COR1 CURRENT STATUS AND FUTURE PLANS

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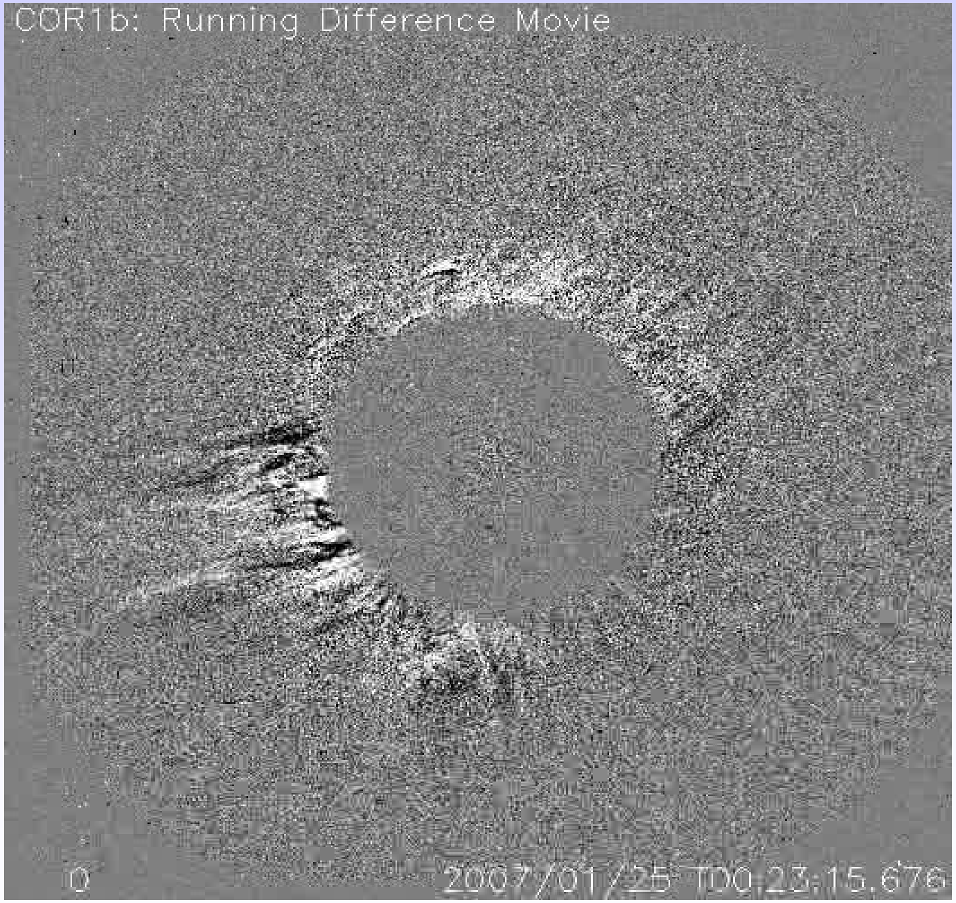
COR1 Status

- **COR1-A and COR1-B are both observing regularly as part of the synoptic program**
  - **Both are returning scientifically-useful images!**
- **First light:**
  - **COR1-A -- December 4, 2006**
  - **COR1-B -- December 13, 2006**
- **COR1-B has lower stray light than COR1-A**
  - **COR1-B objective lens changed at KSC**

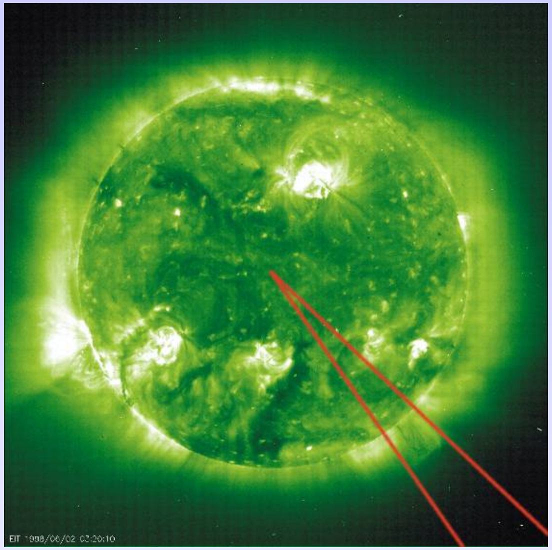
COR1 Performance

Running Difference 25 Jan 2007

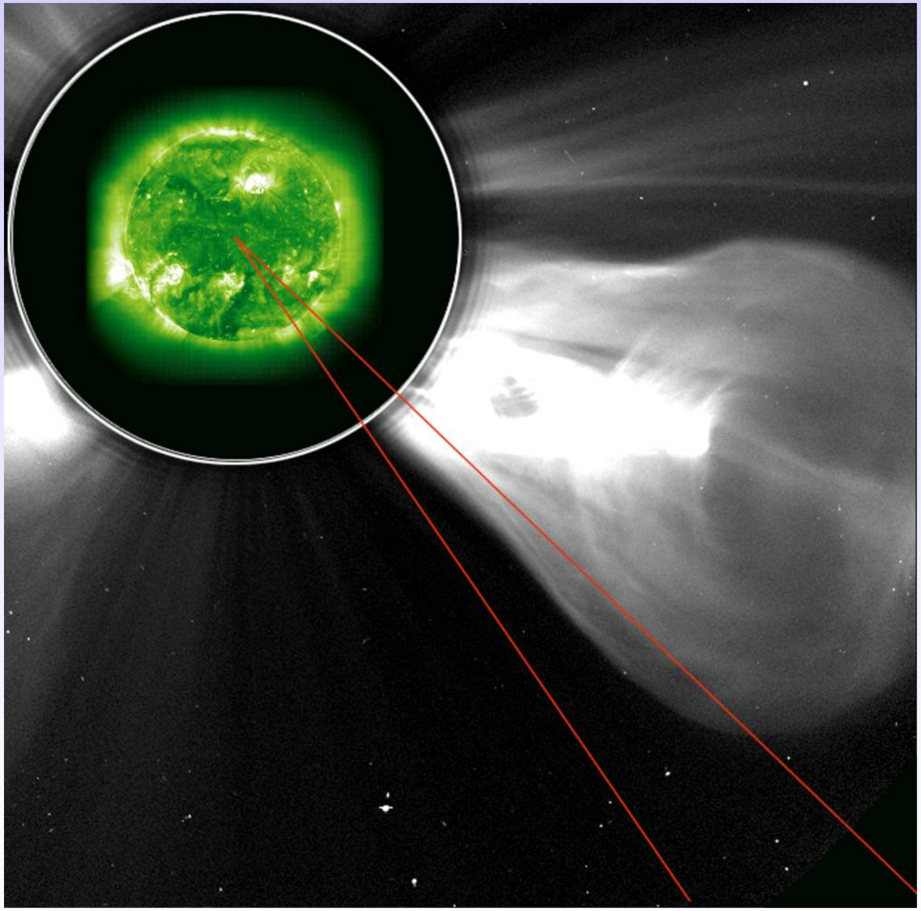


- Coronal streamers visible to edge of the FOV
- Dynamics and evolution of the low corona
- CME events
  - Speed, Location, acceleration, etc
- Background stars (5^{th} magnitude)

COR1 Primary Science Goal



Understanding the Origin of CMEs



1998-06-02 SOHO EIT (195A) and LASCO C2 (Plunkett et al, 2000)

There are four parameters that are critical to understanding the origins of CMEs and the forces acting on them. But these are difficult to measure above 2 R_S (depicted by white circle).

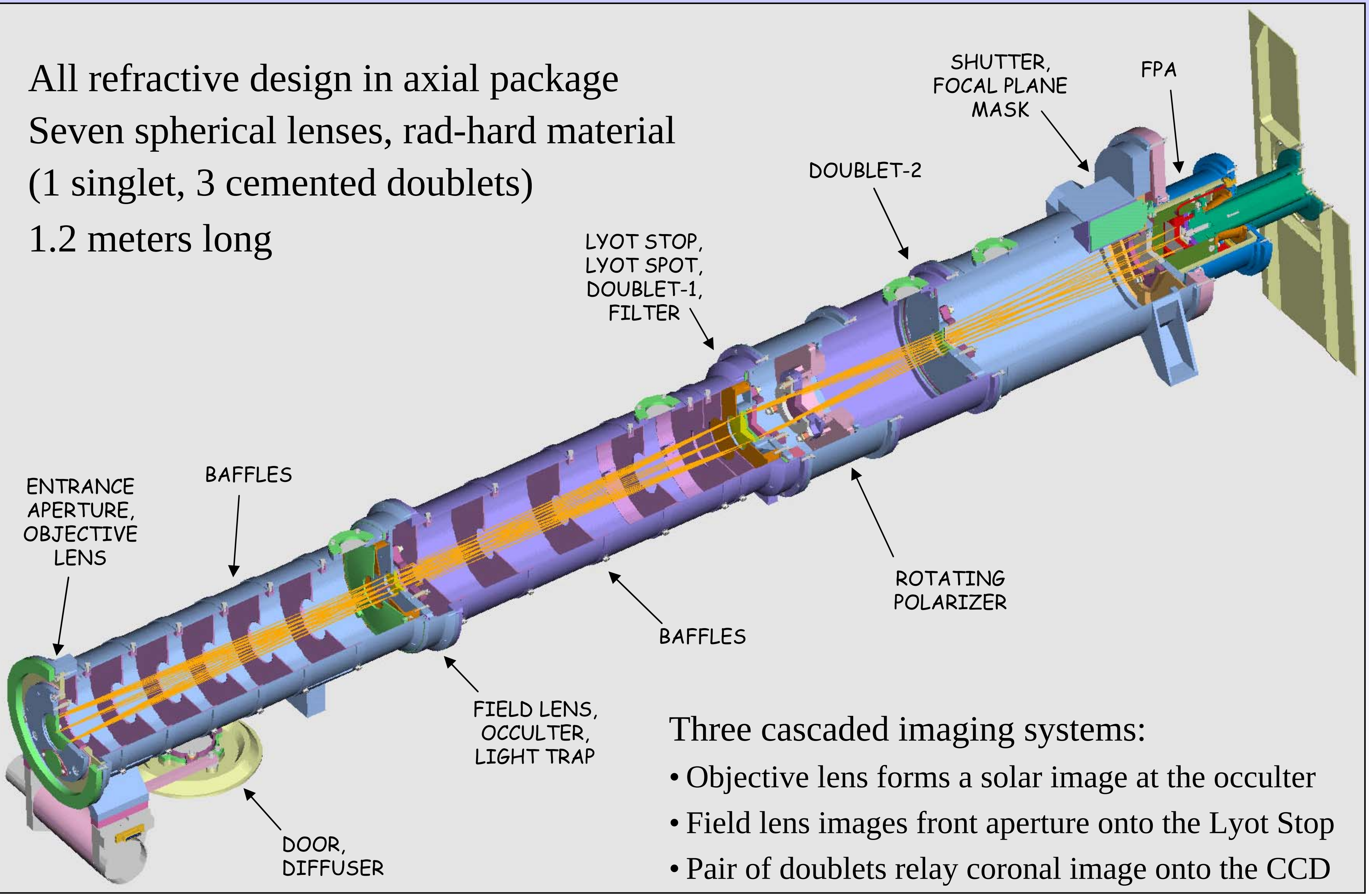
- **initial acceleration**
- **non-radial motions**
- **transverse (latitudinal) expansion**
- **initial radial expansion**

All refractive design in axial package

Seven spherical lenses, rad-hard material

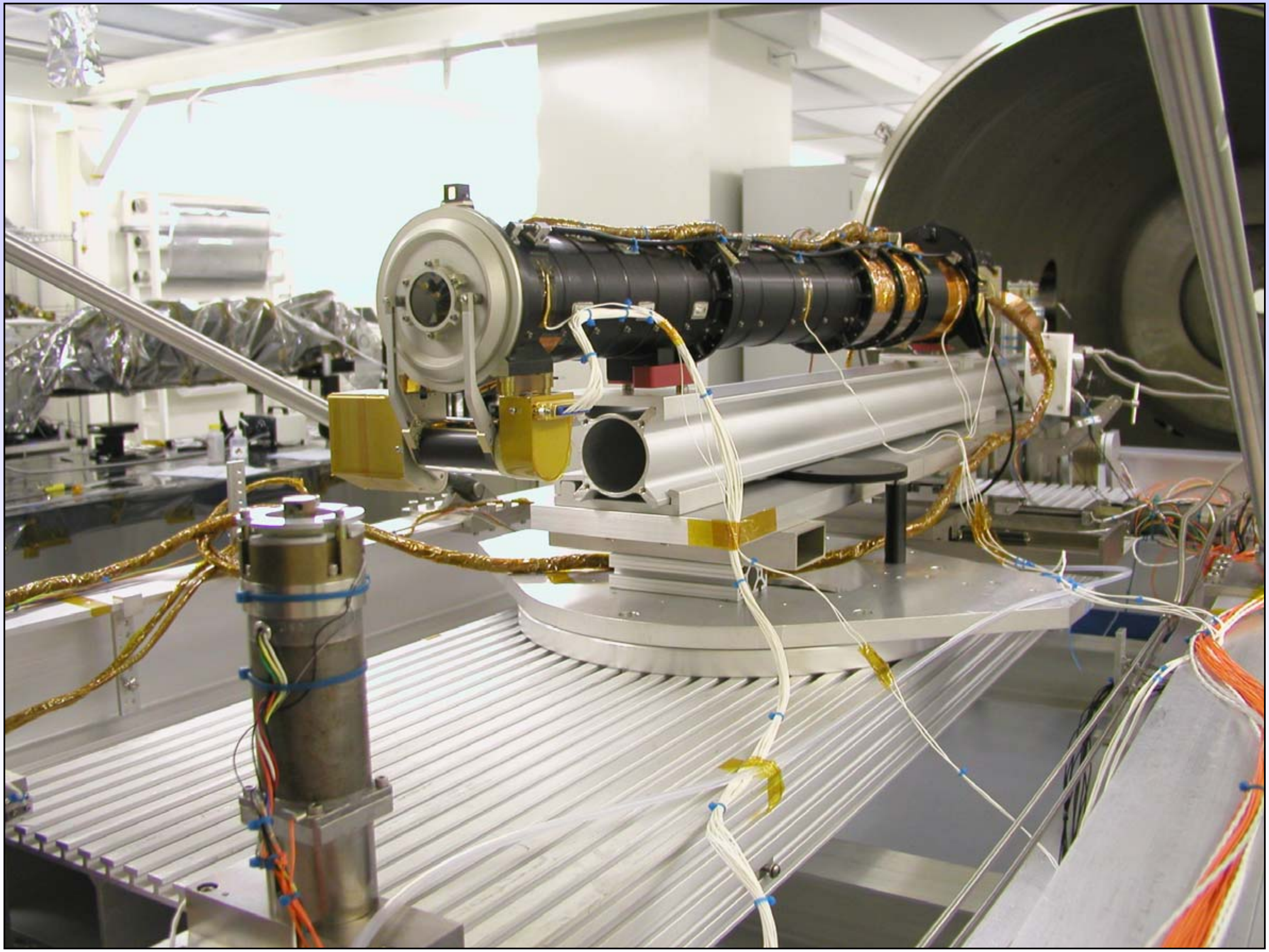
(1 singlet, 3 cemented doublets)

1.2 meters long

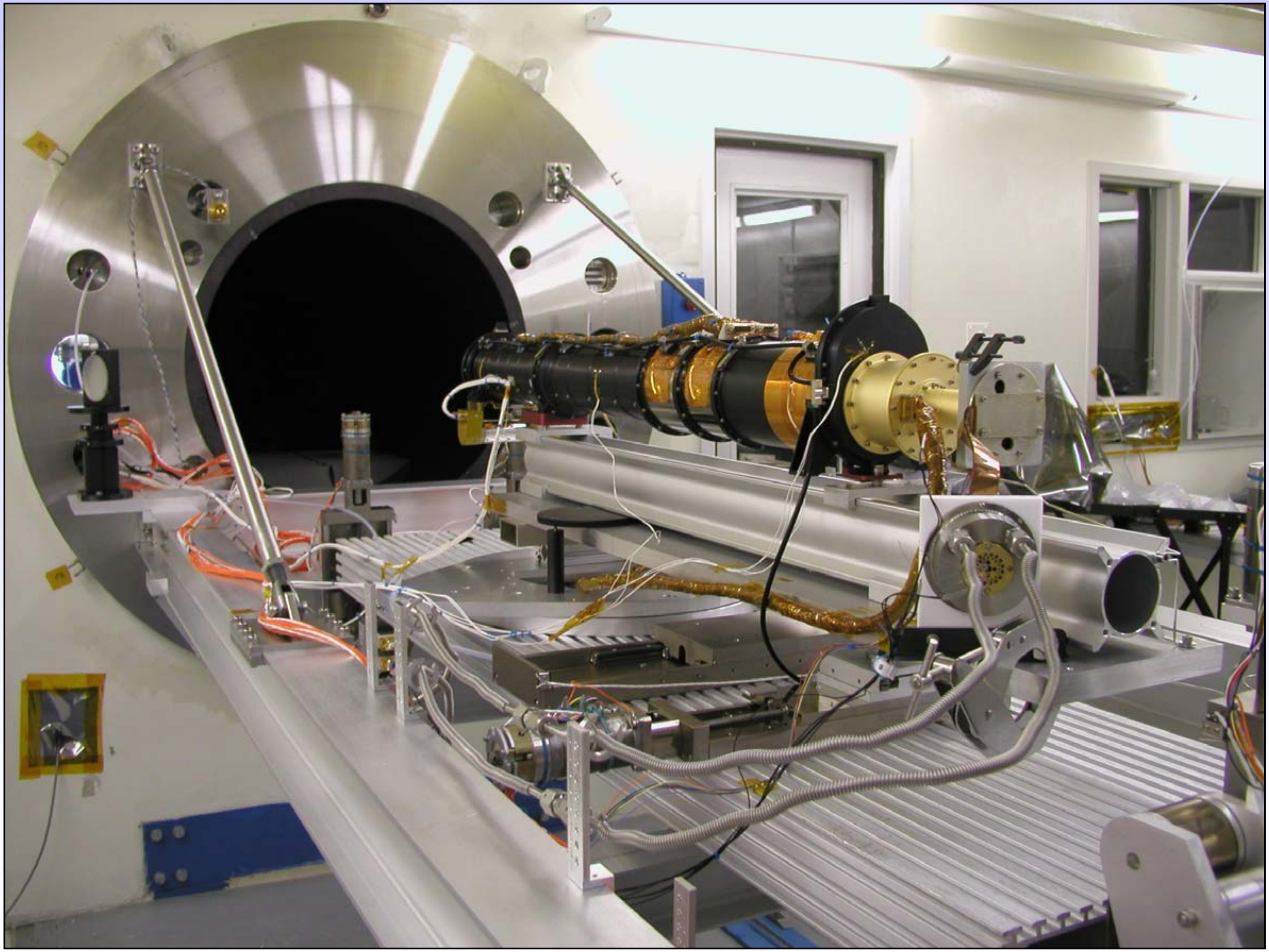


Three cascaded imaging systems:

- 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



STEREO SWG



STEREO SWG

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.

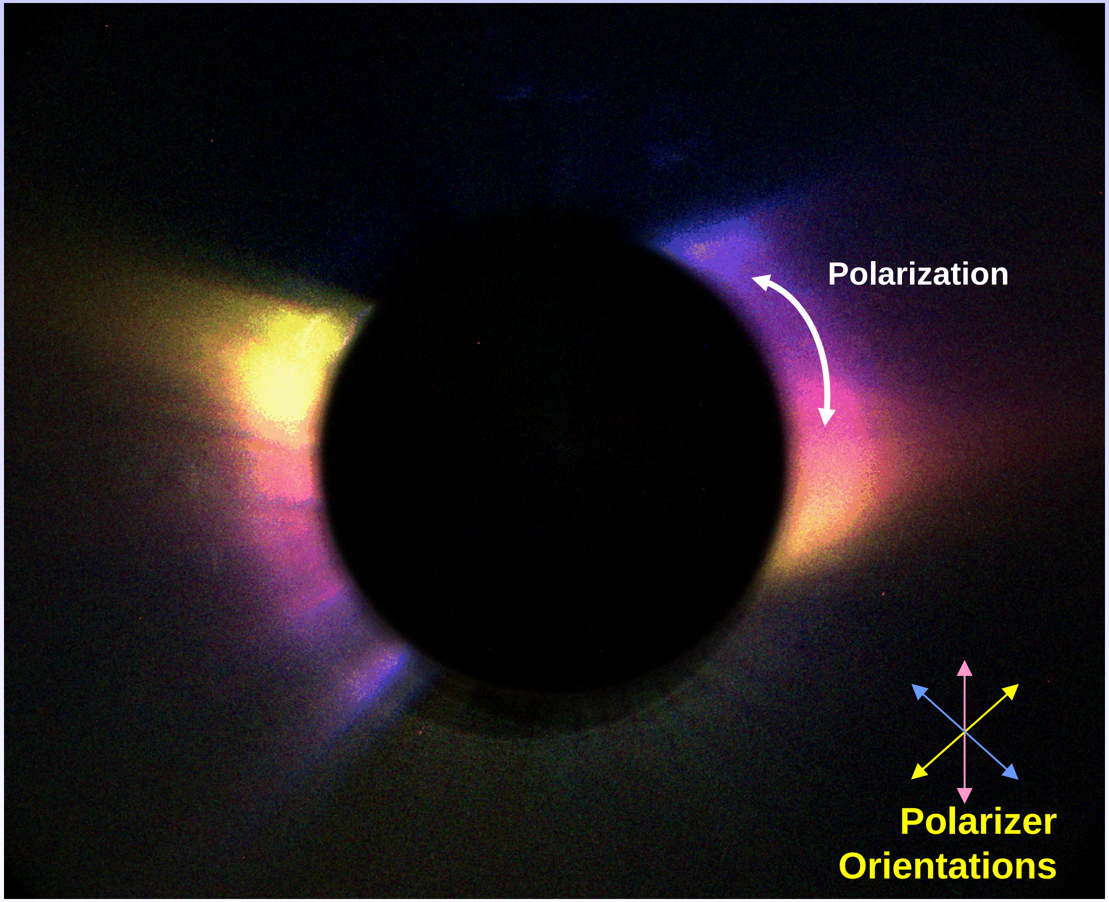
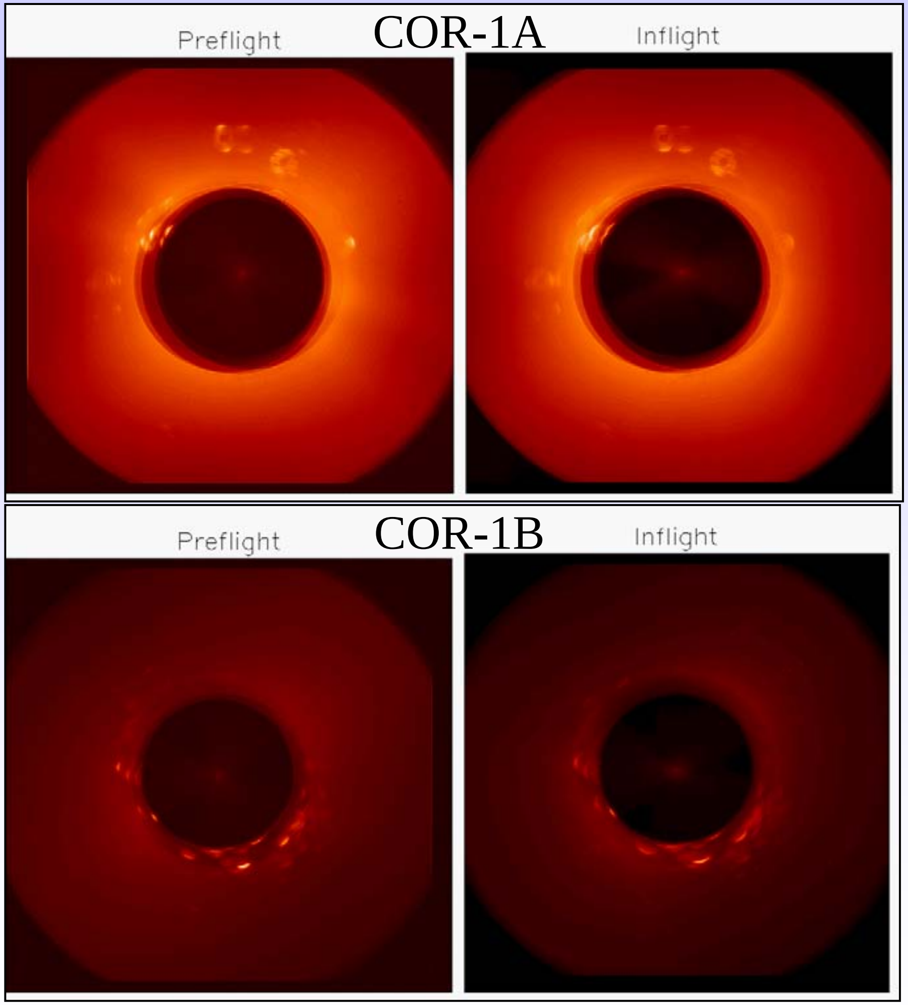
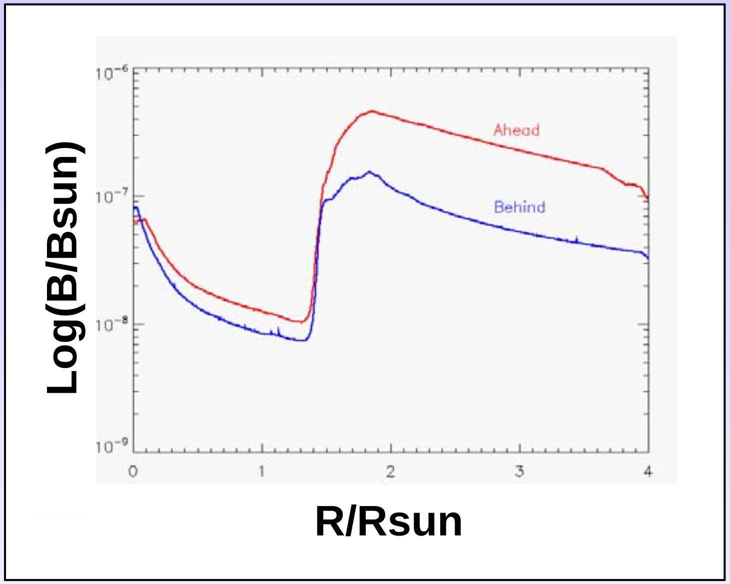


Image showing 3 separate polarization components

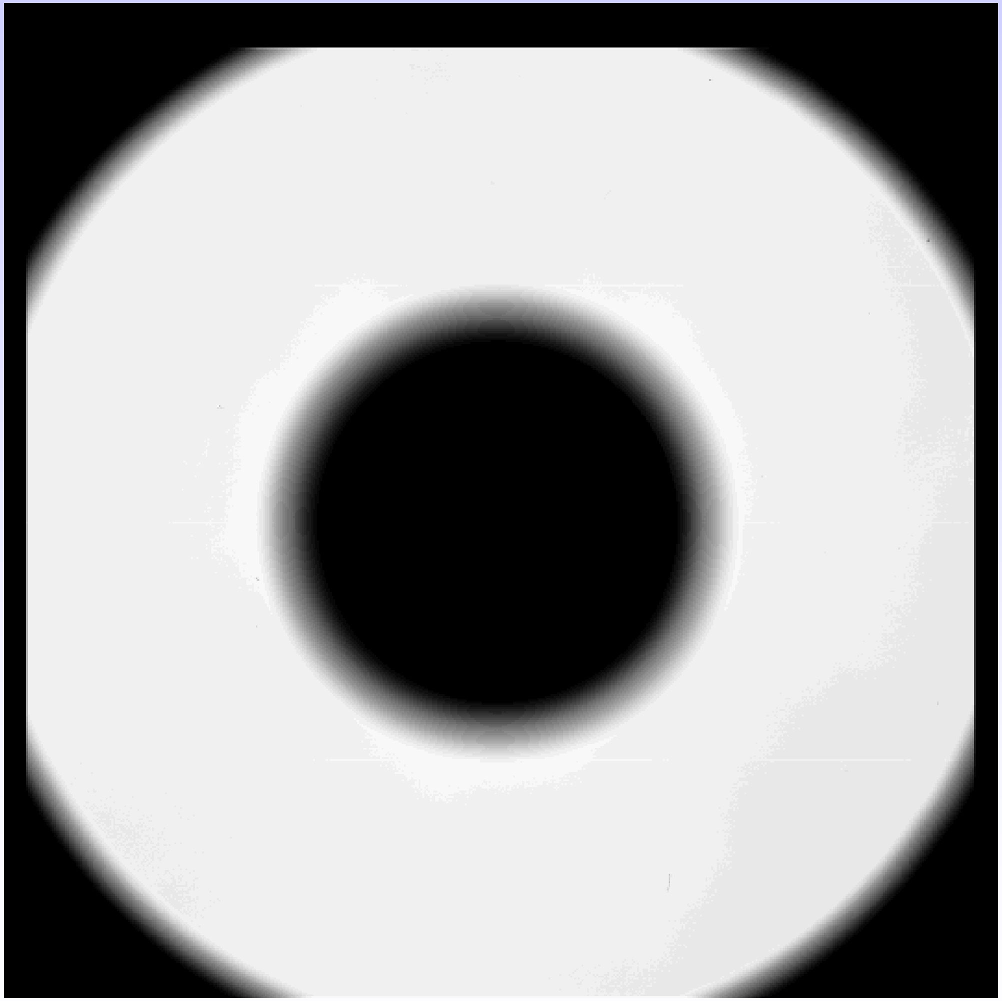
Inflight Comparison





- Scattered light unchanged (A), or better (B) than pre-flight level
- B (refurbished at the Cape) is slightly better than A
- Both are below 10^{-6} requirement

Flat Field

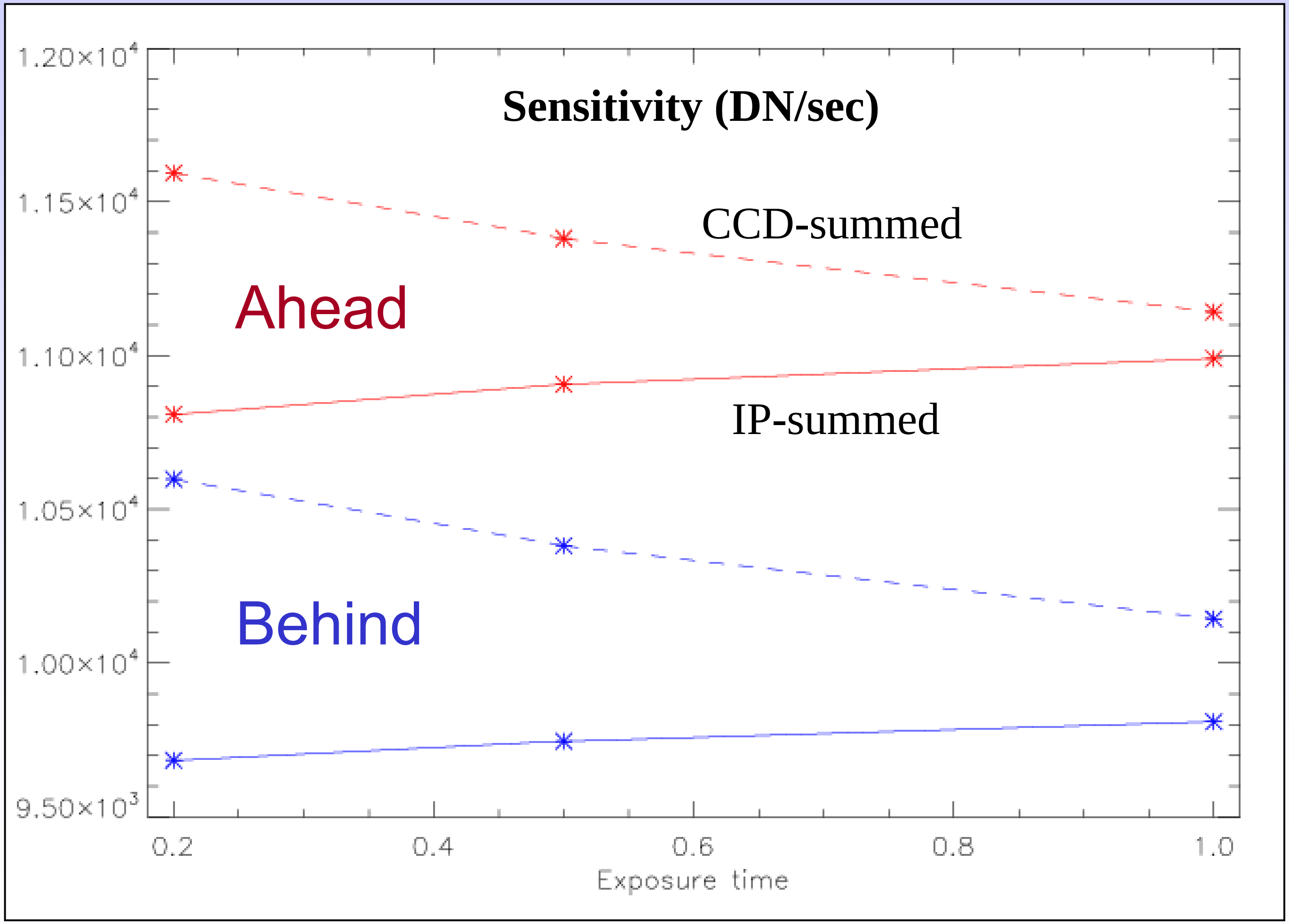


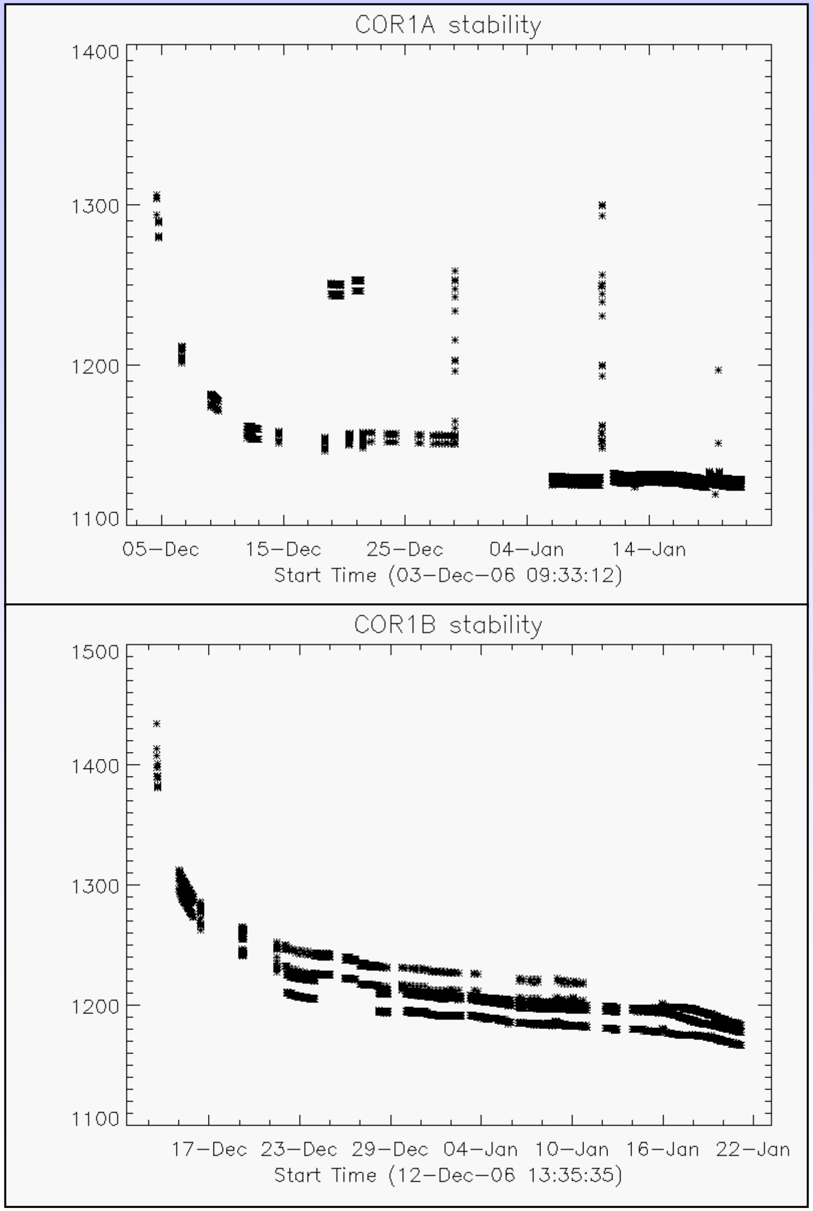
- The field is highly flat, with discrete areas of vignetting near the occulter and camera aperture edges.
- The flat field is monitored in flight with the diffuser window mounted in the door.

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.

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

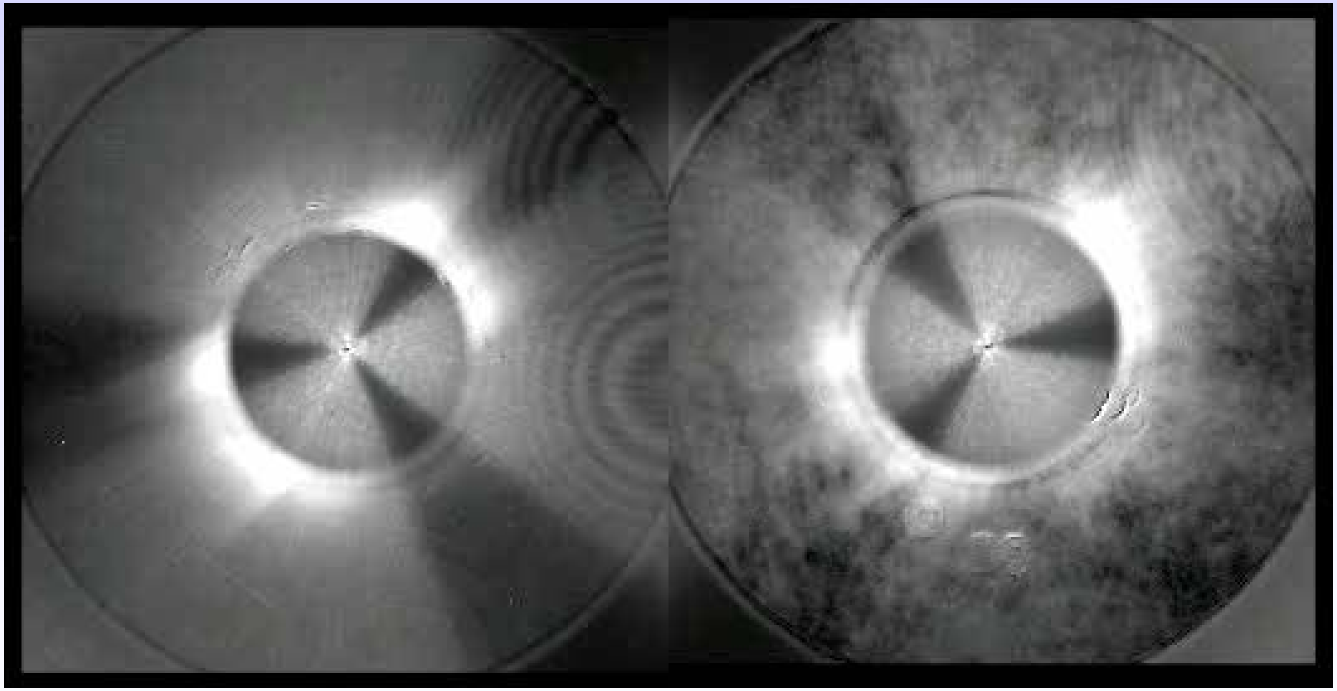
Removing Scattered Light

- 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.

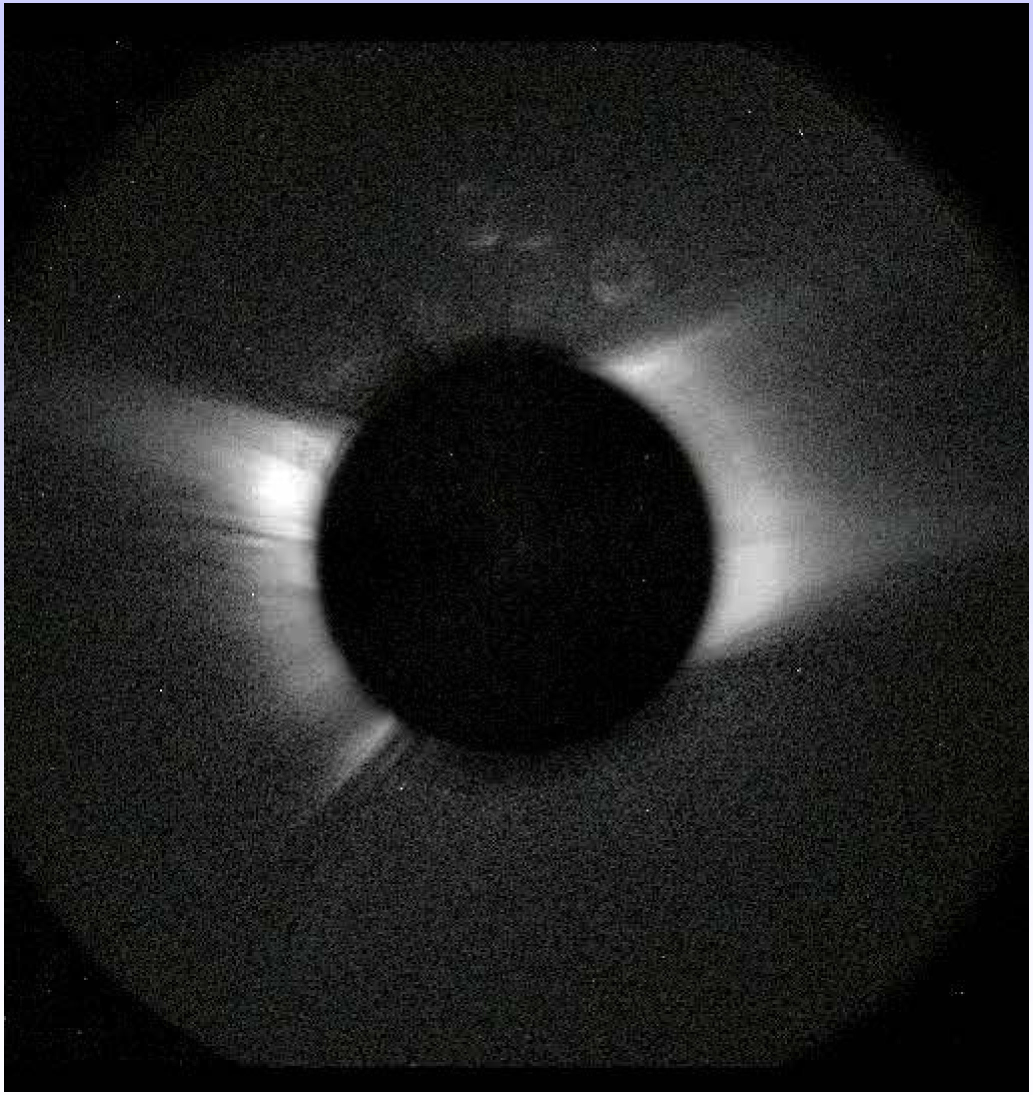
pB



Behind **Ahead**

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.

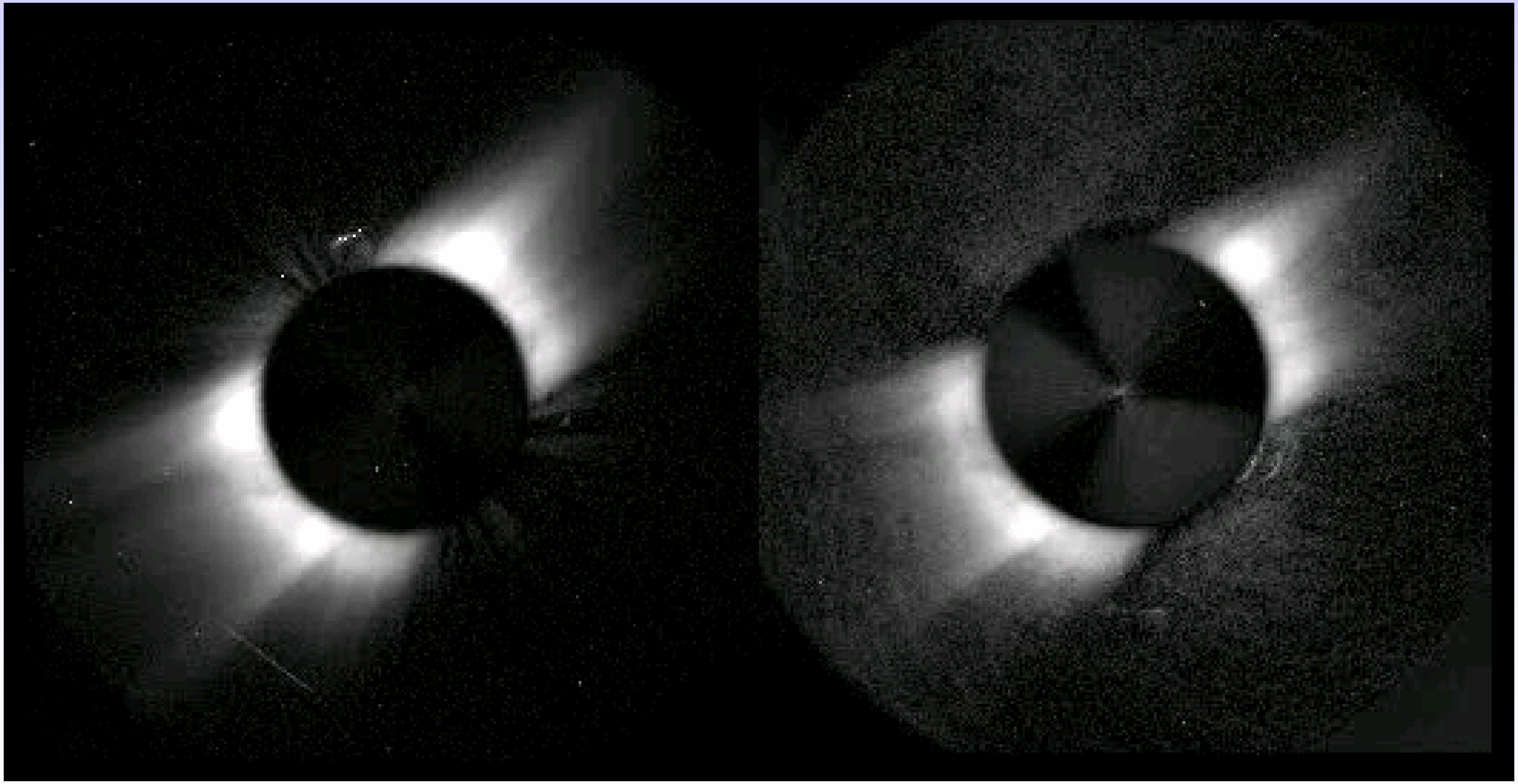


SWAVES roll on Ahead, Dec 18th

COR1 “B” (24-Jan-2007)

Subtracting Rotation Model

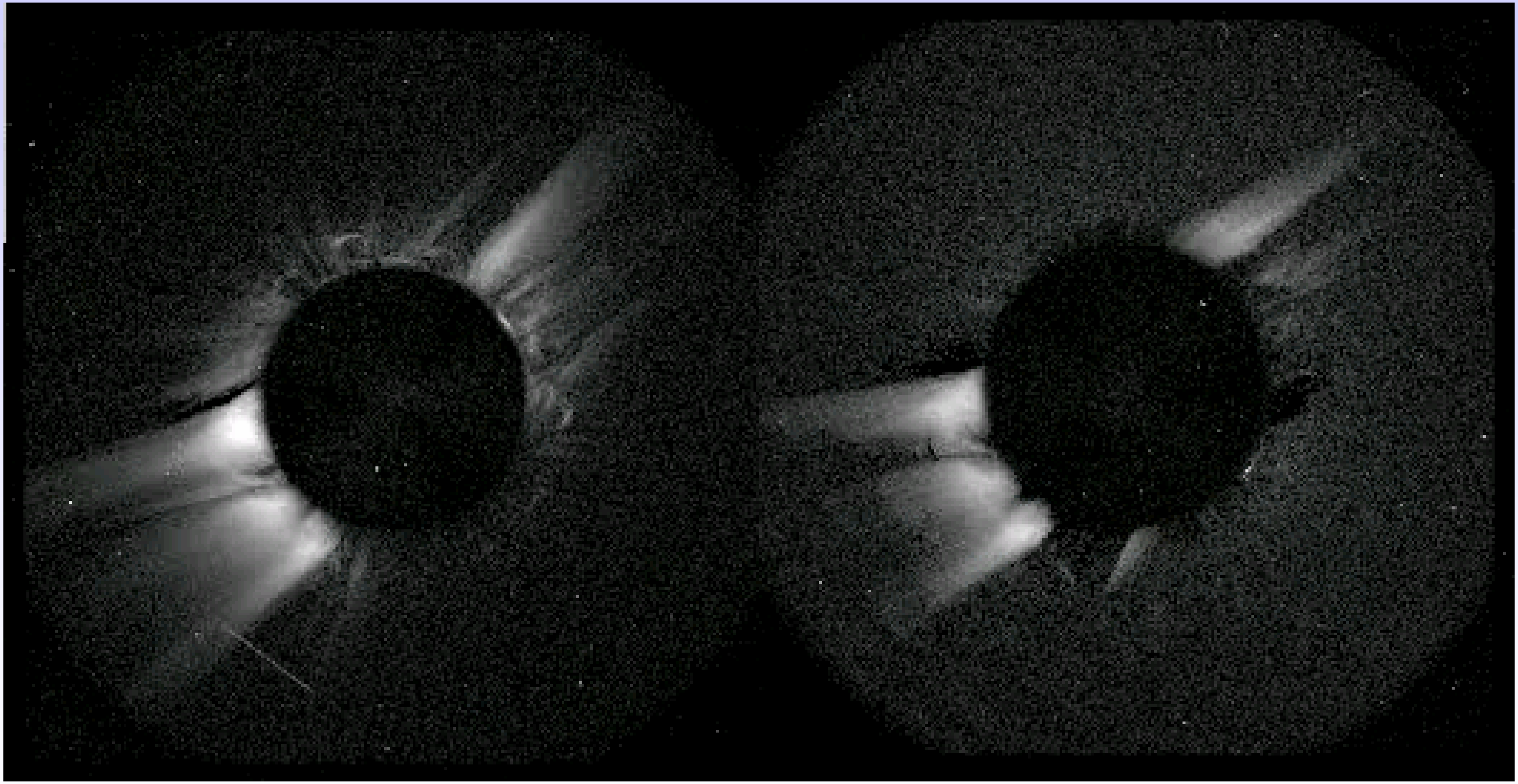
- Most representative of corona.



Behind **Ahead**

COR1 “B” (24-Jan-2007)

Subtracting Daily Minimum

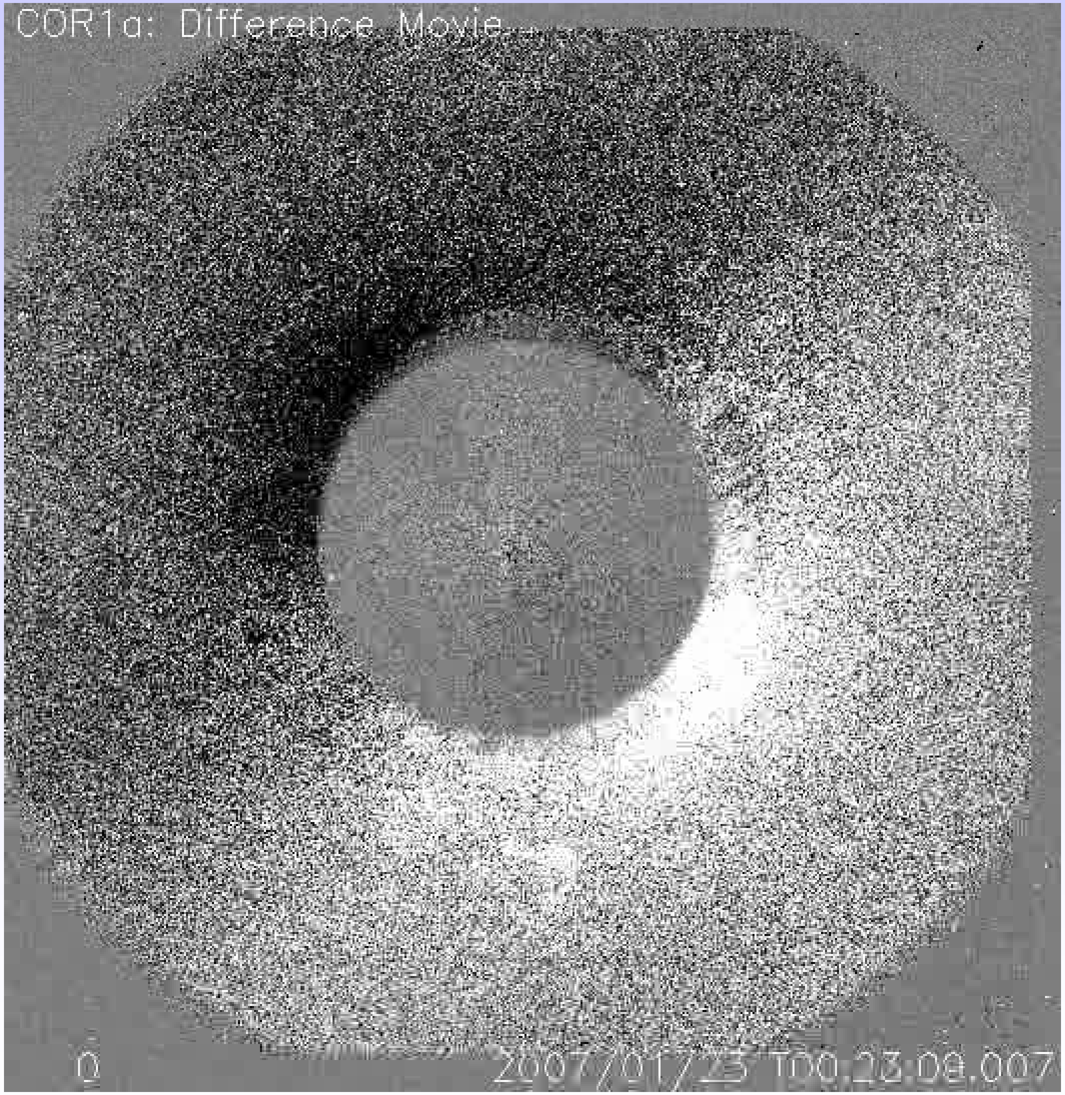


Behind **Ahead**

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

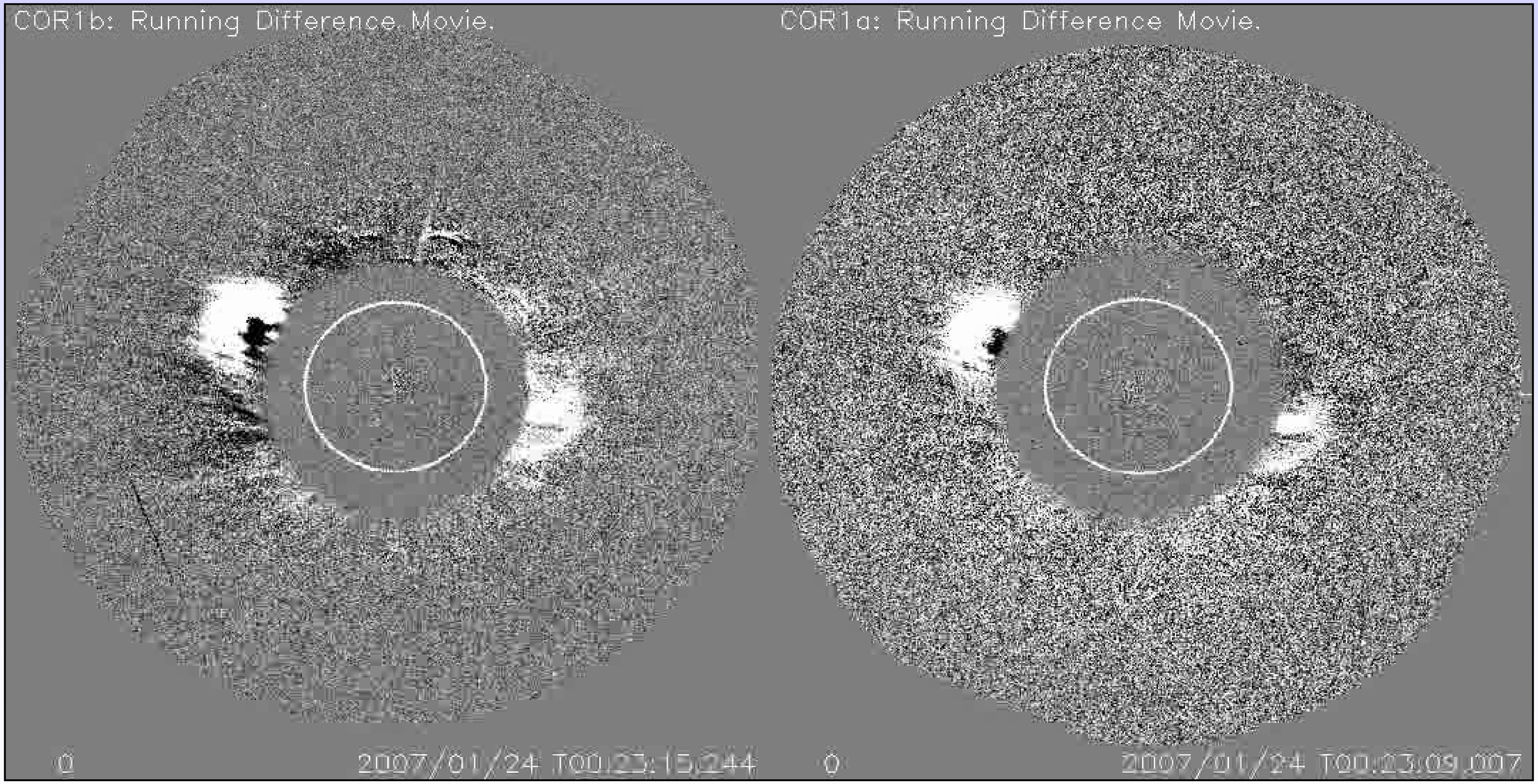
Jitter Sensitivity



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

COR1 “B” (24-Jan-2007)

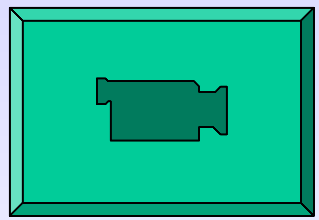
running difference median



Behind **Ahead**

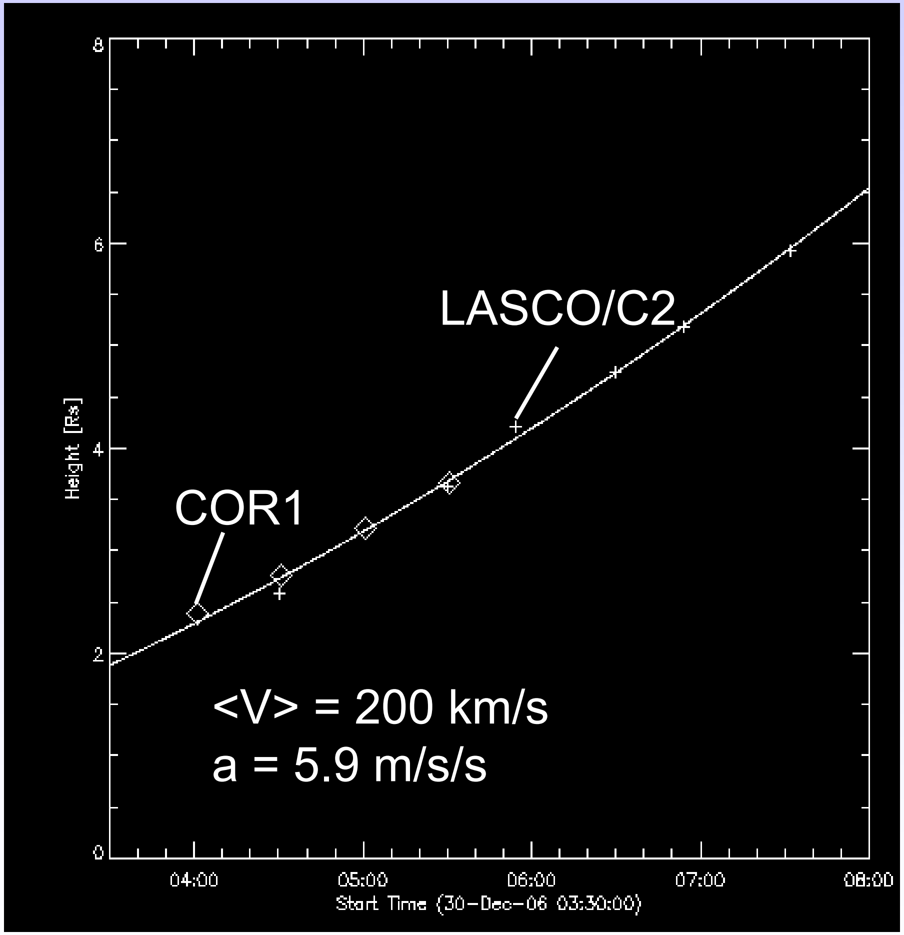
COR1 Event

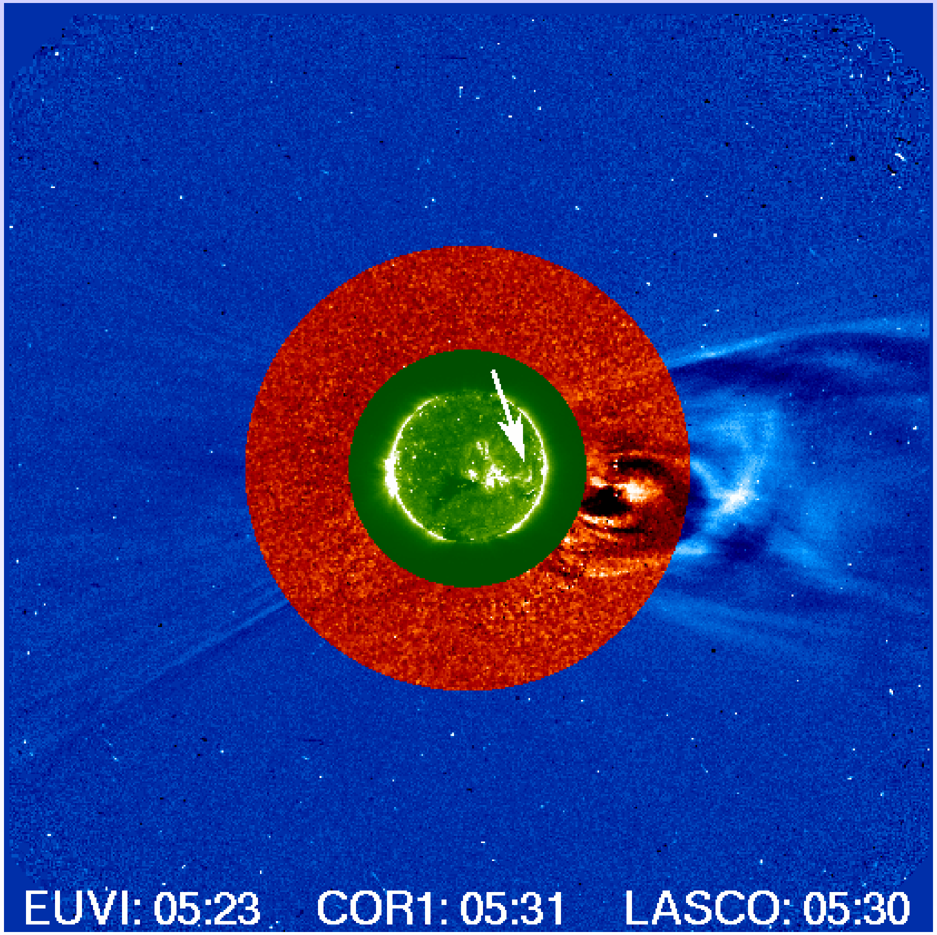
25 Jan 2007



from James McAteer

First CME Height-time Plot





2006/12/30

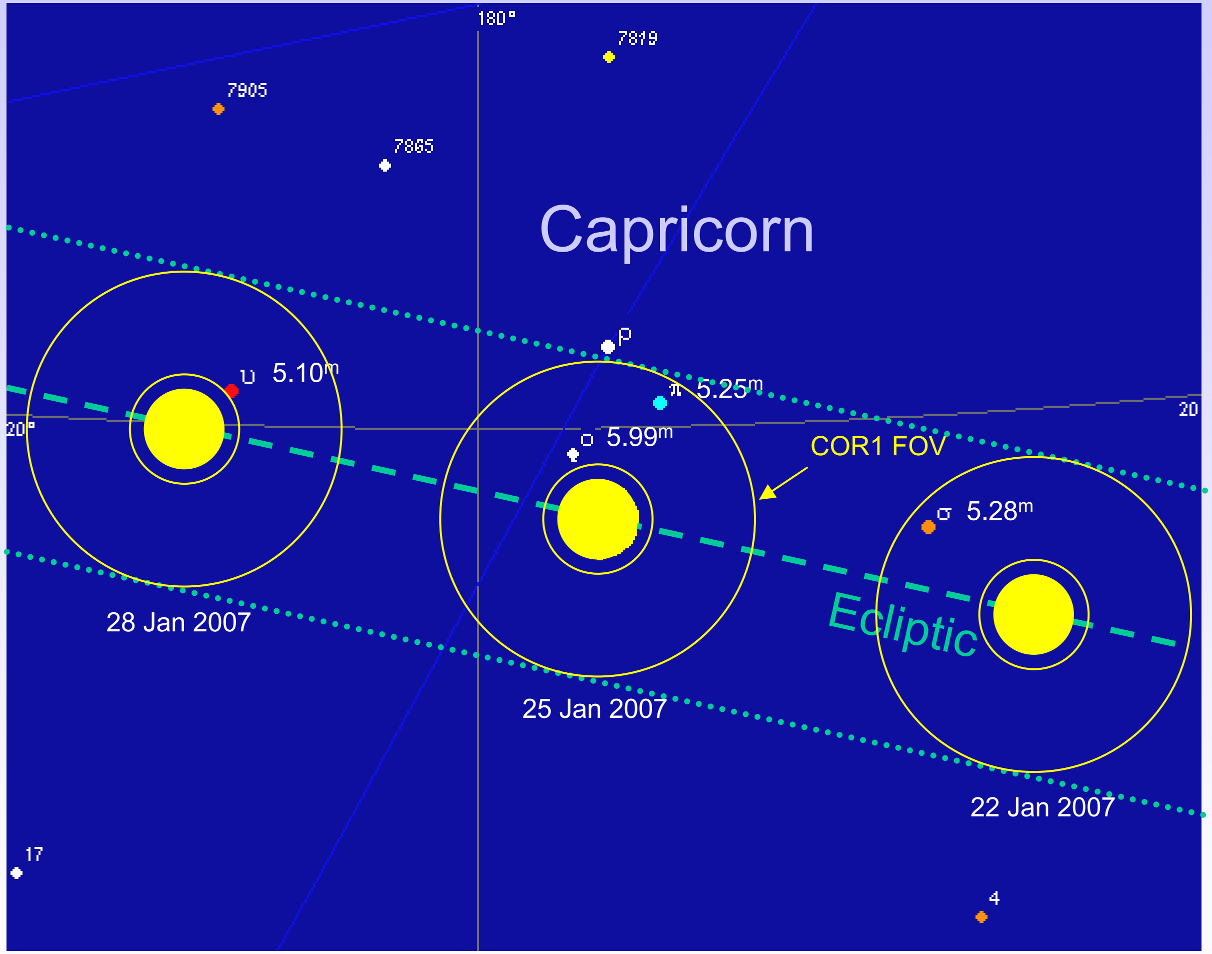
Gopalswamy and Yashiro

Events List

15-Jan to 18-Feb-2007

	COR1-A	COR1-B
Observing [Days]	31	35
Data Gaps [Days]	4	0
Average [Images/Day]	67	62
Cadence [min]	21.5	23.2
CMEs Detected	27	24
Questionable CMEs	6	9
Stars Detected	1	7
Debris Sightings	1	2

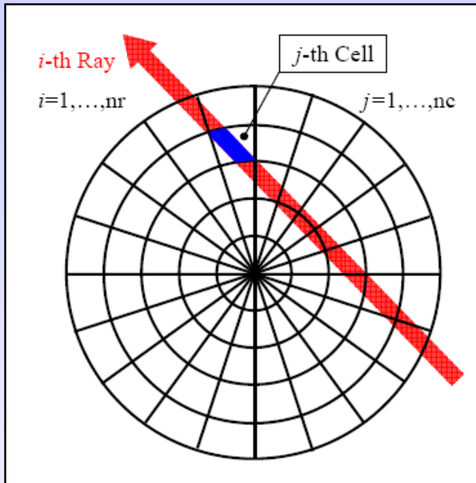
Background Stars

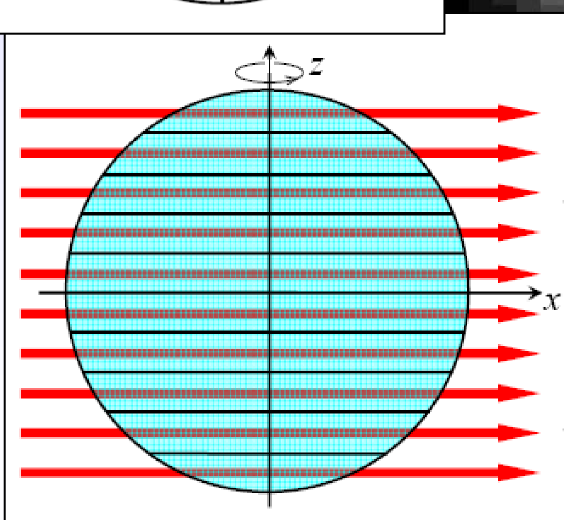


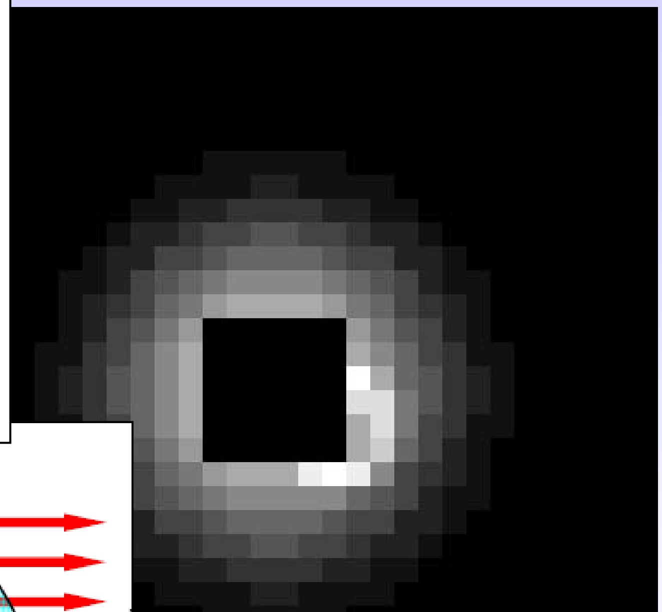
- Stars passing through FOV provide an opportunity to verify alignment and may be useful for intensity calibration
- Four stars observed during last week of January
- Solar pointing determined from stars (A) and Moon (B)

Tomographic Modeling

3D Density Determination







Minimize

$$F = |\mathbf{A} \cdot \mathbf{X} - \mathbf{Y}|^2 + \mu |\mathbf{R} \cdot \mathbf{X}|^2$$

- Combination of rotation and views from A and B to reconstruct 3D corona
- Regularization parameter ❍ controls smoothness

from Shaela Jones and Maxim Kramar

COR1 Work-in-Progress

- **Several people working on different methods to remove stray light pattern**
  - **Dynamic versus static**
- **Using stars to determine COR1 intensity calibration and Sun location**
  - **Stars identified in both A and B**
- **Preliminary event list started (duty cycle, CMEs, stars, space debris, etc...)**
- **Modeling the 3D corona**

COR1 Science Team

- J. M. Davila, O. C. St. Cyr, B. Thompson, J. Gurman, N. Gopalswamy, and W. Thompson (SECCHI co-I's)
- J. McAteer, M. Kramer, H. Cremades, H. Xie, S. Yashiro, N. Reginald, G. Stenborg, T. Moran, D. Spicer
- S. Jones (graduate student)
- Undergraduate students at MLSO (J. Burkepile)
- Image enhancement at Mees (Huw Morgan)

COR1-B Lunar Transit Movie

Base difference in B