Construction Update and Planned Testing of a High-Temperature Solar Sodium Facility

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ASTRI

Australian Solar Thermal Research Institute

Overview

Recap

- ASTRI program
- Timeline and what now
- Albuquerque 2022, 13-page submission on (re design and construction)

2023 Update

- Construction complete
- Commissioning
- Systems Testing

2023/2024

- Solar tower installation
- Planned future activity

ASTRI

Australian Solar Thermal Research Institute

ASTRI is an ARENA funded eight-year, $87 million international research collaboration to deliver *cost reductions and dispatchability* improvements, as well as position Australia in CSP, and Green Heat.

ARENA

Australian Government

Australian Renewable Energy Agency

Australian consortium partners

CSIRO

Australian National University

The University Of Queensland

The University of Adelaide

QUT

University of South Australia

Flinders University

US collaborators

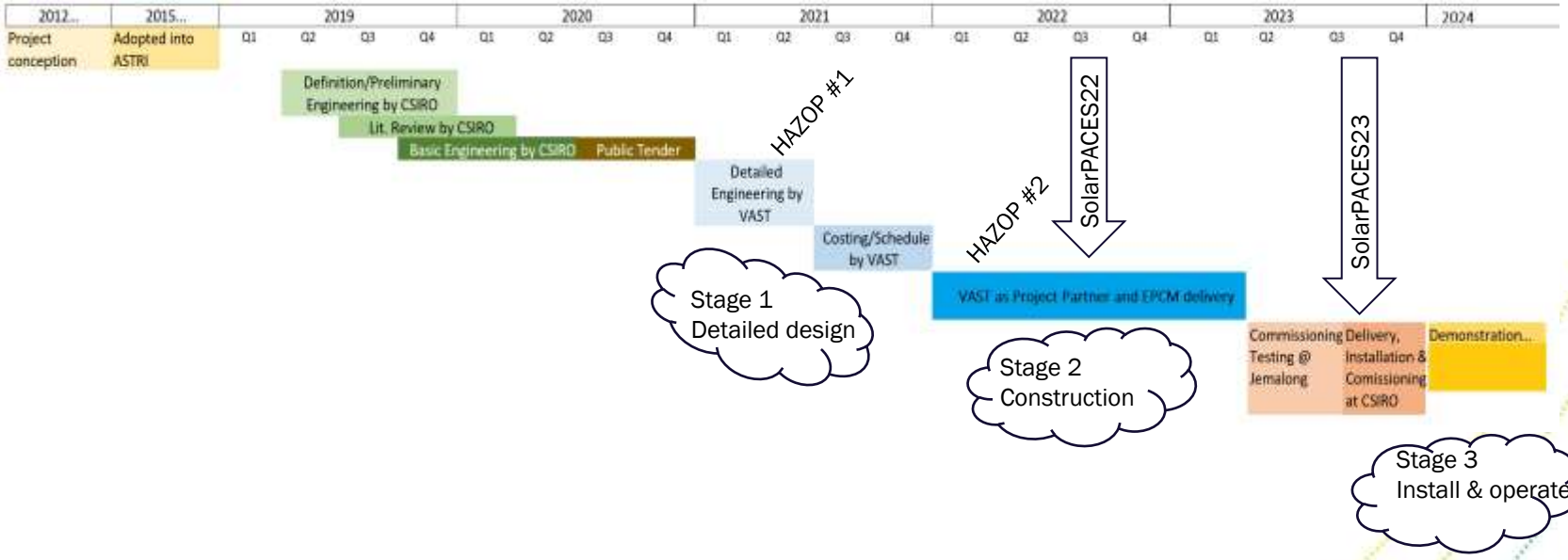
Sandia National Laboratories

ASU Arizona State University

NREL National Renewable Energy Laboratory

ASTRI P7.1 Sodium Test Loop

Project Timeline spanning 5 years



ASTRI P7.1 Sodium Test Loop

A high-temperature liquid-metal Sodium test loop was developed with integral sodium leak/containment and fire detection system.

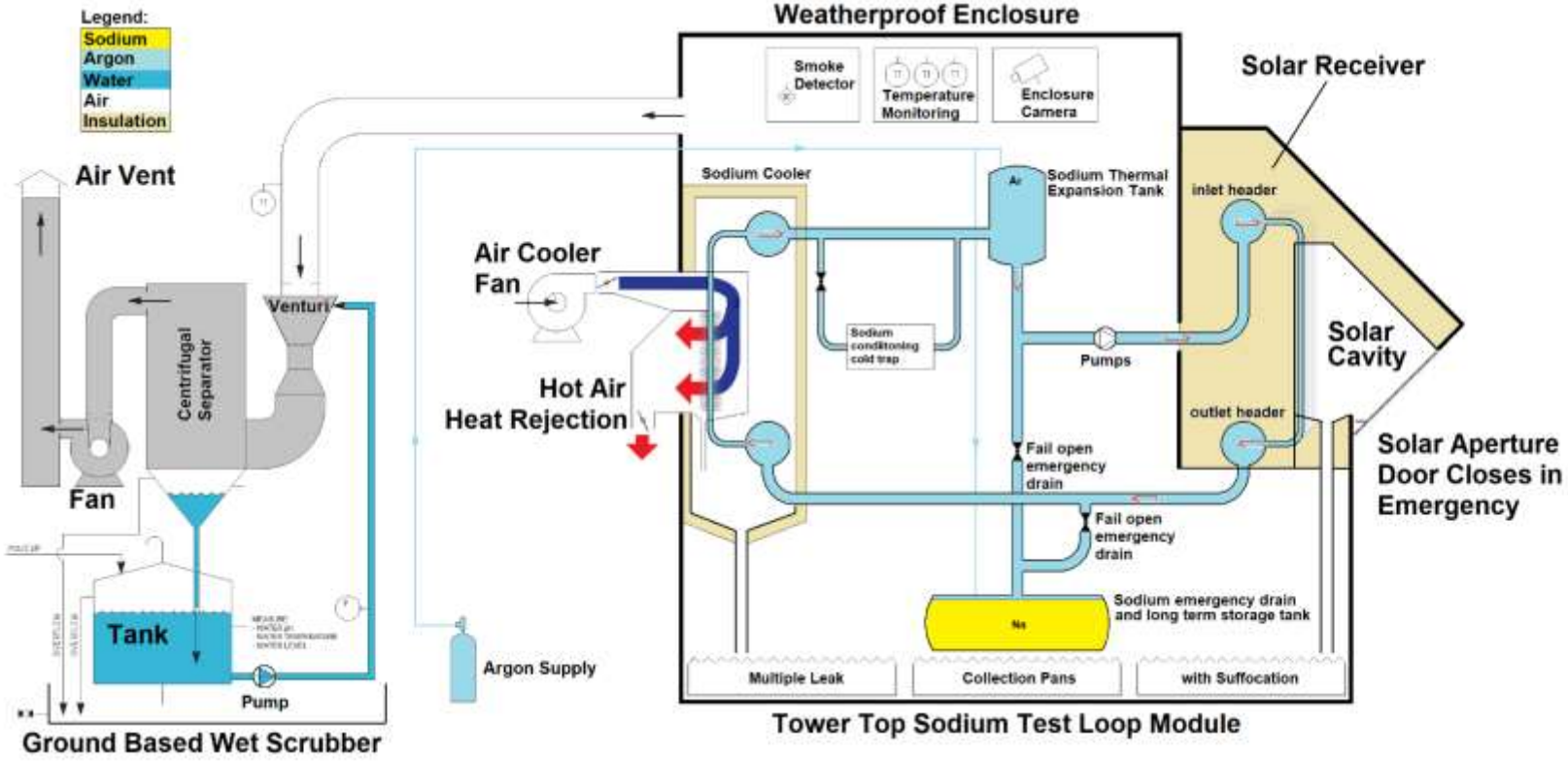
Basic specifications:

- **700kW** prototype Solar Receiver.
- Temperature range of **520-740 °C** (matching Gen3)
- Sodium Cooling capacity is ~**1MW** rated up to **740 °C**.
- Sodium Inventory **250 kg**.
- Peak sodium flow **4 kg/s** (nominal **2.6 kg/s**).
- In a self-contained compact transportable module for:
  - off-site maintenance, or
  - deploy elsewhere.

Outcomes:

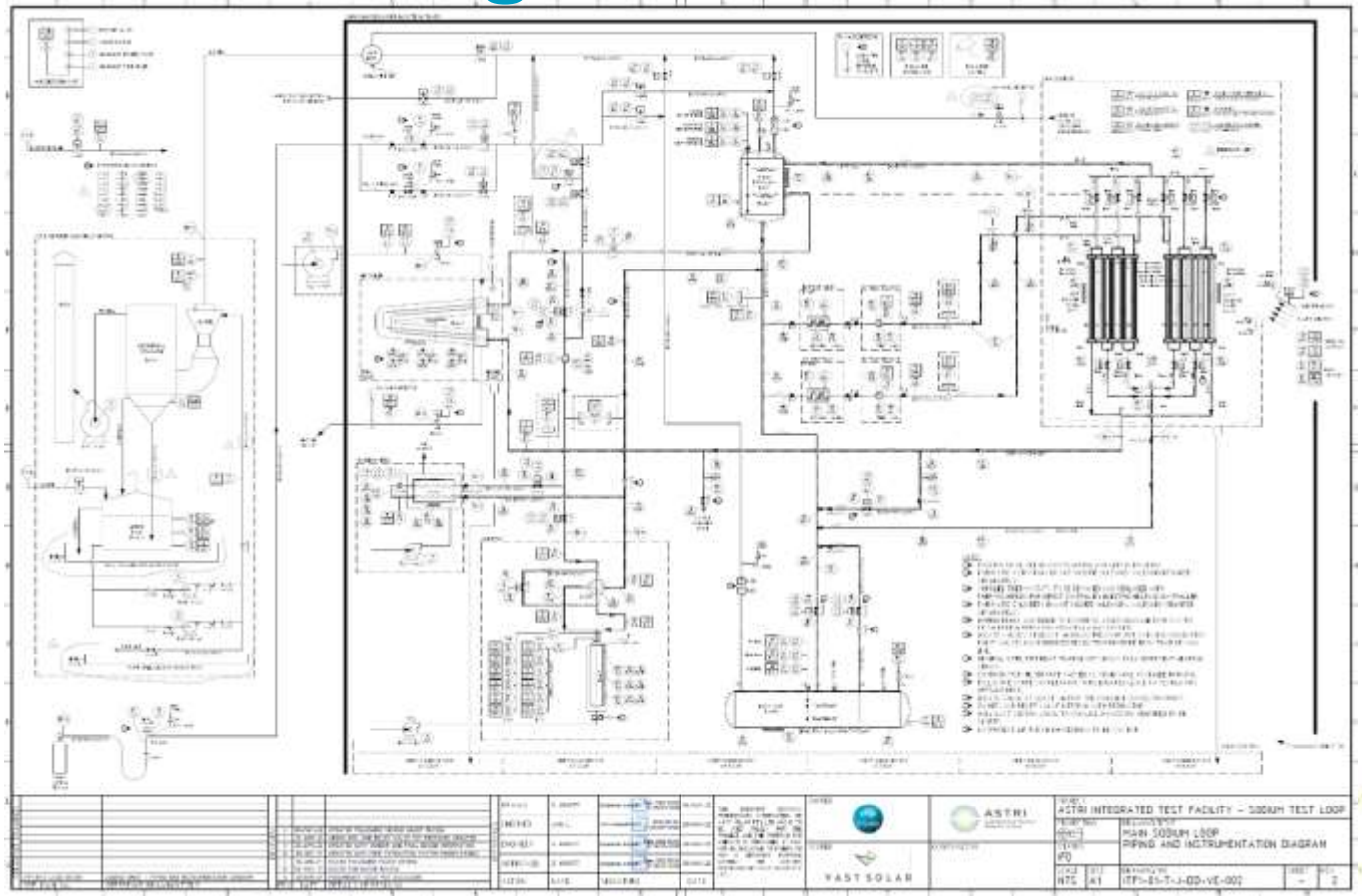
- Learn methodology to de-risk and operate a high-temperature sodium test loop on-sun at CSIRO.
- To attract interest from Industry, and
- Engage Industry who want to use the technology & test with sodium.
- Design an intrinsically safe system, which prevents loss of sodium containment.

Building in Layers or Protection



Sodium Safety System Schematic

Process Design

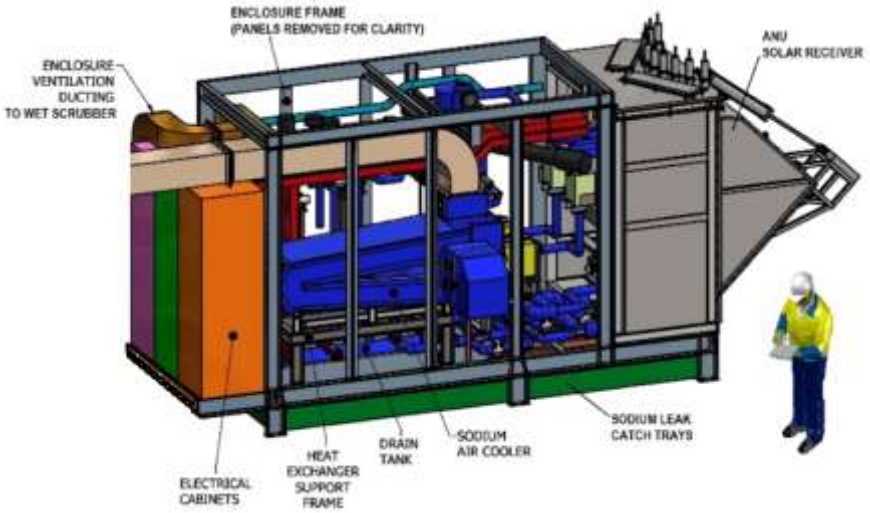


Detailed P&ID of the:

1. IFT Sodium Test Loop

2. Wet Scrubber for sodium smoke extraction (left hand side).

The Sodium Module



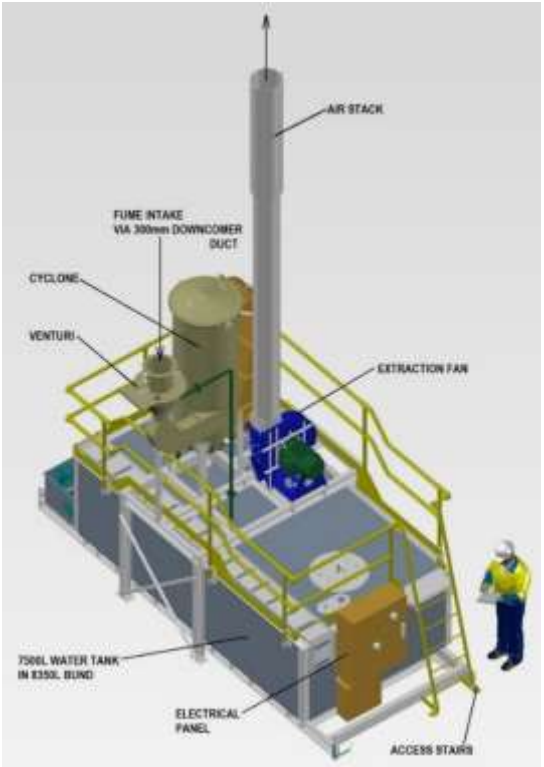
Module as designed

Module as built

Three operating modes:

1. Sodium in drain tank & frozen (off-line, long term lay-up, or for transport).
2. Sodium on heat trace in recirc mode up to 300 °C (standby).
3. On-Sun mode with sodium solar heated up to 740 °C at receiver outlet.

Wet Scrubber Module



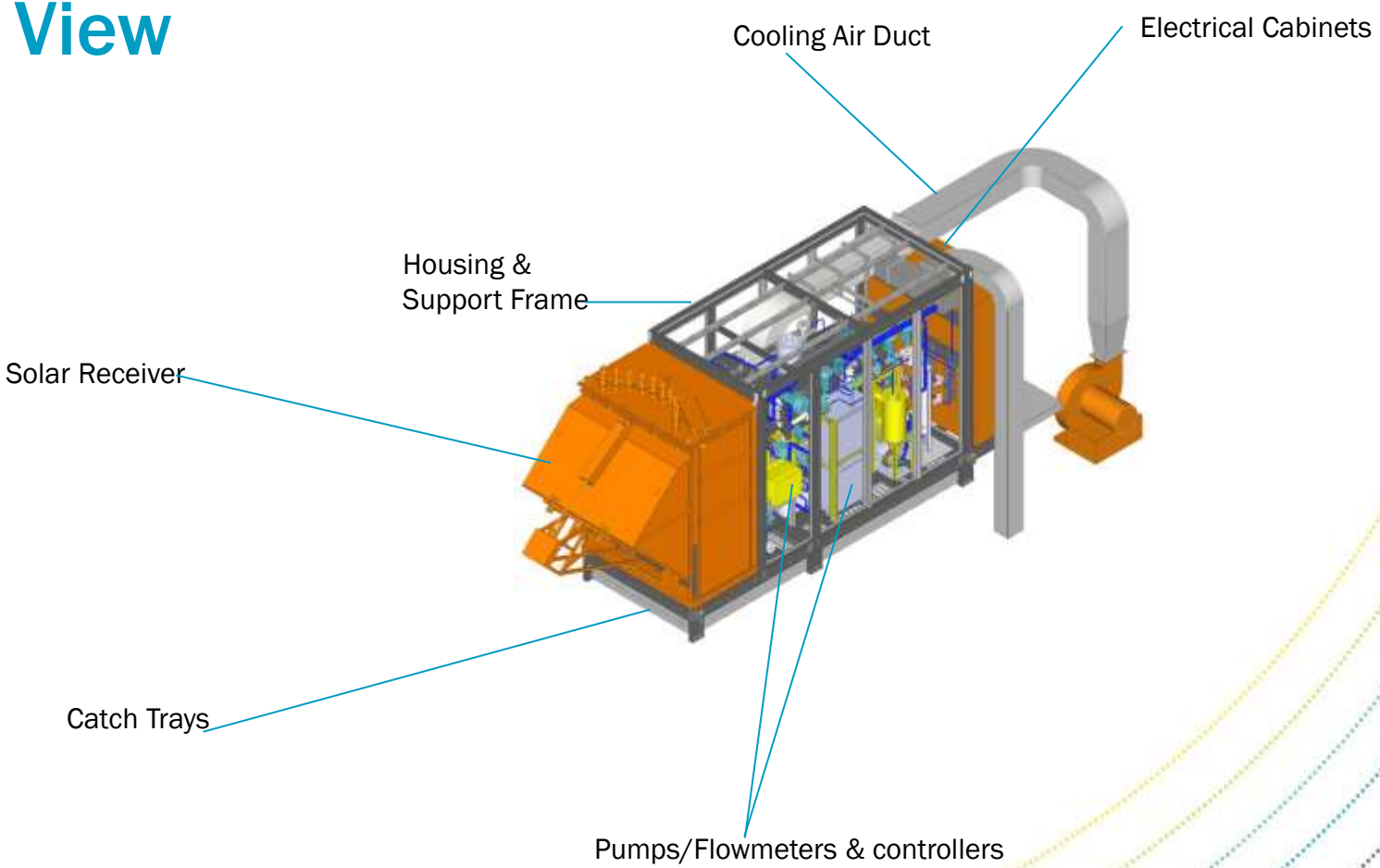
Scrubber module as designed

as built

Functions:
Air extraction fan
40% speed as cooling for electrical items
100% speed for fume extraction

7,500 L of water
300mm intake duct
Wet venturi entrainment

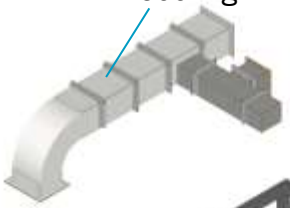
3D View

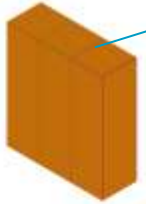

Cooling Air Duct
Electrical Cabinets
Housing &
Support Frame
Solar Receiver
Catch Trays
Pumps/Flowmeters & controllers

3D View Exploded

Sodium Cooler

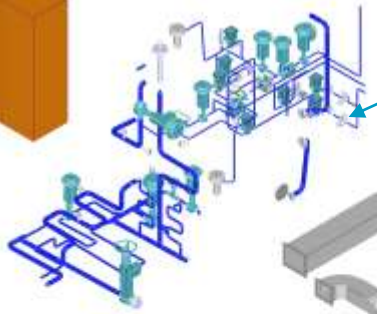
Cooling Air Duct



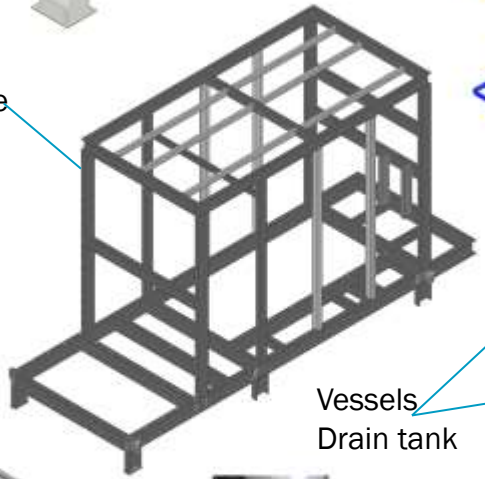


Electrical Cabinets

Piping System



Housing &
Support Frame



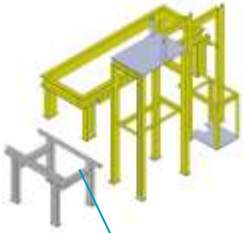
Solar Receiver

Vessels
Drain tank

External
Air Ducts

Catch Trays

Pumps/Flowmeters & controllers



Equipment Supports

Construction activity Aug 2022 to April 2023

Commissioning activity May to August 2023

Tests Conducted

- All electrical power systems
- Heat tracing system
- Sodium melt and system fill (250 kg)
- All sensors tested, corrected, and tested again.
- Argon cover gas system tested.
- Sodium cold trap and plugging meter (sodium conditioning devices)
- Piping fill from drain tank and drain down tested.
- Sodium circulation pumps and flowmeters
- Expansion tank and level probes tested/adjusted.
- **Complete rigorous Shake-Down testing of all control and safety systems (August 2023).**
- Sodium smoke fume wet scrubber remaining at Jemalong for further tests concluding Dec 2023.

Sodium Module Delivered to CSIRO in October made ready for the SolarPACES Technical Tour!

Site Installation at CSIRO

Sodium module installed

Level 5 platform extension

Solar Tower 2 with falling particle system atop

With Ducting

Conclusions

- Built a Sodium test loop for On-Sun testing of solar receivers and related equipment.
- Not only that, but the system is designed to be modular and entirely self-contained to operate as an Intrinsically Safe System.
- Learned how to de-risk and apply best practices for designing, constructing, maintaining, and operating a high temperature sodium test loop.
- Engaged industry that have experience with sodium or seek knowledge and invite involvement - VAST, as a Project Partner and Collaborator (Great Outcome).
- To create impact through demonstration with industry already on board as partnership, and the role of VAST as a path-to-adoption.
- Solar field commissioning and performance tests planned for early 2024.

Acceptance of Emergency Shutdown

Thank you

Question time

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Acknowledgements

Contributors:

- The team at **VAST**
- **The ASTRI and CSIRO teams**