



CAE Fidesys overview and examples of its industrial applications

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CTO at Fidesys LLC



Introduction

Fidesys LLC is an engineering software company with offices in Moscow, Russia and NJ, USA, founded in 2009 as a research group of **Lomonosov Moscow State University**.

Fidesys LLC develops the next-gen universal software suite for high-end structural analysis (CAE, computer-aided engineering) using a new generation of FEA methods.

CAE Fidesys is used in mechanical engineering, mining, oil and gas industries.

The company is a resident of the **Skolkovo Innovation Center** and a member of **NAFEMS**, the International Association for the Engineering Modelling, Analysis and Simulation Community.

CAE Fidesys is verified according to the NAFEMS standards.





Our Team

- **20 programmers–mathematicians** (postgraduates, PhDs and PhD candidates from the top Russian universities*)
- **11 consulting professors**, working in the **Russian Academy of Sciences, Columbia University, University of New Hampshire** and **Iowa State University**
- Management, sales and marketing specialists with extensive experience in various technical fields and international background

Board of directors incl. top-mangers of IT industry (former VPs of PTC CIS, Autodesk CIS)

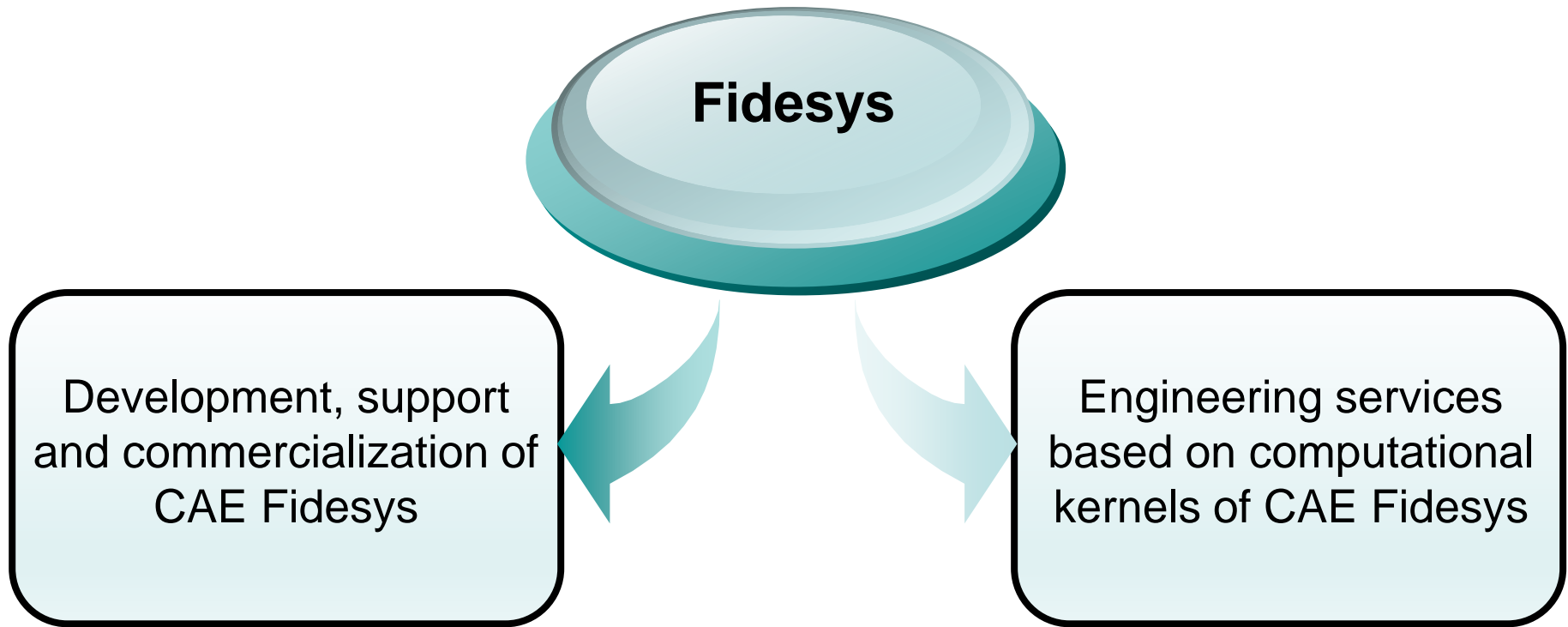
Key expertise: precise math modeling for structural analysis and related engineering fields

*incl. Lomonosov Moscow State University, Bauman Moscow State Technical University, Moscow Institute of Physics and Technology, and other leading regional universities





Business directions

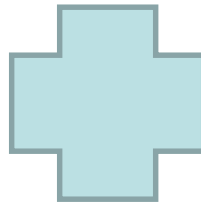




CAE Fidesys - Desktop bundles

CAE Fidesys Standard 1.7

- Linear problems of elasticity
- Plane stress and plane strains problems
- 3D static and dynamic (transient) analysis
- Modal and buckling analysis
- Beam/Shell/Solid elements and their combinations



CAE Fidesys Professional 1.7 = CAE Fidesys Standard 1.7 +

- Accurate estimation of the nonlinear effects: physical, geometrical and contact nonlinearities
- Problems for weakly compressible and completely incompressible materials
- Strength analysis for elastoplastic materials: Mises, Drucker-Prager
- Bonded/sliding/friction contacts
- Hyperelastic materials (Murnaghan, Mooney-Rivlin)
- Thermal conductivity and thermoelastic problems

✓ Fidesys HPC

- Parallelization of major stages of computational process
- Speed-up calculations by up to 30 times
- OpenMP technology: parallelization on all computational cores of a workstation
- MPI technology: parallelization on several workstations inside a network or on nodes of a supercomputer

✓ Fidesys Dynamics

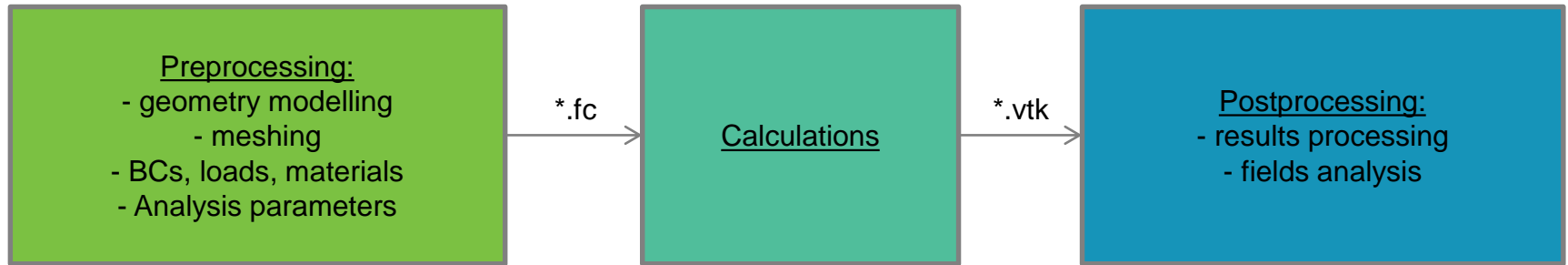
- Application of spectral element method for linear and nonlinear problems
- Non-stationary problems
- Full waveform modeling
- Seismic modeling
- Non-destructive control modeling

✓ Fidesys Composite

- Analysis of composites' effective properties
- Construction of the realistic composite's microstructure
- Strength analysis of tools and parts made of composite materials (including porous, fiber-laminated and woven composites)
- Estimation of effective properties of a monolayer
- Rubber-cord materials modelling



Analysis process



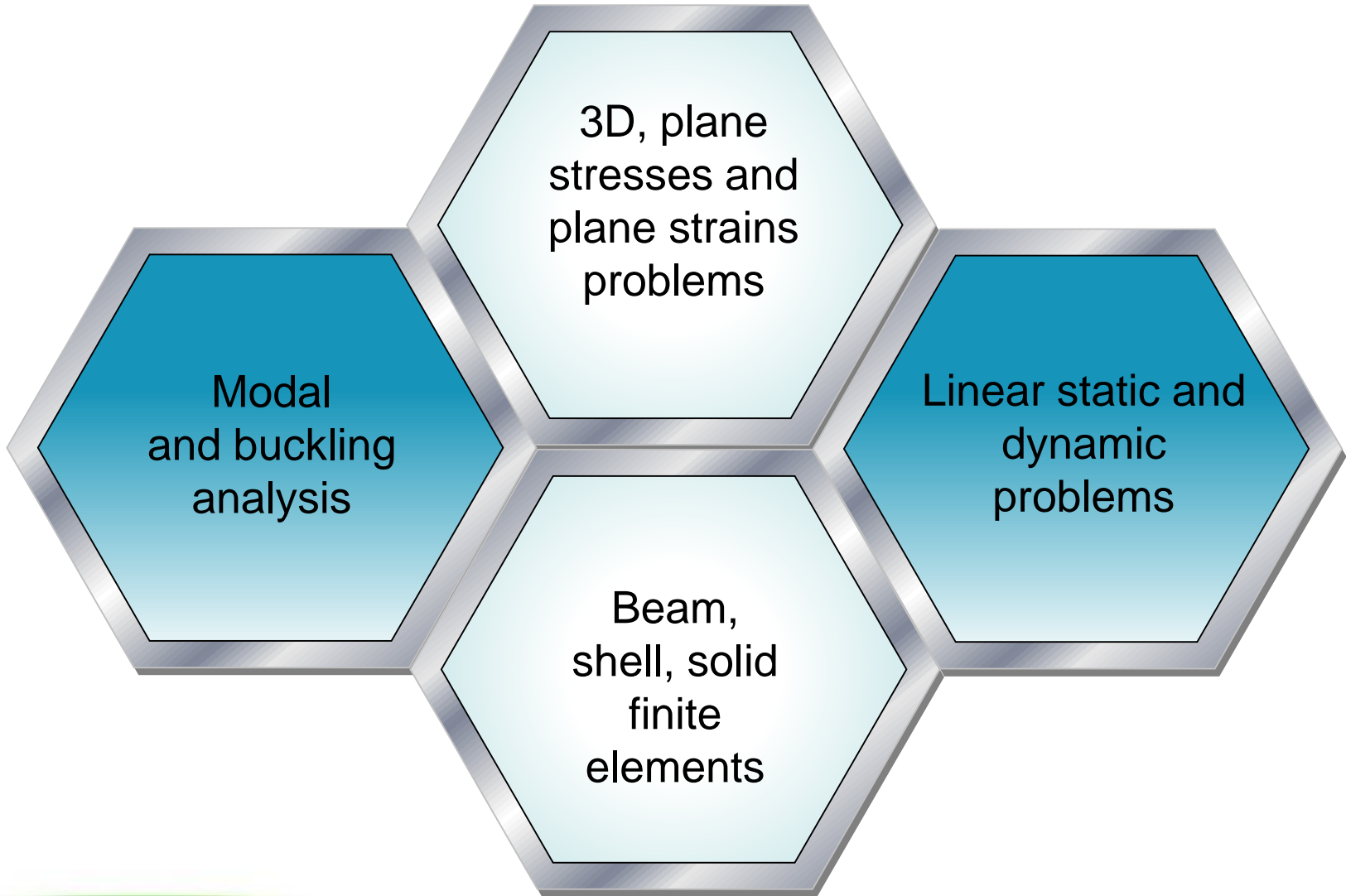
- **Preprocessor**
 - GUI
 - Console interface with an integrated automation mechanism
- **Calculation**
 - Console application with an external Python based API
- **Postprocessor (Fidesys Viewer)**
 - GUI
 - Console interface with an integrated automation mechanism



CAE Fidesys Standard

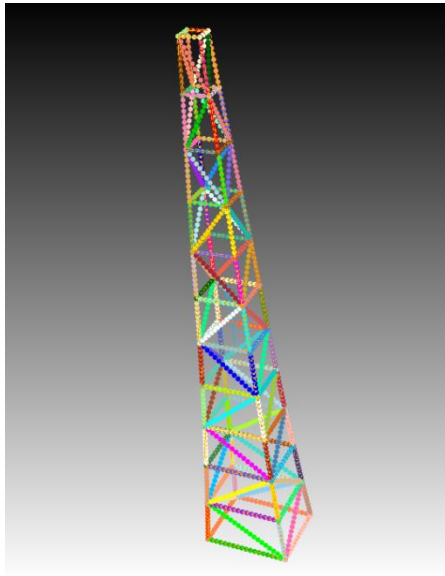


CAE Fidesys Standard

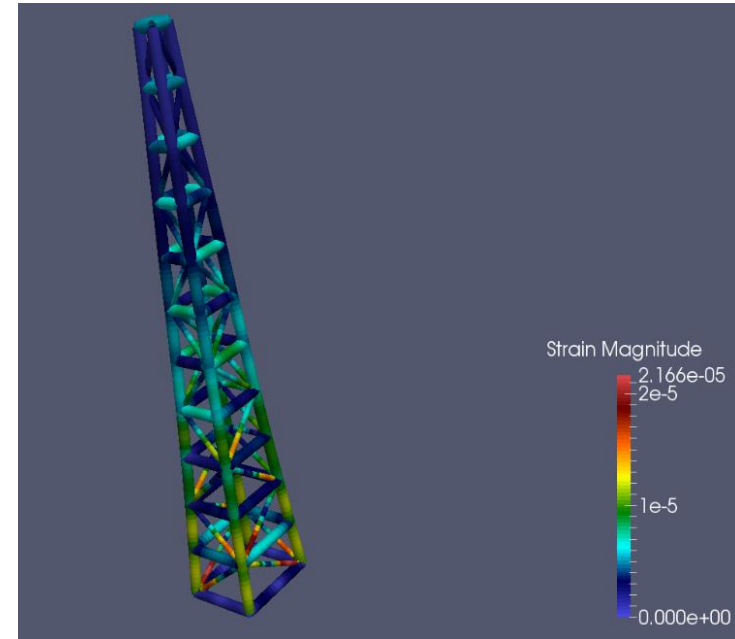




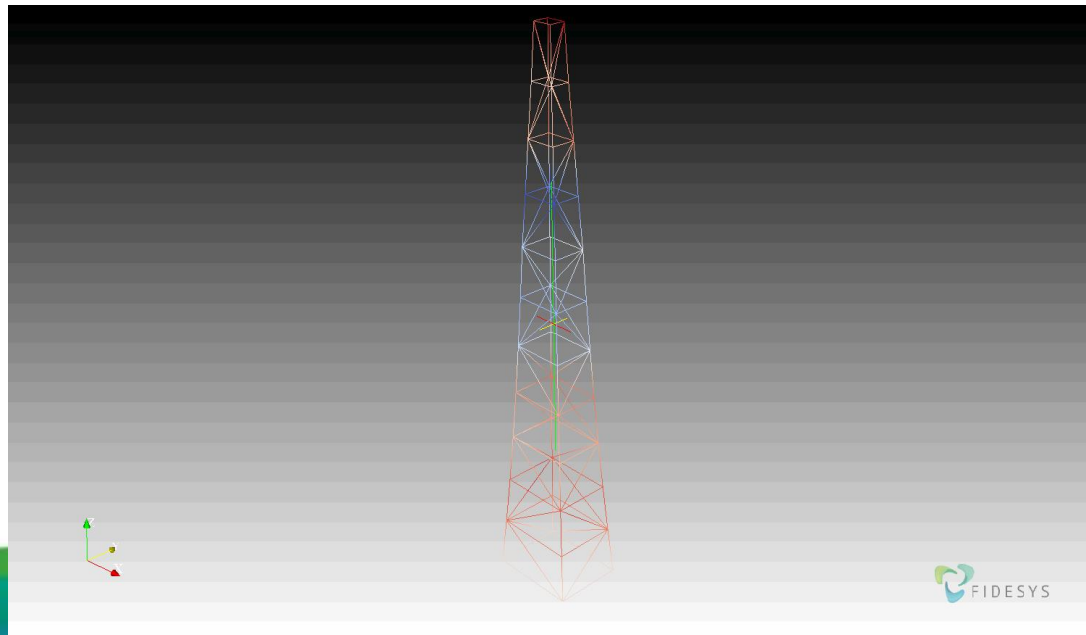
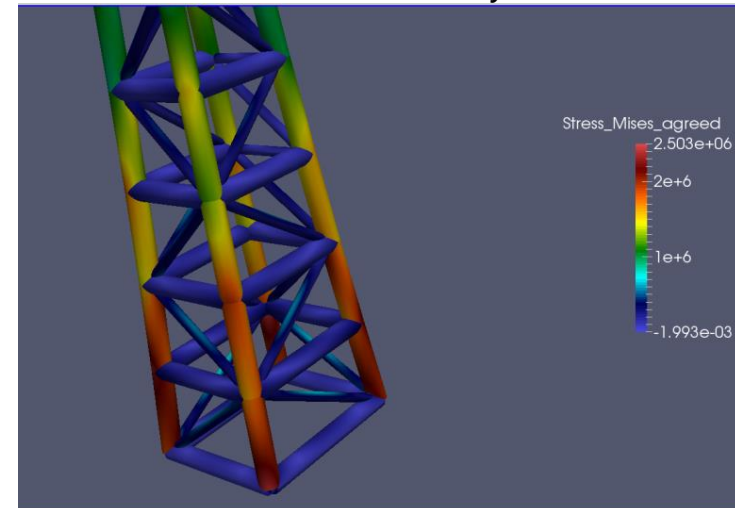
Truss structure analysis



Strain distribution

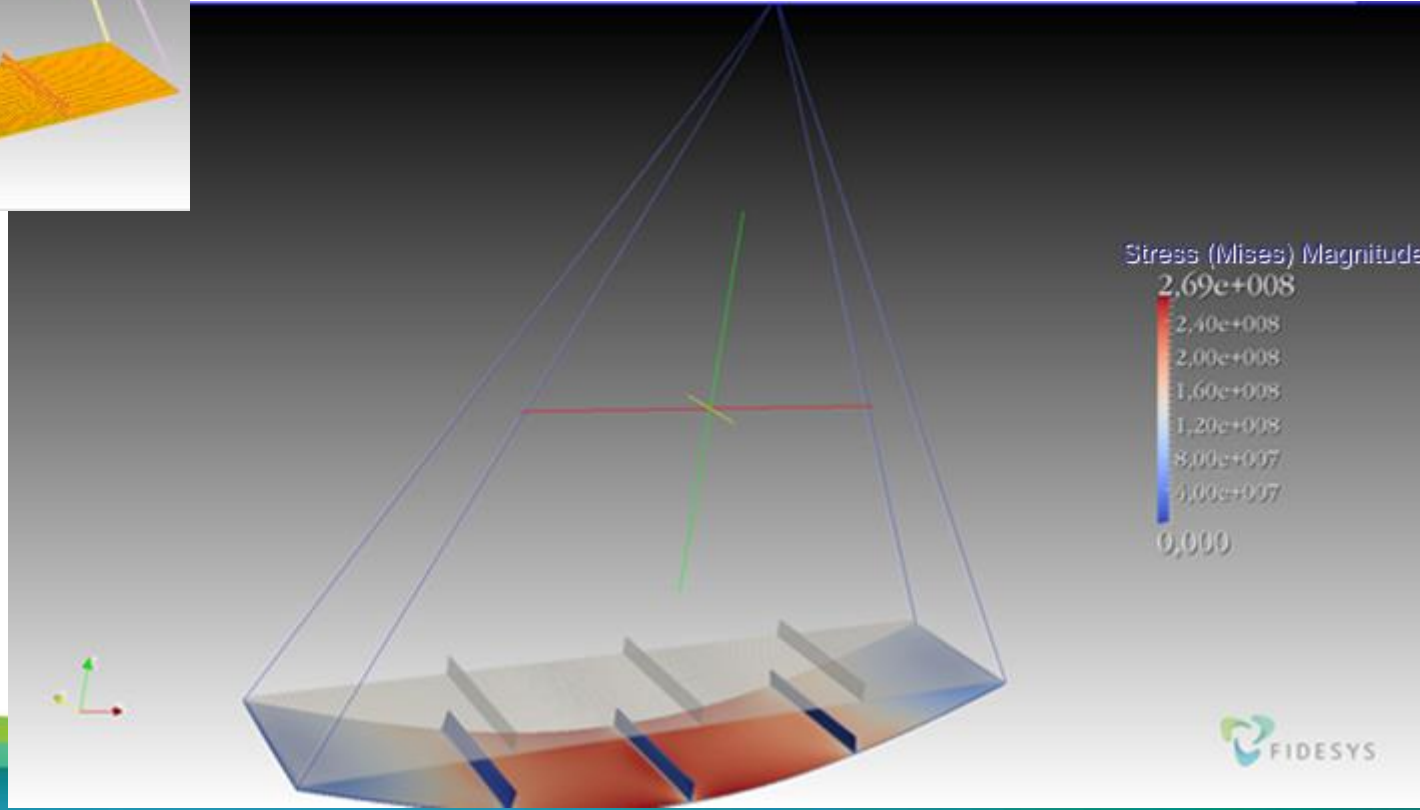
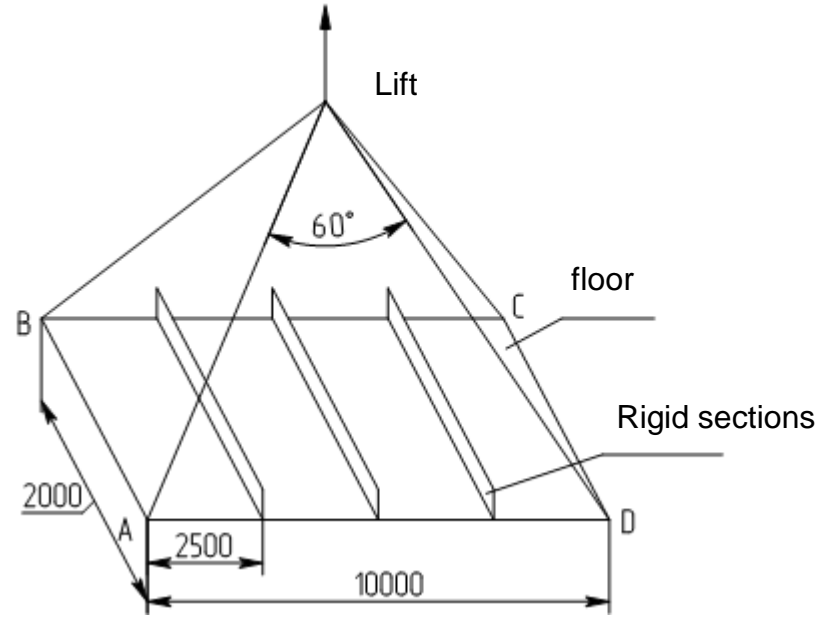
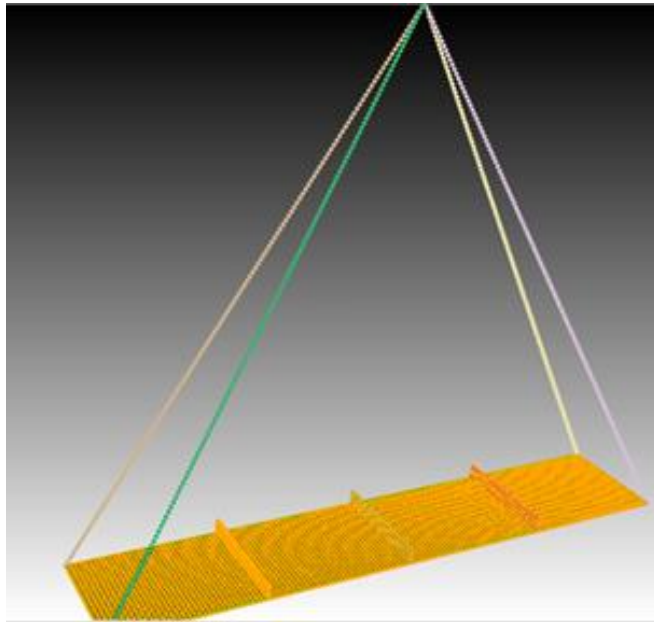


Stress intensity



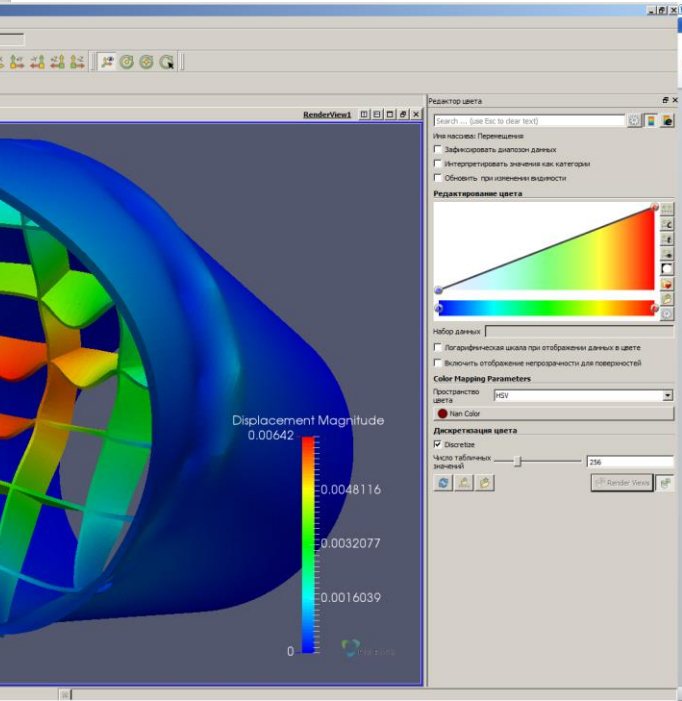
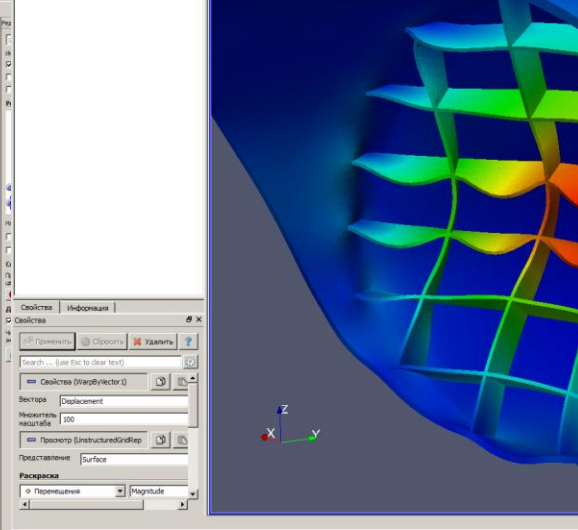
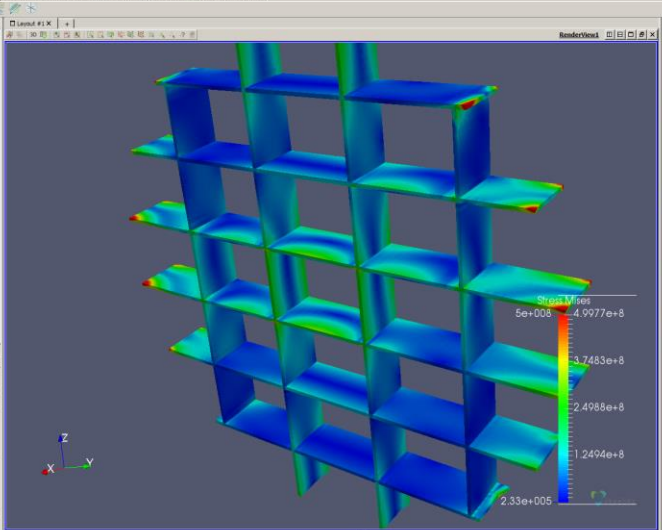
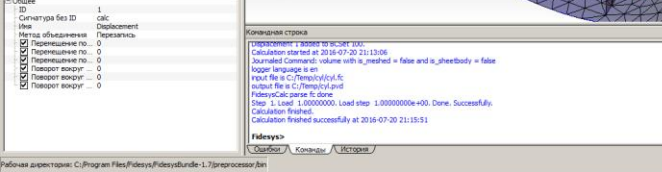
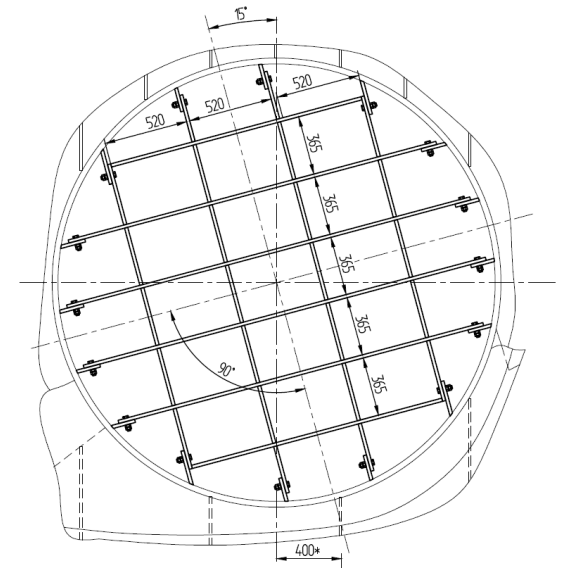
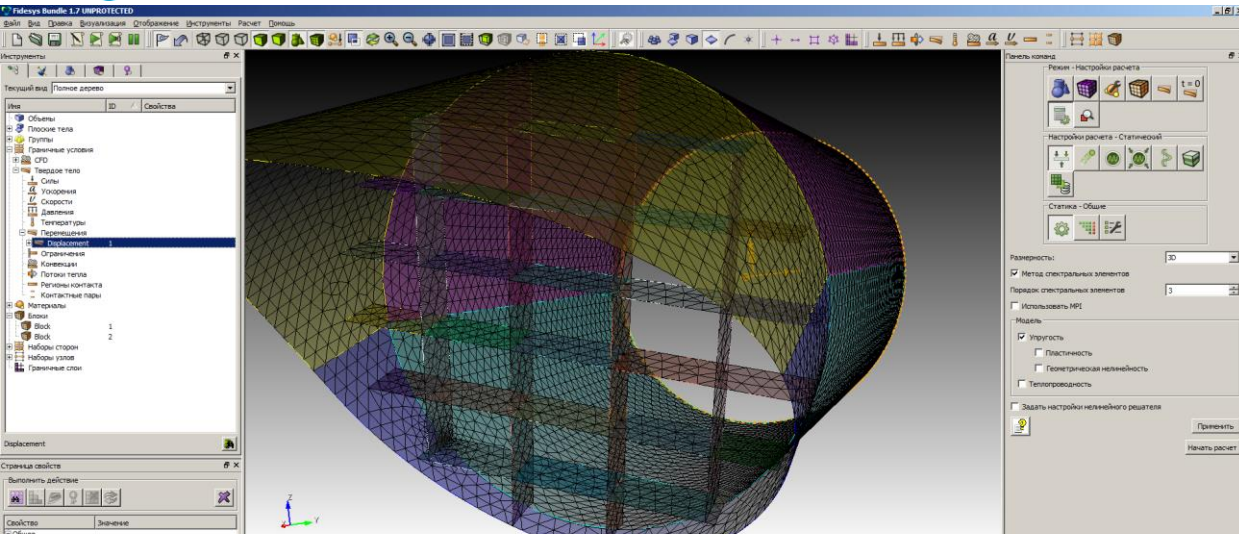


Section lifting





Analysis of the ice load on the thruster





Analysis of the pressure tank

Fidesys Bundle 1.7 UNPROTECTED

Файл Вид Правка Визуализация Отображение Инструменты Расчет Помощь

Инструменты

Текущий вид Полное дерево

Имя	ID	Свойства
Температуры		
Перемещения		
Ограничения		
Конвекции		
Потоки тепла		
Регионы контакта		
Контактные пары		
Материалы		
Блоки		
Block	1	
Block	2	
Block	3	
Block	4	
Наборы сторон		
Наборы узлов		
Граничные слои		

Block

Страница свойств

Выполнить действие

Свойство	Значение
Имя	Block
Описание	
Тип элемента	SHELL4
Цвет	Не указано
Количество эле...	29731
Атрибут	2
Attribute 1	0.015
Attribute 2	0.5

Командная строка

```
set node constraint on  
set hdf5_cub_file on
```

Панель команд

Режим - Настройки расчета

Настройки расчета - Статический

Статика - Общие

Размерность: 3D

Метод спектральных элементов

Порядок спектральных элементов 4

Использовать MPI

Модель

Упругость

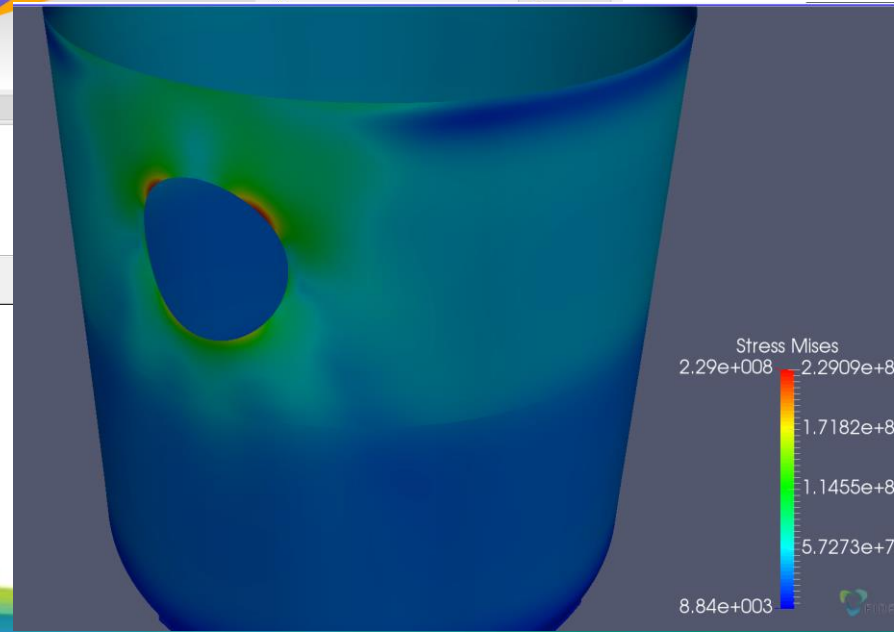
Пластичность

Геометрическая нелинейность

Теплопроводность

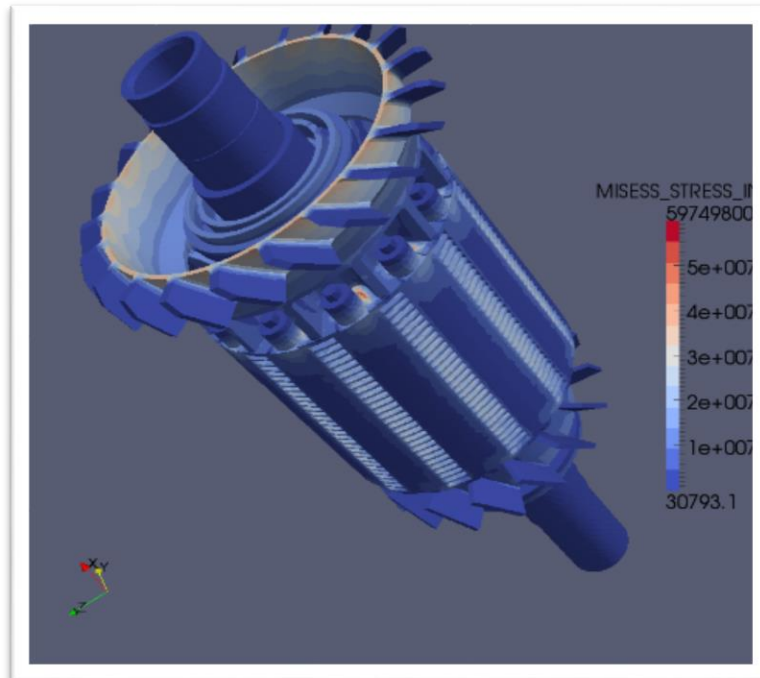
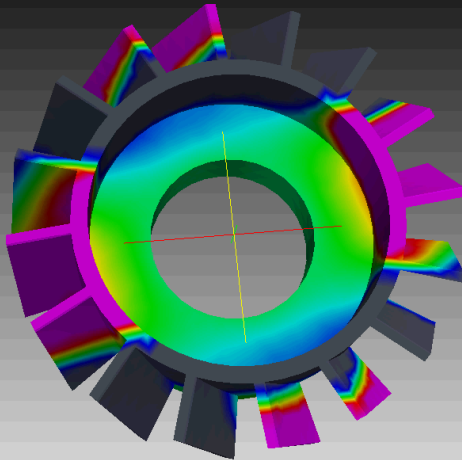
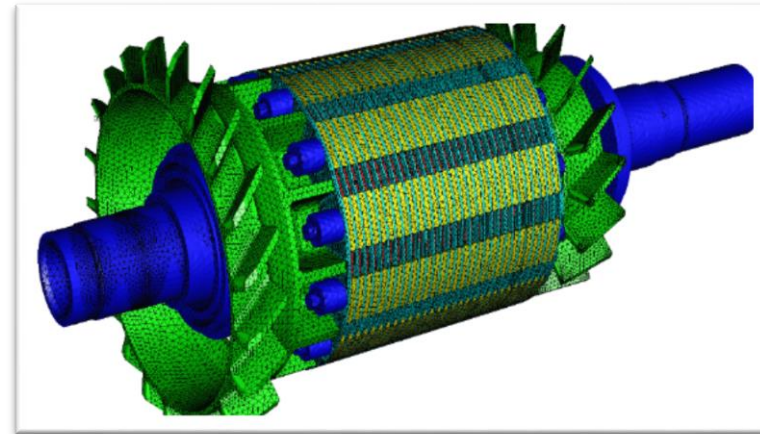
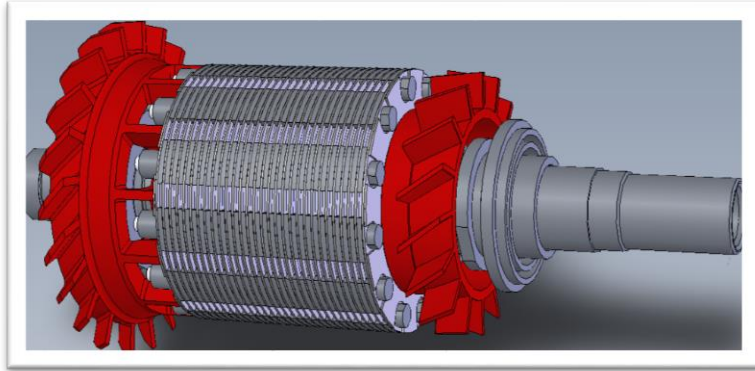
Задать настройки нелинейного решателя

Рабочая директория: C:/Tolya/Science/Start-Up/Clients/Obninsk





Analysis of the of the electrical rotor





Compatibility and support

- Support for the most CAD/CAE formats

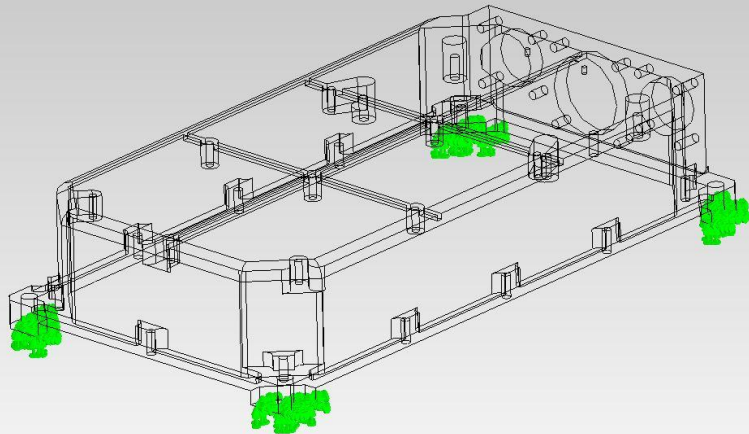


- Support of general data types

- ACIS
- IGES
- STEP
- AVS
- Genesis/Exodus
- Facets
- STL
- Ideas
- Cubit

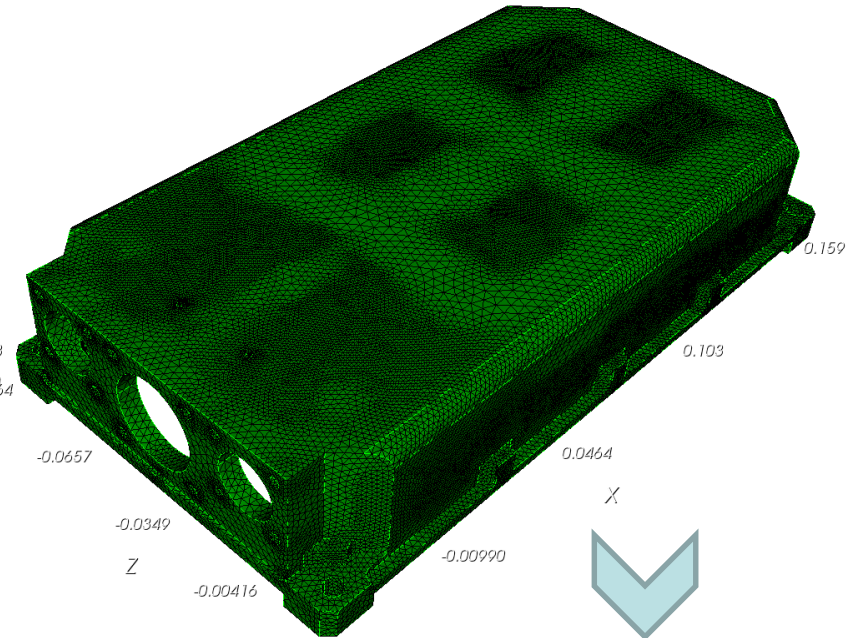


Modal analysis of the cover

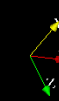
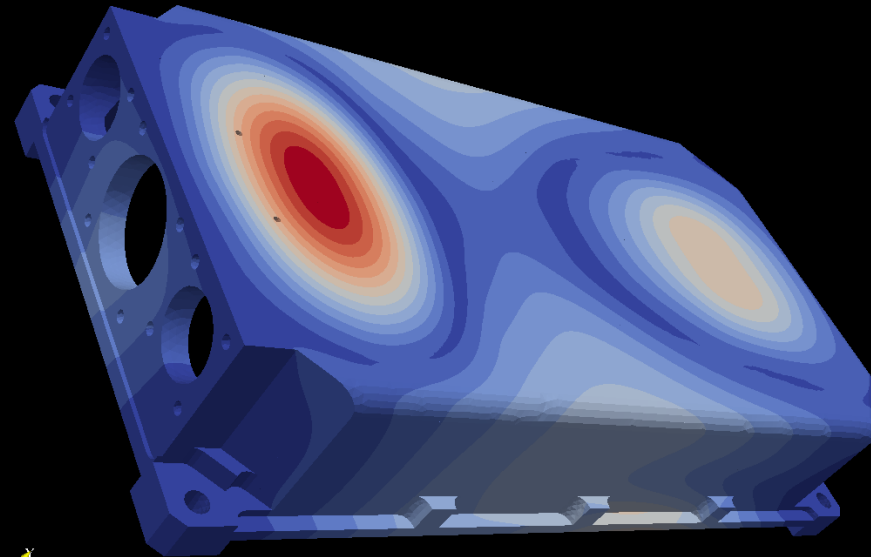
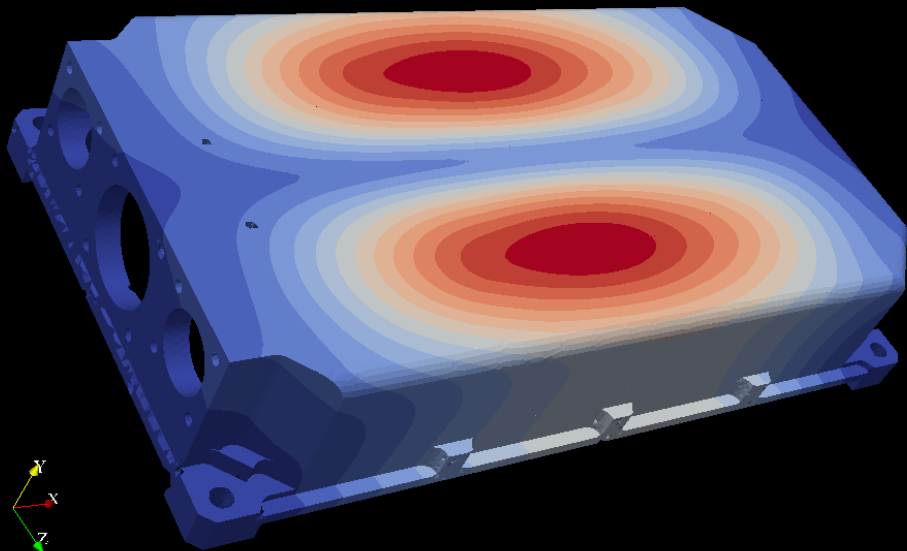


0.0450
0.0338
0.0225
0.0113
-0.00964

Y

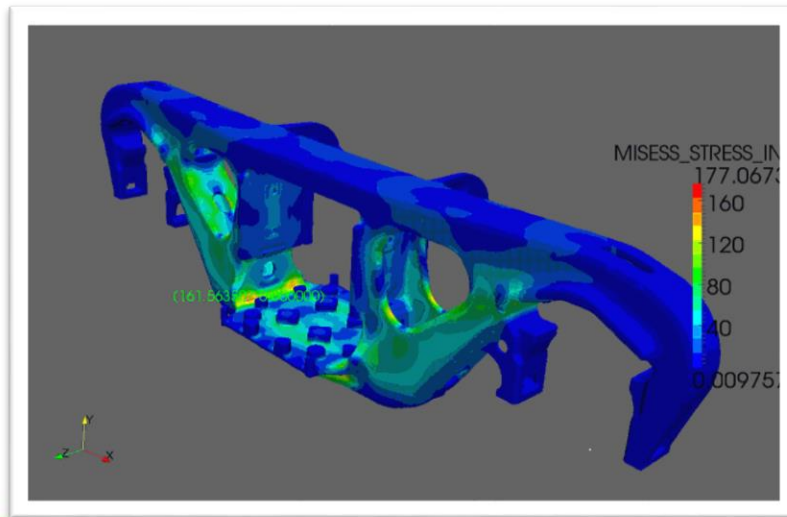
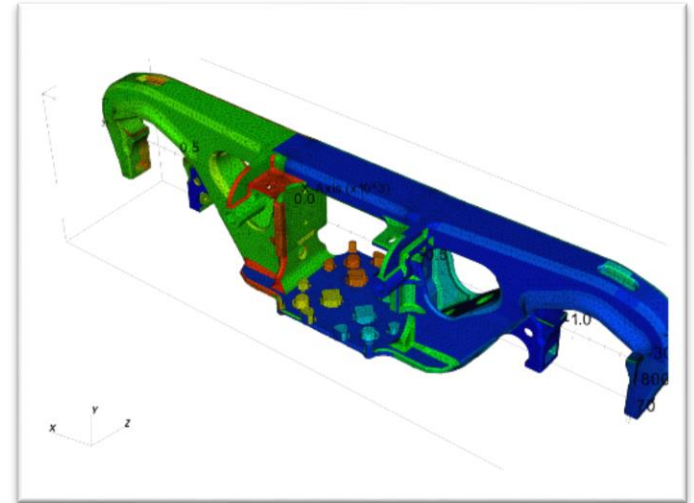
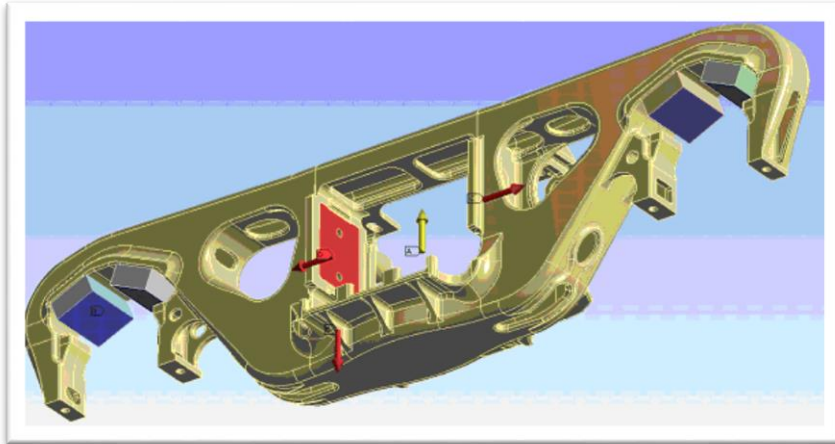



X





Railway wheel side analysis





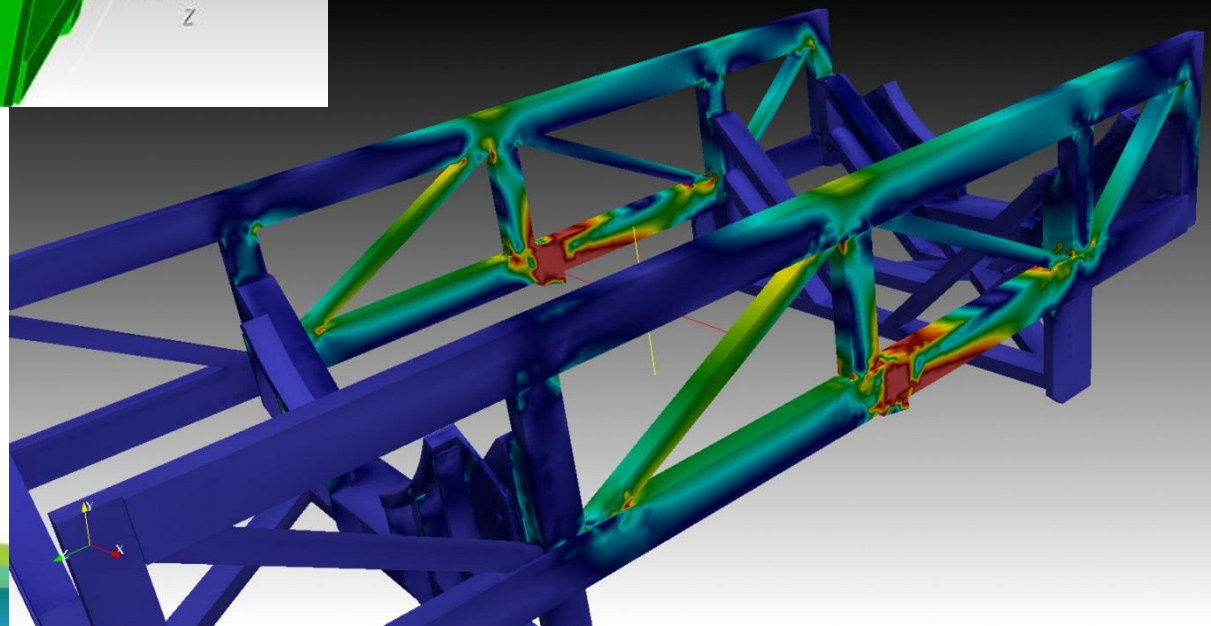
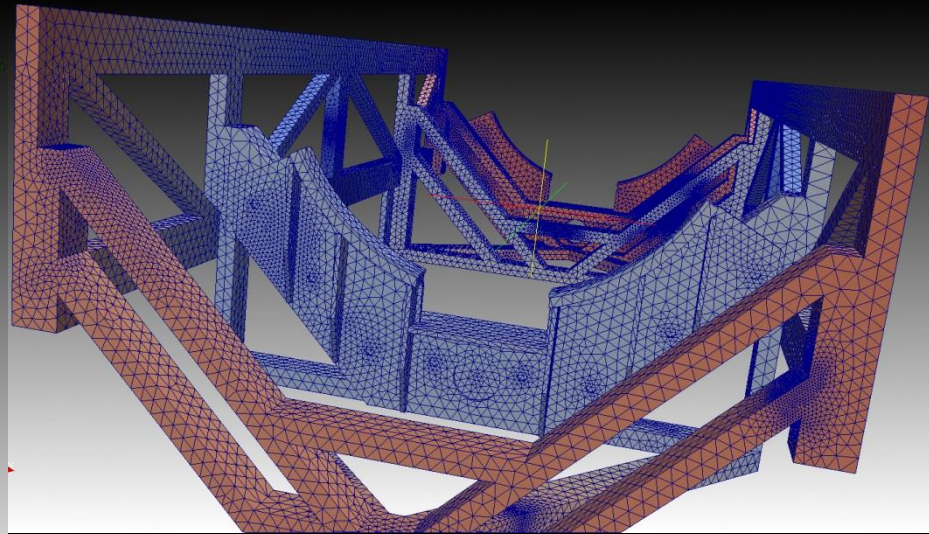
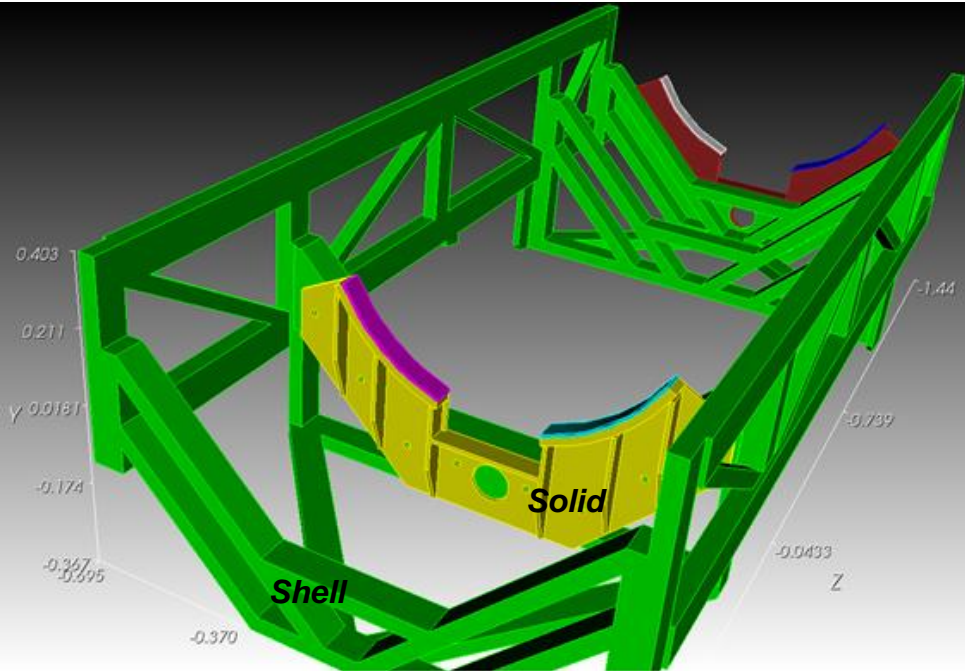
Data formats, finite elements

- **ACIS** (*.sat, *.sab);
- **IGES** (*.igs, *.iges);
- **STEP** (*.stp, *.step);
- **AVS** (*.avs);
- **Genesis/Exodus** (*.g, *.gen, *.e, *.exo);
- **Facets** (*.fac);
- **GAMBIT Real Geometry** (*.dbs)
- **Catia** (*.CATPart, *.CATProduct, *.ncgm);
- **Parasolid** (*.x_t, *.x_b)
- **SolidWorks** (*.sldprt, *.sldasm)
- **Pro/E** (*.prt, *.asm)
- **STL Files** (*.stl);
- **Patran** (*.pat, *.neu, *.out);
- **Ideas** (*.unv);
- **Abaqus** (*.inp);
- **Fluent** (*.msh);
- **Nastran** (*.bdf);
- **LS-Dyna** (*.k*)
- **Ansys** (*.cdb)

- BEAM2 (beam)
- BEAM3 (curved beam)
- QUAD4 (4-noded quadrilateral)
- QUAD8 (8-noded quadrilateral)
- QUAD9 (9-noded quadrilateral)
- SHELL4 (4-noded quadrilateral)
- SHELL8 (8-noded quadrilateral)
- SHELL9 (9-noded quadrilateral)
- TRI3 (3-noded triangle)
- TRI6 (6-noded triangle)
- TRISHELL3 (3-noded triangle)
- TRISHELL6 (6-noded triangle)
- HEX8 (8-noded hexahedron)
- HEX20 (20-noded hexahedron)
- HEX27 (27-noded hexahedron)
- TETRA4 (4-noded tetrahedron)
- TETRA10 (10-noded tetrahedron)
- WEDGE6 (6-noded wedge)
- WEDGE15 (15-noded wedge)
- PYRAMID5 (5-noded pyramid)
- PYRAMID13 (13-noded pyramid)
- SPRING
- LUMPMASS
- CONSTRAINT
- **SEM N (spectral element of N th order)**

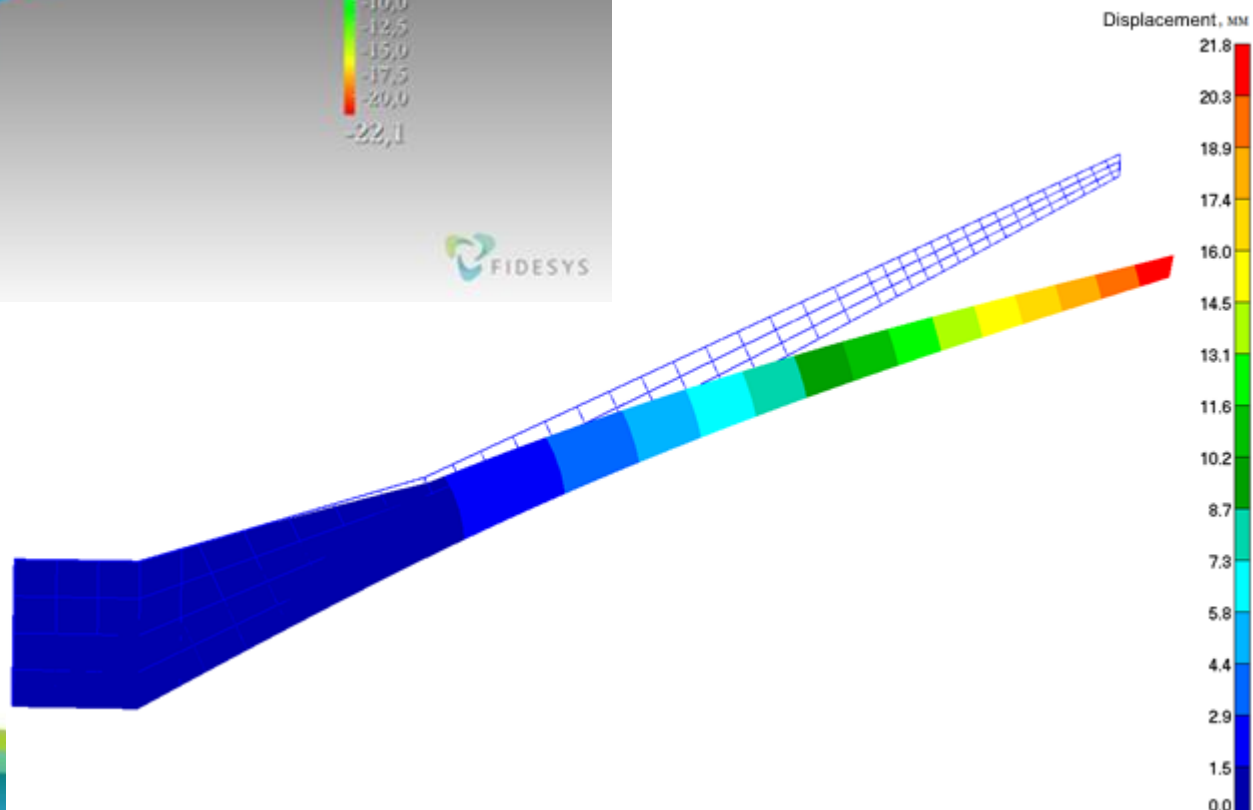
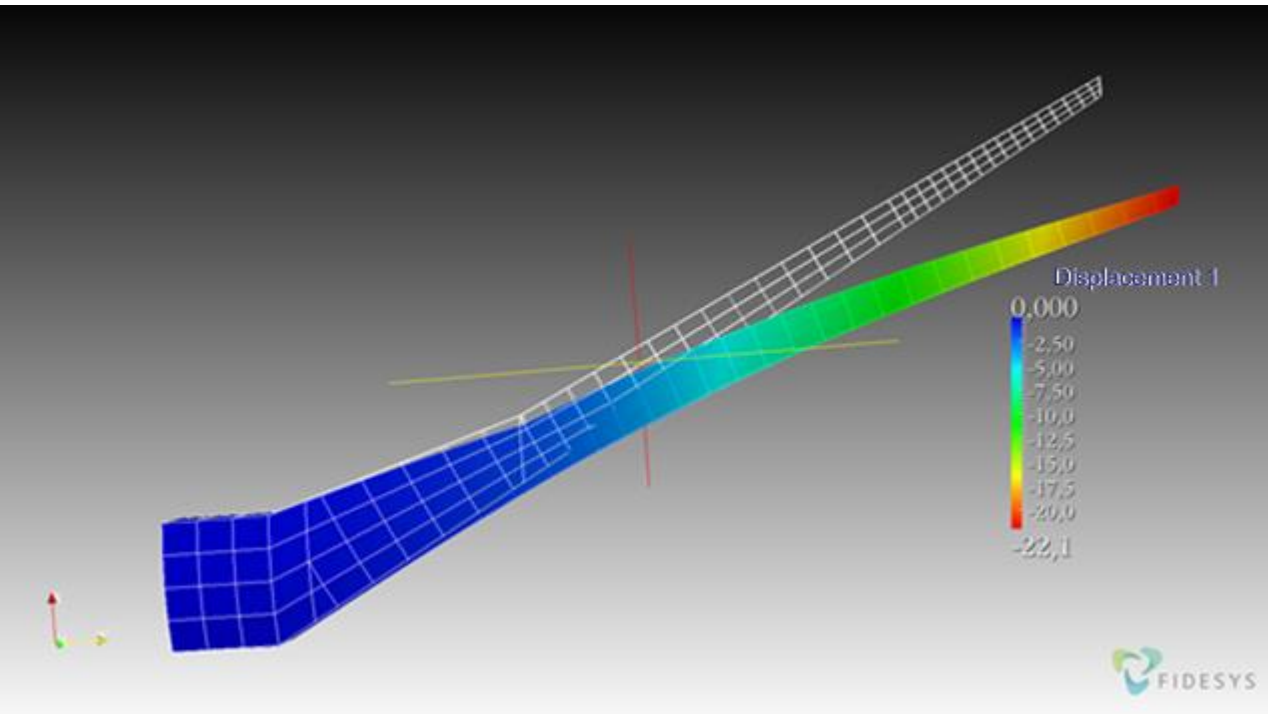


Solid-Shell structural analysis



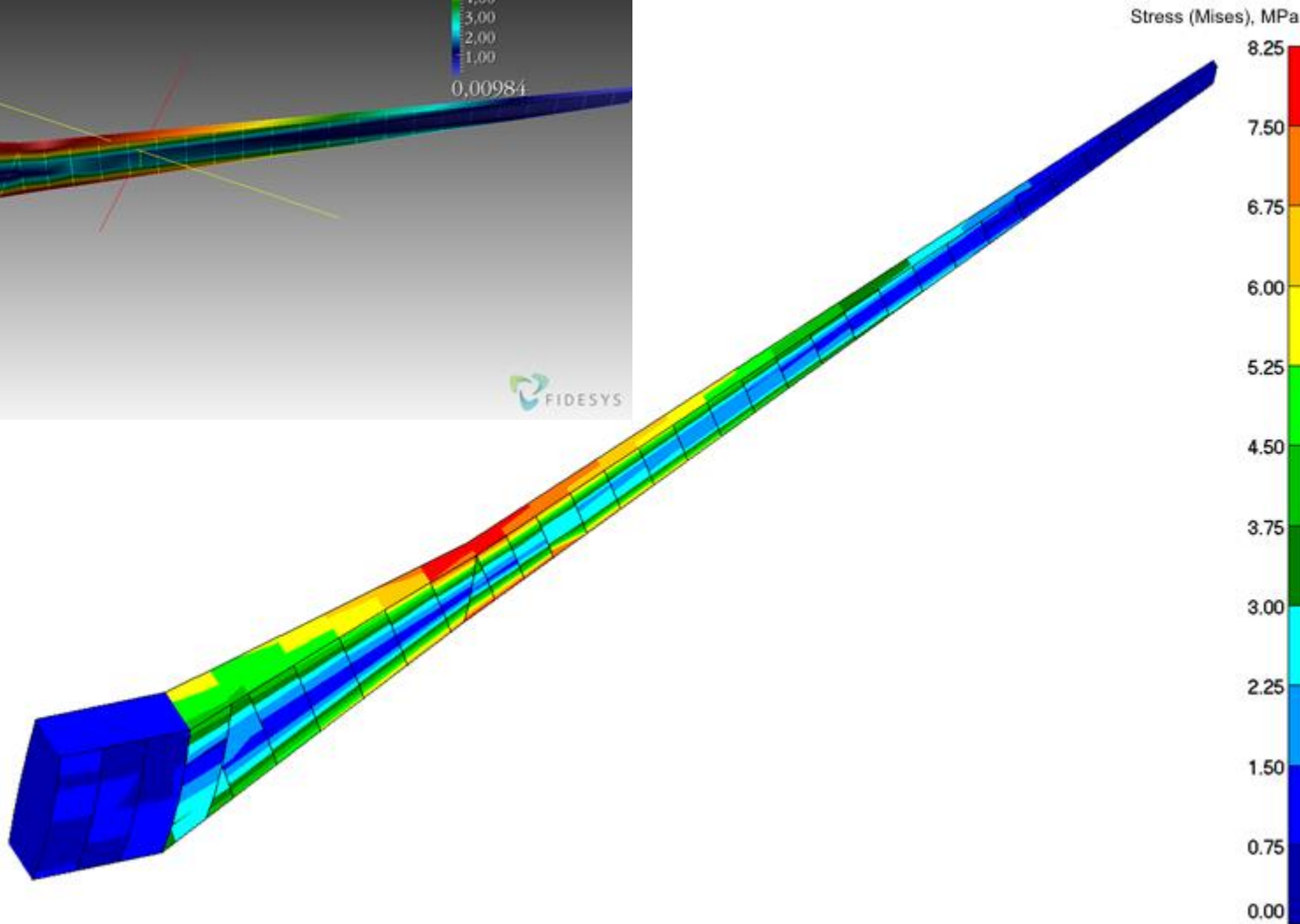
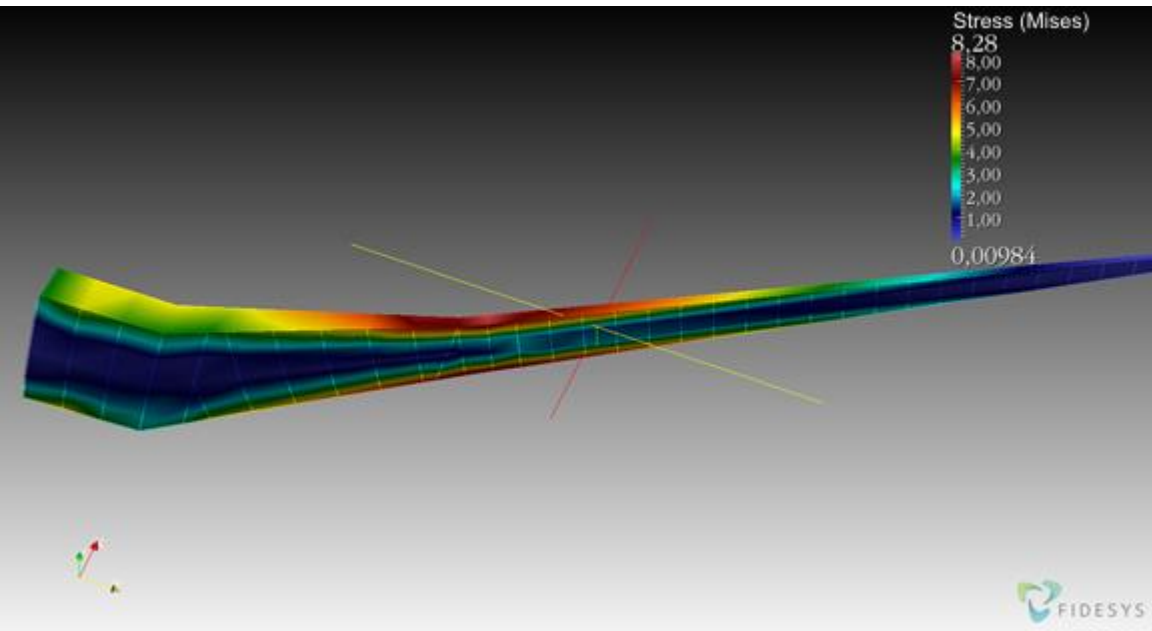


Analysis of the wing box



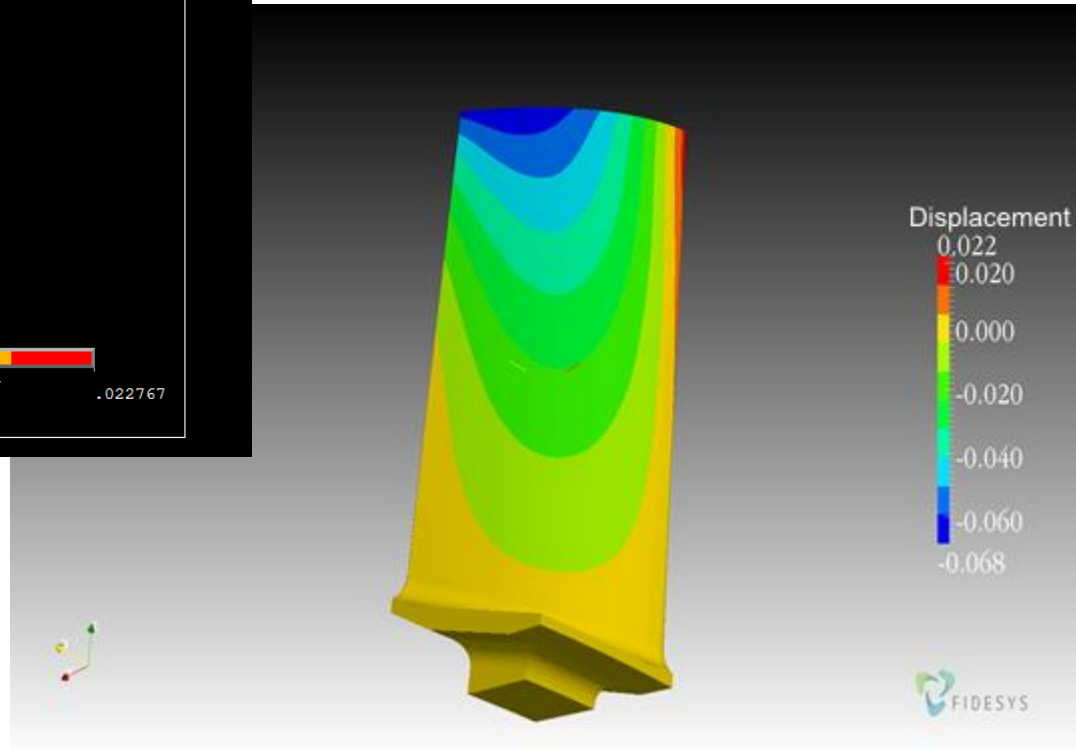
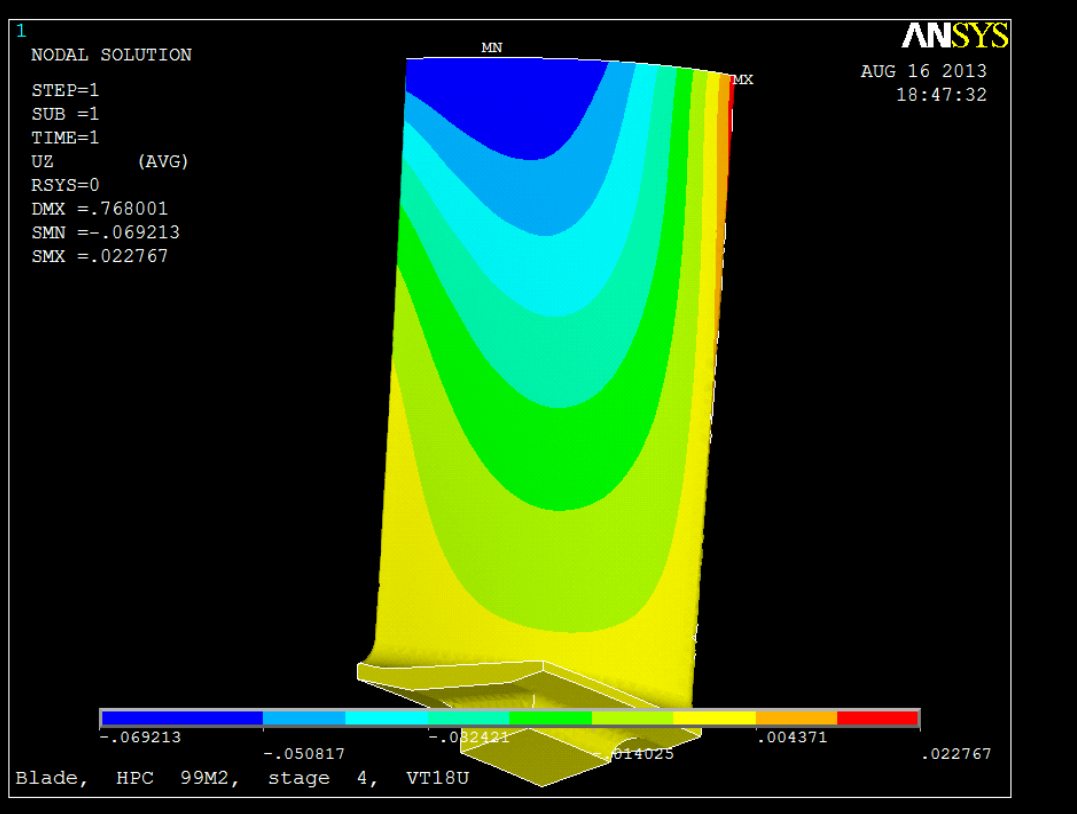


Analysis of the wing box



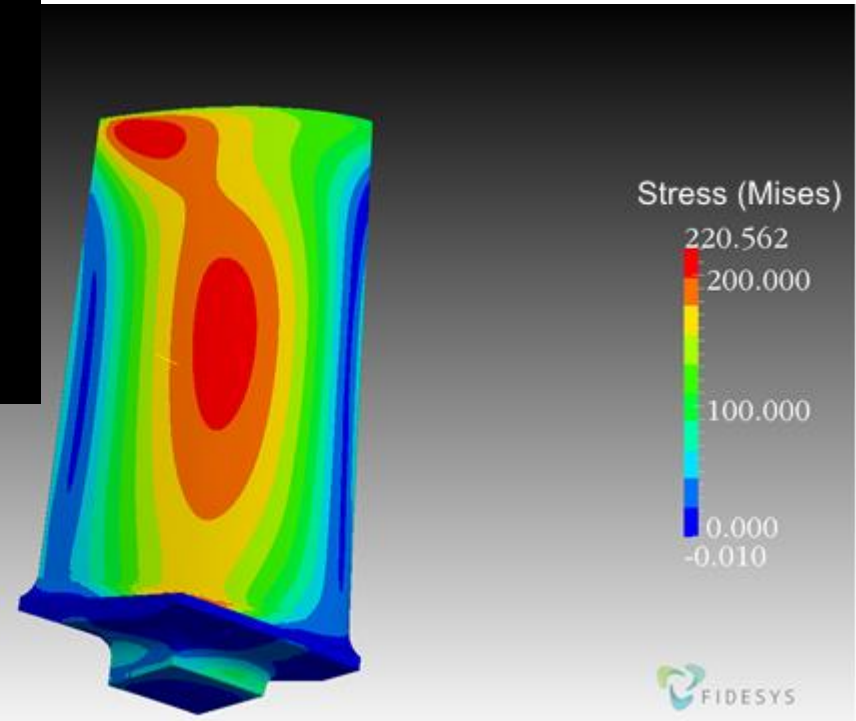
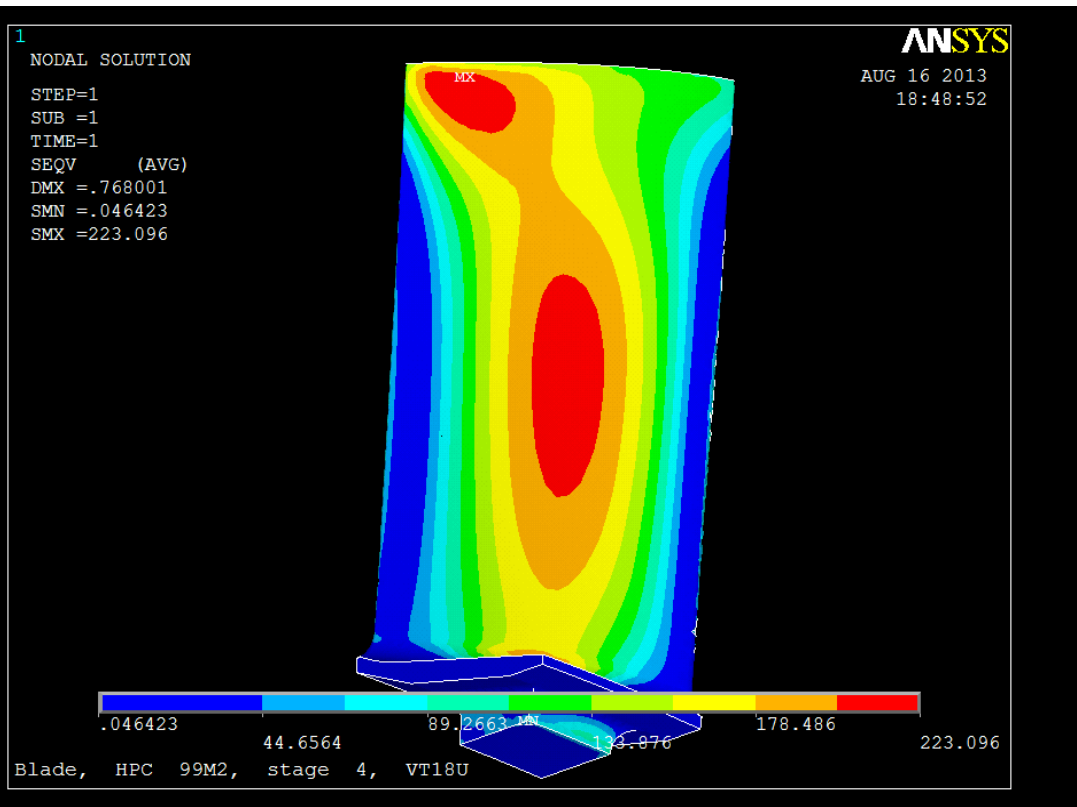


Analysis of engine blades





Analysis of engine blades

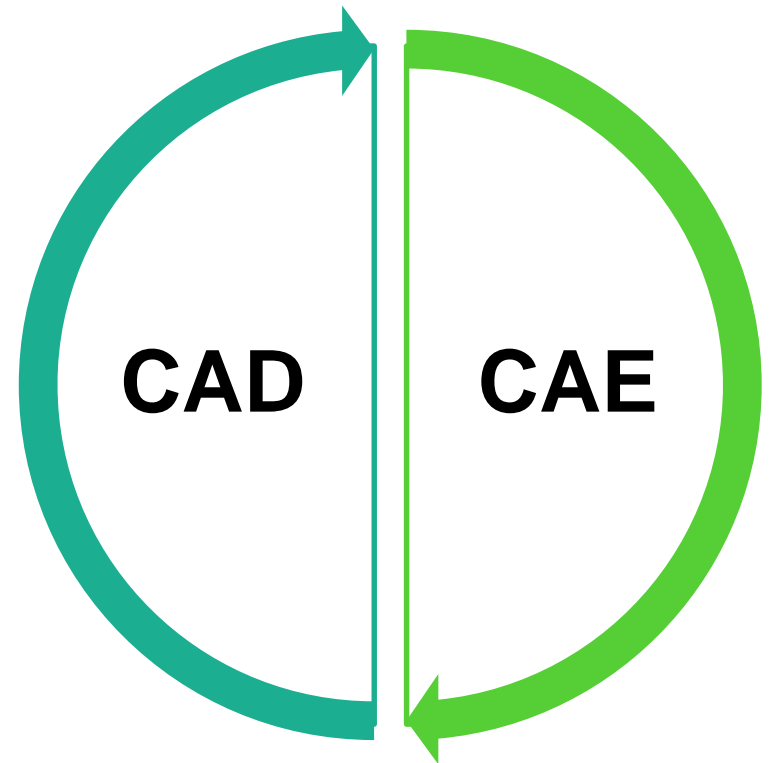




CAE Fidesys features

Integration with CAD software

- A push-button export of CAD-model into CAE Fidesys
- Automatic meshing
- Simulation and analysis at the early design stages
- Evaluation of structural performance for design alternatives



DATADVANCE

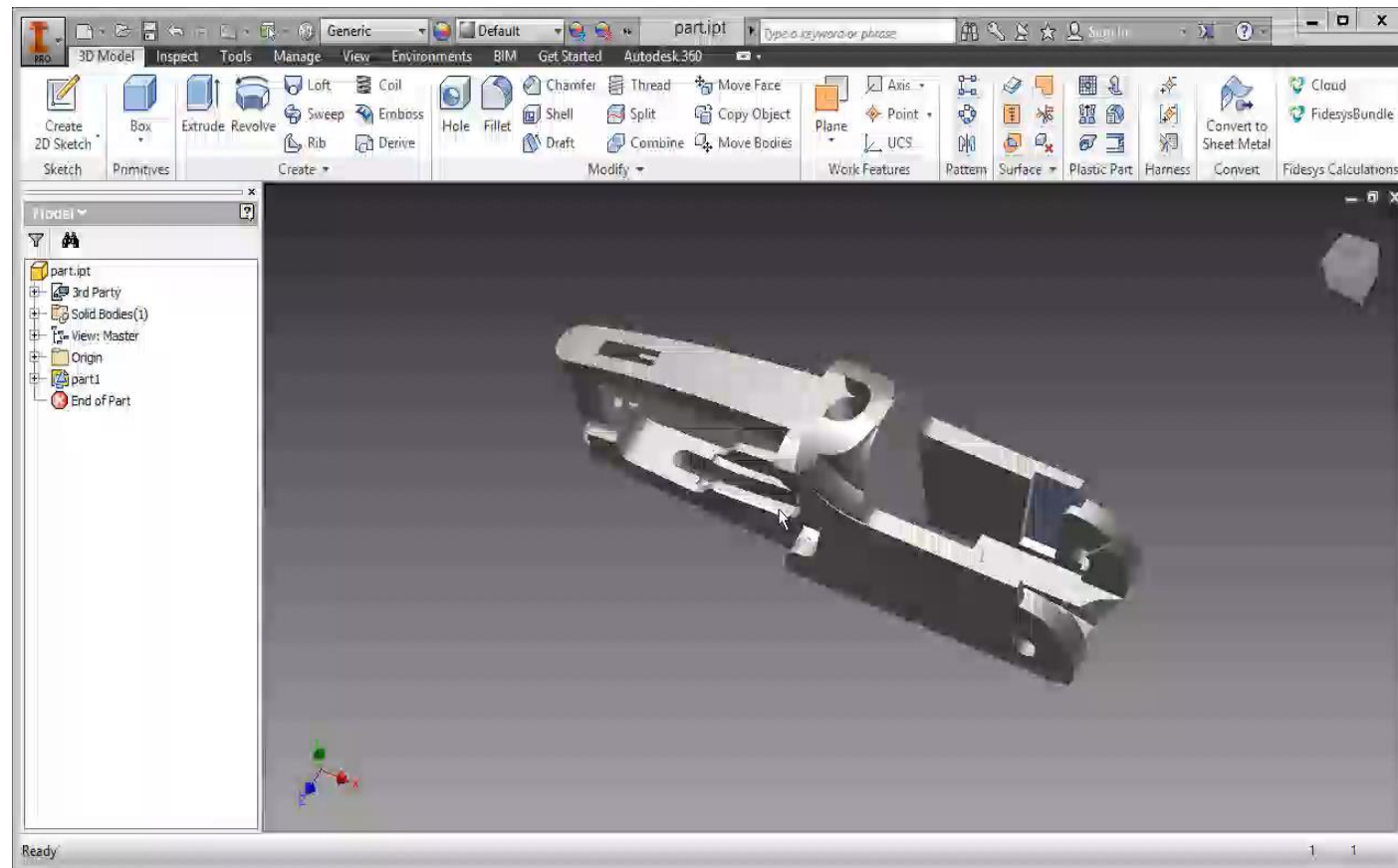


CAE Fidesys features



Integration with Autodesk Inventor

- One-button export of CAD model from Inventor into CAE Fidesys;
- No need to re-build FEA model if the CAD-model parameters were changed in Inventor;
- Export to Sim4Design for analysis in the cloud



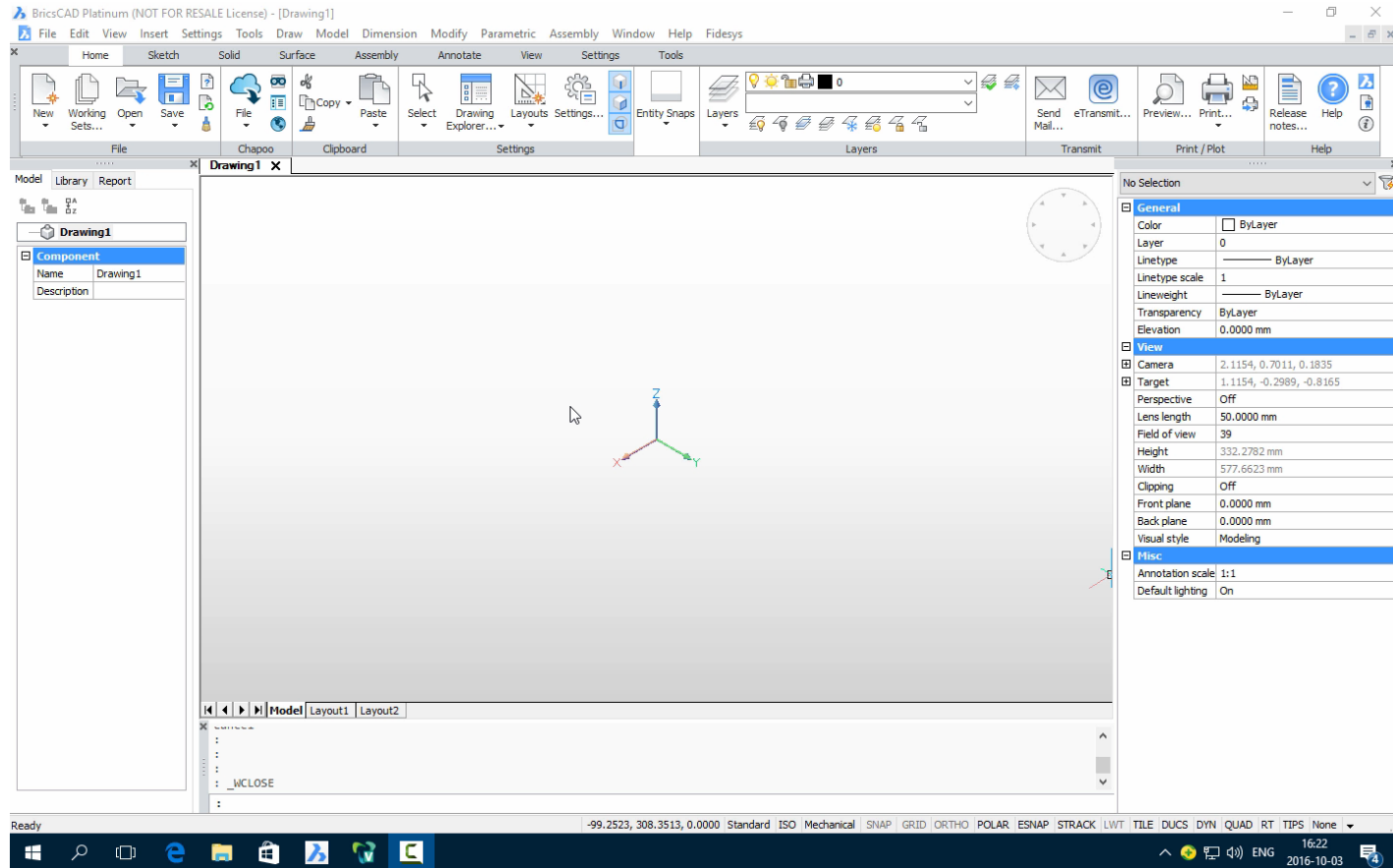


CAE Fidesys features



Integration with BricsCAD

- One-button export of CAD model from BricsCAD into CAE Fidesys;
- Automatization of engineering analysis of the model in BricsCAD;
- A possibility to perform model optimization and tuning



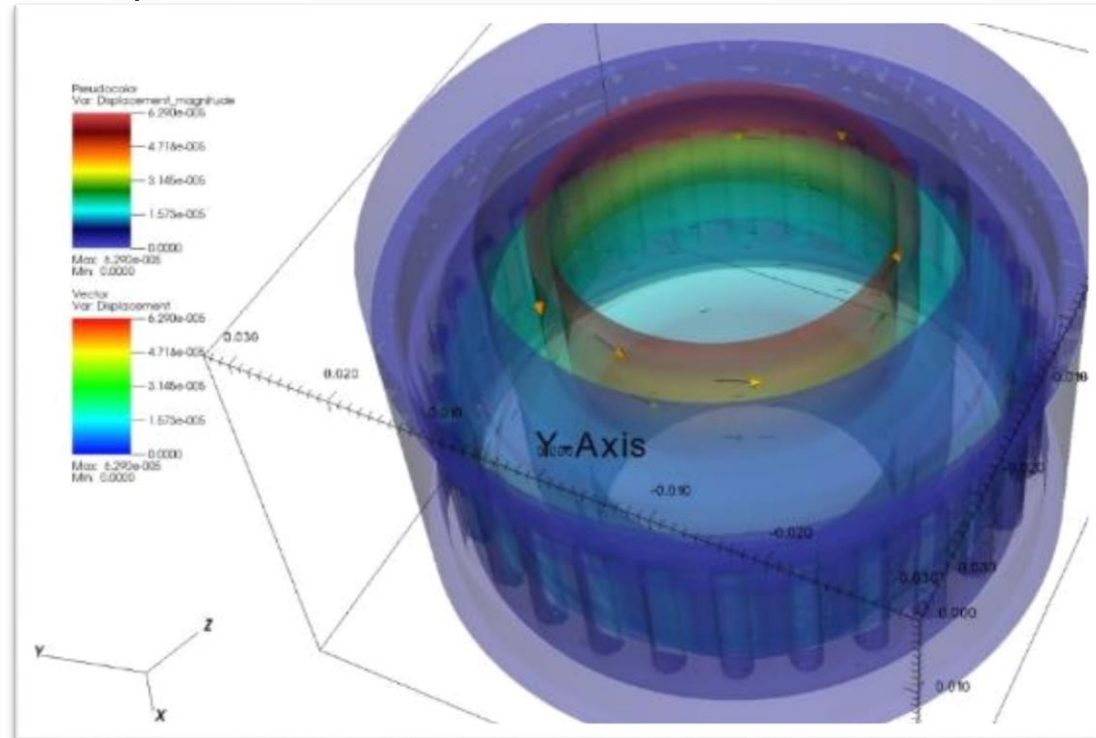
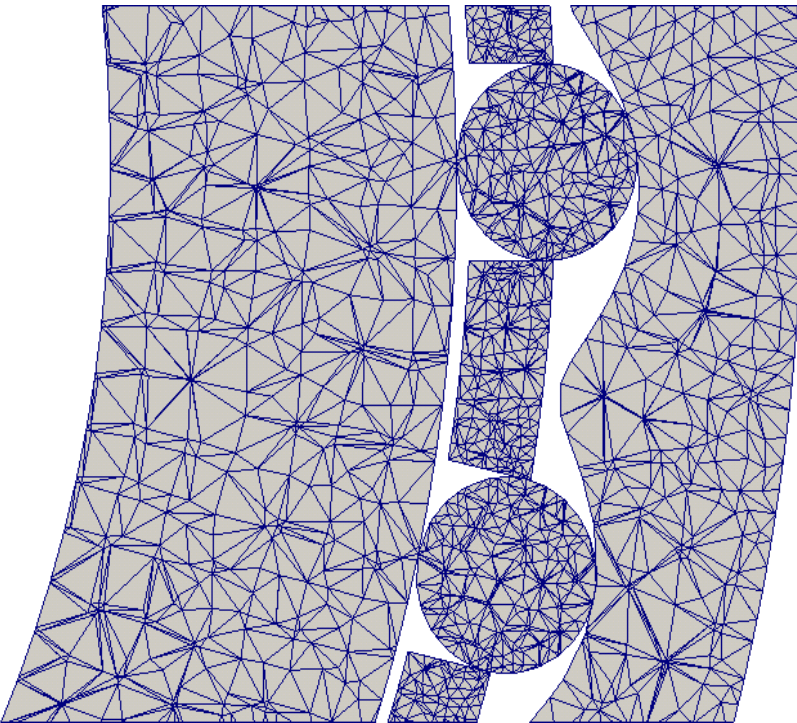


CAE Fidesys Professional



Contact mechanics of elastic bodies

- Non-linear contact interactions between solids
- Static or dynamic (with/without friction) contact problems
- Bonded contact
- Internal penalty method, Lagrange multipliers method



Contact interactions between rollers in the mechanical reductor



Automatic contact pairs detection

The screenshot displays the Fidesys Bundle 1.7 UNPROTECTED software interface. The central 3D view shows a ring of 19 vertical cylinders, each highlighted with a different color. The software has automatically detected contact pairs between adjacent cylinders. The interface includes a menu bar, a toolbar, a left-hand tree view, a right-hand command panel, and a bottom command line.

Left Panel (Tree View):

- Имя
- ID
- Свойства
- Объемы
- Группы
- Граничные условия
- CFD
- Твердое тело
- Силы
- Ускорения
- Скорости
- Давления
- Температуры
- Перемещения
- Ограничения
- Конвекции
- Потоки тепла
- Регионы контакта
- Контактные пары
- Contact Pair 1
- Contact Pair 2
- Contact Pair 3
- Contact Pair 4
- Contact Pair 5
- Contact Pair 6
- Contact Pair 7
- Contact Pair 8
- Contact Pair 9
- Contact Pair 10
- Contact Pair 11
- Contact Pair 12
- Contact Pair 13
- Contact Pair 14
- Contact Pair 15
- Contact Pair 16
- Contact Pair 17
- Contact Pair 18
- Contact Pair 19

Right Panel (Command Panel):

- Режим - Граничные условия
- Объект - Контактная пара
- Действие - Создать
- ID / Имя
- Новый ID
- Имя
- Автоматическое присвоение ID
- ID / Имя ведущего региона: 2
- ID / Имя ведомого региона: 3
- Метод: Штрафов
- Коэффициент трения: 0.0
- Допустимое проникновение: 0.1
- Коэффициент жесткости по нормали: 1.0
- Коэффициент жесткости по касательной: 0.5
- Точность определения контакта: 0.1
- Связанные поверхности

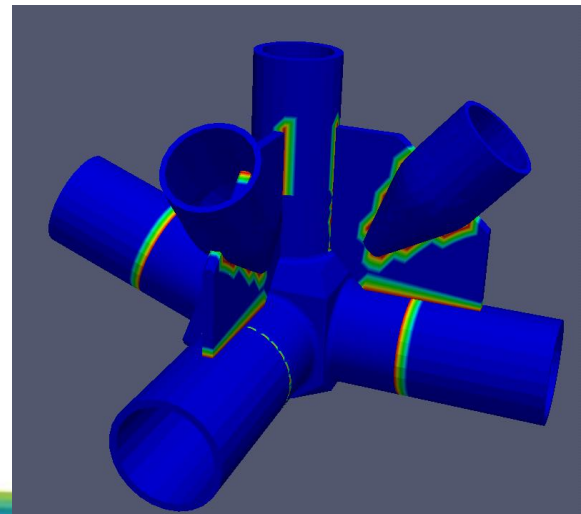
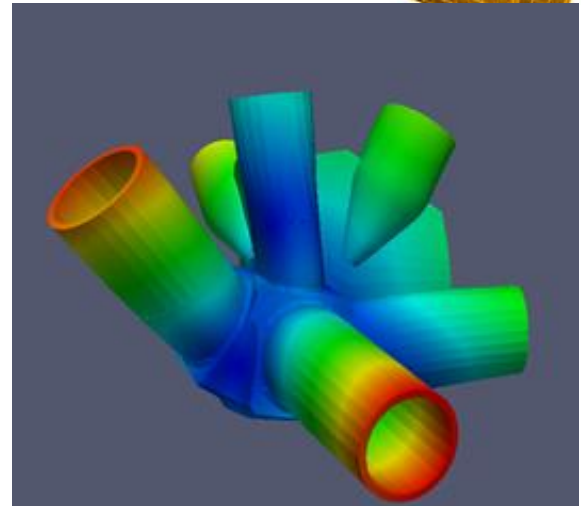
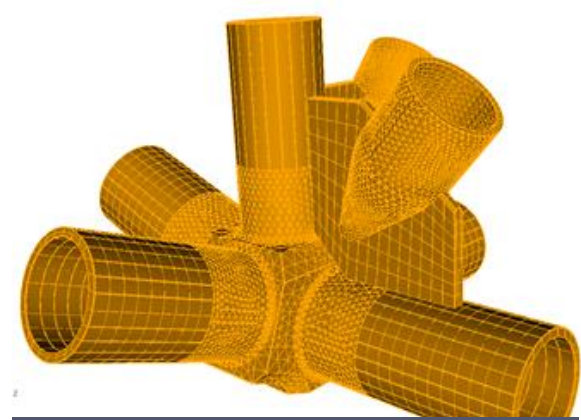
Bottom Panel (Command Line):

```
Command line: create contact pair autoselect volume all
Surface 258 and 380 overlap
Surface 258 and 375 overlap
Surface 258 and 260 overlap
Surface 258 and 390 overlap
Surface 258 and 395 overlap
Found 145 overlapping surface pairs (added to group 'surf_overlap')
Created 114 contact pairs from 145 overlapping Surface pairs.
Journal Command: create contact pair autoselect volume all
```



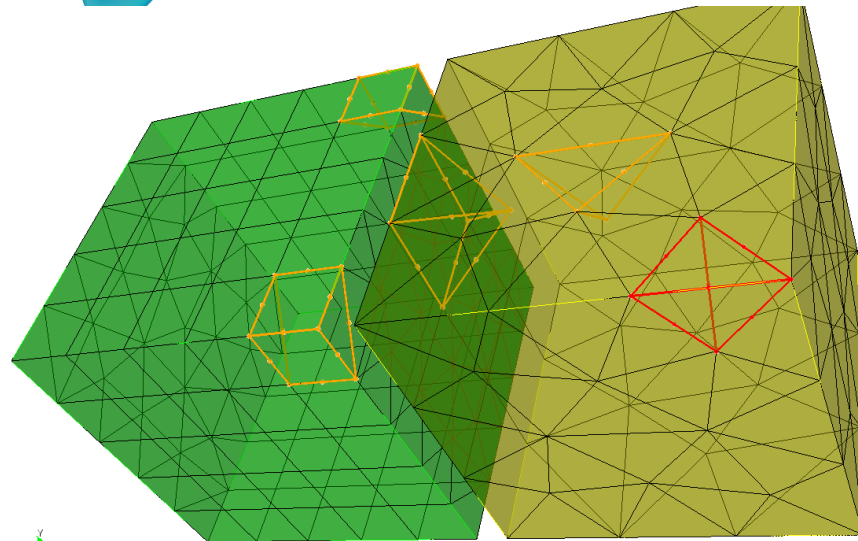
Bonded contact

- Support for nonconformal meshes with gaps/overlaps between contacting bodies => no need for simplification/healing of an input CAD assembly
- Continuous displacements and stresses even in case of gaps/overlaps!
- Automatic contact zones detection based on a specified geometrical parameter

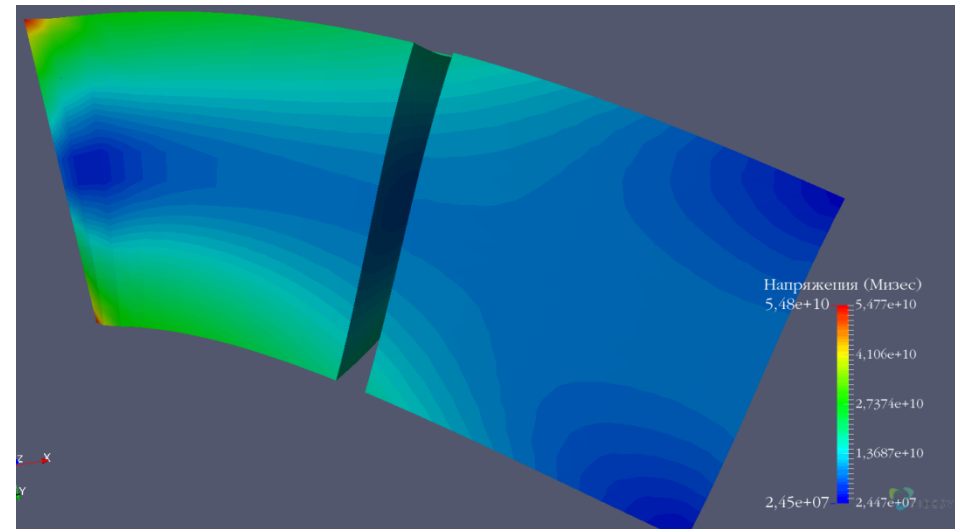




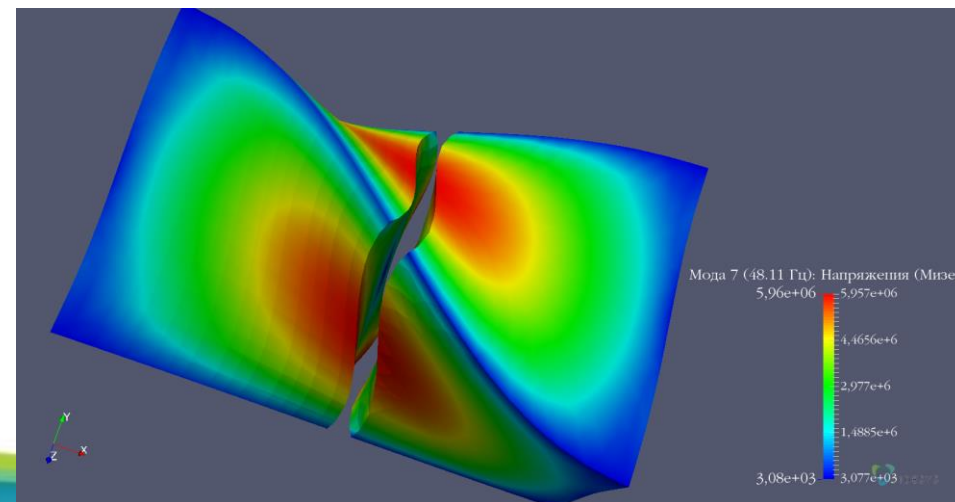
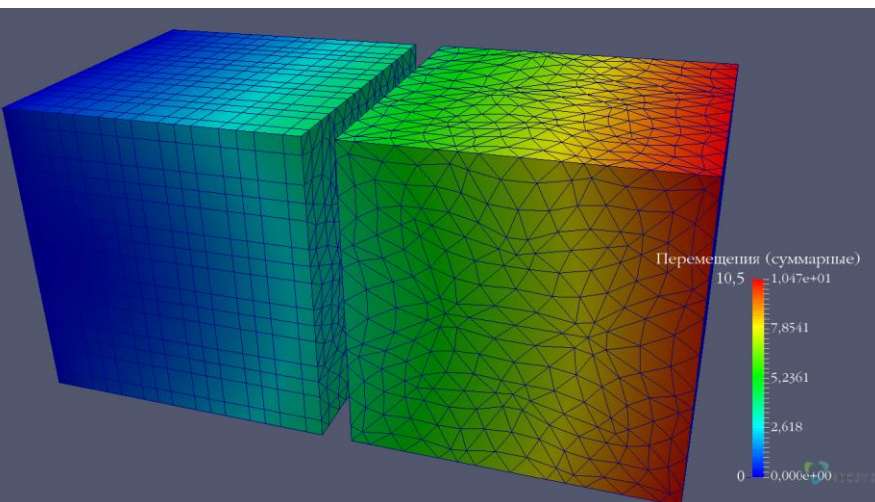
Bonded contact: example



Nonconformal spectral element mesh of different orders and mixed types of elements



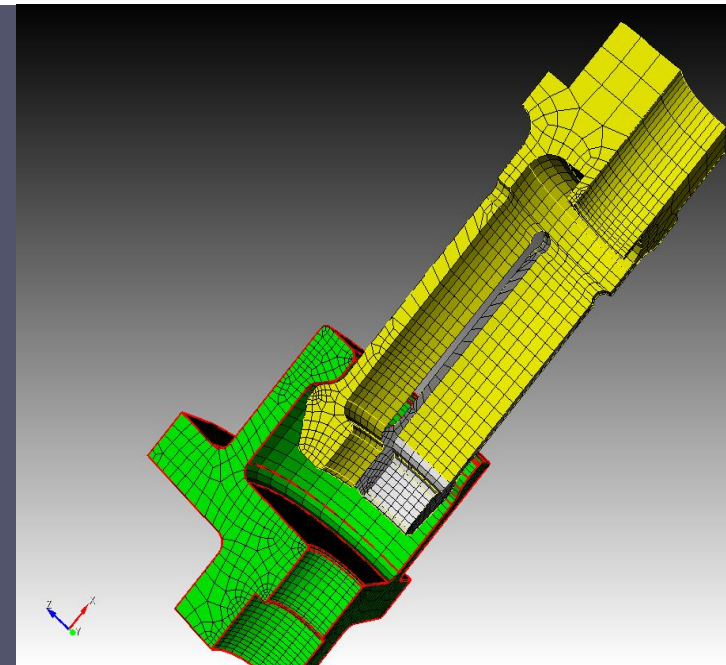
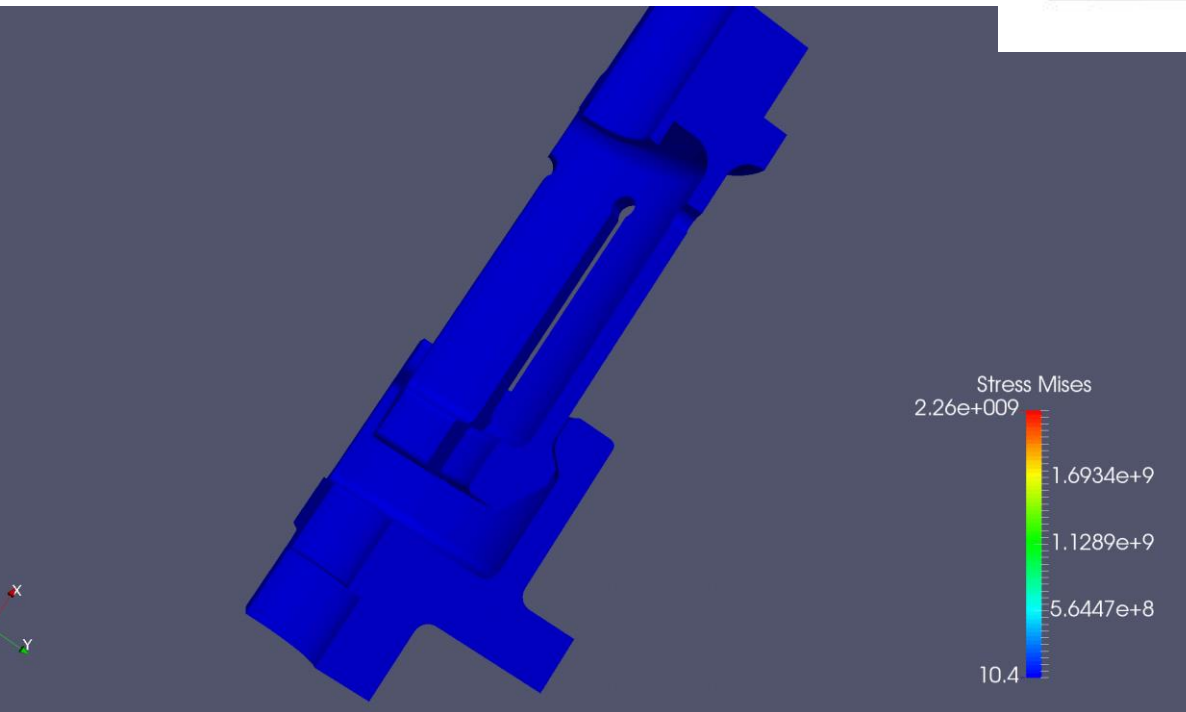
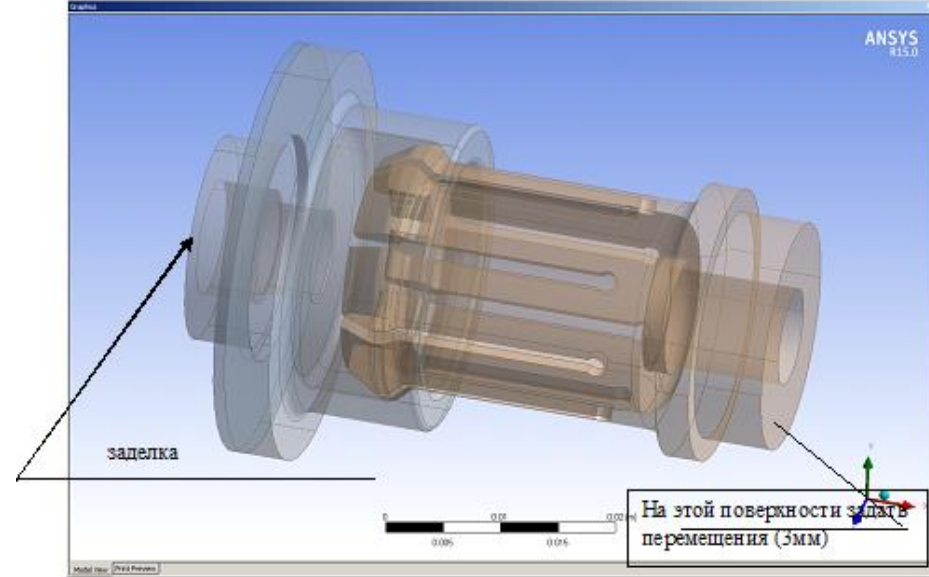
Continuous solution even in the presence of the gap between solids





Collet lock

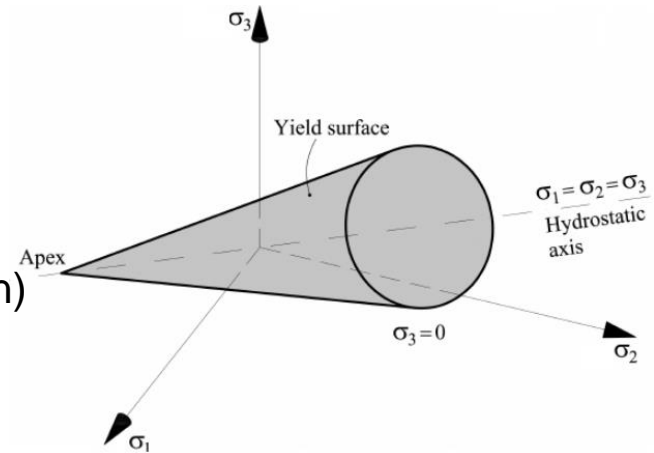
- Kinematic movement of the collet until its complete exit from the bushing
- Variable contact zone at different loading steps





Physical nonlinearity

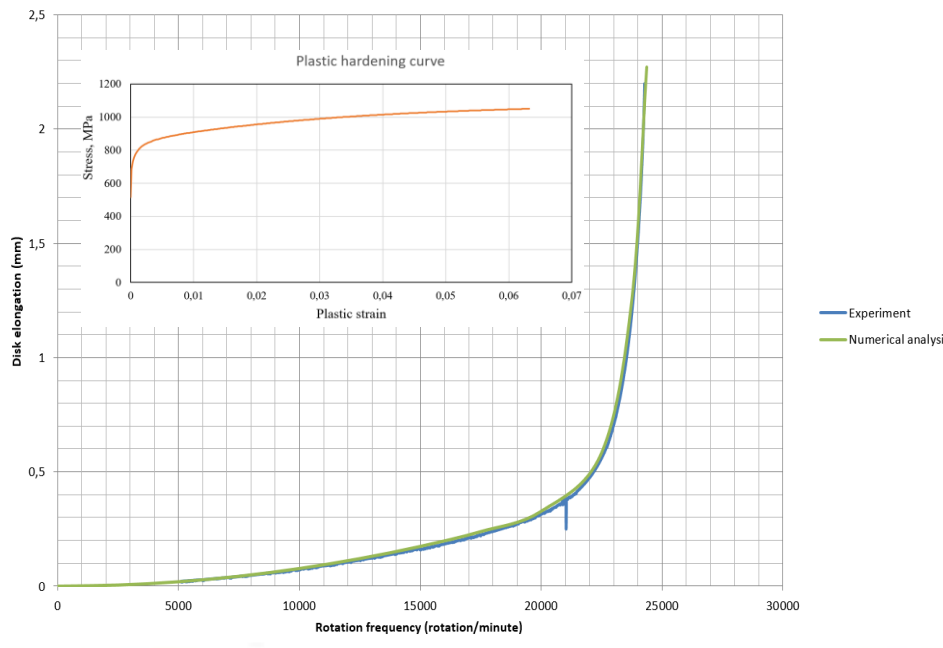
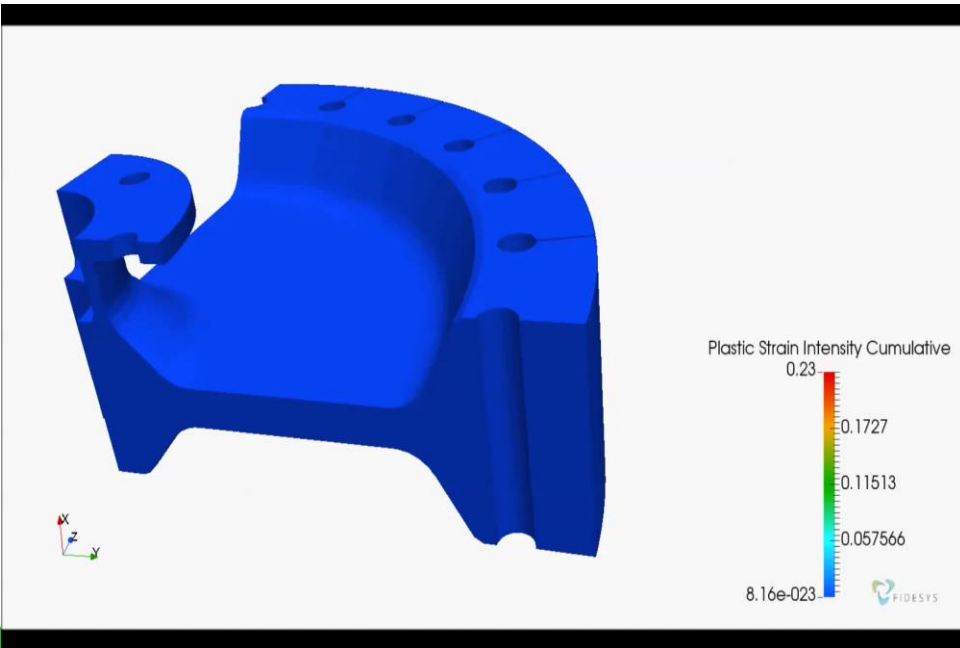
- Nonlinear elastic material models (Murnaghan, Mooney–Rivlin)
- Elastoplastic models (Mises, Drucker-Prager)
- Non-associated plastic flow rule
- Linear/Polylinear/Power hardening



$$f(\sigma_{ij}, \varepsilon_{ij}^p) = 0, \quad f(\sigma, \tau) = \tau - \alpha\sigma - Y$$

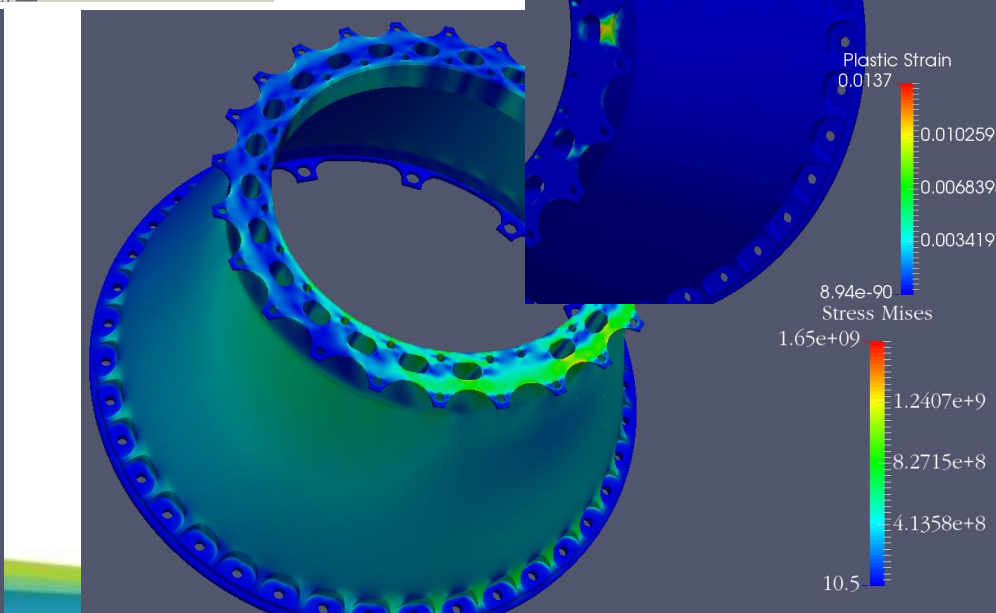
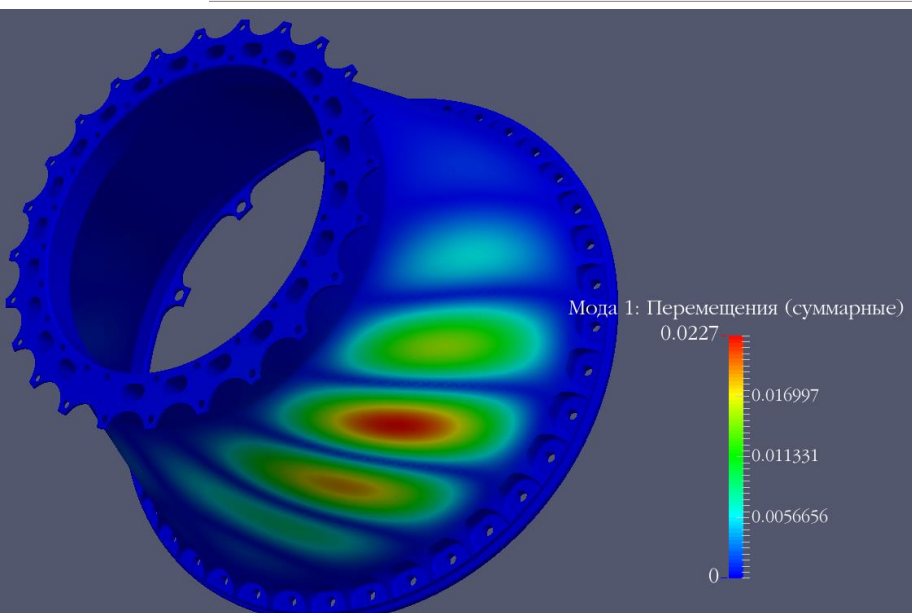
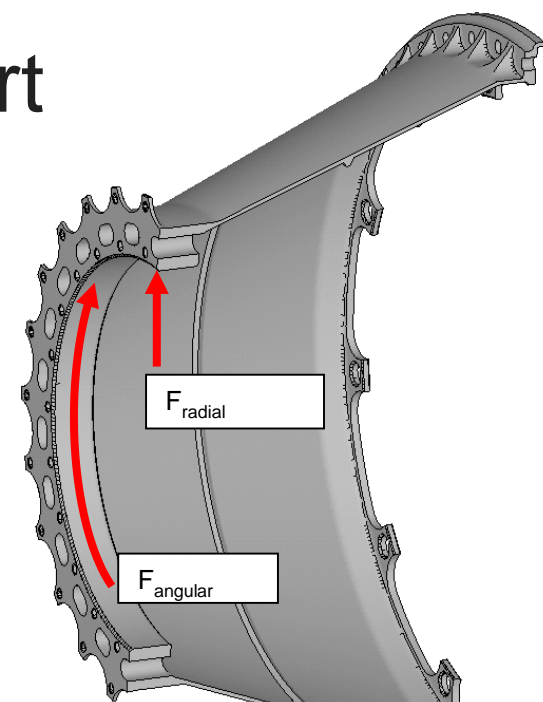
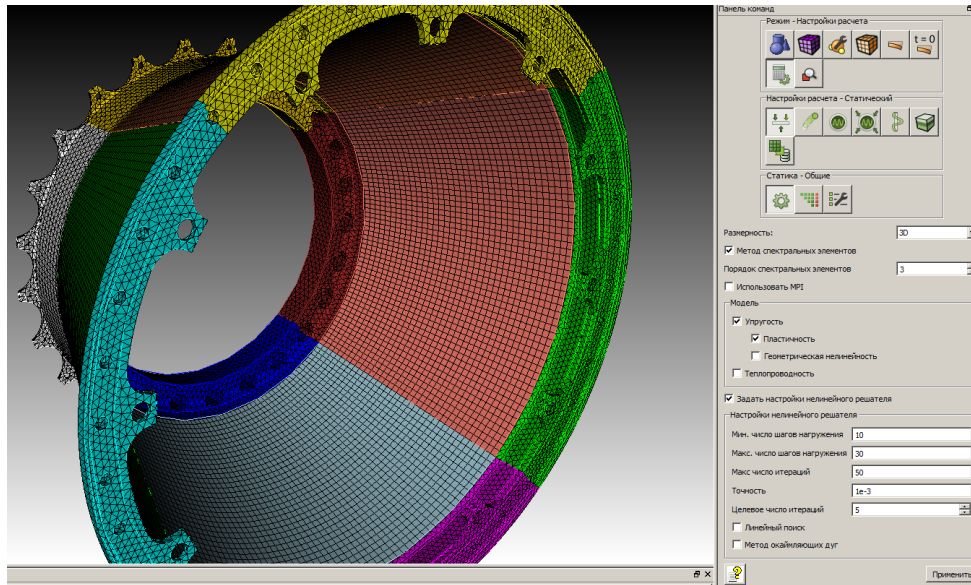
$$g(\sigma_{ij}, \varepsilon_{ij}^p) = 0, \quad g(\sigma, \tau) = \tau - \Lambda\sigma$$

$$d\varepsilon_{ij}^p = d\lambda \frac{\partial g}{\partial \sigma_{ij}}$$



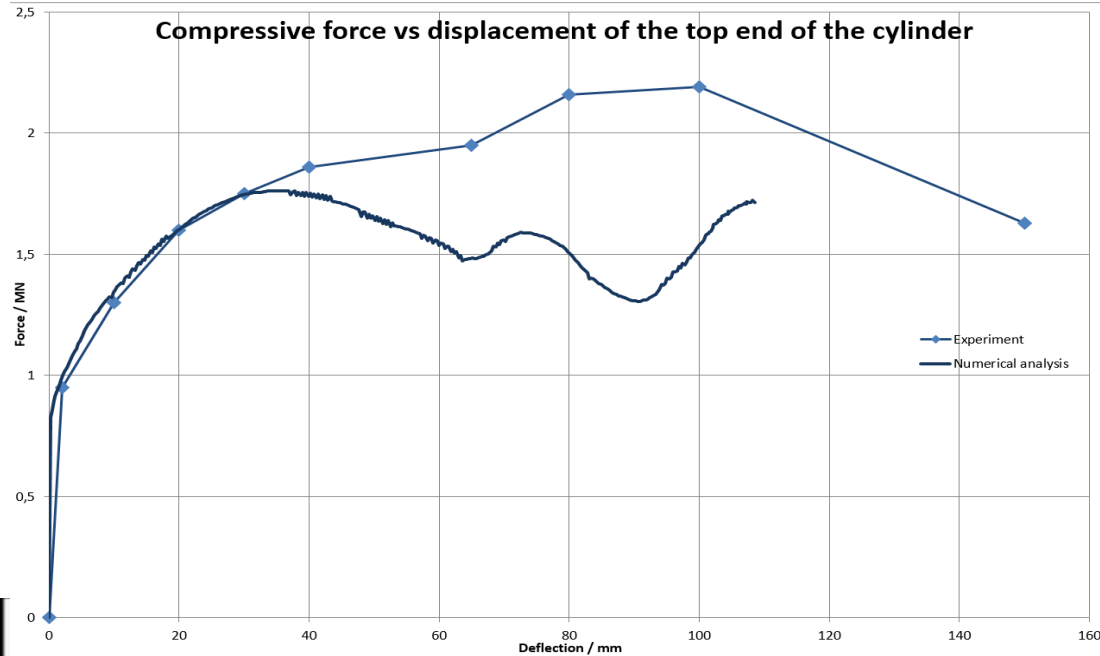
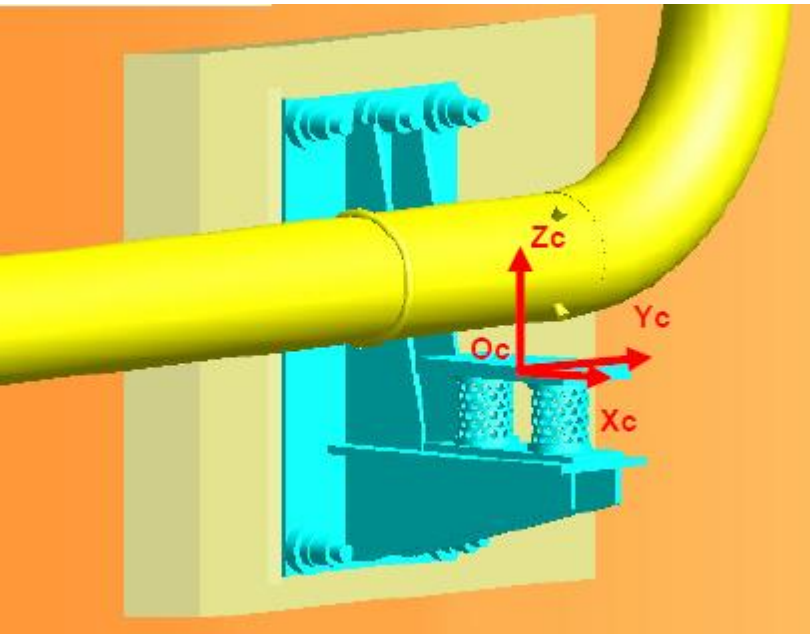


Stresses in the bearing support due to the fan blade breakage

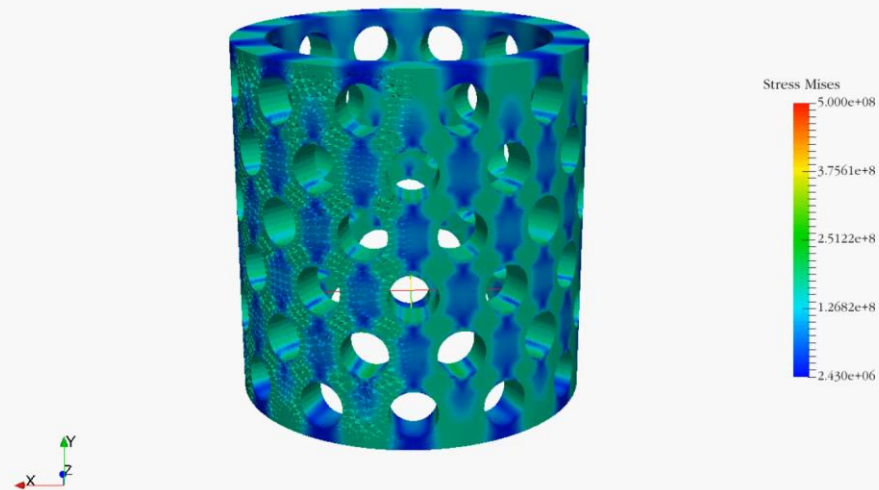




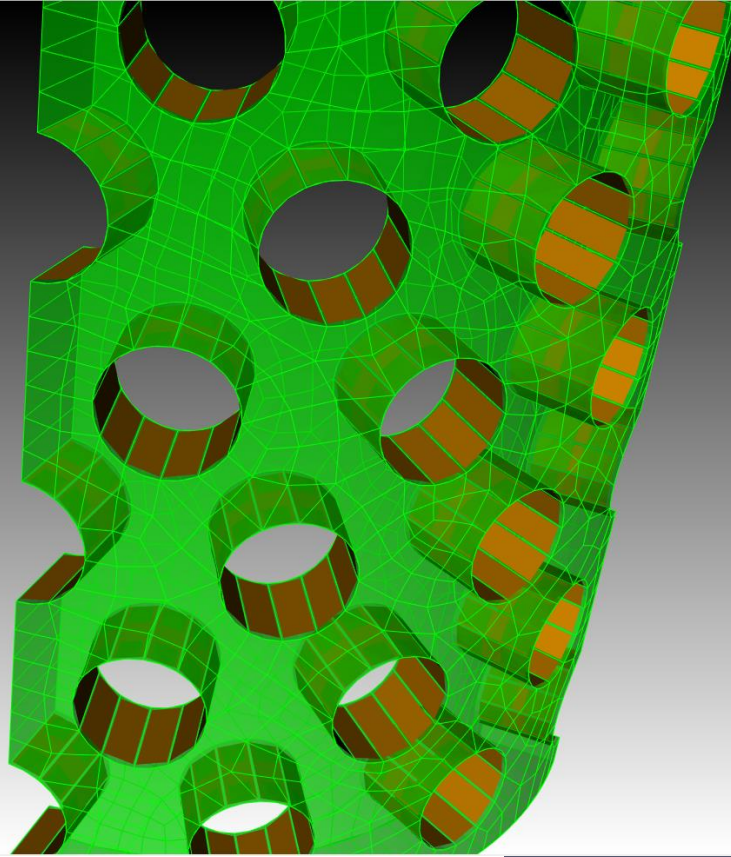
Mathematical modeling of whiplash limiters for pipeline ruptures



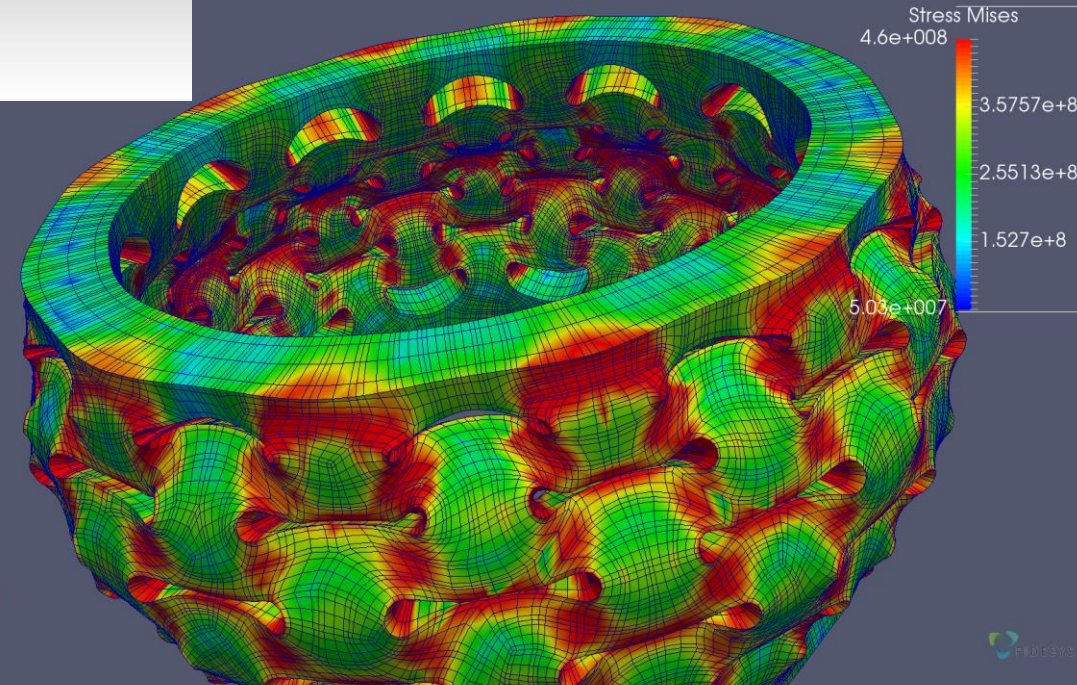
Elastoplastic nonlinear hardening under finite strains and multiple self contacts



Curvilinear coarse mesh used for simulation



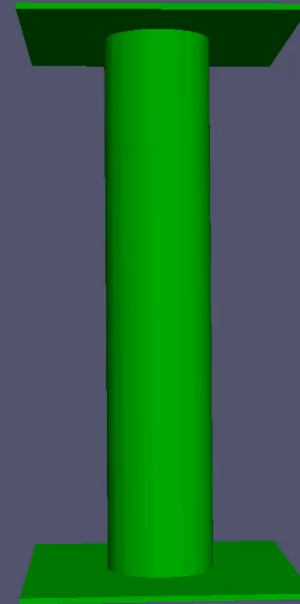
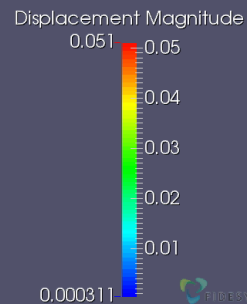
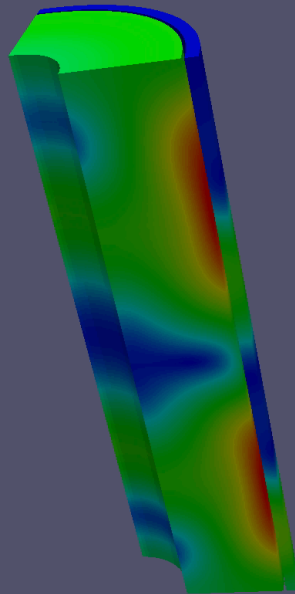
Numerical results at high order spectral element mesh





Complex nonlinear problems

- Steady-state and transient thermal conduction
- Different kinds of BCs: temperature, heat flux, convective heat transfer and radiative heat transfer
- Thermo(Poro)elasticity, Thermo(Poro)elastoplasticity
- Self contact problems under large plastic strains

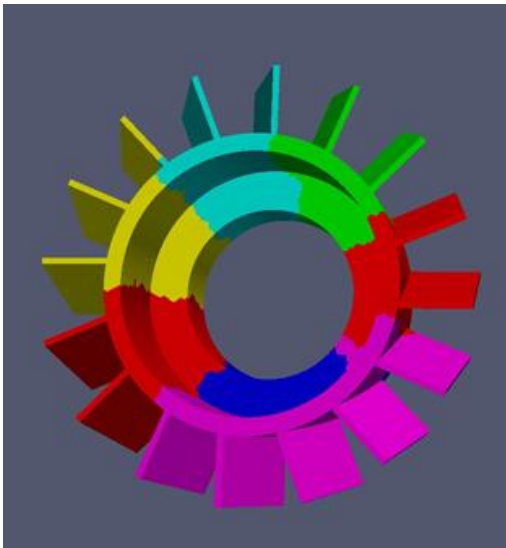




Additional modules



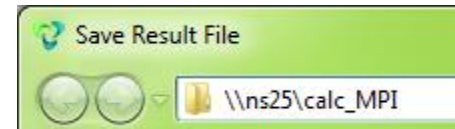
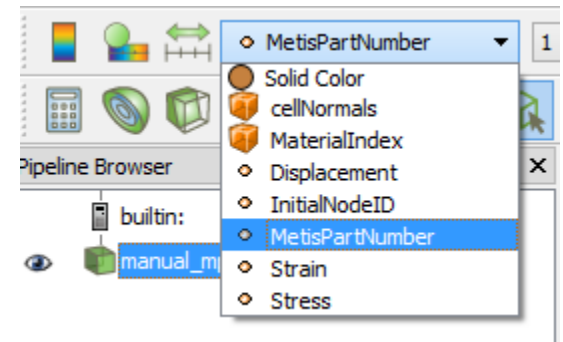
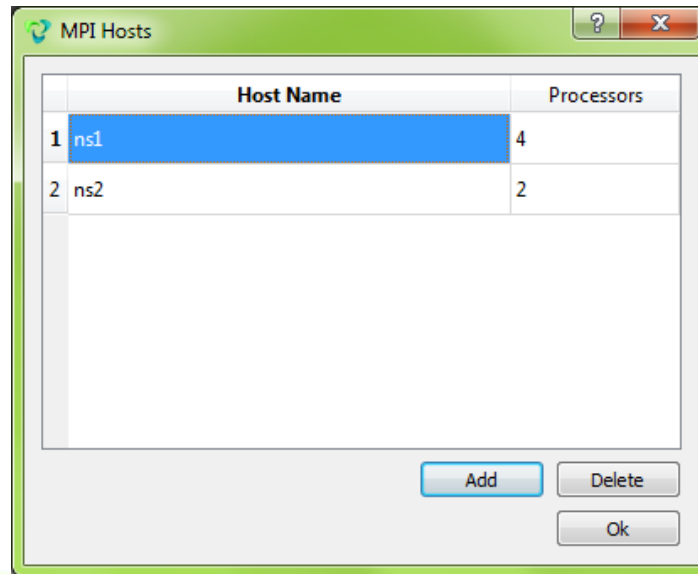
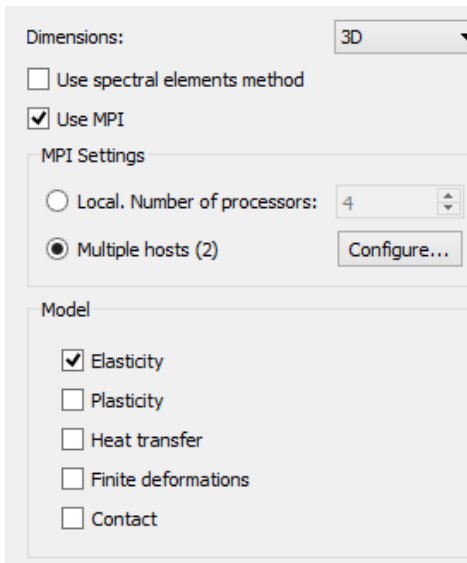
CAE Fidesys structure



Fidesys HPC
high-performance computing

Acceleration of calculations

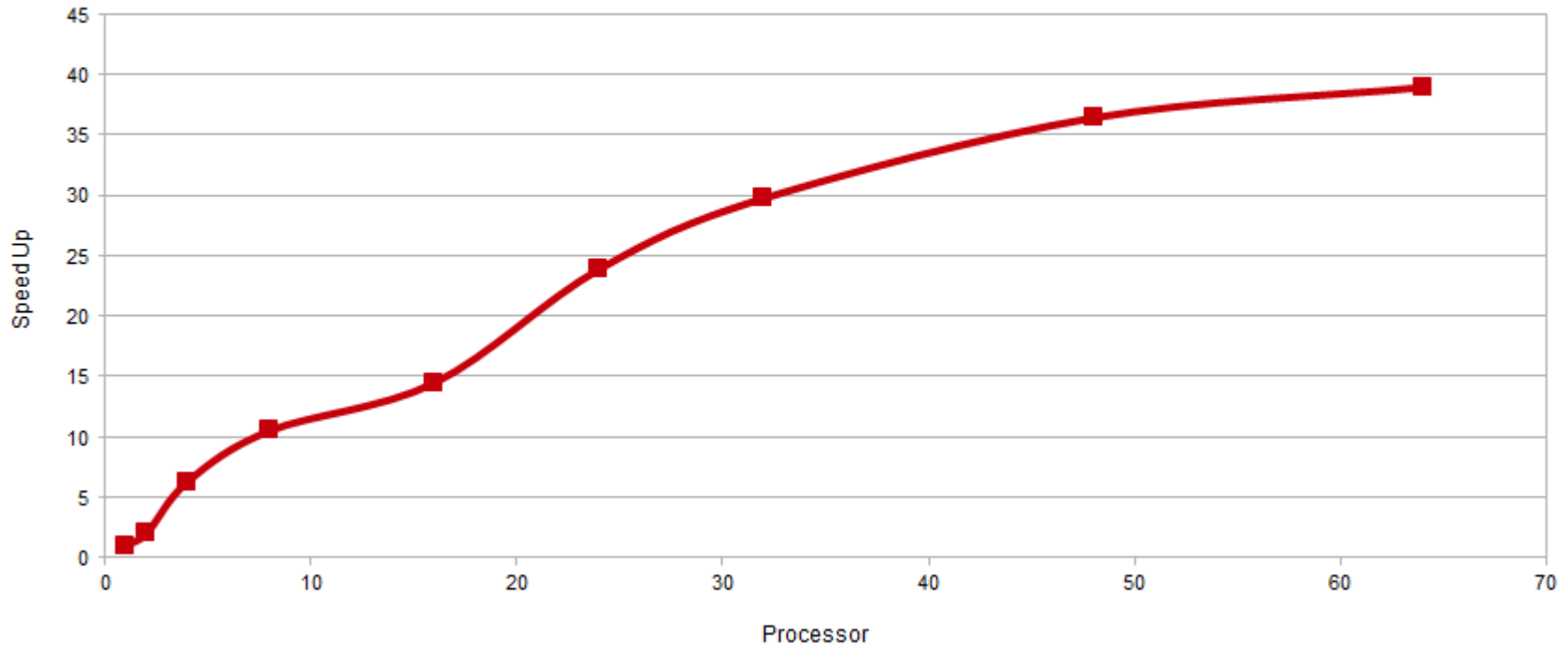
- All major analysis stages are parallelized by
- OpenMP & MPI technologies at
- Multi-core systems and
- Cluster/network systems which gives
- A drastic reduction of the total analysis time





Scalability – 500 thousands of DOFs

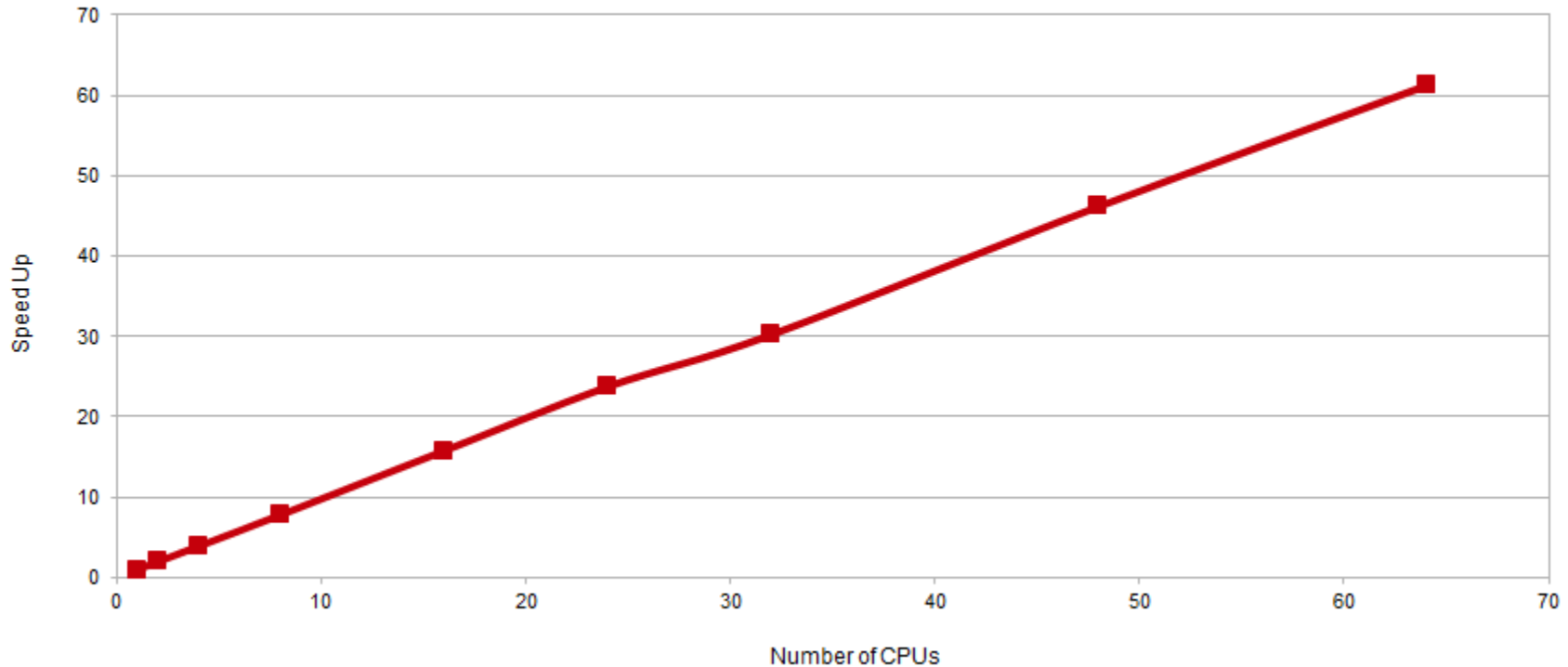
Process vs. Speed Up





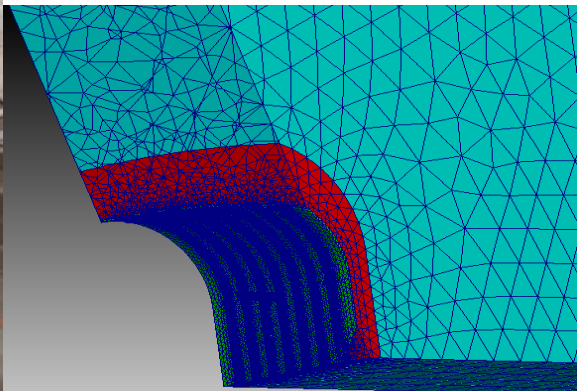
Scalability – 4 millions of DOFs

Process vs. Speed Up





HPC example: geomechanical analysis of mine workings (> 30 mln. elements)



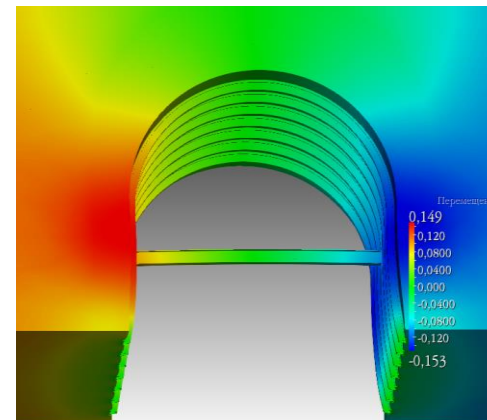
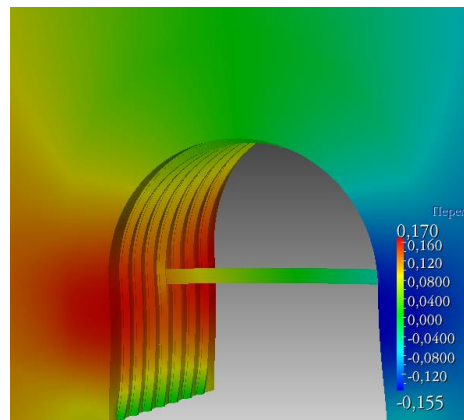
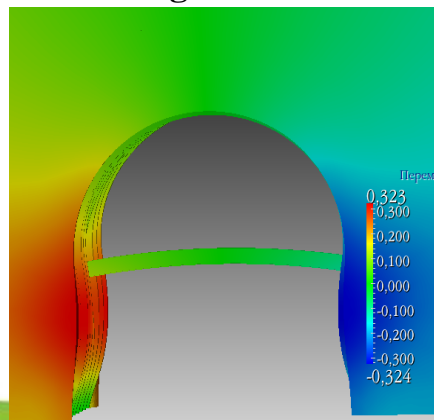
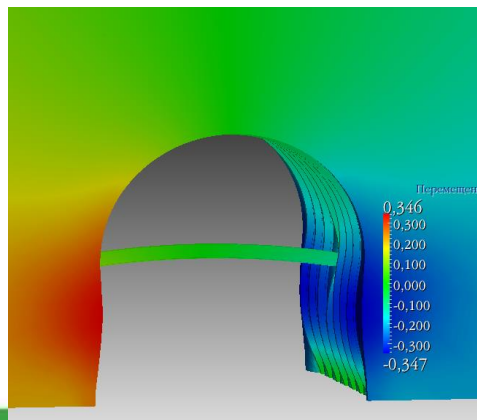
The current geomechanical situation in the mine is reproduced and the result of the possible strengthening of the rock mass after puffing (tamponage) or the replacement of the linings.

Current situation
horizontal convergence
70cm

**Replacement of SVP 27 for
SVP 33** Horizontal
convergence **64 cm**

**Reinforcement
(tamponage)**
Horizontal
convergence **32 cm**

**Reinforcement (tamponage) +
Replacement of SVP 27 at SVP 33**
Horizontal convergence **30 cm**



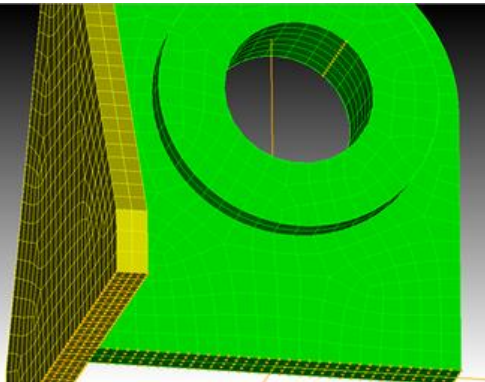


CAE Fidesys structure

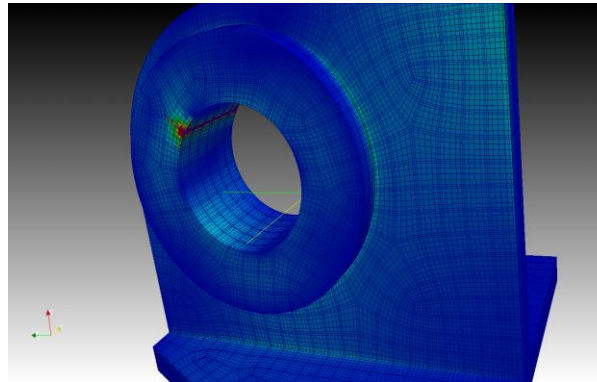
Fidesys Dynamics
Spectral element method.

High order space discretization (SEM)

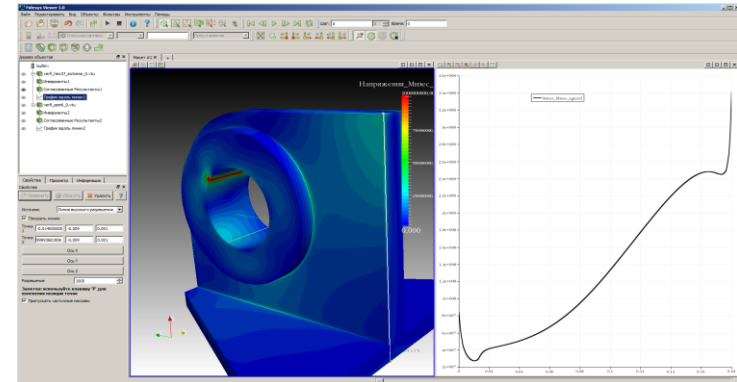
- High accuracy and stability of the numerical algorithm
- Automatization of grid convergence analysis
- Lack of locking issues for high orders of the numerical scheme



A 3D discrete model of the deck eye



Spectral element mesh of the model



Analysis of stress concentrations

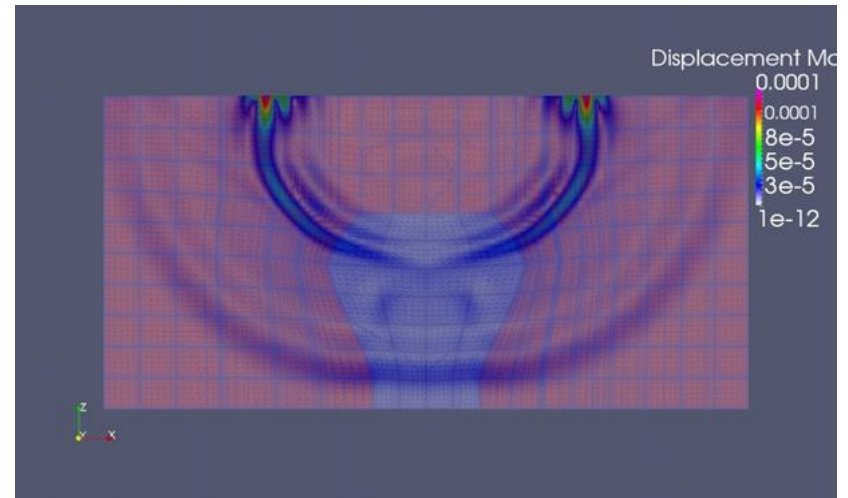
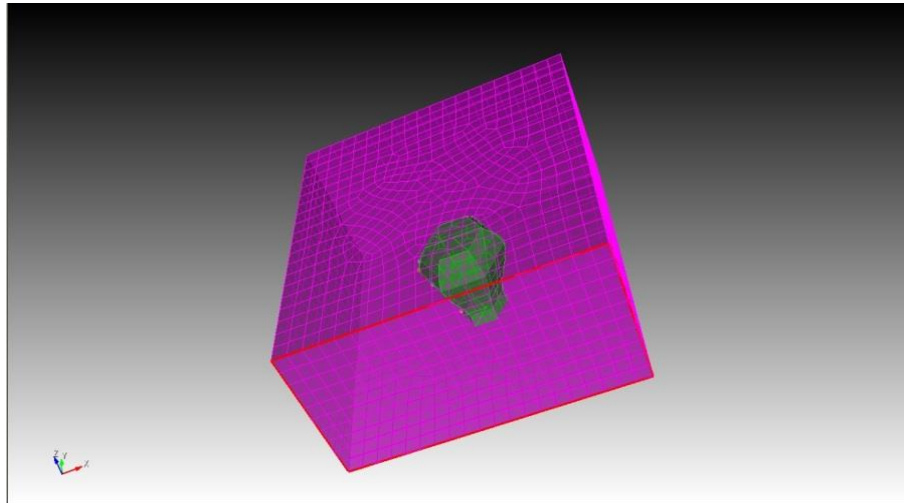


Additional modules

Fidesys Dynamics

Spectral element method.
High-precision non-stationary problems

- Spectral element method – a modern FEM modification
- Most effective for dynamical analysis
- Non-stationary problems with fast changing processes
- Increased speed and accuracy of calculations
- Effective parallelization available with Fidesys HPC

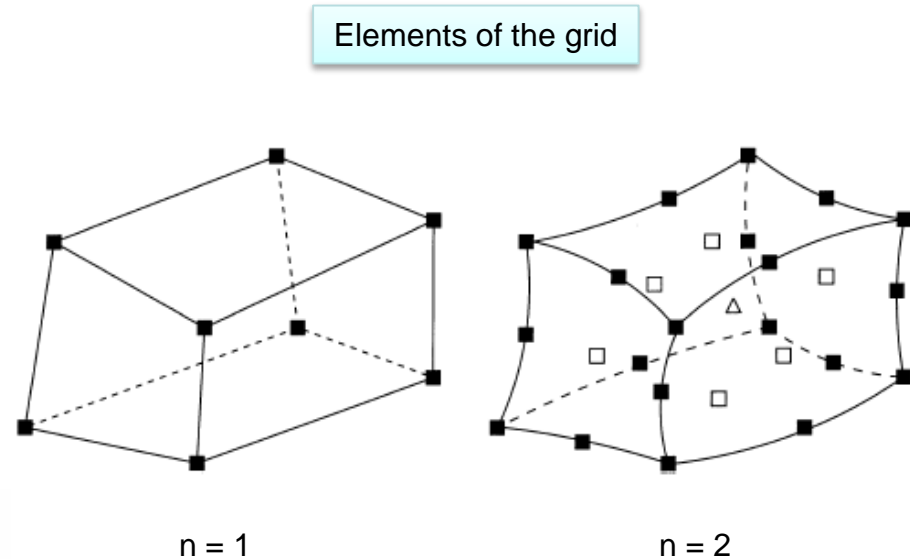
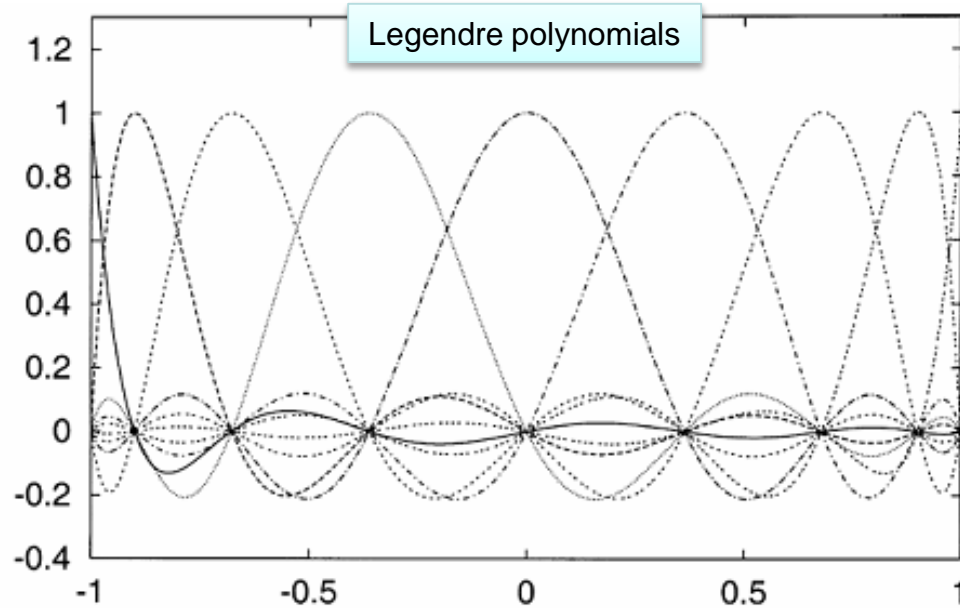


3D seismic full wave modelling

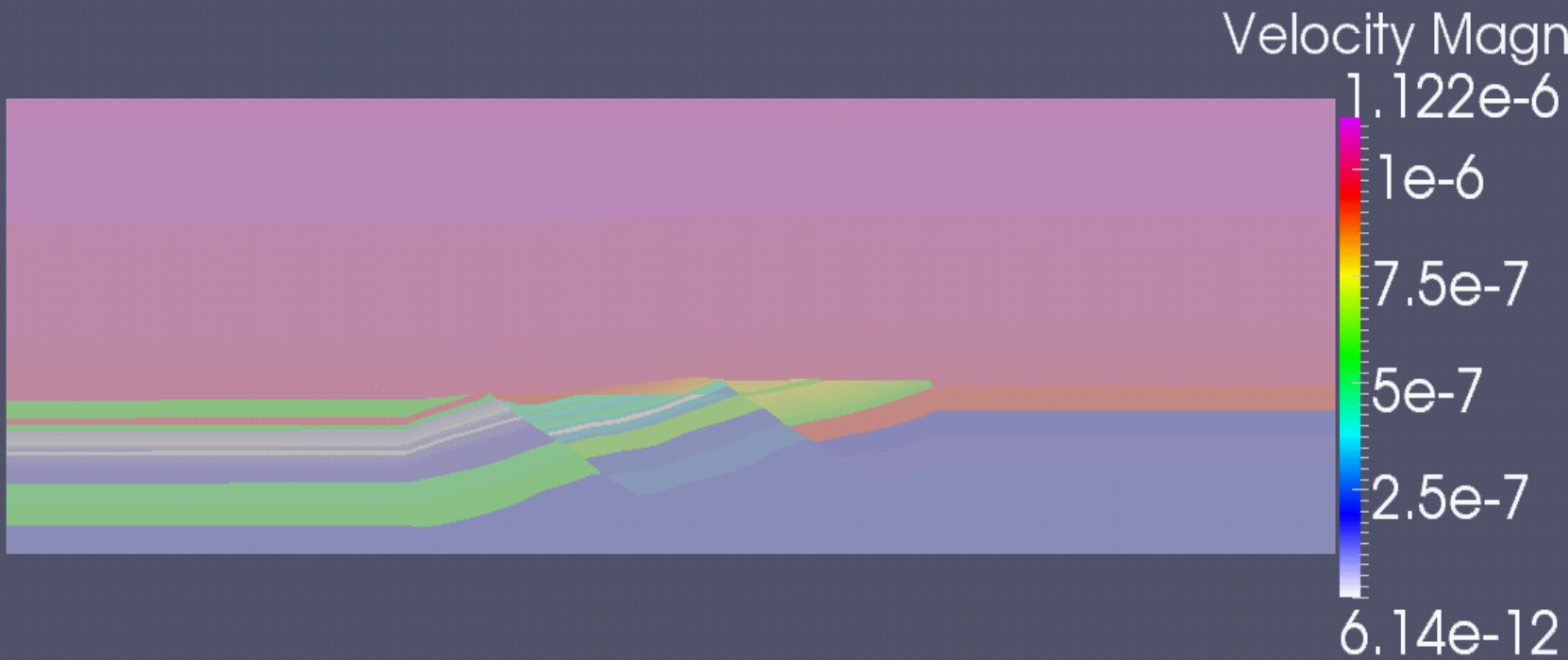


Spectral Element Method

Basis functions — Legendre polynomials, providing a spectral-order approximation in space

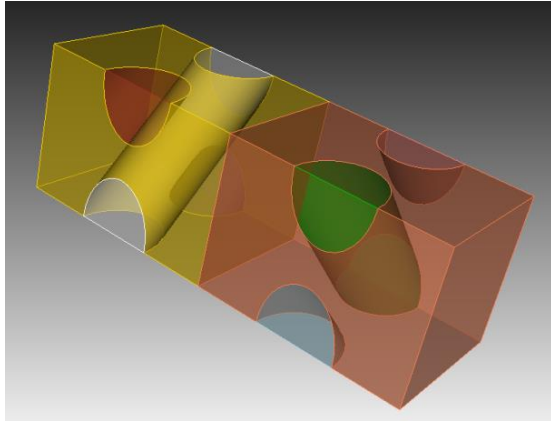


High accuracy in approximating the curvilinear geometry of the body



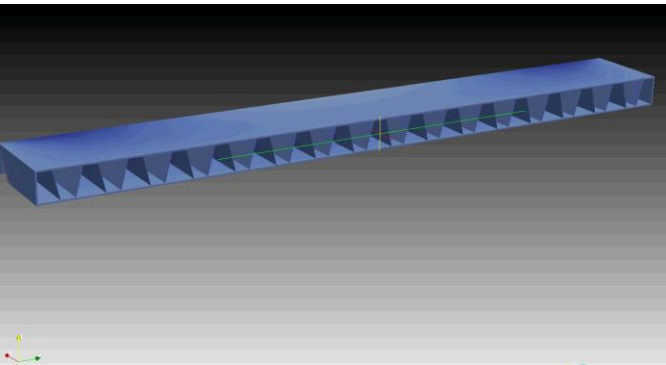
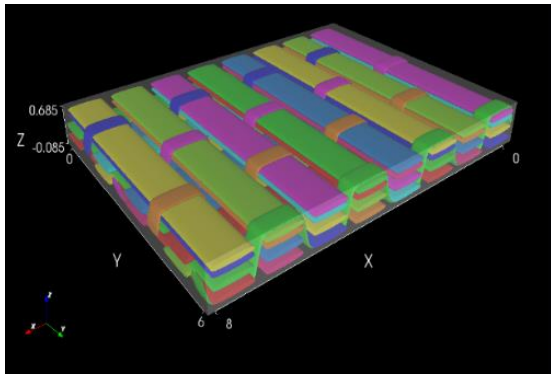


CAE Fidesys structure



Fidesys Composite
Multiscale simulation

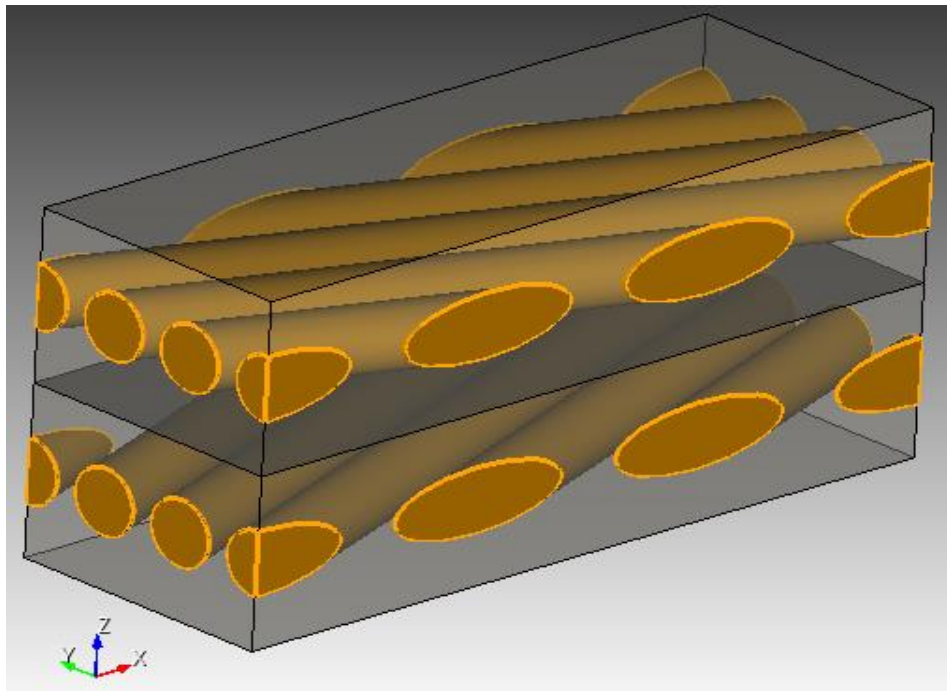
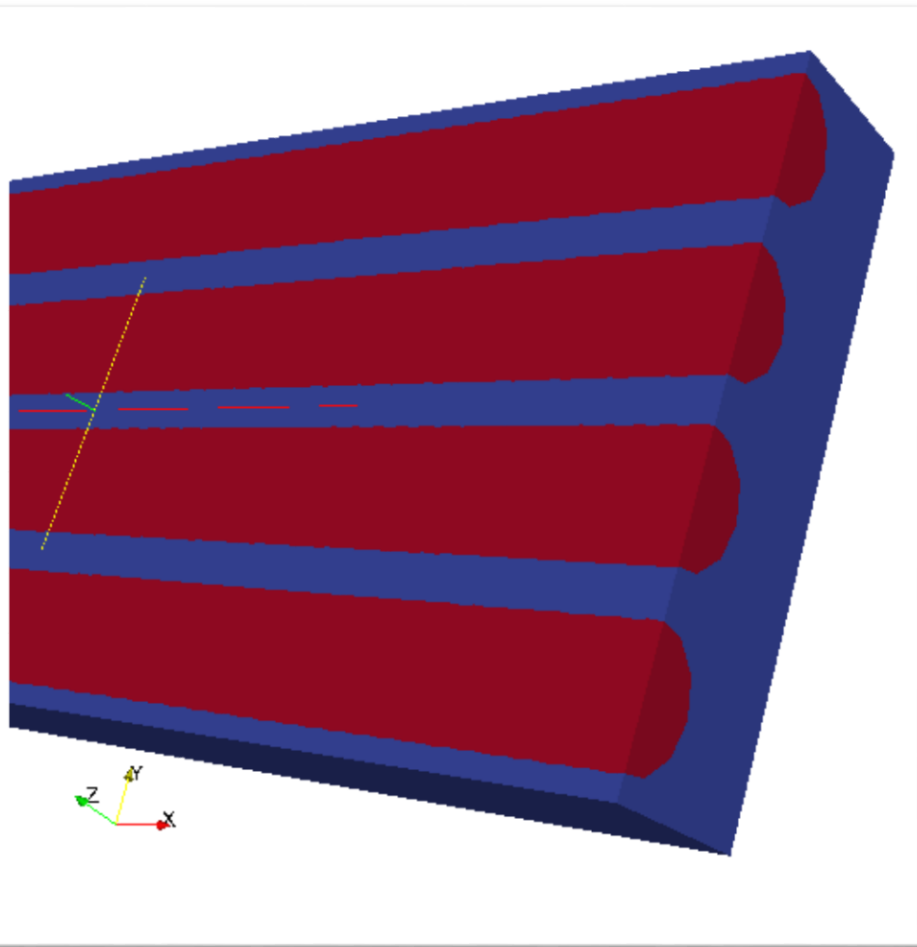
Estimation of the composite effective properties



- Engineering analysis of composites and structural elements made of them
- Multiscale simulations
 - Properties of reinforcing fibers
 - Composite matrix modeling
 - Effective properties of the composite are estimated based on the representative volumetric element (RVE) analysis
- Progressive fracture growth in the composite
 - Determination of the critical stress value of the structure
 - Simulation of a composite behavior after fracture initiation
- Nonlinear effective properties, prestressed materials



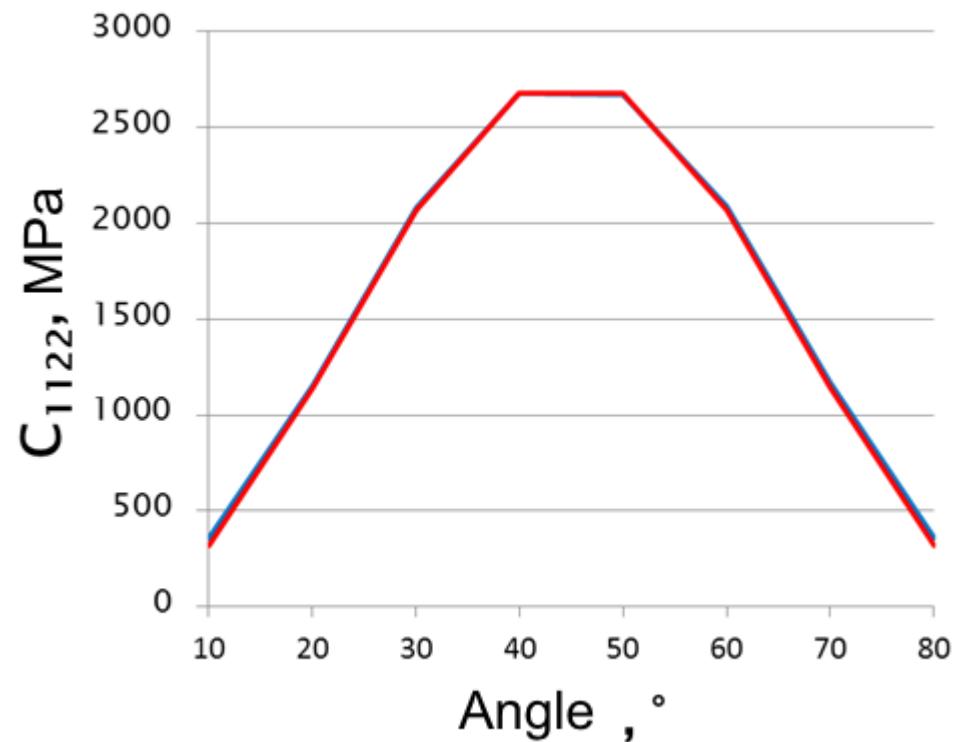
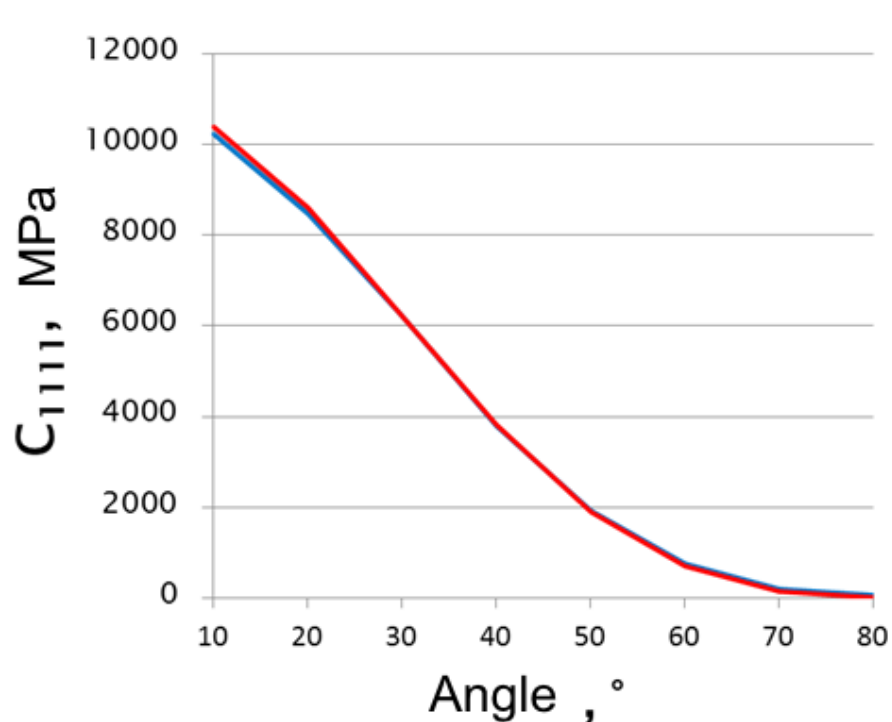
Evaluation of rubber cord effective properties





Numerical vs Analytical results

- Linear problem, dual-layer rubber cord
- Young's modulus of the cord and the rubber differ in 4 orders



--- Numerical solution

--- Analytical solution (Bidermann, 1963)

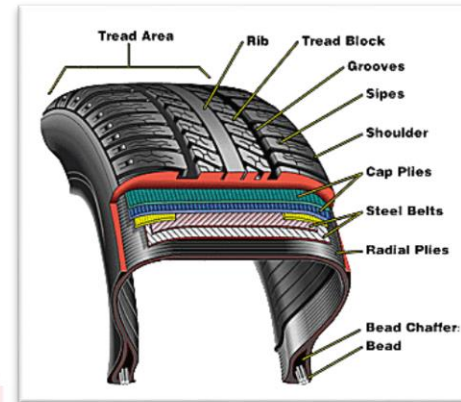
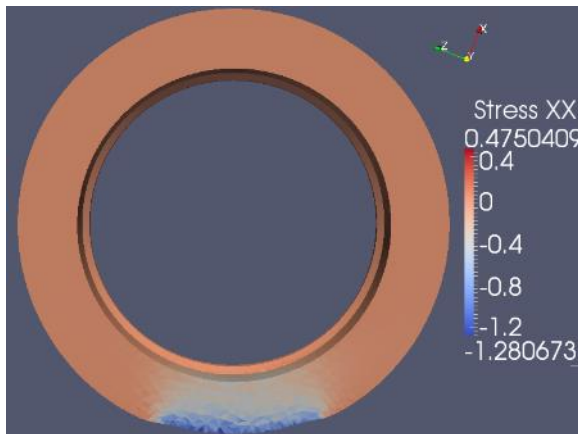
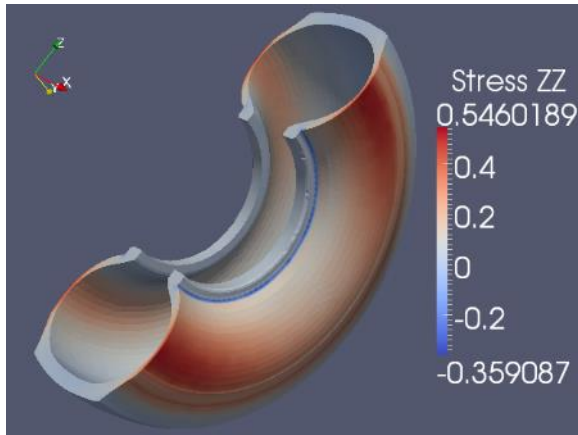


CAE Fidesys structure

Fidesys Composite
Multiscale simulation

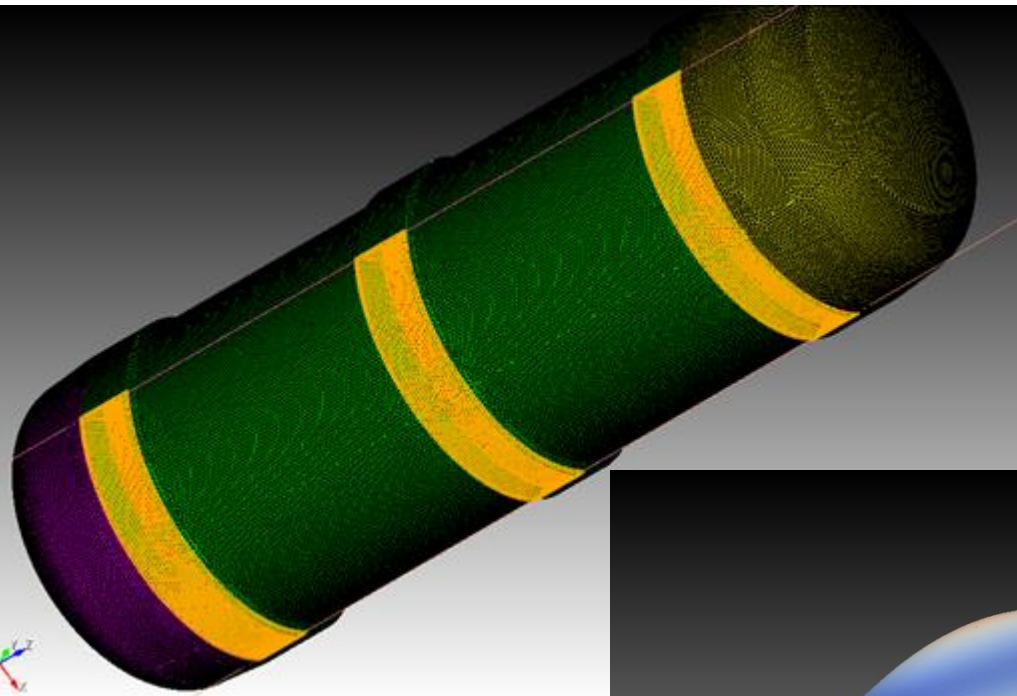
Effective properties of composite materials

- Modeling a realistic composite microstructure
- Simulation of products made of a rubber cord

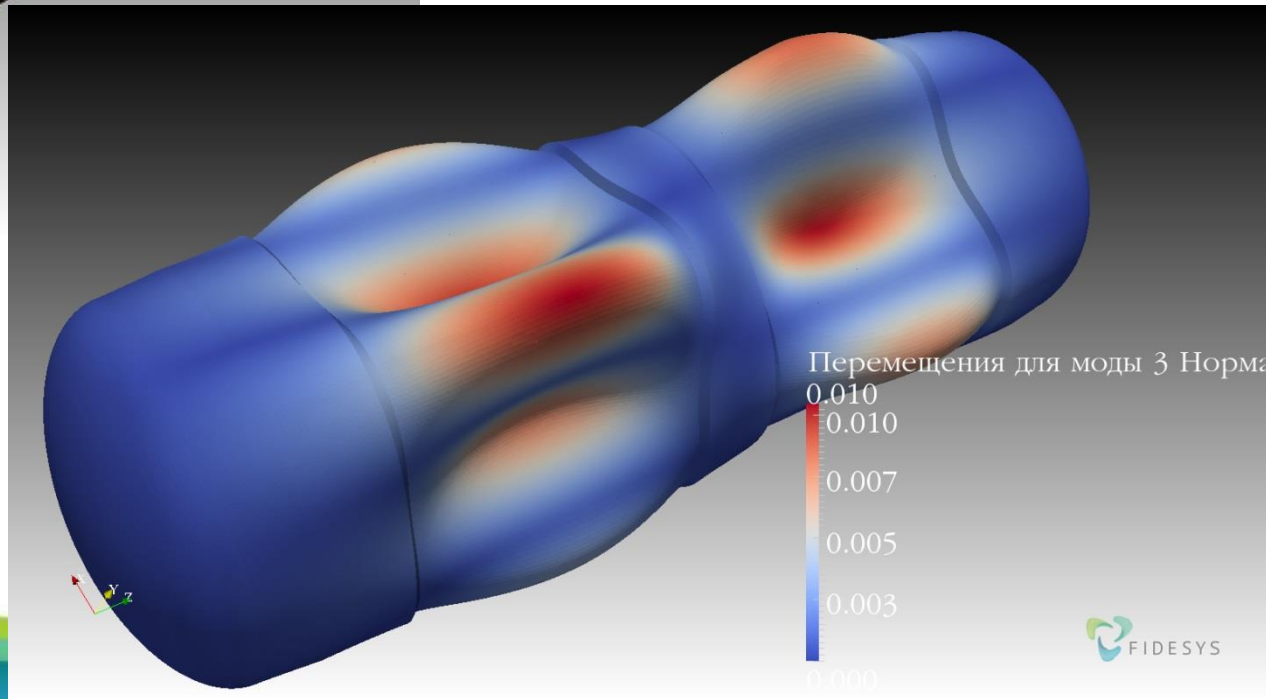
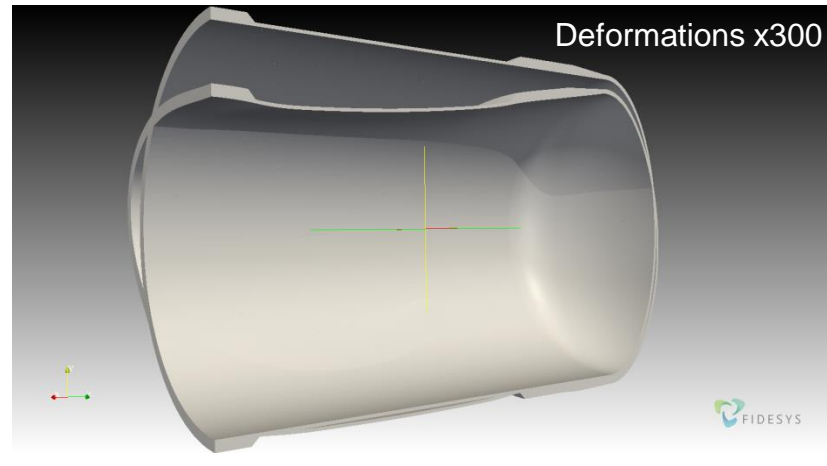




Analysis of the composite tank under internal hydrostatic pressure



3rd Buckling mode



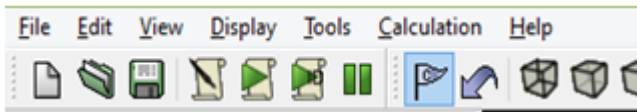


CAE Fidesys interfaces

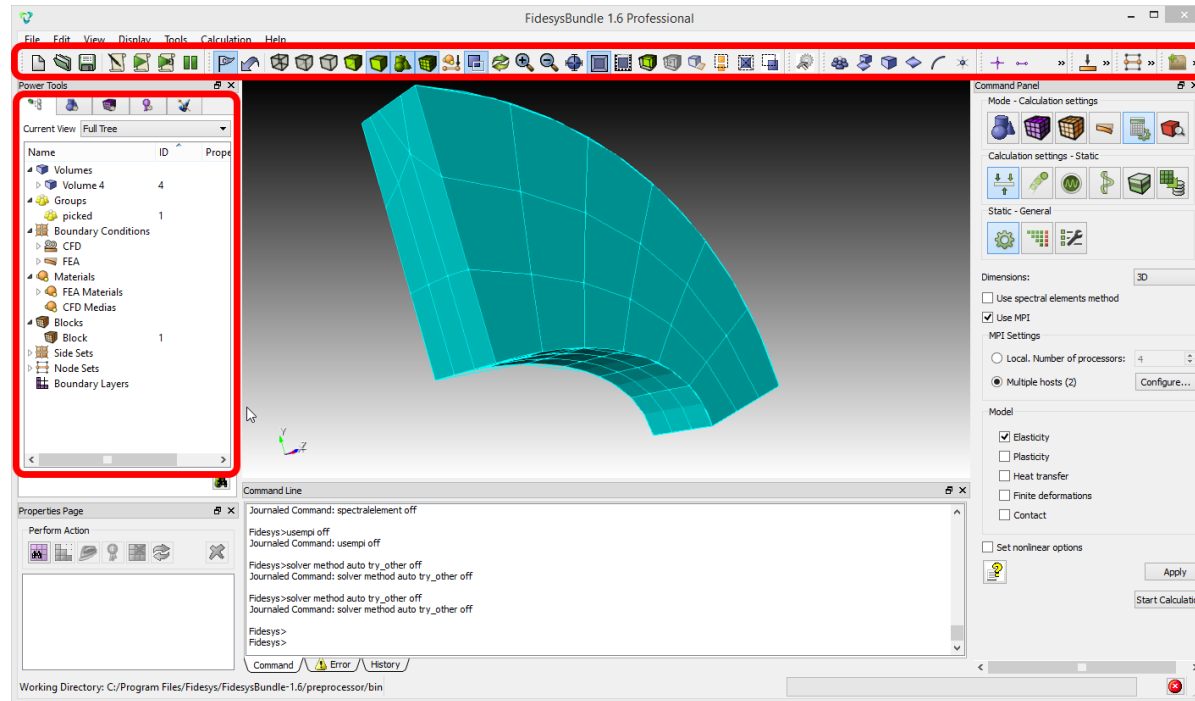
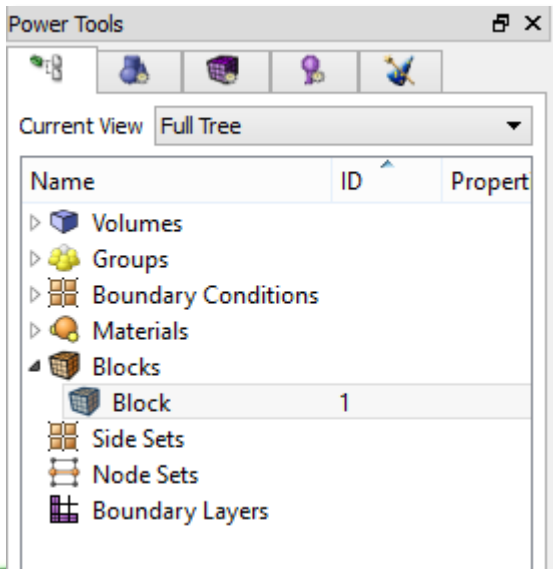


CAE Fidesys interface

- Standard operations on files and projects



- The Model Tree

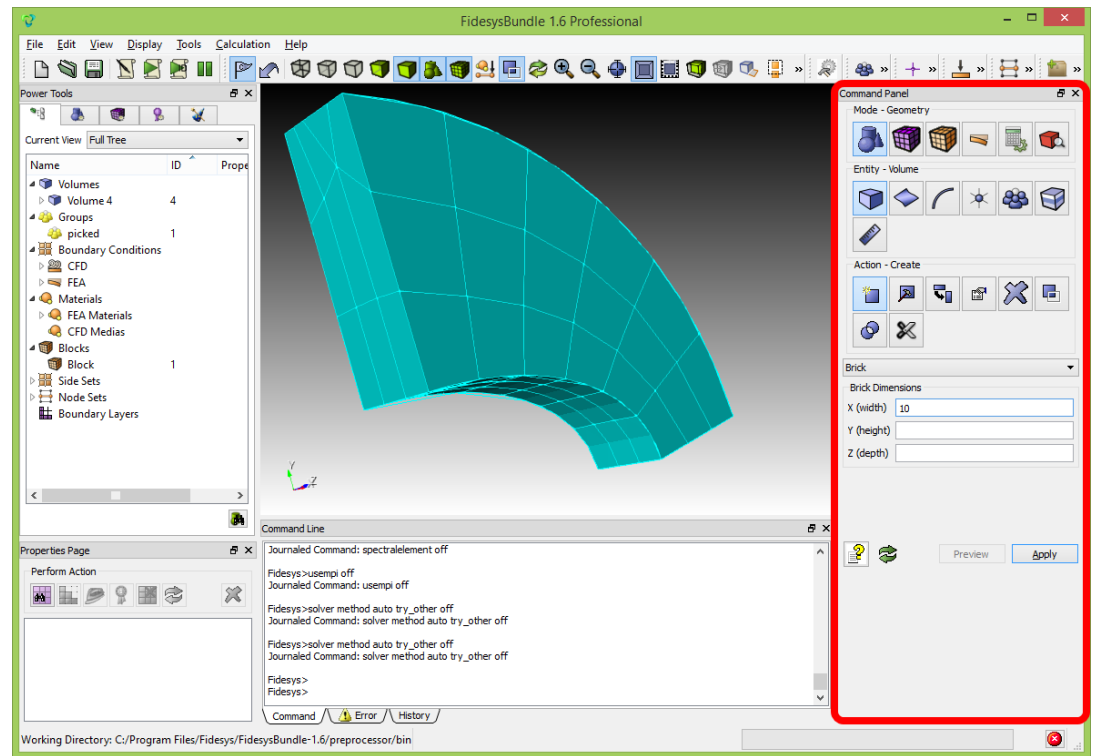
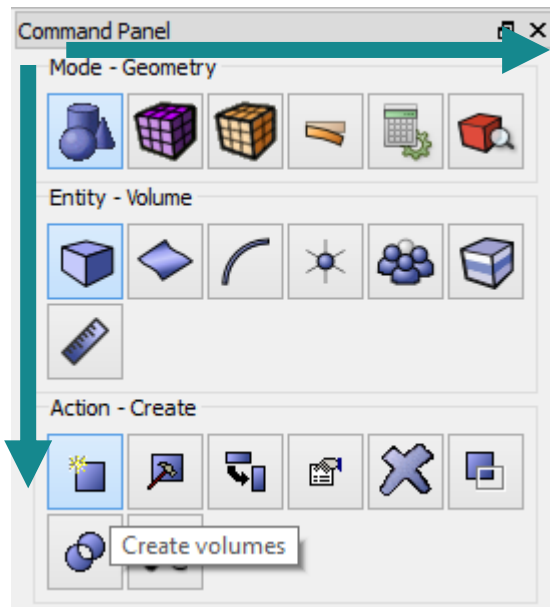


Main window



CAE Fidesys interface

- Logically arranged Command Panel



Main window



CAE Fidesys interface

- Properties of the selected object (Properties Page)

Properties Page

Perform Action

Property	Value
General	
Id	1
Idless Signature	calc
Name	Block
Description	
Element Type	QUAD4
Color	TRISHELL
Element Count	TRISHELL3
Attributes	TRISHELL6
	TRISHELL7
	SHELL
	SHELL4
	SHELL8
	SHELL9
	QUAD
	QUAD4

FidesysBundle 1.6 Professional

File Edit View Display Tools Calculation Help

Power Tools

Current View Full Tree

Name	ID	Pr
Volumes		
Volume 4	4	
Groups		
picked	1	

Volume 4

Properties Page

Perform Action

Property	Value
General	
id	4
Type	Volume
Name	Volume 4
Idless Signature	calc
Color	Not Set
Geometry	
Engine	ACIS
Volume	calc
Meshing	
Is Meshed	Yes
Number of Elements	60
Number of Nodes	715
Requested Intervals	Not Set
Requested Size	0.142587 (N)
Meshed Volume	calc
Mesh Scheme	Polyhed
Smooth Scheme	Equipotential
Metadata	
Dart Name	

Command Panel

Mode - Geometry

Entity - Volume

Action - Create

Brick

Brick Dimensions

X (width) 10

Y (height)

Z (depth)

Command Line

```
Journaled Command: spectralelement off
Fidesys>usempi off
Journaled Command: usempi off
Fidesys>solver method auto try_other off
Journaled Command: solver method auto try_other off
Fidesys>solver method auto try_other off
Journaled Command: solver method auto try_other off
Fidesys>
Fidesys>
```

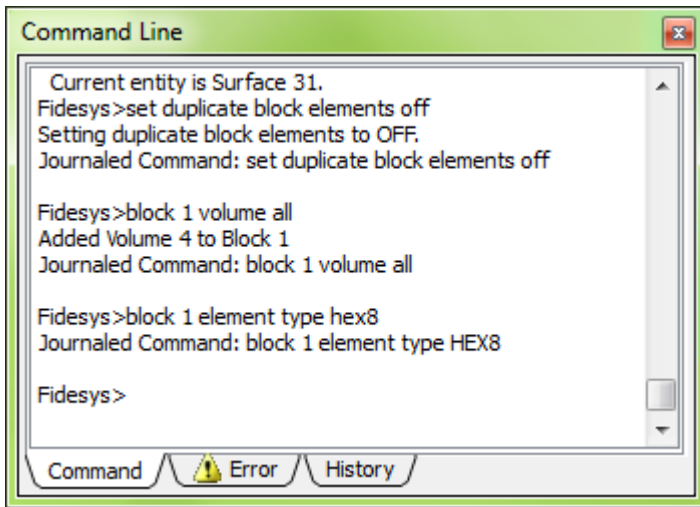
Working Directory: C:/Program Files/Fidesys/FidesysBundle-1.6/preprocessor/bin

Main window

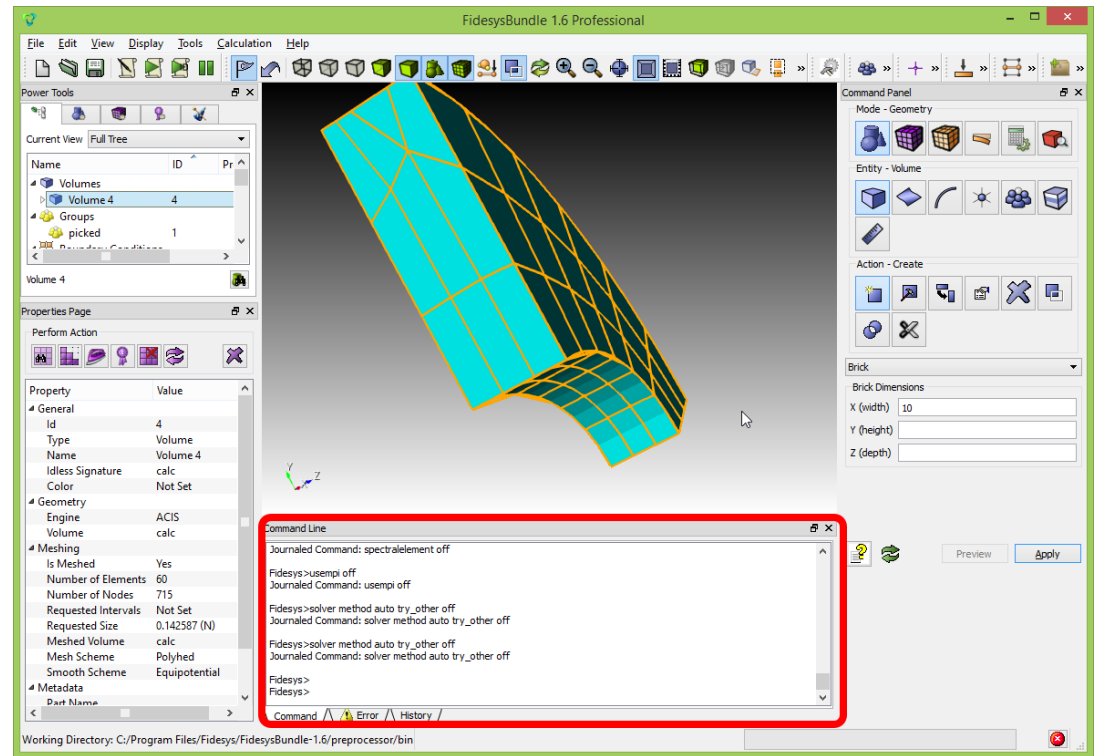


CAE Fidesys interface

■ Console



- ✓ Entering Commands
- ✓ Displaying messages
- ✓ History
- ✓ Running scripts

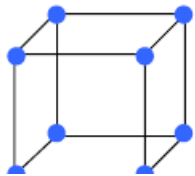


Main window

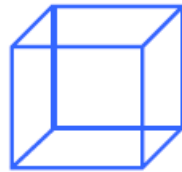


CAE Fidesys interface

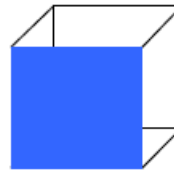
Geometry creation



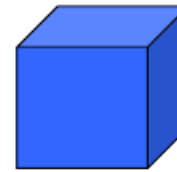
Vertex



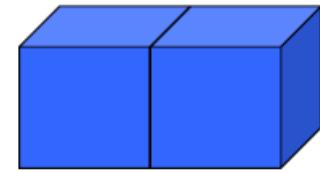
Curve



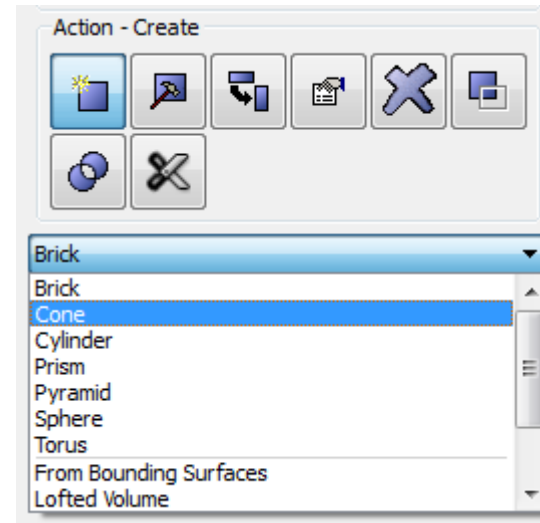
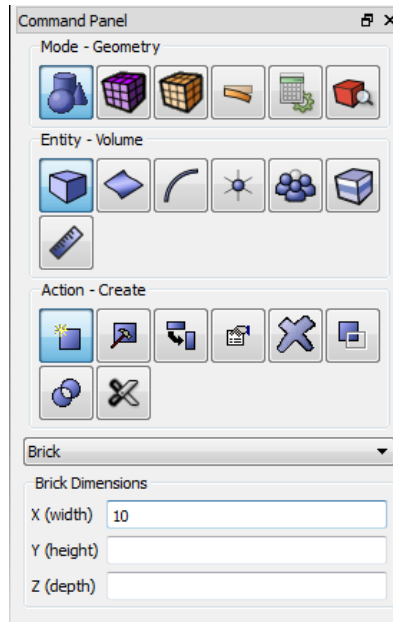
Surface



Volume



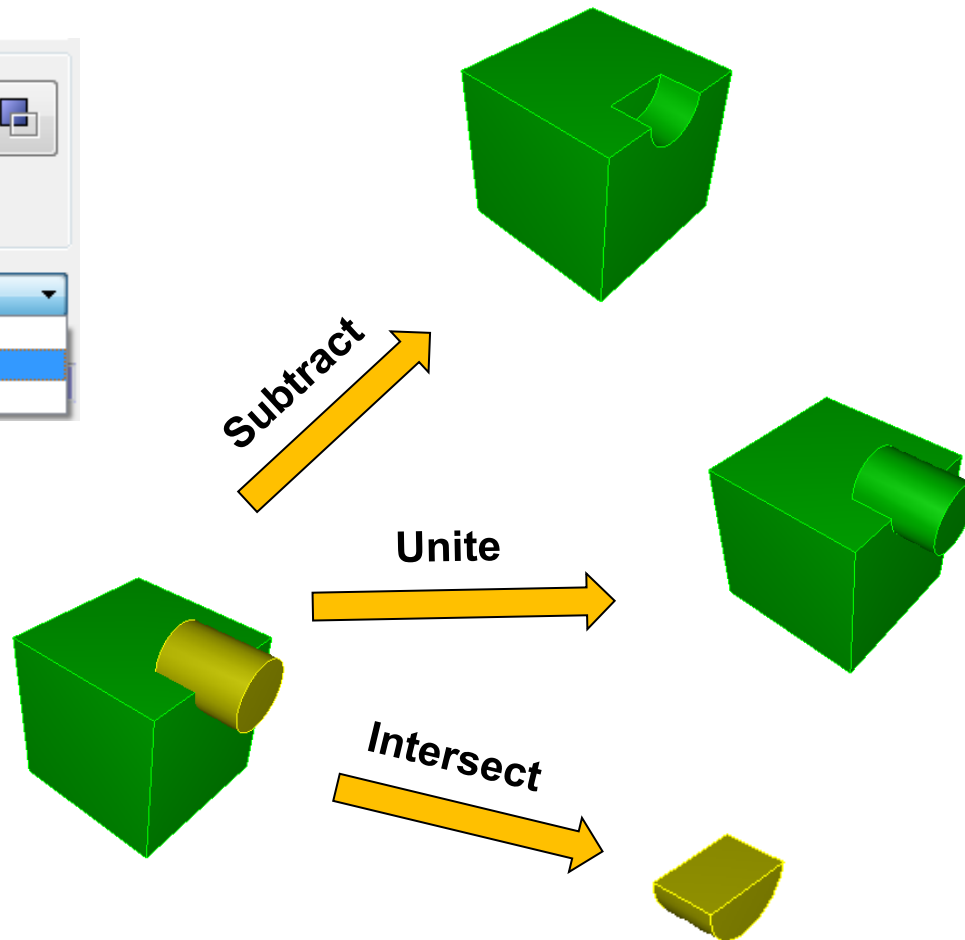
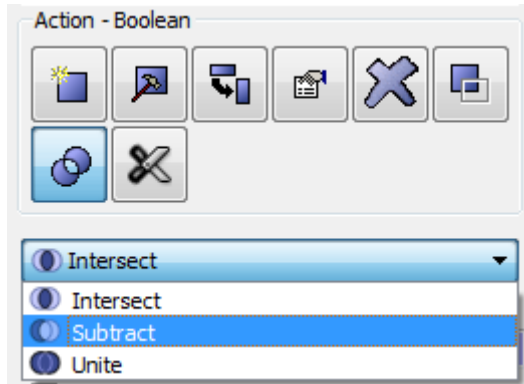
Body





CAE Fidesys interface

Geometry editing





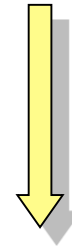
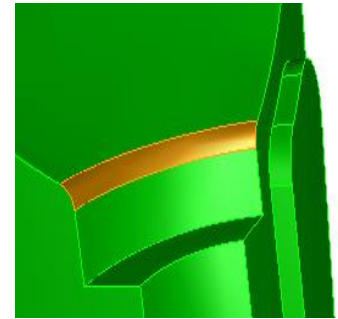
CAD vs CAE

- CAD-model
 - In most cases is 3D
 - Acknowledges all the geometrical tiny details
 - Possible intersections and overlappings
- CAE-model
 - Strength characteristics are of major importance
 - Some three-dimensional parts should be replaced by beams and shells



Model preparation

- 3D → 2D, 1D
 - Beam structure generation
 - Shell structure generation
- 3D geometry editing
 - Chamfers and roundings elimination
 - Virtual combining of surfaces
 - Conformity of volumes



Removing
rounding

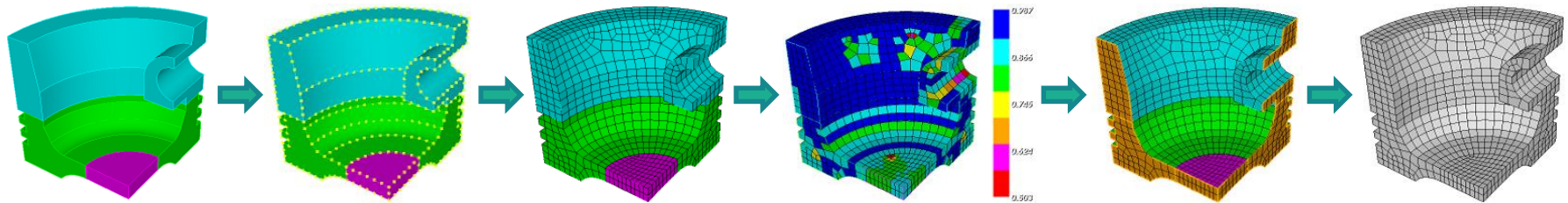




CAE Fidesys interface

Meshing

1. Geometry import
2. Specifying meshing intervals
3. Mesh generation
4. Mesh quality checking
5. Creating BCs
6. Calculation parameters



- Supported types of the finite elements for meshes:

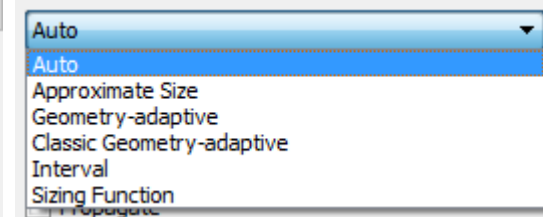
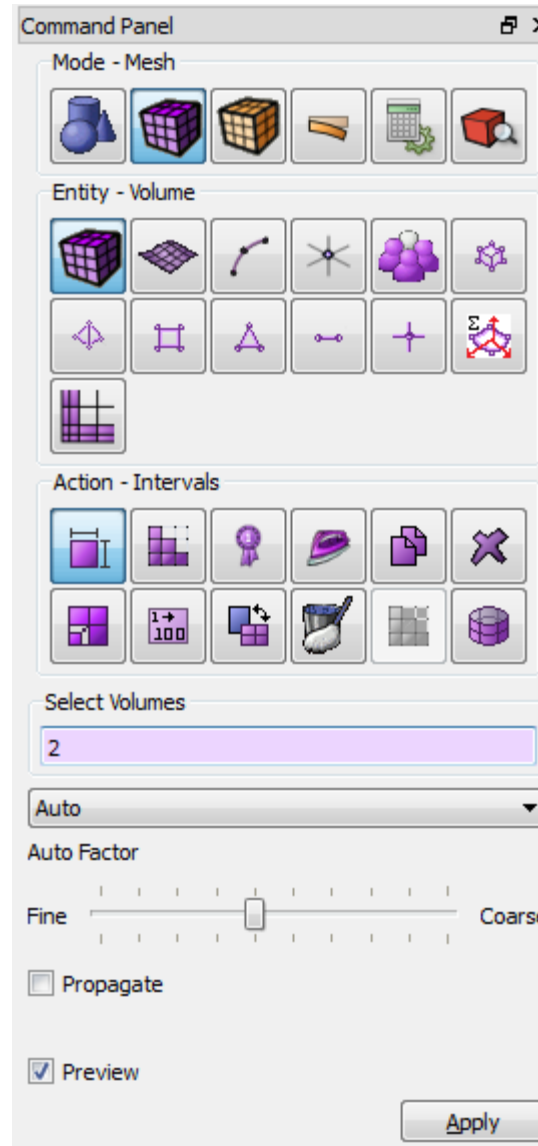
3D	2D	Shells	Beams
4-noded tetrahedron (TETRA/TETRA4), 10-noded tetrahedron (TETRA10)	3-noded triangle (TRI/TRI3), 6-noded triangle (TRI6)	3-noded triangle (TRISHELL/TRISHELL3), 4-noded quadrilateral (SHELL/SHELL4)	2-noded beam (BEAM/BEAM2)
8-noded hexahedron (HEX/HEX8), 20-noded hexahedron (HEX20), 27-noded hexahedron (HEX27)	4-noded quadrilateral (QUAD/QUAD4), 8-noded quadrilateral (QUAD8), 9-noded quadrilateral (QUAD9)	6-noded triangle (TRISHELL6), 8-noded quadrilateral (SHELL8), 9-noded quadrilateral (SHELL9)	3-noded beam (BEAM3)
5-noded pyramid (PYRAMID/PYRAMID5), 13-noded pyramid (PYRAMID13)			
6-noded wedge (WEDGE/WEDGE6), 15-noded wedge (WEDGE15)			



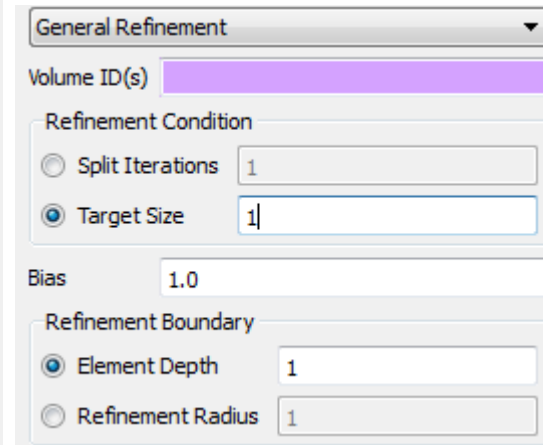
CAE Fidesys interface

Meshing

- Adjustable degree of mesh refinement (interval);
- Several meshing algorithms:
 - Automatic
 - Specifying approximate element size
 - Geometry-adaptive
 - Interval meshing
- Meshing schemes and attributes;
- Mesh refinement;
- Mesh optimization and smoothing.



Specify meshing schemes and attributes



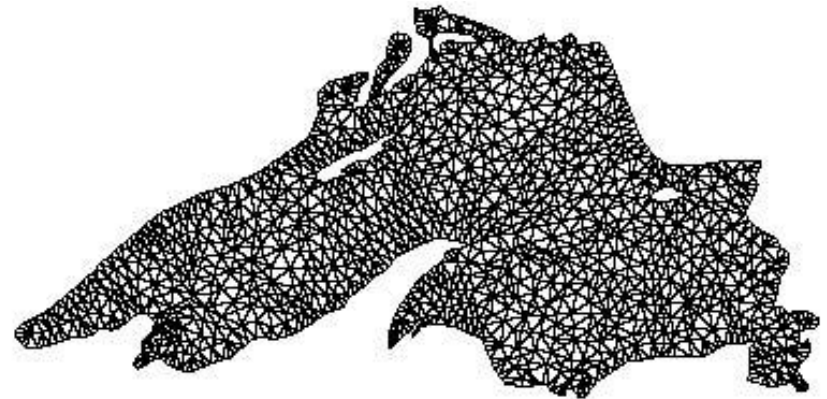
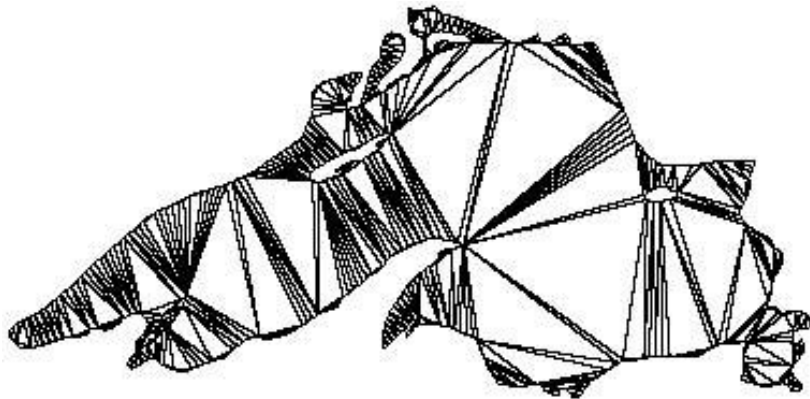
Mesh refinement



CAE Fidesys interface

Generation of irregular mesh and quality control

- Mesh refinement in accordance to user-defined metric

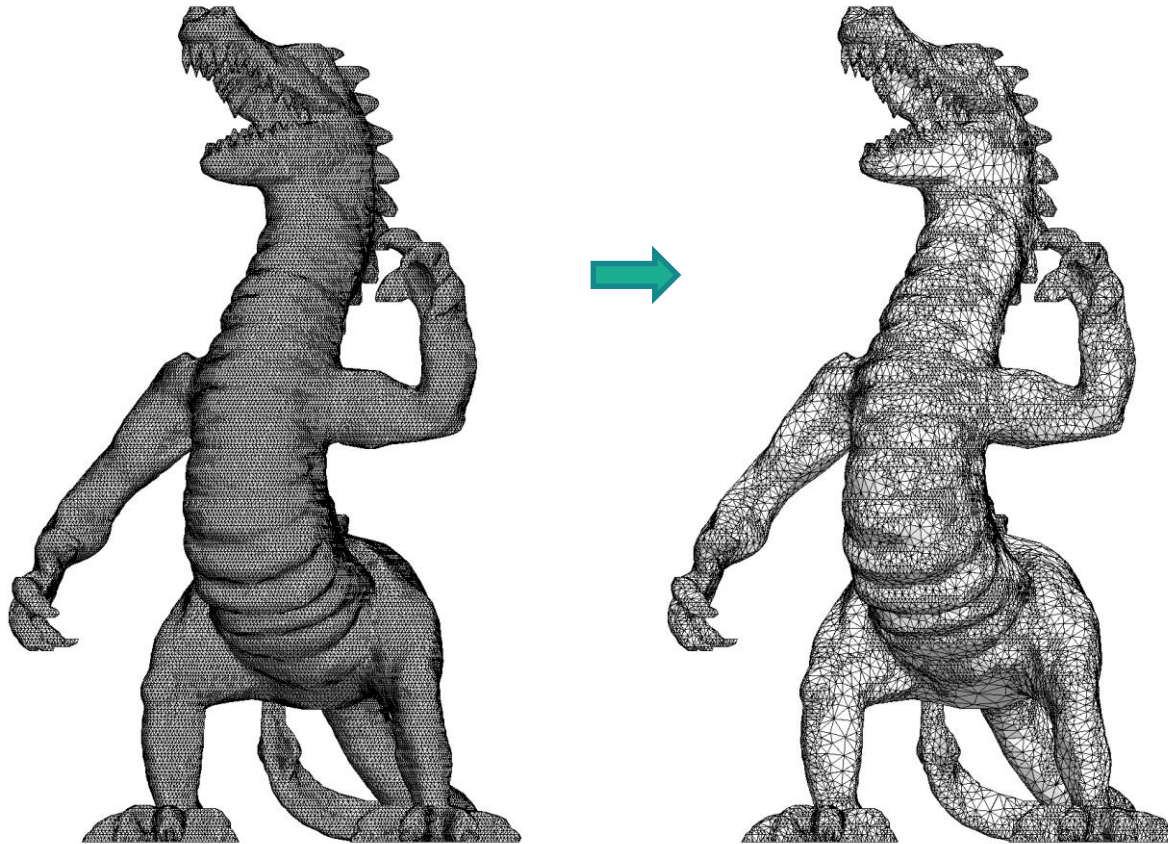




CAE Fidesys interface

Generation of irregular mesh and quality control

- 3D-mesh refinement













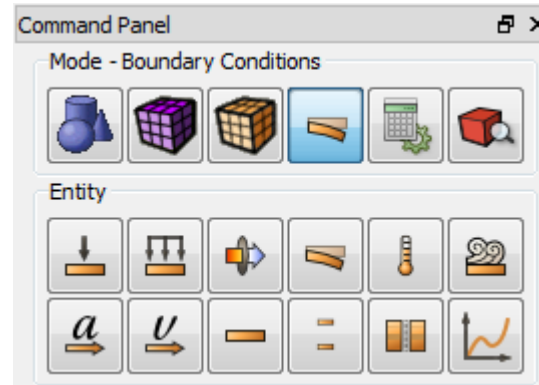


CAE Fidesys interface

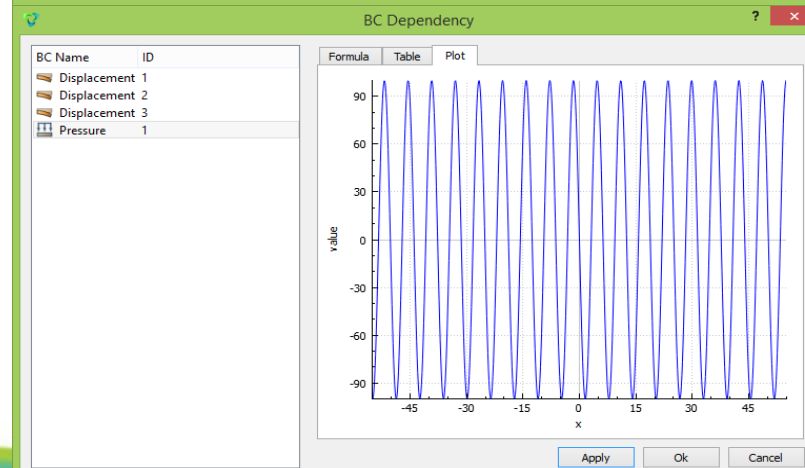
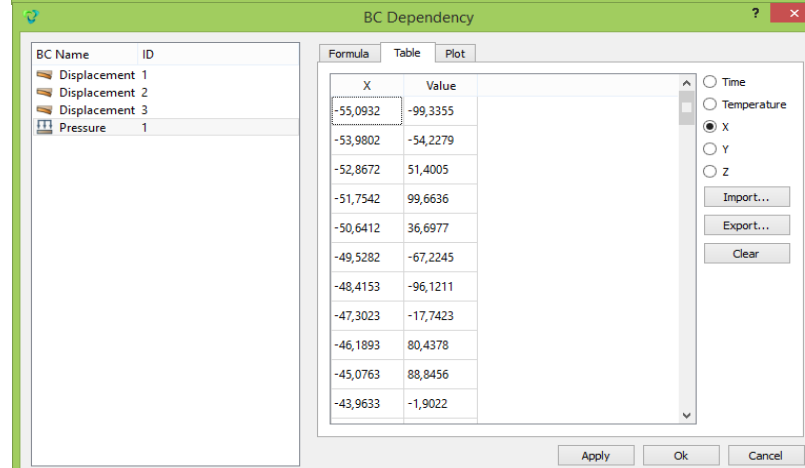
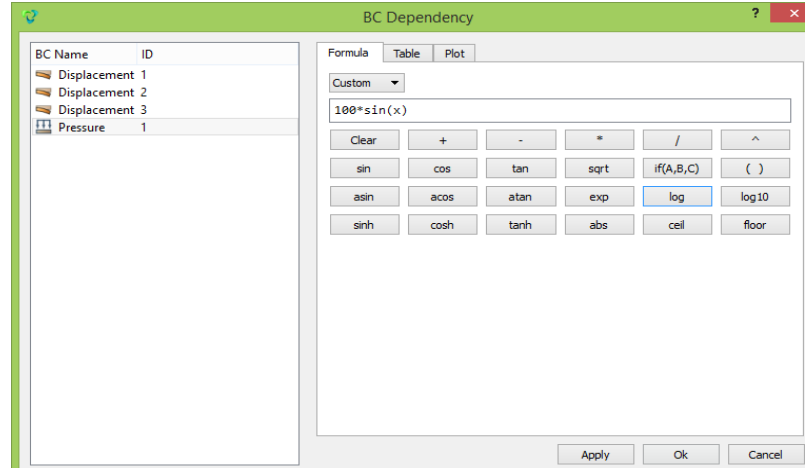
Boundary Conditions

Supporting different types of BCs:

-  ➤ Force;
-  ➤ Pressure;
-  ➤ Heat flux;
-  ➤ Displacement;
-  ➤ Temperature;
-  ➤ Convection;
-  ➤ Acceleration;
-  ➤ Velocity;
-  ➤ Contact pair;
-  ➤ Rigid connection.



Mode – Boundary Conditions





CAE Fidesys interface

Materials

- Physical models:
 - Linear isotropic material (Hooke's material);
 - Composite materials, concrete, geomechanical samples;
 - Rubber materials;
 - Steel, plexiglass, copper, etc.
- Materials library;

Process effective properties data

Data file:

Material Type:

Orthotropic

Transversely Isotropic

Isotropic

Name	Value	24385,2	8171,72	36,7224	78,4162	0,036054	0,123156
Young's Modulus	10478,9		2659,79	37,4092	40,5934	-0,171397	-86,7912
Poisson's Ratio	-0,141917			42,9152	0,006055	-0,000648	-0,444483
					8112,99	-0,023243	0,003506
						1,28037	0,02068
							1,03233

Command Panel

Mode - Blocks and Materials

Entity - Material

Action - Create Material

Name:

Description:

Set ID

Copy Material

Property Group:

Property	Value
Young's Modulus	2e+11
Shear Modulus	0
Poisson's Ratio	0.3
Density	8000
Specific Heat	500
Conductivity	0.045
Coeff. of Thermal Expansion	1.2e-05
Yield Strength in tension	1.6e+08

Material generation window

Power Tools

Current View

Name	ID	P
▶ Volumes		
▶ Groups		
▶ Boundary Conditions		
▶ Materials		
▶ FEA Materials		
▶ test material	1	
▶ CFD Medias		
▶ Blocks		
▶ Side Sets		
▶ Node Sets		
▶ Boundary Layers		

Materials and blocks in the Object Tree



CAE Fidesys interface

Beams and shells

- Thickness and Loft Factor for shells;
- Beam cross section properties;

Shell Thickness

Block ID(s)

Display

Normal

Thickened

Scale

Use Constant Color

Pick Color

Add

Thickness

Loft Factor

Block ID

CS Rotation Angle

Select profile

I-Beam

Height (H)

Bottom Width (B_1)

Top Width (B_2)

Bottom Thickness (c_1)

Top Thickness (c_2)

Thickness (d)

Center mass coordinate (Z_1)

Set Parameters

Inertia moment Iy

Inertia moment Iz

Inertia moment Ix



CAE Fidesys interface

Calculation parameters

- Analysis types:
 - Static;
 - Dynamic (transient);
 - Modal;
 - Harmonic;
 - Buckling;
 - Effective properties of composites.
- Solvers:
 - Finite element method (by default);
 - Spectral element method.
- Solution progress in the console.

Method

Choose Automatically

On fail

Try other Methods and Preconditioners

Apply

Start Calculation

Static - General

Dimensions: 3D

Use spectral elements method

Use MPI

Model

Elasticity

Plasticity

Heat transfer

Finite deformations

Contact

Set nonlinear options

Nonlinear options

Min load steps: 1

Max load steps: 10

Max iterations: 100

Tolerance: 1e-6



Harmonic analysis: damping parameters

$$[C] = \alpha[M] + \sum_{j=1}^{N_m} \alpha_j^m [M_j] + (\beta + \beta_c)[K] + \sum_{j=1}^{N_m} \left[\left(\beta_j^m + \frac{2}{\Omega} \beta_j^z \right) [K_j] \right] + \sum_{k=1}^{N_m} [C_k]$$

2 4 3 1 5 6 7

Calculation settings - Harmonic analysis

Calc.

Harmonic - Damping

1 → Structural damping 0.0

2 → Mass Matrix damping 0.0

3 → Stiffness Matrix damping 0.0

Apply

Start Calculation

Name

- > Elasticity
- ▼ General
 - 6 → Density
 - 4 → Damping coefficient
 - 5 → Mass damping coefficient
 - 5 → Stiffness damping coefficient
- > Strength
- > Plasticity
- > Hardening
- > Thermal
- > Geomechanic
- > Preload

Entity - Spring Properties

Block ID

Spring type: Linear spring

7 → Tension spring constant 0

Torsion spring constant 0

Damping coefficient 0

Linear damping coefficient 0

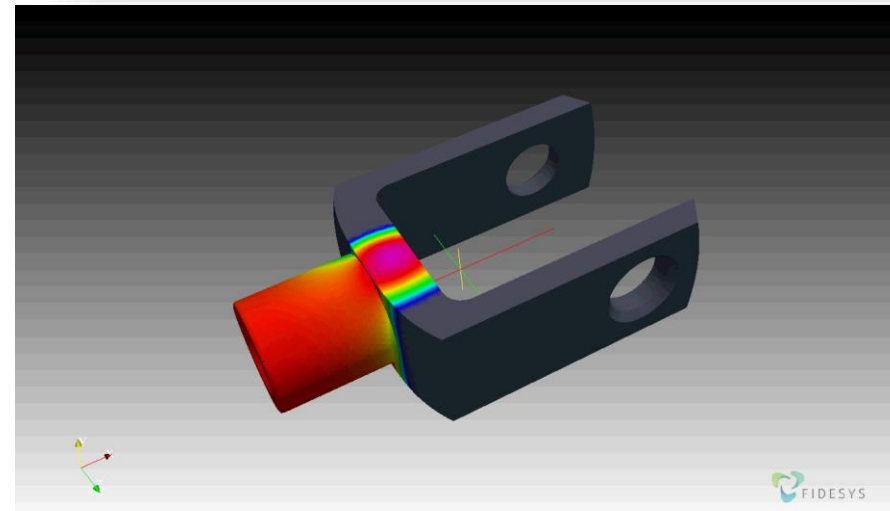
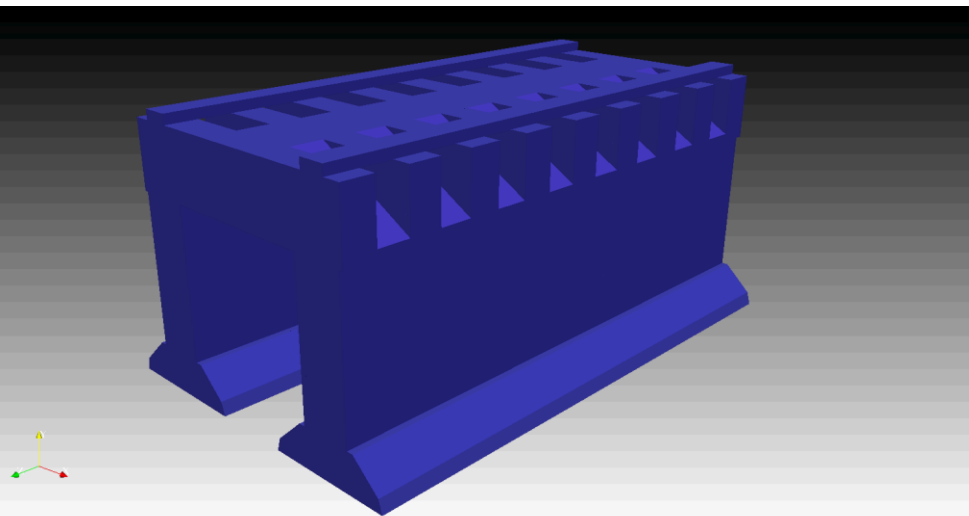
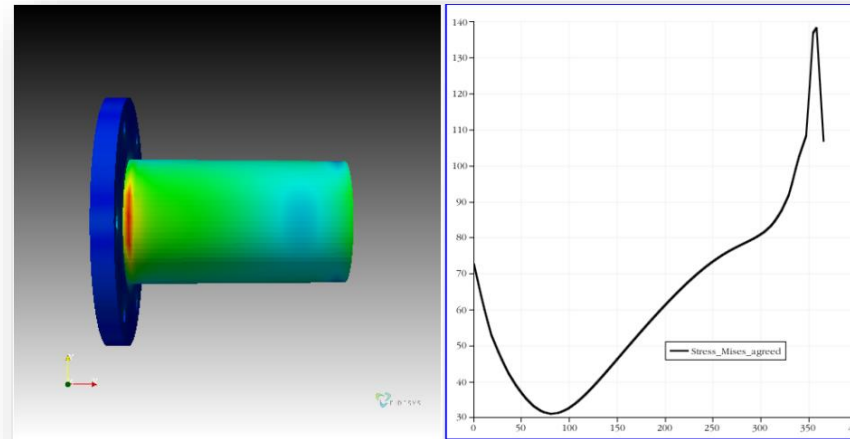
Apply



CAE Fidesys interface

Results Visualization and Postprocessing

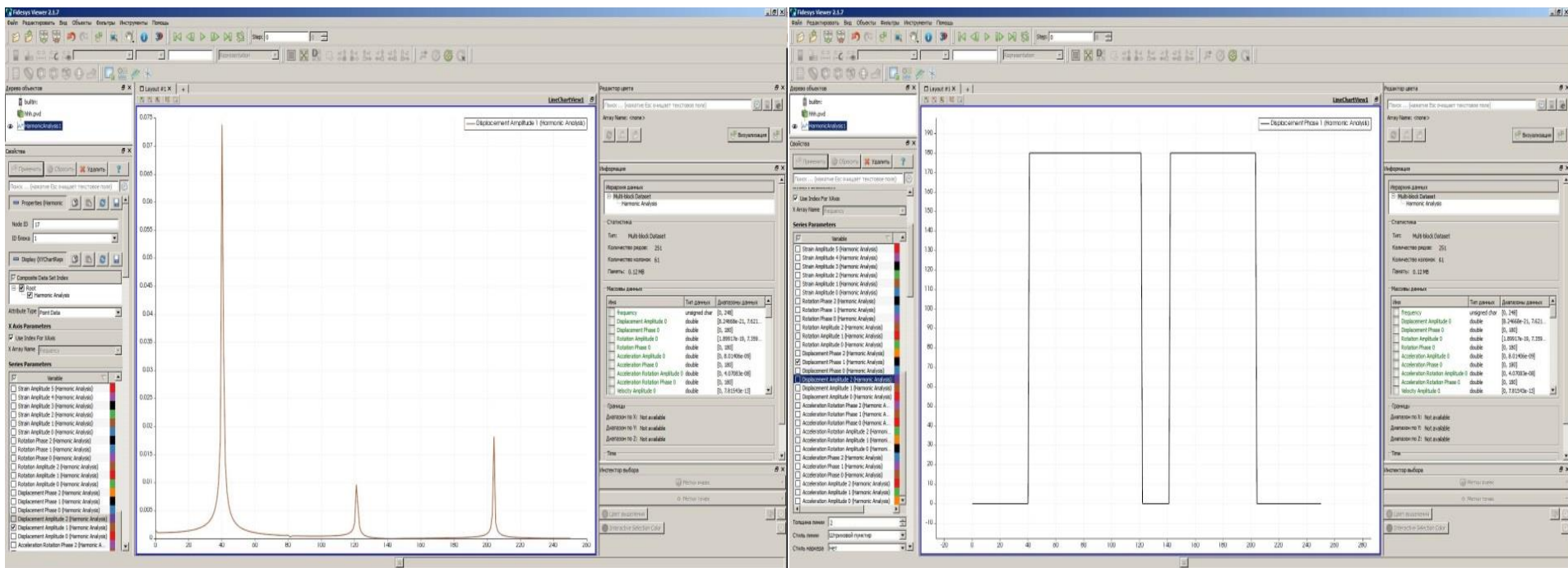
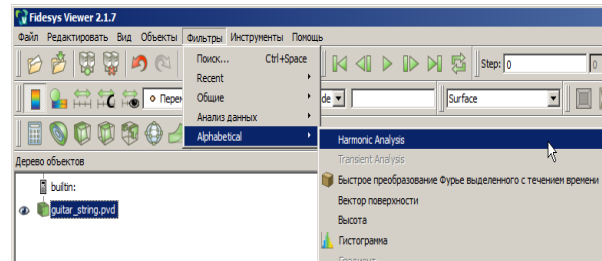
- Visualization and analysis of the obtained results:
 - Visualization of vector and tensor fields;
 - 1D plots, export to CSV;
 - Time dependency analysis.
- Evaluation of the mesh quality
- Slice and cross section views
- Data export





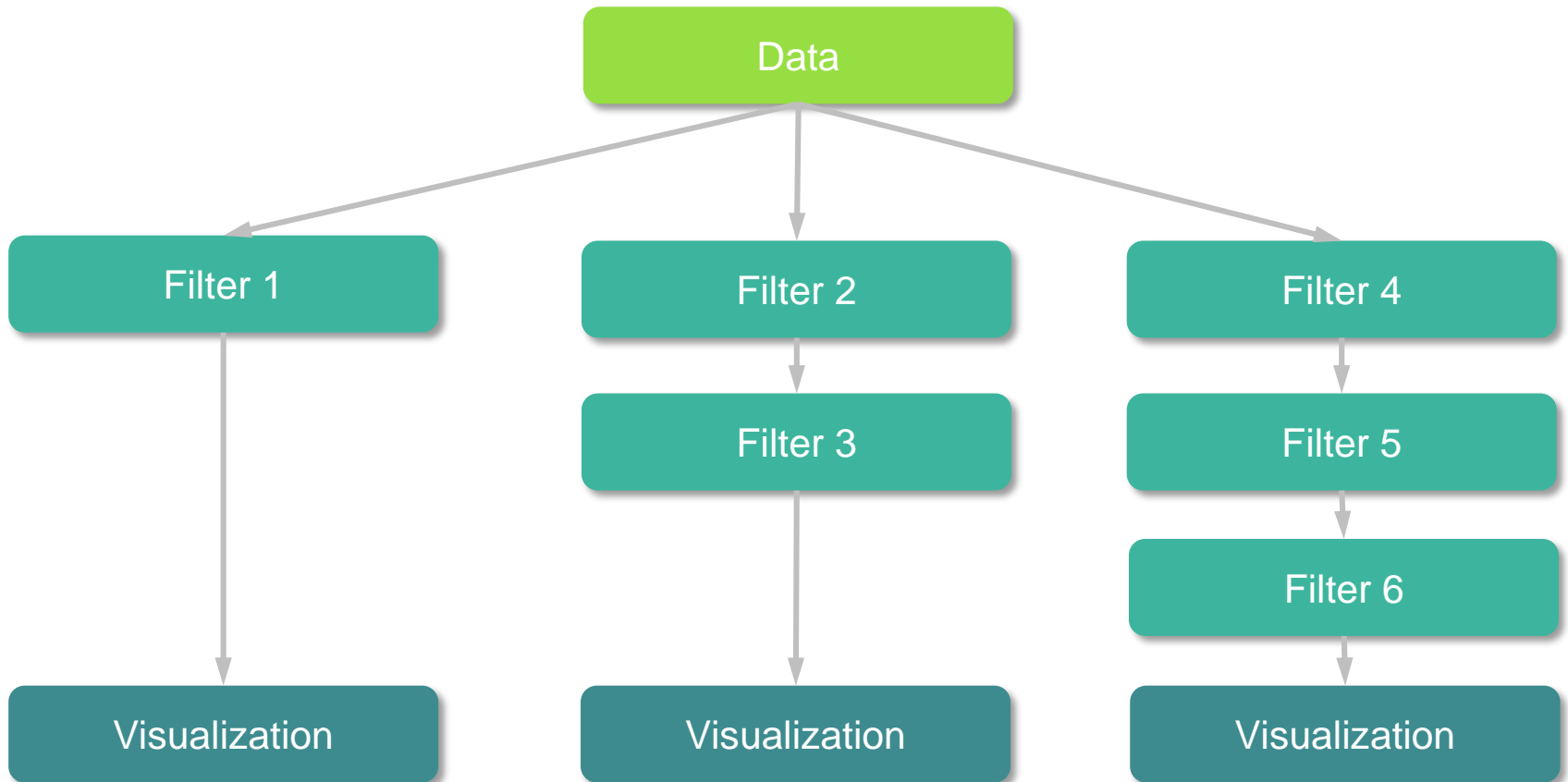
Harmonic analysis

Visualization of amplitudes and phases for displacements, velocities, stresses etc.





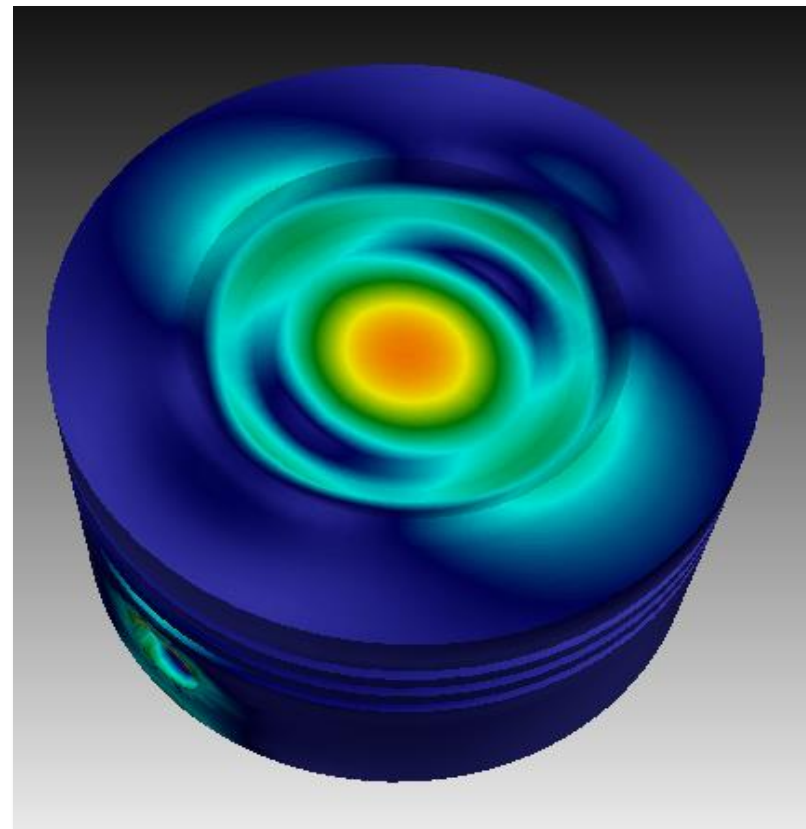
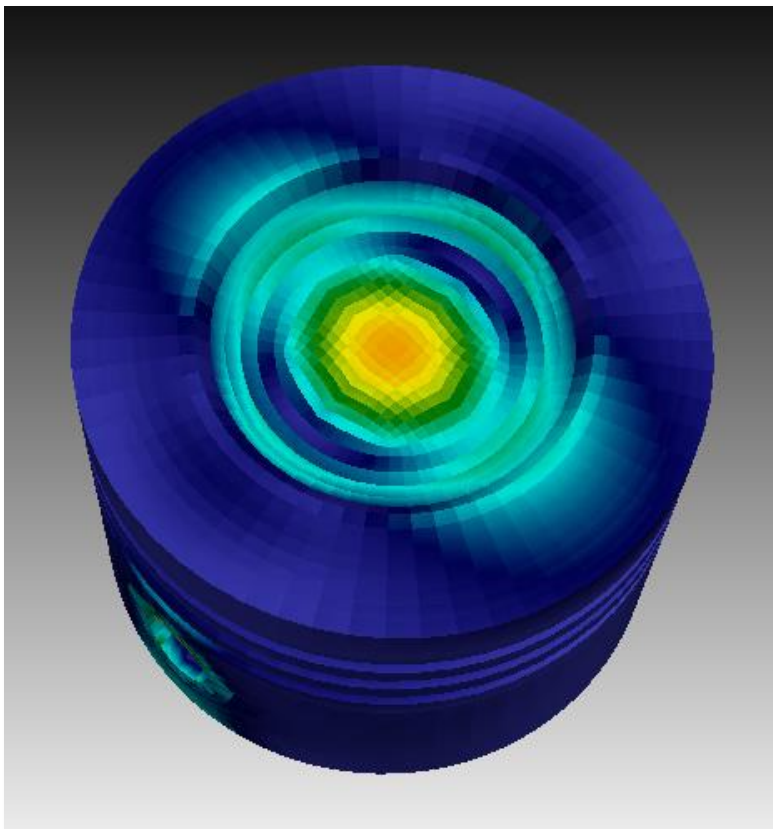
Visual filters





Smoothing the obtained results

Physically consistent stresses and strains





Safety margins

- The first theory of strength $n = \frac{\sigma^+}{\sigma_1}$
- Energy theory $n = \frac{\sigma_T}{\sigma_i}$
- Pisarenko-Lebedev theory

$$n = \frac{\sigma^+}{\chi\sigma_i + (1-\chi)\sigma_1}, \text{ where } \chi = \frac{\sigma^+}{\sigma^-}$$

- Mohr's theory $n = \frac{\sigma^+}{\sigma_1 - \chi\sigma_3}, \text{ where } \chi = \frac{\sigma^+}{\sigma^-}$

- Tresca theory $n = \frac{\sigma^+}{\sigma_1 - \sigma_3}$

$\sigma_1, \sigma_2, \sigma_3$ — principal stresses

σ_i — stress intensity (von Mises)

σ^+, σ^- — tensile and compression strength

σ^T — yield strength

n — safety margin

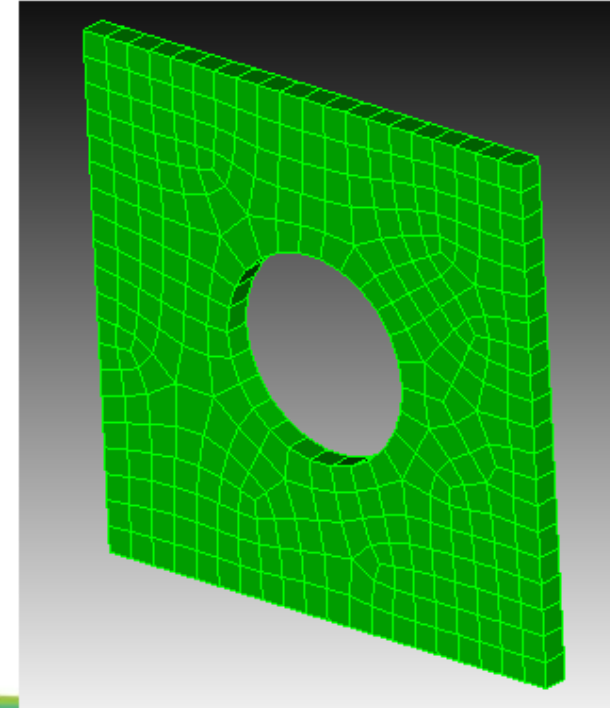


Fidesys scripting language

Fidesys can be controlled using the commands:

- Commands in special language are generated in GUI and then transferred to the command handler
- Command history is written to a ***.jou** file
- Commands are displayed in the command console window
- One can program using this command language

```
bri x 10  
cyl radius 2 z 12  
subtract vol 2 from vol 1  
vol 1 size .5  
vol 1 scheme auto  
mesh vol 1  
draw surf in vert 1  
draw hex in node in surf 1
```





Aprepro

- Aprepro = **A**lgebraic **P**re-**P**rocessor
- Integrated programming language:
 - Parametrization of the journal files
 - Error control
 - Logical control

```
#{i=1}  
#{size=10}  
#{loop(50)}  
brick x {size}  
move volume {i} location {size*i} 0 0  
#{i++}  
#{endloop}
```



Python - widely used scripting language.

Lots of software use it for automation, eg.:

- *Abaqus*
- *Paraview*
- *PyTrilinos*

Installer and full documentation are available on the official website www.python.org.



Example

```
# Results file open
```

```
from vtk import *
```

```
reader = vtkXMLUnstructuredGridReader()
filename = os.path.abspath(os.path.join(os.getcwd(), "C:/result/result.vtu"))
reader.SetFileName(filename)
reader.Update()
grid = vtkUnstructuredGrid()
grid = reader.GetOutput()
```

```
# Stress intensity calculation (based on Mises)
```

```
stress = grid.GetPointData().GetArray("Stress")
maxmises = -1.0
```

```
for i in xrange(stress.GetNumberOfTuples()):
    XX = stress.GetTuple(i)[0]
    YY = stress.GetTuple(i)[1]
    ZZ = stress.GetTuple(i)[2]
    XY = stress.GetTuple(i)[3]
    YZ = stress.GetTuple(i)[4]
    ZX = stress.GetTuple(i)[5]
    mises = math.sqrt( ( SQUARE(XX - YY) + SQUARE(YY - ZZ) + SQUARE(ZZ - XX) +
                       6 * ( SQUARE(XY) + SQUARE(YZ) + SQUARE(ZX) ) ) * 0.5)
    if maxmises < mises:
        maxmises = mises
print maxmises
```




Advantages of CAE Fidesys

High speed and accuracy of calculations

Flexible & adaptive geometry-mesh generator

Wide range of supported CAD-formats

Cross-platform (OS Windows, Linux)

Low system requirements

Low price compared to other solutions

Cloud version - Fidesys online (SaaS)



Custom software development

- On the basis of CAE Fidesys's software modules, a custom corporate or industry-specific software is developed (e.g. Fidesys Geomechanics for NTC Gazpromneft).
- The customized package will be more functional and easy-to-use than the general purpose CAE. It is focused on specific problems of the client.
- Development cycle of a custom software takes about 6-18 months depending on the customer's specifications with the involvement of leading industry consultants.
- As a result, the customer obtains a dedicated corporate product.
- **The package can be used as a simulation software which is capable for fine tuning and extensively applied during R&D stage.**



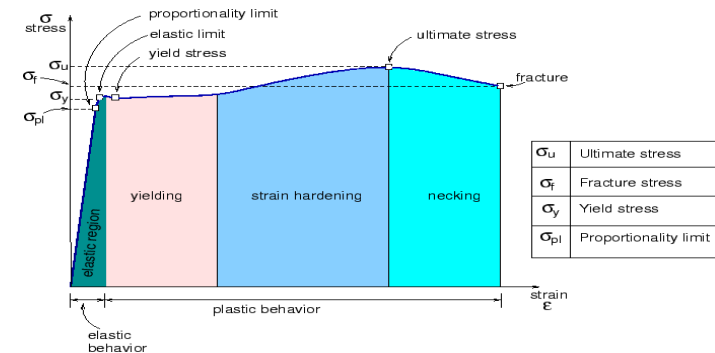
Simulation Designed for Design

Why aren't more companies using Simulation as an integral part of Design?

- Simulation is often considered too much to be used for influencing design decision
 - Too difficult - Too complex - Too much expertise required - Too expensive - Too compute intensive
- Just too much?

Simulation Designed for Design is now available!

- Simulation is no longer too much

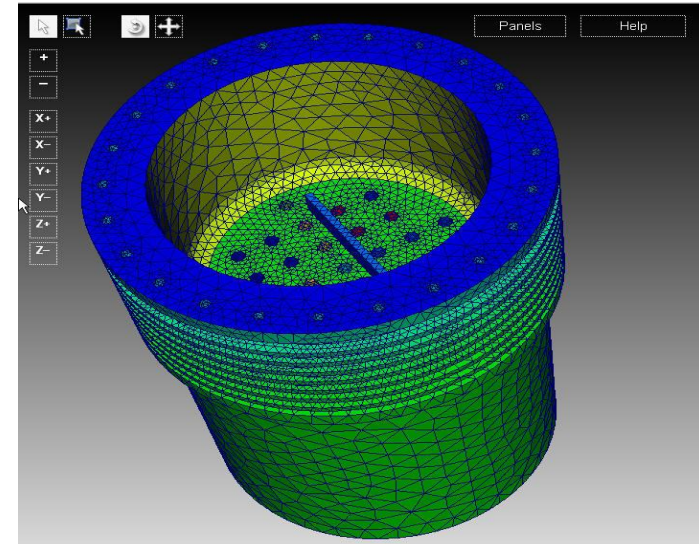




SimForDesign - Released in January 2015

Streamlined simulation for design

- Making simulation accessible to designers and other non-simulation specialists
- Assess parts and simple assemblies
 - Single material and linear behavior
- Web browser based analysis
 - No software to license or install
- Pre-Paid Usage pricing

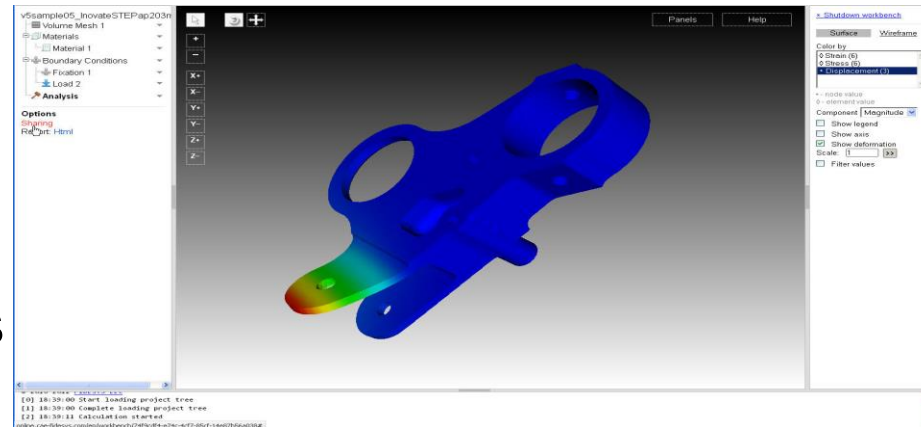




Simulation Designed for Design

Streamlined simulation process

- Upload a STEP or IGES file
 - CAD plug-ins coming
- Mesh created automatically
- Define Material
- Assign Boundary Conditions
- Run Calculation
- Visualize Results in Web browser
- Generate a report





Pay-as-you-go pricing model

Free	Standard	Premium	Professional	Corporate
\$0 ⁰⁰	\$10 ⁰⁰	\$50 ⁰⁰	\$250 ⁰⁰	\$500 ⁰⁰
1 User	1 User	1 User	1 User	Multiple Users
0 CPU Hours	1 CPU Hours	10 CPU Hours	60 CPU Hours	150 CPU Hours
0 GB Storage	1 GB Storage	10 GB Storage	100 GB Storage	1000 GB Storage
Free Examples Project	5 Projects (+ Free Examples)	10 Projects (+ Free Examples)	Unlimited Projects (+ Free Examples)	Unlimited Projects (+ Free Examples)
Sign Up Now!	Sign Up Now!	Sign Up Now!	Sign Up Now!	Sign Up Now!



Fidesys Online – cloud CAE

- Available 24/7 in your browser at <http://sim4design.com>
- All calculations, renderings etc are done by the cloud
- Collaboration and joint project analysis

The screenshot displays the Onshape web interface. The browser address bar shows the URL <https://partner.dev.onshape.com/documents?filter=recently-opened&column=modifiedAt&order=desc>. The interface includes a search bar, user profile 'Ivan Nikiforov', and storage usage indicators: '4 of 10 Private documents' and '3 MB of 100 MB Private storage'. A table titled 'Recently opened' lists documents with columns for Name, Workspace, Modified, Modified by, Owned by, and Size. The 'Knuckle Joint' document is highlighted. A detailed view of the 'Knuckle Joint' document is shown on the right, featuring a 3D model of a blue metal part and metadata such as Owner (me), Sharing (Not shared), Created by (me, 7:30 PM Yesterday), and Last modified by (me, 2:13 PM Today). A 'Delete' button is visible above the document details. At the bottom left, there is an 'Upgrade to Professional' button. The footer contains copyright information: '© 2013 - Present, Onshape Inc. All Rights Reserved', 'Terms & Privacy', and '(1.37.12466.f338a1198)'.

Name	Workspace	Modified	Modified by	Owned by	Size
Knuckle Joint	me	2:13 PM Today	me	me	165
One more	Main	5:02 PM Yest..	me	me	2 MB
Something	Main	10:44 PM Au..	me	me	173
Imported	Main	10:31 PM Jul..	me	me	639



Corporate CAE-platform

- Private cloud solution for the client's internal usage
- Available from any device connected to internal Ethernet/VPN
- Cost reduction: cost of ownership, support, security

The screenshot shows the Fidesys website interface. At the top, there is a navigation bar with links for PRODUCTS, SERVICES, DOWNLOAD, SUPPORT, ABOUT, REVIEWS, and SIMFORDESIGN. The main content area features a large banner for 'Fidesys Viewer' with the text 'Postprocessing, analysis and visualization of computational results' and a 'Free download' button. Below the banner, there are three columns of text: 'Buy CAE Fidesys', 'About', and 'Training'. The 'Buy CAE Fidesys' section states that the CAE Fidesys Standard costs less than competitors' solutions and is faster and more accurate in the speed of calculations. The 'About' section mentions that Fidesys was founded in 2009 by experts and graduates of Lomonosov Moscow State University. The 'Training' section notes that Fidesys experts can provide training at the client's workplace and at their training center. At the bottom, there is a 'News' section with a date of August 28, 2015, and a headline: 'Fidesys LLC visited Teknopark Istanbul AS'. The footer of the page reads '© 2018 Fidesys LLC'.



Fidesys in Azure/Amazon marketplaces

Preprocessing, simulation, analysis, rendering etc. are done in the cloud. 24/7 access in the browser.

The screenshot shows the Azure Marketplace page for Fidesys. The URL is <https://azuremarketplace.microsoft.com/en-us/marketplace/apps/fidesys.fidesys?tab=Overview>. The page features a navigation bar with options like 'Why Azure', 'Solutions', 'Products', 'Documentation', 'Pricing', 'Training', 'Marketplace', 'Partners', 'Support', 'Blog', and 'More'. Below the navigation, there's a search bar and a 'Sign in' button. The main content area includes the Fidesys logo, a 'GET IT NOW' button, and a list of categories: 'Pricing information' (Starting at 0,30 \$/hour + Azure infrastructure costs), 'Categories' (Compute), 'Support' (Support), and 'Legal' (License Agreement, Privacy Policy). The description states: 'Innovative CAE system, which performs a full cycle of engineering-strength analysis. CAE Fidesys is an innovative CAE system, which performs a full cycle of engineering-strength analysis from meshing to results visualization. By choosing our software you get:'. A list of benefits follows:

- The universal CAE system with the wide functionality range for any type of industry
- Attractive price – several times lower than for well-known international CAE brands
- Powerful and flexible pre-processor allowing to get high-quality finite-element meshing
- High speed and accuracy of calculations confirmed by international NAFEMS tests
- Convenient interface.

The screenshot shows the AWS Marketplace page for Fidesys. The URL is <https://aws.amazon.com/marketplace/seller-profile?id=7c456747-5771-41a7-ae00-55a874b8d645>. The page features the AWS Marketplace logo, a 'Sign in or Create a new account' button, and a search bar. The main content area includes the Fidesys logo, a 'Visit the Fidesys Website' link, and a section titled 'Fidesys Products (2)'. The first product is 'CAE Fidesys', sold by Fidesys, with plans from \$10 to \$500. The description states: 'CAE Fidesys is an easy-to-use and effective tool for performing a full cycle of engineering-strength analysis including loading a CAD mode and its analysis, meshing, setting ...'. The second product is 'CAE Fidesys on Windows', Version 1.6.3.560, sold by Fidesys, with plans from \$1.00 to \$11.506/hr for software + Charges for EC2 with Windows + AWS usage fees. The description states: 'CAE Fidesys makes the full cycle of engineering strength analysis including loading a CAD model and its analysis, meshing, setting loads and material mechanical properties, ...'.

Pay-as-you go and subscription based licensing models flexible for different problem sizes.



CAE Fidesys trial version

<http://www.cae-fidesys.com/>

- 30 days
- Fully functional
- Step by step examples (+scripts)
- Test report
- Windows/Linux 32/64
- Fidesys Viewer (free of charge!)

The screenshot shows the 'Download' page of the CAE Fidesys website. The navigation bar includes links for PRODUCTS, SERVICES, DOWNLOAD, SUPPORT, ABOUT, REVIEWS, and SIMFORDESIGN. The user 'Andy Gusev' is logged in. The page is titled 'Download' and features two tables: 'Fidesys Professional' and 'Fidesys Viewer'. The 'Fidesys Professional' table lists various versions and operating systems. The 'Fidesys Viewer' table lists two versions for Windows x32 and x64. A note states that all Fidesys Professional distributions contain Fidesys Viewer. The footer includes links for Products, Company, and Services, along with social media icons for Facebook and YouTube, and a copyright notice for 2012-2015 Fidesys LLC.

Download Andy Gusev [\[Logout\]](#)

Fidesys Professional

Name	Version	Operating System	Date
CAE Fidesys	1.5 R2	Linux, 64-bit	2014-08-05
CAE Fidesys	1.6 R2	Windows 7 / 8 / 8.1 / 2008 R2 / 2012 R2, 64-bit	2015-04-29
CAE Fidesys	1.6 R2	Windows XP / 7 / 8 / 8.1 / 2003 R2 / 2008 R2 / 2012 R2, 32-bit	2015-05-19
CAE Fidesys	1.6 R2	Windows XP / 2003 R2, 64-bit	2015-05-19
Journal files	1.6 R2		2015-08-31
User Guide	1.6 R2		2015-08-31

* All Fidesys Professional distributions contain Fidesys Viewer as well. Spectral element analysis and MPI technology are available for 64 bit versions only.

Fidesys Viewer

Name	Version	Operating System	Date
Fidesys Viewer	1.1.5	Windows x32	2014-08-08
Fidesys Viewer	1.1.5	Windows x64	2014-08-08

Please check [system requirements](#) before installing.

Products
CAE Fidesys Professional
Fidesys Viewer
SimForDesign

Company
Info
Jobs
Contact

Services
Consulting
Training

[f](#) [YouTube](#)

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Thank you!

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Phone: +7 (916) 184-49-28

WWW: www.cae-fidesys.com

