How the UW imaging pipeline prepares 350 hours of MWA observations for EoR power spectrum measurements

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The Murchison Widefield Array began science observations in the summer of 2013, with the goal of measuring the Epoch of Reionization (EoR) power spectrum through redshifted 21 cm neutral hydrogen emission. With the first semester of observing completed, the EoR analysis team faces the challenge of reducing 350 hours of data to a manageable size for the power spectrum pipeline. Several obstacles exist when reducing such a large data set to the precision necessary for cosmological measurements. The EoR fields were deliberately chosen to be void of bright calibrator sources, and thus conventional calibration methods fall short. Even in the absence of such bright calibrators, the existing foregrounds are 4-5 orders of magnitude brighter than the EoR signal, and must be subtracted to great precision to unlock the EoR window. The sheer size of the data set also presents problems. Even with the Fast Holographic Deconvolution (FHD) algorithm running on a computing cluster, reducing this data would take several months without finding ways to take advantage of the symmetry in the observations.

I will present the imaging pipeline developed at the University of Washington to address these challenges. Our analysis is based on FHD, and includes several novel techniques including fitting a complex calibration model to increase instantaneous signal to noise, joint deconvolution across several days of data to reach mJy flux levels, and transferring solutions and mapping functions across observations to save computing time. The result is a frequency dependent image cube that has been integrated through 350 hours, and very clean of spectrally smooth foregrounds.