Imaging the EUV corona with the Extreme Ultraviolet Imager

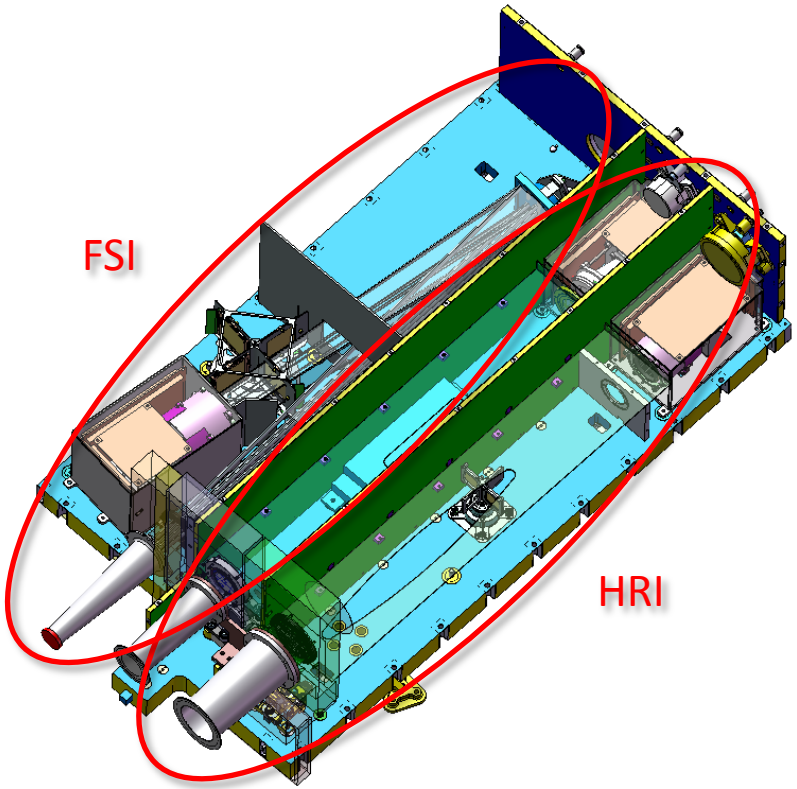
Precursor observations from the HeCOR sounding rocket experiment

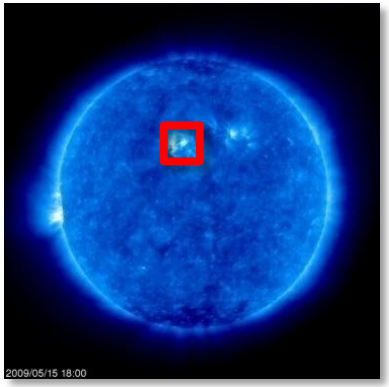
Frédéric Auchère, for the EUI consortium

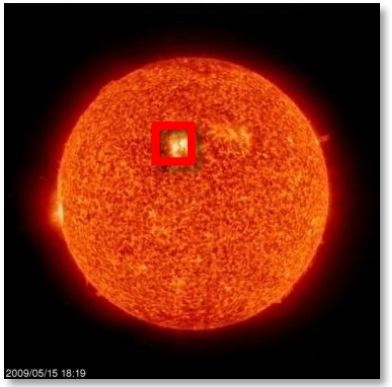
2nd METIS science & technical meeting

EUI: Extreme Ultraviolet Imager

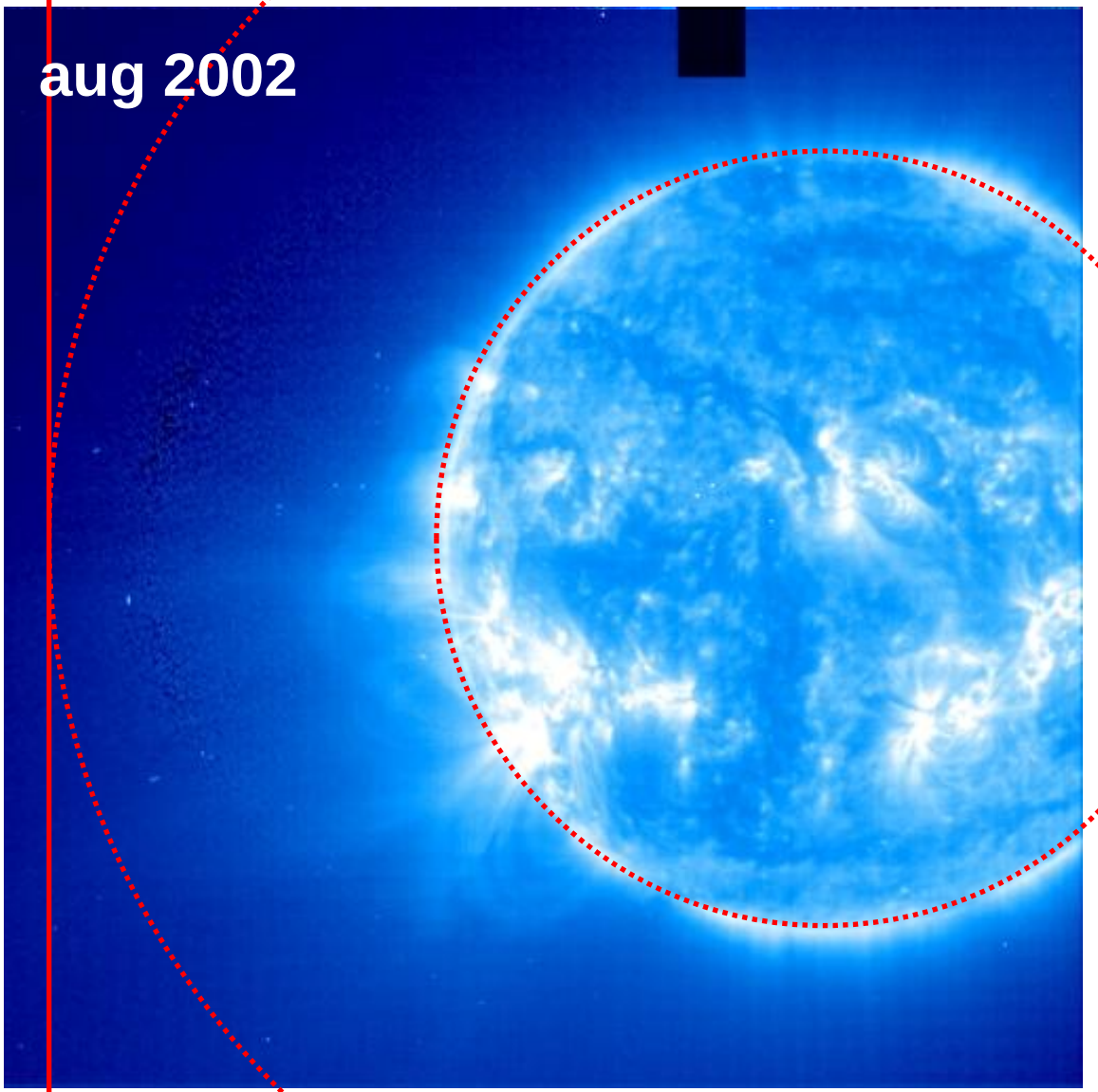
Channel	Parameter	Value
	Dimensions	
	- Optical bench	550x175x785mm
	- Electronics box	120x300x250mm
	Mass	18.20 kg
	Power	28 W
	Telemetry	20 kb/s
FSI dual EUV	Passbands	174 Å et 304 Å
	Field of view	5.2°
	Resolution (2 px)	9 arcsec
	Cadence	600 s
HRI EUV	Passband	174 Å
	Field of view	17’
	Resolution (2 px)	1 arcsec
	Cadence	2 s
HRI Lyman-α	Passband	1216 Å
	Field of view	17’
	Resolution (2 px)	1 arcsec
	Cadence	< 1s







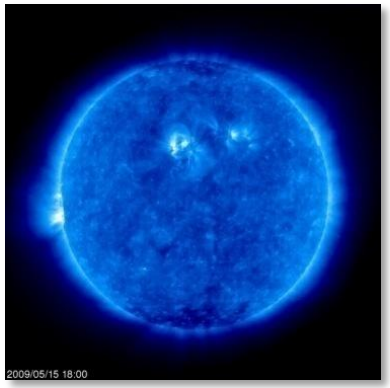
EUV structures beyond $2R_S$: EIT 171

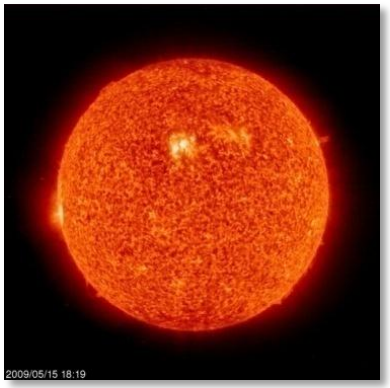


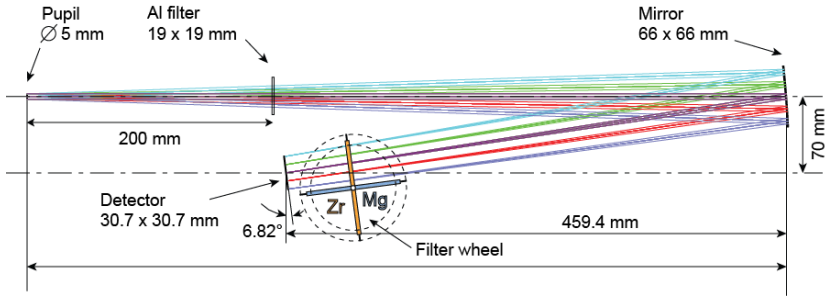
FSI: Full Sun Imager

Wavelength choice

- 17.4 nm for 1MK corona (HRI-EUV context)
- 30.4 nm for cool plasma (HRI-Lyα contex)

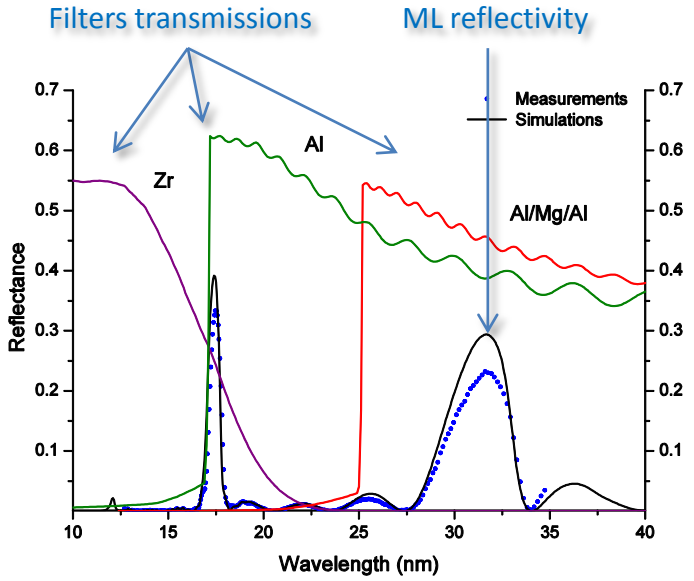




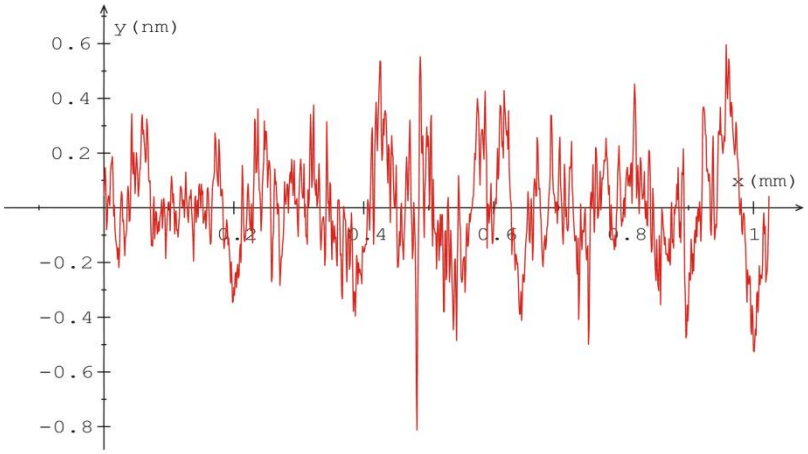


Implementation

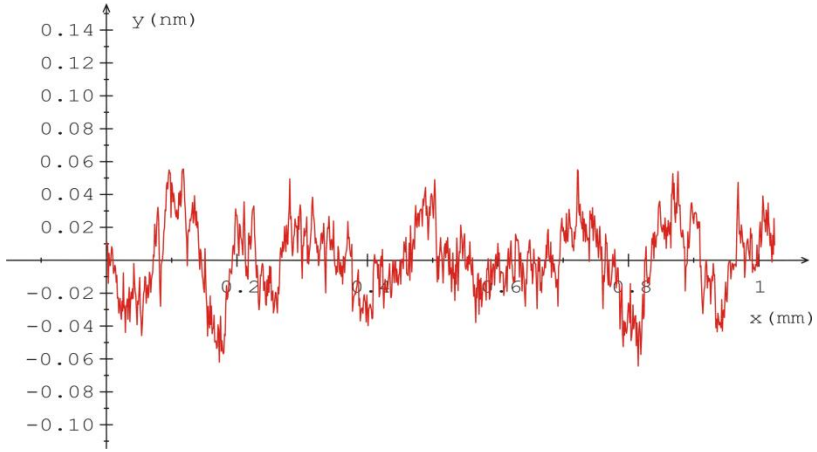
- Small entrance aperture reduces heat load
- Single mirror design maximizes response
- Al filter rejects visible & IR
- Dual band multilayer
- Filter wheel: Al/Zr/Al & Al/Mg/Al



Low roughness substrates

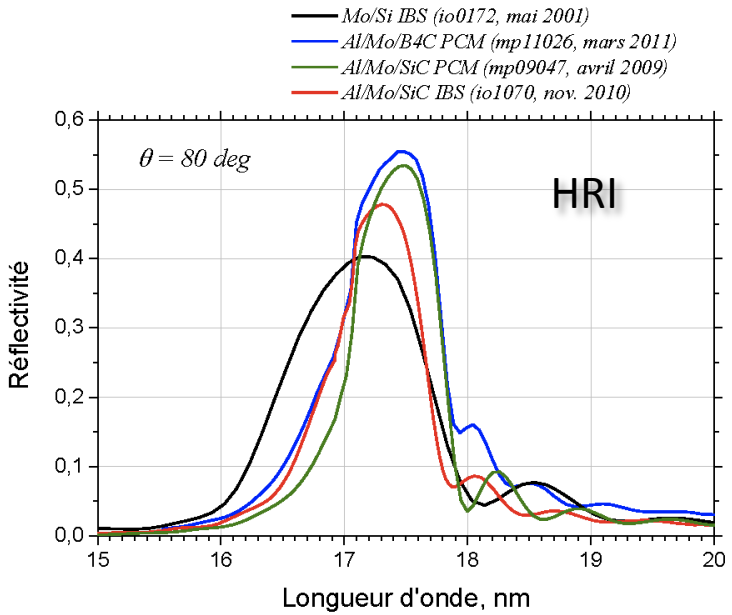


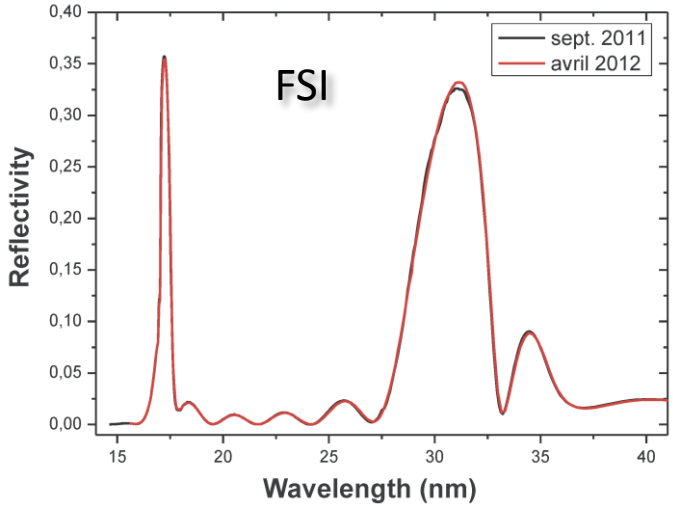
EUVI / STEREO: 1.88 Å RMS

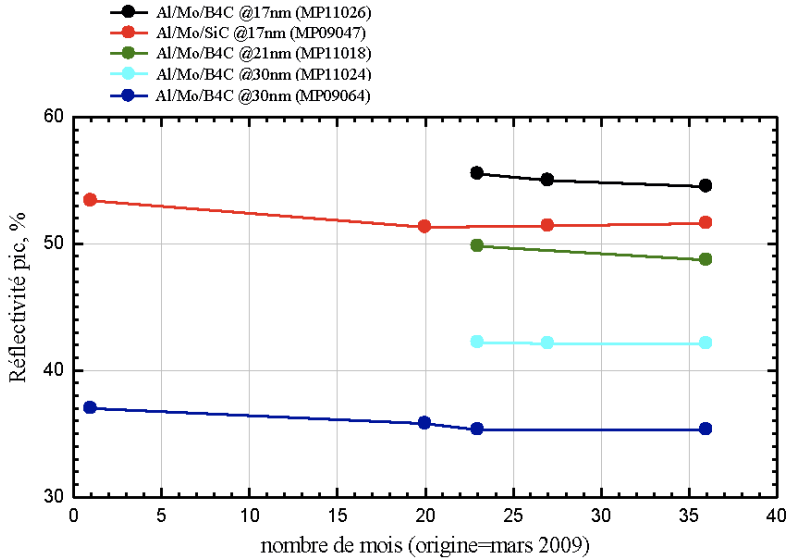


Improved superpolish: 0.22 Å RMS
Local defects persist: 1.23 Å RMS

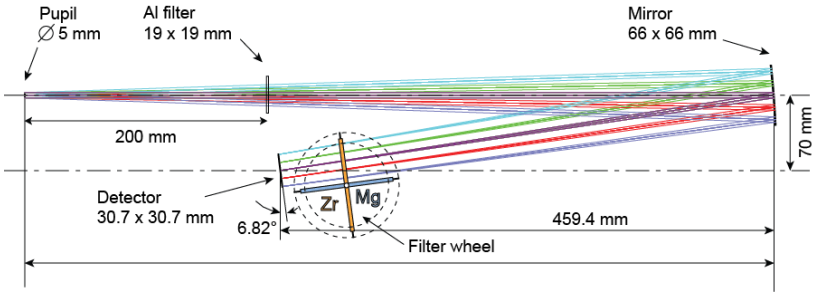
High reflectivity coatings: Al/Mo/B4C & Al/Mo/SiC

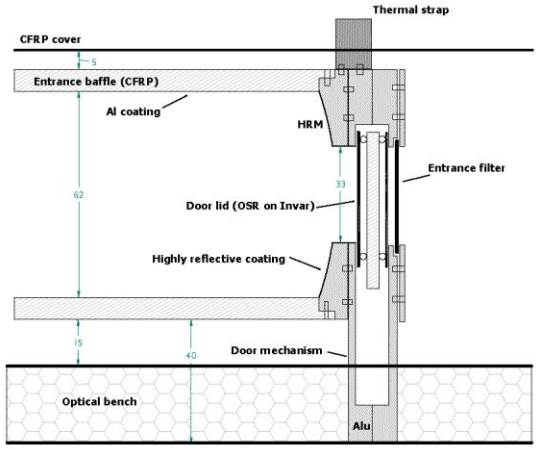


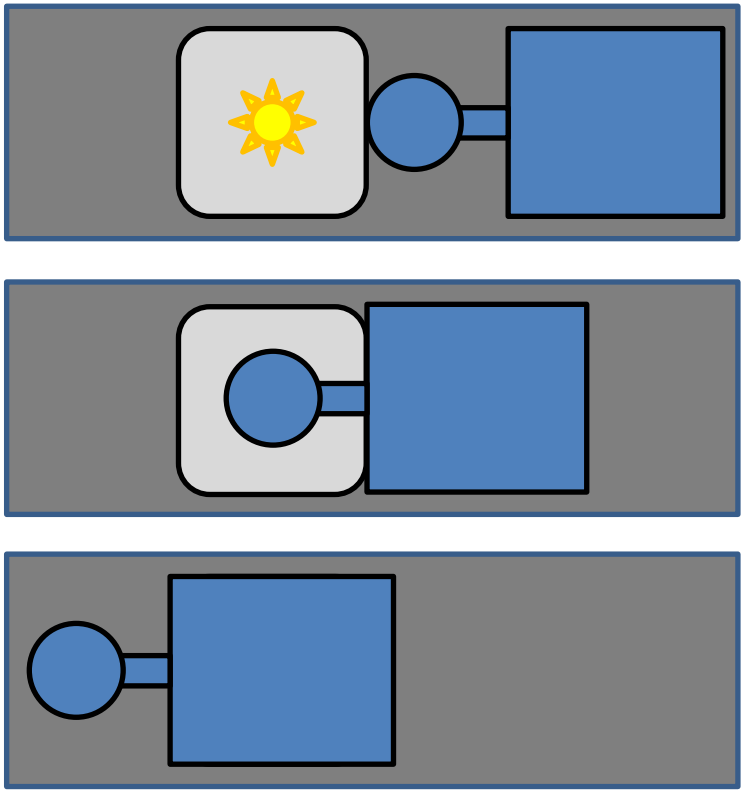




Addition of an occulting disk …







… on the door

- Simple occulter design OK @ 174 & 304

- Door modifications are implemented

- Limited number of operations
  - Campaign mode
  - Only when far from the Sun (0.4)?

A precursor of EUI & METIS: Herschel

Helium **R**esonant **S**cattering in the **C**orona and **Hel**iosphere

Herschel = HEIT + HECOR + SCORE

PI J. D. Moses (Naval Research Laboratory)

HEIT (US)

Solar disk @ 30.4 nm

EM of EUVI / STEREO

HECOR (FR)

He II coronagraph (30.4 nm)

FSI / Orbiter testbed

SCORE (IT)

Coronagraph Visible / H Ly α / He II Ly α

METIS / Orbiter testbed

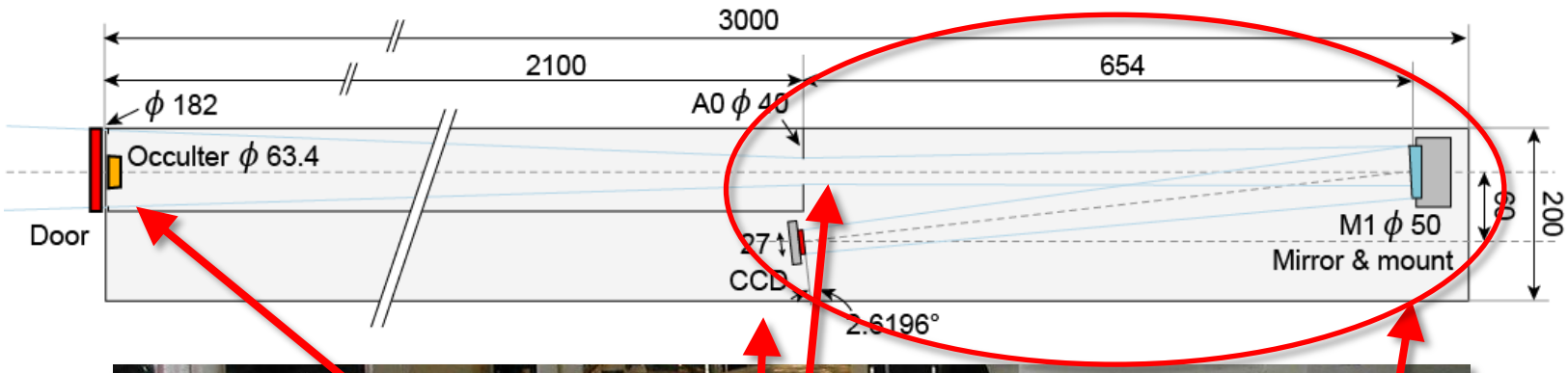
- First proposal in 2001
- Selection in 2003
- Launched on September 14, 2009
- Selected for a re-flight in 2016

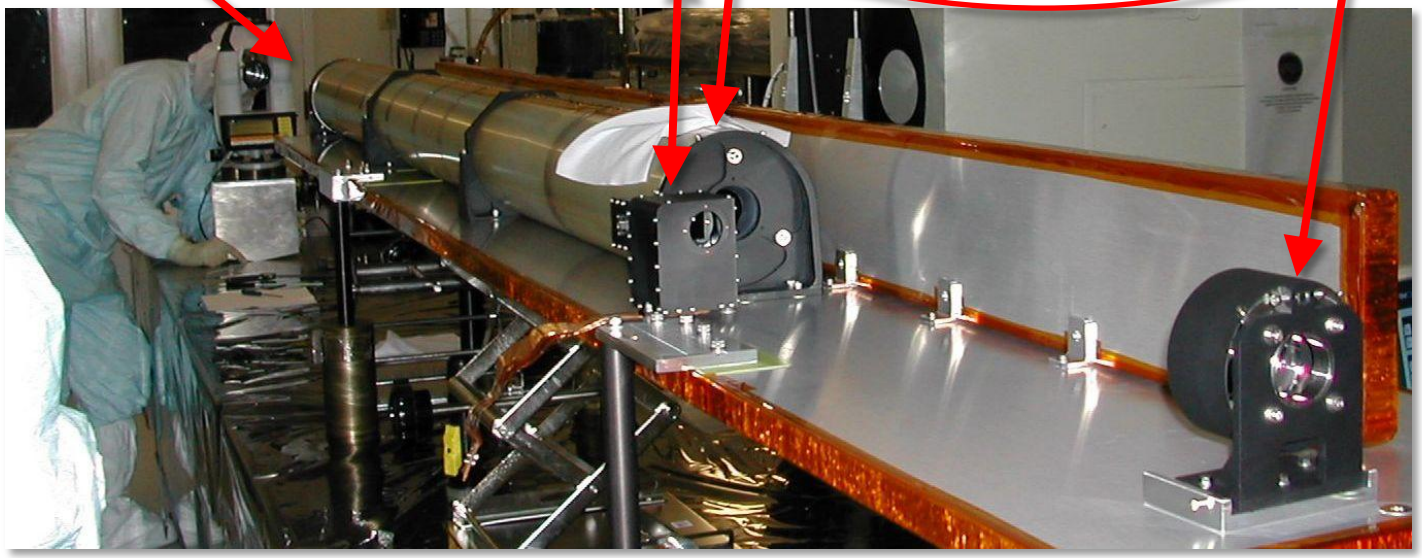
FSI precursor: HeCOR (Helium CORonagraph)

Externally occulted EUV coronagraph

- Wavelength: **30.4 nm (He II)**
- Field of view: **4R_s**
- Resolution: **8.26''/pixel**

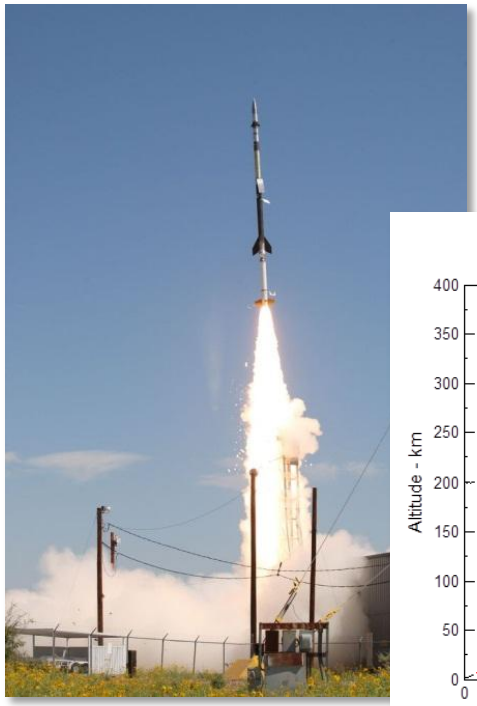
= FSI





Launch

14 September2009 at 17:00 UT
White Sands Missile Range, NM



315 km

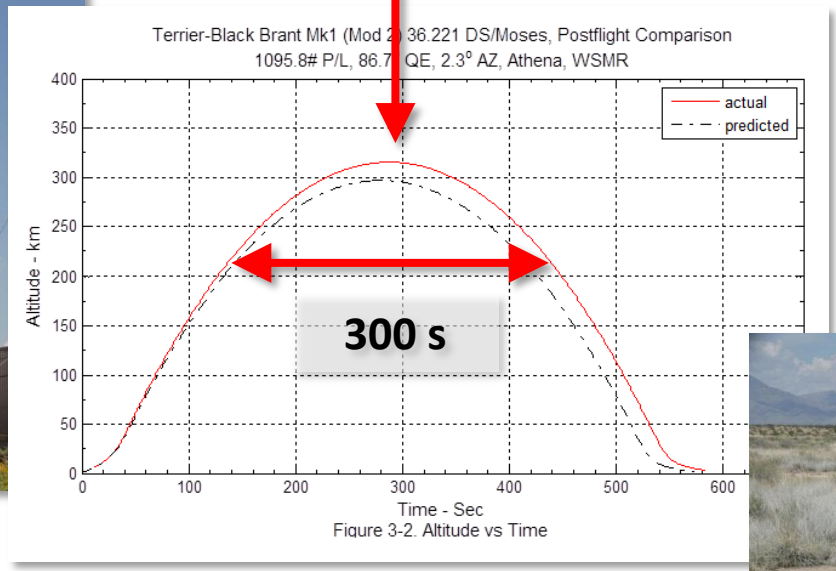
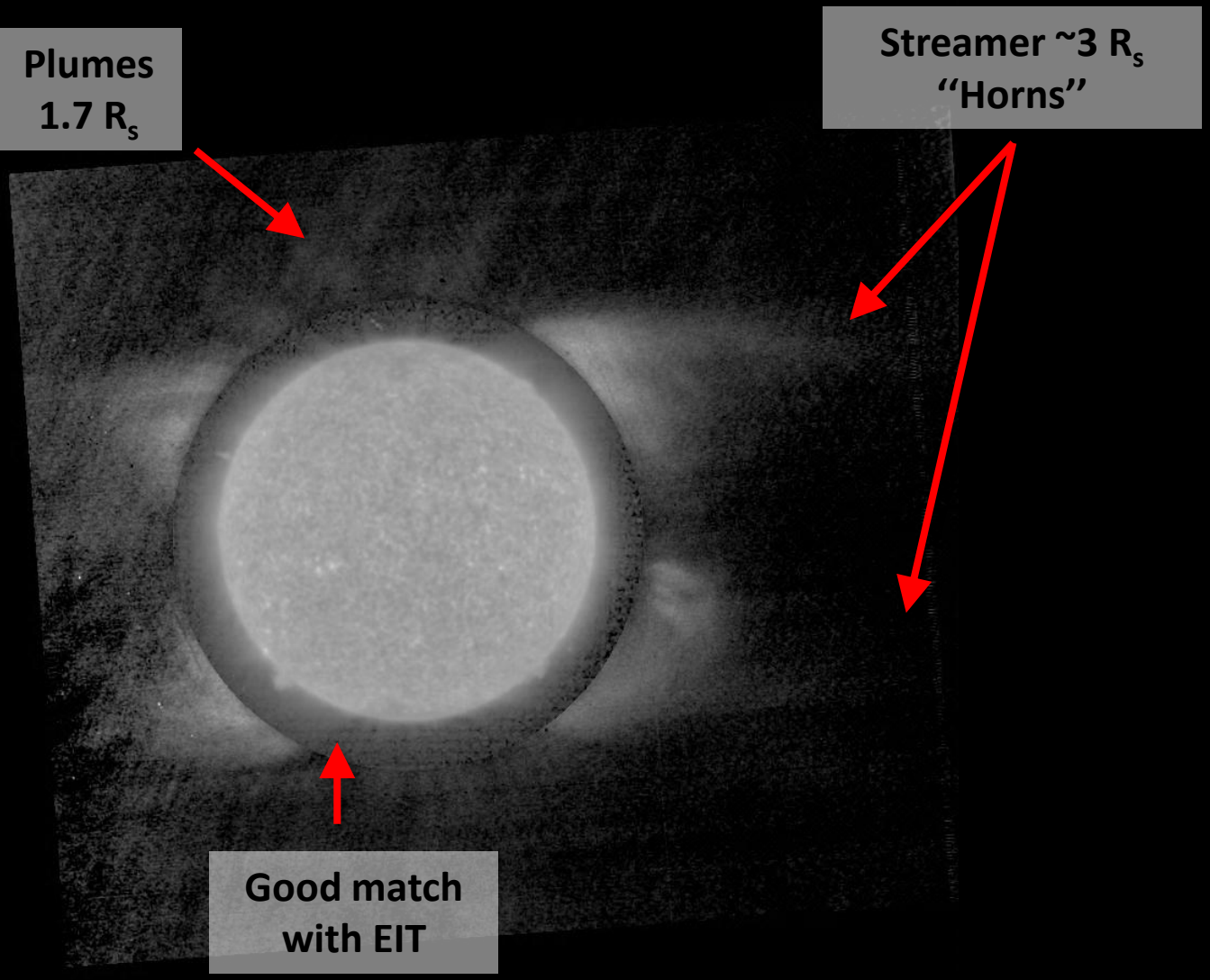


Figure 3-2. Altitude vs Time

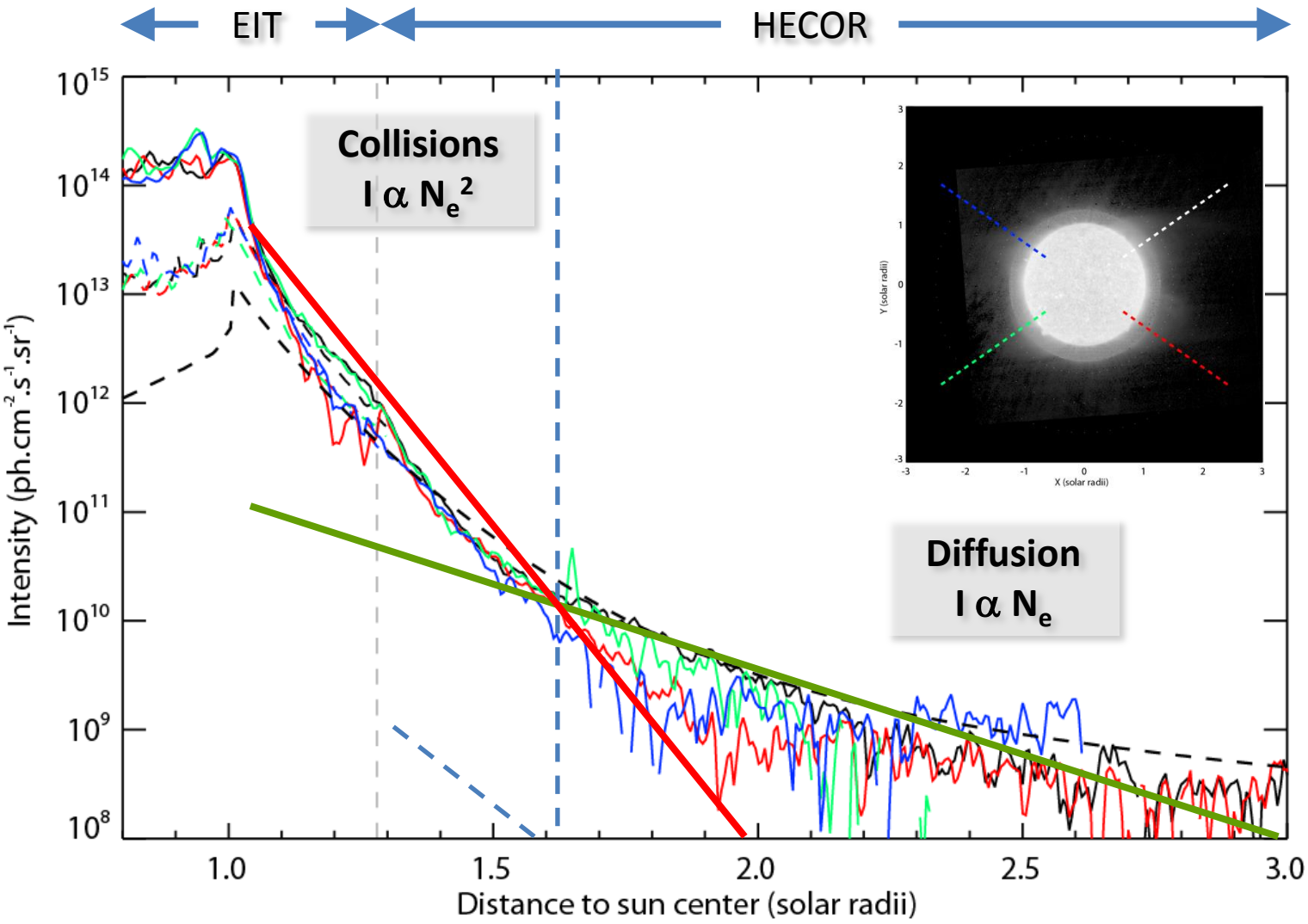
300 s

6 exposures of 40 seconds
The instrument is intact and will be re-flown

HECOR + EIT composite

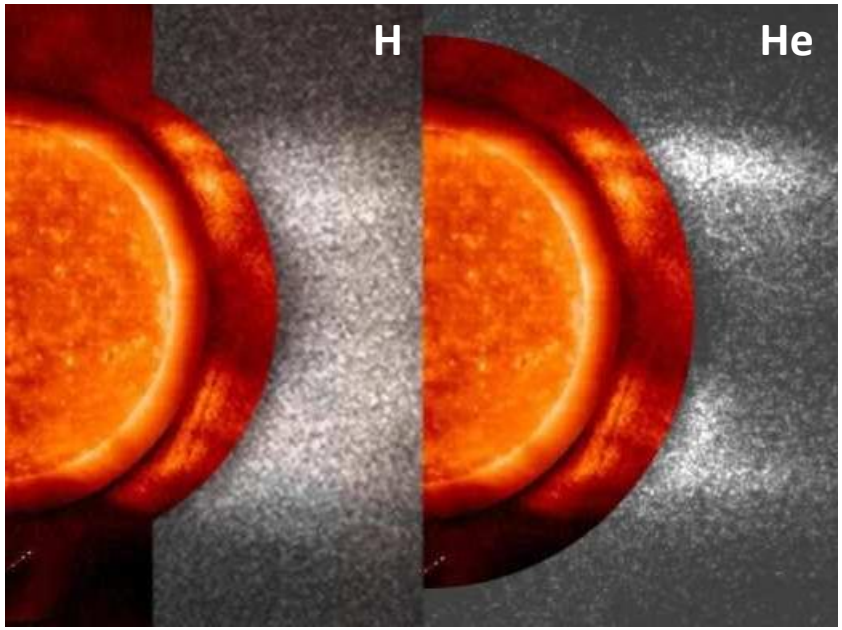


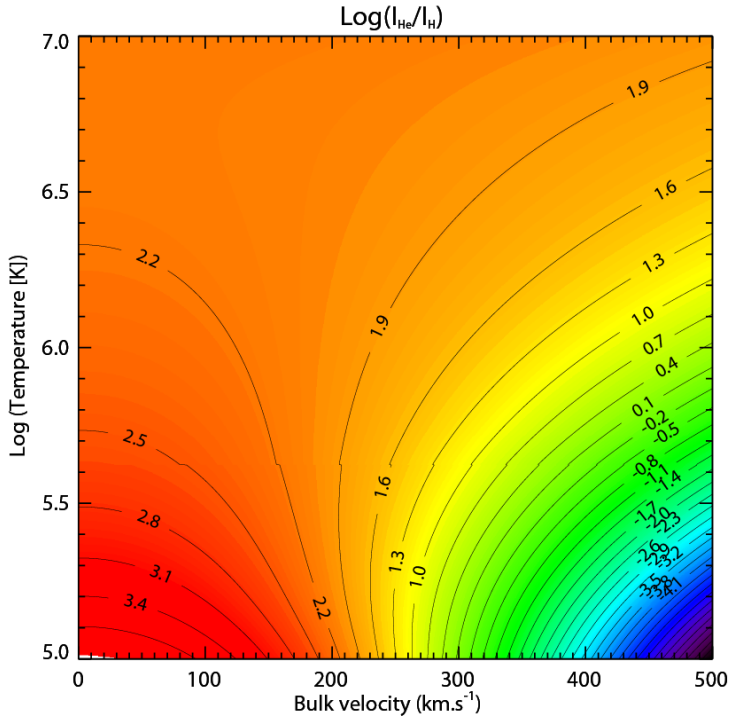
Evidence for resonant scattering



What are the 'horns'? SCORE

Courtesy S. Fineschi

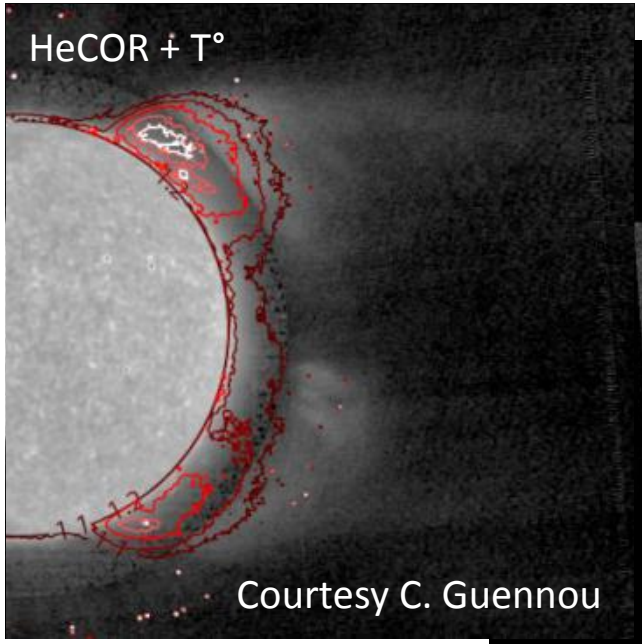


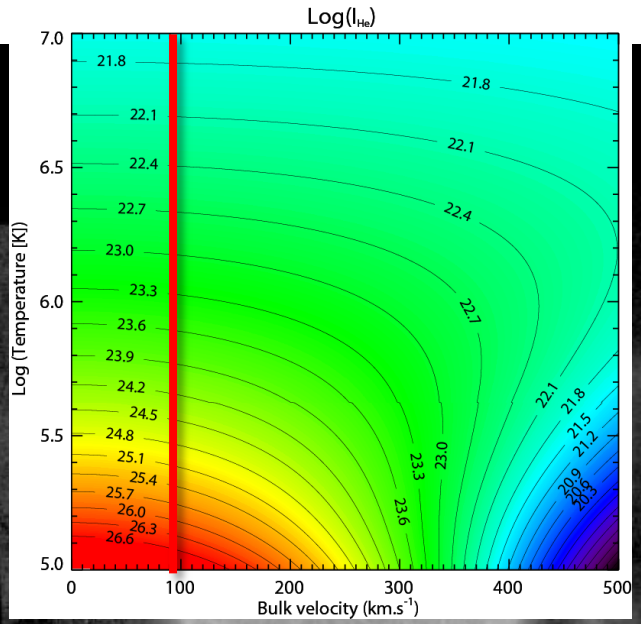


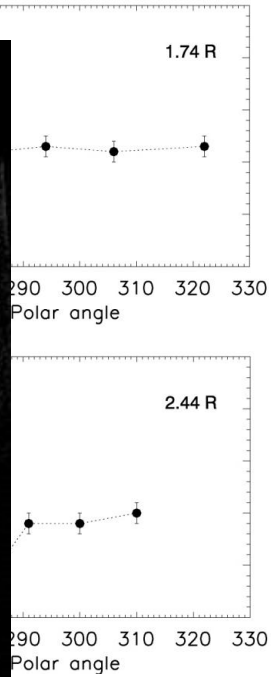
$$\frac{I_{H_e}}{I_H} = A_{H_e} \frac{N_{He^+}/N_{He}}{N_{H^+}/N_H} \frac{B_{12}^{He}}{B_{12}^{H}} \frac{I_t^{He}}{I_t^{H}} \frac{f(v_{He}, T_{He}, P_{He})}{f(v_H, T_H, P_H)}$$

The observed variations of I_{He} are linked to Helium abundance variations

What are the ‘horns’? HeCOR







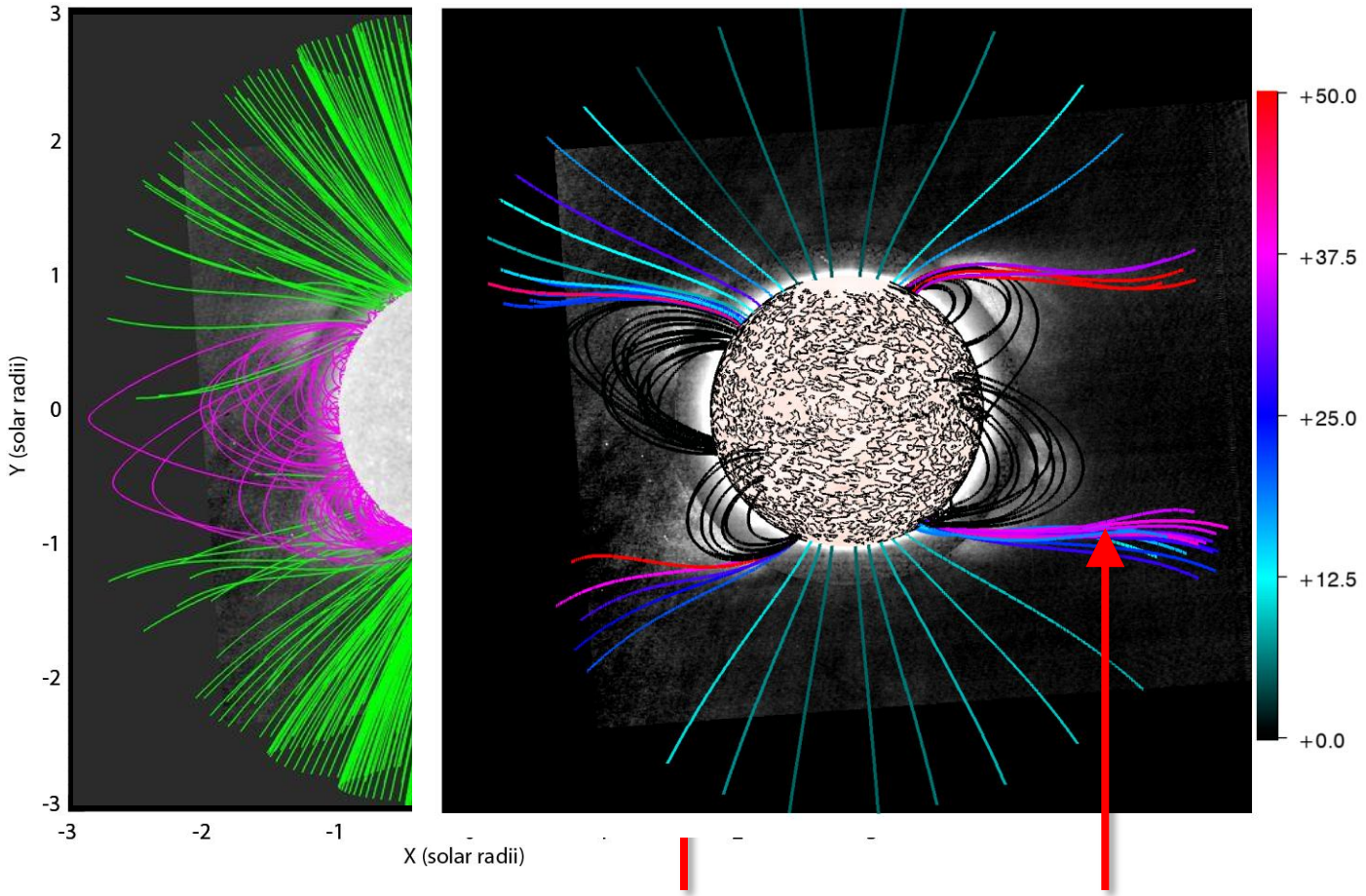
Courtesy L. Abbo

The observed variations of I_{He} are linked to Helium abundance variations

Intensity vs B

Potential extrapolation **Expansion factor**

Courtesy A. Canou & T. Amari



"Horns" at open/closed boundary

"Horns" where the expansion factor is maximum

Conclusions

EUI

- Imaging of the corona up to a few R_s will be possible *via*
  - Improvements of the optics (roughness, efficiency)
  - Addition of an occulting disk on the door

- If METIS retains H channel, then H + He science still possible

- Obvious synergies with METIS (cf. Susanna's talk)
  - HRI: source regions (ARs, CHs, plumes, etc.)
  - FSI: overlapping FOVs but different lines

HeCOR results

- Validation of technologies for EUI / FSI
- Best images to date of the 30.4 nm corona up to $3R_s$
- He II 30.4 nm line formed by resonant scattering
- He II dominates the band above 1.6 R_s
- Local variations of the He abundance
- Variations linked to the **B** morphology & expansion factor