AQUARIUS/SAC-D

6th Aquarius/SAC-D Science Meeting

High Sensitivity Camera (HSC) Overview

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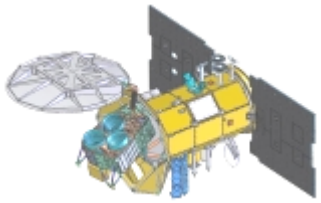
19-21 July 2010
Seattle, Washington, USA

NASA

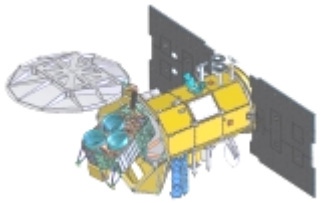
CONAE
COMISION NACIONAL DE ACTIVIDADES ESPACIALES

E S R



HSC Overview & characteristics

Instrument Presentation



❖The High Sensitivity Camera (HSC) is an instrument based on TDI CCD technology. The HSC instrument measures the Top of Atmosphere Radiance in the visible range of the spectrum (490-610 nm).

❖Data collection is performed over the dark side of the sun terminator to avoid sensor saturation due to sun light reflection and atmospheric scattering effects.

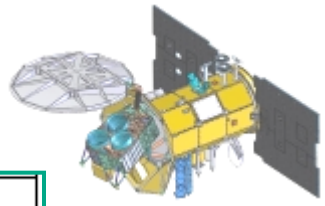
❖The HSC Instrument shall operate in Real Time Mode over Argentina and in Stored Mode over other opportunity targets around the world.

❖The HSC contains two (2) cameras, that is two (2) independent Optical Systems associated with their respective TDI CCD sensors and spectral filters. 2 x TDI with 96 stages (6, 12, 24, 48 or 96) of 2048 elements each.

❖ Each Optical System has 36.25º FOV and the angle between the optical axes of each system is 35º. The total resulting FOV is 71.3º with a little overlap of 1.2º in the center.

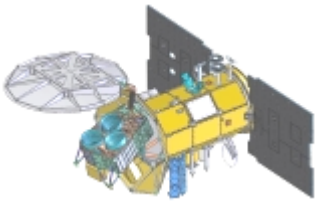
❖The center of the total FOV (boresight direction) is pointing 25º away from NADIR.

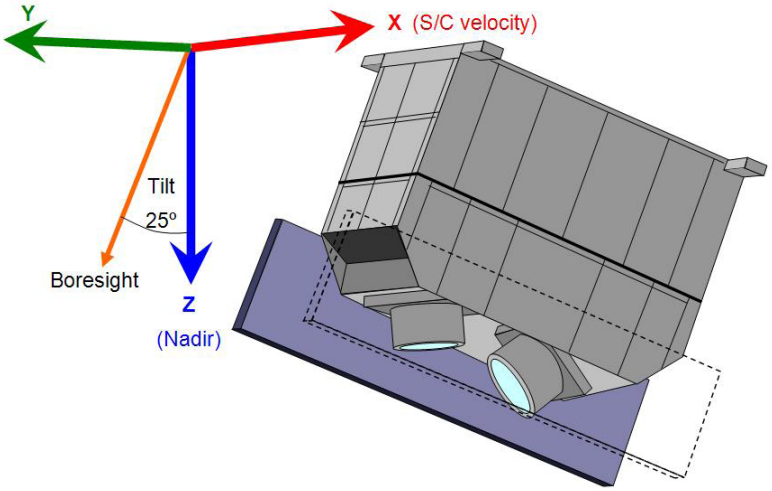
Main Characteristics of the Instrument

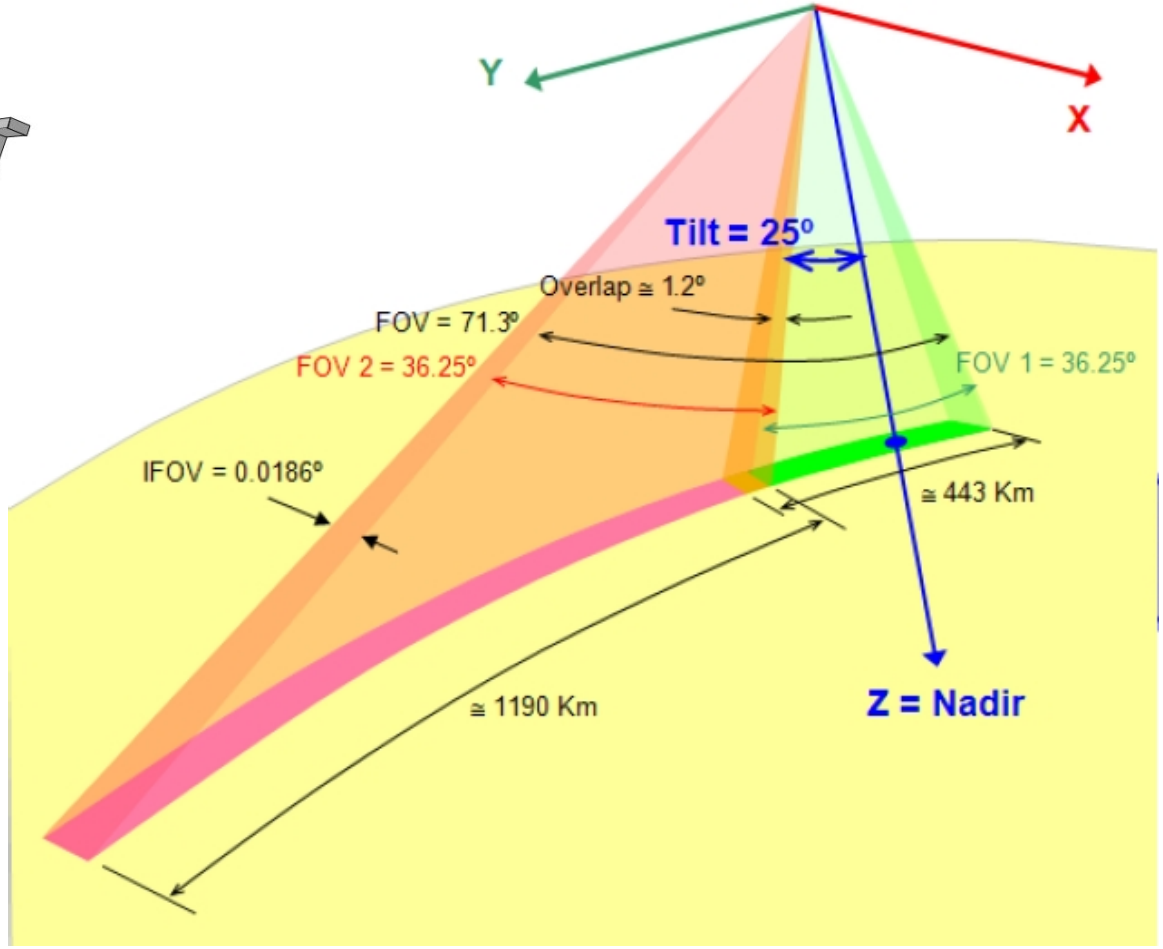


	Value	Units
Spectral Range:	490-610	nm
Ground Pixel Size @ nadir :	≅ 213	m
Field of View FOV1= FOV2 : Total FOV :	 36.25 71.3	 degrees degrees
FOV Overlap :	1. 2	degrees
Swath Width :	1614	km
Full Scale Radiance:	0.15	μW / cm^2 sr
Switchable Ranges of Full Scale Radiance:	x2, x4, x8, x16	
Radiometric Error :	< 20	%
SNR :	> 200	
Quantization :	10	bits
Mass Memory Size :	96	MBytes
Maximum Length of Stored Image :	3500	km
Required Time to fill Mass Memory :	≅ 9	minutes

HSC - FOV & Swath Width



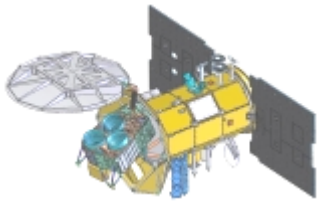




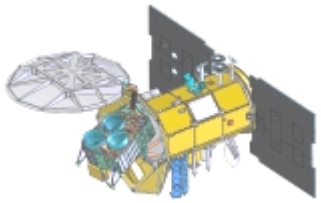
The HSC/SAC-D camera is an enhanced version of the HSTC camera, currently on operation onboard SAC-C. ➔ Easy modification of algorithms and procedures already tested as:

- **Operational procedures**
- **Science Data Processing Algorithms**

Operating Modes

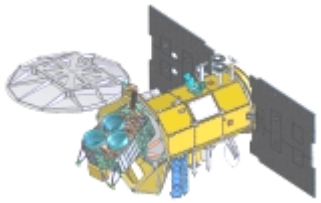


MODE	DESCRIPTION
Off	Power lines from S/P to Electronics Module are off
Stand-by	Electronics Module is powered on. HSC is ready to receive commands, S/C time and to send HK data, etc.
Real Time Acquisition & Downlink	Science Data is acquired and delivered to S/P for Real Time downlink to ground station
Stored Acquisition	Science Data is acquired and stored in HSC Mass Memory
Stored Downlink	Science Data (already stored in Mass Memory) is delivered to S/P for downlink to ground station
Configuration	Profile Tables are customized to configurate HSC to required functioning characteristics
Test	Test and Diagnostic procedures are executed



Products definitions
&
Processing levels

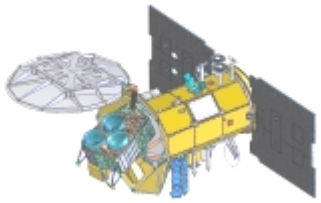
Products definitions



- **Basic Products:**
  - **Specification of the Processing Levels:**
    - ✓**Level 0A (raw counts)**
    - ✓**Level 1A (L0A + rel. rad. corr. + eath location)**
    - ✓**Level 1B1 (L1A + abs. rad. corr.)**
    - ✓**Level 1B2 (L1B1 + map projection)**

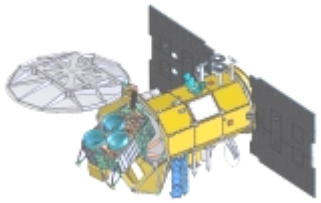
- **Possible applications:**
  - ✓**Fires distribution**
  - ✓**Volcanic eruptions**
  - ✓**Electronic storms**
  - ✓**Studies of urban light intensities**
  - ✓**Studies of auroras in polar regions**
  - ✓**Snow mapping**
  - ✓**Sea Surveillance**

Basic Products – L0A



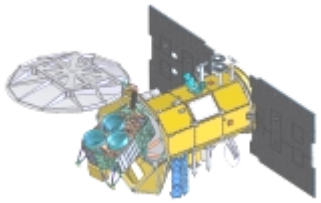
- **Raw Sample Counts of the instrument**
- **Without radiometric/geometric corrections**
- **Easy to access: The User doesn't need to know the downlink format in order to work with the data**
- **Includes telemetry from the spacecraft (eph, att) and from the sensor (timestamp, temperatures, etc)**
- **Includes all auxiliary information needed to make corrections: radiometric coefficients, geometric vectors and matrices, etc.**
- **Includes information related to the quality of the data (loosed lines, CRC problems, etc).**

Basic Products – L1A



- Results from applying the following processes to the L0A data:
  - Relative radiometric correction
  - Earth Location parameters calculation (included in the geoloc file)
- It doesn't contain absolute radiometric corrections (units are digital numbers)
- It doesn't contain any geometric corrections besides the inter-band registration
- Contains telemetry information from the spacecraft and sensor
- Contains information related to the quality of the data
- Contains all the information needed for the remainder corrections (absolute radiometric correction coefficients, etc)

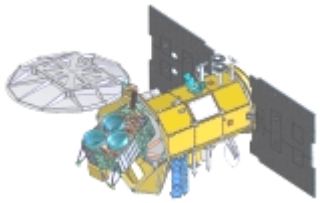
Geoloc File Contents



A grid over the data is defined. Each point in the grid will contain:

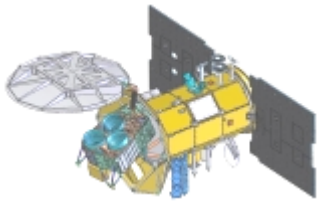
- **Latitude**
- **Longitude**
- **Zenith angle to the spacecraft**
- **Azimuth angle to the spacecraft**
- **Range to the spacecraft**
- **Zenith angle to the sun**
- **Azimuth angle to the sun**
- **Zenith angle to the moon**
- **Azimuth angle to the moon**

Basic Products – L1B - L1B1

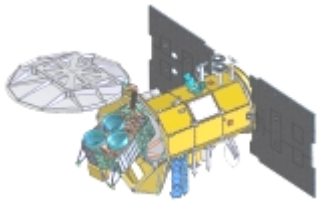


- Results from applying the following processes to the L1A data:
  - Absolute radiometric correction
- It doesn't contain any geometric corrections
- Contains telemetry information from the spacecraft and sensor
- Contains information related to the quality of the data
- Contains Earth Location Parameters (geoloc)
- Contains all the information needed for the remainder corrections

Basic Products – L1B - L1B2

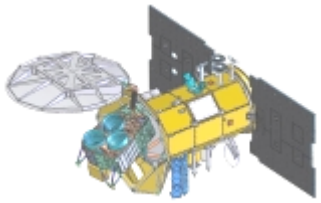


- Results from applying the following processes to the L1B1 data:
  - Resampling to a Map Projection
  - Earth Location Parameters Calculation
- Contains information related to the quality of the data
- Contains Earth Location Parameters (geoloc)
- Contains all the information needed for the remainder corrections



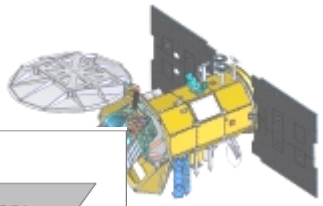
Processor: Project, Arquitecture and Flow Diagram

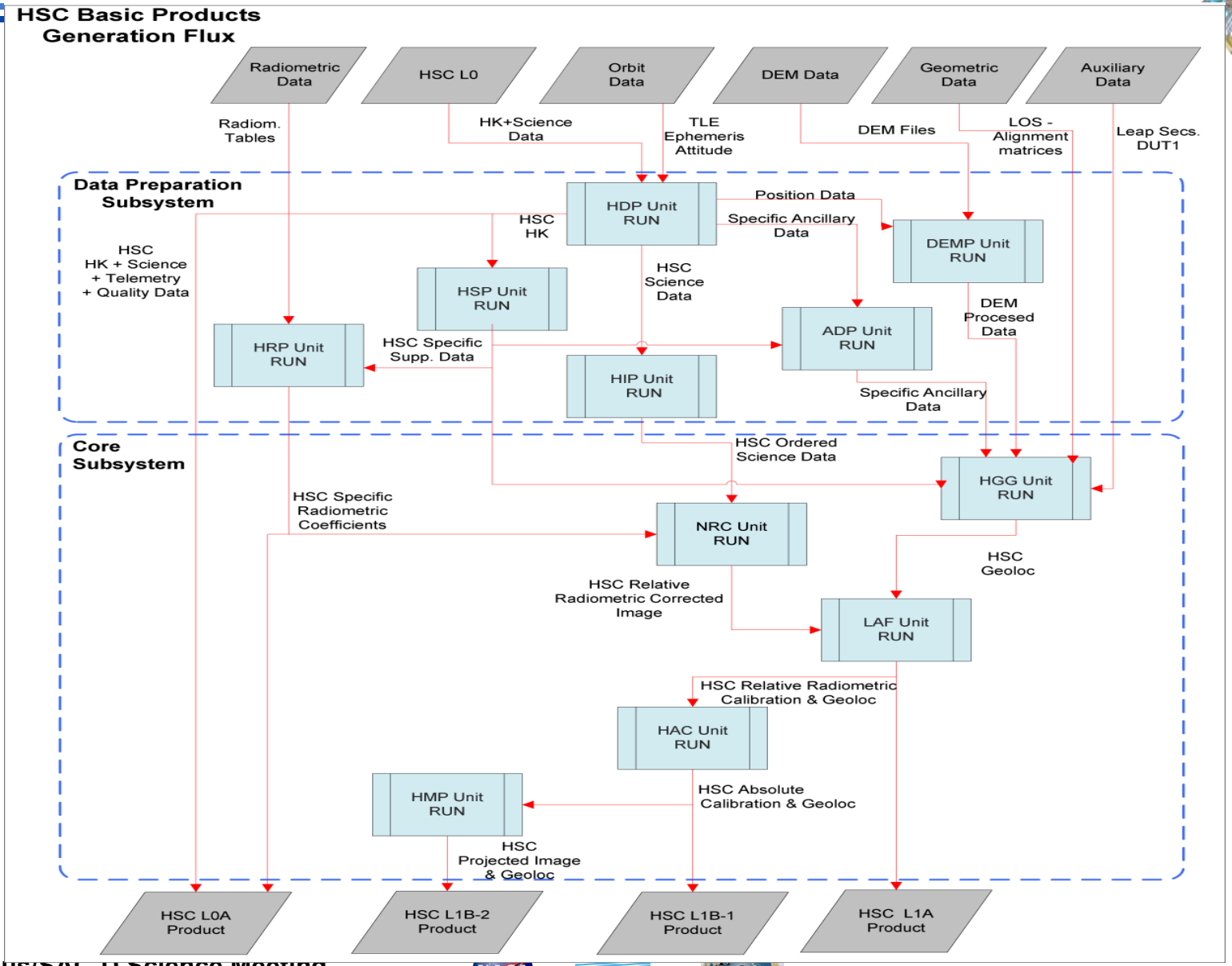
Software Project

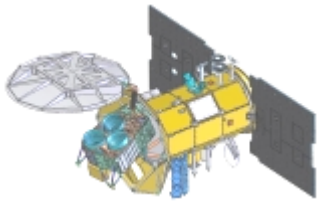


- The HSC processor is being developed as part of the VNIP (Visible and Near Infrared Processors) project at CONAE
- The VNIP System is defined as a set of units which shall be part of CUSS (Conae User Segment Service)
- The development is guided by a software prototype developed with Python
- The testing will be supported by a HSC simulator which is currently beign developed, also using Python
- The specification of the algorithms to the software provider is based on radiometric and ATBD documents, which were developed hand-in-hand with the software prototype
- The design enables data based parallelization.

Execution Flux - HSC

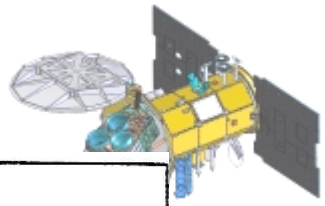


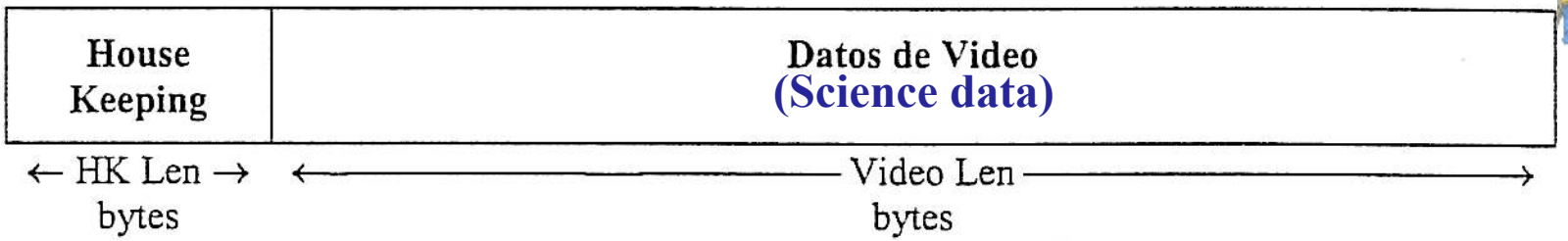




Science
&
Supplementary Data

HSC – Frame & Operation mode





Real Time mode:

HK Len: [(80 + TI*8) * $\frac{BPP}{8}$ * (NCAM)] bytes
Video Len : [2056 * $\frac{BPP}{8}$ * NCAM] bytes

Stored Mode:

HK Len = 166 bytes (fixed)
Idem Real Time

HSC - HK & Video length				
TI(msec)	32,8	32,8	32,8	32,8
TI(code)	114	114	114	114
BPP[8 ó 10]	8	8	10	10
NCAM[1 ó 2]	1	2	1	2
HK Len [bytes]	992	1984	1240	2480
Vid Len [bytes]	2056	4112	2570	5140
Frame Len	3048	6096	3810	7620

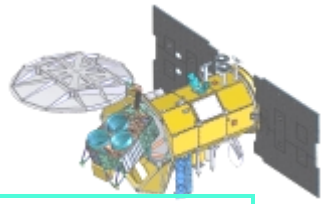
Where:
TI: Integration time
BPP: bits per pixel (8 or 10)
NCAM: number of cameras (1-2)

Modes of operation: real-time mode or store mode

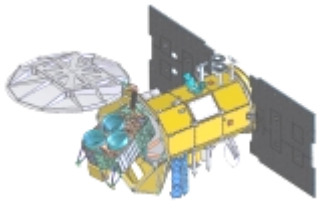
Any of these modes has Sub-modes of operation:

- **Cameras: camera A, camera B or 2 cameras.**
- **Radiometric resolution: 8 or 10 bit.**

Switchable ranges

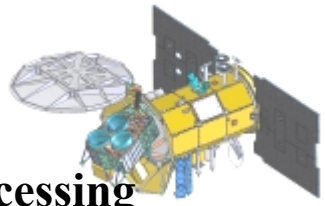


- HSC is a versatile instrument. Besides setting the different operating modes and submodes, the following parameters can be set by command:
  - ✓Number of Stages (6, 12, 24, 48 or 96)
  - ✓Integration Time (23 to 44.966 msec)
  - ✓Gain (4.5 to 34.5 dB)
  - ✓Offset (0 to 1023) which must be coherent respect the first three parameters.
- The HSC Instrument has switchable ranges giving the capability of Full Scale Radiance adjustment for different light conditions during the orbit.
- All the needed information so as to know the operating mode/submode, and other parameters that define the state and characteristics of HSC are present in the HK.
- An appropiate IT must be calculated taking into account SAC-D orbit: the altitude and speed of the spacecraft, together with the IT, determine the pixel resolution along track.
- Also present in the HK is the temperature of the CCD. The radiometric correction coefficients depend on this temperature.



Radiometric Corrections

Spectral and Radiometric Characterization



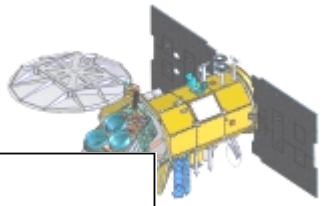
- HSC has two optical systems and each one of them has two Signal Processing Chains (SPC). Each of the optical system with each of the two SPCs was spectral and radiometrically characterized.

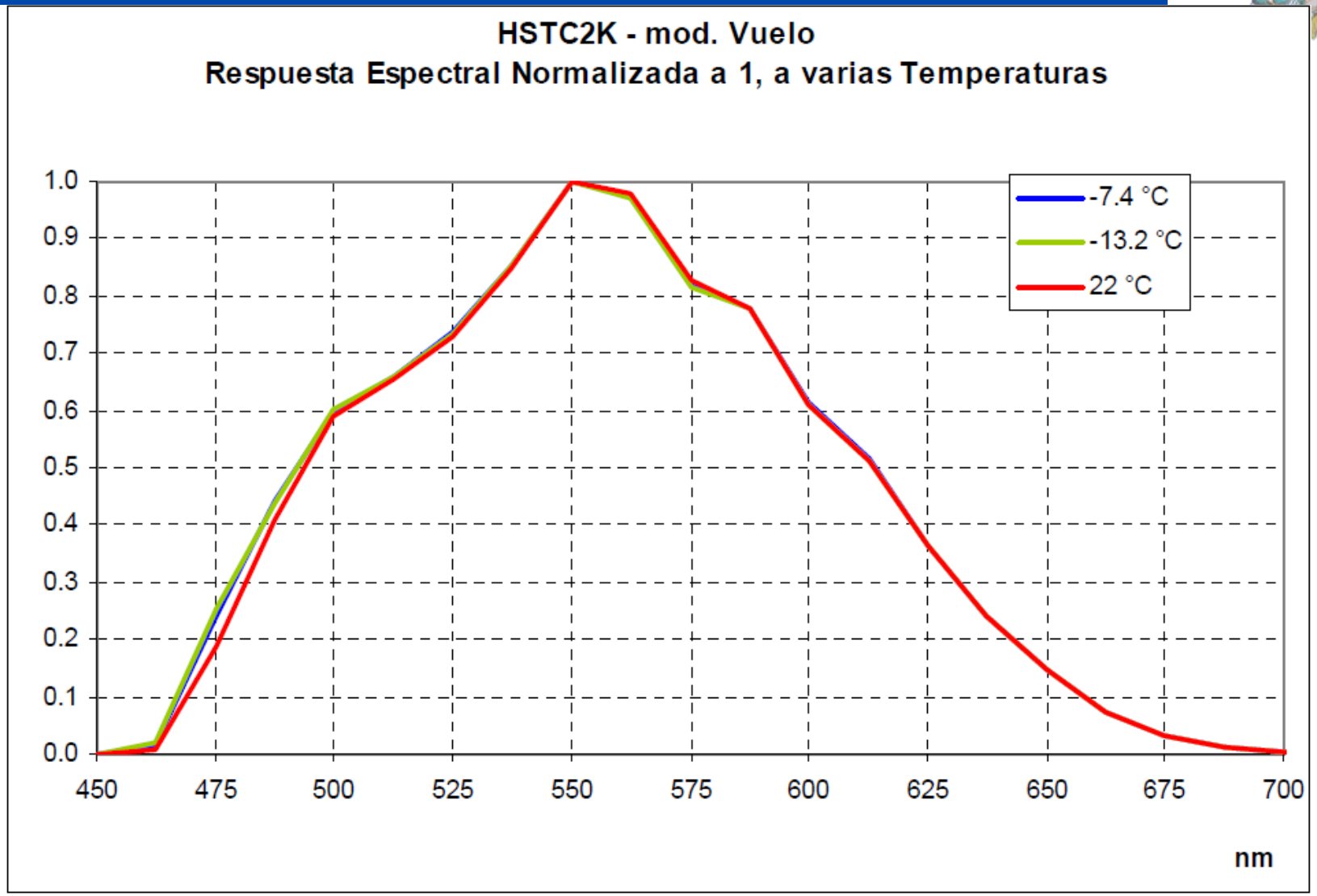
- The measurements were made at temperatures in the operating range of the optical system (Range: –5°C to –15°C). Two temperatures were used:
  - one in the range –6.1°C to –7.4°C
  - the other in the range –12.3°C to –13.5°C.

- Each optical system was iluminated using an integrating sphere, spectral and radiometrically calibrated. Two reference points were determined:
  - One with the optic covered (Ls=0). Changes were made in the offset to obtain ~8 DN.
  - The other changing Ls, without changing the offset, in order to obtain almost saturation (~1010 DN)

- The measurement covered all the FOV (Field of View) of the optical system. As the integrating sphere doesn't cover all the FOV, the characterization was made in two stages.

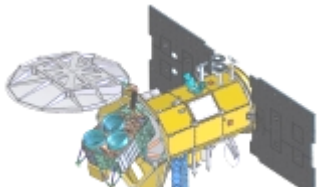
Spectral Response





The bandwidth at 50% is 490nm-610nm.

Image in Radiance (DN ➔ L)



CALIBRACIÓN RADIOMÉTRICA HSTC2K

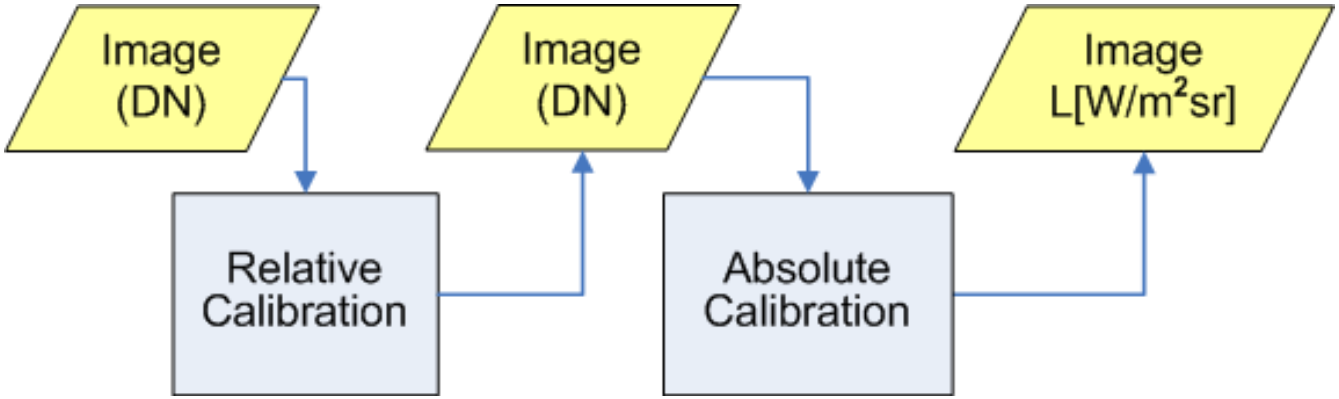
Tabla T-R5
CAMARA 2 RANGO –10°C -15°C
Lado Pixeles Menores

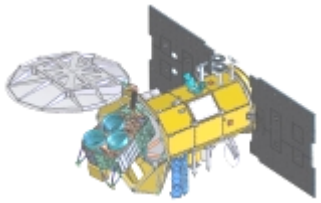
CAMARA 2		SPC X		Fecha: 24NOV05			Hora: 15:35
Temp °C	Gan	Offset	Nro Eta.	Ilum.	Rad. [A]	DN P1028	Archivos (*.txt)
-13.2	201	480	24	fondo	0	6	T-Rc2xn13f24-1
-13.2	201	470	48	fondo	0	7	T-Rc2xn13f48-1
-13.2	201	450	96	fondo	0	9	T-Rc2xn13f96-1
-13.3	201	450	96	Ilum	2.39E-9	996	T-Rc2xn13i24-1
-13.3	201	470	48	Ilum	4.75E-9	998	T-Rc2xn13i48-1
-13.3	201	480	24	Ilum	9.41E-9	999	T-Rc2xn3i96-1

CALIBRACIÓN RADIOMÉTRICA HSTC2K

Tabla T-R2
CAMARA 1 RANGO –5°C -10°C
Lado Pixeles Menores

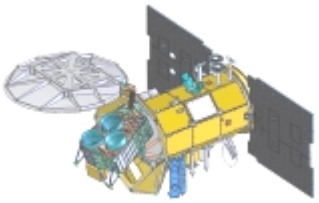
CAMARA 1		SPC X		Fecha: 2 NOV05			Hora: 12:30
Temp °C	Gan	Offset	Nro Eta.	Ilum.	Rad. [A]	DN P1028	Archivos (*.txt)
-6.8	209	500	24	fondo	0	8	T-Rc1xn7f24-1
-6.9	209	484	48	fondo	0	10	T-Rc1xn7f48-1
-7.0	209	450	96	fondo	0	14	T-Rc1xn7f96-1
-7.0	209	450	96	Ilum	2.40E-9	1008	T-Rc1xn7i24-1
-7.1	209	484	48	Ilum	4.79E-9	1009	T-Rc1xn7i48-1
-7.1	209	500	24	Ilum	9.44E-9	1004	T-Rc1xn7i96-1





Geometric Corrections

Goals

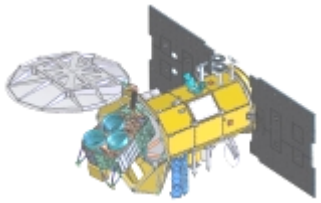


The objectives of the corrections are:

- **To be able to obtain the latitude, longitude, and other earth location information, for each pixel in an image, with the best accuracy at hand**

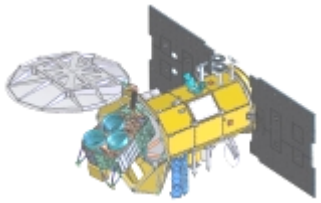
- **To resample the band to a given Map Projection**

Earth Location Parameters

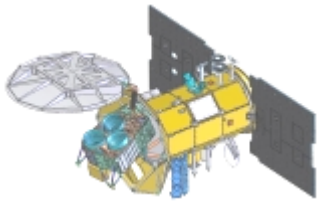


- Plenty earth location parameters are provided: latitude, longitude, range to spacecraft, azimuth and zenith angles to spacecraft, sun, and moon.
- Processor inputs (attitude and ephemeris data) are validated, and when suitable, interpolated.
- Using geometric auxiliary data, such as line of sight vectors measured at INVAP, and alignment matrices measured at Brasil.
- The methods used try to obtain the best available accuracy by using systematic methods. So all the needed precession, nutation, polar wander calculations are considered.
- A geometric budget error analysis was done before designing the algorithms. From it, it was considered as a good option to use an earth intersection algorithm based on DEM, which is currently being developed at prototype level.
- The parameters are disposed on a grid, in order to have less computing requirements, while maintaining good accuracy. This grid is later used in the resampling stages.

Resampling to a Map Projection

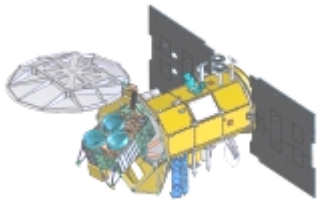


- Resampling based on a partition of the input space in cells (using the grid of the geoloc), and calculating forward and reverse transformations for each cell, between geodetic coordinates and projected coordinates.
- Transformations calculated using Singular Value Decomposition methods.
- Interpolation currently using NN, Bilinear and CC. Considering using reconstruction based on a MTF.
- Map Projections: as provided by proj4. Currently using UTM, and GK-AR. Checking if it suitable and possible to use a Space Oblique Mercator Projection.



Product Format

Product formats

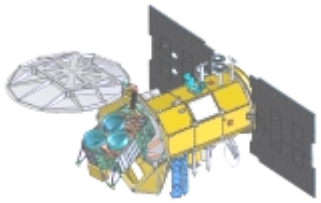


- **Processor output: XML files.**

- **CUSS will have libraries and tools to automatically generate (from XML files) products in HDF5, and other, formats.**

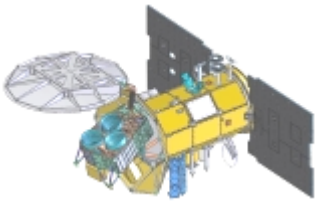
- **CUSS will pack the products using any packing format (rar, zip, gz, tar, etc). The content of the packet file will be:**
  - **A folder with the product (XML, HDF5, GeoTiff),**
  - **The associated metadata in XML format**
  - **Any other needed data such as calibration files, and auxiliary data files.**

END



E N D

HSC Instrument Heritage



- **The HSC/SAC-D camera is an enhanced version of the HSTC camera, currently on operation onboard SAC-C.**

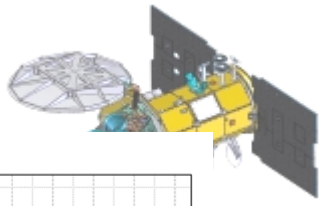
This similarity permits to take some advantages from the acquired experience after more than 9 years of HSTC operation.
Easy modification of algorithms and procedures already tested as:

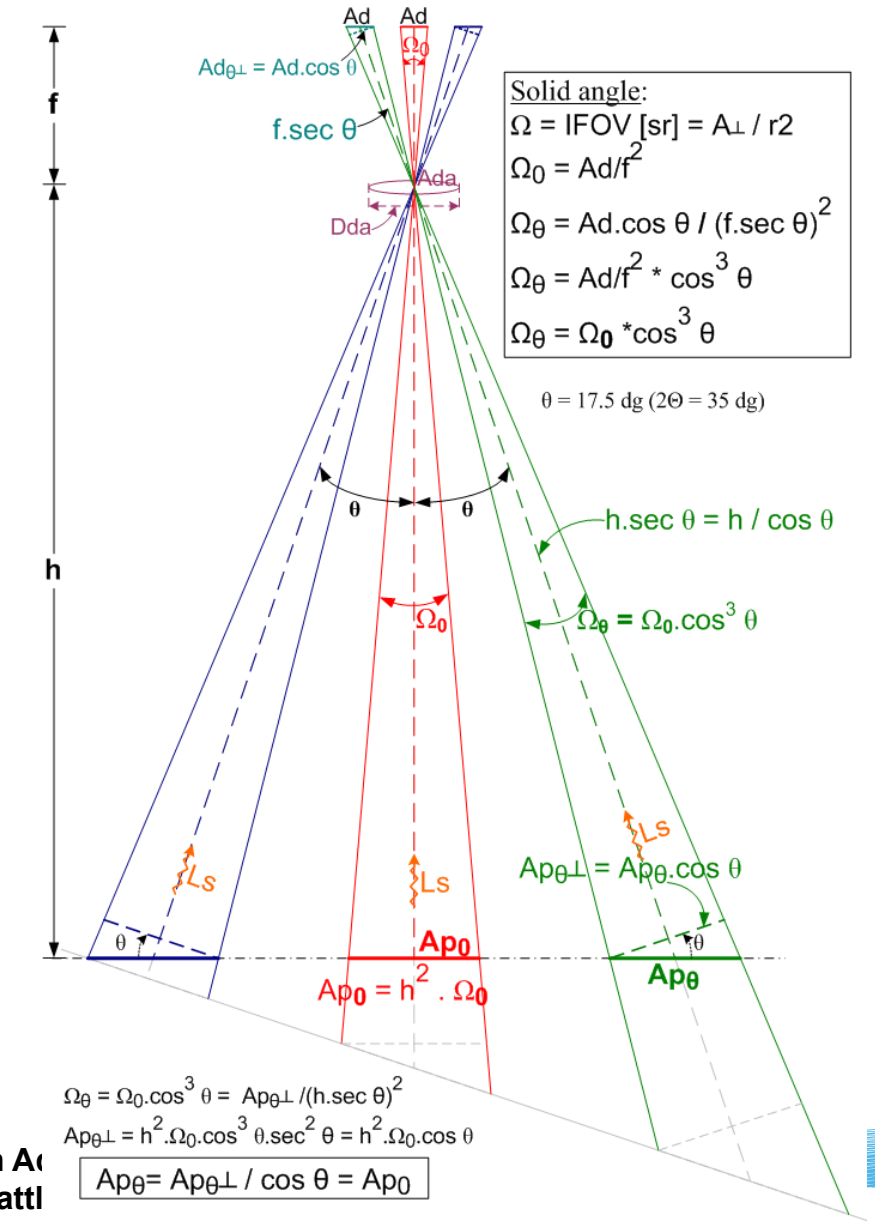
- **Operational procedures**
- **Science Data Processing Algorithms**

- **Instrument Enhancements:**

	HSCT SAC-C	HSC SAC-D
SNR	50	> 200
ADC Res.	8 bits	10 bits

Apuntamiento Nadiral y Lateral





Solid angle:

Ω = IFOV [sr] = $A_\perp$ / r2

$\Omega_0 = Ad/f^2$

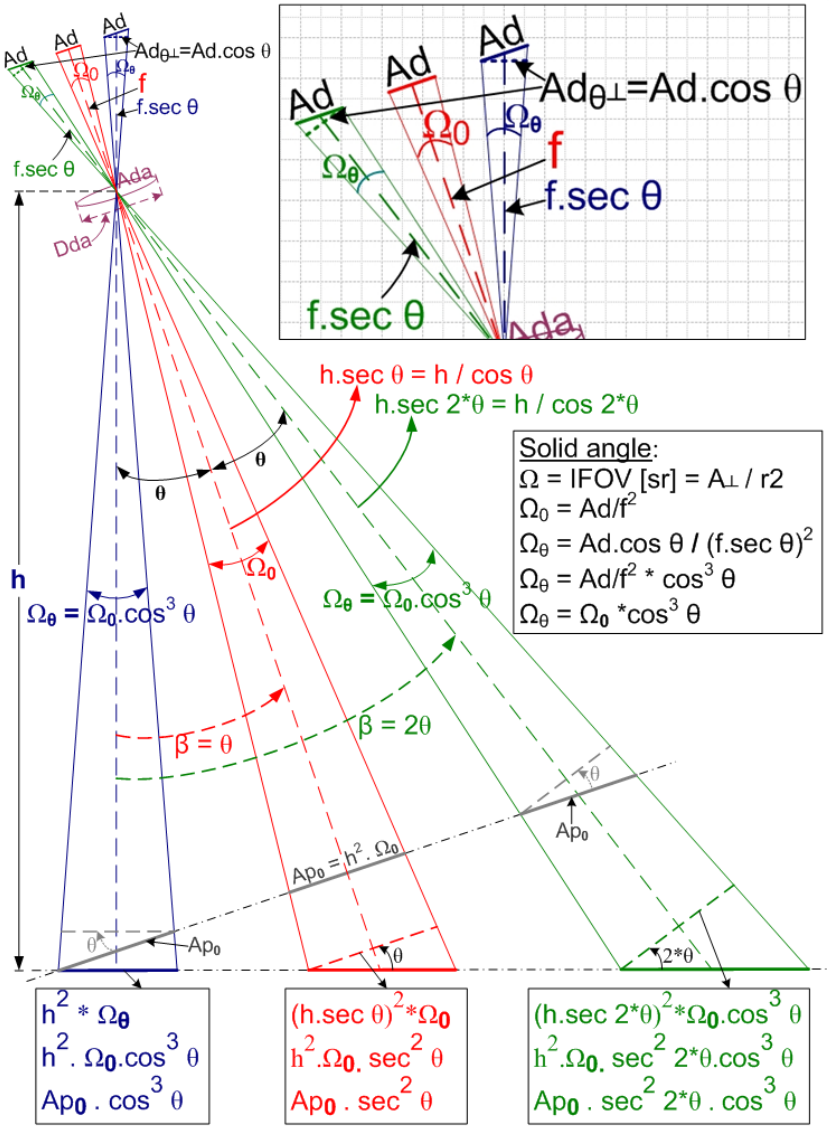
$\Omega_\theta = Ad.\cos \theta / (f.\sec \theta)^2$

$\Omega_\theta = Ad/f^2 * \cos^3 \theta$

$\Omega_\theta = \Omega_0 * \cos^3 \theta$

θ = 17.5 dg (2Θ = 35 dg)

Lateral vision



Solid angle:

Ω = IFOV [sr] = $A_\perp$ / r2

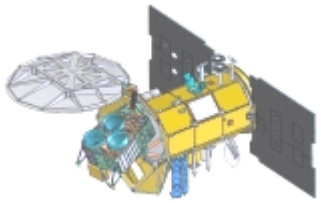
$\Omega_0 = Ad/f^2$

$\Omega_\theta = Ad.\cos \theta / (f.\sec \theta)^2$

$\Omega_\theta = Ad/f^2 * \cos^3 \theta$

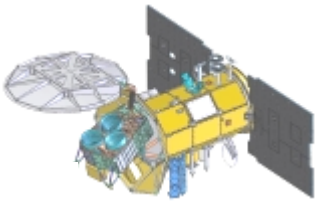
$\Omega_\theta = \Omega_0 * \cos^3 \theta$

Projected or apparent area of the land´s pixels



Radiometric Corrections

Radiometric Calibration



CALIBRACIÓN RADIOMÉTRICA HSTC2K

Tabla T-R5
CAMARA 2 RANGO –10°C -15°C
Lado Pixeles Menores

CAMARA 2		SPC X		Fecha: 24NOV05			Hora: 15:35
Temp °C	Gan	Offset	Nro Eta.	Ilum.	Rad. [A]	DN P1028	Archivos (*.txt)
-13.2	201	480	24	fondo	0	6	T-Rc2xn13f24-1
-13.2	201	470	48	fondo	0	7	T-Rc2xn13f48-1
-13.2	201	450	96	fondo	0	9	T-Rc2xn13f96-1
-13.3	201	450	96	Ilum	2.39E-9	996	T-Rc2xn13i24-1
-13.3	201	470	48	Ilum	4.75E-9	998	T-Rc2xn13i48-1
-13.3	201	480	24	Ilum	9.41E-9	999	T-Rc2xn3i96-1

CAMARA 2		SPC Y		Fecha: 24NOV05			Hora:
Temp °C	Gan	Offset	Nro Eta.	Ilum.	Rad. [A]	DN P1028	Archivos (*.txt)
-13.3	201	448	24	fondo	0	8	T-Rc2yn13f24-1
-13.3	201	437	48	fondo	0	8	T-Rc2yn13f48-1
-13.3	201	422	96	fondo	0	11	T-Rc2yn13f96-1
-13.4	201	422	96	Ilum	2.40E-9	996	T-Rc2yn13i24-1
-13.4	201	437	48	Ilum	4.77E-9	995	T-Rc2yn13i48-1
-13.4	201	448	24	Ilum	9.34E-9	984	T-Rc2yn13i96-1

Lado Pixeles Mayores

CAMARA 2		SPC X		Fecha: 25NOV05			Hora: 13:50
Temp °C	Gan	Offset	Nro Eta.	Ilum.	Rad. [A]	DN P1028	Archivos (*.txt)
-13.5	201	480	24	fondo	0	6	T-Rc2xn13f24-2
-13.5	201	470	48	fondo	0	7	T-Rc2xn13f48-2
-13.5	201	452	96	fondo	0	10	T-Rc2xn13f96-2
-13.5	201	452	96	Ilum	2.40E-9	1008	T-Rc2xn13i24-2
-13.5	201	470	48	Ilum	4.73E-9	992	T-Rc2xn13i48-2
-13.5	201	480	24	Ilum	9.43E-9	1002	T-Rc2xn13i96-2

CAMARA 2		SPC Y		Fecha: 25NOV05			Hora: 15:21
Temp °C	Gan	Offset	Nro Eta.	Ilum.	Rad. [A]	DN P1028	Archivos (*.txt)
-13.4	201	456	24	fondo	0	8	T-Rc2yn13f24-2
-13.4	201	437	48	fondo	0	8	T-Rc2yn13f48-2
-13.4	201	422	96	fondo	0	11	T-Rc2yn13f96-2
-13.5	201	422	96	Ilum	2.41E-9	1001	T-Rc2yn13i24-2
-13.5	201	437	48	Ilum	4.70E-9	982	T-Rc2yn13i48-2
-13.5	201	456	24	Ilum	7.45E-9	1000	T-Rc2yn13i96-2

CALIBRACIÓN RADIOMÉTRICA HSTC2K

Tabla T-R2
CAMARA 1 RANGO –5°C -10°C
Lado Pixeles Menores

CAMARA 1		SPC X		Fecha: 2 NOV05			Hora: 12:30
Temp °C	Gan	Offset	Nro Eta.	Ilum.	Rad. [A]	DN P1028	Archivos (*.txt)
-6.8	209	500	24	fondo	0	8	T-Rc1xn7f24-1
-6.9	209	484	48	fondo	0	10	T-Rc1xn7f48-1
-7.0	209	450	96	fondo	0	14	T-Rc1xn7f96-1
-7.0	209	450	96	Ilum	2.40E-9	1008	T-Rc1xn7i24-1
-7.1	209	484	48	Ilum	4.79E-9	1009	T-Rc1xn7i48-1
-7.1	209	500	24	Ilum	9.44E-9	1004	T-Rc1xn7i96-1

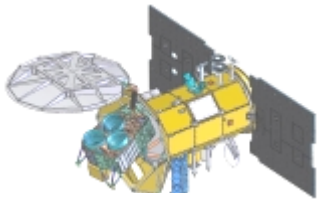
CAMARA 1		SPC Y		Fecha: 22NOV05			Hora: 12:45
Temp °C	Gan	Offset	Nro Eta.	Ilum.	Rad. [A]	DN P1028	Archivos (*.txt)
-7.3	209	458	24	fondo	0	9	T-Rc1yn7f24-1
-7.3	209	448	48	fondo	0	11	T-Rc1yn7f48-1
-7.3	209	415	96	fondo	0	14	T-Rc1yn7f96-1
-7.4	209	415	96	Ilum	2.40E-9	997	T-Rc1yn7i24-1
-7.4	209	448	48	Ilum	4.78E-9	994	T-Rc1yn7i48-1
-7.4	209	458	24	Ilum	9.49E-9	996	T-Rc1yn7i96-1

Lado Pixeles Mayores

CAMARA 1		SPC X		Fecha: 23 NOV05			Hora: 12:06
Temp °C	Gan	Offset	Nro Eta.	Ilum.	Rad. [A]	DN P1028	Archivos (*.txt)
-6.1	209	500	24	fondo	0	9	T-Rc1xn6f24-2
-6.1	209	484	48	fondo	0	10	T-Rc1xn6f48-2
-6.1	209	450	96	fondo	0	15	T-Rc1xn6f96-2
-6.1	209	450	96	Ilum	2.39E-9	1004	T-Rc1xn6i24-2
-6.4	209	484	48	Ilum	4.79E-9	1006	T-Rc1xn6i48-2
-6.4	209	500	24	Ilum	9.37E-9	994	T-Rc1xn6i96-2

CAMARA 1		SPC Y		Fecha: 23NOV05			Hora:
Temp °C	Gan	Offset	Nro Eta.	Ilum.	Rad. [A]	DN P1028	Archivos (*.txt)
-6.4	209	458	24	fondo	0	8	T-Rc1yn6f24-2
-6.4	209	448	48	fondo	0	11	T-Rc1yn6f48-2
-6.4	209	415	96	fondo	0	17	T-Rc1yn6f96-2
-6.4	209	415	96	Ilum	2.41E-9	1001	T-Rc1yn6i24-2
-6.4	209	448	48	Ilum	4.80E-9	996	T-Rc1yn6i48-2
-6.4	209	458	24	Ilum	9.53E-9	998	T-Rc1yn6i96-2

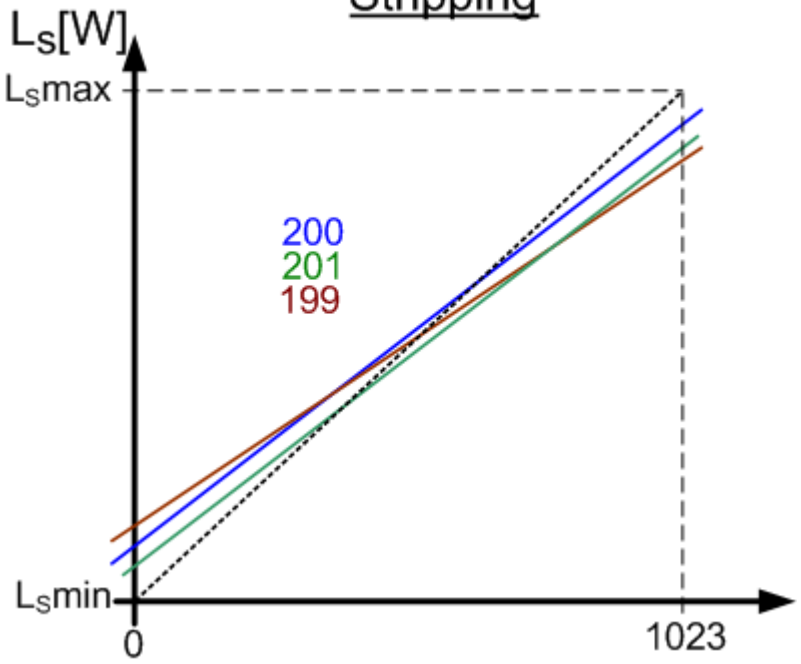
Radiometric Calibration



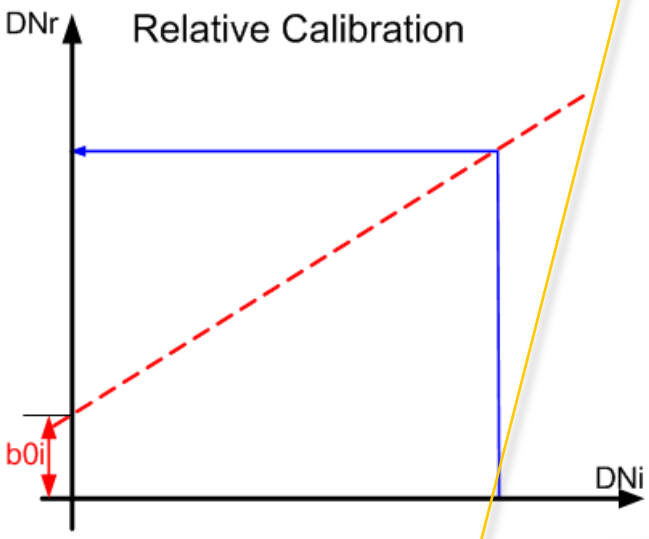
Pre–launch Radiometric Table:

L_S [W/(m².sr)]	DN_{P1}	DN_{P2}	…	DN_{P2048}
0	4	7	…	5
Near saturt	1019	1015	…	1022

Stripping



Relative calibration:



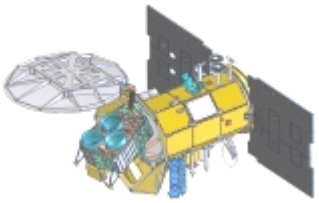
$DNi^{RC} = b0i + b1i*Dni$

Absolute calibration:

$Li = a0r + b0r*DNi^{RC}$

$Lr = a0r + b0r*DNr$

Set of relative and absolute calibration coefficients:

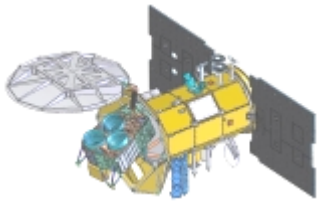


DATE OF VALIDITY:
Date from:
Date until:
RELATIVE CAL:
2048 detectors x 2 sensors
$b0_i$, $b1_i$
ABSOLUTE CAL:
1 x 2 sensors
$a0_r$, $a1_r$
TEMPERATURE RANGE:
Date from:
Date until:
INTEGRATION TIME:

SPC:

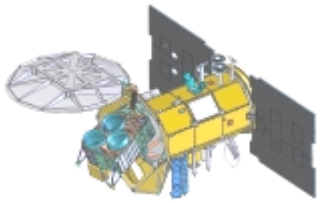
STAGES:

GAIN:



Datos de Ciencia
y
Datos suplementarios

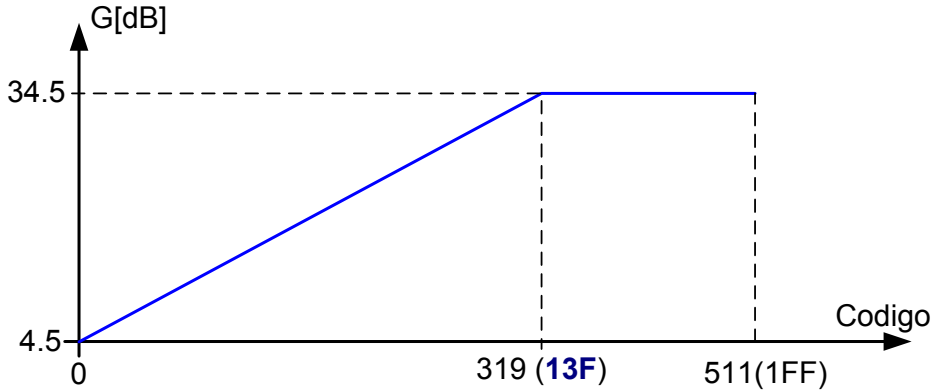
Etapas, Tiempo de Integración, Ganancia y Offset



Etapas	6	12	24	48	96
Codigo	0xE (14)	0xD (13)	0xB (11)	0x7 (7)	0xF (15)

Tiempo de Integración: Es programable entre 23 y 44.966ms, con 256 pasos de programación y con una resolución de 0,08614ms por paso.

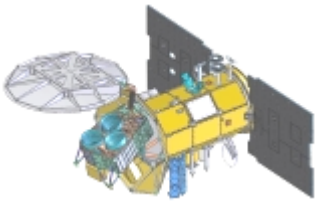
La ganancia varia linealmente entre 4.5 y 34.5 dB en saltos de 0.1 dB. Los códigos de ganancia van de 0 a 319, para cualquier código por encima de 13F la ganancia queda en 34.5 dB.



Tiempo de Integracion		
TI - hex	TI - dec	TI - ms
0	0	23.0000
A	10	23.8614
14	20	24.7228
1E	30	25.5842
28	40	26.4456
32	50	27.3071
3C	60	28.1685
46	70	29.0299
50	80	29.8913
5A	90	30.7527
64	100	31.6141
6E	110	32.4755
78	120	33.3369
82	130	34.1984
8C	140	35.0598
96	150	35.9212
A0	160	36.7826
AA	170	37.6440
B4	180	38.5054
BE	190	39.3668
C8	200	40.2282
D2	210	41.0896
DC	220	41.9511
E6	230	42.8125
F0	240	43.6739
FA	250	44.5353
FF	255	44.9660

El offset es una función línea de los código de offset que van de 0 a 1023.

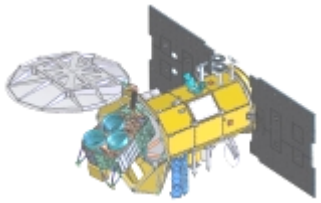
Estructura del HK



Position	Bytes	Description	Mnemonics	Data Format	Generated by	Used by
0	4	Sync words	SYNC	FA F3 34 00 h	OBC	IP-ORG
4	3	Line Counter	LCNT	00 00 00 h to FF FF FF h	OBC	IP-ORG
7	5	On-Board Time (*)	OBT	TBD	plataforma	IP-ORG
12	10	Mode Identification	MODE	Ver (**)	OBC	IP-ORG
22		SubModoCam - 5 bits	SUBM	0 a 1F	OBC/CTU	
		CantEtapas1 - 4 bits	ETAPAS	0 a F	OBC/TIU	
		CantEtapas2:- 4 bits	ETAPAS	0 a F	OBC/TIU	
		SelSPC1 - 2 bits	SELSPC	0 a 2	OBC/TIU	
		SelSPC2 - 2 bits	SELSPC	0 a 2	OBC/TIU	
		Tintegr1 - 8 bits	TINT	0 a FF	OBC/TIU	
		Tintegr2 - 8 bits	TINT	0 a FF	OBC/TIU	
	11	CutOffAGC1 - 4 bits	COAGC	0 a F	OBC/SPC	
		CutOffAGC2 - 4 bits	COAGC	0 a F	OBC/SPC	
		CutOffCDS1 - 4 bits	COCDS	0 a F	OBC/SPC	
		CutOffCDS2 - 4 bits	COCDS	0 a F	OBC/SPC	
		Gain1 - 9 bits	GAIN	0 a 1FF	OBC/SPC	
		Gain2 - 9 bits	GAIN	0 a 1FF	OBC/SPC	
		Offset1 - 10 bits	OFFSET	0 a 3FF	OBC/SPC	
		Offset2 - 10 bits	OFFSET	0 a 3FF	OBC/SPC	
		ACS Data				
33	9	Magnetómetro (Yaw)	Mag	TBD	ACS	IP-CORR
42	11	Scan Wheel 1 (Roll & Pitch)	SWheel1	[Ref]	ACS	IP-CORR
53	11	Scan Wheel 2 (Roll & Pitch)	SWheel2	[Ref]	ACS	IP-CORR
64	4	Time of Fix	ACSTime	TBD	ACS	IP-ORG
		ARP GPS Position Fix, XYZ ECEF				
68	4	X	Pos X	Single meters	GPS	IP-CORR
72	4	Y	Pos Y	Single meters	GPS	IP-CORR
76	4	Z	Pos Z	Single meters	GPS	IP-CORR
80	4	time of fix	Pos Time	Single second	GPS	IP-ORG
		ARP GPS Actitude				
84	8	time of solution	Act Time	Double seconds	GPS	IP-ORG
92	4	quaternion[1]	Act Q1	Single element	GPS	IP-CORR
96	4	quaternion[2]	Act Q2	Single element	GPS	IP-CORR
100	4	quaternion[3]	Act Q3	Single element	GPS	IP-CORR
104	4	quaternion[4]	Act Q4	Single element	GPS	IP-CORR
		ARP GPS Velocity Fix, XYZ ECEF				
108	4	X velocity	Vel X	Single meters/second	GPS	IP-CORR
112	4	Y velocity	Vel Y	Single meters/second	GPS	IP-CORR
116	4	Z velocity	Vel Z	Single meters/second	GPS	IP-CORR
120	4	bias rate	Vel Bias	Single meters/second	GPS	IP-CORR
124	4	time of fix	Vel Time	Single second	GPS	IP-ORG
		Star Sensor KM 1301				
128	1	N° Bytes structure	NrBytes	Unsigned char	Star Sensor	IP-CORR
129	1	N° of actual image	NrImage	Unsigned char Range 0-127	Star Sensor	IP-CORR
130	2	Operation Mode Register	OMR	Unsigned int Range Note 1	Star Sensor	IP-CORR
132	2	Star Recognition Modes	STR	Unsigned int	Star Sensor	IP-CORR
134	4	Quaternion[1]	Star Q1	Single IEEE 754 Note 2	Star Sensor	IP-CORR
138	4	Quaternion[2]	Star Q2	Single IEEE 754	Star Sensor	IP-CORR
142	4	Quaternion[3]	Star Q3	Single IEEE 754	Star Sensor	IP-CORR
146	4	Quaternion[4]	Star Q4	Single IEEE 754	Star Sensor	IP-CORR
150	2	Terminator	Ter	Unsigned int AA55h	Star Sensor	IP-CORR
		OBC Data				
152	2	Focal Plate#3 Temperature	T_FP#3	0000h-0FFFh	OBC	IP-CORR
154	2	Focal Plate#4 Temperature	T_FP#4	0000h-0FFFh	OBC	IP-CORR
156	2	Focal Plate#1 Temperature	T_FP#1	0000h-0FFFh	OBC	IP-CORR
158	2	Focal Plate#2 Temperature	T_FP#2	0000h-0FFFh	OBC	IP-CORR

Toda esta estructura se ha heredado de la cámara HSTC (SAC-C), ahora no se usan y estarán rellenadaos con ceros.

(HK - Supplementary data)



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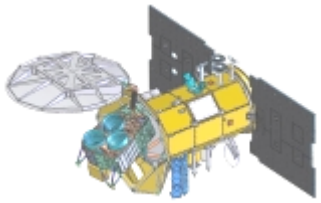
7	5	On-Board Time (*)	OBT	TBD	plataforma	IP-ORG
12	10	Mode Identification	MODE	Ver (**)	OBC	IP-ORG
22		SubModoCam - 5 bits	SUBM	0 a 1F	OBC/CTU	
		CantEtapas1 - 4 bits	ETAPAS	0 a F	OBC/TIU	
		CantEtapas2:- 4 bits	ETAPAS	0 a F	OBC/TIU	
		SelSPC1 - 2 bits	SELSPC	0 a 2	OBC/TIU	
		SelSPC2 - 2 bits	SELSPC	0 a 2	OBC/TIU	
		Tintegr1 - 8 bits	TINT	0 a FF	OBC/TIU	
		Tintegr2 - 8 bits	TINT	0 a FF	OBC/TIU	
	11	CutOffAGC1 - 4 bits	COAGC	0 a F	OBC/SPC	
		CutOffAGC2 - 4 bits	COAGC	0 a F	OBC/SPC	
		CutOffCDS1 - 4 bits	COCDS	0 a F	OBC/SPC	
		CutOffCDS2 - 4 bits	COCDS	0 a F	OBC/SPC	
		Gain1 - 9 bits	GAIN	0 a 1FF	OBC/SPC	
		Gain2 - 9 bits	GAIN	0 a 1FF	OBC/SPC	
		Offset1 - 10 bits	OFFSET	0 a 3FF	OBC/SPC	
		Offset2 - 10 bits	OFFSET	0 a 3FF	OBC/SPC	

Sub Modo Cam (5 bits)



SubmodoModoCam:
Cámaras (bits 0 y 1):

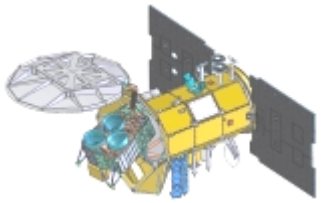
- **00 = 2 cámaras**
- **01 = cámara A**
- **10 = Test CTU (2 cámaras)**
- **11 = cámara B**

Convolucionado (bit 2):
0 = convolucionado
1 = no convolucionado
Se usará siempre 1 (no convolucionado)

8/10 bits (bit 3):
0 = 10 bits
1 = 8 bits

Selección señales (bit 4):
0 = selección señales cámara A
1 = selección señales cámara B
(De las 2 cámaras, una se usa como master para el Clock)

Mode Identification / OBT



Mode Identification:

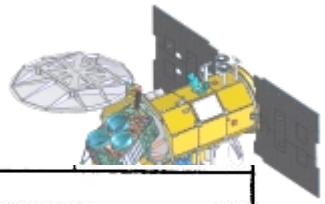
10 caracteres ascii que permiten identificar el modo de operación:

- **"HSTC HR-RT"** (High Resolution Real Time)
- **"TEST HR-RT"**
- **“HSTC HR-SB”** (High Resolution Stored Video y House Keeping)
- **“TEST HR-SB”**

OBT: con una resolución de 4 milisegundos.

SPC: Cada sistema óptico tiene además 2 SPC (Signal Processing Chain).

HSC HK - Temperatures



OBC Data						
152	2	Focal Plate#3 Temperature	T_FP#3	0000h-0FFFh	OBC	IP-CORR
154	2	Focal Plate#4 Temperature	T_FP#4	0000h-0FFFh	OBC	IP-CORR
156	2	Focal Plate#1 Temperature	T_FP#1	0000h-0FFFh	OBC	IP-CORR
158	2	Focal Plate#2 Temperature	T_FP#2	0000h-0FFFh	OBC	IP-CORR

En las posiciones 152 a 158 del HK van las temperaturas "Focal Plate" 3, 4, 1 y 2 (en ese orden). Las temperaturas que se ponen en esas posiciones son T11 a T14, que corresponden a temperaturas de la cámara 1:

- **T11: Bafle de cámara 1**
- **T12: Placa focal cámara 1**
- **T13: Radiador, a media altura, lado cámara 1**
- **T14: Cuerpo superior de estructura, lado cámara 1**

La temperatura de la Placa Focal es la que se usará para seleccionar el rango de Temp de la calibración radiometría.

Notar que en el HK solo viene la Temp de la Cámara 1. Si se necesitara las temperaturas de las 2 camara deberá recurrirse a la telemetria de laplataforma, en donde vienenlas 8 temperaturas: T3, T4, T5 y T6 y T11, T12, T13 y T14.