
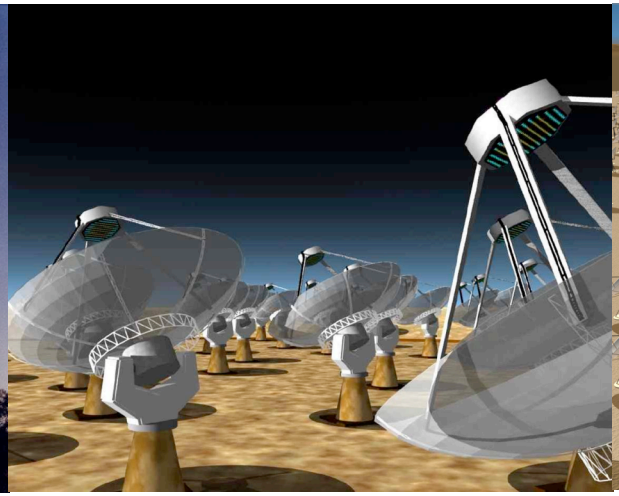
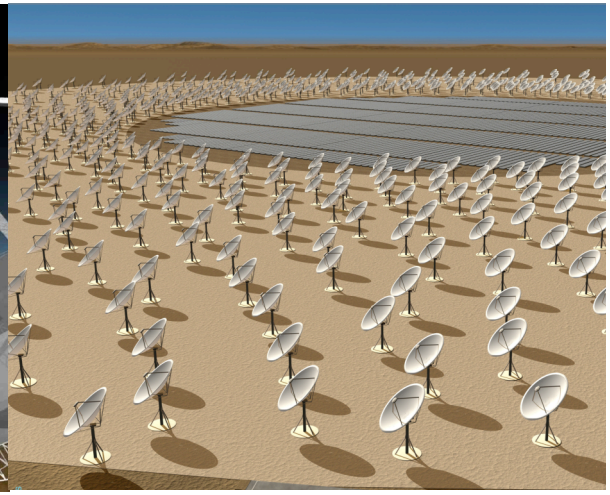

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ASKAP Science

Robert Braun

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SKA Key Science Projects

Five projects have been identified by the radio astronomy community as being the key science drivers for the SKA:

- **Cradle of Life**
- **Probing the Dark Ages**
- **The origin and evolution of Cosmic Magnetism**
- **Strong field tests of gravity using pulsars and black holes**
- **Galaxy evolution, cosmology and dark energy**

Last 3 of 5 are driving force for ASKAP

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PASA Summary now under review

Science With The Australian Square Kilometre Array Pathfinder

S. Johnston[A], *M. Bailes*[B], *N. Bartel*[C], *C. Baugh*[D], *M. Bietenholz*[C], *C. Blake*[B], *R. Braun*[A], *J. Brown*[E], *S. Chatterjee*[F], *J. Darling*[G], *A. Deller*[B], *R. Dodson*[H], *P. Edwards*[A], *R. Ekers*[A], *S. Ellingsen*[I], *I. Feain*[A], *B. Gaensler*[F], *M. Haverkorn*[J], *G. Hobbs*[A], *A. Hopkins*[F], *C. Jackson*[A], *C. James*[K], *G. Joncas*[L], *V. Kaspi*[M], *V. Kilborn*[B], *B. Koribalski*[A], *R. Kothes*[E], *T. Landecker*[N], *E. Lenc*[B], *J. Lovell*[I], *J.-P. Macquart*[O], *R. Manchester*[A], *D. Matthews*[P], *N. McClure-Griffiths*[A], *R. Norris*[A], *U.-L. Pen*[Q], *C. Phillips*[A], *C. Power*[B], *R. Protheroe*[K], *E. Sadler*[F], *B. Schmidt*[R], *I. Stairs*[S], *L. Staveley-Smith*[T], *J. Stil*[E], *R. Taylor*[E], *S. Tingay*[B], *A. Tzioumis*[A], *M. Walker*[U], *J. Wall*[S], *M. Wolleben*[N]

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Possible A_{eff}/T_{sys} ~ 120 m²/K

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Table 1.1: System parameters for MIRANdA

Parameter	Strawman	Expansion
Number of Dishes	30	45
Dish Diameter (m)	12	12
Total collecting area (m^2)	3393	5089
Aperture Efficiency	0.8	0.8
System Temperature (K)	50	35
Number of beams	30	30
Field-of-view (deg^2)	30	30
Frequency range (MHz)	800 – 1700	800 – 1700
Instantaneous Bandwidth (MHz)	300	300
Maximum number of channels	16000	16000

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Possible Specs.

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Table 1.2: Sensitivity and survey speeds for MIRANdA

Parameter	Strawman	Expansion
Continuum survey speed (300 MHz, 100 μJy)	250	1150 deg^2/hr
Line survey speed (100 kHz, 5 mJy)	209	960 deg^2/hr
Surface brightness survey speed (5 kHz, 1 K, 1′)	18	83 deg^2/hr
Point source sensitivity (1 MHz, 1 mJy)	1290	280 sec

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ASKAP Science Surveys

- HI emission surveys
  - Detect > 10^6 galaxies all sky with M* to z ~ 0.1 (cf Parkes HIPASS survey 4500 galaxies to z ~ 0.02)
  - Deep surveys, small regions with M* to z ~ 0.4
- HI absorption against background sources to z ~ 1
- Continuum and polarization surveys
  - $10^{7.8}$ sources to 10 μJy in parallel with the HI survey
  - 500,000 polarized sources and > 60,000 RMs
- OH megamasers to z~1
- Galactic/Magellanic/Local Volume HI emission surveys
- Pulsar survey, ~1000 new pulsars
- Transients and variability
  - IDVs, GRBs, all radio SNe to 50 Mpc
- Multiplexed VLBI on faint sources in wide FoV

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ASKAP HI Surveys: Key science questions

- HI density evolution as a function of red-shift
  - Relation with star formation rate
- HI mass function for different environments / red-shifts / galaxy types possible with large statistical samples
- Clustering of HI galaxies versus red-shift
  - Underlying dark halo properties
  - Environmental influences

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ASKAP HI Surveys

- **Shallow survey**
  - 1 year observing time, ½ sky coverage
    - Detects > 10^6 galaxies to z ~ 0.25, M* to z ~ 0.1
- **Medium survey**
  - 1 year observing, 600 sq deg
    - Detects > 200,000 galaxies to z ~ 0.5, M* to z ~ 0.2
- **Deep survey**
  - 1 year observing, single pointing, 30 sq deg
    - Detects > 100,000 galaxies to z ~ 1, M* to z ~ 0.4

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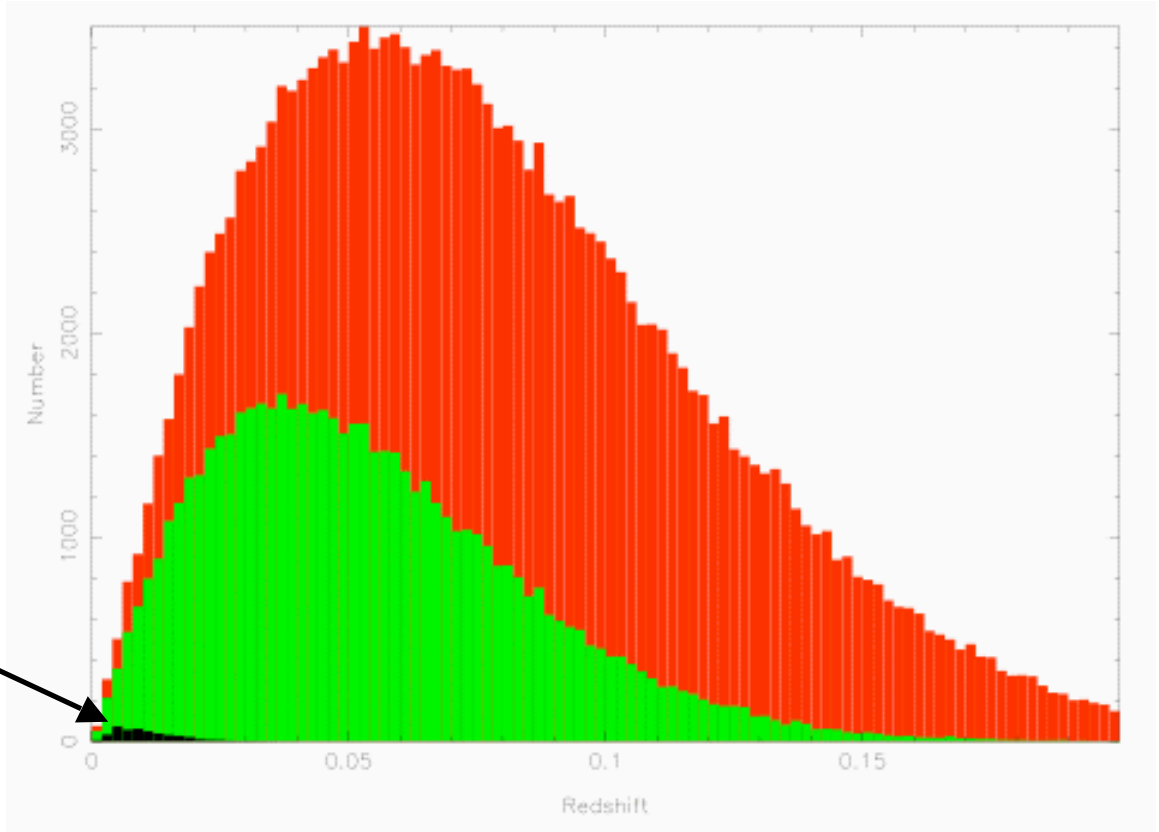
ASKAP HI Surveys

- **Shallow survey**
  - 1 year observing time, ½ sky coverage
    - Detects > 10^6 galaxies to z ~ 0.25, M* to z ~ 0.1



HIPASS

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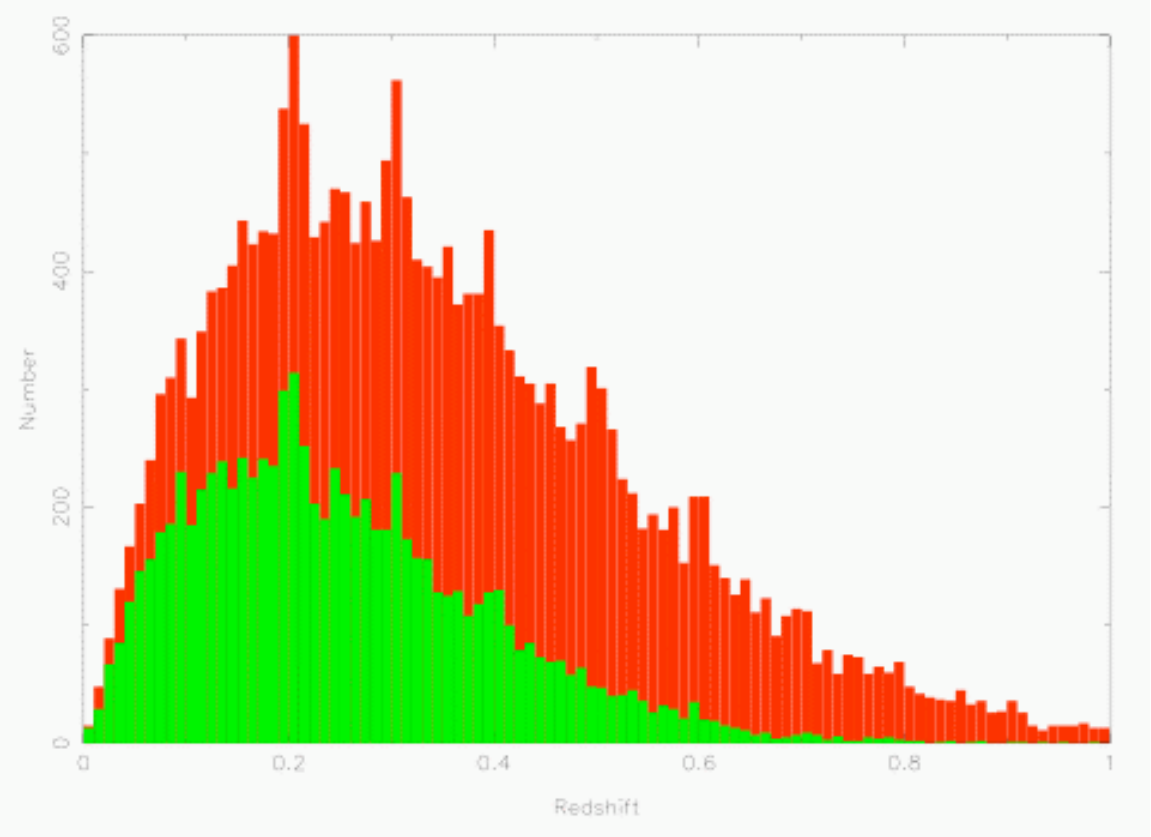
ASKAP HI Surveys

- **Deep survey**
  - 1 year observing, single pointing, 30 sq deg
    - Detects > 100,000 galaxies to z ~ 1, M* to z ~ 0.4



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ASKAP Continuum Surveys

- Compare NVSS survey (Condon et al. 1998)
  - 1.4 GHz, all-sky, 23s / point, 5-sigma detection of 2 mJy
  - 75 days VLA time, 10^6 objects, 45 arcsec resolution
- ASKAP surveys
  - 1.4 GHz, all-sky, 75s / point, 5-sigma detection of 2 mJy
  - Achieve in 1 day (every day(?)) with ASKAP !!!!
  - All-sky RMS in 1 year is 9 μJy
  - Polarization, RM-grid, galactic structure etc
- Variable sky every day
  - 2% level for 100 mJy sources, 10% for 10 mJy sources
  - cf MASIV (targeted) survey with the VLA

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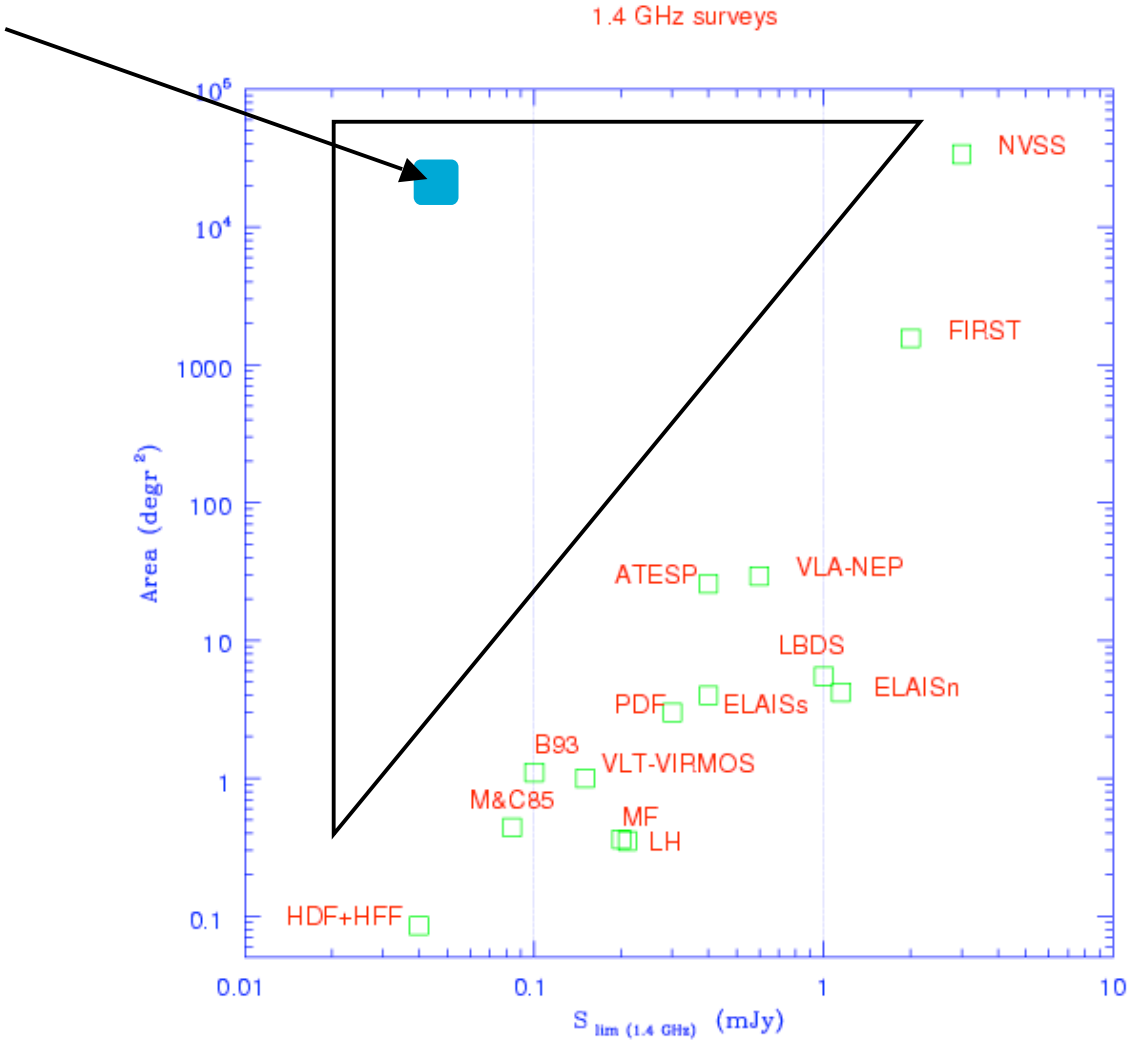
ASKAP Continuum Surveys: open new territory



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ASKAP Continuum Surveys: Polarimetry

- How are magnetic fields generated?
- Are they primordial?
- What is the strength of the B field in the IGM?
- How do B fields affect galaxy evolution?

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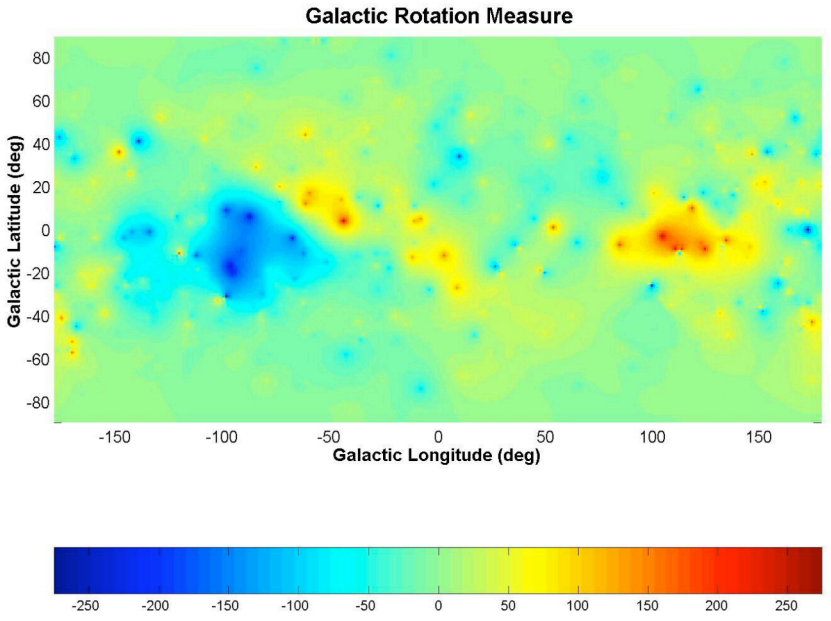
ASKAP Continuum Surveys: Polarimetry

- Currently ~1200 extra-galactic RMs, ~300 pulsar RMs across the sky.
- ASKAP will yield ~ 60,000 ex-gal. RMs and ~ 2000 pulsar RMs, providing a source density of about 1/9 arcmin
- Detailed 3-D magnetic tomography of Galaxy
- Possible detection of IGM B field and evolution with z



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ASKAP Pulsar Surveys and Timing

- Perhaps 1000 new pulsars but surveys are strongly computing limited (need pulsar processing of 10^5 pencil beams of 1 arcmin to fully tile 30 deg^2 telescope FOV)
- Trade-off of number of beams vs. flux sensitivity (determined by degree of central concentration of telescope configuration)
- If 120 m^2/K available, then very competitive for timing since source location is known in advance

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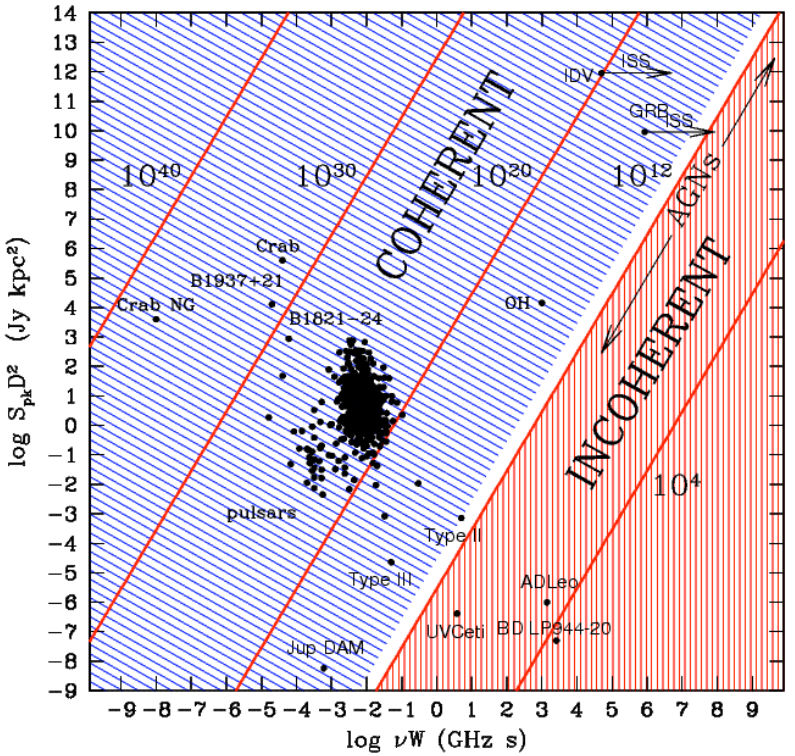
ASKAP Continuum Surveys: Transients

- Ultra-high energy particles
- Sun – solar flares
- Planets – magnetic flares
- Stars – flare stars, brown dwarfs
- Pulsars – normal, giant, AXPs, SGRs
- X-ray binaries, micro-quasars
- AGN
- Gamma-ray bursts
- Supernovae
- Aliens
- Scintillation
- New classes



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Configuration Trade-offs

- **Small ~ 500 m**
  - Best for pulsars and low surface brightness HI
- **Medium ~ 2 km**
  - Best for HI galaxy surveys (keep them unresolved)
- **Large ~ 8 km**
  - Best for deep continuum surveys (confusion limit)
- **Reconfigurable (?)**
  - Pickup and move (many) dishes on annual timescale
  - Eg. small => medium => large (simple => challenging)
  - Some cost penalty to set up multiple pads, but dominated by data transport and computing costs of largest configuration
- **Strong central concentration, but extends to 8 km**
  - ~Good for everything, but are 45 telescopes enough for (u,v) coverage on all scales?
  - Simulations will address

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ASKAP User Requirements Document

- **Define survey and analysis strategies and deliverables**
  - Need sufficient detail for implementation
  - Need local "interpreter" for ASKAP software team

Topic	ATNF liaison	Science Working Group Lead
Extragalactic HI	Baerbel Koribalski	Lister Staveley-Smith, Tom Oosterloo
Extragalactic Cont./Polar.	Ray Norris	Ilana Feain, Jasper Wall, Russ Taylor
Galactic HI/Cont/Polar.	Naomi McClure-Griffiths	Sean Dougherty
Transients	Simon Johnston	Simon Johnston
Pulsars	George Hobbs	Ingrid Stairs
VLBI	Tasso Tzioumis	Steve Tingay

- **Timeline:**
  - Document in place by end 2007
  - Resourcing of "software instruments" by mid-2008
  - Work with community to resource all essential modes 2008+

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Science with the Australian Telescope Network

ASKAP fully integrated with ATCA, Mopra, Parkes

- **Require 5 - 10 year forward look for all telescopes for cost-effective operational plan**
  - A year in a life of the Australian Telescope Network …

- **Timeline:**
  - Parkes “Science Day” was yesterday
  - ATCA “Science Day” early-2008
  - Integrate for implementation stage of Ops. plan mid-2008

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