Point and focus algorithms

4/2/2016:

- Adaptive matched filter pointing algorithms allow pointing on weak sources in a variety of total power noise without use of a chopper system
- https://github.com/sao-eht/lmtscripts
- Frequency-domain implementation (Python)
    - agave: /home/lmtmc/lindy/lmtscripts/loclib.py
    - stitch together, and time-align multiple scans
    - Welch estimate PSD from same data (or use external PSD estimate)
    - model source contribution along telescope track
    - matched filter model signal into colored total power data
    - take location at maximum SNR
    - Log[Probability] maps (SNR^2) for Apr 1, 2016 1.3mm scans
    - 1058+015 (3 Jy), 1246-257 (1.9 Jy)
    - mf_mars.png

mf_3c273.png

mf_1058+015.png

mf_1246-257.png

- Confidence regions (1,2,3-sigma) after 4 and 11 scans

- 4scans.png

  11scans.png

- Time-domain implementation (Matlab - filterPointingMaps.m in https://github.com/sao-eht/lmtscripts)
  - Estimate covariance of the noise by computing the cross correlation of the time-series data
  - model source contribution along telescope track using a Gaussian blob of set standard devation and varying center position
  - construct matched filter in time-domain
    - filter_response = (inverse(noise_covariance) * source_contribution) / (source_contribution^T * inverse(noise_covariance) * source_contribution
  - stack SNR from multiple scans

Apr 1, 2016 1.3mm scans of 3C273

singleMap_3c273_r2.png

finalResults_3c273_r2.png

Apr 1, 2016 1.3mm scans of 1058+015 (3 Jy Source)

singleMap_1058+015_r2.png

finalResults_1058+015_r2.png

Apr 2, 2016 1.3mm scans of 1246-257 (1.8 Jy Source) singleMap_1246-257.png

finalResults_1246-257.png

Apr 2, 2016 1.3mm scans of SgrA*

singleMap_SgrA.png

finalResult_SgrA.png

- -- L. Blackburn and K. Bouman

3/25/2015:

- total power recording for 1mm scans was increased to ~83 Hz (from 10 Hz subsampled) in order to measure and compensate for gain fluctuations (few

% or less) in the receiver which were happening above nyquist (and aliasing in).

- new total power data seems promising, although it is a bit of a challenge to process (short segments, time glitches, discontinuous, irregular sampling)
- noise behavior of receiver/totalpower system varies
- attempt to filter and detrend data to prepare for pointing tests, processed data is successfully gridded onto a sky map by Gopal's libraries so it can be used for current sky location fitting routines.
- Before and after filtering:
  detrended_timeseries.png

- All of our available scans from the new aquisition system are of Saturn, saturn_scans_mar24.png

- algorithm in brief:
    - fix data artifacts (time errors, interpolate through gaps, resample onto regular time spacing)
    - remove mean
    - low pass 10 Hz and line filter (1.2 Hz, 1.5 Hz, 11.45 Hz and harmonics, mixed frequencies)
    - running minimum window to find points for detrending
    - low pass filter applied to minimum series to establish trend
    - trend subtracted
    - interpolate onto sky grid
- on agave:
    - ~lmtmc/lindy/pyinit.process(iobs, showmap=True)

Low-pass filtering point scans from 3/21

total_power_psd.png

total_power_1hz_filtered.png

total_power_0.5hz_filtered.png

Measuring total power at VLBI backend

- Measure total power using Mark6 recorded 2-bit data by checking 2-bit occupancy
- There is a time offset (4.5s) between the scan time and that reported in the total power files (leap seconds?)
- Assumed every packet was exactly 8 microseconds, and used 31250 = 0.25s per integration.
- Same time offset in A and B channels (IF0 and IF1)

- IF0 and APower are both noisy (Saturn scan)
  mark6_totalpower.png

- Time aligned (added 4.5s to Mark6 time)
  mark6_totalpower_aligned.png

- Measure total power using Mark6 eht3 and eth5 packets by checking 2-bit occupancy
- Measure total power using R2DBE regular 8-bit snapshots as fast as possible
- Measure total power using custom R2DBE bitcode

3/22/2015

- Tried some simple detrending (splines) plus high-pass filtering
- Made cleaner images, but not able to find any 3C279 in scans
- I think the detrending is too aggressive, will work on some ad-hoc methods to make this more robust against DC level in the transit signal
- Ideally the background estimation would be different for every hypthoetical signal position.

Forward model fitting into time domain

- useful for dealing with regions of spectrum that have both signal and noise contributions
- starting beam width of 10 (arcsec, FWHM?)
- can characterize noise as stationary?
- how to get good local estimate of power spectrum?

Averaging multiple scans

Detrending with splines or high-pass filter