Vitalizing Algorithm & Techniques Development Activities across NRAO

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7 June 2007 – Draft v1

1. Strategy

Our mission is to create a culture of open, innovative algorithm development and sharing of ideas through which NRAO will substantially increase its capability to deliver particular EVLA and ALMA algorithms early in the operations period.

The strategy for accomplishing this overarching goal is to segment algorithm design and research from work on algorithm implementation.

The outcome from an algorithm research activity will be a memo describing the analytical aspects of the algorithm (added to a new memo series), a discussion of the pros/cons/limitations/needs of the algorithm as described, and demonstration or prototype code if available.

2. Objectives

2.1 **Raise Visibility** of the algorithm development activities taking place within NRAO. Increase organizational visibility of individual contributions to advancing Observatory goals in algorithm design.

2.2 **Set Boundary Conditions**/Realistic Expectations for what EVLA and ALMA algorithm status may look like on Day 1 of early science and Day 1 of regular operations. By constructing a worse case scenario immediately, we will be better able to set expectations in the user community over the next few years and formulate contingency plans if necessary.

2.3 **Establish and Communicate Clear Policy Statements** on techniques development work. The activity will be facilitated, but not managed, to ensure that the creative work of the scientist is not impeded. Any scientist can participate or opt-in to the discussions and activities of interest. The focus of the activity is exploration not implementation; the research develops methods and techniques rather than production software.

2.4 **Procure Shared Hardware Resources** for exploratory development. Facilities will be available to investigators working on any relevant operational research problem throughout NRAO.

2.5 **Encourage Teaming and Mentorship** between NRAO senior and junior members, and between NRAO community and students. Encourage teaming across organizational boundaries with institutions working on similar problems and encouraged continued participation by inviting outside representatives to regular workshops.

3. Approach

3.1 **Engage Code Integrators [E2E]**. Relieve production software responsibilities of scientists who should be focusing on algorithm and techniques work by October 1. Expertise could be obtained from companies such as CSC or SAIC.
3.2 **Engage Resources in Data Rate/Volume Problem [E2E]**.
3.3 **Launch Workshop Series [Leader]**. Workshops will be held once per quarter; two at NRAO sites and two near sites where NRAO would like to leverage necessary expertise by inviting external members to the workshop.
3.4 **Secure Postdoc/Graduate Student expertise [SAA]** (already identified).

4. Costs Per Year ($250K) in FY08 and FY09:

E2E will procure required equipment in Q3 2007. Workshops will begin in Q4 2007 (beginning of FY08).

???:	Sponsor workshops for FY08 and FY09, $50K/yr	=	$50K
SAA:	2 pre-docs for 2 years (Urvashi, Datta)	=	$66K
	Outsource/temp expertise in RFI solutions	=	$33K
E2E:	2 code integrators, up to 2 years	=	$75K
	Outsource/temp expertise in data rates & volumes	=	$25K

5. Description of Required Algorithms and Techniques

A. Wide-band, Full-field of view imaging/deconvolution/self-calibration

Rao thesis, 2 years (target end date Q4 2009) wide-band imaging
Advisors Myers and Cornwell. 2009 goal: algorithms and implementation suitable for EVLA in this area
Support needed: NRAO predoc for 2 years

Golap/Myers/Bhatnagar - multiscale deconvolution and wide field imaging. One graduate student. 2009 goal: tractable wide-field MS-Clean, ingegrated with MFS (Rao)

B. Adding second order self-calibration (isoplanicity, bandpass, pointing) to improve dynamic range

Datta thesis - ionospheric calibration and reconstruction
Advisors Bhatnagar and Myers. Support needed: NRAO predoc for 2 years (possible some outside funding).
2009 goal: Demonstration algorithm for ionospheric modeling/reconstruction; prototype software for VLA and LWA testing

Bhatnagar/Golap/Moellenbrock - direction dep calibration and imaging. 2009 goal: pointing self-cal/correction and full polarization beam inclusion

C. Removing interference signals

Strategy: Outsource
And tap into expertise with SKAD / LOFAR / LWA

D. Full polarization calibrations, imaging, self-calibration

Moellenbrock/Golap - polarization calibration and imaging and spectral calibration development. 2009 goal: algorithms and code for support of initial EVLA and ALMA

ALMA algorithm requirements are already embedded into ALMA development plans. These include:

A. Interferometric mosaicking/self-calibration

* Golap/Bhatnagar/Myers - ALMA implementation already budgeted algorithm design mostly done already, the rest will be common with EVLA work.

B. WVR and other methods to reduce phase fluctuations

* AFAIK, a UK deliverable. Check with Mangum on Cal plans but leverage outside expertise through outsourcing if necessary.

C. Combining ACA+12m+ALMA into one image (mosaic)

* Again, this is implementation. No show-stoppers here. Mostly will be annoying work to deal with all the ALMA antennas and the proof will be in the doing...

D. On-the-fly interferometric imaging

* This is a future development and is mostly a technology and implementation issue to deal with the huge data rates.