



Noise measurements for the SKA

Neil Roddis

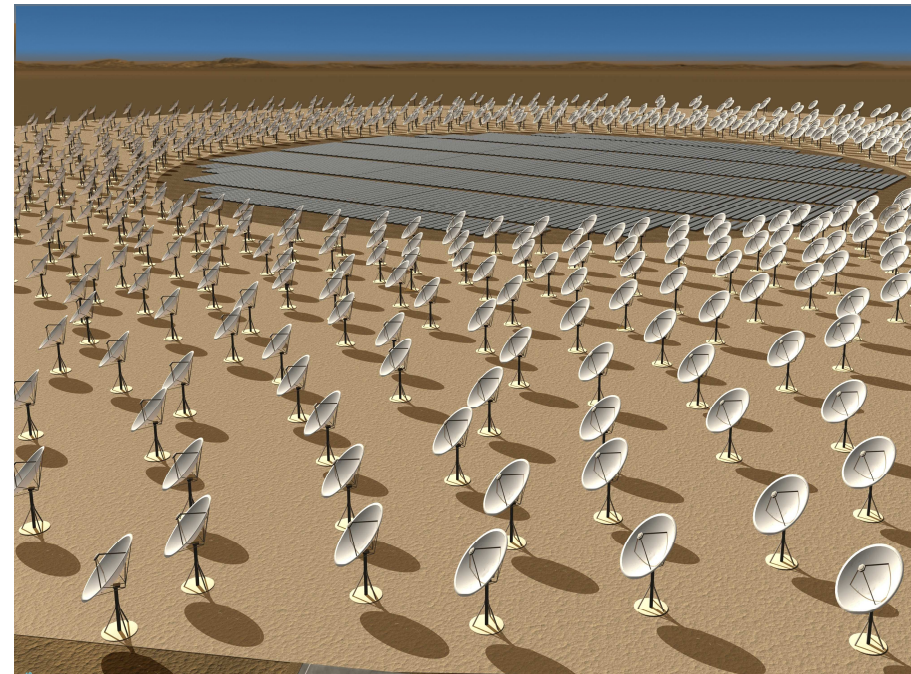
SKA Program Development Office



The Square Kilometre Array: An industrial scale radio telescope

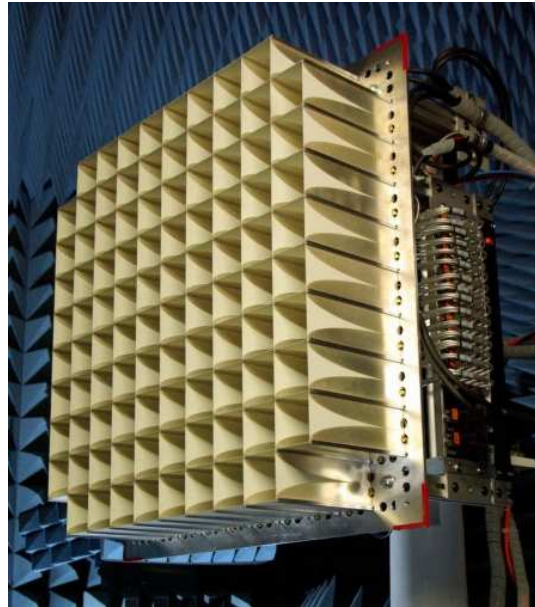
SPDO

- Thousands of 12 – 15 metre dishes
- Dense aperture arrays
- Sparse aperture arrays
- Extending over thousands of kilometres in Australia or Southern Africa
- Expected cost €1.5 bn
- Design driven by science requirements

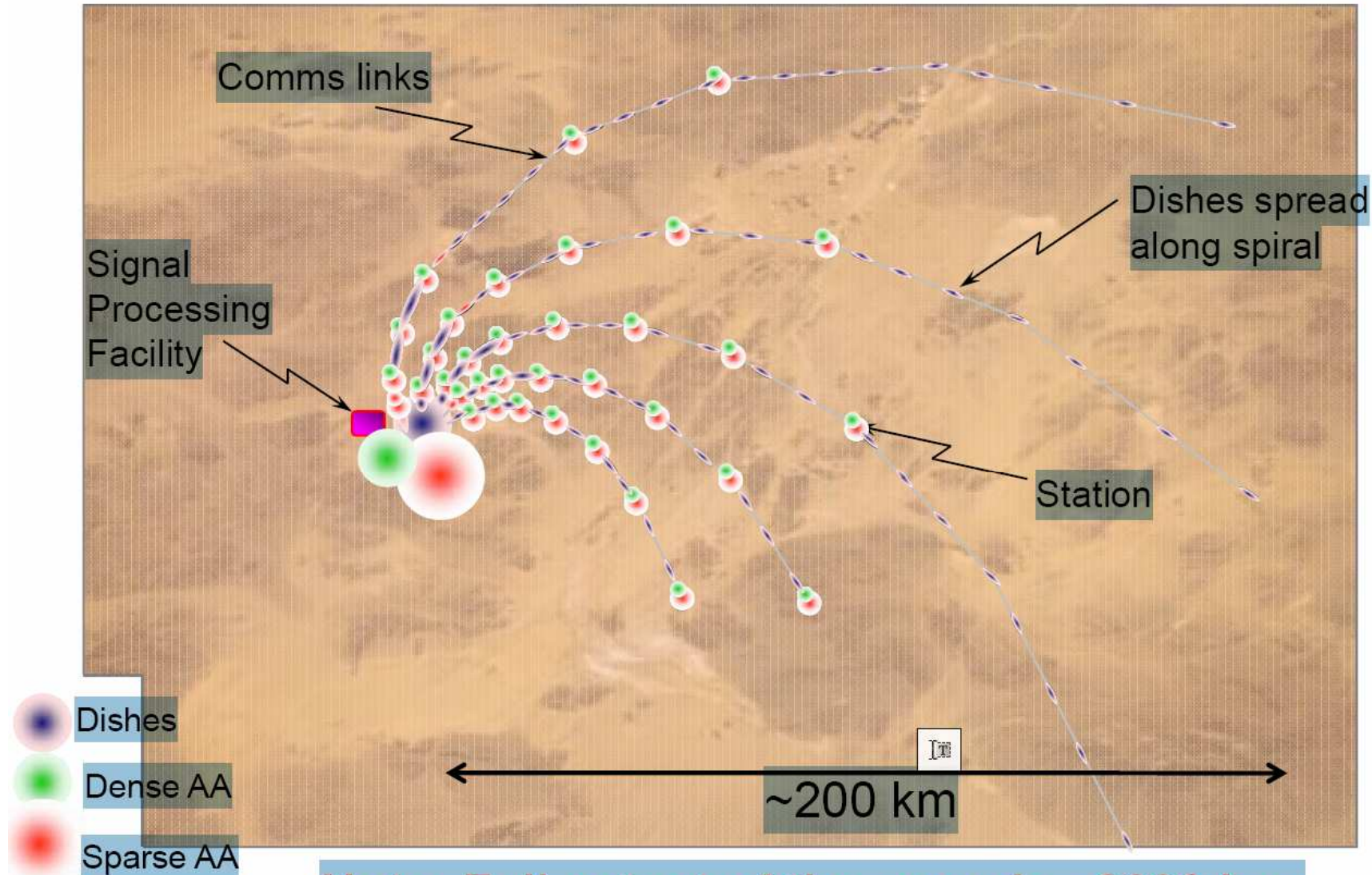


SKA Antenna Technology

SPDO



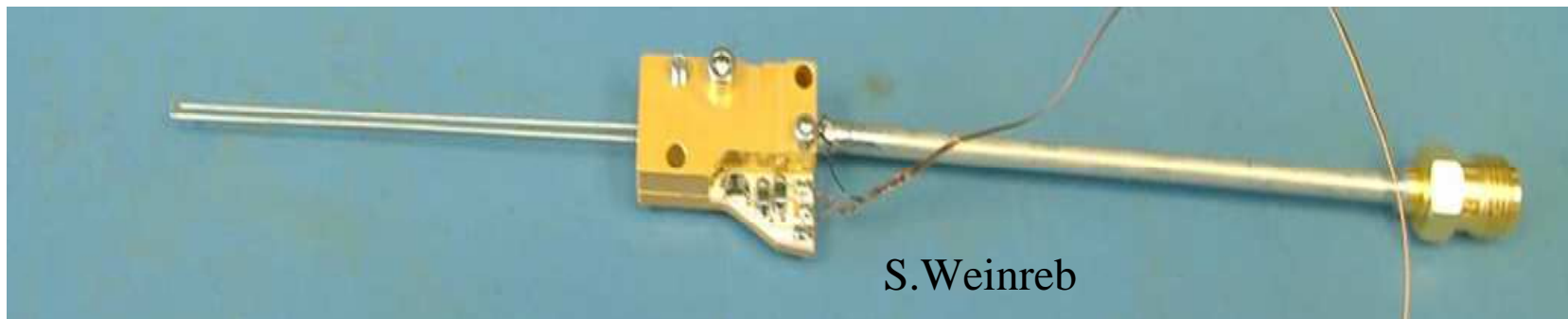
SKA Layout



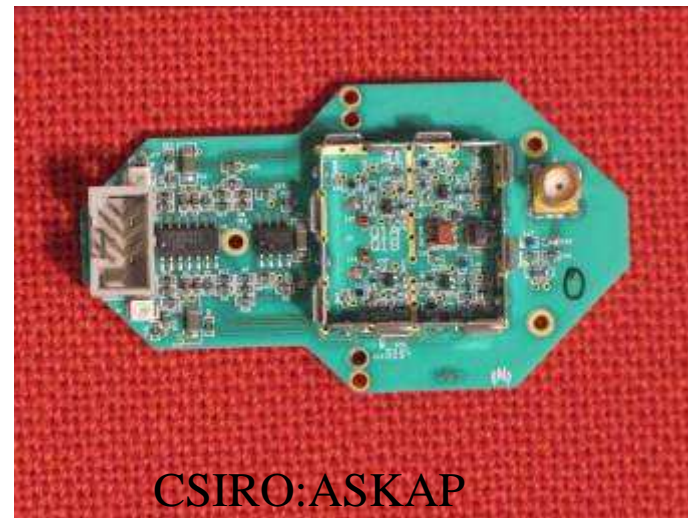
Note: Full extent of the array is ~3000 km.

LNAs for the SKA (1)

- Thousands of cryogenic LNAs for the dish antenna systems.
- Millions of room temperature LNAs for the Dense Aperture arrays.
- Thousands of room temperature LNAs for the sparse aperture arrays and phased array feeds (?).



- Cryogenic: differential 300 Ω and single-ended 50 Ω .
- Room temperature: differential 300 Ω and 100 – 150 Ω , single-ended 50 Ω and 100 Ω .
- Highly integrated LNAs will be essential for dense aperture arrays.



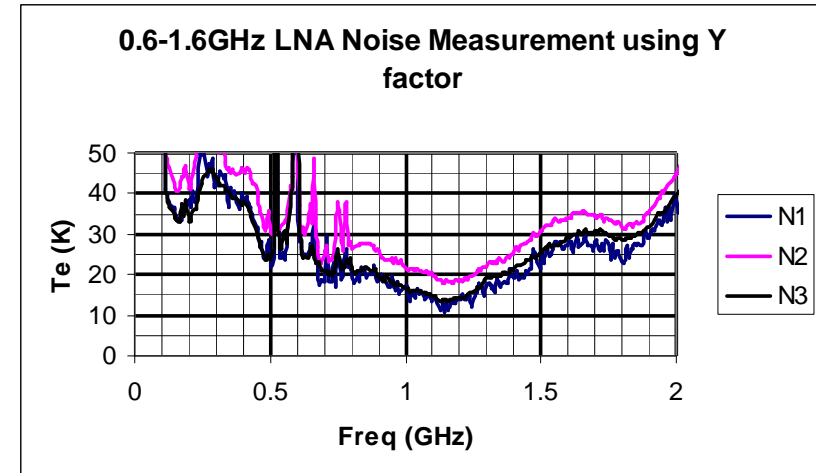


Do we need very low noise?

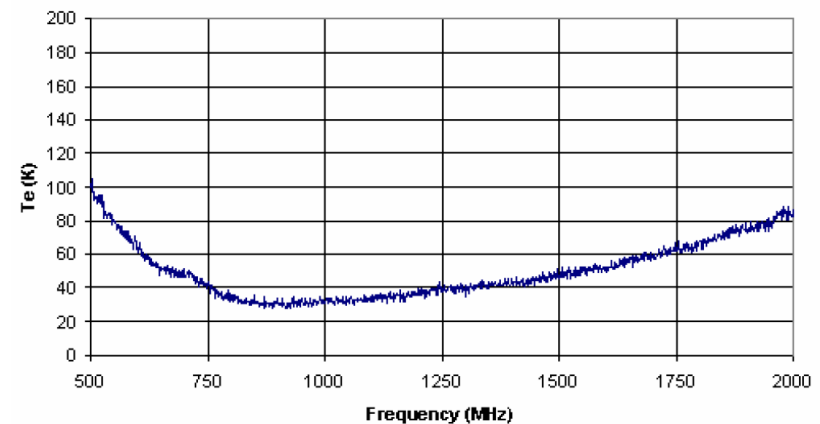
SPDO

- Major selling points for the SKA:
 - Large A_e/T_{sys}
 - High survey speed [proportional to $(A_e/T_{\text{sys}})^2$]
- For a given A_e/T_{sys} : cost proportional to T_{sys}
- For a given fixed cost: A_e/T_{sys} proportional to $1/T_{\text{sys}}$
- Conclusion:
 - WE NEED THE LOWEST NOISE WE CAN GET!

- Differential LNAs:
 - Room temp
 - Cryogenic
- Non 50 Ω
- Mass production:
 - Thousands (cryogenic)
 - Millions (room temp)

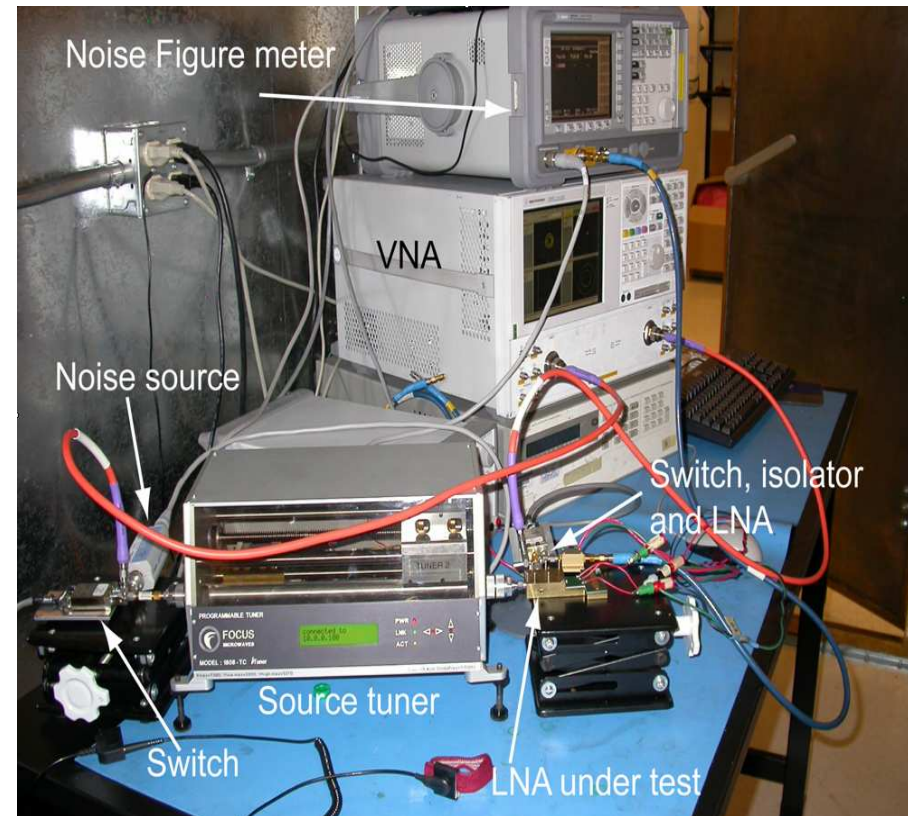


Gawande: CalTech



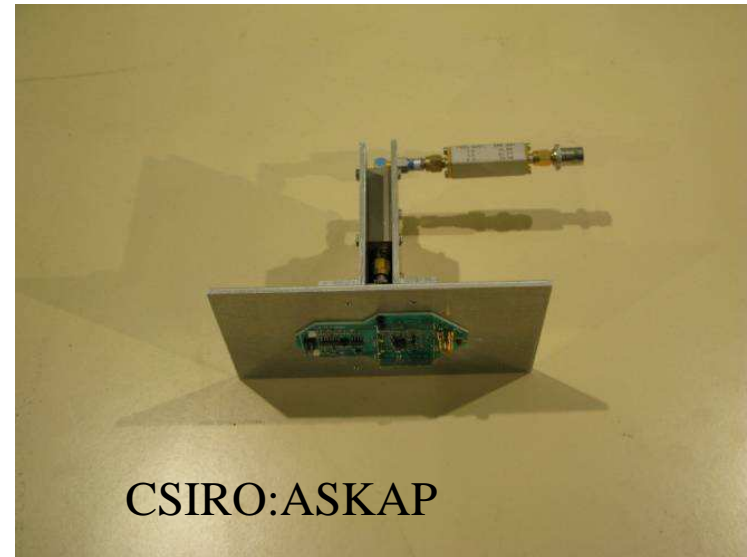
Shaw: CSIRO

- Very thorough test of prototypes and small-scale production runs
- Fully test samples throughout production: including cryogenic test



U. Calgary

- 100 % testing of LNAs including cryogenic LNAs for dish wide band feeds
- Automated test systems will be essential
- Trained semi-skilled personnel



Dense aperture array production testing

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- Build on the good work at ASTRON
- LNA test must be fully automatic
- Learn from the mobile phone manufacturers?



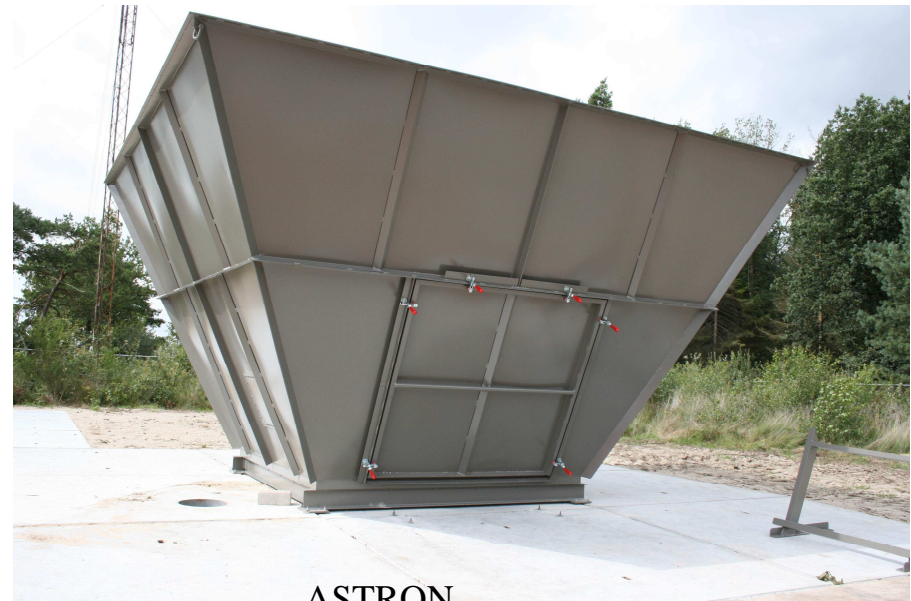
The Antenna/LNA interface is also critical

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- Losses must be minimized
- Impedance matching is also critical, especially for phased arrays
- We need to be able to measure the noise performance of the integrated antenna element(s) or feed with the LNA(s).



Weinreb CalTech



ASTRON

- The SKA is providing some interesting challenges in noise measurement:
 - Differential LNAs
 - Non-50 Ω LNAs
 - Automated measurements: cryogenic and room temperature
 - Mass production measurements
 - Integrated antenna/LNA noise measurement

