CARMA Observing Scripts

http://cedarflat.mmarray.org/observing/scripts

Goals

1. Demonstrate how to prepare scripts

2. Describe key inputs for the script

3. Describe how to upload scripts / catalogs / mosaics

Script Writer

1. Purpose
   - Write python script to perform observations
   - Handles single sources and mosiacs
2. Web page to create scripts
   - http://cedarflat.mmarray.org/observing/scripts
3. Web page to upload revised scripts, catalogs, and mosaic files
   - http://cedarflat.mmarray.org/scripts/scripts
4. FAQ page
   - http://cedarflat.mmarray.org/observing/scripts/script_faq.html

Observing Steps

1. Tune receivers
2. Configure correlator
3. Pointing
4. Observe flux calibrator
5. Observe passband calibrator
6. Observe phase calibrator and science target; repeat

Required Parameters

1. Source name (8 characters or less)
2. Right ascension (e.g. 06:12:54.0 in J2000)
3. Declination (e.g. +17:59:23.1 in J2000)
4. Velocity (V_{LSR}; km/s)
5. Project (e.g. cs040)
6. Obsblock (e.g. 1E_115S255)
7. Source catalog (e.g. cs040.cat)
8. Tuning and correlator information

Output from Script Writer

1. Observing script template
    - save and edit if needed, or upload immediately
2. Adopted phase calibrator
3. Table of nearby phase calibrators
    - may wish to choose a better calibrator

Choosing a Phase Calibrator

1. Flux limit (signal to noise for phase, amplitude)
    - > 1 Jansky
2. Separation (slew time, baseline errors)
    - < 20 degrees (3mm)
    - < 10-15 degrees (1mm)
3. Check date when last observed
    - brightness varies in time
    - < 2 months is probably ok

Tuning

```
tuning = {
        # 'restfreq' : linefreq('12CO(1-0)'),
        'restfreq'    :  95.0,    # [GHz] Line rest frequency
        'sideband' :   USB,   # Sideband (LSB or USB)
        'IFfreq'       :  2.75,    # [GHz] IF frequency
 }
```

Tips:

- USB for lines near 115 GHz
- LSB for lines near   85 GHz
- Line catalog

http://cedarflat.mmarray.org/observing/doc/SpectralLine.cat

Correlator - CARMA15

```
def setCorrelator(tuning):
        clearastroband(0)
        configastroband(1, 'LL', BW500, tuning['restfreq'])
        ...
        configastroband(8, 'LL', BW8, 99.5)
```

Tips:

- Have at least one BW500
- Avoid placing band at IF = 5.0 GHz
- Correlator graphical setup (CGS) generates commands
- Best to keep line in signal sideband
- Be careful of large VLSR !
- http://cedarflat.mmarray.org/observing/doc/instrument_desc.html

Correlator - CARMA23

```
def setCorrelator(tuning):
    clearastroband(0)
    configastroband(1, 'CARMA23', BW8, 88.631847) # HCN
    configastroband(3, 'CARMA23', BW8, 93.173704) # N2H+
    configastroband(5, 'CARMA23', BW8, 89.188518) # HCO+
    configastroband(7, 'CARMA23', BW500, 92.79)    # continuum
```

Tips:

- Specify only 4 bands (bands 1, 3, 5, and 7)
- Have at least one BW500
- Avoid placing band at IF = 5.0 GHz
- Best to keep line in signal sideband

Correlator - CARMA8 / SZA

1. Do not need to specify correlator configuration
2. Only one configuration allowed

Source and phase calibrators

```
sources = {
    'target'            : ‘S255’,
    ‘mosaicTarget’ : False,
    'phaseCal'          : ‘0530+135',
    'tintTarget'        :  20.0,    # [minutes] per pointing
    'tintPhaseCal'   :   3.0,    # [minutes]
    'callist'              :  None,
 }
```

Tips:

- You can specify multiple science targets
- You can specify multiple phase calibrators

Signal to noise on phase calibrator

$$\sigma_{pha} \approx \sigma_{amp}/S_{source}$$ per baseline

$$= 8^\circ \left(\frac{T_{sys}}{300\,K}\right) \left(\frac{D}{8\,m}\right)^{-2} \left(\frac{BW}{500\,MHz}\right)^{-0.5} \left(\frac{t_{int}}{1min}\right)^{-0.5} \left(\frac{S_{source}}{1Jy}\right)^{-1}$$

Bandwidth (MHz)	Amplitude uncertainty (%)	Phase uncertainty (deg)
500	2.1%	1.2 deg
8	17%	9.4 deg

Assumptions:

- S_{source} = 1 Jy
- tint = 3 minutes
- antenna-based solution

Mosaics

```
mosaic = {
   'startpos'        :       1,
   'nphase'          :       0,
   'arcminUnits':   True,
   'offsetFile'      :   None,
   'offsets'         :  None,
}
```

Tips:

- Specify pointing offsets
- Integration time is *** per pointing ***
- On-the-fly mosaicking is available
- “Single-dish” mode is available for zero spacings

Pointing

```
pointing = {
   'doPointNight'  :  True,
   'doPointDay'    :  True,
   ‘doOptPoint’    :  True,
   'intervalNight’ :   4.0, # [hours]
   'intervalDay’   :   2.0, # [hours]
   'intervalOpt‘   :   1.0, # [hours]
   'minflux'       :   2.0, # [Jy]
}
```

Tips:

- Defaults are usually ok
- Optical pointing often fails during daytime

Flux Calibration

```
fluxcal = {
    'doPrimary'       :  True,
    'doSecondary'     :  True,
    'doBoth'          :  False,
    'doPoint'         :  True,
    'tint'            :  5.00,
}
```

Tips:

- Calibrators are ~ 1 Jy; noise in 5 minutes is ~ 4 mJy
- Defaults are usually ok

Passband

```
passband = {
   'doPassband'  :  True,
   'tint'                : 15.00, # [minutes]
   'minflux'          :  4.00 , # [Jy]
   'preferred'       :  None,
}
```

Tips:

- Tint can be decreased for continuum projects
- Phase calibrator may be used for passband

Signal to noise on passband calibrator

$$\sigma_{pha} \approx \sigma_{amp}/S_{source}$$

per baseline

$$= 8^\circ \left(\frac{T_{sys}}{300\ K}\right) \left(\frac{D}{8\ m}\right)^{-2} \left(\frac{BW}{500\ MHz}\right)^{-0.5} \left(\frac{t_{int}}{1 min}\right)^{-0.5} \left(\frac{S_{source}}{1 Jy}\right)^{-1}$$

Bandwidth	Channel width	Amplitude uncertainty (%)		Phase uncertainty (deg)	
(MHz)	(MHz)	per band	per channel	per band	per channel
500	5.3	0.24%	2.4%	0.13 deg	1.3 deg
8	0.02	1.9%	37%	1 deg	21 deg

Assumptions:

- S_{source} = 4 Jy
- tint = 15 minutes
- antenna-based solution

Other tips

1. Directories
   - Scripts : /home/obs/scripts/currSci1 (or currSci2)
   - Catalogs: /array/rt/catalogs
   - Mosaics : /array/rt/mosaics
2. Editing dictionaries
   - place comma at end of lines !!
   - (most) character strings must be in quotes