Calibration errors

1. **PACS**

Reference : Herschel Science Center webpage

http://herschel.esac.esa.int/twiki/bin/view/Public/PacsCalibrationWeb#PACS_calibration_and_performance

- Use 5 stars as primary calibrators plus fainter stars and asteroids as secondary calibrators
- Model uncertainties : 5% in all 3 bands
- Reproducibility for a given non-variable point source is about 2% for all PACS bands -> correspond to variation of the calibration in time ? Do not take it into account ?

Technical note : Section 6.1

http://herschel.esac.esa.int/twiki/pub/Public/PacsCalibrationWeb/pacs_bolo_fluxcal_report_v1.pdf

- Absolute accuracy of the flux calibration based on measured absolute standard deviation of the obs/model values of all independent fiducial star observations
  - Blue band : 36 indpt observations, 5 stars : stddev = 0.014
  - Green band : 21 indpt observations, 5 stars : stddev = 0.016
  - Red band : 43 indpt observations, 5 stars : stddev = 0.035
- The individual stellar models have an absolute accuracy of 5% in the PACS wavelength range

Conclusion from 08/07/2013 discussion :

➔ σ_{cal}(model) = 5% correlated between the 3 bands
➔ σ_{cal}(rms) = 1.4, 1.6, 3.5 % independant from band to band

2. **SPIRE**

Reference : Herschel Science Center webpage

http://herschel.esac.esa.int/twiki/bin/view/Public/SpireCalibrationWeb#SPIRE_calibration_and_performance

➔ σ_{cal}(Neptune model) = 4% correlated between the 3 bands
➔ σ_{cal}(rms) = 1.5 % independant from band to band, from repetitive measurements on Neptune
➔ Additionnal error for extended sources : σ_{cal}(beam) = 4% for current uncertainty in measured beam areas. -> one cal err per galaxy !

3. MIPS

Reference : Use Fred's values from Galliano2011

- ➔ σ_{cal}(M24) = 4% independent
- ➔ σ_{cal}(M70) = 5% correlated with M160
- ➔ σ_{cal}(M160) = 12% correlated with M70

4. IRAC

Reference : Reach et al. 2005

- σ_{cal}(model) = 2% correlated between the 4 bands

Reference : IRAC Handbook, v2.0.1, June 2011, Section 4.3

- « Analysis of the flux calibrator data indicates that absolute flux calibration is accurate to 3% (reflecting mostly the uncertainty in the models). Repeatability of measurements of individual stars is better than 1.5% (dispersion), and can be as good as 0.01% with very careful observation design *(e.g., Charbonneau et al. 2005, [6])*. The absolute calibration is derived taking several systematic effects into account. The steps are described in detail by *Reach et al. (2005, [22])*. If this methodology is not applied, then point source photometry from the Level 1 products (BCDs) can be in error by up to 10%. »

- σ_{cal}(model) = 3% correlated between the 3 bands
- σ_{cal}(rms) = 1.5 % independant from band to band, from repetitive measurements on individual stars
- Or 10% of calibration error if « methodology » by Reach 2005 not followed ? as in Dale2007 for KINGFISH…

-> What does this mean compared to Reach 2005 ?

Conclusion from 08/07/2013 discussion :

- ➔ Take Reach et al. 2005 2% for now.

5. IRS

The calibration error depends on the wavelength : 1 calibration error for each lambda in the IRS spectrum, and this error is NOT a constant fraction of the flux.

- ➔ Ask Vianney
- ➔ generate one calib err per galaxy when IRS data

6. 2MASS

Reference : Jarrett 2003, AJ 125:525

- « The relative calibration of 2MASS is uniformely 2-3% across the sky »
- « Photometric zero-point calibration : 2-3% »

Reference : Cohen 2003, AJ 126 :1090, 2MASS calibration paper

- Photometric zero-point calibration : use 33 calibrators of intermediate brightness
- The isophotal quantities show a ~2% variation.
- Refers to x numbers of papers called Paper XIII, Paper X, … need to check ?

Conclusion from 08/07/2013 discussion :

➔ 2MASS bands do not have a big influence in the end on Mdust, so take 2% independent from band to band.

7. WISE

Reference : Jarrett 2011, AJ 735 :112 -> not really clear

Reference : http://wise2.ipac.caltech.edu/docs/release/allsky/expsup/sec4_4h.html

- Section ii : WISE is calibrated on the same absolute basis than Spitzer. Networks of calibration stars support Spitzer observations with IRAC, MIPS and IRS, further providing cross-calibration between all three instruments. (-> what does it mean ???) The WISE team, in collaboration with the Spitzer Science Center, carried out a survey of the north and source ecliptic poles (NEP and SEP), the WISE "continuous viewing zones" (CVZs), using the full complement of Spitzer instrumentation: IRAC and MIPS broad-band mapping of a 47x47 arcmin (0.6 deg2) region for each CVZ, and IRS spectroscopy of either previously identified calibrator stars or newly developed standard calibrators. The imaging and spectroscopic observations include the galaxy NGC 6552, which is used to cross-calibrate the long-wavelength band of WISE (W4) with the Spitzer IRS-LL and MIPS 24 micron channel. -> results in Jarrett2011
- Section vii : Time variability in the instrumental zero point magnitude is ruled out with individual (repeated) measurements over the lifetime of the mission; repeated observations of the individual calibrators reveal an RMS scatter, typically better than 1% (Figure 6). -> i.e. calibration is stable over the lifetime of the mission
- The ensemble results suggest that the WISE absolute calibration, tied to that of Spitzer, has an RMS scatter in the standard calibration stars at the 2.4, 2.8, 4.5 & 5.7% levels for W1, W2, W3 and W4, respectively.

➔ Add a correlated error coming from the model ? IRAC one ? check Jarrett2011, not clear…

➔ « calibration tied to IRAC » : does this mean that they use IRAC fluxes to get a distance to the source and thus we need to add a correlated error with IRAC ? Or do they just use IRAC to select their calibrators ? -> send mail to Tom Jarrett.

Conclusion from 08/07/2013 discussion :

➔ σ_{cal}(rms) = 2.4, 2.8, 4.5 & 5.7% independant from band to band
➔ see answer from Tom Jarrett ?

8. IRAS

Reference : http://irsa.ipac.caltech.edu/IRASdocs/exp.sup/ch6/C.html

- Section C.1 : « The absolute calibration of the IRAS point source observations is tied directly to the absolute calibration by Rieke et al. (1984) of the ground based photometric system at 12 μm. Specifically, the 12 μm IRAS band is calibrated via measurements of alpha-Tau, with the assumption that its absolute flux density is as given in Rieke et al. 1984.
    - Extrapolation to the 25 and 60 μm bands is achieved using models of stars, normalized to observations of the Sun.
    - The extrapolation of the absolute calibration from 60 to 100 μm is based on observations and model calculations of asteroids whose absolute flux at 60 μm was obtained using the stellar calibration. »
- Section C.2c « The estimated absolute accuracy of the stellar plus asteroid calibration relative to the 12 μm ground based calibration is 2%, 5% and 5% at 12, 25 and 60 μm, based on the uncertainty in the stellar models and the scatter in the standard stars, and l0% at 100 μm based on the uncertainty of the asteroid model extrapolation. The stated accuracy of the 12 μm absolute calibration is 3% (Rieke et al. 1984). The dispersion of the ratio of observed to model fluxes at 100 μm is only 3%, the mean being identical to unity by definition of the asteroid calibration procedure. »
- Section C.2.a : « A comparison of several stellar model calculations (Gustafsson, et al. 1975; Kurucz, 1979; Bell, 1984) with the data in Vernazza et al. predicted a smaller color difference, by about 2%, in the models than observed for the Sun. »
- Section C.2.b : « Color temperatures were derived for each observation using the stellar calibration at 25 and 60 μm, and the assumption was then made that these color temperatures would remain unchanged between 60 and 100 μm. The flux at 100 μm was then calculated for each observation from the appropriate blackbody function and the stellar calibration at 60 μm. Use "standard asteroid model" of Morrison (1973) and Jones and Morrison (1974). -> check paper for uncertainty on asteroid model ?

Conclusion from 08/07/2013 discussion :

➔ σ_{cal}(rms) = 2, 5, 5 % at 12, 25, 60 μm from stellar model, independent
➔ σ_{cal}(rms) = 10 % at 100μm from asteroid model, independent

➔ σ_{cal}(model) = 2% for stellar model : what to do with that ??
➔ σ_{cal}(model) for asteroid model ??

➔ σ_{cal}(Rieke1984 photometric system) = 3% for stellar model, correlated between 12, 25, 60 μm.
➔ and also 100 μm because of Section C.2.b and c notes.