

A Simple Step-by-Step Guide to SMA Data Calibration. A.K.A. MIR Cheatsheet

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Data reduction procedures

1. At Unix prompt, set up the MIR environment, launch IDL and load the data in:

```
% source /opt/mir/setup
% idl
IDL> readdata, dir='<directory>'
```

See MIR Cookbook Section 2.2 for setup locations and various programs to load subsets of data.

2. Continuum reconstruction

```
IDL> select, /pos_wt, /reset
IDL> uti_avgband, /all
```

This step will pre-inspect the data and flag out flat-line spectra and regenerate continuum band. Certain channel ranges can be used to generate continuum bands. See MIR Cookbook Section 3.2 for details.

Regenerating the continuum band in the presence of bad delays or poor chunk-to-chunk phase offsets can be useful after a phase-only passband calibration. See MIR Cookbook Section 5.1.

3. Data inspection:

```
IDL> select, source='0423-013', /pos_wt, /reset
IDL> plot_continuum, x='int'
IDL> plot_spectra, frame_v='blcd,sb', color='band'
IDL> plot_var, x='prbl', y='ampave', frame_v='sb', color='blcd'
IDL> select, source='0423-013', int=[200,250], /reset
IDL> flag, /flag
```

Use **plot_continuum**, **plot_spectra** and **plot_var** to inspect the data, check any strange phase jump, **flag** those suspicious data points with **select** or **dat.filter**. It is always good to check the amplitude of quasars or planets vs projected baselines with **plot_var**. See MIR cookbook Section 3.3, 3.4 and 3.5.

4. Tsys correction:

```
IDL> select, /pos_wt, /reset
IDL> apply_tsys
```

Please note that before using **apply_tsys** to do tsys correction, please check the system temperature using **plot_var** and fix any bad tsys with **uti_tsys_fix** according to the correlation between the elevation and tsys:

```
IDL> uti_tsys_fix, tel_bsl='telescope', loose=30, refant=1, /refit, /verbose
```

use **plot_continuum** to check whether the amplitude scale is on pseudo-Jy. See MIR Cookbook Section 4 for details.

5. Passband calibration:

```
IDL> select, /pos_wt, /reset
IDL> pass_cal, smoothing=20, refant=5, tel_bsl='telescope', ntrim=3
```

Other keywords can be used to set the smoothing windows and also delay fitting. See details in MIR Cookbook Section 5.1.

6. Gain calibration:

```
IDL> select, /pos_wt, /reset
IDL> gain_cal, x='hours', smoothing=0.7, refant=5, tel_bsl='telescope'
```

Other keywords can be used to do time- or elevation-dependent antenna- or baseline-based calibration. Dual band and line mode calibration can be used to calibrate dual-receiver data. The flux of the calibrator(s) can be derived from flux calibration described below. See details in MIR Cookbook Section 5.2.

7. (Flux calibration):

```
IDL> select, /pos_wt, /reset
IDL> sma_flux_cal
```

Usually we don't do flux calibration at end. Instead we use **sma_flux_cal** along with **flux_measure** just to derive the flux of the gain calibrator(s) in a separate procedure. The flux of the gain calibrator(s) can be inserted in the gain calibration described above for amplitude calibration.

A combination of passband and gain calibration can be used to scale the amplitude and phase before flux calibration. **flux_measure** can be used to derive the flux of calibrators by vector-averaging. See details in MIR Cookbook Section 5.3.

8. Data output

```
IDL> select, /pos_wt, /reset
IDL> result=fits_out('twhya.lc', 'uvf', 'twhya', '', '', 'c1', '1', '', '')
or
IDL> select, /pos_wt, /reset
IDL> idl2miriad, dir='twhya.lc.vis', sideband='1', /cont, source='twhya'
```

Data can be written to a FITS file or a Miriad file. See details in MIR Cookbook Section 7.

Common problems

1. Lower sideband phase flip

```
IDL> select, sideband='1', /reset
IDL> phase_conjugate
```

For data taken before April 28th 2005, the lower sideband phase needs to be flipped before data output or any phase manipulations.

2. Baseline correction

```
IDL> select, /pos_wt, /reset
IDL> sma_cal_bas
```

Phase can be corrected if a better baseline solution is obtained. See details in MIR Cookbook Section 6.3.

3. Header problems

```
IDL> uti_vel_fix
IDL> uti_uvw_fix
IDL> uti_pos_fix
```

Header problems (velocity, uvw coord. etc) can be fixed anytime. See MIR Cookbook Section 6.5.

4. Velocity shifting

```
IDL> select, source='twhya', sideband='u', band='s15', /pos_wt, /reset
IDL> uti_erot_fix
```

For data taken between December 10 2004 and April 29 2005, the velocity shift due to the earth rotation needs to be fixed. See details in MIR Cookbook Section 6.4.

5. Other utilities. See MIR Cookbook Section 6.