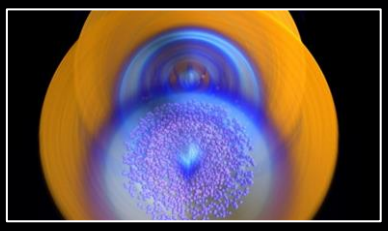
EuPRAXIA Doctoral Network

>>> Newsletter

Latest developments in plasma accelerator research and training.

>>> Highlights



Coherence and superradiance from a quasi-particle accelerator

Joint LIV.INNO and EuPRAXIA-DN researcher training hosted in Liverpool

Meet our EuPRAXIA Doctoral Network Fellows – Part 1

>>> Welcome

A new doctoral network is born!

It is my great pleasure to launch this new quarterly newsletter of the EuPRAXIA Doctoral Network.

The network officially started on 1 January 2024, but the first of our 12 Fellows started their positions only a few months ago. Now, all but one of the Fellowships have been filled (the last remaining position is advertised here) and it was fantastic to meet all those who had started their roles last month for their first training events.

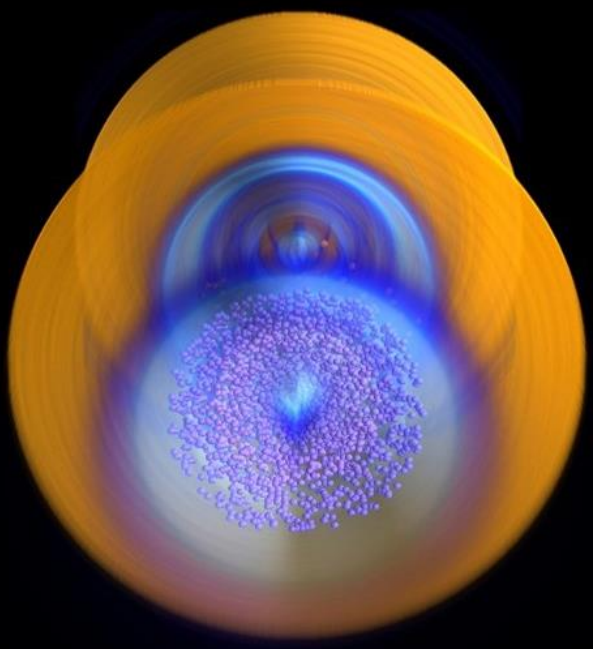
The EuPRAXIA Doctoral Network is closely connected with the EuPRAXIA project, on the ESFRI roadmap since 2021, and the EuPRAXIA Preparatory Phase project. All these projects share the vision of a new distributed research infrastructure that provides plasma-accelerated beams with superior quality to a wide range of user. The doctoral network will directly train the next generation of experts in this exciting field and our many events will be open also to the wider scientific community.

This newsletter will keep you up to date with our latest news and research results. I hope you enjoy reading about our “first steps”.

Prof Carsten P. Welsch
Coordinator

>>> Research Highlights

Coherence and superradiance from a quasi-particle accelerator



Representation of super-intense light cones (yellow). These light cones form from a quasi-particle located at the centre of each cone. Quasi-particles are a result of a plasma electron (spheres) accumulation at the back of each plasma wave (blue).
Credits: Bernardo Malaca/IST (OSIRIS simulation).

"Nothing can move faster than light. Absolutely nothing, except perhaps rumours." This belief comes from the British writer and humourist Douglas Adams, who decided to challenge one of the fundamental ideas in Einstein's theory of relativity. But what if there were tiny particles that could? These super-speedy particles, known as tachyons, were first suggested by a German physicist named Gerald Feinberg back in 1967. Since then, the idea of breaking the speed limit of light has captured the imagination of scientists and thinkers alike.

A group of international scientists led by researchers from EuPRAXIA partner Instituto Superior Técnico (Laser and Plasma Group, Institute of Plasma and Nuclear Fusion) and including experts from the University of Rochester and University of California Los Angeles in the United States and the Applied Optics Laboratory in France, have discovered something fascinating.
If these particles exist, they might be the key to creating a new kind of super-bright light source, just as powerful as the most advanced ones we have today, but much smaller. This groundbreaking research has been published in a paper in *Nature Photonics* recently.

Instead of focusing on individual particles (which can't go faster than light), they looked at something called "quasi-particles." These quasi-particles are the result of electrons moving together in sync, similar to the Mexican wave that goes around football stadiums even though every person stays put. The fascinating part is that these quasi-particles can travel at any speed, even faster than light, and can withstand intense forces.

According to Jorge Vieira, a professor at the Instituto Superior Técnico, and coordinator of this study, *"these special quasi-particles provide an exciting new way to explore and suggest extremely powerful sources of light that nobody had thought of before."* This approach is simple enough that it can be tried in dozens or even hundreds of labs around the world, bringing the theoretical concept a step closer to becoming a reality.

Bernardo Malaca, a doctoral student at IST and the study's primary author, said: *"The flexibility is enormous. Even though each electron is performing relatively simple movements, the total radiation from all the electrons can mimic that of a particle moving faster than light or an oscillating particle, even though there isn't a single electron locally that's faster than light or an oscillating electron."*

Light sources have a huge impact on our lives, from science and technology to everyday applications. For example, they play a crucial role in non-destructive imaging (like scanning for viruses or checking product quality), understanding biological processes (like photosynthesis), manufacturing computer chips, and exploring the behaviour of matter in planets and stars.

Bernardo Malaca added: *"We started with the basics - what conditions make multiple particles emit light as if they were one? - and then applied that to the most intense sources of light."* The most powerful sources of light, like free electron lasers, are rare and massive, making them impractical for most laboratories, hospitals, and businesses. But with the

theory proposed here, these quasi-particles could produce incredibly bright light with just a tiny distance to travel, potentially sparking a scientific and technological revolution in labs everywhere.

The researchers explored quasi-particles in plasma waves, using intense laser and electron beams. To study the behaviour of these quasi- particles and their light emissions, the researchers ran advanced computer simulations on supercomputers available in Europe through the EuroHPC consortium.

According to the latest theory, these almost-particles only have to travel a tiny fraction of an inch to create extremely bright light. So, if this theory turns out to be true in experiments, it could lead to a small but significant scientific and social revolution.

Further reading:
B Malaca, M Pardal, D Ramsey, *et al.*, *"Coherence and superradiance from a plasma-based quasiparticle accelerator"*, Nature Photonics (2023) https://doi.org/10.1038/s41566-023-01311-z

»» Network News

Joint LIV.INNO and EuPRAXIA-DN researcher training hosted in Liverpool

Cutting-edge postgraduate training schemes guarantee international competitiveness of the researchers trained and provide them with the necessary skills for a future career as researcher in either the academic sector or in industry.

EuPRAXIA-DN Coordinator, Prof. Carsten P Welsch, has been leading large-scale PGR training schemes for more than a decade. As past chair of STFC's Education Training and Careers Committee and member of the UKRI Talent and Skills Advisory Group, he has held key roles in defining and continuously improving PGR training in the UK and beyond.

Together with his project partners and members of his project TEAM based at the Cockcroft Institute, he organized an interdisciplinary 5-day training for researchers in the EuPRAXIA Doctoral Network and the LIV.INNO Center for Doctoral Training. This researcher skills school took place in Liverpool between 13 – 17 November 2023 and was designed for the particular needs of the researchers in these two programs, focusing on synergies, networking opportunities and possible collaboration.

Photograph of the LIV.INNO and EuPRAXIA-DN researchers.

The concept for this course was developed by Professor Welsch during the delivery of his previous training networks, praised in formal project reviews as ‘best practice’ in Europe. The School featured project-specific and general-skills parts. After an icebreaker exercise on Monday morning and an introduction to presentation skills training, the importance of scientific writing was covered by Kate Kahle from CERN’s media team. Her session familiarized participants with different writing styles required by specific journals, media and as part of scientific outreach.

The theory of project management was introduced on day 2 by Dr Fraser Robertson of Fistral. Participants were asked to develop a detailed project plan for their PhD projects which will feed into structured career development plans they all have to establish at the start of their PhDs. The importance of peer review was covered on that day by Dr Eva Villela, a UKRI Future Leader Fellow in Liverpool’s physics department.

On Wednesday, the training moved to Daresbury laboratory. Presentation skills sessions in the morning required all participants to give short presentations about their PhD projects in small groups. These were video-recorded and then reviewed critically with detailed feedback provided by the presenter, their peers and professional trainers to identify best practice whilst giving every participant the opportunity to identify a presentation style that works best for them. In the afternoon, colleagues from STFC/ASTeC offered tours of their cutting-edge labs and gave an overview of the many R&D activities they are involved in.

In addition to the above, sessions on mental health by Alexander Drake and Barry Farrington from the Mental Health Advisory Service and on a look back on their time as LIV.DAT PhD candidate by Dr Alexander Hill completed an intense week.

Professor Welsch said: *“It was fantastic to have all doctoral candidates together during this week and to have very focused discussions on how they can get most out of their projects, as well as the opportunities that are in collaboration with other school participants. It was intense, enjoyable and very forward-looking. Many thanks to all of the trainers, my project TEAM, and of course the early-stage researchers for engaging with the many activities that were on offer.”*

A final year skills training, focusing on the transition to the international job market after graduation, will be offered to all school participants in 2026. This will again be hosted in Liverpool.

Presentation skills training at Daresbury Lab.

Media Training offered to EuPRAXIA-DN Fellows

Throughout their careers, researchers are expected to promote and advertise their research using professional media techniques. However, most researchers never receive any form of professional media training throughout their careers.

A media training week, hosted by EuPRAXIA-DN partner Carbon Digital, allowed to address this problem head-on. The event took place at Manchester's MediaCity, where the multi award winning company worked with the EuPRAXIA-DN Fellows and members of the QUASAR Group to help them develop the skills required to storyboard, script, film and produce their very own project outreach video by the end of an intense training week.

The training concept was developed by EuPRAXIA-DN Coordinator Professor Carsten P Welsch who joined the participants during the entire week. The training started with an overview of the creative process, followed by preproduction. The participants then learned how storyboards and scripts are created before moving on to virtual production.

At RecodeXR studios, everyone got the opportunity to be filmed for the video. Participants recorded sections of the script relating to specific activities of the network, and later decided who will star in the final version of the film. Further work included generating audio and video content using AI technology, learning about special effects and transitions, as well as the fundamentals of green screen filming and film editing.

This unique training introduced all participants to the creative and technical processes behind modern media production. It was pioneered between the QUASAR Group and Carbon Digital in the Marie Curie network AVA and led to the critically acclaimed short film *'AVA - Nature (anti)matters'* showcasing the AVA research, jointly developed by the Fellows and Carbon Digital. The AVA film was selected by the EU as excellent communication practice and highlighted in EU-wide Coordinators' training days.

The EuPRAXIA Doctoral Network capitalized on this experience and successfully produced a film showcasing the EuPRAXIA-DN Fellows, their research plans and the comprehensive training offered by the network. This puts our Fellows in an ideal position to produce videos about their own R&D in the future, using the skills obtained during this training.

The EuPRAXIA-DN film will be officially launched in January 2024– *watch this space!*

Media Training at RecodeXR studios.

>>> Fellows News

Meet our EuPRAXIA-DN Fellows – Part 1

EuPRAXIA-DN will train a cohort of 12 Fellows (ten Fellows will be funded from the HE-MSCA-DN funds, while two Fellows will be funded by the UKRI Guarantee Funds) between universities, research centers and industry who will carry out an interdisciplinary and cross-sector plasma accelerator research and training program for this new research infrastructure. The network focuses on scientific and technical innovations and on boosting the career prospects of its Fellows.

11 Fellows have already been recruited to the EuPRAXIA Doctoral Network. Below we present those who recently started work in their host institutions, with other Fellows to be introduced in the upcoming issues.

Andrés Leiva Genre

Andrés is an Argentinian applied physicist. He studied at the National University of Córdoba (UNC), where he became interested in Medical Physics. His bachelor's thesis was on *"Online Dosimetry by Electron-positron Annihilation Detection using Nanoparticles for Tumour Targeting."*

Andrés interest in nuclear medicine prompted him to enrol in the ERASMUS MUNDUS Joint Master's Degree in Nuclear Physics. In this international program, he studied at several European Universities, namely, the University of Seville, the University of Catania, and the University of Caen Normandy, located in Spain, Italy, and France, respectively.

During his Master's Degree, he learned about novel concepts in accelerator physics and became passionate about it. In the last semester, he worked on "Modelling of Tapered Co-propagating Structures for Dielectric Laser-driven Accelerators." in collaboration with the Italian research institute INFN.

He joined EuPRAXIA-DN at the University of Pécs within the High-field Terahertz Research Group on THz-based Dielectric Laser-driven Accelerators. His research project will focus on THz-driven dielectric accelerators.

In his free time, Andrés balances his activities between training, meeting with friends, dancing Tango, and traveling. He likes engaging in different physical activities like Hiking or combat sports. On the other hand, he never misses the chance to play chess with other players. Andrés is very open to talking, learning, and discussing any topic. He likes to spend high-quality time in any social meeting. He considers making people smile and laugh very important. For Andrés, experience teaches life, and travel is a part of education.

David Gregocki

David was born in Slovakia, although he spent his university life in Prague, Czech Republic. He obtained a bachelor's degree in Experimental Nuclear and Particle Physics (September 2021) and a master's degree in Nuclear and Particle Physics (June 2023),. Both his degrees were obtained from a CTU in Prague. His field of interest during this period has been laser-driven plasma-based acceleration.

From 2021 to 2023, he was a team member of a working group of scientists and students at the FNSPE, CTU in Prague, that performed research and development of compact laser-driven accelerators.

David joined EuPRAXIA-DN at CNR-INO. His project will address challenges in generating a train of ultrashort pulses suitable for LWFA. He will study ultrashort and ultra-intense fields, analyse the longitudinal functions of focused beams, investigate wavefront-tailoring techniques, and examine the stability and reproducibility of laser pulse trains. His research will involve theoretical and numerical studies as well as experimental activities at the Intense Laser Irradiation Laboratory of CNR-INO.

In his free time, David enjoys reading all types of books, watching online lectures and podcasts. During the summer, he likes to go hiking, and during the winter, he loves to ski. He was also a member of the SPIE Student Chapter, where he helped organize meetings and events for the public.

Ana Maria Guisao Betancur

Ana Maria is from Medellin, Colombia. She obtained an Engineering Physics degree (June 2019) and a Master's in Applied Physics degree (June 2022), both from EAFIT University in her natal city. Her research focus during those degrees was on optical instrumentation and image processing.

Ana Maria's research within EuPRAXIA-DN focuses on developing a novel longitudinal profile monitor using broadband imaging of coherent radiation with University of Liverpool as the host institution, based at the Cockcroft Institute.

This system should be simple to operate on a shot-to-shot basis and offer femtosecond-level precision in determining the width and other features of the bunch profile, also integrating machine learning techniques to combine this monitor with existing diagnostic systems to develop a suite of so-called "virtual diagnostics" for EuPRAXIA and beyond.

In her free time, Ana Maria enjoys reading fantasy books, embroidery/handcrafts, dancing, and learning languages. Other interests related to science include the participation in physics outreach activities for all audiences and science communication in general.

>>> Partner Updates

EuPRAXIA-DN Coordinator invited by EU to share best practice in PGR training

Panel conversation during the 2023 MSCA Info Day.

Each year the European Commission organizes a briefing day for coordinators of new networks funded within the Marie Skłodowska-Curie Actions (MSCA). The main objective of these events is to provide a briefing on the key management and procedural aspects of the project life cycle, on how to comply with the MSCA rules under Horizon Europe, and to share and discuss best practice.

This year's event took place on 8 and 9 November in Brussels and was streamed to more than 1,000 project coordinators, managers and researchers. For the first time, it included a session to raise awareness on networking opportunities and potential synergies between projects.

Professor Welsch, EuPRAXIA-DN Coordinator, who has initiated and coordinated no less than six MSCA networks across physics, engineering and life sciences over the past decade, was invited to talk about his experience in fostering networking and synergies, the additional opportunities for project partners and Fellows that have arisen from these collaborations, and examples of some of his highly successful initiatives.

Professor Welsch said: *"We have seen enormous advantages from working across large scale postgraduate training programmes: Firstly, international and cross-sector collaboration has helped us boost interdisciplinary R&D, and this has driven cutting-edge science and innovation. In addition, by jointly hosting researcher skills trainings between several networks and doctoral training centers, we have successfully developed new skills of early-stage researchers, helped them establish new contacts and maximized their employability. Finally, we have seen that collaboration in the areas of communication and outreach was key to maximizing both, reach and impact. It was a great pleasure sharing the experiences we have made over several framework programs with the leaders of new networks."*

In the discussion, he also highlighted the opportunities that arose from exploiting synergies across the EuPRAXIA, EuPRAXIA-PP and EuPRAXIA-DN projects.

»»Upcoming Events

EuPRAXIA-DN School on Plasma Accelerators

22 - 26 April 2024, Rome, Italy

Several tens of thousands of particle accelerators are in use today with varied applications in research, industry, medicine and other fields. Yet accelerator usage could be much more widespread, were it not limited by cost and size constraints, especially in hospitals, universities, and small and medium size companies. This would enable ground-breaking applications and innovations on a much larger scale.

A possible solution to this bottleneck is the development of more compact – and consequently more cost-efficient – accelerator technologies, a strategy that has been investigated in the past two decades bringing forth plasma accelerators as one of its most promising candidates.

This interdisciplinary school will bring together all research areas within EuPRAXIA-DN and will be held in the 'Eternal City' Rome in Italy from 22-26 April 2024. Lectures and topical talks will be presented by research leaders from academia and industry.

The school will be organized in partnership with INFN and introduce the basic principles of plasma accelerators, including basic plasma physics, laser- and beam-driven acceleration, plasma injection schemes, plasma and beam diagnostics, particle-in-cell codes, as well as specific high impact projects, including EuPRAXIA and AWAKE.

Tutorial sessions in smaller problem classes will reinforce content and promote discussion. All participants will be given the opportunity to present their own research in a poster session.

Social events, an excursion to INFN-LNF, and a public talk on plasma accelerator science and technology will complement the diverse and interesting programme.

Several scholarships for early-stage researchers from outside of the EuPRAXIA Doctoral Network will be available.

For more information and to register please visit:
https://agenda.infn.it/e/eupraxia-school-on-plasma-accelerators

Registration deadline: 29th February 2024

The EuPRAXIA-DN School will take place at the Botanical Garden of Rome.

>>> Job Opportunities

Open position withing the EuPRAXIA Doctoral Network

The EuPRAXIA-DN offers a ***Fellowship*** on *Theoretical and Technological Studies into Femtosecond Synchronization* at INFN, Italy.

The Fellow will study the main jitter sources in a photo-injector, including phase noise of accelerating fields, photo-cathode and interaction laser arrival time, together with their impact on beam arrival time. This will be achieved by means of a linear/non-linear model and the simulation of jitter propagation for different accelerator working points, such as RF on crest acceleration and RF/magnetic/hybrid compression using appropriate numerical codes. These simulation studies will be complemented by measurement taken at SPARC_LAB.

In addition, the Fellow will have access to the wide-ranging EuPRAXIA-DN training program which will include several international schools and workshops on plasma accelerator science and technology, as well as complementary skills.

More info

https://www.eupraxia-dn.org/how-to-apply

Open positions at the University of Liverpool/The Cockcroft Institute:

Postdoc position *Novel Gas Jet Monitors*
A Postdoc position focusing on R&D into gas jet-based beam diagnostics is available in the QUASAR Group at Liverpool University for an initial duration of 2 years. The post will be based at the Cockcroft Institute on Daresbury Science and Innovation Campus.

Application deadline 7 January 2024. More info

Postdoc position *Sustainable technologies for accelerators*
A Postdoc position focusing on R&D into sustainable technologies for particle accelerators is available in the QUASAR Group at Liverpool University for an initial duration of 2 years.

Application deadline 7 January 2024. More info

Furthermore, the QUASAR Group offers several ***PhD positions*** over a range of projects. Find out more

>>> Notice Board

EuPRAXIA Doctoral Network

Selection of Events	
11 – 13 March 2024	AWAKE Collaboration Meeting, Liverpool, UK
22 - 26 April 2024	EuPRAXIA-DN School on Plasma Accelerators, Rome, Italy
18 – 24 May 2024	15th International Particle Accelerator Conference (IPAC24), Nashville, USA
23 – 27 Sept 2024	EuPRAXIA Workshop, Isola d'Elba, Italy

Help us communicate interesting events, updates and latest R&D in plasma accelerator physics and send us your news and updates.

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