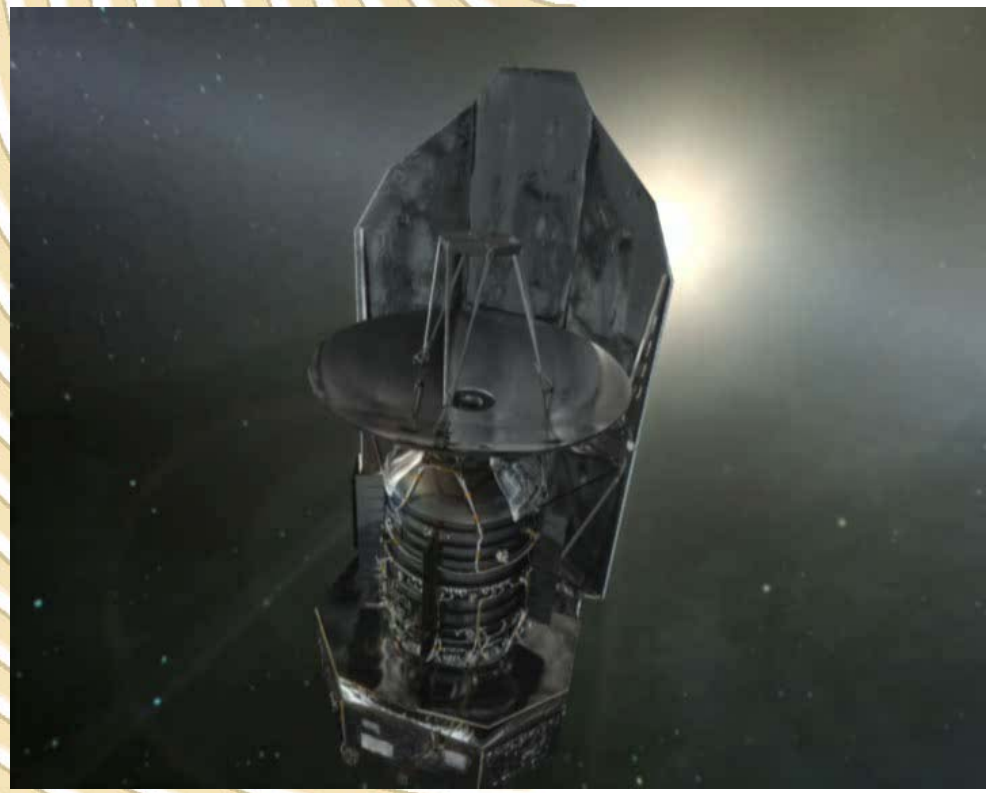
Herschel Mission and Observing Opportunities

HSpot workshop
ESAC, 20 September 2007

Göran L. Pilbratt
Herschel Project Scientist
Herschel Science Centre
European Space Agency

Overview

- Herschel heritage
- Why the (far) infrared and submillimetre?
- Herschel in some detail from the perspective of an astronomer
- Observing opportunities
- More information and how to get involved



HERSCHEL SPACE OBSERVATORY


Herschel heritage

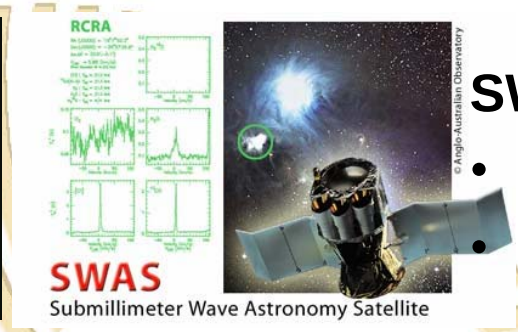
Infrared/submm space missions

IRAS (1983)
- 57 cm
- 12-100 μm

ISO (1995-98)
- 60 cm
- 2.4-240 μm

Spitzer (2003-09)
- 85 cm
- 3.6-160 μm

AKARI (2006-07)
- 69 cm
- 1.7-180 μm



SWAS (1998-2004/5)
- 55x71 cm
- 538-609 μm

Odin (2001-2006)
- 1.1 m
- 517-617 μm

Herschel (2008-12)
- 3.5 m
- 55-672 μm

HERSCHEL SPACE OBSERVATORY

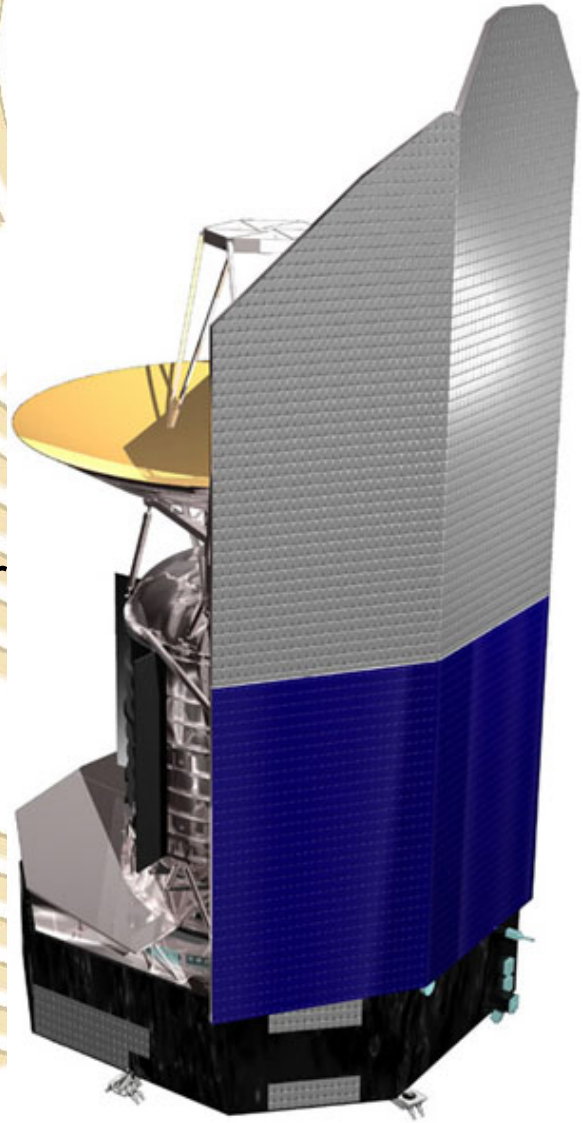
What is Herschel?

- **ESA cornerstone observatory**
  - Instruments ‘nationally’ funded
  - International – NASA, CSA, Poland – collaboration
- **Far Infrared (55 - 672 μm) space facility**
  - 3.5-m, passively cooled telescope (it uses a large sunshield to stay cool, instead of a liquid helium overcoat)
  - 3 science instruments
  - 3 years routine operational lifetime

HERSCHEL SPACE OBSERVATORY

What makes Herschel special?

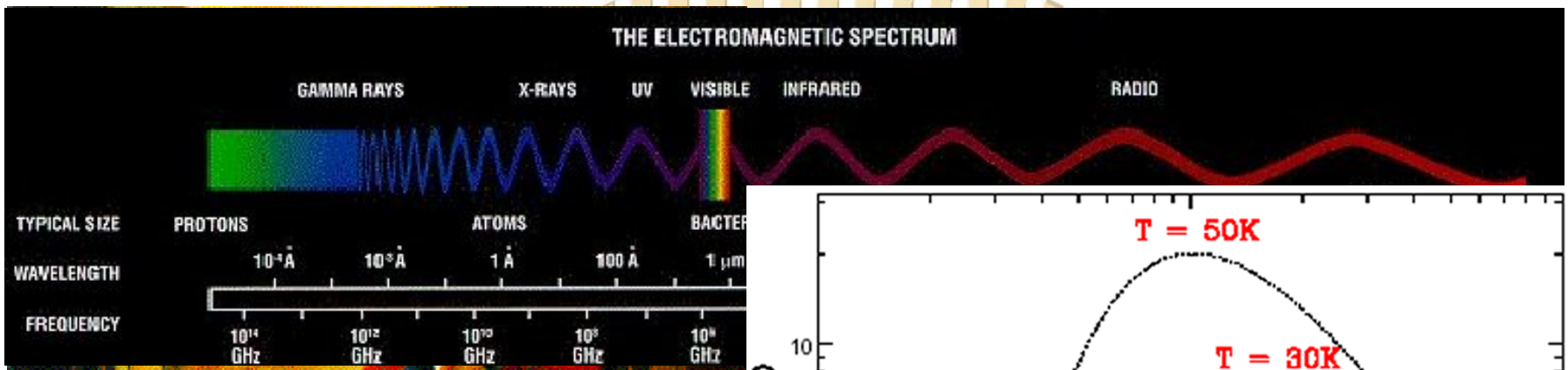
- **Larger telescope and longer wavelengths than previous IR satellites**
  - Telescope outside the cryostat allows a much larger – but warmer – telescope
  - Diameter limited by the size of the fairing on the Ariane 5 ECA rocket
  - Imaging hotometers and spectrometer – plus very high res heterodyne
- **Sources: it sees *colder* objects**
- **Angular resolution: it sees *deeper* and *sharper* into space**
- **Spectral resolution: it gives much *higher resolution* spectra**

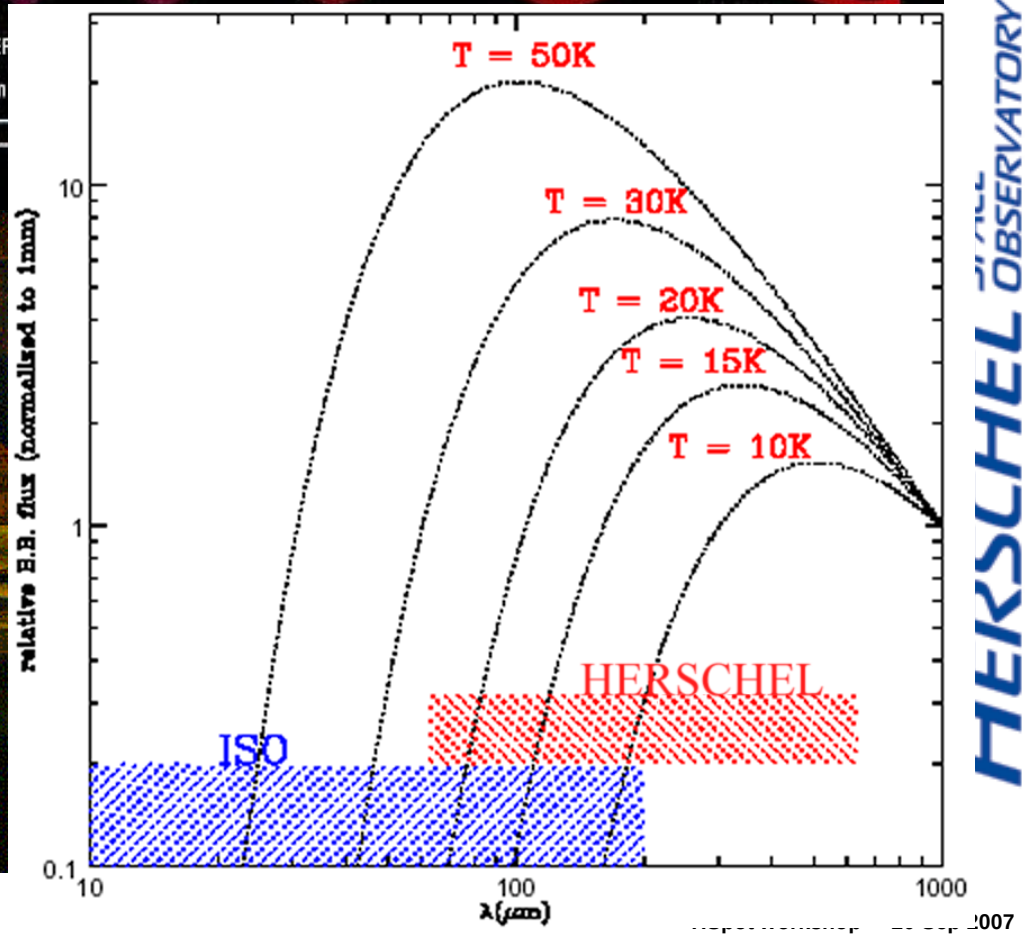


HERSCHEL SPACE OBSERVATORY


The need for
FIR & submm
observations?

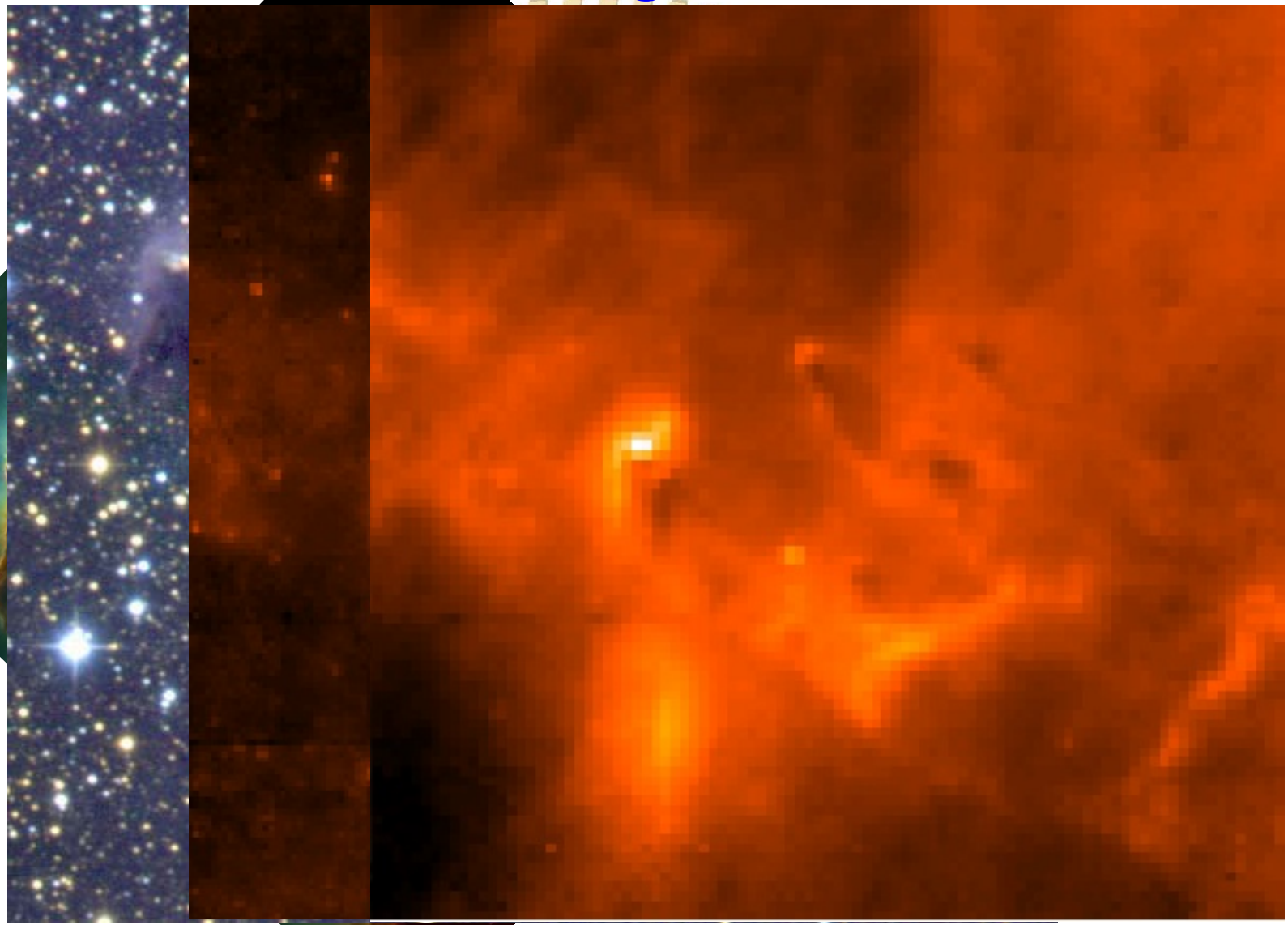
Pushing into the far infrared





HERSCHEL SPACE OBSERVATORY

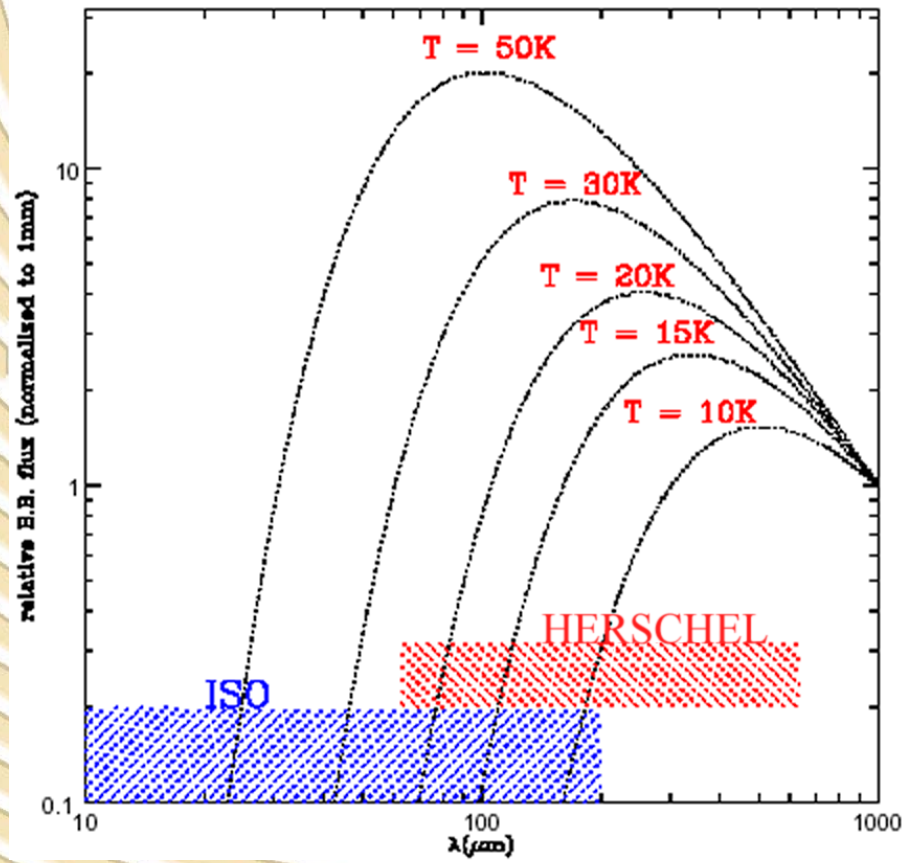
M16 ‘Eagle Nebula’



HERSCHEL SPACE OBSERVATORY

Herschel – the Cool Universe

- **Herschel spectral coverage**
  - black-bodies 5-50 K
    - continuum radiation
    - dust grains (re-)radiating
  - gases 10-few100 K
    - brightest atomic/molecular lines
- **Herschel strengths**
  - covers IR dominated galaxies & protostar SED peaks
  - wide area mapping
  - full coverage spectral scans & particular (water) lines
- **Herschel emphasis**
  - formation and evolution of galaxies & stars
  - ISM physics & chemistry
  - solar system bodies



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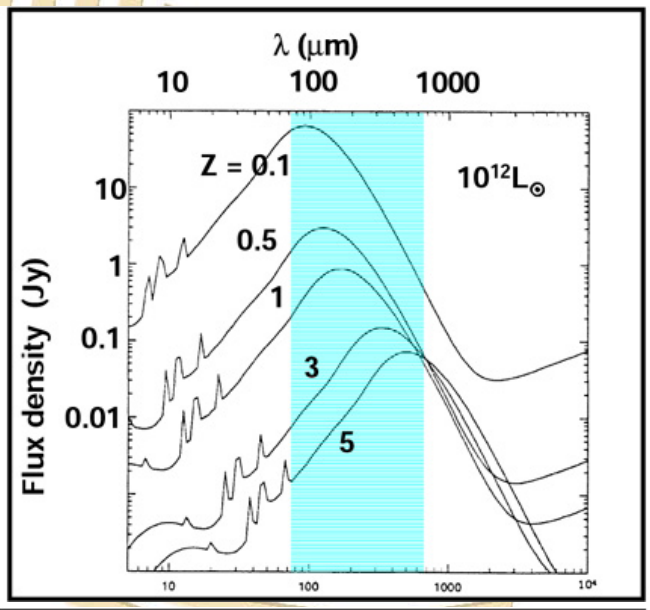

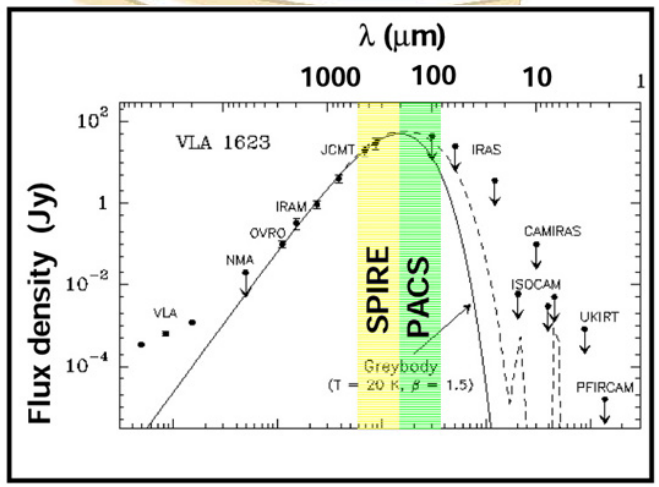

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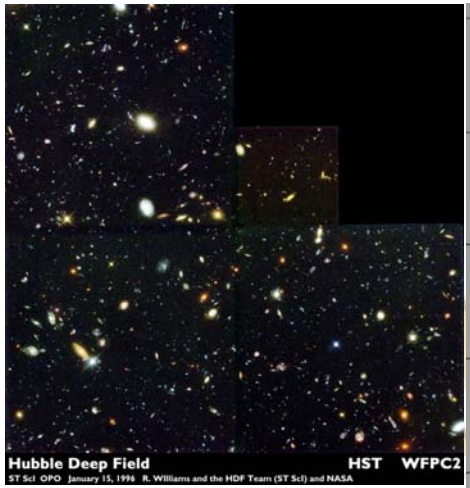
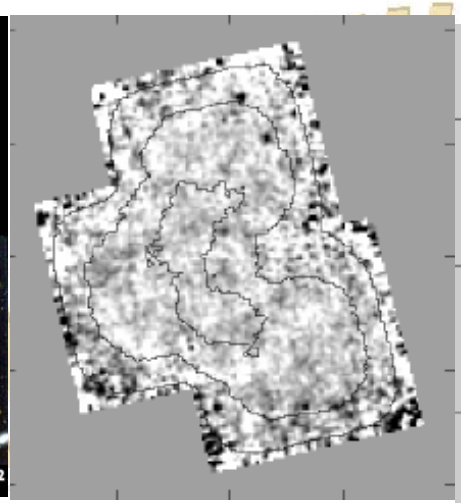
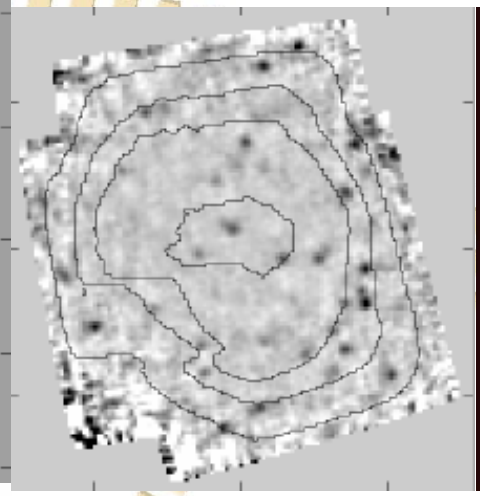
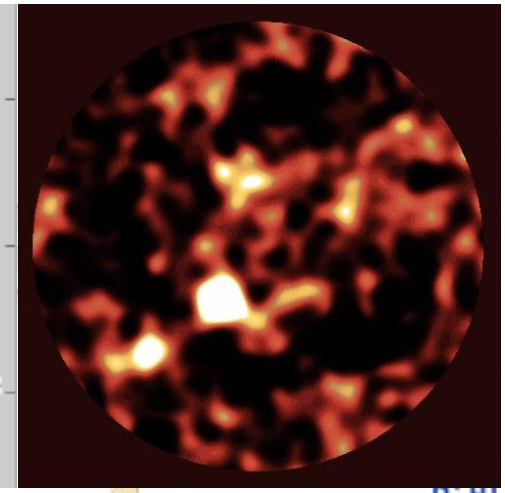
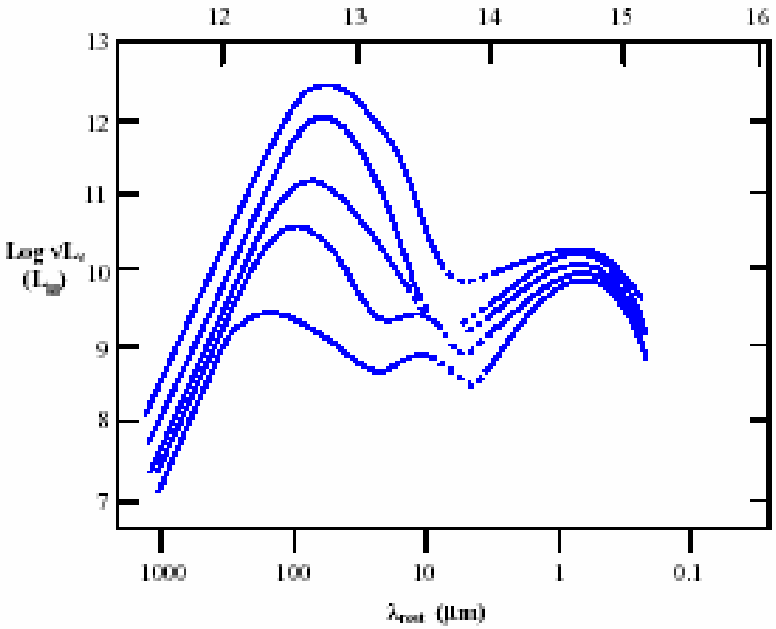


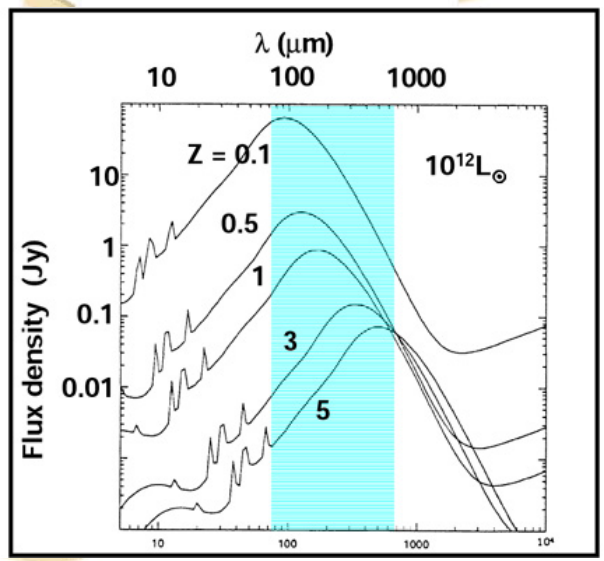






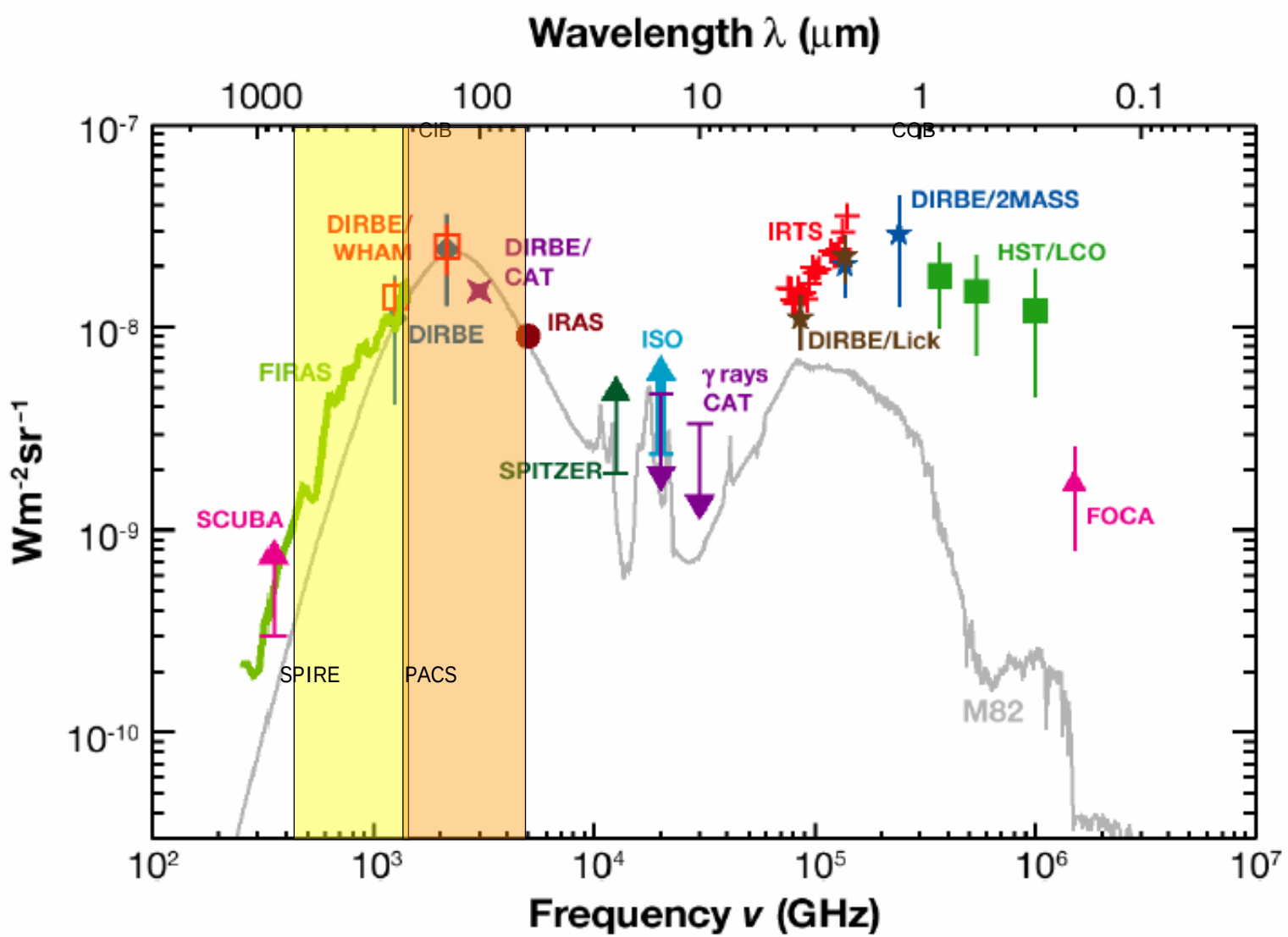


Sanders & Mirabel 1996



After Guiderdoni et al. MNRAS 295, 877, 1998

Spectrum of the Universe

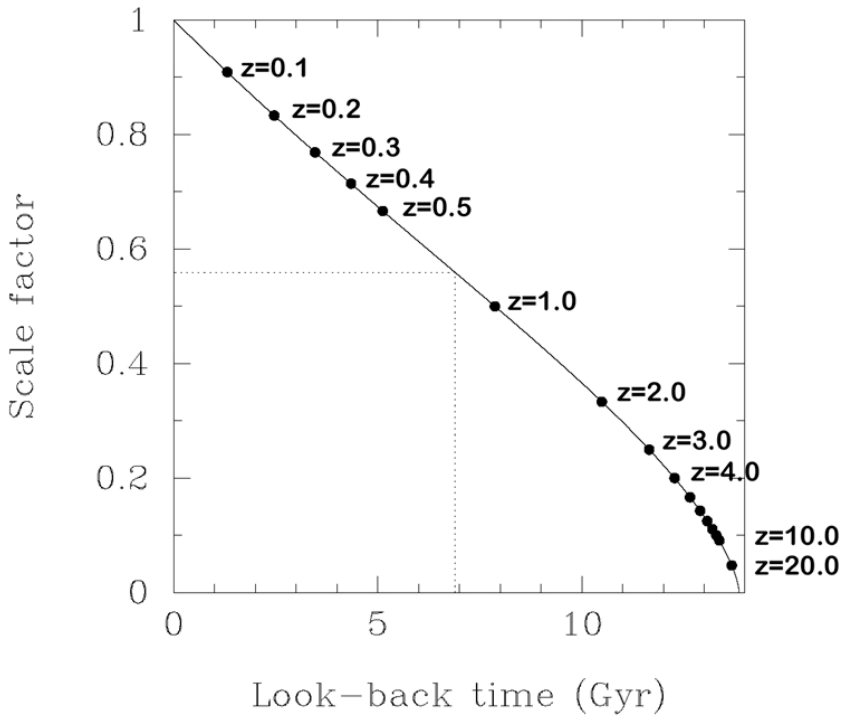


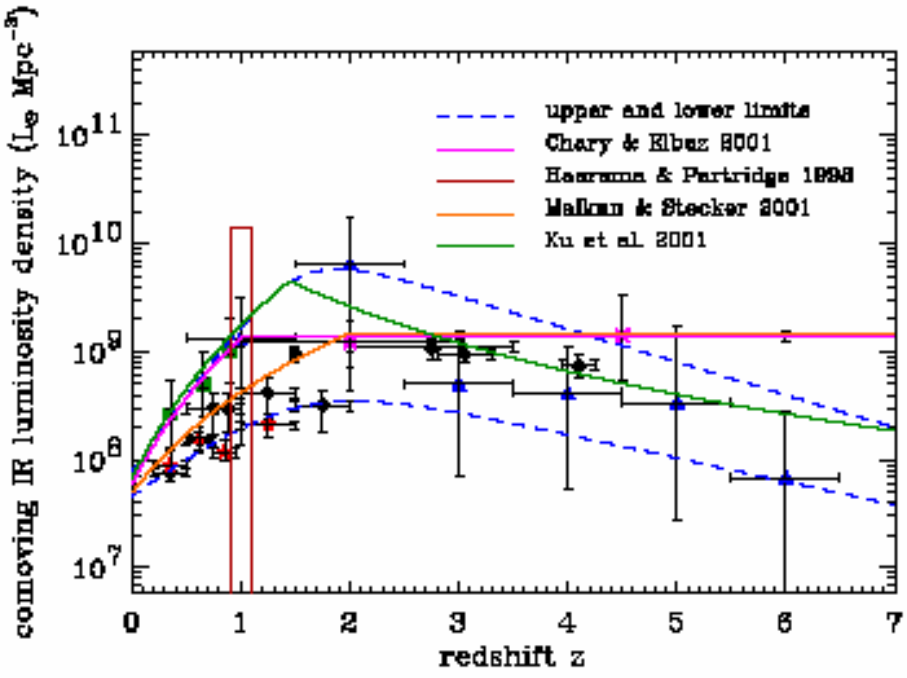
HERSCHEL SPACE OBSERVATORY

Lagache et al. 2005 ARAA

Universal star formation rate - energy production history

Herschel probes the rest-frame bolometric emission from galaxies as they formed most of their stars

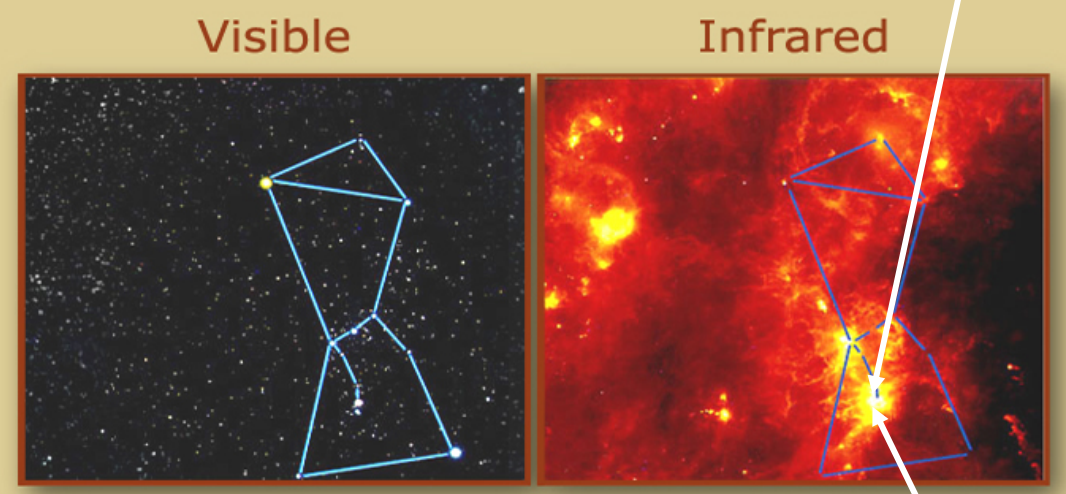




Dwek & Barker 2002

HERSCHEL SPACE OBSERVATORY

Spitzer image of the Orion Molecular Cloud

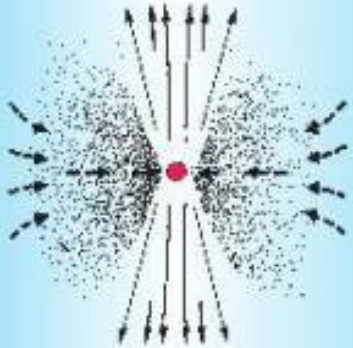


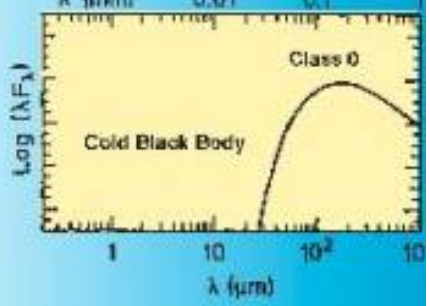
From space

esa

CLASS 0:
Main accretion phase?

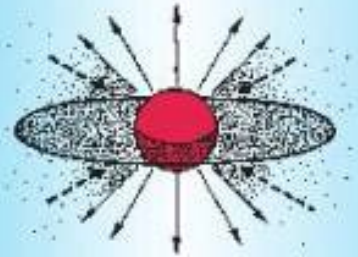
Age $\lesssim 10^4$ years
$M_{env} \gtrsim 0.5\ M_\odot$

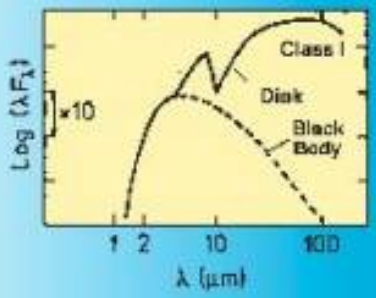




CLASS I:
Late accretion phase?

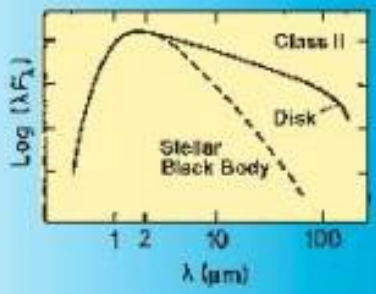
Age $\sim 10^5$ years
$M_{env} \lesssim 0.1\ M_\odot$





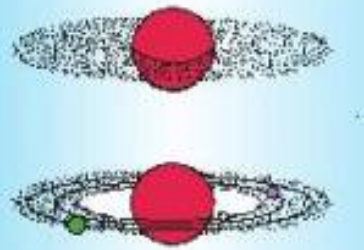
CLASS II:
Optically thick disk

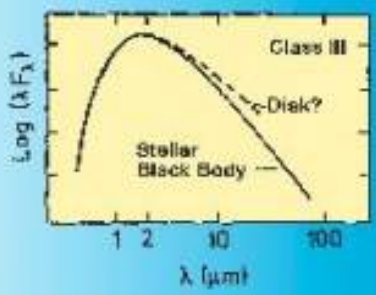
Age $\sim 10^6$ years
$\langle M_{disk} \rangle \sim 0.01\ M_\odot$



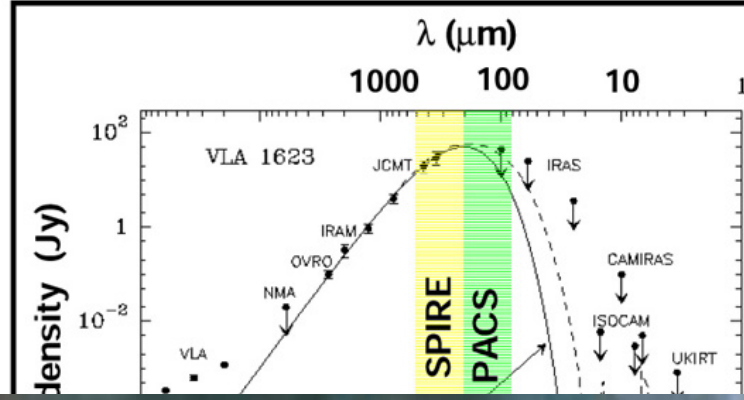
CLASS III:
Optically thin disk?

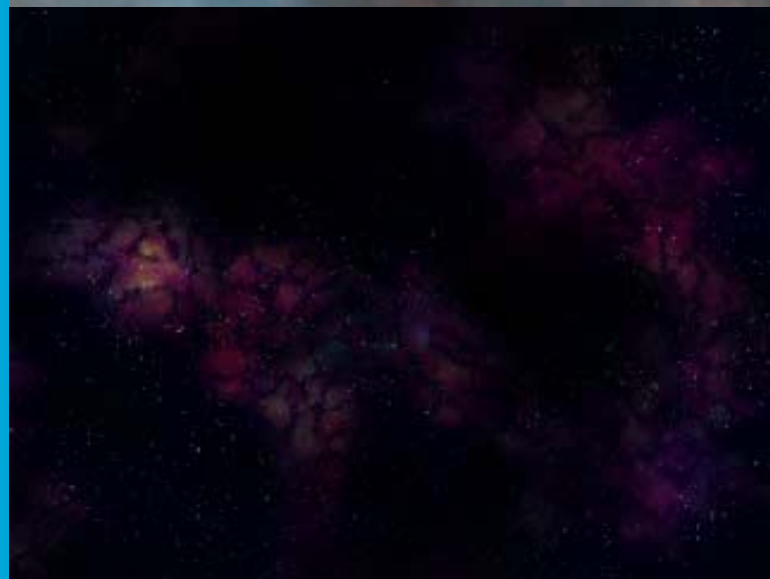
Age $\lesssim 10^7$ years
$\langle M_{disk} \rangle < 0.003\ M_\odot$



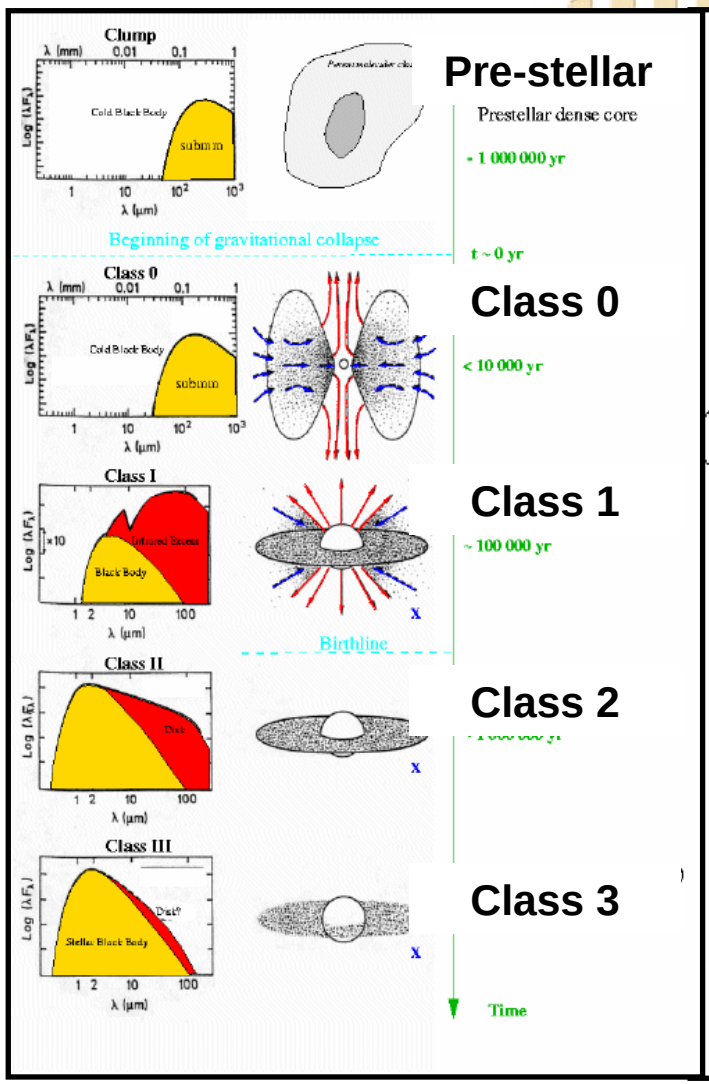


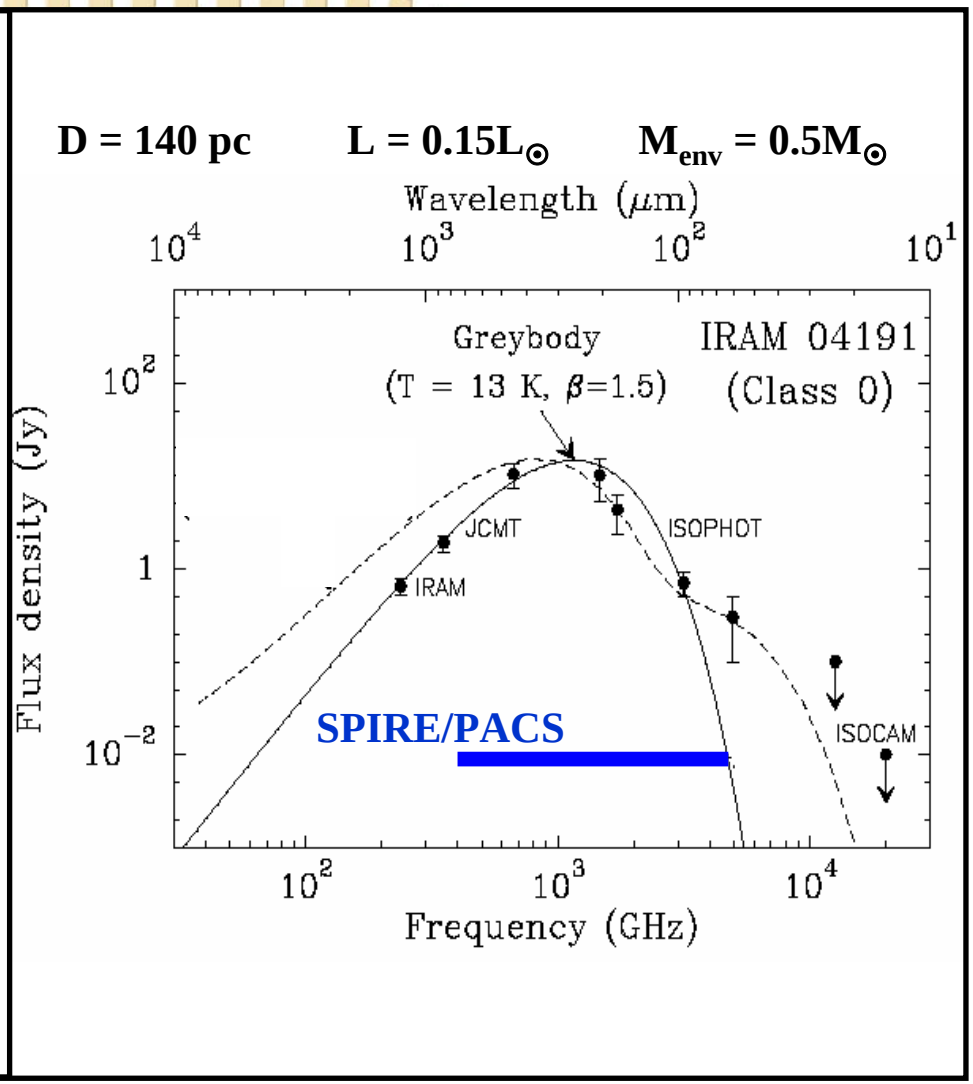
Planetary system





Need to cover SED peak



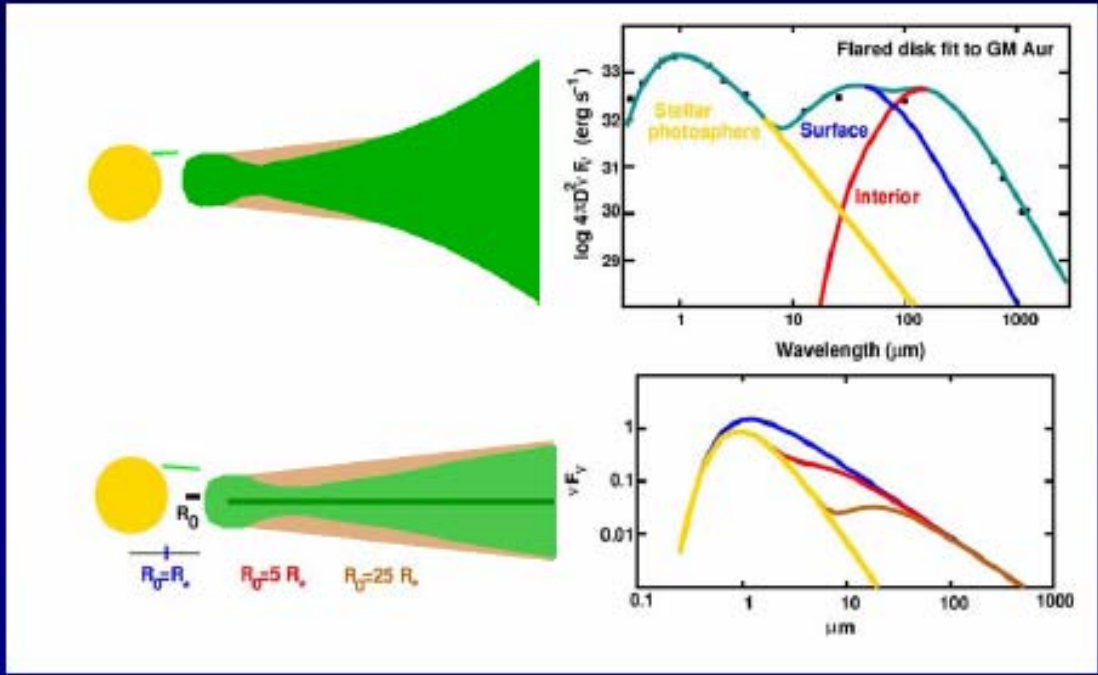


HERSCHEL SPACE OBSERVATORY

Physical and spectral properties of disks

Flared Disk

Geometrically flat disk
(self shadowed disk)



Flaring models: e.g., Kenyon & Hartmann 1987, Chiang & Goldreich 1997, Dullemond et al. 2002, Calvet 2004

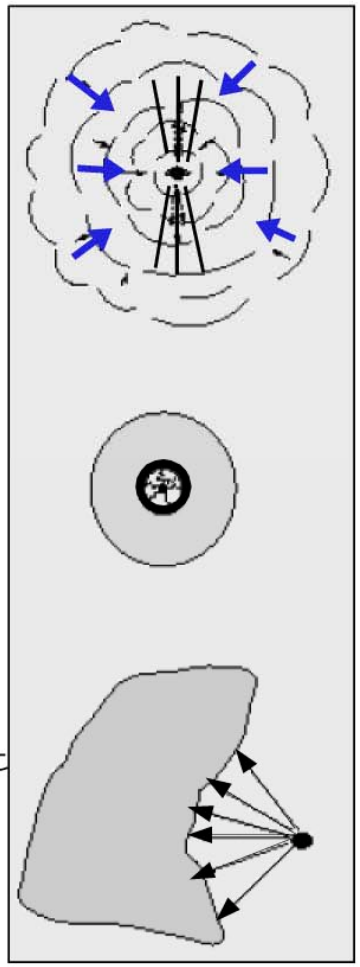
Fit disk models to SED to constrain T_d, n => calculate chemistry

Chemistry - also diagnostic tool

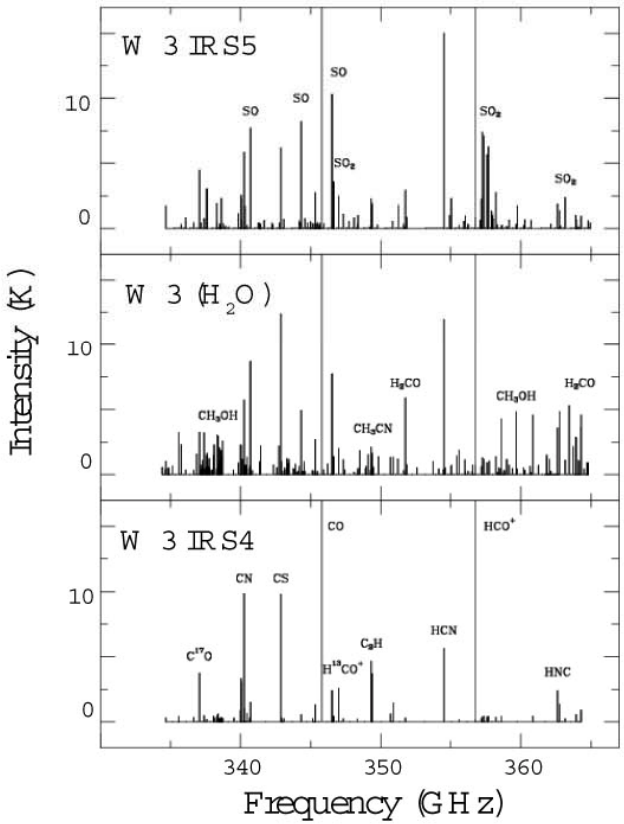
Embedded phase

Hot core phase

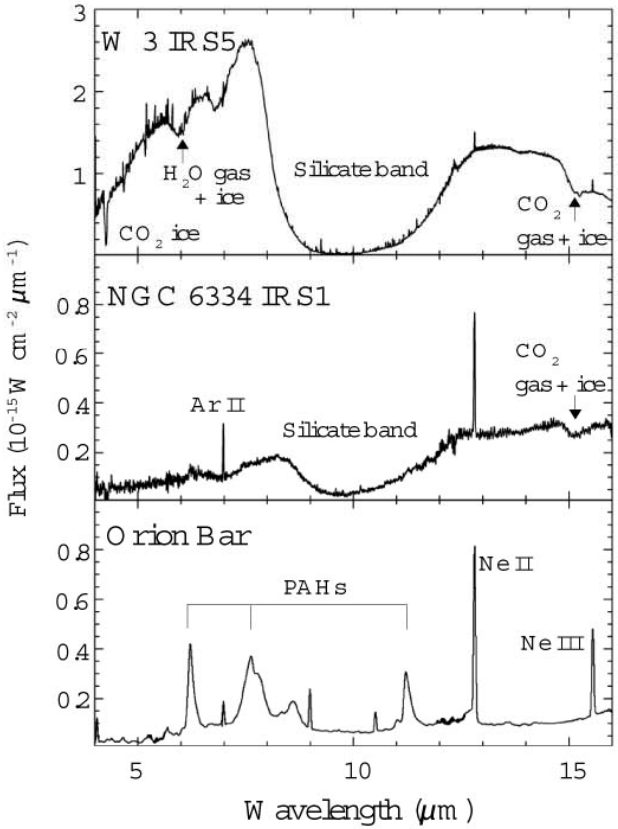
Ultracompact H II phase



Submillimeter

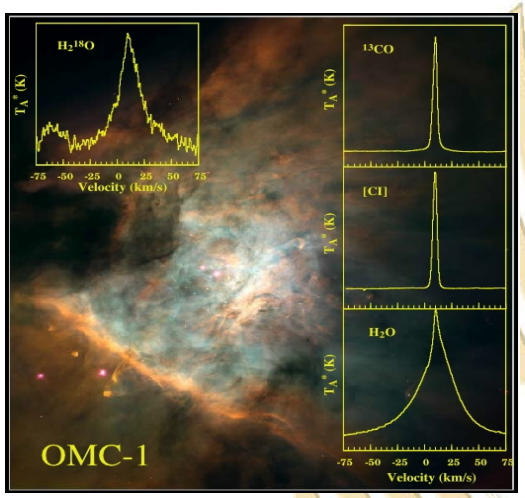


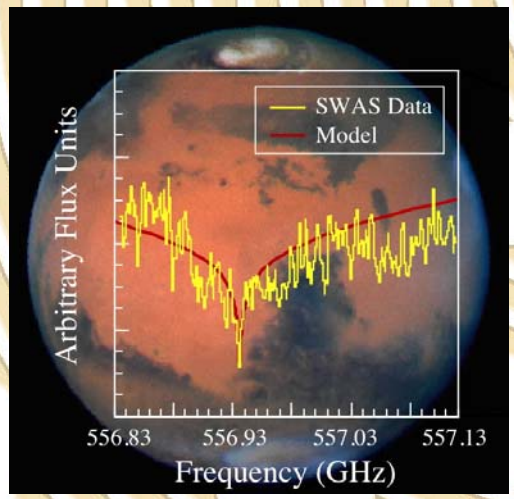
Mid-infrared

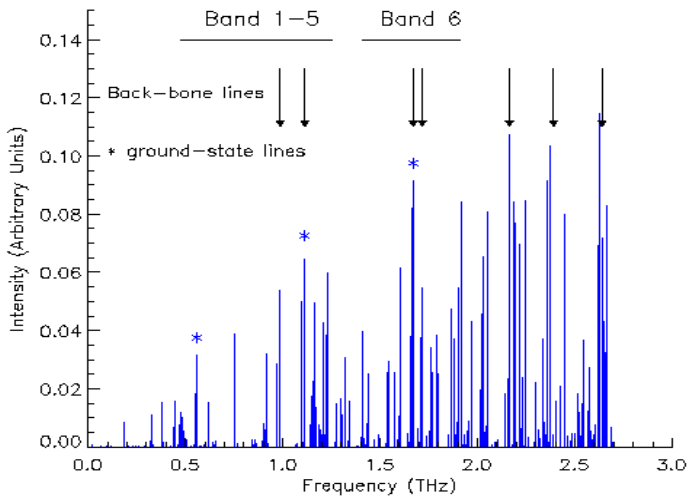


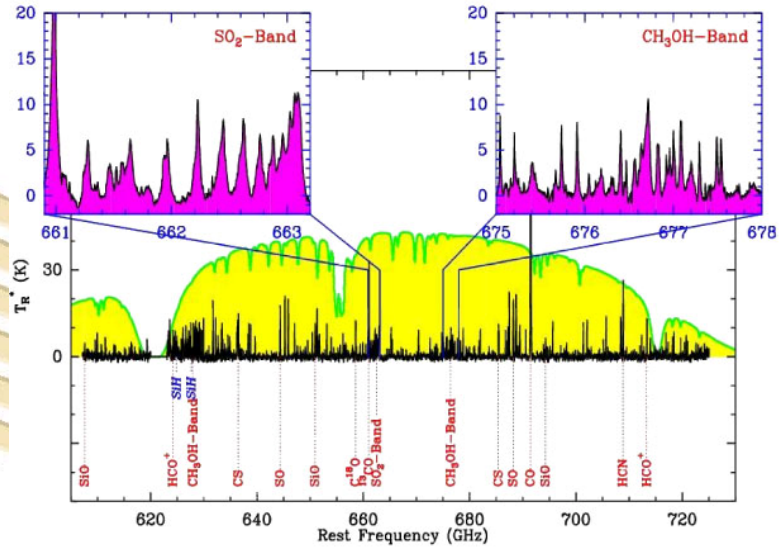
Ph.D. Thesis, Boonman (2003)

Connection ISM – solar system(s)









HERSCHEL SPACE OBSERVATORY

Herschel Main Scientific Areas

Formation and evolution of galaxies and structure

– Formation, evolution, and physics of galaxies
– Understanding the Cosmic Infrared Background
– Star formation history of the Universe
– History of heavy element (‘metal’) production

Formation of stars and stellar systems – physics and chemistry of the interstellar medium

– Structure, dynamics, composition of the ISM
– Pre-stellar cores to young stellar systems
– Late stages in stellar evolution
– Circulation/enrichment of the interstellar medium – astrochemistry
– Detailed studies of nearby resolvable galaxies

Cometary, planetary, and satellite atmospheres – our solar system as an example

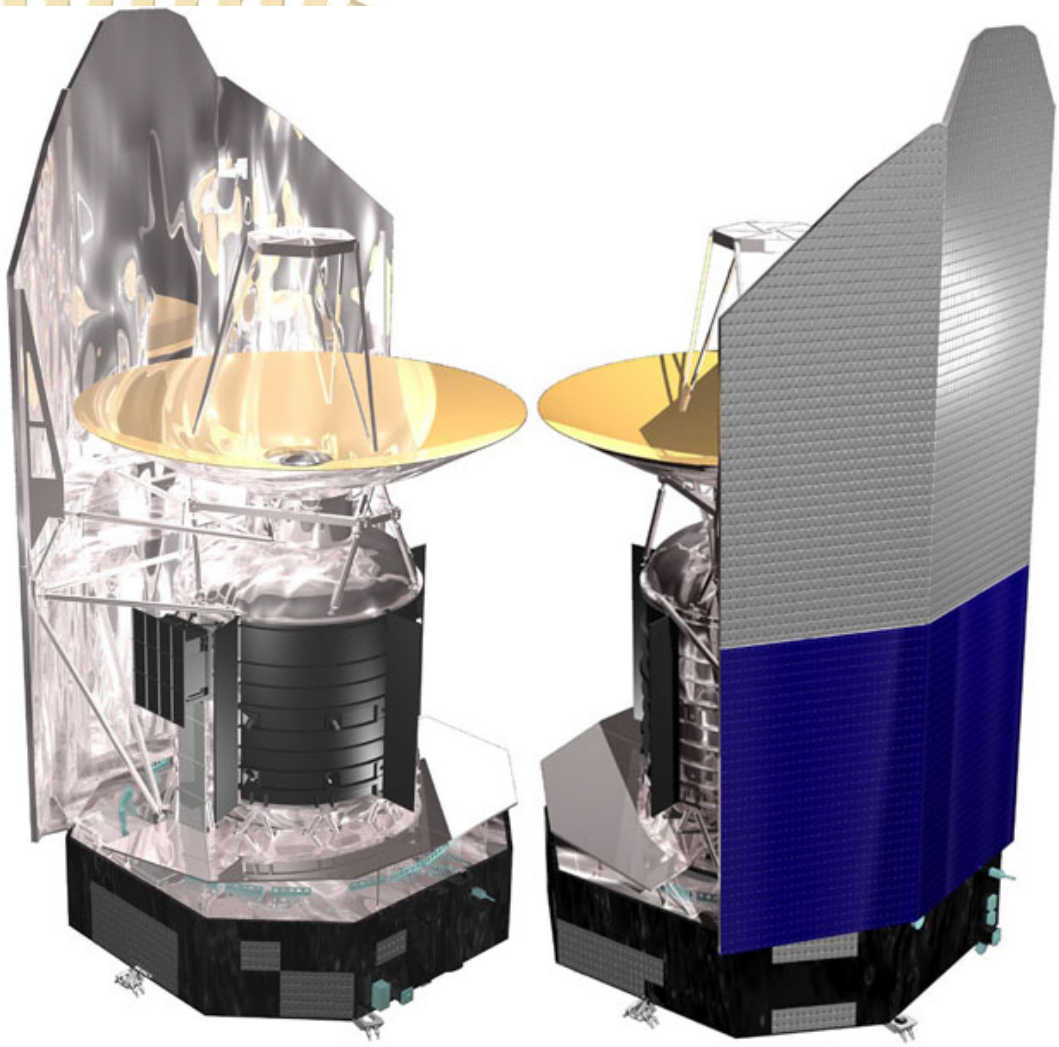
– Pristine material in comets and outer solar system bodies
– Composition of giant planets
– Water origin and activity

HERSCHEL SPACE OBSERVATORY


Herschel as seen by
an astronomer

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 ~ 3200 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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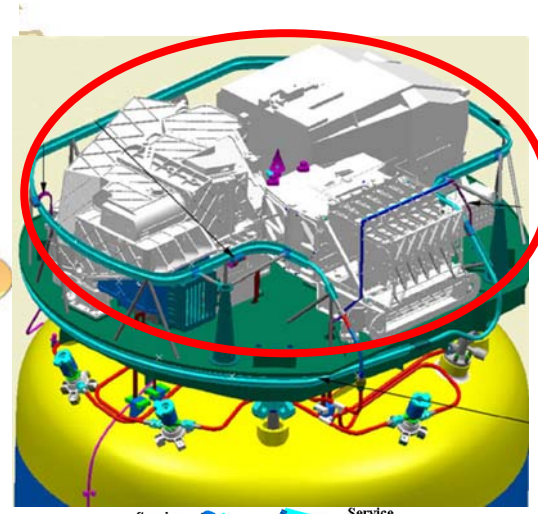

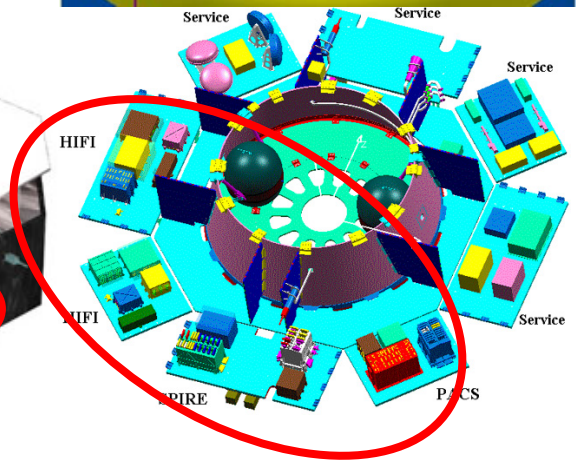

Herschel science instruments

- **PACS - Photodetector Array Camera and Spectrometer**
  - PI: Albrecht Poglitsch, MPE, Garching, Germany
  - imaging photometry and spectroscopy over 55-210 μm
  - 2 bolometer arrays for photometry, 2 (stressed) Ge:Ga arrays for spectroscopy

- **SPIRE - Spectral and Photometric Imaging REceiver**
  - PI: Matt Griffin, U Cardiff, Cardiff, United Kingdom
  - imaging photometry and spectro-photometry/-scopy over 194-672 μm
  - 3 bolometer arrays for photometry, 2 bolometer arrays for spectroscopy

- **HIFI - Heterodyne Instrument for the Far Infrared**
  - PI: Thijs de Graauw, SRON, Groningen, The Netherlands
  - very high resolution spectroscopy over 480-1250 and 1410-1910 GHz
  - SIS and HEB mixers, auto-correlator and AOS spectrometers

HERSCHEL SPACE OBSERVATORY

PACS

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  - Co-PI: Christoffel Waelkens, KU Leuven, Belgium
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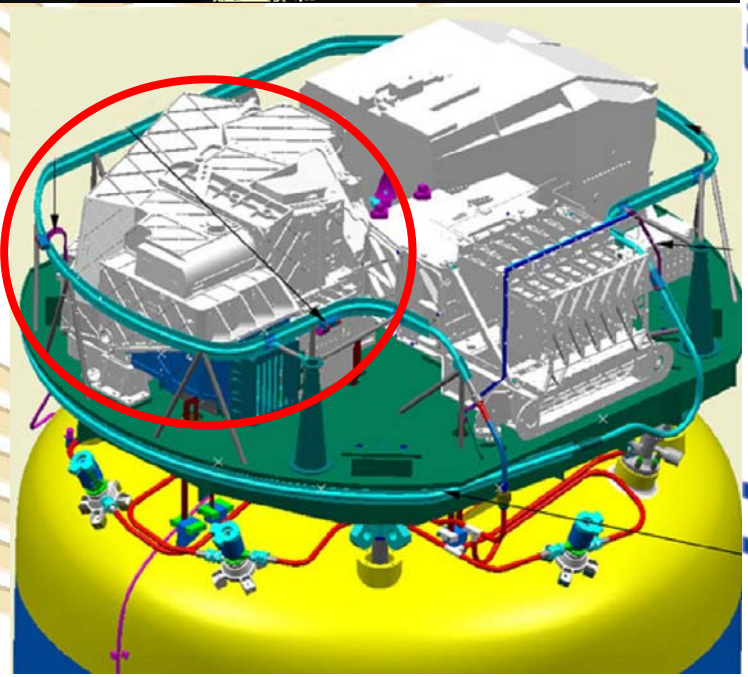
Max-Planck-Institut für extraterrestrische Physik
Katholieke Universiteit Leuven
Instituto de Astrofísica de Canarias
Max-Planck-Institut für Astronomie
Interuniversity Microelectronics Center Leuven
Institut für Astronomie der Universität Wien
Centre Spatial de Liège
Commissariat a l'Energie Atomique
Istituto di Fisica dello Spazio Interplanetario



HERSCHEL SPACE OBSERVATORY

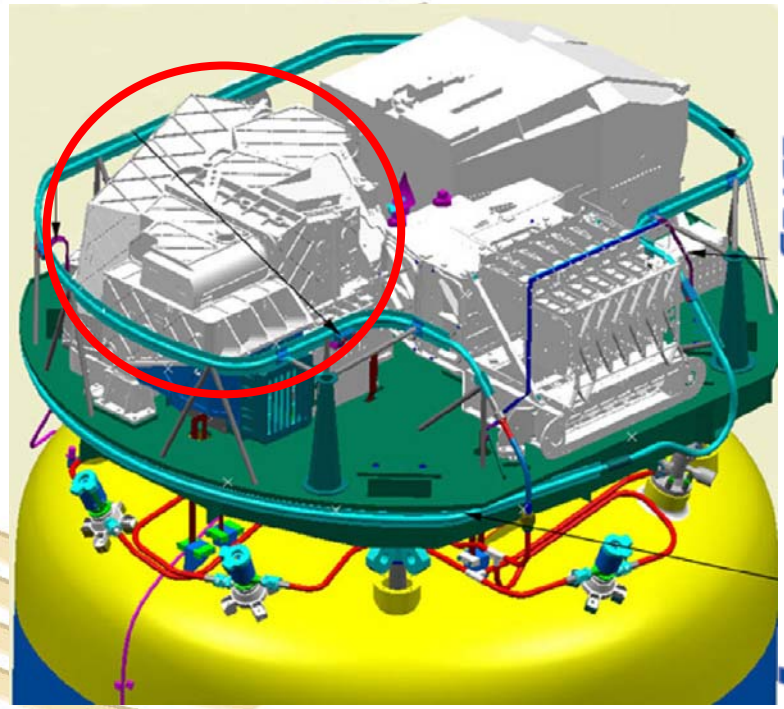
PACS:

Photodetector Array Camera and Spectrometer

3-band imaging photometer

λ (μm)	70	100	170
FWHM (arcsec)	6	8	12
λ/Δλ	2.5	2.8	2.1

- Simultaneous observation at 170 μm and (70 or 100) μm
- 3.5 x 1.75 arcmin field of view



Imaging line spectrometer

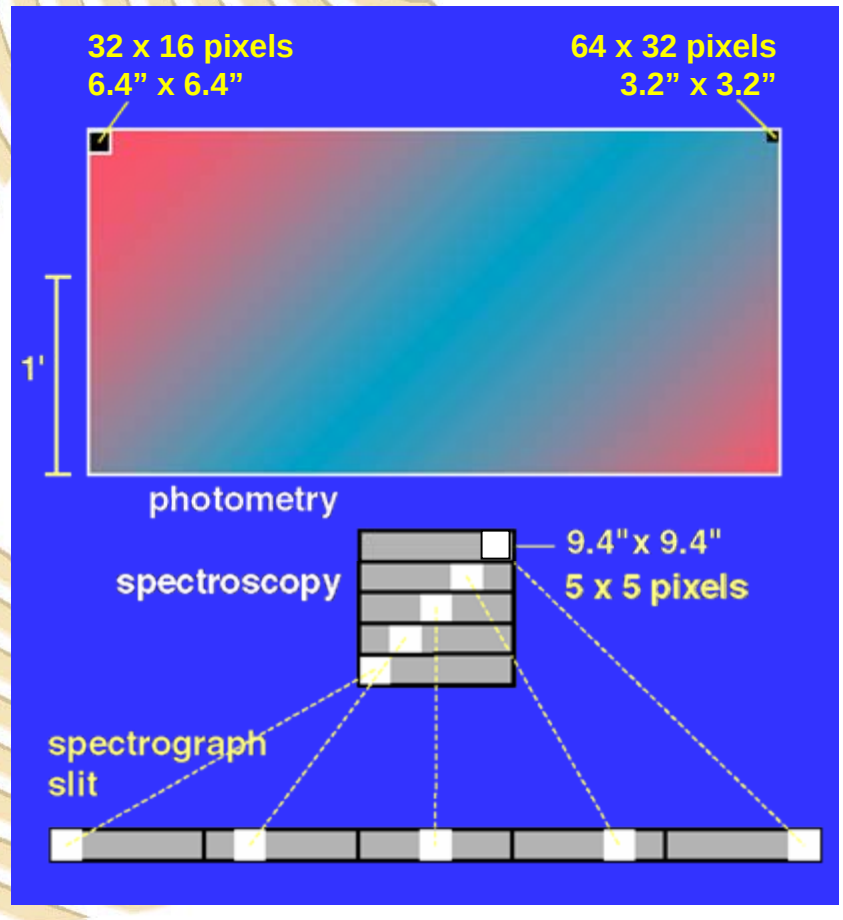
- Field of view (arcmin) 0.8 x 0.8
- Wavelength range 55 - 210 μm
- λ/Δλ 1500-4000

HERSCHEL SPACE OBSERVATORY

Instrument concept

- **Imaging photometry**
  - two bands simultaneously (60-85 or 85-130 μm and 130-210 μm) with dichroic beam splitter
  - two filled bolometer arrays (32x16 and 64x32 pixels, full beam sampling)
  - point source detection limit ~3 mJy (5σ, 1h)
- **Integral field line spectroscopy**
  - range 55 - 210 μm with 5x5 pixels, image slicer, and long-slit grating spectrograph (R ~ 1500)
  - two 16x25 Ge:Ga photoconductor arrays (stressed/unstressed)
  - point source detection limit 3…20 x10^{-18} W/m^2 (5σ, 1h)

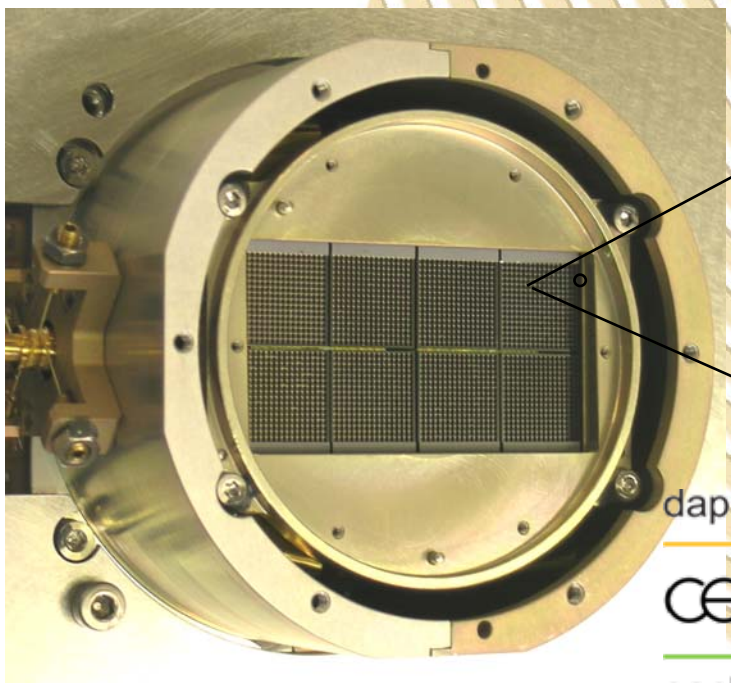
Focal Plane Footprint



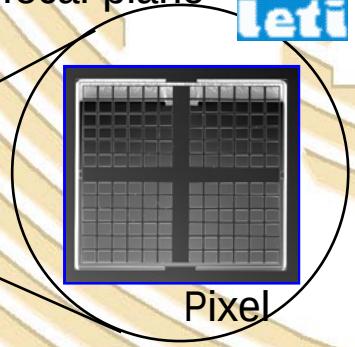
HERSCHEL SPACE OBSERVATORY

Bolometer arrays

- Two filled arrays: 64x32 pixels (blue) and 32x16 pixels (red)
- Bolometers and multiplexing readout electronics operating at 0.3K
- Detector/readout noise comparable to background-noise
- Cooler hold time ~50h



Blue
focal plane

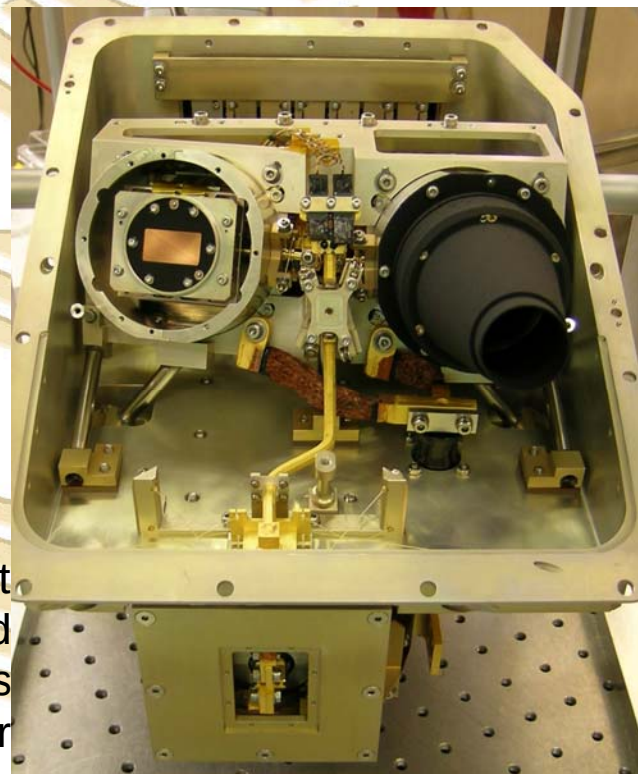


Pixel

dapnia

saclay

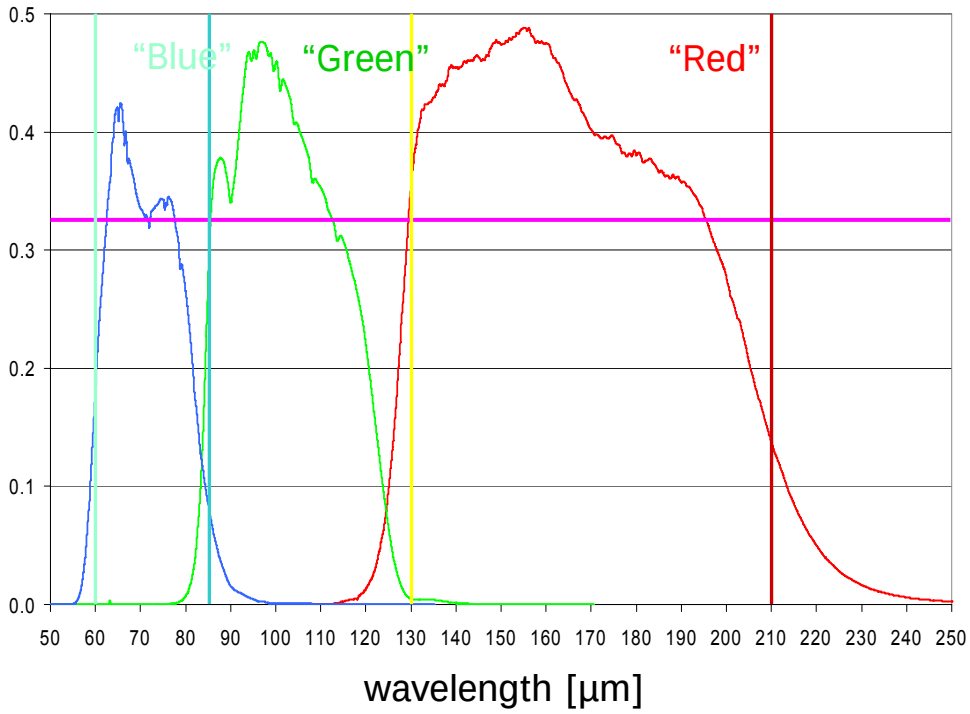
Photometer unit
with blue + red
focal planes
and ^{3}He cooler



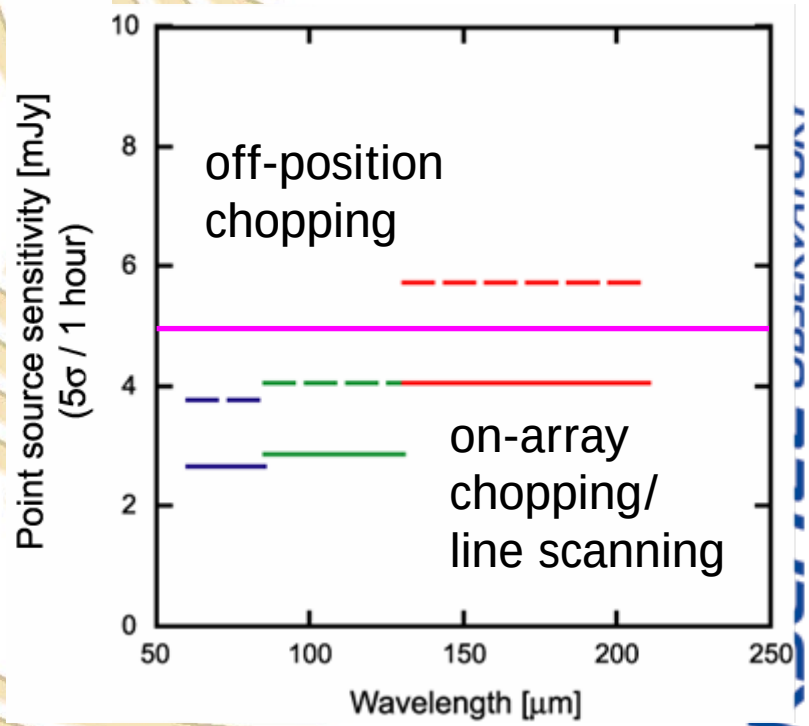
HERSCHEL SPACE OBSERVATORY

Expected performance

Photometer bands: filter transmission x detector efficiency



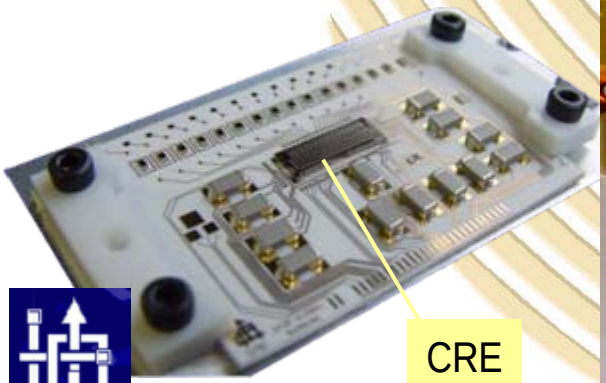
Sensitivity

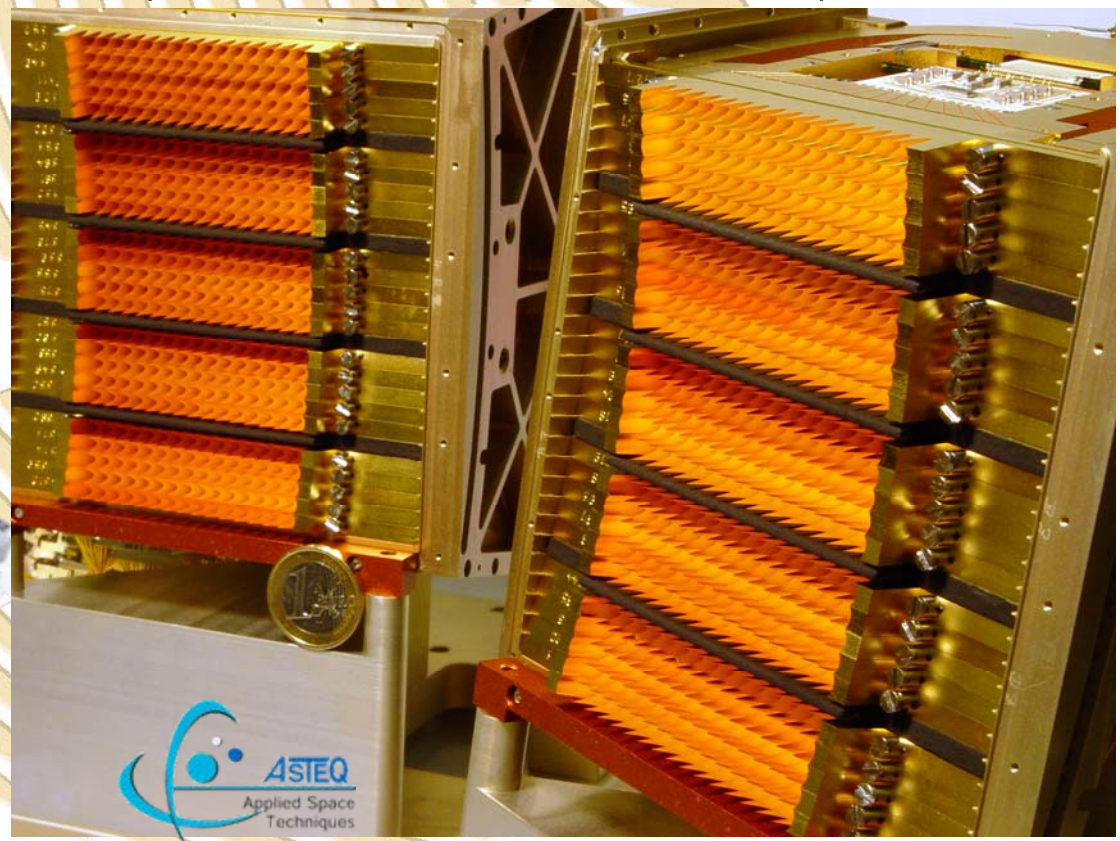


- Requirements:
  band definition: ±5%, sensitivity: 5mJy, 5σ/1h

Photoconductor arrays

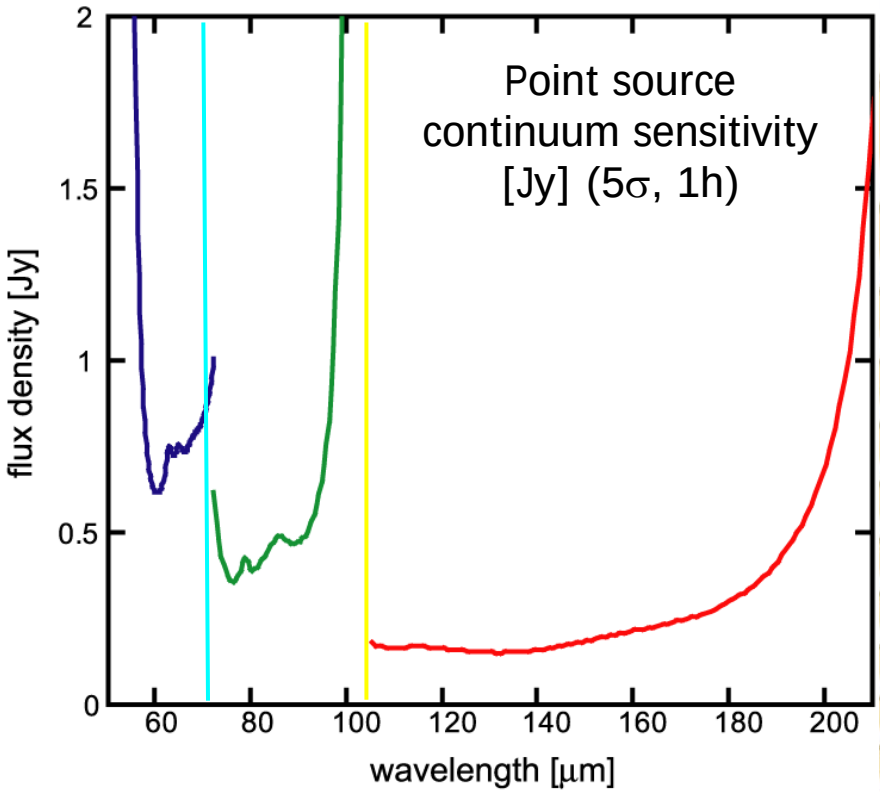
- Two 25x16 pixel filled arrays
- Extrinsic photoconductors (Ge:Ga, stressed/unstressed)
- Integrated cryogenic readout electronics (CRE)
- Near-background-noise limited performance

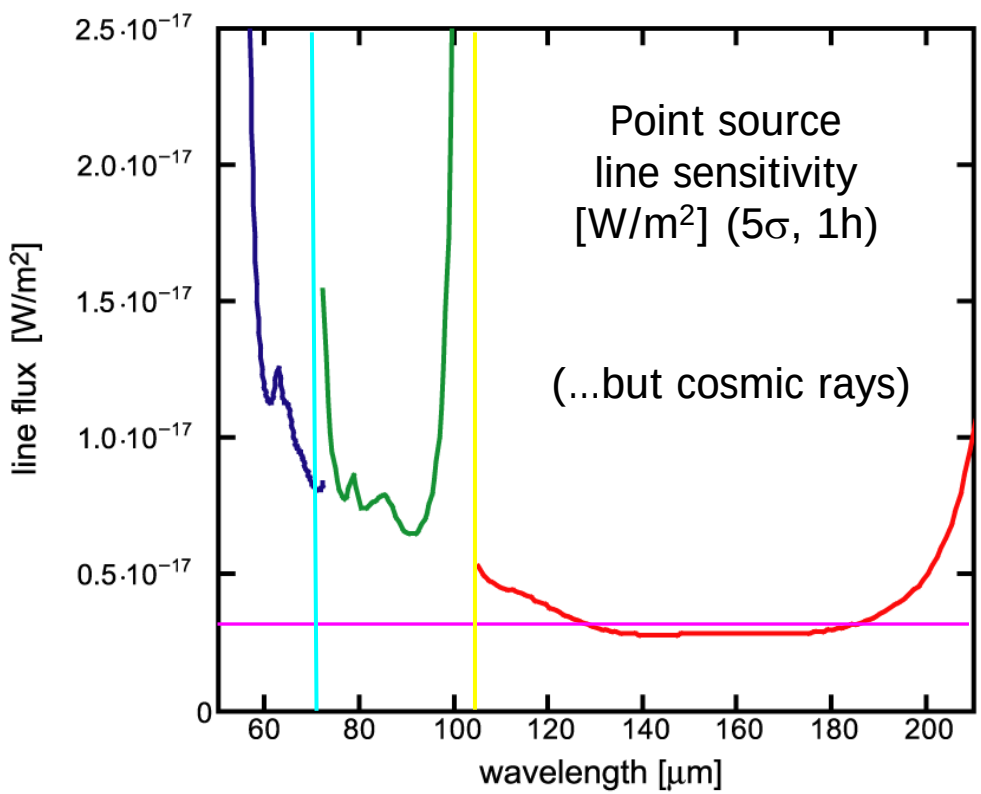




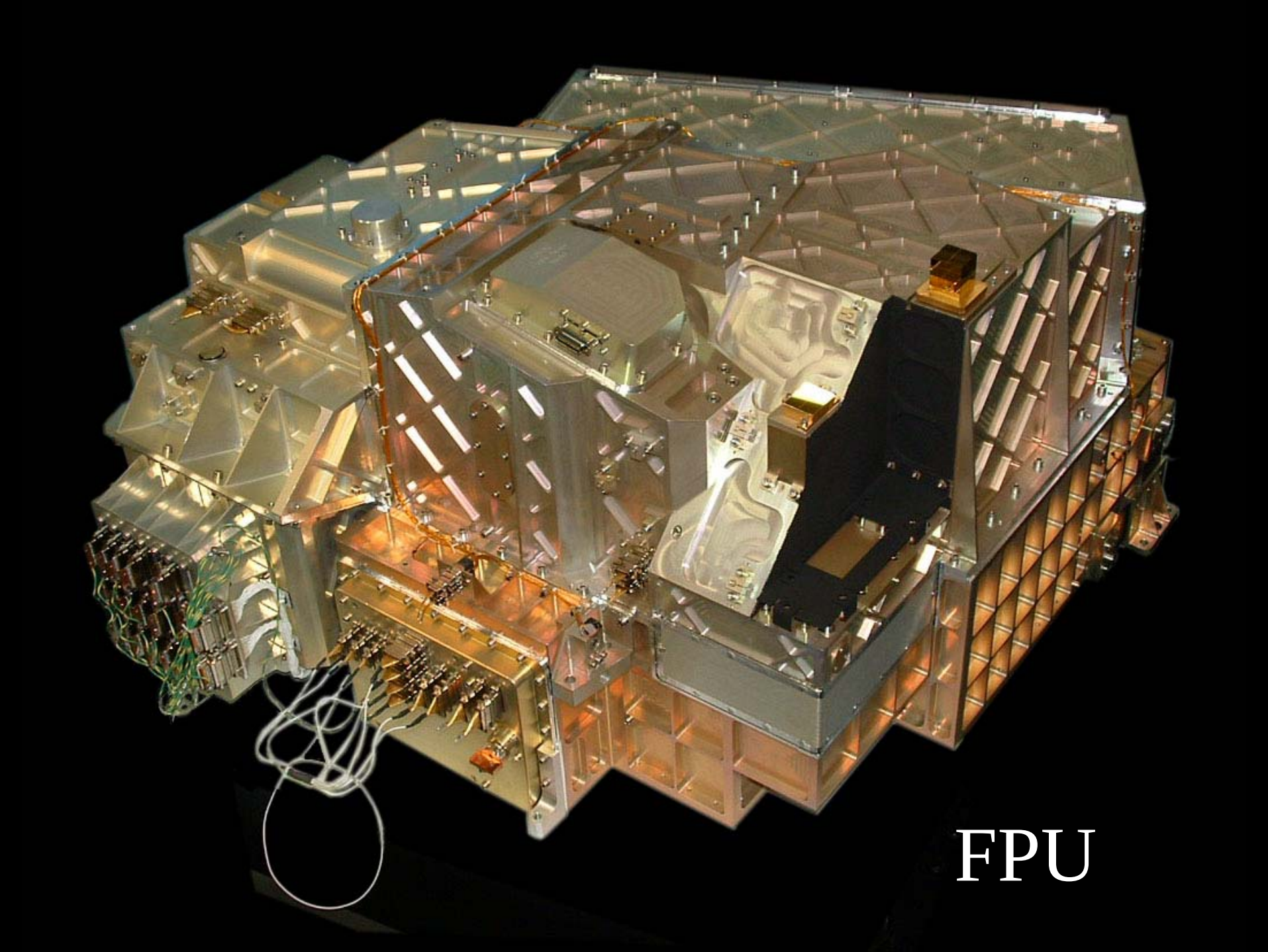
HERSCHEL SPACE OBSERVATORY

Expecteded performance





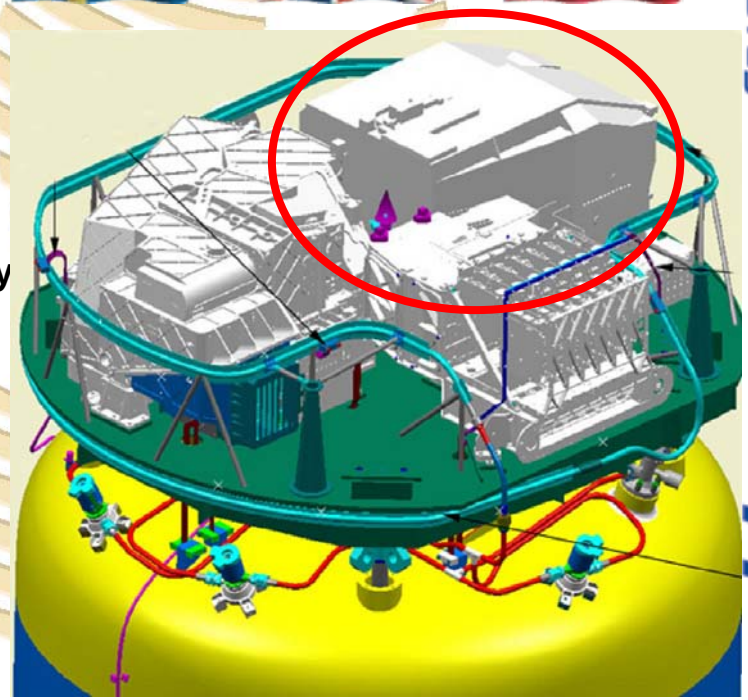
- Sensitivity gap from ~ 95 to 105 μm
- Calculated for (off-array) chopping
- Sensitivity requirement partly met


FPU

SPIRE

- **SPIRE - Spectral and Photometric Imaging REceiver**
  - PI: Matt Griffin, U Cardiff, Cardiff, United Kingdom
  - Co-PI: Laurent Vigroux, CEA, Saclay, France
  - imaging photometry and spectro-photometry/-scopy over 194-672 μm
  - 3 bolometer arrays for photometry, 2 bolometer arrays for spectroscopy

Cardiff University, UK
CEA Service d'Astrophysique, Saclay, France
Institut d'Astrophysique Spatiale, Orsay, France
Imperial College, London, UK
Instituto de Astrofisica de Canarias, Tenerife, Spain
Istituto di Fisica dello Spazio Interplanetario, Rome, Italy
Jet Propulsion Laboratory/Caltech, Pasadena, USA
Laboratoire d'Astronomie Spatiale, Marseille, France
Mullard Space Science Laboratory, Surrey, UK
Observatoire de Paris, Meudon, Paris
Rutherford Appleton Laboratory, Oxfordshire, UK
Stockholm Observatory, Sweden
UK Astronomy Technology Centre, Edinburgh
Università di Padova, Italy
University of Lethbridge, Canada

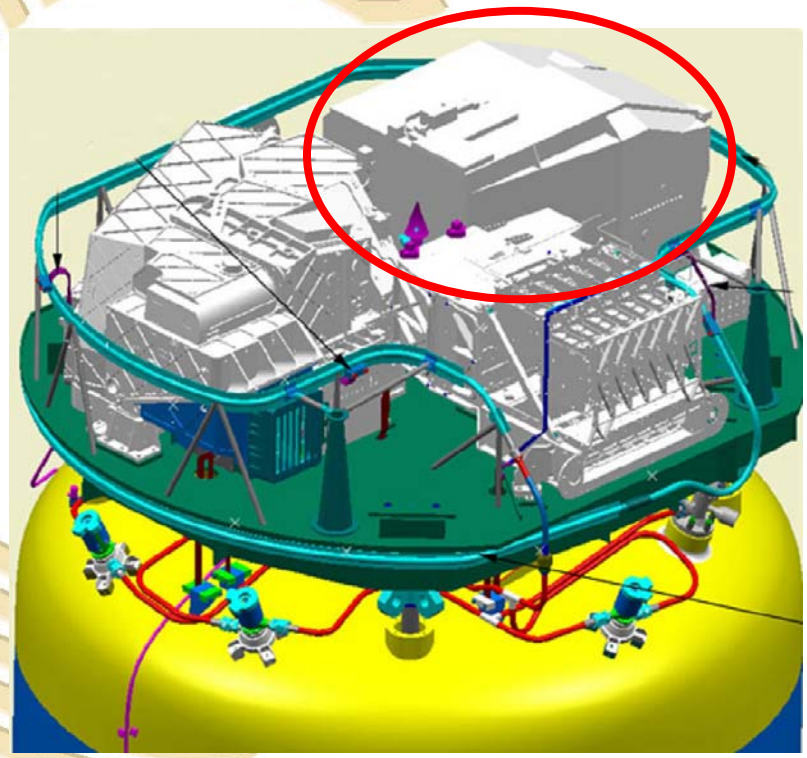


HERSCHEL SPACE OBSERVATORY

SPIRE:

Spectral and Photometric Imaging Receiver

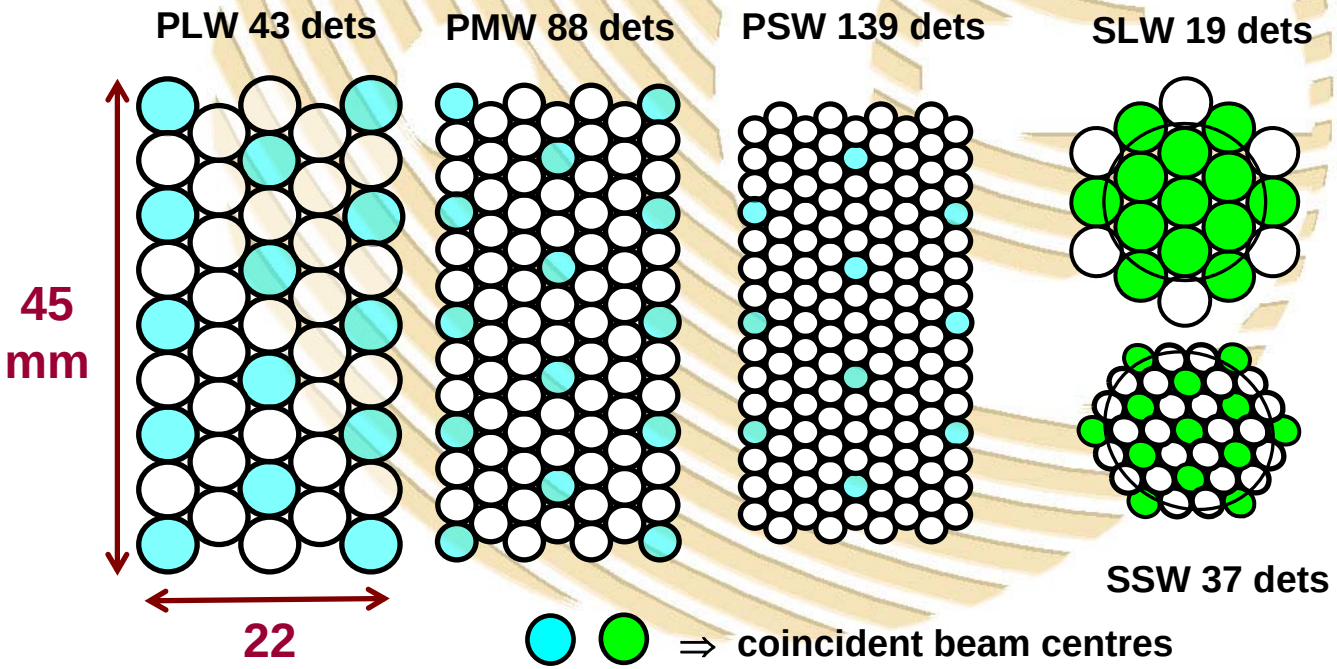
- **3-band imaging photometer**
  - **250, 350, 500 μm (simultaneous)**
  - **λ/Δλ ~ 3**
  - **4 x 8 arcminute field of view**
  - **Diffraction limited beams (17, 24, 35")**
- **Imaging Fourier Transform Spectrometer**
  - **194 - 672 μm**
  - **2.6 arcminute field of view**
  - **$\Delta\sigma$ = 0.04 cm^{-1} ($\lambda/\Delta\lambda$ ~ 20 - 1000 at 250 μm)**



HERSCHEL SPACE OBSERVATORY

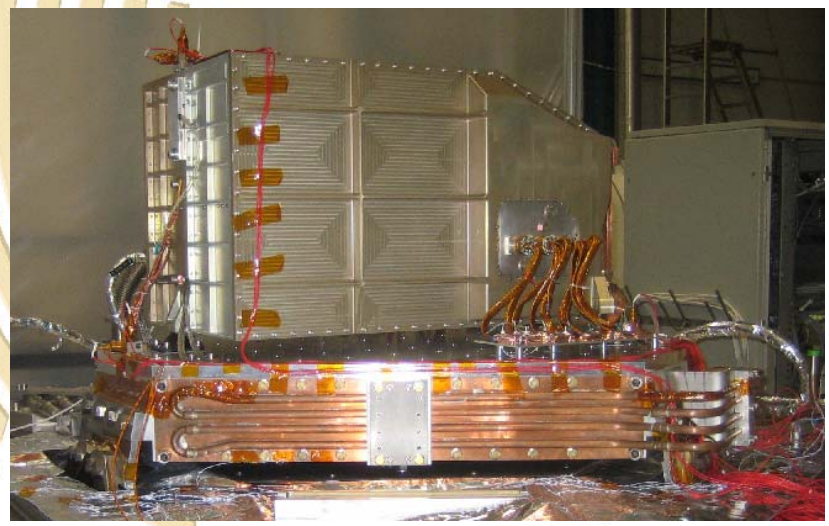
Instrument concept

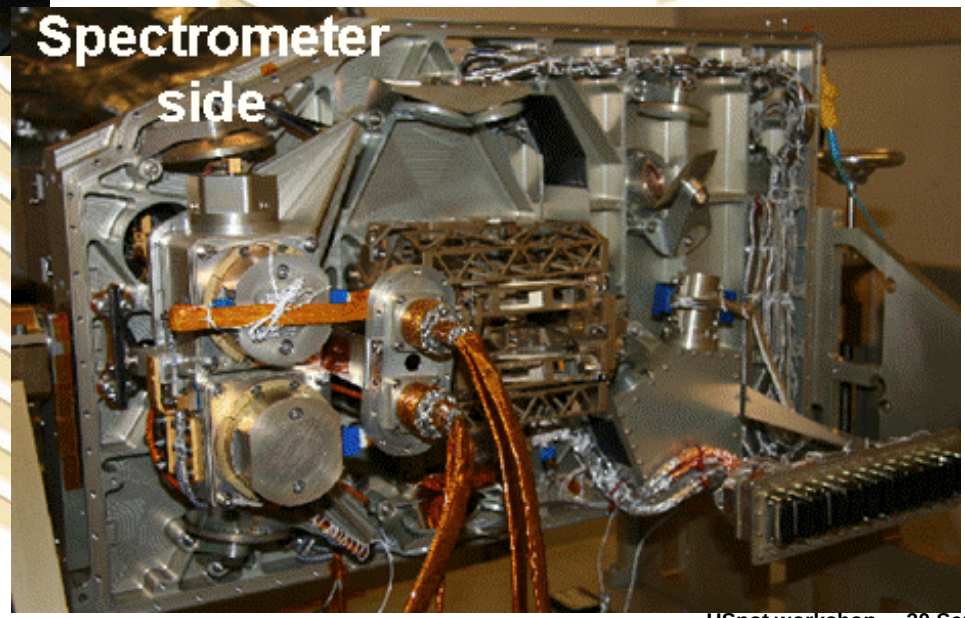
- **Imaging photometry**
  - three bands simultaneously (250, 350, 500 μm) with dichroic beam splitters
  - 4x8 arcmin field of view
  - diffraction limited beams (17”, 24”, 35”)
- **Imaging FTS**
  - range 194 - 672 μm
  - 2.6 arcmin Ø field of view
  - Δσ = 0.04 cm-1 (R~20-1000 at 250 μm)



HERSCHEL SPACE OBSERVATORY

Under construction





HERSCHEL SPACE OBSERVATORY


RAL
ALAN PEARCE

Photometer expected performance

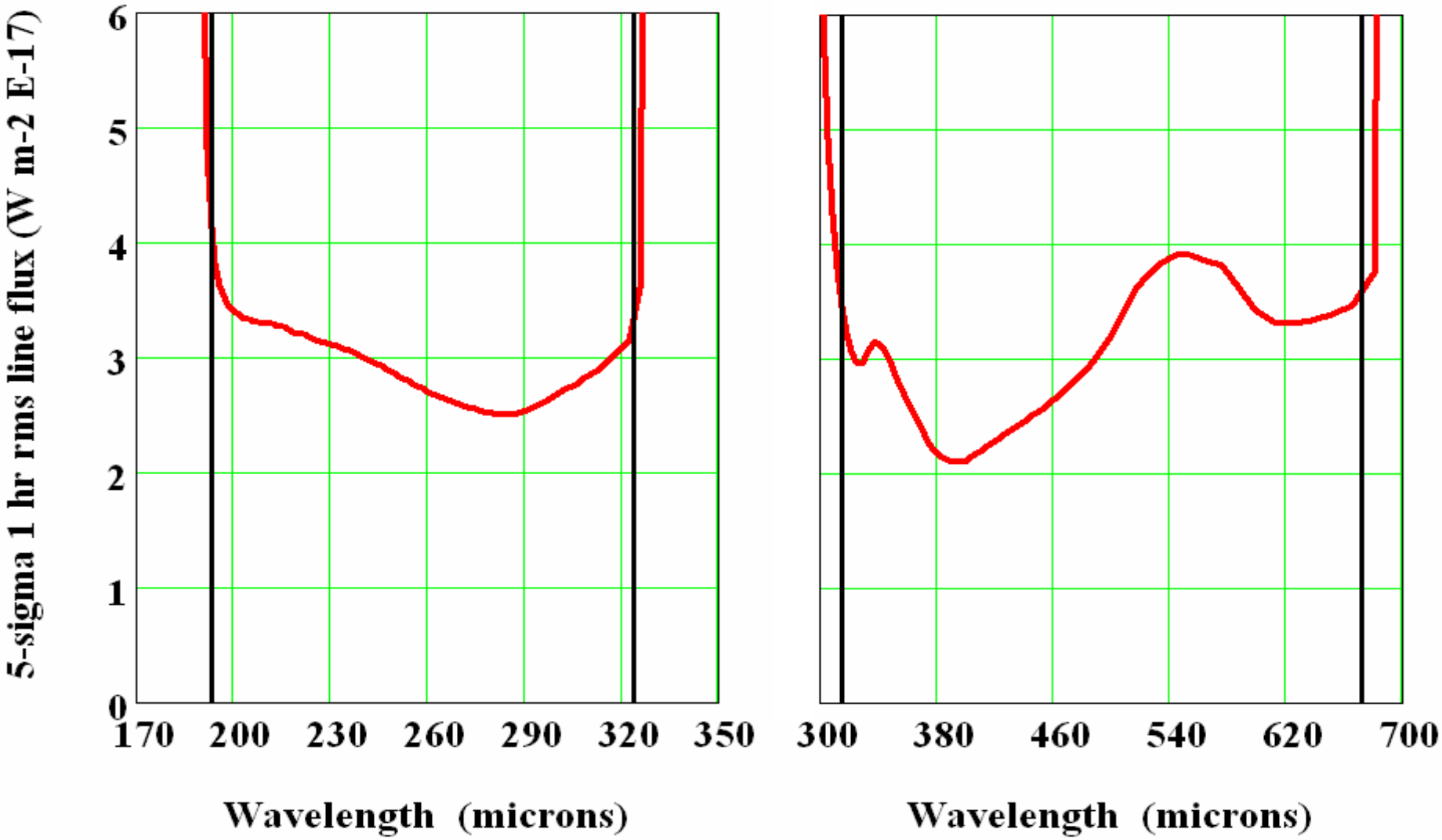
Band (μm)		250	350	500
Point source	(mJy 5-σ 1 hr)	1.8	2.2	1.7
Jiggle map (4 x 4 arcmin)	(mJy 5-σ 1 hr)	6.2	8.4	7.1
Scan map (with cross-linking)				
1 scan	(mJy 5-σ)	55	75	65
On-source time (hrs) to map 1 sq deg. to 3 mJy rms		7.8	16	13

HERSCHEL SPACE OBSERVATORY

esa

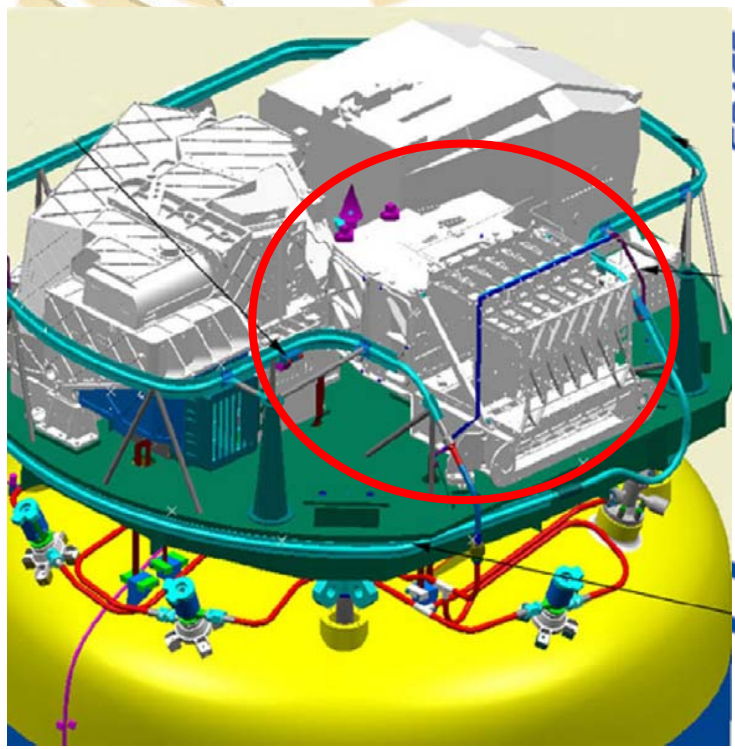
FTS line spectroscopy

(W m^{-2} x 10^{-17} 5-σ 1 hr)



HIFI

- **HIFI - Heterodyne Instrument for the Far Infrared**
  - PI: Thijs de Graauw, SRON, Groningen, The Netherlands
  - Co-PIs: Tom Phillips, Caltech, USA; Jürgen Stutzki, U Köln, Germany; and Emmanuel Caux, CESR, France
  - very high resolution spectroscopy over 480-1250 and 1410-1910 GHz
  - SIS and HEB mixers, auto-correlator and AOS spectrometers

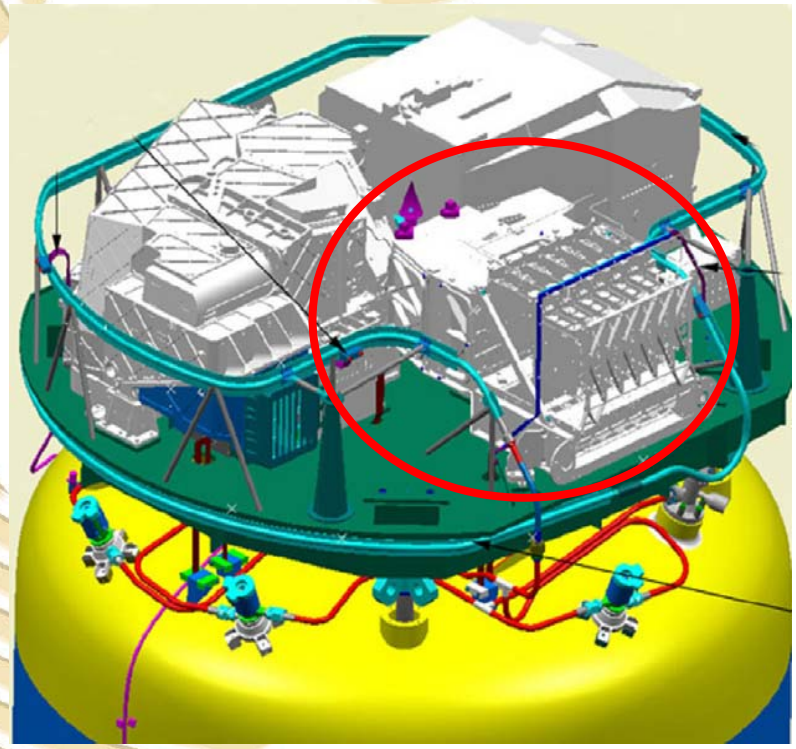


HERSCHEL SPACE OBSERVATORY

HIFI:

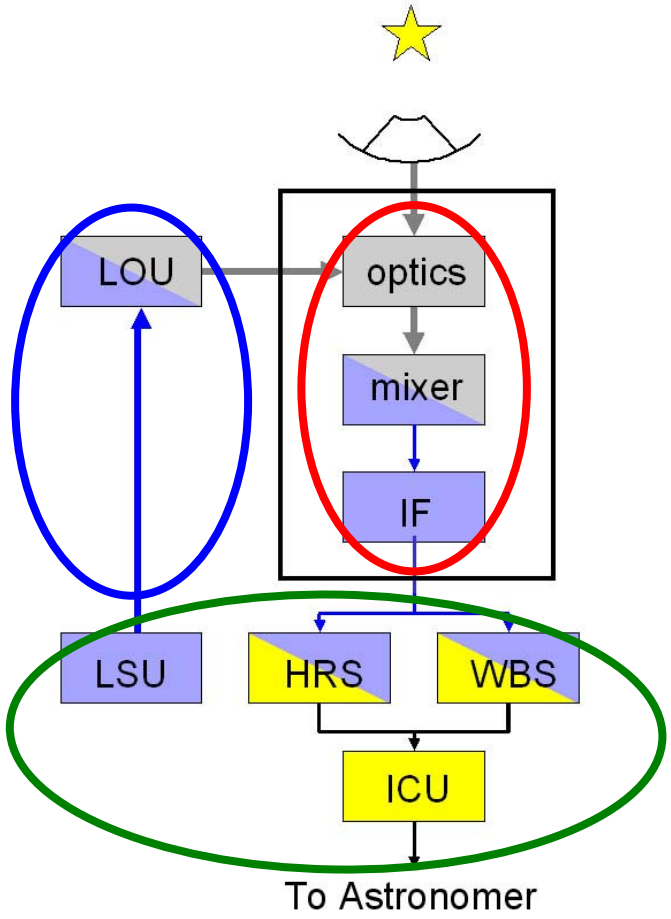
The Heterodyne Instrument for the Far-Infrared

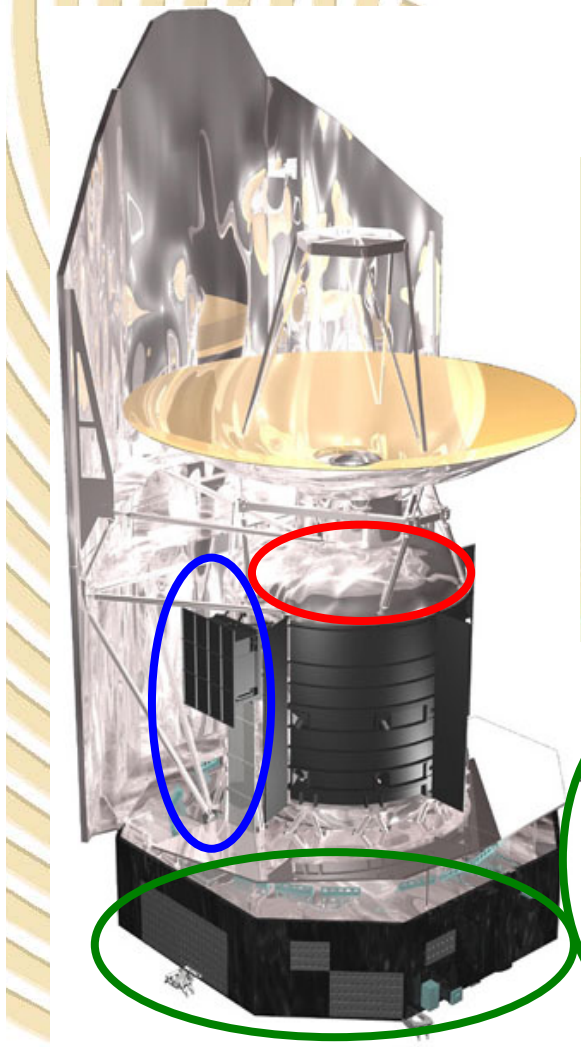
- Seven-channel heterodyne receiver (non-imaging)
- Frequency coverage:
  - 480 - 1250 GHz (625 - 240 μm)
  - 1410 - 1910 GHz (212 - 157 μm)
- Frequency res. 140 kHz - 1 MHz
- Instantaneous IF BW: 4 GHz
- Beam FWHM 12 – 45”

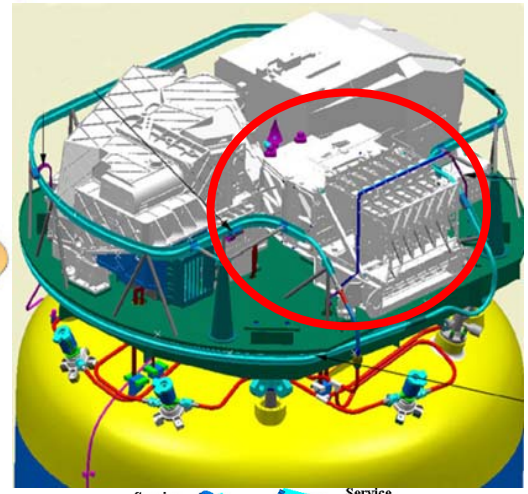


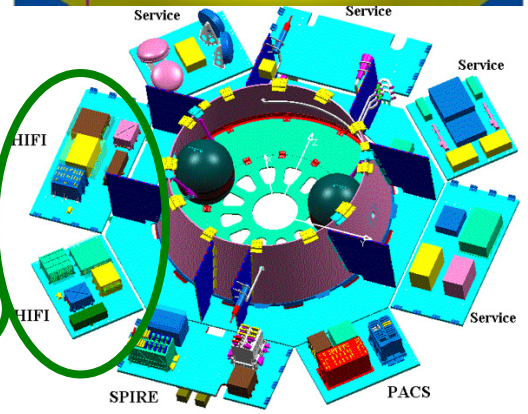
HERSCHEL SPACE OBSERVATORY

Heterodyne principle

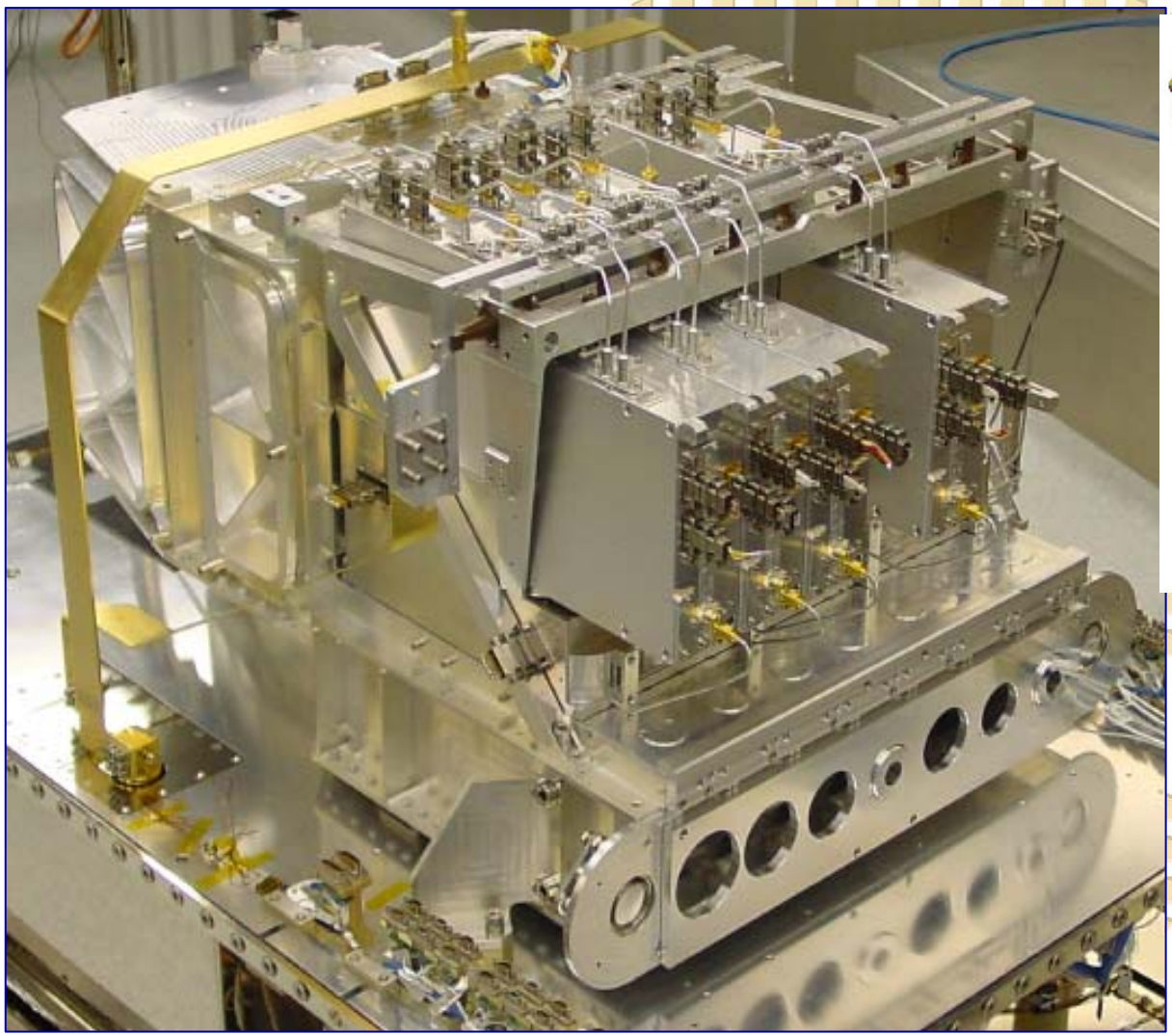


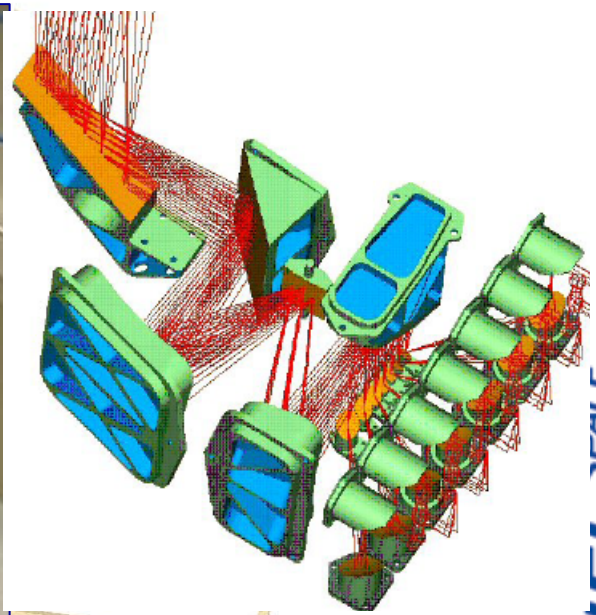




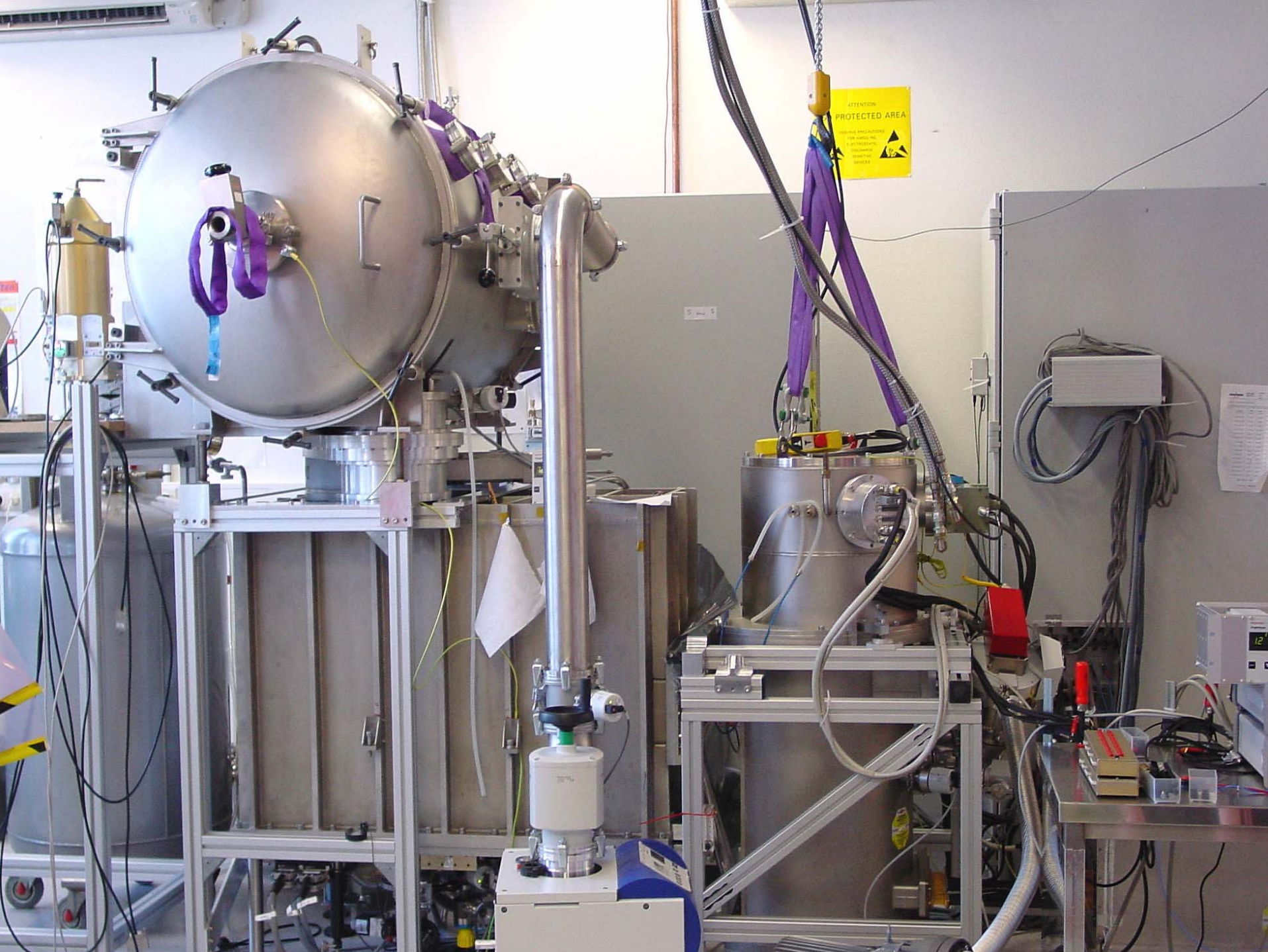


HIFI FPU



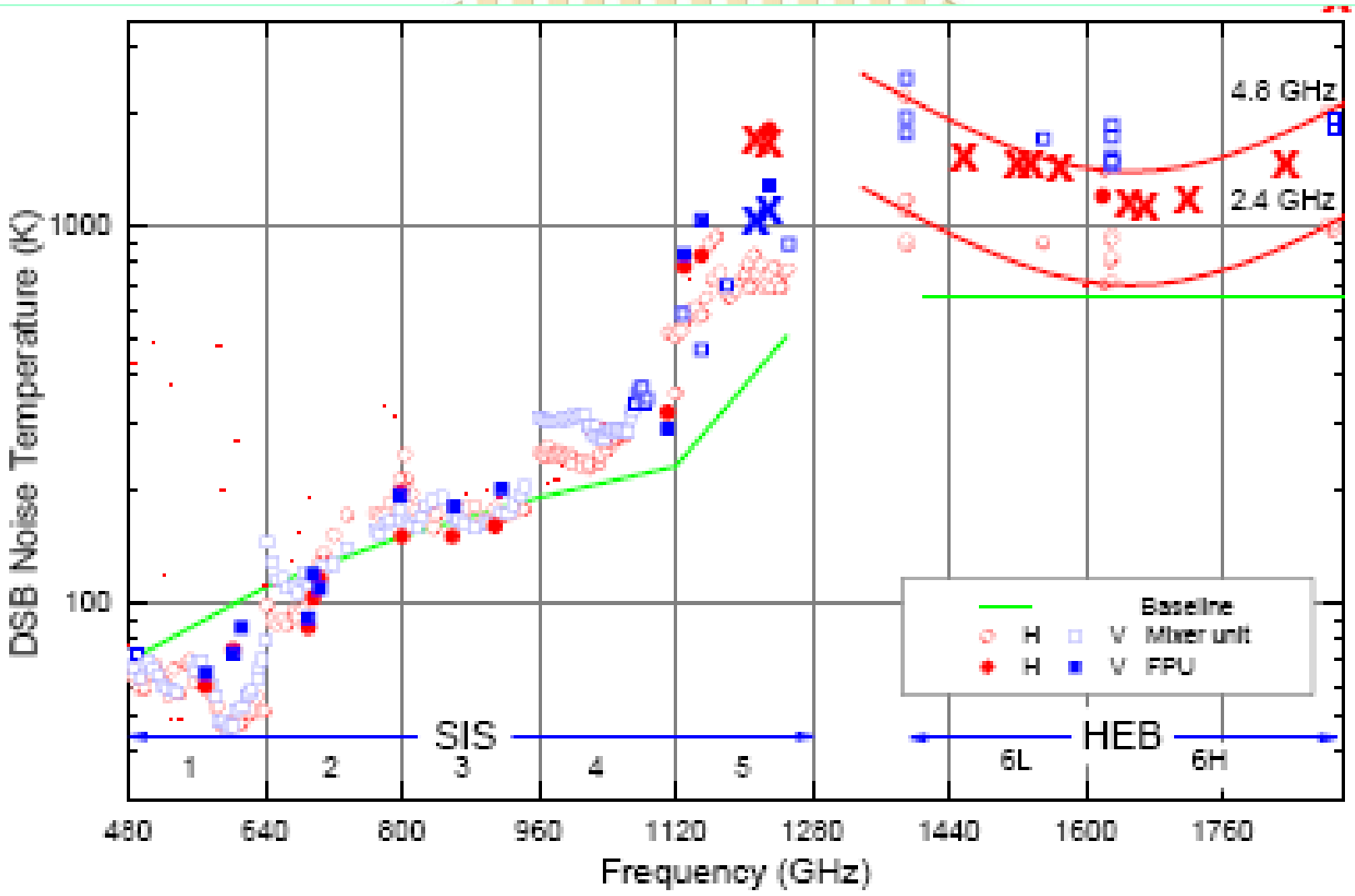


HERSCHEL SPACE OBSERVATORY


ATTENTION
PROTECTED AREA

HIFI performance

open (at mixer level), solid (after integration in FPU)



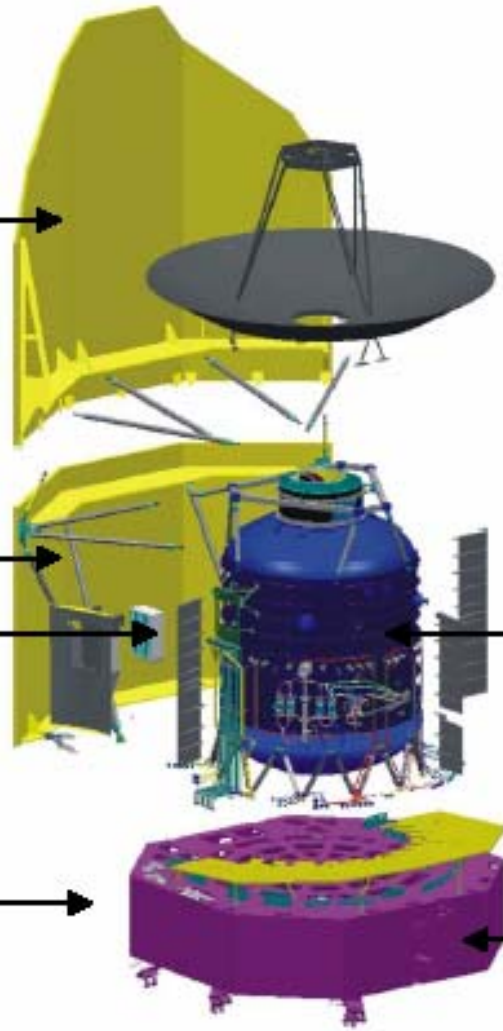
HERSCHEL SPACE OBSERVATORY

Herschel observatory capabilities

- **Photometry - imaging, 6 broad bands in 75-500 μm range**
  - **PACS** – simultaneous 2 colour fully-sampled (0.5Fλ) imaging with FOV 1.75x3.5 arcmin and R~2.5 centred at 70/100 and 170 μm
  - **SPIRE** – simultaneous 3 colour 2Fλ imaging with FOV 4x8 arcmin and R~3 centred at 250, 350, and 500 μm
  - for larger fields 'on-the-fly' mapping, mosaicing
  - sensitivity is somewhat wavelength and observing mode dependant, very roughly for point sources 1mJy - 1σ - 1 hour; for mapping confusion limit is important
- **Spectroscopy - in 55-672 μm range, varying R in 20-10^7 range**
  - **PACS** – grating spectrometer, 5x5 spatial x16 spectral pixels, FOV 0.8 arcmin, R ~ 1500-4000, λ ~ 55-210 μm
  - **SPIRE** – FTS spectrometer, R ~ 20-100+, FOV 2.6 arcmin, λ ~ 194-672 μm
  - **HIFI** – heterodyne spectroscopy with R up to 10^7, λ ~157-212 and 240-625 μm, 2 orthogonal polarisations, 4000 spectral channels per polarisation, single pixel on the sky, mapping by 'on-the fly' or mosaicing observations

HERSCHEL SPACE OBSERVATORY

Herschel spacecraft



Sun Shade

Telescope

Solar Array

Local Oscillator Unit

Cryo Vacuum Vessel

Service Module

Thermal Shields

Instrument Warm Units

Herschel STM satellite

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

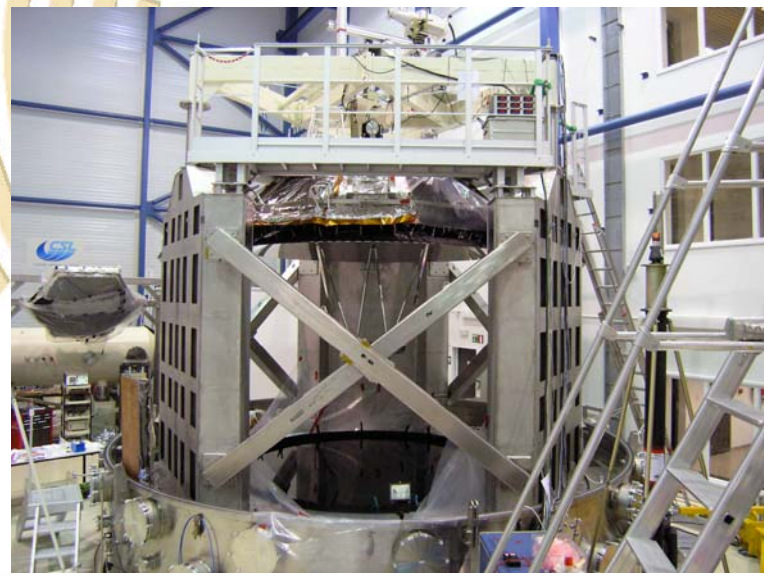
HERSCHEL SPACE OBSERVATORY

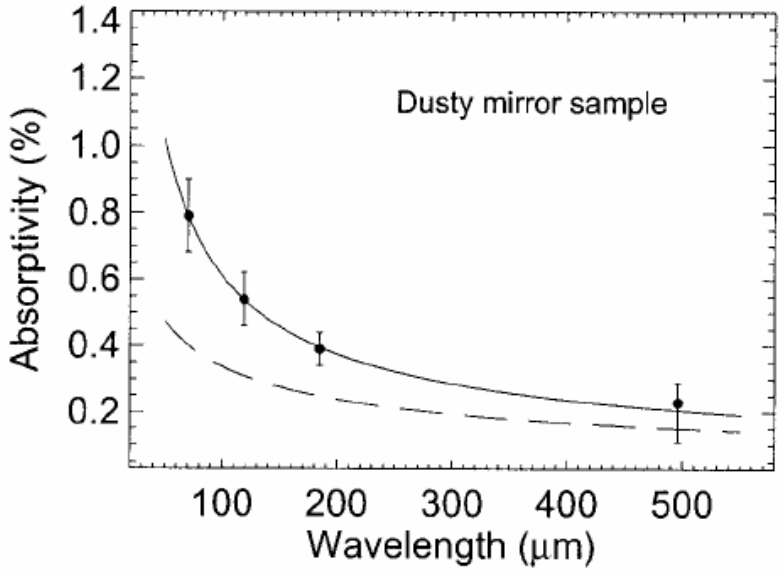
Herschel telescope

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

➔ **effective aperture 3.3 m**

- **WFE at the best focus 5.5 μm at 70 K OK**
- **Encircled energy OK**
- **Mass 315 kg (~90% SiC)**
- **Predicted**
  - operating temp somewhere in the range 60-90 K
  - Gradients across M1 small
    - Sun direction ~0.2 K
    - Orthogonal ~0 K
  - Gradient M1-M2 ~2 K

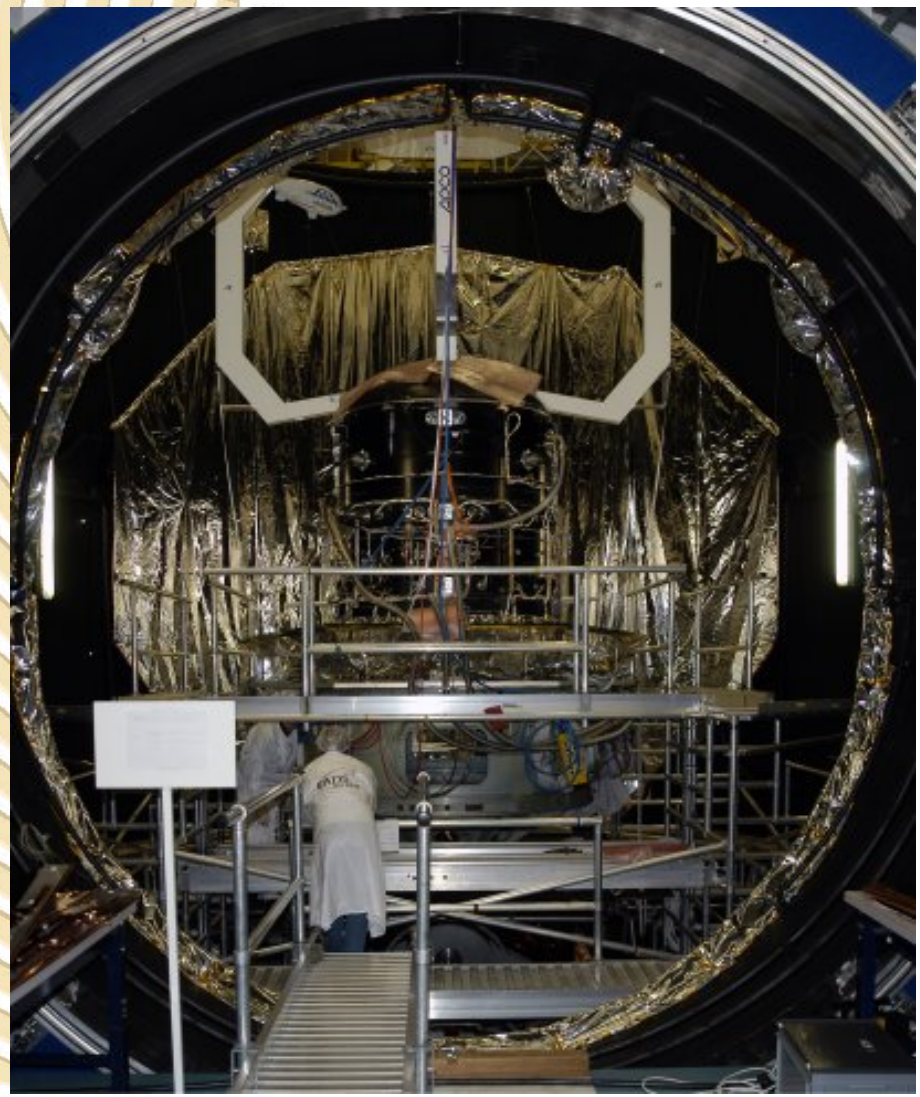




HERSCHEL SPACE OBSERVATORY

Lifetime

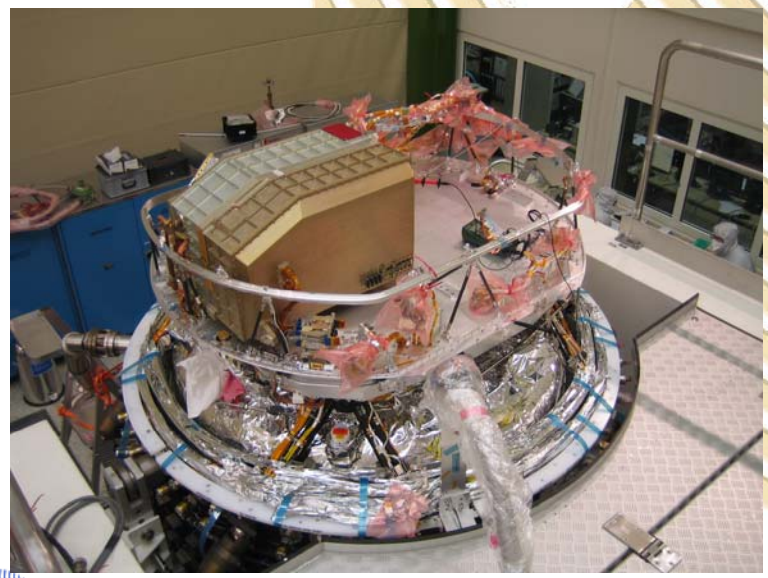
- **Lifetime requirement is being validated**
  - TB/TV test Jan-Feb 2007
  - Model correlation
- **Science requirement**
  - Routine science operations for 3 years
  - Cryostat lifetime 3.5 years
- **Model predictions**
  - Contractual conditions 3.9 +/-0.4 years
  - ‘Actual’ dissipations 4.1 +/- 0.4 years
  - ‘Predicted’ lifetime 4.7 +/- 0.4 years
- **Test assessment**
  - Initial feedback ‘slightly less’
  - Lifetime requirement validated
  - Need certain boil-off rate for interface requirements

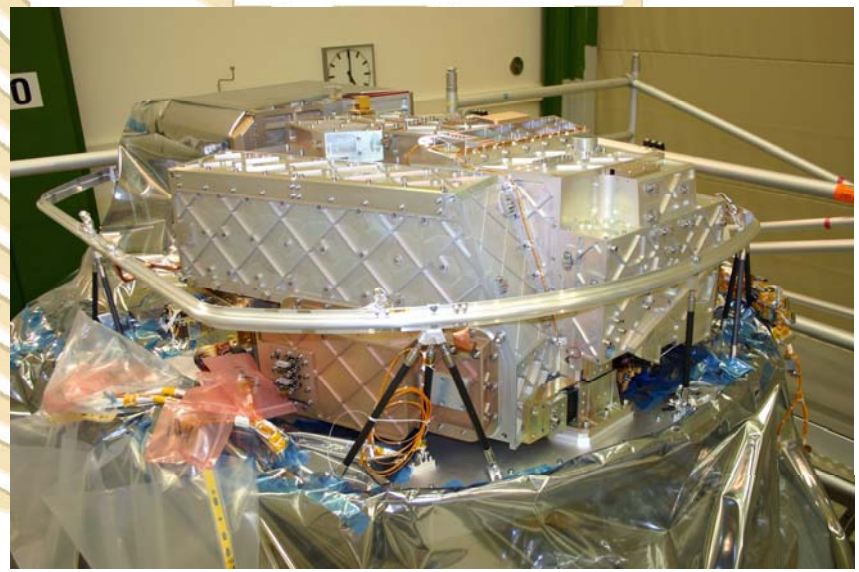


HERSCHEL SPACE OBSERVATORY

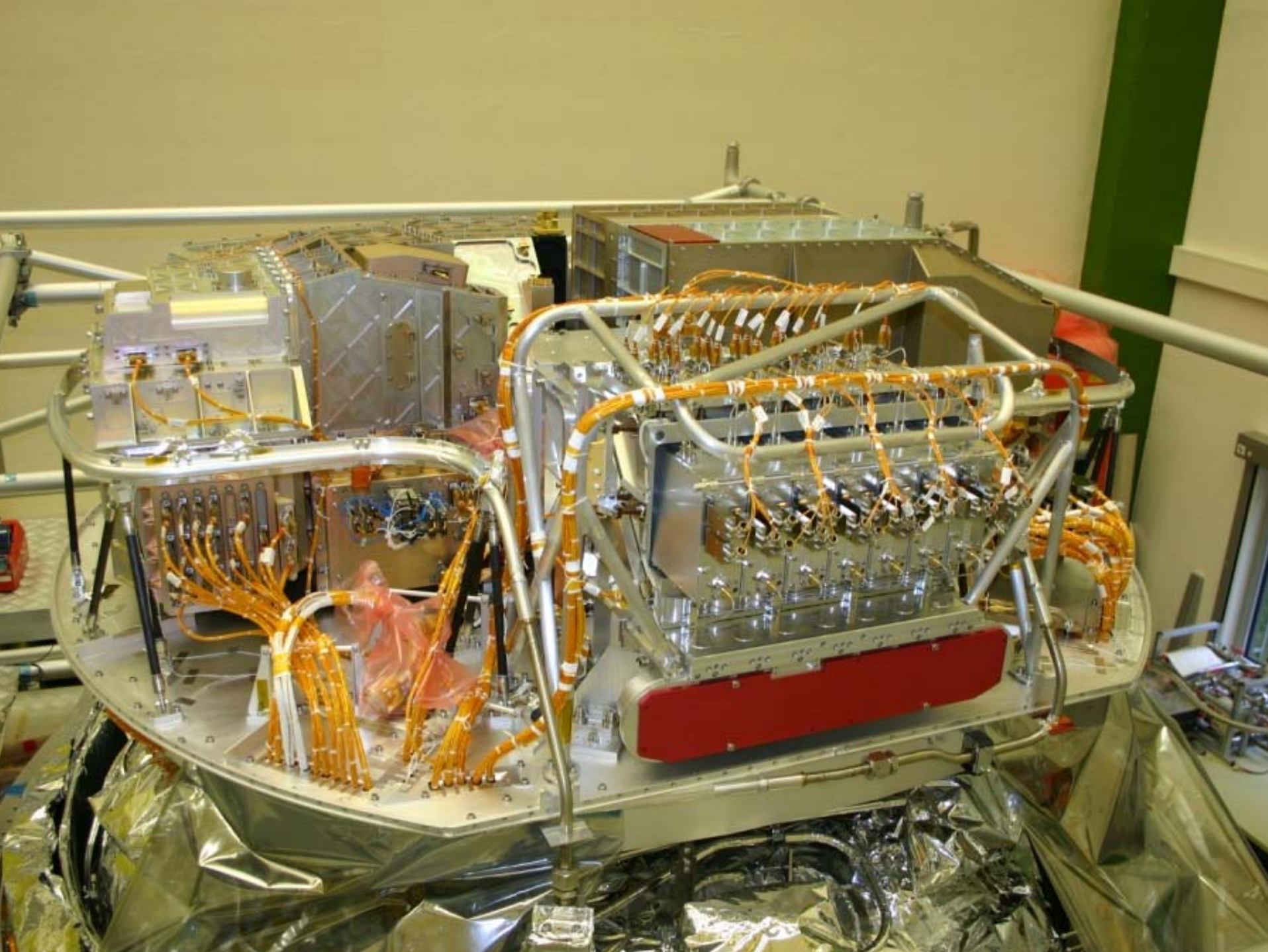
Payload integration

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





HERSCHEL SPACE OBSERVATORY



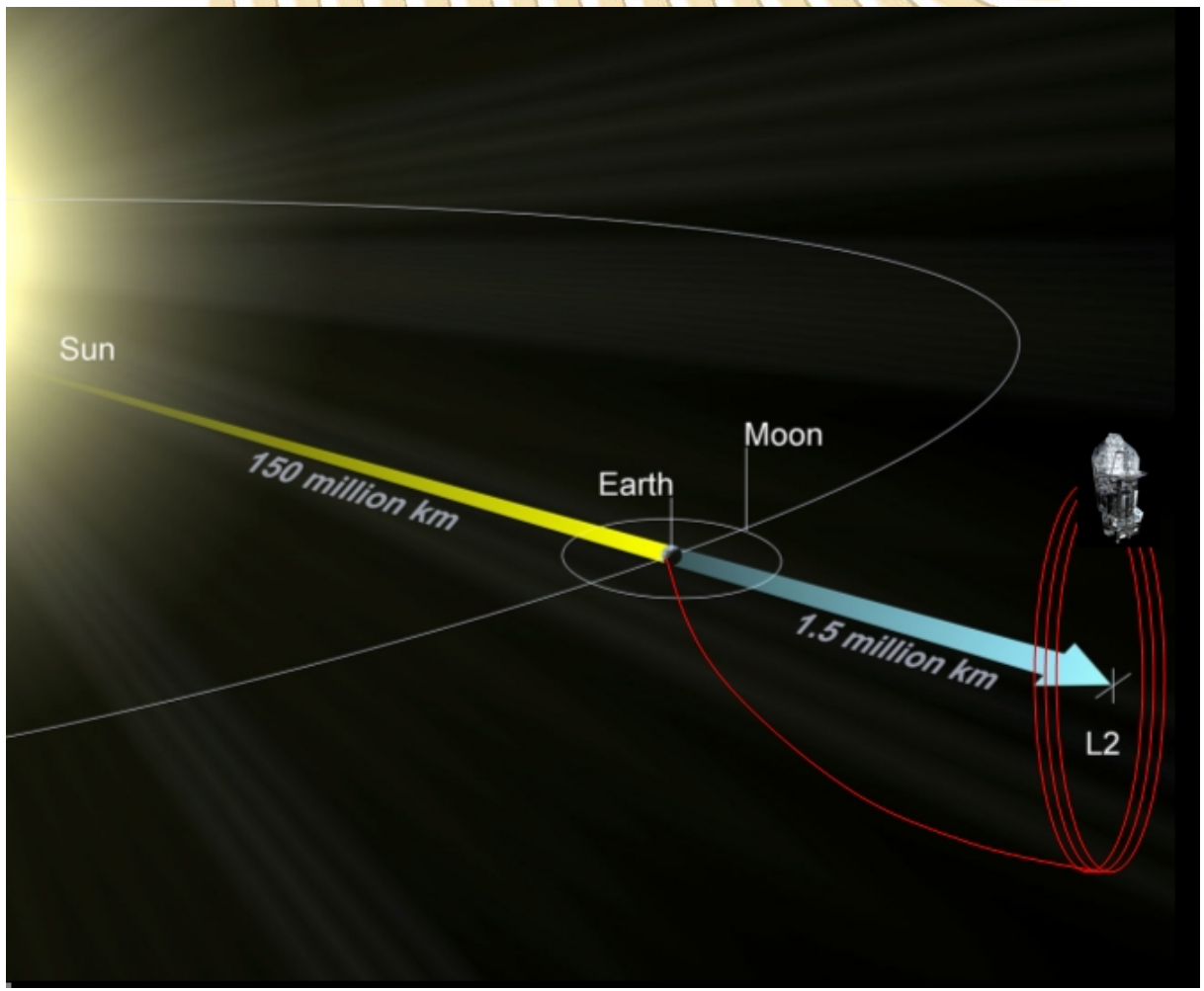
Launch

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

HERSCHEL SPACE OBSERVATORY

Why L2?

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



HERSCHEL SPACE OBSERVATORY

Herschel key dates

- FIRST feasibility study: 1982-83
- …
- FIRST confirmed 4th Cornerstone: Dec 1993
- …
- Selection of science instruments/PIs: 1997-98
- FIRST becomes Herschel: Dec 2000
- Start of spacecraft Phase B: mid 2001
- Start of spacecraft Phase C/D: early 2003
- SVM, PLM, telescope, CQM/EQM testing 2005
- SVM, PLM, instruments, telescope deliveries: 2006-07
- Issue of first AO for proposals: 1 Feb 2007
- Integration & tests/verification: 2007-08
- Launch: (planning date 31 Jul) 2008
- Early operations: first 6 months
- Routine Science Operations: 2009 - 2012

HERSCHEL SPACE OBSERVATORY

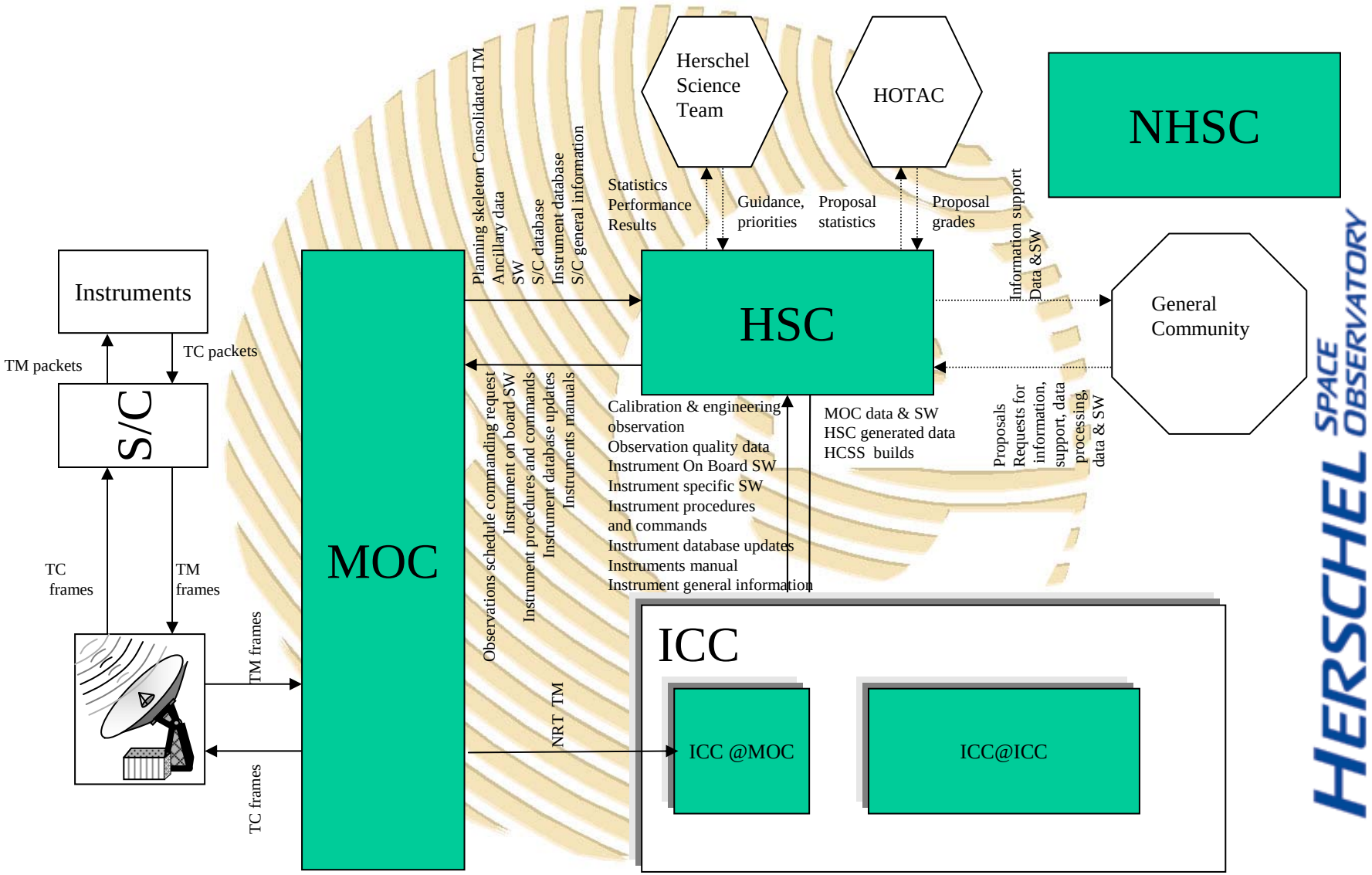

Observing
Opportunities

Herschel mission phases

- **Launch and early operations (LEOP) – month 1**
  - telescope kept warm during s/c cooldown (~20 days after launch)
  - cryo-cover opening (first light!) ~1 month after launch
- **Commissioning and performance verification – months 2-4**
  - CPV plan being worked on
  - telescope cooling down 'completed' (~60 days after launch)
  - availability of particular sources (often solar system objects)
- **Science demonstration phase – months 5-6**
  - 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 – poor ToO capability

HERSCHEL SPACE OBSERVATORY

Ground segment



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) **– ongoing!**
  - 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

Herschel 'Key Projects'

- **Foreseen to be important upfront (SMP/instrument AO)**
  - introduced to ensure that 'unusually large' observing programmes can be proposed, selected, and observed
  - need 'pre-identified' due to the nature of the foreseen science objectives and the lack of 'precursor' (IRAS-type) mission
- **Definition of a 'Key Project' programme - it must**
  - exploit unique Herschel capabilities address (an) important scientific issue(s) in a comprehensive manner
  - require a large amount of observing time to be used in a uniform and coherent fashion
  - produce a resulting well characterised dataset of high archival value
- **Data reduction**
  - it is recognised that there is a legitimate science return interest that
    - the data generated by the observations are timely reduced, and
    - the data products and tools are made public
  - therefore 'Key Project' consortia must demonstrate commitment and ability to perform data reduction, and must make data products and tools publicly available at the end of the proprietary time period

HERSCHEL SPACE OBSERVATORY

Overall AO schedule

- **1 Feb 2007: Issue AO for 'Key Projects' proposals**
- **4 Apr 2007: Submission deadline for GT KP proposals**
- **HOTAC procedure – 21 proposals received**
- Phase 2 proposal entering
- Construction of Reserved Observations list
- **9 Jul 2007: Announcement of GT KP programmes**
  'Effectively' the AO date for open time proposers
- **25 Oct 2007: Submission deadline for OT KP proposals**
- HOTAC procedure
- Phase 2 proposal entering
- Construction of Reserved Observations list
- **28 Feb 2008: Announcement of OT KP programme**
- **3 Mar 2008: Issue AO for Cycle 1 'regular proposals' GT only**
- **OT only after in-flight science demonstration**
- **Issue AO for Cycle 2 'regular proposals'**

HERSCHEL SPACE OBSERVATORY


Detailed information
and responding

Herschel on the web – level 1

- **Three-tier structure of ESA Herschel websites:**
- **ESA Corporate level**
  - **intended for general public, media, …**
  - **http://www.esa.int/science/herschel/**

HERSCHEL SPACE OBSERVATORY

esa Space Science
European Space Agency

Herschel overview

Status
In development

Objective
Herschel will investigate the history of how stars and galaxies formed and to study how they continue to form in our own and other galaxies. Herschel will observe at wavelengths never covered before.

Bookmark this page as:
http://www.esa.int/science/herschel
(Ctrl+D)

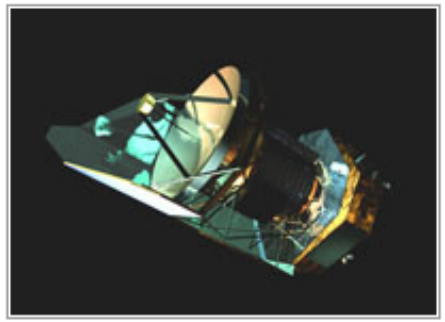
For more in-depth scientific and technical details of our Space Science Programme and missions, follow this link.

Herschel in depth

Space Science
- About Space Science
- ESA's 'Cosmic Vision'
- Science & Technology in-depth

Multimedia
- Science images
- Science videos
- Animations
- Downloads
- Sounds from space
- RSS feeds

Media centre
- Press Releases
- Press kits



Artist's impression of Herschel

Mission

Herschel will be the largest space telescope of its kind when launched. Herschel's 3.5-metre diameter mirror will collect long-wavelength infrared radiation from some of the coolest and most distant objects in the Universe. Herschel will be the only space observatory to cover the spectral range from far-infrared to sub-millimetre wavelengths.

Infrared radiation is invisible for the human eye. It is actually 'heat', or thermal radiation. Even objects that we think of as being very cold, such as an ice cube, emit infrared radiation. For this reason, infrared telescopes can observe astronomical objects that remain hidden for

More about...
- Herschel factsheet
- ISO overview
- Planck overview

Related articles
- Observations: Seeing in infrared wavelengths
- L2, the second Lagrangian Point
- Why infrared astronomy is a hot topic
- The infrared explorers

Herschel on the web – level 2

- **Three-tier structure of ESA Herschel websites:**
- **ESA Corporate level**
  - **intended for general public, media, …**
  - **http://www.esa.int/science/herschel/**
- **Science Directorate level – 'SciTech'**
  - **intended for 'interested' public, 'general' science community, media, …**
  - **http://sci.esa.int/herschel/**

HERSCHEL SPACE OBSERVATORY

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http://sci.esa.int/science-e/www/area/index.cfm?fareaid=16

herschel

ESA Science & Technology: Her... | Herschel Science Centre | ESAC TeamCal Pro

HERSCHEL

17-Aug-2007 16:45:01 UT

IMAGES AND VIDEOS

LAUNCH DATE:	2008
MISSION END:	2011-2012
LAUNCH VEHICLE:	Ariane-5
LAUNCH MASS:	3300 kg
MISSION PHASE:	Implementation

ORBIT:
Lissajous orbit about the second Lagrange point of the Earth-Sun system (L2)

OBJECTIVES:

- Study the formation of galaxies in the early universe and their subsequent evolution
- Investigate the creation of stars and their interaction with the interstellar medium
- Observe the chemical composition of the atmospheres and surfaces of comets, planets and satellites
- Examine the molecular chemistry of the universe

THE MISSION:
The European Space Agency's Herschel Space Observatory (formerly called Far Infrared and Sub-millimetre Telescope or FIRST) has the largest mirror ever built for a space telescope. At 3.5-metres in diameter the mirror will collect long-wavelength radiation from some of the coldest and most distant objects in the Universe. In addition, Herschel will be the only space observatory to cover a

Herschel on the web – level 3

- **Three-tier structure of ESA Herschel websites:**
- **ESA Corporate level**
  - **intended for general public, media, …**
  - **http://www.esa.int/science/herschel/**
- **Science Directorate level – 'SciTech'**
  - **intended for 'interested' public, 'general' science community, media, …**
  - **http://sci.esa.int/herschel/**
- **Herschel Science Centre – user! – level**
  - **intended (primarily) for (potential) users of missions, …**
  - **http://herschel.esac.esa.int/**
  - **(old URL http://www.rssd.esa.int/herschel/ redirects to above)**
  - **this the Herschel Science Centre site**

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HERSCHEL

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

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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.

Open Time Key Programme AO!

- **NEW!** Herschel Key Programme Announcement of Opportunity was issued on 1 February 2007 and the GT KP phase has now been completed. The observing planning tool HSpot has now been updated for OT KP phase 1, more tools have been added and the AO documentation has been updated. **The updated AO documentation and tools are available on this website** (see menu on the left). The user services the HSC provides are

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Herschel Latest News

The HIFI FM FPU has joined SPIRE and PACS on the optical bench. After leaving SRON, Groningen on 9 July 2007 and arriving in Astrium, Friedrichshafen the following day, the HIFI FM FPU was integrated onto the Herschel optical bench. By joining the SPIRE and PACS FPUs already there all Herschel science instruments have been integrated. In the pictures above from left to right: HIFI with PACS to the left, HIFI with SPIRE to the right, HIFI under the instrument shield. Images courtesy of Astrium. [July 2007]

PACS FM FPU also mounted on the Herschel optical bench. The PACS flight model (FM) instrument has been delivered from the Max-Planck-Institut für extraterrestrisch Physik (MPE), Garching, to the Astrium premises in Friedrichshafen, Germany. The warm electronics were delivered on 3 July, the focal place unit (FPU) on 6 July, and in the pictures above the FPU can be seen being hoisted and mounted onto the Herschel flight cryostat optical bench next to SPIRE on 9 July 2007. [July 2007]

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Herschel Open Time Key Program workshop
ESTEC, Noordwijk, 20-21 February 2007

Workshop generalities

- Final (3rd) Announcement (PDF 31 kb) with workshop program
- List of participants (PDF 85 kb) updated on 2 March 2007

Presentations

- Herschel and Guaranteed Time Key Programmes
  - Herschel mission overview and the Key Programme AO (PDF 7.1Mb) by Göran Pilbratt, Herschel Project Scientist, ESA/HSC
  - HIFI instrument and GT programmes (PDF 4.1 Mb) by Thijs de Graauw, HIFI Principal Investigator, SRON
  - PACS instrument and GT programmes (PDF 6.9 Mb) by Albrecht Poglitsch, PACS Principal Investigator, MPE

Herschel Observation Planning workshop
ESAC, Spain, 20-21 September 2007

Topic

The Herschel Science Centre (HSC) is organising a hands-on Herschel Observation Planning Workshop oriented toward the Open Time Key Programme submission.

The workshop will include:

- Overview of the Herschel mission, with special attention to Herschel operations and how they affect observation planning.
- Instrument presentations, with a detailed description of available observing modes and their use for particular science tasks.
- Overview of accepted Guaranteed Time Key Programmes.
- A lot of practical information that will help you when preparing your Key Programme proposal observing plan.
- Practical demonstrations on the use of HSpot - the Herschel Observation Planning Tool. Learn how to generate and improve your observing requests.
- Topic oriented hands-on sessions, with time to work in the preparation of your own proposals and the possibility to ask the HSC experts for advice in real time.

Agenda

A Preliminary Agenda of the Herschel Observation Planning workshop can be found here

Venue

The workshop will be held at the European Space Astronomy Centre (ESAC) situated at Villafranca del Castillo near Madrid (Spain). Maps and driving directions to ESAC from Madrid airport (Barajas) and from Madrid (City Centre) can be found here.

Accommodation

A limited number of rooms have been pre-booked in a hotel in the vicinity of ESAC with a special discount (-10%) for the workshop

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Announcement of Opportunity for Herschel Key Programmes

AO Documentation

The Announcement of Opportunity (AO) for Key Programmes (KPs) package consists of the following documentation:

- **Herschel Key Programme Announcement of Opportunity**, PDF (58kb). This letter from the ESA Director of Scientific Programme is the formal Announcement of Opportunity inviting the scientific community to apply for the Herschel Key Programme observing time.
- **Executive Summary**, PDF (32kb) or HTML. Summarises the AO and associated documents, tools, and services, providing the reader with a concise overview and help on where to find what information.
- **Policies and procedures**, PDF (106kb) or HTML. This is the "administrative" document of the Announcement of Opportunity, providing all necessary information about the policies adopted and the procedures to be followed.
- **Herschel Observers' Manual**, PDF (1.6Mb) or HTML. Provides information about Herschel pertinent to using the observatory from the perspective of an observer.
- **Heterodyne Instrument for the Far Infrared (HIFI) Observers' Manual**, PDF (3.5Mb) or HTML. Provides information about and how to use the HIFI instrument to perform observations.
- **Photodetector Array Camera & Spectrometer (PACS) Observers' Manual**, PDF (10.3Mb) or HTML. Provides information about and how to use the PACS instrument to perform observations.
- **Spectral and Photometric Imaging Receiver (SPIRE) Observers' Manual**, PDF (5.0Mb) or HTML. Provides information about and how to use the SPIRE instrument to perform observations.
- **SPIRE PACS Parallel Mode Observers' Manual**, PDF (565kb) or HTML. Provides information about and how to use the SPIRE and PACS instruments in Parallel Mode to perform observations.
- **Reserved Observations**: webpage; describes the Guaranteed Time Key Programme reserved observations, together they make up the GT Key Programme, and provides access to the Reserved Observations Search Tool.
- The AO Latest News webpage provides last minute updates and corrections to the AO documention package.

Last updated: Tuesday, 24-Jul-2007 15:49:13 CEST

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Announcement of Opportunity for Herschel Key Programmes

AO Tools

The Announcement of Opportunity (AO) for Key Programmes (KPs) package contains the following tools:

- The AO **HerschelFORM PDFLaTeX package** with a proposal template.
- The **Reserved Observations Search tool**, providing easy search of GT KP AORs around a given point on the sky with a specified radius.
- The **observation planning tool HSpot** for designing your observations requests and calculating the required observing times.

AO HerschelFORM PDFLaTeX package

The Herschel OT KP proposals must be written using the provided HerschelFORM PDFLaTeX package. The proposal template provided will force you to write a proposal that follows the applicable style and page rules.

Reserved Observations Search tool

Checks for duplications between your planned observations and already approved Guaranteed Time Key Programme AORs can be made using the Herschel Reserved Observations Search Tool. The tool will enable you to search all the AORs included in the Reserved Observations List in a simple fashion through a java-based web interface available here (requires Java 1.5 or higher).

Once you start the application you can access and download the whole list of accepted GT KP AORs if in the search form all fields are left blank and you click on the 'Search Reserved Observations' button. For any other query enter a position in the sky and a search radius as input and the tool will return as output a summary description of all AORs in the database overlapping your search area.

Potential duplications found using this tool can be further investigated in detail using HSpot. You can access and download those AORs of your interest by using the option "View accepted proposals" under the 'File' menu of HSpot.

Observation planning tool - HSpot

The Herschel observation planning tool has been built starting from the tool developed for the Spitzer Space Observatory called Spot, thus Herschel-Spot or simply HSpot. The look and feel of this tool is that of the Spitzer tool, but it has been fully adapted for Herschel.

- Herschel Observation Planning Tool (HSpot) download
- **HSpot Users' Guide**, PDF (19Mb) or HTML. Provides information about and how to use the HSpot tool itself for planning Herschel observations.

Herschel Observation Planning Tool (HSpot) Download

For detailed HSpot installation instructions, please have a look at the Herschel-Spot User's Guide.

Installation Files	Size	To Install the software
Windows HSpot_V3_0_7_Windows_Installer.exe	~75MB	(a) Download the relevant installer (b) Double-click on the file via an explorer window to install it (c) Launch the application via Start/Programs/HerschelSpot
Solaris HSpot_V3_0_7_Solaris_Installer.bin	~100MB	(a) Right click on the link and Save As... (b) Run the installer: from the directory where you have saved the file: type sh HSpot_V3_0_7_Solaris_Installer.bin (c) Launch the application by typing: ./HerschelSpot from the installation directory.
Linux HSpot_V3_0_7_Linux_Installer.bin	~100MB	(a) Right click on the link and Save As... (b) Run the installer: from the directory where you have saved the file: type sh HSpot_V3_0_7_Linux_Installer.bin (c) Launch the application by typing: ./runHerschelSpot from the installation directory.
Mac OS X HSpot_V3_0_7_MacOSX_Installer.zip	~35MB	(a) Download and unzip the relevant installer (b) Run the Installer that has been unzipped (c) Launch the application by double-clicking on HerschelSpot

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Guaranteed Time Key Programmes

A total of 21 Key Programmes were accepted containing more than 6600 AORs which form the Reserved Observation List. These observations cannot be duplicated by Open Time Key Programmes. If you want to check whether your planned observationsare already covered by one or more AORs in this list, use the Reserved Observations Search Tool.

Below you can find the list of accepted Guaranteed Time Key Programmes sorted by Science Category. Click on the proposal id's to access the text of the abstracts.

Stars (2)

KPGT_mgroen01_1
"The circumstellar environment in post-main-sequence objects"
(PI: Martin Groenewegen)

KPGT_vbujarra_1
"HIFISTARS: The physical and chemical properties of circumstellar environments around evolved stars"
(PI: Valentín Bujarrabal)

ISM/Star formation/Solar system (11)

KPGT_aabergel_1
"Evolution of interstellar dust"
(PI: Alain Abergel)

KPGT_mgerin_1

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http://herschel.esac.esa.int/Docs/GTKP/KPGT_accepted.html#KPGT_soliver_1

herschel

http://herschel...KPGT_soliver_1

Proposal ID: KPGT_mgroen01_1
Title:
"The circumstellar environment in post-main-sequence objects"
Principal Investigator:
Martin Groenewegen (University of Leuven)
Category:
KPGT
Summary:
Mass loss is one of the most fundamental properties of post-main sequence evolution. The mass-loss process leads to the formation of circumstellar shells containing dust and molecules. Although the mass-loss phenomenon has been studied since the 1960s, and important results have been obtained with the IRAS, ISO and Spitzer space missions, the details of the mass-loss process and the formation and evolution of the circumstellar shells are still not well understood. With its improved spatial resolution compared to ISO and Spitzer, better sensitivity, the extension to longer and unexplored wavelength regions, and medium resolution spectrometers, the combination of PACS and SPIRE observations will lead to a significant improvement in our understanding of the phenomena of mass loss and dust formation. The main aims of this programme are three-fold: (1) to study the time dependence of the mass loss process, via a search for shells and multiple shells around a wide range of evolved objects, in order to quantify the total amounts of mass lost at the various evolutionary stages of low to high-mass stars, (2) to study the dust and gas chemistry as a function of progenitor mass, and (3) to study the properties and asymmetries of evolved star envelopes. To this end, a sample of 103 Asymptotic Giant Branch and Red Super Giants, post-AGB and Planetary Nebulae, Luminous Blue Variables and Wolf-Rayet stars, and 5 Supernovae remnants will be imaged with PACS at 70+170 micron, and a sub-set of 32 stars will be imaged at all 3 wavelengths with SPIRE. In spectroscopy, a sample of 55 stars will be observed over the full wavelength range of PACS and, 23 stars will be observed with the SPIRE FTS. The sample of AGB stars has been selected to cover all chemical types (M-, S-, C-stars), variability types (irregular, semi-regular, Miras) and periods, and mass-loss rates. Stars have been selected to have high IRAS fluxes and low background levels. The spectroscopic targets are typically the brightest of the mapping targets

Done

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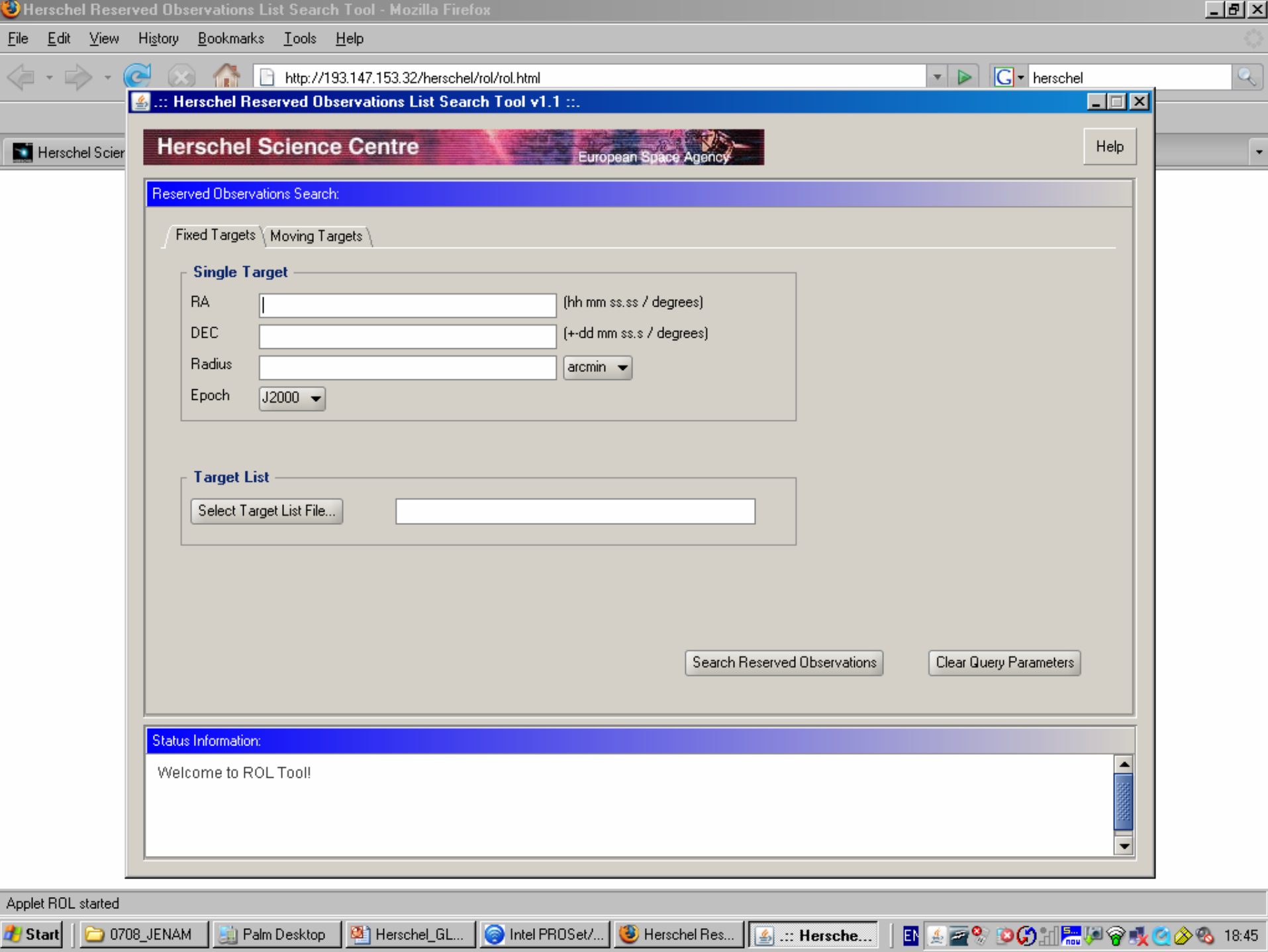
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File Edit View History Bookmarks Tools Help
http://193.147.153.32/herschel/rol/rol.html
herschel
.:: Herschel Reserved Observations List Search Tool v1.1 ::.
Herschel Science Centre
European Space Agency
Help
Reserved Observations Search:
Fixed Targets
Moving Targets
Single Target
RA
(hh mm ss.ss / degrees)
DEC
(+-dd mm ss.s / degrees)
Radius
arcmin
Epoch
J2000
Target List
Select Target List File...
Search Reserved Observations
Clear Query Parameters
Status Information:
Welcome to ROL Tool!
Applet ROL started
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0708_JENAM
Palm Desktop
Herschel_GL...
Intel PROSet/...
Herschel Res...
.:: Hersche...
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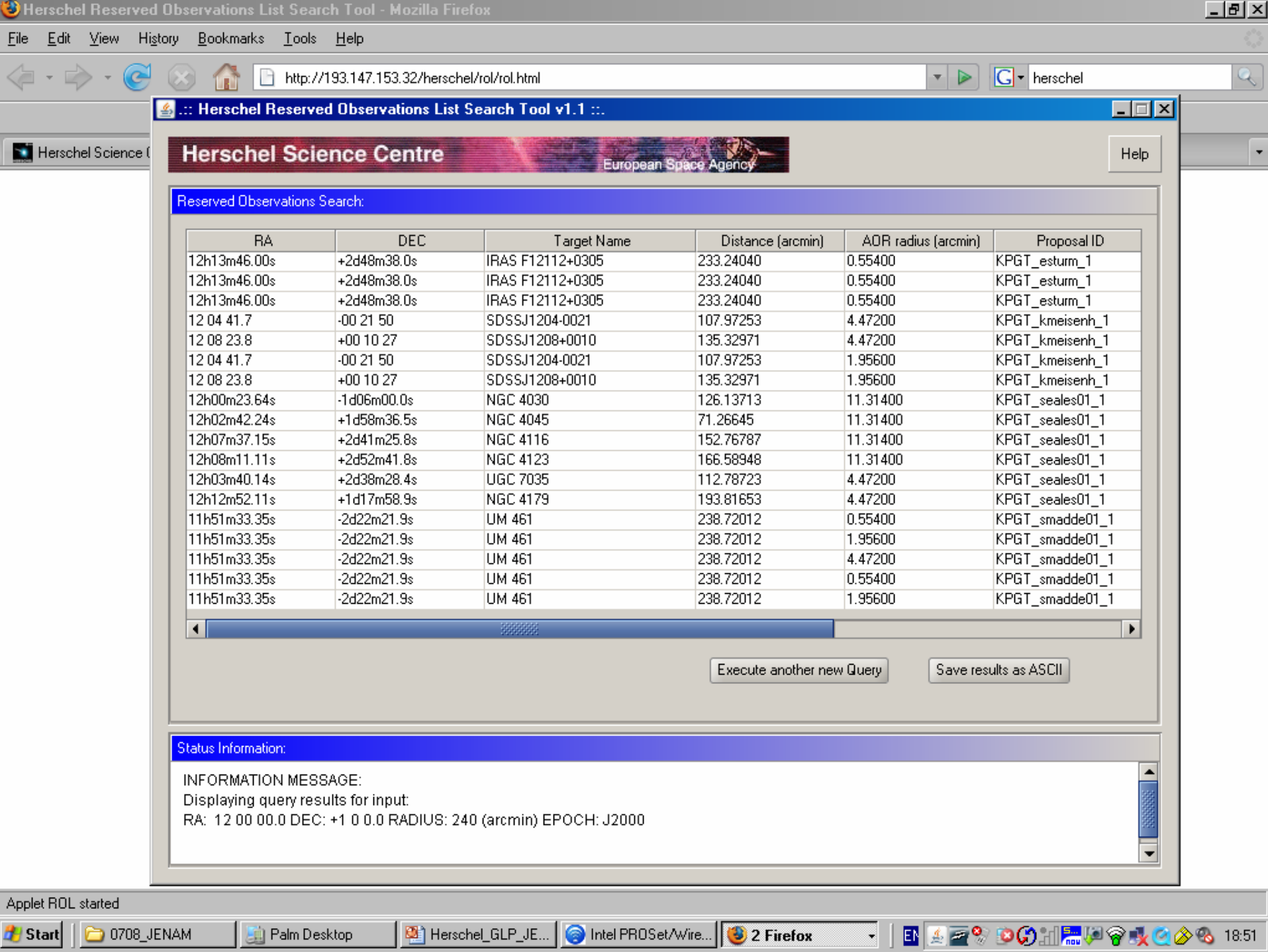
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.:: Herschel Reserved Observations List Search Tool v1.1 ::.
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Reserved Observations Search:
RA DEC Target Name Distance (arcmin) AOR radius (arcmin) Proposal ID
12h13m46.00s +2d48m38.0s IRAS F12112+0305 233.24040 0.55400 KPGT_esturm_1
12h13m46.00s +2d48m38.0s IRAS F12112+0305 233.24040 0.55400 KPGT_esturm_1
12h13m46.00s +2d48m38.0s IRAS F12112+0305 233.24040 0.55400 KPGT_esturm_1
12 04 41.7 -00 21 50 SDSSJ1204-0021 107.97253 4.47200 KPGT_kmeisenh_1
12 08 23.8 +00 10 27 SDSSJ1208+0010 135.32971 4.47200 KPGT_kmeisenh_1
12 04 41.7 -00 21 50 SDSSJ1204-0021 107.97253 1.95600 KPGT_kmeisenh_1
12 08 23.8 +00 10 27 SDSSJ1208+0010 135.32971 1.95600 KPGT_kmeisenh_1
12h00m23.64s -1d06m00.0s NGC 4030 126.13713 11.31400 KPGT_seales01_1
12h02m42.24s +1d58m36.5s NGC 4045 71.26645 11.31400 KPGT_seales01_1
12h07m37.15s +2d41m25.8s NGC 4116 152.76787 11.31400 KPGT_seales01_1
12h08m11.11s +2d52m41.8s NGC 4123 166.58948 11.31400 KPGT_seales01_1
12h03m40.14s +2d38m28.4s UGC 7035 112.78723 4.47200 KPGT_seales01_1
12h12m52.11s +1d17m58.9s NGC 4179 193.81653 4.47200 KPGT_seales01_1
11h51m33.35s -2d22m21.9s UM 461 238.72012 0.55400 KPGT_smadde01_1
11h51m33.35s -2d22m21.9s UM 461 238.72012 1.95600 KPGT_smadde01_1
11h51m33.35s -2d22m21.9s UM 461 238.72012 4.47200 KPGT_smadde01_1
11h51m33.35s -2d22m21.9s UM 461 238.72012 0.55400 KPGT_smadde01_1
11h51m33.35s -2d22m21.9s UM 461 238.72012 1.95600 KPGT_smadde01_1
Execute another new Query
Save results as ASCII
Status Information:
INFORMATION MESSAGE:
Displaying query results for input:
RA: 12 00 00.0 DEC: +1 0 0.0 RADIUS: 240 (arcmin) EPOCH: J2000
Applet ROL started
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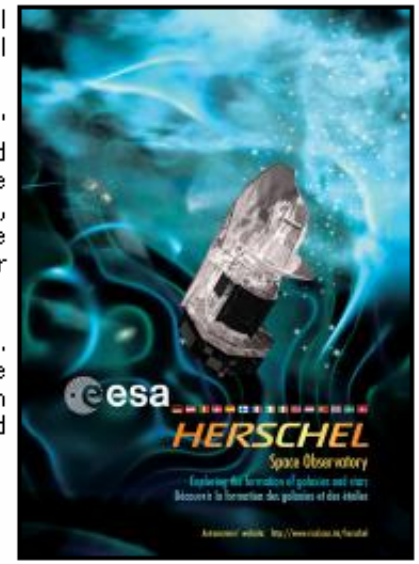

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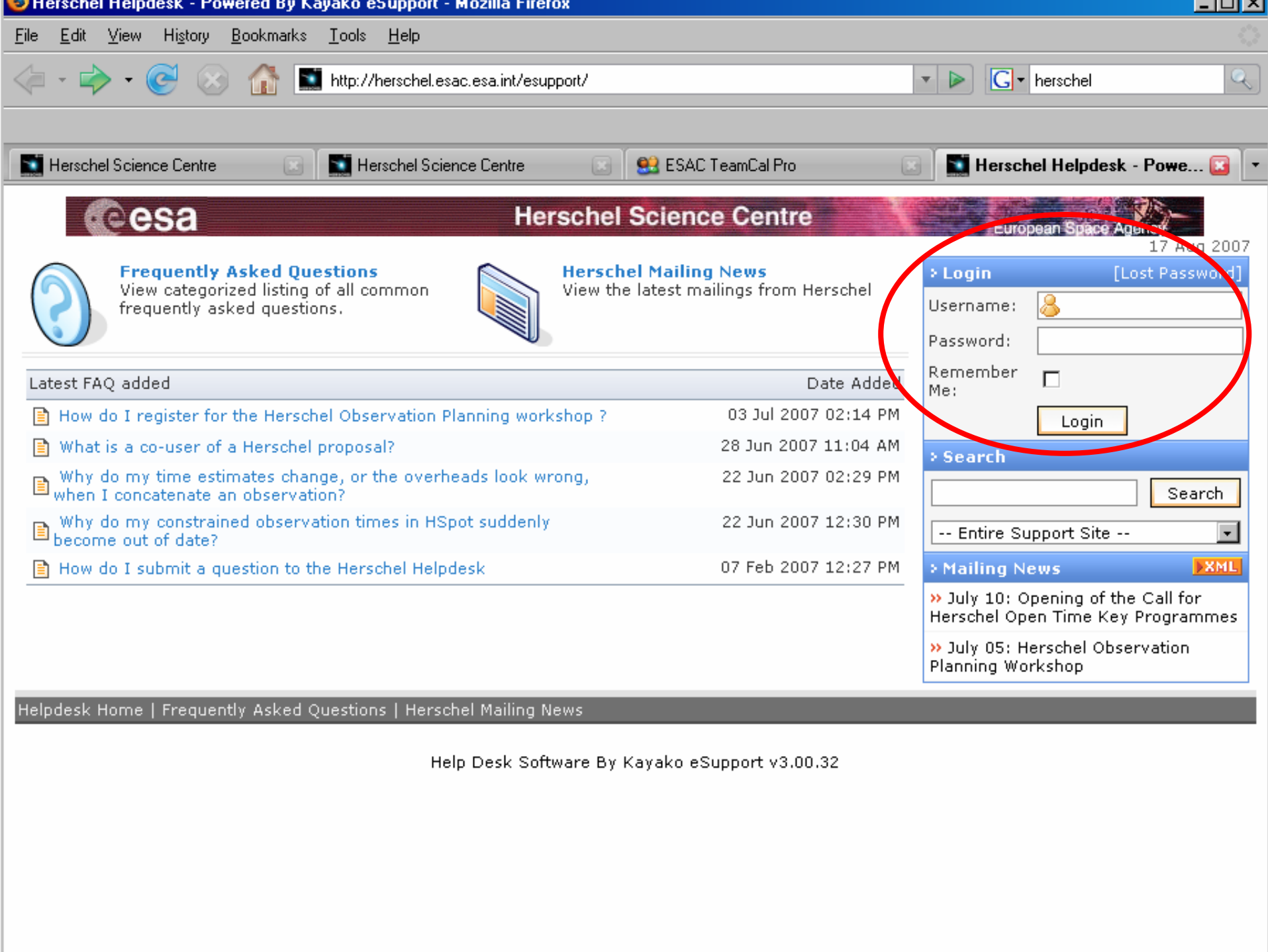
Herschel, short for the `Herschel Space Observatory', is the fourth `cornerstone' mission in the ESA science programme. It will perform photometry and spectroscopy in approximately the 55-672 μm range and is designed to observe the `cool universe'; it has the potential of discovering the earliest epoch 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.

Open Time Key Programme AO!

- **NEW!** Herschel Key Programme Announcement of Opportunity was issued on 1 February 2007 and the GT KP phase has now been completed. The observing planning tool HSpot has now been updated for OT KP phase 1, more tools have been added and the AO documentation has been updated. **The updated AO documentation and tools are available on this website** (see menu on the left). The user services the HSC provides are summarised in the Services Overview page.
- **NEW!** There will be a two-day Herschel observation planning workshop including hands-on HSpot demonstrations and practice organised by the HSC in ESAC on 20-21 September 2007. Please register before 31 August 2007!
- The Herschel Open Time Key Program Workshop was held in ESTEC, Noordwijk on 20-21 February 2007. Presentations now available online.

Last updated: Tuesday, 24-Jul-2007 15:24:56 CEST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- But you need to give us the chance
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Welcome to
Herschel ! !