



Writing Proposals and Scheduling

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Outline

- 1. How to plan an experiment
 - Scientific idea
 - Feasibility - choice of array - tools for planning
- 2. Writing an observing time proposal
 - Scientific justification – general suggestions
 - Proposal submission tools
- 3. Scheduling & observing file preparation
- 4. After the observations

1. How to plan an experiment

- Scientific idea
 - ~infinite variety of topics, methods, techniques
- Feasibility
- Choice of the array and its configuration
- Some useful tools for planning

Science ideas

- Why would you need more data?
 - test a scenario/prediction
 - validate/disprove a previous, uncertain, result - e.g. from imaging or statistics
 - just look at something “new”, or in a new way - do try and have an idea of possible outcomes
- **The science goal drives the choice of the instrument and the design of the experiment, not the other way around**

The proposal: science context

- Make a good search of the literature
 - it will help you understand the problem
 - it will avoid to repeat previous efforts
 - you will want others to do it after you publish!
 - (most?) referees will not be expert of the area

Different experiment designs

- Your goal will generally have a parameter of primary importance: sensitivity, angular/spectral/temporal resolution, field of view, polarisation
- study one/a few source(s) in great detail: multi-scale, multi-frequency, multi-epoch, full polarisation
- study many sources in lesser detail - let statistics rule
 - often need a lot of automation - sometimes can be scheduled as filler

The proposal

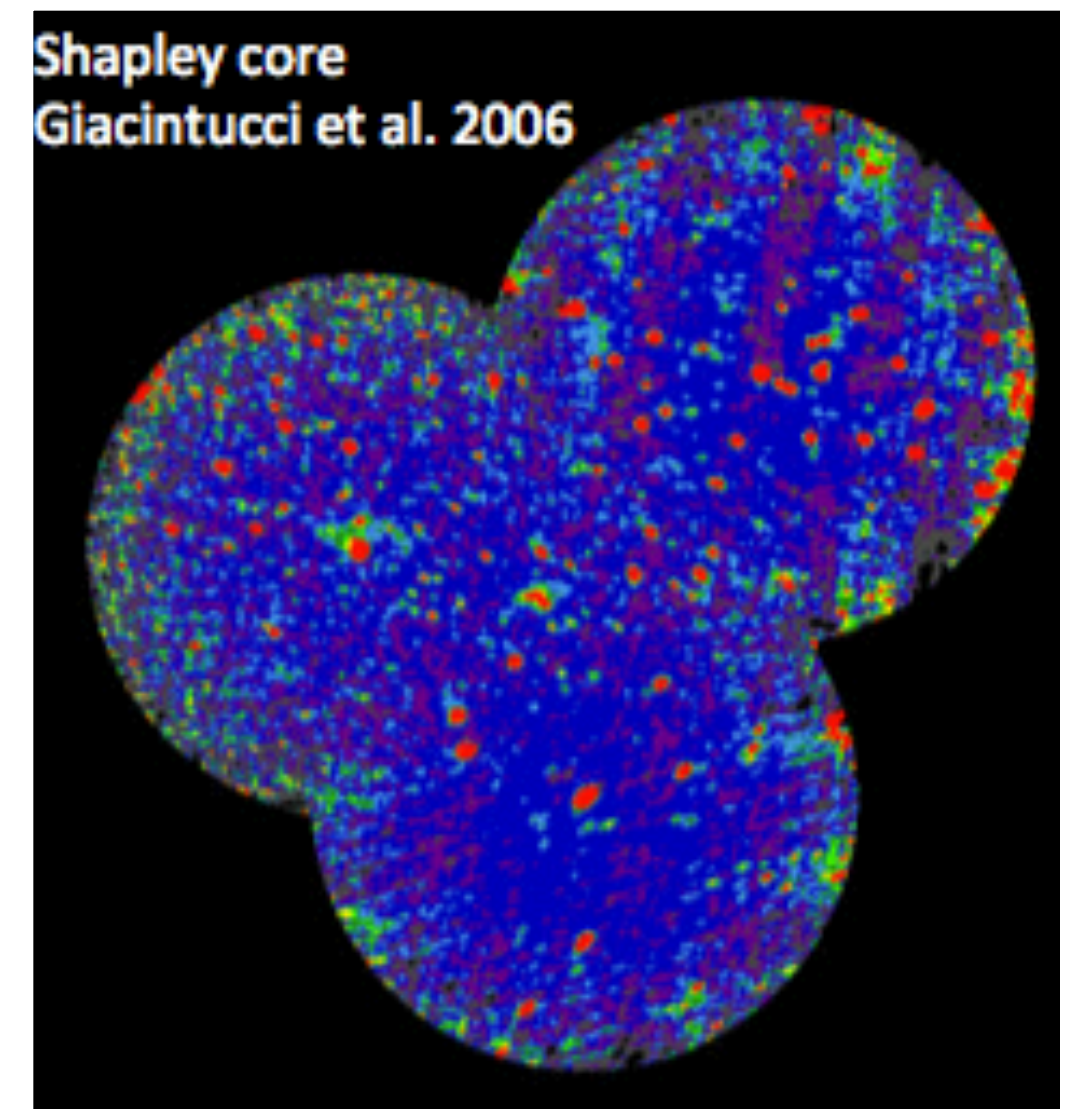
- After the context, define clearly what is the question that needs to be addressed, and its importance in the general picture
- When the general picture is clear, you can (have to!) focus on the details
 - what are the flux density, the size, the spectral & variability properties that you expect?
- Consider alternative scenarios - convince yourself and the referees that the one you pick is the most reasonable. Be quantitative as much as you can.
- Why is your target necessary? Or why do you need more than one? What significance will n new targets bring (often goes with \sqrt{n})? Are more target useful just for statistics, or they sample a new region of the parameter space?
- This part needs to be **all about science**.

Angular resolution: VLBI

- flexibility (multi-frequency, irregular multi-epochs, fillers): VLBA
- sensitivity, real time: EVN, e-EVN
- southern targets: LBA
- extra sensitivity and resolution: Global VLBI^(*)
- high frequency: 3mm, GMVA^(*); 1.3mm, EHT^(*)
 - ^(*) these are scarce resources so you need extra-strong science case to improve your chances

Angular resolution - others

- Sometimes you will not want too high angular resolution - you do not want to resolve out extended low surface brightness emission regions, or you want a wide field of view
- VLBI -> e-Merlin -> JVLA/ATCA/ALMA/GMRT -> LOFAR/MWA/...
- some instruments have different configurations/resolution: check the calendar!
- if you want both high angular resolution and wide field of view, you will have to do a “mosaic”
- supporting single dish or compact array data are also needed to remove artefacts due to very extended emission (“zero-spacings”)



Sensitivity

- You can improve sensitivity through **collecting area, exposure time, bandwidth**
- Keep in mind the spectral properties of your source, and its declination. Steep (flat/rising) spectrum sources are best observed at low (high) frequency, e.g. with LOFAR (ALMA)
- sensitivity could also be limited by **confusion** - so you are back to angular resolution consideration
- dynamic range is also important: it is hard to get to very low noise levels if there are strong sources in the field and the (u,v) coverage is not good
- note **polarised** emission is generally much fainter

$$S_{rms} = \frac{2kT_{sys}}{A_{eff} \sqrt{N_A(N_A - 1)t_{int}\Delta\nu}}$$

$$\sigma_{conf, Condon} = 1.2 \left(\frac{\theta}{8''} \right)^{10/3} \left(\frac{\nu}{3.02 \text{ GHz}} \right)^{-0.7} \mu\text{Jy beam}^{-1}$$



VLA Exposure Calculator

Array Configuration	A	
Number of Antennas	25	
Number of Polarizations	<input type="radio"/> Single <input checked="" type="radio"/> Dual	
Type of Weighting	<input type="radio"/> Natural <input checked="" type="radio"/> Robust	
Frequency	0.0000	GHz
Receiver Band	Unspecified	
Approximate Beam Size	Unknown	
Digital Samplers	<input type="radio"/> 3 bit <input checked="" type="radio"/> 8 bit	
Elevation	Zenith (90 degrees)	
Average Weather	Winter	
Calculation Type	<input checked="" type="radio"/> Time <input type="radio"/> BW <input type="radio"/> Noise/Tb	
Time on Source	0h 0m 0s	
Total Time	0h 0m 0s	
Bandwidth (Frequency)	0.0000	GHz
Bandwidth (Velocity)	0.0000	km/s
RMS Noise (units/beam)	100.0000	μJy
RMS Brightness (temp)	0.0000	mK

Help

Save

v16A | 2015-08-25 10:18:14 MDT | build #190

$$S_{rms} = \frac{2kT_{sys}}{A_{eff}\sqrt{N_A(N_A-1)t_{int}\Delta\nu}}$$

$$\sigma_{conf,VLSS} = 29 \left(\frac{\theta}{1''}\right)^{1.54} \left(\frac{\nu}{74\text{ MHz}}\right)^{-0.7} \mu\text{Jy beam}^{-1}$$

www.evlbi.org/cgi-bin/EVNcalc.pl

obs.vla.nrao.edu/ect/

EVN Calculator

EVN e-EVN VLBA GLOBAL GMVA

Observing band & data rate [Mbit/s]

L - 18cm 1024

☐Ef ☐Nt ☐My ☐Pv ☐Pa ☐Hn
☐Mc ☐Sh ☐Km ☐Ro70 ☐Ho ☐Nl
☐On ☐Tm65 ☐Sv ☐Ro34 ☐Cd ☐Fd
☐Tr ☐Ur ☐Zc ☐Pb ☐Ap ☐La
☐Jb1 ☐Mh ☐Bd ☐Ku ☐Go ☐Kp
☐Jb2 ☐Ys ☐Wz ☐Ky ☐Gb ☐Pt
☐Cm ☐Sr ☐Ka ☐Kt ☐Y1 ☐Ov
☐Wb ☐Ar ☐Ny ☐At ☐Y27 ☐Br
☐W1 ☐Hh ☐Tc ☐Mp ☐Sc ☐Mk

Number of spectral channels per subband, integration time [s], and maximum baseline length

16 ch 2 s 10000 km (Full EVN)

Please select an array (N>2) and an observing band.

RESET GO

On-source integration time [min]

150

A simple guide:
- one station: SEFD
- two stations: baseline sensitivity
- more stations: image thermal noise
- field of view and EVN MkIV correlator limitations are given below

Number of polarizations, subbands per polarizations, and bandwidth of a subband [MHz]

2 pols 8 sb 16 MHz

MkIV Correlator limitations no longer apply.

RESET GO

<https://almascience.eso.org/proposing/sensitivity-calculator>
www.narrabri.atnf.csiro.au/myatca/interactive_senscalc.html

Spectral lines

- Find an instrument with a frequency coverage good for your line - and with the adequate spectral resolution
- If the source is extragalactic, keep the redshift in mind!
- Are there other lines that you can get “for free”?

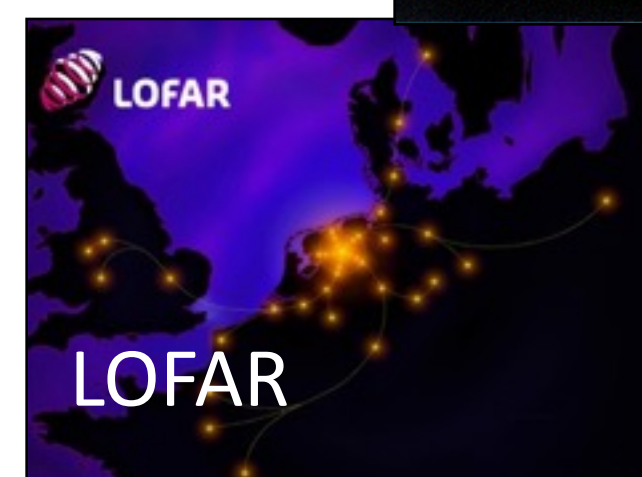
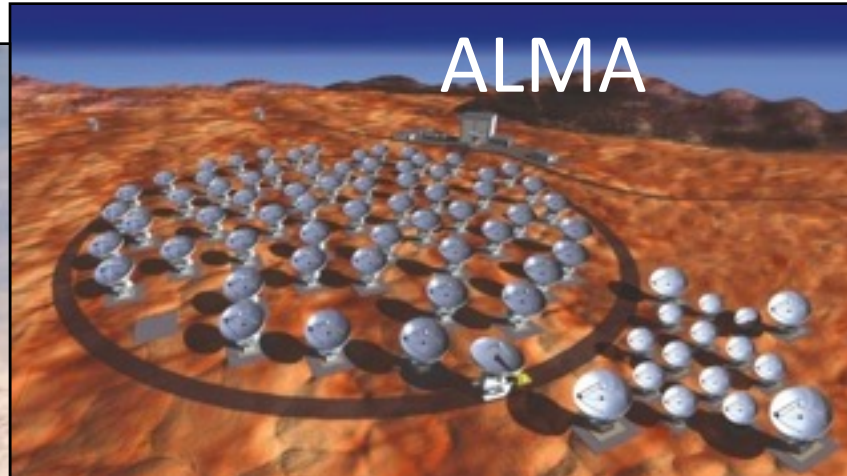
Frequency

- Choosing the right frequency is essential - not only when spectral lines are concerned
- Frequency determines the angular resolution, and the sensitivity
 - directly, because of the telescope/receiver performance
 - indirectly, because of the source spectrum
- It also has implications on how to design calibration
- Multi-frequency is often very informative on the physics but it has a price
 - some instruments are frequency agile or intrinsically broadband, others are less flexible
 - again, you may have to do trade offs

Freq.
> 100 GHz

1 GHz

< 1 GHz



Angular resolution

arcmin

arcsec
14

milliarcsec

JVLA/VLBA
bands

Band	Range ¹ (GHz)
4 m (4)	0.058-0.084
90 cm (P)	0.23-0.47 ²
20 cm (L)	1.0-2.0 ³
13 cm (S)	2.0-4.0
6 cm (C)	4.0-8.0
3 cm (X)	8.0-12.0
2 cm (Ku)	12.0-18.0
1.3 cm (K)	18.0-26.5
1 cm (Ka)	26.5-40.0
0.7 cm (Q)	40.0-50.0

also EVN bands

When you know what you want...

- Make sure it is not already there!
- during the literature search you may already have some surprise
- but a lot of good quality data do not get published - or data are published but not in the context of what you are interested in
- so go look at the archives!
- even if you still need to propose for new observations, you could
 - find useful information (improve your guesses, pick calibrators, ecc.)
 - convince the referees that you know what you are doing

Archives – more in tomorrow's lecture

EVN, eVLBI	<code>archive.jive.nl</code>
(J)VLA, VLBA	<code>archive.nrao.edu</code>
MERLIN	<code>www.merlin.ac.uk/archive</code>
GMRT	<code>naps.ncra.tifr.res.in/goa/mt/search/basicSearch</code>
WSRT	<code>wow.astron.nl</code>
ATCA	<u>atoa.atnf.csiro.au/</u>

- this is where your data will end up eventually... you generally have one year to publish!

About your co-investigators...

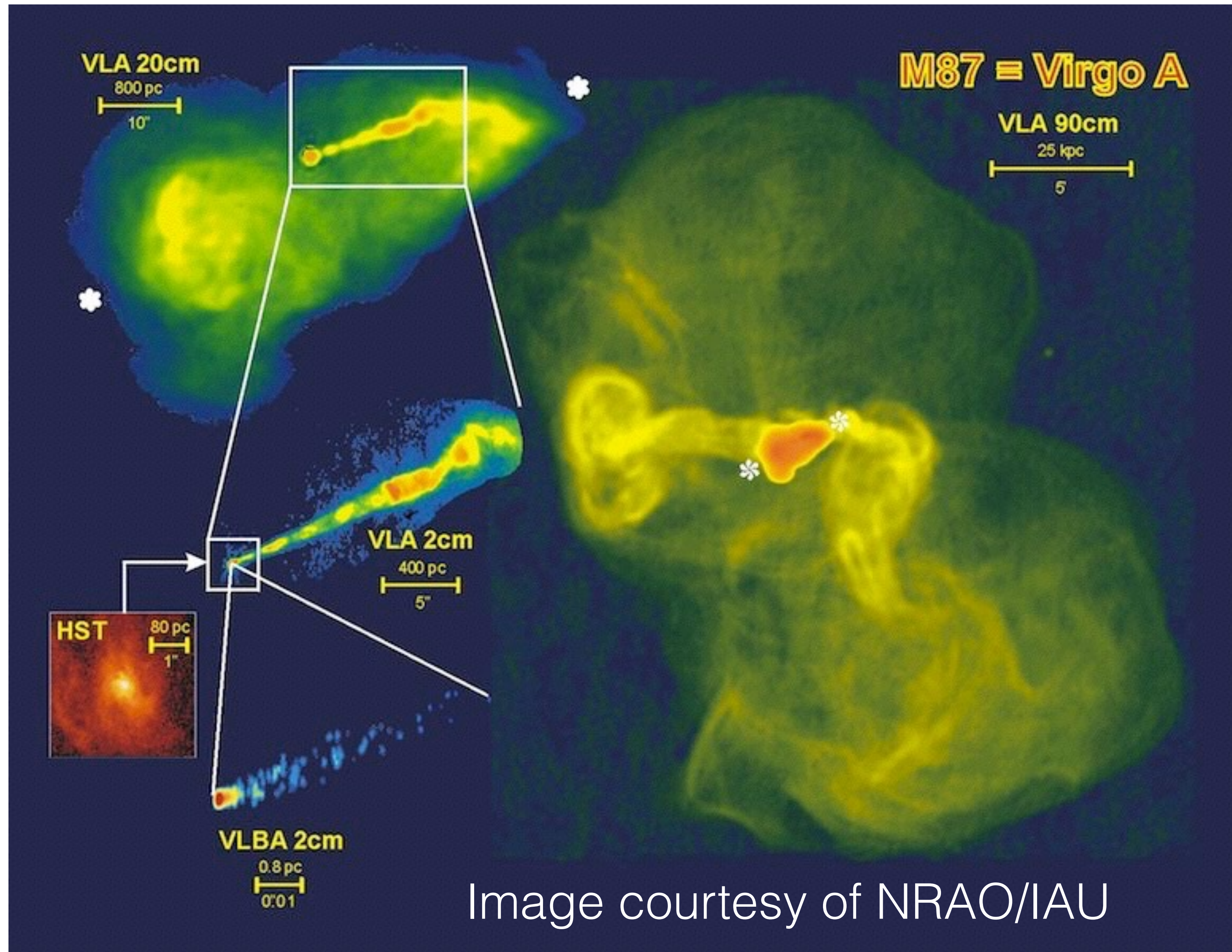
- Choose them carefully - alert them well in advance and make sure they are happy to cooperate
- You will find very different characters and skills - try to understand them, do not be surprised (people are strange!), know what and when each of them can contribute best (sometimes it's after the submission)
- Do not do all on your own - but do not expect them to do everything for you (or even something)

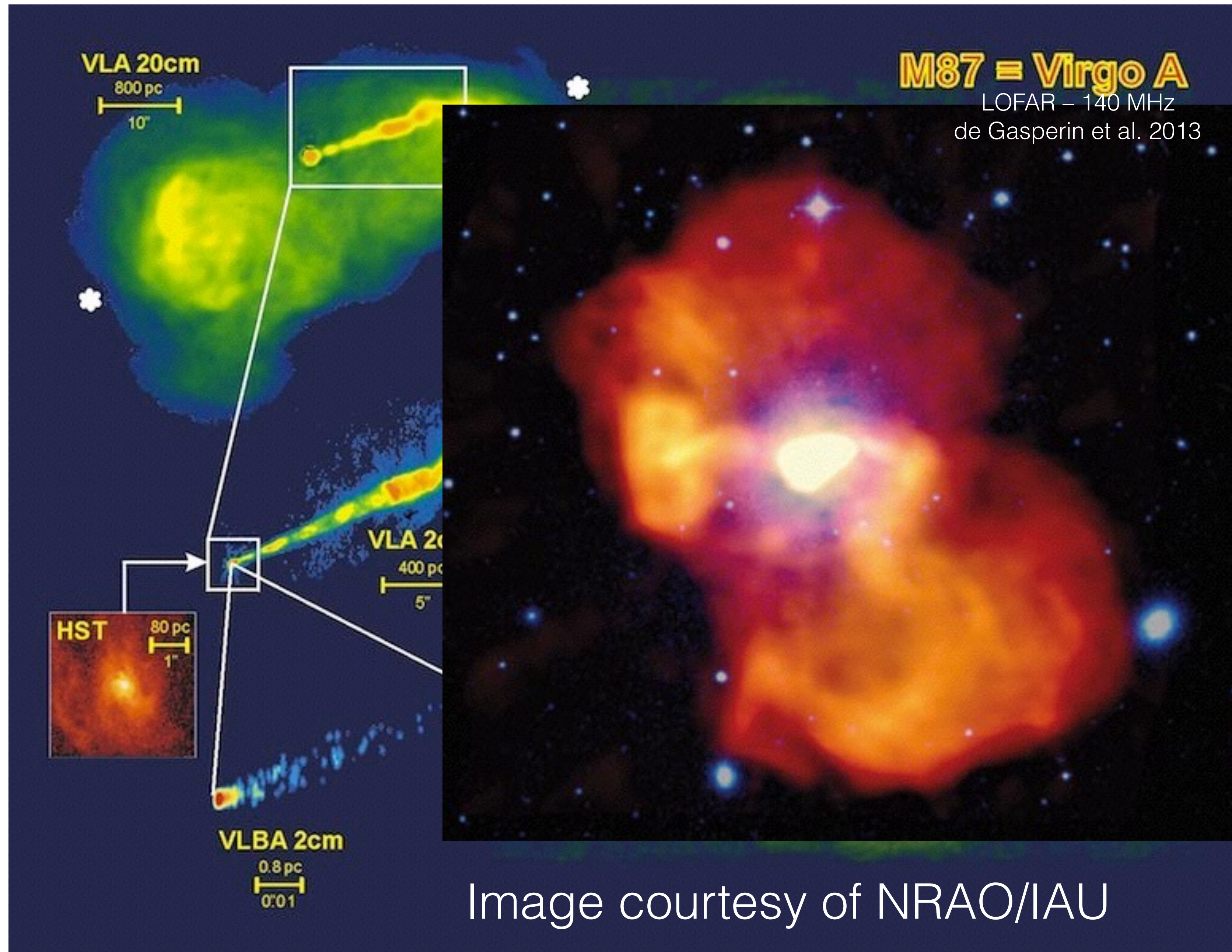
In summary

- 1) Type of experiment (continuum, spectral line, polarisation)
- 2) Resolution, field of view, largest angular scales
- 3) Frequency
- 4) Brightness sensitivity
- 5) Source location in the sky (declination)

... lead to the choice of

- a) the array (if VLBI => choice of the telescopes)
- b) observing band
- c) observing setup
- d) total time on-source

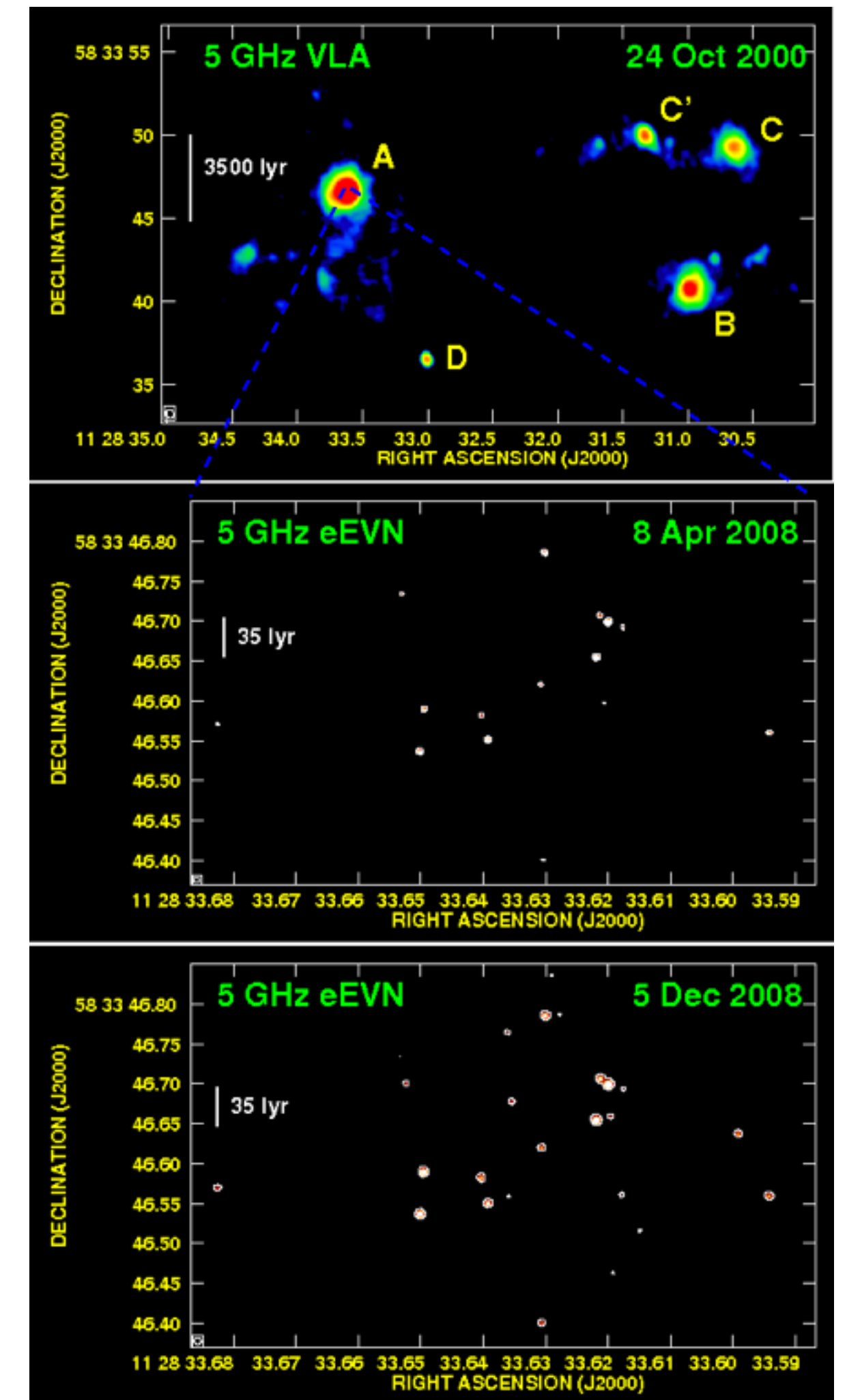




About calibration

- Designing a good calibration may seem unnecessary at the time of proposal preparation - but it is in fact very useful to get things right from the beginning
 - do not discover that what you proposed for can not actually be done!
 - save you a lot of time when your observations will be scheduled
- Some examples:
 - VLBI: is there a suitable reference source? look at www.vlba.nrao.edu/astro/calib/ and if it is not there maybe ask for a short e-VLBI observation (can be done at any time)?
 - polarisation: is the parallactic angle coverage good enough to determine leakages?

- Calibration strategy
 - Phase calibrators/phase-reference sources (see VLBI talk)
 - Special needs: Astrometry/Polarimetry (antenna leakage terms, EVPA)
- Scheduling constraints
 - Fixed or dynamic?
 - Need for dry atmosphere (at high freq.) or quiet ionosphere (at low freq.)?
 - Distance from the Sun
 - Coordinated observations with other instruments



Perez-Torres et al.

In practice...

- Radio astronomical facilities announce a call for proposals one (i.e. ALMA, e-MERLIN), two (VLBA, GMVA, VLA, GMRT, WSRT, LOFAR, ATCA), or three (e-EVN, Global VLBI) times per year
- Targets of Opportunity (ToO, sometimes called Director's Discretionary Time, DDT) are accepted at any time
- Different over-subscription factors at different observatories and at different LST ranges – keep this in mind
- **Consult observatory web pages and read the call for proposal!**

The proposal itself

- Generally consists of three parts
 1. a **cover sheet**

It includes basic information, i.e. authors & affiliation, source list, requested time and a technical summary. It is generated by the web-based proposal submission tool.
 2. a **science justification**
 3. a **technical justification**

The science justification

- Usually uploaded as a pdf file
- Be clear and concise: include the necessary background material needed to understand the scientific goal, but not more
- Clearly explain how the scientific goal is achieved by making the proposed observations
- Use clear, appropriate and readable **figures**
- Avoid unnecessary repetition and jargon
- **TAC Committees usually dislike**
 - Poorly justified sample sizes (why 10, or 20, or 100?)
 - Blind fishing
 - Vague statements
 - Non-astronomical statements
 - Proposals exceeding the given page limits

The technical justification

- Sometimes also uploaded as pdf (separate or included with the science part) - sometimes in a dedicated web interface
- Justify the requested time and setup
 - Required rms
 - Required u-v coverage/selected array
 - Required dynamic range
 - Time needed for calibration
 - Observational constraints

Proposal submission & submission tools

- Electronic submission via web-based tools is now the norm
- Different tools for different observatories
 - EVN, eMERLIN, LOFAR: NorthStar (proposal.jive.nl)
 - VLBA, VLA: NRAO PST (my.nrao.edu)
 - ALMA Observing tool (download from www.almascience.org)
 - ATCA: OPAL (opal.atnf.csiro.au)
 - GMRT: naps (naps.ncra.tifr.res.in)
- Cover & technical justification to be filled on web, scientific justification to be uploaded.
- Changes are possible until the very last minute

Future proposal deadlines

- e-Merlin: 16 Nov 2017
- ATCA: 15 Dec 2017
- GMRT: mid Jan 2018
- EVN, JVLA, VLBA, GMVA: 1 Feb 2018; Radioastron (Space VLBI) ~Jan'18
- LOFAR: ~March 2018?
- ALMA: Spring 2018?
- IRAM PdB: mid March 2018
- **GOOD LUCK WITH YOUR PROPOSAL PREPARATION!**

Useful tools and links

- EVN sensitivity calculator: www.evlbi.org/cgi-bin/EVNcalc
- ALMA sensitivity calculator: <http://almascience.eso.org/proposing/sensitivity-calculator>
- VLA exposure calculator: <https://obs.vla.nrao.edu/etc/>
- ATCA CABB sensitivity calculator: www.narrabri.atnf.csiro.au/myatca/interactive_senscalc.html
- GMRT users observing help: www.gmrt.ncra.tif.res.in/gmrt_hpage/Users/Help/help.html
- Sched (useful for planning VLBI experiments): www.aoc.nrao.edu/~cwalker/sched/
- LOFAR tools: www.astron.nl/radio-observatory/lofar/lofar-tools/lofar-tools
- VLA Calibrator Manual: www.aoc.nrao.edu/~gtaylor/csource.html
- GMRT calibrator search page: www.gmrt.ncra.tifr.res.in/~astrosupp/calib/vlacal.html

Sometimes after the deadline...

- The proposal is **accepted** 😊
 - Preparation of the required observing files using observatory specific tools
 - Observatory staff checks the observing files and schedules the observations (either on a fixed date or dynamically)
- The proposal is **rejected** 😞
 - read the feedback comments - sometimes they can really be annoying but sometimes they are really useful
 - be humble - know your limits and resources, too
 - keep in mind the annoying referee might still be there - or someone like him/her
 - remember the oversubscription of your call; did you just need an ϵ or you failed miserably?

Scheduling and observing file preparation

- Observing file contains:
 - Array configuration
 - Receiver setups
 - Correlator setup
 - Scans of targets and calibrators
 - Constraints for dynamic scheduling
- Remember to:
 - Check the visibility of the targets and calibrators, and their separation on the sky
 - Duty cycles
 - Be extra careful if using non-standard receiver setups.
 - Be sure to observe all the required calibrators (flux, phase, polarization leakage and evpa, bandpass, fringe finder in VLBI observations...)

The VLA Calibrator Manual

Hop to RA [\[01\]](#) [\[02\]](#) [\[03\]](#) [\[04\]](#) [\[05\]](#) [\[06\]](#) [\[07\]](#) [\[08\]](#) [\[09\]](#) [\[10\]](#) [\[11\]](#) [\[12\]](#) [\[13\]](#) [\[14\]](#) [\[15\]](#) [\[16\]](#) [\[17\]](#) [\[18\]](#) [\[19\]](#) [\[20\]](#) [\[21\]](#)

IAU NAME	EQUINOX	PC	RA(hh,mm,ss)	DEC(ddd,mm,ss)	POS.REF	ALT.NAME
0001+192	J2000	A	00h01m08.621563s	19d14'33.801860"	Aug01	JVAS
2358+189	B1950	A	23h58m34.865400s	18d57'51.753000"		

BAND	A	B	C	D	FLUX(Jy)	UVMIN(kL)	UVMAX(kL)
0.7cm	Q	W	W	W	0.18		

IAU NAME	EQUINOX	PC	RA(hh,mm,ss)	DEC(ddd,mm,ss)	POS.REF	ALT.NAME
0003-174	J2000	T	00h03m21.9969s	-17d27'11.781"		
0000-177	B1950	T	00h00m48.4200s	-17d43'54.000"		

BAND	A	B	C	D	FLUX(Jy)	UVMIN(kL)	UVMAX(kL)
90cm	P	X	S	S	7		7
20cm	L	X	X	S	2.2		7

IAU NAME	EQUINOX	PC	RA(hh,mm,ss)	DEC(ddd,mm,ss)	POS.REF	ALT.NAME
0004+462	J2000	A	00h04m16.127651s	46d15'17.970010"	Aug01	
0001+459	B1950	A	00h01m41.453100s	45d58'36.145000"		

BAND	A	B	C	D	FLUX(Jy)	UVMIN(kL)	UVMAX(kL)
0.7cm	Q	W	W	W	0.12		

IAU NAME	EQUINOX	PC	RA(hh,mm,ss)	DEC(ddd,mm,ss)	POS.REF	ALT.NAME
0004+203	J2000	B	00h04m35.7576s	20d19'42.249"	May01	JVAS
0002+200	B1950	B	00h02m01.6329s	20d03'00.311"		

BAND	A	B	C	D	FLUX(Jy)	UVMIN(kL)	UVMAX(kL)
0.7cm	Q	W	W	W	0.21		

IAU NAME	EQUINOX	PC	RA(hh,mm,ss)	DEC(ddd,mm,ss)	POS.REF	ALT.NAME
0005+544	J2000	A	00h05m04.363531s	54d28'24.926230"	Aug01	
0002+541	B1950	A	00h02m29.056400s	54d11'43.187000"		

Continuum phase calibrators should be:

- Compact
- Strong at the observing frequency
- As close as possible to the target

VLBA Calibrators Search Form

RA: DEC:

Examples:
RA = 6h45m10.76s DEC = 16d41'57.82"
RA = 06H45M DEC = 16d42'
RA = 06:45:10.76 DEC = 0.2914594


A '*' for RA or DEC will not restrict the search on that axis.

The default search radius is 10 degrees.
The maximum search radius is 45.0 degrees.

Search Radius:

Maximum Number of sources returned:

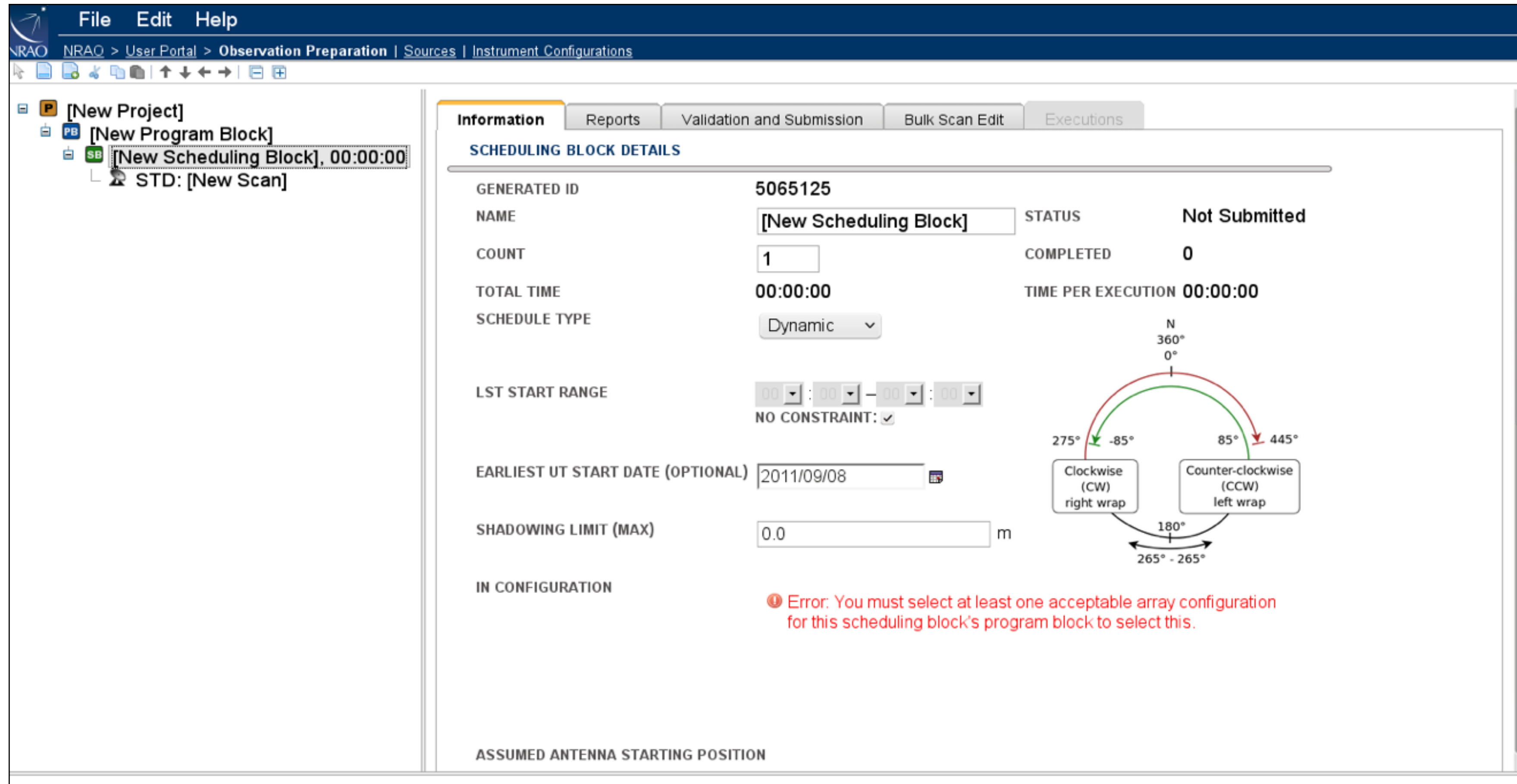
Sort the Resulting list by:



Check images on NVSS, FIRST, VLSS image surveys

Examples of observing file preparation tools

OPT for EVLA



The screenshot shows the NRAO User Portal Observation Preparation interface. The left sidebar contains a tree view with the following items:

- [New Project]
- [New Program Block]
- [New Scheduling Block], 00:00:00
- STD: [New Scan]

The main panel displays the 'Information' tab for a 'SCHEDULING BLOCK DETAILS'.

GENERATED ID	5065125	STATUS	Not Submitted
NAME	[New Scheduling Block]	COMPLETED	0
COUNT	1	TIME PER EXECUTION	00:00:00
TOTAL TIME	00:00:00		
SCHEDULE TYPE	Dynamic		
LST START RANGE	<input type="text" value="00"/> : <input type="text" value="00"/> : <input type="text" value="00"/> : <input type="text" value="00"/> NO CONSTRAINT: <input checked="" type="checkbox"/>		
EARLIEST UT START DATE (OPTIONAL)	<input type="text" value="2011/09/08"/>		
SHADOWING LIMIT (MAX)	<input type="text" value="0.0"/> m		
IN CONFIGURATION	⚠ Error: You must select at least one acceptable array configuration for this scheduling block's program block to select this.		
ASSUMED ANTENNA STARTING POSITION			

Diagram illustrating antenna configurations and wrap-around:

- Top: N 360° 0°
- Left: 275° -85°
- Right: 85° 445°
- Bottom: 180° 265° - 265°
- Left box: Clockwise (CW) right wrap
- Right box: Counter-clockwise (CCW) left wrap

- Log in at e2e.nrao.edu

Examples of observing file preparation tools

Observing file creator for GMRT

Observation Setup

- Project Code :
- Project Title :
- User's Name :
- User's Email :
- Date of Obs. :
- Start Time (IST hours) :
- Integration Time (sec) :
- Correlator Mode :
- Beam Mode (pulsar) :
- Channel nos. :
- Radio Frequency Band :
- Observation Type :
- Spectral line Frequency (MHz) (line obs only) :
- Band Width (MHz) :
- Special Requirement (If any) :

Source List

Source(s) Co-ordinates :-

Source_Name	RA	Dec	Epoch
3C147	05h38m43.50s	+49d49'42.7"	1950.0
0837-198	08h37m11.18s	-19d51'56.8"	2000.0
NGC1851	05h14m06.30s	-39d02'50.0"	2000.0

Command File

- Flux Cal at beginning :
- Target Source(s) & Phase cal(s) Loop :

Scan-Time(minutes)	Target-Name
10	1254+116
30	NGC5435

- Flux Cal at End :

- Go to www.gmrt.ncra.tifr.res.in/gmrt_hpage/Users/Help/sys/setup.html

Sched for VLBI observations

- VLBI observing file (schedule) is prepared with a program called Sched, which makes control files for all the individual telescopes : www.aoc.nrao.edu/~cwalker/sched/
- Sched handles automatically a lot of things like calculating the slewing times of different telescopes
- Since VLBI telescopes are distributed around the world, your source transits at different times at different telescopes sites. The schedule has to match the allocated UT slot, which corresponds to the requested GST range. Use sched to check source uptimes already when planning the experiment.
- If preparing VLBI schedule for the first time, seek help from an experienced user/JIVE staff; if EVN, Bob will contact you first with instructions and patches
- Remember to schedule strong and compact “fringe-finder” sources several times during the observation. Try to schedule these when they are observable from all the antennas.

Sched for VLBI observations

```
schedules : sched
File Edit View Scrollback Bookmarks Settings Help
bs179.key~      s3125csch.pt      s3125jsch.la      s3125sch.br
bs179.oms       s3125csch.sc      s3125jsch.mk      s3125sch.fd
bs179sch.br     s3125c.sum        s3125jsch.nl      s3125sch.hn
bs179sch.fd     s3125c.v2d        s3125jsch.ov      s3125sch.kp
bs179sch.hn     s3125c.vex        s3125jsch.pt      s3125sch.la
bs179sch.kp     s3125dcrd.br      s3125jsch.sc      s3125sch.mk
bs179sch.la     s3125dcrd.fd      s3125j.sum        s3125sch.nl
bs179sch.mk     s3125dcrd.hn      s3125j.v2d        s3125sch.ov
bs179sch.nl     s3125dcrd.kp      s3125j.vex        s3125sch.pt
bs179sch.ov     s3125dcrd.la      s3125kcrd.br      s3125sch.sc
bs179sch.pt     s3125dcrd.mk      s3125kcrd.fd      s3125.sum
bs179sch.sc     s3125dcrd.nl      s3125kcrd.hn      s3125.vex
bs179.sum       s3125dcrd.ov      s3125kcrd.kp      sched.runlog
bs179.vex       s3125dcrd.pt      s3125kcrd.la      sun_distances.txt
bw086f.key      s3125dcrd.sc      s3125kcrd.mk
bw086f.oms      s3125d.flag       s3125kcrd.nl
tukasa@linux-db67:~/Work/vlbi_data/schedules> sched

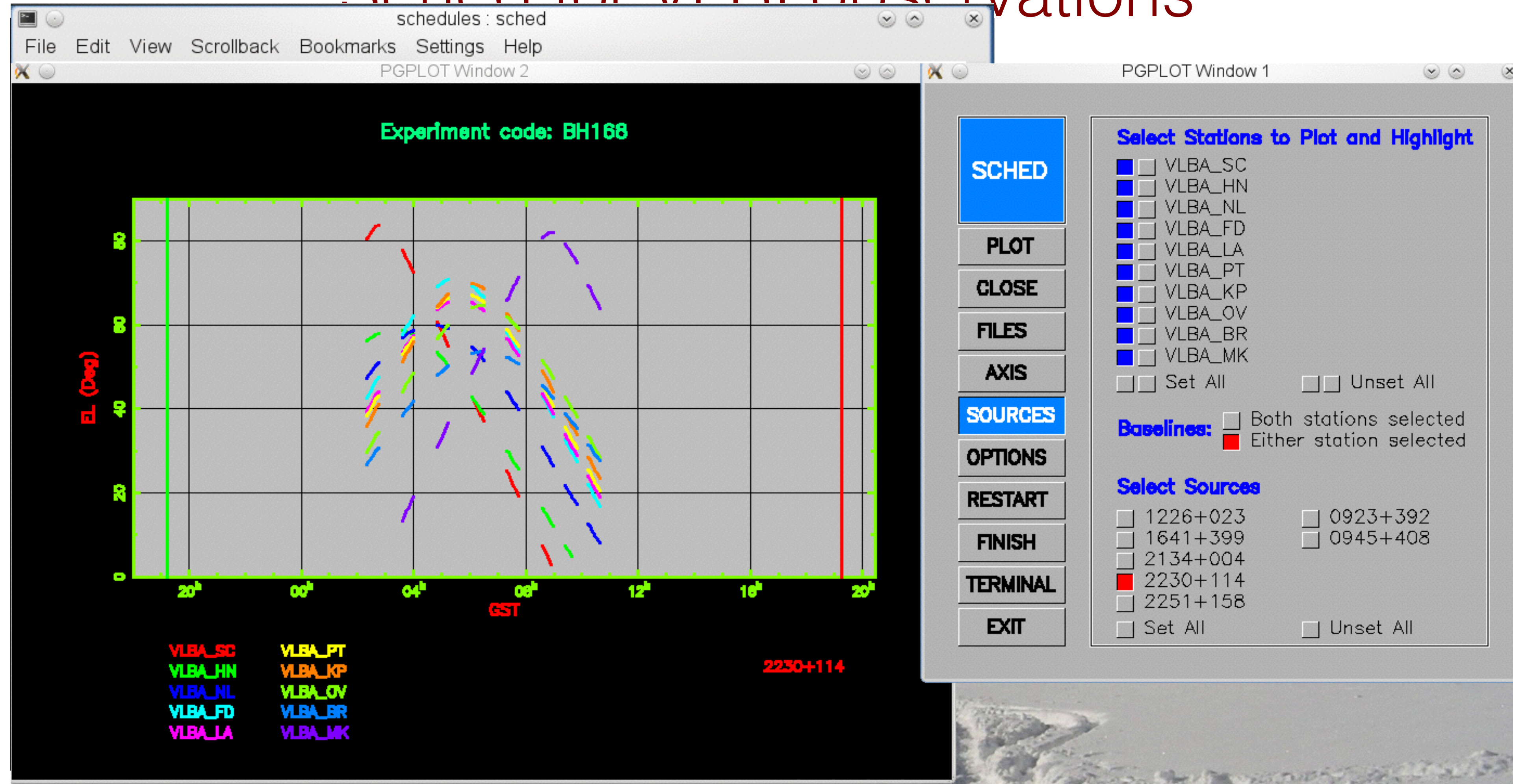
Welcome to program SCHED.  Version:  9.40  Release Jan. 13, 2011.

The manual is at http://www.aoc.nrao.edu/software/sched/index.html
Unix users should set $SCHED to the base area where SCHED is installed.
Most run time messages will be in sched.runlog

Some useful commands to give now if running interactively:
SCHEDULE=<filename>      : Specify input file.
PLOT                     : Invokes uv, xy, rd, and uptime plotting.
FREQLIST=lowF,highF     : Make frequency list (MHz).  Then exit.
EXIT                     : Leave program.
/                         : End of inputs - run program (or EXIT).

* sch = bh168.key plot /
```


Sched for VL RI observations



Summary

- Writing a proposal is the first step for a new project
 - an exciting moment your research but also a decisive place where things can go wrong
 - these guidelines can help you to avoid some mistakes - but your style and experience will do the rest
 - if you fail - understand why; if you succeed, profit of your good planning
- *RadioNet has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 730562*