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Analyses On An Undulator

Dr.-Ing. Stefan Reul, PRETECH GmbH

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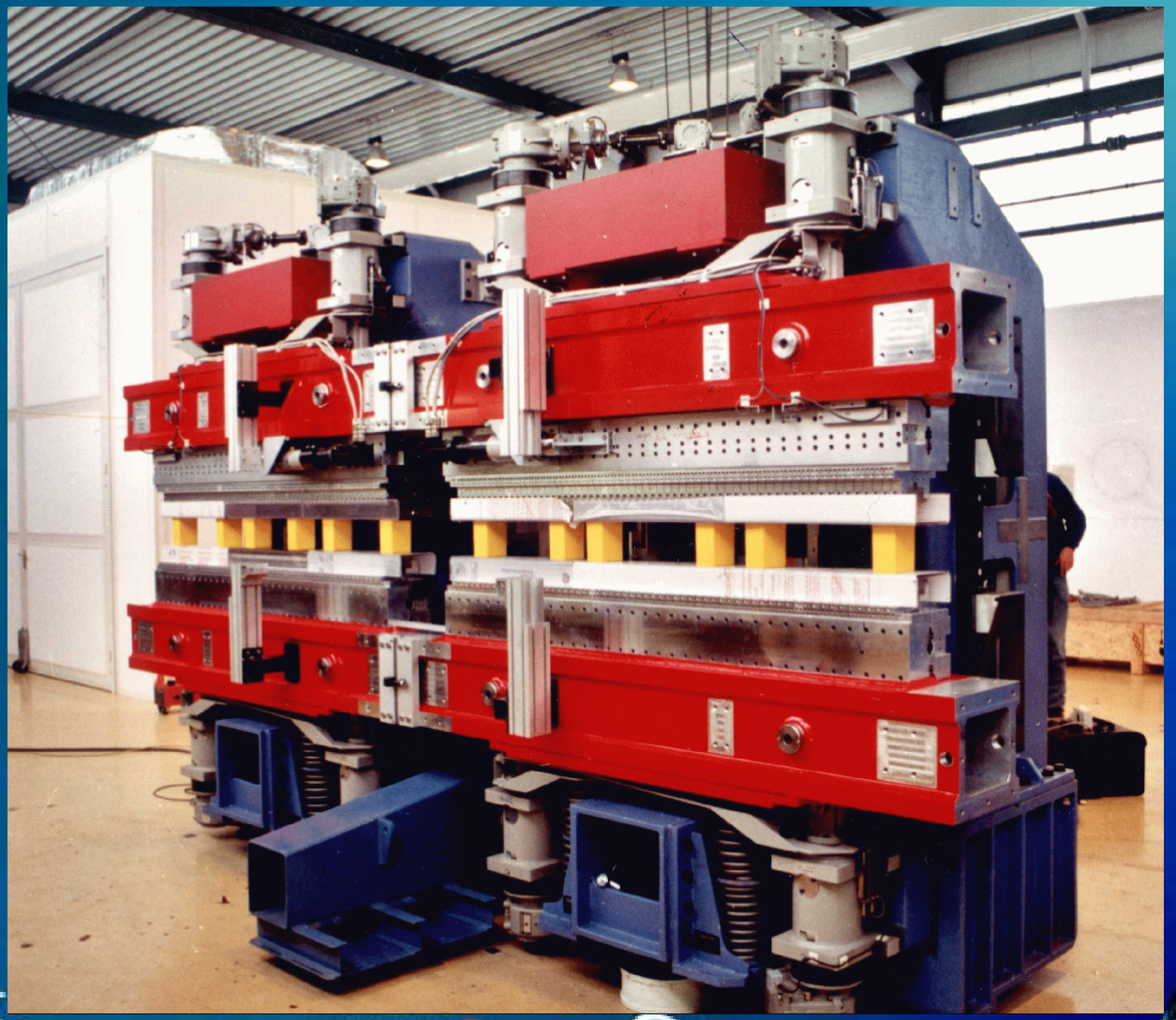
What's An Undulator ?

- Produces electromagnetic rays from an electron beam
- Electron beam is produced in a synchrotron with 1.7 GeV
- Range: from infrared to x-rays, 'laser like' quality in very short pulses
- Great number of magnets (e.g. 84) in four rows on two beams
- Deflection of electrons by displacement of the magnet rows

Undulator UE56 (typical)



Some Requirements For The Undulator UE46

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- Beam y-deflection (vertical): max. 10 micron
- Beam z-deflection (horizontal): max. 40 micron
- Beam tilt in y-direction: max. 80 micron
- Forces: up to 34 kN per magnet row -> great moments
- Length: 3.4 m
- Beam cross section: about 410 mm x 300 mm
- Material: Al
- All bearings free from backlash -> loads only in one direction

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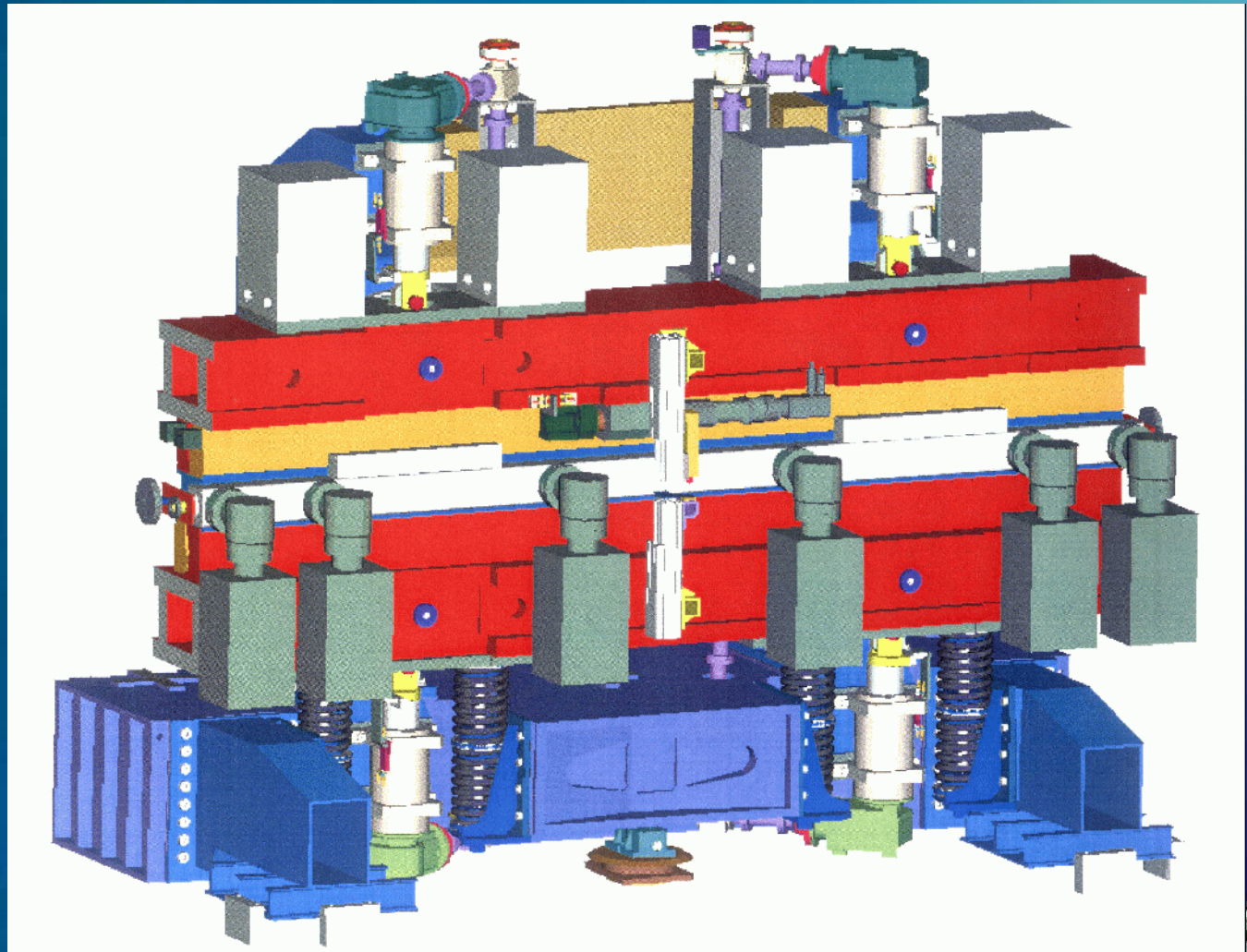
Pro/ENGINEER Model Of UE46



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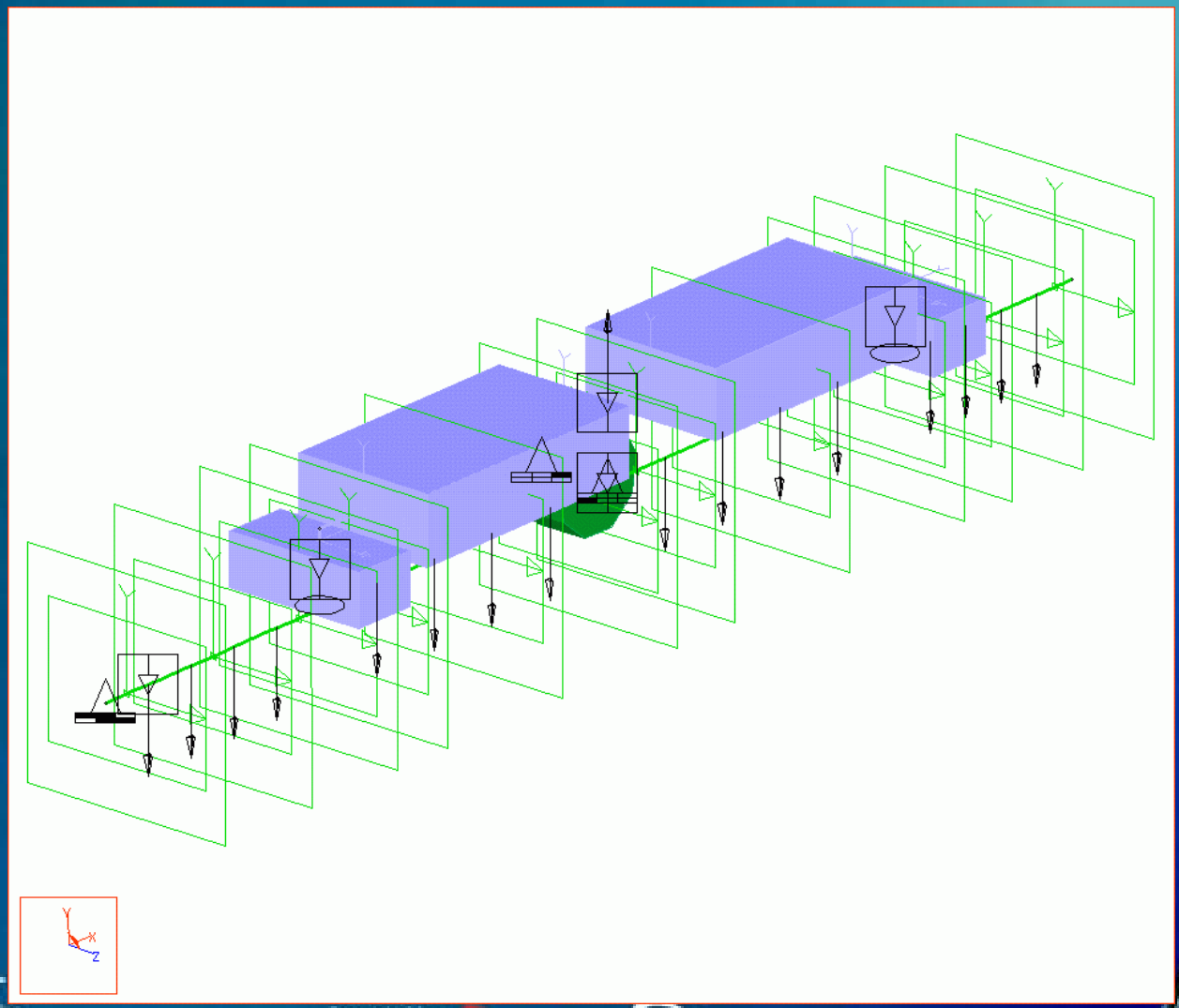
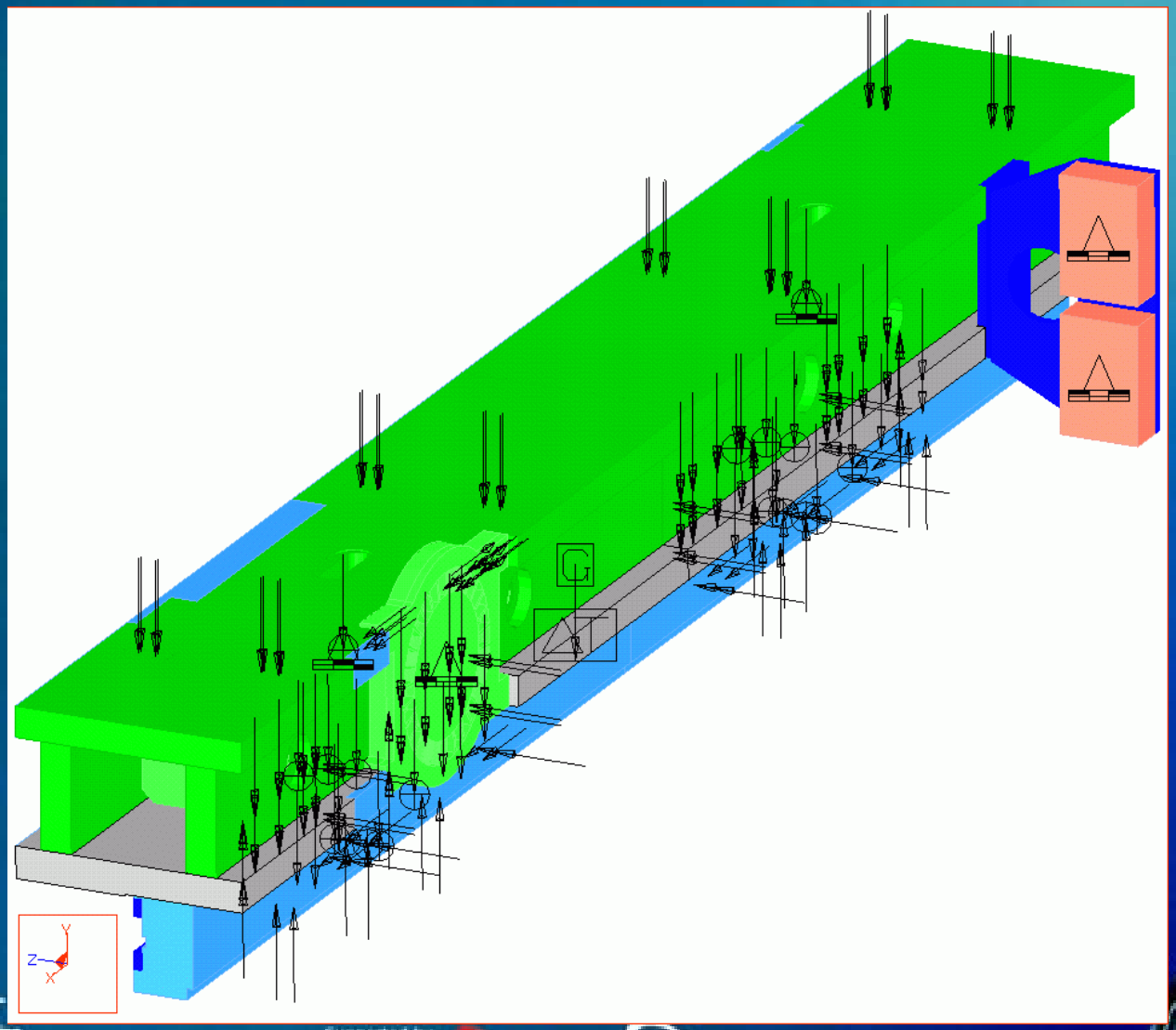
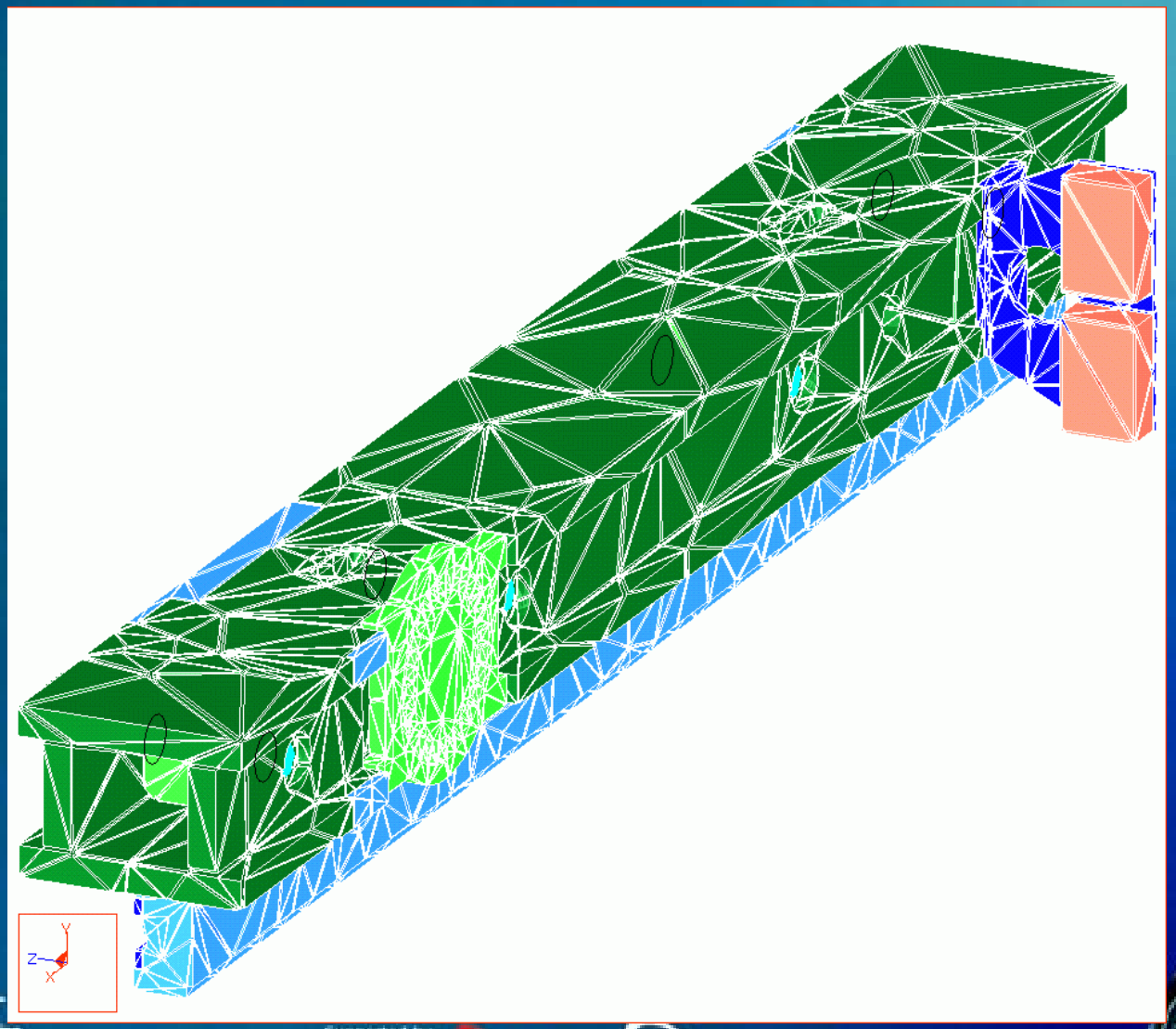
Pro/MECHANICA Beam Model Of UE46 For Optimization



Pro/MECHANICA 3D-Model Of UE46 With Loads / Constraints



Pro/MECHANICA 3D-Model Of UE46 With Elements



Model And Calculation Characteristics

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- 236 beams and 11,550 volume elements
- Computer: SGI OCTANE, 2x CPU's 300 MHz
- Single pass adaptive solver with 367,614 DOF
- CPU time: 7,193 sec; elapsed time: 8,485 sec
- Memory: 2,196 MB; disk space: 1,521 MB
- Failure against multi pass solver: < 10 % in displacements
- Multi pass solver: 1,906,661 DOF; 4,113 MB memory; 59,821 CPU time

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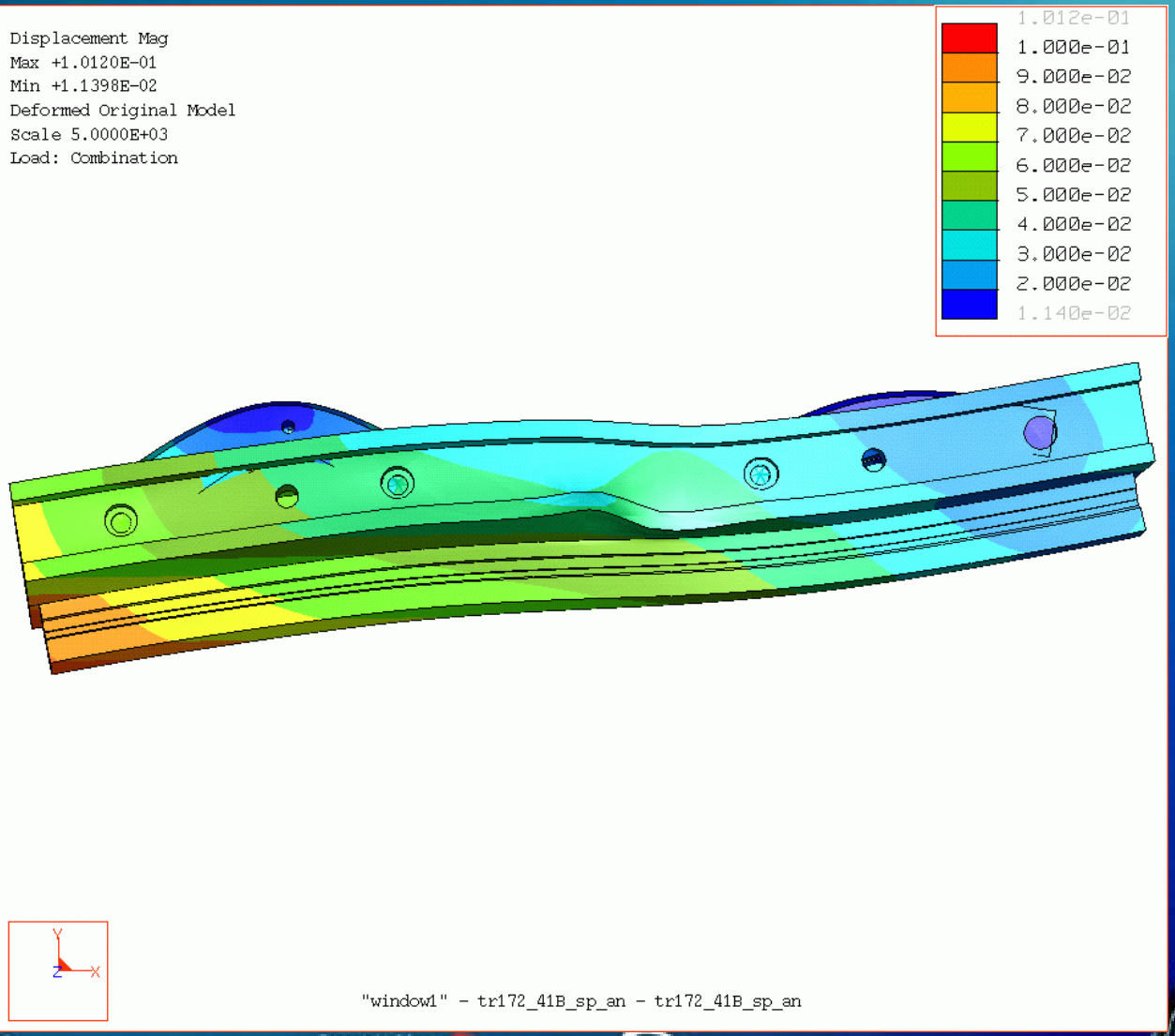
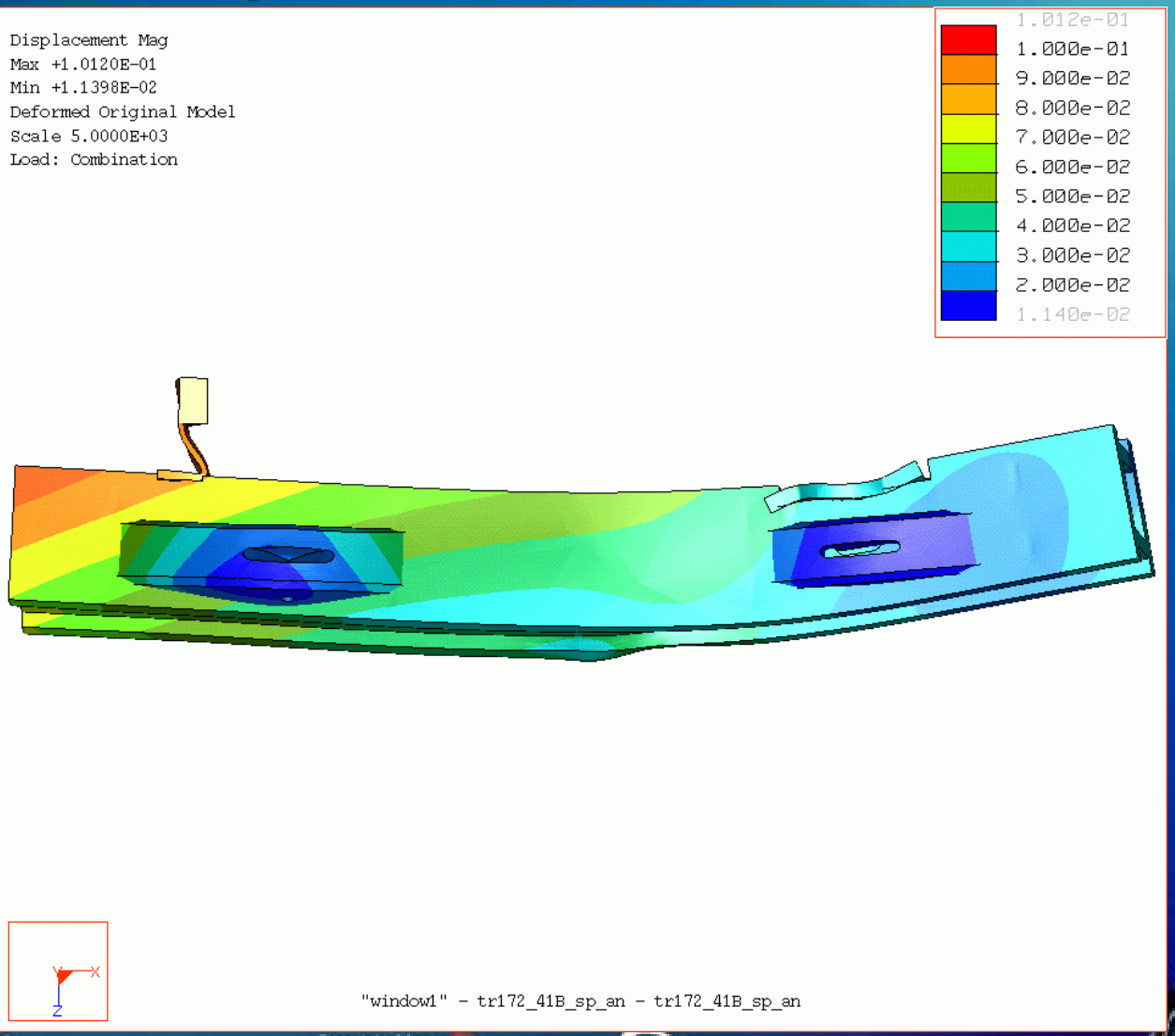
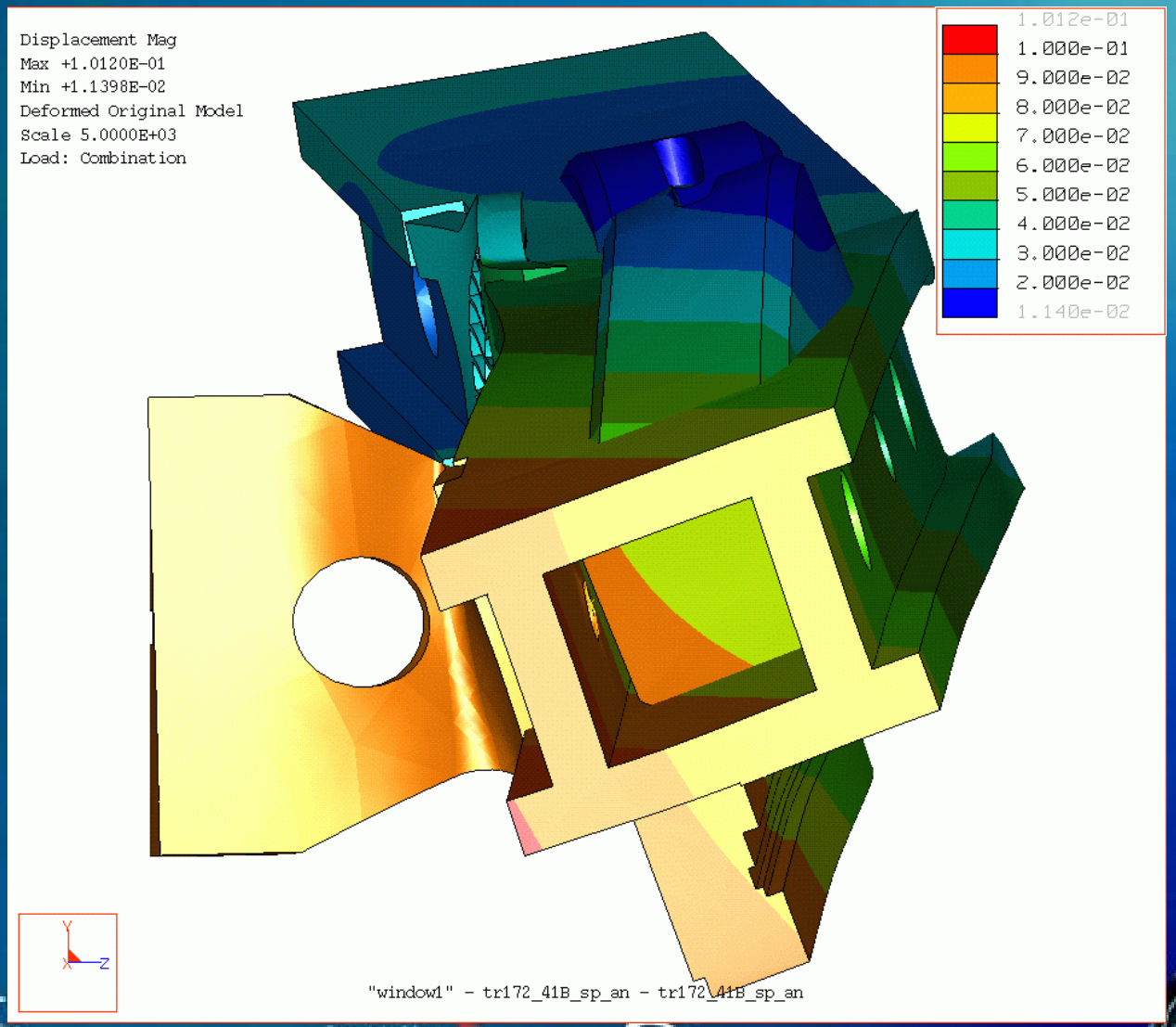
Displacement Results In All Directions, Front View



Displacement Results In All Directions, Top View



Displacement Results In All Directions, Side View



Model And Calculation Characteristics

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- All Requirements were met
- Forces by the lead masses and springs had to be increased to get free from backlash
- Positions of the bearings have been optimized
- Further undulators have been investigated to capture also the influence of the movable magnet rows and more load cases
- Pro/MECHANICA is a precise tool to dimension and optimize such complex equipment before manufacturing

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