Herschel Mission Overview and Key Programmes

SPIE Astronomical Instrumentation 2008

Space Telescopes and Instrumentation I: Optical, Infrared, and Millimeter Wave

Marseille, 23-28 June 2008

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Overview

- What is Herschel?
  - Herschel heritage
  - Herschel in a nutshell
- Why Herschel?
  - Scientific objectives
  - Scientific capabilities
- Herschel status
- Observing opportunities & Key Programmes
- Way forward

HERSCHEL SPACE OBSERVATORY

Overview

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HERSCHEL SPACE OBSERVATORY

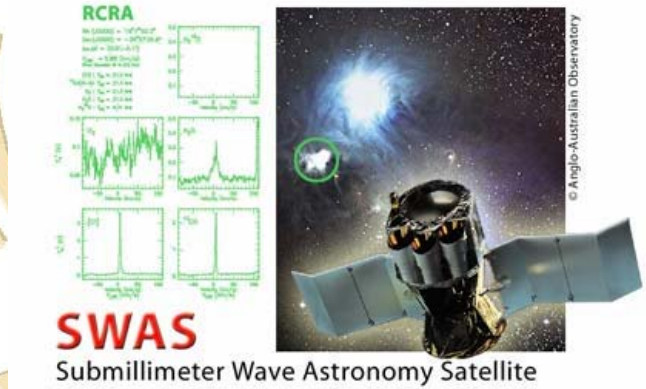
Infrared/submm space missions

- **IRAS (1983)**
  - **57 cm**

- **ISO (1995-98)**
  - **60 cm**

- **Spitzer (2003-08)**
  - **85 cm**
  - **+5 years warm**

- **AKARI (2006-07)**
  - **67 cm**
  - **+3? years warm**

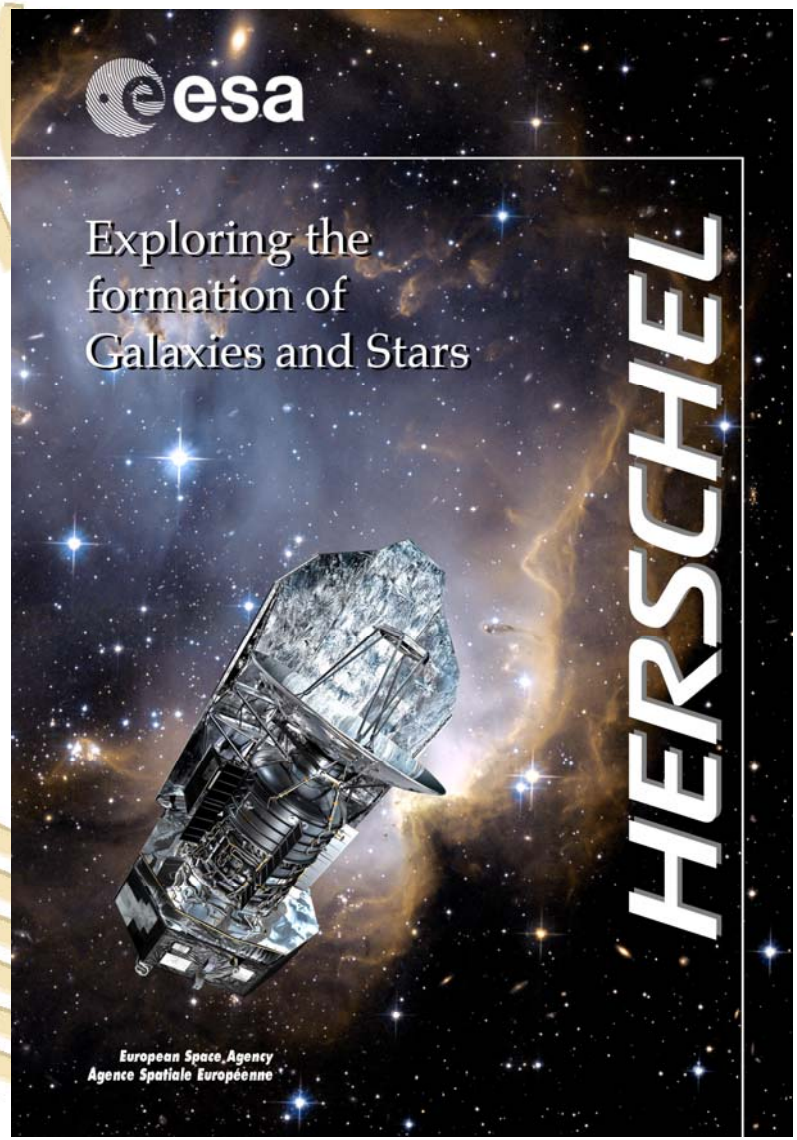


- **SWAS (1998-2004, 2005)**
  - **55x71 cm**
  - **492-557 GHz (5 lines)**
- **Odin (2001-2006)**
  - **1.1 m**
  - **486-580 & 119 GHz**

HERSCHEL SPACE OBSERVATORY

Herschel in a nutshell

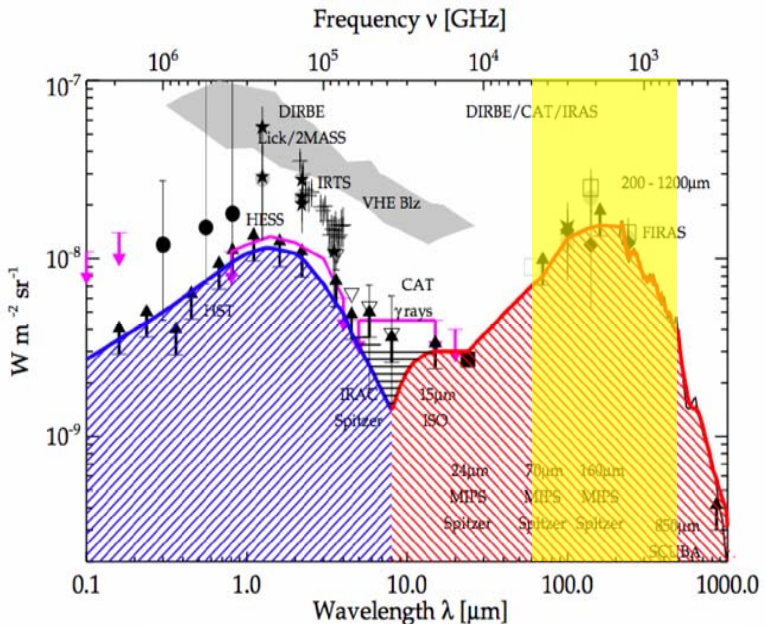
- **ESA cornerstone observatory**
  - first large aperture space IR observatory
  - bridges the ‘wavelength gap’
  - ~1/3 guaranteed time, ~2/3 open time
- **FIR (55 - 672 μm) space facility**
  - large (3.5 m) monolithic low emissivity passively cooled telescope
  - 3 focal plane science instruments
  - 3 years routine operational lifetime
  - full spectral access, stable background
  - targets SEDs of SF galaxies & proto-stars
- **Unique and complementary**
  - for $\lambda < 200$ 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 concluded**
  - ~57% of nominal obs time allocated
- **To Kourou later this year**
  - launch date being agreed between ESA and Arianespace

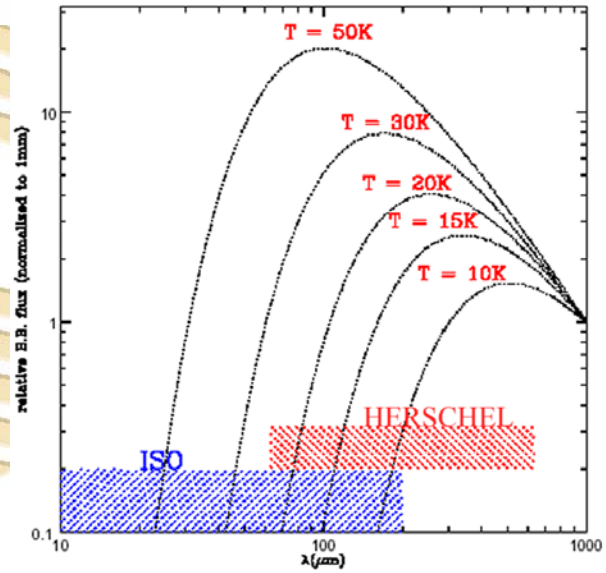



Herschel –
Why and What

The Cool Universe

- **Herschel spectral coverage**
  - ~50% of the energy and most photons are in the IR
  - relatively poorly studied
- **Herschel covers the peak of the SED**
  - do physics
- **Herschel spectral emission**
  - black-bodies 5-50 K
    - continuum radiation
    - dust grains (re-)radiating
    - 'reprocessed' UV/optical/NIR emission





HERSCHEL SPACE OBSERVATORY

The Cool Universe

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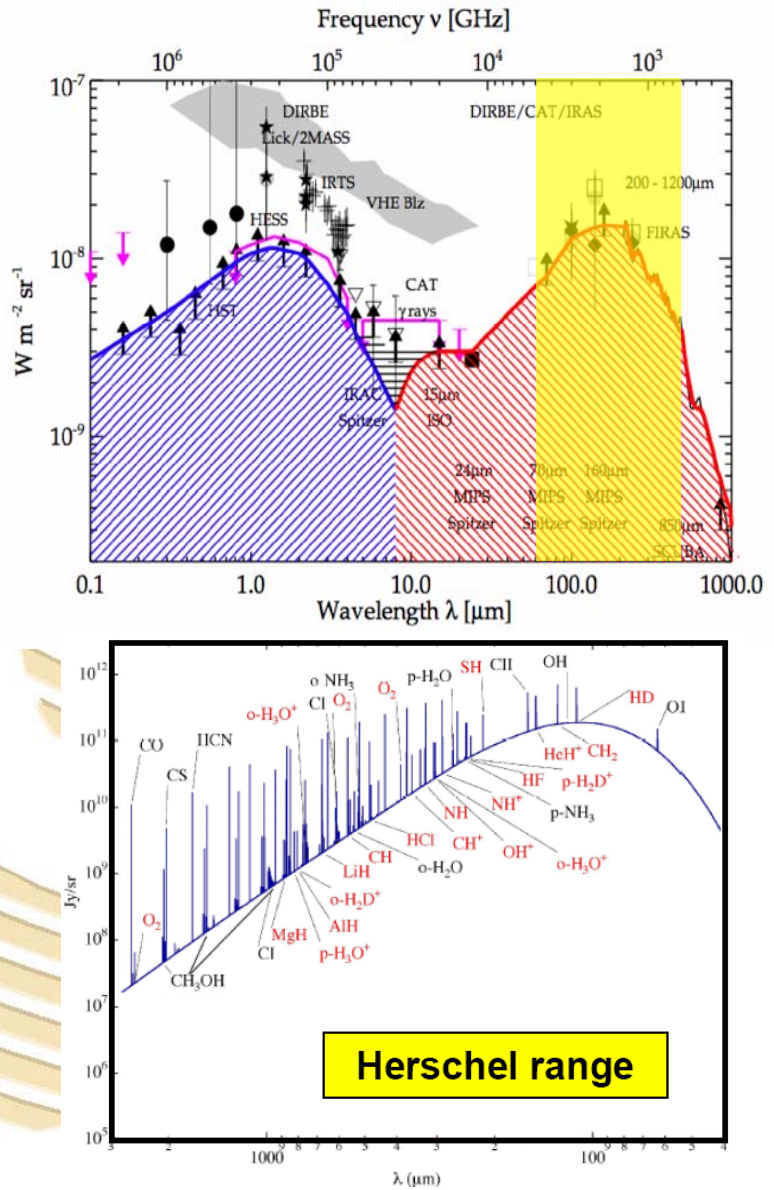
- **Herschel spectral emission**
  - gases 10-few100 K
    - brightest atomic/molecular lines
    - C^+
    - H_2O



HERSCHEL SPACE OBSERVATORY

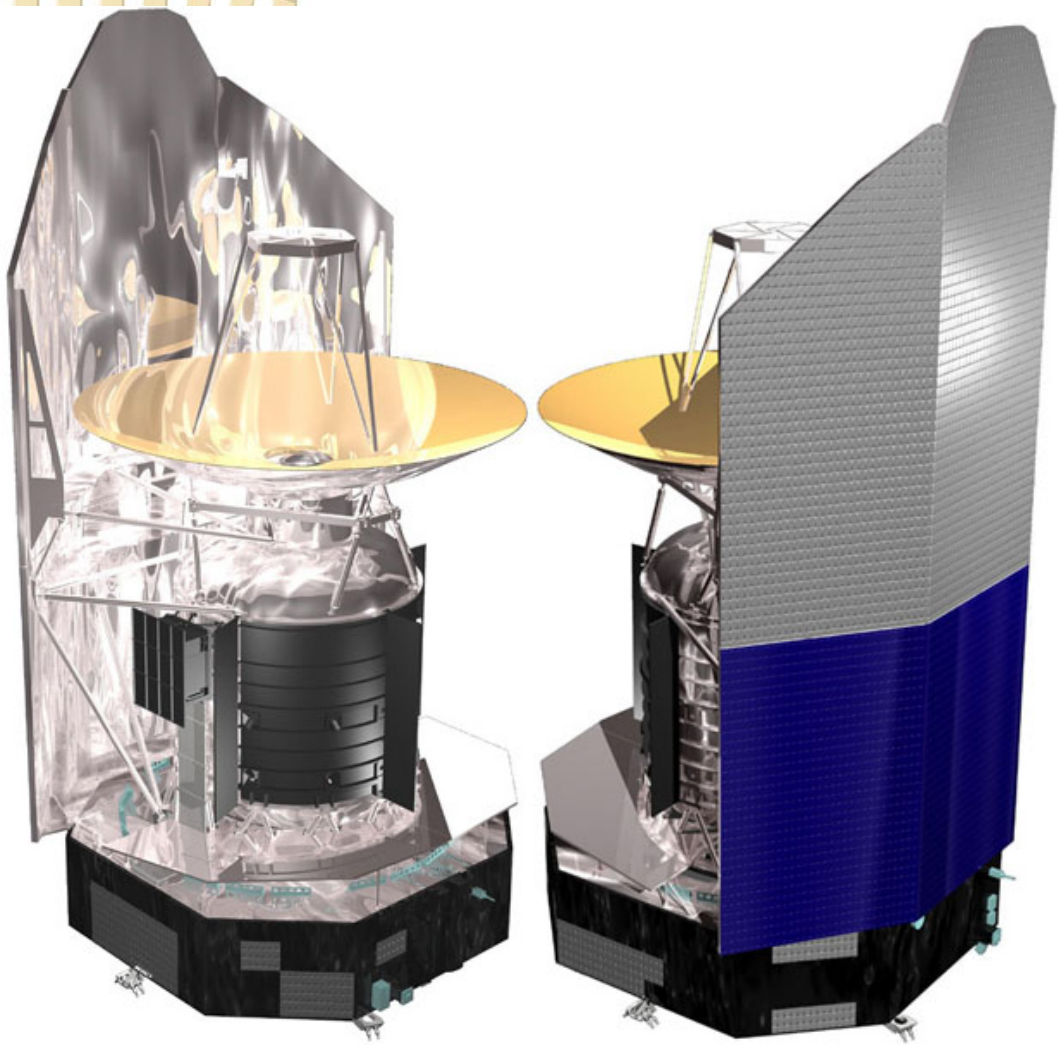
Herschel main objectives

- **Wide-area photometric surveys of the extragalactic and galactic sky**
  - to measure dust-enshrouded starformation activity
  - throughout cosmic time and in our own and nearby galaxies today
- **Detailed studies of the physics and chemistry of the interstellar medium**
  - both locally in our own Galaxy as well as in external galaxies
  - by means of photometric and spectroscopic surveys
- **Observational astrochemistry of gas and dust as a quantitative tool for understanding the stellar/interstellar lifecycle**
  - investigating the physical and chemical processes involved in star formation, early and late stages in stellar evolution
  - Including gas and dust disks around young and mature stars
- **Spectroscopic and photometric study of solar system objects and their atmospheres**
  - also crucial as calibration sources

HERSCHEL SPACE OBSERVATORY

Spacecraft

- telescope (eff) diam (3.3) 3.5 m
- telescope WFE < 6 μm
- *telescope temp* *< 90 K*
- *telescope emissivity* *< 4%*
- *abs/rel pointg (68%)* *< 3.7” / 0.3”*
- science instruments 3
- science data rate 130 kbps
- *cryostat lifetime* *> 3.5 years*
- height / width ~ 7.5 / 4 m
- launch mass ~ 3300 kg
- power ~ 1500 W
- orbit ‘large’ Lissajous around L2
- solar aspect angle 60-120 deg
- launcher (w Planck) Ariane 5 ECA



Science payload

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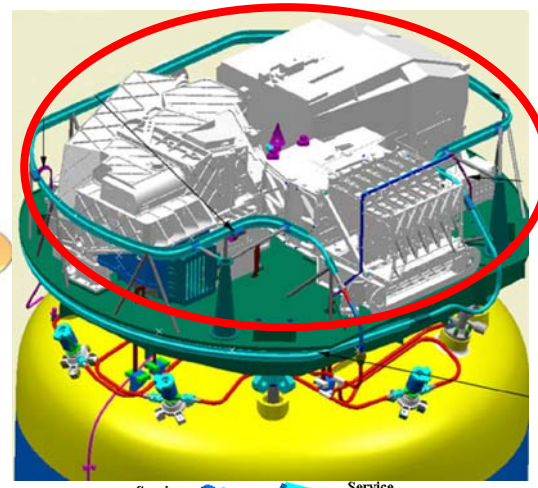
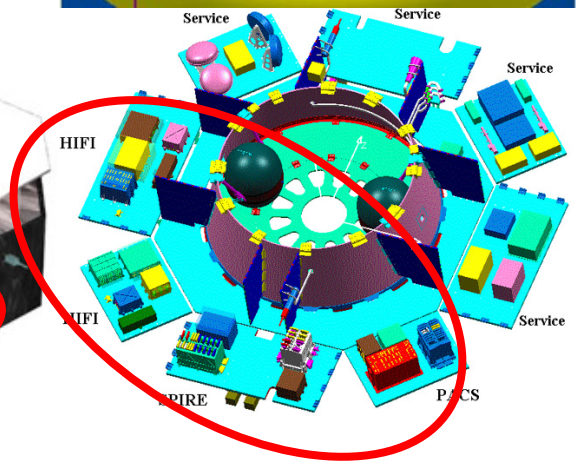
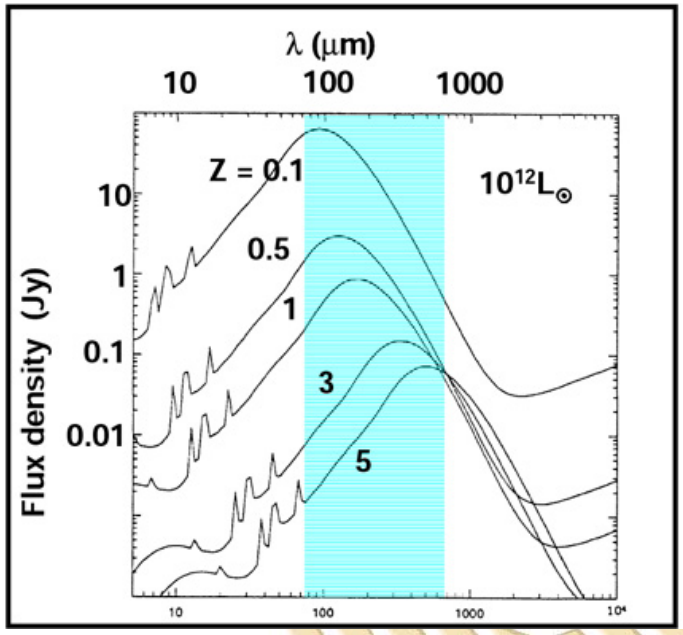
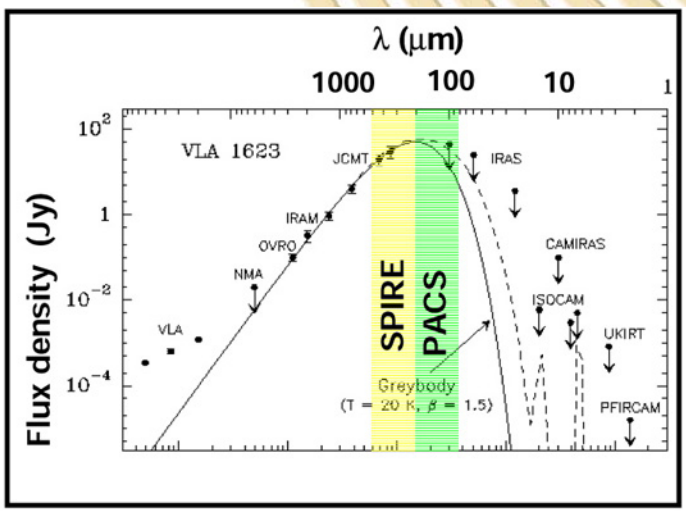
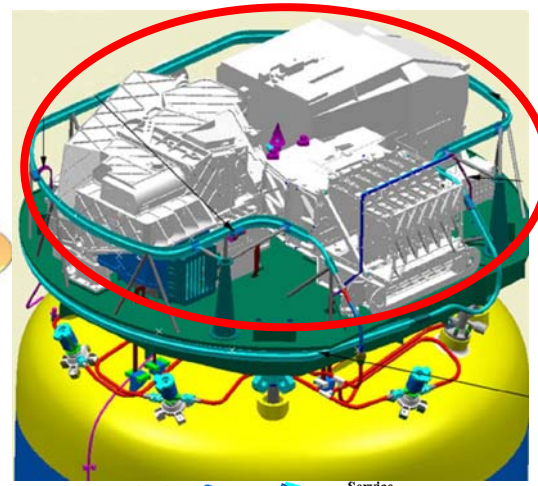


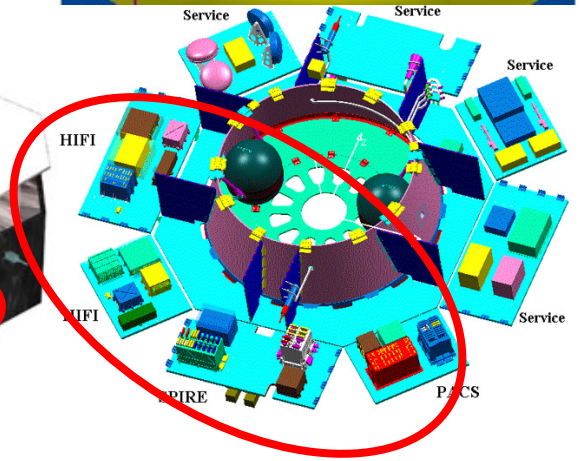


Science capabilites










Current status

Current status

- Herschel instruments were delivered and integrated in the cryostat in mid-2007 in Astrium, Friedrichsafen
- Cryostat and service module were mated in Sep 2007
- Herschel came to the ESTEC Test Centre on 5 Jan 2008
- Cooldown started 13 Feb, full HTT on 1 Mar
- Herschel in He-I conditions ever since
- SVT-1 performed 11-20 Mar
- HSS has been integrated – 2nd week of Apr
- The telescope has been integrated – 3rd week of Apr
- Instrument tests in He-I conditions
- Spacecraft 'completion' achieved in May => mechanical validation underway

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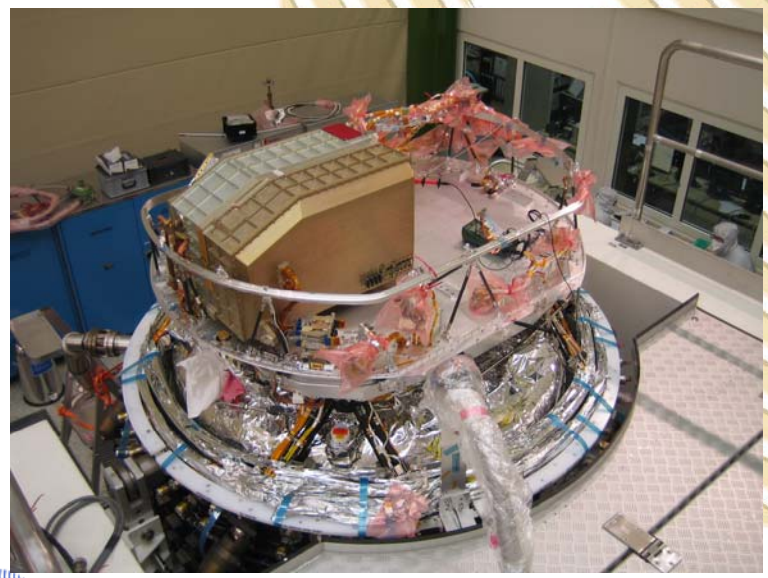
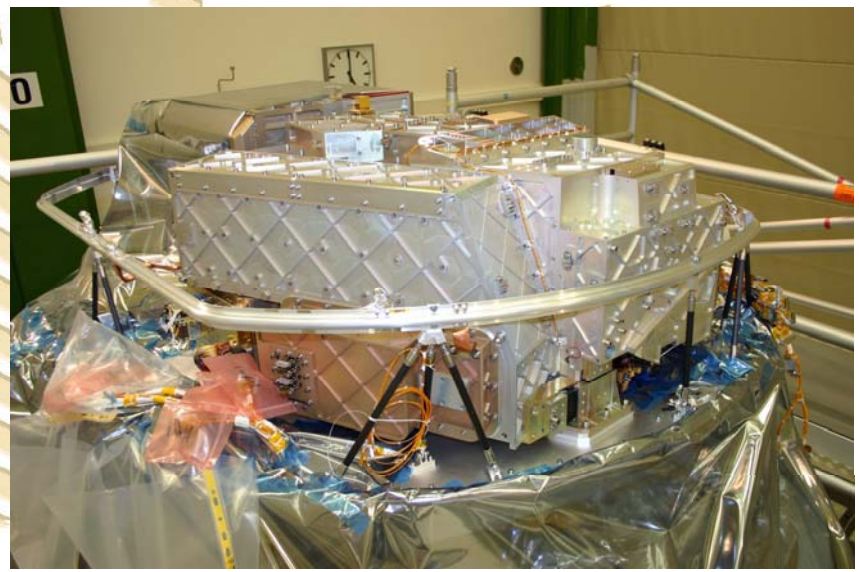
Flight payload integration

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





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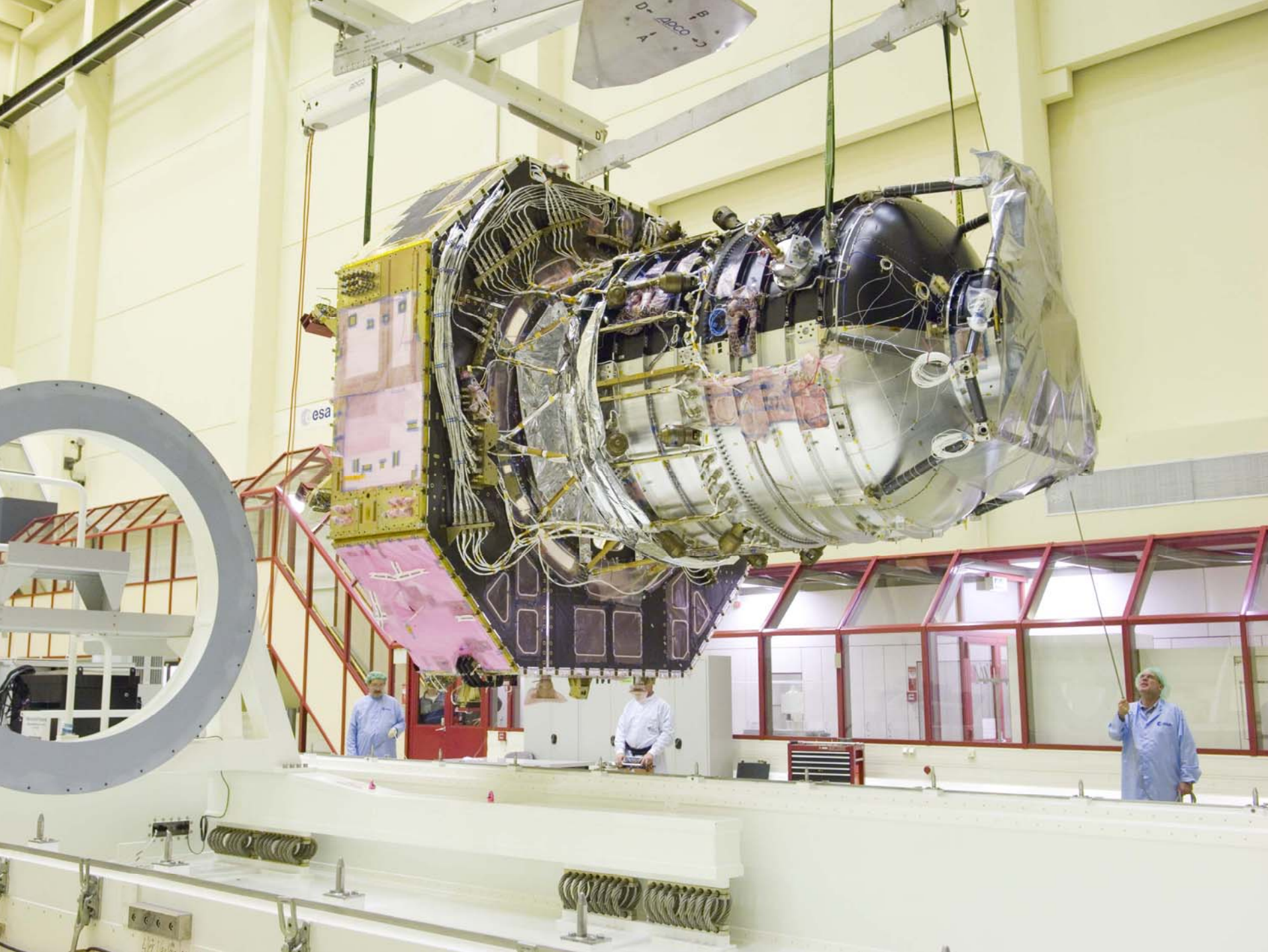

esa

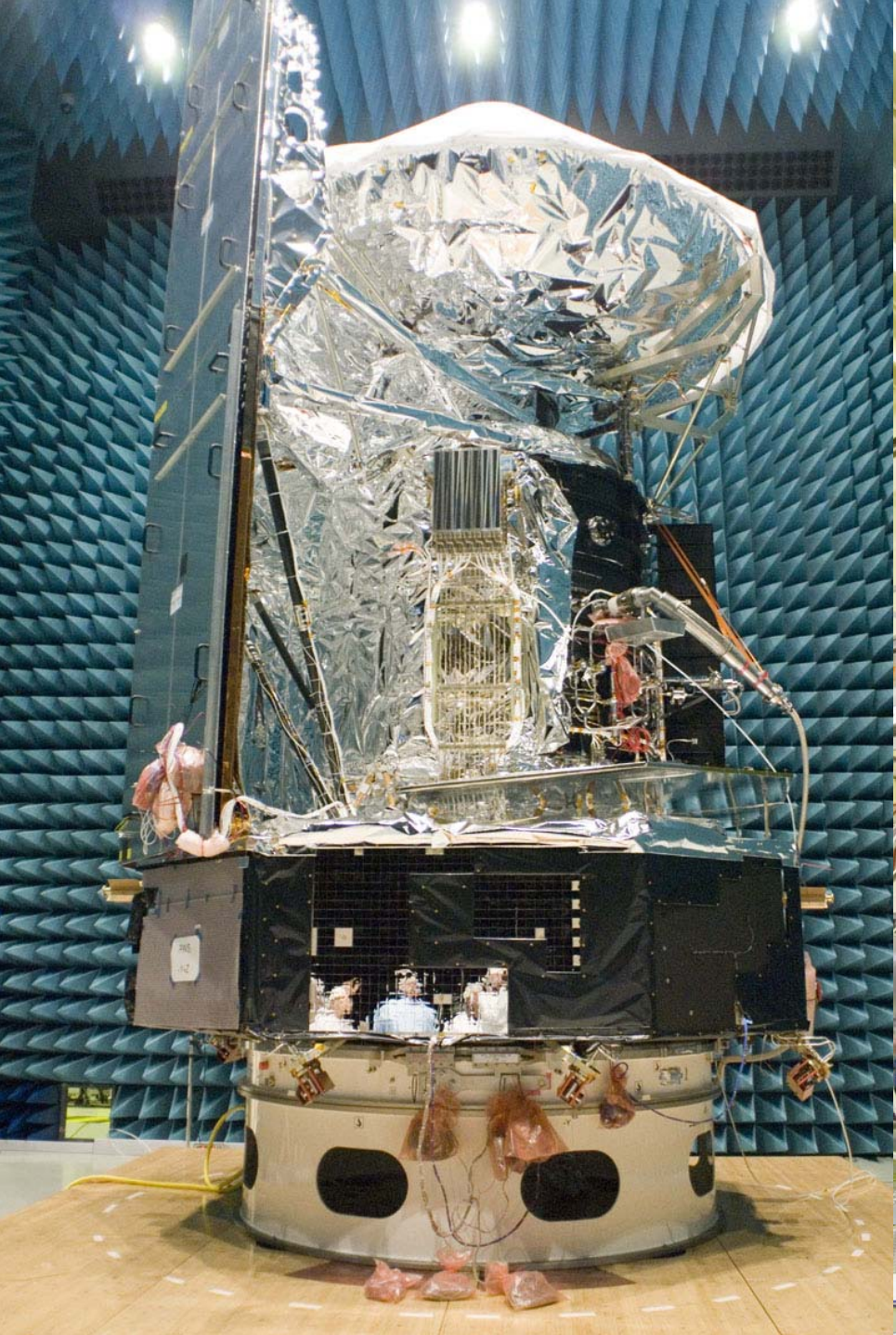

astrium


EADS
CASA ESPACIO
esa
SWL 1000KG


8528
Linde
HELIUM
module 5.1


HERSCHEL VERTICAL
LIFTING DEVICE
-Z
esa


esa
esa
2
N
4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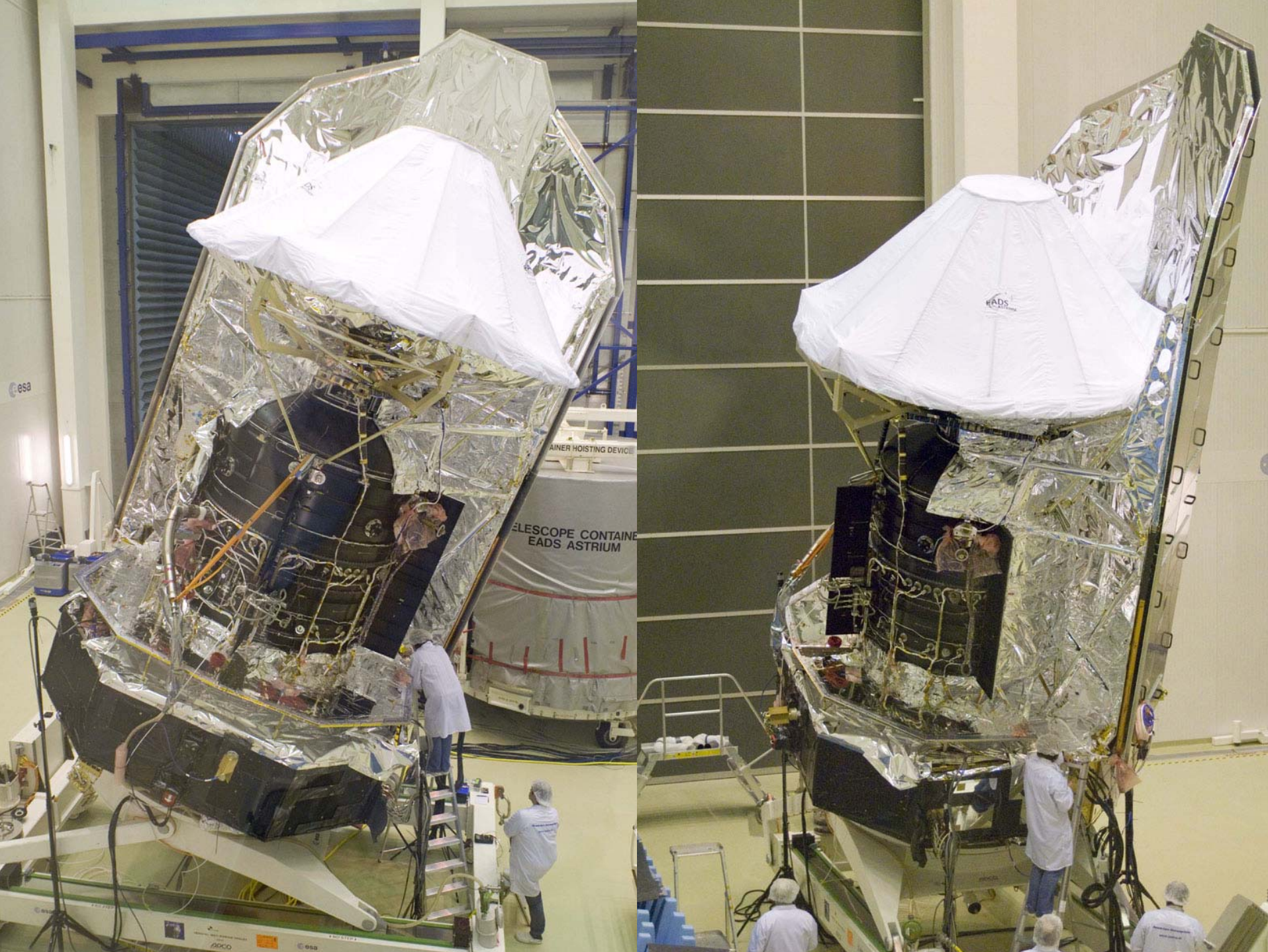
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AINER HOISTING DEVICE
ELESCOPE CONTAINE
EADS ASTRIUM
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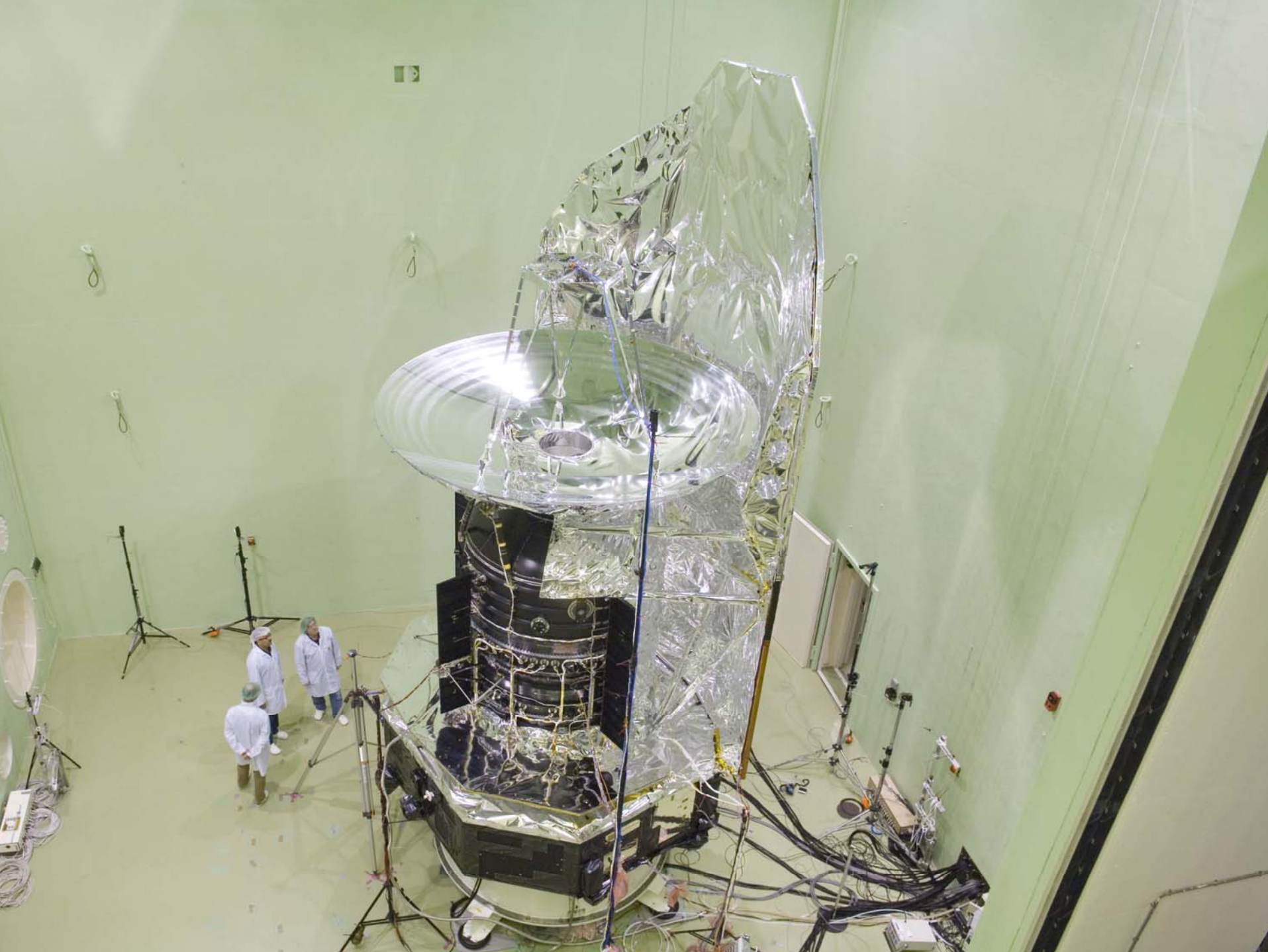


Observing Opportunities
– Key Programmes

Herschel observing opportunities

- **Herschel is an observatory**
  - Guaranteed and Open Time
  - Open Time open to worldwide scientific community
  - Standard competitive proposal procedure
- **Routine science operations phase (36 months)**
  - **Approx 1000 days / 20000 hours of schedulable science time**
  - **Guaranteed time programmes – GT (32%)**
    - open for GT holders only
  - **Open time programmes – OT (68%)**
    - including discretionary time and targets of opportunity
    - open for all – including GT holders
- **Three 'Call for proposals' (AO) cycles are foreseen**
  - one Call for 'Key Projects' programmes only (GT and OT) **– concluded!**
  - two Calls for regular programmes (GT and OT)
- **Each AO will be divided in two parts**
  - GT awarded first
  - OT awarded after GT in same cycle

HERSCHEL SPACE OBSERVATORY

Approved proposals

- **KP GT**
  - Submitted: 21 6148.7h
  - **Approved: 21 5878.9h**
- **KP OT**
  - Submitted: 62 17984.6h
  - **Approved: 21 5378.8h**
- **KP total**
  - Submitted: 83 24133.3h
  - **Approved: 42 11257.7h**

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Approved proposals by science areas

Science category	KP GT		KP OT		KP Total	
	Proposals	Hours	Proposals	Hours	Proposals	Hours
Solar system	1	293.7	1	372.7	2	666.4
ISM/Star formation	10	2337.5	10	2113.2	20	4450.7
Stars	2	544.6	0	0	2	544.6
Galaxies/ AGNs	5	983.7	8	1930.3	13	2914.0
Cosmology	3	1719.4	2	962.6	5	2682.0

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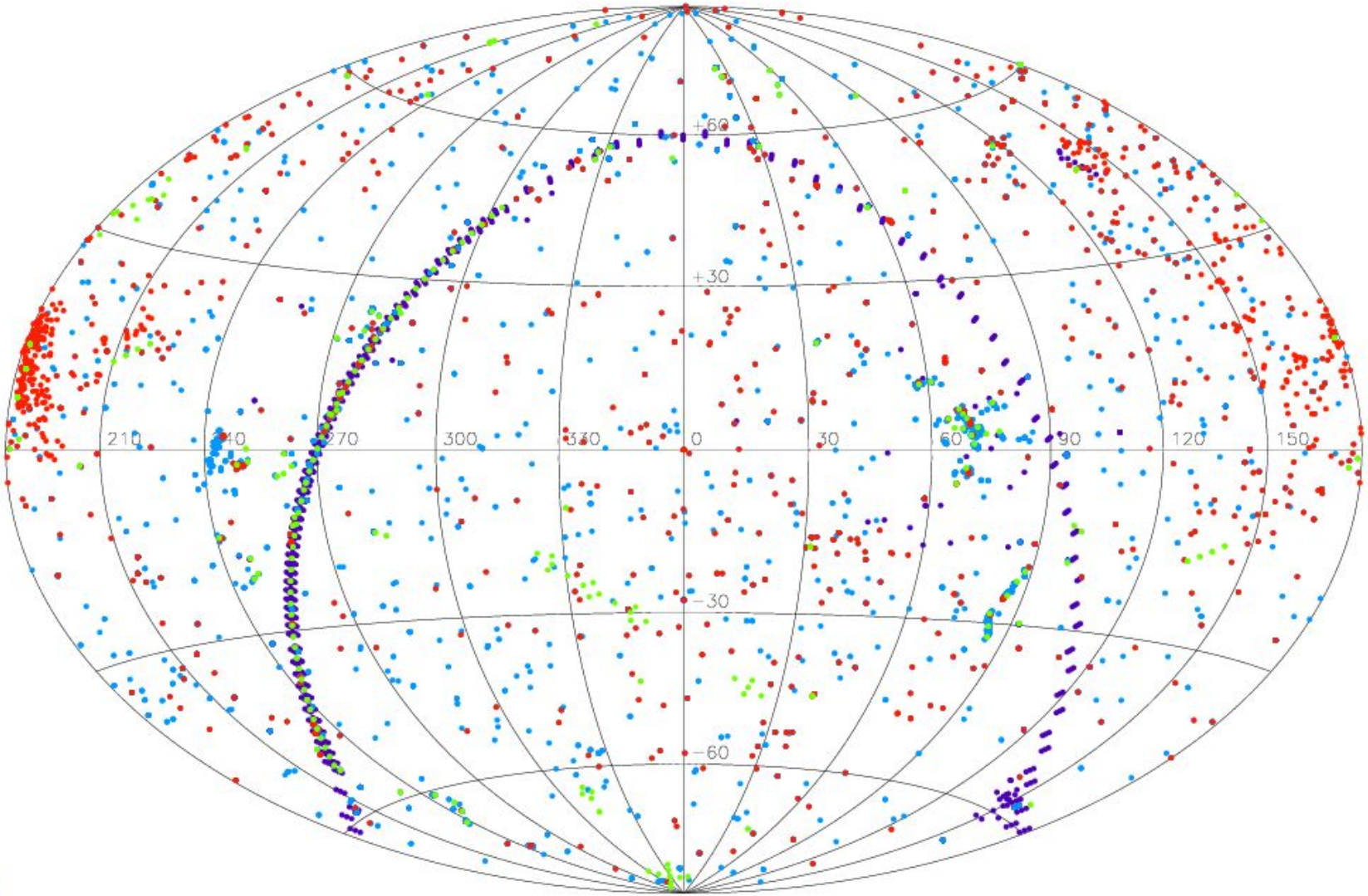
Sky distribution of targets



PACS

SPIRE

HIFI

Parallel

Herschel KP observations

(ecliptic coordinates)

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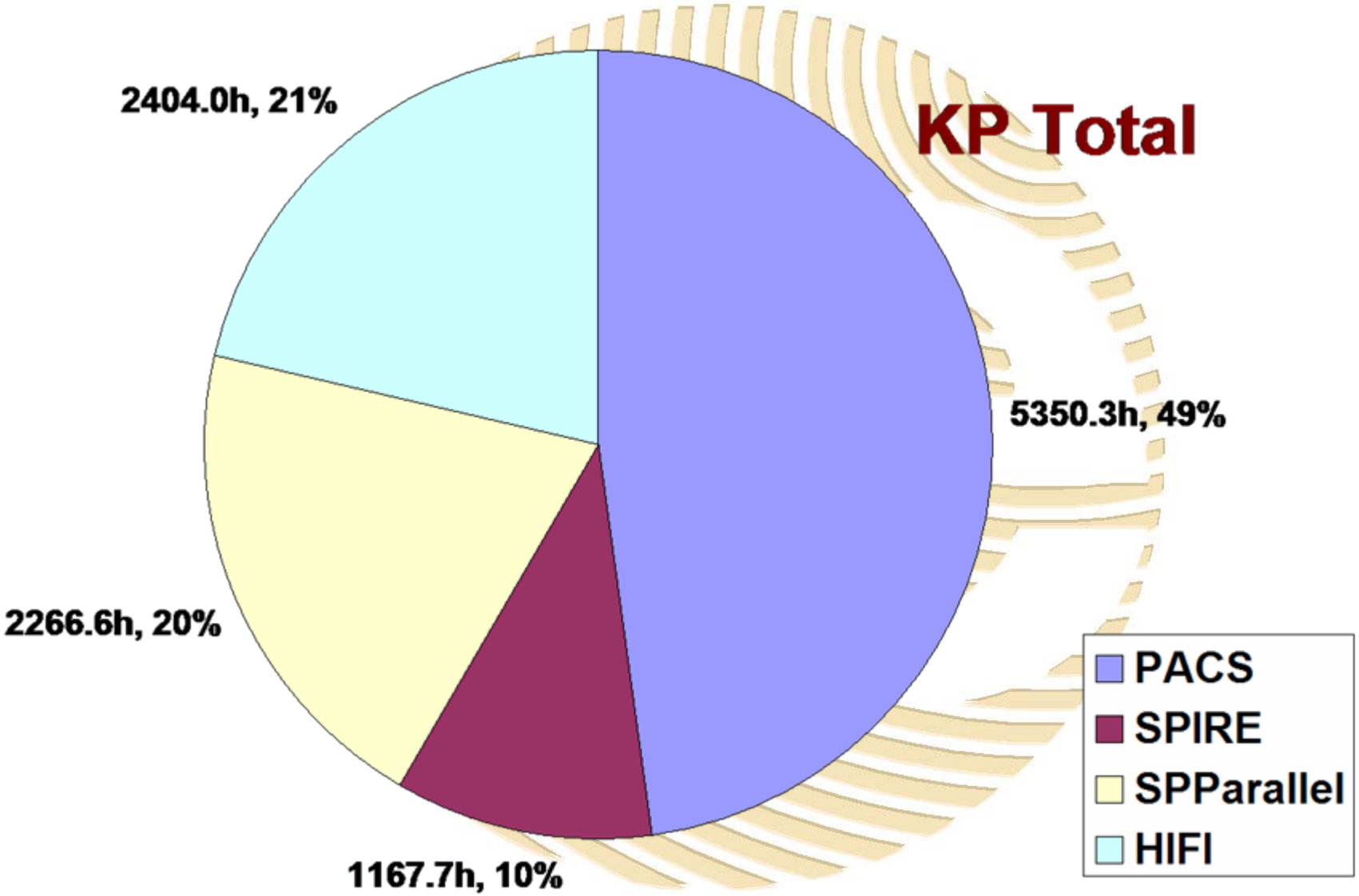
Instrument use share



HERSCHEL SPACE OBSERVATORY

esa

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 established
  - 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)**
  - until depletion of helium
- **Next AO cycle – Call for proposals**

HERSCHEL SPACE OBSERVATORY


Way forward

Planned activities

• Mechanical testing	**Jun 2008**
– Acoustics	Jun 2008
– Vibration	Jun 2008
• He-II production	**Jun – Jul 2008**
– System tests in He-II	Jul 2008
– Payload performance tests	Jul-Aug 2008
– End-to end tests	Jul 2008
– Launch autonomy test	Jul – Aug 2008
– TB/TV test (in LSS)	Aug – Sep 2008
– More end-to-end tests	Sep 2008
– Final tests & packing	Oct 2008
• FAR	**Sep – Oct 2008**
• Launch campaign	**Oct – Dec 2008**
• Launch readiness	**end 2008**

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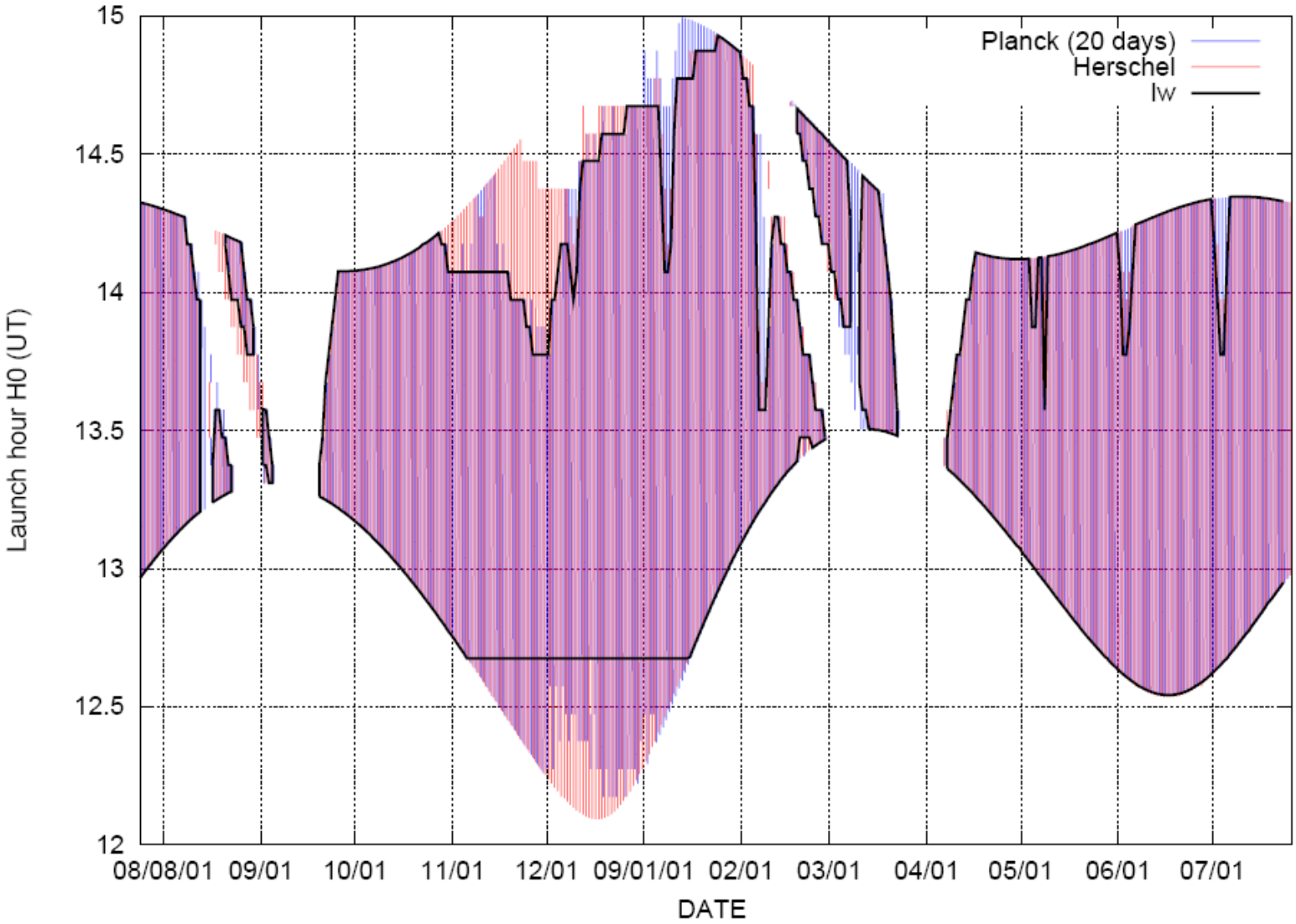
Herschel launch window



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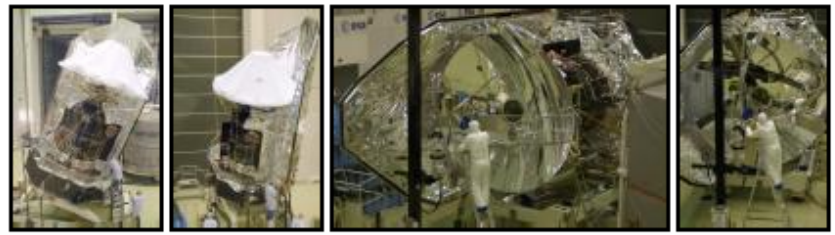
Herschel Latest News

Herschel acoustic testing performed. Based on the availability of test facilities it was decided to perform acoustics testing before vibration rather than, as initially foreseen, the other way round. In the pictures above Herschel is seen during the final test preparations in the Large European Acoustic Facility (LEAF) in the ESTEC Test Centre. The left picture also provides a nice view of the local oscillator unit (LOU) radiator. The telescope cover has been removed which indicates that the start of testing is imminent. The 'rings' which can be seen (in visible light!) on the telescope primary mirror is a purely cosmetic effect. The acoustics testing runs were performed on 5-6 June 2008. [June 2008]



Herschel mechanical testing underway. After completing the EMC campaign mechanical testing of Herschel is now underway. The initial activities concerned PACS chopper and grating tuning which was performed with the spacecraft inclined at an angle of 20° (left two pictures). Then exceptionally Herschel was tilted 90° to perform SPIRE SMEC testing, and the telescope cover was removed to perform an M1-M2 distance confirmation measurement (right two pictures) which will be repeated after the upcoming vibration and acoustics tests at spacecraft level have been performed; see also the SciTech

Launch

- **Launch in early 2009 from Kourou**
  - **Using an Ariane 5 ECA**
  - **Shared with Planck**
- **Date under negotiation**

HERSCHEL SPACE OBSERVATORY