



# OPTIMUS

## Observing with Parkes, Training & Introduction, Module for University Science

Robert Hollow

6 July 2017

ASTRONOMY AND SPACE SCIENCE

[www.csiro.au](http://www.csiro.au)



# Challenge

- Develop and implement engaging radio astronomy activities for high school students
- Provide opportunity for students to use a national facility and engage with professional scientists
- Have students doing science that is appropriate for them and useful for professional astronomers



PULSE@Parkes

*PUL*sar Student *Expl*oration online at Parkes

We have a large telescope



We have scientific expertise



We have a successful education package for high school students



# PULE@Parkes:

<http://pulseatparkes.atnf.csiro.au/>

- Free high school education program
- Aimed at students Yrs 10-12
  - Pre-observing school visit
  - Maximum ~ 24 students
  - 2 hours telescope time, remote observing
  - Online data analysis module
  - Interaction with scientists, PhD students & other schools
- Opportunity for follow-on student investigations

# Our progress

- Started, November 2007
- > 130 sessions to date
- Australian sessions in NSW, Victoria, Western Australia, ACT
- International sessions in at Cardiff, Oxford, Astron in Netherlands, Canada + 2 x tours to Japan, 2 tours to China,
- Special sessions for teachers in Canberra, Perth, Adelaide, Brisbane & Toronto.

# Our students

- ~ 1,700 students, ~ 260 teachers
- ~ 140 schools
- Yrs 10-12, some 9s and 7s
- Strong repeat demand from schools
- Strong engagement from girls' schools





# Useful Points

- Web-based
- No need to install anything
- Make resources tablet-friendly
- Ensure data is free and archived

# Our science

- 2 science papers so far + 1 in progress
- Nulling pulsars are REALLY INTERESTING!
- Students working on data analysis
- Spin-off observing project P863
- Undergraduate Vacation Scholarship student projects.

# Where we started

*... let's take PULSE@Parkes to the next stage ...*

- “let’s engage university level students in science using our iconic radio telescope”
- “let’s give students the opportunity to make real scientific discoveries.”

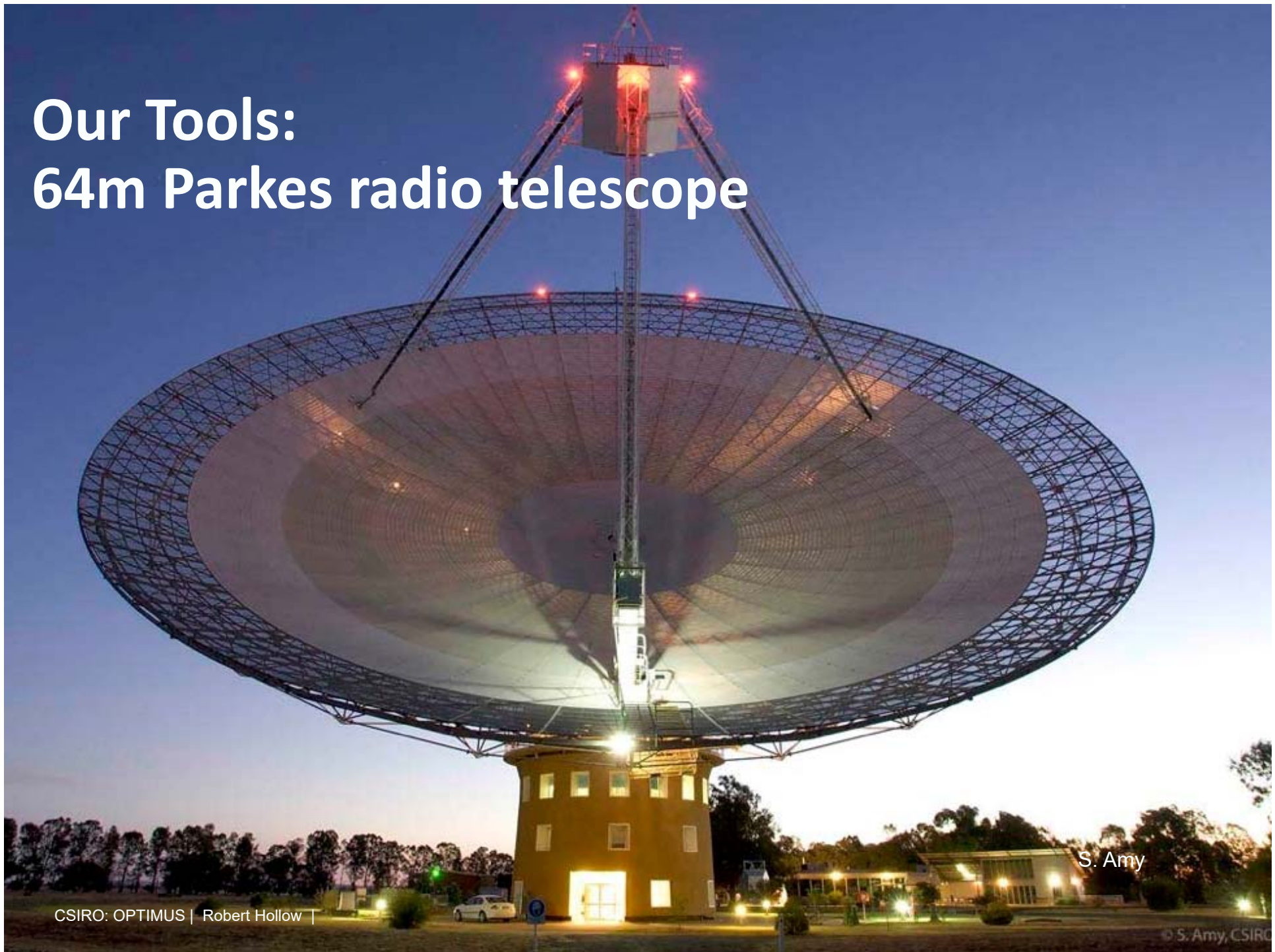


-> we went on CSIRO’s OnPrime course

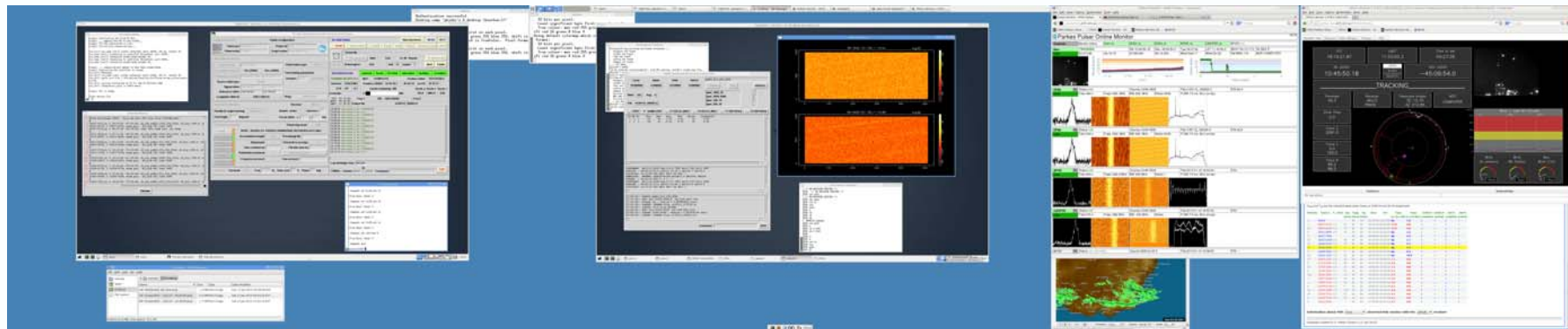
# University Package - OPTIMUS

- IPTA schools, Sydney, South Africa
- Undergraduate projects –3<sup>rd</sup> year with Macquarie University
- Undergraduate Vacation Scholarship project 2016/17
- ON Prime business accelerator development of a teaching package:
  - Educational materials
  - Observer training
  - *N* hours of telescope time
  - Online support
  - Access to data and software tools
  - Hands-on access to major facility to differentiate undergrad program

# Our Tools: 64m Parkes radio telescope



# Remote observing



# TCS: Telescope Control Software

The screenshot displays the Telescope Control Software (TCS) interface, which is divided into several functional panels:

- Telescope Information:** Shows 'Telescope' as Parkes 64m and 'Observer(s)' as LT RMS. Project details include 'Project id' P456 and 'Project name' P456\_MB\_DFB3.
- ANTENNA CONTROL:**
  - Source name: J1045-4509
  - Observation type: TRACK
  - Coordinate system: RA (J2000) and Dec (J2000)
  - Catalogue position: 10h45m30.180s, -45°09'54".10
  - Track timing parameters: Duration 3840 SECONDS
  - Source offset type: NONE
  - Signal offset: +00°00'00" (RA), +01°00'00" (Dec)
  - Reference offset: +00°00'00" (RA), +01°00'00" (Dec)
  - Longitude offset is: ARCLENGTH
  - Wrap: SHORTEST
- RECEIVER CONTROL:**
  - Receiver: MULTI
  - Parallactic angle tracking: DISABLED
  - Beams: active 1, reference 1
  - Feed angle: 0.0 degrees
  - Focus offset: y 0.0, z 0.0 mm
- PULSAR BACKENDS:**
  - Observing mode: PSR
  - Backend: BPSR - BERKELEY-PARKES-SWINBURNE RECORDER (OFFLINE)
  - Accumulation length: 25
  - Processing file: [empty]
  - Bits/sample: 1
  - Channels to average: 0
  - Time constant (s): 1
  - File time max (s): 0
  - Polarization products: 1
  - Wind park mode: [unchecked]
  - Frequency scrunch: 1
  - Time scrunch: 1
- SYSTEM STATUS:**
  - Buttons: STOP, Start TRACK, Drive, Tsys, Park, Stow, Unstow-ExLim, Check
  - Sched file: /nts/psr1/cs/sched/P456/P456\_MB\_DFB3.sch
  - Record mode: [unchecked]
  - Schedule: Start 14, End 15 of 46 Repeat 1, Start sched [checked]
  - Sched agent: GUI, unit 15, repeat 1
  - Buttons: Next, Finish
  - Subsystem tabs: antenna, focus, LO chain, attenuator, auxiliary, correlator
  - Running Sched File: MCP, COMPUTER, Position offset, REFERENCE
  - Antenna: TRACKING, Position (J2000) 10:45:50.1, -45:09:54 at UTC, 18:10:15
  - ETA: 0.0, 0.1
  - Cycles remaining: 326
  - focus-y: 195.0, focus-z: 2081.0, focus-r: 0.00
  - Controller: 0, 384
  - UTC: 18:10:23, AEST: 04:10:23, LMST: 11:33:01
  - Freq 1: SIG 1369.000000, Freq 2: -
  - Output file: s130112\_180025.rf
  - Log messages: 18:09:05: recv value: p\_trk = DISABLED, p\_rot = 0.0; 18:09:15: recv value: p\_trk = DISABLED, p\_rot = 0.0; 18:09:25: recv value: p\_trk = DISABLED, p\_rot = 0.0; 18:09:35: recv value: p\_trk = DISABLED, p\_rot = 0.0; 18:09:45: recv value: p\_trk = DISABLED, p\_rot = 0.0; 18:09:55: recv value: p\_trk = DISABLED, p\_rot = 0.0; 18:10:05: recv value: p\_trk = DISABLED, p\_rot = 0.0; 18:10:15: recv value: p\_trk = DISABLED, p\_rot = 0.0
  - Log message entry: Remark: 50
  - Buttons: EXIT

# FROG

Synoptic View | Webcams | Ignored Alarms | TPS Status | TCS Error Log | Help

## TRACKING



J2000

RA J2000	Dec J2000
19:01:55.50	-36:57:37.9

UTC	LMST
06:38:52.88	15:57:40.5

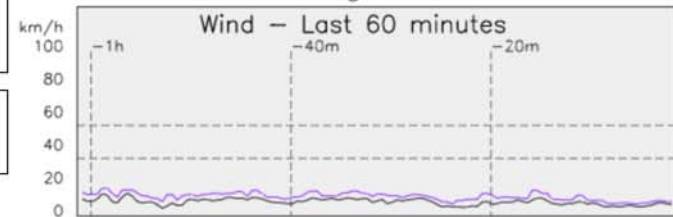
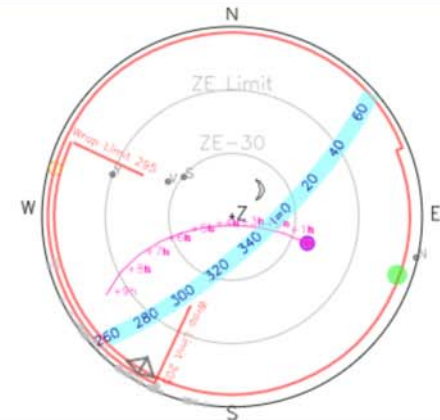
AZ	ZE
109.39	37.76

Control  
**COMPUTER:  
REMOTE**

Receiver  
**1050CM**

AEST  
**16:38:57.96**

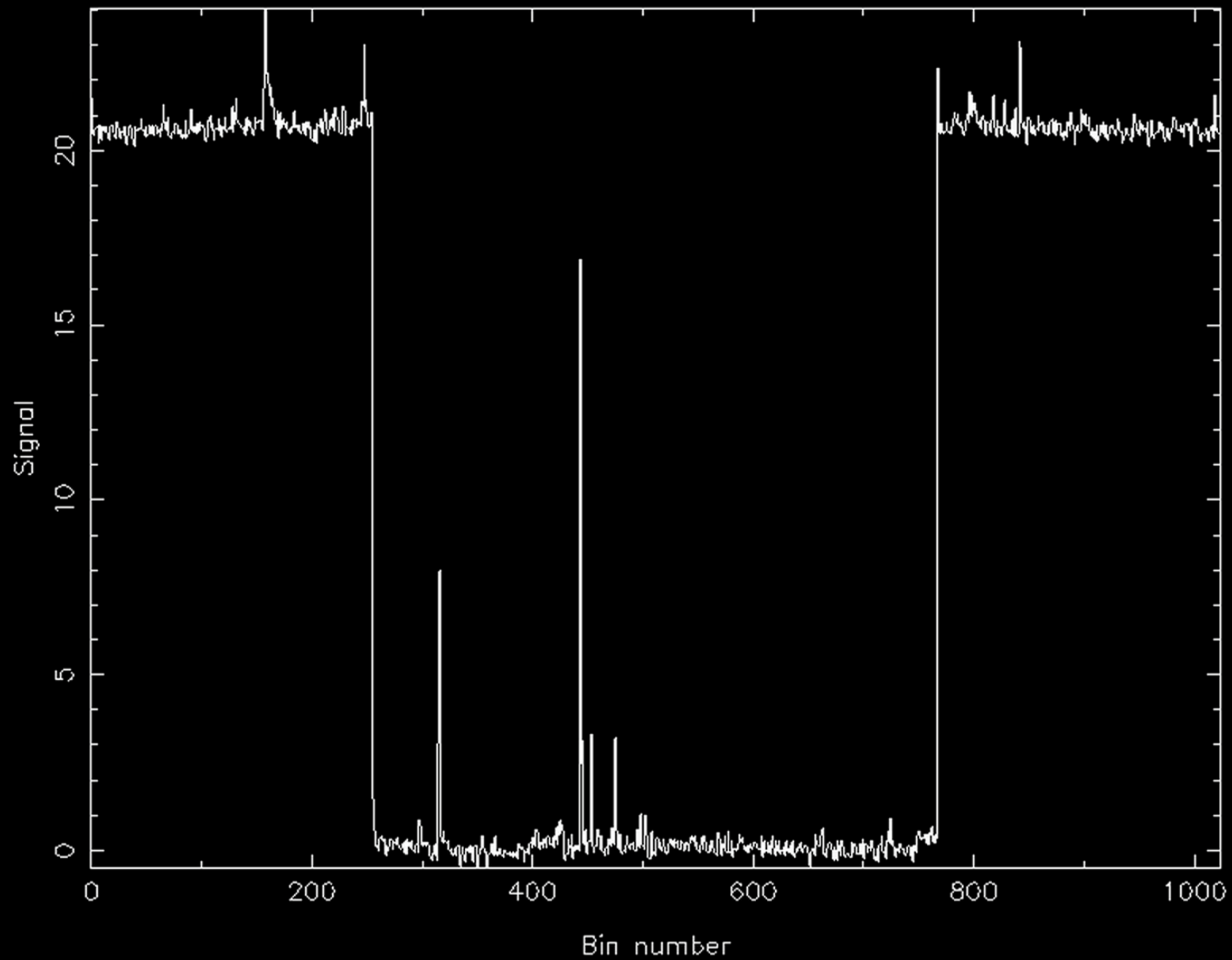
Time to set  
**08:04:03**



UTC	Alarm Name	Priority	Guidance	Acknowledge	Ignore
No alarms.					



/nfs/PKCCC3\_1//s131205\_010925.cf




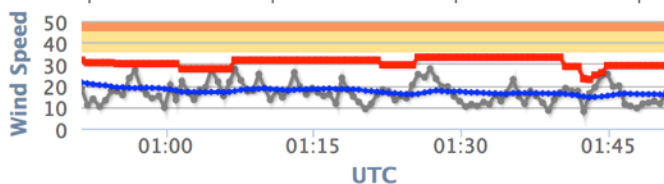
# Live Web-based Data Monitor

<http://www.parkes.atnf.csiro.au/online/psrmon/>

**CSIRO Parkes Pulsar Online Monitor** MUTE

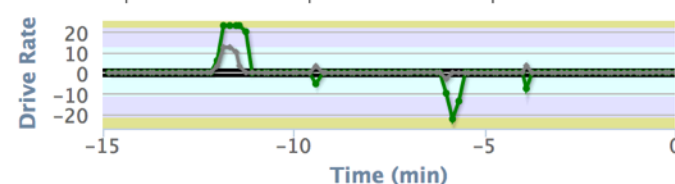
<b>Controls</b>	Monitor status:	64m:ok	DFB3:ok	DFB4:idle	APSR:idle	CASPSR:idle	BPSR:idle	
<b>64m</b>	<b>DISH IS STATIONARY</b>	RA:17:18:33.38	Dec:-41:03:06.3	Tset:01:28:49	LST:20:57:09.4	AEST:11:50:44.9	Rx:MULTI	
<b>Live</b>	Az:243.06	Ze:43.47	Gl:346.836	Gb:-1.997	Wind Spd:11	Wind Dir:314	Rel WDir:72	MCP:COMPUTER





Wind Speed

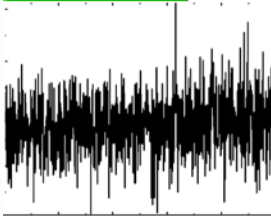
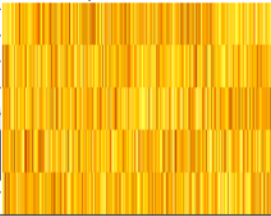
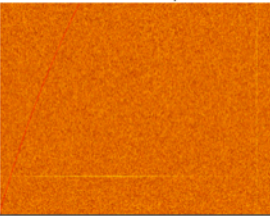
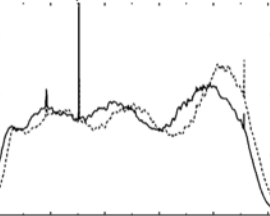
UTC



Drive Rate

Time (min)

<b>DFB3</b>	^^	Status:fold	Source:J1717-4054	File:s130208_014657.rf	S/N:7.2	
<b>Live</b>		Tobs:146 s	Freq:1369. MHz	BW:256. MHz	Nchan:1024	P,DM:887.7 ms, 308.5 cm-3pc

<b>DFB4</b>	^^	Status:not_recording	Source:J0835-4510	File:t130207_224045.cf	S/N:
<b>APSR</b>	^^	Status:not_recording	Source:J1729-2121	File:2013-02-07-23:05:00	S/N:--
<b>CASPSR</b>	^^	Status:not_recording	Source:J1546-4552	File:2013-02-07-17:21:44	S/N:--
<b>BPSR</b>	^^	Status:not_recording	Source:G014.5+16.9	File:2013-02-07-23:43:15	S/N:--

Also includes live webcam

# The pain: Interviews

We interviewed 103 people!

*“We’re looking for a follow-on from our astronomy course for more advanced students”*

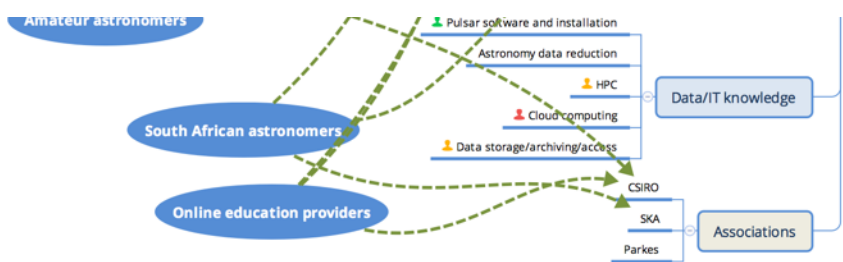
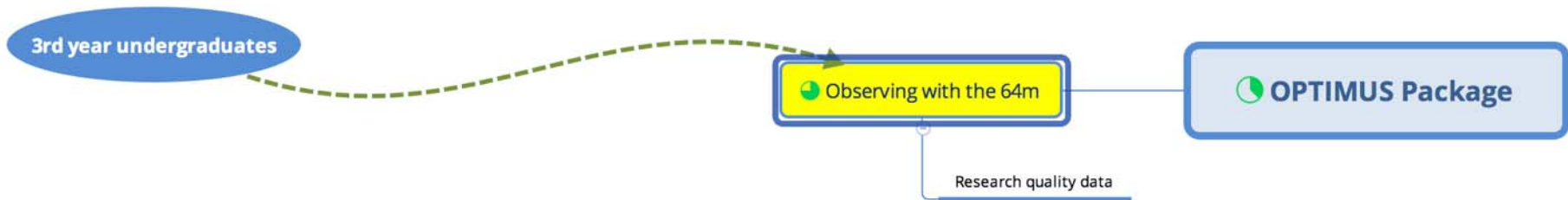
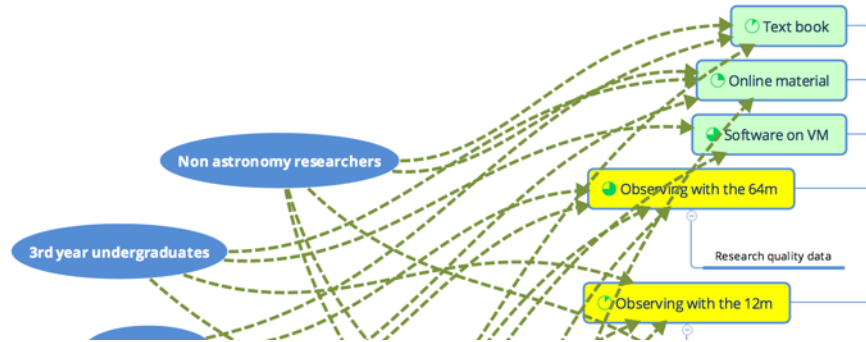
(Maura McLaughlin, West Virginia University)

# The pain

*“We’re looking for a project relating to large data sets, cloud computing and China”*

**(Stefan Gillard, engineroom.io Director)**

# After a few weeks in OnPrime



# Our learnings in the OnPrime course

Huge interest from diverse groups



# Our learnings in the OnPrime course

## Interest in the 12m telescope at Parkes

Interview respondees:



A big telescope

25%



A small telescope

34%



+



Both

34%

6% don't want a telescope!

# Our Tools: 12m Parkes Testbed Facility





# Four viable products

## Undergraduate students:

Interest so far: Macquarie University, multiple US universities, multiple Indian universities

Want: teaching material, access to real data, ability to use a small (12m) telescope

## Research institutes:

Interest so far: Kumamoto University, Xingjiang Astronomical Observatory

Want: training on 64m telescope, pulsar software, installation guide

## Astronomy online course providers:

Starting discussion with Swinburne Online Astronomy Course

Want: plug-and-play extension to radio astronomy module allowing students to use an iconic telescope

## Advanced, international high school students:

Interest so far: Chinese high schools

Want: projects relating to astronomy and real data sets.

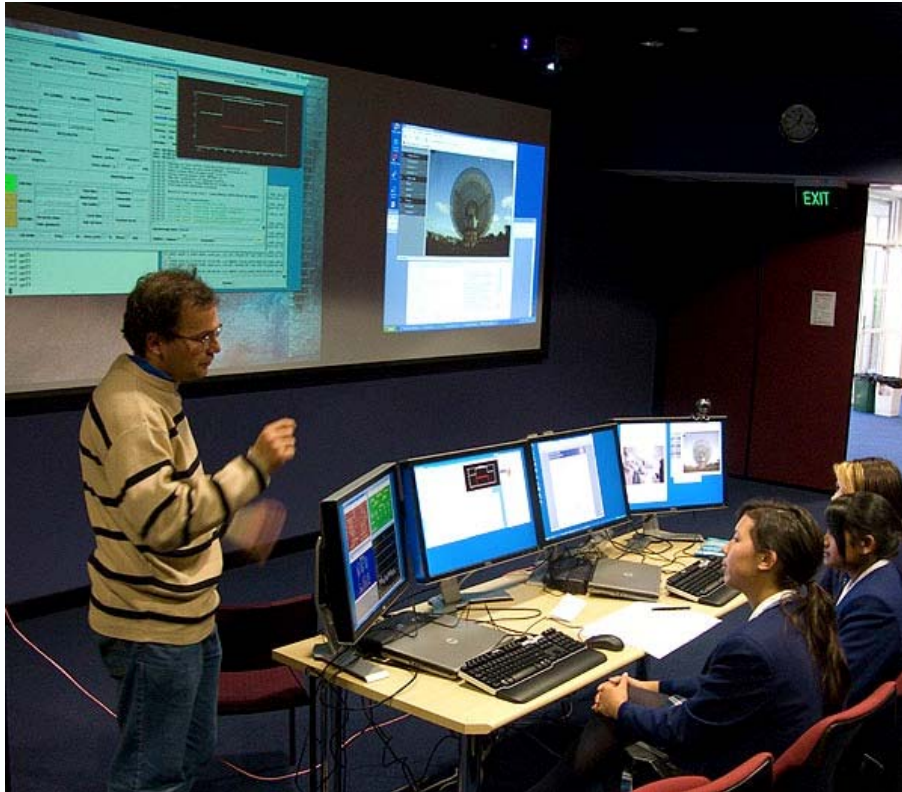
# Our products

- Website: <http://pulseatparkes.atnf.csiro.au/>  
(upgrade coming soon!)
- Data archive:  
<http://pulseatparkes.atnf.csiro.au/database>
- Distance analysis module:  
<http://pulseatparkes.atnf.csiro.au/pulsardistance/>
- Pulsar online monitor – real time data:  
<http://www.parkes.atnf.csiro.au/online/psrmon/>

# Our issues

- Scalability of observing sessions – telescope time
- Telescope scheduling out of sync with schools
- How to follow through with student engagement
- Linkage to curriculum
- Staff commitments
- Wind stow or technical problems in observing sessions?

# Observing - Early days



# Observing now



# Japan & China Tours – 2013 - 2016

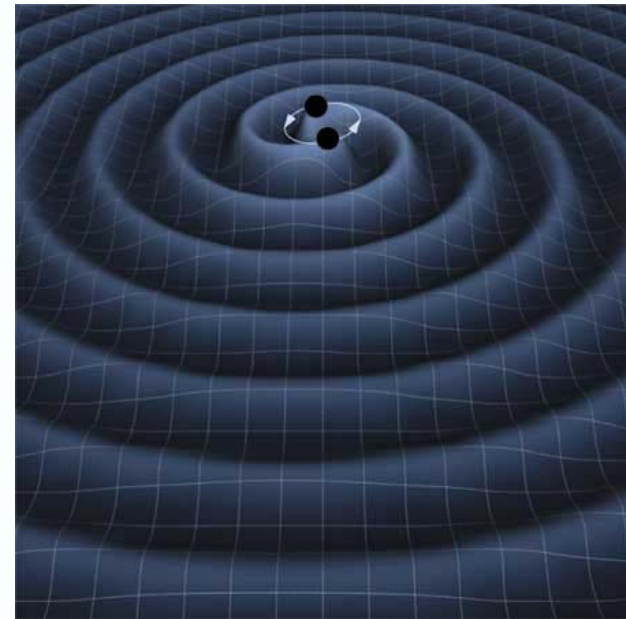
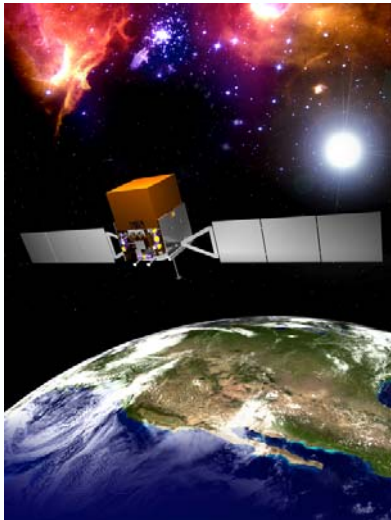


CSIRO: OPTIMUS | Robert Hollow |



# What else are observations be used for?

- NASA's Fermi gamma-ray space mission
- Pulsar timing irregularities – nulling & intermittent pulsars, glitches
- The timing array project to detect Gravitational Waves
- FRBs and Perytons





# Our plans!

- More modules
  - Spin-down rates – pulsar age
  - Sound files & Pulsar piano!
  - Single pulses
  - Pulsar navigation
- Toolbox for student investigations
  - Schools
  - Undergraduates
- Enhance data archive
- More remote remote observing

# More plans & opportunities

- Trialled student investigation with International Baccalaureate student (Extended essay)
- 2017 tour to South Africa
- Possible tour to Thailand
- Major public event in Perth in December (IFLS?)
- Extend concept to eg spectral line & maser observations
- Massive data sets from ASKAP & SKA era

# What have we learnt?

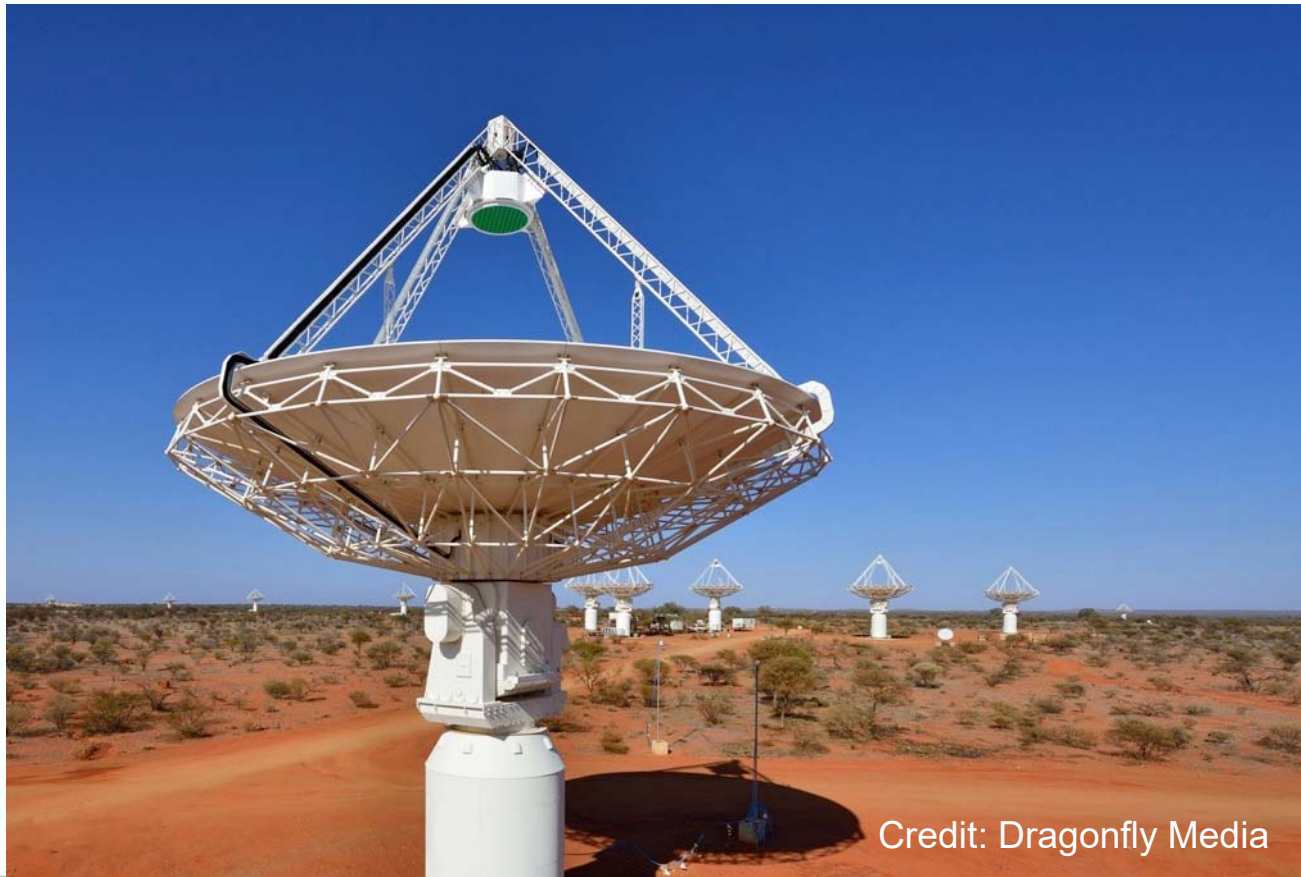
- Students can be engaged with radio astronomy data
- Interactions are valuable! Interviews!
- Pulsar observations provide rapid and dynamic feedback
- Students appreciate use of authentic software
- Be flexible with design and delivery of programs
- High demand for real data so make your open and accessible

# What have we learnt?

- Radio astronomy generally less weather dependent
- Real-time observing challenges are educationally useful
- Be flexible with delivery
- Data can be used for science

# Our plans!

- Develop radio astronomy educational activities for ASKAP & SKA – Massive data challenge



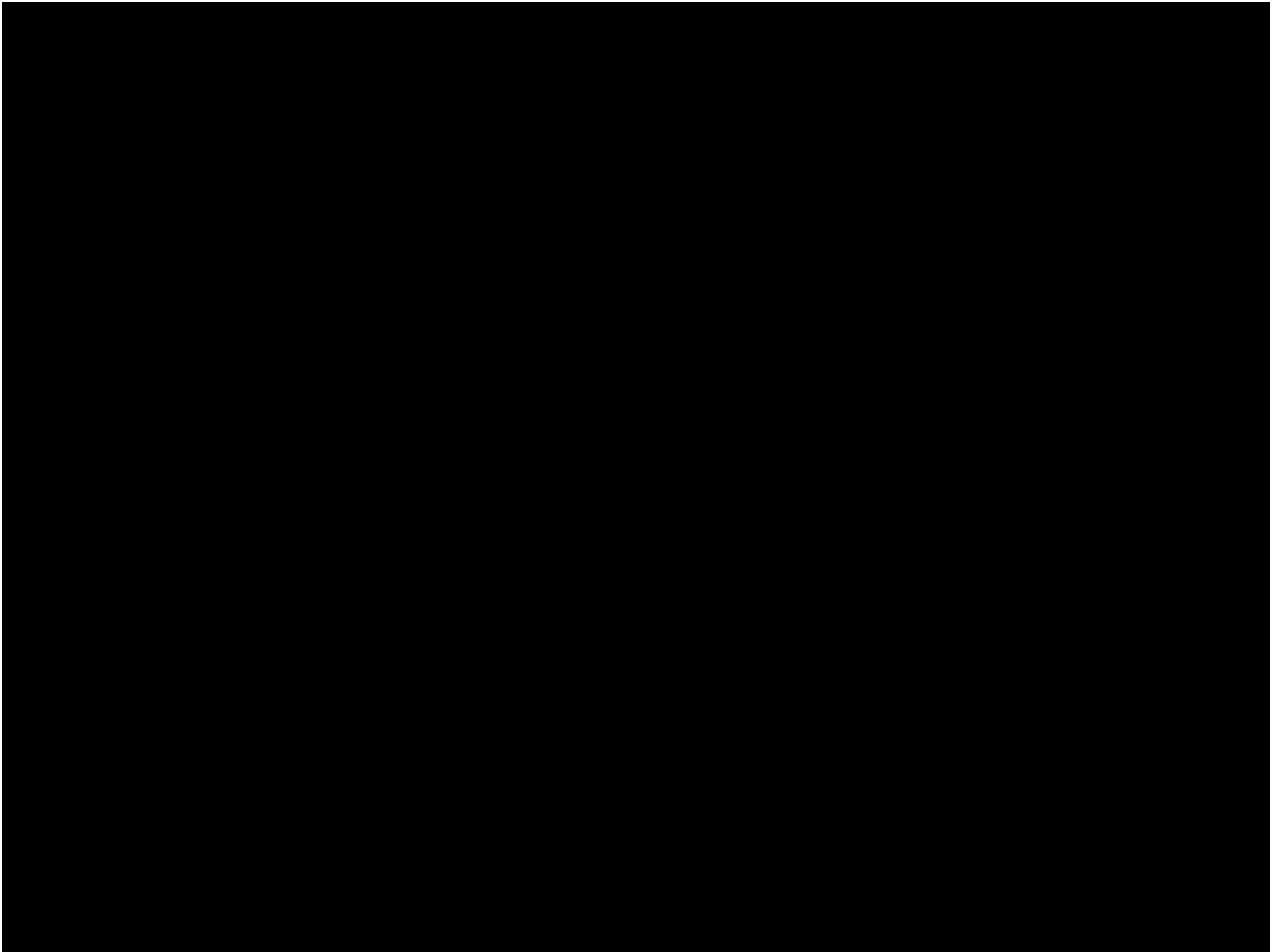
Credit: Dragonfly Media

# Interested?

Please contact me:

[robert.hollow@csiro.au](mailto:robert.hollow@csiro.au)

Drop by the CASS booth for a flyer



# Thank you

**CSIRO Astronomy and Space Science**  
Robert Hollow

Education Specialist

**t** +61 2 9372 4247

**E** robert.hollow@csiro.au

**w** <http://www.atnf.csiro.au/>

Twitter: @roberthollow

**ASTRONOMY AND SPACE SCIENCE**

[www.csiro.au](http://www.csiro.au)

