The STEREO-SECCHI Extreme Ultraviolet Imager

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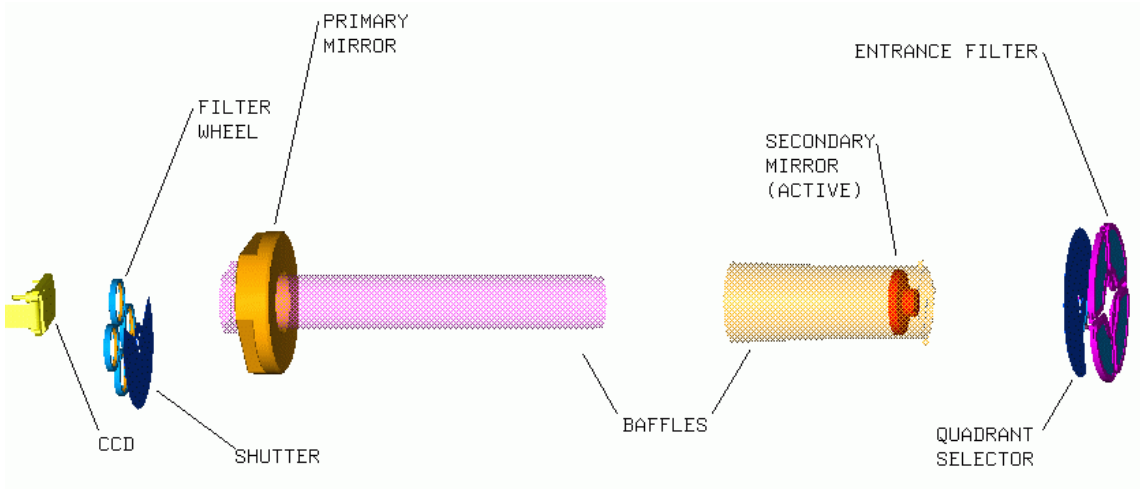
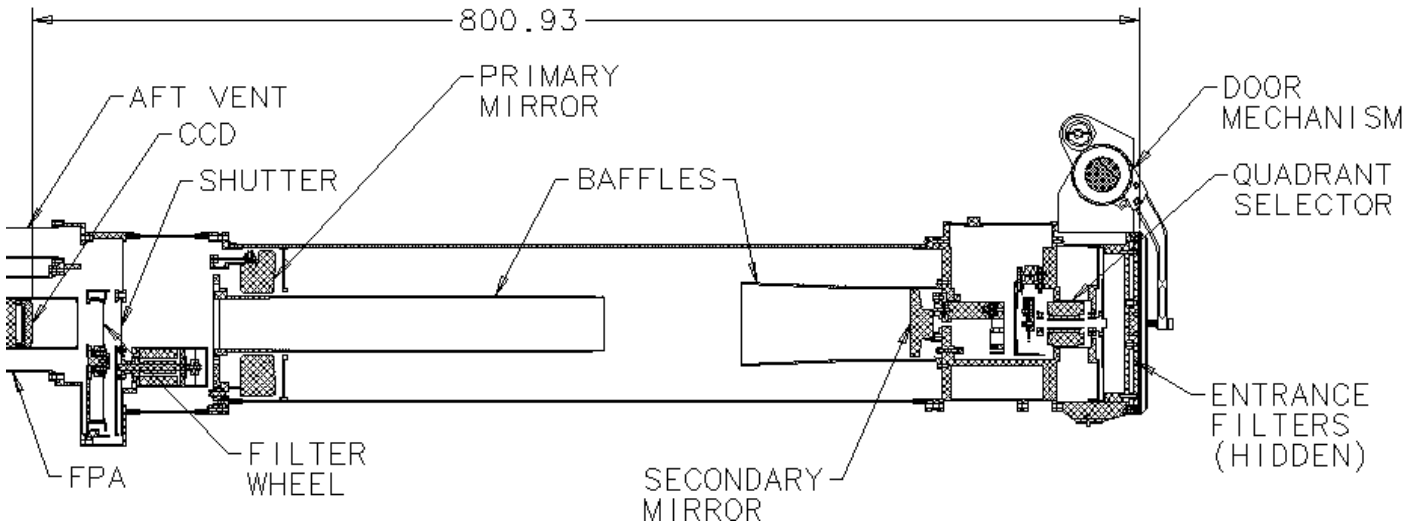
Science Goals

The Extreme Ultraviolet Imager (EUVI) supports the STEREO-SECCHI science goals, including:

- Initiation of CMEs
  - Interactions of flux systems, reconnection
  - Role of coronal dimming
- Physical evolution of CMEs
  - 3-D structure, CME acceleration
  - Response of the low corona
- 3-D structure of Active Regions

Instrument Cross Section





Main Design Features

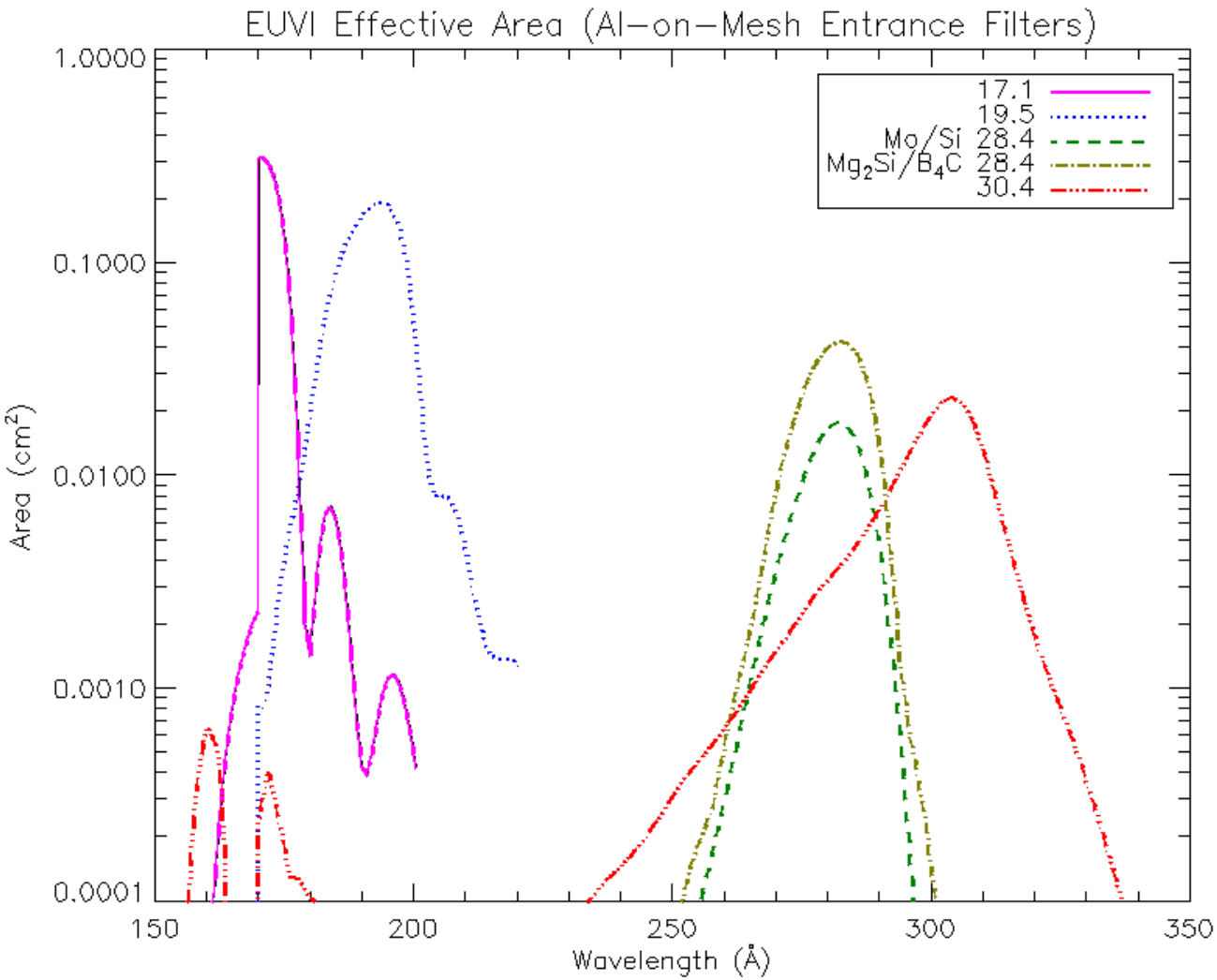
- Normal incidence Ritchey-Crétien telescope
- Multilayer coated optics, thin film filters
- Heritage: EIT/TRACE
- 98 mm aperture, 4 spectral channels, one in each optical quadrant
- Fine pointing system with active secondary
- 2k x 2k backside illuminated CCD, 1.6” pixels
- Circular full sun field of view to ± 1.7 $R_{\odot}$

Wavelength Selection and Instrument Response

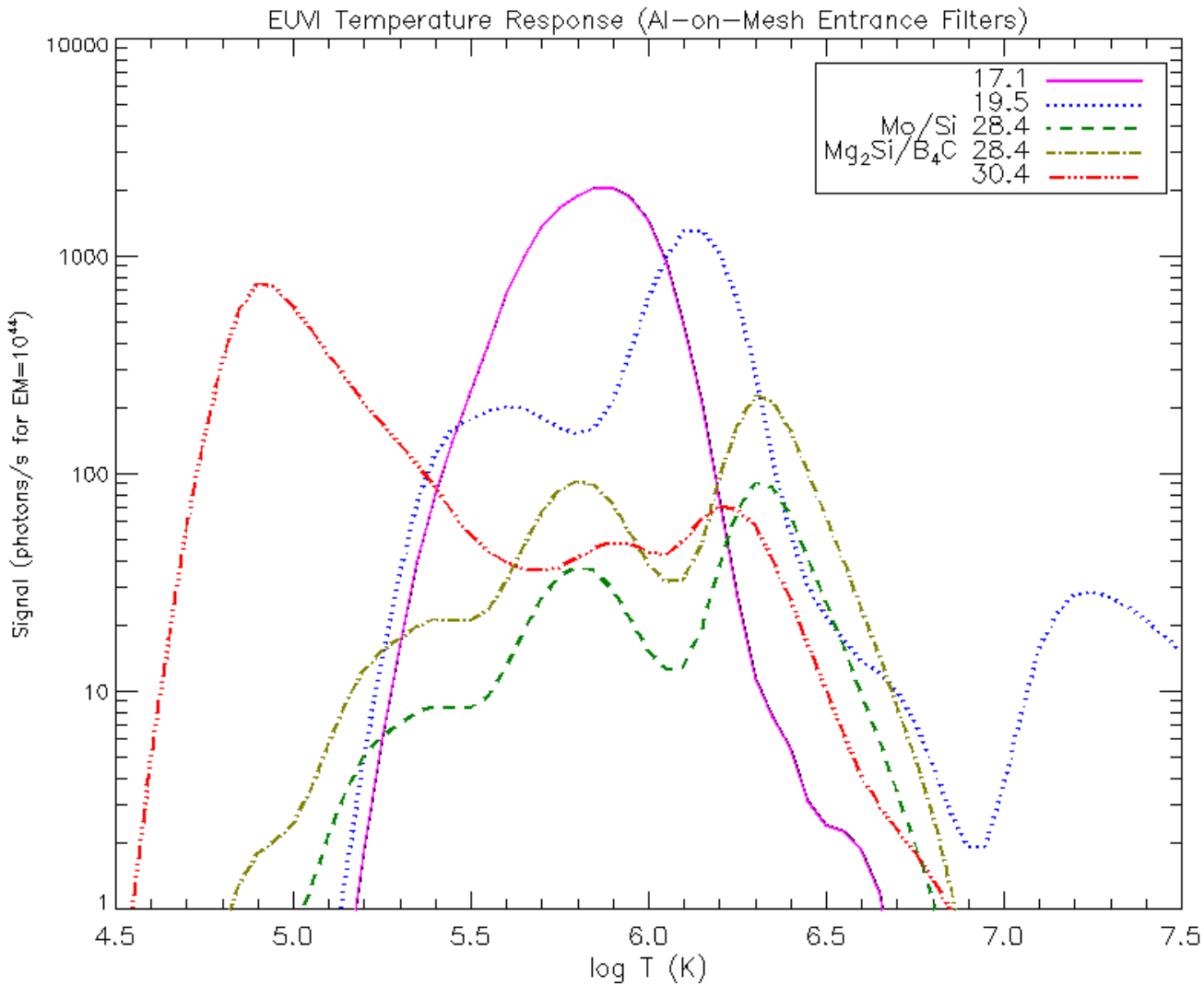
- Wavelength selection: like EIT
  - He II 30.4 nm: chromosphere, erupting prominences
  - Fe IX 17.1 nm: high contrast in coronal loops
  - Fe XII 19.5 nm: “typical” quiet corona
  - Fe XV 28.4 nm: “hotter”, 2.5 MK corona
- Response to solar plasma
  - Using Chianti to predict instrument response as a function of plasma temperature
  - Preliminary response functions available as an IDL SolarSoft “genx” file at:

    http://secchi.lmsal.com/Science/euvi_response
  - File includes response functions for four channels and for both TRACE-like, and EIT-like entrance filters

Instrument Effective Area



Response to Solar Temperatures



Predicted Exposure Times

- CHIANTI code and typical DEM for solar features
- Polyimide supported entrance filters and Mo/Si coatings. Other filters or coatings result in shorter exp. times
- Predicted typical exposure times:

Channel	Typical exposure times (5000 phot/pix in ARs)	S/N in areas of quiet sun
17.1 nm	2 sec	18
19.5 nm	2 sec	10
28.4 nm	41 sec*	7
30.4 nm	37 sec**	13

*12 sec for baselined mesh supported filter

**Predicted exposure time for 30.4 nm is upper limit

- Typical exposure times chosen to provide 5,000 photons/pixel exposure levels in Active Regions (37-63% of CCD full well, depending on wavelength)

Sensitivity Comparison With TRACE

- Compare EUVI sensitivity with TRACE to assess performance
- Element comparison:
  - Detector: ~ 8 x higher QE than TRACE
  - Aperture: ~ 27 x smaller area than TRACE
  - Pixel area ($arcsec^2$): ~ 10 x larger than TRACE
  - Pixel saturation (phot/pix): 5 x lower than TRACE
  - Aluminum-on-mesh entrance filters
  - TRACE-like multilayer coatings
- Exposure times:
  - 3 x shorter than TRACE for same # photons/pixel
  - Min. exp. time: 60 ms (15 x shorter than TRACE)

Entrance Filters

Baseline: 1500 Å Aluminum on a fine mesh
  - TRACE heritage
  - Maximizes EUV throughput
- Alternate design: 1500 Å Al + 700 Å Polyimide (PI) on coarse support grid
  - EIT / EIT Calroc heritage
  - Reduced diffraction pattern
  - Lower throughput due to EUV absorption in PI:

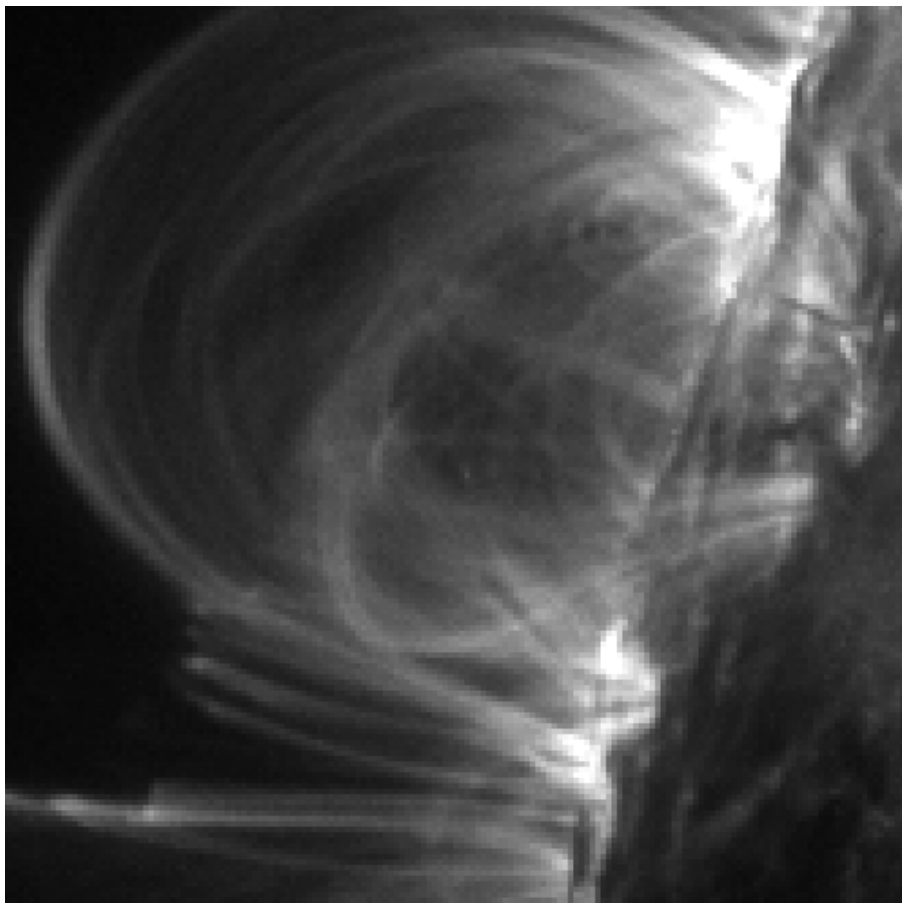
Wavelength	17.1	19.5	28.4	30.4
Transmission of 700 Å PI	54 %	45 %	20 %	16 %

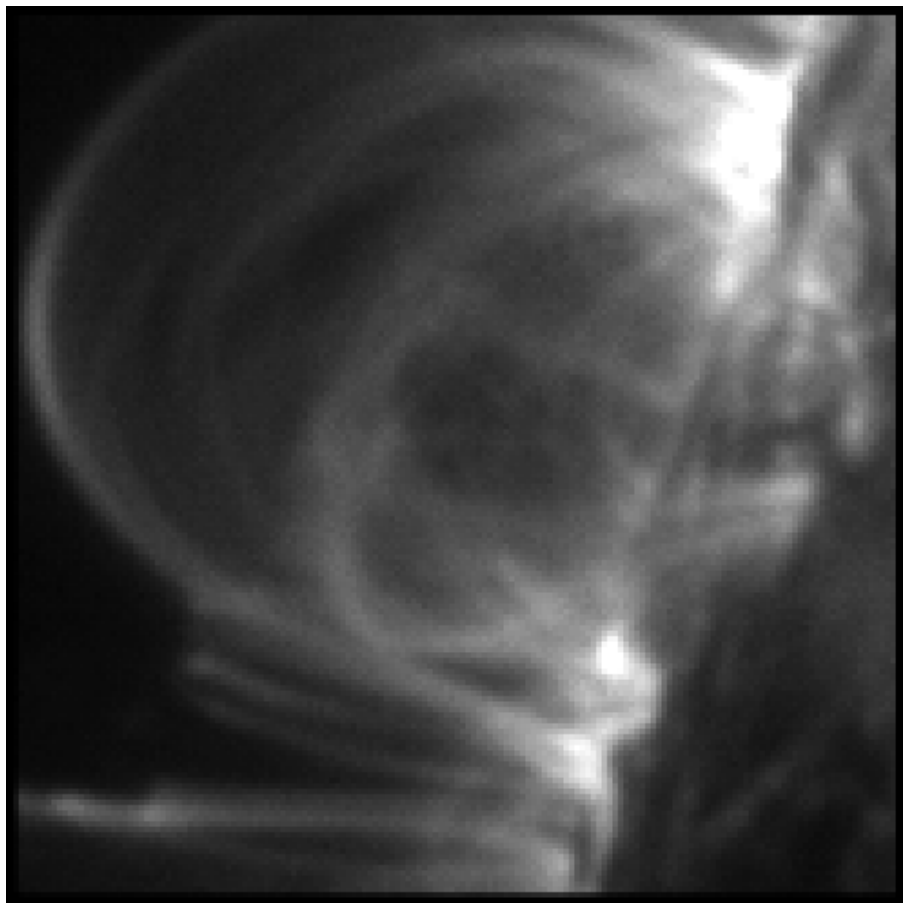
- Selection after structural model vibration test
- May fly different types of filters in different channels

Fine Pointing System

- The EUVI requires a pointing stability of 1.9" (3σ) or better to match or exceed the resolution of SOHO-EIT
- The spacecraft is only required to meet 3.8" (2σ)
- The EUVI Fine Pointing System bridges the gap between the EUVI pointing requirement and the S/C jitter spec.
- The Fine Pointing System features:
  - Active secondary mirror driven open loop via Guide Telescope signals
  - Improves S/C pointing stability by a factor of 3-5
  - Tilt range covers worst-case 5.7" S/C jitter amplitude
  - Simple digital control
  - No compensation of PZT hysteresis

EUVI Images With and Without Fine Pointing System





Sample Observing Sequences

- Synoptic:
  - two 1k x 1k images every 2.5 min.
  - two 2k x 2k images every 30 min.
- Initiation of CMEs:
  - three 1k x 1k images every 60 sec.
- Campaign mode:
  - two 2k x 2k images every 60 sec.
  - Limited time observations, or:
  - Observing into circular “event buffer” (to be “frozen” after detection of a CME)

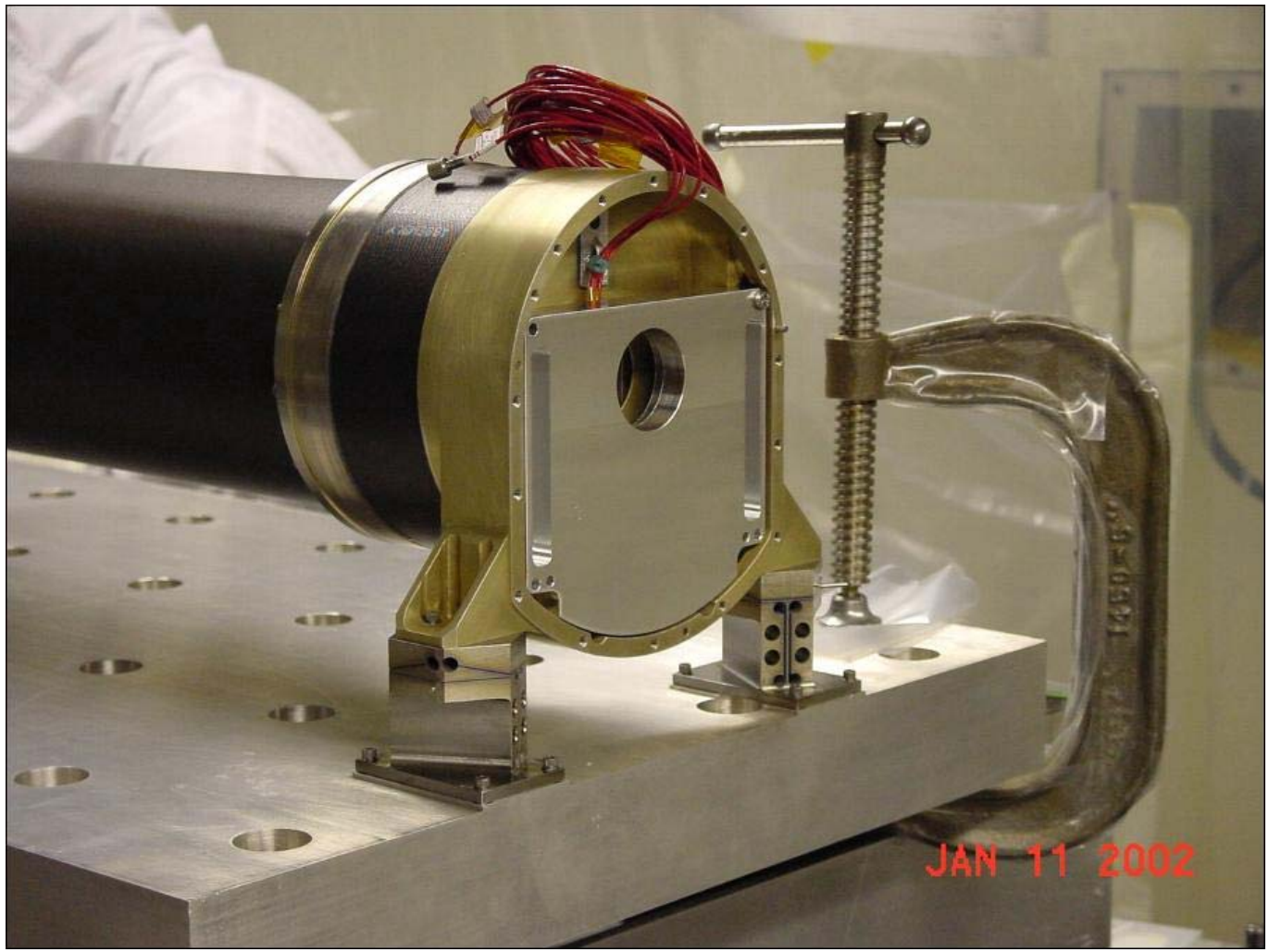
Development Status

- Detailed design in progress
- Grinding of first mirrors in progress
- Vibration test of structural model on January 16.

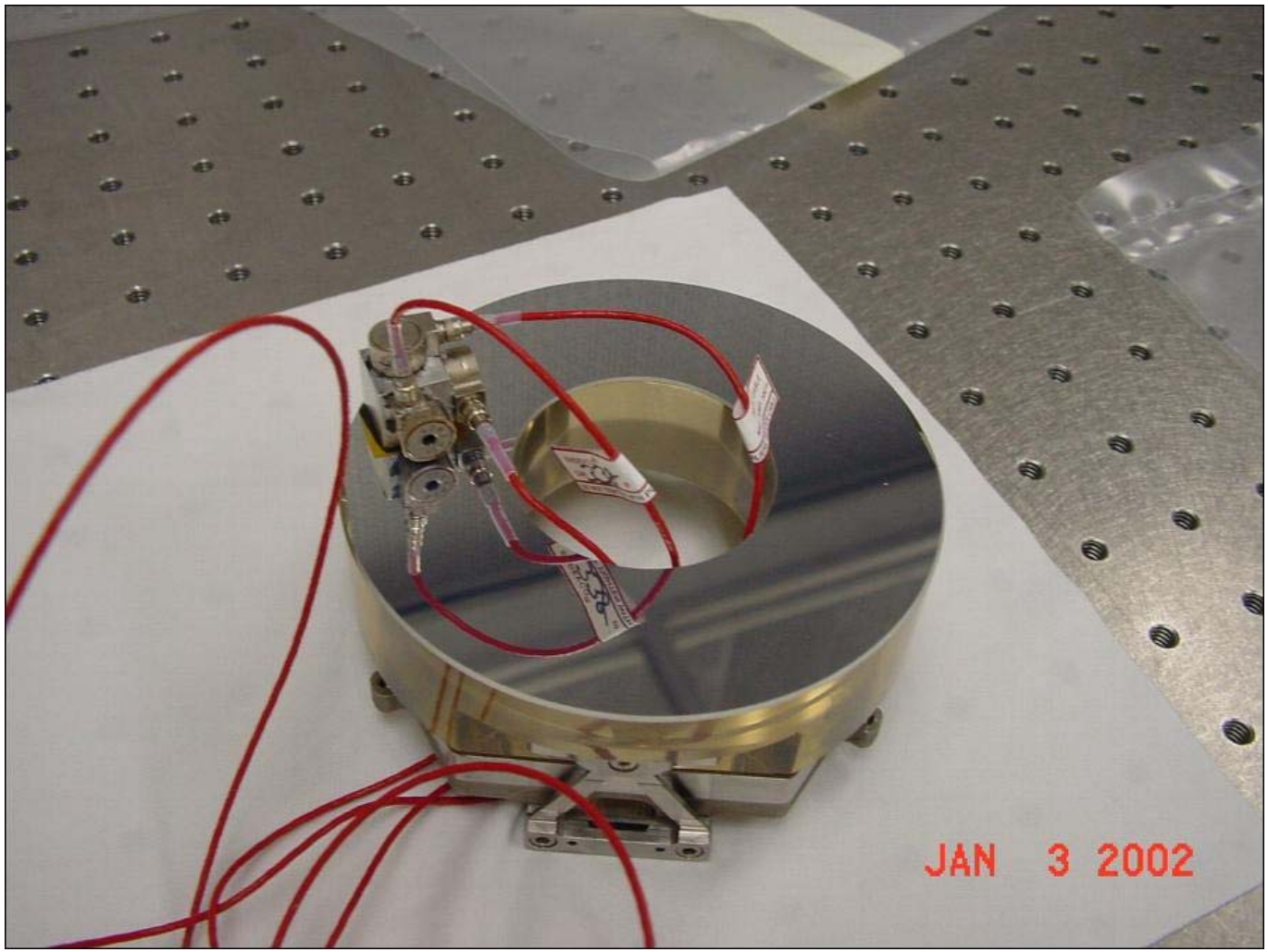
  Initial results of test in one axis:
  - Structure, mirror mounts, and fine-mesh supported, TRACE-like entrance filters survived
  - Some damage to grid-supported, EIT-like entrance filters
  - Lid of front door vibrated against door rim, most likely causing the observed filter damage
- Upcoming:
  - Conclude structural model vibration test in early April: tightly sealed door lid, thicker Polyimide layer on grid-supported filters
    - Update: all filters survived the April vibration test
  - Life test of quadrant selector mechanism

EUVI Structural Model (SM)

SM with Filter Wheel Mass Model



SM Primary Mirror with Mount



Vibration Test