Metsähovi Reports
Espoo 2007

HUT-KURP-33

Metsähovi Radio Observatory
Annual Report 2006

M. Tornikoski, A. Mujunen, S. Hurtta (editors)

Metsähovi Radio Observatory
Helsinki University of Technology TKK

Director:
Dr. Merja Tornikoski
Tel. +358-9-2564 423
Email: Merja.Tornikoski@tkk.fi

Secretary:
Ms. Solveig Hurtta
Tel. +358-9-2564 831
Email: Solveig.Hurtta@tkk.fi

Metsähovi Radio Observatory
Helsinki University of Technology TKK
P.O. Box 3000
FIN-02015 HUT
Finland

Metsähovin radiotutkimusasema
Teknillinen korkeakoulu
Metsähovintie 114
02540 KYLMÄLÄ

ISSN 1455-9579

Contents

List of Figures

1 Introduction

Metsähovi Radio Observatory, a separate research institute of Helsinki University of Technology (TKK) since May 1988, operates a 14 m diameter radio telescope at Metsähovi, village of Kylmälä in Kirkkonummi, about 35 km west from the Otaniemi university campus.

Metsähovi is active in the following fields: radio astronomical research, multifrequency astronomy and space research, development of instruments and methods for radio astronomy, and (radio) astronomical education. Since 2004 also geodetic VLBI observations are done in Metsähovi in collaboration with the Finnish Geodetic Institute.

In year 2006 20 scientists, engineers, research assistants and support personnel worked at the institute. Six of the employees are funded by the Helsinki University of Technology, and the others are funded by research projects financed from outside sources. In 2006 the total expenditure of the Metsähovi Radio Observatory was 768 105 euros, including salaries and the rent of the office and laboratory space at the Metsähovi premises. This was financed by Helsinki University of Technology (70 %), Academy of Finland (13 %), European Union (7 %) and other outside sources (10 %).

The funding situation has not improved during the recent years. The TKK funding has increased a little, mainly in the form of directed project funding that has e.g., enabled us to get the 10 Gbit/s data connection to Metsähovi, but the Academy of Finland funding level has deteriorated during this decade. Luckily the Metsähovi PhD students have been successful in obtaining positions with the Finnish Graduate School in Astronomy and Space Physics. Currently two of our students (Ilona Torniainen, Talvikki Hovatta) are funded by the graduate school.

Once again, in 2006 Metsähovi was part of a consortium that applied for the Academy of Finland's Center of Excellence program. The consortium was led by professor Valtaoja from the Tuorla Observatory. In the first phase we were successful, and during the second phase we submitted a very extensive research plan and were interviewed by international expert evaluators. We received the highest possible grades, but were still not selected as one of the Centers of Excellence in the very tight competition.

However, the Planck research team lead by Dr. Anne Lähteemäki was selected as one of the "Outstanding Junior Research Groups" of TKK. This means extra funding from TKK for the group for two years.

Our research goals are set high: we aim to be among the top level research institutes in those fields of astronomy and technology that we are active in. The staff of Metsähovi is talented and motivated, and we are determined to keep this "Metsähovi spirit" alive also in the future.

June 7th, 2007

Merja Tornikoski
Director of the TKK / Metsähovi Radio Observatory

2 Research Activities

In this chapter the main research activities at Metsähovi are introduced. Some of the project teams include also scientists working at other institutes. The contact person at Metsähovi is underlined in each project team list.

2.1 Radio Astronomical Instrumentation

Research Group at Metsähovi: Tornikoski, Peltonen, Mujunen, Kallunki, Oinaskallio, Ritakari, Rönnberg

2.1.1 3 and 2 mm SIS Receivers

Project team: Peltonen, Mujunen, Oinaskallio, Kallunki, Rönnberg

The mm-wave SIS receiver constructed by Institute of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, Russia was used twice for 3 mm VLBI observation sessions in 2006. For the April session the receiver was tuned carefully in the laboratory and it showed high sensitivity (noise temperatures $\sim$ 80 K) for both polarization channels. However after installing the receiver up on the telescope the sensitivity was degraded to 130 K for the B-channel (LCP) and to 240 K for the A-channel (RCP), respectively. Another drawback was observed i.e. the sensitivities were dependent of the elevation angle. This might indicate that there was some loose contact inside the dewar which cannot be anymore repaired during the session.

For the October session the IAP personnel did not succeed to restore the sensitivity of the receiver even in the laboratory. For the channel B 180 K was measured and the RCP-channel was almost dead. On the telescope again the noise temperature of the working channel increased to 300 K. With such a receiver the session could not be performed successfully.

In August, 2006 the Agreement between the Governments of the Russian Federation and the Republic of Finland was finally signed. Metsähovi Radio Observatory is included in the list for delivery of radioastronomic receivers from IAP with a total value of the Contract as one million US dollars. The severe problems during the October session have led the original plan to simply upgrade the old SIS receiver with new components. The InP HFET technology at 3 mm frequencies now competes with SIS mixers and the choice between these two is determined rather by other requirements than only the noise performance. The most severe drawbacks of SIS mixers are the cooling requirement to 4 K, receiver cannot be tested at all at room temperature, the observed unreliability of the system and need for expert services for the start-up, tuning and shut down. Negotiations with IAP personnel have been started with help of Pekka Sjöman (DA-Design Oy) to change the receiver structure to be based on the MMIC technology cooled to 20 K ambient temperature.

The 2 mm receiver was not tested during 2006. The plan for the future is that when the 3 mm part is changed to the new dewar, this old 4 K system is used only for 2 mm receiver.

2.1.2 Receiver Maintenance and Upgrades

Project team: Peltonen, Mujunen, Oinaskallio, Kallunki, Rönnberg

During the year 2006 the repair of the 43 GHz dual channel VLBI receiver was started. First the room temperature part of the system was tested. This part consists of a 40-45 GHz mixer/tripler assembly, two phase locked local oscillators and two IF-sections. The first LO(1) frequency is set to 11.62 GHz and after the tripler the Q-band LO is at 34.86 GHz. The first IF-band is amplified 46 dB and limited by a bandpass filter to 8.0-9.5 GHz. The second LO is set to 7.62 GHz to down convert the signal to the standard 0.5-1.0 GHz VLBI band. Both of these LO's are YIG-oscillators

Figure 1: Receiver change in progress (J. Kallunki, H. Rönnberg)

Figure 2: Receiver change in progress (J. Kallunki, A. Mujunen)

Figure 3: Receiver change in progress. Getting ready to lift up the 37 GHz continuum receiver. (A. Mujunen, J. Kallunki, H. Rönnberg)

Figure 4: Receiver change in progress. Riding up with the continuun receivers (H. Rönnberg)

Figure 5: Receiver change in progress. Installing the 22 GHz continuum frontend (J. Kallunki, A. Mujunen)

with voltage coarse tuning and the FM-coil is exploited for the phase locking. The LO(1) can be tuned via ADAM/NuDAM module network and LO(2) is set manually to the desired fixed frequency. The phase locking scheme uses 100 MHz frequency standard followed by a comb generator and the PLL IF-frequency is 20 MHz. Thus the LO frequency is N x 100 MHz + 20 MHz and the harmonic numbers are N = 116 and 76, respectively. The phase lock status can be monitored via the above mentioned module and both of the LO's are operating without failures.

The receiver was tested with a coherent signal at 43.23 GHz center frequency which can be generated by Rohde&Schwarz synthesizer multiplied by a Spacek quadrupler. These tests indicate that the room temperature part of the receiver works correctly according to the block diagram and theoretically calculated signal levels and frequencies were measured.

The new MMIC-based LNA's developed at Ylinen Electronics were installed to the cryogenic front end. The cooling capacity of the CTI model 22 refrigerator (1 W at 20 K) is quite not enough to cool the LNA's adequately. The ambient temperature reaches only down to 50 K but this is considered to be acceptable with some sacrifice to the sensitivity. However the LNA's did fail to operate probably due to an electrical static discharge. The MMIC devices are more sensitive to bias transients than the separate HEMT transistors and the operation points (voltages) are significantly lower. The LNA's were sent to DA-Design Oy (Pekka Sjöman) to be repaired and the bias circuitry and especially the grounding problems are investigated thoroughly.

The 22 and 37 GHz continuum receivers have been operated again without severe failures. This is actually amazing because both of these use GaAs Gunn oscillators as LO sources. The low efficiency of these old GaAs devices means that the inside temperature of the semiconductor material is very high and this predicts theoretically a short lifetime for the active component.

In conjunction with the earlier mentioned new contract with IAP also these receivers should be replaced to a modern receiver complex. The original plan is to install both 22 and 37 GHz receivers in one dewar (if mechanically possible) and the front end should be cooled to 20 K. Also a new scheme for continuum receivers should be adapted i.e. pseudo-correlation radiometer principle. This means two important advantages: Dicke-switch and LO are not needed, the broadband signal is detected directly. The drawback is the need of a phase shifter for the high signal frequency. Negotiations with IAP personnel have been continued to clarify their technical capability to construct such a complex system.

The 2/8 GHz Geo-VLBI receiver has proven to be reliable. Only some cleaning and tightening of the SMA-connectors has been done and the feed horn was protected with an extra tape to avoid moisture penetration into the feed system.

2.1.3 IT Infrastructure

Project Team: Mujunen, Lindfors

Metsähovi Internet connection based on two regular ADSL modems was replaced with a tunneled access over the direct 10 Gbits/s Funet fiber connection. Just like with the modems, the tunnel endpoint is at university campus to ensure access to services only available on the university internal network.

Both hardware and operating system consolidation continued with new desktop purchases being made with the Hansel government purchasing arrangement of Dell OptiPlex GX620 computers with long-term on-site warranties (3–4 years). A single installation of Windows Server 2003 Terminal Server for networked access to selected Windows applications was established with a VMware virtual machine environment. This allowed the new "winapps" server to run on the same powerful "apps1" Linux hardware as the general Linux application server, sharing the CPU and memory resources. Additionally, virtual machines allow easier rollback of irreversible Windows operating system changes and failed software installations.

Accessing remote desktops has increased constantly at Metsähovi. Practically all observations are performed using Linux VNC servers which are being accessed by observers both at Metsähovi and at home offices. Windows applications can be accessed in "rdesktop" RDP sessions from both Linux and Windows computers, and a similar general tunneled RDP access was set set up to enable everyone at Metsähovi to use new university systems Rondo (invoices) and Travel (travel expense claims).

Multi-site network backup system was enhanced with a centralized Linux system disk backup computer "remus" which enables emergency network boot in case of system disk failures. Another small dedicated server "cds" was created to host CD and DVD images, making them available in the internal network in a variety of ways such as web, NFS, and Samba. The "cds" additionally provides a wall-mounted LCD display in the vicinity of Metsähovi entry door which has proved to be especially useful for using the car pool reservation system "commute.pl". This system is based on Perl and MySQL and it was created by Miika Turunen to alleviate the problem of maintaining car seat reservations on a physival paper list at university campus.

2.1.4 Hydrogen Masers

Project Team: Oinaskallio, Kallunki, Mujunen

The performance of Kvarz 70 Ch1-75 H maser frequency standard continued to be very good. Second maser (Kvarz 69) had problems with pps (Pulse Per Second) signal. The maser didn't sent the pps signal. Reason for this was that pps board was broken. PPS board was changed by IEM Kvarz in October. After this Maser has been worked without failures. During the year 2007 molecular hydrogen source and frequency comparator will be changed in maser 69. In Figure 6 the time differences between the two H masers and several GPS clocks is being illustrated.

2.1.5 Clock Difference Measurement

Project Team: Mujunen, Kallunki, Oinaskallio, Rönnberg

Metsähovi started to use clock difference measurement system (called "Clodi") in 2002 for measuring to clock difference between different GPS (General Position System) clocks and hydrogen maser. During the years was appeared that "Clodi" gives fault values which aren't related to maser itself. In 2006 "Clodi" abel software was reprogrammed with using new compiler. Also CPLD (Complex Programmable Logic Device) was changed to faster CPLDs (Xilinx XC9572XL-10-PC44 –> Xilinx XC9572XL-5-PC44). These changes caused that unwanted failures disappeared. Figure 6 was generated with Clodi system. Also other maser monitoring softwares were development during year for helping to find out maser condition.

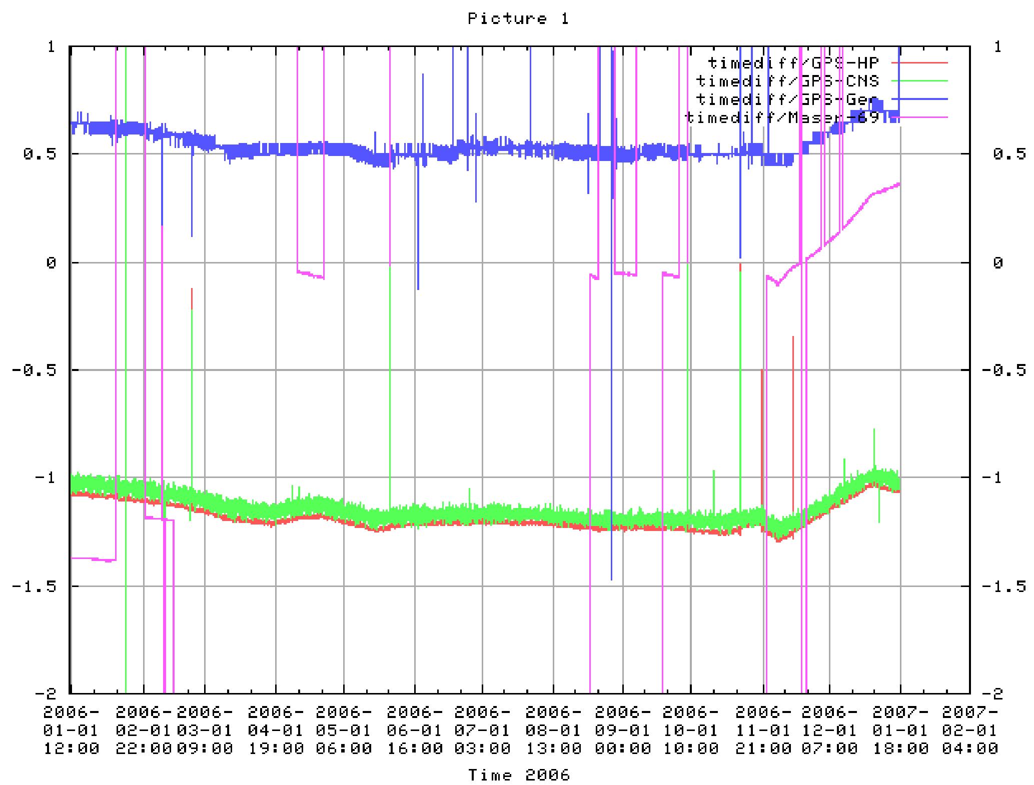


Figure 6: Time differences of H maser and GPS clocks, in microseconds.

In January 2006 pps board of maser 69 was broken which can be seen from Figure 6. The level of measured value went out of scale. During the year pps signal was adjusted to the scale several times.

2.1.6 New Hardware

Project Team: Mujunen, Kallunki, Oinaskallio, Rönnberg

Harmful frequency measurement system

The old interference measurement system was renewed. Antenna pole was modified. Preamplifier was changed to more sensitive amplifier and also the noise level of new amplifier is much more lower. In addition the spectrum analyzer was replaced by a new one. Software (for saving the results) development is still unfinished. Software will be completed during the year 2007. Figure 7 illustrates a general overview of interference measurement system.

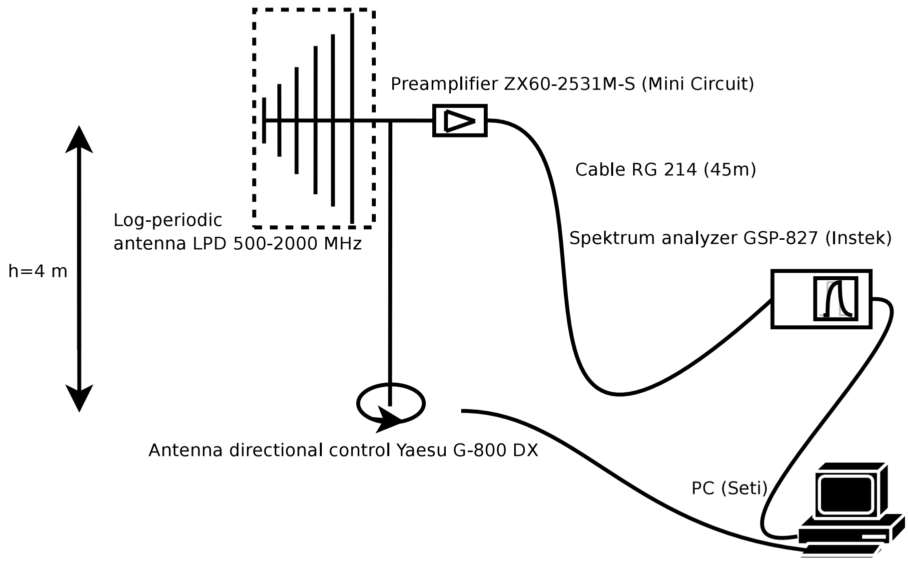


Figure 7: Interference antenna.

Sunant

Both motors (including gearbox) in SunAnt antenna were changed during the year. New gear ratio of azimuth motor is 159:1 (old: 66:1) and new gear ratio of elevation motor is 246:1 (old: 159:1). These changes make more accurate tracking of sun possible and lifetime of the motor is higher. Also some offset parameters were checked and changed in antenna tracking software.

UPS (uninterruptible power supply)

New UPSes were added in the VLBI (Very Long Baseline Interferometry) rack, also some UPS extra batteries were added and changed.

Monitoring

New monitoring sensors were added in various locations. Examples for those are temperature and humidity sensors in the control room and temperature sensor in the antenna control rack. Also sensors for monitoring UPS extra battery current were added.

Building maintenance in Metsähovi

In the antenna area the old power feed fuse boxes were renewed during August and September. The old four wire wiring system was substituted by a modern five wire system and the traditional fuses replaced by automatic circuit breakers and ground fault circuit interrupters where appropriate. The old system originated from 1973 when Metsähovi Radio Observatory was founded. The new system improved the quality of electricity in the whole antenna area. This renewing was made by ISS.

The Air-conditioning unit was renewed in control room in June. This was made by Airtek Oy.

Radome heater was renewed in January 2007. This was made by MEPU Oy.

2.1.7 Automatization of Quasar Observations

Project Team: Tornikoski, Hovatta, Kotiranta, Lähteenmäki, Turunen, Lindfors, Mujunen, Oinaskallio

The automatization of quasar observations has reached a point where we can use the current measurement software and practically all of the auxiliary functions needed during quasar observations over the Internet. The observations are always run through a vnc session. This enables any observer to pick up the observing session from any terminal connected to the net, ie., transition from observations done on site to a remote session are smooth.

A human observer is still needed for the major tasks of source selection, pointing offset determination and noise diode calibration, as well as naturally for the overall monitoring of the data quality. The current automatization system, however, enables the observer to take relatively long breaks (a few hours to a full night, depending on the source selection and the weather conditions etc.).

An effort was started to completely replace the old Contobs program by new software, and even though this software reached a point where it could be tested by observers, Contobs was still used for actual observations. We hope to be able to finally replace Contobs by new and much more advanced software in 2007.

2.2 VLBI Instrumentation

Project team: Ritakari, Mujunen, Wagner, Molera

In April 2006 Jan Wagner repaired the bank of failing BBC baseband converters by replacing dividers in the LO synthesizer. In August 2006, correlation plots from geodetic VLBI experiments revealed a filter board signal leakage problem in most of the BBCs. The filter boards were subsequently modified and fixed by Jan Wagner and Guifre Molera.

2.2.1 eVLBI and EU FP6 EXPReS

Project team: Ritakari, Mujunen, Lindfors, Wagner, Molera

During 2006, 10 Gbps Internet connectivity to CSC/Funet was established in Metsähovi. Metsähovi was the first radio observatory in the world to have a 10G connection. The 10G connectivity was acquired for EU EXPReS SA2, in order to create an e-VLBI test bed at Metsähovi, and a dark fibre was ordered already at the end of 2005. The required contracts were worked out by Jouko Ritakari and Ari Mujunen.

For local networking, an Extreme Networks Summit X450 24-port switch with an optional 10 GBASE-ZR extended range (up to 80 km) fibre module was bought. The switch was configured by Timo Lindfors and Jan Wagner for a new e-VLBI test network on the Internet.

Guifré Molera and Jan Wagner built several e-VLBI test bed PCs, and installed a preconfigured Metsähovi e-VLBI Debian system image created and maintained by Jan Wagner. Initial 10G fibre commissioning tests resulted in overflooding the by that time bottlenecked 2.5G link capacity at CSC, as a result of which Ritakari was invited to give presentations at FUNET.

During summer 2006, in cooperation with several other European stations, real-time e-VLBI on the Metsähovi 10G fibre was tested using the further improved Tsunami protocol. Tests successfully achieved aggregate rates up to 1.5 Gbit/second. Participating stations included Jodrell Bank, Onsala, Bonn, Jive and Torun. Test accounts to the Metsähovi e-VLBI PCs were handed out to several interested people in other European and Japanese observatories.

In October 2006, a larger scale e-VLBI test and transfer demonstration was carried out for the EU EXPReS Month 7 Demo. Real-time streaming several VLBI experiments over the Internet to JIVE and Metsähovi from Jodrell Bank, Onsala and Metsähovi was a full success. Rates of 256 and 512 Mbit/second were easily maintained.

After a real-time Tsunami modification by Wagner and Ritakari, another world first was achieved in December 2006. Antenna data was streamed at real-time 896 Mbit/second over a 1G network connection bottleneck, both locally and over the Internet to Jodrell Bank. The higher rate allows 1.32 times better VLBI sensitivity.

For the EU EXPReS project and real-time e-VLBI data acquisition, Jan Wagner carried out several software development tasks. The earlier Linux 2.4 kernel driver for the VSIB data acquisition board, programmed by Ari Mujunen, was ported to the new Linux 2.6 kernel. Some additional small VSIB software tools, such as a real-time spectrum display, were developed. Guifre Molera carried out several long-term stress tests for the new kernel module, which at the same time tested the noise immunity of the VSI cabling in the VLBI computer rack.

The Tsunami UDP transfer protocol, modified in 2005 by Jouko Ritakari and Timo Lindfors for real-time e-VLBI with the VSIB board, was further developed by Jan Wagner. A new open-source project for Tsunami was opened on SourceForge by Wagner. Tsunami needed several stability improvements and a number of new features to be usable for production use in real-time e-VLBI observations. In winter 2006, Wagner developed additional FieldSystem schedule interoperability scripts for real-time Tsunami that had been desired by other European observatories.

Aspiring EVN stations in Ukraine and Latvia were equipped with the Metsähovi PCEVN system. Hardware setup was aided and initial fringe checking tests were run at the stations under consultation of Mujunen, Wagner and several other participants.

In later autumn 2006, the capabilities of the IBM Cell Broadband Engine, tentatively to be used in a Metsähovi software correlator, were researched by Jouko Ritakari and Ari Mujunen. Jan Wagner began testing and evaluating the Linux based Cell software development kit and the included Cell simulator.

2.3 VLBI Observational Activities

Project Team: Mujunen, Ritakari, Wagner, Molera

2.3.1 VLBI Sessions in 2006

Project Team: Mujunen

No EVN 22 GHz nor 43 GHz sessions. Eight 24 h geodetic schedules were run in six receiver change sessions.

Two 3 mm/86 GHz mm-VLBI sessions of GMVA (Global mm-VLBI Array) were conducted in April and in May.

2.3.2 ESA Smart-1

Project Team: Mujunen, Ritakari, Wagner, Molera

In May 2006, Metsähovi was one of the stations to participate in accurate VLBI tracking of the trajectory of ESA's electronic propulsion SMART-1 moon mission spacecraft using the geodetic S/X receiver.VLBI was used also to track the S/C final descent and international crash landing on the Moon on 03-Sep-2006.

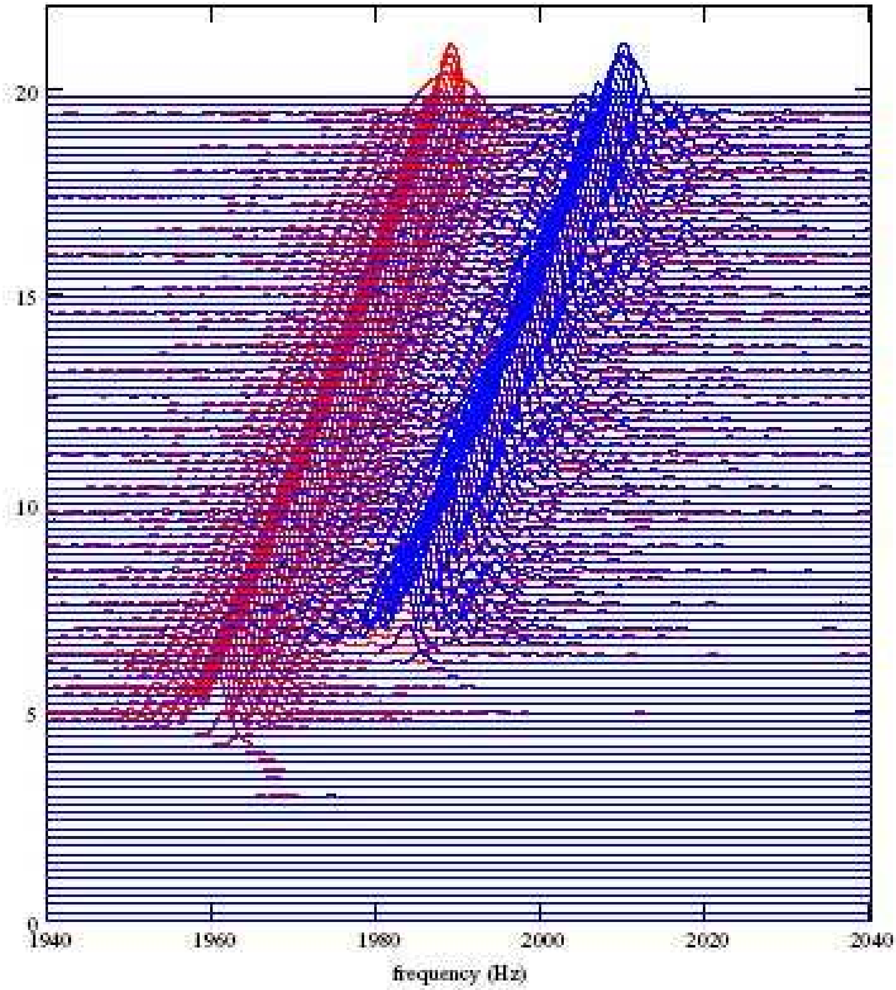


Figure 8: Dynamic spectra of S/C signal as observed by Medicina (left) and Metsähovi (right) during the spacecraft's egress from an occultation (Graph courtesy of Sergei Pogrebenko).

2.4 AMS-02

Project Team: Ritakari, Molera

Metsähovi Radio Observatory has again got involved regularly in the AMS-02 project. First attending the Technical Interchange Meetings held every trimester in Geneve and specially developing the software and hardware needed on the Ground System Equipment. The foreseen plan for AMS-02 is to be launched at the end of 2008, so currently the technicians are hurrying up to finish and assemble the modules and prepare the first tests with the payload mounted in the structure.

A large server is needed to ensure the correct reception of the data incoming from the International Space Station and facilitate an easy interface to handle the data stored on the hard disks. The scientific community will be able to have 24 hours connection availability and almost real-time access to the AMS data.

Software developed in Metsähovi to use the experience and success achieved by the Tsunami protocol and using a circular buffer, high speeds up to 50 Mbytes are achieved without any loss of UDP packets. Tests with computers in the VLBI rack have shown that is totally possible to have several users connected and handling the internal data without perturbing the receiving system and causing loss of packets.

2.5 Extragalactic Radio Sources

2.5.1 BL Lacertae Objects

Project Team: Tornikoski, Nieppola, Hovatta, Kotiranta, Lähteenmäki, Torniainen, Valtaoja (Turku)

In the very beginning of the year, the study of the spectral energy distributions (SEDs) of BL Lacertae objects (BLOs), submitted and accepted the previous year, was published in *Astronomy and Astrophysics*. There are still many open questions concerning the physics behind the formation and properties of the BLO SEDs. Some preliminary work and planning was done in preparation a manuscript that would shed light on the subject. It will discuss the peak frequencies of the synchrotron components of the SEDs in relation to other known properties of the BLOs when the effect of Doppler boosting is taken into account. We expect to start the work on this manuscript in earnest in 2007.

The study of BLOs in Metsähovi in 2006 was mostly marked by the impending data release of the 37 GHz BLO observing campaign. The Metsähovi BLO sample includes 398 sources, for which we have collected over 3000 datapoints between December 2001 and April 2005. Our observing project is unique, covering an exceptionally extensive sample of BLOs and using high radio frequencies. Thus far, high radio frequency data for especially high-energy BLOs (HBLs) and X-ray selected BLOs (XBLs) have been very few, and they have been thought too faint to be detected in those wavelengths. Therefore it is vital to obtain real high frequency datapoints for these sources, especially considering the removal of extragalactic foregrounds from the CMB maps produced by the Planck satellite. If found to exhibit inverted spectra, HBLs are a source population which contaminates the Planck maps more than previously predicted.

Each source was observed at least once and roughly a third of them was detected at the signal to noise ratio $S/N > 4$. Most of the detected objects were low-energy BLOs (LBLs), but a surprisingly large fraction of HBLs was also detected. Typically they have a few nondetections and one or two detections at $S/N > 4$. This means that either they are constantly on the verge of our detection limit of 0.2 - 0.5 Jy, or they exhibit flaring behaviour similar to their more luminous cousins, the LBLs. The mean variability index $\Delta S_2 = (S_{max} - S_{min}))/(S_{max} + S_{min})$ of BLOs was found to be 0.31. We also calculated non-simultaneous broad band spectral indices for the sample using 5 and 90 GHz archival data. As could be expected, the average spectra are flat, but the distributions of both indices are broad. The final publication of the BLO data is expected in the first half of 2007 in *Astronomical Journal*. The results of the study were presented in two international meetings: the 8th ENIGMA meeting in Espoo and the IX Russia-Finland Symposium on Radio Astronomy in Russia.

The preparation of the manuscript on the long term radio variability of BLOs resumed in 2006. The aim is to study the variability of a particularly well-monitored subsample of the Metsähovi BLOs in many radio frequencies. The 4.8, 8 and 14.5 GHz data are from the University of Michigan Radio Observatory, the 22 and 37 GHz data from Metsähovi and the 90 and 230 GHz data from the Swedish - ESO Submillimetre Telescope in Chile. We report the individual time scales of the sources, calculated with the structure function, the discrete correlation function and the Lomb-Scargle periodogram. The first results of BLO time scales compared to those of the other AGN groups will be published in a separate paper, to be submitted early 2007 (see Section 2.5.2). Also, we study the individual flares of 13 sources and compare their behaviour to the generalized shock model. The emphasis is on the flux curves of the sources, being very well sampled, but also the flux vs. frequency and frequency vs. time projections of the flares have been investigated. The radio variability study of BLOs is expected to be submitted in mid-2007.

The 37 GHz observations of BLOs as part of the Metsähovi-Tuorla Observatory collaboration project continued in 2006. Many of the brightest BLOs (eg. AO 0235+164, S5 0716+714, OJ 287 and BL Lac) were observed very frequently (for more information, see Section 2.5.6).

2.5.2 Variability time scales

Project Team: Tornikoski, Hovatta, Lähteenmäki, Torniainen, Nieppola, Valtaoja (Turku), Lainela (Turku), Lehto (Turku)

In Metsähovi we have been monitoring a large sample of Active Galactic Nuclei (AGNs) at 22 and 37 GHz frequencies for almost 30 years. Using this large data set it is possible to study the long term variability behaviour of AGNs. In 2006 we have continued the work done in the master's thesis of Talvikki Hovatta (2005) to study the characteristic time scales of AGNs in more detail.

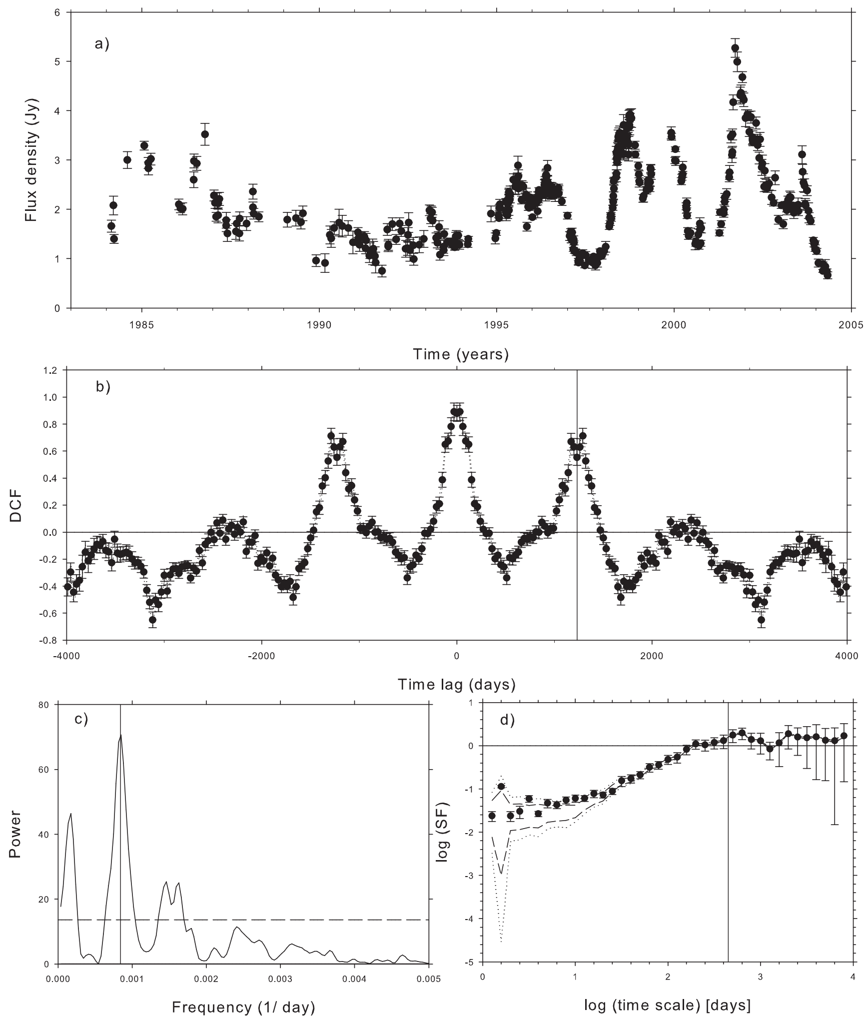


Figure 9: Analyses of the HPQ source 4C 29.45 at 22 GHz.
a) Flux Density curve. b) The discrete correlation function. The 99.5% significance level is shown with dotted line. c) The Lomb-Scargle periodogram. Dashed line shows the false-alarm probability. d) The structure function. Dashed and dotted lines show the 97.5% and 99.5% significance levels. Time scales obtained with each method are marked by vertical lines. The most significant spike of the periodogram is at time scale of 3.29 years, which is 0.2 years shorter than the first correlation in the DCF at 3.49 years. The SF gives a time scale of 1.21 years.

We have used a sample of 80 sources and studied the time scales at 7 different frequencies. The 22, 37 and partly the 90 GHz data are from the Metsähovi monitoring database. The 90 and 230 GHz data are from our monitoring programme at the SEST telescope, obtained between 1986-2003, and also collected from the literature. Lower frequency data at 4.8, 8 and 14.5 GHz were provided by the

University of Michigan Radio Observatory.

We used three different statistical methods to study the time scales: The Structure Function (SF), The Discrete Correlation Function (DCF) and the Lomb-Scargle periodogram. The SF gives a time scale related to the rise and decay times of the flares in these sources whereas the DCF and the periodogram give a time scale between the outbursts.

In Figure 9 all the analysis results for a source 4C29.45 at 22 GHz frequency is shown. The DCF gives a time scale of 3.49 years for this source, which is 0.2 years longer than the time scale obtained with the periodogram, 3.29 years. This is a good example where both the methods give very similar results. We can also identify outburst in the flux curve with approximately 3.5 years apart. The SF gives a shorter time scale of 1.21 years corresponding to the rise and decay times of the flares.

The analyses of the whole sample showed that outbursts happen quite rarely in these sources, on average every 6 years. The time scales were also shortening with increasing frequency. We did not find any significant differences between the different source classes. We compared our results from SF analysis with earlier study made by Lainela & Valtaoja (1993) and found out that many of the sources have changed their behaviour during the years. This shows that even 10 years of monitoring is not long enough for some sources. The results will be published in Astronomy & Astrophysics.

2.5.3 Inverted-Spectrum Sources

Project Team: Tornikoski, Torniainen, Hovatta, Kotiranta, Lähteenmäki, Tröller, Valtaoja (Turku)

In 2006, our studies of inverted-spectrum sources were concentrated on the galaxy-type gigahertz-peaked spectrum(GPS) sources and high frequency peakers (HFPs). We collected a sample of 96 GPS and HFP galaxies and studied their radio continuum spectra in order to determine if there were misidentified sources among them. Surprisingly, we found that only $\sim 30\%$ of the sources could be confirmed to be GPS sources considering the shape of the spectrum, the turnover frequency and the flux density variability. Another $\sim 30\%$ of the sources had a potential gigahertz-peaked spectrum but it consisted of very few datapoints. No solid classification should be done with such small data sets. For the rest of the sample ($\sim 40\%$), there were no arguments for GPS classification: there were sources with simply flat or steep spectra and very variable sources with inverted spectra. Thus, at least $\sim 40\%$ of the galaxy-type GPS and HFP sources are something else than previously has been thought. Our paper "Radio continuum spectra of gigahertz-peaked spectrum galaxies" was submitted to Astronomy & Astrophysics in Dec 2006 and has been accepted for publication.

The paper was done in collaboration with Margo and Hugh Aller form University of Michigan Radio Astronomy Observatory and Marat Mingaliev from the RATAN-600 telescope from Russia. They provided valuable multifrequency data for the study.

The monitoring of both galaxy- and quasar-type GPS and HFP sources was continued in 2006, with a special emphasis on the galaxy-type sources for the abovementioned study in the spring. We detected some very faint GPS sources that were not expected to be detectable with the Metsähovi telescope, which implies that there are considerable flux density variations in some these sources.

2.5.4 Planck Satellite Science

Project Team Lähteenmäki, Tornikoski, Aatrokoski, Torniainen, Valtaoja (Turku)

The Planck satellite will map the sky at nine high radio frequencies from 30 GHz to 857 GHz, and measure the cosmic microwave background (CMB) radiation.

At the same time all foreground radio sources in the sky, including extragalactic radio sources, will be observed, too. Planck will produce unprecedented all sky catalogs of sources at several high radio frequencies. They will, finally, fill the gap in the present radio survey data. The satellite launch is scheduled for autumn 2008.

The annual Planck LFI and HFI Consortia meeting was held on the island of Ischia in Italy in April. A. Lähteenmäki, M. Tornikoski, J. Aatrokoski and E. Valtaoja (Tuorla) participated. WG 6 also met and briefly discussed the latest developments.

Our Metsähovi Radio Observatory and Tuorla Observatory Planck collaboration team has actively participated in the core activities of the Planck Extragalactic Point Sources Working Group (WG 6). In 2006 the process of defining the final science programme for Planck was started, in preparation for the approaching launch. The programme will be created within the Working Groups, based on the Baseline Core Programme proposals collected into the Planck ”Bluebookť". WG 6 is set to have a meeting, discussing the issue, in early 2007. The deadline of the final science programme proposals is expected to be in spring 2007.

Our preliminary observing proposal for the Herschel satellite ”Target of Opportunity observations of interesting Active Galactic Nuclei detected with the Planck Quick Detection Systemť" was reviewed and accepted by the Planck Science Team (PST) in April. A. Lähteenmäki participated in a PST meeting in July where the proposals and their further development were discussed. The official Announcement of Opportunity for Herschel and the proposal deadline are expected in winter and autumn 2007, respectively.

The preparatory work for Planck continued. Observations, analysis, and publication of our Planck-related AGN data were carried out in Metsähovi in cooperation with our collaborators worldwide (see Section 2.5.6). The development of the Quick Detection System (QDS) progressed very well. The software was delivered to the Low Frequency Instrument (LFI) Data Processing Centre (DPC) in Trieste, Italy, in October. From now on, the work consists mainly of adding features and testing. A closer account on the QDS status will be given in Section 2.5.5. J. Aatrokoski finished his M.Sc.(Tech.) thesis on QDS in November, and was awarded the highest possible grade for his excellent work.

The Finnish Planck science group, led by A. Lähteenmäki, met several times during the year. The group was particularly worried about the diminution of funding of Planck related projects in Finland, and also seeked the advice of the PST. Group members are also looking into strengthening their collaboration, for example, by submitting common funding applications.

2.5.5 Quick Detection System (QDS)

QDS is a software package designed to detect interesting point sources (for example, active galactic nuclei, AGNs) in the time-ordered datastream of the Planck satellite within one or two weeks from the time of the observation. AGNs are rapidly variable, in the timescale of a few days to a few weeks, and any significant event must be investigated without delay. QDS makes this possible by alerting observatories for followup observations when it detects something interesting in the Planck data.

In 2006 the software was completed in the sense that it is fully functional and further development is mainly testing and adding useful but not strictly essential features. The user manual was written and is being kept up-to-date with the software, many features were added and extensive testing of the software began.

One of the major developments was the integration of the QDS software into the Planck Low Frequency Instrument's Data Processing Center (LFI DPC) in Trieste, Italy. This consisted mainly of adding support for the database interface used in the DPC, which was only preliminary since the DPC infrastructure was in a very early stage. The QDS requirements for the final database interface were submitted to the DPC people, and the final integration is estimated to be done in summer 2007.

The following is an overview of some of the features of the software as well as a more detailed look at the data processing steps (Figure 10).

General Features

- Very configurable. Most configuration variables can have frequency- and detector-specific values as well as a default value.

- Support for arbitrary number of detectors and frequencies.
- Not strictly Planck-specific: the main restriction is that the data must be arranged in rings similar to those in Planck.
- Save/resume options make incremental (possibly automatic) running of QDS easy as newly received data is entered into the ring database.
- Program output is fully customizable, and can be sent to the operator via email instead of printing it to the terminal.
- Can also be run in interactive mode where the results can be examined and source histories can be plotted as graphs.
- Comprehensive user manual.

Processing Pipeline

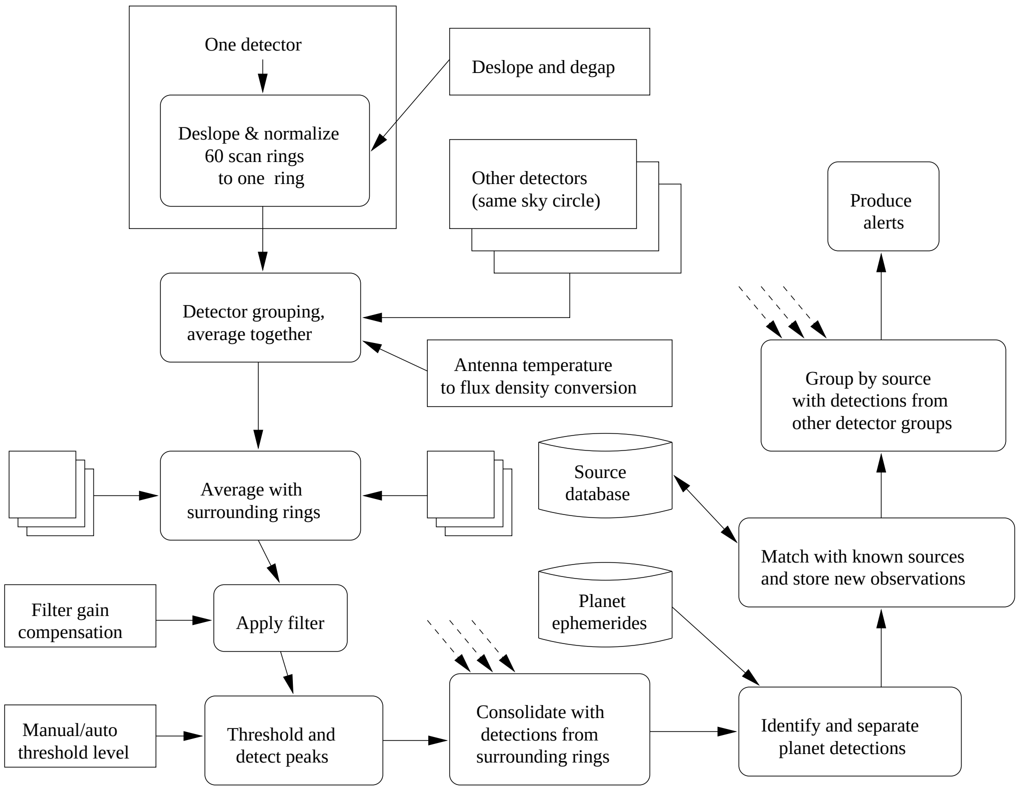


Figure 10: A detailed chart of the QDS processing pipeline. This procedure is repeated for every ring and every detector.

Planck data is organized as rings in the sky. The first step in the processing pipeline is the *normalization* of the data rings. The normalization (Figure 11) performs the following operations:

- Any gaps caused by missing data and possible discontinuities at ring boudaries caused by low-frequency noise are removed from the signal.
- The 60 very noisy sampling rings from the same sky circle are averaged together to produce a noise-reduced ring.

- The rings are adjusted to have a well-defined and consistent starting point and direction.
- Sample units are converted from antenna temperature to flux density.

Normalized rings can be cached so that the normalization can be skipped on the next time the ring is needed. Reading a ring from the cache is about 50 to 60 times faster than reading from the ring database and normalizing, depending on the actual amount of data per ring.

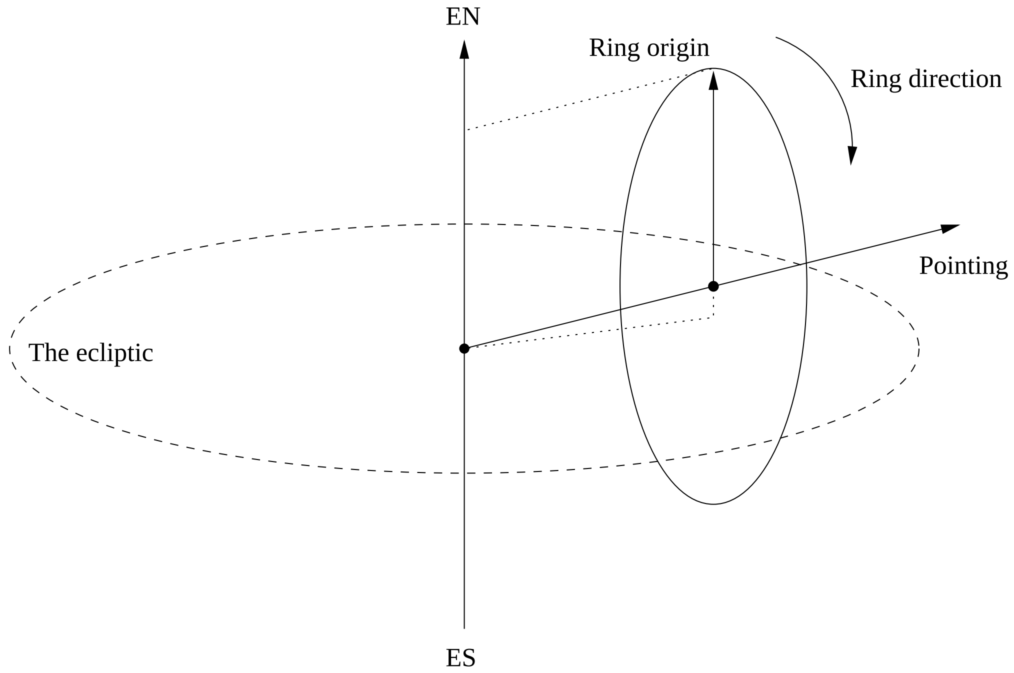


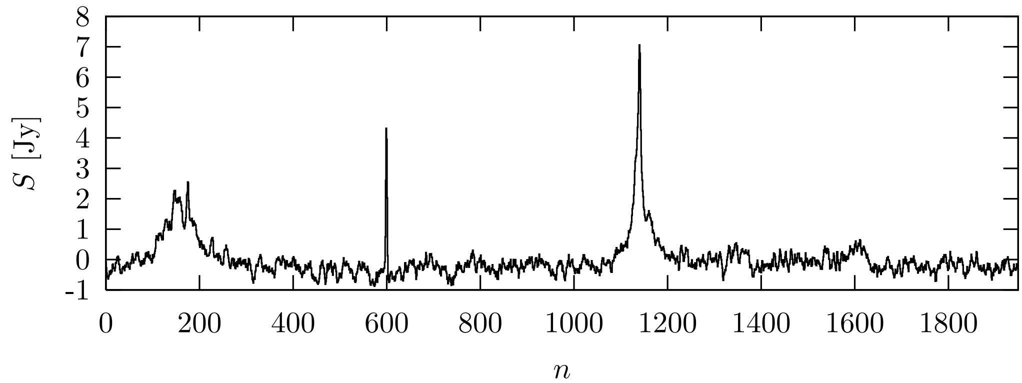
Figure 11: QDS ring normalization principles. A normalized ring starts at the ecliptic north and goes around the satellite pointing vector in the clockwise direction.

The normalized rings can be easily averaged with rings from other detectors in the same sky circle (detector grouping) and also with surrounding rings to further reduce noise.

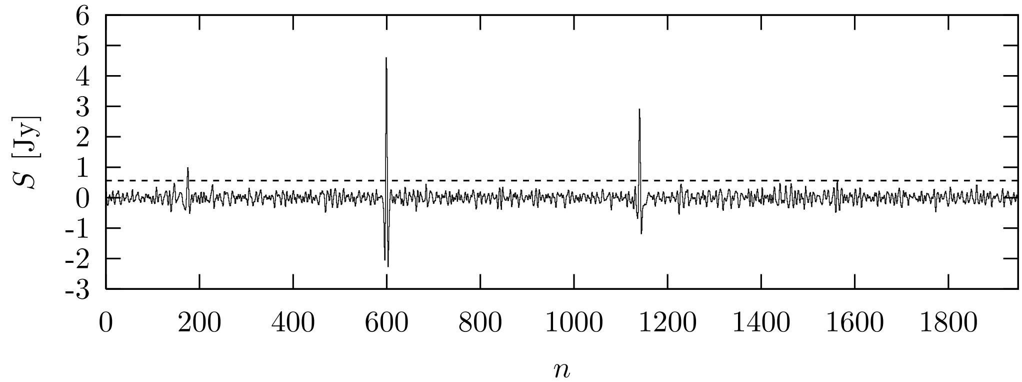
The next step is filtering and thresholding, which are the actual steps that detect the point sources. Filtering uses a filter defined by the Mexican Hat Wavelet (MHW) with its width parameter configurable for each detector either as a multiple of the beam FWHM or directly in arc minutes. The filter is constructed so that its gain is compensated for i.e. peaks with the beam FWHM will have correct height after filtering. In addition to MHW also the second order Mexican Hat Wavelet (MHW2) can be used as the filter. The effect of the MHW filter is illustrated in Figure 12.

After filtering the noise level σ of the data is determined and the data is thresholded to detect point sources. The threshold is usually configured as a multiple of the noise level.

As a point source is usually visible in several rings, the detection results for each ring must be consolidated with the results from all the other rings being processed to remove duplicates and determine the correct values for coordinates and brightness, after which these consolidated detections are matched against the sources in the point source database. The detections can also be matched against ephemerides to separate detections caused by solar system bodies from the rest. Finally those detections that are deemed interesting will produce an alert for the operator.



(a) Noise-reduced ring before filtering. There is a 5 Jy point source at $n = 600$, everything else is background. The signal has been adjusted so that its mean is zero.



(b) The ring after filtering. A detection threshold of 4σ is marked with dashes. Note the spurious detections at $n \approx 150$ and $n \approx 1150$.

Figure 12: Simulated Planck ring data before and after filtering with a Mexican Hat Wavelet in QDS.

Alert Criteria

A detection must satisfy one of the following criteria to be deemed interesting and produce an alert:

- The source is previously unknown. Most of these will probably be spurious. These will be added to the source database so they will not show as an unknown source again.
- The source is brighter than ever by a certain factor i.e. the flux is great enough compared to the maximum flux in the source's history on that frequency.
- The source is brighter than the previous, recent enough observation on that frequency. This criterion is triggered when there is a steep rise in the flux of the source.
- The source has an inverted spectrum. Generally this means that the spectral index between two frequencies is larger than a given threshold.

2.5.6 Multifrequency Observing Campaigns

Project Team Tornikoski, Lähteenmäki, Torniainen, Hovatta, Nieppola, Kotiranta, Turunen

We took part in several multifrequency campaigns in 2006, and did individual observing requests as usual. Typically we support the campaign with daily observations, and continue regular monitoring also before and after the core campaign.

0716+714 & 0836+710 Monitoring of 0716+714 and 0836+710 was continued regularly. In addition there was a Suzaku campaign of 0836+710 in March.

0235+164 The source started brightening in December, and was intensively monitored also by us.

3C 279 There were WEBT, Integral, Chandra and SWIFT observations of 3C 279 in January and February. We are also keeping an eye on 3C 279 for MAGIC (Elina Lindfors, Tuorla Observatory), in case it starts brightening at 37 GHz.

3C 454.3 We supported WEBT and XMM-Newton observations of 3C 454.3 in July and December, and also Spitzer and Chandra observations in December, along with 3C 273 and 3C 279.

PKS1510-089 Suzaku observed PKS1510-089 in August.

4C 38.41 4C 38.41 has been the target of intensive VLBA and GMVA observations since its major mm flare in 2002. In 2006 we continued to observe it, particularly during the VLBA sessions.

OJ 287 There will be extensive multifrequency campaigns of OJ 287 in 2006 and 2007, trying to catch the predicted outburst(s). We will be taking part in the campaigns and are monitoring this source frequently, along with the optical observatories, and, for example, XMM-Newton (November).

MARK 421 In June we participated in a SWIFT, RXTE, and Integral campaign on MARK 421.

Cyg X-3 Cyg X-3, a microquasar, started brightening in May, and we supported the multiwavelength campaign that followed. The source was triggered again in July.

BL Lac BL Lac is also on our MAGIC source list. Our data were recently used in a publication related to the discovery of BL Lac at TeV energies by MAGIC.

VERITAS cooperation Merja Tornikoski and Anne Lähteenmäki were invited to join the VERITAS Collaboration as Associate Members. We are observing a handful of sources for VERITAS Blazar Science Working Group multiwavelength campaigns (1ES2344+514, 1ES1959+650, MARK 421, H1426+428, and MARK 501) and support also VERITAS Target of Opportunity campaigns.

Others & requests We monitor a list of sources for Prof. Alan Marscher (Boston University, USA), in connection with VLBA monitoring programme. We also frequently observe sources according to special requests from observatories and researchers from around the world.

2.5.7 RATAN-600 Collaboration

Project team: Tornikoski, Lähteenmäki, Torniainen, Nieppola, Hovatta, Valtaoja (Turku)

We have continued our collaboration with the Russian RATAN–600 team for multifrequency, multi-epoch observations of inverted-spectrum sources and BL Lacertae Objects. The observations at RATAN–600 are made between the frequency bands 1 and 22 GHz, and we complement them with 37 GHz data from Metsähovi (semi-simultaneous data and also some longer term flux history).

In this project we want to determine the true shape of the continuum spectrum of these sources in different variability stages, and we also want to study their general variability behaviour. The project is part of our preparatory work for the Planck satellite foreground science.

2.5.8 The Eighth ENIGMA Meeting in Otaniemi 6.-8.9.2006

The Metsähovi AGN team organised the eighth – and the very last! – meeting of the EU-funded ENIGMA network (European Network for the Investigation of Galactic nuclei through Multifrequency Analysis). We hosted the meeting in Otaniemi at the Dipoli conference facilities. It was a three-day meeting, with two full and one half day of scientific talks. One afternoon and evening were reserved for visiting the Metsähovi research facilities (the Metsähovi Radio Observatory and the Geodetic Institute), after which there was a tour, a music & light performance "Storm Oratorio" and a conference dinner at the Tytyri limestone mine in Lohja.

Figure 13: The conference participants gathering at the venue on the first morning.

The ENIGMA funding period ended in October 2006, so this was the last meeting of the network in its current form, and a very nice opportunity to wrap up the science achieved during the four-year funding period. With this meeting, we said goodbye to the ENIGMA PhD students and postdocs that we had collaborated with during these years, but hoping to see them again soon in other scientific meetings.

Figure 14: Conference participants.

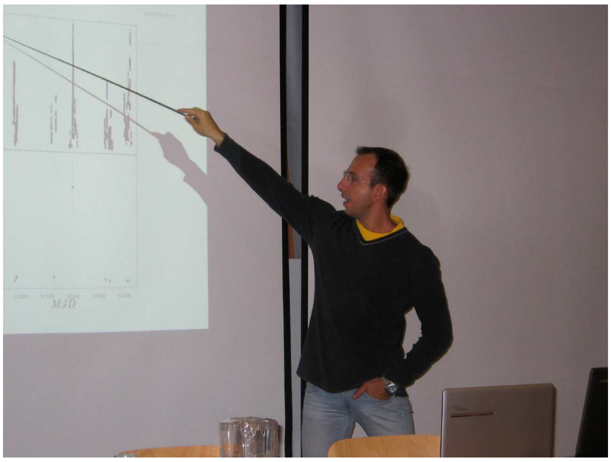


Figure 15: Dimitrios Emmanoulopoulos giving his talk

Figure 16: Metsähovi student Talvikki Hovatta giving her talk

Figure 17: An informal gettogether in the first evening.
On the left: Anne Lähteenmäki from Metsähovi, on the right Stefan Wagner from Heidelberg (he was the Coordinator of the ENIGMA network).

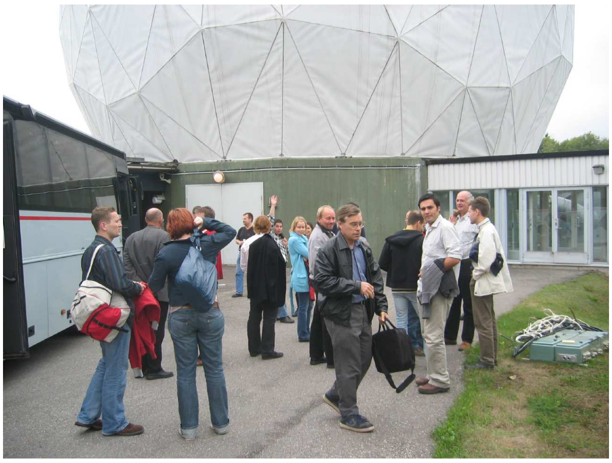


Figure 18: Visit to Metsähovi.

Figure 19: Down to the pit of the Tytyri mine...

Figure 20: Conference dinner at 110 metres below the sea level!

Figure 21: Entertainers from the Polytech Choir. (Second from the right, a Metsähovi staff member Ari Mujunen.)

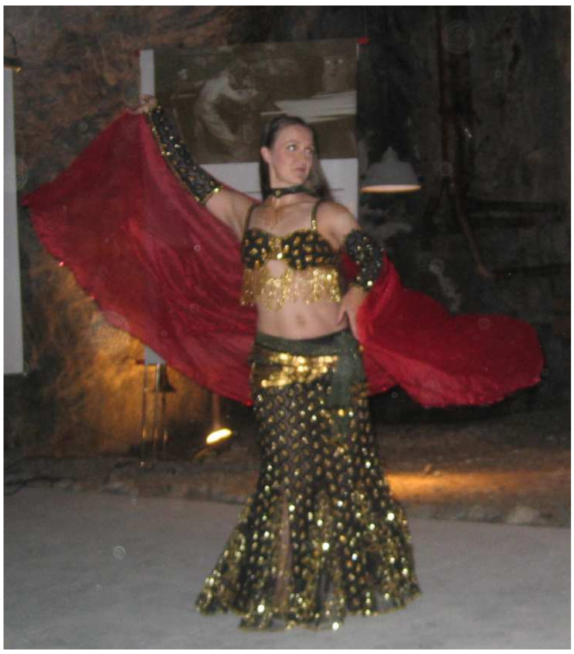


Figure 22: Metsähovi students are really multitalented!
(A student from the AGN team and a professional teacher of belly dancing Ilona Torniainen.)

2.6 Solar Observations

Project Team: Tornikoski, Riehokainen (Turku)

In 2006 we continued to use the 37 GHz frequency band for observing Solar maps during the summer months. Solar radio flares observed during earlier observing epochs (during higher activity) were studied in detail in order to model interacting coronal magnetic loops with our Russian collaborators.

Additionally, the small (1.8-metre) telescope was used for continuous monitoring of the whole Solar disk at 11.7 GHz.

2.7 Recreational events & keeping fit

During the last few years, we have put special emphasis on encouraging the Metsähovi staff to take care of their physical well-being. Long hours of office work too easily takes its toll on the body!

In 2006 our main physical activities at Metsähovi were offered in the form of exercise given by our PhD student and trained aerobics & belly dance instructor Ilona Torniainen. Twice a week she organised a short "coffee-break stretching session", to which the staff members eagerly participated. During the summer months she also offered a more thourough after-hours aerobics class once a week in the Metsähovi backyard lawn, and even though the number of participants there was not quite as high, everybody that attended was very happy with the "blood & sweat & tears"-sessions.

This year we had no formal recreational outing mainly due to severe schedule constraints. Instead we organised a "pre-midsummer barbeque" during which we first discussed our research and technical activities with the whole staff in a relatively leisurely manner out in the backyard, and then had a barbeque party.

The traditional Metsähovi Christmas Porridge party was given on December 20th. This year's speciality was the extra meal offered after the traditional Christmas sauna: our new staff member Guifré prepared us wonderfully delicious paellas, using a secret receipe from his home village in Catalonia...

Figure 23: The staff is seated for the Christmas porridge

Figure 24: The "juniors" were forced to be our official elves...

Figure 25: The happy Chef and the paella to die for

3 Publications

3.1 International Journals

1 Witasse, O., Lebreton, J-P., Bird, M.K., Dutta-Roy, R., Folkner, W.M., Preston, R.A., Asmar, S.W., Gurvits, L.I., Pogrebenko, S.V., Avruch, I.M., Campbell, R.M., Bignall, H.E., Garret, M.A., van Langevelde, H.J., Parsley, S.M., Reynolds, C., Szomoru, A., Reynolds, J.E., Phillips, C.J., Sault, R.J., Tzioumis, A.K., Ghigo, F., Langston, G., Brisken, W., Romney, J.D., Mujunen, A., Ritakari, J., Tingay, S.J., Dodson, R.D., vanŠt Klooster, C.G.M., Blancquaert, T., Coustenis, A., Gendron, E., Hirtzig, M., Sicardy, B., Luz, D., Negrao, A., Kostiuk, T., Livengood, T.A., Hartung, M., de Pater, I., Adamkovics, M., Lorenz, R.D., Roe, H., Schaller, E., Brown, M., Bouchez, A.H., Trujillo, C.A., Buratti, B.J., Caillault, L., Magin, T., Bourdon, A., Laux, C.: Overview of the coordinated ground-based observations of Titan during the Huygens mission. Journal of Geophysical Research & Planets, Vol. 111, 2006.

2 Villata, M., Raiteri, C.M., Balonek, T.J., Aller, M.F., Jorstad, S.G., Kurtanidze, O.M., Nicastro, F., Nilsson, K., Aller, H.D., Arai, A., Arkharov, A., Bach, U., Benitez, E., Berdyugin, A., Buemi, C.S., Böttcher, M., Carosati, D., Casas, R., Caulet, A., Chen, W.P., Chiang, P-S., Chou, T., Ciprini, S., Coloma, J.M., Di Rico, G., Diaz Lopez, C., Efimova, N.V., Forsyth, C. Frasca, A., Fuhrmann, L., Gadway, B., Gupta, S., Hagen-Thorn, V.A., Harvey, J., Heidt, H., Hernandez-Toledo, H., Hroch, F., Hu, C-P., Katskay, E., Kotaka, D., Kovalev, Y.Y., Kovalev, Yu. A., Kubota, K., Kurosaki, M., Lanteri, L., Larionov, V.M., Larionova, L., Laurikainen, E., Lee, C-U., Leto, P., Lopez,-Cruz, O., Lähteenmäki, A., Marilli, E., Marscher, A.P., McHardy, I.M., Mondal, S., Mullan, B., Napoleone, N., Nikolashvili, M.G., Ohlert, J.M., Postnikov, S., Pursimo, T., Ragni, M., Ros, J.A., Sadakane, K., Sadun, A.C., Savolainen, T., Sergeeva, E., Sigua, L.A., Sillanpää, A., Sixtova, L., Takalo, L.O., Teräsranta, H., Tornikoski, M., Trigilio, C., Umana, G., Volvach, A., Voss, B., Wortel, S.: The unprecedented optical outburst of the quasar 3C 454.3. The WEBT campaign of 2004-2005. Astronomy and Astrophysics, Vol. 453, pp. 817-822, 2006.

3 Savolainen, T., Wiik, K., Valtaoja, E., Tornikoski, M.: Multifrequency VLBA Monitoring of 3C273 during INTEGRAL Campaign in 2003. I. Kinematics of the parsec scale jet from 43

GHz data. Astronomy and Astrophysics, Vol. 446, pp. 71-85, 2006.

4 Nieppola, E., Tornikoski, M., Valtaoja, E.: Spectral energy distributions of a complete sample of BL Lacertae objects. Astronomy and Astrophysics, Vol. 445, pp. 441-450. 2006.

5 Kislyakov, A.G., Zaitsev, V.V., Stepanov, A.V., Urpo, S.: On the possible connection between photospheric 5-min oscillation and solar flare microwave emission. Solar Physics, Vol. 233, pp.89-106, 2006.

6 Khodachenko, M.L., Rucker, H.O., Kislyakov, A.G., Zaitsev, V.V., Urpo, S.: Electrodynamic processes in solar magnetic loops and their relation to the low-frequency modulaitons of solar microwave emissions. Central European Astrophysical Bulletin, Vol. 30, pp. 97-112, 2006.

7 Pian, E., Foschini, L., Beckmann, V., Soldi, S., Türler, M., Gehrels, N., Ghisellini, G., Giommi, P., Maraschi, L., Pursimo, T., Raiteri, C.M., Tagliaferri, G., Tornikoski, M., Tosti, G., Treves, A., Villata, M., Barr, P., Courvoisier, T.J-L., Di Cocco, G., Hudec, R., Fuhrmann, L., Malaguti, G., Persic, M., Tavecchio, F., Walter, R.: INTEGRAL observations of the blazar 3C 454.3 in outburst. Astronomy and Astrophysics, Vol. 449, pp.L21-L25, 2006.

8 Türler, M., Chernyakova, M., Courvoisier, T.J.-L., Foellmi, C., Aller, M.F., Aller, H.D., Kraus, A., Krichbaum, T.P., Lähteenmäki, A., Marscher, A., McHardy, I.M., OŠBrien, P.T., Page, K.L., Popescu, L., Robson, E.I., Tornikoski, M., Ungerechts, H.: A historic jet-emission minimum reveals hidden spectral features in 3C273. Astronomy and Astrophysics, Vol. 451, pp. L1-L4, 2006.

9 Ostorero, L., Wagner, S.J., Gracia, J., Ferrero, E., Krichbaum, T.P., Britzen, S., Witzel, A., Nilsson, K., Villata, M., Bach, U., Barnaby, D., Bernhart, S., Carini, M.T., Chen, C.W., Chen, W.P., Ciprini, S., Crapanzano, S., Doroshenko, V., Efimova, N.V., Emmanoulopoulos, D., Fuhrmann, L., Gabanyi, K., Giltinan, A., Hagen-Thorn, V., Hauser, M., Heidt, J., Hojaev, A.S., Hovatta, T., Hroch, F., Ibrahimov, M., Impellizzeri, V., Ivanidze, R.Z., Kachel, D., Kraus, A., Kurtanidze, O., Lähteenmäki, A., Lanteri, L., Larionov, V.M., Lin, Z.Y., Lindfors, E., Munz, F., Nikolashvili, M.G., Nucciarelli, G., O'Connor, A., Ohlert, J., Pasanen, M., Pullen, C., Raiteri, C.M., Rector, T.A., Robb, R., Sigua, L.A., Sillanpää, A., Sixtova, L., Smith, N., Strub, P., Takahashi, S., Takalo, L.O., Tapken, C., Tartar, J., Tornikoski, M., Tosti, G., Tröller, M., Walters, R., Wilking, B.A., Wills, W., Agudo, I., Aller, H.D., Aller, M.F., Angelakis, E., Klare, J., Körding, E.: Testing the inverse-Compton catastrophe scenario in the intra-day variable blazar S5 0716+71. Astronomy and Astrophysics, Vol. 451, pp. 797-807, 2006.

10 Molera Calvés, G., Mujunen, A., Ritakari, J., Wagner, J.: First 10 Gbps installed at Metsähovi Radio Observatory. European VLBI Network, Newsletter Number 15, http://www.ira.inaf.it/evnnews, 2006.

11 Sambruna, R.M., Markwardt, C.B., Mushotzky, R.F., Tueller, J., Hartman, R., Brandt, W.N., Schneider, D.P., Falcone, A., Cucchiara, A., Aller, M.F., Aller, H.D., Torniainen, I., Tavecchio, F., Maraschi, L., Gliozzi, M., Takahashi, T.: Discovery of an Extreme MeV Blazar with the Swift Burst Alert Telescope., The Astrophysical Journal, Vol. 646, pp.23-25, 2006.

12 Savolainen, T., Wiik, K., Valtaoja, E., Kadler, M., Ros, E., Tornikoski, M., Aller, M.F., Aller, H.D.: An extremely curved relativistic jet in PKS 2136+141. The Astrophysical Journal, Vol. 647, pp. 172-184, 2006.

13 Raiteri, C.M.; Villata, M.; Kadler, M.; Ibrahimov, M.A.; Kurtanidze, O.M.; Larionov, V.M.; Tornikoski, M.; Boltwood, P.; Lee, C.-U.; Aller, M.F.; Romero, G.E.; Aller, H.D.; Araudo, A.T.; Arkharov, A.A.; Bach, U.; Barnaby, D.; Berdyugin, A.; Buemi, C.S.; Carini, M.T.; Carosati, D.; Cellone, S.A.; Cool, R.; Dolci, M.; Efimova, N.V.; Fuhrmann, L.; Hagen-Thorn, V.A.; Holcomb, M.; Ilyin, I.; Impellizzeri, V.; Ivanidze, R.Z.; Kapanadze, B.Z.; Kerp, J.; Konstantinova, T.S.; Kovalev, Y.Y.; Kovalev, Yu.A.; Kraus, A.; Krichbaum, T.P.; Lähteenmäki, A.; Lanteri, L.; Leto, P.; Lindfors, E.; Mattox, J.R.; Napoleone, N.; Nikolashvili, M.G.; Nilsson, K.; Ohlert, J.; Papadakis, I.E.; Pasanen, M.; Poteet, C.; Pursimo, T.; Ros, E.; Sigua, L.A.; Smith, S.; Takalo, L.O.; Trigilio, C.; Tröller, M.; Umana, G.; Ungerechts, H.; Walters, R.; Witzel, A.; Xilouris,

E.: Multifrequency variability of the blazar AO 0235+164. The WEBT campaign in 2004-2005 and long-term SED analysis. Astronomy and Astrophysics, Vol 459, pp. 731-743, 2006.

14 Osterman, M.A.; Miller, H.R.; Campbell, A.M.; Marshall, K.; McFarland, J.P.; Aller, H.; Aller, M.; Fried, R. E.; Kurtanidze, O.M.; Nikolashvili, M.G.; Tornikoski, M.; Valtaoja, E.: Multiwavelength Observations of the Extreme X-Ray-selected BL Lacertae Object PG 1553+11 (1ES 1553+113). The Astronomical Journal, Vol.132, pp. 873-882, 2006.

15 Pyatunina, T.B.; Kudryavtseva, N.A.; Gabuzda, D.C.; Jorstad, S.G.; Aller, M.F.; Aller, H.D.; Teräsranta, H.: Frequency-dependent time-delays for strong outbursts in selected blazars from the Metsähovi and the University of Michigan Radio Astronomy Observatory monitoring databases - I. Monthly notices of the Royal Astronomical Society,. Vol. 373, pp. 1470-1482, 2006.

16 Nieppola, E., Tornikoski, M., Lähteenmäki, A., Valtaoja, E., Hakala, T., Hovatta, T., Kotiranta, M., Nummila, S., Ojala, T., Parviainen, M., Ranta, M., Saloranta, P-M., Torniainen, I., Tröller, M.: 37 GHz observations of a large sample of BL Lacertae objects. Astronomy and Astrophysics, submitted 2006.

17 Savolainen, T., Wiik, K., Valtaoja, E., Tornikoski, M.: Multifrequency VLBA monitoring of 3C 273 during INTEGRAL Campaign in 2003. II Extraction of the VLBI component spectra. Astronomy and Astrophysics, submitted, 2006.

18 Torniainen, I., Tornikoski, M., Lähteenmäki, A., Aller, M.F., Aller, H.D., Mingaliev, M.G.: Radio continuum spectra of gigahertz-peaked spectrum galaxies. Astronomy and Astrophysics, submitted, 2006.

19 Villata, M.; Raiteri, C.M.; Aller, M.F.; Bach, U.; Ibrahimov, M.A.; Kovalev, Y.Y.; Kurtanidze, O.M.; Larionov, V.M.; Lee, C.-U.; Leto, P.; Lähteenmäki, A.; Nilsson, K.; Pursimo, T.; Ros, J.A.; Sumitomo, N.; Volvach, A.; Aller, H.D.; Arai, A.; Buemi, C. S.; Coloma, J.M.; Doroshenko, V.T.; Efimov, Yu.S.; Fuhrmann, L.; Hagen-Thorn, V.A.; Kamada, M.; Katsuura, M.; Konstantinova, T.; Kopatskaya, E.; Kotaka, D.; Kovalev, Yu.A.; Kurosaki, M.; Lanteri, L.; Larionova, L.; Mingaliev, M.G.; Mizoguchi, S.; Nakamura, K.; Nikolashvili, M.G.; Nishiyama, S.; Sadakane, K.; Sergeev, S.G.; Sigua, L.A.; Sillanpää, A.; Smart, R.L.; Takalo, L.O.; Tanaka, K.; Tornikoski, M.; Trigilio, C.; Umana, G.: The radio delay of the exceptional 3C 454.3 outburst. Follow-up WEBT observations in 2005-2006. Astronomy and Astrophysics, Vol. 464, pp.L5-L9, 2007.

20 Aguilar, M., Alcaraz, J., Allaby, J., Alpat, B., Ambrosi, G., Anderhub, H., Ao, L., Arefiev, A-. Azzarello, P., Baldini, L., Basile, M., Barancourt, D., Barao, F., Barbier, G., Barreira, G., Battiston, R., Becker, R., Becker, U., Bellagamba, L., Béné, P., Berdugo, J., Berges, P., Bertucci, B., Biland, A., Blasko, S., Boella, G., Boschini, M., Bourquin, M., Brocco, L., Bruni, G., Buénerd, M., Burger, J.D., Burger, W.J., Cai, X.D., Camps, C., Cannarsa, P., Capell, M., Cardano, F., Casadei, D., Casaus, J., Castellini, G., Cecchi, C., Chang, Y.H., Chen, H.F., Chen, H.S., Chen, Z.G., Chernoplekov, N.A., Chiueh, T.H., Cho, K., Choi, M.J., Choi, Y.Y., Cindolo, F., Commichau, V., Contin, A., Cortina-Gil, E., Cristinziani, M., Dai, T.S., Delgado, C., Difalco, S., Djambazov, L., D'Antone, I., Dong, Z.R., Emonet, P., Engelberg, J., Eppling, F.J., Eronen, T., Esposito, G., Extermann, P., Favier, J., Fiandrini, E., Fisher, P.H., Fluegge, G., Fouque, N., Galaktionov, Yu., Gast, H., Gervasi, M., Giusti, P., Grandi, D., Grimms, O.,Gu, W.Q., Hangarter, K., Hasan, A., Hermel, V., Hofer, H., Hungerford, W., Jongmanns, M., Karlamaa, K., Karpinski, W., Kenney, G., Kim, D.H., Kim, G.N., Kim, K.S., Kim, M.Y., Klimentov, A., Kossakowski, R., Kounine, A., Koutsenko, V., Kraeber, M., Laborie, G., Laitinen, T., Lamanna, G., Lanciotti, E., Laurenti, G., Lebedev, A., Lechanoine-Leluc, C., Lee, M.W., Lee, S.C., Levi, G., Liu, C.L., Liu, H.T., Lu. G., Lu, Y.S., Lübelsmeyer, K., Luckey, D., Lustermann, W., Maña, C., Margotti, A., Mayet, E., McNeil, R.R., Meillon, B., Menichelli, M., Mihul, A., Mujunen, A., Oliva, A., Olzem, J., Palmonari, F., Park, H.B., Park, W.H., Pauluzzi, M., Pauss, F., Perrin, E., Pesci, A., Pevsner, A., Pilo, F., Pimenta, M., Plyaskin, V., Pojidaev, V., Pohl, M., Produit, N., Rancoita, P.G., Rapin, D., Raupach, F., Ren, D., Ren, S., Ribordy, M., Richeux, J.P., Riihonen, E., Ritakari, J., Ro, S., Roeser, U., Rossin, C., Sagdeev, R., Santos, D., Sartorelli, G., Sbarra, C., Schael. S., Schultz von Dratzig, A., Schwering, G.,

Seo, E.S., Shin, J.W., Shoutko, V., Shoumilov, E., Siedenburg, T., Siedling, R., Son, D., Song, T., Spinella, F., Steuer, M., Sun, G.S., Suter, H., Tang, X.W., Ting, Samuel C.C., Ting, S.M., Tornikoski, M., Torsti, J., Trümper, J., Ulbricht, J., Urpo, S., Valtonen, E., Vandenhirtz, J., Velikhov, E., Verlaat, B., Vetlitsky, I., Vezzu, F., Vialle, J.P., Viertel, G., Vité, D., von Gunten, H., Waldmeier Wicki, S., Wallraff, W., Wang, B.C., Wang, J.Z., Wiik, K., Williams, C., Wu, S.X., Xia, P.C., Xu, S., Yan, J.L., Yan, L.G., Yang, C.G., Yang, J., Yang, M., Ye, S.W., Yeh, P., Xu, Z.Z., Zhang, H.Y., Zhang, Z.P., Zhao, D.X., Zhu, G.Y., Zhu, W.Z., Zhuang, H.L., Zichichi, A., Zimmermann, D., Zuccon, P.: Cosmic-ray positron fraction measurement from 1 to 30 GeV with AMS-01. Physics Letters B, Vol. 646, pp. 145-154, www.sciencedirect.com, 2007.

21 Hovatta, T., Tornikoski, M., Lainela, M., Lehto, H.J., Valtaoja, E., Torniainen, I., Aller, M.F., Aller, H.D.: Statistical analyses of long-term variability of AGN at high radio frequencies. Astronomy and Astrophysics, submitted, 2007.

3.2 International Conferences

1 Osterman, M.A.; Miller, H.R.; Marshall, K.; Aller, H.; Aller, M.; Fried, R.; Kurtanidze, O.; Tornikoski, M.: Analysis of Simultaneous Observations of the BL Lac Object PG 1553+11 in the Radio, Optical, and X-ray Regimes. Blazar Variability Workshop II: Entering the GLAST Era ASP Conference Series, Vol. 350, Proceedings of the Conference Held 10-12 April, 2005 at Florida International University, Miami, Florida, USA. Eds.: H. R. Miller, K. Marshall, J. R. Webb, and M. F. Aller, p. 18, 2006.

2 Aatrokoski, J., Lähteenmäki, A., Tornikoski, M., Valtaoja, E.: Quick Detection System for Planck satellite. CMB and Physics of the Early Universe, 20-22.4.2006, Ischia, Italy. Proceedings of Science PoS(CMB2006)026, Editors: G. De Zotti et al., 2006.

3 Nieppola, E., Tornikoski, M., Lähteenmäki, A., Valtaoja, E.: 37 GHz observations of a large sample of BL Lacertae objects. CMB and Physics of the Early Universe, 20-22.4.2006, Ischia, Italy. Proceedings of Science PoS(CMB2006)062, Editors: G. De Zotti et al, 2006.

4 Nieppola, E.; Tornikoski, M.; Lähteenmäki, A.; Valtaoja, E.: The research of BL Lacertae objects in Metsähovi Radio Observatory. 8th ENIGMA meeting, Espoo, Finland, September 6-8, 2006, Editors: T. Hovatta, E. Nieppola, I . Torniainen, http://kurp.hut.fi/enigma/Enigma8_proceedings.pdf, 2006.

5 Tornikoski, M.; Lähteenmäki, A.; Valtaoja, E.; Hovatta, T.; Nieppola, E.; Torniainen, I.; Kotiranta, M.; Trushkin, S.: Long Term Monitoring - Why Do We Need It?. 8th ENIGMA meeting, Espoo, Finland, September 6-8, 2006, Editors: T. Hovatta, E. Nieppola, I . Torniainen, http://kurp.hut.fi/enigma/Enigma8_proceedings.pdf, 2006.

6 Hovatta, T.; Tornikoski, M.; Lainela, M.; Valtaoja, E.; Torniainen, I.; Aller, M. F.; Aller, H. D.; Variability time scales from long term monitoring. 8th ENIGMA meeting, Espoo, Finland, September 6-8, 2006, p. E2. Editors: T. Hovatta, E. Nieppola, I . Torniainen, http://kurp.hut.fi/enigma/Enigma8_proceedings.pdf, 2006.

7 Torniainen, I.; Tornikoski, M.; Lähteenmäki, A.; Aller, M. F.; Aller, H. D.; Mingaliev, M. G.: GPS studies during the ENIGMA era. 8th ENIGMA meeting, Espoo, Finland, September 6-8, 2006, Editors: T. Hovatta, E. Nieppola, I . Torniainen, http://kurp.hut.fi/enigma/Enigma8_proceedings.pdf, 2006.

8 Wagner, Jan; Ritakari, Jouko; Mujunen, Ari; Molera, Guifre; Burgess, Paul, Kruithof, Nico, van Langvelde, Huib Jan, Paragi, Zsolt, Lindqvist, Michael, Conway, John: Report on FABRIC Month 7 Demonstration 'eVLBI Fringes with PC-EVN'. http://www.jive.nl/dokuwiki/doku.php/fabric:wp1_scalable_connectivity (section 1.2.3, Broadband Integration and Test, document link "FABRIC Month), 2006.

9 Tornikoski, Merja; Lähteenmäki, Anne; Hovatta, Talvikki; Nieppola, Elina; Torniainen, Elina: Metsähovi AGN projects contributing to the Planck foreground science. IX Russia-Finland Symposium on Radio Astronomy, 15.10-20.10.2006, Nizhnij Arkhyz, Venäjä, p. 33, 2006.

10 Lähteenmäki, Anne; Tornikoski, Merja; Aatrokoski, Juha: Planck - unlocking the secrets of the universe. IX Russia-Finland Symposium on Radio Astronomy, Nizhnij Arkhyz, Venäjä 15.10-20.10.2006, p. 25, 2006.

11 Hovatta, Talvikki; Tornikoski, Merja; Lainela, Markku; Valtaoja, Esko; Torniainen, Ilona; Aller, M.F.; Aller, H.D. Long term radio time scales of Active Galactic Nuclei. IX Russia-Finland Symposium on Radio Astronomy, Nizhnij Arkhyz, Venäjä, 15.10-20.10.2006. p. 21, 2006.

12 Torniainen, I.; Tornikoski, M.; Aller, M., Aller, H., Mingaliev, M.: Radio spectra of GPS galaxies. IX Russia-Finland Symposium on Radio Astronomy, Nizhnij Arkhyz, Venäjä, 15.10-20.10.2006, p. 32, 2006.

13 Lähteenmäki, A., Tornikoski, M., Hovatta, T., Valtaoja, E.: Total flux density radio observations as a tool for understanding AGN jets. 5th Stromlo symposium, Disks, winds & Jets from Planets to Quasars, Canberra, Australia, 3-8.12.2006.

14 Tornikoski, M., Lähteenmäki, A., Valtaoja, E., Hovatta, T., Nieppola, E., Torniainen, I., Kotiranta, M., Trushkin, S.: Long term radio monitoring - why do we need it?. Proceedings of the 8th ENIGMA meeting, Espoo, Finland, September 6-8, 2006, editors: Hovatta, T., Nieppola, E., Torniainen, I., http://kurp.hut.fi/enigma/, 2006.

15 Tornikoski M., Lähteenmäki A., Hovatta T., Nieppola E., Torniainen I., Valtaoja E.: Metsähovi AGN projects contributing to the Planck foreground science. Abstracts of the IX Russia-Finland Symposium on Radio Astronomy: Multi-Wavelength Investigations of Solar and Stellar Activity and Active Galactic Nuclei, Nizhnij Arkhyz, Karachaevo-Cherkesia, Russia, October 15-20, 2006. http://cats.sao.ru/ satr/RFSymp/, 2006.

16 Nieppola E., Tornikoski M., Lähteenmäki A., Valtaoja E.: "Spectral energy distributions and 37 GHz monitoring of BL Lacertae objects", Abstracts of the IX Russia-Finland Symposium on Radio Astronomy: Multi-Wavelength Investigations of Solar and Stellar Activity and Active Galactic Nuclei, Nizhnij Arkhyz, Karachaevo-Cherkesia, Russia, October 15-20, 2006. http://cats.sao.ru/ satr/RFSymp/, 2006.

17 Wagner, J.: Developments in real-time eVLBI in the EVN and at Metsähovi. XXXXVI Young European Radio Astronomer's Conference (YERAC),Westerbork, The Netherlands, September 11-16, 2006, http://www.astron.nl/wsrt/YeracTalks.mht, 2006.

3.3 National Conferences

1 Lähteenmäki, A.: Helsinki Testbed - säätietojen käyttö Metsähovin radiotutkimusasemalla. Talk at the Helsinki Testbed Workshop (http://testbed.fmi.fi/Meetings/HTBworkshop20060406/), Helsinki, Finland, 6.4.2006

3.4 Laboratory Reports

1 Tornikoski, M., Mujunen, A., Hurtta, S. (editors): Metsähovi Radio Observatory Annual Report 2005. Metsähovi Reports HUT-KURP-32, 30 p., 2006

3.5 Other Publications

1 Lichti, G. G., Neronov, A., Mowlavi, N., Ajello, M., Beckmann, V., Boisson, C., Buckley, J., Charlot, P., Collmar, W., Degrange, B., Djannati-Atai, A., Falcone, A., Finley, J., Fossati, G., Henri, G., Katarzynski, K., Kieda, D., Lähteemäki, A., Mannheim, K., Marcowith, A., Punch, M., Saggione,ă A., Sauge, L., Schoenfelder, V., Sillanpää, A., Smith, D., Sol, H., Tavecchio, F., Takalo, L., Tornikoski, M., Kienlin, A. Von, Weekes, T.: High state of Mkn 421 in the hard X-rays, The Astronomer's Telegram, #840, 2006.

2 Lichti, G. G.; Paltani, S.; Mowlavi, M.; Ajello, M.; Collmar, W.; Kienlin, A. Von; Beckmann, V.; Boisson, C.; Sol, H.; Buckley, J.; Charlot, P.; Degrange, B.; Djannati-Atai, A.; Punch, M.; Falcone, A.; Finley, J.; Fossati, G.; Henri, G.; Sauge, L.; Katarzynski, K.; Kieda, D.; Lähteenmäki, A.; Tornikoski, M.; Mannheim, K.; Marcowith, A.; Saggione, A.; Sillanpää, A.; Takalo, L.; Smith, D.; Weekes, T.: Integral observation of flaring activity of Mark 421. The Astronomer's Telegram.#848, 2006.

3 Hovatta, T., Nieppola, E., Torniainen, I., editors. Proceedings of the 8th ENIGMA meeting, Espoo, Finland, Sep 6-8, 2006, www.kurp.hut.fi/enigma, 2006.

4 Visits to Foreign Institutes

ESA Headquarters, Paris, France, 12.-13.1.2006, M. Tornikoski

ESO Headquarters, Garching, Germany, 2.-4.4.2006, M. Tornikoski

ESTEC, Noordwijk, Netherlands, 6.-7.4.2006, M. Tornikoski

Observatoire de Paris, Paris, France, 28.-29.9.2006, M. Tornikoski

Pulkovo Observatory, St. Petersburg, Russia, 14.-15.10.2006, 20.-21.10.2006, M. Tornikoski, A. Lähteenmäki, I. Torniainen, E. Nieppola, T. Hovatta

Special Astrophysical Observatory RAS, Nizhnij Arkhyz, Russia, including visits to the RATAN-600 radio telescope and the 6-metre optical telescope BTA, 15.-19.10.2006, M. Tornikoski, A. Lähteenmäki, I. Torniainen, E. Nieppola, T. Hovatta

Visit to the Kislovodsk Solar Observatory (Northern Caucasus, Russia), 20.10.2006. M. Tornikoski, A. Lähteenmäki, I. Torniainen, E. Nieppola, T. Hovatta

Visit to the Evpatoria station, Ukraina, 1-5.8.2006, A. Mujunen, J. Wagner

Figure 26: Evpatoria station

Figure 27: Irbene station

Visit to the Irbene station, Latvia, 12-15.11.2006, A. Mujunen, J. Wagner

Visit to National Institute for Astrophysics, Trieste, Italia, October 8-14,2006, J. Aatrokoski

4.1 Visit to astronomical facilities in St. Petersburg and Caucasus

In October the Metsähovi AGN team attended the IX Russian-Finnish Radio Astronomy Symposium in Nizhnij Arkhyz, and also got the chance to visit several astronomical facilities.

Figure 28: At the Pulkovo Observatory in St. Petersburg.
From left to right M. Tornikoski, A. Riehokainen (Tuorla), prof. A. Stepanov (director of the Pulkovo Observatory), E. Valtaoja (Tuorla).

Figure 29: The hospitality of our hosts was overwhelming, and our team got superb meals every day. (Metsähovi students T. Hovatta and I. Torniainen.)

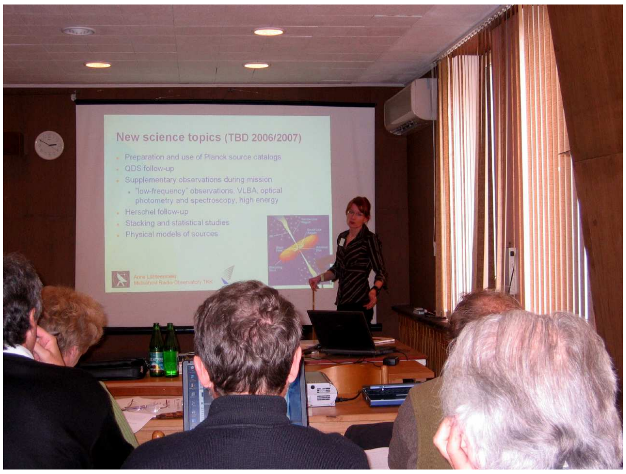


Figure 30: A. Lähteenmäki (Metsähovi) giving a talk at the symposium.

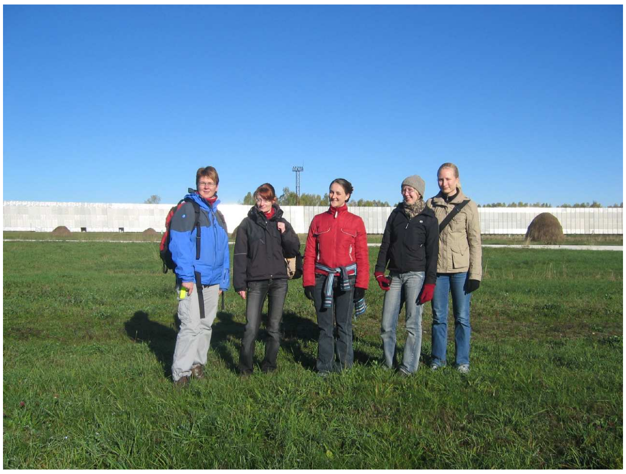


Figure 31: The Metsähovi team at RATAN.

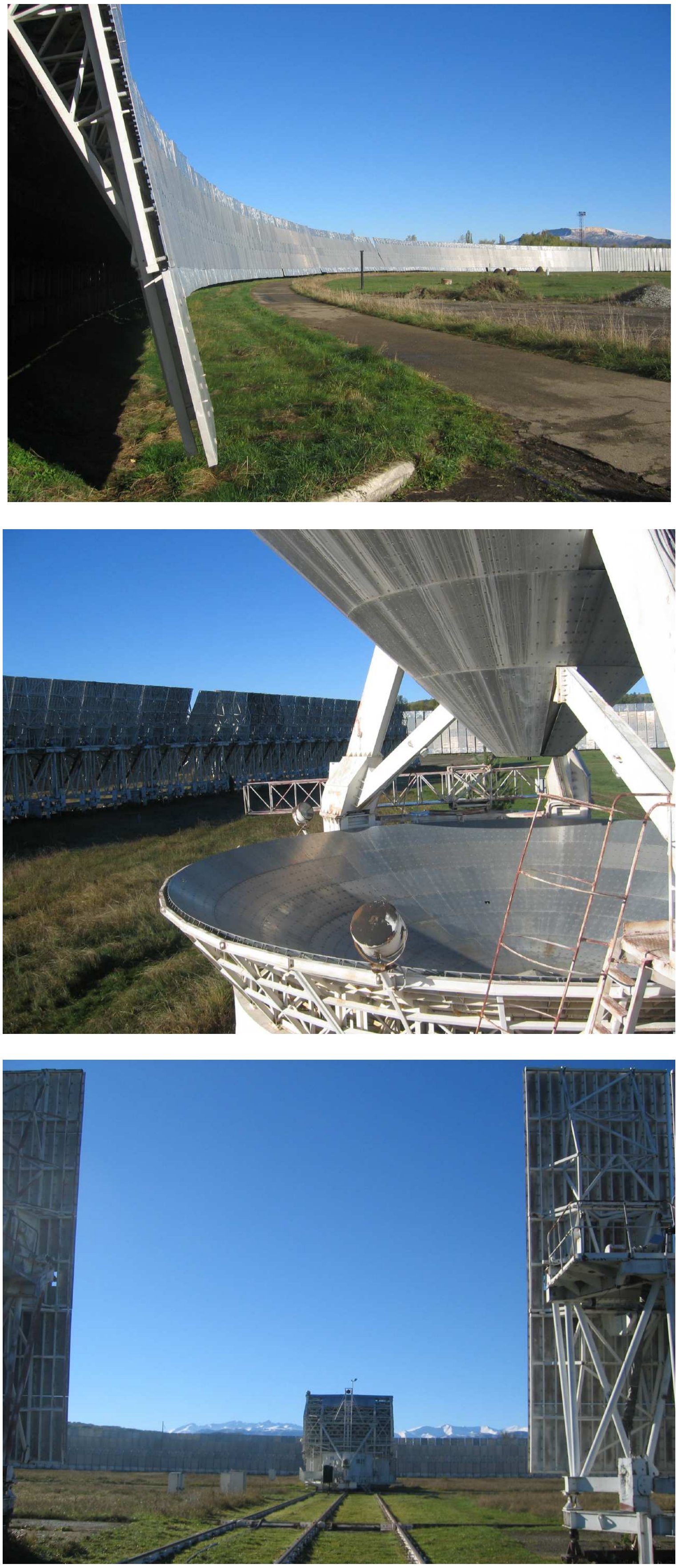


Figure 32: The RATAN-600 telescope.

Figure 33: A barbeque picnic in the mountains. Dr. M. Mingaliev (SAO RAS) gives a toast, on the left prof. Yu Parijskij (SAO RAS).

Figure 34: Visit to the Kislovodsk Solar Observatory in Northern Caucasus.

Figure 35: Group photograph in front of the giant (6-m) optical telescope. It was snowing during our visit!

5 Visiting Scientists

Vyacheslav, Vdovin, Dr., Institute of Applied Physics, Russian Academy of Sciences, Russia
Oleg Bolshakov, Institute of Applied Physics, Russian Academy of Science, Russia
Alexander Shtanyuk, Institute of Applied Physics, Russian Academy of Science, Russia
N. Demidov, Dr., Institute of Electronic Measurements KVARZ, Russia
Marscher, Alan, Prof., Boston University, USA
Stepanov, Alexander, Prof., Pulkovo Observatory, Russia
Mingaliev, Marat, Dr., Special Astrophysical Observatory, Russia

7.9.2006 The participants of the 8th ENIGMA meeting (31 scientists and PhD students mostly from European countries) visited Metsähovi and the Geodetic Institute.

6 Thesis

Aatrokoski, Juha M.Sc. (Tech) thesis: QDS: Software For Point Source Extraction From Planck Satellite Data. Helsinki University of Technology, Department of Computer Science and Engineering, supervised by A. Lähteenmäki, 2006.

7 Teaching

Radio Astronomy course, autumn 2006, M. Tornikoski, A. Lähteenmäki, I. Torniainen

"Planck –unlocking the secrets of the Universe seminar" talk in Helsinki University Observatory, 15.11.2006, A. Lähteenmäki

Radio Astronomy laboratory exercise for space technology students, spring 2006, I. Torniainen

8 Other Activities

Planck satellite Co-Investigator, Planck Scientist, A. Lähteenmäki

Academy of Finland Research Fellow 1.8.2005 — 31.7.2010, A. Lähteenmäki

"Planck –unlocking the secrets of the Universe" Outstanding Junior Research Group of Helsinki University of Technology for the academic years 2006 — 2007 and 2007 — 2008, A. Lähteenmäki

Referee for Monthly Notices of the Royal Astronomical Society, M. Tornikoski

Referee for Global Millimetre-VLBI Array (GMVA) observing proposals, M. Tornikoski

Associate member of the Very Energetic Radiation Imaging Telescope Array System (VERITAS) collaboration, A. Lähteenmäki, M. Tornikoski

Chairman of the local organising committee and the scientific organising committee of the 8th ENIGMA meeting, M. Tornikoski

Local coordinator for the EC research training network ENIGMA ("European Network for the Investigation of Galactic nuclei through Multifrequency Analysis"), M. Tornikoski

Member of the American Astronomical Society (AAS), M. Tornikoski

8.1 Participation in Boards and Committees

Member of the Astronomy Working Group (AWG) of the European Space Agency (ESA), M. Tornikoski

Steering group member of the Academy of Finland graduate school of astronomy and space physics, A. Lähteenmäki

Member of the Planck/TEKES 70 GHz instrument steering group, A. Lähteenmäki

Member of the scientific organising committee of the IX Russian-Finnish Symposium on Radio Astronomy: "Multi-Wavelength Investigations of Solar and Stellar Activity and Active Galactic Nuclei", held in Nizhnij-Arkhyz, 15.-20.10.2006, M. Tornikoski

Member of the EXPReS eVLBI Science Advisory Group, A. Lähteenmäki

Finland's delegate to the Scientific Comission J (Radio Astronomy) of the International Union of Radio Science (URSI), M. Tornikoski

Local coordinator for the EC research training network ENIGMA (European Network for the Investigation of Galactic Nuclei through Multifrequency Analysis), M. Tornikoski

Member of the Finnish Astronomical Advisory Group for the ESO project "Development of distributed data analysis system for extensive astronomical data", a.k.a Sampo, M. Tornikoski

Member of the TEKES steering group for the Sampo project for ESO, M. Tornikoski

Finland's representative to the ESO Users Committee, M. Tornikoski

Member of the board, secretary, of Finnish Astronomical Society, I. Torniainen

Secretary of the organising committee of "Tähtitieteilijäpäivät 2006", May 19, 2006, University of Helsinki), I. Torniainen

Member of the ESF:n Committee for Radio Astronomy Frequencies, Jouko Ritakari

EXPReS Consortium Board, chairman, A. Mujunen

Member of the local and scientific organizing committees of the 8th ENIGMA meeting, Espoo, Finland, 6 — 8.9.2006, Anne Lähteenmäki, Ilona Torniainen , Elina Nieppola, Talvikki Hovatta

Member of the scientific organising committee of the IX Russian-Finnish Symposium on Radio Astronomy: "Multi-Wavelength Investigations of Solar and Stellar Activity and Active Galactic Nuclei", held in Nizhnij-Arkhyz, 15.-20.10.2006, M. Tornikoski

8.2 International Meetings and Talks

ESA AWG meeting#124, 12.-13.1.2006 ESA Headquarters, Paris, France, M. Tornikoski

ESO UC meeting, ESO Headquartersm Garching, Germany, 2.-4.4.2006, M. Tornikoski

ESA AWG meeting#125, 6.-7.4.2006, ESTEC, Noordwijk, Netherlands, M. Tornikoski

Planck LFI/HFI Consortia Meeting in Ischia, Italy, 18 — 20.4.2006, A. Lähteenmäki, M Tornikoski, J. Aatrokoski. Poster "37 GHz observations of a large sample of BL Lacertae objects", J. Aatrokoski, Poster "Quick Detection System for Planck satellite", M. Tornikoski talk "High-frequency radio observations of AGNs: Source samples, continuum spectra & variability statistics"

The 7th ENIGMA meeting, Hydra, Greece, 8 — 19.5.2006, A. Lähteenmäki, M.Tornikoski

Planck Science Team meeting, Frascati, Italy 11.7.2006, A. Lähteenmäki

The 8th ENIGMA meeting, Espoo, Finland, 6.—8.9.2006, M. Tornikoski, A. Lähteenmäki, I. Torniainen, E. Nieppola, T. Hovatta.
M. Tornikoski talk: “Long term radio monitoring – Why do we need it?”, I. Torniainen talk: “GPS studies during ENIGMA era”, T. Hovatta talk: “Variability time scales from long term monitoring”, E. Nieppola, chairman of a session and talk: “Spectral energy distributions and 37 GHz monitoring of BL Lacertae objects”

ESA AWG meeting#126, 28.-29.9. Observatoire de Paris, Paris, France, M. Tornikoski

The IX Russian-Finnish Symposium on Radio Astronomy, Multi-wavelength Investigations of Solar and Stellar Activity and Active Galactic Nuclei, Nizhnij Arkhyz, Karachaevo-Cherkesia, Russia, 15 — 20.10.2006, M. Tornikoski, A. Lähteenmäki, I. Torniainen, E. Nieppola, T. Hovatta.
M. Tornikoski talk “Metsähovi AGN projects contributing to the Planck foreground science” & chairman of the session “Extragalactic Sources”. A. Lähteenmäki talk ”Planck –unlocking the secrets of the universe‘t’, T. Hovatta talk “Long term radio time scales of Active Galactic Nuclei”, I. Torniainen talk “Radio spectra of GPS galaxies”, E, Nieppola talk ”Spectral energy distributions and 37 GHz monitoring of BL Lacertae objects”

Fifth Stromlo Symposium “Disks, winds & jets –from planets to quasars”, Canberra, Australia, 3 — 8.12.2006, A. Lähteenmäki, Talk “Total flux density radio observations as a tool for understanding AGN jets”

AMS technical interchange meeting, CERN, Geneve, Switzerland, 23-28.4.2006, G. Molera Calves

AMS technical interchange meeting, CERN, Geneve,Switzerland, 23-28.7.2006, G. Molera Calves

EU EXPReS-FGP kick off meeting and EVN TOG kokous, Dwingeloo, The Netherlands, 22-24.3.2006, A. Mujunen, J. Ritakari

European VLBI Network (EVN) Consortium Board of Directors Meeting, Firenze, Italy, 17-20.5.2006, A. Mujunen

VSOP-2/ASTRO-G kick-off meeting, Dwingeloo, The Netherlands, 15.6.2006, A. Mujunen

EXPReS planning meeting, Dwingeloo, The Netherlands, 16.6.2006, A. Mujunen

MIT Haystack Observatorio, e-VLBI workshop, Westford, MA, USA, 16.9-21.9.2006, A. Mujunen, J. Ritakari

EU FP6 EXPRes project Board Meeting, Zaandam, The Netherlands, 1.11-2.11.2006, A. Mujunen konferenssin tai sen ohjelma- tai järjestelytoimikunnan puheenjohtajuus.

EVN Consortium Board of Directors Meeting, Dwingeloo, The Netherlands, 28.11-1.12.2006, A. Mujunen

AMS-02 consortium Financial Review Committee meeting, CERN Geneve, Switzerland, 20.11-21.11.2006, A. Mujunen

EU/EXPReS Fabric meeting, Poznan, Poland, 24.9-26.9.2006, A. Mujunen

eVLBI bits and bytes meeting, ESLEA protocol group meeting, UCL, Lontoo 2.5-5.5.2006, J. Ritakari

eVLBI bits and bytes meeting, Fabric get-together meeting, Manchester, UK, 31.8-1.9.2006, J. Ritakari

EVN technical operations group, Noto, Italy, 2.12-6.12.2006, J. Ritakari

Eslea, Expres and Fabric meeting, Manchester, UK, 7.12-9.12.2006, J. Ritakari

8.3 National Meetings and Talks

Helsinki Testbed Workshop, Finnish Meteorological Institute, Helsinki, 6.4.2006, A. Lähteenmäki, Talk Using the Helsinki Testbed weather data in Metsähovi.

Lähteenmäki, A.: Planck - unlocking the secrets of the Universe. Suomen Tähtitieteilijäseuran Tähtitieteilijäpäivät (Annual meeting of the Finnish Astronomical Society), Helsinki, Finland, 19.5.2006

Molera, Guifré: AMS-02 and eVLBI other involving of Metsähovi to the space, Helsinki, Finland, 19.5.2006.

8.4 Participation in winter and summer schools

Summer school of the Finnish Graduate School in Astronomy and Space Physics, Helsinki, June 5-9, 2006, E. Nieppola, I. Torniainen, T. Hovatta.

Fifth IRAM Millimeter Interferometry School, Grenoble, France, October 2-6, 2006, E. Nieppola, T. Hovatta.

8.5 Public Relations

Newspaper Helsingin Sanomat, Science section, 23.8.2006, "Suomen kallein radio valmis avaruuteen" ("Finland's most expensive radio ready for space").

Electronic Journal Digitoday.fi 30.8.2006, "Metsähovi kiitää 10 gigabitin sekuntivauhdilla" ("Metsähovi speeds at 10 gbit/s").

Journal Mikro-PC 9/2006, "Nyt rakennetaan hybridiverkkoja" ("Hybrid nets are hot"), Metsähovi is shown as an example of one of the large data producers, and the Metsähovi Gbit connection and data transfer are described.

Journal CSC News 3/2006 "Finnish radio astronomers first in world with ten-gigabit connection"

Newspaper Kirkkonummen sanomat 1.9.2006, "Metsähovi taas nopein" ("Metsähovi fastest once again"), about the 10 Gbit fiber connection.

Newsletter TKK Nyt 31.8.2006, "Metsähovi ensimmäisenä Funetissa uuteen nopeusluokkaan" ("Metsähovi first in Funet to reach new speed levels").

Newspaper Helsingin Sanomat, Science Section, 15.11.2006 "Avaruuden tutkijat kokoavat maailmankaikkeuden palapeliä" ("Space researchers are putting together the pieces of the cosmic puzzle"), a full page article about Planck, including interview with M. Tornikoski and A. Lähteenmäki.

General Metsähovi excursions and short talks about radio astronomical research to many visiting groups, M. Tornikoski, J. Ritakari, A. Mujunen, I. Torniainen, A. Lähteenmäki, E. Oinaskallio, T. Hovatta.

9 Personnel in 2006

Permanent Positions funded by the Helsinki University of Technology

Tornikoski, Merja, Dr.Tech.	Director of the institute Docent of Radio Astronomy and Space Technology	Merja.Tornikoski@hut.fi
Hurtta, Solveig, Ms.	Department Secretary, part-time	Solveig.Hurtta@hut.fi
Mujunen, Ari, M.Sc. (Tech)	Laboratory engineer	Ari.Mujunen@hut.fi
Oinaskallio, Erkki, Mr.	Technician	Erkki.Oinaskallio@hut.fi
Peltonen, Juhani, Dr.Tech.	Laboratory engineer, part-time	jussi@kurp.hut.fi
Rönnberg, Henry, Mr.	Mechanician	

Scientific and Technical Staff Funded by Research Contracts

Aatrokoski, Juha, M.Sc. (Tech)	Research assistant	jha@kurp.hut.fi
Hovatta, Talvikki, M.Sc. (Tech)	Researcher	tho@kurp.hut.fi
Kallunki, Juha, M.Sc. Tech)	Operations engineer, from 1.4.2006	
Kotiranta, Mikko, student	Research assistant, part-time from 14.8.2006	
Lindfors, Elina, M.Sc.	Researcher, 1.10-31.12.2006	
Lindfors, Timo, student	Research assistant, part time 1.1-31.5.2006 and 1.9-31.12.2006, full time 1.6-31.8.2006	lindi@kurp.hut.fi
Lähteenmäki, Anne, D.Sc.(Tech.)	Academy Research Fellow	alien@kurp.hut.fi
Molera Calvés, Guifré, M.Sc.	Researcher, from 1.4.2006	gofrito@kurp.hut.fi
Nieppola, Elina, M.Sc.	Researcher	eni@kurp.hut.fi
Ritakari, Jouko, M.Sc. (Tech)	Researcher, part time	jr@kurp.hut.fi
Torniainen, Ilona, M.Sc. (Tech)	Researcher	ilo@kurp.hut.fi
Turunen, Miika, student	Research assistant, full time 22.5-31.8.2006 part time 1.9-31.12.2006	maturun@kurp.hut.fi
Tröller, Mirko, M.Sc.	Researcher until 30.4.2006	
Wagner, Jan, student	Research assistant part time from 14.2.2006, full time from 1.5.2006	jwagner@kurp.hut.fi

Metsähovi Advisory Committee

Korpela, Seppo, Dir.
Koskinen, Hannu, Prof.
Nygren, Tuomo, Prof.
Somervuo, Pekka, Dr.Tech.
Tanskanen, Pekka, Prof.
Tiuri, Martti, Prof.emer., M.P. (Chair)
Tornikoski, Merja, Director (Secretary)
Valtaoja, Esko, Prof.