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Summary of issues identified during PAFSKA workshop

BYU, Provo Utah (25-27 May 2011)

Context; This is a summary of the issues raised at the PAFSKA workshop as compiled by the participants 'round the table' on Friday 27 May 2011 and forms a 'debrief' to the workshop. These issues will be incorporated into the preparation of the WP2.2.3 PAF CoDR documents for the WP2.2 Dish Array CoDR as well as being more generally progressed within the SKA/PAF development communities.

Feed types on SKA dishes

Despite existing multi-beam systems, the community has yet to recognise multi-pixel feed advantage (and inevitability of the adoption of these systems) given investment/cost of dishes and other infrastructure.

Need to design SKA_1 and SKA_2 to accept PAFs; cannot afford major re-design or re-work in any reasonable future time (this means we must avoid locking into e.g. optics design which limits future options, allow for suitable (e.g. PAF) feed payloads).

Do the dish designs suitably accommodate future feed packages (mechanically, optically, etc) and continue to meet the SKA pointing spec?

PAF pre-CoDR studies suggest that cost/complexity etc, might make larger SKA dishes more efficient and effective (telling us where to invest SKA $s, to meet or increase sensitivity, noting that max FOV & max survey speed may not be the prime drivers for the SKA, nor equivalent). The community needs to understand if survey speed is an absolute priority.

WP2.2 has assumed a single for the CoDR/SKA_1 PAF covering 0.6 – 1.5 GHz for SKA_1. This is not consistent with the SKA_1 baseline spec by itself. Therefore is might be more sensible to have two PAFs proposed to cover whole SKA_1 freq range (450 – 1000 MHz, 1000 – 2000 MHz); no OBSPFs? We could then do better than the baseline design (2.5:1 BW).

SKA frequency band definition

Can the SKA community define the SKA frequency bands (and prioritize science) e.g. 2-4, 4-8 GHz etc beyond SKA_1?

Lowest freq PAF band is the hardest to accommodate (physical size of elements); so band definition is important, i.e. 450 - 1100 MHz has relatively larger (compared to 1500 MHz PAF) elements, larger in size etc. In turn, all SKA dish designs need to be checked for what PAF size estimates have been used. Note that to date a 0.9 m diameter assumed at secondary focus for the TDP offset dish.

Highest freq PAFs would be smaller (i.e. about 0.5m diameter – this is a first estimate only).

SKA dish design must meet SKA2 expectations; we might need up to 8 feed slots on feed turntable – all potentially PAFs (and the higher freq ones would be cryo-cooled systems)?

SKA observing bandwidths

Need trade-off/study of cost of processed bandwidth for a PAF system – i.e. 500 MHz systems. Astronomers do not (or may not) need to do max/full bandwidth in one hit (e.g. 1 GHz instantaneous) - but they will take whatever they can get.

APERTIF, ASKAP and eVLA get to HI at z~0.2 for highest mass galaxies; this sets some of the spec for SKA1 to go beyond this. This then tells us that BW ~500 MHz is reasonable.

Survey speed is *the* metric (for surveys), not FOV.

Breakpoints are ~1100 MHz – SKA_1 must do below this well with large sensitivity as APERTIF, ASKAP, eVLA etc will do 1100 - 1420 well. Other breakpoint is ~500 MHz as even SKA_2 starts to struggle with sensitivity (and there are arguments to swap from dishes to AAs).

PAF Polarisation purity & DR

Stable and coincident polarization patterns should be aligned on the sky; and stable to attain SKA spec requirements.

10^7 DR is required for only one science case: early star-forming galaxies. The area of the sky to be mapped is only a few square degrees and can be selected in regions without strong sources nearby, making high DR easier to achieve. In general SKA imaging will be pipelined ("from telescope to archive"), not requiring human intervention, but this science project may require investigators to iteratively work with their data.

The DR for all other science projects is at least a factor of ten lower (10^6) and will be achieved post-calibration which will need a detailed model of the variable polarisation response on the sky. What we know is we need accurate calibration of the PAF itself and improve this via astronomical calibration. These techniques are to be optimized for wide-field observations and sensitivity. Good work is in progress at BYU (contribution from B Jeffs) and at ASTRON, to be complemented by ASKAP (when PAF results are available).

The ability to tailor beam shapes from PAFs offers flexibility to maximise sensitivity or polarisation performance. This is an option which is beyond SPFs.

At some level these options have already been demonstrated, e.g. at BYU; Tony Willis (DRAO – Gaussian beam shapes, SNR costs etc).

Field flatness, calibration

There are 2 effects

1. Beams have different sensitivity and vary in subtle ways over an observation.

2. Formation of beams across the PAF results in sensitivity ripple (20% or so in the case of ASKAP) across the single observation field; this can be addressed by mosaicing and interleaving (computing domain).

The best way to handle these effects is to be investigated, and is strongly related to the previous point.

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