RSRO Final Report
Ann Mao, 31 October 2012

I was the RSRO and PI for projects 12A-414, 12B-180. I spent 3 months at the AOC, divided into two visits (5/28/12-8/2/12, 10/3-10/26). My first priority was to work with Steve Myers on polarization commissioning.
I summarize my RSRO activities in the following.

Priority 1:

Polarization stability of the VLA:

Rick Perley has demonstrated, using the feed rotation trick (see e.g. EVLA Memo 131, 141) that the absolute cross polarization of VLA antennas at L, S and C bands is stable within 0.1 \% on time scales of a few days and 0.5 \% on time scales of $\sim$ 9 months. We would like to monitor the instrumental polarization of the VLA on a more regular basis.

To do so, we make use of the polarization calibrator monitoring runs that Steve conducts (the first OSRO mode 2X128 MHz bandwidth). By observing an unresolved and unpolarized source monthly, we are able to solve for the leakage terms.
I have used polcal runs from mid-2011 to 2012 and determined the leakage terms for all runs at all bands. The D-term calibration tables from CASA task polcal is in the frame of the telescope. To compare leakage solutions from different nights requires transforming the D term matrices into the sky frame. I used a python script to do this transformation and then compare the leakage terms.

We find that the leakages at C U and X bands all have amplitudes between 3 to 4 \%. The instrumental polarization is very stable over time and it only varies $\sim$ 0.5-1 \% over the period of a year.
The frequency dependence of the leakage term vary little with time as well.

The higher frequency bands required higher signal-to-noise to solve for reliable leakage terms. We discovered that the CASA task polcal with mode= Xf was not able to handle binning in frequency channels.
George modified the task so that it now allows one to specify a solint in frequency when calibrating the polarization position angles.

Since the leakage terms are stable, it looks promising that one can apply the leakage solutions found for one run onto another run. Currently, CASA does not offer the option to perform this operation.
I have been working with George to implement this in CASA. I will continue to help to test the task after the RSRO period.

In the future, polcal runs with full 2 GHz bandwidth would be extremely useful in

characterizing the leakage terms across entire bands. Investigation of the leakage terms of 3-bit samplers across 8GHz bandwidth would also be helpful.

Polarization Calibration Strategy:

Currently the way to set the polarized flux of a source is to specify in SETJY a constant polarized fraction and position angle as a function of frequency across a spectral window. This is fine for our primary polarization angle calibrator as it has a constant angle of 33 degrees. However, for sources that has a non-zero Faraday rotation (3C138, 3C48), using the same fractional polarization and angle across a spectral window artificially inject the wrong Faraday rotation measure. I have written a python script that creates a model image cube of the sources with the correct Q and U values across the SPWs. The next CASA release will likely modify SETJY such that specifying frequency dependent angle and fractional polarization would be possible.

Others:

During the summer, while Steve was on travel, I had help REU summer student Katie Weil to understand CASA calibration scheme and to troubleshoot the data reduction script.

I have submitted a director's discretionary time observing proposal to search for Zeeman splitting in OH masers in the central region of M82.

Data Reduction:

I have performed data reduction and polarization calibration for projects 12A-414, 12B-180 as well as archival M51 data during my RSRO stay.

Lowe Priority: Faraday rotation measure synthesis.

Unfortunately, I did not have time to work on this during my RSRO.