Metsähovi Radio Observatory

Annual Report 2010

M. Tornikoski, A. Mujunen, B. Holmberg, M. Uunila

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Aalto University
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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 2010 twenty-four scientists, engineers, research assistants and support personnel worked at the institute. In 2010 the total expenditure of Metsähovi Radio Observatory was 1 177 941 euros including salaries and the rent of the office and laboratory space. This was funded by Aalto University, Academy of Finland, European Union, and other outside sources.

The past few years have been full of organisational changes in our university. In the introduction of the previous Annual Report I wrote: "These years of reformation have been full of increased administrative load. We are looking forward to the new university taking its form and becoming fully operational, when we will hopefully once again have time to concentrate on scientific research!" Unfortunately I was overly optimistic. Year 2011 was even worse than the ones before that, which is also the reason why our Annual Report 2010 was delayed so much (published in spring 2012).

The faculty of Electronics, Communications and Automation that was established in 2008 (and where Metsähovi was merged) ceased to exist in 2011, and now we are part of the Aalto University School of Electrical Engineering (ELEC).

Merja Tornikoski
Director of the Aalto University Metsähovi Radio Observatory

Kylmälä, April 2, 2012,

M. Tornikoski, A. Mujunen, 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

The receiver saw first light in March 2010. Focusing and pointing efforts were made to prepare the receiver for May GMVA session. On the grounds of the tests several modifications were suggested and part of those were carried out in co-operation with the instrument suppliers, IAP and DA-Design. Many of the subjects remained unanswered, however, because the lack of documentation. These include the beam focusing and shape, signal amplifiers' temperature stability and polarisation purity. Work continues to define these important operational specifications reliably. In May we participated in a GMVA session. The receiver worked decently with the exception of some instability issues on one polarisation channel and temperature sensors. After correlation some fringes were detected.

In October we participated again in a GMVA session. We have done a few modifications since May. Calculations had shown that the gaussian beam might be distorted when travelling through the quasioptics. In order to test this hypothesis a plano-convex lens was inserted in place of planar IR filter. There was only minor improvement in sensitivity and

even weakening of SiO calibration source detection, probably due to incorrect antenna surface illumination caused by the installation of the above mentioned focusing lens in front of the feed horn. The planar IR filter was changed back before the start of the session. Also some hardware were replaced and adjusted and control firmware was updated. Unfortunately the observing session run out quickly because the dewar leaked. Later the reason turned out to be both vacuum and helium sealing problems in the hosing which now has been corrected.

After the session the receiver was disassembled and the front end delivered to DA-Design for further improvements of LNA and calibration noise source. For verification of feed horn radiation pattern and quasioptics performance a special waveguide transition was ordered from Flann.

1.1.2 RFI diploma thesis work

A survey of the current RFI environment was made by Jukka-Pekka Porko as his diploma thesis work. The title of the work was "Radio frequency interference in radio astronomy." The work consisted of studying the current interference situation, especially in the bands used in Metsähovi. The measurements covered widely the possible sources of harmful radio emissions both outside the observatory and also inside the building. While the need to protect the observation bands from external interference has been recognised for many decades, it has become more and more important to protect also from internal, self-made interference. It is crucial to continue the constant monitoring of the external and internal radio frequency environment in the future.

1.1.3 Maintenance of receivers

New semirigid coaxial cables were manufactured and installed into geo-VLBI receiver feed assembly. The original intermediate cable between power combiner and dewar connector was fractured and consequently causing lowered sensitivity at S band. During investigation of the reduced S band performance a set of hot-cold noise temperature measurements was made at different points of the receiving chain. The results indicate that the low-noise front end is still working fine, but the majority of system noise comes from the large size room temperature feed horn construction.

In addition a faulty mechanical switch on the front panel was replaced.

1.1.4 Miscellaneous

Petri Kirves and Jan Wagner participated in the Radio Frequency Interference Mitigation workshop in Groningen, Netherlands. A presentation was prepared about the RFI situation in Metsähovi.

The wide spread interference in Callisto data was traced to a low-quality chinese led bulb in the control room.

The lease term of Metsähovi's Kia Carnival minivan expired. It was replaced with a leased SEAT Alhambra minivan.

1.1.5 IT Infrastructure

Project Team: Mujunen, Lindfors, Aatrokoski

Data Storage

After reading an article about how data on modern hard disks slowly fades away if the sectors are not read or rewritten for a while, we managed to verify its claims. All of our important data is stored on RAID 1 mirrored disks, which are checked monthly for consistency. There had been several cases of these checks failing, leading to mirror reconstruction. Inspired by the article we implemented a script called hdrefresh, which is run weekly and just reads (by way of starting a S.M.A.R.T. long self test) every sector of the hard drives to "refresh" them. After deploying hdrefresh to our servers, the monthly RAID 1 consistency checks never failed again, which suggests that data does indeed fade from modern hard drives if it is not "refreshed" by accessing the sectors.

A "scratch" disk for temporary/miscellaneous storage which is not backed up was added to the internal network, accessible from all computers.

Virtualization

The motherboards of the two virtualization servers were upgraded, as there were some problems with the old ones. And as Debian Squeeze gained proper and stable support for Xen hosting, the OS was switched to it from OpenSUSE (which in 2009 replaced Debian Lenny, which in turn had pretty unstable support for Xen hosting).

Communications

A new gigabit ethernet switch for the computers involved in measurements was installed in the control room rack and connected to the internal network via a firewall computer. Some degree of isolation between

the measurement machines and the rest of the internal network would be desirable, and may be implemented in future; currently the firewall just passes all traffic between the network segments.

Servers

A nasty bug was found in the power supply system of the new server rack built in 2009: a large enough transient power spike, caused by e.g. turning on multiple computers simultaneously (low-quality power supplies may also have been a contributing factor), could trip the circuit breaker of the UPS output. As all the equipment of the rack is fed by the same UPS, the whole rack would go down. To fix this, each of the remote-controlled socket pairs (as the pairs are fed by a single cable) was put behind a circuit breaker more sensitive than the one in the UPS, so that power spikes would only take out the machine responsible (and its neighbor), not the whole rack.

Miscellaneous

The support contract of the old Dell 5100cn color printer expired, and furthermore the print quality was nothing to write home about. It was replaced with a Konica Minolta bizhub C452 printer/scanner/copier from Aalto-Print, the first ever delivered by them after Aalto university switched to a rental scheme with printers.

1.1.6 Hydrogen Maser

Project Team: Oinaskallio, Kallunki, Mujunen

Both Hydrogen Masers 69 and 70 continued to work throughout 2010 without any failures. Only the synthesizer value of H-maser 69 was adjusted four times and H-maser 70 value was adjusted twice during the year 2009. In Figure 1.1 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.

Clodi's broken power supply caused unnormal pikes in Figure 1.1.

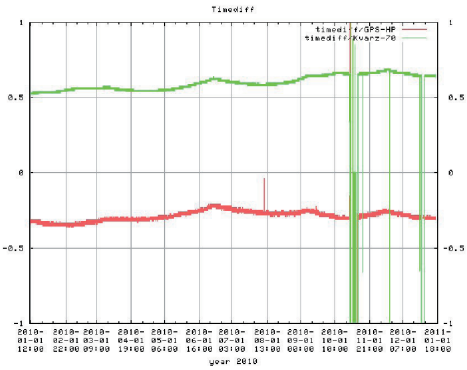

Figure 1.1. Time difference of H maser (69) and GPS clocks, and H maser (69) and H maser (70), in microseconds.

1.1.7 New Hardware

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

Linux antenna control

The new Linux-based antenna control computer was deployed. The first version used a PCISA single-board computer with a Geode processor, but it had a problem of the serial port (which is used to communicate with the control computer from the control room) ceasing to work periodically and needing a reset, so it was replaced with a newer PCISA SBC with a Celeron processor. However, as the weather got colder in the autumn, the control computer started "freezing" every once in a while, requiring a hard reset. After a lot of investigation, which included trying to switch back to the Geode-based computer, the fault was finally isolated to the Metsähovi-made PWM generator ISA card. As there was no immediate replacement option, the solution was to keep the antenna rack warm enough with a heater and some covers so that the freezes wouldn't happen, while we started considering viable replacement options.

Sunant and Callisto

The azimuth motor was replaced twice in 2010 (May and September). Also the feedhorn of the antenna was fixed after the insulation leakage in Spring 2010. The Callisto antenna (+ pre-amplifier) was installed to Sunant antenna disk frame.

The hardware and operating system of the computer recording the data from the small Sun antenna was upgraded, as well as the recording software, including a simple kernel driver for the A/D PCI card. The original

design specified a 1000 Hz sampling rate for the data, but due to hardware and OS constraints the actual sampling rate used with the old computer was only 50 Hz, which was fine to store in Metsähovi's standard text format. However, the new computer achieves the designed 1000 Hz sampling rate, resulting in an increase of data by a factor of twenty. This meant that the data recording had to be switched to binary format, and additionally the data files are later compressed with FLAC to keep the disk space usage reasonable.

Quality of power supply impromevents in MRO
The main UPS batteries were replaced or added in the last part of the year 2010 (November/December).

- Hydrogen maser backup battery (4 x 105 Ah, 12 V)
- Cellar back-up UPS, extra battery (3 x 92 Ah, 36 V)
- Clock room UPS, extra battery (3 x 92 Ah, 36 V)
- Computer room UPS, extra battery (3 x 7.2 Ah, 36 V) (February, 2010)

To test battery condition, specified battery tester was built (See Figure 1.2). The tester is based on continuous or periodic loading tests (resistor).

Monitor Systems
New temperature and humidity sensor (Vaisala Oyj, HMT100) was added to the antenna platform (Spring 2010). Several voltage and current sensors were added to monitor the condition of the UPS extra batteries.

The storage format and filesystem hierarchy of Metsähovi's auxiliary data, such as weather and time measurements, was finally formally specified, and tools to access it were implemented. The tools provide a uniform interface to access the data, regardless of whether the data is compressed or filed into hierarchical directories.

Other technical upgrades
The connection of the gate surveillance cameras to our intranet was replaced with a new VDSL connection. VSDL modem in the gate end was inserted into specified, insulated and temperature stabilized box.

Two faulty power supplies (+5 Vdc and +12 Vdc) were replaced in an-

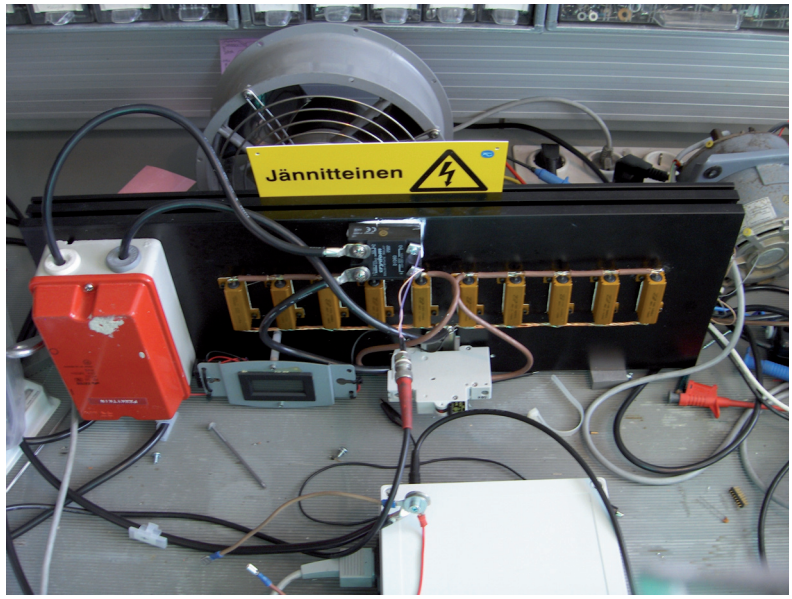

Figure 1.2. Battery tester

tenna control rack (in the antenna platform). Additionally, the rack fans were replaced after they were destroyed (melted down) due to too powerful and faulty termostate temperature sensor, which also was replaced.

The automatic circuit breakers were added to server rack wall sockets. Power supplies of Mark IV formatter and baseband converters were replaced in 2010. Five new receiver beds were constructed in 2010.

1.2 VLBI Instrumentation

Project team: Ritakari, Kirves, Uunila

The new 86 GHz receiver arrived in June, 2009 in our laboratory (see Section 1.1.1). The 86 GHz receiver was used for the first time for the session c101a in May 2010. First we did preliminary tests for finding fringes with Onsala, Metsähovi and Yebes. Data was transferred electronically to Bonn and correlated with DiFX. Fringes were found.

The 43 GHz receiver has been out of order for the last years and it is still waiting 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 will be fixed in 2011. We are

ordering one DBBC unit for geodetic purposes in 2011 and it should be ready for use in mid-2012. For the time being we will use an iBOB 1xVSI => 10G workaround design.

1.2.1 Metsähovi Data Processing Site

In 2010 we have continued the processing of VLBI data using programs developed by Jan Wagner.

We have also an opportunity to use two Finnish supercomputer clusters, one has 2100 cores and the other has 2880 cores. There are some differences in Unix versions and connectivity. The computers rank at roughly number 100 in the world top-500 supercomputer list.

This is rare opportunity to test the scalability of VLBI software correlators. So far the scalability tests have been done with maximum of 12 computers with four processor cores each, so moving to really powerful system is unknown territory. Scalability of high-speed data streams is also an interesting topic.

We have also been encouraged to apply for the computing grand challenge program in Finland and/or request resources in the world's top-5 supercomputer in Jülich, Germany. Because of lack of personnel resources, summer vacations and the migration to the new Aalto University we did not do these yet in 2010.

1.2.2 eVLBI and EC FP7 NEXPReS

Project team: Ritakari, Wagner, Molera, Mujunen, Uunila, Turtiainen

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, "Provisioning High-Bandwidth, High-Capacity Networked Storage on Demand". Its goal is to develop on-demand networked storage that can match the multi-Gbps bandwidth and Petabyte-class capacity requirements of VLBI in a distributed manner.

In the first 6 project months NEXPReS WP8 was focusing on hardware selection process and on getting explanations and solutions to most of the open questions of EXPReS 20-disk 4Gbps performance issues, CPU consumption, eliminating expensive memcpy()s, and further understanding how to deal with close-to-10Gbps UDP networking efficiently. Addition-

ally, ideas how to do simultaneous reads and writes to the same set of disks and how to make best use of large RAM buffers are evolving.

We had some difficulties in hiring people to some of the tasks requiring simultaneous expertise in several fields (Linux kernel, advanced communications, hardware and FPGAs, networking security etc.). We finally managed to hire Esa Turtiainen in the beginning of December 2010. We were also able to interact with Metsähovi Linux experts Timo Lindfors and Juha Aatrokoski in disk and 10GbE Linux performance related issues.

1.3 VLBI Space Science Applications and Spacecraft tracking

Project team: Molera, Wagner, Mujunen

Tracking observations of spacecraft at X-band have continued during the year 2010. Planetary spacecrafts as targets of radio astronomy offer new possibilities to study a broad variety of physical processes: planetary atmospheres, geodynamical diagnostics of the interior of planets, fundamentals of spacecraft motion or characterisation of the solar wind. Phase analysis of the spacecraft signal for more than 60 sessions has been used to characterise the interplanetary plasma scintillations (Molera Calvés et al., presentation at the International Planetary Probe Workshop, Barcelona, June, 2010).

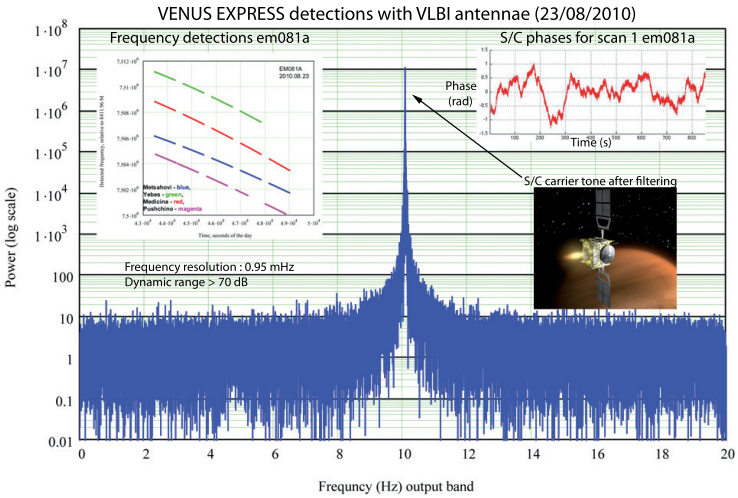

Figure 1.3. Frequency (Hz) output band

During 2010 we conducted more than 20 sessions observing ESA's Venus Express spacecraft with Metsähovi radio telescope. Furthermore, around 20 other sessions were also observed with other VLBI telescopes. These sessions were coordinated and processed by Metsähovi. The stations included Wettzell (GE), Yebes (SP), Onsala (SW), Pushchino (RU), Hartebeesthoek, (SA), Medicina, Matera, Noto (IT), Warkworth (NZ). The sessions included a couple of VLBI observations, in where the tracking of the spacecraft signal was alternated with a near-by quasar for phase referencing. The positioning of the spacecraft was located within a margin of a few hundred meters of error.

Data were processed using the ultra-high accurate processing software for phase-locked satellite tracking based on phase referencing method. Metsähovi became a new correlator centre, allowing processing the data with 4 main servers in parallel and with an internal capacity to storage the spacecraft data up to 50 TB.

In 4.3.2010 we observed the ESA's Mars Express spacecraft timed to the MEX-Phobos flyby event. We demonstrated the Doppler tracking accuracy at a level of few mHz at few seconds integration. Such experiment with 3 EVN stations (Metsähovi, Wettzell, Yebes) could help to better determine the Phobos gravity field. The multi-station observations together with phase referencing can provide additional geometrical constrains on the orbiter/Phobos trajectories.

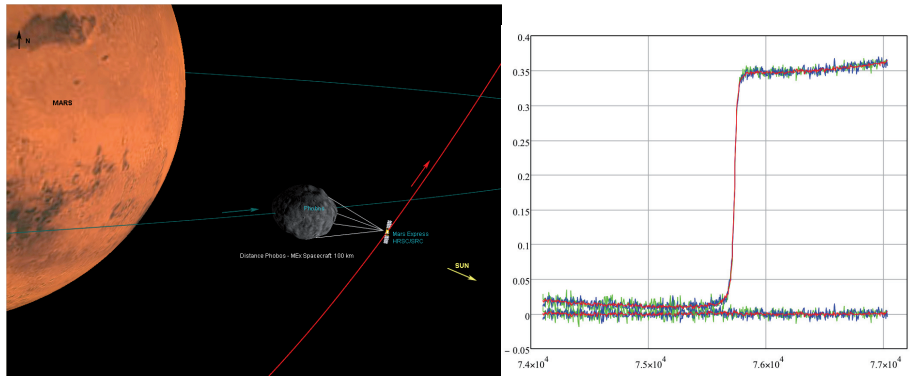

Figure 1.4. Phobos flyby and Venus Express detection observed with 4 VLBI antennae.

1.3.1 VLBI tracking of GLONASS satellites

Project team: Tornatore (IT), Haas (SW), Molera Calvés, Pogrebenko (NL)

Several tests to observe signals transmitted by GLONASS (GLObal NAvigation Satellite System) satellites have been performed using the VLBI technique. The experiments on 16.6.2010 and 16.8.2010 involved the radio telescopes of Medicina (Italy) and Onsala (Sweden). Observations at the stations were performed using the standard Mark4 VLBI data acquisition rack and Mark5A disk-based recorders. Data were processed with on-purpose spacecraft tracking software developed at Metsähovi and with the DiFX software correlator developed at Australia.

The goals of the observations were to develop and test the scheduling, signal acquisition and processing routines to verify the full tracking pipeline, foreseeing the cross-correlation of the recorded data on the baseline Onsala-Medicina. The natural radio source 3C286 was used as a calibrator before the beginning of the satellite observation sessions. We are investigating how these observations can benefit traditional measurement of VLBI geodesy.

1.3.2 Interplanetary plasma scintillations

Project team: Molera Calvés, Pogrebenko (NL)

The phase analysis of the Venus Express spacecraft signal demonstrated a high level of fluctuations to a supposed stable behaviour. The variations on the phase are caused by the Earth's ionosphere, temperature noise of the system and primarily by the interplanetary plasma. Motivated by these fluctuations, we started a campaign measuring the propagation of the spacecraft signal through the interplanetary plasma.

The sessions initiated at the ends of 2009 and have continued until ends of 2010. We have observed more than 50 sessions with eight different radio telescopes. The sessions targeted to cover a full cycle of Venus around the Sun. Venus was at the major conjunction on January 2010 and again on August 2011.

The observations allowed us to relate the phase scintillation index with respect to the angle Sun-Observer-Target and to estimate index of scintillations regarding the Total Electron Content (TEC) in the path of view.

1.4 VLBI Observational Activities

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

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 (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.

1.4.1 VLBI Sessions in 2010

In 2010 Metsähovi took part in seven geodetic VLBI sessions (in four EUROPE sessions and in three T2 sessions). The Global mm-VLBI Array (GMVA) observed two sessions, in May and October of 2010. Two EVN sessions were conducted at the station. In June and July 2010 two 22 GHz EVN ToO experiments were observed.

1.5 Geodetic VLBI data analysis

Project team: Uunila

Geodetic VLBI data is analyzed with the Vienna VLBI Software (VieVS) developed at the Institute of Geodesy and Geophysics, Vienna University of Technology. In 2010 the analysis was concentrated in the Fennoscandinavian-Japanese ultra-rapid dUT1 experiments and the IVS intensive sessions.

1.6 AMS-02

Project Team: Ritakari, Molera, Uunila

Metsähovi Radio Observatory has been involved in the development of AMS-02 (Alpha Magnetic Spectrometer). AMS-02 will start operating in space onboard the Shuttle Endeavour in 2011. Spectrometre will be installed in one of the ISS (International Space Station) arms and will operate for the following 2 to 3 years.

AMS-02 has been developed for the last 13 years in many research institutes of Europe and China. It is the continuation of the AMS project launched in 1998 which resulted as a total success. Metsähovi Radio Observatory´s role in the project is to provide help to the mission in the Ground System Equipment and acquisition of data in the Johnson Space Center (Houston). Data acquired from a HRDL link must be acquired and stored in a server, which needs to allow the access from the researcher for checking, revising and downloading to their respective working-sites.

AMS-02 is a state-of-the-art particle physics detector designed to operate as an external module on the ISS. It will use the unique space environment to study the universe and its origin by searching for antimatter, dark matter while performing precision measurements of cosmic rays composition and flux.

1.7 Extragalactic Radio Sources

1.7.1 Active Galactic Nuclei

Project team: Tornikoski, Lähteenmäki, Nieppola, León-Tavares, Tammi, Oksman, Valtaoja (Turku),

In 2010 the main focus of our AGN science was on Planck-related studies (described in the following section) and in radio- to gamma-ray connections.

We extensively analysed Metsähovi radio data and Fermi satellite's gamma-ray data from various angles. At the "Fermi meets Jansky" conference in Bonn our team members had several presentations, and subsequently we worked on journal papers about the results.

Our findings included the following:

- We compared the gamma-ray photon flux variability of northern blazars

contained in the Fermi/LAT First Source Catalog with 37 GHz radio flux curves from the Metsähovi quasar monitoring program. We find that the relationship between the millimeter (mm) and gamma-ray fluxes arises differently for each type of blazar. The flux relation between the two bands is positively correlated for quasars and absent for BL Lac type objects. Furthermore, we find that the levels of gamma-ray emission in high state depend on the phase of the high frequency radio flare, where the brightest gamma-ray events coincide with the initial stages of a millimetre-flare.

- We compared the 11-month fluxes from Fermi/LAT and 37 GHz fluxes from Metsähovi to look for possible correlations in the average properties. Assuming the scenario of common origin of radio and gamma-ray emission is valid, also the average radio and gamma-ray properties should be interdependent. According to our analysis, the Fermi and 37 GHz fluxes correlate significantly, indicating a common origin of emission. Gamma dominance (S_γ/S_r) has a wide distribution, peaking roughly at 100. High synchrotron peak frequency sources seem to be more gamma dominated, although their gamma luminosities are lower.

- We studied properties of a flux-limited complete sample of radio sources, ca. 2/3 of which were detected by Fermi/LAT. The non-detected sources have radio fluxes and historical variability comparable to those of the detected sources, but typically the Fermi/LAT-detected sources were flaring during the 1FGL observing period, whereas the nondetected ones were in a relatively uneventful state. The Fermi/LAT-detected sources also have higher Doppler boosting factors and higher synchrotron peak frequencies than the non-detected ones.

1.7.2 Planck Satellite Science

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

The Planck satellite will map the sky at nine high radio frequencies from 30 GHz to 857 GHz, and measure the cosmic microwave background (CMB) radiation. At the same time all foreground radio sources in the sky, including extragalactic radio sources, will be observed, too. Planck will produce unique all-sky catalogs of sources at several high radio fre-

quencies. They will, finally, fill the gap in the present radio survey data. Planck was launched on May 14, 2009.

Multifrequency campaigns with our collaborators continued in 2010. A reminder e-mail was sent every week to everyone who participates in the campaign. A wiki site and a webpage were set up, containing, for example, the satellite pointing schedule and source lists. Some of the first results were also published at the password protected wiki site.

The first Planck dataset, the Early Release Compact Source Catalog (ERCSC) was validated during the summer. A. Lähteenmäki was a member of this team. The team met once in Bologna and had several telecons. The purpose of the validation team was to ensure that the ERCSC data complied with certain criteria. The ERCSC has a cumulative reliability of >=90%, and it contains lists of extragalactic and Galactic sources at 9 Planck frequencies. The measurements were taken between August 13 2009 and June 6 2010.

Towards the end of the year our work concentrated on the Planck Early Papers. These are papers that use the ERCSC or other early Planck data. We proposed a paper that describes the spectral energy distibutions (SEDs) of a complete 1 Jy northern sample of AGN. Subsequently it was accepted as one of the official Planck Early Papers and was due to be submitted in January 2011. We started by collecting all available multifrequency data from our collaborators, and combined those with the 9 frequencies from the Planck ERCSC. Due to a very tight publication schedule set by the Planck Editorial Board, late 2010 turned out to be extremely hectic for our entire Planck team.

1.7.2.1 Quick Detection System (QDS)

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

The software was completed in 2006. In 2009 the Planck satellite was finally launched and began its mission, and QDS also began its work. Based on the first sets of Planck data in late 2009, we concluded that the QDS was working as expected and was producing good data. The QDS

data were successfully used for validating the ERCSC in summer 2010. In this work, a dedicated LFI validation team compared various datasets to ERCSC data to see whether they agreed. Both QDS and also Metsähovi 37 GHz data complied well with the ERCSC data.

However, later in 2010 it became evident that the LFI DPC, responsible for updating the Planck database, could not deliver regular updates. This meant that the time elapsed from the observation until the data became available was too long – sometimes several months. The software worked perfectly, but as the data were not anymore new when finally processed by the QDS, they could not be used for alerts. Despite our efforts to resolve the problem, finally we had to admit that we could not use the QDS as we had planned. This was a big disappointment to our team, particularly as it was not of our own making.

1.7.3 Numerical modelling

Project Team: Tammi, Hovatta, Lähteenmäki, Valtaoja (Turku)

During 2010 we continued developing the numerical tools for modelling shocks and ”blobs” in AGN jets. We began building a comprehensive numerical code with strong emphasis on ”bottom–up” methodology both in software-developing sense but also physically. The code starts with particle-level physics and builds up from there, paying close attention to accurate modelling of the synchrotron emission and radio frequencies in particular. With this kind of an approach it is relatively easy to test different physical scenarios, compare single-vs-multinode models, include various particle acceleration and energy loss mechanisms, as well as to go far beyond most models in what comes to limitations to the jet properties, number of the emitting components, etc. The code was used for the first time in modelling various sources for the Planck early release study, and was found to work very well in explaining the radio - to - optical spectrum of 3C 454.3, where the observational data were fitted with just one strong synchrotron component and low-frequency tail from the underlying jet, both modelled using the code.

1.8 Galactic Sources

1.8.1 X-ray Binaries

Project team: Hannikainen, Koljonen, Savolainen

During 2010, Dr. Diana Hannikainen mostly prepared for her departure from Finland, and consequently her departure from Metsähovi, scheduled for the end of 2010. However, one fruitful event was obtaining a Väisälä Foundation grant to invite two colleagues, Prof. Kinwah Wu from the Mullard Space Science Laboratory (UCL) and Dr. Michael McCollough from the Smithsonian Astrophysical Observatory, for a period of approximately one week in April for discussions with Petri Savolainen and Karri Koljonen.

1.8.2 The multiwavelength Nature of the Enigmatic Microquasar Cygnus X-3

Project team: Koljonen, Hannikainen, McCollough (Cambridge, MA), Droulans (Toulouse), Pooley, (Cambridge), Trushkin (Nizhnij Arkhyz), Tavani (Rome), Steegs (Warwick)

Continuing the work on deciphering the huge multiwavelength data set from enigmatic microquasar Cygnus X-3, Karri Koljonen published a paper in MNRAS at the beginning of the year. This paper consisted of an analysis of the disk/jet connection by using simultaneous, archived X-ray and radio observations of Cygnus X-3. Based on the analysis, a new X-ray state was discovered. This state, named hypersoft state, existed only in very brief intervals, which was dominated by a strong soft X-ray component but very weak or non-existent radio and hard X-ray component. In addition, only during this state gamma-ray flares were observed, unambiguously for the first time from the microquasar population, which has added an excitement in the microquasar community throughout the year.

Based on this work, the results were presented in multiple occasions, beginning in the previous year in the 7th AGILE Workshop held in Frascati, Rome by Dr. Hannikainen (proceedings by McCollough et al.), and continuing during 2010 in the Probing Strong Gravity near Black Holes -conference held in Prague and Jets at all Scales -symposium held in Buenos Aires by Karri Koljonen and finally at the 8th INTEGRAL workshop held at Dublin by Dr. McCollough.

The new hypersoft state led to an idea, that during this time the accretion disk might be visible to us and not occluded by strong stellar wind emanating from the companion star. This further gave thought to search for quasi-periodic oscillations (QPO) that are thought to arise in the accretion disk and have been observed numerously in other microquasars, but have not been detected in Cygnus X-3 apart from a couple of tentative studies. By a thorough search of archival X-ray data and strict analysis to prevent false detections, two observations were found that showed distinct millisecond-scale modulations, a tell-tale signal of a QPO. However, these QPOs were not found during the hypersoft state, but during a decline of a major radio flare which was a surprising result. Thus, QPOs in Cygnus X-3 are somehow connected to the jet ejection events. Based on this work a paper was submitted to MNRAS at the end of the year.

In the summer, as a member of the board of Finnish Astronomical Society, Karri Koljonen took part organizing the first bigger scale meeting organized by the society, called Astronomers' Days 2010, that gathered most of the working astronomers in Finland and it was deemed as a success by every attendee.

Being part of the graduate school from the beginning of the year, Karri Koljonen attended the annual summer school that was held this year in Mariehamn, Åland with a subject of simulations methods in astrophysics.

Karri Koljonen was also coinvestigator in two monitoring proposals of Cygnus X-3 with infrared observatory PAIRITEL as well as X-ray observatory Swift.

1.8.3 Neutron Star Low-Mass X-ray Binaries

Project Team: Savolainen, Hannikainen, Paizis (Milan), Farinelli (Ferrara), Vilhu (Helsinki)

Petri Savolainen has worked at Metsähovi since January 2008 as a postgraduate student of Dr. Diana Hannikainen. He is a co-investigator in a project led by Dr. Paizis of INAF-IASF, Milan. The project studies bright neutron star Low-Mass X-ray Binaries (LMXBs) near the Galactic Center using the large amounts of data available to us from the European Space Agency's INTEGRAL satellite.

During 2010 Mr. Savolainen continued working on an extensive review of INTEGRAL spectral data of four bright Atoll-type LMXBs and four Z-type LMXBs, from 2003 to the present. The project involves testing a recently developed spectral model, CompTB, which seeks to explain the X-ray spectral evolution of these sources in a unified physical scenario. In it, soft X-ray photons from the accretion disc and/or the neutron star surface are scattered to higher energies by thermal Comptonization, mixed to some degree with bulk motion Comptonization.

In terms of this model, the transient hard X-ray tails exhibited by the Z sources and the peculiar Atoll source GX 13+1 can be explained by efficient bulk motion Comptonization in a free-fall region near the neutron star surface. When the hard tail is not present, bulk motion Comptonization may be too weak to be observed due to an insufficient local accretion rate, or stopped by radiation pressure due to a high local accretion rate.

The apparent long-term periodicity seen in the Rossi X-ray Timing Explorer All-Sky Monitor (RXTE/ASM) light curves of some bright Atoll sources was found not to be coupled with the evolution of the spectral

shape, rather with just the normalization of the components. If the modulation is the result of changes in the matter transfer rate from the companion star, possibly due to a Solar-like magnetic cycle, Z sources could be less affected due to the output from the companion exceeding the Eddington limit for accretion onto the neutron star; the local accretion/emission rate remains near the Eddington limit, and the surplus matter is ejected. The cycle of the evolved Z source companion stars could also be too long or too weak to be observed.

Initial results were presented in the posters "Disentangling the Z and Atoll sources: results from a NS LMXB survey with INTEGRAL" and "A comparison between the spectral and long term timing properties of GX 3+1, GX 5-1 and GX 13+1", at the conferences Astrophysics of Neutron Stars 2010 (2.–6.8.2010, Çeşme, Turkey), and the 8th INTEGRAL Workshop (27.–30.9.2010, Dublin, Ireland), respectively. March 2010 also saw the publication of a paper from our collaboration in the journal Astronomy and Astrophysics, Volume 512, titled "Spectral evolution of bright NS LMXBs with INTEGRAL: an application of the thermal plus bulk Comptonization model" (L.I. Mainardi et al. 2010).

In April, the group was visited by Dr. Michael McCollough from the Harvard-Smithsonian Center for Astrophysics (CfA), and Prof. Kinwah Wu from Mullard Space Science Laboratory (MSSL) of the University College London. Discussions during the visit and preparations during the next months led to Mr. Savolainen paying a return visit to MSSL in November 2010, and spending the year 2011 as a Predoctoral Fellow at the CfA.

1.8.4 Numerical modelling of microquasars

Project Team: Tammi

Following the idea that the collapse of the accretion disk surrounding the supermassive black hole in an active galaxy (2009), we modified our model and applied it to microquasars. In the "Restless Gamma-ray Universe" we reported that while in an AGN the flare would be only visible in the optical waveband for such a short time that it would be very hard to detect (the flare lasting only a day or so, much too quickly for the once-a-day to once-a-month frequency of most observing campaigns), in microquasar the process could lead to an observable outburst in the optical and X-rays that, although only lasting for some seconds, could indeed be more observable due to the shorter duty cycles in these sources.

1.9 Multifrequency Observing Campaigns

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

We took part in several multifrequency campaigns in 2010, and as usual, did individual observing requests, too. Typically we support the campaign with daily observations, and continue regular monitoring also before and after the core campaign. Metsähovi radio data are in high demand, and the number of campaigns and requests have steadily increased during the last few years. This is also reflected in the growing number of publications using Metsähovi data.

Examples of recent campaigns are the WEBT and GASP collaborations on several sources in connection to satellite observations at high energies, particularly Fermi. 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, for example, MAGIC observations.

The largest observing campaign of the year was again the support campaign for the Planck satellite (see "Planck satellite science" for details).

1.10 Solar Research

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

The e-Callisto system was installed at Metsähovi, and the development of a Linux version of the data recording software was started.

During 2010, at beginning of the solar cycle 24, the main emphasis was on using the 37 GHz frequency band and on observing solar radio maps and tracking objects on solar disk during the summer months. The number of observation days was around 80 in 2010. These data were used for studying quasi-periodic solar oscillations (quiet Sun areas, sunspots and faculaes, normal / polar), differential rotation of the Sun and the general solar activity, together with data obtained from our collaboration observers (Nobeyama Radio Heliograph and RT-7.5 BMSTU, Solar physics laboratory of the Saint-Petersburg State University).

Also, during 2010, we finally switched to use the new solar measurement software (Linux), which replaced the old Micro-Vax based software. The new software enables us to do more versatile solar observations than

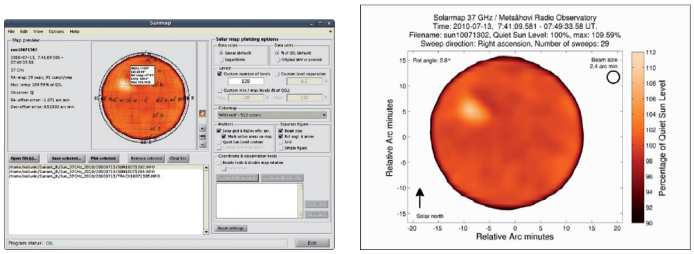

Figure 1.5. Left: A graphical interface of Sunmap. Right: a solar radio map plotted by Sunmap.

previously.

The small radio telescope (diameter 1,8 m) was used for continuous monitoring of the whole solar disk at a frequency of 11,7 GHz. Observed data was also used for studying solar oscillations.

Sunmap

Since July 2009, a new piece of Matlab software has been developed for the visualization and analysis of solar observation data from the 13,7 - meter telescope. The new program, called "Sunmap", can be used among other things in plotting and saving solar radio maps and tracks, saving active area and tracking data from batches of solar radio maps, interactive selection of tracking observation sources from solar radio maps and automatic determination of the center and radius of the solar disk. The program is controlled by a graphical user interface shown in Figure 1.5 (left figure). Figure 1.5 (right figure) shows a 37 GHz solar radio map from July 13, 2010 as plotted by Sunmap. The brightening on the map is the active region AR 11087.

Callisto - solar radio spectrometer

Metsähovi Radio Observatory joined a worldwide e-Callisto (16th station of the e-Callisto network) network in September 2010 to monitor the Sun's broadband radio bursts in the metric and desimetric scale (45-890 MHz). e-Callisto network is coordinated by ETH Zurich. The first solar radio burst was observed September 24th, 2010, 14:10:42 UT (type I solar radio burst). In Figure 1.6 is presented the first observed solar radio burst and, additionally installation setup of the Callisto antenna. Total number of observed solar radio burst was around 15 in 2010.

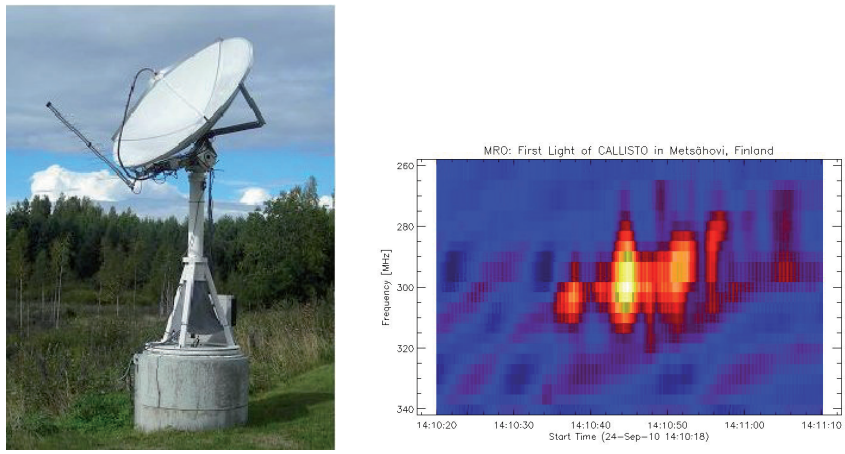

Figure 1.6. Left: Log-periodic Callisto-antenna installed to Sunant disk frame. Right: The first solar radio burst was observed September 24th, 14:10:42 UT.

1.11 Recreational Events & Keeping Fit

1.11.1 Recreational day at Kisakallion Urheiluopisto

The annual Metsähovi recreational day was held on October 13th 2010. We began the day by warming up with Kisakallio Games and after lunch it was time for curling. The day ended with sauna and some food.

1.11.2 Metsähovi Christmas Party

The traditional Metsähovi Christmas party was held on December the 22nd, with porridge and ham.

Figure 1.7. First row, left: Scenery from the beautiful Kisakallion Urheiluopisto. First row, right and Second row, left: Metsähovi staff getting ready for the Kisakallio Games. Second row, right: "It's a goal!" Third row, left: Karri, Petri, Timo and the rest of the group warming up. Right: Merja, "What a good team I have!" Fourth row: Finally, after a fun day, it was time for sauna and food at the fireplace.

2. Publications

2.1 International Journals

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22. Tammi, Joni: Thermal flares from collapsed accretion disks?, 8th INTEGRAL Workshop “The Restless Gamma-Ray Universe”, September 27-30, 2010, Dublin Castle, Dublin, Ireland, submitted 2010.

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(IPPW-7), Barcelona, Spain, June 12-18, 2010.

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45. Gurvits, L.I.; Cimo, G.; Pogrebenko, S.V.; Campbell, R.M.; de Pater, I.; Vermeersen, B.; Zegers, T.; Oberst, J.; Nothnagel, A.; Pätzold, M.; Mujunen, Ari; Molera, Guifré; Charlot, P.; Frey, S.; Montebugnoli, S.: Status of the Planetary Radio Interferometry and Doppler Experiment (PRIDE) for the Europa Jupiter System Mission, EJSM Laplace Workshop, ESTEC, Noordwijk, January 2010.

46. Koyama, Y.; Kondo, T.; Sekido, M.; Hobiger, T.; Takiguchi, H.; ... Wagner, Jan; Mujunen, Ari; Ritakari, Jouko et. al. (11 coauthors): Ultra Rapid Dut1 Estimations from E-VLBI Sessions, Advances in Geosciences, Vol. 20, Solid Earth (SE), eds. Satake, K. Singapore: World Scientific, pp. 209, 2010.

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Planetary Radio Interferometry and Doppler Experiment (PRIDE) for the Europa Jupiter System Mission, EJSM Laplace Workshop, ESTEC, Noordwijk, January, 2010.

2.3 Laboratory Reports

1. Tornikoski, M., Mujunen, A., Holmberg, B., (editors): Aalto University Metsähovi Radio Observatory Annual Report 2010.

2.4 Other Publications

1. Wagner, Jan; Molera, Guifré: Latest miscellaneous software code developed at Metsähovi (Aalto(MRO), European VLBI Network Newsletter, Number 25, http://www.jive.nl/dokuwiki/doku.php?id=evnnews:evnnews, 2010.

2. Elina Nieppola: Synchrotron emission from blazar jets-energy distributions and radio variability. Thesis for the degree of Doctor of Science in Technology, 2010.

3. Kallunki Juha; Riehokainen, A.: Quiet Sun areas oscillations at centimeter wavelengths, CESRA 2010, La-Roche-En-Ardenne, Belgium, 15-16 June 2010.

4. Riehokainen, A.; Kallunki, Juha: Solar radio oscillations at wavelengths 1.76 cm and 8.2mm. CESRA 2010, La-Roche-En-Ardenne, Belgium, 15-16 June 2010.

5. Lavonen, Niko: Observations software development in Metsähovi Radio Observatory, YERAC2010, Alcala de Henares, Spain, 5-8 July 2010, pp. 36. http://eprintweb.org/S/article/astro-ph/1003.4278 , 2010.

6. Uunila, Minttu: Experiencing the First VieVs User Workshop, IVS Newsletter, nr. 28, pp. 7., 2010.

7. Tuomi, Tapio J.; Raudaskoski, Marjatta; Hannuksela, Matti. . . Tammi, Joni et. al.: Miten astronautit peseytyvät? Koottu Tiede-lehden asiantuntijapalstan kysymyksistä ja vastauksista. Onko Linnulla napa? Ja muita tieteen arvoituksia, pp. 10., 2010.

8. Pogrebenko, S.V.; Molera Calvés, Guifré: EVN space science applications extend across Europe, the Earth and the Solar System. Elektroninen julkaisu: http://www.astro.uni.torun.pl/~magda/EVN_NEWSLETTER/October10/EVN_Newsletter_27_October10.htm#VEX , 2010.

9. Molera Calvés, Guifré: Observations of Mars Express and Venus Express spacecraft and first EVN VLBI space science session. http://www.astro.uni.torun.pl/~magda/EVN_NEWSLETTER/October10/EVN_Newsletter_27_October10.htm#VEX, 2010.

10. Wagner, Jan; Molera Calvés, Guifré: Latest miscellaneous software code developed at Metsähovi-Aalto-MRO. http://www.astro.uni.torun.pl/~magda/EVN_NEWSLETTER/January10/EVN_Newsletter_25_Jan10.htm#Mets%C3%A4hovi_update, 2010.

3. Visits to Foreign Institutes

- Chalmers University of Technology, Sweden, 26.01.2010, M. Tornikoski
- University of Sydney, Australia, 5 - 29.1.2010, D. Hannikainen
- Florida International University, Miami, FL, USA, 12.3.2010, D. Hannikainen
- Max Planck Institut für Radioastronomie, 6 & 9.4.2010, J. Tammi
- Geospatial Information Authority of Japan (GSI), VLBI station, Tsukuba, Japan, 15.4.2010, G. Molera, M. Uunila
- Kashima Space Center (KSC), Kashima, Japan, 18 - 19.4.2010, G. Molera, M. Uunila
- Max Planck Institut für Radioastronomie, Bonn, Germany, 21 - 23.6. 2010, M. Tornikoski, A. Lähteenmäki, E. Nieppola.
- Max Planck Institut für Radioastronomie, Bonn, Germany, 21.6 - 6.7.2010, J. León-Tavares
- Joint Institute for VLBI in Europe (JIVE), 26.7 - 13.8.2010, G. Molera
- University of Berkeley, USA, 1.10.2010 - 31.12.2010 (continues to 30.9.2011), G. Molera
- CEA Saclay and Université Paris-Diderot, France, 4 - 7.10.2010, D. Hannikainen

- Onsala Space Observatory, Onsala, Sweden, 12 - 15.10.2010, M. Uunila

- Pushchino Radio Observatory, Russia, 21.10.2010, A. Lähteenmäki, M. Tornikoski, E. Nieppola, P. Kirves, J. León-Tavares, P. Savolainen

- ASI Science Data Center, Rome, Italy, 24 - 29.10.2010, J. León-Tavares

- Smithsonian Astrophysical Observatory, Cambridge, MA, USA, 25 - 29.10.2010, D. Hannikainen

- University of Würzburg, Germany, 1 - 5.11.2010, J. Tammi

- Mullard Space Science Laboratory of the University College London, Holmbury St. Mary, United Kingdom, 2.–12.11.2010, P. Savolainen

- Florida Technical University, Melbourne, FL, USA, 5.11.2010, D. Hannikainen

- Purdue University, West Lafayette, IN, USA, 7 - 10.11.2010, D. Hannikainen

- Istituto di Radioastronomia of INAF, Bologna, Italy, 7 - 10.11.2010, J. León-Tavares, M. Tornikoski, A. Lähteenmäki

- University of Florida, Gainesville, FL, USA, 16 - 19.11.2010, D. Hannikainen

4. Visiting Scientists

- Dr. Michael McCollough, Smithsonian Astrophysical Observatory, Cambridge, MA, USA, 6 -14.4.2010

- Prof. Kinwah Wu, MSSL, UCL, Holmbury St. Mary, Surrey, UK, 7 - 13.4.2010

- Dr. Silke Britzen, Max-Planck-Institute for Radio Astronomy, Bonn, 27 - 29.5.2010

5. Theses

Thesis for the degree of Doctor of Science in Technology: Elina Nieppola, “Synchrotron emission from blazar jets - energy distributions and radio variability”.

Figure 5.1. First row, left: Thesis defence on 28.5.2010. Elina ending her Lectio Praecursoria. On the left: Opponent, Dr. Silke Britzen from Max-Planck-Institute for Radio Astronomy, Bonn. On the right: Custos of the defence, Prof. Martti Hallikainen. Right: Dr. Britzen and Elina Nieppola discussing. Second row, left: Opponent and the candidate at the blackboard. Right: Opponent delivering her final conclusions about the defence, with the candidate standing up to listen.

6. Teaching

1. Spring 2010, post-graduate course on space technology “Science with a CMB satellite - a PBL approach”, M. Tornikoski, A. Lähteenmäki

2. Autumn 2010, visiting lecturer to the course “Radio science for space and environmental applications”, M. Tornikoski

7. 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
- Academy of Finland Research Fellow 1.8.2005 - 31.7.2010, A. Lähteenmäki
- Member of the jury, PhD defense, CEA Saclay, France, 5.10.2010, D. Hannikainen
- Metsähovi Radio Observatory participated in the EVN effort to track MEX Phobos-flyby. Link to the event: www.esa.int/marsblog/

7.1 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 Graduate School Board of the Faculty of Electronics, Communications and Automation, A. Lähteenmäki

- Planck ERCSC LFI validation team, A. Lähteenmäki

- Scientific Committee, International Workshop on Radiation Imaging Detectors. D. Hannikainen

- 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

- EXPReS Consortium Board, chairman, A. Mujunen

- ESO Observing Proposal Committee P86, Garching, Germany, 17 - 20.5.2010, D. Hannikainen

- PhD Thesis Jury Board, CEA Saclay, France, August - October, 2010, D. Hannikainen

7.2 International Meetings and Talks

1. Planck LFI Core Team meeting and Planck LFI Core Team meeting on non CMB science, Bologna, Italy, 20 - 22.1.2010, J. León-Tavares

2. Onsala Space Observatory Time Allocation Committee meeting (OSO + APEX time allocation) in Göteborg, Sweden, 26.1.2010, M. Tornikoski

3. An evaluation hearing relating to the following proposal submitted to Call FP7-INFRASTRUCTURES-2010-2, Brussels, Belgium, 8 - 9.2.2010, A. Mujunen

4. Probing Strong Gravity Near Black Holes, Prague, Czech Republic, 15 - 18.2.2010, K. Koljonen

5. Florida International University, Miami, FL, USA, 12.3.2010, D. Hannikainen

6. COST-research network kickoff-meeting Brussels, Belgium, 23 - 24.3.2010, M. Tornikoski

7. The Radio Frequency Interference Mitigation workshop, Groningen, Netherlands, 28 - 31.3.2010, J. Wagner, P. Kirves

8. Steady Jets and Transient Jets workshop, Bonn, Germany, 6 - 10.4.2010, J. Tammi

9. The East-Asian VLBI workshop, Kagoshima, Japan, 22 - 24.4.2010, M. Uunila, G. Molera

10. The European Geosciences Union General Assembly 2010, Vienna, Austria, 2 - 7.5.2010, G. Molera

11. Joint Planck Core meeting, Paris, France, 2 - 5.5.2010, J. León-Tavares

12. The FP7 9th Call Info Day, Brussels, Belgium, 10 - 11.6.2010, A. Mujunen

13. 12th International Workshop on Radiation Imaging Detectors, Cambridge, UK, 11 - 15.6.2010, D. Hannikainen

14. The International Planetary Probe Workshop 2010, Barcelona, Spain, 14 - 18.6.2010, G. Molera

15. The CESRA2010 workshop, La-Roche-en-Ardenne, Belgium, 15 - 19.6.2010, J. Kallunki

16. EVN TOG meeting, Metsähovi Radio Observatory, Finland, 21 - 22.6.2010, A. Mujunen, G. Molera, M. Uunila, N. Kareinen

17. "Fermi meets Jansky — AGN at radio and gamma-rays" conference, Bonn, Germany, 21.-23.6.2010, A. Lähteenmäki, M. Tornikoski, E. Nieppola, J. León-Tavares

18. 2nd School on Multiwavelength Astronomy, Amsterdam, The Netherlands, 28.6. – 9.7.2010, P. Savolainen

19. The Young European Radio Astronomers Conference (YERAC 2010), Alcala de Henares, Spain, 5 - 8.7.2010, N. Lavonen

20. Planck LFI Core Team and ERCSC validation team meetings, Bologna, Italy, 7 - 10.7.2010, A. Lähteenmäki

21. Outflows in AGN-workshop, Belgrade, Serbia, 7 - 11.7.2010, J. León-Tavares

22. The 38th COSPAR Scientific Assembly, Bremen, Germany, 17 - 24.7.2010, J. Tammi

23. Astrophysics of Neutron Stars 2010, Çeşme, Turkey, 2.–6.8.2010, P. Savolainen

24. The 22nd European Cosmic Ray Symposium, Turku, Finland, 2 - 6.8.2010, J. Tammi

25. 25th International Conference of Physics Students, Graz, Austria,

17.–23.8.2010, P. Savolainen

26. The Vienna VLBI Software userworkshop, Vienna, Austria, 6 - 9.9.2010, M. Uunila

27. IAU Symposium 275: Jets at all Scales, Buenos Aires, Argentina, 13 - 17.9.2010, K. Koljonen

28. Planck Joint Core Team meeting, Bologna, Italy, 13 - 15.9.2010, A. Lähteenmäki, J. León-Tavares

29. The NEXPReS Board-meeting, Manchester, Great Britain, 20 - 21.9.2010, A. Mujunen

30. European Planetary Science Congress 2010, Rome, Italy, 20 - 23.9.2010, G. Molera

31. Planck Early Paper Workshop, Cambridge, United Kingdom, 27 - 29.9.2010. A. Lähteenmäki

32. 8th INTEGRAL Workshop, Dublin, Ireland, 27 - 30.9.2010, D. Hannikainen, P. Savolainen, J. Tammi

33. XI Russian-Finnish Radio Astronomy Symposium, Pushchino, Russia, 18.–22.10.2010, A. Lähteenmäki, M. Tornikoski, J. León-Tavares, M. Tornikoski, P. Savolainen, P. Kirves, E. Nieppola, E. Valtaoja

34. The CRAF 51st meeting, Madrid, Spain, 2 - 6.11.2010, J. Ritakari

35. Florida Technical University, Melbourne, FL, USA, 5.11.2010, D. Hannikainen

36. Planck Consortia meeting, Bologna, Italy, 8 - 10.11.2010, A. Lähteenmäki, M. Tornikoski, J. León-Tavares

37. Purdue University, West Lafayette, IN, USA, 9.11.2010, D. Hannikainen

38. University of Florida, Gainesville, FL, USA, 17.11.2010, D. Hannikainen

39. American Geosciences Union Annual General Meeting (AGU), San Francisco, USA, 12 - 17.12.2010, G. Molera

40. ISSI team “Decrypting and Modeling the High-Energy Emission of Blazars” meeting, Bern, Switzerland, 13 - 16.12.2010, J. Tammi, A. Lähteenmäki, J. León-Tavares

Figure 7.1. The XI Russian-Finnish Astronomy Symposium. First row, left: The 22-metre radio telescope RT22. Right: RT22 control room. Second row, left: Large Phased Arry, operating in the metre-wavelength range. Right: Wide-band Cross Type Array DKR-1000.

7.2.1 The XI Russian-Finnish Radio Astronomy Symposium in Pushchino, Russia

Several members of the Metsähovi team participated in the XI Russian-Finnish Radio Astronomy Symposium in Pushchino, Russia 18-22.10.2010.

7.3 National Meetings and Talks

- Astronomers' Days 2010: The Biennial Meeting of the Finnish Astronomical Society, Kangasala, 2 - 4.6.2010, D. Hannikainen, P. Savolainen, K. Koljonen

- Planck satellite - we've got data! Astronomers' Days of the Finnish Astronomical Society in Kangasala, Finland, 2.-4.6.2010, A. Lähteenmäki

- Extragalactic point sources, Planck seminar, Micronova, 7.4.2010, A. Lähteenmäki

- The Finnish Graduate School in Astronomy and Space Physics Sum-

mer School 2010: Simulation methods in astrophysics, Mariehamn, 16 - 20.8.2010, K. Koljonen

- Tuorla-Tartu annual meeting 2010: observational cosmology, 2 - 3.9.2010, J. León-Tavares

- The opening of the Finnish Centre for Astronomy with ESO (FINCA), Turku, Finland, 16.9.2010, M. Tornikoski

7.4 Public Relations

- Teleskooppi tutkii Aurinkoa Kirkkonummella, interview for Helsingin Sanomat, 19.10.2010, J. Kallunki

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

7.4.1 Ladies Day at the faculty

Ladies day at ETA faculty, 8.3.2010. M. Tornikoski, A. Lähteenmäki, M. Uunila, E. Nieppola, D. Hannikainen

Figure 7.2. Left: Metsähovi stand at the Ladies Day. We displayed posters about Metsähovi, books about (radio) astronomy and some other related material. Radio astronomical observations were shown in real-time on a laptop, and we also had presentations about the research in Metsähovi. Right: The audience was interested in our research and especially the observations that we displayed in real-time.

8. Personnel in 2010

Permanent Positions funded by Aalto University

Tornikoski, Merja, Prof.	Director of the institute Docent of Radio Astronomy and Space Technology	merja.tornikoski@aalto.fi
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Kallunki, Juha, Lic.Sc. (Tech)	Operations Engineer	juha.kallunki@aalto.fi
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