CASS = ATNF
ASKAP Overview

• **ASKAP is a scientific and technical precursor**
  - HI and continuum science – Science Survey Teams
  - Science instrument on a candidate site
    - operations/infrastructure/rfi-quiet/energy/…
  - Phased array feeds – wide-field-of-view techniques
  - Antenna systems
  - Digital systems
  - Data and signal transport
  - Computing platforms and algorithms (heavily coupled)
  - Calibration and imaging

• **First light on deployed antenna**
• **CDR of all systems – ASKAP design is complete**
• **International collaboration to improve PAF performance**
• **BETA late this year**
• **Pawsey HPC Centre for SKA Science**
• **National Broadband Network (NBN)**
# ASKAP Design Goals

## High-dynamic range, wide field-of-view imaging

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of dishes</td>
<td>36 (3-axis)</td>
</tr>
<tr>
<td>Dish diameter</td>
<td>12 m</td>
</tr>
<tr>
<td>Max baseline</td>
<td>6km</td>
</tr>
<tr>
<td>Resolution</td>
<td>30″</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>65 m²/K</td>
</tr>
<tr>
<td>Speed</td>
<td>$1.3 \times 10^5$ m⁴/K²·deg²</td>
</tr>
<tr>
<td>Observing frequency</td>
<td>700 – 1800 MHz</td>
</tr>
<tr>
<td>Field of View</td>
<td>30 deg²</td>
</tr>
<tr>
<td>Processed Bandwidth</td>
<td>300 MHz</td>
</tr>
<tr>
<td>Channels</td>
<td>16k</td>
</tr>
<tr>
<td>Focal Plane Phased Array</td>
<td>188 elements</td>
</tr>
</tbody>
</table>

Murchison Radio Observatory (MRO) and other projects (MWA, EDGES, +)
ASKAP System and Data Flow

MRO

Geraldton

Perth

Anywhere

Control Building

MRO Support Facility

NBN

ASDAF

Nat'l SKA Science Centre

SKA University
Integrated Project Teams (IPT)

- Project Management
- Industry Engagement
- Antennas
- Analog Systems
- Digital Systems
- Data and Signal Transport
- Computing
- Science and User Policy
- Murchison Radio-astronomy Observatory
- MRO Energy
- MRO Support Facility
- ASKAP Processing Facility
- Support of Other Projects
- SKA WP2
- SKA RFI Monitor
- SKA WP3
- Single digital backend

~70 FTE

Technical

Infrastructure

SKA
Survey Science Projects

- **What are they?**
  - Large (>1500hrs) and coherent science projects that utilise ASKAP’s wide field-of-view and fast survey speed to enable major science outcomes early in its lifetime.

- **Who has access to the data?**
  - All data and data products produced by the Survey Science Projects (subject to storage capacity) will be made publicly available to the ASKAP Science Archive, on a timescale determined by operational issues (e.g. quality control) and not proprietalor interests.

- **How much time will they take?**
  - During the first five years of science operations, up to 75% of observing time will be available.

- **How were they chosen?**
  - Through a proposal process with surveys selected by competitive peer review.
  - Survey Teams must provide clear statements on data release
  - Project ranking took into account the intention of teams to provide value added data products into the Archive and the timeline for so doing.
• Large & coherent projects that utilise ASKAP’s wide field of view and fast survey speed to enable major scientific outcomes

• Ten SSPs were chosen, 363 unique authors, 131 institutions.
  • 33 per cent Australia and New Zealand,
  • 30 per cent North America,
  • 28 per cent Europe,
  • 9 per cent rest of world

• Three rankings:
  • A : ATNF will provide full support to these SSPs.
  • A- : ATNF will make all reasonable efforts to support these SSPs.
  • Strategic Priority: ATNF will work to ensure that capabilities defined by these SSPs are enabled to the extent possible.
ASKAP SSPs

- **WALLABY (Koribalski/Staveley-Smith)** All sky HI survey to $z \sim 0.2$
- **EMU (Norris)** All sky continuum to 10 uJy rms

- **GASKAP (Dickey)** Galactic and Magellanic HI and OH
- **VAST (Murphy/Chatterjee)** Transients and variables (>5 sec)
- **CRAFT (Dodson/Macquart)** Fast transients (<5 sec)
- **FLASH (Sadler)** HI absorption to $z \sim 1$
- **POSSUM (Gaensler/Landecker/Taylor)** Polarization / RM grid
- **DINGO (Meyer)** Deep HI emission survey

- **COAST (Stairs)** Pulsar timing and searching
- **VLBI (Tingay)** ASKAP as part of the LBA
# Survey Science Projects

<table>
<thead>
<tr>
<th>Rank</th>
<th>Type</th>
<th>Frequency (MHz)</th>
<th>Θ (°)</th>
<th>δ (deg) range</th>
<th>T(_{\text{pointing}}) (hrs)</th>
<th>T(_{\text{total}}) (hrs)</th>
<th>δ(_{\text{u}}) (kHz)</th>
<th>n(_{\text{chan}})</th>
<th>Stokes</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A)</td>
<td>WALLABY</td>
<td>1130-1430</td>
<td>30</td>
<td>-90 to +30</td>
<td>8</td>
<td>9600</td>
<td>18</td>
<td>16384</td>
<td>I</td>
</tr>
<tr>
<td>(A)</td>
<td>EMU</td>
<td>1100-1400</td>
<td>10</td>
<td>-90 to +30</td>
<td>~12</td>
<td>15000</td>
<td>1000</td>
<td>256</td>
<td>I</td>
</tr>
<tr>
<td>(A-)</td>
<td>FLASH</td>
<td>700 - 1000</td>
<td>30</td>
<td>-90 to +10</td>
<td>2</td>
<td>1700</td>
<td>18</td>
<td>16384</td>
<td>I</td>
</tr>
<tr>
<td>(A-)</td>
<td>VAST</td>
<td>1150 -1450</td>
<td>10</td>
<td>various</td>
<td>0.01-1</td>
<td>4290 (50%)</td>
<td>10000</td>
<td>30</td>
<td>I,Q,U,V</td>
</tr>
<tr>
<td>(A-)</td>
<td>GASKAP</td>
<td>1393-1693</td>
<td>30,60, 90,180</td>
<td>Low latitude &amp; Magellanic</td>
<td>various</td>
<td>6000</td>
<td>1.1*</td>
<td>15384</td>
<td>I</td>
</tr>
<tr>
<td>(A-)</td>
<td>DINGO</td>
<td>1100-1400 990-1290</td>
<td>30</td>
<td>0 or -33</td>
<td>500-2500</td>
<td>7500</td>
<td>18</td>
<td>16384</td>
<td>I</td>
</tr>
<tr>
<td>(A-)</td>
<td>POSSUM</td>
<td>1200-1500</td>
<td>18</td>
<td>-90 to +30</td>
<td>10</td>
<td>5500 (50%)</td>
<td>1000</td>
<td>300</td>
<td>I,Q,U,V</td>
</tr>
<tr>
<td>(A-)</td>
<td>CRAFT</td>
<td>any</td>
<td>any</td>
<td>any</td>
<td>0</td>
<td>0</td>
<td>18-1000</td>
<td>n/a</td>
<td>I,Q,U,V</td>
</tr>
<tr>
<td>SP</td>
<td>VLBI</td>
<td>1350 -1700</td>
<td>4 TAB</td>
<td>-90 to +30</td>
<td>~12</td>
<td>1500</td>
<td>baseband</td>
<td>256</td>
<td>I, Q, U, V</td>
</tr>
<tr>
<td>SP</td>
<td>COAST</td>
<td>1150 1450 700 - 1000</td>
<td>20-30 TAB</td>
<td>-90 to +30</td>
<td>~1hr -1hr</td>
<td>2250</td>
<td>3000</td>
<td>baseband 0.5kHz</td>
<td>I, Q, U, V</td>
</tr>
</tbody>
</table>
Science Imaging Modes

• **Continuum & Polarisation**
  - 300 MHz, full stokes, 1MHz channels, DR $10^5$, 1400MHz, 5 sec, 10”, 30 deg$^2$, clean/image the whole sky
  - Spectral sidelobes <20dB, poln purity (post-calib) < 25dB

• **Spectral Line (basic)**
  - BW 300 MHz, 18 kHz channels, 30 deg$^2$ at 700-1450MHz, image the whole sky, postage stamps of interesting regions

• **Spectral Line (zoom)**
  - Tuned to 1543MHz, BW 300MHz, 4x~6MHz sub-bands, 30 deg$^2$ imaging of the Galactic plane and MCs

• **Slow Transients**
  - 300MHz, 10MHz channels, 10”, 5 sec, 30 deg$^2$, whole sky every day plus piggybacking

Science cases translated into science functional requirements (May 2009), formalised and prioritised following the selection of the survey science projects in Sept 2009.
Phased Array Feed Testing at Parkes
$T_{\text{sys}}$ (WBSPF) $\sim T_{\text{sys}}$ (PAF)

Efficiency, SSFOV=32.6deg$^2$

$S_{\text{max}}=2.63 \text{ m}^2/\text{K}$
$S_{\text{eff}}=15.0 \text{ m}^2/\text{K}$
ASKAP Digital System
ASKAP and MWA requirements

MRO requirements for Pawsey Centre

Pawsey Centre

- Enterprise class server
- Optiportal, iDome, 3D projector
- Science Archive Server
- Visualisation facility

- GPU cluster 100 TFlops
- IBM Blue Gene, 200 TFlops, 7.2 T/s

Science Data Archive

- Science Archive ~30PB HSM
- Online 50TB, 1GB/s, distributed file system
- Online 1PB, 10GB/s, distributed file system

Central Processor fast file system

- 5TFlops, 10Gb/s, large memory
- 100TFlops, 40Gb/s, large memory

Central Processor

MRA

- MRO-Pawsey Centre fast link ~8Tb/s

ICRAR Data Intensive Research Pathfinder

ICRAR

ASKAP Technical Operations, Geraldton

Geraldton-Greenough hub and portal

b=bit, B=byte

T. Cornwell, Feb 8 2010
Climbing Mount Exaflop

Projected Performance Development

Note that Flops numbers are not achieved - we actually get much lower efficiency because of memory bandwidth - so scaling is relative.
MRO Protection

- **Observatory grounds (120 km²)**
  - Full/self-control
- **Boolardy Pastoral Station (3467 km²/856,835 acres)**
  - CSIRO held and operated
- **Mineral Management Area (80 km radius) - State**
  - Controls for non-licensed radiators
- **Section 19 - State**
  - Embargo on new mines in the region
- **ACMA RALI September 2007 - Commonwealth**
  - (Aus Communication & Media Authority Radiocommunications Assignment and Licencing Instruction)
  - “FCC RQZ” protection (various radii)
- **Additional State/Commonwealth Legislation being pursued**
MRO

Gazetted towns: 0
Population: “up to 160”
gazetted towns: 0
population: “up to 160”
MRO Support Facility - Geraldton
We acknowledge the Wajarri Yamatji people as the traditional owners of the Observatory site.