



MWA

MURCHISON
WIDFIELD
ARRAY

MWA Archive & VO Overview

May 2024 IVOA Interop, Sydney (Australia)

-Mouriyan Rajendran, Curtin University/ICRAR/MWA



Curtin University





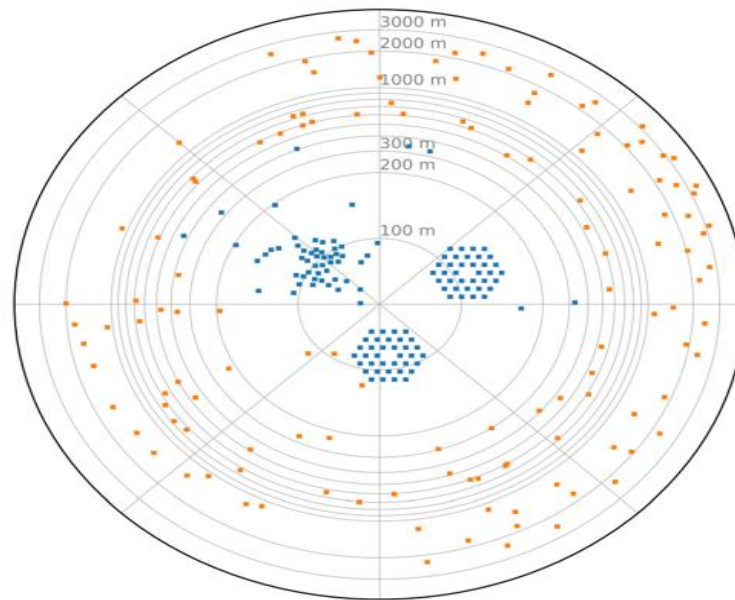
About the MWA

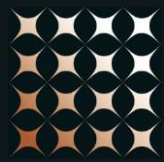
- SKA Low Precursor that is operating since 2013
- International collaboration of 26 partner institutions led by Curtin University
- Thousands of antennas
- 256 dual pol. Tiles
- MWA tile: Array of 16 dipole antennas and a beamformer (right)
- 70-300 MHz, 30.72 MHz inst. bandwidth



Cont.

- 3km or 6km max baselines
- compact configuration (blue) or extended configuration (orange) for deep surveys and detailed imaging.
- 4.7 FTE – v.small team!





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

RADIO QUIET ZONE

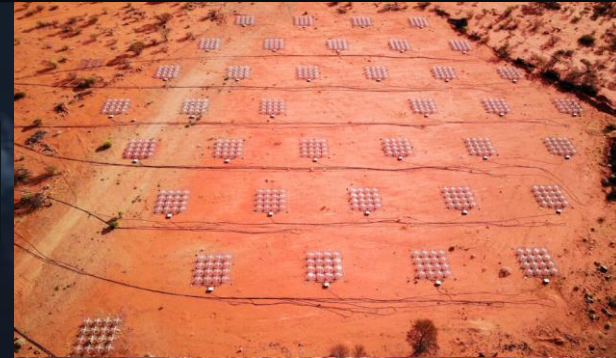
You are now entering the Murchison Radio-Astronomy Observatory



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, ASKAP, SKA-Low, EDGES



Perth ★

Murchison

Sydney ★

Melbourne ★





MWA: Types of Raw Data

RAW Voltages

- Raw data from our receivers
- 0.781 μ s time resolution (~85 TB per hour)
- Black belt MWA research groups

Raw uncorrected, uncalibrated visibilities

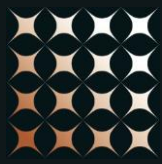
- Bespoke MWA FITS format
- Black belt MWA research groups

On-the-fly corrected, uncalibrated visibilities

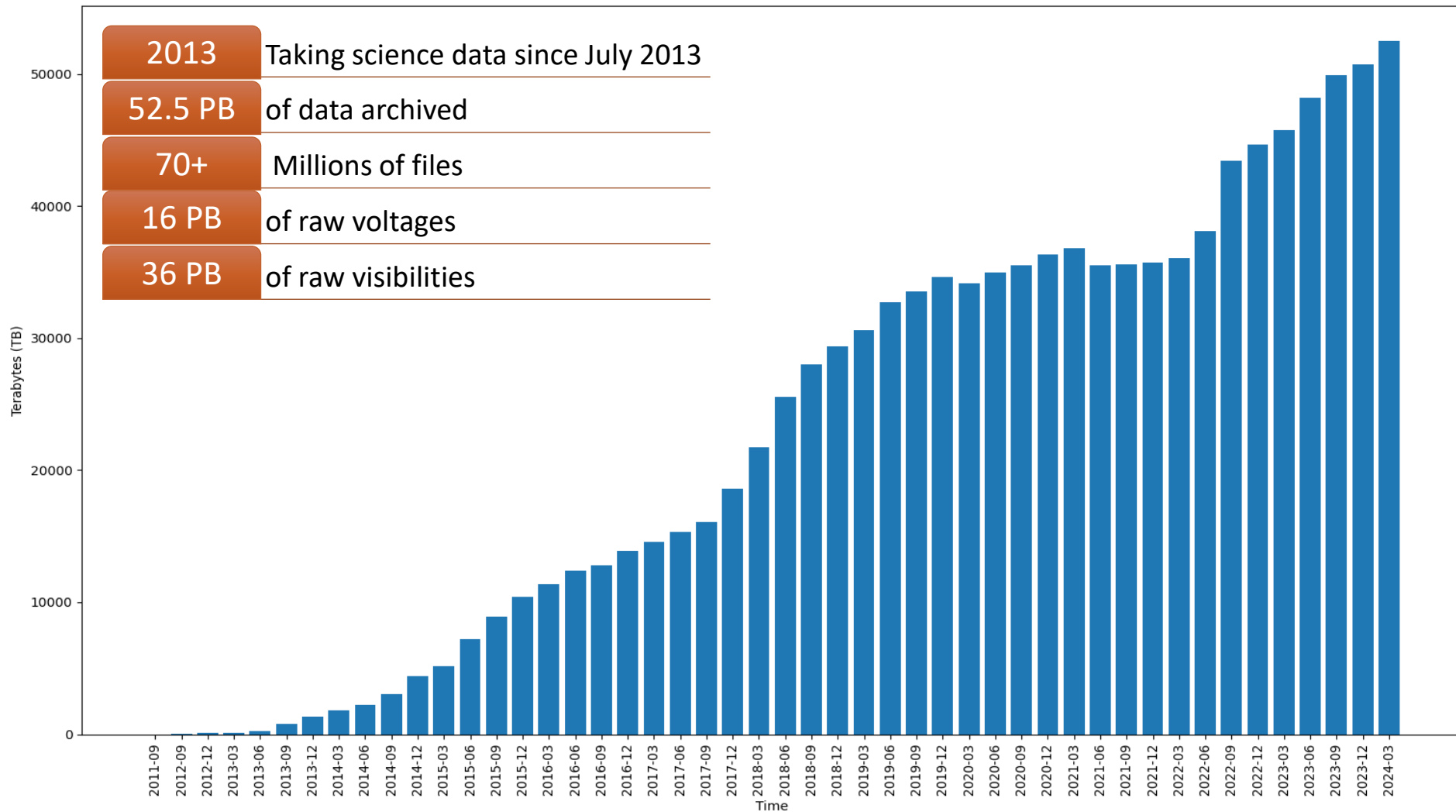
- CASA MS or UVFITS
- Pre-processed by **Birli**
- Intermediate users do calibration themselves

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

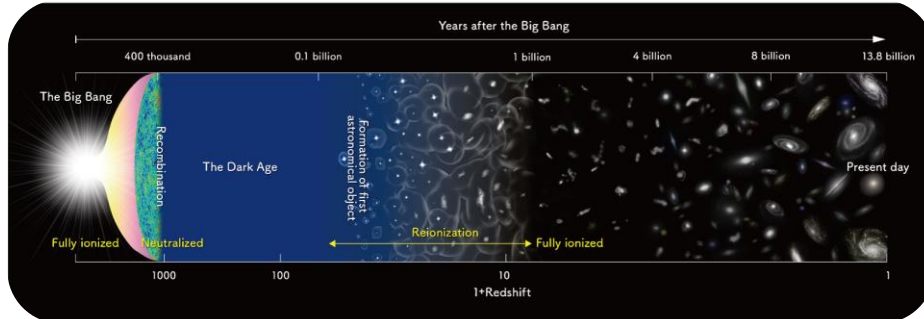


MWA Archive Statistics

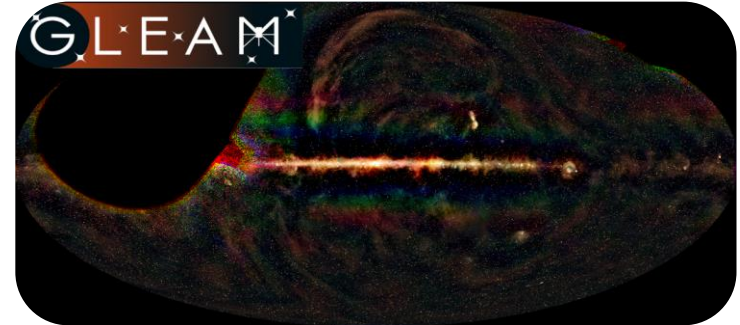




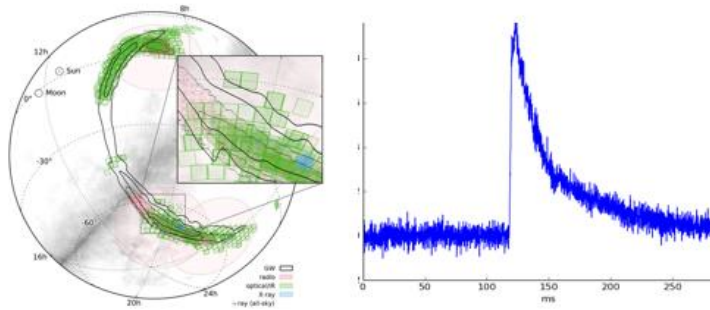
MWA Key Science Areas



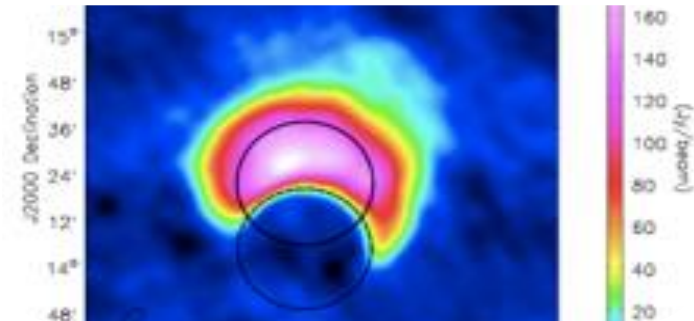
The Epoch of Reionisation (EoR)



Galactic & extragalactic astrophysics



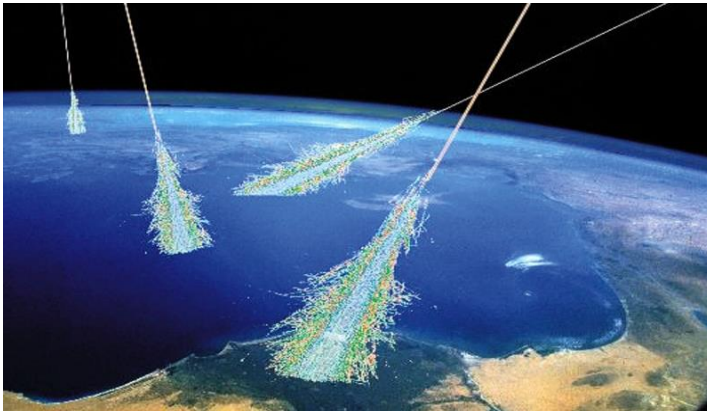
Transient & variable universe (pulsars/FRBs/GRBs)



Solar & heliospheric science



MWA Science (continued)



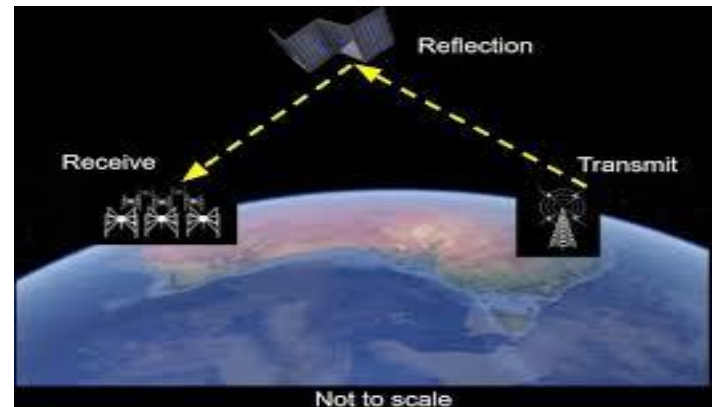
Cosmic Rays



Search for Extra Terrestrial Intelligence (SETI)



Molecular line surveys of the Galaxy



Space situational awareness (SSA)

Images (top-left to bottom-right: space.com, ESO/M. Kornmesser, Chenoa Tremblay, Paul Hancock)



MWA Large Archive Opportunities...

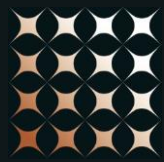


A mysterious interstellar radio signal has been blinking on and off every 22 minutes for over 30 years

Published: July 19, 2023 4.00pm EDT

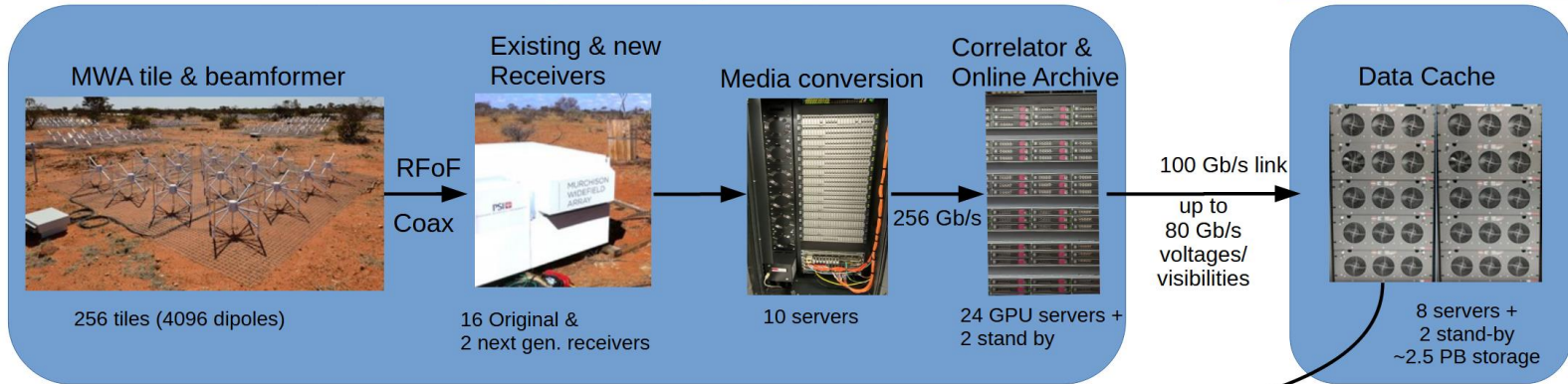
The International Centre for Radio Astronomy Research, Author provided

<https://www.nature.com/articles/s41586-023-06202-5>



MWA Data Flow

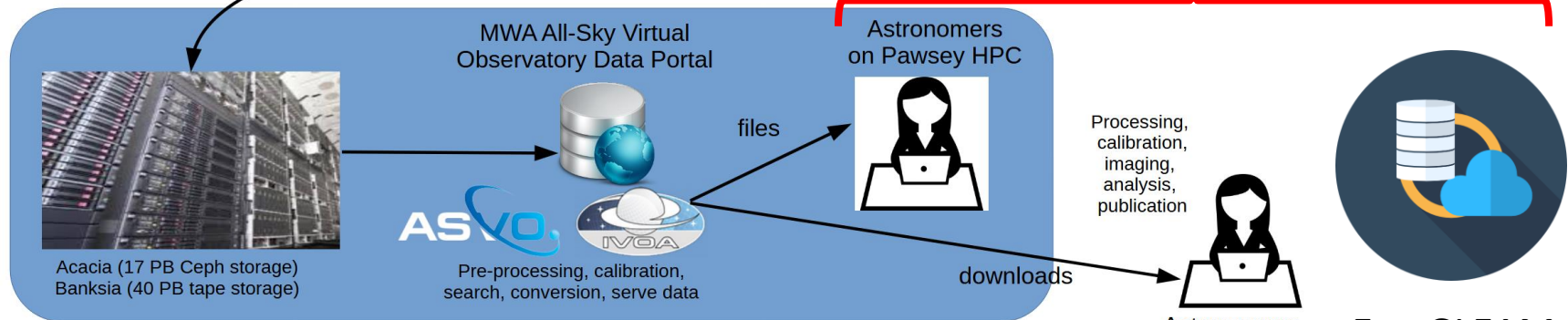
Tier 0: Murchison Radio Astronomy Observatory (MRO), Western Australia



Tier 1: Curtin University, Bentley, Western Australia

100 Gb/s link
Voltages & visibilities

Responsibility of science groups



Tier 2: Pawsey Supercomputing Centre, Kensington, Western Australia

Astronomers around the world

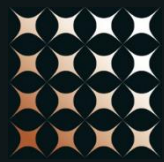
E.g. GLEAM



MWA Public Data Access

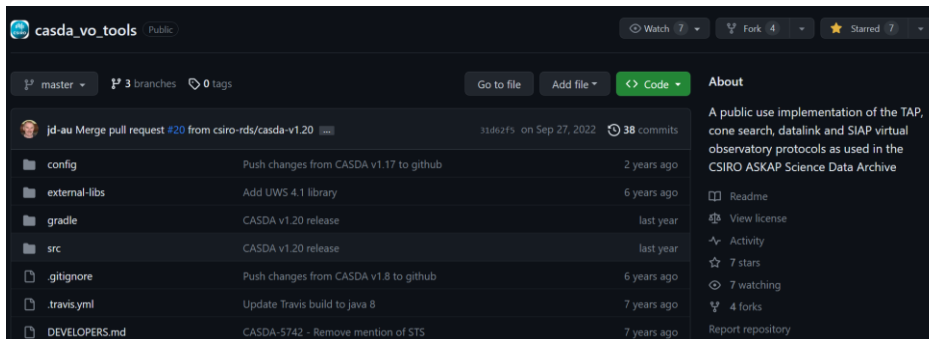
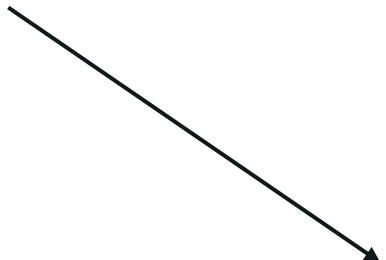
- All-Sky Virtual Observatory (ASVO) <https://asvo.org.au>
 - 5 data portals (including MWA)
 - <https://asvo.mwatelescope.org>





MWA Services Provided

- MWA ASVO portal (Public and proprietary)
 - Slightly federated A&A
 - Web UI
 - Command-line clients
 - **VO interfaces (TAP, SCS)**



CASDA VO Tools:
Thanks, James Dempsey!



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 ASVO Workflow


Registration Process

- Choose how to register:
 - Register through your AAO Data Central account. Click the button below.
 - Or, register an MWA ASVO account: Fill in and submit this registration form.
- You will be sent an email to verify your email address. Data central users do not need to follow this process.
- Confirm your email address by clicking on the link in the email.
- An administrator will review the registration and then activate your account.
- You will receive an email confirming your account is active.
- Until then you will not be able to log in to the system.

Personal information collected is handled in accordance with the Australian Privacy Principles. Further information on privacy is available on Curtin University's [privacy webpage](#).

Register with your AAO Data Central account

Choosing this option allows you to register with your AAO Data Central account.

 **Sign in with Data Central**

OR

Register for an MWA ASVO account

This option allows you to create a username and password for use with the MWA ASVO.


First Name

Last Name

Email Address

Username

Organisation/Affiliation

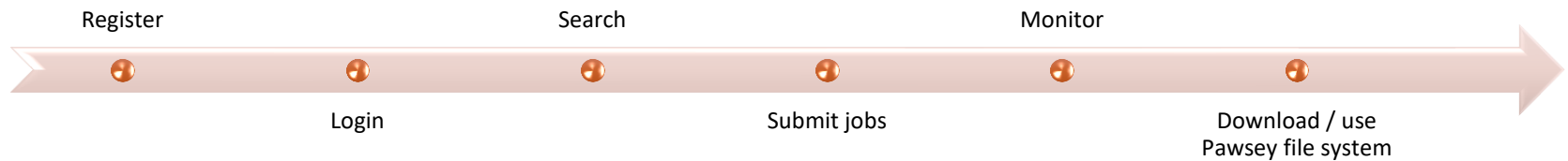
 ORCID (optional)

Format: XXXX-XXXX-XXXX-XXXX

Password

Retype Password

Submit





MWA ASVO Workflow – CLI client

```
mwa_giant_squid
Christopher H. Jordan <christopherjordan87@gmail.com>, Harrison Barlow
<harrison.barlow@curtin.edu.au>, Dev Null <dev.null@curtin.edu.au>, Greg Sleaf
<greg.sleaf@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)
```

- giant-squid
- <https://github.com/MWATelescope/giant-squid#readme>
- Built in Rust

```
lenz) root@C-A0062414:~/workspace/ASVO_CLIENT/manta-ray-client# mwa_client --help
manta-ray-client version 1.2.5
usage: mwa_client [-h] [-s | -l] [-w DOWNLOAD_JOB_ID] [-c FILE] [-d DIR] [-e ERRFILE] [-v] [-ar]

manta-ray-client version 1.2.5
=====

The mwa_client is a command-line tool for submitting, monitoring and
downloading jobs from the MWA ASVO (https://asvo.mwatelescope.org).
Please see README.md for csv file format and other details.

options:
-h, --help show this help message and exit
-s, --submit-only submit jobs from csv file then exit (-d is ignored)
-l, --list-only list the user's active jobs and exit immediately (-s, -c & -d are ignored)
-w DOWNLOAD_JOB_ID, --download-only DOWNLOAD_JOB_ID Download the job id (= DOWNLOAD_JOB_ID), if it is ready; or all downloadable jobs (-w all | -w 0).
-c FILE, --csv FILE csv file
-d DIR, --dir DIR Download directory
-e ERRFILE, --error-file ERRFILE, --errfile ERRFILE Write errors in json format to an error file
-v, --verbose verbose output
-ar, --allow-resubmit allow resubmitting of jobs

Examples:
mwa_client -c csvfile -d destdir Submit jobs in the csv file, monitor them, then download the files, then exit
mwa_client -c csvfile -s Submit jobs in the csv file, then exit
mwa_client -d destdir -w JOBID Download the job id (assuming it is ready to download), then exit
mwa_client -d destdir -w all Download any ready to download jobs, then exit
mwa_client -d destdir -w all -e error_file Download any ready to download jobs, then exit, writing any errors to error_file
mwa_client -l List all of your jobs and their status, then exit
lenz) root@C-A0062414:~/workspace/ASVO_CLIENT/manta-ray-client#
```

- mwa_client
- <https://github.com/MWATelescope/manta-ray-client#readme>
- Built in Python





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
- 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 / pre-processing required)
- How can we be FAIR-er?



Thank you

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Developer

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<http://www.mwatelescope.org>



<https://asvo.mwatelescope.org>



@mwatelescope



Murchison Widefield Array



Curtin University

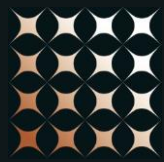


Australian Government



GOVERNMENT OF
WESTERN AUSTRALIA

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



MWA Collaboration

