Keck Next Generation Adaptive Optics

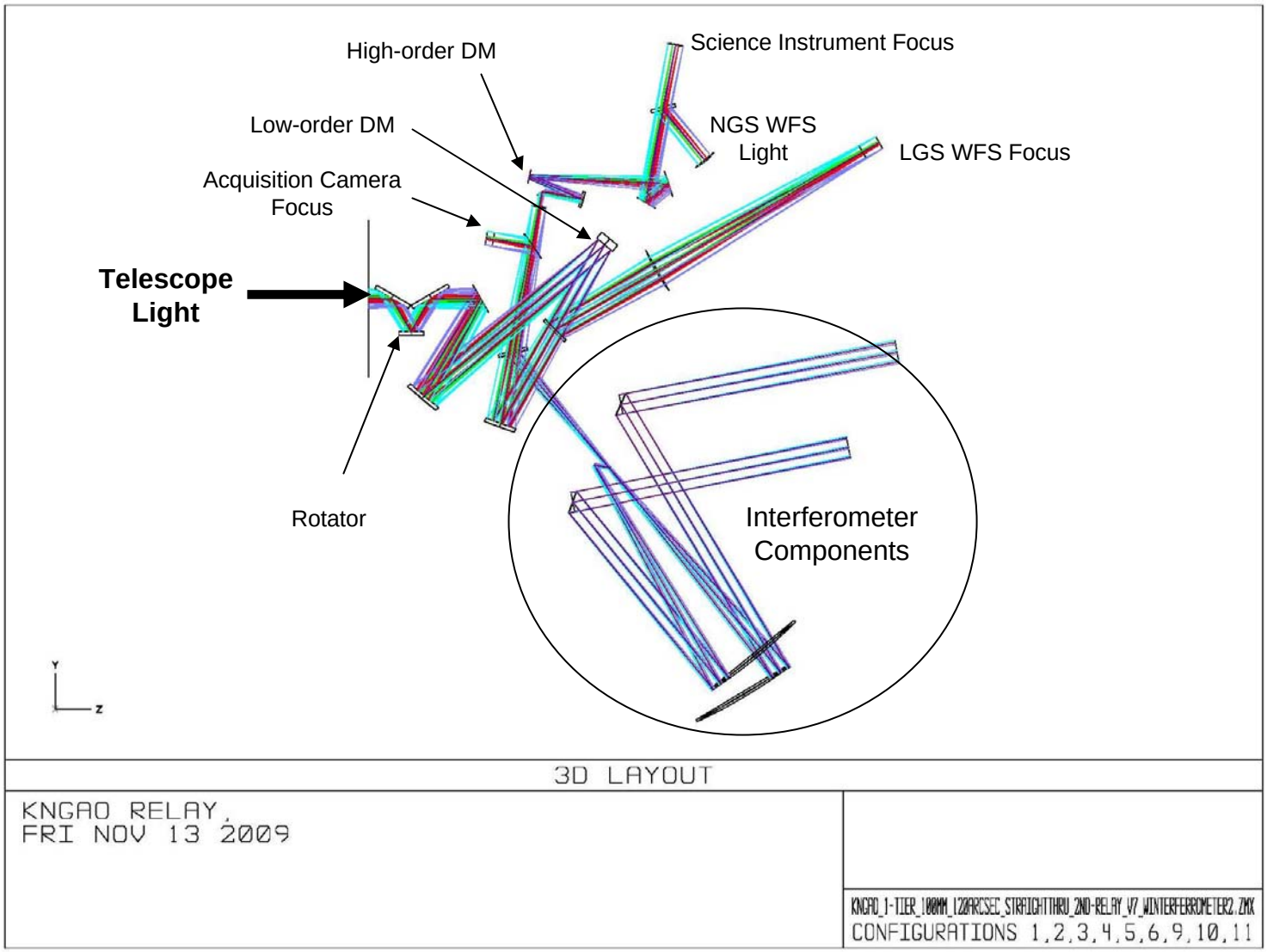
Instrument Bench

Preliminary Mechanical Design

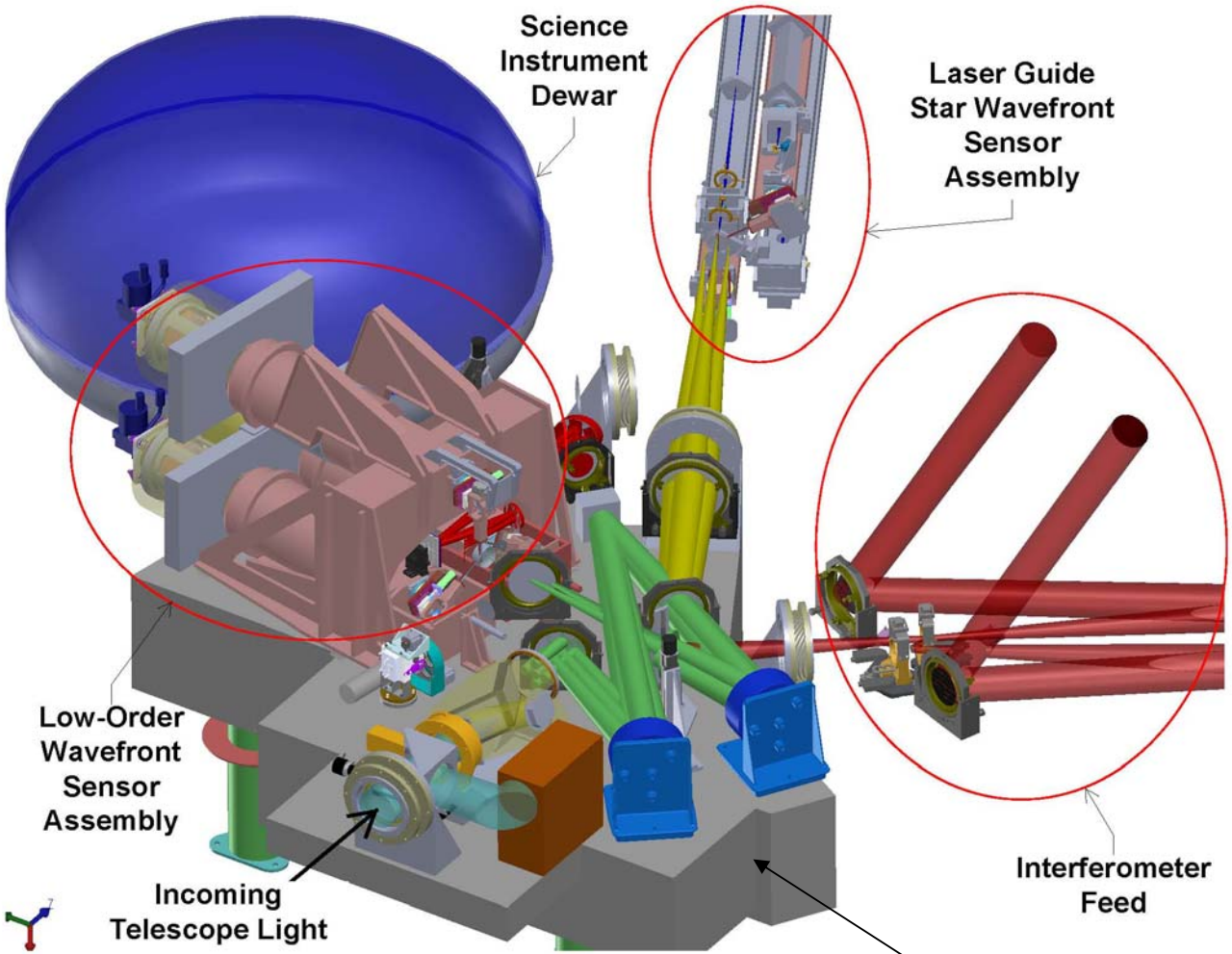
Scope and Goals (AO relay only)

- Iterate optical and mechanical designs to a compatible layout.
- Generate design detail at levels adequate to show feasible mountings without interference or vignetting.
- Verify adjustment resolution can satisfy alignment tolerance requirements of optical design.
- Evaluate thermal stability from maintenance (dome) temperatures, to instrument operating conditions.
- Evaluate stability of instrument interface to telescope.
- Assess vibration stability considering internal and external sources.
- Identify challenges for subsequent phase.

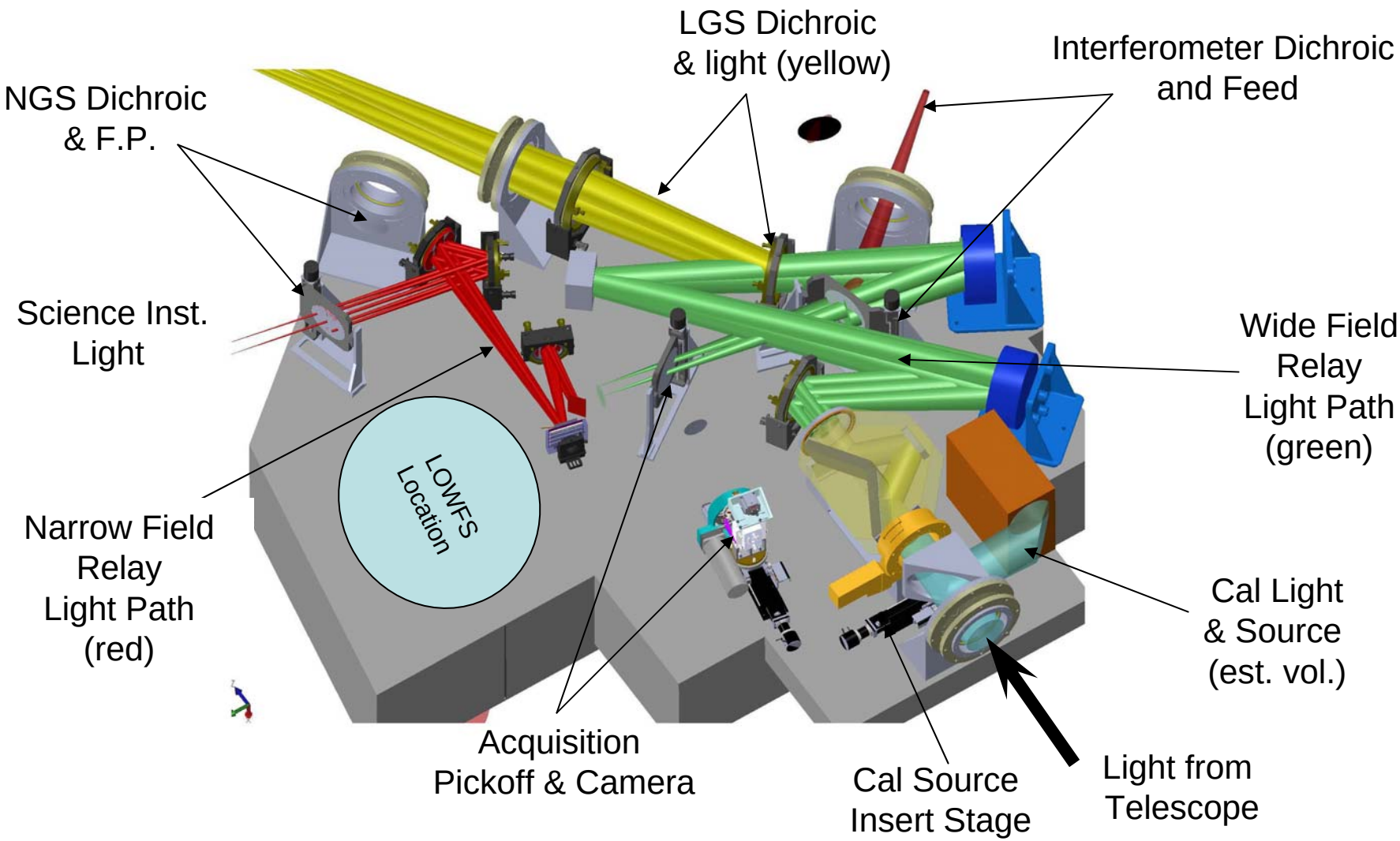
Zemax Design Layout



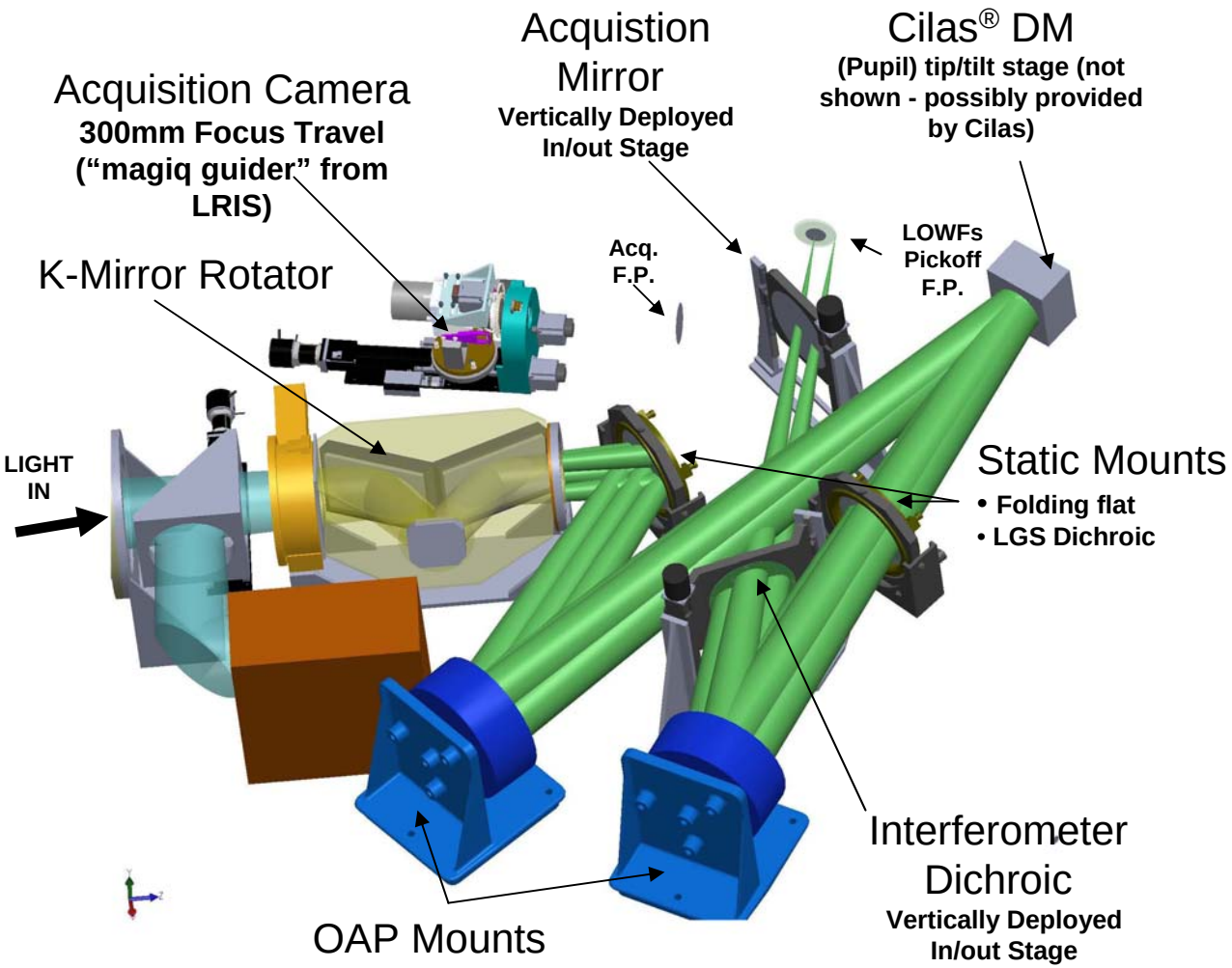
Bench & Related Assemblies



Bench Layout



Wide Field Relay



- Tip/tilt stage-mounted Deformable mirror (mfg's design pending)
- 2 Static mounts (choice – TBD). Shown are Optosigma gimbal mounts w/out (desired) lockable adjustments.
- Acquisition camera shown is "magiq guider" design from LRIS.
- Interferometer dichroic and acquisition camera require custom in/out stages to avoid vignetting.
- Parabola mounts shown are mfg'd by SORL. Packaging limitations may require other choice other choice to fit in final enclosure walls.

K-Mirror Rotator

Newport RV240 Rotational Stage

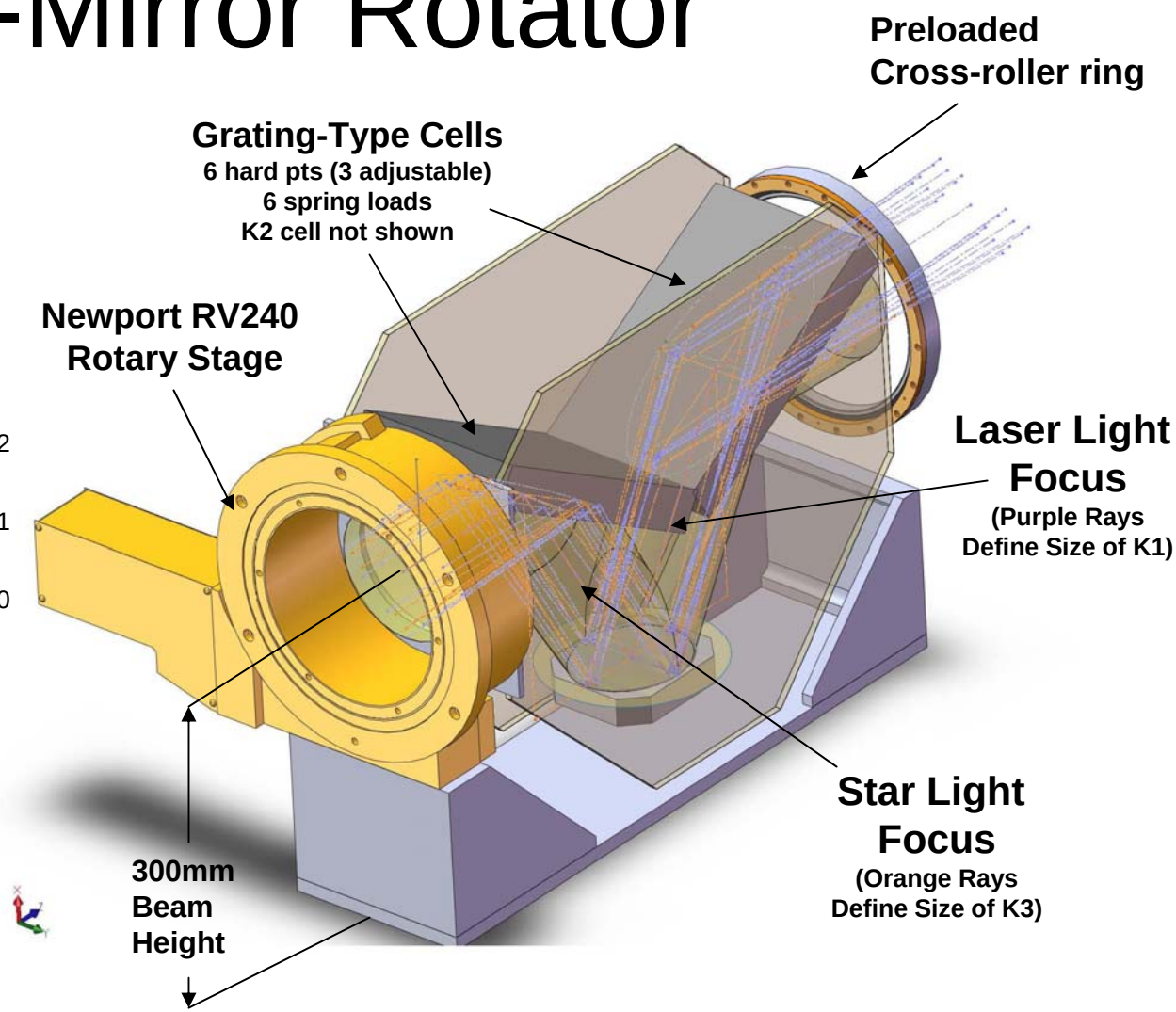
Mfg Specifications

Aperture diameter (mm)	240
Travel Range (°)	360
Resolution (°)	0.001
Minimum Incremental Motion (°)	0.001
Uni-directional Repeatability (°)	0.001 typical, 0.002 guaranteed
Reversal Value (Hysteresis) (°)	0.001 typical, 0.001 guaranteed
Absolute Accuracy (°)	0.007 typical, 0.010 guaranteed
Maximum Speed (°/s)	80
Wobble (µrad)	8 typical, 16 guaranteed
Eccentricity (µm)	1.4 typical, 4 guaranteed

Not Specified

Minimum Operating Temperature

Pressure/Altitude limits

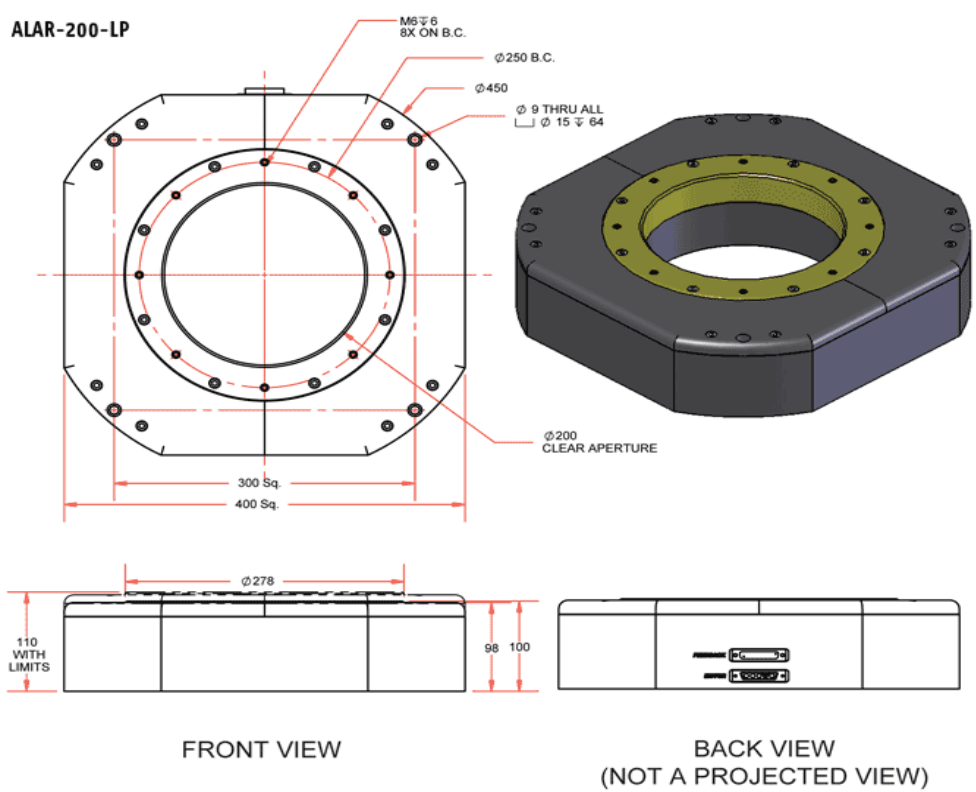


K-Mirror Rotator (cont'd)

- Performance TBD (FR1890 thru 1896).
- Previous Alignment (KAON093)
  - ~1.8 mm on the bench.
  - ~+/-10 arcsec tip/tilt internal/external => 5 micron over 100mm.
- New sub-apertures of 1/3 size => 2 micron req'd.
- Tracking Speed: Up to 1.8deg/sec
- Tracking Acuracy: +/- 5% sub-aperture, 64 across, ~5 arcmin/(2x rotator motion) ~ 2.5arcmin during an exposure…
- Slew rate TBD

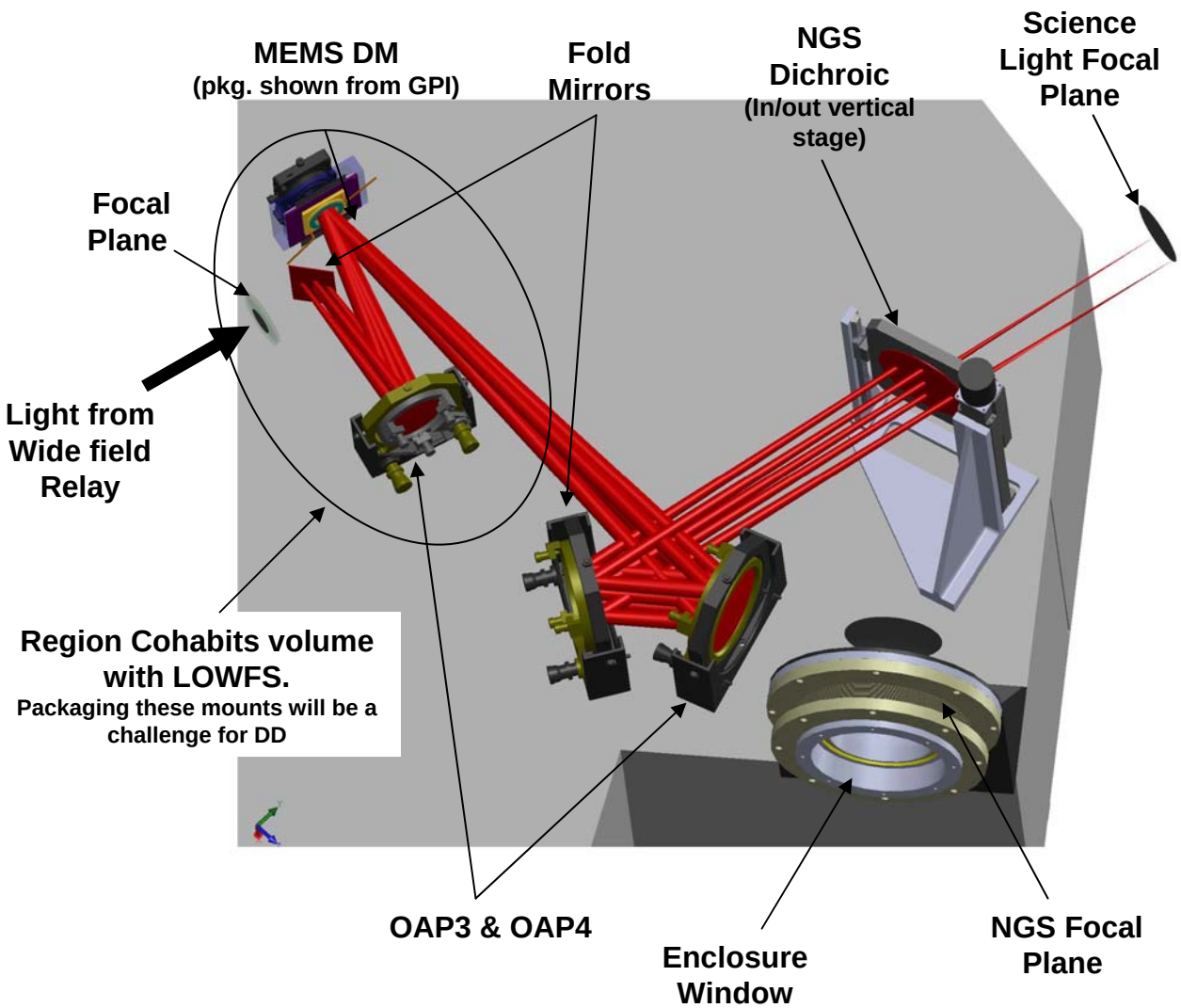
K-Mirror Rotator (cont'd)

- Alternative Rotary Stage being considered
- Aerotech Direct Drive
- Meets resolution, accuracy, speed, and travel requirements (of the current system).
- No gearing backlash
- DC servo

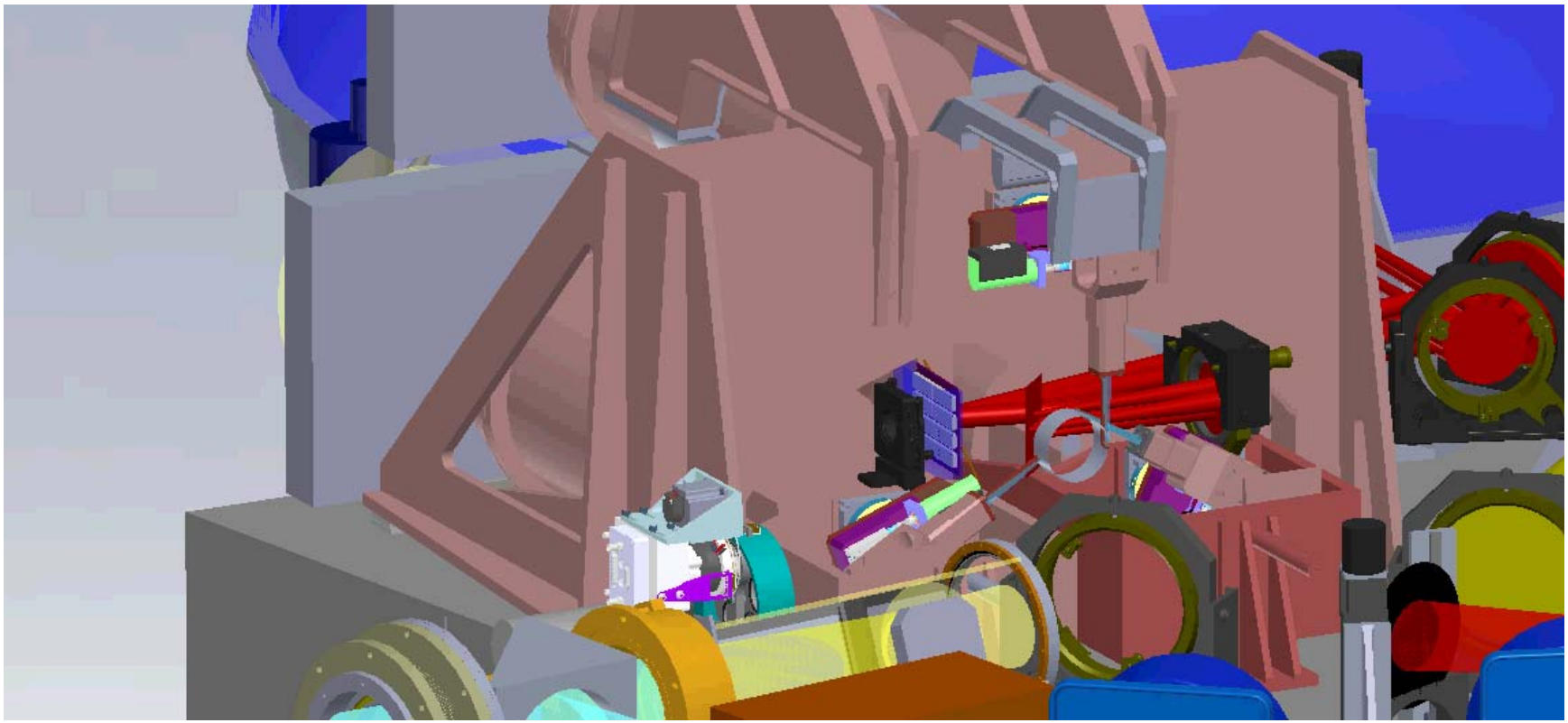


Narrow Field Relay

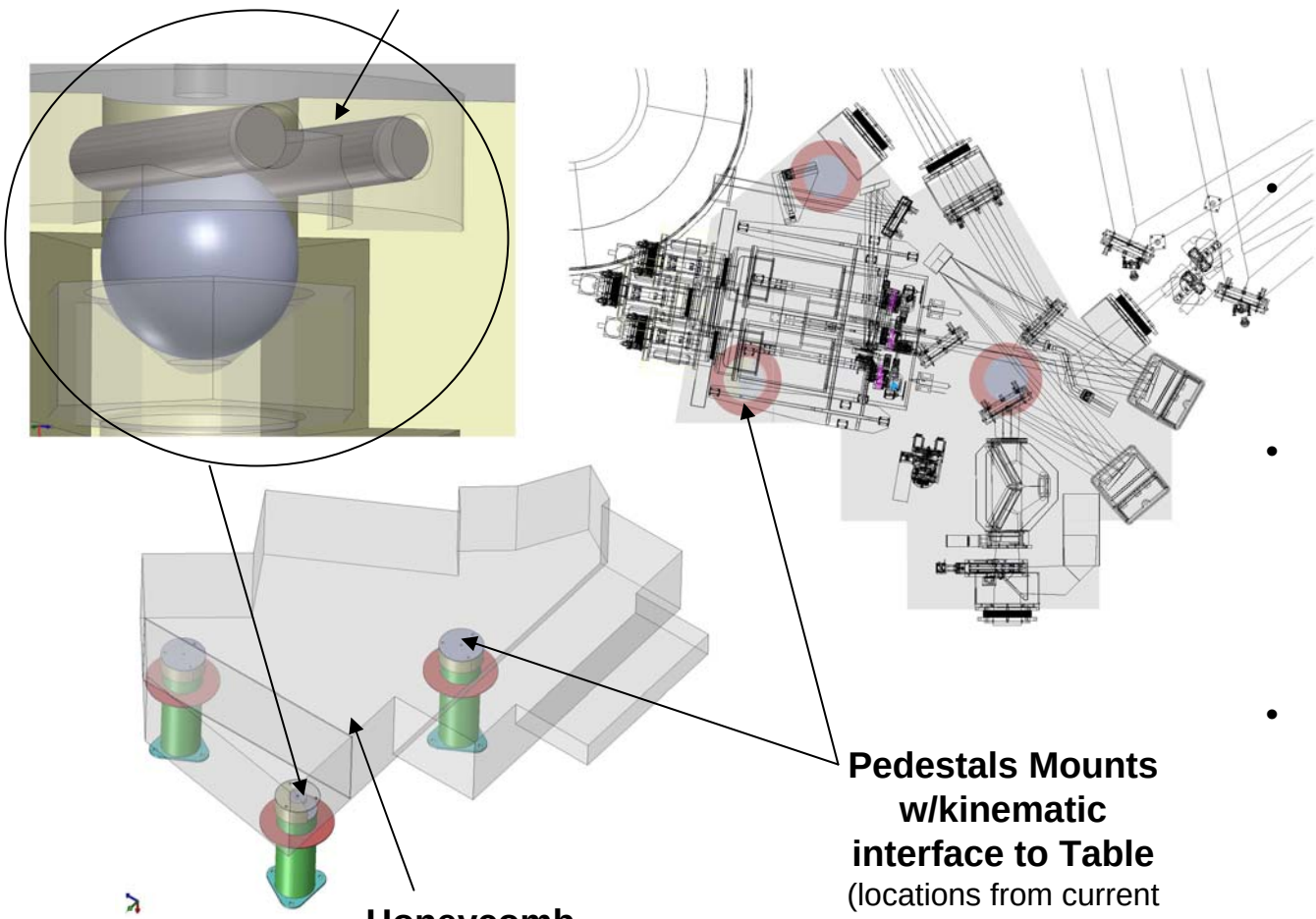
- MEMs Deformable mirror shown on 5-DOF Newport mirror mount. Slow tip/tilt stage-mount will be pursued in DD.
- MEMs & OAP3 mount must be suspended inside LOWFS structure (see next slide).
- Static mounts choice TBD. Shown are Optosigma gimbal mounts w/out lockable adjustments (desired).
- In/out stage req'd NGS WFS dichroic.
- Parabola mounts are TBD. Packaging is tight for this relay.



Packaging Issue for Narrow Field Relay
(right click, “play movie”)



Bench Structure



- **Complex Table shape required for clrnc of external structures and minimization of thermal enclosure vol. (not shown).**
- **Size and Mat'l: Thickness nominally 500mm. Weight, stiffness, thermal expansion, payload, and dynamic forces req'd for full specification.**
- **Location for pedestals based on current configuration – may change in Detailed Design with better mass estimates.**
- **Current kinematics are cone-groove-flat type. Will evaluate 3-radial-groove type as well as matching upper and lower structures for rolling vs. sliding DOFs, in Detailed design.**

Alignment

- General positioning req'd not difficult to achieve with commercial mounts - from optical design tolerance analysis:
  - Decenter < ~100 micrometers
  - Tilt < ~14 arcsec
  - Separation < ~200 micrometers

- K-mirror Rotator alignment specs not yet set (FR-1892). From KAON093 most difficult is internal/external tip/tilt, +/-10arcsec required for pupil alignment to +/-5% of a sub-aperture. **3x better req'd for 63 actuator DM – or ~ 2micron over 100mm.**

- Narrow field DM will require more stringent alignment. If we use the 5% of a sub-aperture criteria, decenter will be approximately +/-20 micrometers.

- OAP alignment procedure and adjustment requirements to be established in DD.

Vibration Stability

- On-instrument sources – required to operate during observations:
  - K-mirror rotator
  - Tip/tilt stage for (woofer) deformable mirror
  - Slow tip/tilt mount for MEMs deformable mirror
  - LOWFS (CCRs and pickoff motors)
- Telescope coupling.
- No stability specification set (FR-1879) - optical design tolerances set upper limit.
- Mass and CG of all subsystems are required to continue with modal analysis of bench mount, table & components.

Thermal Stability

- ~20deg C difference between maintenance/alignment conditions, and operating conditions.

- In-plane displacements of ~ 0.25mm expected for SS (across a meter at dT=20) – detailed image quality impact & consideration of options (low cte table material, metering elements) req'd for DD.

- Vertical displacements expected on same scale. Impact and options (optical mount compensators, low cte/compensator table mounts) req'd in DD.

Motorized Mechanisms

Component	Mode	Type	Accuracy	Cooling** ?
Cal source	in/out config	stepper	~2mm	unlikely
K-mirror Rotator	tracking	servo	unspecified (FR-1894)	likely
Tip/Tilt Stage	Continuous	Electro-static (nominally from Cilas)	100 mas	unknown
Cilas DM	Continuous	Deformable mirror	-	no
IF Dichroic	in/out config	stepper	moves normal to beam. ~few mm	Unlikely
Acq. Camera Mirror	in/out config	stepper	moves normal to beam. ~few mm	Unlikely
LOWFS *				
Slow Tip/Tilt Stage	Continuous	unknown	high	likely
NGS Dichroic	in/out config	stepper	moves normal to beam. ~few mm	unlikely
Narrow Field ADC	Continuous	servo	TBD	TBD

* The LOWFS are addressed in a separate report and mentioned here only for ref.
** Device/motor selection and power dissipation slated for Detailed Design