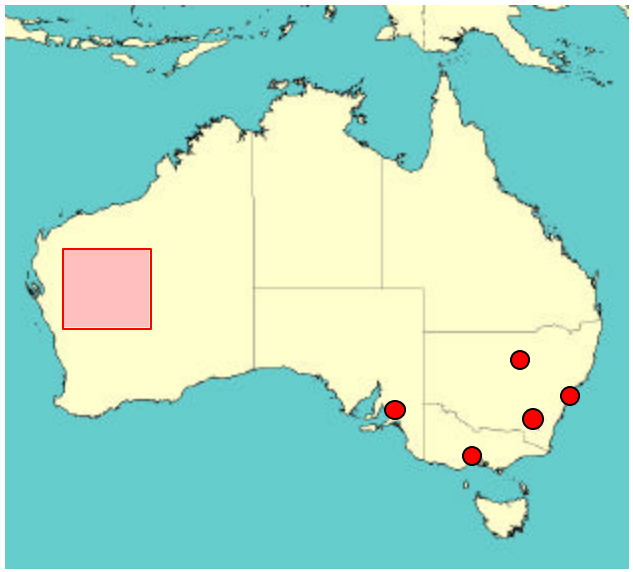
Australian SKA – Progress & Directions



Peter Hall

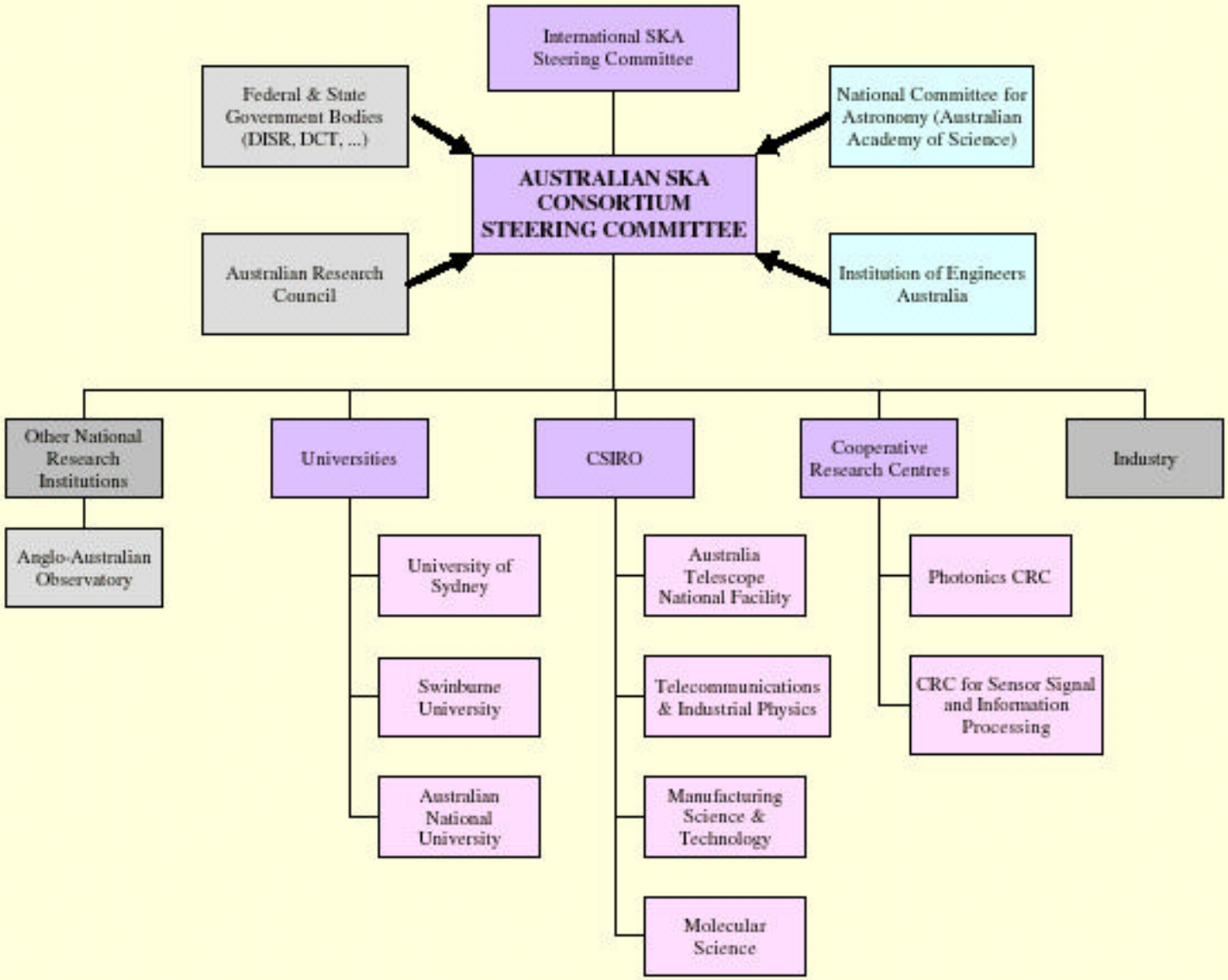
Berkeley, July 2001

http://www.atnf.csiro.au/SKA

Australian SKA – Year At A Glance

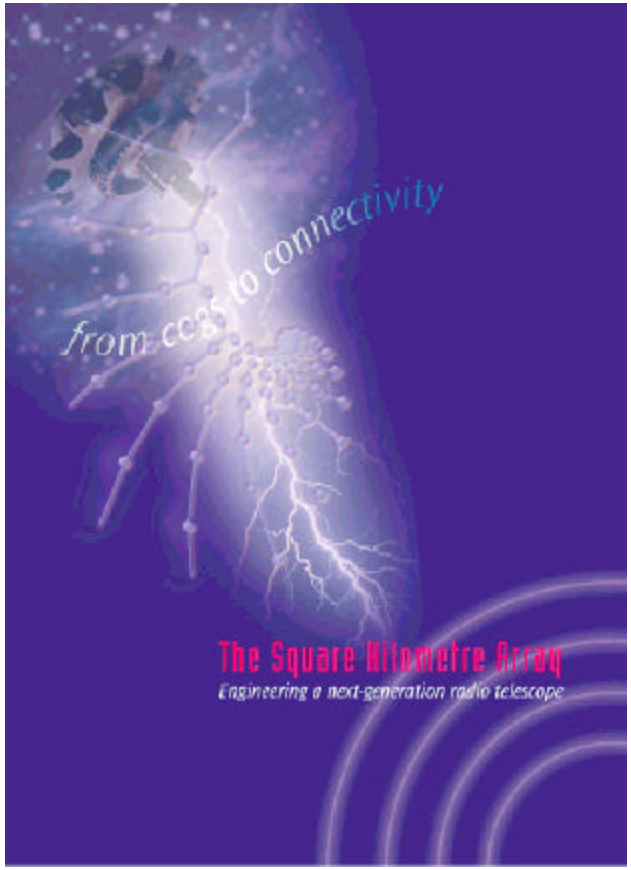
- **Formation of Australian SKA Consortium**
  - Executive Committee, Science & Engineering Working Groups now functional
  - First symposium held Feb. 2001
- **Major National Research Facilities (MNRF) bid**
  - Submitted May 2001; outcome known August 2001
  - Contained proposals for 2 major SKA demonstrators
- **Technical Work**
  - Significant results in antenna and interference mitigation projects
- **Site Survey**
  - First field work completed in Western Australia
- **Collaborations**
  - Industry and international SKA joint work increasing
- **Outreach**
  - Professional and community

Australian SKA Involvement

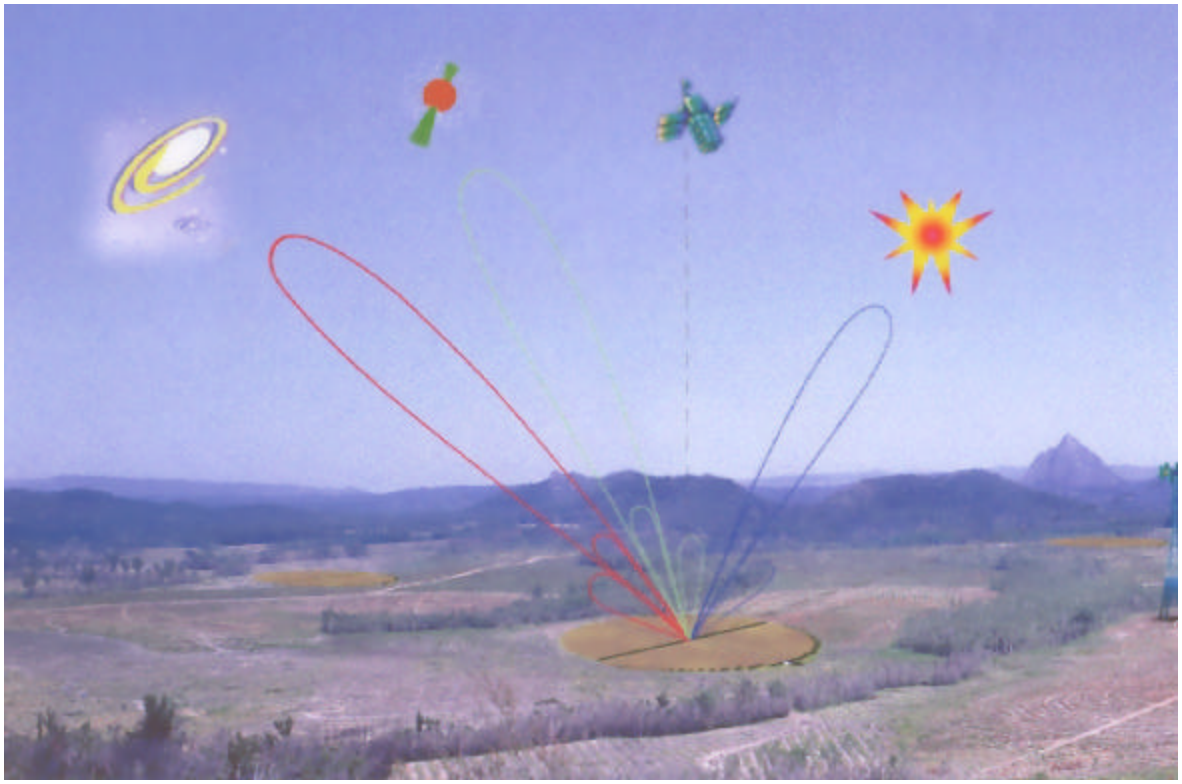


SKA Outreach

- **Professional**
  - Institution of Engineers national congress
  - ‘Engineering World’ article
  - ITEE Society mailout
  - Spectrum management & community issues
    - » Introducing Radio Quiet Zone concept
- **Government**
  - Federal parliamentary briefing
  - South Australian Govt. briefing
  - Continuing Western Australian interaction
  - Emerging New South Wales interest
- **General**
  - Radio, TV, print material
    - » Site tests
    - » Prototype Luneburg Lens
  - Local & indigenous community contact



Australian SKA: Some Pictorial Philosophy



Widely separated multi-beaming
Wide field-of-view
Active interference mitigation
Broadband

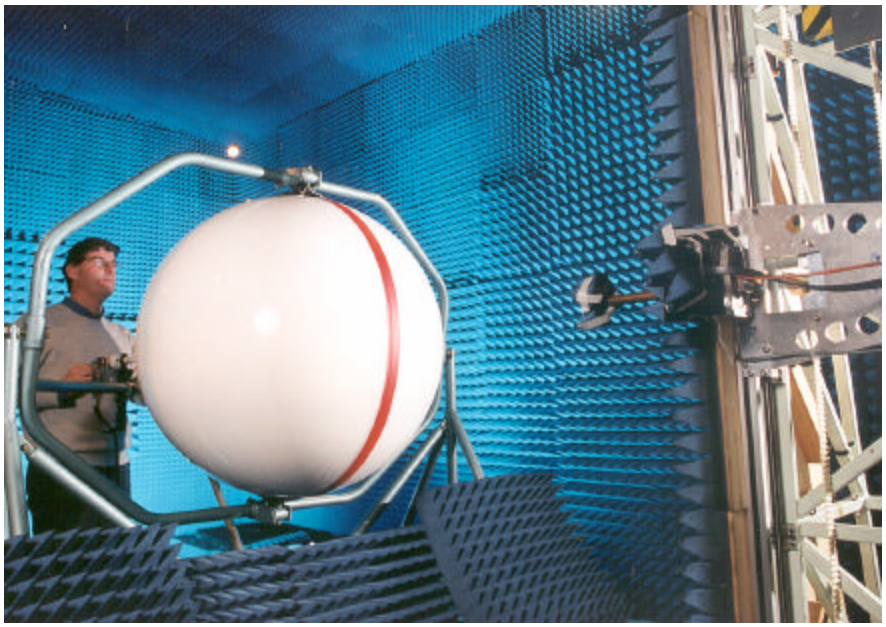
CSIRO SKA Program – Highlights

- **Antennas**
  - Luneburg Lens EM design & analysis – encouraging first results
  - Russian prototype Luneburg Lens
  - Materials science: Artificial dielectrics & manufacturing
    - » Powders and wires
  - Phased array collaboration (ASTRON, industry….)
- **Site tests & data visualization**
  - Initial Western Australia field work
  - Characterize sites AND contribute to international site selection process
- **Interference mitigation**
  - Strengths in post-correlation IM
  - Extending to simultaneous multiple satellite sources (IRIDIUM, GLONASS)
  - ATCA operational IM goals

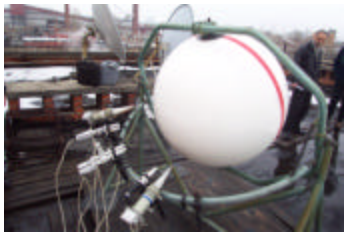
N → Poster N & coffee

Luneburg Lenses for SKA

Konkur Luneburg Lens



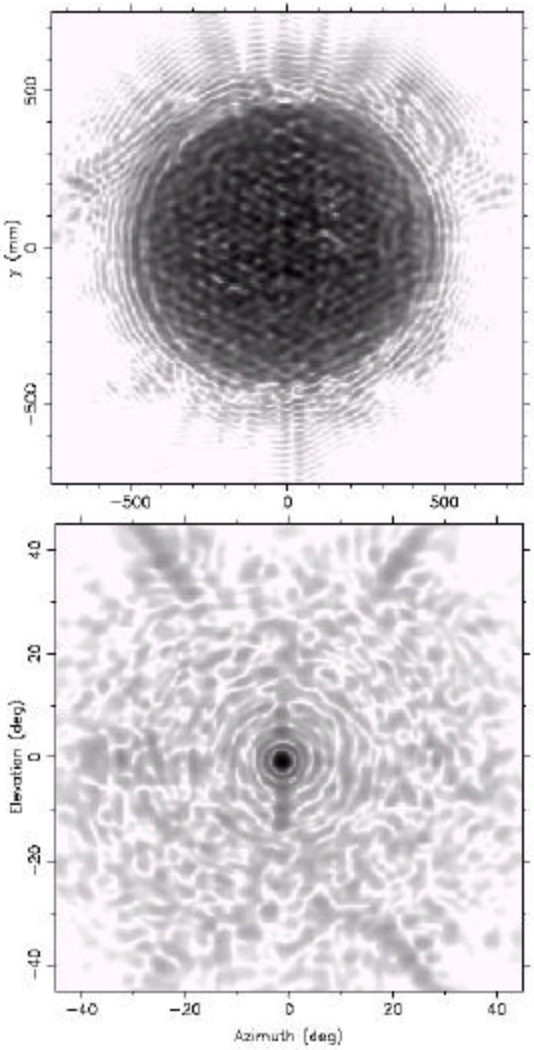
- Obtained with PRAO collaboration
- Two initial uses:
  - Verify EM design & analysis
  - Int Mit reference antenna
- Currently under test by CSIRO



(Patented construction process)

Diameter	2r = 0.9 m
Operating frequency range	To 12 GHz
Gain (12 GHz)	39 ± 0.5 dB
Aperture efficiency	> 50%
Sidelobe level (standard horn feed)	< -17 dB
Focal distance	1.5r
Mass	90 kg
Operating temperature range	-50 to +50 °C

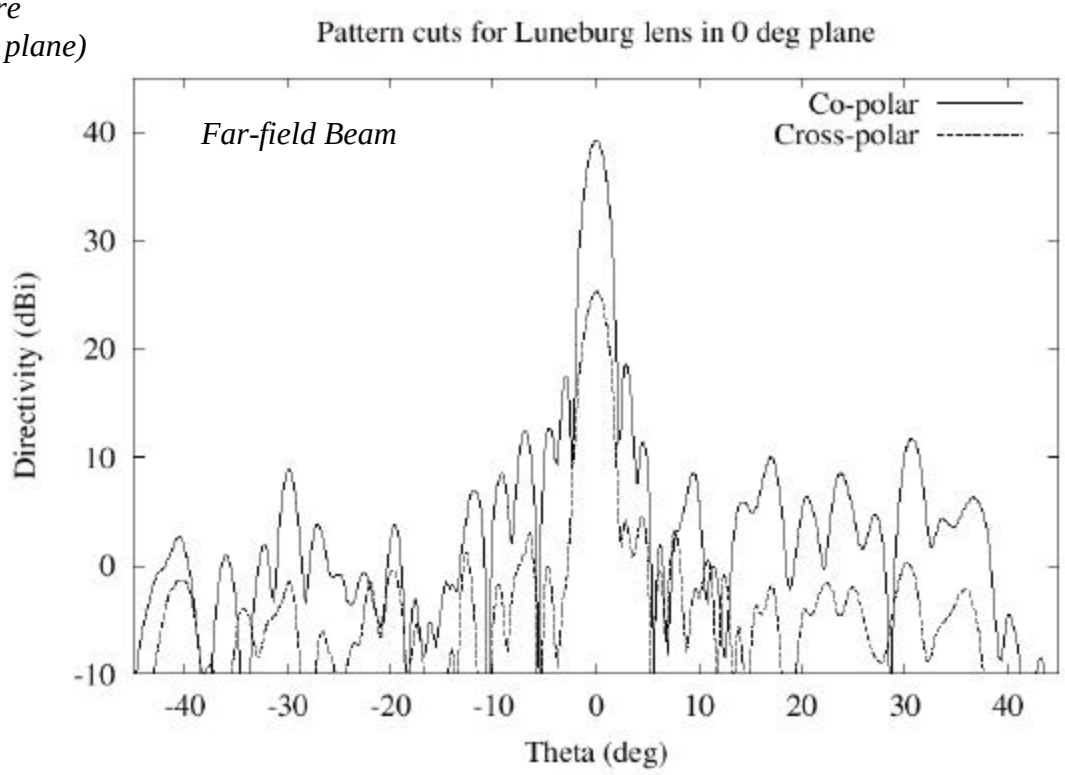
Konkur Lens: First Results



Amplitude (Ref centre meridian plane)

2D Beam (Co-polar)

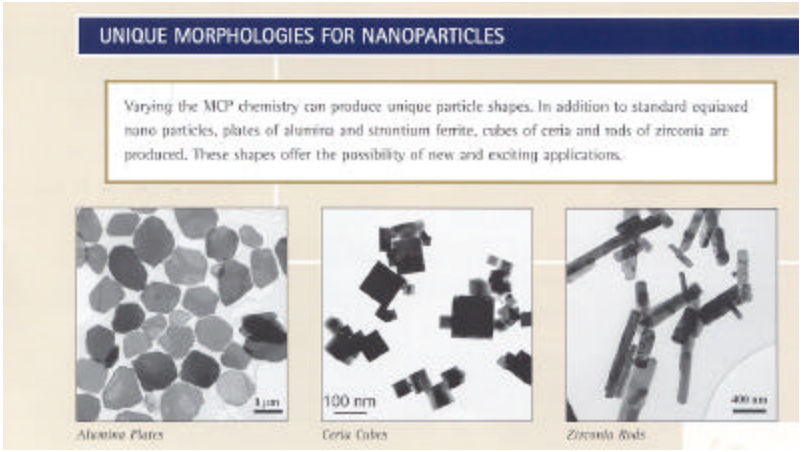
12 GHz Tests; TV Feed

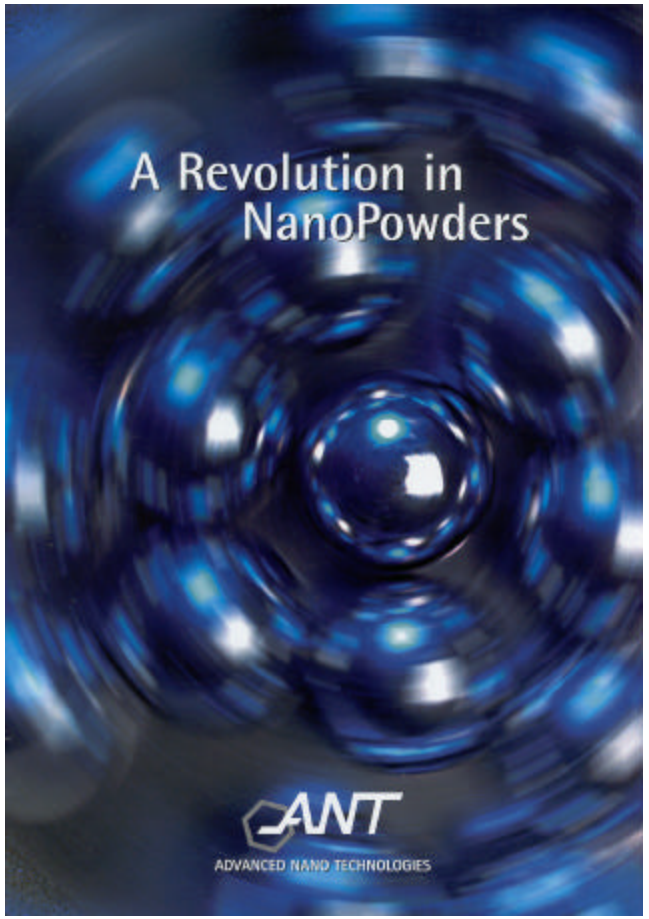


Directivity ~ 39.3 dBi
Raw aperture eff ~ 67%
- with 0.5 dB dielectric loss ~ 57%

Industry Link: Advanced Nano Technologies

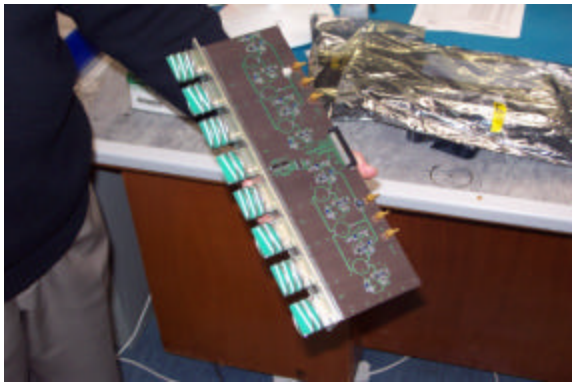
- Collaboration between Advanced Powder Technology (Aust) and Samsung Corning (Korea)
- Make particles smaller than thickness of DNA string
- Unique chemical, mechanical, optical, magnetic properties
- Great potential in artificial dielectrics

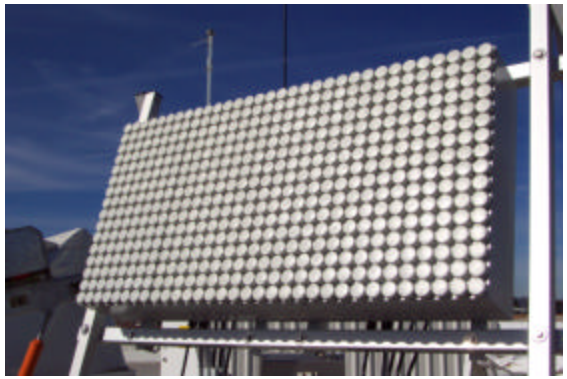




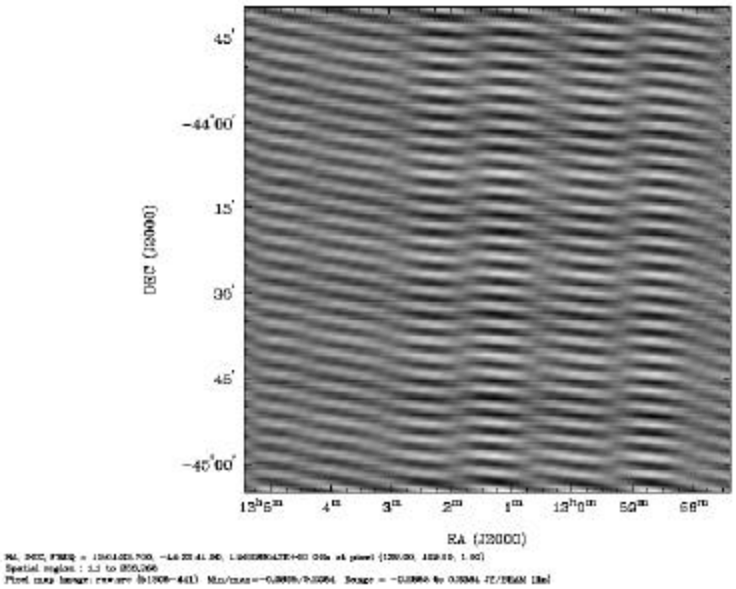
Industry Link: CEA Technologies

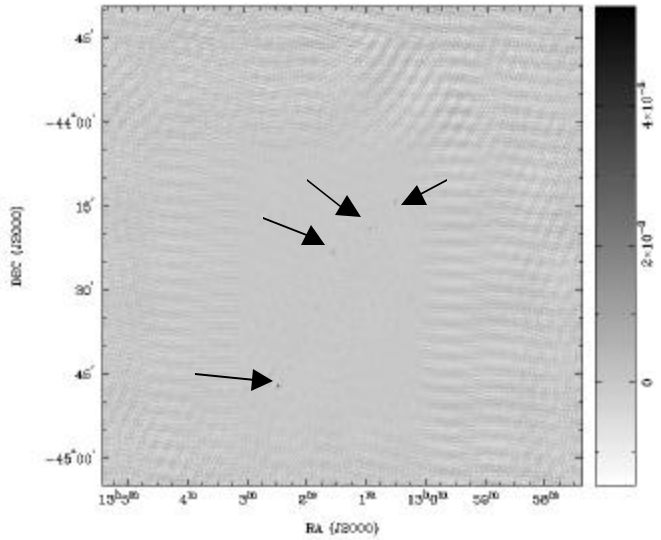
- Canberra based
- 150 employees, $20M turnover
- Modular S and X-band radars sold internationally
- Interested in becoming involved in SKA prototyping





Practical Interference Mitigation





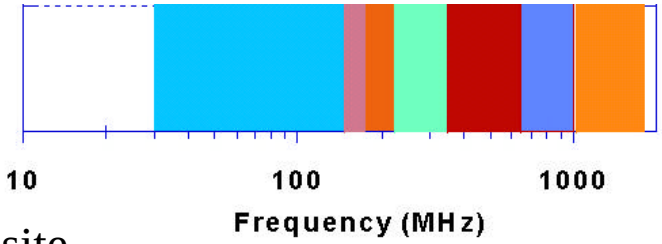
Before After

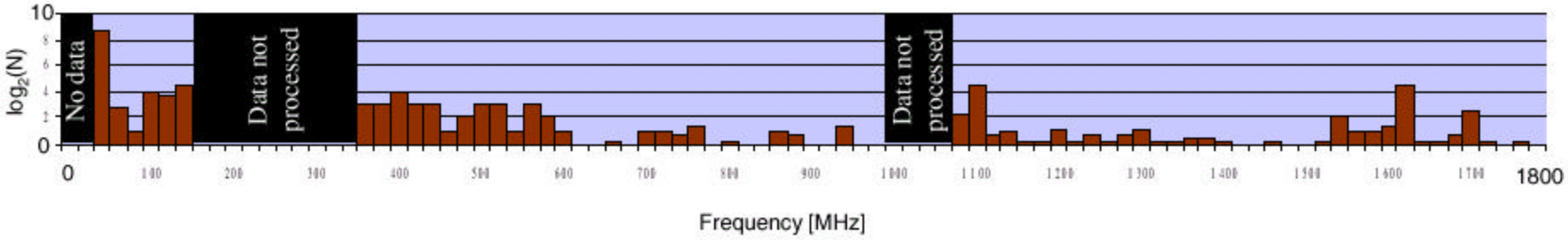
ATCA, 1500 MHz, Terrestrial Data Link Interference

Post-Correlation Interference Mitigation

Site Tests – First WA RFI Survey

- CSIRO & WA Govt
  - -Private contractor
- 27 March – 17 April 2001
- "First look" study
  - -Representative RFI at one site
  - -Highlight practical challenges
  - -Compare with spectrum database
- Analysis continuing – reports this week

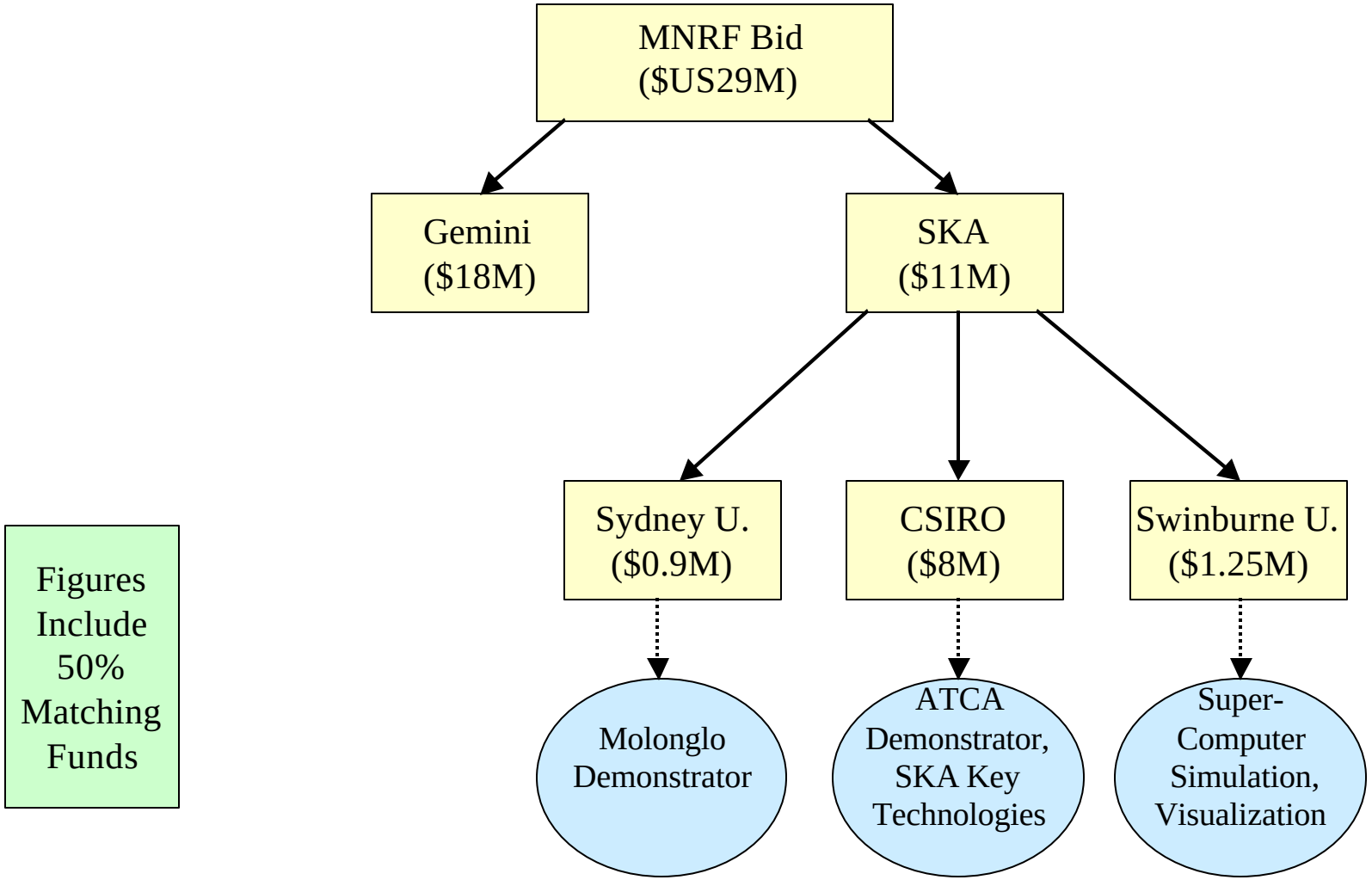




Australian SKA Demonstrators

- **Explore new territory**
  - Concentrators, signal processing….
- **Money amounts are small (~ $US 10M)**
  - Careful selection of concepts
    - » Best short-term astronomy ≠ best SKA demo
- **Cover “big” and “smart”**
  - Address hard radio science issues AND
  - Focus on scaling and cost issues relevant to SKA
- **Integrate with existing telescopes**
  - Extends host’s capabilities
  - Allows detailed assessment of concept
- **Contribute to 2005 concept assessment**

MNRF Bid – The Money Trail



SKA Demonstrators: What We Propose

- **AT Compact Array demonstrator** *($US 6M)*
  - New 2 GHz F/X correlator
    - » Main short-term "astronomical" deliverable
    - » Complements recent mm-wave ATCA upgrade
  - 2 x mini SKA stations
    - » Final number and form TBD
      - Lenses or phased arrays prime contenders
  - 4 m Luneburg Lens
    - » Multi-beaming IM reference antenna using AD

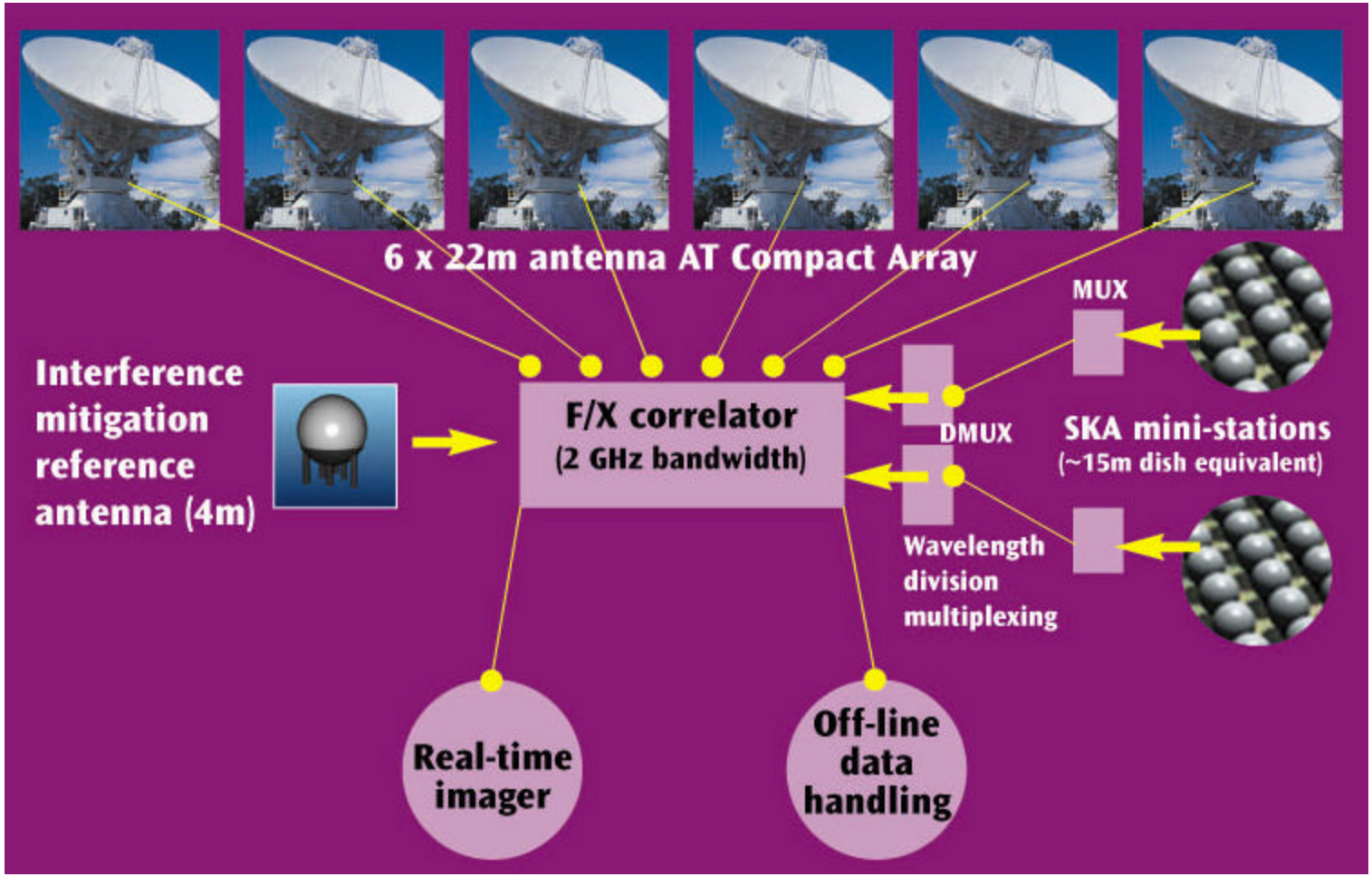
} **"Smart"**

- **Molonglo cylindrical reflector demonstrator** *($US 0.9M)*
  - Multibeaming and advanced DSP

} **"Big"**

- **SKA enabling technology** (*$US 1.5M*)
  - Active focal plane/surface arrays, highly-integrated receivers
- **System simulations & software correlators** *($US 1.25M*)

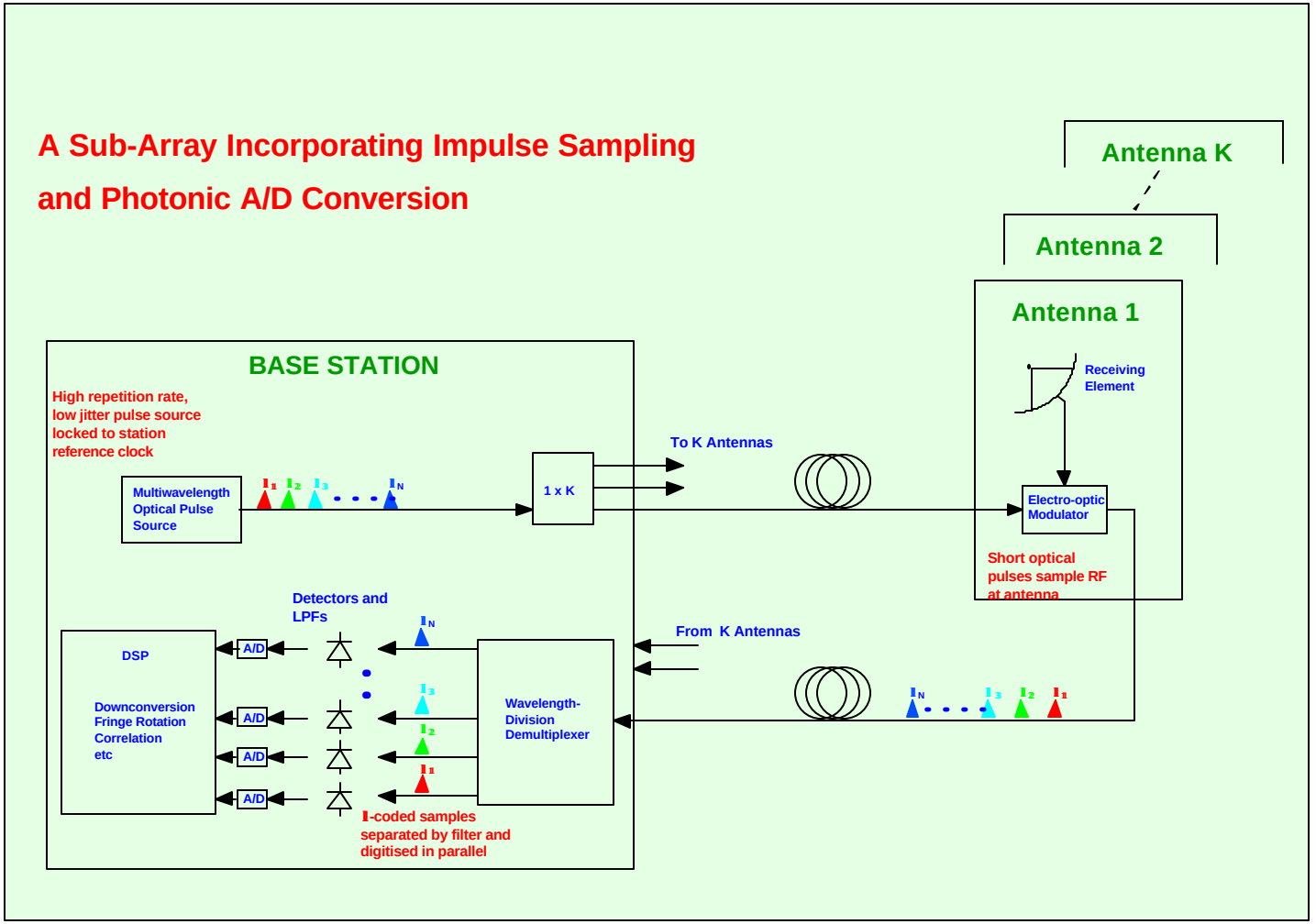
ATCA Demonstrator



ATCA Demonstrator – Design Decisions

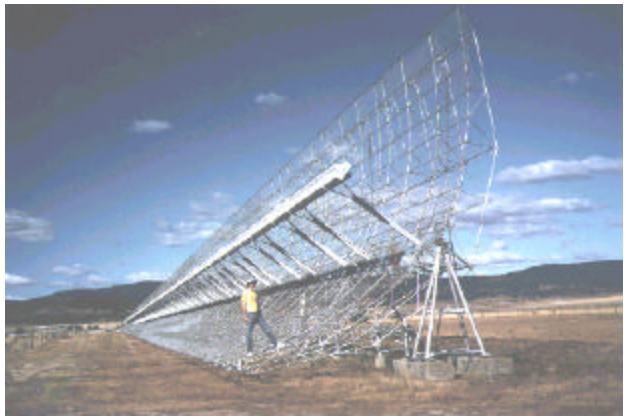
- **Form of station**
  - Concentrator (lens) vs phased array
- **Number & layout of stations**
  - Balance ATCA gains vs breadth of SKA demonstrator
    - » Calibration issues crucial (min size, ability to adequately test homogeneous elements….)
      - Potentially powerful ‘holography’ modes
- **Nature of interconnection**
  - Fibre interconnect – analog or digital?
  - DWDM demonstrator
- **RF issues**
  - Should demonstrate highly integrated receiving systems
  - New photonic sampling scheme

Photonic PAM System



Molonglo Demonstrator

- **18,000 sq m cylindrical paraboloid**
- **Currently:**
  - 843 MHz operation
  - Analog beamforming
- **Proposed:**
  - 300-1420 MHz coverage
  - Multi-beam line feeds
  - Digital beam formation
  - Versatile FX correlator
- **New observing modes, new science**



Australian SKA Directions

- **Demonstrator design & construction**
  - Selection of demonstrator concepts by Dec 2002
- **More site studies work**
  - Extension to other states
- **More R&D in additional key technical areas**
  - Phased array concept
  - Highly-integrated RF systems
  - Photonics
    - » Transport, connectivity, RFI filtering
    - » High speed analog – digital conversion
  - Configurations and system simulation…need to un-stall
- **Engagement of wider astronomy community**
  - e.g. making the Gemini link real
- **Expansion of industry and international SKA links**
  - Artificial dielectrics → prototype Luneburg Lenses
  - Phased array prototypes, integrated receivers, signal processing…