

**MWA**

MURCHISON  
WIDFIELD  
ARRAY

# MWA Archive & VO Overview

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Gurlgamarnu

Presented by Greg Sleap, Curtin University/ICRAR/MWA



Curtin University





# About the MWA

- Mid-west Australia
- Operations mid 2013
- International collaboration of 20 led by Curtin University
- SKA Low Precursor
- 70-300 MHz, 30.72 MHz inst. bandwidth
- 3km or 6km max baselines
- 256 dual pol. tiles
- 50 PB raw data archive
- 4.7 FTE – v.small team!



*Foreground: One MWA tile has 16 dipole antennas and a beamformer (right)*



# Inyarrimanha Ilgari Bundara - The Murchison Radio Astronomy Observatory (MRO)



**MWA, ASKAP, SKA-Low, EDGES**



## RADIO QUIET ZONE

You are now entering the Murchison Radio-Astronomy Observatory



Please switch off and do not use your mobile and satellite phones or CB radio while inside the Observatory.

Please only use these devices in case of Emergency.

Your co-operation is appreciated



# MWA: A Raw Data Archive

- **Raw voltages**
  - Three bespoke data formats over time (use **mwlib**)
  - Channelised (output of receiver's PFB)=24x 1.28 MHz
  - 0.781 us time resolution (~85 TB per hour)
  - Black belt MWA research groups
- **Raw uncorrected, uncalibrated visibilities**
  - Black belt MWA research groups
  - Bespoke MWA FITS format (use **mwlib**)
- **On-the-fly corrected, uncalibrated visibilities**
  - CASA MS or UVFITS
  - Pre-processed by **Birli**
  - Intermediate users do calibration themselves
- **On-the-fly corrected and calibrated\* visibilities**
  - CASA MS or UVFITS
  - For “non-MWA radio astronomers”
  - \* Calibration is **very** basic, but enough for simple/quick look imaging

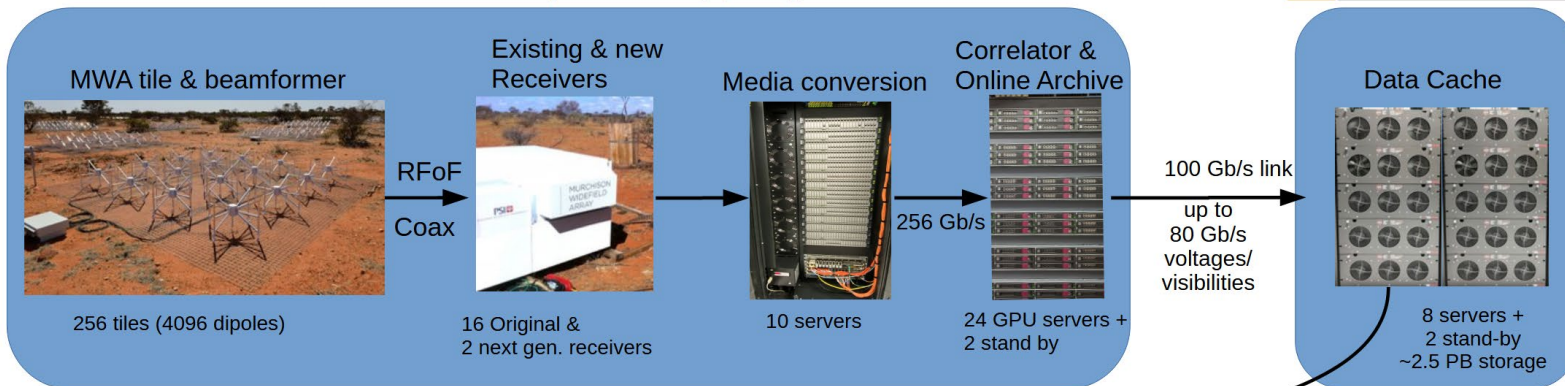


Cen A: Ben McKinley



# MWA Data Flow

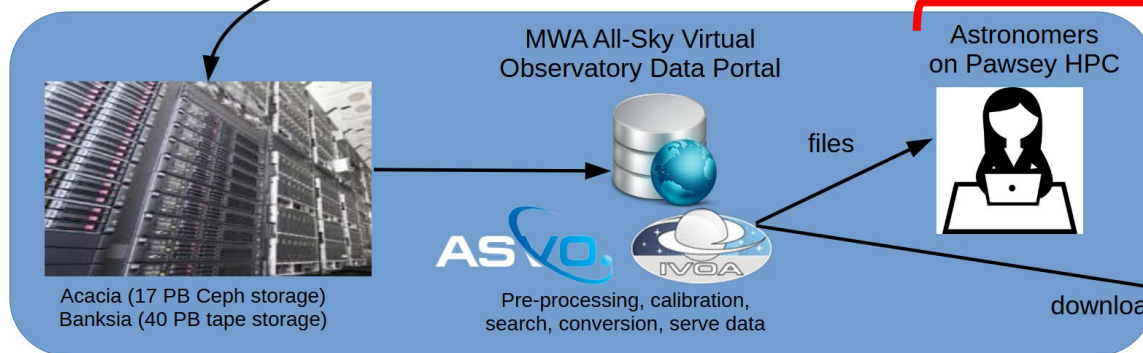
Tier 0: Murchison Radio Astronomy Observatory (MRO), Western Australia



Tier 1: Curtin University, Bentley, Western Australia

100 Gb/s link  
Voltages & visibilities

**Responsibility of science groups**



Processing,  
calibration,  
imaging,  
analysis,  
publication



Astronomers  
around the world



E.g. GLEAM



Tier 2: Pawsey Supercomputing Centre, Kensington, Western Australia



# MWA Public Data Access



## Murchison Widefield Array All-Sky Virtual Observatory

Virtual observatory compatible metadata and downloadable public visibility data from the MWA Archive.

Image credit: Natasha Hurley-Walker (Curtin / ICRAR) and the GLEAM T

A project to make **MWA telescope** data available to radio astronomers.

In this phase, raw visibility sets are available, with options for calibration, averaging and conversion to measurement sets or uvfits.

### Outage Notices

For service status updates and information about outages, please visit the MWA Wiki Service Outage Page.

[View current outages and service status](#)

## Our Services

### Web Dashboard

A web-based dashboard to search for observations and submit data conversion or download jobs.

[Learn more...](#)

### Command Line Tools

Open-source command line clients for effortless MWA ASVO job submission and data download

[Learn more...](#)

### VO TAP Service

We provide an International Virtual Observatory Alliance (IVOA) compliant Table Access Protocol (TAP) service.

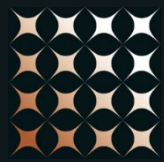
[Learn more...](#)



# MWA Public Data Access

- All-Sky Virtual Observatory (ASVO) <https://asvo.org.au>
  - 5 data portals (including MWA)
  - <https://asvo.mwatelescope.org>
  - Petabytes of data served to astronomers around the world!





# MWA Services Provided

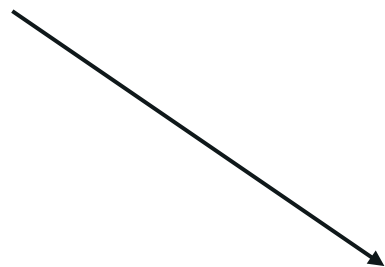
- MWA ASVO portal (Public and proprietary)

- Slightly federated A&A
- Web UI
- Command-line clients
- **VO interfaces (TAP, SCS)**

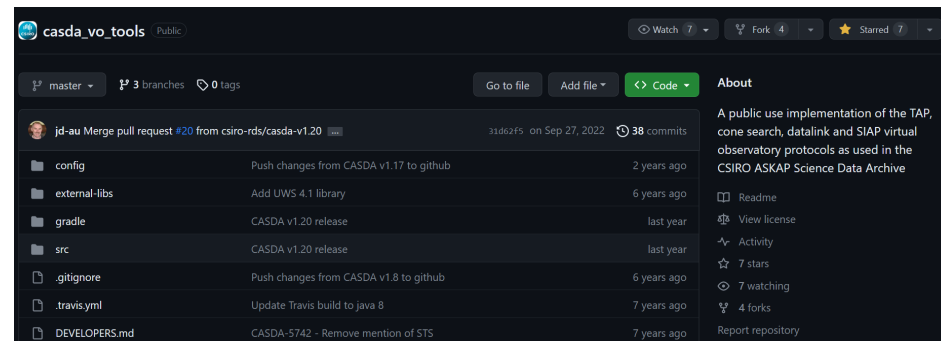


- Workflow:

- Login (or API key)
- Search (uses TAP service)
- Submit / monitor jobs
- Stage data (opt. preprocess)
- Download via URL or
- filesystem (Pawsey users)





CASDA VO Tools:  
Thanks, James Dempsey!







# MWA ASVO: Search

[HOME](#)
[ABOUT](#)
[SERVICES](#)
[SUPPORT](#)

OBSERVATIONS

MY JOBS

[ADMIN](#)
GREG

Search for Observations

Hide Search Form

Reset Fields Search

**Cone Search** ICRS (J2000.0)

Cone Right Ascension (deg)

Cone Declination (deg)

Cone Radius (deg)

Date From

Date To

Time Zone

Obs ID (GPS Starttime)  
From  To

Group ID

**Advanced Search**

TIME +

Select All
Select None
?
Submit Conversion
Submit Download
Download XML
Request Deletion

0 rows selected

Showing 1 to 50 of 500 entries.

« ( 1 2 3 4 5 ) »

Obs ID	Project	Group ID	Quality	Data Files	Flags?	UTC Start	LST (deg)	Duration (s)	Obs Name	Creator	Mode
1381094896	D0006	1381094672	Good	24	✗	2023-10-11T21:27:58.000Z	98.99	56	Cal_PicA_Ch169	andrew	MWAX_CORREL
1381094840	D0006	1381094672	Good	24	✗	2023-10-11T21:27:02.000Z	98.76	56	Cal_PicA_Ch145	andrew	MWAX_CORREL
1381094784	D0006	1381094672	Good	24	✗	2023-10-11T21:26:06.000Z	98.52	56	Cal_PicA_Ch121	andrew	MWAX_CORREL
1381094728	D0006	1381094672	Good	24	✗	2023-10-11T21:25:10.000Z	98.29	56	Cal_PicA_Ch95	andrew	MWAX_CORREL
1381094672	D0006	1381094672	Good	24	✗	2023-10-11T21:24:14.000Z	98.05	56	Cal_PicA_Ch69	andrew	MWAX_CORREL
1381093072	G0009	1381093072	Good	24	✗	2023-10-11T20:57:34.000Z	91.5	120	low_PicA_2023B_2460228_RADec80.0,-45.8_Ch121	andrew	MWAX_CORREL
1381092952	G0009	1381092952	Good	24	✗	2023-10-11T20:55:34.000Z	91	120	low_3C161_2023B_2460228_RADec96.8,-5.9_Ch121	andrew	MWAX_CORREL
1381092832	G0009	1381092832	Good	24	✗	2023-10-11T20:53:34.000Z	90.5	120	low_J0522-3_2023B_2460228_RADec80.7,-36.5_Ch121	andrew	MWAX_CORREL
1381092712	G0009	1381092712	Good	24	✗	2023-10-11T20:51:34.000Z	90	120	low_2023B_2460228_EOR1_RADec60.0,-30.0_Ch121	andrew	MWAX_CORREL
1381092592	G0009	1381092592	Good	24	✗	2023-10-11T20:49:34.000Z	89.5	120	low_2023B_2460228_EOI		
1381092472	G0009	1381092472	Good	24	✗	2023-10-11T20:47:34.000Z	88.99	120	low_2023B_2460228_EOI		
1381092352	G0009	1381092352	Good	24	✗	2023-10-11T20:45:34.000Z	88.49	120	low_2023B_2460228_EOI		
1381092232	G0009	1381092232	Good	24	✗	2023-10-11T20:43:34.000Z	87.99	120	low_2023B_2460228_EOI		
1381092112	G0009	1381092112	Good	24	✗	2023-10-11T20:41:34.000Z	87.49	120	low_2023B_2460228_EOI		
1381091992	G0009	1381091992	Good	24	✗	2023-10-11T20:39:34.000Z	86.99	120	low_2023B_2460228_EOI		
1381091872	G0009	1381091872	Good	24	✗	2023-10-11T20:37:34.000Z	86.49	120	low_2023B_2460228_EOI		
1381091752	G0009	1381091752	Good	24	✗	2023-10-11T20:35:34.000Z	85.99	120	low_2023B_2460228_EOI		
1381091632	G0009	1381091632	Good	24	✗	2023-10-11T20:33:34.000Z	85.49	120	low_2023B_2460228_EOI		
1381091512	G0009	1381091512	Good	24	✗	2023-10-11T20:31:34.000Z	84.98	120	low_2023B_2460228_EOI		

44 fields can be searched

TAP  
Inside!



# MWA ASVO: Jobs / Downloads



## Job Results

New Data Job



Showing All jobs of type All Types

Job ID	Observation ID	Details	Parameters	Created (UTC)	Completed (UTC)	Delivery	Download
691930 <span>Completed</span>	1381094896	Data Conversion	<span>Parameters</span>	2023-10-11T23:50:03.747Z	2023-10-12T00:04:42.830Z	astro	Astro Location: /astro/mwaops/asvo/691930 Job Size: 5.52 GB
690460 <span>Completed</span>	1380425520	Data Conversion	<span>Parameters</span>	2023-10-05T22:33:08.533Z	2023-10-05T22:35:25.048Z	astro	Astro Location: /astro/mwaops/asvo/690460 Job Size: 519.04 MB

```
mwa_giant_squid
Christopher H. Jordan <christopherjordan87@gmail.com>, Harrison Barlow
<harrison.barlow@curtin.edu.au>, Dev Null <dev.null@curtin.edu.au>, Greg Sleep
<greg.sleep@curtin.edu.au>
An alternative, efficient and easy-to-use MWA ASVO client.
Source: https://github.com/MWATelescope/giant-squid
MWA ASVO: https://asvo.mwatelescope.org

USAGE:
  giant-squid <SUBCOMMAND>

OPTIONS:
  -h, --help  Print help information

SUBCOMMANDS:
  list          List ASVO jobs
  download     Download an ASVO job
  submit-vis   Submit ASVO jobs to download MWA raw visibilities
  submit-conv  Submit ASVO conversion jobs
  submit-meta  Submit ASVO jobs to download MWA metadata (metafits and cotter flags)
  submit-volt  Submit ASVO jobs to download MWA voltages
  wait        Wait for ASVO jobs to complete, return the urls
  help        Print this message or the help of the given subcommand(s)
```





# MWA TAP Service schema

ivoa.ObsCore

mwa.observation

MWA-specific



1:1

obs\_id



Access URL

mwa.obs\_data\_files

1:many

obs\_id,  
file\_type

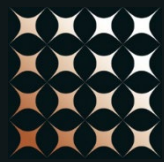
mwa.obs\_download\_history

1:many

obs\_id,  
dl\_date



Download Data: jump to  
The observation in search



# TAP: MWA.Observation

- **Start/stop time** in GPS, MRO, UTC, MJD
- **Proposal info** (code, PI, description)
- **Modes** (Voltages, Correlator, fringe-stopping, etc)
- **Pointing** (LST, gal, ra/dec, az/el, Sun, Moon, Jup)
- **Frequency info** (channels, bandwidth, low, high & centre channel in MHz & ordinal number)
- **Correlator info** (frequency res, integration time)
- **Quality info** (tiles, good\_tiles, iono\_qa, errors)
- **Data info** (types, deleted, archived, downloads)
- Full schema is documented on the **MWA wiki**



# Motivations for TAP design

- Make mwa.observation “one stop shop”
- Machine AND human readable
- Use MWA terminology
- Unification of data portal search and TAP
- Simple
  - Denormalised
  - No joins or complex ADQL required for most use cases
  - Don't make the user write code if they don't have to!



# VO & FAIR Next Steps/Challenges

- Get TAP service in a registry (!)
- Add more metadata to TAP
- Add support for Astroquery
- Pivot from *inward* focus to *outward* (*Radio IG!*)
- MWA archive serves “raw” data- very high barrier to entry and access- try to lower the bar!
- Moving users/code close to data a challenge when it’s not your compute facility!
- Data not directly accessible (staging required)
- How can we be FAIR-er?



# Thank you

Greg Slep

MWA Data Manager

greg.slep@curtin.edu.au



<http://www.mwatelescope.org>



<https://asvo.mwatelescope.org>



@mwatelescope



Murchison Widefield Array



Australian Government



GOVERNMENT OF  
WESTERN AUSTRALIA

*We acknowledge the Wajarri people as the traditional owners of the MRO site.*



# MWA Collaboration

