COR1 Current Status and Future Plans

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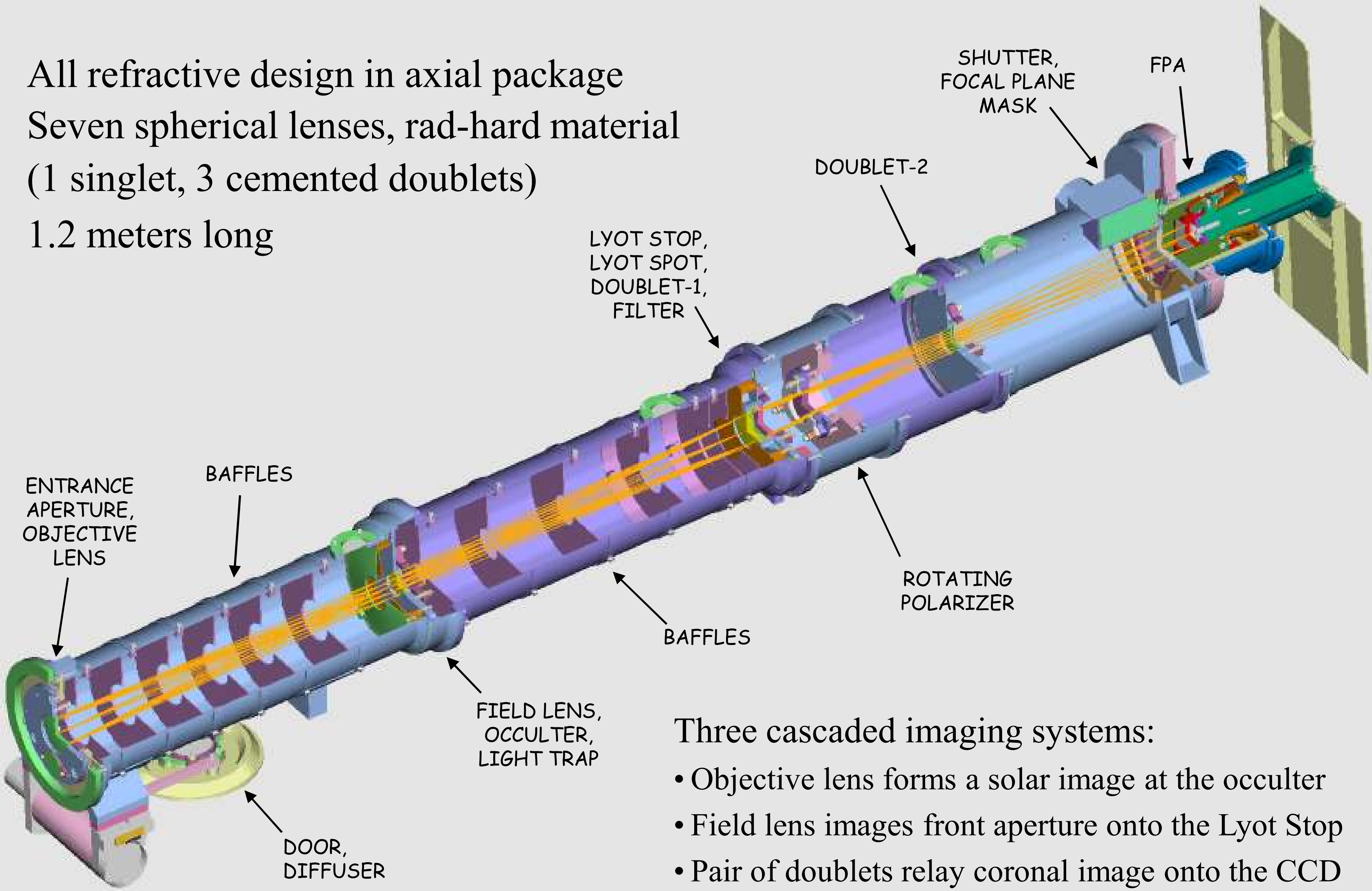
All refractive design in axial package

Seven spherical lenses, rad-hard material

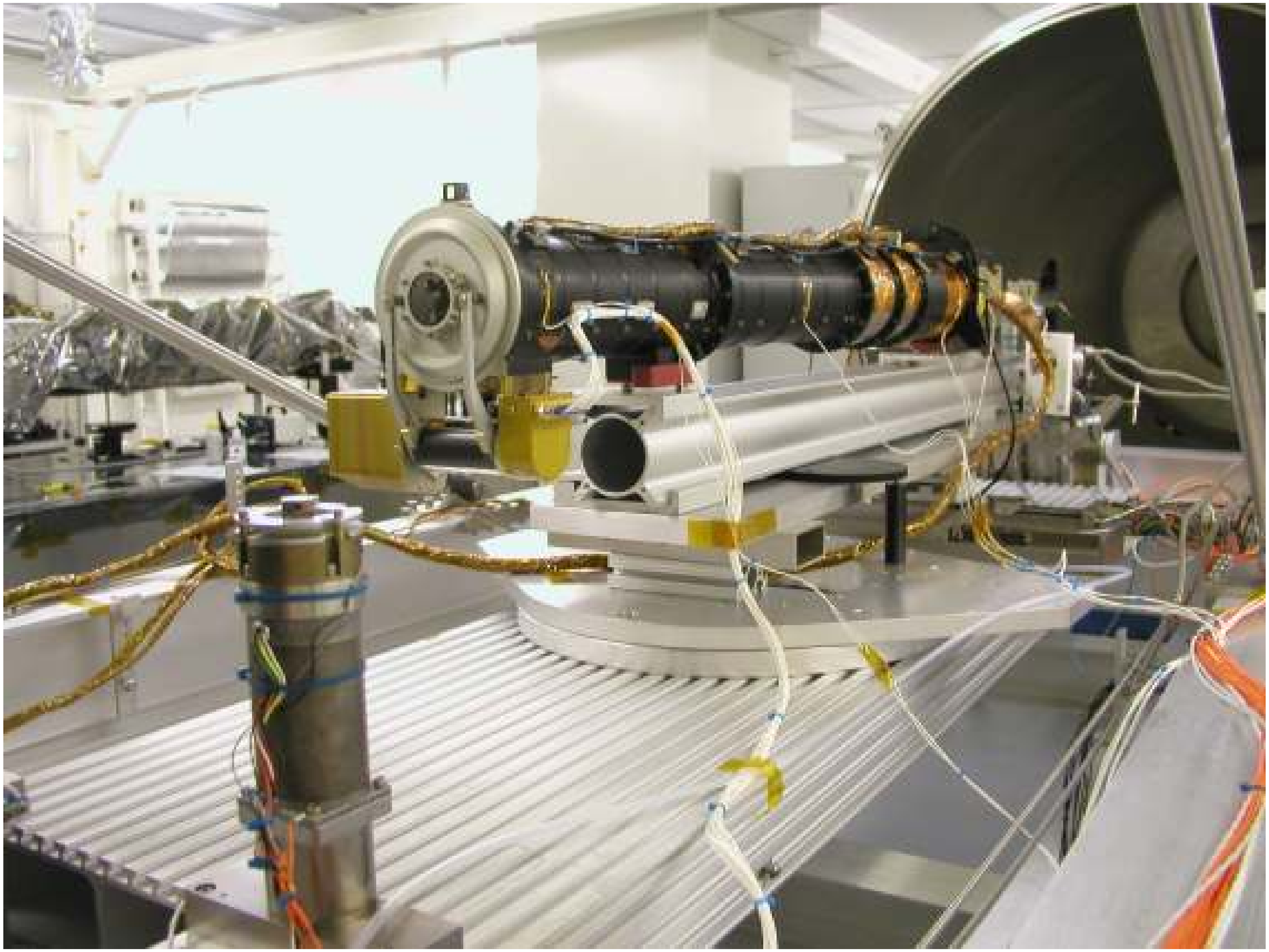
(1 singlet, 3 cemented doublets)

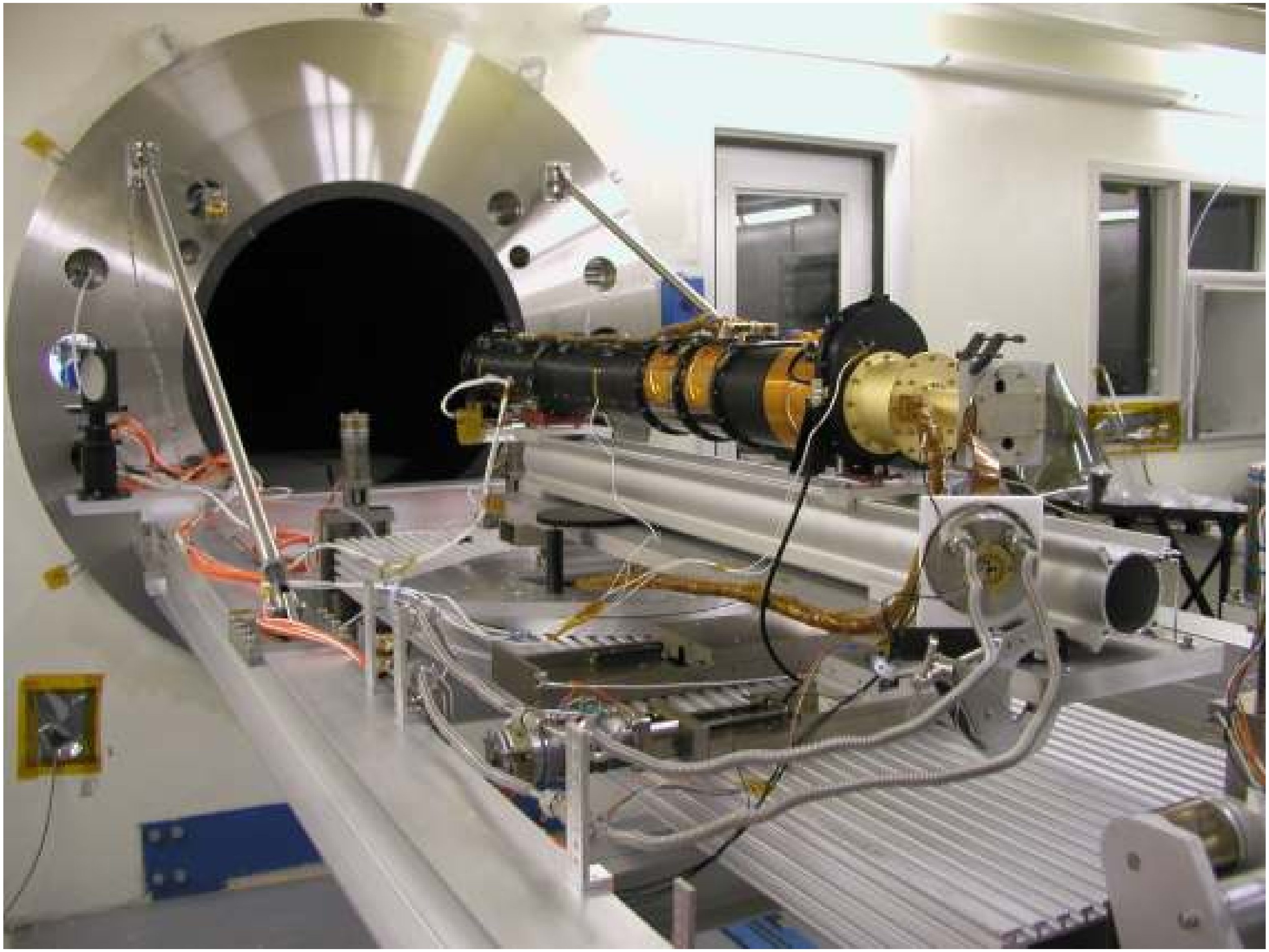
1.2 meters long



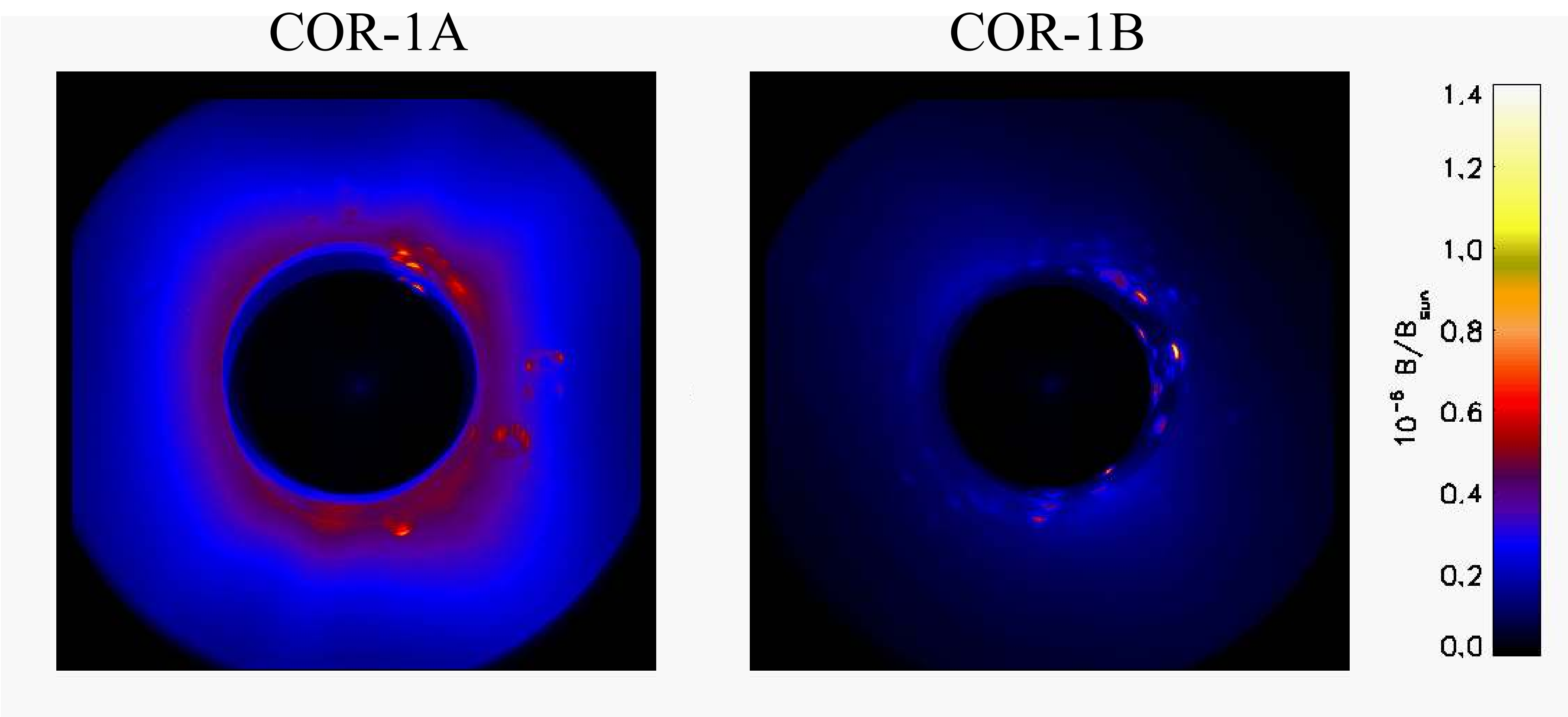
Three cascaded imaging systems:

- Objective lens forms a solar image at the occulter
- Field lens images front aperture onto the Lyot Stop
- Pair of doublets relay coronal image onto the CCD



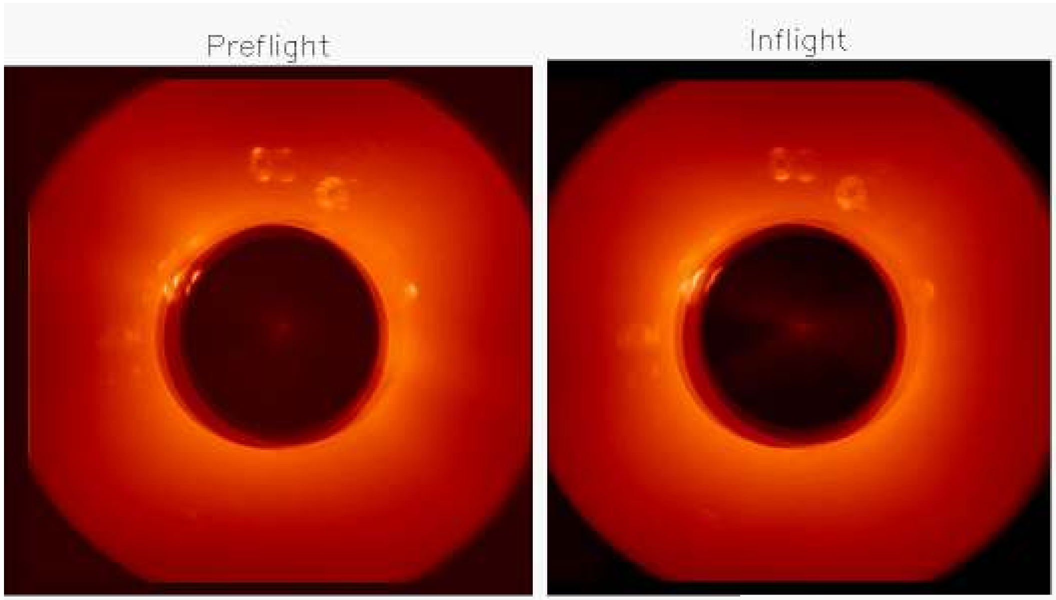


Scattered Light (preflight)



- Overall scattered light levels are much better than the 10^{-6} B/B$_{sun}$ requirement.
- Small areas with higher scatter due to features on front surface of field lens.

Inflight Comparison

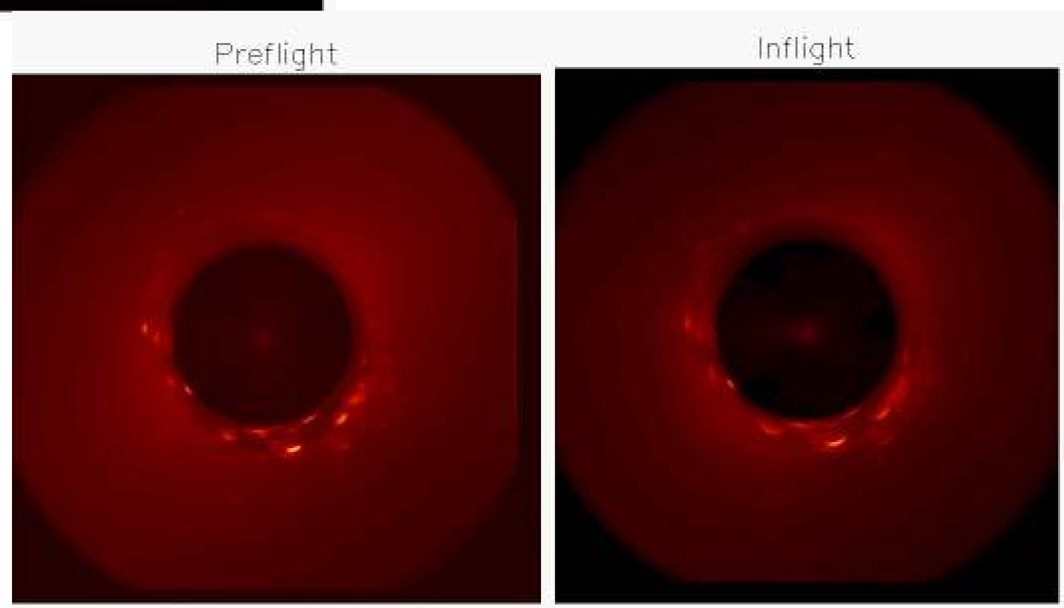


Inflight scattered light levels match the predictions from preflight testing.

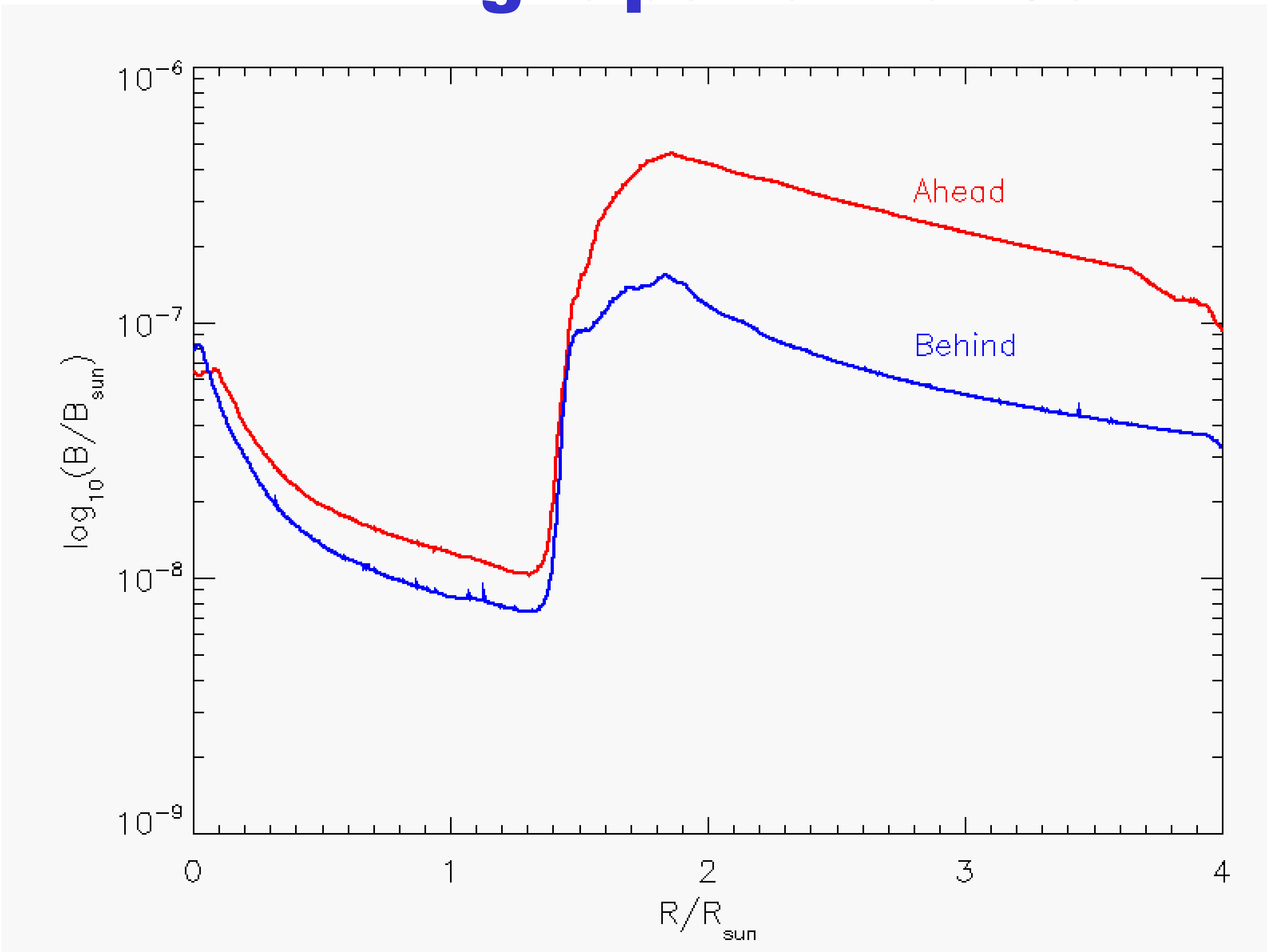
COR-1B

COR-1A

Behind objective switched out at Cape— actually cleaner than preflight testing.



Inflight performance



Concept of Operations

- Three images are taken at polarizer positions of 0°, 120°, and 240°.
- Combining the three images allows one to derive both the polarized brightness (***pB***) and the total brightness (***B***).
- The polarized brightness calculation rejects most of the stray light.

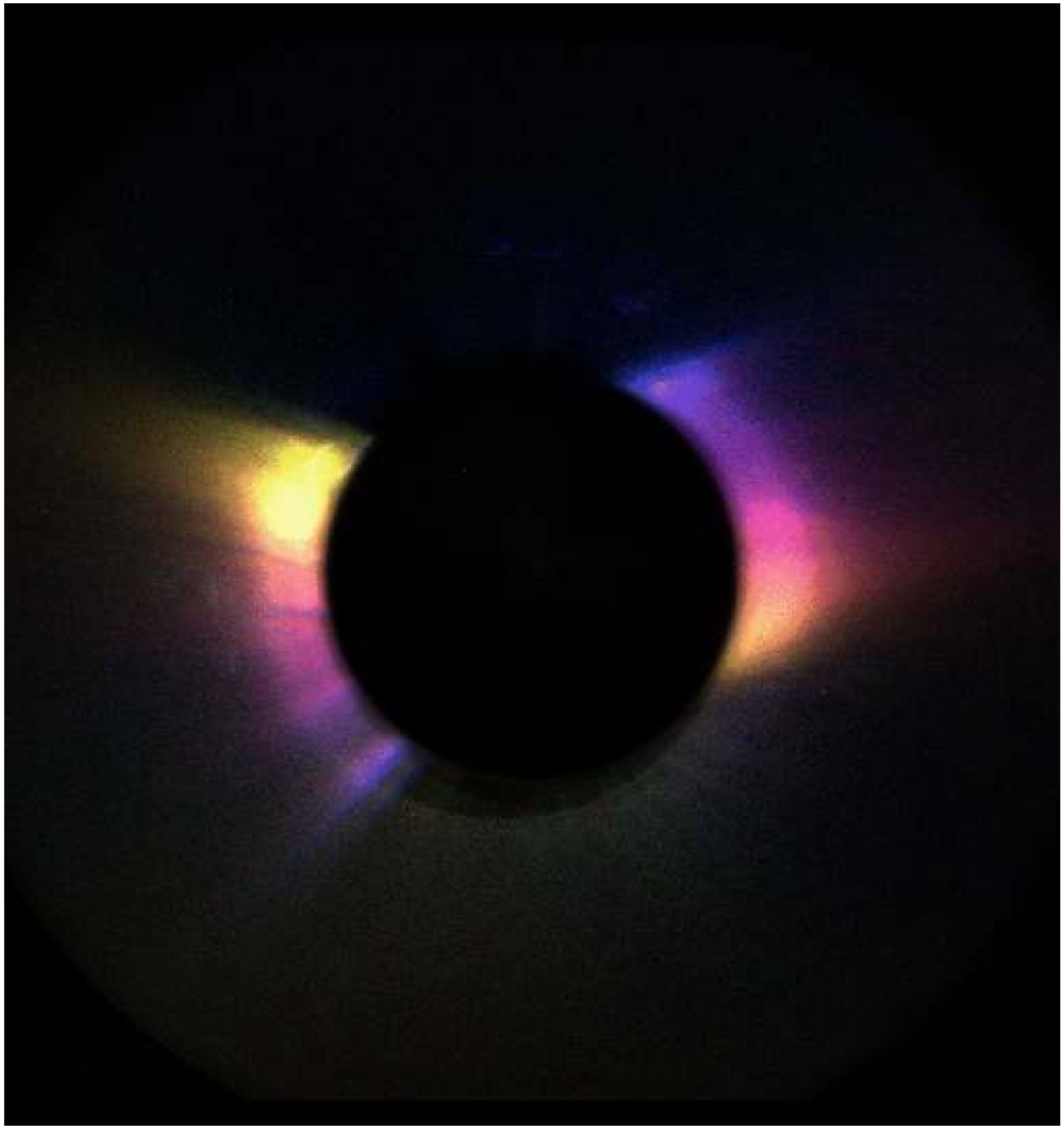
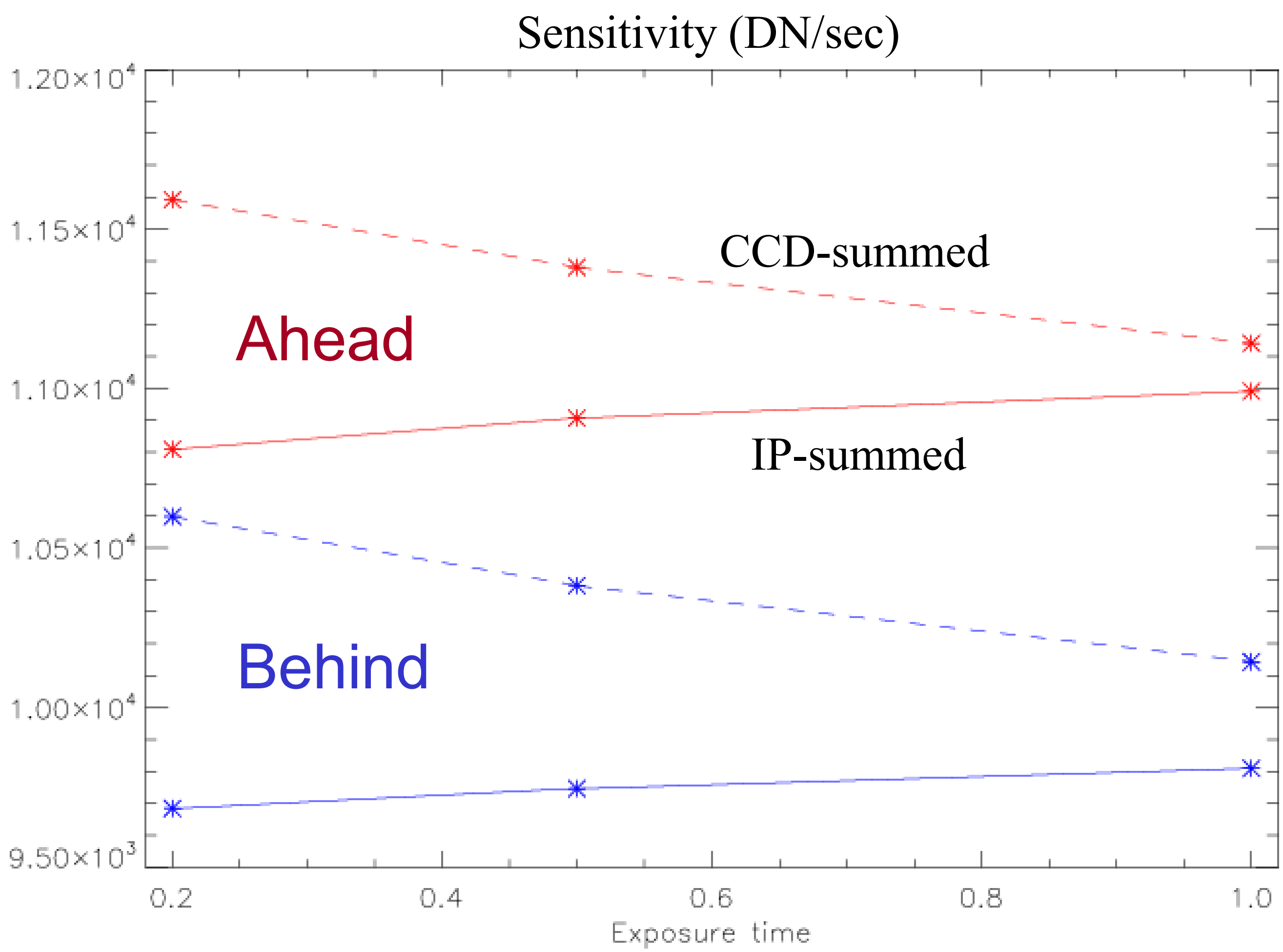


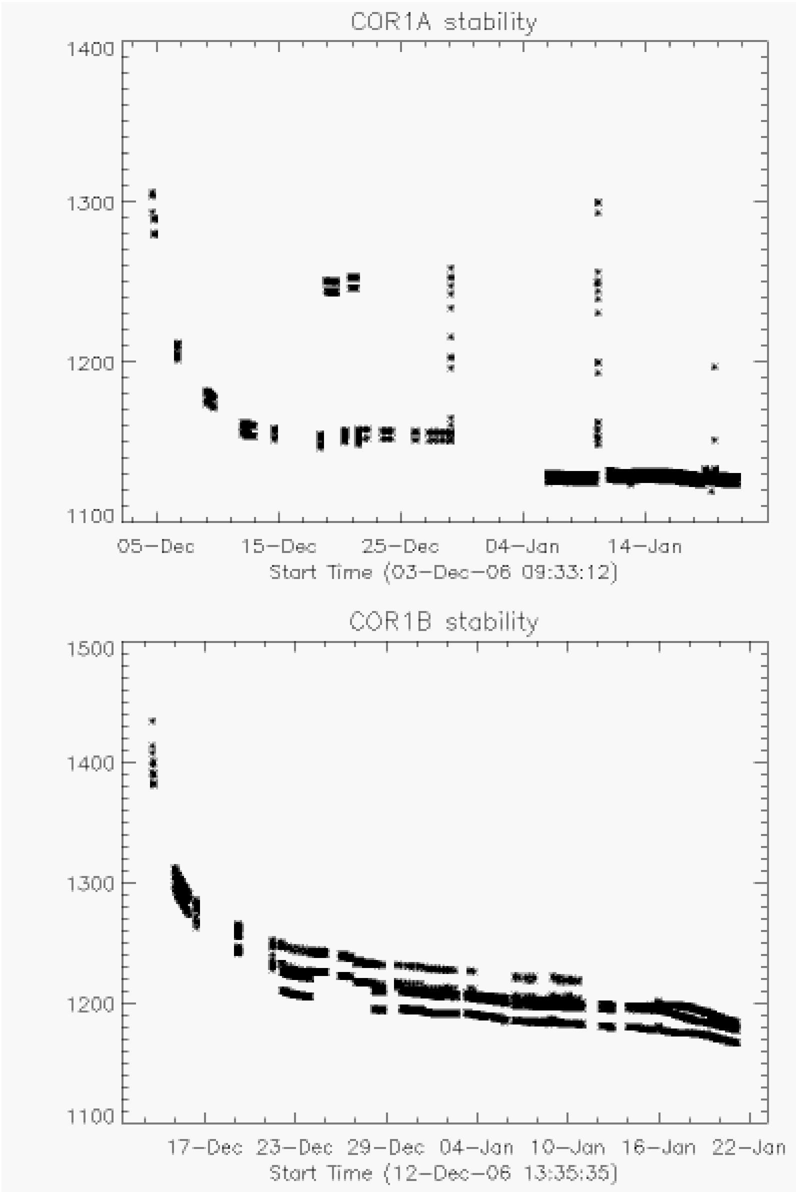
Image showing 3 separate polarization components

Linearity

- Detectors on both COR1A and COR1B are slightly non-linear

- IP-summed ~1%
- CCD-summed ~3%
- Measured with two separate techniques
- Exposure time of 1.7 seconds chosen to keep well within linear range.

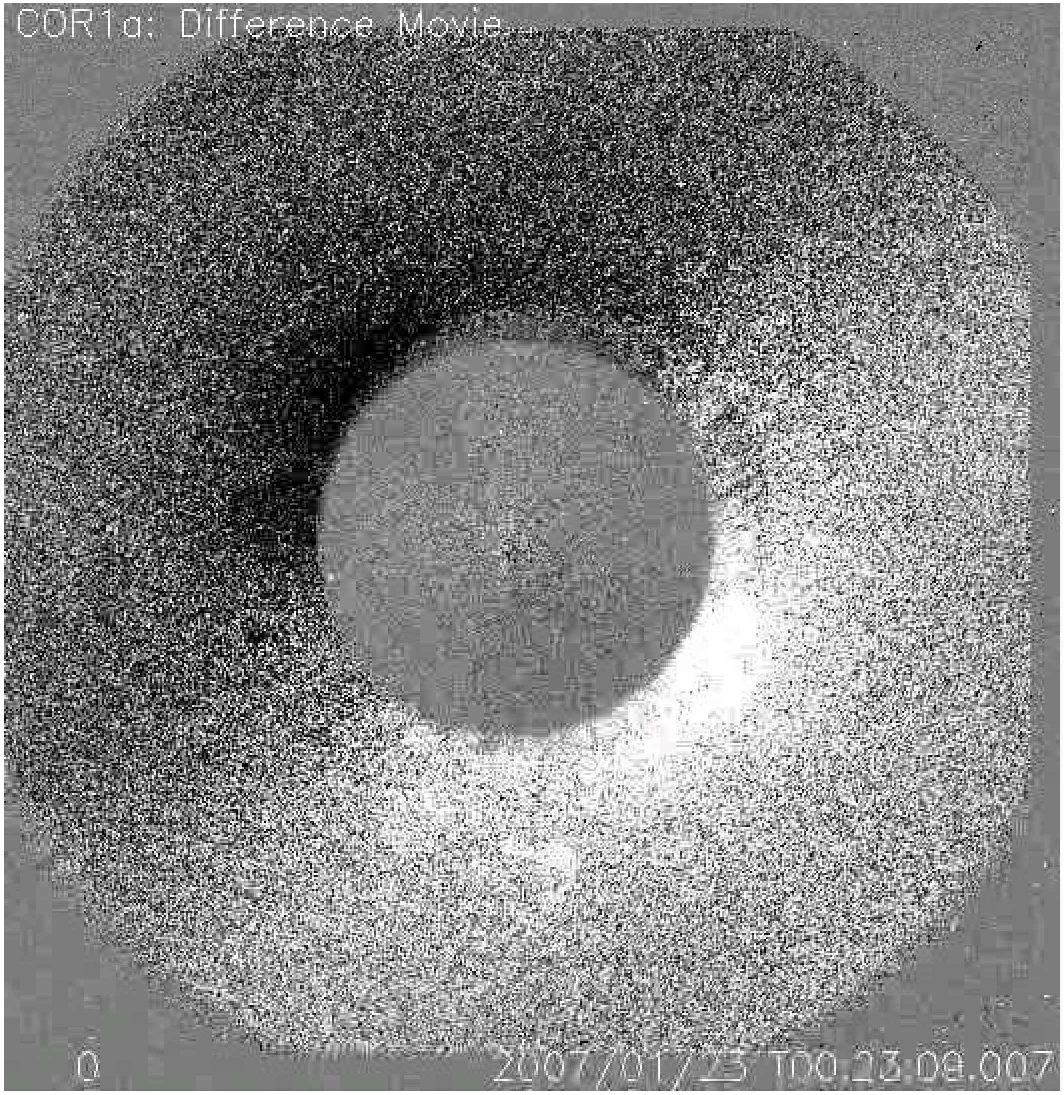




Stability

- Both COR1A and COR1B have shown decreases in the scattered light since their doors were opened, by about 15%
- Only the diffuse scattered light shows a decrease—the discrete features remain constant
- COR1B shows some evolution between the 3 polarizer components.

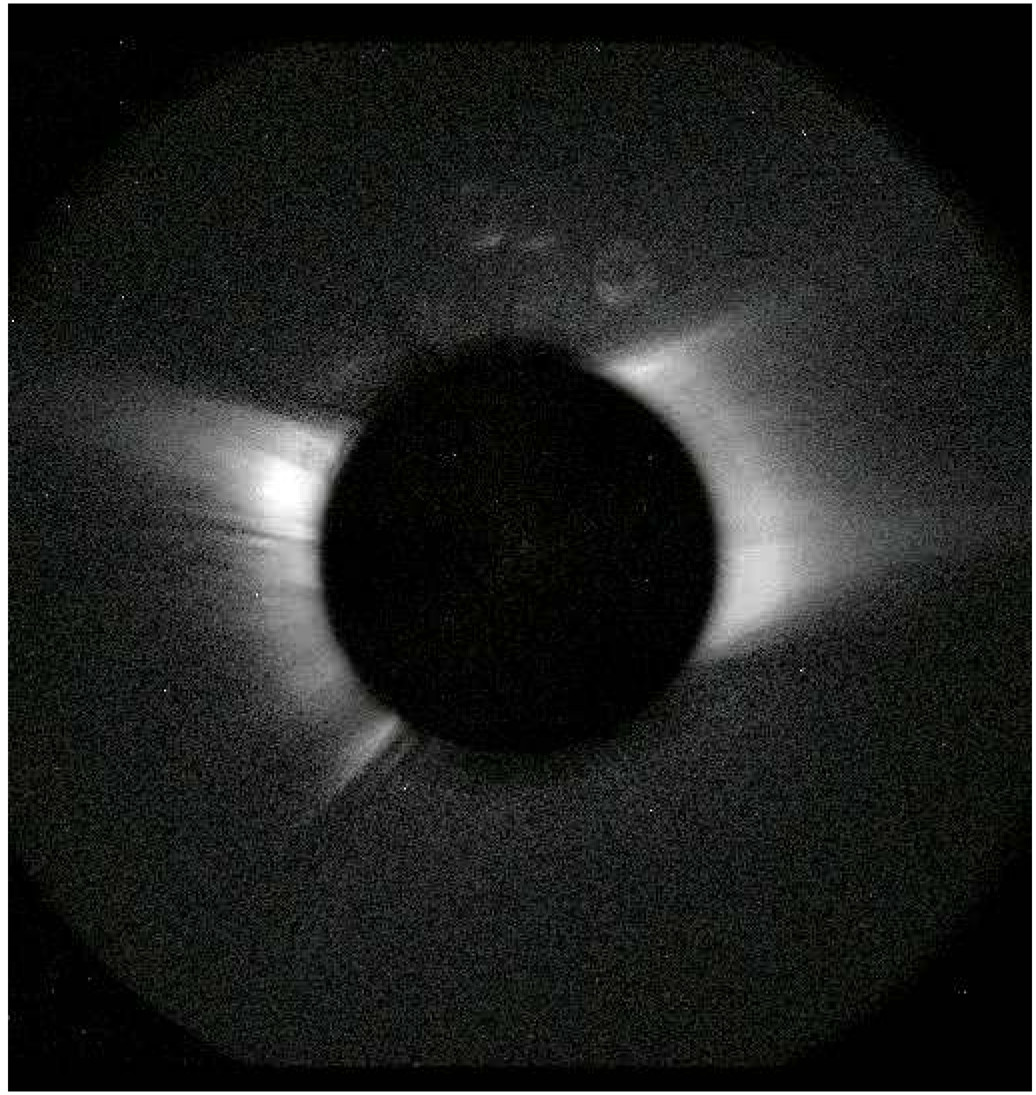
Jitter Sensitivity



- Spacecraft jitter affects COR1 scattered light pattern.
- Spacecraft jitter greatly improved on Jan 23 (Ahead) and Jan 24 (Behind).
- Still studying how to model jitter effects in data.

Roll Maneuvers

- Roll maneuvers allow the separation of instrumental and coronal effects.
  - Coronal hole assumed to be zero intensity
- Derived scattered light suitable for extracting ***pB***
  - ***B*** affected more by instrumental evolution
  - Behind evolution also affecting ***pB*** calculation
- There are several roll maneuvers now on each spacecraft.



SWAVES roll on Ahead, Dec 18th

Compression

- Image compression is required to be able to bring down data with sufficient cadence to see all CMEs.
- ICER is limited to a dynamic range of just over 13 bits.
- Dynamic range in COR1 is limited by scattered light
  - Top end limited by brightest part of the image, near occulter.
  - Bottom end limited by Poisson noise in fainter outer regions.
  - Resulting dynamic range is less than 13 bits for 2x2 binning for both COR1A and COR1B
- Strategy is to select a compression mode that keeps the digital noise below the Poisson noise.
  - Binning to 1024x1024 first improves statistics
    - Optics designed for 1024x1024 operation
  - Selected ICER 05 compression mode
  - Space weather: 128x128 binned with ICER 11

Observing Plans

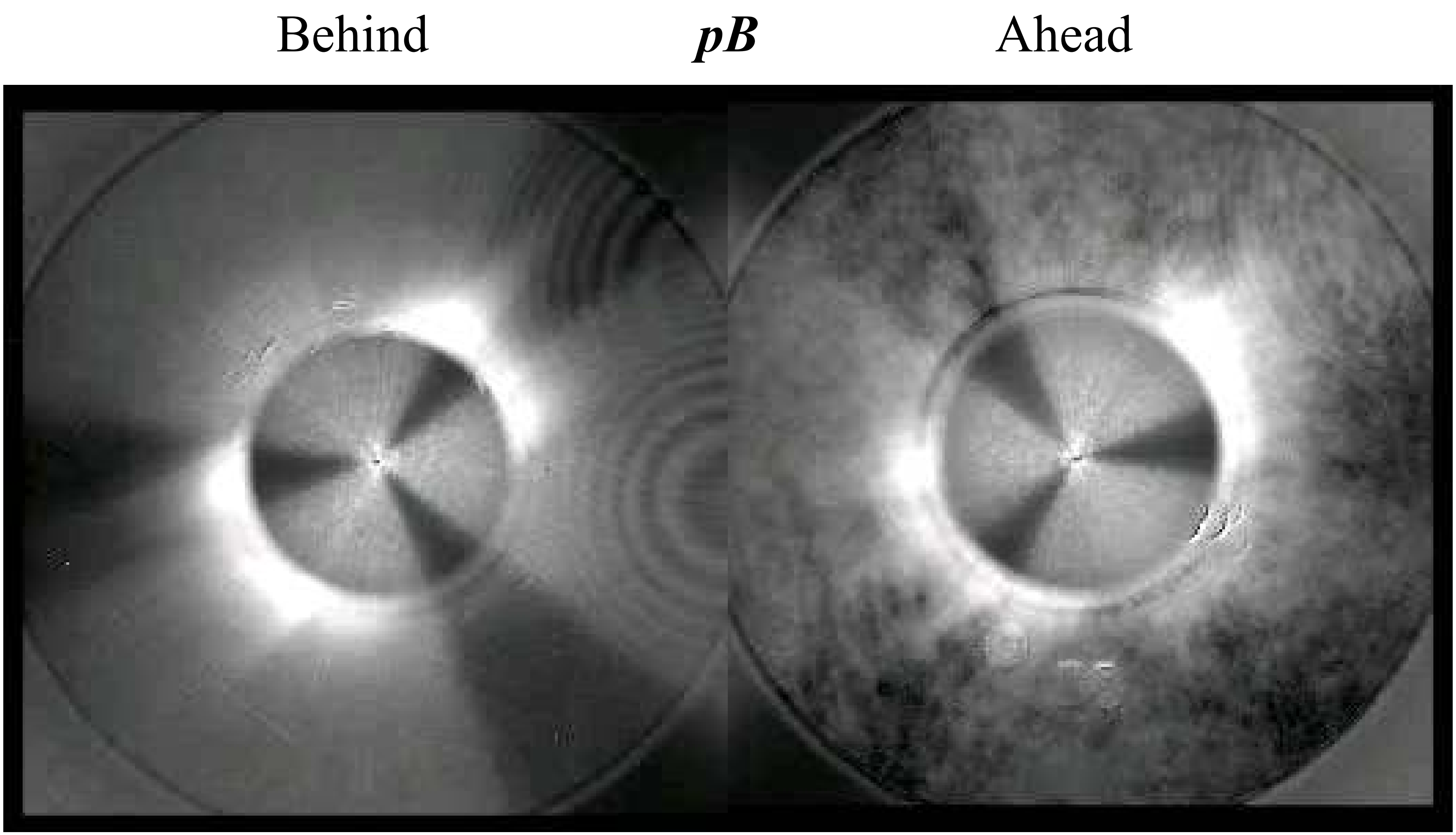
- Three polarizer positions (0°, 120°, 240°) taken in rapid sequence
- All images binned to 1024x1024 resolution
- Currently planning on IP-binning for better linearity
  - May need to go to CCD-binning to reduce radiation-induced noise
- Images scaled to 13 bits and compressed with ICER 05
- Complete polarizer sequence repeated every 10 minutes
  - SSR2 data decreases cadence to 5 minutes for few hours

Removing Scattered Light

- Polarized brightness (***pB***) calculation removes much of the scattered light.
  - Still some residual scattered light
- Running and base difference movies also work well
  - Jitter sensitivity less for ***B*** than for ***pB***
- Other strategies include:
  - Removing model derived from calibration rolls
    - Works well for pB
    - Instrument evolution limits effectiveness for B
  - Monthly minimum image technique
    - Effect of instrument evolution not yet clear
  - Daily minimum image technique
    - Mainly effective for CMEs
- Above models are applied to each polarization component before combining into ***pB***

Without Background Subtraction

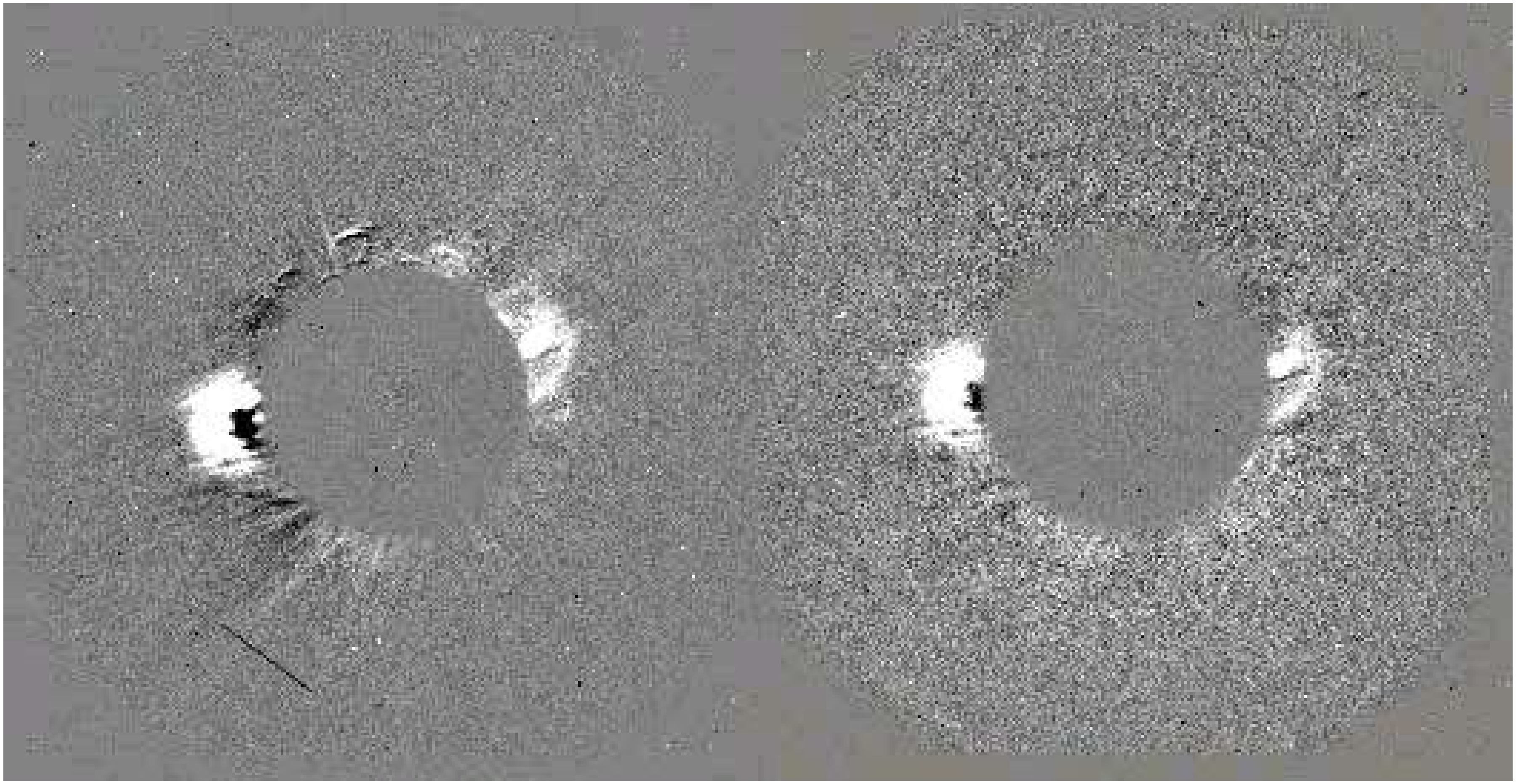
- Most of the scattered light is removed by the ***pB*** calculation.



Running Difference

- Running differences appear best in brightness images.

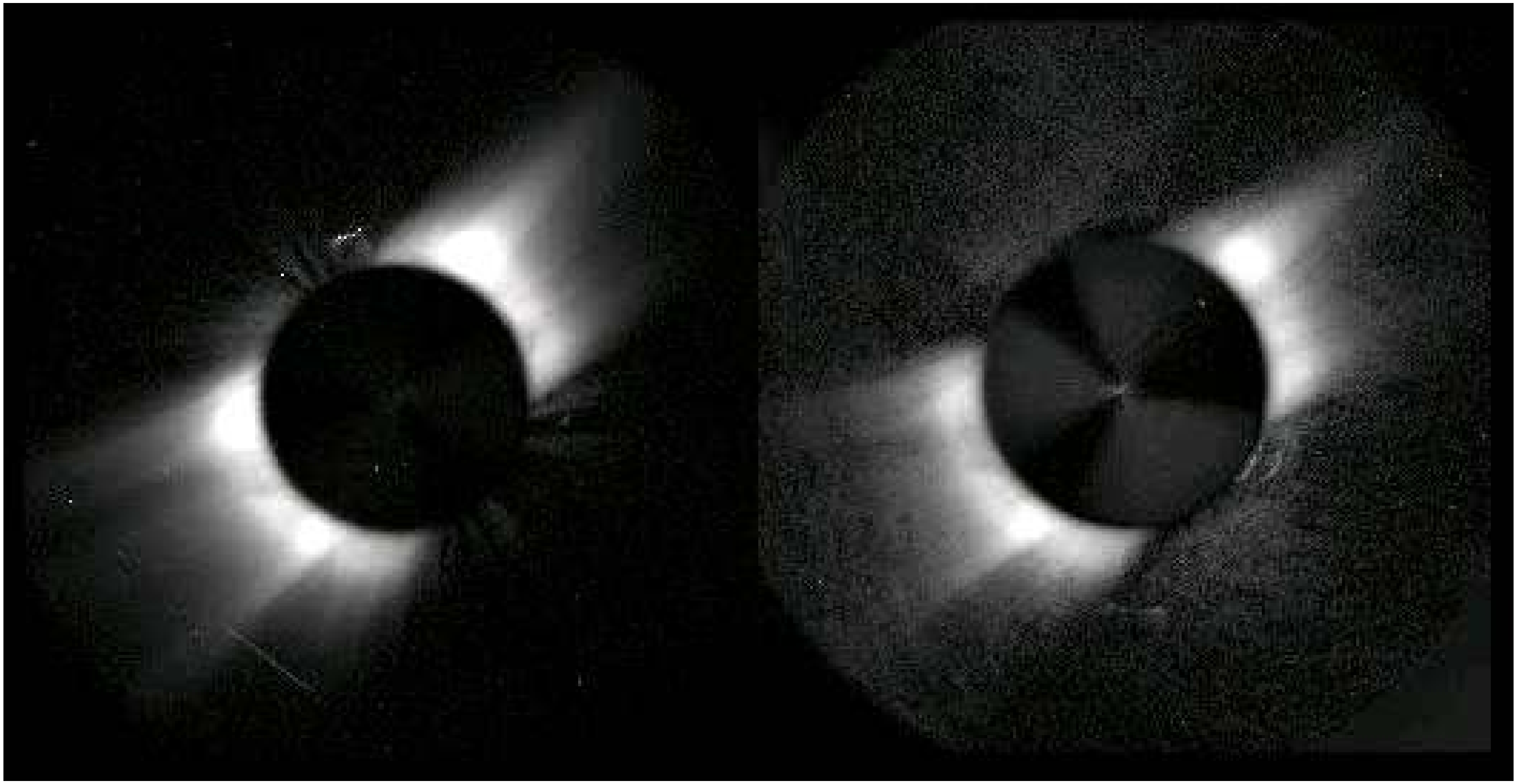
Behind ***B*** Ahead



Subtracting Rotation Model

- Most representative of corona. Instrument evolution so far restricts use to ***pB***.

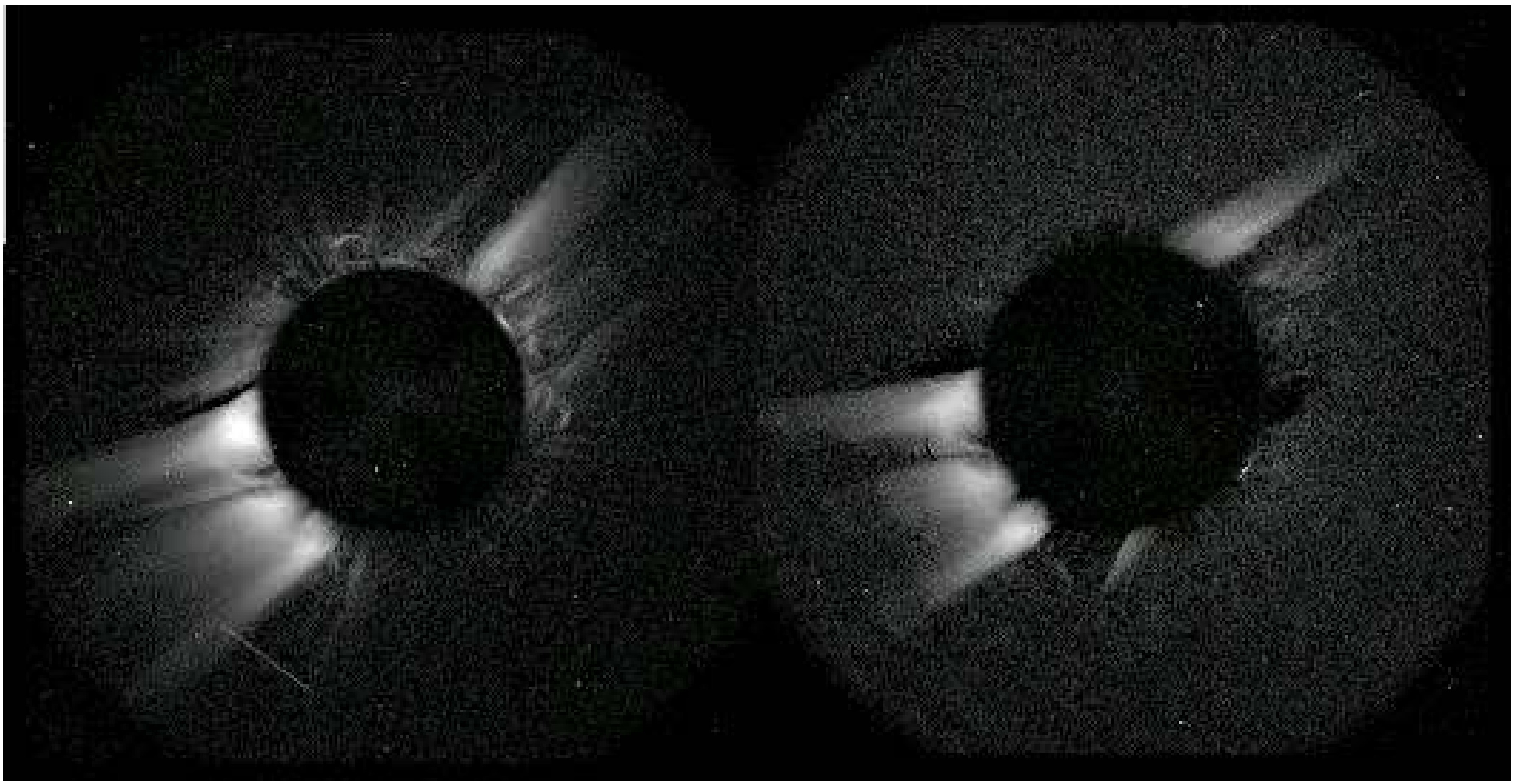
Behind ***pB*** Ahead



Subtracting Daily Minimum

- Below is a demonstration of subtracting the daily minimum image from polarized brightness data

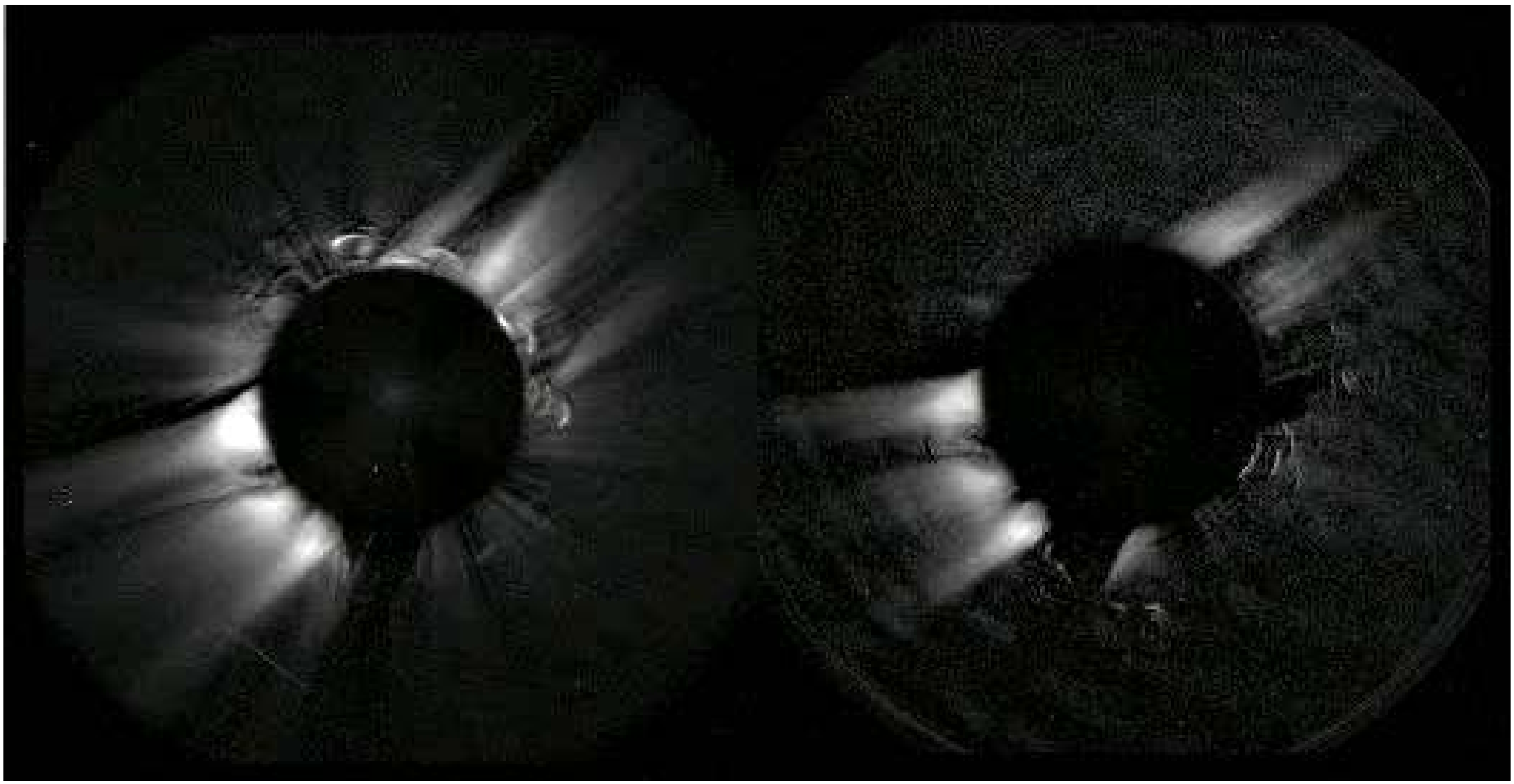
Behind ***pB*** Ahead



Subtracting Daily Minimum

- It also works for total brightness. Some evolution in background can be seen for Ahead.

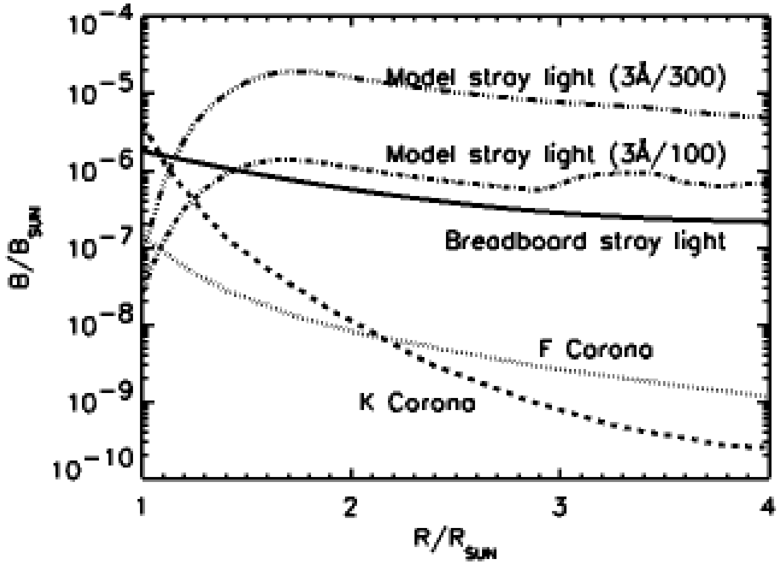
Behind *B* Ahead



Extra Slides

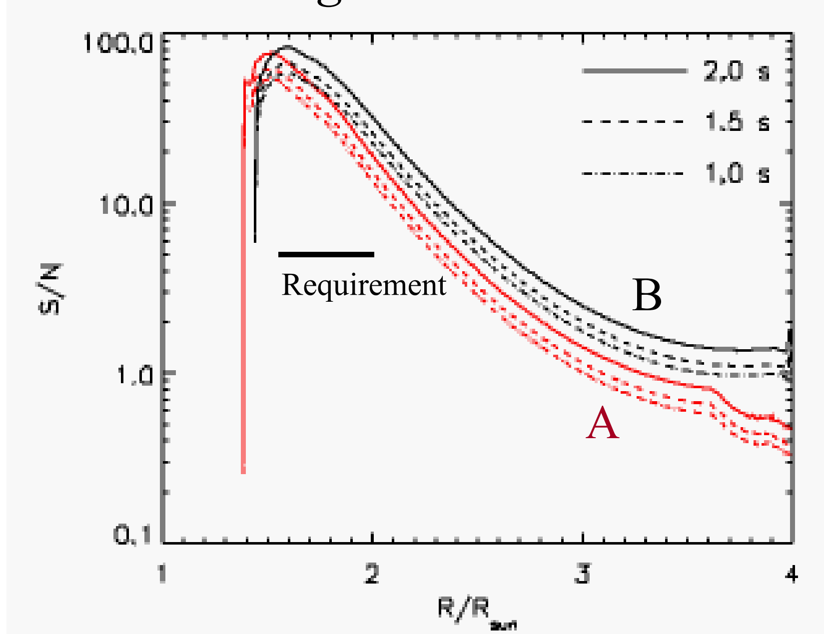
Instrument Performance

Relative brightness



- The measured straylight is lower than the model predictions.
- The K corona is fainter than the stray light, but significantly brighter than the noise floor.

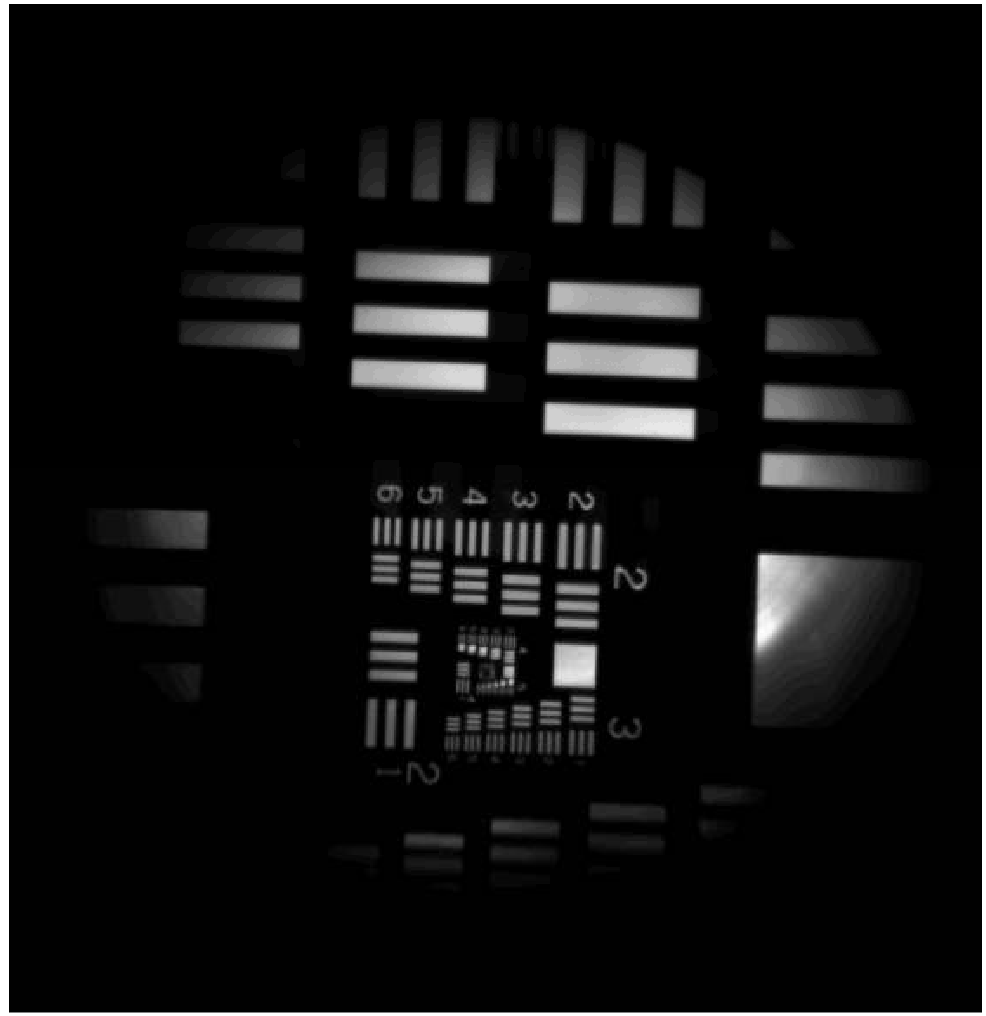
Signal to noise ratio



- When the 3 polarization angles are combined, the pB of the K corona is recovered from the unpolarized background
- CMEs are visible from the occulter to the detector edge.

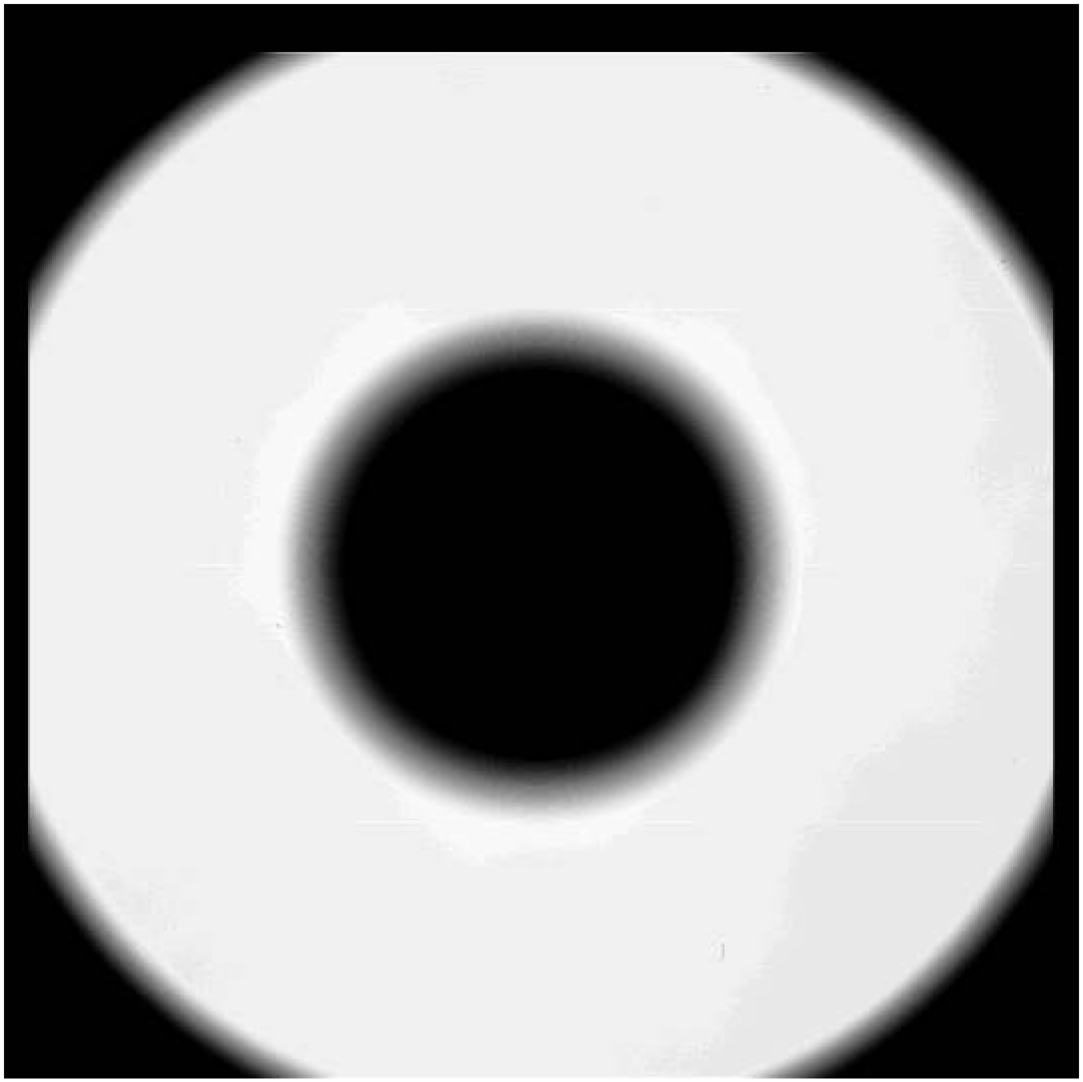
Resolution

- Resolution tested by projecting Air Force resolution test target onto various portions of the detector.
- Measurements done in vacuum, to avoid problems with air vs. vacuum focal lengths.
- Were able to resolve with high contrast all the way down to the Nyquist frequency.



Sample subfield image (COR-1A)

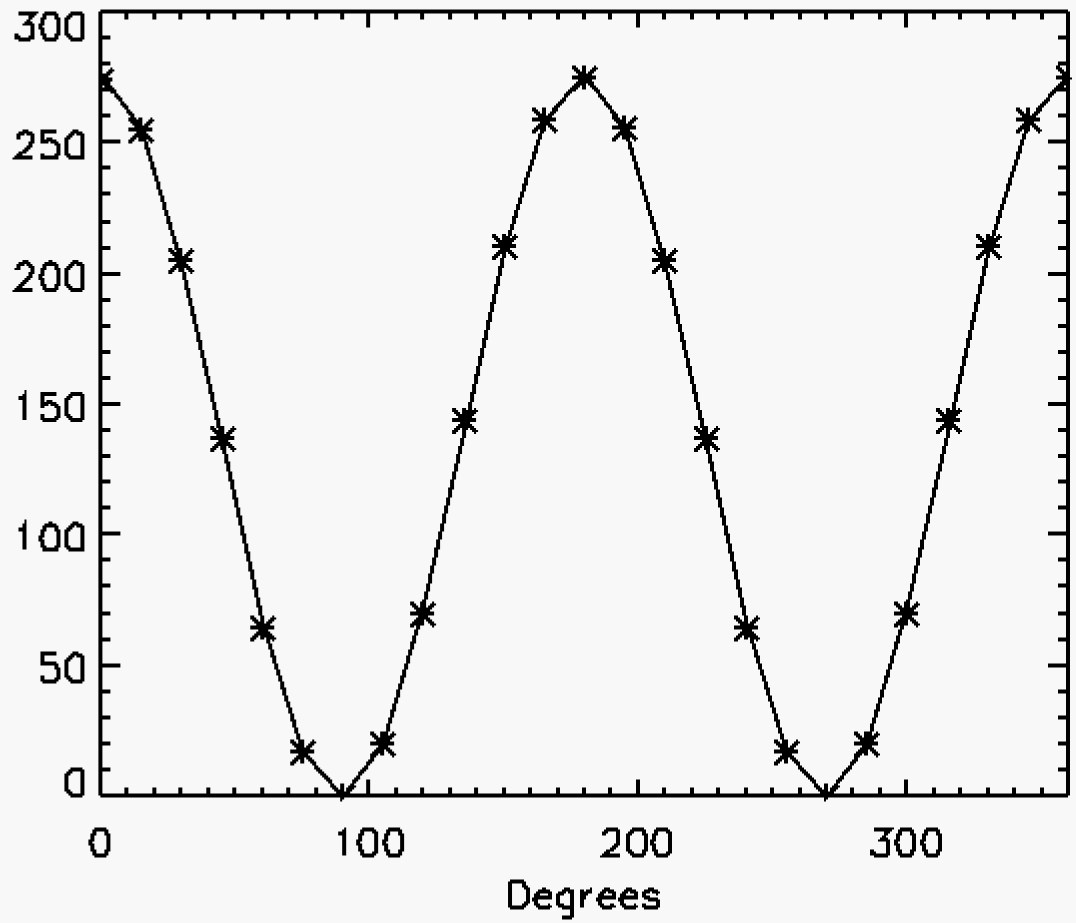
Flat Field



- The field is highly flat, with discrete areas of vignetting near the occulter and camera aperture edges.
- The flat field is monitored in flight with the diffuser window mounted in the door.

Polarization Response

- **Polarcor** linear polarizers provide better than 10,000:1 contrast ratio.
- Hollow core motor rotates polarizer in beam to angles 0°, 120°, and 240° to derive polarized brightness.
- Rotation of polarizer moves image on detector by ~0.3 pixels for both COR-1A & B. Minimized by putting slight tilt on polarizer.



Measurements of polarization response compared to fitted curve (COR-1A)