SKADS DS2-T2: Work Package Synopses

ASTRON. *Willem Baan*

1. Studies of the properties - including polarization, frequency and temporal stability - of the near-in and far- sidelobe antenna patterns of synthesis arrays consisting of aperture and/or focal plane arrays. => de Bruyn
2. Studies of calibration procedures and algorithms for FPA systems with particular application to the envisioned APERTIF system. These studies are contingent on APERTIF being funded. => Oosterloo
3. Studies and application of advanced imaging techniques with applications for LOFAR and WSRT.
4. Studies of imaging issues relating to EMBRACE-like arrays.
5. Design of data reduction procedures using HPC applications and distributed computing.
6. Other studies that develop in time.

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CSIRO. *Carole Jackson*

Areas of expertise & topics relevant to this work package (note by CR: this was submitted in Jan 2005 and probably needs updating - included here as a rough guide to the likely contribution):

The ATNF has a small team of researchers investigating configuration and imaging requirements for the SKA. In particular they are developing SKA configurations that best match the science requirements and high dynamic range imaging algorithms needed to produce sensitivity limited continuum images. Primary 'deliverables' will be papers, conference presentations and simulation software.

These investigations are conducted in collaboration with the SKA Simulation Working Group at Swinburne University group led by Steven Tingay.

Research will be on array configuration studies centred o low-frequency (< 2 GHz aperture) arrays and cylindrical antenna concepts, and also a long baseline (VLBI) SKA concept (inc. high frequency capability) extending to SKA+SVLBI. It includes both the development of configurations and the analysis tools to judge the relative merit of different configuration with respect to the science requirements.

Investigating the imaging algorithms needed to produce sensitivity limited images using the SKA, in particular the dynamic range limitations imposed by current algorithms (e.g., clean and wide field imaging).

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Glasgow. *Graham Woan*

Within the UKSKADS proposal, Glasgow will have one PDRA to work on aspects of DS2-T1 and DS2-T2 WP4 and 5. It's likely the majority of our effort will be DS2-T2. I'm hoping

the the meeting will help clarify how the various groups will work together on these packages, but our intention is to concentrate on technical design drivers for polarisation surveys, transient sources and pulsars surveys, together with (and in the light of) the gravitational wave drivers. Deliverables will be in the form of reports, but the time line is dependent on when money is released from PPARC to support the PDRA. We aim for a final report by 12/2008 of course.

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JIVE. *Cormac Reynolds*

Include a model description of the aperture array in a simulations software package (TBD) running on the Swinburne supercomputing facilities (in collaboration with Swinburne staff). Aperture array model description will require quantitative inputs from DS5 (EMBRACE).

Assess the impact of instrumental characteristics (e.g. instrumental stability and calibratability - bandpasses, time and directional dependence of the electronically-formed beam response, etc.) on the proposed key science projects. Will require model skies and quantitative description of imaging requirements from DS2-T1, e.g. dynamic range, image fidelity (in total intensity and polarization), FoV.

Contribute to comparison of imaging and calibration performance of Aperture Arrays versus other proposed SKA receptors (e.g. 'smart dishes').

Attempt to address possible scientific impact of an aperture array 10% SKA (Phase 1 of the Reference Design, input from SKA SWG and EWG).

Investigate requirements for calibrating and imaging high-resolution (long baseline) SKA images.

Consider possible role of SKA in space VLBI missions and precision spacecraft navigation.

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Leiden. *Huub Rottgering*

TITLE: Optimising the Calibration Techniques for SKA based on the properties of the low-frequency Universe.

Two important effects that limit the dynamic range of radio astronomy at low frequencies (< 2 GHz) are the ionosphere and radio frequency interference. Unique data about the properties of the ionosphere and RFI will be obtained with LOFAR and the new low frequency front ends at Westerbork. The implications of the new data for the design of SKA will be investigated, concentrating on optimising the calibration of SKA at < 2 GHz. Particular emphasis will be placed on the viability of iterative
self-calibration techniques such as (PEEL) for calibrating SKA. Such techniques use large number of radio sources simultaneously to calibrate the array and therefore it is essential to develop calibration models using well-established properties of radio sources at low frequencies. To this end, the following will be carried out:

(i) A physically realistic model of the ionosphere will be developed using constraints from data to be obtained from the Westerbork Low-Frequency Front Ends at 100 - 200 MHz and LOFAR's initial test stations.

(ii) Model radio maps of the low frequency (< 2GHz) sky will be generated incorporating radio source fluxes and sizes. The modeled radio source populations that will be used to generate these mapes include AGN, radio halos, starburst galaxies and variable radio sources. For each of these populations their space density as a function of redshift will be estimated on the basis of a combination of (i) extrapolation of know space densities, (ii) physical models of the evolution of the populations. As a further constraint, sources counts at other wavelengths such a mm/submm and X-ray will be taken into account.

(iii) These models will be refined using actual data from LOFAR surveys which will reach several orders of magnitudes below existing surveys.

(iv) The suitability of iterative self-calibration techniques for SKA will be investigated based on the results of (i) to (iii) and their effect on the calibratability of LOFAR as a function of baseline.

Given the amount of resources, we need to prioritize taken into account what comes out of the meeting.

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Bonn. *Andrei Lobanov*

The group at the MPIfR is interested to contribute to the array performance simulations of the SKA, primarily in the configuration studies and assessing the imaging capaibilities of different SKA designs.

The array simulations will be aimed at assessing the instrumental performance of the SKA designs proposed and determining those technical specifications of the array and station design which are critical for reaching the dynamic range and calibration accuracy required. Specific tasks will include:

1) Array configuration studies. The aim here is to estimate the costs of various trade-offs between resolution and sensitivity requirements outlined in the SKA key science projects. In a wider scope, comparative assessment of the imaging capabilites of various SKA realizations and other major future astrophysical facilities will be made.

2) Simulations of the effect of variable station gains (time- and position-dependent variability) and active RFI excsision (in spectral and time domain) will have on the image dynamic range. The main aim here to assess the feasibility of the tile design for reaching the dynamic range specifications of the SKA.

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University of Kwa-Zulu Natal. *Catherine Cress*

Currently we are investigating science that involves cross-correlation of an SKA HI-survey with cosmic microwave background observations (e.g., using the Integrated Sachs Wolfe Effect to study dark energy properties and the kinetic Sunyaev-Zeldovich effect to study dark

energy and "missing baryons"). I think we can continue working on these projects independently but eventually it would be good to have some interaction with others in the SKADS group.

We have also recently run some fairly large N-body simulations to study aspects of galaxy evolution and could participate in radio sky simulation projects.

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Swinburne. *Steven Tingay*

0. Contribute to the definition of the specific work program for the DS2-T2 task. The most important tasks will be in determining specific requirements for DS2-T2 simulations i.e. what are the design specifications of the instrument under study, what are the science requirements (interaction with DS2-T1), therefore what is a feasible list of simulations that can be undertaken to investigate the imaging and calibration quality of the proposed instrument (noise characteristics, dynamic range, fidelity: impact of instrumental stability, bandpasses, LNAs, antenna surface etc: atmospheric and ionospheric effects: calibration and imaging of multi-feed data).

1. Contribute to the implementation plan to achieve these simulations i.e. which software package(s) should be used, what supercomputing facilities should be used. Swinburne have nominated ~0.5 FTE over the course of SKADS to contribute to software development and implementation. Personally I recommend close collaboration with the ATNF and South African teams on points 0 and 1, if possible, as they are well advanced in very similar work for KAT and the xNTD.

2. Provide, over the course of the SKADS program, access to the Swinburne supercomputer for SKADS simulations through both DS2-T1 and DS2-T2. Host European workers at Swinburne to undertake simulation development work and run the final simulations.

3. Provide coordination with the Simulations Working Group of the ISPO. For example, studies of array configurations are well advanced as part of the international site selection process, managed by the SimWG. Progress through the SKADS component of the array configuration work may therefore be accelerated via this effort, leaving SKADS to concentrate on more advanced simulations of multi-feed imaging.

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Valencia. *Jose Carlos Guirado*

The Radioastronomy Group of the Universidad de Valencia will collaborate closely with the MPIfR group in SKA configuration studies and, particularly, will provide external access to the computer facilities of the Department of Astronomy for SKA-related simulations. At present, the computer power of our Department consist of: 1) a parallel supercomputer SGI Altix 3700 Server and 2) a five-unit server SUN Fire V40Z -5x16GHz RAM-.

Time and man-power permitted, our group has special interest in the exploration of the astrometric performance of the SKA, in connection with the detection of extrasolar planets around main-sequence stars.

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