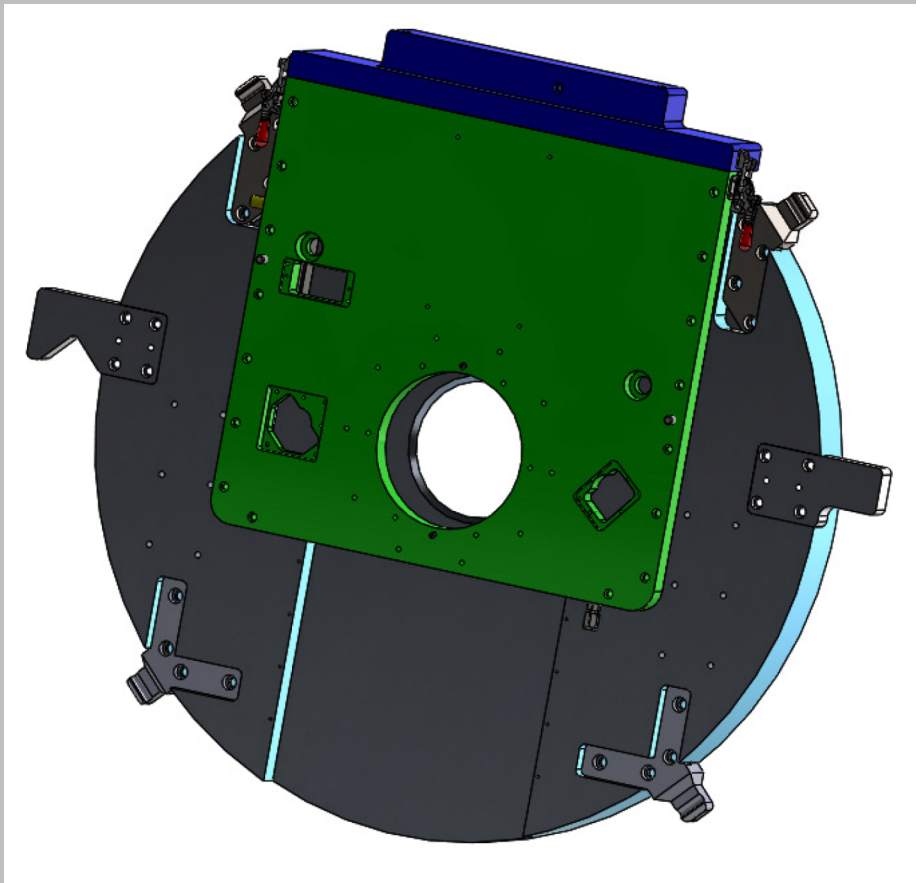
Mechanical Structure

- Two piece design
- NA2 Mounting Plate
  - Spacing built into mounting plate for strength
  - Light baffle surface on front of mounting plate
- Rear Structural Housing
  - 1” thickness
  - Secured to mounting plate with 16 x 5/16 socket head cap screws
  - Machined lip around outer edge for light protection
  - Filter wheel drive mechanisms accessible externally, all are mounting on the green plate
  - Dewar connection on back plate

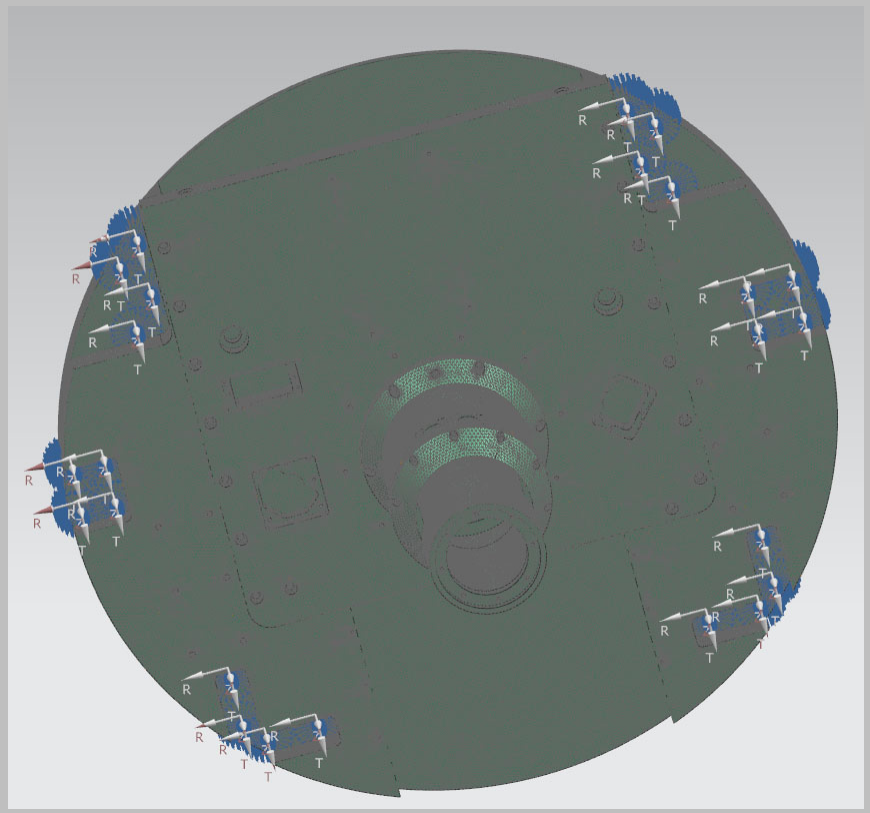


Thermal Analysis

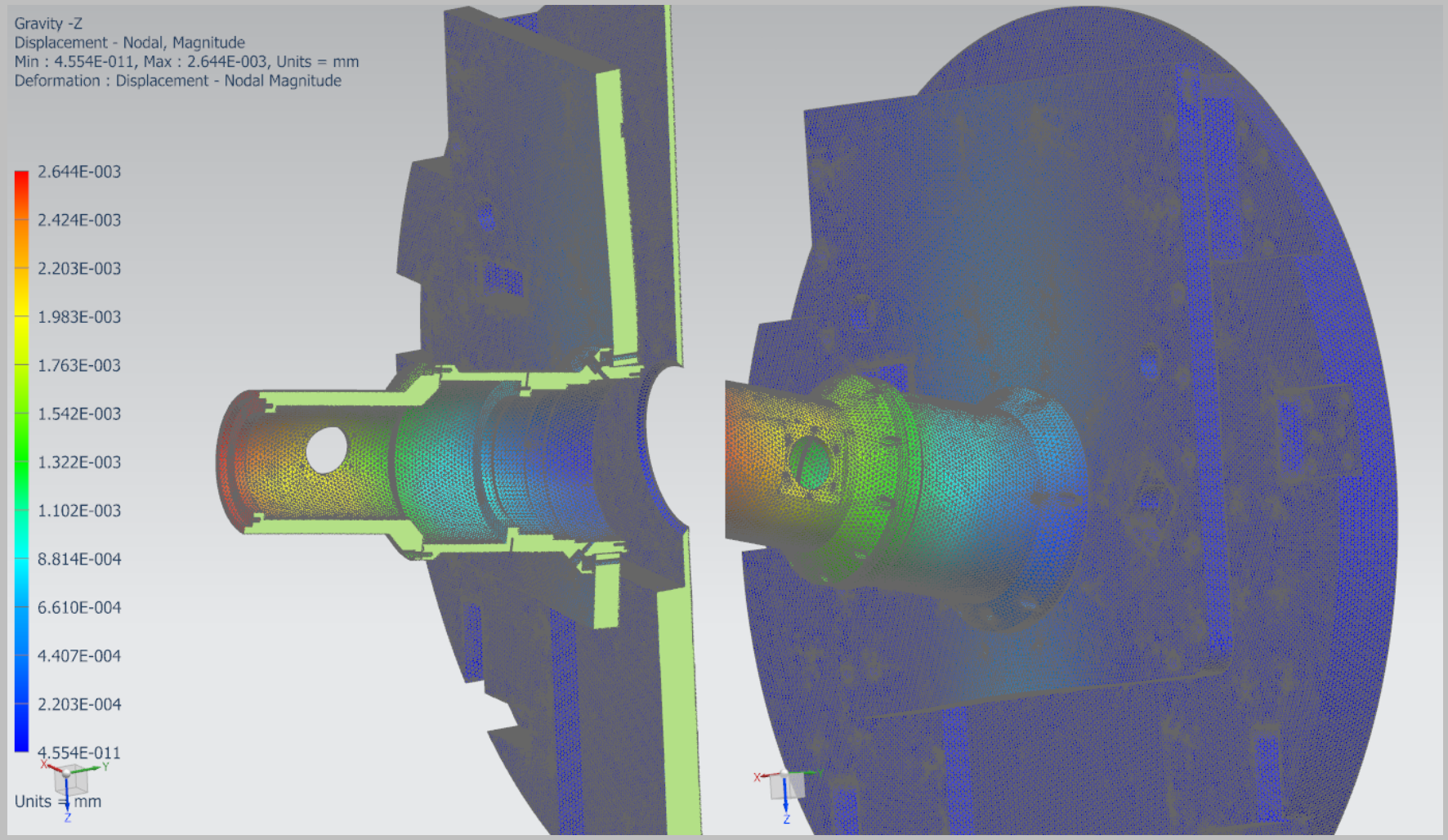
- Temperature Range from -20C to +30C
- Aluminum thickness from mounting plate to CCD mount = 6.939”
- G10 thickness from CCD Mount to CCD = 1.050”
- 0.008” difference between minimum and maximum thicknesses
- Use M2 as compensator

FEA Analysis

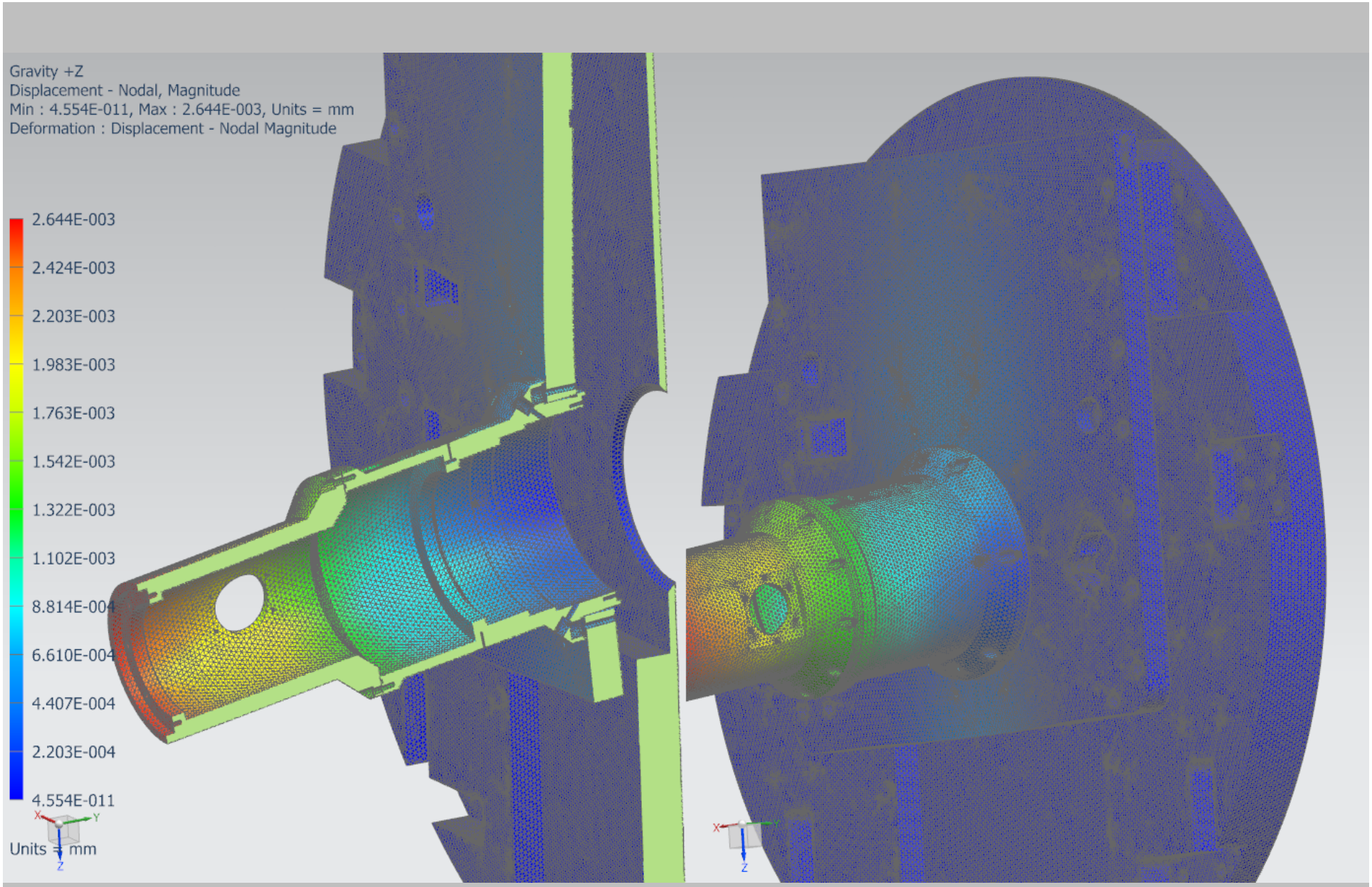
- NX Nastran Structural Simulation
- Restraints
  - Mounting plate is pinned through bolt holes that attach clamping points
  - Gravitational direction changed with each simulation
  - Increased stress analysis in two simulations
  - Idealized mating of components
- Tetrahedral mesh with 4mm elements
- Gravitation loading
  - 1 micron flexure
  - Designed to minimize load on dewar
- 100lb force
  - 7 – 15 microns of flexure
  - Dewar should never see this force



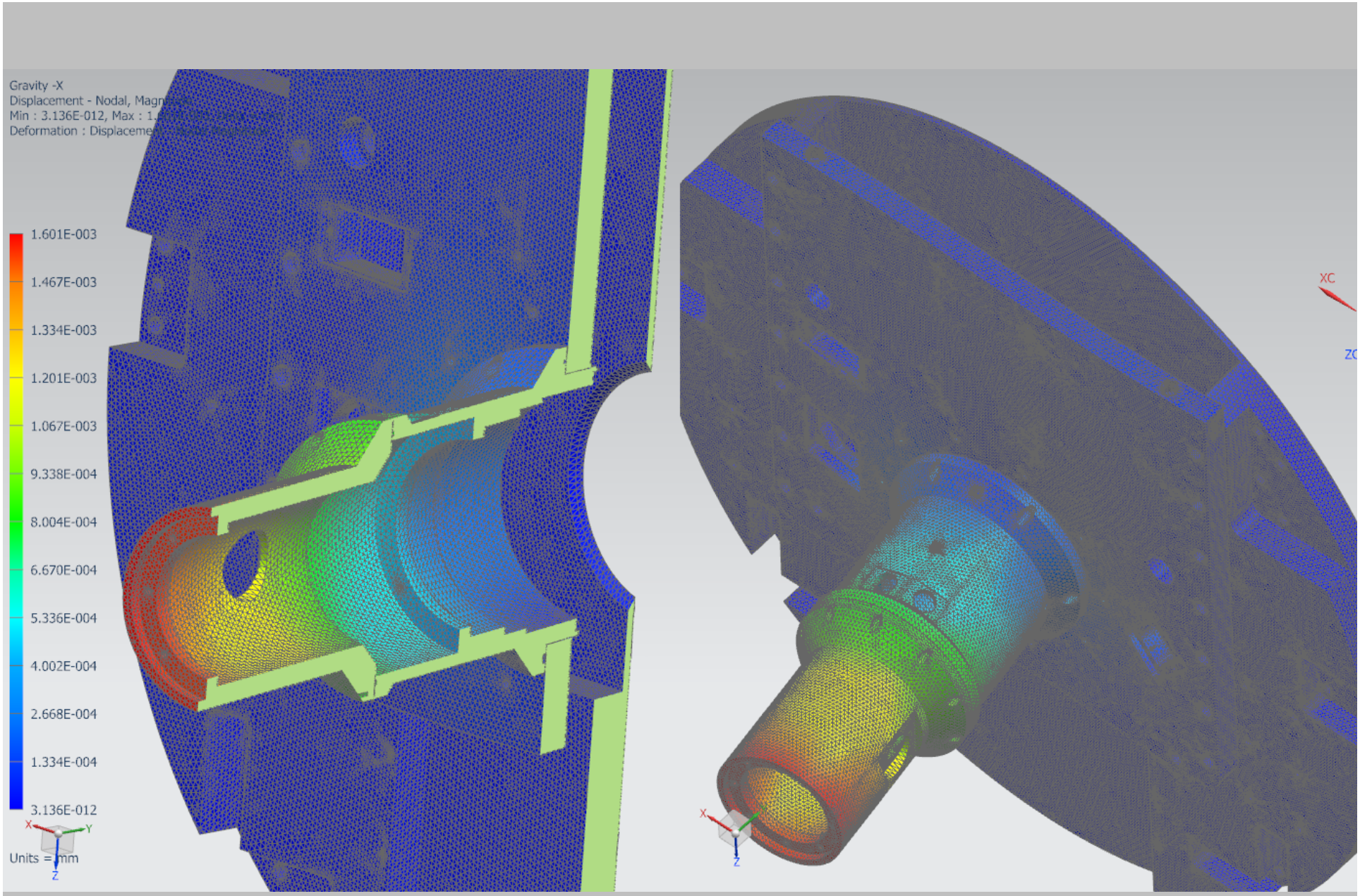
FEA Results with Gravity



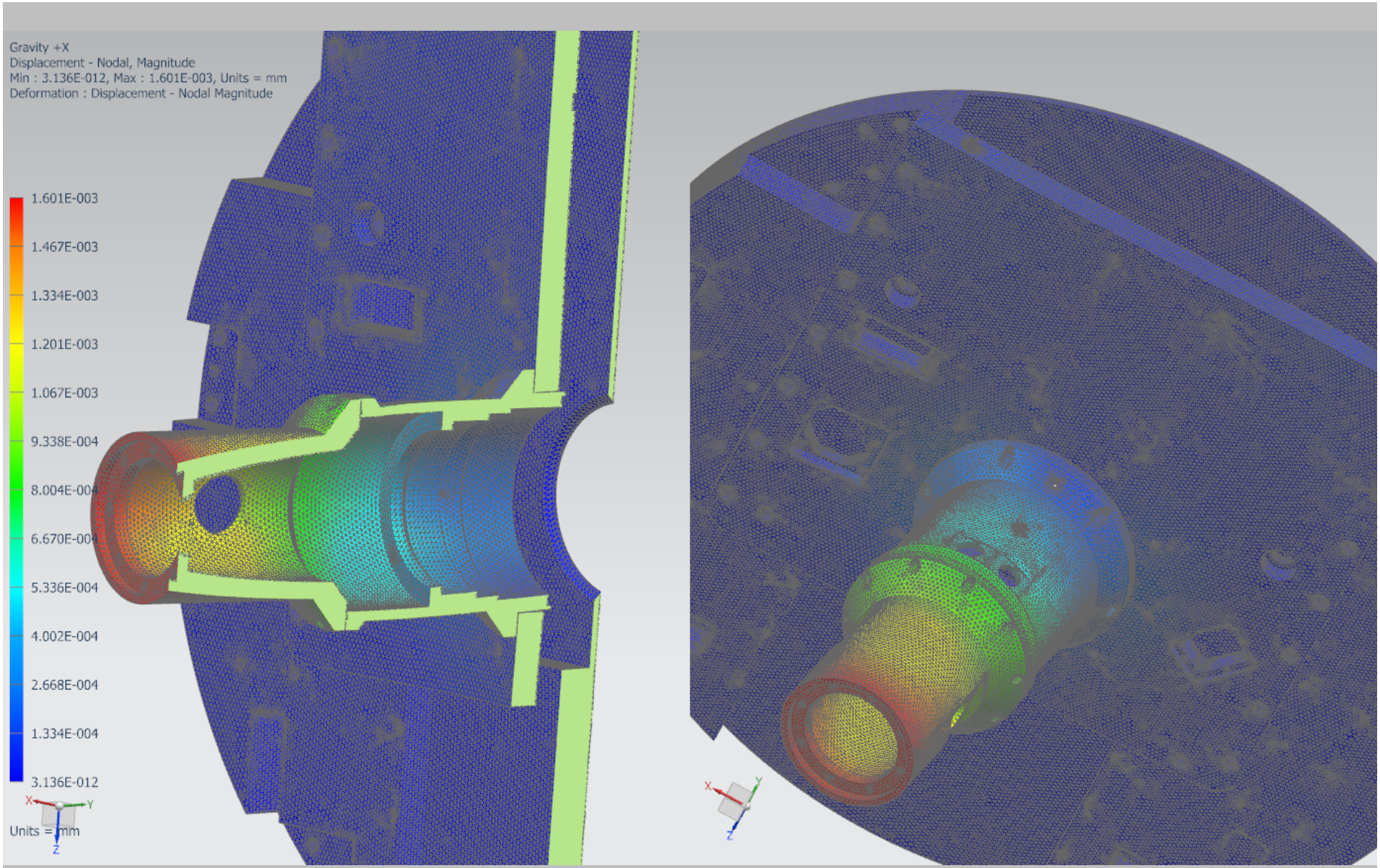
- Gravity in Up direction
- 1 micron flexure at CCD mounting surface



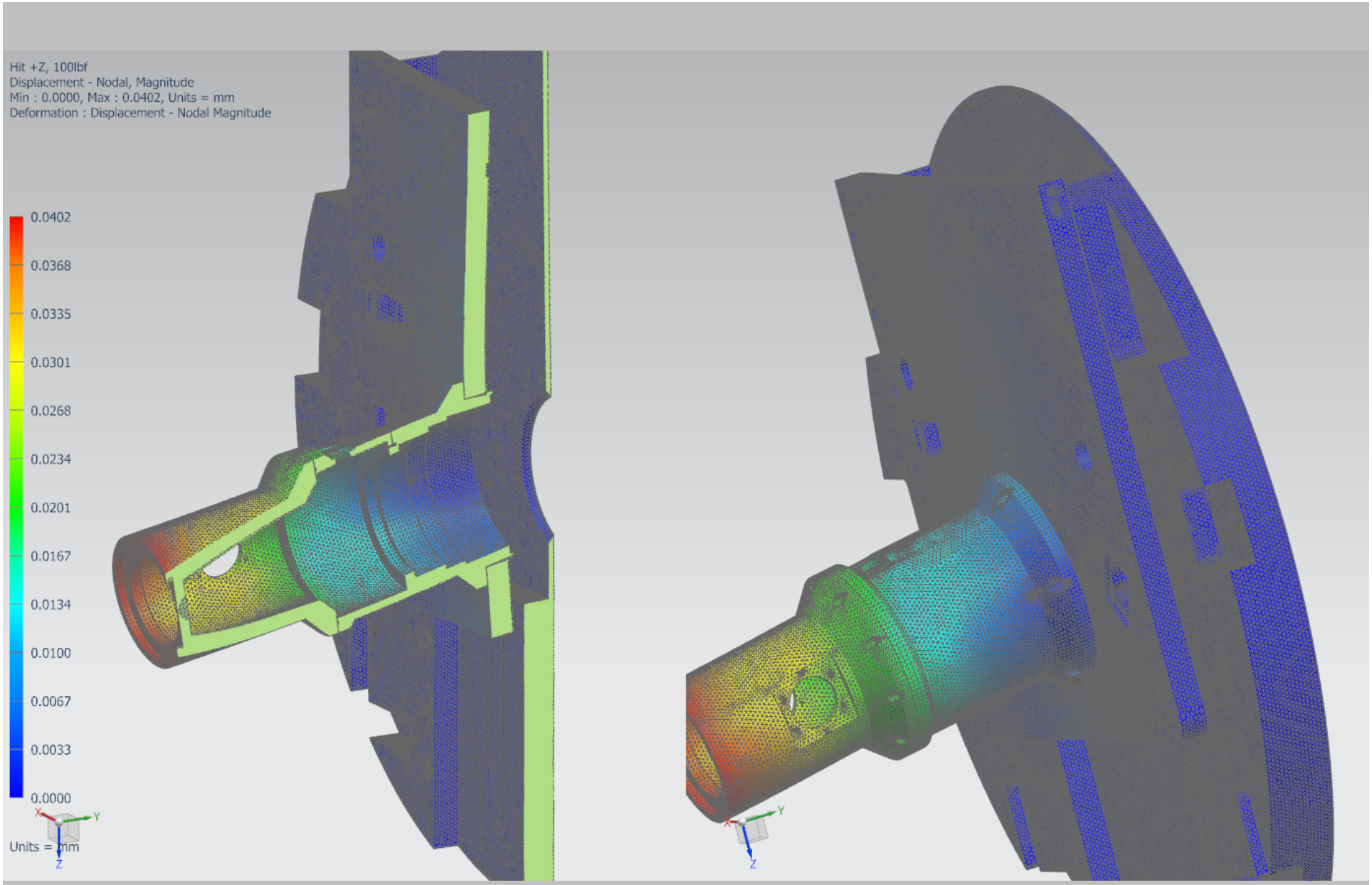
Gravity in Down Direction



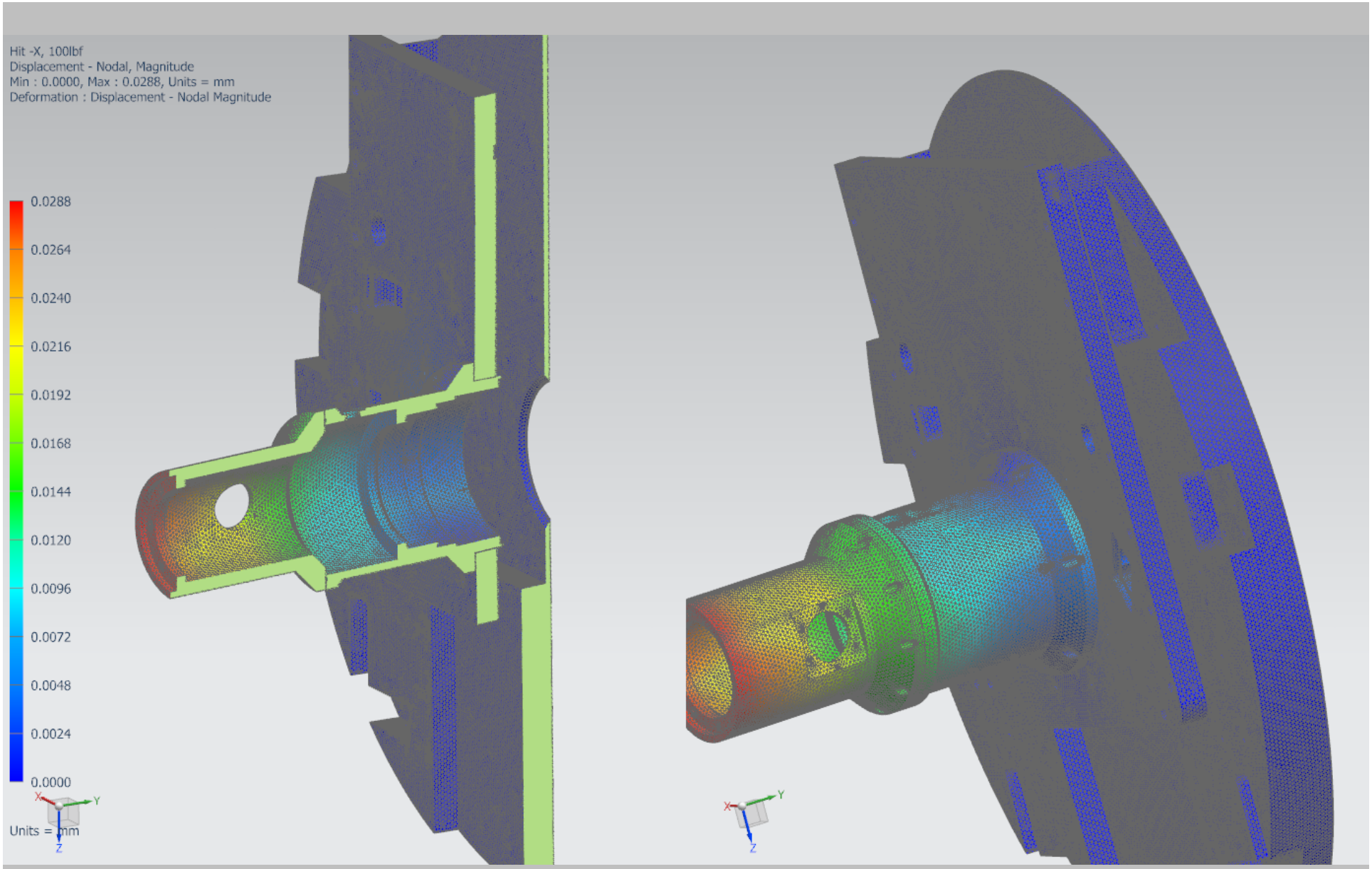
Gravity towards right



Gravity towards left



100lb force on back of dewar in down direction



100lb force on back of dewar towards the right

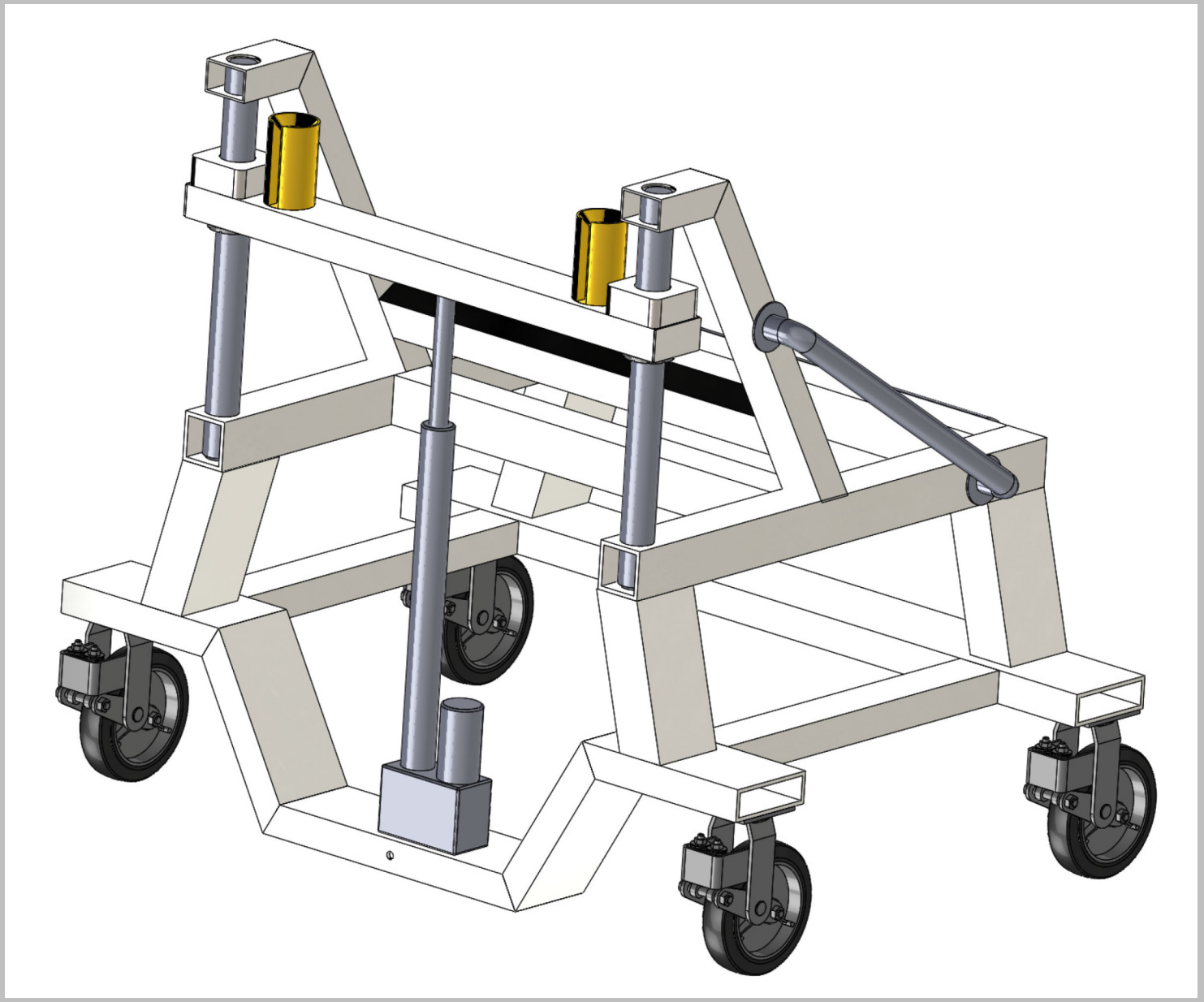
Instrument Cart

- Why can't we use a standard cart?
  - Compact instrument does not have flat surfaces for support
  - Want to pick up instrument from structural point
- Cart will add to cost (approximately 4x the cost of a die cart)
- Benefits
  - Maneuverability
  - Compact: length x width x height = 36" x 52" x 46"
  - Safer for instrument while in motion due to shock absorbing wheels
  - Easier on observing specialist because no special straps will be necessary (think GIFS)

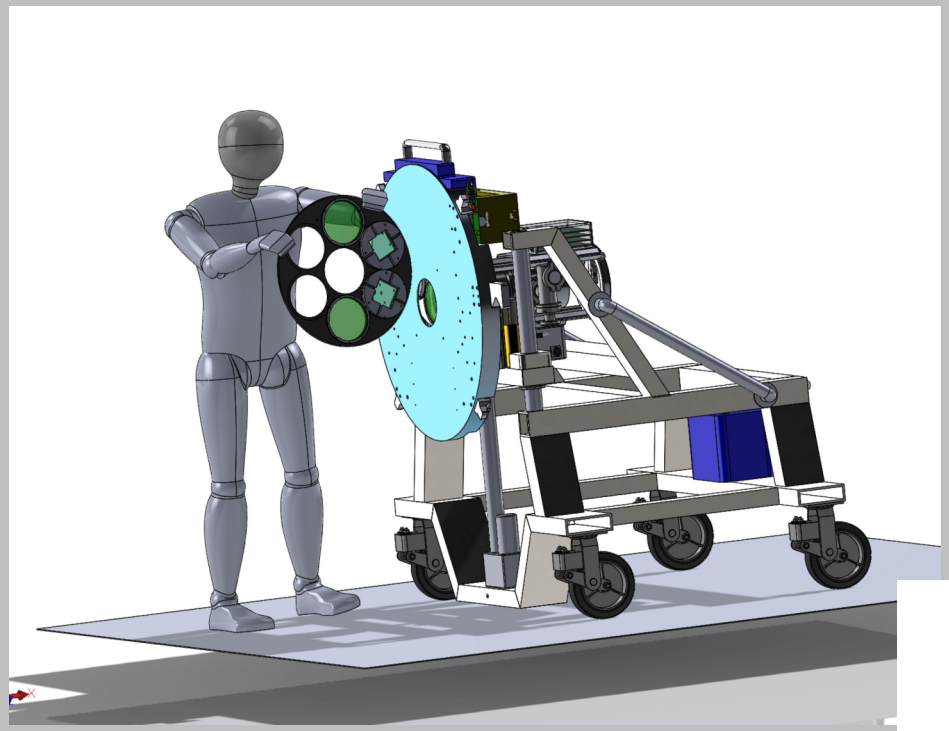
Details

- Cart structure
  - Steel rectangular tubing
  - Wall thickness of 0.125” and 0.25” depending on structural importance
- Bronze receivers capture the linear rod on the instrument
- 2” linear rods and bushing set allow for travel of the instrument height
- Electric linear actuator (with limit switches) automate the control
  - Planned 12V, 50Ah deep cycle automotive style battery
  - Linear actuator power draw approximately 3A
  - Power charging when not in use
  - Battery adds counterbalance to cart to lower center of mass
- Range of travel
  - 12” limit to limit
  - NA2 Mounting position near top of travel
  - Maximum travel point places vacuum valve parallel to vacuum pump
  - Minimum travel places top of mounting plate at 52”, a comfortable height for changing filter wheels (when instrument is off the telescope)

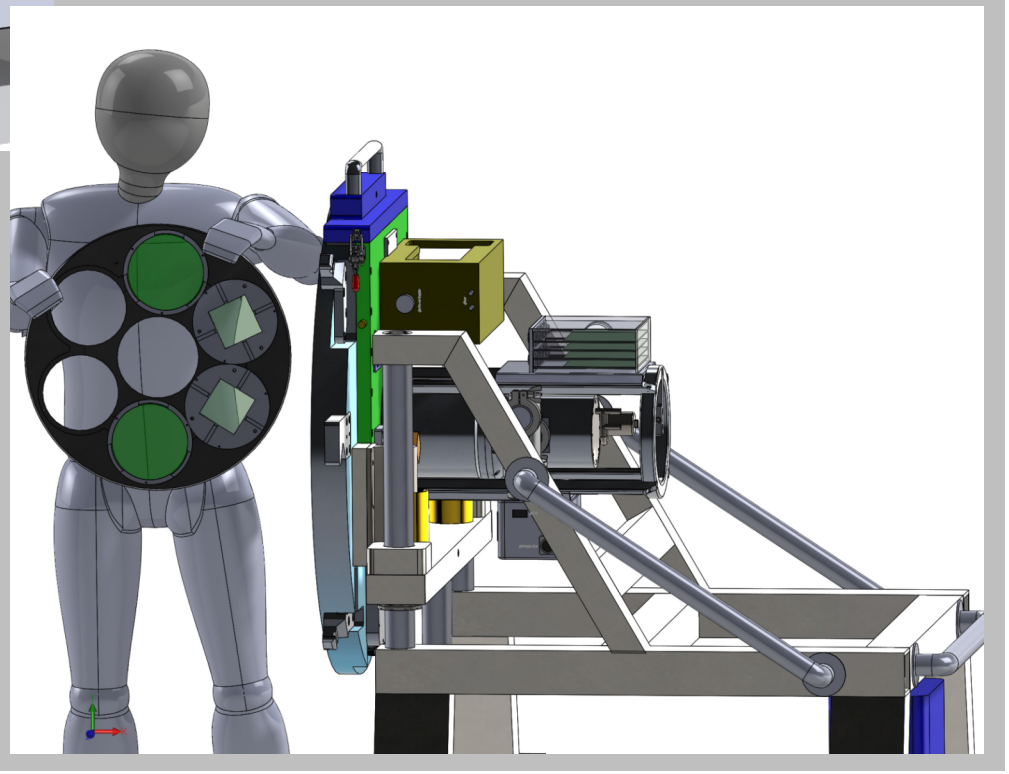
Cart Design



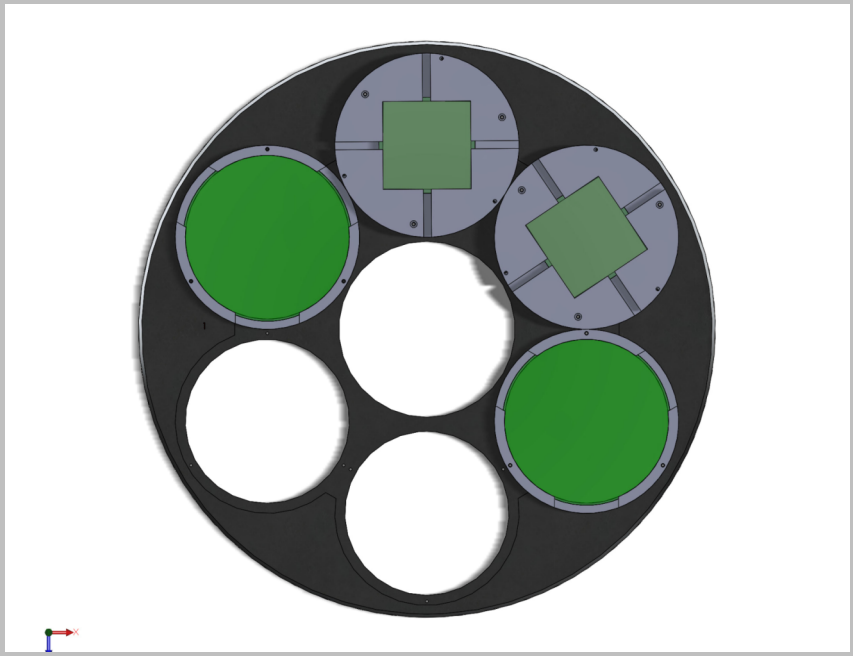
Cart Ergonomics



- Instrument shown in lowest position
- Model Person = 5’ 3”
- Filter Wheel 18” diameter
- Floor to Top of Instrument = 4’ 6”



Filter Wheel

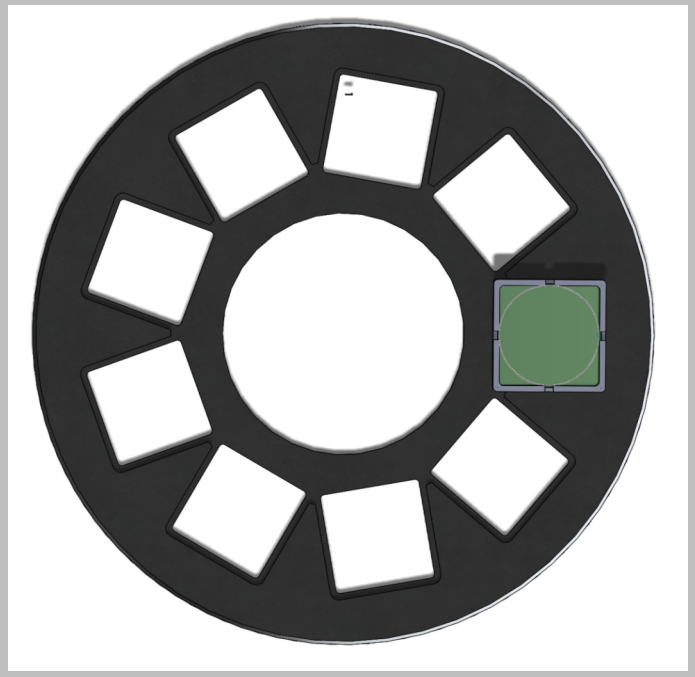


- Single plate design
- Maximum filter thickness (unmounted) = 0.75”
- Multiple positional feedback encoders
- Multiple filter configure options
- High positional repeatability
- Speed
  - Stepper motor highest rotational velocity for maximum torque = 200rpm
  - Gear reduction of 21.1:1
  - Filter wheel cycle = 6.3 seconds
  - Single position change = 1.1 seconds + (detent overhead) = 1.25 seconds

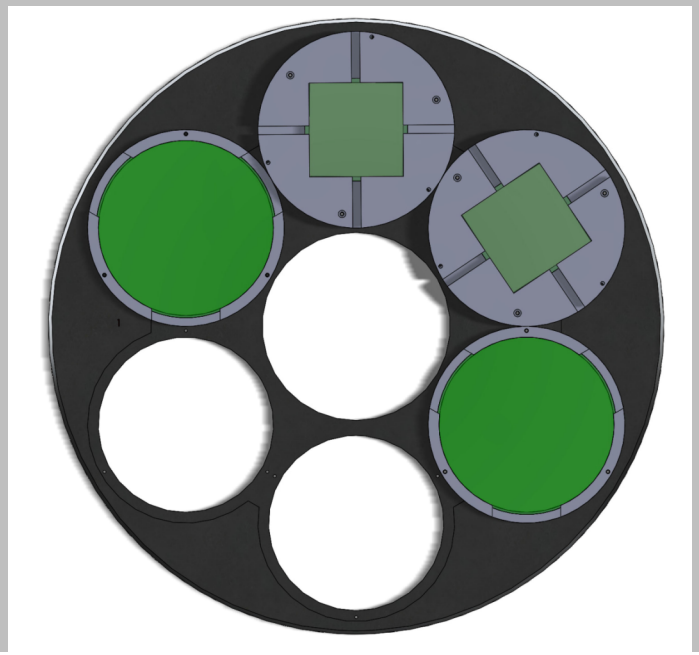
Filter Sizes

- Multiple filter sizes will be supported: 2” - 5.25”
- 5.25” Round will be standard full field filter size
- Full field SDSS filter set provided to users as part of instrument
- Adapters for smaller filters to fit larger mounting holes
- Maximum filter thickness
  - 0.75” un-mounted
  - Wide band filters typically 0.2”
- Broadband, Narrowband, and Inteference filters available in this size in either square or round
- Full field filter flatness for narrow band filters difficult
  - 50nm band pass easy
  - 20nm band pass costly but possible
  - Uniformity across field decreases as filter band pass decreases

Filter Wheel Variations

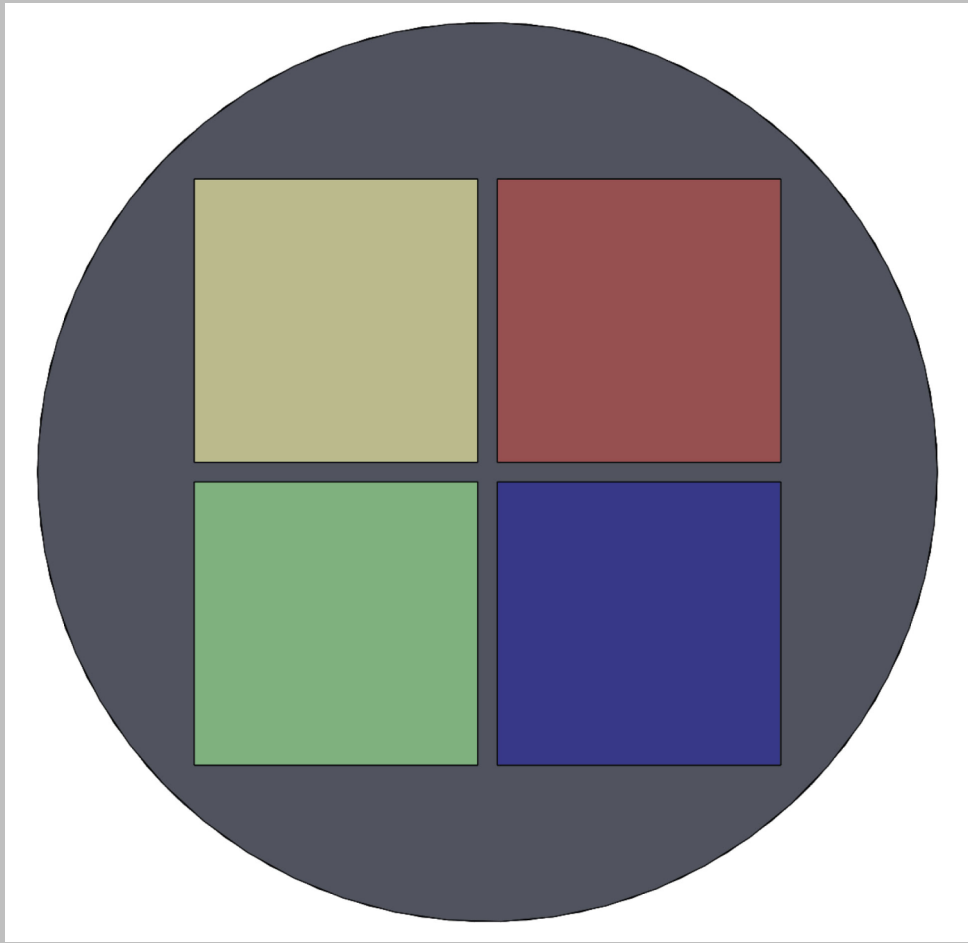


- Six filter wheels will be made
- Configurations (2 each)
  - 6 x full size filter positions
  - 9 x 3” filters
  - Combination of full size and 3” filters
- The 3” filter positions will allow for usage of 2” filters
- No intended 2” only filter wheels, but available if users deem necessary
- Tooling plate for machining kept so that subsequent filter wheels can be machined with less setup cost



Slide on 2x2 filter setup

- Option to observer 4 x 2 inch filters simultaneously
- Remember CCD readout capabilities
  - Differential readout rates for upper and lower section
- No dithering necessary for each filter, instead just rotate the instrument
- Not exactly simultaneous across the entire field but a good additional feature at little cost
- Filter holder fits into full field filter wheel

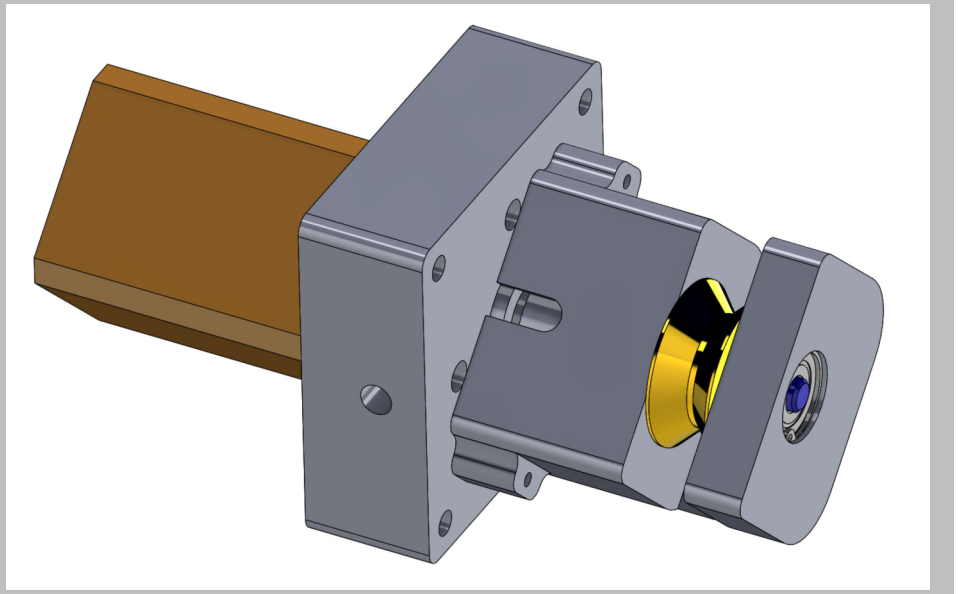


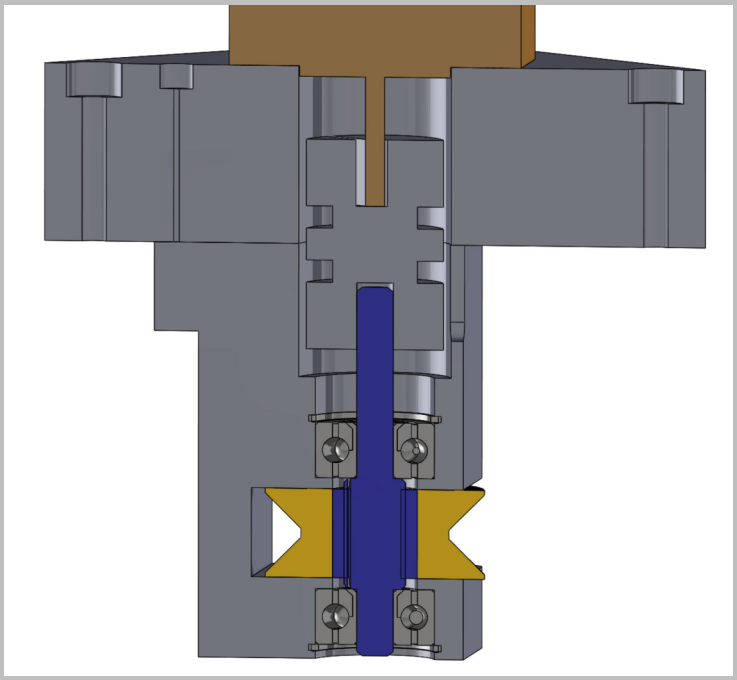
Changing Out the Wheel

- The filter wheel will be installed through the top of the instrument (due to compactness of optical path)
- A large handle on the top cover will allow for easy handling
- Once the top housing cover is removed the filter wheel can be installed
- The filter wheel is guided into near position with loose tolerance delrin guides
- The filter wheel will slide into the chamfered drive and idler wheel
- After being seated, the top cover will be re-installed, which will tension the filter wheel into stable action
- The top cover is held into position by harden locator pins and bushings (mostly to reduce wear not for positional accuracy)
- A set of De-Staco clamps can will then be tightened to hold the top in position

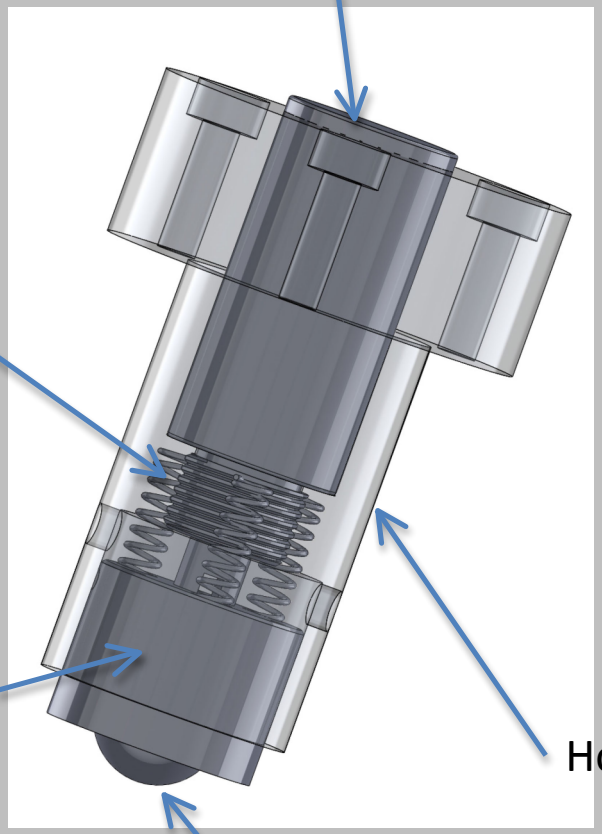
Drive Mechanism

- Vexta PKP246 Stepper Motor
  - Torque = 70oz-in @ 200rpm
- Splined shaft for power transfer to drive wheel
- V shaped drive wheel with mating spline bushing
- Bearings located near force load
- Phenolic material for drive wheel (filter wheel will be hard anodized)
- Idle Roller same design but without motor





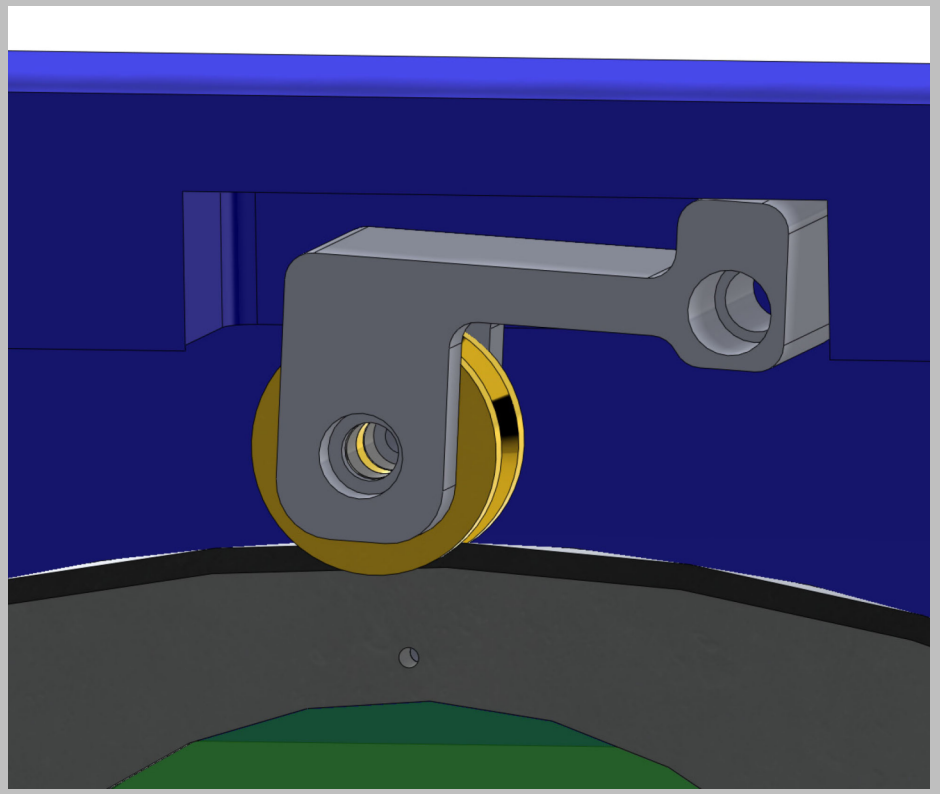
Detent



- Aluminum Housing
- Slip fit and threaded Solenoid
  - ½” travel
  - Active only when moving filter wheel
- Extended push force – 10lbs
- Two detents placed 180deg apart to push equally on the filter wheel

Drive Tensioner

- Tensions from top against Drive Roller and Idle Roller
- Located in removable top
- Bearings pressed into wheel
- Spring tensioned (spring not shown) to force against filter wheel
- Closeness of pivot point to wall prevents over travel



Encoding Scheme

- The stepper motor will contain an encoder to verify steps
- Positional information will be through hall affect sensors
- The home position will be a 4 bit filter wheel address
- At each filter position is a single magnet (in the 0 bit position) to denote that the filter wheel is at a viable position
- It is planned that the stepper motor will count steps and while looking for the positional magnet. When in position the detent will extend and drive motor will turn off. This will push the filter wheel into a highly repeatable position while adding no active heat load.