SPIRIT/CORONAS-F experiment

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1. Description of the SPIRIT instrument

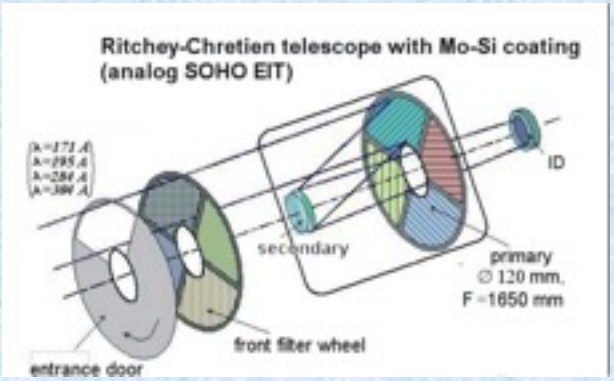
Spectral bands of the SPIRIT instrument and excitation temperatures of ions in solar plasma

Spectral band	Main ions	T, 10^6 K
8.418 - 8.423 Å	MgXII	10 - 20
177 – 207 Å	OIV, FeIX-XXIV, CaXIV-CaXVII	0,3 – 16
285 – 335 Å	HeII, SiXI, FeXV-FeXVI, MgVIII, NiXVII, CaXVII	0,05 – 5
171 Å	FeIX – FeX	1,3
175 Å	FeIX – FeXI	1,3
195 Å	FeXII	1,6
284 Å	FeXV	2
304 Å	HeII, SiXI	0,05
304 Å	HeII, SiXI	0,05 - 2

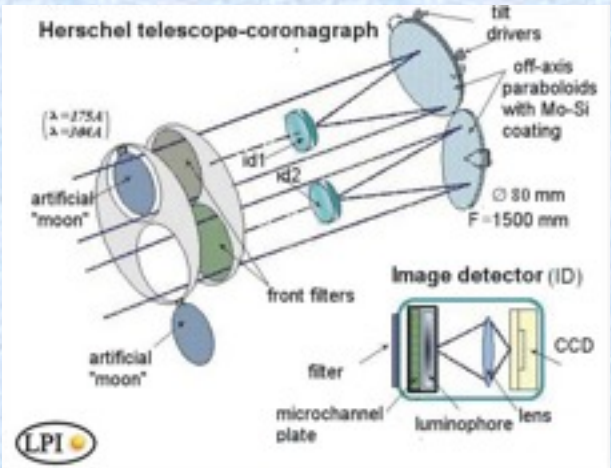
The instrument includes two units:

SRT-C telescope/coronagraph assembly:

Ritchey-Chretien telescope
with 171, 195, 284, 304 A bands
(multilayer optics is analogous
to the SOHO EIT telescope).
FOV 42', angular scale 2,4"/pix.

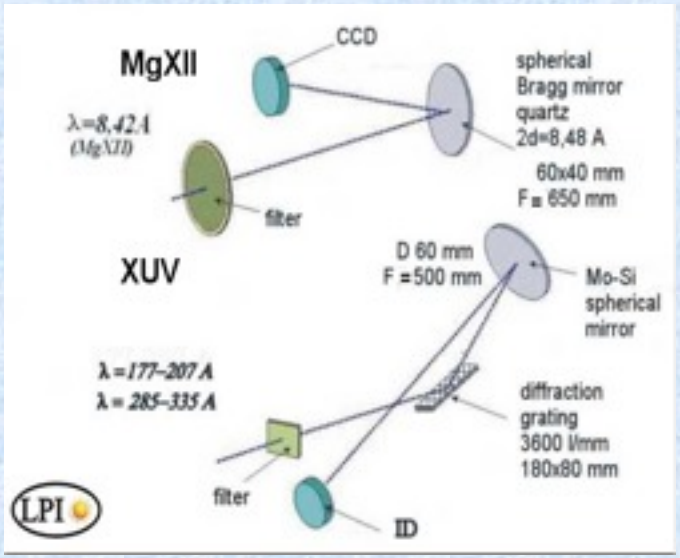


Herschel telescope-coronagraph
with 175, 304 A bands having off-axis
paraboloids with Mo-Si coating.
FOW 45', angular scale 2,6"/pix.
In the coronagraphic mode the instant
FOV 45" at 2-5 R_{sun}.



RES-C spectroheliograph assembly

Two MgXII full Sun bragg crystal spectroheliographs (λ = 8,418-8,423 A) with orthogonal dispersion planes. FOV 1,3^0, angular scale 4,1”/pix, spectral resolution 3.10^{-3}A.



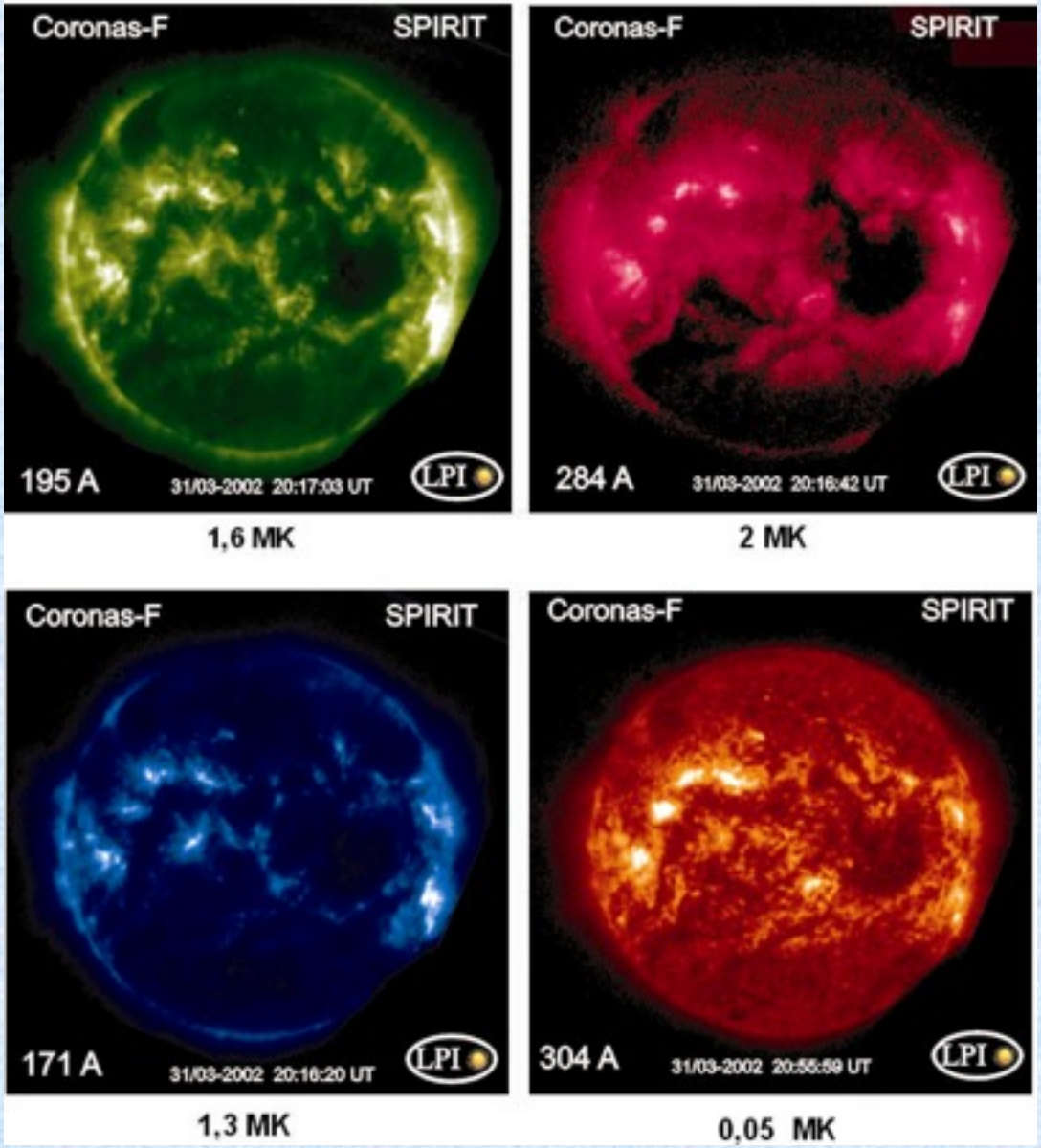
Two XUV diffraction grating slitless spectroheliographs, each gives full Sun spectral images in two selectable spectral bands 177-207A and 285 – 335 A.
Angular scale 6”x1’/pix, spectral resolution 0.03A/pix.

Electronics

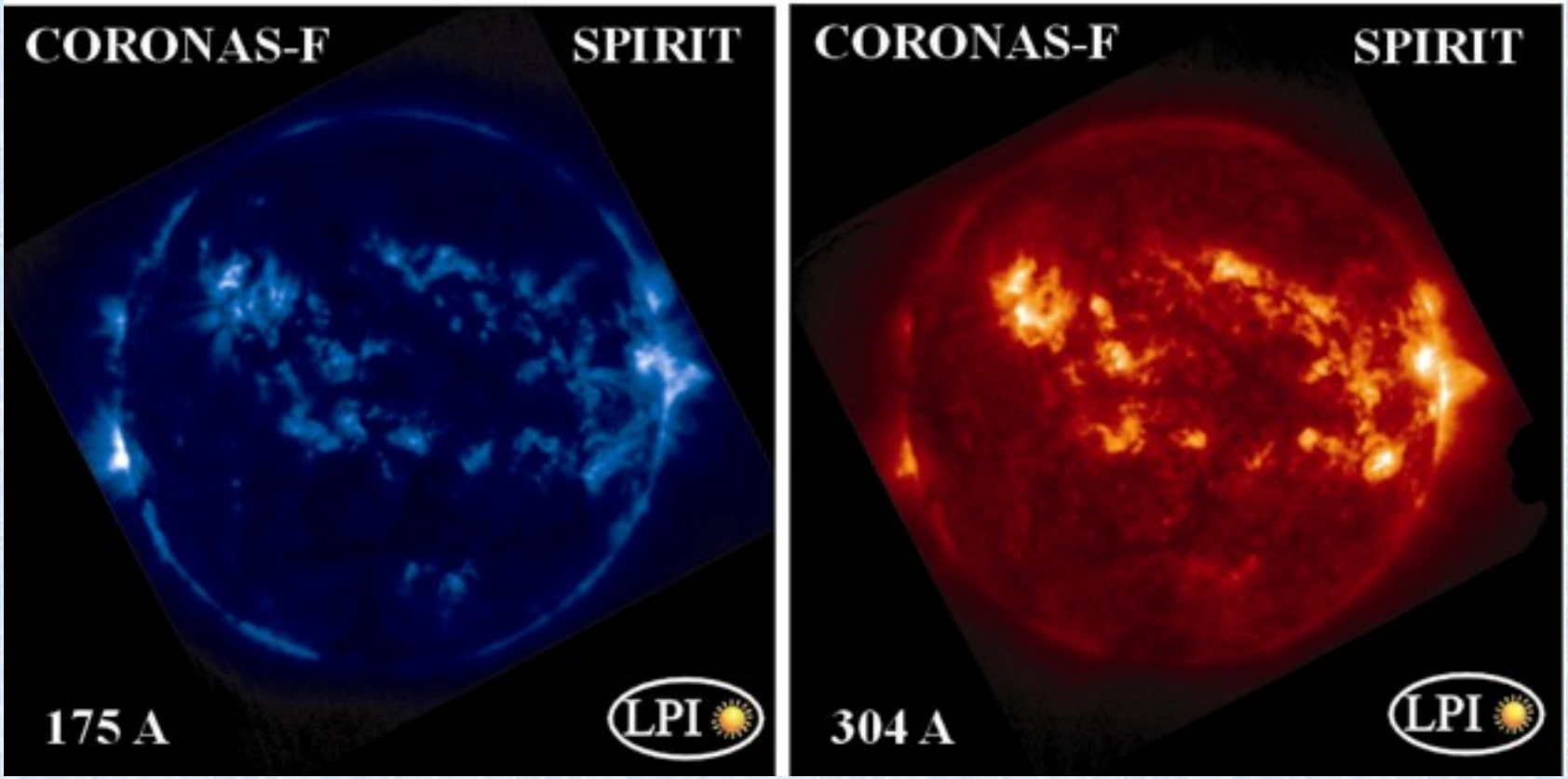
Two independent units, each doubled for redundancy

- Each unit includes 100 MOPS DSP CPU with 32 MB data buffer, 64 KB RAM, 4 KB NVRAM, 8KB ROM;
- data are going in two independent flows, so images in two different channels may be acquised at the same time;
- observing sequences may be run by pre-programmed commands or by uploaded command files;
- allows to upload on-board processing software;
- compression of images by the Huffmann lossless algorithm, binning 2x2
- readout time for 1 image 1024x1152 – 2,5 s, exposure times from 0.01 to 600 s, delays from 0.1s to 60 min.

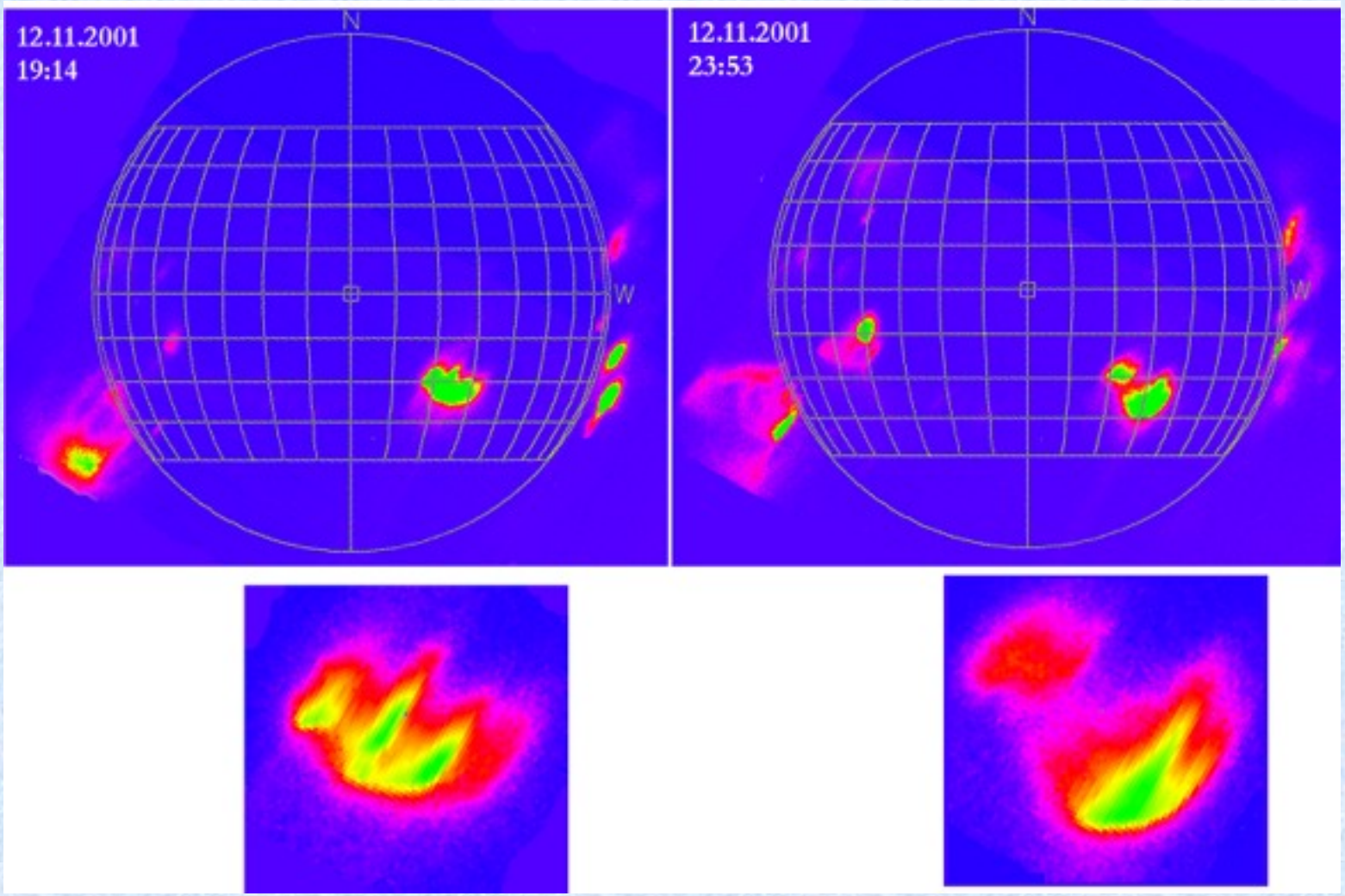
XUV solar images in 171, 195, 284 and 304 A spectral bands of the SPIRIT Ritchey-Chretien telescope

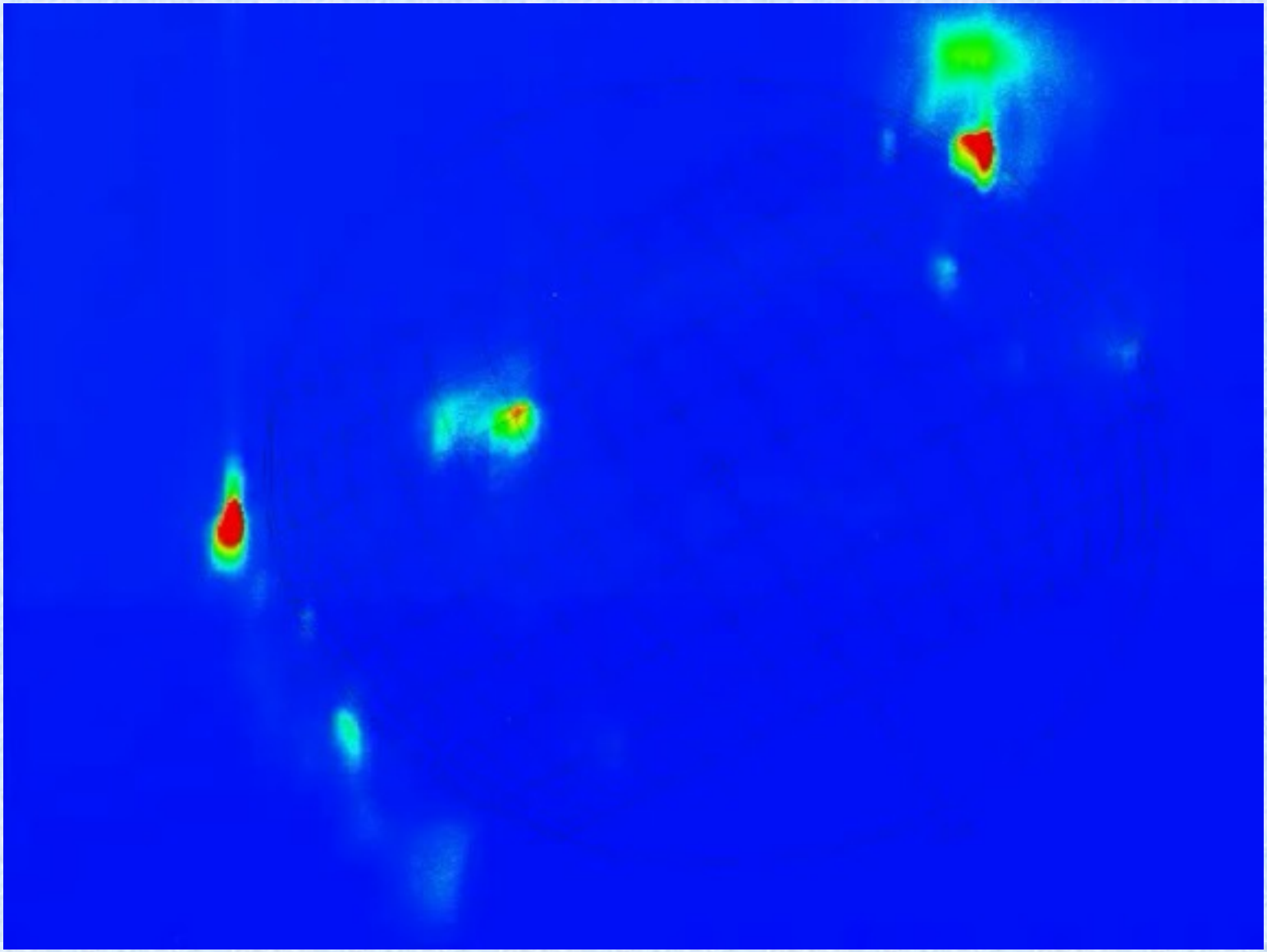


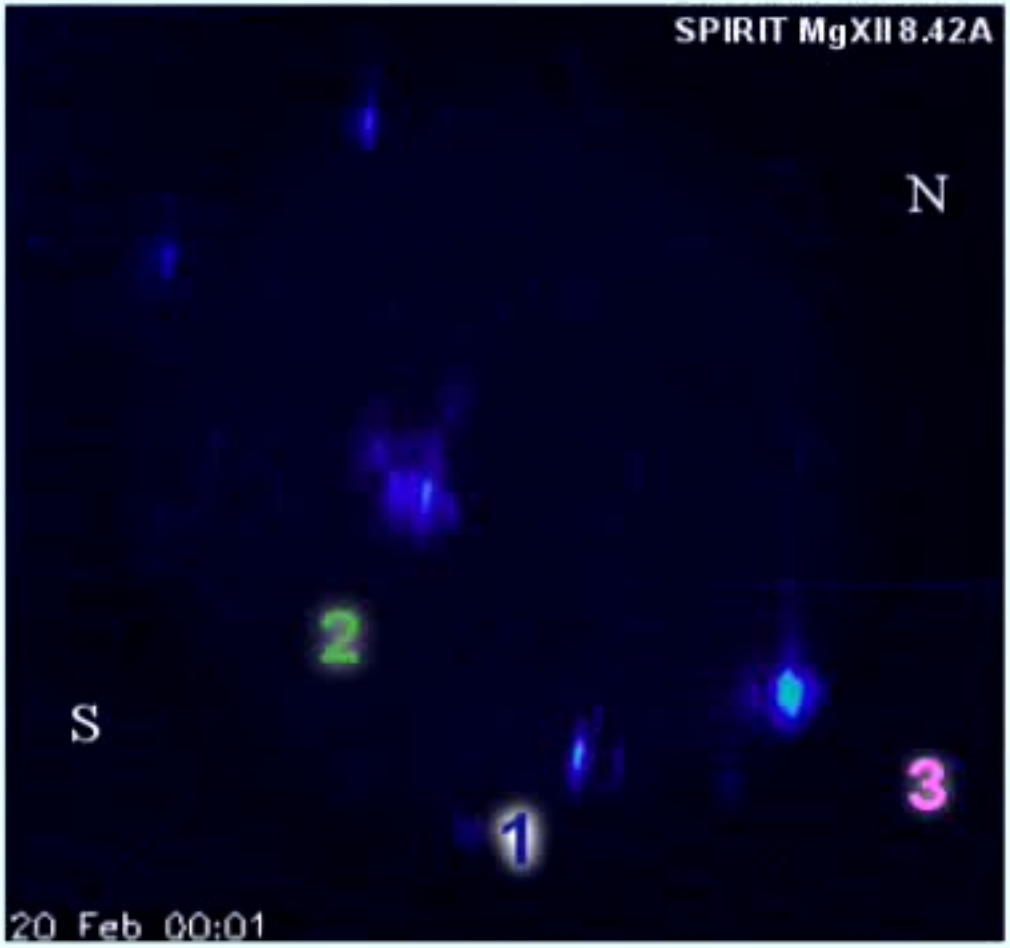
A pair of simultaneous solar images in 175 and 304 A obtained by the SPIRIT Herschel telescope on 03/01-2002 at 02:54 UT

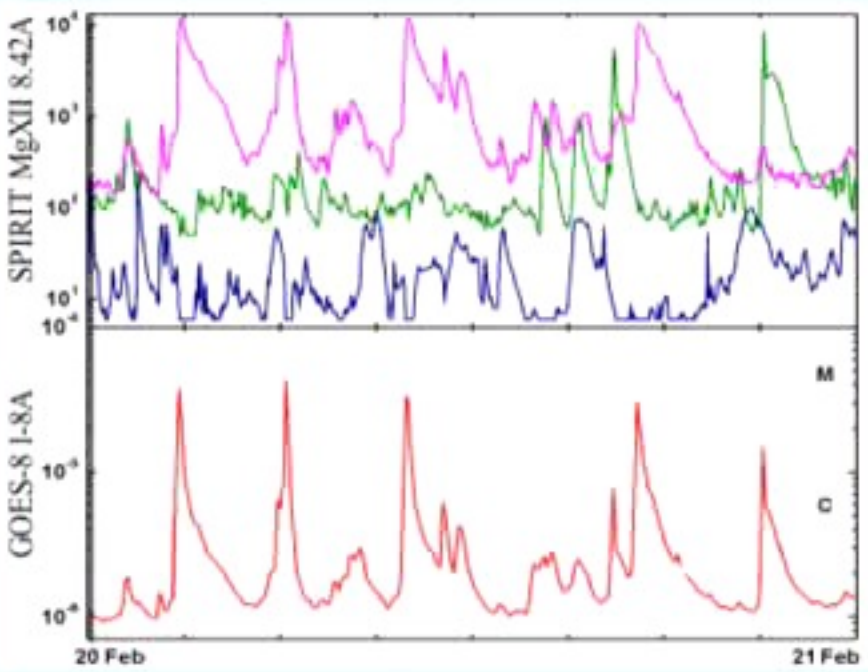


Full-Sun images in MgXII 8,43 A line (T~ 10MK)

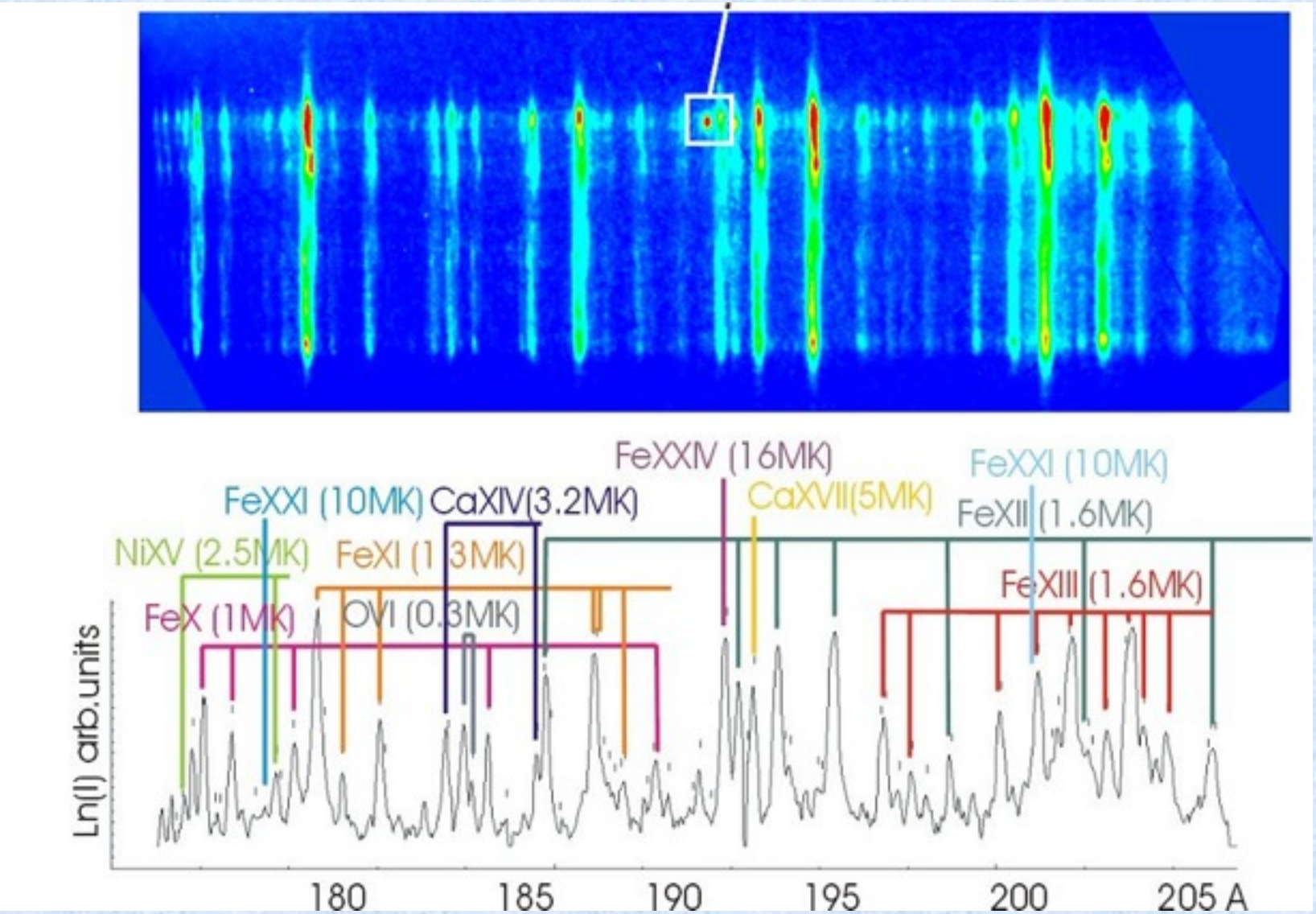




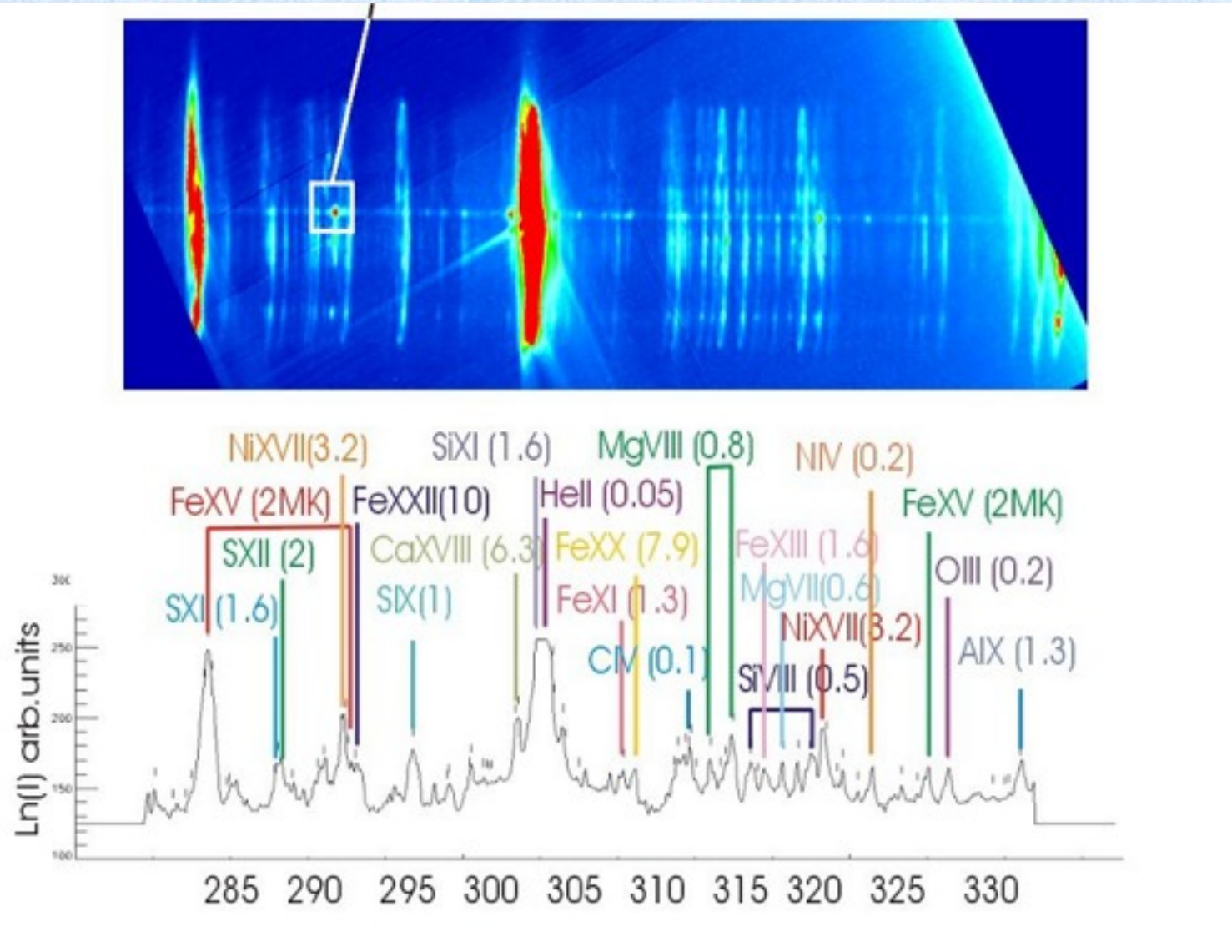

SPIRIT MgXII 8.42A
N
S
2
1
3
20 Feb 00:01


SPIRIT MgXII 8.42A
GOES-8 1-8A
M
C
20 Feb
21 Feb

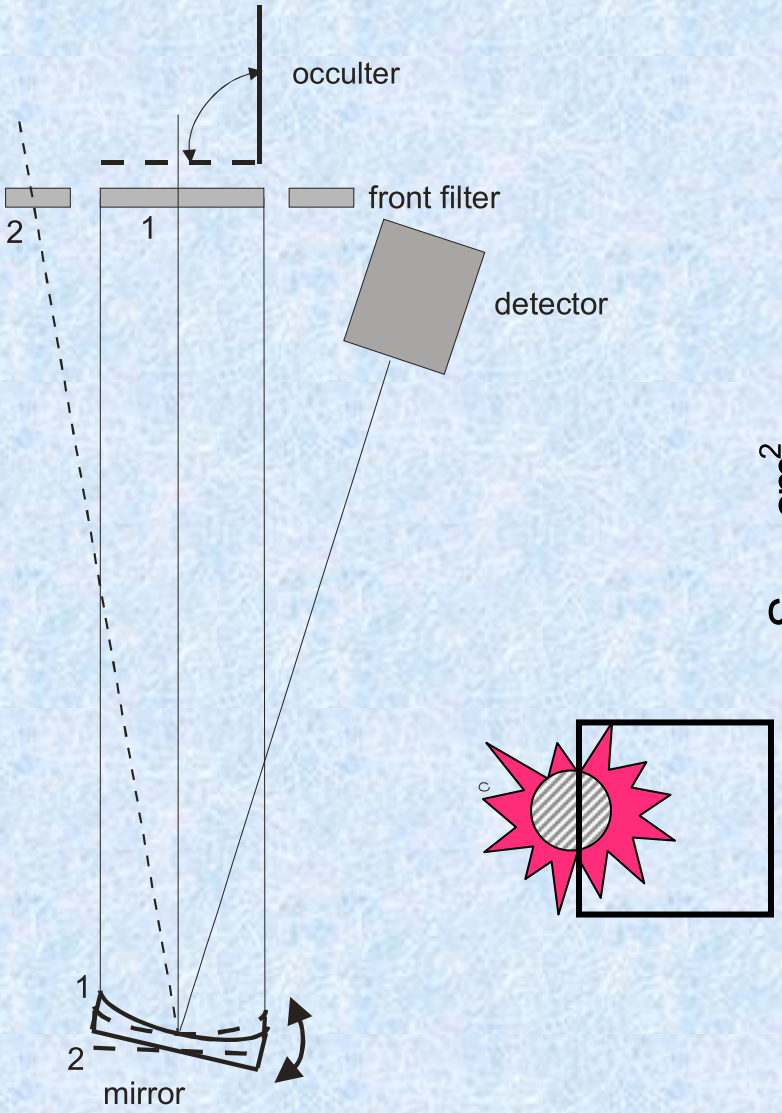
XUV spectroheliometer: 177-210A band

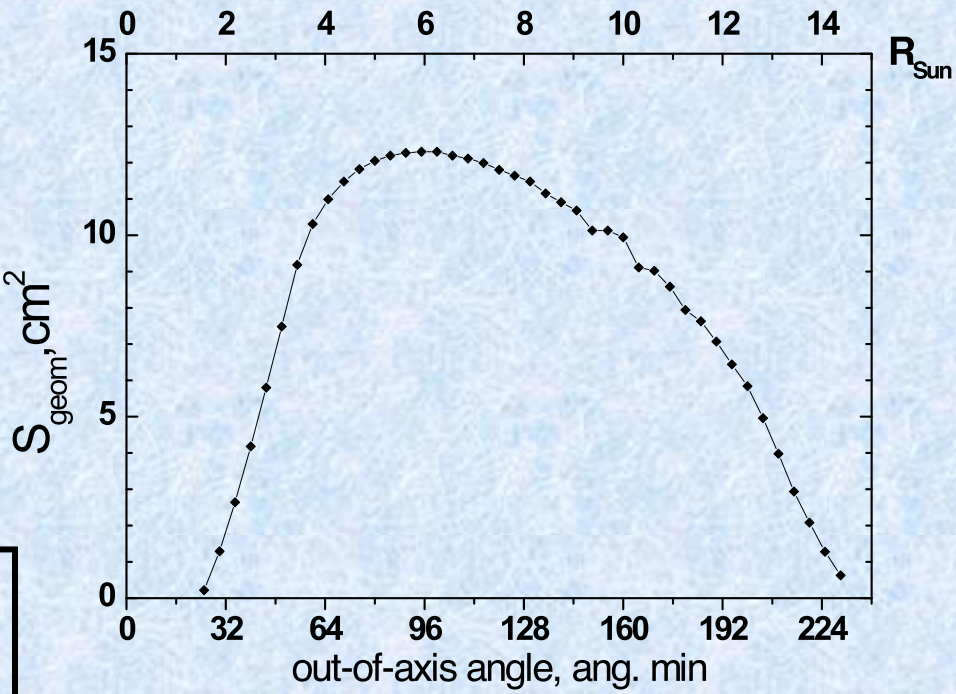


XUV spectroheliometer: 177-210A



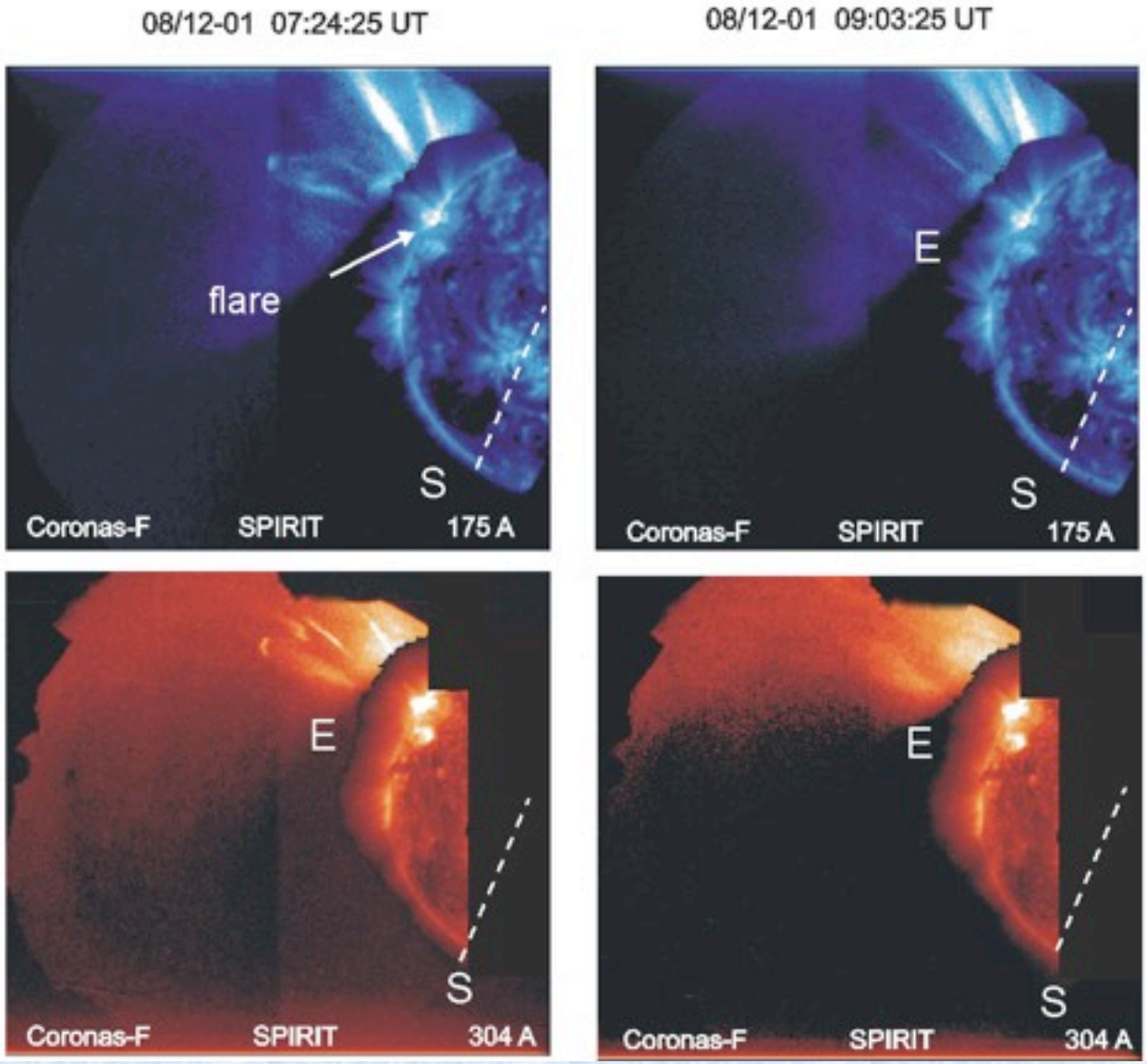
Observations of solar EUV-corona by the Herschel telescope in the coronagraphic mode





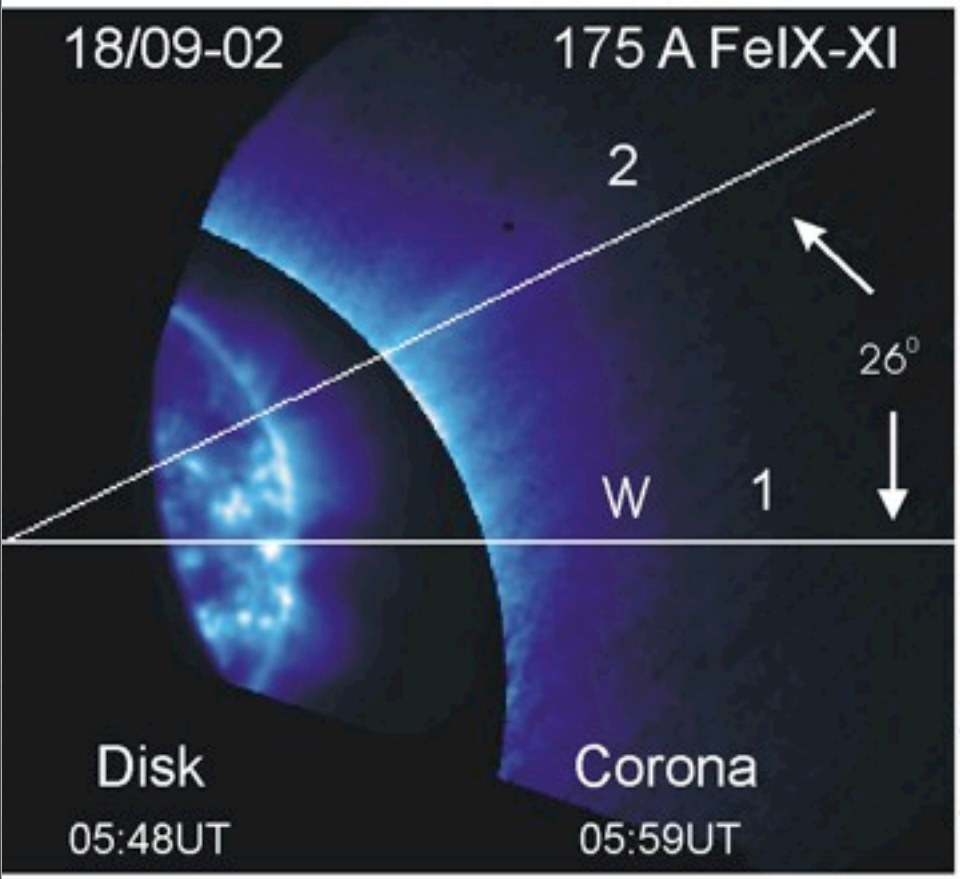
Vignetting function

XUV-corona after flare (GOES M3, 08/12-01, 06:02-06:55 UT)
SPIRIT Herschel telescope/coronagraph

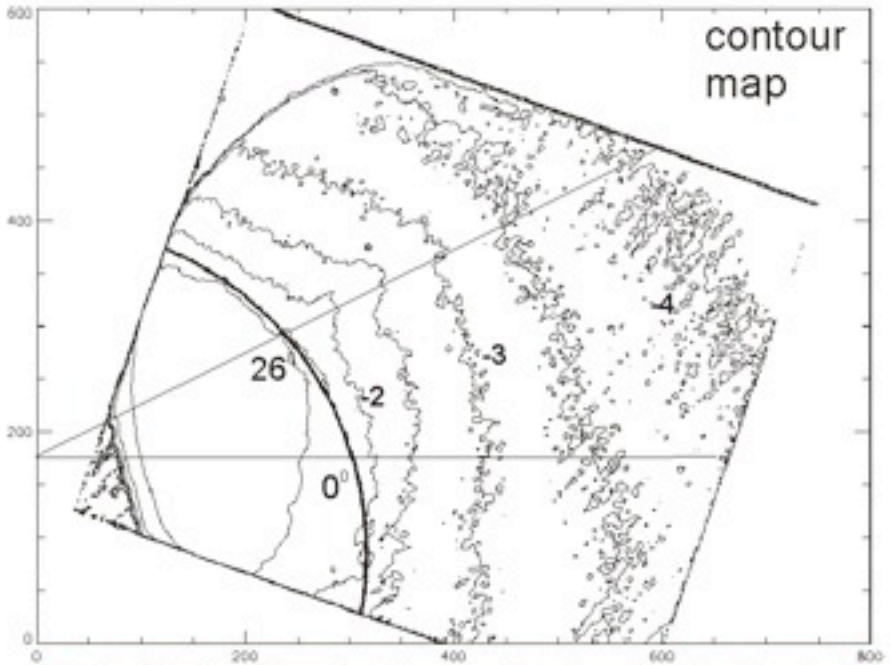


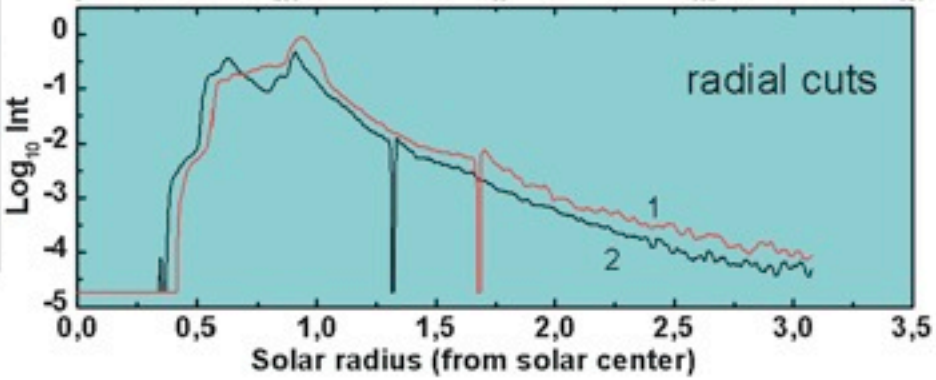
Observation of solar XUV corona up to $3R_{sun}$ by the Herschel telescope/coronagaph

A. 175 A band



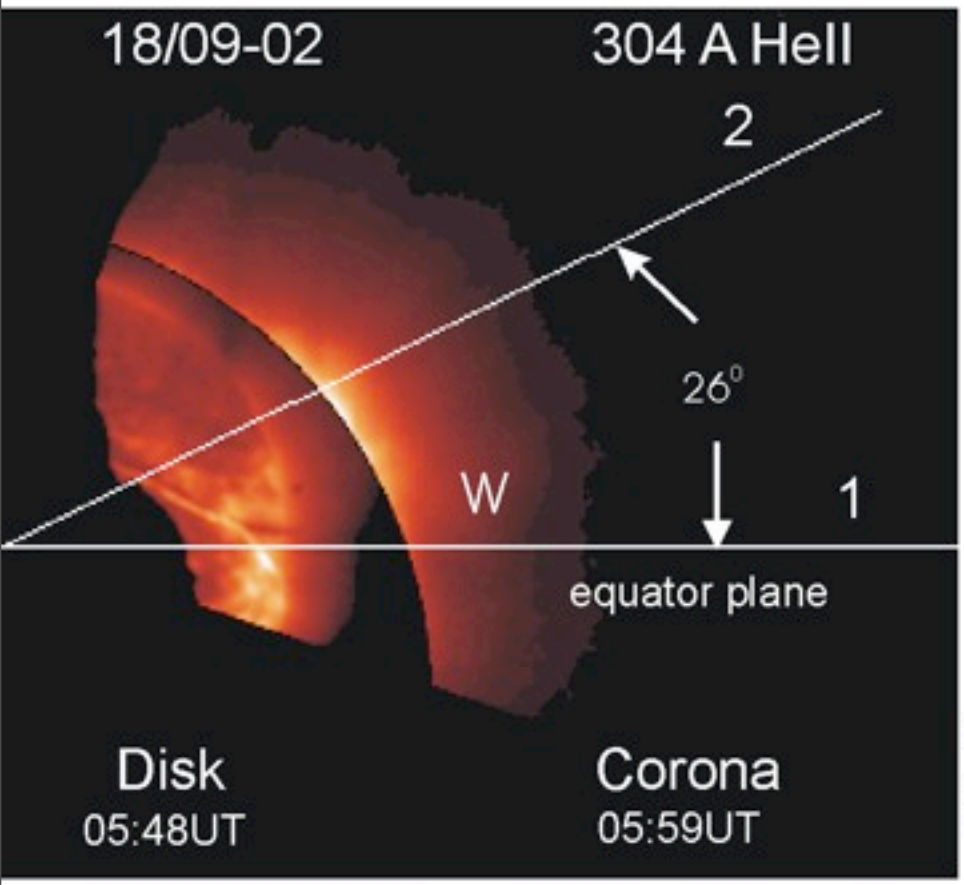
Superimposed images of the disk ("moon" open) and the corona ("moon" closed)



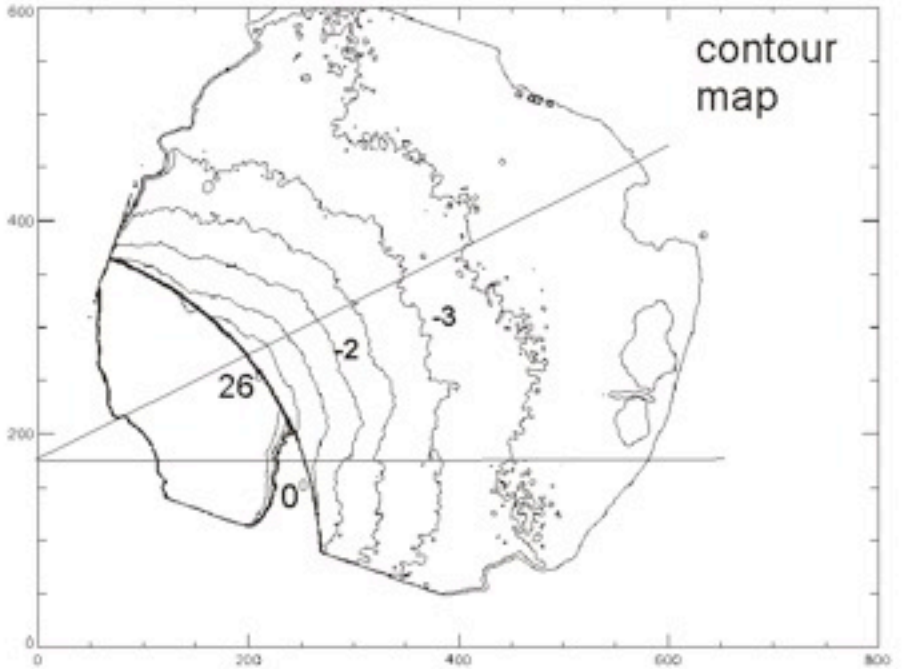


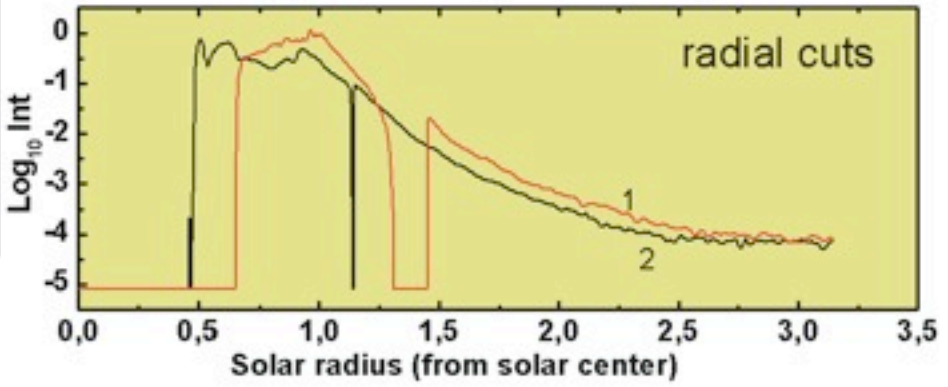
Observation of solar XUV corona up to $3R_{sun}$ by the Herschel telescope/coronagaph

B. 304 A band



Superimposed images of the disk ("moon" open) and the corona ("moon" closed)





Summary: the main parameters of SPIRIT for solar observations

Simultaneous full-Sun multi-wavelength imaging in 4 of 7 spectral bands from 8.42 to 335 A (T=0.05 – 10 MK);

Real temporal resolution up to 5 s (telescope), 7s (spectroheliometer);

Flexible control – the observing program may be changed up to twice in a day by sending on-board control files;

On-board processing (monitoring of flares)

2. **Observations on-board CORONAS-F**

The CORONAS-F satellite (launched on July 31, 2001)

Orbit – near circular, init. Alt. ~ 500 km,
now is 430 km

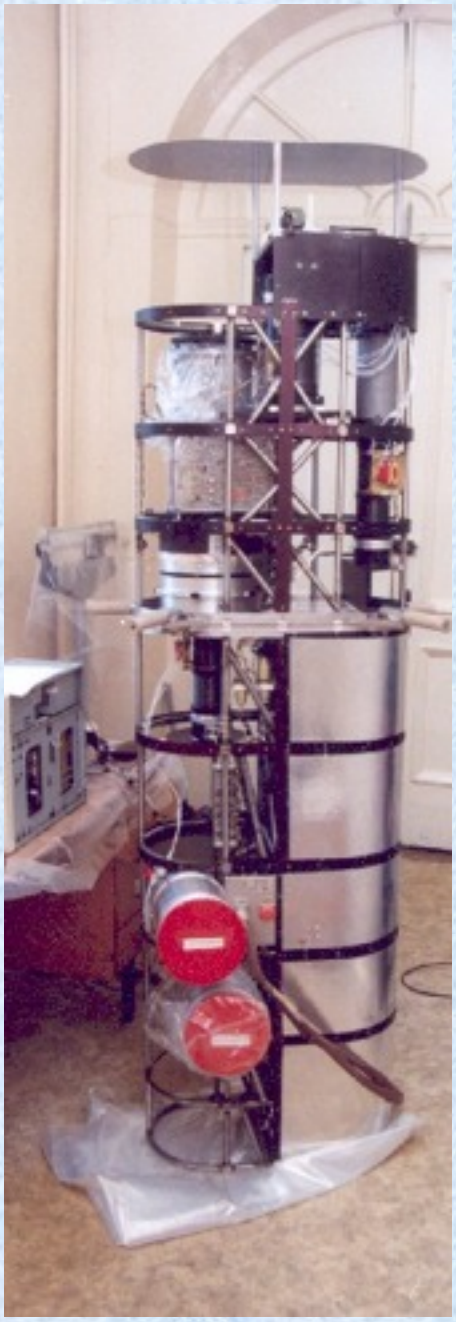
Inclination – $83{,}5^0$

Period – initial 94,5 min, now ~ 93 min

Pointing – 2-axis (slow rotating around solar axis)

Drift < 2’ with velocity ~ 0,1 “/sec

Scientific payload – 560 kg



Observing conditions and limitations

Orbit with occultation.

Illuminated part - 45 min of 93 min.

Other parts of the orbit are not usable because of occultation or atmospheric absorption

Each 3 months there are 2-3 week periods without occultation (or with partial occultation).

Satellite roll angle must be restored (Star cameras are used)

Telemetry volume

only one receiving ground station DLR, Germany

2 dumps a day, a total SPIRIT volume is up to 90 Mbytes/day (100-400 full format images).

Observing programs in 2001-2003

Synoptic observations

in 171-195-284-304A - 4 times a day,
from July 2002 – at 4, 10, 16, 22^h (between EIT)

full Sun , 1024x1024 or 512x512.

in 175/304 A – each orbit with a cadence of
15-30 min – 512x576.

in MgXII – each orbit with a cadence of 0,5-15 min
(full Sun or box)

High cadence campaigns (with EIT shutterless, other SOHO devices and TRACE) Box 12'x12',1x1

4 campaigns #8-11, Oct 02-June 03 (see http://sol.oma.be)
MEDOC campaign of Oct-Nov 2002

Observations of EUV-corona

typical during one-two weeks each 3 months with a cadence of 30 min. 512x512

Flare monitoring in Mg XII

~50 runs, needs a lot of TM and commands

CME watch in 175A (during SOHO keyholes)

Sept 22 – Oct 11 2003. 512x576

3. SPIRIT data format and processing

Data processing levels

Row data – fits-files (some differences from EIT)

SH171_031026_163641.fits, SR304_031020_162008.fits,

SMg1_031025_175213.fits, SV190_031025_045234.fits

Level 1 processed data

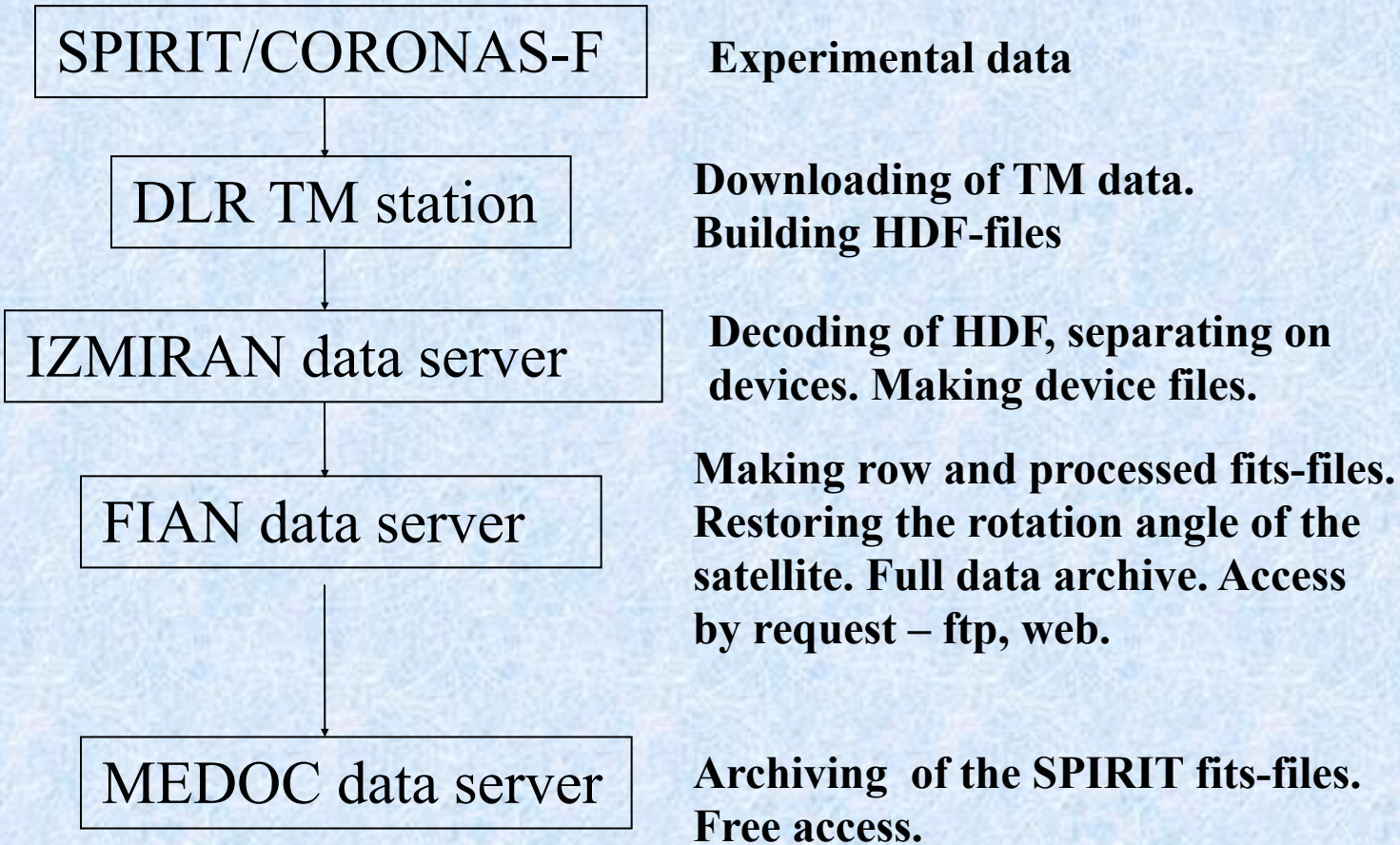
SAR175_031023_193022.fits – bgr illuminated, rotated to solar axes, centered by aligning to reference file

SXH304_031026_163621.fits, the same, but individually centered

Processing software

Equivalent to EIT_prep software. Now exists only at the Lebedev Institute, soon will be transmitted to MEDOC.

Intercalibration with EIT - will be soon

4. Access to the SPIRIT data

SPIRIT data flow