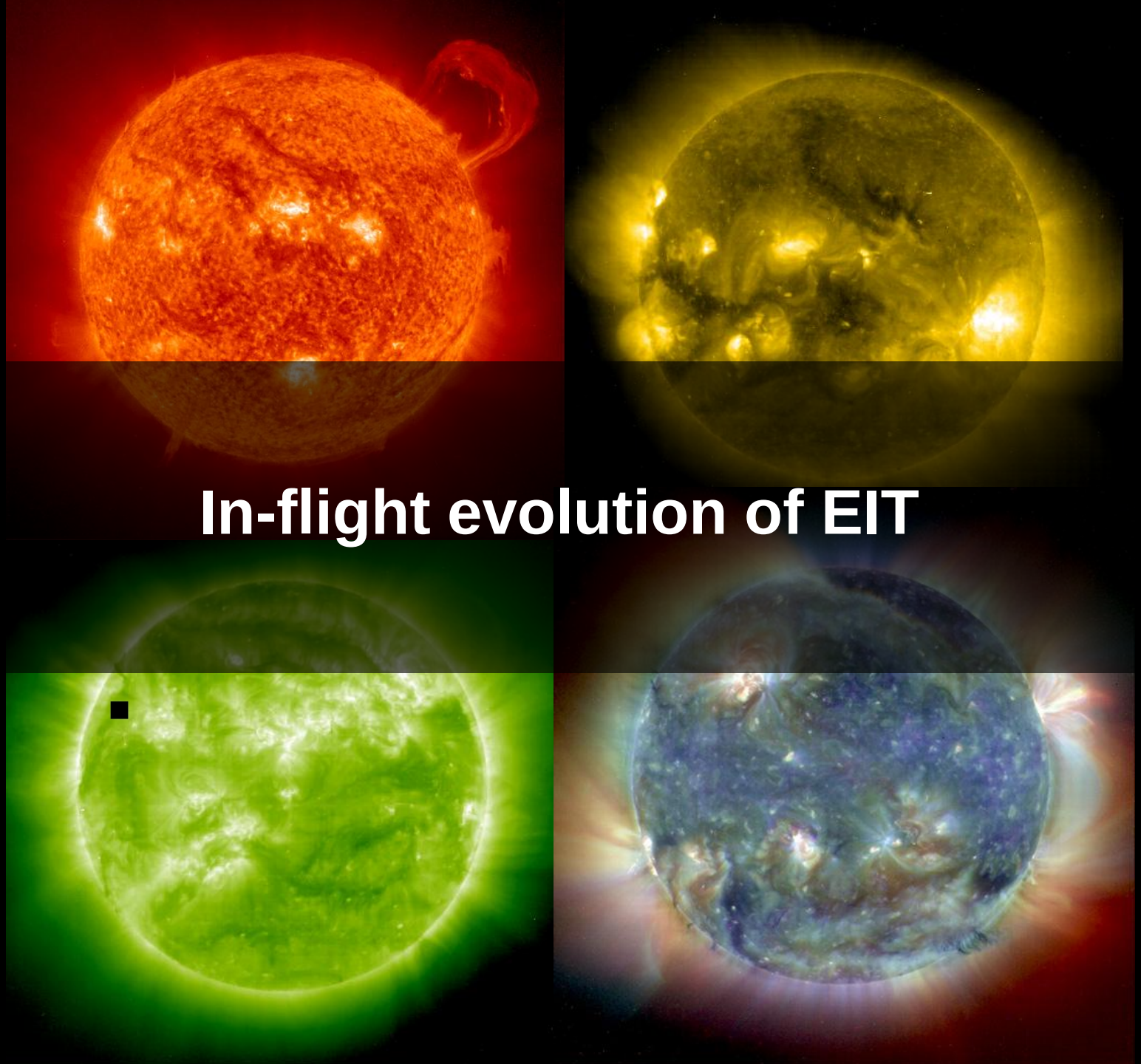
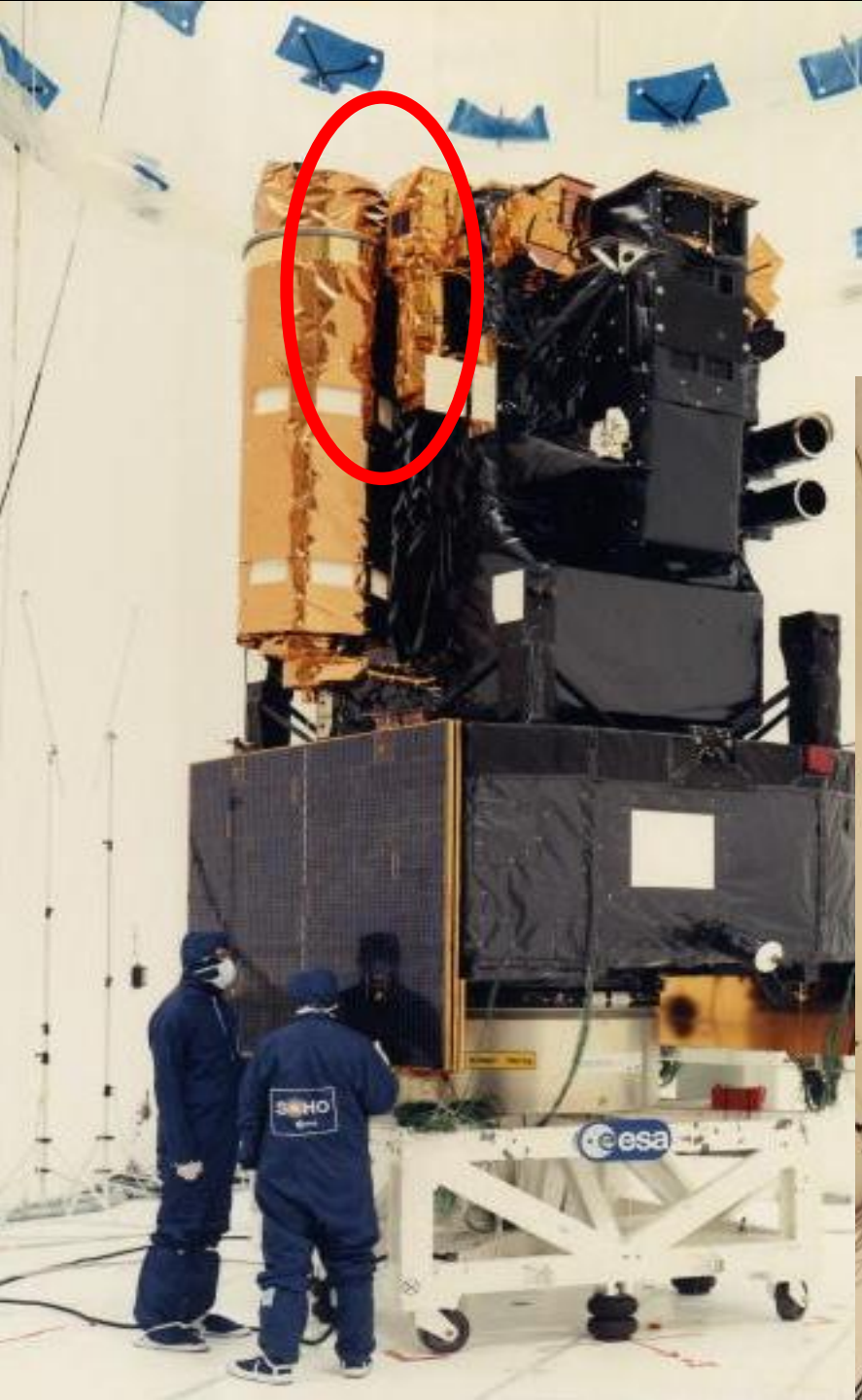
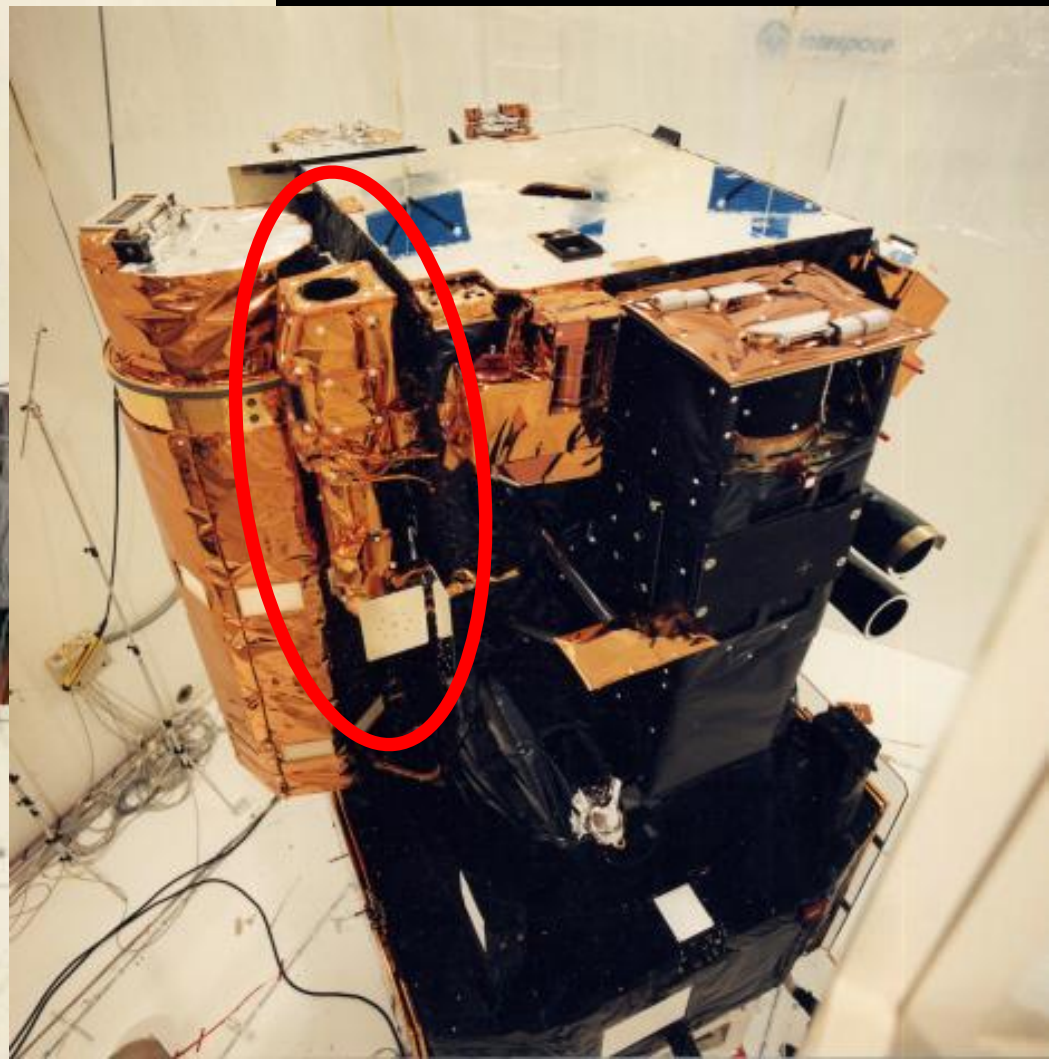

In-flight evolution of EIT

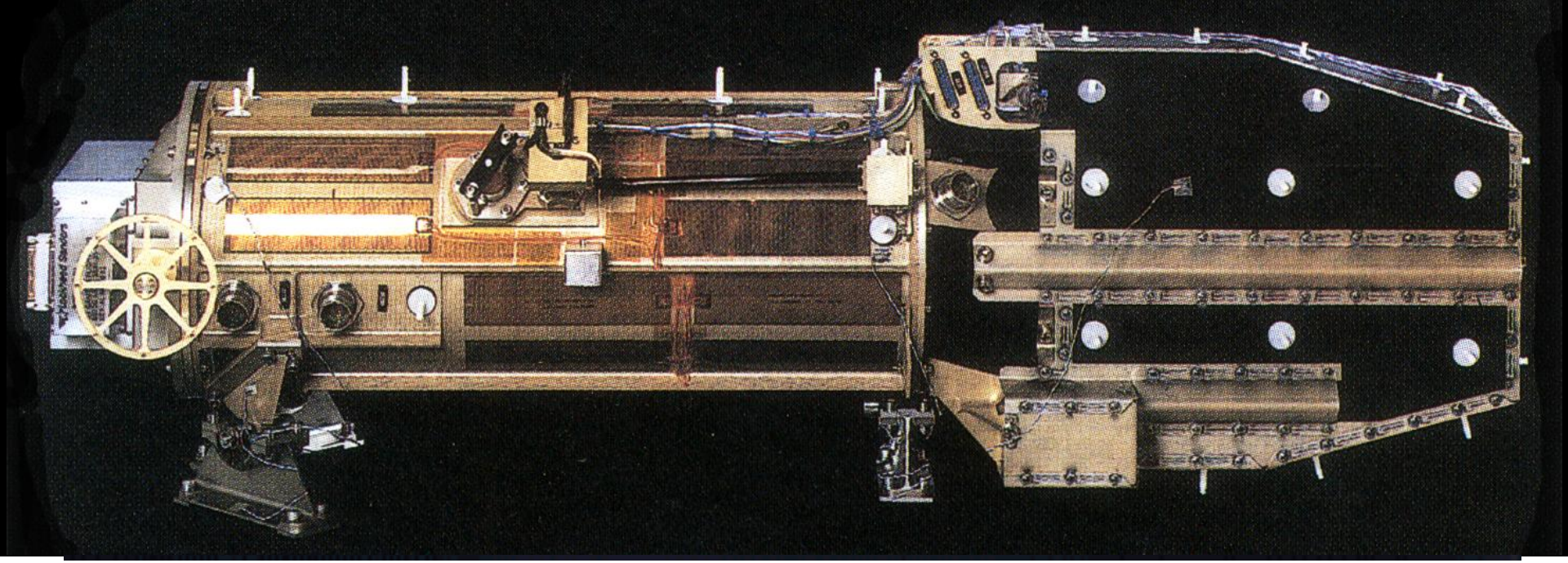
Extreme-ultraviolet

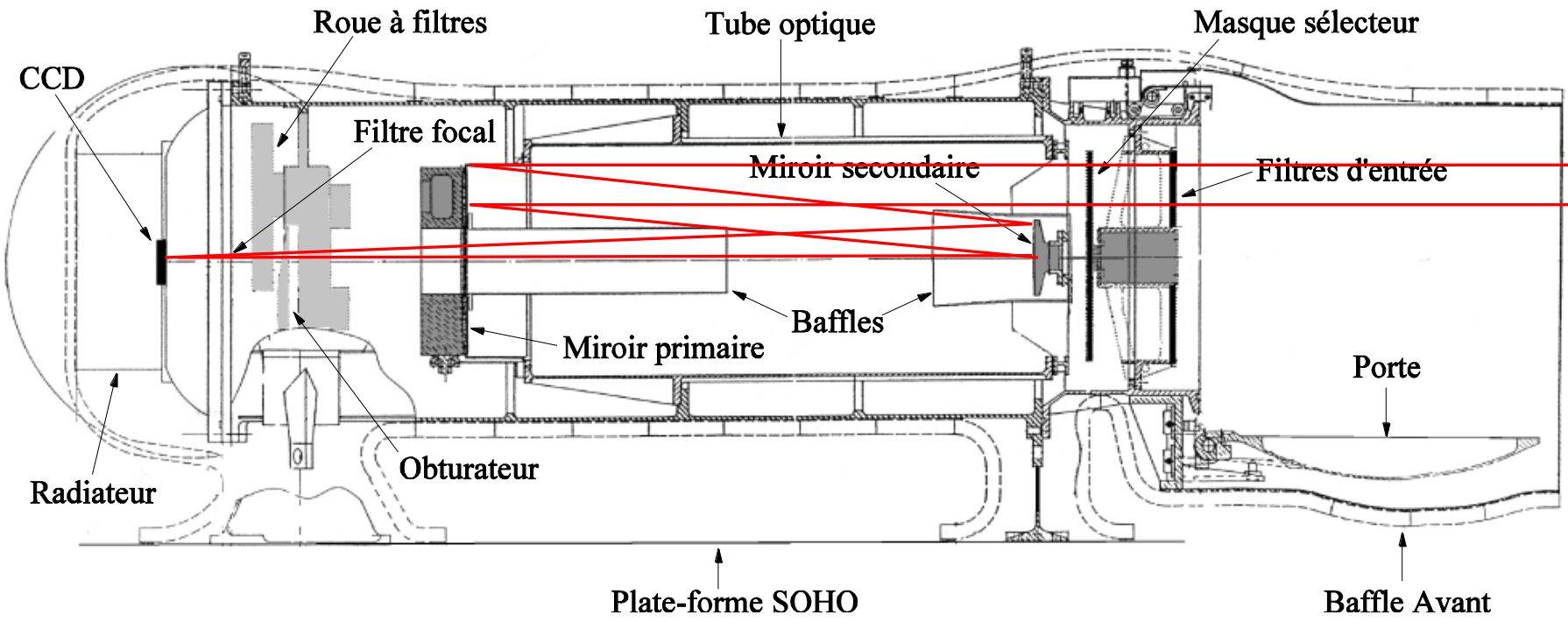
Imaging

Telescope

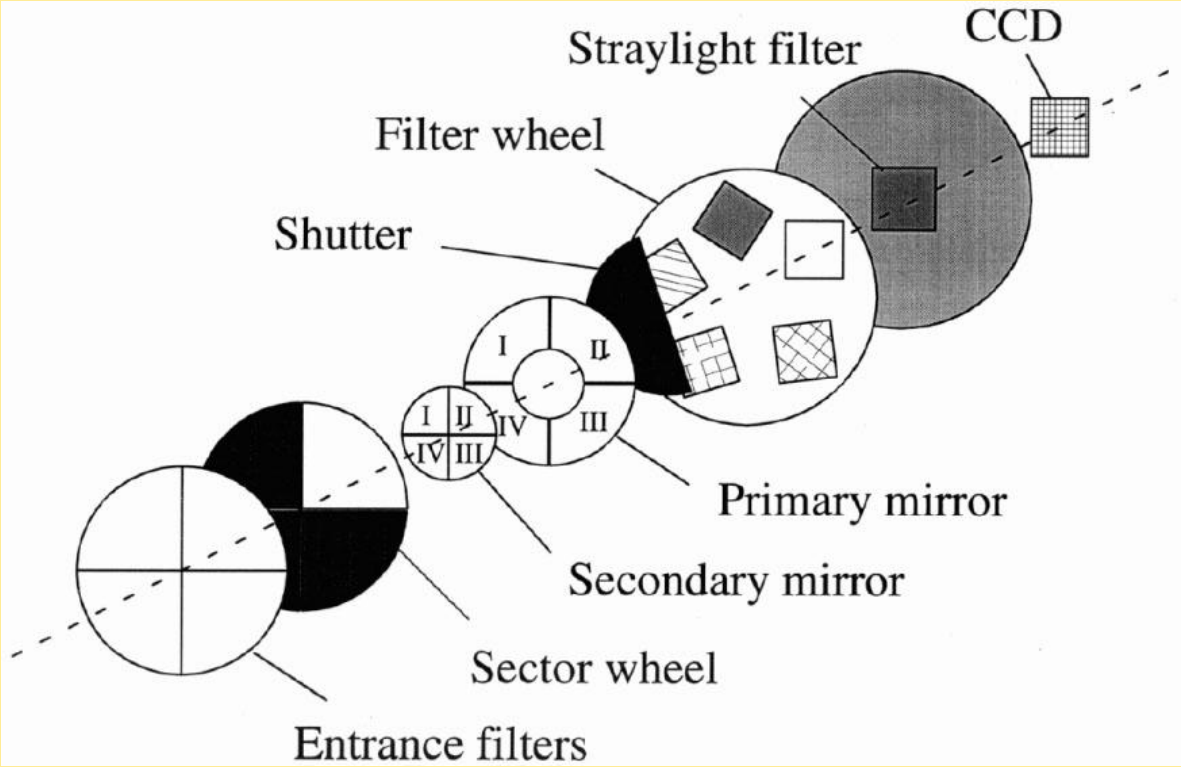







Roue à filtres
Tube optique
Masque sélecteur
CCD
Filtre focal
Miroir secondaire
Filtres d'entrée
Baffles
Miroir primaire
Porte
Obturateur
Radiateur
Plate-forme SOHO
Baffle Avant

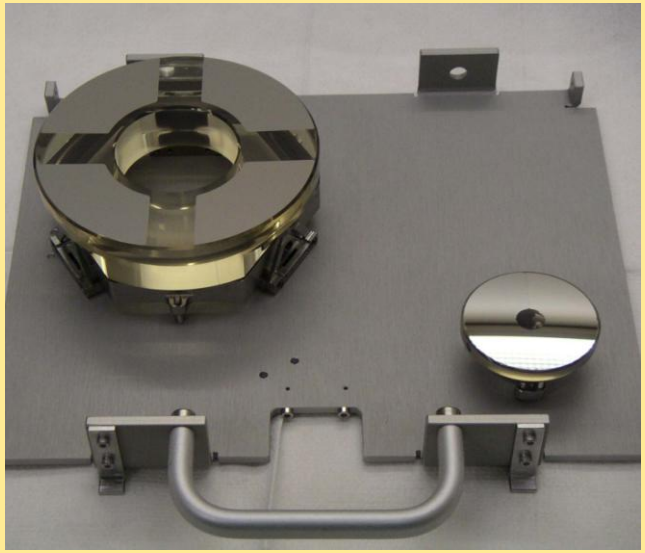
General Layout

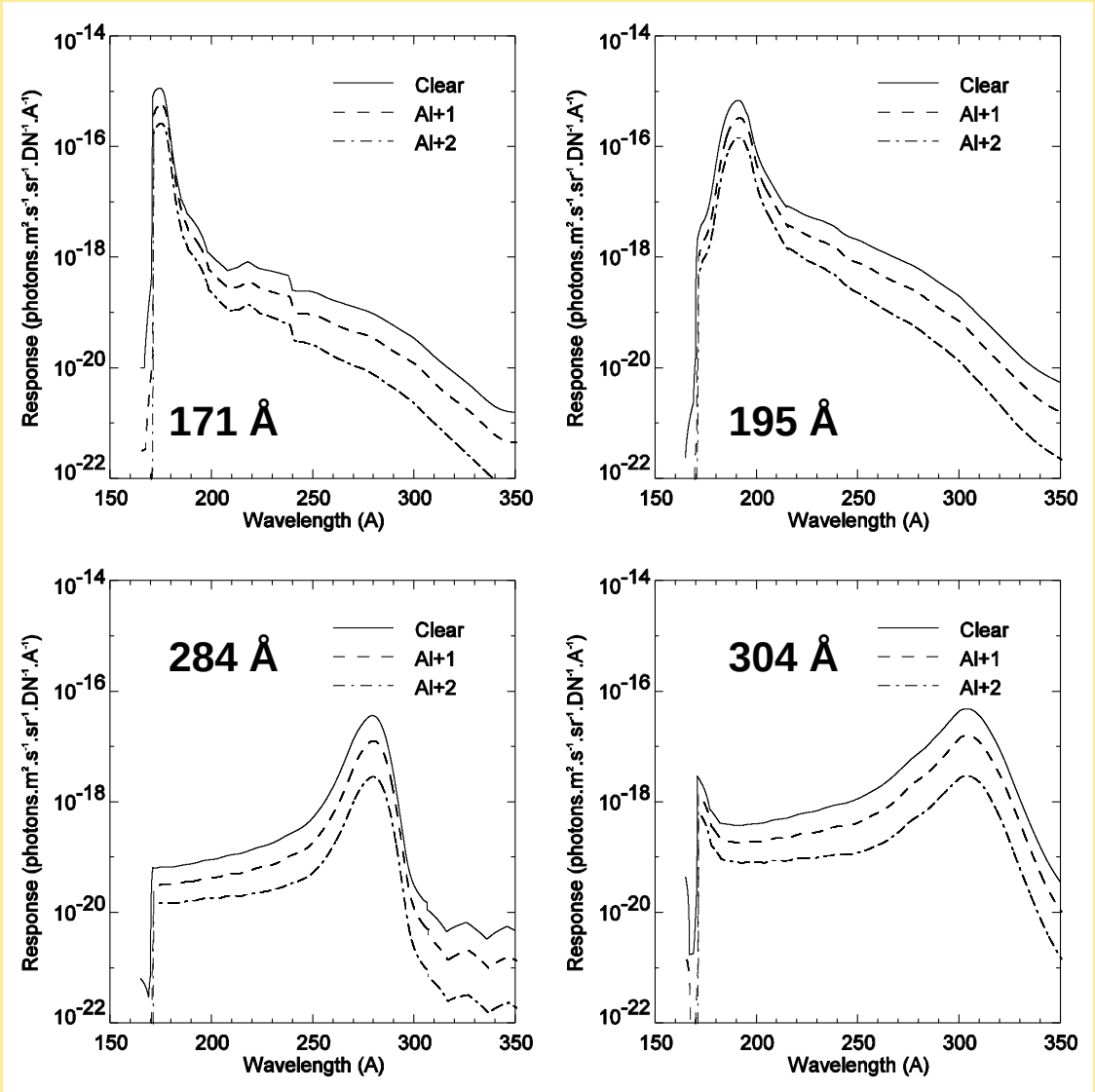


- Ritchey-chretien design
- Primary diameter 12 cm
- Geometrical area per quadrant 13 cm^2
- Effective focal length 165.2 ± 0.2 cm
- Multilayered Mirrors
- Mo-Si Mutilayers tuned to different wavelengths
- 1024 x 1024 CCD, 45 x 45 arcmin FOV

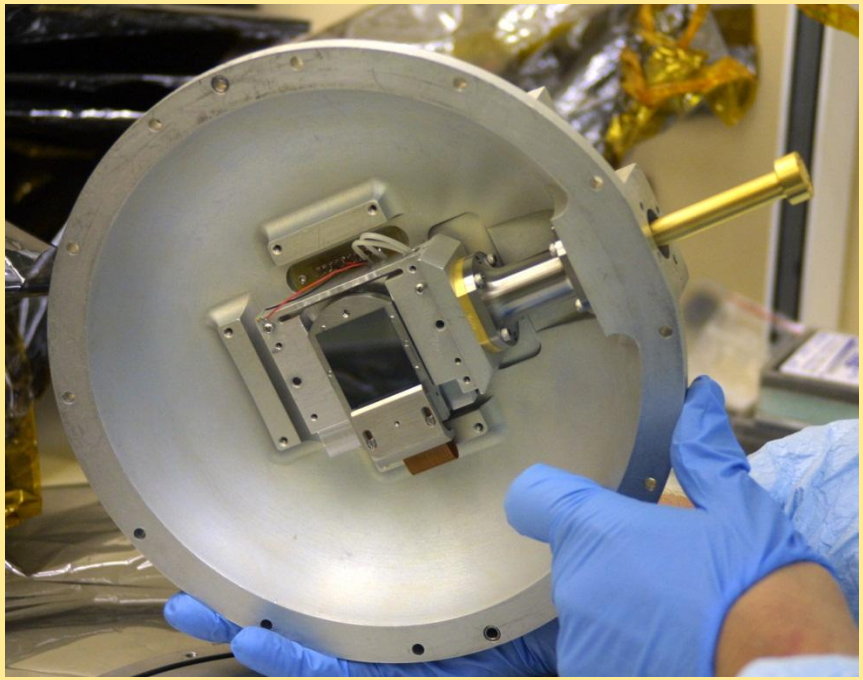
Spectral Selectiviy

Molybdenum-Silicon mutilayers tuned to different λ





Focal Plane Assembly - Electronics

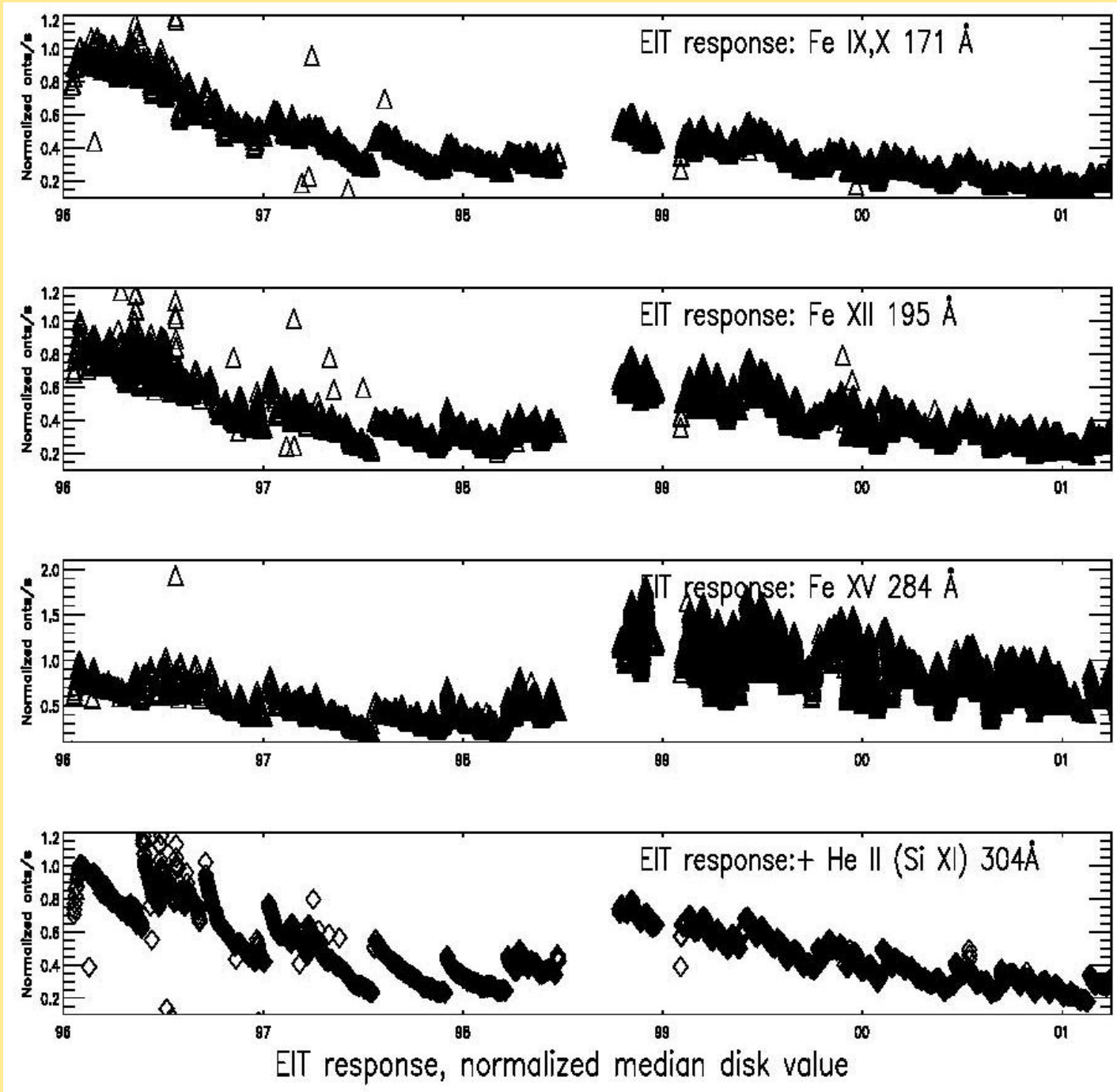


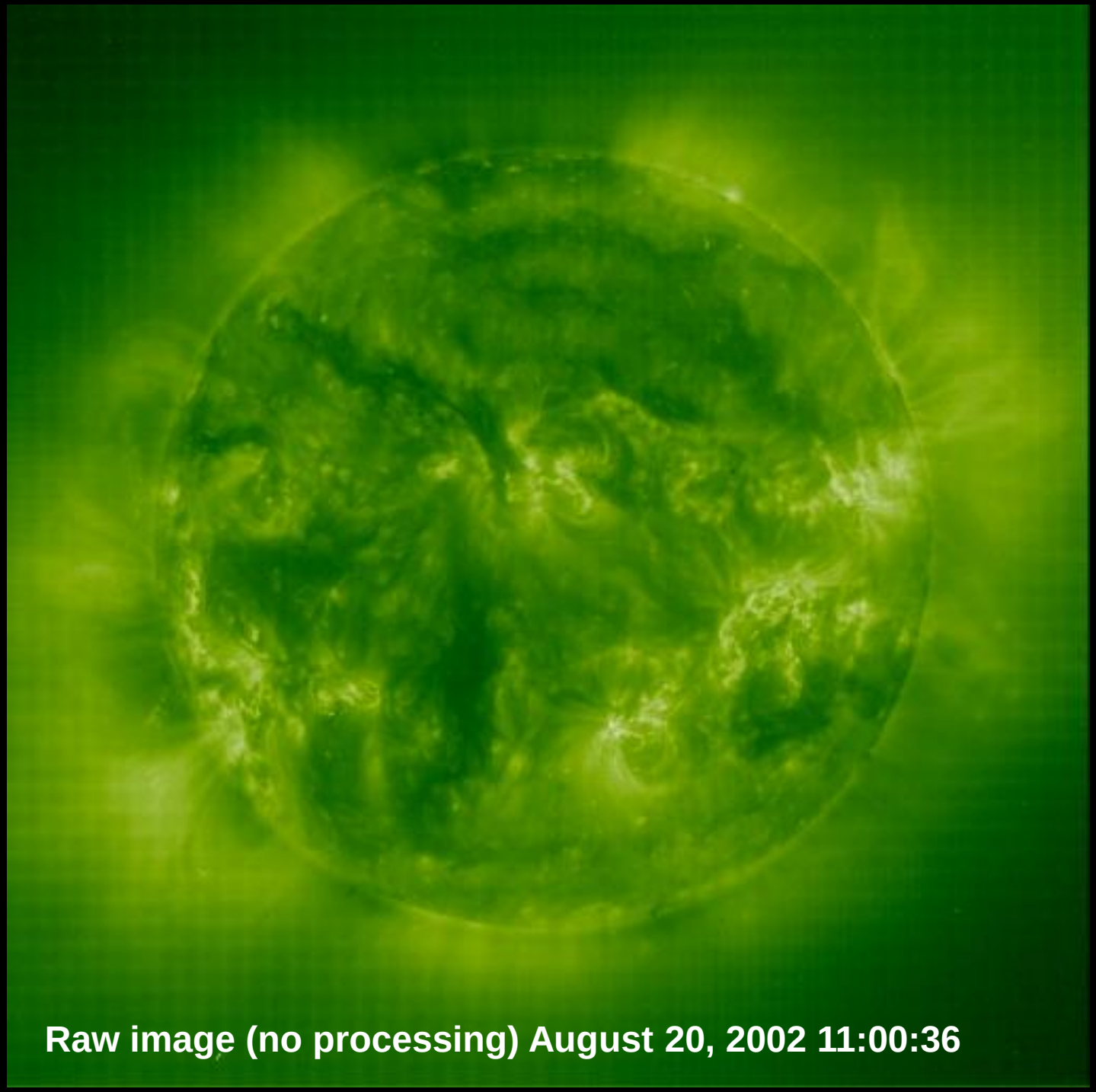
Thinned, back-illuminated CCD
1024 x 1024 pixels
21 μm
2.627 arcsec/pix

Passively cooled to T ~ -80C
Negligible dark current

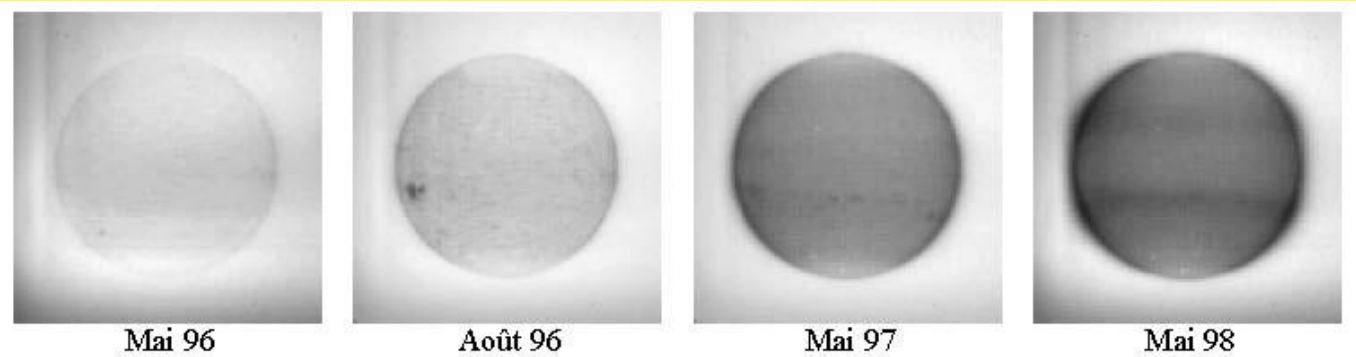
Full well ~150000 electrons
Readout Noise ~30 electrons ~2 DN
Saturation ~13000 DNs

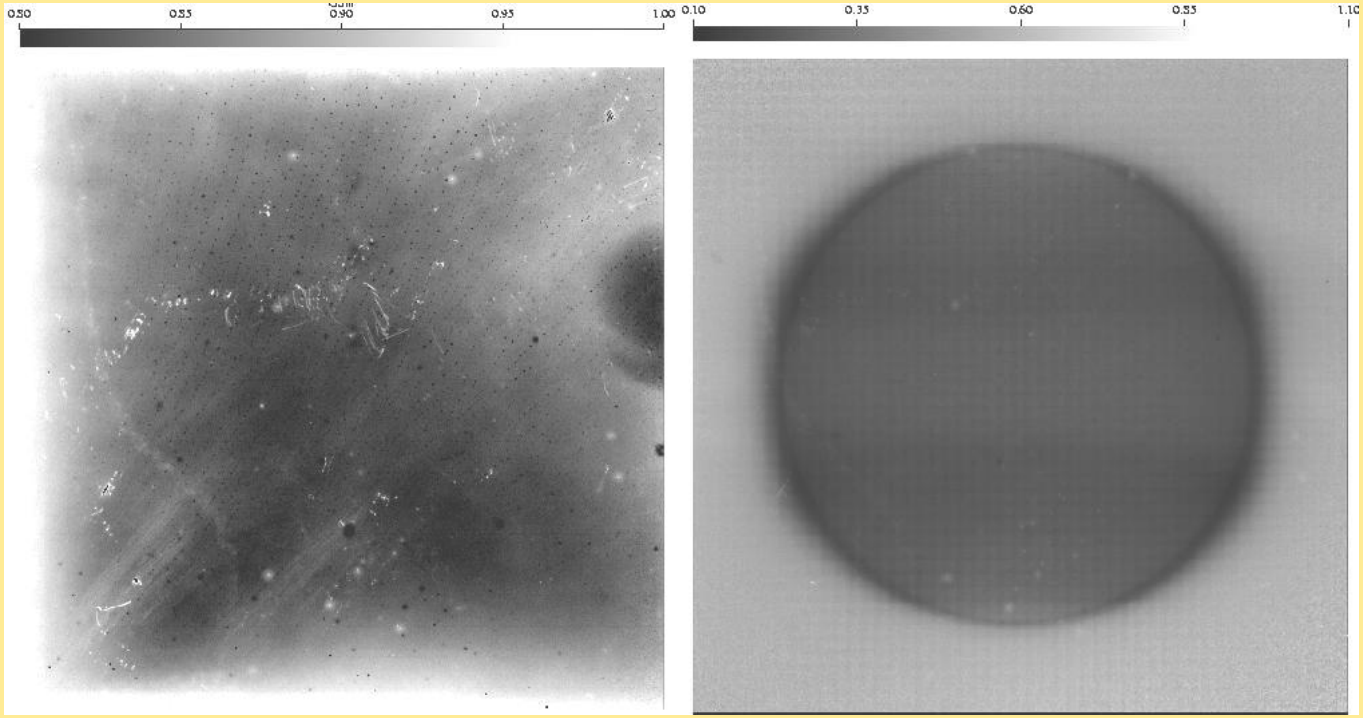
20 seconds full frame readout


EIT response: Fe IX,X 171 Å
EIT response: Fe XII 195 Å
EIT response: Fe XV 284 Å
EIT response:+ He II (Si XI) 304Å
Normalized ont/s
96
97
98
99
00
01
EIT response, normalized median disk value


Raw image (no processing) August 20, 2002 11:00:36

Degradation of the CCD EUV Response I



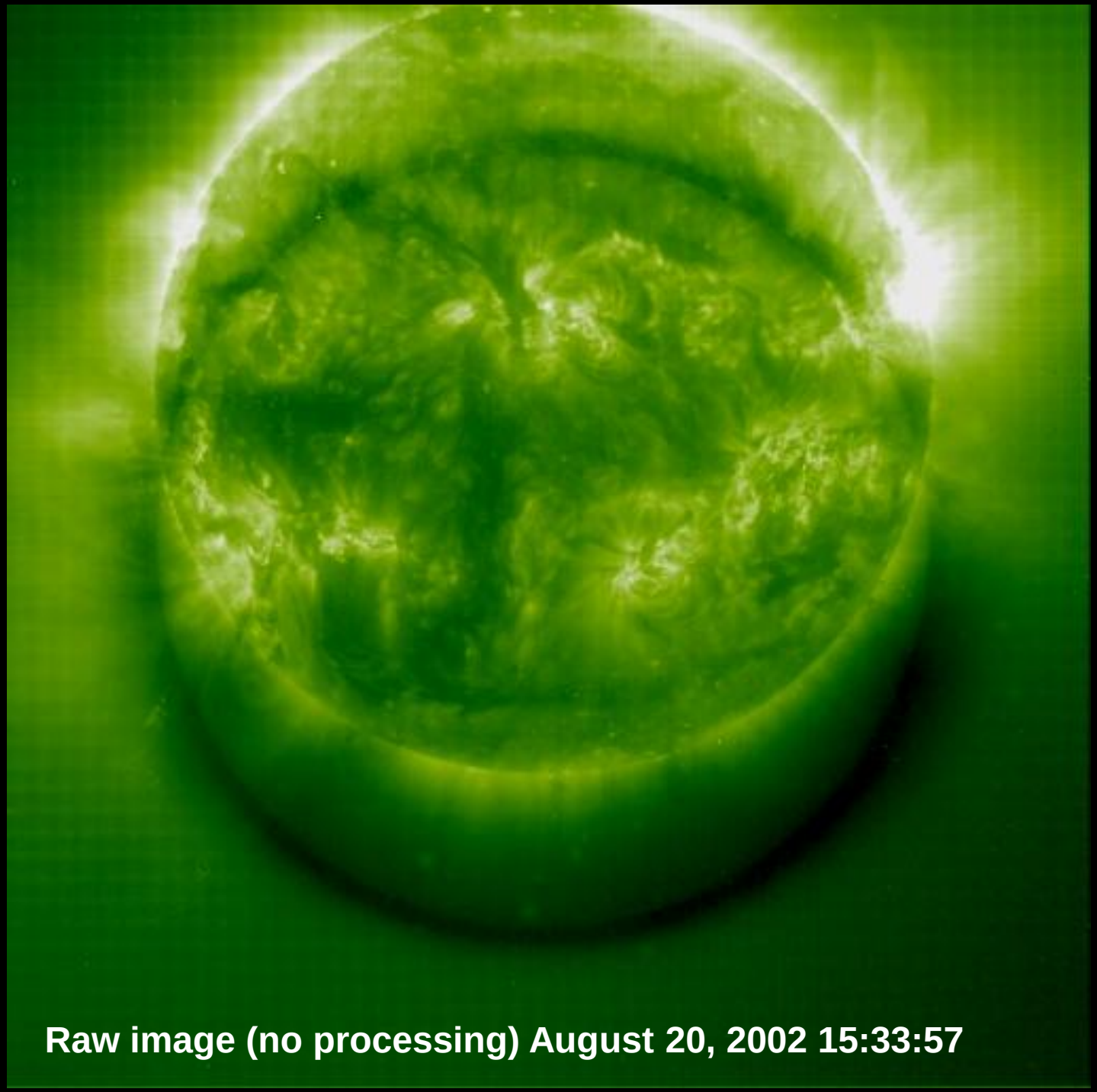


Pre-flight:

10 % variations P2P

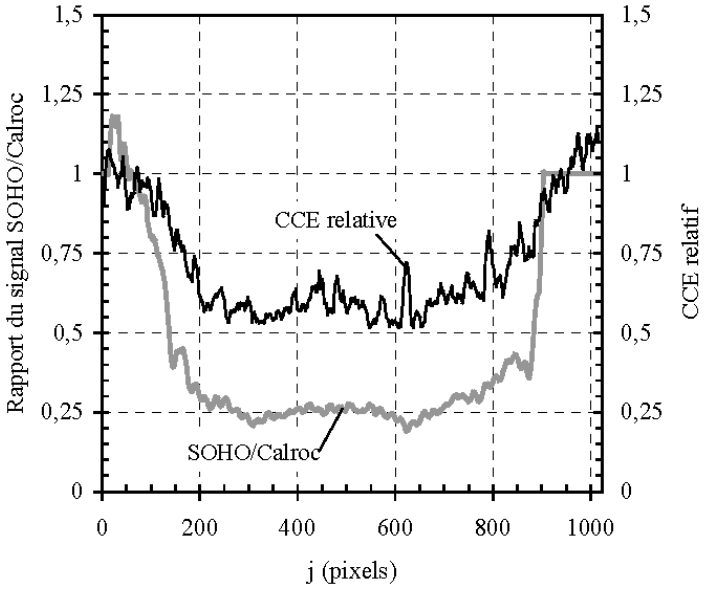
August 2002 offpoint:

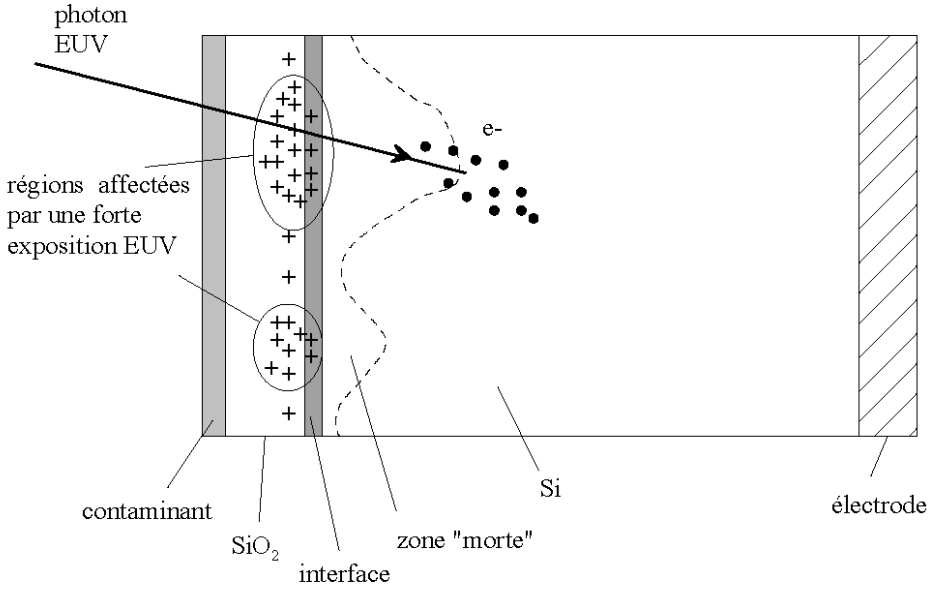
Burnt areas at 10 % of the original QE

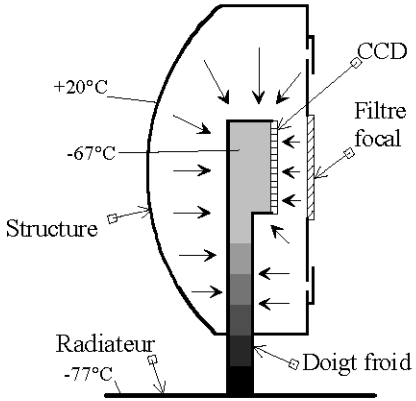

Raw image (no processing) August 20, 2002 15:33:57

Cause of sensitivity loss: CCE + water

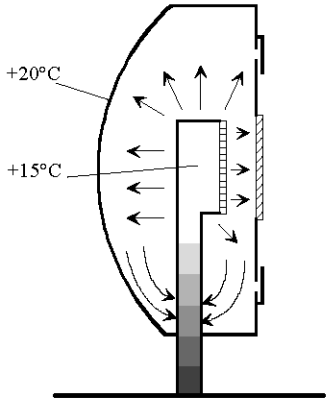
Defise 2000, Ph. D. Thesis





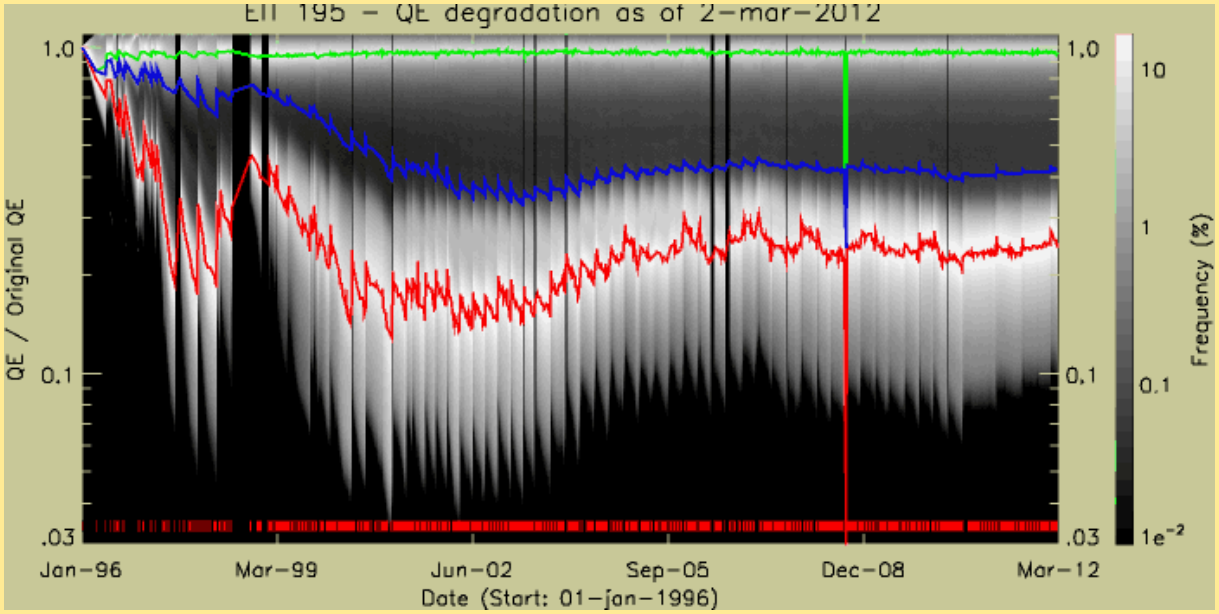


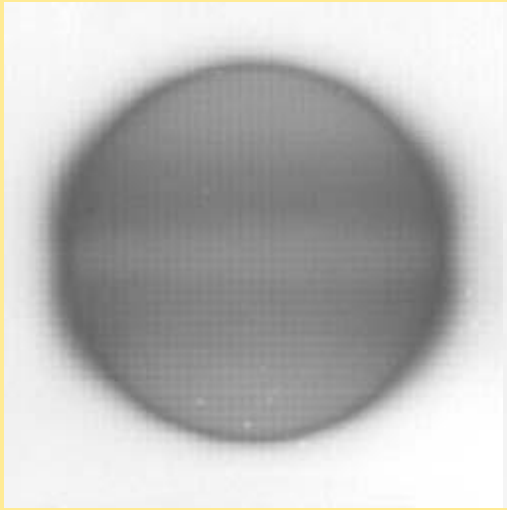
Phases opérationnelles

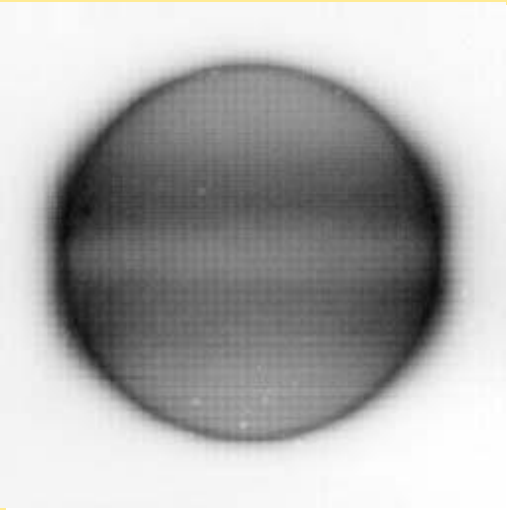


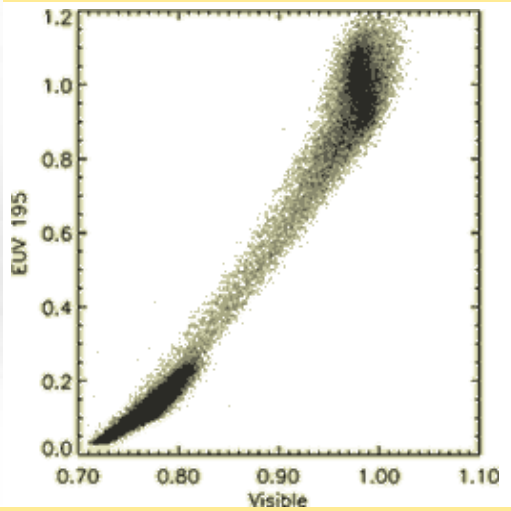
Phases de réchauffage

Correction of the EUV degradation





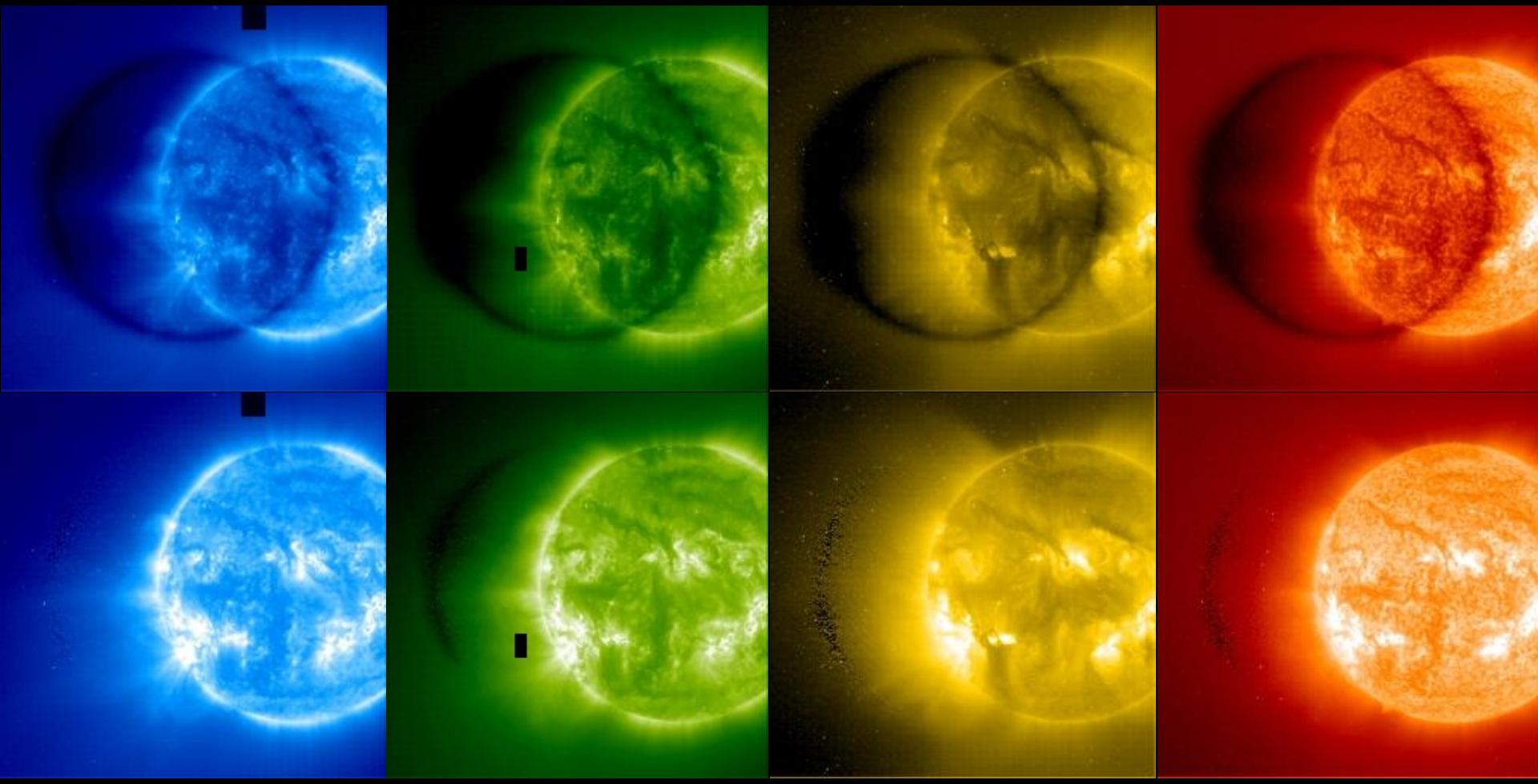


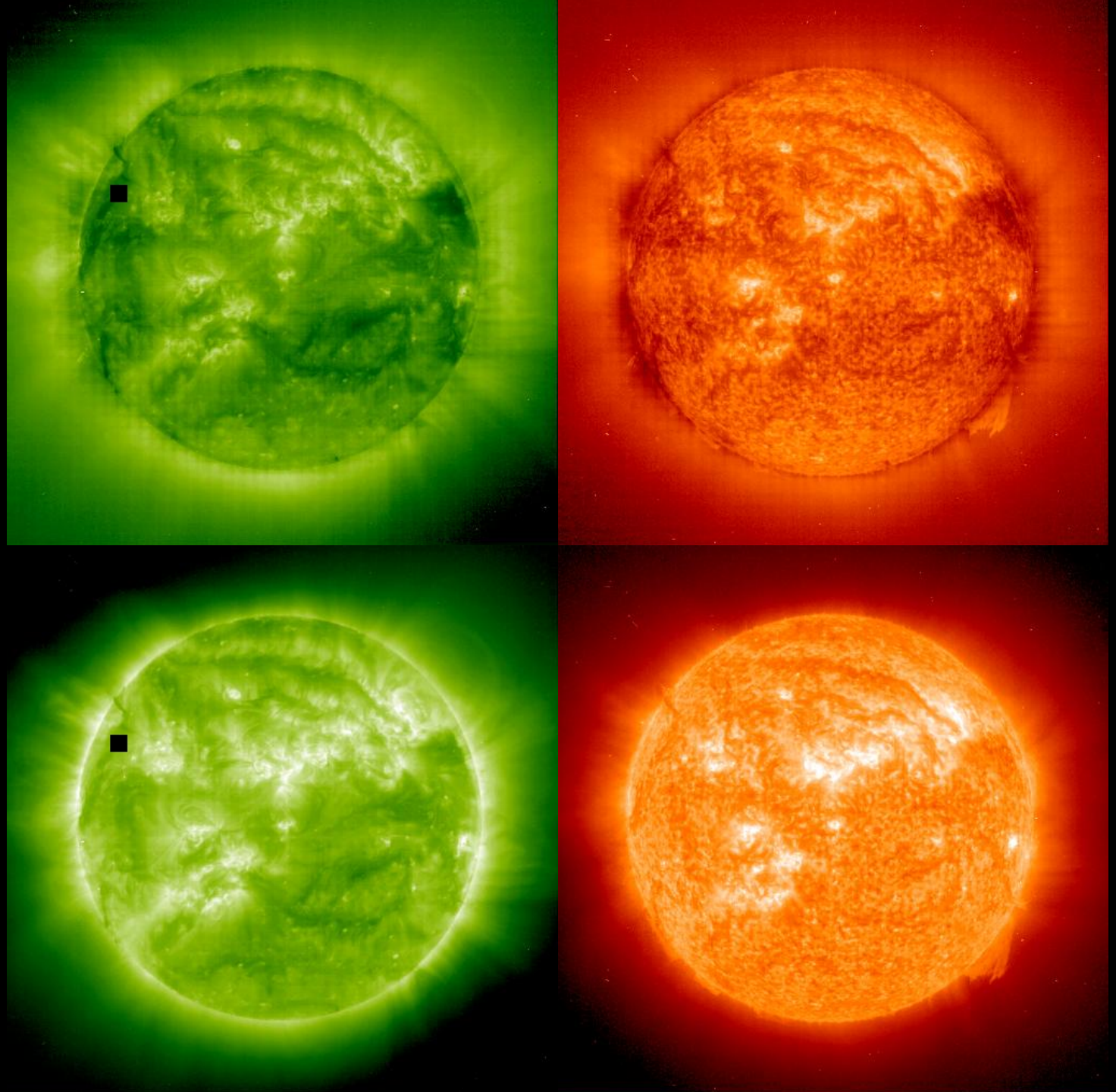


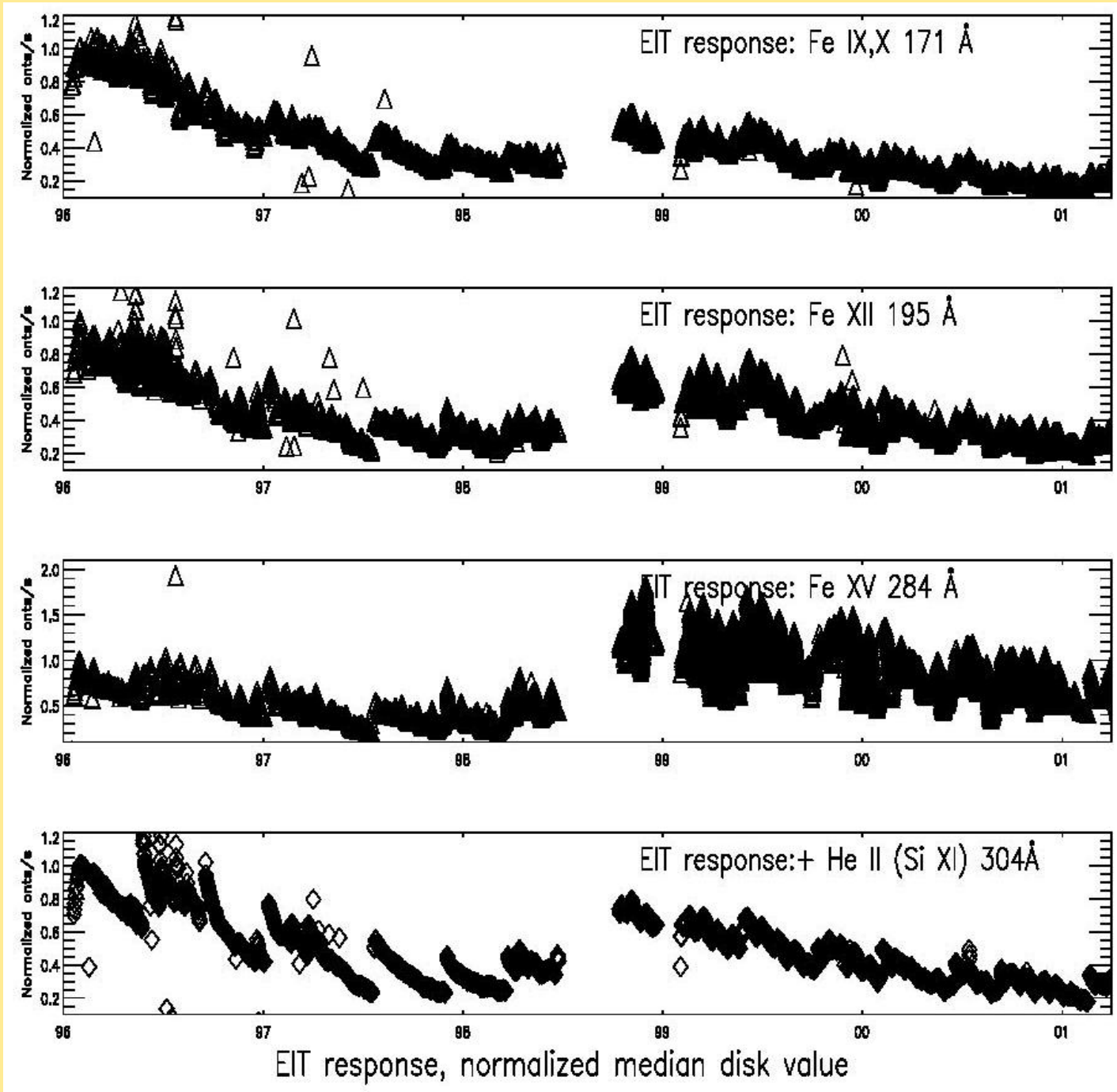
1. Calibration lamp ratio

2. EUV response (e.g. from offpoint)

3. WL to EUV relationship






EIT response: Fe IX,X 171 Å
EIT response: Fe XII 195 Å
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EIT response:+ He II (Si XI) 304Å
Normalized ont/s
96
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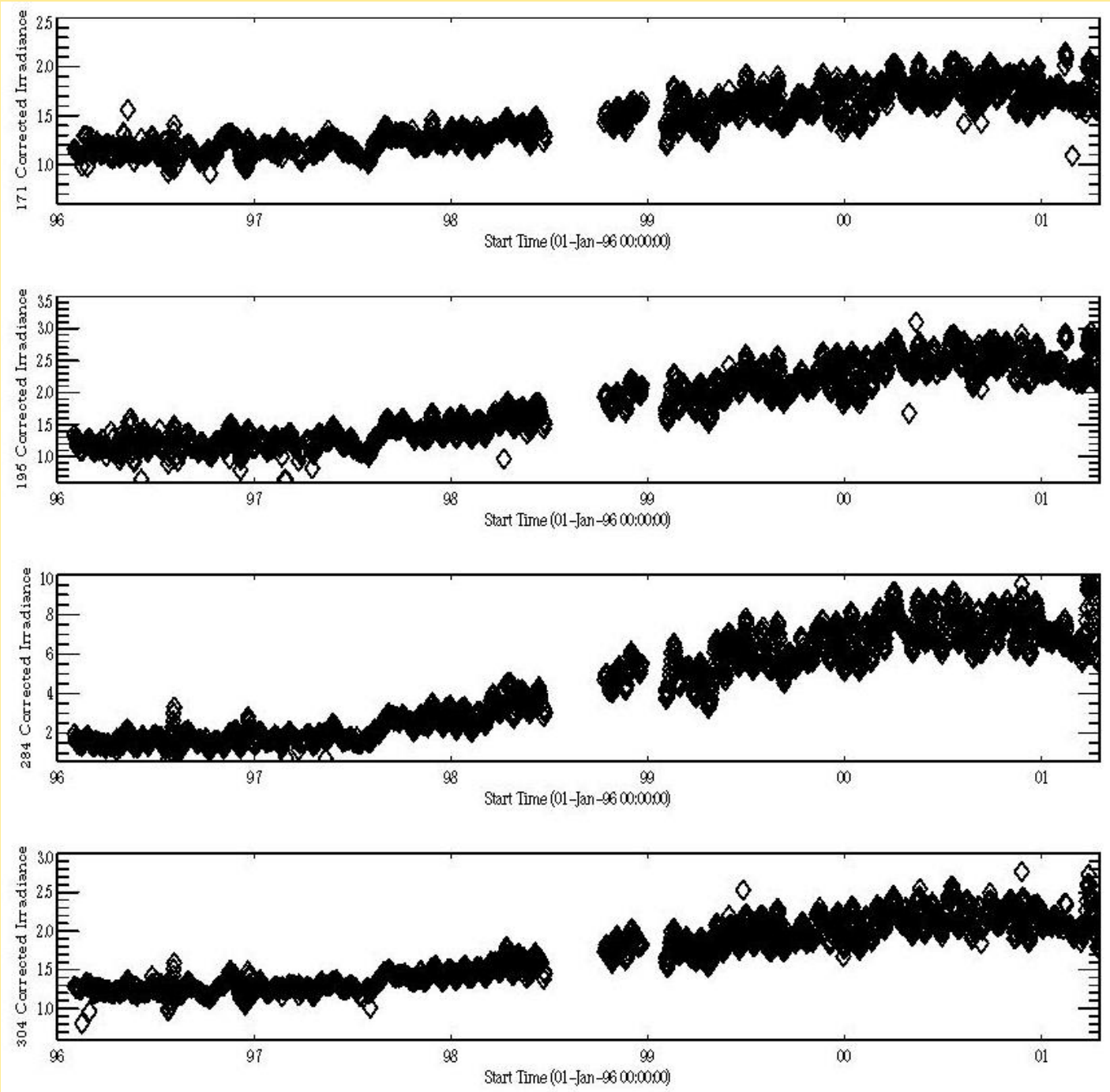
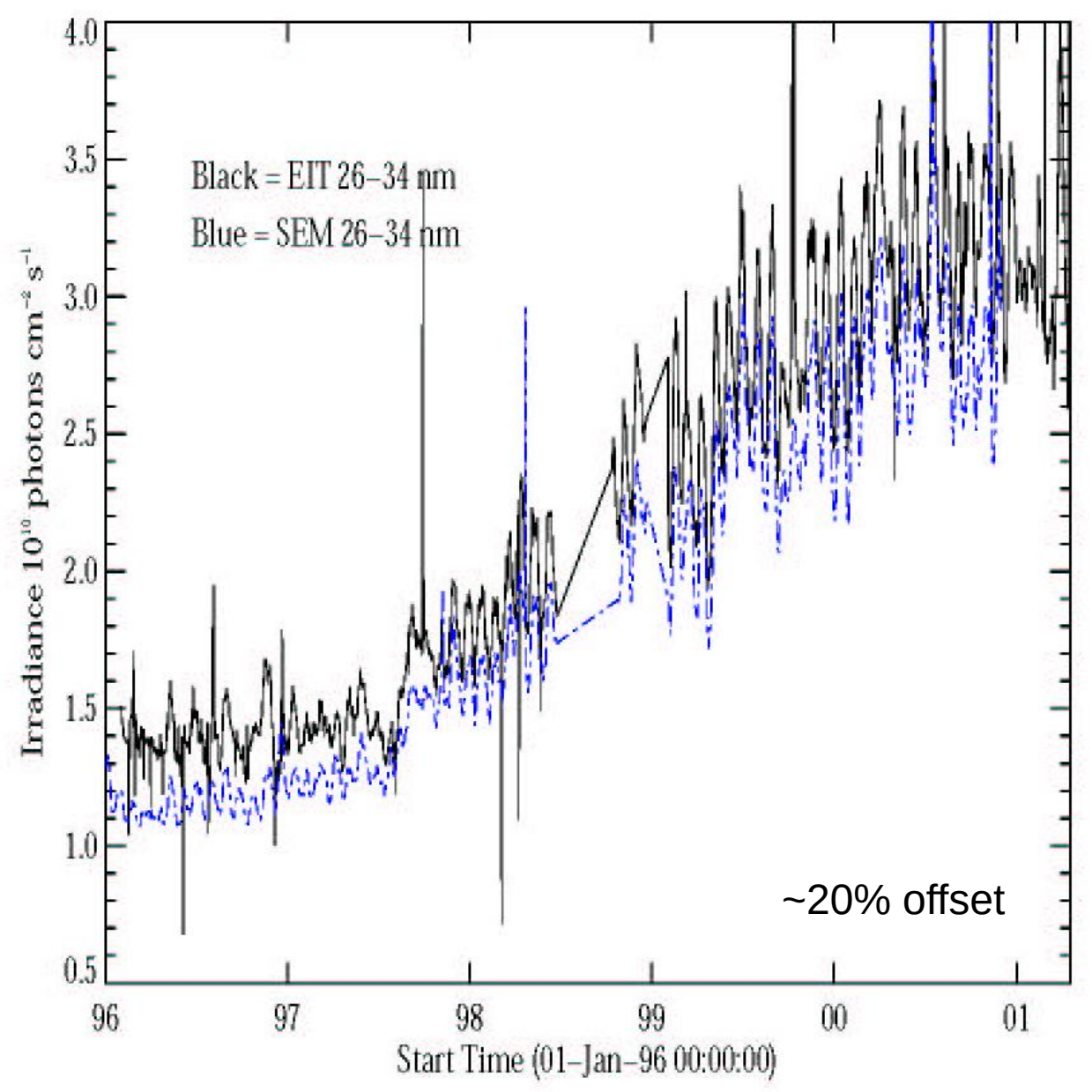
EIT response, normalized median disk value


171 Corrected Irradiance
2.5
2.0
1.5
1.0
96
97
98
99
00
01
Start Time (01-Jan-96 00:00:00)
195 Corrected Irradiance
3.5
3.0
2.5
2.0
1.5
1.0
96
97
98
99
00
01
Start Time (01-Jan-96 00:00:00)
284 Corrected Irradiance
10
8
6
4
2
96
97
98
99
00
01
Start Time (01-Jan-96 00:00:00)
304 Corrected Irradiance
3.0
2.5
2.0
1.5
1.0
96
97
98
99
00
01
Start Time (01-Jan-96 00:00:00)

Comparison EIT – SEM



Aluminum filters

1- Entrance filter 5 mm mesh grid
1500 Å Al / 700 Å Cellulose / 1500 Å Al

White light rejection, additional rejection of longer EUV wavelengths (e.g. 584 Å)
Pinholes during launch, extra pinholes in February 1998

2- Filter wheel 70lines/inch mesh

Pos 0	**Al+1**	1500 Å Al
Pos 1	Al+2	1500 Å Al / 700 Å Cellulose / 1500 Å Al
Pos 2	Block	East CCD bottom third blocked, bottom 1500 Å Al
Pos 3	**Clear**	Open no filter
Pos 4	Block	West CCD top third blocked, bottom 1500 Å Al

Redundancy !

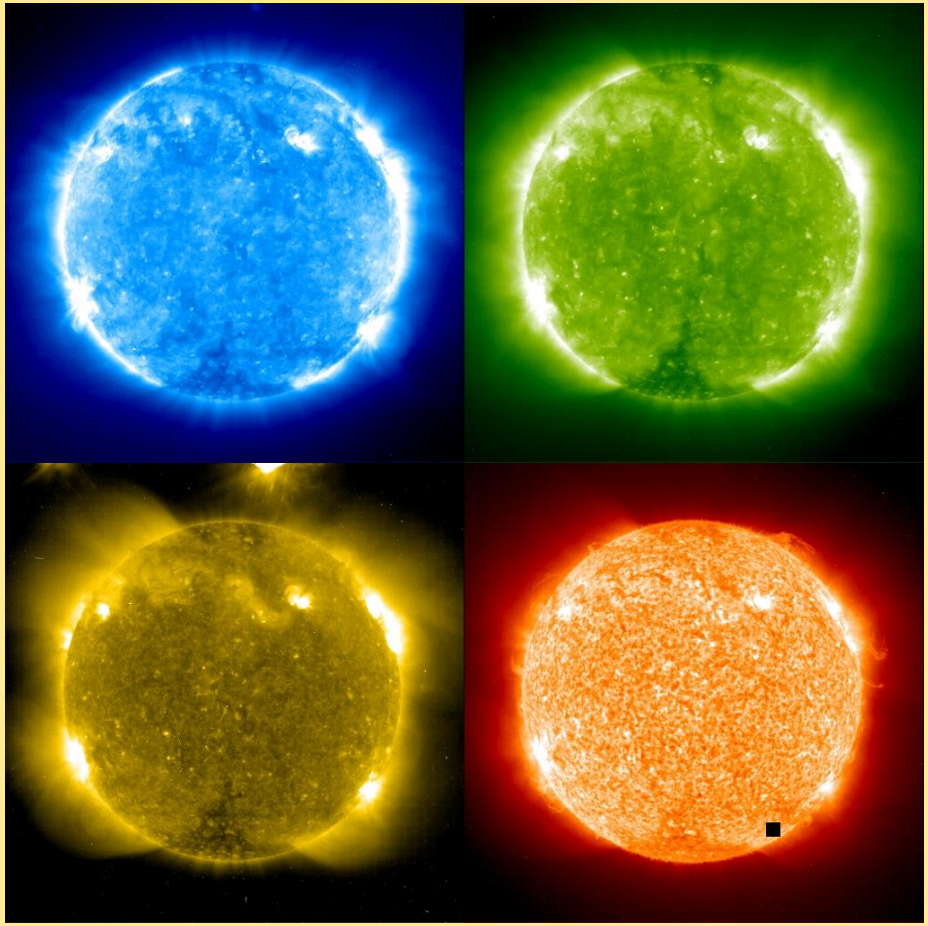
3- CCD stray light filter 70 lines/inch mesh
1500 Å Al

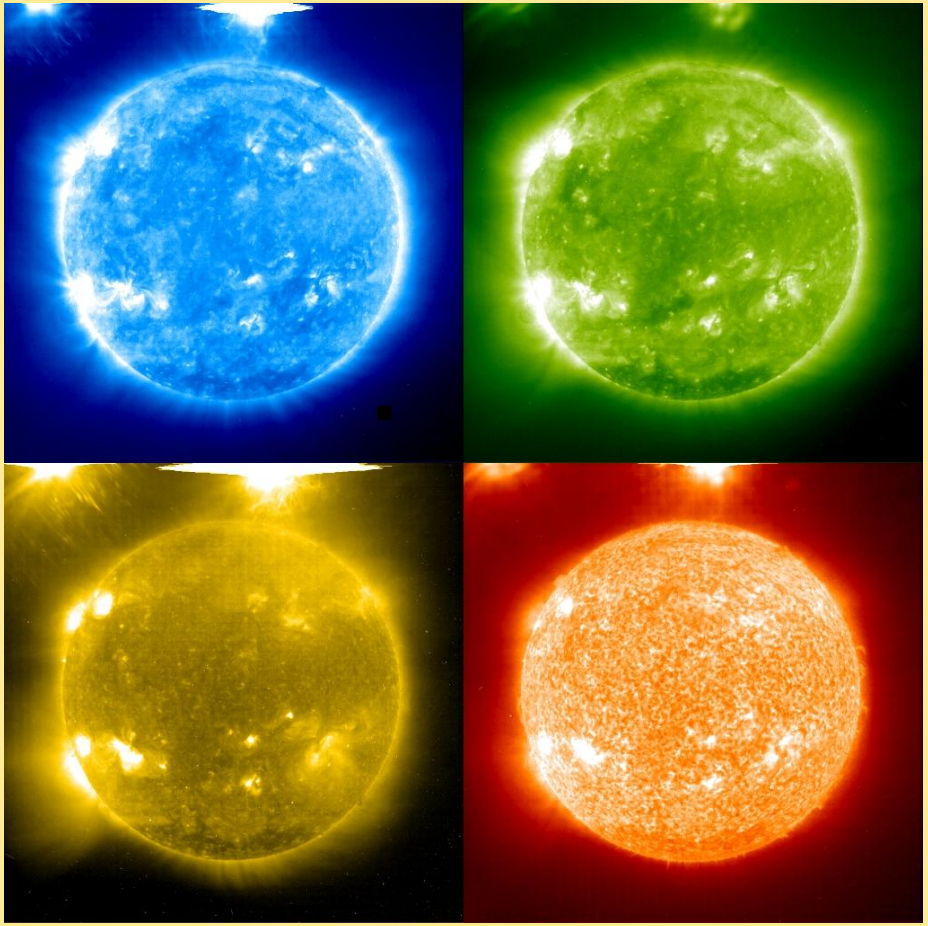
Redundancy !
Tear during launch

Visible Light Leaks

Before meterorite

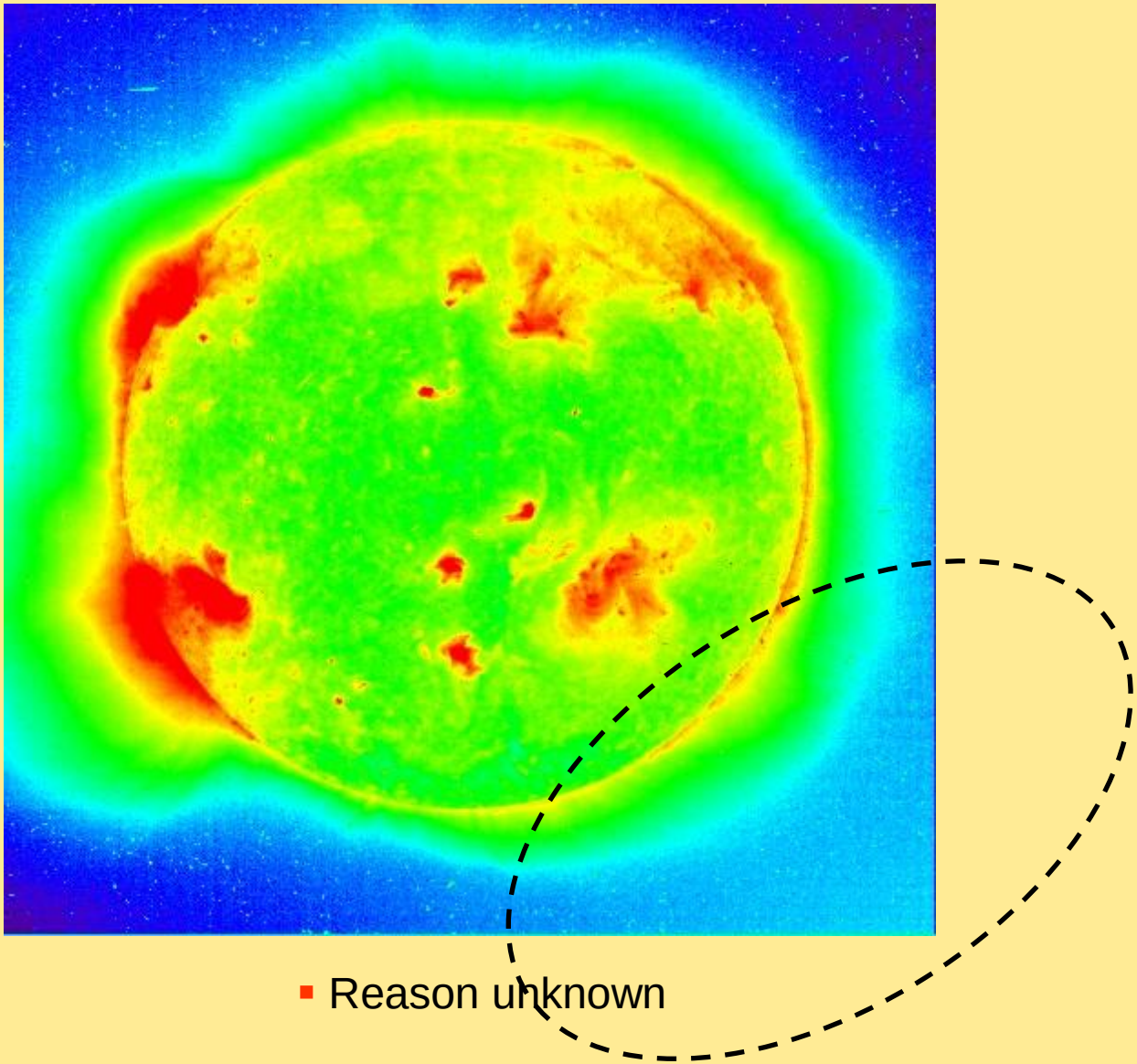
After meteorite





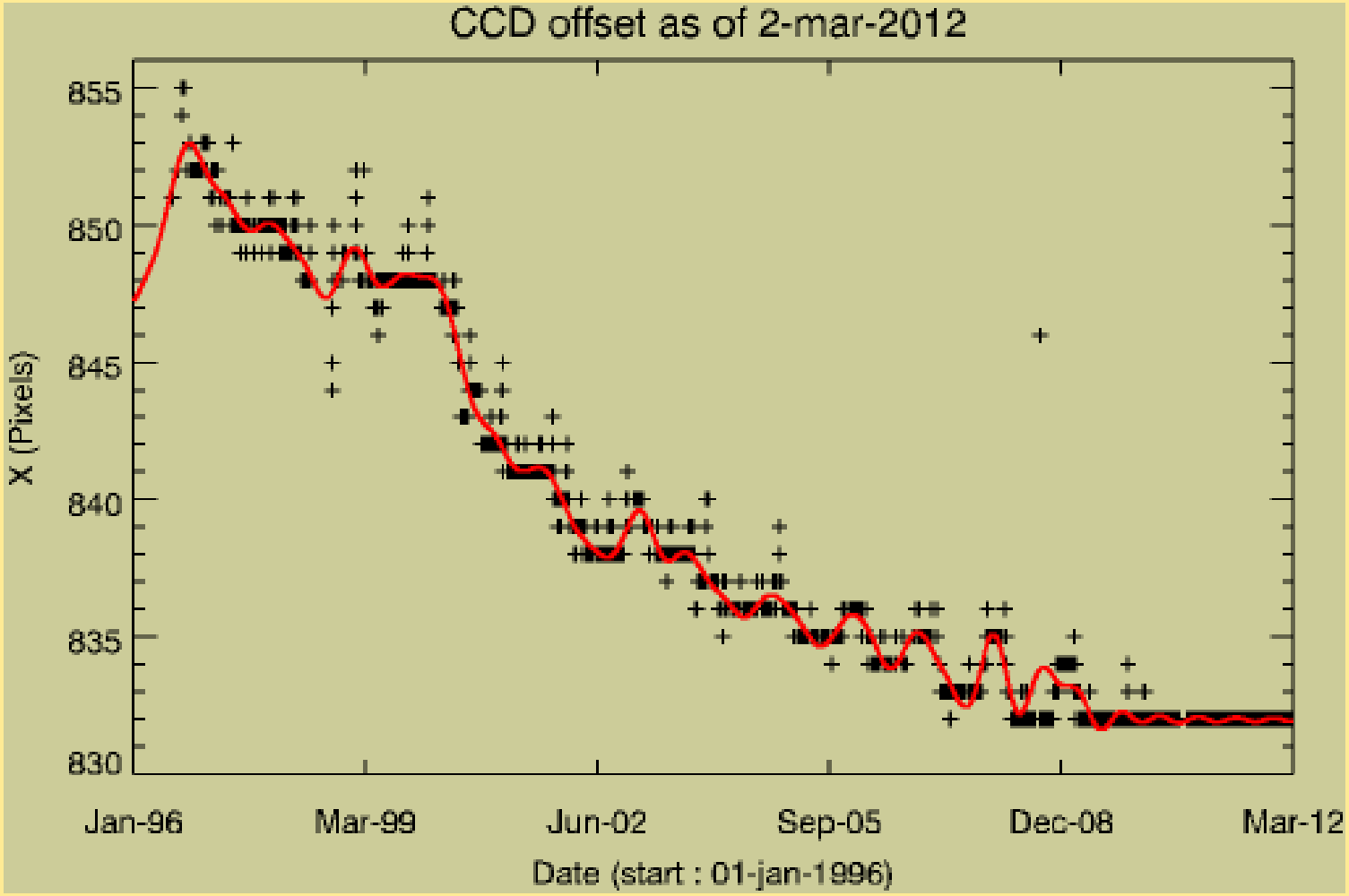
Filter wheel: Always Al+1 after February 1998 (two years in flight)

EUV Light Leak (?) at 284 Å



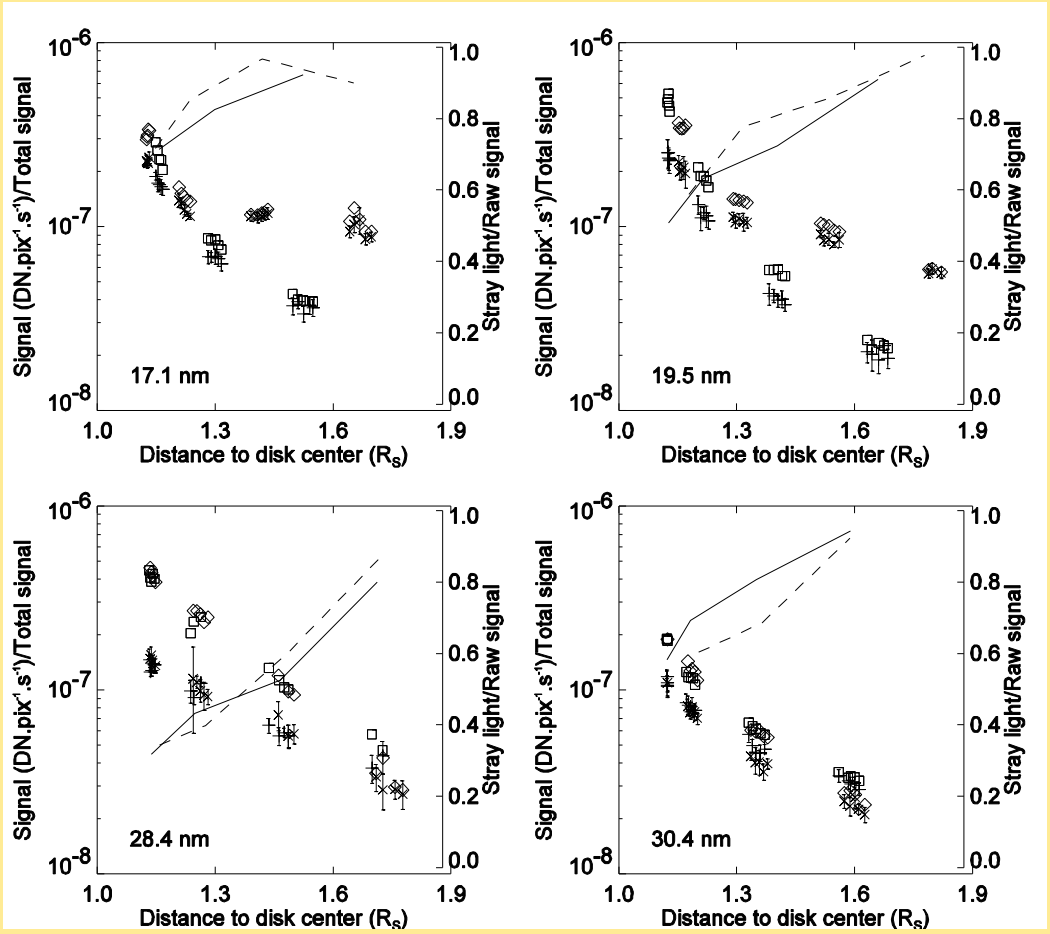
- Reason unknown

ADC offset



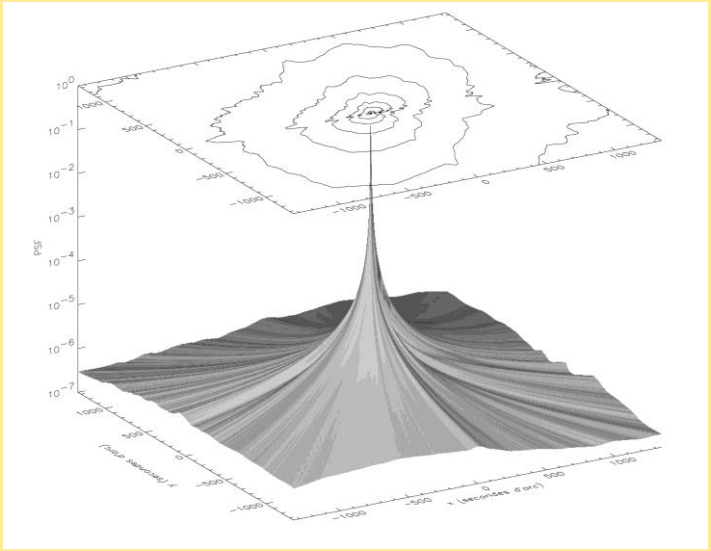
- Reason unknown

Stray-light



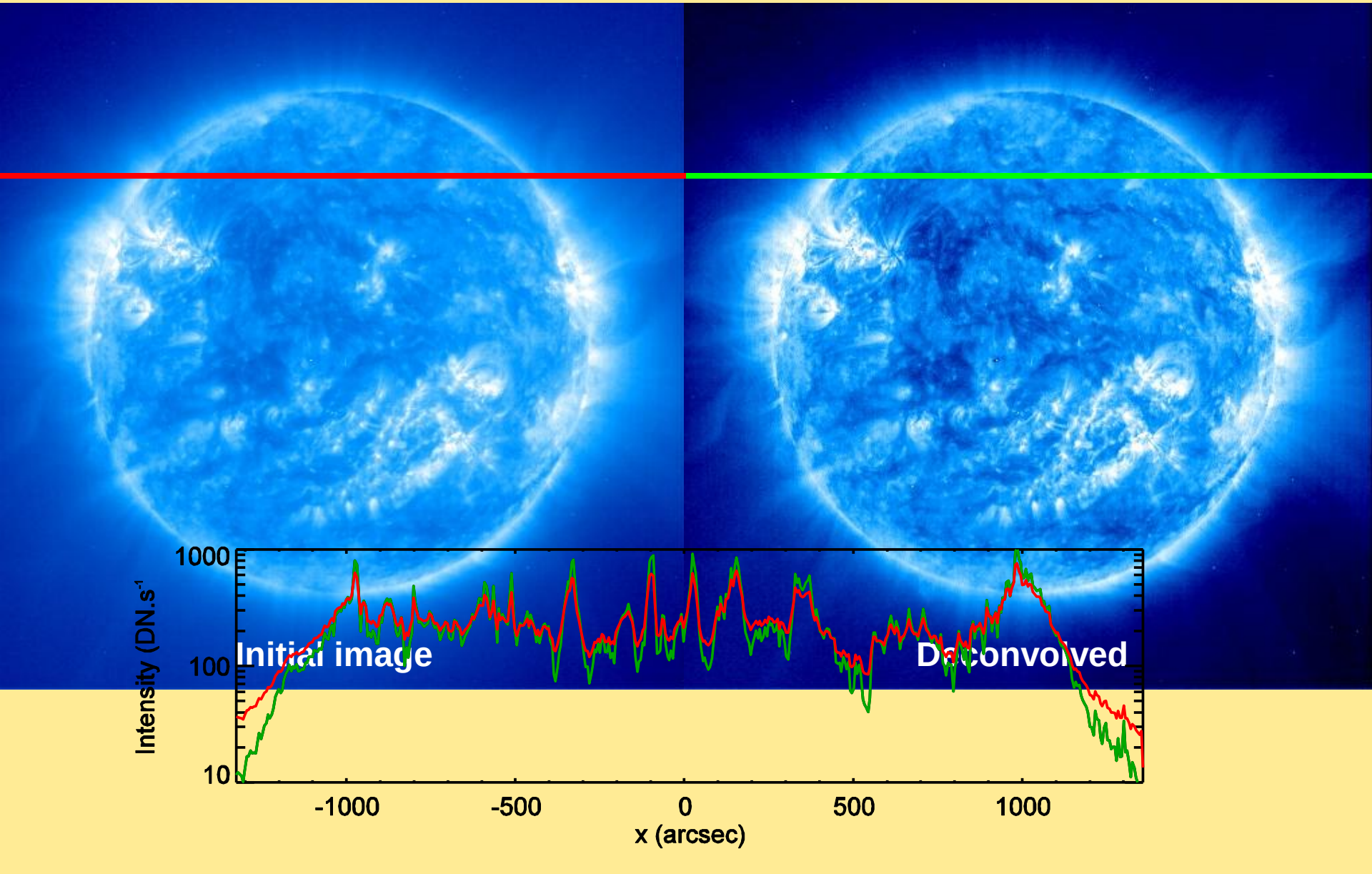
At 304 Å, the stray-light represents :

- 40% of the signal at 1.2 R
- 70% at 1.4 R
- 80% at 1.6 R



Stray-light correction

- Maximum likelihood Richardson-Lucy deconvolution algorithm



Lessons learned for EUV imagers

- No signs of changes in spectral selectivity over >16 years
- Need to be clean
- Need to design the instrument for outgasing
- Need to outgas
- Importance of the passivation layer of the detector (cf. CCE degradation)
- Importance of the on-board calibration source
  - Need a good reference image taken during commissioning
  - Need to know the relationship between VL and EUV degradations
- Usefulness of off-points and rolls
  - Flat field
  - Stray light
- Thin film filters are thin
  - Mechanisms are not evil
- Pre-flight calibration IS crucial
- In-flight calibration may be complex and potentially never ending
- Hope for the best, but prepare for the worst