Marshall Grazing Incidence

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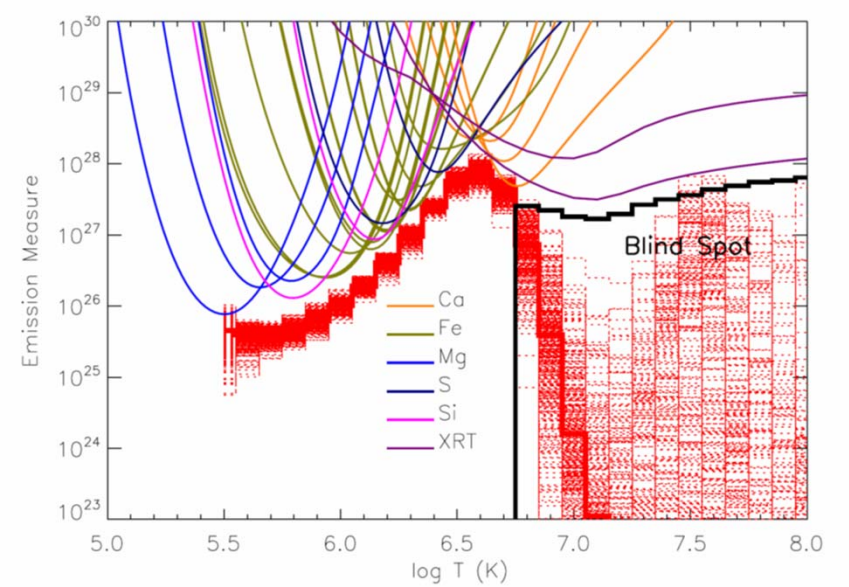
1: NASA Marshall Space Flight Center

2: Smithsonian Astrophysical Observatory

3: Izentis LLC

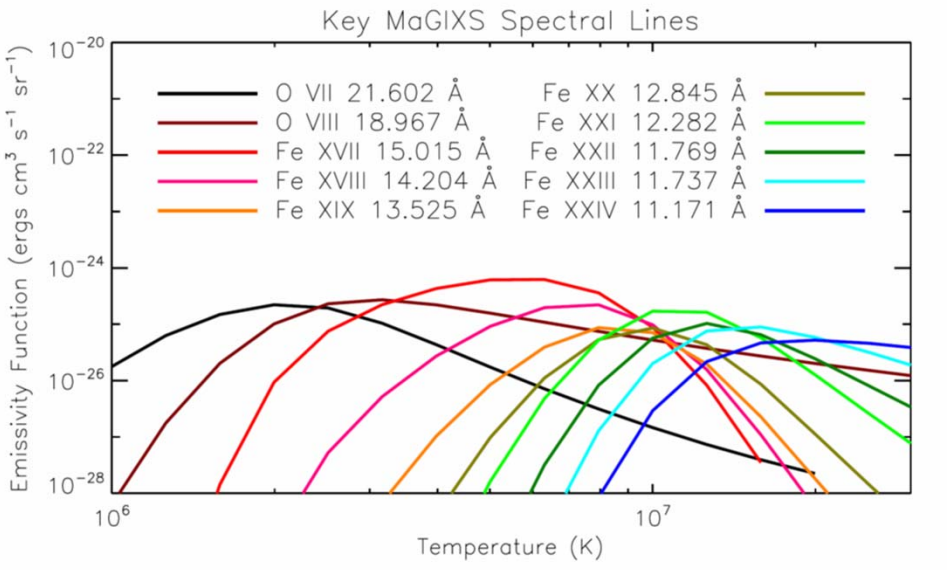
4: Massachusetts Institute of Technology

Background



- Science Goals:
  - Measure the temperature distribution (Differential Emission Measure) of the solar corona to better understand the coronal heating mechanism
  - Measure the elemental abundance in the solar corona

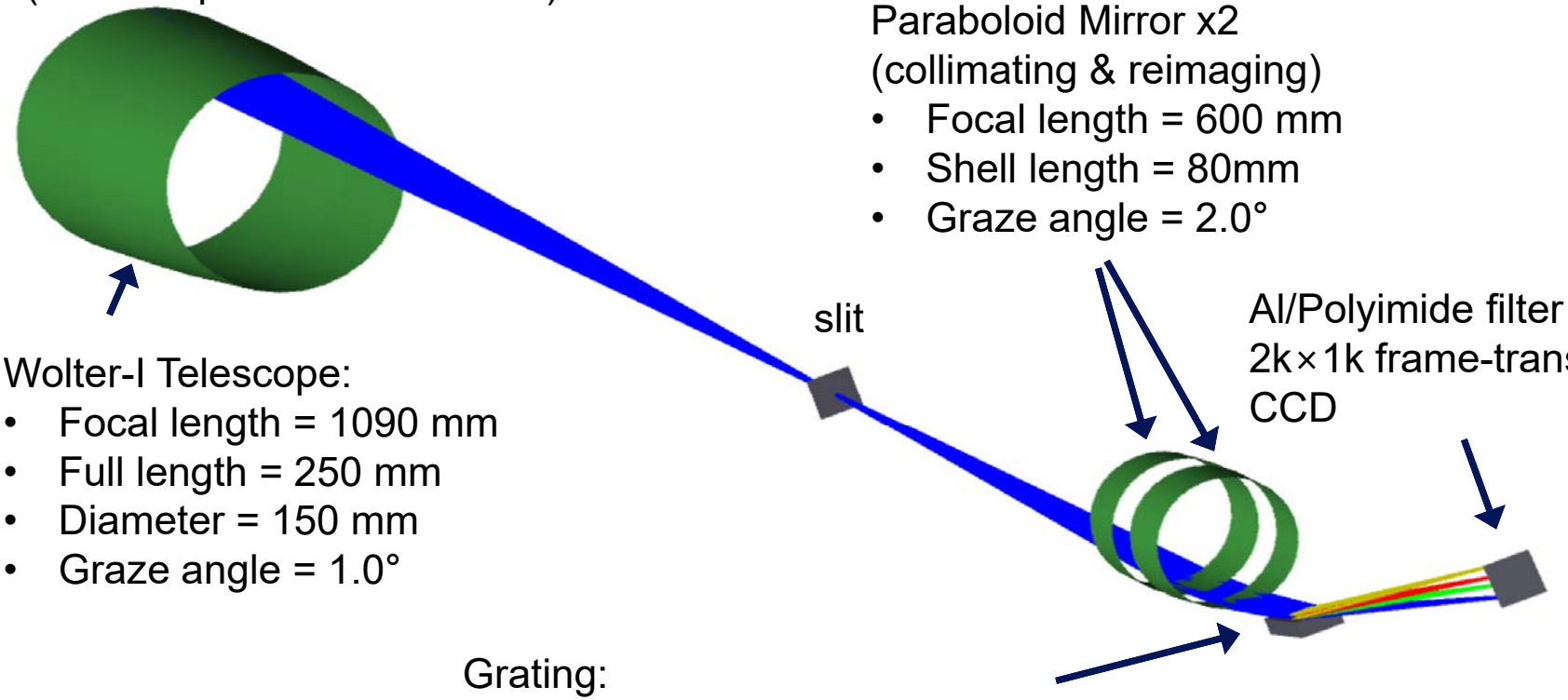
Observation Goals



- Observation Goals:
  - Energy range: 0.57 – 1.3 keV (0.91 – 2.16 nm)
  - Energy resolution: ~1 eV (0.005 nm)
  - Slit spectrograph with 260” slit length
  - 6” spatial resolution along slit

Optical Design

(Al/mesh pre-filter not shown)



Paraboloid Mirror x2
(collimating & reimaging)
- Focal length = 600 mm
- Shell length = 80mm
- Graze angle = 2.0°

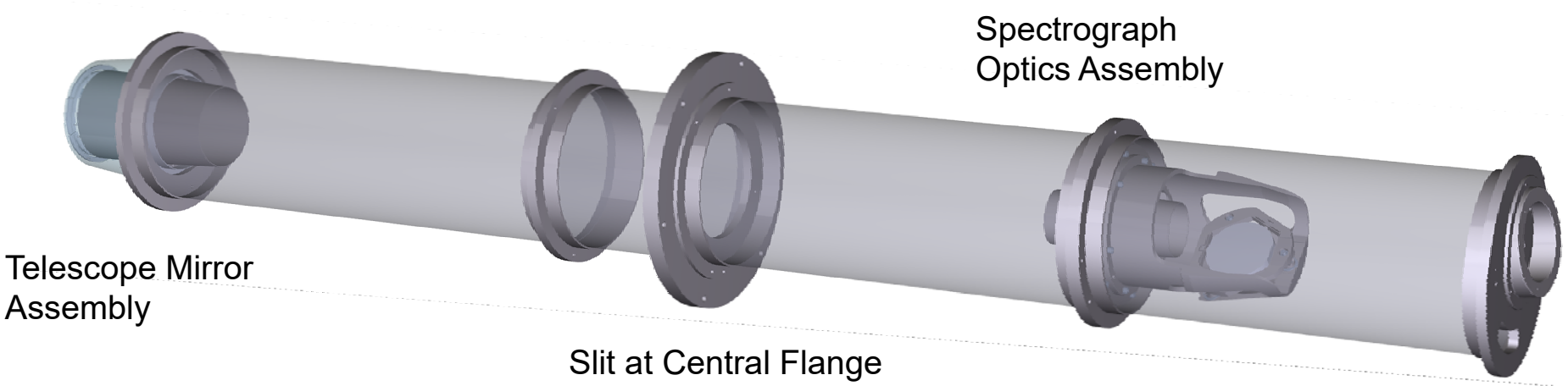
slit

Al/Polyimide filter +
2k×1k frame-transfer
CCD

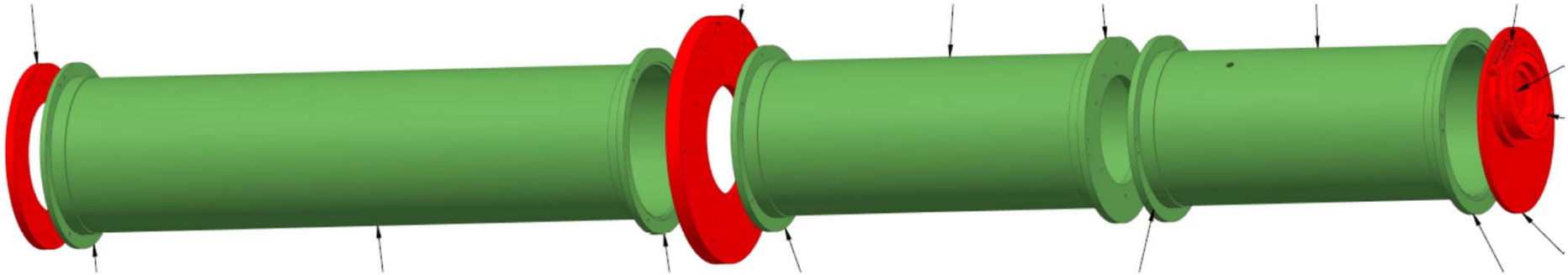
Wolter-I Telescope:
- Focal length = 1090 mm
- Full length = 250 mm
- Diameter = 150 mm
- Graze angle = 1.0°

Grating:
- Planar, 25 mm × 73 mm
- 1850 – 2500 lines/mm

Instrument Layout

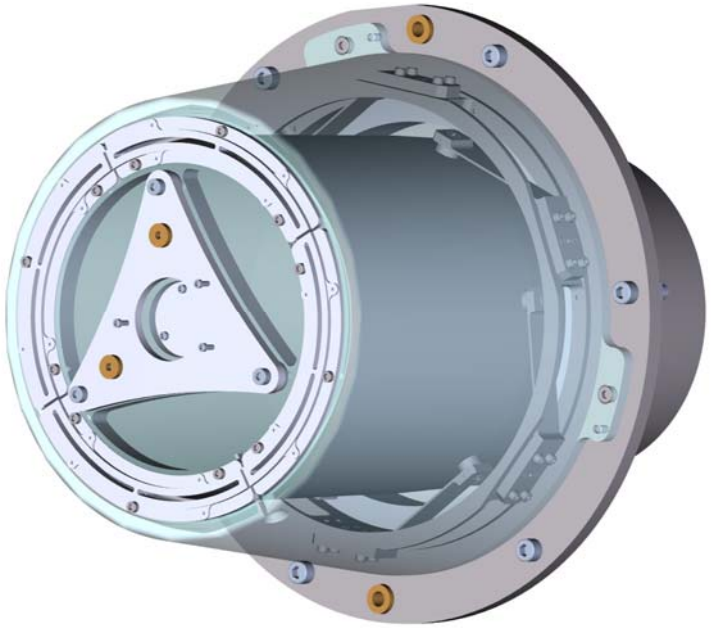


Instrument Structure



- Structure is cantilevered from central flange
- Stainless steel tubing with welded & machined flanges for low cost & acceptable thermal stability

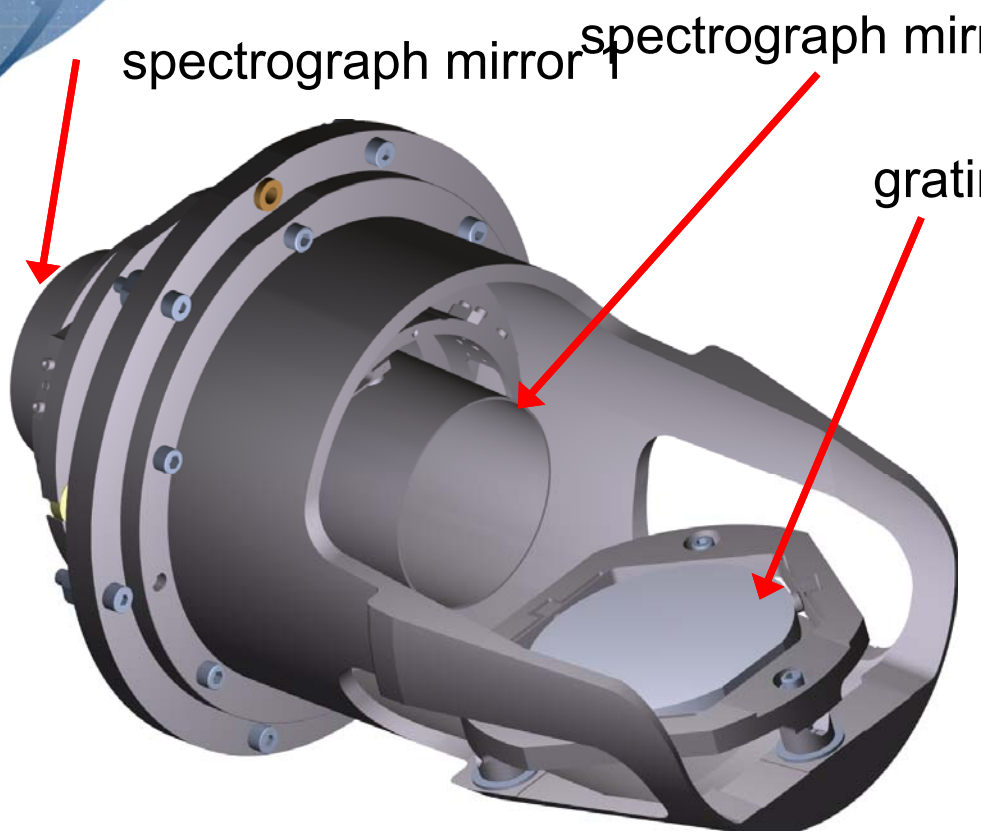
Telescope Mirror Assembly



Telescope Mirror Assembly:

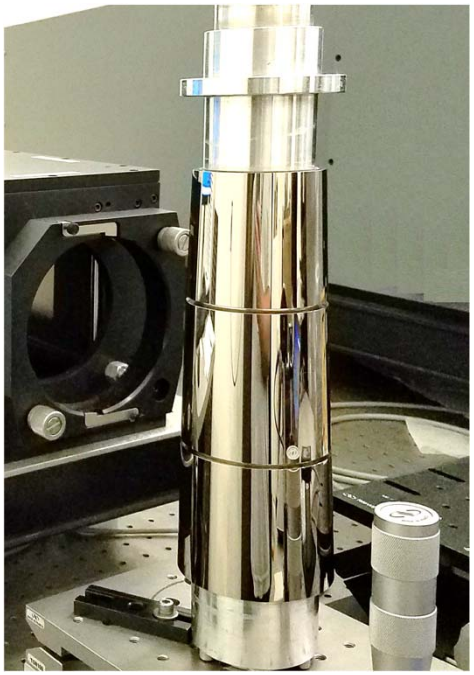
- Sun sensor mount
- Pre-filters (Al on mesh); light tight design
- Telescope mirror supported at CG by 6 flexures
- Alignment features (centering reticle and optical flat)
- Mirror aligned to optical flat with CDA (centroid detector assembly) before bonding
- Hardware delivery expected in September.

Spectrograph Optics Assembly



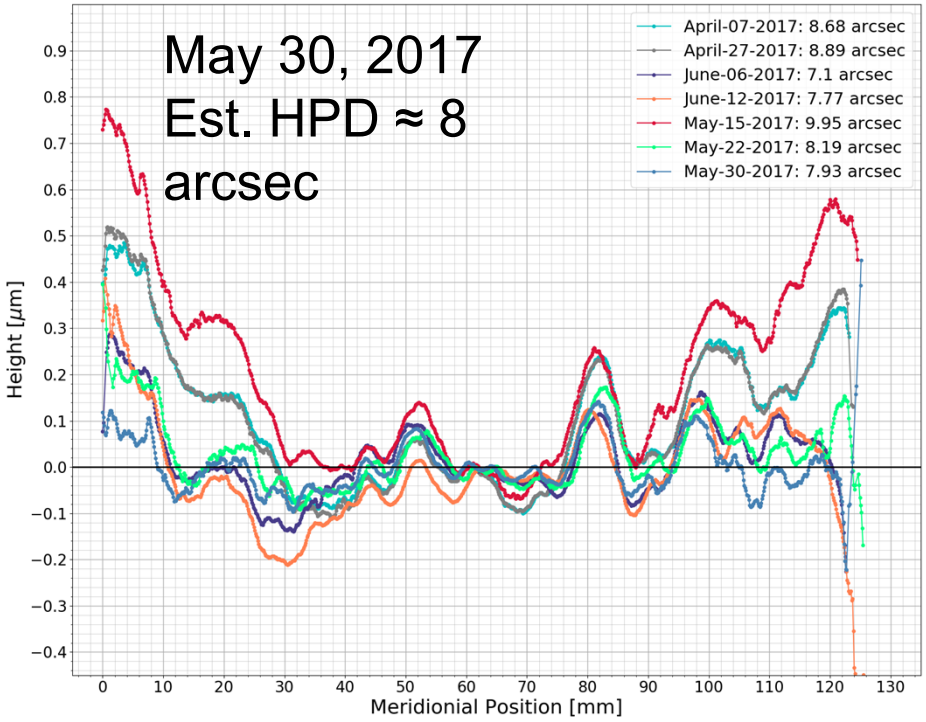
- Spectrograph mirror pair aligned to each other optically to ~6” and bonded
- Mirrors aligned to centering reticle & reference flat
- Kinematic grating mount

Mirrors



- Electroformed nickel replicated mirrors, fabrication at NASA MSFC, based on heritage from FOXSI, HERO, ART-XC, etc
- Unique challenges:
  - Short focal length, long segment length
  - High resolution requirement (<6 arcsec half power diameter)
- Status:
  - Machining completed on both mandrels
  - Hand polishing and lapping of both mandrels completed
  - Test mirror shells replicated & tested in X-ray
  - Further mandrel polishing using Zeeko polisher underway

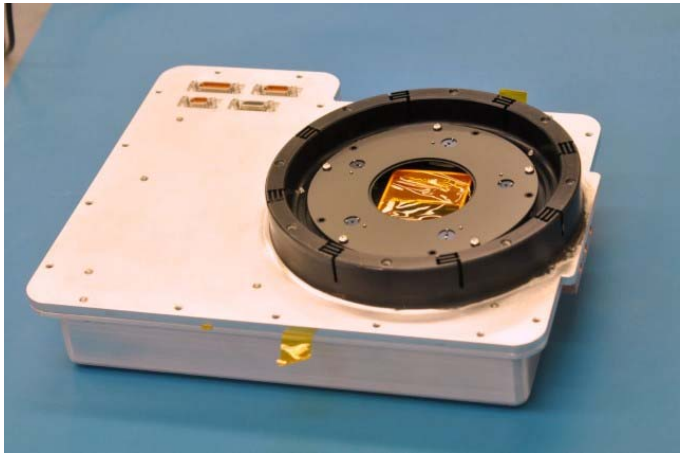
Mirrors


May 30, 2017
Est. HPD ≈ 8 arcsec
April-07-2017: 8.68 arcsec
April-27-2017: 8.89 arcsec
June-06-2017: 7.1 arcsec
June-12-2017: 7.77 arcsec
May-15-2017: 9.95 arcsec
May-22-2017: 8.19 arcsec
May-30-2017: 7.93 arcsec
Height [μm]
Meridionial Position [mm]

Grating

- Planar grating with varied line spacing
- Challenges:
  - Blazed grating required for good efficiency at grazing incidence
  - Large variation in line spacing (398nm to 541nm over 73mm) precludes use of holographic grating
- Electron-beam lithography + etching to be used
- Grating substrate is crystalline silicone with the {111} crystal orientation matched to the desired blaze angle
- KOH etching, with {111} plane of crystal acting as etch stop
- Substrate procured; fabrication preparation underway at Izentis LLC

Camera



- Custom designed at MSFC, originally for the High Resolution Coronal Imager 2 (Hi-C II).
- e2v CCD230 – 2k x 2k full-frame / 2k x 1k frame-transfer (frame-transfer mode for MaGIXS)
- Flight heritage from Hi-C (used in full frame mode)
- 6 e- rms noise demonstrated at 500 kpixel/s readout speed
- CCD connected to LN2-cooled thermal reservoir; <-30C temperature to be maintained for flight
- Data transfer through SpaceWire to flight computer for control onboard image storage & downlink

Status

- Major instrument structures in fabrication
- Mirror mandrels in polishing