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Engineering Fellows at ESO

ESO's core missions are to build and operate state-of-the-art facilities for the advancement of astronomical research and to foster international cooperation in astronomy. A strong research and development programme is therefore at the core of ESO's activities. For this reason, for a few years ESO has established, in addition to the ESO fellowship programme for researchers in astronomy, an engineering fellowship programme. The profile of one of these ESO engineering fellows is presented here.

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Writing this article was an interesting opportunity to reflect on how I became an adaptive optics researcher/engineer. What probably set the foundations for a career in science is the fact that I grew up in an area called la Vallée de Chevreuse in France — known to host many scientific research institutes — and that most of the people I knew were somehow related to a scientific institute, including some members of my family (I have an uncle working at NASA).

My first contact with astronomy occurred during a short internship in high school at the Institut d'Astrophysique Spatiale d'Orsay with L. D'Hendecourt; there I heard for the first time about the search for exoplanets. I remember that at the time I was very disappointed to hear that we had only a few pictures of them and that most of them had been detected indirectly! However, this internship really aroused my curiosity for our Universe, and this is probably when I first started to think about a career in astronomy.

To that end, I specialised in fundamental physics at the Paris-Saclay University. As part of my master's degree and thanks to the Erasmus programme, I got the chance to study in Rome for a year, at La Sapienza University. This year abroad definitely changed my life. A large part of this experience was personal as I was able to discover a new culture and a new language. Also, I decided to take a course in optics for astronomy to get a background in instrumentation, although I had chosen most of my classes to focus on astronomy.

This is when I got introduced to a technique called adaptive optics (AO) that is used to compensate in real time for the optical aberrations induced by the atmosphere. This technique seemed magical to me and sounded quite fun to study. Therefore, I decided to specialise in instrumentation with the goal of working on AO instruments. The transition from fundamental physics ended up being quite smooth, although I had to get familiar with completely different tools and concepts. However, it became clear to me that the "magical" aspect of AO relied in fact on a deep understanding of optics, mechanics, automatic control, electronics, and algebra.

At the end of this year of specialisation I was able join ESO for the first time, to do my master's thesis with J. Paufique working on the NAOMI instrument for the VLTI. The goal was to characterise the performance of the new wavefront sensors (WFS) of the Auxiliary Telescopes to improve the flux available for interferometry purposes. A few years later, NAOMI became fully operational in Paranal and the feeling that I contributed to at least a small part of its success makes me very happy.

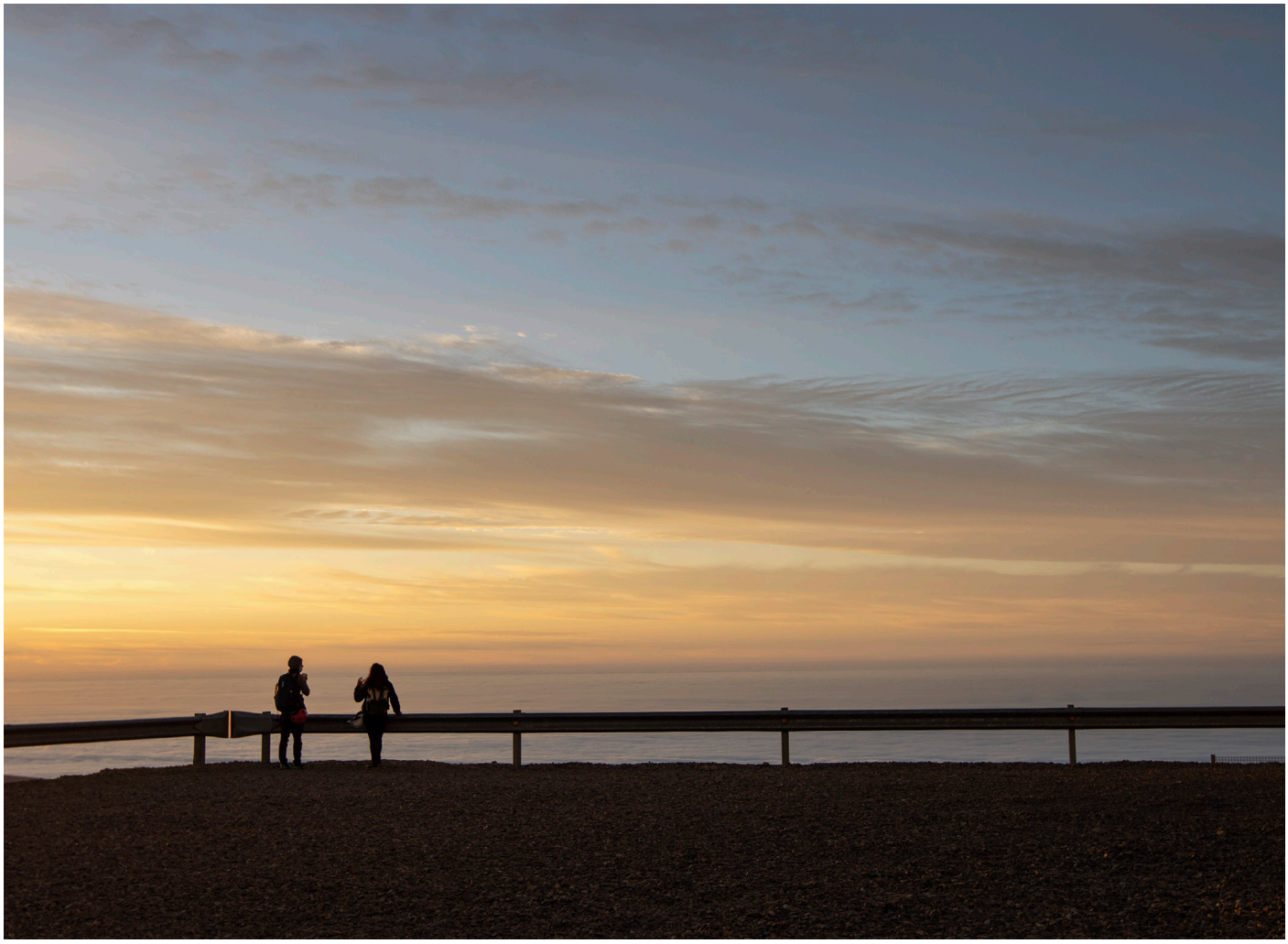
After this first technical experience, I was selected to do a PhD on the calibration of the future AO instruments of ESO's Extremely Large Telescope (ELT). This topic sounded very attractive to me as it would help minimise the instrument overheads due to imperfect calibrations and provide more time for the science. It really gave some practical sense to my work. Another very exciting aspect of this PhD is that four institutes were involved in the supervision (T. Fusco from ONERA, B. Neichel from LAM, S. Oberti from ESO and S. Esposito from INAF–Arcetri) and that I could spend a year in each country (France, Germany and Italy). This peculiar organisation ended up being valuable for my research and I am grateful that I have been able to interact with so many AO experts across Europe.

The goal of my PhD was to find ways to ensure that the calibration of the AO system stays nominal during the scientific observations, regardless of the fact that mechanical flexures might lead the adaptive mirror M4 to move frequently with respect to the WFS. In order to do that, I developed an algorithm called SPRINT to track the relative motions of one with respect to the other. Although parts of this method have been validated on existing telescopes, I will still have to wait many years to see how my piece of work will perform on the real ELT AO systems!

I wanted to carry on this research by investigating other effects that might affect the AO performance and stability due to the complexity of an ELT AO instrument (WFS specificity, pupil fragmentation effects, complexity of the M4 mirror, phasing of the primary mirror, etc.). The problem remains that these different effects may add up and could make the control of the instruments quite challenging. To study these topics, I was selected to be an ESO Engineering and Technology Research Fellow to try to come up with realistic performances of the AO systems while investigating possible ways to mitigate some of these effects. Although my research mainly benefits the AO instruments, being at ESO also allows me to interact with the teams working on the ELT itself which is very useful for understanding better how the instruments will be operated.

In fact, as an ESO Engineering Fellow my engineering duties are very close to my research interests as I am currently leading some activities to develop a common calibration strategy for all the ELT AO instruments. My everyday work includes mostly simulations of ELT AO systems, as well as investigating different wavefront control and reconstruction strategies and new wavefront sensing concepts. I am also involved in a R&D project called GHOST led by M. Kasper. This testbench aims to validate experimentally AO control strategies based on machine learning to improve the contrast of PCS, the future planet finder of the ELT.

Apart from work, if I am not busy playing team sports I am most certainly taking some time off from my computer to listen to and observe the nature around me. The spotting of a rare bird or a friendly encounter with an octopus in the Mediterranean Sea are simple things that always bring me joy.



ESO staff members enjoy the glorious sunset at ESO's VLT platform in the Atacama Desert, Chile.