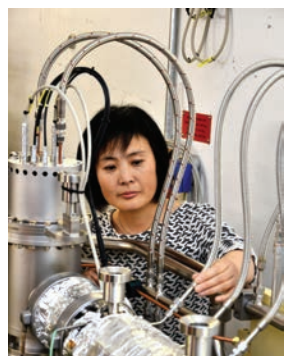
Accelerating innovation in virtually all fields of research

Xia Liu - Mechanical Project Engineer at Diamond Light Source, the UK's National Synchrotron talks about her career development



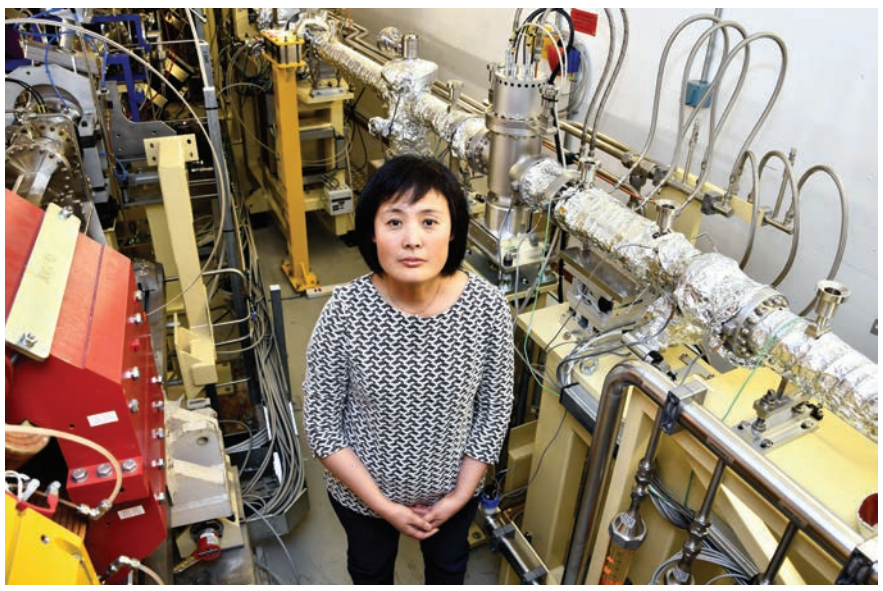
"Like many people I talk to, I was inspired and encouraged by someone in my family to go into engineering. For me, it was my father. He was a draughtsman in an architects' office and later changed to be a customs officer. When the Customs needed a new office building, he was involved in talking to the construction company about the blueprints. I used to love looking at the intricacy of the drawings and plans and thought it was very cool to be able to create designs and build as planned in the drawings. I think it makes a big difference if you have a family member, friend or relation involved in something you are interested in, it makes it easier for you to understand.

It was my university education which allowed me to step into the mechanical engineering field. I got my BEng - Mechanical Engineering in China and after working for a few years in aerospace industry, I took a Master of Science degree at Nanyang Technological University in Singapore. I learnt mechatronics system integration and design through a course called Smart Product Design.

After my Masters, I came to the UK in 2002 and worked for a university spin off at Imperial College in London who did design for optical instruments – and had built a benchtop DNA analysis machine which they were trying to commercialise from a patented technology. I feel fate helped me get the job as it turned out to be the best preparation I could have had for my role at Diamond to work in mechanical design in synchrotron instrumentation. One of the company's owners used to be a researcher of Fermilab - America's particle physics and accelerator laboratory. Because of this experience, he organised the company like a mini Diamond beamline team with a biologist, a chemist and a mechanical, electrical and a control engineer as well as someone to do algorithms and data acquisition. In effect three years working in the company made my transition to Diamond much easier.

When I came to the UK I was thrilled to be in the country of industrial revolution. So when I got the interview for the job at Diamond, I just saw it as a fantastic opportunity to talk to the engineers in this amazing facility. I almost wasn't worried if I got the job, I was so excited to be in the place where all this brilliant science and technology is happening. In fact in the interview when they asked me what I'd been doing - they explained how much my company resembled a beamline team. Back then I didn't even know what a beamline was!

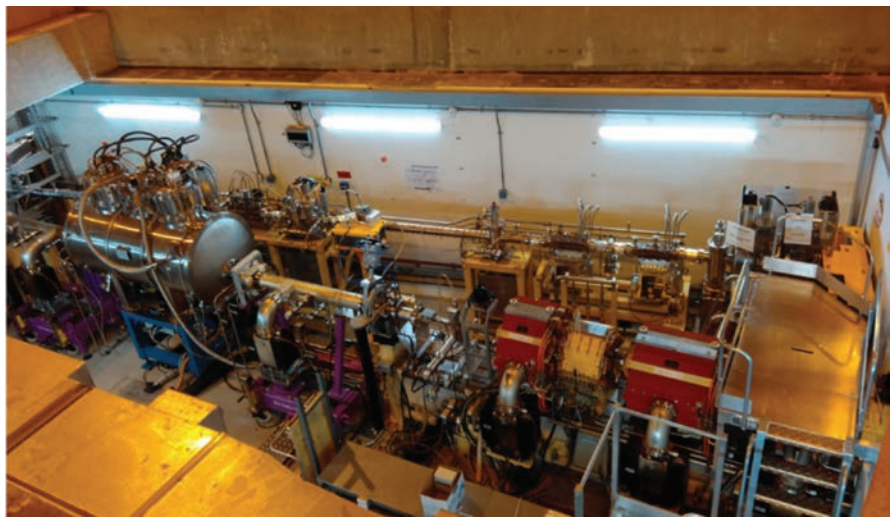
The Diamond project blew me away as it was on an unimaginably huge scale after my previous job. Diamond works like a giant microscope, harnessing the power of electrons to produce bright light that scientists can use to study anything from fossils to jet engines to viruses and vaccines...and I have been part of the team making things happen behind the scene. The



Xia near the DIAD front end in the Diamond storage ring

physics and how the most brilliant light is generated and that people could 'play' with light in this way was initially beyond my imagination. They were so far ahead and doing such amazing science. You wouldn't imagine such a thing exists in the world until you see it and where it is all happening. The people who work here, their knowledge about the science is formidable and the engineering, the knowledge and experience of engineers who build the facility to make all the science happen, even nowadays, is still something special.

I joined Diamond in 2005 to work for synchrotron accelerators as a mechanical design engineer in mechanical engineering in synchrotron instrumentation. I started on the High Resolution Powder Diffraction beamline (I11) and was the first design engineer recruited for Phase two beamlines. Back then the office wasn't so big, this was a very new technology to a lot of engineers who joined and I didn't know synchrotrons at all. It was a completely new and



exciting field for me to work on. I was a beamline line design engineer for ten years moving onto all the different beamlines as they were built and always designing new instruments for different beamline projects. The most interesting aspect is that I've never repeated myself - even after ten years of work - there is always something new to do. And often the 'new thing to do' is not just new to engineering, its new to science. You have to ask yourself how can I make this happen, then form a design and deliver it to meet the scientific expectations to allow the science to take place. It's a very exciting environment and there are so many instruments being designed.

In 2015 a vacancy came up for Mechanical Project Engineer for the front end of beamlines. The front end is a section of the accelerator to channel the X-Ray light to the beamline from the storage ring. This involves not only instruments design but also project management as well as project engineering and liaison with outside suppliers. I got the job and enjoy the challenge of much bigger responsibilities as my decisions in the project directly impact the budgets.

Diamond accelerators are multi-disciplinary engineering systems. I work to initiate the design, produce instrument concept designs and the front end layouts alongside writing. I write technical specifications, I lead a design engineer who implements all the details from my guidance and specifications. I lead design reviews with the multi-discipline team, project

engineering the manufacturing phase and oversee the installation and commissioning of the equipment. Additionally I negotiate and collaborate with stakeholders across the organisation (e.g. Accelerator Physics, Scientific and Engineering staff) to ensure designs and projects are delivered fit for purpose and performing effectively.

I'm also involved in the maintenance of the front end of all of Diamond's 33 beamlines.This a big responsibility as they operate 7 days a week with one day dedicated for machine testing and physics. Our target for the technical division is to have a 100 hour mean time between failure. We need to make sure the machines work with reliability so essential maintenance can take place in our shut down periods that take place every two months for two weeks.

One of my recent big science projects was a new beamline called Dural Imaging and Diffraction (DIAD) that has its first light pass through the front end just before Christmas in 2018. My involvement was to deliver the front end from scratch for this new beamline. The magnetic configuration of the synchrotron only generated low energy photons at the proposed Beamline location. The magnetic configuration had to be modified to enable the generation of higher energy photons required by the science. The modification of the synchrotron resulted in an unusual beam trajectory and made the design of the front end challenging. The front end components were designed to be used under ultra-high vacuum and handle very high power carried by the X-Ray light. I designed the cooling water services to cool down the components and also designed the first optics of the beamline. This required aligning two pairs of aperture defining blades that are 858mm apart from each other to be parallel and orthogonal to within 10 µm in operation. In the meantime, I carried out the bremsstrahlung ray tracing to design the radiation shielding and maintain radiation safety of the accelerator (Pictured).

It is very rewarding when I see the designs from concepts being turned into end products and installed on time successfully - and seeing exactly what I specified happening. I feel very proud that I can contribute to the advancement of science through what I do.

I think engineering and physics use similar problem solving techniques. Technical issues normally involve defining the problem – it is important to make an effort to visualize the physical situation; then simplify the problem with sensible assumptions and apply engineering knowledge and build a model to work out solutions. Scientists and engineers take the same approach – it is a standard approach.

My skills have definitely improved a lot over the fourteen years I've been working at Diamond. This is partially because of the driving force of the science. The scientists are always asking for more science and so we have to be more creative. I take training courses and read journal papers and books to continue my professional development. A lot of my colleagues and peers are very advanced engineers so I learn from them as well. All the engineers are sitting in one big open plan office and it is very natural that we are benefiting from peer learning and knowledge sharing.

We also have a conference every two years called MEDSI (Mechanical Engineering Design of Synchrotron Radiation Equipment and Instrumentation) that provides engineers from Synchrotrons from all over the world the opportunity to share their ideas, challenges and present their designs. In addition to successes we also share our mistakes so we all learn from each other. Working here on the Harwell Science and Innovation Campus we can tap into wider knowledge sources if needed – for example precision metrology, if you need a specialist there are often resources we can reach out to on the wider campus.

Picture shows: Diamond Light Source, the UK's national synchrotron

Recently I was invited to go to China who have a new 4th generation synchrotron project HEPS (High Energy Photon Source) in Beijing. They invited me to join their front end design review panel to review their concept designs. I was invited because of Diamond's amazing global reputation, but I'm also proud that I have helped the big Chinese national science project. I also helped to build a bridge between the two institutions. We will be facing similar issues they have already faced when we upgrade to Diamond II project from the current 3rd generation synchrotron. Synchrotrons generally are sharing communities - now Diamond engineers will visit HEPS and Chinese engineers will come to Diamond and collaborate with our beamline engineers and share knowledge.

For me going forward – I want to progress my career in synchrotron technology. I had my interview in April 2019 for Chartered Engineer from Institution of Mechanical Engineers. Often you are very lucky if your career progression can be in harmony with your company and its business needs. For me, with Diamond-II on the horizon, we will be recruiting even more people and this way I can advance myself at the same time as the company and we can grow together. I would also like to continue to promote the profession to young people especially to girls by participating in company career events and act as a tour guide for groups of visitors to the synchrotron facility.

When I get asked about how to choose what areas to go into. I tell people that there are so many interesting things in the world around us. They should think deeply about where their interests are. Because if you have the passion about something, there are no limitations.

www.diamond.ac.uk/careers

A World-Changing Career at Diamond

The UK's National Synchrotron, Diamond Light Source is one of the most advanced scientific facilities in the world; it houses our synchrotron light source, a giant microscope that can produce beams of light 10 billion times brighter than the sun, to probe the structure and composition of matter – making the invisible visible.

Diamond is always looking for candidates who are passionate about science or engineering, who have an excellent understanding of software and computing technologies, along with a good honours degree in Computer Science or a STEM subject.

From viruses and vaccines, to alternative energy solutions and nanotechnology, Diamond underpins research and innovation for more than 8000 scientists, engineers, researchers, and more. The ongoing development of the facility is key to delivering impactful science that can change the world. Scientists and engineers are vital to maintaining its world-class and in many areas, world-leading standing. Developments include improvements in brightness of sources, optical components and state-of-the-art detectors. Such developments initiate new requirements and operational support of the distributed-control systems, along with advances in data acquisition.

Over the past decade, Diamond Light Source and its European collaborators have invested in Laboratory Information Management Systems (LIMS) to capture, process and store experimental data to enable scientific research. These LIMS systems need to evolve to support emerging scientific techniques and improve the ability of users to exploit the results in an efficient manner. This reflects an investment that will broaden the scope from supporting a few domains, to fully supporting over 1000 industry and academic proposals awarded beam time on the facility each year.

Explore Diamond's Careers page - for more information visit www.diamond.ac.uk