

High-powered research: physicist Adrian Mancuso

Adrian Mancuso



Physicist Adrian Mancuso works at the cutting edge of 3D imaging, at what will be Europe's newest and brightest X-ray facility.

By Susan Watt

The use of 3D imagery has gone beyond the gimmickry of monsters leaping out to scare you in the cinema. Today, using ultrahigh-powered X-rays instead of light, it's being used to yield precise knowledge of the shape of molecules. At the European X-ray Free Electron Laser (European XFEL)^{w1} in Hamburg, Germany, this knowledge could, in a few years, enable new drugs to be tailor-made to control diseases.

Working at the forefront of X-ray 3D imaging is physicist Adrian Mancuso, a scientist with a life-long curiosity about all aspects of the physical world. As a child, Adrian was an avid observer of the natural world and a keen reader of science books, which started him on the path to his current

position as a leading scientist at the European XFEL, a giant X-ray laser that is currently under construction.

"What we're trying to do is make high-resolution 3D images of biological molecules, as well as of other materials, so we can better understand how they work," says Adrian. "In particular, we're trying to image the kinds of molecules that can possibly only been seen with an X-ray laser."

So how did a physicist like Adrian find himself working on biological molecules? He says: "I took a physics PhD that focused on how to use laser-like X-rays for imaging – really exploring the methods of X-ray imaging. That background, and my subsequent experience of performing this kind of experiment, provided me with the

right knowledge to design an instrument for X-ray diffractive imaging at the European XFEL."

Which is exactly what he is now doing. Adrian says: "Right now I'm building an instrument to do a kind of X-ray imaging called single-particle imaging. These single particles can be anything from tiny crystals to biomolecules to novel materials that we want to understand the structure of. This work is fascinating, because it combines new ideas in physics and mathematics with state-of-the-art technology to produce practical, applied research that just might change the world around us for the better."

Adrian clearly enjoys his job, enthusing that "every day is different, fun and challenging". His enthusiasm



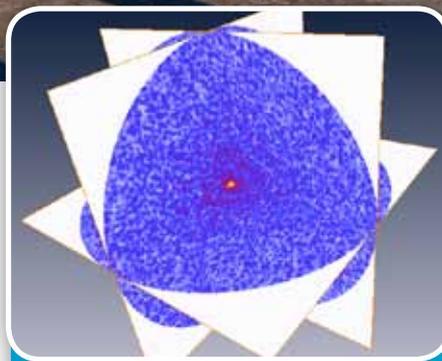
An artist's impression of how the central building of European XFEL will look. The tunnels from which the laser-like X-ray flashes are led to the experiment stations will end in the underground experiment hall beneath the main building. This will house laboratories and offices, seminar rooms, an auditorium and a library

Image courtesy of European XFEL

for research and physics goes back to his early years, as he recalls: "I was always naturally curious. I wanted to understand how things worked, how the Universe works. My parents helped feed that curiosity when I was young by giving me mountains of science books to read. I guess it kept me out of trouble!" Adrian's curiosity became focused on physics when he found one of his father's physics textbooks. "I read it from cover to cover. I just found it so interesting that there was so much to understand about the physical world around us."

Adrian's interests were encouraged at school too. "I was fortunate to have enthusiastic science teachers, who allowed and even encouraged me to use the physics lab out of hours, design experiments, test ideas – and occasionally break stuff."

After he left school, Adrian studied for a science degree at the University of Melbourne in Australia, with a major in physics, followed by a PhD at the same institution. So although he has come halfway around the world, from Australia to Hamburg, to work at the European XFEL, he clearly feels it's been a good move.



Visualisation of the 3D simulated diffraction pattern of a 3-phosphoglycerate kinase molecule. This is a representation of what 'perfect' diffraction data collected at European XFEL may look like

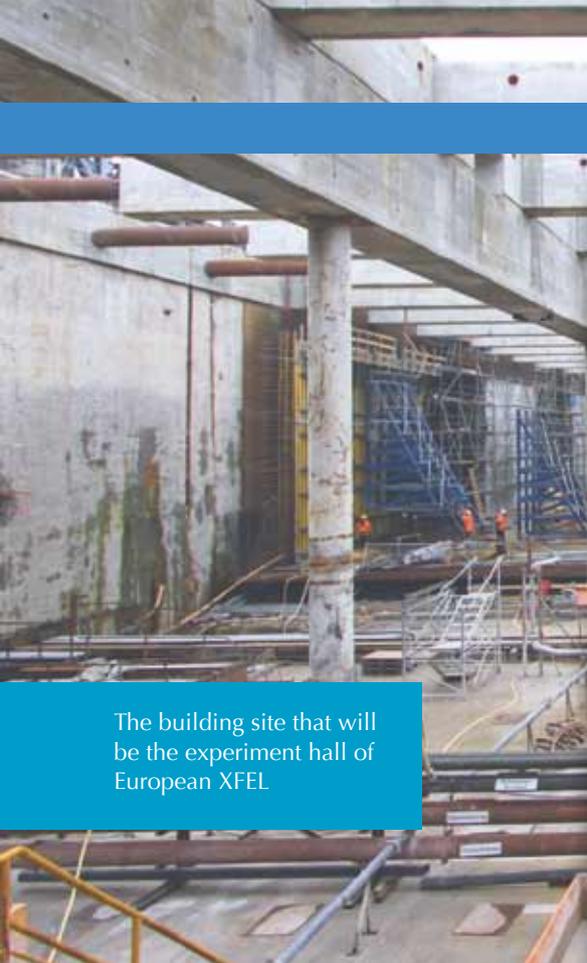
Image courtesy of Z Jurek and B. Ziaja (CFEL), and AP Mancuso (European XFEL)

"There are very few places in the world where one can hope to image non-crystalline biomolecules well enough that the imaged structure may be useful for drug design, or practical applications," he says. "The European XFEL is at the forefront of single-particle imaging research worldwide."

Adrian also thrives in the international team environment at European XFEL, where the staff come from six continents and more than 18 countries. He believes that the cross-cultural interactions and opportunities

to learn about different parts of the world from colleagues is a "wonderful bonus to the top-class work we get to do each day". He explains: "People from different places sometimes see the world around us in different ways. These different perspectives can have a positive influence by diversifying how we think about things – which can be essential for solving scientific problems."

As well as being passionate about his research, Adrian feels it is important to convey the joys of science to a wider audience – and he has had plenty of fun in the process. From helping to put on a science show for junior students while he was at high school – which was so popular he became known as "the guy from the science show" – to inviting high-school students to see how science is done in universities and laboratories and what it's really like to work in them, Adrian has been involved in sharing his enthusiasm for science at every stage of his career. He says he found the activities with students "very rewarding, as the students got a clearer picture of 'doing' science in practice, not just in the classroom".



The building site that will be the experiment hall of European XFEL

Image courtesy of European XFEL

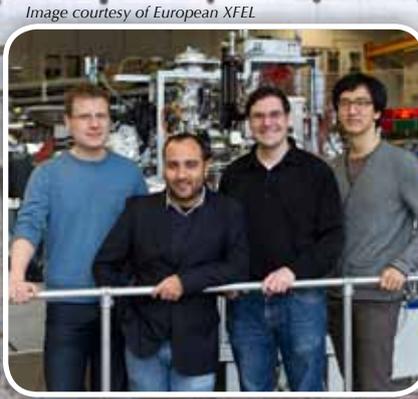
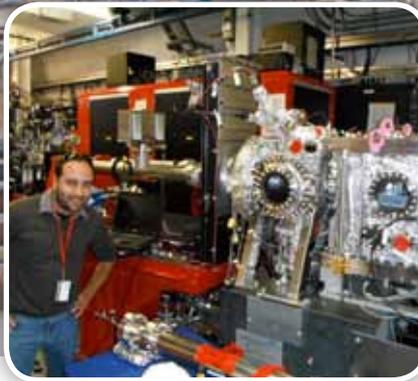


Image courtesy of European XFEL

Adrian Mancuso (second from the left) and his colleagues in the experiment hall of the free-electron laser FLASH at DESY (the German Electron Synchrotron) in Hamburg, Germany



Adrian Mancuso in front of the coherent X-ray imaging (CXI) instrument at the SLAC National Accelerator Laboratory in Stanford, California, USA



Image courtesy of DESY

Adrian Mancuso in the X-ray tunnel that connects the near and far experimental halls of the Linac Coherent Light Source at the SLAC National Accelerator Laboratory in Stanford, California, USA

So what advice would Adrian give to a student wanting to follow in his footsteps? "A good start would be to study physics. If you want to make images of things, it helps to have some knowledge of optics – in our case, especially the strange but fun world of X-ray optics," he says. "This is an increasingly popular field of research, as there is rapid progress in the use of bright, laser-like X-ray sources across the world."

And he would have no hesitation in recommending the intellectual pleasures to be gained from a career in research. Adrian says: "That moment when you realise that you and your colleagues in the room are the only people on the planet that, at that moment, have observed something unique – that's something that one always remembers."

Web reference

w1 – To learn more about European XFEL, see: www.xfel.eu/overview/in_brief

Resources

To find out more about Adrian Mancuso's work, read the abstract of a

talk he gave at the recent EIROforum teacher workshop ('Finding the structure of biomolecules using ultrabright, ultrashort pulses of X-rays'): www.epn-campus.eu/eiro-teachers-school/programme/lectures

To learn more about the EIROforum teacher workshop, see:

Furtado Neves S (2012) Diving into research at the EIROforum teacher school. *Science in School* 22. www.scienceinschool.org/2012/issue22/efschool

To browse the other scientist profiles in *Science in School*, see: www.scienceinschool.org/scientists

Susan Watt is a freelance science writer and editor. She studied natural sciences at the University of Cambridge, UK, after which she did a master's degree in the philosophy of science. After several years spent producing science exhibitions for the Science Museum (London, UK) and for the British Council, she moved into publishing. Currently, she is a school governor.



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