

The North America Array

Technology Development and the Realization of the SKA-High

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The North America Array is ...

Technology development and prototyping program for the SKA-high component

Fully part of US and International SKA program

Some NRAO specific aspects

Concept development for the expansion and incorporation of the EVLA/VLBA as the “SKA-high”, sited in North America

SKA-high siting proposal in 2018+

Astro2020 and construction in 2022+

Decadal Activity

Subject of RFI response to RMS Program
Prioritization Panel (Myers et al.)

Also asked to submit RFI-2 response (28Jul09)

Components:

*NRAO participation in SKA-mid precursors and
pathfinders, such as MeerKAT and ATA*

Continue and expand SKA TDP (TDP-II), extending
to SKA-high antenna evaluation and NAA
preparatory R&D

Construct a NAA Prototype Antenna Station
connected to EVLA, develop SKA-high costing
model and NAA site concept

Decadal RFI Documents

Original RFI-1 (Apr09):

<http://www.nrao.edu/A2010/rfi/PPP-NAA-edited.pdf>

Response RFI-2 (Jul09):

Differences from RFI1:

Total cost \$39850K (FY09), was \$31250 in RFI1
(added managment, antenna prototype, station
construction and testing, removed assumption of
contributed effort)

NAA/SKA-high Science Goals

Mostly taken from Astro2010 Science White Papers, broken down into those 5 areas

CFP: megamasers (dark energy, BH masses),
weighing dark matter (lensing),

GCT: imaging galaxies in early Universe (lines,
continuum),

PSSF: protoplanetary disks

SSE: super-star clusters and supernovae, SNe and
GRB, obscured pulsars and motions

TGN: Local Group motions

High-Level “Design”

SKA-high goals

10-35 GHz top-level spec

$A/T = 5000 \text{ m}^2/\text{K}$ ($\sim 20 \times \text{EVLA}$)

NAA concept

1-50 GHz capability

“core” 5-45 GHz, two 3:1 bands (5-15, 15-45 GHz)

At least 10 x EVLA sensitivity

5 x EVLA on baselines < 500km

Grow from EVLA + VLBA + GBT +ATA?

TDP-II

3 years (2012-2015) \$18350K

Was \$13450K in RFI1, added explicit management line and antenna prototyping

Goals:

Continue and expand SKA TDP-I

Evaluate TDP/PrepSKA antennas for higher frequency operations to guide SKA-high design

- also useful for a 2nd round of SKA-mid prototyping

NAA concept development, initial SKA-high design

Design for NAA Prototype Antenna Station and site

Added: NAA Antenna Prototype (continued in PAS)

TDP-II Components

Antenna Evaluation

Data Transmission

Digital Signal Processing

Digitization

Monitor & Control

Wideband Feed/Receiver

Algorithms, Computing, Software

SKA-high/NAA Concept Design

Added: Antenna Prototype

NAA Prototype Antenna Station

4 years (2015-2019) \$21500K

Was \$17800K in RFI1, added management, personnel for PAS construction and testing (no assumed contributed effort, as in RFI1)

NAA-PAS Goals:

1 year detailed design

3 year prototype construction and evaluation

Develop SKA-high costing model

Develop NAA site proposal for SKA-high CFP 2018+

Preparation for SKA-high Astro2020 proposal

Preparation for SKA-high construction 2022+

NAA Milestones (from RFI2)

Schedule of key TDP-II and NAA-PAS tasks (RFI2 table 5.4)

<u>Project Task</u>	<u>Start Date</u>	<u>End Date</u>
Delivery of TDP-1 Antenna(s) for TDP-2	Jan 2011	Jun 2012
Publish TDP-2 Test Results		Dec 2012
Conceptual PAS Antenna Design	Jan 2011	Dec 2014
Algorithm & Software Development	Jan 2012	Dec 2017
PAS Electronics System Design	Oct 2010	Feb 2015
CoDR		Dec 2013
PDR		June 2014
CDR		Feb 2015
Wideband Feeds and Receivers Design	Jan 2011	Jan 2015
CoDR		Jan 2012
PDR		Jan 2014
CDR		Jan 2015
Detailed PAS Antenna Design	Jan 2014	July 2016
PAS Civil Construction	Jan 2015	Dec 2018
PAS Receiver & Feed Production	Feb 2015	Dec 2017
First Article Delivery		Oct 2016
PAS Electronics Production	Feb 2015	Dec 2017
PAS Antenna Contract	July 2016	July 2018
First Article Delivery		June 2017
PAS Antenna First Light / Testing Begins		Oct 2017
Integration and Testing	Oct 2017	Oct 2019
PAS Operations and Maintenance	Jan 2016	Dec 2019

NAA Proposed Cost Breakdown

Table 6.1 from RFI2 response (Myers et al.)

(FY costs¹ in 2009 Dollars)

WBS	Item	Prior	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
	Cost													2009 \$K
6.03.05	Concept Study and Antenna Evaluation	0.0	3.0	1219.5	552.8	287.1	529.8	0.0	0.0	0.0	0.0	0.0	0.0	2,592
6.03.01	Project Management	0.0	341.5	415.4	302.9	216.6	216.6	326.5	375.4	395.4	336.5	216.6	0.0	3,143
6.03.14	Instrument A 5-15 GHz Feed and Receiver	0.0	0.0	40.3	410.6	135.6	135.6	153.5	153.5	98.5	0.0	0.0	0.0	1,128
6.03.14	Instrument B 15-45 GHz Feed and Receiver	0.0	0.0	33.0	336.0	111.0	111.0	125.6	125.6	80.6	0.0	0.0	0.0	923
6.03.20	Telescope-Prototype Station and Facilities	0.0	0.0	0.0	0.0	0.0	0.0	1163.5	14493.5	2820.8	1047.5	479.5	0.0	20,005
6.03.10	Ground Data system - Digital signals	0.0	247.4	967.3	1167.3	976.5	571.5	461.5	356.5	109.9	109.9	0.0	0.0	4,968
6.03.12	Ground Data system - LO systems and M&C	0.0	0.0	0.0	0.0	346.6	346.6	309.9	173.3	0.0	0.0	0.0	0.0	1,176
6.03.15	Software Development	0.0	0.0	0.0	183.2	329.8	366.5	293.2	256.5	219.9	0.0	0.0	0.0	1,649
6.03.11	Operations and Maintenance	0.0	0.0	0.0	0.0	0.0	0.0	0.0	335.2	514.3	567.6	461.8	0.0	1,879
all	Reserves - Contingency	0.0	0.0	65.0	170.5	144.0	322.5	161.0	1478.0	45.0	0.0	0.0	0.0	2,386
	Total Cost per year	0.0	591.9	2740.5	3123.4	2547.2	2600.1	2994.9	17747.6	4284.6	2061.6	1157.8	0.0	39,850

Other aspects

NRAO SKA Program Office (Ulvestad)

Connection to SKA-mid

Augment antenna evaluation in 2011-2012

- probably 1yr of extra TDP-II ~ \$4M

Dish verification using EVLA

- Eventually extended testing using NAA-PAS

What comes after PrepSKA?

- Scheduling of activities to enhance not collide

Revisit SKA-high science case ~2015-2019

next decade “knowledge explosion”

- ALMA, EVLA, GSMT, LST, JWST, Herschel, Planck, ...

Comments and Issues

Science case

room for improvement!

new cases, e.g. the CO Cosmic Web

TDP-II scope and organization

intent: organized as TDP-I with USSKA

more direct NRAO involvement/funding

international participation?

need to propose in 2011 (or 2010)

NRAO, SKA, EVLA and NAA (also Jim's talks)

ALMA & EVLA personnel move off construction

2012-2014

Food for thought this meeting

TDP-II

- Maintain momentum if positive Decadal review
- When do we want to submit proposal for TDP-II?
- What planning do we want to do now (schedule)?
- Broaden the consortium base (science & tech)?

NAA-PAS

- Plan is lean, international partners?

Bigger Issues

- N.A. site for SKA-high from SKA-international view?
- What happens if SKA-mid schedules slip?