The SPIRE FTS Pipeline

(Do I need to reprocess my data?)

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On behalf of the SPIRE ICC

The SPIRE Spectrometer Pipeline

Common Engineering Conversion
ADU → Volts

Modify Timelines

Create Interferogram

Modify Interferogram

Fourier Transform

Modify Spectra
Volts/cm^{-1} → W/m^2/Hz/sr

Point source
W/m^2/Hz/sr → Jy

Spectral Mapping

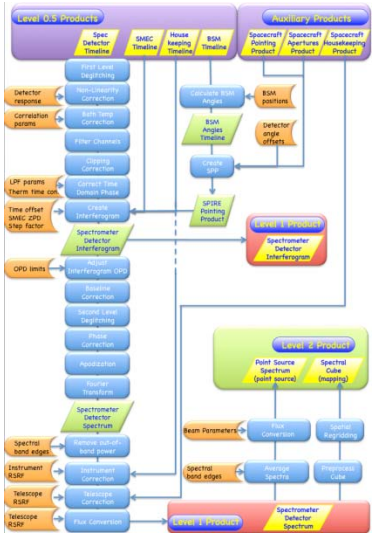
Bolometer processing common with SPIRE Photometer

3 stages of processing:

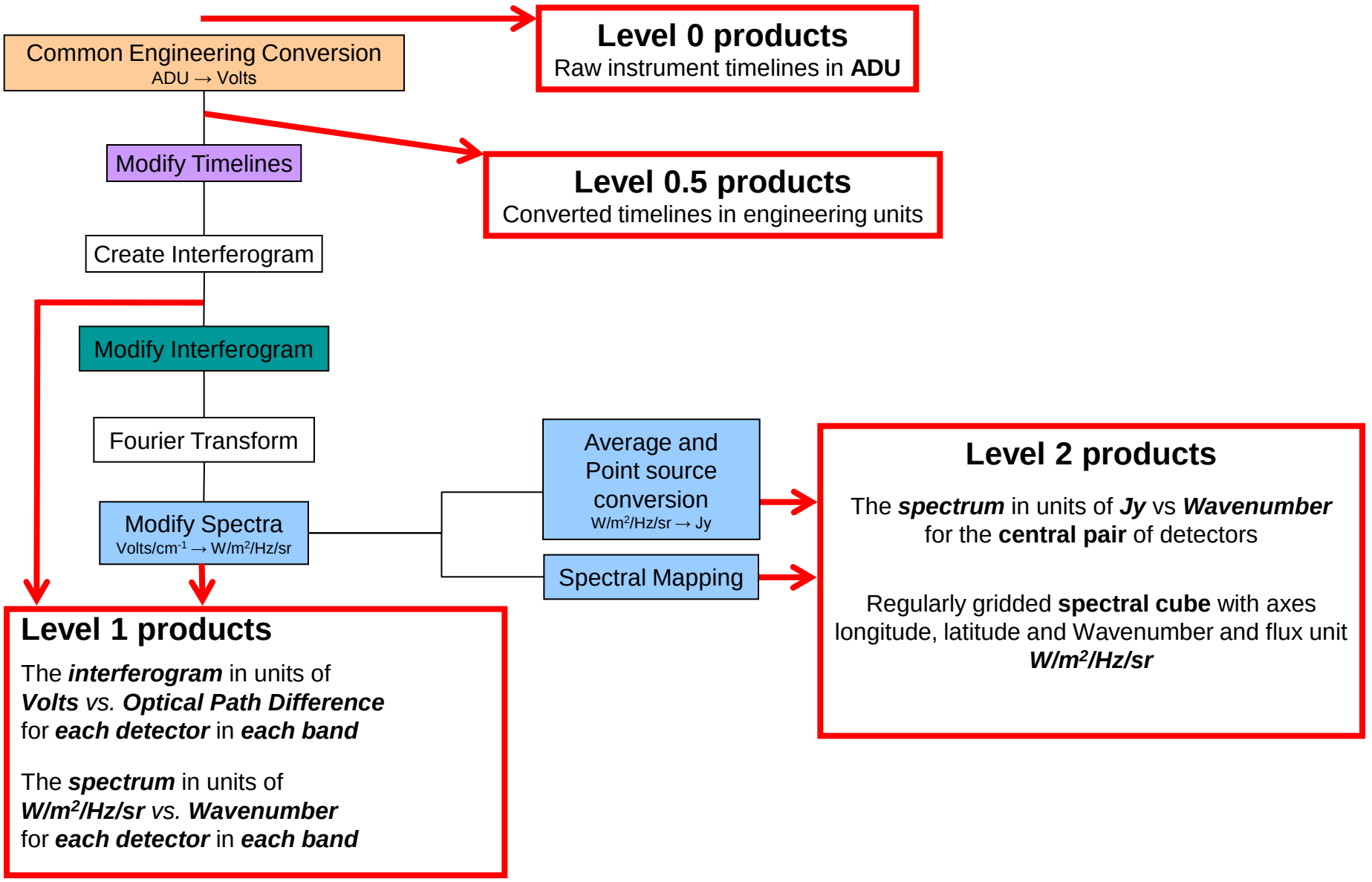
***Time* Domain**

Spatial* Domain** (Mirror position***)

***Spectral* Domain**



Pipeline Outputs

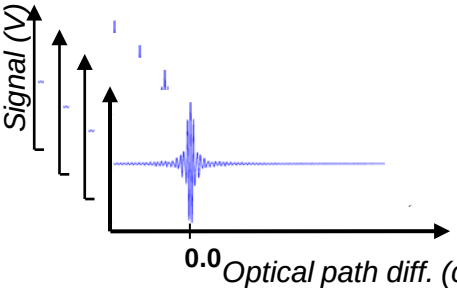


Pipeline Tasks

Common Engineering Conversion
ADU → Volts

- 1st level Degliching
- Bolometer non-linearity
- Clipping
- Phase: bolometer time constants

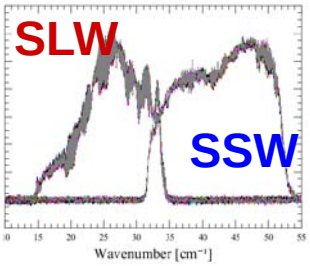
Modify Timelines



Create Interferogram

- Baseline
- 2nd level Deglitching
- Phase Correction
- Apodization

Modify Interferogram

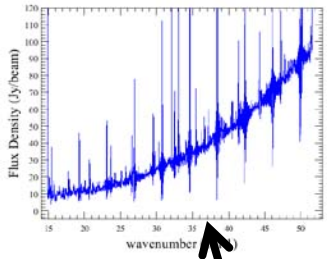


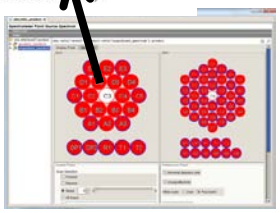
Fourier Transform

Modify Spectra
Volts/cm^{-1} → W/m^2/Hz/sr

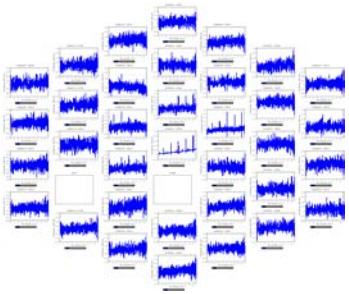
Average and Point source conversion
W/m^2/Hz/sr → Jy

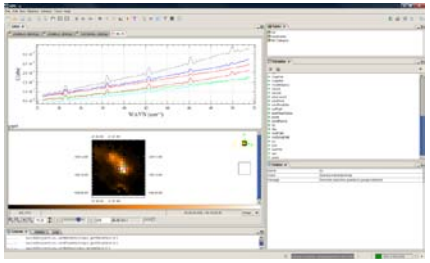
Spectral Mapping





- Subtract Instrument & Telescope background emission
- Flux Conversion





Flux Calibration

Level-0.5 to Level-1

$$I(\sigma) = \frac{\left(\mathrm{FT}[V'(x)] - M_{inst}R_{inst} - M_{tele}R_{tele}\right)}{R_{tele}(\sigma)}$$

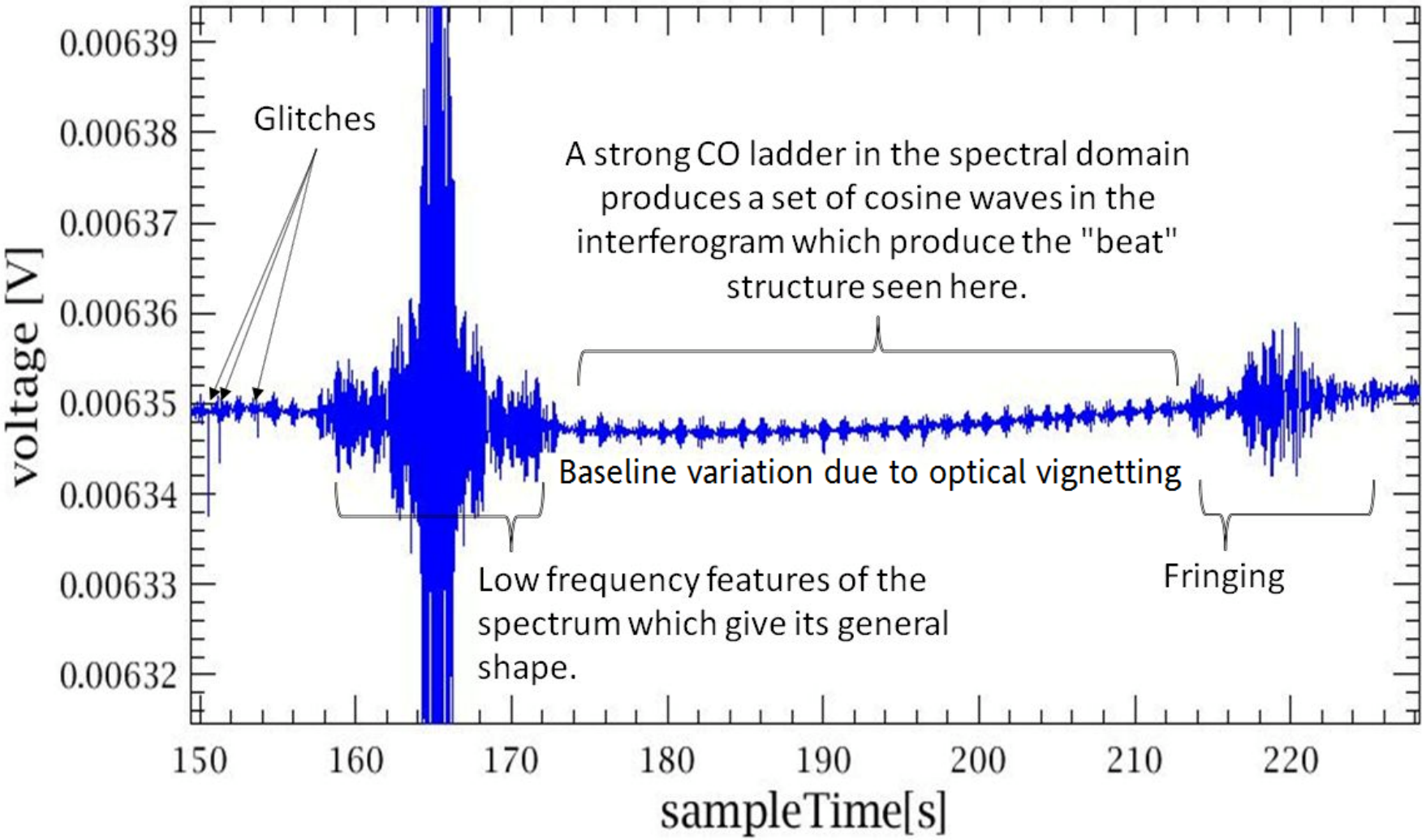
I(σ) is the source **intensity** in units of W/m^2/Hz/sr
R(σ) is the **RSRF** in units of (V/cm^{-1})/(W/m^2/Hz/sr)
M(σ) is a model of the instrument/telescope emission
V'(x) is the **interferogram** in units of linearised Volts

Level-1 to Level-2
(*point sources*)

$$S(\sigma) = C(\sigma)I(\sigma)$$

S(σ) is the **in-beam** source **flux density** in units of **Jy**
C(σ) is the point source conversion factor in units of steradians
(related to $\Omega(\sigma)\eta_{\mathrm{point}}(\sigma)$)

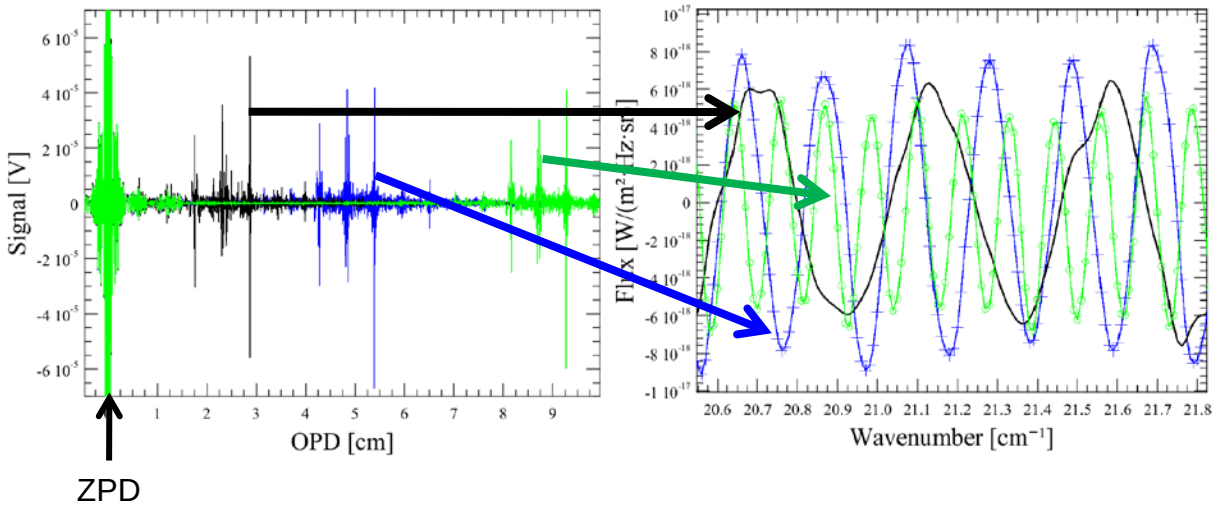
What's in an Interferogram?!



What can be adjusted/checked?

Deglitching parameters

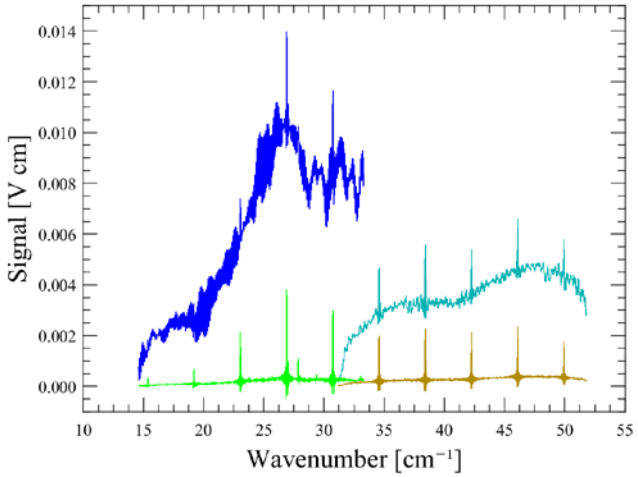
Glitches cause sinusoidal artifacts in the spectrum *(higher frequency the further from ZPD)*



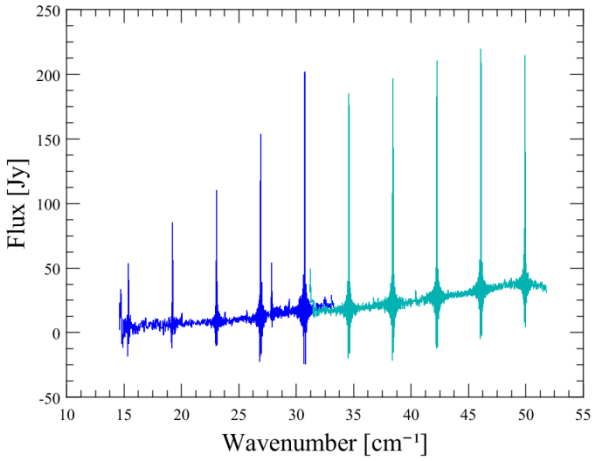
Telescope subtraction

For normal sources, the telescope dominates the flux!

NGC7027 before and after telescopeCorrection task



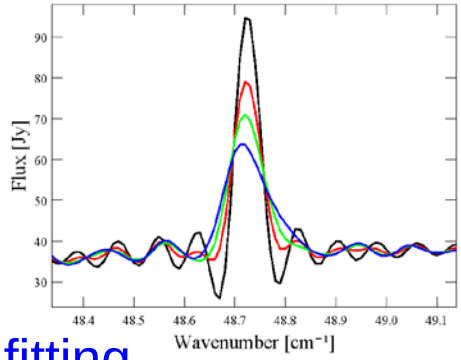
After flux conversion



More details tomorrow in the reprocessing demos...

Apodization

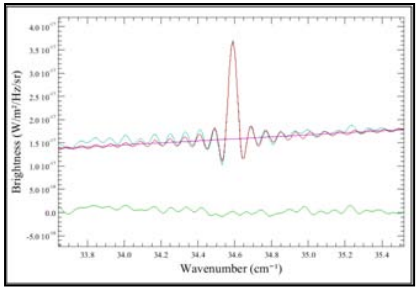
- Apodization tapers the edges of the interferogram...
- ...to reduce the ringing in the instrument line shape
  (*but reduces spectral resolution*)
- Both **unapodized** and **apodized** products are supplied

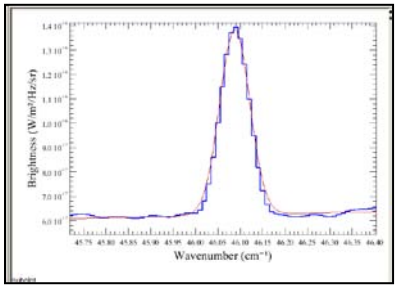


But which to use?

Probably both!

- **Unapodized** provides maximum information for line fitting
- **Apodized** provides a cleaner looking spectrum for human inspection & publication





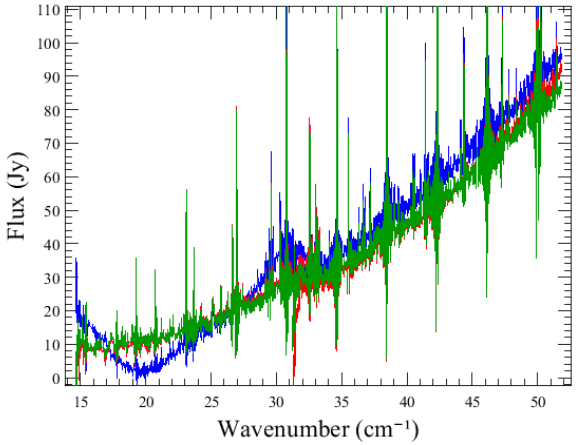
Confused about FTS processing?

- **Read the basic introduction/background to the processing steps in the SPIRE Data Reduction Guide...**

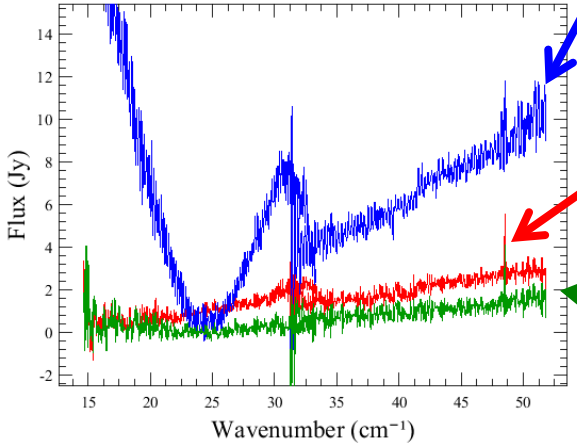
6.2.2. *Introduction to processing FTS data*

Pipeline Latest Status

Medium strength source:
10-100 Jy



Weak source:
~1 Jy



Hipe Version 4 (Aug 2010)

Hipe Version 5 (Dec 2010)

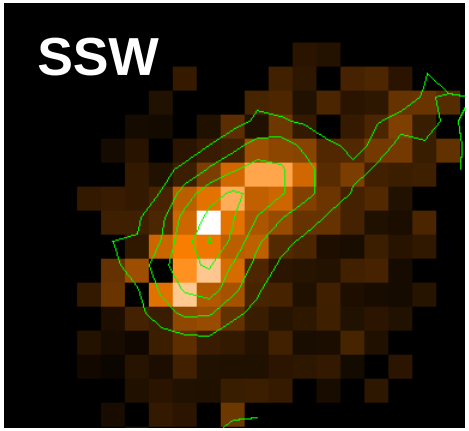
Hipe Version 6 (Mar 2011)

```
HIPE> print obs.calibration.version
HIPE> print obs.creator
```

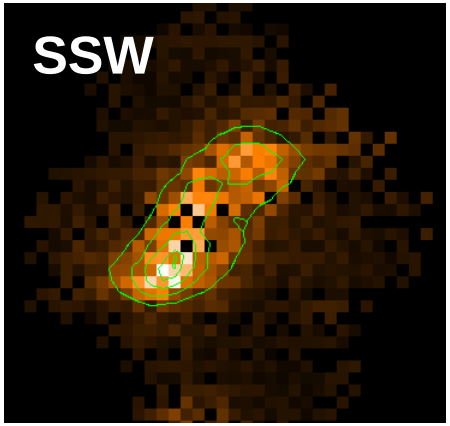
Mapping

250 μm continuum slice from the NGC7023 cube:

Sparse (38” pixels)



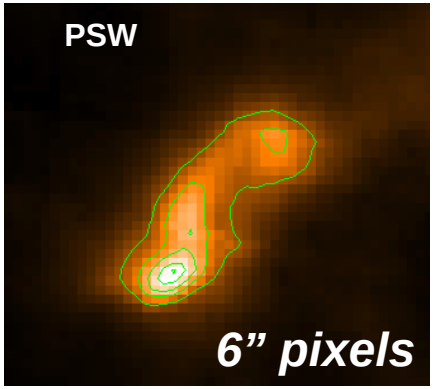
Intermediate (19” pixels)



Full (9.5” pixels)

- Spectral cube produced using Naive map maker
- HIFI OTF “gridding” can also be used
  - (requires SPIRE+HIFI build of Hipe)

SPIRE Photometer



More details tomorrow in the reprocessing demos..

So, do I need to reprocess my data?

At this point, the answer is often yes!

- The data currently in the HSA are mostly processed with SPG 4 (corresponding to HIPE 4 with spire_cal_4). There was a big improvement in the calibration and data processing algorithms from SPG 4 to 5
- For faint sources, even the SPG-6 result may not be satisfactory (e.g., a poor telescope background removal). You may significantly improve it by reprocessing
- There could be cases where tweaking module parameters in your reprocessing could improve the results from the standard pipeline
- There are different algorithms available for creating spectral cubes

Documentation

- The **SPIRE Observers' Manual**
  - *Instrument background, calibration and performance*
- The **SPIRE Data Reduction Guide**
  - *Data processing background & step-by-step pipeline info*
- The **SPIRE Pipeline Specification**
  - *Detailed info on each data processing module in the pipeline*
- The **SPIRE User's Reference Manual**
  - *Reference for SPIRE commands inside Hipe*
- The **SPIRE Spectrometer Pipeline Description**
  - *Algorithms, equations...*

SPIRE FTS User Support Group

Current Members:

- Ivan Valtchanov (Chair; *ESAC, Spain*)
- Ros Hopwood (*Imperial College, UK*)
- Nanyao Lu (*IPAC, USA*)
- Ed Polehampton (*RAL, UK*)
- Sundar Srinivasan (*IAP, France*)
- Bruce Swinyard (*RAL/UCL, UK*)

Objectives:

- Provide advices and assistance to users and potential users with
  a) technical aspects of proposal preparation
  b) observing program definition and optimization, and AOR implementation
  c) data analysis and calibration
- Identify an individual group member to act as the “friend” of each HOTAC-awarded observing program that uses the FTS.
- Organise appropriate workshops, working visits, etc, with users.