Quasar/IAA Highlights

Institute for Applied Astronomy RAS

13th European VLBI Network Symposium & Users Meeting

St. Petersburg, September 21, 2016
Russian VLBI network QUASAR
Main Facility – 32 m Radio Telescope
# Antenna Systems of RT-13 radio telescopes

<table>
<thead>
<tr>
<th>Specifications</th>
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<tbody>
<tr>
<td><strong>Main mirror diameter</strong></td>
<td>13.2 m</td>
</tr>
<tr>
<td><strong>Mount</strong></td>
<td>alt-azimuth</td>
</tr>
<tr>
<td><strong>Sub-reflector scheme</strong></td>
<td>Ringfocus</td>
</tr>
<tr>
<td><strong>Sub-reflector Mount</strong></td>
<td>Hexapod</td>
</tr>
<tr>
<td><strong>Azimuth speed</strong></td>
<td>12 °/sec</td>
</tr>
<tr>
<td><strong>Elevation speed</strong></td>
<td>6 °/sec</td>
</tr>
<tr>
<td><strong>Limits by Az; El</strong></td>
<td>±270°; 0° – 110°</td>
</tr>
<tr>
<td><strong>Operation</strong></td>
<td>24h/7d</td>
</tr>
<tr>
<td><strong>Tracking accuracy</strong></td>
<td>±15 arcsec</td>
</tr>
<tr>
<td><strong>Surface accuracy (RMS)</strong></td>
<td>Bv 0.053 mm</td>
</tr>
<tr>
<td><strong>Frequency range</strong></td>
<td>2-40 GHz</td>
</tr>
<tr>
<td><strong>The surface efficiency</strong></td>
<td>&gt; 0.7</td>
</tr>
<tr>
<td><strong>Polarization</strong></td>
<td>LCP and RCP</td>
</tr>
<tr>
<td><strong>Ambient temperature</strong></td>
<td>–35°C to +50°C</td>
</tr>
<tr>
<td><strong>Humidity</strong></td>
<td>up to 100%</td>
</tr>
<tr>
<td><strong>Snow load</strong></td>
<td>100 kg/m2</td>
</tr>
<tr>
<td><strong>Wind velocity</strong></td>
<td>50 m/sec</td>
</tr>
</tbody>
</table>
Satellite SLR Observations

“Sazhen-TM”

Satellite range:
  - day 400-6000 km
  - night 400-23000 km
Optical Aperture 25 cm
Wave Length 532 nm
Pulse Frequency 300 Hz
Pulse Duration 300 ps
Pulse Energy 2.5 mJ
Weight 170 kg
Normal Points Accuracy 1 cm
Angle Accuracy 1-2”
GLONASS/GPS observations

SVTL
- TOPCON NET-G3 (72 channels)
- Javad Delta-G3T

ZECK
- Javad Delta-G3T

BADG
- Javad Delta-G3T

(216 channels)

Daily and hour files in IGS and EPN
Other Facilities

Water Vapor Radiometer, Temperature profiler MTP-5 (Badary)

DORIS (Badary)

“Sazhen-TM”

Javad Delta-G3T

Daily and hour files in IGS and EPN

Mateo Stations Vaisala WXT 510
Badary Observatory Panorama
Observation Programs on the QUASAR Network

- VLBI Observations on Astrophysical Programs;
- Single Dish Observations on Astrophysical Programs;
- Astrometry VLBI Observations.
Time Statistic on the QUASAR Network

2014

- VLBI IVS: 25%
- VLBI IAA Ru-E+U: 18%
- VLBI EVN: 11%
- VLBI RadioAstron: 15%
- VLBI IAA Astroph.: 4%
- Single Dish: 2%
- Technical works: 25%

2015

- VLBI IVS: 34%
- VLBI IAA Ru-E+U: 23%
- VLBI EVN: 14%
- VLBI RadioAstron: 9%
- VLBI IAA Astroph.: 11%
- Single Dish: 20%
- Technical works: 23%

<table>
<thead>
<tr>
<th>Year</th>
<th>Days</th>
<th>Observations</th>
<th>Technical works</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>308</td>
<td></td>
<td>57</td>
</tr>
<tr>
<td>2015</td>
<td>282</td>
<td></td>
<td>83</td>
</tr>
</tbody>
</table>
VLBI Observations on the QUASAR Network on Astrophysical Programs

- EVN Network;
- Radioastron Mission Support;
- IAA RAS and IKI RAS own Programs (Crab Pulsar, OH Masers).
EVN projects Observations on QUASAR Network

• Each year:
  • – three dense EVN Session:
    (1) Feb-Mar, (2) May-Jun, (3) Oct-Nov;
• Additionally IAA support the next astrophysical observations:
  • – EVN Out-of-Session observations;
  • – RadioAstron selected projects;
  • – JIVE projects on VEX and MEX flyby experiments.
Radioastron VLBI Observations

- QUASAR Network participates Radioastron observations since first pre-launch tests at 2011. Frequency band used: L, C, K;
- Wide range of astronomical objects are observed;
- Data processing is performed on Correlator in ASC;
- Data transferred by e-VLBI from stations to IAA, then to ASC.

IAA-IKI Astrophysical VLBI Observations

- 3-4 sessions per month, about 12 hours each. L and K bands;
- Observed objects: Masers W3OH, W75, W49N, Orion KL and Crab Pulsar;
- Maser data transferred to IAA via e-VLBI. Data processing is performed on DiFX correlator in IAA;
- Pulsar data are processed on MPIfR Correlator, disk modules used for transfers.
Observations of near-Earth asteroid using Quasar VLBI network

Intercontinental bistatic radar observations of near-Earth Asteroid 2011 UW158 during its close approach to the Earth in July 2015. High power continuous wave signal at a fixed 8.4 GHz frequency was transmitted to the asteroid from the 70 m antenna of the Goldstone Observatory (DSS-14) and then the echo reflected back from the target was received by the 32 m radio telescopes of Quasar VLBI network in Zelenchukskaya and Badary observatories.

Convex hull of 2011 UW158 polar silhouette

Echo power spectrum bandwidth as function of UTC

Continuous wave echo power spectra obtained at Zelenchukskaya and Badary observatory

Echo spectra and hull at 9 rotation phases obtained at Badary observatory
Single Dish Astrophysical Observations

- Radio observations of afterglows from the cosmic Gamma-Ray Bursts (+GAO, SAO);
- Active Galactic Nucleus (+GAO);
- Intra-day variations of the extragalactic sources (+MSU GAISH, SAO);
- Spectral observations of OH Masers.
Intra-day variations of the extragalactic sources (+MSU GAISH, SAO)

Project on study of microarcseconds components of the extragalactic radio sources by observations of intra-day variations (IDV).
VLBI observation of the sources with Intra-day variation of radio flux density

In 2003 in IAA in cooperation with Sternberg Astronomical Institute we are started project to search for and analyze IDV on RT-32 (Svetloe, Zelenchuckskaya and Badary) in a single-dish mode. In 2016 we started a series of VLBI observations of IDV sources with RT-32 and RT-13.

Source = 3C454.3  
Experiment = RU0499  
Date = 2016/07/16/19:30-17/18:40 UT  
Band = SR  
Array = Sv + Zc + Zv + Bd + Bv

Center at RA 22 53 57.7479376  
DEC 16 08 53.560929  
Cont peak flux = 4.7247E+00 JY/BEAM  
Levs = 4.725E-01 * (-10, -9, -8, -7, -6, -5, -4, -3, -2, -1, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10)
Astrometry Observations on the QUASAR Network

International Programs:
- IVS R1 & R4  EOP estimation
- IVS Int  UTC-UT1 estimation
- IVS T2  ITRF improvement
- IVS CRF  ICRF improvement
- VLBA  radio sources mapping
- CONT  infraday EOP variations etc.
- APSG  Asian-Pacific regional sessions
- EUROPE  European regional sessions

Domestic Programs:
- Ru-E  EOP estimation
- Ru-U  daily UTC-UT1 estimation
- Ru-M, Ru-A, Ru-T (test sessions)
Achieved Astrometrical Parameters of the QUASAR in IVS Network

- CRF – 100 milliarcsec for ICRF sources;
- TRF – 5 mm for ITRF sources;
- EOP:
  - 100 milliarcsec for Pole Coordinates and Nutation and Precession Angles;
  - 10 usec for UT1-UTC;
- Troposphere Parameters – 5 mm.
Progress in IAA UT1-UTC estimations differences with IERS (Ru-U (32m) ZcBd, 13m ZvBv)
Thank you for the attention!