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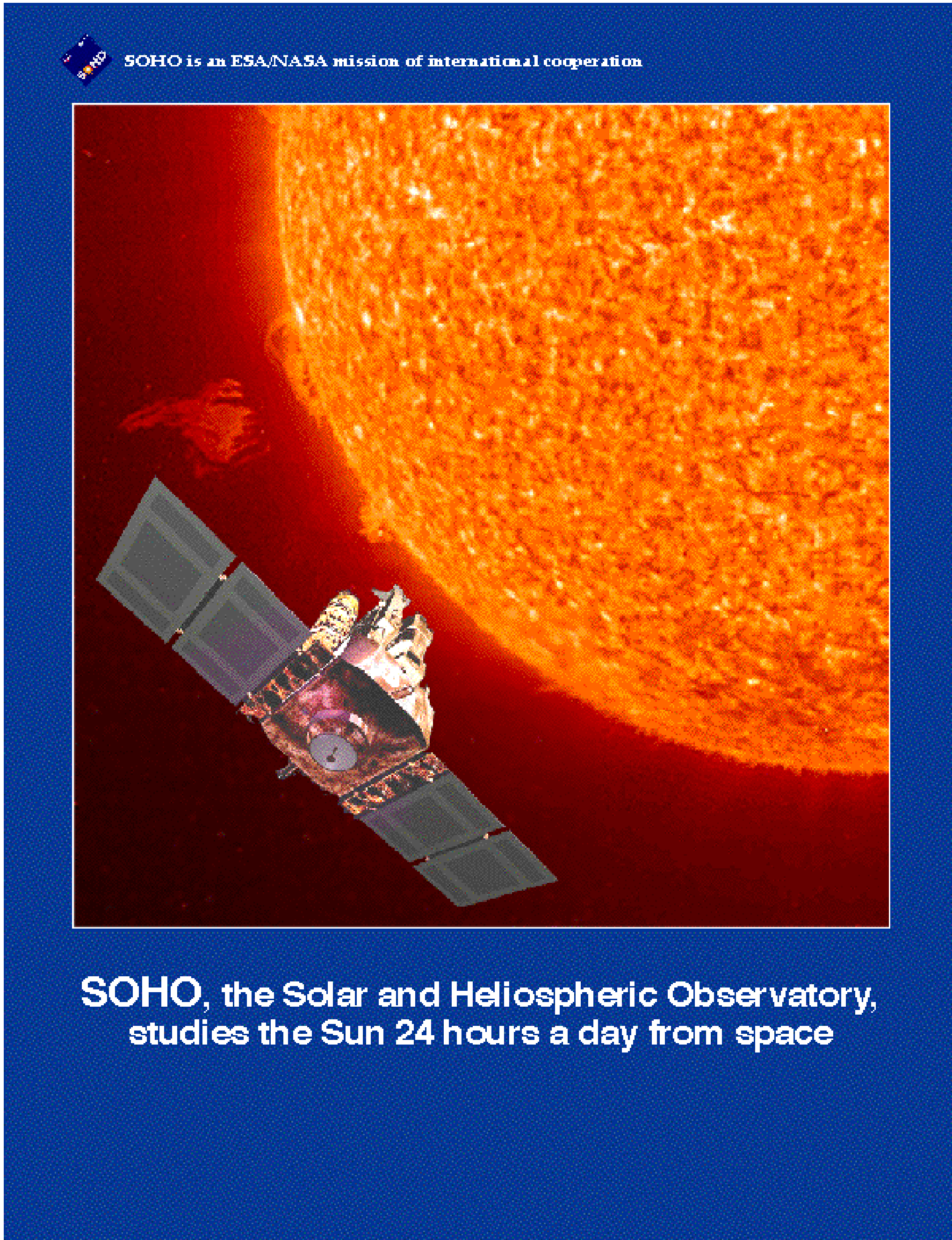
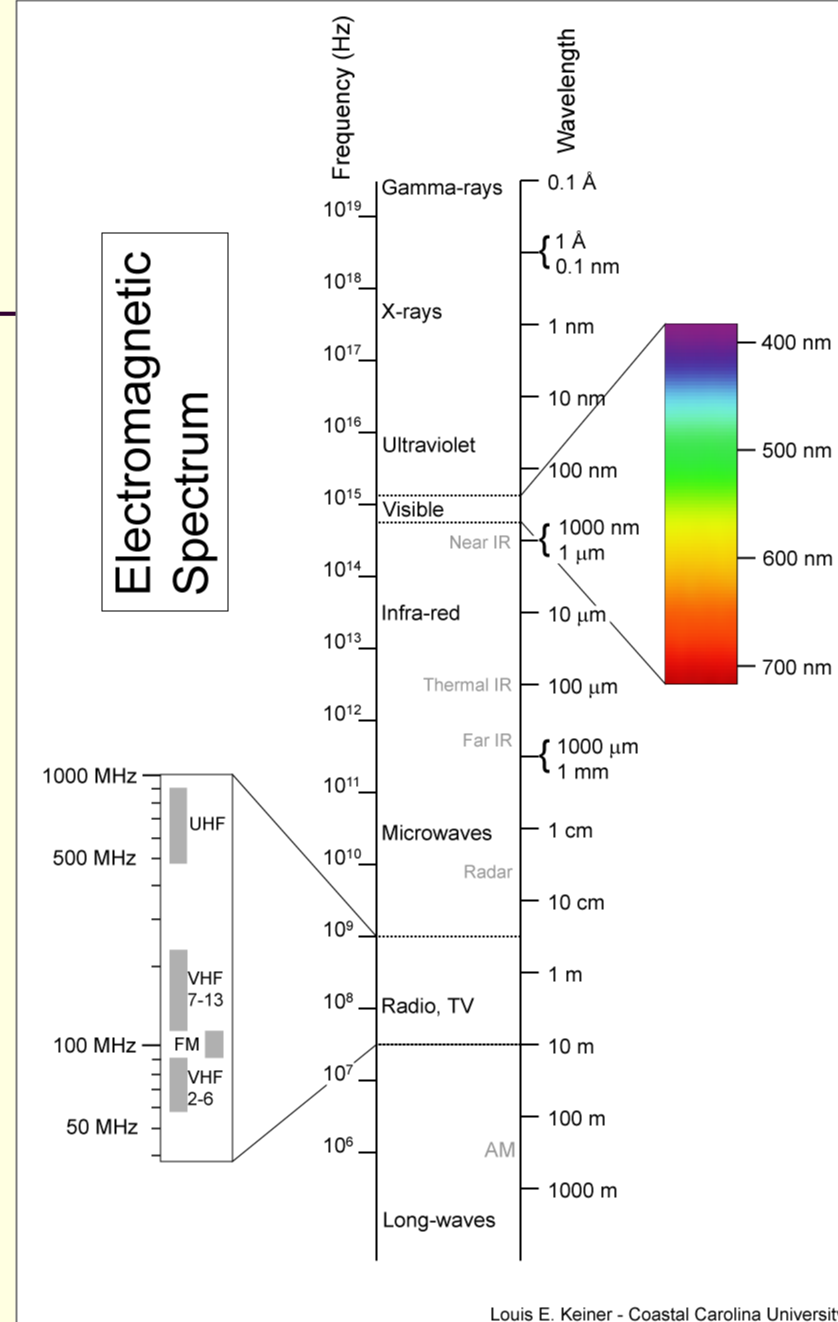
SOHO/SUMER – Results and Lessons learned

EUI Consortium Meeting, Brussels, 26 Apr 2016





Why from space?

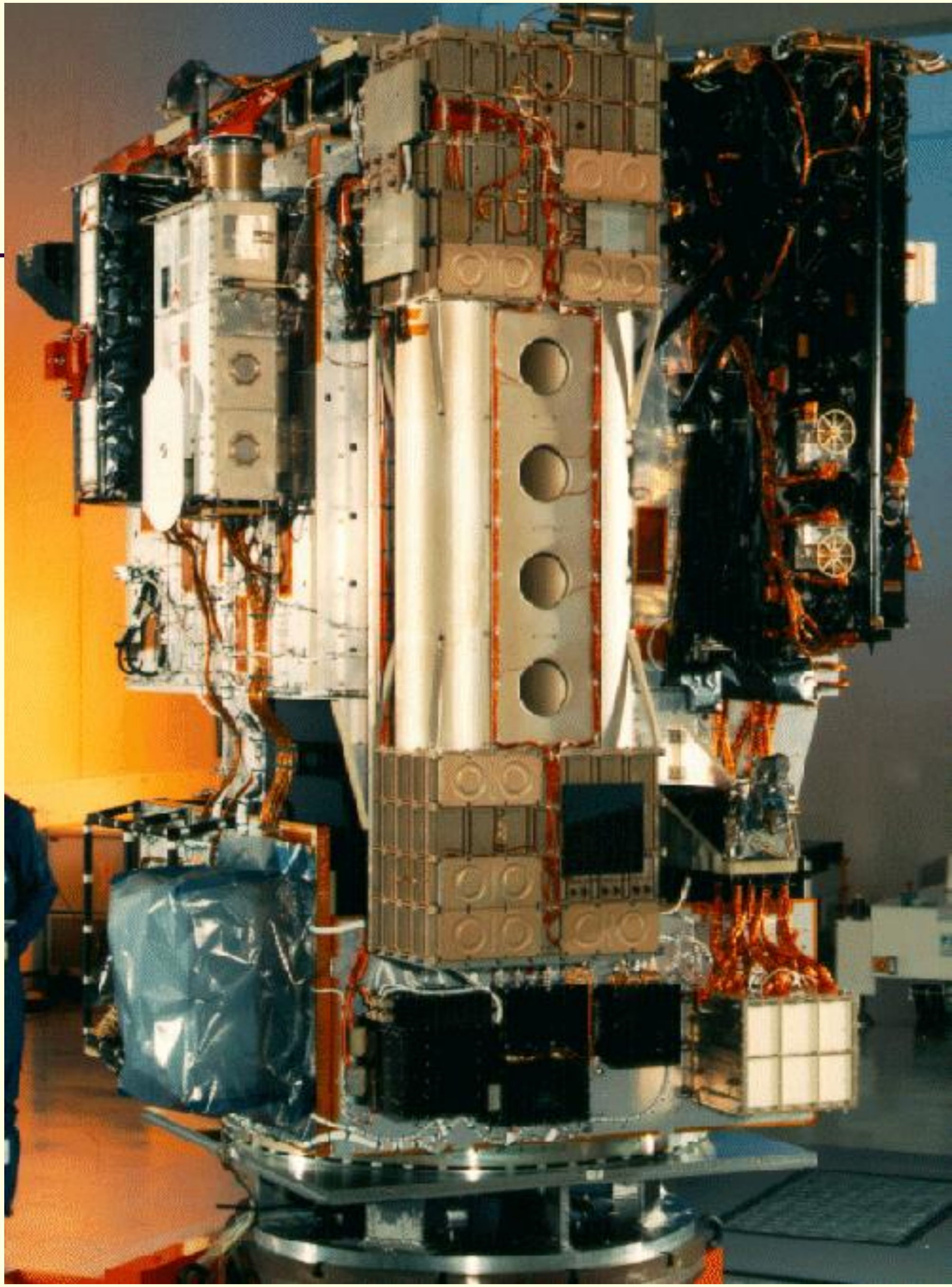
SUMER on Spacecraft

SOHO mission time

- nominal 1996 – 1998
- extended several times

SOHO costs

- approx. 1 000 M Euro
- (75% ESA, 25% NASA, instruments likewise)
- in comparison:
- 1 shuttle start
- = approx. 500 M Euro



SOHO Spacecraft
(**SO**lar and **H**eliospheric **O**bservatory, ESA/NASA)

Size

4.3 x 2.7 x 3.7 m

Solar paddles

9.5 m

Start weight

1850 kg

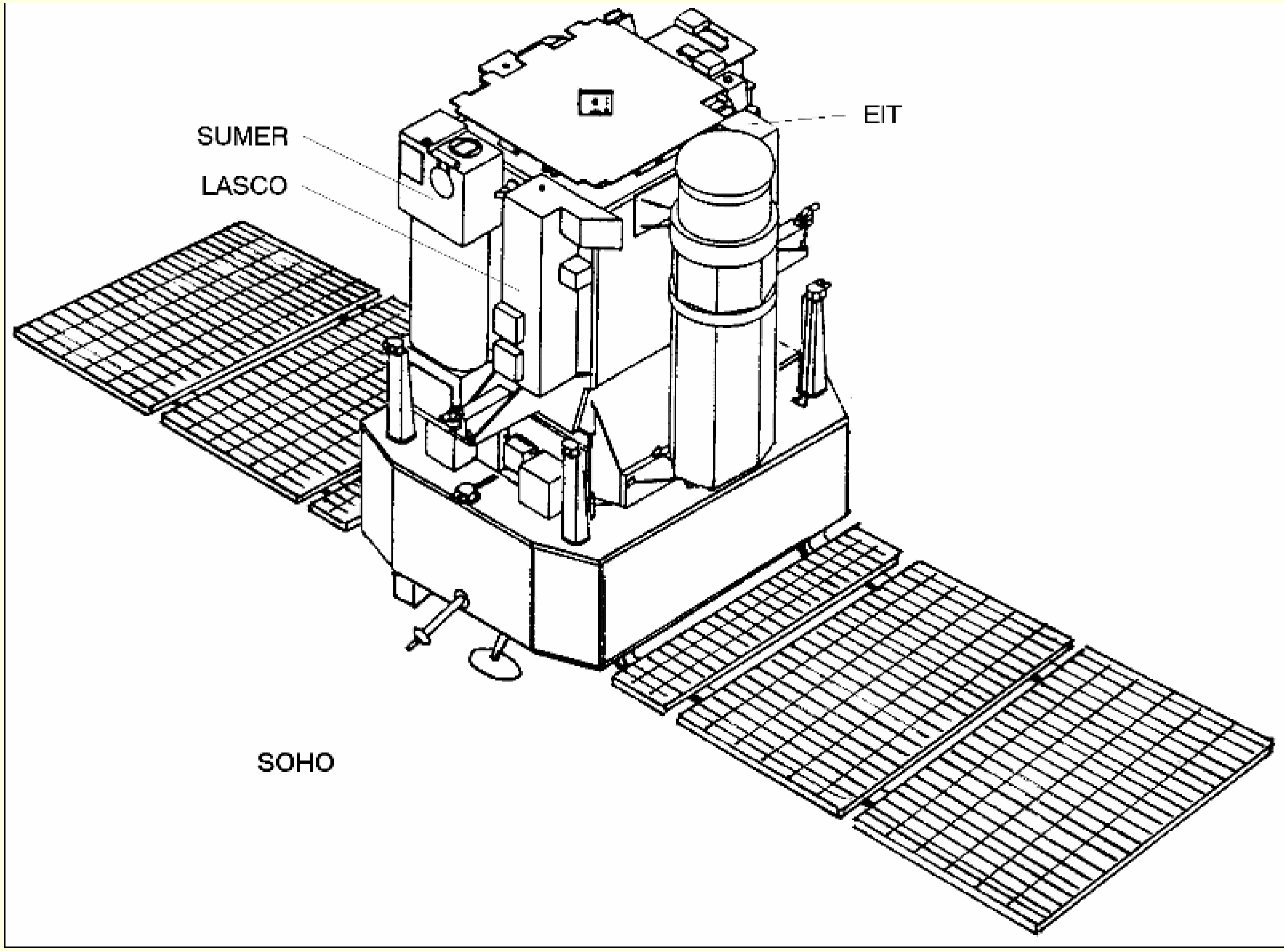
Payload

610 kg

12 scientific

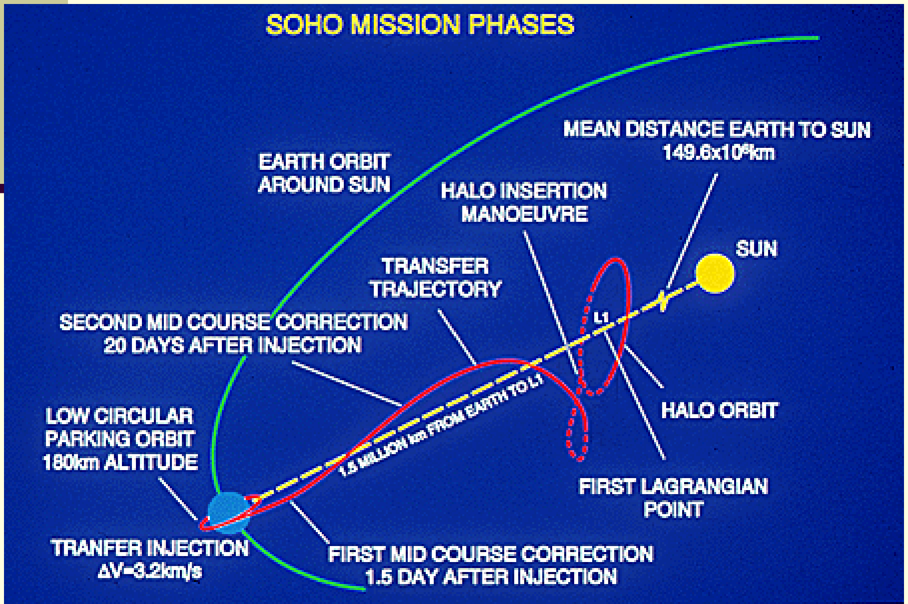
Instruments

(CDS,CELIAS, COSTEP,EIT,ERNE, GOLF,LASCO,MDI, SUMER,SWAN, UVCS,VIRGO)



SOHO Launch

KSC Launch Complex 36
Atlas Centaur Launch Vehicle
start 02 Dec 1995 08:08 UTC
at L1 14 Feb 1996



Anecdotes: Launch

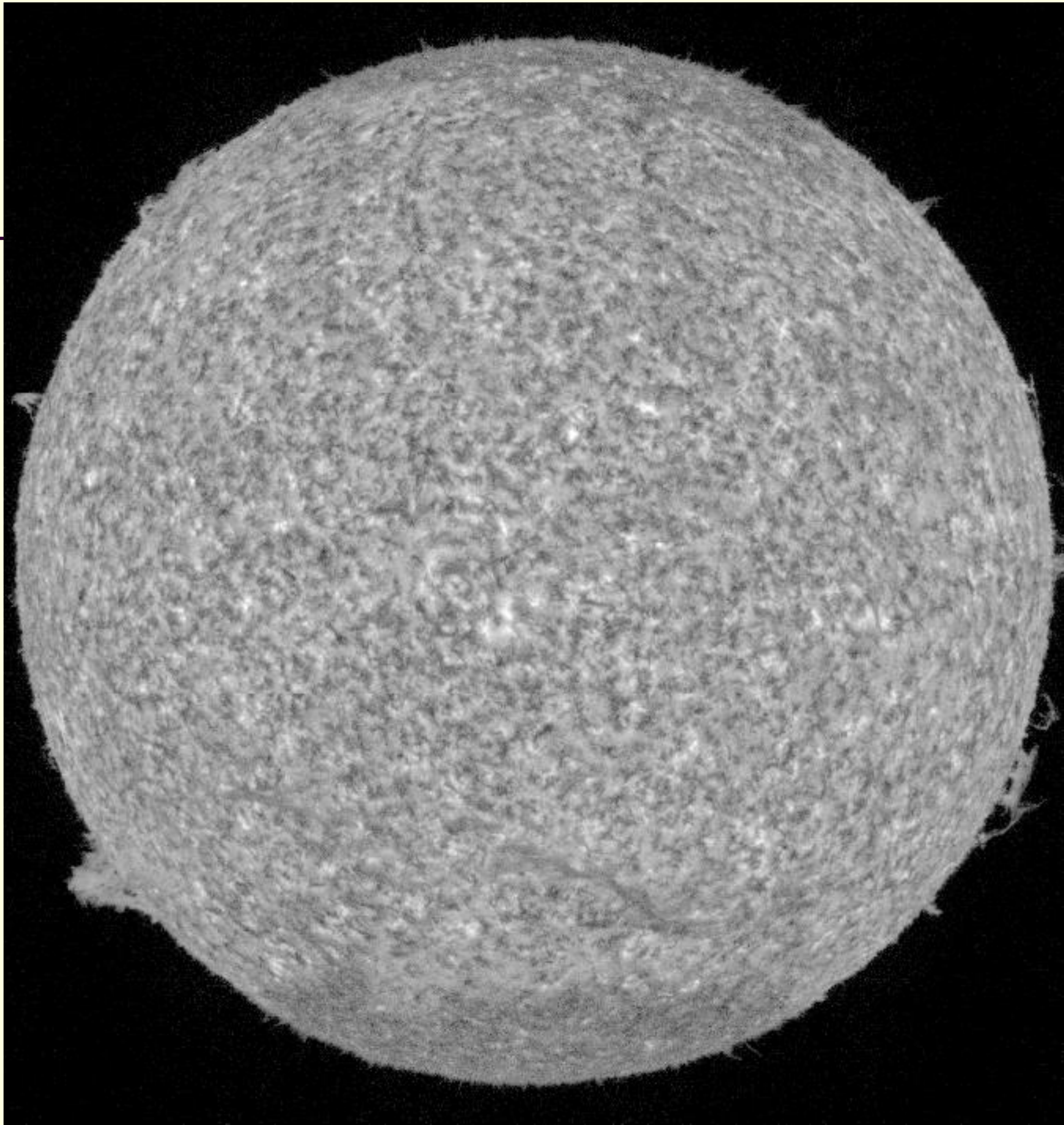
What can SUMER do? (1)

Full disk scan
in He I 58.4
(log radiance)

02 Mar 1996
23:22 UTC –
04 Mar 1996
02:46 UTC

slit 1”x300”
step 1.5”
time 7 s

Challenges: Calibration



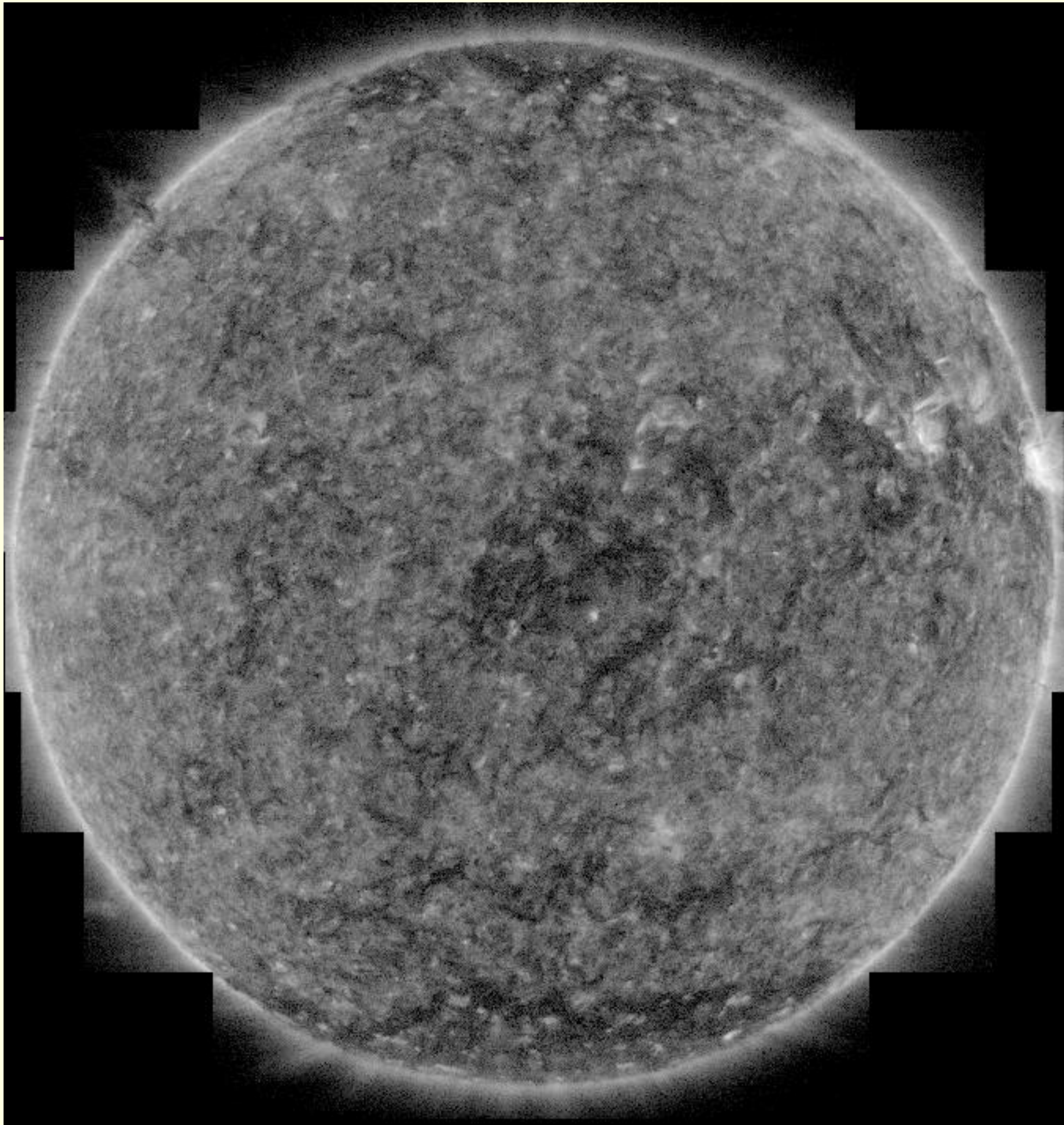
What can SUMER do? (2)

Full disk scan
in Ne VIII 77.0
(log radiance)

02 Feb 1996
02:05 UTC –
18:12 UTC

slit 1”x300”
step 1.88”
time 7.5 s

Solutions: Imager FOV

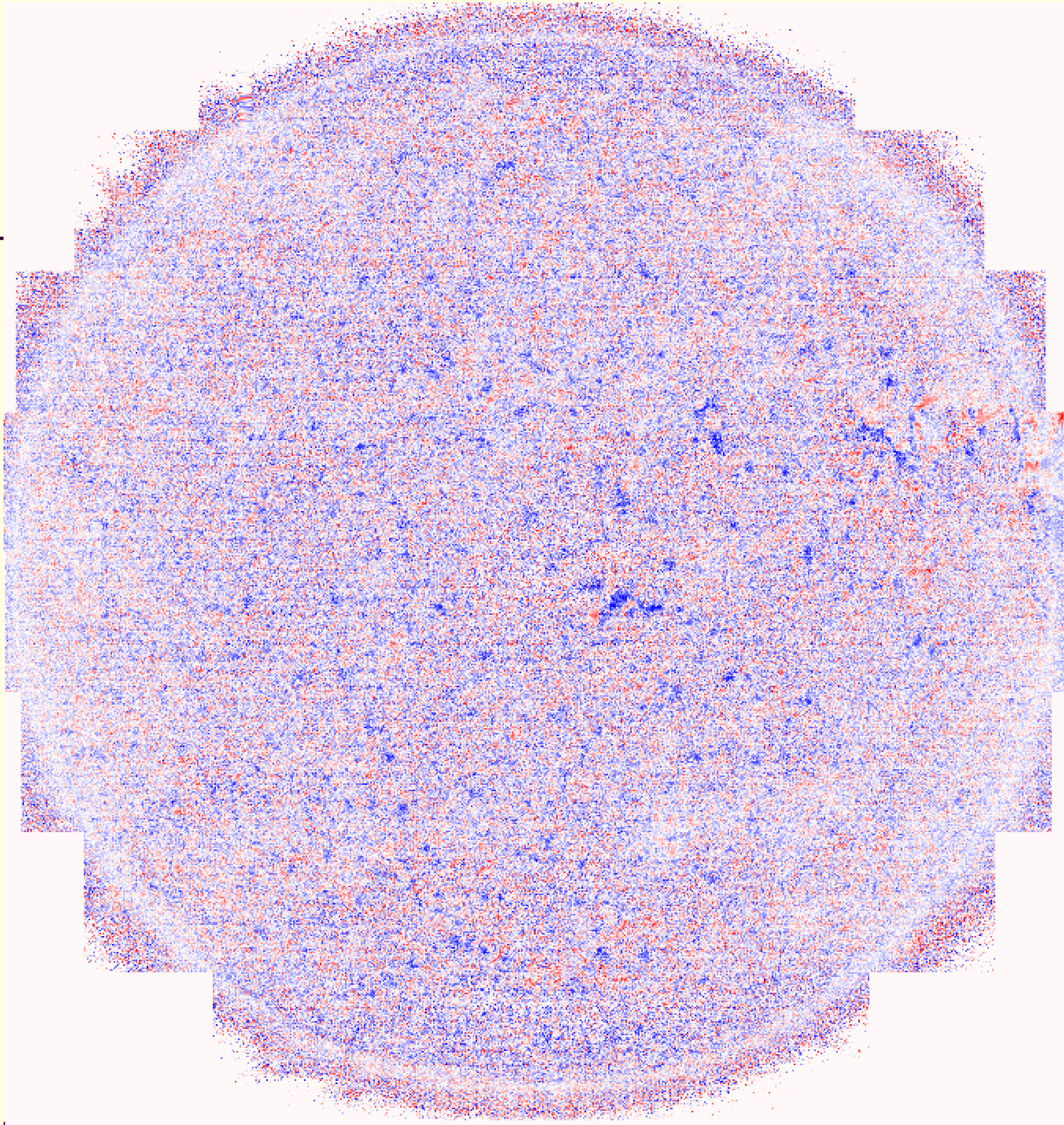


What can SUMER do? (3)

Full disk scan
in Ne VIII 77.0
(Doppler shifts)

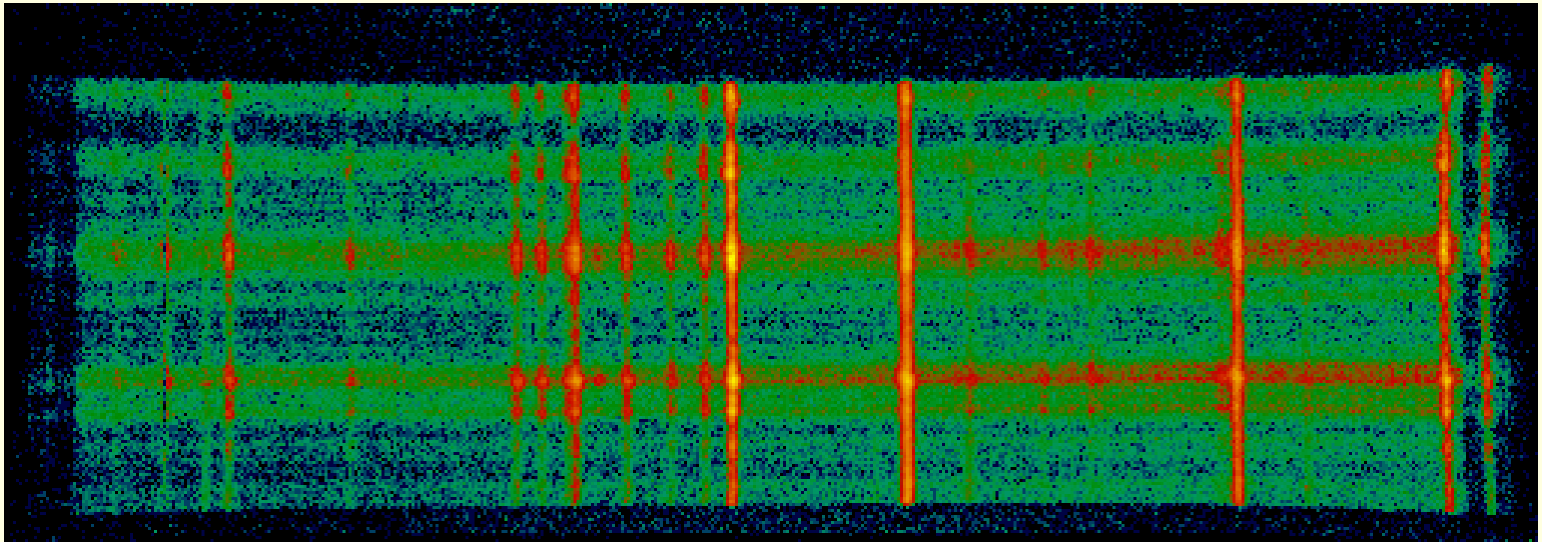
02 Feb 1996
02:05 UTC –
18:12 UTC

slit 1”x300”
step 1.88”
time 7.5 s



SUMER
(Solar Ultraviolet Measurements of Emitted Radiation)

- telescope and spectrometer
- approx. 80 – 160 nm wavelength range (1st order)
- various slit sizes, variable raster step sizes, exposure times
- 2 detectors with 1024 spectral x 360 spatial pixels *(Solutions)*
- spatial resolution approx. 1” (715 km on the Sun)
- spectral resolution approx. 0.004 nm (10 km/s and better)

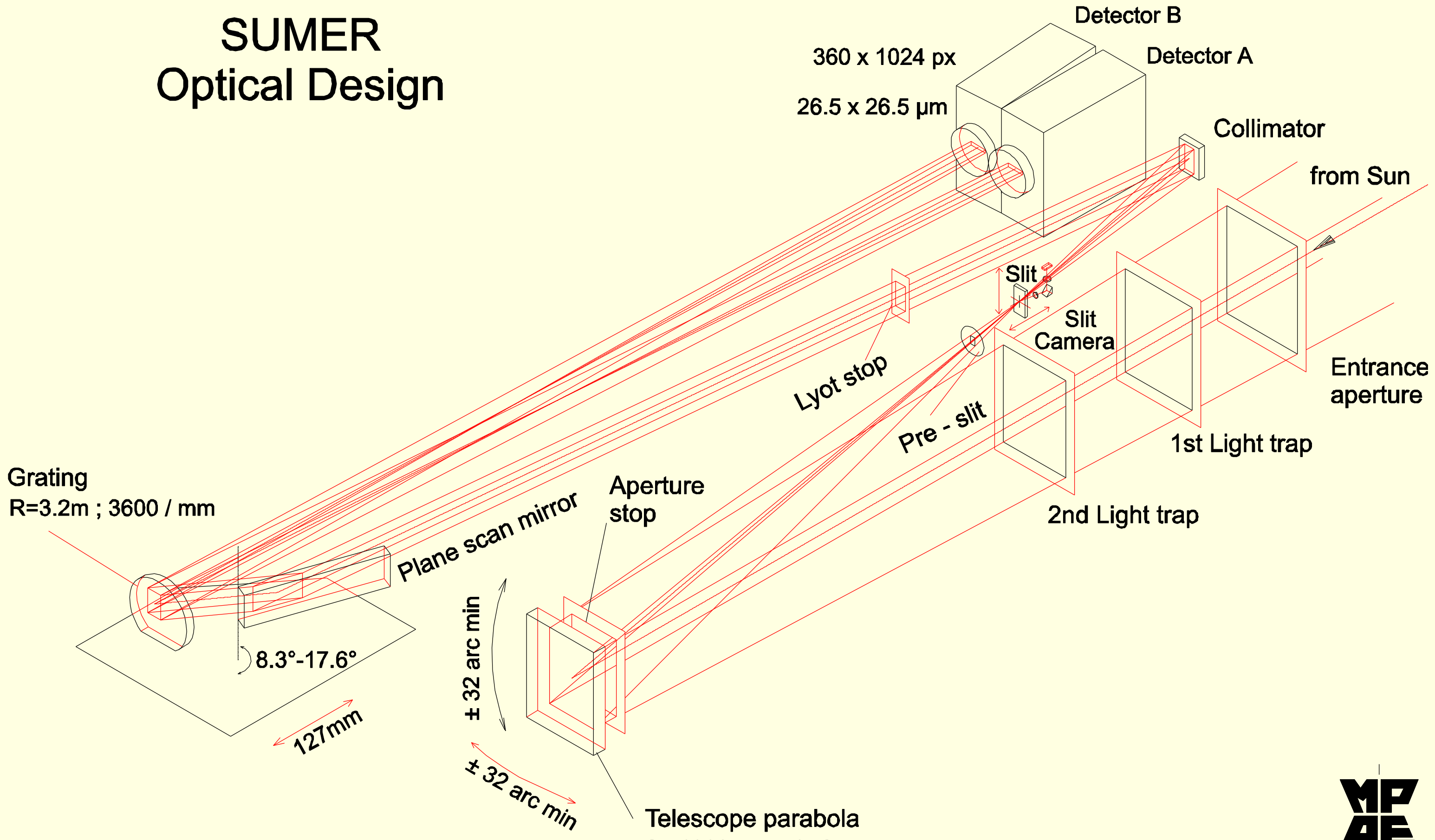


The SUMER Instrument (1)
(Engineering Model, Integration Team in Cleanroom)

designed and built (with international co-operation) at Max-Planck-Institut f. Aeronomie, MPAE (now MPS), Lindau, Germany, 1987-1995

costs approx. 50 M Euro (55% D, 20% F, 20% USA, 5% CH)

The SUMER Instrument (2)



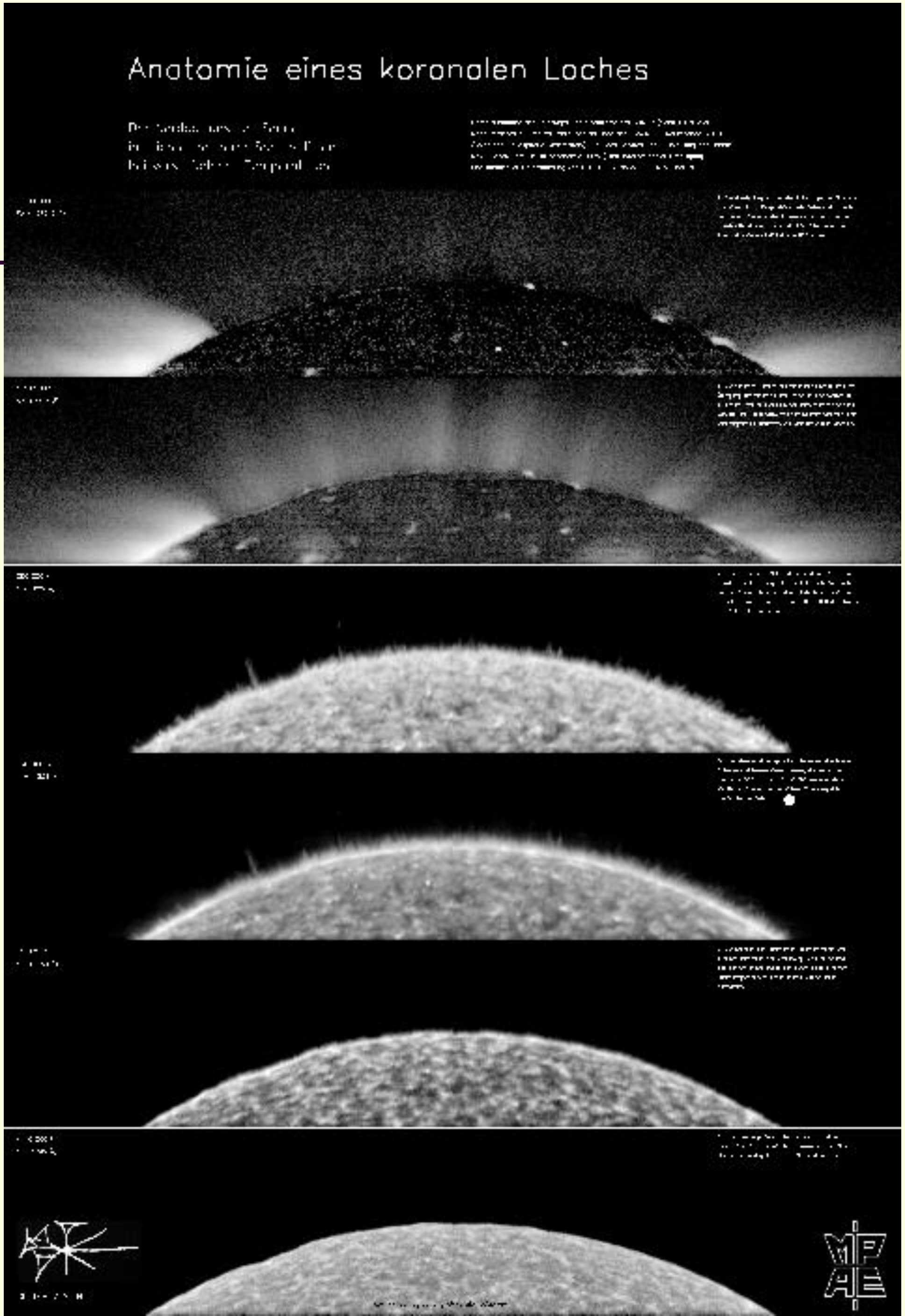
Solutions: Scan mirror

Anatomy of a Coronal Hole

(27 Jul 1996 23:16 – 28 Jul 1996 17:21 UTC)

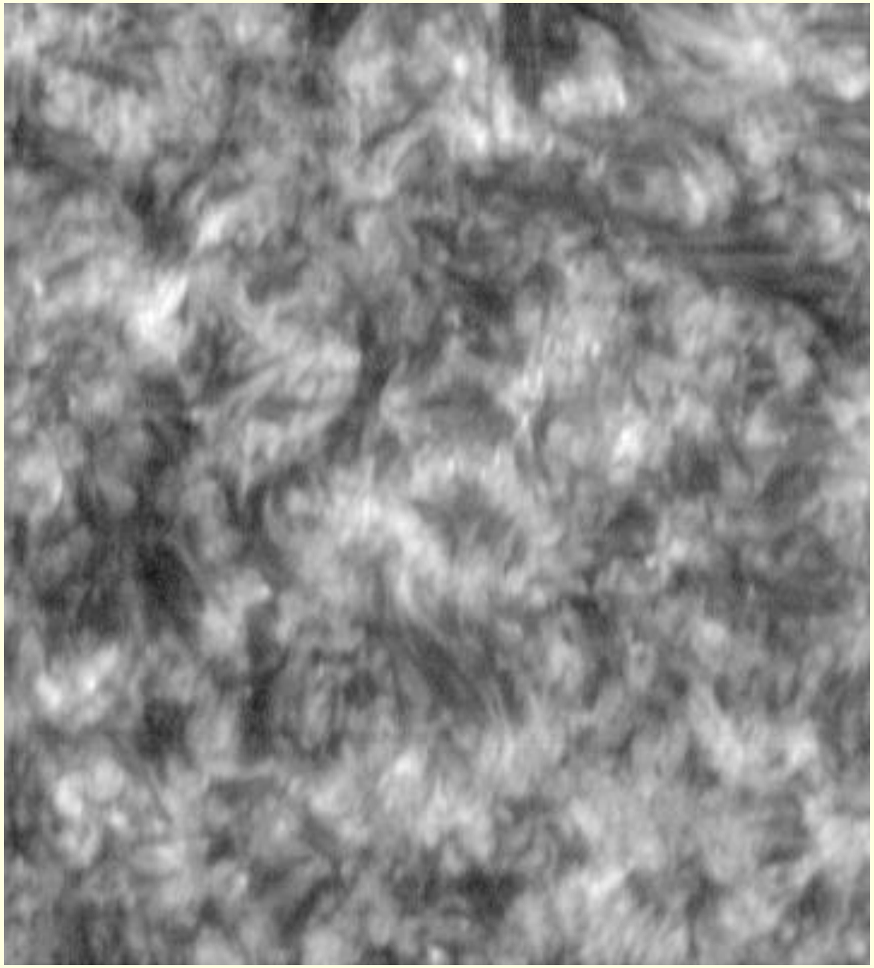
- Fe XII 124.2 nm (1 400 000 K)
- Mg X 62.4 nm (1 100 000 K)
- O V 62.9 nm (250 000 K)
- N V 123.8 nm (190 000 K)
- S II 125.0 nm (30 000 K)
- C I 124.9 nm (< 10 000 K)

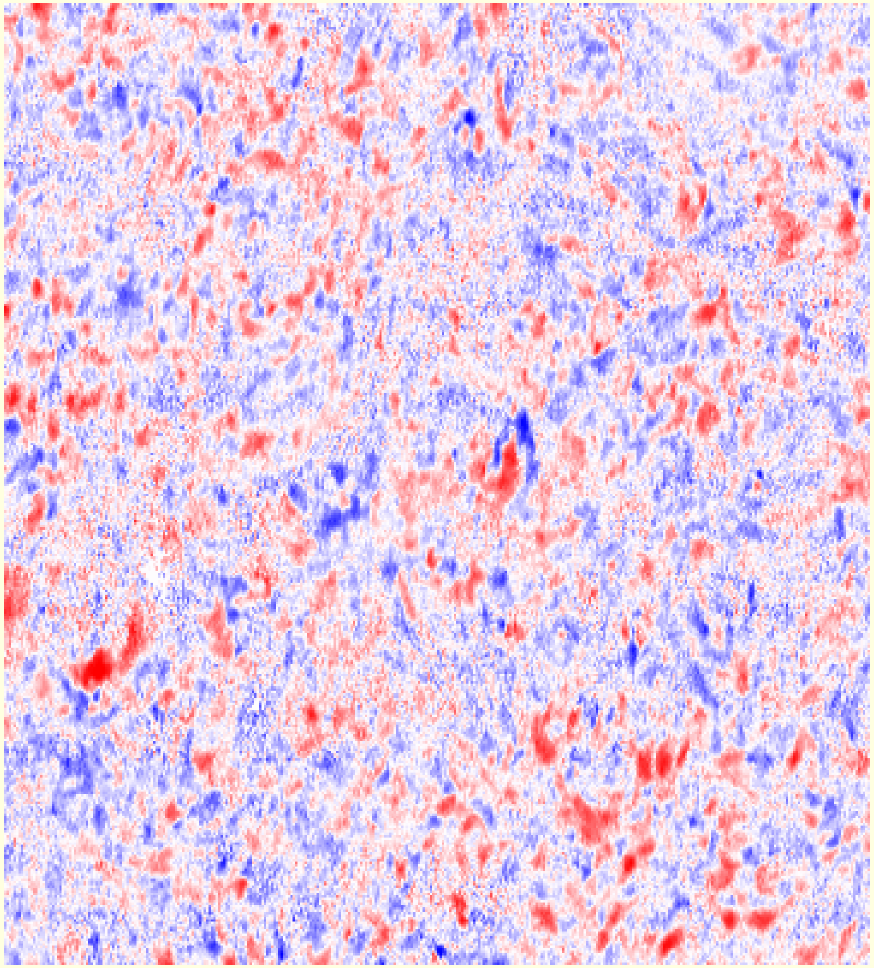
Anecdotes: Poster



Transition Region Morphology, Redshift

(O VI 103.1 nm, 30 Jan 1996 04:38-04:57 UTC)

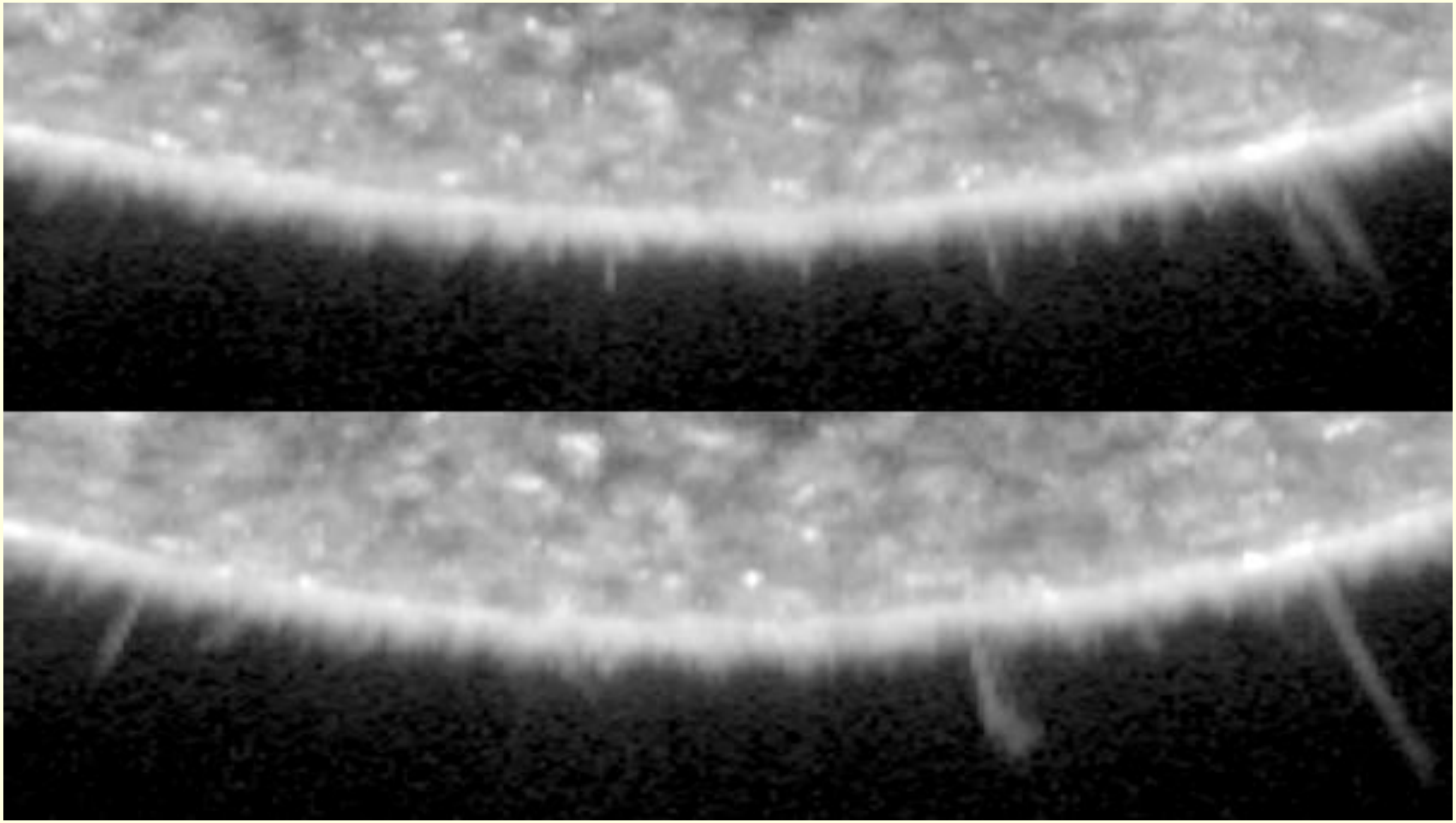




Anecdotes: Initial data chaos

Spicules and Macrospicules

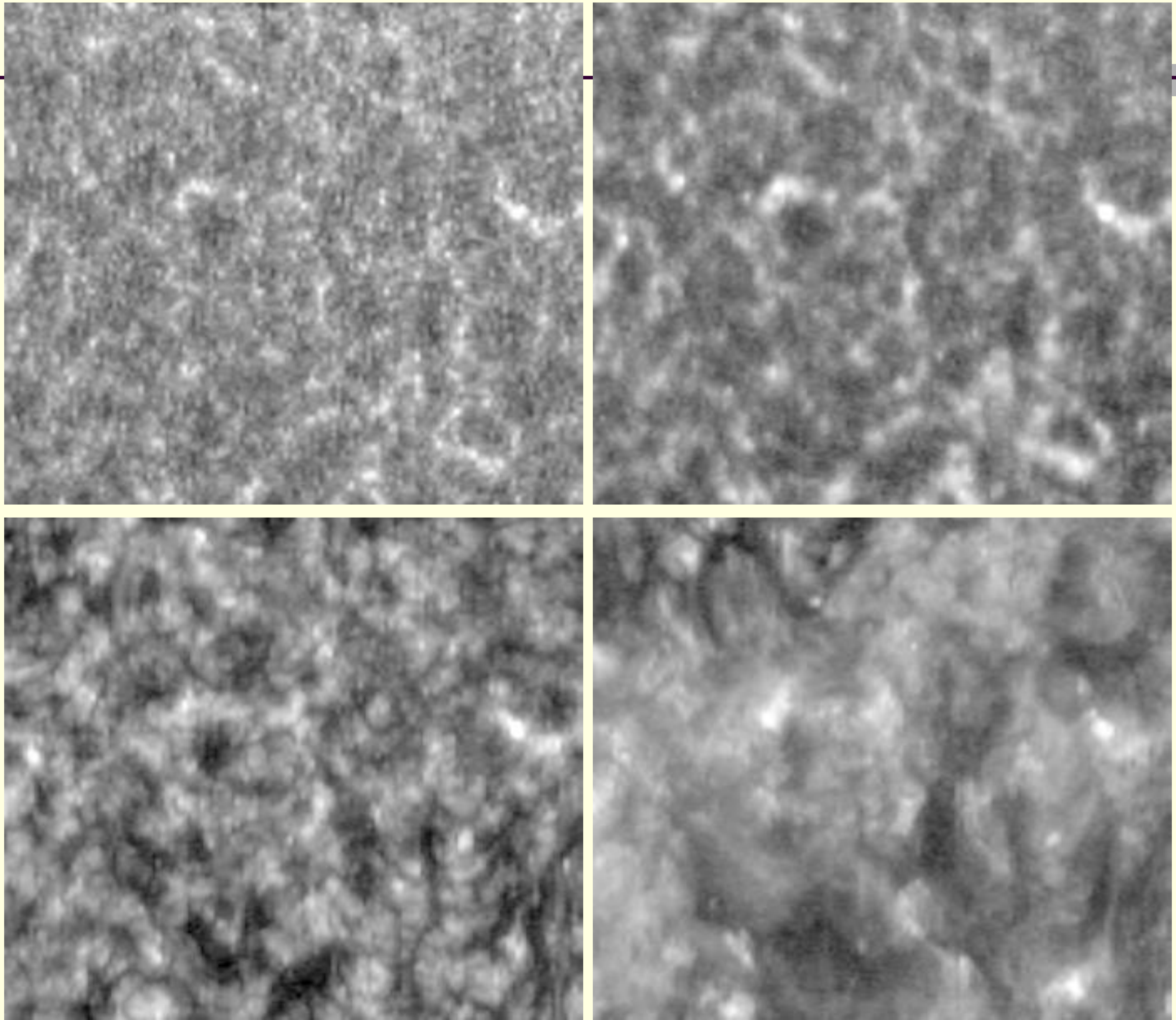
(N V 124.2 nm, 27 Apr 1996 20:01 – 28 Apr 1996 01:03 UTC)



Challenges: Loss of SOHO in 1998

Cont 154.0, Si II 153.3, C IV 154.8, Ne VIII 77.0 nm

(03 Nov 1999 18:55 – 04 Nov 1999 00:25 UTC)



<10 000 K

14 000 K

100 000 K

630 000 K

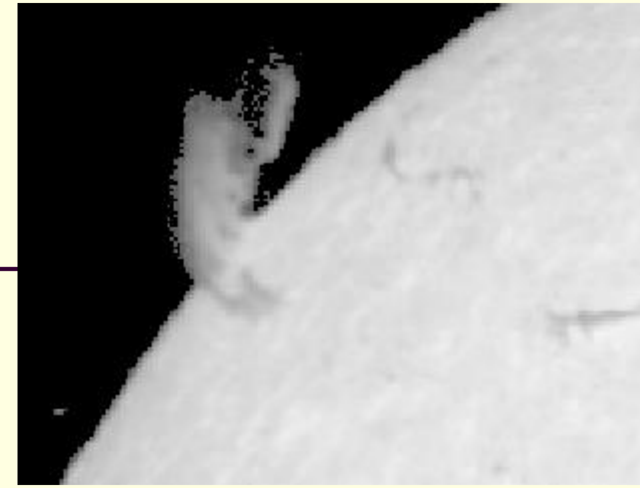
Some Results of SUMER Observations

- The source of the fast solar wind in coronal holes
- High red- and blueshifts at explosive events
- Improved rest wavelength values for coronal lines
- Log-normal distribution of line radiances (in QS, not CH, AR)
- Normal distribution of line shifts and widths (in QS …)
- Interrelation between radiance and redshift (in QS …), esp. TR
- Redshift in footpoints of active region loops
- Damped oscillations in flare lines
- The “height” of chromosphere, transition region, corona
- Emission measures of various regions

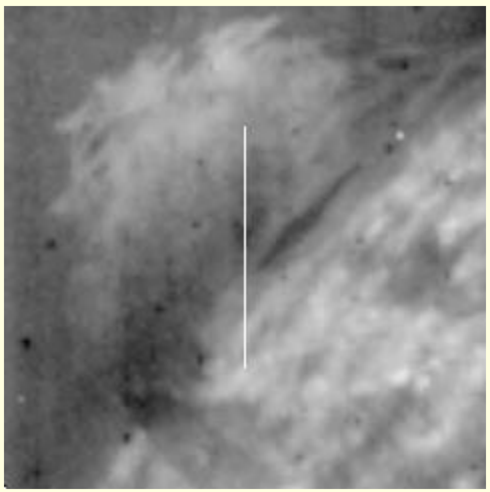
Prominence Observation

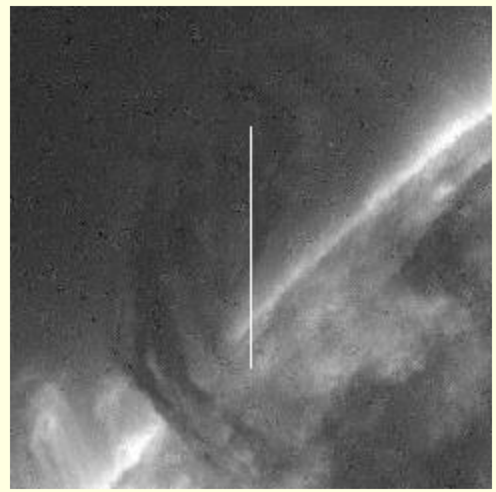
(08 Jul 2000 09:04-12:51 UTC)

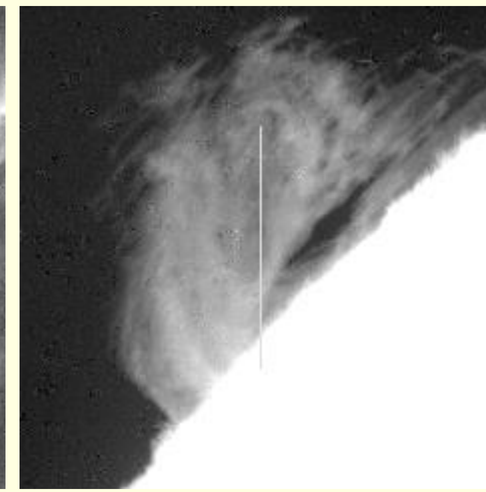
Meudon H-alpha



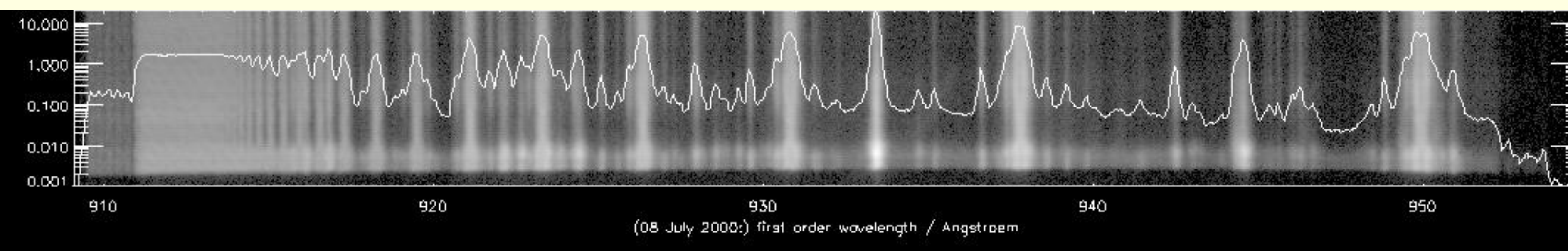
SOHO/EIT He II 30.4,
TRACE Fe IX/X 17.1,
TRACE H I Lyman alpha 121.6 nm





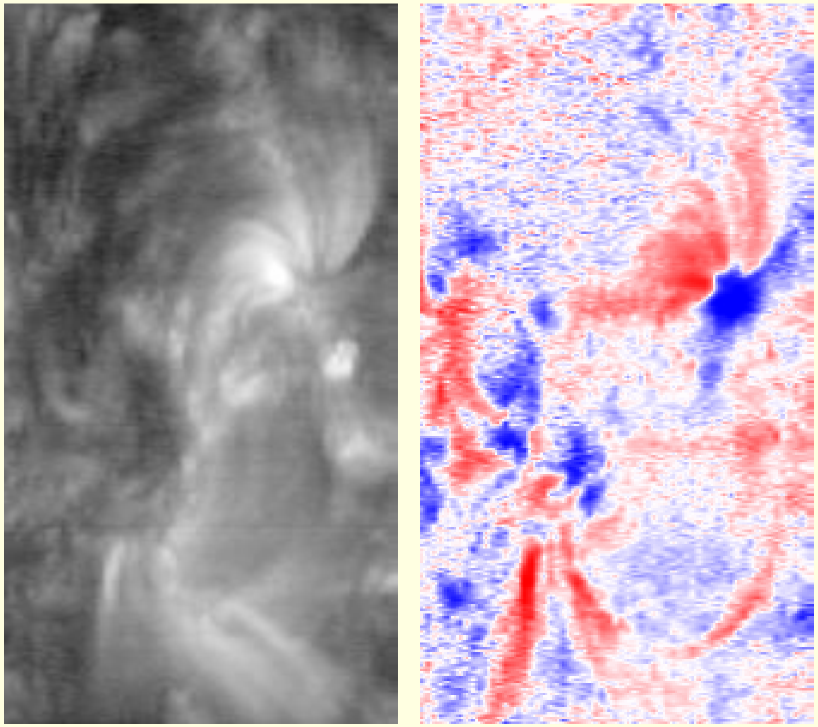


SOHO/SUMER
1”x120” slit
120 s exposure
91-95 nm

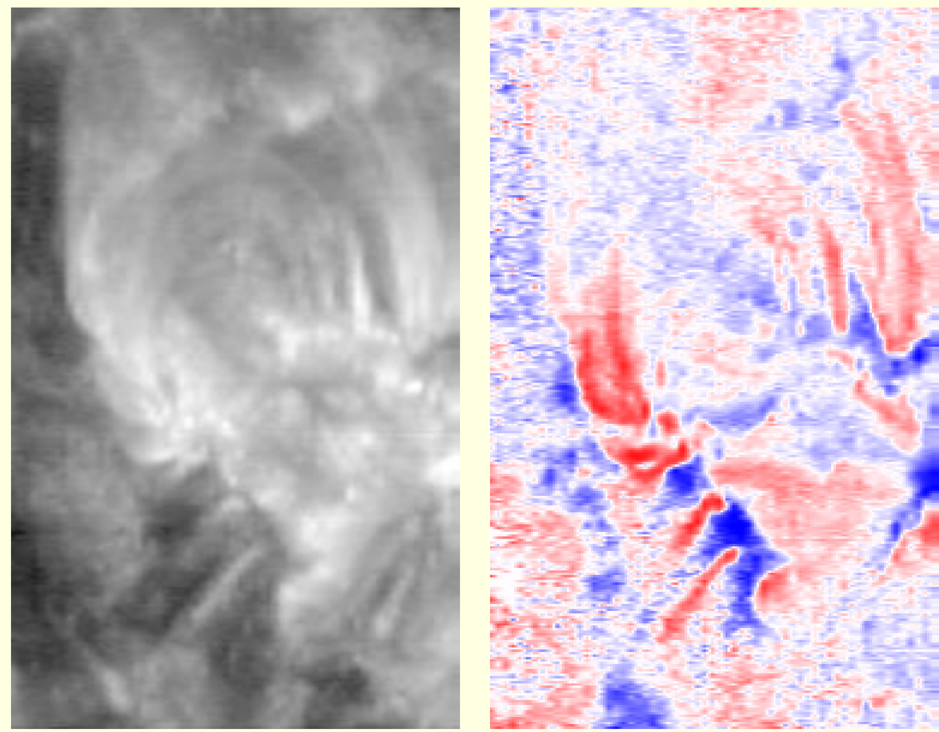


Active Region Loops

Collaboration with W. Curdt, MPS, Germany; B.N. Dwivedi, India; S. Parenti, ROB



Ne VIII 78.0 nm,
20 May 2004
16:29-19:33 UTC

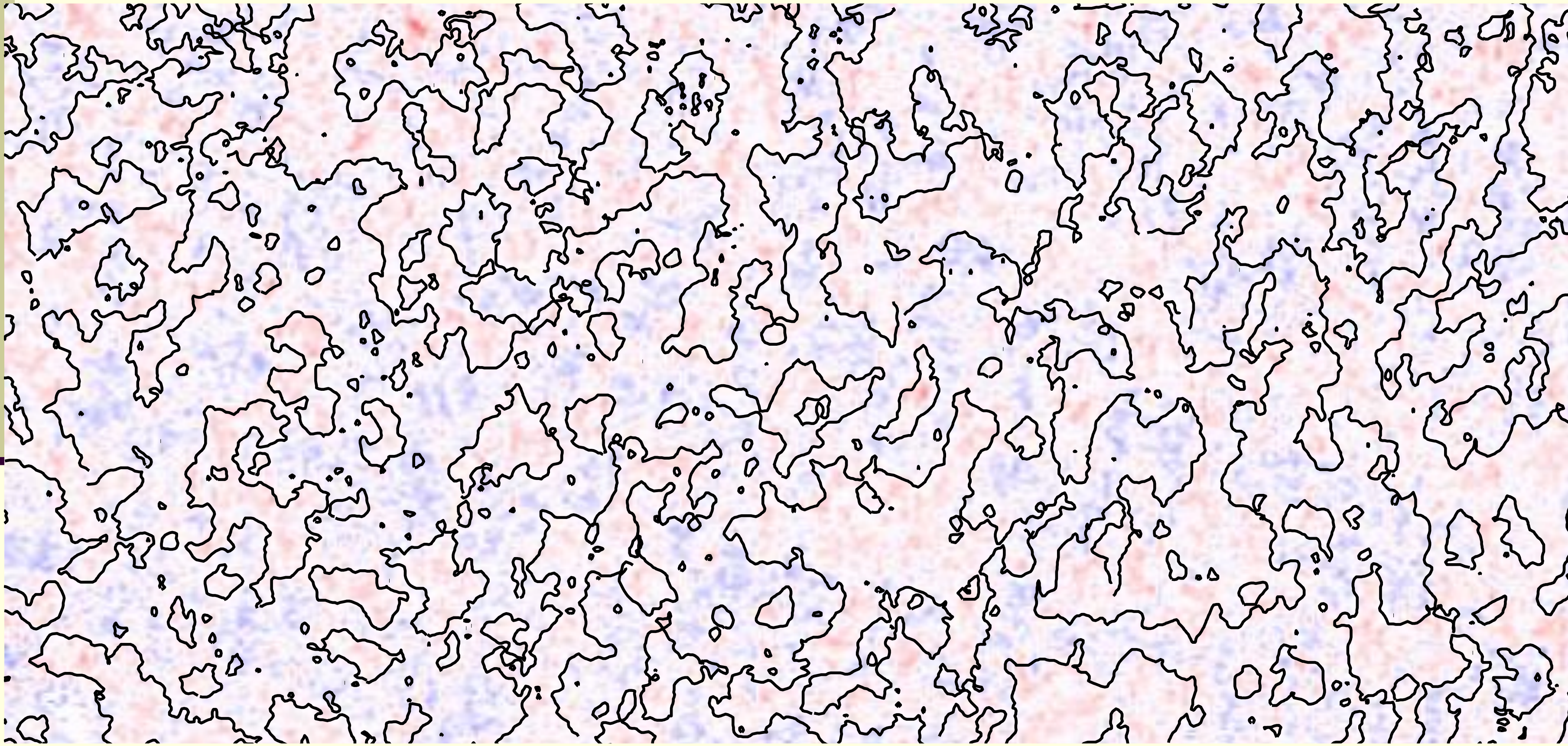


Ne VIII 78.0 nm,
21 May 2004
19:10-22:15 UTC

Redshift in Chromosphere and Transition Region

(well known in Quiet Sun)

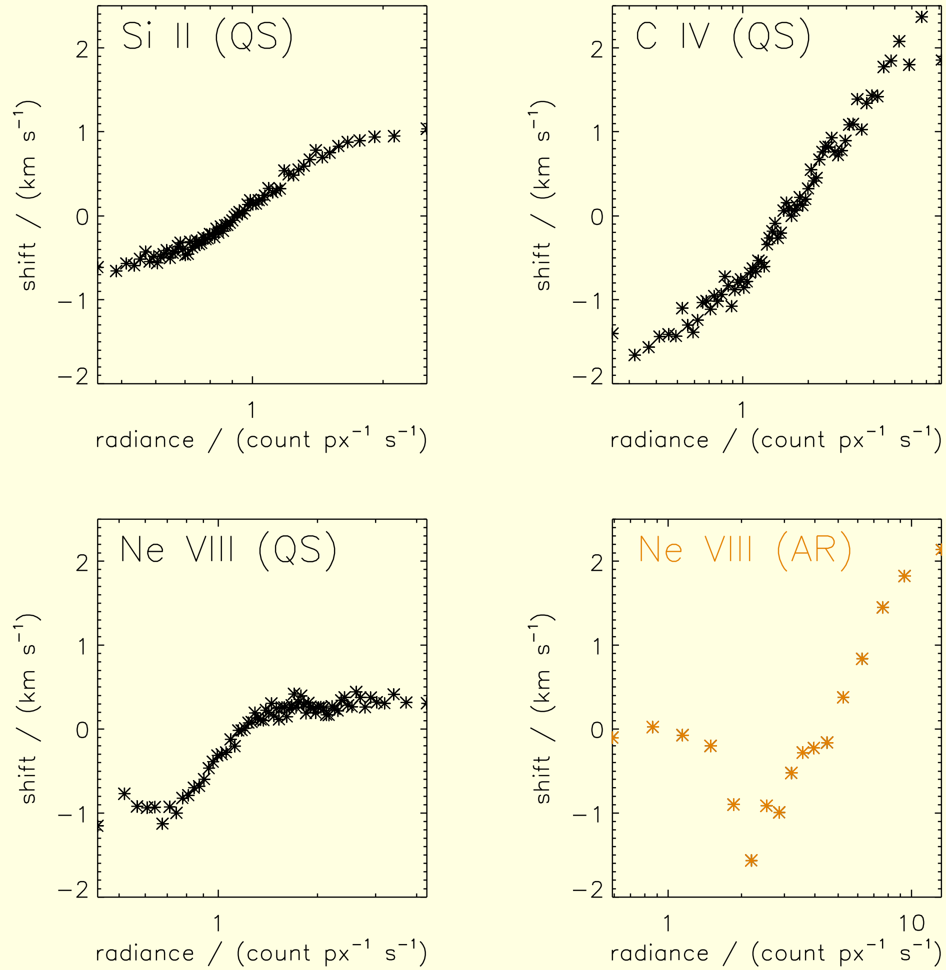
Si II 153.3 nm, 07 Nov 1999 00:05-10:08 UTC



Doppler Shift vs. Brightness

- Straightforward interrelation for chromosphere and transition region in Quiet Sun.

- More complicated in the corona and especially in Active Regions.



Must stop here …

- … despite enthusiasm for spectroscopy.

- Now, what are the lessons learned for future projects?
- (Not all may be applicable for imagers.)

- *Anecdotes: Search for info on EUI website*

Lessons learned

- Inspect the launch vehicle ;-)
- Start early with on-ground calibration, then continue in space
- Get a bigger FOV than your competitors ;-)
- Care for an expensive cleanliness program
- alternatively(?): Get out of the Earth's atmosphere
- alternatively(?): Have some back-ups
- Try to point the instrument without moving the spacecraft
- Don't forget PR ("reach out")
- Have your software, catalogues etc. ready before launch
- Don't mess with gyros, get your tele-commands foolproof ;-)
- It really helps to have a website for communication