Welcome!!
Herschel Mission Overview and the Key Programme AO

Herschel Open Time Key Programme Workshop
ESTEC, Noordwijk, 20-21 February 2007

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

- Science opportunities offered by Herschel
- Information of Herschel science capabilities
- Preliminary information about GT programs
- Provide forum for the exchange of ideas for possible OT programs
- Provide observation planning information
- Maximise science return
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 (57 - 670 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 (IRAS, ISO, Spitzer, Akari,…)
  - more observing time than balloon- and/or air-borne instruments
  - larger field of view than interferometers
- **Launch in 2008**
  - the initial observing AO was issued on 1 Feb 2007
The Cool Universe

- **Herschel spectral coverage**
  - black-bodies 5-50 K
    - continuum radiation
    - dust grains (re-)radiating
  - gases 10-few 100 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
Herschel mission elements

- **Space segment**
  - Spacecraft, with
  - Payload
  - Telescope

- **Mission operations**
  - Mission Operations Centre (MOC), ESOC
  - Ground stations, Australia & Spain

- **Science ground segment**
  - Herschel Science Centre (HSC), ESAC
  - Instrument Control Centres (ICCs), SRON-G, RAL, MPE
  - NASA HSC, IPAC
Herschel spacecraft specs

- 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
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Herschel STM satellite

Herschel Science Team visited the ESTEC Test Centre to view the Herschel STM satellite on 1 Feb 2006.
Cryostat refurbishment & lifetime

• Lifetime requirement is being validated
  – TB/TV test (ended today)
  – 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

• Should know by QR Board
  – initial feedback positive
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
Brazing of primary mirror ‘blank’
Grinding and lapping/polishing
Focus position

- At the time of commencing the tests a focus shift of 1.6 mm was expected at cooldown to 70 K
- It was immediately apparent that this was wrong
- The real focus shift was about 11 mm
- Confirmed by additional cooldown
- Initial ‘explanation’ was wrong
- Crisis?
- Careful analysis of measurement set-up and data
- Independent parallel work by Telescope Tiger Team
- Agreement T3 and industrial contractor
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Herschel telescope

- **Telescope Tiger Team (T3)**
  - Focus shift with temperature is a real telescope feature
    - Not a measurement artifact
  - It is repeatable over several cryo-cycles
  - In hindsight not surprising
    - Telescope design (fast primary, high magnification)
    - Material properties not known with enough accuracy
      ➔ Not feasible to make (very) accurate prediction

- **Actual measurements**
  - Telescope measured down to 70 K – without thermal blankets
  - Telescope measured down to 130 K – in in-flight configuration
  - Same behaviour ➔ confidence in in-flight focus position
  - Improved materials properties measurements ongoing
    • Could provide more accurate ‘prediction’

- **Telescope in storage – waiting for integration**
- **Integration/alignment of telescope vs instruments still to be performed – telescope considered known well within specs**
Service module

- FM SVM delivered
- In Friedrichshafen
  - in storage
- Instrument WEIs
  - yet to be integrated
Pointing – QR ‘hot of the press’

- **Pointing modes**
  - pointing APE, RPE, AME
  - scanning APE, RPE, AME
  - raster ‘relative’ SRPE
    - APE absolute error
    - RPE noise 1 min
    - AME reconstituted

- **Pointing specs (68%)**
  - pointing 3.7", 0.3", 3.1"
  - scanning 3.7", 1.2", 3.1"
  - raster 1.0"

- **Pointing goals (68%)**
  - pointing 1.5", 0.3", 1.2"
  - scanning 1.5", 0.8", 1.2"
  - raster 1.0"

- **Goal performance**: restricted SAA range & STR interlacing

- **Predicted performance**
  - it is predicted
  - predictions cannot be validated on the ground
  - we will only know in-flight
    - hopefully pessimistic…

- **Pointing performance (68%)**
  - pointing 2.05", 0.24", 1.99"
  - scanning 2.55", 0.96", 2.53"
  - raster 1.97"

- **Pointing goals (68%)**
  - pointing 1.16", 0.24", 1.12"
  - scanning 1.59", 0.62", 1.58"
  - raster 1.32"
Herschel EQM / science payload
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 75/110 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 57-670 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 ~ 57-210 µm
  – SPIRE – FTS spectrometer, R ~ 20-100+, FOV 2.6 arcmin, λ ~ 200-670 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 spacecraft status

- **Service Module**
  - In storage
  - Science payload warm electronics to be integrated

- **Payload Module**
  - Undergoing TB/TV test for lifetime verification
  - Helium-I system repair to be performed
  - Science payload focal plane units to be integrated

- **Telescope**
  - In storage

- **Sunshade/solar array**
  - Under remanufacture due to delamination problem

- **Payload** – next talks

- **Qualification Review**
  - Started last week
  - Finishes end next month

- **Previous reviews**
  - System Requirements Review (SRS) – Oct 2001
  - Preliminary Design Review (PDR) – Jul 2002
  - Critical Design Review (CDR) – Oct 2004

- **Future Reviews**
  - Flight Acceptance Review (FAR) – spring 2008
  - Launch Readiness Review (LRR) – mid 2008
  - In-orbit Commissioning Review (IOCR)
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, telescope, PLM, instruments deliveries: 2006/07
- Issue of first AO for proposals: 1 Feb 2007
- Integration & tests/verification: 2007/08
- Launch: 2008, target date 31 July
- Early operations: first 6 months
- Routine Science Operations: 2009 – 2012/13?
**Launcher**

- Launcher version:
  - Ariane 5 - ECA (cryogenic upper stage)
  - qualification flight V164

- Payload configuration:
  - Planck in lower position
  - Herschel in upper position
  - Sylda5/ACU2624
  - Long fairing

- Launch Autonomy:
  - 25 hours

- L2 Injection strategy:
  - direct injection
  - 25 minutes powered phase

- L2 Injected mass capability:
  - $\geq 6273$ kg including adaptors
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 2-4
  – PV plans being worked on
  – telescope cooling down (~50 days)
  – 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
Ground segment

- **Herschel Science Team**
- **HOTAC**
- **NHSC**
- **General Community**

**Key Components**

- **S/C (Spacecraft)**
- **TM (Telemetry)**
- **TC (Command)**
- **MOC (Mission Operations Centre)**
- **HSC (Herschel Science Center)**
- **ICC (In-轨 Coordination Center)**

**Data Flow**

- Proposals
- Requests for information, support, data processing, data & SW
- Information support
- Data & SW
- Proposals
- Ancillary data
- Data & SW
- Proposal support
- Data & SW

**Tasks**

- Planning skeleton
- TM frames
- Proposal grades
- HCSS builds
- Instruments manuals
- Observation quality data
- Observation schedule
- Ancillary data
- Data & SW
- TM packets
- Calibration & engineering observation
- Instrument On Board SW
- Instrument procedures and commands
- Instrument database updates
- Instruments manual

**Data Products**

- TM data
- SW data
- Ancillary data
- HCSS generated data
- Proposal support
- Data & SW
- Ancillary data
- HCSS generated data
- Proposal support
- Data & SW
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)
  – 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 ‘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
Overall KP AO schedule

• 1 Feb 2007: Issue AO for ‘Key Projects’ proposals
• 4 Apr 2007: Submission deadline for GT KP proposals
• HOTAC procedure
• ~1 June 2007: Phase 2 proposal entering
• Construction of Reserved Observations list
• 5 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

Please note
• AO package was issued on 1 Feb 2007
• HSpot to be reissued for phase 2 proposal entering
• Reissue of (updated) AO package planned for 5 Jul 2007
AO doc package

- Cover letter – formal Call by D/SCI
- Executive summary
  - duplicates as ‘AO manual’
  - points to online package with latest news
- Policies and procedures
  - politics / policies etc.
- Herschel Observers’ manual
  - spacecraft matters (pointing, visibility, etc)
- 4 x Instrument Observers’ manual
  - SPIRE, PACS, HIFI, SPIRE/PACS parallel mode
- HSpot manual
  - + additional tools (background noise estimator, confusion noise estimator, …)
- Guaranteed time programme description (for OT deadline)
  - with Reserved Observations list
- Plus additional information
- Plus ‘latest information’ webpage
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 (94kb) 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 (1.8Mb) 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 (8.9Mb) 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 (361kb) or HTML. Provides information about and how to use the SPIRE/PACS instrument parallel mode to perform observations.

- **Reserved Observations List**: Describes the Guaranteed Time Key...
Spectral and Photometric Imaging Receiver (SPIRE) Observers’ Manual, PDF (5.0Mb) or HTML. Provides information about how to use the SPIRE instrument to perform observations.

SPIRE / PACS Parallel Mode Observers’ Manual, PDF (361kb) or HTML. Provides information about how to use the SPIRE/PACS instrument parallel mode to perform observations.

Reserved Observations List: Describes the Guaranteed Time Key Programme reserved observations, together they make up the GT Key Programme. (Available only as of 5 July 2007 after the completion of the GT HOTAC activities.)

The Latest News page provide last minute updates and corrections to the AO documentation package.

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’ Manual, PDF (19Mb) or HTML. Provides information about and how to use the HSpot tool itself for planning Herschel observations.

HSpot and Proposal Handling Known problems, HTML.

Background and confusion noise

The Herschel observation planning tool HSpot has built in sky background and confusion noise estimator functions.

Herschel Background Estimator. The infrared background estimator provided in HSpot is an extended version of the tool developed for the Spitzer
**Herschel Observation Planning Tool (HSpot) Download**

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

<table>
<thead>
<tr>
<th>Installation Files</th>
<th>Size</th>
<th>To Install the software</th>
</tr>
</thead>
</table>
| Windows            | 70MB | (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            | 99MB | (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_V2_0_0_Solaris_Installer.bin  
(c) Launch the application by typing: ./runHerschelSpot from the installation directory. |
| Linux              | 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_V2_0_0_Linux_Installer.bin  
(c) Launch the application by typing: ./HerschelSpot from the installation directory. |
| Mac OS X           | 30MB | (a) Download and unzip the relevant installer  
(b) Run the Installer that has been unzipped  
(c) Launch the application by double-clicking on HerschelSpot |
Important !!

- You MUST use the AO version of HSpot to plan and submit your proposals
- For KP GT proposals: Version ‘2.0 Final KP AO Version’
- For KP OT proposals: suitably named later version
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• To check your HSpot version:
  • inside HSpot, press ‘Help’ then ‘About’
• It is NOT possible to submit proposals with an incorrect version of HSpot
  • neither for GT proposals
  • nor for OT proposals
Data processing – HCSS/DP

- Ensemble of services in a single, coherent platform-independent system – HCSS/DP
- Offering the astronomical community the means (data, products, software) to do science without the need to buy licenses
- Source of software, calibration and documentation to reduce and do science with Herschel data (‘Observer IA’)  
- Source of software and documentation to support the commissioning of the instruments, the validation of the observing modes and the calibration of satellite pointing and instruments (‘Calibration IA’)
- Toolbox to develop data processing algorithms
- Generation of standard observation products and quality information by using IA modules (‘SPG’ & ‘QC’ pipelines)
- On-line, context-sensitive and printable help documentation for end-users and developers based on XML/DocBook
- Data and services Virtual Observatory compliant + FITS
Herschel data processing

Strip chart
Dec Mec
Colour range
Instrument array
Line summary
Data selector
Linearity test
Demodulated signal
Script debugger for Interactive Analysis
Keeping track

• Three-tier structure of ESA Herschel websites:

• Corporate level
  – intended for general public, media, ...
  – http://www.esa.int/science/herschel/
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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
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• Research and Science Support Dept (RSSD) level
  – intended for (potential) users of missions, …
  – http://herschel.esac.esa.int/
  – http://www.rssd.esa.int/herschel/ redirects to above
  – this the Herschel Science Centre site – intended for you!
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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 57-670 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.
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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.

**Hot off the press!**
Help us help you!

- We are committed to helping you
- But you need to give us the chance
- Let others benefit from your questions
- Register as a Herschel user
- Use the Helpdesk
Welcome to Herschel!