MWA
MURCHISON
WIDEFIELD
ARRAY

MWA Archive & VO Overview

November 2023, IVOA Radio IG, Tucson, Az. USA

Gurlgamarnu

Presented by Greg Sleap, Curtin University/ICRAR/MWA

Curtin University

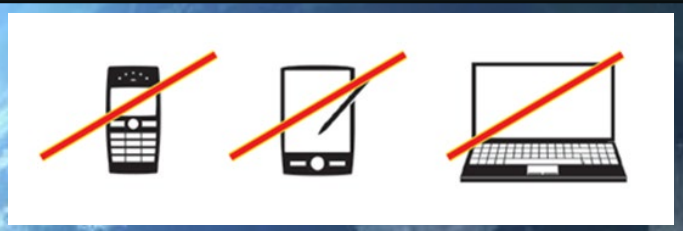
ICRAR

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)



SKAO

MWA, ASKAP, SKA-Low, EDGES

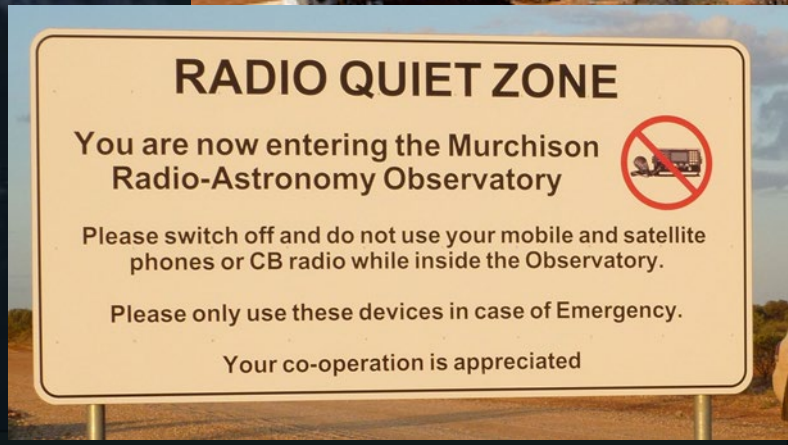
CSIRO

Murchison

Perth

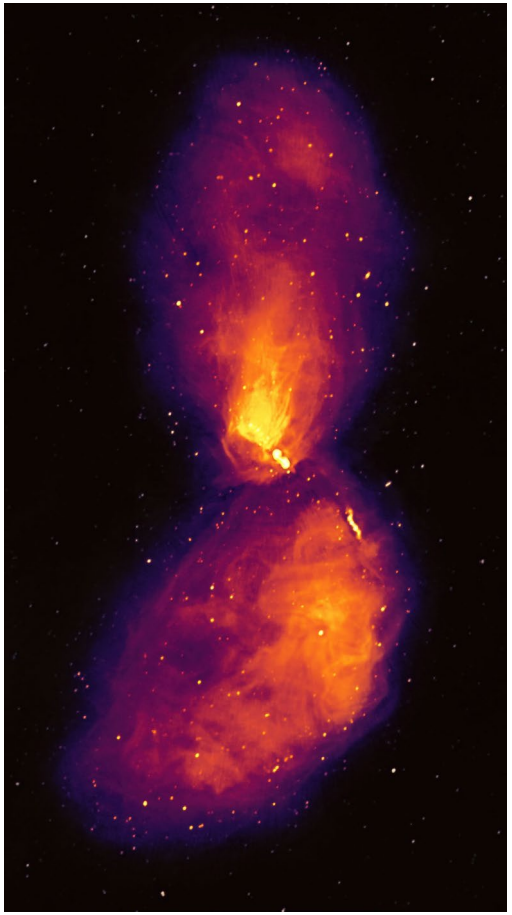
Sydney

Melbourne



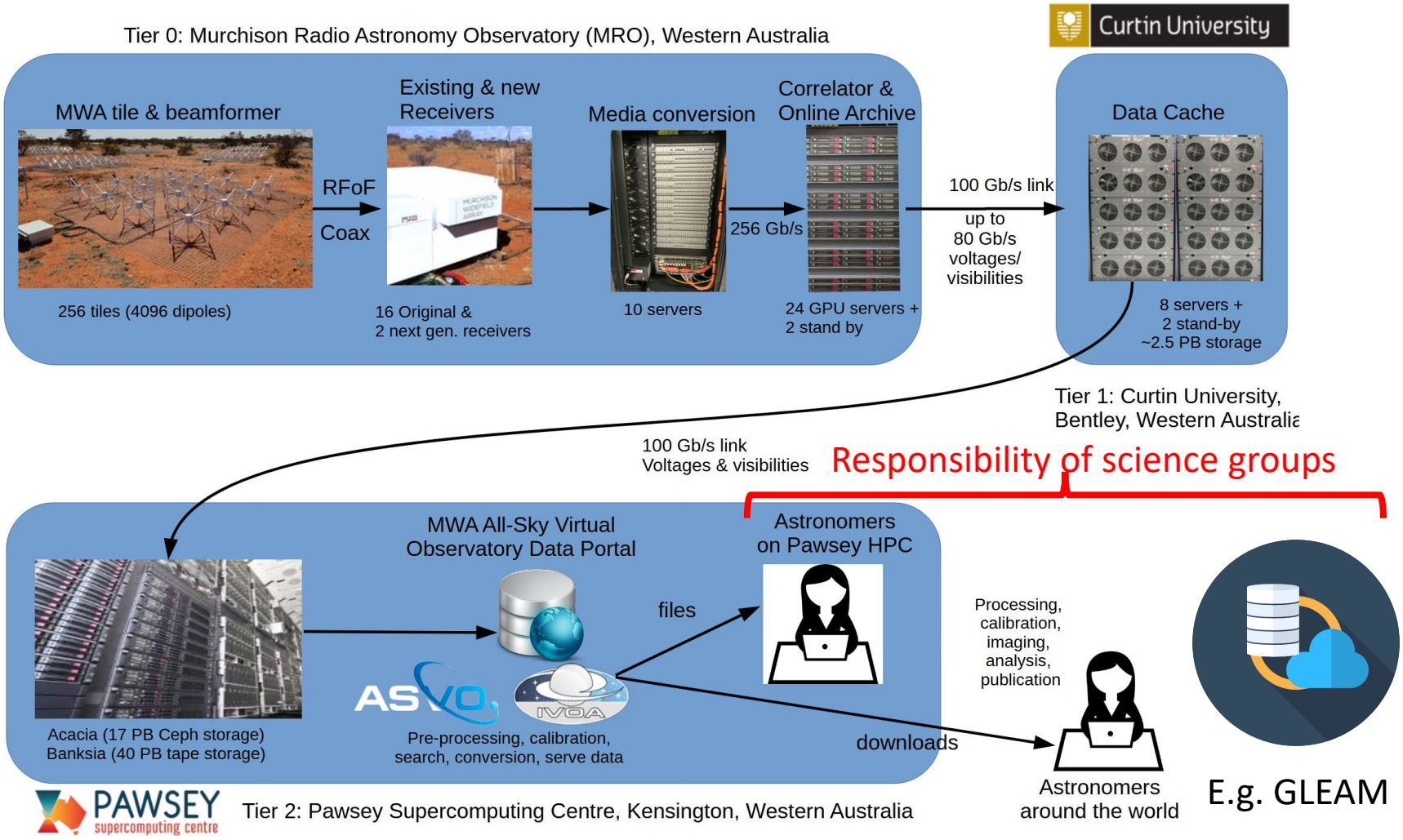
MWA: A Raw Data Archive

- **Raw voltages**
  - Three bespoke data formats over time (use **mwalib**)
  - 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 **mwalib**)
- **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

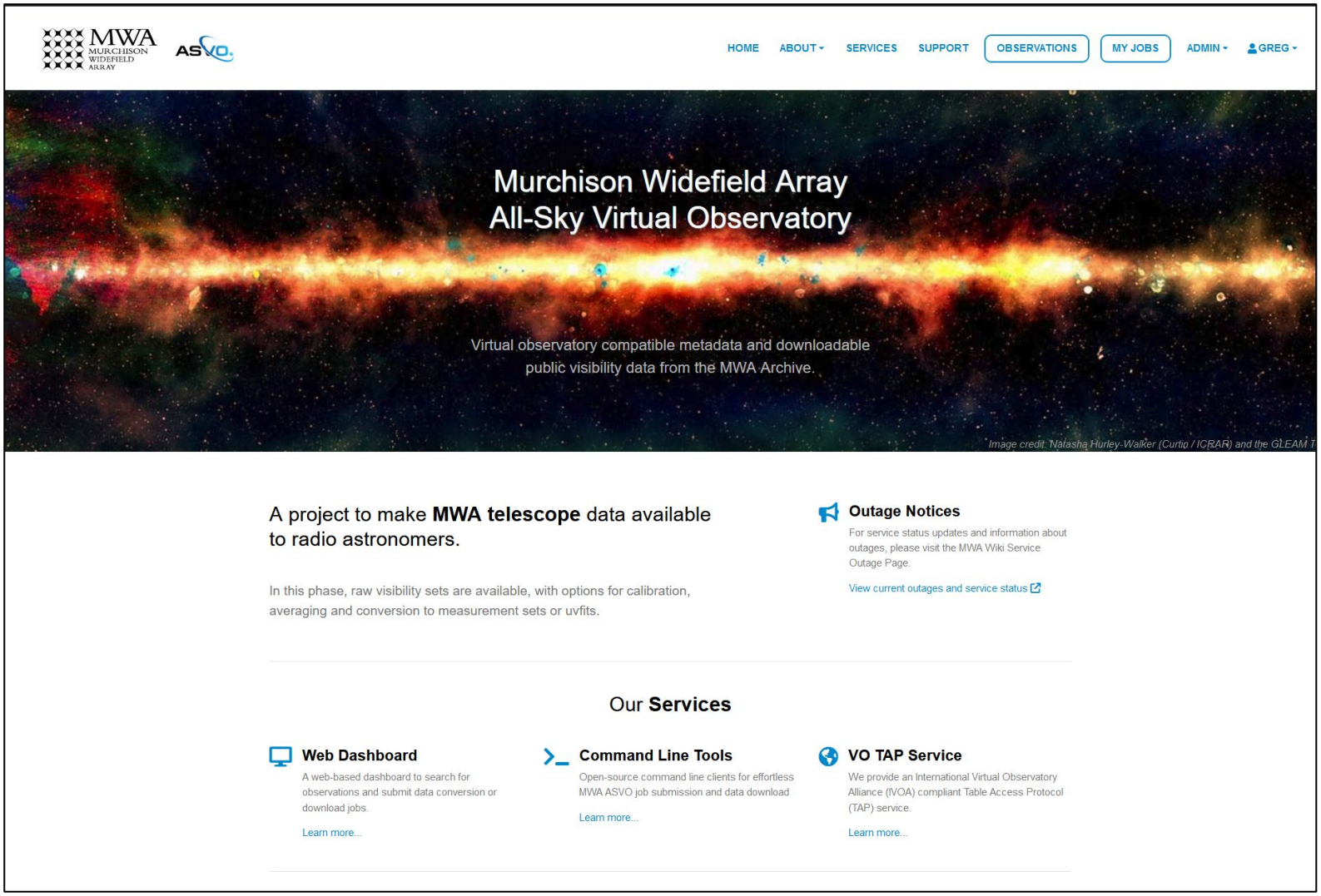


Cen A: Ben McKinley

MWA Data Flow



MWA Public Data Access



MWA Public Data Access

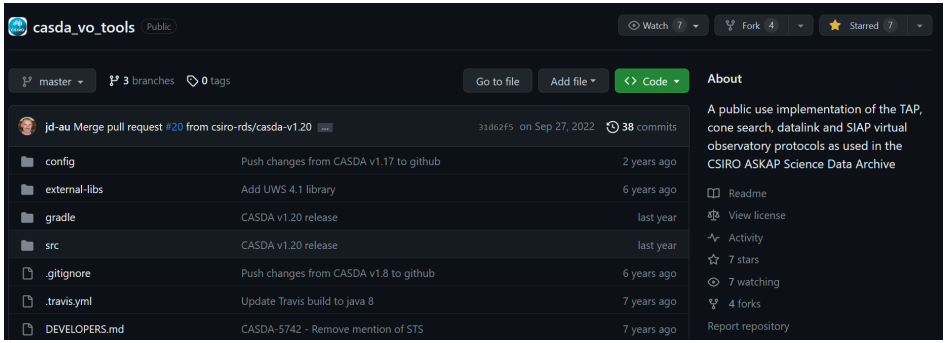
- All-Sky Virtual Observatory (ASVO) https://asvo.org.au
  - 5 data portals (including MWA)
  - https://asvo.mwatelescope.org
  - Petabytes of data served to astronomers around the world!

MWA Services Provided

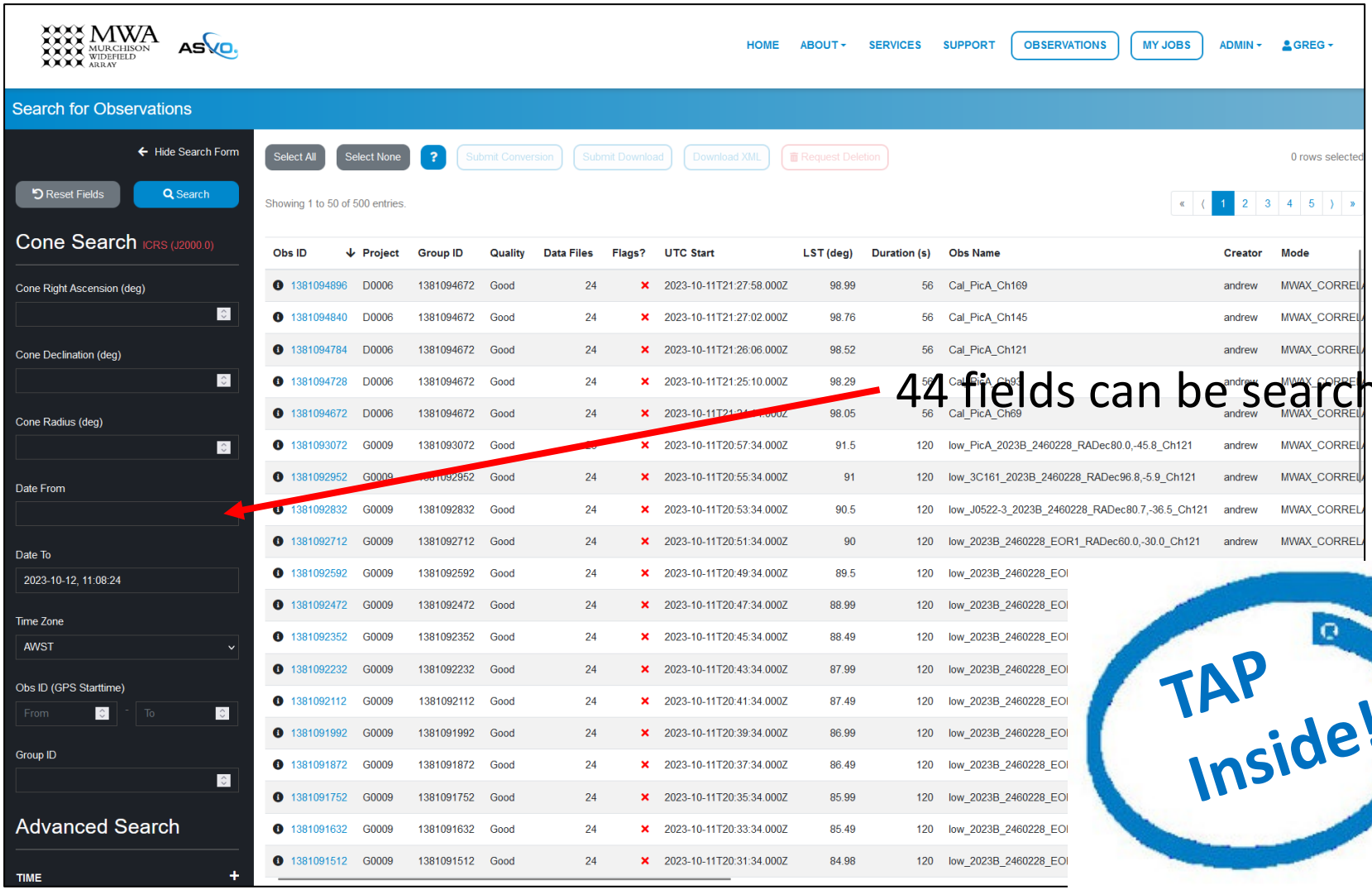
- MWA ASVO portal (Public and proprietary)
  - Slightly federated A&A
  - Web UI
  - Command-line clients
  - **VO interfaces (TAP, SCS)**

- 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



MWA ASVO: Jobs / Downloads

MWA MURCHISON WIDEFIELD ARRAY ASVO

HOME ABOUT SERVICES SUPPORT OBSERVATIONS MY JOBS ADMIN GREG

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 Completed	1381094896	Data Conversion	Parameters	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 Completed	1380425520	Data Conversion	Parameters	2023-10-05T22:33:08.533Z	2023-10-05T22:35:25.048Z	astro	**Astro Location:** /astro/mwaops/asvo/690460 **Job Size:** 519.04 MB

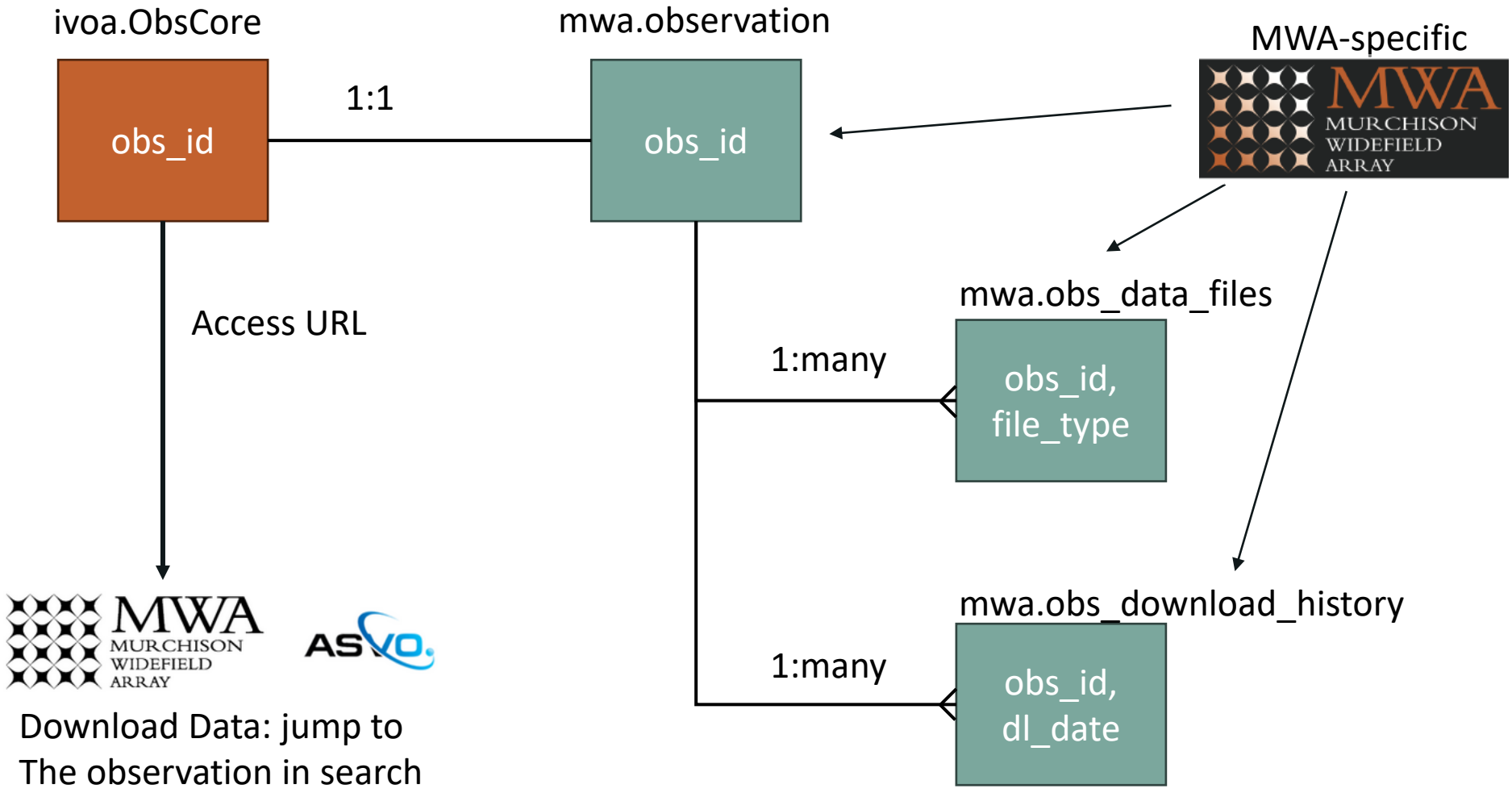
```
mwa_giant_squid
Christopher H. Jordan <christopherjordan87@gmail.com>, Harrison Barlow
<harrison.barlow@curtin.edu.au>, Dev Null <dev.null@curtin.edu.au>, Greg Sleap
<greg.sleap@curtin.edu.au>
An alternative, efficient and easy-to-use MWA ASVO client.
Source:   https://github.com/MWATelescope/giant-squid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



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 Sleap

MWA Data Manager

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http://www.mwatelescope.org

https://asvo.mwatelescope.org

@mwatelescope

Murchison Widefield Array

Astronomy Australia Ltd.

Curtin University

CSIRO

ICRAR

aarnet
Australia's Academic and Research Network

pawsey

Australian Government

GOVERNMENT OF WESTERN AUSTRALIA

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

MWA Collaboration

Australian National University

BROWN

CSIRO

Curtin University

国立大学法人 鹿児島大学 KAGOSHIMA UNIVERSITY

Kumamoto University

NAGOYA UNIVERSITY

国立天文台 NAOJ National Astronomical Observatory of Japan

BERKELEY SETI RESEARCH CENTER

中国科学院上海天文台 Shanghai Astronomical Observatory, CAS

SWINBURNE UNIVERSITY OF TECHNOLOGY

TOHOKU UNIVERSITY

THE UNIVERSITY OF MELBOURNE

THE UNIVERSITY OF SYDNEY

東京大学 THE UNIVERSITY OF TOKYO

UNIVERSITY OF TORONTO

UNIVERSITY of WASHINGTON

THE UNIVERSITY OF WESTERN AUSTRALIA

UNIVERSITY of WISCONSIN UWMILWAUKEE

WESTERN SYDNEY UNIVERSITY