New Infrastructures Require New Training: The Example of the Very Large Telescope Interferometer Schools

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The discovery space for astronomy is dramatically widening with the operation, construction and planning of ambitious new infrastructures. A key aspect of the scientific return from these facilities is the training of its users. We report on a series of summer schools designed to train a new generation of young astronomers in optical interferometry with the Very Large Telescope Interferometer.

Eleven years have passed since first light on the Very Large Telescope (VLT). The last decade has been a vibrant one for astronomy. Common key words in contemporary astronomy such as "dark energy" or "exoplanets" appeared for the first time in the title of a refereed journal article only about ten years ago. The thrust of astronomical discovery is driven by carefully planned new facilities and infrastructure. The last decade has witnessed the deployment of the VLT and the VLT Interferometer (VLTI), the planning and initial construction of the Atacama Large Millimeter/submillimeter Array (ALMA) and the planning of the European Extremely Large Telescope (E-ELT). These new facilities will come online in the next decade. The E-ELT will enable tremendous gains in sensitivity, making it possible, for example, to probe the acceleration of the Universe. The profound gain of the ALMA interferometer in both resolving power and sensitivity is driven by three key science goals, one of them being the study of the physics and chemistry of planet-forming discs around young stars.

New opportunities come with new challenges and these were clearly identified by the *ASTRONET Infrastructure Roadmap* (Bode et al., 2008): "Recruiting and training the future generation of Europeans with advanced scientific and technological skills is therefore a key aspect of any realistic Roadmap for the future." Training new generations of astronomers on new observational techniques is of the utmost importance as new facilities come online. This article shares the very successful experiences of the VLTI training schools project ONTHEFRINGE that took place between January 2006 and December 2008.

The birth of the project

At the start of the training schools project, the VLTI was operational, but had yet to ramp up and become the top optical interferometric facility in the world. Expertise in optical interferometry was concentrated in a few institutes involved in instrument building and was not widespread across Europe and the ESO user community. If this uneven distribution of expertise continued it would clearly inhibit the scientific maximisation of the investment in the new interferometric infrastructure.

A few schools had been organised previously with FP5 funding (for example, the Les Houches school in 2002) and institute funding (for example, the Leiden schools in 2000 and 2004), but any wider coordination was lacking. In contrast, a very successful annual programme of optical interferometry summer schools (the Michelson/Sagan Summer Schools) has been running in the US since 1999. The creation of the European Interferometry Initiative (EII) network signalled the beginning of a European-wide cooperation between countries with and without expertise in optical interferometry. Under the auspices of EII, the ONTHEFRINGE project was submitted to the European Commission for FP6 and awarded funding. The project was coordinated by Universidade do Porto/CAUP, with ESO, Observatoire de Paris/LESIA, Max-Planck-Institute for Astronomy, Heidelberg and INAF/ Osservatorio Astrofisico di Arcetri as partners and, as third parties, the Laboratoire d'Astrophysique de Grenoble, the Nicolaus Copernicus University in Torun, Poland and the Konkoly Observatory of the Hungarian Academy of Sciences.

The goals of the schools

The ONTHEFRINGE project aimed to overcome the training gap by providing an integrated and structured approach to European training in optical interferometry. One goal of the schools was to educate a new generation of young astronomers, equipping them with the ability to carry out scientific programmes at the VLTI (from preparation to data reduction and analysis). Another important goal was to place optical interferometry in context with other techniques in key astronomical areas of European leadership such as adaptive optics and radio/sub-mm interferometry. In contrast with the NEON observing schools that took place at observatories, the VLTI schools were held in relatively geographically isolated locations, but with sufficient computing capacity for hands-on training. The very nature of the VLTI made it unreasonable to carry out the training at the La Silla Paranal observatory. Since VLTI observations are normally carried out in service mode, its location in Chile and the full-time science use of the facility meant that the schools obviously could not take place on-site.

The project consisted of four schools:

- Observation and Data Reduction with the Very Large Telescope Interferometer, Les Houches, June 2006
- Circumstellar Disks and Planets at Very High Angular Resolution, Porto, May–June 2007
- Active Galactic Nuclei at the Highest Angular Resolution: Theory and Observations, Torún, August – September 2007
- Astrometry and Imaging with the Very Large Telescope Interferometer, Keszthely, June 2008.

The first and fourth schools were data reduction schools, aimed at hands-on observation preparation and data reduction, the first focusing on AMBER/MIDI and the fourth on PRIMA and image reconstruction. The second and third schools were science schools aimed at placing optical interferometry in a wider context, in two fields where it has a major impact.

Although the schools were open to all researchers, EU requirements only allowed funding to particular categories of participants, essentially PhD students and young postdocs.

The design of the schools

Previous experience with the one week school at Les Houches in 2002 showed that it was difficult to combine both the teaching of new information and the necessary contact-building time among participants successfully, in such a short time. Although, in theory, optical interferometry is not very difficult to understand (the practice, however, requiring a significantly steeper learning curve), most of the students had not been in contact with the discipline before, in contrast with optical/infrared spectroscopy or photometry, for example. Therefore they had to be immersed in a Fourier space environment for some time to become acquainted with optical interferometry methods. The schools lasted for two weeks, a couple of days more than the ideal. We found that including a free afternoon as early as the second day of the school greatly improved the contact-building among participants. The right balance of fun and work was found important to keep productivity high in the unfamiliar environment of optical interferometry. It should be stressed that during fun time, students were building contacts among themselves and the senior lecturers that not only were the basis for group work at the school, but could, in the future, be important for collaborations or the sharing of information about relevant institutes and supervisors for a future postdoctoral position.

The school's time was essentially divided between lectures/seminars and practical sessions. The lectures addressed the basic aspects of interferometry and the seminars the typical astronomical results obtained. In the astrophysical schools a set of review lectures focused on the astrophysics of the target objects and complementary techniques, such as adaptive optics or radio/sub-mm interferometry. In the practical sessions the students went through the observation preparation software, in groups of two sharing a computer. This experience was found to be very useful in learning the basics of interferometry. Exercises focused initially on the observables measured by the interferometer and how they could be used to constrain models of the astronomical object(s) to be observed. Then, more complex and realistic aspects of the observations were included, such as UV coverage, closure phases, noise in the observables and model-fitting. In the data reduction schools, the participants went through the steps in the reduction pipelines. At the end of the schools, groups of students worked on a VLTI observation proposal and presented it to their colleagues, facing scrutiny and advice from seasoned observers. These sessions helped to mature a student's understanding of the technique and certainly helped to make them more able to design scientific programmes at the VLTI – the main goal of the schools.

As a requirement of an EU funded training programme, we designed a series of lectures on complementary skills — from presentation skills, to paper and telescope proposal writing, career development and ethics. We were surprised at the interest of the students. Many were not aware of what an impact factor was, or what the refereeing process was all about, or even that job hunting should start well in advance of the end of a PhD. Many of them were discussing ethical aspects in the practice of astronomy research for the first time, or learning that a PhD is not enough (c.f. Feibelman, 1993) for a successful career in science.

The number of students attending each school was around 55, with PhD students accounting for well over two thirds of the total. Such a number was a compromise between a school environment and reaching a larger audience. The logistics required to keep 30 computers up and running (including updating and installing software and data) with internet access in isolated regions of Europe was not trivial. Even with so many participants, many more had applied and could not be selected to attend. The selection of participants was based on a motivation letter, institute and national balance, with preference given to PhD students. In order to reach a wider audience, all the materials at the schools (presentations, software, data, lecture notes) were made available on the project website[1]. In retrospect some of the lectures should have been videotaped and streamed through the site.

Highlights and results of the schools

The total number of participants in the four schools, including lecturers, was around 280. A lecturer attending four schools counted as four participants. The number of participants who did not lecture was around 200, composed essentially of PhD students and young postdocs. The selection procedure kept multiple attendance to below 10%. During the three years of the project there were about 1500 PhD students in astronomy, about half of whom were in Europe (Gibson, 2002). The total number of ESO member country participants was around 105. If we assume that half of the total PhDs are awarded in ESO member countries, then this project reached around 14% of the total PhD student population in Europe. This number would increase by a small factor if specific areas were considered, such as ground-based observational astrophysics. The gender balance of the non-lecturing participants was around 60% male: 40% female and increasing to 70% male: 30% female if we included the lecturing participants. Figure 1 presents the distribution of non-lecturing students by country. Interestingly, countries that have recently become members of ESO or intend to join soon had a high attendance at these schools.

These schools were very important for software developers (at ESO and the Jean-Marie Mariotti Center) and they provided a unique opportunity for immediate and massive feedback from a pool of interested new users.

The ambiance of the schools was uniformly excellent, providing a perfect balance between hard-working and brain-cooling moments. The best experts and seasoned lecturers taught not only all about optical interferometry, adaptive optics, radio/sub-mm interferometry, but also the physics of young stellar discs or active galactic nuclei. The participants, from all around the globe, had a taste of the best of Europe! Sampling red wine and French cuisine at the Chateau de Goutelas, or enjoying the sun and the beach at the Portuguese seaside (and of course a glass of Port), visiting the stunning town where Copernicus was born and becoming an expert in *wódka*, or finally watching the views from the hills

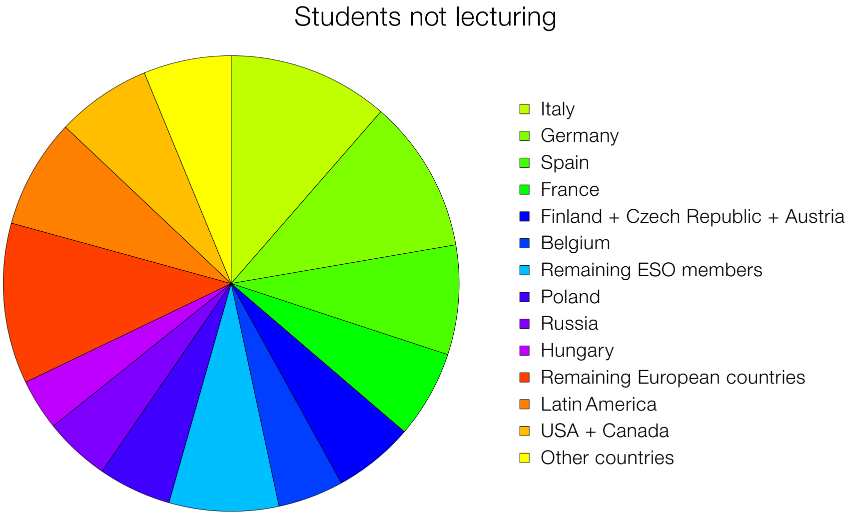

Figure 1. Pie chart showing the distribution of students (non-lecturing participants) by host country attending the four VLTI Summer Schools.

near Lake Balaton while discovering the bouquet of an old Tokay. I will not forget the awed face of lecturers as, when arriving late, they witnessed the computer room full of students working hard on their telescope proposals. At the end of the telescope proposal presentations, the students would rush to Françoise Delplanke and proudly collect ESO stickers, posters, hats or calendars. This new generation of young astronomers surely deserves the great new infrastructure we are now planning and building.

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Notes

[1] http://www.vlti.org




Figure 2. A selection of group photographs from the four VLTI summer schools at (clockwise): Les Houches, France, 2006; Porto, Portugal, 2007; Torun, Poland, 2007; and Keszthaly, Hungary, 2008.