

Diffraction in ASPIICS

S. Shestov A. Zhukov C. Aime R. Rougeot

Metis 10th workshop

11-13 Feb 2026

#StayWithUkraine - strike on 3rd Feb



03.02.2026
(09.30)

▲✈️↑ 521
засіб
повітряного
нападу
(близько 300 ▲)

SHOT DOWN - 450

- 412 ворожих БПЛА
- 3 крилаті ракети X-22/X-32
- 4 ПКР Циркон/Онікс
- 11 балістичних ракет Іскандер-М/С-300
- 20 крилатих ракет X-101

✈️ ▲ ✈️ × 450

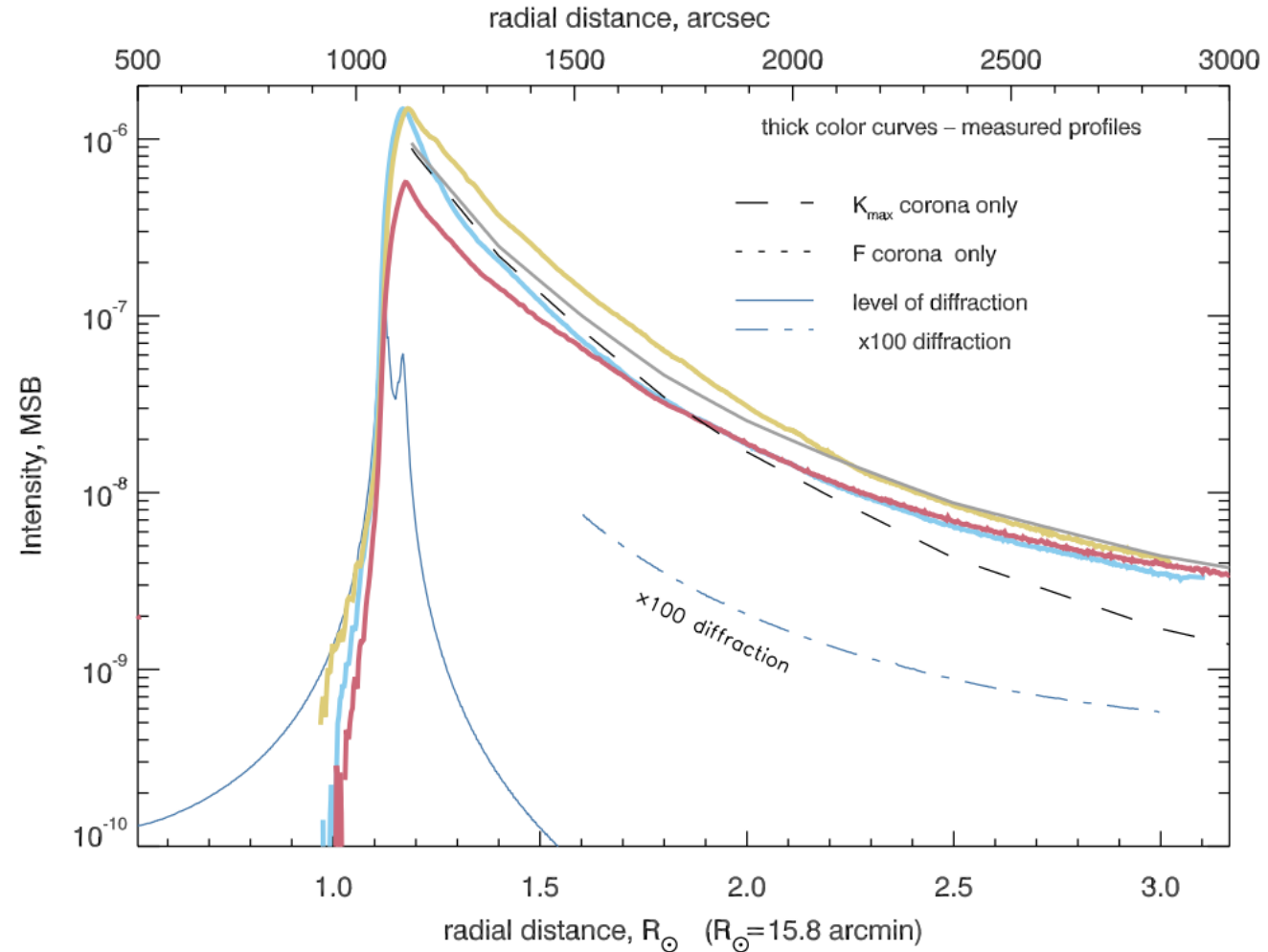
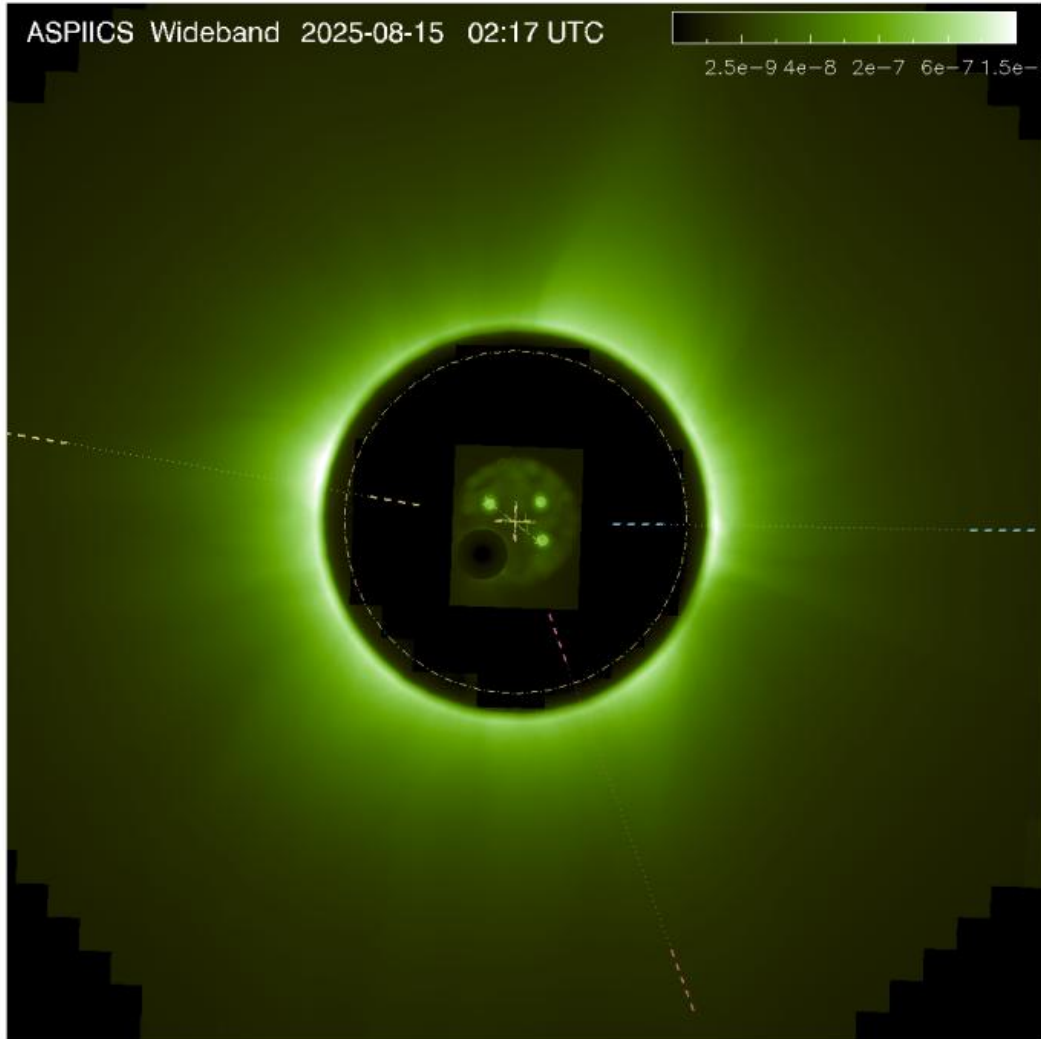
Щ **Повітряні Сили**

<https://t.me/kpszu>
<https://www.facebook.com/kpszu>



ASPIICS observations

- Diffraction is weak – we normally do not see it directly (large ISD and large R_{10})



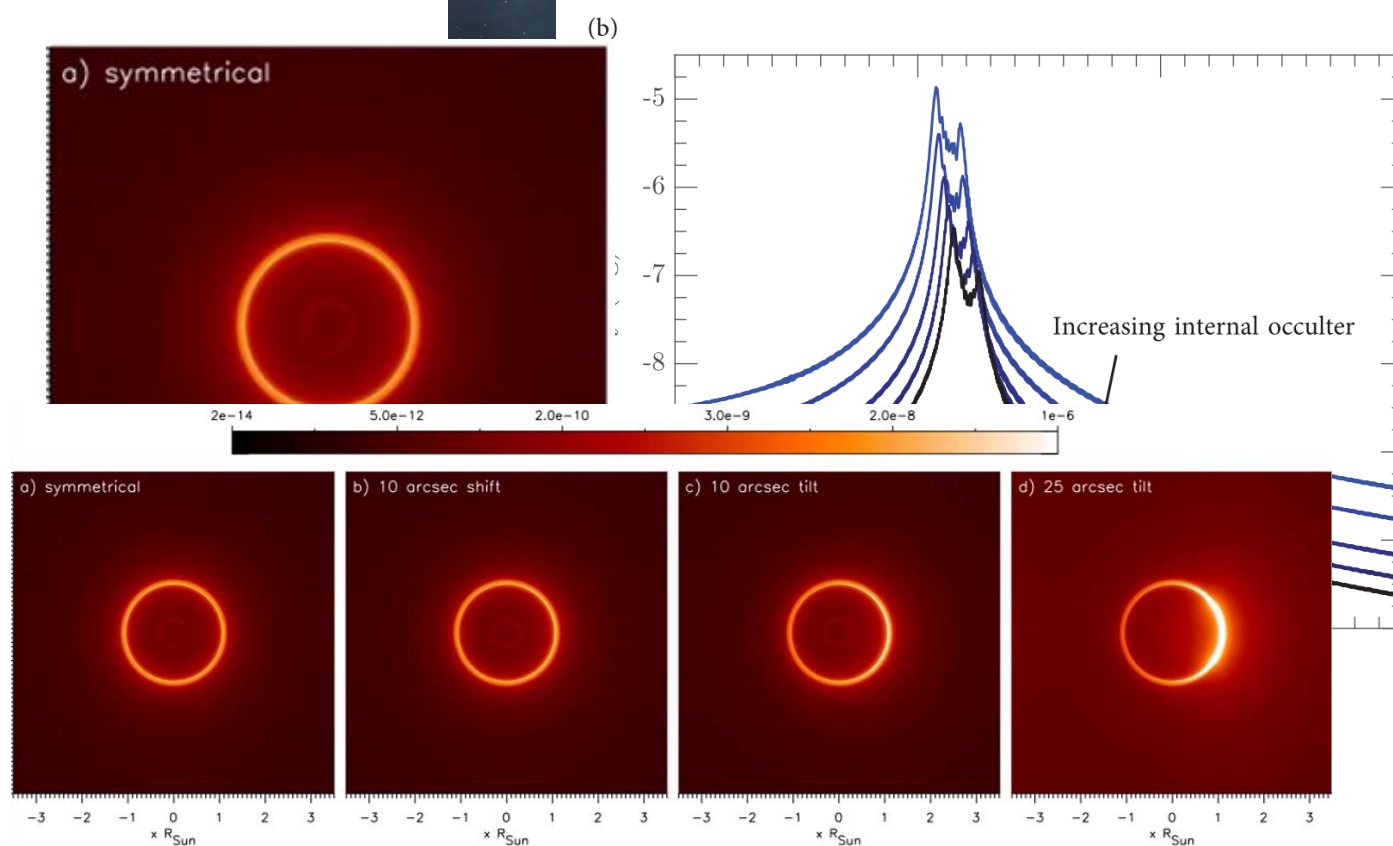
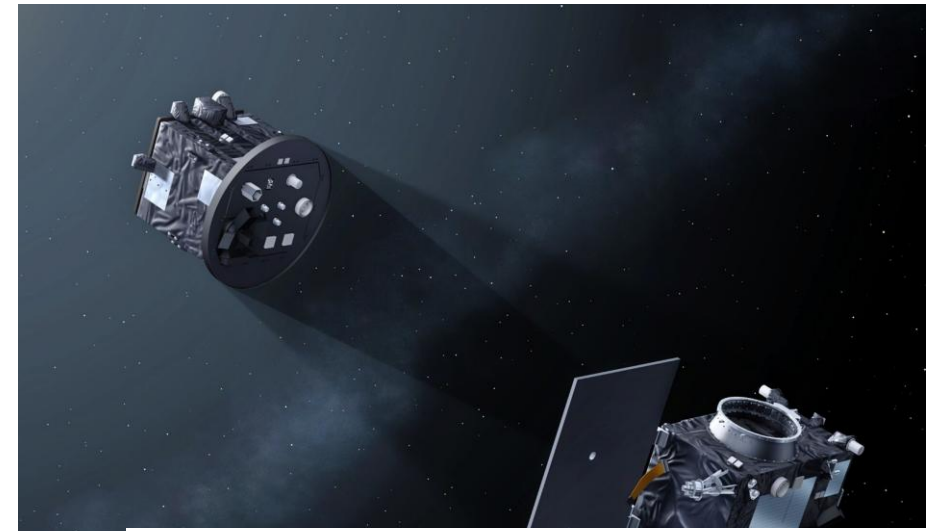
ASPIICS Diffraction

Models of

- Aime C. 2013
- Rougeot et al. 2017
- Shestov & Zhukov 2018

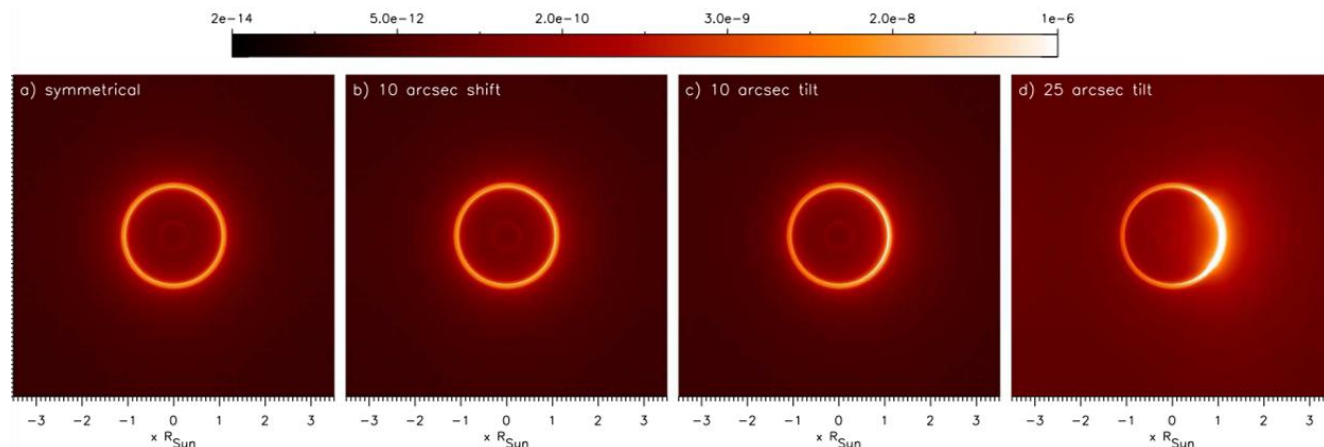
Main properties:

- Depends on R_{sun} , ISD , R_{EO} , R_{IO} , geometry
- Circular shape (shade of the IO), two-peak profile
- Depends on symmetry & pointings

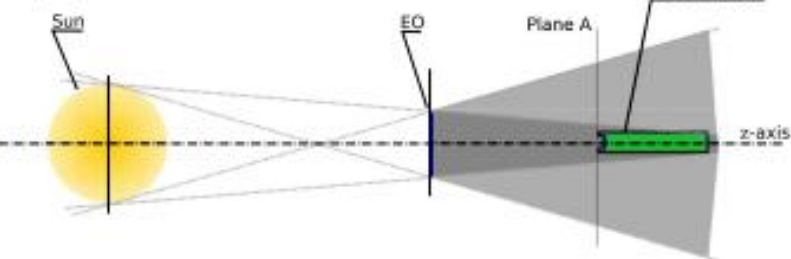


ASPIICS , diffraction and misalignments

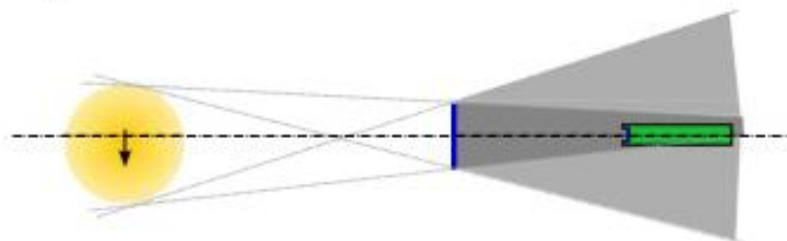
Shestov & Zhukov 2018



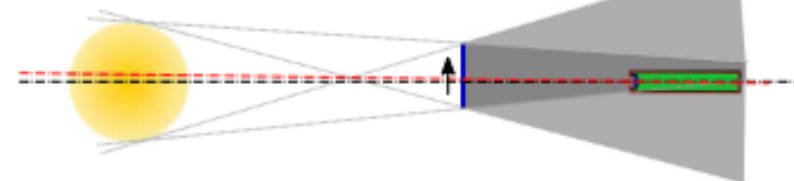
a) Symmetrical case



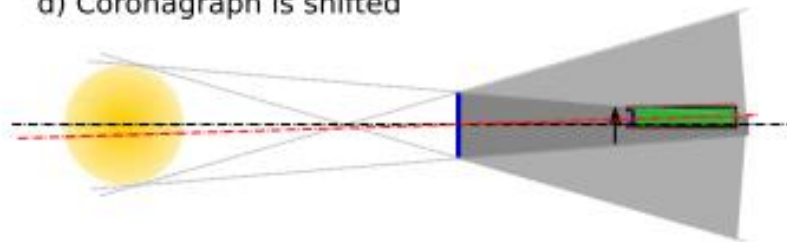
b) Sun is shifted



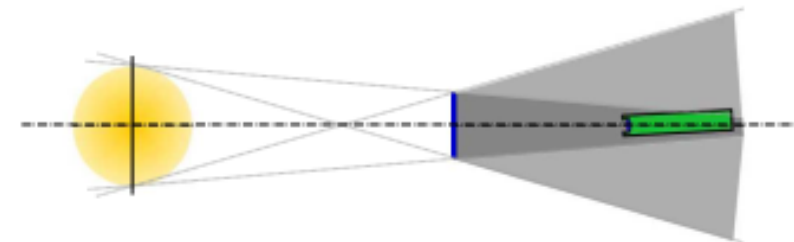
c) EO is shifted



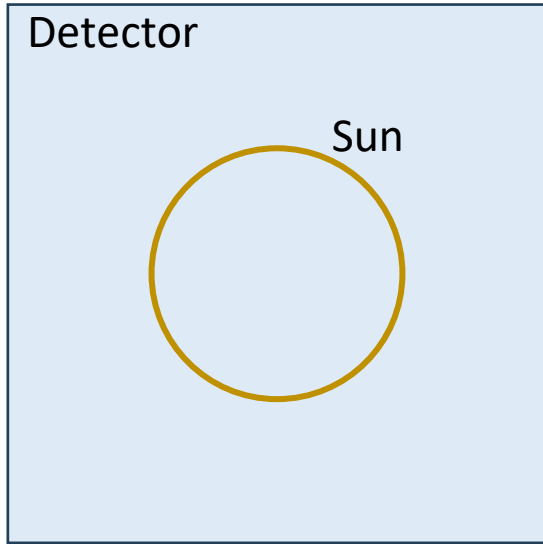
d) Coronagraph is shifted



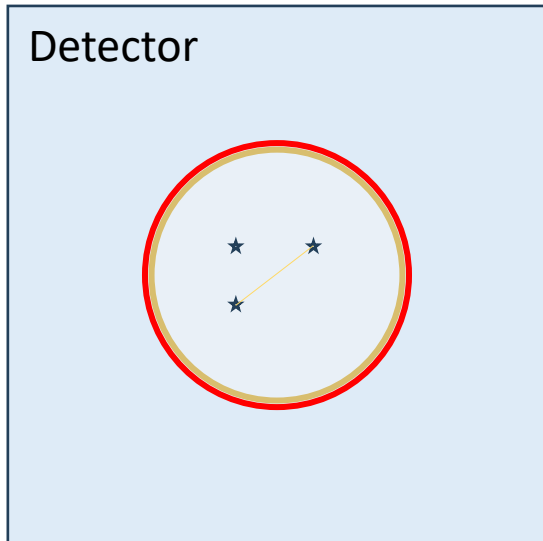
e) Coronagraph is tilted



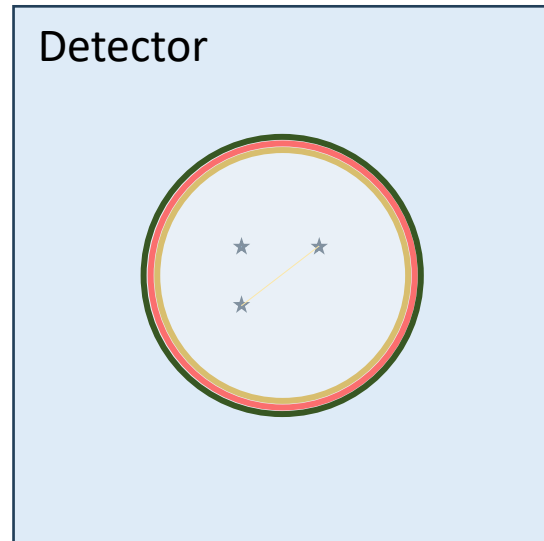
ASPIICS , diffraction and misalignments



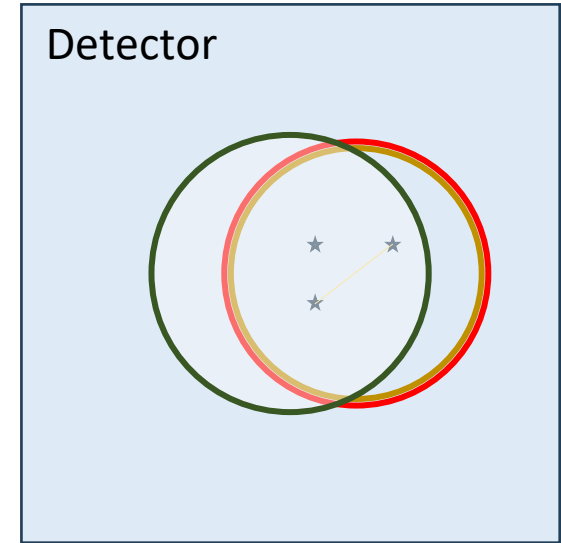
External occulter



Internal occulter

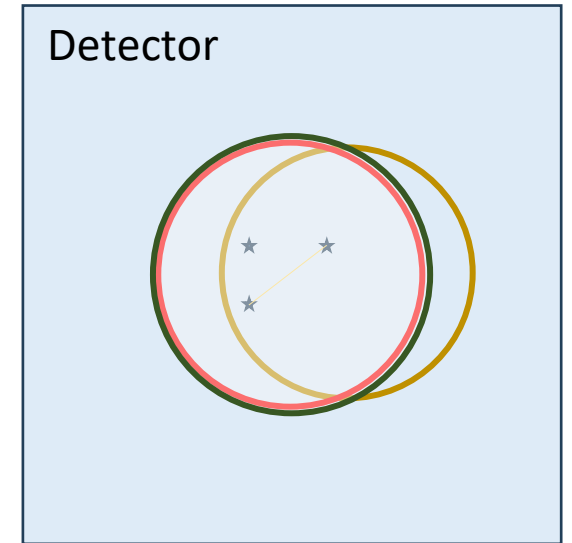


Case 1 – telescope tilt



Case 2 – solar shift

Exaggerated! 5 pix = 14"
↔ 10 mm displacement



ASPIICS Diffraction

Models of

- Aime C. 2013
- Rougeot et al. 2017
- Shestov & Zhukov 2018

Main properties:

1. **Primary focus** – bright ring (single peak, broadened)
2. **Detector plane** – bright ring (two-peaks)
3. Depends on the IO, ISD, R_{Sun}
4. Detector plane - remains in the same geometrical location (IO projection)
5. **Misalignments** => nonuniformity along PA (ϕ)
6. Under large tilt – unobscured **bright ring** is projected to the detector

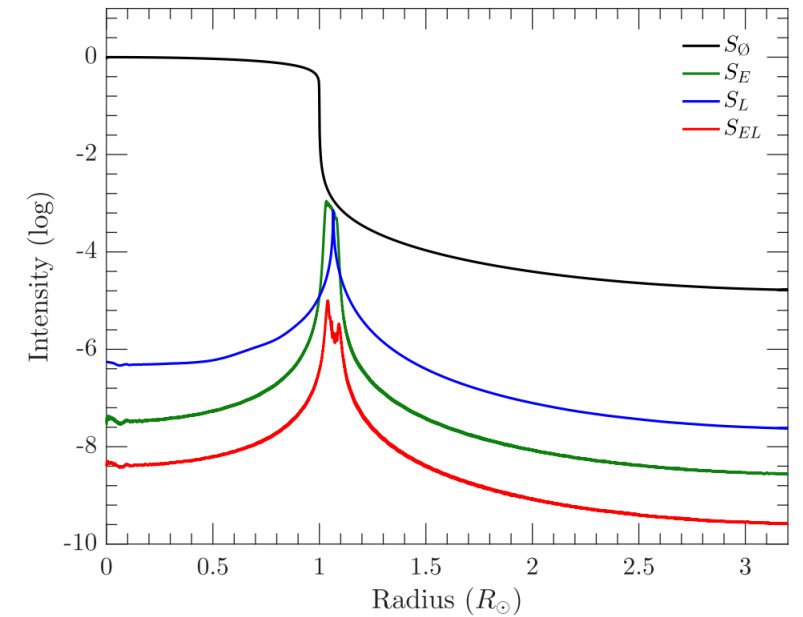
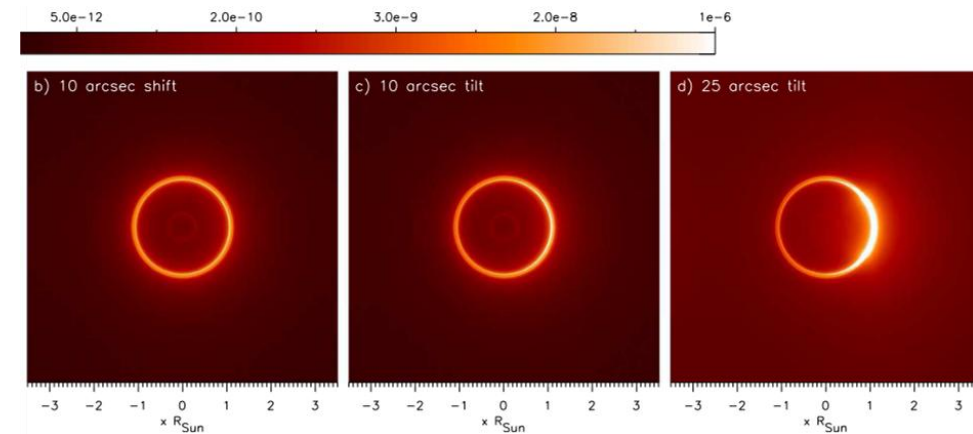
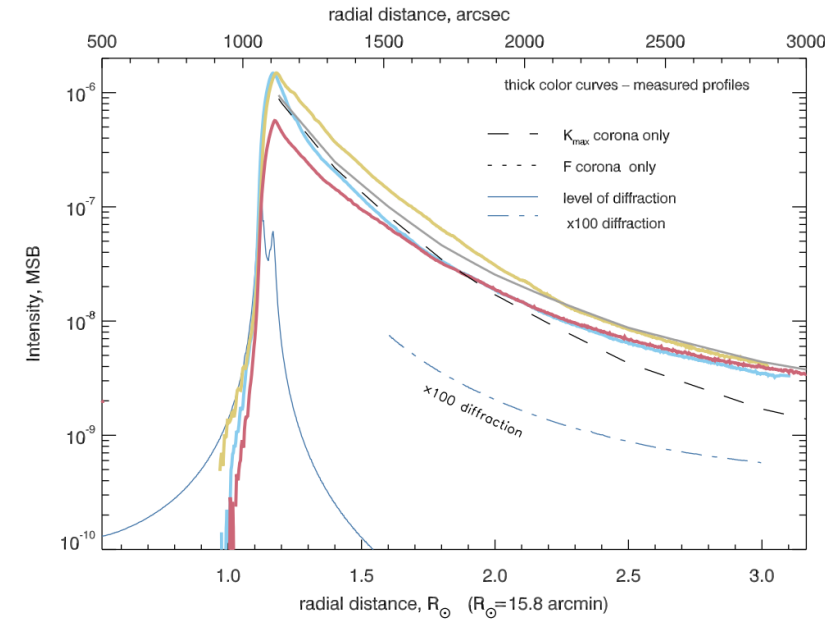
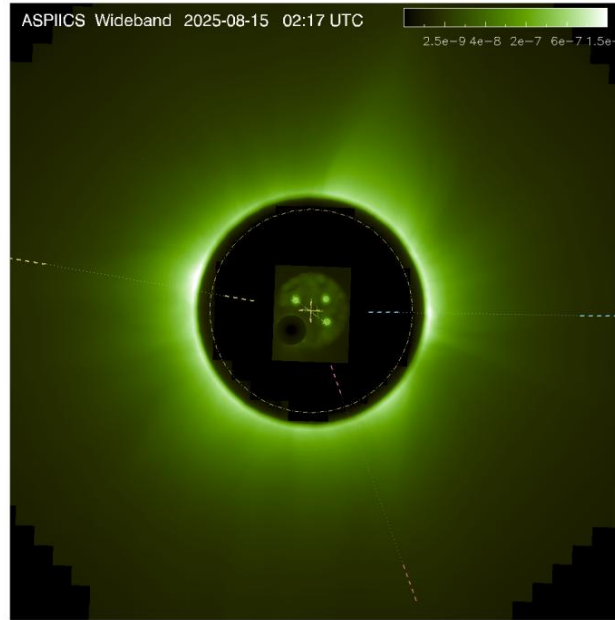


Fig. 10. Observed intensities as final response in the focal plane, in logarithmic scale. The transverse radius is given in solar units. The intensities are normalized to the mean solar brightness. Black: system S_0 given by $I_B(r)$ in plane B. Blue: system S_L given by $I_D(r)$ in plane D. Black: system S_E given by $I_B(r)$ in plane B. Red: system S_{EL} given by $I_D(r)$ in plane D.



ASPIICS observations

- Diffraction is weak – we normally do not see it directly

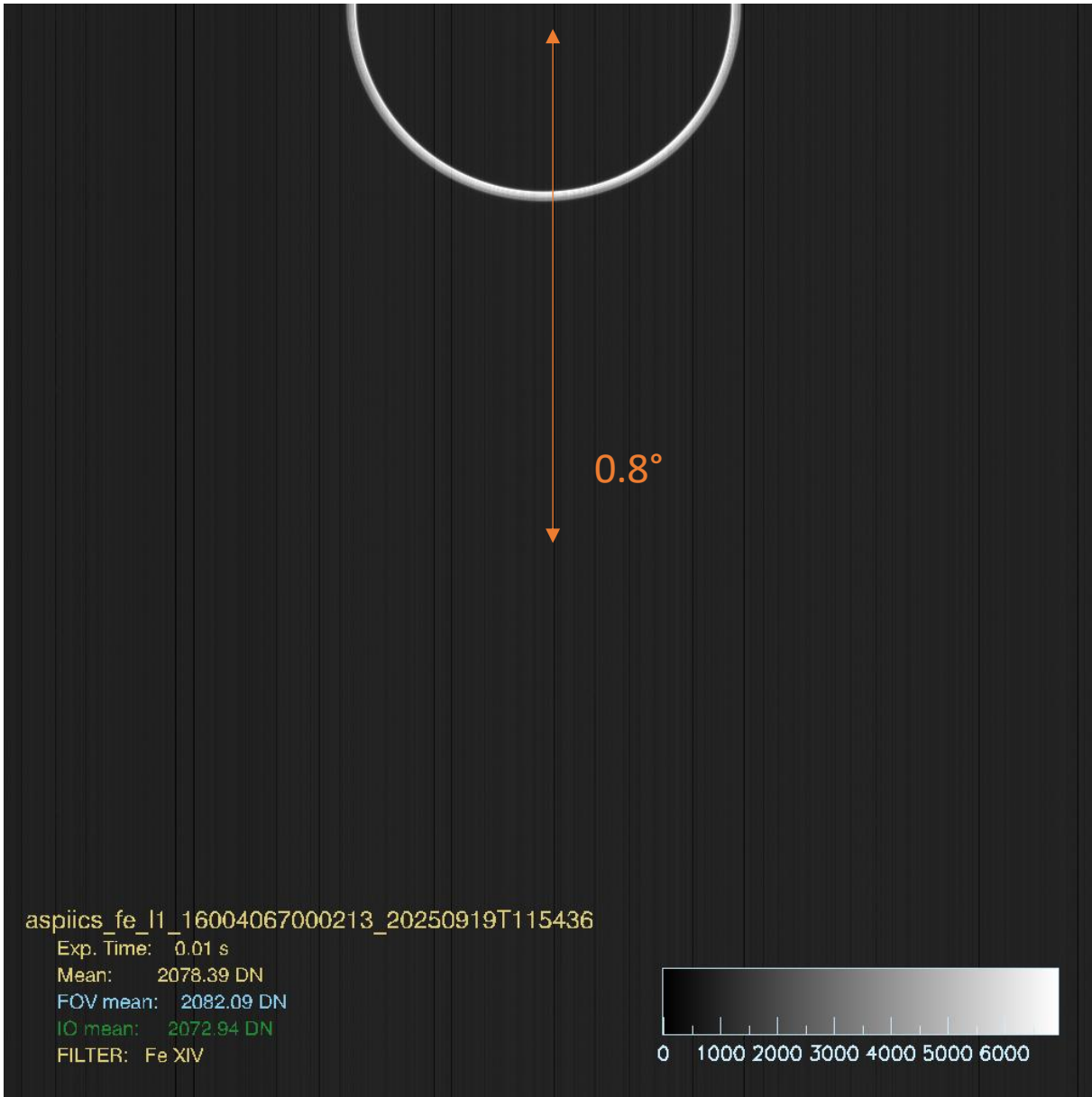


BUT

- Large off-pointings $\sim 1^\circ$ – the main diffracted ring is not covered by the IO, we see it on the detector (orbit 352 – 0.8° , orbit 152 – 1.5°)
- Diffraction appears in the vignetting zone under moderate off-pointings $\sim 20\text{-}40$ arcsec (orbit 152)

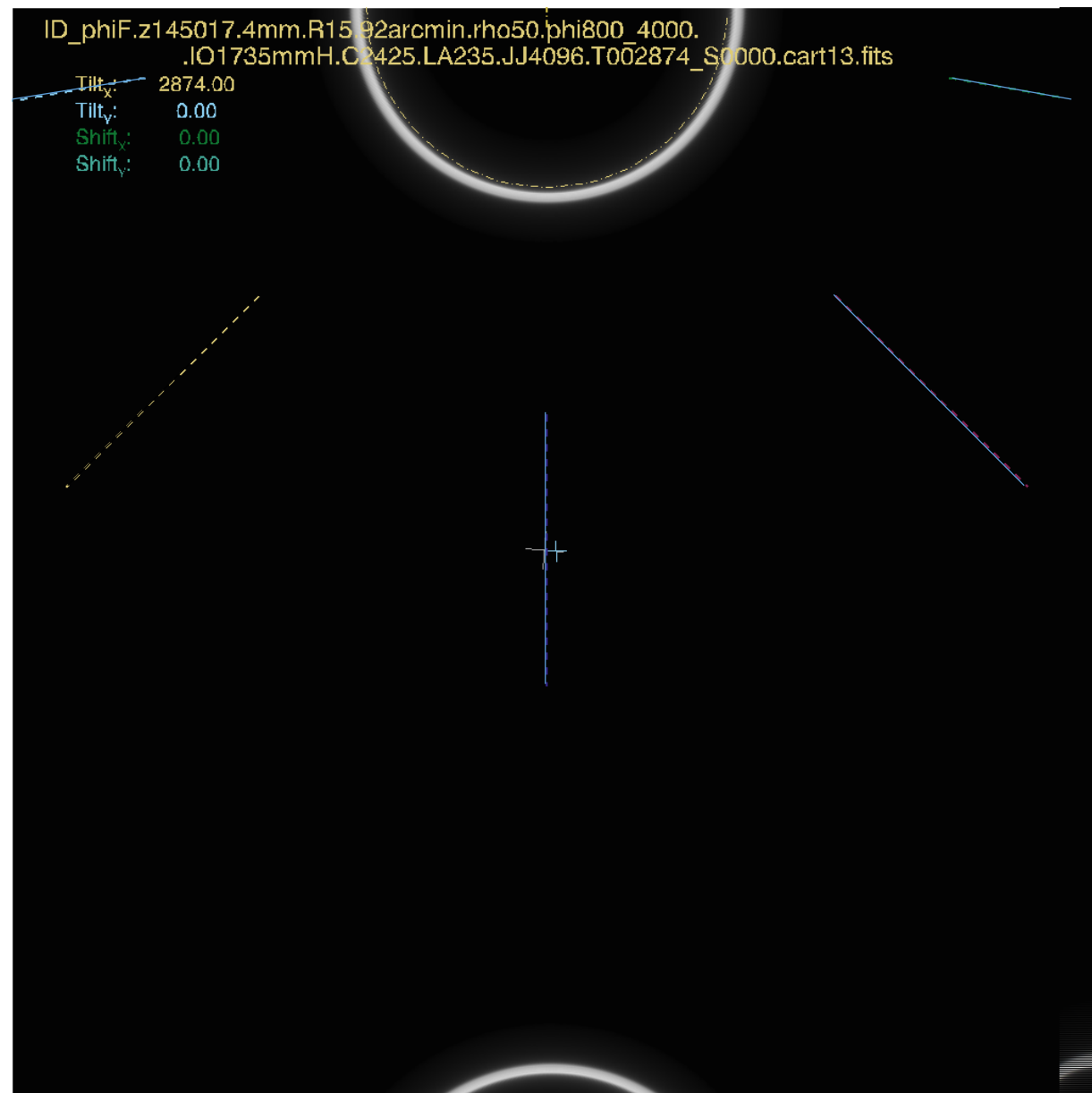
Large off-pointing

Orbit 352 – 2025 Sept 19
~0.8° off-pointing



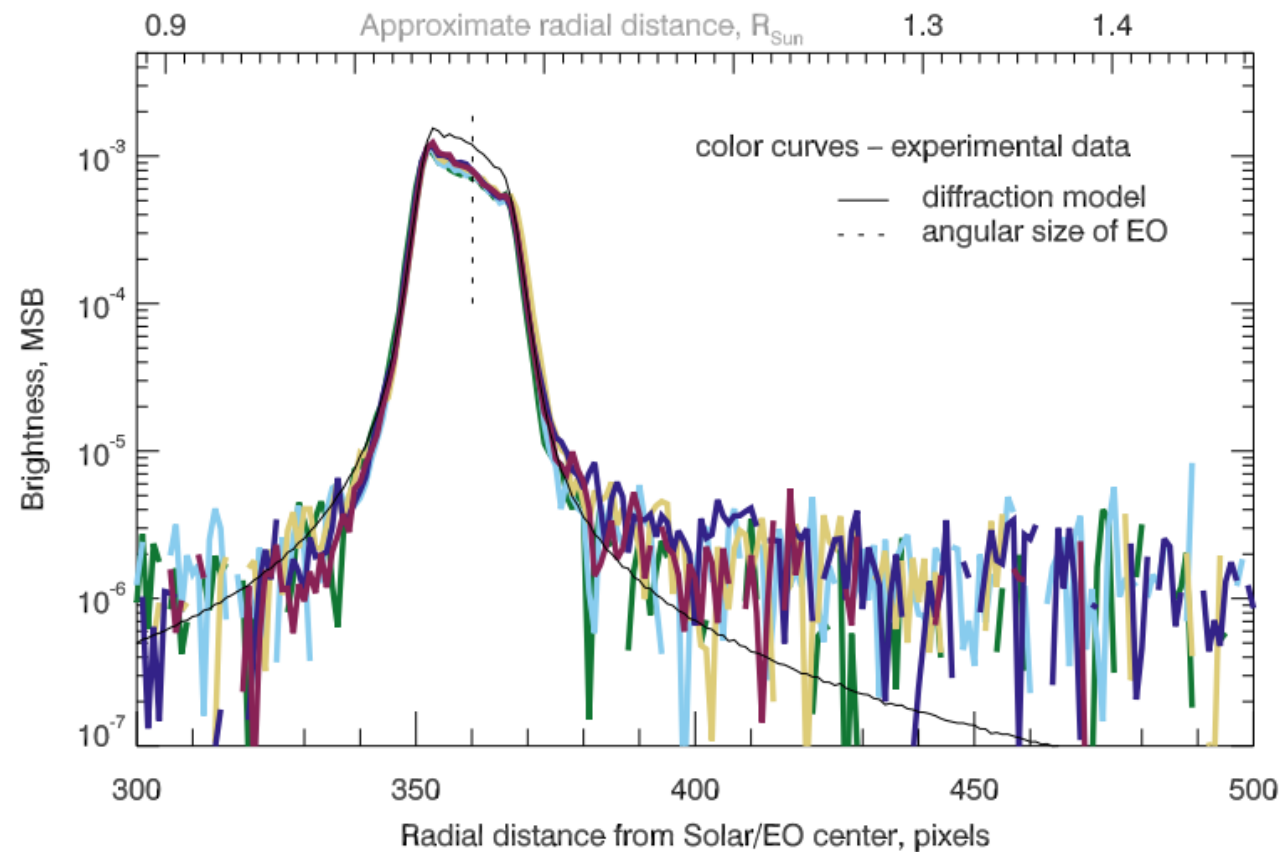
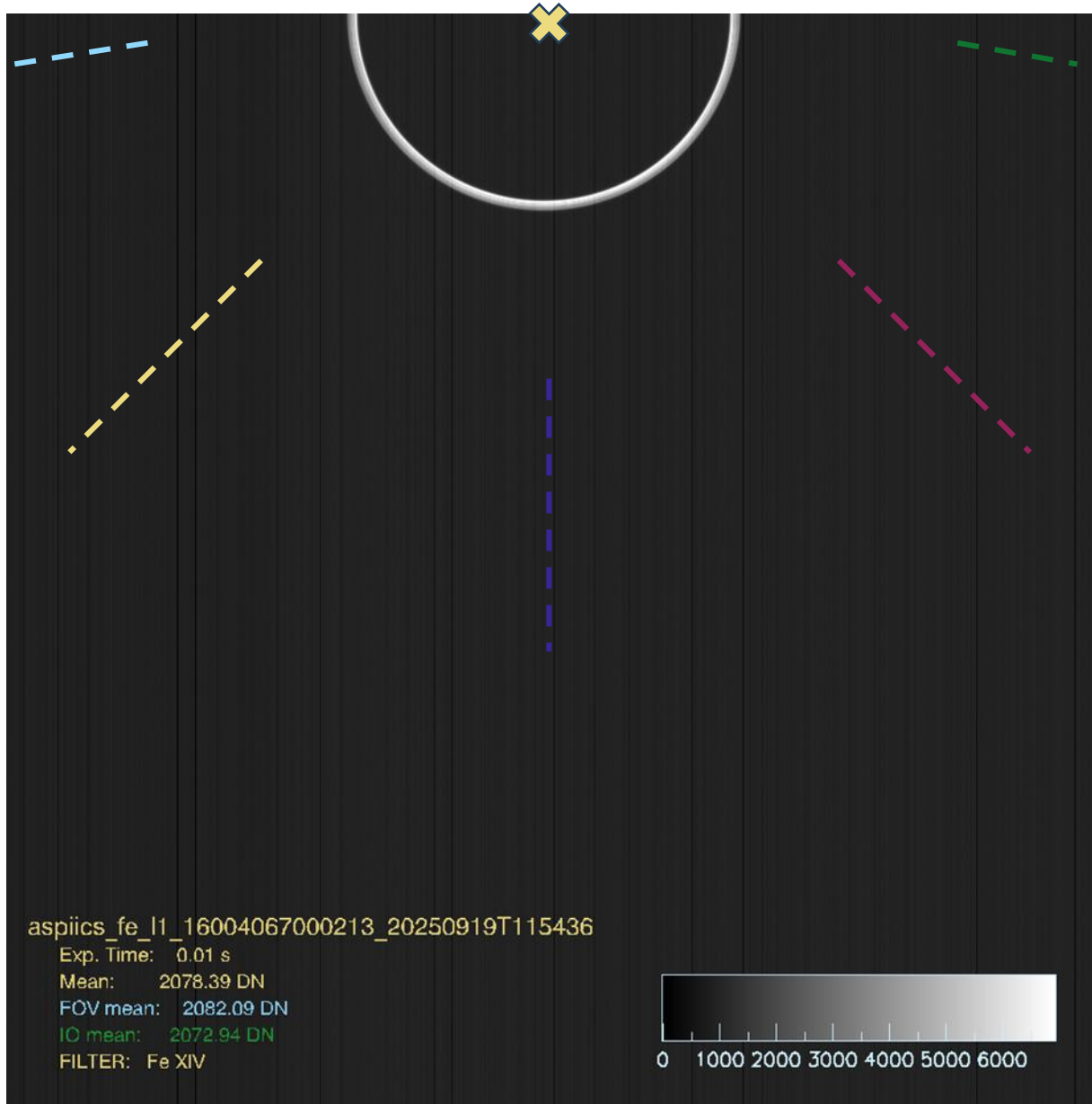
Large off-pointing

Orbit 352 – 2025 Sept 19
~0.8° off-pointing



Large off-pointing

Orbit 352 – 2025 Sept 19
~0.8° off-pointing



- Higher efficiency of the 3D occulter
- Verification of ASPIICS calibration

Orbit 152

aspiics_wb_l2_0980400A000111_20250408_175111

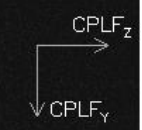
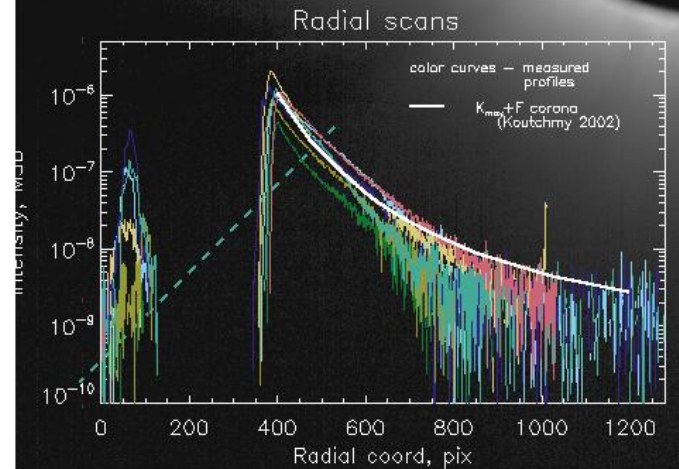
Mean: 5.43E-08 MSB
FOV mean: 4.38E-08 MSB
IO mean: -6.42E-09 MSB
FILTER: Wideband
Exp. time: 0.11 s
FILT_POS: unknown
APS_TEMP: -20.1 °C

X_{IO} : 1002.4 pix
 Y_{IO} : 1027.0 pix
CRVAL1: 40.76 arcsec
CRVAL2: -119.94 arcsec
CROTA: -85.80 deg
 Sun_x : 996.81 pix
 Sun_y : 1036.19 pix
(constant in time as of 37.6/20.5 pixels were used)
 ΔX_{Sun} : 16.68 arcsec
 ΔY_{Sun} : -25.77 arcsec
(with respect to IO)
OPLFNY: -6.8 mm
OPLFNZ: -88.9 mm
- - - Sun from telemetry + Δ
+ OPLF center from telemetry

Orbit 152
CRVAL1 corrected +
 $\Delta_x \Delta_y$

Commanded:
Pitch: 0
Yaw: 0

My estimation:
17"
-26"



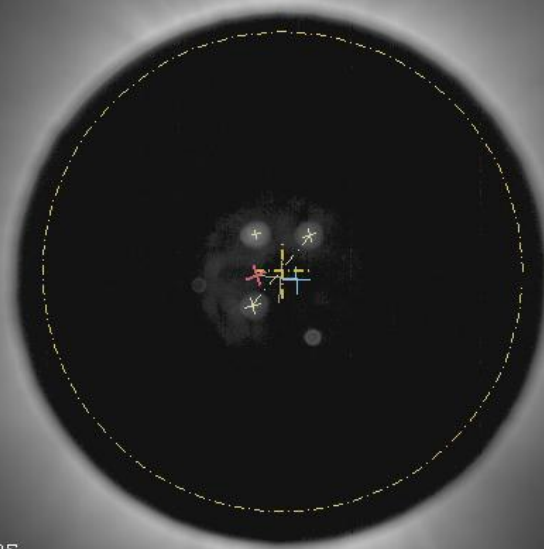
Orbit 152

Orbit 152
CRVAL1 corrected
+ $\Delta_x \Delta_y$

asplics_wb_l2_0980400C000111_20250408180047

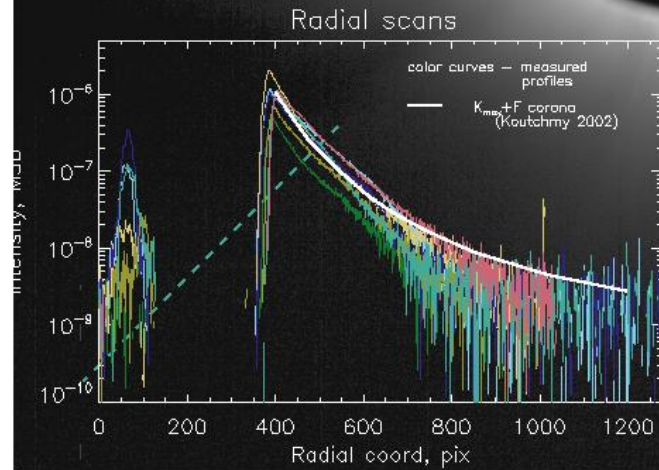
Mean: 5.36E-08 MSB
FOV mean: 4.37E-08 MSB
IO mean: -6.44E-09 MSB
FILTER: Wideband
Exp. time: 0.11 s
FILT_POS: unknown
APS_TEMP: -19.8 °C

X_{IO} : 1002.4 pix
 Y_{IO} : 1027.0 pix
CRVAL1: 39.22 arcsec
CRVAL2: -98.15 arcsec
CROTA: -85.80 deg
Sun_x: 1004.27 pix
Sun_y: 1036.17 pix
(constant in time as of 37.6/20.5 pixels were used)
 ΔX_{Sun} : -5.17 arcsec
 ΔY_{Sun} : -25.72 arcsec
(with respect to IO)
OPLFNY: -6.8 mm
OPLFNZ: -70.6 mm
- - - Sun from telemetry + Δ
+ OPLF center from telemetry



Commanded:
Pitch: -20"
Yaw: 0

My estimation:
-5"
-26"



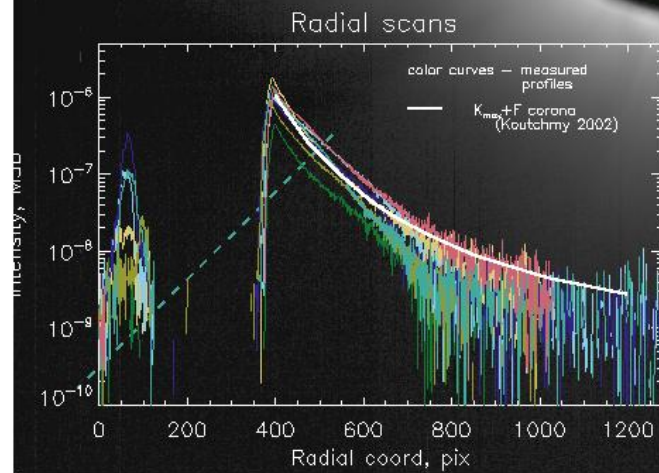
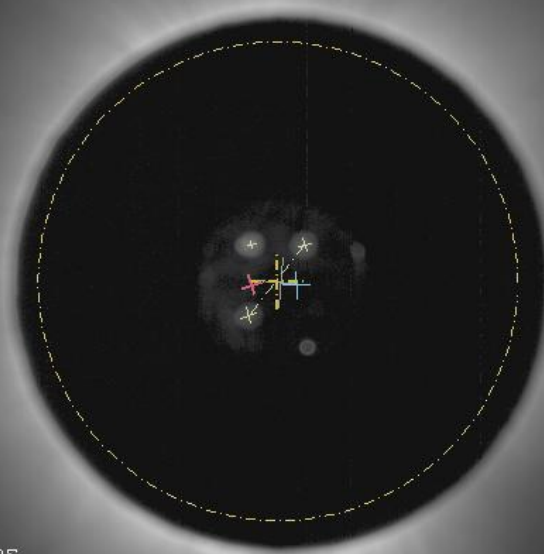
Orbit 152

Orbit 152
CRVAL1 corrected
+ $\Delta_x \Delta_y$

aspiics_wb_l2_0980400E000111_20250408_180433

Mean: 5.45E-08 MSB
FOV mean: 4.45E-08 MSB
IO mean: -5.12E-09 MSB
FILTER: Wideband
Exp. time: 0.11 s
FILT_POS: unknown
APS_TEMP: -19.7 °C

X_{IO} : 1002.4 pix
 Y_{IO} : 1027.0 pix
CRVAL1: 59.57 arcsec
CRVAL2: -116.82 arcsec
CROTA: -85.80 deg
 Sun_x : 997.12 pix
 Sun_y : 1029.45 pix
(constant in time as of 37.6/20.5 pixels were used)
 ΔX_{Sun} : 14.95 arcsec
 ΔY_{Sun} : -6.80 arcsec
(with respect to IO)
OPLFNY: 6.5 mm
OPLFNZ: -84.7 mm
- - - Sun from telemetry + Δ
+ OPLF center from telemetry



Commanded:
Pitch: 0
Yaw: -20''

My estimation:
15''
-7''

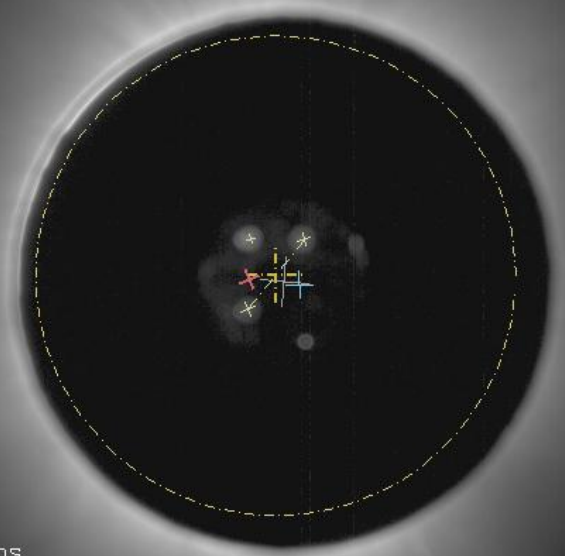
Orbit 152

Orbit 152
CRVAL1 corrected
+ $\Delta_x \Delta_y$

asplics_wb_l2_09804010000111_20250408180754

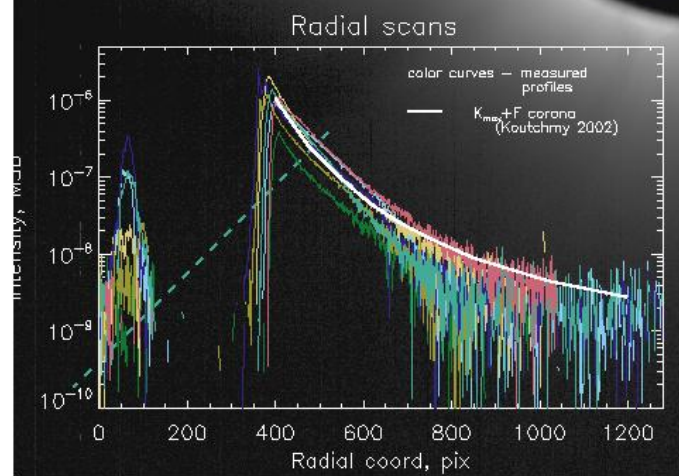
Mean: 5.67E-08 MSB
FOV mean: 4.47E-08 MSB
IO mean: -4.47E-09 MSB
FILTER: Wideband
Exp. time: 0.11 s
FILT_POS: unknown
APS_TEMP: -19.6 °C

X_{IO} : 1002.4 pix
 Y_{IO} : 1027.0 pix
CRVAL1: 42.34 arcsec
CRVAL2: -138.52 arcsec
CROTA: -85.80 deg
Sun_x: 989.89 pix
Sun_y: 1036.11 pix
(constant in time as of 37.6/20.5 pixels were used)
 ΔX_{Sun} : 35.32 arcsec
 ΔY_{Sun} : -25.56 arcsec
(with respect to IO)
OPLFNZ: -6.7 mm
OPLFNZ: -98.9 mm
-+ Sun from telemetry + Δ
+ OPLF center from telemetry



Commanded:
Pitch: 20"
Yaw: 0

My estimation:
35"
-26"



Orbit 152

asplics_wb_l2_09804012000111_20250408181114

Mean: 5.73E-08 MSB
FOV mean: 4.47E-08 MSB
IO mean: -3.51E-09 MSB
FILTER: Wideband
Exp. time: 0.11 s
FILT_POS: unknown
APS_TEMP: -19.3 °C

X_{IO} : 1002.4 pix
 Y_{IO} : 1027.0 pix
CRVAL1: 21.42 arcsec
CRVAL2: -122.11 arcsec
CROTA: -85.80 deg
 Sun_x : 996.25 pix
 Sun_y : 1043.09 pix
(constant in time as of 37.6/20.5 pixels were used)
 ΔX_{Sun} : 17.42 arcsec
 ΔY_{Sun} : -45.22 arcsec
(with respect to IO)
OPLFNY: -20.5 mm
OPLFNZ: -86.4 mm
- - - Sun from telemetry + Δ
+ OPLF center from telemetry

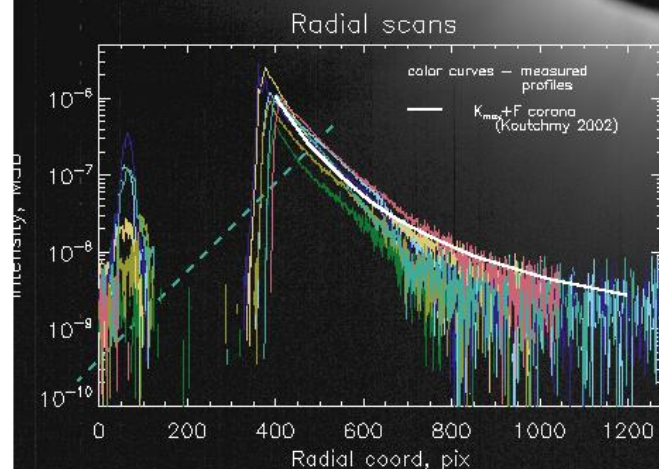
Clearly two-peak structure



Orbit 152
CRVALs corrected +
 $\Delta_x \Delta_y$

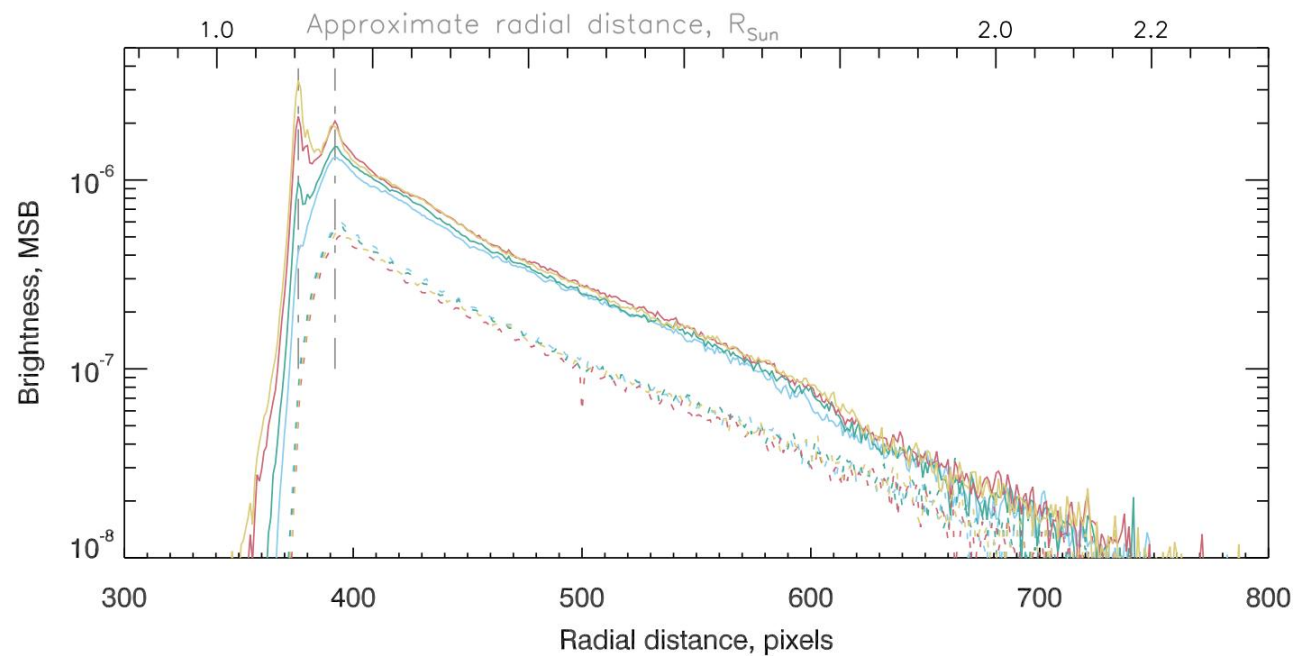
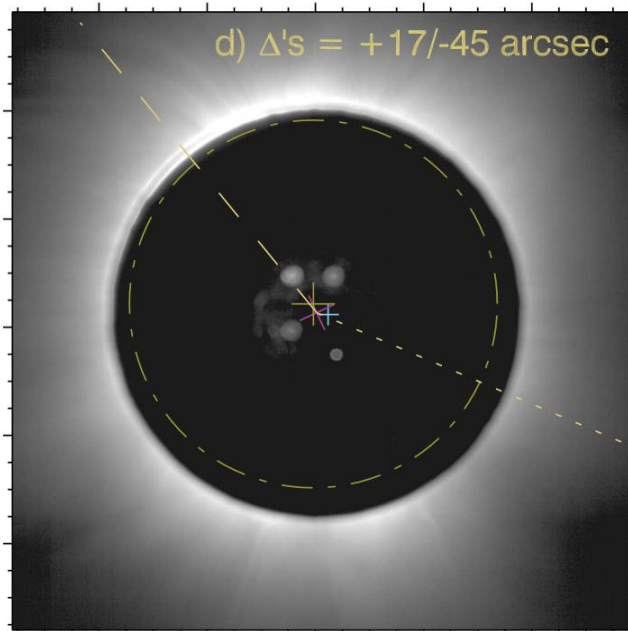
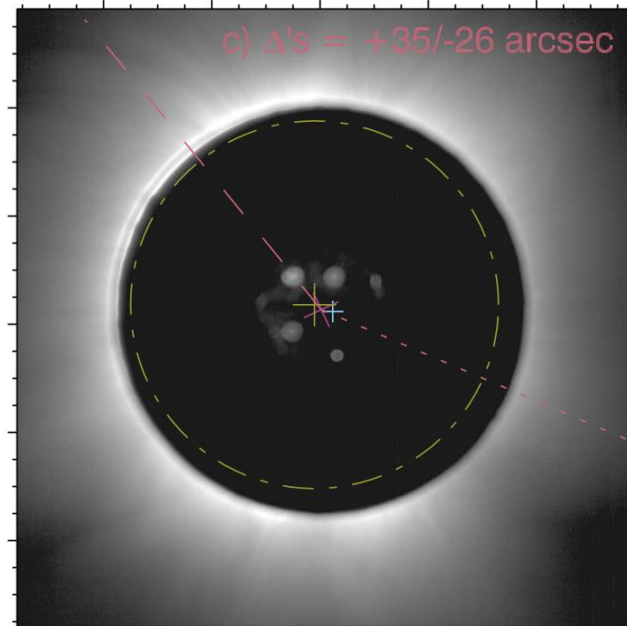
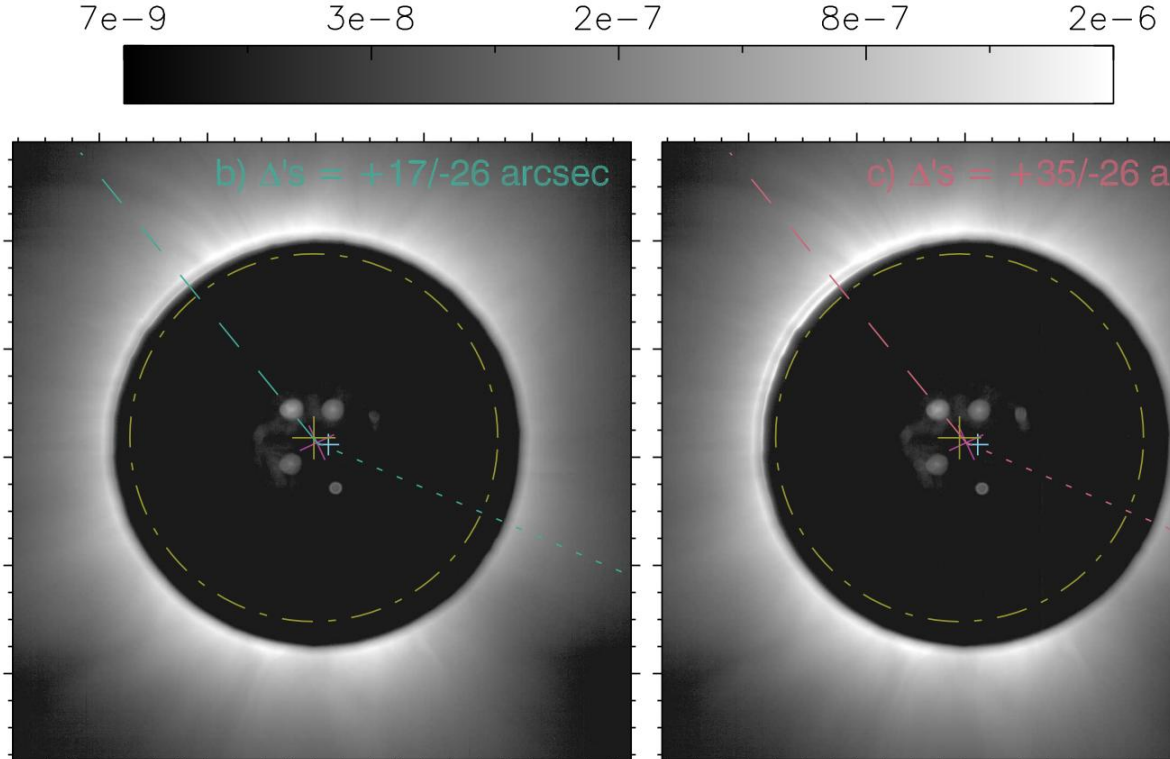
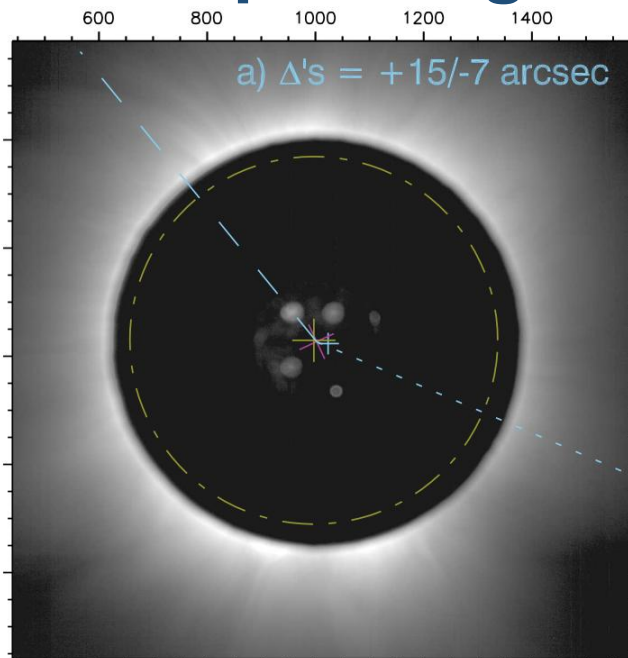
Commanded:
Pitch: 0
Yaw: 20''

My estimation:
17''
-45''



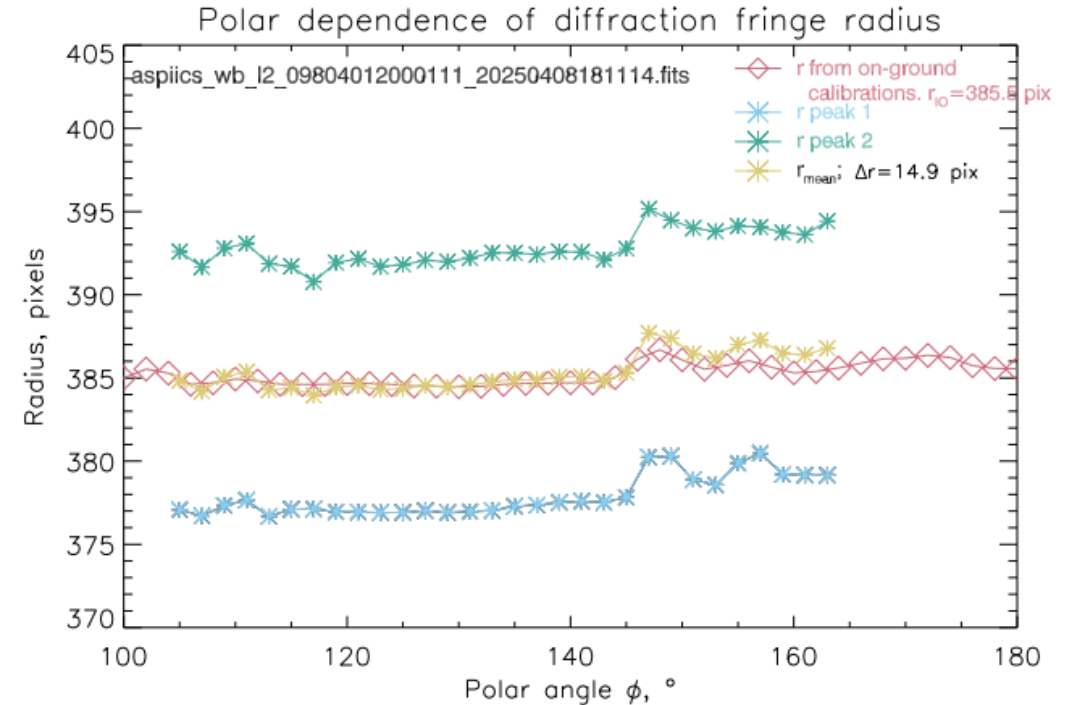
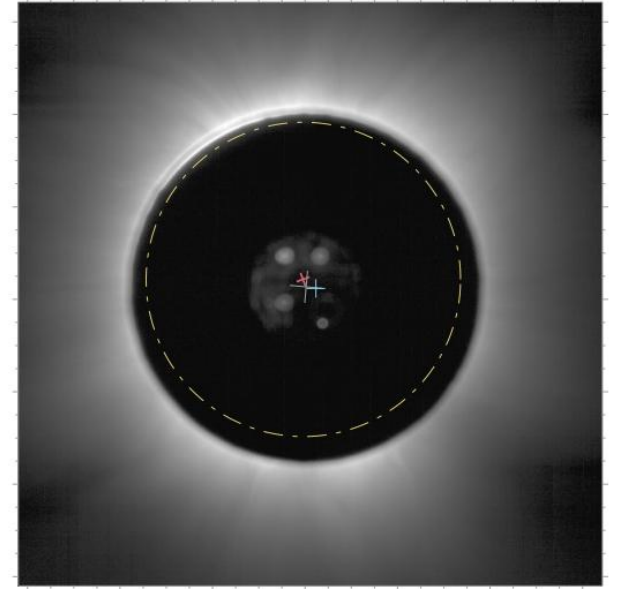
Comparison off-pointings

Inner part 1144 x 1144 pixels



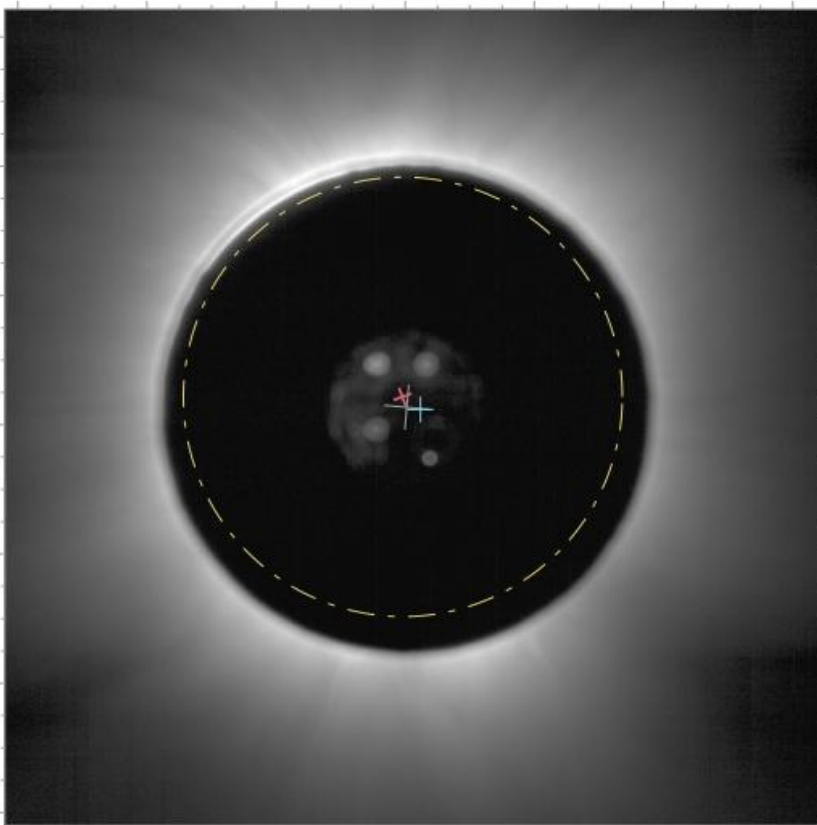
Refinement of the model

- Geometrical prescription
- Variable $R_{I0}(\phi)$
- Scales in simulations
- Empirical radiometric factor 20%
- Solar limb darkening
- Influence of ISD



Orbit 152 observations vs model

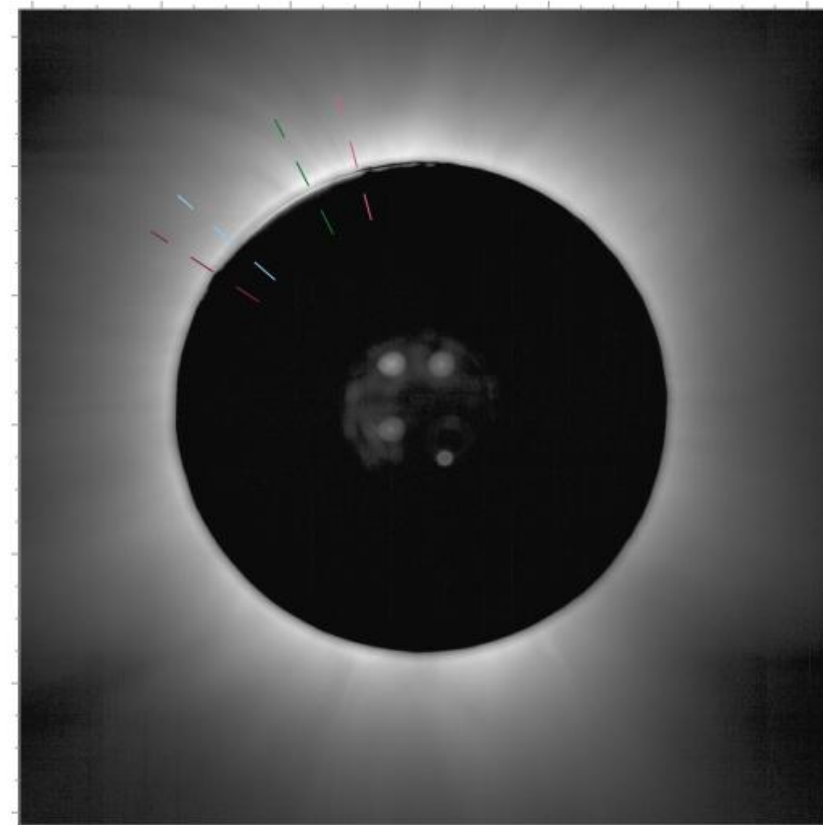
Original image



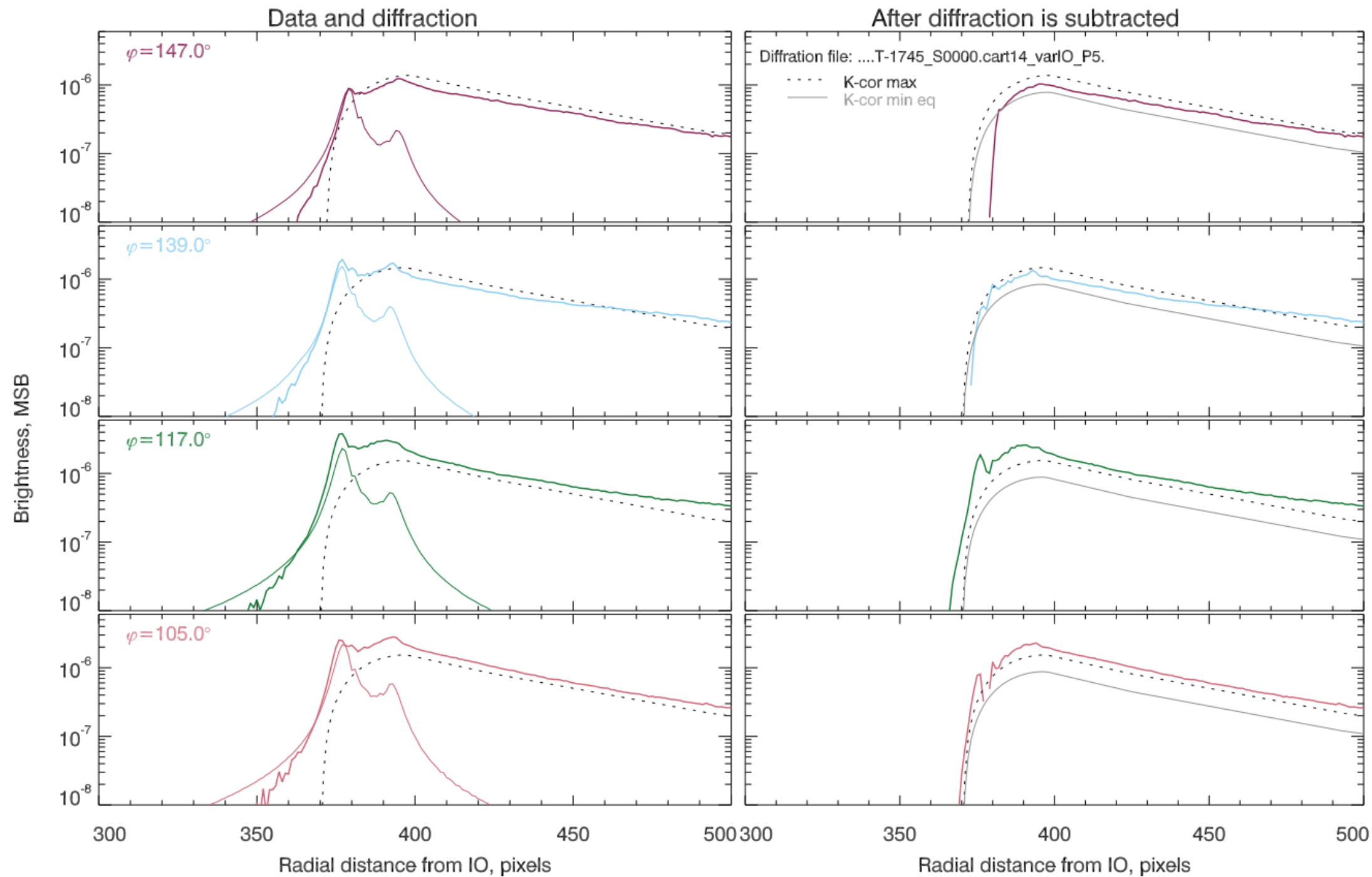
Diffraction



After removal (next slide)

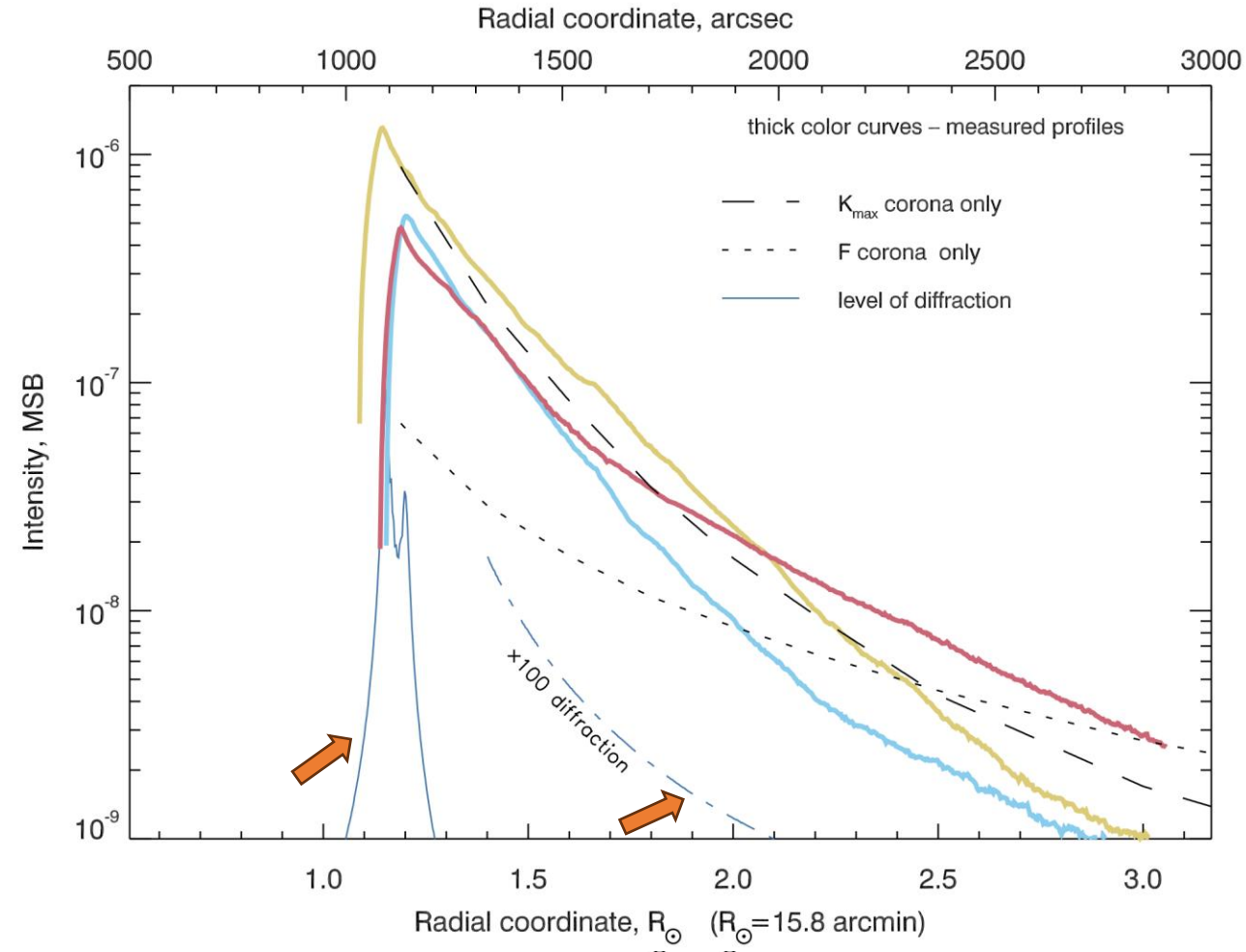
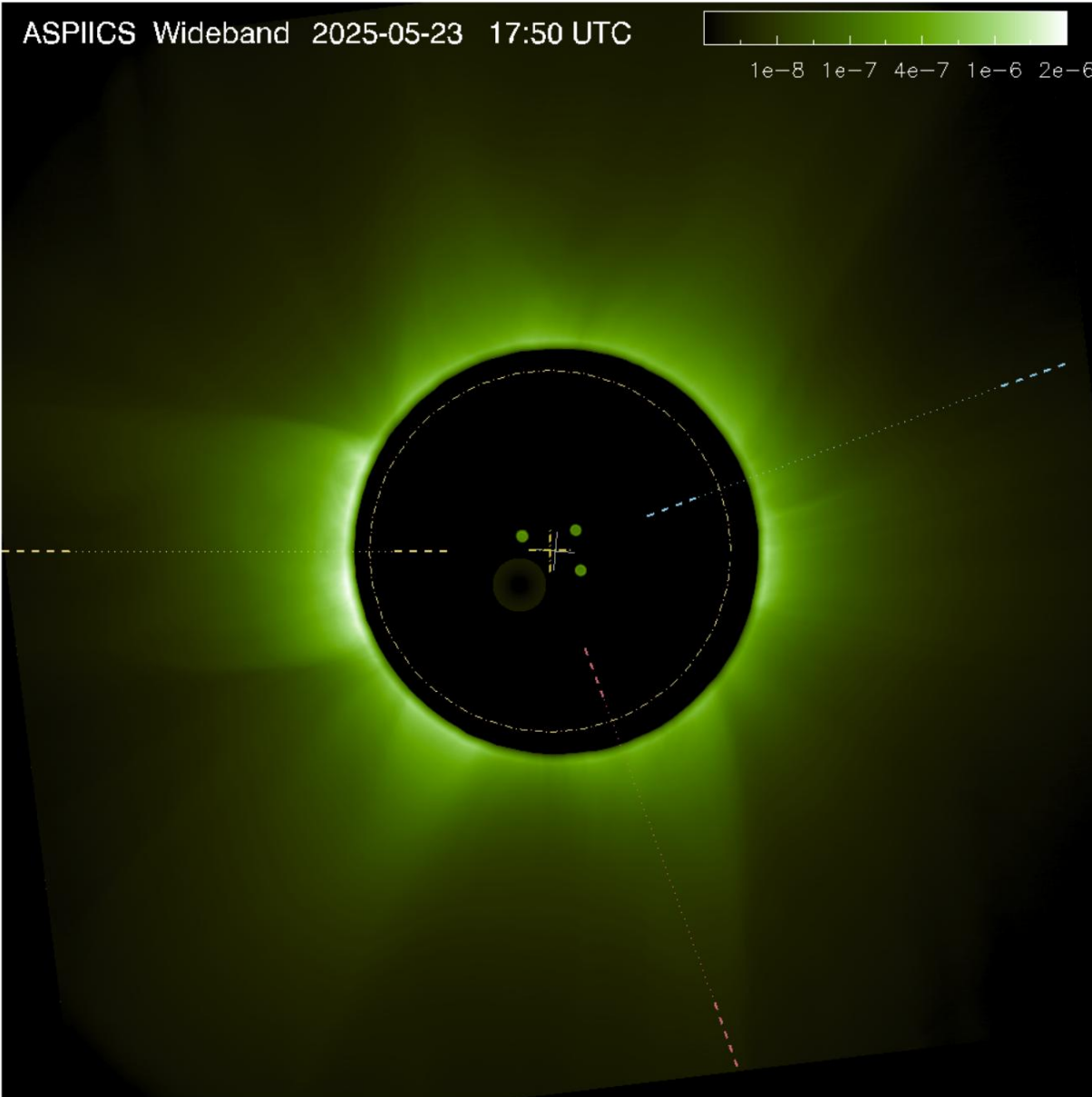


Inner part 1144 x 1144 pixels



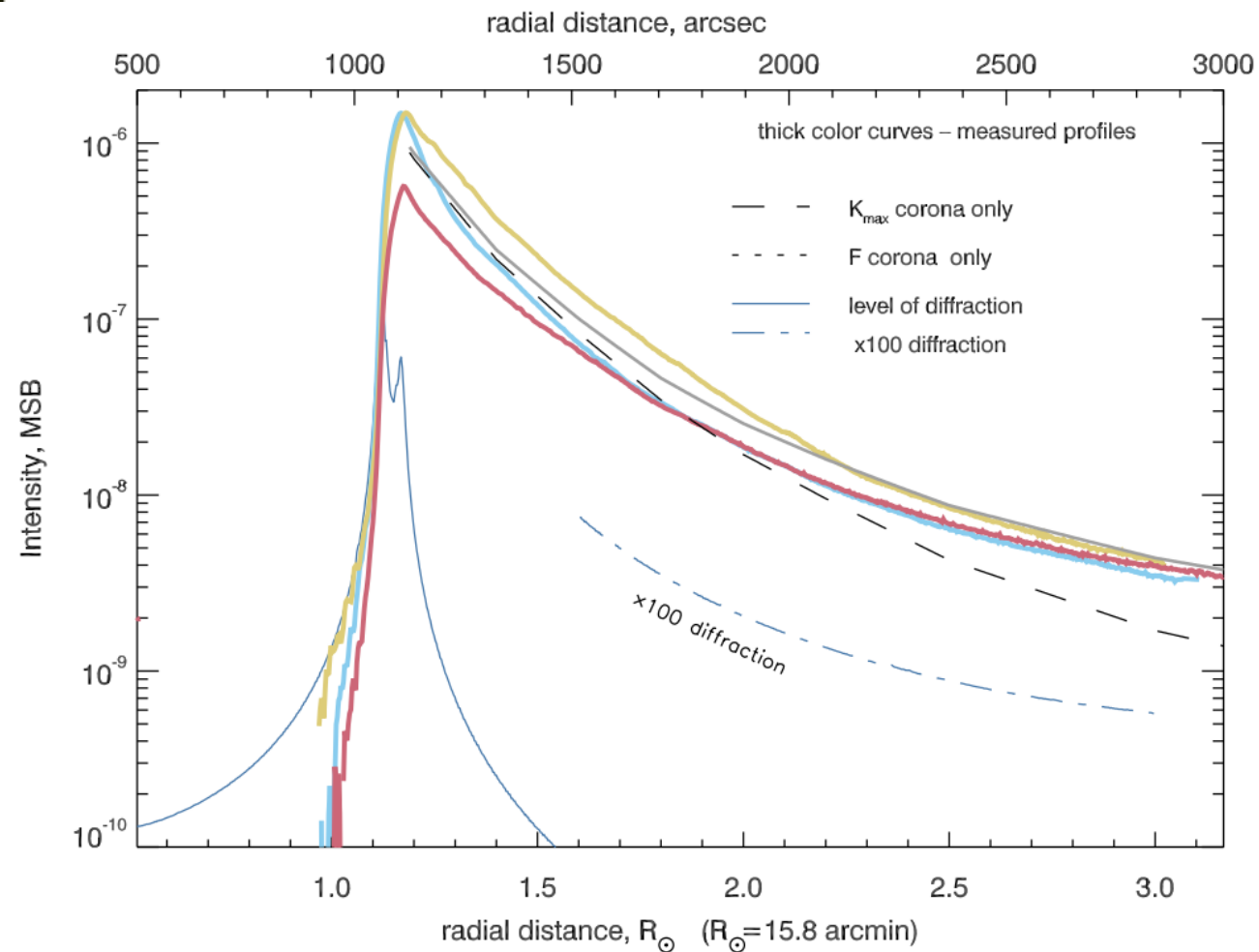
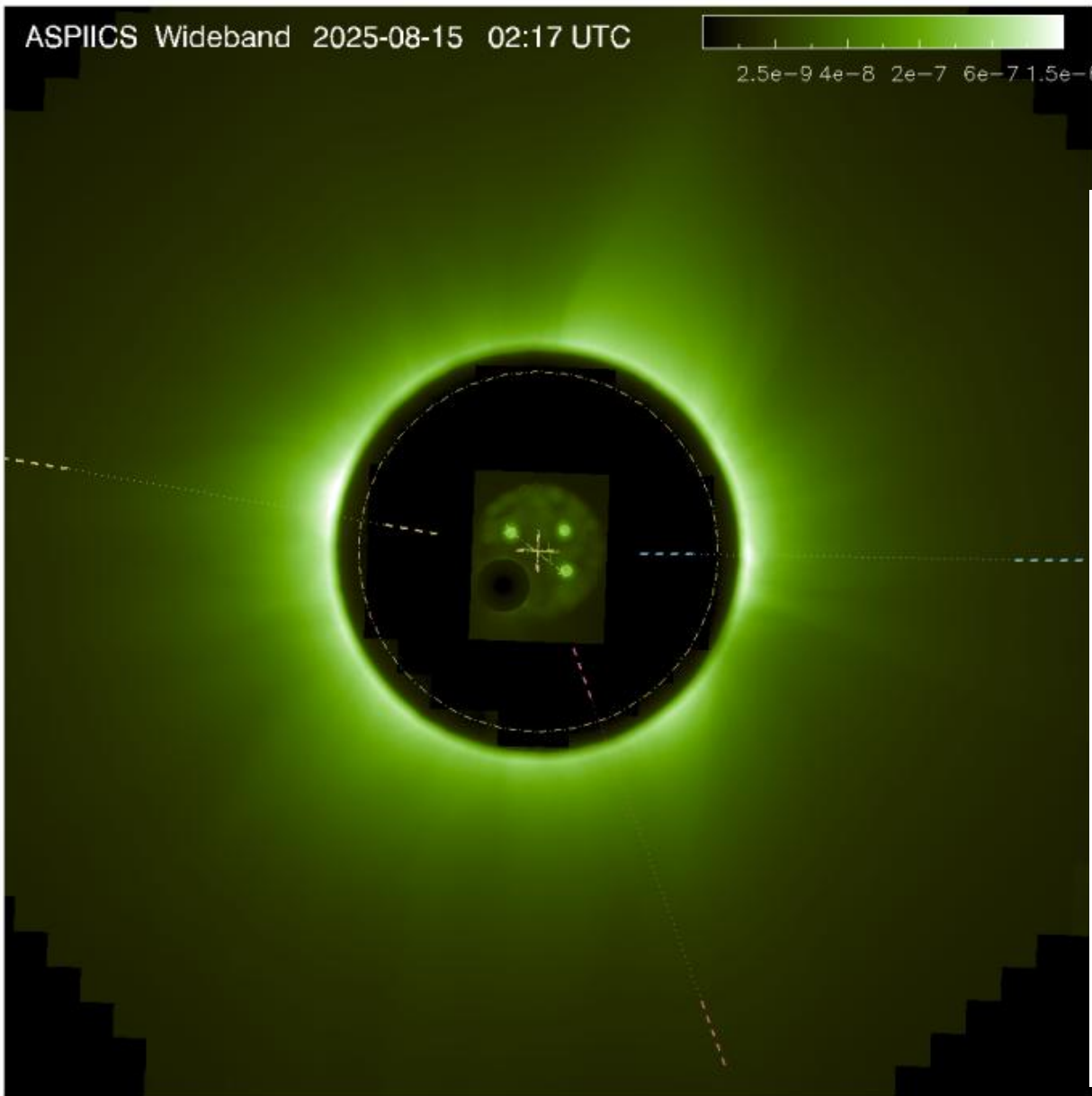
Typical configuration

23 May 2025



Typical configuration

15 Aug 2025



Conclusions

- Diffraction (and straylight) is very low – at least 2 orders below coronal signal
- We had few opportunities to directly see diffraction
- Diffraction model of Shestov & Zhukov 2018 (based on Rougeot et al 2017, based on Aime 2013) works reasonably well
- Qualitative behavior was fully confirmed!
- Excellent correspondence at large off-pointings ($\sim 1^\circ$), reasonable at moderate (~ 40 arcsec)
- Some refinement was necessary