THE PICARD mission

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Jean PICARD (1620 - 1682)

Outline

PICARD launch and solar activity predictions

PICARD scientific objectives

PICARD measurements

PICARD Mission with its associated measurements

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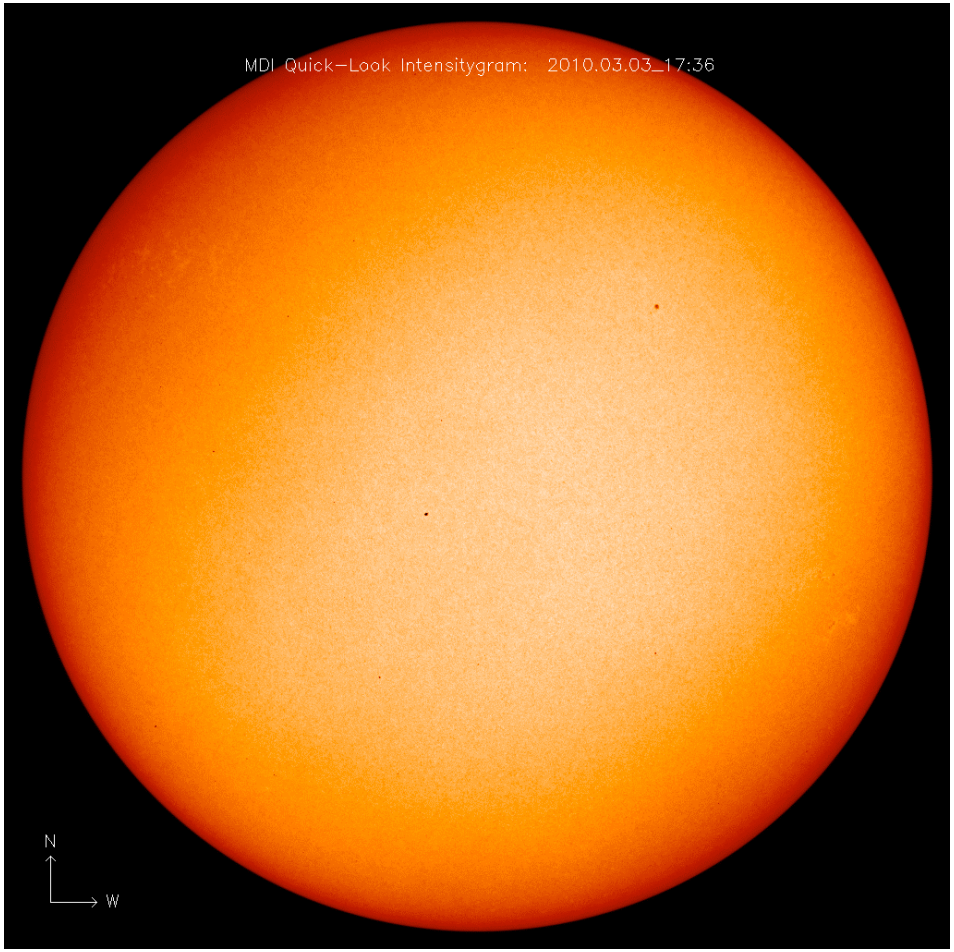
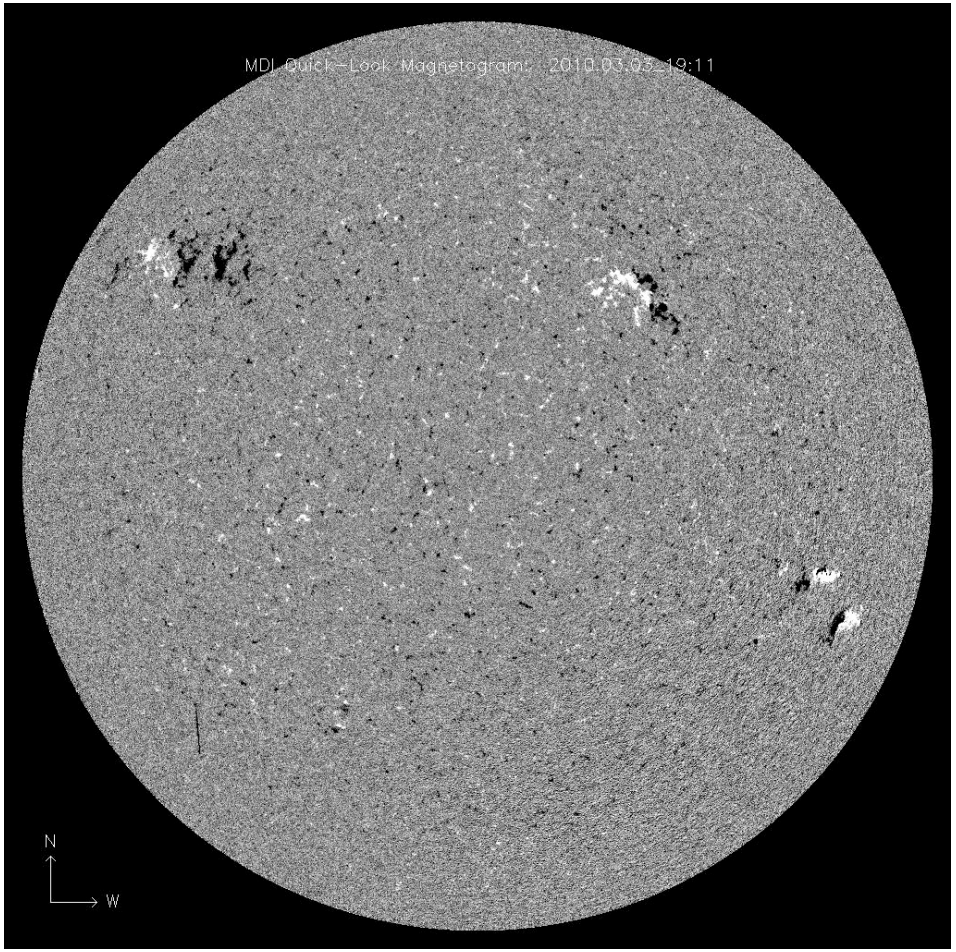
Workshop 8-9 March 2010

MDI DATA 3 MARCH 2010

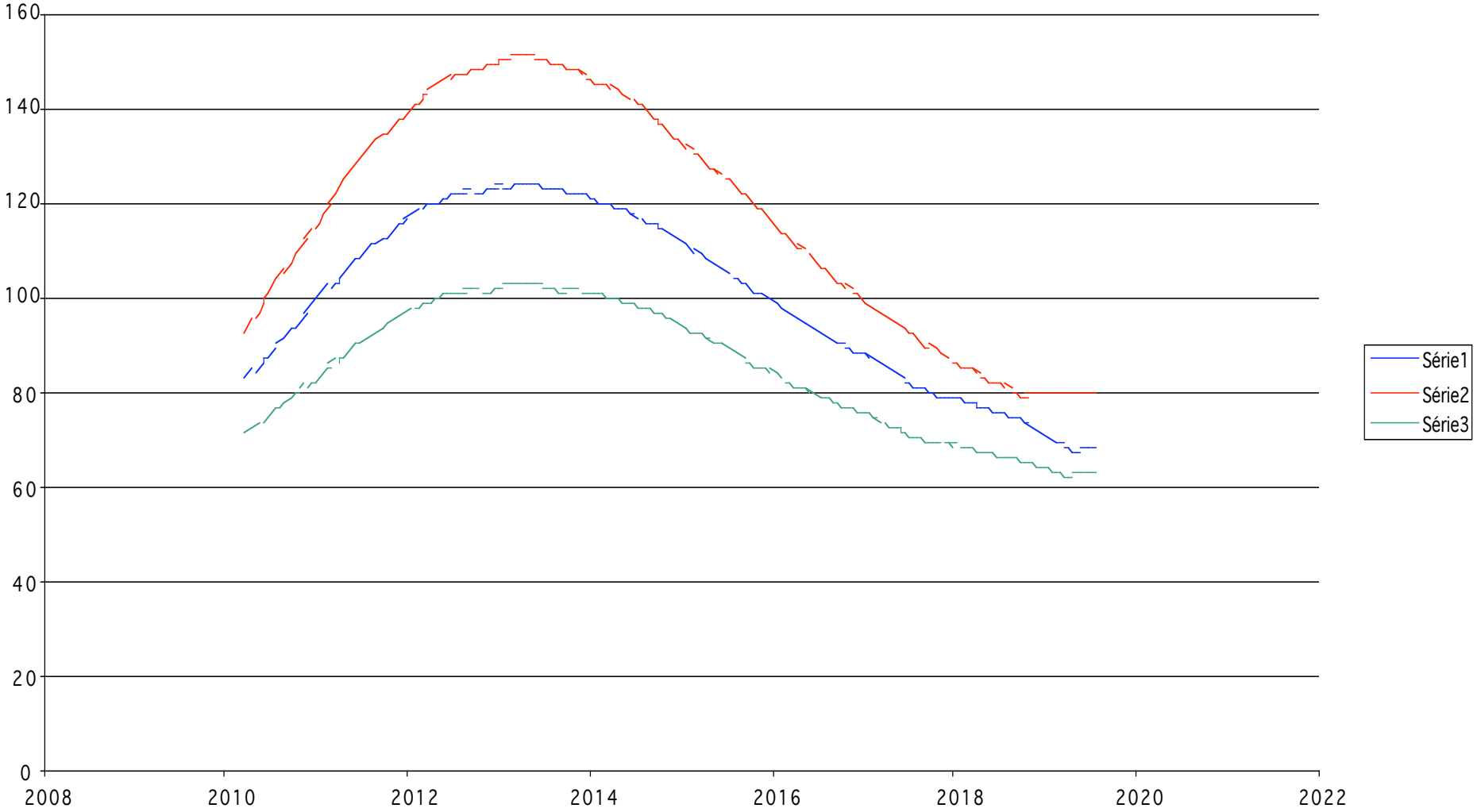


INTENSITY



MAGNETOGRAM

PICARD and the solar activity



Solar activity prediction by Ken Schatten (28 February 2009).
The blue prediction is the one having the highest probability.

PICARD MISSION MAIN SCIENTIFIC OBJECTIVES

(1) Modelling of the solar machine

using simultaneous measurements of several fundamental solar properties and their variability.

Role of the magnetic field, on surface or deeper in the convective zone. Origin of the solar activity?

(2) Contribution to solar luminosity reconstruction for application to climate modeling

(3) Long term trend using the solar diameter refered to stars angular distances

(4) Understanding of the ground based measurements

(5) Contribution to Space Weather

PICARD MISSION SPECIFIC FEATURES

The PICARD mission is based on:

- a spacecraft carrying several instruments,

- several investigations from the ground and from balloon,

- the development of solar models to interpret the measurements,

- the development of climate models.

THE PICARD MEASUREMENTS FROM SPACE

To achieve the PICARD objectives, the following measurements will be made:

- TSI by two independent radiometers as on board SoHO,

- Bolometric measurements (unscaled TSI),

- Solar oscillations (helioseismology),

- Diameter, asphericity and limb shape measured in the solar photospheric continuum using an imaging telescope incorporating an angular reference,

The absolute diameter will be referred to a set of angular distances of
9 couples of stars for future use.

- Spectral irradiance at several wavelengths using photometers with redundancy,

- Data from the SES system sampled at 4Hz, will be also available (782 nm).

SYNERGY BETWEEN SPACE AND GROUND BASED MEASUREMENTS

- allows validation of the space data,

- provides complementary information (e.g. wavelength, ……),

- allows to extend the period of measurement,

- allows to extend studies to other scientific fields (e. g. atmospheric science).

COMPLEMENTARY MEASUREMENTS DURING THE PICARD MISSION

- PICARD-Sol, including SODISM II

- SOLAR DISK SEXTANT: Balloon based instrument providing the first reference of diameter and solar limb shape measured at low solar activity. The first flight was achieved on 17 October 2009.

- Eclipse observations providing diameter and limb shape information. This technique could be used for long terms observations.

- Diameter measurement by transit method.

- PSPT images

- High resolution Ca II images at Observatoire de Meudon

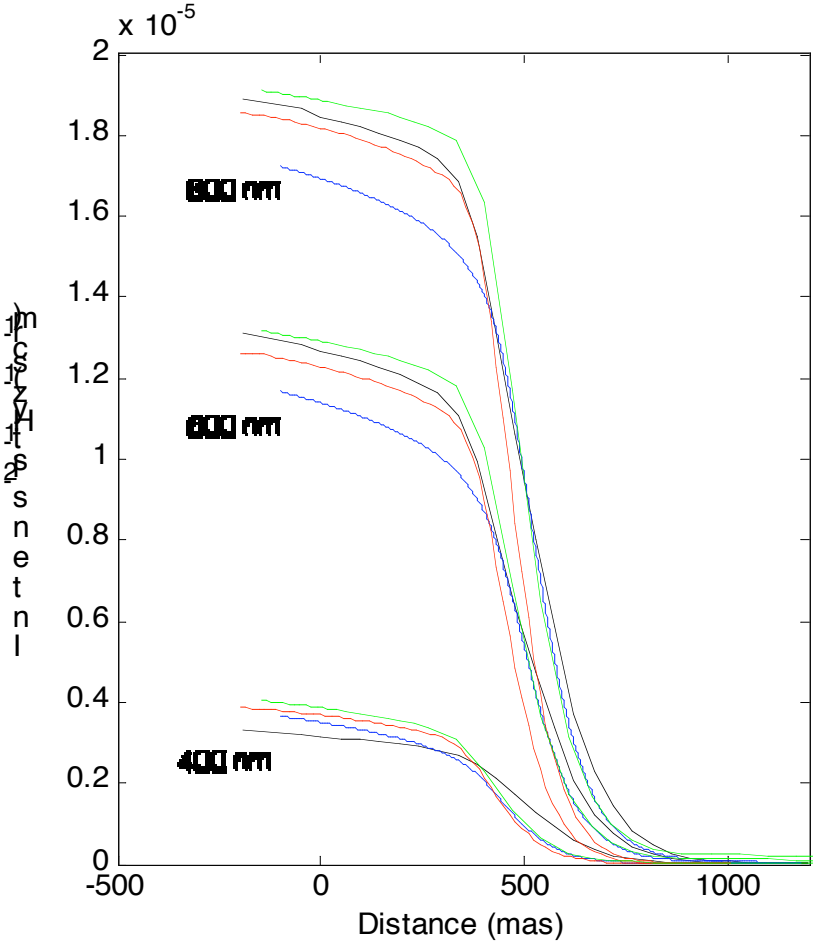
SOLAR MODELING

Solar modeling: solar interior and atmophere at CEA and Yale

Climate Modelling: EC, LATMOS and PMOD

Limb modelling: PMOD, LASP, U. St Mary, EC and LATMOS

Simulations using different models



Limb shapes for three wavelengths predicted by:
SH09 (red), FCH09 (black),
VAL-C (blue), and COSI (green),
without Fraunhofer lines

An article has been submitted showing the different predictions in the solar continuum and active regions and their applications to PICARD data.

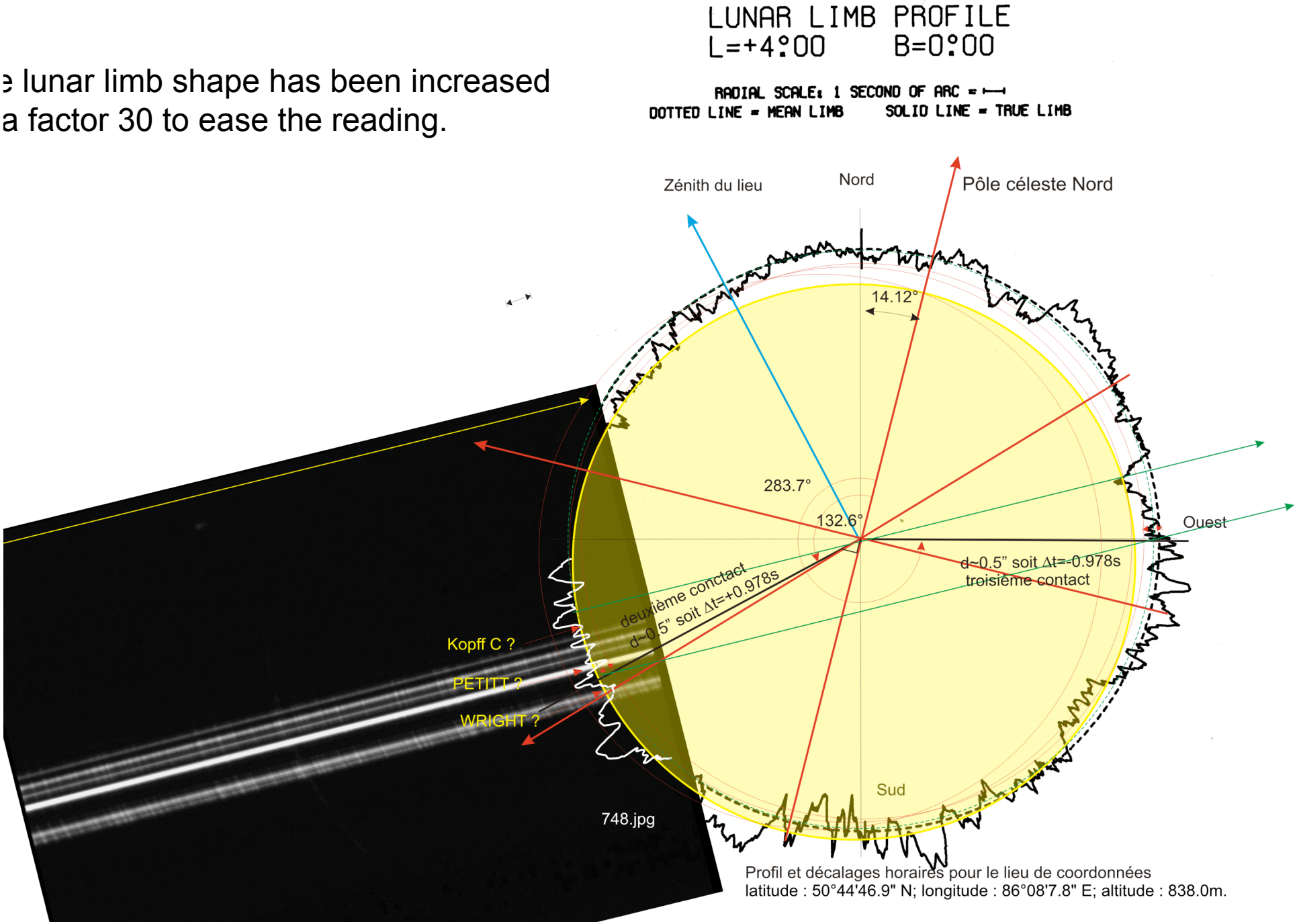
DIAMETER MEASUREMENT USING SOLAR ECLIPSES

PRELIMINARY RESULTS OF THE 22 JULY 2009 ECLIPSE measured on China

Team: **A. Baillard, C. Bazin, S. Koutchmy, F. Ricquebourg, P. Rocher, F. Sèvre, J-Y Prado, Philippe Lamy from LAM, IAP, IMCCE, CNES**

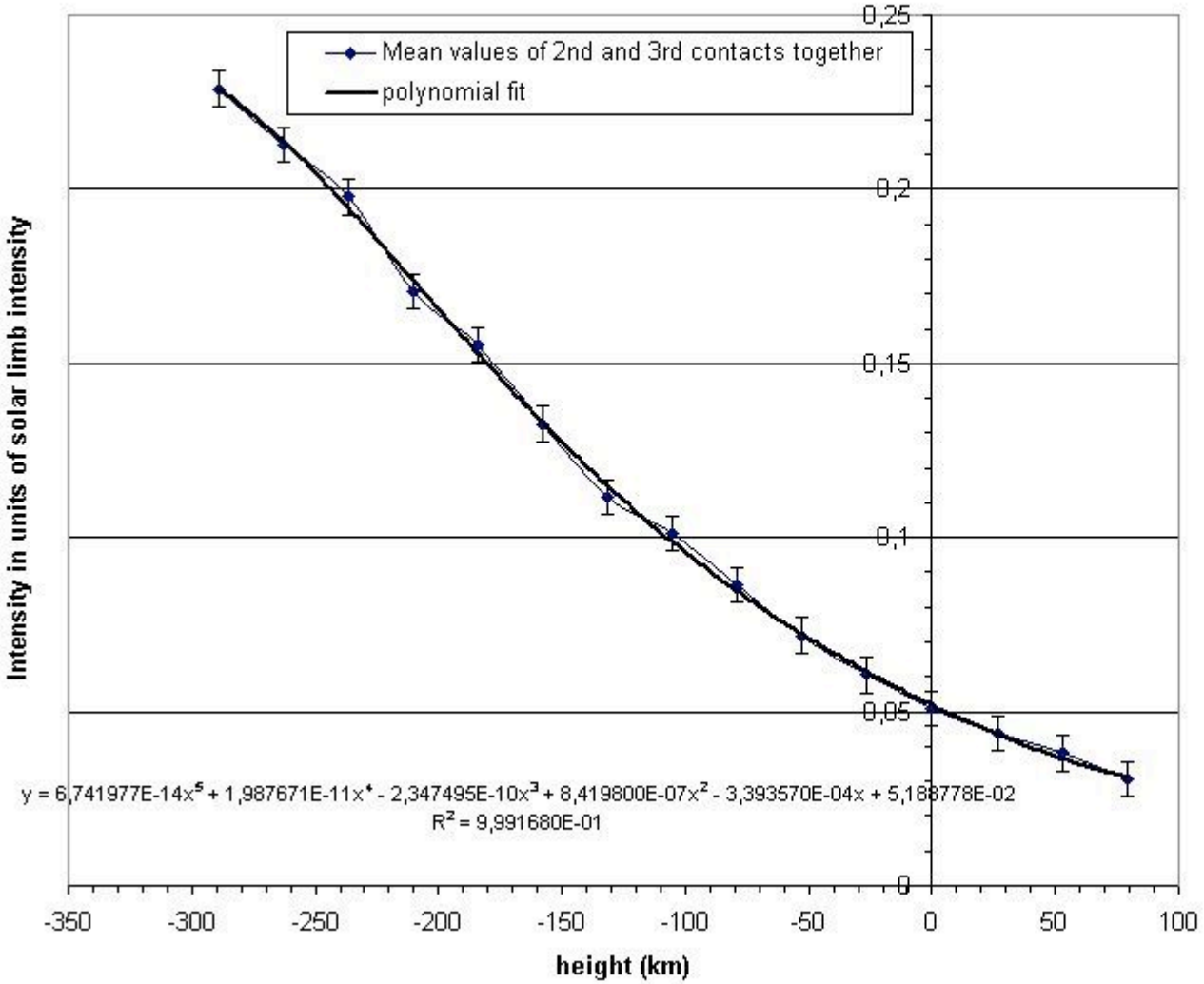
Principle: the moon acts as a sharp edge. This method is relatively free from atmospheric effects as the occultation is performed in vacuum. An important condition is the fast sampling (15 / s) and precision of dating.
The movement of the Moon is very well known, and allows us to precisely relate the time of measurements with the altitude in the solar atmosphere.

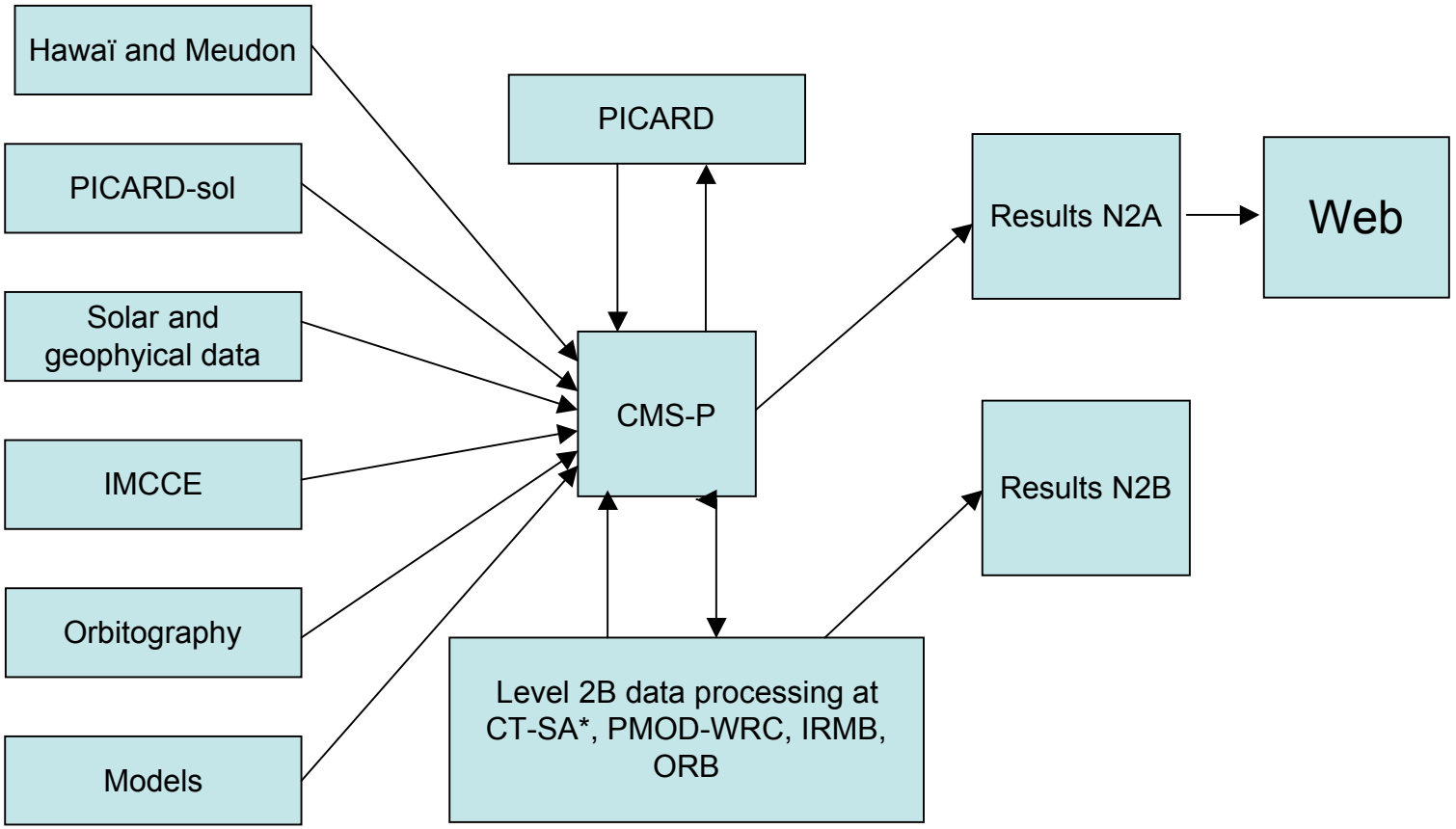
e lunar limb shape has been increased
a factor 30 to ease the reading.



Profil et décalages horaires pour le lieu de coordonnées
latitude : 50°44'46.9" N; longitude : 86°08'7.8" E; altitude : 838.0m.

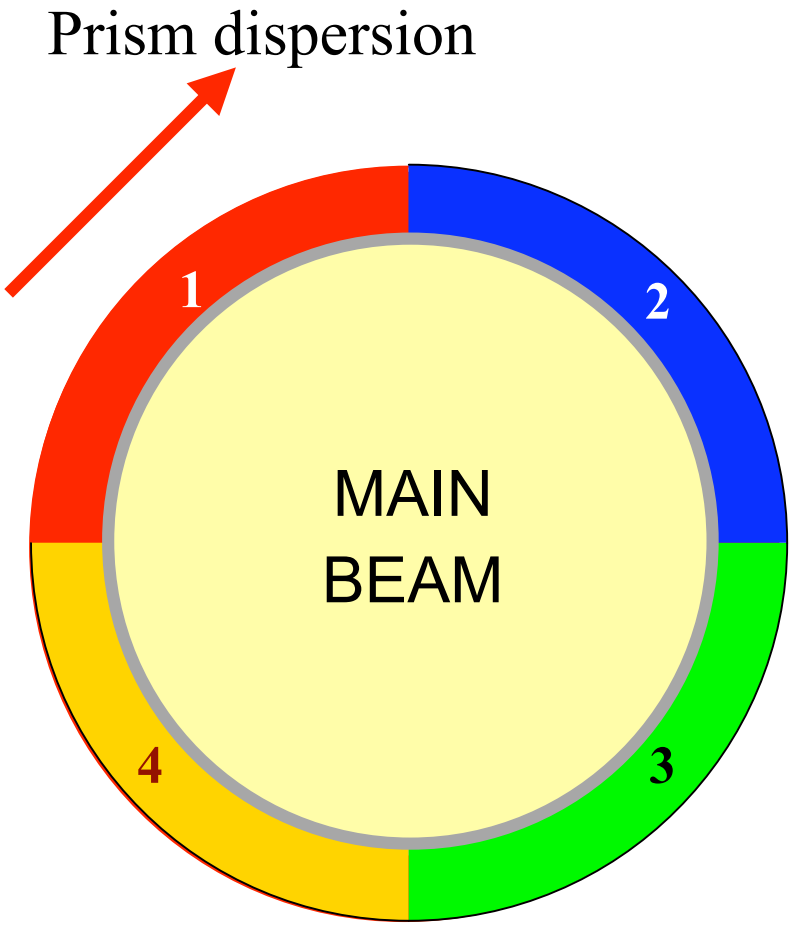
Mean values of 2nd and 3rd contacts of the continuum with the height above the limb
22nd July 2009 solar eclipse in China



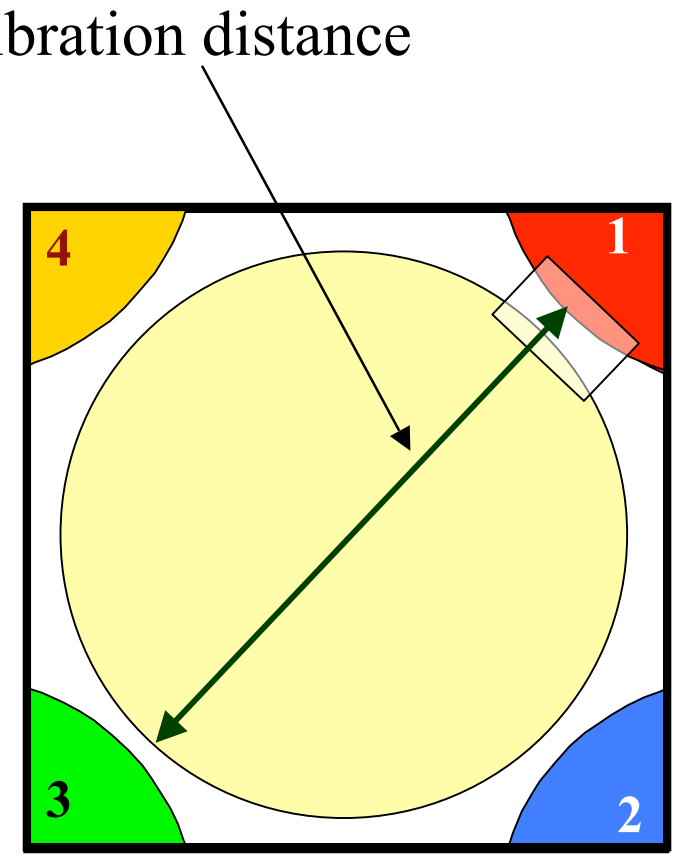


* processing of stellar data, optical distorsion, flatfield, thermal corrections, …

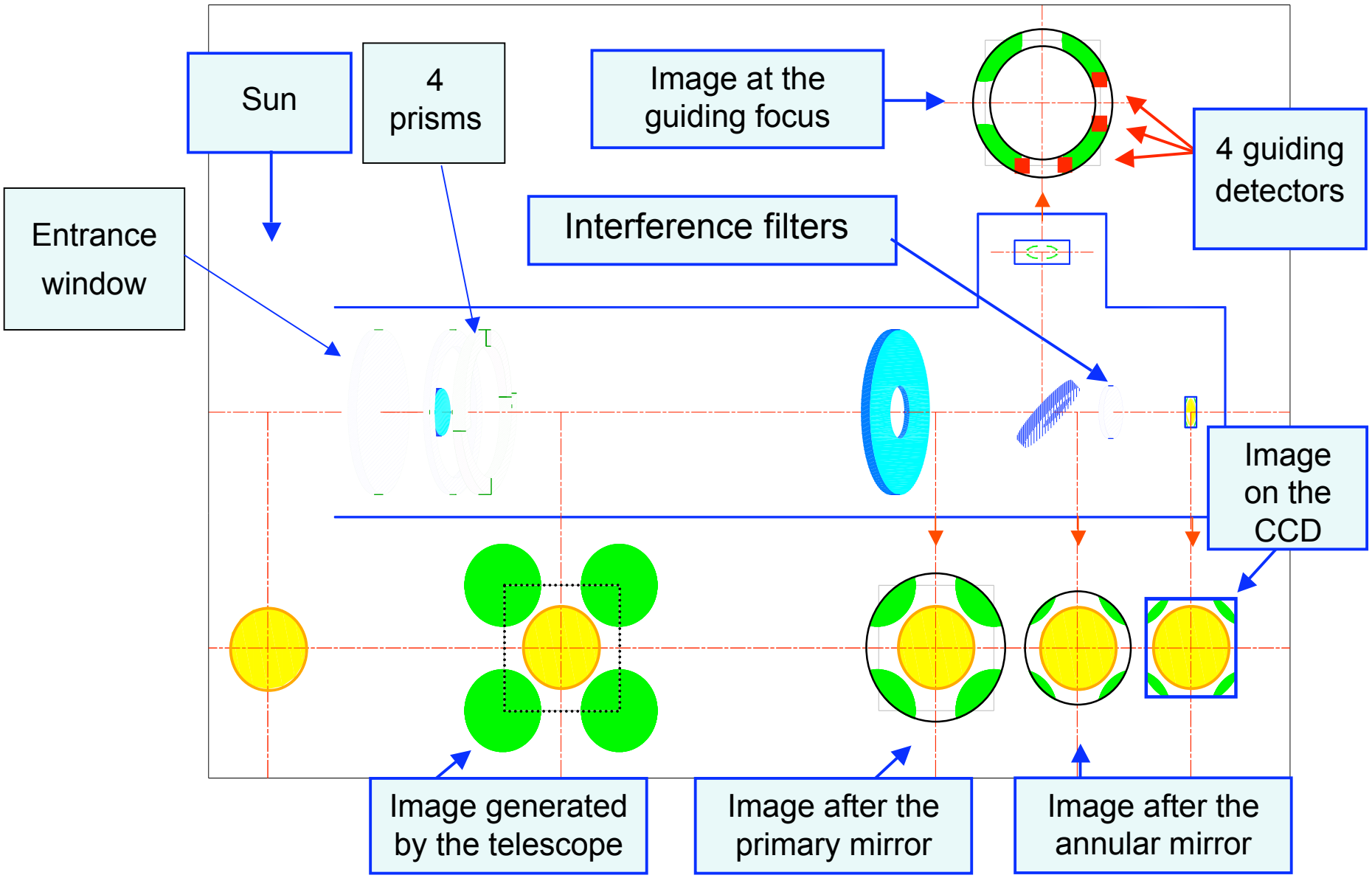
SODISM - MAIN IMAGE - AUXILIAIRY IMAGES



PUPIL PLANE

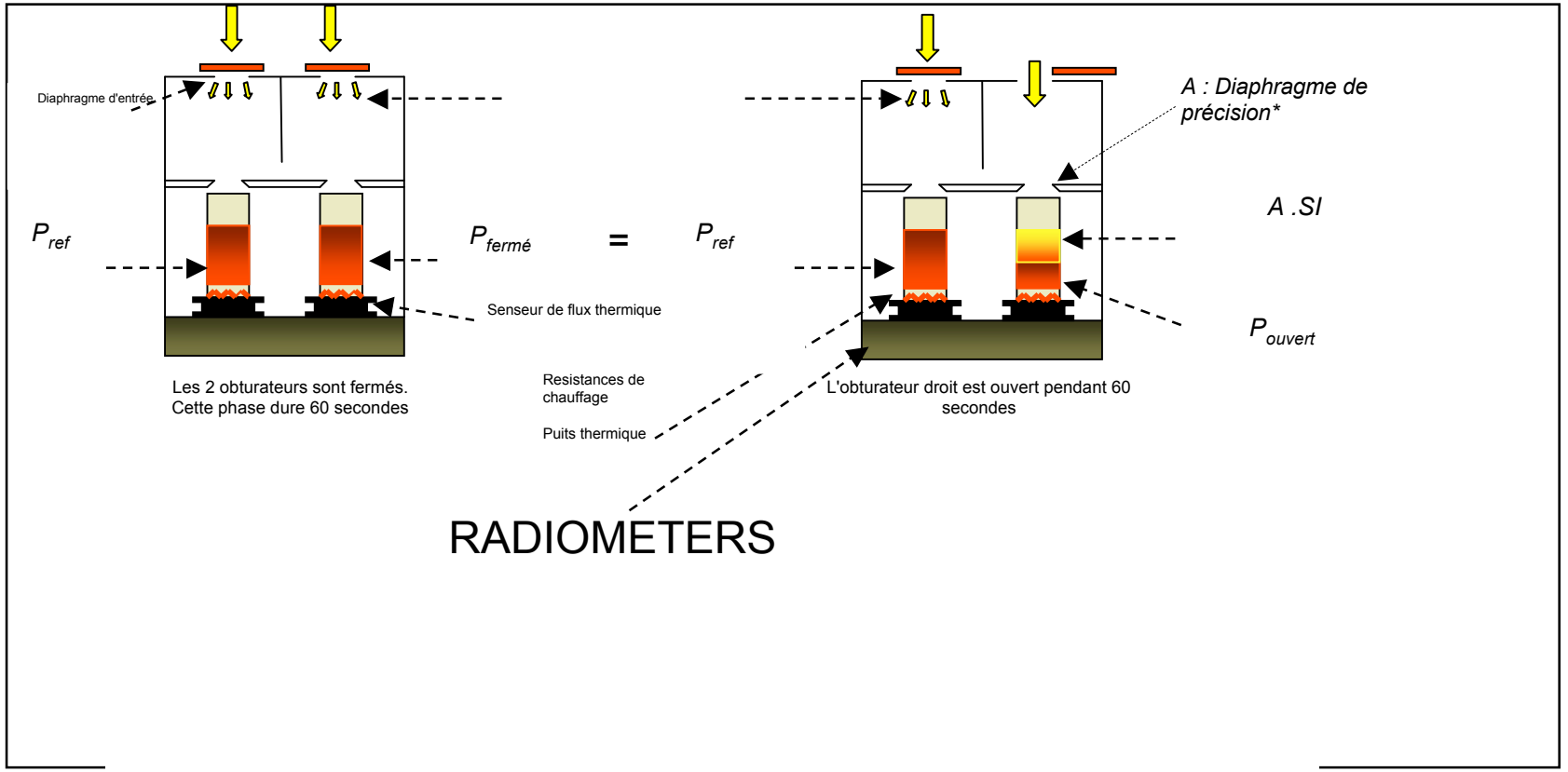


CCD PLANE

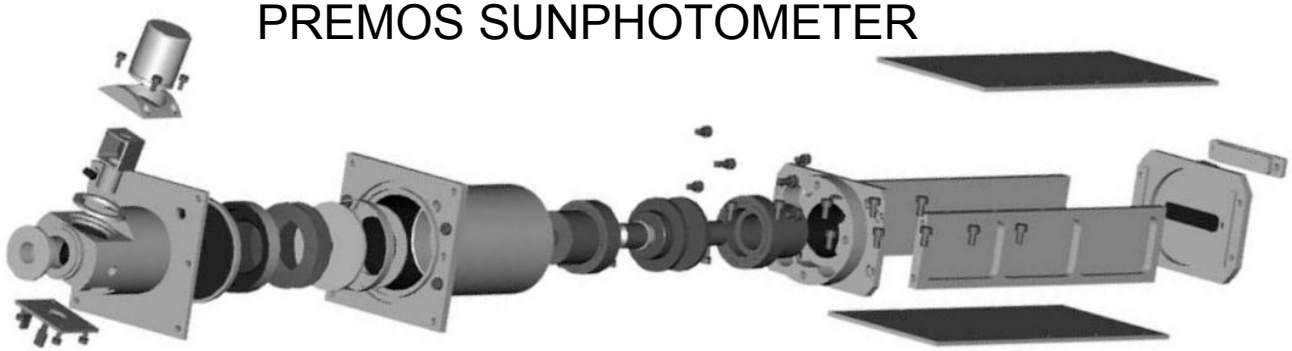


SODISM OPTICAL SCHEMATICS

PRINCIPLE OF PREMOS AND SOVAP TSI MEASUREMENT



PREMOS SUNPHOTOMETER



SODISM DATA

THREE TYPE OF IMAGE:

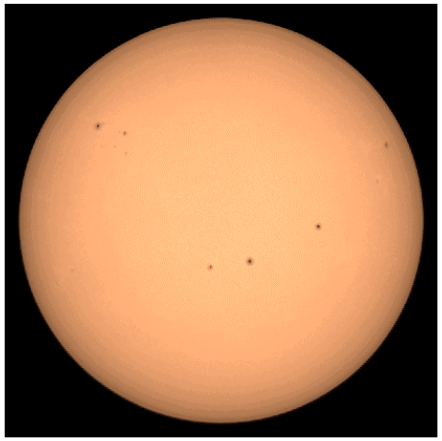
1) Helioseismology measurements at λ = 535 nm :

- Limbs 22 pixels width (1/2MN)

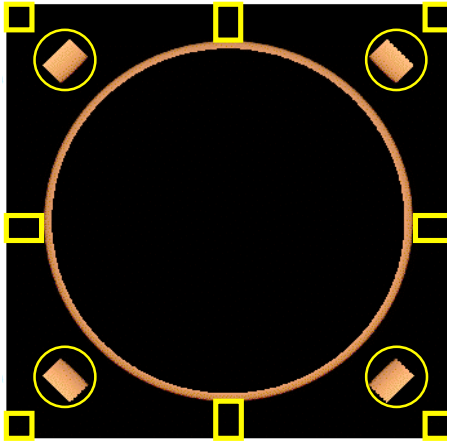
- Macropixels (8 x 8) each minute

2) Full Images (1/orbit/λ; λ = 215, 393, 535, 607, 782 nm)

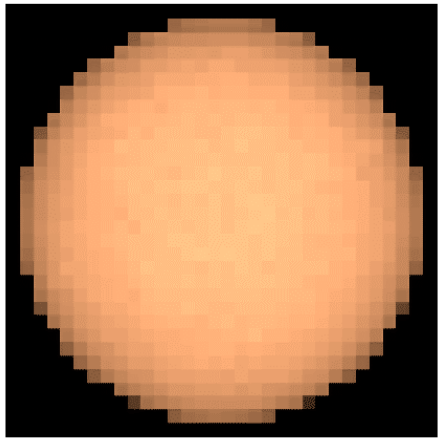
3) Diameter measurements: Limb 40 pixels width (2/orbite/λ)



Full Image



Limb and reference



Macropixel image

Other: Images DK & Flat Field (1/d/λ); monthly stars couple;
Instrument characterisation: internal scale, scattered light, DK

MEASUREMENTS CARRIED OUT by PICARD

Instrument	Measurements	λ (nm)	Sampling	Int. Time
SODISM	40 pixels limb width	215,393,535.7, 607, 782	2 / orbit / λ	1 s
SODISM	22 pixels limb width	535.7	2 mn	8 s
SODISM	8x8 macropixels (full disk)	535.7	1 mn	8 s
PREMOS	Spectral irradiance	215	0.1 s	0.1 s
PREMOS	Spectral irradiance	268,535.7,607,782	10 s	10 s
PREMOS	TSI	NA	2 mn	20 s
SOVAP	TSI	NA	3 mn	10 s
BOS	Bolometric meas. (Δ TSI)	NA	10 s	10 s
Instruments on ground	Limb and full imagess	All λ except 215 nm	TBD	As SODISM I

Measurements in orbit are synchronized with the one minute signal

SPECIAL OBSERVATIONS

SODISM:

OPTICAL DISTORSION: by rotation of the spacecraft

FLATFIELD: by sun scanning using the primary mirror

STELLAR OBSERVATIONS: by spacecraft pointing toward two stars having an angular distance of about 30 arcminutes.

RADIOMETERS:

Covers thermal emissivity
Dark current

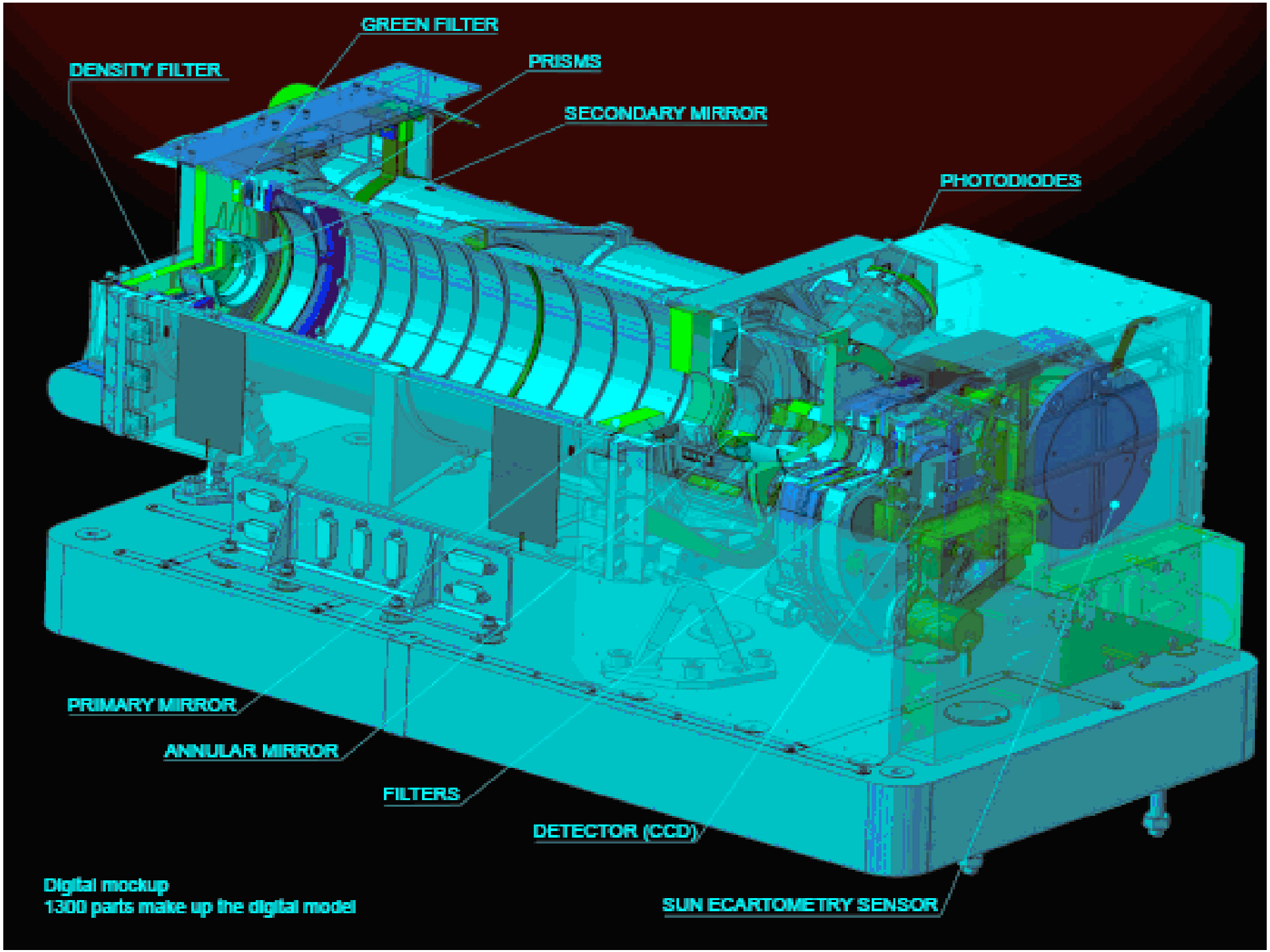
COMMISSIONING PHASE

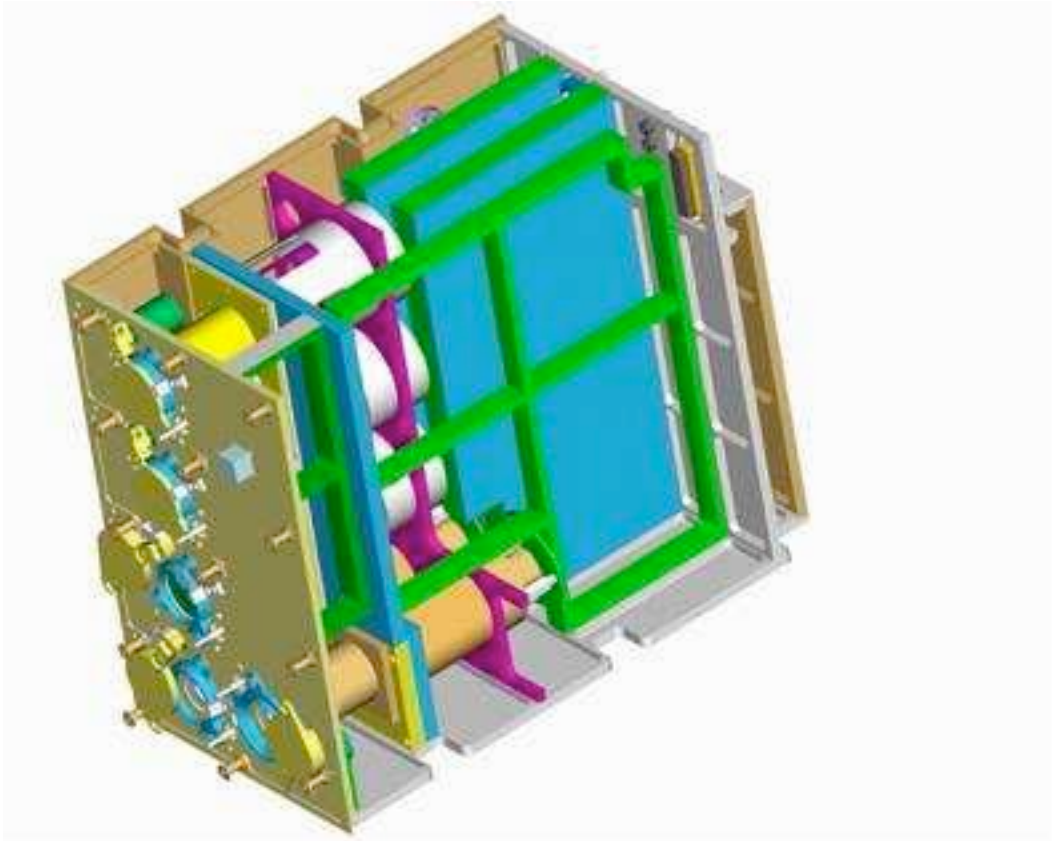
The first month in orbit in orbit will be dedicated to the outgassing of the equipments and different mechanical actions (unlocking of doors, check of mechanisms, sequencing, instruments parameters adjustment, ….).

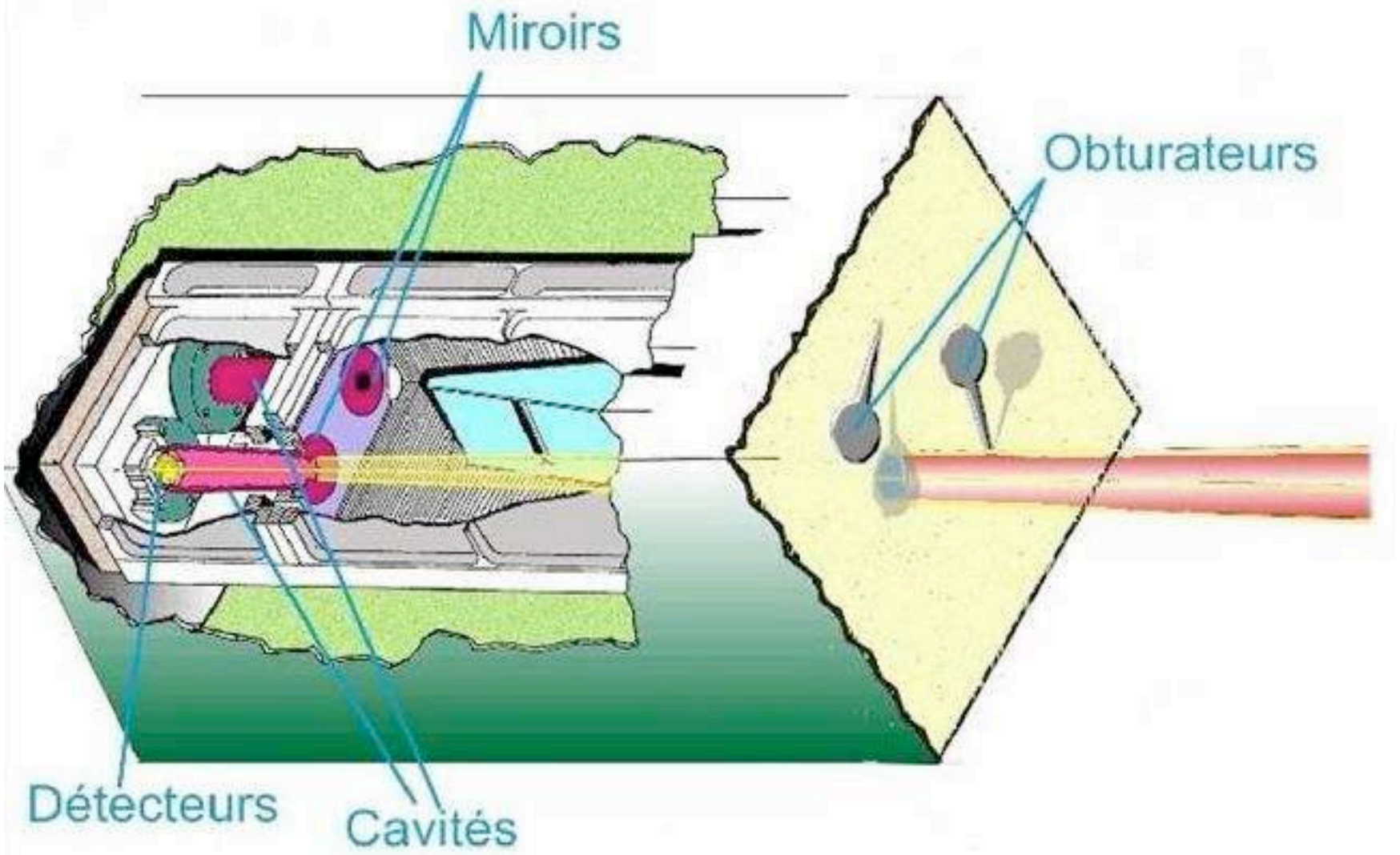
The first light is now foreseen 6 weeks after launch.

An important operation is the angular biais between the instruments and the Sun Pointing Sensor (SES).

Series of reference measurements will be registered for analysis by the instruments.


GREEN FILTER
DENSITY FILTER
PRISMS
SECONDARY MIRROR
PHOTODIODES
PRIMARY MIRROR
ANNULAR MIRROR
FILTERS
DETECTOR (CCD)
SUN ECARTOMETRY SENSOR
Digital mockup
1300 parts make up the digital model




Miroirs
Obturateurs
Détecteurs
Cavités

SUMMARY and CONCLUSION

- Solar activity development is just appropriate for PICARD mission

- Launch

- The instruments are in good shape

- The commissioning phase is well organised, which will allow us to adjust the different instruments parameters for optimized configuration

- CMSP is ready for receiving data, commanding the instruments, and processing
up to level 2A.

- A SDS flight is expected for September 2010

- The PICARD-sol instruments will be in operation by September 2010

- Complementary images will be provided by Observatoire de Meudon and PSPT

- PICARD will also benefit of the SORCE and ISS solar spectrum measurements

- SDO being launched, data will be available for complementary investigations.