Warsaw University of Technology

Faculty of Power and Aeronautical Engineering

WARSAW UNIVERSITY OF TECHNOLOGY

Institute of Aeronautics and Applied Mechanics

Finite element method (FEM)

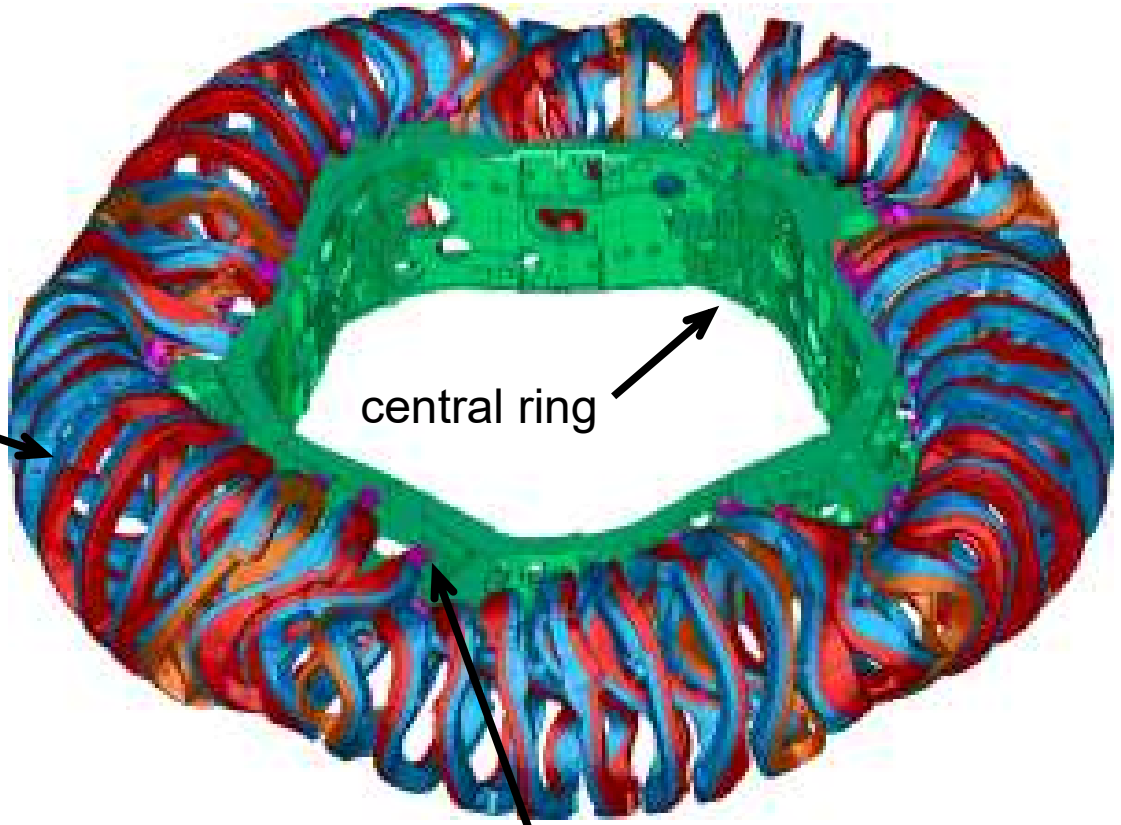
Part 2. Examples of FE analyses

03.2021

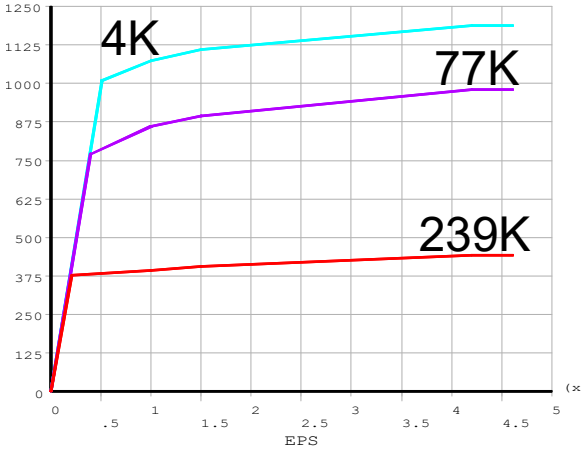
STELLATOR-TYPE FUSION REACTOR
Wendelstain 7-X

The project was done
for Max-Planck Institute, Germany

Operating conditions
- plasma channel,
- magnetic field,
- low temperature (4K)



stress

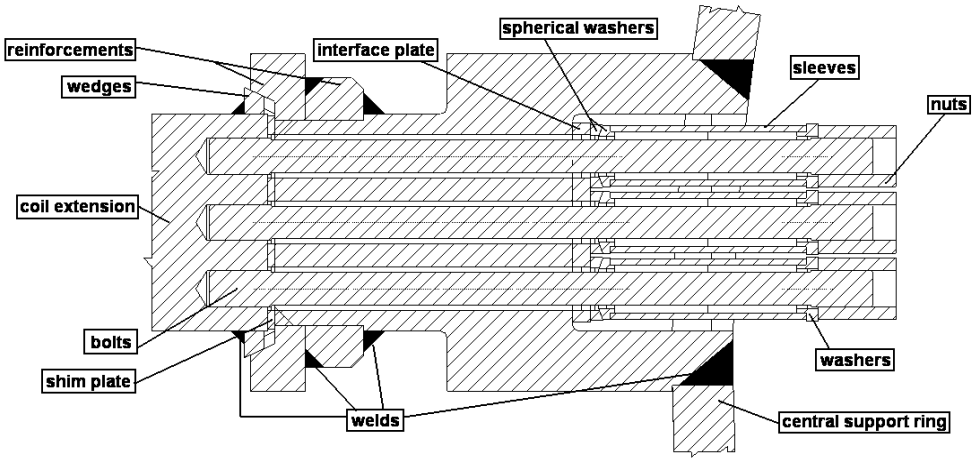


strain

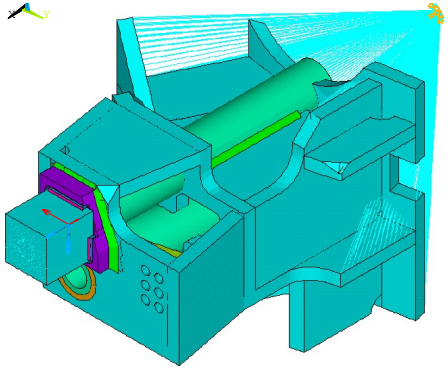
STELLATOR-TYPE FUSION REACTOR
Wendelstain 7-X

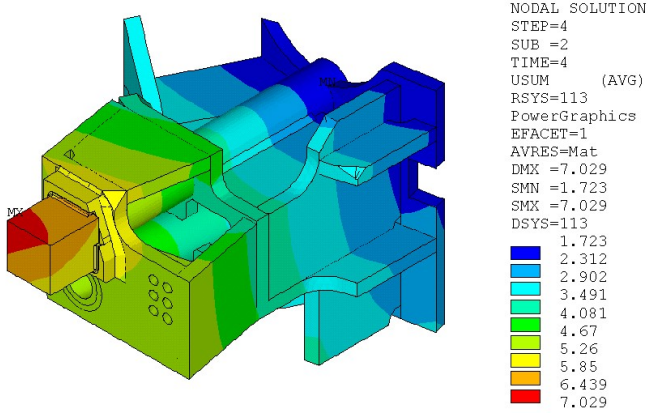
The project was done
for Max-Planck Institute, Germany

TARGET OF ANALYSIS:
To evaluate displacement and stress magnitudes in the support elements.

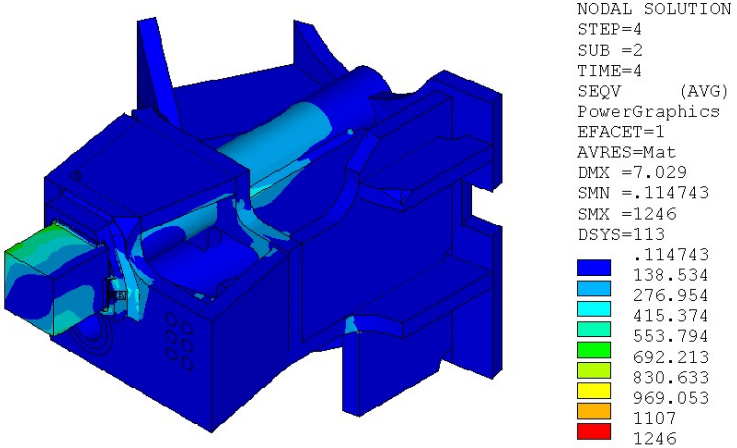


support element





Displacements [mm]

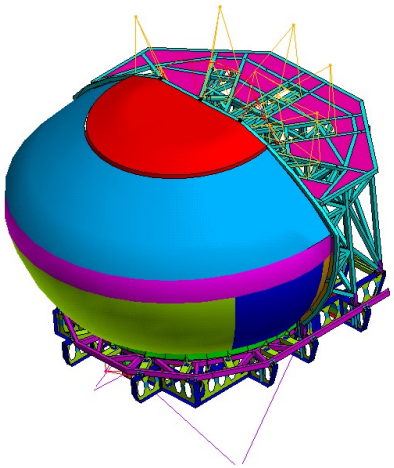


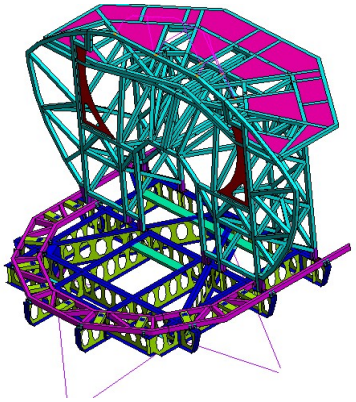
Von Mises stress [MPa]

FLIGHT SIMULATOR Claudia

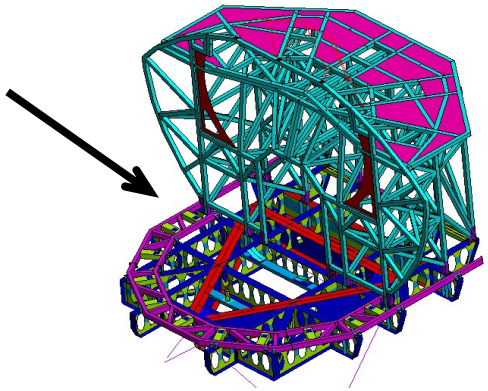
The project was done for MP-PZL Aerospace Industries, Poland

TARGET OF ANALYSIS:
To improve too flexible structure



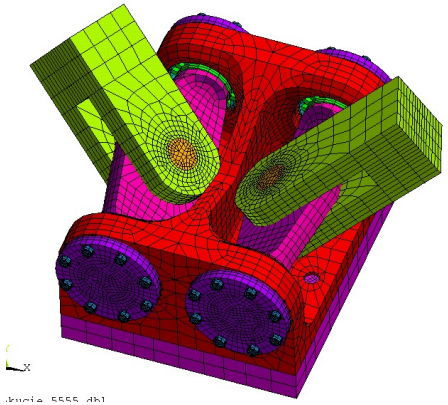


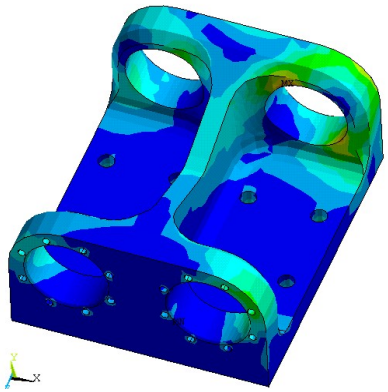
before modification



after modification

Finite elements:
- link,
- beam,
- shell

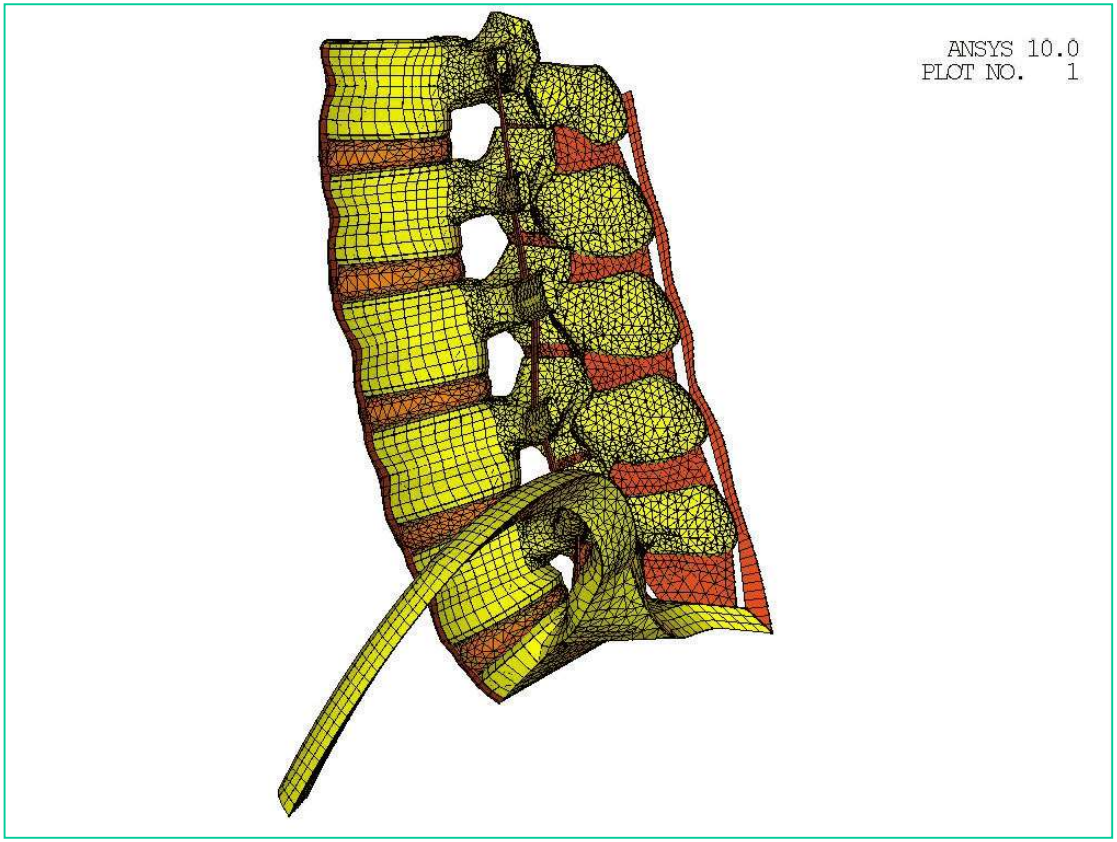




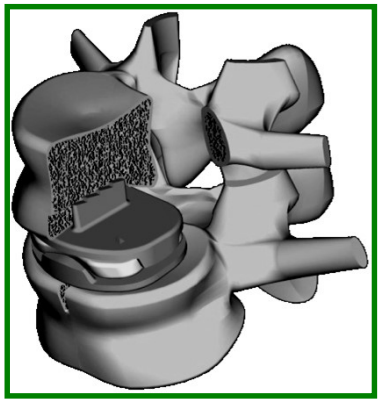
3D submodel of the joint (solid finite elements)

ARTIFICIAL DISC IN LUMBAR SPINE

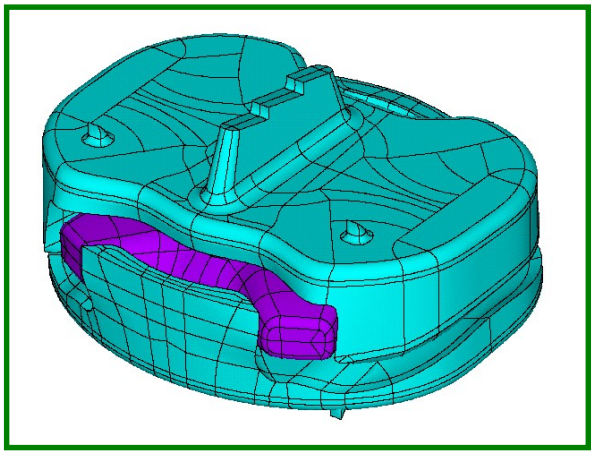
TARGET OF ANALYSIS:
To design a new implant



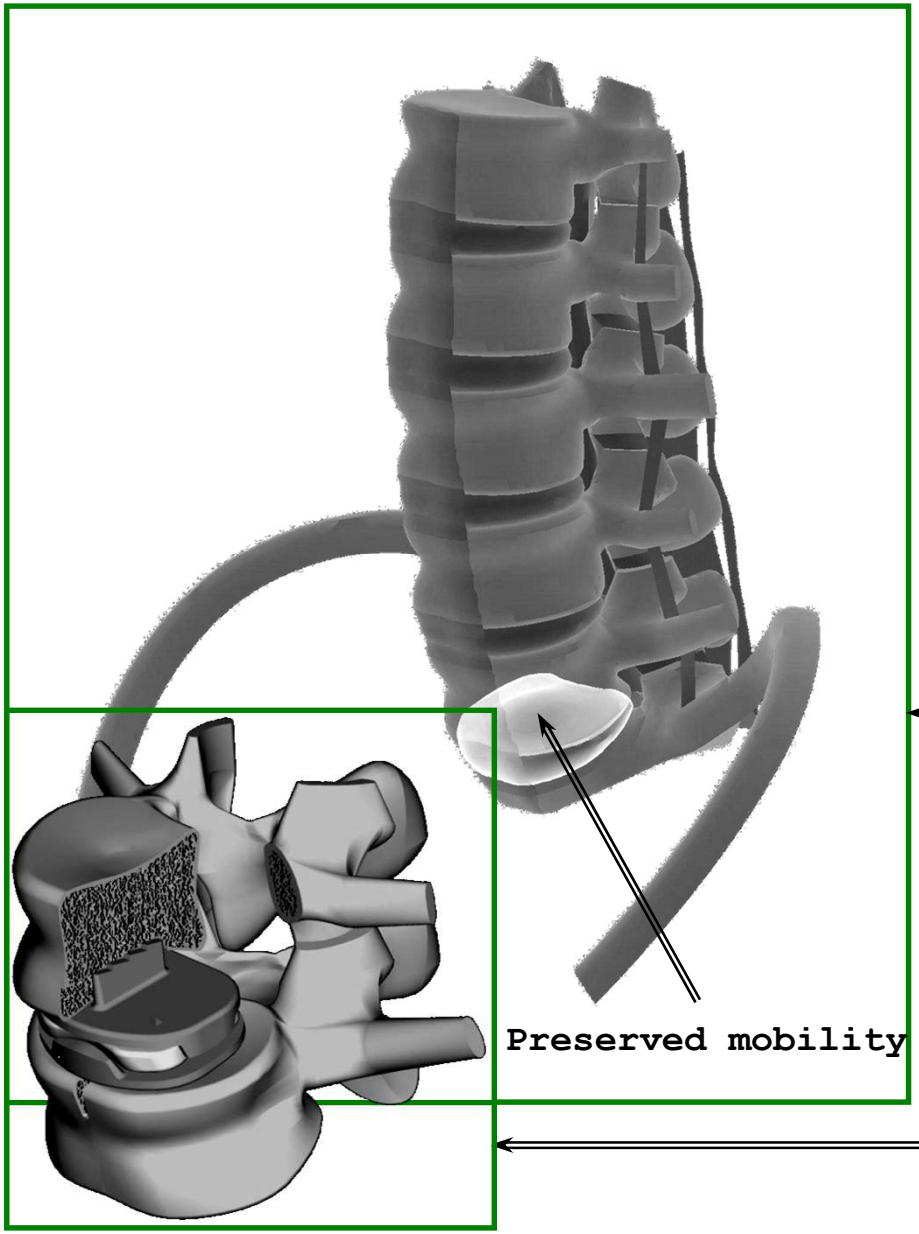
LUMBAR SPINE



IMPLANTS



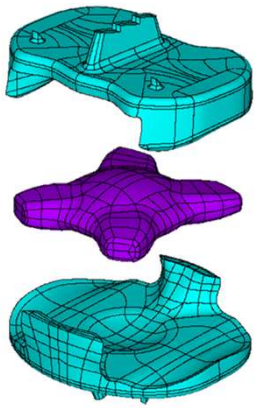
ARTIFICIAL DISC IN LUMBAR SPINE



Degenerative disc desease

Artificial disc as an alternative treatment method

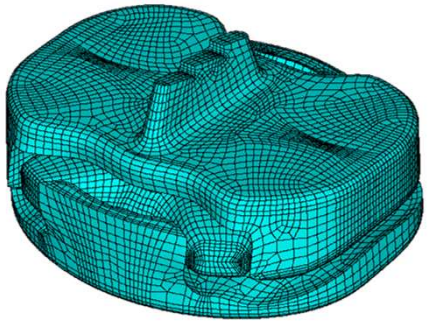
ARTIFICIAL DISC IN LUMBAR SPINE



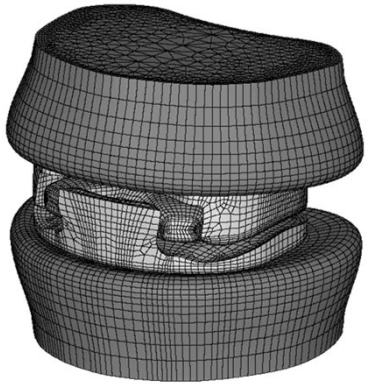
upper plate

inlay

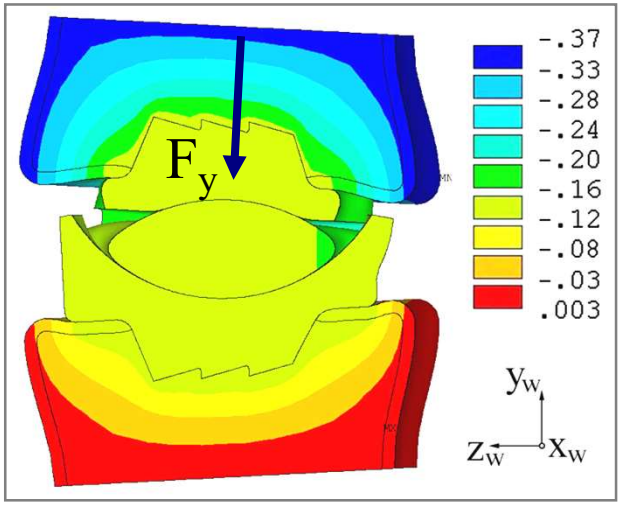
lower plate



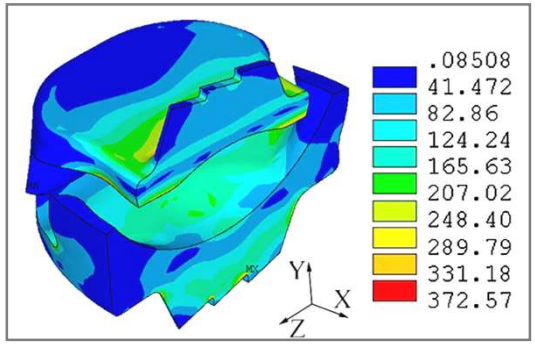
upper vertebrae

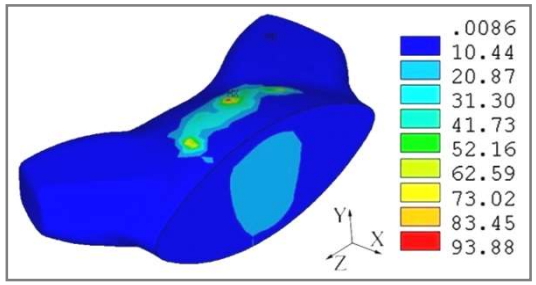


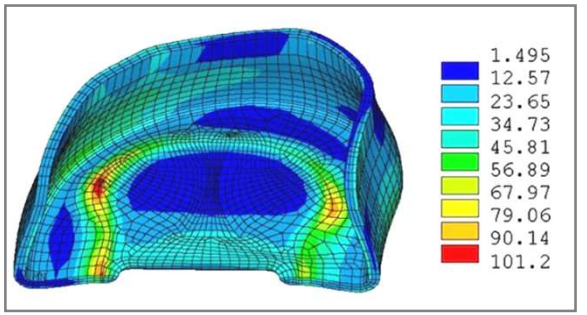
lower vertebrae



Vertical displacement [mm]



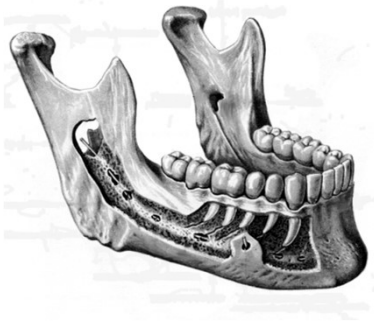




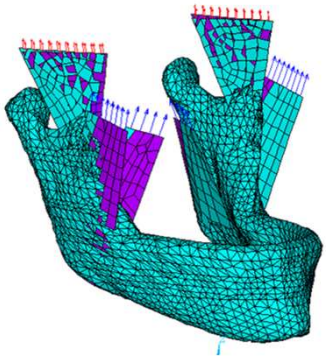
equivalent Von Mises stress [MPa]

MANDIBLE WITH FRACTURE

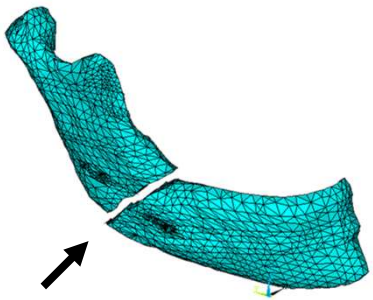
TARGET OF ANALYSIS:
To evaluate the osteosynthesis process after the connector implantation



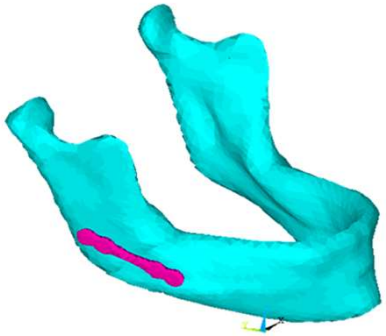
mandible



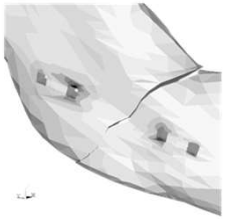
FE model

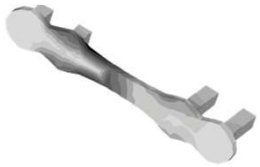


FE model
with fracture



FE model with the
connector



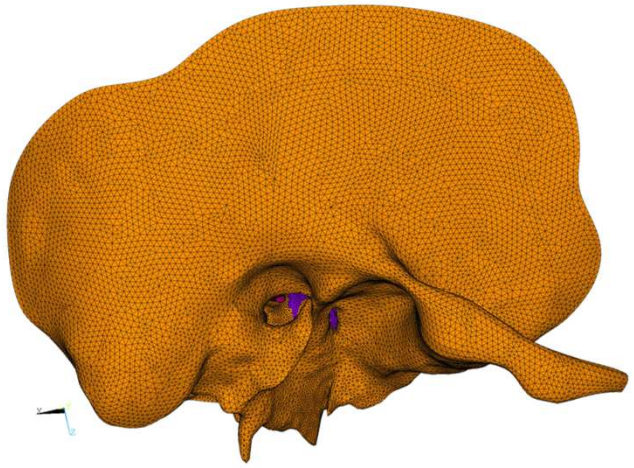


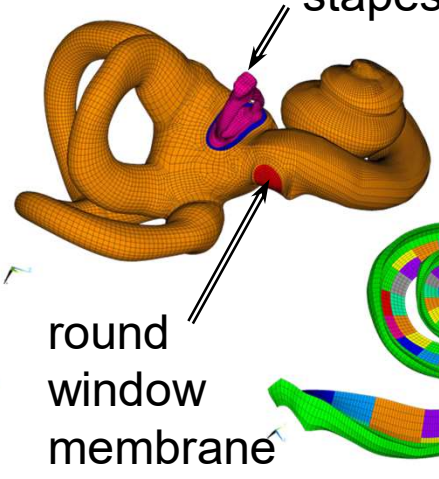
equivalent Von Mises stress [MPa]

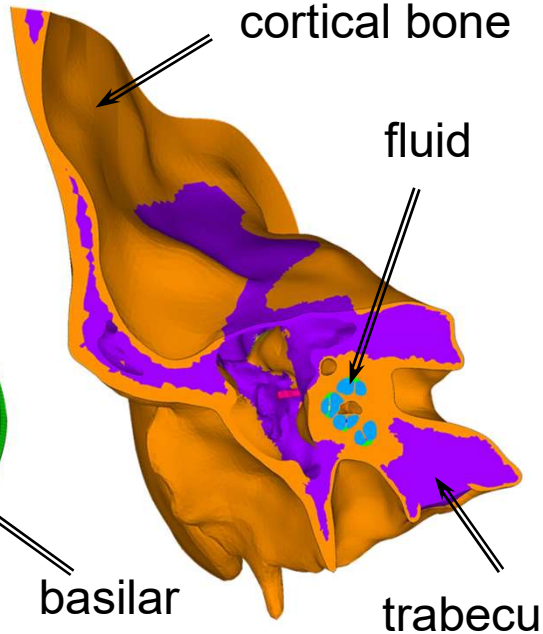
TEMPORAL BONE WITH INNEAR EAR

TARGET OF ANALYSIS:

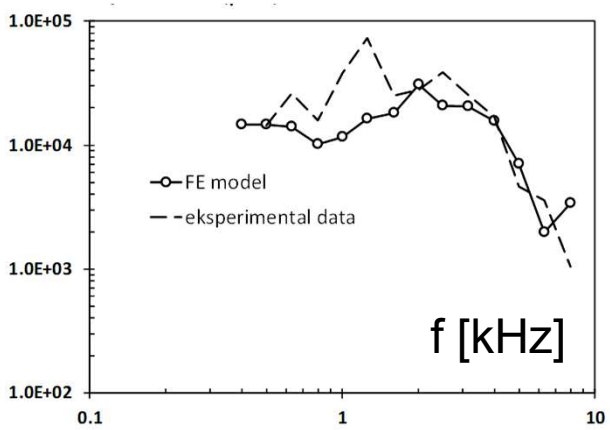
To investigate stimulation of the cochlea by bone conduction



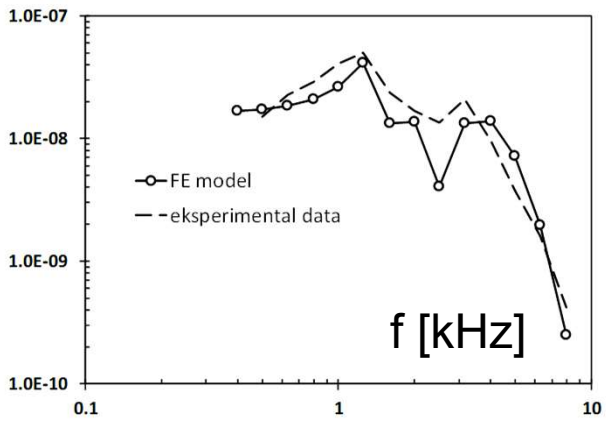




volume displacement [μm^3]



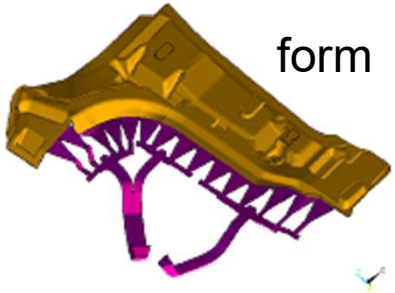
bone vibration [m]



MANUFACTURING OF A CAR BODY PART

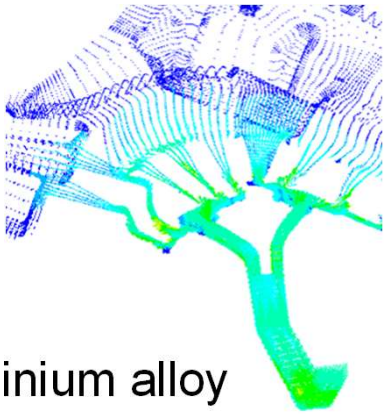
The project was done for Alusuisse Technological Center, Switzerland

TARGET OF ANALYSIS:
To minimize geometrical changes
caused by shrinkage

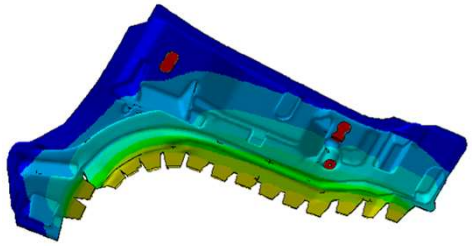


form

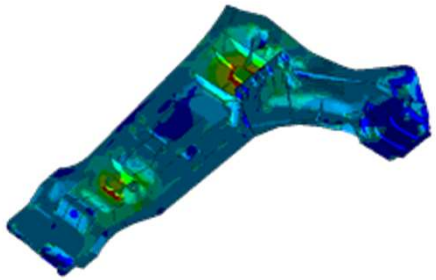
injection system



fluid flow (velocity) of liquid aluminium alloy



temperature distribution
(transient thermal analysis)

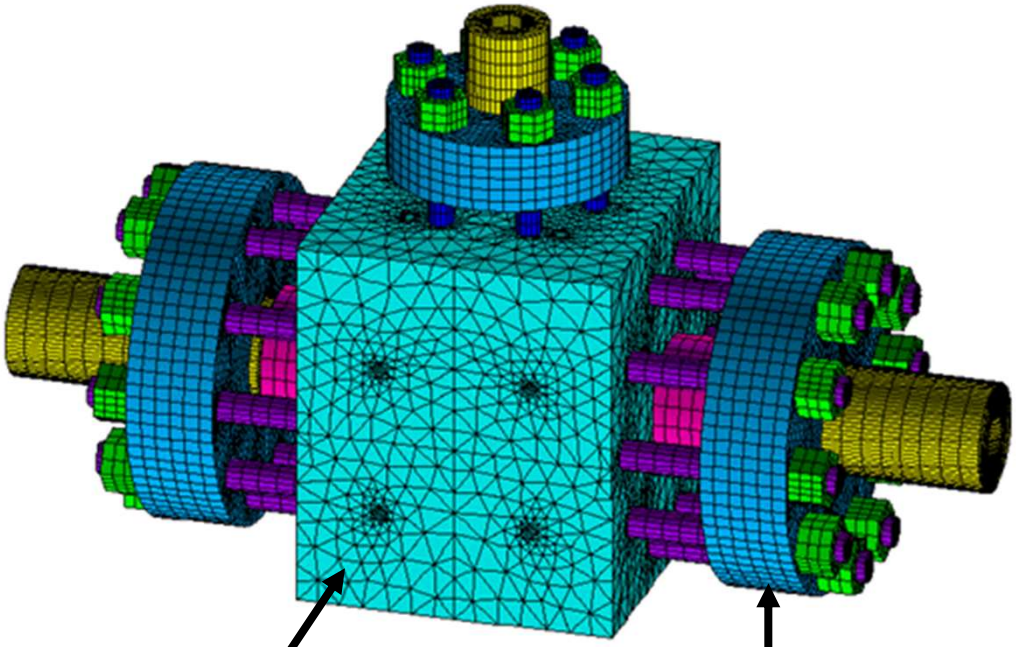


residual stress
(structural analysis)

HIGH-PRESSURE T-CONNECTION

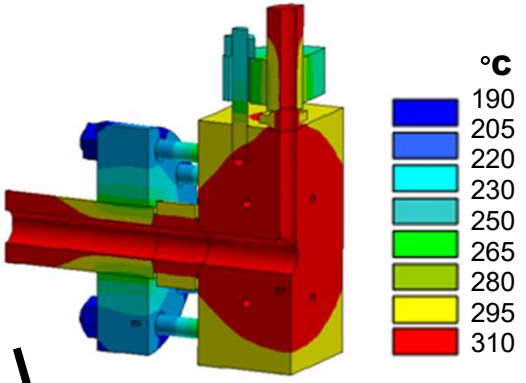
The project was done for Orlen Petrochemical Company

TARGET OF ANALYSIS:
To determine stress magnitude
(pressure 2600at and thermal load)

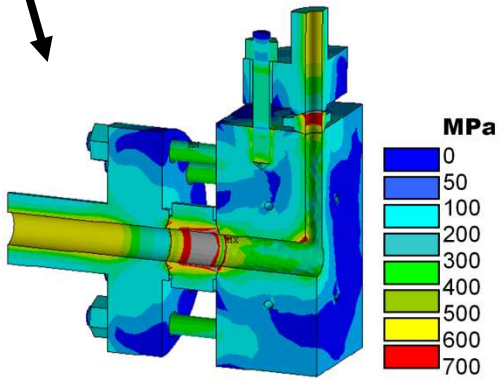


free mesh (tetrahedral elements)

mapped mesh (hexahedral elements)



temperature distribution
(transient thermal analysis)

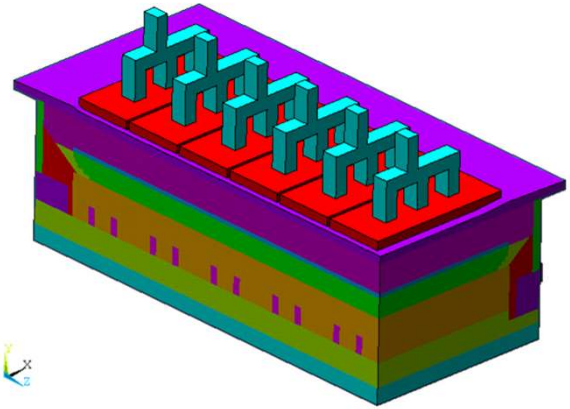


Von Mises stress (structural analysis)

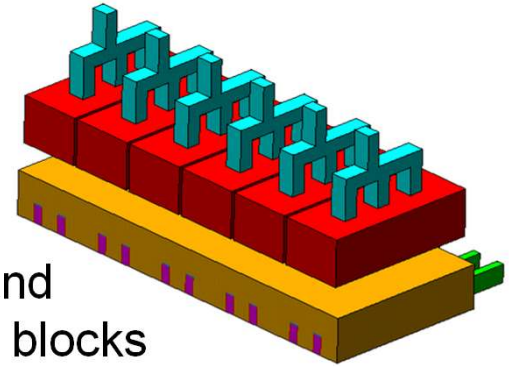
ALUMINUM REDUCTION CELL

TARGET OF ANALYSIS:
To find temperature and electrical potential distributions to correct the design and to improve efficiency

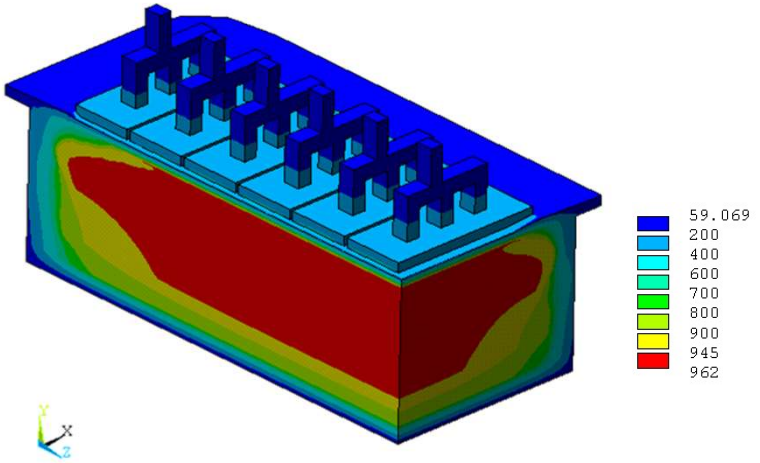
The project was done for Alusuisse Technological Center, Switzerland



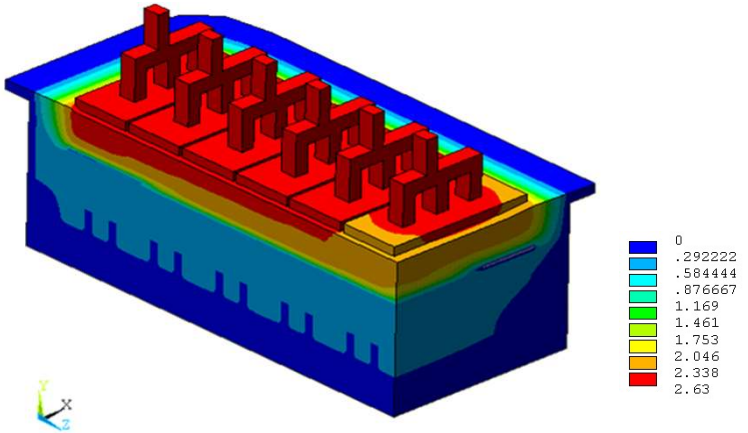
FE model (one quarter of the cell)



anode and
cathode blocks



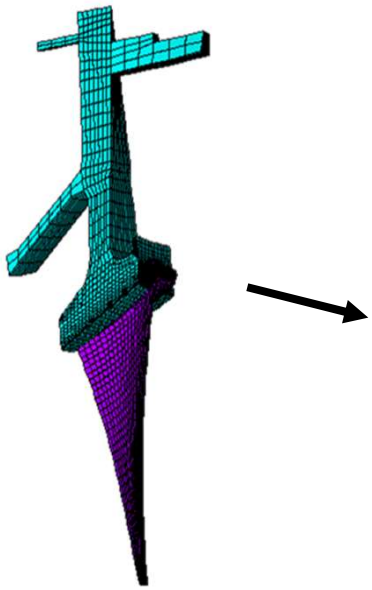
temperature distribution



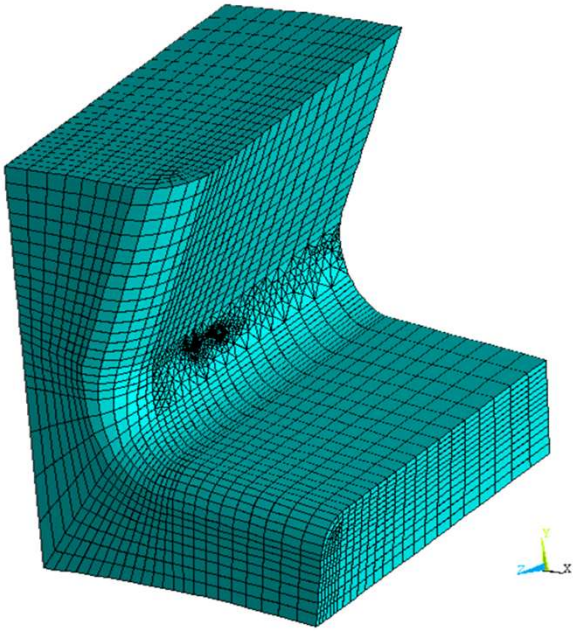
electric potential distribution

TURBINE DISC CRACK

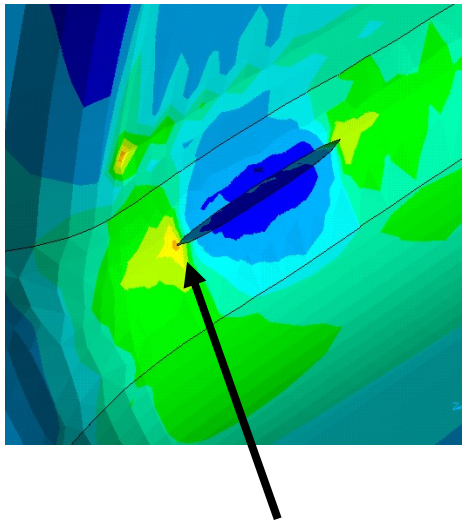
TARGET OF ANALYSIS:
To find stress intensity factor at the tip of the crack



one sector
of rotating disc
(cyclic
symmetry)



submodel with a crack

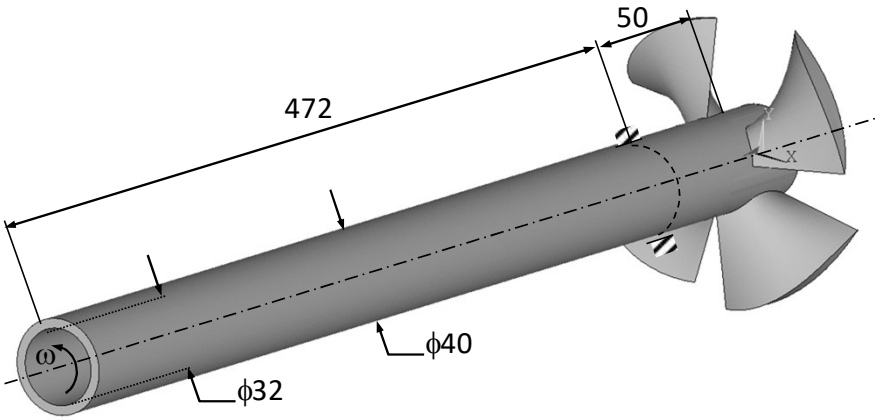


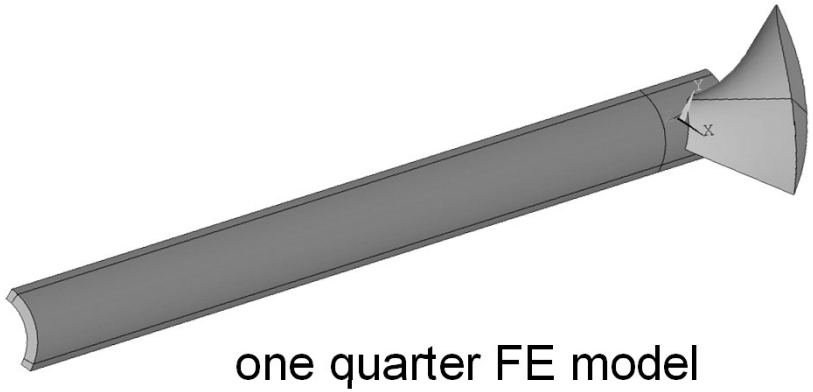
stress concentration

SCREW PROPELLER

TARGET OF ANALYSIS:
To find displacements, stress and natural frequencies

Conditions:
- angular velocity 100 rad/s,
- pressure on blades 0.5-1MPa

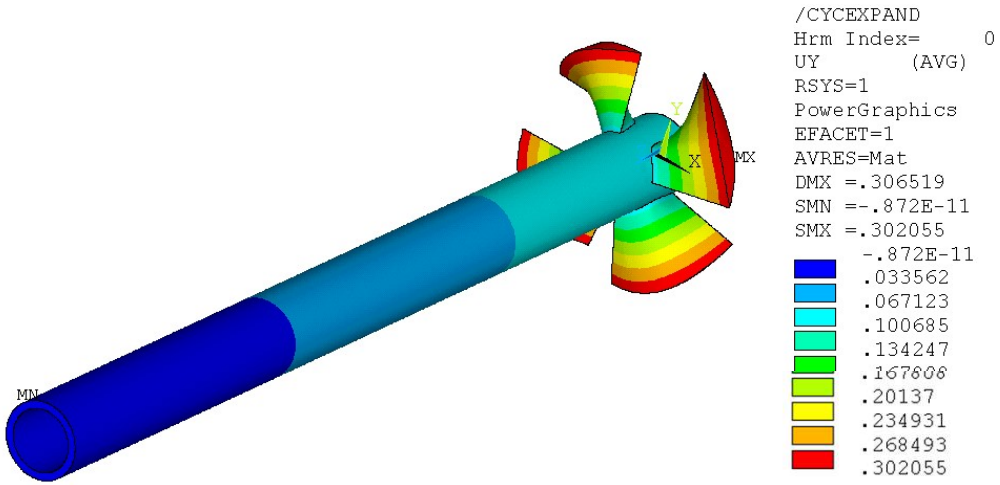




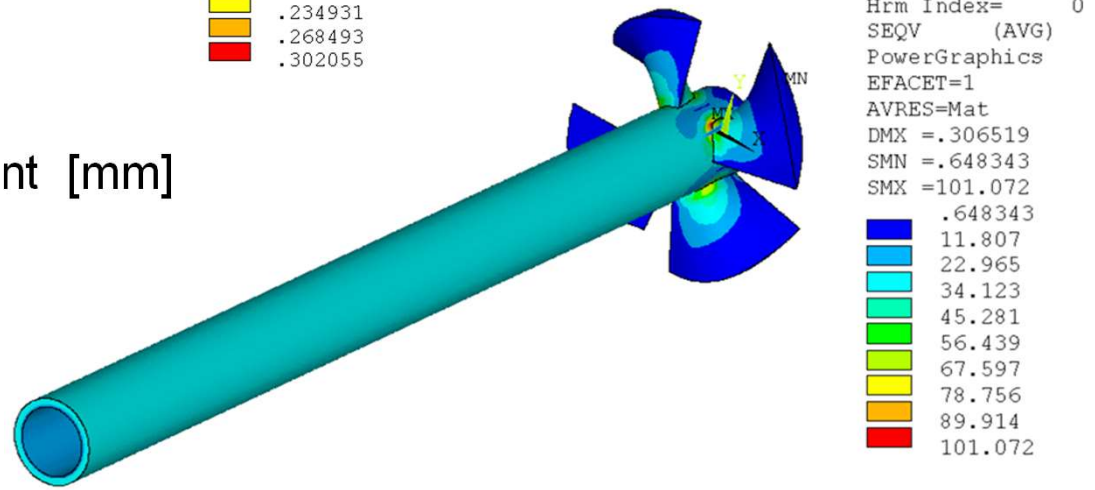
one quarter FE model
(cyclic symmetry)

SCREW PROPELLER

TARGET OF ANALYSIS:
To find displacements, stress and natural frequencies



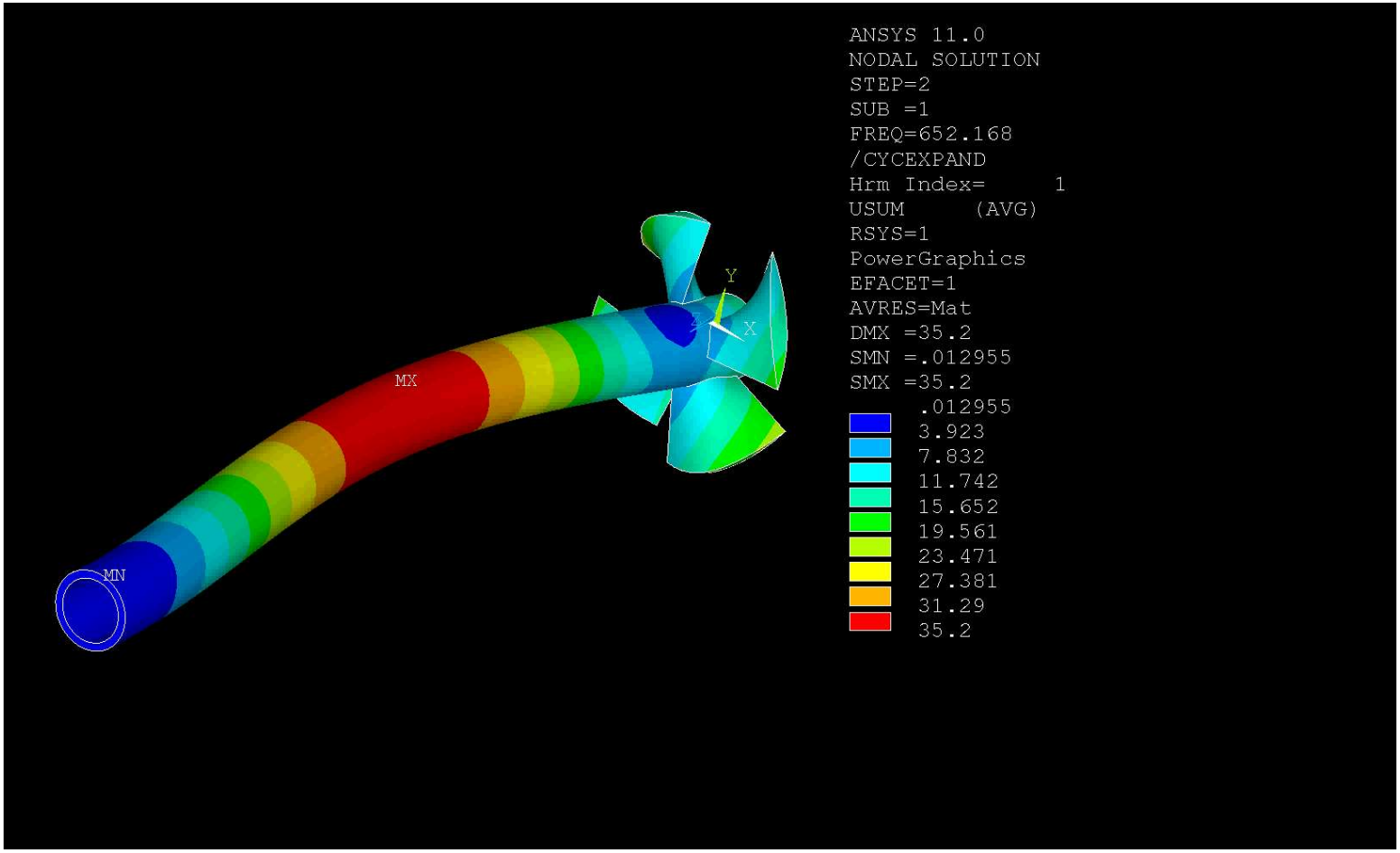
circumferential displacement [mm]



Von Mises stress [MPa]

SCREW PROPELLER

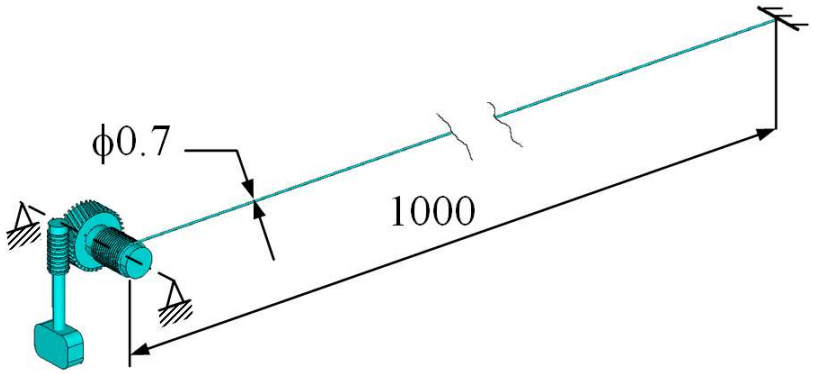
TARGET OF ANALYSIS:
To find displacements, stress and natural frequencies



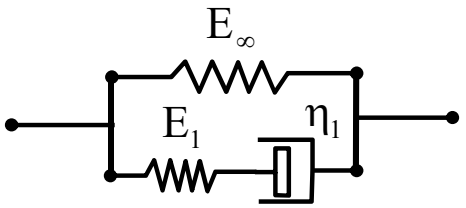
first mode of natural vibrations

RELAXATION OF A GUITAR STRING

TARGET OF ANALYSIS:
To find the time period to achieve nominal tension in a new string

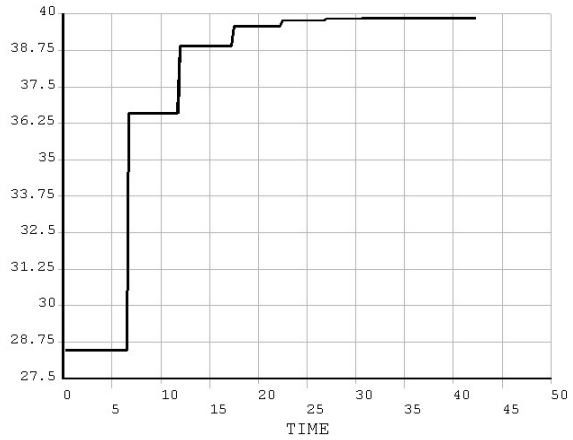


worm gear

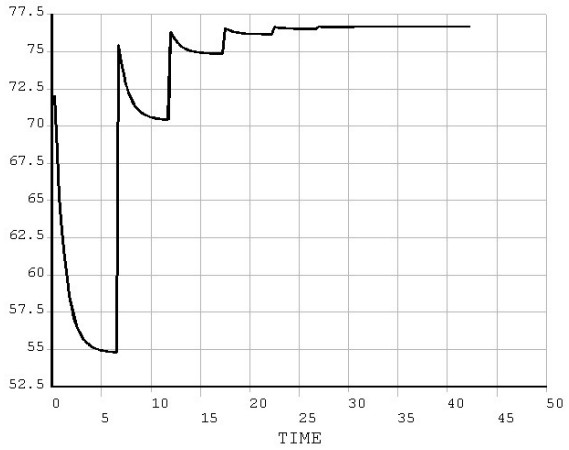


$$\sigma + \frac{\eta_1}{E_1}\frac{d\sigma}{dt} = E_\infty \varepsilon + \frac{(E_1 + E_\infty)\eta_1}{E_1}\frac{d\varepsilon}{dt}$$

viscoelastic model



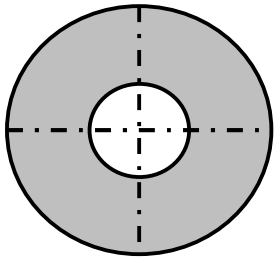
imposed displacement [mm]



force in the string [h]

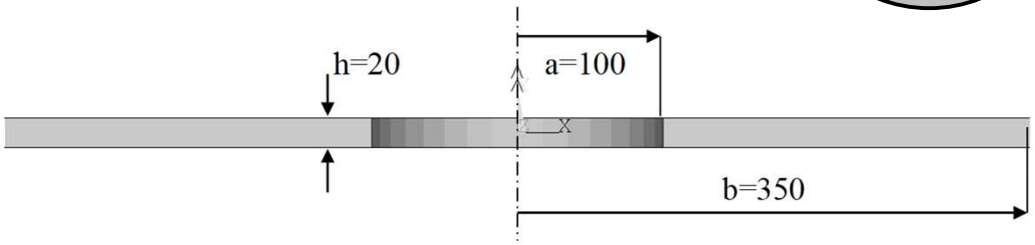
CREEP ANALYSIS OF A ROTATING DISC

TARGET OF ANALYSIS:
To find displacement and stress after 20000 hours in a steel disc

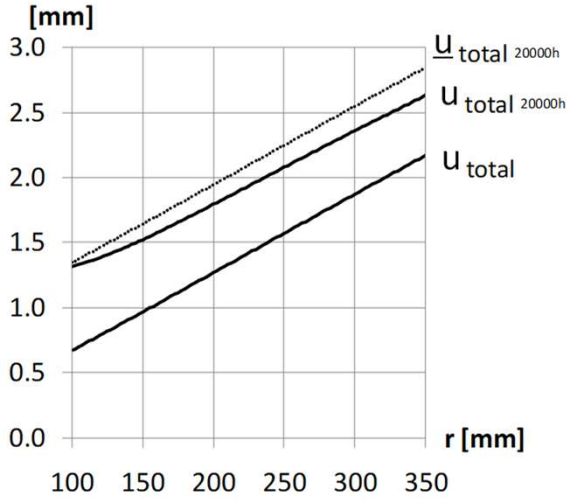


Norton creep model

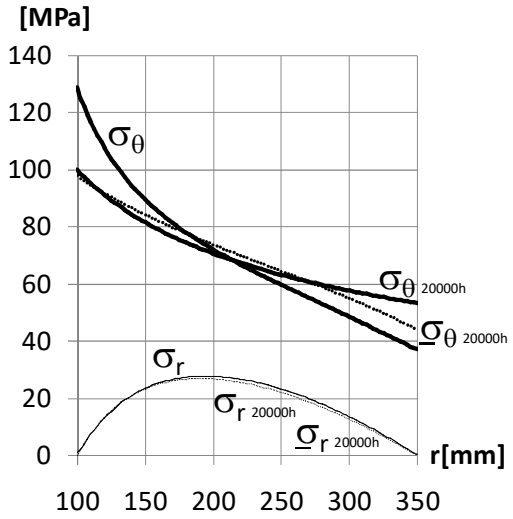
Conditions:
- angular velocity 400 rad/s,
- high temperature (500°C)



radial displacement



radial and hoop stress components

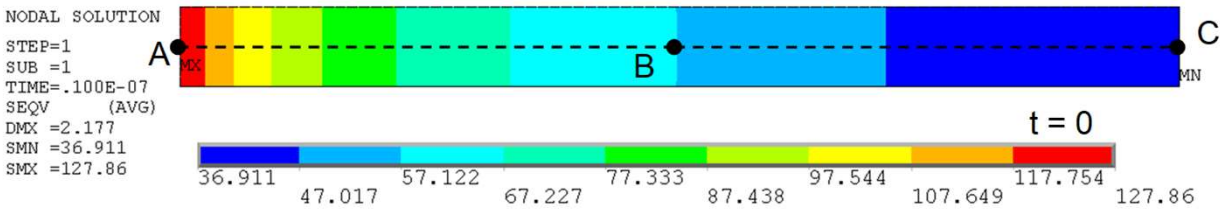


CREEP ANALYSIS OF A ROTATING DISC

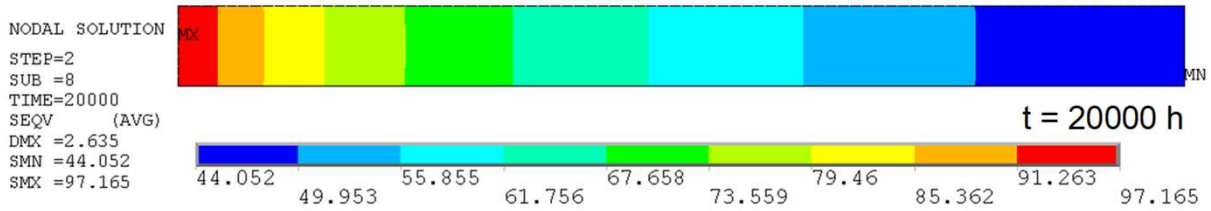
TARGET OF ANALYSIS:
To find displacement and stress after 20000 hours

Von Mises stress [MPa]

first step



last step



Von Mises stress in time [MPa]