SPIRE Spectroscopy Observing Strategies

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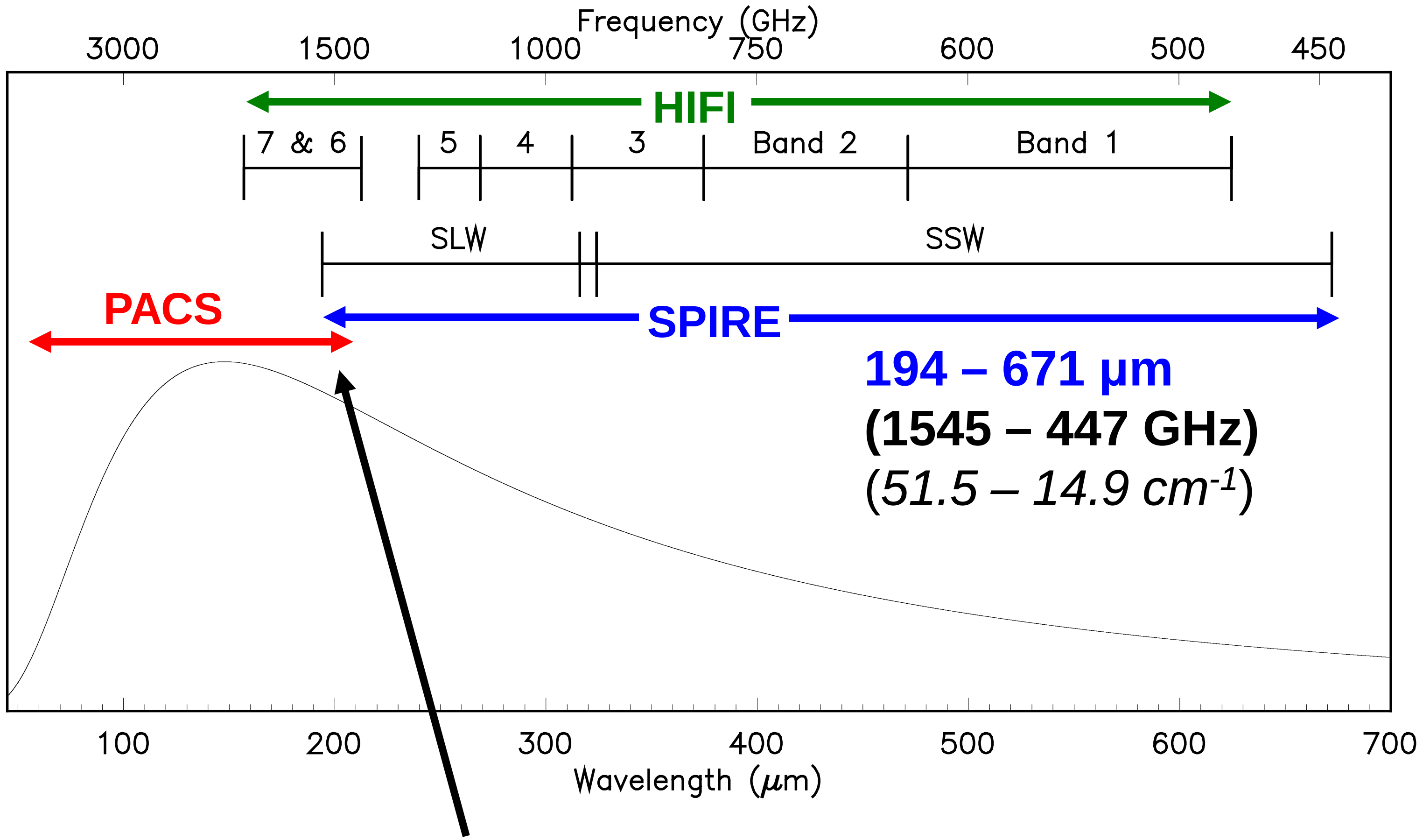
on behalf of the SPIRE ICC

Spectral Coverage



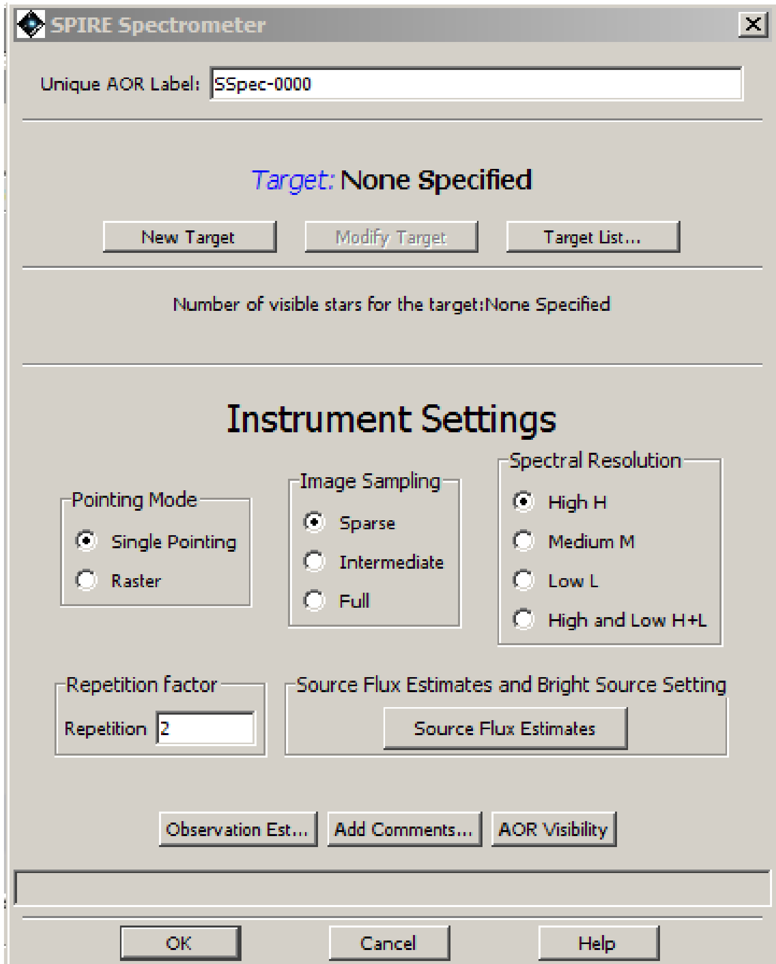
194 – 671 μm

(1545 – 447 GHz)

(51.5 – 14.9 cm^{-1})

Good overlap with PACS (194 – 210 μm)

HSpot



Spectral resolution:

- High
- Medium
- Low
- High + Low

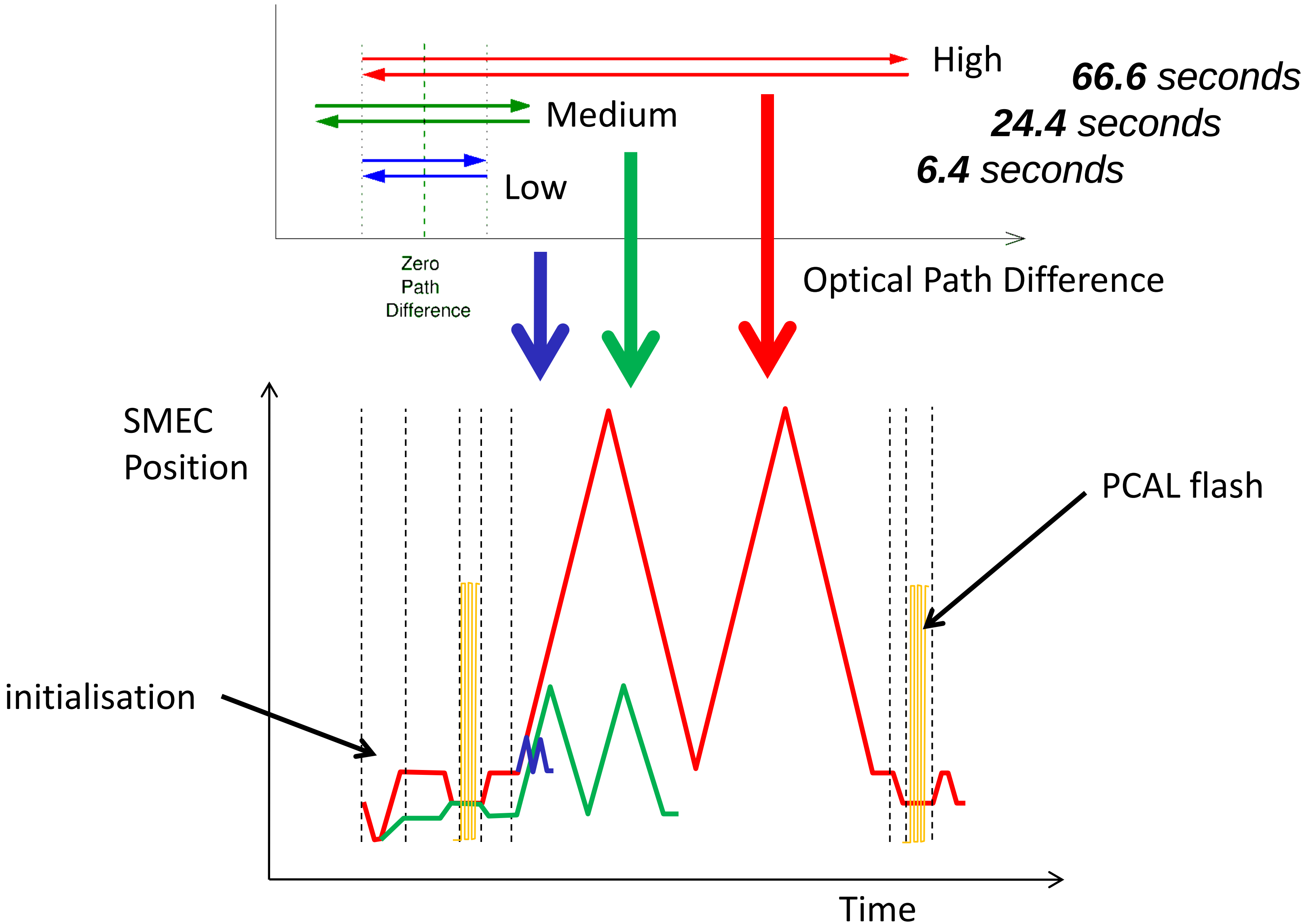
Image sampling:

- Sparse (~2 beam)
- Intermediate (~1 beam)
- Full (~1/2 beam)

Telescope pointing:

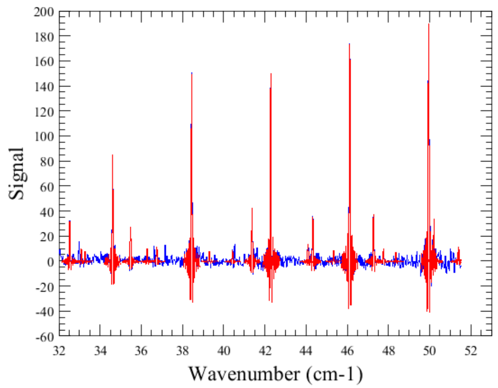
- Single pointing
- Raster

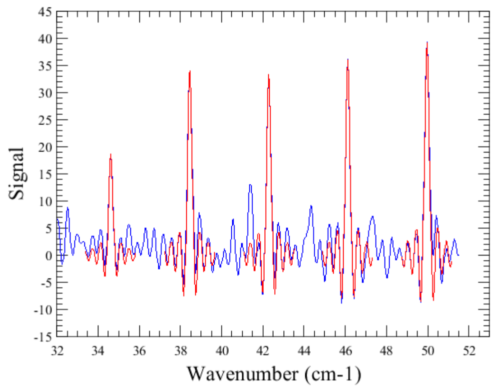
SMEC Scan Ranges

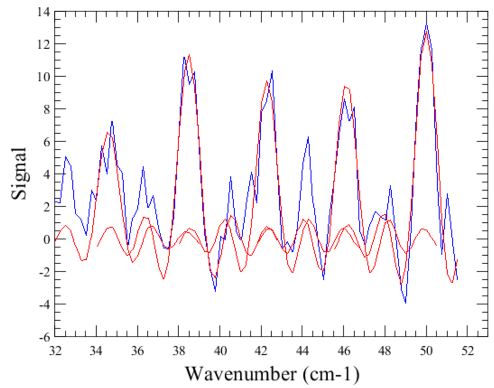


Spectral Resolution

CO lines in the SSW band:







High: $\Delta\sigma = 0.04\ cm^{-1}$ (1.2 GHz)

230 – 800 km/s

Medium: $\Delta\sigma = 0.24\ cm^{-1}$ (7.2 GHz)

Low: $\Delta\sigma = 0.83\ cm^{-1}$ (25 GHz)

Spectrum provided by pipeline has 4 bins per resolution element

SPIRE FTS Arrays

Final detector layout with measured detector positions

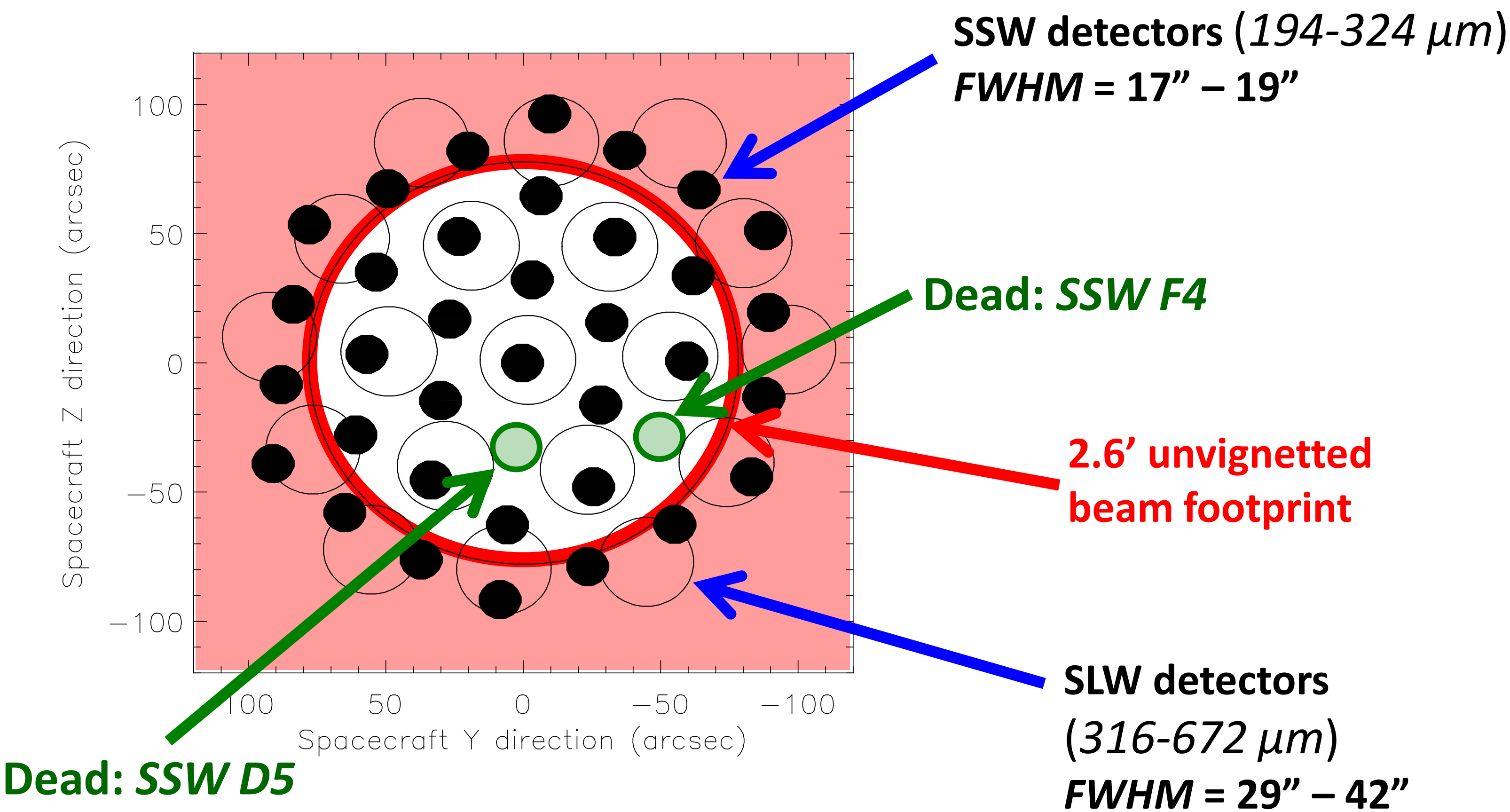
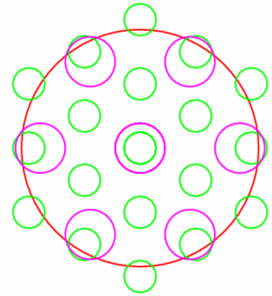


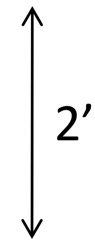
Image sampling

Point source spectroscopy:

Sparse

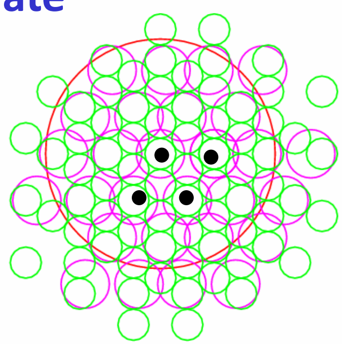


2 beam spacing



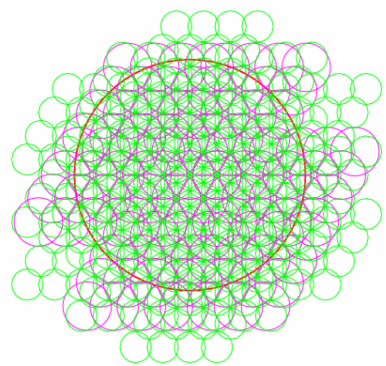
Jiggle Mapping:

Intermediate



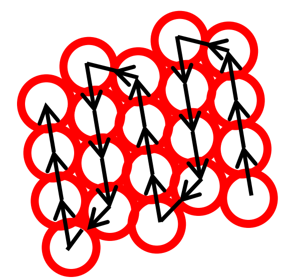
1 beam spacing (4 jiggle positions)

Full

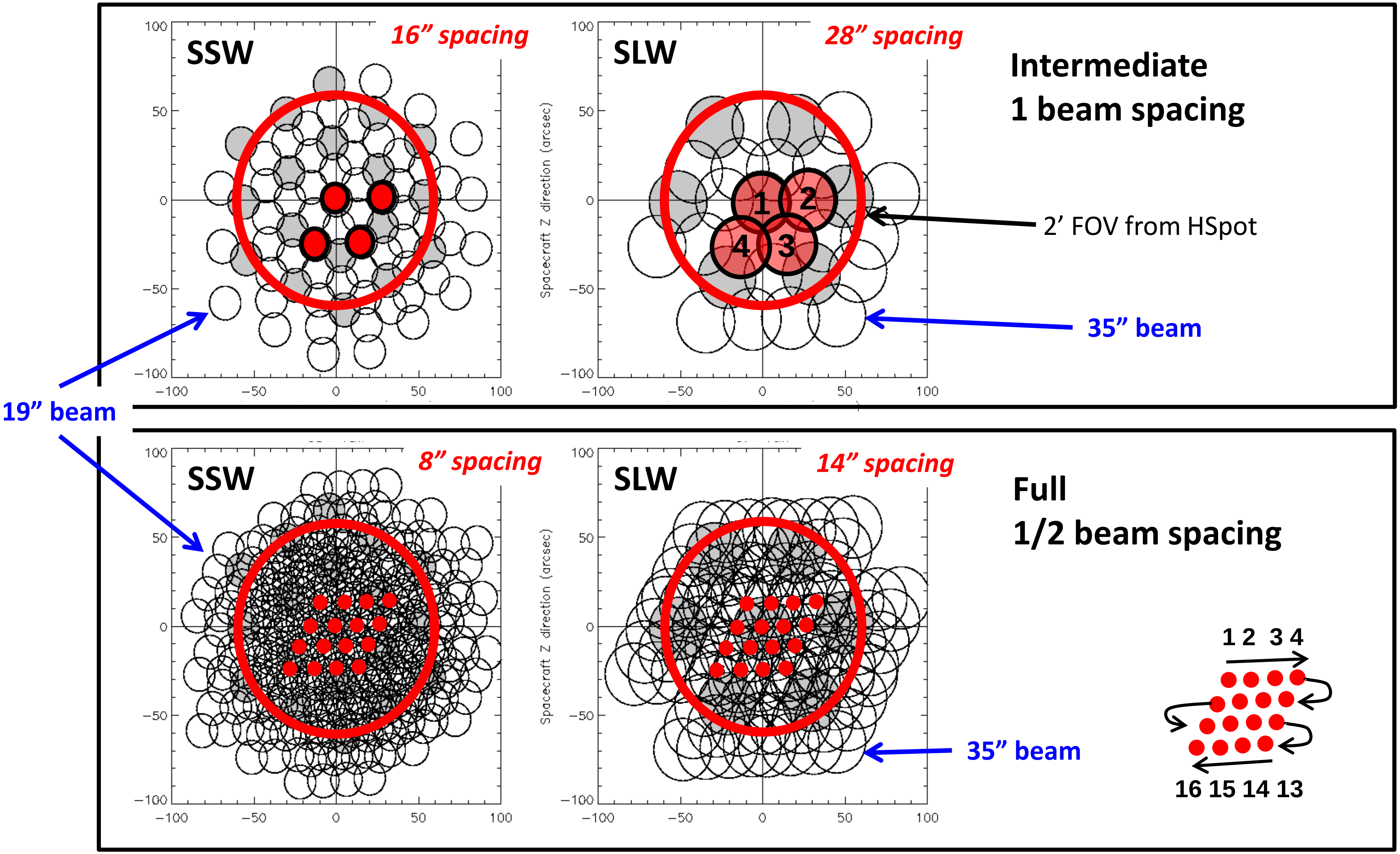


1/2 beam spacing (16 jiggle positions)

Raster Mapping:

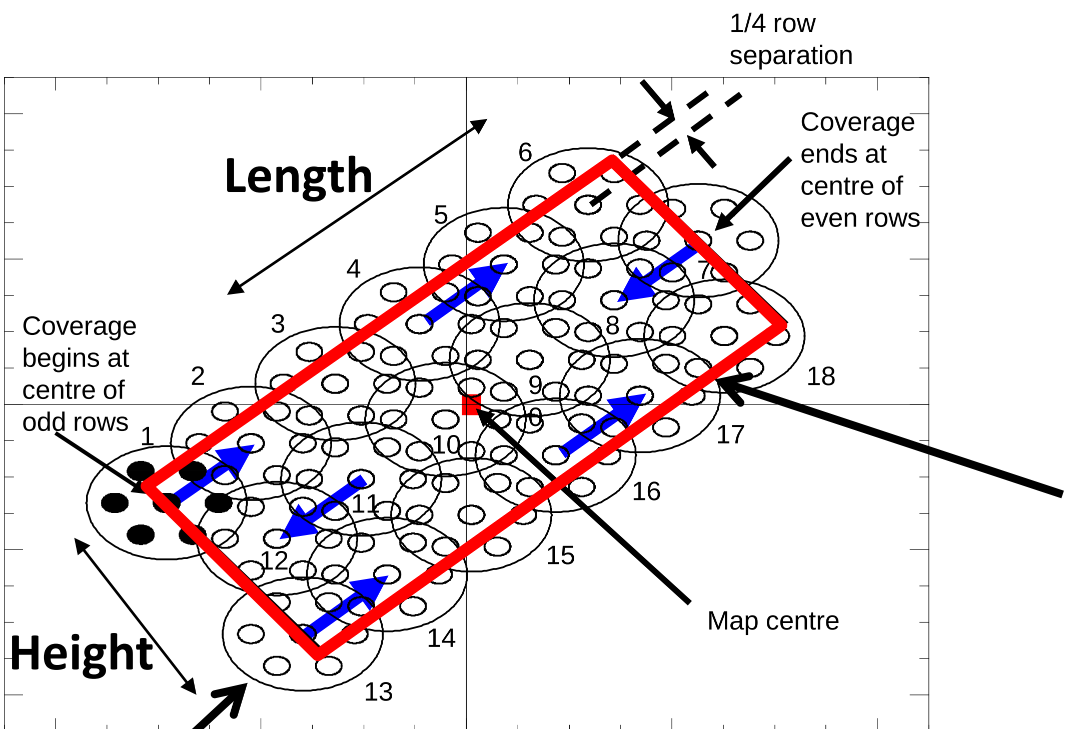


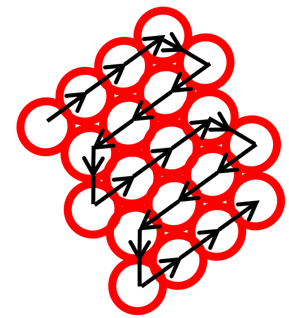
Jiggle Patterns



Raster Patterns

Raster can be done with either Sparse, Intermediate or Full sampling

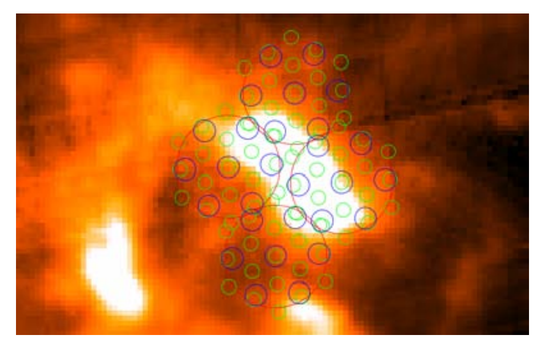




Map size entered into HSpot

2.6’ unvignetted circle

Visualisation in HSpot:



Raster based on 2’ FOV (unvignetted detectors) so more overlap when all detectors included

Example Timings

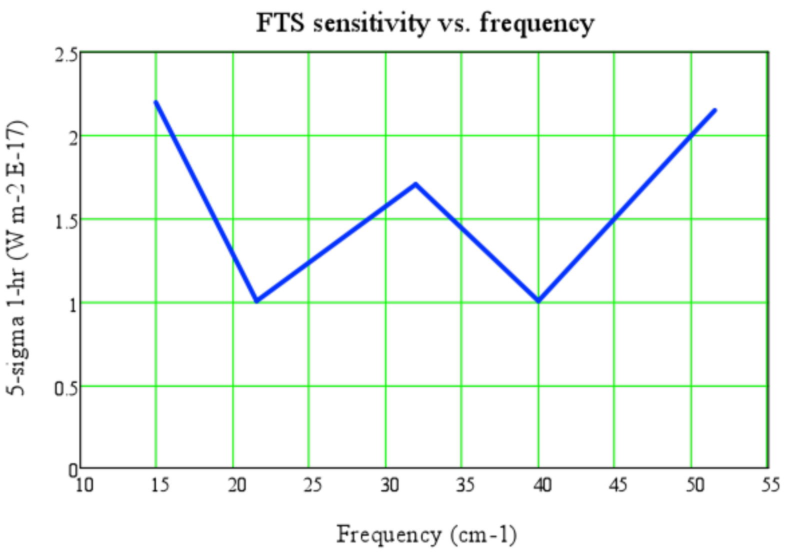
- Rough example timings from HSpot:

sparse	HR, 2 reps **11 min** (4 min on-source)	MR, 2 reps **8.3 min** (1.6 min on-source)
intermediate	HR, 2 reps **26 min** (4 min on-source per posn.)	MR, 2 reps **14.4 min** (1.6 min on-source per posn.)
full	HR, 2 reps **84 min** (4 min on-source per posn.)	MR, 2 reps **38.8 min** (1.6 min on-source per posn.)

Noise & Sensitivity

- **Typical High res. FTS sensitivity (*5σ 1hour*) achieved to date:**
  - **1 – 2 × 10^{-17} W/m²** *(integrated line at high resolution)*
  - **0.8 – 1.7 Jy** *(continuum noise at high resolution)*

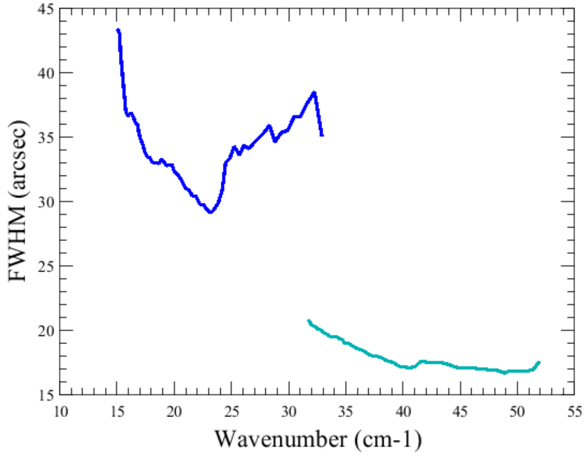
- Established using Uranus calibration of Ceres
- Featureless spectrum
- Noise established from RMS after co-adding, and subtracting polynomial



Extended Sources

- **The FTS beam is not Gaussian in shape**
  - *for extended sources, significant power comes from a wider area than calculated from the FWHM*
- **The beam size varies in a non-intuitive way with frequency**
  - *The feedhorns are multi-moded, particularly at the high frequency end of each band*

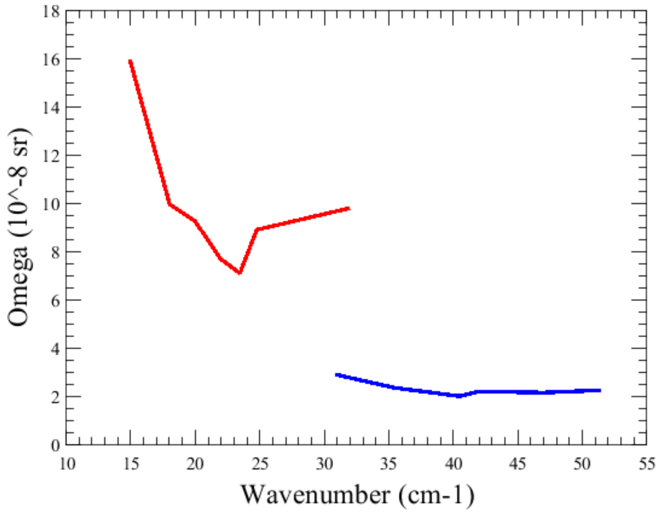
Variation in FWHM with wavenumber:



Extended sources

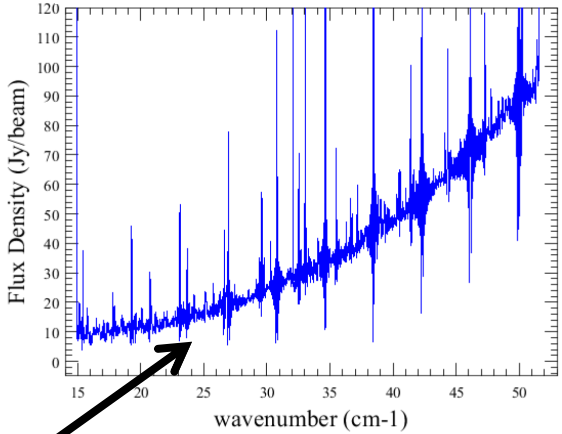
- Extended sources are calibrated from the telescope (completely fills the beam)
- Units of $W/m^2/Hz/sr$
- In order to compare with other telescopes, and to convert to Jy in beam, the full beam area must be used (will be supplied as calibration product)

Beam area in steradians:



Effect on real spectra

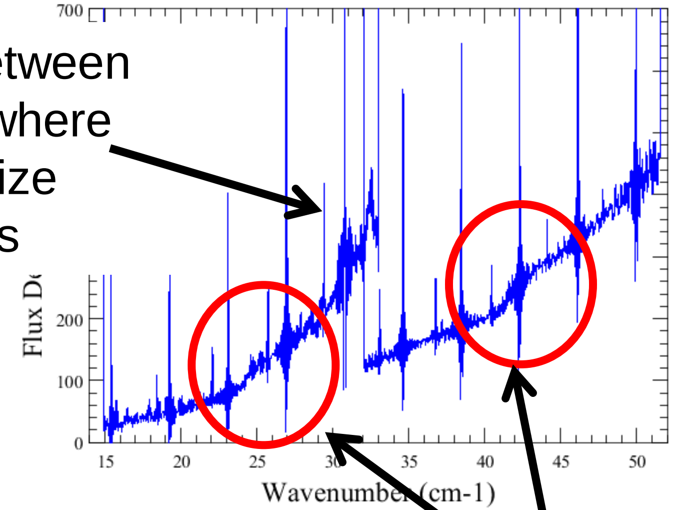
Point source (in Jy)



True point source shows no step in flux density between bands

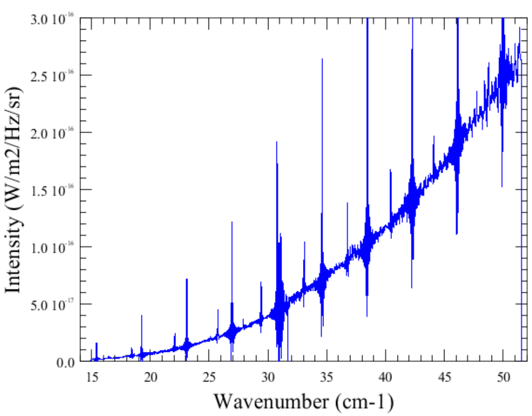
Extended source (in Jy per beam)

Step between bands where beam size changes



Step in flux density due to change in beam size at feedhorn mode boundary

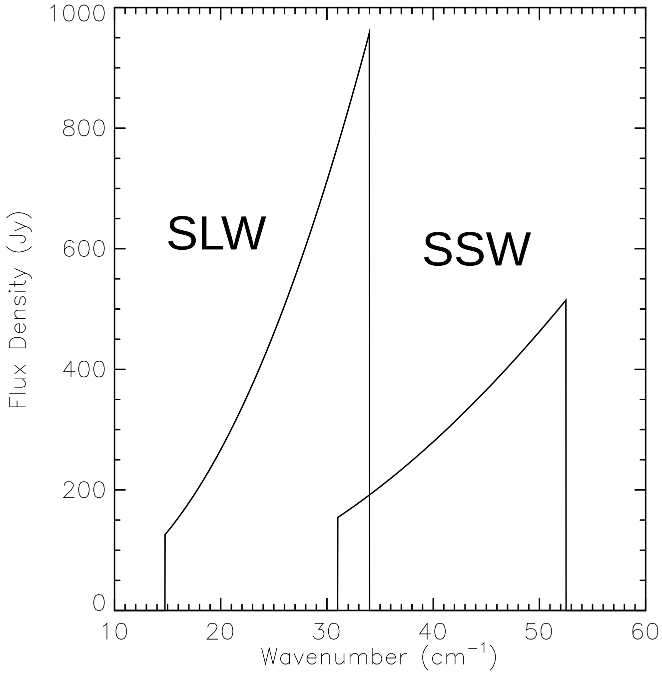
Extended source (in W/m^2/Hz/sr):



Faint source – Bright Telescope

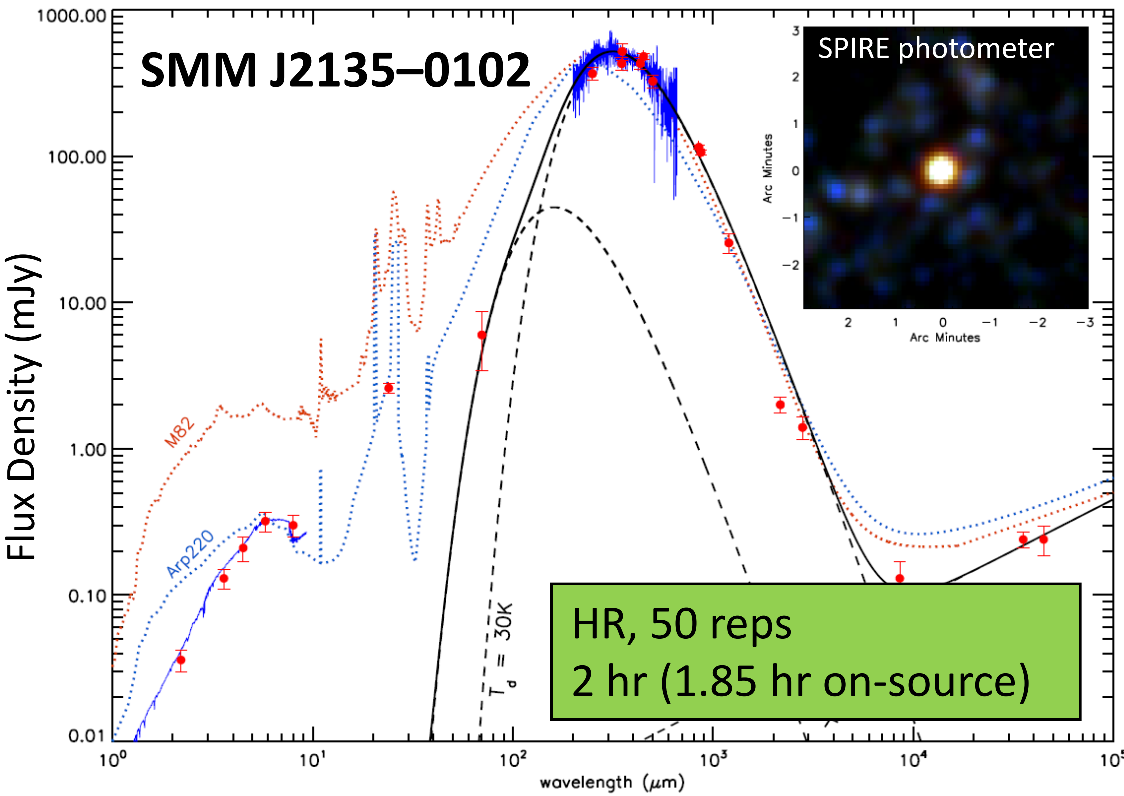
- The telescope completely dominates the flux into the instrument
- We can theoretically extract very faint fluxes < 1Jy
- The limit is determined by systematics:
  - Telescope temperature drifts (slowly)
  - Instrument temperature drifts (less slowly)

Typical spectrum of the telescope

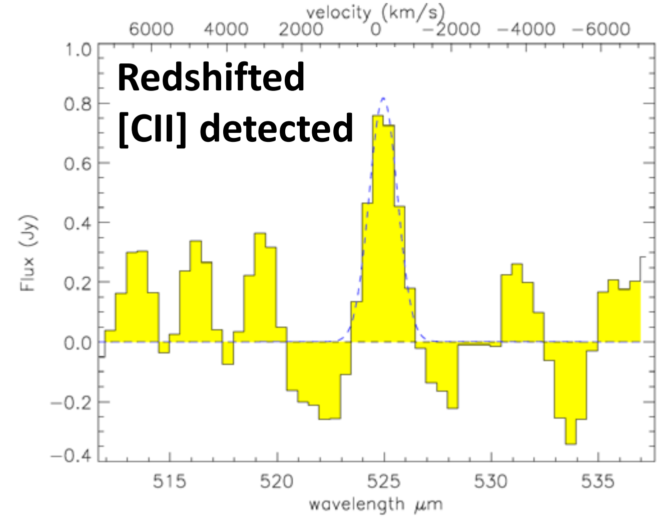


Faint target results so far

Comet Christensen (***Bockelée-Morvan et al. 2010***) and a z=2.3 galaxy (***Ivison et al. 2010***) both observed successfully



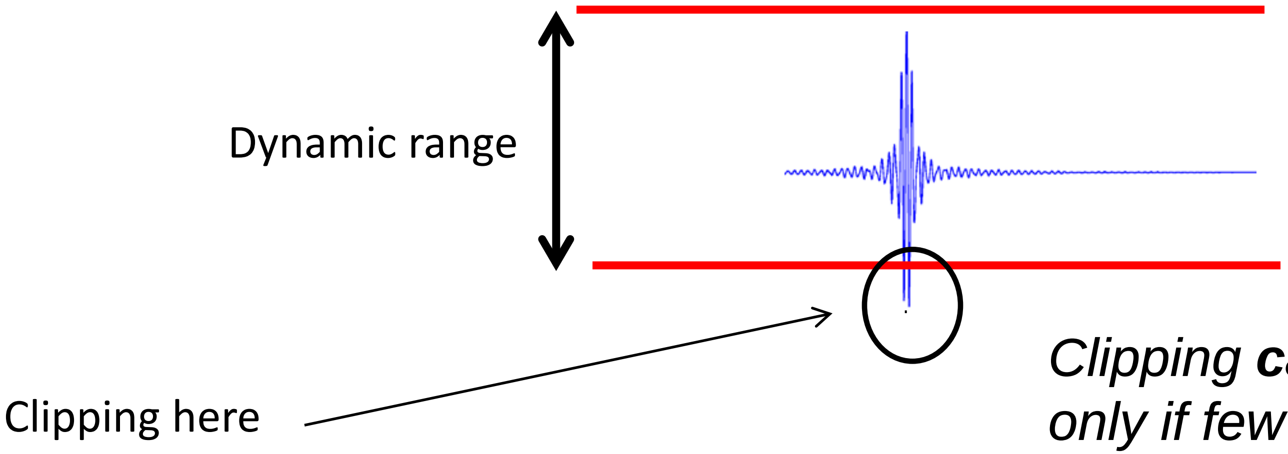
Herschel imaging and spectroscopy of a bright, lensed submillimetre galaxy at z=2.3, **Ivison et al. 2010**



- **Photometer map very important**
- **Don't consider targets less than several 100 mJy**

Bright Sources

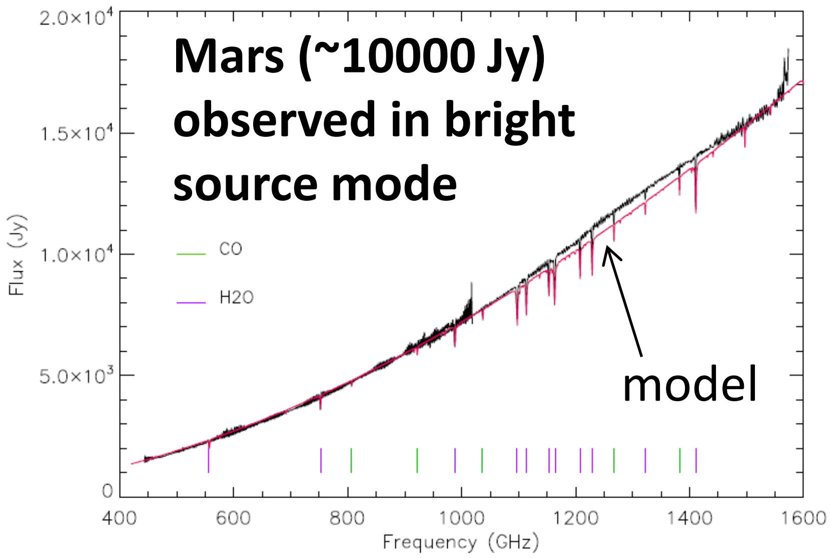
- Total power received from source reflected in the amplitude of modulation at zero path difference in interferogram
- Very bright targets (e.g. Orion, Sgr B2, Mars) can be observed using a **bright source mode**
- This uses a different bolometer bias amplitude & phase to **lower the responsivity** and so **reduce the maximum modulation**



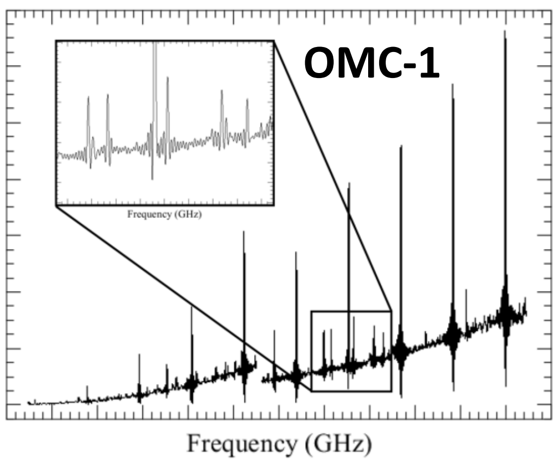
*Clipping **can** be corrected but only if few consecutive clipped points*

Bright source mode

- We are in the process of optimising bright source mode
- Bright source mode reduces clipping but at the cost of reduced sensitivity
- Appropriate for sources of brightness greater than ~**175 / 55** Jy for SSW, SLW



Tests to optimise bright source mode using Orion



Summary

- FTS can be used for **point sources** and **spectral mapping**
- Advantage of FTS: **simultaneous** coverage of entire band
- **High resolution** recommended for line studies
- **Extended sources:** beam not Gaussian and varies across band
- **Weak sources:** always add a photometer map
  - Sources of 100's mJy possible but challenging
- **Bright sources:** consider bright source mode