STIS Coronagraphy

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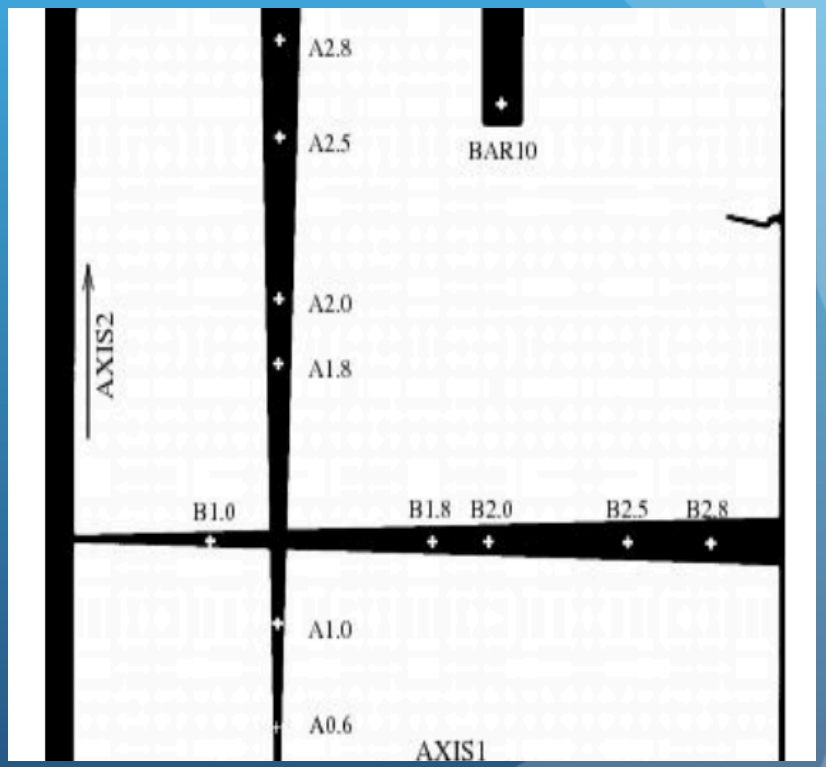
HST Coronagraphs

- HST has supported 3 coronagraphs: NICMOS, ACS, and STIS
- Bulk of image properties are set by the OTA, but instrumental effects are also present
- None of the HST coronagraphs have been optimal
  - ACS spot size issues
  - NICMOS parts moving in dewar
  - STIS incomplete apodization, and lack of peakdown software

STIS Coronagraphic Imaging

- Main function of STIS occulting wedge structure is to prevent bleeding over region of interest in image
- Mainly used to image circumstellar disks – both protoplanetary and debris
- All disks have required removal of a PSF template to reveal the disk : the star typically accounts for 95-99% of the signal in the raw image

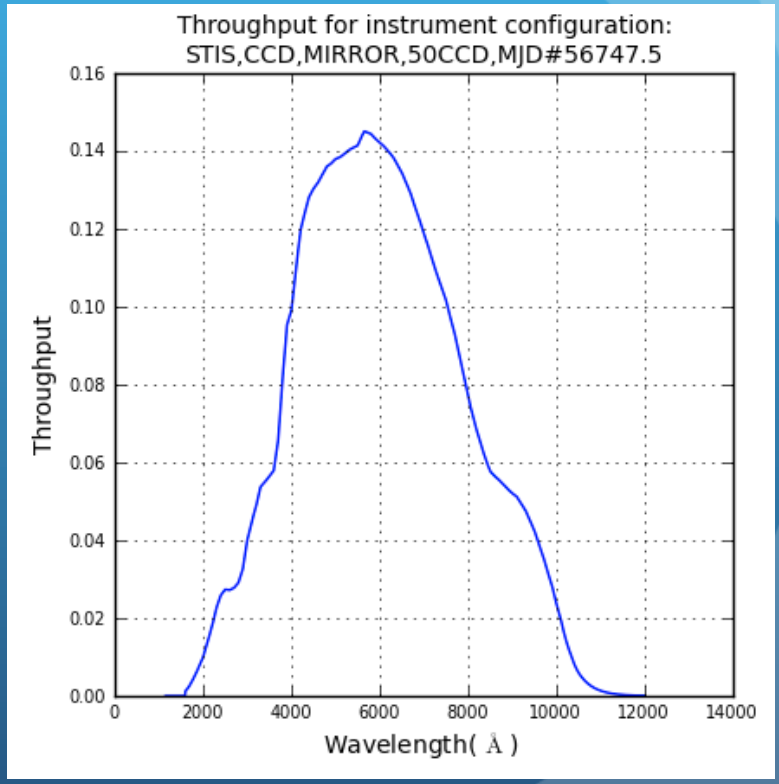


The Bandpass - 50 CORON

The Mode

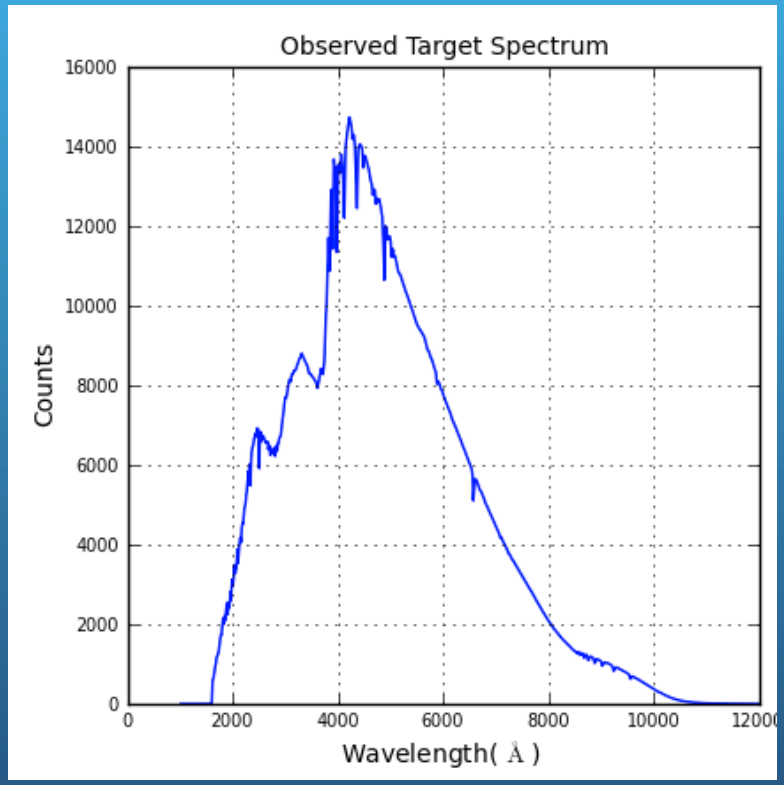
- Remaining working coronagraph on HST
- Simple Lyot coronagraph
- Broadest bandpass of the HST coronagraphs
  - Advantage: sensitivity to faint nebulosity
  - Disadvantage: huge color effects

Bandpass

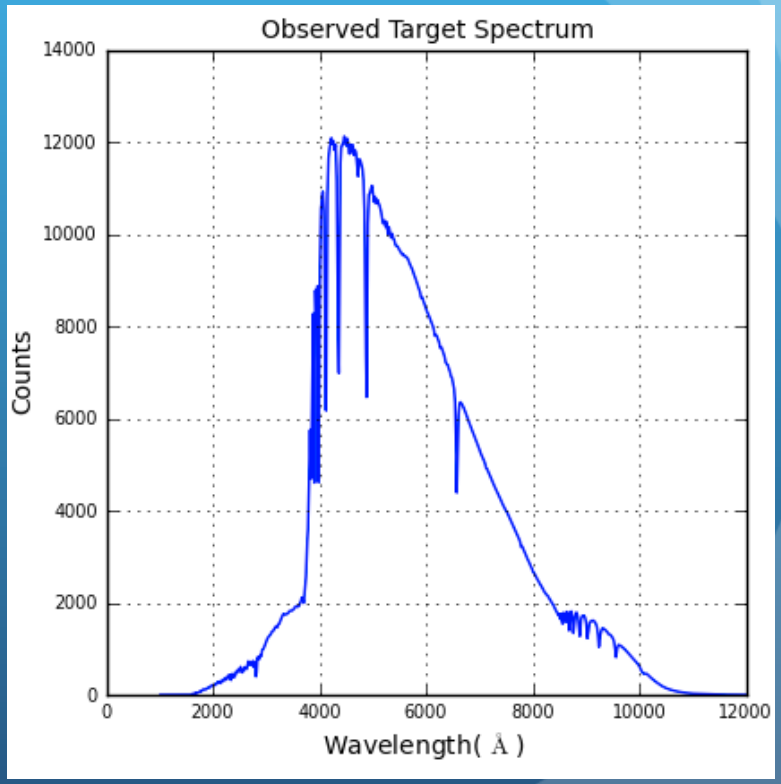


Shape of PSF is F(wavelength)

B3V

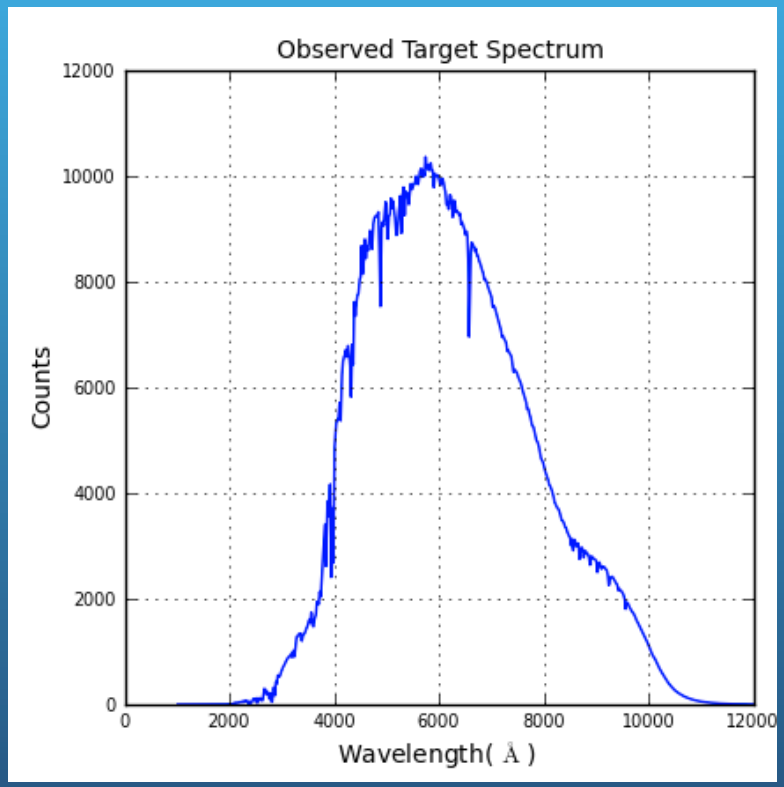


A0V

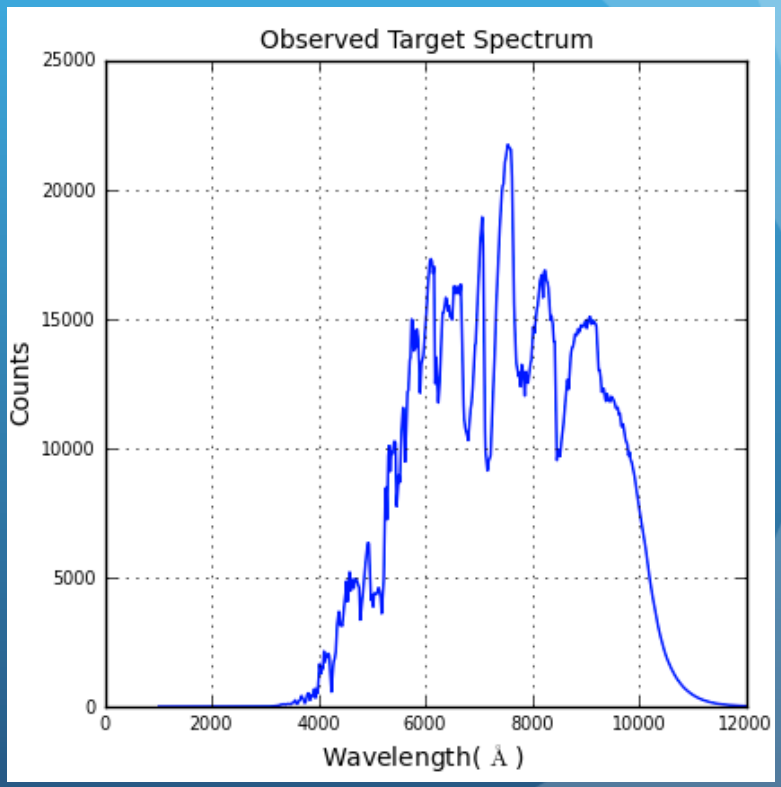


Shape of PSF is F(wavelength)

G0V



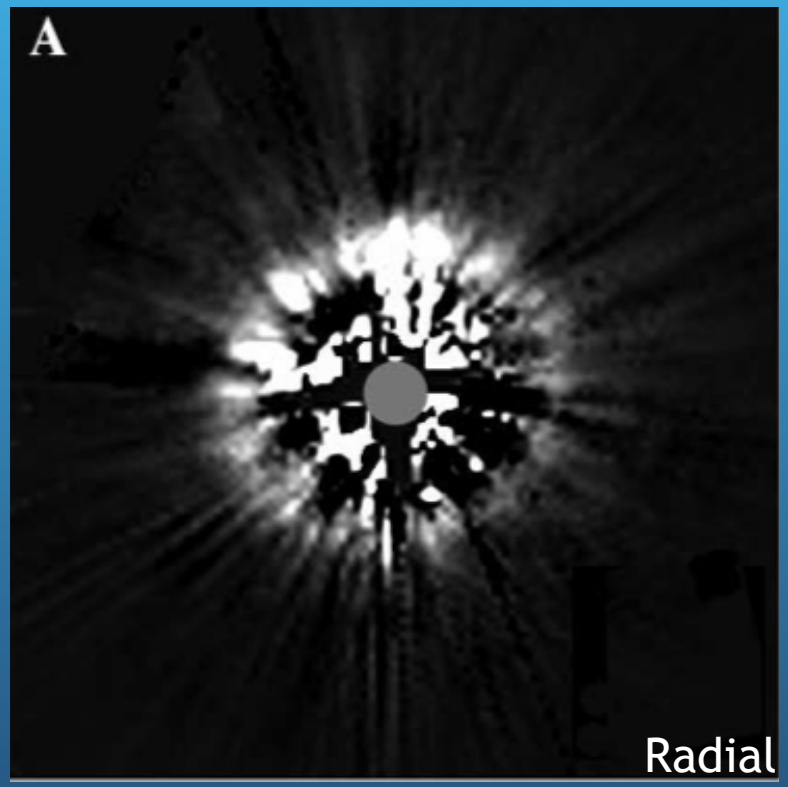
M2V

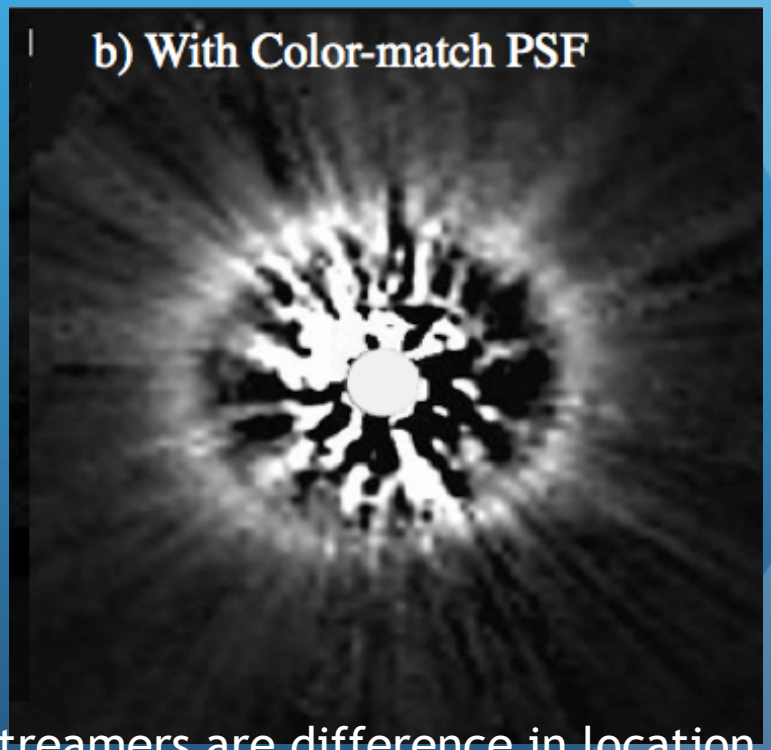


Matching the Shape of the PSF Improves Image Fidelity - NICMOS

Discovery NICMOS imagery

HD 181327 NICMOS Discovery



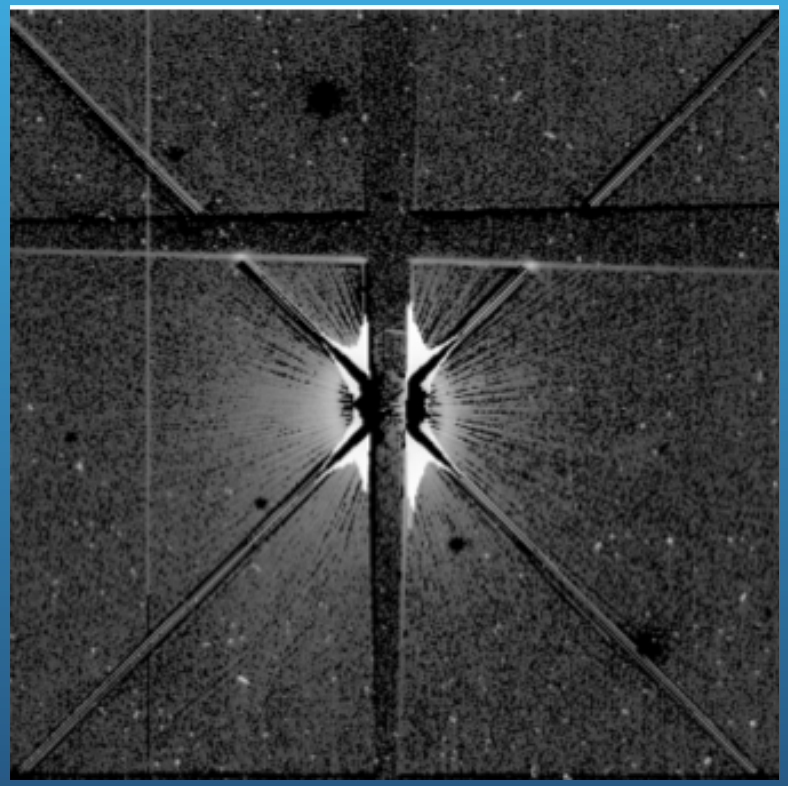


Radial streamers are difference in location of Dispersed speckles between the target and PSF

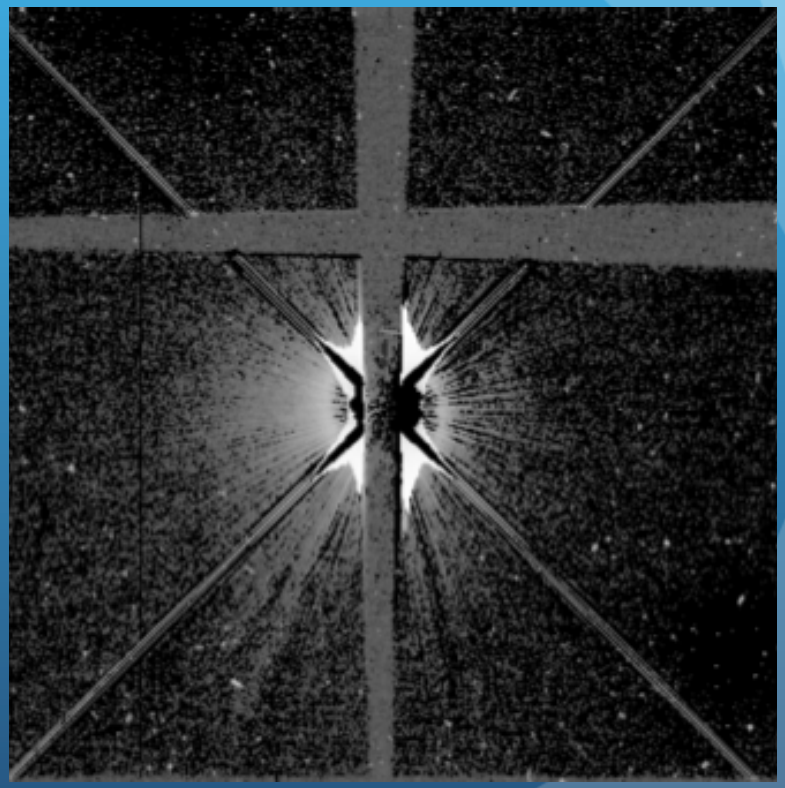
Schneider et al. 06

Matching the Shape of the PSF Improves Image Fidelity -STIS

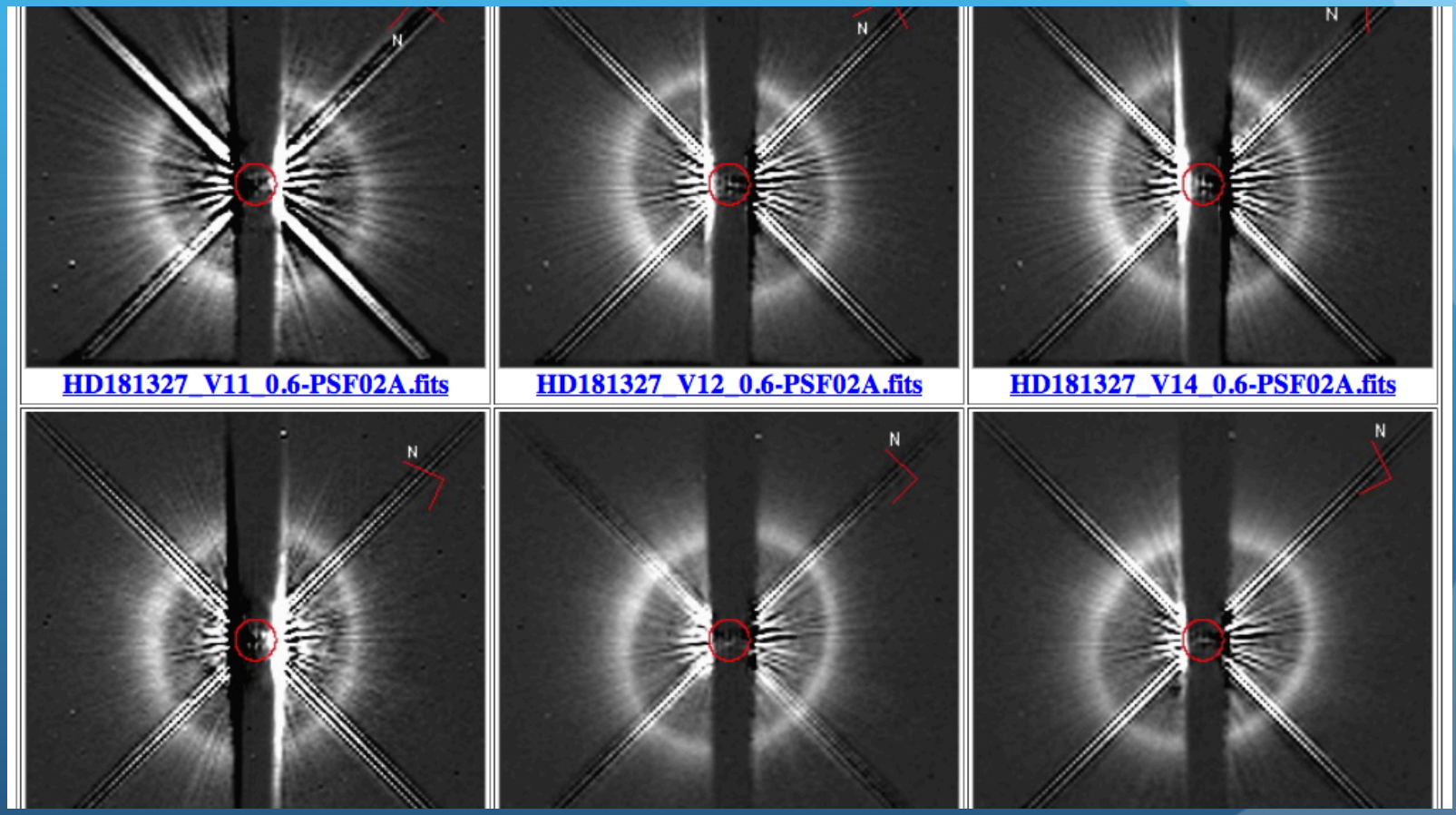
PSF star hr4413 – 2001 data



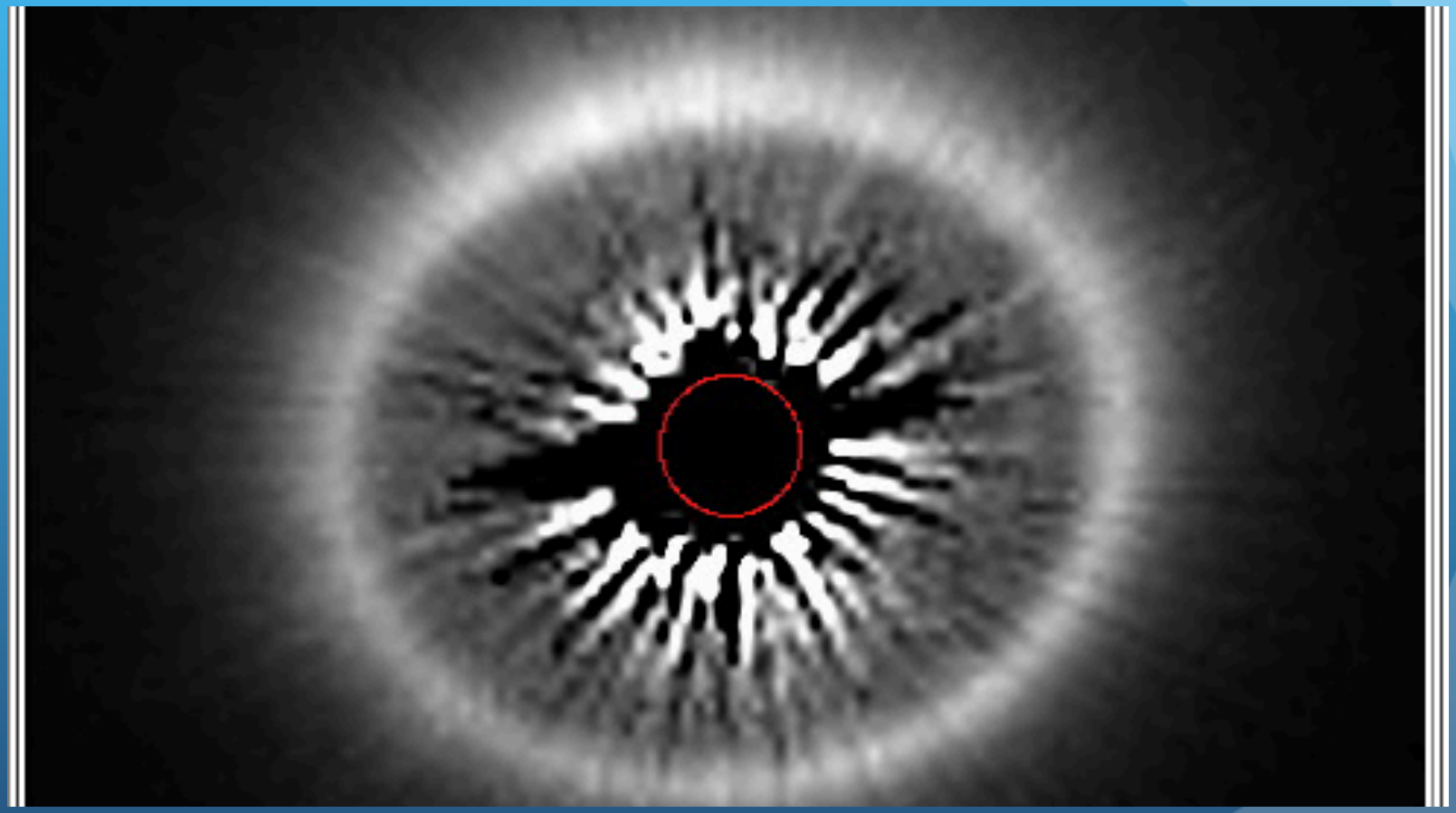
PSF star HD 134970 – 2001 data



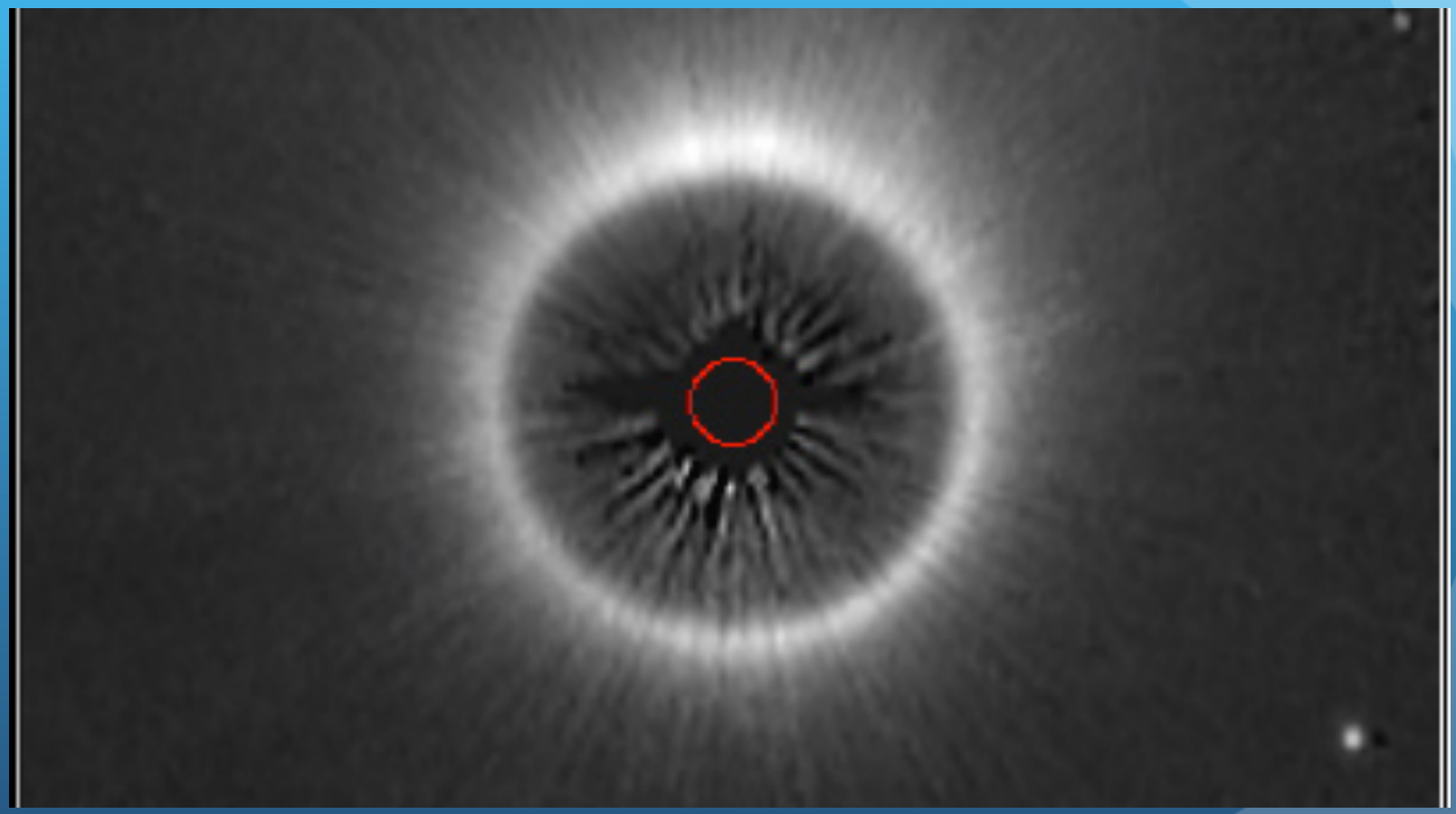
Color-Matched and Contemporary PSF Further Improves Image Fidelity - STIS



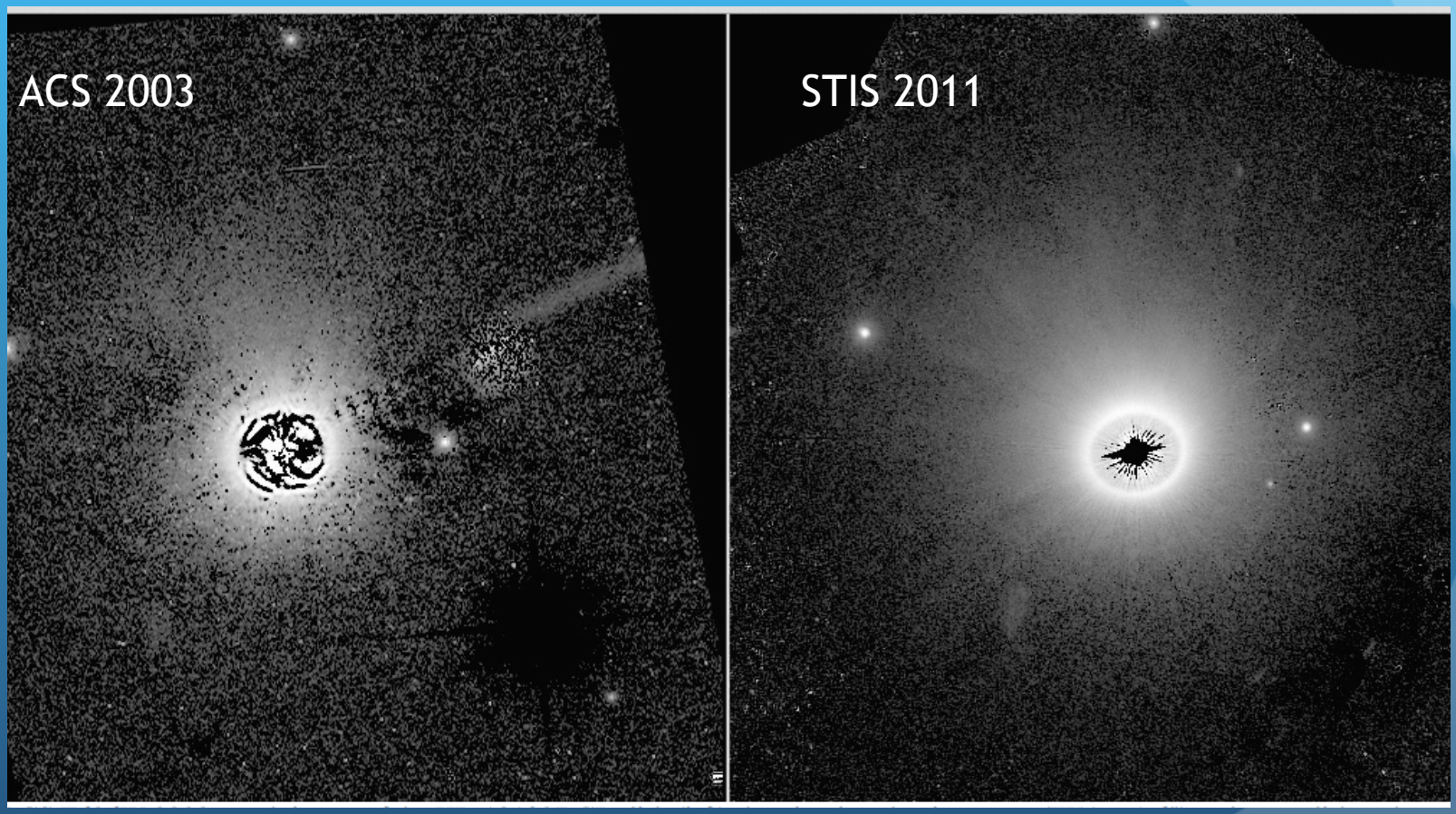
Composite of 6 rolls



Analysis Quality Image can be deprojected and scaled by r^2



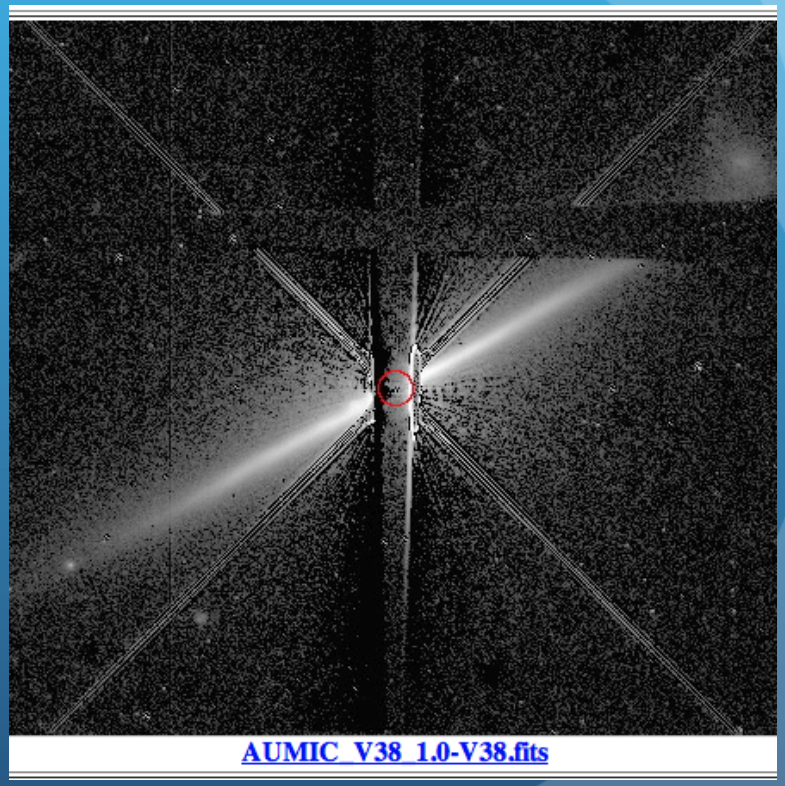
Far-field – sensitivity limited



Alternate Approaches

- Use nebulosity-free regions of multi-roll image set with star itself as the PSF (ADI with few S/C rolls)
  - Works best for edge-on systems or point source detection (Lowrance et al. 2005).
  - May work if the PSF star is not as good a match to the science target (e.g. stellar activity for M stars)
  - Can be used in an exploratory effort to detect disks (Krist et al. 2010), if can tolerate non-detection of disks with i<30-40 degrees.

Roll Differencing – AU Mic



AUMIC_V38_1.0-V38.fits

When the target star is a poor match to a reference object

- Options: have several reference objects and hope that one will be better, check what's available in archival data. If have spectrum of target, explore which kinds of PSF target might be a reasonable fit to the target – use ETC for this.
- If extinction is an issue, select PSF object with has similar line-of-sight reddening - have recovered disks when the template is fainter than the target.
- If STIS coronagraphy continues to be popular may eventually have sufficient data to try LOCI or other techniques (Soummer et al. 2011) – these rely on a sufficient base of similar color imagery.

HST Experience Relevant to JWST

- NICMOS observed targets which were redder in (J-H) or (H-K) than any MS star. STIS has observed young stars which are either more active or bluer due to accretion than MS comparison objects.
- For JWST, this situation will be routine as diskless stars will be blue compared to any system with circumstellar material near the star.
- 10-15° constraint on contemporary PSF templates is similar to field of regard issues with JWST.

You CAN Teach an Old Coronagraph New Tricks!