



Herschel cross-calibration strategy

Pedro García-Lario

*European Space Astronomy Centre
Herschel Science Centre*

HERSCHEL SPACE OBSERVATORY





Why do we need cross-calibration?

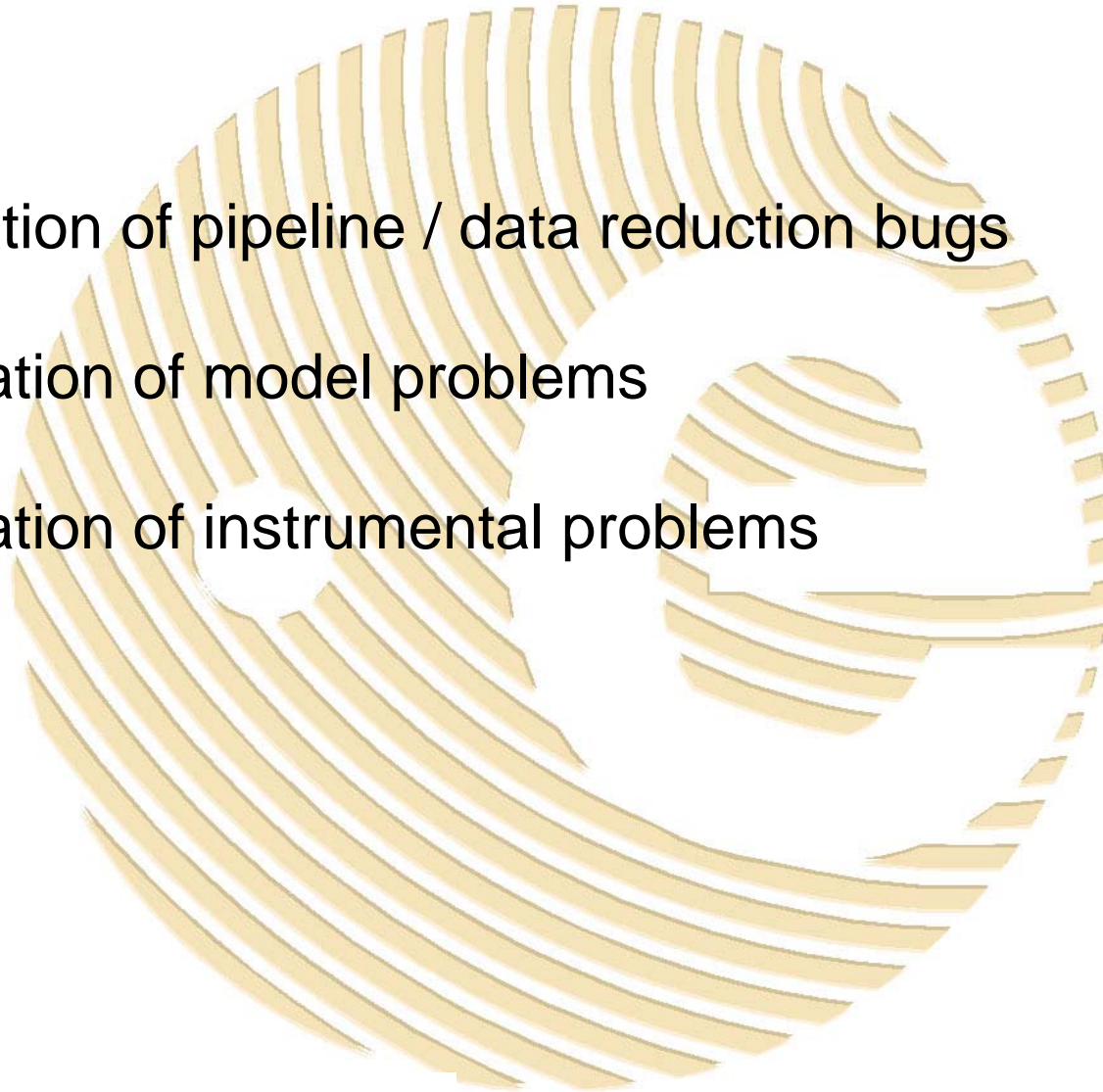
- ❑ To check for consistency among the calibrated data (photometry, mapping and spectroscopy) to be provided by the various Herschel instruments and with the calibrated data provided by other ground- and space-based facilities
- ❑ This includes absolute and relative flux scales, as well as the spatial and spectral information contained in the data (absolute flux scale, spectral match in continuum level AND shape, wavelength calibration, maps, line fluxes and profiles,..)

HERSCHEL SPACE OBSERVATORY

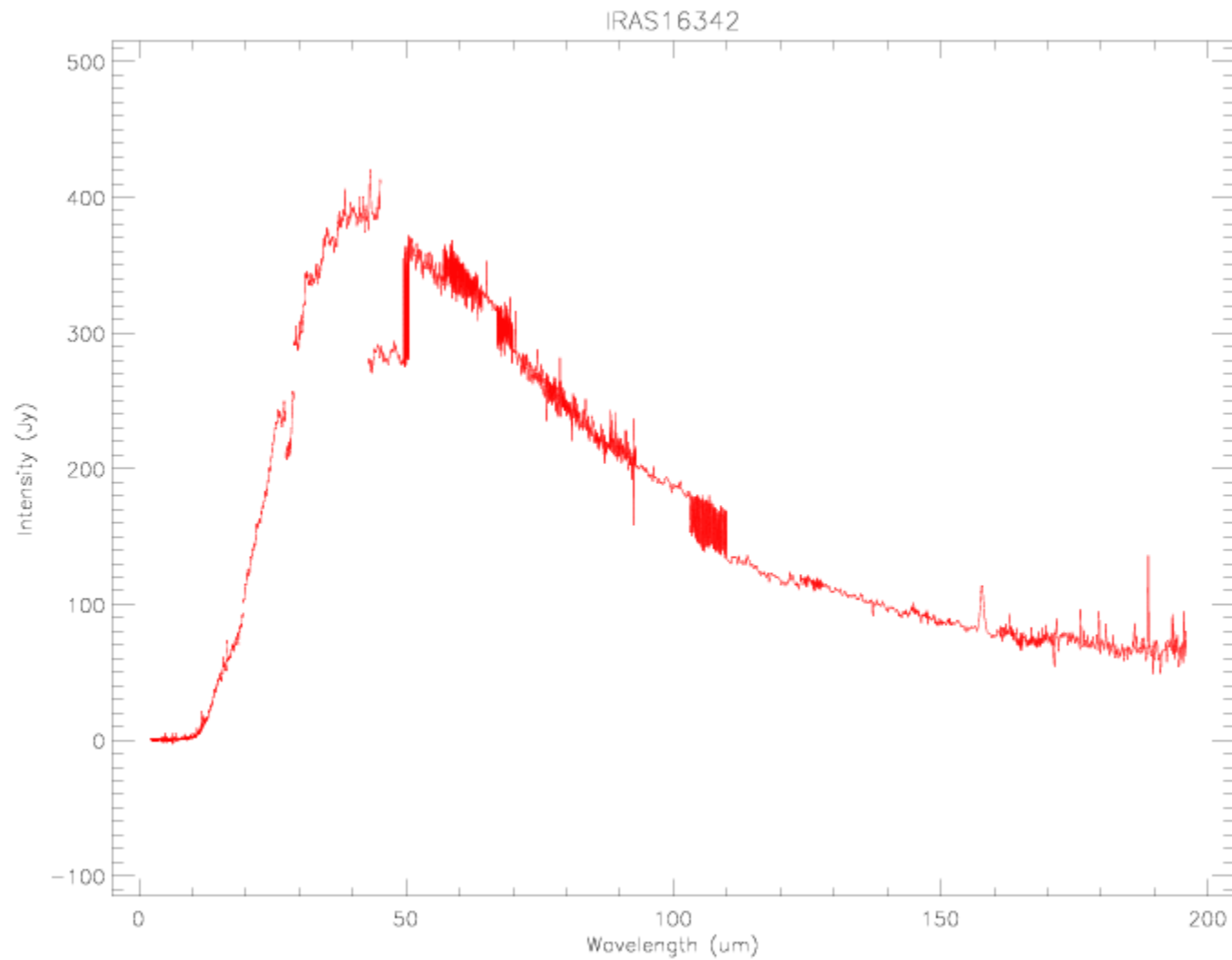
What benefits can be expected?



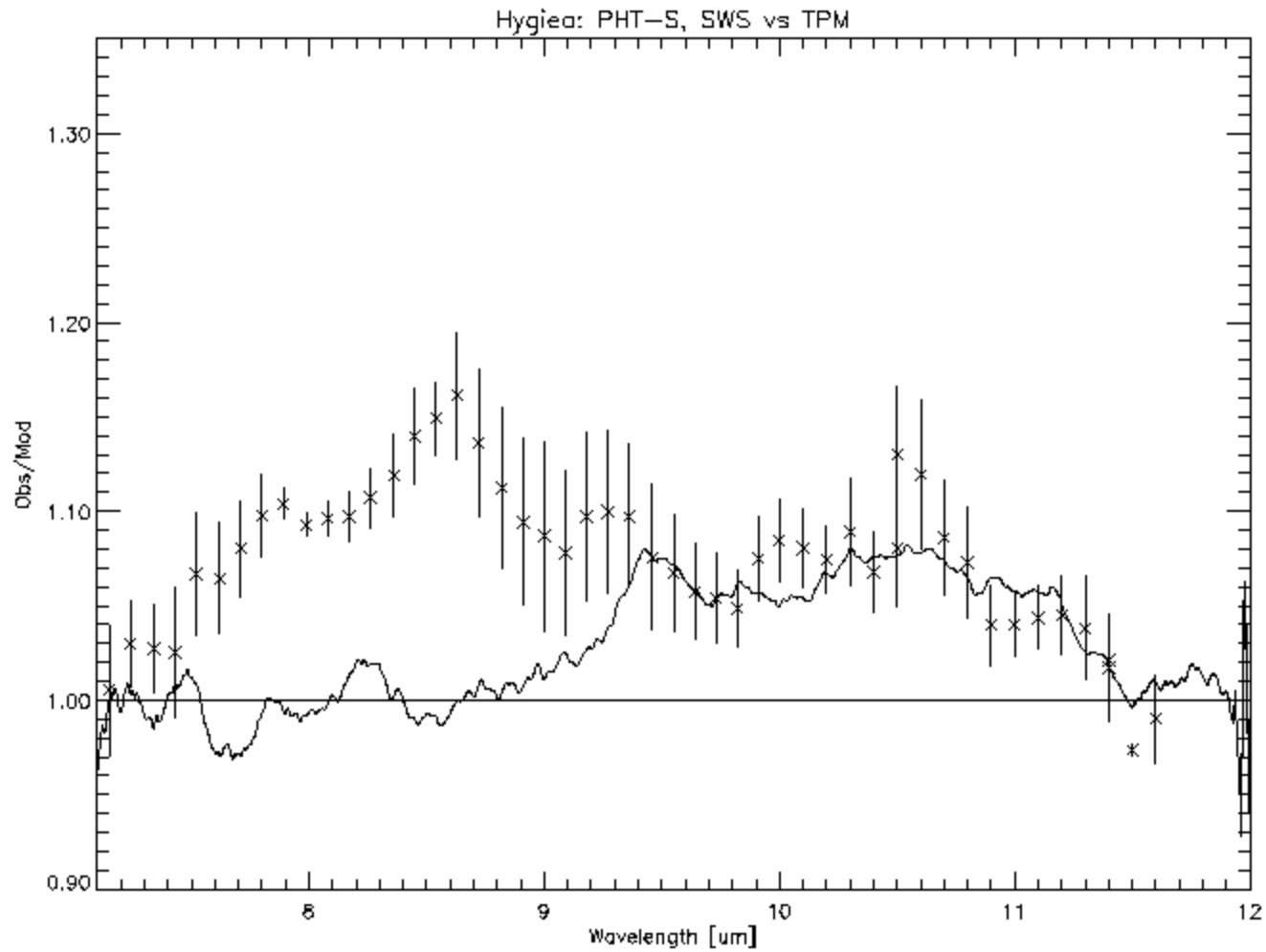
- Identification of pipeline / data reduction bugs
- Identification of model problems
- Identification of instrumental problems



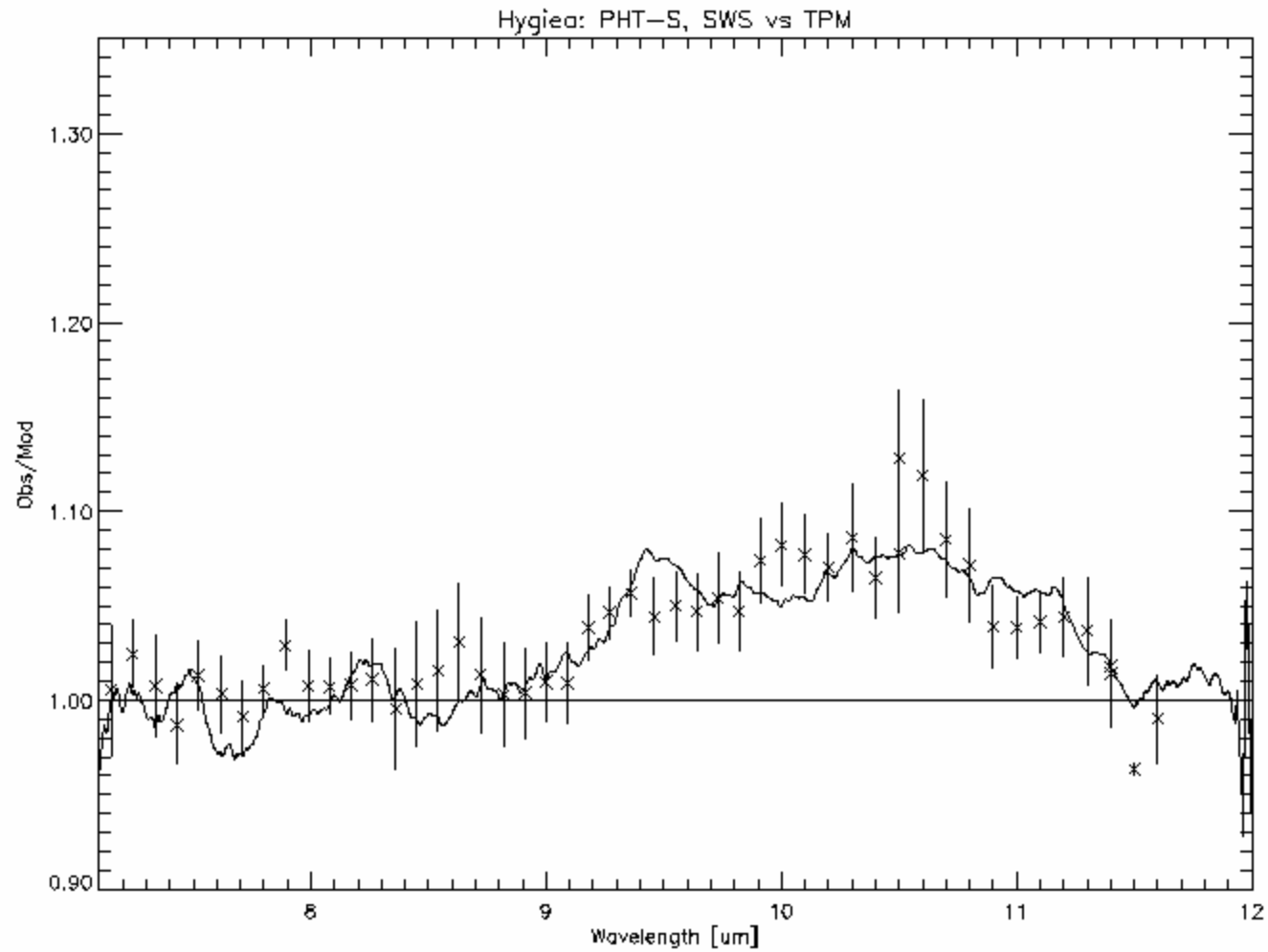
HERSCHEL SPACE OBSERVATORY



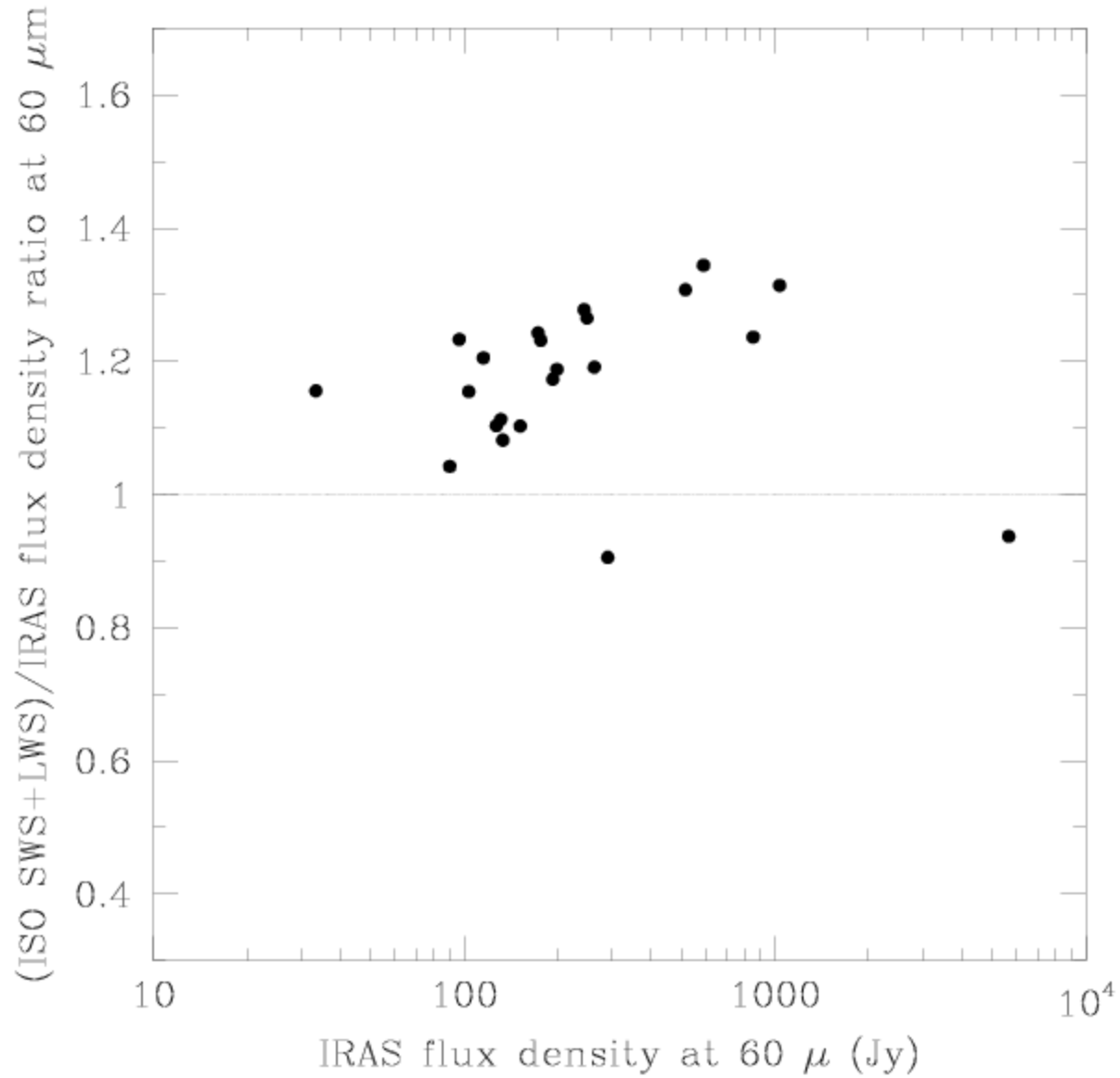
HERSCHEL SPACE OBSERVATORY



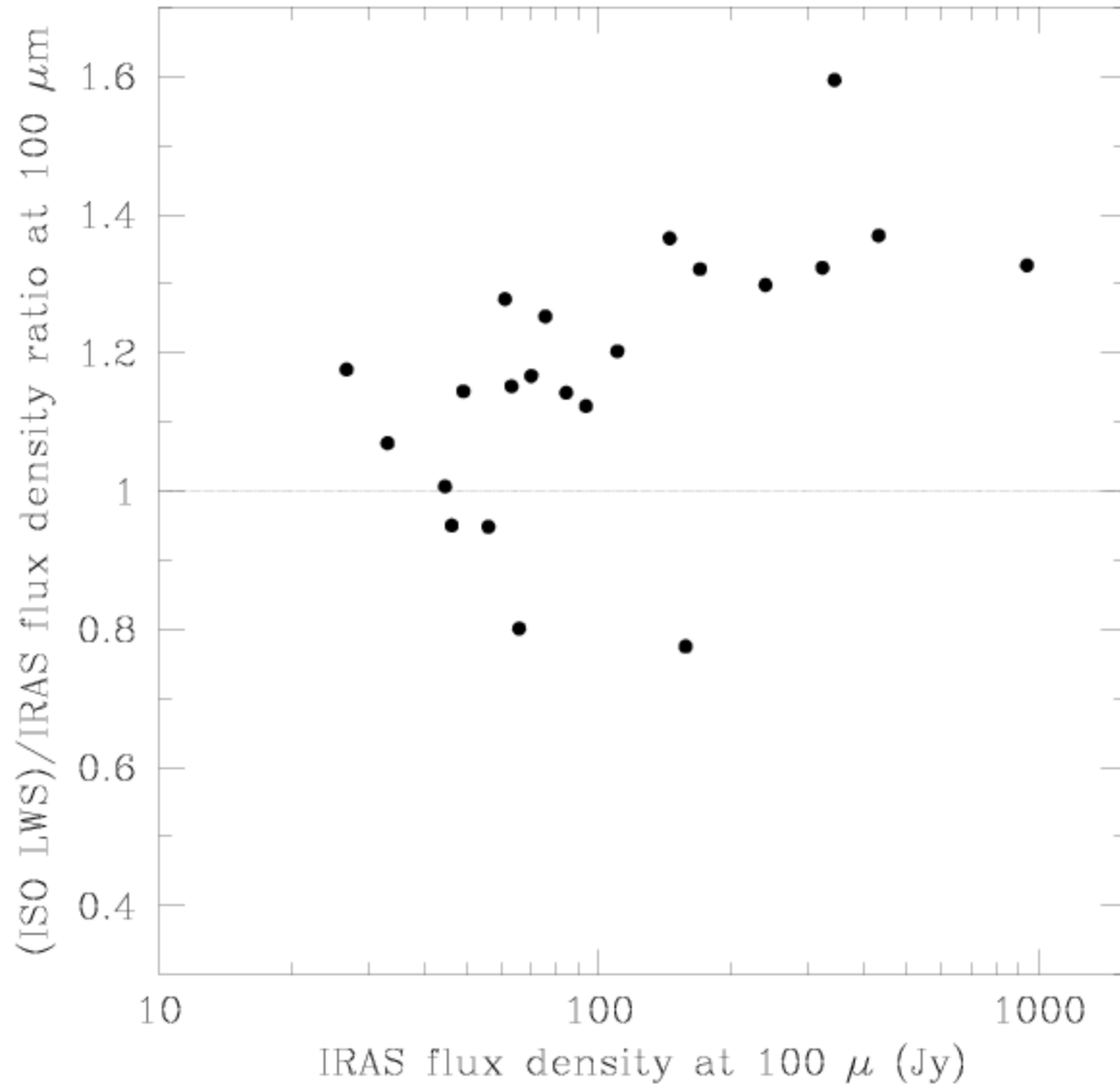
HERSCHEL SPACE OBSERVATORY



HERSCHEL SPACE OBSERVATORY



HERSCHEL SPACE OBSERVATORY



HERSCHEL SPACE OBSERVATORY



What do we need?

- ❑ Mutual knowledge of calibration strategies
 - What is the absolute flux reference used for calibration?
 - What are the primary calibrators used?
 - Which models were used?

- ❑ Proper characterisation of the instruments under comparison
 - Filter info
 - Beam info
 - Spectral resolution info
 - ...

HERSCHEL SPACE OBSERVATORY

Which sources?



- Not those used as primary calibrators
- Point-like / non-variable sources at different brightness levels (highly visible, in low background regions,..)
- From individual cases to statistical analysis
- Use of science data; even variable and extended sources can also be sometimes useful

HERSCHEL SPACE OBSERVATORY

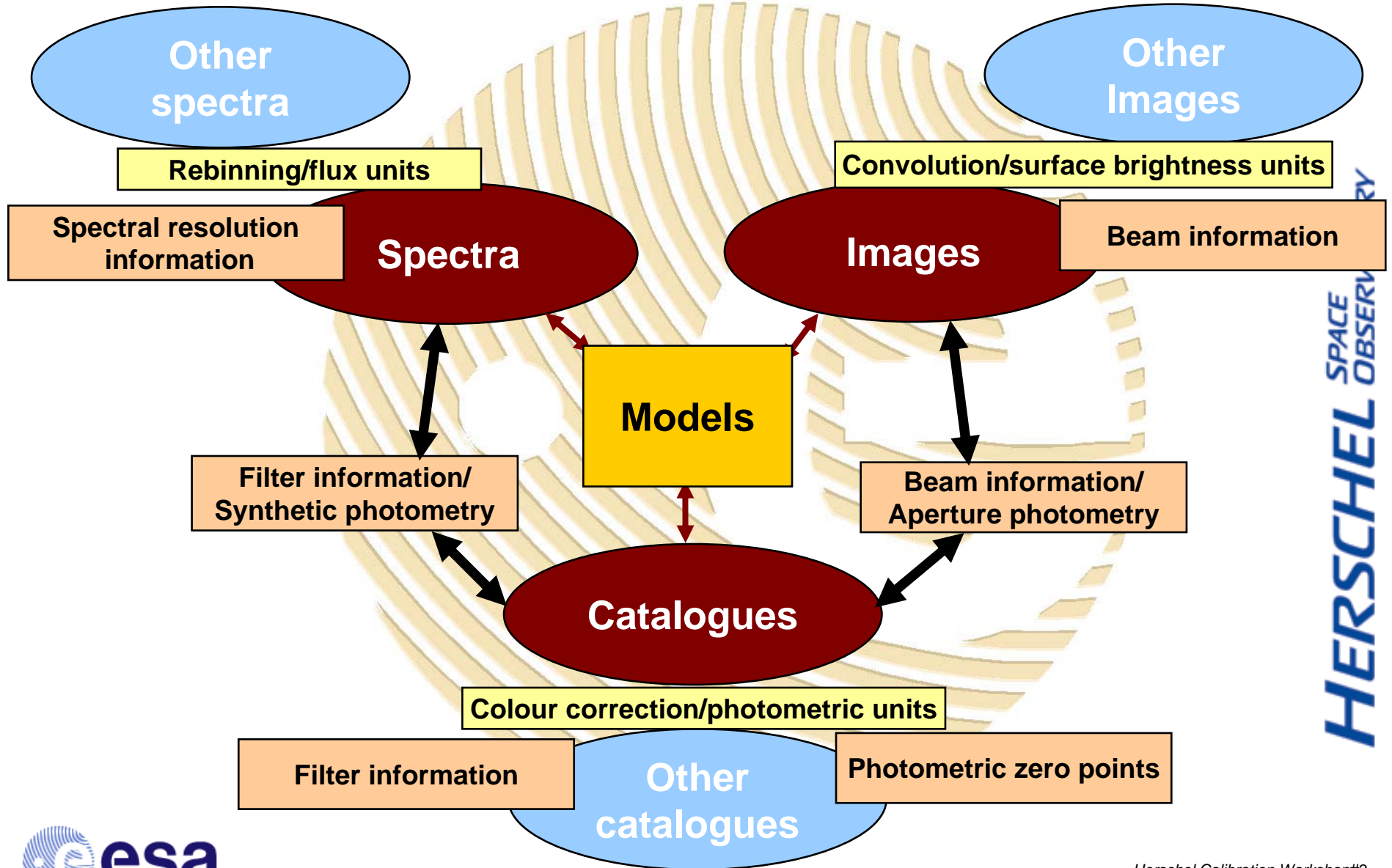


Problems

- ❑ Some homogeneization needed on:
 - instrument characterisation (e.g. beam description)
 - data format
- ❑ Limited access to external data
 - through VO or existing archives,...
- ❑ No proper tools available to handle efficiently data from different facilities (effort being done within HCSS)
 - e.g. change of units, spatial convolution, spectral rebinning, aperture photometry, synthetic photometry, statistical analysis to evaluate accuracies)

HERSCHEL SPACE OBSERVATORY

The cross-calibration 'world'



HERSCHEL SPACE OBSERVATORY



Cross-calibration tools

- Tools under development / to be implemented as part of HCSS include:
 - Import/export data into/from HCSS
 - Change of units
 - Aperture photometry
 - Synthetic photometry
 - Spectral extraction
 - Spatial Convolution tools
 - Rebinning tools

HERSCHEL SPACE OBSERVATORY

Cross-calibration database contents



- Auxiliary information needed
 - Model SEDs/line fluxes
 - Filter transmission profiles
 - Beam information
 - Spectral resolution information
 - Colour correction tables
 - ... plus database of reference measurements (links to other archives and/or to individual data sets)

HERSCHEL SPACE OBSERVATORY



Herschel cross-calibration strategy

- Identification of suitable cross-calibration sources.
 - Secondary calibrators, preferably bright, point-like, non-variable, highly visible, located in low background area, emission line, bright continuum source
 - Asteroids, evolved stars, stellar standards (not for HIFI), but also selected map regions

- Ideally, sources will be selected from the pool of instrument-specific calibration sources with available measurements taken with other facilities (no need of dedicated cross-calibration measurements)

- Using pipeline data and cross-calibration tools in HCSS

HERSCHEL SPACE OBSERVATORY



Herschel cross-calibration strategy

□ Identification of suitable cross-calibration use cases

- Internal cross-calibration:

- PACS/SPIRE/HIFI observations at 205 micron
- PACS/SPIRE photometry/spectroscopy through model SEDs
- PACS/HIFI and SPIRE/HIFI spectroscopy

- External cross-calibration:

- PACS spectroscopy with LWS spectroscopy
- PACS spectroscopy with adjacent SWS through model SEDs
- SPIRE with LWS through model SEDs
- PACS with IRAS, MIPS and AKARI photometry
- PACS photometry with LWS synthetic photometry
- SPIRE with CSO-SHARCII photometry
- ...

HERSCHEL SPACE OBSERVATORY



Herschel cross-calibration strategy

- A continuous activity extending throughout all mission phases
 - To be started with PV Phase calibration sources common to more than one instrument
 - Other secondary calibration sources in routine operations, as they become visible (taken from calibration observations, as much as possible; no dedicated cross-calibration observations are planned)
 - From science data, at a later stage of the mission (statistical analysis)

- Absolute flux scale: cross-calibration with Planck?
(see Bernhard Schulz's presentation)

HERSCHEL SPACE OBSERVATORY