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Metsähovi Radio Observatory
Annual Report 2004

M. Tornikoski, A. Mujunen (editors)

Metsähovi Radio Observatory
Helsinki University of Technology

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

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

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

Metsähovin radiotutkimusasema
Teknillinen korkeakoulu
Metsähovintie 114
02540 KYLMÄLÄ

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1 Introduction

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

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

Around 13 scientists, engineers, research assistants and support personnel work at the observatory. Six of the employees are funded by the Helsinki University of Technology, and the others by research projects financed mainly by the Academy of Finland. In 2004 the total expenditure of the Metsähovi Radio Observatory was about 685 000 euros, including salaries and the rent of the office and laboratory space at the Metsähovi premises. This was financed by Helsinki University of Technology (65 %), Academy of Finland (25 %), European Union (6 %) and other outside sources (4 %). Unfortunately the funding situation has been getting worse during the recent years, forcing us to cut back expenditure on many items, including both scientific research as well as maintenance and technical development issues.

Year 2004 marked the end of an era in Metsähovi: the long-term director of Metsähovi, professor Seppo Urpo, retired at the end of February, and Dr. Merja Tornikoski was appointed the acting director. Seppo Urpo now has a professor emeritus status and still works on the Metsähovi Solar database and often visits the observatory. During his first weeks of retirement Seppo also wrote the early history of Metsähovi (at the request of the present staff—we realized that Seppo is the only person who knows all the details and anecdotes related to the early history of Metsähovi). These memoranda were published in the Metsähovi publication series (in Finnish), and they are a vivid collection of the eventful early history, ending at the Metsähovi "First Light". We are grateful to Seppo for having spent his long career making Metsähovi a top notch international level radio astronomical research institute, and we are also happy that he wrote and published the early history, which is both informative and very entertaining.

On April 6th 2004 Metsähovi celebrated its 30th anniversary. We celebrated this event, "30 Years of Radio Astronomy in Finland" with colleagues, collaborators, and high-level guests, for example from the Ministry of Education. The programme consisted of a short presentation of Metsähovi's recent developments and achievements by Merja Tornikoski, cocktails inside the radome, a tour of the Metsähovi premises, coffee and cake, and talks about the history of Metsähovi by the two former directors, professors emeritae Martti Tiuri and Seppo Urpo.

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, Oinaskallio, Ritakari, Rönnberg, Sjöman, Urpo

2.1.1 3 and 2 mm SIS Receivers

Project team: Peltonen, Mujunen, Oinaskallio, Urpo

A new mm-wave SIS receiver for 3 and 2 mm wavelengths designed at Institute of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, Russia, was delivered to Metsähovi in 2003. During 2004 some improvements to the front end, the LO system and IF processing unit were performed by the IAP personnel together with Metsähovi engineers. The receiver showed stability problems of the IF output level on the antenna as a function of the elevation angle. These fluctuations were finally suppressed to an acceptable level in order to make VLBI observations possible. Repairing or upgrading the SIS front end is a very tedious job because the receiver always needs to warm up, the dewar must be opened, and a new cooling cycle started (which takes about 12 hours) after the repair operation.

The dual channel SIS receiver was tuned for a signal center frequency of 86.251 GHz. For the front end adjustment two backshorts, bias voltages for the SIS junctions and LO power levels for both mixers must be remotely controlled from the control room with a computer in order to achieve the best sensitivity. The average noise temperature at this signal frequency was around 100 K. Basically there exists three main inherent drawbacks in SIS receivers compared to old Schottky mixer receivers. The LO power is fed in an open structure with lenses, mirrors and a beam splitter which reflects only a fraction of the LO power to the mixer and the main part is wasted to an absorber. Even a small change in this environment will cause LO power level to vary and that will directly affect the output IF level. The bias voltage for SIS junction is around 5 mV (compared to Schottky‘s 700 mV), thus any electrical interference from outside can have an adverse effect to the output stability. The third drawback is that the SIS receiver front end cannot be tested at all at room temperature.

The LO source for the 3 mm receiver is an InP Gunn oscillator. Due to the fact that the output frequency is a monotonic function of the bias voltage, the phase locking can be accomplished with the adjustable DC power supply. The output frequency of the Gunn oscillator mount can be remotely adjusted by a coarse tuning micrometer, and in the same way the optimum output power level set by a adjustable backshort. Part of the LO signal is fed to a harmonic mixer and is mixed with a X-band frequency standard derived from a Rohde & Schwarz synthesizer. The first IF frequency of the PLL system is selected to be 275 MHz, thus f(LO) = Nxf(snt)+275 MHz. The harmonic mixer seems to favour odd harmonic numbers, i.e. N=9 is selected. With this scheme the synthesizer frequency is set to f(snt) = 9.114 GHz and the desired LO output frequency of 82.301 GHz can be exactly stabilized. The PLL IF signal is divided by 11 in order to perform the phase comparison at 25 MHz. This signal can be monitored in the control room with a spectral analyzer allowing the spectral purity to be optimized. If the PLL fails, an alarm signal is sent to the control computer.

One of the many problems with the phase locking was the tendency of the Gunn diode for bias oscillations which can cause a permanent failure of the diode. This problem was solved by a suppression circuitry at the output of the bias supply. This protective circuit has, however, an unfavourable influence on the PLL system as it decreases the loop bandwidth. A suitable compromise between these two contradictory requirements was found, and the phase locking proved to be reliable during the measurement session.

Two new circular polarizers were designed and fabricated with centre frequencies of 86 and 147 GHz, respectively. The material used for both is STYCAST 0005 low loss plastic material which is hard enough to allow machining with high accuracy. The polarizers are constructed of consecutive grooves symmetrically machined on both sides of the solid support material. The groove widths and the ridges between the grooves are 0.5 mm for 86 GHz and 0.3 mm for 147 GHz, respectively. The solid support material thickness is selected to be one wavelength in the dielectric material ($\varepsilon_r = 2.54$) which gives the following values : 2.2 mm for 86 GHz and 1.28 mm for 147 GHz. The performance of these polarizers cannot be measured at our Observatory. However, another polarizer designed and manufactured with the same principles was measured in 2002 at IRAM (Grenoble) and results confirm that it exhibits the desired phase shift and has very low transmission losses.

2.1.2 Receiver Maintenance and Upgrades

Project team: Peltonen, Oinaskallio, Rönnberg

During 2004 both 22 GHz and 37 GHz old Dicke-switched continuum receivers (which are used during most of the telescope time allocation) operated without any failure. However, there have arised doubts how long the LO sources will survive. Both of them have a GaAs Gunn oscillator mount as a LO and it is well known that these devices have only a limited life time because of the low efficiency and thus a high operation temperature of the semiconductor material. For this reason plans to replace these in case of failure have been made in advance. A YIG oscillator with an output of +13 dBm and center frequency of 11 GHz followed by a power amplifier and a doubler gives enough power at 22.2 GHz to drive the mixer. The frequency of the YIG oscillator can be coarse tuned by a tuning voltage which must have very small ripple to create a spectrally pure microwave signal. For the 37 GHz receiver the Gunn oscillator can be readily replaced by a similar commercial oscillator used in the 37 GHz Solar receiver. This receiver has not been used much during the last years.

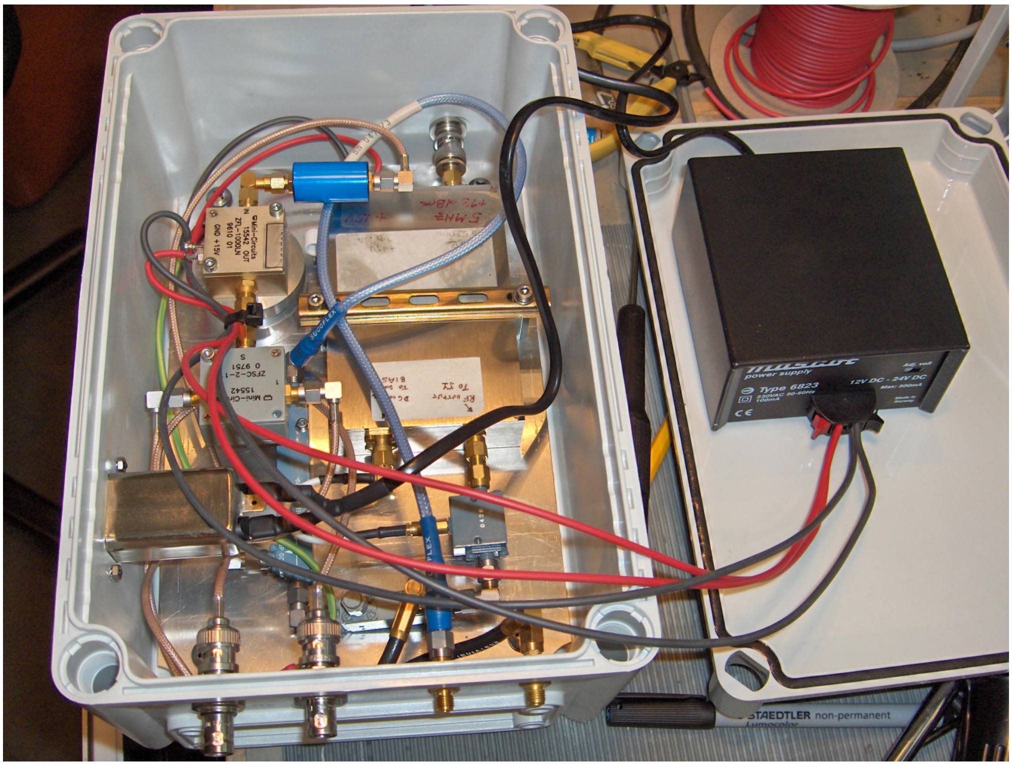

Figure 1: VLBI phase calibrator unit.

Phase calibration is essential for VLBI observations. A unit which can be used for both Geo-VLBI receiver and 22 GHz receiver was constructed. The basic phase calibrator was designed at Istituto di Radioastronomía (IRA), Italy, and it gives a train of pulses with 1 MHz separation generated from the 5 MHz frequency standard. The strength of the spikes is of course higher at lower frequencies and will diminish with increasing frequency up to K-band. With two cascaded directional couplers appropriate bands can be selected, first for Geo-receiver (S and X bands), and secondly, for any VLBI-receiver which uses the standard IF output of 500–1000 MHz.

The scheme is based on the fact that stripline couplers have a limited bandwidth for the coupled (usually 20 dB coupling) port but the thru port passes actually all frequencies up to K-band.

2.1.3 IT Infrastructure

Project Team: Mujunen, Lindfors

Metsähovi computing facilities are based on networked Linux computers. A core set of Linux servers offer general-purpose and observational data storage. Another set of dedicated Linux control computers manage the telescope, data acquisition, and auxiliary services such as GPS receivers and weather stations. Finally, a larger set of Linux workstations running the X Window System provide access to Metsähovi personnel.

Apart from the central servers, the installed base of general-purpose workstations is aging rapidly with the mean age of more than 6 years. This has to be addressed in the near future. After severe thunderstorm damage in July 2003, the local area networking equipment is, on the other hand, sufficiently advanced, featuring a gigabit Ethernet fiber-optic backbone and four 24-port 10/100 megabit port wire-speed switches. Two Allied Telesyn switches were acquired to allow for the lengthy repair process of the existing two Hewlett-Packard switches. In addition to these, the experimental four-PC VSIB VLBI disk-acquisition "tower" (see section 2.2) features its internal 8-port gigabit switch. The new Allied Telesyn switches allow easy server connectivity with their extra copper-based gigabit Ethernet ports, and this is planned for the central "`/home`" and "`/data`" NFS servers.

The observatory site was connected to the Internet using a 2 Mbps dedicated leased line. As its monthly lease is approximately fifty times more expensive than a regular asymmetric 2 Mbps/512 kbps ADSL line, the 2 Mbps dedicated line was terminated at the end of year.

The replacement was accomplished with two 2 Mbps/512 kbps ADSL lines from two different service providers. These lines are used to establish a Virtual Private Network (VPN) tunnel to Otaniemi campus. The connection utilizes Linux multilink pppd and OpenSSH encrypted TCP tunnels as the transport for pppd.

However, the emerging eVLBI data transfer tests (see section 2.2) would necessitate a significantly faster 1–2 gigabit link to the CSC/FUNET backbone. Initial request for a quotation was sent to several service providers, and indeed solutions are generally available, including the preferable solution of leased dark fiber giving access to multi-gigabit bandwidths with COTS low-cost equipment. The application for funds to start acquiring the fiber has been finally approved at the university for 2005.

Both the "`/home`" and "`/data`" NFS servers with AMD Athlon 1GHz-class processors and 512MB of memory have been upgraded to 250GB. A subsequent memory/processor upgrade is planned for "`/home`" in 2005. The existing disk subsystems do not use a Linux RAID setup for simplicity. However, they do feature a "live" backup of an equal amount (250GB for both "`/home`" and "`/data`") of regular IDE disk space.

"`/home`" and "`/data`" areas and their backups have been supplemented with an off-site "`rsync`" remote backup server with a perpetual daily snapshot capability. This kind of triple redundancy has eliminated the need for DAT tape-based backups which have proved to be impossible to make without an automated tape switcher. This server is located at Otaniemi campus and it features 400GB of snapshot space for "`/home`" and 250GB for "`/data`".

IDL remains at version 5.4 on "`kurp.hut.fi`" (2 floating licenses). Matlab with shared license support from the university computing centre also remains at version 6.0 on "`kurp.hut.fi`".

For electronics development, PADS (Mentor) PowerLogic and PowerPCB 5.1 were used, together with Xilinx Foundation v2.1i VHDL tools for FPGA development. For future FPGA projects, an upgrade to the latest Xilinx ISE VHDL environment is planned, as well as the upgrade to Mentor PADS2005 release.

2.1.4 New Observational Hardware

Project Team: Mujunen, Oinaskallio, Rönnberg

The long-awaited remote control of the radome heater was finally completed close to Christmas 2004. Its control system was built using a small programmable logic controller (Creuzet Millennium II) to facilitate both manual and computer-invoked control and safety features (time limits, automatic switch-off if overtime). Remote control integrates with the existing ADAM/NuDAM RS-485 control network and its standard "`dammer`" TCP/IP server software. A similar remote control was established for both 22 GHz and 37 GHz continuum receiver calibration noise diodes, too.

Figure 2: Radome heater remote control unit.

The antique antenna pedestal hoist winch, which had not been used since approximately 1985, was dismantled and removed from the pedestal for a complete revamp and upgrade of the winch construction. This is being performed in-house by Mr. Rönnberg with the main design goal that receiver swaps can be performed without manual carrying and lifting of the heavy receiver complexes at the antenna pedestal. This should facilitate one-man operation during receiver swaps, as well as make handling of heavy and bulky receivers such as the geodetic S/X and the 2/3mm SIS receiver much more acceptable.

2.1.5 Automatization of Quasar Observations

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

The automatization of quasar observations has been an important project in 2004. In order to save resources and manpower for actual scientific work instead of having research staff personally run routine observations 24 hours a day through the whole year, we have developed several computer programmes that assist observers in the various phases of the observation process (Figure 3). This system does not perform fully automated observations, but human intervention is needed only at certain critical stages. Now practically everything can be run also in a remote mode (for example, observer's home). Thus a researcher can take care of a 24 hour observing shift and still get some other work done, plus sufficient sleep during the night. However, some time must be spent on taking care of the pointing and calibration checks, and planning observing lists for automated observing periods (which typically last for several hours but only rarely a full night or more).

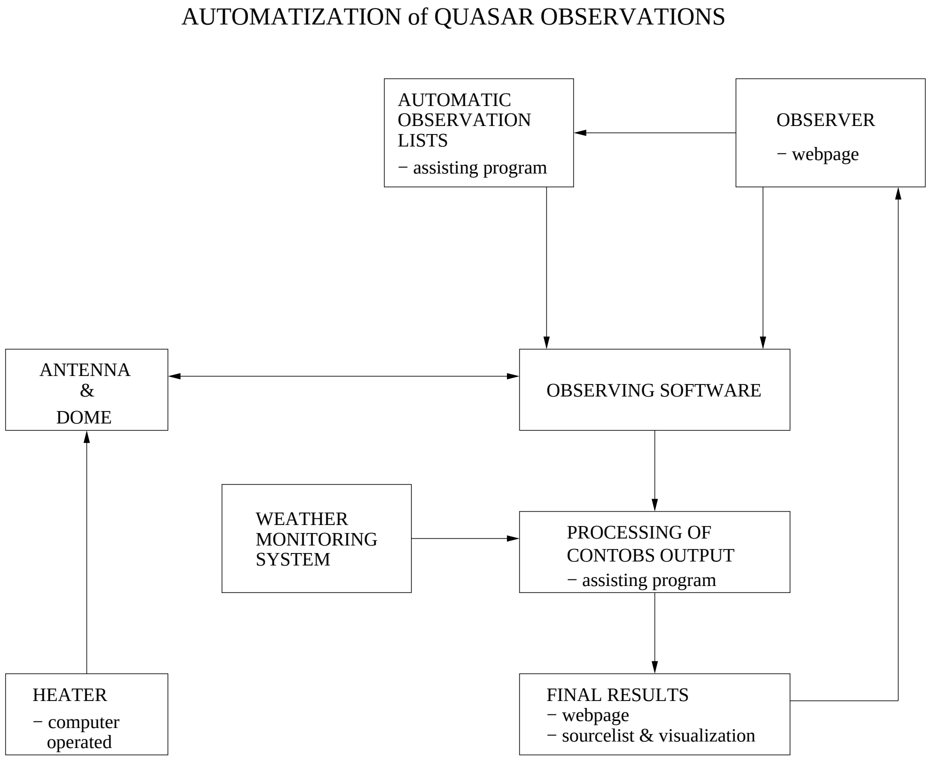

Figure 3: Automatization of quasar observations.

In order to make automatic observations, a list of sources has to be fed into the computer. One of the new programmes helps the observer in selecting suitable sources for these lists (that is, sources that are visible at the right time and in the right direction of the sky). It also takes care that the list is in a correct format.

Another programme serves as an interactive sourcelist and visualization tool. The programme, for example, notifies users if some sources have not been observed for a long time, and it can also draw lightcurves of the sources. Observers can set high priority marks to interesting sources, manage the source list according to the recent behaviour of the sources, or to point out requests from our collaborators (flaring sources, targets of multifrequency campaigns etc.). This tool has become increasingly important due to the large number of sources on our master source list: it is very difficult for the observers to be familiar with each individual object on the list, so the priority system and the attached information fields act as a guide for making the choices when designing a source list for the shift's observations.

The output of the observing software is raw data, from which only certain parts are needed to calculate the final results. Moreover, weather data has to be taken into account when reducing the data. The manual derivation of the final results is rather time consuming and thus a programme was developed to gather the needed data and to attach the correct weather information to it, so that the need for manual result log keeping has been eliminated.

The computer control of the radome heater was finished in December 2004. The heater can be operated even with a remote computer, which makes remote observations possible also after rain or snow fall. Timed heatings can be implemented as well.

Besides the automatization, changes were made also in the areas of management of observation shifts and information exchange between the members of quasar monitoring project in order to make the observing sessions more fluent and efficient. The key factor in this progress has been a webpage in which all the needed information about quasar observations is collected.

Acknowledgements Our team thanks Mr. Erkki Jussila / Heinolan Poltinohjaus Oy for kindly providing us with the necessary hardware and expertise that was required to complete the remote control of the heater.

2.1.6 Clock Difference Measurements

Project team: Koski, Oinaskallio, Mujunen

The design of "Clodi" clock difference counter was completed in 2004 and a protype series of five units was manufactured. The internals of the latest revision, "Clodi 6" is shown if Figure 4.

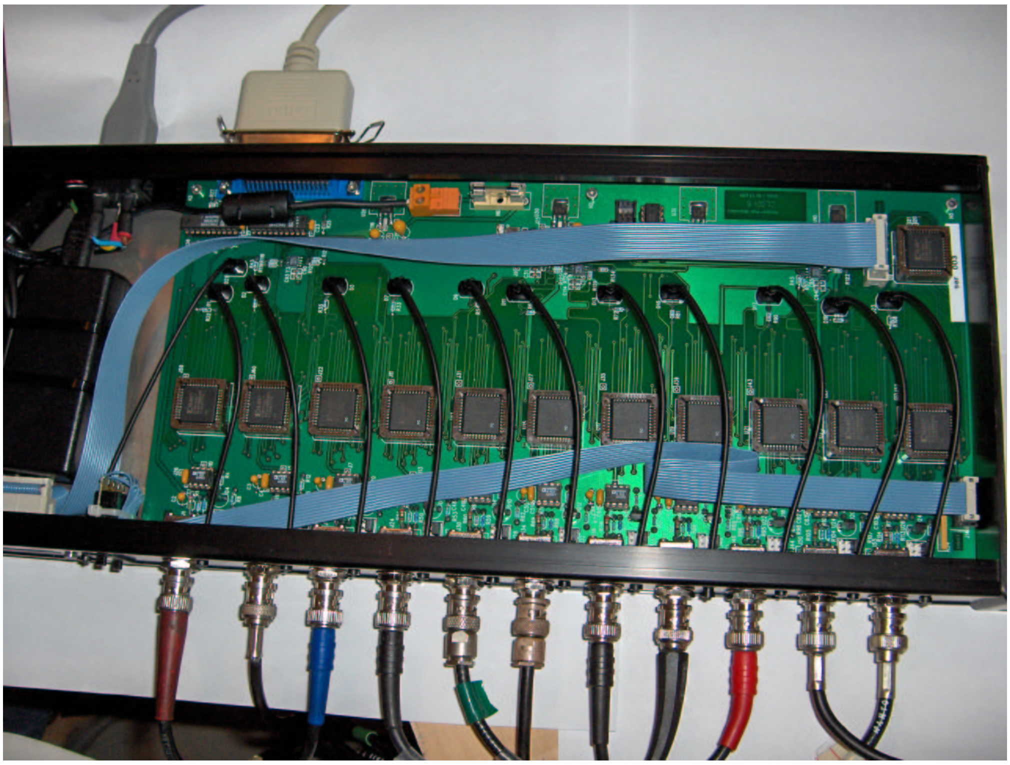

Figure 4: Clodi 6.

2.2 Development of Next Generation VLBI Recording Systems

Project team: Ritakari, Mujunen

Since the early 1990's Metsähovi Radio Observatory has been one of the few institutes in the world where Very Long Baseline Interferometry (VLBI) data acquisition systems have been constructed and developed further. Recently our team has focused on transforming Commercially Available Off-the-Shelf (COTS) technology for VLBI data acquisition applications. The highly successful COTS Linux PC-based Metsähovi disk recorder design was completed in 2002, and a total of one hundred VSIB data acquisition boards and VSIC converter boards were produced.

The system has been put to test on several occasions: in 2002 resulting in world-first 1Gbps international VLBI experiment ever, in February 2003 getting the first international 1Gbps 22 GHz continuum fringes between Metsähovi and NICT/Kashima, in March 12th 2003 Metsähovi and Jodrell Bank Observatory succeeded in the first European 1Gbps VLBI experiment, and in June 17th 2003 Metsähovi and NICT/Kashima succeeded in the first international 2Gbps experiment. This VLBI speed record is still unbroken. The data were recorded with Metsähovi designed terminals at Metsähovi and PC-VSI terminals at Kashima. Metsähovi data was transferred via Internet to Kashima and correlated with a high-speed software correlator.

In the first eVLBI tests it was quickly realized that the conventional Internet protocols are in practice two orders of magnitude too slow for high-speed networks. Thus we have started evaluating high-speed Internet protocols for eVLBI and have identified several candidates: Sabul, UDT, Tsunami, Fobs, Reliable Blast UDP, and GTP. In the preliminary data transfer tests to JIVE, Metsähovi VLBI team achieved an order of a magnitude improvement to the normal TCP/IP transfer speed.

A second set of record-breaking file transfer experiments were performed in cooperation with CSC, the Finnish information technology centre for science, and the operator of the Funet network. Large files of actual observed VLBI data were transferred to JIVE at speeds constantly above 512Mbps. The experiment was internationally acknowledged (see the article "58 GigaByte File Transfers" in EU Information Society Technologies (IST) newsletter at `http://www.cordis.lu/ist/rn/ri-cnd/news_oct_04.htm`). Soon after the first success, the transfer rate was further improved to be consistently more than 640Mbps (see `http://ivscc.gsfc.nasa.gov/pipermail/ivstech/2004/000071.html`). This discussion list of International VLBI Service (IVS) clearly depicts how Metsähovi is leading the current eVLBI development (see `http://ivscc.gsfc.nasa.gov/pipermail/ivstech/2004/thread.html`.)

This far all the previous data transmission tests have been file-to-net-to-file based and have been performed at the Otaniemi campus. In the near future Helsinki University of Technology will support a multi-gigabit fiber-optic network connection to the Metsähovi Radio Observatory site, which will allow development of real-time transmission of VLBI data, directly from the radio telescope into the JIVE VLBI correlator. This will speed up tremendously the data processing turn-around time of scientific VLBI observations.

The Australia Telescope National Facility (ATNF, operated by CSIRO) and University of Tasmania (UTAS) have enhanced their VLBI observational capabilities by acquiring seventeen Metsähovi disk-based VLBI data acquisition systems to be used at their six observatories. Furthermore, the system has been extended to support 24 hour continuous and automated extreme resolution Vela pulsar observations at ATNF Mount Pleasant station. (See `http://www.oan.es/evn2004/WebPage/RDodson.pdf`.) Several systems are also in use in Canada, Germany, Italy, the Netherlands, UK, and USA.

Metsähovi disk VLBI recorders were to play a key role also during the ESA Huygens probe, on-board the Cassini Saturn mission, descend into Titan on January 14th 2005. Even though not visible for European stations, an exceptionally large number of VLBI observatories in the US and on the Australian continent, seventeen, will follow and record the faint Huygens-Cassini S-band signal during the descent to Titan. VLBI observations are correlated and specially post-processed at JIVE to reconstruct the descent trajectory of Huygens probe. Since four of the Australian observatories (including the 64-meter Parkes dish) are equipped with Metsähovi VLBI disk recorders and ATNF DAS systems, a way had to be found to convert ATNF DAS bit stream data into a format acceptable by the JIVE correlator. The versatility of Metsähovi PC-based recording allowed us to develop reformatting and narrow-band data extraction software which allows the Australian stations to join this unique experiment.

Future developments will focus on transforming eVLBI data transfers to a commodity operation which will be performed routinely during regular VLBI observation sessions. Software development both in protocols and in observation control and transmission automation will be needed. The general trend in VLBI developments will lead us to consider problems in radio astronomy as problems in Information and Communication Technology (ICT). We will continue our successful series of technology demonstrations of applying COTS ICT in VLBI data acquisition.

2.3 VLBI Observational Activities

2.3.1 Geodetic VLBI Project

Project Team: Mujunen, Urpo, Oinaskallio, Rönnberg

Figure 5: Setting up one of the first VLBI Standard Inteface (VSI) based acquisition systems for unformatted VLBA sampler data at 1Gbps. Two Metsähovi VSI disk recorders have been connected in daisy-chain fashion using standard VSI cabling. The universal VSIC converter on top of the recorders provides VSI output out of unmodified VLBA samplers.

The swap-in/swap-out mountings for the 1.7m geodetic subreflector have proved to provide repeatable mount/unmount sequences in five geodetic VLBI runs in 2004. A rechargeable battery operated precision winch was adapted to subreflector lifting, enabling the swap to be performed by just one operator.

The problems regarding the S/X receiver autonomous control system and the auto-controlled vacuum pump and cryocooler power switches were resolved by disabling and removing these facilities in the receiver. This made the receiver unit approximately 15 kg lighter, speeded up the vacuum establishing process, eliminated blown fuse issues, and ensured that a cold He compressor is not started without warm-up.

Additionally, the phase cal injector now has a pedestal-mounted enclosure with power supply and RF electronics, and the Finnish Geodetic Institute provided a cable length measuring system based on a high-accuracy picosecond-class counter and a Linux PC.

At the end of the year a formal research cooperationg agreement was established and signed by the university and the Finnish Geodetic Institute, officially establishing geodetic VLBI observations at Metsähovi Radio Observatory as an on-going venture.

2.3.2 Station Hardware/Software

Project Team: Mujunen, Oinaskallio, Ritakari

The recording quality of our single-headstack VLBA4 recorder remains less than desirable. Numerous attempts to reveal the underlying problem have all failed, and only vague speculations of headstack wear-out or miscontouring remain. Furthermore, one power failure caused the recorder control electronics to power up without resetting the control computer, causing a long continuous run of headstack movement pulses, de-

Figure 6: Geodetic subreflector precision winch (below) with its self-locking mount (above).

stroying the inchworm motor of headstack positioner. The inchworm was replaced and the recorder is again operational but with mediocre recording quality.

For the November EVN session the Joint Institute for VLBI in Europe (JIVE) loaned us a Mark5A hard disk based recorder unit (“mark5-620”). During its setup it was revealed that our Mark4 formatter firmware had to be upgraded to support automatic auxiliary data field updates for it to function correctly with the Mark5A unit.

The total power detectors of IF distributor C/D still have a fault resulting in zero readouts, preventing full-band Tsys measurements of the astronomy RCP channel.

Approximately five BBCs have had synthesizer/PLL faults for years. In conjunction of the start of geodetic VLBI where 14 BBCs are routinely needed for bandwidth synthesization, we started a project to repair a sufficient number of BBC LO synthesizer boards to get at least 15 BBCs up and running.

We had good success in scavenging and mixing and matching LO oscillator boxes and LO synthesizer boards from retired BBC units. However, we remained short of a few synthesizers and had several boards where the same type of fault appeared: the first 10/11 GaAs divider chip was not outputting anything.

We contacted Paul Burgess at Jodrell Bank Observatory, UK, to get one spare synthesizer board from the EVN spare parts pool. He also managed to acquire us a few of the scarce and obsolete GaAs chips, with the hope that we will be able to fix several of our own defective synthesizer boards and could thus replenish the EVN spare pool with these boards. The EVN spare board enabled us to get all 14 BBCs working in the way geodetic VLBI requires in the November geo session.

The FS was upgraded to the version 9.7.1 which supports the “formal” parsing mode of Mark5A control software.

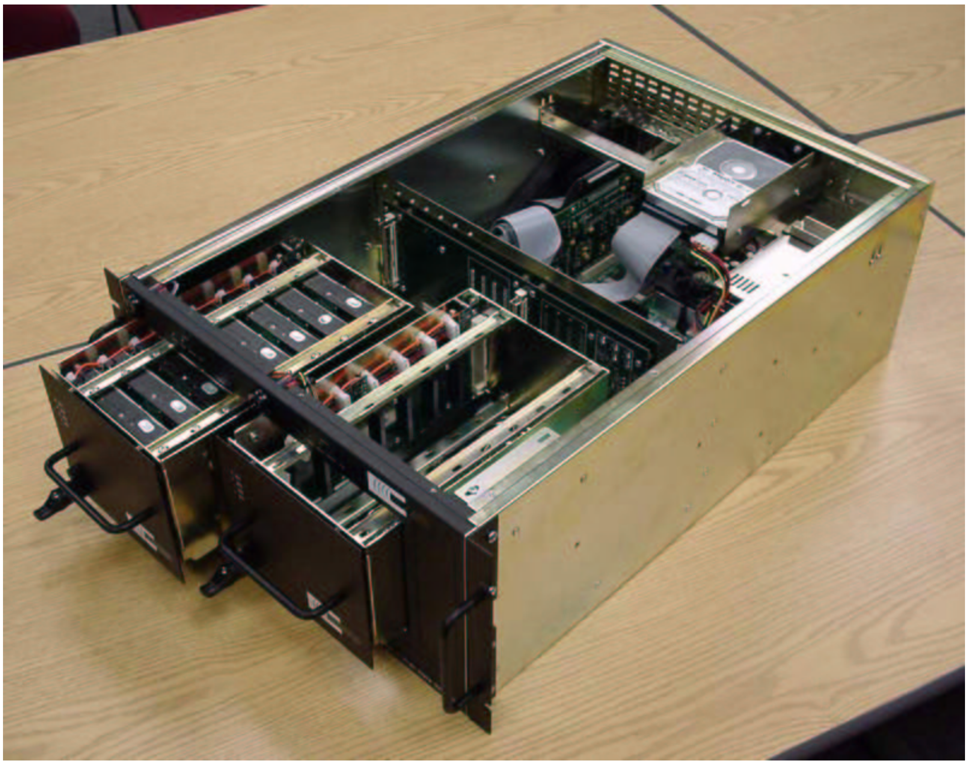

Figure 7: Mark5A disk recorder.

2.3.3 VLBI Sessions in 2004

Project Team: Mujunen

Only two EVN VLBI sessions contained observations at K band, 22 GHz, in February and November 2004. A total of five thin tapes were shipped to the JIVE correlator in February, whereas two disk packs were built for the November session, one 3200GB and one 980GB.

Five geodetic trial runs and test sessions were conducted in 2004, in March, May, September, November, and December. Each of them consisted of a 24 hour run generating approximately one thin tape (or 600GB) of data.

The Coordinated Millimeter VLBI Array (CMVA) was restructured in 2003–2004 as the coordination responsibility was transferred from Haystack Observatory to Max-Planck Institut für Radioastronomie, under the new name of "Global mm-VLBI Array". Metsähovi took part in two GMVA 5-day sessions organized in April and October 2004. Four thin tapes with degraded recording quality were created in April and in October five Mark5A disk packs of 1TB each were recorded. The new 3mm/2mm SIS receiver was successfully used at 86 GHz in these observations in dual-polarization LCP/RCP mode.

2.4 AMS

This project was effectively halted due to manpower problems.

2.5 Micromechanics

Project Team: Rönnberg

Our mechanical workshop manufactured several demanding precision systems for Helsinki University of Technology Radio Laboratory and VTT Technical Research Centre of Finland. The most noteworthy of these are the adjustable micromechanical hologram support structure for the ADMIRALS RTO Compact Antenna Test Range of Radio Laboratory and the miniature waveguide impedance adjuster with a precision quartz blade micropositioner, also for Radio Laboratory.

2.6 Extragalactic Radio Sources

2.6.1 BL Lacertae Objects

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

Observations of a complete sample of BL Lacertae Objects (BLOs) was started in 2001 with the Metsähovi telescope at 37 GHz as part of our studies of various source populations for the Planck foreground science (see subsection Planck). Our aim is to study a complete sample of BLOs from the radio-selected BLOs (RBLs) to the X-ray selected BLOs (XBLs), and to put special emphasis on the study of the Intermediate BLOs (IBLs). It is still unclear whether the detection of the IBLs was due to a selection effect when producing the sample, or whether the sample represents the actual distribution of BLOs, showing a continuous distribution of properties from the XBLs to the RBLs. If we study a complete sample of BLOs, we can get a full understanding of the spectral energy distribution of the BLOs, all the way from the radio-selected to X-ray-selected BLOs, and we can see if there is a continuity from subsample to subsample, and whether this fits within the framework of the unification models of AGNs.

Most of the XBLs and IBLs have never been observed at high radio frequencies beforem and we wanted to see whether this is justified or not. By autumn 2004 we had covered almost 100 % of the sample (about 400 sources from Véron-Cetty & Véron 2000), and for some of them we have multi-epoch data. Of all of these, more than one third were detected, and, about one third of the X-ray and intermediate BLOs, too, that have previously been thought to be too faint at higher radio frequencies. In the near future we are going to apply the updated version of the BLO source catalog with doubly as many sources, and expand this programme for a longer-term monitoring of their variability.

In her Master's thesis Elina Nieppola studied the properties of the Metsähovi BL Lac sample. Traditionally BL Lacs have been classified as either RBLs or XBLs according to the frequency band on which they were discovered (radio, X-rays). These two classes differ, for example, in variability and polarization properties, and at first seemed to be completely separate. Later objects with intermediate properties were found, suggesting that the BL Lac population might be continuous. This continuum in properties is thought to be caused by the difference in the synchrotron cutoff frequency. BLOs got a new classification scheme: objects with their synchrotron peak in the radio/IR band are low-energy synchrotron peak BL Lacs (LBLs) and objects peaking at the UV/X-ray frequencies are high-energy synchrotron peak BL Lacs (HBLs). Objects in between are called intermediate BL Lacs (IBLs).

The aim of Nieppola's thesis was to use the Metsähovi BL Lac sample of 398 objects to determine if the BL Lac population is in fact continuous. A large database of flux data points at several frequency bands was collected. When possible, the data were used to plot the object's spectral energy distribution (SED). The SEDs were fitted with a parabolic function to determine the synchrotron peak frequency. This could be done to 308 plots. The objects were classified according to their synchrotron peak as follows: for LBLs $\log \nu_{peak} < 14.5$, for IBLs $\log \nu_{peak}$=14.5–16.5 and for HBLs $\log \nu_{peak} > 16.5$. The average luminosities at 37 GHz were also calculated to check the correlation of the synchrotron peak frequency and the radio luminosity. The logarithmic ratio of x-ray to radio flux, $\log (S_x/S_r)$, was determined for each object, as well as broad band spectral indices from radio to optical (α_{ro}) and optical to x-ray (α_{ox}) frequencies.

The sample was divided evenly between the different classes, so that there were about 100 of each. There was significant negative correlation between the synchrotron peak frequency and the radio luminosity at 37 GHz. No evidence of low luminosity LBLs or high luminosity HBLs were found. There were 22 objects with $\log \nu_{peak} > 19$. These can be considered as candidates for ultra-high-energy BL Lacs (UHBLs). They are ex-

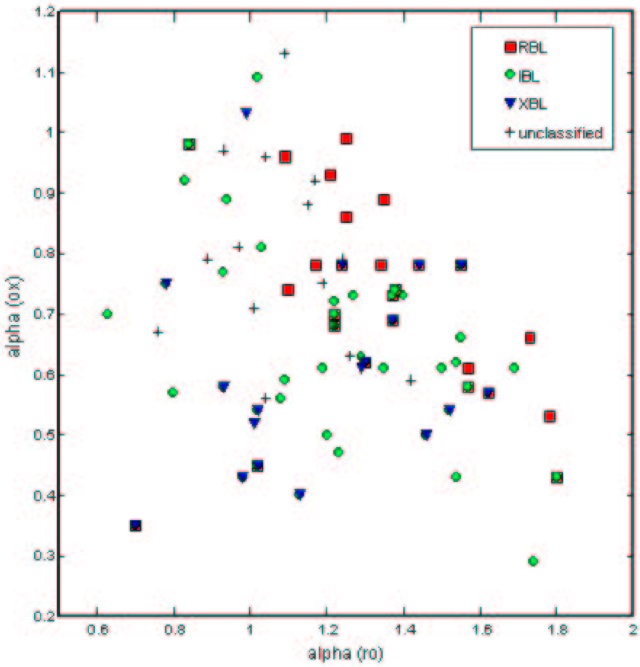

Figure 8: α_{ro} vs. α_{ox} -plot of BL Lacertae objects.

cellent targets for gamma-ray observations. The distribution of x-ray to radio flux ratios, $\log(S_x/S_r)$, appeared smooth and consistent. The division around the value -5.5, which is characteristic of RBLs and XBLs, cannot be seen. In the α_{ro} vs. α_{ox} plot well-known RBLs and XBLs occupy different regions of the plane as expected, but the sample as a whole is evenly distributed (Figure 8). Therefore, it can be concluded that the BL Lac population is continuous and the luminosities seem to depend on the synchrotron peak frequency.

The results derived by Elina Nieppola during her thesis work will be published in 2005, and we are also preparing a data paper about our BLO observations.

2.6.2 Fainter Flat-Spectrum Sources

Project Team: Lähteenmäki, Tornikoski, Valtaoja (Turku)

When selecting candidates for high radio frequency observations, it is generally assumed that the radio spectra peak at relatively low frequencies and get very steep in the millimetre wavelength range. Thus, only sources exceeding a certain flux limit and showing a flat spectrum at the low frequencies often end up being monitored in the millimetre domain. This is why studies made at radio frequencies higher that 8.4 GHz have usually excluded the fainter (say, 0.1–1 Jy) flat-spectrum sources, and practically no high frequency data exist for sources with the flux density S less than 0.5 Jy at 2.7 GHz. Also, the selection is often based on only one-epoch observations at low frequencies (especially true for southern sources). These sources may have been observed during a quiescent state, and in reality even their low frequency fluxes can be much higher than assumed.

Our earlier studies (for example, Tornikoski et al. 2000, 2001) have shown that at high radio frequencies, a typical variable AGN spends much more time in the quiescent or intermediate state than in an active state, and that many sources assumed to be “too faint to be detected at millimetre frequencies” can at times reach relatively high (up to 1 Jy) flux levels. These emphasize the importance of making multi-epoch observations of “faint” AGNs, because also these sources may at times significantly contribute to the Planck extragalactic foreground (see subsection Planck). Also, the brightest sources mostly observed, of course, are not very representative of the whole population. This is why we have started a programme to study the instantaneous continuum spectrum of fainter flat-spectrum sources with RATAN-600, the world’s largest radio telescope, at a frequency range of 1–22 GHz. We have signed a collaborative agreement with the Special Astrophysical Observatory of Russian Academy of Sciences, the St. Petersburg State University, and the St. Petersburg State Technical University. We have already had several successful observing runs, and more are planned for winter 2004/2005 and spring 2005.

2.6.3 WMAP Point Sources

Project Team: Lähteenmäki, Tornikoski, Hovatta, Kotiranta

The WMAP satellite detected 208 extragalactic foreground radio point sources (Bennett et al. 2003). WMAP is not as sensitive an experiment as the Planck satellite will be. Nevertheless, its results can give some indication of what can be expected of Planck. Thus, immediately after the release of the WMAP results in early 2003, we started follow-up observations of the WMAP point sources, together with Planck Extragalactic Working Group 6. Most of the WMAP sources are of course well known but many (19) have multiple identification candidates. Also, some well known sources seem to be mysteriously missing from the WMAP list. WMAP observed the sources at five radio frequencies, thus giving an insight also to the shape of the spectra. Some of the sources have been observed with the Very Large Array (VLA) by Bruce Partridge and his group, to confirm the coordinates of the multiple identification WMAP point source detections. Our group observed all candidates for each source with the Metsähovi telescope at 37 GHz and 7 primary candidates with the SEST at 90 GHz during 2003 and 2004. According to the preliminary results, some of the primary candidates certainly are the correct identifications but for some sources the identification is much more complicated, a result confirmed also by Trushkin (2003). A paper is in preparation, combining the VLA and the Metsähovi results.

2.6.4 Inverted-Spectrum Sources

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

We have been observing new samples of Gigahertz-Peaked Spectrum (GPS) sources with the Metsähovi telescope at 37 GHz, every other week since November 2001, and with the SEST (Swedish-ESO submillimetre Telescope) at 90 GHz until the end of its operation in 2003. Initially the purpose was to search for new high-peaked sources, to study the variability of the “bona fide” GPS sources and the models used for describing them, and to study the impact of our findings on the Planck mission. Our group has identified some new extreme peaking GPS sources, but in particular we have shown (Tornikoski et al. 2001; Torniainen et al. 2005) that many sources currently identified as “bona fide” GPS sources and candidates in the literature actually are ordinary flat spectrum sources with high variability and spectra that get inverted only during flares. The current working hypothesis is that the number of genuine GPS sources is smaller than the estimates given in the literature. However, the number of sources that sometimes, i.e. in their active state, peak at high radio frequencies seems to be higher than earlier assumed. This result is also of great importance for the Planck mission, because these sources can at times be extremely bright at the Planck frequency range. This emphasizes the importance of the prediction of source activity states during the mission, as well as the role of the radio flare modelling.

2.6.5 Compact Steep Spectrum Sources

Project Team: Tröller, Tornikoski, Valtaoja (Turku)

Compact steep spectrum sources are high luminosity radio sources with steep spectra. Their (radio) size is much smaller than normal radio galaxies. They may be young sources or alternativey old and frustrated objects. In either case they provide important constraints on the environmental factors influencing the origin and evolution of powerful radio sources.

A sample of CSS sources obtained with the Nordical Optical Telescope (NOT) in R- and V-bands has been studied to distinguish between the two evolution scenarios.

A detailed photometric analysis was applied using a two-dimensional surface brightness model. The model consists of two components, a core representing the nuclear component and a host galaxy. The core was described by a scaled point-spread-function (PSF) whereas the model of the host galaxy was assumed to have constant elliptical surface brightness contours.

It was found that in the optical the nuclear component is nearly always weaker that the host galaxy (except for two cases). The hosts of CSS sources are large and bright ellipticals, with an absolute brightness in the R-band of $< M_R >$ = -24.4mag and $< M_V >$=-24.9mag in the V-band. The mean half-light radius is $r_{eff} = 11kpc$.

The shapes (see Figure 9) of the hosts would seem to confirm the youth scenario in which these sources are evolving radio galaxies. The results will be published in the first half of 2005.

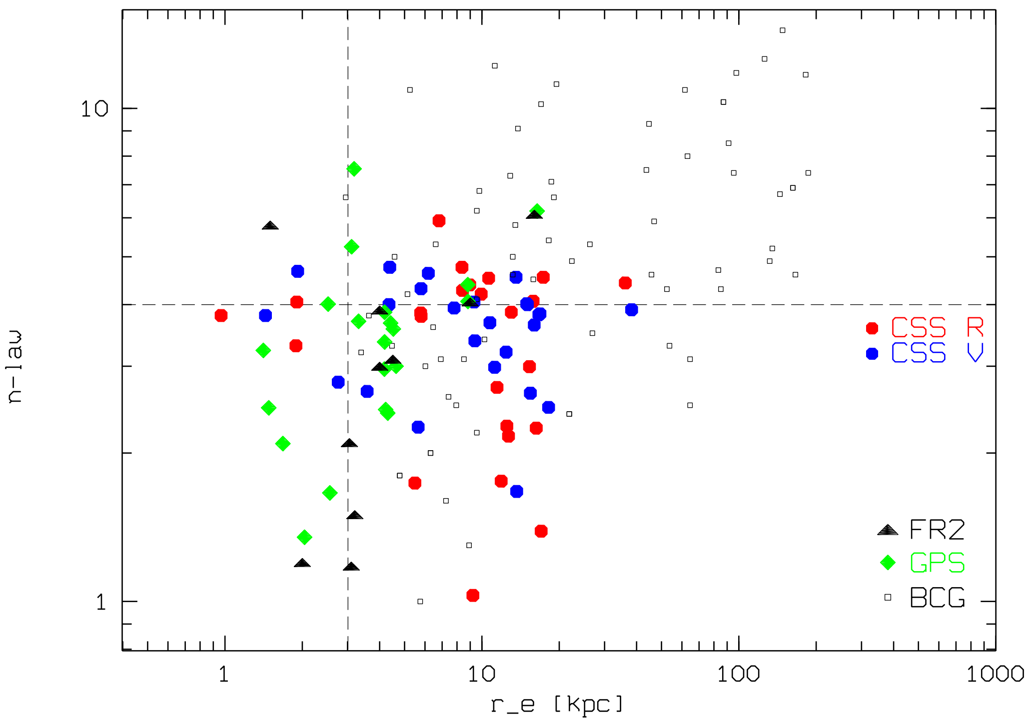

Figure 9: The shape (n) of the hosts of CSS sources confirm the youth scenario. The hosts are more similar to Fanaroff-Riley-Type2 (FR2) and Gigahertz-Peaked sources (GPS) than to brightest cluster galaxies (BCG). This result supports the GPS-CSS-FR2 sequence.

2.6.6 Planck Satellite Science

Project Team Lähteenmäki, Tornikoski, Parviainen, Urpo, Valtaoja (Turku)

The Planck satellite will map the sky at several radio frequencies 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 as well. The satellite launch is scheduled for August 2007.

Our Metsähovi Radio Observatory and Tuorla Observatory Planck collaboration team has enthusiastically participated in the core activities of the Planck Extragalactic Point Sources Working Group. In 2004 the main tasks for our team have been the development of the Planck Quick Detection System software and the definition of its triggering criteria, the construction of the Planck Pre-launch Catalog of point sources (including observations and analysis as well as the delivery of the data for the Catalog), and analysing the scientific data of extragalactic point sources (see *AGN-luvut tässä vuosikirjassa*). A major task was to formulate preliminary Herschel satellite proposal abstracts for the Planck Science Team in early December. Our team submitted two abstracts, called “Observing submm bright active galactic nuclei with Herschel” and “Target of Opportunity Herschel observations of interesting active galactic nuclei detected with the Planck Quick Detection System”.

The Extragalactic Point Sources Working Group had a meeting in connection with the the 2nd Planck Symposium in Paris in January. Our representatives in the meeting were A. Lähteenmäki, E. Valtaoja, and M. Parviainen. The Working Group also held several teleconferences for WG coordinators (A. Lähteenmäki).

The homepage of the Metsähovi and Tuorla Planck collaboration can be found at
`http://kurp.hut.fi/quasar/planck/index-en.htm`.

2.6.7 Multifrequency Observing Campaigns

Project Team Tornikoski, Lähteenmäki, Torniainen, Tröller, Parviainen, Hovatta, Kotiranta

We took part in several multifrequency campaings also in 2004, and did individual observing requests. Typically we support the campaign with daily observations, and continue regular monitoring even before and after the actual core campaign.

0716+714 & 0836+710 The main WEBT campaign for 0716+714 was in November 2003 but the project continued until May 2004. In April another observing campaign took place to support Integral Target-of-Opportunity observations of the source. At this time it was noticed that also 0836+710 was visible in the Integral data, and more observations were promptly made.

3C 273 3C 273 was in a very faint multifrequency state in June 2004, and Target-of-Opportunity observations on the very weak jet emission were initiated, together with multifrequency support observations (XMM and ground based instruments; Metsähovi making frequent 37 GHz and some 22 GHz observations).

0235+164 The ENIGMA/WEBT campaign of 0235+164 is ongoing. In 2004 we supported the XMM pointings of the source in January and August.

MARK 421 We joined in VERITAS and RXTE observations of MARK 421 in May and December.

MARK 501 In June we observed MARK 501 in support of Whipple observations.

H1426+428 We supported the XMM and RXTE pointings of this source in August. We have continued to observe it regularly as it is also occasionally observed with MAGIC, and seems to be sporadically detected at 37 GHz.

0202+149 0202+149 was observed in autumn to support simultaneous MAGIC observations.

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 have started monitoring this source frequently.

Others & requests In spring we observed three sources (PG0007+106, PG1718+48, PG2209+18) for Niall Smith (Cork Institute of Technology). We are watching BL Lac and 3C 279 for MAGIC (Elina Lindfors, Tuorla Observatory), in case they start brightening in 37 GHz. We also observed a sample of high-peaking BL Lac objects for Elina Nieppola (Tuorla Observatory).

2.6.8 RATAN-600 Collaboration

Project Team: Tornikoski, Lähteenmäki, Valtaoja (Turku)

We have used the Russian RATAN-600 to make simultaneous multifrequency (1–22 GHz) observations at several epochs of a sample of ca. 80 of our sources (GPS sources and candidates, and many BLOs).

One set of sources in this campaign includes objects that show at least at times a rising continuum spectrum. For some of them we possess a lot of data points but are still interested in the simultaneous RATAN spectrum to determine the true instantaneous shape of the spectrum, and for some of them we only have some historical low-frequency data points so that it is impossible to say whether the spectra are truly inverted or whether the shape of the non-simultaneous spectrum is caused by considerable variability.

In addition to these, we also observed a sample of BL Lac Objects using the RATAN. Some of these BLOs were detected in Metsähovi at a significant level, but we also included a set of sources that were too faint to be detected in Metsähovi at 37 GHz.

We carried out the "pilot" observations in 2003, and continued the project through 2004. The instantaneous RATAN spectra revealed lots of interesting features in our sources.

- Some of the BL Lac objects that have relatively faint low-frequency data point in published catalogs, but which we have detected at a significant level at 37 GHz, indeed seem to be at a much more active state also during the RATAN observations than when the historical data points were taken. Some of these sources even have convex RATAN spectra.
- For some of our recent identifications for inverted-spectrum sources (identifications published in Tornikoski et al. (2000; 2001) or later identified by Ilona Torniainen during her thesis work) the spectra seem to retain their convex shape also during the instantaneous data taking.
- Two High Frequency Peakers (HFPs) from literature also have beautifully convex RATAN spectra, peaking at ca. 10 and 8 GHz, respectively.
- Already from the 2003–2004 data obtained with RATAN we can see considerable variability in some of these sources. Our primary reason for extending our observations to 2005 (and, hopefully, beyond) is to study how the shape of the continuum spectrum and the peak of the spectrum changes with time, and to study how the activity stage affects the shape of the spectrum. We have established (for example, in Torniainen et al, submitted to A&A) that when monitored for a longer time, some of the so called "bona fide" GPS sources in the literature turn out to be variable flat-spectrum sources with inverted spectra during the active stage only. We want to study the true differences between the sources that have a consistently convex spetrumm and those with spectra that become inverted only during their most active stages.

Our collaboration with the RATAN group will continue in 2005, and we are preparing a paper about our Metsähovi-RATAN collaborative observations.

2.6.9 Observations with Other Facilities

INTEGRAL
"Target of Opportunity Observations of Flaring Blazars", P.I. E. Pian, Co–I M. Tornikoski

Very Long Baseline Array, VLBA
VLBI observations of the flaring blazar 0716+714, P.I. Kaj Wiik, Co–I M. Tornikoski.

RATAN–600 "Instantaneous 2–22 GHz observations of a sample of BL Lacertae Objects and GPS candidates", P.I. S. A. Trushkin, Co–I M. Tornikoski, observations in April, September and October 2004.

Australia Telescope National Facility 3x5 hours "VLBI and Doppler Tracking of the Huygens Probe", Co-I A. Mujunen, J. Ritakari.

2.7 Solar Research

Project Team: Tornikoski, Urpo, Riehokainen (Turku)

Due to the current funding situation, Metsähovi has not been able to recruit any new Solar scientists recently, and now that professor Urpo has retired we do not have anyone in our team working on the Solar data. We are still gathering data, however, using the automatic 1.8-metre Solar monitoring telescope for total flux density observations of the full Solar disk and also occasionally making Solar maps using the 14 m antenna. Professor emeritus Seppo Urpo is still working on the data after his retirement, and also our Russian collaborators (professor Stepanov and his team) are using the Metsähovi data. Dr. Alexandr Riehokainen from Tuorla Observatory is periodically making Solar observations using the Metsähovi telescope, and the focus of his research is especially on the active regions at high Solar latitudes.

At the end of the year professor emeritus Seppo Urpo and his Russian colleagues were awarded Russian Science Academy's price for the best science article in 2003 in the field of mathematics and physics (Figure 10). The article is: Zaitsev, V.V., Kislyakov, A.G., Urpo, S., Stepanov, A.V., Shkelev, E.I.: "Spectral-temporal evolution of low-frequency pulsations in the microwave radiation of solar flares", Astronomy Reports, Vol. 47, pp. 873-882, 2003. The authors studied Solar flares observed in Metsähovi at 22 and 37 GHz. The dynamic spectra of low-frequency fluctuations were obtained, and they were interpreted in terms of eigen oscillations of coronal magnetic loops. The authors discuss the three different types of oscillations that they found.


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"15" декабря 2004 года.

г. Москва

Figure 10: Certificate of honour.

3 “30 Years of Radio Astronomy in Finland” Picture Gallery

On April 6th 2004 Metsähovi celebrated its 30th anniversary. We celebrated this event, “30 Years of Radio Astronomy in Finland” with colleagues, collaborators, and high-level guests.

Metsähovi 30th anniversary photos. Names from left to right.

Figure 11: Jukka Piironen, Risto Kuittinen, Tuija Pulkkinen, Mirja Arajärvi, Seppo Urpo, Ilona Torniainen, Risto Pellinen, Esko Heikkilä, Kalevi Mattila, Anne Lähteenmäki, Esa Luomala.

Figure 12: Pekka Somervuo, Risto Pellinen, Jukka Piironen, Seppo Korpela, Jouko Ritakari, Mirja Arajärvi, Tauno Turunen, Jan Engelberg, Martti Tiuri.

Figure 13: Henry Rönnberg, Ari Mujunen, Esko Valtaoja, Jan Engelberg, Mikko Parviainen, Mirko Tröller.

Figure 14: Talvikki Hovatta, Pekka Somervuo, Risto Pellinen, Tuija Pulkkinen, Kalevi Mattila.

Figure 15: Ilona Torniainen, Seppo Korpela, Jukka Piironen, Marko Pekkola, Risto Kuittinen, Juhani Peltonen, Minttu Koski.

Figure 16: Tauno Turunen, Mirko Tröller.

Figure 17: Solveig Hurtta, Kalevi Mattila, Pekka Somervuo, Jukka Piironen, Seppo Korpela.

4 Publications

4.1 International Journals

1 Ciaramella, A., Bongardo, C., Aller, H.D., Aller, M.F., De Zotti,G., Lähteenmäki, A., Longo, G., Milano, L., Tagliaferri, R., Teräsranta, H., Tornikoski, M., Urpo, S.: A multifrequency analysis of radio variability of blazars. *Astronomy and Astrophysics*, Vol. 419, pp. 485-500, 2004.

2 Bloom, S.D., Dale, D.A., Cool, R., Dupczak, K., Miller, C., Haugsjaa, A., Peters, C., Tornikoski, M., Wallace, P., Pierce, M.: An optical survey of the position error contours of unidentified high energy gamma-ray sources at galactic latitude $|b| > 20°$, *The Astronomical Journal*, Vol. 128, pp. 56-61, 2004.

3 Ciprini, S., Tosti, G., Teräsranta, H., Aller, H.D.: Radio- optical flux behavior and spectral energy distribution of the intermediate blazar GC 0109+224.*Monthly Notices of the R.A.S.*, Vol. 348, pp.1379-1387, 2004.

4 Heidt, J., Tröller, M., Nilsson, K., Jäger, K., Takalo, L., Rekola, R., Sillanpää, A.: Evolution of BL Lac host galaxies. *Astronomy and Astrophysics*, Vol. 418, pp. 813-825, 2004.

5 Mattila, K., Tornikoski, M., Tuominen, I., Valtaoja, E.: Astronomy in Finland,*ESO Messenges*, September 2004, pp. 3-11, 2004.

6 Villata, M., Raiteri, C.M., Aller, H.D., Aller, M.F., Teräsranta, H., Koivula, P., Wiren, S., Kurtanidze, O.M., Nikolashvili, M.G., Ibrahimov, M.A., Papadakis, I.E., Tosti, G., Hroch, F., Takalo, L.O., Sillanpää, A., Hagen-Thorn, V.A., Larionov, V.M., Schwartz, R.D., Basler, J., Brown, L.F., Balonek, T.J.: The WEBT campaigns on BL Lacertae, Time and cross-relation analysis of optical and radio light curves 1968-2003.*Astronomy and Astrophysics*, Vol. 424, pp. 497-507, 2004.

7 Teräsranta, H., Achren, J., Hanski, M., Heikkilä, J., Holopainen, J., Joutsamo, O., Juhola, M., Karlamaa, K., Katajainen, S., Keinänen, P., Koivisto, P., Koskimies, M., Könönen, P., Lainela, M., Lähteenmäki, A., Mäkinen, K., Niemelä, T., Nurmi, P., Pursimo, T., Rekola, R., Savolainen, T., Tornikoski, M., Torppa, J., Valtonen, T., Varjonen, N., Vilenius, E., Virtanen, J., Wiren, S.: Twenty years monitoring of extragalactic sources at 22, 37 and 87 GHz. Astronomy and Astrophysics, Vol. 427, pp. 769-771, 2004.

8 Mennella, A., Bersanelli, M., Butler, R.C., Maino, D., Mandolesi, N., Morgante, G., Valenziano, L., Villa, F., Gaier, T., Seiffert, M., Levin, S., Lawrence, C., Maihold, P., Lubin, P., Tuovinen, J., Varis, J., Karttaavi, E., Hughes, N., Jukkala, P., Sjöman, P., Kangaslahti, P., Roddis, N., Kettle, D., Winder, F., Blackhurst, E., Davis, R., Wilkinson, A., Castelli, C., Aja, B., Artal, E., de la Fuente, L., Mediavilla, A., Pascual, J.P., Gallegos, J., Martinez-Gonzalez, E., de Paco, P., Pradell, L.: Advanced pseudo-correlation radiometers for the Planck-LFI instrument. Astronomy and Astrophysics, submitted, 2004.

9 Ogle, P.M., Davis, S.W., Antonucci, R.R.J., Colbert, J.W., Malkan, M.A., Page, M.J., Sasseen, T.P., Tornikoski, M.: Multiwavelength observations of radio galaxy 3C 120 with XMM- Newton. Astrophysical Journal, submitted, 2004.

10 Pian, E., Foschini, L., Beckmann, V., Sillanpöö, A., Soldi, S., Tagliaferri, G., Takalo, L., Barr, P., Ghisellini, G., Malaguri, G., Maraschi, L., Palumbo, G.G.C., Treves, A., Courvoisier, T.J-L., Di Cocco, G., Gehrels, N., Giommi, P., Hudec, R., Marcowith, A., Pursimo, T., Raiteri, C.M., Savolainen, T., Sikor, M., Tornikoski, M., Tosti, G., Türler, M., Valtaoja, E., Villata, M., Walter, R.: INTEGRAL observations of the field of the BL Lacertae object S5 0716+714. Astronomy and Astrophysics, submitted, 2004.

11 Torniainen, I., Tornikoski, M., Teräsranta, H., Aller, M.F., Aller, H.D.: Long term variability of inverted-spectrum sources. Astronomy and Astrophysics, submitted, 2004.

4.2 International Conferences

1 Parviainen, M., Lähteenmäki, A., Tornikoski, M., Valtaoja, E.: Quick Detection System (QDS) for Planck. *Abstracts of the 2nd Planck Symposium*, Orsay, France 26-30.1.2004.

2 Lähteenmäki, A., Tornikoski, M., Parviainen, M., Torniainen, I., Valtaoja, E.: The Metsähovi/Tuorla Planck collaboration: observations and analysis of the data. Abstracts of the 2nd Planck Symposium, Orsay, France 26-30.1.2004.

3 Tornikoski, M., Lähteenmäki, A., Torniainen, I., Parviainen, M., Nieppola, E., Tröller, M., Valtaoja, E., Trushkin, S.: Identification of new inverted-spectrum sources. Abstracts of the 2nd Planck Symposium, Orsay, France 26-30.1.2004.

4 Tornikoski, M., Lähteenmäki, A., Torniainen, I., Parviainen, M., Nieppola, E., Tröller, M., Saloranta, P-M., Valtaoja, E., Trushkin, S.A., Nizhelskij, N.A.: High radio-frequency study of a complete sample of BL Lacertae Objects. Abstracts of the 2nd Planck Symposium, Orsay, France, 26-30.1.2004

5 Tuovinen, J., Varis, J., Hughes, N., Jukkala, P., Sjöman, P., Ovaska, S., Laaninen, M., Mandolesi, N., Bersanelli, M., Butler, C., Hoyland, R.: Planck Mission with advanced cryogenic mm- and submm-wave receiver arrays. IEEE Aerospace and Electronics Conference, Boston, January 2004.

6 Ritakari, J., Mujunen, A.: Gbit/s VLBI and eVLBI with Off-The-Shelf Components. IVS 2004 General Meeting Proceedings, Ottawa, Canada, 9-11.2.2004, pp. 182-185, 2004.

7 Mujunen, A., Ritakari, J.: VLBI2010: Commercial-off-the-Shelf Technology Perspectives in 1996, 2003, and 2010. IVS 2004 General Meeting Proceedings, Ottawa, Canada, 9-11.2.2004, pp. 56-59, 2004.

8 Lähteenmäki, A.: Planck extragalactic foreground sources. The 3rd ENIGMA meeting, Jerisjärvi, Finland, 26-28.4.2004, Proceedings of the 3rd ENIGMA meeting, Tuorla Observatory, http://www.lsw.uni-heidelberg.de/users/swagner/Efiles/proceedingsEM3.pdf, pp. 278-293, 2004.

9 Lähteenmäki, A., Tornikoski, M., Tröller, M., Parviainen, M., Torniainen, I., Hovatta, T., Saloranta, P-M., Nummila, S., Ojala, T., Ranta, M.: Metsähovi and JCMT observations.. The 3rd ENIGMA meeting, Jerisjärvi, Finland, 26-28.4.2004, Proceedings of the 3rd ENIGMA meeting, Tuorla Observatory, http://www.lsw.uni-heidelberg.de/users/swagner/Efiles/proceedingsEM3.pdf, 2004.

10 Torniainen, I., Tornikoski, M., Teräsranta, H., Aller, M.F., Aller, H.D.: Long term variability of inverted-spectrum sources. Proceedings of the 4th ENIGMA meeting, Perugia, Italy, 6.-8.10.2004, eds. G. Ghisellini, S. Ciprini, G. Tosti, pp. 144-146, 2004

11 Tröller, M., Tornikoski, M., Valtaoja, E: Host Galaxies of Compact Steep Spectrum Radio Sources. Proceedings of the 4th ENIGMA meeting, Perugia, Italy, 6.-8.10.2004, eds. G. Ghisellini, S. Ciprini, G. Tosti, pp. 156-159 2004

12 Courvoisier, J-L., Türler, M., Chernyakova, M., Favre, P., Walter, R., Deluit, S., Staubert, R., Stuhlinger, M., Tornikoski, M., Valtaoja, E., Bourban, G., Robson, I.: Integral observations of the bright quasar 3C 273. 5th Integral Workshop, Munich, 16-20.2.2004, Abstracts Booklet, p. 113, 2004.

13 Collmar, W., Böttcher, M., Burwitz, V., Courvoisier, T., Komossa, S., Kretschmar, P., Nieppola, E., Nilsson, K., Ojala, T., Pottschmidt, K., Pasanen, M., Pursimo, T., Sillanpää, A., Takalo, L., Tornikoski, M., Ungerechts, H., Valtaoja, E., Walter, R., Webster, R., Whiting, M., Wiik, K., Wong, I.: Multifrequency observations of the gamma-ray blazar 3C 279 in low-state during integral AO-1. 5th Integral Workshop, Munich, Germany, 16-20.2.2004, Abstracts Booklet, p. 116, 2004.

14 Heidt, J., Tröller, M., Nilsson, K., Jäger, K., Takalo, L., Rekola, R., Sillanpää, A.: Evolution of BL Lac host galaxies. The Interplay among Black Holes, Stars and ISM in Galactic Nuclei. Proceedings of IAU Symposium No 222, Rio Grande do Sul, Brasil 1-5.3.2004, Th. Storchi Bergmann, L.C. Ho, H.R. Schmitt (eds.), pp. 521-522, 2004.

15 Ogle, P.M., Davis, S.W., Antonucci, R.R.J., Sasseen, T.P., Colbert, J.W., Malkan, M.A., Page, M.J., Tornikoski, M.: X-ray spectroscopy of radio galaxy 3C 120, Proceedings of the X-ray/radio connection conference, Santa Fe, 3-6.2.2004, submitted, 2004.

16 Savolainen, T., Wiik, K., Valtaoja, E., Tornikoski, M.: An extremely curved relativistic jet in PKS 2136+141. Proceedings of the 7th European VLBI Network Symposium, Toledo, Spain, October 12-15, 2004, editors: Bachiller, R., Colomer, F., Desmurs, J.F., de Vicente, P., submitted, 2004.

17 Krichbaum, T.P., Graham, D.A., Alef, W., Kraus, A., Sohn, B.W., Bach, U., Platidis, A., Witzel, A., Zensus, J.A., Bremer, M., Greve, A., Grewing, M., Doeleman, S., Phillips, R.B., Rogers, A.E.E., Fagg, H., Strittmatter, P., Zurys, L., Conway, J., Booth, R.S., Urpo, S.: Towards the event horizon - the vicinity of AGN at micro-arcsocond resolution. Proceedings of the 7th European VLBI Network Symposium, Bachiller, R., Colomer, F., Desmurs, J.F., de Vicente, P. (eds.), October 12-15, 2004, Toledo, Spain, submitted, 2004.

18 Dodson, R., Tingay, S., Westm C., Phillips, C., Tzioumis, A., Ritakari, J., Briggs, F.: The Australian experience with the PC-EVN recorder. Proceedings of the 7th European VLBI Network Symposium, Bachiller, R., Colomer, F., Desmurs, J.F., de Vicente, P. (eds.), October 12-15, 2004, Toledo, Spain, submitted, 2004.

4.3 Laboratory Reports

1 Tornikoski, M., Mujunen, A.(editors): Metsähovi Radio Observatory Annual Report 2003. Metsähovi Reports HUT-KURP-28, 34 p., 2004.

2 Urpo, S. Hajatarinoita Kurpitsan historiasta. Metsähovi Reports HUT-KURP-29, 76 p., 2004.

3 Urpo, S., Puhakka, P., Mujunen, A., Oinaskallio, E., Tornikoski, M., Lindfors, T., Teräsranta, H.: Aurinkomittausohjeet ja aurinkopurkausten piirto ja kalibrointi Metsähovissa 2004. Metsähovi Reports HUT-KURP-30, 18 p., 2004.

4 Urpo, S., Tornikoski, M., Mujunen, A., Oinaskallio, E., Lindfors, T.: Major solar radio flares measured at Metsähovi in 2003. Metsähovi Publications on Radio Science HUT-MET-50, 36 p., 2004.

4.4 Other Publications

1 Parviainen, M.: Pistelähteiden nopea erottelu Planck-satelliitin datasta. Master's thesis, 2004.

2 Dodson, R., Tingay, S., West, C., Hotan, A., Phillips, C., Ritakari, J., Briggs, F., Torr, G., Quick, J., Koyama, Y., Brisken, W., Reid, B., Lewis, D.: The Australian experience with the PC-EVN recorder. Technology Development Center News, National Institute of Information and Communications Technology, Serial No. 24, 2004.

5 Visits to Foreign Institutes

JIVE, Dwingeloo, The Netherlands, Conversion and correlation of ESA Huygens probe Titan descent data recorded in Australia, 26.9-1.10.2004 and 2-7.12.2004, A. Mujunen

Onsala Space Observatory, Sweden. EVN CBD meeting 14.-15.5.2004, M. Tornikoski, A. Mujunen.

Landessternwarte, Heidelberg, Germany, 9.5-12.6.2004 and 14-18.10.2004, M. Tröller

6 Visiting Scientists

Alexander Eliseev, IAP, Russia
Igor Kuznetsov, IAP, Russia
Andrey Perminov, IAP, Russia
Alexander Shtanyuk, IAP, Russia
Dr. Vyacheslav Vdovin, IAP, Russia
Dr. Igor Zinchenko, IAP, Russia
Prof. A. V. Stepanov, Pulkovo Observatory, Russia

Dr. A. G. Kislyakov, IAP, Russia
Dr. V. V. Zaitsev, IAP, Russia

7 Thesis

Master's thesis

Parviainen, Mikko M.Sc. Tech) thesis " Quick Point Source Extraction From Planck Satellite Data", supervised by M. Tornikoski.

8 Teaching

Radio Astronomy course, autumn 2004 (M. Tornikoski, A. Lähteenmäki)

Radio astronomical laboratory exercise for space technology students, spring 2004 (A. Lähteenmäki)

Lecturer at the "Cosmology and the Planck satellite" summer school of the Academy of Finland graduate school for astronomy and space physics (31.5–4.6.2004, Tuorla Observatory) (A. Lähteenmäki)

6 hours of lectures about single-dish blazar radio astronomy at the ENIGMA winter school (EU-funded research training network for AGN variability studies), Jerisjärvi, Finland, April 2004, M. Tornikoski.

9 Other Activities

Referee for Astrophysical Journal, M. Tornikoski.

Referee for a proposal for the James Clerk Maxwell Telescope (JCMT), M. Tornikoski.

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

2004 Referee for the science competition "Viksu" for high school students, arranged by the Academy of Finland. M. Tornikoski.

Evaluator of the docenture application of Dr. Diana Hannikainen, Helsinki University. M. Tornikoski.

9.1 Participation in Boards and Committees

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

Member of the scientific organizing committee of "Cosmology and the Planck satellite" summer school of the Academy of Finland graduate school for astronomy and space physics (31.5–4.6.2004, Tuorla Observatory) A. Lähteenmäki.

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 steering group of ANTARES (Academy of Finland and National Technology Agency Research Programme for Space Research). M. Tornikoski.

Member of the TEKES steering committee for Planck 70 GHz instrument. 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 committee for the Sampo project for ESO. M. Tornikoski.

Finland’s representative to the ESO Users’ Committee. M. Tornikoski.

9.2 International Meetings and Talks

The 2nd Planck Symposium in Paris, France, 26–30.1.2004, A. Lähteenmäki, M. Parviainen

3rd IVS General Meeting, Ottawa, Canada, 8–13.2.2004, J. Ritakari

EVN Technical and Operations Group (TOG) meeting, Wettzell, Germany, 31.3–2.4.2004, J. Ritakari

The 3rd ENIGMA meeting, Jerisjärvi, Finland, 26–28.4.2004, A. Lähteenmäki, Talk “Host galaxies of CSS radio sources” M. Tröller, M. Tornikoski, E. Valtaoja

EVN Consortioum Board of Directors (CBD) meeting, Onsala, Sweden, 14–15.5.2004, A. Mujunen, M. Tornikoski

“Compact radio sources” seminar talk at the Landessternwarte Heidelberg, Germany, 9.6.2004, M. Tröller

Digital Backends + digital BBC meeting, MPIfR, Bonn, Germany 6–7.9.2004, J. Ritakari

The 4th ENIGMA meeting, Perugia, Italia, 5–9.10.2004, I. Torniainen, Talk “Host galaxies of CSS radio sources”, M. Tröller, M. Tornikoski, E. Valtaoja

3rd eVLBI Workshop, Makuhari, Japan, 6–7.10.2004, J. Ritakari

9.3 National Meetings and Talks

AMS Meeting, Turku, Finland, 6.4.2004 and 25.11.2004, A. Mujunen

Evolution of BL Lac host galaxies, seminar talk at the Helsinki University, Observatory, 31.3.2004, M. Tröller

9.4 Participation in winter and summer schools

ENIGMA winter school, Jerisjärvi, Muonio 19–25.4.2004, I. Torniainen, M. Tröller

Cosmology and Planck summer school, Tuorla, Piikkiö 31.5–4.6.2004, T. Hovatta, M. Parviainen, I. Torniainen

Graduate courses in physics, University Heidelberg, Germany, 11–15.10.2004, M. Tröller

9.5 Public Relations

Studia generalia and a student debate about manned spaceflight at the University of Tampere, March 31st, review talk by M. Tornikoski.

Newspaper Aamulehti, March 29th, interview with M. Tornikoski about manned spaceflight.

Newspaper Aamulehti, March 31st, article about the lecture & debate event at the University of Tampere.

Newspaper Kirkkonummen sanomat, April 1st, about the 30th anniversary of Metsähovi.

Newspaper Västra Nyland, April 2nd and April 7th, about the 30th anniversary of Metsähovi.

Newspaper Länsiväylä, April 4th, about the 30th anniversary of Metsähovi.

TV2 News, April 5th 17:50, about the 30th anniversary of Metsähovi (interview with M. Tornikoski).

Newspaper Helsingin sanomat (Science section), May 11th, about the 30th anniversary of Metsähovi.

Radio program “Radiaattori” at Yle Radio 1, April 7th, 10:03–10:43, about Metsähovi research projects and geodetic VLBI, interview with M.Tornikoski, A. Mujunen, M. Poutanen (FGI) and J. Piironen (FGI).

General Metsähovi tours and short talks about radio astronomical research to many visiting groups, S. Urpo, H. Teräsranta, M. Tornikoski, E. Oinaskallio.

10 Personnel in 2004

Permanent Positions funded by the Helsinki University of Technology

Urpo, Seppo, Prof., Dr.Tech.	Director of the institute until 29.2.2004 Docent, professor emeritus	Seppo.Urpo@hut.fi
Tornikoski, Merja, Dr.Tech.	Acting director of the institute from 1.3.2004, appointed until 31.12.2006 Docent of Radio Astronomy and Space Technology Academy Research Fellow, until 29.2.2004 Academy of Finland, Research Council for Natural Science and Engineeering	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, full-time 1.1-31.7.2004 part-time 1.8-31.12.2004	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

Hovatta, Talvikki, student	Research assistant, part-time 1.1-31.5.2004 full-time 1.6-31.8.2004, part-time 1.9-31.12.2004	tho@kurp.hut.fi
Koski, Minttu, Engineer	Researcher, part-time until 31.7.2004	minttu@kurp.hut.fi
Kotiranta, Mikko, student	Research assistant, full-time 17.5-31.8.2004 part-time 13.9-31.12.2004	
Liljeström, Tarja, Dr.Phil.	Researcher, part-time until 31.8.2004	tml@hut.fi
Lindfors, Timo, student	non-military service until 6.7.2004 research assistant, full time 13.7-31.8.2004 part-time 18.10-31.12.2004	lindi@kurp.hut.fi
Lähteenmäki, Anne, D.Sc.(Tech.)	Researcher	alien@kurp.hut.fi
Parviainen, Mikko, M.Sc.(Tech.)	Researcher	pare@kurp.hut.fi
Ritakari, Jouko, M.Sc. (Tech)	Researcher	jr@kurp.hut.fi
Saloranta, Pia-Maria, M.Sc.	Research assistant, part-time until 31.8.2004	pia@kurp.hut.fi
Sjöman, Pekka, M.Sc. (Tech)	Researcher, 1.1-29.2.2004	psj@kurp.hut.fi
Teräsranta, Harri, Dr.Tech.	Researcher, until 30.6.2004	hte@kurp.hut.fi
Torniainen, Ilona, M.Sc. (Tech)	Researcher	ilo@kurp.hut.fi
Tröller, Mirko, M.Sc.	Researcher	mtr@kurp.hut.fi

Metsähovi Advisory Committee

Korpela, Seppo, Dir.	Tanskanen, Pekka, Prof.
Pellinen, Risto, Prof.	Tiuri, Martti, Prof.emer., M.P. (Chair)
Somervuo, Pekka, Dr.Tech.	Urpo, Seppo, Prof. (Secretary)