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# Herschel Spacecraft and Instrument Status

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# Outline of Presentation

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- 1. General Items Regarding S/C and Instruments**
- 2. Instrument Calibration**
  - a. PACS Phot**
  - b. PACS Spec**
  - c. SPIRE Phot**
  - d. SPIRE Spec**
  - e. HIFI**
- 3. Cross-Calibration**
- 4. Pointing**
- 5. Conclusions**

# General Items Regarding Current Performance



Spacecraft (observatory) and instrument Twiki pages now available more directly from the Herschel Science Centre web pages. Includes direct calibration information and links to calibration files (e.g. PSFs).

Spacecraft performing more than 18 hours of science observations every day (+3 hours for communications).

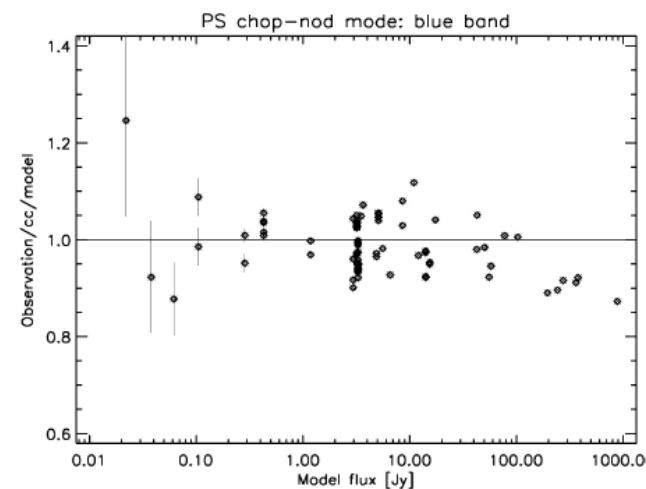
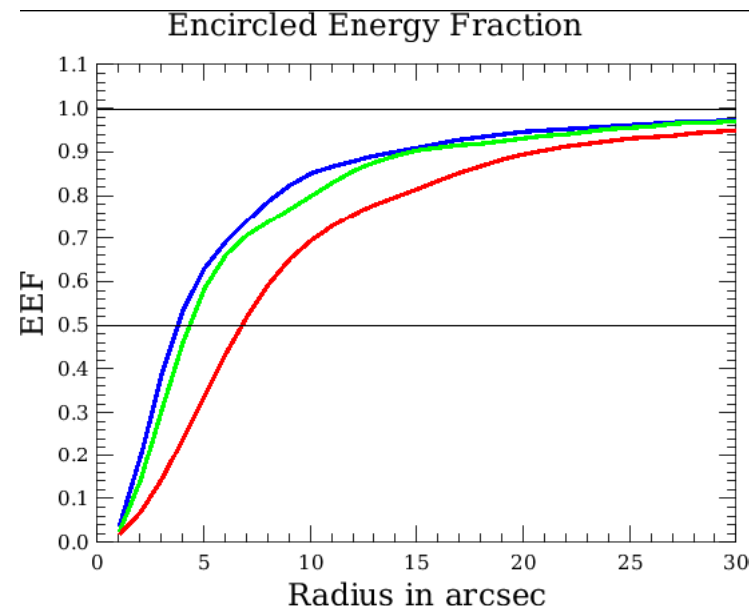
Pointing and instrument health and calibration checks done on a regular basis.

- a. pointing quite consistent throughout mission (APE  $\sim 2''$ ; note this is  $1\sigma$ ).
- b. instruments suffer memory corruptions due to Single Event Upsets (SEUs). Mostly affect HIFI but occasionally SPIRE too. Usually repaired within a single 3 hour communication.
- c. regular calibration checks have helped determine best set of calibrator stars (5 primary ones used by PACS) and allowed the improvement of models used in calibrations.
- d. general increase in mirror temperature due to slow degradation over time (as predicted) plus seasonal variations.
- e. instruments relatively immune to recent strong solar flares.



# Instruments: PACS photometer

- *PSF identified to have important wings outside of 1'. PSFs now measured very accurately out to 10'. Improved PSFs available for some time. These are available from HSC web site.*
  - PSFs available from PACS instrument web page. Beyond 1' come from Mars measurements.
- Now determined that (together with removal of some "contaminated" stellar calibrators) that
  - overall point source calibration is **good to 3%**. Estimate 2% systematic error from model/assumed calibrator fluxes and 1% from the measurements of those calibrators.
  - **(for point-sources below 100 Jy: 3/3/5% in blue/green/red)**
- Convolution kernels being developed for the following.
  - convolution between any of the 6 Herschel photometer bands (PACS/SPIRE)
  - convolution between Spitzer MIPS/PACS bands.
  - these, together with instructions on their use should be available in the near future.
- **Extended emission calibration** is consistent with MIPS data and IRAS data when correct convolution kernels used (TN forthcoming).
- Extended pipeline (level 2.5) combining normal and orthogonal scans will become available in reprocessing using HCSS 6.
- Finishing off non-linearity assessment above 100Jy.

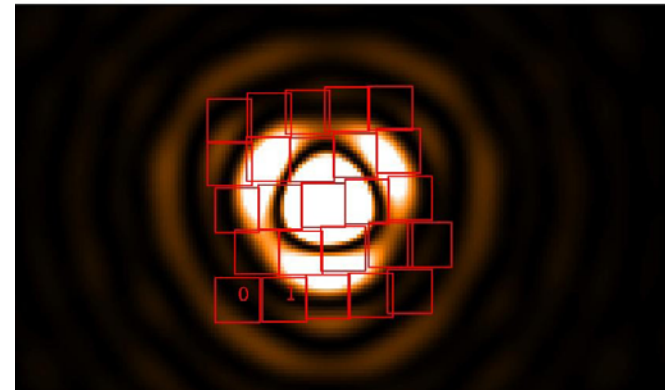




- *Unchopped spec bright source mode requested being tested now and should be on-line shortly. A number of AORs on hold waiting for this version of the mode. Expected to be available in HSpot 5.3. Full performance information not available until late March.*
- **1) Recent calibration tree for HIPE 6.0 (PCAL-12):**
  - The calibration sources absolute flux tables are flat-fielded and scaled to fit to the flux of standard objects.
  - The 1.3 and 1.1 correction factors to bring the ILT responses to flight performance are included in the NominalResponse calibration. Also, improvements in the flatfield are included in the NominalResponse calibration file (based on internal TNs of PACS).
- **2) SED mode calibration issues**
  - Flat-fielding works fine in HIPE 6.0 interactive scripts that may significantly reduce the 'fringing' pattern due to the systematic response variations among the 16 spectral pixels.
  - A prototype code for flux calibration with telescope normalization is available.
- **3) Ongoing activities that have been recently prototyped but not yet available to the community:**
  - **Point-source flux correction and pointing reconstruction.** This method applies an accurate PSF fitting of observed point-source continuum to high-resolution Neptune rasters, the derived pointing offset is used to estimate flux correction on the central spaxel.
  - **The method can significantly reduce the uncertainty on the absolute flux scale of the Spectrometer,** factors 2.5-3.0 have been measured on HD161796 key-wavelength test measurements. This method may effect individual science observations as well as the flux calibration of the instrument when applied to calibration observations.

- **5) Spectrometer ghosts**

- Two ghosts in spectrometer observations have been reported at the last PACS ICC meeting **around 108 and 123 micron**. The ghosts have been seen so far only on sources which have strong atomic fine structure lines. In extragalactic observations, the ghost wavelengths change in agreement with the redshift of the sources.
- Spatial ghosts. **Spatial ghosts in the PSF are found at 62 + 124 and 75 + 150  $\mu\text{m}$** . The ghost was seen strongest in the red section but it is present also in the blue section.



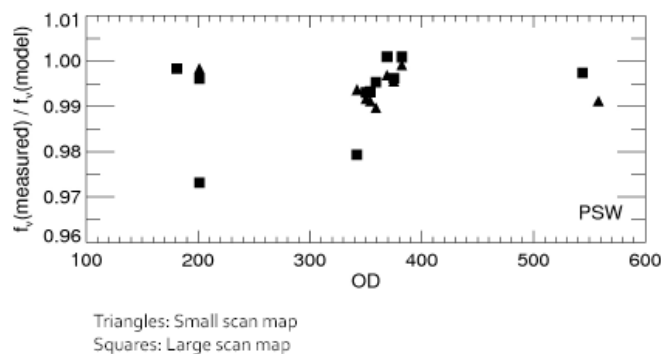
- **6) The long-range spectroscopy unchopped grating scan** mode has indicators of ON/OFF positions, this information will be used in the extended pipeline to automatically combine ON/OFF OBSIDs even for clustered observations



## SPIRE photometer issues

- PMW calibration changed of  $\sim 0.4\%$ : the change took into account a change in the PMW RSRF used for calculating the Neptune fluxes on which the flux conversion is based.
- Moving to *updated flux model of Neptune (esa3)* which increases fluxes slightly.
- SPG pipeline now includes a **jump detection task**: this automatically corrects data in case of jumps in the thermistors timelines (which caused annoying stripes in maps)

Neptune Measured/Model  
Flux Densities

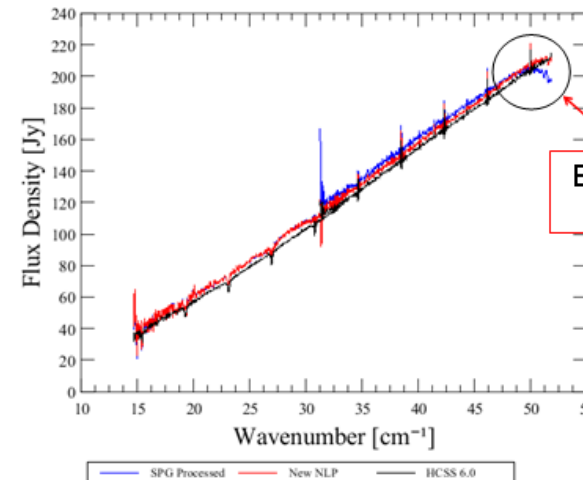
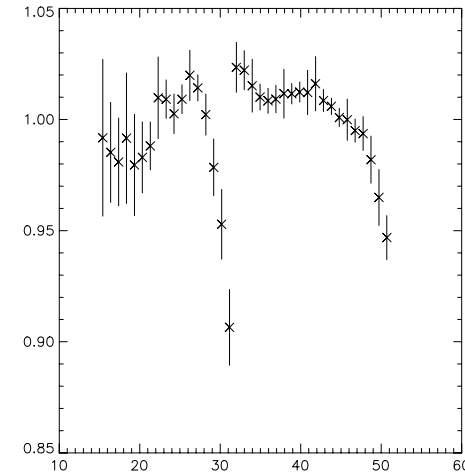


• SPIRE photometer good to  $\sim 3\%$  but requires *optimum flux extraction*. Script now available but is being prepared as a tool in HIPE (extracts flux from the timeline of observations rather than the final map).



# SPIRE Spectrometer Issues

- Bright source spectrometer mode available.
- HIPE 4 to 5 improvements. Two wavelength sections now have consistent flux scaling.
- Processing with proper version of dark sky usage makes major difference. Now standard in pipeline.
- **Use of telescope as absolute calibrator.** Checks show totally consistent with planetary models (Neptune) currently being used to calibrate the SPIRE products.
- **HIPE pipeline updates:**
  - Version 6 involves a major change to calibration tree structure with some new product definitions, and so *this update will be incompatible with previous versions of the HCSS.*
  - Improved phase correction module in the pipeline no longer requires a calibration file. The final correction should be better using the new method.
  - **Telescope and instrument RSRFs and beamParam updated** to follow the new v6 pipeline scheme and use improved phase correction - *should lead to improvement in shape of final spectra.*
  - BeamParam file modified to improve information for IA - updated beamAreas and added point source RSRF - this should have no effect on the SPG pipeline.
  - OpLimits added to clean up the pipeline script - should have no effect on data.

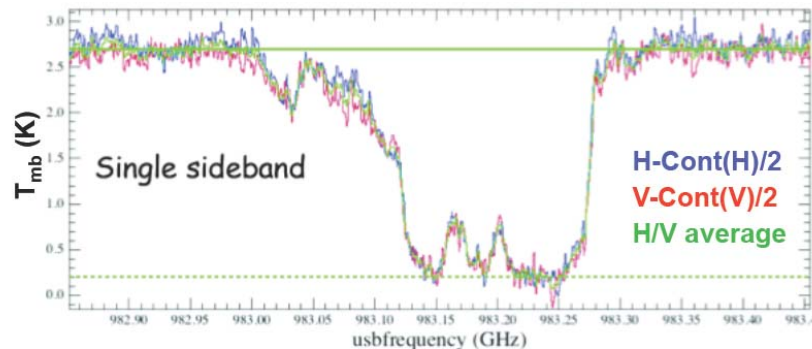






# HIFI Calibration Issues 1/2

- **Calibration scheme includes all efficiencies known** -- including forward efficiency of 0.96 in most recent pipeline.
- **Beam position information** in calibration information and separate H and V polarization maps now possible through pipelines. Usage of beam offsets.
- **Sideband Ratio (SBR)** -- receiving more attention. Group fully resuming meetings/telecons.
  - Ph.D. recently submitted containing the best known information on SBR measurements from on-ground ILT measurements.
  - Report on gain estimates from deconvolution techniques (need to take this with a piece of salt -- for instance SBR varies across the IF, notably for the diplexer bands), not just a single number at a single frequency!
  - This is the largest overall source of error in the **HIFI error budget (15-30%)**.
  - In certain observations the value is measurable. Combination of on-ground and space measurements being used to get the overall situation.



**Should be at 0.5 –  
SBR not 1.**

- **Note:** Irregular single event upsets (SEUs) occur (average 1 / 2 weeks or so). Requires manual intervention during a DTCP. New recent event found the updates can get corrupted. Solution worked. Generally does not disrupt science measurements.

# HIFI calibration issues 2/2



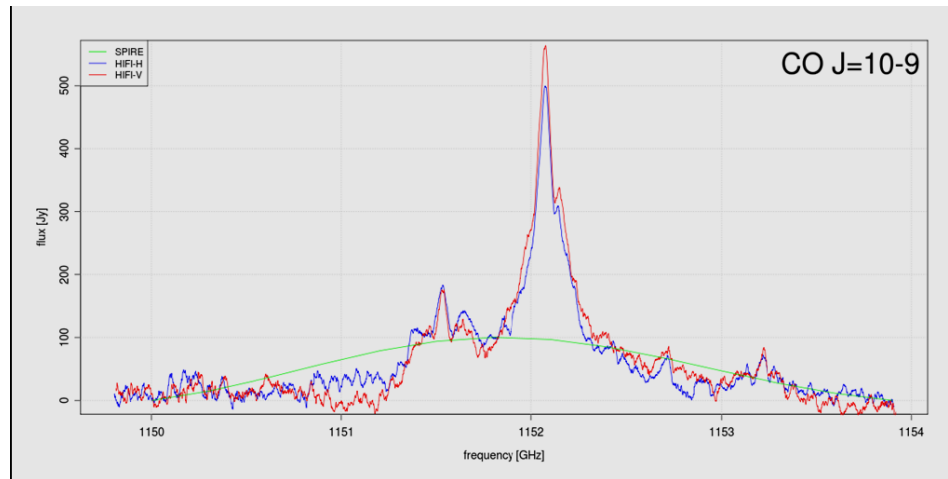
- **1. Progress on existing calibration issues**
  - **Purification of bands 5a and 5b complete**, spur removed from band 1a. Updates to sensitivities in HSpot/HCSS/documentation.
  - We have **updated the beam efficiencies** in all bands. This is reflected in the HIFI cal tree in HIPE and within HSpot.
  - **WBS spectrometer COMB-V still dying** -> alternative cal. scheme being refined – good prospect these will work well if needed.
  - **Incorrectly working heater on oscillator source (OCXO)**. This leads to varying supply current to the local oscillator source unit. Working within specified range but unclear if it will fail in the future.
  
- **2. New calibration issues**
  - **Spur in band 7b around 1834 GHz** (affects an OH line) was not fully propagated to users (it escaped our current detection scheme). On short term we will check possibly affected past and future AORs. On mid term, spur shall be removed by setting adjustment.
  - **Purity issues at upper end of band 5a** that were not fully appreciated at the time of releasing the first HIFI observations ~ a year ago. Correction factor are been worked out
  - *Usage of AGB stars for calibration monitoring is inadequate in many lines due to variability. Monitoring needs to be done a more regular basis to follow light curve. New science result.*
  - **Smoothing algorithm for OFF subtraction in FSW and LChop with Ref was not optimal** -> consequence on standing wave and noise at leve2 (not exactly a cal issue but this is pipeline-related). This is being fixed for HIPE 6, so will be in for bulk-reprocessing



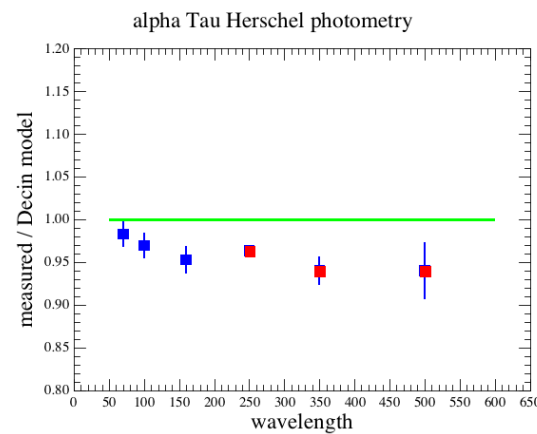
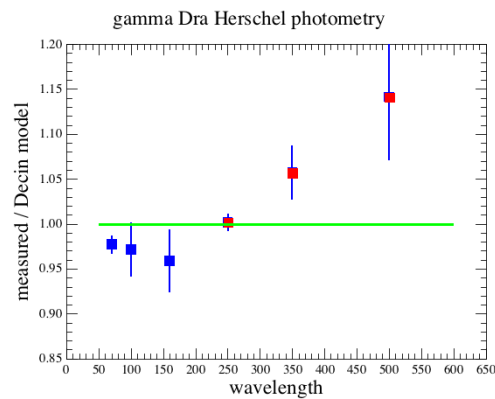
- **Observations:**
  - Cross-calibration information available through regular observations and calibration measurements.
  - **SPIRE and PACS photometer calibrations include cross-calibration targets, including asteroids** (also shared with Planck crossing times – part of a larger scheme of cross-calibration with Planck, should improve offsets in flux [e.g. HIGAL extended emission]).
  - Models and calibrator information used is contained in central **calibration source database (CalSDB)**. Publicly available but needs more user documentation.
- **Cross-calibration measurements taking place:**
  - PACS-SPIRE photometer
  - PACS-P and PACS-S, SPIRE-P and SPIRE-S
  - HIFI and SPIRE-S line emission.
  - Very limited PACS-S and HIFI line emission (mainly anecdotal).



# Cross-Cal Example Cases



**SPIRE-S -HIFI line measurements, CRL618. Initial results within 14%.**



**SPIRE-PACS photometer measurements compared to calibration models.**



- Loss of STRs before Christmas. Jupiter moving towards the edge of the STR FOV? Rare but indicates issue of offset between use of the 2 STRs.
- **Pointing generally** -- being monitored regularly (now using scans rather than PACS PS mode). API generally consistent, some suggestion there could be some degradation -- need to be careful -- scan versus pointed mode observations.
- Pointing improvements are available for many objects with the use of **interlacing of the STRs** (use of up to 18 instead of 9 stars).
- **Pointing using gyros -- CP raster tests.** So far, drifts during time on GYRs make this less useful. Second test just performed suggests nothing improved with changes to setup. Situation degrades when moving on from an initial observation too. Awaiting a final report on this.



## Conclusions

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- Calibration is generally excellent for all instruments!
- **Photometers probably pushing as far as we can go with flux cal.**
- **Spectrometers some way to improve.** HIFI errors estimates likely to come down considerably when sideband ratios become available later this year.
- Model sources used for calibration can be limiting factor, but at high accuracy now and show consistency with absolute calibration being used with the telescope.
- **Cross-calibration measures show excellent consistency,** within the errors of the instrument measurements (especially when using the same calibrator models!).



# Absolute scaling.....

