



SPOT 5 / HRS: a key source for navigation database



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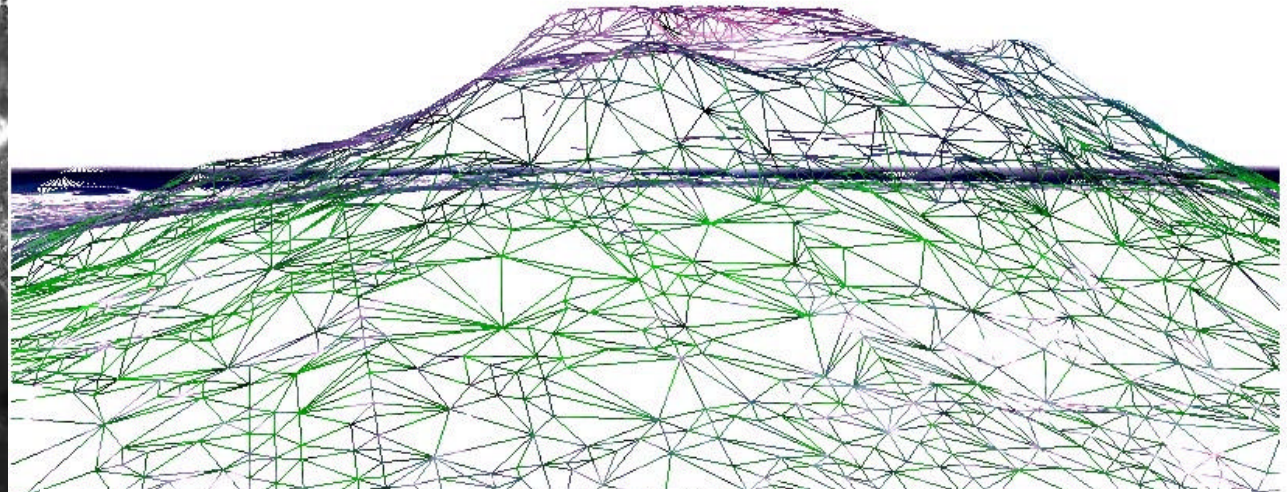
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Stereoscopy and DEM



1 Stereo pair...



= 2 images from 2 different points of view



= 1 DEM (Digital Elevation Model)



Spot Image and the DEMs



- ◆ The SPOT satellites provide stereopairs since 1986
- ◆ DEM customers come from various domains (telecom, mapping & surveying, agriculture, geology, defence...)
- ◆ The needs of DEM range from ... a single stereopair...
... up to country-wide procurement.

◆ **main DEM quality criteria**

accuracy / completeness / homogeneity / artifact ratio / sharpness



From image to DEM : a touchy process



A complicated process which requires expertise

◆ 100 % automatic steps

- ⇒ relative positioning of both images within the pair by tie points
- ⇒ matching : search for the best corresponding pixel in the other image
- ⇒ DEM calculation : computing altitudes from the parallaxes

◆ semi-automatic steps

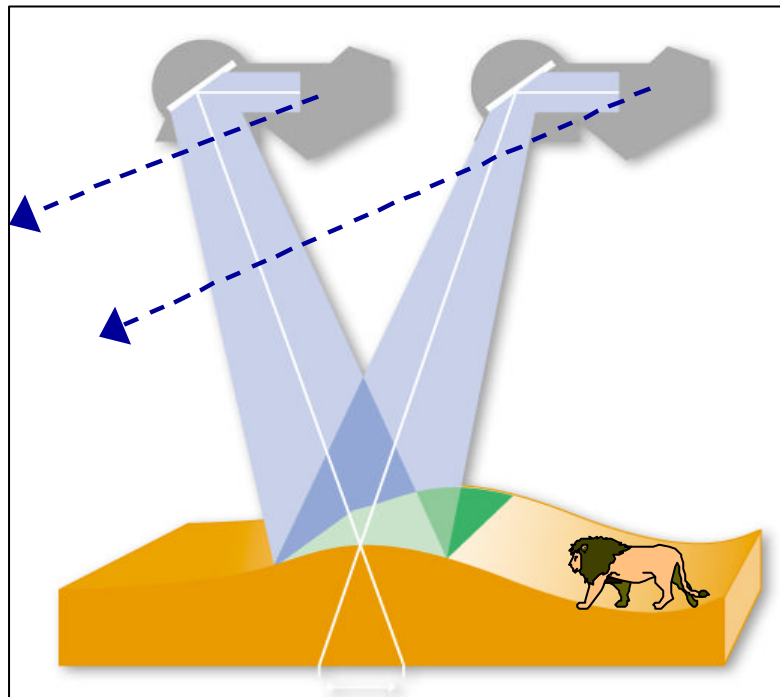
- ⇒ absolute location : map or GPS Ground Control Points injection
- ⇒ basic QC stats : residuals, checking against GCPs and neighbouring DEMs

◆ mainly manual / visual steps

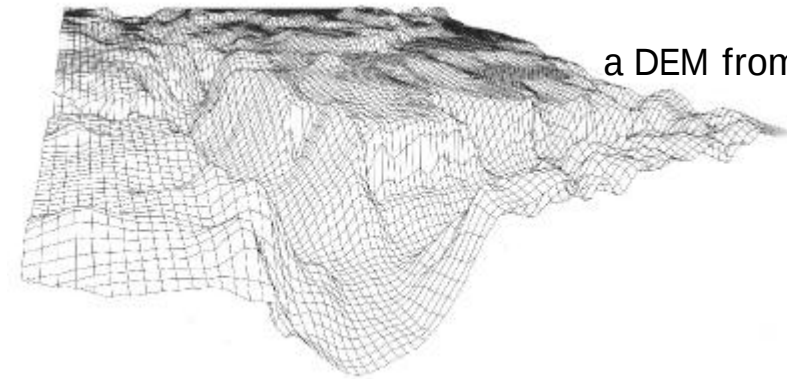
- ⇒ error detection : visual inspection of the DEM against best available maps
- ⇒ corrections of the DEM : interpolation, smoothing, water levelling, ...
- ⇒ mosaicking with neighbouring DEMs



SPOT 1 to 4 : cross-track viewing



SPOT 1 , 2, 3, 4 :
stereo acquisition
from different orbits
(cross-track viewing)



a DEM from SPOT

SPOT 1 to 4 : DEM production chain

stereo method	cross-track viewing
main risk	difference of dates
drawbacks on the DEM	more artifacts created completeness damaged
result	rather high effort & cost



HRS : a revolution, not less !



HRS : the May 3rd, 2002 revolution

- ◆ **HRS : along-the-track, ie **simultaneous** stereopairs**
 - ⇒ maximum completeness
 - ⇒ less artifacts

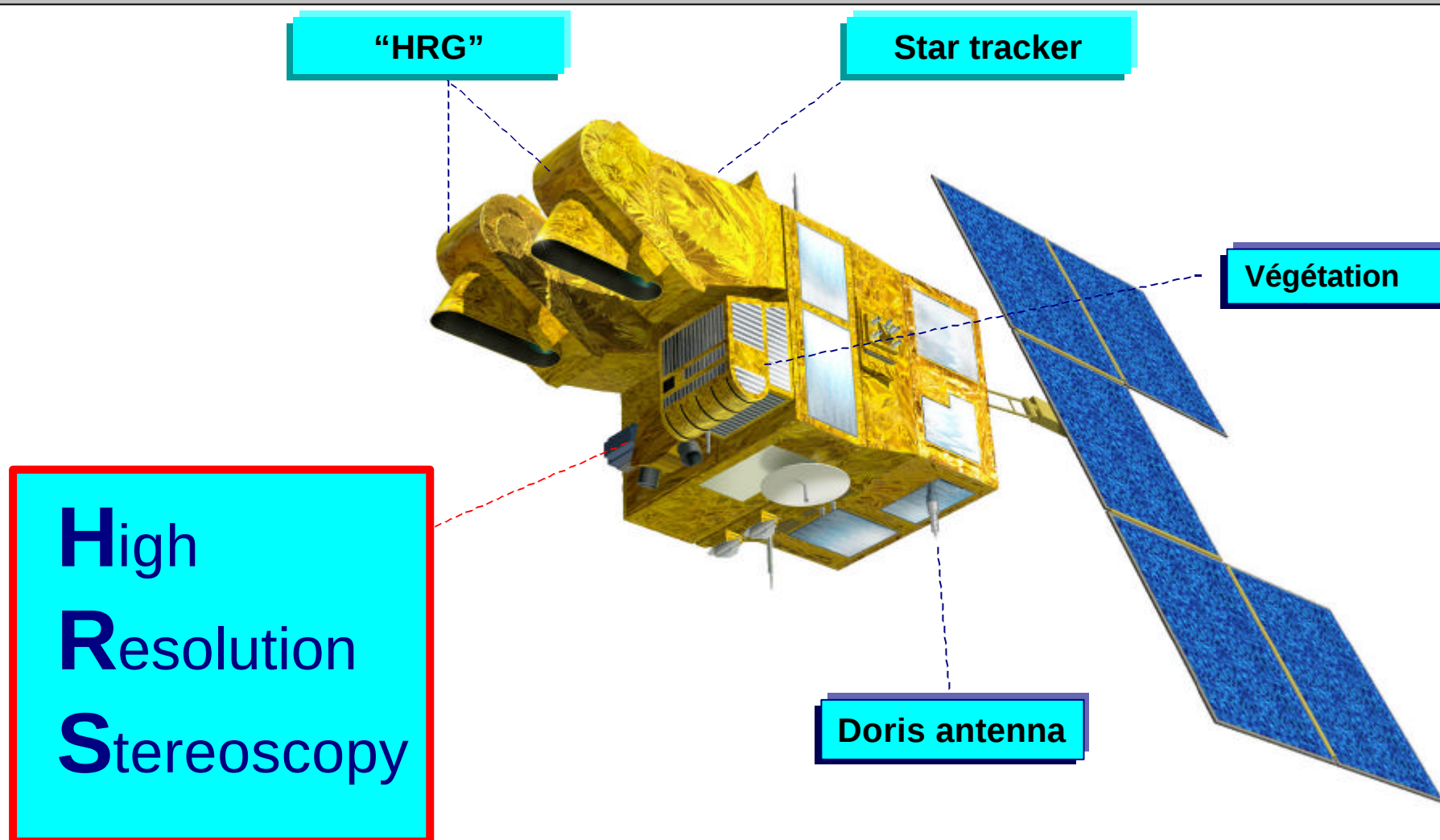
- ◆ **Unprecedented swath (600 km x 120 km stereoscopic strips)**
 - ⇒ less “steps” between adjacent DEMs
 - ⇒ minimizes the effort (and the cost)

- ◆ **Massive coverage (at least 6 Millions sq. km per year)**
 - ⇒ off-the-shelf data offering reduces the delay of procurement



SPOT 5 : 3000 kg of technology

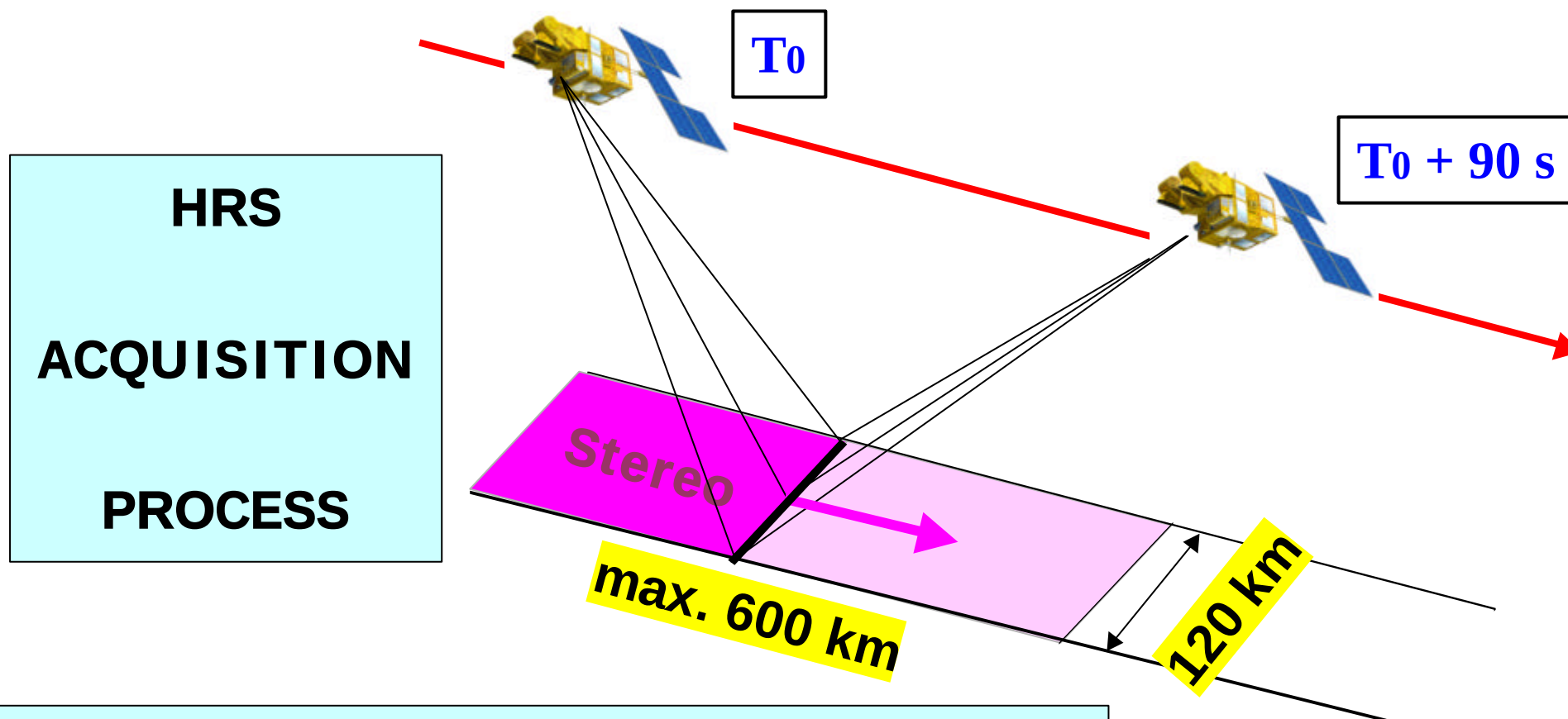
S P O T
I M A G E





HRS : the acquisition process

S P O T
I M A G E



**The same pixel line is acquired twice
from the same orbit , after 90 seconds.**



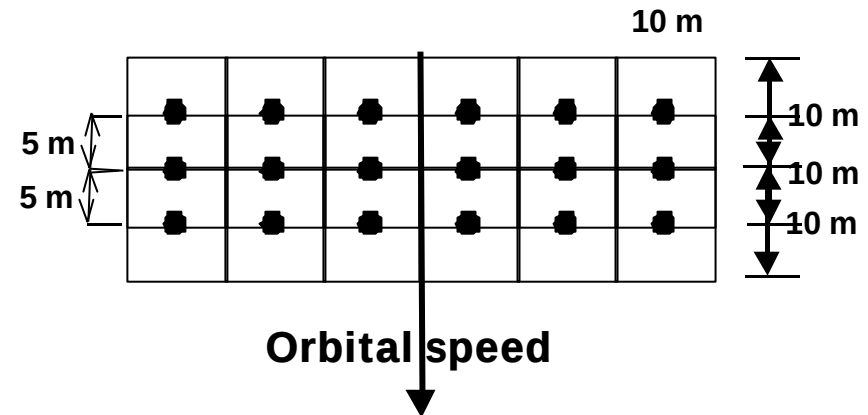
HRS : some technicals



HRS DATA

- ◆ Pixels in a row : 12 000
- ◆ Swath : 120 km
- ◆ Pixel size : 10 m
- ◆ Viewing angles :
20° (both rear & front)
- ◆ B/H : ca. 0.8
- ◆ Channel : 0.48 - 0.70 μm
- ◆ Sampling :
10 m (across track)
5 m (along track = parallax)

**HRS pixels are 10m x 10m,
but
each next row is acquired after 5 m**



**HRS has no side-looking mirror
The revisit time is 26 days.**



SPOT 5 : The absolute accuracy



- ◆ **DORIS**, provides the co-ordinates of the satellite within a few feet .
- ◆ **The star tracker** is aimed at pre-determined stars. Starting from the position given by DORIS, it computes a very accurate set of orientation angles (the “attitude” of the satellite).
- ◆ The expected (horizontal) location accuracy of the images is impressive :

HRS location accuracy : 15m @ 90% without GCP [DTED2 = 23m @ 90%]
(*Expected value to be confirmed by the in-flight commissioning phase ⇨ july 2002*)
- ◆ First results show excellent (vertical) height accuracy :

5m rms , 10m @ 90% [DTED2 = 18m @ 90%]
(*Provisional value to be confirmed by the in-flight commissioning phase ⇨ july 2002*)



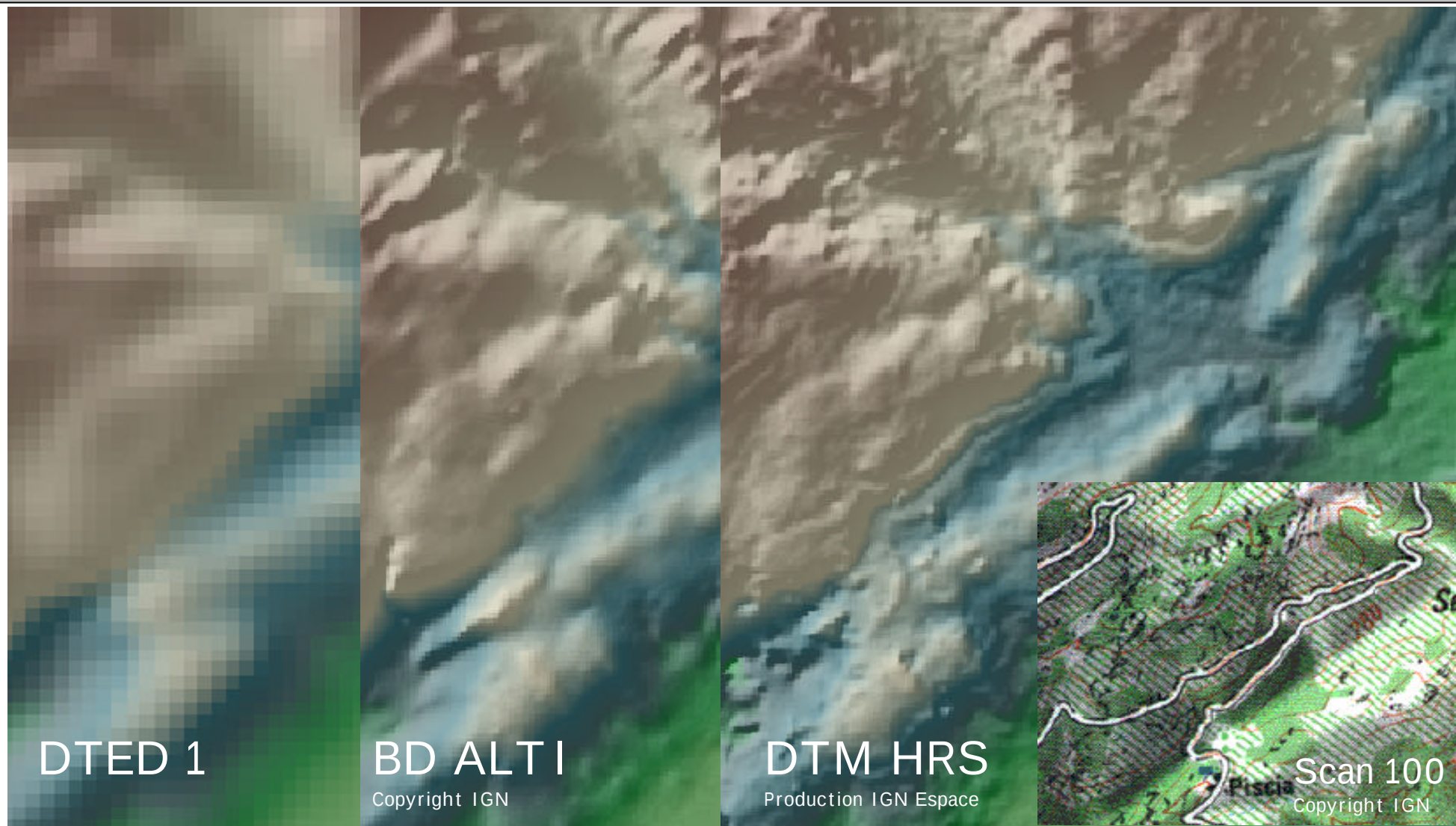
Impacts of HRS horizontal accuracy



- ◆ The intrinsic **HRS** absolute location accuracy neighbours the pixel size, and can easily compare with most of regular maps . Thus :
 - ⇒ ... no more need of maps to process HRS imagery
 - ⇒ ... no more headache about spheroids, datum ...
 - ⇒ ... the user is freed from control points (GPS, Doris,...) field campaigns
- ◆ Guarantees a perfect compatibility/ redundancy with GPS
- ◆ Provides a geometrical reference when no reliable maps are available
- ◆ Possibility to check or evaluate existing maps



DEM over Corsica: 1st evaluation





◆ Preliminary results (in meters)

Figures to be assessed during the commissioning phase (July 2002)

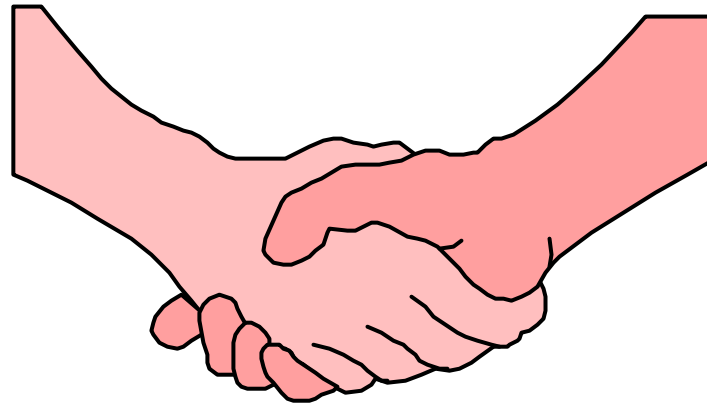
	@68 %	@90 %	@98 %
Average	-0.4	-0.1	-0.1
Std. Dev	2.7	3.9	5.3
Max errors	-5 / +5	-8 / +10	-18 / +22

DTED2 standard

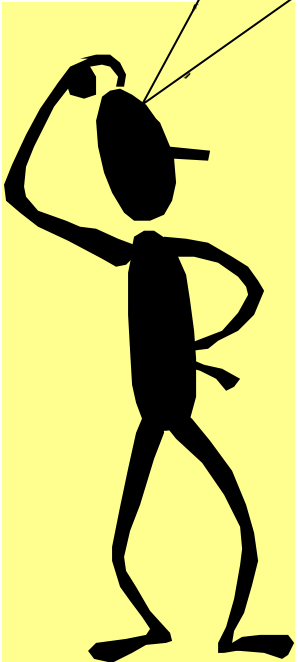
+ / - 18 m



**Nice data
What after ??**



**IGN - Spot Image partnership :
a joint effort towards a
strategic objective.**





Producing from HRS

- ◆ **Partnership with IGN (French mapping)**
- ◆ **Coverage is secured by a systematic validation**
- ◆ **Reference3D provides exceptional material for navigation databases, training and simulation**
- ◆ **Efforts have been focused to squeeze the costs**



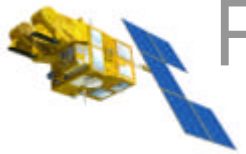
Reference3D[®] :

a strategic partnership with IGN



IGN will ensure :

- ◆ Systematic validation of HRS strips
- ◆ Over the validated areas, systematic computation of DTM and HRS orthoimage, then integrated into a global database (1° x 1° tiles)
- ◆ The « holes in the carpet » will be filled by available data (from ERS, SRTM, existing DEMs, maps, ASTER, SPOT...)



Reference3D[®] :

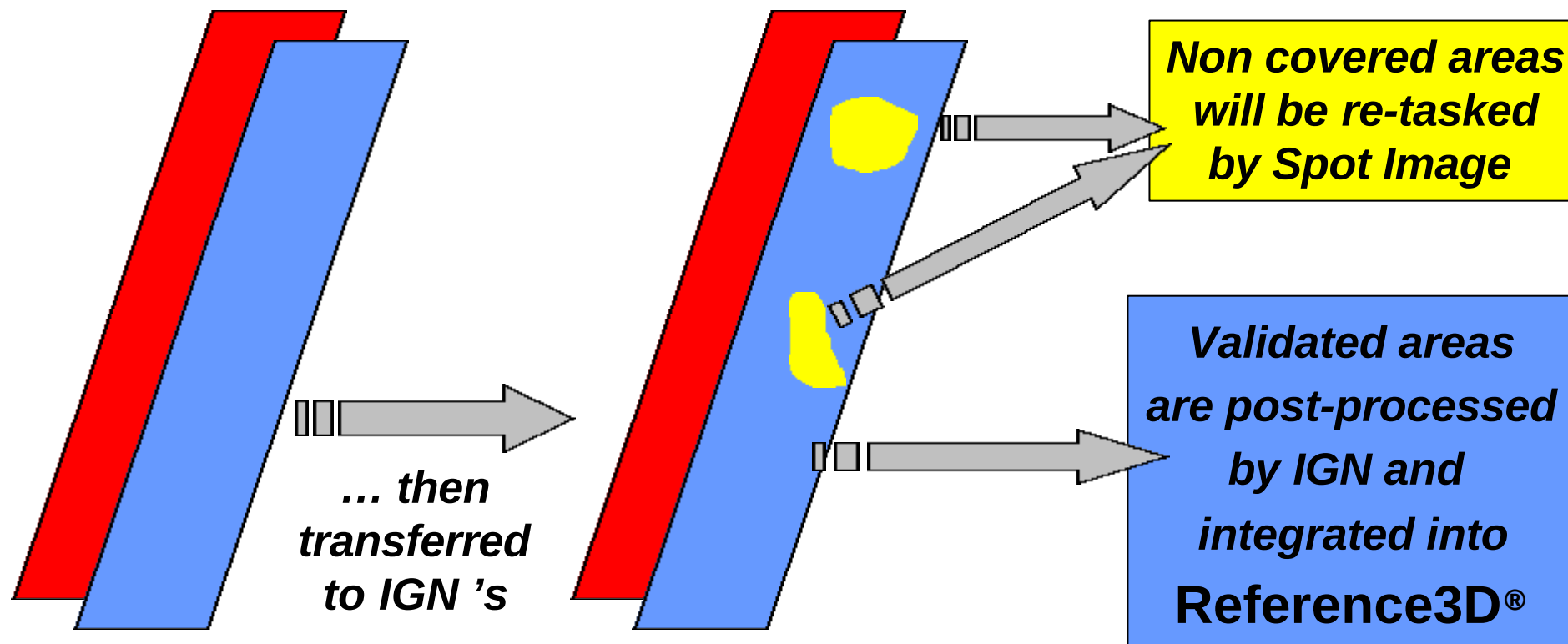
the HRS archive is secured in real time

SPOT
IMAGE



The HRS stereo strip is received at Spot Image

IGN checks the matching process





Reference3D[®] : a 3-layer database



◆ Reference3D[®] DTM

- § Sampling : 1 arcsec (~ 30 m)
- § Accuracy : 10 m (1σ) horizontal & vertical, for slopes lower than 20%
- § No GCP needed

◆ Reference3D[®] Orthoimage

- § Sampling : 1/3 arcsec (~ 10 m)
- § Location accuracy : 15 m @ 90% , with no GCP

◆ Reference3D[®] Quality & tracability data

- § References and exact coverage of sources (DTM and images)
- § DTM processing description (processing masks)
- § Accuracy estimates

* Accuracy figures to be assessed during the in-flight commissioning phase, ending July 2002



➔ **DIMAP format (XML based)**

- § DTM file : GeoTIFF (lossless compression)
- § Orthoimage file : GeoTIFF (lossless compression)
- § Parameter files : XML

➔ **Reference3D[®] tiling**

- § **Reference3D[®]** tile size : 1 degree latitude x 1 degree longitude

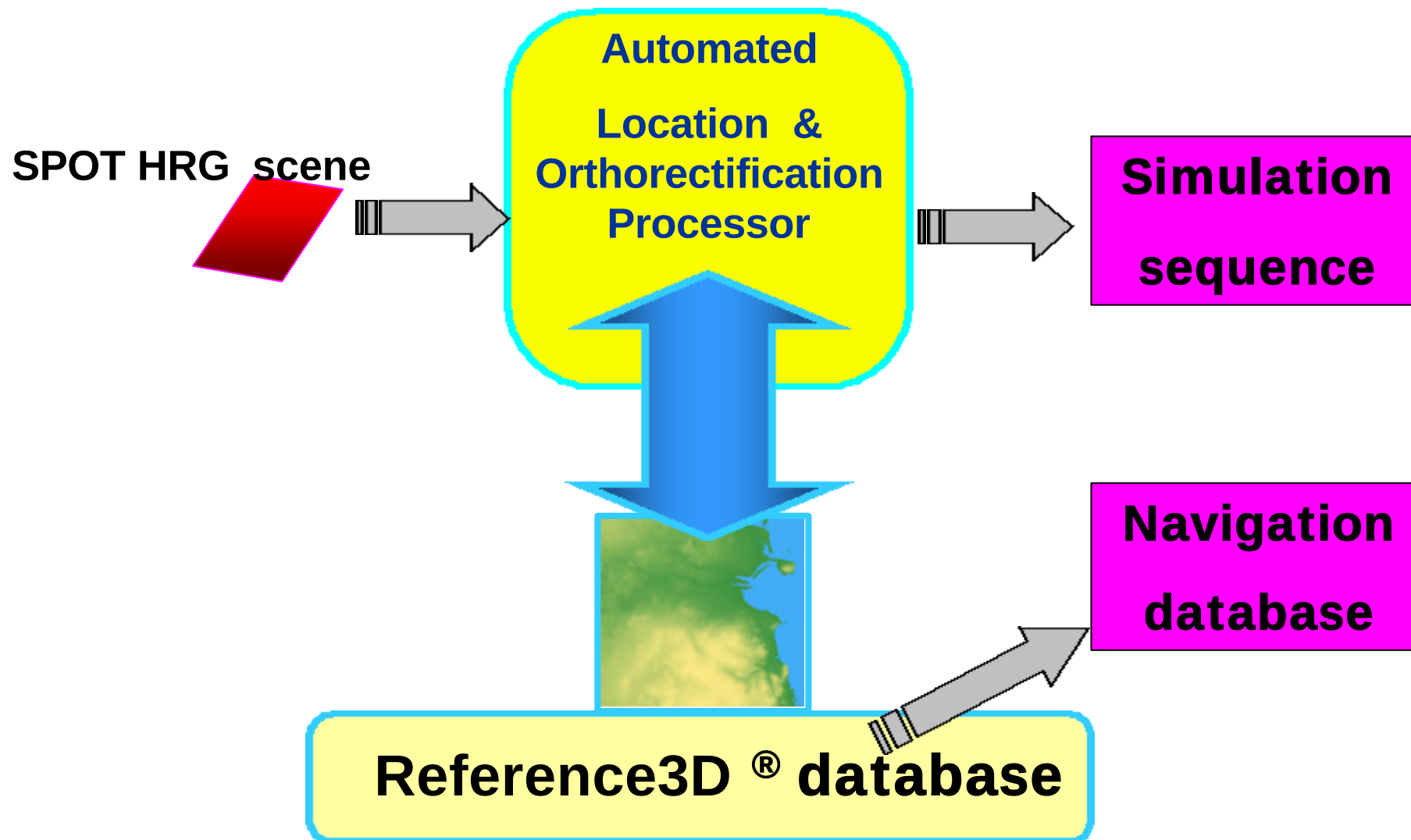
➔ **Reference3D[®] file size**

- § Approx. 60 Mbytes of 1 tile (variable because of compression)



An automated production tool

SPOT
IMAGE





Punta Campanella in 3D, by HRS

S P O T
IMAGE

