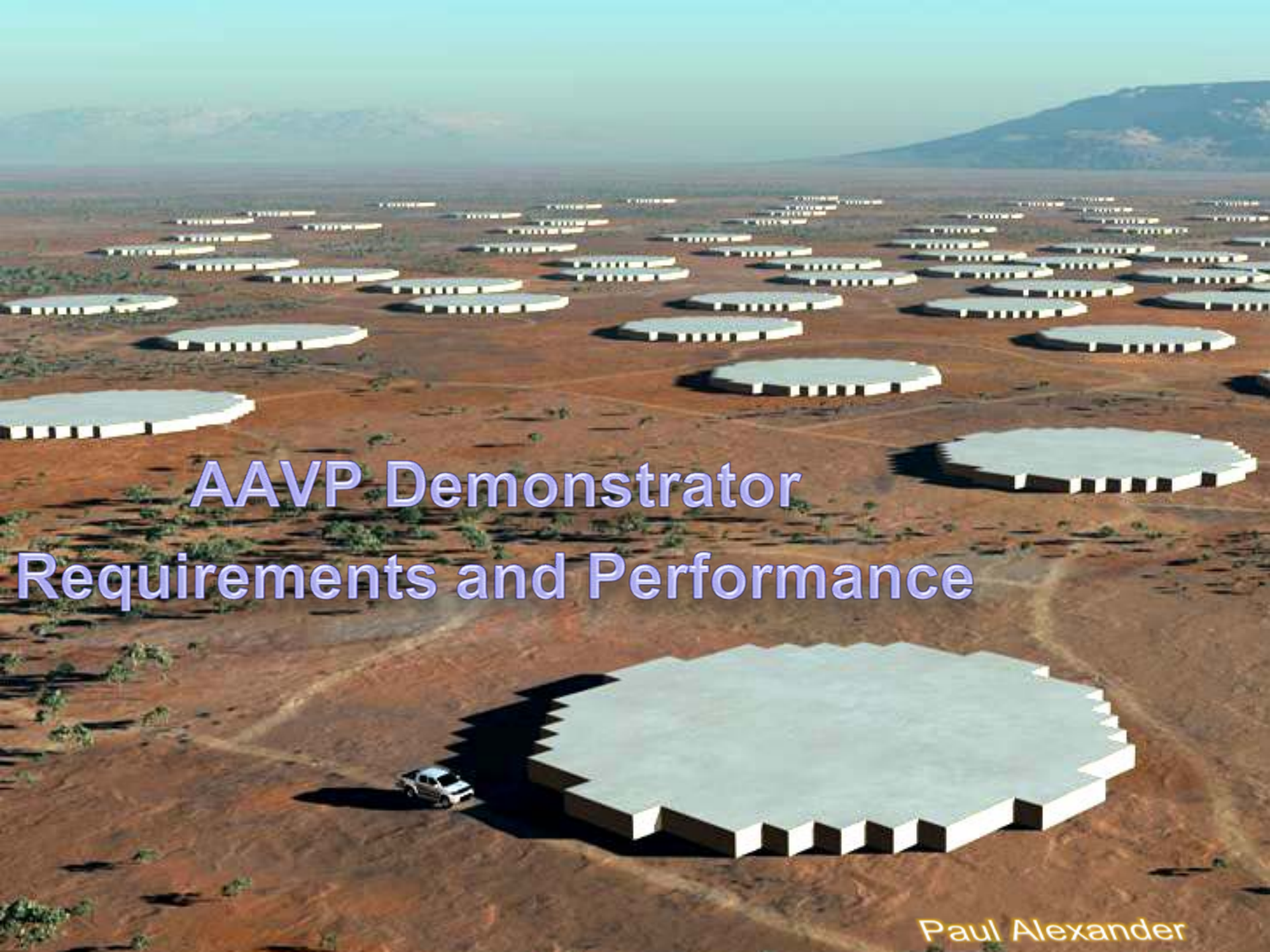

AAVP Demonstrator
Requirements and Performance
Paul Alexander

AAVP Demonstrator

- AAVP demonstrator is intrinsic part of the SKA Programme
  - Not selling AA's – developing AA programme as part of SKA
  - Programme must ensure we have all the information we need for the collectors CDR – end 2013
  - Need to consider AA demonstrator in relation to DVP

- Outcome – ***required by us as part of SKA project***

Will Aperture Arrays deployed in the SKA provide the performance at an appropriate cost to deliver science and technical requirements

Technology path

- Demonstrator must be at right point of technology path to SKA deployment
  - Test / demonstrate as much as possible of SKA deployable system
  - Retire as many technology risks as possible
  - System aspects most directly influencing calibration and stability should be SKA acceptable
    - *Can still improve but sub-systems are being tested against SKA performance requirement*
    - Antenna, LNA+Matching, RF beam former, data transmission to digitiser

Decision as to SKA readiness levels of each sub-system need to be made objectively by the project

Performance vs Capability

- Must not confuse performance with capability
  - Priority is to demonstrate performance of a dense AA as an astronomical system
  - Requirement is to achieve performance at least equivalent to a dish + feed
    - *See later for my definition*
- Capability
  - AA ability to provide flexibility, survey speed etc.
  - Capability is more limited by processing

Performance requirements

- Ability to calibrate at element level to achieve equivalent dish-based performance
  - Phase calibrated to $\lambda/20$; amplitude TBD by simulation
    - *Simulation needed to verify these requirements*
  - Independent demonstration of calibration achieved
    - *Holographic-like test of achieved calibration at element level*
  - Demonstrate system stability on timescales longer than element-level calibration duty cycle
  - Demonstrate dynamic appodisation during tracking
    - *Measured station beam and cross-power beams agree with simulation to agreed tolerance (c.f. DVP).*

Astronomical performance requirements

- Ability to calibrate at element level to achieve equivalent dish-based performance
  - Stations very comparable to DVP or Precursor dishes
  - Phase calibrated to $\lambda/20$; amplitude TBD by simulation
    - *Simulation needed to verify these requirements*
  - Independent demonstration of calibration achieved
    - *Holographic-like test of achieved calibration at element level*
  - Demonstrate system stability on timescales longer than element-level calibration duty cycle
  - Demonstrate dynamic appodisation during tracking in I, Q, U & V
    - *Measured station beam and cross-power beams agree with simulation to agreed tolerance (c.f. DVP).*

Astronomical performance requirements

- Band-pass calibration after beam forming
  - Beam former maintains spectral dynamic range – inject narrow band signal
- Achievable sensitivity
  - Sensitivity on development path to SKA
    - $T_{sys} < 50K$
  - Deploy astronomically capable instrument
    - *$A \sim 1000\text{-}2000\ m^2$ $A/T = 40\ m^2/K$ (20% MeerKAT)*
- Imaging instrument in I,Q,U and V
  - Deploy as interferometer with adequate imaging capability:
    - *15 13-m stations*
    - *Sensitivity ~ 42 μJy/beam in 1 hr integration 500 MHz BW*

Astronomical performance requirements

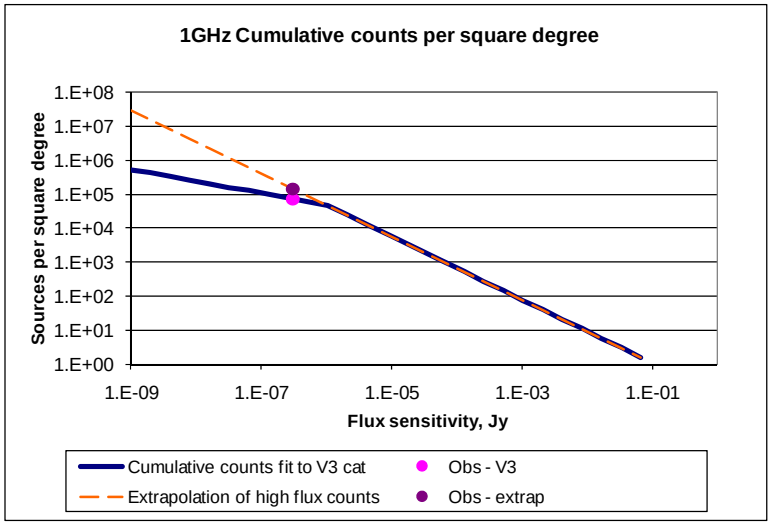
- Low systematics
  - Integrate on a (near blank) field for N hrs to achieve $\sigma \propto N^{1/2}$
    - *N ~ 25 – 100 at least* $\sigma = 42 / N^{1/2}$ μJy/beam
- Dynamic range
  - Demonstrate dynamic range of X (> 10^5)
    - $\sigma = S_{max} / X$ μJy/beam
- Low cross-talk between beam-formed and PBs
  - One beam on blank field, one on bright source
  - Synthesize blank field

Instrument requirements

- To achieve an instrument noise of σ on the sky must avoid confusion
- N(>S) ~ (100mJy / S)
  - Have one 100 mJy source per sq degree

$$\frac{(3600)^2}{n_b \theta_b^{\,2}} \geq \left(\frac{\sigma}{100mJy}\right)^{-1}$$

- Taking $n_b = 32$
  - $\theta_b = 630\ (\sigma/100\text{mJy})^{1/2}$



- 24 hr integration
- 10^5 dynamic range field of 1Jy source

θ_b = 6.5 arcsec
baseline ~ 10 km

Capability

- All astronomical performance demonstrated with 1 or 2 beams
  - Potentially also narrow band except for band-pass stability
- Capability demonstration good, but less crucial
  - Demonstrate potential – road mapping to show SKA capability
- Capability demonstration
  - Many independent beams, wide FoV
  - Frequency / beam tradeoffs
  - ...

Conclusions

- Demonstrator has to meet performance requirements on path to SKA
  - Critical input to the collectors CDR
  - Performance demonstration must equal (at least) equivalent dish-based system
  - Also demonstrate capability
  - Critical sub-systems for calibratability must be close to SKA ready
  - The performance tests define what we need to build ....