Writing Proposals and Scheduling

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Outline

- 1. How to design an experiment
  - Scientific idea
  - Feasibility study
  - Choice of the array and its configuration
  - Some useful 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

How to design an experiment

- Begin with a scientific idea
  - This is the fun part, but remember that the aim must be clear.

- Make a proper literature search

  has someone already observed our target(s)?

  - Use ADS, CDS, NED and observatory archives
  - Check data from different public surveys

Archives

- Check the telescope archive for earlier observations of your targets
  - Need to re-observe?
  - Use existing data instead starting from scratch?
  - Use to justify feasibility

EVN, eVLBI	`archive.jive.nl`
(J)VLA, VLBA	`archive.nrao.edu`
MERLIN	`www.merlin.ac.uk/archive`
GMRT	`naps.ncra.tifr.res.in/goa/mt/search/basicSearch`
WSRT	`www.astron.nl/radio-observatory/astronomer/wsrt-archive`
ATCA	`atoa.atnf.csiro.au/`

How to design an experiment

1) Type of experiment

- Is it *continuum* or *spectral line*?
- If it is spectral line, which is the *frequency of the line*? Which is the *distance* of the target source? (Ciriaco's talk)
- Is it single or full *polarization*?

2) Resolution and angular scales

$$\theta \sim \frac{\lambda}{D}$$

$$\theta_{\mathrm{LAS}} \sim \frac{1}{shortest\ \ baseline}$$

- How compact/extended is the target source?
- Which is the largest angular size we want to image?
- How large is the field of view needed? Is it necessary to prevent bandwidth smearing?
  Is one pointing enough or is *mosacing* necessary?

How to design an experiment

3) Frequency required

- Just one frequency or more? If more, should they be simultaneous?
- Frequency agility necessary?

4) Brightness of the target source

$$\mathrm{rms} \propto (\Delta\nu \Delta t)^{-1/2}$$

- Which sensitivity is needed to image the weakest features in our target source?
- How long is the integration time needed?
- Which bandwidth is necessary?

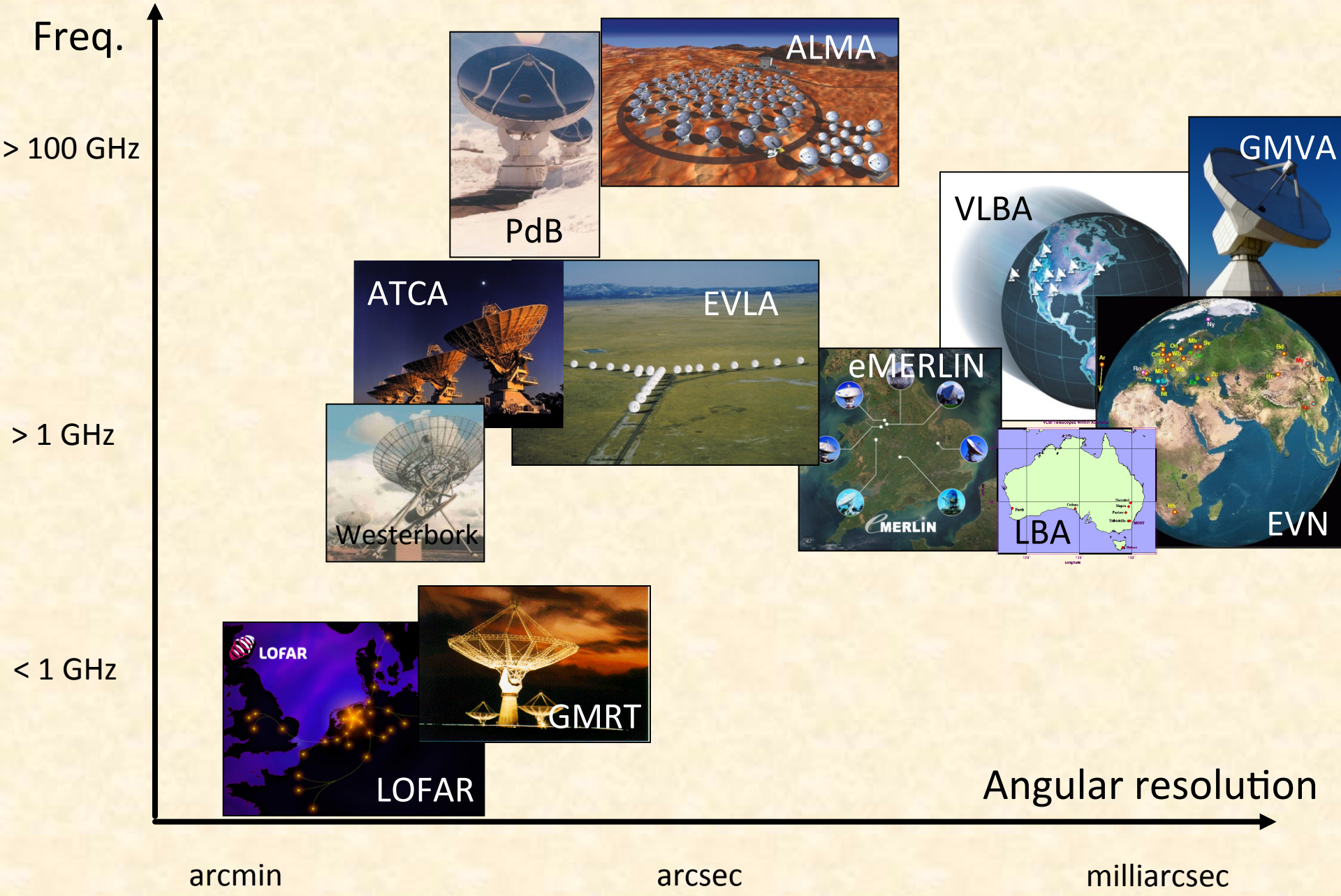
How to design an experiment

In summary

1) Type of experiment (continuum, spectral line, polarization)
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 setup
c) bandwidth/filters
d) total time on-source


Freq.
> 100 GHz
> 1 GHz
< 1 GHz
PdB
ALMA
GMVA
VLBA
ATCA
EVLA
eMERLIN
Westerbork
LBA
EVN
LOFAR
GMRT
LOFAR
Angular resolution
arcmin
arcsec
milliarcsec

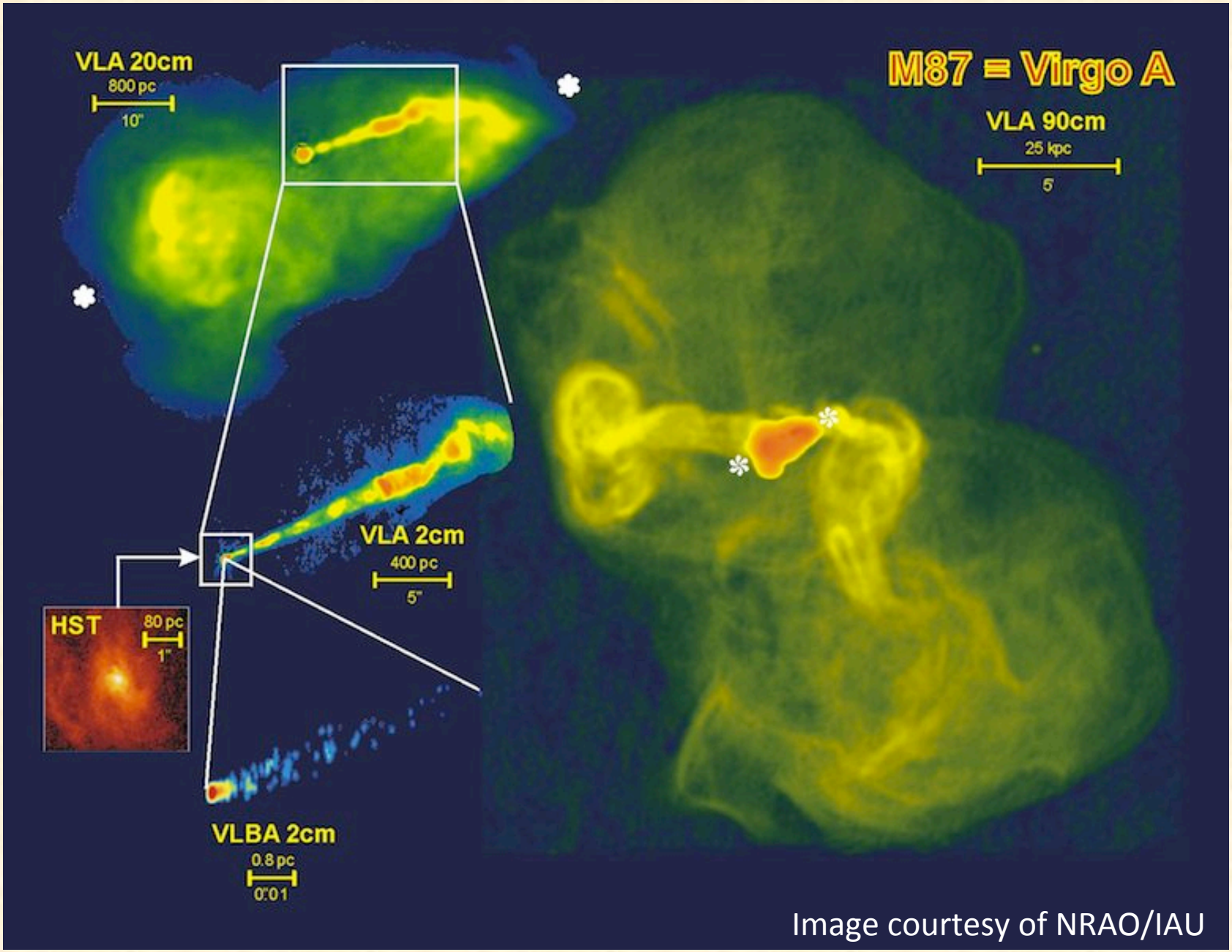
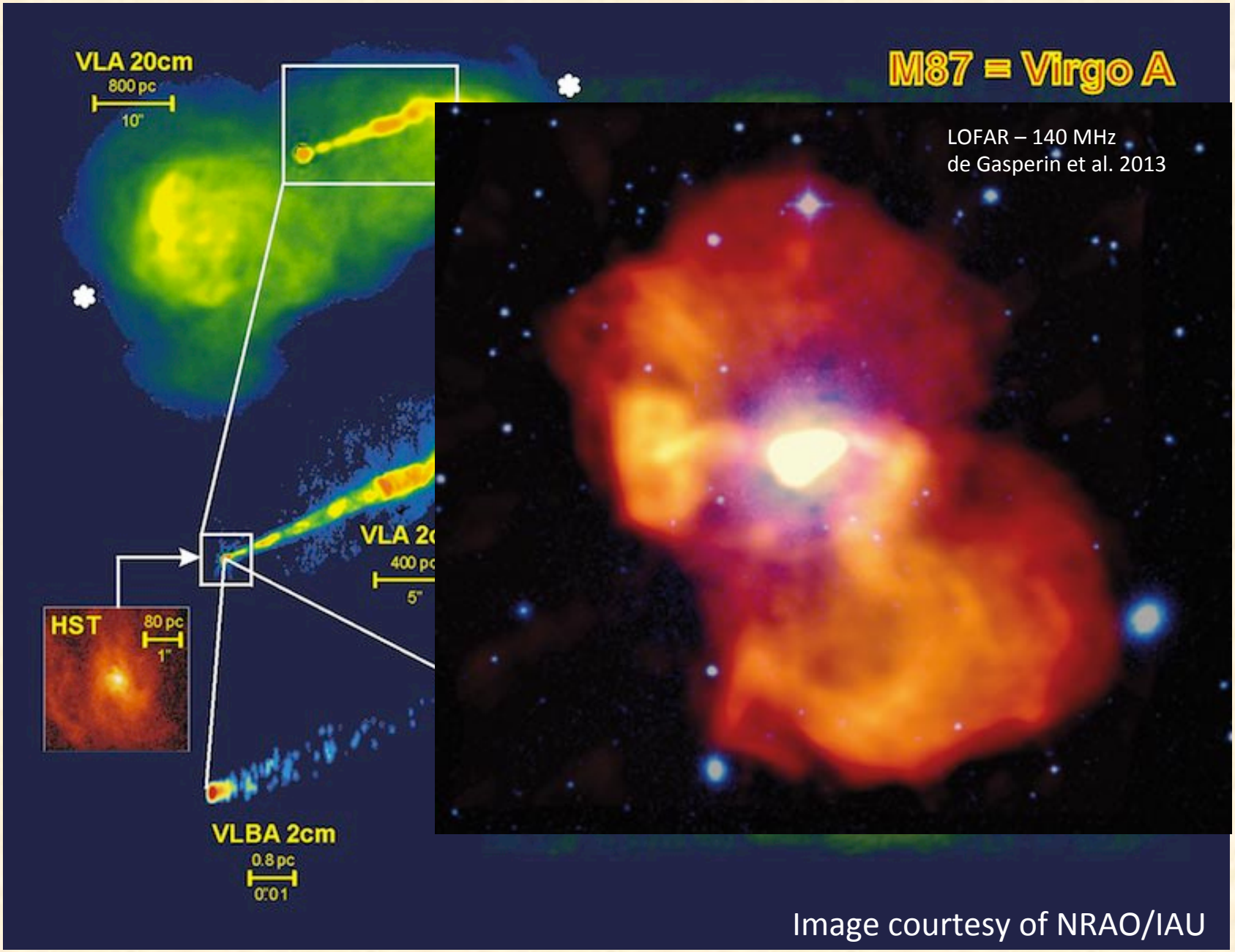


Image courtesy of NRAO/IAU


M87 = Virgo A
VLA 20cm
800 pc
10"
LOFAR – 140 MHz
de Gasperin et al. 2013
VLA 2
400 pc
5"
HST
80 pc
1"
VLBA 2cm
0.8 pc
0.01
Image courtesy of NRAO/IAU

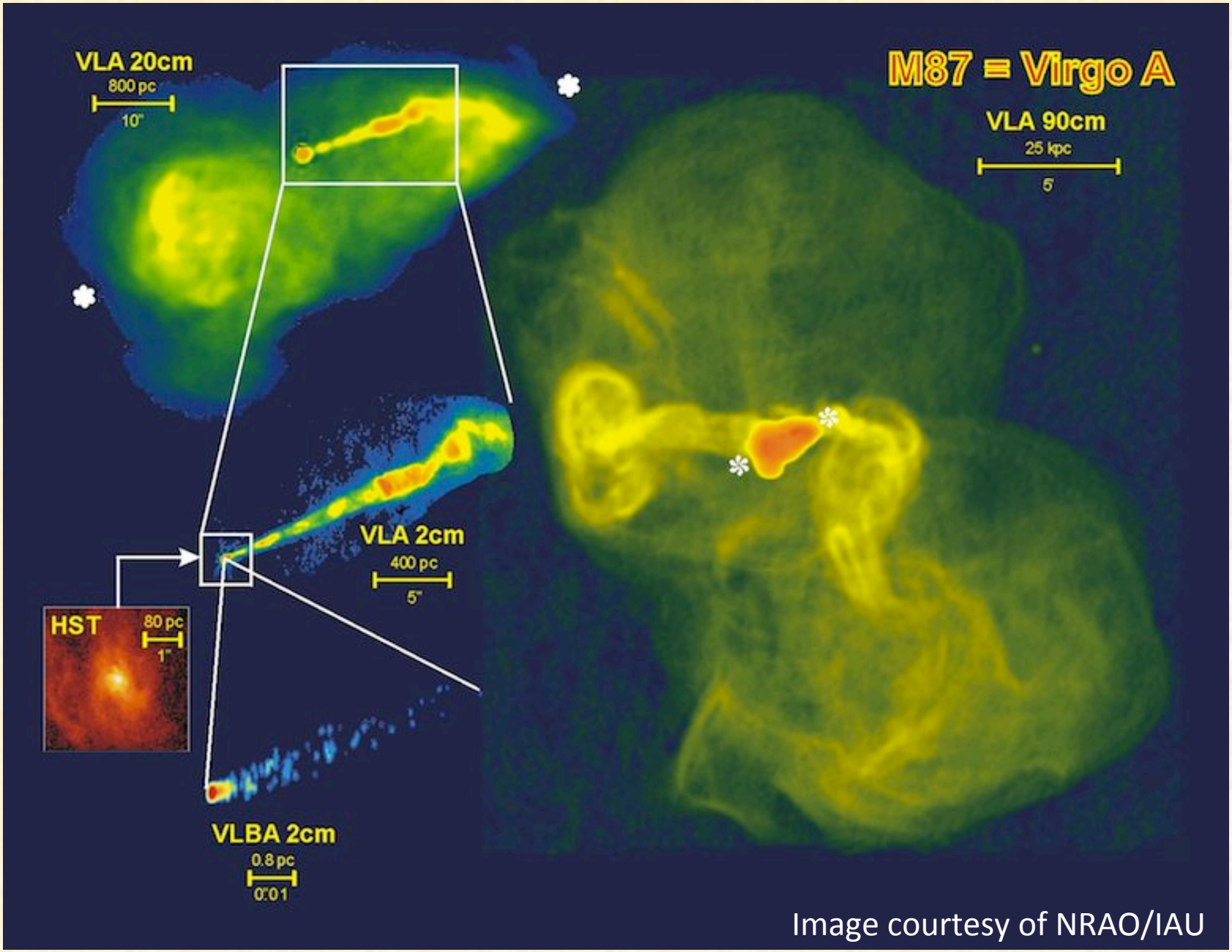
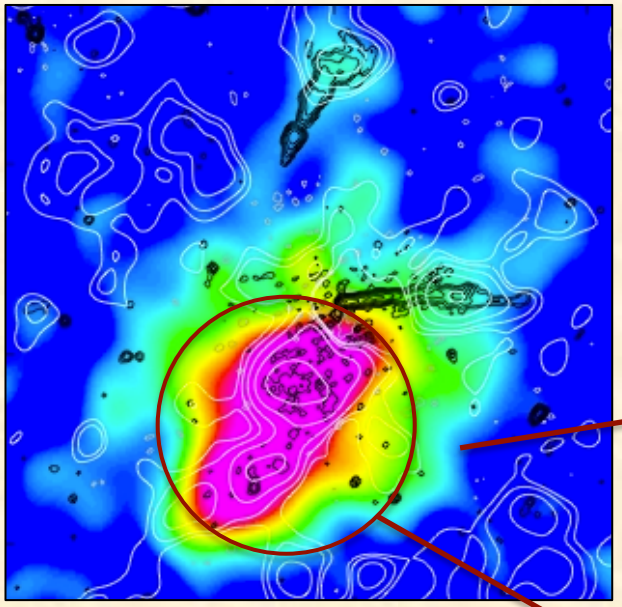
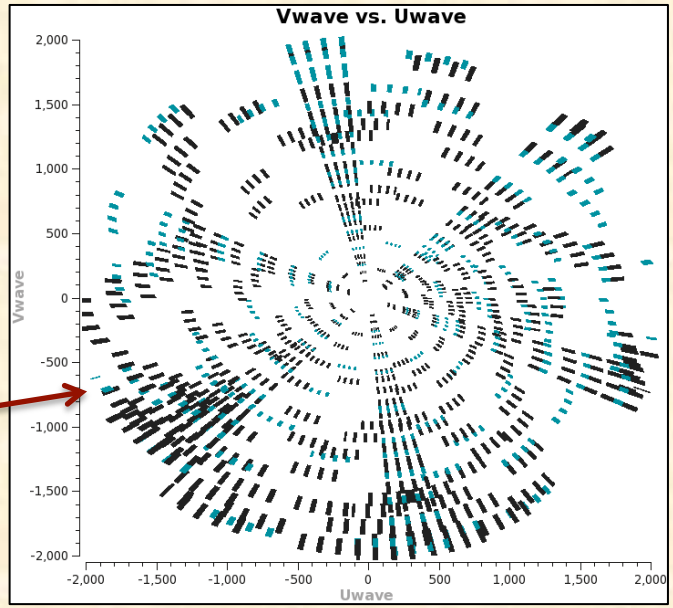


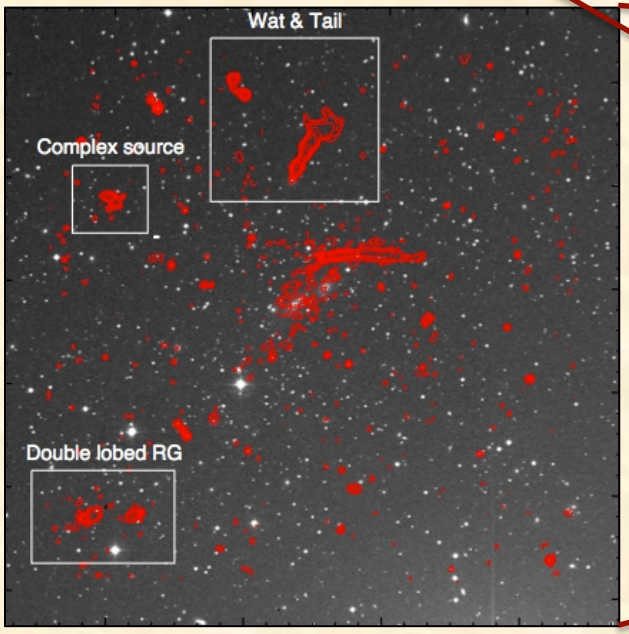
Image courtesy of NRAO/IAU

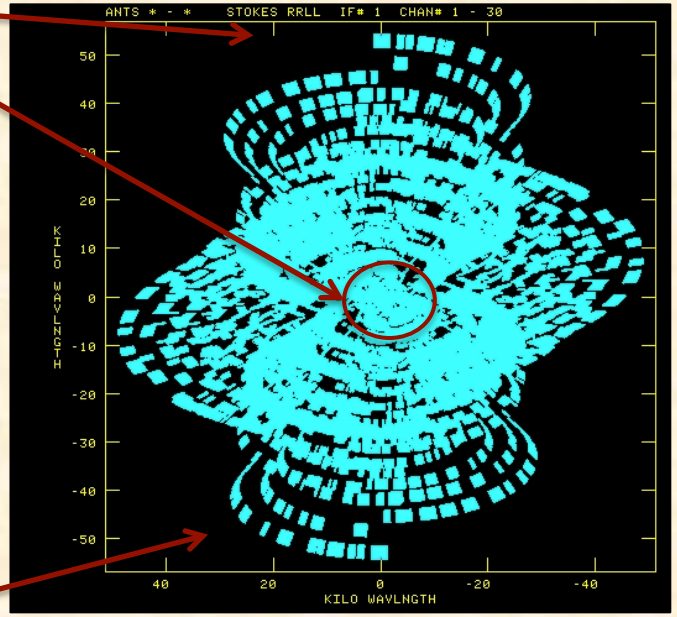
Galaxy cluster Abell 2142



JVLA-D
Lband







GMRT
610 MHz

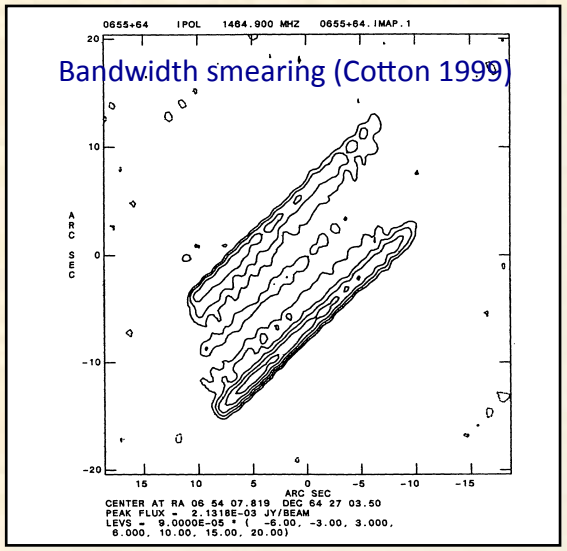
Feasibility checks

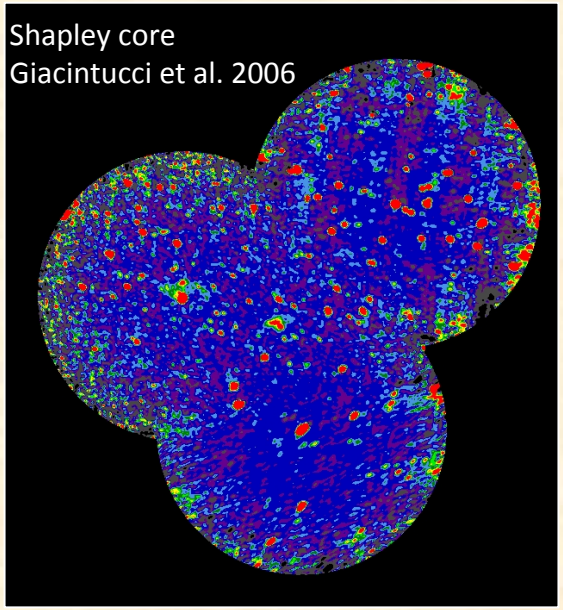
Is a wide field of view needed?

- Avoid bandwidth smearing -> need high spectral resolution
- Larger than the primary beam -> multiple pointings, mosaicing

Be aware that this can generate a lot of data: will you be able to handle it?

… Disk space, computing facilities, proper software…





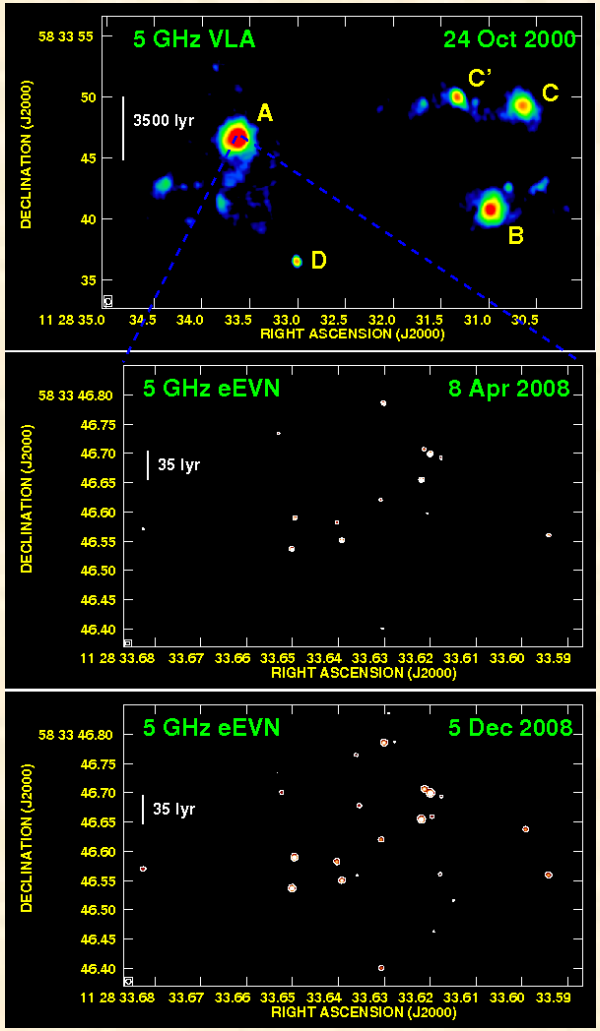
Feasibility checks

Calibration strategy

- Phase calibrators / phase-reference sources (see VLBI talk)
- Special needs:
  - Astrometry
  - Polarimetry (antenna leagake terms, EVPA)

Scheduling constraints

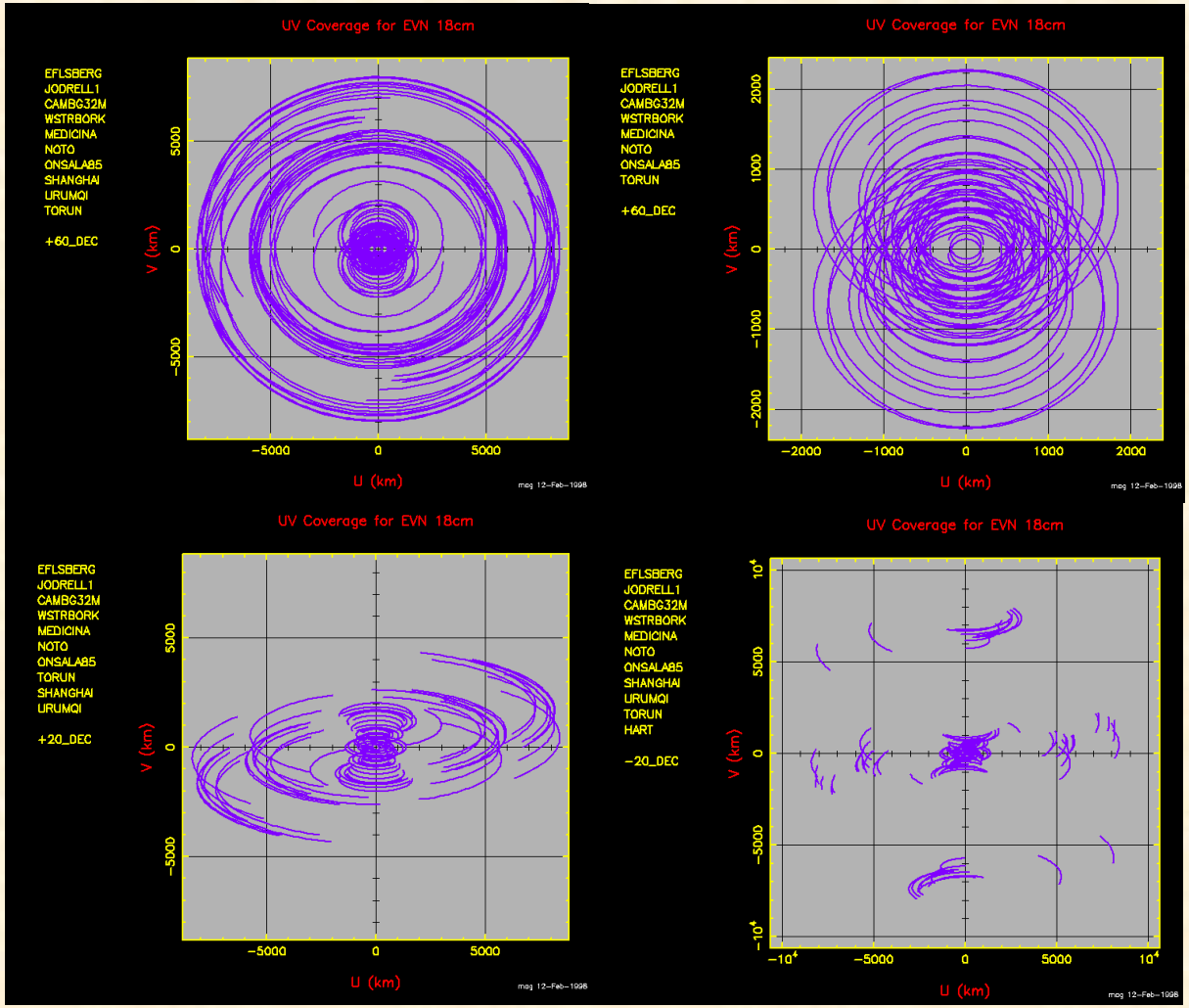
- Fixed or dynamic?
- Need for dry atmosphere (at high freq.) or quiet ionosphere (at low freq.)?
- Sun limits
- Coordinated observations with other instruments



Perez-Torres et al.

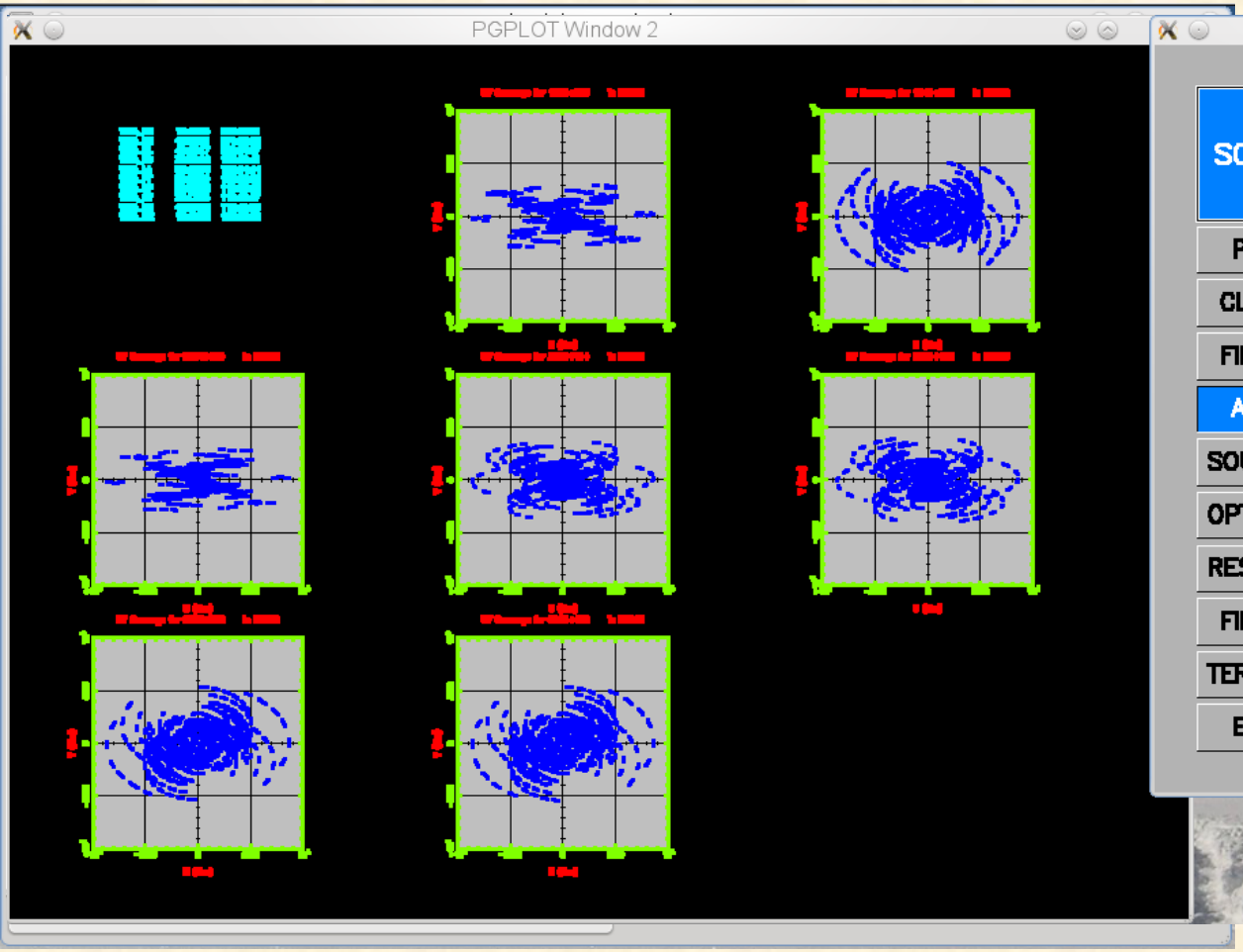
Selection of telescopes for VLBI observations

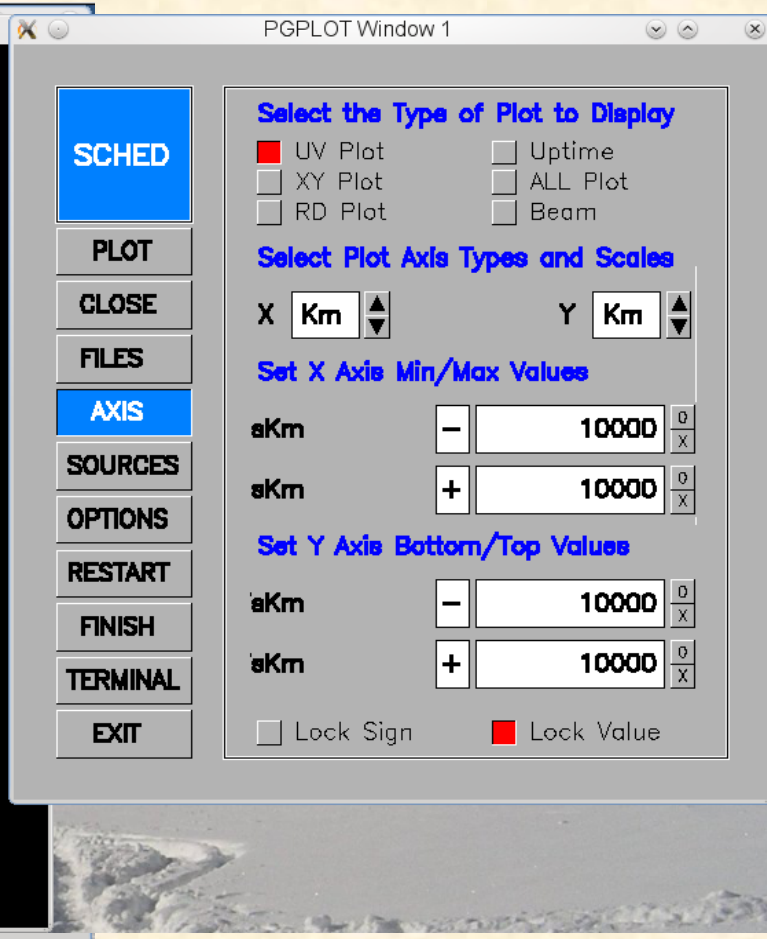
- Depending on the required angular resolution, sensitivity, and observing band one may choose EVN (multiple telescope choices), eVLBI, VLBA, HSA, GMVA, LBA or global VLBI
- Check the u-v coverage (telescopes and duration of observations)

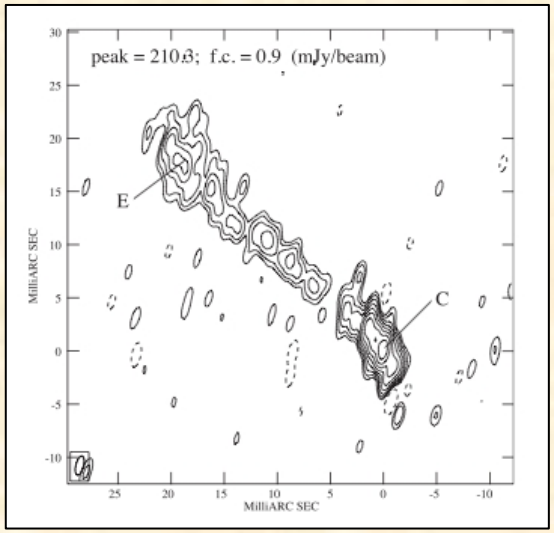


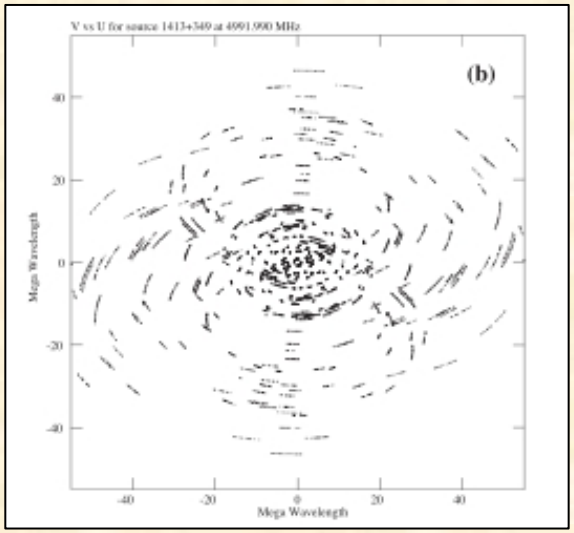
Examples of EVN (u,v) coverages

Sched for VLBI observations

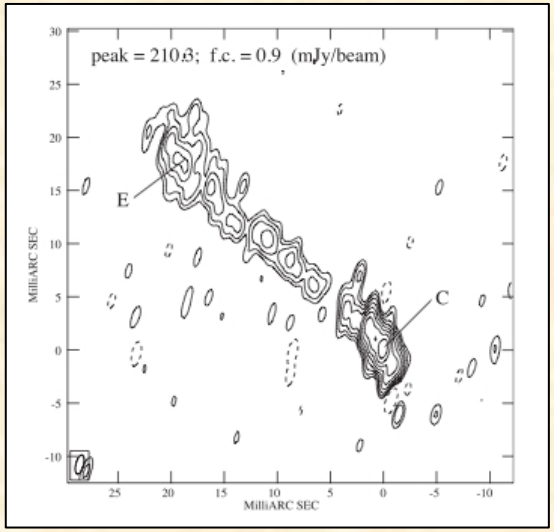


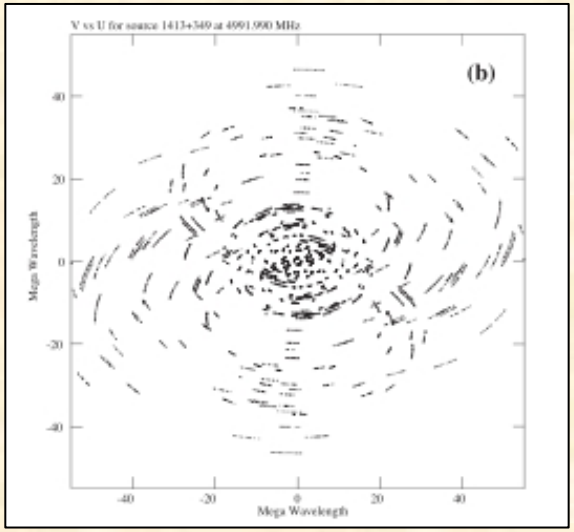






Dallacasa et al. 2013 – CSS radio source at 5 GHz, Global VLBI Array of 16 antennas, snapshot mode, total time on source 1.5 hr – Peak 209 mJy/beam





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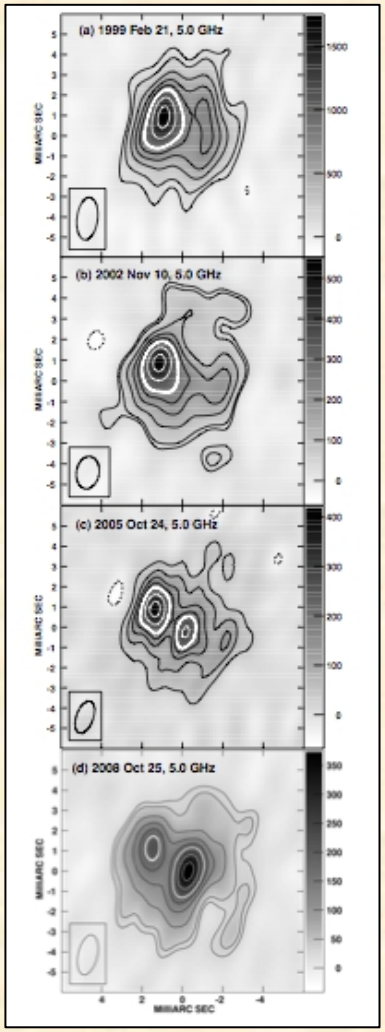


Bientenholz et al. 2010

Peaks ~ 1 mJy/beam

Table 1
VLBI Observations of SN 1986J

Date	Frequency (GHz)	Antennas[a]	Total Time (hr)	Recording Rate (Mbit s^{-1})
2005 Apr 25	22	VLBA, Ef, Gb, Y27	12	256
2005 Oct 24	5	VLBA, Ef, Gb, Y27, Jb, On, Wb, Tr	12	256
2006 Dec 3	8	VLBA, Ef, Gb, Y27	15	512
2006 Dec 10	22	VLBA, Ef, Gb, Y27	15	512
2008 Oct 26	5	VLBA, Ef, GB, Y27, Jb, Mc, Nt, Tr, Wb	18	512

Note. [a] VLBA, ten 25 m dishes of the NRAO Very Long Baseline Array; Ef, 100 m, MPIfR, Effelsberg, Germany; Gb, ~105 m, NRAO, Green Bank, WV, USA; Y27, equivalent diameter 130 m, NRAO, near Socorro, NM, USA; Jb, 76 m, Jodrell Bank, UK; Mc, 32 m, IdR-CNR, Medicina, Italy; Nt, 32 m, IdR-CNR, Noto, Italy; On, 20 m, Onsala Space Observatory, Sweden; Tr, 32 m, Torun, Poland; Wb, equivalent diameter 94 m, Westerbork, the Netherlands.

Writing an observing time proposal

General information

- Common radio astronomical facilities usually announce a call for proposals one (i.e. ALMA) two (VLBA, GMVA, EVLA, GMRT, WSRT, LOFAR, ATCA) or three (EVN, eVLBI) times per year
- ToOs are accepted any time
- Different over-subscription factors at different observatories and at different LST ranges – keep this in mind

Writing an observing time proposal

A proposal consists of three parts

Cover sheet

It includes the source list and technical requirements. It is generated by the web-based proposal submission tool

Scientific justification

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

Writing an observing time proposal

A proposal consists of three parts

Cover sheet

It includes the source list and technical requirements. It is generated by the web-based proposal submission tool

Scientific justification

TAC Committees usually don't like:

Poorly justified sample sizes (why 10, or 20, or 100?)

Blind fishing

Vague statements

Non-astronomical statements

Proposals exceeding the given page limits

Writing an observing time proposal

Technical justification

- Justify the requested time and setup
- Required rms
- Required u-v coverage/selected array
- Required dynamic range
- Time needed for calibration
- Observational constraints

If non-standard setups or a very stringent scheduling is needed, it is a good idea to consult the observatory staff beforehand. It may turn out that what you are requesting is in fact impossible to do!!!

Some useful tools and links

- EVN sensitivity calculator: `www.evlbi.org/cgi-bin/EVNcalc`
- ALMA sensitivity calculator: `almascience.eso.org/call-for-proposals/sensitivity-calculator`
- EVLA exposure calculator: `science.nrao.edu/facilities/vla/docs/manual/propvla/determining/source`
- ATCA observing tools: `www.narrabri.atnf.csiro.au/observing/#tools`
- Sched (useful for planning VLBI experiments): `www.aoc.nrao.edu/~cwalker/sched/`

Some useful tools and links

- GMRT users observing help: www.gmrt.ncra.tif.res.in/gmrt_hpage/Users/Help/help.html
- LOFAR tools: www.astron.nl/radio-observatory/lofar/lofar-tools
- VLA Calibrator Manual: www.aoc.nrao.edu/~gtaylor/csource.html
- GMRT calibrator search page: ncra.tifr.res.in/ncra_hpage/calib.html

Proposal submission & submission tools

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

Scheduling and observing file preparation

- After the acceptance of the proposal:
  - 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)

- 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…)

Search for calibrators

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 W       0.18

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 S         7                      7
 20cm    L  X X X S       2.2                      7

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 W       0.12

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 W       0.21

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

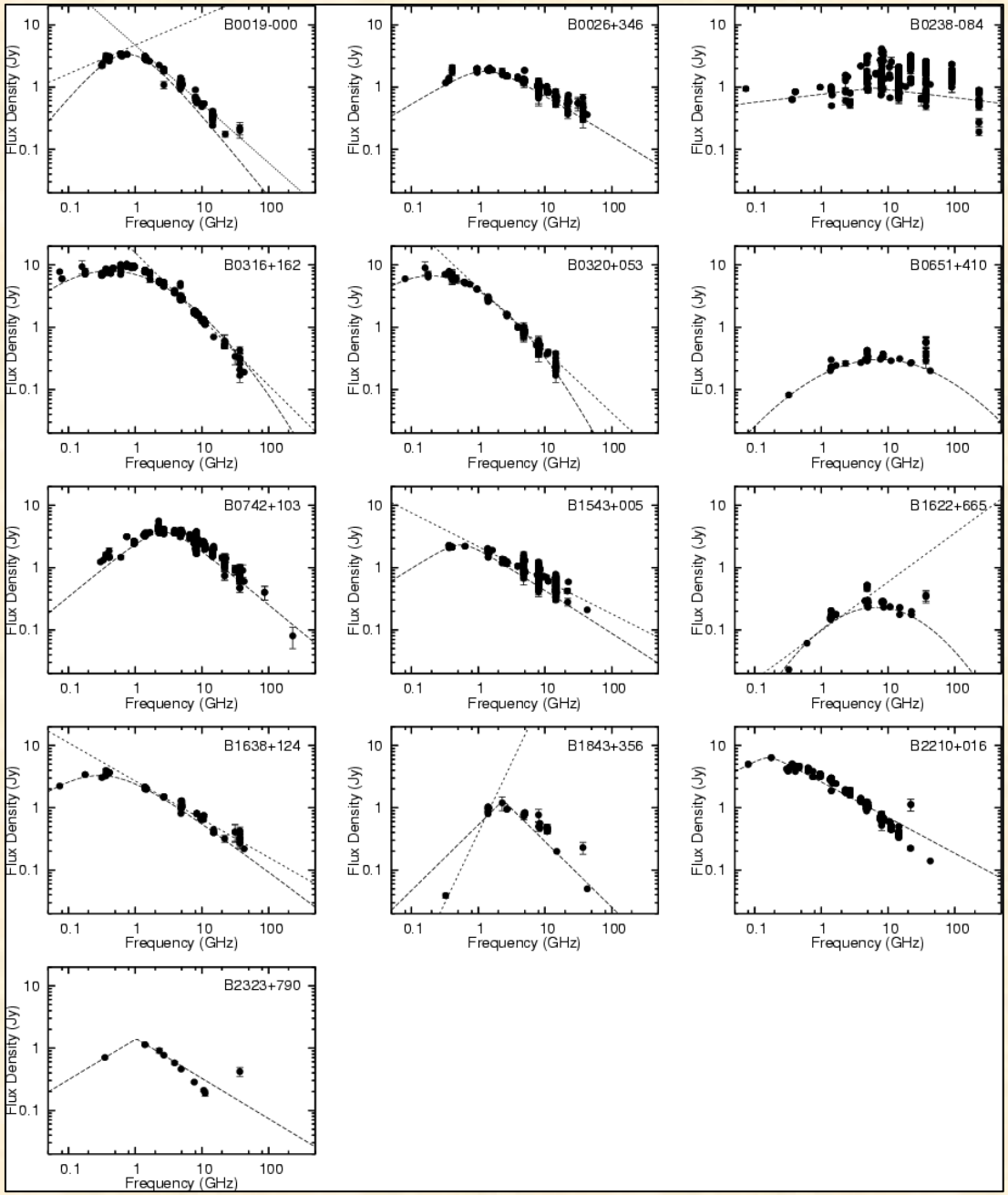
RA :	0h0m0.0s	Examples: RA = 6h45m10.76s DEC = 16d41'57.82" RA = 06H45M DEC = 16d42' RA = 06:45:10.76 DEC = 0.2914594
DEC :	0d0'0.0	*A '*' for RA or DEC will not restrict the search on that axis.*
Search Radius :	10d	*The default search radius is 10 degrees.* *The maximum search radius is 45.0 degrees.*

Maximum Number of sources returned: 5

Sort the Resulting list by: Distance

SEARCH

Check images on NVSS, FIRST, VLSS image surveys

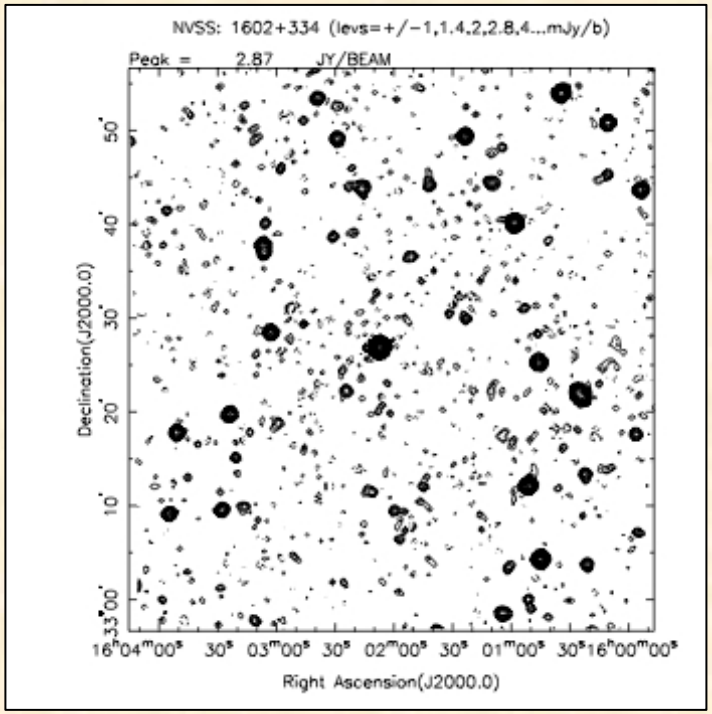

B0019-000
B0026+346
B0238-084
B0316+162
B0320+053
B0651+410
B0742+103
B1543+005
B1622+665
B1638+124
B1843+356
B2210+016
B2323+790
Flux Density (Jy)
Frequency (GHz)
10
1
0.1
0.1
1
10
100

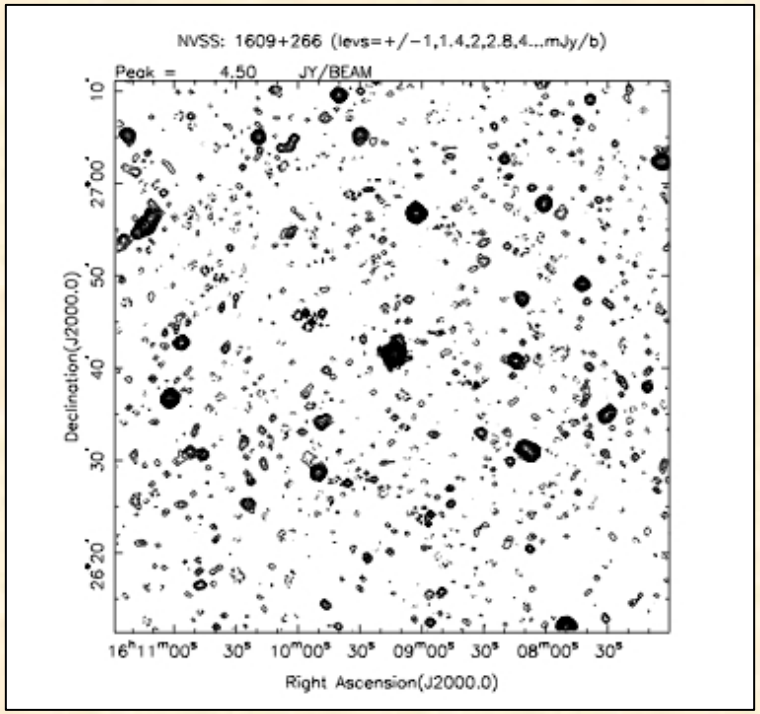
Example:
Calibrator search for GMRT observations of Abell 2142 at 610, 325, 240 MHz

RA_{J2000}=15 58 16.1 DEC_{J2000}=+27 13 29

```
1602+334   J2000  A 16h02m07.263468s  33d26'53.072670"  Aug01
1600+335   B1950  A 16h00m11.909300s  33d35'09.593000"
-------------------------------------------------------
BAND         A B C D    FLUX(Jy)    UVMIN(kL)  UVMAX(kL)
=======================================================
 20cm    L   P P P P       2.60
  6cm    C   P P P P       2.00
3.7cm    X   P P P P       2.05
  2cm    U   P P P P       1.40
0.7cm    Q   W W W W       0.41                  visplot
```

```
1609+266   J2000  B 16h09m13.320753s  26d41'29.036380"  Aug01
1607+268   B1950  B 16h07m09.290100s  26d49'18.658000"
-------------------------------------------------------
BAND         A B C D    FLUX(Jy)    UVMIN(kL)  UVMAX(kL)
=======================================================
 20cm    L   P P P P       4.83
  6cm    C   S P P P       1.70                    300
3.7cm    X   S P P P       0.85                    300
  2cm    U   X S S S       0.50                    300
0.7cm    Q   X X X X       0.0
```





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RA_{J2000}=15 58 16.1 DEC_{J2000}=+27 13 29

```
1602+334   J2000  A 16h02m07.263468s  33d26'53.072670"  Aug01
1600+335   B1950  A 16h00m11.909300s  33d35'09.593000"
-------------------------------------------------
BAND         A B C D    FLUX(Jy)    UVMIN(kL)  UVMAX(kL)
=================================================
 20cm    L   P P P P       2.60
  6cm    C   P P P P       2.00
3.7cm    X   P P P P       2.05
  2cm    U   P P P P       1.40
0.7cm    Q   W W W W       0.41                  visplot
```

```
1609+266   J2000  B 16h09m13.320753s  26d41'29.036380"  Aug01
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-------------------------------------------------
BAND         A B C D    FLUX(Jy)    UVMIN(kL)  UVMAX(kL)
=================================================
 20cm    L   P P P P       4.83
  6cm    C   S P P P       1.70                    300
3.7cm    X   S P P P       0.85                    300
  2cm    U   X S S S       0.50                    300
0.7cm    Q   X X X X       0.0
```
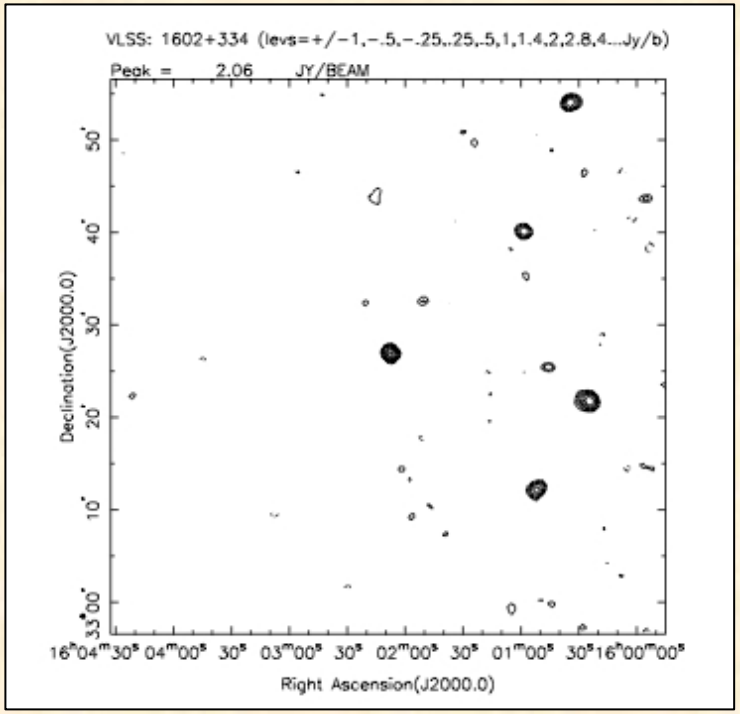
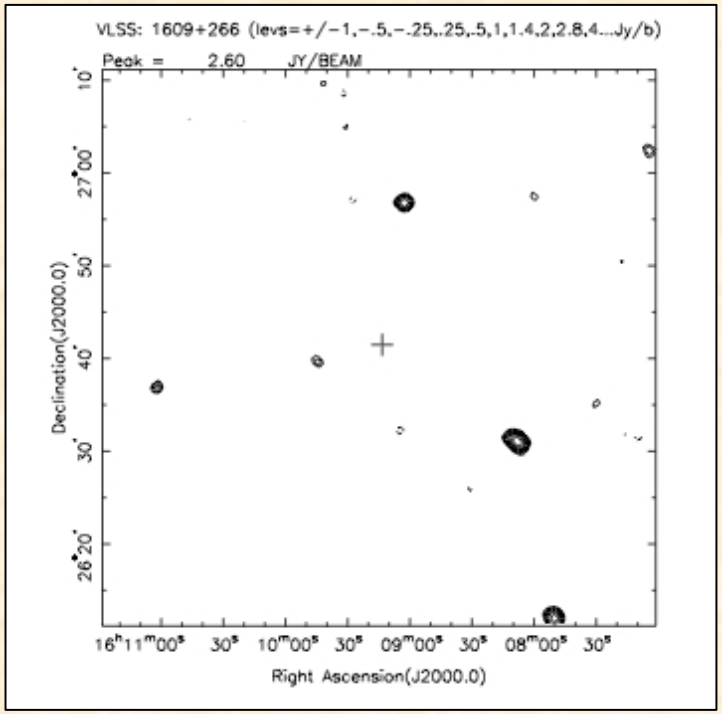
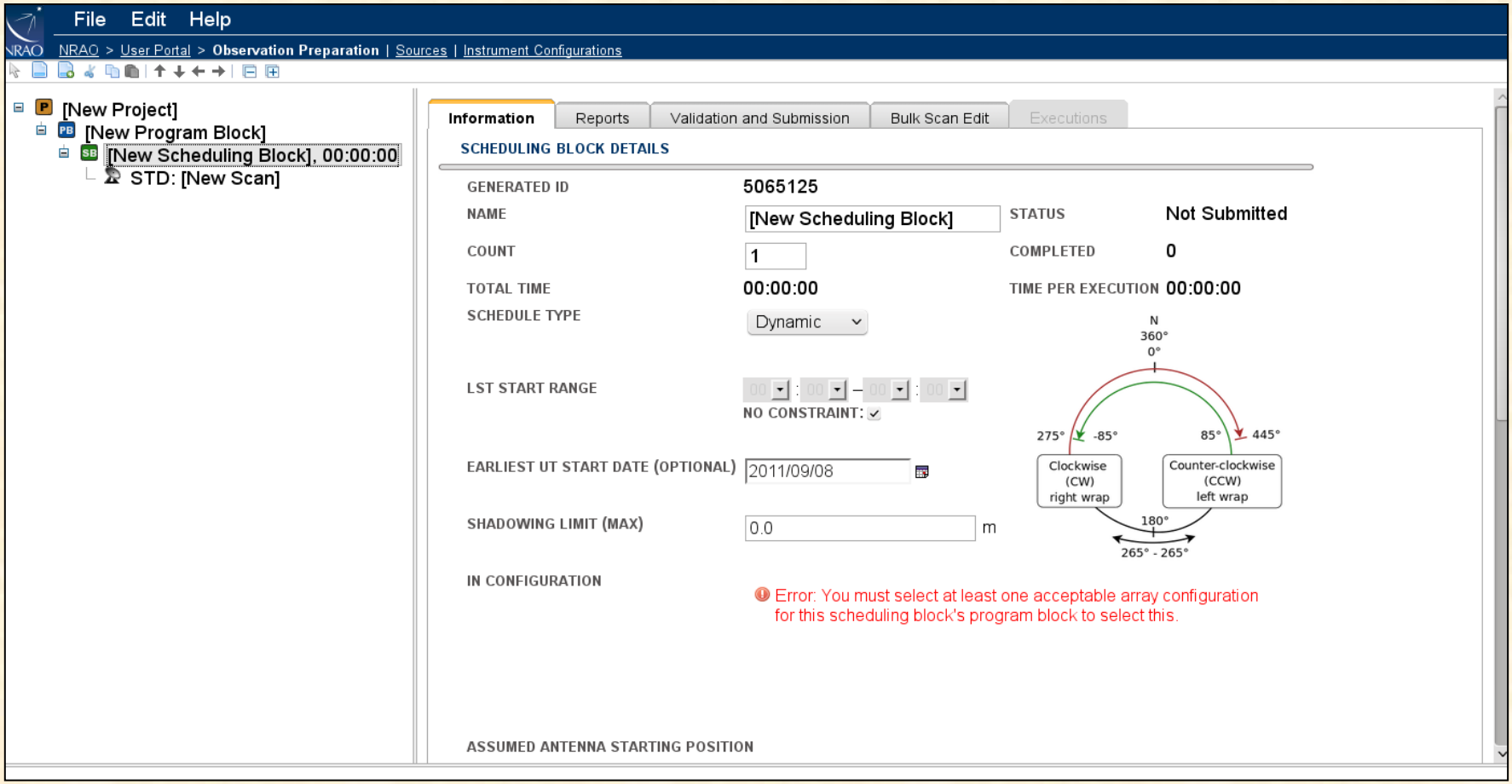





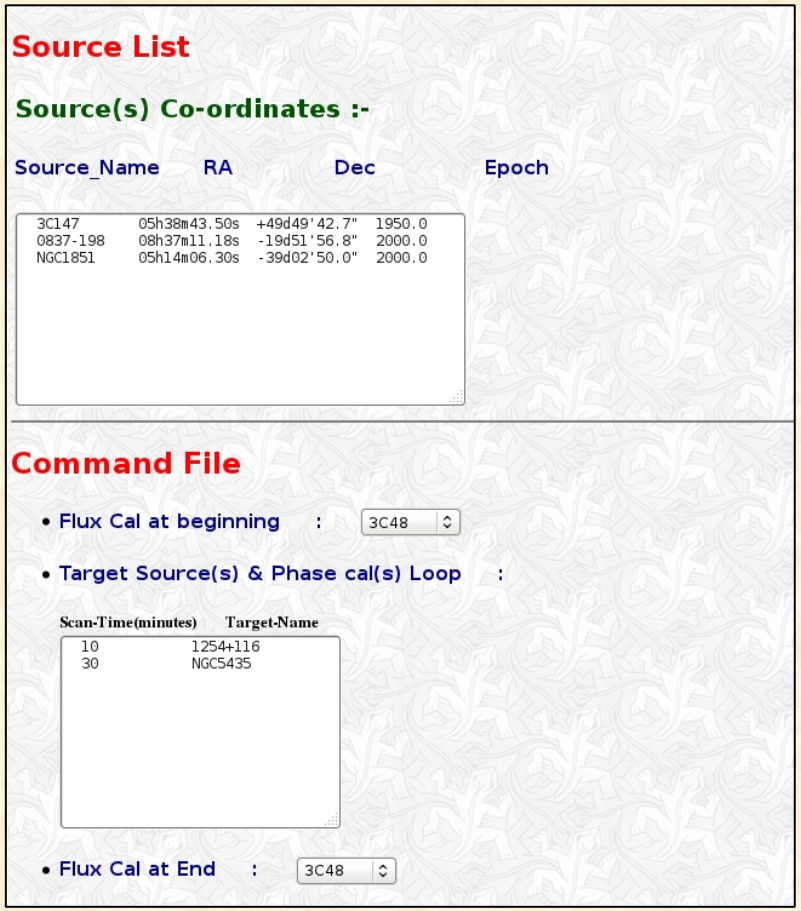
Examples of observing file preparation tools
OPT for EVLA

- Log in at `e2e.nrao.edu`



Examples of observing file preparation tools
Observing file creator for GMRT

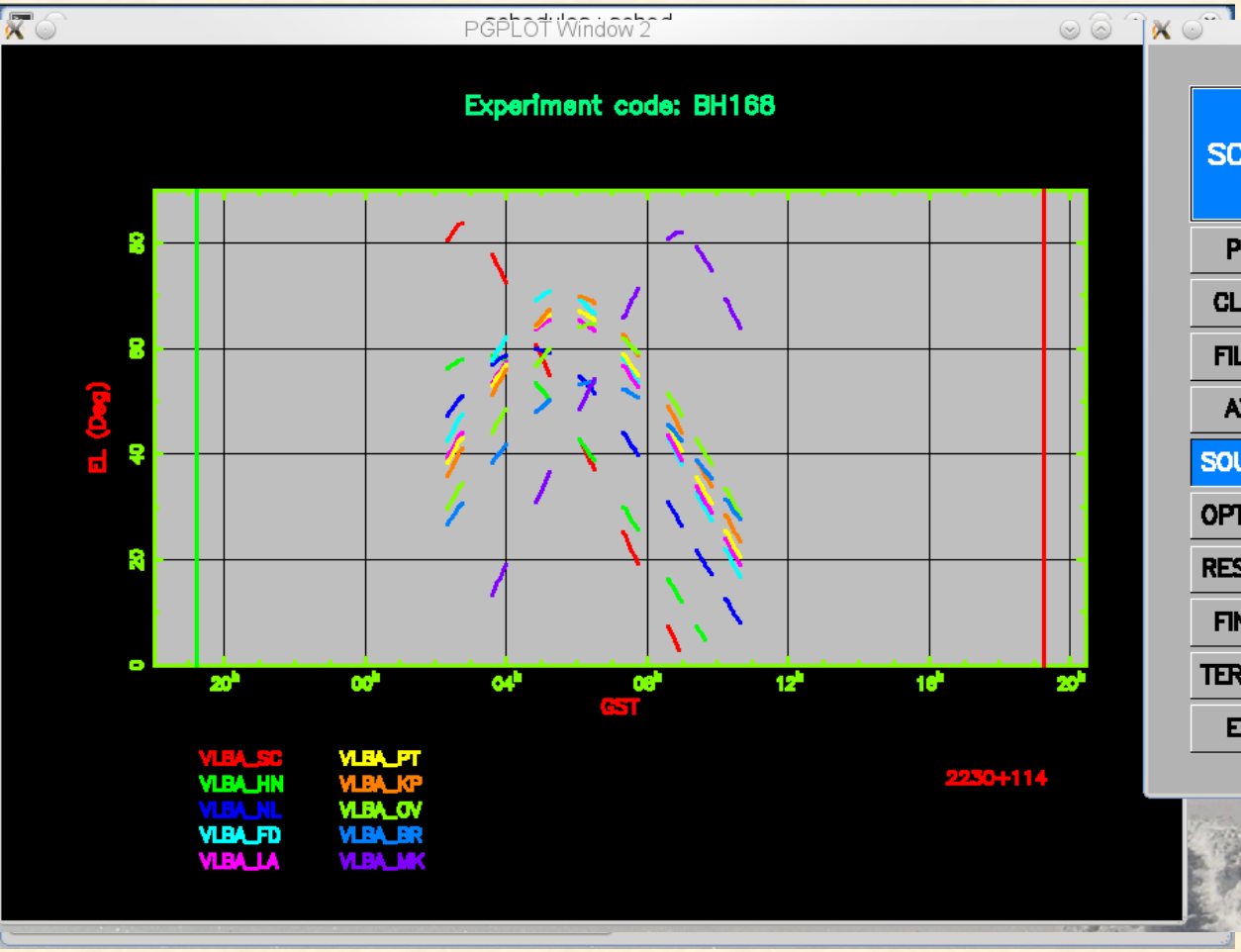
- Go to `www.gmrt.ncra.tifr.res.in/gmrt_hpage/Users/Help/sys/setup.html`

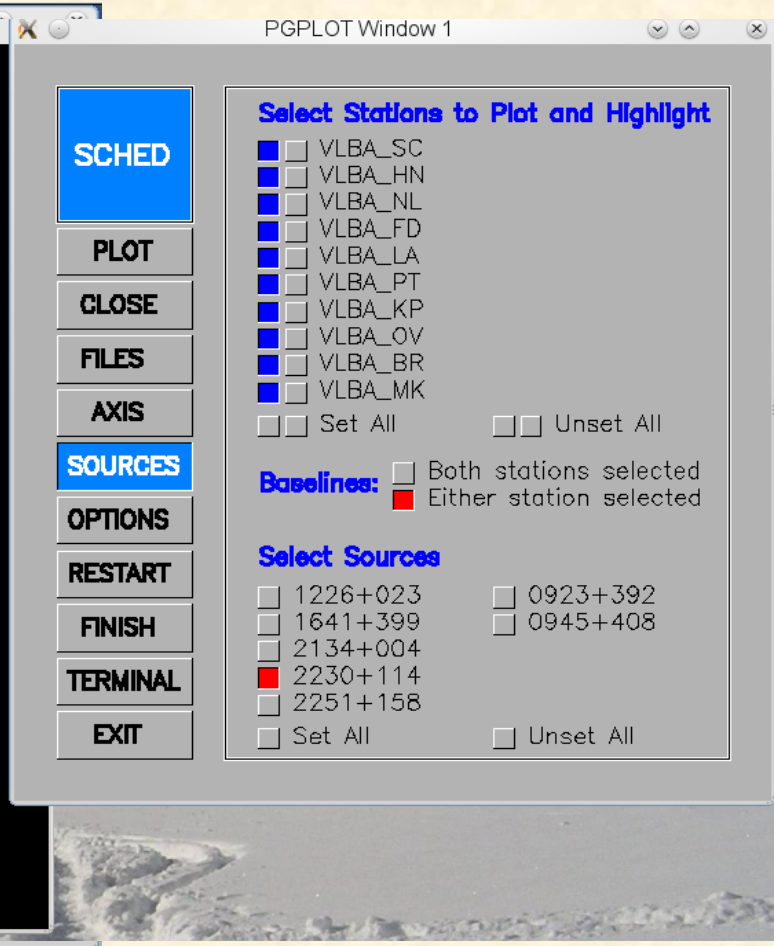


Sched for VLBI observations

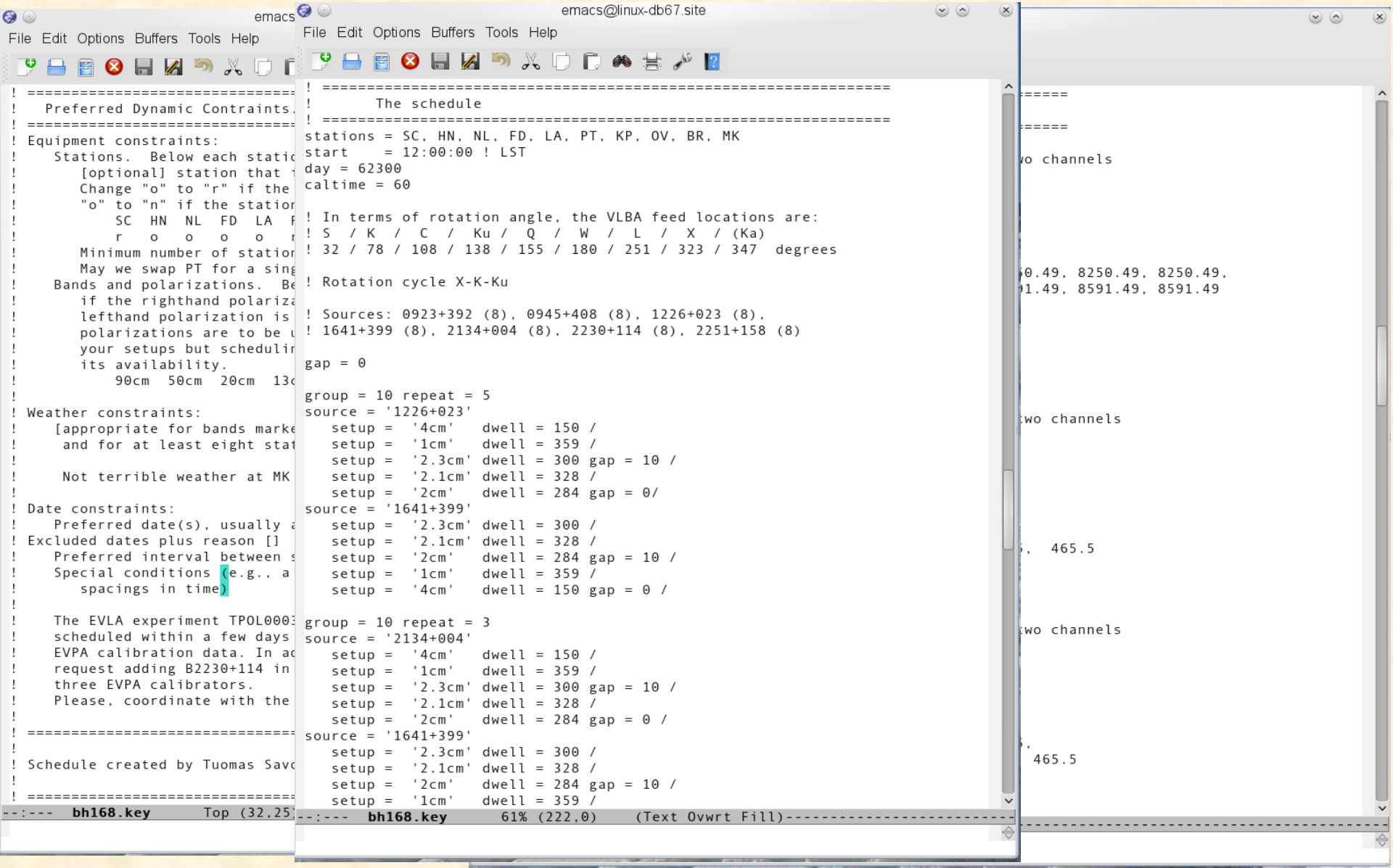
- VLBI observing file (*schedule*) is prepared with a program called Sched, which makes control files for all the individual telescopes (www.aoc.nrao.edu/~cwalker/sched/)
- Sched handles automatically a lot of things like calculating the slewing times of different telescopes
- Since VLBI telescopes are 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.
- 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.
- Send <obscode>.key file to the observatory staff

Sched for VLBI observations





Sched for VLBI observations



After the observations

In most cases the raw data may be retrieved from the observatory machines.
At this point the the data reduction starts...

Monday 09/09

08:50-09:00 Welcome	R. Vermeulen & **H. J. van Langevelde**
09:00-09:45 1. Interferometric Radio Science	**H. J. van Langevelde**
09:45-10:30 2. Fundamentals of Interferometry	R. Laing
10:30-11:00 Coffee Break	
11:00-11:45 3. Modern interferometers	J. McKean
11:45-12:30 4. Data acquisition and calibration	D. Dallacasa
12:30-14:00 Lunch	
14:00-14:45 5. From visibilities to images	Tom Muxlow
14:45-15:15 Radio astronomical data formats and packages	A. Richards
15:15-15:45 Coffee Break	
15:45-17:30 Tutorial T1: Calibration	D. Dallacasa
17:30–17:45 Introduction to Tutorials T6 and T10 'Writing a proposal'	T. Venturi, R. Laing, A. Richards

Tuesday 10/09

09:00-09:45 6. Polarization: data acquisition, calibration, and imaging	M. Brentjens
09:45-10:30 7. Spectral line interferometry: science and principles	M. Verheyen
10:30-11:00 Coffee Break	
11:00-11:45 8. Spectral line interferometry in practice	A. Richards
11:45-12:30 9. Millimeter interferometry	M. Bremer
12:30-14:00 Lunch	
14:00-15:45 Tutorial T2: Imaging - continuum and polarization	J. McKean
15:45-16:15 Coffee Break	
16:15-17:00 10. (Sub)mm observing & data reduction in practice	C. Goddi
17:00-18:45 Tutorial T3: Introduction to CASA: spectral line data reduction	A. Richards
Dinner	

Future proposal deadlines

- WSRT: Sep 15 2013
- IRAM PdB: Sep 12 2013
- EVN: Oct 1 2013
- ATCA: Dec 15 2013
- GMRT: Jan 15 2014
- EVLA, VLBA, GMVA: Feb 1 2014
- ALMA: December 2013
- LOFAR: September 2014

GOOD LUCK WITH PROPOSAL PREPARATION!