平成 28 年 2 月 26 日

国立研究開発法人
産業技術総合研究所　殿

検査成績書

売買契約書　整理番号　AA15046738
表題：自動太陽追尾サンフォトメーター　1 式

		動作確認
電気ボックス		合格
アンテナ	GSM, RADIO、GPS	合格
センサヘッド	CE318T TU9　（BRDF）	合格
コリメーター		合格
太陽自動追尾用ロボット　動作確認		合格
AC/DC アダプタ　（100VAC を 12VDC 変換）		合格
CD/ROM　（計測ソフトウエア）		合格
USB ケーブル、その他ケーブル類		合格
光学フィルター9 種類のデータ（電子、印刷）		合格
光学ワイプ（光学窓クリーニング用）		合格
取り扱い説明書（ハードウエア）1 冊（英文）		合格
同、計測ソフトウエア用		合格

以上動作確認の上納品させて頂きました。

〒231-0004 横浜市中区元浜町 3-21-2
ヘリオス馬車道ビル 305 号室
ホロニクス・インターナショナル株式会社
代表取締役 高橋幹明

CIMEL Electronique
172 rue de CHARONNE - 75011 - PARIS
Téléphone : 01 43 48 79 33
Télécopie : 01 43 48 62 61
Web: http://www.cimel.fr

Automatic PHOTOMETER CE 318 - TU9

Date	**February , 2016**
Customer	Japan
Order N°	**150207**

STATEMENT of TESTS & CONFORMITY

	Qt.	Part	N °
X	1	**Electronic box CE 318 - C**	1602 - 038 / **UA 4797**
X	3	**Antenna for electronic box**	GSM Radio GPS
		" 97685 " " 97686 " " 97687 "	
X	1	**Head CE 318 - T**	1602 - 039 / **T 1320 TU9**
X	1	**Collimator**	CL 211 – 1379¤¤ – 1517
X	1	**Head photometer's cable**	**15 pts** 12 m
X	1	**Azimuthally Robot CE 318 - M**	1602 - 040 *with calib report*
X	1	**Robot motor's calibration report**	AZ & ZN 12m cable
X	1	**Cable collar**	PVC Nicoll
X	1	**Directional Antenna**	5m cable
	with	**Solar panel**	K S 5 – 12V *Phoenix*
	with	**Wetness sensor**	CE 187 1,5 m
X	1	**Lighting rod with M10 nut**	
X	1	**Copper braided wire for ground network 16mm² in 25m coils with one copper tubular lug M10**	
X	1	**Earth rod + lug**	
X	1	**Couple of batteries 6V**	with cable
X	1	**Supply 100 ~ 240 V** *MASCOT*	SP green connector / plug cable
X	1	**PC serial transfer cable**	PC / DCP
X	1	**PC transfer cable USB A - USB B**	USB *" 89024 "*
X	9	**Paper printed filter curves**	**T 1320 TU9**
X	1	**CD ROM** *with filters data files*	
X	1	**Cleaning optic cloth**	

CIMEL Electronique

172 rue de CHARONNE - 75 011 - PARIS
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HEAD NUMBER	1320 TU9

DATE	Feb 2016

SKY & GROUND CALIBRATION

wavelength	1020	1640	870	675	440	550	740
Coef AUREOL	2.4080E-05	4.4650E-06	2.3638E-05	2.8831E-05	5.1214E-05	3.7636E-05	3.5054E-03
	1020	1640	870	675	440	550	740
Coef SKY	7.5015E-07	1.3910E-07	7.3638E-07	8.9726E-07	1.5943E-06	1.1713E-06	1.0896E-04
		1640	870	675	440	550	740
Coef GROUND	7.5015E-07	1.3910E-07	7.3638E-07	8.9726E-07	1.5943E-06	1.1713E-06	1.0896E-04

Coef = Radiance/Digital Count
Radiance W/m².sr.nm
Wavelength : nm

SUN CALIBRATION

	1020	1640	870	675	440
CN0	633272	1035851	835911	1097562	754683
	550	1020i	936	380	740
CN0	990214	824539	618946	138192	947948

Equipement **ASTP** **Optique**

CE 318 BRDF 9F

In Ga As

Judson

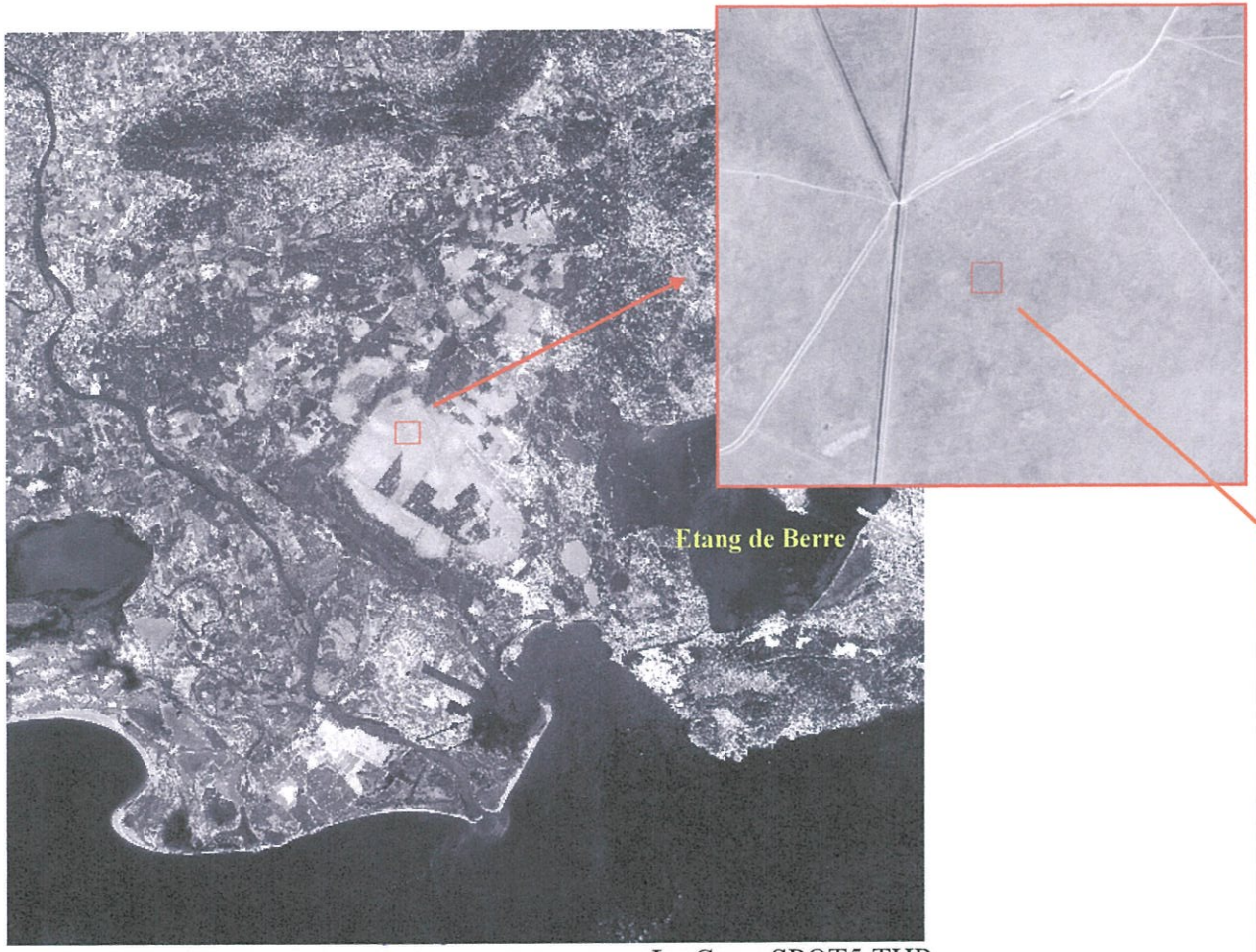
Tête N° >	T 1320 BRDF	
UA N° >	UA 4797	
		Japon

	désignation	cde	code P.	Code lot	batch	N° #
A4	**filtre 440 BP 10 nm** IRIDIAN (Canada)	810362	*74052 IR*	ABX000005	006	19043
A3	**filtre 675 BP 10 nm** JDSU (USA)	810364	*74062 JD*		03	413
A2	**filtre 870 BP 10 nm** IRIDIAN (Canada)	810365	*74068 IR*	ABX000008	005	13938
WV2	**filtre 937 BP 10 nm** IRIDIAN (Canada)	810366	*74070 IR*	ABX000009	004	19293
A1	**filtre 1020 BP 10 nm** IRIDIAN (Canada)	810367	*74072 IR*	ABX000010	007	18300
UV2	**filtre 740 BP 2 nm** BK	810360	*74049 IR*	ABX000003	n°3	#
UV1	**filtre 380 BP 4 nm** IRIDIAN (Canada)	810361	*74050 IR*	ABX000004	007	17362
N	**filtre 550 BP 10 nm** BK	810363	*74054 JD*		02/03	11
WV1	**filtre 1640 BP 25 nm** IRIDIAN (Canada)	810368	*74077 IR*	ABX000012	006	16919

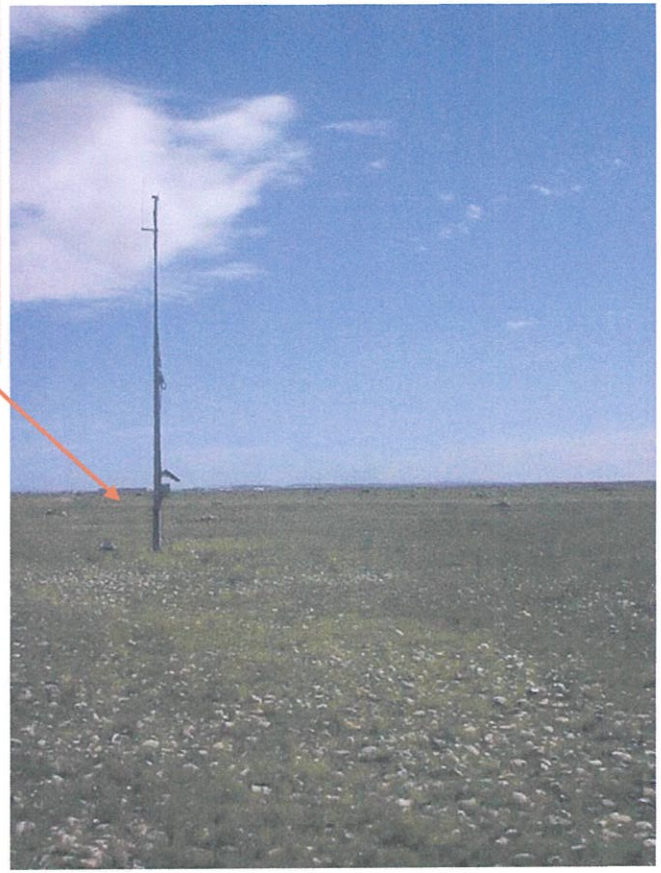
La Crau - ROSAS

(RObotic Station for Atmosphere and Surface)

P. Henry - A. Meygret

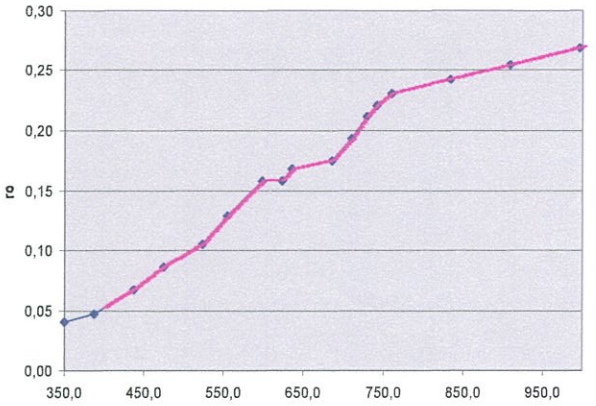


La Crau, SPOT5 THR



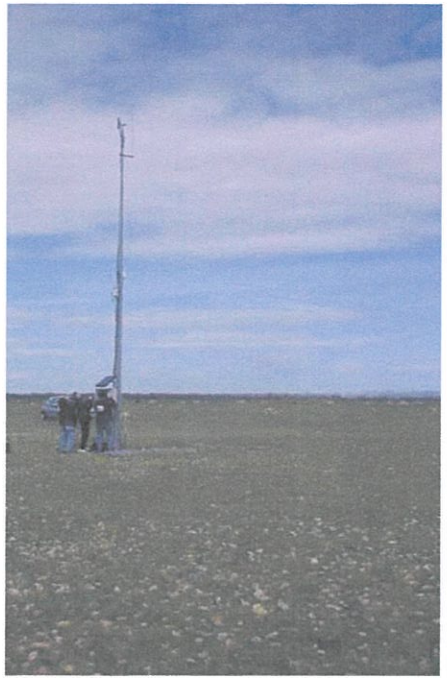
The calibration site

- Situation: La Crau
  - located South-East of France (lat. = 43.56° ; long. = 4.86°)
  - rather good surface stability (dry area with small rocks)
- Calibration historic
  - first CNES campaign in march 1989 (coop. with LOA and INRA)
  - 9 SPOT 1 calibrations (1989 ⇒ 1993)
  - In 1994 : decision to develop an automatic calibration station



The calibration instrument

- CIMEL Instrument
  (derived from AERONET one)



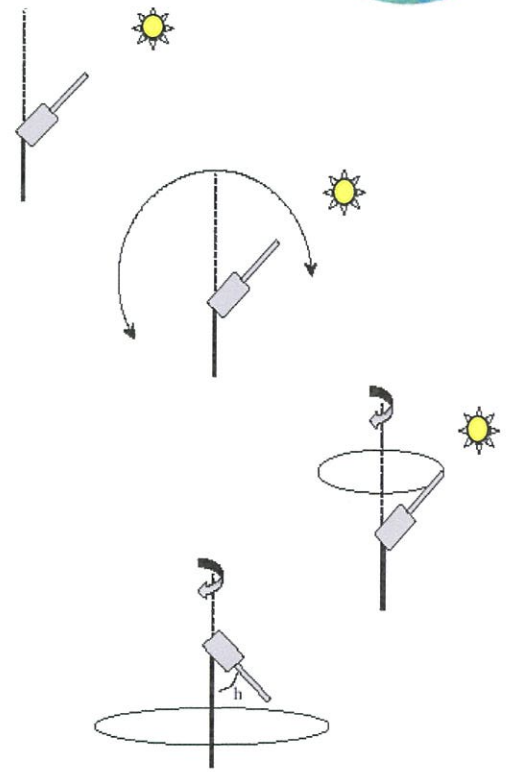
- Filters wheel : 8 filters + 1 dark plate
- 2 collimators and 2 detectors: Si and InGaAs

#	1	2	3	4	5	6	7	8	9	10	11	12	13
λ(nm)	870Si	1600 InGaAs	670Si	1020 InGaAs	550Si		440Si		380Si	870InGaAs	1020Si		937Si

- Maintenance including calibration once a year

Measurements protocol

- « Sun » protocol
  - Direct sun view : extinction measurement
- « Principal plane » protocol
  - Sky radiance : measurements in the principal plane
- « Almucantar » protocol
  - Sky radiance : complete azimuth rotation for $\theta v = \theta s$
- « Ground » protocol (specific to this prototype)
  - Ground radiance measurements for different θv



⇒ Automatic and continuous acquisition :
first morning acquisition air mass<5 - last evening acquisition air mass>5

⇒ Complete measurement set every 90 min. : *SUN + ALM + PPL + GND (1st elevation) + SUN + GND (2nd elevation) +…+ GND (12th elevation) + SUN*

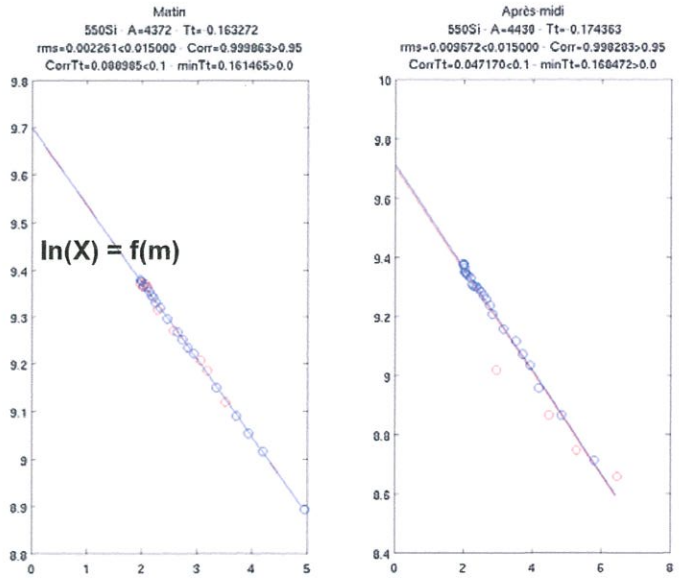
⇒ Transmitted to CNES every evening via a GSM link

Instrument calibration (1/4)

- Irradiance calibration
  - based on the Bouguer-Langley extinction law (all wavelength)

$$X_k = A_k * G_{uk} * I_k$$
(direct sun viewing)

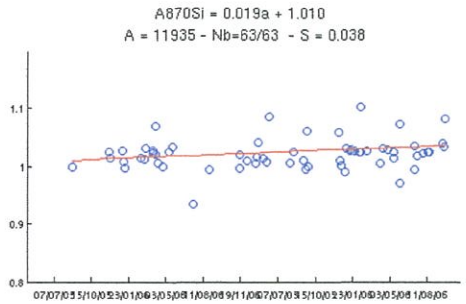
$$I_k = I_{0k} * (d/d_0) * \exp(-m.\tau_k)$$

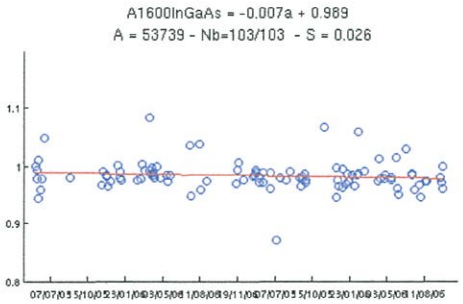


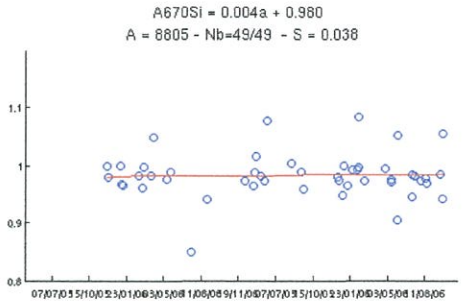
A_k = instrument irradiance calibration coefficient

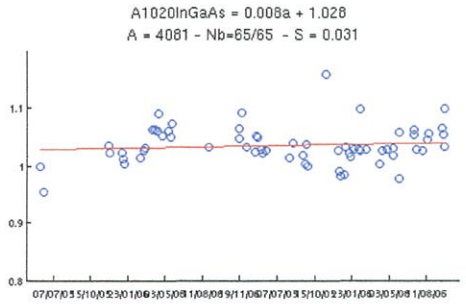
Instrument calibration (2/4)

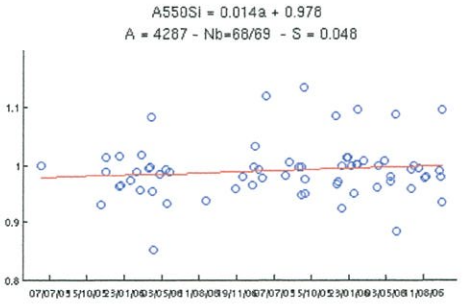
- Irradiance calibration performed every day : A_k monitoring

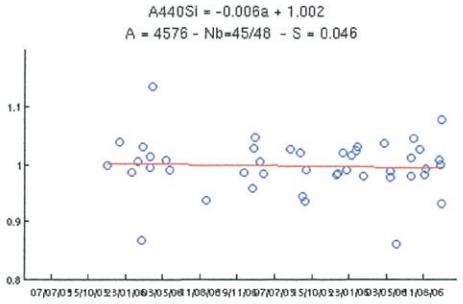


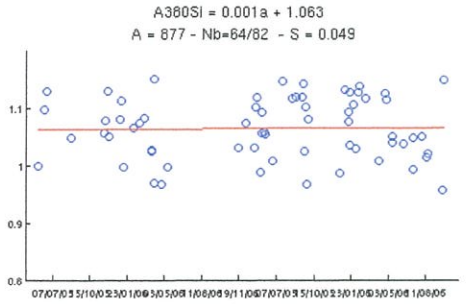


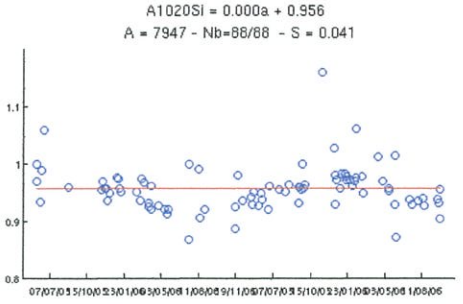












Instrument calibration (3/4)

- Radiance calibration
  - based on Rayleigh scattering for 380, 440, 550 nm bands

$$X_k = B_k * G_{kk} * L_k$$

(sky radiance in the principal plan)

L_k estimated using a radiative transfert code

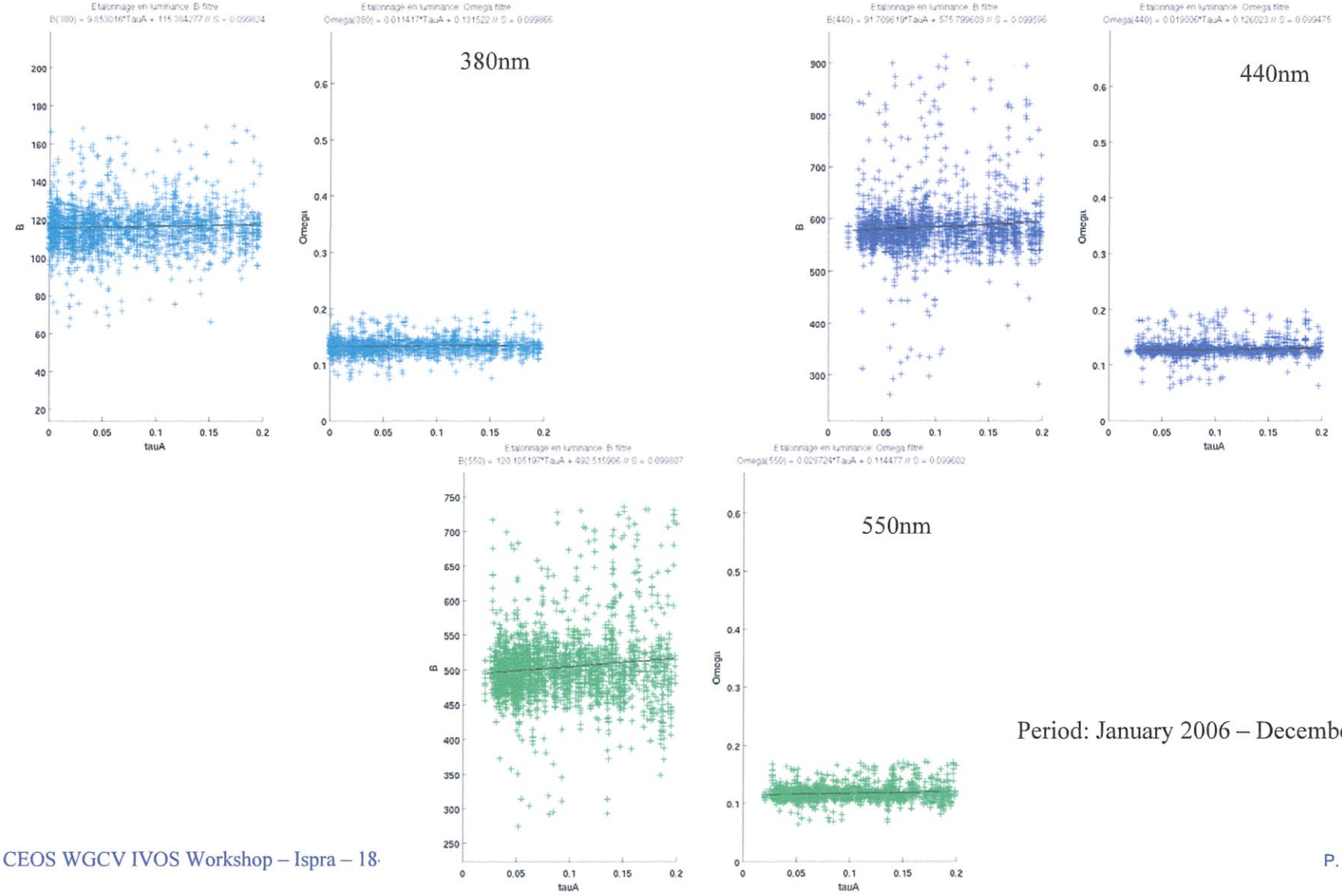
B_k = instrument radiance calibration coefficient

- $\Omega = B_k / A_k$: instrument solid angle (wavelength independent)

$\Rightarrow$ Computation of the radiance calibration coefficient for the other spectral bands (red, NIR and SWIR)

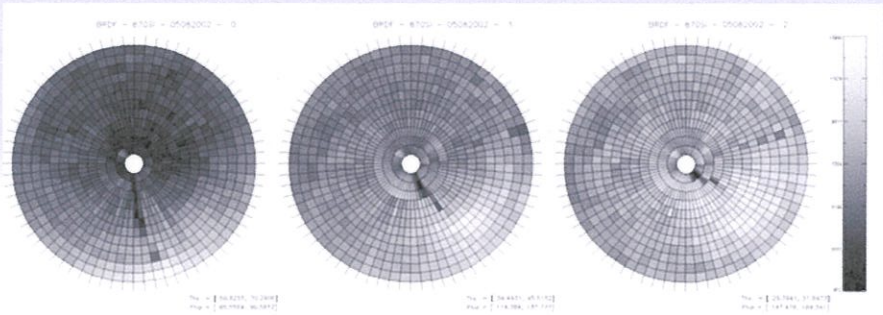
Instrument calibration (4/4)

- Rayleigh scattering calibration and Ω estimation

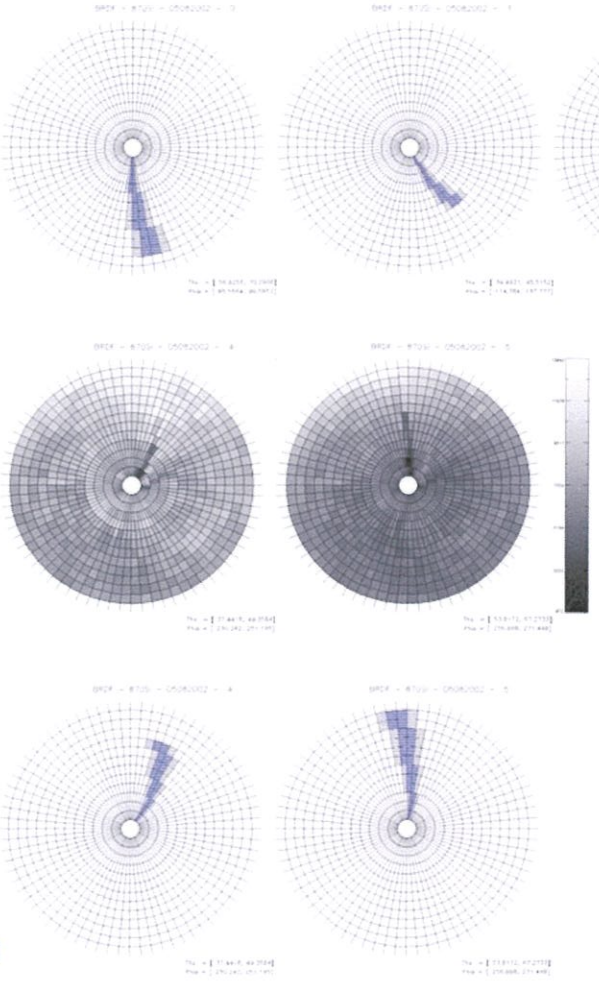


Period: January 2006 – December 2006

Ground reflectance

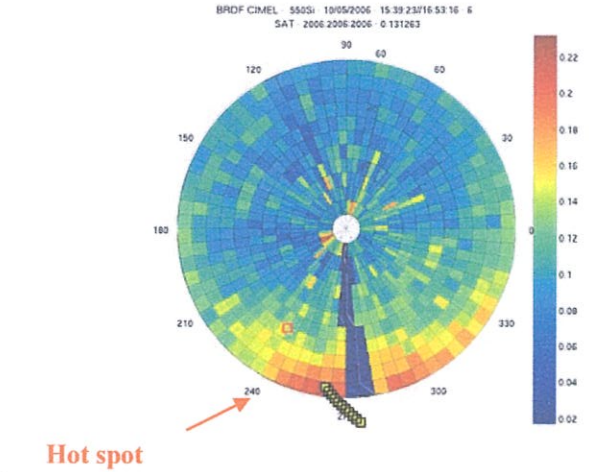


Shadow mask of the pole

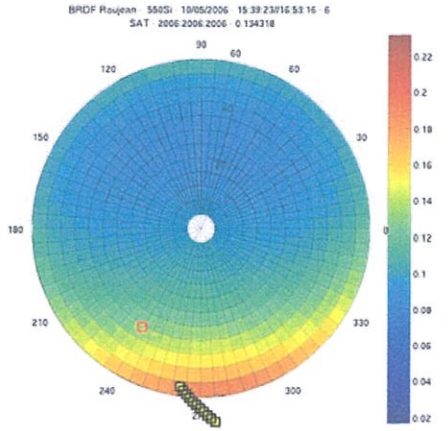


Ground reflectance

- Adjustment of a BRDF model (iterative filtering)

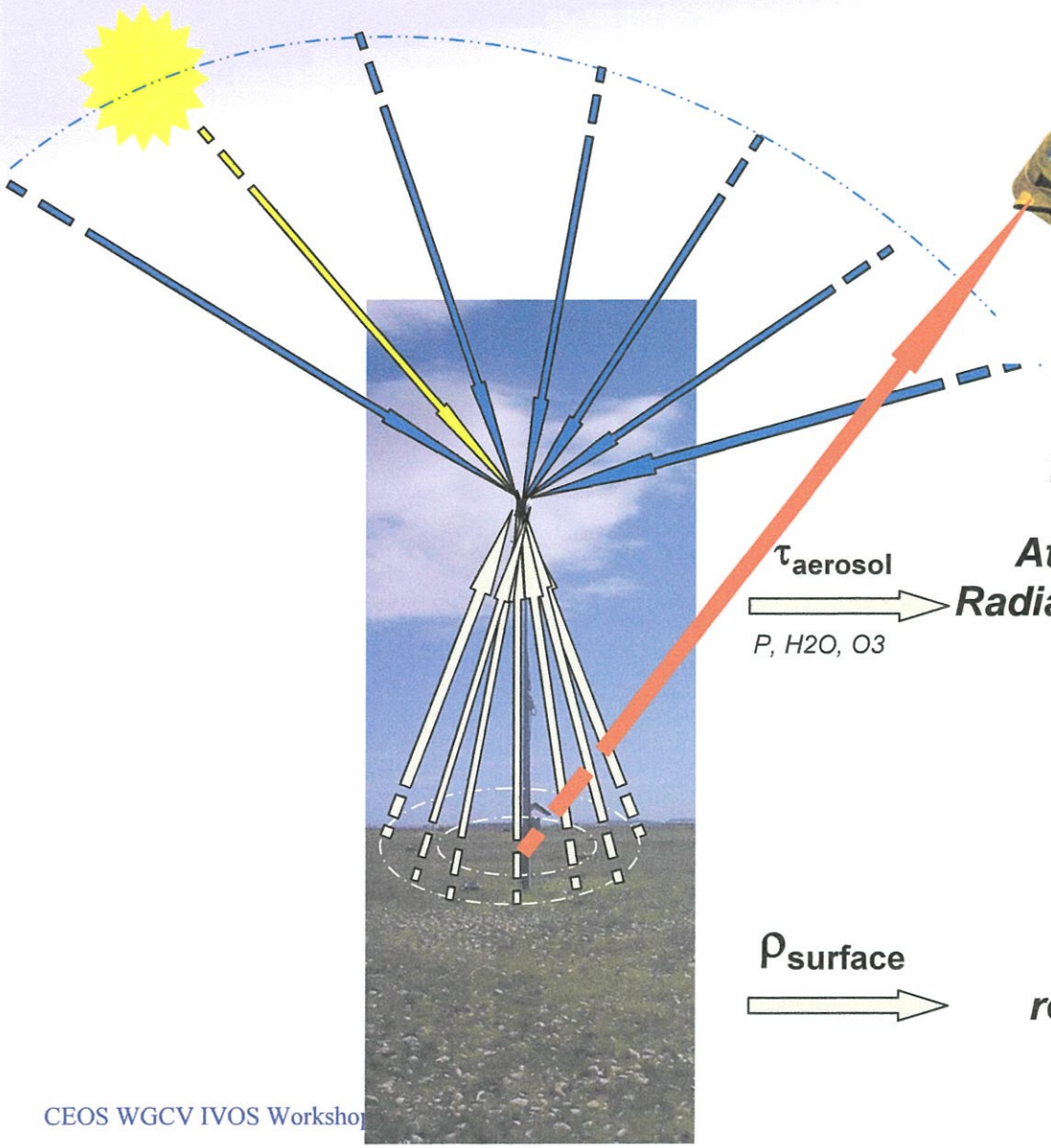


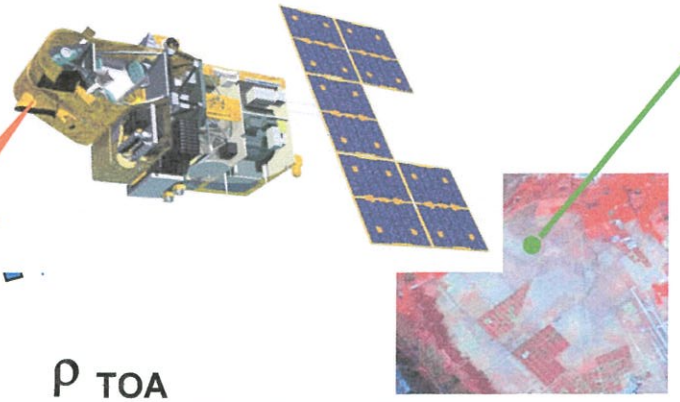
ROSAS ground reflectance (550nm)



Estimated BRDF model (550nm)

In flight calibration procedure





ρ_{SAT}

ρ_{TOA}

$\tau_{aerosol}$

P, H2O, O3

Atmospheric Radiative Transfert Model

+

$\rho_{surface}$

Spectral resampling

Calibration coefficient

ρ_{SAT} / ρ_{TOA}

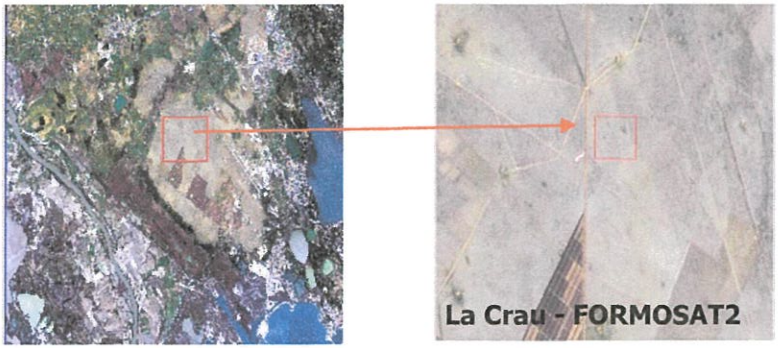
SPOT4 calibration

Date	B1 (green)	B2 (red)	B3 (NIR)
07-Nov-05	0.720	0.819	0.771
13-Mar-06	0.752	0.764	0.763
23-Mar-06	0.801	0.826	0.836
03-Apr-2006	0.770	0.824	0.786
02-Nov-06	0.732	0.822	0.794
13-Nov-06	0.751	0.842	0.796
22-Nov-06	0.729	0.807	0.789
Average	**0.751**	**0.815**	**0.791**
Standard deviation	**0.026**	**0.023**	**0.022**
Official cal. (01/06/06)	**0.743**	**0.821**	**0.809**
Discrepancy	**+1.1%**	**-0.7%**	**-2.2%**

- ☺ **Low scattering over 7 measurements**
- ☺ **Good consistency with the official calibration**
- ☹ **No calibration for the SWIR band**

Present status

- ROSAS : operational for SPOT calibration
  - one calibration campaign per year
- Successfully tested with a set of Formosat 2 images



- Development of an operational software for ROSAS data archiving, testing and processing
  - industrial development
  - friendly interfaces, calibration results traceability, expertise toolbox
  - acceptance : October 2010

Prospects

- Improve the calibration method :
  - H_2O content using the 937nm band
  - extend the calibration to the SWIR domain
- Transfer the ROSAS software to the operational calibration team
- Calibrate Pleiades using ROSAS during in-flight commissioning
- Try to install a 2nd ROSAS system on a new calibration site
- Study a ROSAS evolution for the Sentinel-2 in-flight calibration