Optics Subsystem Update

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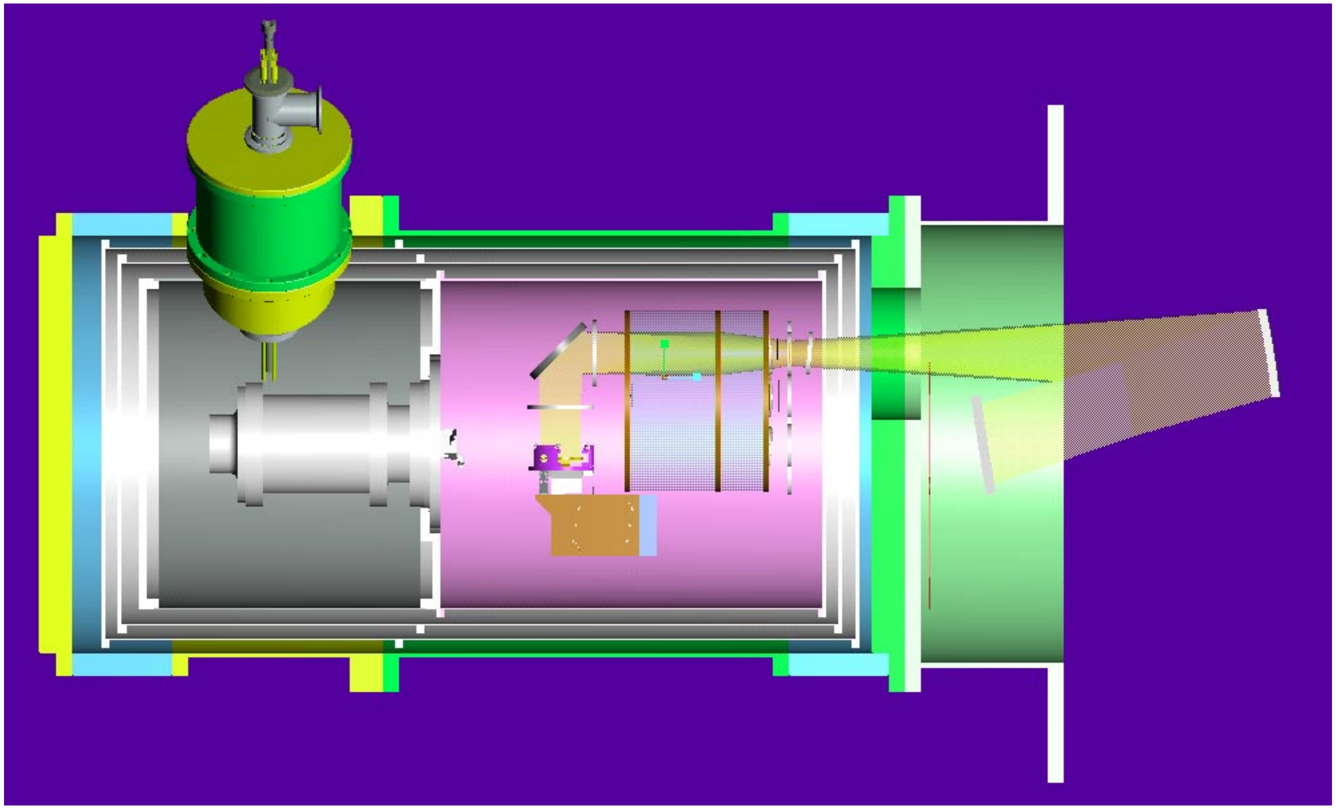
Optics design has been simplified and refined since PDR

- Key design decisions made since PDR
  - Warm fore-optics
  - Reduced number of mechanisms
  - No internal calibration sources



Requirements flowdown

- Cover 40-300 μm range in 3 or 4 bands
  - What are optimal choices for central wavelengths and bandwidths?
- Preserve highest spatial frequencies of telescope
  - 2 pixels per Airy fwhm gives good compromise between efficiency on small objects and large areas
  - Complete sampling of highest spatial frequencies requires subsampling by about a factor of two
- Spectral bands and pixel sizes determine detector backgrounds and photon-noise-limited sensitivities
- Pixel size and array size determine field of view
  - Field must be larger than physical size of array
    - To avoid vignetting
    - To avoid scattered light from outside telescope entrance pupil
    - So that all detectors see the same pupil illumination (necessary for good rejection of common-mode noise from modulated background radiation)

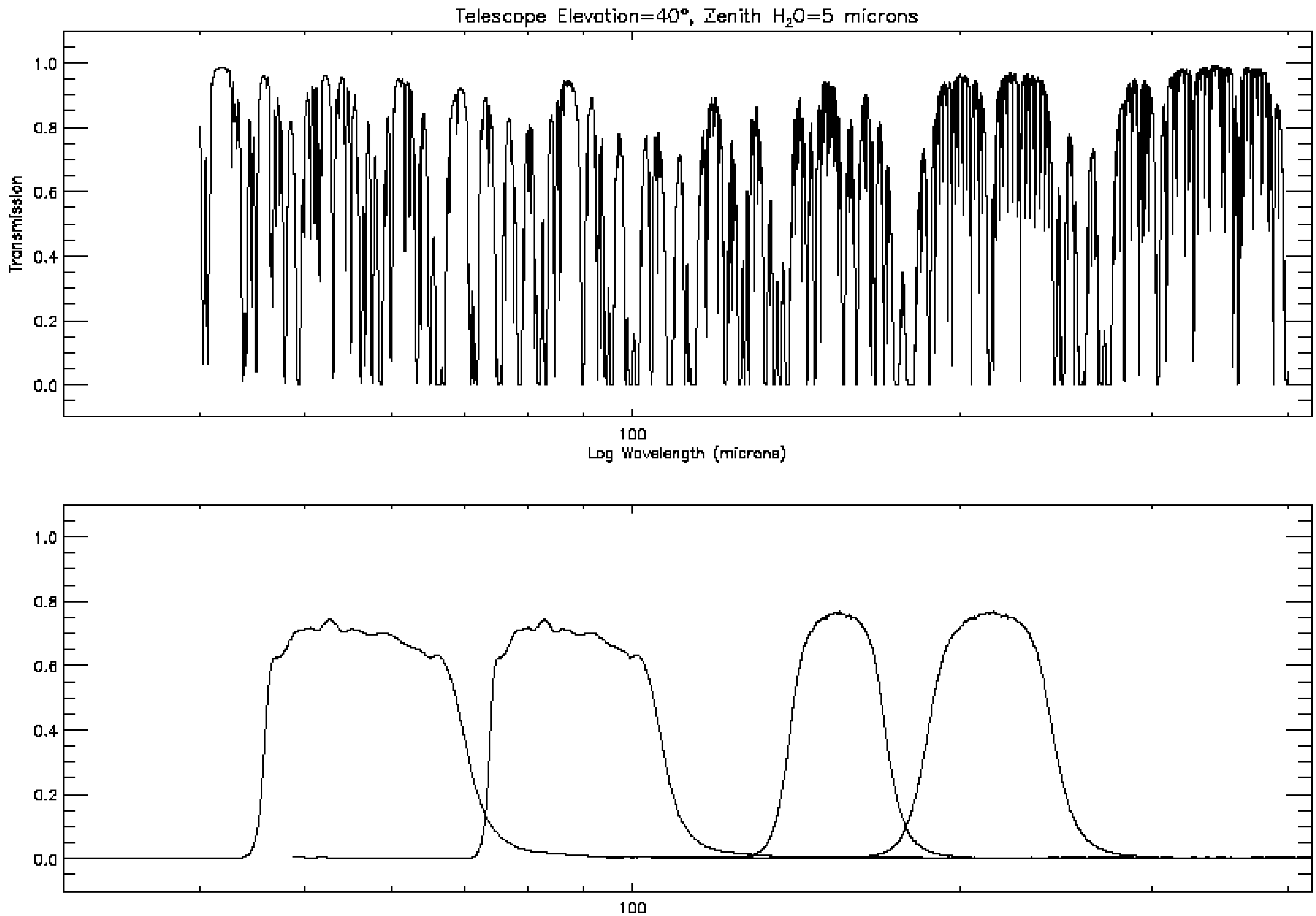
Requirements flowdown (cont.)

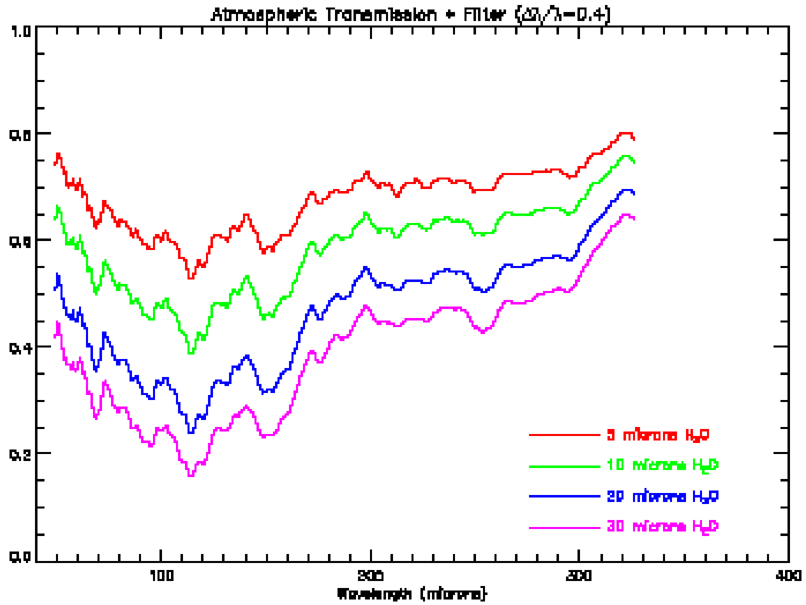
- Field of view of longest-wavelength band drives size of window
  - Large window must be thick, which implies low transmission and high emission
  - Putting pupil near window results in smallest window, best signal-to-noise ratio
- Can place pupil at window with warm, reflective fore-optics
  - Reduced emission from window offsets emission from warm mirrors
  - Common pupil for all bands
  - One warm adjustment matches cold pupil to telescope entrance pupil
  - One mechanism carries pupil masks or auxiliary filters and serves as shutter
  - Pupil-masking offers simple option for improving signal-to-noise ratio for highest spatial frequencies
  - Re-imaging optics and bandpass filters for four bands can be mounted in a single mechanism
  - Convenient placement of point and “hotplate” calibration sources

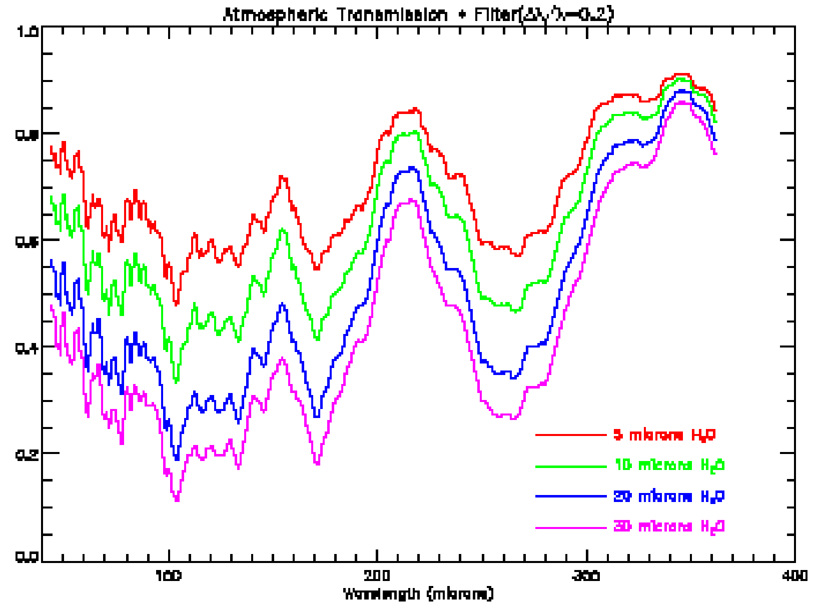
Requirements flowdown (cont.)

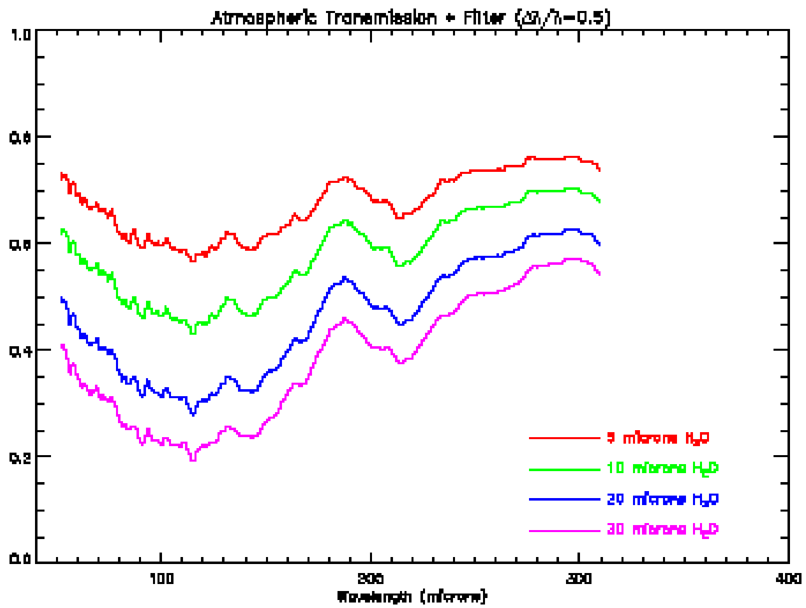
- Simple singlet or doublet lenses can achieve diffraction-limited imaging
  - Anti-reflection coating can give high throughput
  - Silicon lenses required in shortest wavelength bands to control chromatic aberration
  - Testing required to determine optimal lens material for longest-wavelength bands

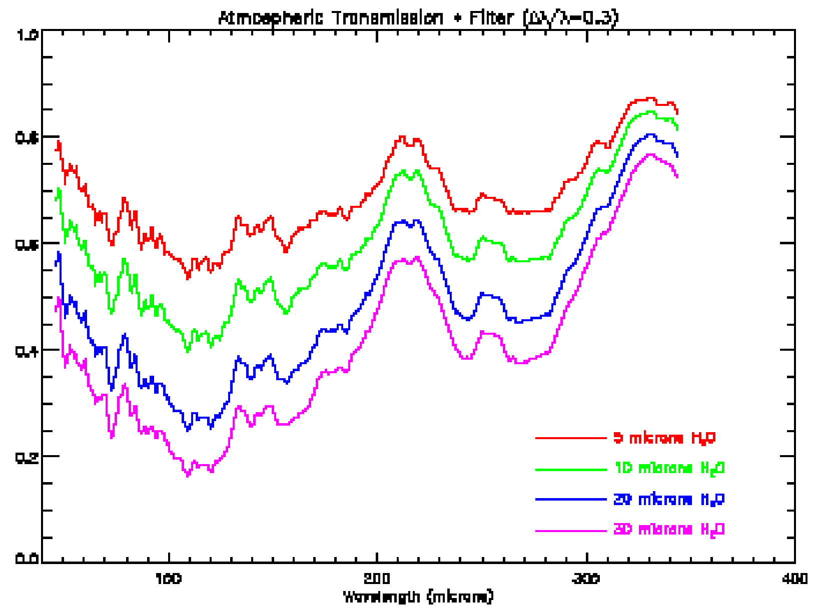
Filters optimized to match atmospheric transmission and minimize emission

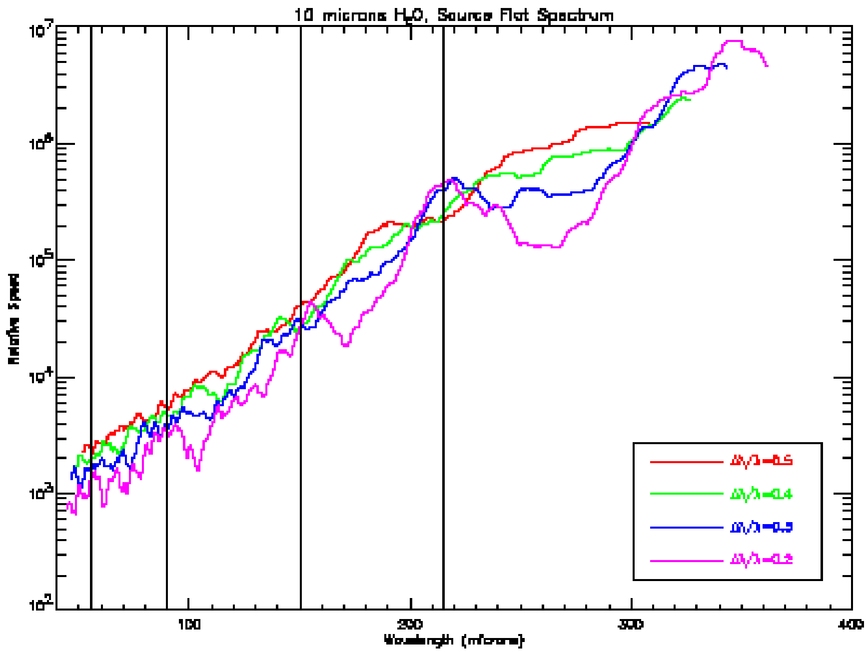


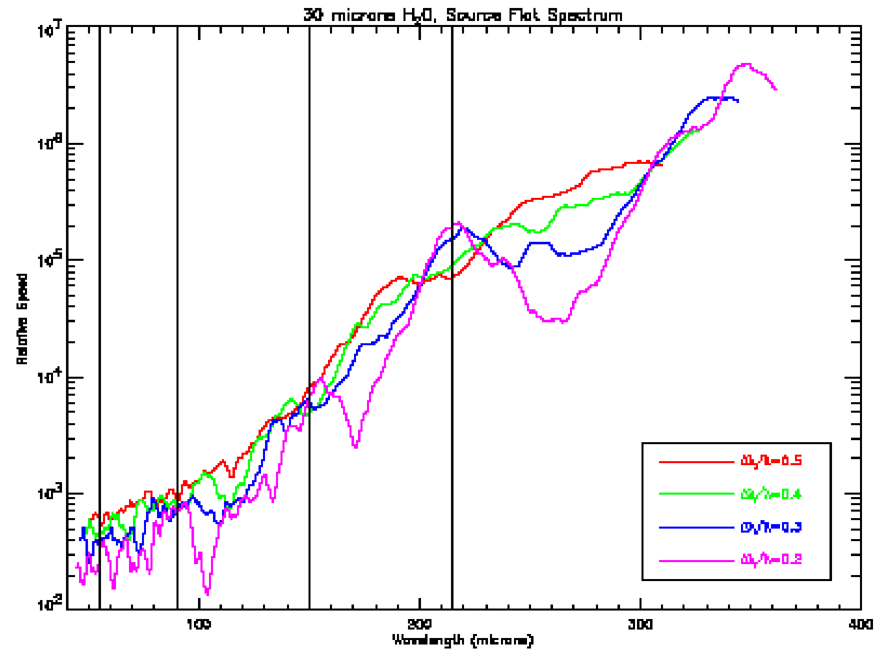

Atmospheric Transmission + Filter (Δλ/λ=0.4)
1.0
0.8
0.6
0.4
0.2
0.0
100
200
300
400
Wavelength (microns)
5 microns H2O
10 microns H2O
20 microns H2O
30 microns H2O

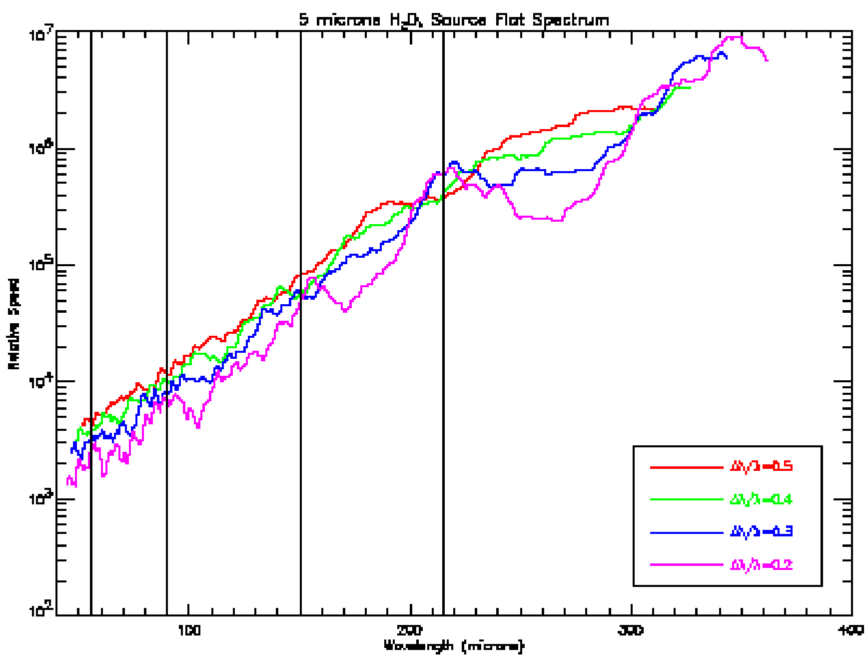

Atmospheric Transmission + Filter(Δλ/λ=0.2)
1.0
0.8
0.6
0.4
0.2
0.0
100
200
300
400
Wavelength (microns)
5 microns H2O
10 microns H2O
20 microns H2O
30 microns H2O

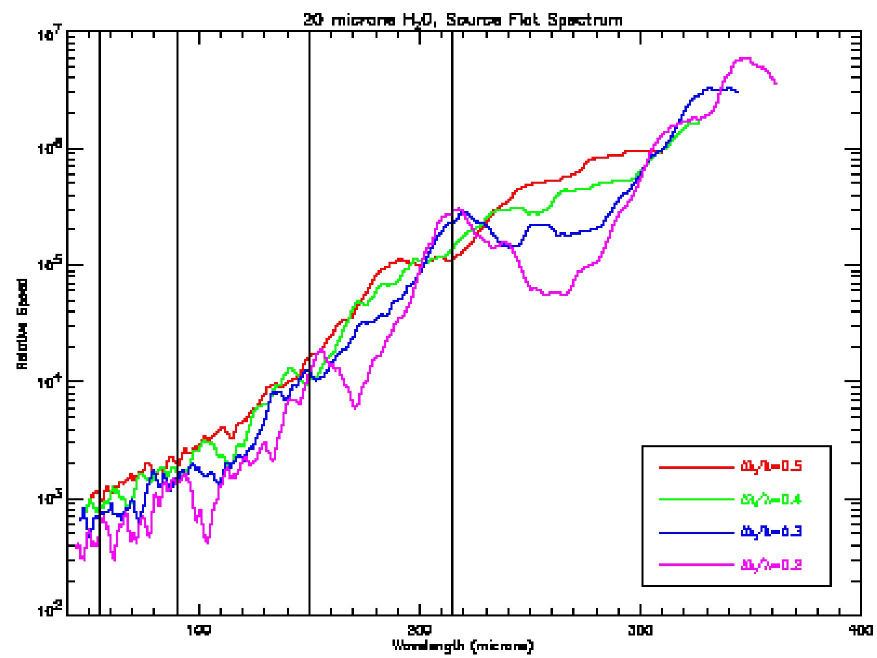

Atmospheric Transmission + Filter (Δλ/λ=0.5)
1.0
0.8
0.6
0.4
0.2
0.0
100
200
300
400
Wavelength (microns)
5 microns H2O
10 microns H2O
20 microns H2O
30 microns H2O

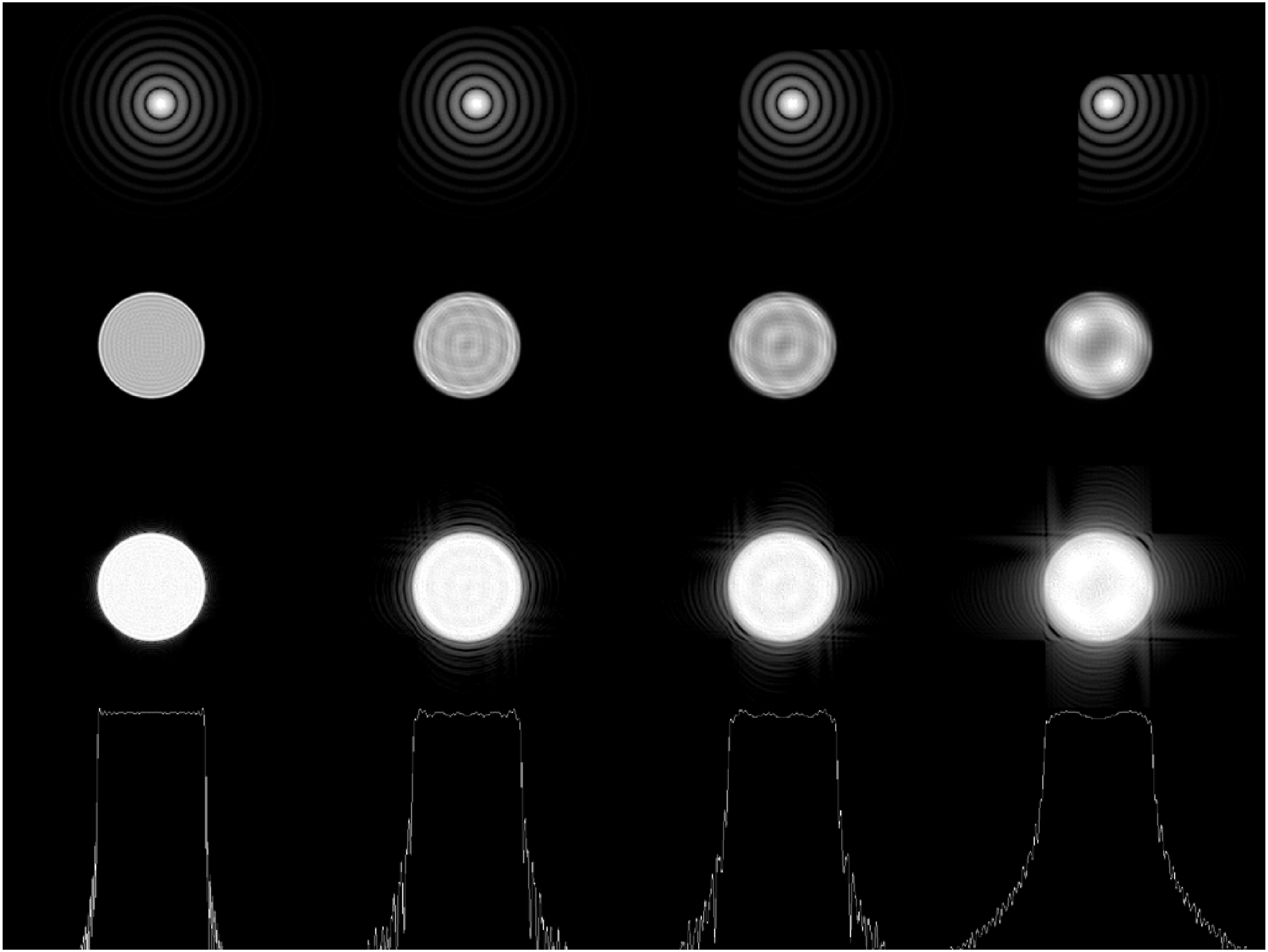

Atmospheric Transmission + Filter (Δλ/λ=0.3)
1.0
0.8
0.6
0.4
0.2
0.0
100
200
300
400
Wavelength (microns)
5 microns H2O
10 microns H2O
20 microns H2O
30 microns H2O


10 microns H2O, Source Flat Spectrum
Relative Speed
Wavelength (microns)
Δλ/λ=0.5
Δλ/λ=0.4
Δλ/λ=0.3
Δλ/λ=0.2

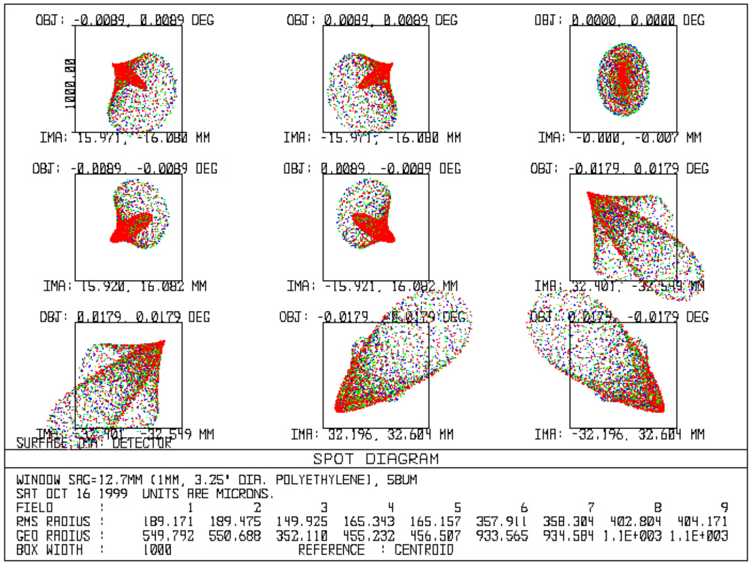

30 microns H2O, Source Flat Spectrum
Relative Speed
Wavelength (microns)
Δλ/λ=0.5
Δλ/λ=0.4
Δλ/λ=0.3
Δλ/λ=0.2

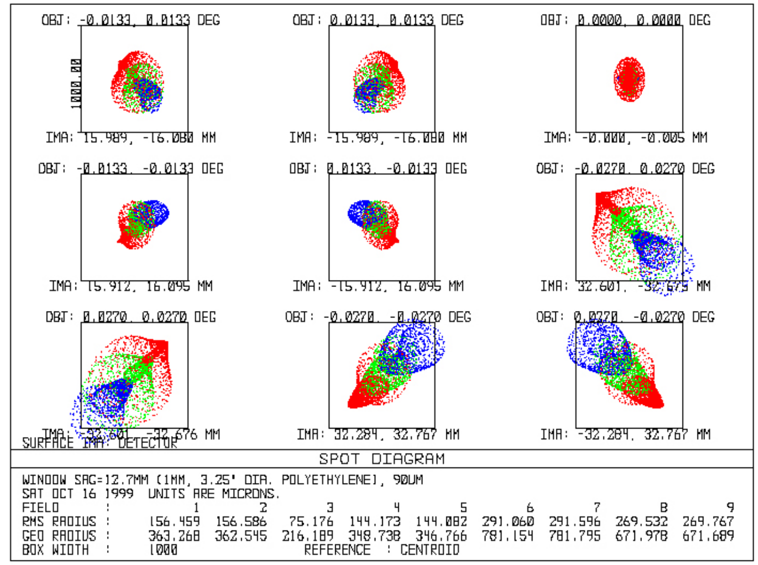

5 microns H2O, Source Flat Spectrum
Relative Speed
Wavelength (microns)
Δλ/λ=0.5
Δλ/λ=0.4
Δλ/λ=0.3
Δλ/λ=0.2

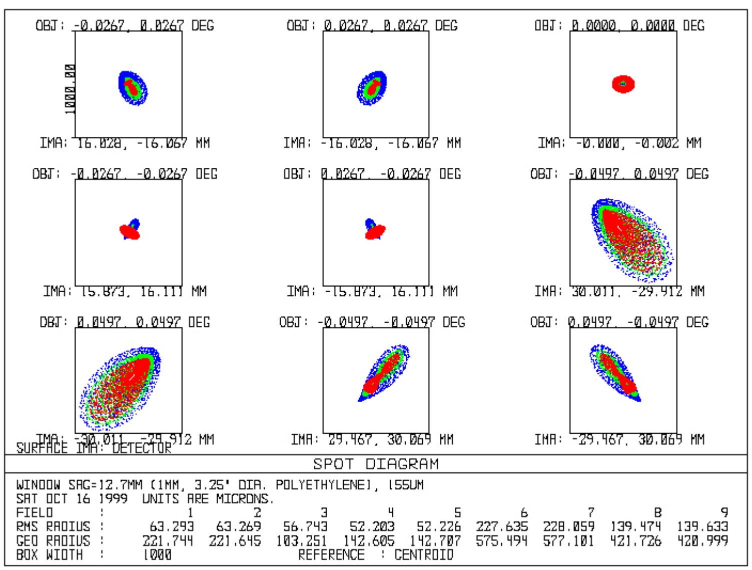

20 microns H2O, Source Flat Spectrum
Relative Speed
Wavelength (microns)
Δλ/λ=0.5
Δλ/λ=0.4
Δλ/λ=0.3
Δλ/λ=0.2

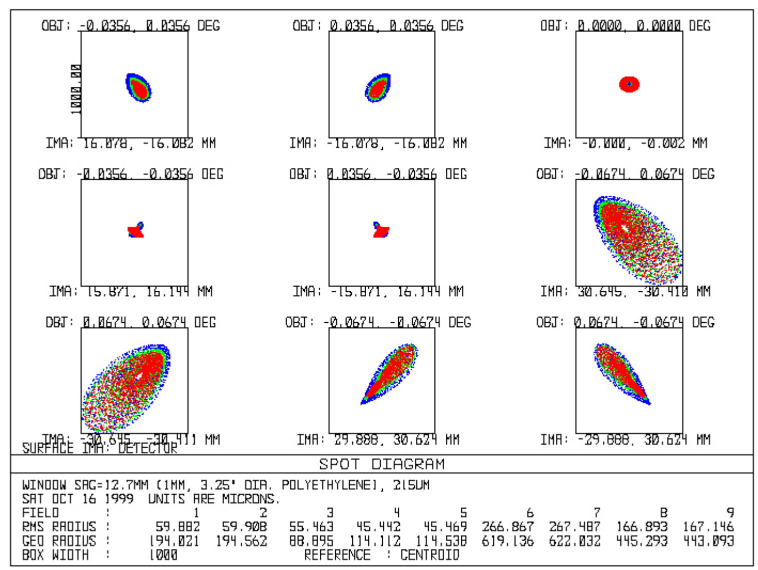


4 bands all diffraction-limited

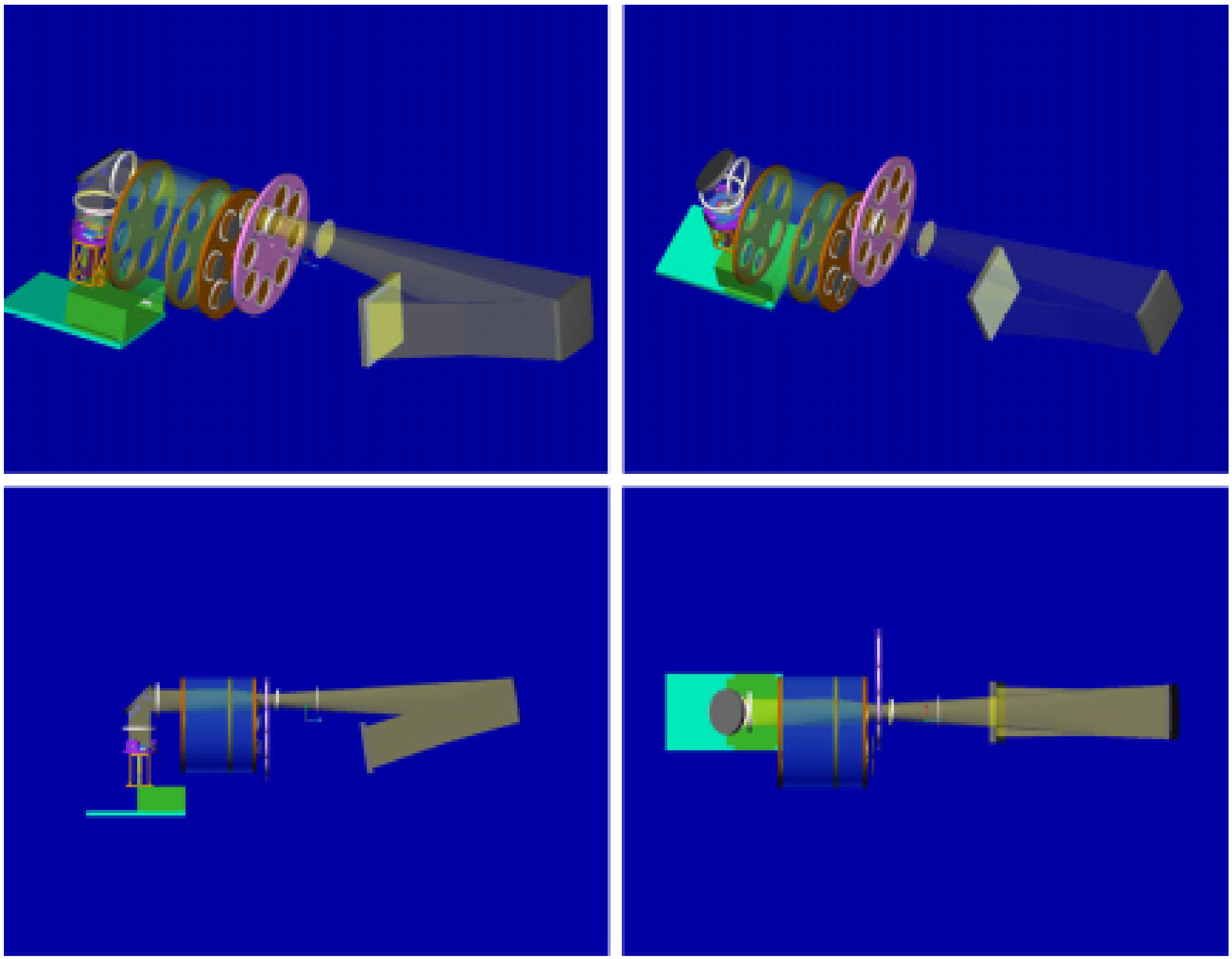




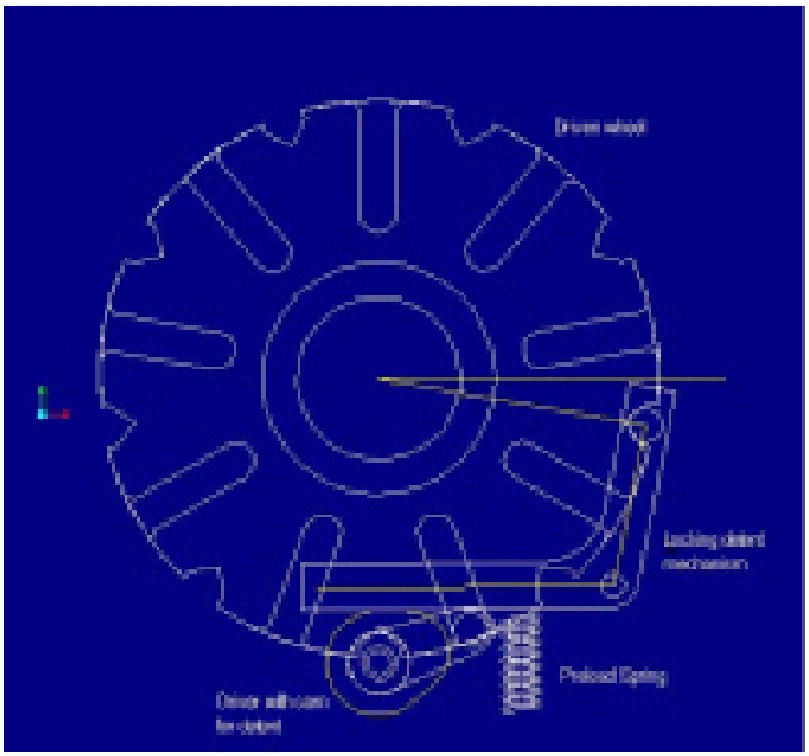




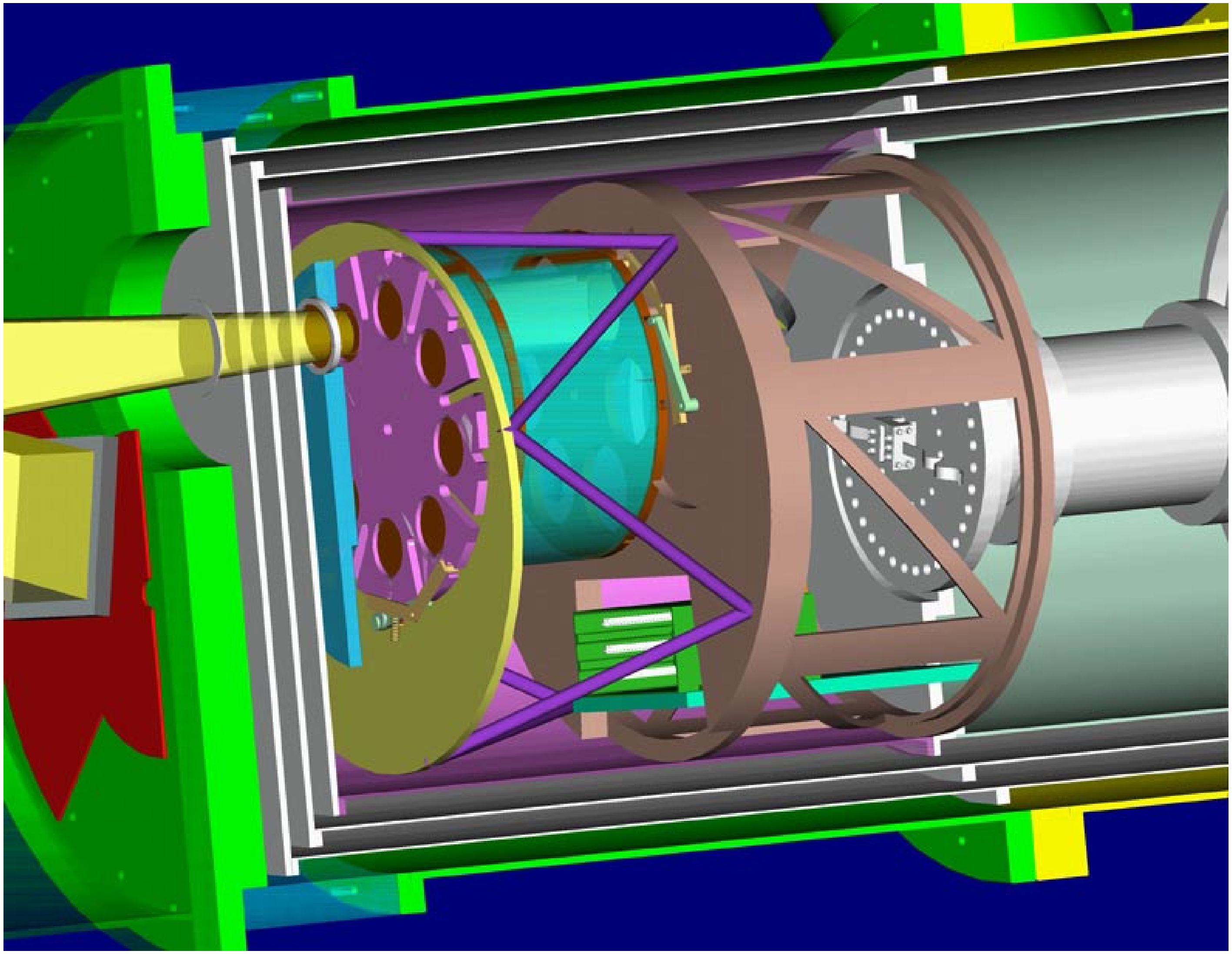
Optical prescription is set



Geneva mechanisms assure positive location



Mechanisms are being designed around optics prescription



Optical design is ready to move to critical design stage

- Complete tolerance analysis
  - Bolt and go? Shim to adjust? If so, then what range?
- Detail and finalize design of optical mounts, mechanisms, and baffles
- Detail and finalize design of calibration subsystem
- Test optical materials and finalize selection of lens materials and coating process
- Finalize prescription of filter passbands using filter curves from vendor