SPIRE Status

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for the SPIRE ICC

Overall Summary

Photometer

- Scan map
  - Fully released
- Parallel mode
  - Fully released
- Small Map
  - Changing mode from 64 point jiggle to small scan map, hope to complete early in new year
- Point Source
  - On hold due to issues with BSM tuning which should be completed early in the new year, some consideration being given to using small map

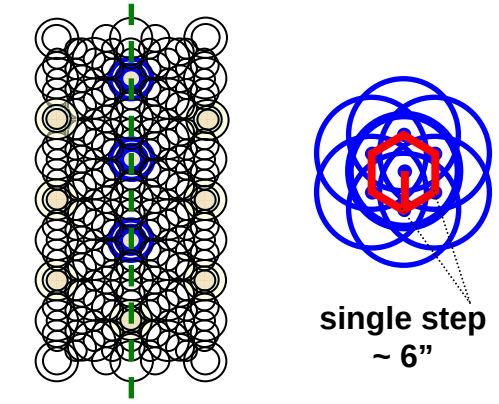
Spectrometer

- Sparse map/Point Source
  - Released for non-bright point sources, high and low resolution, expect further optimisation of outer detectors
- Intermediate or Fully Sampled Map
  - Expect to be released within a few months

Overview of SPIRE Photometry

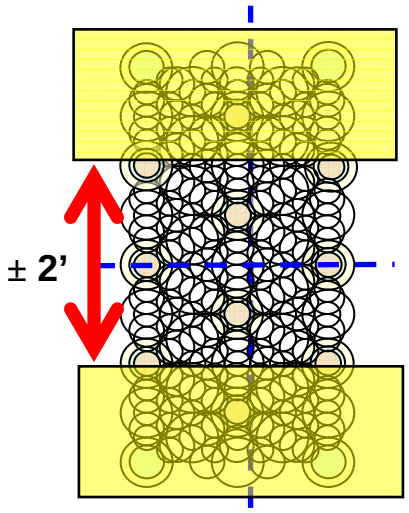
Observing Modes

7 point jiggle (point source)



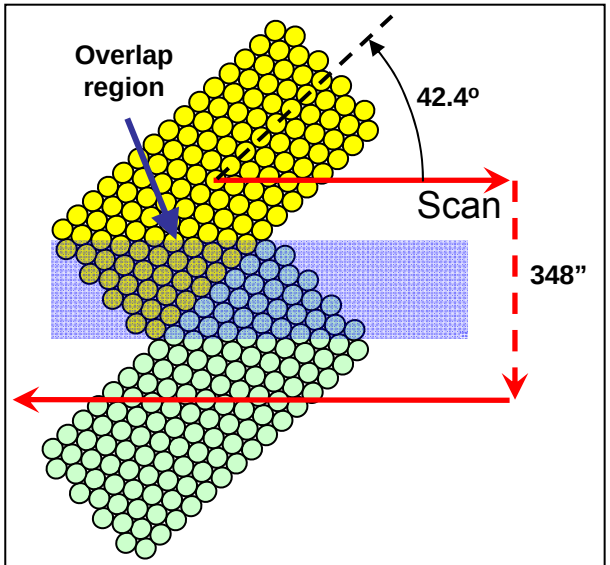
7-point jiggle for **point source photometry**, to compensate pointing error and under-sampling. Chopping and nodding at each jiggle position.

64 point jiggle (4’x4’small map)



64-point jiggle for **full spatial sampling** in 3 bands simultaneously. Chopping and nodding at each jiggle position. Available field 4’ x 4’.

scan (large) map



Scan map at speeds of **30** and **60 ”/sec** is most efficient mode for **large-area surveys**. Parameters are optimized for full spatial sampling and uniform distribution of integration time. **Cross scan capability** (**84.8º**)

Scan-Map Sensitivity

Pre-launch estimates (instrument noise):

- One repeat = two cross-linked scans
- Numbers referred to point source detection in a map
- For (250, 350, 500 μm)
  - 5-σ sensitivity for one repeat: (48, 66, 56) mJy
  - 1-σ sensitivity for one repeat: (10, 13, 11) mJy
  - No. of repeats to achieve 3 mJy rms: (10, 19, 14)

Achieved sensitivity (instrument noise)

- 1-σ sensitivity for one repeat: (12, 8, 12) mJy
- Comparable to pre-launch prediction for 250, 500 um and a bit better for 350 um

Confusion levels :

- Measured 1-σ confusion noise for (250, 350, 500 μm): (4, 5, 6 mJy/beam)

- **Overall sensitivities are slightly better than HSPOT pre-launch predictions**

Other Sensitivities

Photometer Small Map and Point Source

- These estimates are still not final and will improve after the BSM is tuned!
- HSPOT predicted instrumental noise (5σ, I hour)
  PSW = 1.4 mJy (5.73 mJy including confusion)
  PMW = 1.6 mJy (6.97 mJy)
  PLW = 1.3 mJy (5.59 mJy)

- Measured noise
  - RMS value for the sensitivity of one ABBA repetition, i.e. the smallest observation that can be made in this mode

  PSW = 6.68 mJy

  PMW = 7.85 mJy

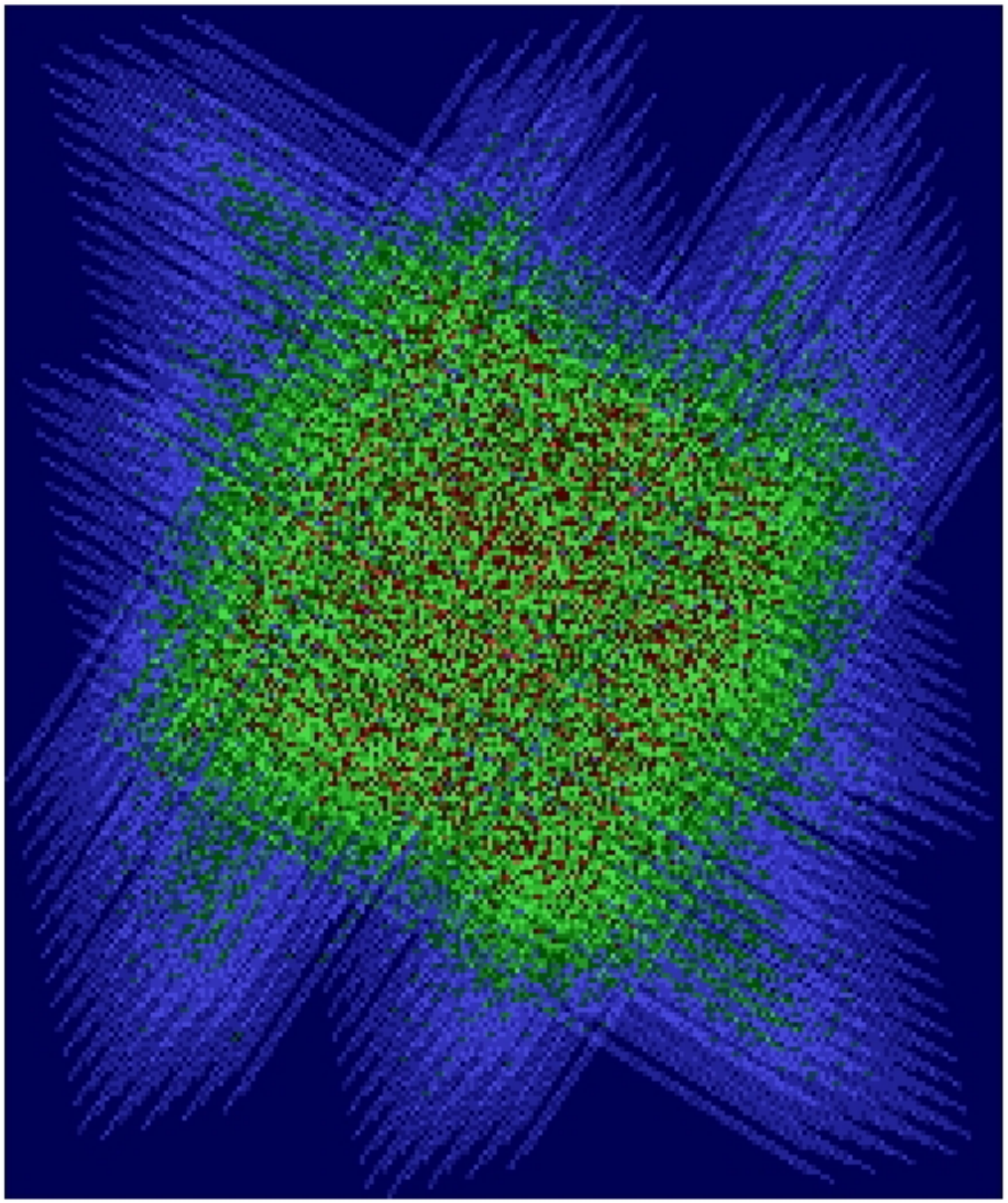
  PLW = 7.03 mJy

In–Flight Updates

- **Changes to uplink so far:**
  - New detector bias settings
- **No-change to uplink found to be required for:**
  - Bias frequency
  - Scanning speeds
  - Scanning geometry
  - Angle
  - Separation
  - PCAL level
  - PCAL only used at the end of the AOT
- **Possible future changes to uplink**
  - Less frequent PCAL Flashes in long observations
  - Use of PTC?
  - Dithering?

Coverage maps POF5 (fast):

- **Scan A B**
- **Hits:**
  - 0-5: blue
  - 5-10: green
  - **10-15: red**



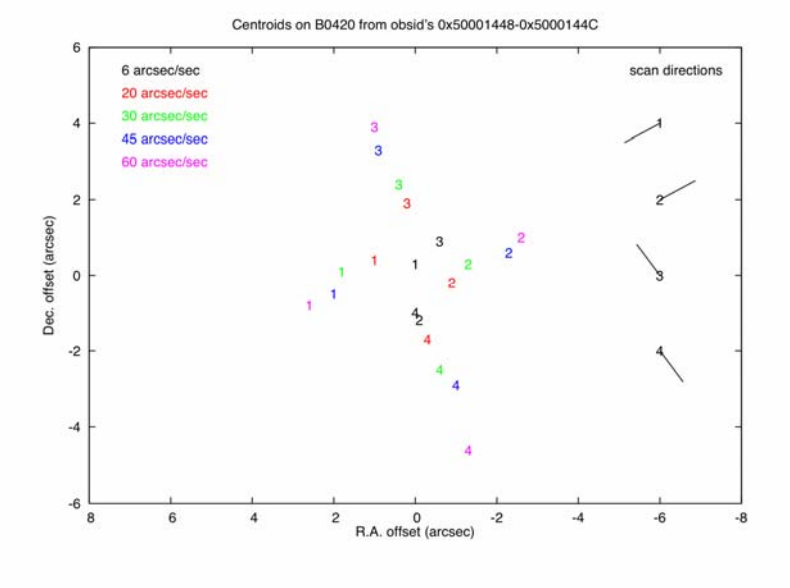
Data Processing/Calibration Issues

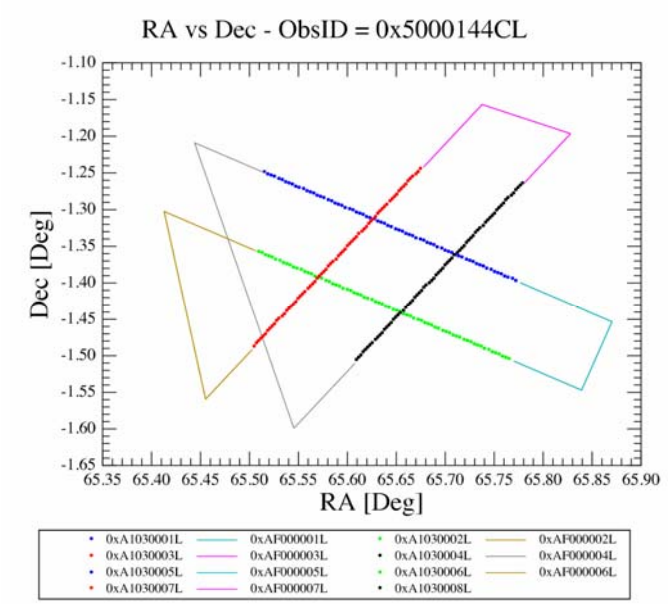
Issues

- Pointing shift
- Baseline removal
- 1/f noise
- Replacement of glitches

Additional pointing shift

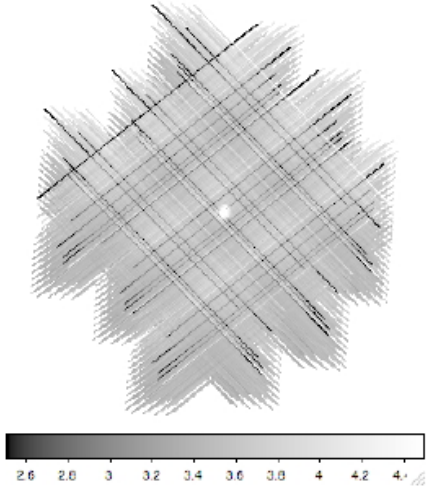
- Spacecraft APE = 2”
- SPIRE scan has systematic shift of ~60ms along scan direction between signal and pointing (the *signal leads the pointing*)
  - (at 60”/sec == ~3.6”; at 30”/sec == ~1.8”)
- Also small perpendicular shift
- One reason likely to be a drift in SPIRE DRCU clock
- **Fix under test**

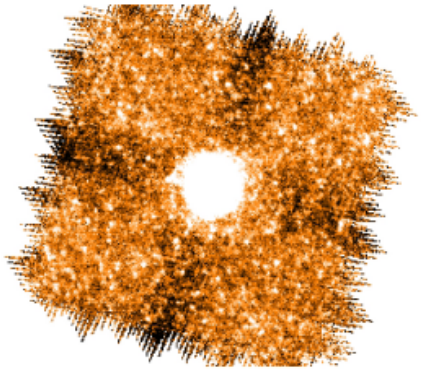




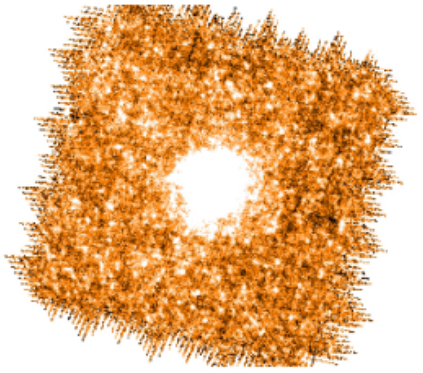
Baseline Removal

- After pipeline processing small DC offsets between timelines of individual detectors remain.
- Can lead to
  - Strong striping (if no baseline removal done)
  - Shadow effects (depending on field)
- Improved calibration will ease (but not eliminate) the problem.
  - Median baseline removal added to level 2 processing before the map making stage
  - SPIRE observers will be encouraged to interactively find the best algorithm for their science aim





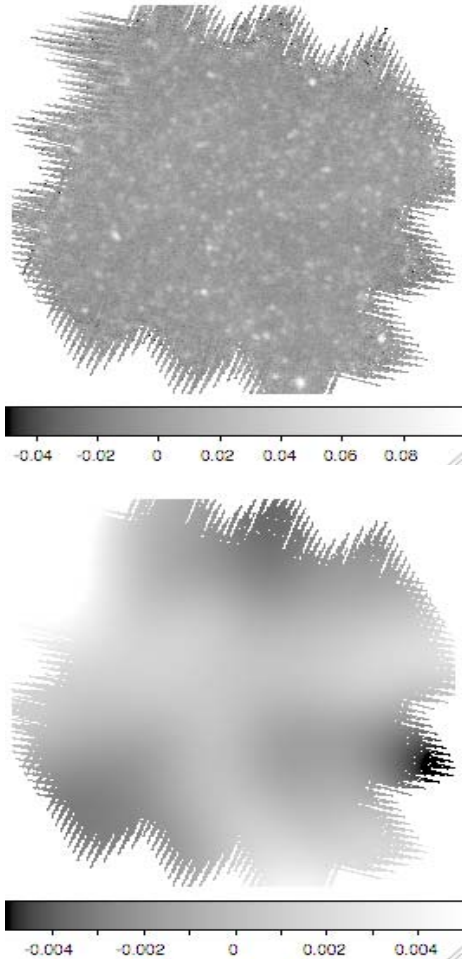
median baseline subtraction



robust linear baseline subtraction per scan

1/f noise

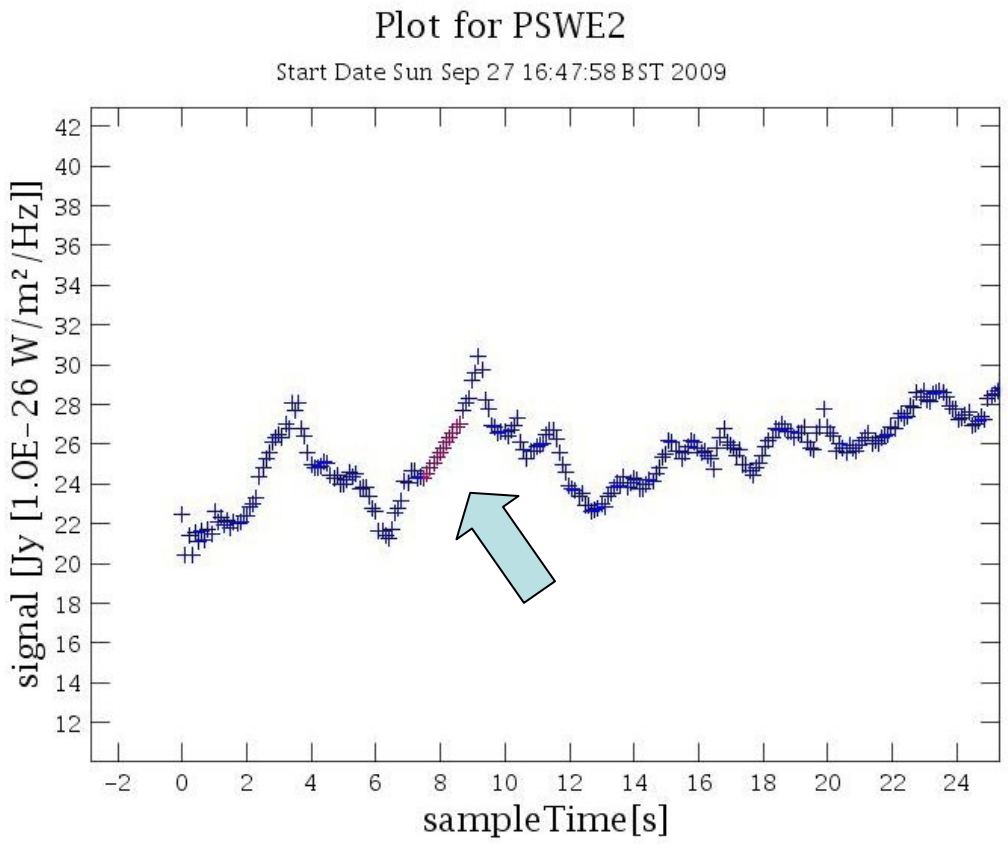
- Remaining from temperature drift correction, albeit small effect.
  - Gives low level structures in the background
- Needs to be addressed in the map making stage
  - Use of PTC may operationally improve matters



smoothed to 5’ resolution: noise 10× too high

Replacement of glitches

- Replacement currently done by simple interpolation.
  - Mask will tell map maker which readouys not to use



Deglitcher NaNs in shallow maps

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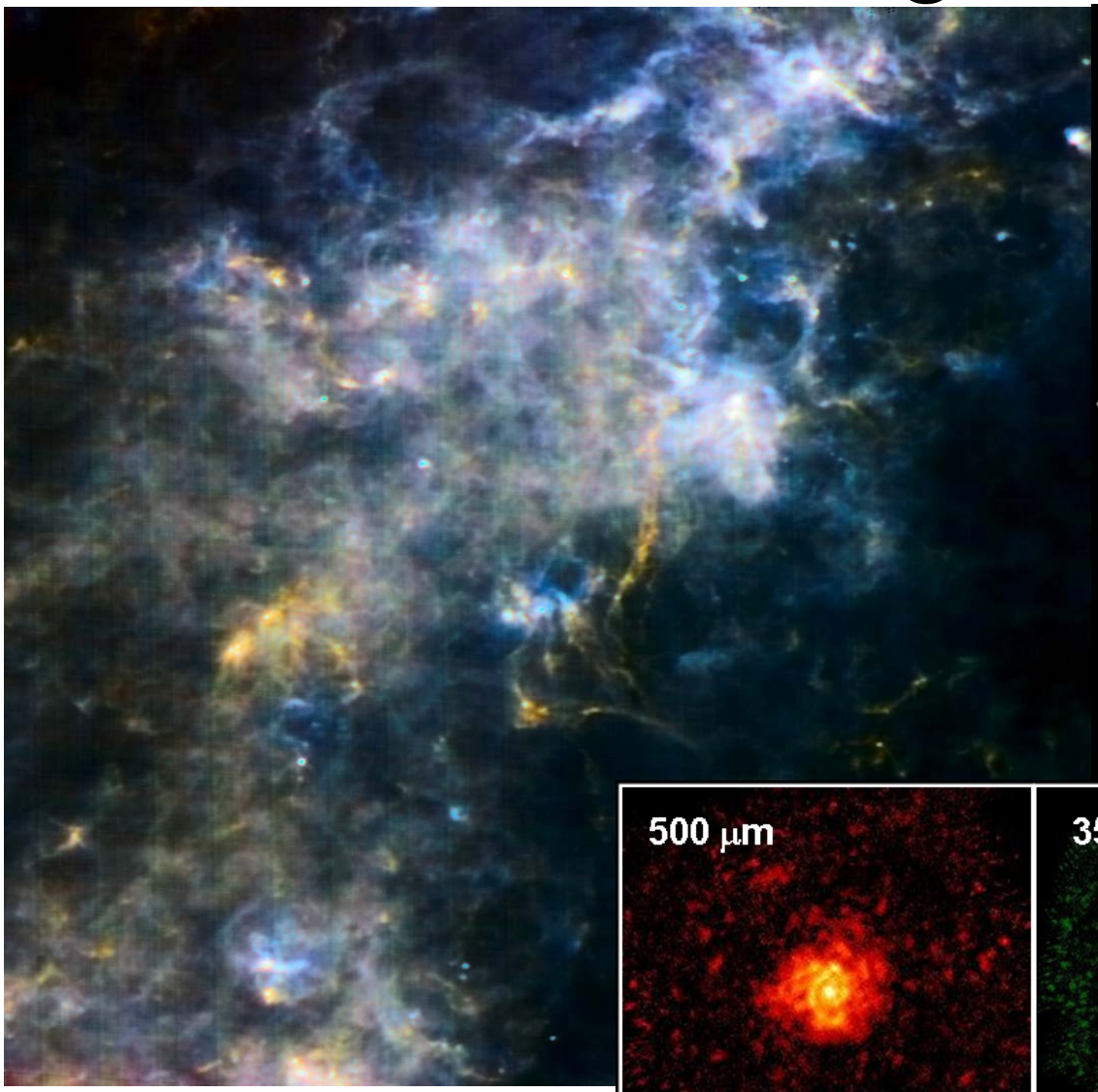
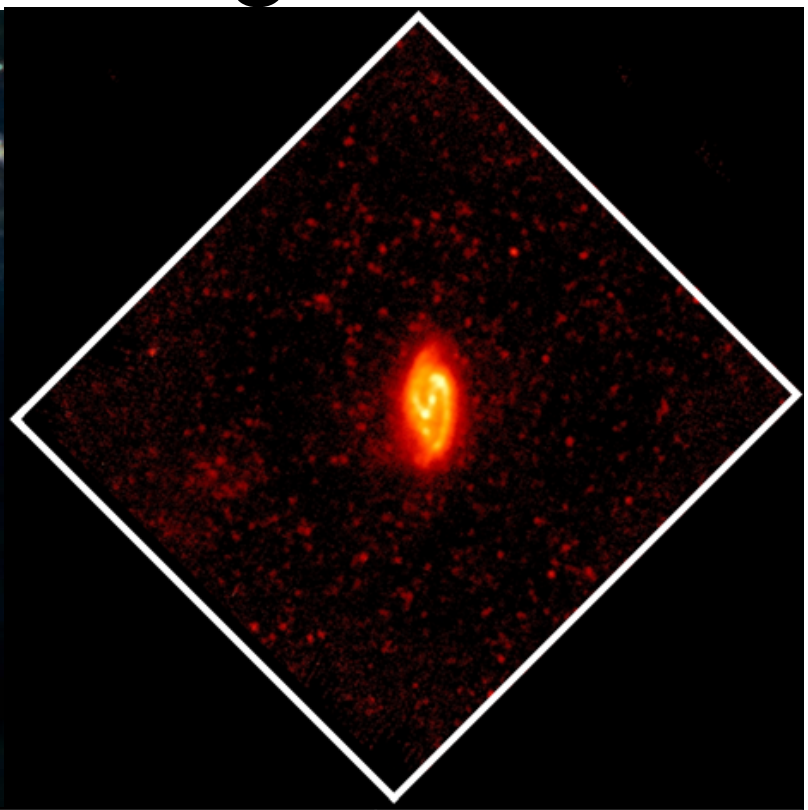
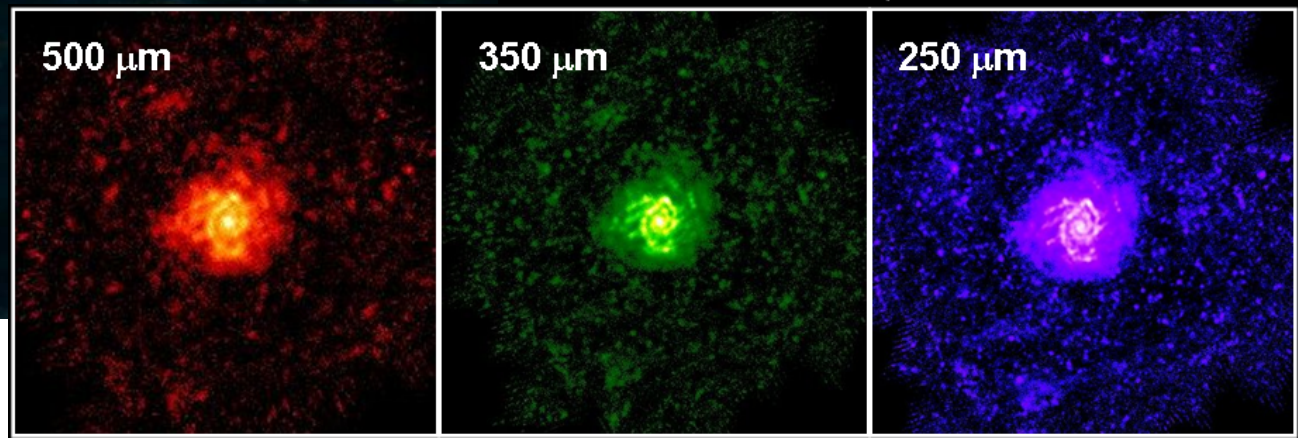
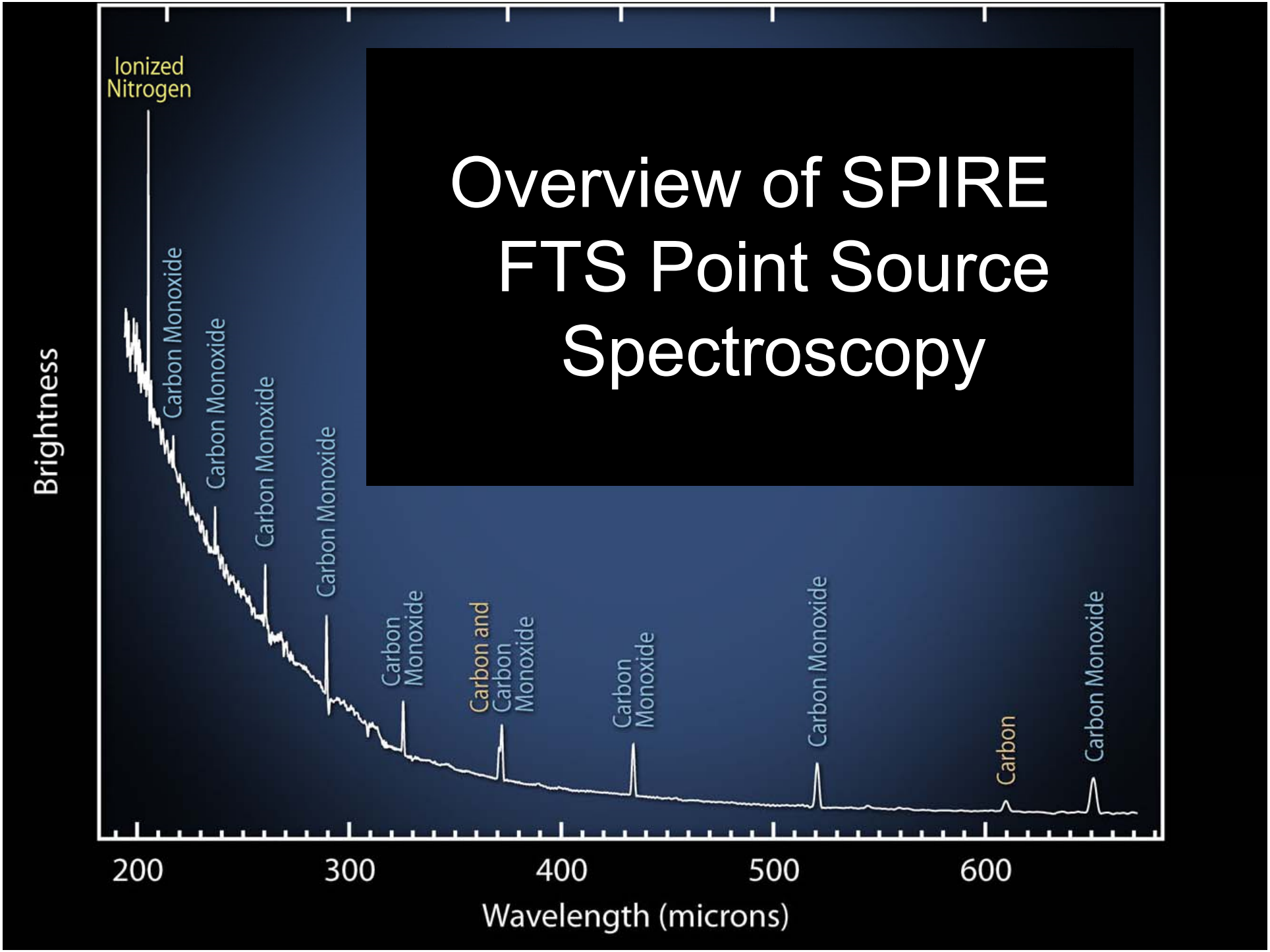
Final images are great!








Overview of SPIRE FTS Point Source Spectroscopy
Ionized Nitrogen
Carbon Monoxide
Carbon Monoxide
Carbon Monoxide
Carbon Monoxide
Carbon Monoxide
Carbon and Carbon Monoxide
Carbon Monoxide
Carbon Monoxide
Carbon
Carbon Monoxide
Brightness
200
300
400
500
600
Wavelength (microns)

Observing Modes

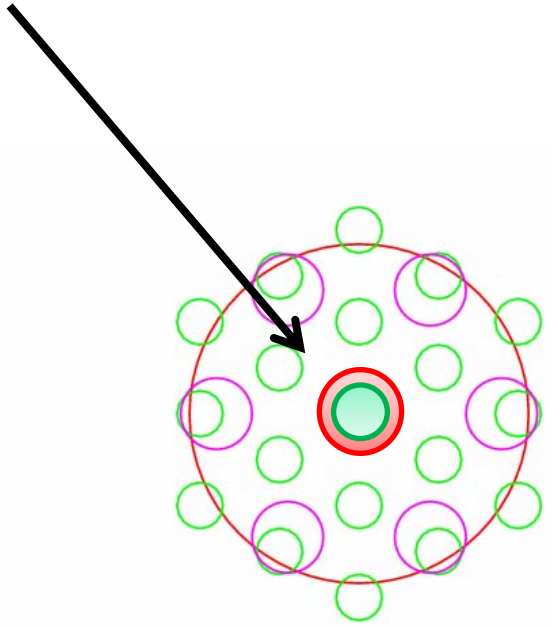
Point Source/Sparse Map

Part Released:

- Single Pointing *(central detectors only)*
- Sparse
- High (H) and Low (L) resolution
- High + Low (H+L) resolution*

Part Not Released Yet:

- Bright source settings
- Medium spectral resolution
- Raster mapping



**we strongly recommend to review "H+L" AORs with users to optimise usage*

Notes:

- Clipping is optimised for centre detectors only
  - If people are interested in or expecting emission in the off-axis detectors, it would be better to wait..
- (Bright) Sources with an average flux density greater than 50/150Jy for the SLW/SSW bands cannot be guaranteed to be within the dynamic range of the central detectors

Observing Modes

Intermediate and Fully Sampled Maps

Not Released

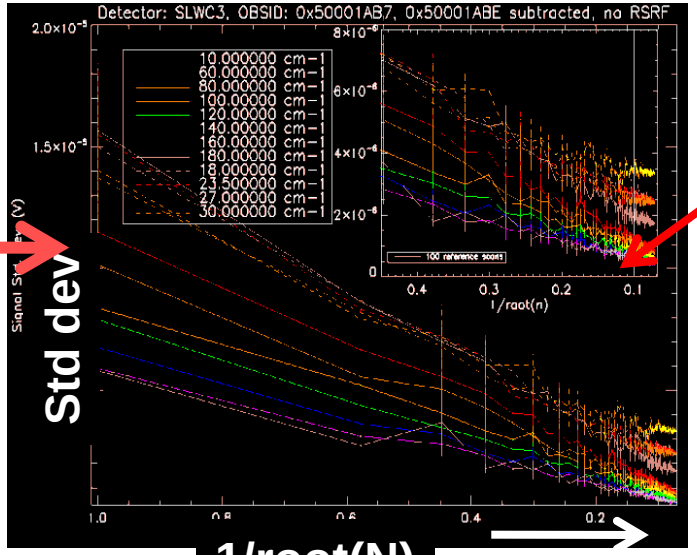
- Following recent release of point source mode optimisation of outer detector settings and BSM angle calibration now the focus of the team

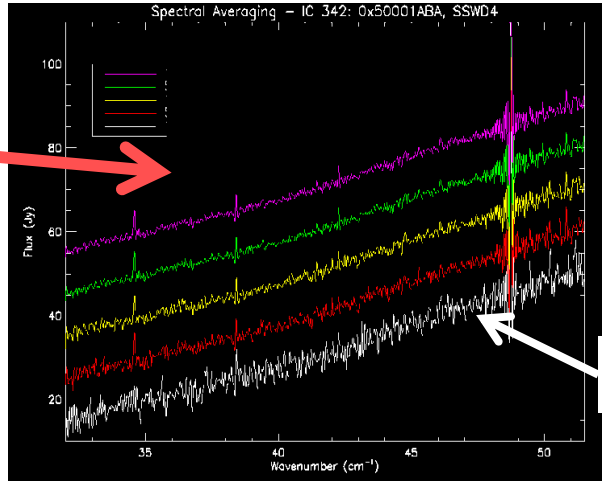
Uplink: Pointing

- Central detector pair (SSWD4/SLWC3) **to be used for point source spectroscopy (fringing to be addressed)**
- **Based on raster observations,** the SIAM was updated twice (OD 82 & 122) **specifically addressing the centre of the spectrometer detector arrays**
- **On OD123, the** pointing for the centre apertures was confirmed to be accurate within <2”
  (i.e. the absolute pointing error)

Noise

- **Tests have shown that the noise in the *interferograms* beats down as expected with increasing repetitions**
- **Also true in the spectrum** *out of the optical band*
- **However, currently some** inaccuracies in the RSRF **mean RMS noise in the baseline does not yet follow this**
  systematic effects after ~5-10 repeats
  (this is under investigation: see later)





Sensitivity

Investigation of the continuum sensitivity indicates:

- After 5 repetitions, we are already better than stated in HSpot & Observers Manual
- We believe we are *at least* a factor of 2 better than HSpot in final sensitivity ***(HSpot currently includes factor 2 "pessimism factor")***
- Sensitivity achieved depends on noise from dark subtraction **(i.e. for long integrations this will improve as we improve the dark background measurements through the mission)**
- We believe sensitivity will improve further once we have final calibration and processing **(i.e. properly accounting for systematics)**

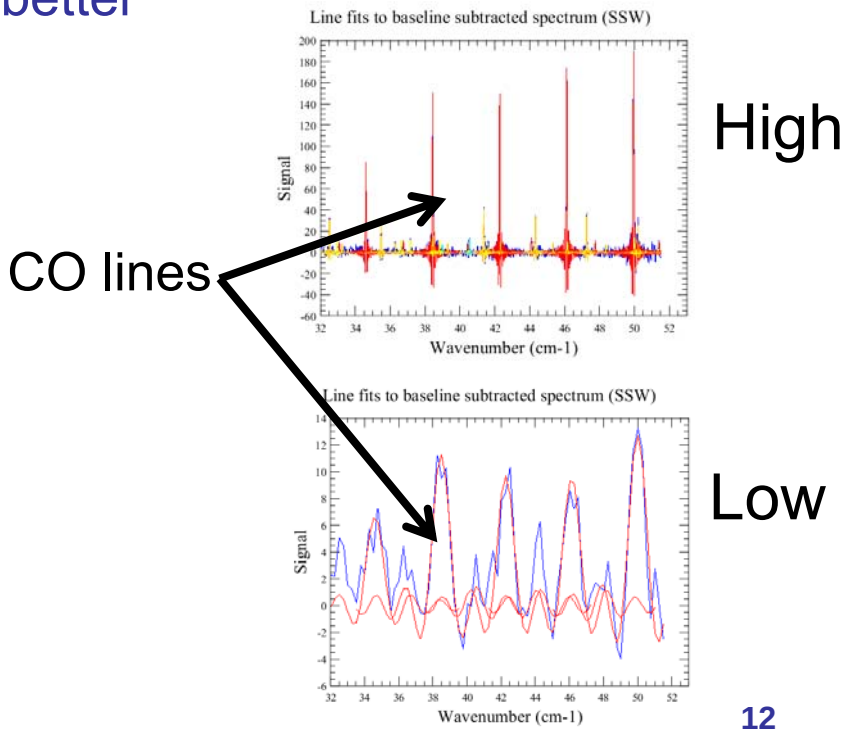
Spectral Resolution

- Scans designed to give resolution of:
  (defined as Δσ=1/2L)
  High: 0.04 cm^{-1}**; Low:** 1.0 cm^{-1}

- Actual measured resolution slightly better (due to using turnaround data):
  - **High: 0.0398 ± 0.0002 cm^{-1}**
  - **Low: 0.83 ± 0.04 cm^{-1}**

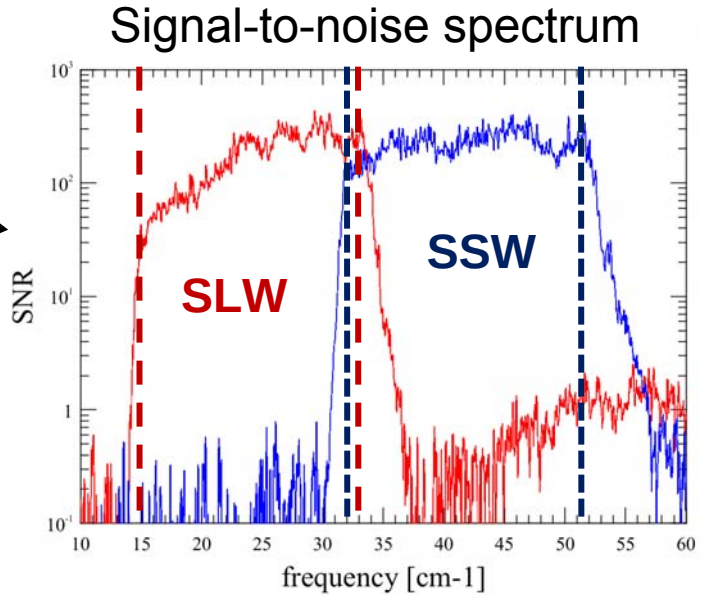
- FWHM = 1.20671*Δσ
  - **High: 0.0480 cm^{-1}**
  - **Low: 1.00 cm^{-1}**

No difference between SSW and SLW



Spectral Range

- As per observer manual:
  - **SLW: 14.9–31.6 cm^{-1}**
  - **SSW: 30.9–51.5 cm^{-1}**
- Slight shift in the overlap region to higher frequencies:
  - **SLW: 14.9–**33.0 **cm^{-1}**
  - **SSW:** 32.0**–51.5 cm^{-1}**
- Overlap still sufficient for cross-calibration between
  - SLW and SSW
  - SPIRE and PACS



Beam Size

Preliminary measurements of beam size from line scans:

SSW D4: 19 ± 1” ***(Observers Manual: 16”)***

SLW C3: 35 ± 1.5” ***(Observers Manual: 34”)***

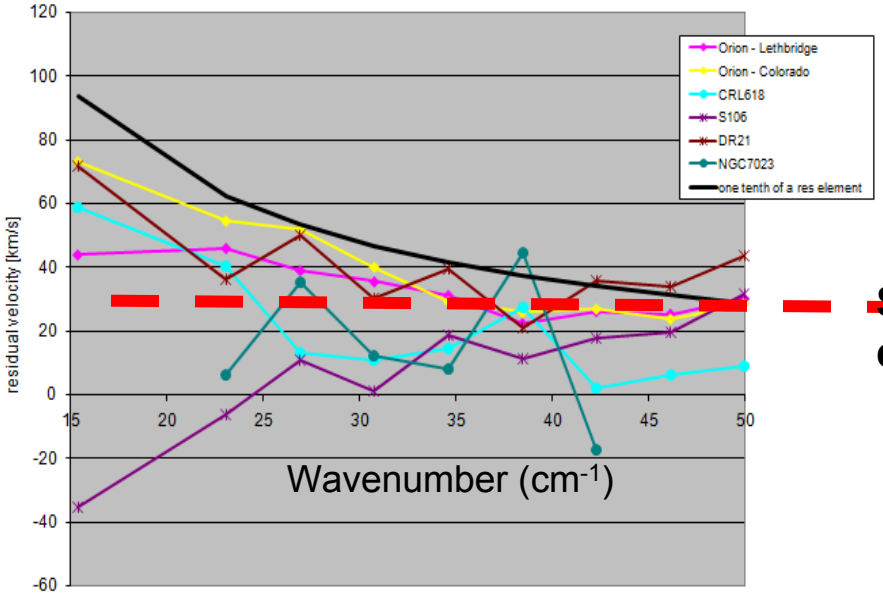
Confirmed by fine scan measurements

Will be repeated with Neptune (brighter source)

Currently only broad-band information:
Wavelength dependence to be determined

Wavescale Accuracy

- Wavescale verified with CO lines in five Galactic sources – fitting the theoretical instrumental line shape (sinc profile)
- Shows that instrument-based calibration is accurate within 1/10 of a spectral resolution element across both bands
- Next step: **Follow up on a slight systematic deviation. Measured wavenumbers are slightly lower than expected (~ +30km/s offset)**



Systematic offset of +30 km/s

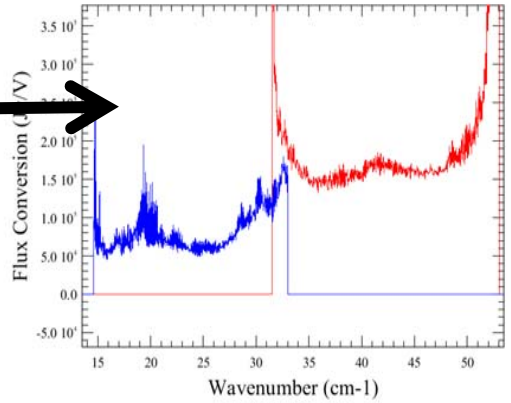
Flux Calibration: comparison with Neptune

Flux calibration currently based on Vesta

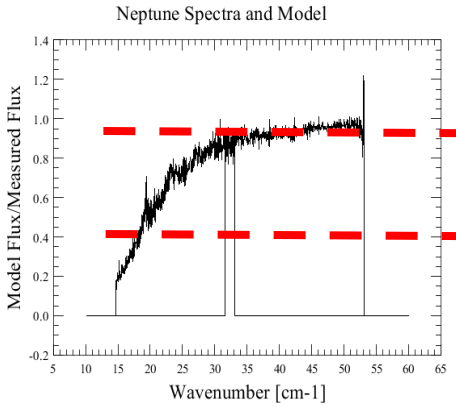
Vesta model from Thomas Muller for time of observation used

Vesta calibration at High resolution

Effectiveness at removing fringes under investigation



Apply the Vesta calibration to Neptune & compare with Neptune model:



10%

40%

Currenly working on understanding this discrepancy

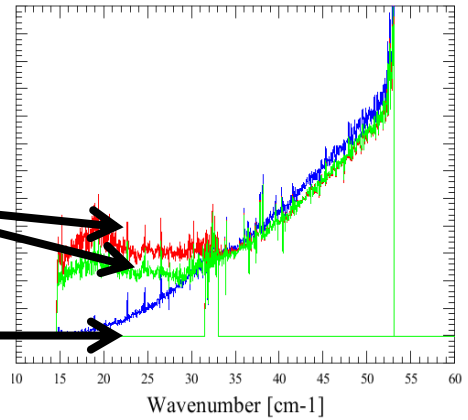
Conclusion: current flux accuracy is at worst ~20% for SSW, and typically ~30% for SLW***, but will improve..***

Flux Calibration: reference subtraction

- Systematic *additive* uncertainty due to temperature changes since reference measurement
  - ***Spectral shape on** SLW **most affected***
  - ***Line fluxes** unaffected*
  - ***Much smaller effect on** SSW **due to telescope temperature changes***

Different reference measurements

Ideal reference used



Worst case offset ~20 Jy

Data Processing

Calibration file updates are required for this release:

- Non-linearity coeffs ***(updated for new bias)***
- Temperature drift coeffs ***(updated for new bias)***
- Reference interferogram ***(update with real values)***
- Flux Conversion ***(update with real values)***

All other necessary updates to the pipeline were already included in HCSS v2.0

Final product is at level-1 only **(i.e. one spectrum per detector, rather than a spectral cube)**

Caveats and Remaining Issues

- Fringes
  - **Known issues with standing waves inside the instrument**
  - **Characterization and remedial procedures are under development**
  - **Fringe removal currently not complete – to be improved**
- Glitches
  - **Glitch shapes are consistent and repeatable**
  - **No significant challenges from glitch frequency**
  - **Two deglitching routines are to be optimized**
- Instrument & Telescope temperature variations
  - **Detailed models to be developed and verified**
  - SCR HCSS-8895 **was raised to make telescope temperatures available for SPG processing**

Final Spectra are great!