PLANCK HFI operations: lessons learned

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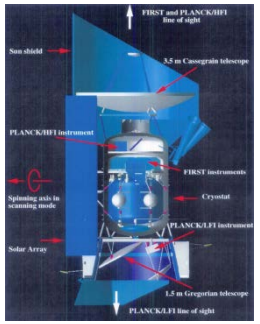
Introduction

«Planck HFI operations: lessons learned» …
more precisely:

- a partial view of 7 years experience
- in few concrete messages …
- That - I think - could somehow be beneficial to future missions

- Overview
  - The Planck surveyor
  - The preparation of the operations
  - The running of the operations
  - Conclusions

The Planck project

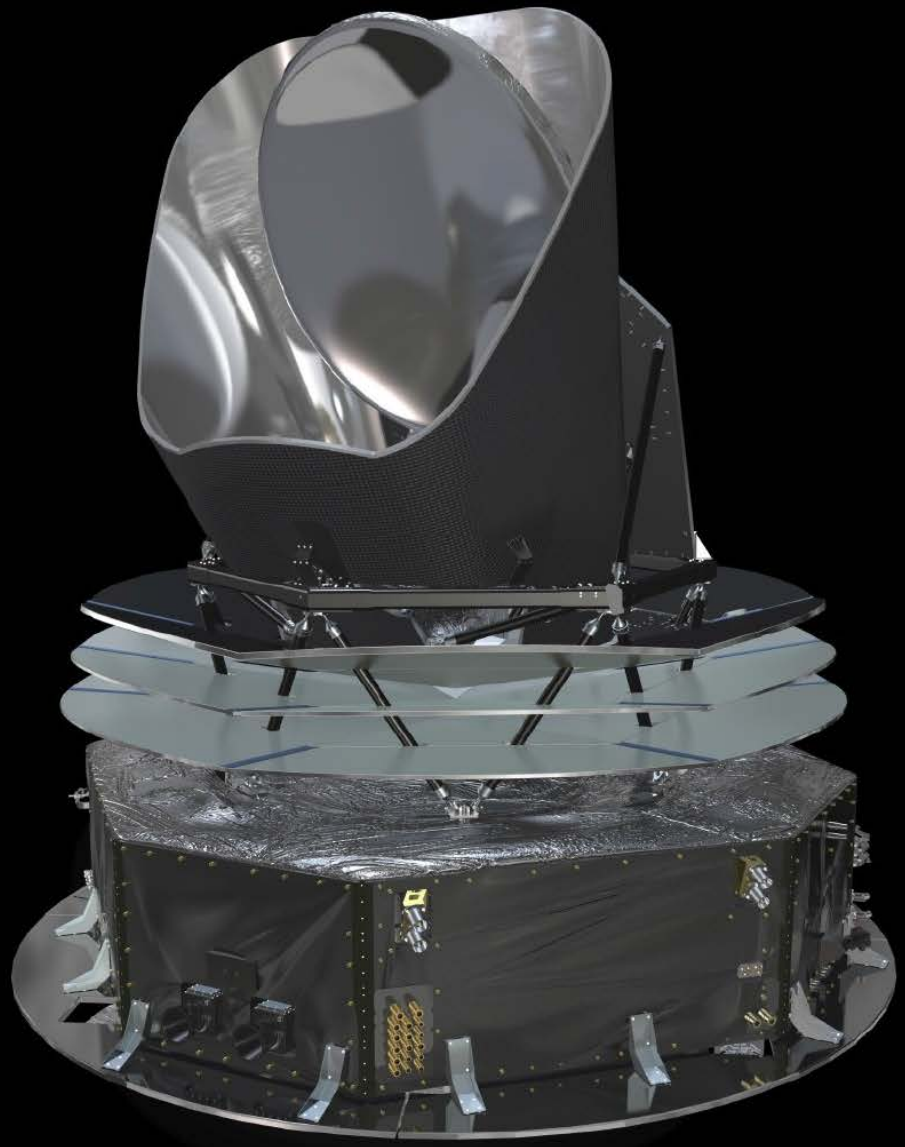


- 1993 : proposed to ESA as two separate satellites COBRAS SAMBA (launch in 2003)
- 1997: combined with FIRST (aka Herschell) in one satellite (launch in 2007)
- 2000 : prime selected
- 2002 : inaugural Ariane 5 ECA failure
- 2003 : instruments final requirements
- 2009 : launch

The Planck organization

Planck is a project of the European Space Agency, with instruments provided by two scientific Consortia funded by ESA member states (in particular the lead countries: France and Italy) with contributions from NASA (USA), and telescope reflectors provided in a collaboration between ESA and a scientific Consortium led and funded by Denmark.

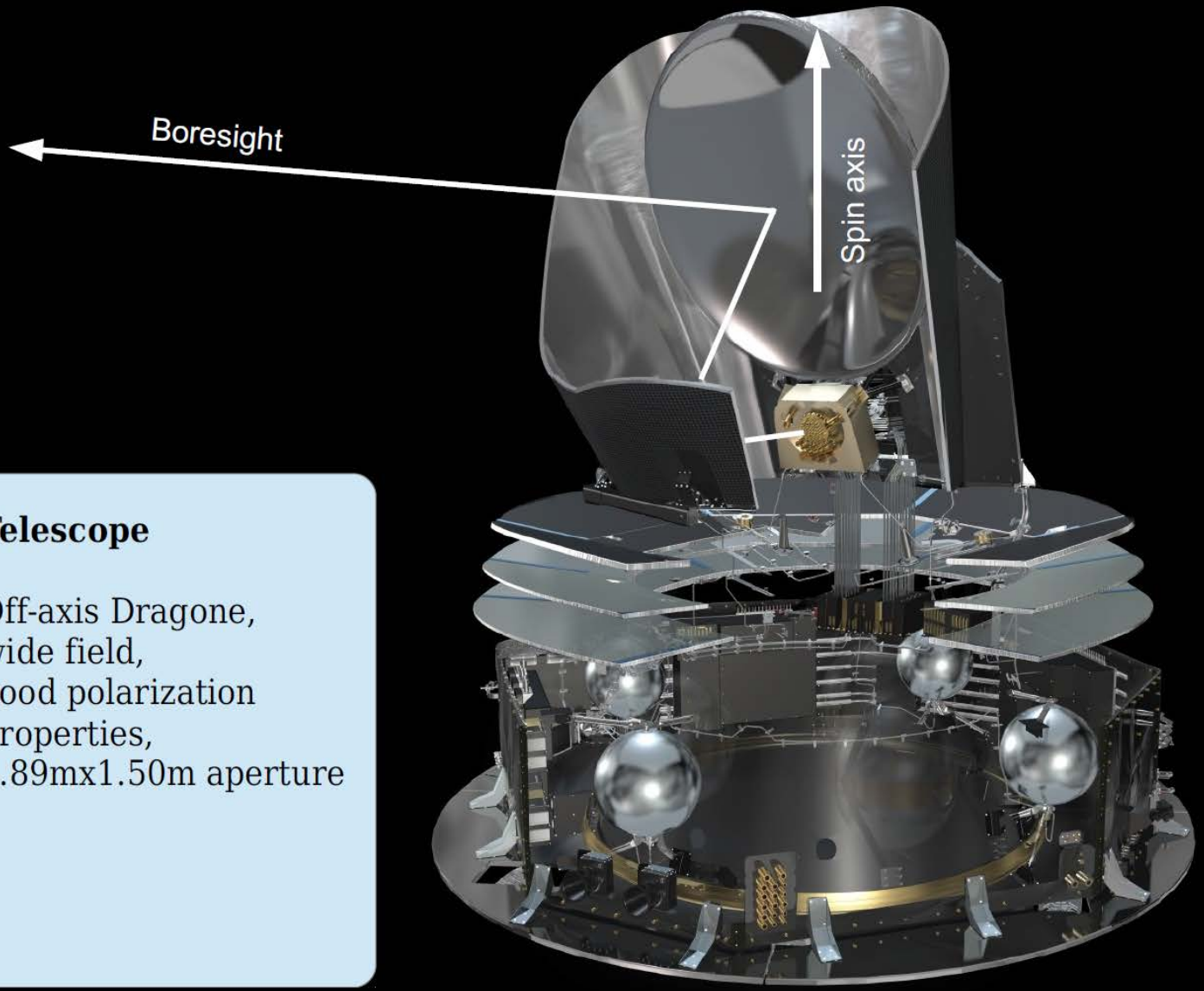
The Planck surveyor



Weight: 2000 Kg

Power: 1600 W

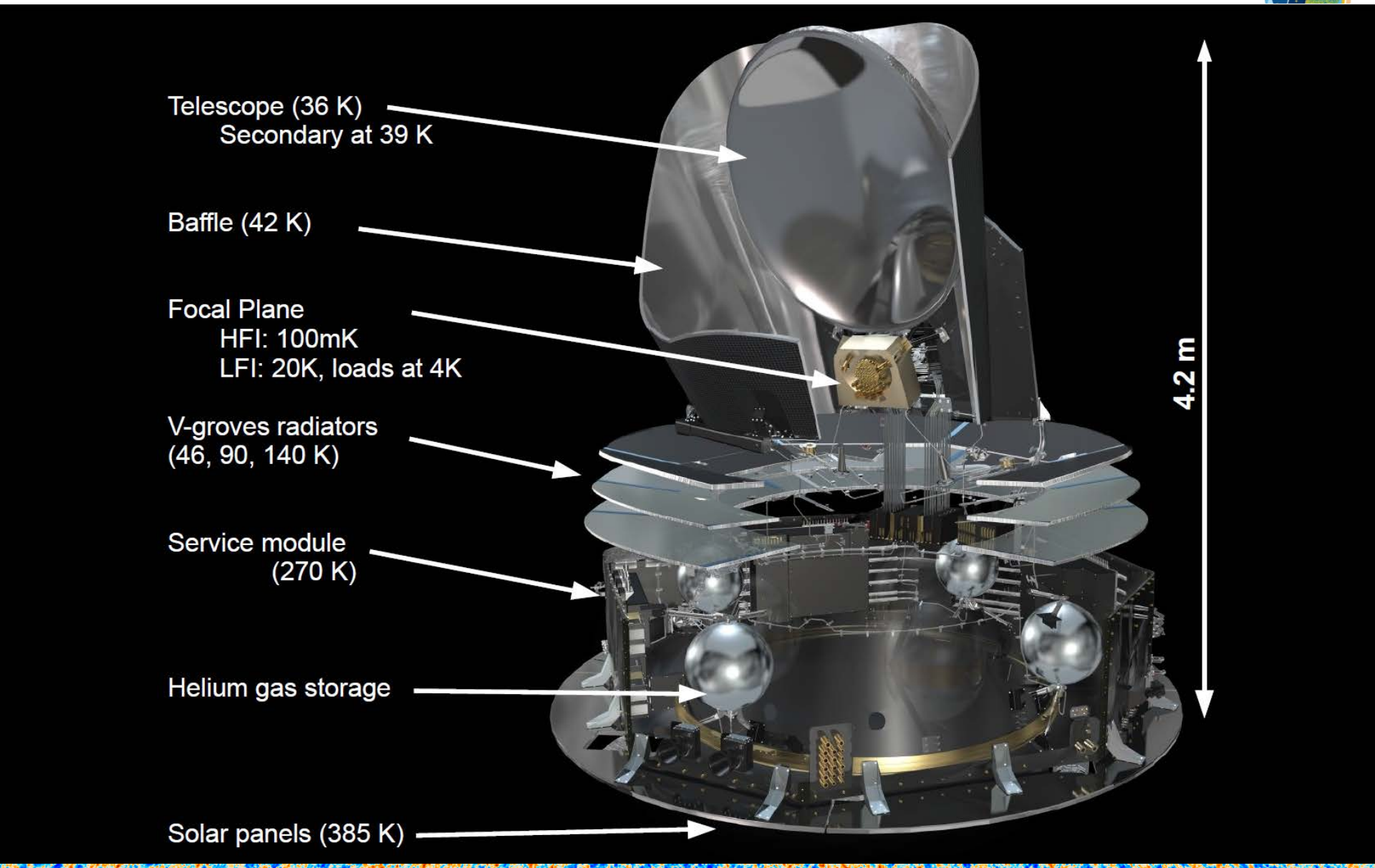
Lifetime: 21 months (design)
33 months (HFI)
Still alive (LFI)



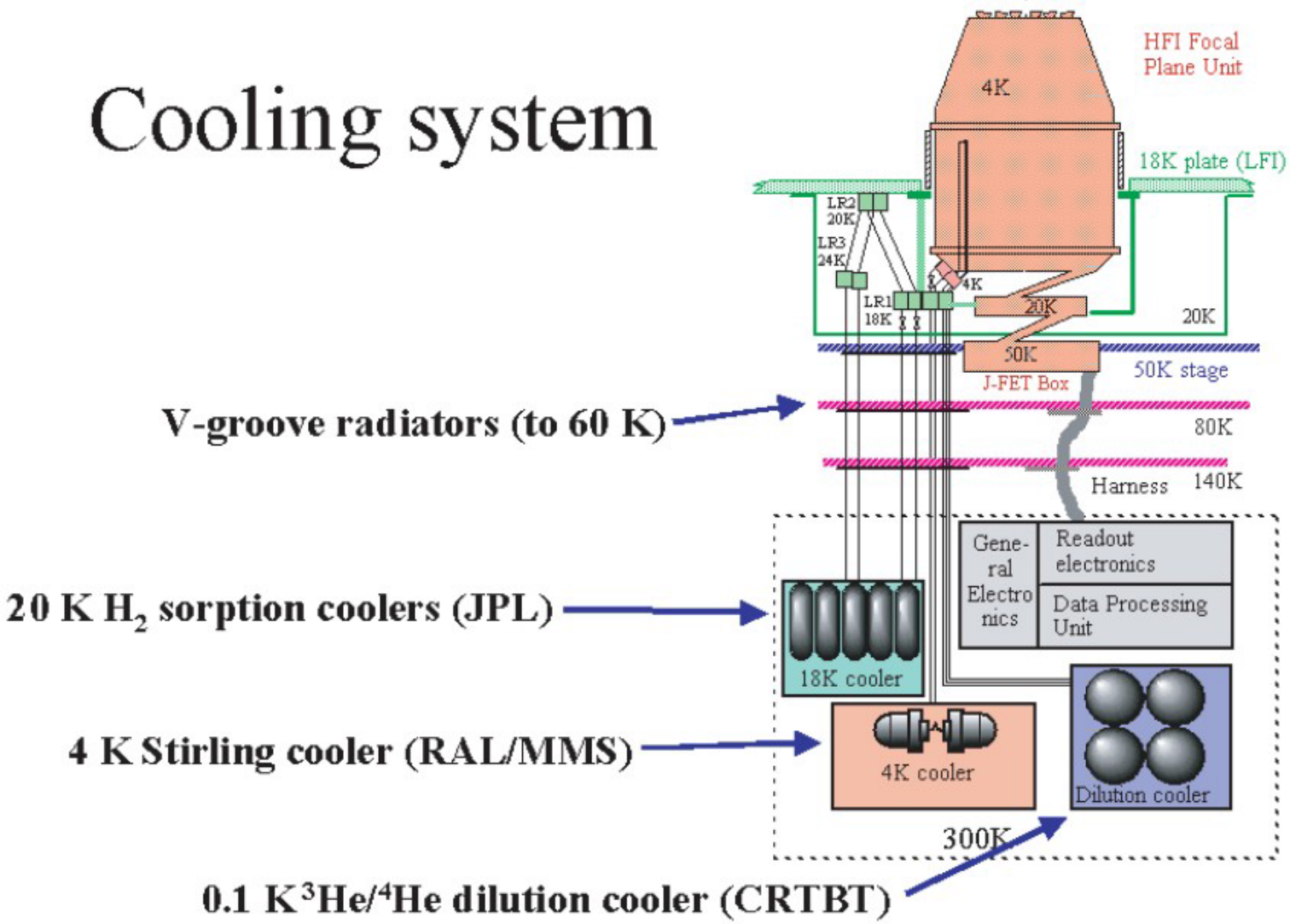
Telescope

Off-axis Dragone,
wide field,
good polarization
properties,
1.89mx1.50m aperture

HFI and LFI


Telescope (36 K)
Secondary at 39 K
Baffle (42 K)
Focal Plane
HFI: 100mK
LFI: 20K, loads at 4K
V-groves radiators
(46, 90, 140 K)
Service module
(270 K)
Helium gas storage
Solar panels (385 K)
4.2 m

A complex active cryo system …



The High Frequency Instrument specificities

- The sensitive cryo chain had not be FINE tuned before launch
  - dilution cooler in 0-gravity
  - cosmic rays heating the focal plane at L2
  - cryo stages to be chained
  - potential Helium leaks

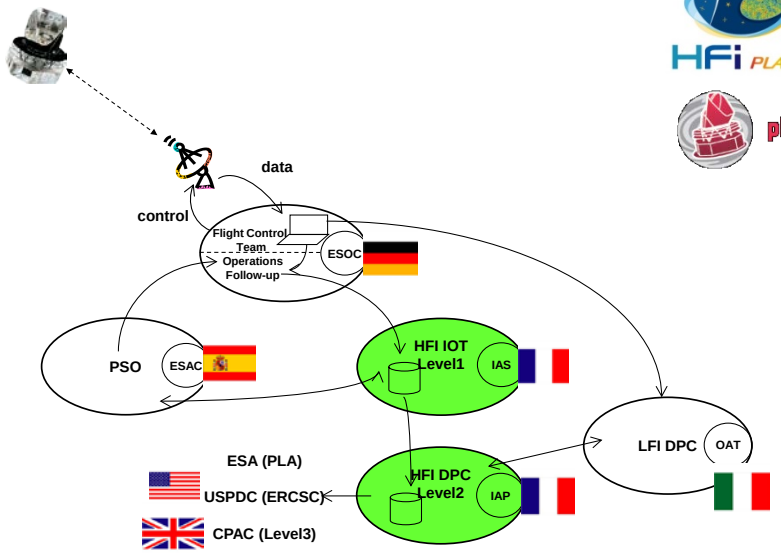
=> «very fine features» to be understood in situ

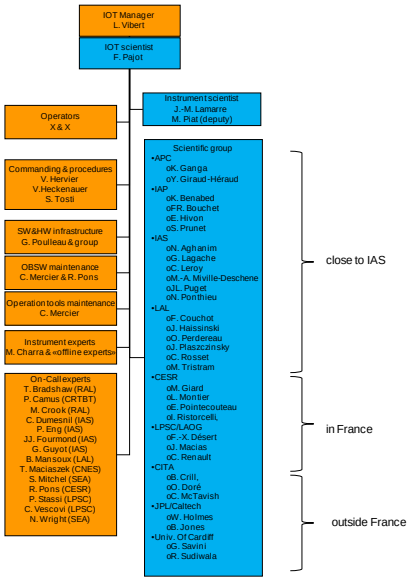
- Any loss of the cold end would have implied at least 12 days of survey loss (versus a nominal mission of 1.5 years)

- Only couple of experts able to understand (and react)

Be ready to face instrument problems

- A «complex» SGS entirely designed in that perspective
  - Data handling (flow, processing, analysing) on a just-in-time basis (<10 hours)
  - Great importance of the daily 20 mn NRT data
  - The small gap recovery system





- An intense (and tense) monitoring:
  - IOT initially designed with 60+ people
  - 3 hours real time monitoring during DTCP 7/24/365
  - Quick Look Analysis software designed for monitoring all 2600+ Instrument housekeeping parameters and many SVM ones.
  - Trend analysis software (including L1 and L2 processing levels) monitoring the scientific data

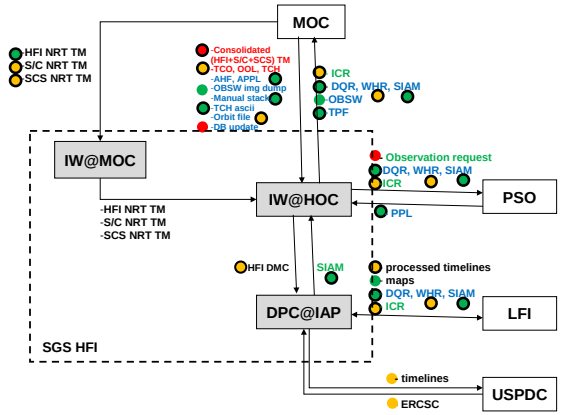
Preparation of the operations : message #1

- Understand the instrument
  - Smooth transition from IDT to IOT
  - Keep commited experts in the teams
  - HFI Instrument User Manual
    - *difficullt to precisely predict how the Instrument will behave in space*
    - *=> the IUM was definitively not the tool (if any) to describe how to react in flight*
  - One year before launch: implication of the MOC team during the integrated satellitte tests/calibrations
  - Instrument simulator
    - *A «light» instrument simulator could have been a nice tool for SGS testing and operations rehearsal*
  - AVionic Model
    - *didn't play any role (electronics only)*

Preparation of the operations : message #2

- Be ready in time
  - ESA SGS reviews
    - *Very usefull as internal drivers but not real checkpoint for the operations*
    - *Have not the priority on the Instruments reviews*
    - *Are not operations oriented*
    - *SGS status isn't easily quantifiable*
    - *Essentially focussed on the interfaces readiness*

Interfaces readiness



Preparation of the operations : message #3

- Prepare the operations while still on ground
  - Learn how the instrument behaves during ground calibrations(the more you test, the better)
  - Avoid different systems/procedures (Industry vs ESOC)
    - *Enormous amount of effort spent to do, redo, crosscheck, test, re-test …: real time software, procedure langage*
  - The System Validation Tests
    - *Usefull to test the FCP/CRP but unitary tests only*
  - The System Operation Validation Tests
    - *The first multi interfaces tests*
    - *Reaction time is involved*
  - The sims campaign
    - *Instrument operations not involved*
    - *Very few FCP/CRP tested in real time*

Operations in flight

- L0 : launch / start of LEOP
- L+3: start of commissioning phase / cooldown/trip to L2 (53 days)
- L+56: calibration and performance verification phase (33 days) including First Light Survey
- L+90: Survey#1 (180 days)
- L+270: Survey#2 (184 days)
- L+455: Survey#3 (180 days)
- L+530: end of HFI nominal operations (=cooldown+1.5 year)
- L+635: Survey#4 (170 days)
- L+806: Survey#5 (185 days)
- L+975: HFI helium EOL / start of “LFI only” 1st extension (1 year)
- L+1327: “LFI only” 2nd extension
- L+1579 : today
- L+1622: last DTCP (23 October 2013)

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intrication of CoP and CPV phases, activities and responsibilities :
ESA Project (and Industry) vs ESA science vs Instrument team
=> Warning on a possible management difficulty

Operations in flight : message #2

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The only HFI incident: the 4K cooler unexpected shutdown:
- **Very efficient IOT**
- **But slow decision time**

=> carefull : procedures might slow down your reaction time

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The last «minute» activities:
- **EOL activities**
- **instrumental discovery**
- **instrumental tests**

=> prepare the EOL activities at the beginning of the mission

Operations in flight : message #4

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HFI extension 17-> 33 months + 2 «LFI only» extensions : people, hardware, fundings have had to cope with duration x 3
=> Be ready for this !

Operations in flight : message #5 …
… and questions

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- **No ressource planned for cleaning, archiving and dismantling the ground segment**
- **Once the day to day rush is over, be sure that data, software, docs, hardware are cleaned up, archived, documented**

- **What to archive ? What for ? For how long ?**
- **What should be the mission «full» legacy ?**

Conclusions

- We have been very lucky:
  - Planck (instruments and satellite) worked incredibly well
  - Committed HFI operation team (mostly scientists)
  - Efficient and comprehensive MOC team (direct contact did help a lot!)

- The IOT is a major player of the SGS:
  - At the interface of science, engineering, operations, management
  - strongly involved in the instrumental systematic effects search
  - the first segment of the data processing chain (controls the data flow)
  - understands housekeeping parameters and L1&L2 scientific data)

- And now
  - I hope my experience would profit to some of you
  - I'm eager to explain, detail and answer questions.
  - Thank you for your attention !