

Industrial Commissioning of the SKA: Learning from the ALMA, EVLA and MeerKAT Experiences



ALMA



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NRAO & SKA SA

EVLA



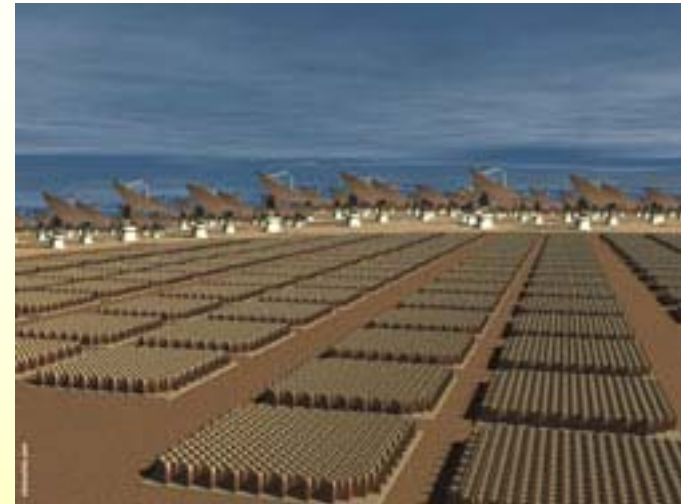
Manchester, UK
24 March 2010

Commissioning the SKA



The Commissioning Challenge

- Four separate array/feed configurations under consideration each with different commissioning requirements and staged, but interdependent construction:
 - Aperture Arrays (AAs):
 - Sparse Aperture, 70 - 300 MHz
 - Dense Aperture, 300 - 700 MHz
 - Dish+Phased Array Feed (PAF), ~ 500 MHz - 3 GHz, large surveys
 - Dishes+Wide Band Feed (WBF) arrays, 500 MHz - 35 GHz



Parameter		First Stage		Full SKA			
		Phase 1 <i>Mid-band – inc. dense AA</i>		Phase 2 scenarios <i>Low & mid-bands – all inc. AAs to 500MHz</i>			Phase 3 <i>High band</i>
		WBF only	WBF+PAF*	WBF only	WBF+PAF*	WBF+dense AA	
Frequency	Low	500 MHz	500 MHz	70 MHz	70 MHz	70 MHz	10 GHz
Range:	High	10 GHz	10 GHz	10 GHz	10 GHz	10 GHz	35 GHz

Commissioning the SKA

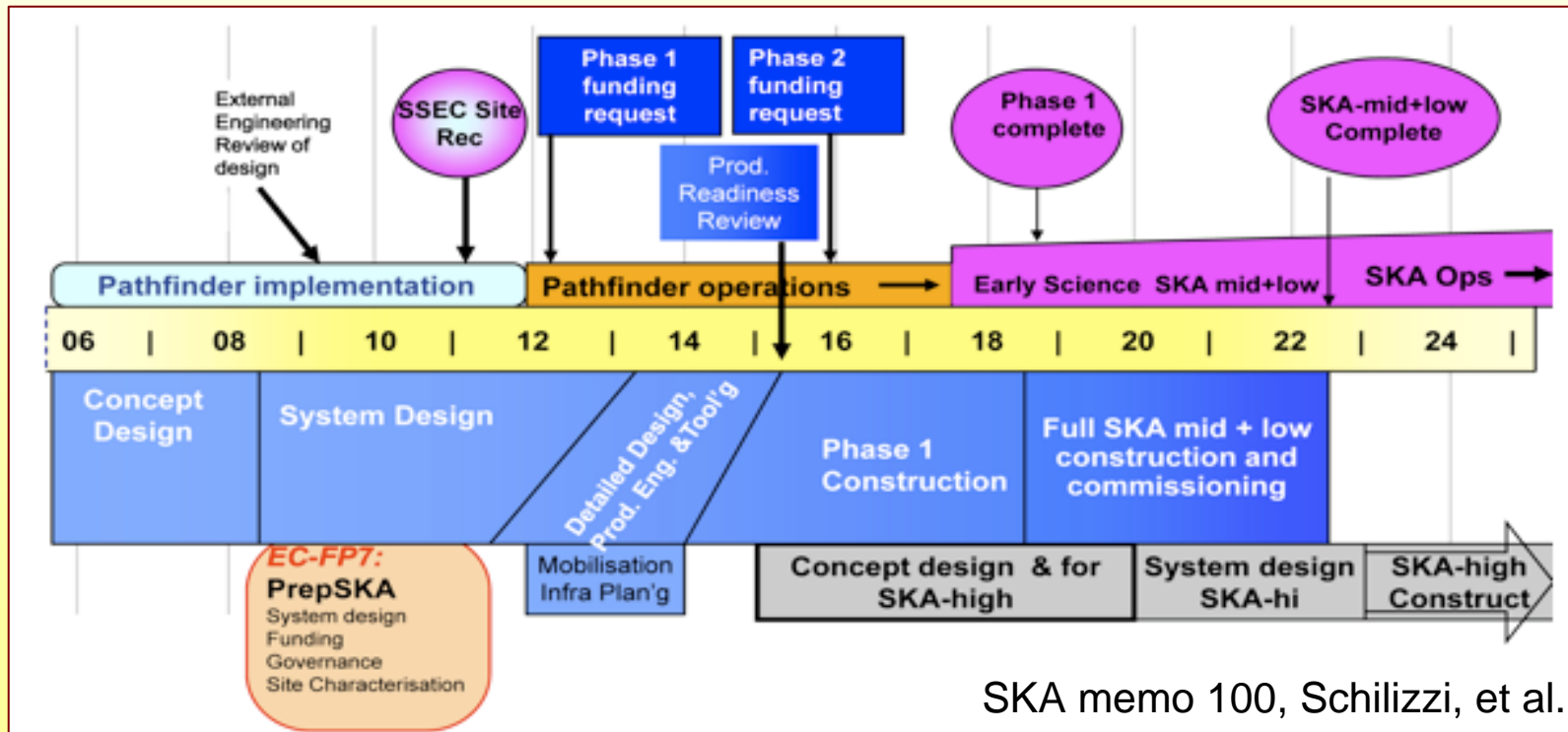


- **Separate** hardware, software & operations, e.g.:
 - Antennas, backend/RF hardware (signal chain), correlators (?)
 - Antenna Control & monitoring, post-processing software components
 - Environment (RFI, atmospheric response)
 - Maintenance tasks, LRUs
 - Commissioning problems can be very different
 - Sub-array operations, pipeline process control
- **Shared** infrastructure, software and operations, e.g.:
 - Fibre routing & patch panels, data transfer, archive, computing hardware, correlator
 - Operations interface, array scheduling software
 - Distributed cooling & power, control & correlator buildings, water, communications links
 - Post-processing software infrastructure & pipeline operations
 - Maintenance management and personnel

Commissioning the SKA



- SKA Phase I antenna roll-out (2013-2018)
 - If infrastructure completed by 2014, assume 300-400 dishes with at least 90% rolled out in last 3 years (2016-2018). *One dish commissioned every 3 days.*



SKA memo 100, Schilizzi, et al.

What can help to get ready for this process?



- EVLA - Expanded Very Large Array, 1-50 GHz
 - Mechanical retrofit of 28 antennas, 8 new receivers, new infrastructure (fiber optics, correlator room, power plant improvements), new WIDAR correlator, some new software (e.g. correlator controller, operator interface, post-processing)
 - ~ 0.5 antennas commissioned/months, individual attention
- ALMA - Atacama Large Millimeter Array, 30 - 950 GHz
 - 66 antennas: 50-12m dishes, 12-7m dishes & 4 single dishes
 - Infrastructure, receivers, and correlator built at the same time as antennas. All new software (control, operator interface, archive, obs-prep, post-processing)
 - ~ 1 antenna commissioned/month
- MeerKAT - Karoo Array Telescope
 - 80 antennas, about 1% of the collecting area of SKA. New infrastructure, receivers, expandable correlator, software.
 - ~ 3.5 antennas commissioned/month, focus on industrial commissioning methods

Commissioning Scope for SKA



- Commission a major instrument: 24hrs/day with turno shifts
4 full shifts of people = 1 'team'
 - Minimum team members: 1-2 astronomers, 1 SW developer, 1 systems engineer, 1 technician
 - 4 shifts = 20 person/'team' (vacation, etc...not included here)
- SKA 'scatter gun' approach has multiple technologies that must be commissioned in parallel, each requires separate 'teams' for:
 - Single antenna integration and commissioning
 - Ph I/II - dish WBF / PAF core & system (backend, correlator, operations software)
 - Ph I/II - dish WBF / PAF core evolving to first station deployment
 - Ph I/II - dense aperture array
 - Science Verification team - post processing, archive/VO, RFI excision, ionospheric modeling, early science results
 - Ph II - Sparse aperture Array
 - 20 people/team = 100 people (minimum)
- Not included: software development, maintenance, systems engineering, infrastructure, archive
- Add operations: effectively double number of people needed (more for multiple points of contact for user community)

EVLA - what we can learn



- Understand how to merge newly commissioned antennas into an existing array producing science.
- Large data rates and volumes
- Quantify issues limiting high dynamic range & fidelity
- Balance engineering, commissioning and operations priorities and resources.
- Dual operations: supporting an established user community (radio black-belts and novices) while commissioning antennas, sub-arrays and integrated functionality of the merged array.

Steve Myers' talk
on Monday

ALMA - what we can learn

- Largest ground-based radio astronomy project
- International collaboration with multiple antenna contractors & distributed development
- Large data rates and volumes
- Quantify issues limiting high dynamic range & fidelity
- Distributed science operations and wide user-base
- Power and infrastructure challenges in remote site
- International commissioning team drawn from diverse member countries with different political motivations

See Jeff Kern's talk
later this afternoon



MeerKAT - what we can learn

- Starting from scratch as an SKA precursor
 - develop procedures and infrastructure geared to solve anticipated SKA problems
- Scalability key design requirement (EVLA and ALMA have finite size, SKA can almost be considered to be infinite because it will be commissioned for so many years).
- Industrialized Commissioning:
 - Rapid commissioning model can be developed, honed and then lessons learned applied to SKA.

Industrialized Commissioning



- MeerKAT industrial commissioning model includes:
 - Heavy reliance on fully functional hardware and software delivered by contractors
 - Thorough verification by systems engineering and software teams before hand over to commissioning
 - High priority to document often repeated procedures.
 - Build verification procedures upon foundations of previous procedures (single dish → single baseline → antenna batches)
 - Multiple, parallel commissioning teams.
 - Shift to remote operations as soon as possible
 - Sustain test efficiency for years
 - Commissioning teams responsible for training the first operations personnel so there is a smooth transition between commissioning and operations activities.
- Commissioning model being vetted for KAT-7

KAT-7 Commissioning



- KAT-7 commissioning is the time to transition to an industrial model of commissioning in which high priority is given to documentation, training, and plug-and-play verification.
- Process defined and initially tested during KAT-7 and then modified as needed for MeerKAT.
- Commissioning with weekly, on-site presence began 3 weeks ago.
- ***Already can do tipping scans, pointing, gain curve, raster scans ...***



KAT-7



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KATCommissioning / **KAT Commissioning**

This page will hold all primary information, links to the commissioning organizations, links to the commissioning schedule.

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- [Activities](#)
- [Documentation for different phases](#)
- [Planning](#)

Activities

- [Weekly Commissioning](#)
- [Procedure for Site Trips](#)
- [Contact with IRC chat](#)
- [Focus commissioning activities](#)
 - [Logging - Deb \(D\)](#)
 - [GUIs - Anja \(R\)](#)
 - [Data Write and File Transfer - SCAPE & CASA](#)
 - [Scripts - Tony \(L\)](#)
 - [Configuration Database - SCAPE](#)
 - [Science operations - SCAPE](#)
 - [Testing operations - SCAPE](#)

Documentation

- [NominalProcedures.doc](#)
- [archive-structure.pdf](#) - 11/09/09, access various data structures
- [Documentation Recommendations](#) - python commands, Configuration Database
- [0_KATResolution.pdf](#) - SCAPE baseline (19nov09, DSS)
- [0_KATsensitivity.pdf](#) - EsCAPE Large Proposals (19nov09, DSS)
- [0_KATspectralLineSpec](#) (20nov09, DSS)

Documentation for Fringe Finder

- [How To Setup FFSIM](#)
- [Link to contractor documentation](#)

Client : NRF (National Research Foundation)

Project : KAT-7/MeerKAT

Type : Commissioning

Karoo Array Telescope Commissioning Verification

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SKA SOUTH AFRICA
SQUARE KILOMETRE ARRAY

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Commissioning started



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Questions?

