



2nd ERIS, Bonn, September 2007

Max-Planck-Institut
für Radioastronomie



Planning an interferometer observation

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Outline

- I. Planning an experiment/Preparing a proposal
- II. Proposal submission
- III. Schedule preparation
- IV. After the observations

I. Planning an experiment

Preparing a proposal

The scientific goal must be clear in mind!!!

1) Type of experiment

- Is it continuum or spectral line (or continuum with spectral line mode of observation)?
- If it is spectral line, which is the frequency of the line?
And the distance of the target source?
(presentation by R. Bewskic on Friday)
- Is it single or dual polarization?

2) Resolution and angular scales

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

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

- How compact/extended is the target source?
- How big is the structure you want to image?

3) Field of view

- How large is the field of view needed? Is spectral line mode necessary to prevent bandwidth smearing?
Is one pointing enough or is mosacing necessary?

4) Frequency required

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

5) Brightness of the target source

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

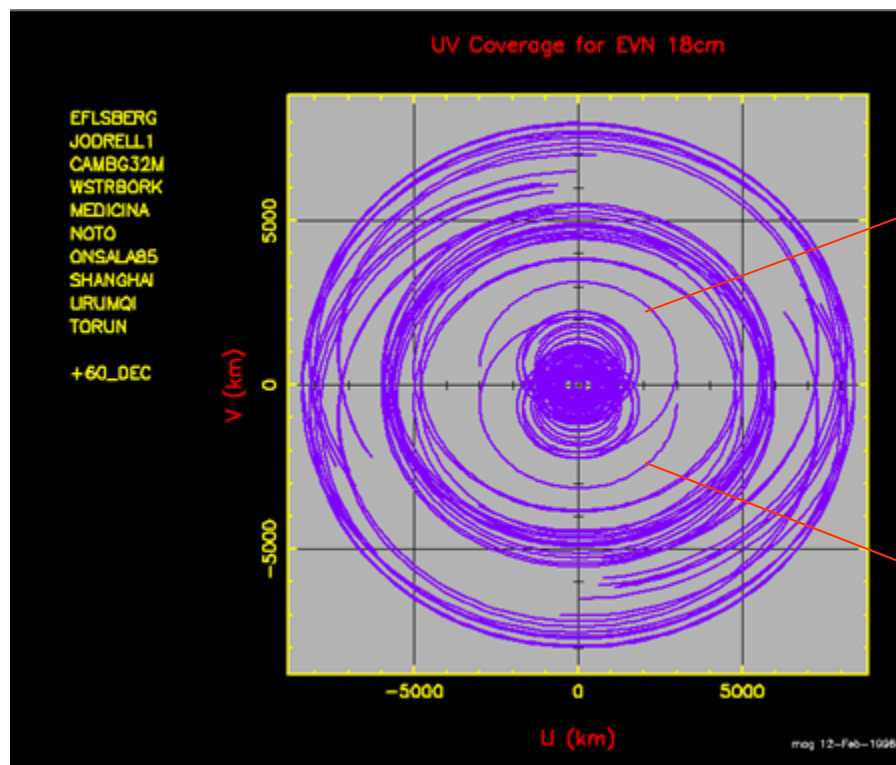
- Which sensitivity is needed to image the weakest features in our target source?
- How long is the integration time needed?
- Which bandwidth is necessary?

1 + 2 + 3 + 4 + 5 => Which telescopes/arrays are suitable?

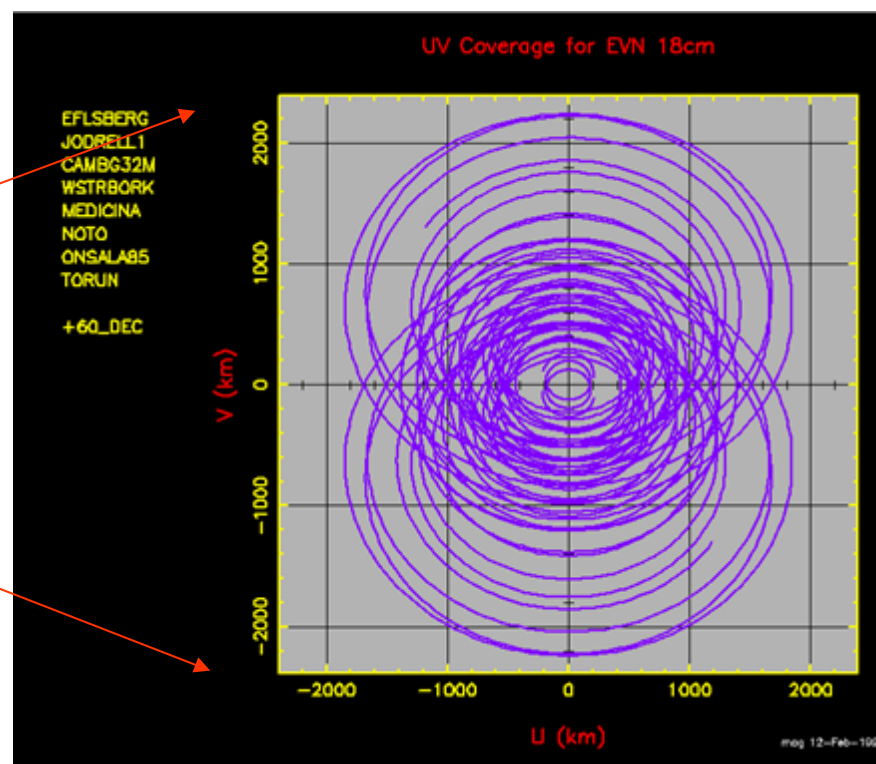
The selection of the telescopes is crucial for VLBI observations (collecting area, u-v coverage ...)

Consult the EVN User Guide at
www.evlbi.org/user_guide/user_guide.html

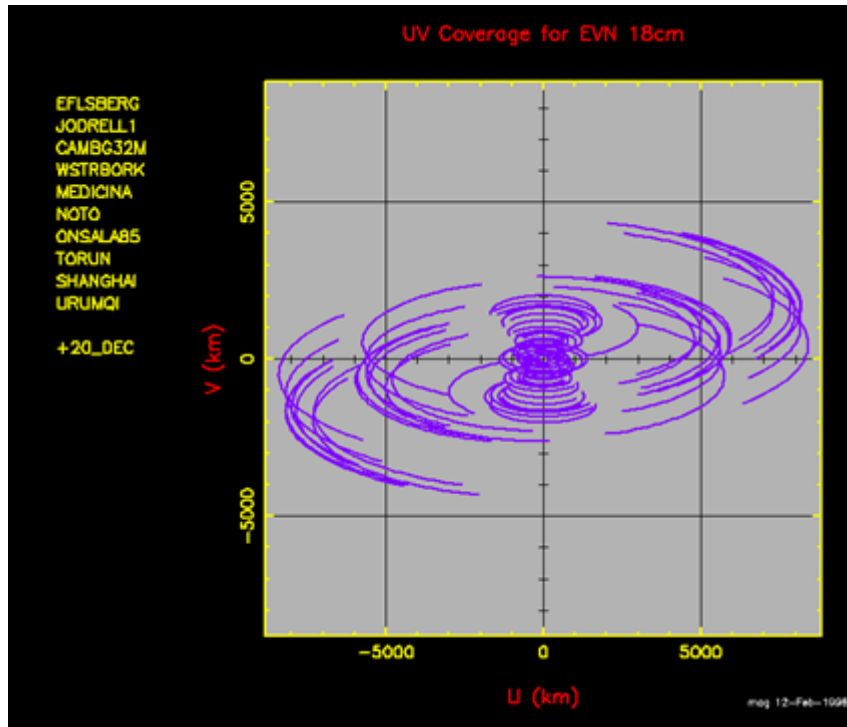
EVN+Sh+Ur, 18 cm $\delta=60^\circ$



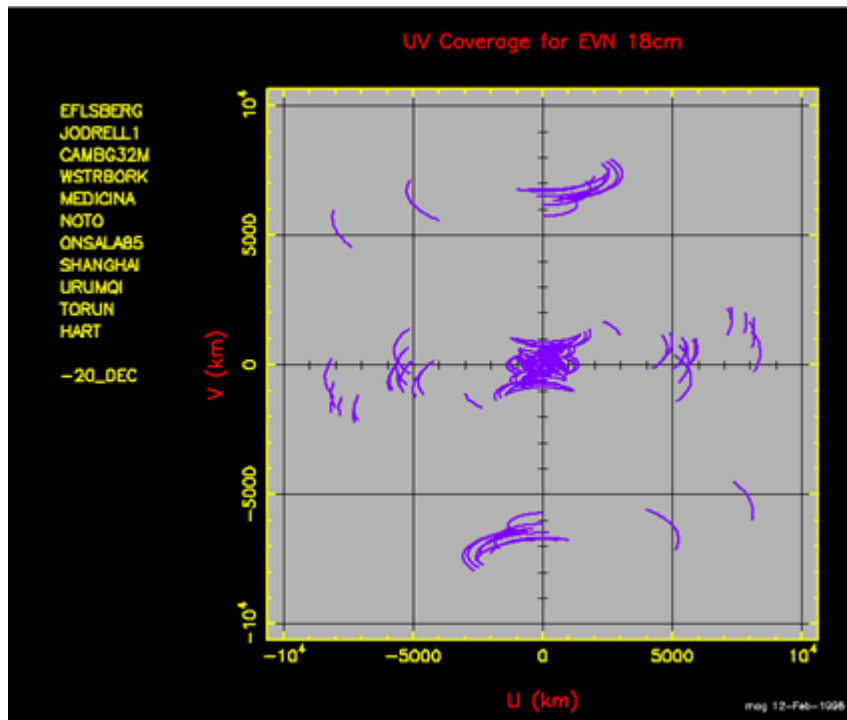
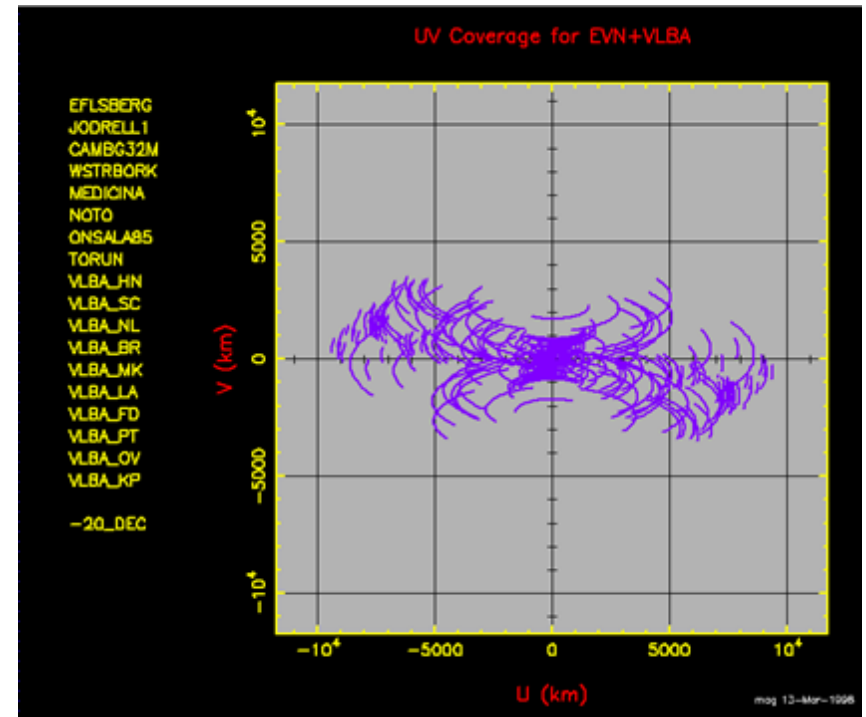
EVN, 18 cm $\delta=60^\circ$



EVN+Sh+Ur, 18 cm, $\delta=20^\circ$



EVN+VLBA, 18 cm, $\delta=20^\circ$



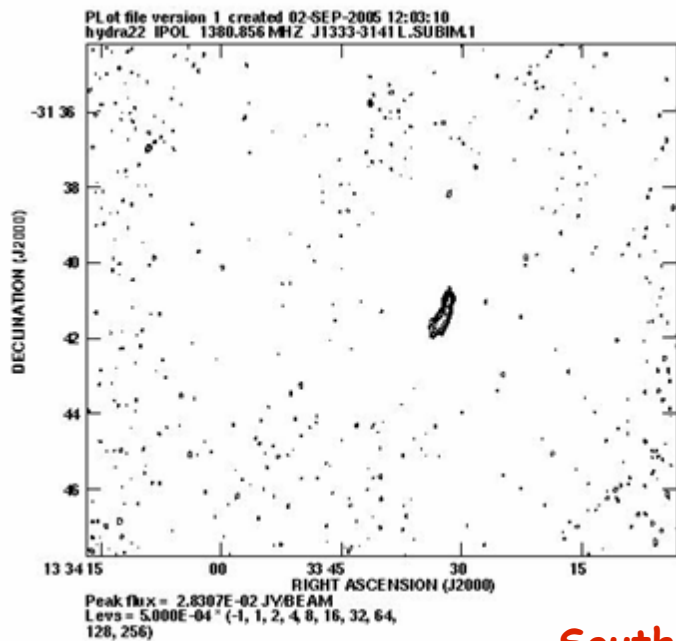
EVN+Sh+Ur+Hh, 18 cm, $\delta=-20^\circ$

... to summarize

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

... lead to the choice of

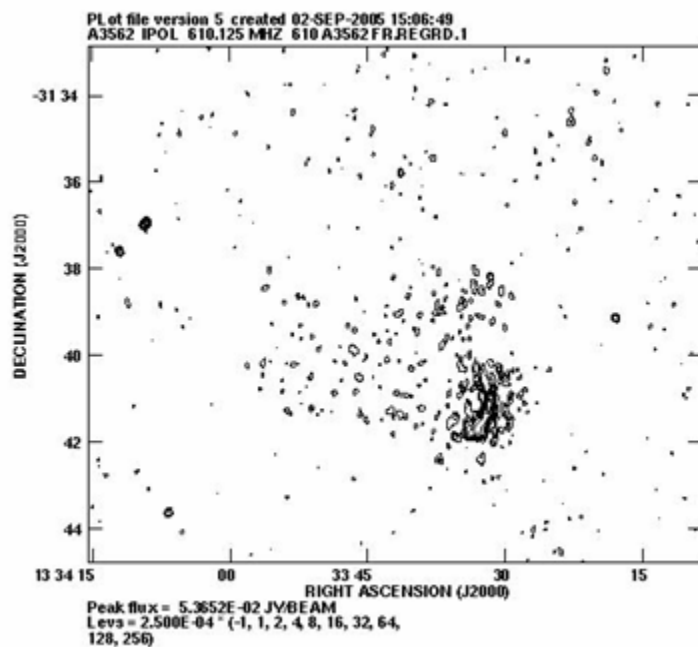
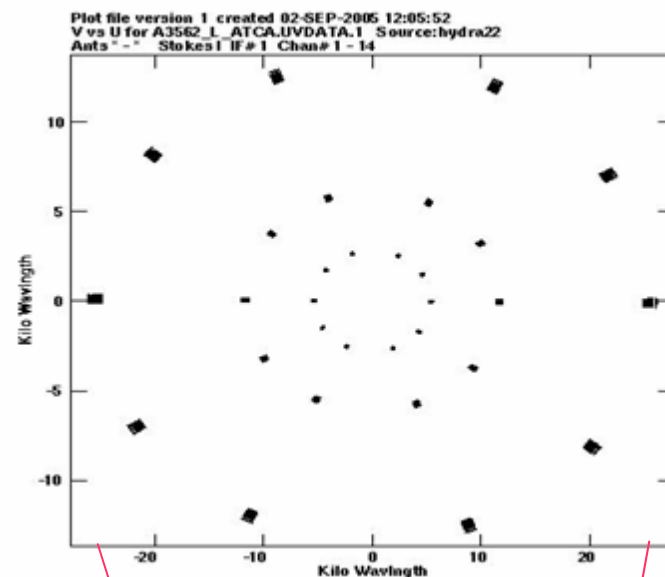
- a) the array (if VLBI => choice of the telescopes)
- b) observing setup
- c) bandwidth/filters
- d) total time on-source



ATCA - 1.4 GHz
Res. $\sim 10'' \times 5''$

rms ~ 0.15 mJy/b

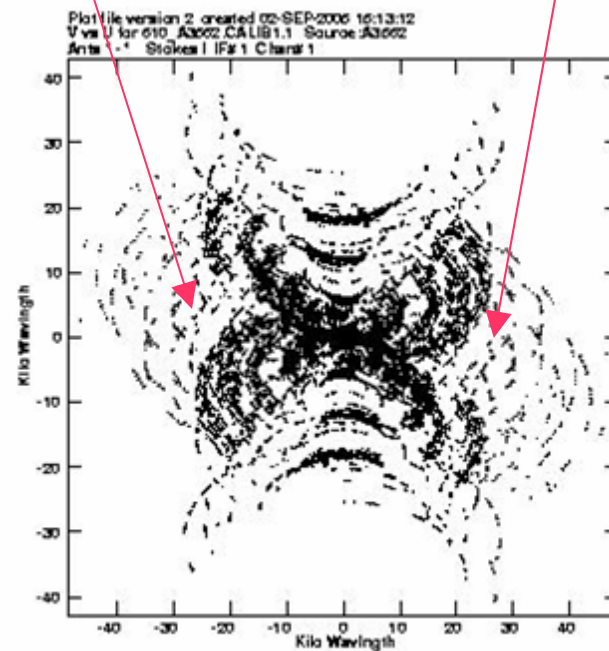
Southern Cluster of galaxies A3562



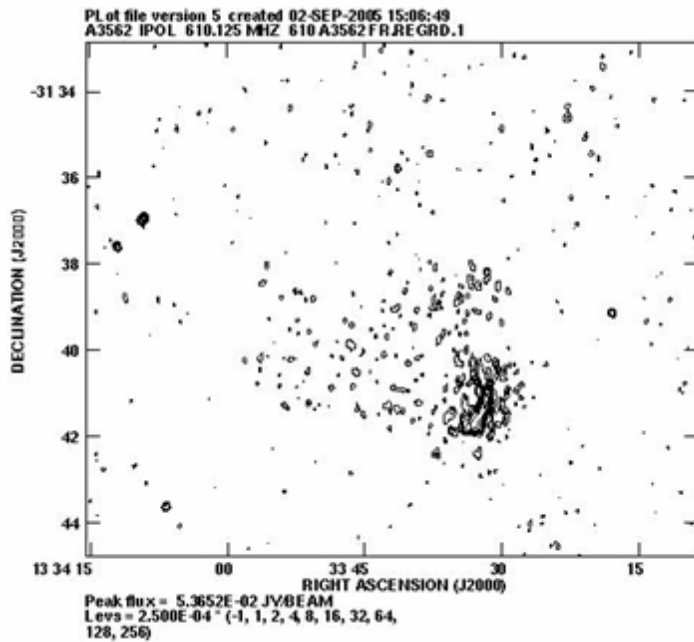
GMRT - 610 MHz

Res. $\sim 8'' \times 6''$

rms ~ 0.08 mJy/b



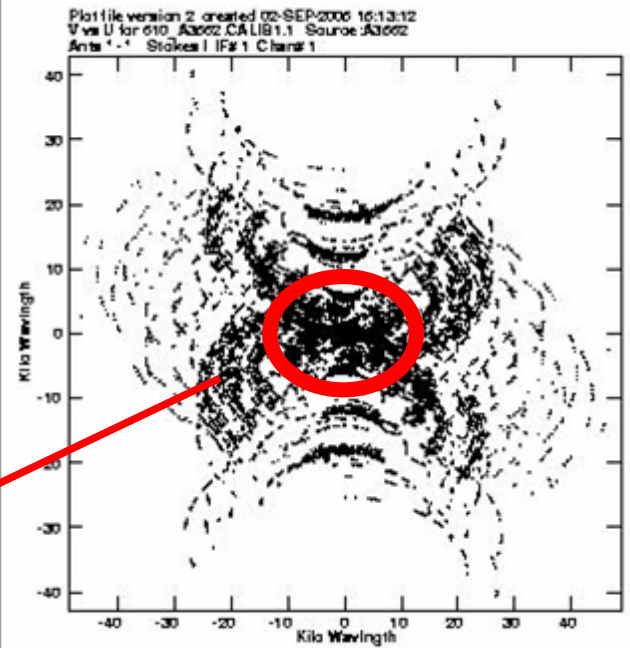
Southern Cluster of galaxies A3562



GMRT - 610 MHz

Res. $\sim 8'' \times 6''$

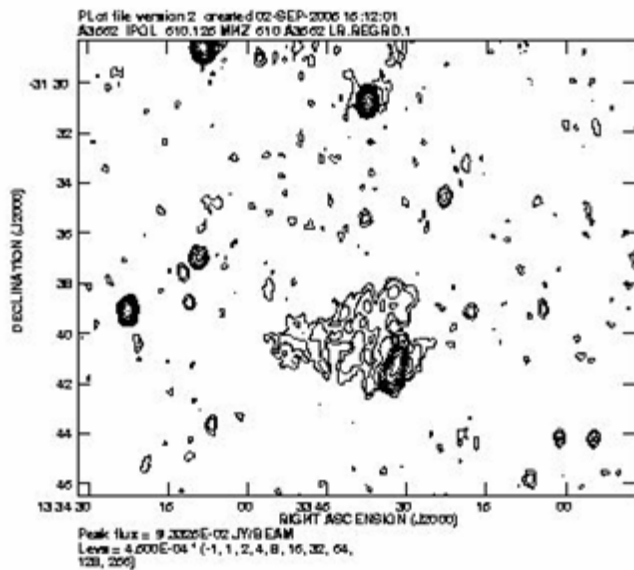
rms ~ 0.08 mJy/b



GMRT - 610 MHz

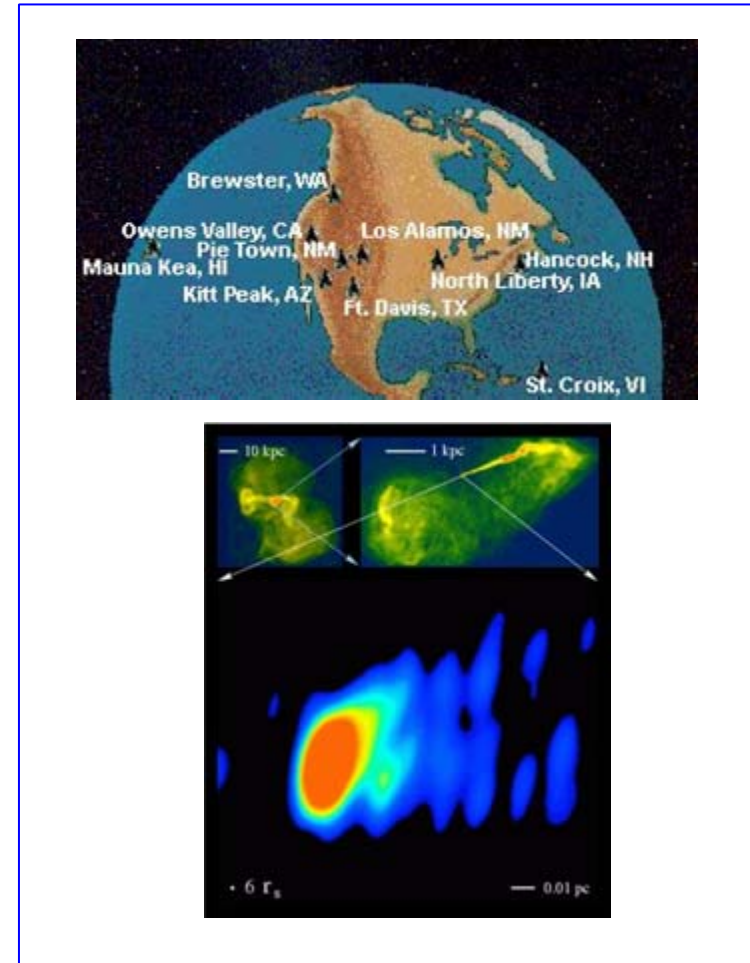
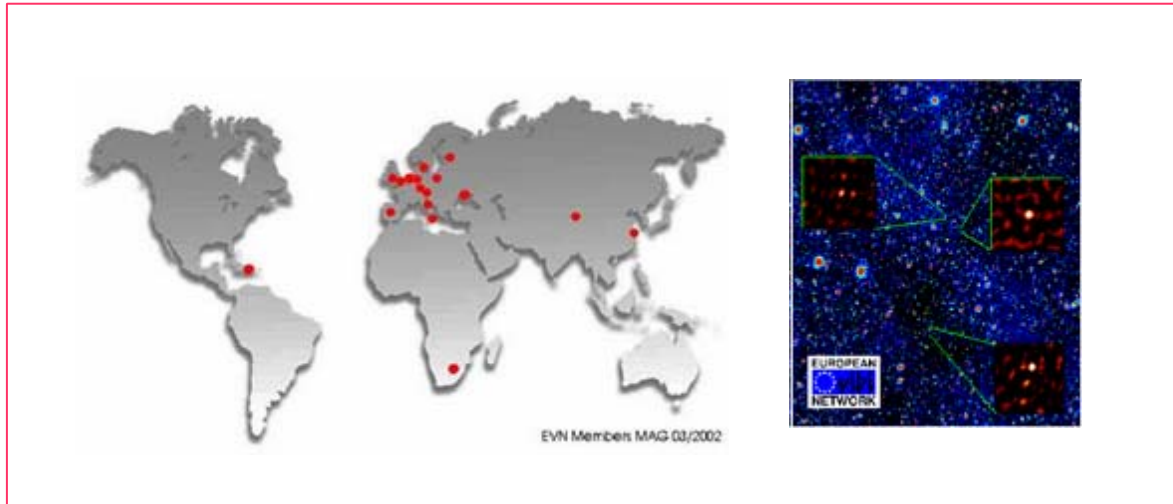
Res. $\sim 30'' \times 20''$

rms ~ 0.14 mJy/b



Parsec scale resolution needed => EVN, VLBA (+GBT, Y27+Ar),

LBA



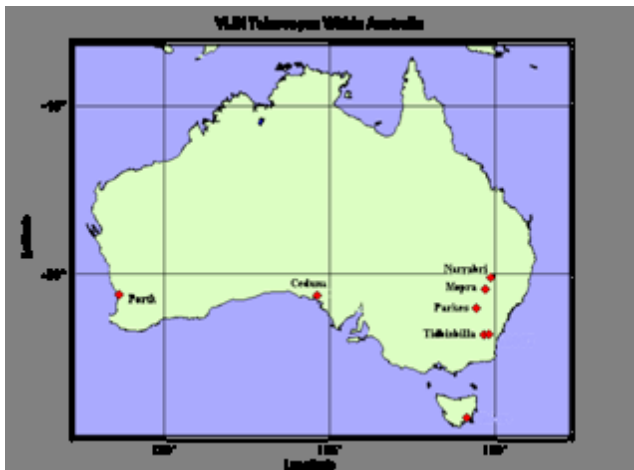
EVN: <http://www.evlbi.org>

VLBA: <http://www.vlba.nrao.edu>

Standard: 1.4 – 22 GHz

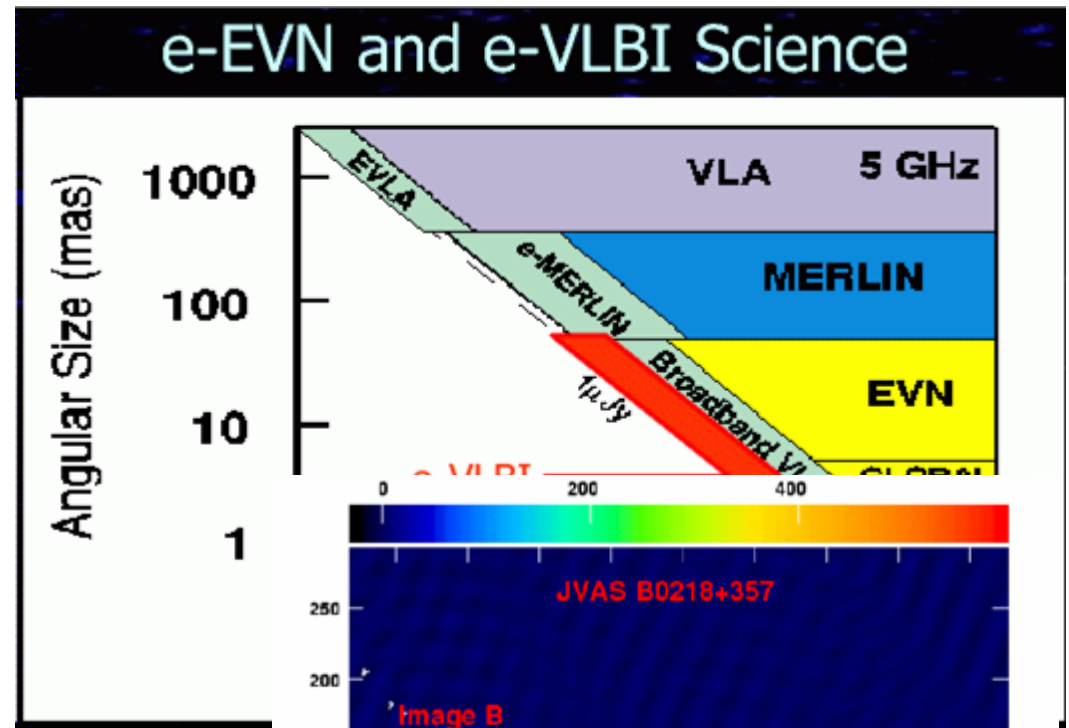
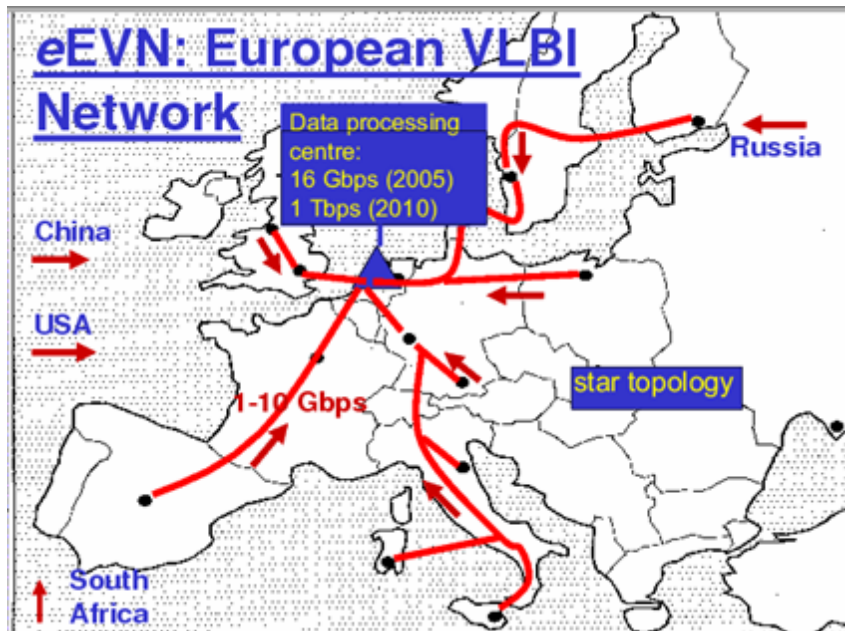
Fewer stations at
327 MHz, 610 MHz

43 GHz and higher (VLBA,
GMVA)



LBA: <http://www.atnf.csiro.au/vlbi/>

e-VLBI in Europe



Available bit-rates and frequencies

Station	Bit-rate (Mbit/s)	Frequencies available	
Wb	128/256	6cm	18cm
Jb2	128/256	6cm	18cm
Cm	128	6cm	18cm
On	128/256	6cm	18cm
Tr	128/256	6cm	18cm
Mc	128/256	6cm	18cm

Sub-arcsec scale resolution needed => MERLIN

LAT $\sim 52^\circ$

Maximum distance between the
6 telescopes 217 km

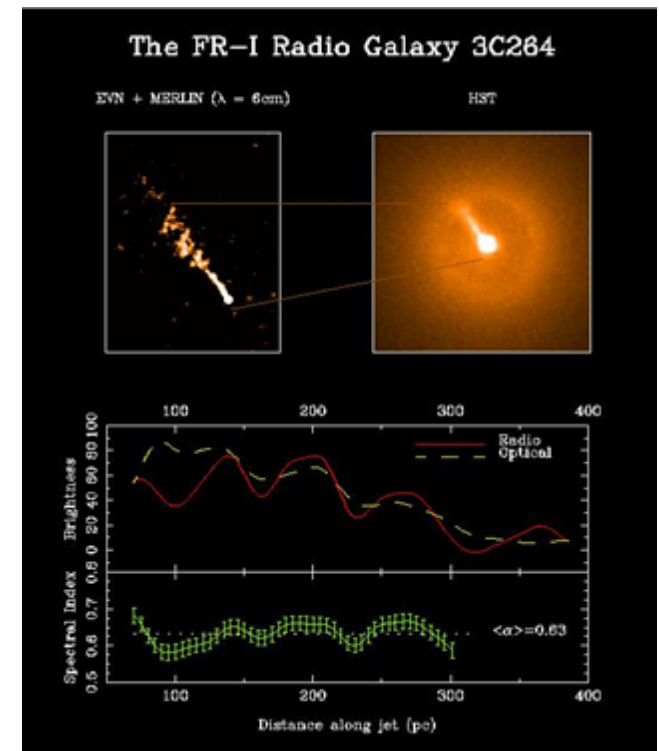
Observations in the frequency
range 151 MHz - 24 GHz

Resolution ~ 50 mas at 5 GHz

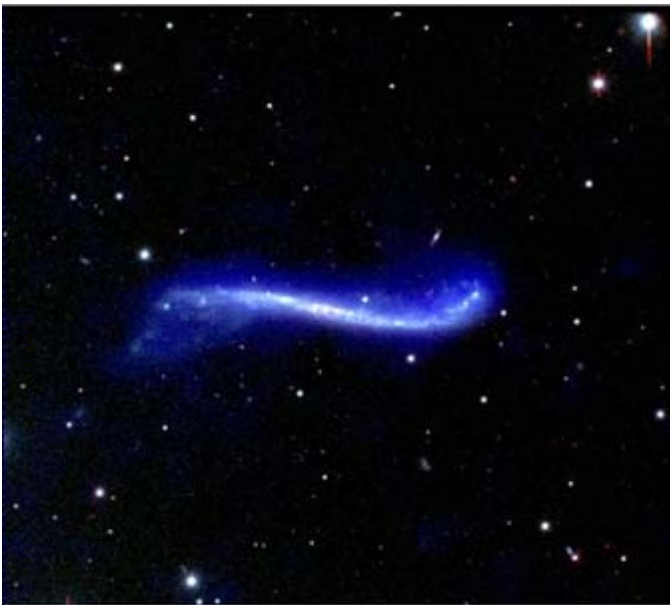


<http://www.merlin.ac.uk>

EVN+MERLIN observations @ 1.4GHz, 5 GHz, 22 GHz
eMERLIN & Legacy Programs



Arcsec to arcmin resolution => Very Large Array (NM, USA)



<http://www.vla.nrao.edu>

Receivers Available at the VLA								
	4 Band	P Band	L Band	C Band	X Band	U Band	K Band	Q Band
Frequency (GHz)	0.073-0.0745	0.30-0.34	1.34-1.73	4.5-5.0	8.0-8.8	14.4-15.4	22-24	40-50
Wavelength (cm)	400	90	20	6	3.6	2	1.3	0.7
Primary beam (arcmin)	600	150	30	9	5.4	3	2	1
Highest resolution (arcsec)	24.0	6.0	1.4	0.4	0.24	0.14	0.08	0.05
System Temp	1000-10,000.K	150-180.K	37-75.K	44.K	34.K	110.K	50-190.K	90-140.K

LAT ~ 34°
27 antennas
4 standard configurations
4 hybrid configurations

Arcsec to arcmin resolution => Giant Metrewave Radio Telescope (Pune, India)



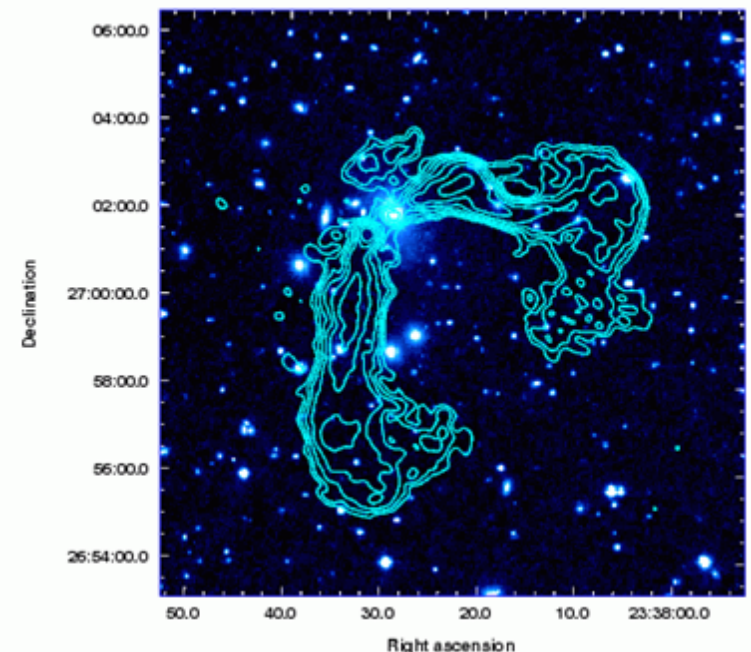
<http://www.gmrt.ncra.tifr.res.in>

30 antennas - one configuration
14 antennas form the inner compact array
(1 x1 km)

Frequency: 151, 235, 330, 610, 1420 MHz

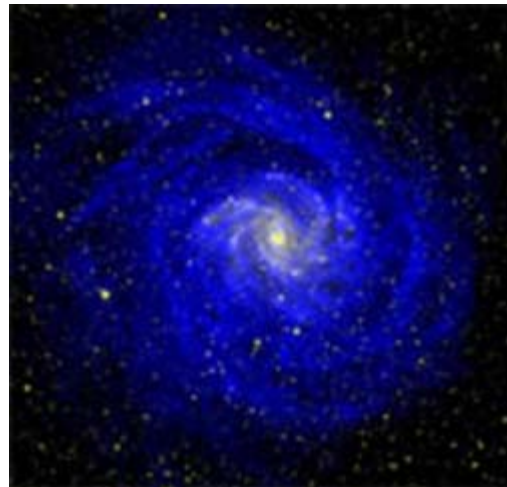
Full Resolution: 2" (@1420) - 20" (@151)

LAS: 7' (@1420) - 68' (@151)



Arcsec to arcmin resolution => Westerbork Synthesis Radio Telescope (Westerbork, NL)

<http://www.astron.nl/wsrt/wsrtGuide>



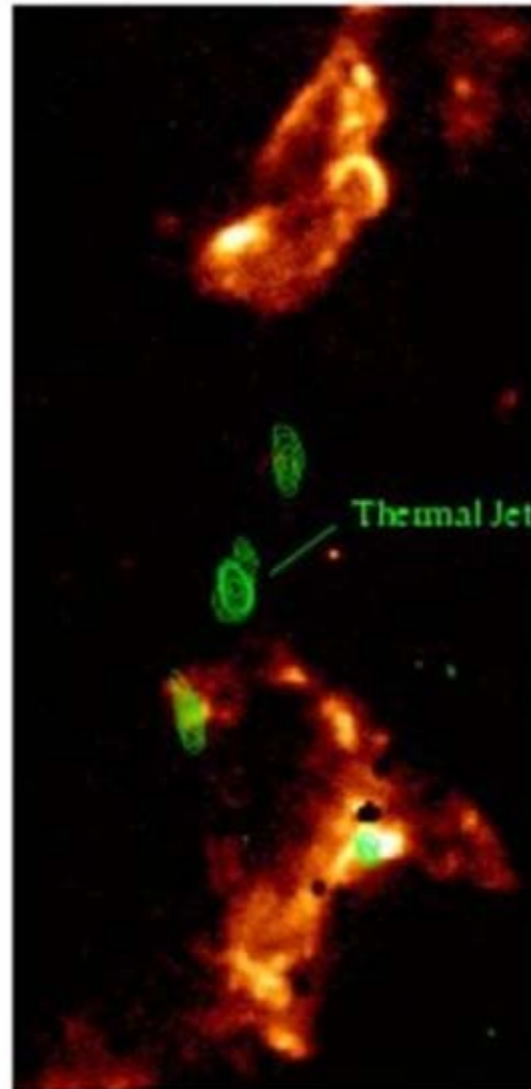
LAT ~ 53°

14 antennas - 10 fixed and 4 movable
in 4 different configurations

Wavelength	Polarization	Freq. Range	Sys. Temperature	rms in 12h ^a	Conf. Limit
(cm)		(MHz)	(K)	(mJy/beam)	(mJy/beam)
LFFE (260-170)	dual, linear	117-175	700-400 ^g	5-3 ^g	5000-10000 ^g
92	dual, linear	310-390	125	0.250 ^{b,c}	300
49	dual, linear	560-610	75	0.150 ^c	50
21/18	dual, linear	1150-1750	27-31	0.012-0.013	5
13	dual, circular	2215-2375	60	0.021	1.3
6	dual, linear	4770-5020	65	0.021	
3.6	dual, linear ^d	8150-8650	110	0.042	
UHF-low	dual, linear	250-460 ^e	120-250 ^f	0.500 ^c	
UHF-high	dual, linear	700-1200	120-180 ^f	0.085	

Wavelength	Aperture	Single antenna FWHM	Synthesized beam
(cm)	Efficiency	field of view (deg)	(arcsec)
LFFE (260-170)	0.30	5-8	160-104
92	0.59	2.6	55
49	0.59	1.4	30
21-18	0.54	0.6-0.5	13-11
13	0.54	0.37	7.8
6	0.48	0.17	3.7
3.6	0.35	0.10	2.2
UHF-low	0.39	2.0-3.1	39-72
UHF-high	0.39	0.83-1.11	15-26

Arcsec scale resolution needed => Australia Telescope Compact Array (Narrabri, Australia)



BAND NAME (λ)	20 cm	13 cm	6 cm	3 cm	1 cm	3mm
Frequency range (GHz)	1.25	2.20	4.40	8.00	16.0	83.5
	-1.78	-2.50	-6.70	-9.20	-25.0	-106.0
Fractional frequency range	35%	13%	44%	14%	44%	24%
Number of antennas	6	6	6	6	6	5
Number of baselines	15	15	15	15	15	10
Primary beam ^a	33'	22'	10'	5'	2'	53"
Synthesized beam (arcsec) ^a	8"	4"	2"	1"	0.8"	2"
System temperature (K) ^c	32	36	33	39	50	300
System sensitivity S (Jy) ^d	350	440	420	390	670	8400
Strongest confusing source (mJy) ^e	140	24	2.3	0.4	-	-
Flux sensitivity (mJy) ^f	0.19	0.24	0.22	0.21	0.37	5.6
(10 min, 1280 MHz)						
Brightness sensitivity (K) ^g	2.1	2.6	2.1	2.0	3.2	0.2
(10 min, 1280 MHz, Dec -45°)						
Flux sensitivity (mJy) ^f	0.022	0.029	0.027	0.025	0.043	0.66
(12 hrs, 1280 MHz)						
Brightness sensitivity (K) ^g	0.26	0.31	0.24	0.23	0.37	0.02
(12 hrs, 1280 MHz, Dec -45°)						

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

6 movable antennas

13 configurations

Bands: 20 cm - 3 mm

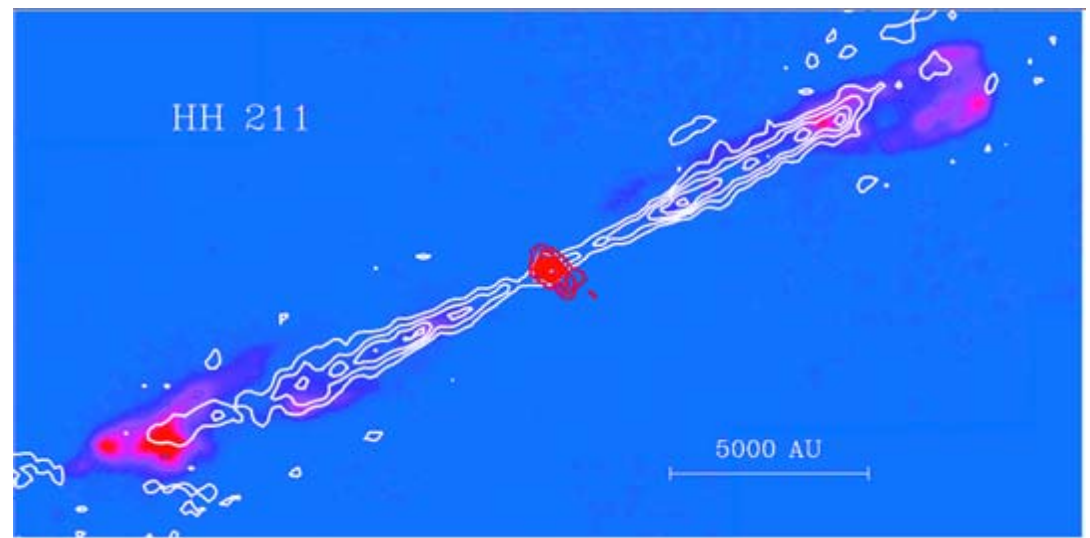
Full Resolution: 0.5" - 6"

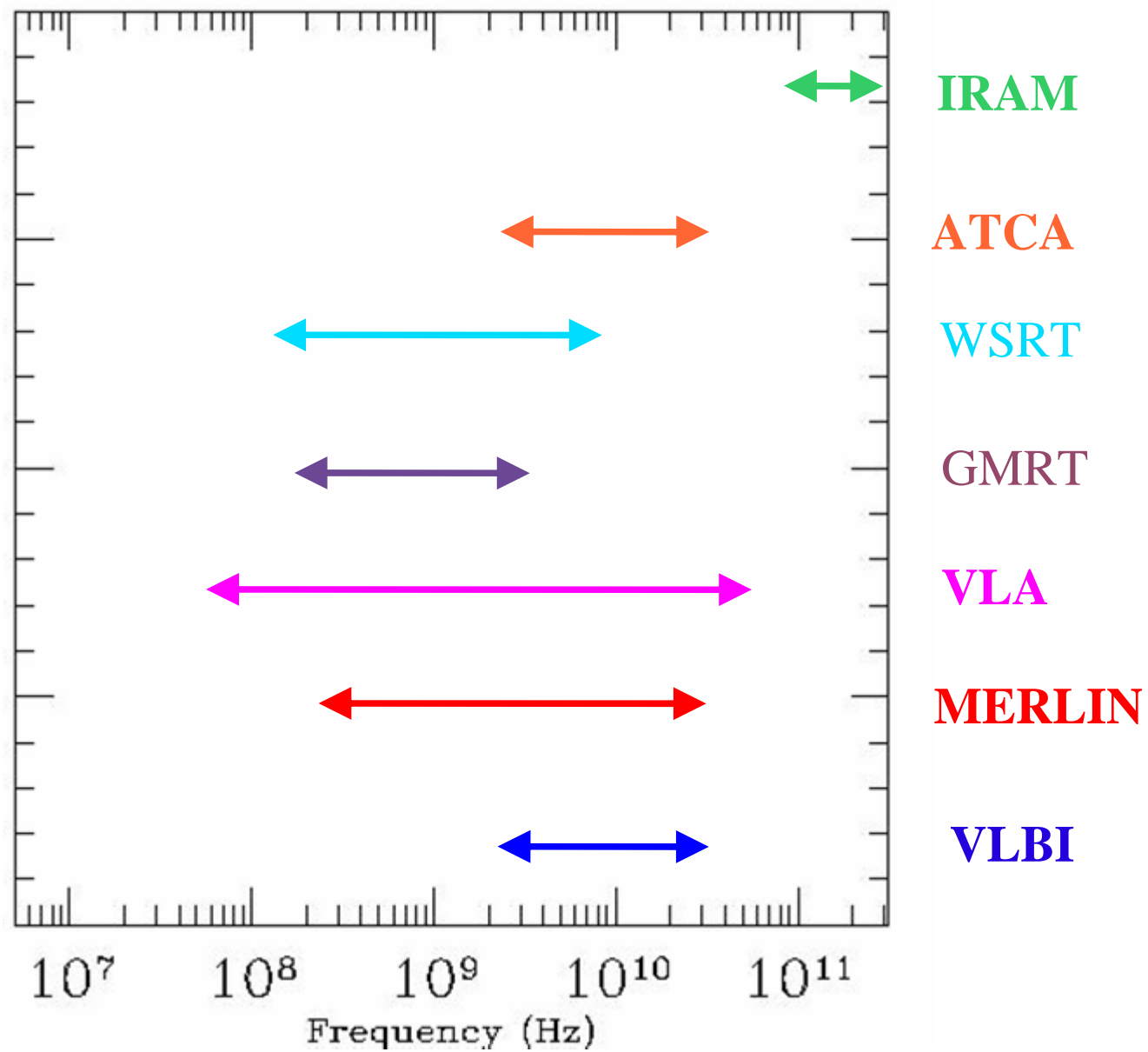
Arcsec scale resolution needed => Institut de Radioastronomie Millimetrique, IRAM (Grenoble & Granada)



<http://www.iram.fr/IRAMFR/index/htm>

6 antennas of 15-m diameter & 5 configurations
Frequency: 81 - 115 GHz & 205 - 250 GHz
Full Resolution: 7" (@100 GHz) - 0.5" (@230 GHz)





Data Archives

Before submitting a proposal consult the radio data archives relative to your project

Each observatory adopts a policy on the data proprietary periods, and observational data become public after some time (usually 1 year).

Data archives are easily accessible from the web:

EVN	http://archive.jive.nl/scripts/listarch.php	http://db.ira.inaf.it/evn/
VLBA	http://vlba.nrao.edu/astro/archive	
MERLIN	http://www.merlin.ac.uk/archive	
VLA	http://www.vla.nrao.edu/astro/#D9	
GMRT	http://neptune.gmrt.ncra.tifr.res.in/obsastro/	
WSRT	http://www.astron.nl/p/WSRT4.htm	
ATCA	http://atoa.atnf.csiro.au/	
IRAM	http://iram.fr/IRAMFR/PDB/arch.html	

II. Proposal Submission

Each array/institution releases a Call for Proposals twice or three times a year, with usually well known deadlines (consult the web pages)

The proposal consists of two parts: Cover Sheet and Scientific Justification

The Cover Sheet contains all the details concerning the observations (frequency, setup, total time) and the target source and calibrators (position, expected flux density at the requested frequency/ies, visibility).

The Scientific Justification contains the scientific case

Electronic Submission is now the rule in
most cases

Example of electronic submission

Different tools but very similar approach

The screenshot shows the 'Applicants - Mozilla Firefox' window displaying the 'EVN Proposal' web application. The browser's address bar shows the URL <https://proposal.jive.nl/proposal/setupApplicants.do>. The application interface includes a header with the 'EUROPEAN NETWORK' logo and the 'EVN Proposal' title. Below the header, there are tabs for 'Applicants', 'Justification', 'Observing Request', and 'Additional Issues'. A table lists the active participants, with one entry for Dr. Tiziana Venturi. At the bottom, there are buttons for 'Add applicant', 'Save and Continue', 'Save and Preview', 'Save and Exit', 'Save and Submit', and 'Quit without i'. The status bar at the bottom of the browser window shows 'proposal.jive.nl'.

Applicants - Mozilla Firefox

File Edit View Go File Edit View Go File Edit View Go Bookmarks Tools Help

<https://proposal.jive.nl/proposal/setupApplicants.do> Go thstar proposal tool

Members Web Members Web Members Web Members Web

Welcome at JIVE Welcome at JIVE Welcome at JIVE Welcome at JIVE Applicants Giant Metrewave Radio Telescop...

EUROPEAN NETWORK

EVN Proposal

RadioNet jive

Help Ind

Community: Ev
Category: req
Semester: 07

Applicants Justification Observing Request Additional Issues

Active Participant	Contact Author	PI	Name	Affiliation	Country	Email	Potent Obsen
yes			Dr. Tiziana Venturi	INAF (Istituto di Radioastronomia)	Italy	tventuri@ira.inaf.it	

Add applicant

Save and Continue Save and Preview Save and Exit Save and Submit Quit without i

NorthStar version v3.2.8 (2007-06-01)

Done Done Done Done Done proposal.jive.nl

III. Schedule Preparation

- 1) Visibility of the targets/calibrators
- 2) Duty cycle targets/calibrators
- 3) Setup of the observations

Calibrators fringe finder (for VLBI observations)
primary (amplitude calibrator) & secondary (phase calibrator)
polarization and/or bandpass if needed

Duty cycle depends on frequency, array ...

- 4) Software to produce the command file necessary to run the
telescopes Note that each telescope/array has a different one!
- 5) Command file sent to the telescope operators

SCHED for VLBI Observations

File to be edited named **code.key** and processed by the program **SCHED** which produces: **codesch.nn**, **code.sum** and **code.skd**

```
! =====
! ===== Cover Information =====
! =====
!
version = 3
expt    = 'The Compact Structure of Radio-loud BAL Quasars'
expcode = EJ007A

pname   = 'D.R. Jiang'
address1 = 'SHANGHAI ASTRONOMICAL OBSERVATORY'
address2 = '80 Nandan Road'
address3 = 'Shanghai, 200030'
address4 = 'CHINA'
phone    = '+86 21 64386191 526'
obsphone = '+86 21 64386191 526'
email    = 'djiang@center.shao.ac.cn'
fax      = '+86 21 64384618'
obsmode  = '18cm 256-8-2 '
obstype  = VLBI
! ===== Initial Scan Information =====
! =====
!
!-----
setinit = EJ007.18CM / !The following defines 256-8-2
band    = '18cm'
nchan   = 8
bits    = 2
bbfilter = 8.0
pol     = dual
barrel  = roll_off
/
endset /
!-----
srccat /
equinox= J2000

Source = J1150+2819  ra=11:50:23.570 dec= 28:19:07.50 / !be checked.
Source = J1413+4212  ra=14:13:34.404 dec= 42:12:01.76 / !be checked.
Source = J1603+3002  ra=16:03:54.162 dec= 30:02:08.88 / !see notes.
!becker,2000 article show:54.159,but from NED, we can use 54.162
Source = J1655+3945  ra=16:55:43.235 dec= 39:45:19.94 / !use NED,in becker,19.
91
endcat /

! ===== Correlator Information =====
! =====
!
correl    = JIVE
coravg    = 4.0
corchan   = 16
cornant    = 10
corpol     = on
corwtfn    = 'uniform'
corsrcs    = standard
cortape    = DAT
corship1   = 'D.R. Jiang'
corship2   = '80 Nandan Road'
corship3   = 'Shanghai, 200030'
corship4   = 'CHINA'
cornotel   = ' '
!
! =====
!
!
! Block 9
!
source = 'J1048+2115'  dur = 00:02:00 gap = 00:00:40 /
group 2 repeat 3
source = 'G030329'     dur = 00:02:00 /
source = 'J1048+2115'  dur = 00:01:00 /
group 2 repeat 1
source = 'J1051+2119'  dur = 00:01:30 /
source = 'J1048+2115'  dur = 00:01:00 /
group 2 repeat 3
source = 'G030329'     dur = 00:02:00 /
source = 'J1048+2115'  dur = 00:01:00 /
!
exit /
```

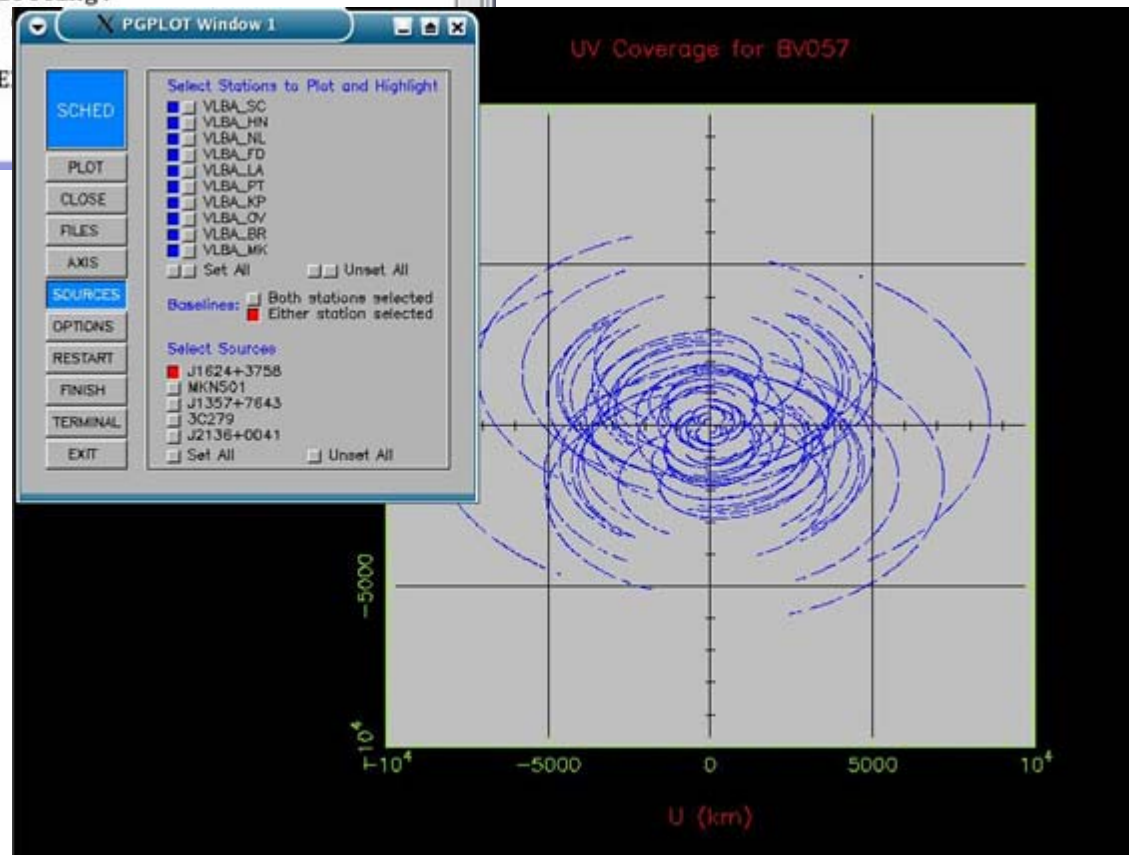


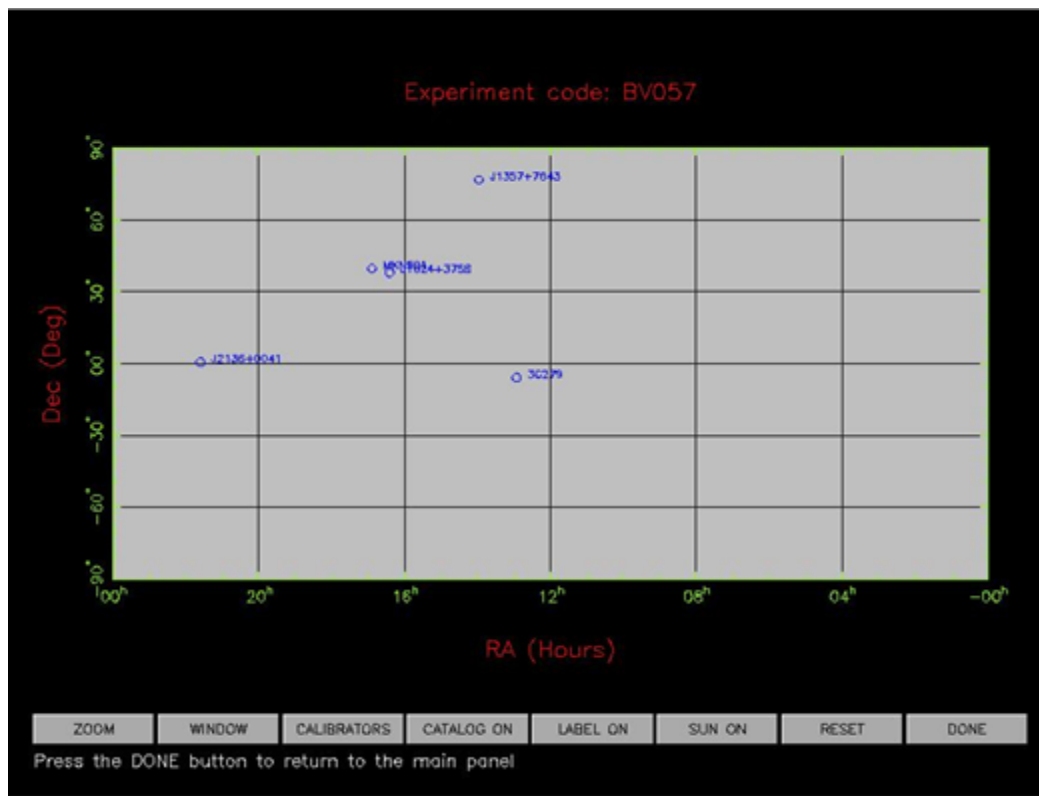
```
Shell - Konsole <5>
Session Edit View Bookmarks Settings Help

ifni:/home2/tventuri/varie/radionet/eris2005/lectures> ls tv*
tv2.jpg tv3.jpg tv4.jpg tv.jpg
ifni:/home2/tventuri/varie/radionet/eris2005/lectures> xv tv.jpg
ifni:/home2/tventuri/varie/radionet/eris2005/lectures> xv tv2.jpg
ifni:/home2/tventuri/varie/radionet/eris2005/lectures> xv tv3.jpg
ifni:/home2/tventuri/varie/radionet/eris2005/lectures> xv tv4.jpg
ifni:/home2/tventuri/varie/radionet/eris2005/lectures> vsched &
[1] 4405
ifni:/home2/tventuri/varie/radionet/eris2005/lectures>
Welcome to program SCHED. Version: 6.02 July 2005

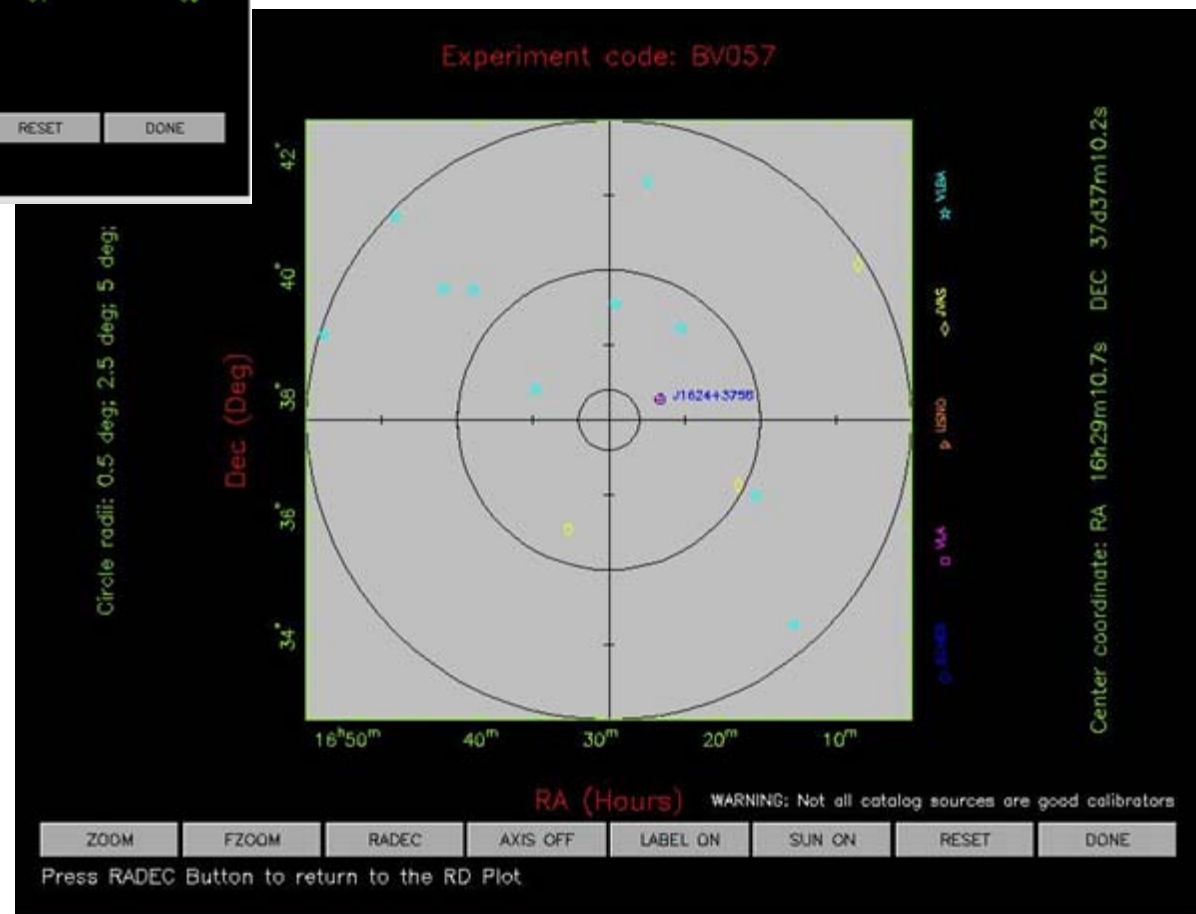
The manual is at http://www.aoc.nrao.edu/~cwalker/sched/sched/sched.html
Unix users should set $SCHED to the base area where SCHED is installed.
Most run time messages will be in sched.runlog

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 : Leave program.
/ : End of inputs - run program (or E
```



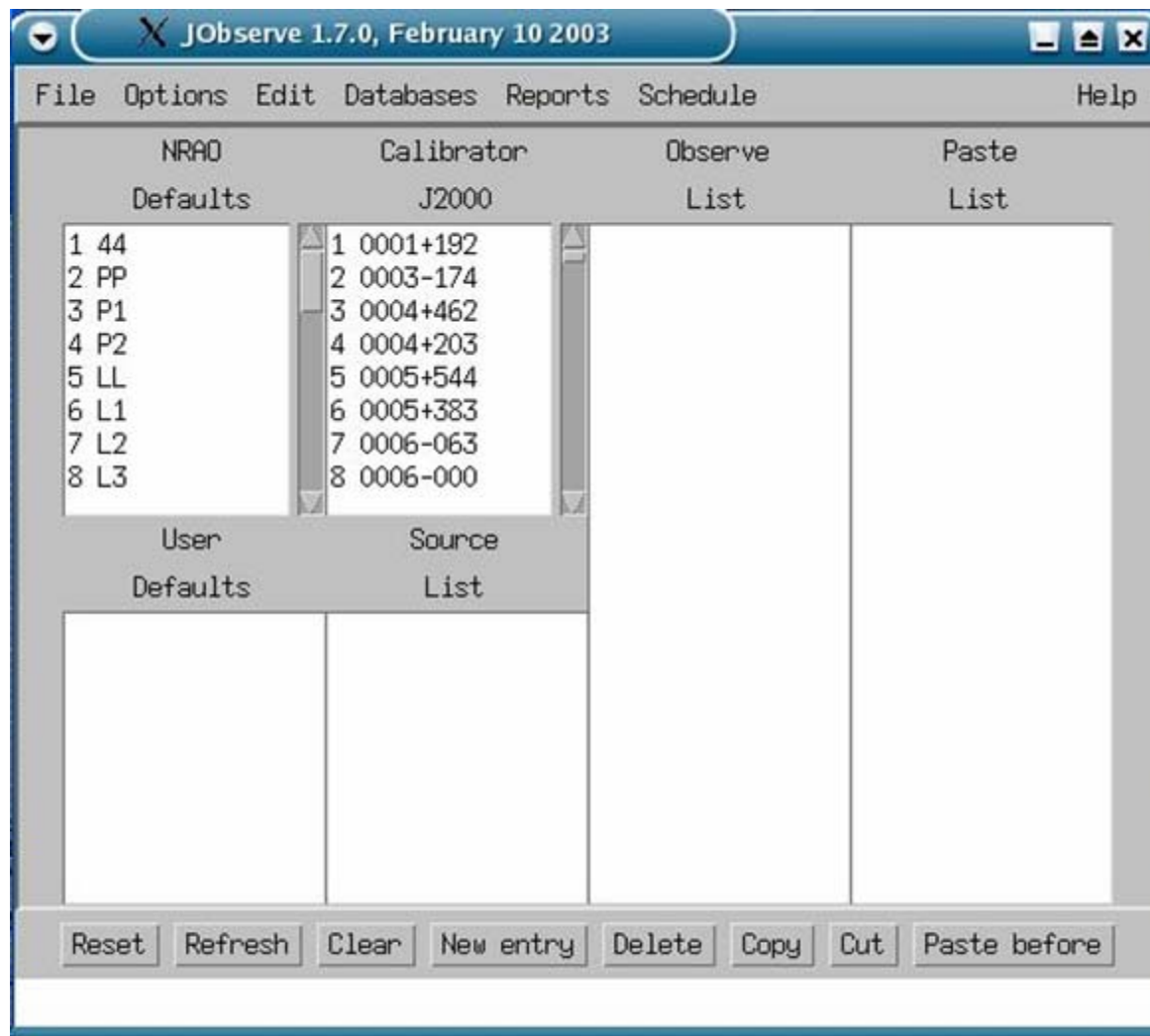


Position of targets and calibrators in the plane of the sky



Search for nearby calibrators

Jobserve for VLA Observations



ATCA has a software similar in concept to JObserve

IV. After the observations...

In most cases the observer receives a dat tape/cdrom with the raw data, or a message with instructions for data retrieval.
At this point the the data reduction starts...

TUESDAY 11th SEPTEMBER

09:00	Simon Garrington	Introduction to Interferometry Analysis - Basic Mapping Demonstration
10:30 — 11:00		Coffee Break
11:00	Simon Garrington	Visibility Data Calibration, Editing, Averaging Demonstration
12:30 — 14:00		Lunch
14:00	Andrei Lobanov	Self-Calibration and Hybrid Mapping Demonstration
15:00	Simon Garrington	The MERLIN Array and eMERLIN
15:30 — 16:00		Coffee Break
16:00	Richard Strom	The Westerbork Synthesis Radio Telescope (WSRT)
16:30	Tom Muxlow	Wide Field Interferometry Demonstration?

WEDNESDAY 12th SEPTEMBER

08:00 — 12:30		Visit to the 100m Effelsberg Radio Telescope
12:30 — 14:00		Lunch
14:00	Richard Porcas	Very Long Baseline Interferometry (VLBI)
15:00	Cormac Reynolds	The European VLBI Network (EVN)
15:30 — 16:00		Coffee Break
16:00	Steve Tingay	VLBI in the Southern Hemisphere
16:30	Cormac Reynolds	VLBI Calibration and Mapping Demonstration

END SESSION

Future proposal deadlines

- EVN, e-VLBI, VLBA, VLA* => 3 times/year:
1st Feb, 1st Jun, 1st Oct
Next one is on *1 October 2007*
- GMVA* => 2 times/yr
1st Feb, 1st Oct
Next one is on *1 October 2007*
- MERLIN* => every six months
15 Mar, 15 Sep (usually)
Next one is on *15 October 2007*
- WSRT* => every six months
15 Mar, 15 Sep
Next one is on *15 September 2007*
- ATCA* => every six months
15 Jun, 15 Dec
Next one is on *15 December 2007*
- GMRT* => every six months
Jan, July
Next one *January 2008*
- IRAM* => every six months
Next one is on *13 September 2007*