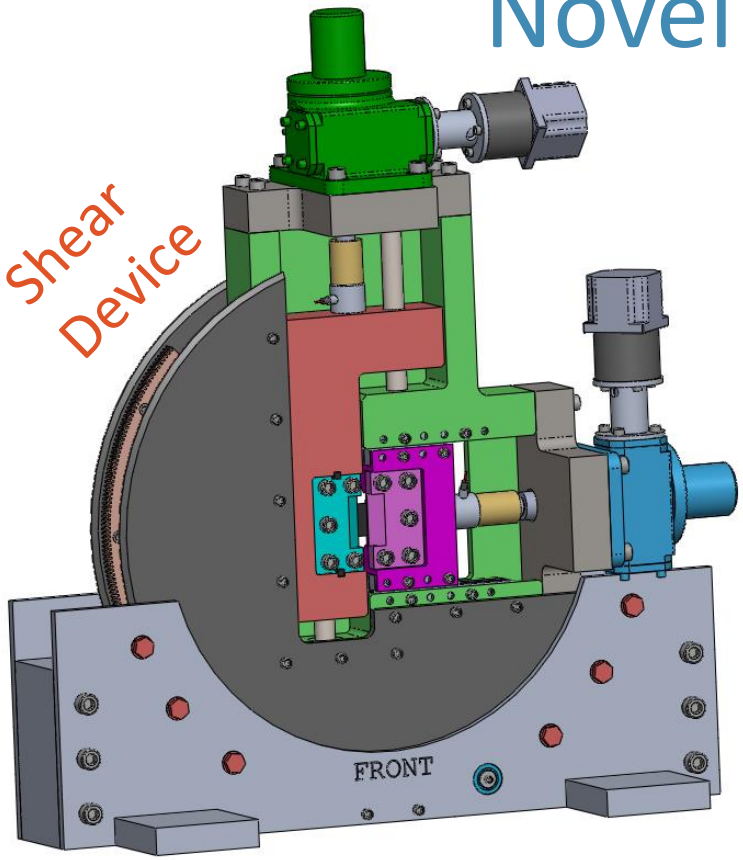
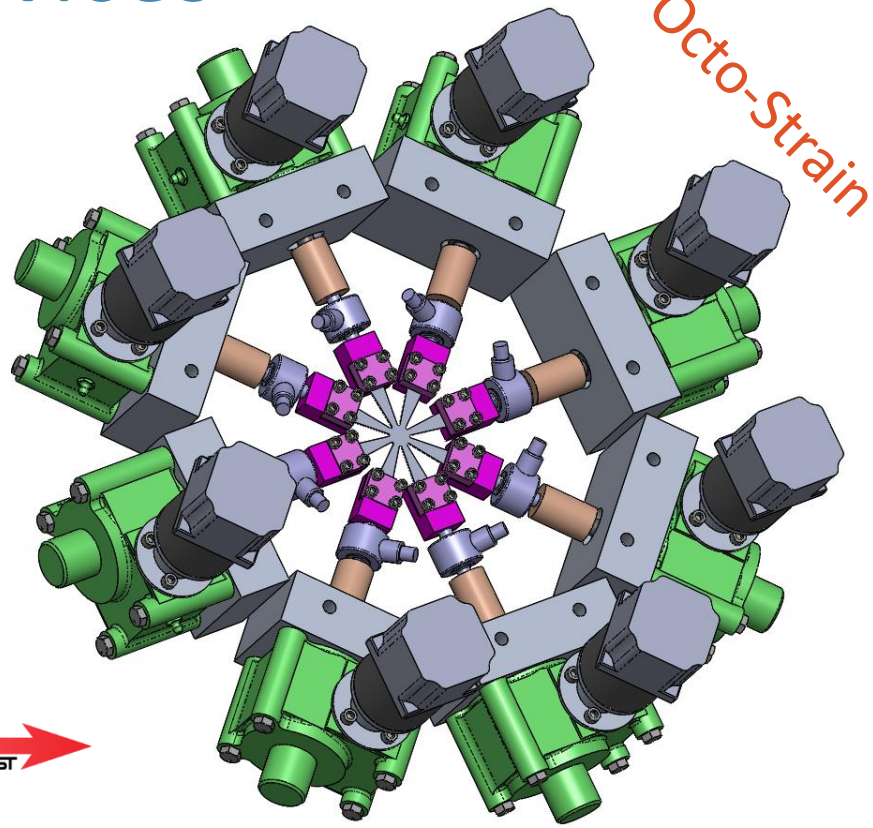
Super Sheet Metal Stressing

The Stimulating Design Process of Two Novel Straining Devices

Shear Device



Octo-Strain

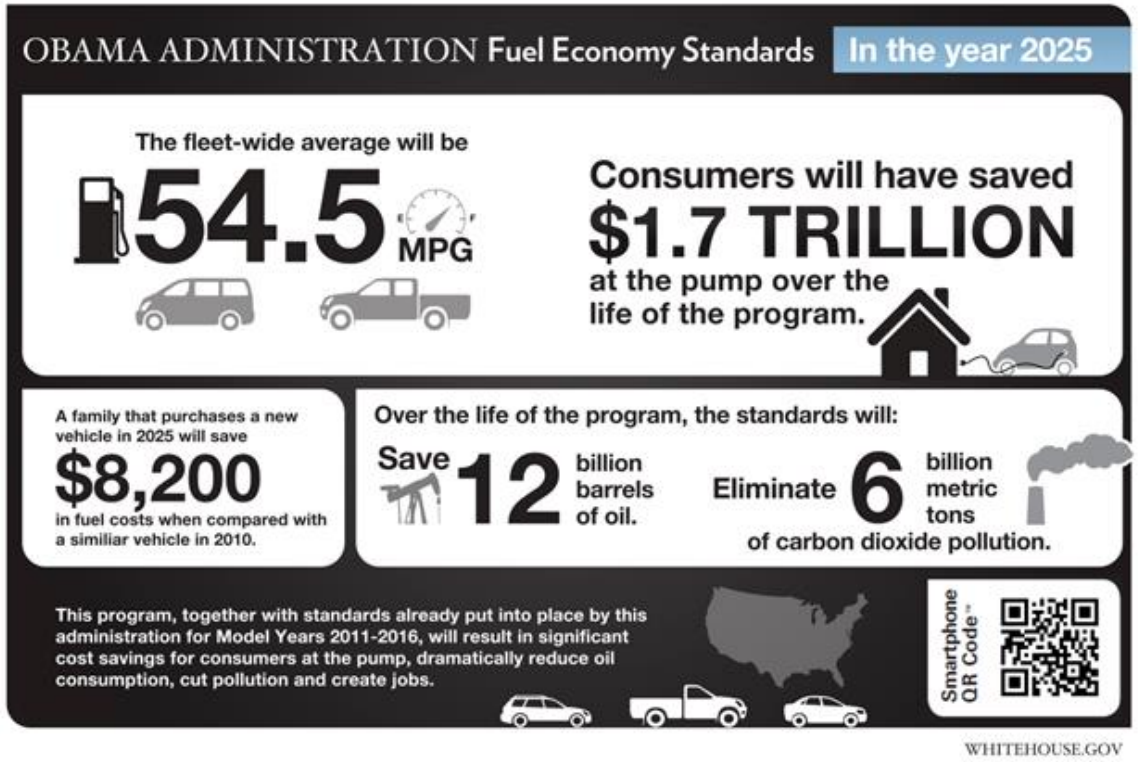


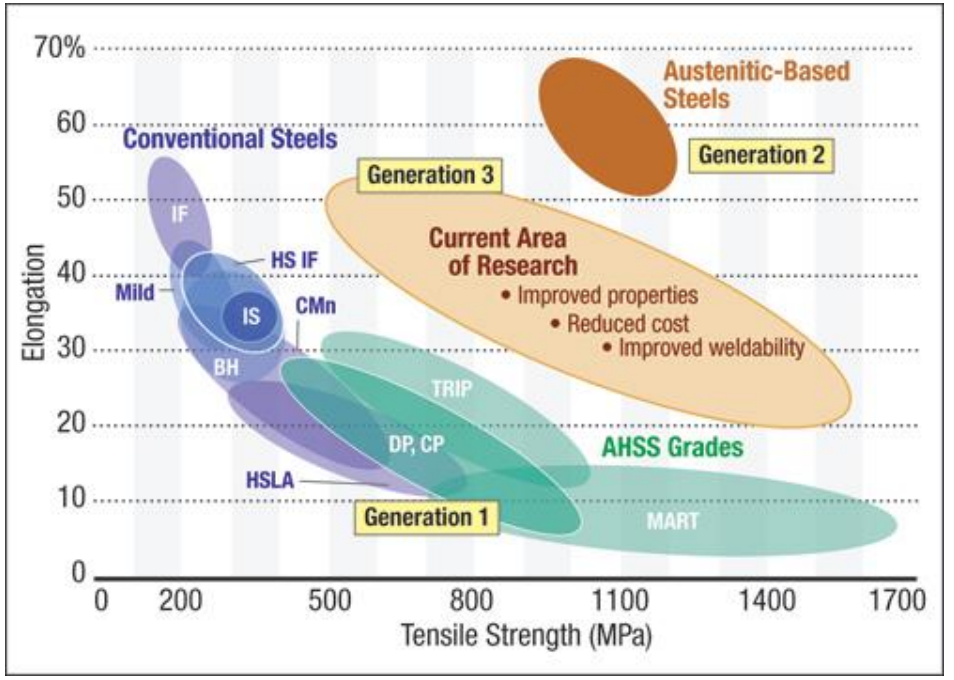
National Institute of Standards and Technology
U.S. Department of Commerce

Scott Jiawei Hallock, Thomas Gnaeupel-Herold

Motivation

- Corporate Average Fuel Economy (CAFE) Regulations
- Automotive lightweighting ➔ improved fuel economy

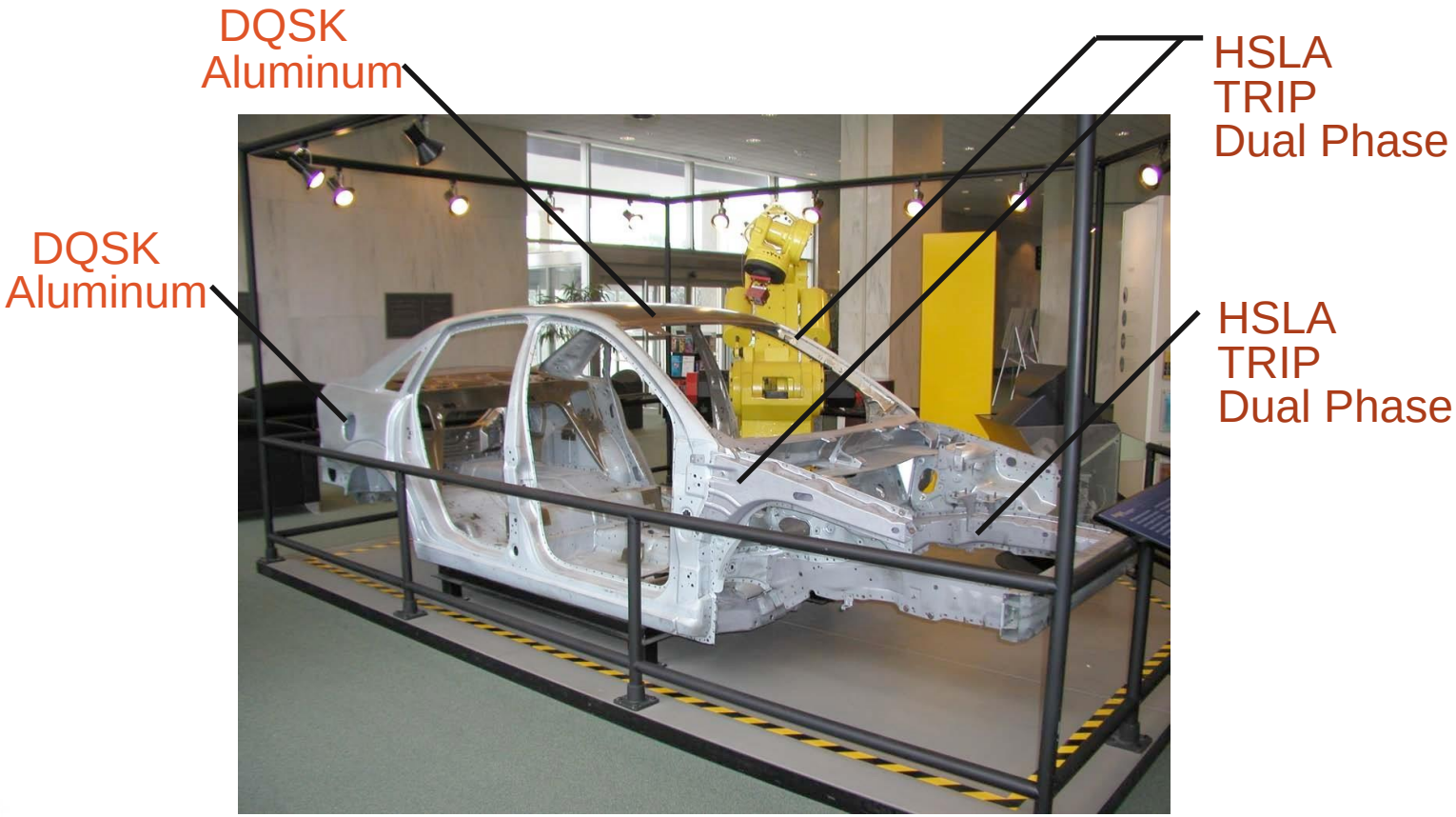




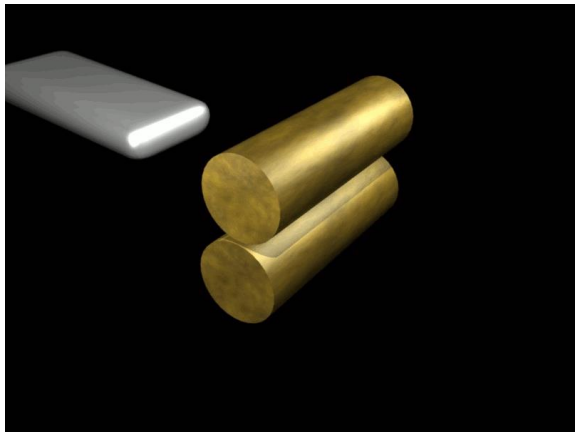
Courtesy of WorldAutoSteel

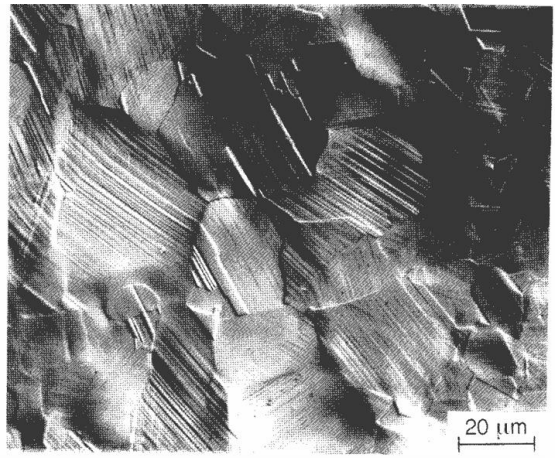
Automotive Sheet Metals

- Improve the predictability of forming outcomes
- Need for mechanical data on samples under different strain conditions
- Desire for stronger/thinner sheet metals

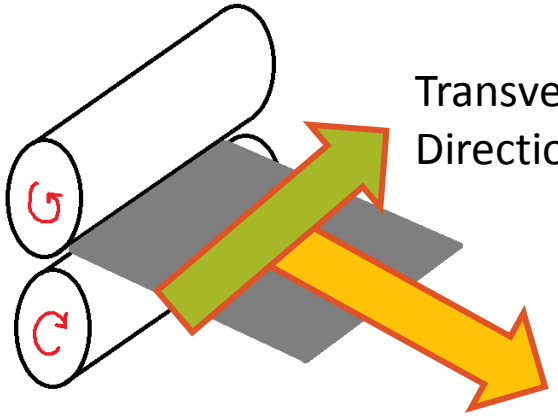


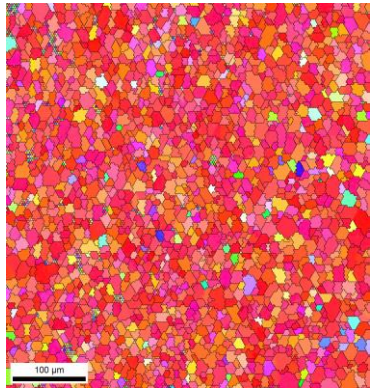
Cold Rolling → Grain Slipping → Preferred Orientation (Texture) → *Mechanical Anisotropy*



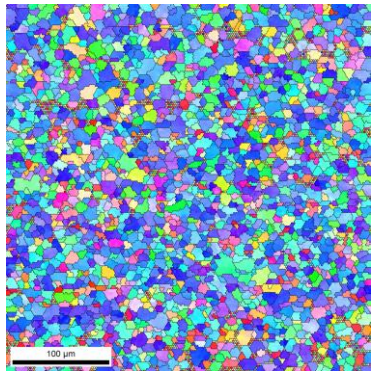


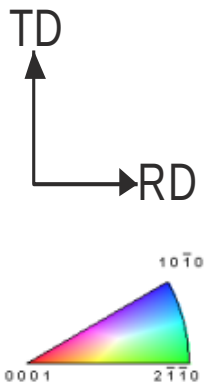
Cobalt-Nickel Alloy

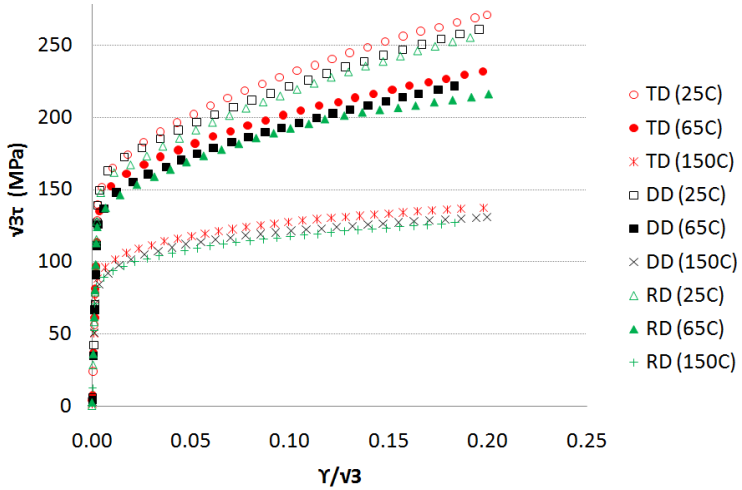




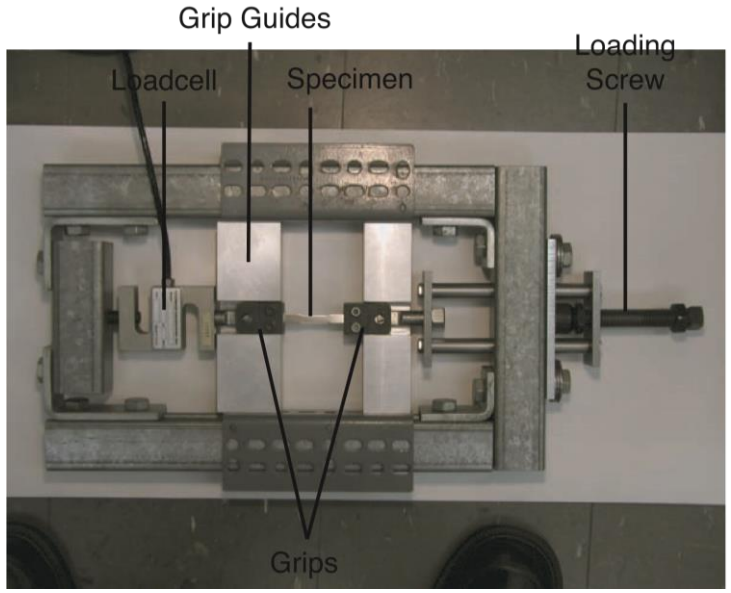
DEFORMATION





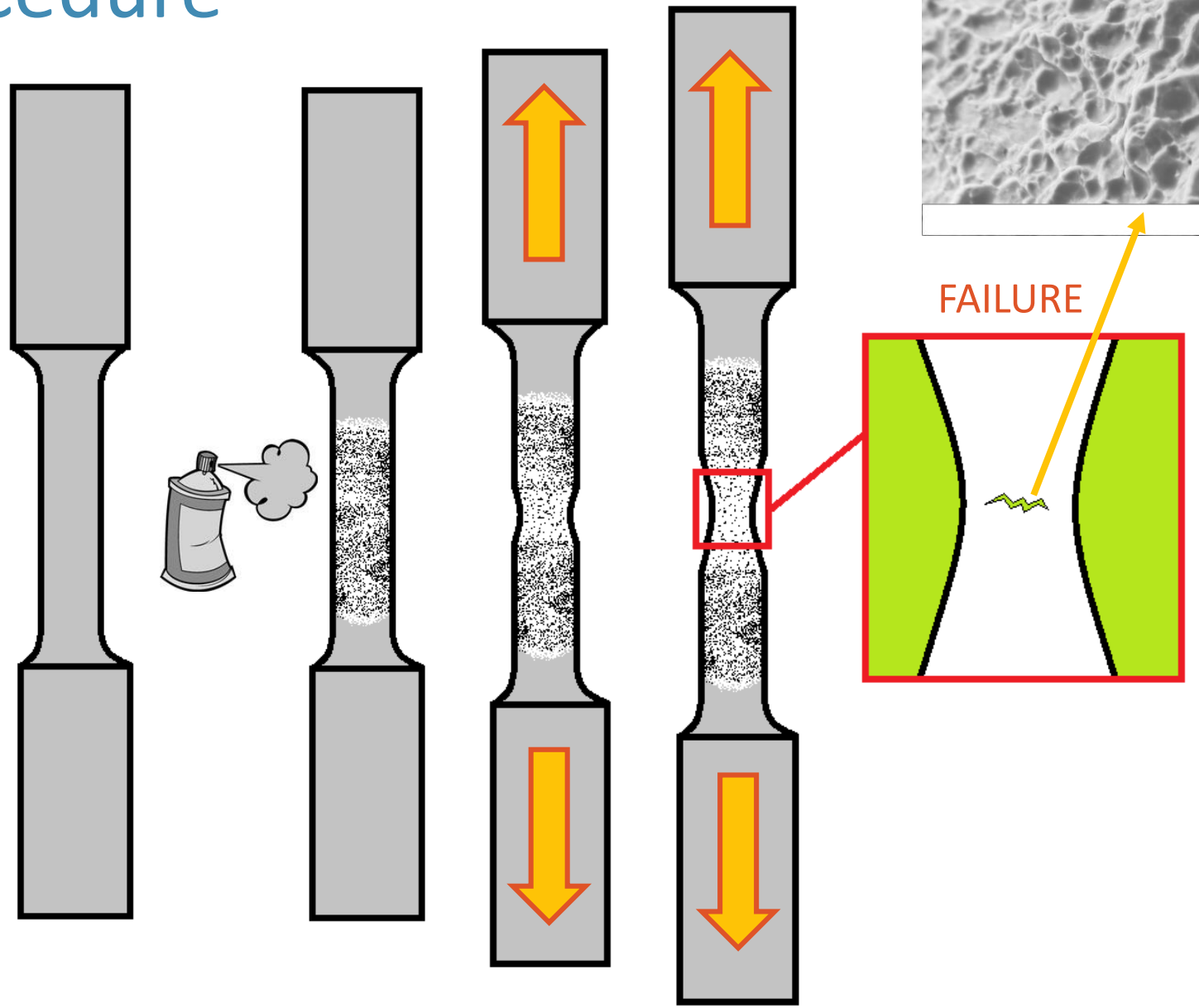


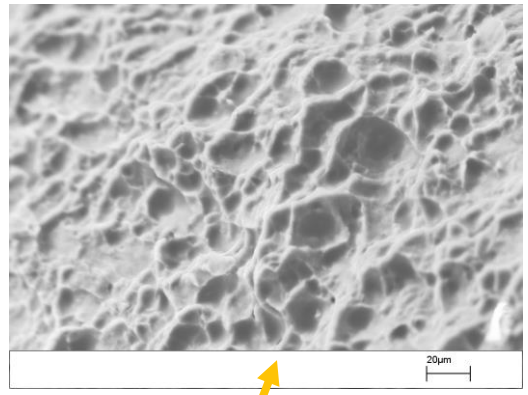
Simple Testing Procedure



Uniaxial Tester

- Load Cell to measure stress
- Digital Image Correlation to measure strain

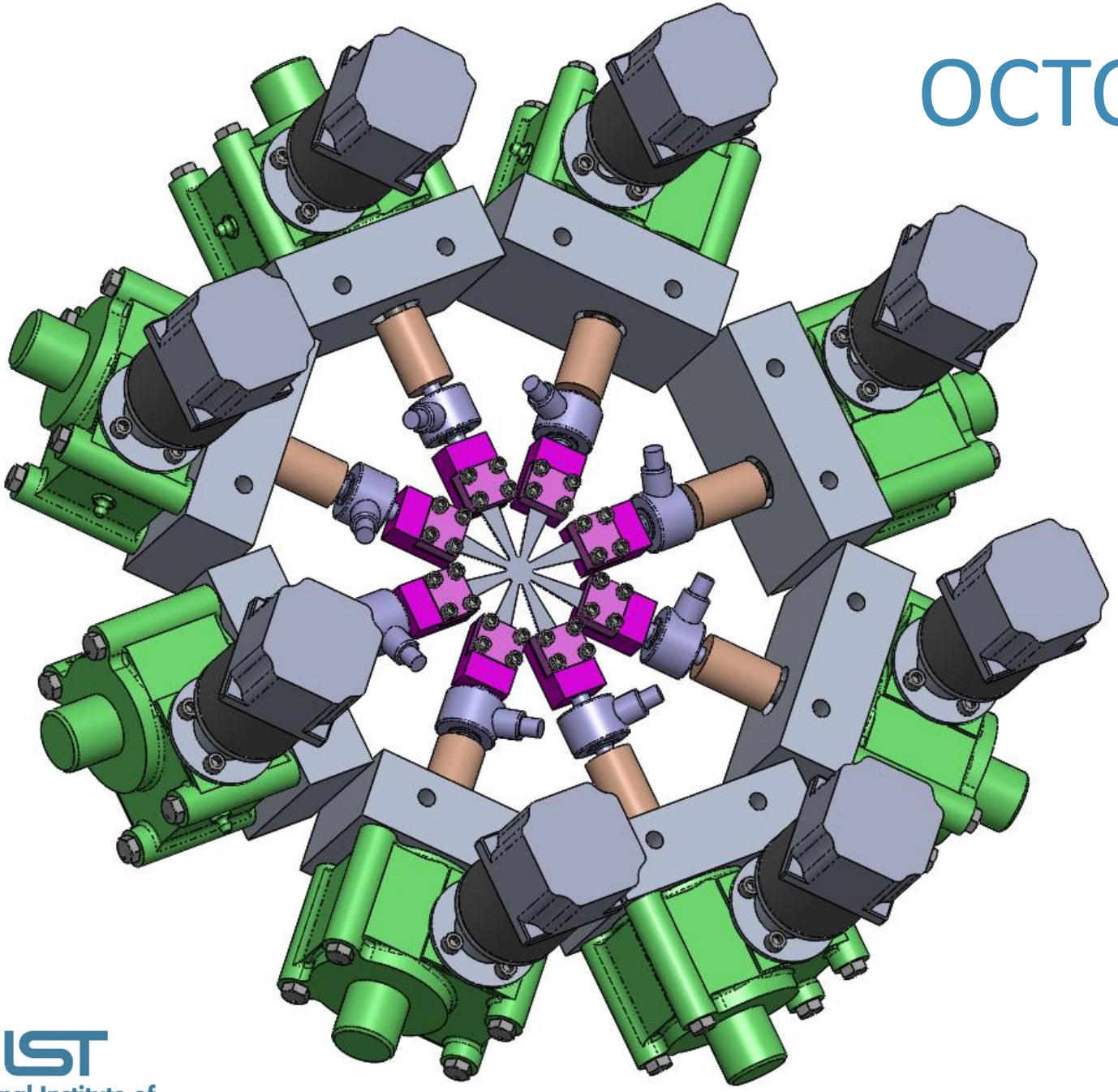


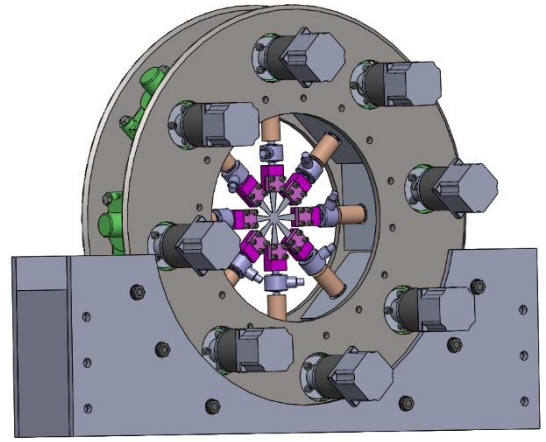


Why Neutron Diffraction?

- Limitations of X-Ray Diffraction and load cells
- Ability to measure strain differential of sample
- Size constraints

OCTO-STRAIN

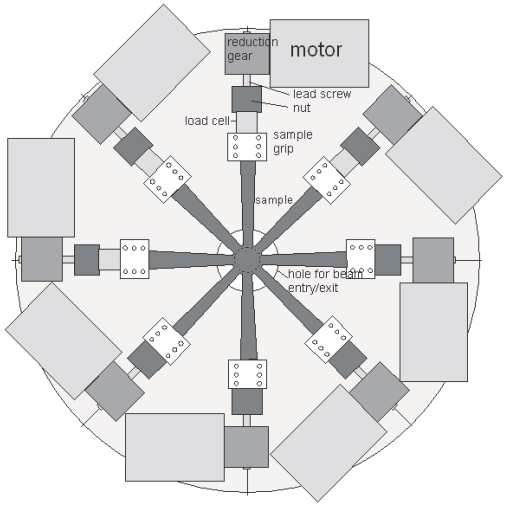




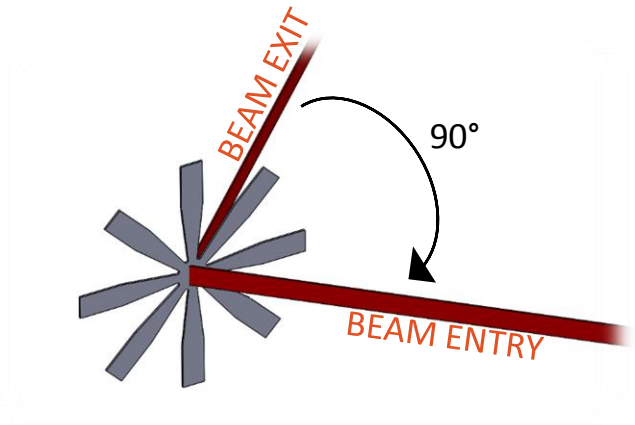
CAPABILITIES:

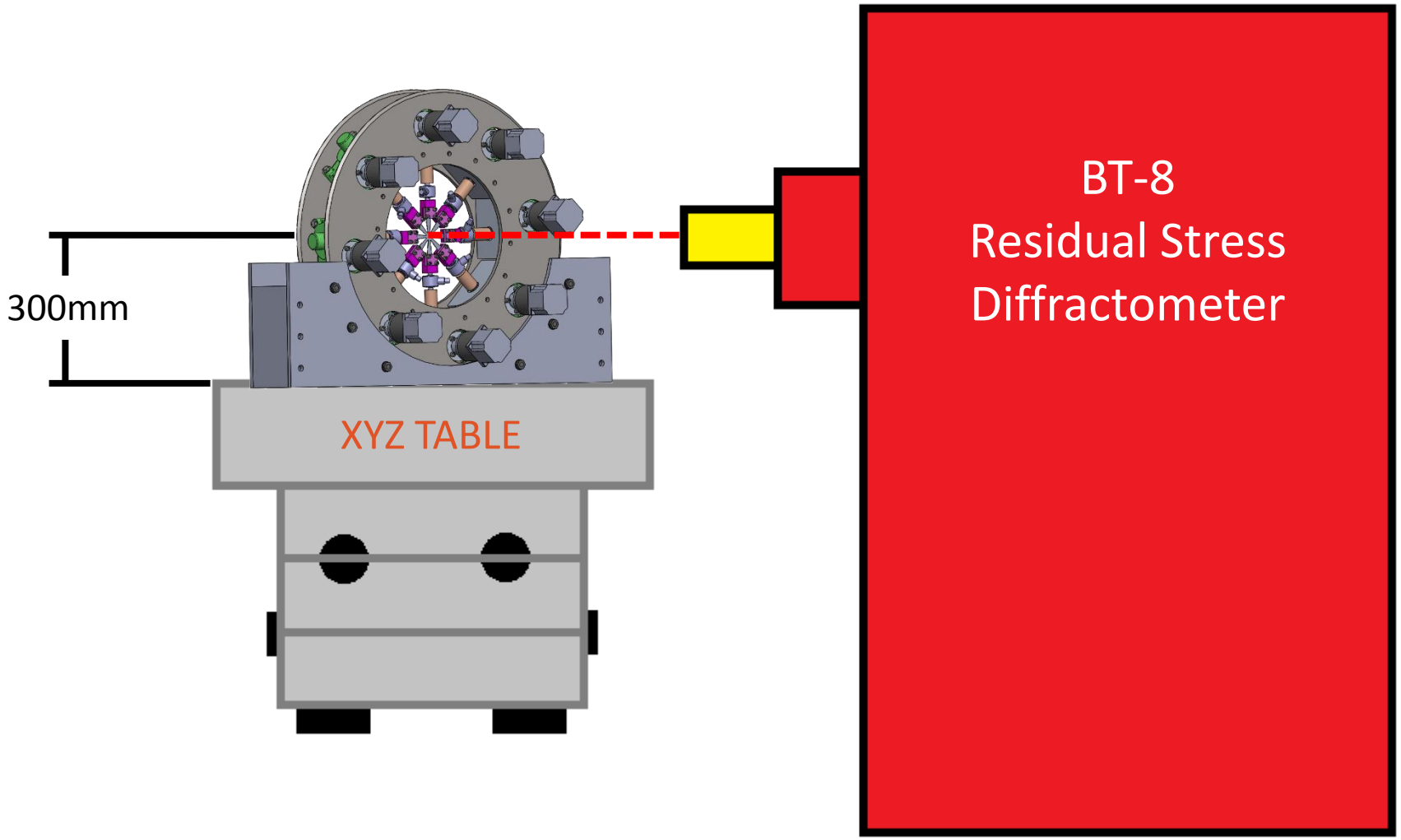
- Biaxial strain
- Plane strain
- Equibiaxial strain
- Ability to define different strain paths – infinite possibilities!

Original Concept

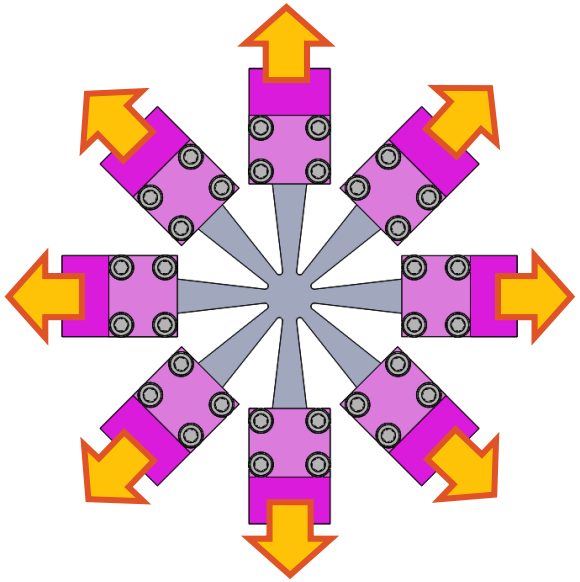


Design Parameters

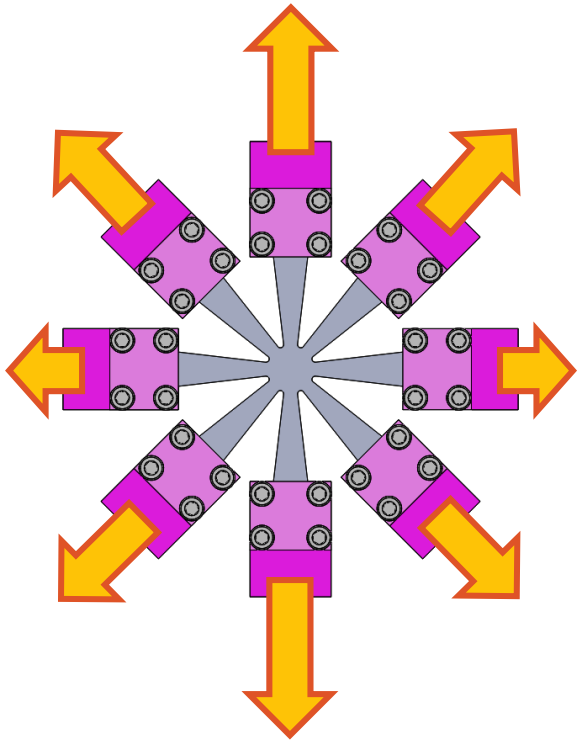




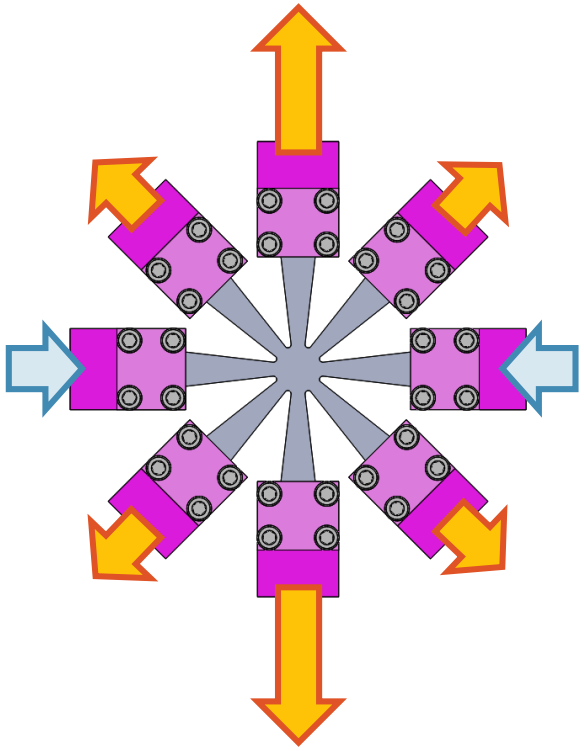
Modes of Deformation



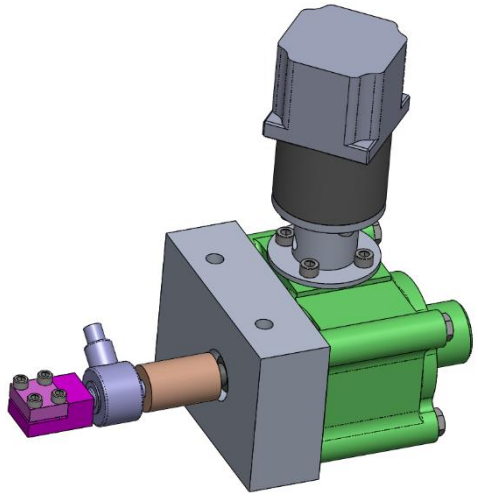
Equi-biaxial strain

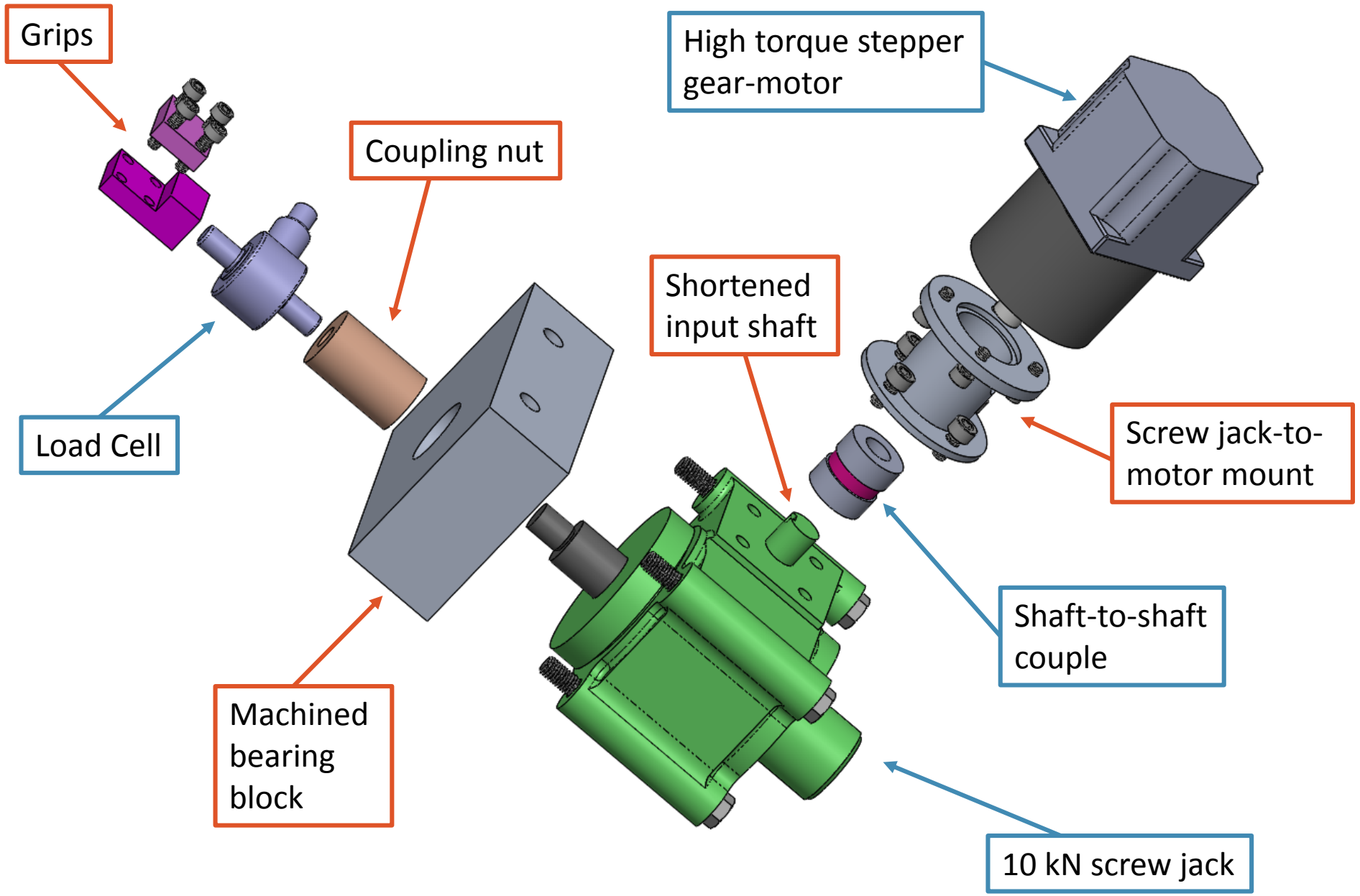


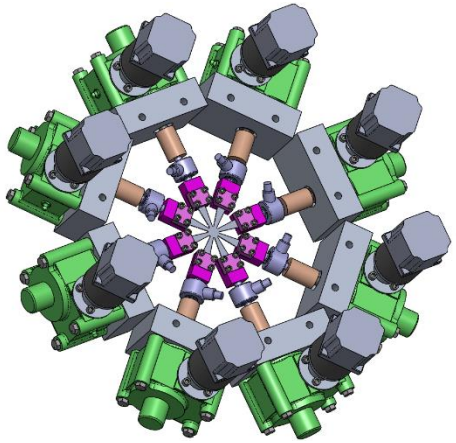
Plane strain



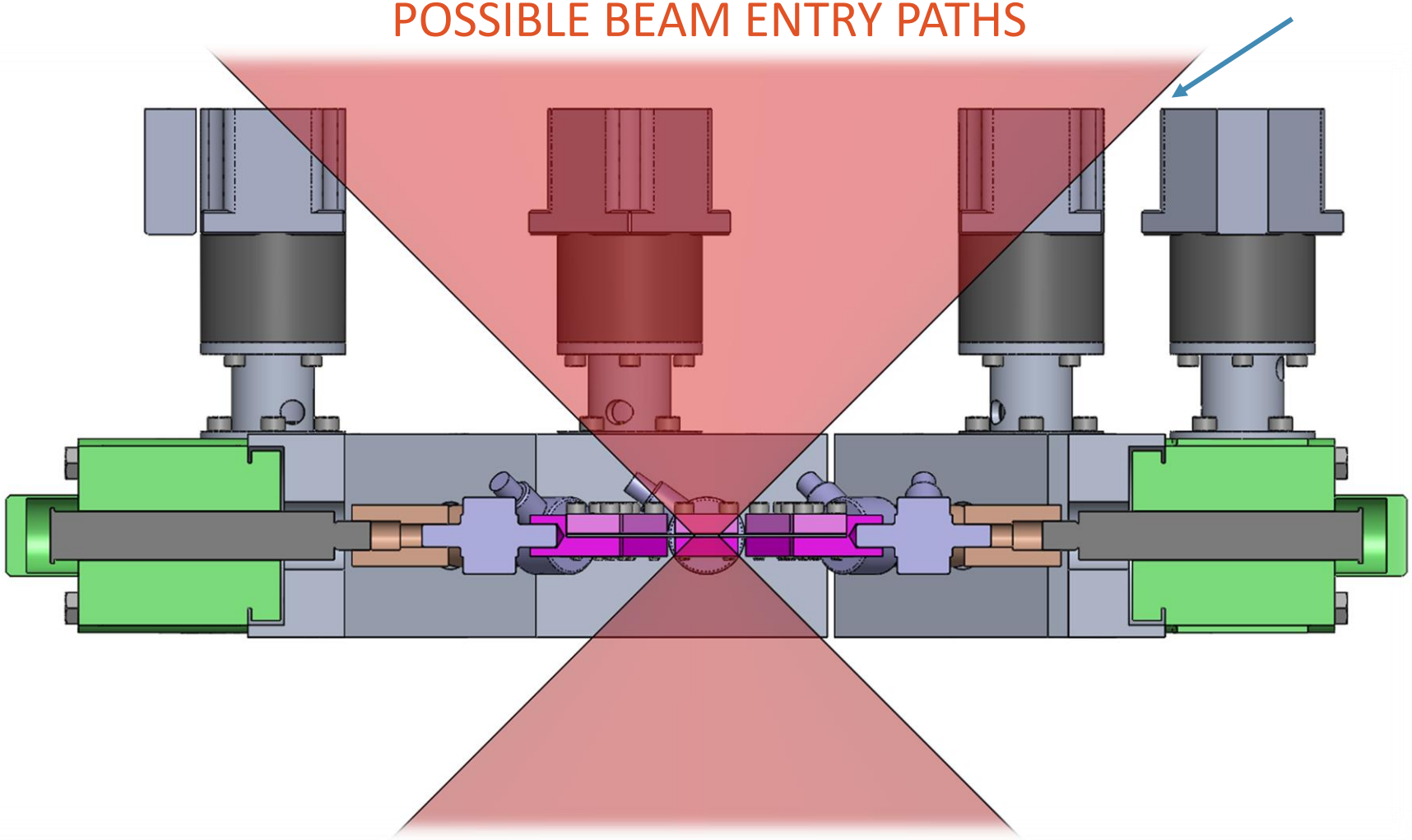
Tension with compression




Grips
Coupling nut
High torque stepper gear-motor
Load Cell
Shortened input shaft
Screw jack-to-motor mount
Shaft-to-shaft couple
Machined bearing block
10 kN screw jack

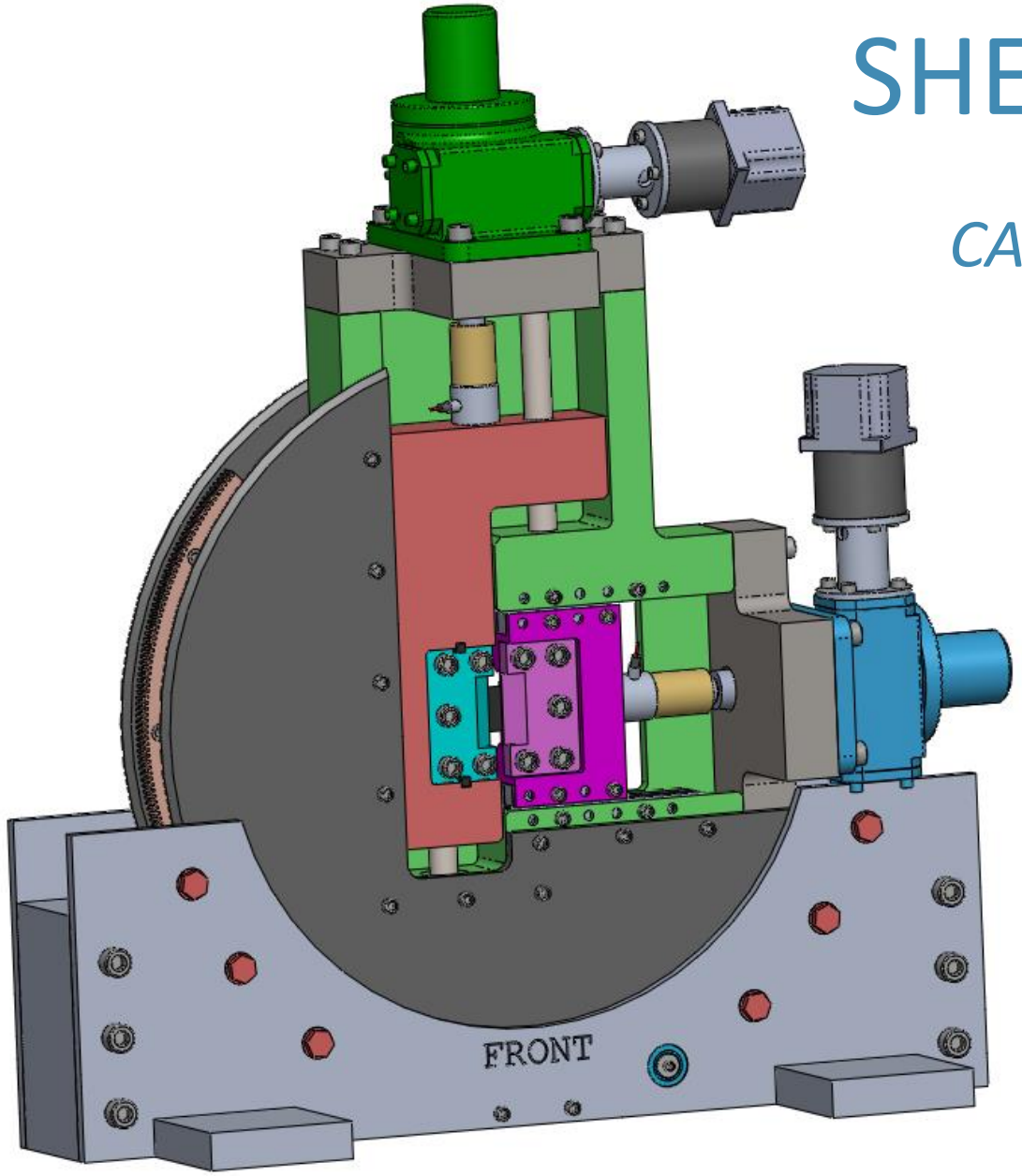


POSSIBLE BEAM ENTRY PATHS



POSSIBLE BEAM EXIT PATHS

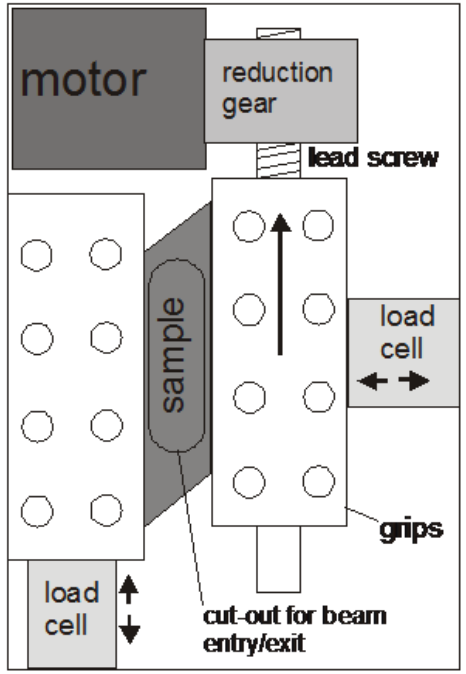
SHEAR DEVICE

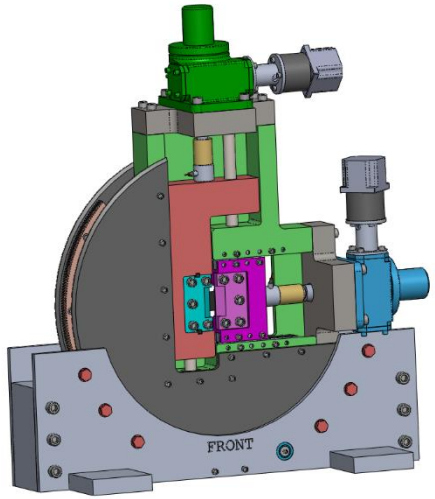


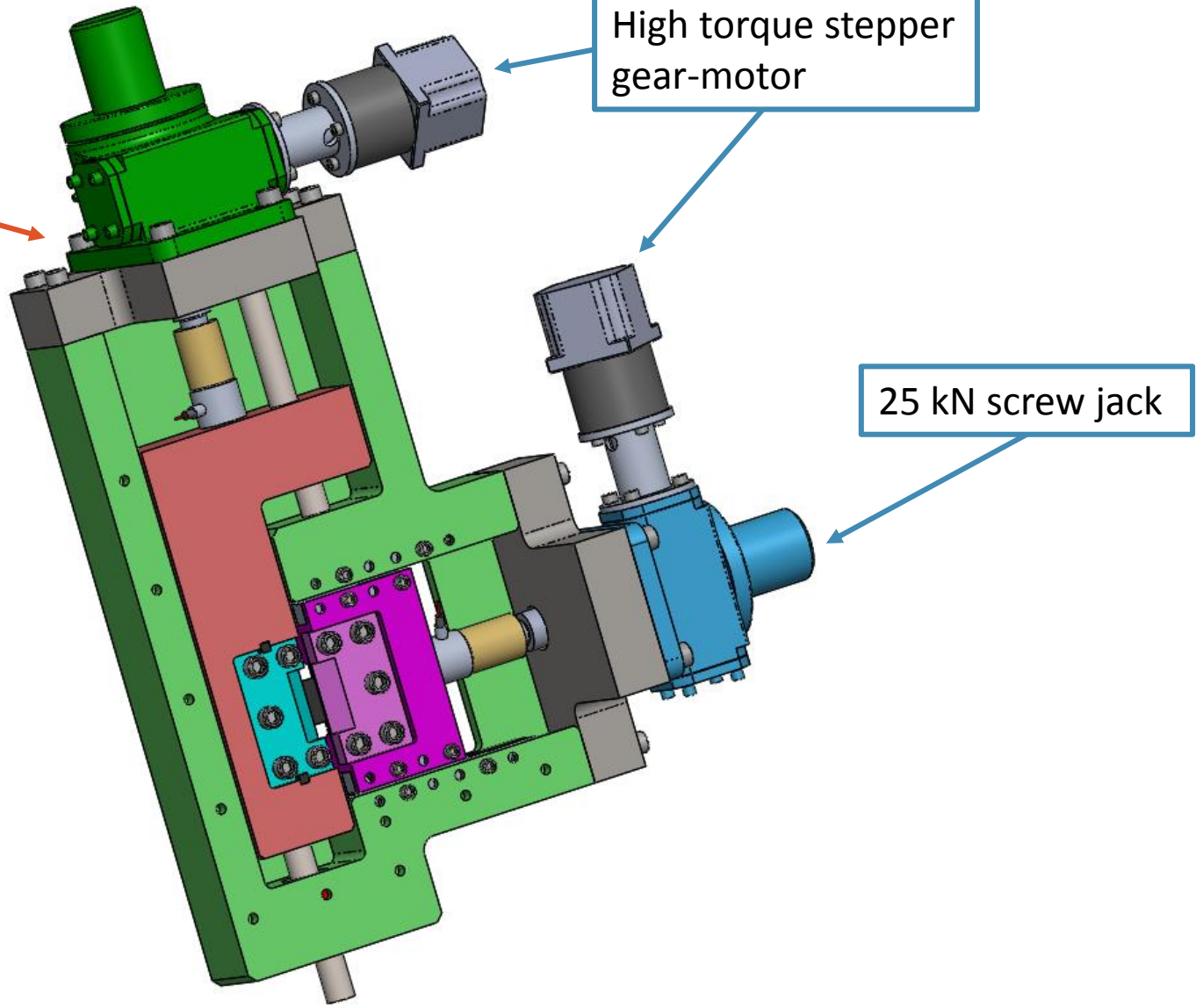
CAPABILITIES:

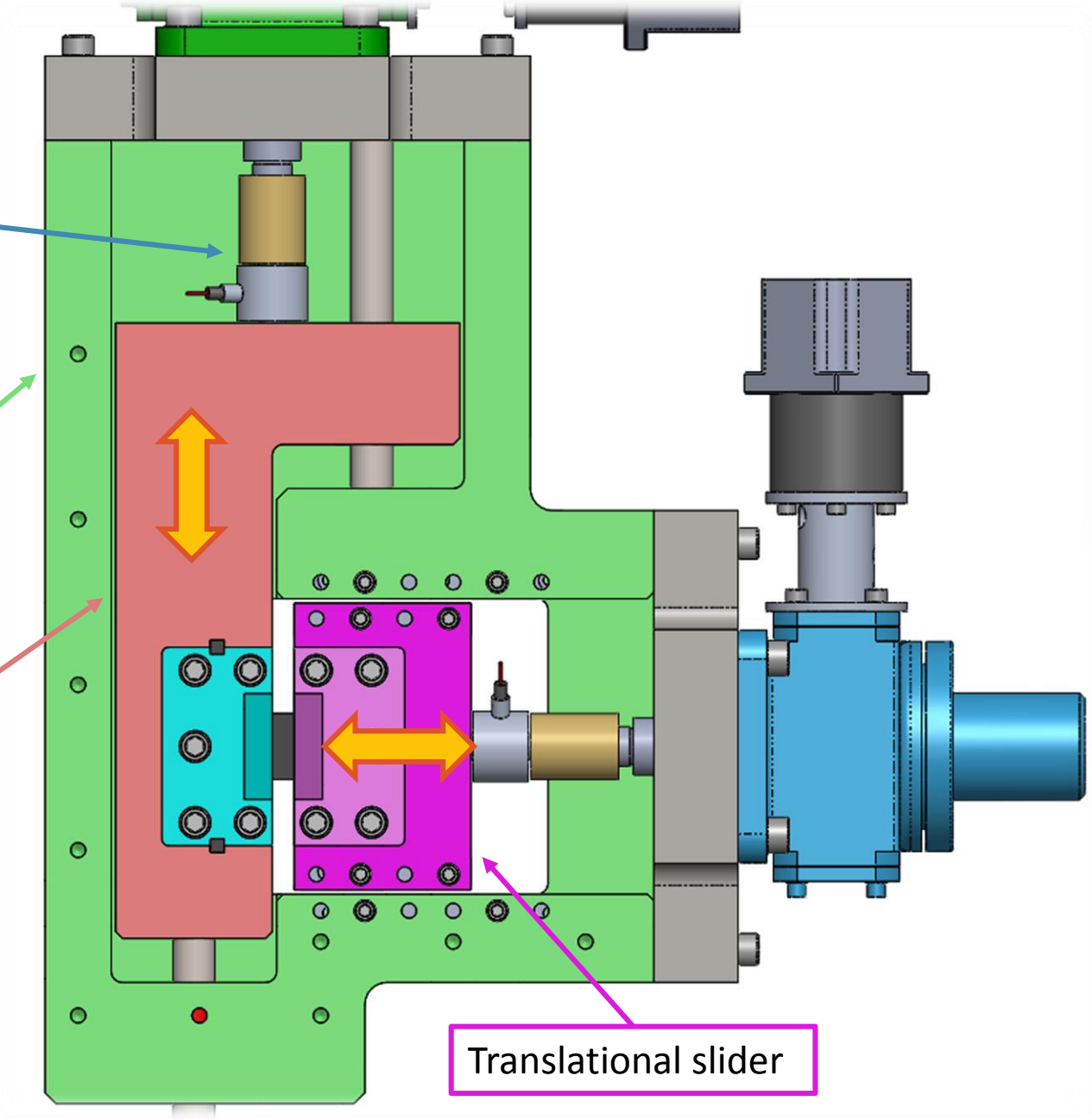
- Simple shear
- Pure shear
- Shear + tension/compression

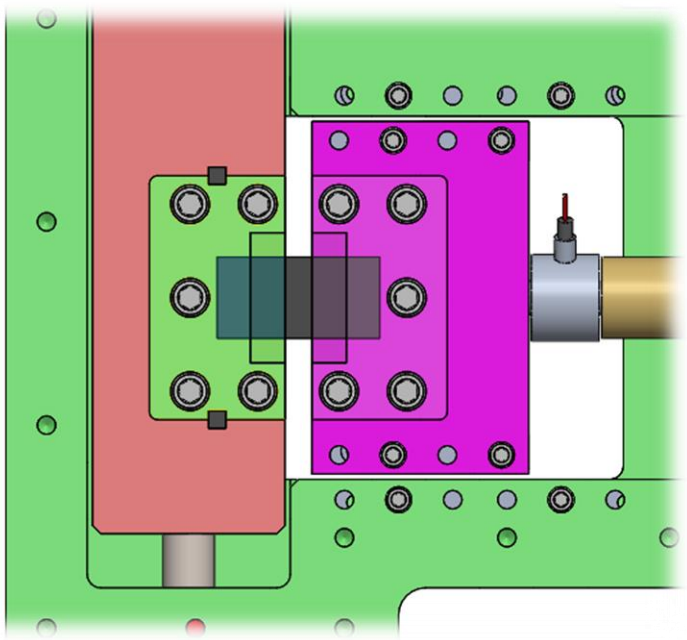
Original Concept




FRONT


High torque stepper gear-motor
25 kN screw jack

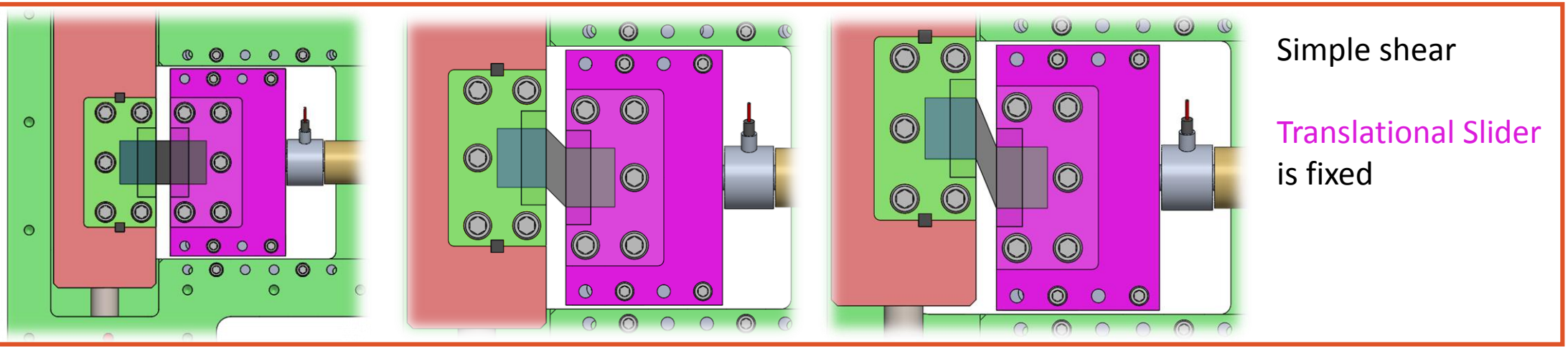




30mm x 60mm x 1mm sheet metal sample

30mm x 10mm exposed surface

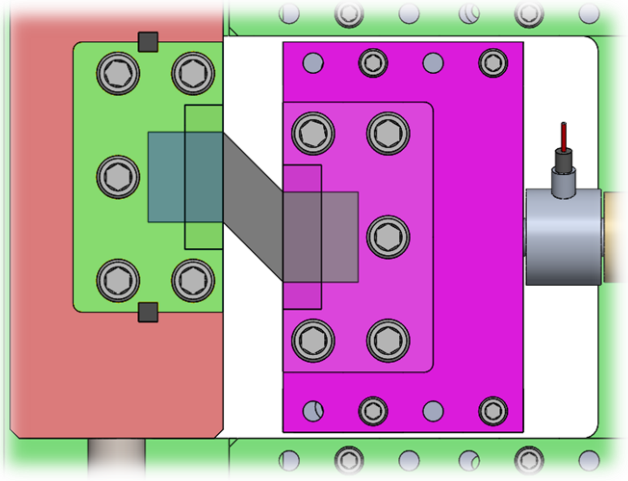
Possible Modes of Deformation



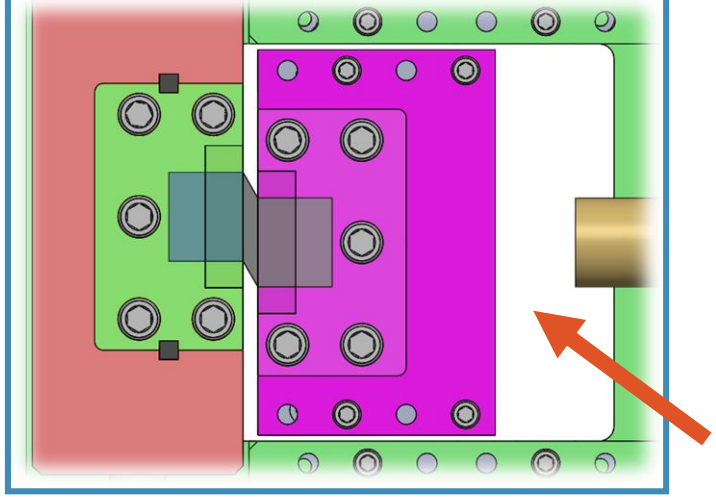
Simple shear

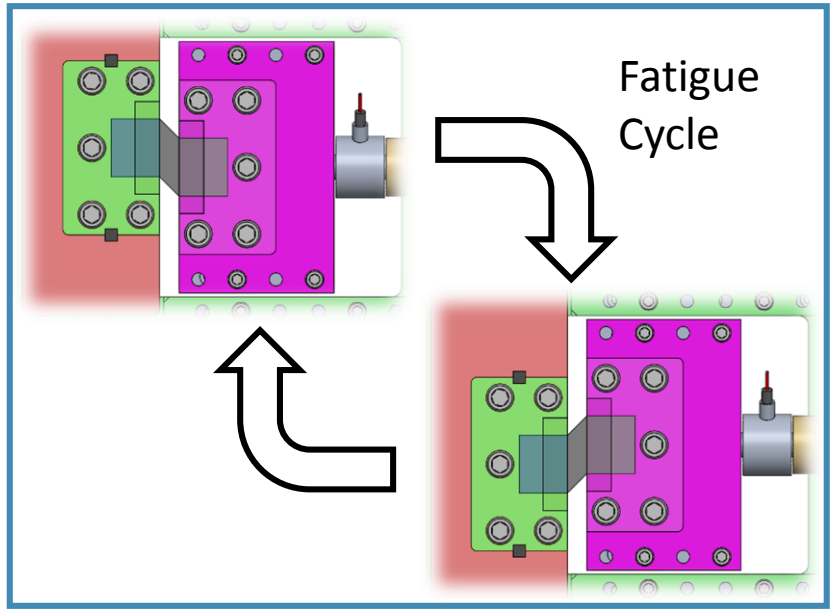
Translational Slider is fixed

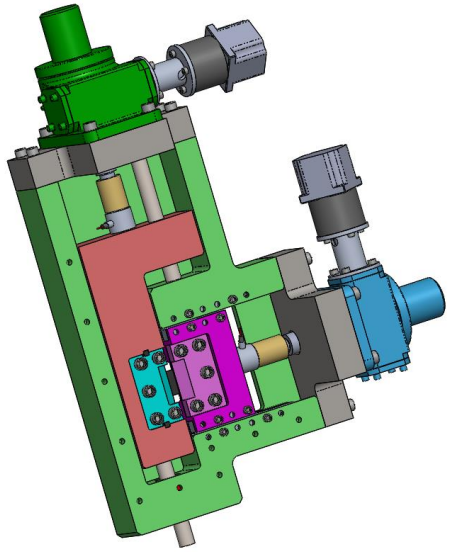
Shear with tensile force



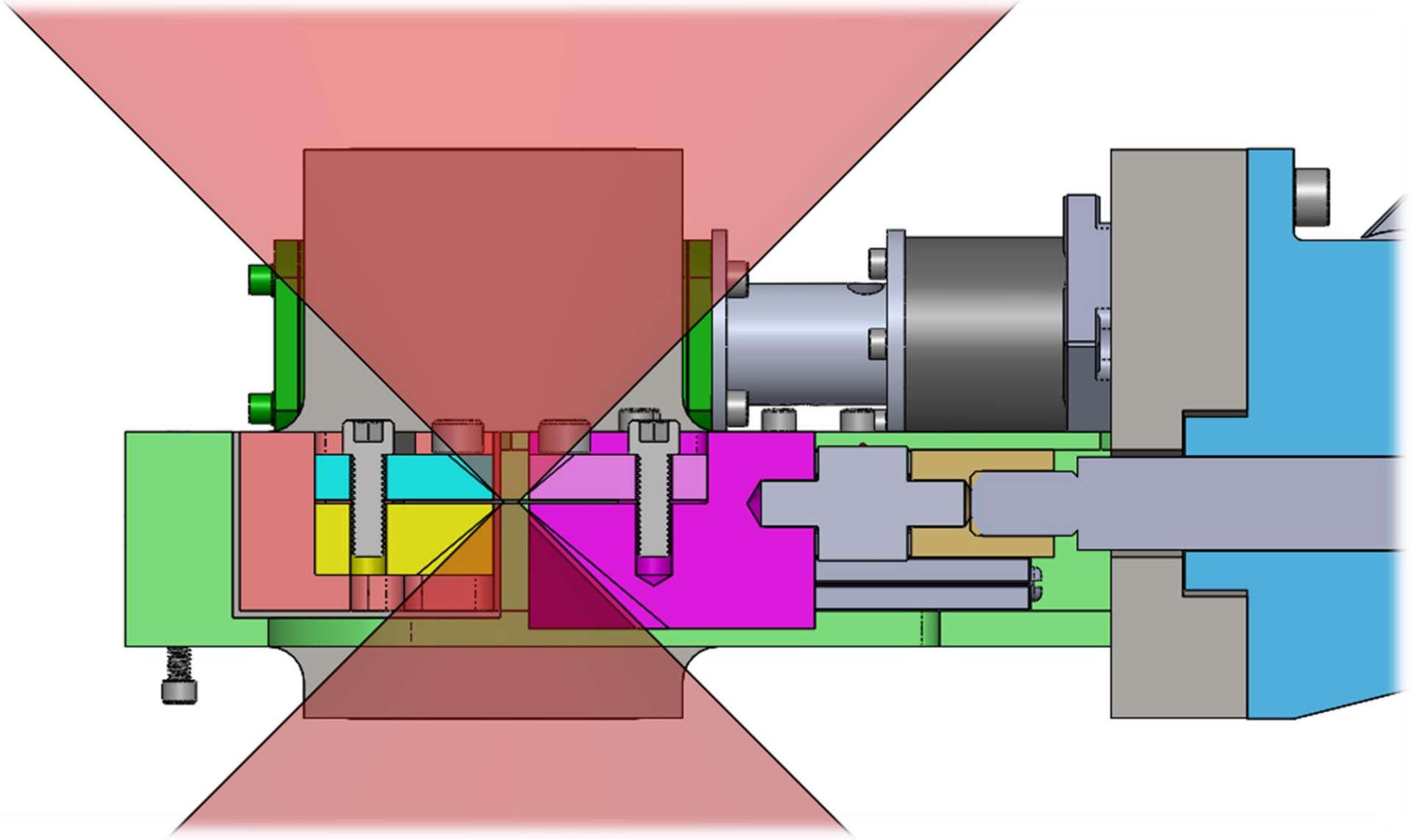
Pure shear





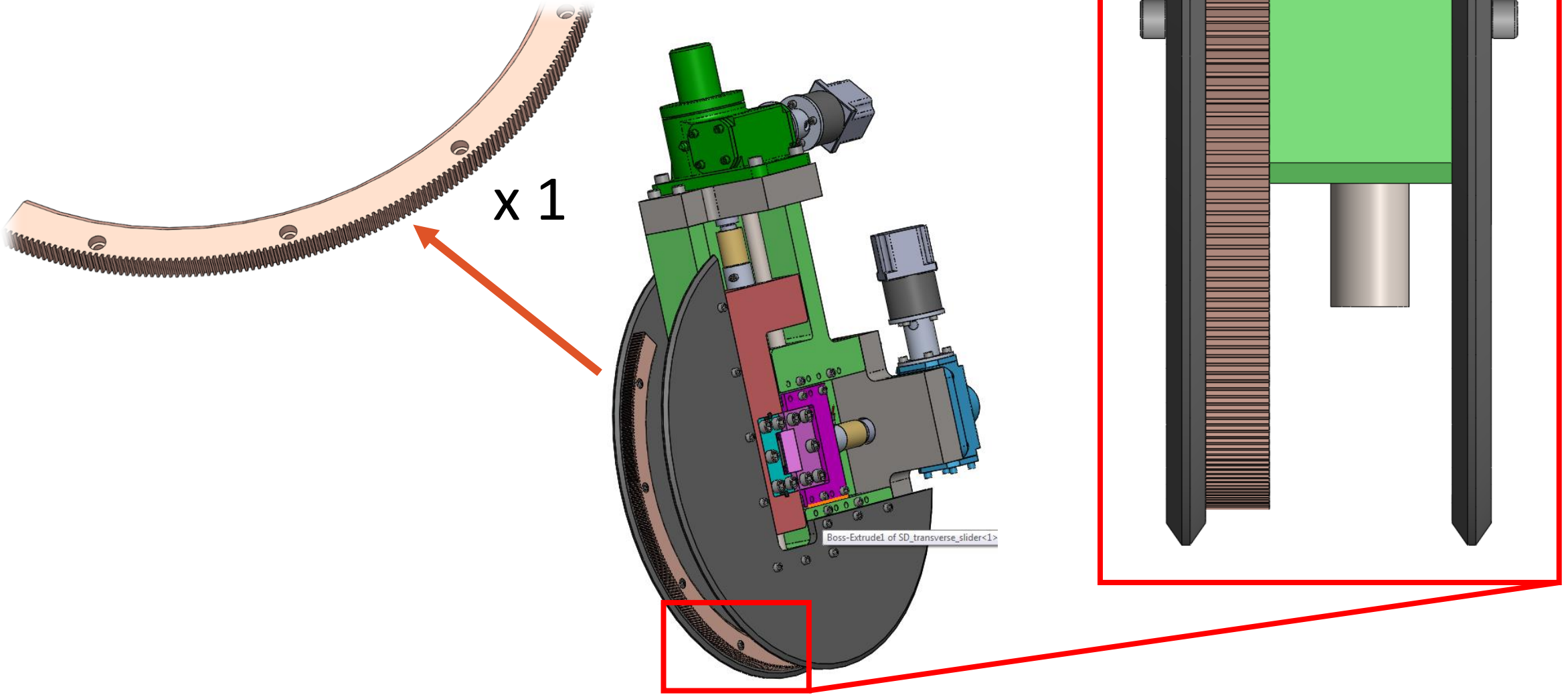


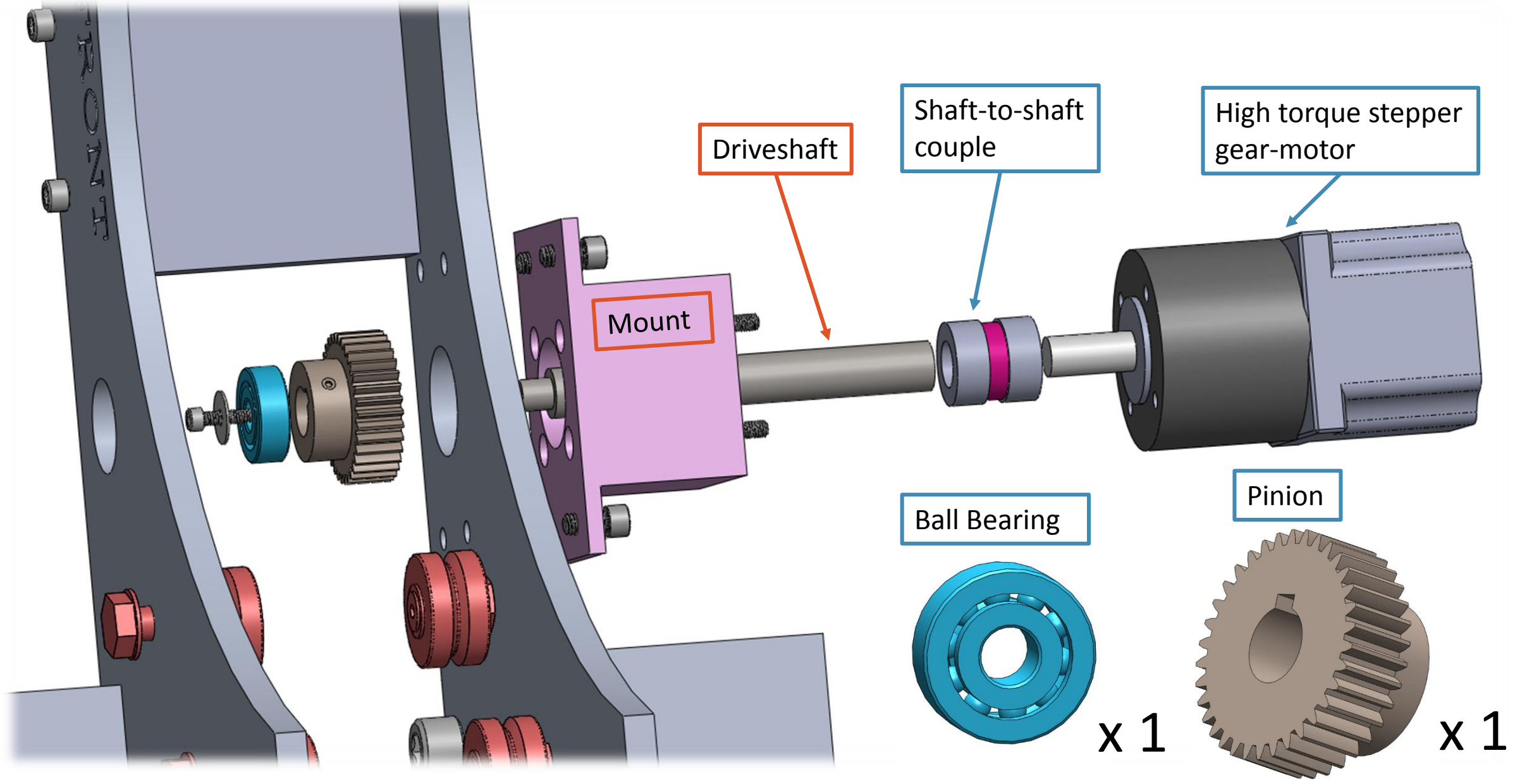
POSSIBLE BEAM ENTRY PATHS



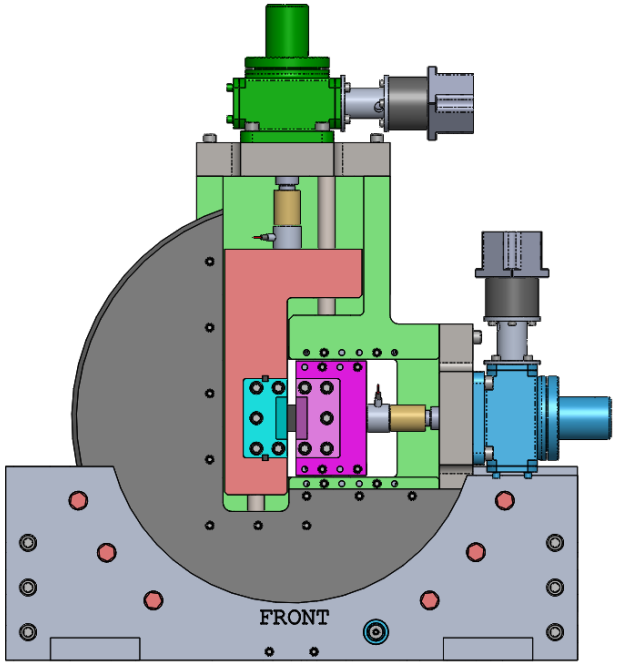
POSSIBLE BEAM EXIT PATHS

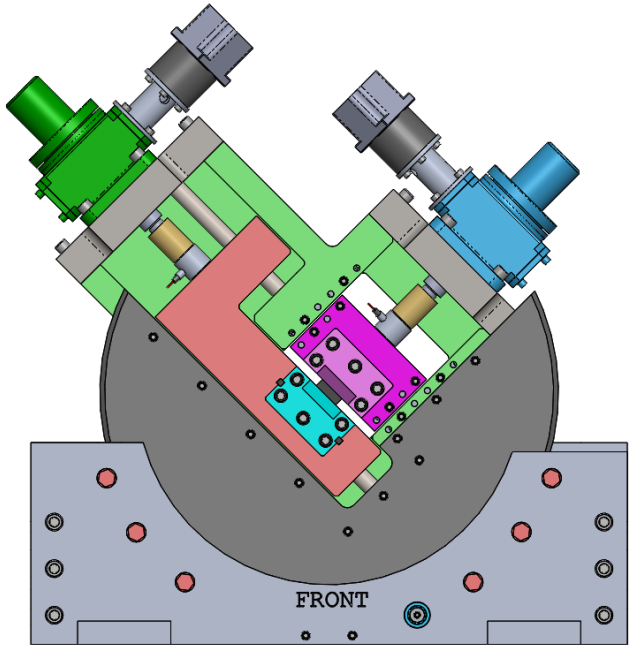
Mechanism of Rotation

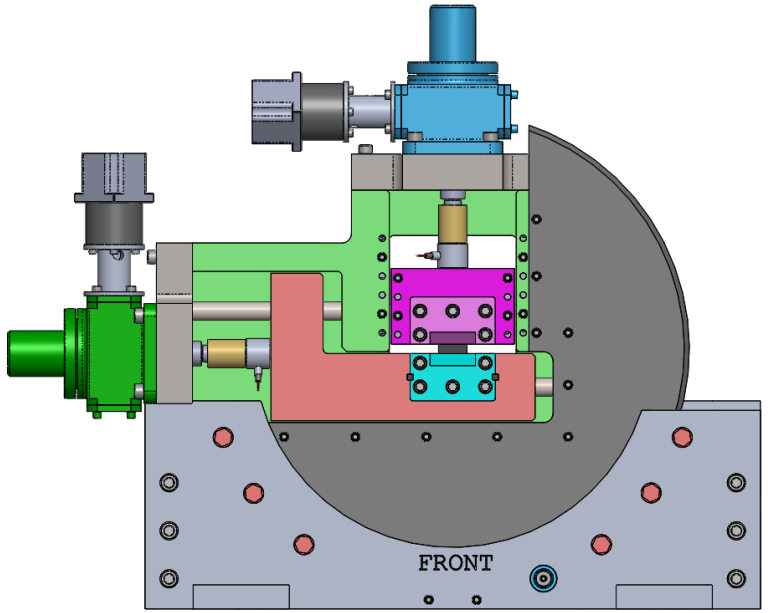



Driveshaft
Shaft-to-shaft couple
High torque stepper gear-motor
Mount
Ball Bearing
x 1
Pinion
x 1

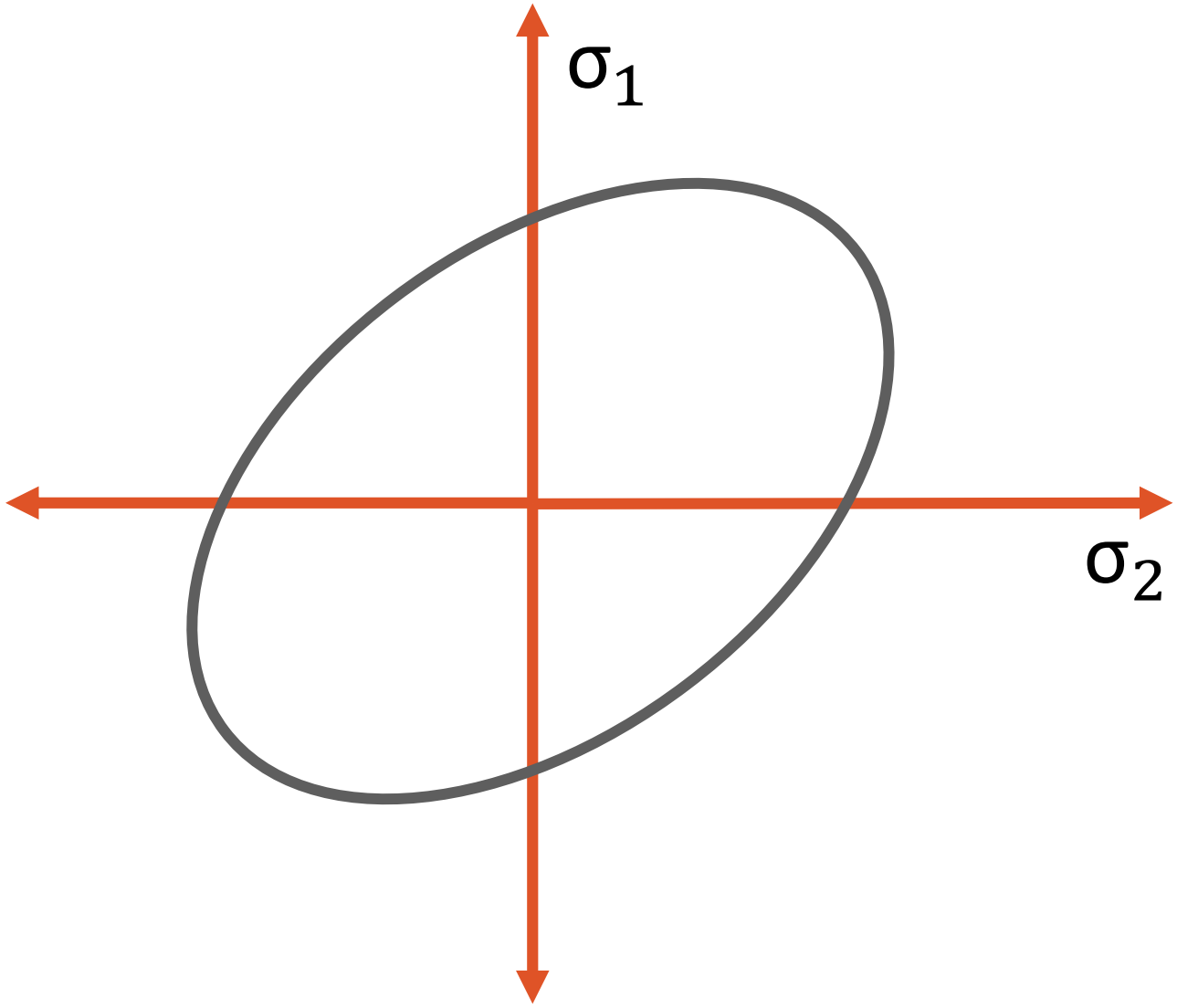
90 degree Rotation







New Areas in Stress-Space



Acknowledgements

- SURF Program
- Thomas Gnaeupel-Herold
- NIST Center for Neutron Research
- NIST Center for Automotive Lightweighting
- Daniel Pajerowski & Julie Borchers