Herschel overview

Herschel Calibration workshop#2

CSIC, Madrid, 6-8 Feb 2008

Göran L. Pilbratt
Herschel Project Scientist
Astrophysics Missions Division
Research and Scientific Support Department

HERSCHEL SPACE OBSERVATORY

esa

Topics

- Herschel in a nutshell
- Progress since Herschel STM
  - Telescope
  - Science instruments
  - Lifetime
  - Pointing
- Some considerations related to early mission phases
- Keeping track

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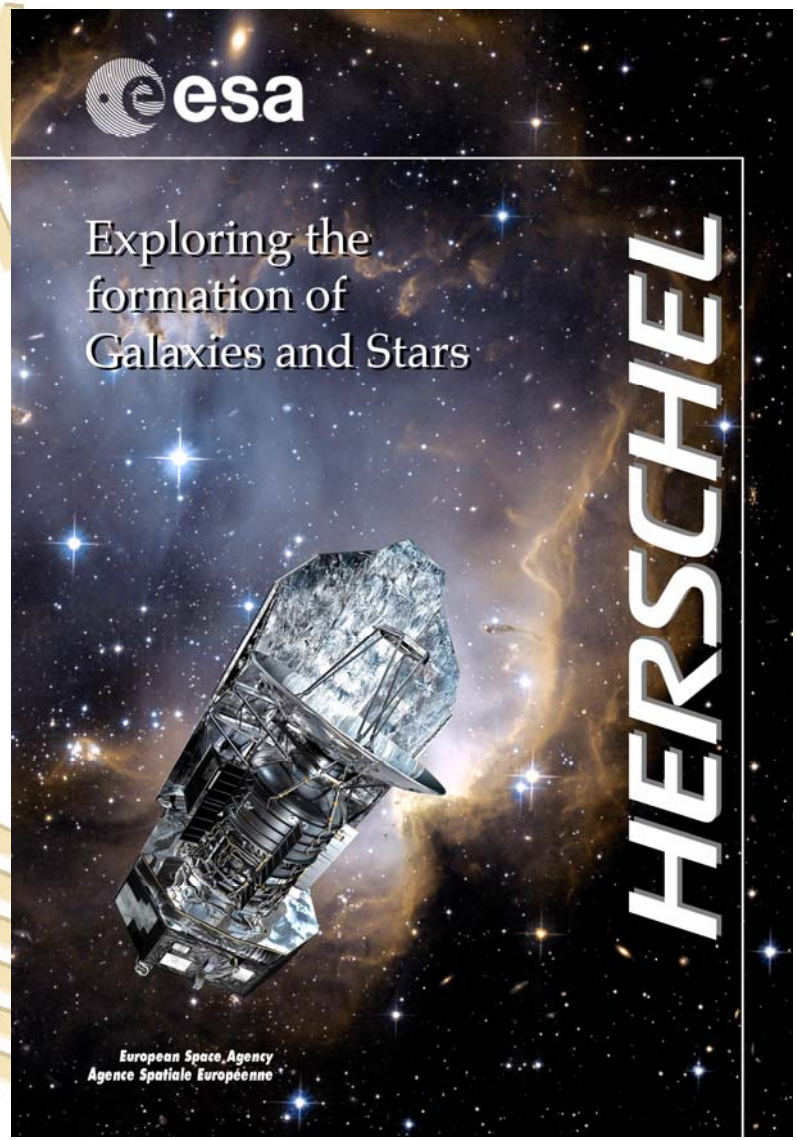
Herschel in a nutshell

- **ESA cornerstone observatory**
  - instruments ‘nationally’ funded, int’l - NASA, CSA, Poland – collaboration
  - ~1/3 guaranteed time, ~2/3 open time
- **FIR (55 - 672 μm) space facility**
  - large (3.5 m) monolithic low emissivity passively cooled telescope
  - 3 focal plane science instruments
  - 3 years routine operational lifetime
  - full spectral access
  - low and stable background
- **Unique and complementary**
  - for λ < 200 μm larger aperture than cryogenically cooled telescopes
  - more observing time than balloon- and/or air-borne instruments
  - larger field of view than interferometers
- **KP AO process since 1 Feb 2007**
  - ~57% of nominal obs time allocated
- **Launch in late 2008**
  - **target date is 31 Oct 2008**
  - **… but nobody can give a guarantee**



Herschel STM satellite

Herschel Science Team visited the ESTEC Test Centre to view the Herschel STM satellite on 1 Feb 2006

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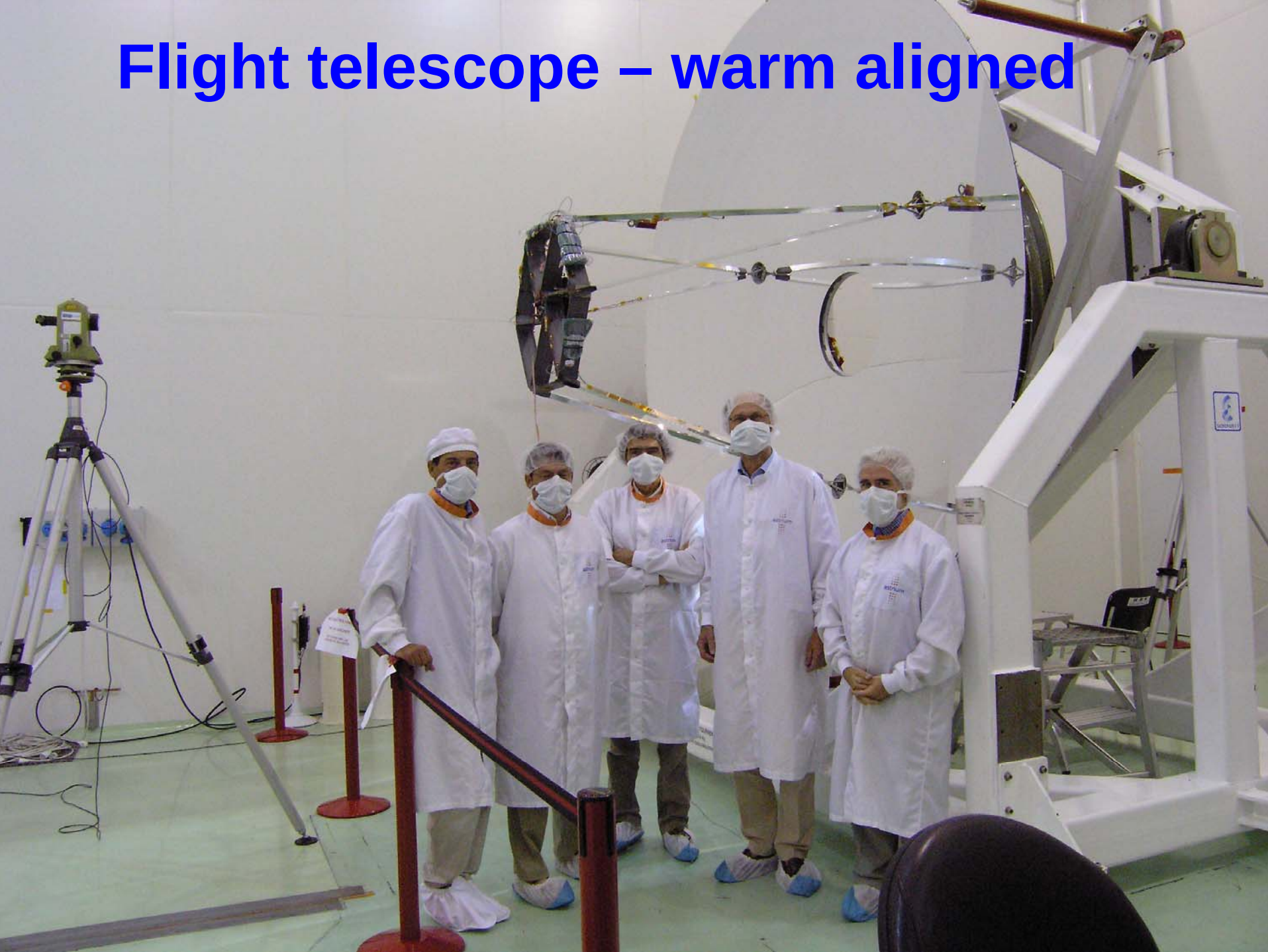
Flight telescope – warm aligned

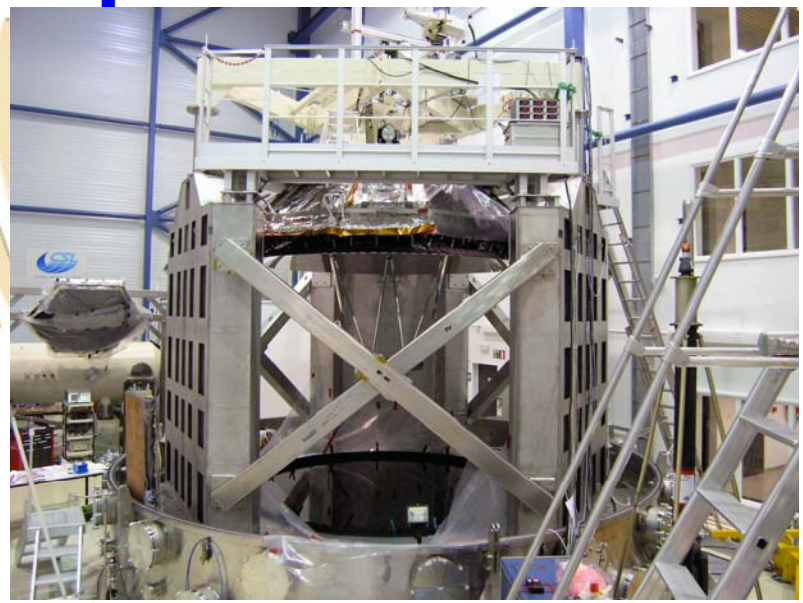


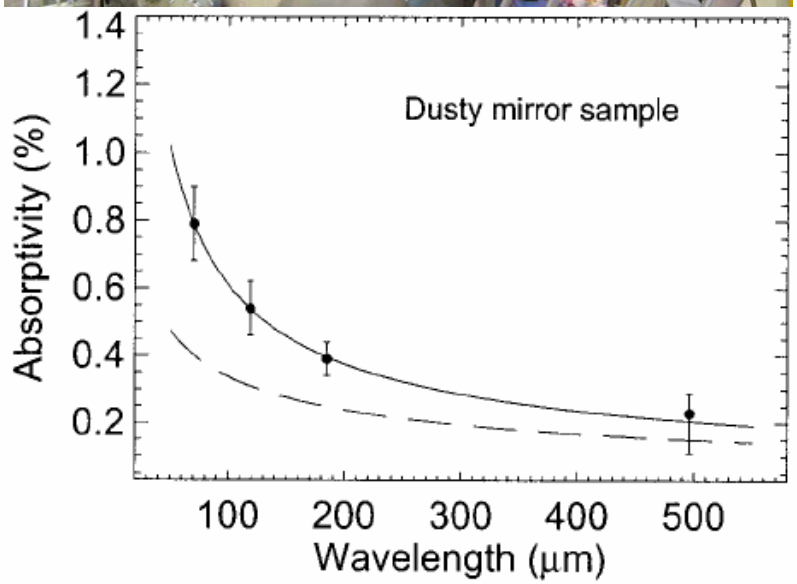
Telescope optics

- **Cassegrain optics**
- **M1 diameter 3.5 m**
- **M2 is undersized (stop)**

➔ **effective aperture 3.3 m**

- **WFE at the best focus 5.7 μm at 70 K**
- **Encircled energy**
- **Mass 315 kg (~90% SiC)**
- **Predicted**
  - Operating temp expected close to 80 K
  - Gradients across M1 small
    - Sun direction ~0.2 K
    - Orthogonal ~0 K
  - Gradient M1-M2 ~3 K





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Telescope temp gradients

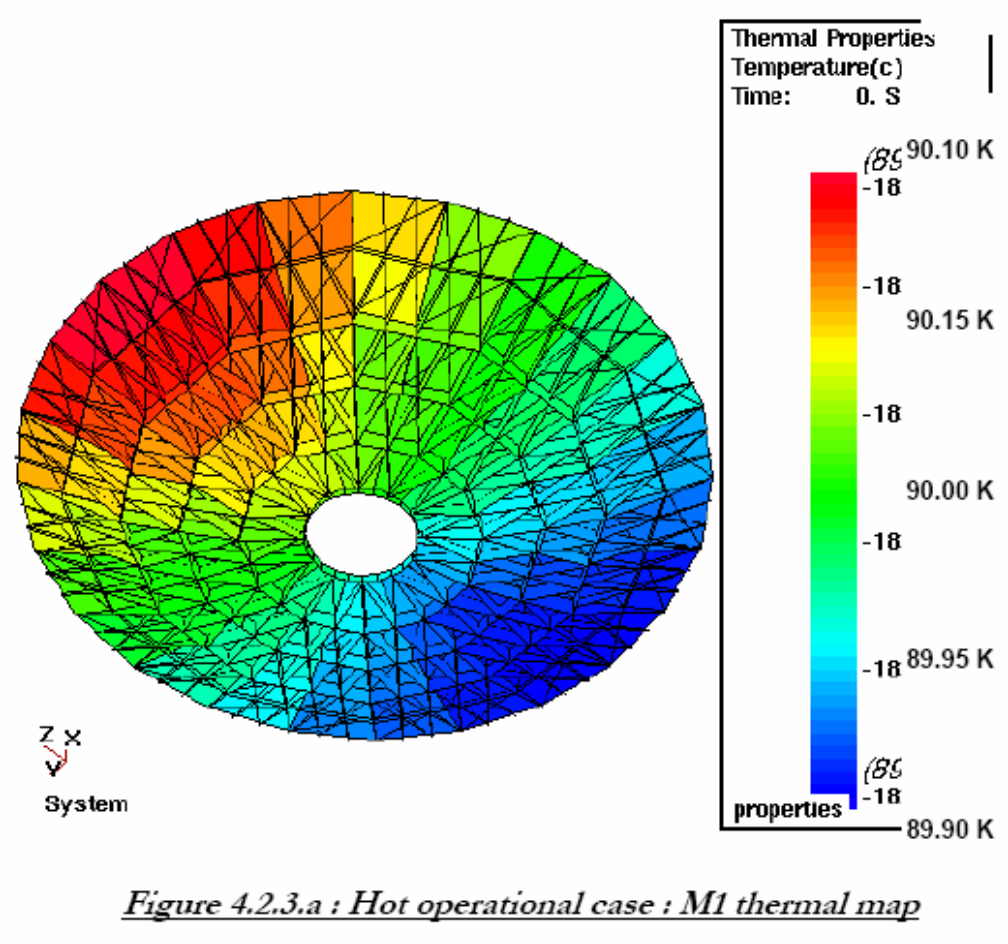

Figure 4.2.3.a : Hot operational case : M1 thermal map

Gradients

hot (90 K) / nominal (81 K)

Δ(M1) =	0.2 / 0.2 K
Δ(M1-M2) =	3.5 / 3.2 K
Δ(M2-barrel) =	0.1 / 0.1 K
Δ(M2-hexapod)=	0.1 / 0.1 K
Δ(hexapod) =	0.1 / 0.1 K
Δ(hex-bipod) =	2.3 / 2.1 K
Δ(M1-bipod) =	1.0 / 0.9 K

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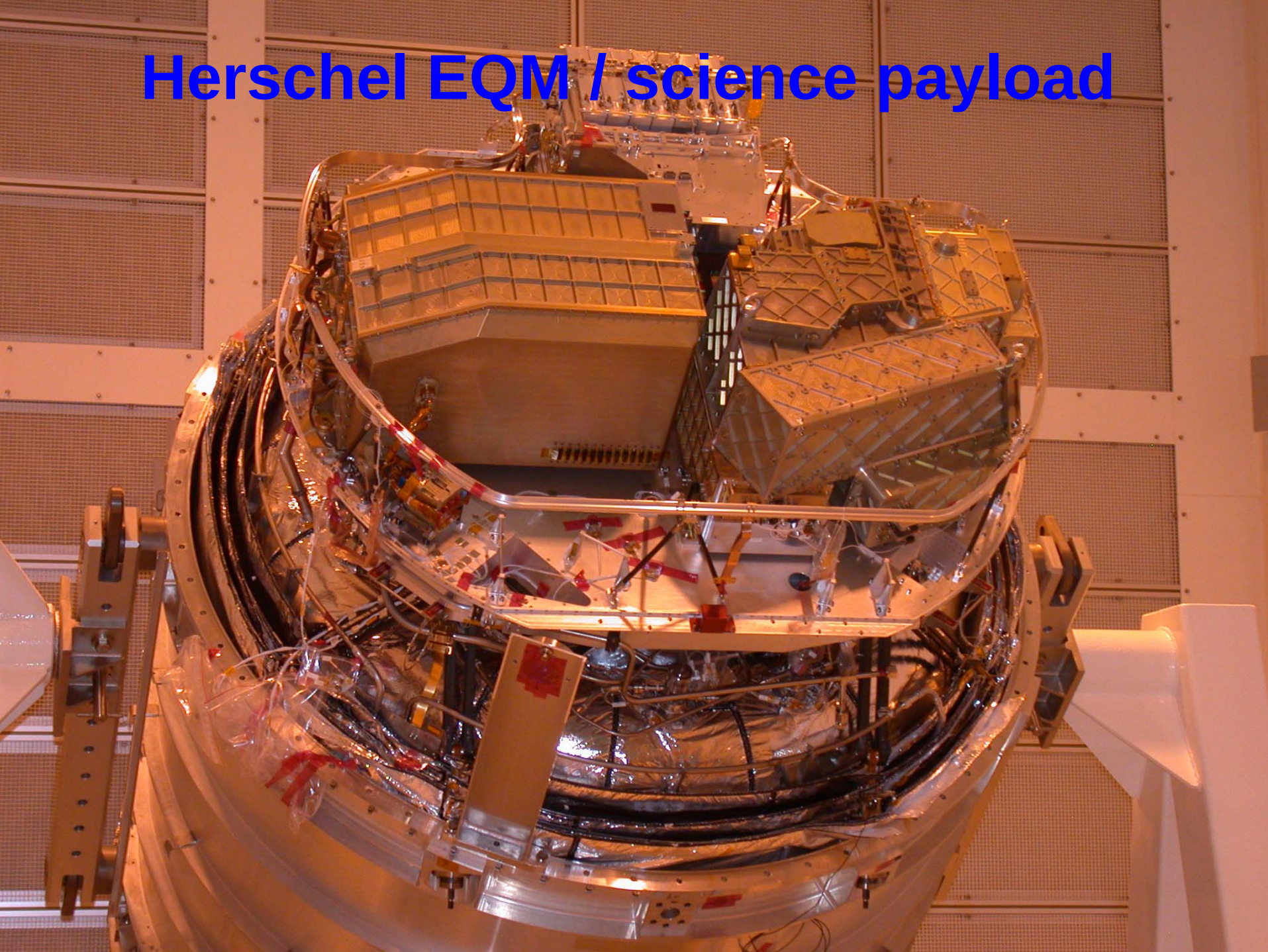
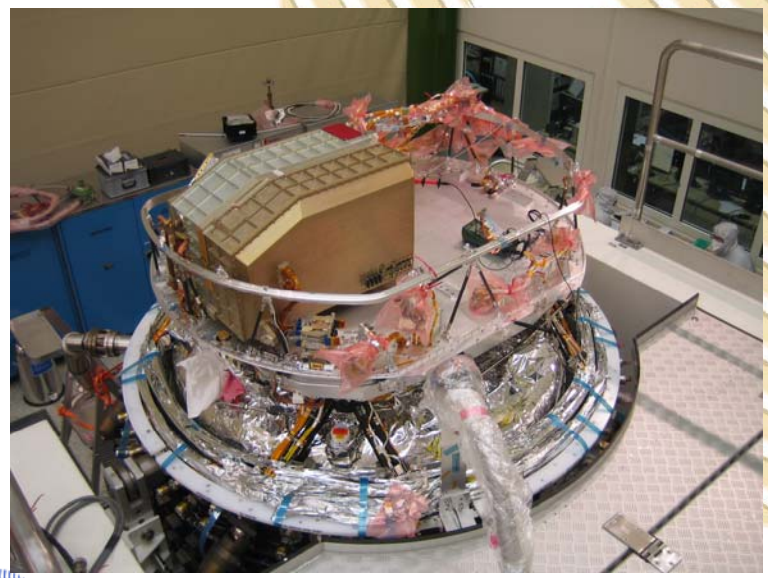
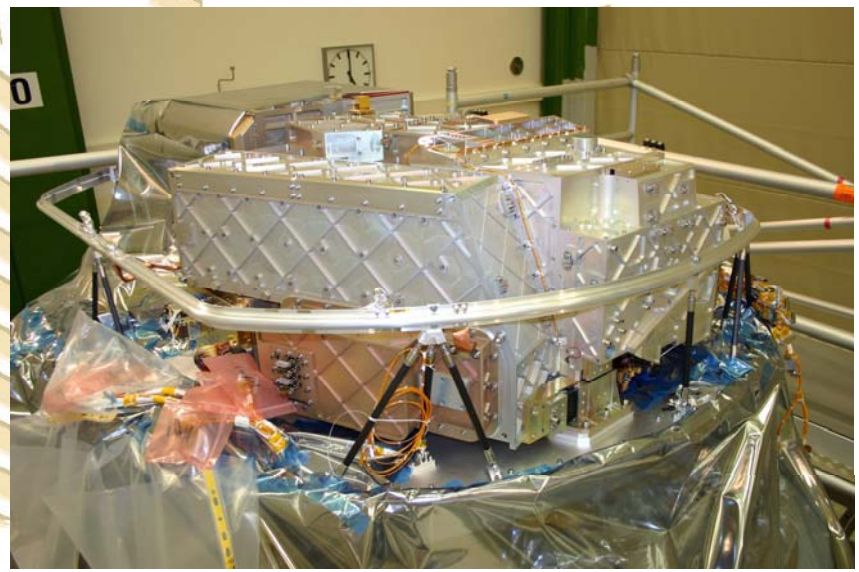
Herschel EQM / science payload



Flight payload integration

- FM instrument deliveries and integration in Astrium
- SPIRE – April 2007
- PACS – July 2007
- HIFI – July 2007





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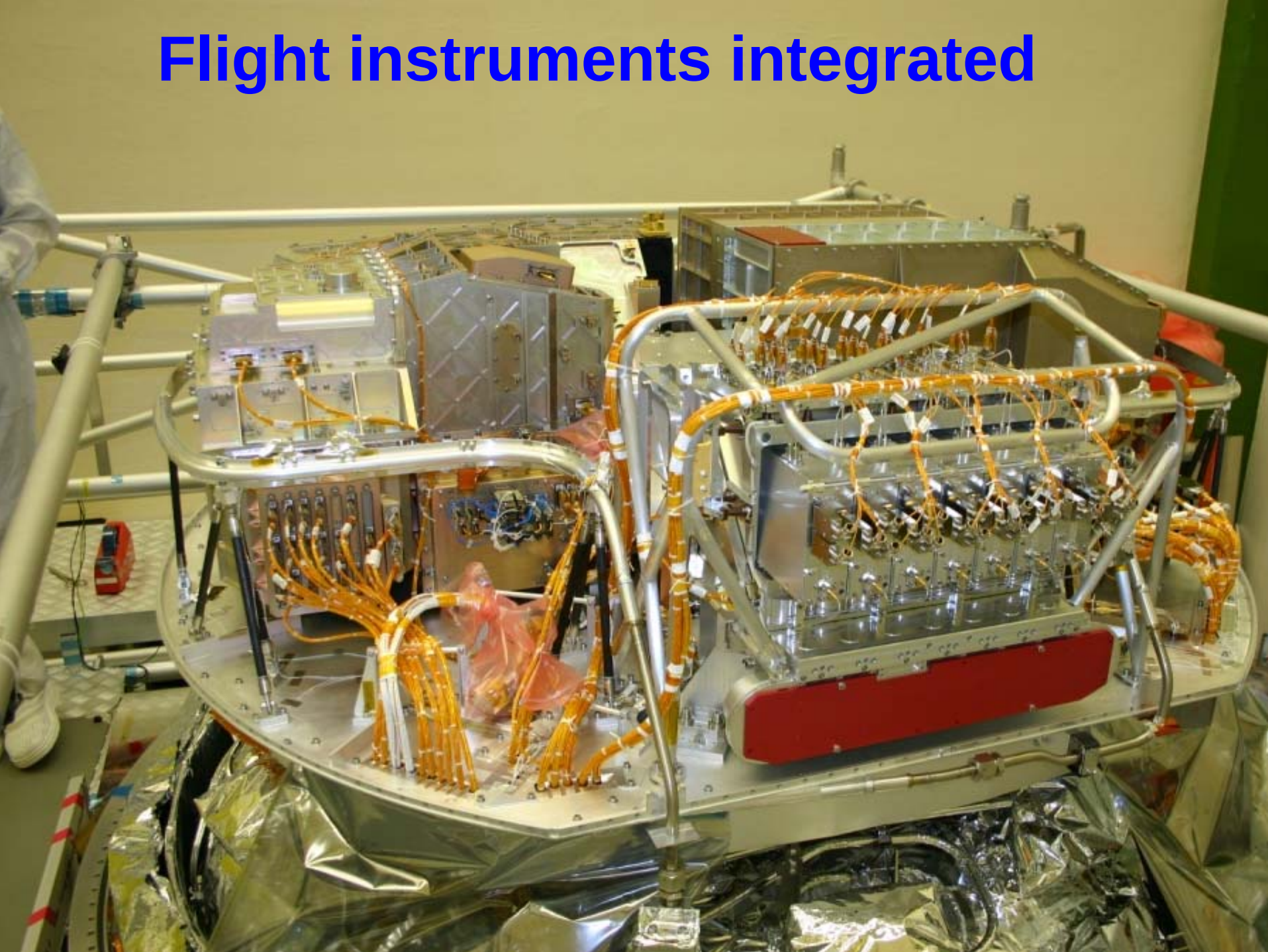
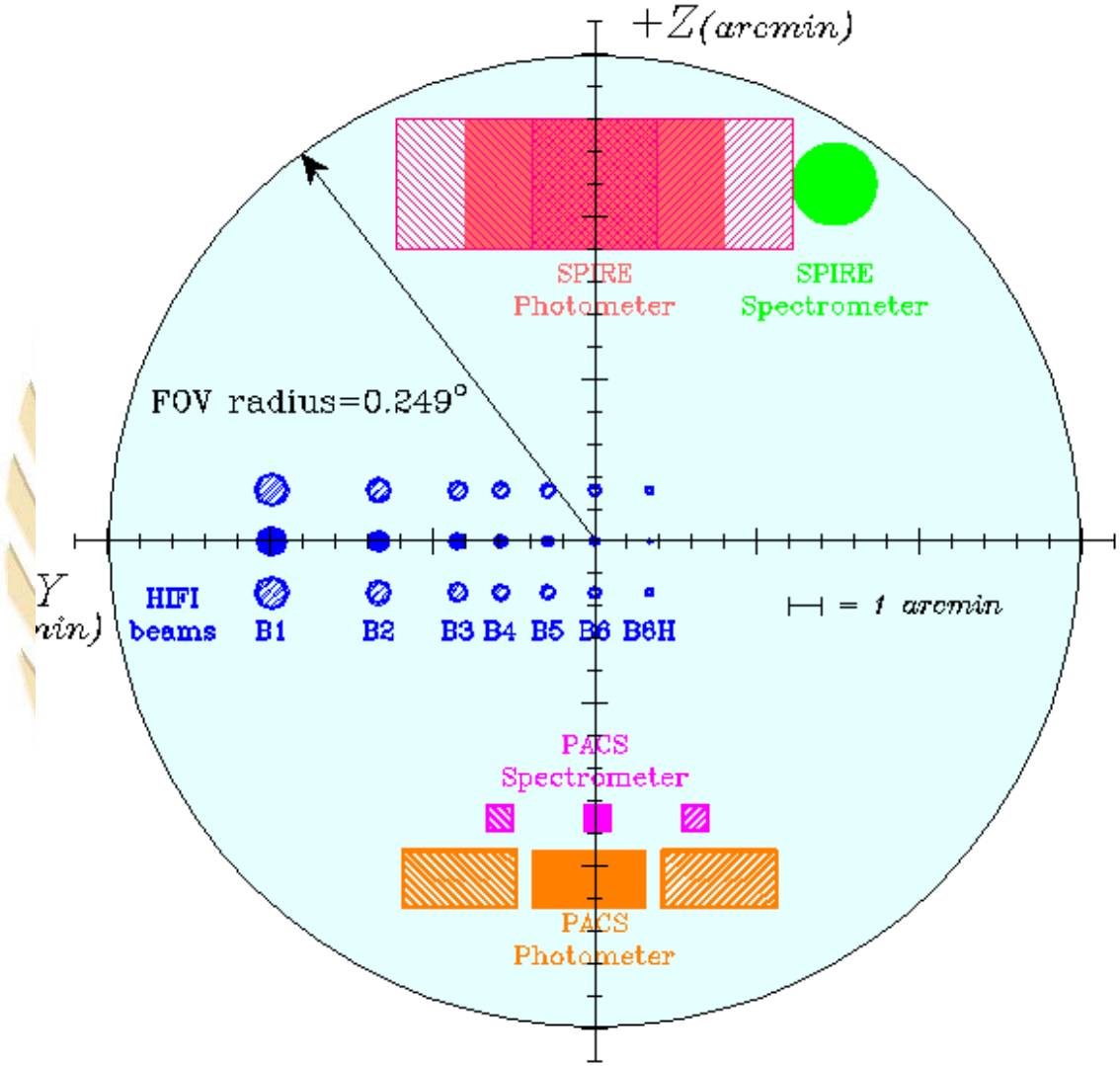
Flight instruments integrated



Herschel focal plane



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Pointing predictions

H/P System Budget – H-P-1-ASPI-BT-0264_v8 – 31 Jan 2007

	LOS [Arcsec]				Around LOS [Arcmin]			
error	performance	*requirement*	compliance	margin percentage	performance	*requirement*	compliance	margin percentage
APE Pointing	2,05	*3,70*	C	45%	0,52	*3,00*	C	83%
goal	1,16	*1,50*	C	23%	0,48	*3,00*	C	84%
APE Scanning	2,55 + 0,0001ω	*3,70* + 0,05ω	C	31%	na	*na*	na	
goal	1,59 + 0,0002ω	*1,50* + 0,03ω	C					
PDE 24 hours	0,47	*1,20*	C	61%	0,03	*3,00*	C	99%
RPE 1 min Pointing	0,24	*0,30*	C	20%	0,03	*1,50*	C	98%
RPE 1 min Scanning	0,96	*1,20*	C	20%	0,11	*1,50*	C	93%
goal	0,62	*0,80*	C	23%	0,10	*1,50*	C	94%
AME Pointing	1,99	*3,10*	C	36%	0,43	*3,00*	C	86%
goal	1,12	*1,20*	C	7%	0,38	*3,00*	C	87%
AME Scanning	2,53 + 0,0001ω	*3,10* + *0,02 ω*	C	18%	0,51	*3,00*	C	83%
goal	1,58 + 0,0001ω	*1,20* + *0,02 ω*	C		0,49	*3,00*	C	84%
AME Slew	2,61	*10,00*	C	74%	0,51	*3,00*	C	83%
Goal	1,71	*5,00*	C	66%	0,50	*3,00*	C	83%
SRPE	1,97	*1,00*	NC	-97%				
(goal)	1,32	*1,00*		-32%				
SRPE with GYR-based control	1,12	*1,00*	NC	-12%				
(goal)	1,05	*1,00*						
APE with GYR-based control	2,69	*3,70*	C	27%				
AME with GYR-based control	2,68	*3,10*	C	13%				

Mission lifetime

- **Top-level requirement**
  - 3 years routine science operations, which was translated into
  - 3.5 year cryostat lifetime
    - Last top-off about 4 days before launch
    - Launch conditions matter (24-hr delay costs …. days
    - Must allow for/include uncertainties to demonstrate compliance
- **Steady state analysis:**

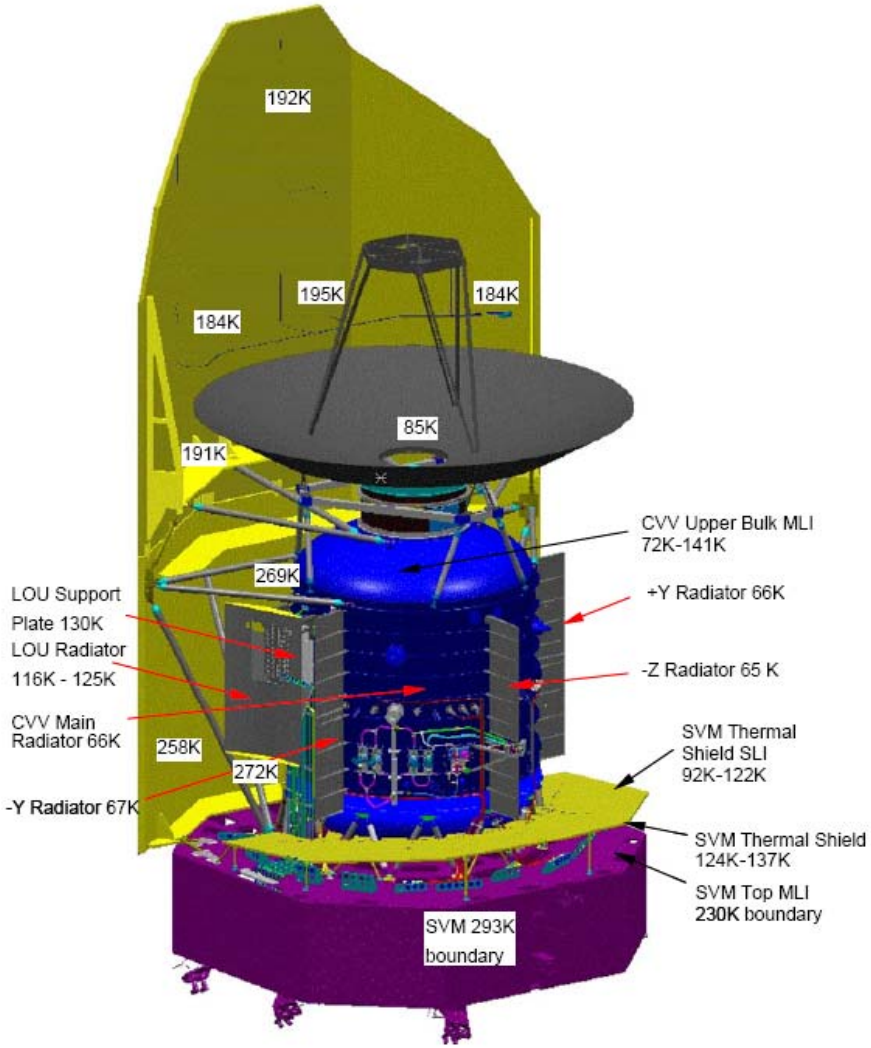
	T (CVV)	T (TS3)	T (TS2)	T (TS1)	T (OBA)	T (HTT)	He Mass Flow
Hot case	67.4 K	54.8 K	45.4 K	34.2 K	13.0 K	1.65 K / boundary	2.331 mg/s
Cold case	64.2 K	52.4 K	43.6 K	33.1 K	12.8 K	1.639 K	2.177 mg/s
Safe Mode *	60.3 K	50.1 K	42.2 K	32.2 K	11.4 K	1.595 K	1.764 mg/s
Average (IID-B) **	65.9 K	53.7 K	44.6 K	33.7 K	12.9 K	1.65 K / boundary	2.261 mg/s

*) All dissipation set to zero + SVM in safe mode; thermal environment equal to cold case

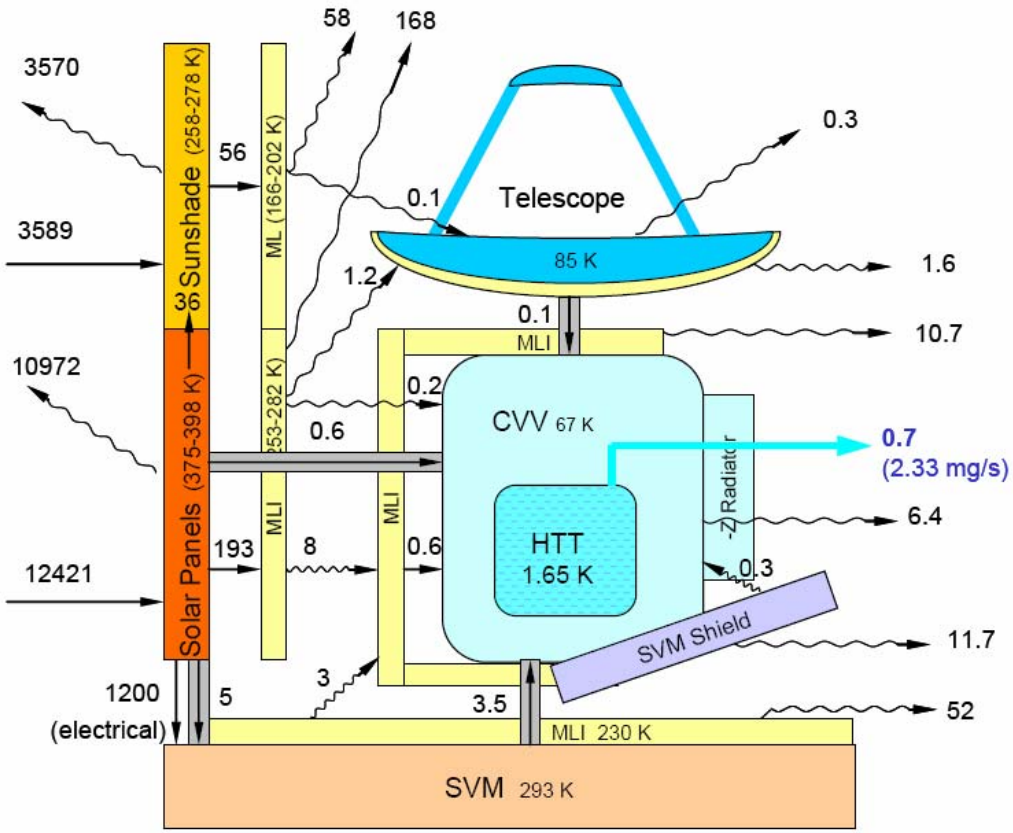
**) Used for lifetime calculation

H-EPLM Thermal Model Analyses – HP-2-ASED-RP-0011_v5

Hot case temps and heat flows



Heat flows in W



Cryostat lifetime

- **Science requirement**
  - Routine science operations for 3 years
  - Cryostat lifetime 3.5 years
- **Model predictions**
  - Contractual conditions 3.9 +/-0.4 years
  - ‘Actual’ dissipations 4.1 +/- 0.4 years
  - ‘Predicted’ lifetime 4.7 +/- 0.4 years
- **Lifetime requirement validated Jan 2007**
  - TB/TV test
  - Model correlation
  - Measurements indicate slightly less
  - Interface temp issue
- **Expect req’t fulfilled**

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Launch

- Launch in 2008 from Kourou
  - Using an Ariane 5 ECA
  - Shared with Planck
  - Injection towards large orbit around L2

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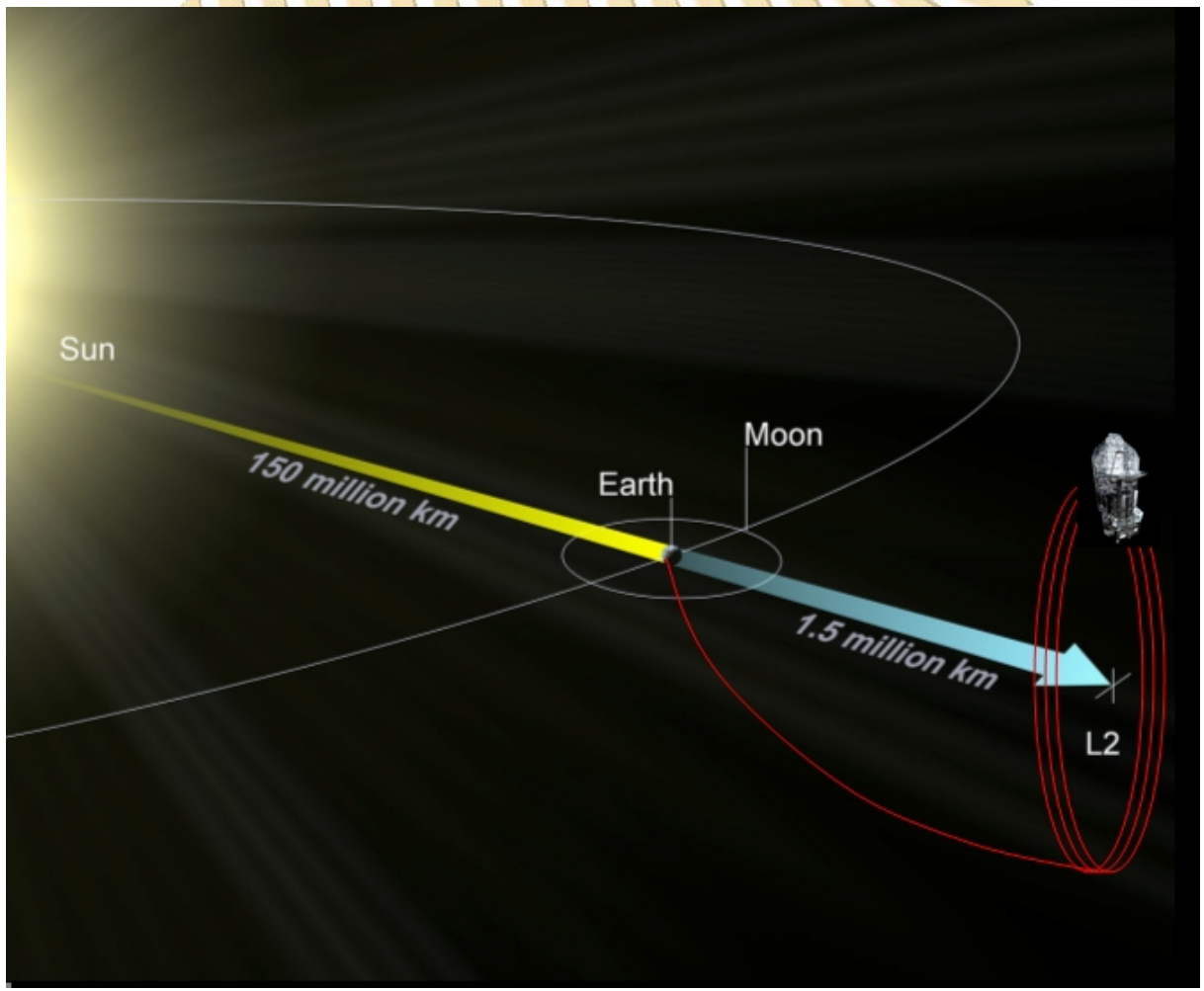
Why L2?

- **Sun, Earth, and Moon in the ‘same direction’ in the sky**
  - **Thermally favourable and stable environment**
  - **Good access to the sky for observations**



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Herschel mission phases

- **Launch and early operations (LEOP) – month 1**
  - telescope kept warm during s/c cooldown (~20 days)
  - cryo-cover opening (first light!) ~1 month after launch
- **Commissioning and performance verification – months 2-5**
  - PV plans being worked on
  - telescope cooling down (~50 days)
  - availability of particular sources (often solar system objects)
- **Science demonstration phase – month 6**
  - optimise how to best operate the observatory using in-flight knowledge (sensitivities, stability, background, pointing, …)
  - demonstrate the capabilities of the observatory
  - convince ourselves we can achieve expected science objectives
  - generate ‘pretty pictures’ – and ‘pretty spectra’ – for PR
  - **workshop & observations updating for routine phase**
- **Routine science operations phase (month 7 onwards)**
  - initially Key Progs (GT & OT) and ‘regular’ GT progs
  - Herschel operates autonomously – limited ToO capability

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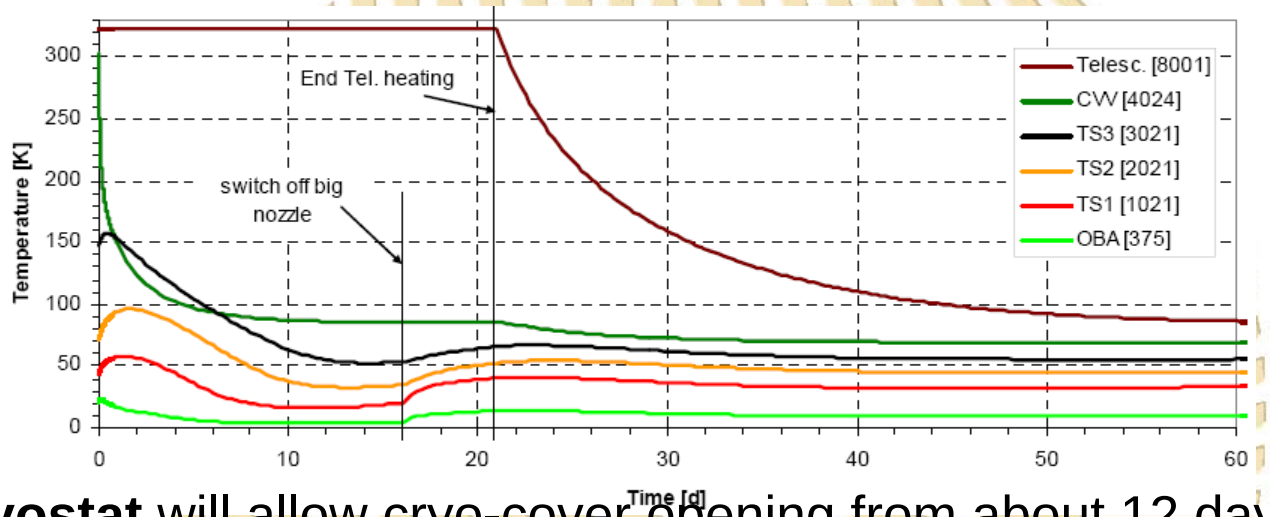
Cooldown & ‘first light’

- **Consider in-flight cooldown – cryo-cover opening**



- **Cryostat** will allow cryo-cover opening from about 12 days or so
  - Boil-off higher when open – only open when ‘useful’
- **Telescope** should not be warmer than about 150-200 K
  - Wait 5-10 days after decontamination period
  - Can decontamination period be shortened?
- Total duration of ‘closed’ activities? Under investigation
  - Could be there is ‘no need’ to consider ‘open early(earlier)’
- **Current assumption is ~30 days after launch**
  - Cut 1 week decontamination & wait ‘only’ 5 days => open after 20 days

Target visibility

- **Reaching operational orbit – target visibility**
- **Herschel transfer trajectory is 'fast'**
  - Passing Moon orbit in couple of days (remember Apollo ~3 days)
  - 15 days after launch distance to Earth ~1 million km
  - 45 days after launch distance to Earth ~1.5 million km
- **For all 'astronomical purposes' when the cryo-cover is open we are 'always' in operational orbit**
  - Formal 'transfer time' about 100 days
  - Distance during mission varies between 1.2-1.8 million km
- **Visibility constraints / availability for any given source will depend**
  - Primarily and importantly on the actual date of launch

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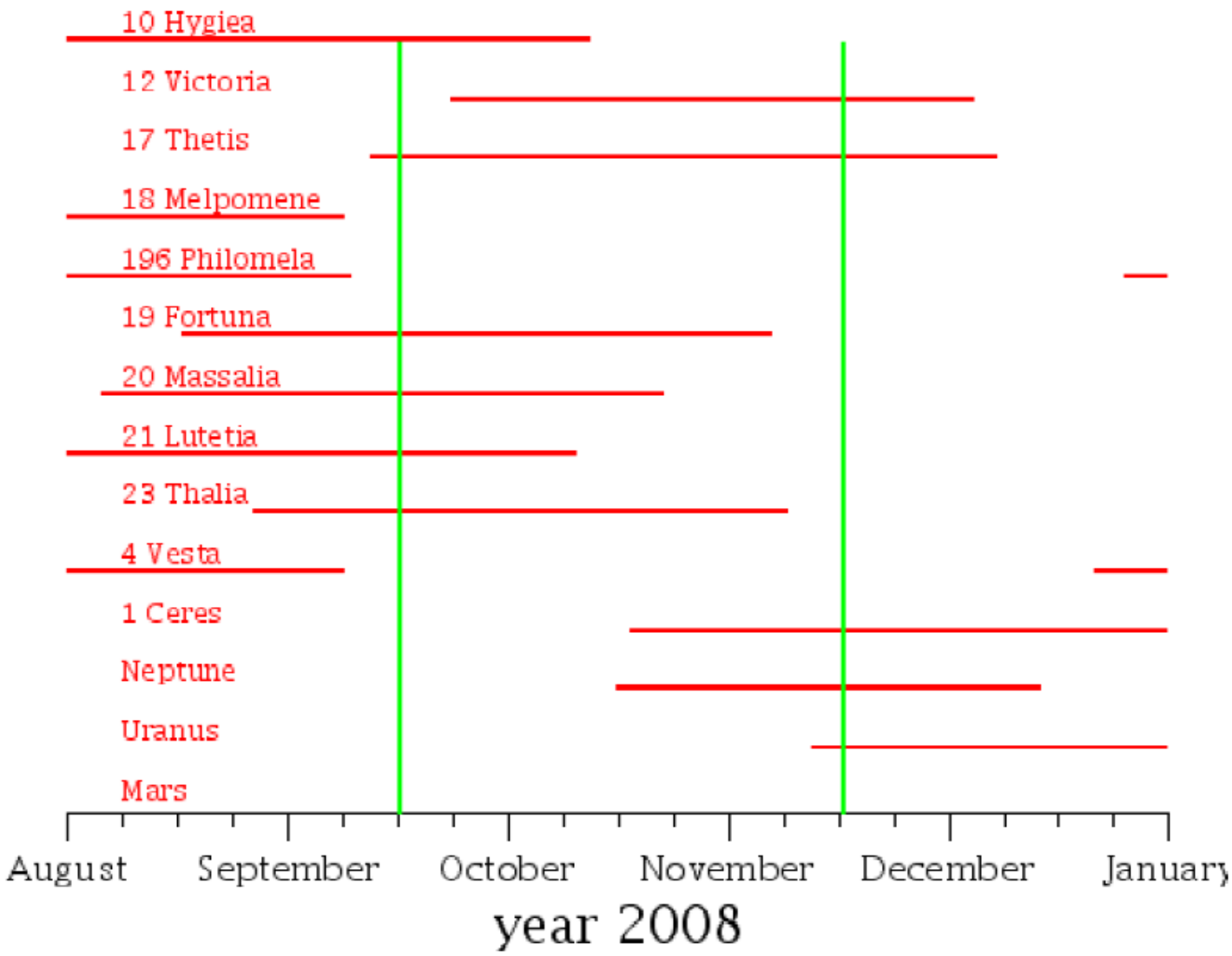
Target visibility - example



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Main messages to you

- **Herschel currently on track for late 2008 launch**
  - Target date 31 October 2008
  - … but no guarantee can be given
- **After launch we will have a very busy period**
  - 'First light' after about 1 month
  - Science demonstration in month 6
  - Only a few months available to get ready (C/PV)
  - Routine ('production') operations start beginning month 7
- **Pointing and AOT activities**
  - Need pointing 'in place' to perform many other tasks
  - Need calibration 'in place' to perform AOT validation
  - Need to construct 'calibration plans'
    - fitting within task and time constraints
    - working for any launch date
  - Need to identify and ensure adequate tools in place
    - uplink – observation construction and scheduling
    - downlink – data processing

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- AO Introduction and Schedule Overview
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HERSCHEL

Exploring the formation of galaxies and stars
Découvrir la formation des galaxies et des étoiles

Welcome to the **Herschel Astronomers' website** provided by the Herschel Science Centre (HSC) for the scientific community. For additional ESA Herschel websites see Useful links.

Herschel, short for the `Herschel Space Observatory', is the fourth `cornerstone' mission in the ESA science programme. It will perform photometry and spectroscopy in approximately the 55-672 μm range and is designed to observe the `cool universe'; it has the potential of discovering the earliest epoch proto-galaxies, revealing cosmologically evolving AGN/starburst symbiosis, and unravelling the mechanisms governing the formation of stars and planetary systems, such as our own.

Herschel will be launched in 2008 and operated as an observatory facility. Commencing about six months after launch it will offer three years of routine science observations. It will be available for the worldwide scientific community, with roughly two thirds of the observing time being `open time', which will be allocated through a standard competitive proposal procedure.

Key Programme Open Time AO results available!

- The KP OT proposal submission was closed on 25 October 2007. A total of 62 proposals were received, see HSC e-News #4. In total 21 proposals have been awarded observing time, see the list of successful proposals and HSC e-News #5. The phase 2 observation entry is taking place in the period 18 January to 15 February 2008, by end February additional KP OT information will be provided.
- The Herschel observation planning workshop including hands-on HSpot demonstrations and practice was held at ESAC on 20-21 September 2007. Presentations available online.
- The Herschel Open Time Key Program Workshop was held in ESTEC, Noordwijk on 20-21 February 2007. Presentations available online.

Done

Start | Intel PROSet/Wireless | Herschel Scienc... | Palm Desktop | 2 Windows Explorer | Herschel_GLP.ppt | EN | 19:34

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Herschel Latest News

Herschel telescope unpacked. The Herschel telescope has been unpacked and the incoming inspection has been performed. A small amount of loose dust was removed by a non-touching method on 29 Jan 2008, this can be seen in the left picture above, in the right picture the floor in the clean room and the people in front of the telescope can be seen in reflection in the telescope. [January 2008].

The Herschel flight telescope has arrived in ESTEC. The Herschel flight telescope has arrived safely in ESTEC by road from Astrium, Friedrichshafen, and was unloaded on 18 January 2008. After acclimatisation and preparation of ground support equipment it was moved out of its transport container on 24 January 2008. [January 2008].