+00
!NEAR   :  2.57091E+02
!FAR    :  4.71334E+02
CAME   2 EYE   6.71853E+01 -2.50690E+02 -1.91386E+02 ! Fluid from below
!        Q     4.36824E-01  8.88745E-01  1.29042E-01  5.16350E-02
         VIEW -2.04518E-01  7.63124E-01  6.13037E-01
         RIGH  9.61364E-01  2.74482E-01 -2.09566E-02
         UP    1.84260E-01 -5.85066E-01  7.89776E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  0.00000E+00  0.00000E+00  1.00000E+01
!RSPHERE:  7.14143E+01
!RADIUS :  3.28506E+02
!ASPECT :  1.00000E+00
!NEAR   :  2.57091E+02
!FAR    :  4.71334E+02
SCEN GEOM NAVI FREE
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 0.99E5 PAS 0.01E5 1.12E5 TERM
          SUPP LECT flui TERM
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS FICH AVI NOCL NFTO 101 FPS 15 KFRE 10 COMP -1
          OBJE LECT flui TERM REND
GOTR LOOP 99 OFFS FICH AVI CONT NOCL
          OBJE LECT flui TERM REND
GO
TRAC OFFS FICH AVI CONT
          OBJE LECT flui TERM REND
ENDPLAY
FIN
```

blas63b.epx

```
BLAS63B
ECHO
 CONV WIN
OPTI PRIN
RESU SPLI ALIC 'blas63.ali' GARD PSCR
SORT VISU NSTO 1
PLAY
CAME   1 EYE   7.58567E+01 -2.50532E+02  2.08483E+02 ! Fluid from above
!        Q     8.87589E-01  4.39167E-01  7.09425E-02  1.19521E-01
         VIEW -2.30915E-01  7.62641E-01 -6.04199E-01
         RIGH  9.61364E-01  2.74482E-01 -2.09566E-02
         UP   -1.49859E-01  5.85695E-01  7.96558E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  0.00000E+00  0.00000E+00  1.00000E+01
!RSPHERE:  7.14143E+01
!RADIUS :  3.28506E+02
!ASPECT :  1.00000E+00
!NEAR   :  2.57091E+02
!FAR    :  4.71334E+02
CAME   2 EYE   6.71853E+01 -2.50690E+02 -1.91386E+02 ! Fluid from below
!        Q     4.36824E-01  8.88745E-01  1.29042E-01  5.16350E-02
         VIEW -2.04518E-01  7.63124E-01  6.13037E-01
         RIGH  9.61364E-01  2.74482E-01 -2.09566E-02
         UP    1.84260E-01 -5.85066E-01  7.89776E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  0.00000E+00  0.00000E+00  1.00000E+01
!RSPHERE:  7.14143E+01
!RADIUS :  3.28506E+02
!ASPECT :  1.00000E+00
!NEAR   :  2.57091E+02
!FAR    :  4.71334E+02
SCEN GEOM NAVI FREE
          LINE HEOU SSHA
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 0.99E5 PAS 0.01E5 1.12E5 TERM
          SUPP LECT flui TERM
     LIMA ON
SLER CAM1 2 NFRA 1
FREQ 1
TRAC OFFS FICH AVI NOCL NFTO 101 FPS 15 KFRE 10 COMP -1
          OBJE LECT flui TERM REND
GOTR LOOP 99 OFFS FICH AVI CONT NOCL
          OBJE LECT flui TERM REND
GO
TRAC OFFS FICH AVI CONT
          OBJE LECT flui TERM REND
ENDPLAY
FIN
```

blas63c.epx

```
BLAS63C
ECHO
 CONV WIN
OPTI PRIN
RESU SPLI ALIC 'blas63.ali' GARD PSCR
SORT VISU NSTO 1
PLAY
CAME   1 EYE   7.58567E+01 -2.50532E+02  2.08483E+02 ! Fluid from above
!        Q     8.87589E-01  4.39167E-01  7.09425E-02  1.19521E-01
         VIEW -2.30915E-01  7.62641E-01 -6.04199E-01
         RIGH  9.61364E-01  2.74482E-01 -2.09566E-02
         UP   -1.49859E-01  5.85695E-01  7.96558E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  0.00000E+00  0.00000E+00  1.00000E+01
!RSPHERE:  7.14143E+01
!RADIUS :  3.28506E+02
!ASPECT :  1.00000E+00
!NEAR   :  2.57091E+02
!FAR    :  4.71334E+02
CAME   2 EYE   6.71853E+01 -2.50690E+02 -1.91386E+02 ! Fluid from below
!        Q     4.36824E-01  8.88745E-01  1.29042E-01  5.16350E-02
         VIEW -2.04518E-01  7.63124E-01  6.13037E-01
         RIGH  9.61364E-01  2.74482E-01 -2.09566E-02
         UP    1.84260E-01 -5.85066E-01  7.89776E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  0.00000E+00  0.00000E+00  1.00000E+01
!RSPHERE:  7.14143E+01
!RADIUS :  3.28506E+02
!ASPECT :  1.00000E+00
!NEAR   :  2.57091E+02
!FAR    :  4.71334E+02
SCEN GEOM NAVI FREE
         LINE HEOU SSHA
     ISO  SULI FIEL ECRO 1 SCAL USER PROG 0.99E5 PAS 0.01E5 1.12E5 TERM
          SUPP LECT flui TERM
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS FICH AVI NOCL NFTO 101 FPS 15 KFRE 10 COMP -1
         OBJE LECT flui TERM REND
GOTR LOOP 99 OFFS FICH AVI CONT NOCL
         OBJE LECT flui TERM REND
GO
TRAC OFFS FICH AVI CONT
         OBJE LECT flui TERM REND
ENDPLAY
FIN
```

blas63p.epx

```
BLAS63P
ECHO
OPTI PRIN
RESU ALIC TEMP 'blas63.alt' GARD PSCR
SORT GRAP
AXTE 1.0 'Time [s]'
COUR  1 'p01' ECRO COMP 1 ELEM LECT p01 TERM
COUR  2 'p02' ECRO COMP 1 ELEM LECT p02 TERM
COUR  3 'p03' ECRO COMP 1 ELEM LECT p03 TERM
COUR  4 'p04' ECRO COMP 1 ELEM LECT p04 TERM
COUR  5 'p05' ECRO COMP 1 ELEM LECT p05 TERM
COUR  6 'p06' ECRO COMP 1 ELEM LECT p06 TERM
COUR  7 'p07' ECRO COMP 1 ELEM LECT p07 TERM
COUR  8 'p08' ECRO COMP 1 ELEM LECT p08 TERM
COUR  9 'p09' ECRO COMP 1 ELEM LECT p09 TERM
COUR 10 'p10' ECRO COMP 1 ELEM LECT p10 TERM
COUR 11 'p11' ECRO COMP 1 ELEM LECT p11 TERM
COUR 12 'p12' ECRO COMP 1 ELEM LECT p12 TERM
COUR 13 'p13' ECRO COMP 1 ELEM LECT p13 TERM
COUR 14 'p14' ECRO COMP 1 ELEM LECT p14 TERM
COUR 15 'p15' ECRO COMP 1 ELEM LECT p15 TERM
COUR 16 'p16' ECRO COMP 1 ELEM LECT p16 TERM
COUR 17 'p17' ECRO COMP 1 ELEM LECT p17 TERM
COUR 18 'p18' ECRO COMP 1 ELEM LECT p18 TERM
COUR 19 'p19' ECRO COMP 1 ELEM LECT p19 TERM
COUR 20 'p20' ECRO COMP 1 ELEM LECT p20 TERM
COUR 21 'p21' ECRO COMP 1 ELEM LECT p21 TERM
COUR 22 'p22' ECRO COMP 1 ELEM LECT p22 TERM
COUR 23 'p23' ECRO COMP 1 ELEM LECT p23 TERM
COUR 24 'p24' ECRO COMP 1 ELEM LECT p24 TERM
COUR 25 'p25' ECRO COMP 1 ELEM LECT p25 TERM
COUR 26 'p26' ECRO COMP 1 ELEM LECT p26 TERM
COUR 27 'p27' ECRO COMP 1 ELEM LECT p27 TERM
COUR 28 'p28' ECRO COMP 1 ELEM LECT p28 TERM
COUR 29 'p29' ECRO COMP 1 ELEM LECT p29 TERM
COUR 30 'p30' ECRO COMP 1 ELEM LECT p30 TERM
COUR 31 'p31' ECRO COMP 1 ELEM LECT p31 TERM
COUR 32 'p32' ECRO COMP 1 ELEM LECT p32 TERM
COUR 33 'p33' ECRO COMP 1 ELEM LECT p33 TERM
COUR 34 'p34' ECRO COMP 1 ELEM LECT p34 TERM
COUR 35 'p35' ECRO COMP 1 ELEM LECT p35 TERM
COUR 36 'p36' ECRO COMP 1 ELEM LECT p36 TERM
COUR 37 'p37' ECRO COMP 1 ELEM LECT p37 TERM
COUR 38 'p38' ECRO COMP 1 ELEM LECT p38 TERM
COUR 39 'p39' ECRO COMP 1 ELEM LECT p39 TERM
COUR 40 'p40' ECRO COMP 1 ELEM LECT p40 TERM
COUR 41 'p41' ECRO COMP 1 ELEM LECT p41 TERM
COUR 42 'p42' ECRO COMP 1 ELEM LECT p42 TERM
COUR 43 'p43' ECRO COMP 1 ELEM LECT p43 TERM
COUR 44 'p44' ECRO COMP 1 ELEM LECT p44 TERM
COUR 45 'p45' ECRO COMP 1 ELEM LECT p45 TERM
COUR 46 'p46' ECRO COMP 1 ELEM LECT p46 TERM
COUR 47 'p47' ECRO COMP 1 ELEM LECT p47 TERM
COUR 48 'p48' ECRO COMP 1 ELEM LECT p48 TERM
COUR 49 'p49' ECRO COMP 1 ELEM LECT p49 TERM
COUR 50 'p50' ECRO COMP 1 ELEM LECT p50 TERM
!TRAC 1 5 10 15 20 25 30 35 40 45 50 AXES 1.0 'PRES. [Pa]' YZER
!COLO NOIR ROUG TURQ VERT NOIR ROUG TURQ VERT NOIR ROUG TURQ
!LIST 1 5 10 15 20 25 30 35 40 45 50 AXES 1.0 'PRES. [Pa]' YZER
!TRAC   5 10 15 20 25 30 35 40 45 50 AXES 1.0 'PRES. [Pa]' YZER
!COLO      ROUG TURQ VERT NOIR ROUG TURQ VERT NOIR ROUG TURQ
!TRAC     10 15 20 25 30 35 40 45 50 AXES 1.0 'PRES. [Pa]' YZER
!COLO           TURQ VERT NOIR ROUG TURQ VERT NOIR ROUG TURQ
FVAL  1 1.001E5
FVAL  2 1.001E5
FVAL  3 1.001E5
FVAL  4 1.001E5
FVAL  5 1.001E5
FVAL  6 1.001E5
FVAL  7 1.001E5
FVAL  8 1.001E5
FVAL  9 1.001E5
FVAL 10 1.001E5
FVAL 11 1.001E5
FVAL 12 1.001E5
FVAL 13 1.001E5
FVAL 14 1.001E5
FVAL 15 1.001E5
FVAL 16 1.001E5
FVAL 17 1.001E5
FVAL 18 1.001E5
FVAL 19 1.001E5
FVAL 20 1.001E5
FVAL 21 1.001E5
FVAL 22 1.001E5
FVAL 23 1.001E5
FVAL 24 1.001E5
FVAL 25 1.001E5
FVAL 26 1.001E5
FVAL 27 1.001E5
FVAL 28 1.001E5
FVAL 29 1.001E5
FVAL 30 1.001E5
FVAL 31 1.001E5
FVAL 32 1.001E5
FVAL 33 1.001E5
FVAL 34 1.001E5
FVAL 35 1.001E5
FVAL 36 1.001E5
FVAL 37 1.001E5
FVAL 38 1.001E5
FVAL 39 1.001E5
FVAL 40 1.001E5
FVAL 41 1.001E5
FVAL 42 1.001E5
FVAL 43 1.001E5
FVAL 44 1.001E5
FVAL 45 1.001E5
FVAL 46 1.001E5
FVAL 47 1.001E5
FVAL 48 1.001E5
FVAL 49 1.001E5
FVAL 50 1.001E5
TRAC  1  2  3  4  5  6  7  8  9 10 AXES 1.0 'PRES. [Pa]' YZER
COLO NOIR ROUG TURQ VERT NOIR ROUG TURQ VERT NOIR ROUG
TRAC 11 12 13 14 15 16 17 18 19 20 AXES 1.0 'PRES. [Pa]' YZER
COLO NOIR ROUG TURQ VERT NOIR ROUG TURQ VERT NOIR ROUG
TRAC 21 22 23 24 25 26 27 28 29 30 AXES 1.0 'PRES. [Pa]' YZER
COLO NOIR ROUG TURQ VERT NOIR ROUG TURQ VERT NOIR ROUG
TRAC 31 32 33 34 35 36 37 38 39 40 AXES 1.0 'PRES. [Pa]' YZER
COLO NOIR ROUG TURQ VERT NOIR ROUG TURQ VERT NOIR ROUG
TRAC 41 42 43 44 45 46 47 48 49 50 AXES 1.0 'PRES. [Pa]' YZER
COLO NOIR ROUG TURQ VERT NOIR ROUG TURQ VERT NOIR ROUG
LIST  1  2  3  4  5  6  7  8  9 10 AXES 1.0 'PRES. [Pa]' YZER
LIST 11 12 13 14 15 16 17 18 19 20 AXES 1.0 'PRES. [Pa]' YZER
LIST 21 22 23 24 25 26 27 28 29 30 AXES 1.0 'PRES. [Pa]' YZER
LIST 31 32 33 34 35 36 37 38 39 40 AXES 1.0 'PRES. [Pa]' YZER
LIST 41 42 43 44 45 46 47 48 49 50 AXES 1.0 'PRES. [Pa]' YZER
FIN
```

blas63q.epx

```
BLAS63$
ECHO
OPTI PRIN
RESU ALIC TEMP 'blas63.alt' GARD PSCR
SORT GRAP
AXTE 1.0 'Time [s]'
*
DCOU 101 'X_WAVE' 50
  0.00000D+00  1.00000D+00
  1.00000D-05  1.50000D+00
  1.26265D-04  2.50000D+00
  2.18291D-04  3.50000D+00
  3.03681D-04  4.50000D+00
  4.53831D-04  5.50000D+00
```

```
  6.52466D-04  6.50000D+00
  9.27883D-04  7.50000D+00
  1.25604D-03  8.50000D+00
  1.64243D-03  9.50000D+00
  2.11007D-03  1.05000D+01
  2.65619D-03  1.15000D+01
  3.29081D-03  1.25000D+01
  4.00837D-03  1.35000D+01
  4.81838D-03  1.45000D+01
  5.72335D-03  1.55000D+01
  6.71387D-03  1.65000D+01
  7.80492D-03  1.75000D+01
  8.96870D-03  1.85000D+01
  1.02228D-02  1.95000D+01
  1.15575D-02  2.05000D+01
  1.29424D-02  2.15000D+01
  1.43960D-02  2.25000D+01
  1.59097D-02  2.35000D+01
  1.74780D-02  2.45000D+01
  1.90987D-02  2.55000D+01
  2.07639D-02  2.65000D+01
  2.24731D-02  2.75000D+01
  2.42193D-02  2.85000D+01
  2.60043D-02  2.95000D+01
  2.78238D-02  3.05000D+01
  2.96763D-02  3.15000D+01
  3.15569D-02  3.25000D+01
  3.34638D-02  3.35000D+01
  3.53990D-02  3.45000D+01
  3.73571D-02  3.55000D+01
  3.93367D-02  3.65000D+01
  4.13384D-02  3.75000D+01
  4.33603D-02  3.85000D+01
  4.54010D-02  3.95000D+01
  4.74597D-02  4.05000D+01
  4.95358D-02  4.15000D+01
  5.16282D-02  4.25000D+01
  5.37334D-02  4.35000D+01
  5.58556D-02  4.45000D+01
  5.79903D-02  4.55000D+01
  6.01397D-02  4.65000D+01
  6.23021D-02  4.75000D+01
  6.44868D-02  4.85000D+01
  6.67163D-02  4.95000D+01
DCOU 102 'VX_WAVE' 49
  1.00000D-05  5.00000D+04
  1.26265D-04  8.60104D+03
  2.18291D-04  1.08665D+04
  3.03681D-04  1.17110D+04
  4.53831D-04  6.66001D+03
  6.52466D-04  5.03436D+03
  9.27883D-04  3.63086D+03
  1.25604D-03  3.04732D+03
  1.64243D-03  2.58806D+03
  2.11007D-03  2.13840D+03
  2.65619D-03  1.83110D+03
  3.29081D-03  1.57575D+03
  4.00837D-03  1.39361D+03
  4.81838D-03  1.23455D+03
  5.72335D-03  1.10501D+03
  6.71387D-03  1.00957D+03
  7.80492D-03  9.16548D+02
  8.96870D-03  8.59269D+02
  1.02228D-02  7.97385D+02
  1.15575D-02  7.49232D+02
  1.29424D-02  7.22074D+02
  1.43960D-02  6.87947D+02
  1.59097D-02  6.60633D+02
  1.74780D-02  6.37633D+02
  1.90987D-02  6.17017D+02
  2.07639D-02  6.00528D+02
  2.24731D-02  5.85069D+02
  2.42193D-02  5.72672D+02
  2.60043D-02  5.60224D+02
  2.78238D-02  5.49602D+02
  2.96763D-02  5.39811D+02
  3.15569D-02  5.31745D+02
  3.34638D-02  5.24411D+02
  3.53990D-02  5.16742D+02
  3.73571D-02  5.10699D+02
  3.93367D-02  5.05153D+02
  4.13384D-02  4.99575D+02
  4.33603D-02  4.94584D+02
  4.54010D-02  4.90028D+02
  4.74597D-02  4.85743D+02
  4.95358D-02  4.81672D+02
  5.16282D-02  4.77920D+02
  5.37334D-02  4.75014D+02
  5.58556D-02  4.71209D+02
  5.79903D-02  4.68450D+02
  6.01397D-02  4.65246D+02
  6.23021D-02  4.62449D+02
  6.44868D-02  4.57729D+02
  6.67163D-02  4.48531D+02
TRAC 101 AXES 1.0 'X_WAVE [m]' YZER
TRAC 102 AXES 1.0 'VX_WAVE [m/s]' YZER
TRAC 102 AXES 1.0 'VX_WAVE [m/s]' YLOG
FIN
```

pxordpoi.proc

```
*$$$$ PXORDPOI
*
* pour ordonner une serie de points PLIN en partant de P1
*
* Input:
* =====
* PLIN = objet MAILLAGE de type POI1 (ligne de points)
* P1   = premier point de la ligne (typ POINT)
*
* Output:
* ======
* PORDO = objet MAILLAGE de type POI1 (ligne de points) contenant
*         les points ordonnes a partir de P1
*
'DEBPROC' PXORDPOI PLIN*'MAILLAGE' P1*'POINT' ;
*-----------------------------------------------------------------
*
PORDO=P1;
PPA=P1;
NE='NBEL' PLIN;
*
I=0;
'REPETER' LAB1 (NE-1);
  I=I + 1;
* mess I;
  PLIN= 'DIFF' ((PPA 'ET' PPA) 'ELEM' 1) PLIN;
  PPA=PLIN 'POIN' 'PROC' PPA;
  PORDO=PORDO 'ET' PPA;
'FIN' LAB1;
*
'FINPROC' PORDO;
```

wave61.F90

```
      PROGRAM wave61
      IMPLICIT NONE
      INTEGER, PARAMETER :: NP = 50
      REAL(8) :: T(NP), X(NP), V(NP), DT, DX
      INTEGER :: I
      DO I = 1, NP
        READ (5, *) T(I), X(I)
      END DO
      V(1) = 0.D0
      DO I = 2, NP
        DX = X(I) - X(I-1)
        DT = T(I) - T(I-1)
        V(I) = DX / DT
      END DO
      DO I = 1, NP
        WRITE (6, 1001) I, T(I), X(I), V(I)
 1001   FORMAT ('I=',I2,' T=',1PD13.5,' X=',1PD13.5,' V=',1PD13.5)
      END DO
      WRITE (6, *) ' '
      DO I = 1, NP
        WRITE (6, 1002) T(I), X(I)
 1002   FORMAT (1P2D13.5)
      END DO
      WRITE (6, *) ' '
      DO I = 1, NP
        WRITE (6, 1002) T(I), V(I)
      END DO
      STOP 'NORMAL END'
      END PROGRAM wave61
```

wave61.out

```
I= 1 T=  0.00000D+00 X=  1.00000D+00 V=  0.00000D+00
I= 2 T=  1.00000D-05 X=  1.50000D+00 V=  5.00000D+04
I= 3 T=  1.26265D-04 X=  2.50000D+00 V=  8.60104D+03
I= 4 T=  2.18291D-04 X=  3.50000D+00 V=  1.08665D+04
I= 5 T=  3.03681D-04 X=  4.50000D+00 V=  1.17110D+04
I= 6 T=  4.53831D-04 X=  5.50000D+00 V=  6.66001D+03
I= 7 T=  6.52466D-04 X=  6.50000D+00 V=  5.03436D+03
I= 8 T=  9.27883D-04 X=  7.50000D+00 V=  3.63086D+03
I= 9 T=  1.25604D-03 X=  8.50000D+00 V=  3.04732D+03
I=10 T=  1.64243D-03 X=  9.50000D+00 V=  2.58806D+03
I=11 T=  2.11007D-03 X=  1.05000D+01 V=  2.13840D+03
I=12 T=  2.65619D-03 X=  1.15000D+01 V=  1.83110D+03
I=13 T=  3.29081D-03 X=  1.25000D+01 V=  1.57575D+03
I=14 T=  4.00837D-03 X=  1.35000D+01 V=  1.39361D+03
I=15 T=  4.81838D-03 X=  1.45000D+01 V=  1.23455D+03
I=16 T=  5.72335D-03 X=  1.55000D+01 V=  1.10501D+03
I=17 T=  6.71387D-03 X=  1.65000D+01 V=  1.00957D+03
I=18 T=  7.80492D-03 X=  1.75000D+01 V=  9.16548D+02
I=19 T=  8.96870D-03 X=  1.85000D+01 V=  8.59269D+02
I=20 T=  1.02228D-02 X=  1.95000D+01 V=  7.97385D+02
I=21 T=  1.15575D-02 X=  2.05000D+01 V=  7.49232D+02
I=22 T=  1.29424D-02 X=  2.15000D+01 V=  7.22074D+02
I=23 T=  1.43960D-02 X=  2.25000D+01 V=  6.87947D+02
I=24 T=  1.59097D-02 X=  2.35000D+01 V=  6.60633D+02
I=25 T=  1.74780D-02 X=  2.45000D+01 V=  6.37633D+02
I=26 T=  1.90987D-02 X=  2.55000D+01 V=  6.17017D+02
I=27 T=  2.07639D-02 X=  2.65000D+01 V=  6.00528D+02
I=28 T=  2.24731D-02 X=  2.75000D+01 V=  5.85069D+02
I=29 T=  2.42193D-02 X=  2.85000D+01 V=  5.72672D+02
I=30 T=  2.60043D-02 X=  2.95000D+01 V=  5.60224D+02
I=31 T=  2.78238D-02 X=  3.05000D+01 V=  5.49602D+02
I=32 T=  2.96763D-02 X=  3.15000D+01 V=  5.39811D+02
I=33 T=  3.15569D-02 X=  3.25000D+01 V=  5.31745D+02
I=34 T=  3.34638D-02 X=  3.35000D+01 V=  5.24411D+02
I=35 T=  3.53990D-02 X=  3.45000D+01 V=  5.16742D+02
```

```
I=36 T=  3.73571D-02 X=  3.55000D+01 V=  5.10699D+02
I=37 T=  3.93367D-02 X=  3.65000D+01 V=  5.05153D+02
I=38 T=  4.13384D-02 X=  3.75000D+01 V=  4.99575D+02
I=39 T=  4.33603D-02 X=  3.85000D+01 V=  4.94584D+02
I=40 T=  4.54010D-02 X=  3.95000D+01 V=  4.90028D+02
I=41 T=  4.74597D-02 X=  4.05000D+01 V=  4.85743D+02
I=42 T=  4.95358D-02 X=  4.15000D+01 V=  4.81672D+02
I=43 T=  5.16282D-02 X=  4.25000D+01 V=  4.77920D+02
I=44 T=  5.37334D-02 X=  4.35000D+01 V=  4.75014D+02
I=45 T=  5.58556D-02 X=  4.45000D+01 V=  4.71209D+02
I=46 T=  5.79903D-02 X=  4.55000D+01 V=  4.68450D+02
I=47 T=  6.01397D-02 X=  4.65000D+01 V=  4.65246D+02
I=48 T=  6.23021D-02 X=  4.75000D+01 V=  4.62449D+02
I=49 T=  6.44868D-02 X=  4.85000D+01 V=  4.57729D+02
I=50 T=  6.67163D-02 X=  4.95000D+01 V=  4.48531D+02

  0.00000D+00  1.00000D+00
  1.00000D-05  1.50000D+00
  1.26265D-04  2.50000D+00
  2.18291D-04  3.50000D+00
  3.03681D-04  4.50000D+00
  4.53831D-04  5.50000D+00
  6.52466D-04  6.50000D+00
  9.27883D-04  7.50000D+00
  1.25604D-03  8.50000D+00
  1.64243D-03  9.50000D+00
  2.11007D-03  1.05000D+01
  2.65619D-03  1.15000D+01
  3.29081D-03  1.25000D+01
  4.00837D-03  1.35000D+01
  4.81838D-03  1.45000D+01
  5.72335D-03  1.55000D+01
  6.71387D-03  1.65000D+01
  7.80492D-03  1.75000D+01
  8.96870D-03  1.85000D+01
  1.02228D-02  1.95000D+01
  1.15575D-02  2.05000D+01
  1.29424D-02  2.15000D+01
  1.43960D-02  2.25000D+01
  1.59097D-02  2.35000D+01
  1.74780D-02  2.45000D+01
  1.90987D-02  2.55000D+01
  2.07639D-02  2.65000D+01
  2.24731D-02  2.75000D+01
  2.42193D-02  2.85000D+01
  2.60043D-02  2.95000D+01
  2.78238D-02  3.05000D+01
  2.96763D-02  3.15000D+01
  3.15569D-02  3.25000D+01
  3.34638D-02  3.35000D+01
  3.53990D-02  3.45000D+01
  3.73571D-02  3.55000D+01
  3.93367D-02  3.65000D+01
  4.13384D-02  3.75000D+01
  4.33603D-02  3.85000D+01
  4.54010D-02  3.95000D+01
  4.74597D-02  4.05000D+01
  4.95358D-02  4.15000D+01
  5.16282D-02  4.25000D+01
  5.37334D-02  4.35000D+01
  5.58556D-02  4.45000D+01
  5.79903D-02  4.55000D+01
  6.01397D-02  4.65000D+01
  6.23021D-02  4.75000D+01
  6.44868D-02  4.85000D+01
  6.67163D-02  4.95000D+01

  0.00000D+00  0.00000D+00
  1.00000D-05  5.00000D+04
  1.26265D-04  8.60104D+03
  2.18291D-04  1.08665D+04
  3.03681D-04  1.17110D+04
  4.53831D-04  6.66001D+03
  6.52466D-04  5.03436D+03
  9.27883D-04  3.63086D+03
  1.25604D-03  3.04732D+03
  1.64243D-03  2.58806D+03
  2.11007D-03  2.13840D+03
  2.65619D-03  1.83110D+03
  3.29081D-03  1.57575D+03
  4.00837D-03  1.39361D+03
  4.81838D-03  1.23455D+03
  5.72335D-03  1.10501D+03
  6.71387D-03  1.00957D+03
  7.80492D-03  9.16548D+02
  8.96870D-03  8.59269D+02
  1.02228D-02  7.97385D+02
  1.15575D-02  7.49232D+02
  1.29424D-02  7.22074D+02
  1.43960D-02  6.87947D+02
  1.59097D-02  6.60633D+02
  1.74780D-02  6.37633D+02
  1.90987D-02  6.17017D+02
  2.07639D-02  6.00528D+02
  2.24731D-02  5.85069D+02
  2.42193D-02  5.72672D+02
  2.60043D-02  5.60224D+02
  2.78238D-02  5.49602D+02
  2.96763D-02  5.39811D+02
  3.15569D-02  5.31745D+02
  3.34638D-02  5.24411D+02
  3.53990D-02  5.16742D+02
  3.73571D-02  5.10699D+02
  3.93367D-02  5.05153D+02
  4.13384D-02  4.99575D+02
  4.33603D-02  4.94584D+02
  4.54010D-02  4.90028D+02
  4.74597D-02  4.85743D+02
  4.95358D-02  4.81672D+02
  5.16282D-02  4.77920D+02
  5.37334D-02  4.75014D+02
  5.58556D-02  4.71209D+02
  5.79903D-02  4.68450D+02
  6.01397D-02  4.65246D+02
  6.23021D-02  4.62449D+02
  6.44868D-02  4.57729D+02
  6.67163D-02  4.48531D+02
```

wave61.txt

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 0.000010000    1.5
 0.000126265    2.5
 0.000218291    3.5
 0.000303681    4.5
 0.000453831    5.5
 0.000652466    6.5
 0.000927883    7.5
 0.00125604     8.5
 0.00164243     9.5
 0.00211007    10.5
 0.00265619    11.5
 0.00329081    12.5
 0.00400837    13.5
 0.00481838    14.5
 0.00572335    15.5
 0.00671387    16.5
 0.00780492    17.5
 0.00896870    18.5
 0.0102228     19.5
 0.0115575     20.5
 0.0129424     21.5
 0.0143960     22.5
 0.0159097     23.5
 0.0174780     24.5
 0.0190987     25.5
 0.0207639     26.5
 0.0224731     27.5
 0.0242193     28.5
 0.0260043     29.5
 0.0278238     30.5
 0.0296763     31.5
 0.0315569     32.5
 0.0334638     33.5
 0.0353990     34.5
 0.0373571     35.5
 0.0393367     36.5
 0.0413384     37.5
 0.0433603     38.5
 0.0454010     39.5
 0.0474597     40.5
 0.0495358     41.5
 0.0516282     42.5
 0.0537334     43.5
 0.0558556     44.5
 0.0579903     45.5
 0.0601397     46.5
 0.0623021     47.5
 0.0644868     48.5
 0.0667163     49.5
```

List of input files

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