The SMAP Extended Emission Mapper

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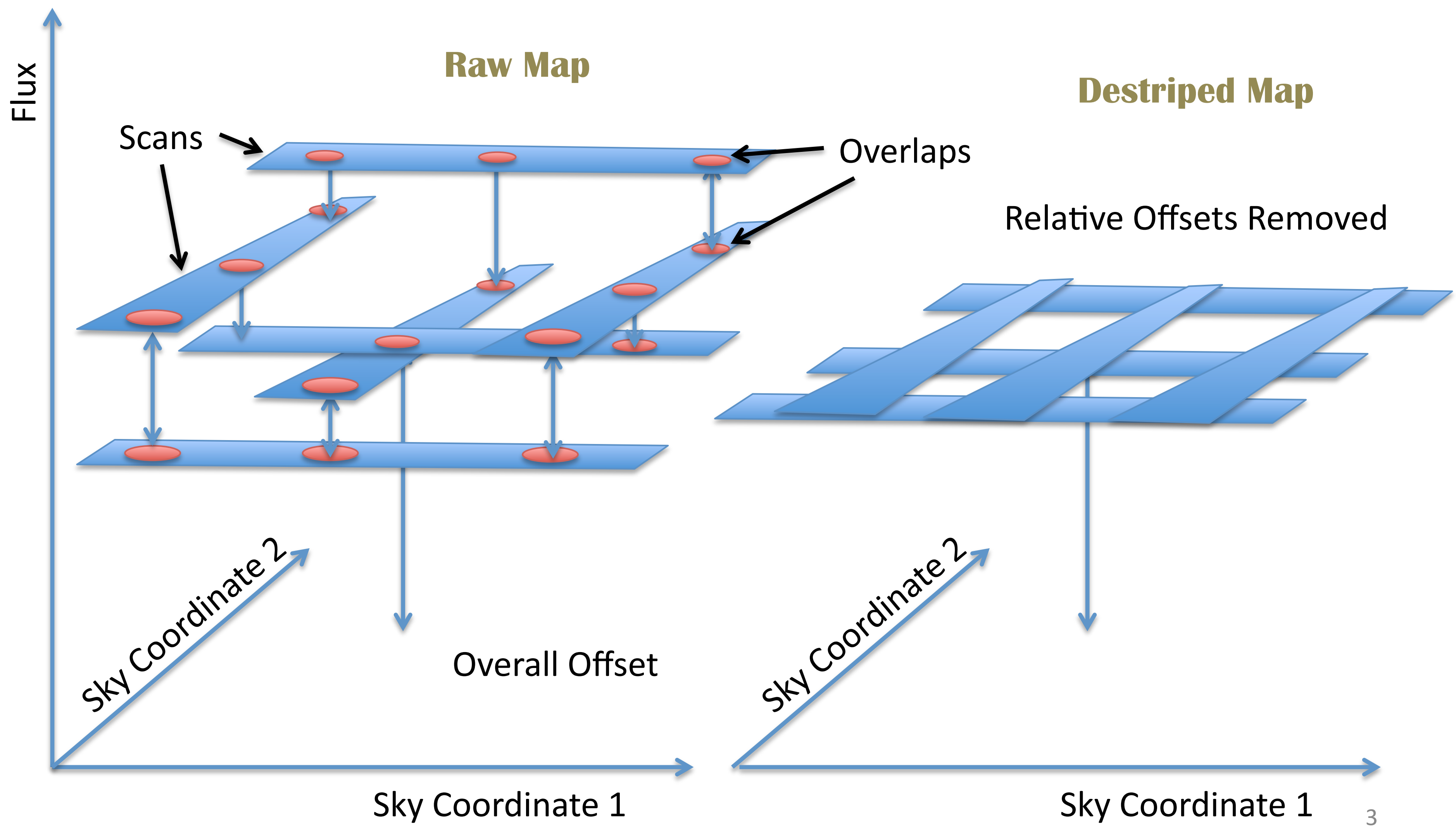
28 Jan 2013

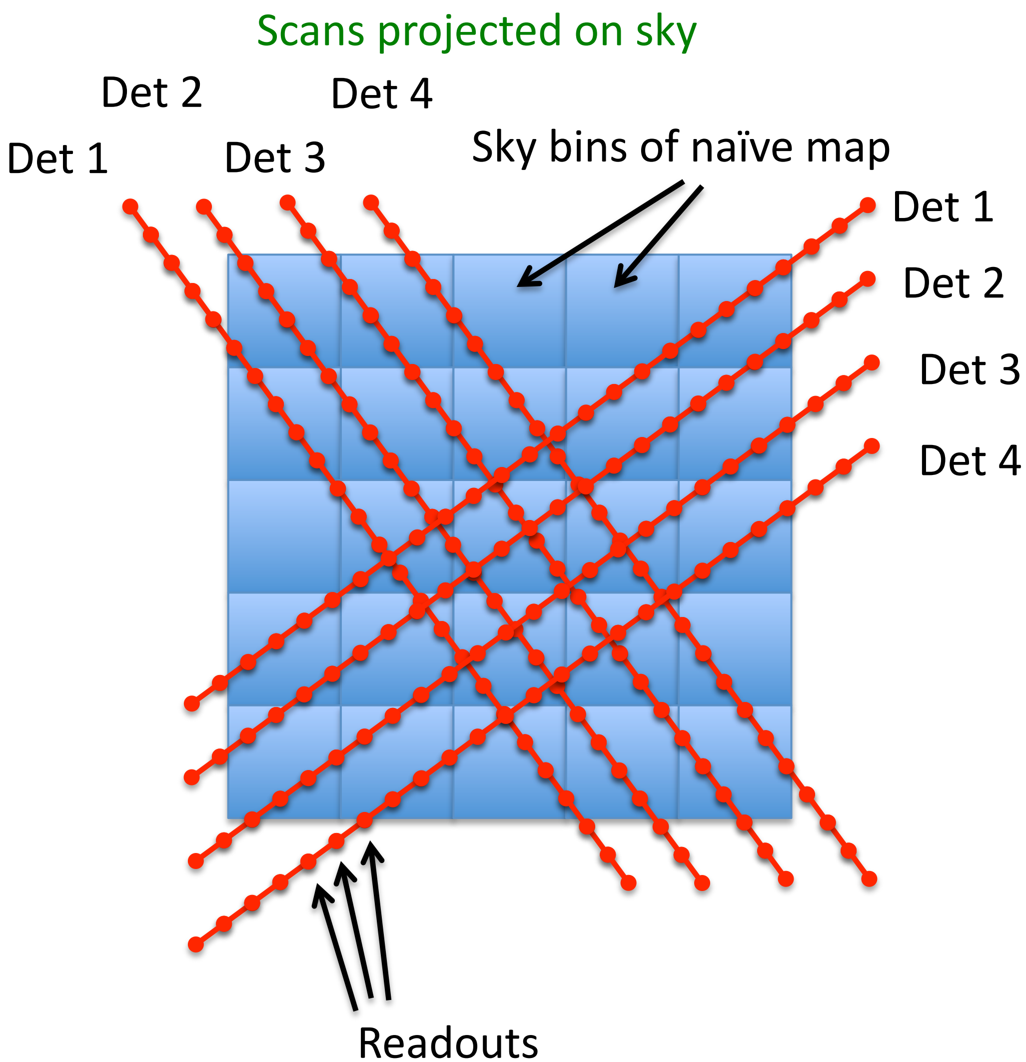
Short Description

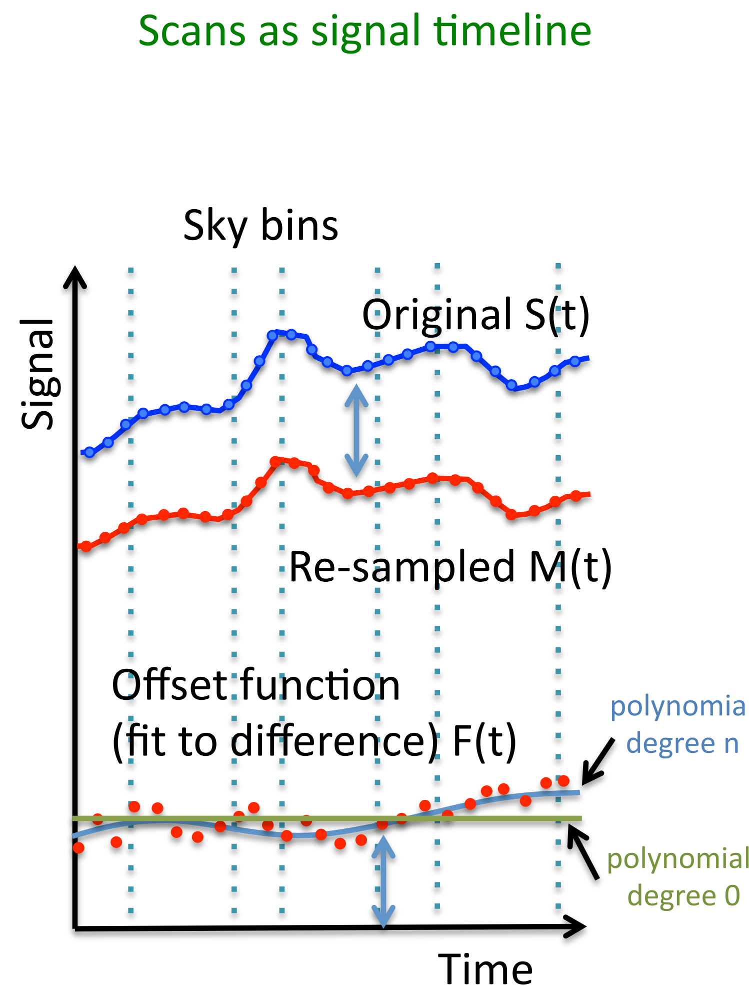
- The HerMES collaboration has two major groups that do data reduction:
  - (SCAT) specializing in point source catalogues
  - (SMAP) specializing in extended emission maps
- SMAP developed a software package in IDL that includes pre-processing steps and an iterative mapmaker.
- We start with Level 1 standard processed data but including turnaround data, using the sigma-kappa deglitcher instead of wavelet, and omitting the HIPE temperature correction.
- The mapper searches an iterative solution via fitting an offset function to the difference between timelines and back-projected timelines, generating a naïve map from offset subtracted timelines, and repeating this procedure until conversion is achieved. The mapping algorithm is based on Fixsen, Moseley & Arendt (2000), but the SMAP pipeline could also use other mapmakers.
- The mapmaker served as prototype for the SPIRE destriper, although the HerMES maps lack bright structured emission.
- The main difference to the SPIRE destriper:
  - proper temperature correction method
  - the astrometry correction
  - weighting method
  - manual data cleaning for jumps and undetected glitches

Overlaps Constrain Offsets



Re-Sampling and Offset-Function





Weighting Method

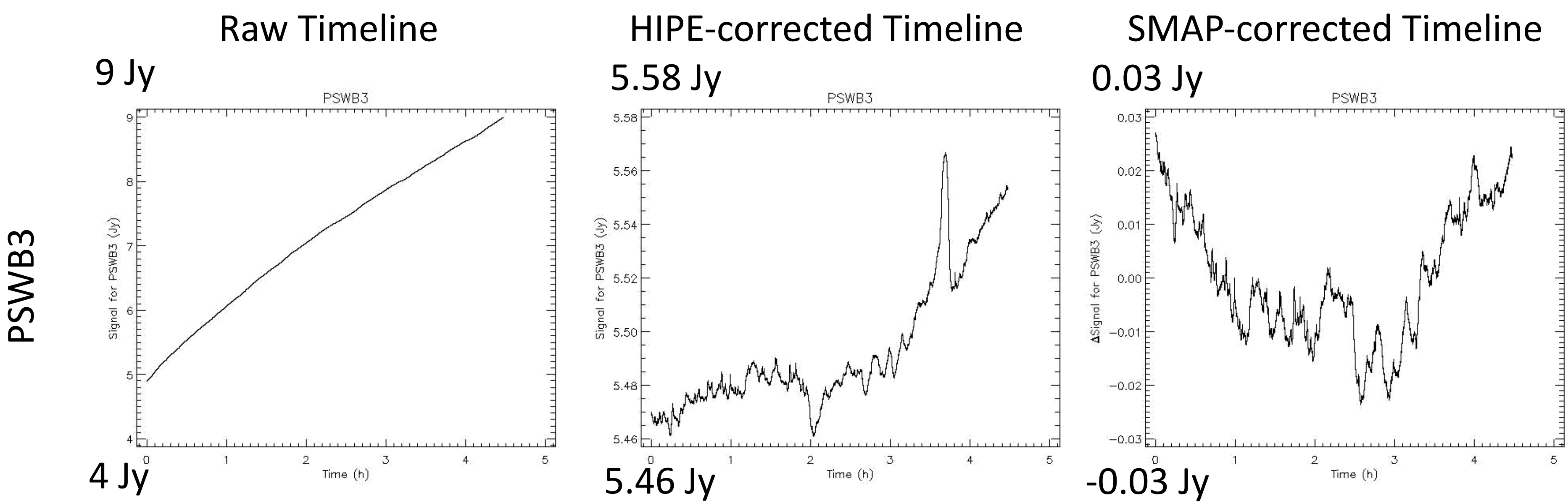
- Weights are calculated as inverse variance of the updated timeline residuals $(S_{l,d}(t) – M_{l,d}(t))$.
- Each scan is weighted separately when constructing the next Naïve Map.
- Weights change in every iteration.

Temperature Correction

- The Level 1 timelines were reduced without the standard HIPE temperature correction.
- Instead a special temperature correction was applied that was derived from the dataset itself, making use of the fact that these maps show mostly “empty” sky.
- Similar technique as used by ATLAS.

- Procedure:
  - Stitch together continuous detector timelines (fill in missing bits with constrained noise realization).
  - Generate best guess thermistor timeline from combined thermistor data.
    - If only one valid thermistor: Match to ends of best guess timeline
    - If none available: Make constrained noise realization (linear interpolation with comparable Gaussian noise)
  - Low pass filter all timelines (1-pole Butterworth with 3dB point at 120s)
  - Regress each full detector timeline against mean thermistor time stream
  - Subtract best fit relation from detector data.
- Advantage:
  - No requirement on accuracy/stability of tabulated temperature correction parameters
- Disadvantage:
  - This method won’t work for structured backgrounds.

Example Timeline Plots, FLS, PLW



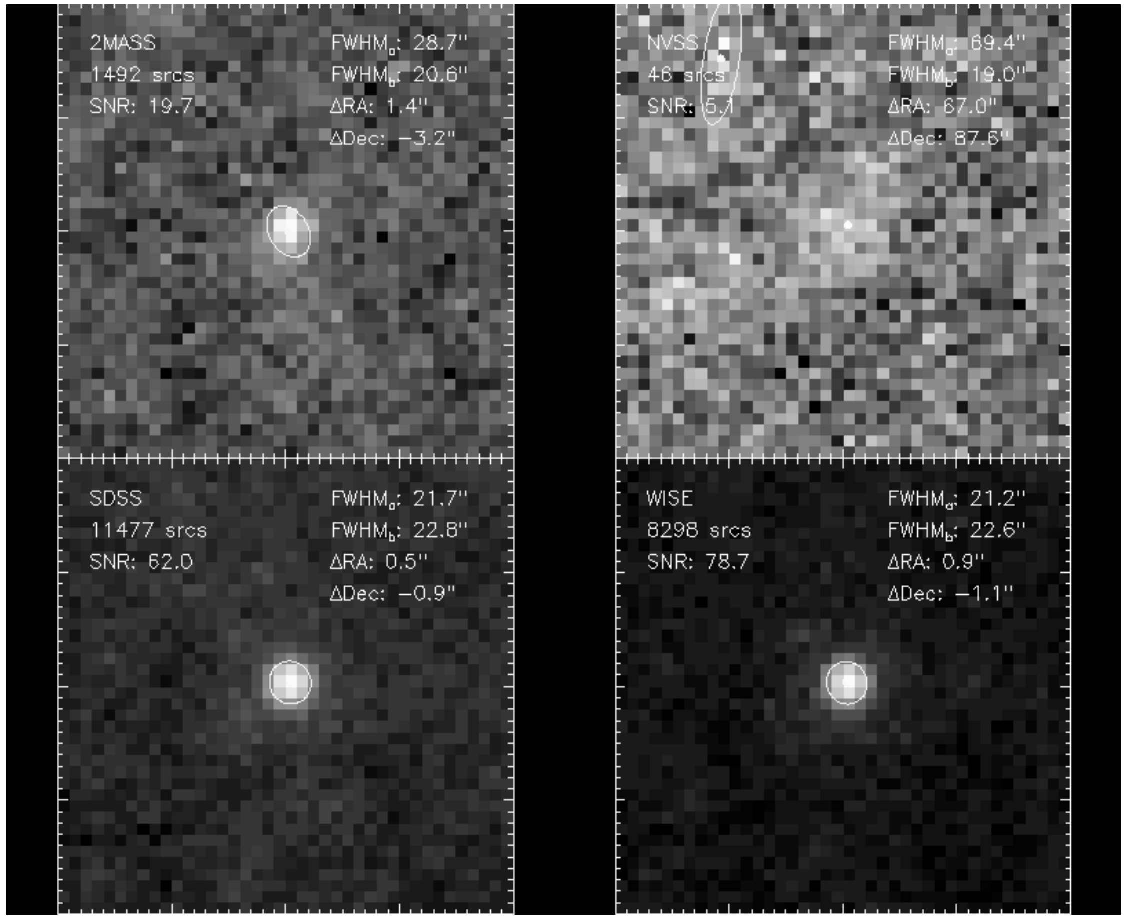
- The accuracy of the temperature correction parameters under different conditions is limited.
- In this particular case of "empty" sky, residual trends can be calibrated better from the dataset directly.
- Method not general enough for pipeline application.

Astrometry Correction

- Herschel pointing is not perfect, especially it was not in the starting phase.
- We applied a correction to the astrometry per AOR, stacking on catalogs of either Spitzer 24μm maps or WISE.
  - Cut out 30x30 pixel maps centered on catalog positions and co-add.
  - Fit Gaussian beam profile to resulting high S/N point source image and obtain correction as offset from the center.

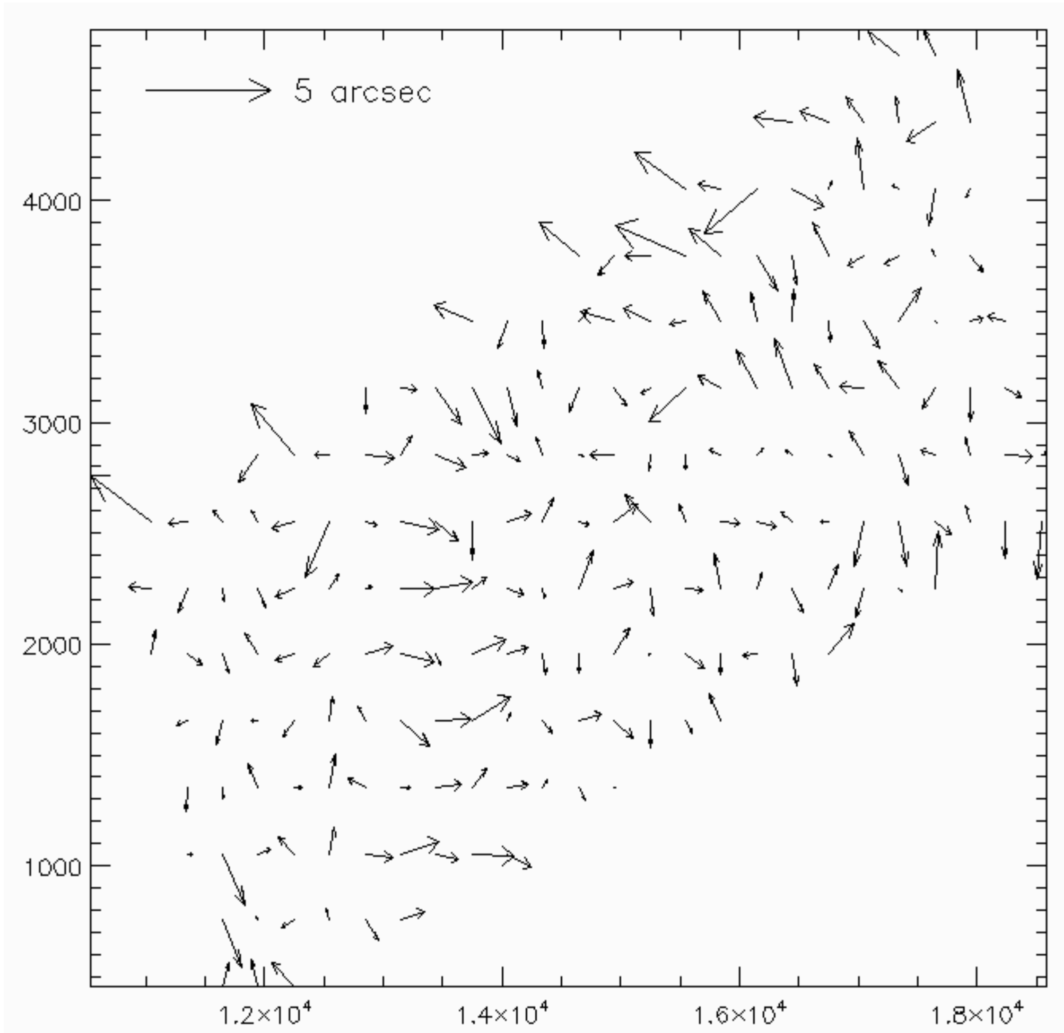
Stacking on Different Catalogs

- Stacking of HELMS 250μm map in a 1 deg^2 patch on 2MASS, NVSS, SDSS, and WISE.
- Taken all sources of the catalogs without cut on flux.
- NVSS not enough sources.
- SDSS is good, but only covers a fraction of the field.
- WISE is best.



Offsets in HELMS Field

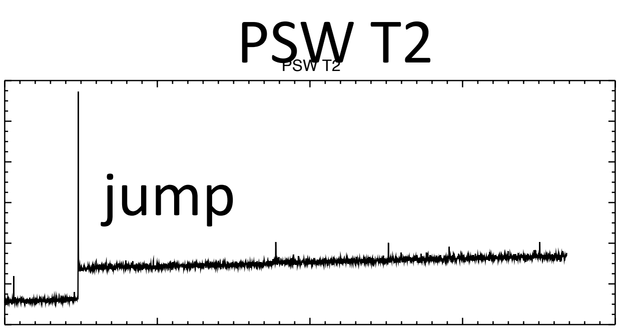
- WISE S/N is large enough to look for position dependent offsets in the map.
- Plot shows offsets in a 0.5x0.5 deg field of first HELMS exposure (1342234749).
- Mean shift (x,y)=(1.79,0.27)" removed.
- Axes are in pixels (6").
- Mean shift in residuals is 0.9".
- We find small systematic residual offsets that vary on intermediate scales.

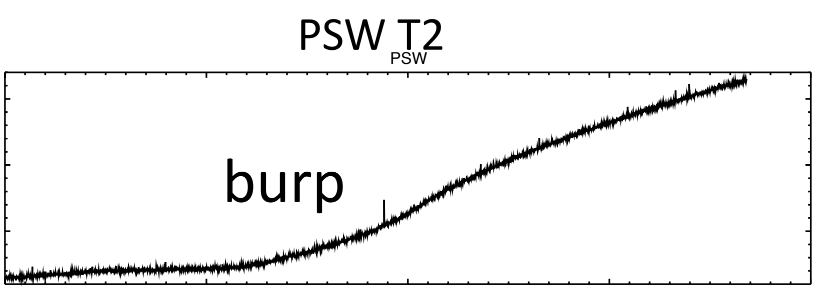


Jump and Burp

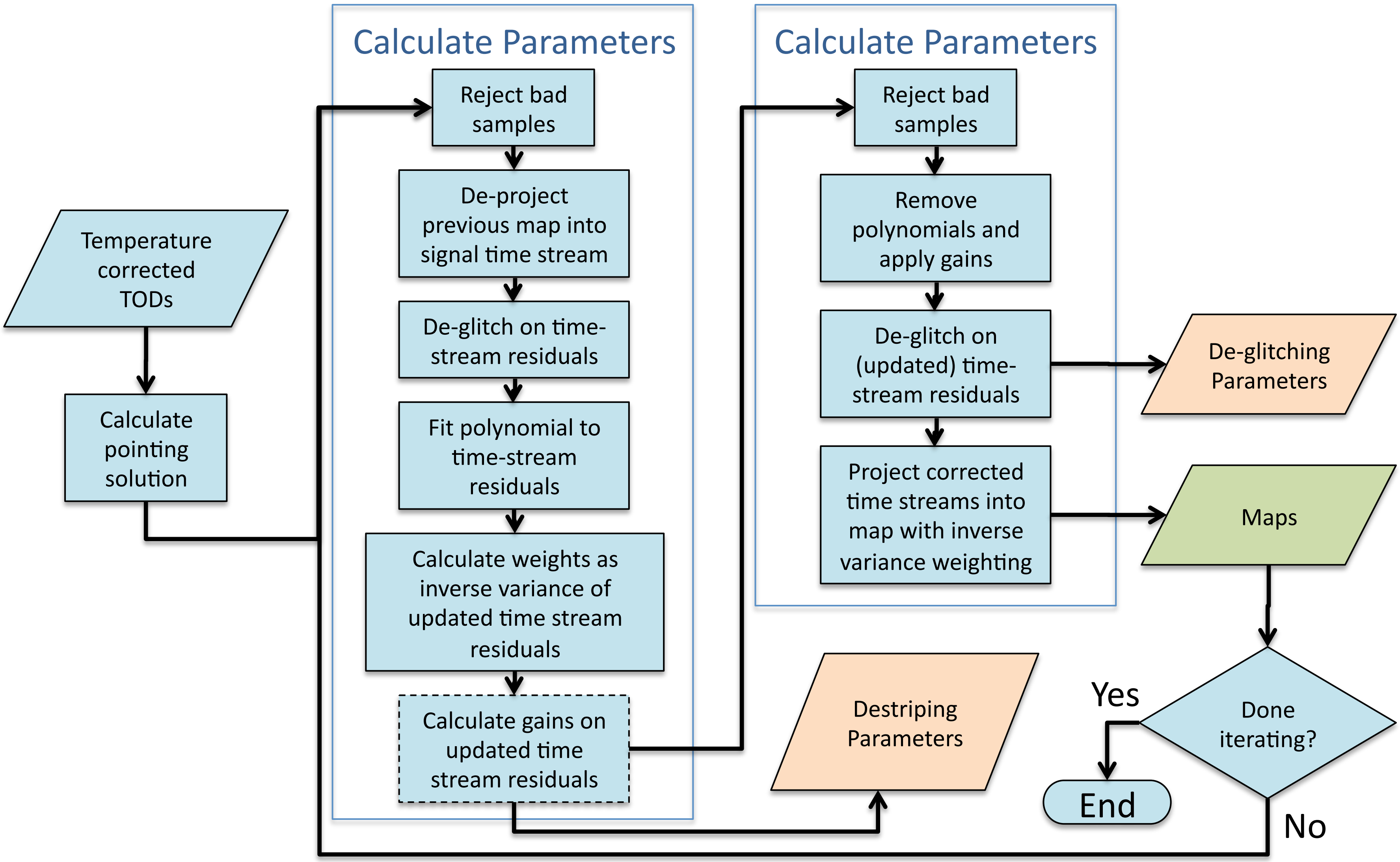
- Timeline jumps have the strongest impact when they occur in the thermistor channels as they change the signals or all detectors through the temperature correction.
- In the earlier time of Herschel there was not yet a working jump detector and jumps were detected and eliminated manually by visual map inspection and flagging.
- Jumps usually appear only in one thermistor and are only a real issue for PMW which has only one operational thermistor.

- The cooler burp appears about 6h after cooler recycle and changes the parameters for the temperature correction for a short interval.
- We manually removed the associated map scans in such cases.

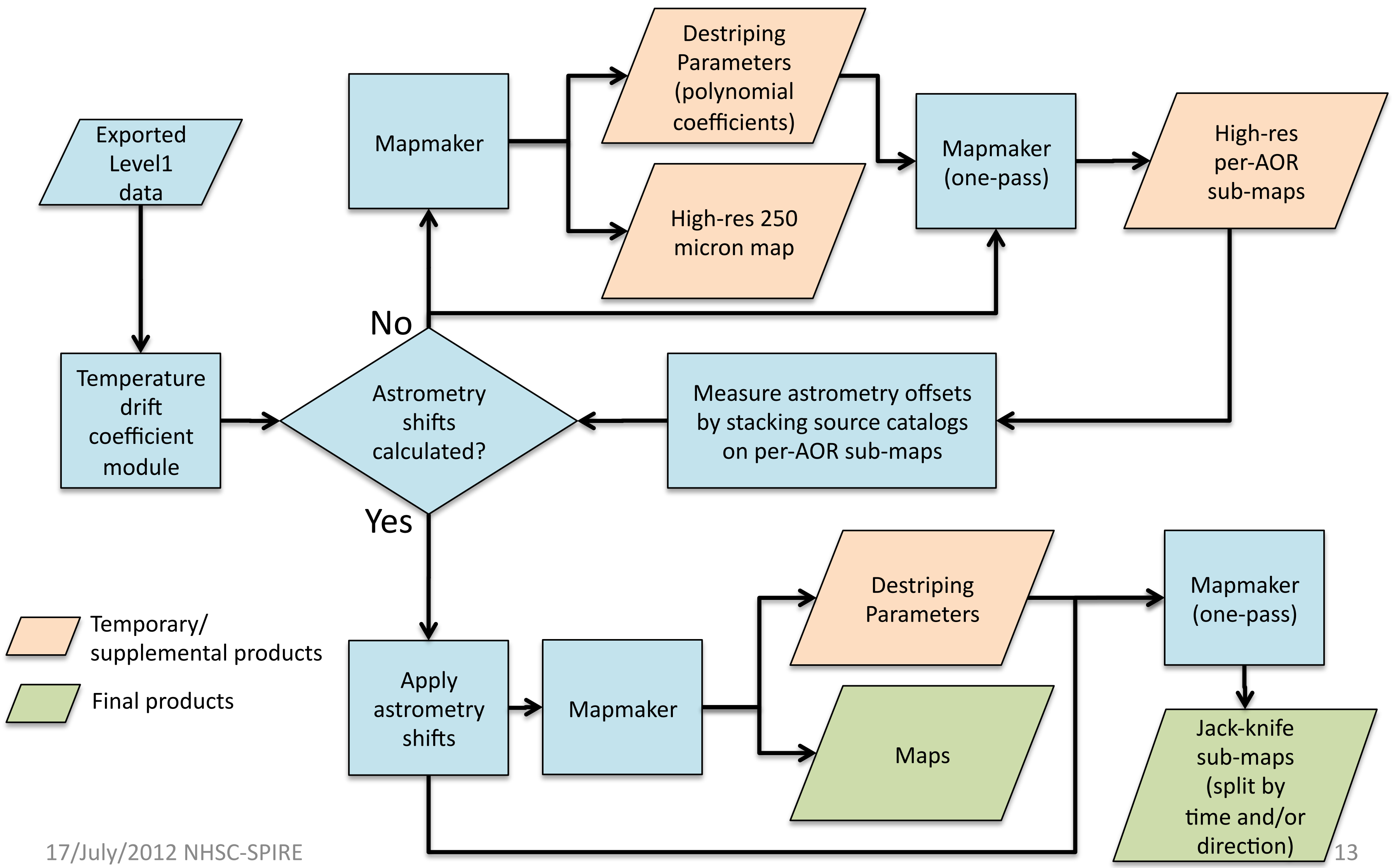




SMAP Mapmaker



SMAP Pipeline



Conclusions

- The SMAP pipeline was used successfully on the entire HerMES program.
- The experience and parts of the algorithm could be fed back into the SPIRE destriper.
- Some parts are still somewhat "manual".
- More accurate temperature correction can be provided in the case of "empty" maps, but this method is not applicable to the general case.
- Automatic astrometry correction through stacking is possible if good catalogs at 24μm are available.