CENTRE NATIONAL D'ÉTUDES SPATIALES	**Centre National d'Etudes Spatiales**	
SAP_GEO_08 TRO-33-NT-2808-CNES	**Activity : CAL/VAL** **SAPHIR** **Absolute pointing location**	**Prepared by : MT team** **Verified by : N Karouche**

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1. OBJECTIVE

The objective of this note is to check the absolute geolocation performances of Saphir.

This study was conducted by CNES with Magellium company.

The geolocation performances are computed on L1A1 products.

2. PRODUCTS USED

See below

3. SUCCESS CRITERIA

The pointing location knowledge accuracy for the SAPHIR instrument shall lie within 5 km. This pointing constraint is absolute, and therefore includes instrument and bus constraints.

4. SAPHIR GEOMETRIC CALIBRATION

4.1. COMPARISON WITH REFERENCE IMAGE

4.1.1. METHOD

We are comparing channel 6 of SAPHIR with the SWIR channel of VGT synthesis images.

VGT image is binned to obtain a 10km image (VGT native resolution is 1km), and then resampled into the SAPHIR focal plane geometry. Then, on parts of the images where the landscape can be seen, a correlation is performed between both images which now share the same geometry.

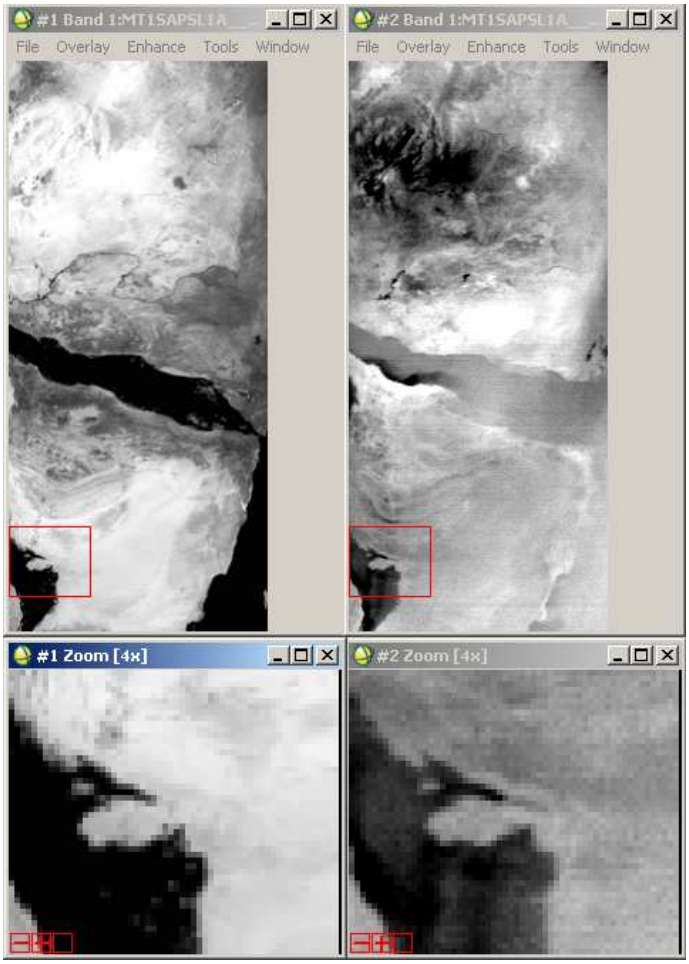


Figure 1: VGT image in SAPHIR focal plane, and the corresponding SAPHIR image.

This method successfully applied for SCARAB, is not so adequate when used on SAPHIR.

Indeed, SWIR channel of VGT and channel 6 of SAPHIR are not acquiring the same details, and we can see that most of the details of the landscape have inversed contrast.

The coastal lines are the only details which usually have the same contrast.

The correlations are performed using CNES tool called “MEDICIS”.

4.1.2. RESULTS

A set of clear sky SAPHIR images has been studied.

The table below shows the list of these images, and the results obtained in terms of shift in columns and lines.

From the initial set of images, half of them were rejected :

Some of them are observing the landscape (with clear weather) by night, where the sea is warmer than the ground. The contrast on the coast-lines is therefore inversed, compared to SWIR VGT band.

Others were rejected due to bad contrast on coastal zone.

Moreover, correlation results are considered more or less accurate depending on the landscape. The number of valid correlation points and the shape of the histogram allow us to have a good idea of the confidence we can have in the correlation results. A colour code is used in this table, to describe this degree of confidence (Red : bad, yellow=medium, green=good).

N° orbit	Extract	Landscape location	Contrast	Flip	Line-shift	Column-shift	comments
582	125,365	Yemen	OK	1	-0.32	Not significant	
1414	120,350	Yemen	OK	1	Not significant	-1.32	
2014	590,820	Cap vert	OK	1	-0.12	-1.6	
2037	3760,4160	Yemen	OK	1	0.3	-1.5	
2056	580,750	Cap vert	OK	1	-0.1	-1.5	
2070	585,760	Cap vert	OK	1	0	-1.5	
4055	4100,4300	Cote ouest Namibie	OK	0	-0.66	Not significant	Possible bias: correlation zone is only on one side of the swath.

Table 1: shifts obtained from correlation between SWIR-VGT and B6-SAPHIR

4.1.3. CONCLUSION

Results gathered in Table 1 show a column shift (shift across track) of about -1.5 SAPHIR pixels. The line shift is not so easy to understand, about 0.3 for FLIP=1, and -0.6 for FLIP=0, but strongly differ from an orbit to another one. The line-shift (along track) is supposed to vary with FLIP. It seems that on these observations, 0.3 is observed for FLIP=1 and -0.6 is observed for FLIP=0. It is difficult to conclude, as data set was too limited. More extensive verifications have been performed, see chapter 4.3.

4.2. COMPARISON WITH MHS

Flip	Line-shift	Column-shift
1	Not significant	-2 pixels

The line shift result is not enough accurate.

The column shift result is consistent with the VGT comparison.

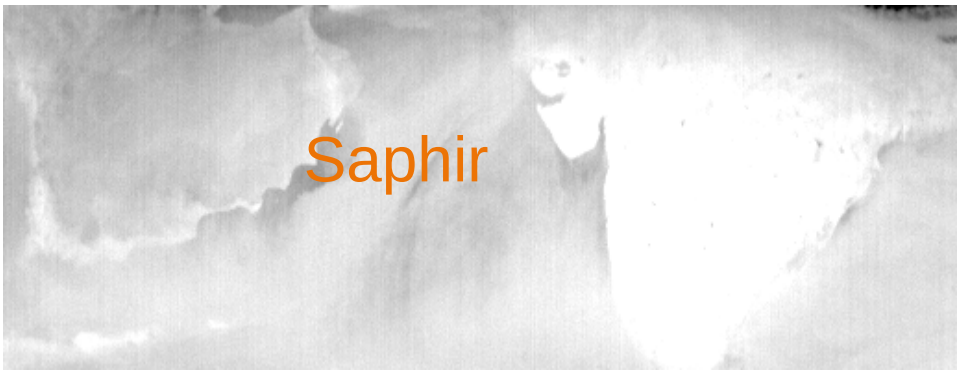
4.3. SCARAB/SAPHIR GEOMETRIC REGISTRATION

As Saphir is designed to observe humidity and clouds, it is very difficult to find clear sky images over land, to check the geolocation.

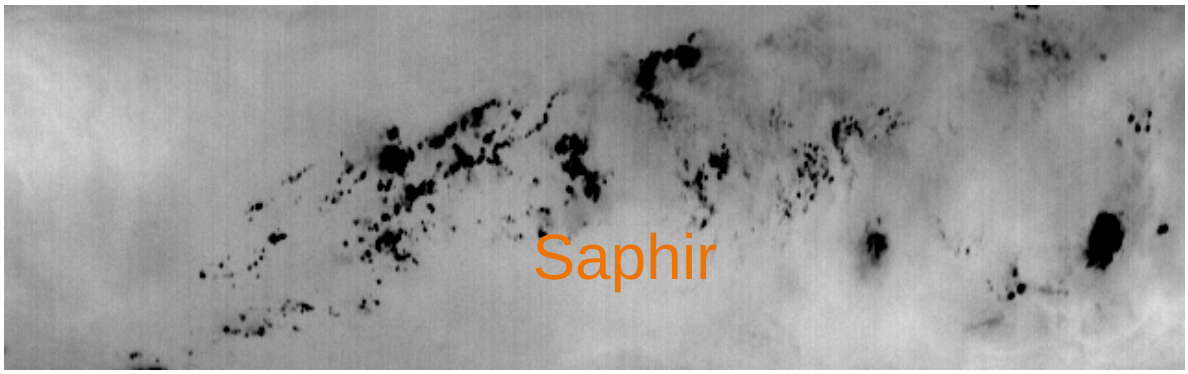
As the geolocation of Scarab was already checked with the visible channel, it is possible to use the window IR channel to compare SAPHIR and SCARAB images.

As the geometric viewing conditions of the two instruments are quite exactly the same, at the same time, it is possible to compare them, even on cloudy area.

SCARAB (channel 4) / SAPHIR (channel 6), “clear sky image” :



SCARAB (channel 4) / SAPHIR (channel 6), “cloudy image” :



4.3.1. METHOD USED

SCARAB images are resampled in the SAPHIR focal plane.

Then, a correlation is performed between SAPHIR image and SCARAB resampled image.

We will compare SAPHIR channel 6 with SCARAB infrared channel.

As the geometric viewing conditions are nearly the same (same scan method at Nadir), SAPHIR and SCARAB images can be easily compared. We expect to retrieve a large number of correlation values, spread over the swath. Then statistics across track will be analysed in order to find consequences of possible Yaw misregistration between SCARAB and SAPHIR instruments.

4.3.2. RESULTS OBTAINED

The correlation is performed on several orbits, and results are gathered in lists depending on the flip status. Based on massive correlation, these results are more accurate than those presented in section 4.1.2.

List 1: orbits 3746 3731 4055 : FLIP status=0

Correlation results : dX~ -1.5 dY~ -0.3

List 2: orbits 832 860 900 956 1055 1859 : FLIP status=1

Correlation results: dX~ -1.7 dY~ +0.25

List 3: orbits 2070 582 2056 2014 1414 : FLIP status=1

Correlation results: dX~ -1.5 dY~ +0.3

4.3.3. CONCLUSION:

These massive correlations show a column shift of about -1.5 SAPHIR pixels, and a line shift of about -0.3 SAPHIR pixels.

We also notice that, as expected, the column shift is reversed when the satellite is flipped.

Based on these results, we have calibrated the geometric parameters of SAPHIR.

5. SAPHIR GEOMETRIC VERIFICATION AFTER CALIBRATION

5.1. COMPUTATION OF THE NEW MATRIX

The SAPHIR viewing model has been modified in L1 processing to correct for the following shifts:

- -1.5 SAPHIR pixels across track,
- -0.3 SAPHIR pixels along track.

5.2. VERIFICATION OF GEOLOCATION AFTER CALIBRATION

After calibration, one dump file has been reprocessed for a check, and in order to avoid any kind of errors in the matrix computation.

The SAPHIR dumpfiles corresponding to 2037 has been reprocessed.

They are compared with SCARAB. The result of the correlation is the following.

For Orbit 2037, the result is perfect. There is no remaining shift measured between SCARAB and SAPHIR. Both histograms for dX and dY are centered on “0 shift”.

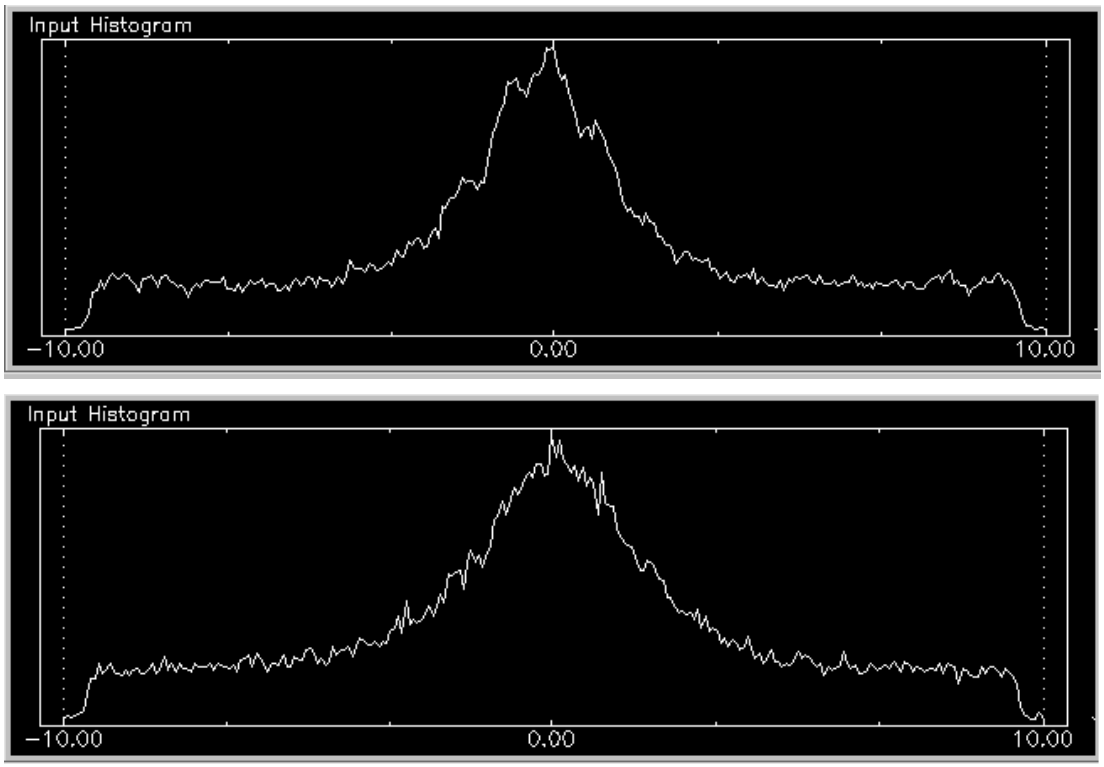


Figure 2: Orbit 2037: Correlation results (1: line shift, 2: column shift) obtained between SCARAB and SAPHIR product computed with calibrated parameters.

6. CONCLUSION

The most accurate way to calibrate the geometry of Saphir was to correlate it with Scarab. These results were used to compute a new matrix. This new matrix is used since IODD 9_14.

Other methods were used (MHS and VGT comparison). Although they were less accurate, the consistency is still very good with the Scarab correlation.

So we can be very confident with the SAPHIR pointing accuracy.

The final performance of absolute geolocation of SAPHIR is:

	Nadir		Swath border	
	across track	along track	across track	along track
Uncertainty of Saphir calibration	1km	1km	1km	1km
Scarab geolocation accuracy	1.5km	2km	2km	2.7km
Total	3km		3.6km	
Requirement	5km		5km	

Table 2: Absolute geolocation