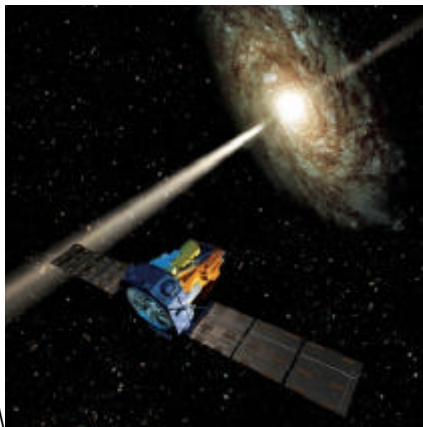


# Pre graduate projects at the European Space Astronomy Centre (ESAC) in 2006

## 1 Introduction

The Science Operations and Data Systems Division of ESA's Research and Scientific Support Department develops and runs projects to do astronomy in space. These projects take about 10 years to build the instruments and software that are then used for several years making observations devised by the world's astronomers. During operations, the emphasis shifts to understanding exactly how well the instruments perform in order to



**Figure 1-2: INTEGRAL**



**Figure 1-1: XMM-Newton**

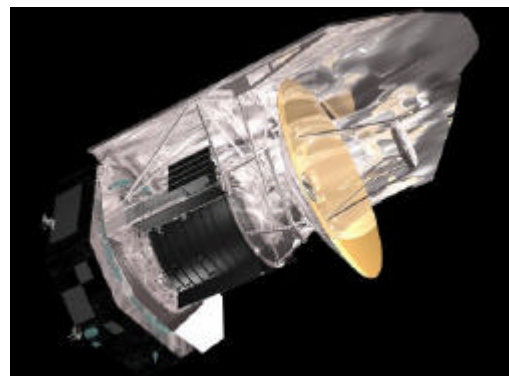
reveal as clearly as possible the physics of the sun and stars or neutron stars or black holes or galaxies at large within the universe. This involves a range of different types of work such as data analysis; software development, the design of suitable calibration observations, user support and scientific research. All of those tasks are done through extensive teamwork both within the division and in external collaboration with international partners.

Various astronomical satellites are currently operated from the European Space Astronomy Centre (ESAC), Villafranca del Castillo near Madrid/Spain.

For example:

- XMM-Newton, an X-ray observatory
- INTEGRAL a  $\gamma$ -ray observatory
- Herschel an infra red observatory (launch in 2007)

We offer the possibility for students to perform training at ESAC. The trainees will be integrated in the respective working teams. The following topics depending on knowledge and interests of the Trainee and team-needs in the final training period are offered:



**Figure 1-3: Herschel**

## 2 Projects

### 2.1 XMM-Newton-4: Constraining the extragalactic soft X-ray background with XMM-Newton spectra

Tutor at ESAC: Dr. N. Schartel

Recent studies based on XMM-Newton and Chandra observations were able to demonstrate that a high fraction (>90%) of the X-ray background in the energy range from 0.5 to 2.5 keV is caused by discrete extragalactic sources, - most of them are Active Galactic Nuclei at a red shift below 2.0. On the other side the soft energy range can serve as window to look back to the very young universe. This might be supported by evidence recently found for a cross-correlation of the WMAP satellite map of the cosmic microwave background (CMB) and the HEAO1 satellite map of the hard X-ray background (XRB). The proposed project aims to determine the X-ray background of various suited XMM-Newton observations, which then will allow various studies with respect of cosmological questions. The successful candidate will be asked to identify suited observations in the XMM-Newton Science Archive. The proposed project requires that existing spectra extraction scripts are modified and new scripts are developed such that they can identify "good" ranges in time and area for a background determination. The developed scripts should be of such nature that they can easily be applied for a large number of observations.

- Project duration: 3-6 months, depending on knowledge of the candidate.
- One programming language. Although no specific language is required, knowledge of IDL, FORTRAN, or C would be regarded as a preferential title
- Basic astronomy courses. Although not strictly required, some knowledge of astronomical and cosmological concepts would be regarded as a preferential title.

### 2.2 XMM-Newton-5: Planck and XMM-Newton: are there common challenges?

Tutor at ESAC: Dr. N. Schartel

Planck was selected as the third Medium-Sized Mission of ESA's Horizon 2000 Scientific Programme, and is today part of its Cosmic Vision Programme. It is designed to image the anisotropies of the Cosmic Background Radiation Field over the whole sky, with unprecedented sensitivity and angular resolution. It is planned to launch Planck in the first quarter of 2007. The X-ray Multi-mirror Mission (XMM-Newton) is the second cornerstone of ESA's Horizon 2000 Science Programme, providing an observatory-class X-ray facility. The observatory provides simultaneous non-dispersive spectroscopic imaging and timing, medium resolution dispersive spectroscopy and optical/UV imaging, spectroscopy and timing from a co-aligned telescope. XMM-Newton has the largest effective area of all astronomical X-ray satellites to date. The successful candidate will be asked to identify the expected astronomical measurements of the Planck mission based on a study of the corresponding literature and Internet. The main aim is to identify source populations which are observable with both instruments and to evaluate the hypothetical scientific impact of simultaneous and follow-up observations. For the latter part simulations might be required.

Project duration: 3-6 months, depending on knowledge of the candidate.

Desirable expertise or programming language:

- One programming language. Although no specific language is required, knowledge of IDL, FORTRAN, or C would be regarded as a preferential title
- Basic astronomy courses. Although not strictly required, some knowledge of astronomical and cosmological concepts would be regarded as a preferential title.

### 2.3 Integral-2: Studying gamma-ray AGN with INTEGRAL

Tutor at ESAC: Dr. Rees Williams

Several Active Galactic Nuclei, which were bright sources for the Compton Gamma-Ray Observatory, have not been studied in-depth with INTEGRAL, despite significant overall observation time. The proposed project is to analyse large INTEGRAL datasets from the INTEGRAL archive with the standard software, and to study images and spectra for these sources, relating them to the knowledge obtained in the past with CGRO and existing theoretical understanding.

Project duration: Several months, depends also on number of sources studied and involvement of student.

Desirable expertise or programming language:

- Some knowledge in astronomy, ideally related to extragalactic sources.

### 2.4 Herschel-1: Analysis of instrument ground test data from the HIFI instrument for the Herchel Observatory

Tutor at ESAC: Dres. A.P.Marston & D.Teyssier

The Herschel Observatory is currently under construction with a planned launch date in 2007. First ground tests are carried out and the data from these tests need to be analysed in order to understand the performance of the instruments and prepare the calibration.

The scientific services company VEGA Group PLC who will take an active interest in the progress of the trainee sponsors this post.

Project duration: up to 6 months

Desirable expertise or programming language:

- Java and/or Jython desired but not essential

### 2.5 Herschel-2: Analysis of instrument ground test data from the PACS instrument for the Herchel Observatory

Tutor at ESAC: Dres. B. Altieri & R.Vavrek

The Herschel Observatory is currently under construction with a planned launch date in 2007. First ground tests are carried out and the data from these tests need to be analysed in order to understand the performance of the instruments and prepare the calibration.

Project duration: up to 6 months

Desirable expertise or programming language:

- Java and/or Jython desired but not essential

## 2.6 Computer Support Group 1 - Security Scripts for the Computer Support Group

The Computer Support Group at ESAC provides computer and grid activities support for the Science Operations Centres of most of ESA's astronomical satellites (ISO, XMM-NEWTON, INTEGRAL, HERSCHEL, GAIA, PLANCK). Besides this, ESAC holds the Science Archives Team, which is developing the mission, archives for these and others scientific satellites in the Agency. These archives are also located in ESAC

Due to the fact that the number of machines and the complexity of their configuration is growing, it becomes a necessity to automate the installation and use of several security tools. Several of those tools are already in place but there is the need to adapt them to the current network environment and make them more scalable. The idea of this internship would then be to improve the current setup of some security tools, allowing easier and cost effective deployment and maintenance of those security tools. In particular, as most of the security tools are script-based, some re-writing of the existing scripts or creation of new ones will be required. All the development is to be done on UNIX workstations, either SUN Solaris or DELL Linux RedHat.

Inputs for this task are existing security tools and scripts as well as existing network infrastructure.

Goals of this task: re-write tripwire installation scripts; re-write tripwire logging system; migrate current nmap scripts; release nmap monitoring tool; make proposal to improve or create new security scripts and implement them if accepted

Duration: 5-6 months

## 2.7 Computer Support Group 2: Nagios Monitoring System deployment

The Computer Support Group at ESAC provides computer and grid activities support for the Science Operations Centres of most of ESA's astronomical satellites (ISO, XMM-NEWTON, INTEGRAL, HERSCHEL, GAIA, PLANCK). Besides this, ESAC holds the Science Archives Team, which is developing the mission, archives for these and others scientific satellites in the Agency. These archives are also located in ESAC.

Currently, there are more than fifty Unix/Linux servers and approximately one hundred of workstations (tens of systems are coming along the next year) in ESAC that need to be closely monitored in order to operate them properly to offer the expected service level. Nagios is a very-popular open-sourced monitoring system, widely used both on academic - research and commercial networks to monitor hardware devices like computers, switches, routers, etc., services like DNS, DHCP, WWW, FTP, NTP, etc. and applications like Oracle or Postgresql.

Hence, we are looking for computer engineer students with a good knowledge of Linux and/or Solaris operating system and knowledge of Shell-script and/or Perl programming (Java and/or Python skills would also be highly appreciated) interested in:

- Learning system and Internet services administration basics and
- Improving his/her system programming skills.

The internship would be divided into these two phases:

Phase 1: Introduction to Nagios: shell-script and Perl programming; Nagios architecture and configuration; Adding new servers to the list of monitored systems; Evaluate, select and install a suitable GUI for Nagios management.

Phase 2: Analysis, Development and Deployment of new Nagios "probes": Identify mission-critical servers and services at ESAC; Design, code, test and deploy new "probes" for monitoring mission-critical servers and services; Integrate Nagios with statistics packages .

### 3 Project Concept

Young scientists participate in a trainee programme taking place at the European Space Astronomy Centre (ESAC) and contributing to the XMM-Newton satellite project.

The trainees as of now have been from the following universities:

- University of Madrid (Spain)
- University of Bonn (Germany)
- University of Tuebingen (Germany)
- University of Warwick (England)

The project is supervised by tutors and comprised of students from the following three areas.

- The pre graduate program for Spanish students from the UCM, that every year allows students from the Madrid Complutense University to do an internship at ESAC and get the results credited for their university career.
- The ESA internship trainee programme.
- Other universities are welcome to participate.

The project is every year split in sub-projects that overlap in the techniques of data analysis and benefit in conceptual structure from each other. However it is assured not to introduce dependencies that slow one project down, because important input from other sub-projects is needed such that the situation of a single point of failure could arise.

To get the sub-projects started, a "First definition" and the "First steps and goals" of the project are defined by the tutor as a first guideline. The "First definition" is then refined and extended by the trainee to a real project definition after the first weeks. The "First steps and goals" are transformed into a Timeline for the project by the trainee supervised by the tutor. This strategy allows the trainee to start from the outset on a well defined project, which is highly important for projects on short time-scales, but also to redefine and structure the project after a short period of introduction and adjustment. The concept of a realistic timeline also allows room for contingencies. After successful completion of the work, a self-assessment and review enable the trainee to get a first impression of the structure of project work, and to develop skills for the future regarding similar based project set-ups.

Once per week a meeting of all trainees with the tutor is held in order to discuss briefly the status of the projects. The responsibility for minutes writing is rotated amongst the members of the group, and is used in order to track the activities for the tutor and to force the trainee on a regular basis to self-assess and review the own project.

Each trainee, after the first introductory period of their traineeship, gives a talk on the principle ideas of their project, which is complemented, by a final talk on the content and outcome of the project at the end of the project period.

#### 4 The Project in 2005

In 2005 six young scientists participated once again in a trainee programme within the XMM-Newton project. The project took place at the European Space Astronomy Centre (ESAC), contributing to the XMM-Newton satellite mission.

The project was split into three project lines addressing different topics such as XMM-Newton timing data analysis, calibration investigations and the processing of XMM-Newton slew data.

Detailed reports will be presented in the proceedings of the "The X-ray Universe 2005" Symposium.

- Monitoring of the EPIC Cameras at the XMM-Newton SOC
- XMM-Newton Timing Monitoring at ESAC
- The XMM-Newton Slew Survey: Towards the XMMSL1 Catalogue
- Extended Sources in the XMM-Newton Slew Survey

The trainees were from the University of Madrid (Spain), the University of Tuebingen (Germany) and the University of Warwick (England).



Figure 4-1: Trainees of 2005

## 5 The Project in 2004

In 2004 five young scientists participated in a pilot trainee programme taking place at the European Space Astronomy Centre (ESAC) and contributing to the XMM-Newton satellite project.

The trainees are from the University of Madrid (Spain), the University of Bonn (Germany) and from the ESA Young Graduate Trainee Programme.

The project has been supervised by tutors and comprised of students from the following three areas.

- The pre graduate program for Spanish students from the UCM, that every year allows students from the Madrid Complutense University to do an internship at ESAC and get the results credited for their university career.
- The ESA internship trainee programme.
- The ESA young graduate trainee programme.

The project was split in five sub-projects that overlapped in the techniques of data analysis and benefited in conceptual structure from each other. However it was assured not to introduce dependencies that slow one project down, because important input from other sub-projects is needed such that the situation of a single point of failure could arise.

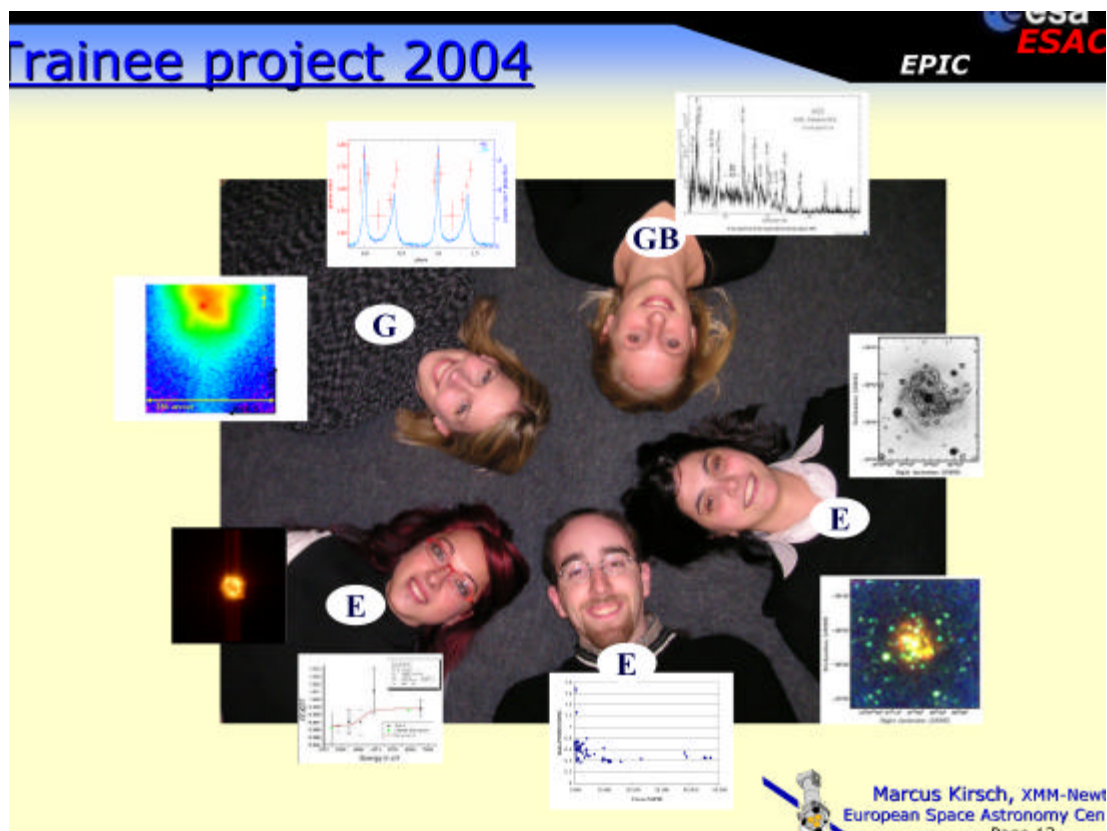


Figure 5-1: Trainees of 2004

## **6 More Information**

You will find further information on the project at:

[http://xmm.esac.esa.int/external/xmm\\_links/trainee/index.shtml](http://xmm.esac.esa.int/external/xmm_links/trainee/index.shtml)

and are welcome to contact M. Kirsch for details at:

[Marcus.Kirsch@sciops.esa.int](mailto:Marcus.Kirsch@sciops.esa.int)