Technical Status and developments at the EVN

P. de Vicente
(as TOG chair)

Observatorio de Yebes (IGN)
The TOG

The people

VLBI friends at stations & personnel from the correlators
The TOG

The meetings

• First meeting in 1982.
• Every 8-9 months
• Rotate the location at the EVN stations
• They are open, and attended by non-EVN
• Try to make it match with the EVN symposium every 3 meetings
• Make a double session every one meeting: GTG (GMVA) + TOG
• Minutes, as other documentation, public available in web pages.
**EVN Stations**

![Graph showing the diameter (m) of the EVN Telescopes](image)

- **Diameter (m) of the EVN Telescopes**

- **Telescope**:
  - Arecibo
  - Effelsberg
  - Badary
  - Cambridge
  - Harrebeesthoek
  - Idaho
  - Jodrell
  - Kunning
  - Jodrell
  - Meudon
  - Metsahovi
  - Noto
  - Onsala
  - Onsala
  - Robledo
  - Sardinia
  - Sliangal25m
  - Svelto
  - Sodankyla
  - Tama
  - Toruń
  - Ulans
  - Westerbork
  - Yebes
  - Yonsei
  - Zelenchuks...

**September 2016**
EVN Stations

SEFD 6 cm & 1.3 cm (EVN antennas)

Telescope
### Observing frequencies

<table>
<thead>
<tr>
<th>Band</th>
<th>Instantaneous BW</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>329 MHz</td>
<td>32 MHz</td>
<td></td>
</tr>
<tr>
<td>21/18 cm</td>
<td>60 - 500 MHz</td>
<td>1.4 GHz Atomic H &amp; OH</td>
</tr>
<tr>
<td>13 cm</td>
<td>300 MHz ?</td>
<td>S/X S band</td>
</tr>
<tr>
<td>6 cm</td>
<td>500 MHz ?</td>
<td></td>
</tr>
<tr>
<td>5 cm</td>
<td>425, &gt;500 MHz</td>
<td>6.6 GHz Methanol maser</td>
</tr>
<tr>
<td>3.6 cm</td>
<td>&gt;500 MHz ?</td>
<td>S/X X band</td>
</tr>
<tr>
<td>1.3 cm</td>
<td>100, 400, &gt;500 MHz</td>
<td>22 GHz H$_2$O maser</td>
</tr>
<tr>
<td>0.7 cm</td>
<td>&gt; 500 MHz</td>
<td>43 GHz SiO maser</td>
</tr>
</tbody>
</table>

(from EVN status table)
Observing frequencies

EVN antennas per frequency band

<table>
<thead>
<tr>
<th>Wavelengths</th>
<th>N. of antennas</th>
</tr>
</thead>
<tbody>
<tr>
<td>21/18 cm</td>
<td>18</td>
</tr>
<tr>
<td>13.6 cm</td>
<td>17</td>
</tr>
<tr>
<td>6 cm</td>
<td>19</td>
</tr>
<tr>
<td>5 cm</td>
<td>16</td>
</tr>
<tr>
<td>3.6 cm</td>
<td>15</td>
</tr>
<tr>
<td>1.3 cm</td>
<td>17</td>
</tr>
<tr>
<td>0.7 cm</td>
<td>7</td>
</tr>
</tbody>
</table>
# Data Acquisition & recording equipment

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>VLBA</td>
<td>1</td>
</tr>
<tr>
<td>DBBC2</td>
<td>14</td>
</tr>
<tr>
<td>DAS R1002</td>
<td>3</td>
</tr>
<tr>
<td>KDAS</td>
<td>3</td>
</tr>
<tr>
<td>DVP</td>
<td>1</td>
</tr>
<tr>
<td>Mark5A</td>
<td>1</td>
</tr>
<tr>
<td>Mark5B/B+</td>
<td>15</td>
</tr>
<tr>
<td>Mark5C</td>
<td>2</td>
</tr>
<tr>
<td>Mark6</td>
<td>1</td>
</tr>
<tr>
<td>Flexbuff</td>
<td>3</td>
</tr>
</tbody>
</table>

### Recording formats

<table>
<thead>
<tr>
<th>Source</th>
<th>Format</th>
<th>Destination</th>
</tr>
</thead>
<tbody>
<tr>
<td>DBBC</td>
<td>Mark5B</td>
<td>All EVN stations</td>
</tr>
<tr>
<td>DAS R1002</td>
<td>Mark5B</td>
<td>Quasar</td>
</tr>
<tr>
<td>KDAS</td>
<td>Mark5B</td>
<td>KVN</td>
</tr>
<tr>
<td>DBBC</td>
<td>Fila10G</td>
<td>VDIF</td>
</tr>
<tr>
<td>DVP</td>
<td>VDIF</td>
<td>Ef, On, Ys, Mc, Sr, Hh</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ro</td>
</tr>
</tbody>
</table>
**Recorders**

**Mark5/6** requires disk shipping
- Does not require a high speed conn.
- Limited number of diskpacks + size

**Flexbuff** avoids disk shipping
- Avoids problems from the quantization of the disks
- Requires a high speed connection

**Storage Capacities**
- 2, 4, 8, 16, 32 TB
- 144, 216, 288 TB
Available bandwidths and recording rates

Standard Operations:

2 pols x 128 MHz  
1024 Mbps

DDC mode

Limited by the DBBC (2 COREs)

Limited by the Mark5B

All EVN stations

Available since 2015/3:

2 pols x 256 MHz  
2048 Mbps

DDC mode

Requires DBBC2 (4 COREs)

Requires Mark5B+, Mark5C, Mark6 or Flexbuff

All EVN stations except 3 + KVN
**Frequency (observing) modes**

**DDC mode**  
(Digital Down Conversion)  
Frequency flexibility  
BW/channel: 1, 2, 4, 8, 16, 32 MHz (currently)  
Maximum rate: 2 Gbps (2x256 MHz)

**PFB mode**  
(Polyphase Filter Bank)  
All channels contiguous (some selectable)  
BW/channel: 32 MHz  
Maximum rate: 4 Gbps (2x512 MHz)
## Developments during the last 2 years

**Goal:** Increase the bandwidth and the recording rate

\[ 2 \text{ pols} \times 512 \text{ MHz} = 4 \text{ Gbps} \]

**Means:** EVN Contract with NVI Inc. (2015) for FS works
- Implement DDC mode 32 MHz / channel
- Implement **VDIF** to allow usage of Mark6 & Flexbuff

- April 2015: 2 Gbps
- October 2015:
Developments during the last 2 years

- Implement PFB mode (VDIF)

Several experiments performed to test PFB mode and 2 & 4 Gbps.

But … need more disk space,
high speed connections
common frequency ranges
Developments during the last 2 years

**Goal:** Continuous calibration (80 Hz)

Single shot scans: diode off, diode On

- Easy to do
- Takes time: 10-20 s & needs a gap
- Once per scan or less frequent
- Does not monitor “fast” G changes

Continuous 80 Hz

- Monitors G (gain) changes continuously
- Does not take time from the scans
- Requires hardware at the telescopes

Implemented at telescopes: Ef, On, Ys, Ro... Hh, ?
Developments during the last 6 months

**Goal:** VDIF eVLBI at 2 Gbps

Tests from Nov 2015 to May 2016

6 stations can currently yield 2 Gbps eVLBI

The correlator can handle 8 2 gbps stations

15 1 gbps stations

Aug. 2016
Developments during the last 2 years

**Goal:**

Include Irbene and Kunming

Ir is fully ready to take part in EVN observations

L, C, M, X bands

Can do 2 & 4 Gbps (to be tested)

Km needs more testing

X band available

C & M band new and requires testing