

## Thierry Fusco

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### Adaptive Optics Scientist

At the forefront of research and developments in Adaptive Optics (AO) both in France and in Europe for more than 20 years, I carried out a thesis dedicated to the proposal of theoretical, numerical and operational concepts to overcome the two fundamental limitations of adaptive optics: partial correction and anisoplanatism. Since 2000, I mainly worked for the astronomical community in order to develop innovative **AO systems that have led to the first images of extrasolar planets on the VLT**.

I was at the heart of the integration, testing and commissioning of **NAOS the first OA of the VLT**. Then, I took responsibility for **SAXO, the extreme AO of SPHERE**. As AO scientist for the project, I managed to go from very first conceptual ideas to an operational implementation on the telescope in less than 12 years, making **SAXO the most efficient AO system in the world**. In parallel, I am deeply involved in image processing developments and I propose new concepts of wavefront sensors (Filtered Fourier Wavefront sensors) to **further improve the precision, sensitivity and final contrast of future planet finder instruments**.

Finally, I am involved in the new adaptive optics of GNAO (Gemini North new AO system) and the future **Giant European Telescope (ELT)**. As AO scientist of the **HARMONI** project, I am again in charge of its multiple adaptive optics modes and especially the SCAO one that will allow reaching the ultimate performance of the instrument and the telescope in order to **pave the way to new discoveries, in particular in the field of detection and characterization of extrasolar planets**

**Main ERC Panel number : PE9\_13 (and potentially PE9\_2; PE9\_3, PE10\_14)**

### Diploma, Title, Awards

- 2020 : French Academy Scientific Award "Grand prix de Charles Defforey"
- 2020 : French Aeronautics and Astronautics Association "Scientific Excellence Price"
- 2019 : Senior Research Director, ONERA
- 2012 : Research Director, ONERA
- 2009 : Fabry de Gramont award (Société Française d'Optique)
- 2008 : Habilitation à Diriger les Recherches: "*Adaptive Optics and Post-processing for astronomy : new challenges and new solutions*"
- 2000 : Thesis in Physics from université de Nice – Sophia Antipolis : "*Partial correction and anisoplanatism in adaptive optics*". With honnors

### Work Experience

- Since 2021 : Science Deputy Director of the ONERA's Optics Department (more than 200 collaborators)
- 2011 – Today : Invited researcher at Laboratoire d'Astrophysique de Marseille
- 2000 – Today : Researcher at ONERA, optics Department
- 2000 – 2001 : Postdoc at LESIA (Meudon) : NAOS (VLT first AO system) integration and tests

### Research Activities

My research activities are characterized here by a unique position at the interface between astronomical applications and complex technological developments with a "system" and co-design approach (instrumentation - signal processing / associated images). This translates into 4 major, and closely related, items;

- **Instrumentation for high angular resolution:** development of new AO concepts for "high contrast imaging" and "large field imaging": from the theoretical concepts to sky validation and integration into operational astrophysical instruments
- **Wave-Front Sensing:** Improvement of existing concepts (weighted center of gravity for the Shack-Hartmann and Filtered Shack-Hartman, Phase diversity) and proposal of new concepts (LIFT, Fourier Filter wavefront sensors). From theoretical to on-sky experimental validations (see ANR WOLF)
- **Propagation and control of the wavefront:** characterization of the propagation channel, measurement and prediction of turbulent phenomena (laser propagation and pre-compensation, propagation in complex media...)
- **Signal and Images post-processing :** Myopic deconvolution (MISTRAL algorithm), PSF reconstruction. Theoretical developments and practical applications (close collaboration with astronomers for image processing for more than 20 years)

### Publication

**213 referee publications** with 16 as 1<sup>er</sup> author, 52 within the 3 first authors and 22 as last author.

**+400 international conferences with proceedings**, 41 as 1<sup>st</sup> author and 133 within the 3 first authors

**H<sub>index</sub> = 62 (Google scholar) / 45 (ADS), citations : 16506 (Google) / 9237 (ADS)**

## Scientific and instrumental responsibilities

Since 2022	Science deputy director of the Optics Department
2023 – 2028	Co-PI of the AO bench of GNAO the new AO facility of the Gemini North Telescope
2019 – 2023	PI of the WOLF ANR : innovatie wavefront sensors for high contrast imaging
2015 – 2026	« <i>AO scientist</i> » for HARMONI, ELT first light Spectro-Imager
2006 – 2015	« <i>AO scientist</i> » for SPHERE, VLT planet Finder In charge of the SAXO project (Sphere AO for eXoplanet Observation)
2009 – 2011	PI of the ATLAS project: phase A study for a « Laser Tomographic AO » for the ELT
2006 – 2010	In charge of the pre-design of the EAGLE AO (MOAO) system (ELT project)
2004 – 2005	AO responsible for the VLT Planet Finder project (future SPHERE project)
2017 – 2020	In charge of the VASCO research project (Visible AO and Sky Coverage Optimisation)
2013 – 2015	In charge of the NAIADÉ research project (New Approach for Imaging with AO and Deconvolution)
2008 – 2011	In charge of the CASSIOPEE research project: internal coordination of ONERA efforts on E-ELT
2011 – 2013	Project scientist of ODISSEE : Low Orbite Satellite imaging from the ground
2001 – 2002	On sky commissioning of NAOS, the first AO system of the VLT
2000 – 2001	NAOS Integration and tests in lab.

## Animation et administration of research

- President of ONERA Optics Department Scientific Council
- Member of Paris-Saclay «Institut de la Lumière » Council
- Member of ONERA Scientific Council
- Member of Scientific Council for the Labex FOCUS
- Member of Scientific Council for GIS-PHASE gathering High Angular Resolution team from ONERA and Paris, Grenoble and Marseille Observatories (2008 à 2014)
- Feature editor JOSAA (vol 21) et Applied Optics (vol 49) special issues on AO
- Chairman (2009) and co-chairman (2011 - today) for the international conference « *AO for ELT* »
- Chairman (2016) and co-chairman (2017 - today) for the international conference « *Wavefront Sensing in the ELT era* »
- SOC of SPIE conference « *Astronomical Telescope* » (2008 to 2018)
- SOC of « *AO workshop week* » (2018 - today)
- Expertise for NSF, HRC, STFC, ANR, H2020, Pole de compétitivités (France et Belgique) ...
- *Referee* for JOSAA, App. Opt., Opt. Let., A&A, MNRAS, Opt. Com., Opt. Exp., JATIS ...
- Participation to PhD and HDR defence (~3 per an).

## Supervision of young researchers

- Supervision or co-supervision of 22 PhD
- Supervision of 12 postdocs

## National and international collaborations

- Main collaborators: J-F Sauvage, L Mugnier, C Petit, JM Conan et V Michau (ONERA), B Neichel, J-L Beuzit, K Dohlen, K El-Hadi et A Costille (LAM), D Mouillet (IPAG), R Bacon (CRAL)
- Main international collaborators: STScI, ESO, LBT, ESO, INAF-Arcetri, INAF-Padova, Oxford Univ, Durham Univ, Porto Univ, UK-ATC

## Dissemination

- CNRS movie «Un œil sur les exoplanètes» (<https://lejournal.cnrs.fr/videos/sphere-un-oeil-sur-les-exoplanetes>)
- Interview (France inter et France info, podcasts ONERA)
- Press : Le Monde, Le Figaro, Photoniques
- Participation to « journées du Ciel et de l'Espace »
- Participation to « ONERA, Journées de la Science »
- Conferences at « collège de France »
- Conferences « nuit des étoiles, Journées de la Science »
- Participation to « C'est pas sorcier » on the VLT