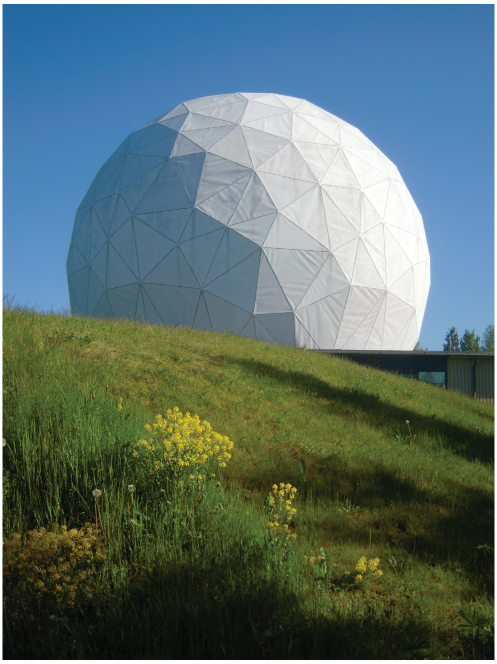
Metsähovi Radio Observatory

Annual Report 2012

M. Tornikoski, B. Holmberg,
M. Uunila



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Metsähovi Radio Observatory Annual Report 2012

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Aalto University
School of Electrical Engineering
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Preface

Metsähovi Radio Observatory, a research institute at Aalto University (formerly: Helsinki University of Technology, TKK), operates a 14 m diameter radio telescope at Metsähovi, the 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. Geodetic VLBI observations are also done in Metsähovi in collaboration with the Finnish Geodetic Institute.

In 2012 twenty-four scientists, engineers, research assistants and support personnel worked at the institute. In 2012 the total expenditure of Metsähovi Radio Observatory was 1 678 677 euros including salaries and the rent of the office and laboratory space at the Metsähovi premises. This was funded by Aalto University, Academy of Finland, European Union, and other outside sources.

Merja Tornikoski
Director of the Aalto University Metsähovi Radio Observatory

Kylmälä, February 20, 2014,

M. Tornikoski, B. Holmberg, M. Uunila (editors)

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1. 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.

1.1 Radio astronomical instrumentation

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

1.1.1 3 mm

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

It was decided that a major rebuild of the receiver was needed due to the fact that the original construction proved to be too unreliable if not even non-functional. Rebuild meant that the whole receiving chain starting from the gaussian beam geometry and ending to IF bandwidth and detection needed to be thought over. Several new components were needed to substitute the Russian standard devices: directional coupler, power divider, harmonic mixer, phase lock circuitry, waveguide transition, a couple of new waveguides, new dewar flanges and several intermediate frequency components.

Mechanical parts to place the feed horn 80 mm forward were manufactured at site. They included lengthening of the dewar as well as the radiation shield and various parts to supports to mount the new parts firmly and thermally non-conductively to the surroundings. Some precision mechanics parts were manufactured at Precia Oy. Electrical components were ordered from well known manufacturers.

New LO system is still based on the Gunn oscillator but the PLL design was started from scratch. Because the observatory staff has no recent experience on designing such system, a related firm RF-shamaanit were consulted at the beginning. Phase locking system is build from a registry settable PLL chip and a low noise active loop filter circuit already available today. The system fits in a small space.

In the autumn the modification of the feed system was ready and was measured at the near field scanner facility at Department of Radio Science and Engineering. The measurement results were as expected. Radiation pattern was improved clearly but still the mirror edge cuts the beam notably which was verified by calculating the beam width at the distance of the mirror. The consequence is seen as a diffraction pattern in the horizontal plane. The pattern is nearly undistorted between the angles ± 7 degrees, the illumination angle of Metsähovi antenna subreflector, however. Therefore it is assumed that the feed would work now adequately. Rebuilding started in November with dewar dismantling, wash and assembly of the new parts.

1.1.2 Miscellaneous

Changing the receiver especially before and after geo-VLBI sessions is relatively labour-intensive. We want to make sure that the receiver change can be done also in case of unforeseen absence of some of the key personnel and want to train most of our scientific-technical staff members to at least be able to act as general-purpose handymen/women. One such training period was on October 30th, see figure 1.1.

1.1.3 IT infrastructure

Project Team: Mujunen, Lindfors, Aatrokoski

In March, our 10 Gbps main internet connection fiber was severed, causing an outage of a couple of days until it was fixed. This prompted us to implement a better support for switching to our backup ADSL connection, which for this outage had to be done manually in several places.

At the time of the World IPv6 Launch on 2012-06-06, Metsähovi also deployed IPv6 both internally and externally. The main web site www.metsahovi.fi and our SSH server are reachable via IPv6. However, later in the year most of www.metsahovi.fi was changed to redirect to Aalto's content management system at metsahovi.aalto.fi, which does not yet support IPv6.

Figure 1.1. First row, left: Installing the large subreflector required for geo-VLBI is still the most critical part of the procedure and can reliably only be done by Henry Rönnberg. Ground-level help is needed for the ropes etc., and that can be done by several other staff members, too. First row, right: Minttu Uunila and Elizaveta Rastorgueva-Foi and the continuum receiver that was taken down from the antenna. Second row, left: Lifting up the front end part of the receiver. Second row, right: Lifting up the second part of the receiver. Third row: Ari Mujunen and Merja Tornikoski carrying the geo-VLBI receiver to the radome.

In addition to repairing the HP GPS receiver power supply that was broken in the Christmas storms of 2011, two new GPS receivers were acquired to provide NTP time to the network.

As native Linux kernel support for the ZFS filesystem became available, we installed it on our main backup server. The native snapshot support of ZFS speeded up the daily backup process considerably.

All the desktop computers were upgraded to Ubuntu 12.04 "Precise Pangolin". This was not so straightforward due to Gnome's decision to deprecate the classic desktop environment. We will be considering a switch to Xfce as the default desktop environment, though Gnome3 and Unity will of course also be available for our users.

The June leap second caused some minor disturbance, both due to a Linux kernel bug as well as some of our software not handling it seamlessly. Fortunately, as they are known in advance, leap seconds can in most cases be considered a scheduled interruption of service, instead of trying to come up with sometimes very complex workarounds to handle them seamlessly.

A wide-angle all-sky camera was acquired to monitor weather conditions to aid astronomical observations. Additionally, a proxy server was written that converts the special image format of the camera to normal images on the fly, as well as timestamps and archives them.

Using the Arduino-based I/O devices designed and built in 2011, we assembled an A/D unit dubbed Daqbox and started testing it in operation. It consist of three Arduinos with A/D add-on boards, for a total of 12 A/D channels at 10 kHz sampling rate, and one Arduino for controlling the receiver digital backend and monitoring the quality of the sample clock. The Daqbox is intended to replace the current PCI-416 4-channel A/D PCI card used for measurement data acquisition, see Figure 1.2.

We discovered that the coordinate origin calibration process of the incremental position sensors of the main antenna is direction dependent on the azimuth axis: there is a 100-millidegree difference in the coordinate if the azimuth axis slews in the "wrong" direction during sensor calibration. This had gone on unnoticed for several years, though normal operating patterns made one direction more dominant in calibrations. The fix was to force the calibration to always happen in the same direction for the azimuth axis.

In order to get rid of the old Heidenhain IK121 incremental sensor ISA card, and also in preparation for upgrading the main antenna incremen-

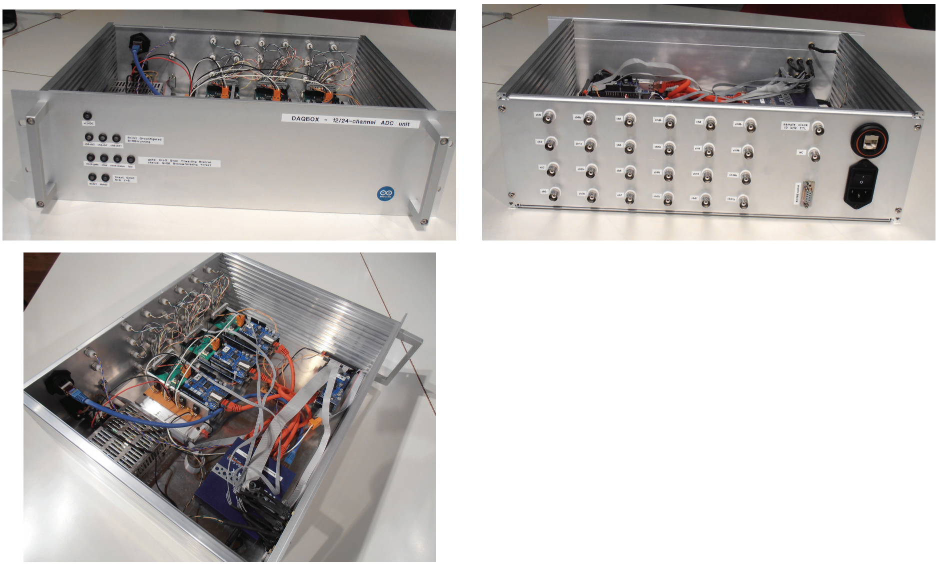

Figure 1.2. The Daqbox with its three A/D Arduinos, one control/monitor Arduino, a power supply and an ethernet switch.

tal sensors, we acquired a Heidenhain EIB741 Ethernet-connected sensor interface box and started testing it.

To replace a broken wall clock in the conference room, a fancy wall clock displaying local, UTC, and local sidereal time was made from a small computer and a flatscreen display.

1.1.4 Hydrogen maser

Project Team: Oinaskallio, Kallunki, Mujunen

Both Hydrogen masers 69 and 70 continued to work throughout 2012 without any failures. Only the synthesizer value of H-maser 69 was adjusted three times and H-maser 70 value was adjusted five times during the year 2012. In Figure 1.3 the time differences between the H masers (69) and GPS (HP-GPS) and between the H masers (69) and H masers (70) clocks is illustrated.

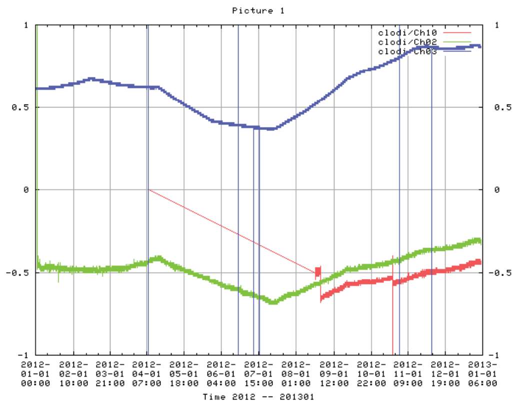

Figure 1.3. Time difference of H maser (69) and GPS (Lantime) clocks in red, H maser (69) and GPS (HP) in green, and H maser (69) and H maser (70) in blue, in microseconds.

1.1.5 New hardware

Project Team: Kallunki, Mujunen, Oinaskallio, Aatrokoski, Rönnberg

The first preliminary laboratory tests with new radome electrical heater was completed. The system will replace an old oil heater used between the Spring and the Fall period (moisture removal). The power of the heater can be adjusted in steps, thus it is possible to increase total observation time and to get more energy efficient solution for the heating issue. The system will be in full operation in 2013.

Comms-UPS extra batteries (6 x 60 Ah) were replaced in February 2012.

Two new GPS receivers were purchased in 2012 (Lantime and M300/GLN Symmetricom XLi).

New motion sensors were added to the gate to switch the lights on. In addition, a new motion alarming system was completed.

The middle weather station's leaf-sensor was replaced in Summer 2012.

The building of the adjusting counterweights system in the antenna was started in 2012. The system will be in full operation in 2013.

Serious phase unstability issues in VLBI measurements were noticed in Summer 2012. They were caused by corrupted reference signal (5 MHz) or more precisely 5 MHz distribution unit. This unit was replaced (in clock room) and, after this, the phase coherence problem vanished. Also, 1 pps distribution unit was replaced.

We started to monitor a number of daily GSM interferences in Fall 2012. The daily statistic is illustrated in Figure 1.4.

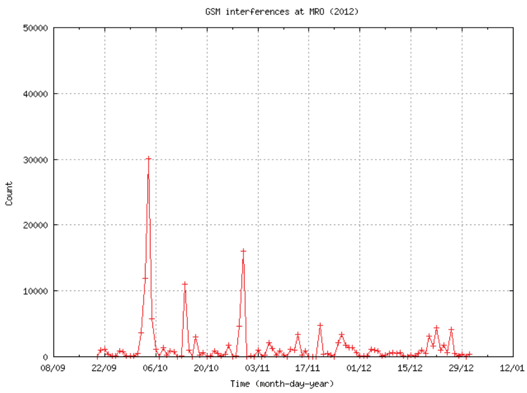

Figure 1.4. Number of daily GSM interferences.

1.1.6 DBBC firmware

Project Team: Uunila, Tuccari (IT)

A firmware to enable auto-correlation at VLBI stations with a DBBC and a Fila10G board was written.

1.2 VLBI instrumentation

Project team: Ritakari, Kallunki, Mujunen, Kirves, Oinaskallio, Uunila, Rastorgueva-Foi, Molera-Calvés (NL)

The 43 GHz receiver has been out of order for the last years and it is still waiting to be repaired. The 86 GHz needs also to be repaired. The 22 GHz receiver is working fine. There have been some problems with the S-band of the geodetic S/X receiver since 2007. We changed the semi-rigid coaxial cables of the receiver which were broken.

Status of our VLBI hardware: only 9 BBCs were being used in the experiments in 2010. Three of the broken ones were fixed in 2011. Digital backend (one DBBC unit in geodetic configuration) was ordered in 2011 and arrived at Metsähovi in September 2012, after which various technical modifications were completed. The receivers' IF-levels were not sufficient for the DBBC, therefore a separate IF-amplifying box was built (10 dB amplifying). Additionally, the DBBC needed 10 MHz reference input, thus an active doubler was purchased (5 MHz –> 10 MHz). The system was completed with the recording system (Mark5B+/FILA10G), the controlling system (Field System), the monitoring unit and the UPS device, see Figure 1.5.

Figure 1.5. The digital VLBI-rack: oscilloscope to monitor the pps-signal, IF-amplifying box, Field System computer, Mark5B+, FILA10G, dBBC and UPS (from up to down).

The first fringes with the new digital back-end were observed in December 2012, see Figure 1.6. Additionally, before the fringe test, the dBBC was tested successfully with the VEX observations. The results with the dBBC were substantially better than with an old analog system (both phase and frequency stabilities).

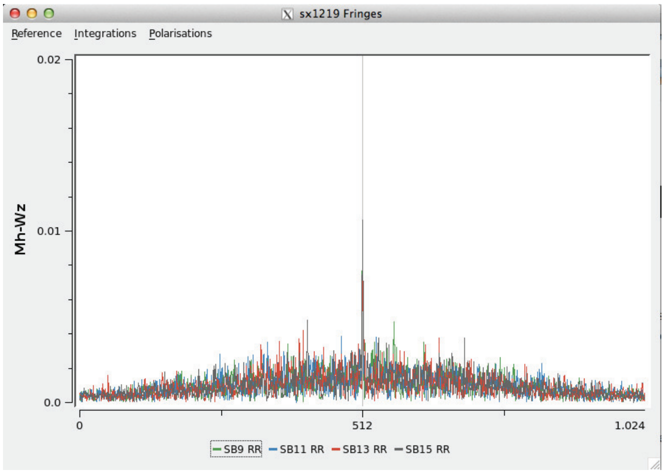

Figure 1.6. The first detected fringes between Metsähovi and Wettzell on 19 December 2012 at X-band (observed quasar J0555+3948).

1.2.1 eVLBI and EC FP7 NEXPReS

Project team: Ritakari, Mujunen, Salminen, Uunila

Metsähovi is taking part in a 3-year EC FP7 CP CSA project called "NEXPReS - Novel EXplorations Pushing Robust e-VLBI Services" (Grant Agreement 261525). The project started in July 2010 and Metsähovi is leading its Joint Research Activity Work Package WP8, Work Package WP8, originally titled "Provisioning High-Bandwidth, High-Capacity Networked Storage on Demand" but later shortened to FlexBuff, is exploring ways to implement on-demand networked storage to match the multi-Gbps bandwidth and petabyte-class capacity requirements of VLBI in a distributed manner. Additionally, the work package addresses the use of such high-capacity storage systems for the data archives of the future.

The objective of WP8 is to determine the best practical combination of commercially-available technologies which will serve the needs of evolving, multi-Gbps high rate data acquisition and processing. This includes determining both the most suitable hardware and operating system architecture and the most applicable user software architecture which can support multiple simultaneous high-speed input and output streams. The VLBI application is a forerunner in being able to fully exploit this unique capability when recording local real-time telescope data at a given station while providing access to previously made recordings.

In WP8 Metsähovi is responsible for the coordination of the work package and for providing the basic technologies and software upon which the storage systems are being built. In 2012 we had one full-time software engineer devoting all his time to the development of ”vlbi-streamer” data acquisition software. A large fraction of effort was spent also on assisting participating partners in installing and testing ”vlbi-streamer” at their sites.

Work during 2012 in WP8 FlexBuff concentrated on testing and verification of the ”vlbi-streamer” data acquisition application software running on generic, commercially available Linux platforms. Several test FlexBuff systems were (and are) available at partner sites, representing a wide variety of COTS Linux platforms, including several instances of both kinds of systems recommended in WP8 hardware study and also hardware RAID systems at partner INAF and computing-centre nodes at partner PSNC. ”vlbi-streamer” software was exercised on all of them and it showed remarkable capability of adapting to the varying environments, still retaining its high-rate performance.

The so-called ”first round” of prototype tests were conducted around July 2012, and based on the feedback received in these tests, a refinement iteration of ”vlbi-streamer” software was released in September 2012. The main focus of development was a single invocation, service-like mode of running vlbi-streamer in the background continually, in daemon mode. This enabled better sharing of disk resources and simultaneous receiving and sending of recordings which was one of the main design goals of FlexBuff. A face-to-face meeting (4th in WP8) was arranged in December 2012 to better coordinate the final integration tests (the so-called ”second round” of tests), designed to exercise the newly- acquired multi-station, multi-stream capabilities of ”vlbi-streamer”, see figure 1.7. A suitable time slot was determined to be in March–April 2013.

1.3 VLBI observations and research

1.3.1 VLBI observational sessions in 2012

Project team: Rastorgueva-Foi, Uunila, Mujunen, Ritakari

Metsähovi performs both astronomical and geodetic VLBI observations in conjunction with three global networks of VLBI: the European VLBI Network (EVN), the International VLBI service for Geodesy and Astrom-

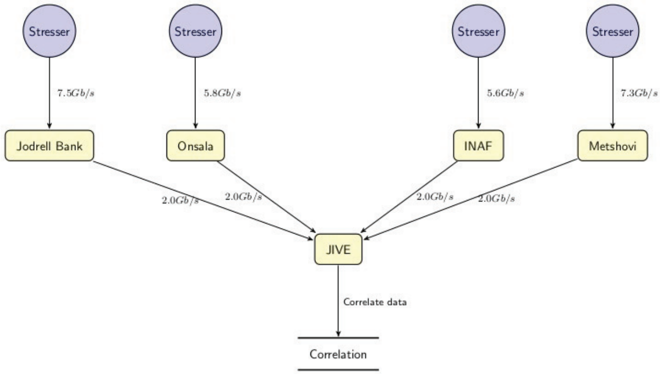

Figure 1.7. Multi-station high-speed streaming setup for ”vlbi-streamer”.

etry (IVS: in collaboration with FGI), and the Global Millimeter VLBI Array (GMVA). Furthermore, Metsähovi has actively taken part in spacecraft VLBI tracking observations organized by Joint Institute for VLBI in Europe (JIVE) in cooperation with the European Space Agency (ESA) as well as real-time dUT1 experiments with Japan and Sweden.

In 2012, Metsähovi took part in seven geodetic VLBI sessions (in three EUROPE sessions and in four T2 sessions). Three EVN sessions were conducted at the station. DBBC was used in parallel with the analog back-end during EVN Session 3/2012 in October 2012. Metsähovi also participated in tracking of Venus Express (VEX) and RadioAstron space VLBI spacecrafts in 2012. VLBI spacecraft tracking for study of the interplanetary plasma scintillations was used in X-band as a part of EVN Planetary Radio Interferometry and Doppler Experiment (PRIDE). Metsähovi did not participate in the Global mm-VLBI Array (GMVA) sessions in 2012 due to the 86 GHz VLBI receiver refurbushing.

1.4 Geodetic VLBI data analysis

Project team: Uunila, Kareinen

Geodetic VLBI data is analyzed with the Vienna VLBI Software (VieVS) developed at the Institute of Geodesy and Geophysics, Vienna University of Technology. In 2012 the analysis was concentrated on the IVS intensive sessions (INT1, INT2 and INT3), and 24-hours sessions (R1 and R4).

1.4.1 Automated analysis of IVS intensive sessions

Project team: Uunila, Haas (SWE), Kareinen, Lindfors

Analysis of the intensives with VieVS was automated, to be able to get results as soon as possible. For results and plots, see:
http://www.metsahovi.fi/vlbi/vievs/

1.4.2 Influence source positions on UT1

Project team: Uunila, Nothnagel (DE), Leek (DE)

Influence of source constellations on the quality of UT1 was derived from IVS INT1 sessions. The Kokee-Wettzell baseline midpoint was chosen as a reference point for the analysis, and a Matlab code to classify sessions with quality codes was written.

1.4.3 Comparison of UT1 and polar motion from IVS sessions derived from VieVS and Solve analysis

Project team: Uunila, Baver (US), Gipson (US), Nilsson (AT)

The results of using Vienna VLBI Software (VieVS) and Calc/Solve were compared to estimate UT1 and Polar Motion using IVS sessions from 2012. The results from both 24 hour sessions and intensives were compared.

1.4.4 Determination of Tsukuba VLBI station post-Tohoku earthquake coordinates

Project team: Kareinen, Uunila

Tsukuba VLBI station was affected by the Tohoku earthquake on March 11, 2011. The new coordinates for the station were determined from 38 VLBI XA/XE sessions dating from 2011-01-03 to 2011-09-15 with VieVS. After the initial VieVS analysis, a visualization tool was written in Matlab to analyze the possible change in the coordinates and to detect possible low quality measurements missed by initial processing. The visualization tool has a functionality to transform the ECEF coordinates and errors acquired with VieVS to the local tangent plane of Tsukuba for better comparison possibilities. The visualization tool was written in a way that it could be added in the next version of VieVS as a general time series tool. A master's thesis on the subject was written by Kareinen and instructed by Uunila.

1.4.5 Influence of the fiducial sources' structure on geodetic parameter accuracy

Project team: Rastorgueva-Foi, Zubko (FGI)

Influence of the structure variation of selected ICRF2 defining sources on the accuracy of EOP determination was studied. Total flux variability at 2, 8, 22 and 37 GHz was used as an indicator of sources' activity. Attempts were made to find correlation between EOP accuracy and total flux outbursts in the ICRF2 defining sources.

1.5 VLBI imaging and image model-fitting

Project team: Rastorgueva-Foi, Ramakrishnan, Wiik (UTU), Jorstad (US), Zubko, (FGI)

1.5.1 Multifrequency study of AGN 1156+256

Project team: Ramakrishnan, Rastorgueva-Foi, Wiik (UTU), Jorstad (US)

Multi-band (from mm to gamma-rays) long-term variability of the source 1156+295 flux was connected to its structure changes (jet kinematics) and VLBI polarization variability as seen at 43 GHz VLBA maps (VLBA). A new approach to the jet apparent speed and component ejection time estimation from a set of gaussian component models of source's brightness distribution, based on Bayesian inference, was used to write a model-fitting tool. Also, tools for visualization of the 3D jet structure were developed.

1.5.2 Alert system for ICRF2 defining source database

Project team: Rastorgueva-Foi, Zubko (FGI)

A subset of ICRF2 defining sources that are included in the database of Metsähovi total flux AGN monitoring at 22 and 37 GHz (58 sources) had been studied. Their structure changes in the period 2000-2012 were monitored using 15 GHz VLBA data (MOJAVE) and images obtained from geo-VLBI data at 8 GHz (BVID). Connection of major structure changes that might influence astrometric and geodetic source stability to the total flux variations was studied, and possibility to use single dish monitoring results for alerting geo-VLBI community and schedulers to the sources' activity was investigated.

1.5.3 Circular polarization of AGN

Project team: Rastorgueva-Foi

Work is done to improve the calibration of circular polarization (CP) VLBI imaging of the data obtained from VLBI arrays that are equipped with circularly polarized feeds (e.g., VLBA). It is shown that a source with previously known CP distribution could be used for calibration of R/L ratio.

1.6 Extragalactic radio sources

1.6.1 Active Galactic Nuclei

Project team: Tornikoski, Lähteenmäki, Nieppola, Kareinen, León-Tavares, Tammi, Rastorgueva-Foi, Oksman, Järvelä, Lavonen, Savolainen, Valtaoja (Turku)

In 2012 no new Planck data were released, so our main efforts were related to multifrequency projects, various source samples, and aspects related to the gamma-ray emission of AGNs.

Our most important results are summarized in the following:

- Together with our SAO RAS colleagues we completed and published the results of a long-term study of GHz-peaked spectrum (GPS) sources and candidates. The sample was initially defined from our Metsähovi 37 GHz observations, and now data from RATAN-600 observations were analysed. Twelve observing campaigns were carried out between 2006 and 2010. The sample consisted of 122 sources, both quasar and galaxy type GPS sources or candidates, and the observations were simultaneous broad-band observations at eight bands ranging from 1.1 to 21.7 GHz. As our earlier non-simultaneous long-term data have indicated, the number of genuine GPS sources is lower than the number of sources with temporarily convex or inverted spectra. There were only 17 sources whose radio spectra strictly agree with the spectra of homogeneous self-absorbed synchrotron sources, even though there were a larger number of only moderately variable sources with broader convex spectra. The GPS galaxies demonstrate a steeper spectral index in the optically thin part of the spectra than GPS quasars.

- Together with our SAO RAS colleagues we also started to work on the RATAN-600 -observed sampled of BL Lacertae Objects (BLO) initially included in the Metsähovi BLO study at 37 GHz. The simultaneous multifrequency spectra from 1 to 22 GHz provides a unique tool to study the spectra and variability of these relatively rarely observed sources. Results of this study will be published in 2013-2014.

- The coexistence of Planck and Fermi satellites in orbit has enabled the exploration of the connection between the (sub-)millimeter and gamma-ray emission in a large sample of blazars. We compared Fermi/LAT gamma-ray photon fluxes integrated over three different periods of time with Planck (sub-)mm observations of a sample of 105 blazars. Our main findings can be listed as follows: We have found a significant correlation between gamma-ray and (sub-)millimetre luminosities which holds over five orders of magnitude. Sources with high levels of gamma-ray emission show a characteristic signature in their radio spectra: flat/rising mm and steep sub-mm spectral indices. This spectral shape can be associated with a single synchrotron component which becomes self-absorbed in the middle of the mm wavelength regime. Such high spectral turnover frequencies reveal the presence of emerging disturbances in the jet which are likely to be responsible for the high levels of gamma-ray emission.

- We participated in a multifrequency and VLBI study of the radio galaxy 3C84, published in two papers this year. The total radio flux of this source has been steadily increasing through the period addressed in these studies, 2002-2011. There was a brightening of a VLBI component associated with the GeV gamma-ray detection since August 2008, but no new prominent components or change in morphology associated with the 2009-2010 gamma-ray flares are found on VLBI images. No clear correlation with the radio light curve on the time-scale of the gamma-ray flares is found.

1.6.1.1 The mm gamma-ray connection in blazar 1156+295

Project Team: Ramakrishnan, León-Tavares, Rastorgueva-Foi, Tornikoski, Tammi, Lähteenmäki, Wiik (Turku), Valtaoja (Turku)

Venkatessh Ramakrishnan funded by the Finnish graduate school for astronomy and space physics, started his doctoral studies by February 2012. He joined the AGN group and started working on establishing the mm gamma-ray connection in blazar 1156+295.

This work requires extensive analysis of both radio (VLBA and Metsähovi) and gamma-ray (Fermi) data. The flaring state of the source 1156+295 in the Metsähovi 37 GHz data corresponds very well to the propagation of three moving components observed in the Boston 43 GHz VLBA data. In the gamma-rays (0.1-200 GeV), the source exhibited a major flare and several sub-flares characterising the variability of the source. Through careful timing analysis of the data, a connection between the radio and gamma-ray flare was confirmed and thus placing the high-energy emission site to be on parsec scales in the radio jet. The position-angle swing and the polarization of the jet components are being investigated for further explanation on the physics of the jet and might also yield some information on the missing gamma-ray flare.

The summer school on Instruments and detection techniques in high-energy astrophysics organized by the Finnish graduate school for astronomy and space physics in Savonlinna, Finland was attended by Venkatessh Ramakrishnan. He also presented his work at the XII Finnish-Russian Radio Astronomy Symposium held in Lammi, Finland.

1.6.2 Planck satellite science

Project Team: Lähteenmäki, Tornikoski, Aatrokoski, León-Tavares, Nieppola, Tammi, Valtaoja (Turku)

The Planck satellite has mapped the sky at nine high radio frequencies from 30 GHz to 857 GHz, and measured the cosmic microwave background (CMB) radiation. At the same time all foreground radio sources in the sky, including extragalactic radio sources, have been observed, too. Planck has therefore produced unique all sky catalogs of sources at several high radio frequencies. These catalogs will, finally, fill the gap in the present radio survey data. Planck was launched on May 14, 2009, and in autumn 2011 the nominal (2) and extended (2) all-sky surveys ended. HFI observed until early 2012, and after that the LFI alone continues to observe the sky in 2013, using a slightly different scanning strategy than before.

We submitted two drafts for Planck intermediate papers, one about modelling and understanding the synchrotron spectra of blazars and another about the physics determining SED shapes in blazars. The idea was to start working on the multifrequency data as soon as the Planck data from all four all-sky surveys became available but due to several reasons this work has been delayed until 2013. Due to internal Planck Consortia schedules these papers are now expected to be submitted in 2013 and 2014.

The official multifrequency campaigns with our collaborators ended in autumn 2011, at the end of the nominal and extended all-sky surveys of Planck. However, the Metsähovi telescope continued to monitor the most interesting sources, and also participated in calibration observations with other instruments involved in the Planck project.

In 2012 A. Lähteenmäki participated in several Planck related meetings and telecons where Planck data reduction, analysis, results and publications were discussed. The work at this point concentrated on the publication of the first cosmological results, to take place in spring 2013. However, the work for validating the Planck Catalogue of Compact Sources (PCCS) started.

1.6.3 Numerical modelling

Project Team: Tammi, Oksman, Anjum

The work for developing new numerical modelling tools for studying the standing shocks in AGN jets and the radio-to-gamma connection continued with three main approaches.

In addition to the ongoing work of Tammi, involving determining the evolution and emission spectrum of relativistic particle population using a finite-difference method, we started working on a long-term coding project attacking the problem of particle properties using a new numerical model applying smoothed-particle hydrodynamics (Miika Oksman's doctoral thesis work, began in 2012). The first results are expected in early 2013. Furthermore, we implemented a new synchrotron-self-Compton code and started tests to determine its suitability for modelling gamma-ray emitting AGNs (Master's thesis work, Muhammad Anjum, University of Turku, began in 2012).

1.6.4 Development of quasar observation (and data processing) software

Project Team: Lavonen, Tornikoski, Lähteenmäki, Kareinen

In the beginning of 2012 Niko Lavonen started a diploma thesis project for improving the usability of the quasar observation software. The title of the thesis was "User centered evaluation and design for improving the usability of the quasar observation system for a radio telescope". The goal was to reduce stress and work load of daily quasar monitoring. This was important because Metsähovi's staff conducts quasar observations in shifts parallel with other work. Less time spent on observing means more time for research and other activities.

The project was based on the user centered design (UCD) approach, where the needs and wants of the real users of the system are given high priority. Work started in December of 2011 with the collection of user feedback and developer's ideas. Between May and October of 2012 more usability data was collected using heuristic evaluations and contextual inquiry interviews. Analysis of the data resulted in a large set of usability problems and suggestions for improvement.

Biggest problems in the system were related to the large number of separate tools needed in accomplishing single tasks. Data from weather sensors and telescope receivers was slow to access and scattered over many tools. Creating lists of sources to be observed was not flexible enough. The problems resulted in user frustration, extra work and wasted time.

Implementation of major improvements in the system was started with a web tool used in viewing and processing tabular observation data ("observation summary"). Using DHTML and AJAX technologies, functions previously used in seven separate web tools were integrated to "observation summary". It became possible to modify and pre-process results data interactively in the HTML table. Usability evaluation of the modifications with users revealed that the time to accomplish data pre-processing tasks had dropped between 35 % - 92 %, depending on the task. On a scale from 0 to 5, the average user satisfaction on accomplishing these tasks had increased between 0.8 to 3.0 points. This did not affect accomplishing all the tasks successfully.

Based on the promising results and overall positive feedback from the users, user centered design seems to be an effective approach to improving the observation system. In the future, attention will be shifted toward developing a source queue system for upcoming sources and creating a more common look and feel for the observation tools.

1.7 Galactic sources

1.7.1 The multiwavelength nature of the enigmatic microquasar Cygnus X-3

Project team: Koljonen, Hannikainen (Melbourne, FL), McCollough (Cambridge, MA), Droulans (Toulouse), Tavani (Rome)

Continuing the work on the study of spectral and temporal properties of the microquasar Cygnus X-3, Karri Koljonen started to investigate how principal component analysis (PCA) could be used to distinguish the variability of emission components during radio outbursts. The PCA showed that there are two main variability components in play during outbursts. In addition, during jet ejection a plausible scenario of bremsstrahlung photons inverse-Compton scattering off the relativistic electrons in the jet is supported by the analysis. The results of this study were presented in a national conference Astronomers' Days 2012 in Porvoo, and in two international conferences: in IAU Symposium 290 - Feeding compact objects: accretion on all scales, Peking, China, and in 9th INTEGRAL Workshop and celebration of the 10th anniversary of the launch, Paris, France. Finally, a paper presenting the whole research was submitted and accepted in MNRAS at the end of the year (publish date is scheduled to be early 2013).

Also, a collaboration with the gamma-ray observatory AGILE (PI: Tavani) group continued. Karri Koljonen participated in the X-ray analysis of Cygnus X-3 during the times when gamma-ray flares were observed from the source with AGILE. This research resulted in two papers that were published in Astronomy and Astrophysics.

Karri Koljonen continued to be a co-investigator in monitoring proposals of Cygnus X-3 with the infrared observatory PAIRITEL as well as the X-ray observatory Swift and a monitoring proposal with the gamma-ray observatories Fermi and VERITAS.

Karri Koljonen is part of the Finnish graduate school for astronomy and space physics.

1.7.2 2010-2011 observing campaigns on Cygnus X-3

Project Team: Savolainen, McCollough (SAO), Hannikainen (Florida Institute of Technology)

Petri Savolainen is a postgraduate student of Dr. Diana Hannikainen, who has recently transfered from Metsähovi to the Florida Institute of Technology. He spent 2011 as a Predoctoral Fellow at the Harvard-Smithsonian Center for Astrophysics (CfA), funded from a NASA grant through the Smithsonian Astrophysical Observatory (SAO). While there, he worked with Dr. Michael McCollough of SAO on the enigmatic microquasar Cygnus X-3. After returning to Metsähovi in January 2012 Mr. Savolainen has continued his ongoing thesis projects.

A weekly observing campaign of the microquasar Cygnus X-3 by NASA's Swift satellite started in April 2010 was enhanced with a series of Target of Opportunity observations by Swift and NASA's Rossi X-ray Timing Explorer satellite (RXTE), when the source descended to a quenched state in February 2011 and emerged a month later with a major radio flare. We have modeled ~90 sets of X-ray spectra taken over a period of one year, during which Cygnus X-3 went through all its previously known spectral states. Our dataset features the most extensive coverage of the 0.5–3 keV energy range from Cygnus X-3 ever observed, enabling us to detect and characterize a soft (~50 eV) blackbody- or Bremsstrahlung-like component, which is modulated in phase and correlated with the main continuum. This soft component has a temperature consistent with that of the photoionized Radiative Recombination Continua seen in high-resolution observations by NASA's Chandra satellite, and associated with the stellar wind from the Wolf-Rayet -type companion star. The continuum between 1–60 keV (with the addition of Iron features between 6–9 keV) can be described by a disk blackbody Comptonized by a thermal electron plasma of ~20 keV temperature, optically thick during quiescence and minor flaring, thin in the quenched state and stronger flares, with a non-thermal accelerated population providing the occasional hard power law tail; reflection, while by no means excluded, is not necessary for our model. The consistent fit residuals between 1–5 keV can be eliminated by the addition of unresolved line components, whose consistent presence and characteristics are constrained by Chandra data. The X-ray modeling results will be presented in a paper currently under preparation, in context with near-simultaneous radio fluxes from AMI-LA (Arcminute Microkelvin Imager

Large Array). Further multiwavelength analysis by collaborators using radio data from the RATAN-600 telescope, infrared data from PAIRITEL (Peters Automated IR Imaging Telescope), and gamma-ray data from the Fermi satellite, will be published in another paper.

1.7.3 Analysis of Chandra grating spectra of Cygnus X-3

Project Team: Savolainen, McCollough (SAO), Hannikainen (Florida Institute of Technology)

The observations of Cygnus X-3 by the Chandra satellite's grating instruments in 1999, 2000 and 2006 resulted in a set of X-ray spectra with the best available wavelength resolution, capturing the source in all the major spectral states it exhibits. We have reprocessed and analyzed the data, further improving the resolution to accurately model the evolution of ~30 of the strongest photoionized features through different spectral states and orbital phases. These features are present in each observation integrated over at least a complete orbital cycle, but some, most notably the 6.4 keV neutral Iron line, undergo significant orbital modulation. Emission lines are seen to be relatively stronger in specral states with lower soft X-ray continuum emission. Line broadening and centroid-shifting consistently show stellar wind velocities of ~1000 km/s, variation from the average potentially giving us information on the concentration of emission from different lines in different parts of the system. From the 2006 observations, during which Cygnus X-3 was in the hyper-soft/quenched state, we can start to resolve the triplet structure (Resonance, Intercombination, and Forbidden lines) of the 6.7 keV Helium-like Iron emission line using the third-order spectra; the best-fit line ratios are consistent with an origin in a high-density, low temperature photoionized plasma with a high ionization parameter. The plasma temperatures derived from the Radiative Recombination Continua are in the range 10–70 eV, or 9–60 million K. The phase-resolved part of the analysis, as well as photoionizational modeling of the features with the XSTAR code, are still ongoing.

1.8 Multifrequency observing campaigns

Project Team: Lähteenmäki, Tornikoski, Nieppola, Oksman, Rastorgueva-Foi, Tammi, Lavonen, Järvelä, Savolainen, Ramakrishnan, Kareinen, León-Tavares

We took part in several multifrequency campaigns in 2012, and did individual observing requests, too. Typically we support the campaign with daily observations, and continue regular monitoring also before and after the core campaign. Examples of such campaigns are the WEBT and GASP collaborations on several sources in connection to satellite observations at high energies, particularly Fermi and also Swift. We are also regularly observing selected sources for VERITAS Blazar Science Working Group multiwavelength campaigns and support VERITAS Target of Opportunity campaigns. We also support MAGIC observations.

1.9 Solar research

Project Team: Kallunki, Tornikoski, Lavonen, Riehokainen (University of Turku, Tuorla Observatory)

During Summer 2012, we continued to study the long-periodic solar oscillations and solar cyclicity in the radio brightenings (sunspots) using the 13.7-meter radiotelescope. Totally, 16 feasible observation days were achieved, even 12 hours of continous solar tracks were observed. The weather conditions were not favourable for the solar observations in Summer 2012. However, almost every day around the year, at least one solar radio map was observed (altogether 242 of 366 days). This might be a record on the history of Metsähovi yearly solar observations.

The small radiotelescope (diameter 1,8 m) was used for continuous monitoring of the whole Solar disk at a frequency of 11,7 GHz.

The pyrheliometer (solar irradiance, 280-4000 nm) was installed in Spring 2012 (May) to support solar cyclity studies.

The scientific focus was in the solar oscillation in the active regions (sunspot) of the Sun. Besides our own data, mainly Nobeyama, HMI/SDO and SOHO/MDI data were used for these investigations. Also, the radio pulsating structures of the solar flares were studied at various radio wavelengths along with some optical data. Solar cyclicity studies were completed using Metsähovi's exceptionally long solar radio map collection. The variation of the radio brightenings almost over the four solar cycle (1978-2011), measured in MRO is illustrated in Figure1.8.

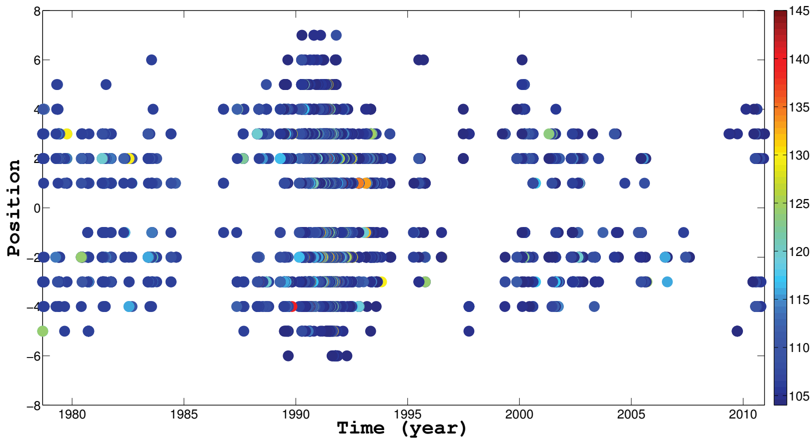

Figure 1.8. The distribution of locations of the solar radio brightenings from 1978 to 2011 (solar cycles 21-24), measured at 37 GHz (with 13.7-meter radiotelescope). A color bar on the right indicates the temperature (relatively to QSL, 7800 K). The strongest solar radio brightenings are 145% to QSL (11300 K), Kallunki et al., 2012.

1.9.1 Callisto - solar radio spectrometer

Due to the continuing rising solar activity during 2012, tens of solar radio bursts were detected with Callisto measurement system with frequency range of 50-1450 MHz. As an example, solar radio burst observed with Callisto is presented in Figure 1.9. The whole e-Callisto network's observation archive can be found from:
http://soleil.i4ds.ch/solarradio/callistoQuicklooks/

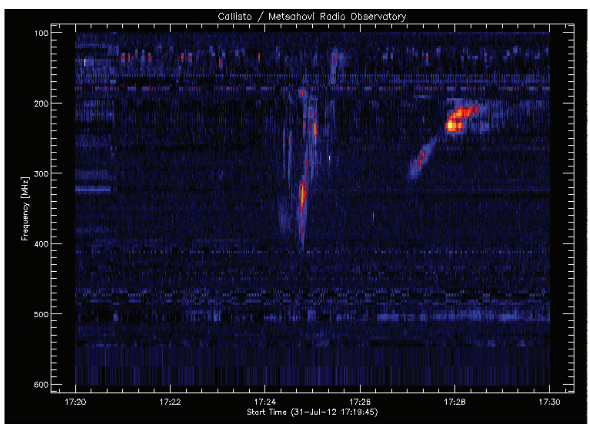

Figure 1.9. An example of a solar radio burst on 31 July 2012. The burst is a wide-band (100-450 MHz) type II burst.

1.10 Recreational events & keeping fit

1.10.1 Recreational day at Sea Life and Sports Museum

The annual Metsähovi recreational day was held on October 4th 2012. We visited Sea Life Helsinki, Helsinki Olympic Stadium Tower and Sports Museum Foundation of Finland.

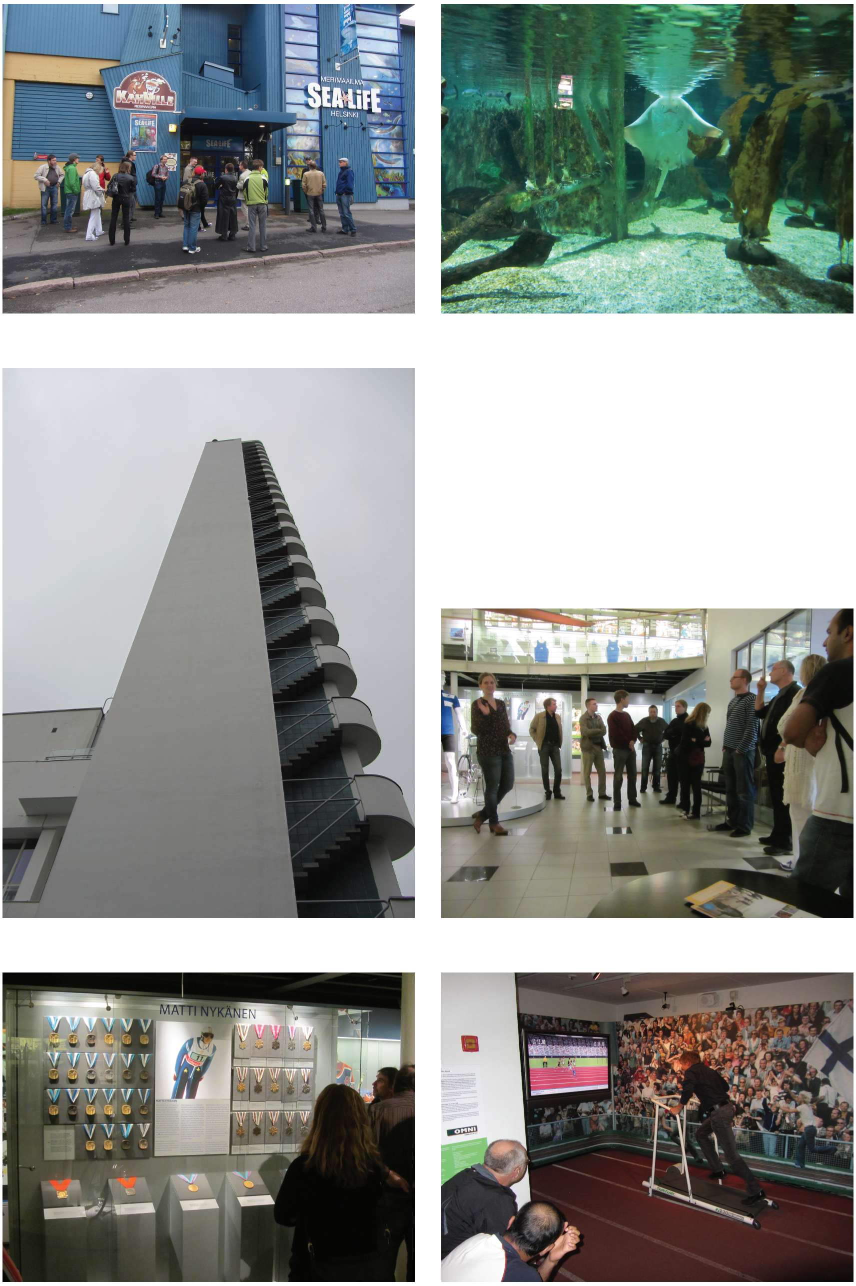

Figure 1.10. First row: Our Hai-Lite guide-tour at Sea Life was very interesting and we saw a lot of peculiar animals. Second row, left: The Helsinki Olympic Stadium Tower, which is 72 meters high. Second row, right onward: At the Sports Museum Foundation of Finland we heard interesting stories about great Finnish Athletes and some of us even tried out the running simulator.

2. Publications

2.1 International journals

1. Giommi, P.; Polenta, G.; Lähteenmäki, A.; Thompson, D.J.; Capalbi, M.; ... Leon-Tavares, J.; Lavonen, N.; Nieppola, E.; Tammi, J.; Tornikoski, M. et al. (95 coauthors): Simultaneous Planck, Swift, and Fermi observations of X-ray and gamma-ray selected blazars. Astronomy & Astrophysics, Vol. 541, No. id. A160, 2012.

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No. 1, pp. L122-L126, 2012.

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G.; Valdes, J. R.; Torrealba, J.; León-Tavares, J.; Mercado, A.; Benítez, E.; Carrasco, L.; Dultzin, D.; de la Fuente, E.: Spectral optical monitoring of the narrow-line Seyfert 1 Galaxy Ark 564. The Astrophysical Supplement Series, Vol. 202, No. 1, id. 10, 2012.

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2.2 International conferences

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23. Erkenov, A.K.; Mingaliev, M.G.; Sotnikova, Yu. V.; Tornikoski, M.: Long-term monitoring Gigahertz-Peaked spectrum sources with the RATAN-600 radio telescope, XII Finnish-Russian Symposium on Radio Astronomy, October 15. - 18.10.2012, Lammi Biological Station of Helsinki University, Finland, abstract 2012.

24. Lavonen, N.: User-centered evaluation and design of Metsähovi Radio Observatory's quasar observation system, XII Finnish-Russian Symposium on Radio Astronomy, October 15. - 18.10.2012, Lammi Biological Station of Helsinki University, Finland, abstract 2012.

25. Lähteenmäki, A.: Observations of Narrow-Line Seyfert 1 galaxies at 37 GHz, XII Finnish-Russian Symposium on Radio Astronomy, October 15. - 18.10.2012, Lammi Biological Station of Helsinki University, Finland, abstract 2012.

26. Mufakharov, T.V.; Mingaliev, M.; Sotnikova, Yu. V.; Lähteenmäki, A.; Tornikoski, M.; Udovitskiy, R. Yu.; Erkenov, A.K.: Simultaneous spectra and radio properties of the BL Lacertae objects, XII Finnish-Russian Symposium on Radio Astronomy, October 15. - 18.10.2012, Lammi Biological Station of Helsinki University, Finland, abstract 2012.

27. Ramakrishnan, V.: The mm-gamma-ray connection in the blazar, 1156+295, XII Finnish-Russian Symposium on Radio Astronomy, October 15. - 18.10.2012, Lammi Biological Station of Helsinki University, Finland, abstract 2012.

28. Rastorgueva-Foi, E.: Alert system for the database of ICRF2 "defining" sources, XII Finnish-Russian Symposium on Radio Astronomy, Oc-

tober 15. - 18.10.2012, Lammi Biological Station of Helsinki University, Finland, abstract 2012.

29. Salminen, T.: Flexbuff and VLBI data streaming, XII Finnish-Russian Symposium on Radio Astronomy, October 15. - 18.10.2012, Lammi Biological Station of Helsinki University, Finland, abstract 2012.

30. Savolainen, P.: Results from observing campaigns on Cygnus X-3 during 2010-2011, XII Finnish-Russian Symposium on Radio Astronomy, October 15. - 18.10.2012, Lammi Biological Station of Helsinki University, Finland, abstract 2012.

31. Smirnova, V.V.; Riehokainen, A.; Solov'ev, A.A.; Kallunki, J.; Zhiltsov, A.V.: Long quasi-periodic oscillations of sunspots and nearby magnetic structures, XII Finnish-Russian Symposium on Radio Astronomy, October 15. - 18.10.2012, Lammi Biological Station of Helsinki University, Finland, abstract 2012.

32. Tammi, J.: Synchrotron modelling of gamma-ray AGNs, XII Finnish-Russian Symposium on Radio Astronomy, October 15. - 18.10.2012, Lammi Biological Station of Helsinki University, Finland, abstract 2012.

33. Tornikoski, M.: Metsähovi radio monitoring as a tool for multifrequency AGN science, XII Finnish-Russian Symposium on Radio Astronomy, October 15. - 18.10.2012, Lammi Biological Station of Helsinki University, Finland, abstract 2012.

34. Tammi, J.: Synchrotron modelling of gamma-ray AGNs, poster at the 5th International Symposium on High-Energy Gamma-Ray Astronomy, Heidelberg, Germany, July 2012.

2.3 Laboratory reports

1. Tornikoski, M., Holmberg, B., Uunila, M. (editors): Aalto University Metsähovi Radio Observatory Annual Report 2012.

2.4 Other publications

1. Tammi, Joni: Termin avaus - Defining term Aika. Aalto University Magazine, No. 3, pp. 11, 2012.

2. Tammi, Joni: Voiko mustasta aukosta saada energiaa? Tähdet ja avaruus, No. 6, Tähtitieteellinen yhdistys URSA, Finland, 2012.

3. Grainge, K.; Alexander, P.; Battye, R.; Birkinshaw, M.; Blain, A.; ... Koljonen, Karri; Savolainen, P. et al. (75 coauthors): Future Science Prospects for AMI. Englanti: 2012. 20 p. (white paper).

3. Visits to foreign institutes

- Max Planck Institut für Radio Astronomie, Bonn, Germany, 1.10.2011 - 31.1.2012, M. Uunila
- National Institute for Astrophysics, Optics and Electronics, (INAOE), Mexico, 27.4. - 1.6.2012, J. León-Tavares
- Department for Physics and astronomy, Stockholm University, 8.6.2012, M. Tornikoski
- Boston University, USA, 17. - 20.10.2012, E. Rastorgueva-Foi
- Max Planck Institute for Radio Astronomy, Bonn, Germany, 20. - 23.8.2012, J. Kallunki
- Max Planck Institute for Radio Astronomy, Bonn, Germany, 20. - 24.8.2012, M. Uunila
- Department for Physics and astronomy, Uppsala University, 12.11.2012, M. Tornikoski
- Department for Physics and astronomy, Uppsala University, 3.12.2012, M. Tornikoski

4. Theses

- Master's Thesis, Department of Real Estate, Planning and Geoinformatics, School of Engineering 12, Kareinen Niko 12/2012: Geodetic Very Long Baseline Interferometry and the effects of Tohoku Earthquake - Case analysis of Tsukuba station.

- B.Sc. Thesis, Kalle Nordling (Aalto University), 1/2012 – 5/2012; "Aktiivisten galaksiytimien suihkujen keskeiset säteilymekanismit", Espoo, May 2012 (Title in English: "The main radiative processes in jets in active galactic nuclei"), supervisor: J. Tammi

- The PhD thesis defense of Guifré Molera Calvés on May 19th, 2012, thesis topic "Radio spectroscopy and space science with VLBI radio telescopes for Solar System research".

Figure 4.1. First row, left: On the left, opponent Dr. Franco Mantovani. In the middle, the candidate, Guifré Molera Calvés. On the right, the custos professor Martti Hallikainen. First row, right: Guifré delivering his Lectio Praecursoria. Second row, left: Defense in process. Second row, right: Dr. Mantovani delivering his final statement. Third row, left: The happy candidate after a successful defense. Third row, right: Equally happy custos and opponent.

5. Teaching

1. S-92.3146 Radio Astronomy, M. Tornikoski, A. Lähteenmäki

2. In early 2012 the application for funding for establishing a new course, submitted by Rastorgueva-Foi, Lähteenmäki and Tammi, was awarded with funding and a slot in the School of Electrical Engineering curriculum. The construction of the new course, "Astronomical View of the World", 6 credits, intended for all students within Aalto, commenced during the summer and the fall 2012, and resulted in a completely new astronomical course beginning in January 2013.

3. S-92.4305 Special Problems in Space Technology P (5 cr), J. Tammi and A. Lähteenmäki

4. RAD teaching seminar, 27. - 28.8.2012, A. Lähteenmäki

5. S-92.2110 Radio Science for space and environmental applications, Visiting lecturer 27.9.2012, The Invisible Universe, M. Tornikoski

6. Invited lecturer at the Space Master programme's closing ceremony, 23.10.2012, M. Tornikoski

7. LuMA course at Metsähovi Radio Observatory: fundamentals of radio astronomy and hands-on observations for selected high-school students, 8.3.2012, M. Tornikoski, J. Tammi, A. Lähteenmäki, M. Oksman

6. Other activities

- Scientific Associate in the Planck satellite's LFI consortium, M. Tornikoski
- Referee for the Publications of the Astronomical Society of Japan, M. Tornikoski
- Referee of observing proposals for the Global Millimetre VLBI Array, M. Tornikoski
- Evaluator for a research funding application to the Latvian Science Council, M. Tornikoski
- Planck satellite Co-Investigator, Planck Scientist, A. Lähteenmäki
- Pre-examiner of Tuomas Lunttila's doctoral thesis "Radiative Transfer Modelling of Interstellar Clouds" at Helsinki University, J. Tammi
- Member of the Examination Committee for Thomas Marquart's dissertation, Uppsala University, Sweden, M. Tornikoski
- Participation in an international pedagogical collaboration project between Aalto University and Tongji University, Shanghai, China, 17. - 24.11. 2012, A. Lähteenmäki

6.1 Participation in boards and committees

- Steering group member of the Ministry of Education graduate school of astronomy and space physics, A. Lähteenmäki

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

- Member of the XMM-Newton A0-11 Observing Time Allocation Committee, A. Lähteenmäki

- Member of IVS Task Force on UT1 Intensives, M. Uunila

- Finnish Astronomical society, vice-president, K. Koljonen

- Finnish Astronomical Society, treasurer, K. Koljonen

- Management Committee member and gender coordinator of the COST-funded research network Black holes in a violent universe, M. Tornikoski

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

- Member of the Finnish National committee of COSPAR (Committee on Space Research), M. Tornikoski

- Member of the Onsala Space Observatory Time Allocation Committee (OSO + APEX time allocation), M. Tornikoski

- ESF Committee for Radio Astronomy Frequencies, CRAF, Finland's representant, J. Ritakari

- NEXPReS Consortium Board, chairman, A. Mujunen

- Member of the Scientific Organizing Committee of the Planck conference 2012 "Astrophysics from the radio to the submillimetre - Planck and other experiments in temperature and polarization", to be held in Bologna, Italy, 13. - 17.2.2012, A. Lähteenmäki

- Deputy member of the steering group for Finnish Centre for Astronomy with ESO (FINCA), A. Lähteenmäki

- Scientific Organising Committee of the 11th European VLBI Network

Symposium, France, M. Tornikoski

- Scientific Organising Committee of the EWASS 2013 symposium, member, Finland, M. Tornikoski

- Local Organising Committee and the Scientific Organising Committee of the XII Finnish-Russian Astronomy Symposium, member and chairman of the science session, Finland, M. Tornikoski

- Local Organising Committee of the “Astronomers’ Days 2012”, the national meeting of the Finnish, Astronomical Society, Porvoo, 2. - 4.6.2012, co-chairman, J. Tammi

- Member of the Local Organising Committee of the “Astronomers’ Days 2012”, K. Koljonen

- Member of the Scientific Organizing Committee of the Finnish Astronomers’ Days 2012, Porvoo, 2. - 6.6.2012, A. Lähteenmäki

- The Finnish Astronomical Society (Suomen Tähtitieteilijäseura ry), vice-chairman, until June 2012, J. Tammi

- ELEC Research Winter Day, organising team member, J. Tammi

6.2 International meetings and talks

1. IVS VLBI2010 Workshop on Technical Specifications, Wettzell, Germany, 29.2. - 3.3.2012, E. Rastorgueva-Foi

2. 7th IVS General Meeting, Madrid, Spain, 4. - 9.3.2012, M. Uunila, N. Kareinen

3. NEXPReS WP8 meeting, Schiphol, Netherlands, 23. - 24.3.2012, A. Mujunen, T. Salminen

4. Planck Joint Core Team - meeting and WG8-meeting, Paris, France, 9. - 11.5.2012, A. Lähteenmäki

5. 54th GRAF-meeting, Cagliari, Italy, 30.5. - 2.6.2012, J. Ritakari

6. The Astronomers' Days 2012, Porvoo, Finland, 4.6. - 6.6.2012, M. Tornikoski, A. Lähteenmäki, J. Tammi, K. Koljonen, E. Rastorgueva-Foi, V. Ramakrishnan

7. Onsala Space Observatory OSO/APEX-Time Allocation - meeting, Stockholm, Sweden, 8.6.2012, M. Tornikoski

8. NEXPReS Board - meeting, Copenhagen, Denmark, 20.6.2012, A. Mujunen, J. Kallunki

9. ALMA Community Days 2012: Early Science in Cycle 1, Munich, Germany, 24. - 27.6.2012, J. León-Tavares

10. EVN TOG-meeting, Onsala, Sweden, 26. - 29.6.2012, A. Mujunen, J. Kallunki, M. Uunila, E. Rastorgueva-Foi, T. Salminen

11. 5th International Symposium on High-Energy Gamma-Ray Astronomy-conference, Heidelberg, Germany, 8. - 13.7.2012, J. Tammi

12. International Conference of Physics Students 2012, Utrecht, The Netherlands, 4. - 10.8.2012, P. Savolainen

13. Summer School on Instruments and detection techniques in high-energy astrophysics, Savonlinna, Finland, 13. - 17.8.2012, V. Ramakrishnan

14. The IAU XXVIII General Assembly, Beijing, China, 17. - 26.8.2012, K. Koljonen

15. The NKG Autumn School, Lammi, Finland, 3. - 7.9.2012, M. Uunila

16. Second Period EC FP7 NEXPReS Project Review, Brussels, Belgium, 20. - 21.9.2012, A. Mujunen

17. The 11th EVN Symposium, Bordeaux, France, 7. - 12.10.2012, E. Rastorgueva-Foi

18. The 9th INTEGRAL workshop and celebration of the 10th anniversary of the launch, Paris, France, 14. - 19.10.2012, K. Koljonen

19. The XII Finnish-Russian Radio Astronomy Symposium, Lammi, Finland, 15. - 18.10.2012, A. Lähteenmäki, N. Lavonen, J. Kallunki, V. Ramakrishnan, E. Rastorgueva-Foi, T. Salminen, P. Savolainen, J. Tammi, M. Tornikoski

20. 1st International VLBI Technology Workshop and DBE Compatibility Testing Workshop, MA, USA, 21. - 27.10.2012, E. Rastorgueva-Foi, T. Salminen

21. The XMM-Newton satellite time allocation committee meeting, Prague, Czech Republic, 31.10. - 2.11.2012, A. Lähteenmäki

22. Onsala Space Observatory OSO/APEX - Time Allocation - meeting, Uppsala, Sweden, 3.12.2012, M. Tornikoski

23. The NEXPReS WP8-meeting, Schiphol, Netherlands, 10.12.2012, A. Mujunen, T. Salminen

6.3 National meetings and talks

1. The Astronomer's Days 2012, Porvoo, Finland, 4.6. - 6.6.2012, M. Tornikoski, A. Lähteenmäki, J. Tammi, K. Koljonen, E. Rastorgueva-Foi, V. Ramakrishnan

2. Summer School on Instruments and detection techniques in high-energy astrophysics, Savonlinna, Finland, 13. - 17.8.2012, V. Ramakrishnan

3. Peda Forum, Espoo, 21. - 22.8.2012, J. Tammi

4. Peda Forum, Esopp, 21. - 22.8.2012, Workshop: Markkinoiko laadukas opetus itse itseään?, A. Lähteenmäki

5. The NKG Autumn School, Lammi, Finland, 3. - 7.9.2012, M. Uunila

6. The XII Finnish-Russian Radio Astronomy Symposium, Lammi, Finland, 15. - 18.10.2012, A. Lähteenmäki, N. Lavonen, J. Kallunki, V. Ramakrishnan, E. Rastorgueva-Foi, T. Salminen, P. Savolainen, J. Tammi, M. Tornikoski

7. Aalto ELEC Winter Research Day 26.2.2012, A. Lähteenmäki

8. Aalto Science Day 20.9.2012, Talk: Planck satellite - solving cosmic conundrums, A. Lähteenmäki

6.4 Public relations

- General Metsähovi excursions and short talks about radio astronomical research to many visiting groups. M. Tornikoski, A. Lähteenmäki

- "Time from the astronomical perspective", an invited lecture and panel discussion for the opening of the photography exhibition "N 45° 54' – N 29° 42' – Standing Still in Motion " by Maija Savolainen (Aalto ARTS), Helsinki, 8.2.2012, J. Tammi

- Solar research presented by Juha Kallunki on YLE program Prismastudio, 21.2.2012

- "Termin avaus: Aika", short article in the Aalto University Magazine, 2/2012, May 2012, Espoo, Finland. ISSN 1799-9324

- "Voiko mustasta aukosta saada energiaa?", an "ask a scientist" answer in ”Tähdet ja avaruus”, 6/2012, Tähtitieteellinen yhdistys URSA, Finland. ISSN 0355-9467

- Härkämäen observatorion AURINKOPÄIVÄ, lecture about the Sun, 22.7.2012, J. Kallunki

- The wall fresco in Myllypuro health centre, Helsinki, created by Terike Haapoja. The work got inspiration from Callisto solar spectrum.

A local grass snake (Natrix natrix) decided that our solar equipment rack was a suitable new home for him (her? we named her Kerttu), see figure 6.1. She had unusual colouring, so we were a bit worried it might be some other species than the non-poisonous one. We tried to catch her, but she was too fast and kept returning back to her new favourite place. Because this species is also protected, we decided to call the local fire brigade to rescue her away from the Metsähovi premises.

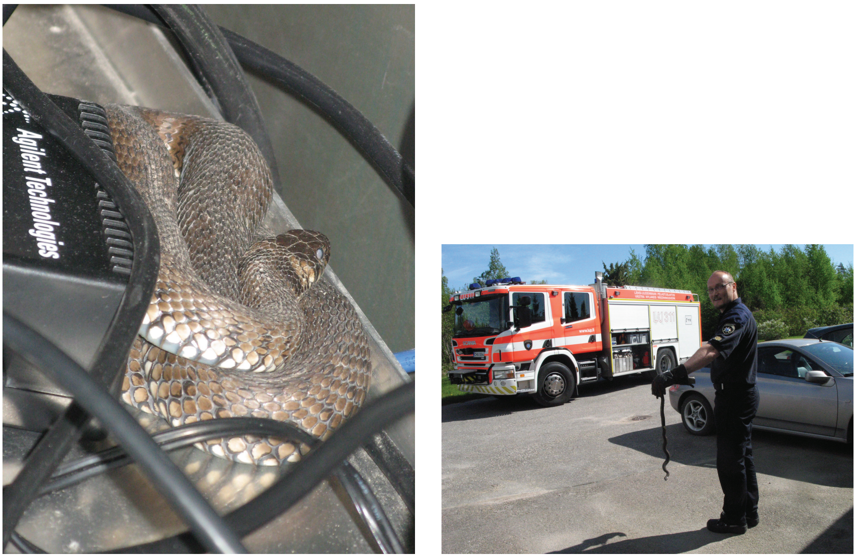

Figure 6.1. Kerttu in her favourite warm spot in the rack and the snake ready to be carried away to her natural habitat.

7. Personnel in 2012

Permanent positions funded by Aalto University

Tornikoski, Merja, Prof.	Director of the institute Docent of Radio Astronomy and Space Technology	merja.tornikoski@aalto.fi
Aatrokoski, Juha, M.Sc. (Tech)	System administrator	juha.aatrokoski@aalto.fi
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Kallunki, Juha, Lic.Sc. (Tech)	Laboratory Engineer	juha.kallunki@aalto.fi
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Lähteenmäki, Anne, D.Sc. (Tech)	Researcher	anne.lahteenmaki@aalto.fi
Mujunen, Ari, M.Sc. (Tech)	Laboratory Engineer	ari.mujunen@aalto.fi
Oinaskallio, Erkki, Mr.	Technician	erkki.oinaskallio@aalto.fi
Rönnberg, Henry, Mr.	Mechanician	henry.ronnberg@aalto.fi

Scientific and technical staff funded by research contracts

Järvelä, Emilia, student	Research assistant part-time 1.1. - 31.5., 1.9. - 31.12.2012 fulltime 1.6. - 31.8.2012	emilia.jarvela@aalto.fi
Kareinen, Niko, student	Research assistant	niko.kareinen@aalto.fi
Koljonen, Karri, M.Sc.	Doctoral candidate	karri.koljonen@aalto.fi
Lavonen, Niko, student	Research assistant part-time 1.1. - 15.5., fulltime 16.5.-31.12.2012	niko.lavonen@aalto.fi
León-Tavares, Jonathan, Ph.D.	Post-doc Researcher 1.1. - 31.7.2012, Visiting Scholar 1.8. - 31.12.2012	j.leontavares@aalto.fi
Lindfors, Timo, student	IT - support part-time 1.1. - 31.12.2012	timo.lindfors@aalto.fi
Molera Calvés, Guifré, D.Sc. (Tech)	Doctoral candidate 1.1. - 8.1.2012 Visiting Scholar 9.1. - 31.12.2012	guifre.molera@aalto.fi
Nieppola, Elina, D.Sc. (Tech)	Visiting Scholar	eni@kurp.hut.fi
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Ramakrishnan, Venkatessh, M.Sc.	Doctoral candidate from 1.2.2012	verama@kurp.hut.fi
Rastorgueva-Foi, Elizaveta, Ph.D.	Post-doc researcher	elizaveta.rastorgueva@aalto.fi
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Salminen, Tomi, student	Research assistant from 1.2.2012	tlsalmin@kurp.hut.fi
Tammi, Joni, Ph.D.	Post-doc researcher	joni.tammi@aalto.fi
Uunila, Minttu, M.Sc.	Doctoral candidate part-time 1.1-31.12.2012	minttu.uunila@aalto.fi

HUT-MET-33 P. Sjöman, N.J. Hughes: Planck Technology 70 GHz Demonstrator Test Report. 2001.

HUT-MET-34 T. Liljeström, C.R. Gwinn: Water Masers Probing Magnetic Pressure and Alfvénic Turbulence in W49N. 2001.

HUT-MET-35 T. Liljeström: Radio Spectroscopic Studies on Cosmic Water Masers. 2001

HUT-MET-36 V.V. Zaitsev, A.G. Kislyakov, S. Urpo, A.V. Stepanov, E.I. Shkelev: Low-Frequency Modulations in Solar Millimeter Wave Bursts. 2001.

HUT-MET-37 F.T. Rantakyrö, K. Wiik, M. Tornikoski, E. Valtaoja, L.B. Bååth: Multifrequency Interferometer and Radio Continuum Monitoring Observations of CTA 102. 2002.

HUT-MET-38 T. Savolainen, K. Wiik, E. Valtaoja, S.G. Jorstad, A.P. Marscher: Connections Between Millimeter Continuum Variations and VLBI Structure in 27 AGN. 2002.

HUT-MET-39 A. Greve, P. Könönen, D.A. Graham, K. Wiik, T.P. Krichbaum, J. Conway, F. Rantakyrö, S.Urpo, M. Grewing, R.S. Booth, D. John, S. Navarro, A. Mujunen, J. Ritakari, J. Peltonen, P. Sjöman, M. Berton: 147 GHz VLBI observations: Detection of Fringes on the 3 100 km Baseline Metsähovi – Pico Veleta. 2002.

HUT-MET-40 Pekka Puhakka: Metsähovin Radiotutkimusaseman aurinkoantennin suuntausvirheitä. 2002.

HUT-MET-41 Pekka Puhakka: Gain measurements of a total power radiometer. 2002.

HUT-MET-42 Kaj Wiik: VLBI and total flux density investigations of the structure of active galactic nuclei. 2002.

HUT-MET-43 Pekka Sjöman: Planck 70 GHz LFI, elegant breadboard FEM/BEM receivers. 2002.

HUT-MET-44 Zaitsev, V.V., Kislyakov, A.G., Urpo, S., Stepanov, A.V., Shkelev, E.I.: Solar millimeter wave bursts: time-frequency analysis. 2003.

HUT-MET-45 Tornikoski, M., Urpo, S. (toimittajat): Astrofysiikan ratkaisemattomat kysymykset. S-92.605 Avaruustekniikan lisensiaattikurssi. 2003.

HUT-MET-46 Urpo, S., Puhakka. P., Oinaskallio, E., Mujunen, A., Peltonen, J., Rönnberg, H., Hurtta, S., Tornikoski, M., Teräsranta, H., Könönen, P.: Selected Radio Maps and Major Solar Radio Flares Measured at Metsähovi in 1996-2001. 2003

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