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The Herschel support center at the ASDC

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Abstract. Herschel is an ESA mission planned as a Space Observatory: it hosts the largest telescope ever launched into space with a 3.5-metres monolithic primary mirror. The mission has been designed to operate in a wide spectral domain that goes from the far infrared up to the sub millimeter and the three scientific instruments on the focal plane (PACS, SPIRE and HIFI) can execute spectroscopy and photometry in the 55-670 μm range. Herschel is optimised to observe the coldest regions in the Universe and it is expected to reveal new information about the earliest, most distant stars and galaxies. It will also take a unique look at our own solar system. Half of the Herschel observing time is still allocated to Key Programmes, while the remaining "Open Time" is available for the worldwide scientific community and will be allocated using a standard proposal procedure, through Announcement of Opportunities. The ASI Science Data Center (ASDC) provides a wide-range support to the Italian astronomical community interested in the mission opportunities. ASDC provides assistance for the preparation and submission of proposals, for the data processing and for the installation and usage of specific tools dedicated to the scientific analysis. Specific tutorials on the mission characteristics (satellite, instruments) and on the data reduction/analysis methods guarantee an adequate knowledge transfer of the instrumental and data analysis expertise from ASDC personnel to the interested astronomers.

Key words. infrared astronomy, space missions, data analysis, groun segment

1. Introduction

The Herschel Space Observatory was launched on 14 May 2009 aboard an Arian 5 rocket. The initial seven months of the mission have been dedicated to early phases (Commissioning, Perfomance Verification and Science Demostration Phases) and the Routine Science Phase could start only on January 2010 (Pilbratt et al. 2010). The Routine Phase started executing the legacy and long time programmes (Key Programmmes) already approved before the launch and the first scientific results have been presented during the Herschel First Results Symposium on May 2010 (see Schisano, this Conference). The first in-flight Announcement of Opportunity (AO) has been opened on 20 May 2010 and allowed the world wide astronomical community to apply for using the mission facilities. Herschel observatory is now starting to provide, to the entire scientific community, the opportunity for observing the far-infrared and sub-mm sky (55 - 672 μm) with an unprecedented resolution and sensitivity. The limited duration of the mission (3.5 years) and the complexity of the observing modes provided by the

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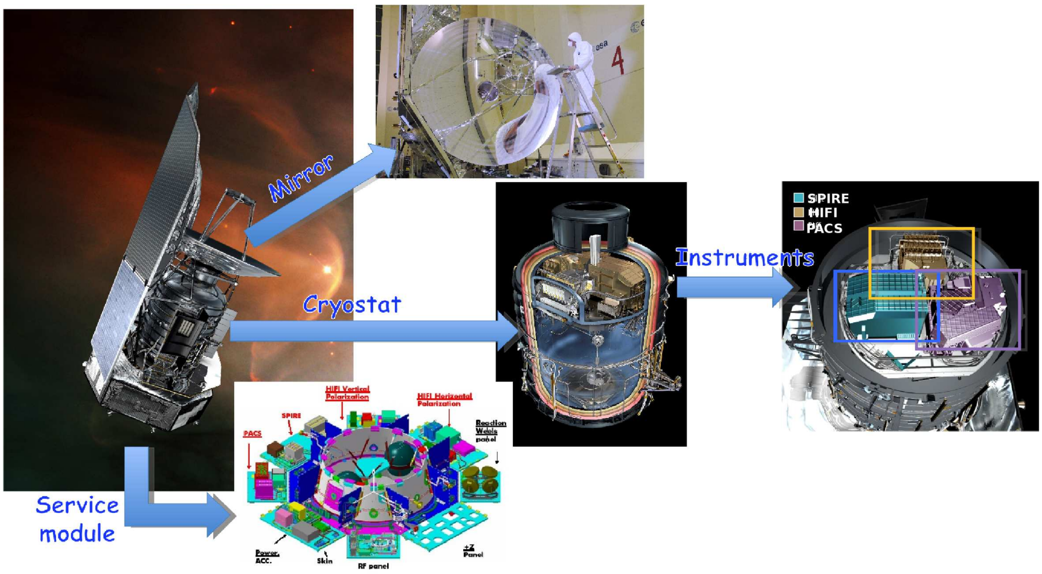

Fig. 1. A schematic view of the Herschel Observatory. On the right the location of the science instruments on the focal plane is shown.

Observatory, encouraged the ASI Science Data Center (ASDC) in creating a team decicated to support the entire Italian astronomical community interested in the Herschel mission, making easier the use of the Herschel facilities and the processing of the scientific data.

2. Herschel science payload

The Herschel payload includes three scientific instruments built to perform photometry and spectroscopy in different wavelength ranges and with different techniques:

- the Photodetector Array Camera and Spectrometer (PACS) (Poglitsch et al. 2010)
- the Spectral and Photometric Imaging REciver (SPIRE) (Griffin et al. 2010)
- the Heterodyne Instrument for the Far Infrared (HIFI) (de Graauw et al. 2010)

Figure 1 shows a schematic view of the Herschel spacecraft. The instruments have been designed to exploit the primary scientific goals of the mission and to offer a wide range of observing capabilities for the general observer. In the following we present a brief description of the instruments, highlighting the instrumental observing modes released for the first in-flight AO.

Table 1. PACS photometer characteristics

Band Name	Blue	Green	Red
Central λ [μm]	70	100	160
Band [μm]	60-85	85-130	130-210
Pixel Scale [arcsec]	3.2		6.4
FOV [arcmin^2]	3.5 x 1.75		
FWHM [arcsec]	5.2	7.7	12.0
N Pixels	32 x 64		16 x 32
N Sub-arrays	2 x 4		1 x 2

2.1. PACS

PACS comprises two mutually exclusive sub-instruments: a camera, with two bolometer arrays to perform photometry in three spectral bands (Blue at 70 μm, Green at 100 μm and

Red at 160 μm) and an Integral Field Unit (IFU) grating spectrometer, with two Ge:Ga photoconductor arrays to obtain medium resolution spectroscopy (R ranging from 1000 to 5000) over the spectral range from 57 to 210 μm. In Table 1 and Table 2 the main characteristics of the PACS photometer and spectrometer are summarized. When in photometric configuration, PACS observes simultaneously 2 bands, the first is fixed at the Red band, while the second can be selected either at the Blue or Green band. The astronomer can use the PACS photometer to observe point-source targets, in small or large field. For point-like or slightly extended sources, the Point Source Photometry mode in standard chopping-nodding technique or the Scan Map mode in Mini-map configuration can be selected. The Scan Map mode can be used to observe large astronomical fields, with the possibility of selecting the PACS/SPIRE Parallele mode, in which the three SPIRE photometric bands (see section 2.2) are observed simultaneously with two PACS photometric bands. The PACS spectrometer performs a dual-band spectroscopy simultaneously in the Blue (55-98 μm) and Red (102-210 μm) channel. Three are the PACS spectroscopic observing mode released: the Chopped Line Spectroscopy for single, unresolved spectral features on sources with a clean background position within 6′, the Chopped Range Spectroscopy, to obtain wide spectral range spectra on sources with a clean background position within 6′ and the Unchopped Grating mode, which include the line and range spectroscopy of extended sources. The three observing modes can be implemented by performing a single pointing on the sky, or repeated in a raster pattern.

2.2. SPIRE

SPIRE includes a photometer, operating in three spectral bands centred on 250 μm (PSW), 350 μm (PMW) and 500 μm (PLW), and an imaging Fourier-Transform Spectrometer (FTS), which provides low resolution spectra over the 195-670 μm band. Both instruments use germanium bolometers coupled to hexagonally packed conical feedhorns. In Table 3 the main characteristics of SPIRE photometer and spectrometer are summarized. The SPIRE photometer observes a field of view of 4′×8′ simultaneously in 3 bands. It is designed to have four observing modes: Point Source mode, for isolated sources with well known position, Small Map mode, to performe jiggled map of sky region up to 4×4 arcmin^2, Scan Map mode, designed to observe large area on the sky, and the Scan Map mode in SPIRE/PACS parallel mode (see section 2.1). The SPIRE spectrometer uses simultaneously two detector arrays (SLW and SSW) to obtain spectra over the entire spectral domain of a circular, unvignetted field of view with a diameter of 2.6 ′. The observing modes used with the SPIRE FTS are set by selecting options for: *(i)* the Spectral Resolution: Low ($\lambda/\Delta\lambda \sim 40$ at 250 μm), Medium ($\lambda/\Delta\lambda \sim 160$ at 250 μm) or High ($\lambda/\Delta\lambda \sim 1000$ at 250 μm); *(ii)* the Pointing Modes: fixed pointing or raster map; *(iii)* Image Sampling: Sparse, Intermediate or Full.

Table 2. PACS spectrometer characteristics

Band [μm]	55-210
Resolution [$\lambda/\Delta\lambda$]	1000-5000
FOV [arcsec^2]	47x47
Number of Spatial Pixels	5x5
spaxel scale [arcsec]	9.7
Number of Detector Pixels	16x25

2.3. HIFI

HIFI is designed to provide very high resolution (up to R$\sim 10^7$) spectroscopy over a large wavelength range (157-625 μm). HIFI adopts the heterodyne technique using 7 mixers with double polarization (5 Semiconductor-Insulator-Semiconductor and 2 Hot Electron Bolometer) and 4 backends (2 High Resolution Autocorrelation Spectrometers and 2 Wide-Band Acousto-Optical Spectrometers).

Table 3. Main characteristics of SPIRE photometer and spectrometer

	SPIRE Photometer			SPIRE Spectrometer	
Array	PSW	PMW	PLW	SSW	SLW
Band [μm]	250	350	500	194-324	316-672
Resolution [$\lambda/\Delta\lambda$]	3.3	3.4	2.5	40-1000 @ 250 μm	
FOV		4′x8′		2.6′ (diameter)	
Beam FWHM [arcsec]	18	25	36	16	34
Number of Detectors	139	88	43	37	19

Table 4. Main characteristics of HIFI spectrometer

	Channel	
Mixers	2 HEB	5 SIS
Band [μm]	157-213	240-625
Number of Pixels	Single Pixel	
FOV(diameter) [arcsec]	11	40
Resolution [$\lambda/\Delta\lambda$]	10^7(0.3-300[kms^{-}1])	

Il Table 4 the main characteristics of the HIFI spectrometer are summarised. Four observing modes are available with HIFI: in the Position Switch mode the telescope is pointed alternatively at a target position and at a reference sky position within 2 degrees from the target; in the Dual Beam Switch mode the chopping-nodding technique is used, with a chopper throw up to 3 arcmin; in the Frequency Switch mode the background removal is performed in the spectral domain, that is subtracting two spectra at the same target position with a switch in frequency; in the Load Chop mode an internal cold calibration source is used as a reference to correct the spectra and it is particularly useful when there are no emission-free regions near the target. The HIFI observing modes can be used for observing a compact source at a fixed position on the sky, for covering an extended target, or for observing a single position over a continuous range of selected frequencies.

3. ASDC involvement in the Herschel project

The ASDC provides a wide-range support to the Italian community involved in the mission. The Herschel lifetime is determined by the evaporation of the helium contained in the cryostat, allowing at least 3 years of Routine Phase. This aspect introduces an high competition level in the selection of observing programmes. About 57% of the Routine Phase is still allocated to execute the Key Programmes, while the remaining ”Open Time” is available for the worldwide scientific community and will be allocated through AOs. The first in-flight AO occurred in the summer 2010, while the second in expected on year later. The ASDC provides an individual support to the Italian astronomers for preparation and submission of proposals; the support consists in selecting the most suitable instrumental observing modes to achieve the scientific goals and using dedicated tools and software (HSPOT) to prepare and manage the observational requests. The ASDC provides assistance for processing the data using the standard pipeline and for installing and using specific tools for scientific analysis. In particular, the ASDC provides tutorial on the Herschel Interactive Processing Environment (HIPE), the official software environment designed to handle the science data, including the data retrieval from the Herschel Science Archive, the data reduction through the standard pipeline and the scientific analysis. The Herschel team in ASDC is developing dedicated modules for the data reduction and specific tools for the analysis that will be released to the astronomical community.

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