

# 1. Создаем новый проект

**1) Нажимаем**

**2) Указываем папку и название проекта**

**3) Выбираем единицы измерения**

**4) Нажимаем**

В случае двухмерной осевой симметрии осью симметрии является ось X

Folder: D:\Autodyn\11\70mm

Ident: !

Heading:

Description:

Symmetry:  2D  3D

Units:

Length	Mass	Time
<input type="radio"/> μm	<input type="radio"/> pg	<input type="radio"/> μs
<input type="radio"/> mm	<input type="radio"/> mg	<input type="radio"/> ms
<input checked="" type="radio"/> cm	<input checked="" type="radio"/> g	<input checked="" type="radio"/> s
<input type="radio"/> m	<input type="radio"/> kg	
<input type="radio"/> in	<input type="radio"/> lbm	
<input type="radio"/> ft		

Folder: D:\Autodyn\Test

Ident: ✓ Test

Heading:

Description:

Symmetry:  2D  3D  Axial  Planar

Units:

Length	Mass	Time
<input type="radio"/> μm	<input type="radio"/> pg	<input checked="" type="radio"/> μs
<input type="radio"/> mm	<input type="radio"/> mg	<input type="radio"/> ms
<input checked="" type="radio"/> cm	<input checked="" type="radio"/> g	<input type="radio"/> s
<input type="radio"/> m	<input type="radio"/> kg	
<input type="radio"/> in	<input type="radio"/> lbm	
<input type="radio"/> ft		

## 2. Определяем материалы

1) Нажимаем

2) Выбираем материалы. Можно сразу несколько (удерживая «Control»)

3) Нажимаем

Material Name	Equation of State	Strength Model	Failure Model
24DNUJ1	Lee-Tarver	von Mises	None
ADIPRENE	Shock	None	None
AIR	Ideal Gas	None	None
AL 1100-O	Shock	Steinberg Guinan	None
AL 2024	Shock	None	None
AL 2024-T4	Shock	Steinberg Guinan	None
AL 6061-T6	Shock	Steinberg Guinan	None
AL 7039	Shock	Johnson Cook	None
AL 7075-T6	Shock	Steinberg Guinan	None
AL 921-T	Shock	None	None
AL-2024-T3	Tillotson	None	None
AL2024T351	Shock	Johnson Cook	None
AL203-99.5	Polynomial	Johnson-Holmquist	Johnson Holmquist
AL203-99.7	Polynomial	Johnson-Holmquist	Johnson Holmquist
AL203 CERA	Shock	von Mises	None
AL5083H116	Linear	Johnson Cook	None
AL6061-T6	Puff	von Mises	Hydro (Pmin)
ALUMINIUM	Tillotson	None	None
ALUMINIUM	Shock	von Mises	None
ANB 3066J1	Lee-Tarver	von Mises	None
ANFO	JWL	None	None
ANTIMONY	Shock	None	None
Al/AP HE	JWL	None	None
BARIUM	Shock	None	None
BE (S200)	Puff	von Mises	Hydro (Pmin)
BERYLLIUM	Shock	None	None
BERYLLIUM	Shock	Steinberg Guinan	None
BERYLLIUM	Tillotson	None	None

test  
Cycle 0  
Time 0.000E+000  $\mu$ s  
Units cm, g,  $\mu$ s  
Axial symmetry

### 3. Редактируем свойства материалов

1) Выбираем материал и нажимаем

Для каждого материала

2) Разворачиваем и выбираем способ и критерий «эрозии»

3) Нажимаем

**Material Data Input - AL 2024-T4**

Name	AL 2024-T4
Reference Density	2.785000 (g/cm3)
<b>EOS</b>	Shock
Gruneisen coefficient	2.000000 (none)
Parameter C1	0.532800 (cm/us)
Parameter S1	1.338000 (none)
Parameter Quadratic S2	0.000000 (us/cm)
Relative volume, VE/V0	0.000000 (none)
Relative volume, VB/V0	0.000000 (none)
Parameter C2	0.000000 (cm/us)
Parameter S2	0.000000 (none)
Reference Temperature	300.000000 (K)
Specific Heat	8.630001e-006 (Terg/gK)
Thermal Conductivity	0.000000 (Terg/mKus)
<b>Strength</b>	
<b>Failure</b>	None
<b>Erosion</b>	Geometric Strain
Erosion Strain	2.000000 (none)
Type of Geometric Strain	Instantaneous

## 4. Определяем геометрию

ANSYS Workbench [AUTODYN]

[Project] test [AUTODYN]

File Import Setup View Options Help

View

Plots

Settings

History

Slides

View Slides

Setup

Materials

Init. Cond.

Boundaries

Parts

Component

Groups

Joins

Interaction

Detonation

Parallel

Controls

Output

User var.

Run

AUTODYN-2D v11.0 from Century Dynamics

Material Location

AL 2024-T4

PAR

STE

test

Cycle 0

Time 0.000E+000  $\mu$ s

Units cm, g,  $\mu$ s

Axial symmetry

2) Нажимаем

3) Даем название и определяем тип элементов

1) Нажимаем

4) Нажимаем

Create New Part

Part name

Solver

Definition

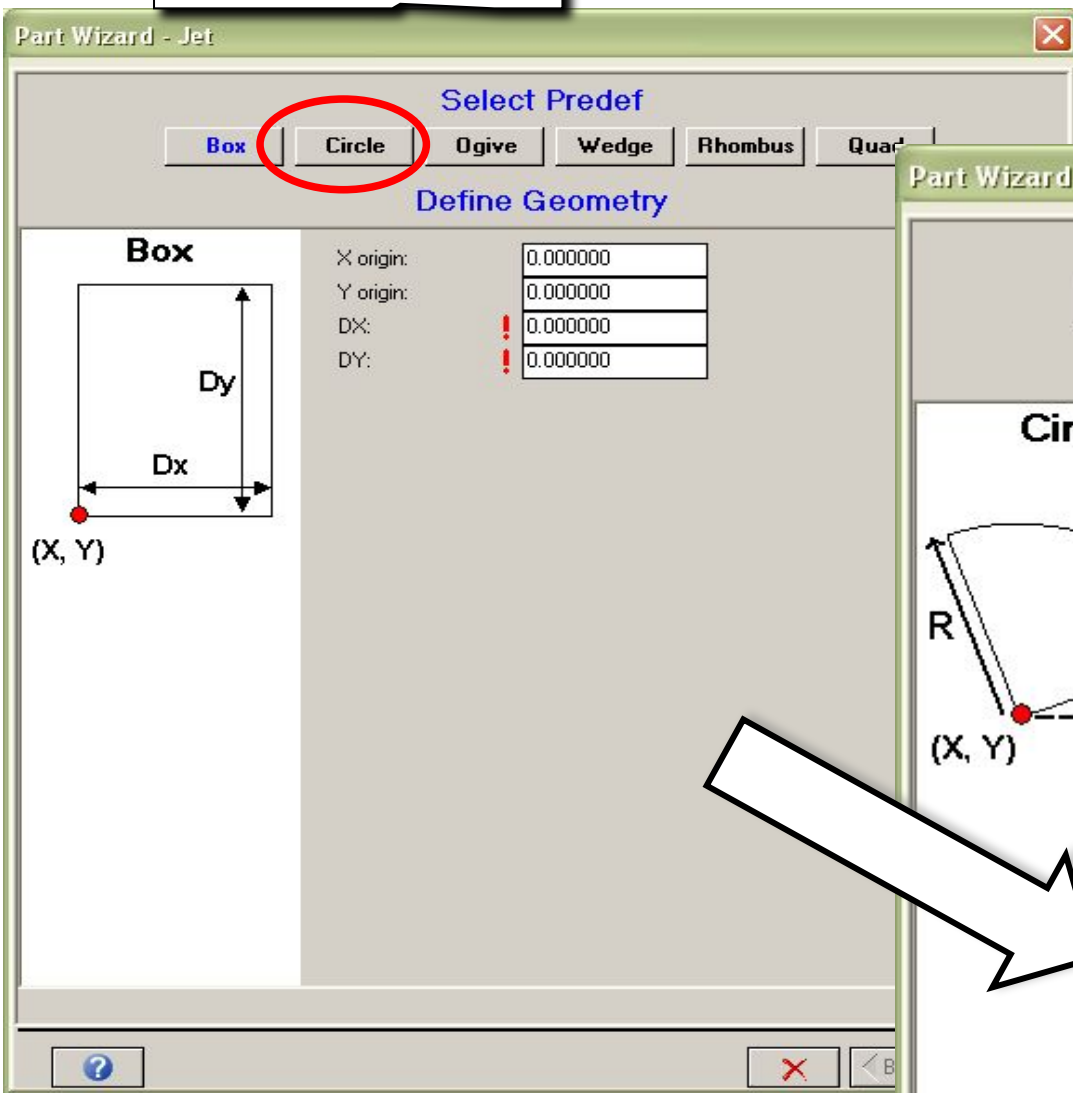
Create New Part

Part name

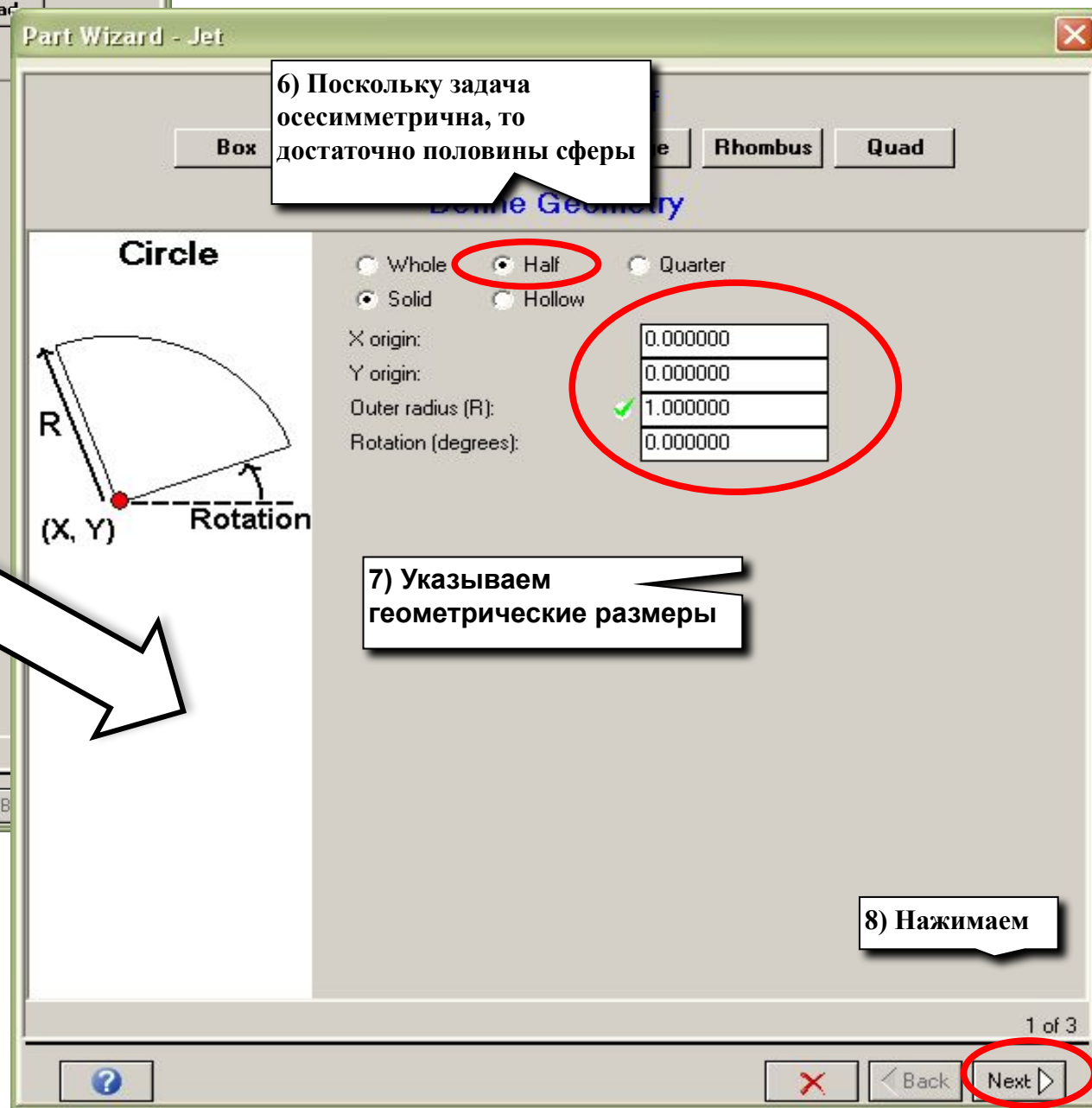
Solver

Definition

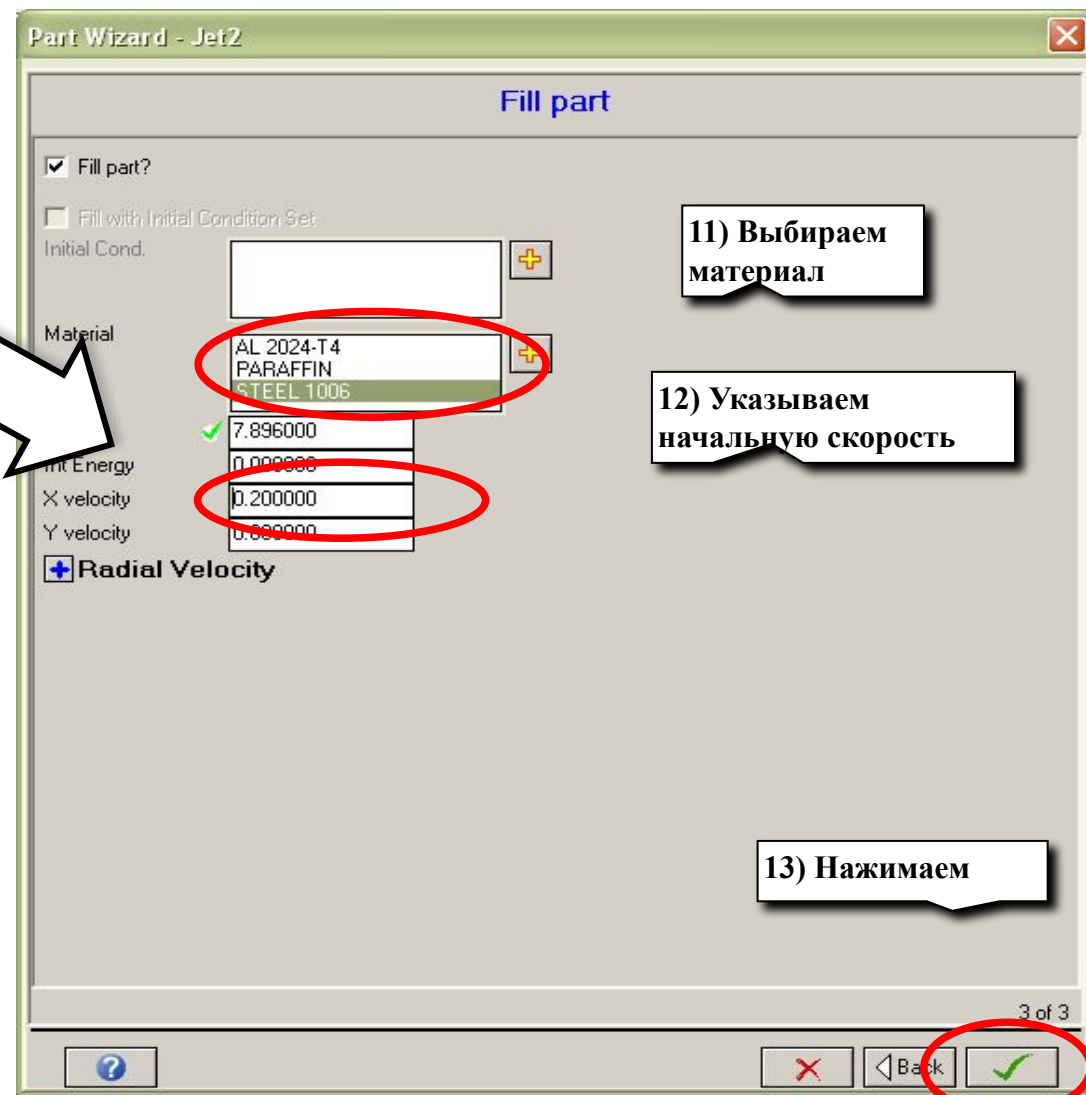
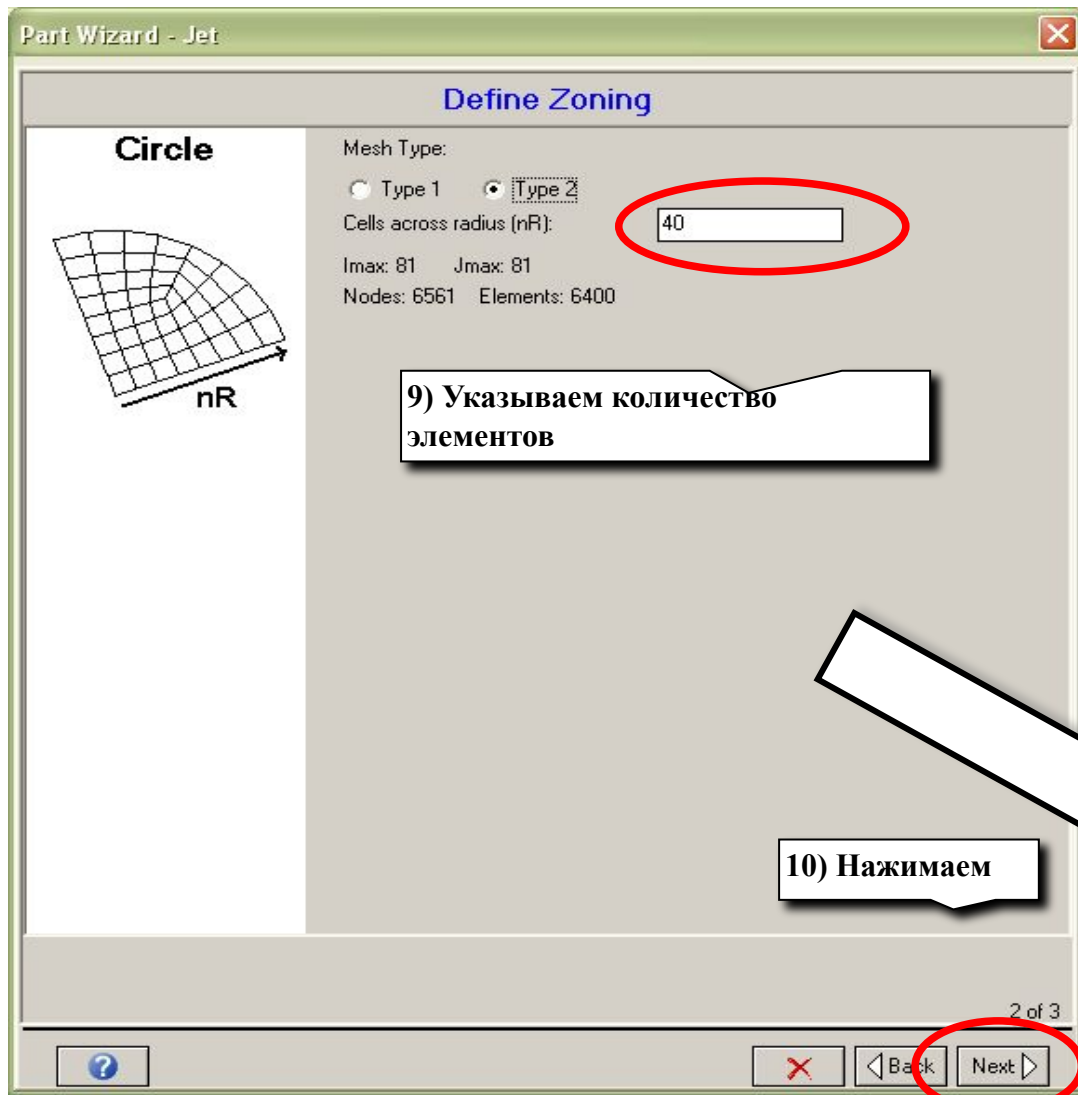
5) Выбираем геометрию детали



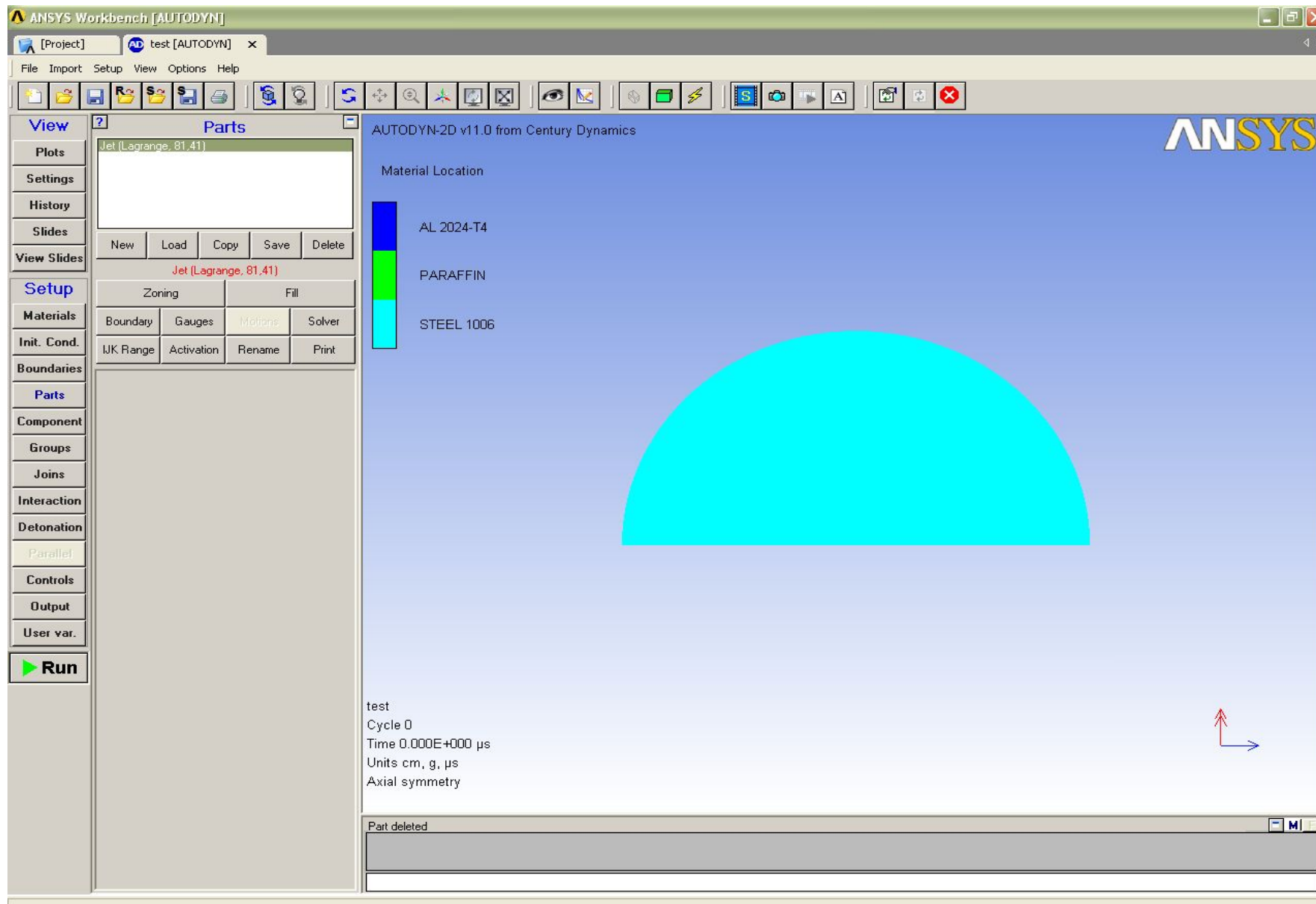
6) Поскольку задача осесимметрична, то достаточно половины сферы

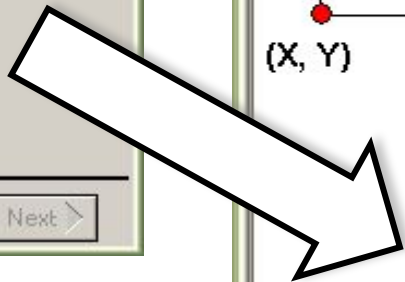
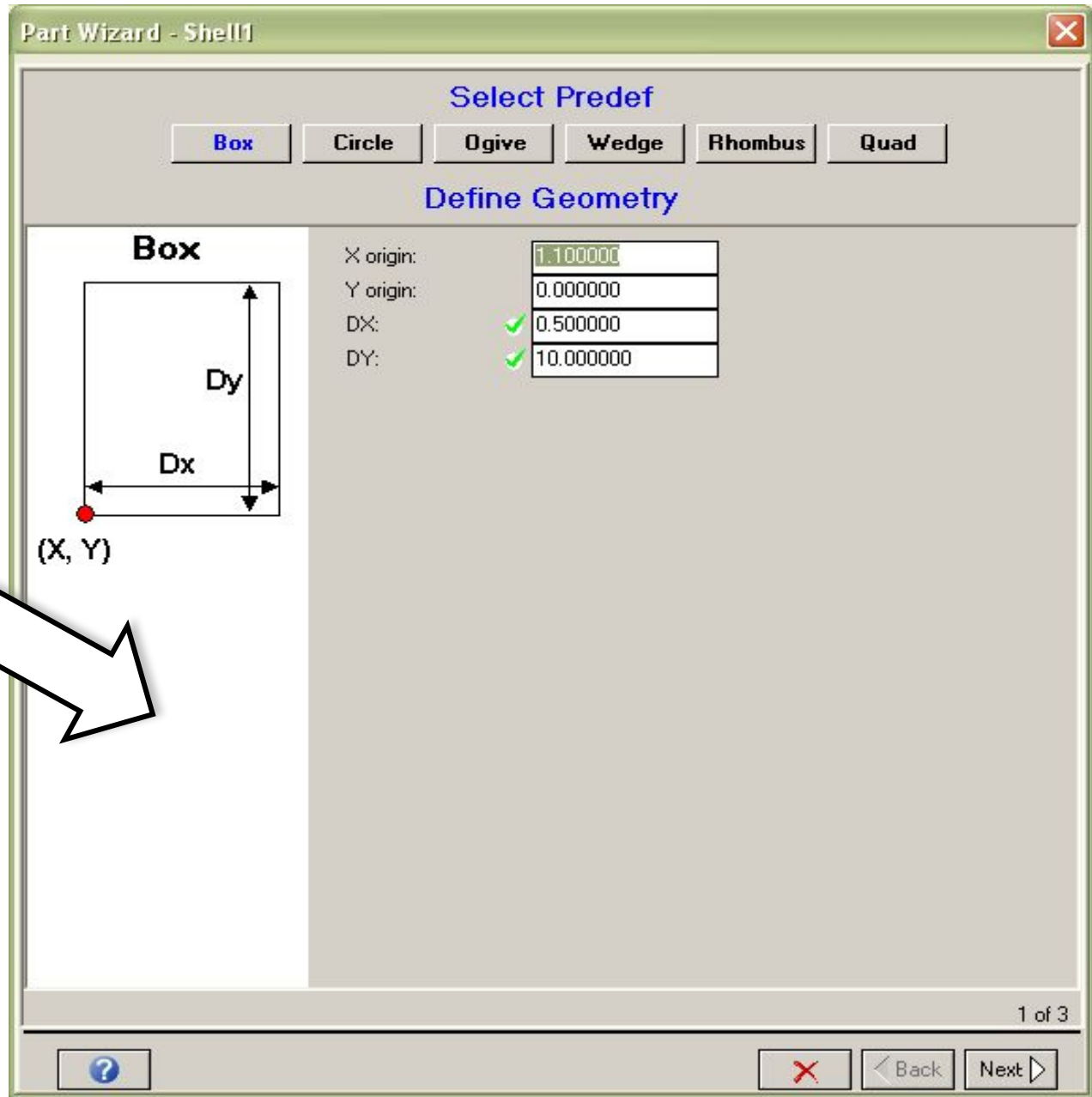
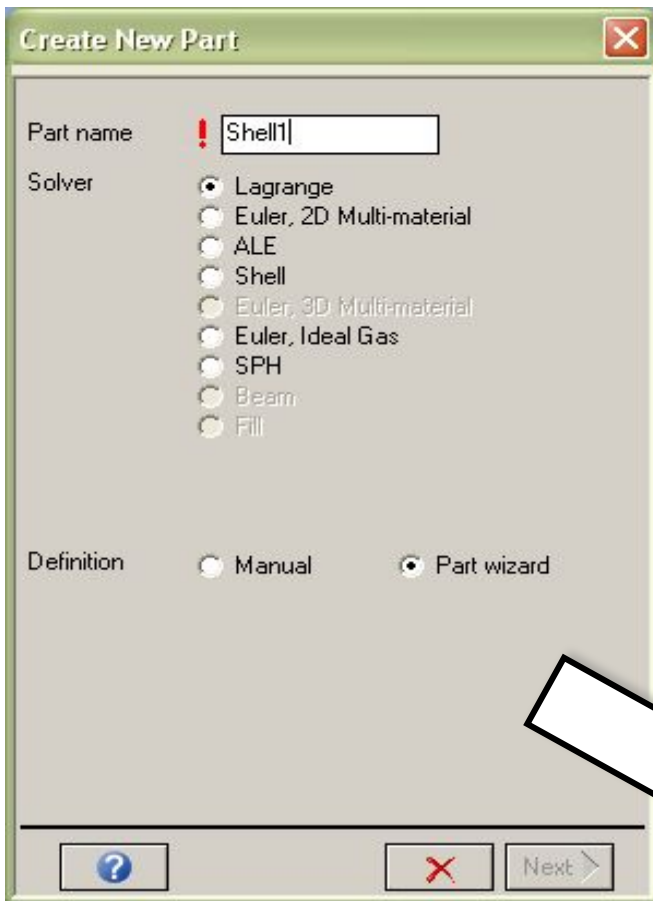






#### 4. Первая деталь готова. По аналогии создаем остальные.







### Part Wizard - Shell1

#### Define Zoning

**Box**

Cells in I direction:   
Cells in J direction:

Nodes: 1661 Elements: 1500

Grade zoning in I-direction:  
 Grade zoning in J-direction:

Fixed size (dy):    
Times (nJ):

Centred  Lower J  Upper J

Buttons: ? [X] < Back Next >

### Part Wizard - Shell1

#### Fill part

Fill part?  
 Fill with Initial Condition Set

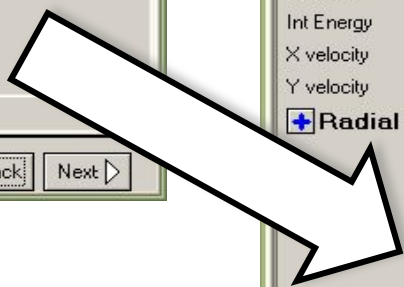
Initial Cond.  +

Material  +

Density    
Int Energy   
X velocity   
Y velocity   
 Radial Velocity

3 of 3

Buttons: ? [X] < Back ✓



# Одну из деталей получим копированием существующей

ANSYS Workbench [AUTODYN]

[Project] test [AUTODYN] x

File Import Setup View Options Help

View ? Parts

Plots

Settings

History

Slides

View Slides

Setup

Materials

Init. Cond.

Boundaries

Parts

Component

Groups

Joins

Interaction

Detonation

Parallel

Controls

Output

User var.

Run

Jet (Lagrange, 81,41)  
Shell1 (Lagrange, 11,151)

1) Нажимаем

New Load Copy Save Delete

Shell1 (Lagrange, 11,151)

Zoning Fill

Boundary Gauges Motions Solver

IJK Range Activation Rename Print

AUTODYN.2D.v11.0 from Century Dynamics

Copy Part

Select Part to copy:

Jet (Lagrange, 81,41) ML

Shell1 (Lagrange, 11,151) ML

2) Выбираем копируемую деталь

New Part Name !

3) Указываем имя новой детали

4) Нажимаем

test  
Cycle 0  
Time 0.000E+000  $\mu$ s  
Units cm, g,  $\mu$ s  
Axial symmetry

Zoning box data

После копирования новая деталь расположена там же где исходная, поэтому перемещаем ее в нужное место

The screenshot displays the ANSYS Workbench [AUTODYN] interface. The main window shows a project named 'test [AUTODYN]'. The 'Parts' list on the left contains 'Jet [Lagrange, 81,41]', 'Shell1 [Lagrange, 11,151]', and 'Shell2 [Lagrange, 11,151]'. The 'Setup' panel is open, showing 'Zoning' settings. The 'Zoning for IJK range' section is visible, with 'From I = 1' and 'To I = 11', and 'From J = 1' and 'To J = 151'. The 'Manual Zoning' section is also open, showing 'Transformations' with 'Translate', 'Rotate', and 'Scale' options. The 'Zoning Transformation' dialog box is open, showing the 'Translate' tab. The 'X distance (DX)' is set to 1.500000 and the 'Y distance (DY)' is set to 0.000000. The 'OK' button is highlighted with a red circle.

1) Выбираем деталь

2) Нажимаем

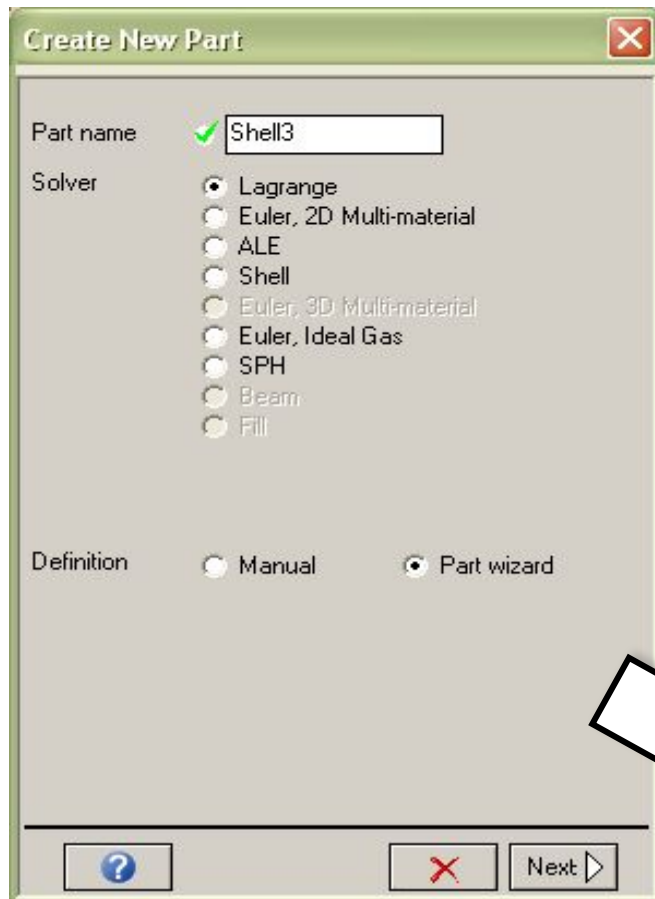
3) Нажимаем

4) Нажимаем

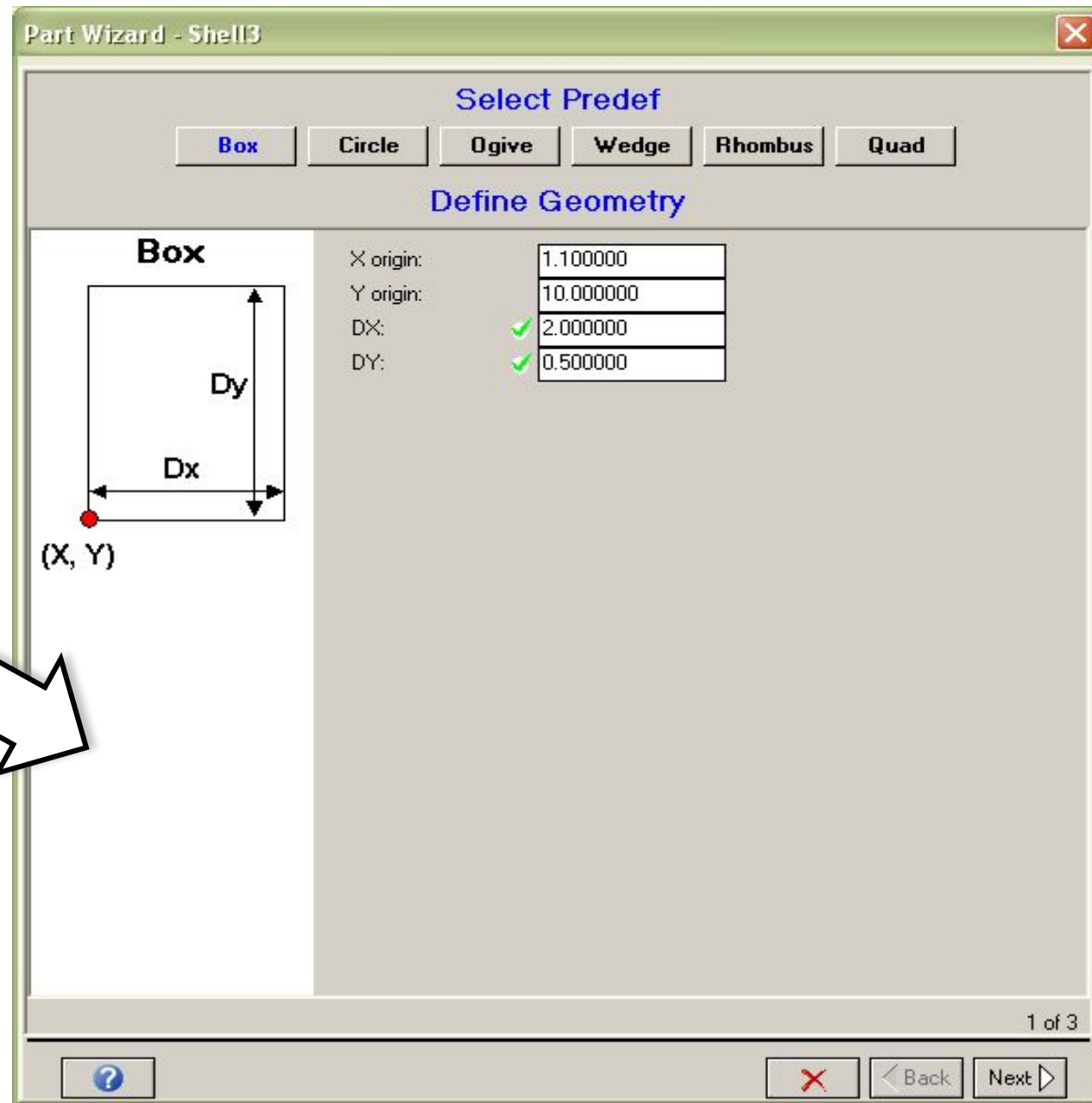
5) Указываем перемещения

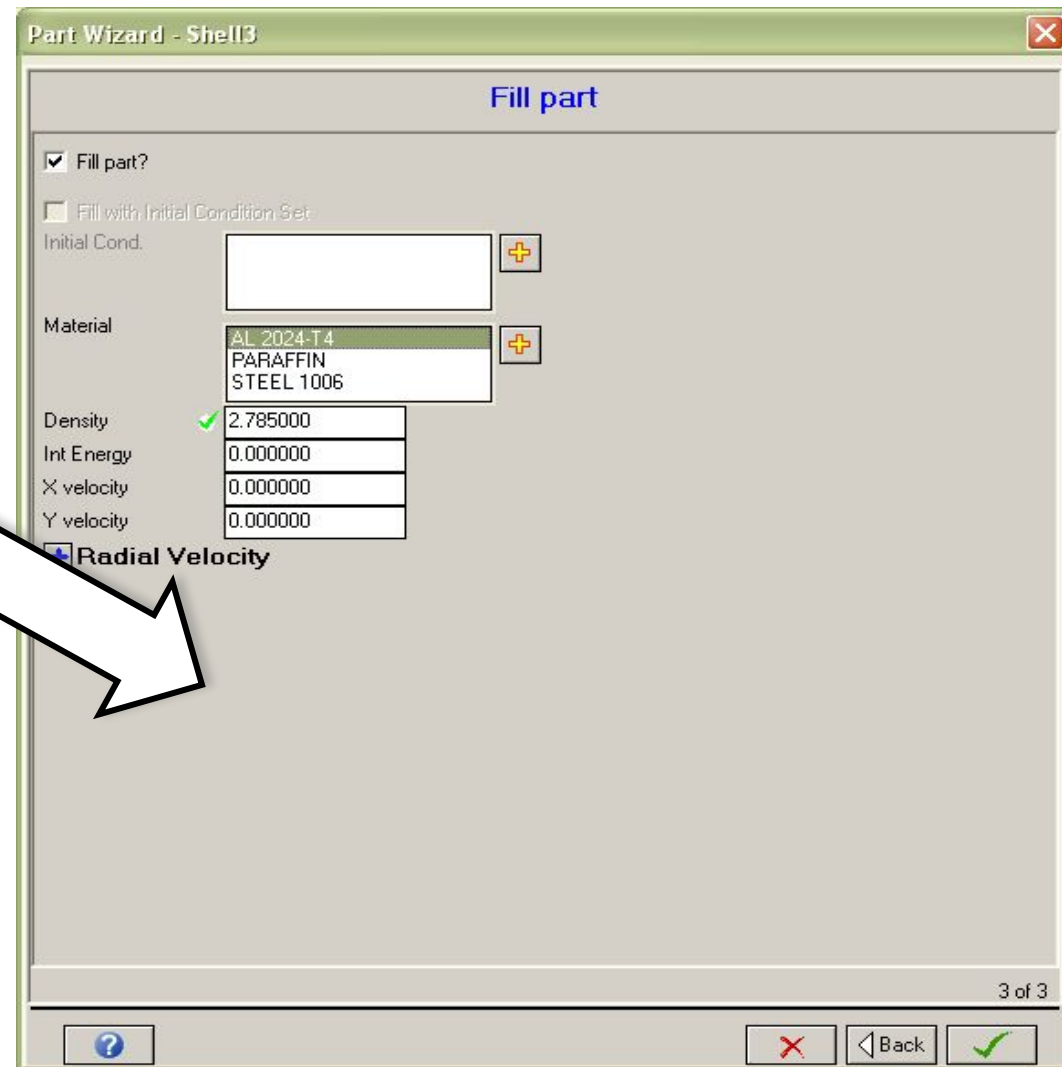
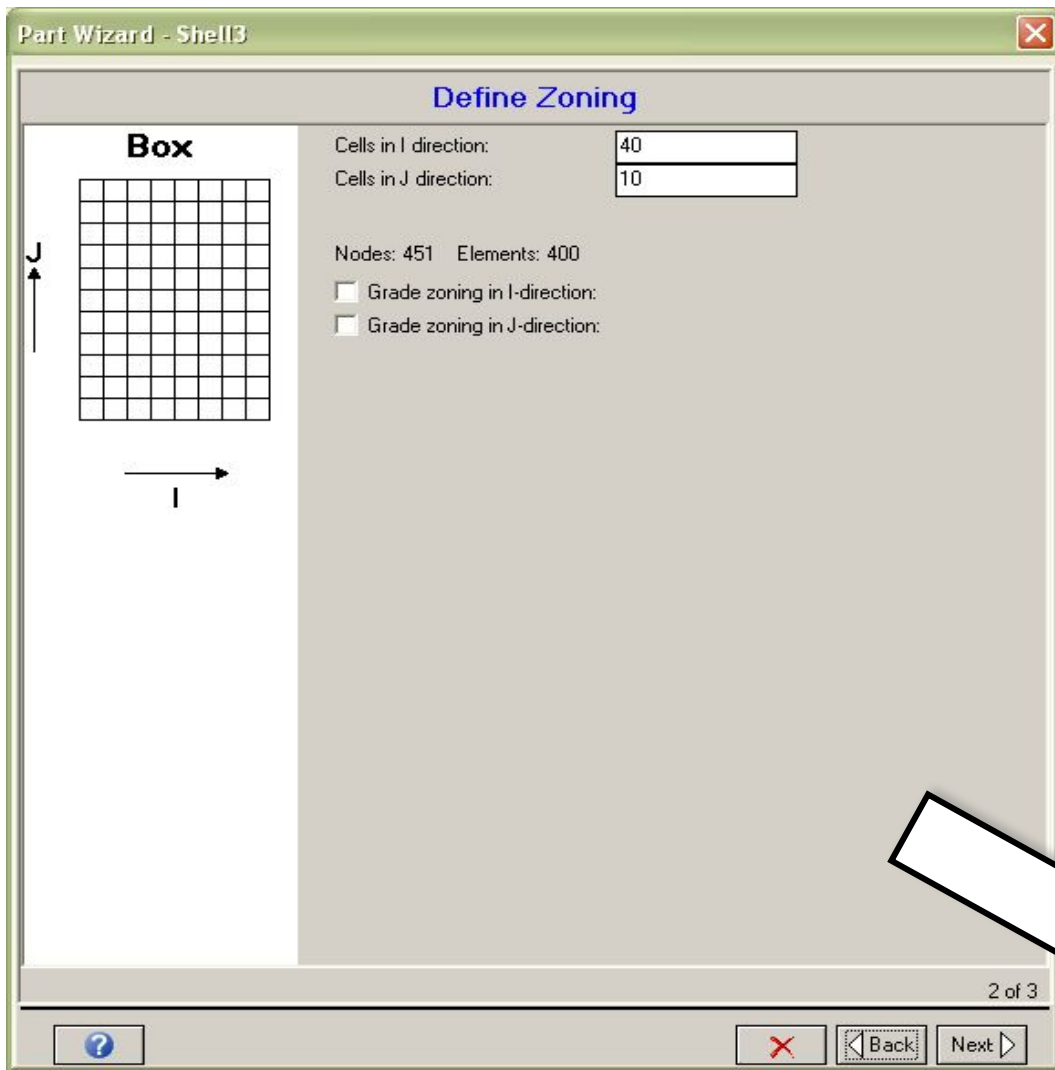
6) Нажимаем

## Продолжаем создавать детали



При создании не связанных (не «склеенных») деталей между ними необходимо оставлять зазоры размером 0,1...0,5 размера ячейки (для осуществления алгоритма взаимодействия поверхностей).







### Create New Part

Part name  PF

Solver

- Lagrange
- Euler, 2D Multi-material
- ALE
- Shell
- Euler, 3D Multi-material
- Euler, Ideal Gas
- SPH
- Beam
- Fill

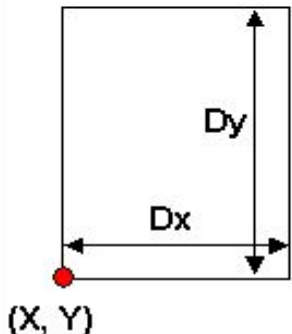
Definition  Manual  Part wizard

### Part Wizard - PF

Select Predef

Define Geometry

**Box**



X origin: 1.605000  
Y origin: 0.000000  
DX:  0.990000  
DY:  8.995000

1 of 3

### Part Wizard - PF

#### Define Zoning

**Box**

Cells in I direction:

Cells in J direction:

Nodes: 3171 Elements: 3000

Grade zoning in I-direction:

Grade zoning in J-direction:

Fixed size (dy):

Times (nJ):

Centred  Lower J  Upper J

Buttons: ? [X] < Back Next >

### Part Wizard - PF

#### Fill part

Fill part?

Fill with Initial Condition Set

Initial Cond.  +

Material

- AL 2024-T4
- PARAFFIN**
- STEEL 1006

Density

Int Energy

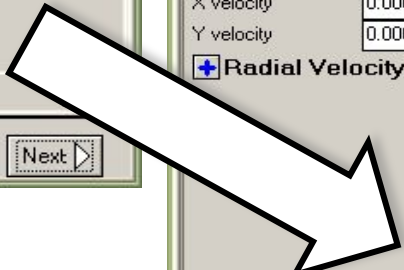
X velocity

Y velocity

Radial Velocity

Buttons: ? [X] < Back [✓]

3 of 3



## 5. Склеиваем части, образуя единую деталь

ANSYS Workbench [AUTODYN]

[Project] test [AUTODYN] x

File Import Setup View Options Help

View Define Joins

Plots **Join** Join All Unjoin Unjoin All

Settings Matrix Review

History

Slides

View Slides

Setup

Materials  Plot joined nodes  
 Plot joined parts  
 Remove joined faces from plot

Init. Cond.

Boundaries

Parts

Component

Groups

**Joins**

Interaction

Detonation

Parallel

Controls

Output

User var.

**Run**

Join parts

Select part(s):

Shell1  
Jet  
Shell2  
Shell3  
PF

Select part(s) to join to above list:

Shell1  
Jet  
Shell2  
Shell3  
PF

Apply X Join

test  
Cycle 0  
Time 0.000E+000 μs  
Units cm, g, μs  
Axial symmetry

Zoning box data

1) Нажимаем

2) Нажимаем

3) Выбираем склеиваемые части

4) Нажимаем

## 6. Определяем параметры взаимодействия

ANSYS Workbench [AUTODYN]

[Project] test [AUTODYN]

File Import Setup View Options Help

View Interactions

Lagrange/Lagrange Euler/Lagrange

Material Location

Interaction Gap

Gap size

Gap Type  External  Internal

Quick Check

2A) Или устанавливаем требуемый размер зазора в ручную.

2) Нажимаем

1) Нажимаем

Interaction

Self-interaction

Safety Factor  0.200000

Material Location

AL 2024-T4

STEEL 1006

test

Cycle 0

Time 0.000E+000  $\mu$ s

Units cm, g,  $\mu$ s

Axial symmetry

Gap size has been set to: 1.22E-03

# 7. Параметры расчета

ANSYS Workbench [AUTODYN]

File Import Setup View Options Help

View Define Solution Controls AUTODYN-2D v11.0 from Century Dynamics

Plots Settings History Slides View Slides

Setup Materials Init. Cond. Boundaries Parts Component Groups Joins Interaction Detonation Parallel Controls Output User var. Run

**Wrapup Criteria**

Cycle limit	10000
Time limit	50.000000
Energy fraction	0.050000
Energy ref. cycle	0

**Timestep Options**

Start time	0.000000
Minimum timestep	0.000000
Maximum timestep	1.000000e+008
Initial timestep	0.000000
Safety factor	0.666600
Method of calculating characteristic zone dimension	Diagonals

**2) Указываем**

**1) Нажимаем**

Если минимальный шаг по времени не указан, то он принимается равным 1/10 от начального.

AL 2024-T4

test  
Cycle 0  
Time 0.000E+000 μs  
Units cm, g, μs  
Axial symmetry

Gap size has been set to: 1.22E-03



## 7. Результаты

The screenshot displays the ANSYS Workbench [AUTODYN] interface. The main window shows a simulation setup for a vertical bar with a semi-circular base. The bar is colored blue and green. The interface includes a toolbar, a left sidebar with various tabs, and a central workspace.

**Define Output Panel:**

- Interrupt:** Refresh (checked)
- History:** Display freq. 25, Text freq. 1
- Save:** (unchecked)
- Setup:** Cycles (selected), Times (unselected); Start cycle 0, End cycle 100000000, Increment 25
- History:** (checked)
- Capture image:** (checked)
- Print:** (checked)
- Log file(on):** (checked)
- 1) Нажимаем:** (checked)

**Output Panel:**

- Output:** (circled in red)
- User var.:** (unchecked)
- Run:** (green play button)

**Annotations:**

- Частота обновления информации на экране в процессе расчета** (Frequency of information update on the screen during calculation)
- Частота сохранения промежуточных результатов в процессе расчета** (Frequency of saving intermediate results during calculation)
- 1) Нажимаем** (1) We click)

**Simulation Parameters:**

- AL 2024-T4
- test
- Cycle 0
- Time 0.000E+000  $\mu$ s
- Units cm, g,  $\mu$ s
- Axial symmetry

**Outputs set:**

test

## 8. Изменение представления данных

ANSYS Workbench [AUTODYN]

[Project] test [AUTODYN]

File Import Setup

**1) Нажимаем**

View Plots

Select: Parts Cycle: <no name>

Settings History Slides View Slides

Setup

Materials Init. Cond. Boundaries Parts Component Groups Joins Interaction Detonation Parallel Controls Output User var.

**2) Нажимаем**

Fill type

Grid Material Location Material Status

**Contour**

Contour variable: PRESSURE

Change variable View range

Mirror

in plane x = 0 in plane y = 0 in plane z = 0

Rotate 90 deg. Extrude 1.000000

Pressure (Mbar) plot area

**3) Нажимаем**

**Run**

**4) Отключаем сглаживание**

Contour Plot Settings

Change variable

Profile window smoothing Min/Max Value Fragment Plot

Number of contours: 10

Grid lines: None **Outline** Solid Black White

Contour scales: Fix scales Min: 0.000000

**5) Показываем границы деталей**

test Cycle 0 Time 0.000E+000  $\mu$ s Units cm, g,  $\mu$ s Axial symmetry

**6) Нажимаем**

Outputs set



View

- Plots
- Settings
- History
- Slides
- View Slides

Setup

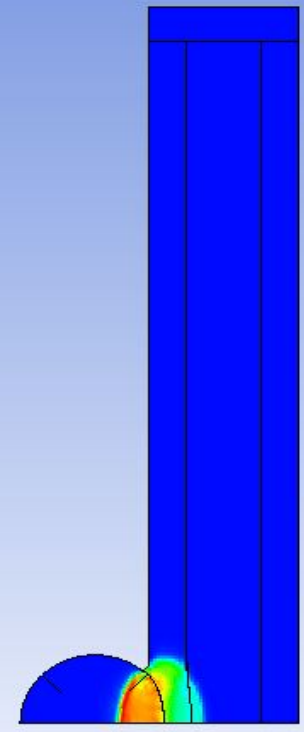
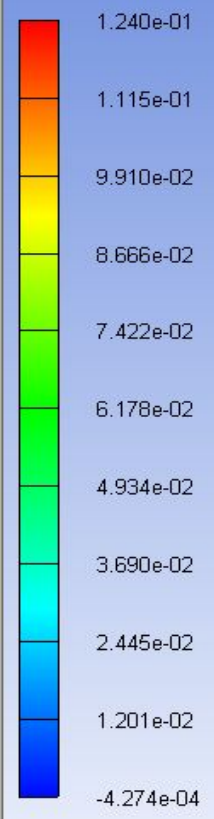
- Materials
- Init. Cond.
- Boundaries
- Parts
- Component
- Groups
- Joins
- Interaction
- Detonation
- Parallel
- Controls
- Output
- User var.

Stop

AUTODYN-2D v11.0 from Century Dynamics



PRESSURE (Mbar)



test  
Cycle 1800  
Time 1.841E+000  $\mu$ s  
Units cm, g,  $\mu$ s  
Axial symmetry



CYCLE: 1814, Time: 1.851E+00, Timestep: 7.433E-04 controlled by Interaction, factor: 10





View

- Plots
- Settings
- History
- Slides
- View Slides

Setup

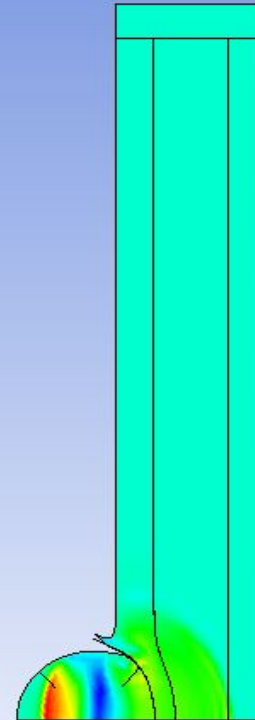
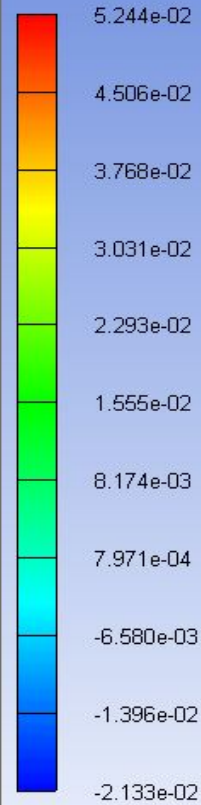
- Materials
- Init. Cond.
- Boundaries
- Parts
- Component
- Groups
- Joins
- Interaction
- Detonation
- Parallel
- Controls
- Output
- User var.

■ Stop

AUTODYN-2D v11.0 from Century Dynamics



PRESSURE (Mbar)



test  
Cycle 4175  
Time 3.821E+000  $\mu$ s  
Units cm, g,  $\mu$ s  
Axial symmetry

CYCLE: 4199, Time: 3.847E+00, Timestep: 1.091E-03 controlled by Interaction, factor: 4



View

- Plots
- Settings
- History
- Slides
- View Slides

Setup

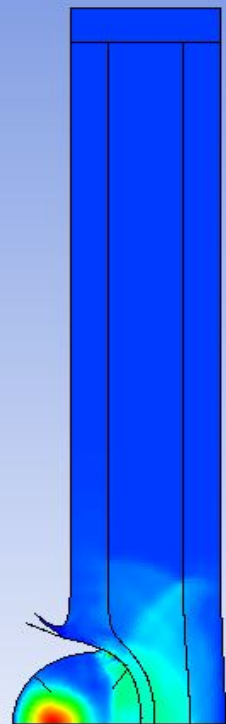
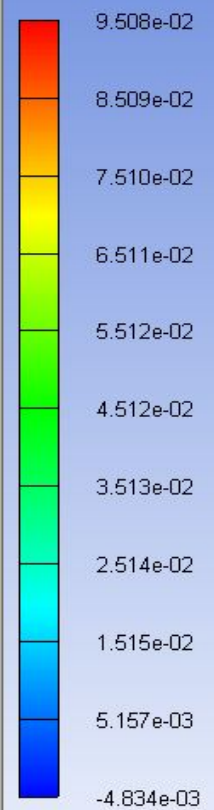
- Materials
- Init. Cond.
- Boundaries
- Parts
- Component
- Groups
- Joins
- Interaction
- Detonation
- Parallel
- Controls
- Output
- User var.

■ Stop

AUTODYN-2D v11.0 from Century Dynamics



PRESSURE (Mbar)



test  
Cycle 6525  
Time 6.574E+000  $\mu$ s  
Units cm, g,  $\mu$ s  
Axial symmetry



CYCLE: 6548, Time: 6.603E+00, Timestep: 1.226E-03 controlled by Interaction, factor: 2





View

- Plots
- Settings
- History
- Slides
- View Slides

Setup

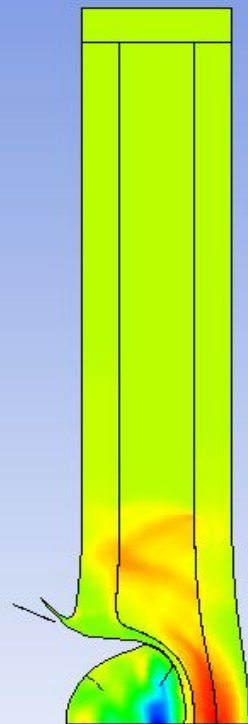
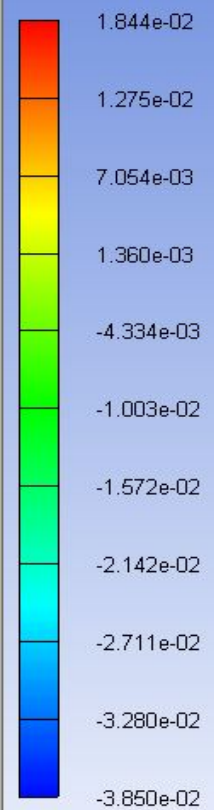
- Materials
- Init. Cond.
- Boundaries
- Parts
- Component
- Groups
- Joins
- Interaction
- Detonation
- Parallel
- Controls
- Output
- User var.

■ Stop

AUTODYN-2D v11.0 from Century Dynamics



PRESSURE (Mbar)



test  
Cycle 8875  
Time 9.497E+000  $\mu$ s  
Units cm, g,  $\mu$ s  
Axial symmetry



CYCLE: 8883, Time: 9.507E+00, Timestep: 1.245E-03 controlled by Interaction, factor: 2





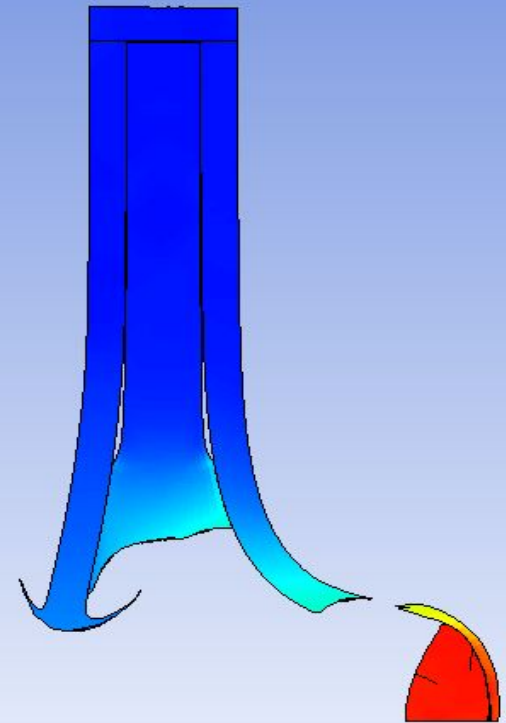
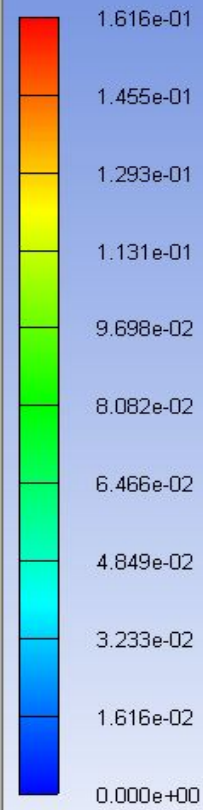
- View
- Plots
- Settings
- History
- Slides
- View Slides

- Setup
- Materials
- Init. Cond.
- Boundaries
- Parts
- Component
- Groups
- Joins
- Interaction
- Detonation
- Parallel
- Controls
- Output
- User var.
- Stop

AUTODYN-2D v11.0 from Century Dynamics



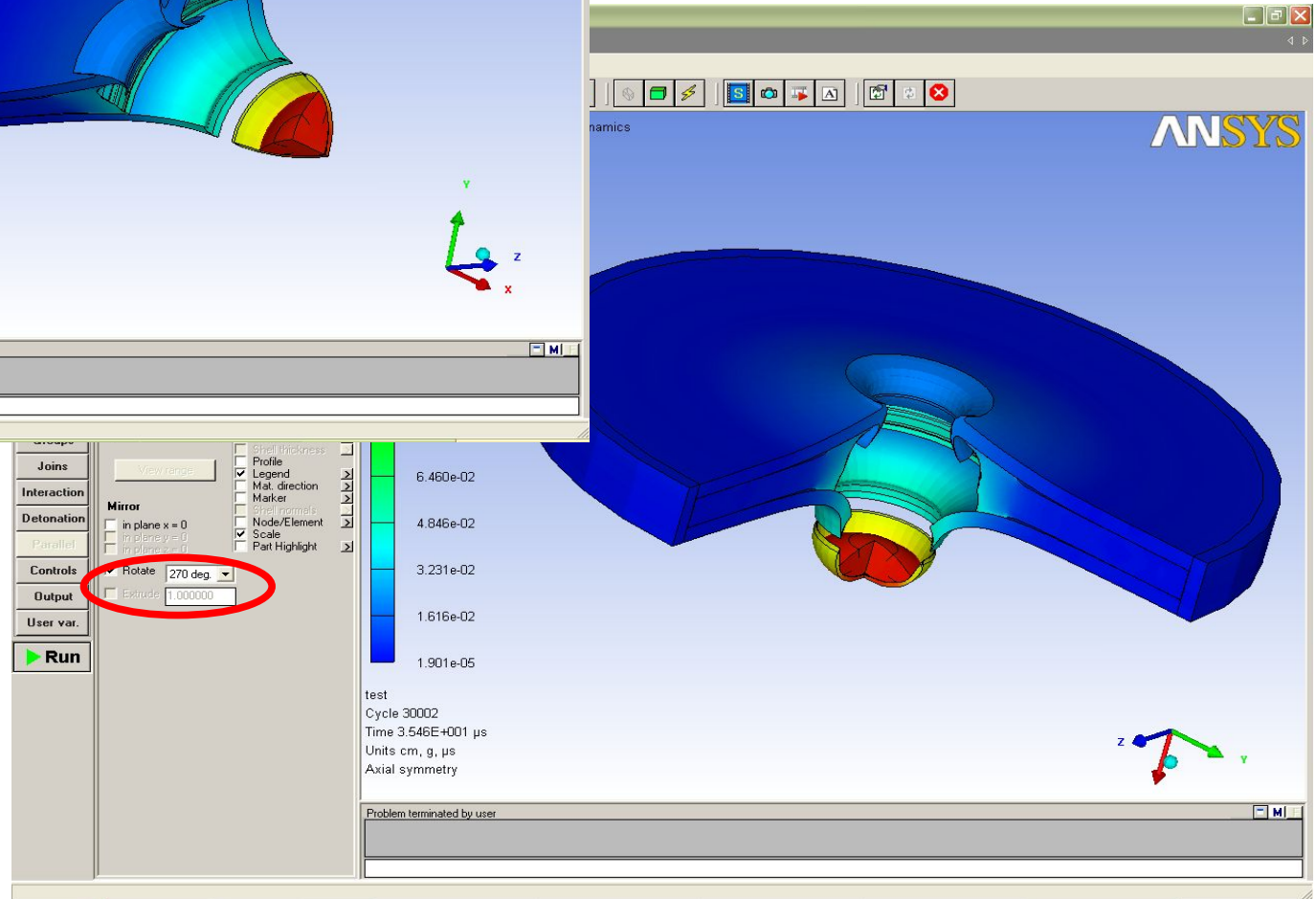
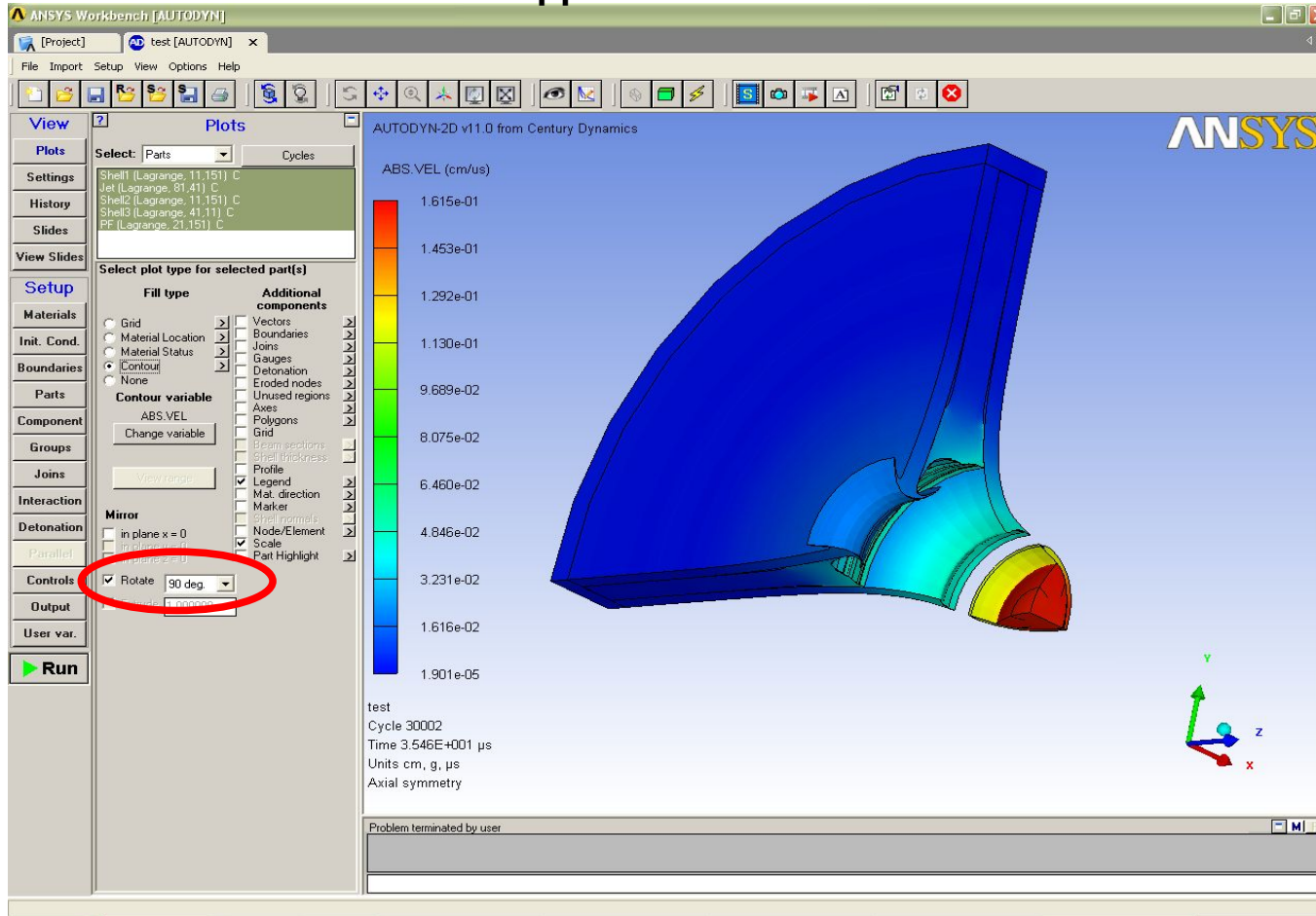
ABS.VEL (cm/us)

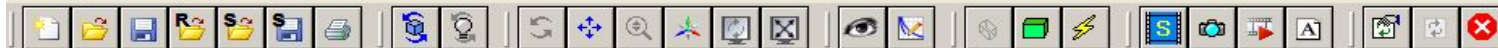


test  
Cycle 29725  
Time 3.505E+001  $\mu$ s  
Units cm, g,  $\mu$ s  
Axial symmetry

CYCLE: 29725, Time: 3.505E+01, Timestep: 1.482E-03 controlled by Interaction, factor: 3

# Представление в «объемном» виде





**View** ?

**Plots**

**Settings**

**History**

**Slides**

**View Slides**

**Setup**

**Materials**

**Init. Cond.**

**Boundaries**

**Parts**

**Component**

**Groups**

**Joins**

**Interaction**

**Detonation**

**Parallel**

**Controls**

**Output**

**User var.**

**Run**

**Plots**

Select: Parts Cycles

Shell1 (Lagrange, 11,151) ML  
Jet (Lagrange, 81,41) ML  
Shell2 (Lagrange, 11,151) ML  
Shell3 (Lagrange, 41,11) ML  
PF (Lagrange, 21,151) ML

Select plot type for selected part(s)

**Fill type**

Grid >  
 Material Location >  
 Material Status >  
 Contour >  
 None

**Contour variable**

PRESSURE  
Change Variable

View range

**Mirror**

in plane x = 0  
 in plane y = 0  
 in plane z = 0

Rotate 270 deg.  
 Extrude 1.000000

**Additional components**

Vectors >  
 Boundaries >  
 Joins >  
 Gauges >  
 Detonation >  
 Eroded nodes >  
 Unused regions >  
 Axes >  
 Polygons >  
 Grid >  
 Beam sections >  
 Shell thickness >  
 Profile >  
 Legend >  
 Mat. direction >  
 Marker >  
 Shell normals >  
 Node/Element >  
 Scale >  
 Part Highlight >

AUTODYN-2D v11.0 from Century Dynamics

**Material Location**

AL 2024-T4  
PARAFFIN  
STEEL 1006

test  
Cycle 39561  
Time 5.000E+001  $\mu$ s  
Units cm, g,  $\mu$ s  
Axial symmetry

Problem terminated .... wrapup time reached