First GraWIToN School

Monday 20 April 2015 - Friday 08 May 2015

EGO - European Gravitational Observatory

Conference Scientific Programme

OPT - Optics

The OPT sub-programme will be focused on the optical technologies, specifically on the development, test and commissioning of the optical components crucial in the advanced and third generation GW detectors.

SIM - Simulation

Laser interferometric precision measurements, such as optical clocks or GWDs, have reached fundamental limits that require advanced concepts to overcome. New numerical methods for modeling the experiments need to be used to understand the technology at this extreme phase sensitivities. Modeling software always involved a compromise between speed and usability on one hand and accuracy and range of validity on the other hand. Thus when computer technology advances or the required precision of the models changes, the computer models should be adapted accordingly. We now face the challenge of implementing the effects of the quantum behaviour of light and the microscopic mirror surface changes into optical simulations. This prompts new understanding and re-implementation of numerical models and the physics algorithms on which these are based. At the same time advancement in parallel processing has promised fast processing on many cores in a desktop computer via GPU (Graphics Processing Unit) programming interfaces, opening new possibilities for higher precision without using super computers. While massive computing for simulating systems is routinely used in several fields of science and technology, in the specific field of optical interferometry this is not so frequent, mainly because powerful analytical methods exist. However dealing with real imperfect devices leads to approximations that are no more suitable. The simulation sub-programme is innovative in this field and its research addresses real practical problems in optics and computing.

HPL - High Power Laser

High power laser are a key ingredient of the future GWDs. It is obviously a technology having a crucial industrial potential, although the requirements imposed by GW experiments, in terms of low noise and stability, are well beyond what usually requested by industrial applications. For the third generation of GWDs, not only laser sources at 1μm but also at 1.55μm will be needed. The current laser technology developed for the laser systems for the second, advanced generation of GWDs relies on well-established Nd-doped solid state laser technology. However, the change to the 1.55μm wavelength region implies also a change not also of the active dopant but also the underlying laser technology. In particular, the 1.55μm wavelength range can be mainly addressed using Er3+-ions active dopant. Furthermore, Er-doped fibres offer the most promising way to date to realize high-power, high-brightness laser sources at 1.55μm.

DAS - Data Analysis

Data Analysis is the final and most important aspect of the chain of activities performed in a GWD. The faint signal must be extracted from the output of the interferometer, embedded in the background noise. Key ingredients of this activity are the modelling of the expected signal, filtering of the data stream, vetoing through a deep knowledge of the technical aspects of the GWD, correlation with the output of the GWD in the world wide network and statistical analysis. High performance programming and parallel computing (GPUs) are crucial competences in this sub-programme.

Complementary and Interdisciplinary Skill Training (TSS)

This programme concerns the development of complementary skills, composed by three major components:
1. Complementary technologies
2. Project management
3. Outreaching and dissemination of scientific results

1. The “Complementary technologies” contents are focused on disciplines close to the main subject of GraWIToN: computer programming elements, numerical methods, introduction to GRID, Distributed computing on High Performances Clusters, Parallel computing on GPUs, MEMs-modeling and fabrication of micro-mechanical oscillators with micromirrors, clean room technologies, cryogenics.

2. Project Management. Gravitational Wave observatories are and will be large scientific enterprises. In such a contest the knowledge and understanding of how scientific projects are managed has the aim of improving the participants’ education. This training course is designed to highlight the role of project managers in the whole project lifetime. This covers project initiation, scoping, costing, planning, budgeting, executing, controlling and closing. The limits of project management approaches, such as when their projects become inefficient, are also taken into account. This training module also refers to major project management and systems engineering standards and methodologies, in particular the PMI’s Project Management Body of Knowledge, the NASA’s Systems Engineering Handbook and the ECSS (European Cooperation for Space Standardization) Standards. This training course is a mixture of interactive lectures, in which discussion and idea sharing are encouraged, and of discussion sessions around real and specifically designed scientific project case studies. A particular attention will be paid to share the lessons learned from the CERN’s Large Hadron Collider project. Teachers of the course will be selected upon either internal or external experts, in order to have the best use of GraWIToN resources and the best achievements for the ESRs.

3. Finally, the outreaching for scientists is the third element of the interdisciplinary training. The scope of the course is to raise awareness about the importance for scientists to reach out and share their activities with a large and non-specialized public. Scientists are increasingly requested to explain their work with journalists but also through social media (videos, tweets, blog posts). Without the specific techniques, this exercise can turn out useless or even detrimental to the scientist’s credibility and overall image.

During this first school the Technical Skill lesson (TSS) will be focused on Statistics, Digital Signal Processing and Outreach.