



# CTA Linkages in Australia (28/29 Nov. Adelaide)

<https://indico.cta-observatory.org/event/2162/>

## Discussion Topics

# CTA Timeline

<https://www.cta-observatory.org/project/status/>

## Project Phases

**Pre-Construction**

Current Phase

**Pre-Production**

2019-2021

**Production**

2021-2025

**Current Phase**

**Pre-Construction**



CTA Offices Open  
in Bologna

Infrastructure Design  
& Procurement



ERIC  
Established

Q1 2017

Q3 2017

Q1 2018

Q3 2018

Q1 2019

Q3 2019

Q1 2020

LST 1 Prototype  
Completed on  
North Site



Financial  
Threshold  
Reached

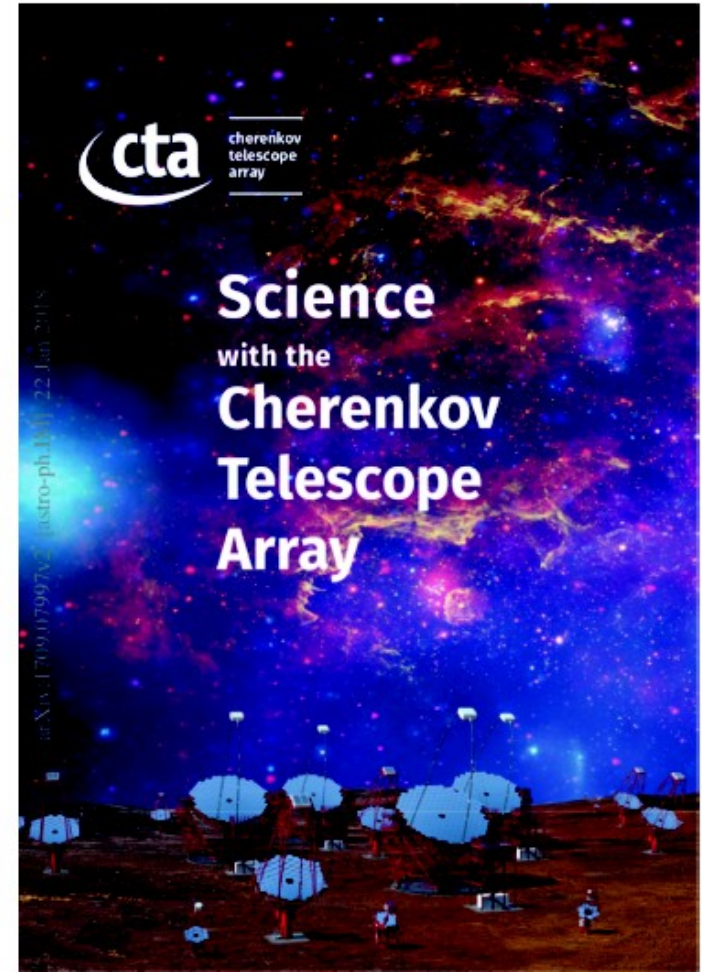
# Science with CTA

<https://www.worldscientific.com/worldscibooks/10.1142/10986>

## Key Science Projects

- Dark Matter Programme
- Galactic Centre
- Galactic Plane Survey
- Large Magellanic Cloud Survey
- Extragalactic Survey
- Transients
- Cosmic-Ray PeVatrons
- Star-forming Systems
- Active Galactic Nuclei
- Cluster of Galaxies
- Beyond Gamma Rays

<https://www.cta-observatory.org/>



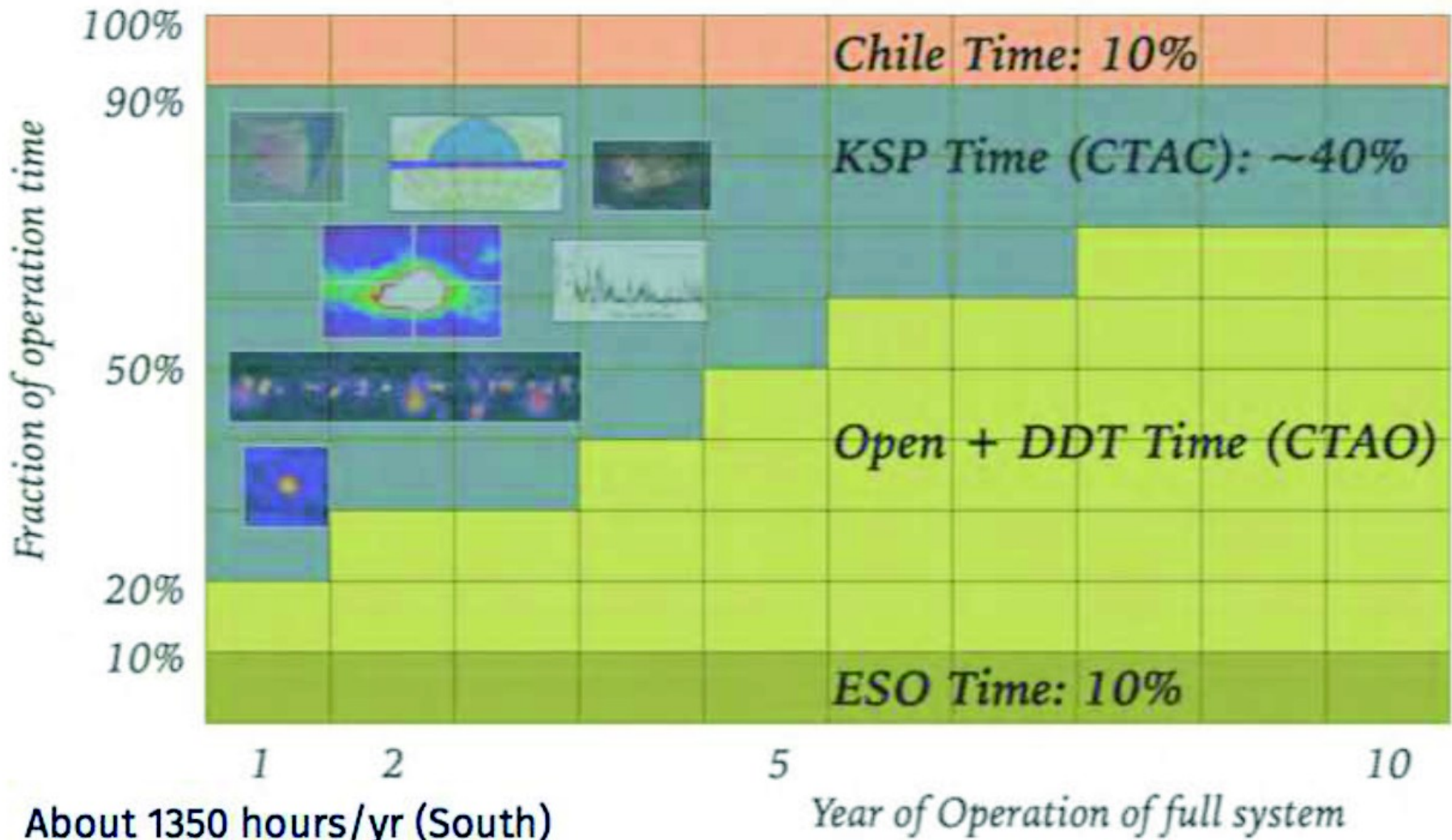
CTA-North (La Palma, Spain) – 29 telescopes  
CTA-South (Paranal, Chile) – 99 telescopes

→ Phase1 70% (~80% funded)

- x10 better sensitivity than HESS;
- Wider energy coverage <50 GeV to >100 TeV
- Arc-minute angular resolution



# TIME BUDGET FOR CTA OBSERVATORY



# External Needs Matrix



cherenkov  
telescope  
array

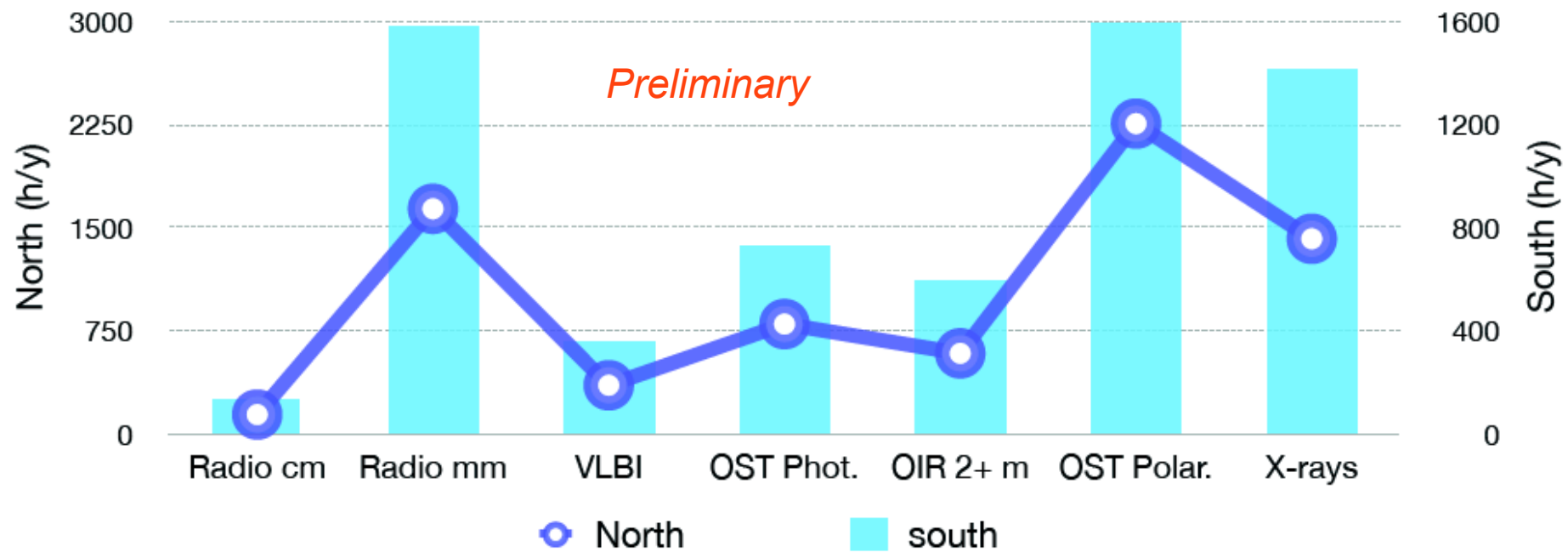
✓ = important    ✓ = critical

Band or Messenger	Astrophysical Probes	Galactic Plane Survey	LMC & SFRs	CRs & Diffuse Emission	Galactic Transients	Starburst & Galaxy Clusters	GRBs	AGNs	Radio Galaxies	Redshifts	GWs & Neutrinos
Radio	Particle and magnetic-field density probe. Transients. Pulsar timing.	✓	✓	✓	✓	✓	✓	✓	✓		✓
(Sub)Millimetre	Interstellar gas mapping. Matter ionisation levels. High-res interferometry.	✓	✓	✓		✓		✓	✓		
IR/Optical	Thermal emission. Variable non-thermal emission. Polarisation.	✓	✓	✓	✓	✓		✓	✓	✓	
Transient Factorles	Wide-field monitoring & transients detection. Multi-messenger follow-ups.						✓	✓			✓
X-rays	Accretion and outflows. Particle acceleration. Plasma properties.	✓	✓	✓	✓	✓	✓	✓	✓		✓
MeV-GeV Gamma-rays	High-energy transients. Pion-decay signature. Inverse-Compton process	✓	✓	✓	✓	✓	✓	✓			✓
Other VHE	Particle detectors for 100% duty cycle monitoring of TeV sky.	✓	✓	✓		✓		✓			
Neutrinos	Probe of cosmic-ray acceleration sites. Probe of PeV energy processes.			✓			✓	✓			✓
Gravitational Waves	Mergers of compact objects (Neutron Stars). Gamma-ray Bursts.						✓				✓

# CTA's Multiwavelength 'Needs' for Key Science Projects

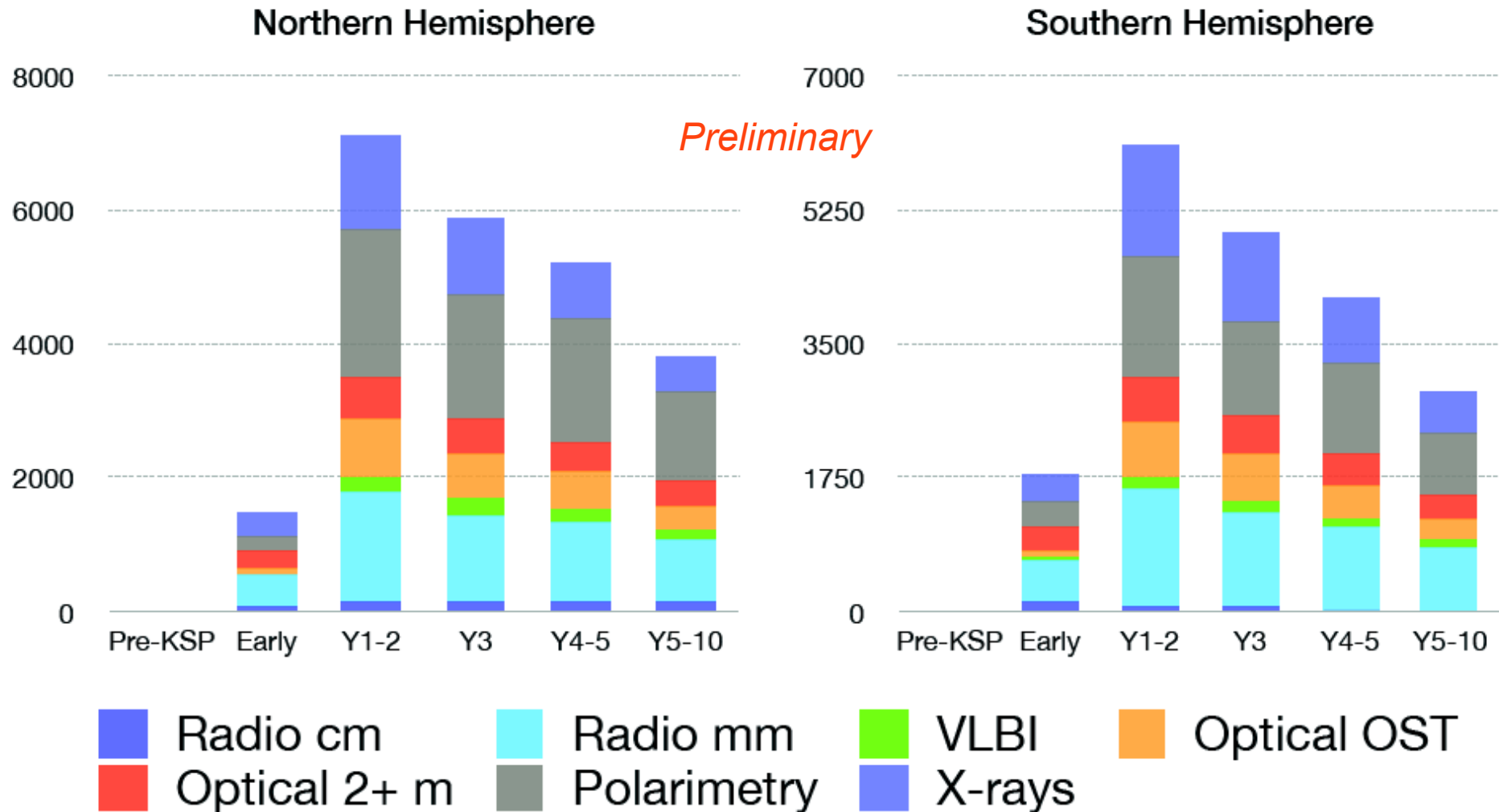
- Draft report under discussion within CTA Consortium
- Does not include radio surveys already done/in progress (e.g. CO/HI/OH surveys)
- OST "Optical Support Telescope" at CTA sites (but off-site telescopes not excluded)

Total Time Demand per Band / Hemisphere



# CTA's Multiwavelength 'Needs' for Key Science Projects

- Breakdown vs. time



**Figure 6.** Summary plots illustrating the total time demand for external data, in function of band, hemisphere and period of CTA KSP internal time.

# WAYS FORWARD

## CTA, for the first 10 years (2025-35) will have 40% of its time dedicated to internal consortium Key Science Projects

- The successful completion of these science cases will demand cooperation with external data in many fronts
  - surveys and catalogues
  - alerts and follow-ups
  - intense monitoring of transients
- Identification of facilitates that can provide such data (through MoUs, scientific cooperations on existing programmes, regular time demands) is a priority for CTA.

Particularly relevant for the near-term (as of now!) is to complement or identify missing survey data from radio, IR and X-rays that is crucial for some galactic and extragalactic science cases.

**Let us establish the links to achieve some of these (mutual) goals through cooperation with Australian groups and facilities!**

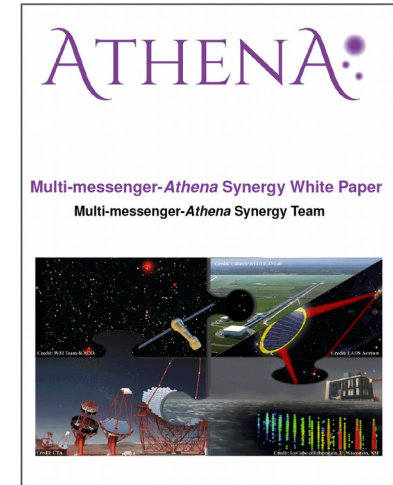


# MWL / MM Coordination

In discussion: CTA-SKA White Paper on synergies

Draft: Athena synergies

In discussion: THESEUS synergies



<b>5</b>	<b><i>Athena</i>, neutrino and VHE observatories: ICECUBE, KM3NET &amp; CTA</b>	<b>15</b>
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**Coordination between  
CTAC and  
CTAO (Project Scientist)**

## Questions/Topics

What MWL/MM inputs can Australia provide CTA?

Can we identify specific CTA+other telescope links now?

Any missing telescope in the CTA-MWL list & other feedback?

CTA Key Science Projects aim to commence ~2025.

What optical/radio facilities will be available then?

What about non-KSP CTA time? Additional MWL needs?

CTA-SKA White paper

CTA Extragalactic Survey – Where to focus? Guided by new radio surveys?

## Action Items

- Identify key optical/radio facilities, contact points and availability
- Identify new student projects..
- Support for CTA-SKA white paper

# CTA Linkages with Radio, Optical programmes in Australia

- Optical monitoring/polarimetry from Australia 1m/2m class.
  - Bespoke polarimeter for AGN D. Cotton, J. Bailey, M. Filipovic WSU proposal  
NCRIS industry funds? Flagged with James Murray.
  - ZADKO 1m telescope Bruce Genre (UWA)
- ISM inputs into Galactic plane analysis
  - Prepare Mopra CO data – galactocentric (G. Rowell, M. Burton)
  - Link with GASKAP (G. Rowell, J. Dawson, K. Jameson, N. McClure-G)
  - GALPROP time-dep (P. Marinos, T. Porter, G. Rowell, F. Voisin)
- FRBs + transients
  - VOEvent UTMOST/HESS T+10min autoslew, T+10min-5hr autoalert  
(G. Rowell, F. Schussler, H. Ashkar, C. Flynn, V. Gupta, )
  - DWF links with HESS (G. Rowell, J. Cooke)
  - ASKAP/HESS shadowing (G.Rowell, S. Einecke, R. Norris, S. Bandhari,...)
  - HESS/ATCA TeV GRBs (G.Rowell, G. Anderson..+HESS)
  - Radio VLBI C. Phillips (CSIRO)
- Radio surveys MWA/HESS (M. Filipovic, G. Rowell, N. Maxted, N. Hurley-Walker)  
ASKAP/HESS (M. Filipovic, G. Rowell, S.Einecke, R.Norris)
- MoUs/agreements for CTA (from 2020/21)? → Need contact points to telescopes
  - >2m optical AAT, 2.3m ANU, GOTO (North Hemis)

## CTA/SKA White Paper

Coordinated by Roberta Zanin (CTAO Project Scientist)

Exploring science synergies between CTA and SKA.

- Essential that Australia has prominent role!
- Who? CTA-Australia and Australian radio community
- Build on recent links with ASKAP, MWA, ATCA + HESS...



## Student Projects (PhD, MSc) and CTA-Oz in Key Science Projects etc..

Ideas for students projects to build activities in CTA KSPs and construction

- SST analysis including machine learning; Improving  $>10$  TeV performance  
(S. Einecke, G. Rowell...)
- CTA performance with gammapy (S. Einecke, G. Rowell...)
- CTA telescopes in Australia (S. Einecke, G. Rowell..)
- Mopra CO + GASKAP ISM preparation for Galactic Plane KSP  
(G. Rowell, M. Ashley, M. Filipovic)
- Radio continuum surveys (ASKAP EMU, MWA GLEAM-X)  
(M. Filipovic, G. Rowell..)
- Machine learning classification of radio to gamma-ray sources (S. Einecke)
- Machine learning classification of ISM features (S. Einecke, G. Rowell)
- Optical studies of SNR, PWN (I. Seintenzahl)
- Transient linkages (G. Rowell, M Filipovic, D. Galloway?,.....)
- Development of polarimeters for AGN (M. Filipovic..)
- CTA studies of UHE cosmic rays and gamma rays;  
Extreme standard model physics (J. Bellido)
- Dark matter + beyond standard model  
(M. White, C.Balazs, C.Boehm, A.Kobahidze..)
- Galactic Centre (R. Crocker..)
- Cosmic ray chemistry/ionisation of the ISM (R. Crocker, G. Rowell..)