

THE NEW SWITCHING MIRROR UNIT AND ITS MECHANICAL PRINCIPLES

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Abstract

Two new beamlines for microfoci of 5 μ m diameter are under construction at BESSY at an undulator. The switching mirror unit provides two positions of the mirror: one deflects the light in one beamline while in the other is moved out of the way for light for the beamline on the undulator axis. The new system is located inside the storage ring tunnel where it must operate very reliably even under X-ray exposure.

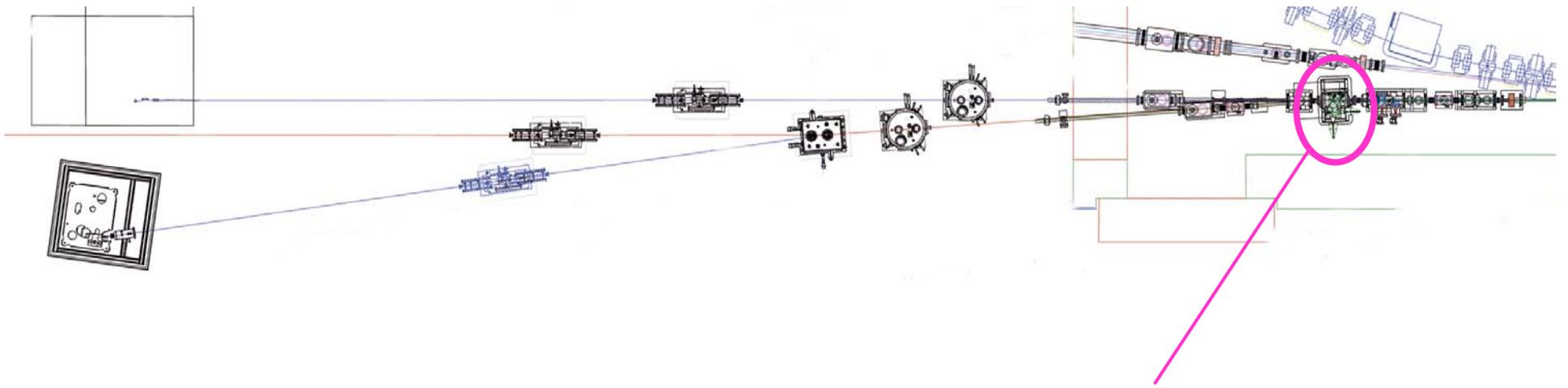
The mirror mechanism is based on a non-monolithic parallel-kinematic approach using flexure fibre joints. This configuration has been thoroughly tested at BESSY and is now the standard on about 30 beamlines. Parasitic motions were minimized by a dedicated topology which provides three cartesian rotations around the midpoint of the mirror with a resolution of 10nrad [patent WO 02/16092 A1]. The lateral translations are also performed orthogonally with respect to the mirror. The lead screw based linear motion feedthroughs provide a full step resolution of 10nm. The stiffness of the structure was optimized and the mass minimized to push the eigen frequencies as high as possible. Thus, the mirror is stiffly connected to the concrete floor which acts as an optical bench.

Feedback systems for automatic beam position correction in the beamlines have been successfully tested for one year. Based on this positive experience, the new mirror system is additionally equipped with a piezo-actuator which acts on the angle of incidence to regulate the beam position with respect to the exit slit of the monochromator.

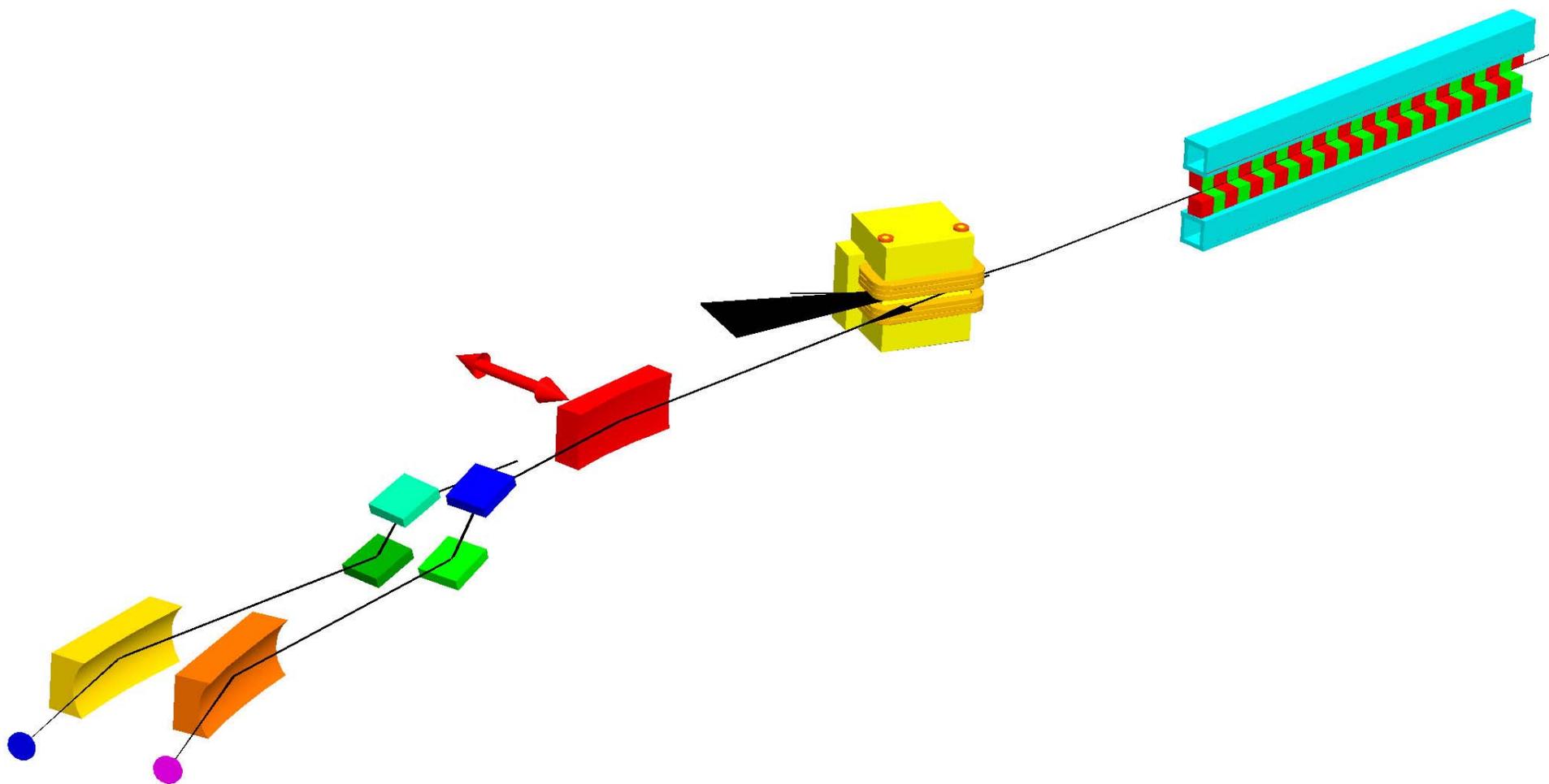
The new Switching Mirror Unit and its Mechanical Principles

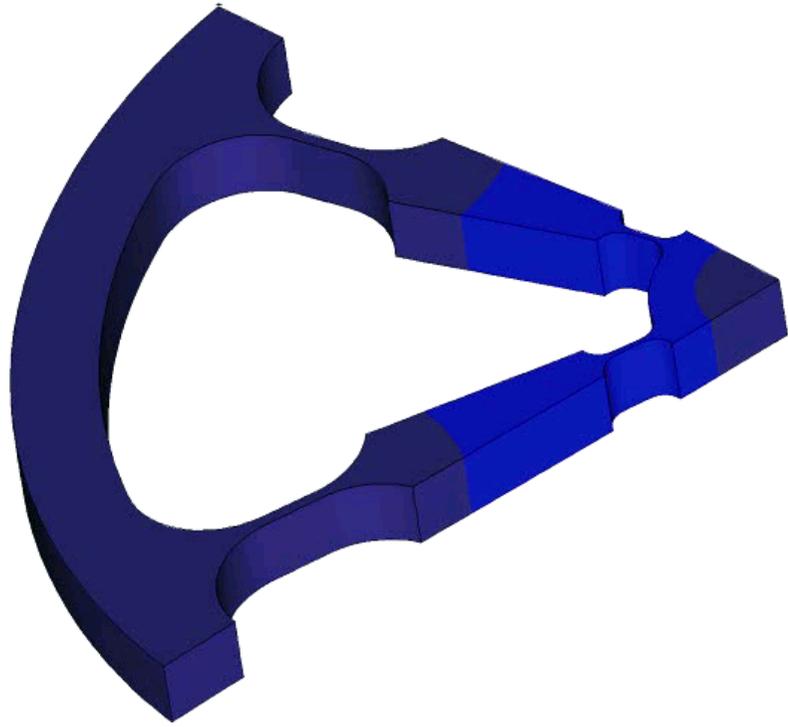
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Switching Mirror Unit (SMU)





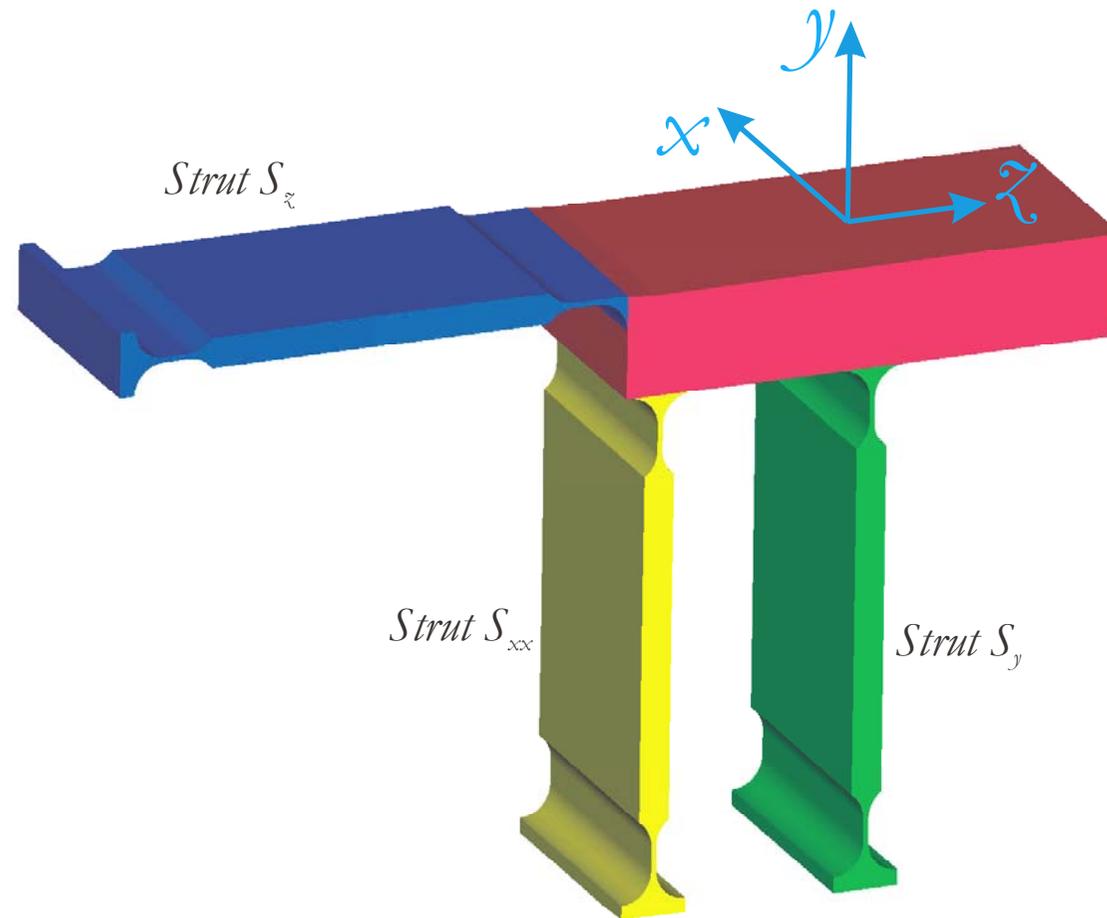
trapezoid strut
arrangement



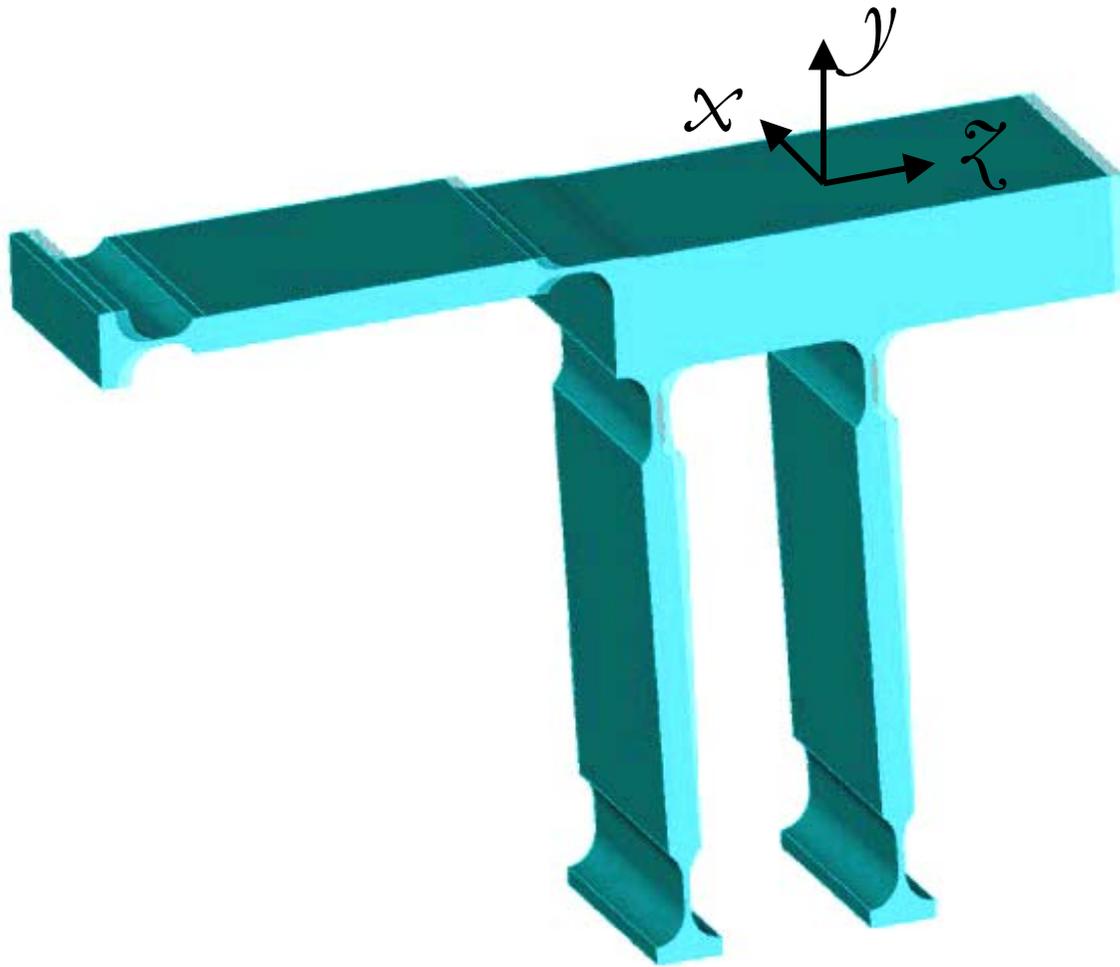
parallelogram
arrangement

combination of parallelogram and trapezoid

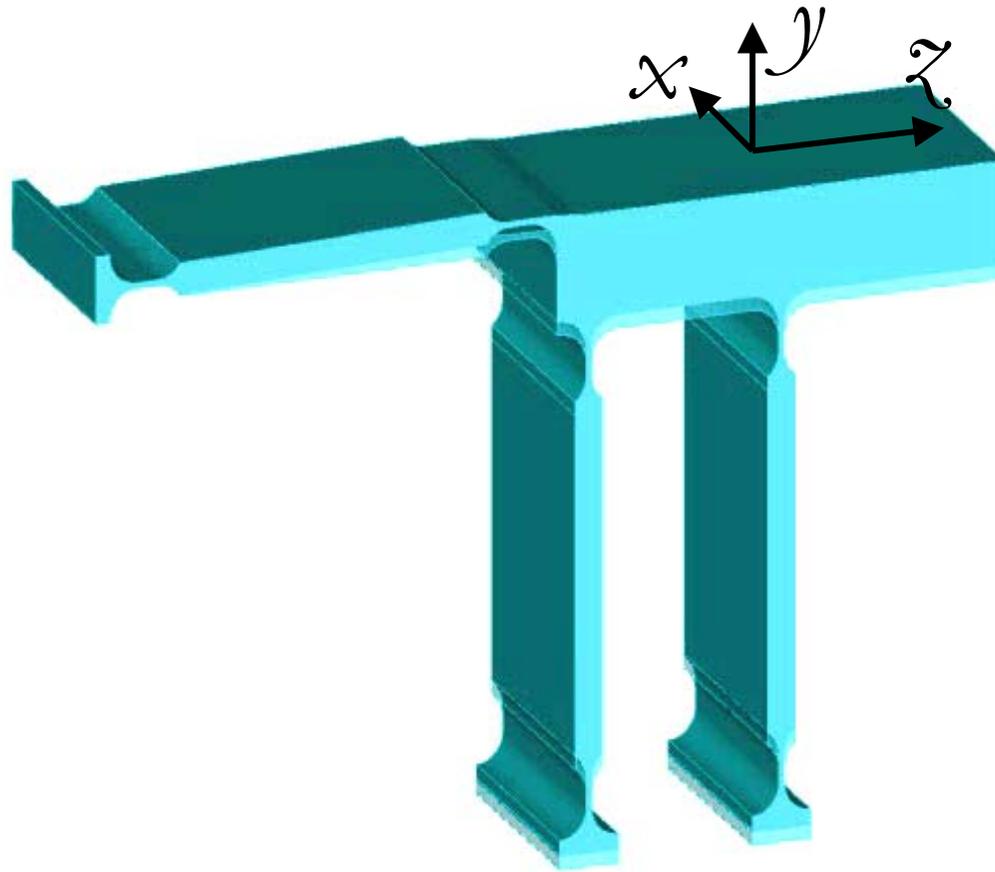
DOF = 3



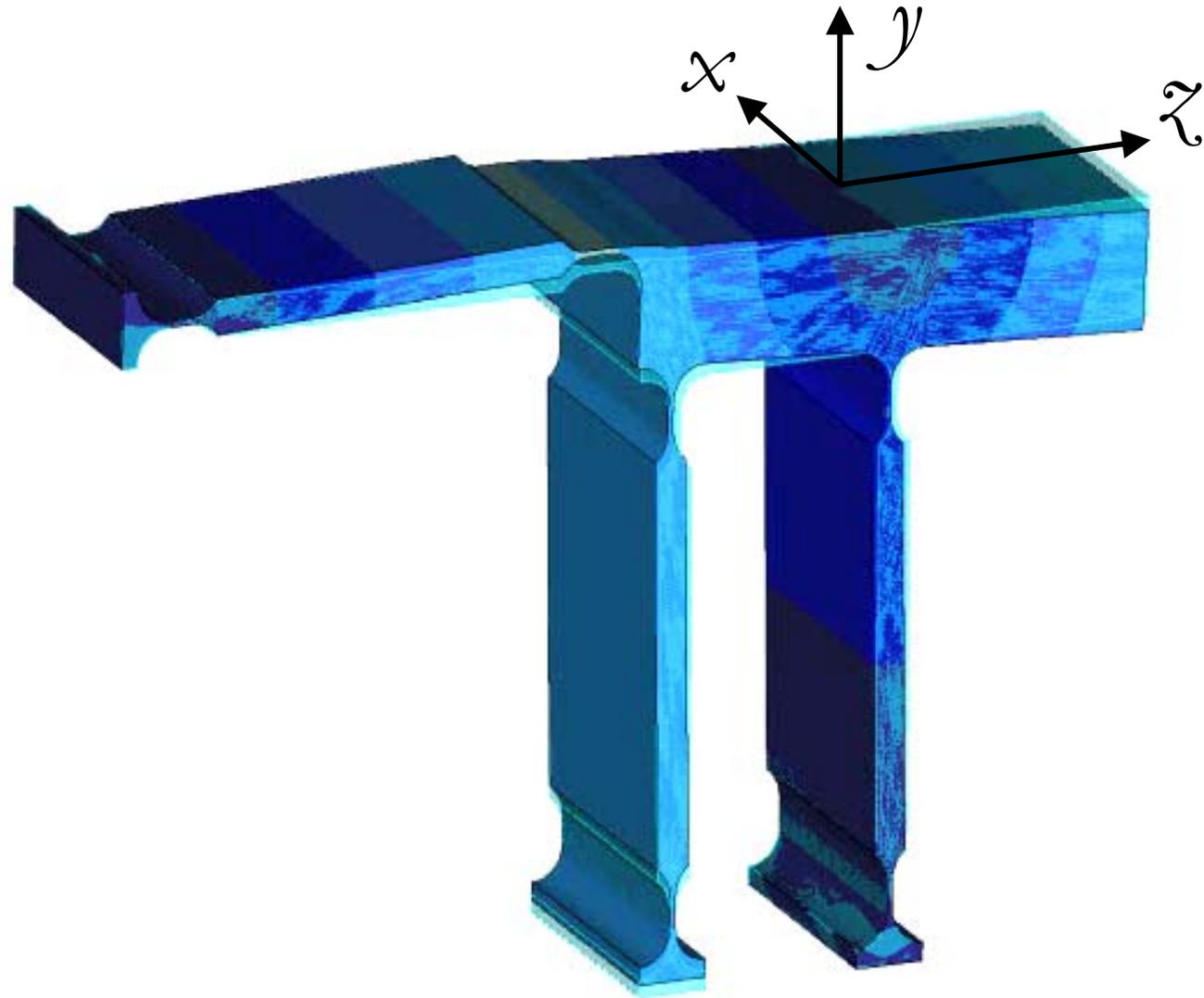
translation in Z-direction



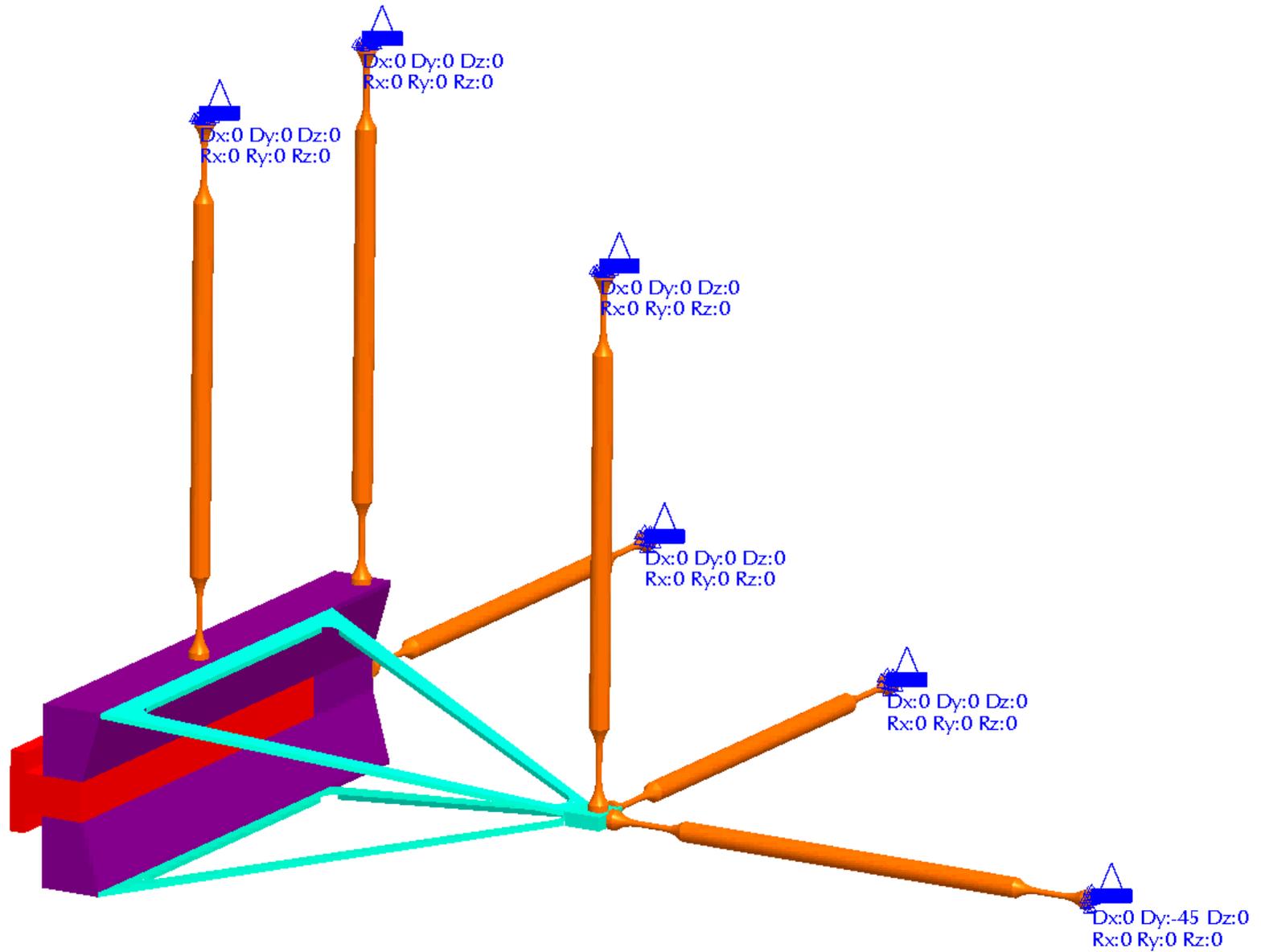
translation in Y-direction



rotation around X

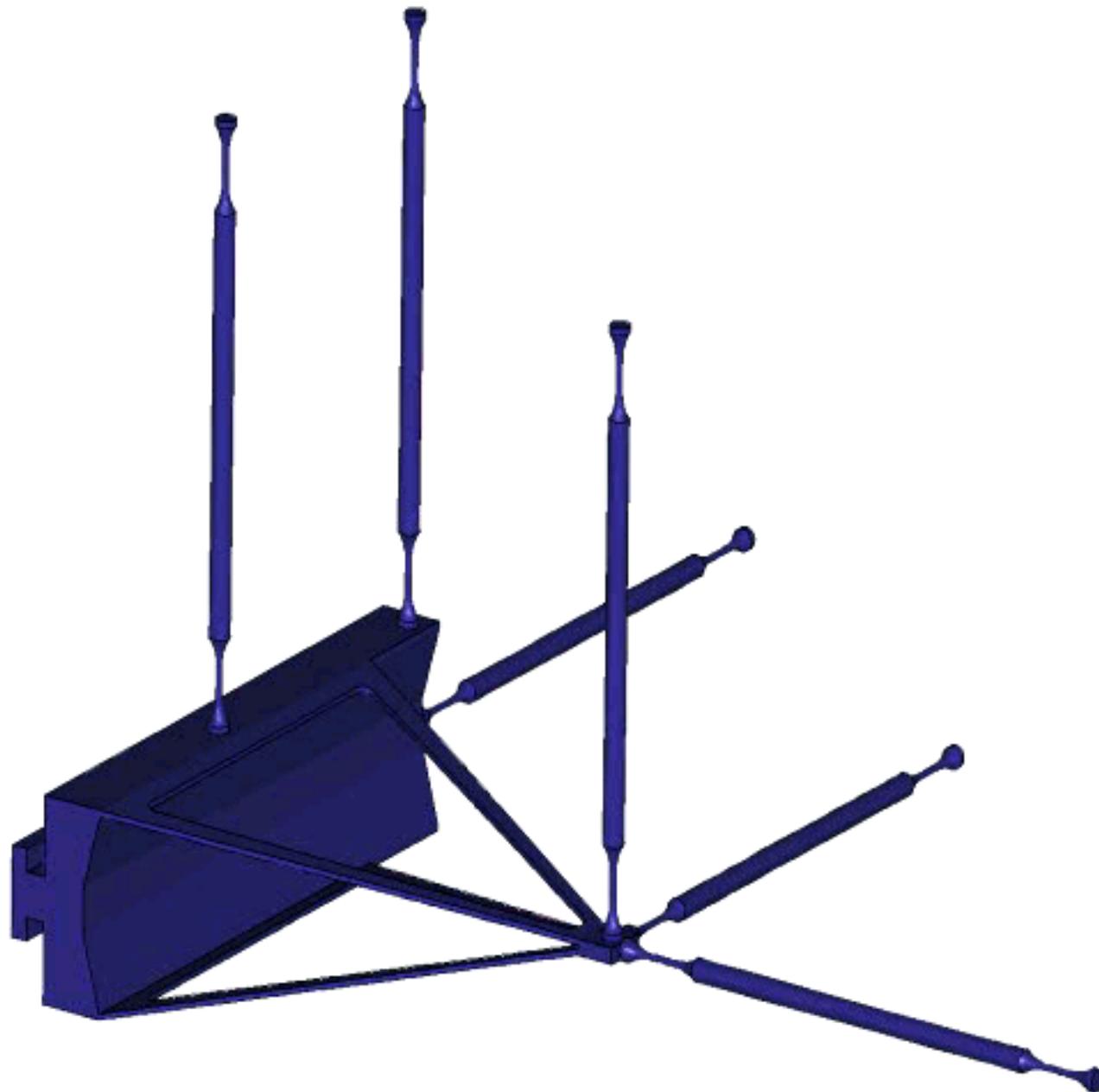


simulation model



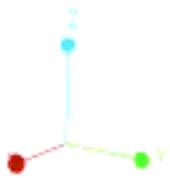
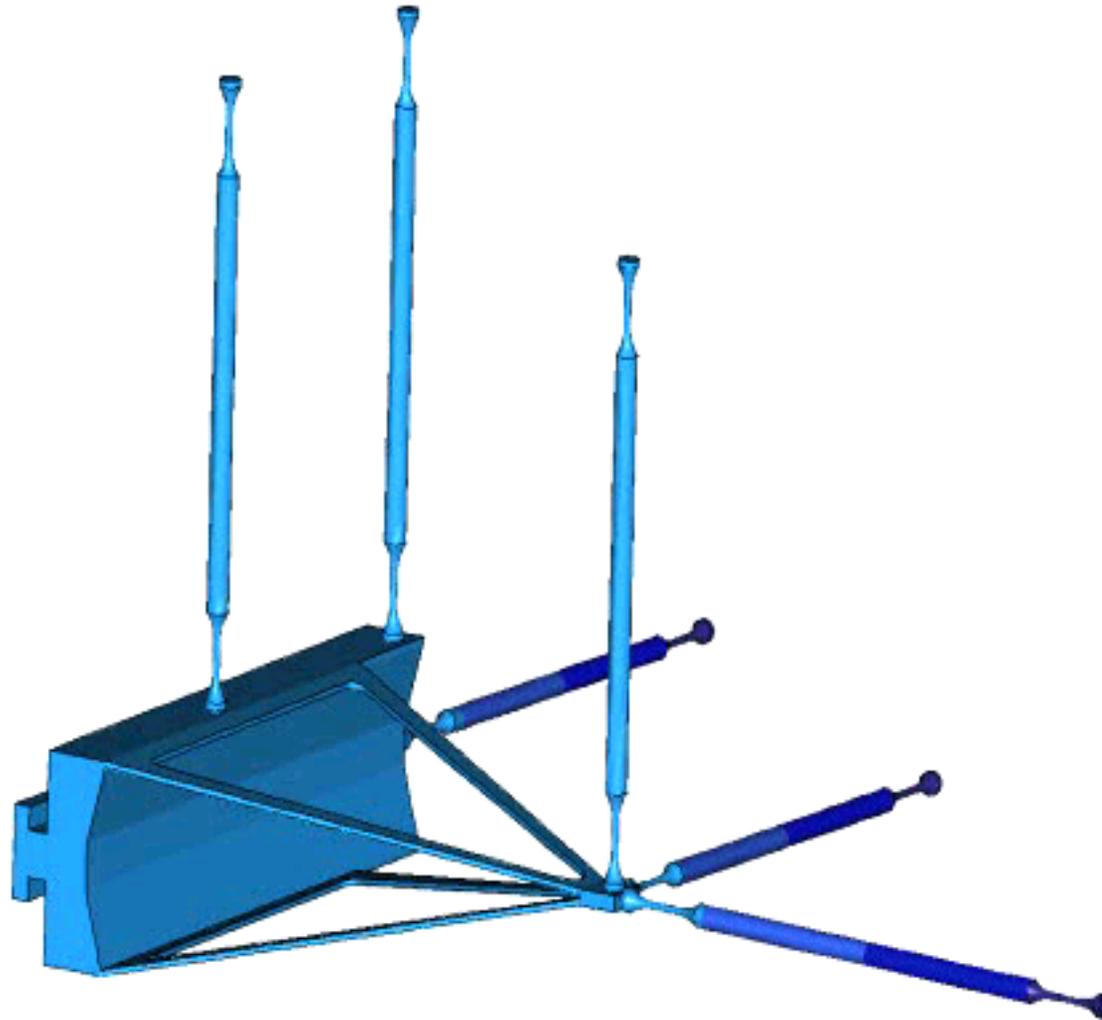
switch translation

Frame 2 of 36
Displacement Mag (WCS)
(mm)
Deformed
Max Disp +4.5328E+01
Scale 5.9742E-01



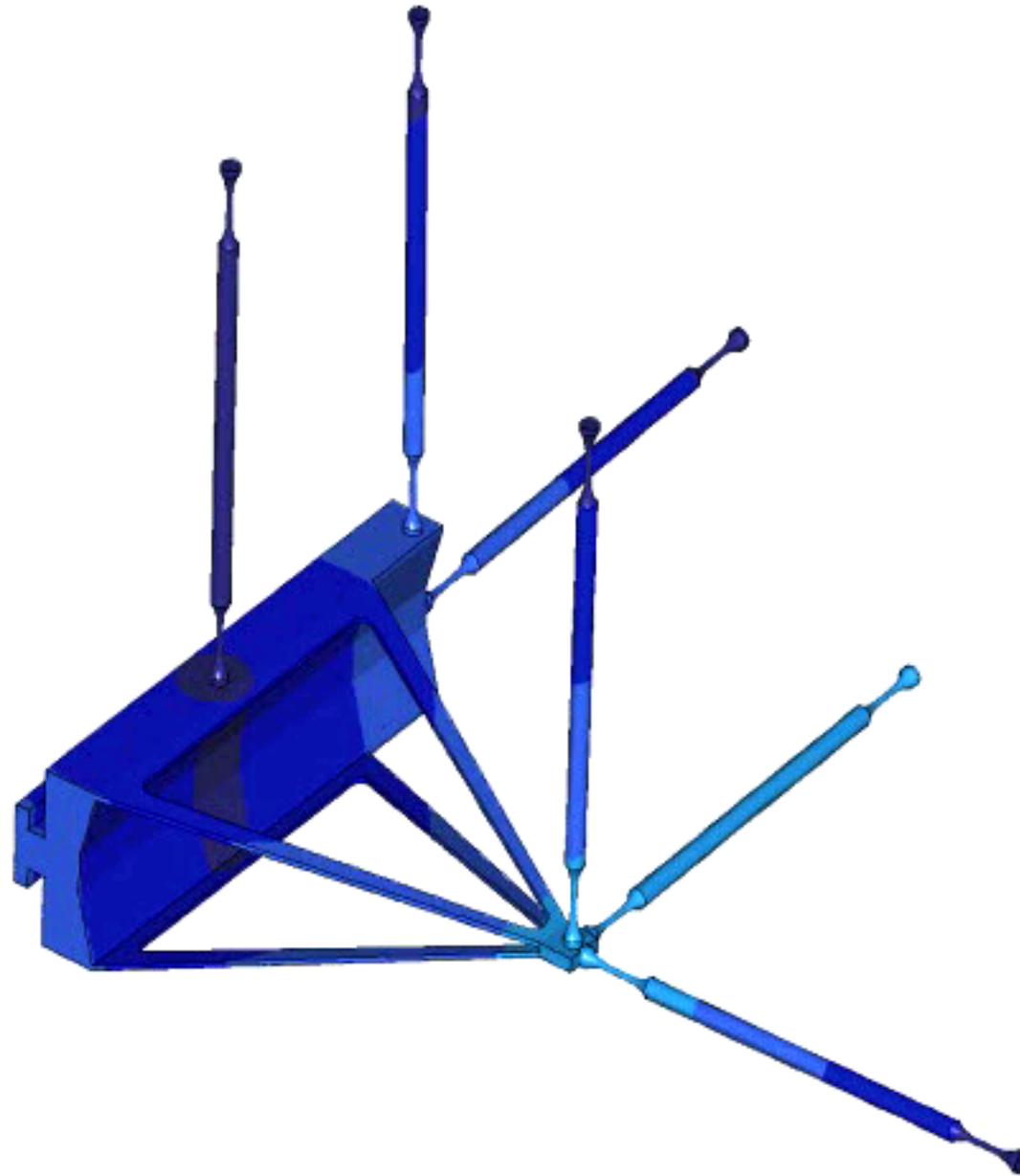
vertical translation

Frame 2 of 36
Displacement Mag (WCS)
(mm)
Deformed
Max Disp +2.0830E+01
Scale 1.3000E+00



angle of incidence

Frame 2 of 36
Displacement Mag (WCS)
(mm)
Deformed
Max Disp +2.1809E+01
Scale 1.2534E+00

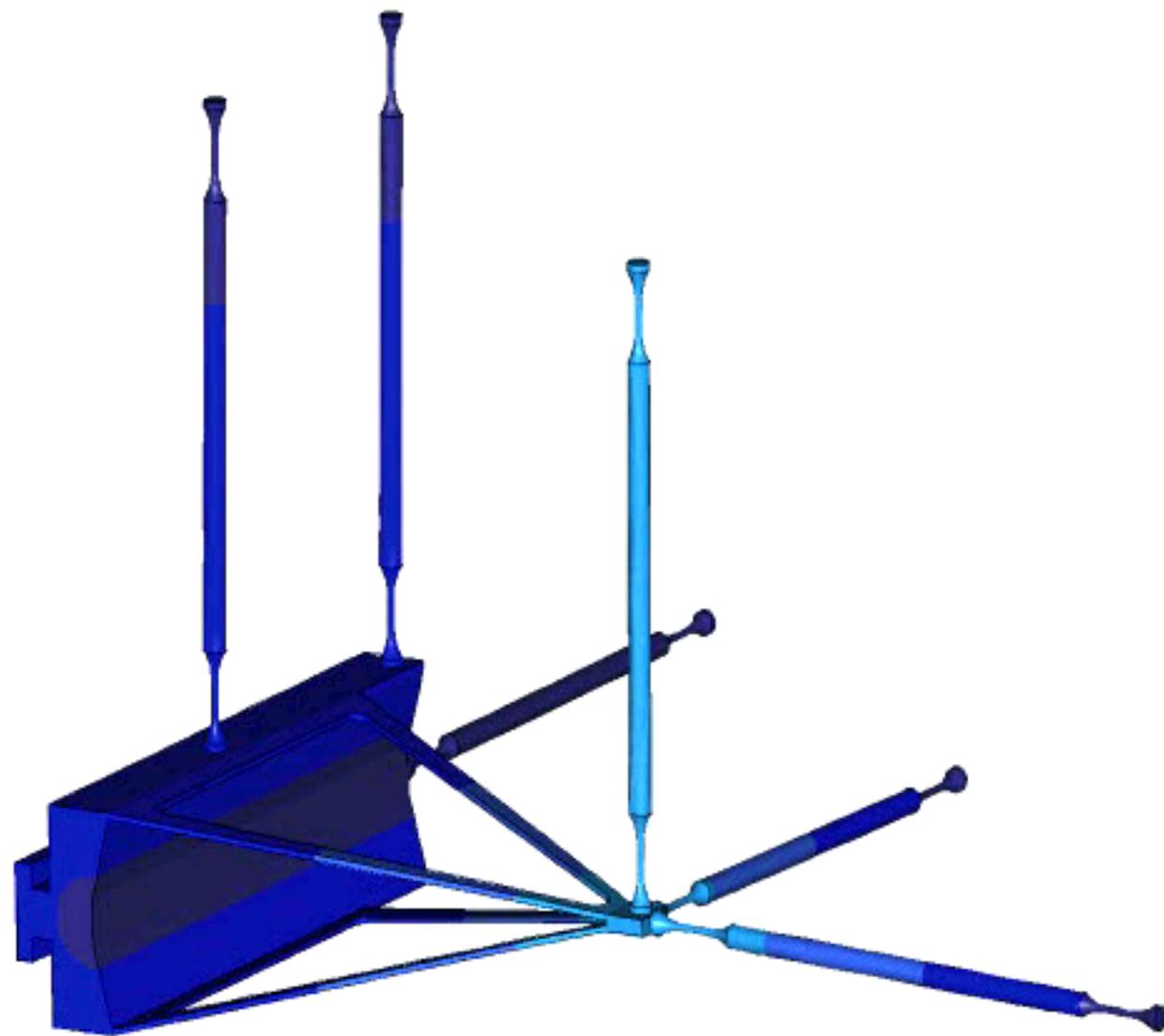


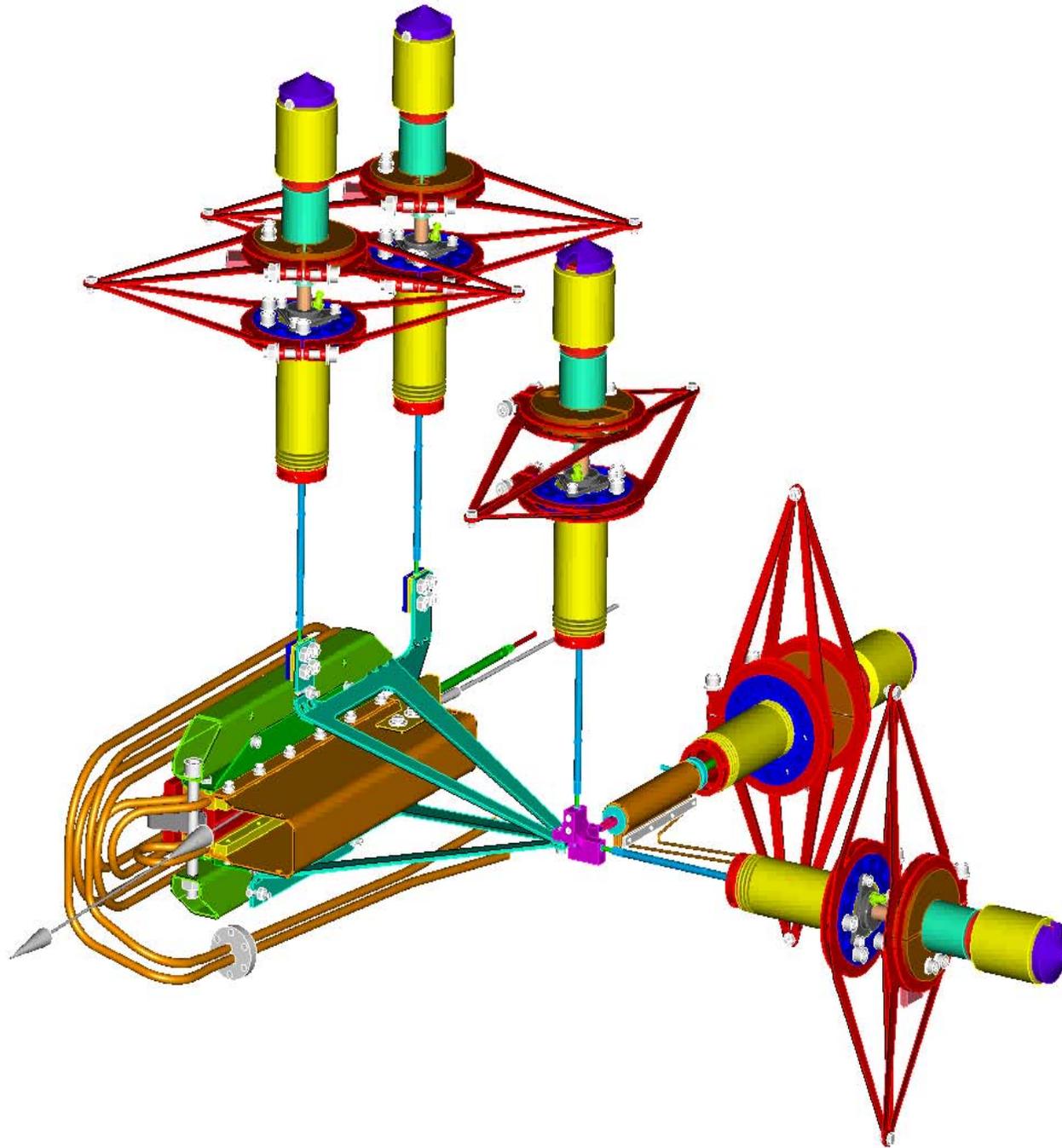
rotation around the mirror normal axis

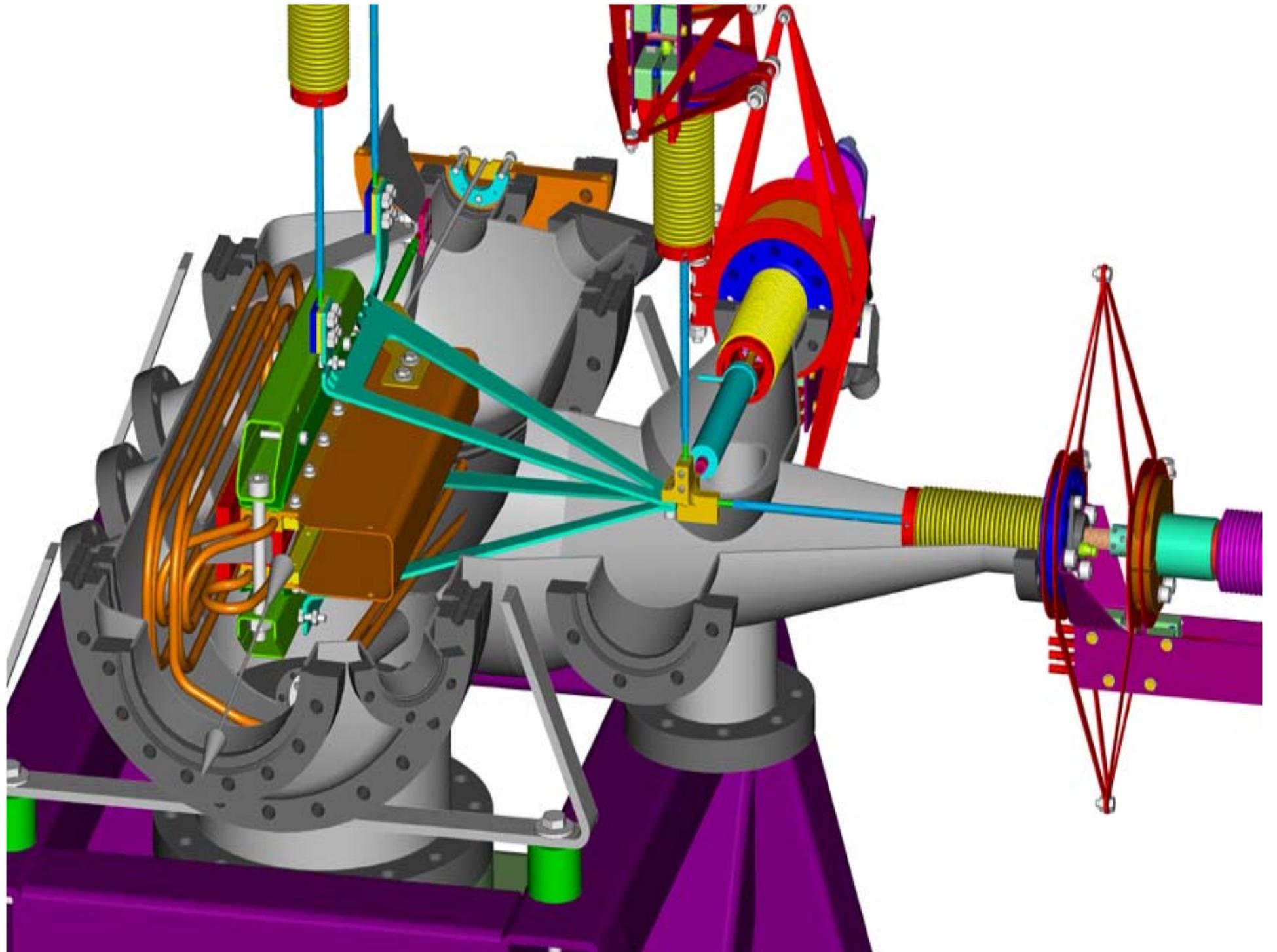
Frame 2 of 36
Displacement Mag (WCS)
(mm)
Deformed
Max Disp +2.3642E+01
Scale 1.1597E+00



Frame 2 of 36
Displacement Mag (WCS)
(mm)
Deformed
Max Disp +2.0816E+01
Scale 1.3009E+00

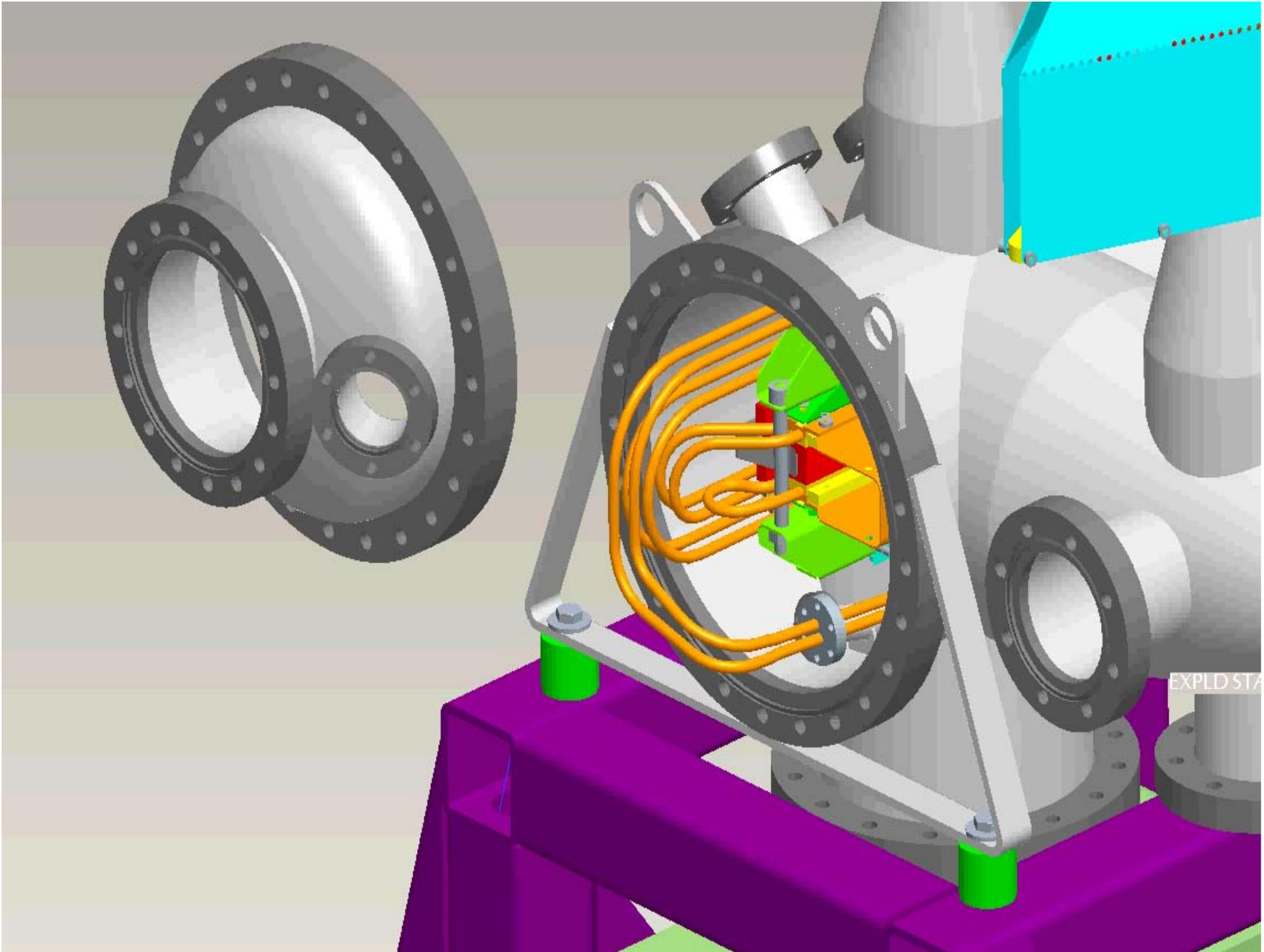


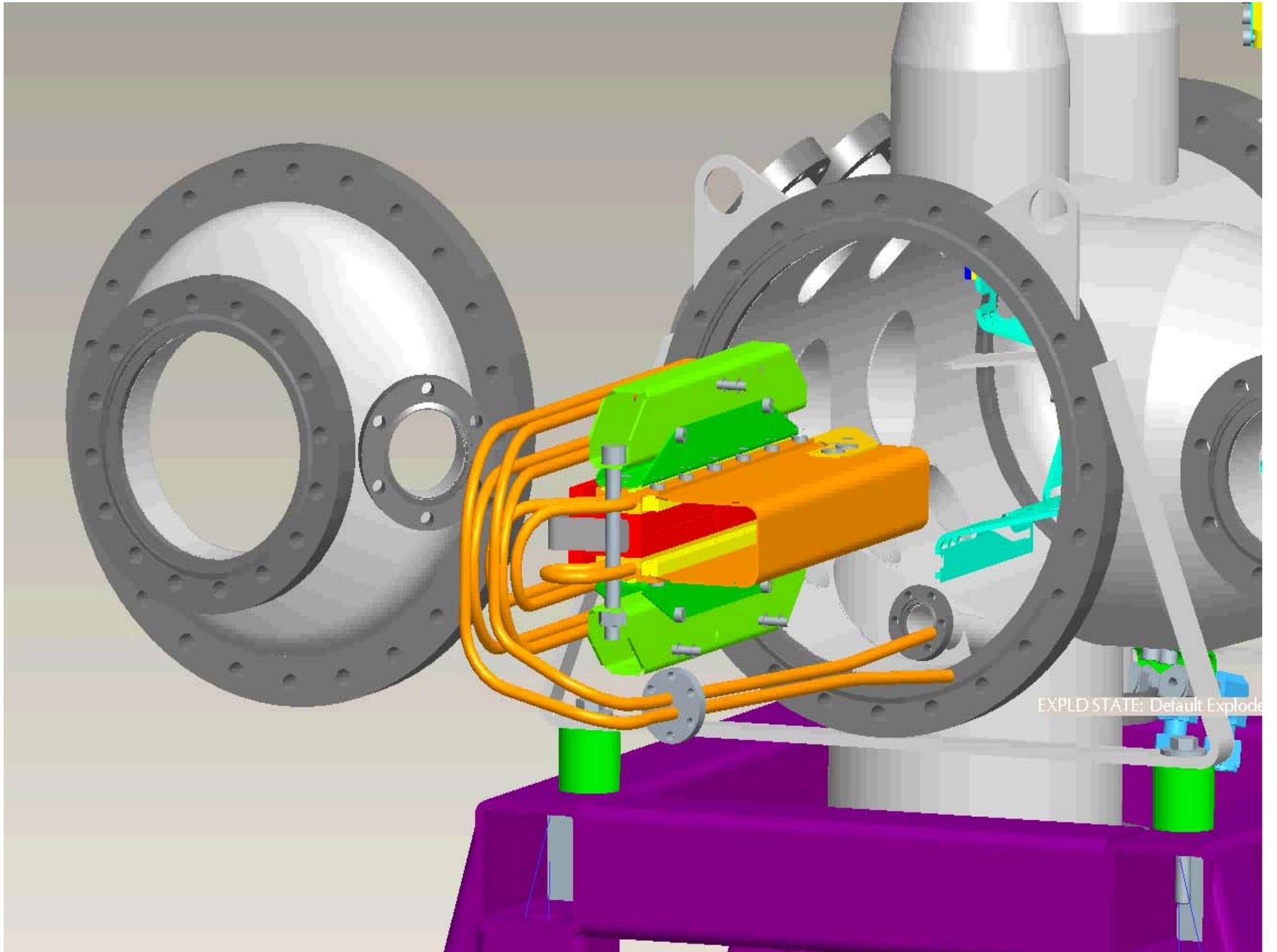




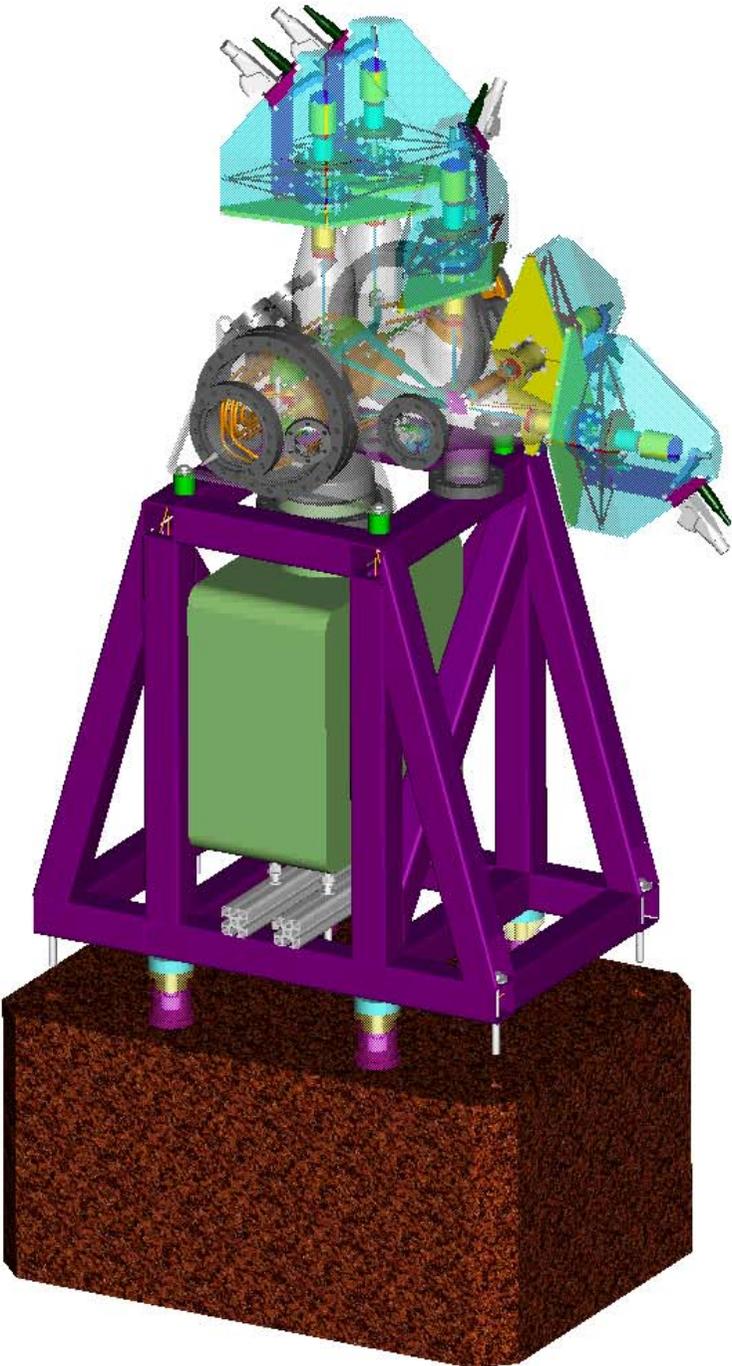
Frame 2 of 20
Displacement Mag (WCS)
(mm)
Deformed
Max Disp +1.0000E+00
Scale 1.1500E+01
Loadset:Mode 1, +2.1844E+02

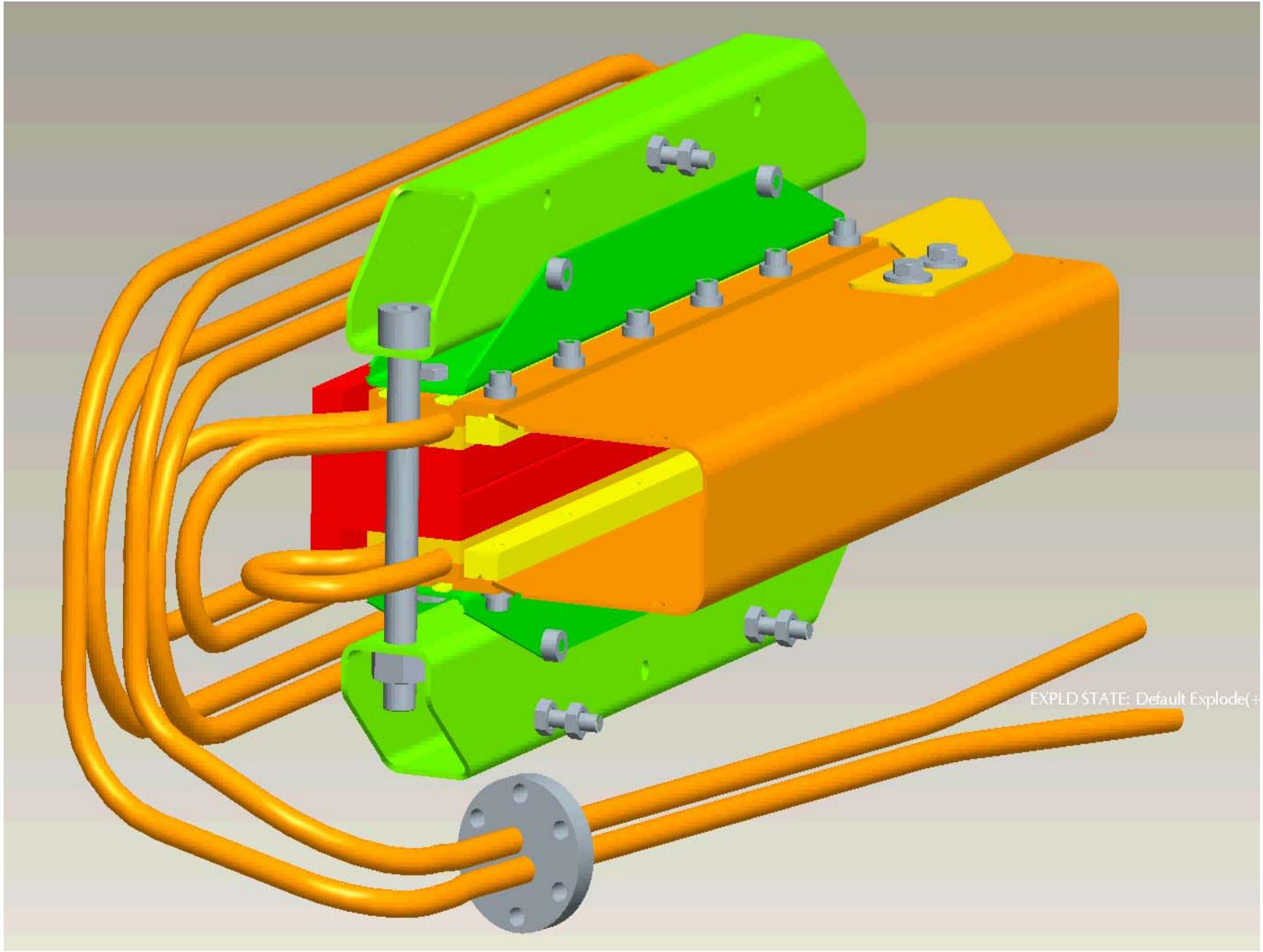




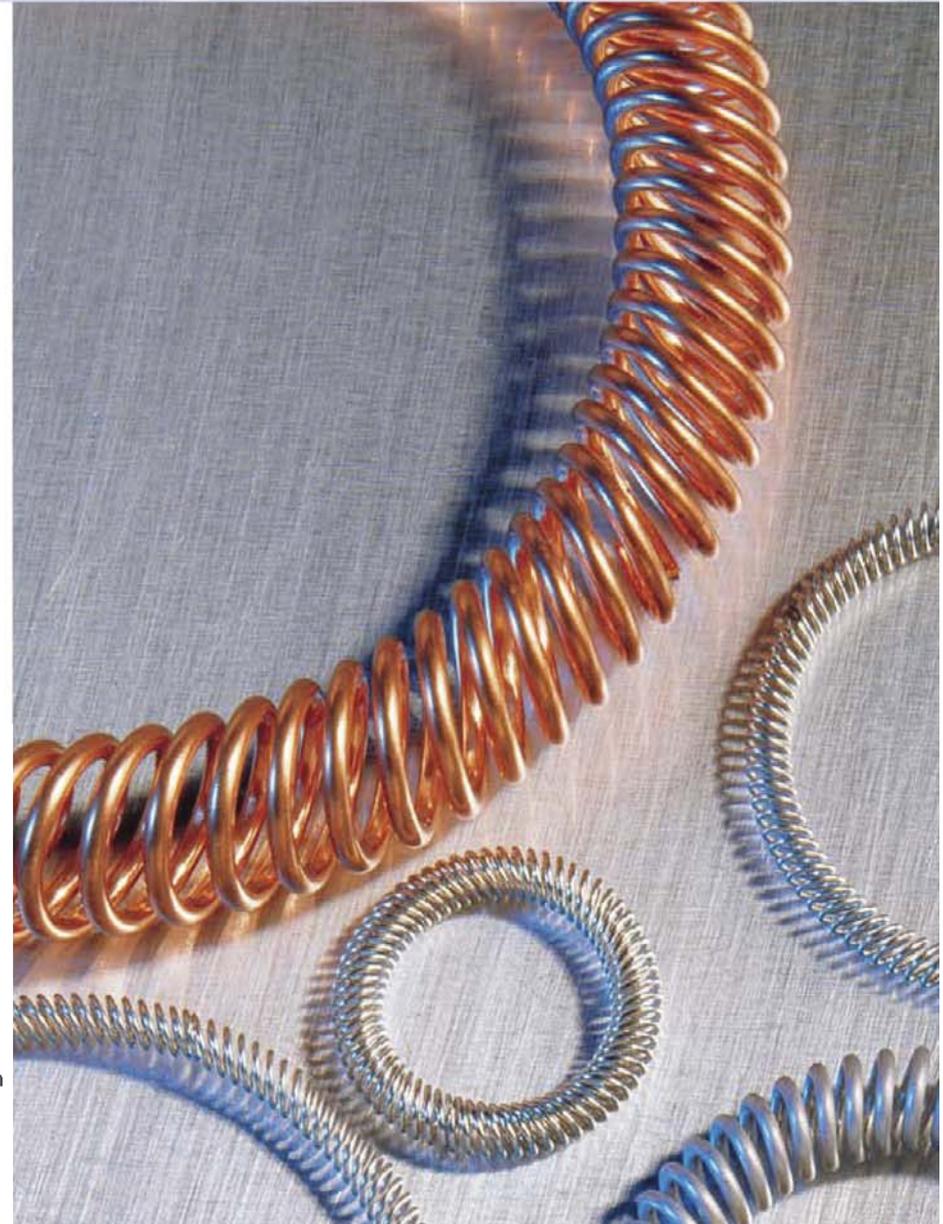
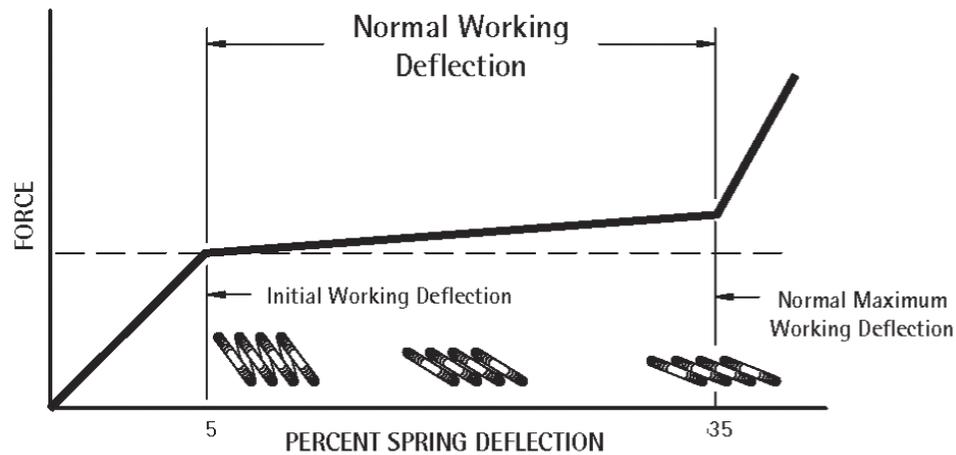
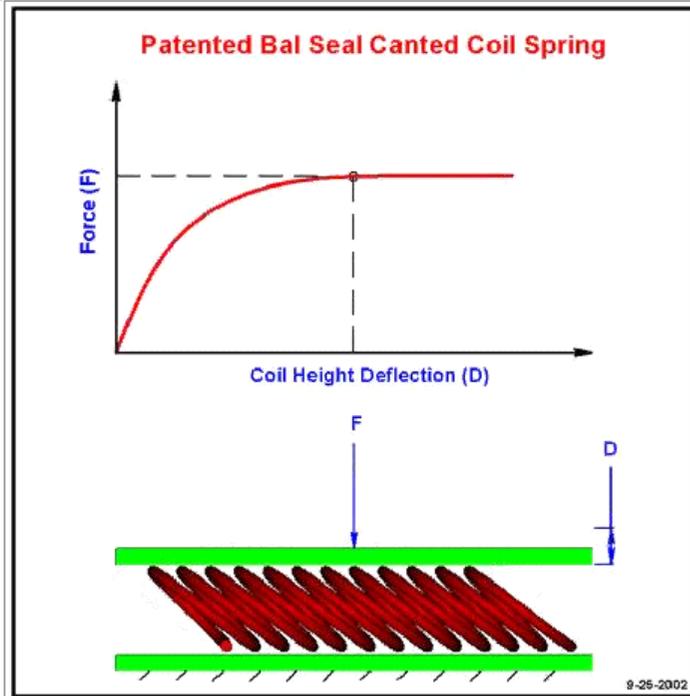


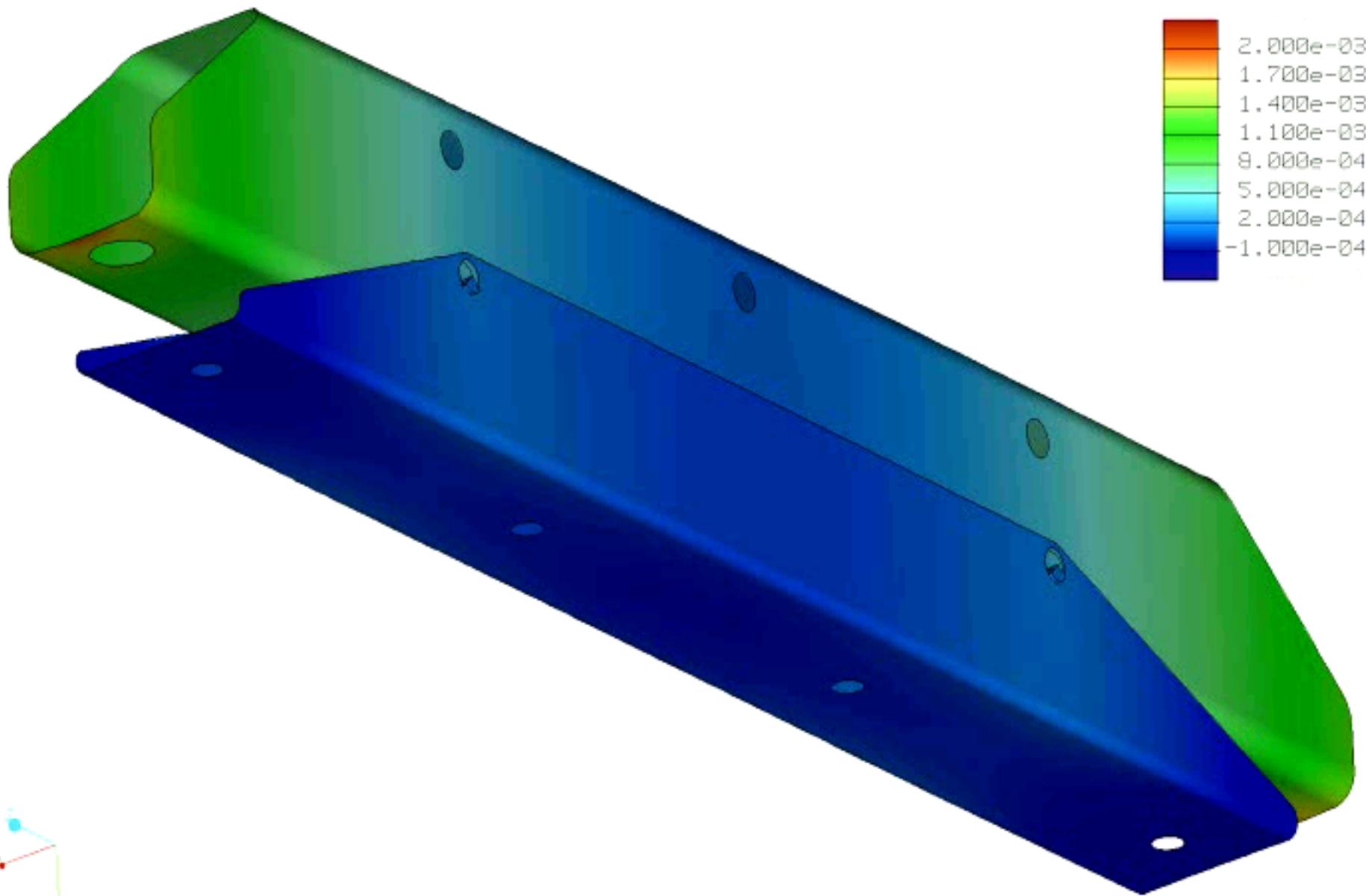
EXPLD STATE: Default Explode

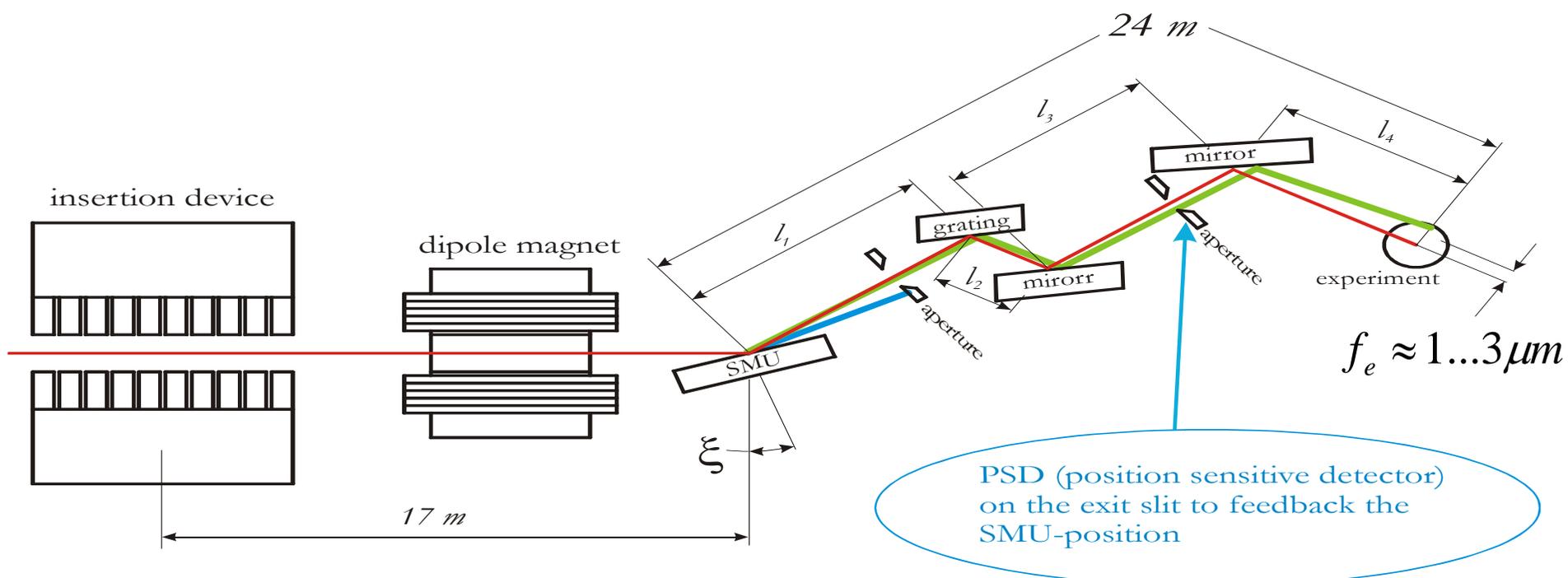


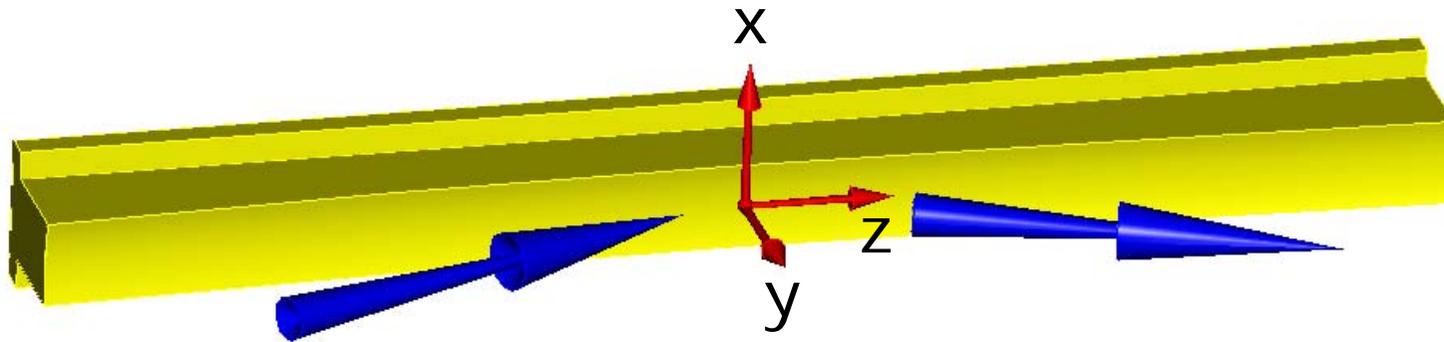


EXPLD STATE: Default Explode(+)









requirements on the mirror movements

	stroke	reproducibility	full step resolution
rotation X	5 °	10 nrad	10 nrad
translation X	20 mm	0.1 μm	0.01 μm
rotation Y	5 °	50 μrad	0.05 μrad
translation Y	50 mm	5 μm	1.5 μm
rotation Z	5 °	0.2 μrad	0.03 μrad
translation Z	-	-	-