# NUMERICAL MECHANICS GROUP

Theoretical and Applied Mechanics Department
Ivanovo State Power Engineering University

# DYNAMIC SIMULATION OF MECHANICAL AND MULIPHYSICAL SYSTEMS

1. Non-linear deformation
2. High-frequency dynamics
3. Low-frequency vibration
4. Non-linear high-frequency dynamics

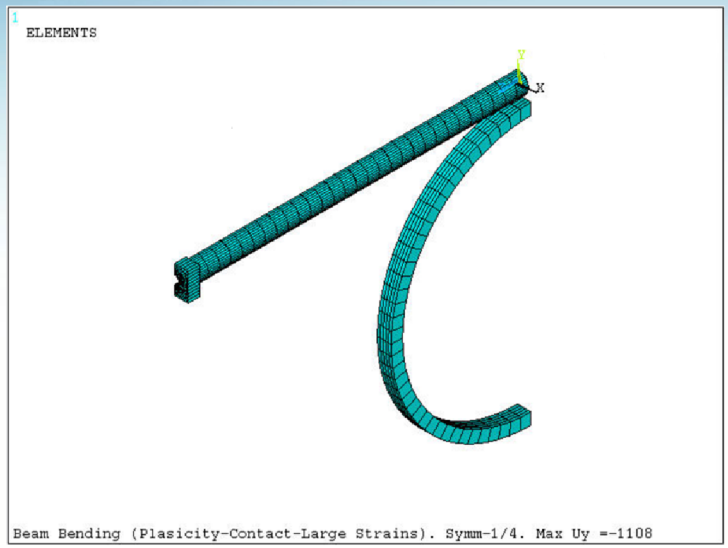
Leonid MASLOV, ScD, Professor
Ivan BELOV, Senior Researcher

www.tipm.ispu.ru

34 Rabfakovskay 153003 Ivanovo
Theoretical and Applied Mechanics Department
Ivanovo State Power Engineering University

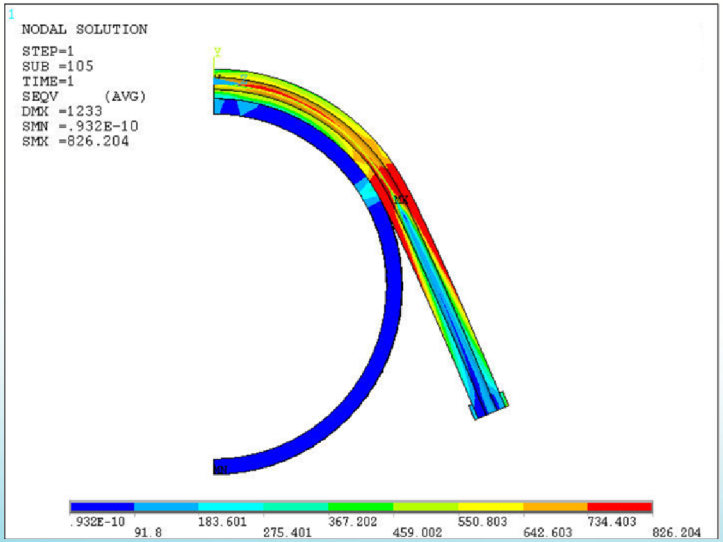
Tel.: +7 4932 269711
Fax: +7 4932 269712
E-Mail: leonid-maslov@mail.ru , maslov@tipm.ispu.ru

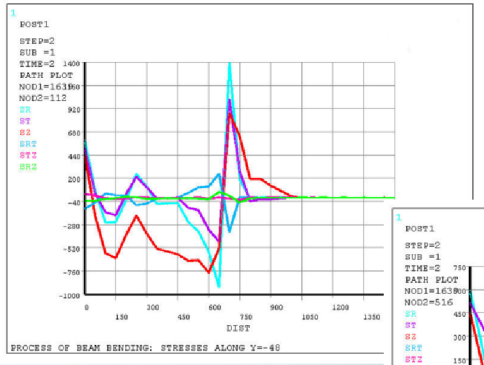
# 1.1. Tube Large Bending

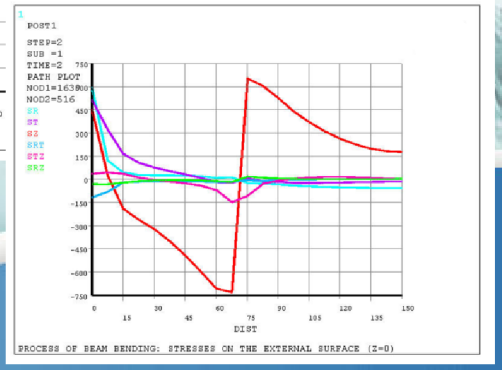



- Goal: Stress analysis for circle-shape forming of the tube

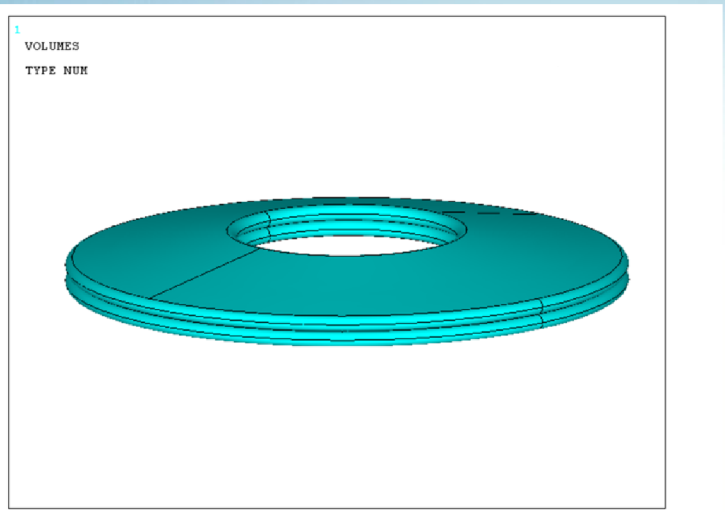
- Analysis: Static
- Material Model: Elastic-plasticity
- Solution Control: Large Displacement
- Contact Behavior: No separation. Surface-to-Surface
- Load: Displacement



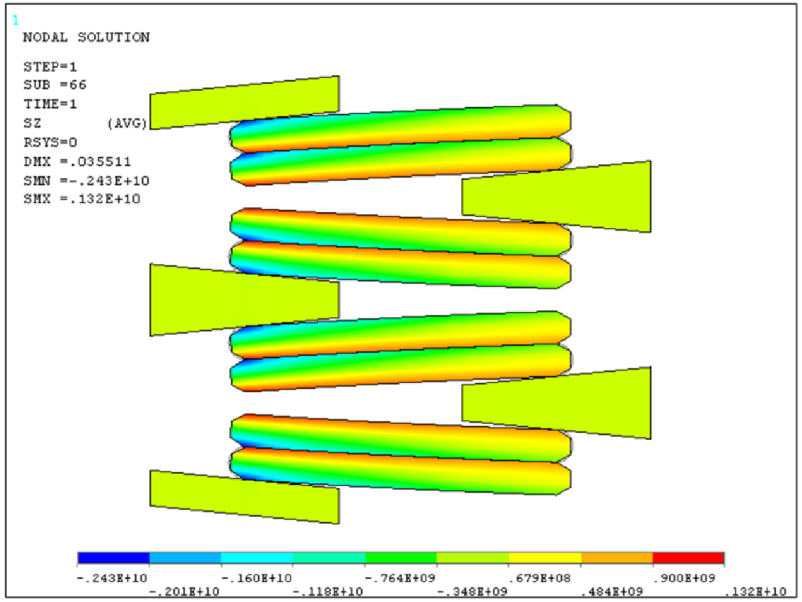



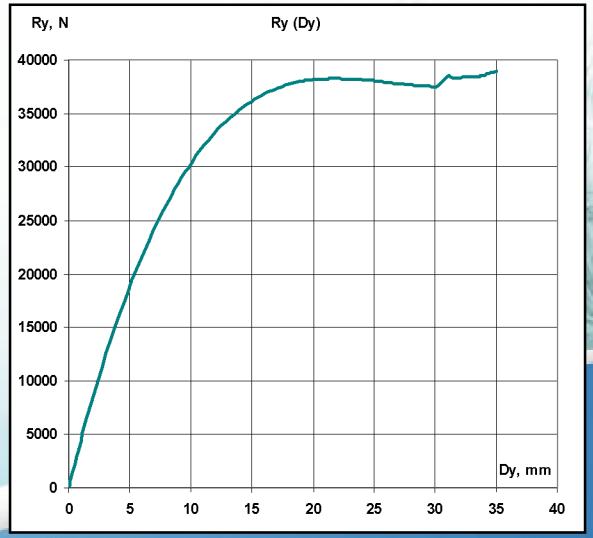
# 1.2. Disk Spring Non-Linear Deformation



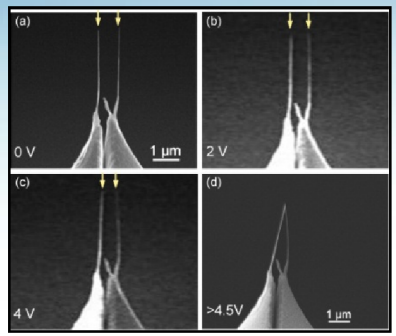

- Goal: Reaction Force Estimation for Disc Spring Set

- Analysis: Static. Axisymmetric
- Material Model: Elastic
- Solution Control: Large Displacement
- Contact Behavior: Surface-to-Surface
- Load: Displacement or Force



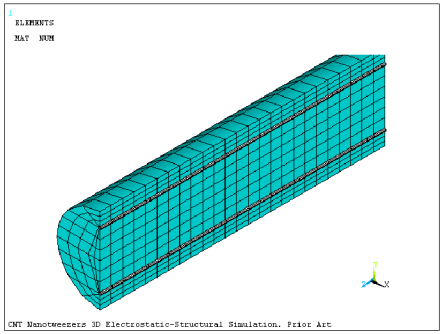



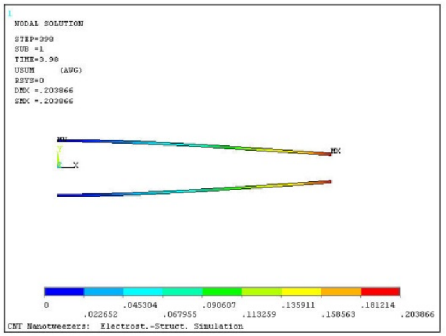
# 1.3. Bending of Carbon Nanotubes

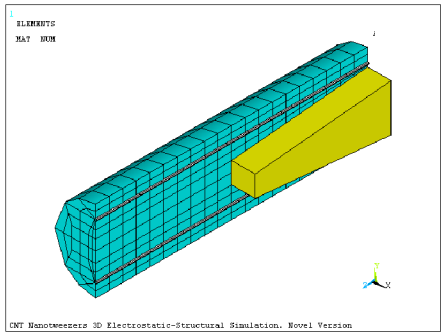


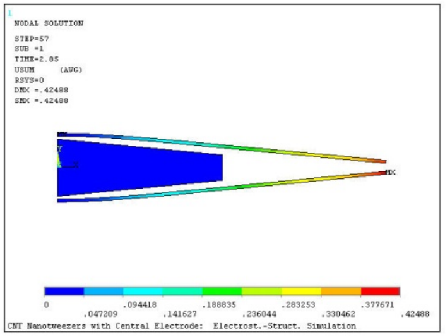

- **Goal: Electrostatic device development based on the CNT elastic motion due to applied voltage**

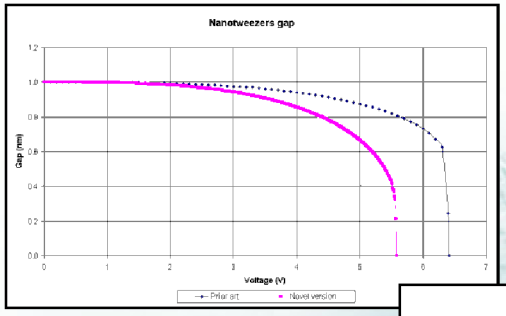
- **Analysis: Static Multiphysics**
- **Material Model: Elasticity**
- **Solution Control: Large Displacement**
- **Load: Voltage**

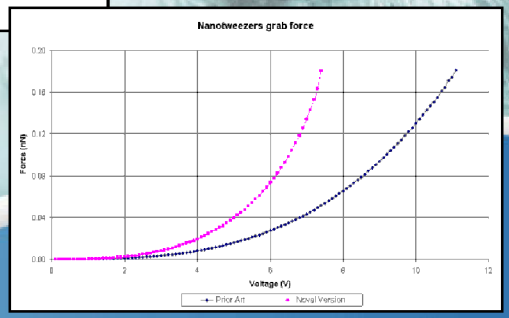


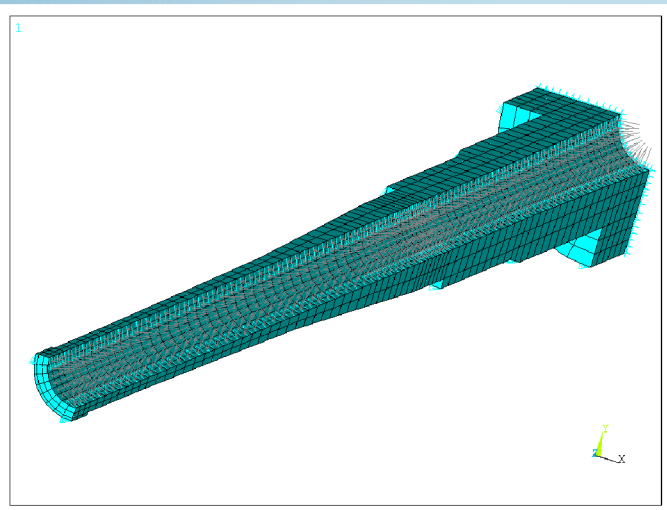



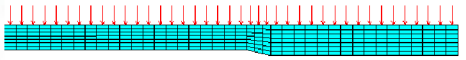



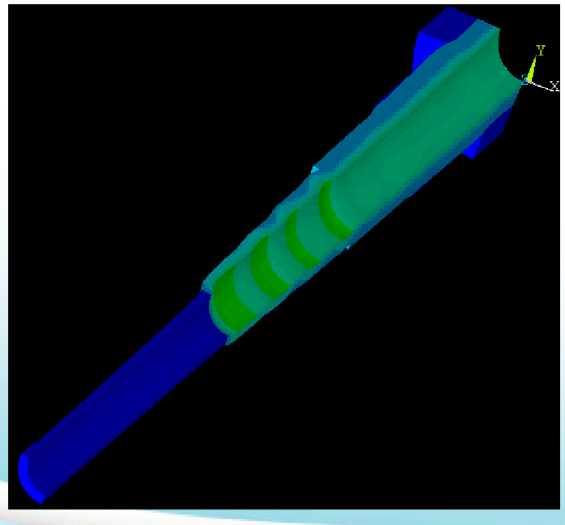
# 2.1. Wave Propagation through a Gun Barrel

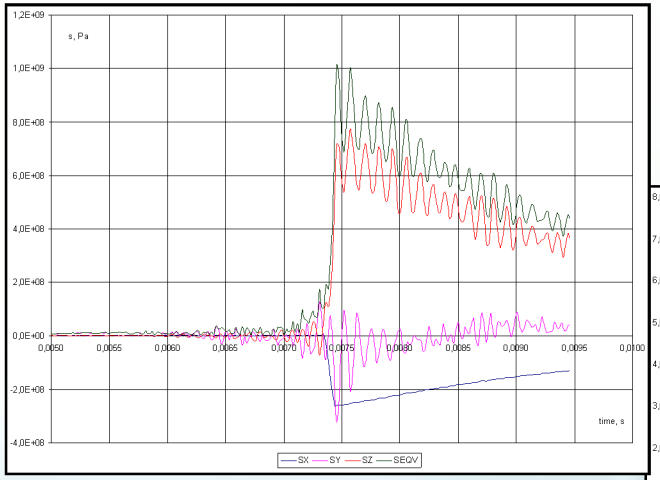


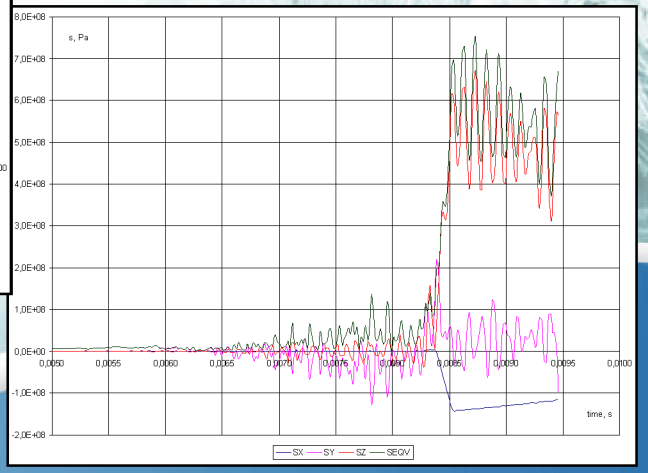
- **Goal: Dynamic Stress Prediction**

- **Analysis: Transient**
- **Material Model: Elasticity**
- **Solution Control: Small Strain**
- **Load: Time-Dependent Internal Pressure Varying Along Gun Barrel Axis**

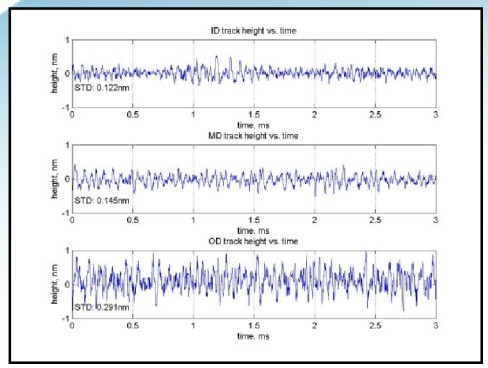


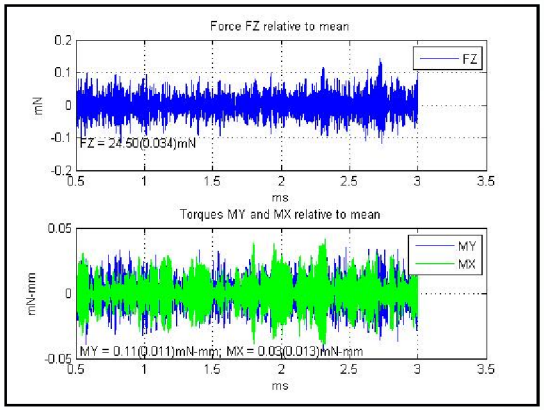


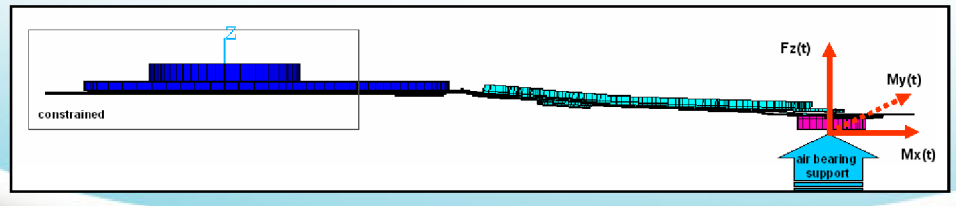


# 2.2. Magnetic Head High-Frequency Dynamics

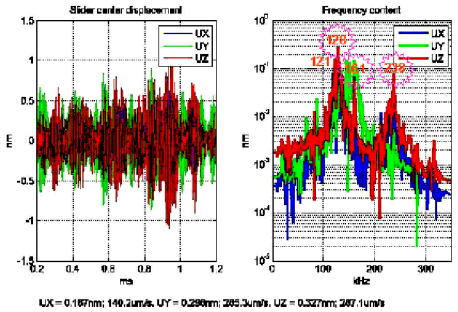


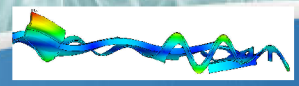



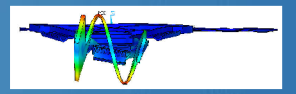




- **Goal: Study of suspension effect to the magnetic head high-frequency dynamics**

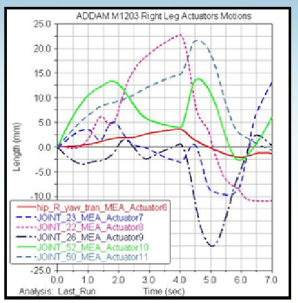
- **Analysis: Transient**
- **Material Model: Elasticity**
- **Solution Control: Small Strain**
- **Load: Excitation forces from air bearing simulation due to disk topography**

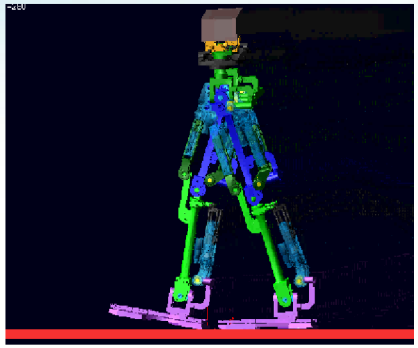




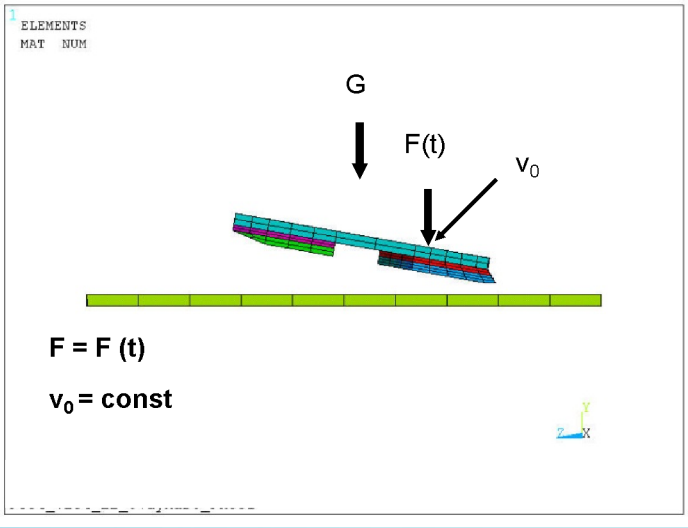
# 2.3. Foot-to-Ground Interaction

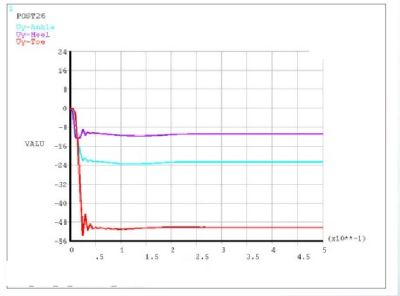


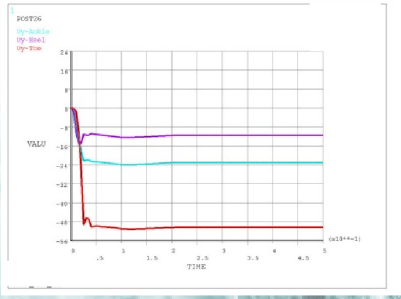



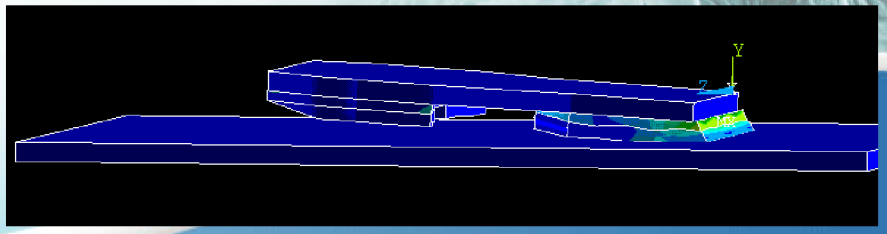
- Goal: Foot oscillation minimization after the ground landing

- Analysis: Explicit Dynamics
- Material Model: Elasticity
- Solution Control: Large Displacement
- Contact Behavior: Elastic-to-Rigid
- Load: Time-Dependent Force

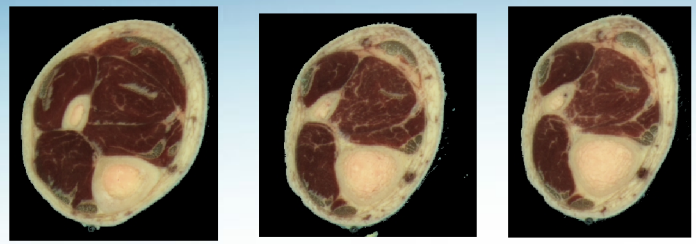


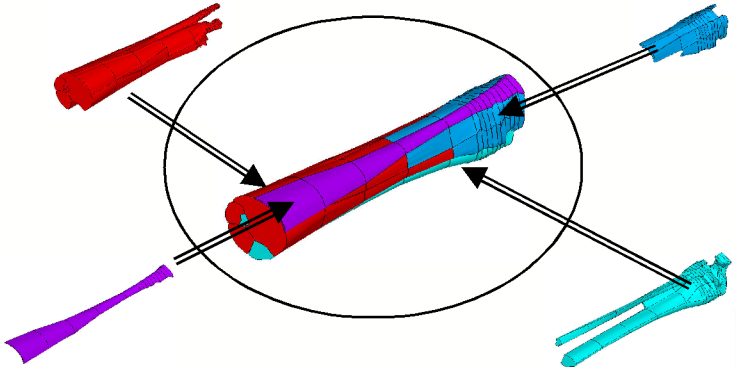



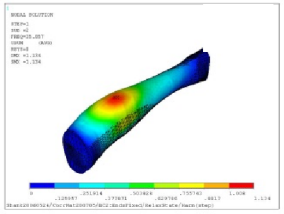


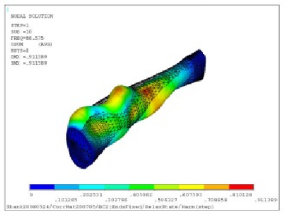


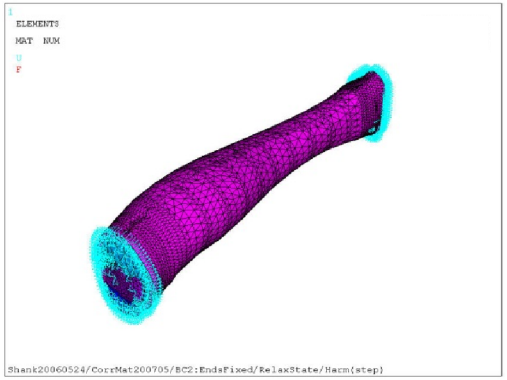
# 3.1. Human Shank Modal and Harmonic Analysis

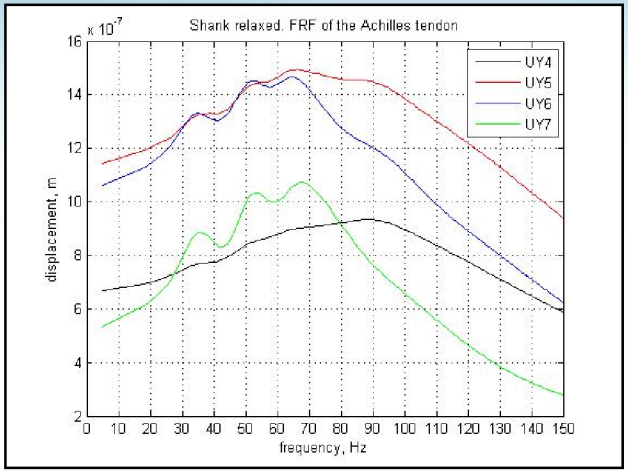




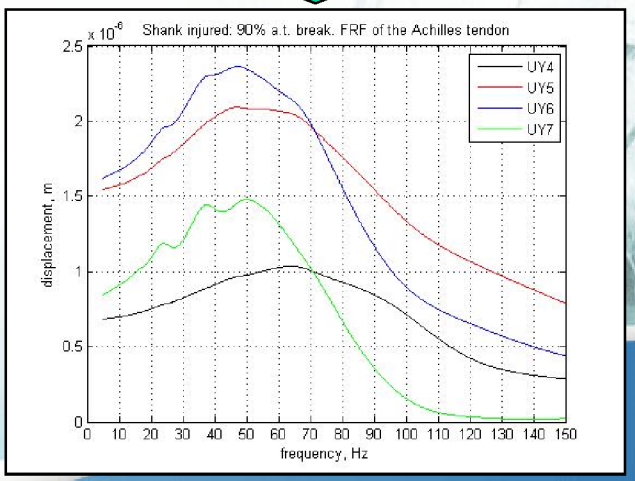






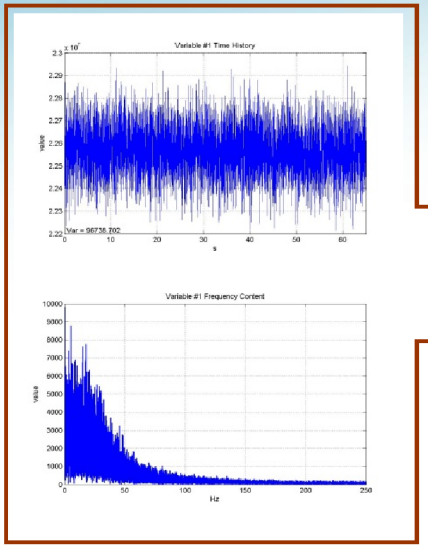



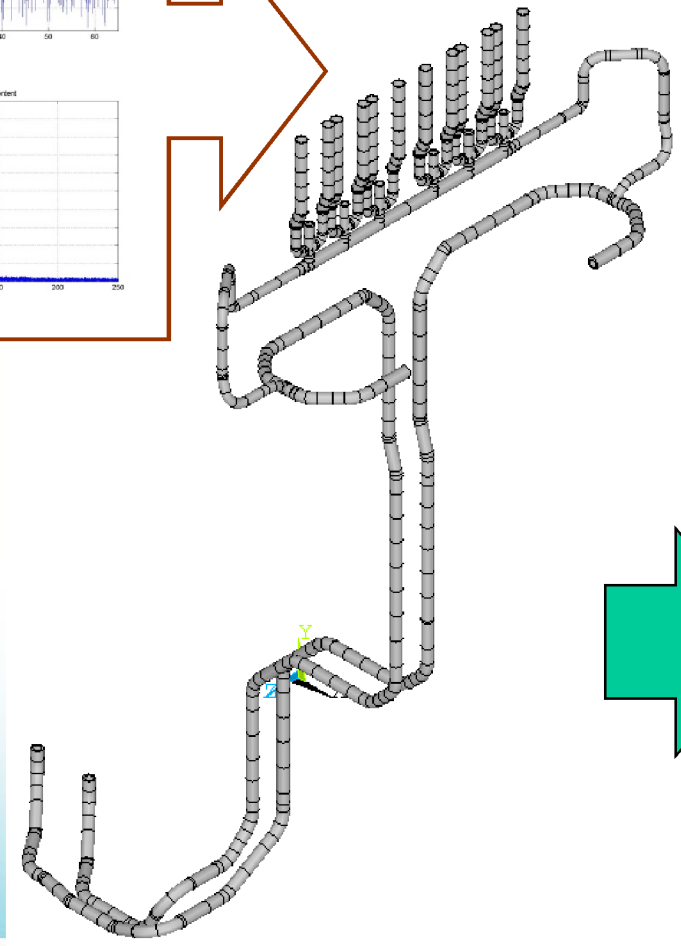

**f2=35.8 Hz, f5=52.1 Hz, f10=66.5 Hz, f24=90.1 Hz**




**f4=24.1 Hz, f18=36.2 Hz, f48=50 Hz, f102=65 Hz**

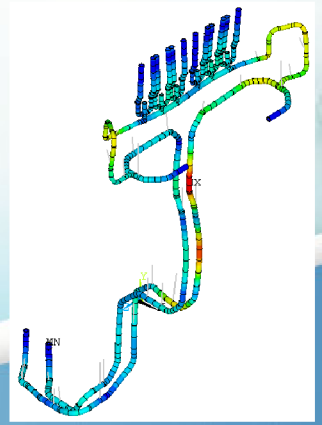
# 3.2. Pipe System Low-Frequency Dynamics

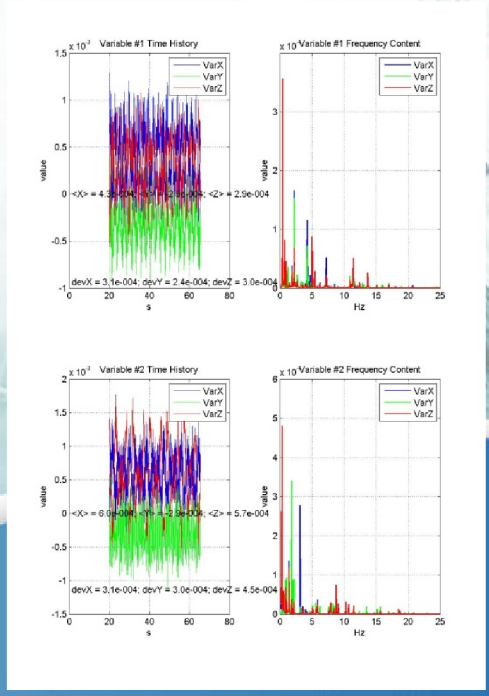


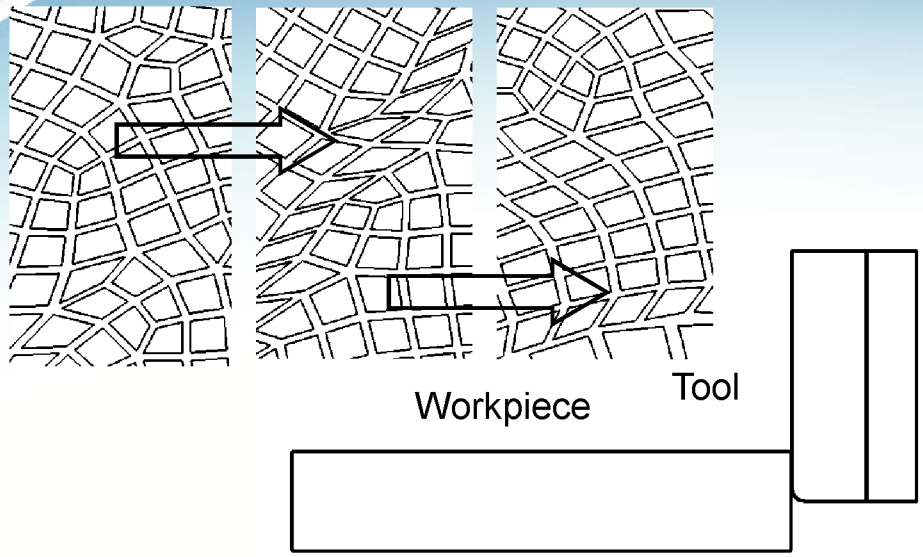
- Goal: Pipe system vibration analysis caused by the steam pressure oscillations

- Analysis: Transient
- Material Model: Elasticity
- Solution Control: Small Strain
- Load: Excitation forces from the random internal pressure oscillation



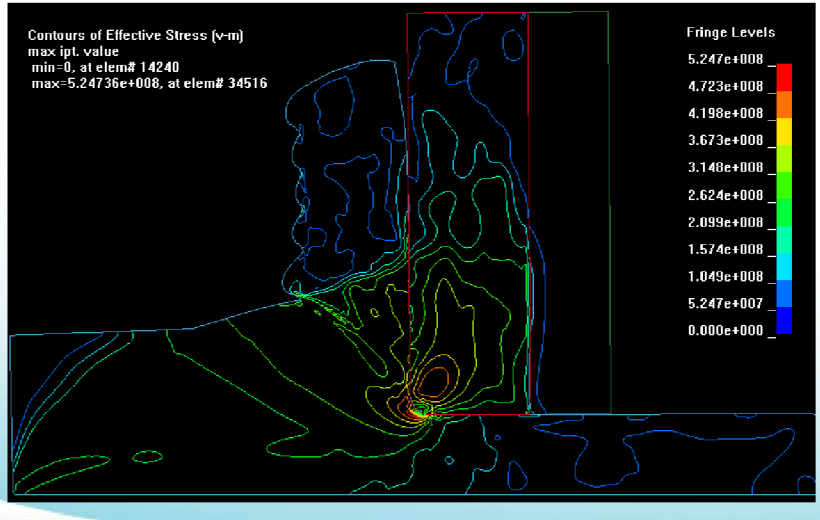


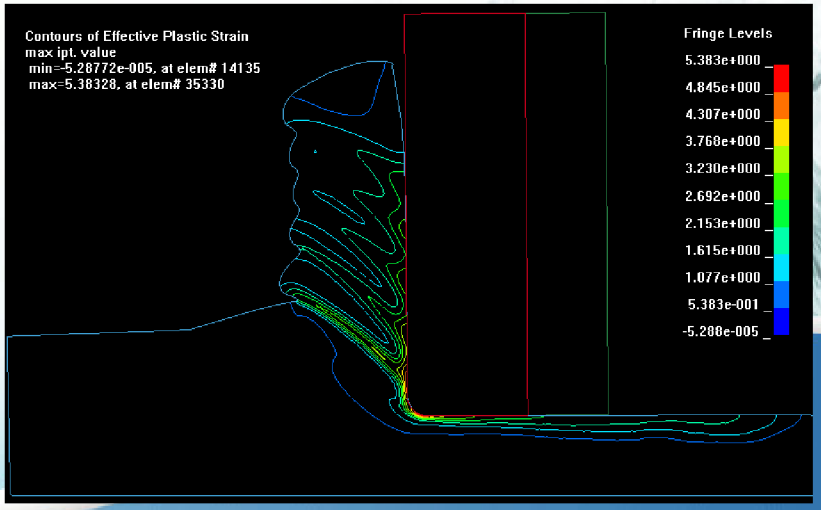
# 4.1. High-Speed Metal Cutting Simulation



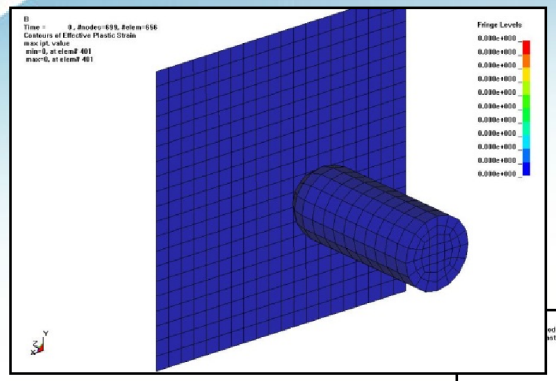

- **Goal: Cutting Force Estimation**

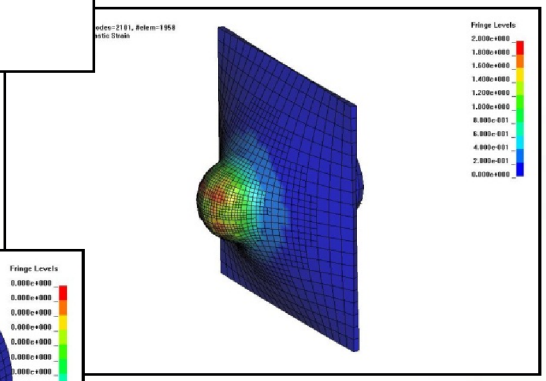
- **Analysis: Transient by LS-DYNA**
- **Material Model: Elastic-plasticity, Kinematic Hardening**
- **Solution Control: Large Strain**
- **Contact: Rate Dependent Friction Coefficient**
- **Extra features: Adaptive Remeshing**

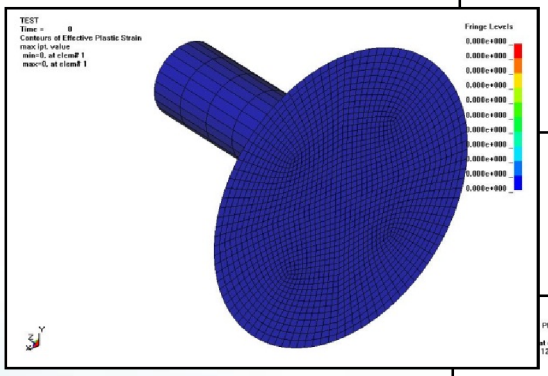


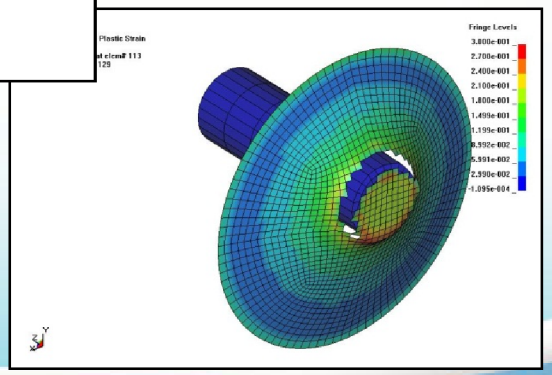



# 4.2. Penetration Modeling



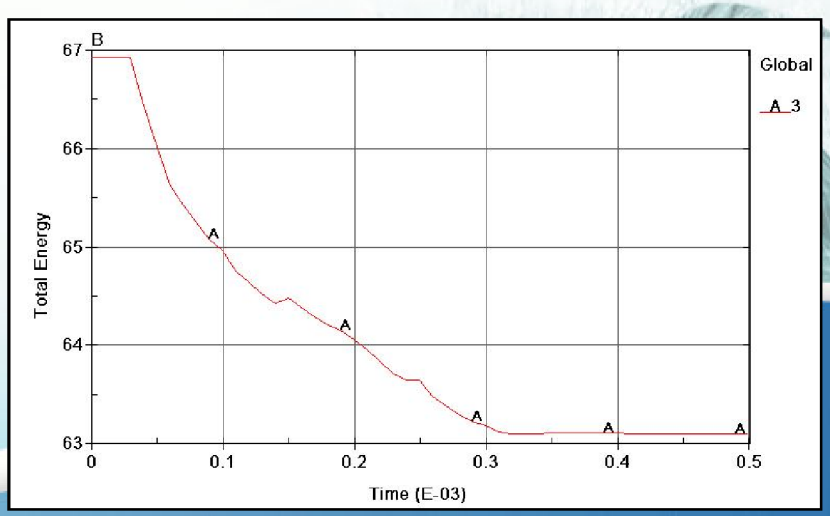




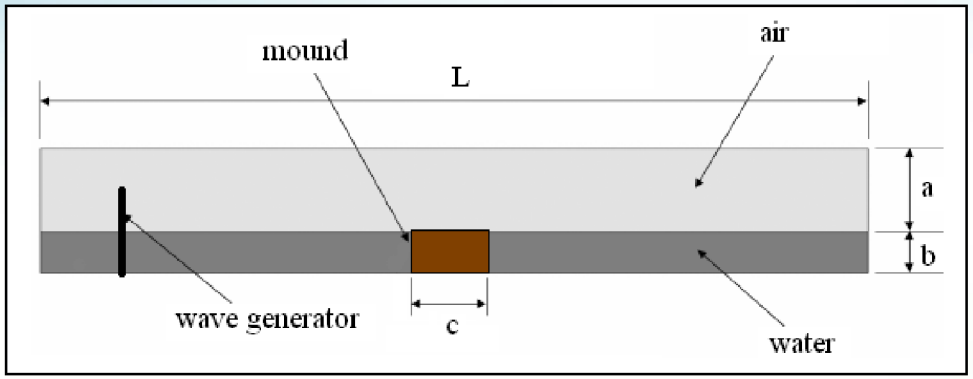


- **Goal: Penetrating Body Shape Effect Estimation**

- **Analysis: Transient by LS-DYNA**
- **Material Model: Elastic-plasticity**
- **Solution Control: Large Strain**
- **Contact: Rate Dependent Friction Coefficient**
- **Extra features: Birth and Death of Element**



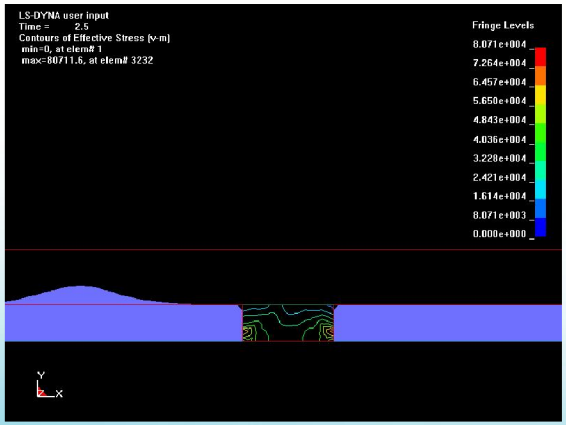
# 4.3. Fluid-Structure Interaction



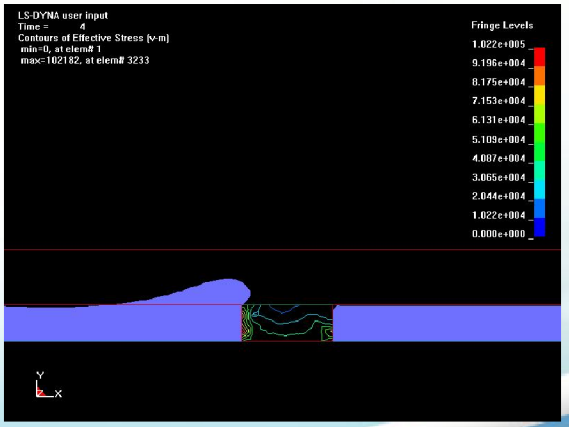

- Goal: Wave Propagation over a Mound and Stress Distribution in the Seashore Protection System Simplified Model

- Analysis: Transient by LS-DYNA
- Material Model: Elastic. Fluid
- Solution Control: ALE
- Extra features: Fluid-Structure Coupling. Free Fluid Surface

t = 2.5 s




t = 4.0 s




t = 5.5 s