



SWAP and LYRA onboard PROBA2

David Berghmans on behalf of
the SWAP consortium and the LYRA consortium





ESA microsat for technology demonstration

- 60 cm x 70 cm x 85 cm, 120 kg
- 2 Years mission,
launch 2007/02, together with ESA
SMOS mission in Eurockot
- LEO sun-synchronous orbit, nearly
continuous Sun viewing
- Operations from ESA station Redu
(Belgium)

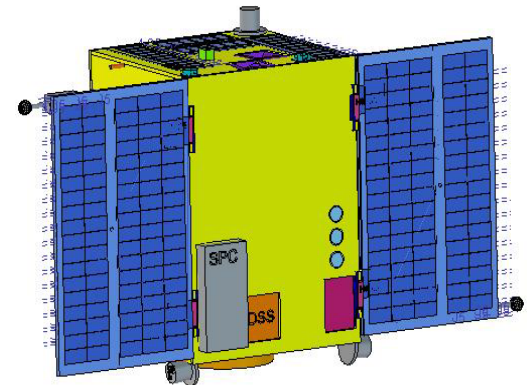
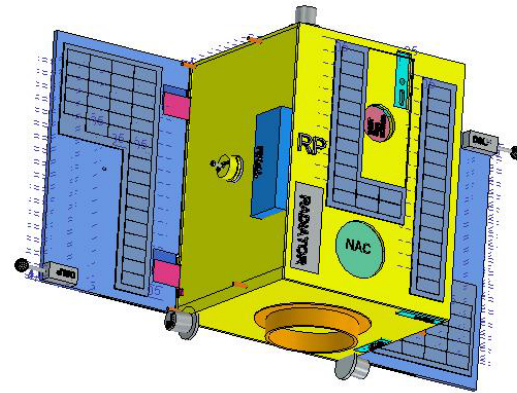
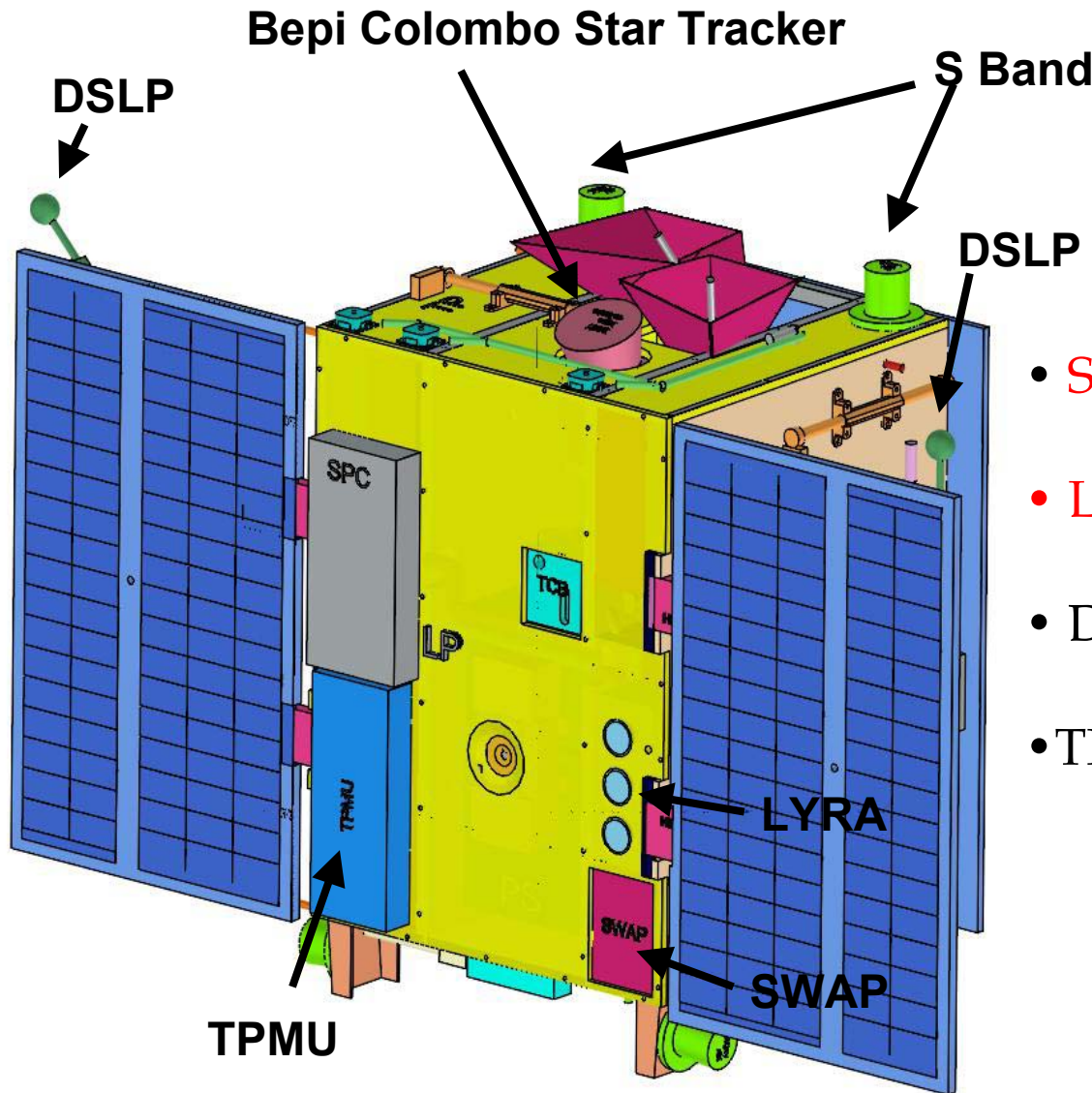


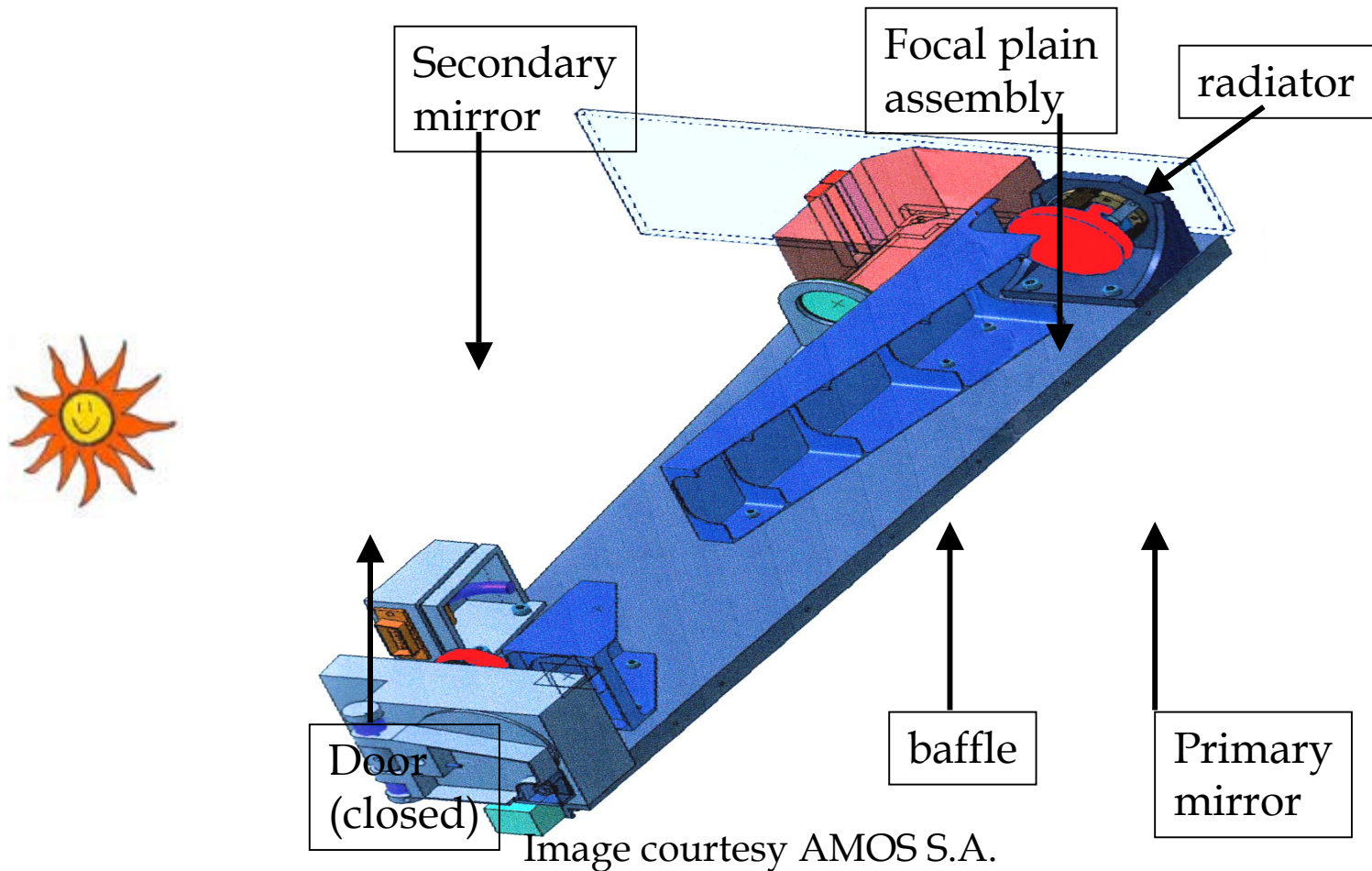
Image courtesy: Verhaert

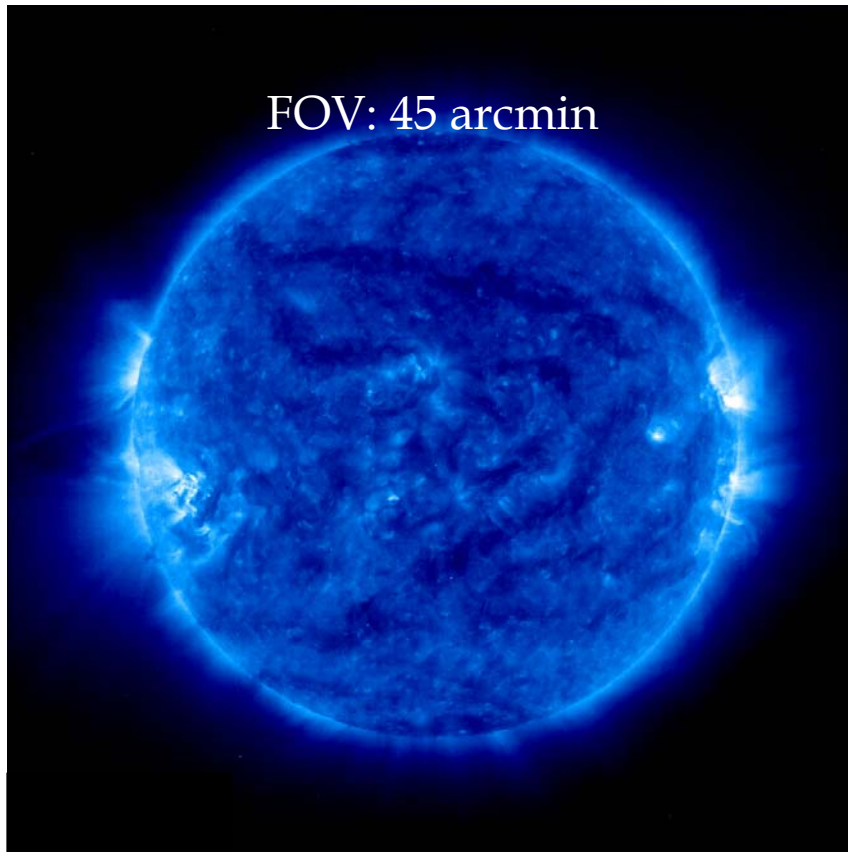
Scientific payload



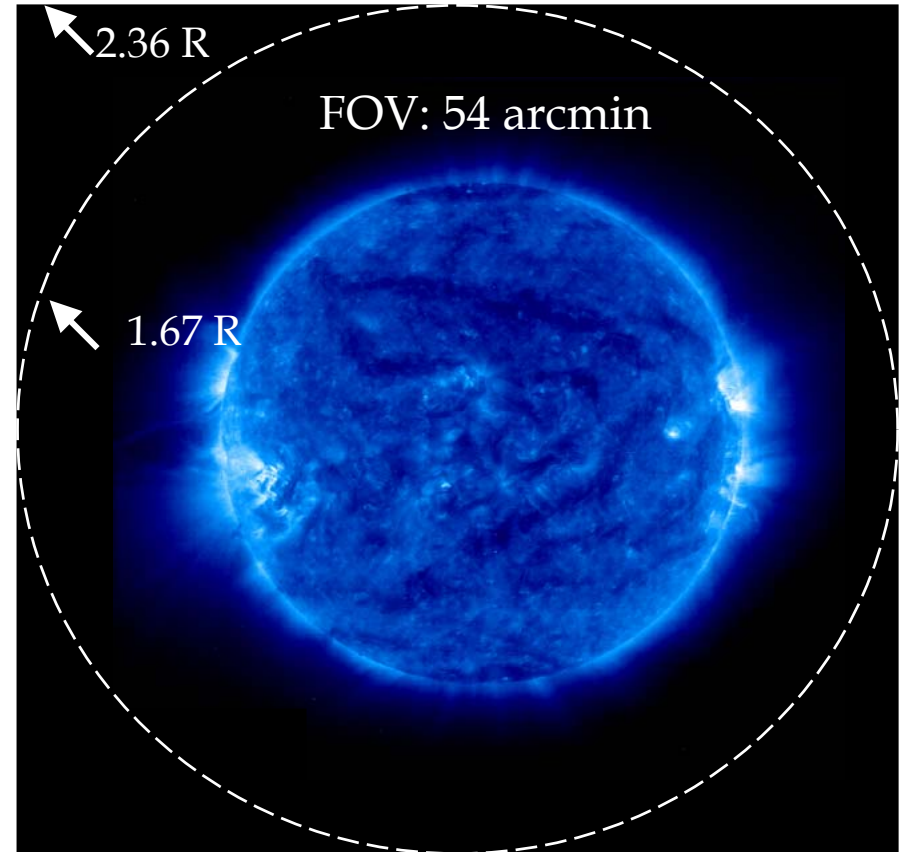
- **SWAP**: Sun Watcher using APS and image processing
- **LYRA**: Lyman- α radiometer
- **DSLP**: Dual Segmented Langmuir Probe
- **TPMU**: Thermal Plasma Measurement Unit for Microsatellites

SWAP, off-axis EUV imager

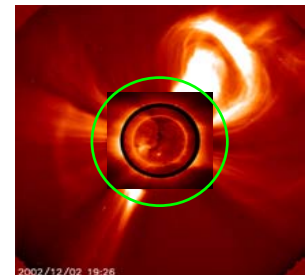




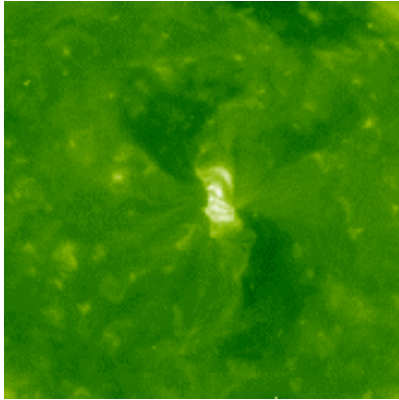
- 1024x1024 backside CCD
- 17.1nm, 19.5nm, 28.4nm, 30.4 nm
- Fixed sun-centering
- at L1
- 12 min cadence



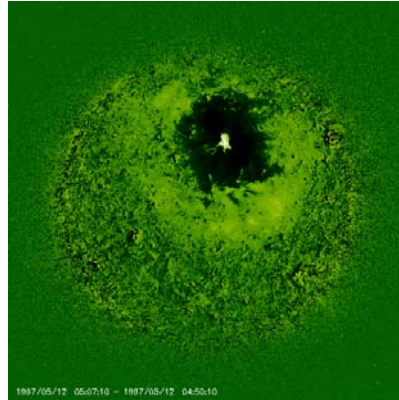
- 1024x1024 coated CMOS APS
- 17.5nm
- Flexible off-pointing
- Protected by magnetosphere
- 1 min cadence



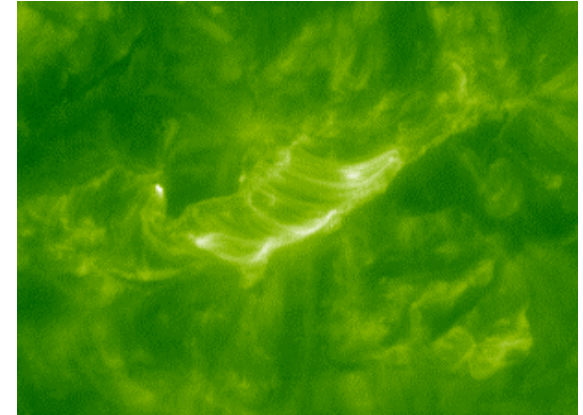
SWAP targets: On disc signatures of CMEs



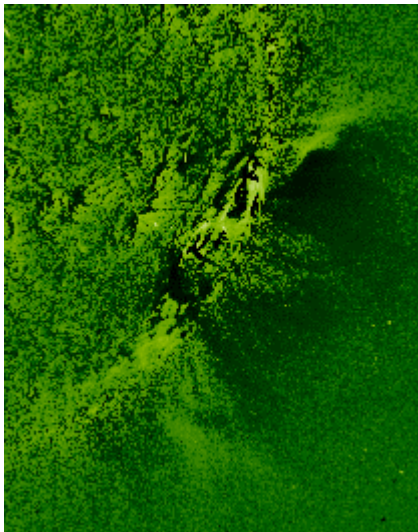
Dimmings



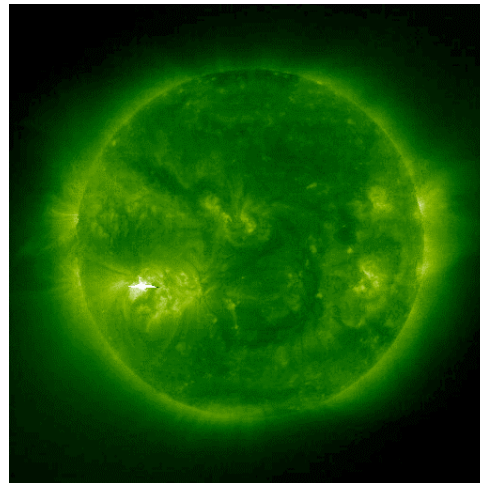
EIT wave



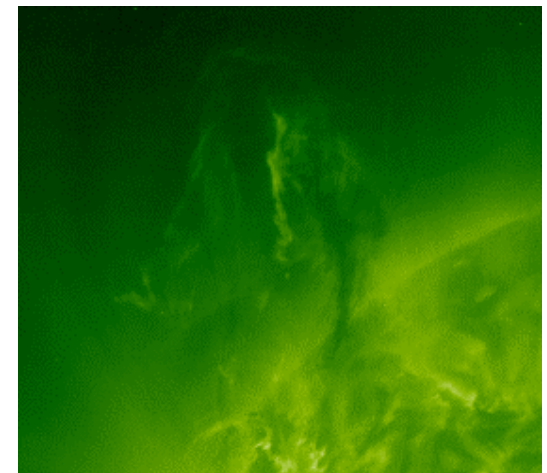
Post-eruption arcade



Loop openings
plasmoid lifting

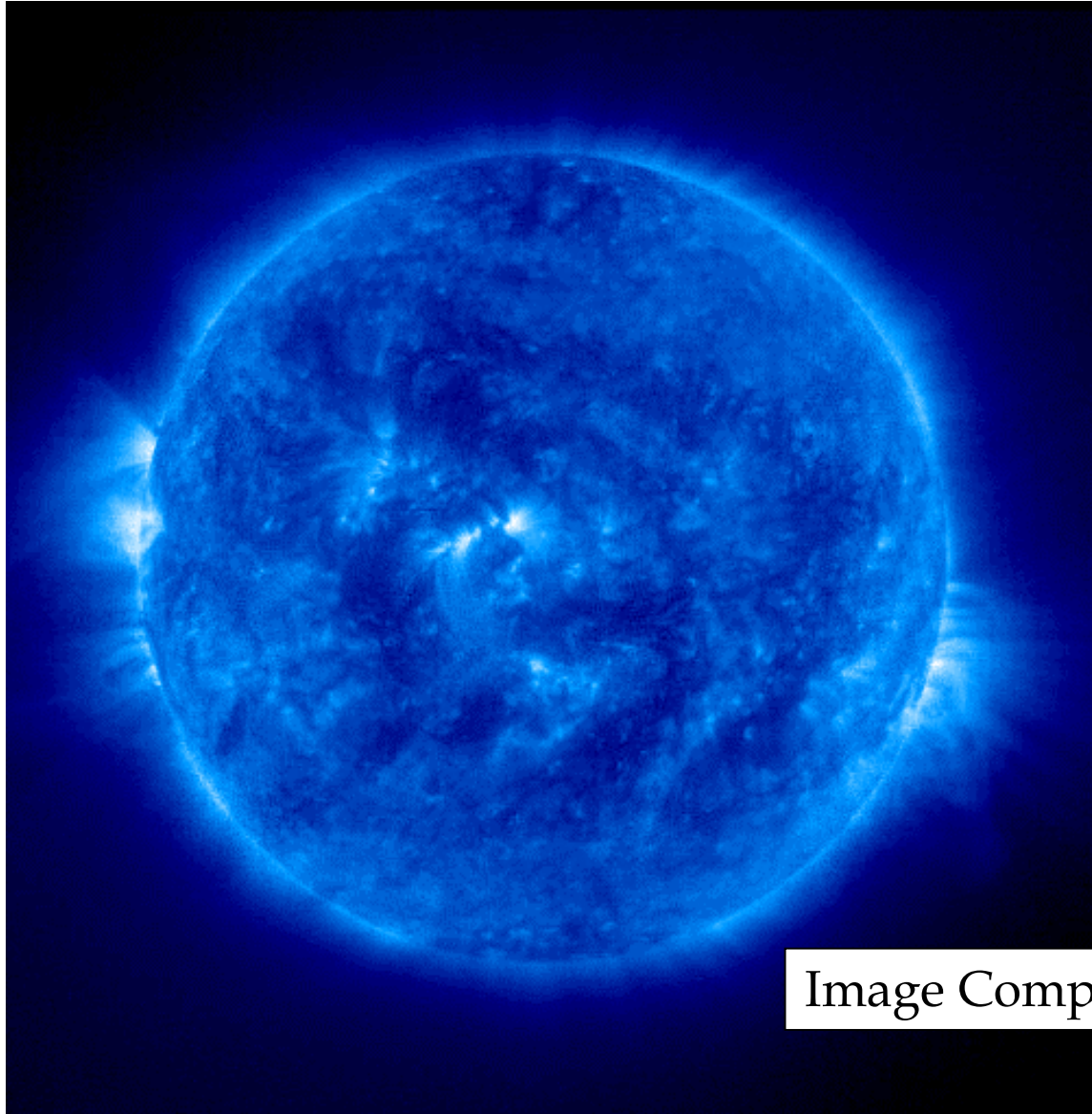


flares



Erupting prominences

Telemetry shortage



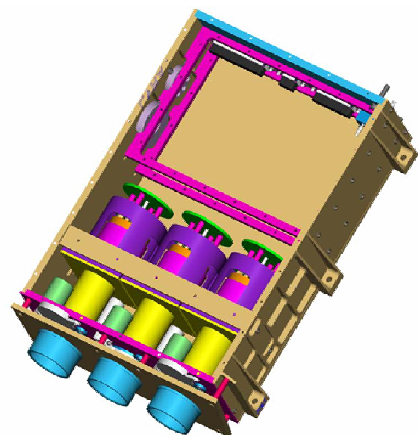
- only 1 ground-station (Redu, Belgium)
- total telemetry volume is low
- Data latency up till 15 hours

Image Compression factor: 16

LYRA

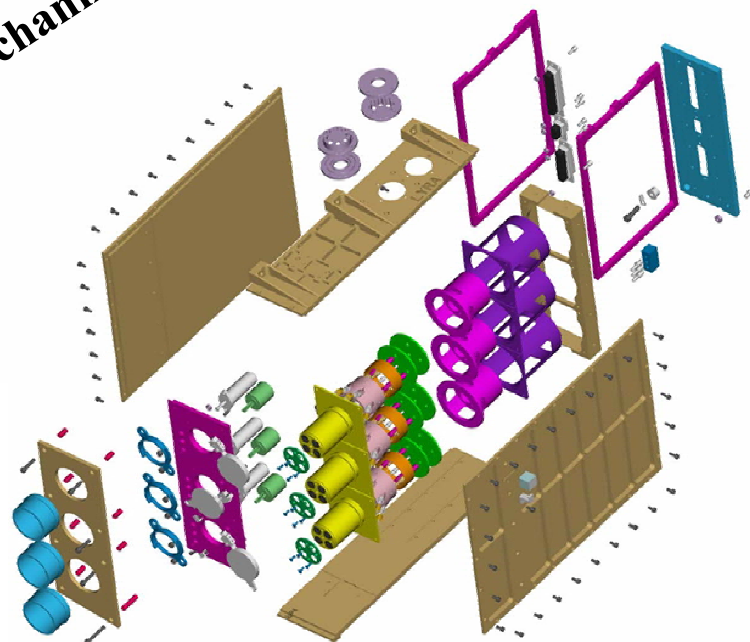
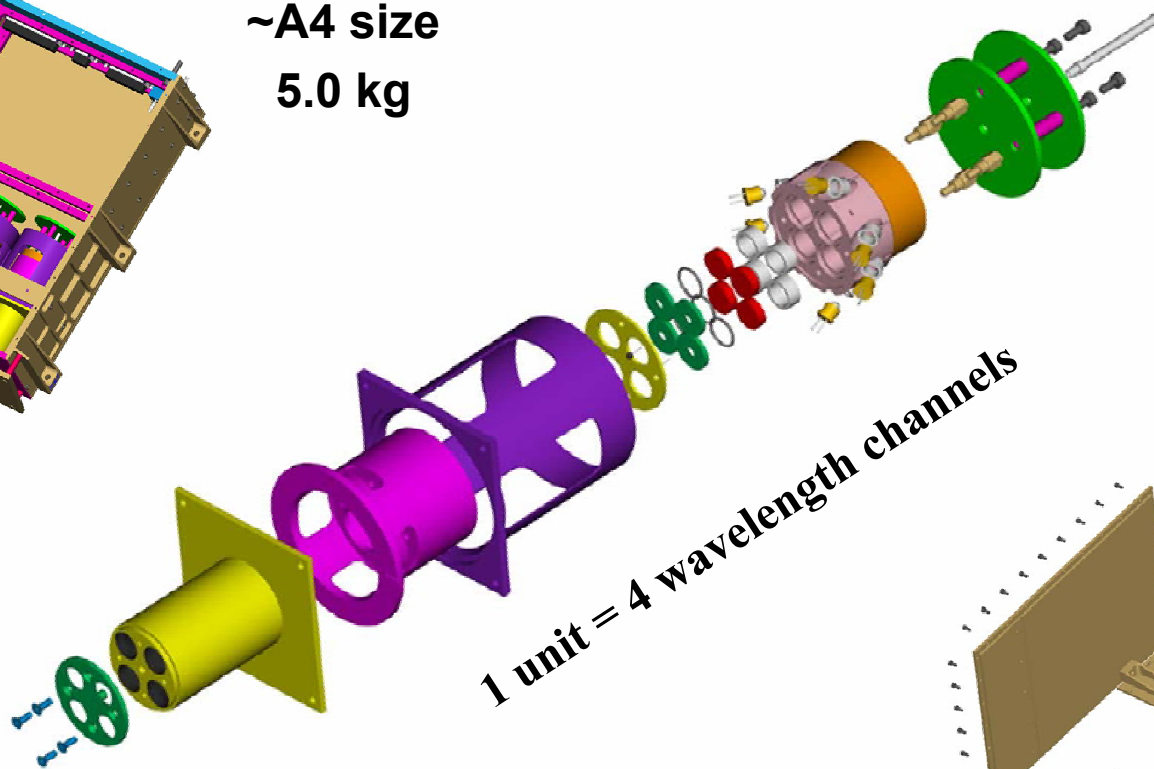


~A4 size
5.0 kg

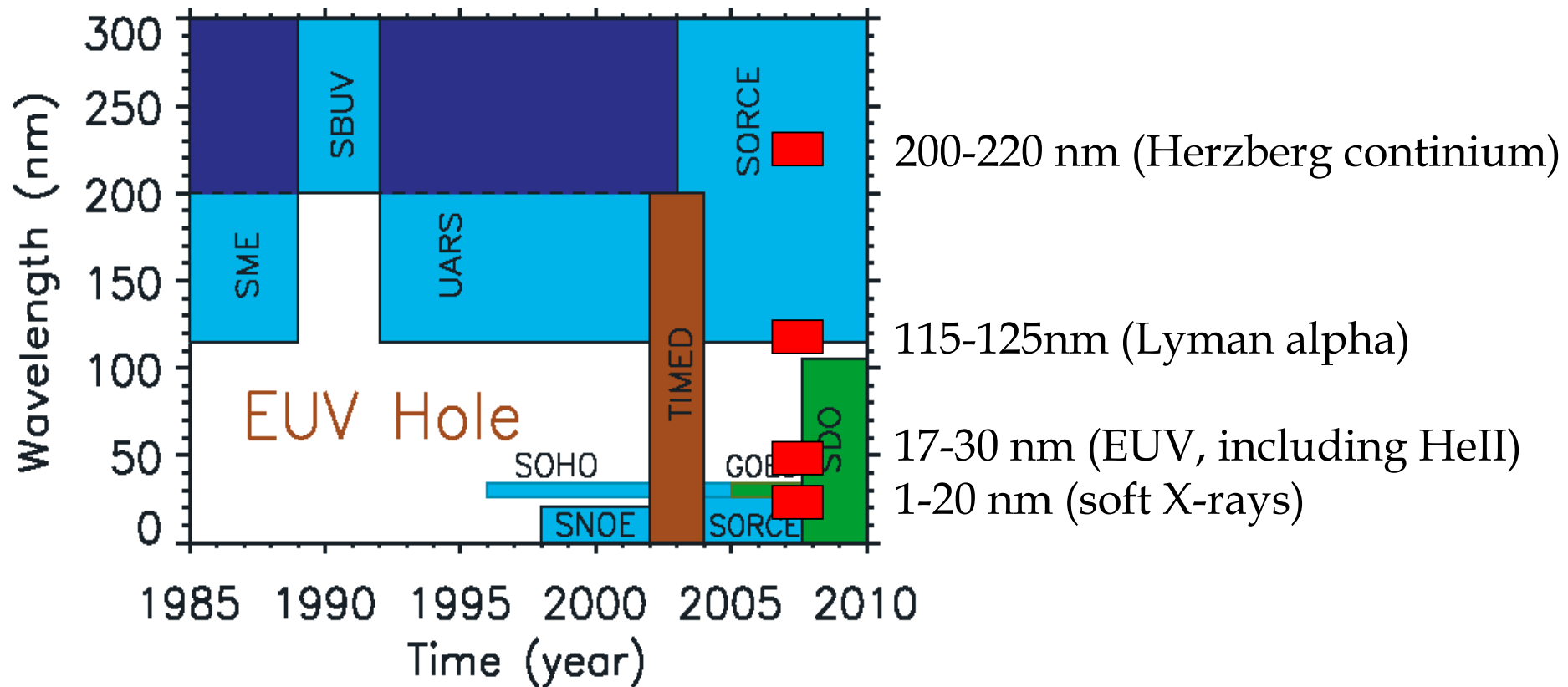


3 units
12 Diamond
detectors

1 unit = 4 wavelength channels



LYRA Passbands



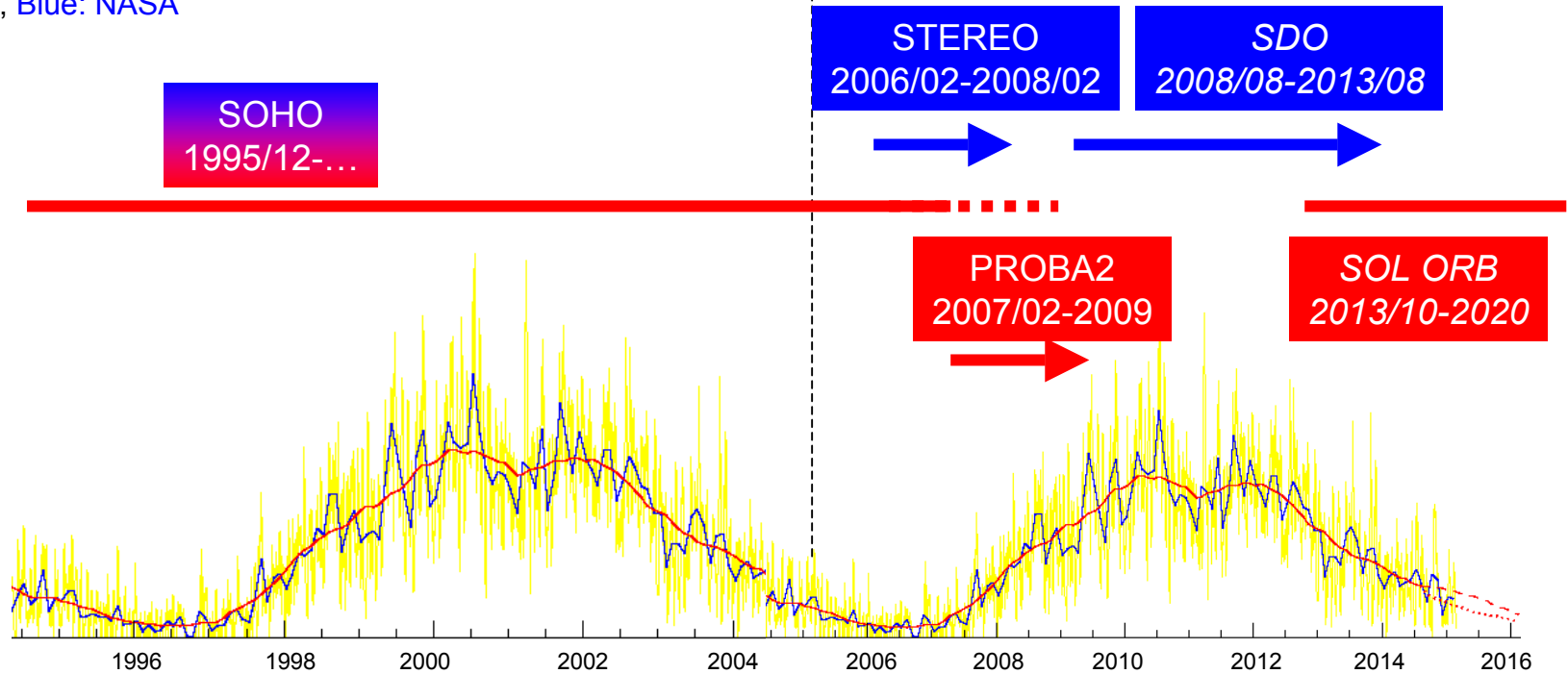
Woods et al 2005

LYRA operates at 100Mhz!

Relation to other missions

Red: ESA, Blue: NASA

SIDC International
Sunspot Number



PROBA2/SWAP as

- 5th wavelength (alternative) for SOHO/EIT
- high cadence extension for SOHO/EIT
- third eye for STEREO/EUVI
- as instrument studying the EUV counterpart in the STEREO coronagraph domain
- as technology demonstration for Solar Orbiter

SWAP and LYRA science Consortium (SCSL)

- Daniel Moses USA
- Daniele Spadaro Italy
- Peter Gallagher Ireland
- Didier Fussen Belgium
- Udo Schühle Germany
- Vladimir Slemzin Russia
- Bart Depontieu USA
- Tatiana Egorova Switzerland
- Thierry Dudok Dewitte France
- Volker Bothmer Germany
- Werner Schmutz Switzerland
- David Berghmans Belgium
- Julian Gröbner Switzerland
- Louise Harra United Kingdom
- Matthieu Kretzschmar Italy
- Jean-Francois Hochedez Belgium
- Don McMullin USA
- Tom Woods USA

Conclusions



- 2 instruments with high potential for space weather studies
- Open data policy, complementary to other missions
- Insufficient telemetry
- Lack of international visibility



LYRA - Consortium

**J.-F. Hochedez¹, W. Schmutz², M. Nesladek^{3a+b}, Y. Stockman⁴, U. Schühle⁵,
A. Ben Moussa¹, S. Koller², K. Haenen^{3b}, J.-P. Halain⁴, D. Berghmans¹, J.-M. Defise⁴,
D. Gillotay⁶, V. Slemzin⁷, A. Mitrofanov⁷, D. McMullin⁸, M. Kretzschmar⁹, M.
Dominique¹, A. Theissen¹, B. Nicula¹, L. Wauters¹, S. Gissot¹, V. Delouille¹,
J.H. Lecat⁴, H. Roth², E. Rozanov², I. Ruedi², C. Wehrli², R. Van der Linden¹,
A. Zhukov¹, F. Clette¹, M. d'Olieslaeger^{3a+b}, J. Roggen¹⁰, P. Rochus⁴**

¹ Royal Observatory of Belgium, Circular Avenue 3., B-1180 Brussels, Belgium

² Physikalisch-Meteorologisches Observatorium Davos (PMOD) and World Radiation Center (WRC), Dorfstrasse 33, 7260 Davos Dorf, Switzerland

^{3a} IMOMEC, Wetenschapspark 1, B-3590 Diepenbeek, Belgium

^{3b} Institute for Materials Research, Limburgs Universitair Centrum, Wetenschapspark 1, B-3590 Diepenbeek, Belgium

⁴ Centre Spatial de Liège - Av. Pré Aily B-4031 Angleur - Belgium

⁵ Max-Planck-Institut für Sonnensystemforschung MPS - D-37191 Katlenburg-Lindau - Germany

⁶ Belgian Institute for Space Aeronomy, Circular Avenue 3., B-1180 Brussels, Belgium

⁷ Lebedev Physical Institute, 53 Leninsky Prospect, Moscow, 119991, Russia

⁸ Naval Research Laboratory, 4555 Overlook Ave., S.W., Washington, DC 20375, USA

⁹ Istituto Fisica dello Spazio Interplanetario, Consiglio Nazionale delle Ricerche, Via del Fosso del Cavaliere, 100, I-00133 Roma, Italy

¹⁰ IMEC, Kapeldreef 75, B-3001 Leuven, Belgium



J. M. Defise
J.H. Lecat
T. Thibert
L. Rossi
P. Rochus
P. Franco
J.M. Gillis
E. Mazy
J.P. Halain

MPS

U. Schule

D. Berghmans
J.F. Hochedez
B. Nicula
G. Lawrence
A. Zhukov
V. Slemzin
R. Van der Linden
F. Clette
L. Wauters
T. Katsyannis
L. Podladchikova

A passband for space weather

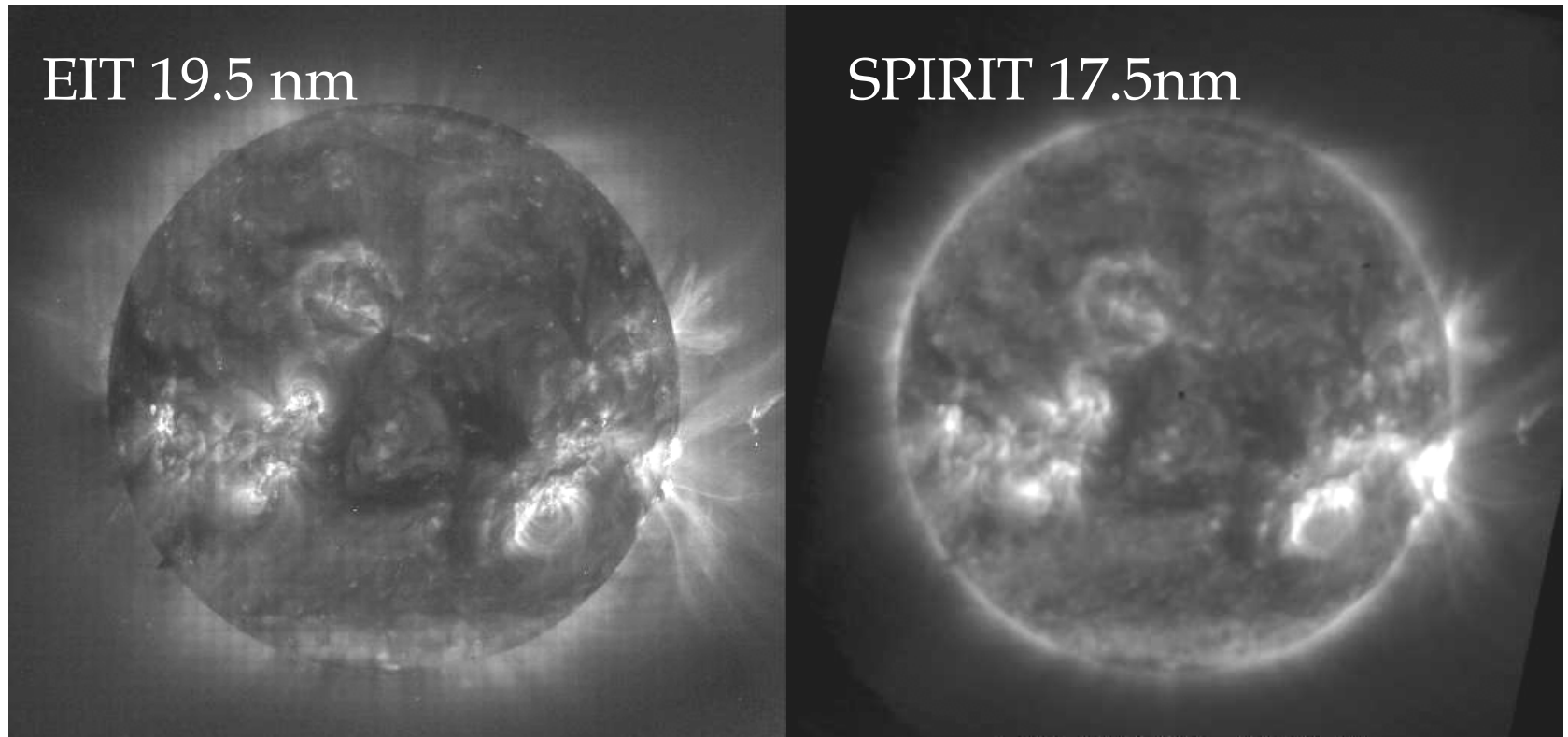
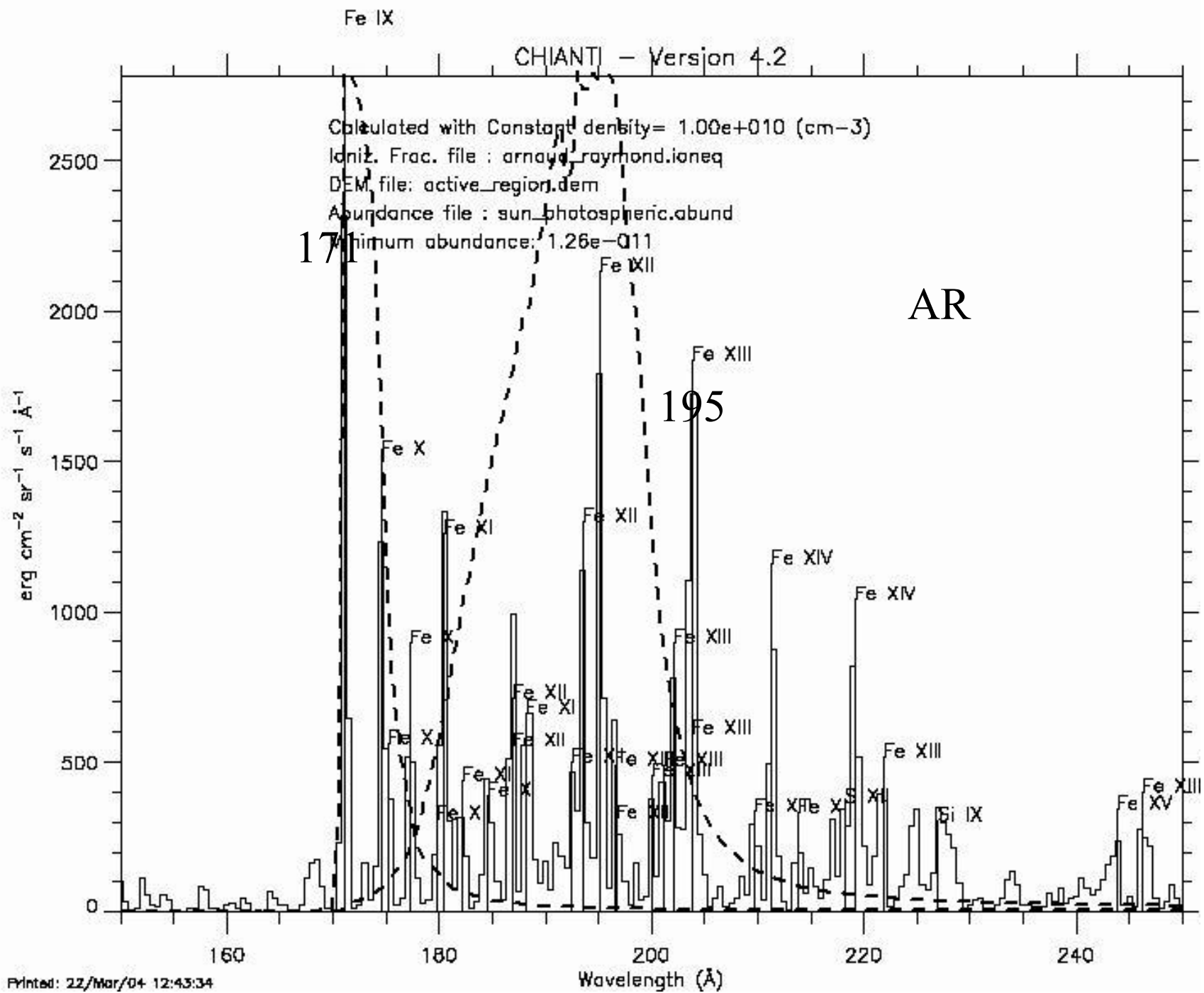


Image Courtesy: V. Slemzin



Temperature response for MLC-mirrors
with different period d
($\log EM=27$)

