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VIRAC automated Single baseline interferometre data processing

Content

Single baseline interferometre at VIRAC uses SFXC correlator. This work automated using The Automatic Correlation System (ACor) system. This system is web-based platform which one of the tasks is to automate the correlation and data processing.

The ACor system allows two types of observations to be processed: 1) Data processing with single scan correlation - to experiment with correlation parameters. 2) Data processing with multi scan correlation - to run line or continuum or both pass correlation. This correlation run selected pass for all scans. Multi scan correlation use these correlation parameters: 1) 2 s integration time is used, 2) In the continuum pass, all channels is correlated with 128 FFT points, 3) In the line-only channel containing the maser signal is correlated with 4096 FFT points. These parameters are sufficient for 8 MHz bandwidths. For multi scan correlation automatic clock search is executed. This is done, by parsing the key file and finding fringe source. After that it is checked if scan which is fringe finder scan, has raw data file. If none of the fringe finder scans have raw data files, clock search is not done. Clock search is done with 1024 FFT points, 2 s integration time and for all channels. This process is done in 5 iterations after the first iteration fringe mean offset value is found. If standard deviation of fringe offset for all channels is larger than 2, clock search is stopped. In the next four iterations, the fringe mean offset is subtracted and added to RT-32 GPS offset and RT-16 GPS offset values. After all iteration from all four gps offset changes, the version where the mean of fringe offset is lower is chosen. If multi scan correlation with both passes are done automatic data processing is done with ParselToung Pipeline. After the correlation MS and FITS files are created, diagnostic plots also is created. To users of system diagnostic plots and ParselToung Pipeline outputs is displayed.

Single baseline interferometre at VIRAC uses standardised processing of astronomical data, with the use of an automated data reduction pipeline written in ParselTongue which is a Python interface to the Astronomical Image Processing Software - AIPS.

The ParselTongue pipeline works as follows. The line and continuum data sets are first loaded. Beginning with the continuum data, corrections for the losses during digital sampling are applied. Then a-priori gain calibration tables (system temperature and gain curve) derived from noise diode temperature measurements conducted during observations are used to calibrate the flux density of visibilities. Bandpass corrections for all targets are made based on the observed bandpass shapes of all continuum calibrators. Then, three stages of fringe fitting and integrations are performed. Starting with a 'manual phase-cal' stage, the phase difference between the RCP and LCP data are corrected, and any phase delay difference between the baseband channels is corrected allowing the channels and both polarisations to be integrated to improve signal to noise. The group delay is then determined on continuum sources by fringe fitting on the partially integrated data at a solution interval of about 20 minutes in order to trace the slowly drifting delay differences and slowly changing phase residuals imparted by the ionosphere. Solutions are applied to all targets in the experiment. Finally the continuum sources are then fringe fitted again and in so dealing with the individual baseband channels individually to obtain channels specific solutions. It should be noted that all fringe fitting stages up to this point are instructed to discard phase rate solutions. At this point, the solutions for the continuum data baseband channel which matches in frequency to the line data set is copied to the line data, thus providing gain, delay and slowly changing phase solutions which can be interpolated to the timeranges of the maser target data. The peak channel of maser emission for each source is then determined and used as the input of a fringe fitting stage which determines the phase and rate fluctuations of the atmosphere with 20 second solution intervals. Phase and rate solutions are concatenated into a single solution table and copied back to the continuum data set, thus enabling long integrations capable of detecting the continuum emission associated with maser targets. A final fringe fitting stage is conducted on the continuum data of all targets as an inspection step as the success or failure at this stage indicates the overall detectability of continuum emission in all sources, both quasars and high-mass protostars. Finally the spectra and visibility plots of all sources are output and the integrated radio continuum flux densities of all sources determined.

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