A HISTORY OF THE EVN

30 YEARS OF FRINGES

Richard Porcas

MPIfR Bonn
1967 First VLBI Experiments in USA and Canada (see Table 3 in Moran, 1998)

1980 First Observations organized by the EVN

2010 10th EVN Symposium in Manchester
The draft agreement on setting up the European VLBI network and Programme Committee would be circulated to the observatories for formal approval. An announcement of observing opportunity would then be issued by the Programme Committee.

1980: March – The EVN is called into being
Announcement: Formation of a European VLBI Programme Committee

A European VLBI programme committee has been formed to review proposals and assign observing time within designated 'network' periods. Four observatories, operating the Effelsberg, Westerbork/Dwingeloo, Jodrell Bank and Onsala telescopes have agreed, with certain provisos, to provide observing time for VLBI at intervals of two months. The Bologna antenna, when available, will also participate. The observing sessions will generally follow those of the US VLBI network. Observers who wish to use US, as well as European network telescopes will have to make 'ad hoc' arrangements with the US observatories.

Deadlines for proposals will generally be the same as for the US network, i.e.

<table>
<thead>
<tr>
<th>Month</th>
<th>Deadline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oct</td>
<td>1 for the sessions in early Feb, April</td>
</tr>
<tr>
<td>Feb</td>
<td>1 for the sessions in June, August</td>
</tr>
<tr>
<td>June</td>
<td>1 for the sessions in Oct, December.</td>
</tr>
</tbody>
</table>

As an exception, the deadline for the October and December sessions this year will be May 15. The observing wavelengths for these two sessions will be 6 cm and 21 cm, respectively.

1980: First EVN Call for Proposals: deadline 15 May
No PCs (computer mainframes only)

No Internet or email

No FAX machines

Moore’s Law: $2^{30 \text{yr}/1.5 \text{yr}} \approx 10^6$ less computer power
### First VLBI Experiments at European Observatories

<table>
<thead>
<tr>
<th>Year</th>
<th>Date of Obs.</th>
<th>Telescope (year built)</th>
<th>Partner Telescopes</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1968</td>
<td>Jan 27–Feb 3</td>
<td>ONSALA (1963–4)</td>
<td>Greenbank, (Haystack)</td>
<td>5 &amp; 1.6 GHz</td>
</tr>
<tr>
<td>1968</td>
<td>Jun 27–29</td>
<td>JODRELL MK I (1957)</td>
<td>Algonquin, Penticton</td>
<td>408 MHz</td>
</tr>
<tr>
<td>1969</td>
<td>Nov–Dec</td>
<td>Jodrell MK I (JB SYSTEM)</td>
<td>Arecibo</td>
<td>610 MHz</td>
</tr>
<tr>
<td>1972</td>
<td>Nov</td>
<td>CHILBOLTON (1967)</td>
<td>Algonquin</td>
<td>10.7 GHz</td>
</tr>
<tr>
<td>1973</td>
<td>Jun 18–21</td>
<td>EFFELSBERG (1971)</td>
<td>Greenbank, Goldstone</td>
<td>2.3 GHz</td>
</tr>
</tbody>
</table>
VLBI DEVELOPMENTS IN THE US

1971  Announcement of discovery of “Superluminal Motion” (Whitney at al.)
      Using model-fitting analysis

1971  NRAO introduces MK2 recording system
      2 MHz bandwidth, TV recorders

1975  Formation of US VLBI Network (NUG)

1976  Start of 6 NUG sessions per year
      Green Bank–140’, OVRO–130’, Haystack, Iowa, Fort Davis,…

1977  “An Intercontinental VLB Array” – NRAO

1978  NRAO introduces “absentee observing”
      No longer need collaborator at each telescope

1979  Haystack introduces MKIII recording system
      28–56–112 MHz bandwidth (up to 224 Mbps)

1970  Westerbork starts up

1971  Cambridge 5 km starts up

1974  CLEAN algorithm (Hogbom)

1974  Reintroduction of “closure phase” in VLBI context (Rogers et al.)

1977  Closure phase incorporated in synthesis imaging (Wilkinson et al.)

1978– VLA (partial) starts up

1980  MERLIN starts up
EUROPEAN VLBI BEFORE 1980

1975  April 7th: Legendary MPIfR Cafeteria discussions on forming a European VLBI Network
Pauliny-Toth, Preuss, Booth, Miley; no minutes!

Various European telescopes take part with US Network
Effelsberg joins the US Network
VLBI experiments named after participating telescopes
E-G-O  H-O-G-F-A-C-E

1976  First all-European VLBI experiment

1977  4th European VLBI meeting at Jodrell Bank

1978  Construction of MkII correlator at MPIfR completed

1978  J-O-D-E observations in January, correlated in Bonn
A polarisation VLBI experiment using polarization switching!

1978  April: first use of WSRT as a phased array for VLBI

1978  International VLBI Conference in Heidelberg (no proceedings!)
1976: October 2 - 1.6 GHz European VLBI observations of 3C236 (Schilizzi et al. 1979)

Dwingeloo (1956) – Onsala – Effelsberg  Correlation at NRAO
1977: 4th European VLBI Meeting at Jodrell Bank
1978: Horst Blaschke at the Bonn MK2 Correlator
1978: J-O-D-E 18 cm observations of 3C309.1 (Kus et al. 1981)

First observation correlated at Bonn MK2 correlator
1978: Heidelberg VLBI Conference
### THE FIRST EVN OBSERVING SESSION – OCTOBER 1980 (6 cm)

<table>
<thead>
<tr>
<th>Date</th>
<th>3 Oct</th>
<th>4 Oct</th>
<th>5 Oct</th>
<th>6 Oct</th>
<th>7 Oct</th>
<th>8 Oct</th>
<th>9 Oct</th>
</tr>
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<tbody>
<tr>
<td>80-4</td>
<td>80-12</td>
<td>AN-1</td>
<td>80-3</td>
<td>80-3</td>
<td>80-6</td>
<td>80-1</td>
<td>80-9</td>
</tr>
<tr>
<td>Fri</td>
<td>SAT</td>
<td>SUN</td>
<td>MON</td>
<td>TUE</td>
<td>WED</td>
<td>THUR</td>
<td>277</td>
</tr>
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<td>279</td>
<td>279</td>
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<td>280</td>
<td>281</td>
<td>282</td>
<td>283</td>
<td></td>
</tr>
</tbody>
</table>
1980: Bonn MK2 correlator

Note 3 generations of MK2 recorders and Moscow 1980 Olympics bear!
Table 1: Observations of SS433.

<table>
<thead>
<tr>
<th>Epoch (JD)</th>
<th>Date</th>
<th>Telescopes *</th>
<th>Wavelength (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2444248</td>
<td>Jan. 80</td>
<td>E, W, K</td>
<td>6</td>
</tr>
<tr>
<td>393</td>
<td>June 80</td>
<td>E, W, C</td>
<td>6</td>
</tr>
<tr>
<td>517</td>
<td>Oct. 80</td>
<td>E, W</td>
<td>6</td>
</tr>
<tr>
<td>589</td>
<td>Dec. 80</td>
<td>E, W, J</td>
<td>21</td>
</tr>
<tr>
<td>651</td>
<td>Feb. 81</td>
<td>O, E, J</td>
<td>18</td>
</tr>
<tr>
<td>705</td>
<td>Apr. 81</td>
<td>O, E, W, J</td>
<td>6</td>
</tr>
<tr>
<td>750</td>
<td>May 81</td>
<td>O, E, W</td>
<td>6</td>
</tr>
<tr>
<td>756</td>
<td>June 81</td>
<td>O, E, W</td>
<td>6</td>
</tr>
</tbody>
</table>


1980: October - Results from First EVN Session (Schilizzi et al. 1982)
II. Observations, Reductions and Results

Short VLBI observations at a wavelength of 6cm, with left circular polarization, were made at different epochs from June 1980 to April 1981 of a sample of spiral and irregular galaxies and two S0 galaxies. The telescopes involved at each epoch and their characteristics are given in Table 1.

\begin{table}[h]
\begin{tabular}{|l|l|l|l|}
\hline
Telescope  & Diameter(m) & Clock   & Epoch              \\
\hline
Onsala(O)  & 25.6        & H Maser & Oct. 6,8 1980       \\
           &             &         & April 9 1981       \\
Effelsberg(E) & 100       & H Maser & June 2 1980        \\
           &             &         & Oct. 6,8 1980      \\
           &             &         & Apr. 9 1981        \\
Westerbork(W) & 93        & Rb      & June 2 1980        \\
           &             &         & Oct. 6,8 1980      \\
           &             &         & Apr. 9 1981        \\
Jodrell Bank(J) & 25       & Rb      & April 9 1981       \\
\hline
\end{tabular}
\end{table}

1980: A result from the first EVN Session (Hummel et al. 1982)

1980  Formation of the EVN Program Committee
      Making sure the best science is done on the EVN

1982  Formation of the Technical Working Group (TWG)
      (later becomes Technical and Operations Group (TOG) in 1998)

1982  December: MPIfR Bonn acquires a MKIII correlator

1983  New telescopes built for VLBI in Europe

1984  First 4-station EVN MKIII observations B-S-W-J

1984  EVN Directors form the “EVN Consortium for VLBI”
      Main aim to find funding for large correlator centre

1987  Jodrell Bank MK II telescope upgraded to work at 1.3 cm

1990  Expansion of Bonn MKIII correlator to 5 stations
THE EVNPC AND SCIENCE

Initial 8 members (5 observatory, 3 others)

3 meetings per year (>90 to date !)

Review “EVN-only” and “Global” (EVN + US-Network)

4 – 6 telescopes, high sens., intermediate resolution, \( \lambda 21/18, 6 \) cm

8 – 9 telescopes, Global baselines, \( \lambda 18, 6, 2.8, 1.3 \) cm

Organize 4 sessions per year, overlap with US Network sessions

Operations section of the agenda for 5 obs. members

EVNPC Chair also EVN Scheduler until 1990
The present members of the Programme Committee are:

I. Pauliny-Toth (MPIfR), P. Biermann (MPIfR),
R. Schilizzi (Dwingeloo),
J. Kuijpers (Utrecht),
R. Booth (Jodrell Bank),
B. Rönnäng (Onsala),
J. Wall (Royal Greenwich Observatory) and
R. Fanti (Bologna).

1980: First EVNPC Members
1984: EVNPC meeting in Herstmonceaux Castle
1984: April – “World Array” at 1.6 GHz (18 stations)

Note use of MERLIN Defford telescope.

EVN+MERLIN observations would become an EVN feature from 1988
(Left): M87 at 4 mas resolution – 3 “exposures” (Reid et al. 1989)

(Right): 3C 48 at ∼8 mas resolution (Wilkinson et al)
1985: EVN 1.6 GHz MK3 observations of RS Ophiuchi 77 days after outburst
Tick interval 10 mas: resolution 35 mas (Porcas et al. 1986)
1987: May–June EVN 6 cm MK3 Observations of SS433 (Vermeulen et al. 1993)
6 epochs, spacing 2 days, most of the EVN MK3 tape supply!
1989: November - Global 1.6 GHz Observations of Gravitational Lens 0957+561A,B 9 telescopes, MK3: images B (left) and A (right) (Garrett et al, 1994)
1988: First EVN VLBI School, Castel S. Pietro Terme, Italy
1989: Guide to Processing in Bonn (Garrett)

No absentee correlation yet...!!
MKII RECORDING AND CORRELATION

1980  MPIfR Bonn MKII 2–3 stations correlator

1980  Domestic VCRs and cassettes make things cheap and easy

**But:** global (EVN + US-Network) experiments need many “passes”

1985  Caltech Block-II correlator becomes correlator of choice for continuum observations

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No more Ampex or IVC please!  Caltech Block-II correlator
MKIII RECORDING AND CORRELATION

1982: December - Bonn MK3 correlator (3-stations)
MK II MK III COMPARISON

<table>
<thead>
<tr>
<th></th>
<th>MARK II</th>
<th>MARK III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of record terminal</td>
<td>a few 1000 $</td>
<td>a few 100,000 $</td>
</tr>
<tr>
<td>Cost of tape or cassette</td>
<td>a few $</td>
<td>several 100 $</td>
</tr>
<tr>
<td>Playing time</td>
<td>4 hours</td>
<td>13 minutes</td>
</tr>
<tr>
<td><strong>BANDWIDTH:</strong></td>
<td>2 MHz</td>
<td>56 MHz</td>
</tr>
</tbody>
</table>

THE PRIZE: A FACTOR OF 5.5 INCREASE IN SENSITIVITY!

1983 – 1989 Observing limited by lack of MK III tapes

1990 – MK III Track density upgrade
12 tape passes with micro-motion of head
Observing starts to become limited by correlator time
1985: First meeting of the EVN Consortium
1985: First meeting of the EVN Consortium
(no lap-tops !)
EVN Consortium Brochure
The long quest for a European source of funding begins...
New EVN telescopes:  Wettzell  Medicina  Noto

Taking part in the EVN:  Jb-Mk2 (resurfaced)  Simiez  Torun-15m
1991 – 2000

1992 – New telescopes join EVN:
Cambridge ~1992  Seshan (Shanghai) ~1993  Urumqi ~1997
Torun-32m 1996  Yebes-14m 1999  Metsaehovi 1999 at 7 mm

1993  JIVE established as a Foundation in the Netherlands

1993  Dedication of the VLBA

1993  First EVN Symposium at Jodrell Bank

1995  1st JIVE/EVN VLBI School

1995  EVN MK IV upgrade (EMU, VIV)

1997  DSN agrees to make Robledo-70m telescope available for some EVN projects

1997  Launch of VSOP satellite HALCA

1997  2nd JIVE/EVN VLBI School

1999  3rd JIVE/EVN VLBI School
The Beginnings of JIVE

1989  First EU funds to support correlator proposal.  
      Partly used at Thorn-EMI (later Penny and Giles) for European record terminal

1993  JIVE established as a Foundation in the Netherlands  
      with funds from various countries to build a correlator

1993  Funds from European Union - “Access to Large Facilities”

1993  Appointment of Support Scientists to assist users:  
      at Bonn and VLBA correlators, and at some EVN telescopes

1998  Official opening of the EVN 16-station Data Processor at JIVE  
      at the time of the 4th EVN Symposium

1999  First EVN observations go to JIVE for correlation
1991: Penny and Giles Playback Terminal at Bonn Correlator
Homeless JIVE staff
THE VLBA COMES

VLBA: 10 telescopes + 20-station correlator
VLBA has new recording modes (wider “IF” channels)
But: VLBA antennas can record some MK III modes

~1992 VLBA takes over from US-Network as EVN partner for Globals
US-Network antennas lose funding as VLBA start up Loss of 2.8 cm!

~1993 Caltech loses NSF grant for running Block II correlator
DEATH OF MK II SYSTEM!!

VLBA correlator can correlate Global MK III experiments
But: requires special “thin” double-length tape, $1000 each

1993 EVN starts “thin tape upgrade” at MK III recorders

1995 EVN starts upgrade to MK IV (very compatible with VLBA modes)
New data formatters reaching 1 Gbps, IF channels up to 16 MHz
Capable of recording “VSOP–mode” 128-2-2
1992: End of Bonn MK2 correlator
SPACE VLBI: VSOP COMES

1990 EVN plays major role in forming Global VLBI Working Group (GVWG)

Organize commitments of ground radio telescope time to VSOP mission

EVN commits observing time to VSOP mission

1997-1999 EVNPC reviews VSOP proposals: EVNPC Chair on VSOP TAC

1997-2001 EVN observes together with HALCA satellite at 6 and 18 cm

Increases from 3 to 4 sessions per year to accommodate projects

Correlation at VLBA correlator
1993: GVWG meeting in Onsala for GRT commitments
New telescopes: Cambridge-32m  Seshan  Urumqi  Torun-32m

INTERCONTINENTAL BASELINES TO CHINA GIVE GLOBAL RESOLUTION

Taking part at 7 mm:  Yebes-14m  Metsaehovi 14-m
EVB 2001 – 2010

Old telescopes join EVN:

2000 Hartbeesthoek (1961)
2001 Arecibo (1963)

2001 VLBI School at Castel S. Pietro Terme, Italy

2002 First EVN observing at 512 Mbps (on tape !)

2003 Replacing tapes with disk recording: MK5 vs PC-EVN
MK5 adopted by IVS, followed by EVN and VLBA

2004 First EVN observing at 1 Gbps (with MK5)

2006 First EVN e-VLBI session in March

2008 First EVN observations with Yebe-40m (“Ys”)

2009 Russian KVAZAR Network joins the EVN
Svetloe-32m Zelenchukskaya-32m Badary-32m
First EVN observations 2010

2010 10th EVN SYMPOSIUM IN MANCHESTER
2008: EVN CBD meeting in Arecibo
2004: EVNPC meeting Bordeaux

Single-polarization observations more sensitive than dual-polarization!
2004: EVNPC meeting Bordeaux
2008: No more tapes please!
Hartebeesthoek  Arecibo  Yebes-40m

Svetloe  Zelenchukskaya  Badary
EVN PROPOSALS 1980–2009
RECORDING MODES OF EVN OBSERVATIONS 1980–2009
CORRELATION OF EVN OBSERVATIONS 1980–2009