

Pléiades 1B and SPOT 6

Image Quality status after commissioning and 1st year in orbit

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Acknowledgments

We would like to express our gratitude to all contributors of Pléiades and SPOT 6 Image Quality for the care they brought in assessing, improving and carrying on monitoring radiometric and geometric performances.

- **Pléiades 1B:**



- French Space Agency, Centre National d'Etudes Spatiales (CNES)
- Responsible of commissioning phase and monitoring along the life

- **SPOT 6:**



- AIRBUS Defense & Space
- Responsible of commissioning phase and monitoring along the life



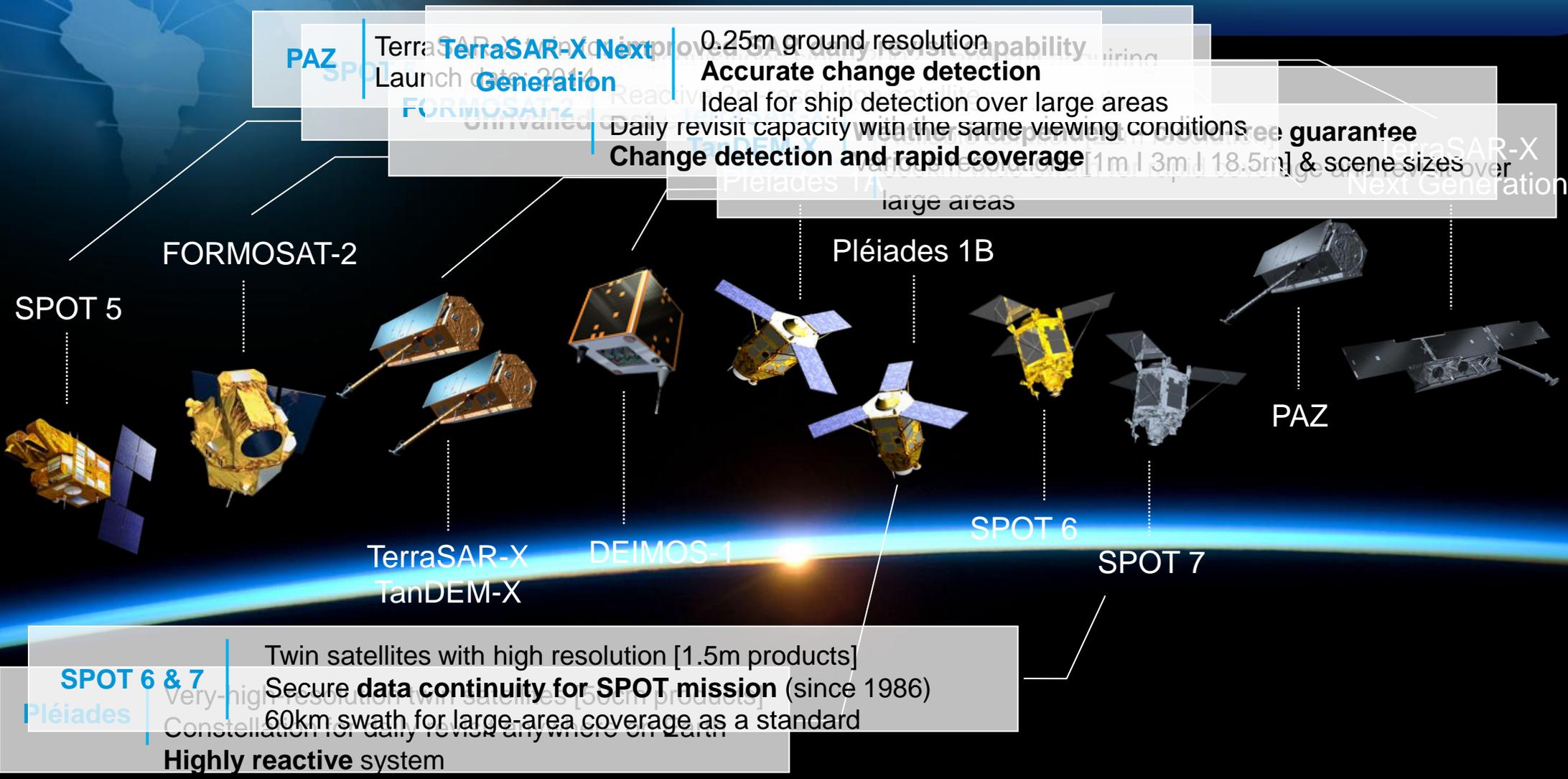
- French Mapping Agency, Institut Géographique National (IGN)
- Commissioning phase: geometric calibration and performance



- French Space Agency, Centre National d'Etudes Spatiales (CNES)
- Commissioning phase and monitoring along the life: radiometric calibration and performance

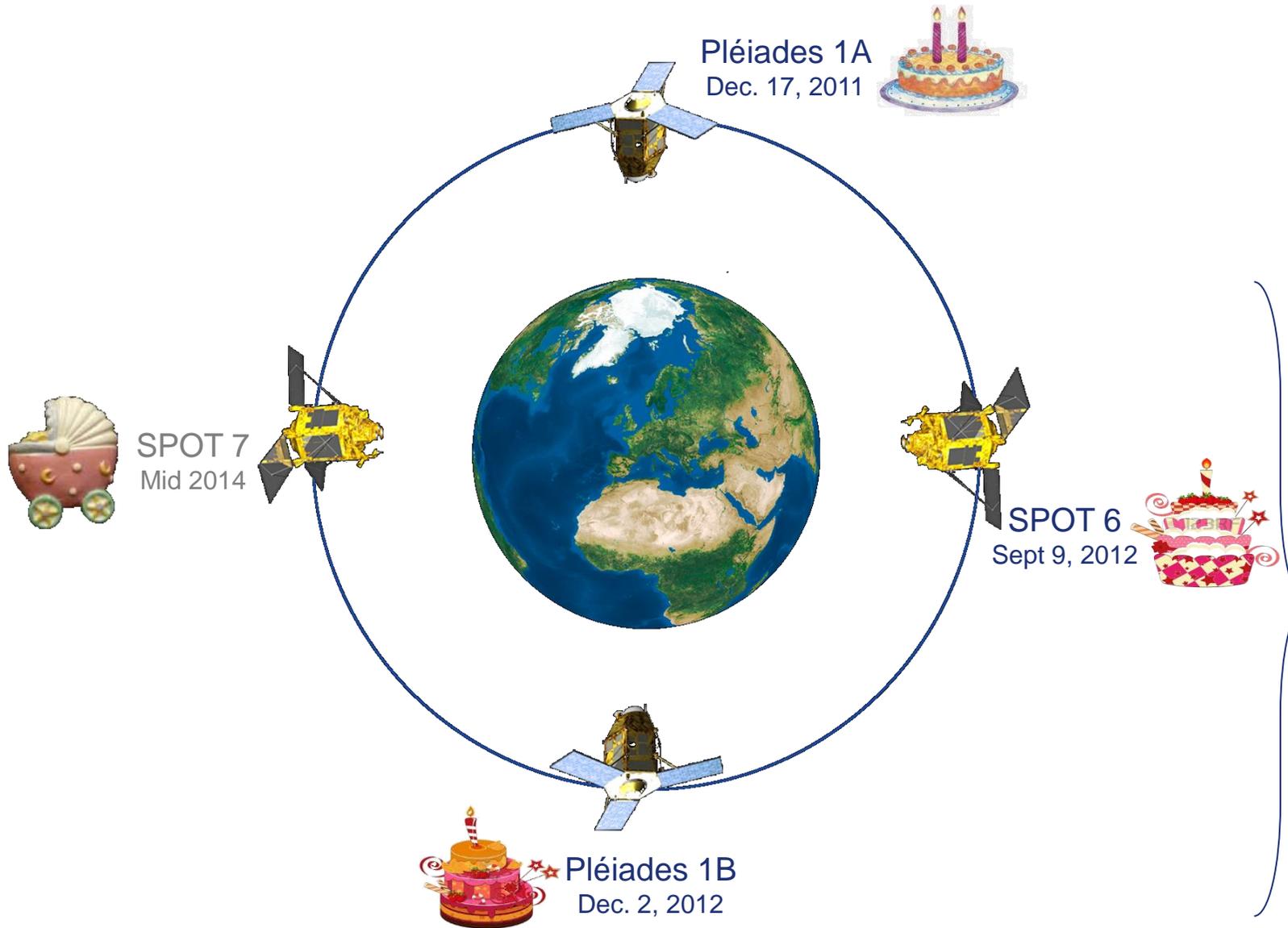


Airbus Defense and Space Assets and Capabilities



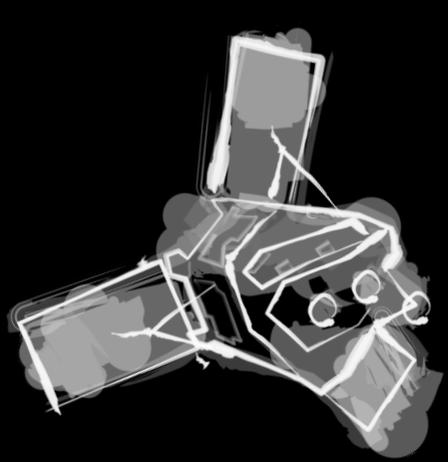
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Have a look on the optical side of the family



◀ *Commissioning and 1st birthday in orbit*

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I. Geometry

II. Radiometry

III. Ortho

IV. DEM

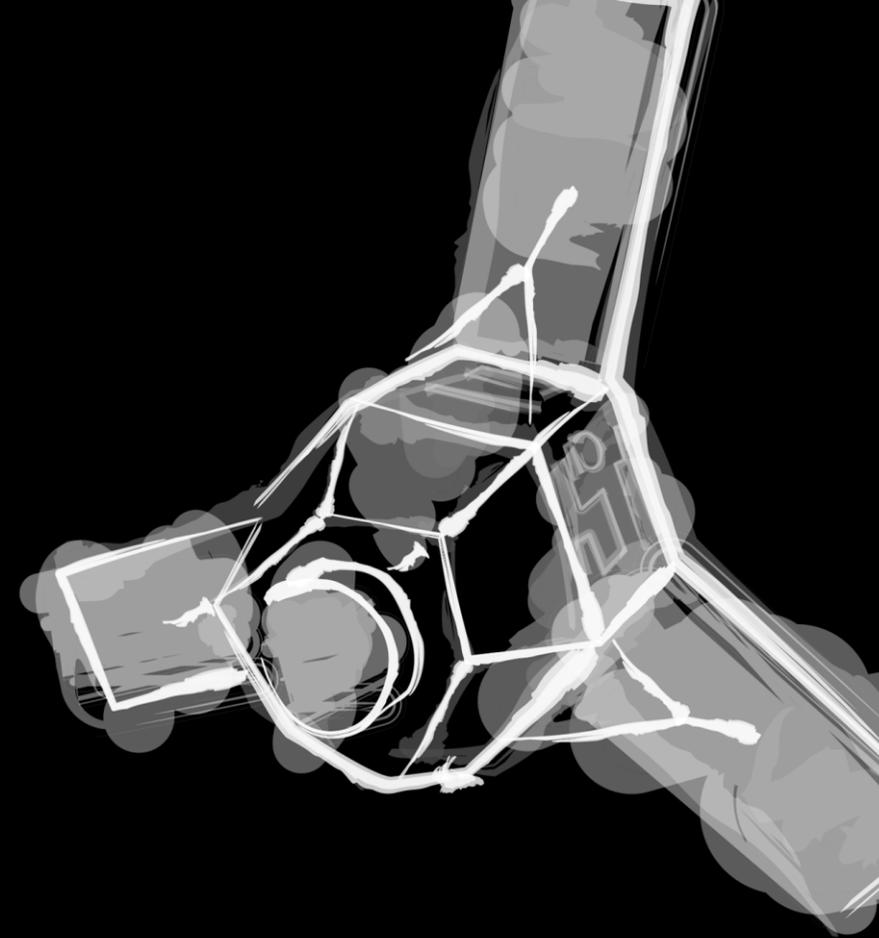


Image quality: assessments/measurements/performances

Main objective of image quality assessments is to provide measurements of the performance of image as acquired by the satellite camera and process by its equipments

- Image quality (IQ) must establish a constant assessment reference frame. Generally provided by:
 - Raw images as archived on-ground after data downlink. Possibly including enhancement not achieved at satellite level.
 - A collection of features (sites...) used as reference.
- Final products cannot strictly be included into this frame as:
 - Some end-user options may modify image contents: bit-depth radiometric resolution, mapping projection...
 - Requirements agreed with end user may differ from observations assessed on IQ reference features: acquisition conditions (angle, sunlight...), atmospheric effects, target characteristics...

Evaluation of image quality on final products (Primary, Ortho) must take into account these aspects.

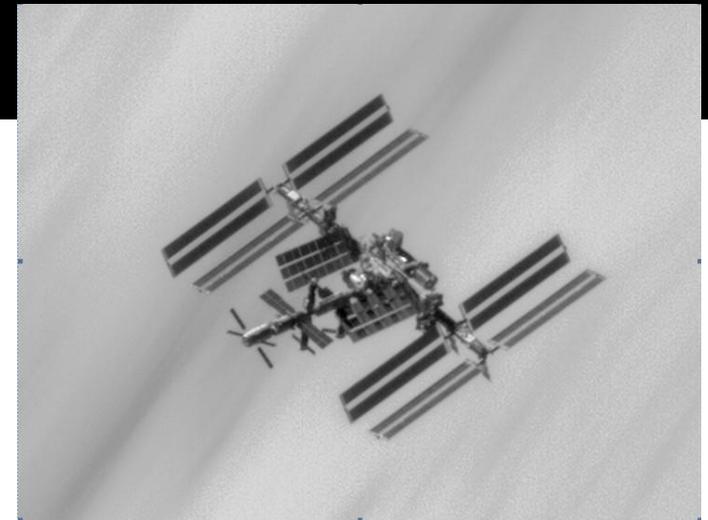
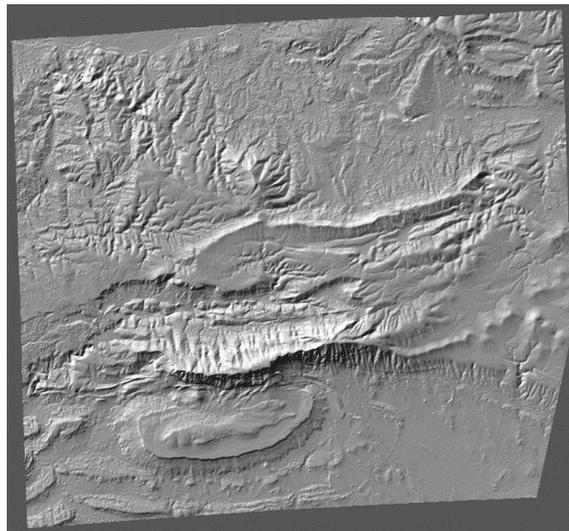
Geometric Performances

Pointing accuracy

Location accuracy

Planimetric accuracy

Vertical accuracy



Pointing Accuracy Performance

The capability to target the instrument toward the desired point when tasking the satellite

- Pléiades 1B performance: requirement reached with a comfortable margin
 - Performance Across track: 275m LE99.7 vs. Requirement 500m LE99.7
 - Performance Along track: 520m LE99.7 vs. Requirement 1000m LE99.7
- SPOT 6 performance: requirement reached with a comfortable margin
 - Performance Across track: 70m LE99.7 vs. Requirement 600m LE95
 - Performance Along track: 362m LE99.7 vs. Requirement 1000m LE95



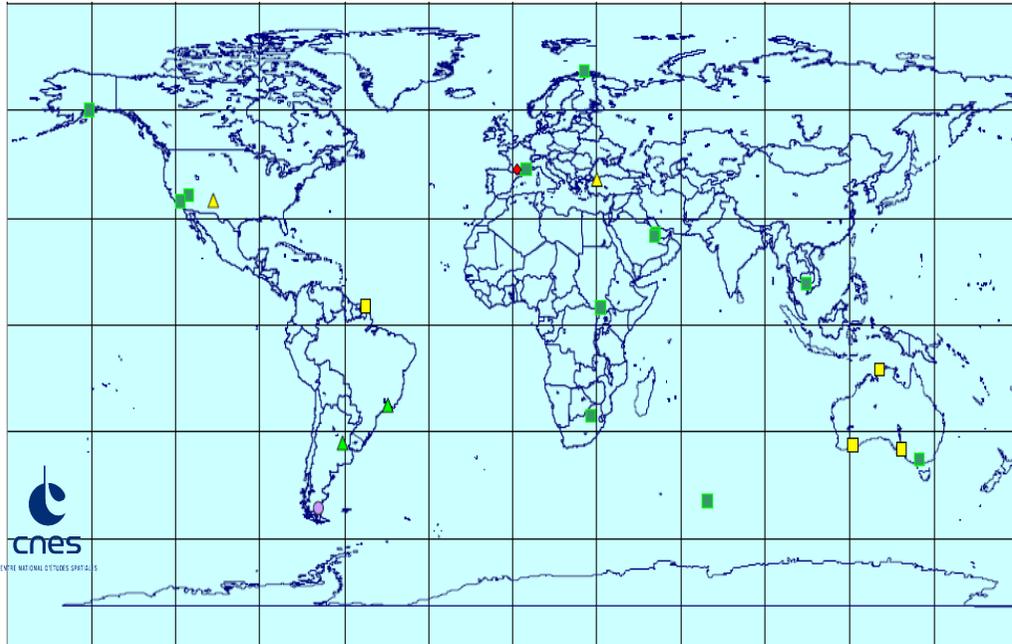
▲ Pléiades 1B single pass tri-stereo
 ◀ (check time on Macca Clock Royal Tower)

Location Accuracy Assessment: How?

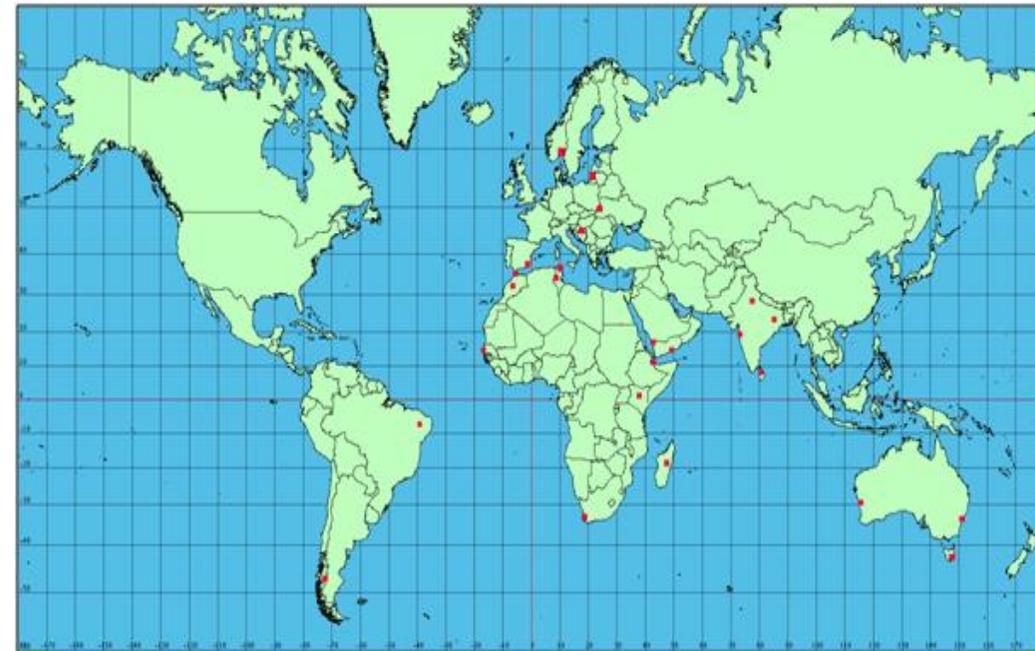
Products location with on-board data only → Rigorous Geometric Model accuracy without GCP

- On board ephemeris
- On board raw attitudes and accurate attitudes for Pléiades (orbitography refined twice a day)

Geolocation assessment (both for commissioning and current monitoring) performed with several hundreds of acquisitions over fully qualified GCPs distributed worldwide in order to reflect the performance all along the orbit and the nominal acquisition domain ($OZA < 30^\circ$)



▲ CNES GCP database used for Pléiades assessment



▲ AIRBUS GCP database used for SPOT 6 assessment

Pleiades: Location Accuracy Performance

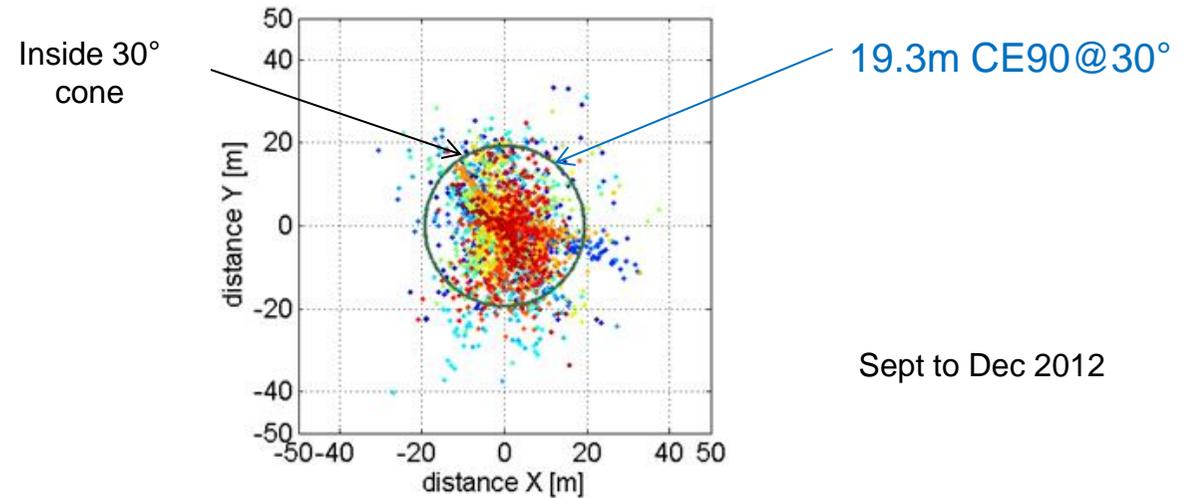
Excellent location accuracy already confirmed at commissioning: 8.5m CE90 @30°

- Better than satellite requirement (12m CE90 @30°)
 - Measurement during the commissioning phase (Jan – May 2013)

SPOT 6: Location Accuracy Performance

Excellent location accuracy already confirmed at commissioning: 19.3m CE90 @30°

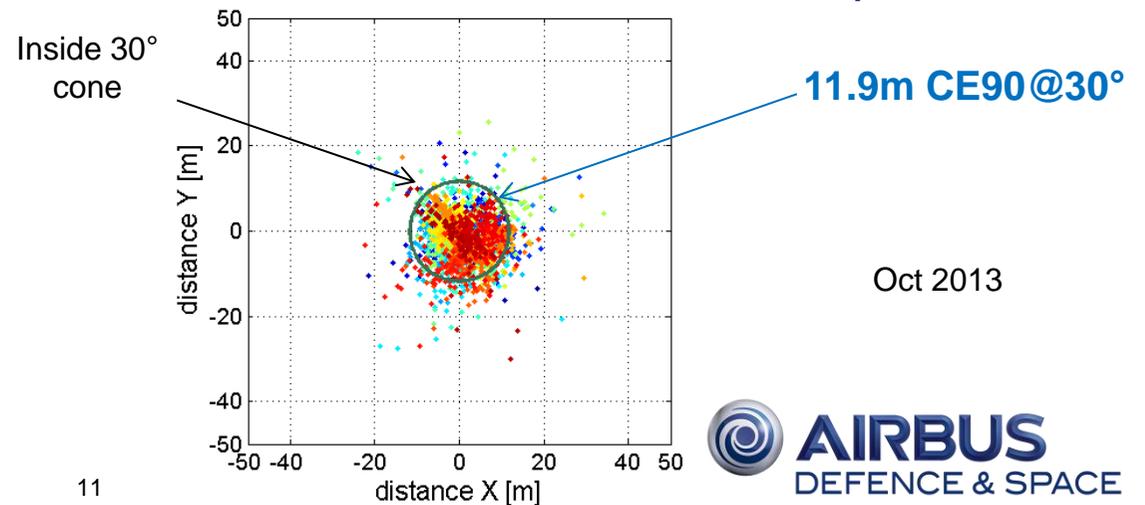
- Nearly 2 times better than satellite requirement (35m CE90 @30°)
 - Measurement during the commissioning phase (Sept-Dec 2012)



Current performance after one year of refinement and temporal drift calibration (Oct 2013)

- Nearly 3 times better than satellite requirement

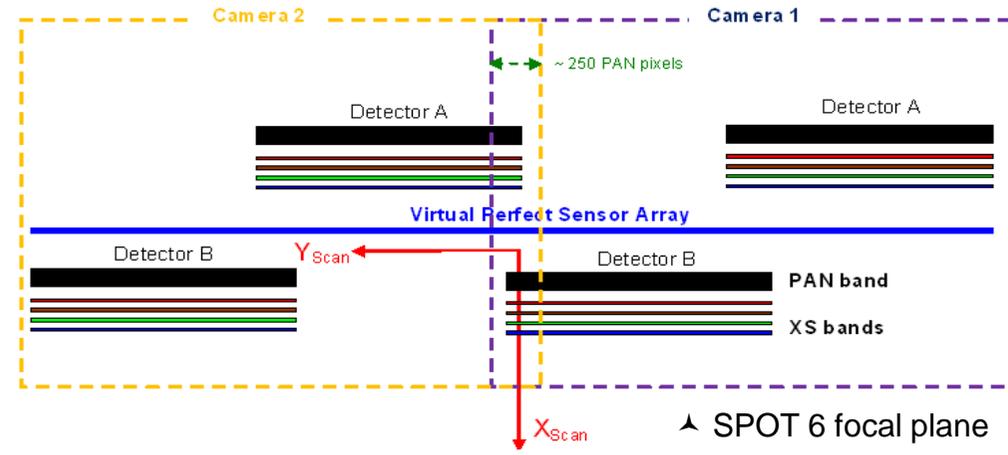
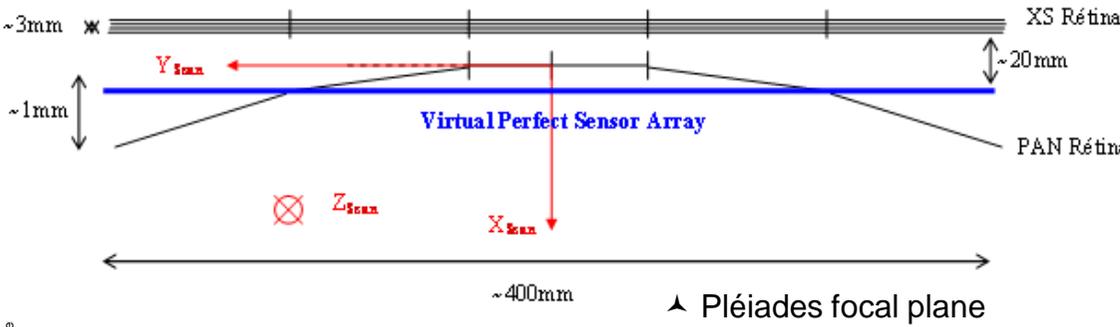
Meter	CE90 @30°
Nominal Attitudes	11.9m



Focal Plane Calibration and Planimetric Accuracy Assessment: How?

out express authorization is

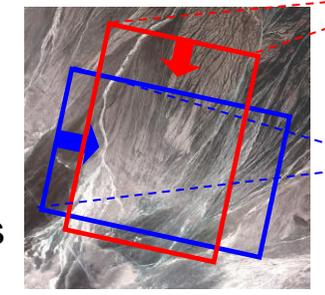
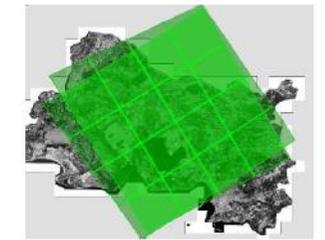
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Planimetric accuracy: residual error of all Line Of Sight contributors after geometric model reset on a Ground absolute reference:

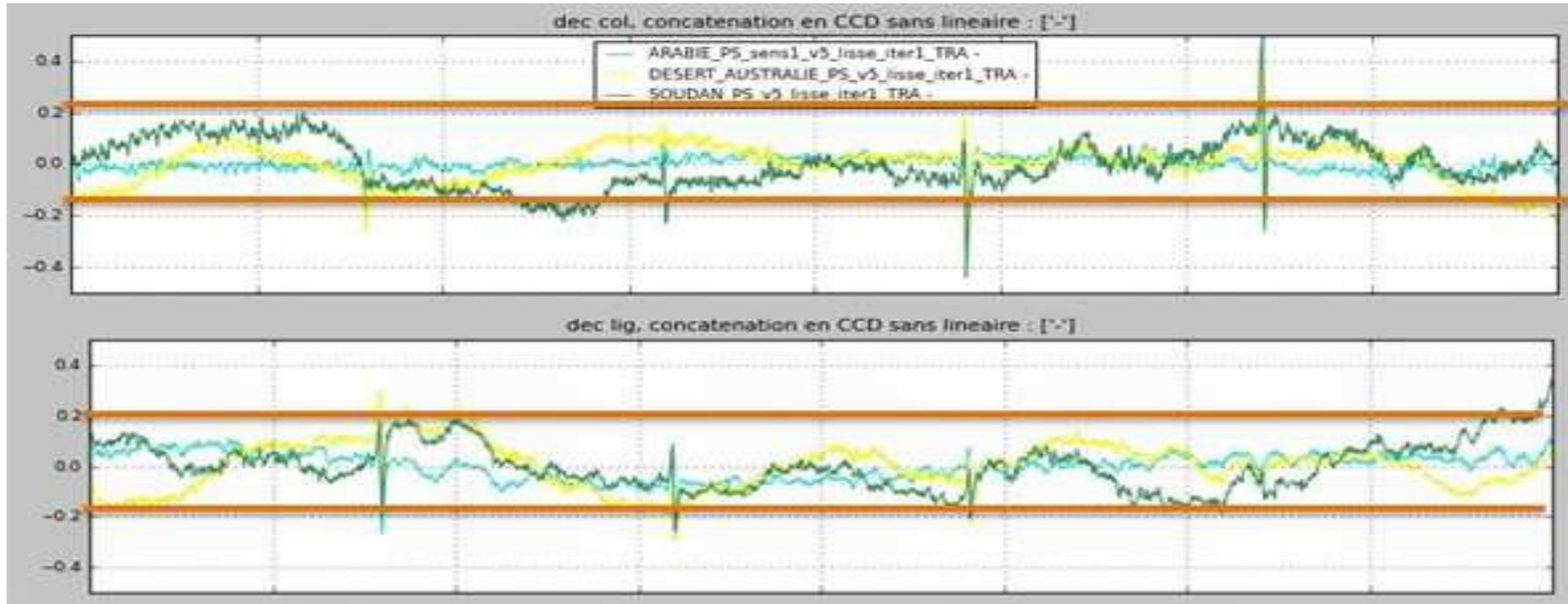
- Assessment on reference site, image auto calibration (cross acquisition) ...
- Reference sites: correlation on nearly perfect reference sites covering the full swath
 - Supersites of Toulouse (France), Bouches du Rhône (France), Napier (New Zealand)
 - XY accuracy <0.2m ; Z accuracy <0.3m
- Auto calibration without reference site
 - Cross acquisition of 2 images (or more) on a same orbit, viewing the same site with opposite viewing angles of 90°
 - Correlation of image couple gives static and dynamic residues along lines and columns

Bouches du Rhône
6/10/2012



Pléiades 1B: Focal Plane and Planimetric Accuracy Performance

Focal plan calibration during commissioning : focal plan residues less than 0.2 pix PAN along track and 0.3 across



◀ Cartography residues along columns and lines at commissioning (PAN pixel unit)

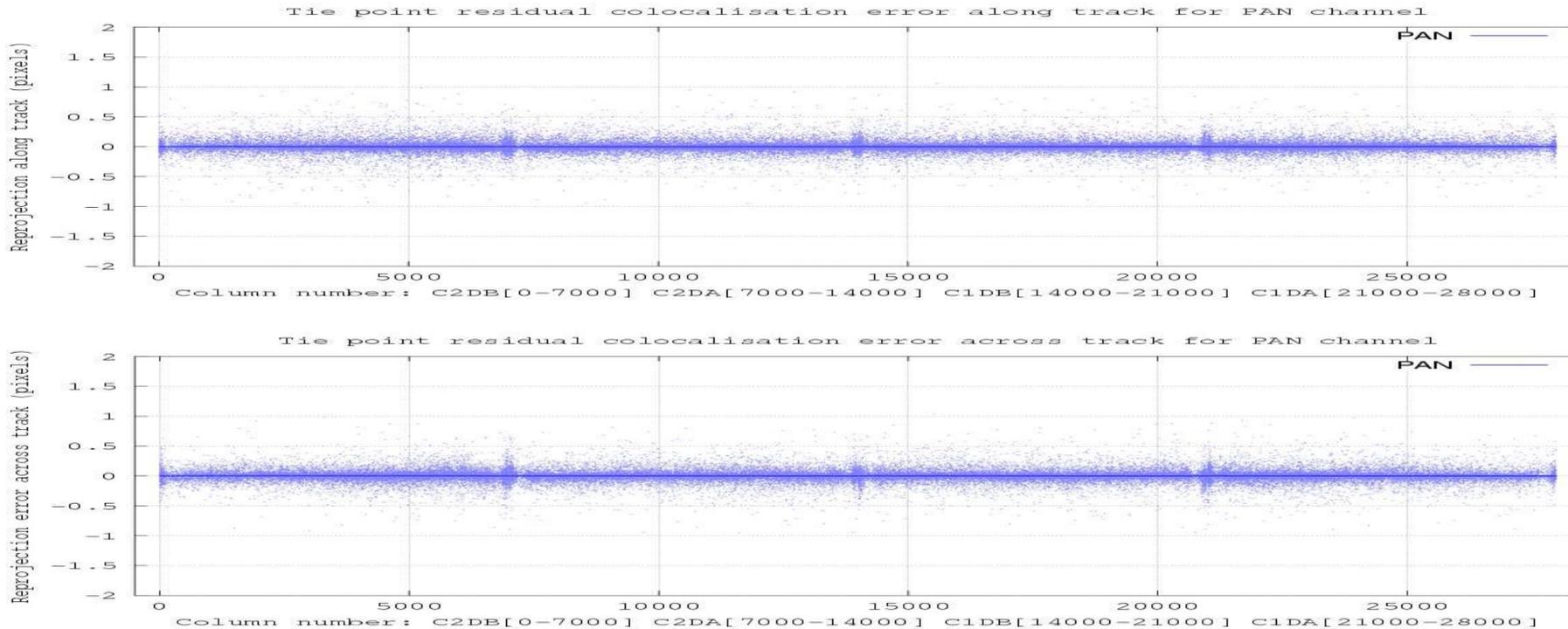
Planimetric accuracy performance on almost perfect reference sites: spec comfortably achieved

Planimetric accuracy (in pixel PAN raw size)	Current performance	Requirement
On 90% of images	0.45	0.5

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SPOT 6: Focal Plane and Planimetric Accuracy Performance

Focal plan calibration during commissioning: focal plan residues less than 0.1 pix PAN along track and 0.2 across



← Cartography residues along columns and lines at commissioning (PAN pixel unit)

Planimetric accuracy performance on nearly perfect reference sites: spec comfortably achieved

Planimetric accuracy (in pixel PAN raw size)	Current performance	Requirement
On 90% of images	0.75	1

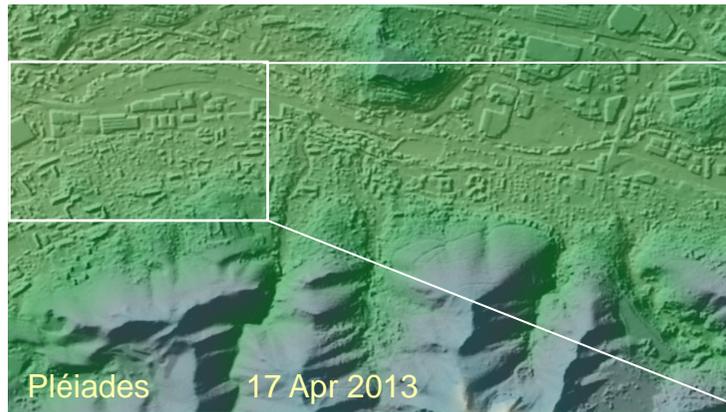
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Pléiades and SPOT 6: Vertical Accuracy Assessment: How ?

Two (multi)stereoscopic pairs acquired on the same path

Assessment on several test sites with reliable ground truth references

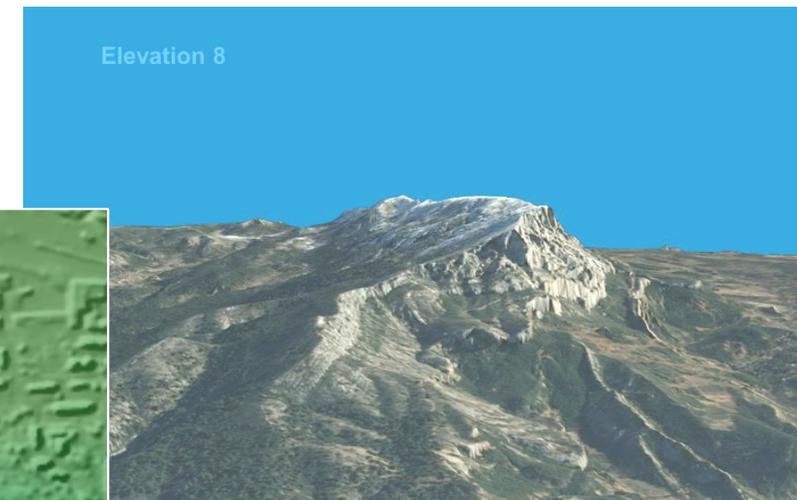
- Australia: Melbourne city (GCP), Hobard (GCP kindly provided by Pr Clive Fraser, Melbourne University)
- France: Sainte-Victoire mount (Provence, photogrammetric site), Cassis (Provence, IGN LIDAR site)
- Afghanistan: Ref3D/GeoBase DEM
- Numerous customer results



02 April 2014



Courtesy IGN



Pléiades: Vertical Accuracy Performance

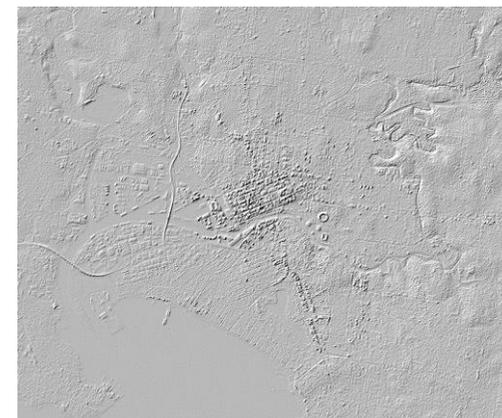
Pléiades (slopes < 20%)

Meter	LE90
B/H 0.22	1.2m
Tri-stereoscopic	1m
B/H 0.5	0.8m

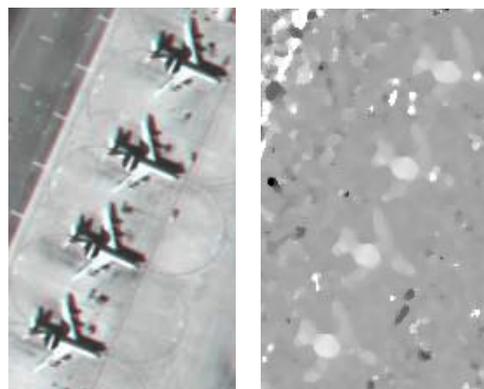
Excellent performance into shadows, thanks to 12 bit-depth dynamic range

DEM Product	Equivalence *
Elevation 1	HRE10 *
Elevation 4	HRE40 *

(*) DEM Product with accurate GCPs



Australia – Melbourne
 ▼ Pléiades DEM ►



AWACS
 airplanes
 Pléiades 3D
 rendering

SPOT 6: Vertical Accuracy Performance

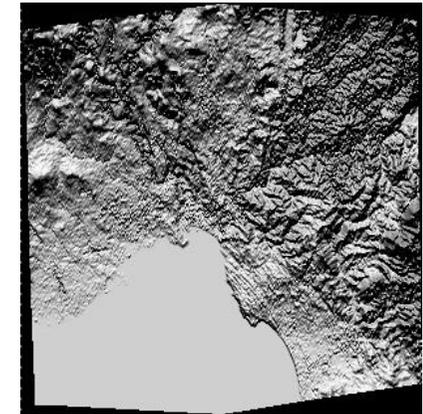
SPOT 6 (slopes < 20%)

Meter	LE90
B/H 0.3	4m
Tri-stereoscopic	2.5m
B/H 0.5	2.5m

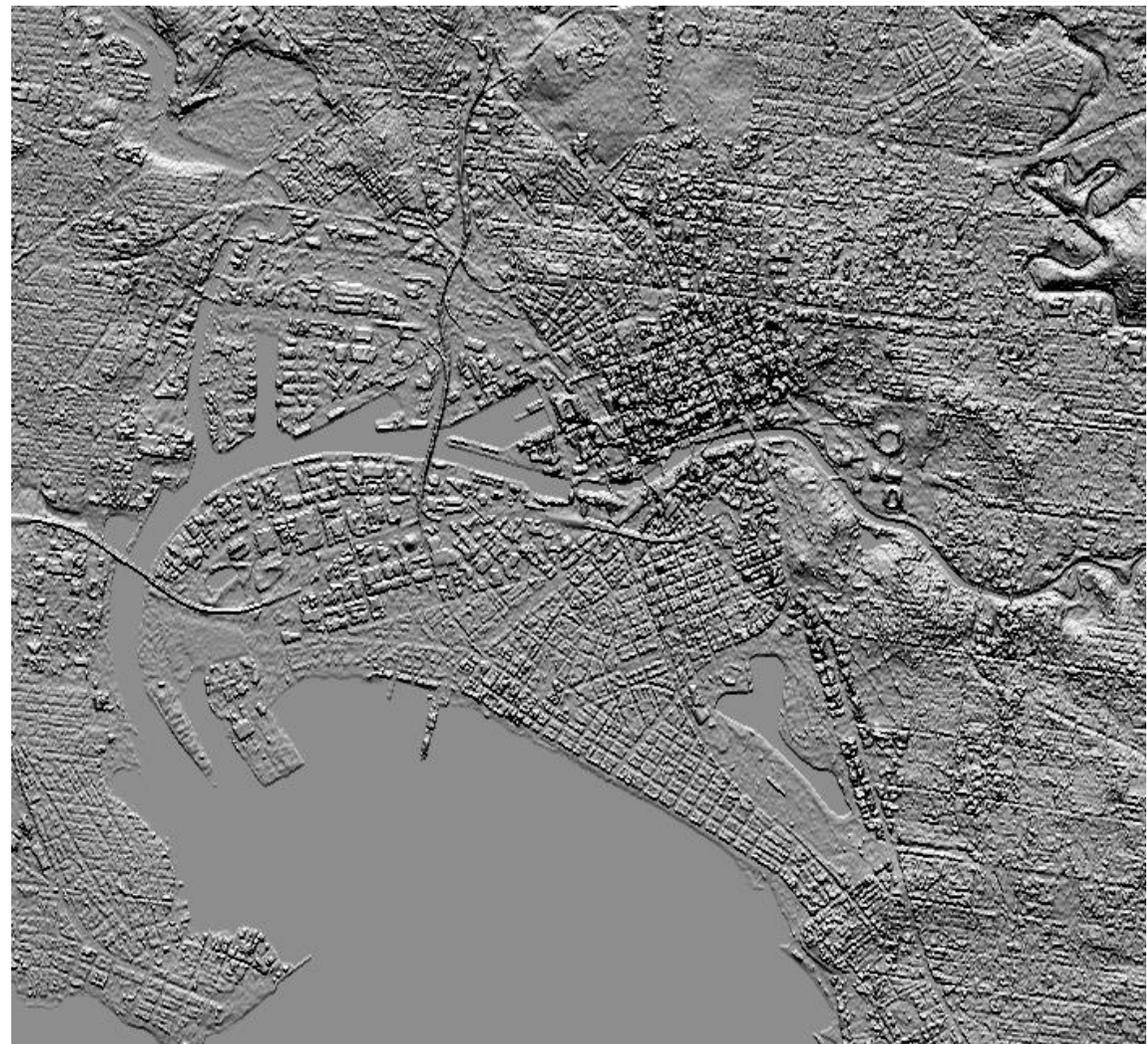
Excellent performance into shadows,
thanks to 12 bit-depth dynamic range

DEM Product	Equivalence (*)
Elevation 8	HRE80 (*)

(*) DEM Product with accurate GCPs



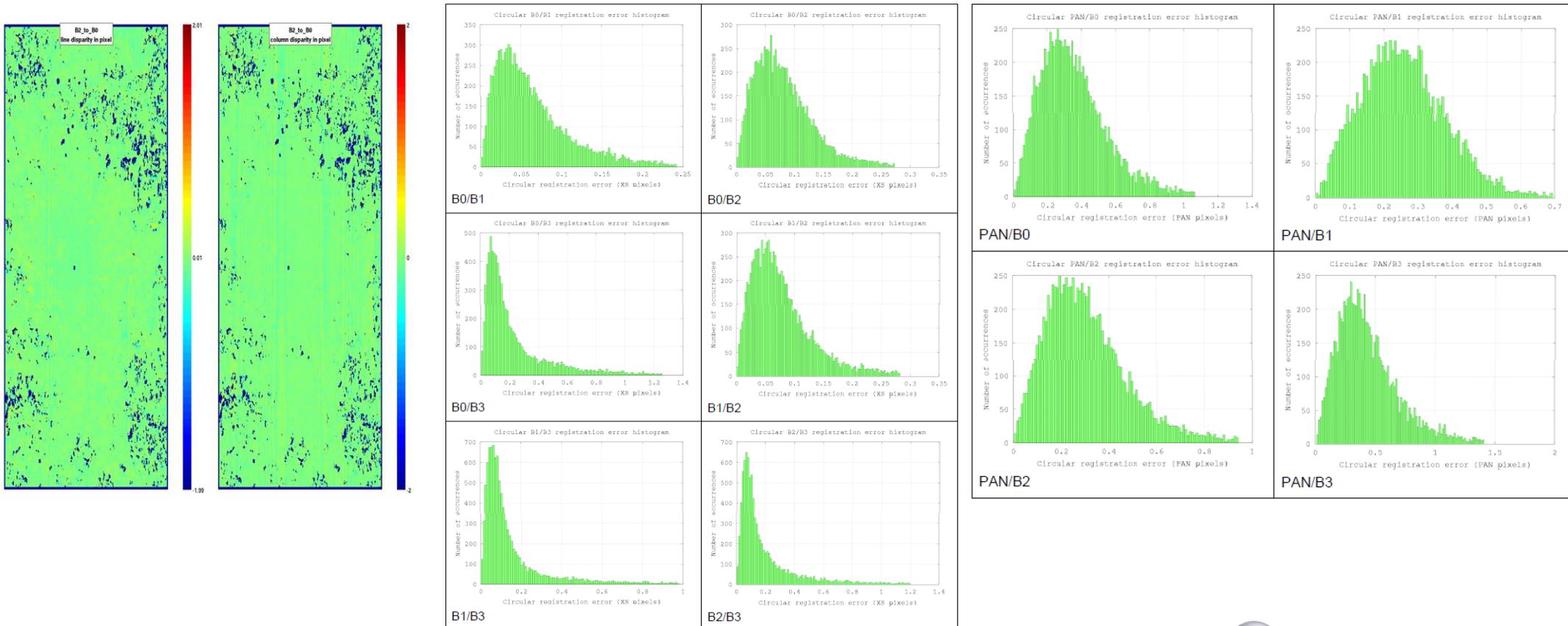
Australia – Melbourne
 ▼ SPOT 6 DEM (Elevation 8) ►



Pléiades 1B and SPOT 6: Inter-Band Registration Assessment

Inter-band registration between each multispectral channel (MS-MS) and with the Pan band (PAN-MS) at product level

- Bands registration on ground at production level (see slide focal plan)
- Direct result of focal plan calibration (static effects) and line of sight stability (dynamics effects)
 - Assessment by inter-band correlation
 - At least 0.25 Pixel MS necessary performance of PAN-MS registration for Pan-sharpening



▲ SPOT 6 inter-band registration measurements (commissioning phase)

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Pléiades 1B: Inter-Band Registration Performance

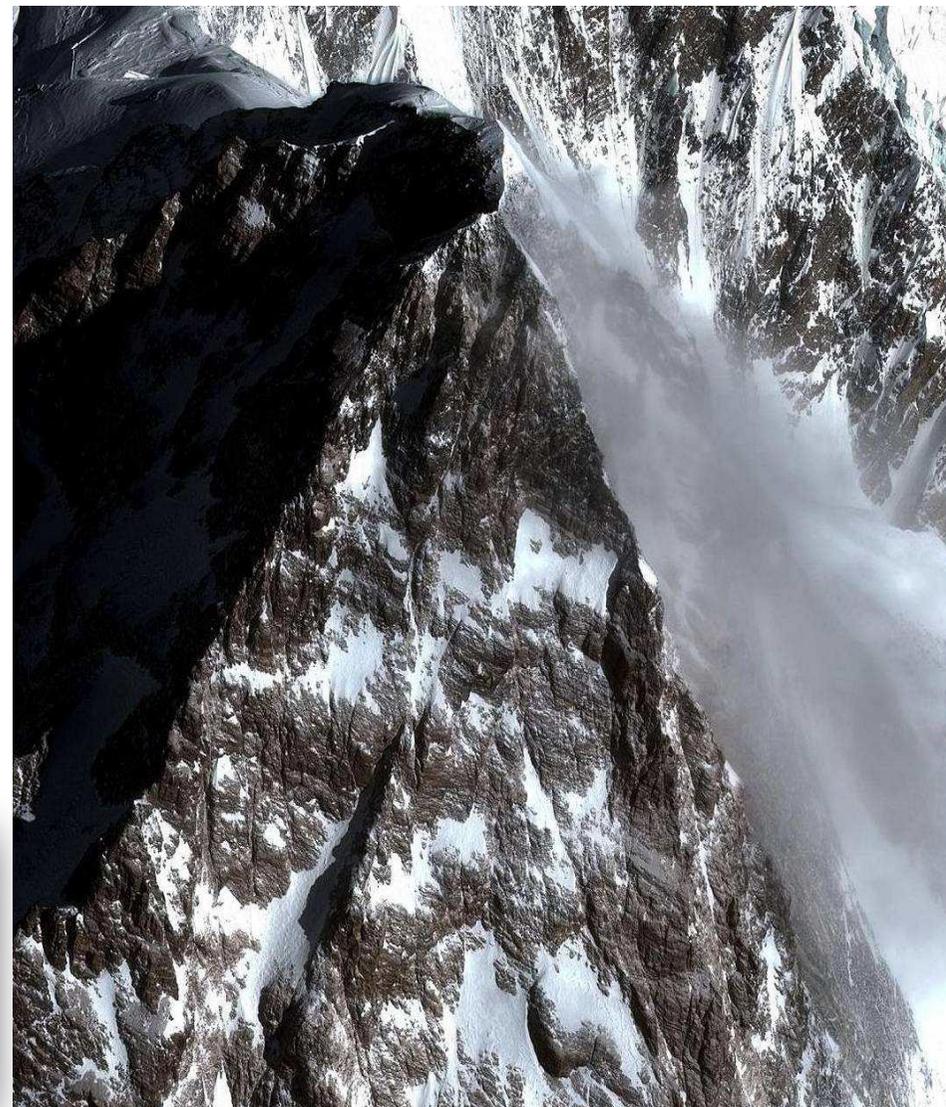
Requirement reached with a comfortable margin

In MS pixel native size	Current performance	Requirement
MS-MS registration	0.18@90%	0.25 @99.7%
PAN-MS registration	0.2@90%	0.5 @99.7%

Excellent registration even in very roughly conditions, thanks to new Pan-sharpening process within

- Significant viewing angles
- Parallax effects caused by relief

K2 Mount elevation of 8,611m
(Karakoram)
45° off-nadir acquisition
0.5m pan-sharpened Product ➤



SPOT 6: Inter-Band Registration Performance

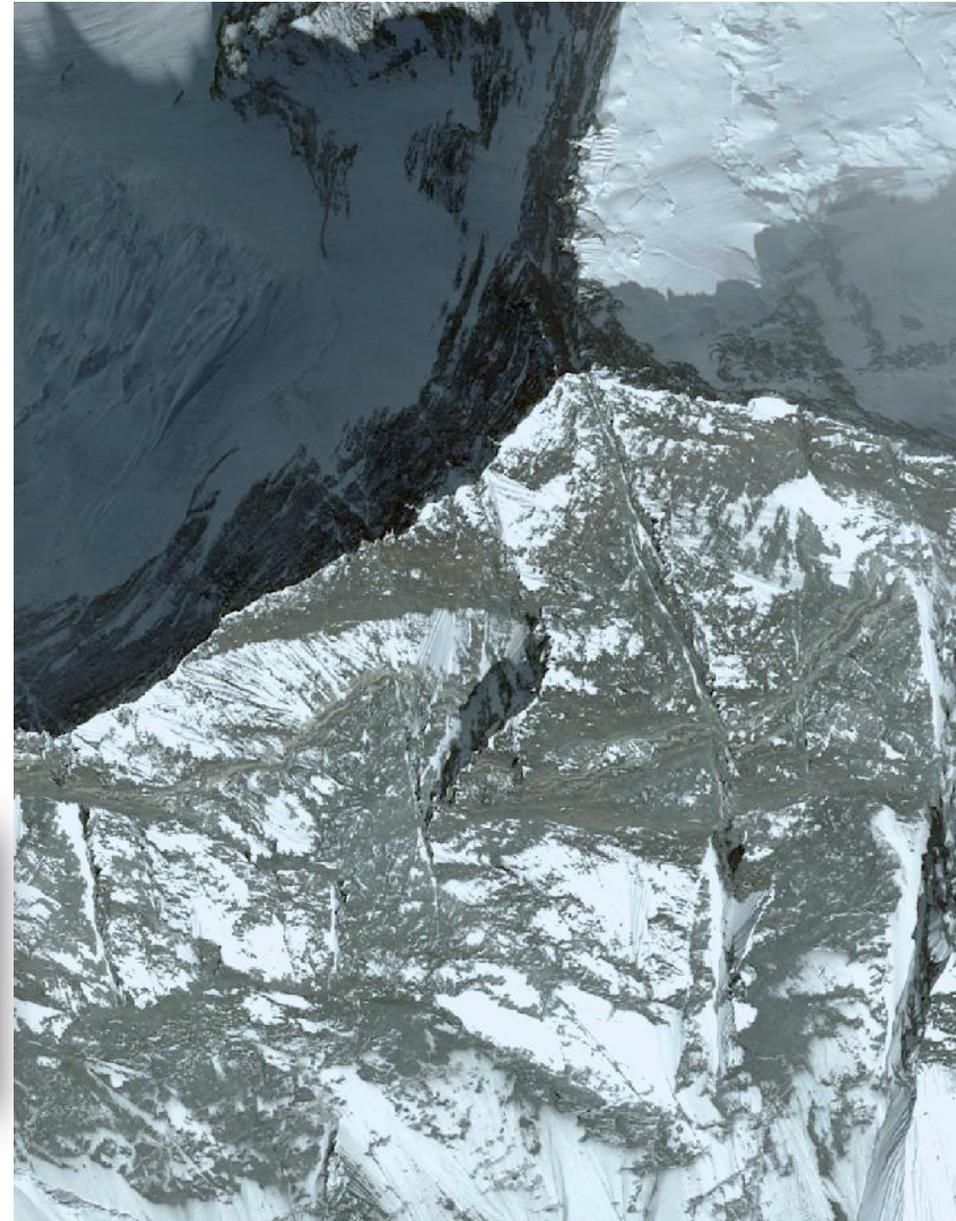
Requirement reached with a comfortable margin

In MS pixel native size	Current performance	Requirement
MS-MS registration	0.2 @99.7%	0.25 @99.7%
PAN-MS registration	0.2 @99.7%	0.25 @99.7%

Excellent registration even in very roughly conditions, thanks to new Pan-sharpening process within

- Significant viewing angles
- Parallax effects caused by relief

Everest Mount 8,848m
(Nepal/Tibet)
27° off-nadir acquisition
1.5m Pan-sharpened product ➤



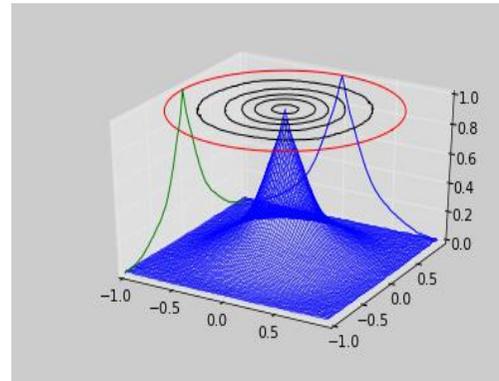
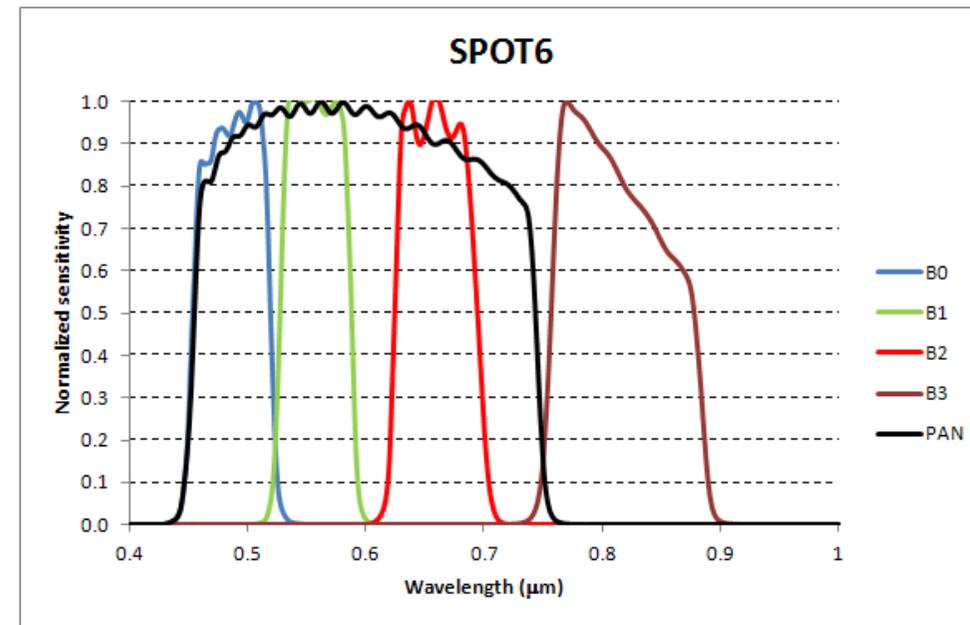
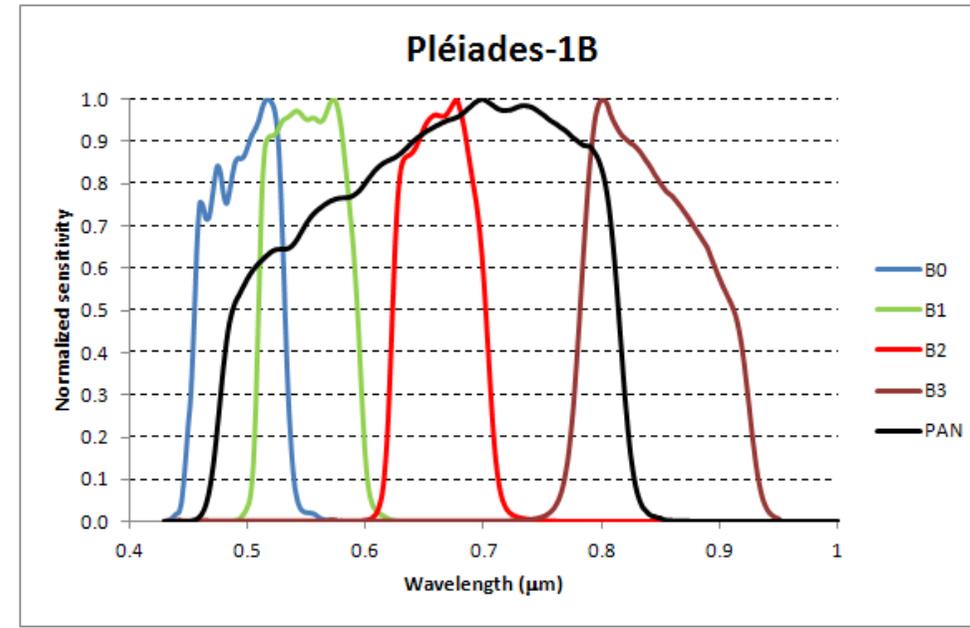
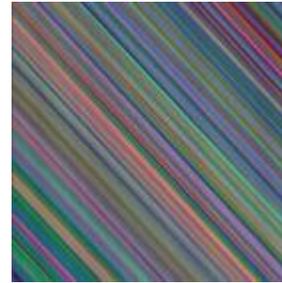
Radiometric performances

Radiance range

Signal to Noise Ratio (SNR)

Modulation Transfer Function (MTF)

Absolute Calibration



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Pléiades 1B: Radiance Range Performance

Radiance encoded over 12 bits-depth (LSB 1 to 4095). 2013 performance:

Nominal gains configuration in $W.m^{-2}.sr^{-1}.\mu m^{-1}$	Linearity minimum Level (L1)	Linearity maximum level (L4)	Detection saturation Level (Lsat)
Panchromatic (PAN)	13.5	321.4	391.1
Blue Band (B0)	30.8	382.7	513.6
Green Band (B1)	21	370.8	473.5
Red Band (B2)	12	332.3	398.5
NIR Band (B3)	4.9	223.5	251.7

PAN: nominal Time Delay Integration (TDI) gain configuration: 13 stages (7/10/13/+2 additional configurations)

Saturation controlled by anti-blooming device

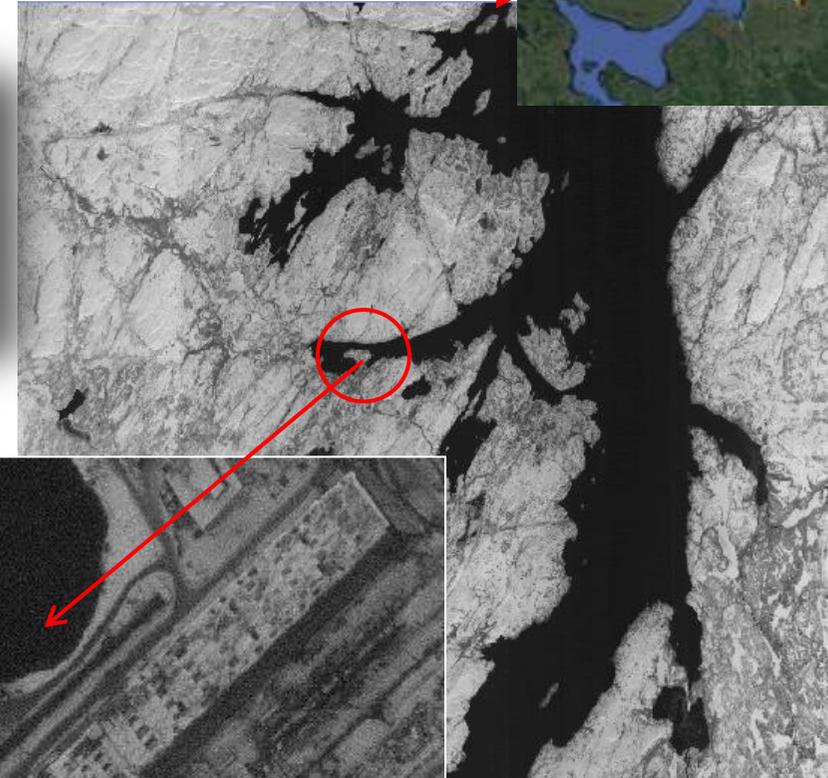
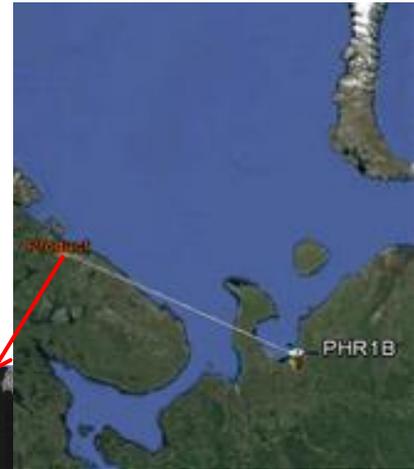
- No degradation along lines and columns



Pléiades 1B: Radiance Range Performance

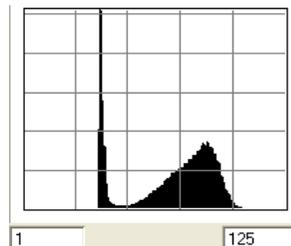
Excellent radiance range: Acquisitions tested in nearly nightly conditions
 Sun elevation < 1° ; mean radiance at ~1.1 W.m⁻².sr⁻¹.μm⁻¹

Kola Peninsula, 2013/11/22
 Lat_center=69.20°
 Long_center=33.36°
 PHR-1B
 UTC: 2013-11-22T09:07:29
 Sun Elevation 0.614° ▼ ➤



Sun Elevation (°)	Band	Histo Min	Histo Max	Histo Mean	Histo STDV
0.614°	PAN (TDI=20)	1	976	20.09	55.54

Usable	Comment
Yes	“Moderate” instrument noise and non-uniformity detector equalization (considering a sun elevation < 1° and a mean radiance at ~1.1 W.m ⁻² .sr ⁻¹ .μm ⁻¹)



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SPOT 6: Radiance Range Performance

Radiance encoded over 12 bits-depth (LSB 1 to 4095). 2013 performance:

Nominal gains configuration in $W.m^{-2}.sr^{-1}.\mu m^{-1}$	Linearity minimum Level (L1)	Linearity maximum level (L4)	Detection saturation Level (Lsat)
Panchromatic (PAN)	17.8	348	364
Blue Band (B0)	33.3	389	424
Green Band (B1)	20.6	376	387
Red Band (B2)	11.9	336	367
NIR Band (B3)	5.6	276	301

PAN: nominal TDI gain configuration: 5 stages (3/5/+5 additional configurations)

Saturation controlled by anti-blooming device

- No degradation along lines and columns



Signal to Noise Ratio (SNR) Assessment: How?

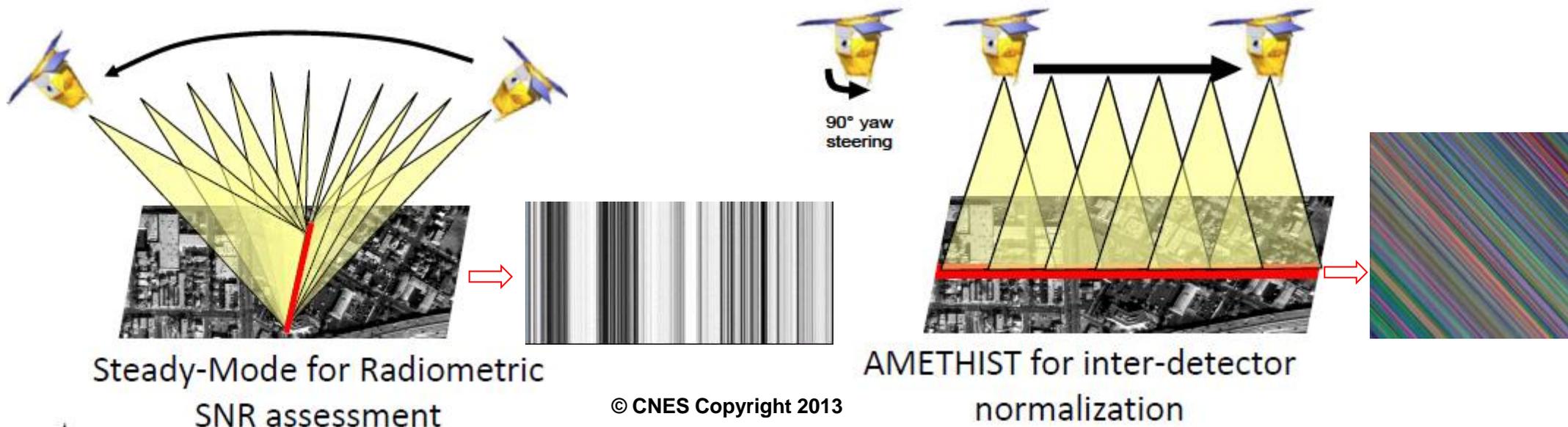
The SNR is the ratio between the information present in the image and its noise. The noise can come from:

- The instrument: signal fluctuation delivered by detectors, onboard electronic chain noises, quantization noise...
- The deviation of the radiometric model: possible inter-detector equalization residuals depending of landscape spectral and polarization properties (also called Photo Response Non-Uniformity, PRNU)

Assessment at instrument level

- With nominal configuration acquisition gains
- At a reference Radiance level: requirements given at Radiance middle value of $100 \text{ W.m}^{-2}.\text{sr}^{-1}.\mu\text{m}^{-1}$ (L2)
- On uncompressed Raw Sensor Products => no external contributors (resampling, filtering...) excepted non-uniformity correction at ground if needed

Assessment mainly on uniform landscapes and specific satellite guidance modes



Pléiades 1B: Signal to Noise Ratio (SNR) Performance

Instrument noise perf (2013): requirement comfortably achieved. No de-noising processing needed on-ground.

Nominal configuration in $W.m^{-2}.sr^{-1}.\mu m^{-1}$	@100 $W.m^{-2}.sr^{-1}.\mu m^{-1}$ (L2)	Requirement (@L2)
Panchromatic (PAN)	161	90
Blue Band (B0)	150	90
Green Band (B1)	165	90
Red Band (B2)	156	90
NIR Band (B3)	183	90

PRNU noise performance (2013): requirement (pick-to peak max values) reached

Nominal configuration in $W.m^{-2}.sr^{-1}.\mu m^{-1}$	@100 $W.m^{-2}.sr^{-1}.\mu m^{-1}$ (L2)	Requirement (pick-to peak max @L2)
Panchromatic (PAN)	0.35	2
Blue Band (B0)	1.05	3
Green Band (B1)	2.11	3
Red Band (B2)	1.44	3
NIR Band (B3)	0.84	3

SPOT 6: Signal to Noise Ratio (SNR) Performance

Instrument noise perf (2013): requirement comfortably achieved. No de-noising processing needed on-ground.

Nominal configuration in $W.m^{-2}.sr^{-1}.\mu m^{-1}$	@100 $W.m^{-2}.sr^{-1}.\mu m^{-1}$ (L2)	Requirement (@L2)
Panchromatic (PAN)	139	100
Blue Band (B0)	258	150
Green Band (B1)	253	150
Red Band (B2)	266	150
NIR Band (B3)	293	150

PRNU noise performance (2013):

- Intra-camera:

Nominal configuration in $W.m^{-2}.sr^{-1}.\mu m^{-1}$	@100 $W.m^{-2}.sr^{-1}.\mu m^{-1}$ (L2)	Requirement (99%@L2)
Panchromatic (PAN)	3	3
Blue Band (B0)	3	3
Green Band (B1)	3	3
Red Band (B2)	3	3
NIR Band (B3)	3	3

← Considering a same FOV aperture value, same performance as Pléiades 1B

- Inter-camera: according to bi-camera focal plane PRNU performance at inter-camera is performed on-ground at production processing step with a performance less than 0.3 W.

Modulation Transfer Function (MTF) Assessment: How?

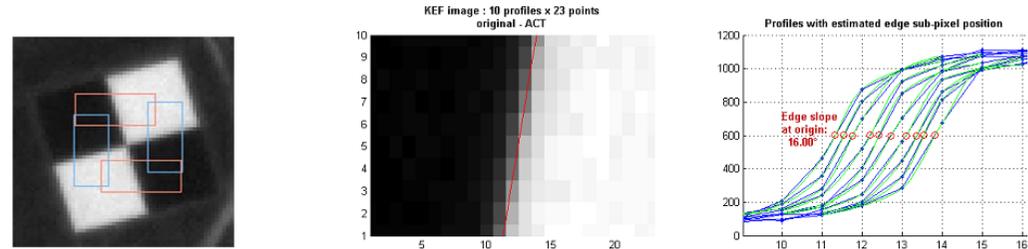
Measures the sharpness of the image (the spatial resolution of the instrument i.e landscape spatial contrasts)

- At sensor level, through the instrument (“Satellite” MTF)
- At ground processing level after specific image restoration (“System” MTF)

A convenient way for end user’s needs is to use the Image Quality Factor defined by CNES – an indicator measuring the sharp (=MTF) and the noise (=SNR) by multiplying SNR and MTF

Assessments on Raw Sensor Products (no external contributors as resampling, filtering...) over targets like:

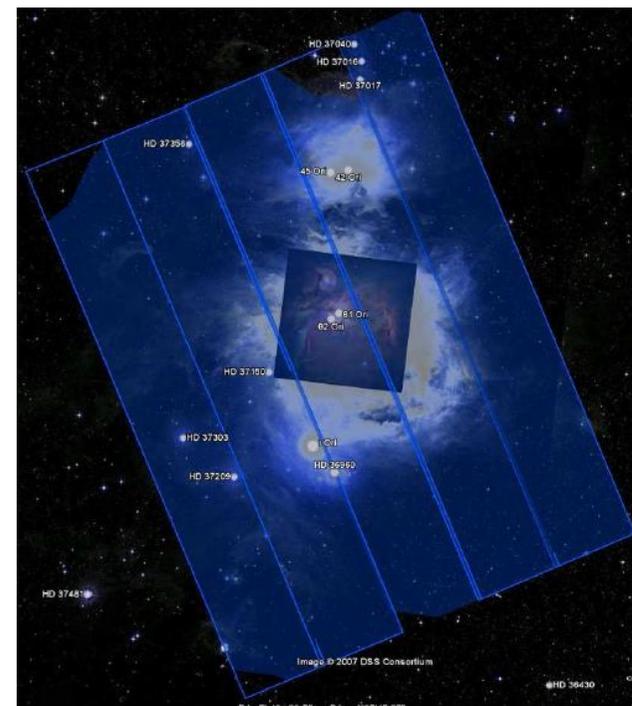
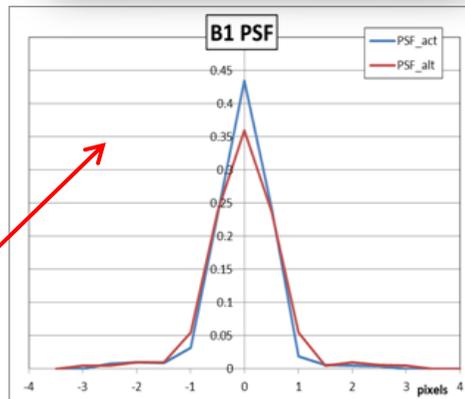
- Edge-patterns (e.g Salon de Provence, Fr...)
- Point-like source (lights, stars...)



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◀ Las Vegas, SPOT 6 night acquisition and Point Spread Function (PSF) measurement



◀ Pléiades star acquisition for PSF measurement © CNES

Pléiades 1B: Modulation Transfer Function (MTF) Performance

Satellite MTF (2013)

- Requirement comfortably achieved: ~2 times better than satellite requirement

Satellite MTF at Nyquist frequency ($f_e/2$)	Mean MTF across track (X) / along track (Y)	MTF requirement across track (X) / along track (Y)	Image Quality Factor MTF x SNR (@L2) across track (X) / along track (Y)
Panchromatic (PAN)	0.14/0.14	0.08/0.08	22/22
Blue Band (B0)	0.3/0.26	0.2/0.2	45/39
Green Band (B1)	0.31/0.26	0.2/0.2	51/43
Red Band (B2)	0.31/0.25	0.2/0.2	48/39
NIR Band (B3)	0.31/0.26	0.2/0.2	57/48

System MTF (ground image restoration)

Allow to enhance on-ground the native sharpness of image (satellite MTF) by a deconvolution process on raw images at early production step. As sharp enhancement will increase level of noise (SNR), MTF target is always a compromise between a good sharp and a moderate noise.

- Panchromatic : on-ground restoration process with a **MTF target of 0.39 at $f_e/2$**
- Multispectral: no restoration on-ground (same as satellite level)

SPOT 6: Modulation Transfer Function (MTF) Performance

Satellite MTF (2013)

- Requirement comfortably achieved: ~2 times better than satellite requirement

Satellite MTF at Nyquist frequency ($fe/2$)	Mean MTF across track (X)/along track (Y)	MTF requirement across track (X)/along track (Y)	Image Quality Factor MTF x SNR(@L2) across track (X)/along track (Y)
Panchromatic (PAN)	0.2/0.15	0.1/0.1	28/22
Blue Band (B0)	0.4/0.26	0.2/0.2	103/67
Green Band (B1)	0.4/0.26	0.2/0.2	101/66
Red Band (B2)	0.4/0.26	0.2/0.2	106/69
NIR Band (B3)	0.4/0.26	0.2/0.2	117/76

System MTF (ground image restoration)

Allow to enhance on-ground the native sharpness of image (satellite MTF) by a deconvolution process on raw images at early production step. As sharp enhancement will increase level of noise (SNR), MTF target is always a compromise between a good sharp and a moderate noise.

- Panchromatic : on-ground restoration process with a **MTF target of 0.39 at $fe/2$**
- Multispectral: no restoration on-ground (same as satellite level)

Absolute Calibration assessment: How?

Ability to compute from image raw numerical count (LSB) a physical value measurement at Top Of Atmosphere (TOA Radiance, $W.m^{-2}.sr^{-1}.\mu m^{-1}$)

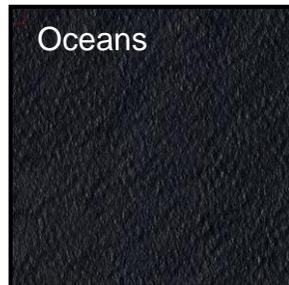
- Evaluate through accuracy of calibration methods to assess the absolute conversion coefficient to TOA Radiance for every spectral bands

Pléiades sensors and SPOT 6/7 sensors calibration managed by CNES with their unique aggregated methodologies, instruments and tools:

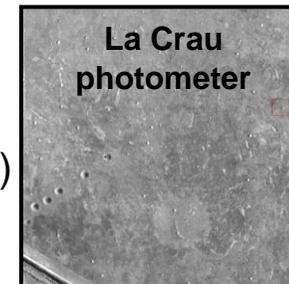
- Cross calibration with other sensors (SPOT4/5/6, PHR, MERIS...) over reference sites
 - Steady landscape as sand deserts
 - Several millions of measurements archived into the SADE CNES multi-sensor database



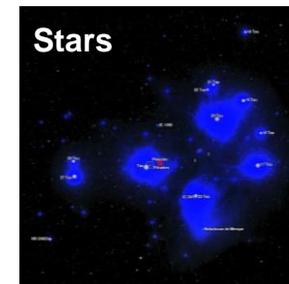
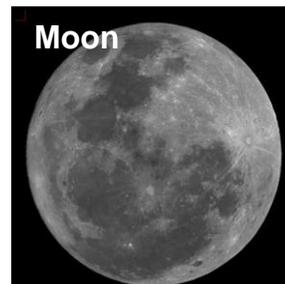
- Rayleigh scattering over ocean sites
 - Blue to Red spectral bands



- On-Ground photometer (ROSAS automated station of La Crau, France)
 - Measurement of multi-angular viewing of atmosphere
 - Measurement close to true ground reflectance



- Moon and stars (Pléiades, probative methods)
 - Perfect photometric target
 - Free of atmosphere constraints (clouds....)
 - Improvement of existing models (Moon ROLO)



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Pléiades 1B: Absolute Calibration Performance

Sensor spectral response nearly unchanged since launch.

LSB to TOA Radiance coefficient (Ak)	Pan (TDI=13)	Blue (B0)	Green (B1)	Red (B2)	NIR (B3)
After launch (Dec 2, 2012)	12.04	10.46	10.47	11.32	17.21
From Dec 2, 2012 to Q1 2014	12.04	10.46	10.47	11.32	17.21

CNES's accuracy assessment methods

(LSB to TOA Radiance) Estimated Absolute calibration accuracy (RMSE)	Performance	Requirement (6 months, polarization rates from 0 to 20%)
Panchromatic (PAN)	<5%	<10%
Blue Band (B0)	<5%	<10%
Green Band (B1)	<5%	<10%
Red Band (B2)	<5%	<10%
NIR Band (B3)	<5%	<10%

(LSB to TOA Radiance) Pléiades 1A/1B Inter-sensor calibration accuracy	Performance	Requirement
All bands	<2%	N/A

SPOT 6: Absolute Calibration Performance

Sensor spectral response nearly unchanged since launch.

LSB to TOA Radiance coefficient (Ak)	Pan (TDI=5)	Blue (B0)	Green (B1)	Red (B2)	NIR (B3)
After launch (11/09/2012)	10.41	8.51	9.52	10.44	14.00
From 11/09/2012 to (Q1/2014)	10.41	8.51	9.52	10.44	14.00

CNES's accuracy assessment methods

(LSB to TOA Radiance) Estimated Absolute calibration accuracy (RMSE)	Performance	Requirement (6 months, polarization rates from 0 to 20%)
Panchromatic (PAN)	4 to 5%	<6%
Blue Band (B0)	5%	<6%
Green Band (B1)	4 to 5%	<6%
Red Band (B2)	3 to 5%	<6%
NIR Band (B3)	4 to 5%	<6%

(LSB to TOA Radiance) SPOT 6/7 Inter-sensor calibration accuracy	Performance	Requirement
All bands	TBC with S7	N/A

Focus on Ortho and DEM/DTM derived products

Ortho products

DEM/DTM derived products



Courtesy IGN

◀▲ SPOT 6 single pass tri-stereo
2012/11/11 Karakoram mountain

Pléiades: Orthos Suite Specifications

Pléiades Ortho Type	Standard	Premium	Tailored
Overview	Automatic Pléiades Ortho computed thanks to Ref3D database	Best precision and best aesthetics	DTM and GCP provided by the customer
Deliverable	A 50-cm Pléiades orthoproduct.		
Aesthetics	Ref3D: ★ - SRTM: ★★	★★★★	Depending on DTM and GCPs
Absolute accuracy	Ref3D: 7 - 8m CE90* SRTM: 7 - 12m CE90*	1m CE 90 with GCPs	
Relative accuracy	3m CE90	1m CE 90	
Options	<ul style="list-style-type: none"> Spectral combination: Panchromatic or Pan-sharpened 3-Band Natural Color or False Color Pixel depth: 8 or 16 bits (12 bit-depth or 16 bit-depth with OVR) Image format: GeoTIFF, JPEG 2000 		
Dynamic Adjustment	OVR available for 8 and 16 bit products	Manual color balancing	Manual color balancing
3D model used	<ul style="list-style-type: none"> R3D if available SRTM otherwise 	Pléiades DTM 5m	Customer's DTM
GCPs	From R3D Ortho Layer	Exogenous (optional)	Exogenous (optional)
Cloud cover	Up to 10%	Less than 10% (20% for tropical areas i.e. +/-23,5° from equator)	
Max viewing angle	Up to 30° - less than 20° recommended	Less than 15° recommended	Less than 15° recommended

* Performance typically assessed for 1 scene AOI and slopes $\leq 20\%$

** Better performances are often achieved

Pléiades: Ortho Premium

A precision ortho produced with a Pléiades DTM 5m; with optional GCPs.

- Accuracy: 1m CE90 (with GCPs)



Pléiades: Ortho Time Series

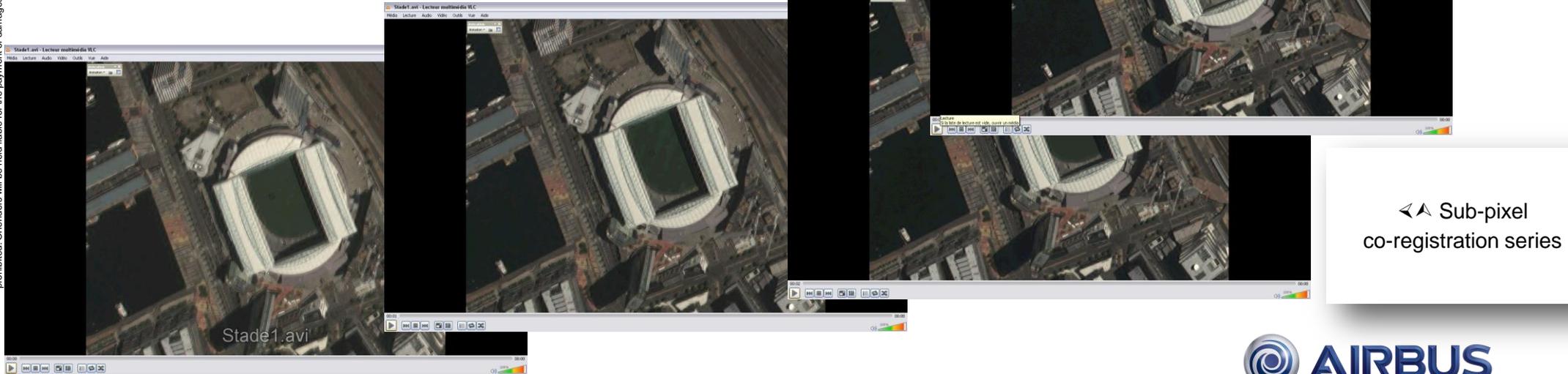
Ortho Time Series: Stack of orthos with different acquisition dates

- No time constraint
- No Viewing angle constraint
- Perfect registration (better than the pixel) between orthos
- Useful to monitor changes for given area (incl automatic change detection)

First element of the series is a “Pleiades ortho premium” product :

- Stereo acquisition
- Computation of an accurate digital terrain model @ 5m posting

Automatic computation for all other elements of the series



◀ ▶ Sub-pixel
co-registration series

SPOT 6 & SPOT 7: Orthos Suite Specifications

SPOT 6 / [7] Ortho Type	Standard	Tailored
Overview	Automatic Ortho based on Ref3D database	DTM and GCP provided by the customer
Deliverable	A 1.5-m SPOT 6 / 7 orthoproduct.	
Aesthetics	Ref3D: ★★ - SRTM: ★★★	Depending on DTM and GCPs
Absolute accuracy	Ref3D: 9 - 12m CE90* SRTM: 9 - 15m CE90*	
Relative accuracy	5m CE90	
Options	<ul style="list-style-type: none"> Spectral combination: Panchromatic or Pan-sharpened 4-Band Pixel depth: 8 or 16 bits (12 bit-depth or 16 bit-depth with OVR (Q2/2014)) Image format: GeoTIFF, JPEG 2000 	
Dynamic Adjustment	OVR available for 8 and 16 bit products (Q2/2014)	Manual color balancing (optional)
3D model used	<ul style="list-style-type: none"> R3D if available SRTM otherwise 	Customer's DTM
GCPs	From R3D Ortho Layer	Exogenous (optional)
Cloud cover	Up to 10%	Less than 10% (20% for tropical areas i.e. +/- 23,5° from equator)
Max viewing angle	Up to 30° - less than 20° recommended	Less than 15° recommended

* Performance typically assessed for 1 scene AOI and slopes $\leq 20\%$

** Better performances are often achieved

Pléiades: Elevation4 Specifications

Products		4m posting DEM + Stereo or Tristereor pair	
Method		Automatic stereo matching including a global auto-filtering of artifacts followed by manual editions. After editing tasks, all remaining voids are interpolated. Large voids over an area not flat are completed in stereo. Final visual Quality Check.	
Manual edition level		<ul style="list-style-type: none"> • Detection of water bodies (sea, lake, large river) and DEM flattening. • Removal of main artifacts (spike, hole). • Manual edition. • Main roads in downtown will be cleaned to remove artificial obstructions. 	
Source data		<ul style="list-style-type: none"> • Pléiades Stereo or Tristereor pair(s), Panchro, Primary, JPEG 2000 Regular. 	
Available option		<ul style="list-style-type: none"> • 50cm Pléiades orthoimage 	
Grid Spacing		<ul style="list-style-type: none"> • 4m. 	
Accuracy	Absolute XY*	<ul style="list-style-type: none"> • With accurate GCPs: 1.5m CE90 • With Ref3D GCPs: 6m to 10m CE90** • Without GCPs: 8.5m to 10.5m CE90 	
	Absolute Z*	<ul style="list-style-type: none"> • With accurate GCPs: 2m LE90 • With Ref3D GCPs: 6m to 10m LE90** • Without GCPs: up to 10m LE90** 	
	Relative	<ul style="list-style-type: none"> • XY: 1.5m CE90 • Z: 2m LE90 	
Format		<ul style="list-style-type: none"> • AsciiGrid or GeoTIFF. 	
Projection		<ul style="list-style-type: none"> • Geo WGS84 or UTM / WGS84 (custom projection upon request). 	

In line with HRE40 requirements by use of accurate GCPs

* Performance assessed on individual Stereopair, for slopes $\leq 20\%$

** Better performances are often achieved

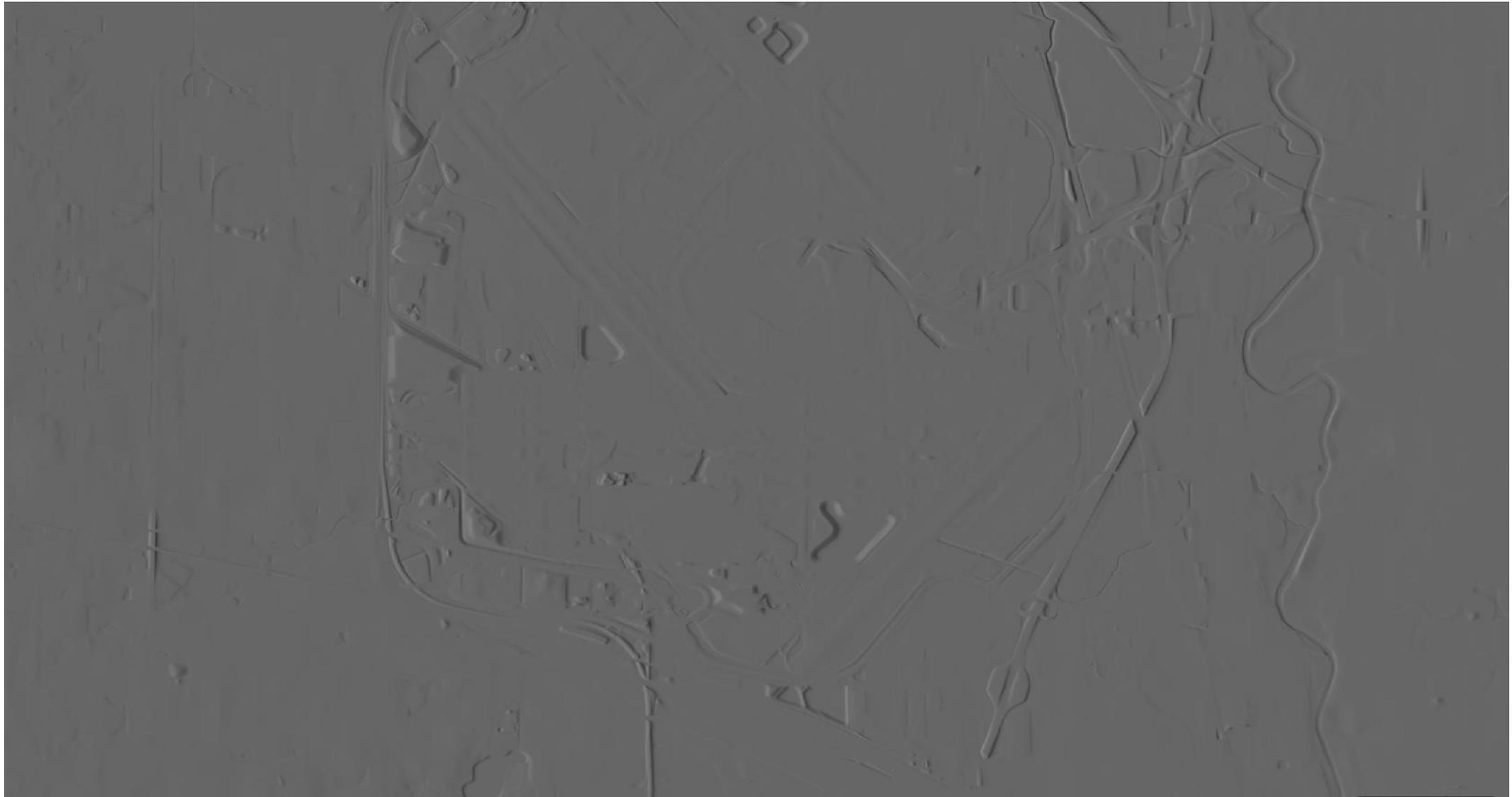
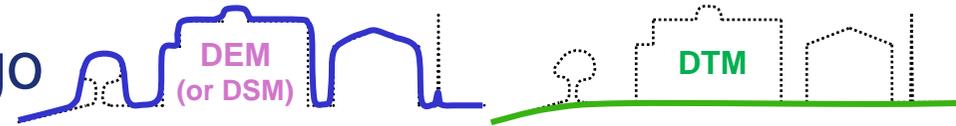
Pléiades: Elevation1 Specifications

Products		1m posting DEM	Orthomosaic (8 bits)
Method		Automatic stereo matching including a global auto-filtering of artifacts followed by an enhanced level of edition. After editing tasks, all remaining voids are interpolated. Large voids over an area not flat are completed in stereo. Final visual quality check.	A Pan-sharpened orthomosaic is also generated (geometrically seamless, but not radiometrically). The cutline between each image is automatic. No global radiometric optimization. Final visual Quality Check.
Manual edition level		<ul style="list-style-type: none"> • Detection of water bodies (sea, lake, large river) and DEM flattening. • Removal of main artifacts (spike, hole). • 3D edition 	
Source data		• Pléiades Stereo or Tristereopair(s), Bundle P & XS 4 bands, Primary, JPEG 2000 Regular.	
Grid Spacing		• 1m.	• 50cm.
Accuracy	Absolute XY*	<ul style="list-style-type: none"> • With GCPs: 1.5m CE90. • With Ref3D GCPs: 6 to 10m CE90**. • Without GCPs: 8.5m to 10.5m CE90. 	<ul style="list-style-type: none"> • With GCPs: 1.5m CE90. • With Ref3D GCPs: 6 to 10m CE90**. • Without GCPs: 8.5m to 10.5m CE90.
	Absolute Z*	<ul style="list-style-type: none"> • With GCPs: 1.5m LE90. • With Ref3D GCPs: 6 to 10m LE90**. • Without GCPs: up to 10m LE90**. 	<p><i>In line with HRE10 requirements by use of accurate GCPs</i></p>
	Relative	• XY 1.5m CE90 ; Z 1.5m LE90.	
Format		• AsciiGrid or GeoTIFF.	
Projection		• Geo WGS84 or UTM / WGS84 (custom projection on request).	

* Performance assessed on individual Stereopair, for slopes ≤ 20%

** Better performances are often achieved

Ortho Premium, DEM and DTM: Chicago



SPOT 6: Elevation8 Specifications

Products		8m posting DEM
Method		Automatic stereo matching including a global auto-filtering of artifacts followed by manual editions. After editing tasks, all remaining voids are interpolated. Large voids over an area not flat are completed in stereo. Final visual Quality Check.
Manual edition level		<ul style="list-style-type: none"> • Detection of water bodies (sea, lake, large river) and DEM flattening. • Removal of main artifacts (spike, hole). • Manual edition.
Source data		<ul style="list-style-type: none"> • SPOT6 Stereo or Tristereopair(s), Bundle P + RGBA Primary, JPEG 2000 Regular.
Available option		<ul style="list-style-type: none"> • 1,5m SPOT6 orthoimage
Grid Spacing		<ul style="list-style-type: none"> • 8m.
Accuracy	Absolute XY*	<ul style="list-style-type: none"> • With accurate GCPs: 2.5m CE90 • With Ref3D GCPs: 6m to 10m CE90** • Without GCPs: 20m CE90
	Absolute Z*	<ul style="list-style-type: none"> • With accurate GCPs: 3m LE90 • With Ref3D GCPs: 10m to 14m LE90** • Without GCPs: 15m to 20m LE90**
Format		<ul style="list-style-type: none"> • AsciiGrid or GeoTIFF float 32bits.
Projection		<ul style="list-style-type: none"> • Geo WGS84 or UTM / WGS84 (custom projection upon request).

In line with HRE80 requirements by use of accurate GCPs

* Performance assessed on individual Stereopair, for slopes $\leq 20\%$

** Better performances are often achieved

Pleiades: Galt House



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Pleiades: Church Hill Downs



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Pleiades: Slugger Field (Louisville Bats)

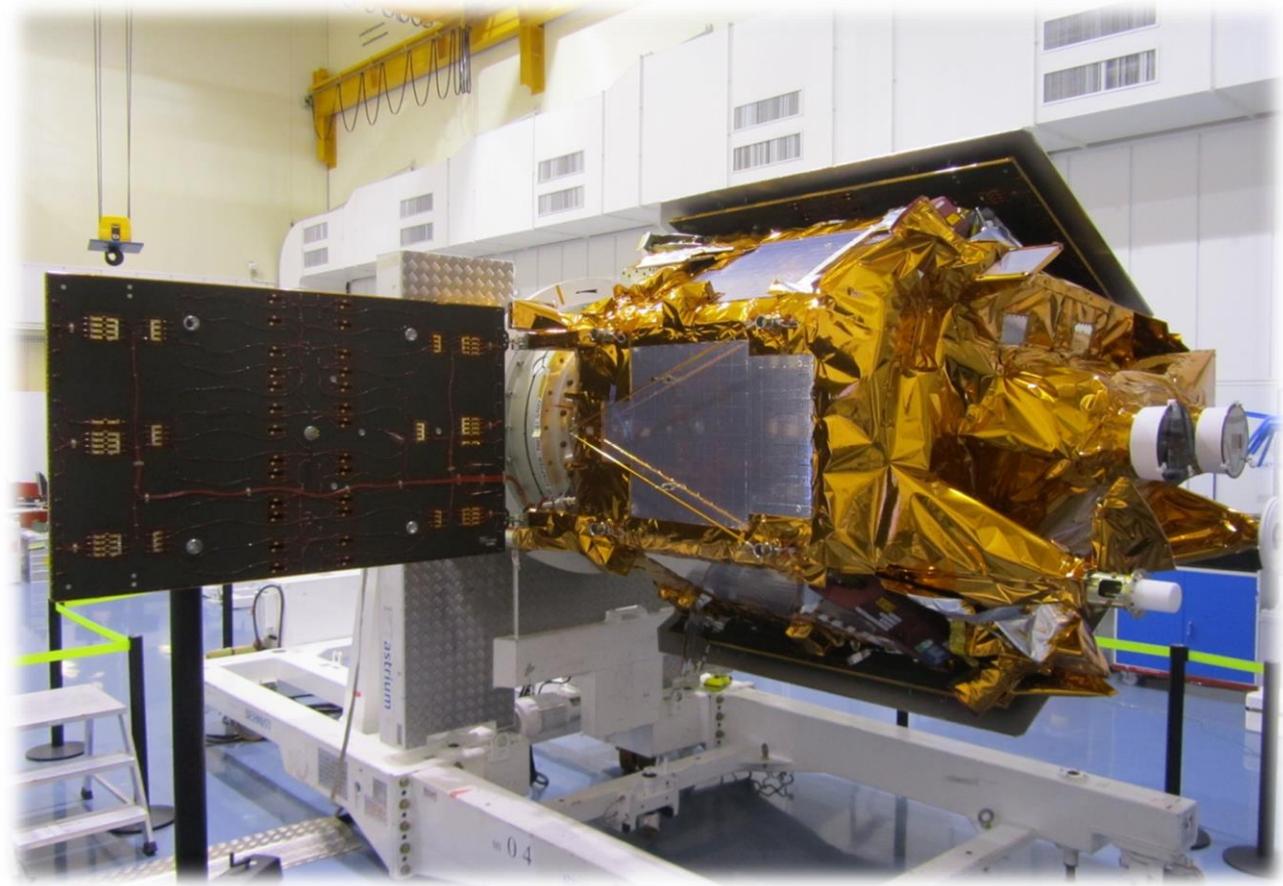


Latest news about SPOT 7

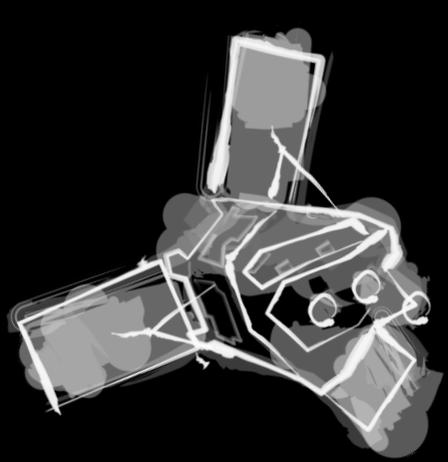
Integration is complete.

Launch is planned for Mid-2014 (by Indian PSLV launcher).

In orbit test period will follow for a 2 to 3-month duration.



SPOT 7: Integration of solar panels.

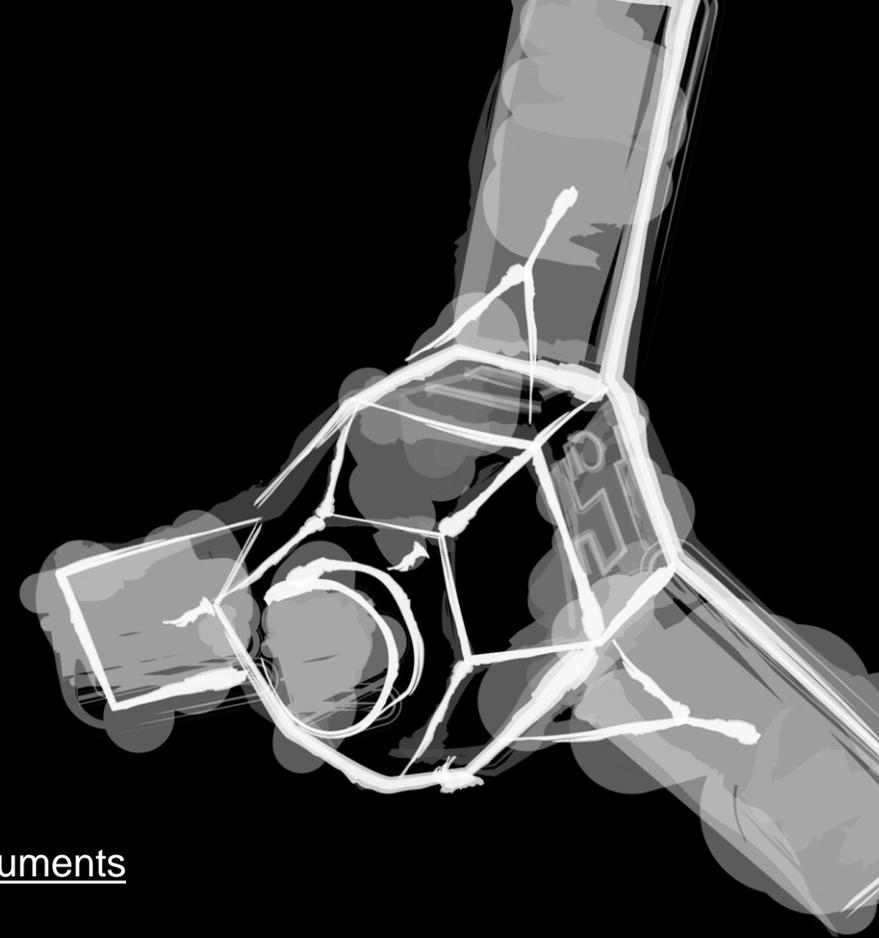


Brian Cutler: cutler@astrium-geo.com

See also our User Guides

•SPOT 6: <http://www.astrium-geo.com/spot6userguide>

•Pléiades: <http://www.astrium-geo.com/en/4572-pleiades-technical-documents>



Thank You!