Pléiades: operational programming first results

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The first satellite of the Pléiades family has been launched the 17th of December, 2011. The in orbit commissioning phase has lasted around two months, during which, the Pléiades system has been progressively opened to users while verifying that it worked in accordance with expected performances. Then the system has been delivered to users for an operational exploitation form the 1st of March, 2012.

Pléiades satellites have a huge agility, offering new acquisition capabilities in comparison with the SPOT family, such as: instantaneous stereo images, under different stereoscopic conditions (up to 300 km x 20 km or 150 km x 40 km) and mosaic images, obtained from along the track enlarging of the field of view (up to 120 km x 120 km). Pléiades is a dual system: this means that it is intended to fulfill an extended panel of both civilian (including institutional needs) and defense users' needs. It has led us to include resource sharing protocols in the satellite mission planning function. In addition, we have improved the average system reactivity, preserving a high acquisition capability, by increasing the number of mission planning activations per day (in an automatic way) and by a new function, named Direct Tasking which allows the improvement of the reactivity locally but also the reduction of the age of the information.

First of all, the article will remind the main mission characteristics of the satellites and the system, and describe the satellite mission planning function. Then it will present the first results of the operational programming, showing in particular, during the in orbit commissioning phase, the way we have followed tuning this function and associated parameters in order to get the biggest operational capability possible, respecting the satellite programming constraints such as: power budget, instrument use duration, etc.

I. Introduction

The first Pléiades satellite has been launched the 17th of December, 2011 from Kourou, French Guiana, by a Soyouz rocket and set on a quasi circular and sun synchronous orbit at 700 km and 10:30 local time. This new satellite will be followed by a second one (whose launch is foreseen by the end of this year) in order to build the new constellation of optical Earth observation satellites whose aim is to succeed to the SPOT constellation.

The in orbit commissioning phase started with the launch of the satellite and finished the 1st of March, 2012. From this date, the system is totally open to users and the operational phase has begun.

Pléiades satellites acquire images with a 70 cm Ground Sampling Distance in nadir conditions in 5 spectral bands: Panchromatic, B0, B1, B2 and B3. One satellite has a two days word wide revisit period with a 48° viewing angle (as a maximum) and with two satellites, it is possible to acquire any area everyday with a 43° viewing angle.

Figure 1: Pléiades Satellite

Pléiades satellites are very agile, thanks to the use of Control Momentum Gyros. This agility offers new acquisition capabilities in comparison with the SPOT satellites such as: instantaneous stereo images or mosaic images got from the same track and thus enlarging the field of view. This agility, combined with good mass memory storage capabilities (750 Gbits) and high rate in downloading Image telemetry (450 Mbits/s), allows each satellite to acquire between 400 and 500 images per day.

From a system point of view, we have tried to improve the average reactivity, preserving as much as possible a high acquisition capability, by increasing the number of mission planning activations per day in an automatic way and by developing a new function, named Direct Tasking which allows for the improvement of the reactivity locally but also reduces the age of the information. To be complete, a specific programming, named Very Urgent Programming, allows an asynchronous programming.

Contrary to the SPOT system which is a civilian system, the Pléiades system is a dual system. It means that there are different users or operators (civilian or defense from different countries), represented by User Ground Centers, which send Programming Requests to the Programming Centre (located in CNES Toulouse) in which The Mission Planning Function has to work out a Mission Plan by sharing the satellite resource between the different users according to their programming rights.

First of all, the article will describe the satellite mission planning function. Then it will present the first results of the programming, showing in particular, during the in orbit commissioning phase, the way we have followed in order to tune this function and associated parameters that allows for getting the biggest operational capability possible, respecting the satellite programming constraints such as: power budget, instrument use duration, etc.

II. The Mission Planning Function

A. Building a Mission Plan

The Mission Planning function aims at producing, as often as necessary, the Mission Plan which will be uploaded to the satellite and which will contain images to be acquired and telemetry to be downloaded on the Image Receiving Stations of the system.

The Mission Plans are worked out in the SDGC (Secure Dual Ground Centre) located in CNES Toulouse and managed by the Satellite Operator. They use as input following data:

- From each User Centre of the System: Programming Requests and Pass Plan over the Image Receiving Stations;
- Satellite status and in particular images which are still on board and which are to be downloaded in the next Mission Plan;
- Slots unavailable for users programming and reserved by the Satellite Operator for specific operations;
- The list of specific operations;
- The most up to date predicted orbital data;

The Mission Plans are built in four main steps (as shown in Figure 2):

- The first step consists of working out the Acquisition Plan by selecting acquisitions among all the users programming requests;
- The second step consists of working out the Complete Acquisition Plan. In this step, the main goal is to have the satellite attitude along the whole Mission Plan Horizon by setting satellite pointing mode (Geocentric pointing or Sun Pointing) between the acquisitions depending on the satellite in orbit position (sun eclipse or not);
- The third step consists of working out the Downloading Plan. That means the way and the instants when Image Telemetry is downloaded on the Image Receiving Station. In case of unfeasibility and memory saturation, the Acquisition Plan is reduced to solve it;
- The forth and last step consists of verifying the Mission Plan mainly from the energy budget point of view. If this energy budget is not respected, here again, the Acquisition Plan and the Downloading Plan are consequently reduced.

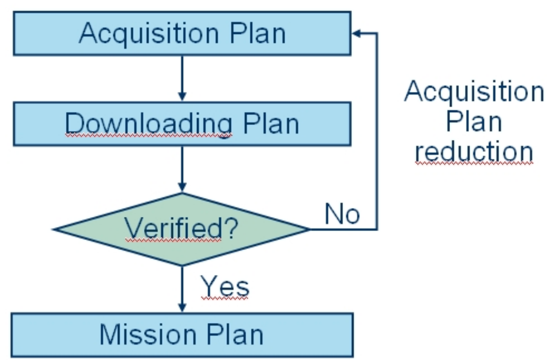

Figure 2: Building a Mission Plan.

1. *Building an Acquisition Plan*

This chapter describes more precisely the way that the Acquisition Plan is worked out.

The Acquisition Plans are built in three main steps which can be considered as three different access priorities to the satellite resource:

- The Technological Step: the biggest priority is given to the satellite operator for programming specific operations or acquisitions in order to verify or calibrate the payload;
- The Defence Step: the second priority is given to defence users for their most important requests;
- The Routine Step: the third priority is given to civilian operator and defence users for their routine requests.

In the two last steps, resource sharing protocols are used to give to each users the number of images to which they can claim in accordance with the international agreements which have been set at the beginning of the project.

When the two satellites will be in orbit, the Acquisition Plans will be worked out in a coordinated manner in order to globally optimise their resources.

As said in the previous chapter, building an Acquisition Plan consists of choosing the images which will be acquired by the satellites among all the input requests, respecting the satellites constraints (use time of the instrument – by orbit or by day – and the agility to be able to manoeuvre between two acquisitions), respecting the rights of the satellite resource for each user and optimising the acquisitions to give to each user their most important requests. Optimisation algorithms are used to doing that which includes a cinematic library in order to verify that every new acquisition inserted in the Acquisition Plan links up with the other acquisitions which are already in the solution. Thanks to their huge agility and their capability to acquire images fore and aft, the satellites are able to acquire over the same area lots of images as shown in Figure 3.

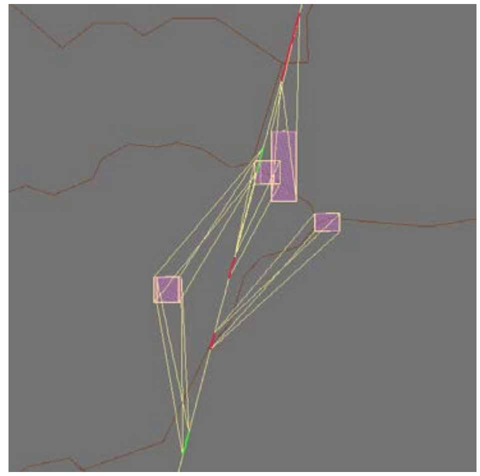

Figure 3: Acquisition Plan example

2. *Building a Downloading Plan*

Once the Acquisition Plan is worked out and in particular, the satellite attitude is known during the Mission Plan horizon, it's possible to build the Downloading Plan.

The first step consists of verifying if the Image Telemetry Link budget is respected during passes over the different Image Receiving Stations. Indeed, as Pléiades has a fixed antenna, the capability to download images depends on the satellite attitude. For example, during flying over a station located in Toulouse, where lots of images are acquired, it could be difficult to guarantee the link budget in the same time.

In a second step, the Downloading Plan is worked out taking into account mainly:

- Possible downloading slots coming from the previous step;
- All the images acquired during the current Acquisition Plan or during the previous ones and stored on board;
- For each image, its downloading priority which if often proportional to its acquisition priority.

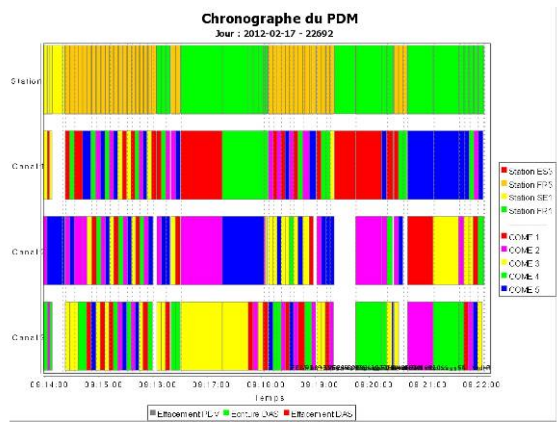

Figure 4: Downloading Plan example.

The main difficulty, in this process, is to balance the three channels of the telemetry in dispatching, for each image, the five files which make up the image.

Another difficulty is to manage, in the best way, the inter visibilities between stations located in the same area and belonging to different users centres.

3. *Verifying a Mission Plan*

When the Acquisition Plan and the Downloading Plan are ready, it's necessary, before uploading them to the satellite, through the Mission Plan, to verify that the energy budget is respected. Indeed, the satellites have been designed in such a way that the power chain can be a limitation of their acquisition capabilities.

For example, due to the fact that they have fixed solar panels, satellites need to have, on each orbit, a minimum duration in Sun Pointing Mode to recharge the batteries and particularly when exiting the eclipse phase.

In any case, an energy budget is worked out and if it's negative, the Mission Planning function has the possibility, automatically, to reduce the Acquisition Plan and consequently the Downloading Plan in order to, finally, respect this constraint. The constraint, presented in § 1, which limits the use time of the instrument per day, is specified especially to limit the size of the Mission Plan and thus to guarantee, a priori, that the energy budget will be positive.

B. System Chronology

We have seen the way the Mission Plans are worked out, this chapter presents the way theses Mission Plans are renewed in order to assume the permanency of the programming and to go towards the best reactivity: that means to be able to shorten as much as possible the delay between the programming request deposit and the acquisition of the corresponding image with the best knowledge of the weather and especially the position of the clouds.

To reach this goal, we have decided to renew the Mission Plans three times a day: each Mission Plan is worked out on a 24 hours Horizon and divided in three Programming Periods: a nominal one and two backup.

When a Mission Plan is uploaded on board, the satellite has 24 hours autonomy in terms of programming. If a new Mission Plan can't be reloaded, it's the backup part of the on-board Mission Plan which is used. Thus, the programming function, and the system, are robust in case of TT&C station failure or problem in working out the Mission Plan on ground and allow using automatic processes for programming.

The following drawing shows the way the three Programming Periods in a day are specified regarding the areas on the Earth and TT&C stations used to upload the Mission Plans.

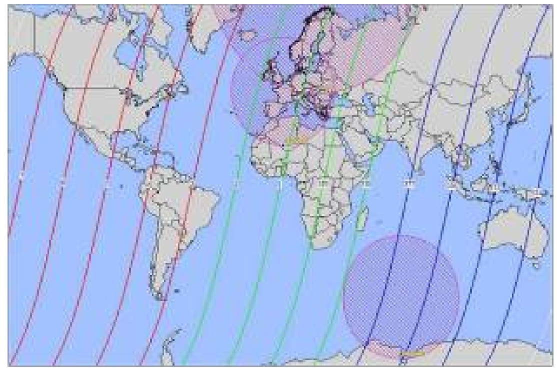

Figure 5: Programming Periods Map.

The Programming Period changes are specified to correspond to the beginning of one of the three most important areas on the Earth: Asia, Europe + Africa and America. We use the three TT&C station of the Cnes Network (Kerguélen, Toulouse and Kiruna) for the Mission Plans uploading.

To be the most efficient possible, concerning clouds cover forecasts; this information is updated at the same frequency: that means three times a day and just before the Mission Plan calculation.

To give an idea of the chronology:

- The Mission Plan which begins on Asia is uploaded around 23h00 UT,
- The Mission Plan which begins on Europe is uploaded around 6h00 UT,
- The Mission Plan which begins on America is uploaded around 13h00 UT.

III. In Orbit Commissioning Phase

A. Operations Chronology

1. Technological Mode

This system mode is used when the programming is limited to the Satellite Operator. It's the case when the satellite has a problem which must be investigated and solved before getting back to the users for an operational use. It's also the case when the satellite is not yet on its final orbit. Indeed, the Programming Request Management, in the users' centres, is base on a phased orbit and as long as this nominal orbit is not reached, it is impossible to involve the users' centres in the programming function. It's obviously the case in the beginning of life.

Thus, it's this system mode which has been used for the very first operations, acquisitions and downloading from the 17^{th} of December, 2011 (Launch date) till the 4^{th} of January, 2012 (date of the last orbit manoeuvre which allowed to set the Pléiades 1A satellite on its final orbit).

During this time, all the requests have been deposited by the Satellite Operator, whether acquisitions or technological operations, directly in the DUal Programming Centre. The first images were acquired and downloaded the 20^{th} of December, 2011 (3 days after launch) on two orbits flying over Europe. Each day, new images were acquired allowing us to begin to validate the Mission Planning function.

In this mode, there is no notion of system chronology. Each Mission Plan horizon is sized depending on operations to do and TT&C stations available.

Of course, this time has been used to assess the first performances of the satellite, to make the first and coarse calibrations of the instruments and the AOCS sub system as well and to verify that all the satellite equipments worked correctly. The main goal of this phase was to be able, as quick as possible, to open the system to final users even if the fine calibration of the satellite and the instrument were not reached.

2. Routine Mode

Once the satellite set on its nominal orbit, it became possible to switch in the Routine Mode and to involve the users' centres in the programming.

This is what has been done from the 4^{th} of January, 2012 and the first Mission Plan, elaborated in the Routine Mode and containing users' requests has been uploaded and started at 13:14 UT.

To open the system progressively, only requests from the Civilian Operator has been authorized in this first step and only requests dedicated to image calibration. The idea here was to validate the ability to use the Routine Mode, using the full system chronology, which means working out three Mission Plans per day, carrying on calibration operations of the commissioning.

Using the Routine Mode rather than the Technological Mode implies the following things:

- Users' requests and Pass Plans allocated for Image Telemetry downloading are provided by users' centres to Dual Programming Centre through dedicated interfaces with a constraining chronology,
- The way to build the Acquisition Plan is different because it uses the first step (technological acquisitions and operations) and the third step (civilian requests) described in § II.A.1,

The starting of the Routine Mode was the opportunity to validate the good transition between the Technological Mode and the Routine Mode.

From this date (the 4th of January, 2012) and up to now, Pléiades 1A has been programmed in the Routine Mode and nominal system chronology without any interruption except three on board anomalies (three times the same) which occurred in January and February. These three events stopped the satellite programming for few hours each time. And at each time, it has been possible to resume the programming without using the technological mode. The anomaly has been solved by tuning a system parameter.

After few days of programming in these limited conditions, the system continued to be deployed in the following way:

- Through specific requests deposited by the Satellite Operator, the Image Telemetry downloading has been tested on each Image Receiving Station of Defence users' centres (the French one the 5th of January and the Spanish one the 11th of January);
- The 17th, the Image Receiving Station of Kiruna was added for the Civilian Operator in order to increase the Image Telemetry downloading capabilities and consequently, the acquisition capabilities of the system;
- Then, the 18th, the system has been open to defence programming that means just one month after the launch.

The result of this opening to defence centres is the addition of a new step in the construction of the Acquisition Plan in accordance of what is described in § II.A.1. This new step is inserted between the Technological Step and the Routine Step and realises the resource sharing between the Defence Operators for their priority requests. In addition, Defence Operators are taken into account in the resource sharing of the Routine Step for their routine requests.

From this date, we can consider that the Pléiades system was fully deployed in its centralised configuration that means using only Image Receiving Station located in Europe (Toulouse and Kiruna for Civilian Operator, Paris for French Defence and Madrid for Spanish Defence).

3. Civilian Crisis Mode

There is another operational system mode: the Civilian Crisis Mode. This mode has been defined to offer to the Civilian Operator the highest programming priority in case of natural disaster such as: earthquake, tsunami, volcano irruption, floods and so on.

This mode could be set off when the Pléiades system will be involved in the International Charter Space and Major Disasters.

In this mode, some civilian requests get a high priority to be inserted in the Acquisition Plan. The way this point is taken into account in the Mission Planning Function and especially in the Acquisition Plan is the following:

- When a Civilian Crisis is declared in the system, a geographic area is defined;
- To be able to insert a request in the Acquisition Plan, this one must intersect the Crisis Area, must come from the Civilian Operator with the right level of priority (CRISIS);

A new step is added in the Acquisition Plan building: between the Technological Step and the Defence Step. There is not limit in terms of satellite resource usage; it's the geographic area which finally limits the number of acquisitions when the satellite flies over the area.

This mode has been tested during the commissioning between the 7th and the 10th of February to show that this mode works correctly as well as the transition between Routine Mode and Crisis Mode and return. This test has been made, using the Turkish territory as crisis area. The figure 6 shows an example of an Acquisition Plan over the area during the test period.

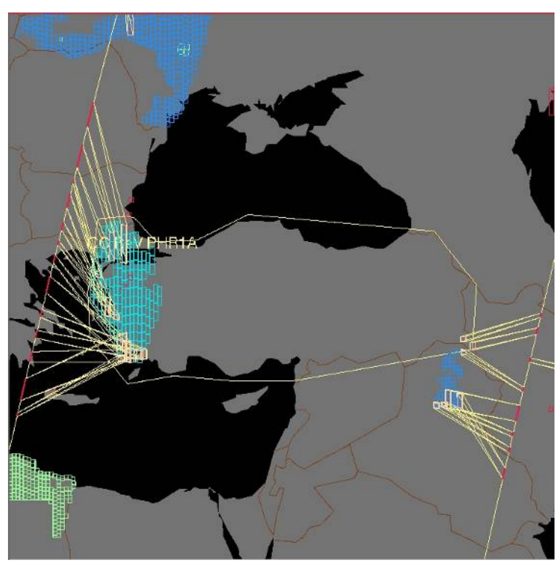

Figure 6: Civilian Crisis Acquisition Plan

4. *Very Urgent Programming*

We have seen that the Pléiades Programming works in a synchronous way: three times a day in Routine or Crisis mode. There is an option in the System to program at any time: the Very Urgent Programming.

This possibility has been defined and designed to be able to take into account emergency cases which could not be solved by the nominal system chronology. It's not defined as a system mode and the use of this function remains exceptional. For example, at the beginning of the commissioning, it wasn't foreseen to test it but particular circumstances have led us to use it and to valid it at the same occasion.

The principle of the Very Urgent Programming is as following if it's necessary to add an acquisition in the current Acquisition Plan before the next synchronous Mission Plan of the nominal system chronology:

- According to the hour of the urgent acquisition, the Dual Programming Centre verifies that before this date, there is, in the Mission Plan, a resumption point from which it will be possible to update the on board Mission Plan in order to include the new acquisition (by definition, there is at least one resumption point on each orbit);
- The Dual Programming Centre verifies as well that there is an available TT&C station in order to upload the new Mission Plan and finally it verifies that there is enough time to rework the Mission Plan containing as a minimum the acquisition and the downloading of the urgent acquisition;
- If it's the case, the urgent request is deposited by the Satellite Operator in the Dual Programming Centre as a Technological operation;
- The Mission Planning function is activated with this new request but also with all the requests which were already selected in the current Mission Plan;
- The new Mission Plan is built, including the new request and preserving as much as possible the current programming depending on the time allocated to carry out this operation.

It's obvious that this possibility needs human activities and can't be made in an automatic way. In another hand, it can disoptimize the Mission Plan replacing a set of important acquisitions by only one, even if it's very important. It confirms that it must be used exceptionally and we are convinced that the nominal system chronology will solve the majority of extreme reactivity cases.

Anyway, the function has been tested and validated in operational conditions and is ready to be used in case of emergency.

5. *Direct Tasking Programming*

The nominal system chronology offers a very good performance in reactivity thanks to the three activations of the Mission Planning per day, but the system proposes, in addition, a possibility to improve even more this reactivity on specific areas.

This improvement is obtained with the Direct Tasking Programming. This function has been partially tested during the commissioning and will be more completely tested in next months.

The principle is the following:

- 24 hours before flying over a specific area, an orbit slot is reserved (Direct Tasking slot), during which the Direct Tasking Programming will be used,
- At each time the Mission Plan is worked out, in Routine mode, this reserved slot is taken into account to make sure that it will be possible, at the last moment (just before entering the slot), to modify, through an additional uploading, the part of the Mission Plan located inside the slot to replace it by a more up to date Mission Plan. To do that, the part of the Mission Plan which is inside the slot is bounded by markers: on at the beginning and one at the end. Inside the Direct Tasking slot, the Mission Plan is called "by default",
- Just before flying over the area corresponding to the Direct Tasking slot, a new Mission Plan, limited to the duration of the slot, is worked out, uploaded using a dedicated TT&C station and plugged in the current on board Mission Plan in order to replace the on board Mission Plan on the horizon of the Direct Tasking slot. If the uploading fails, it's the "by default" Mission Plan which is executed.

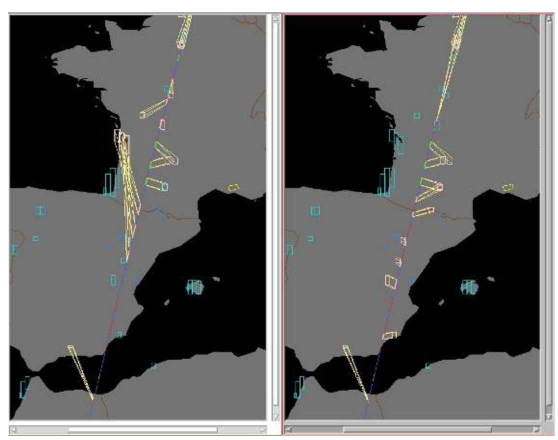

Figure 7: Direct Tasking Acquisition Plans

Direct tasking slots are defined as a part of a pass over an X band antenna (Image Receiving Station) which guarantees that images which will be acquired in the slot can be downloaded during the slot and thus, will be without any effect outside the slot. To upload the Direct Tasking Mission Plan, limited to the Direct Tasking slot, there are two options:

- Use a TT&C station belonging the CNES network and independent of the X band antenna: the S&X Direct Tasking,
- Use the same antenna for TT&C and Image Telemetry: the S+X Direct Tasking.

Obviously, this function allows Civilian Operator to deposit new Requests at the very last time (one hour before) and as well to select the acquisitions to be acquired taking into account the very last weather forecasts, improving consequently the efficiency of the programming.

At this time, the validation of Direct Tasking is still to be achieved. Tests made up to now shows that the functionality works correctly in the S & X case, the S+X case will be tested before summer.

In figure **7**, an example of Direct Tasking Programming is given over France and Toulouse Image Receiving Station. The left map gives the Mission Plan containing the "by default" programming in the Direct Tasking slot and the right map gives the real Direct Tasking Mission Plan.

B. Mission Capabilities Validations

This chapter presents specific operations made in order to test and assess mission capabilities of Pléiades 1A and as well to calibrate some system parameters.

1. Acquisition capabilities

Due to its high agility and high performance of the guidance algorithms, the satellite is capable to image targets along any ground direction within 47° of vertical viewing position, with very low maneuvers durations between two consecutive images.

This high agility permits:

- To minimize scheduling conflicts within the dual use framework, and therefore better meet the simultaneous needs of all users,
- To image in any direction which will allow, for example, coastlines or river routes to be monitored, which could be very useful for optimizing programming,
- To enlarge the swath by taking in the same pass adjacent stripes. Mosaic images ranging from 60x200 km² (3 strips) to 120x65 km² (6 strips) with 20° access authorized, and from 60x340 km² (3 strips) to 140x105 km² (6 strips) with 30° access authorized, can be acquired,
- To acquire, in the same pass, stereoscopic pairs or tri stereoscopic triplets even with low base over height ratio, a very important improvement in order to avoid hidden faces in urban area. Following array shows the maximum length of stereoscopic coverage acquired from the same orbit with different B/H, either for stereo pairs or for triplets.

B/H	Stereo length	Tri-stereo length
0.1	25 km	-
0.2	80 km	25 km
0.4	200 km	80 km
0.6	300 km	135 km
0.8	300 km	200 km
1	300 km	260 km

Figure 8: Stereo and tri-Stereo

During a single overpass of an area of 1000x1000 km², each Pleiades satellite acquires about 20 targets with metric resolution (next figure). In a smaller theatre of operations (100x200 km²), 16 targets may be acquired.

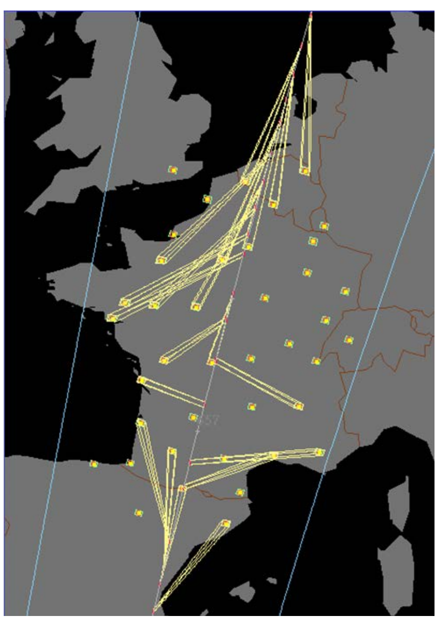

Figure 9: Targeting Capabilities

This amazing agility has been fully demonstrated during the in flight commissioning phase. Five days after launch, the control momentum gyros torque has been unleashed to acquire a set of images with very strong relative pointing angles. The angular rate of the satellite has reached values up to 3.4°/sec to perform the maneuvers between two data captures (Figure 9).

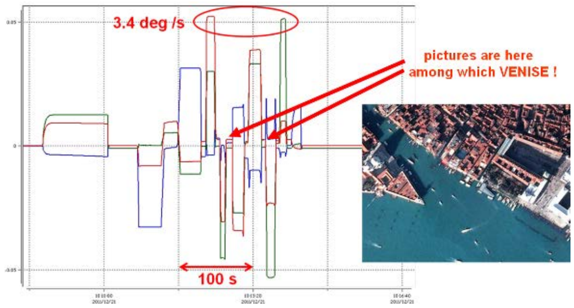

Figure 9: 3 axis angular rate / time sec

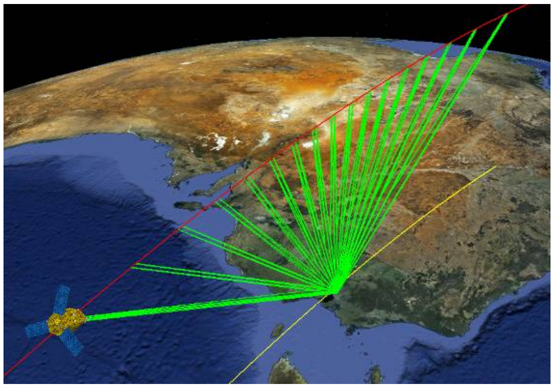

Figure 10: Video Mode

In addition to stereoscopic acquisitions, during commissioning, Pleiades agility has been pushed to its limits in order to acquire more than 20 images in a single pass to produce a sequence of animated images allowing highlighting human activities on the targeted area (Figure 10).

During the commissioning, thanks to the agility and the Mission Planning function capabilities, various image calibration methods have been performed without stopping the users' requests programming. For example, was used:

- Stars or Moon acquisitions,
- AMETHIST acquisitions (Figure 11),
- Slow Motion acquisitions (Figure 12),
- Geometric auto calibration acquisitions (Figure 13).

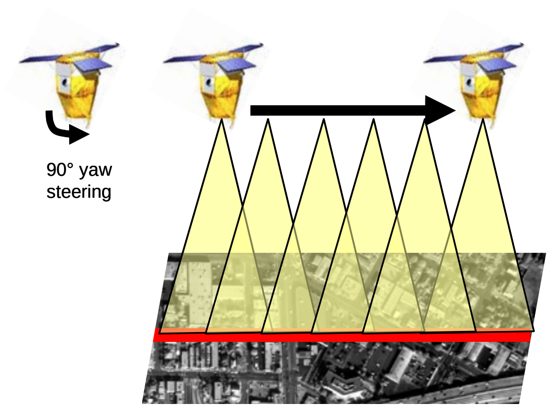

Figure 11: AMETHIST Mode

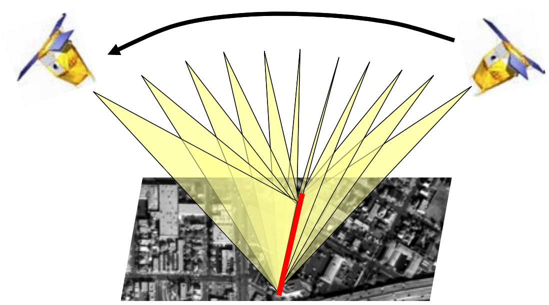

Figure 12: Slow Motion Mode

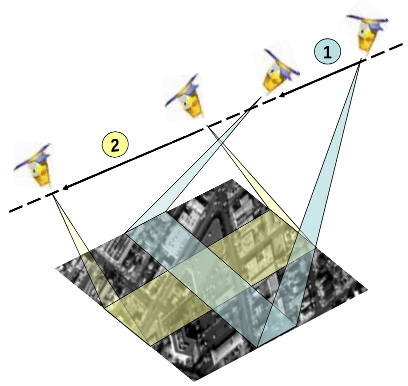

Figure 13: Geometric auto calibration Mode

2. *Instrument Use Duration*

On Pléiades satellites, instrument use duration is constrained due to focal plane thermal constraints. The constraint, which is taken into account when working out the Acquisition Plan, is given for each orbit and could be different from an orbit to another, depending on flown over areas.

One of the objectives of the commissioning was to verify that it was possible to use the instrument inside the domain defined by the previous constraints without endangering the instrument integrity or at least without damaging the image quality.

This operation has been done through a specific programming in which the instrument use duration was forced in order to reach the maximum constraint on each orbit of the Mission Plan. During this specific Mission Plan, on board parameters was monitored. Finally, the instrument behaviour complied with requirements.

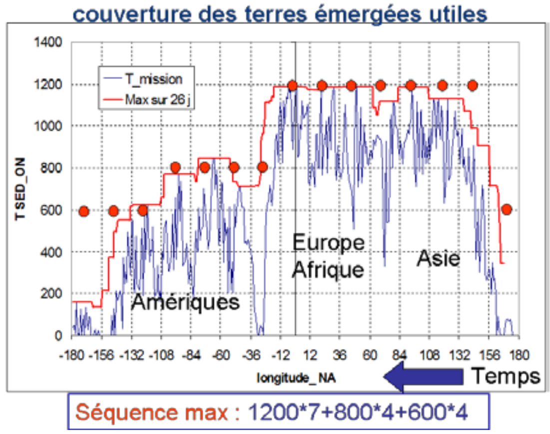

Figure 14: Instrument Use Duration Template

At the same time, energy budget was checked and showed that we have some margins with respect to the predicted budgets. It means that the energy budget won't be a limitation in using the satellite.

Figure 14 gives the template of the constraint.

3. *Image Telemetry Downlink Calibration*

As said in § II.A.2, the Downloading Plan is built taking into account the attitude of the satellite got from the Acquisition Plan after having assessed a link budget for each pass over system Image Receiving Stations.

It has been necessary, during commissioning, to verify and calibrate the downlink budget by comparing the predicted budget with the real budget observed during specific passed. The objectives were to adjust system parameters in order to guarantee the Image Telemetry Quality and to avoid loosing images.

Among parameters we have calibrated, there are:

- The Equivalent Isotropically Radiated Power (EIRP) of the on board antenna and especially the domain located between 70° and 90° of site. This calibration was done, using a specific attitude profile when passing over Toulouse and transmitting well known data to be able to measure the Eb/N0 of the signal;
- The physical masks of each Image Receiving Stations,
- Different parameters involved in the calculation of the predicted Eb/N0 and in particular, the system margin to take into account to adjust the threshold below which it is not possible to download Image Telemetry.

Thanks to these tunings, Image downloading is now guaranteed in any cases.

4. *Mission capabilities*

During the commissioning, after opening the system to all users (that means form the 18th of January), the satellite use increased regularly, in the same rhythm that the users programming data base were fed with new programming requests.

Before the end of the commissioning, we have been able to assess the real mission capabilities of the system and where were the points which limited the number of images acquired by day.

At present, as the users centres only use image receiving stations located in Europe (Toulouse and Kiruna for Civilian Operator, Paris for French defence and Madrid for Spanish defence), it is the downloading capabilities which limits the system mission capabilities. Indeed, without any possibility to download images acquired over Asia, for example, the on board mass memory is quickly saturated before reaching the first downloading possibilities over Europe.

In these conditions, current system mission capabilities are 500 images per day which correspond to what has been assessed during the development phase of the system. This average number will increase when users' centres (and especially the Civilian Operator) will add new regional image receiving stations.

We can note that the increasing of the number of acquired images per day will be possible considering the observed margins of the energy budget.

IV. Operational Phase

The system commissioning ended the 1st of March. From this date, the system has entered in the operational phase even if some technological operations are still programmed in order to continue and finish the full calibration of the instrument.

It means that the system is completely open to the users who can use the system without any restrictions.

The system is obviously in the Routine Mode and the Mission plans are worked out three times a day.

From the beginning of the operational phase, there is no interruption of service concerning the programming function even if some Mission Plans could not uploaded due to few TT&C station unavailability and as well few residual anomalies in the Mission Planning function. Thanks to three activations a day, and the fact that each Mission Plan has a nominal period and two backup periods, it has always been possible to find a quick solution to solve the problem and to assume the continuity of the Pléiades mission.

The end of the Image Quality commissioning is planned for the end of June. It will just remain to wait for the second Pléiades satellite, which launch is foreseen before the end of the year, to have the full Pléiades constellation.

Since the 17th of December, 2011 The first Pléiades satellite has turned more than 2250 times around the Earth, has taken more than 45000 images and thanks to its huge agility and its very big pointing precision, has been able to acquire beautiful images of the Earth but as well exotic images like: the Moon, Stars, planets and so on. The last famous one concerns the ENVISAT satellite as shown in the following figure.

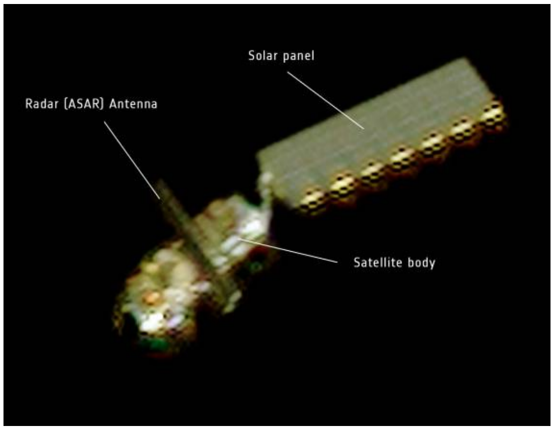

Figure 14: ENISAT by Pléiades