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The Origins of the EVN and JIVE: Early VLBI in Europe

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Although Richard Schilizzi was not involved in the very earliest discussions on VLBI in Europe, he made significant contributions when he took up a position at Astron in Dwingeloo in 1976. Very soon after his arrival from CalTech he made the first nascent European VLBI Network (EVN) observations with 3 antennas - Onsala, Dwingeloo and Effelsberg – even before the network was formally constituted! Already in 1977 he was giving talks and publishing reports and conference proceedings on the importance of the EVN for Astronomy and Geodesy, for example at ESA. He realised the importance of a multi-station VLBI processor and worked tirelessly to establish JIVE, the Joint Institute for VLBI in Europe, now a major VLBI data processing centre, of which he was director from its inception in late 1993 until he was invited to run the SKA project a decade later.

Richard was among the first to recognise the possibilities of a space-borne antenna, not only as a VLBI element but also as a means of distributing time to the various observatories in the network. Together with Arnold van Ardenne, he persuaded ESA to carry out trials of such aa time-transfer project and with other colleagues he took a European Space VLBI mission proposal, QUASAT, beyond a Phase-A study before it was deemed too expensive. He was also involved in other space initiatives and supported both the Russian RadioAstron project, and the Japanese VSOP/Halca as a member of their respective international science groups, and he was a founder member of the Global VLBI working group, as well as becoming its second chairman.

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1. The European VLBI Network, EVN today

Richard Porcas has recently published a paper on the History of the EVN [1], in which he reminds us that, after 30 years of operation and growth, the network now comprises 15 institutes operating as many as 20 telescopes in 18 locations in 12 countries, spread over 4 continents (Fig. 1). At its inception, it consisted of 4 radio telescopes at Jodrell Bank, Onsala Space Observatory, Dwingeloo and Effelsberg. This phenomenal growth reflects the success of the EVN and its processing Centre, JIVE! Let us look back at its beginnings, and trace the development of the network through the work of committees and research initiatives, most – if not all – of which involved Richard Schillizi.

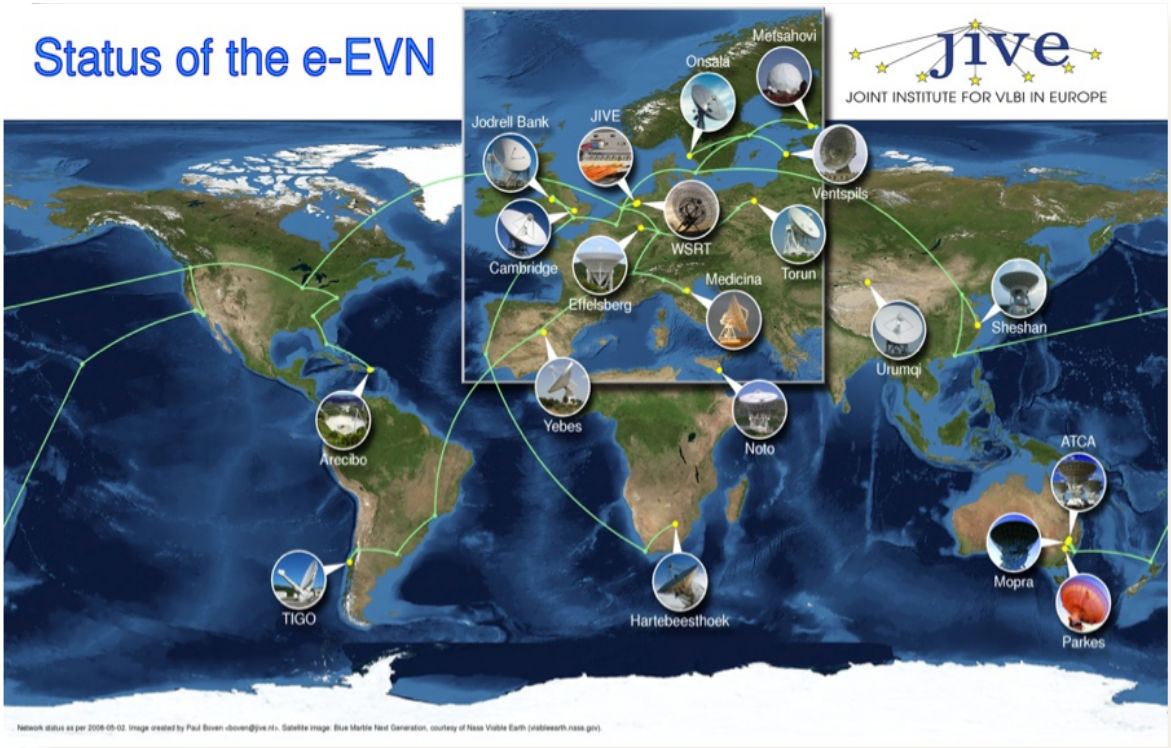

Figure 1. The EVN today (van Langevelde)

2. Early VLBI in Europe

For anyone who worked at Jodrell Bank in the 1960s, as I did, European Long Baseline Interferometry started with the radio-linked interferometer work of Henry Palmer's group and such brilliant radio astronomers as Barry Rowson and Bryan Anderson who, in 1967, achieved high-resolution data on quasars with a baseline of two million wavelengths between telescopes at Jodrell Bank and Defford [2]. The same group also facilitated the early high frequency resolution observations of anomalous OH emission sources made by Davies et al. [3] in the same year, showing that individual spectral features were unresolved on scales of a few hundredths of an arcsecond, giving early support to the maser hypothesis.

However, at that time, it was tape recording interferometry that held the key to seriously long baselines outside the range of radio links, and systems were under development at that time in Canada and the United States; but there were also such developments at Jodrell Bank by Anderson, whose recording system was used in the first Intra-European VLBI between Jodrell Bank and Onsala in 1971 (Fort [4], Stannard et al. [5]). The Anderson system relied heavily on the local computer for the processing and, at that time, had to compete with on-line data processing on the same computer, so the system was not developed further.

Porcas [1] has outlined the emergence of European VLBI where European telescopes operated with notably US or Canadian antennae and VLBI systems. It is interesting to recall the US-Onsala VLBI collaboration. The then Onsala director, Olof Rydbeck, anxious to get involved with VLBI science and mindful of the excellent, very low noise, 1.6 GHz maser receivers at Onsala, wrote to several US observatory directors in 1967 to suggest that VLBI with the Onsala 25.6 m. antenna would produce a most sensitive baseline and even sent his colleague Bert Hansson to the US to plan observations, both line and continuum [6]. This work culminated in lower (milliarcsec) limits on the sizes of OH masers [7] and a truly global VLBI experiment involving NRAO, Caltech, Cornell, Onsala, Simiez and Parkes [8].

3. The origins of the European VLBI Network.

In 1974, I spent an interesting sabbatical year at the Max Planck Institut für Radioastronomie in Bonn where, after some initial teething troubles, the 100m Effelsberg antenna was becoming reliable and the 18 cm receiver was already installed After spending Christmas 1974 at Effelsberg helping to commission that receiver, I was able to get time to make OH VLBI measurements with the Effelsberg–Onsala baseline – an experiment discussed in early 1975 when I visited Onsala for the first time. Using the VLBI was a great learning experience and, while the observations were never published, I was able to process the data myself, in Charlottesville - with some help from Ken Johnson of NRL. Back in Bonn, we began to discuss the idea of a European VLBI Network with the local VLBI group and, after consultation with Marshall Cohen, we asked George Miley (a former Jodrell interferometrist, now in Leiden) to visit in April, 1975. There and then, we formed what was essentially a committee, consisting of Ivan Pauliny Toth, Eugen Preuss, George and myself, and discussed ways of taking the idea forward among potential players in Europe.

As a result of these discussions, we convened a meeting in Bonn in September, 1975. The participants at the meeting were Baars (Bonn), Baud (Leiden), Bieging (Bonn), Booth (Jodrell Bank), Brouw (Dwingeloo), Casse (Dwingeloo), Habing (Leiden), Matthews (Munich), Miley (Leiden), Pauliny-Toth (Bonn), Preuss (Bonn), Rönnäng (Onsala), Seti (Bologna), Wiedenhoffer (Bonn), Wielebinski (Bonn), Winnberg (Bonn), Witzel (Bonn), Wohleben (Bonn), and Zinz (Bonn). There was enthusiasm and support for the idea of a network – especially from Italy, represented by Giancarlo Setti, who even at that stage, promised to build

several dedicated antennas – the last of which is now operational in Sardinia. Further meetings in Bonn (March 1976), Onsala (October 1976) and Jodrell Bank, (September 1977) brought in other European countries, for example Finland, and attracted the interest of the European Geodesy community.

At that time, in the pre-digital age, it was not usual for photographic recording of such meetings, but we value the photograph taken by Jodrell Bank's resident photographer, Bill Harrap (Fig. 2). Richard Porcas has diligently researched the names of the people in the photograph, and they are listed in the caption. Among the group are some six British geodesists, interested to become part of the VLBI network. The suggestion for a European VLBI network had stimulated a lot of interest in the UK and was a major topic of discussion in the National Committees for both Astronomy and Radio Science to which the Director of Jodrell Bank, Sir Bernard Lovell had turned for financial help.

Figure 2: The participants at the 4th informal meeting on European VLBI at Jodrell Bank in September 1977. From left to right they are: **Back:** Ponsonby (JB), Matheson, (Chilbolton), Matveenko (Moscow), Ronnang (Onsala), Pearson (Cambridge), Winnberg (Onsala), Robbins (Oxford), Pauliny-Toth (Bonn), Davies (JB), McLintock (Nottingham), Kellermann (Bonn), Sykes (Nottingham), Porcas (JB), Anderson (JB), Wall (RGO), Van Ardenne (Dwingeloo) **Front**: Stannard (JB), McSteele (NPL), Baath (Onsala), Preuss (Bonn), Booth (JB) and Barber (Chilbolton)

4. The arrival of Richard Schilizzi – *He Came, He Observed, He Published!*

Richard Schilizzi joined the group already in 1976 and was present at the Onsala meeting with his wife, Biddy, and their first child, Daniel, and they were certainly present at the Jodrell Bank meeting, although Richard doesn't appear on the photograph. By that time, discussions on the use of the US VLBI Mk 2 system and its one-inch recorders were more or less complete but not everything was in place. Nevertheless, on his arrival, Richard announced himself by performing a pre-prepared three-station VLBI experiment using of the antennae at Onsala, Dwingeloo and Effelsberg (ODE), and borrowed equipment - and published the first (pre-)EVN VLBI paper [9]. (see Fig Fig.3)

Figure 3. Richard, George Miley (right) and B. Baud peering at the original Ampex VLBI tape recorder used in the *ODE* pre EVN VLBI observations. *Careful George!!*

From this time on, Richard remained a serious force in World- and even Space-VLBI! In fact, already in October 1977, together with Arnold van Ardenne, he initiated a European (ESA) study clock synchronization for VLBI using a satellite. But he also continued his interest in astronomical Space VLBI and was in discussion with MIT and JPL in the US as well as European colleagues about a satellite-borne antenna for VLBI. At a meeting in Toulouse in 1982, a small group comprising Richard, Frank Jordan (JPL), myself and several of the other representatives of the network, agreed to propose a Space VLBI mission, QUASAT, to ESA. Richard discusses this further in his contribution to this meeting but it is good to record that through his persistence and enthusiasm, we took the proposal through an ESA Phase A study until, in 1998, its cost was deemed to be above the available budget and another competing mission was chosen. In addition to these European initiatives, Richard also enthusiastically supported both the Japanese VSOP Space VLBI project and the Russian RadioAstron, which is, at the time of writing, in orbit at last!

5. European VLBI

The development of the EVN continued, and in 1978 the MK 2 correlator built by MPIfR became available. (see Porcas [1]) This great achievement was, unfortunately, not matched by the first full EVN experiment (JODE) in the same year. That was an early attempt to measure radio source polarization – which unfortunately failed, essentially because two of the four telescopes had the wrong hand of circular polarization. Nevertheless, 2 single baseline papers were published. However, the most exciting VLBI results to come out of this period were measurements of SS433 by Schilizzi et al [10] and high resolution observations of the first gravitational lens by Porcas et al [11].

6. 1980-92 Formalisation and initial expansion of the EVN

In 1980 the EVN was formally established when the first meeting of institute directors took place in Bonn. It was agreed that the EVN would conduct 6 x 1 week VLBI observing sessions per year and set up a programme committee (EVNPC) to rate proposals for observing time. Additionally, a decision was taken to work towards the adoption of the Mk III VLBI system, which was being developed in the US. (Naturally, Richard accompanied his director to the EVN meetings in an advisory role and he was a member of the first PC). This led, in 1983, to two competing proposals: an upgrade of the 3-station Mk3 processor already in operation in Bonn to 8 stations, or to develop a new generation (12 station) data processor in Dwingeloo. In a majority decision, the directors supported the more ambitious Dutch proposal – but the problem of how it was to be funded had to be solved

Funding was addressed at subsequent meetings: the Directors decided to emphasize the European/international stature of the EVN by changing its title to the Consortium of European Radio Astronomy Institutes for Very Long Baseline Interferometry and, among other things, by establishing a new European VLBI Institute, the Joint Institute for VLBI In Europe' (JIVE), with its own Board and with Richard as its director. Further, under this trans-European banner, they would intensify the efforts to find the funding required. This idea was formalized in 1984 in Gro Enzersdorf (Austria), held before an early meeting to define QUASAT science (see chapter by Richard Schilizzi in these proceedings). A Memorandum of Understanding was established in July, 1984 and the 'new' Consortium met for the first time in Bonn in February 1985, Giancarlo Setti being the first chairman. Its members were Bologna, Jodrell Bank, MPIfR, NFRA and Onsala, with Nançay, Simeiz, Torun and Wettzell (a then new German Geodesy antenna) as associate members.

I believe that this ambitious new programme gained support by our observatory Directors because of the successful scientific contributions of an expanding EVN (see Porcas [1] for more detail). In 1984 the first of the promised Italian telescopes came on line in Medicina and Global experiments with transatlantic baselines were achieving the highest resolutions on a fairly regular basis. Higher frequencies (up to 22 GHz) were being contemplated with the Effelesberg

antenna as well as the Onsala 20m, the Jodrell Mk2, and Medicina, and new telescopes (e.g. the Torun 32m) were being discussed.

7. The establishment of JIVE

The new Consortium began an intensive series of efforts to raise money for JIVE. It had an ambitious target of building a 16 station EVN correlator, based on the 'next generation' MkIV wide-band design, with an estimated cost of about €10M. Our expectation was that the institute would be ripe for European Community funding but despite strong support from the European Science Foundation and the Journal, Nature, our ambitious hopes were dashed. Nevertheless, we were granted some support from the EU Human Capital and Mobility Programme (access to Large Scale Facilities).

Finally, the Dutch Government took an important initiative in granting €5M and hosting a meeting of representatives from other EVN nations, when decisions on the rest of the capital investment were taken. As a result JIVE was formally established by Deed of Notary, in Dwingeloo, the Netherlands on December 21, 1993. Its mandate was to support, in the widest sense, scientific and technological research using VLBI techniques.

Figure 4. The foundation of JIVE: Richard with the first JIVE team

At the end of 1994, the JIVE staff complement was 14 people, with Richard as Director. The Correlator project was underway as a collaborative project between JIVE and the other EVN Institutes, as well as European industry and MIT Haystack Observatory. Richard managed this collaboration extremely efficiently and the EVN Correlator at JIVE, having seen first fringes in July 1997, was inaugurated on October 22, 1998 by the Queen's Commissioner in the Province of Drenthe, Mr. Relus ter Beek, thereby putting the establishment under Royal Patronage!.

Since about 2000 all EVN data processing has been conducted at JIVE, including a large fraction of global VLBI observations. Over and above a processing centre, it has become a vibrant international scientific institute for VLBI with 20 senior research staff to help users as well as conducting their own research.

The establishment of JIVE was a great achievement and a credit to Richard's foresight, courage, self-belief and leadership. He has played a most important, lasting role in VLBI and World Radio Astronomy.

8. Optical Fibre and the evolution of VLBI

We have seen (Fig. 1) that after 32 years the EVN has grown to comprise 15 institutes operating a total of 20 telescopes at 18 locations in 12 countries spanning 4 continents. This phenomenal growth reflects the exciting nature of VLBI science and the achievements of the EVN and JIVE, as other chapters in these proceedings witness. But it is of interest to reflect how the availability of international fibre networks has facilitated, and even accelerated this growth. The return to the roots of long baseline interferometry through (radio-)linked VLBI, by-passing the processes of recording, transport and play-back of magnetic tape data, is indeed a striking move. And the whole process has been excellently initiated and facilitated by JIVE.

Figure 5. The JIVE correlator with its (now partially redundant) Tape recorders.

A measure of the success of Radio Astronomy in Europe is that it is now well supported by the EU, which, among other things, provides access to the fibre networks for VLBI data transfer to JIVE. The EU also supports the RadioNet programme, which promotes collaborations and new developments in Radio Astronomy.

As for JIVE, it has been in the capable hands of Huib van Langevelde since 2007, when he took over from Richard's successor, Mike Garret (now General Director of ASTRON).

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