Observing Strategies and the art of Science Proposal Writing

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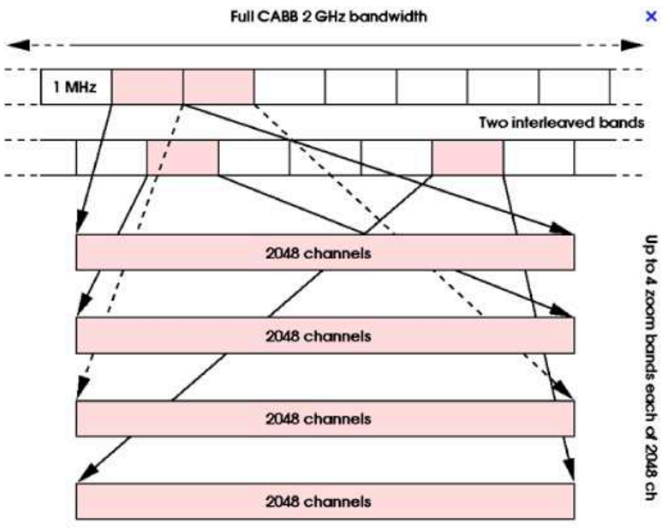
CASS Radio School, Narrabri, September 2017

Outline

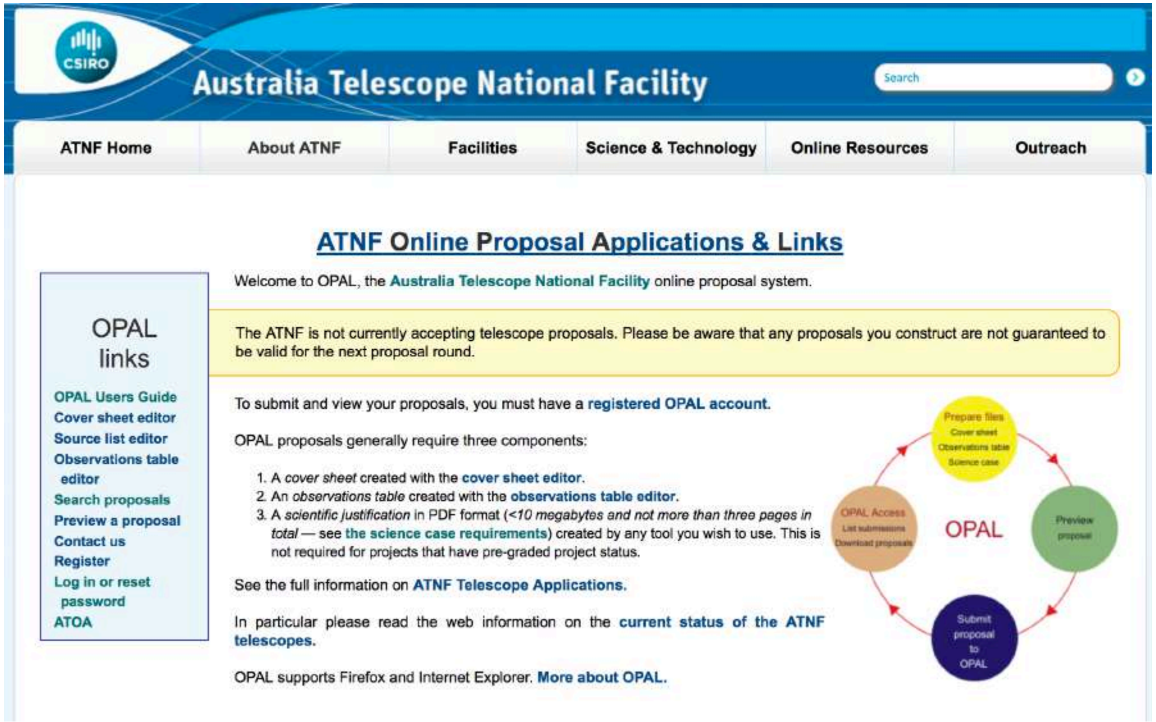
- Why is a good observing strategy important?
- Things to think about
  - What, when, for how long, frequency, array, overheads, CABB mode?
- Observing
  - The simple cm case
  - Slightly less simple cases
  - The mm case
  - Spectral lines
- Turning your plan into a winning proposal



The importance of a good strategy

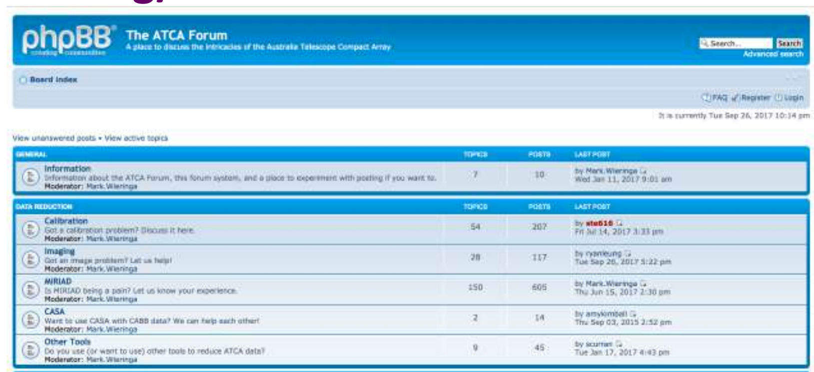
- Starts taking shape at the proposal stage
- Good telescopes are generally oversubscribed (ATCA usually by 2 – 3 times)

- Need to have a good plan to get good data that meets your science goals
- Make sure you are familiar with the current status of the instrument



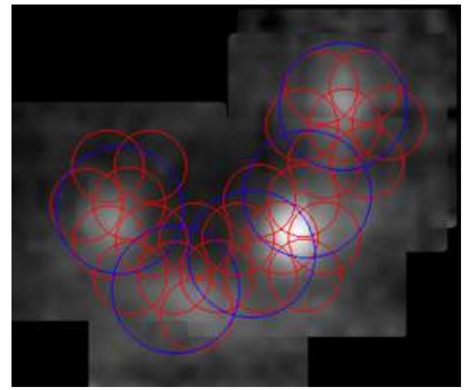
Lots of resources

- Talk to postdocs, other ATCA users, ATNF “friend”, DAs etc and **http://www.narrabri.atnf.csiro.au/observing/**
- The ATCA users guide: **http://www.narrabri.atnf.csiro.au/observing/users_guide/html/atug.html**
- The ATCA forum: **https://atcaforum.atnf.csiro.au/**
- ATCA current issues: **https://www.narrabri.atnf.csiro.au/observing/CurrentIssues.html**
- CABB: **https://www.narrabri.atnf.csiro.au/observing/CABB.html**
- OPAL: **http://opal.atnf.csiro.au/**

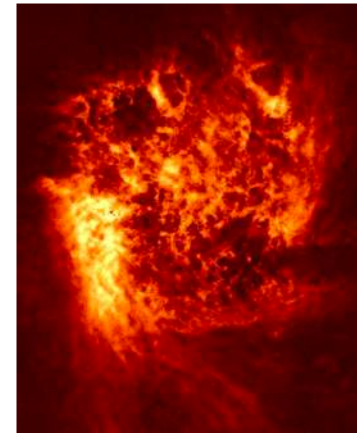


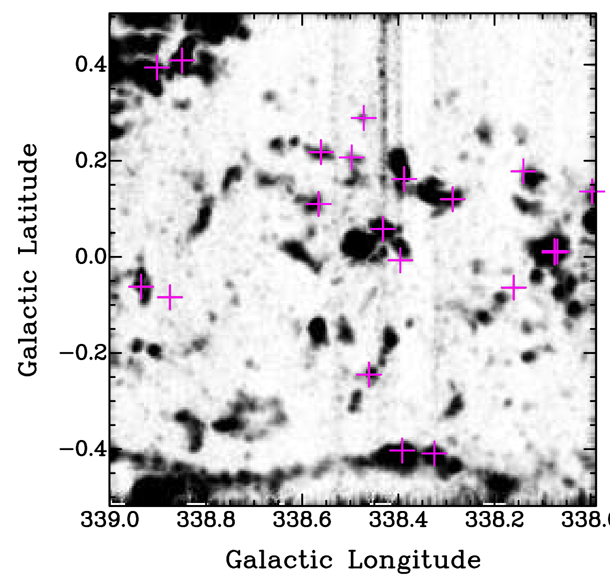
Things to think about – 1) What?

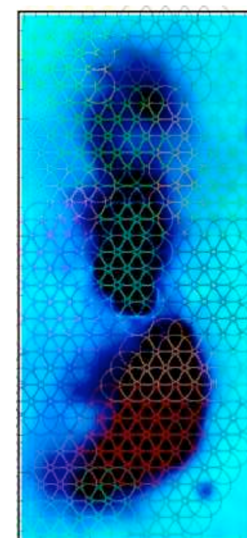
- Strategy dependent on science/object!
  - Complicated extended structure? → might need multiple array configs and single dish data
  - Point source? → a handful of short cuts over several hours might be enough
  - Know where your object is and just need a flux measurement or spectrum? → 1 short observation might be enough
  - Shadowing?
  - Confusion?
  - Location? Dec 0?
  - Mosaic? (primary beam λ/D)
  - Continuum and/or spectral line?



Kim et al.

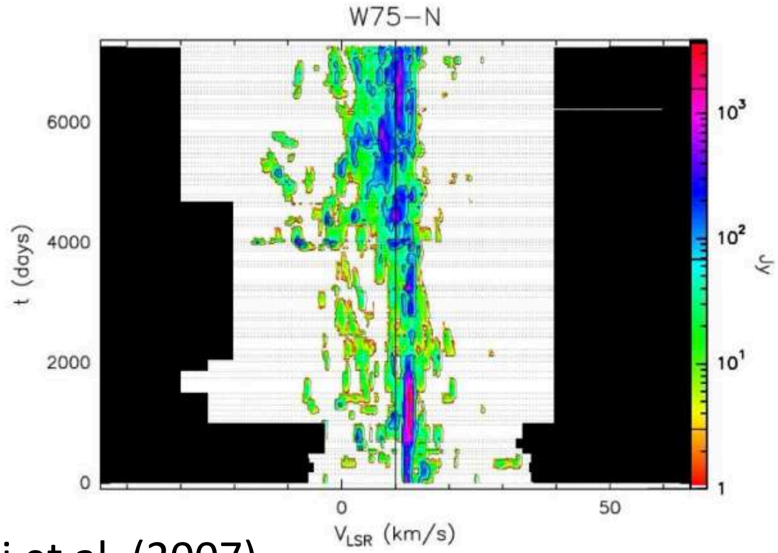




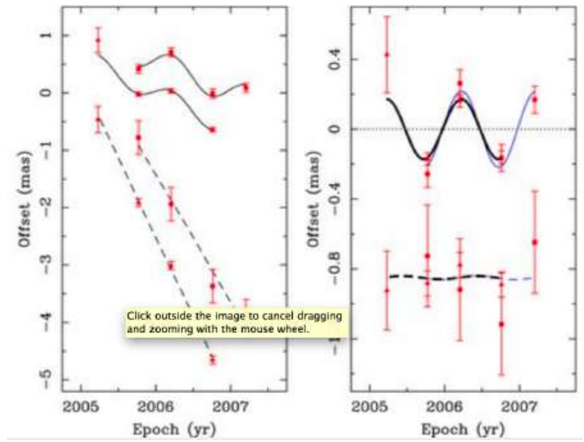


Things to thing about – 2) When?

- Variable source?
  - observe when it is expected to be bright
  - Or track the flux with observations spread over multiple epochs
- Coordination with other telescopes?
- Weather?
  - Atmosphere generally more stable during winter and at night → better mm observing
  - Generally less interference at night at the lower frequencies too (man made and solar)
  - Thunderstorms during afternoon in summer



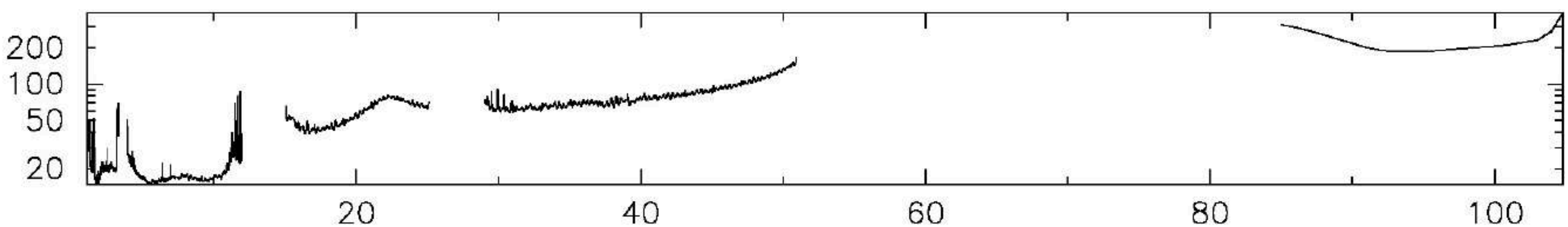
Felli et al. (2007)



Sanna et al. (2009)

Things to think about – 3) Frequency?

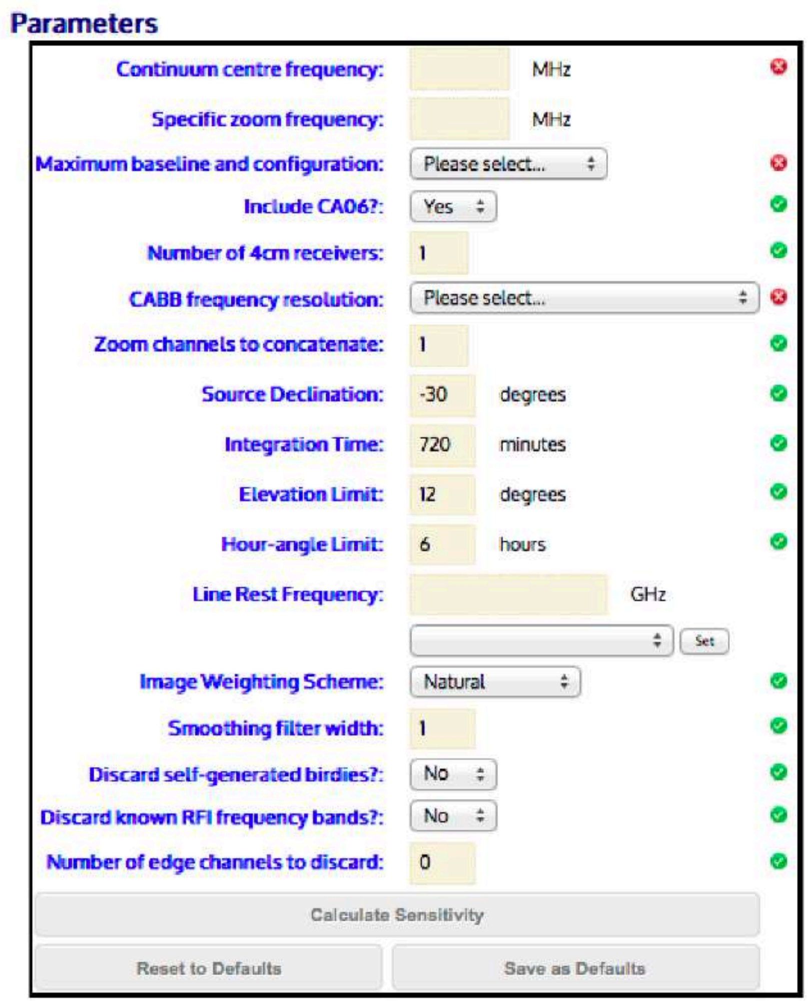
- Usually driven by science
  - Lines?
  - Remember to consider how the telescope performs at different frequencies
  - Spread the 2 IFs as far apart as possible, or continuous coverage?
  - Take the receiver limitations into consideration (e.g. the 13cm receiver works between 1.1 and 3.1 GHz)
  - ‘Standard’ continuum frequencies



Band	IF1 (MHz)	IF2 (MHz)
16cm	2100	2100
4cm	5500	9000
15mm	~~17000~~ 16700	~~19000~~ 21200
7mm (LSB)	33000	35000
7mm (USB)	43000	45000
3mm	93000	95000

Things to think about – 4) For how long?

- Mostly dictated by required sensitivity
  - Effective BW and spectral resolution
- UV coverage (e.g. bright spectral lines)
  - Short integrations across a range of hour angles increases overheads BUT may be the most efficient use of time to cover many sources



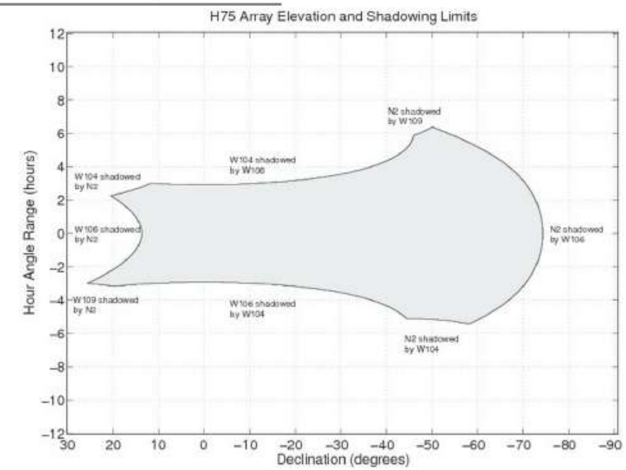
http://www.narrabri.atnf.csiro.au/myatca/interactive_senscalc.html

Things to think about – 5) Array?

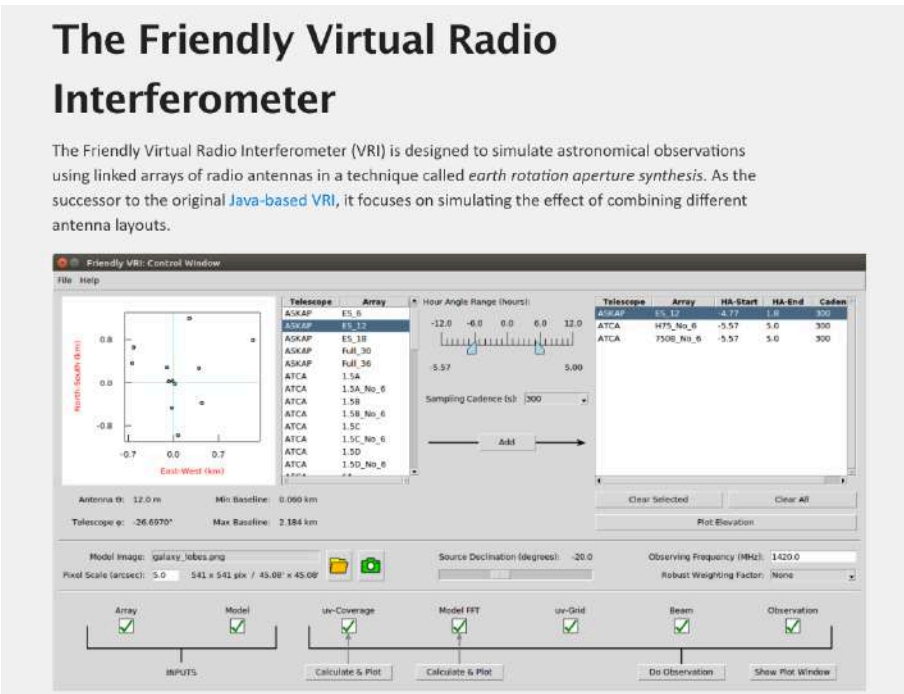
- Dictated by:
  - the resolution required
  - uv-coverage requirements (specific arrays work well together – 6A, 6C, 1.5B, 1.5D)
  - What's offered
  - Where your source is – shadowing?

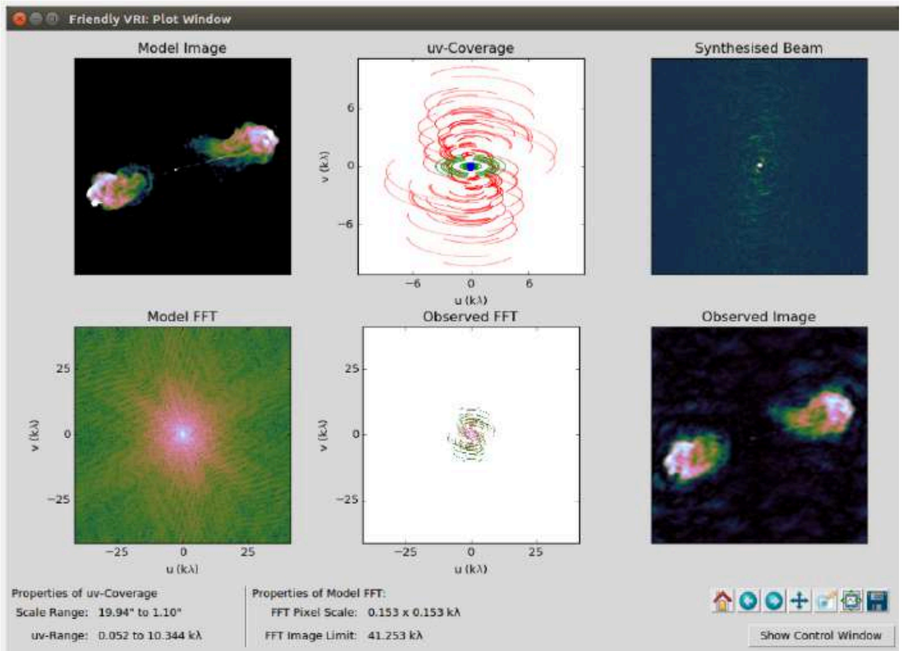
Semester	2010APRS	2010OCTS	2011APRS	2011OCTS	2012APRS
Array					
6A	•	•	•	•	•
6B			•		
6C	•			•	
6D		•			•
1.5A		•		•	
1.5B		•			•
1.5C			•		
1.5D	•			•	
750A		•			•
750B			•		
750C	•			•	
750D		•		•	
EW367		•			
EW352	•	•			
H214	•	•			
H168	•				
H75	•				

Table 1.3: Array configurations



Virtual interferometer

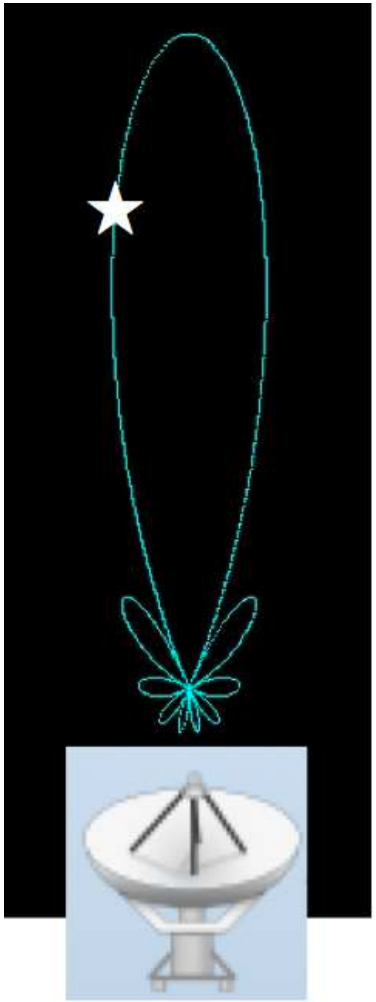




https://crpurcell.github.io/friendlyVRI/

Things to think about – 6) Calibration and other overheads?

- Primary (flux density) calibration
  - 1934-638 at most frequencies (Uranus/Mars at 3mm)
- Bandpass calibration
  - 1934-638 strong enough at most cm wavelengths
  - 1253-055 or 1921-293 often used at higher frequencies
- Phase calibration (~2min every 40min)
  - Unresolved, strongish source within about 10 degrees of target
- Pointing calibration
  - Carried out every hour at all mm frequencies on a source within ~20 degrees of target
- Other overheads
  - Set up, slewing,…..



Cycle time

http://www.narrabri.atnf.csiro.au/calibrators/calcycle.html

CSIRO

Australia Telescope National Facility

Search

ATNF Home | About ATNF | Facilities | Science & Technology | Online Resources | Outreach

Calibrator cycle time calculator

The following calculator determines the calibrator cycle time (the amount of time between successive visits to the calibrator) given observer parameters and parameters describing the phase stability. This assumes that self-calibration is not going to be used.

Observing frequency:	90000	MHz
Max baseline length of interest:	214m	
Seeing monitor rms phase:	400	microns
Phase screen speed:	1	m/s
Kolmogorov exponent:	0.83	

CALCULATE

Explanation of input parame

The calculation of the recommended calibr

- Observing frequency and maximum ba
- Seeing monitor phase stability: this giv winter nights, whereas 1500 μm is mor
- Phase screen speed: This gives the pa 10 m/s. The phase screen speed is tra dominant the phase stability). As a gen observing conditions.
- Kolmogorov exponent β/2: The phase but 6km arrays) β/2 ~ 0.83. For the AT

For more information, see Thompson, Mor

Original: Bob Sault (22-Nov-2004)
Modified: Bob Sault (26-Nov-2004), Phil E

Calibrator cycle time calculator

The following table gives an estimate of the resultant image dynamic range (assuming it is limited by phase errors), the percentage amplitude decorrelation in the resultant image, and the rms uncorrected phase in the visibility data. These are given as a function of the time interval between successive visits to the phase calibrator.
This calculation assumes a frequency of 90000 MHz, maximum baseline of 214 m, rms seeing monitor phase of 400 μm, phase screen speed of 1 m/s and Kolmogorov power law of 0.83.

The dynamic range assumes 5 hours observing on-source and 10 baselines. The dynamic range estimate varies as the inverse square root of these quantities.

t_{cycle}	Dynamic Range	Decorrelation	RMS Phase
20 sec	1343	0%	6°
30 sec	780	1%	8°
1 min	304	3%	14°
2 min	113	9%	25°
3 min	60	17%	35°

Calibrator cycle times longer than 3 min do not degrade the results further.

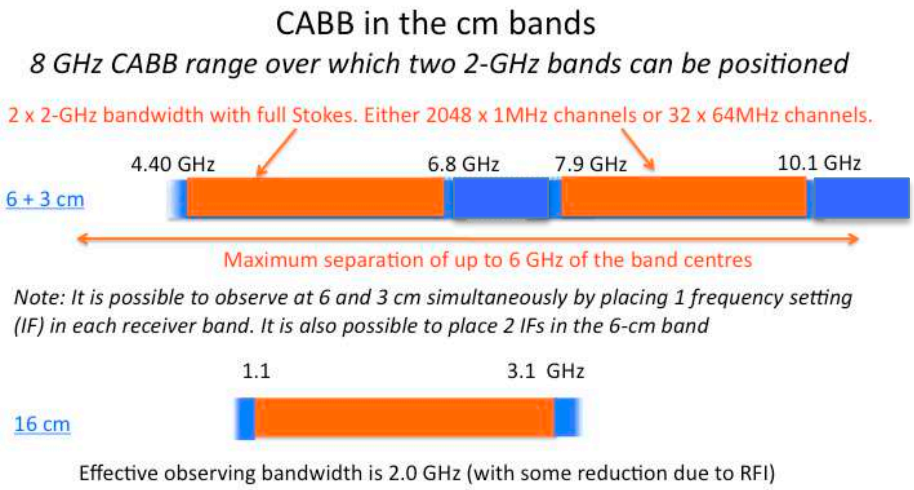
Note: The above calculation assumes that phase errors are dominated by the atmosphere. It does not include the effect of

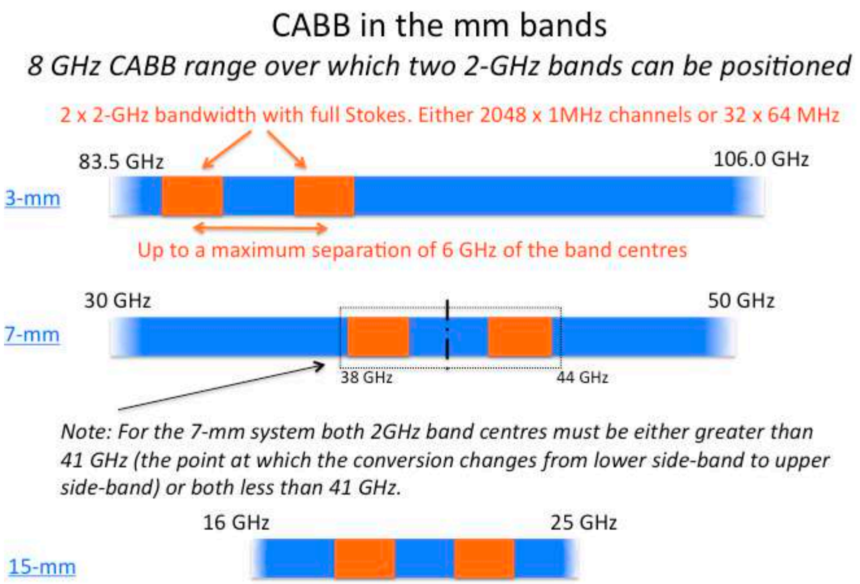
- errors in the assumed geometry of the array;
- errors in deducing the phase from a calibrator (the calibrator phase may be in error because it is measured at a slightly different time, at a different position, and because of sensitivity limits), and
- uncorrected instrumental drifts.

All of these may be significant.

Things to think about – 7) CABB mode?

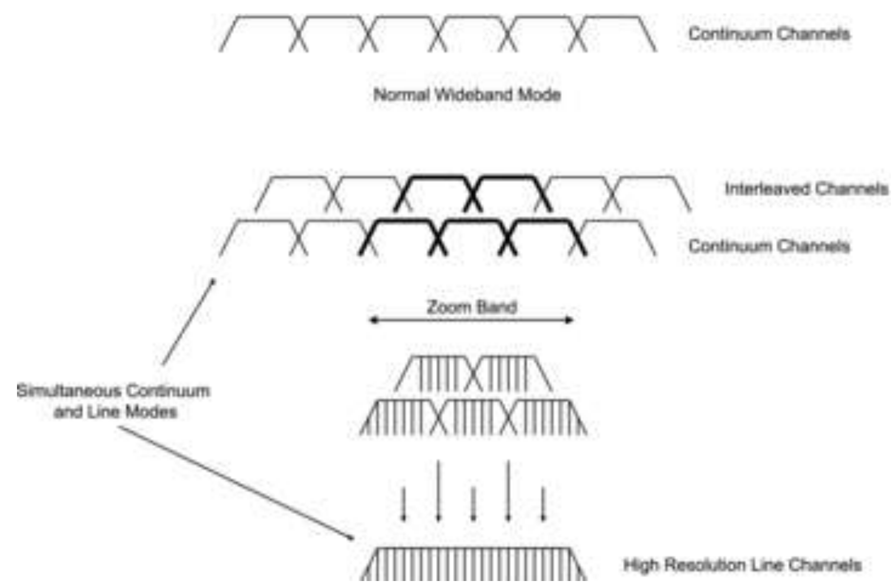
- Two x 2 GHz wide IFs (2048 x 1 MHz channels)
    - Where you can put them depends on the frequency and your science

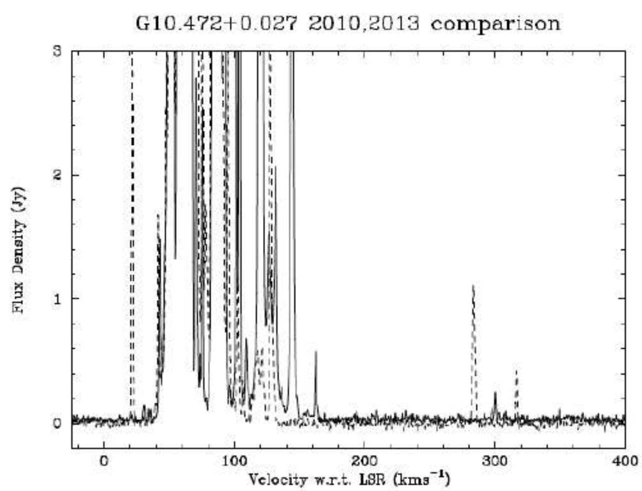


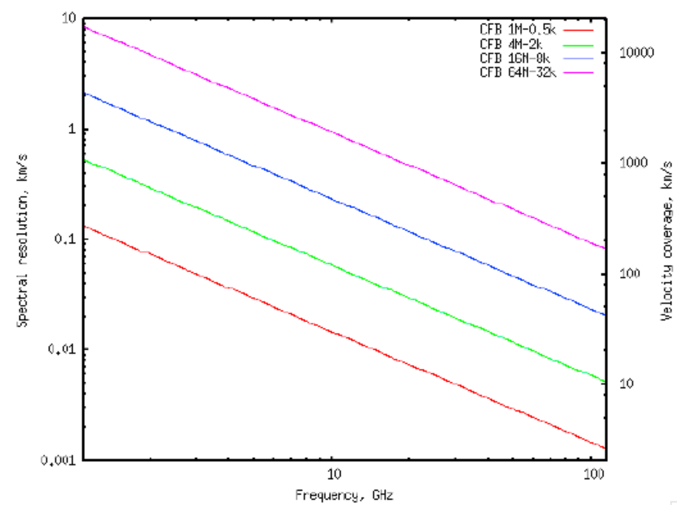


Things to think about – 7) CABB mode?

- Optional zoom windows (currently 32 x 1 MHz zooms, or 32 x 64 MHz zooms each with 2048 channels or a hybrid mode)
  - Concatenate zoom windows for more velocity coverage
  - What mode depends on velocity res/coverage needed







Schedule files https://www.narrabri.atnf.csiro.au/observing/sched/cabb/

CABB Scheduler - c3145g300.sch

Sched | Listing

File Edit Tools

1. j1147-6753
2. g300_b01
3. j1147-6753
4. g300_b02
5. j1147-6753
6. g300_b03
7. j1147-6753
8. g300_b04
9. j1147-6753
10. g300_b05
11. j1147-6753
12. g300_b06
13. j1147-6753
14. g300_b07
15. j1147-6753
16. g300_b08
17. j1147-6753
18. g300_b09
19. j1147-6753
20. g300_b10
21. j1147-6753
22. g300_b11
23. j1147-6753
24. g300_b12
25. j1147-6753
26. g300_b13
27. j1147-6753
28. g300_b14
29. j1147-6753
30. g300_b15
31. j1147-6753
32. g300_b16

New Scan | Search Cal | Delete | Pick Source

Scan Parameters

Source	j1147-6753
RA (hms)	11:47:33.401
Dec (dms)	-67:53:41.766
Epoch	J2000
CalCode	
ScanLength	00:04:00
ScanType	Point
Pointing	Update
Observer	sb,mv
Project	C3145
Time	14:00:00
TimeCode	LST
Date	27/05/2017

Freq1 43195MHz

Freq2 48610MHz

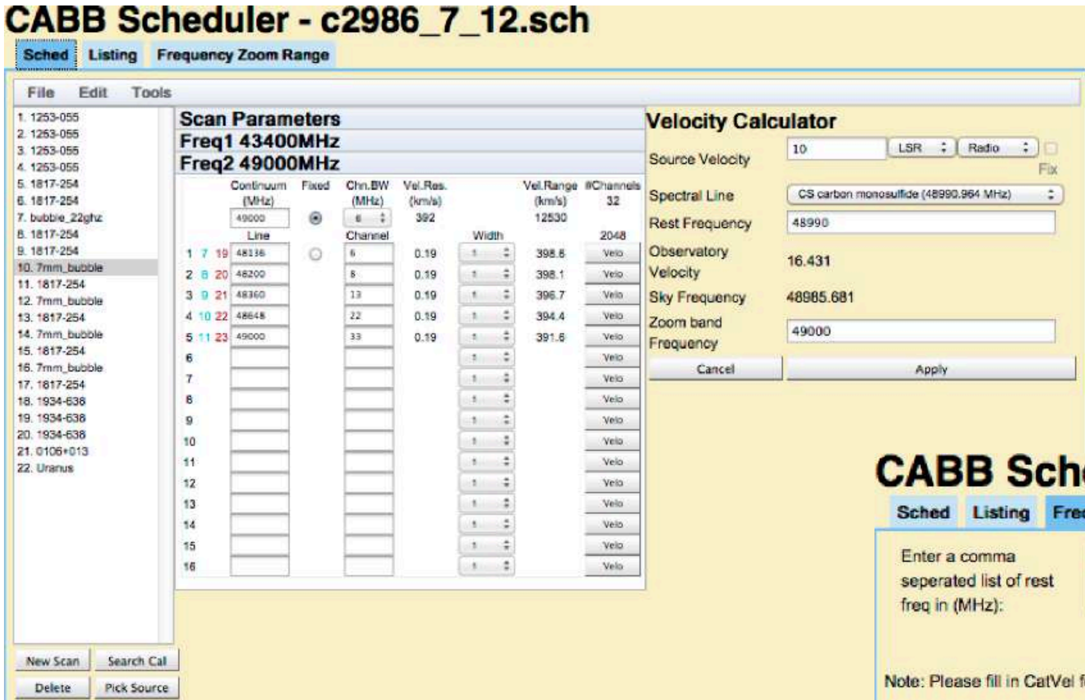
Data rate = 13.33GB/h, or 4GB every 18m

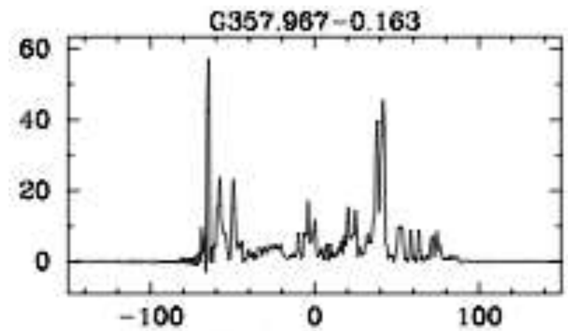
CABB Scheduler - c3145g300.sch

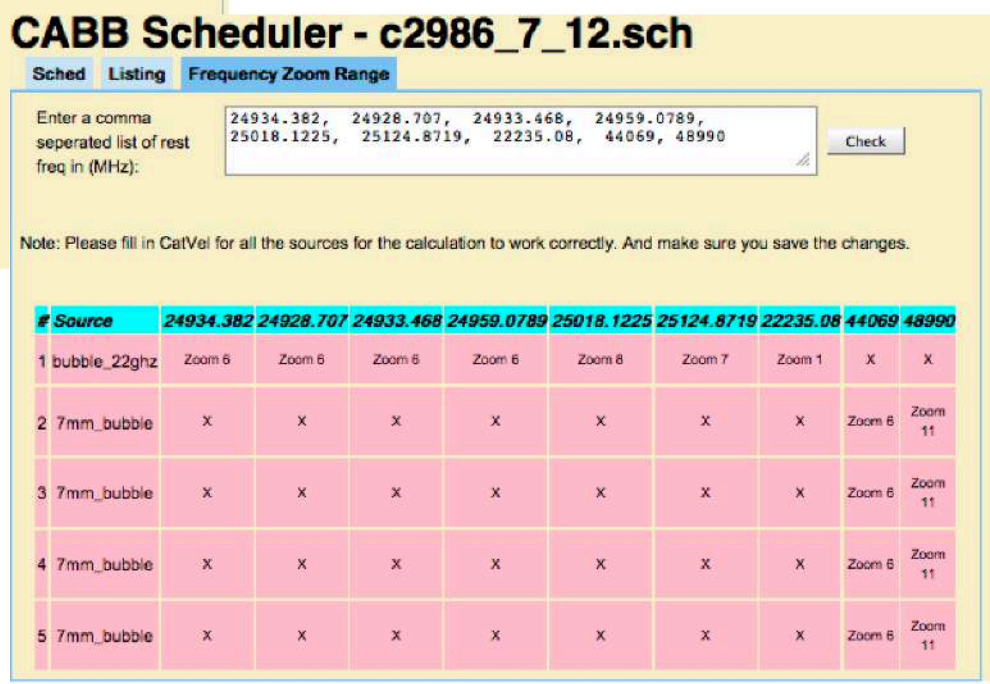
Sched | Listing

#	Source	Cal	RA	Dec	Epoch	Time(LST)	ScanLength	Az	El	Drive	ScanType	Pointing	Freq-1	Freq-2
1	j1147-6753		11:47:33.401	-67:53:41.766	J2000	14:00:00	00:04:00	197:35:42.6	47:41:36.5	00:03:30	Point	Update	43195	48610
2	g300_b01		12:22:54.374	-65:42:32.786	J2000	14:04:01	01:05:06	196:06:40.8	51:20:52.3	00:00:14	Otfmos	Offset	43195	48610
3	j1147-6753		11:47:33.401	-67:53:41.766	J2000	15:09:17	00:04:00	202:58:00.0	42:26:57.1	00:00:15	Point	Update	43195	48610
4	g300_b02		12:23:21.953	-65:42:51.579	J2000	15:13:18	01:05:06	203:27:48.2	46:14:43.0	00:00:15	Otfmos	Offset	43195	48610
5	j1147-6753		11:47:33.401	-67:53:41.766	J2000	16:18:35	00:04:00	205:25:55.0	36:15:59.7	00:00:14	Point	Update	43195	48610
6	g300_b03		12:23:49.543	-65:43:10.069	J2000	16:22:35	01:05:06	207:19:56.7	39:48:37.0	00:00:14	Otfmos	Offset	43195	48610
7	j1147-6753		11:47:33.401	-67:53:41.766	J2000	17:27:52	00:04:00	205:28:08.1	29:47:51.7	00:00:12	Point	Update	43195	48610
8	g300_b04		12:24:17.143	-65:43:28.254	J2000	17:31:53	01:05:06	208:18:23.6	32:49:43.1	00:00:12	Otfmos	Offset	43195	48610
9	j1147-6753		11:47:33.401	-67:53:41.766	J2000	18:37:09	00:04:00	203:32:58.4	23:33:35.4	00:00:10	Point	Update	43195	48610
10	g300_b05		12:24:44.754	-65:43:46.135	J2000	18:41:10	01:05:06	207:00:33.2	25:53:45.4	00:00:10	Otfmos	Offset	43195	48610
11	j1147-6753		11:47:33.401	-67:53:41.766	J2000	19:46:27	00:04:00	200:02:57.2	17:58:43.5	00:00:11	Point	Update	43195	48610
12	g300_b06		12:25:12.376	-65:44:03.712	J2000	19:50:27	01:05:06	203:54:23.6	19:28:55.4	00:00:11	Otfmos	Offset	43195	48610
13	j1147-6753		11:47:33.401	-67:53:41.766	J2000	20:55:44	00:04:00	195:16:51.6	13:25:08.7	00:00:11	Point	Update	43195	48610
14	g300_b07		12:25:40.007	-65:44:20.984	J2000	20:59:45	01:05:06	199:20:28.3	13:59:10.2	00:00:11	Otfmos	Offset	43195	48610
15	j1147-6753		11:47:33.401	-67:53:41.766	J2000	22:05:01	00:04:00	189:33:17.3	10:11:16.4	00:00:00	Point	Update	43195	48610
16	g300_b08		12:26:07.649	-65:44:37.952	J2000	22:05:01	01:05:06	193:58:24.5	9:57:50.3	00:00:00	Otfmos	Offset	43195	48610
17	j1147-6753		11:47:33.401	-67:53:41.766	J2000	22:05:01	00:04:00	189:33:17.3	10:11:16.4	00:00:00	Point	Update	43195	48610
18	g300_b09		12:26:35.301	-65:44:54.615	J2000	22:05:01	01:05:06	194:00:44.7	9:59:31.5	00:00:00	Otfmos	Offset	43195	48610

Schedule files – adding line observations…







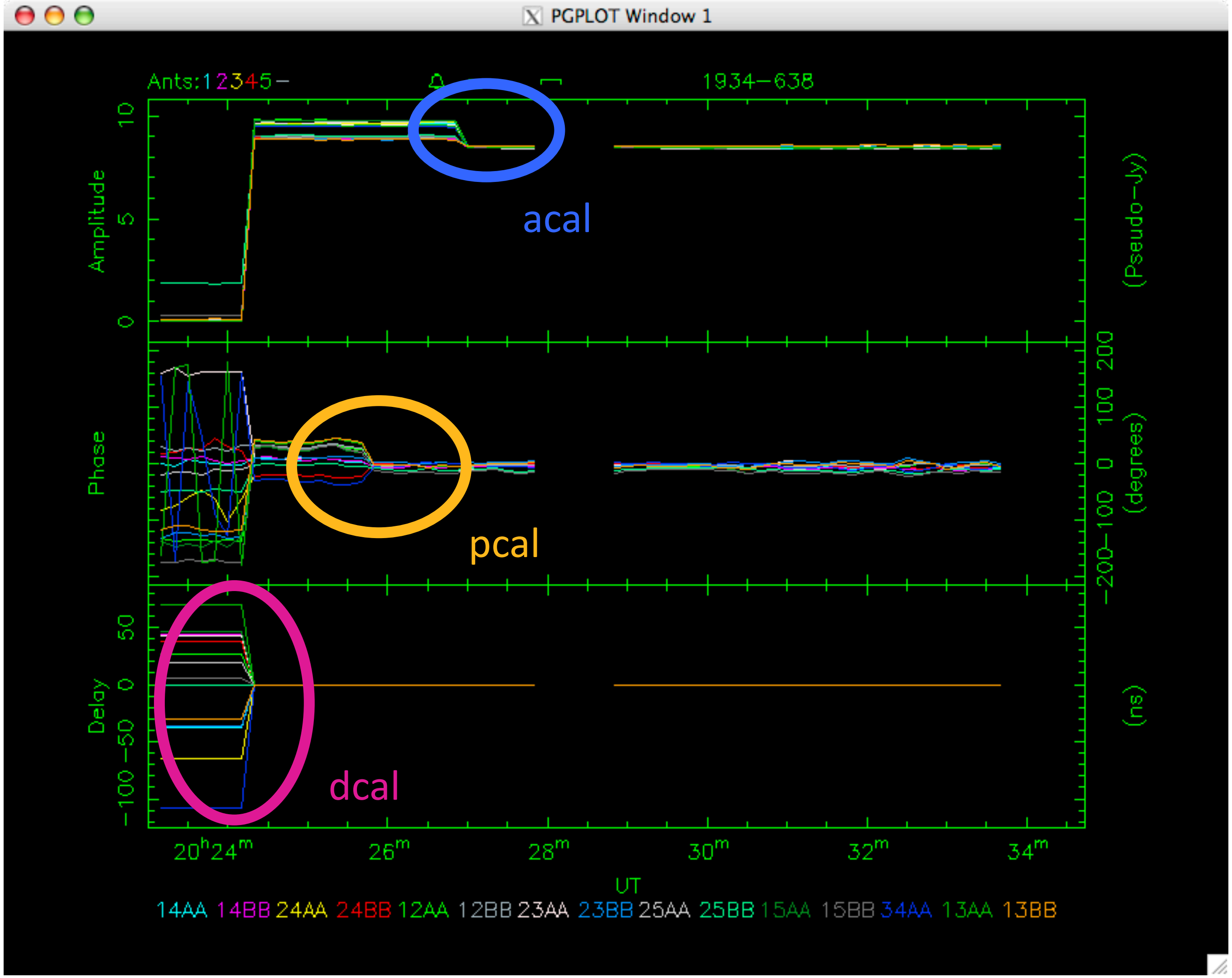
#	Source	24934.382	24928.707	24933.468	24959.0789	25018.1225	25124.8719	22235.08	44069	48990
1	bubble_22ghz	Zoom 6	Zoom 6	Zoom 6	Zoom 6	Zoom 8	Zoom 7	Zoom 1	x	x
2	7mm_bubble	x	x	x	x	x	x	x	Zoom 6	Zoom 11
3	7mm_bubble	x	x	x	x	x	x	x	Zoom 6	Zoom 11
4	7mm_bubble	x	x	x	x	x	x	x	Zoom 6	Zoom 11
5	7mm_bubble	x	x	x	x	x	x	x	Zoom 6	Zoom 11

- Need to calculate sky frequencies
  - All done by the CABB scheduler

Observing – the simple cm case

- If you are prepared the actual observing is not hard
- A simple cm continuum observation of a single source may go something like
  - Observe 1934-638
    - Do initial array calibration (delays, phases, amplitudes; dcal, pcal, acal)
    - Close junk file
    - Track 1934-638 for primary and bandpass calibration (~10min)
  - Go to target schedule which contains
    - Phase calibrator (~2min)
    - Target (~20 – 40 min)
    - Loop through target schedule until the end (start 1/99 or 1-2/99)

Calibrating the array



The less simple cases

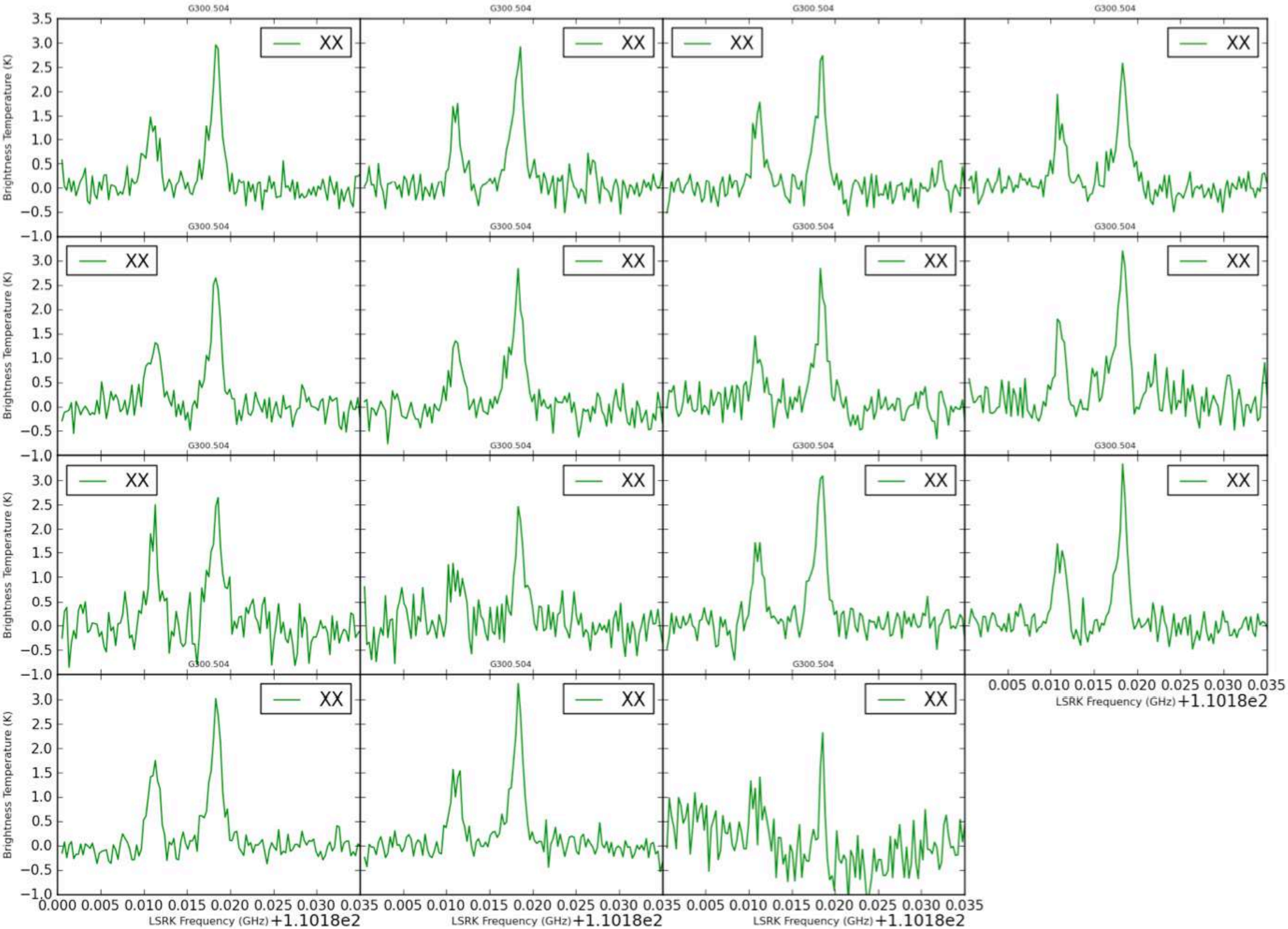
- Lower frequencies (~2.1 GHz)
  - Second IF is redundant
  - Lots of interference → need to choose channel range for calibration carefully (set "tvchan")
  - More chance of confusion

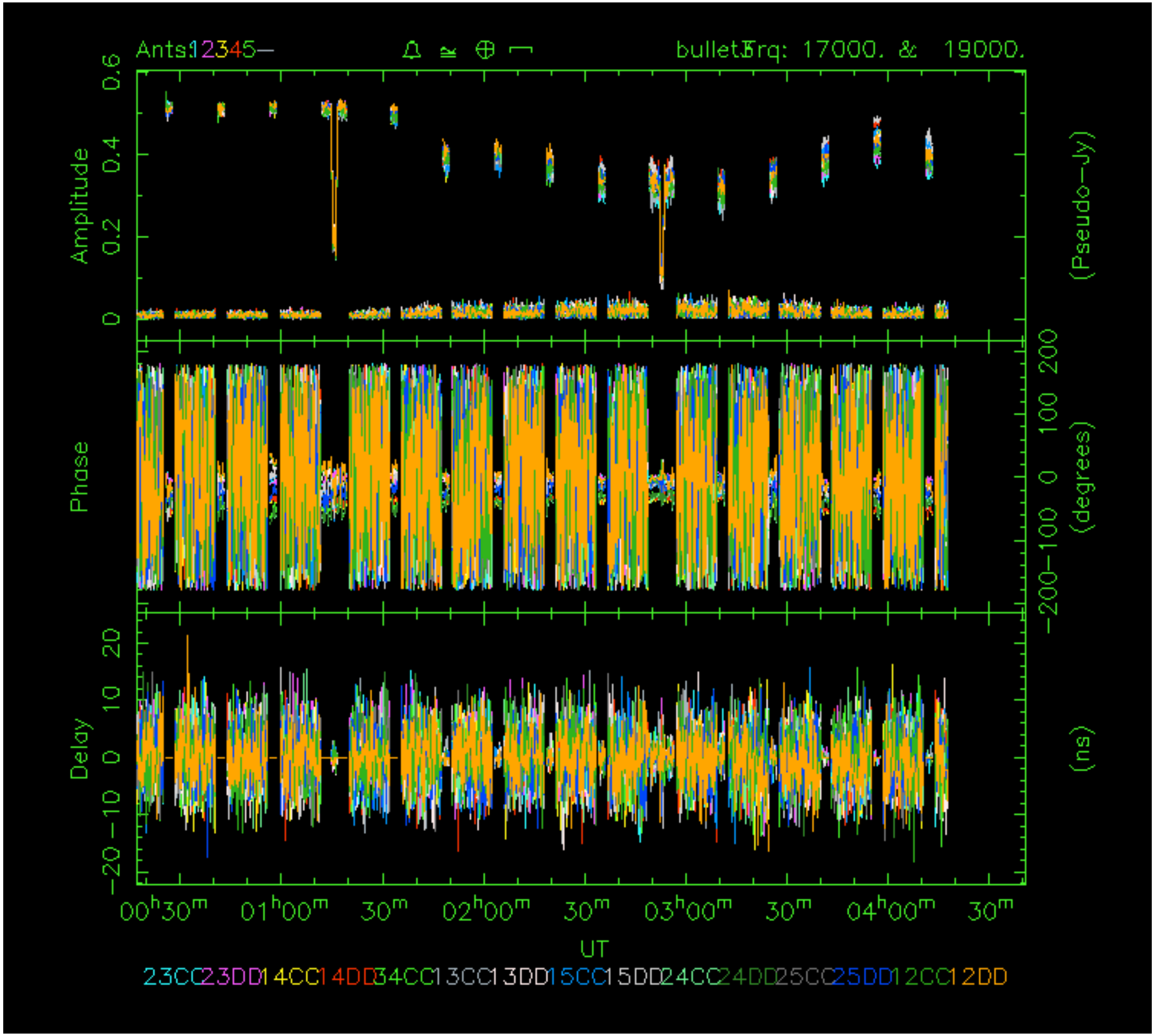
- Higher frequencies
  - 1934-638 gets too weak for setup and bandpass → use a stronger source (e.g. 0537-441, 1253-055, 1921-293)
  - Observe 1934-638 or a planet at 3mm for primary calibration
  - fewer calibrators

mm observing – the least simple case

- Everything becomes more difficult at mm frequencies
  - Atmospheric opacity increases Tsys and attenuates signal
  - Not as many bright calibrator sources
  - Instrument stability is more difficult to maintain
  - Antenna accuracy becomes important
  - The FOV is smaller

  - To overcome some of these difficulties we usually only observe during the winter months (60-65 % chance of suitable 3mm weather) or during the night (especially at 12 or 7mm).

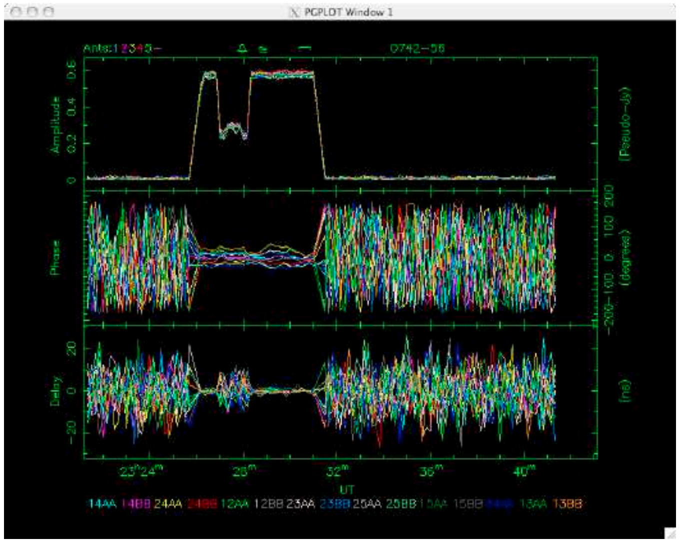

G300.504
XX
Brightness Temperature (K)
LSRK Frequency (GHz)+1.1018e2
0.000 0.005 0.010 0.015 0.020 0.025 0.030 0.035
-1.0 -0.5 0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5



Ants12345—
bullet3 Frq: 17000. & 19000.
Amplitude
(Pseudo−Jy)
0 0.2 0.4 0.6
Phase
(degrees)
−200 −100 0 100 200
Delay
(ns)
−20 −10 0 10 20
00h30m 01h00m 30m 02h00m 30m 03h00m 30m 04h00m 30m
UT
23CC 23DD 14CC 14DD 34CC 13CC 13DD 15CC 15DD 24CC 24DD 25CC 25DD 12CC 12DD

Observing at mm frequencies

- Observe a strong calibrator (e.g. 0537-441, 1253-055 or 1921-295)
    - Calibrate delays (dcal)
    - Do a pointing (can choose specs)
    - Calibrate phase (pcal)
    - Calibrate amplitudes (acal or paddle at 3mm)

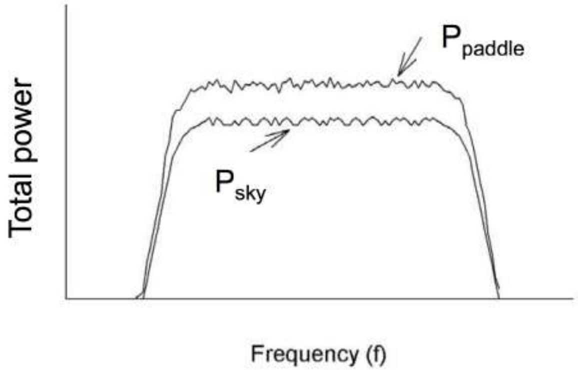


- Observe either 1934-638 (at 12 or 7mm) or a planet (at 3mm) for primary calibration
    - Pointing first (1934-638 or source nearby planet)
- Target observations
    - Include a pointing once an hour (ideally on a strong source within ~20 degrees)

Paddle scans

- Measure Tsys and correct for the atmosphere at 3mm
  - Place an ambient load in front of receiver horn for 30 sec
  - Gives Tsys corrected for the current atmospheric conditions

$$T_{sys}^{eff} = (300\ \mathrm{K}) \frac{P_{sky}}{P_{paddle} - P_{sky}}$$

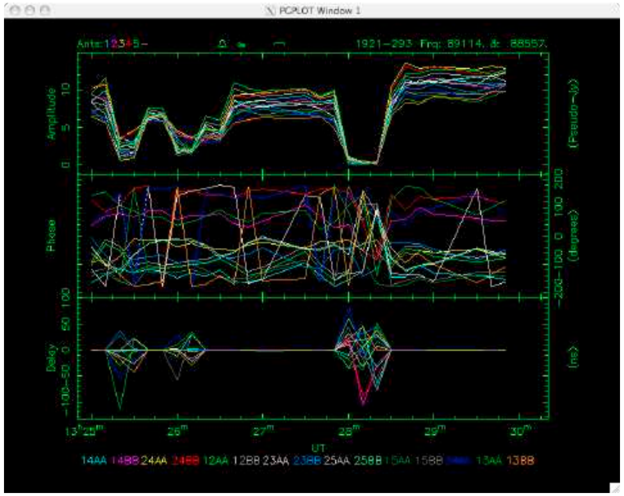


- Every ~15 mins (often every second phase cal) and before primary and bandpass calibrators

CABB Scheduler - c2639-sio.sch

Sched | Listing

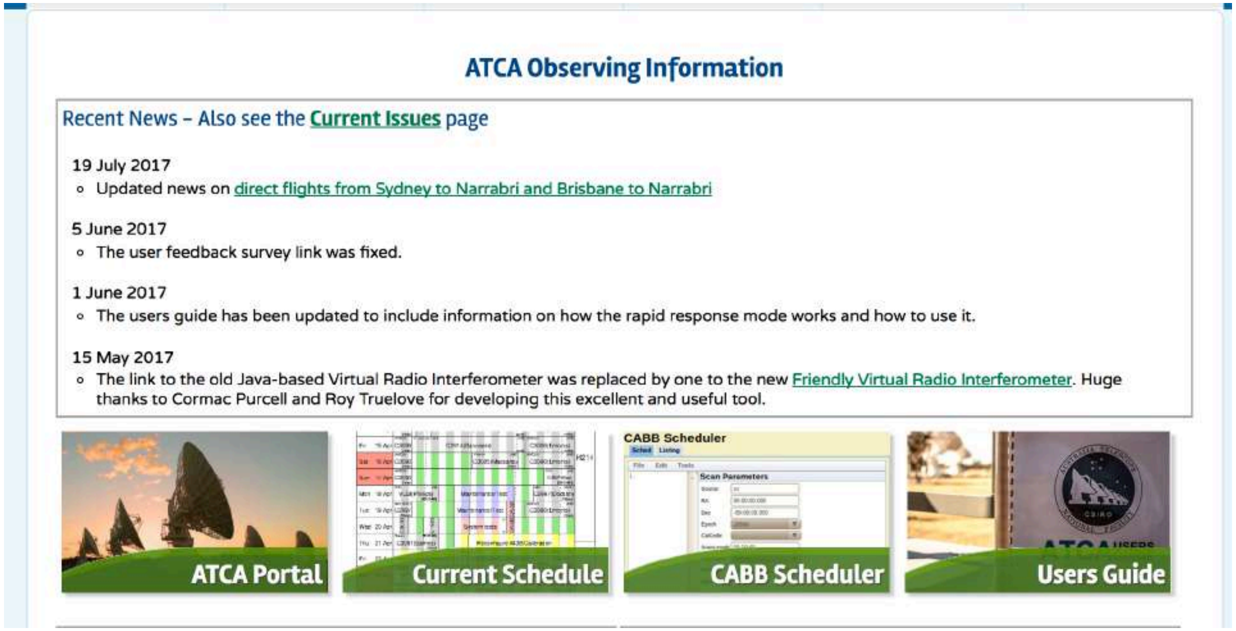
#	Source	Cal	RA	Dec	Epoch	Time(LST)	ScanLength	Az	El	Drive	ScanType	Pointing	Freq-1	Freq-2
1	x1730-130	C	17:33:02.706	-13:04:49.548	J2000	12:00:00	00:01:30	98:11:44.5	12:08:12.0	00:03:54	Point	Update	85908	87400
2	1730-130	C	17:33:02.706	-13:04:49.548	J2000	12:01:30	00:01:30	98:00:57.2	12:27:29.0	00:00:00	Paddle	Offset	85908	87400
3	1730-130	C	17:33:02.706	-13:04:49.548	J2000	12:03:00	00:01:30	97:50:10.0	12:46:46.4	00:00:00	Dwell	Offset	85908	87400
4	g025+02_86		17:46:02.704	-28:44:09.110	J2000	12:04:31	00:12:00	113:33:09.5	17:30:32.4	00:00:34	Mosaic	Offset	85908	87400
5	1730-130	C	17:33:02.706	-13:04:49.548	J2000	12:16:33	00:01:30	96:13:05.9	15:40:44.6	00:00:34	Paddle	Offset	85908	87400
6	1730-130	C	17:33:02.706	-13:04:49.548	J2000	12:18:03	00:01:30	96:02:18.0	16:00:06.6	00:00:00	Dwell	Offset	85908	87400
7	g025+02_86		17:46:02.704	-28:44:09.110	J2000	12:19:33	00:12:00	112:05:16.7	20:30:03.9	00:00:34	Mosaic	Offset	85908	87400
8	1730-130	C	17:33:02.706	-13:04:49.548	J2000	12:31:35	00:01:30	94:24:48.8	18:54:40.1	00:00:35	Paddle	Offset	85908	87400
9	1730-130	C	17:33:02.706	-13:04:49.548	J2000	12:33:05	00:01:30	94:13:56.1	19:14:05.4	00:00:00	Dwell	Offset	85908	87400
10	g025+02_86		17:46:02.704	-28:44:09.110	J2000	12:34:36	00:12:00	110:40:05.0	23:31:26.1	00:00:35	Mosaic	Offset	85908	87400
11	1730-130	C	17:33:02.706	-13:04:49.548	J2000	12:46:38	00:01:30	92:35:22.0	22:09:04.0	00:00:35	Paddle	Offset	85908	87400
12	1730-130	C	17:33:02.706	-13:04:49.548	J2000	12:48:08	00:01:30	92:24:19.6	22:28:31.5	00:00:00	Dwell	Offset	85908	87400
13	g025+02_86		17:46:02.704	-28:44:09.110	J2000	12:49:38	00:12:00	109:17:17.2	26:34:29.0	00:00:35	Mosaic	Offset	85908	87400



Summary and further information

- Have a plan and make sure it is a good one!
- Different science goals require different strategies so think carefully about what is required
- See ATCA webpage for further information and links to other resources:

http://www.narrabri.atnf.csiro.au/observing/



Turning your plan into a compelling proposal

A little about the process

- There are two proposal rounds a year (15 Dec and 15 Jun for the APRS and OCTS, respectively)
- The ATNF receives ~150 proposals a semester
- The TAC is made up of 9 members and ~12 readers and they proposals from Parkes, ATCA, Tid and the LBA
- Each proposal is reviewed by two TAC members and two readers
    - Each gives a grade and comments
    - Grades are finalised during the TAC meeting (held around a month after the proposal deadline)
    - Grades given to the scheduler (Jamie for ATCA, Jimi for Parkes)
- On the ATCA ~35% proposals get most of their time, ~15% get some and ~50% get none

Name
G335-G343

Peak flux (mJy)

Total time for sem

Dense Gas Across the Milky Way - The 'Full-Strength' MALT45

Summary: We will build on Australia's rich tradition of spectral line legacy surveys (e.g. [5, 6, 18, 30, 10]) and deliver a dense gas survey of the Galactic plane to address a wide range of astrophysical challenges. This survey will provide an essential dataset on the large-scale gas distribution and the clearest picture of Galactic structure to date: the distribution of the densest gas will be uncovered, and, combined with data from a number of other surveys will allow us to trace the cycle of material through the interstellar medium (ISM) and into stars. We already know the warm dust, cold dust, diffuse atomic and moderately dense molecular gas content of the Galaxy, and the dense gas provided by this legacy survey will **complete the picture**. Understanding our own Galaxy will provide the astrophysical template that allows us to interpret future sensitive, high resolution surveys of external galaxies with Atacama Large Millimetre Array (ALMA) and the Square Kilometre Array (SKA).

Understanding our own Galaxy is of the utmost importance to many branches of astronomy and astrophysics: "Our Galaxy, the Milky Way, is a benchmark for understanding disk galaxies....Galactic studies will continue to play a fundamental role far into the future because there are measurements that can only be made in the near field and much of contemporary astrophysics depends on such observations" [29]. Crucially, in order to understand galaxies we must solve one of the most fundamental mysteries of our Universe - one of the six 'big questions' posed in the 2016 Decadal Plan for Australian Astronomy: How do stars and planetary systems form? This project will directly address this fundamental question. Specifically, we will:

- Characterise the dense gas structure of our Galaxy through sensitive CS observations, allowing us to detect molecular clouds out to the far side of the Galaxy.
- Gain a new census of high-mass star forming regions (through CS, SiO, methanol masers and radio continuum observations) and directly test theoretical predictions of high-mass star formation and their precursors, feeding directly into future ALMA work on high-mass star formation.
- Produce an essential dataset that will underpin the Galactic plane survey in TeV (10^{12} eV) gamma-rays by the forthcoming multi-national Cherenkov Telescope Array (CTA) facility.

1 Background

Star formation and the structure of our Galaxy

High-mass stars (> 8 $M_\odot$), have shaped galaxies throughout the Universe. In spite of the important role that they play, little is known about how they form. This is because they are intrinsically rare (about one in a million), form very quickly ($<$ 100,000 yrs) and in clusters, confusing contributions from individual stars. Their powerful stellar winds can halt the formation of the next generation of stars, or trigger star formation in adjacent clouds, then, during their time on the main sequence, they may inject as much momentum and energy into the Galaxy as a supernova explosion. Finally, they will explode as supernovae, enriching the ISM with heavy elements. Understanding how high-mass stars form is one of the most important topics in modern astrophysics.

Some advice

- Know your audience, know the rules
  - Write to astronomers but not an expert in your field
  - STICK to the rules. 3 pages means 3 pages.
- Make it clear what the key question/problem you are going to address and how you will achieve it
  - Don't wait to explain this!
  - What observations are you planning (demonstrate in the technical justification that your plan is good!)? How will they address the problem?
- Think about the people reading the proposal
  - Make it concise
  - Use clear language – please avoid acronyms and jargon
  - Make it enjoyable to read – story, background, motivation, what the important question is and how you will answer it. Why is it important? Why are the observations critical to help address the big question?
- Use figures
  - Make sure that they are relevant and support your proposal

Most annoying things from the last proposal round

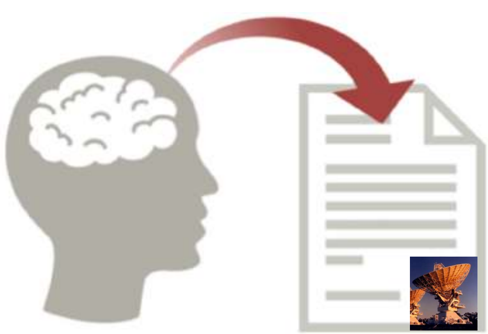
- Figures – relevance, axis labels!!!!! Please make it so I can read them.

SNR, SNRs, SN, CSM, ER, ALMA, ATCA, MWA, GLEAM, ICRAR, CAASTRO, NRAO, ESO, CSIRO, LMC, MCs, CABB, RMS, HI, SINGG, HIPASS, WISE, GALEX, DECam, CTIO, SFE, HST, ISM, SNe, SFR, VLA, HII, ASKAP, GASKAP, RFI, MC, GMC, SMC, UV, CNM, WNM, MW, ANU, CFB, FWHM, LST, WIMP, dSphs, CDM, GBT, EMU, SKA, UFDs, DM, ATOA, CABB, PNe, PN, AGB, IRAS, RMS, BW, IR, AGN, YSO, CMZ, WALLABY, PAF, ASKAPsoft, ACES, SUMSS, ASKAP-12, IMAGINE, BGC, HICAT, JVLA, IRAM, SMA, SDC, NANTEN, SEST, MAGMA, SUPERBx, FRB, SUPERB, GMRT, IGM, GLIMPSE, DM, HESS, LIGO, NSW, TDE, CHIME, MeerKAT, PPTA, CASS, ANDS, CGI, HIPSR, CGM, CSE, LBA, MM1, CM2, HartRAO........

- If resubmitting address the TACs previous comments. If you don't it will piss the person off from the beginning. Do it! Even if the TAC was wrong!

Do

- Ask for help and read successful proposals – writing good proposals is a skill that takes time to learn
- Give yourself enough time
- Put your work into broader scientific context and emphasise how the proposed observations address a problem
- Justify technical requirements!
- Make it enjoyable to read
- Use dot points to summaries main points (added benefit that they stand out and draw the reader’s eye)
- Highlight progress in ongoing projects
- Write for a general astronomy audience



Don’t

- Make extra work for the people reading your proposal
- Ignore the TACs comments from previous rounds – explicitly address them
- Add figures unless they are relevant, you explain them and you can READ THE AXIS LABELS
- Use many acronyms
- Wait to deliver the punch line
- Ignore the rules (3 pages means 3 pages!)
- Assume that the TAC readers know why your science is important
- Just say you need a 6D array and a sensitivity of 40 mJy – justify!!!