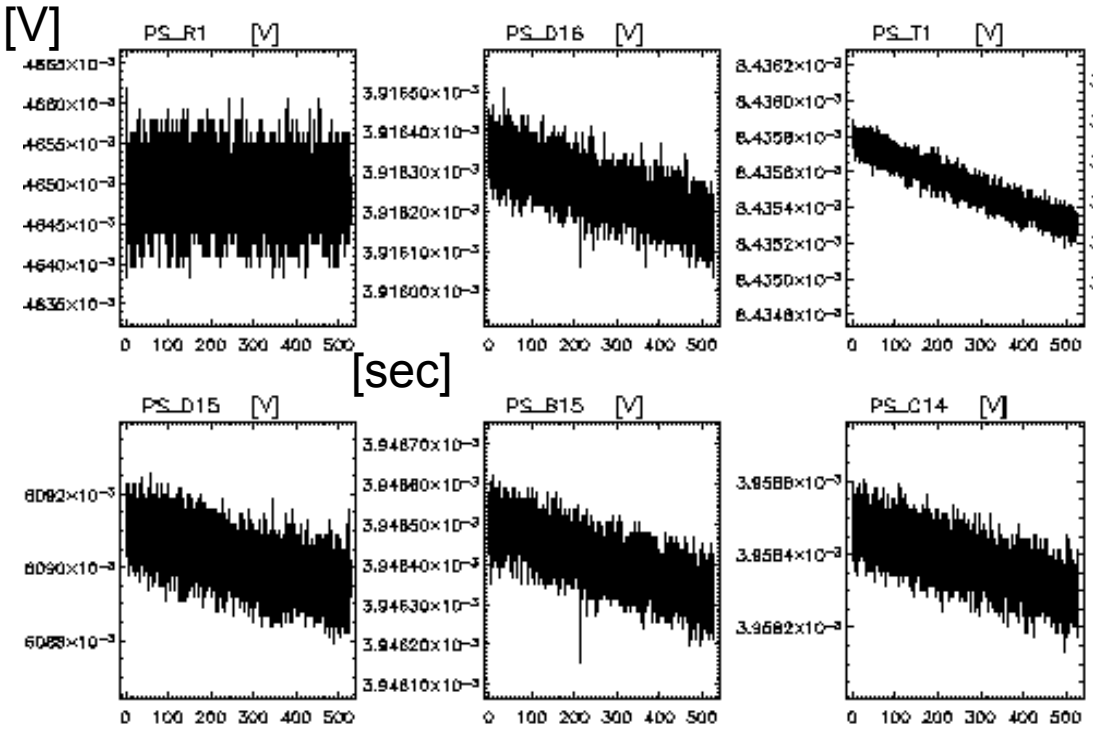
SPIRE Calibration
Important Points

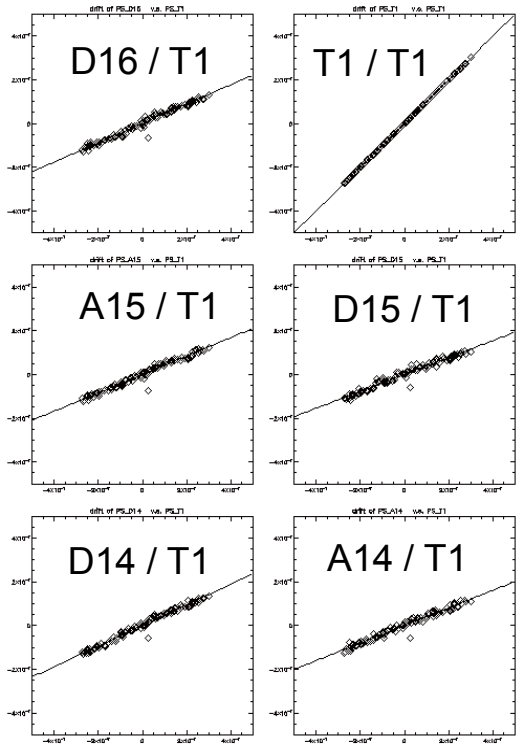
Bernhard Schulz (NHSC/IPAC)

on behalf of the
SPIRE ICC, the HSC and the NHSC

Detector Stability



PSW array

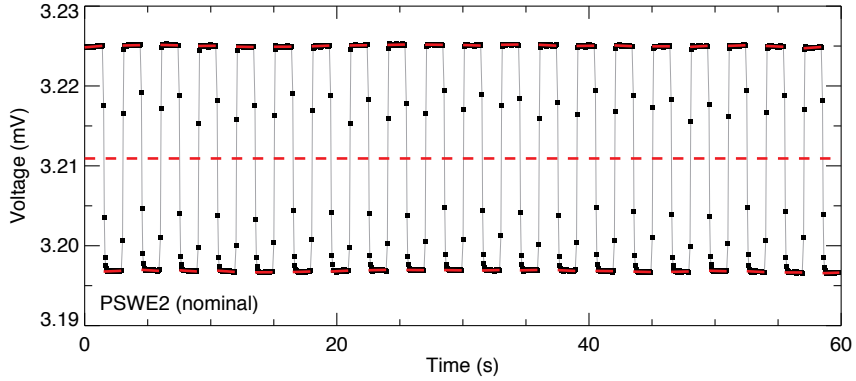


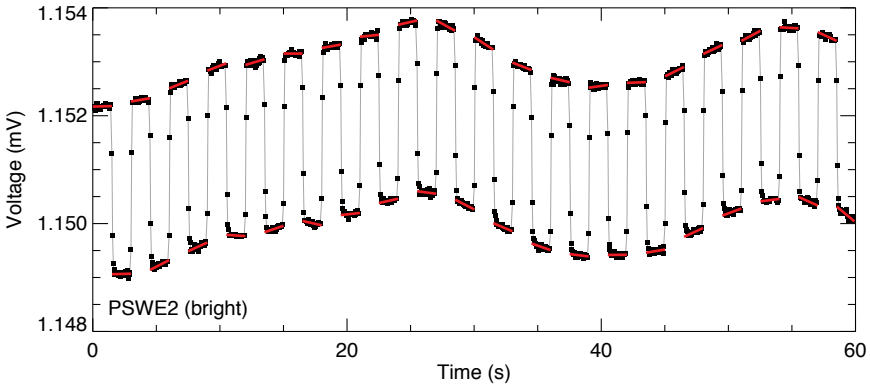
Most signal drifts come from temperature changes, as shown by the perfect correlation of thermistor pixel T1 and detector signals. The resistor pixel R1 does not vary with temperature.

Signal is very stable after correction with thermistor signals (1/f knee < 10mHz).

Linearity Calibration

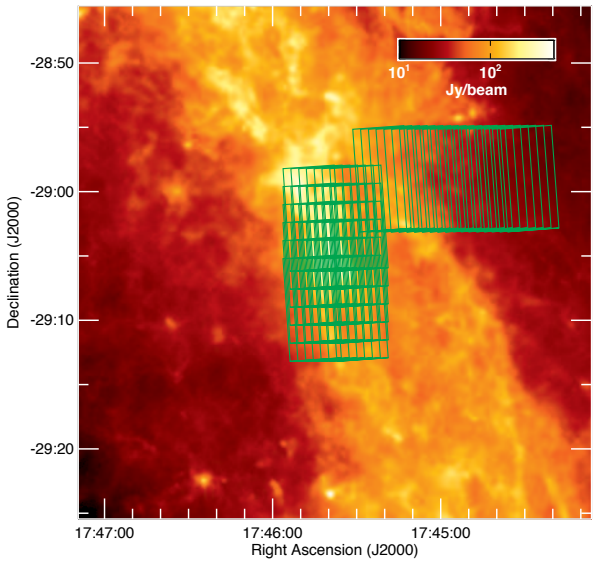
- The SPIRE Spiderweb bolometers are very well understood and good model descriptions exist.
- Still, empirical calibration offers the highest level of accuracy.
- An internal calibration source (PCal) provided highly stable and reproducible infrared flashes illuminating all detectors simultaneously on top of the celestial background.
- These flashes allow to measure a relative detector responsivity at the current total flux level that is a sum of sky and telescope emission.
- for details see Bendo et al. 2013, MNRAS 433, 3062



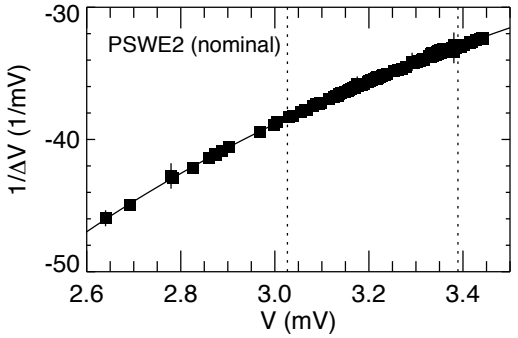


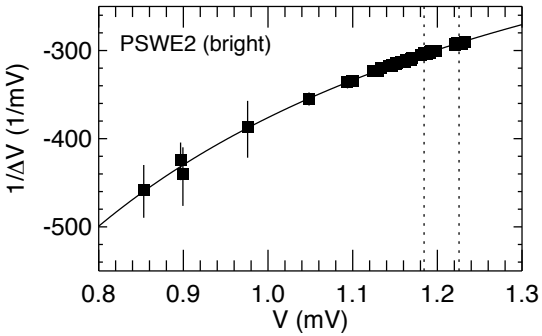
Linearity Calibration

- Each SPIRE observation contains a sequence of calibration flashes.
- Special observations in bright regions were performed to increase the statistics of data points at bright fluxes.
- Thus the flux range for each detector was serendipitously filled in and linearity curves were derived for both, nominal, and bright observing modes.



The diagrams show data from the photmeter calibration, however the spectrometer linearisation is done in the same way.





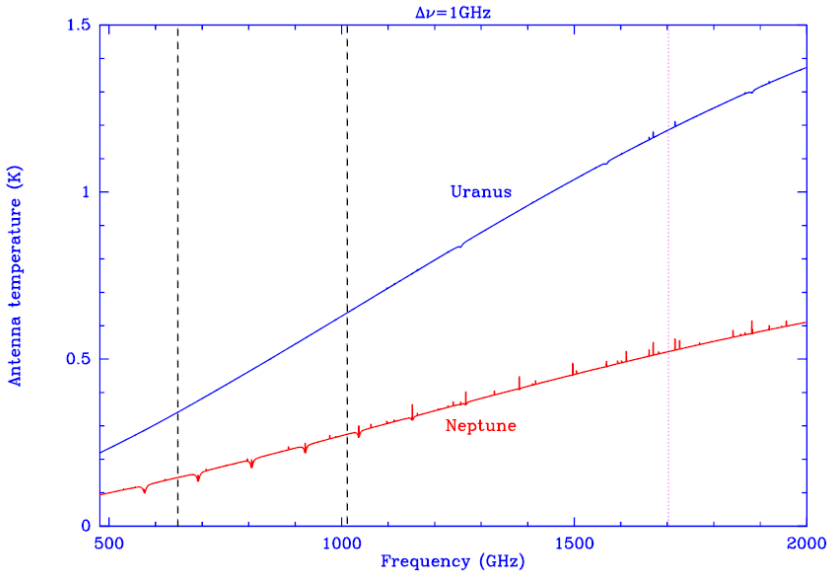
from Bendo et al. 2013, MNRAS 433, 3062

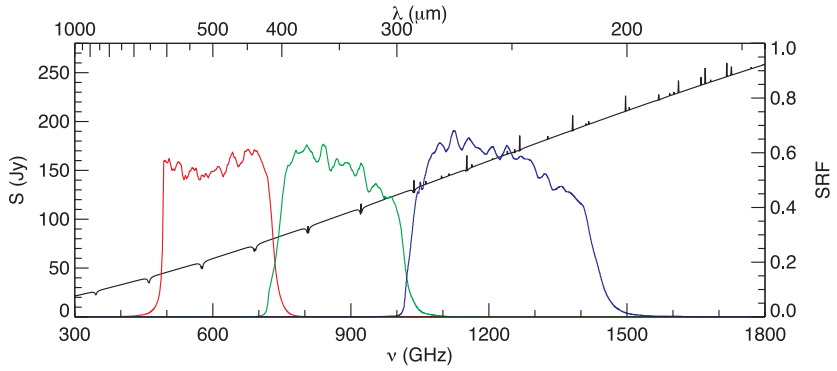
See also Swinyard et al. 2013, in prep.

Flux Calibration Standards

- The SPIRE flux calibration is based on point sources.
- Neptune, for the photometer, and Uranus for the spectrometer.
- We use radiative models provided by Rafael Moreno.
- The models are estimated to be accurate to ~4%.
- Filter spectral resolution is ~3.

→ Color correction is essential!

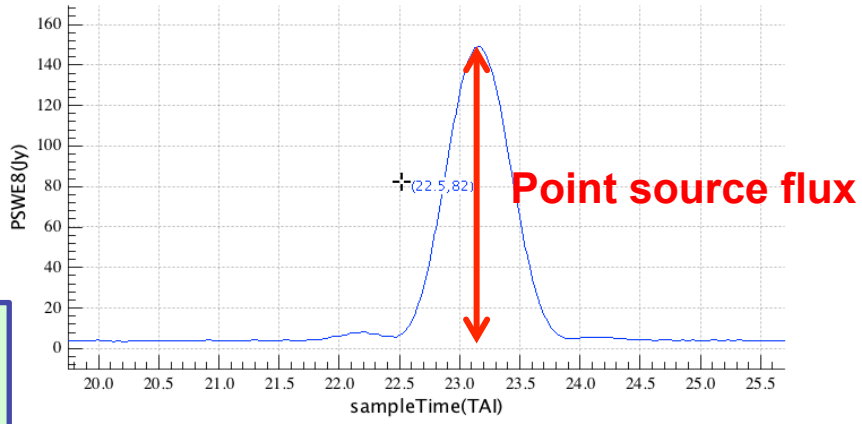




Point Source Photometry

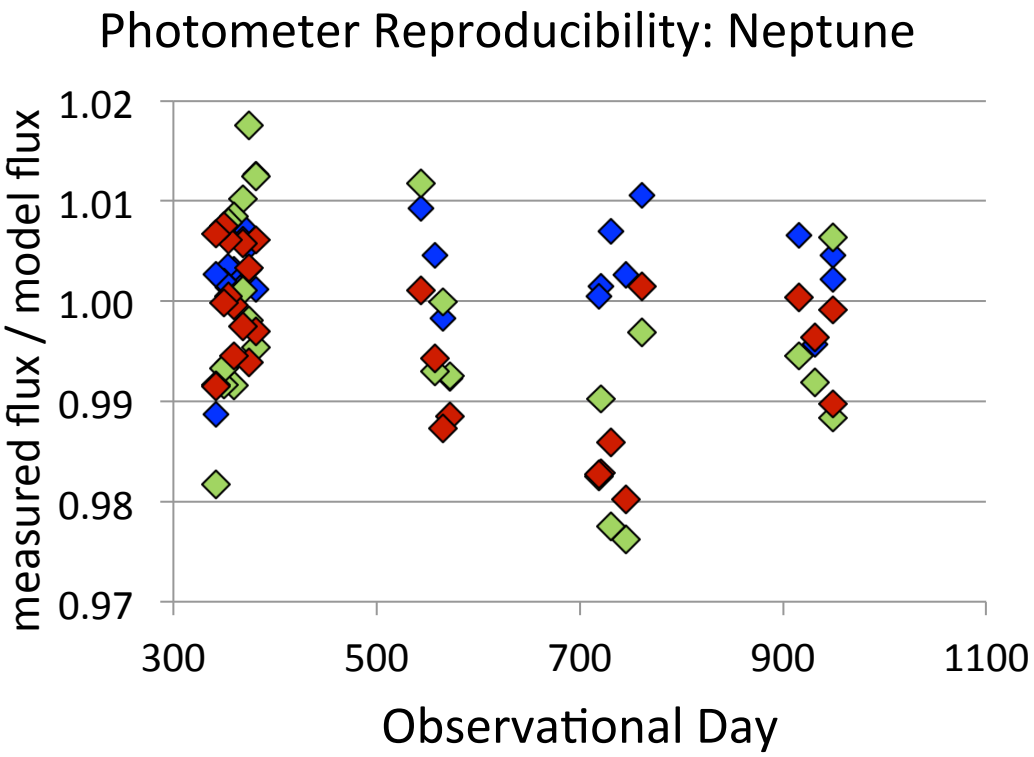
- The SPIRE calibration is based on point source photometry (Prime calibrator: Neptune)
- Standard SPIRE unit is Jy/beam
- When a detector is scanned centrally over a point source, the peak deflection of the signal timeline equals the brightness of the source.
- The spire broad-band photometry is quantified as monochromatic flux density at a reference wavelength (250, 350, 500μm) assuming a reference spectrum of νF_ν = const.
- For a different reference spectrum a color correction must be applied.

Scan of detector PSWE8 over Neptune, obsid 1342187440



The Timeline Fitter was used for the flux calibration with Neptune.

Photometer Flux Accuracies

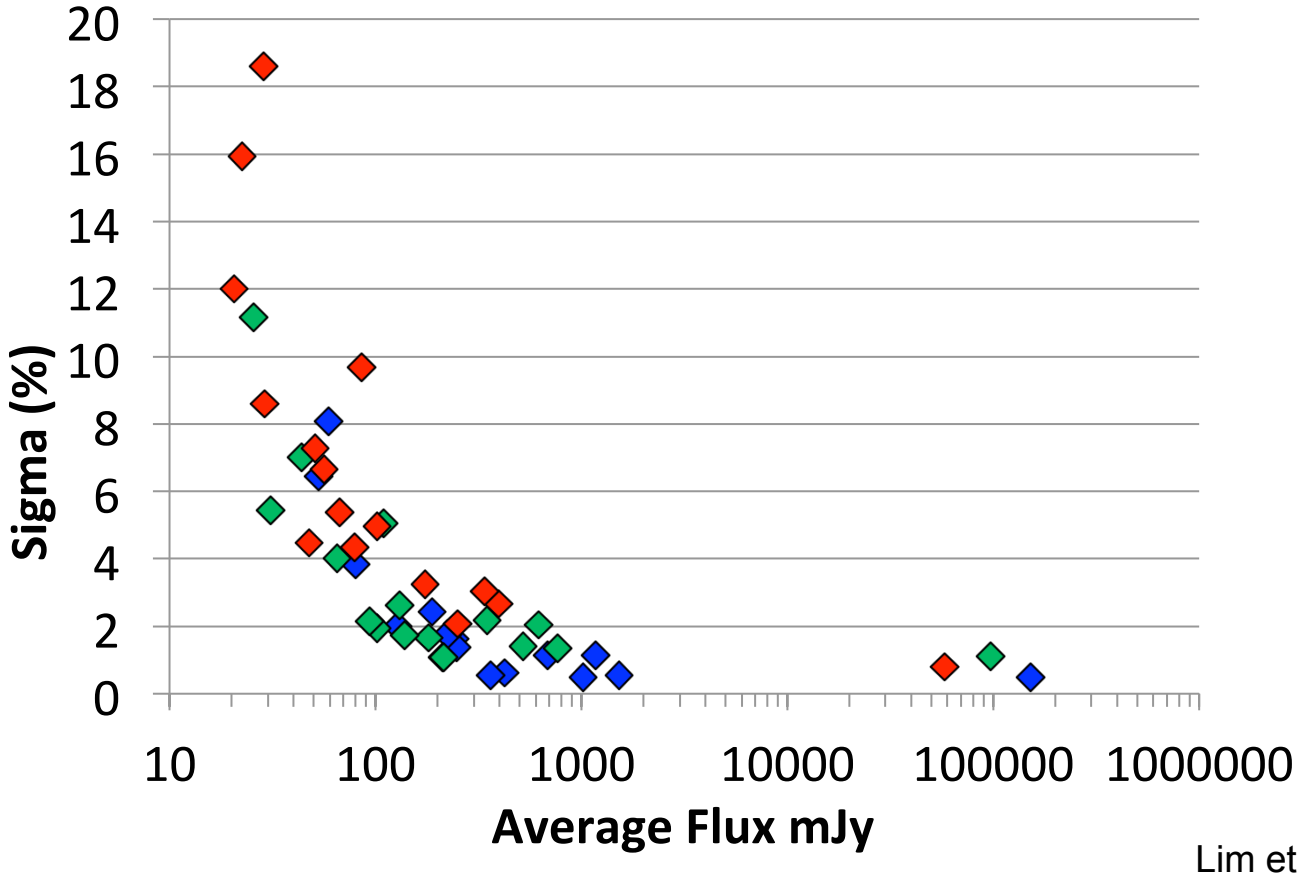


Ratio Standard Deviation:
PSW=0.005, PMW=0.011, PLW=0.008

- Repeatability is ~2%
- Absolute accuracy of flux standard is 4%
- Conservative estimate of absolute flux calibration accuracy is 6%

Bendo et al. 2013, MNRAS 433, 3062

Repeatability at Stellar Fluxes



Lim et al. 2014 in prep.

Uncertainties

- Uncertainty in the derived flux
  - Includes the instrument
  - Confusion noise
    - (minimum of about 5 mJy for point sources)
  - Background estimate
- Point Sources (based on peak photometry with Timeline Fitter)
  - 2% statistical reproducibility
  - 4% absolute level of Neptune model
    - (systematic)
- Extended Sources (assuming aperture correction is understood)
  - 2% statistical reproducibility
  - 4% absolute level of Neptune model
    - (systematic)
  - 4% uncertainty in solid angle determination
    - (systematic)
    - This one will be substantially reduced in the next version.