Silicon pore optics for high-energy optical systems

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LIST OF PUBLICATIONS

5. D.A. Girou, E. Ford, C. Wade, C.v. Aarle, A. Uliyanov, L. Hanlon, J.A. Tomsick, A. Zoglauer, M.J. Collon, M.W. Beijersbergen, and N.M. Barrière, *Design and modeling of a Laue lens for radiation therapy with hard x-ray photons*, Physics in Medicine & Biology, 66, 24 (2021).

4. D.A. Girou, C.v. Baren, I.t. Kloeze, L. Castiglione, B. Okma, G. Vacanti, E. Hauser, L. Babić, A. Bayerle, N.M. Barrière, N. Eenkhoorn, R. Günther, Y. Jenkins, B. Landgraf, L. Keek, A. Thete, S. Verhoeckx, M. Vervest, L. Voruz, M.J. Collon, M.W. Beijersbergen, S. Fransen, G. Campoli, I. Ferreira, E. Wille, M. Bavdaz, F. Marioni, and G. Valsecchi, *Environmental testing of the Athena telescope mirror modules*, Proc. SPIE 11822, Optics for EUV, X-Ray, and Gamma-Ray Astronomy X, 1182209 (2021).

3. D.A. Girou, S. Massahi, D.D.M. Ferreira, F.E. Christensen, B. Landgraf, B. Shortt, M.J. Collon, and M.W. Beijersbergen, *Plasma etching for the compatibility of thin film metallic coatings and direct bonding of silicon pore optics*, Journal of Applied Physics, 128, 9 (2020).

2. D.A. Girou, B. Landgraf, A. Bayerle, M.J. Collon, L. Babić, N.M. Barrière, R. Günther, E. Hauser, L. Keek, B. Okma, G. Vacanti, S. Verhoeckx, M. Vervest, L. Voruz, M.W. Beijersbergen, E. Wille, M. Bavdaz, S. Fransen, C.v. Baren, A. Eigenraam, and N. More, *Environmental testing of silicon pore optics for Athena*, Proc. SPIE 11119, Optics for EUV, X-Ray, and Gamma-Ray Astronomy IX, 111190K (2019).

1. D.A. Girou, C. Wade, N.M. Barrière, M.J. Collon, R. Günther, L. Hanlon, J.A. Tomsick, A. Uliyanov, G. Vacanti, A. Zoglauer, *Development of a second generation SiLC-based Laue lens*, Proc. SPIE 10399, Optics for EUV, X-Ray, and Gamma-Ray Astronomy VIII, 103991Y (2017).

CURRICULUM VITÆ

Growing up in France, I enrolled in "classes préparatoires aux grandes écoles" in Tours after high school. There I spent three intense years studying mathematics, physics, and philosophy preparing for the highly competitive exam to enter one of the French "grande écoles", and did so in 2010.

From 2010, I attended the "Institut supérieur de mécanique de Paris" (ISAE-Supméca), an engineering school that specializes in mechanics, aeronautics, as well as industrial management, and logistics. During this time, I had the opportunity to spend six months erecting wind turbines in Canyon at the West Texas A&M University. While in Texas, I used a piece of software developed by the Technical University of Denmark (DTU) and later found out that my French school had an exchange agreement with the Danish university, which sparked my interest.

In 2013, I then enrolled at DTU, but preferred studying instrumentation for astrophysics, instead of pursuing wind energy. During this period, I had the privilege to spend some time at the California Institute of Technology (Caltech) in Pasadena as a guest graduate student where I used NuSTAR data (a NASA X-ray space telescope) to study high-mass X-ray binaries. In addition, I started working beside my studies in the astrophysics department of DTU Space together with Finn Christensen, Desiree Della Monica Ferreira, Anders Jakobsen, and Sonny Massahi. There, I was introduced to Athena and the silicon pore optics (SPO) technology and was even able to hold an SPO plate for the very first time (and unintentionally broke it during one of my first experiments). Following this experience, I completed a thesis on multilayer coatings for high-energy astrophysics telescopes that I presented at the SPIE Optics and Photonics conference in San Diego in the summer of 2015. At the conference, I met Max Collon, Giuseppe Vacanti, and Nicolas Barrière, all from a company called cosine, as well as Marcos Bavdaz and Eric Wille from the European Space Agency (ESA). At that time, I was looking for funding to start a PhD in Denmark, and it seems like a collaboration between cosine, ESA, and DTU was very much possible.

In September 2015, I completed the master's degree at DTU, adding up to the engineering degree from ISAE-Supméca, equivalent to a second master's degree, and was hired as a research assistant in the astrophysics department of DTU Space. After a few months though, I found an agreement with cosine and moved to the Netherlands in March 2016. Thanks to Marco Beijersbergen, managing director at cosine and professor at Leiden University, I was soon able to pursue a PhD in parallel to my work.

Since March 2016, I have been evolving in cosine's international setting with experts in various disciplines, developing SPO technology for Athena and Laue lenses. Further-

more, in 2019, I had the opportunity to take part in the International Space University's (ISU) Southern Space Studies Program (SHSSP) taking place in Australia. This program touching on all space disciplines enabled me to grow a solid international, intercultural and interdisciplinary network. More recently, I followed an executive program at the graduate business school INSEAD to complete my technical and scientific background with bigger-picture strategic insights and leadership skills. In the coming years, I hope to combine and build on all these experiences, and contribute to strengthening the link between science, space, and business.

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Developing the silicon pore optics technology in general, and in particular for Athena, is an incredible task that dozens of highly skilled technicians, physicists, and engineers have undertaken at cosine for more than 20 years. I wish therefore to express my special thanks to all the past and present members (unfortunately too numerous to list here) of the high-energy optics team at cosine, among which Max Collon, Dr Giuseppe Vacanti, Dr Nicolas Barrière, and Dr Boris Landgraf.

I wish to show my appreciation to ESA as well, and particularly to Dr Marcos Bavdaz, Dr Ivo Ferreira, and Dr Eric Wille for the support and feedback I received over the years during the many extensive reviews.

Silicon pore optics is a versatile technology that can be further developed for a wide range of applications, but doing so besides the efforts for Athena is no small matter. This feat was only made possible for radiation therapy thanks to the invaluable contribution of the following international members of the Laue lens research group: Dr Eric Ford, Dr Colin Wade, Casper van Aarle, Dr Alex Uliyanov, Dr Lorraine Hanlon, Dr John Tomsick, and Dr Andreas Zoglauer.

In addition, my research would have been impossible without the help of many individuals, including Marlies Bonnet, Karin Liang, and Henriëtte van Leeuwen. Thank you all for your patience and for the continuous aid and support you provided during the entirety of my time in the Netherlands.

Finally, I would like to express my gratitude to my friends and former colleagues at the Technical University of Denmark, with whom I started this entire high-energy optics adventure already more than eight years ago, including Dr Finn Christensen, Dr Desiree Della Monica Ferreira, and Dr Sonny Massahi.