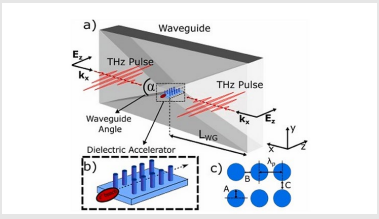
EuPRAXIA Doctoral Network

Newsletter

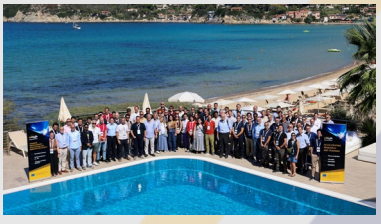
Latest developments in plasma accelerator research and training.



Highlights



New paper on a novel THz-driven accelerating structure



EuPRAXIA-DN Final Conference on the Island of Elba



Phani Deep Meruga awarded Best Student Poster Prize at LINAC 2026

Welcome

Celebrating the achievements of our Fellows

It has been a real pleasure to see our Fellows present their research results at our Final Conference on the beautiful island of Elba. The event brought together researchers from across the plasma accelerator community and highlighted the impressive progress made over the past three years.

I am particularly proud of the many scientific achievements of our Fellows, including journal publications, innovative technologies and awards at key conferences. Their dedication, enthusiasm and friendship have made this network a great experience and success.

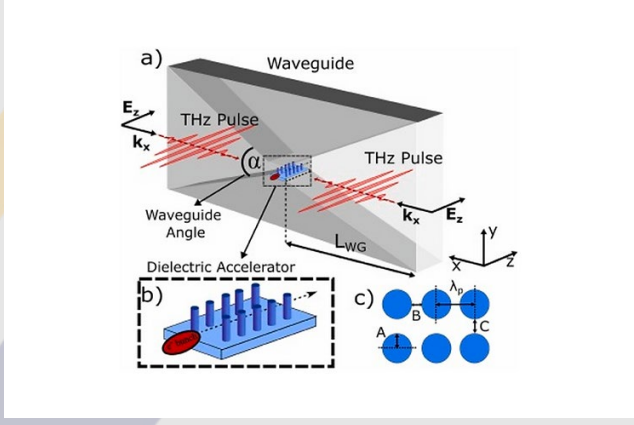
As many of the Fellows are now approaching the end of the contracts, I would like to use this opportunities to wish them every success, and to thank their supervisors and host institutions for their excellent contributions. What the network has also shown is that there is a great demand for talent in this area, and I am sure that this will not be the first and only network on EuPRAXIA technologies – watch this space!



Prof Carsten P. Welsch
Coordinator

New paper on a novel THz-driven accelerating structure

A new study led by EuPRAXIA-DN Fellow Andrés Leiva Genre at the University of Pécs proposes a novel accelerating structure that combines two previously separate technologies, a tapered parallel-plate waveguide (TPPWG) and a dielectric terahertz-driven accelerator (DTA), into a single compact device. The work, carried out with colleagues at the University of Pécs and the HUN-REN-PTE High-field Terahertz Research Group, is published in Optics and Laser Technology under the title "A novel accelerating structure based on a tapered parallel-plate waveguide with an integrated dielectric terahertz-driven accelerator."



Schematic view of the proposed accelerating structure, combining a tapered parallel-plate waveguide with an integrated dielectric THz-driven accelerator. Figure 1 from Leiva Genre et al., Optics & Laser Technology 204 (2026) 116050 © 2026 The Author(s). Licensed under CC BY-NC 4.0.

The article explores accelerating relativistic electrons using a tapered parallel-plate waveguide integrated with a dielectric terahertz-driven accelerator. Although both devices have already been studied individually, they had never been combined into a single structure for particle acceleration and beam manipulation. The waveguide couples incoming terahertz pulses into a confined geometry and amplifies the local electric field through geometric tapering, delivering an enhanced field to a dual-pillar dielectric grating that transfers energy to the electron bunch.

The team validated the terahertz field propagation and amplification inside the waveguide experimentally, using electro-optic sampling, and found close agreement with simulations, confirming a sixfold peak electric field amplification at the end of the waveguide. Building on this validated waveform, particle-in-cell simulations of the full structure showed that it can support net electron acceleration with gradients of up to 1.2 MeV/cm at 1 MV/cm field strengths, while accommodating bunch charges of up to 10 pC with minimal degradation.

According to simulations, the proposed structure can reach acceleration gradients of 120 MeV/m when accelerating a 10 pC electron bunch using current technology. Because the design can be adapted to sub-relativistic beams as well as ultra-relativistic ones, it could be operated not only for acceleration but also for other beam manipulation techniques such as deflection, streaking, and bunching.

The result is a compact and scalable platform for high-gradient THz-driven acceleration that combines a simple, easily fabricated design with strong field enhancement and compatibility with existing electron sources, opening new pathways toward practical, tabletop accelerators for scientific and industrial applications.

Further reading:

Leiva Genre, A., Tibai, Z., Nasi, L., Kiss, M., Almási, G., Hebling, J., Turnár, S. "A novel accelerating structure based on a tapered parallel-plate waveguide with an integrated dielectric terahertz-driven accelerator", Optics and Laser Technology, 204, 116050 (2026). https://doi.org/10.1016/j.optlastec.2026.116050

Upgraded klystron phase feedback system for plasma accelerators

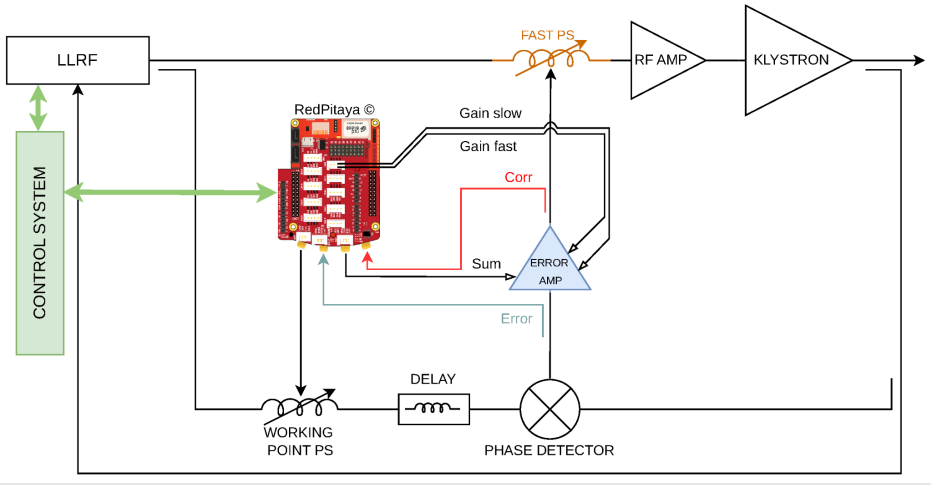
A new study led by EuPRAXIA-DN Fellow Xianghe Fang at INFN-LNF and Sapienza University of Rome presents an upgraded fast feedback system that reduces the phase jitter of the S-band klystrons at the SPARC_LAB facility by a factor of 30. The work, carried out with colleagues at the Laboratori Nazionali di Frascati (LNF-INFN), is published in Applied Sciences, in the Special Issue “New Challenges in Plasma Accelerators”, under the title “S-Band Klystron Intra-Pulse Phase Feedback Upgrade at SPARC_LAB Facility.”

Stable and reproducible acceleration is one of the main challenges in plasma wakefield acceleration. When magnetic or radio-frequency (RF) compression schemes are used, the beam arrival time jitter at the end of the linac is strongly correlated with the phase noise of RF accelerating structures operated off-crest. In klystrons powered by pulse-forming network modulators, high-voltage fluctuations are converted directly into phase fluctuations from pulse to pulse, so conventional slow feedback loops cannot correct them. The paper addresses this with an intra-pulse feedback that measures the klystron phase within each RF pulse, compares it with a stable reference and applies a real-time correction through a fast phase shifter.

The study builds on a first version of the system deployed at SPARC_LAB in 2008. The upgrade includes a new RF circuit design, improved error amplifier electronics, a new acquisition system and new control software integrated into the facility control system. A key addition is the remote control of the loop gain, which allows the operating point to be optimised during machine operation.

Tests on both S-band power plants showed klystron-induced phase jitter below 15 fs rms, compared with a native stability above 400 fs rms, and an improvement of a factor of 2.5 to 6 with respect to the previous version of the feedback. The system also operated stably over several hours and kept the jitter within the required range over a gain interval of about 1 V, showing that it is not highly sensitive to parameter tuning. With this upgrade, both plants meet the phase stability specifications of the EuPRAXIA@SPARC_LAB project.

These results are a key milestone for plasma wakefield acceleration applications that require ultra-low phase jitter. The team now plans to apply the same technique to RF stations driven by solid-state modulators, following a first prototype test on a C-band plant that measured a jitter below 10 fs rms.



Block diagram of the main components of the intra-pulse feedback system. Figure 1 from Fang et al., Applied Sciences 16 (12), 5733 (2026) © 2026 by the Authors. Licensee MDPI, Basel, Switzerland. Licensed under CC BY 4.0.

Further reading:

Fang, X., Bellaveglia, M., Gallo, A., Magnanimi, R., Michelotti, A., Quaglia, S., Scampati, M., Scarselletta, G., Serenellini, B., et al., Piersanti, L. “S-Band Klystron Intra-Pulse Phase Feedback Upgrade at SPARC_LAB Facility”, Applied Sciences, 16(12), 5733 (2026). https://doi.org/10.3390/app1612573

EuPRAXIA-DN Fellows present their research at the Final Conference on the Island of Elba

The EuPRAXIA-DN Final Conference took place from 20 to 25 September 2026 at the Hotel Hermitage, La Biodola Bay, on the Isola d'Elba in Italy, as part of a joint event with the EuPRAXIA Preparatory Phase (EuPRAXIA-PP) Final Meeting. The event attracted 95 delegates and was a chance for our Fellows to share the results of their research with the network's supervisors, partners and experts from leading laboratories and universities. During the week, the Doctoral Network sessions alternated with the final reports of the Preparatory Phase work packages.

The programme of the conference was built around four scientific sessions: Theory and Simulation, Plasma-based Accelerators and New Concepts, Diagnostics and Instrumentation, and Plasma Accelerator Applications. Invited talks from internationally leading researchers, contributed talks and a poster session completed the programme.

The event offered the perfect environment to discuss the latest research advances. It opened with a welcome by EuPRAXIA-PP Deputy Coordinator Massimo Ferrario (INFN) and a status update on the Doctoral Network by the Coordinator Prof Carsten P Welsch (INFN/Liverpool).



Prof Welsch welcoming the participants.

This was followed by the Theory and Simulation session which included invited talks by Francesco Massimo (LPGP-CNRS) and Chiara Badiali (INFN), as well as contributions from the wider community. EuPRAXIA-DN Fellow Bhushan Thakur (Instituto Superior Técnico) used three-dimensional computer simulations to show how light carrying orbital angular momentum, a "twisted" wavefront, can be produced directly in the emission process itself.



Fellow Mihail Miceski during his presentation.

The second day was devoted to new acceleration concepts and the path towards stable operation. Several EuPRAXIA-DN Fellows presented their shared their latest research during this session. Romain Demitra (INFN) presented progress towards operating a plasma accelerator stably at high repetition rates, with a ceramic capillary that operated at 100 Hz for more than 20 million shots. Flanish D'Souza (Lund University) reported the first experimental observation of a comb-like pattern in the energies of an electron beam. Mihail Miceski (ELI ERIC) closed the session with start-to-end simulations of a laser-plasma-driven EUV free-electron laser reaching saturation within a 4 m undulator.

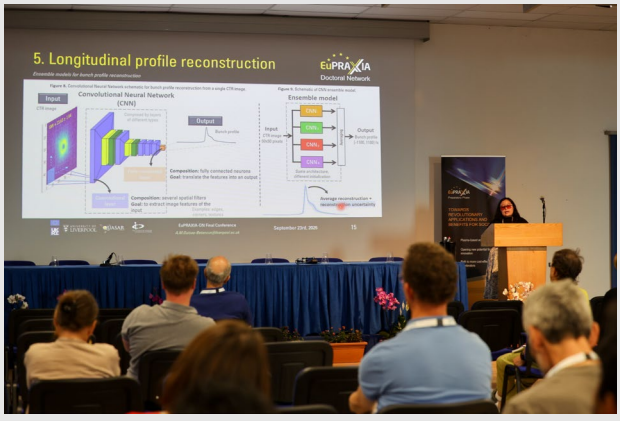
Invited talks by Robert Babjak (Instituto Superior Técnico) and Bifeng Lei (University of Liverpool) rounded off the session, covering topics spanning a proposed single-laser scheme to access the strong-field QED regime to a new mechanism for coherent synchrotron radiation based on surface plasmon polaritons on solid microtubes.

The diagnostics and instrumentation session on Wednesday afternoon focused on machine learning techniques and was the largest showcase of the network Fellows' work. Phani Deep Meruga (Instrumentation Technologies) presented a radio-frequency control system prototype that is now moving towards industrialization.



Participants at the EuPRAXIA-PP Final Annunal Meeting and EuPRAXIA-DN Final Conference.

Xianghe Fang (INFN) showed a feedback system that keeps the timing of an accelerator's radio-frequency source stable to within a few femtoseconds, and David Gregocki (CNR-INO) presented a method to assess the quality of focused laser light. Fellow Ana Maria Guisao Betancur (University of Liverpool) used neural networks to reconstruct the shape of extremely short electron bunches, a technique that is now used routinely at the MAX IV laboratory in Sweden.



Fellow Ana Maria Guisao Betancur presenting her research.

The scientific poster session on Wednesday evening featured R&D from EuPRAXIA-DN Fellows Andrés Leiva Genre (University of Pécs), Alex Whitehead (ELI ERIC), Flanish D'Souza (Lund University) and Farhana Thesni Mada Parambil (University of Liverpool), who presented work on topics ranging from terahertz-driven accelerators to monitoring proton beams used in FLASH radiotherapy.



Fellows presented their work during the poster session

Thursday morning turned to plasma accelerator applications with a series of invited presentations and contributed talks. An engaging talk by Luca Serafini on ERMES, a new technique for earthquake forecasting based on muon beams, and the challenges it poses for compact multi-hundred-GeV muon accelerators, triggered many interesting discussions. The session was completed by an invited talk by Vittoria Petrillo (INFN) on a compton gamma-ray source driven by the EuPRAXIA electron beam.

“The event was a great opportunity see the progress we all made through these three years, share and discuss our research with the wider EuPRAXIA community, and enjoy some time with the rest of the fellows at this very nice location before the doctoral network comes to an end”, commented Fellow Ana Maria Guisao Betancur.

The conference concluded with closing remarks from Carsten P Welsch and Massimo Ferrario. A special video took the audience back on a journey of the doctoral network over the years, celebrating highlights and the people whose dedication shaped the project.

Prof Welsch said: “It was wonderful to see our Fellows present their research results to the plasma accelerator community at this conference. It is very impressive just how much they have achieved over the three years of their PhDs. I certainly wish them all the very best for their future endeavours! They have been a fantastic group.”

The final conference of the EuPRAXIA-DN project marked an important milestone as the project approached its conclusion. The diverse programme gave an excellent overview of the Fellows' research outcomes and cutting-edge research within the wider community. The Fellows’ projects are all directly benefiting the design of the EuPRAXIA facilities, with many scientific and technical innovations ranging from RF synchronisation and beam diagnostics to simulation and laser-plasma physics.

All presentations are available at
https://agenda.infn.it/event/51478/

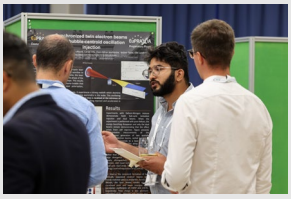


















Fellows reunite in Liverpool as EuPRAXIA Doctoral Network nears completion

Liverpool hosted one of the final training events of the EuPRAXIA Doctoral Network, as all twelve Fellows came together for the project's Supervisory Board Meeting on 9 July 2026, at the close of an Advanced Researcher Skills and Careers Training Workshop, and the day before the Innovations for a Sustainable Tomorrow Symposium held at The Spine.

The meeting marked one of the last occasions on which the full cohort of Fellows was assembled in the same place before the network's Final Conference on Isola d'Elba held in September.

It offered a comprehensive view of three years of work spanning the breadth of cutting-edge plasma accelerator science and technology. Presentations ranged across novel plasma- and laser-driven acceleration techniques, high-repetition-rate laser systems, low-level RF control, and a wide spectrum of beam diagnostics, from bunch-profile reconstruction and gas-jet monitoring to radiation detectors operating under some of the most extreme beam conditions tested to date.

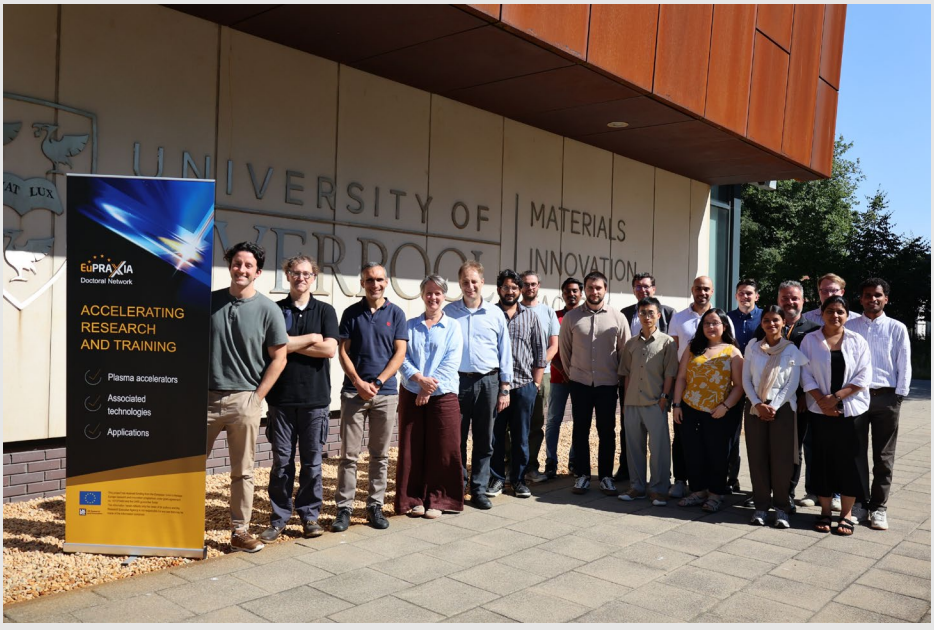
Together, the twelve projects illustrated how the network has pursued research that benefits the EuPRAXIA ESFRI research facility. This included studies into the generation and control of particle beams to the instrumentation needed to understand and exploit them, all the way to applications stretching from fundamental physics to medicine and industry.

Professor Carsten P Welsch, EuPRAXIA-DN Coordinator, reflected on what the meeting represented for the network: "Seeing all our twelve Fellows present together, three years on from when this major project started as little more than an idea on paper, was wonderful evidence of just how much this network has built. One of the most important outcomes are not the papers and prototypes, but the people, the collaborations between institutions, and the careers that are now launching from this foundation."

The Supervisory Board Meeting also served as a moment to take stock of the network's wider achievements and events: two international skill schools, a media skills school that produced a short film viewed more than 20,000 times, an international school on plasma accelerators held in Rome, three international workshops hosted in Pisa, Lisbon and in Pécs, as well as the EuPRAXIA Showcase event in Brussels, where European Commission and REA delegates were briefed on the project's progress.

During the meeting, the Fellows and partners were asked to begin preparing narrative summaries of their fellowships, reflecting on three years of training, secondments and research across the network's nine host institutions.

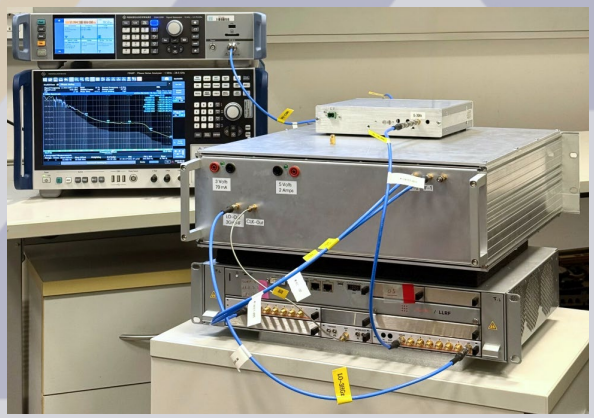
The final Supervisory Board meeting in Liverpool offered an excellent marker of how far the twelve Fellows have come



Group photograph of the Fellows and their supervisors in Liverpool.

EuPRAXIA-DN Fellow Phani Deep Meruga receives BeamNetUS 2026 award for X-band LLRF experiments at SLAC

EuPRAXIA-DN Fellow Phani Deep Meruga, from Instrumentation Technologies in Slovenia, has been selected for a 2026 BeamNetUS award to carry out experimental research at the SLAC National Accelerator Laboratory in the United States. His proposal, entitled Testing and Validation of a Low Noise X-Band Low-Level RF (LLRF) Prototype at the XTA/NLCTA Facility, SLAC, has been officially selected as part of the BeamNetUS 2026 awards programme. The award provides access to the experimental facility and beam time, technical assistance from the SLAC team, and financial support for travel and accommodation.



Original X-band Low-Level RF (LLRF) prototype developed by Instrumentation Technologies within the EuPRAXIA-DN.

BeamNetUS is a network connecting researchers with accelerator test facilities at US national laboratories, facilitating access to experimental infrastructure, technical expertise and opportunities for new scientific collaborations. The programme provides researchers with the opportunity to carry out experiments that benefit from specialised accelerator facilities and their technical capabilities.

The experimental campaign is scheduled for 1–11 December 2026 at SLAC's Next Linear Collider Test Accelerator (NLCTA), where the team will evaluate a preliminary industrialised version of the X-band LLRF.The system combines low-noise RF electronics, high-speed digitisation at 250 MS/s, FPGA-based signal processing and precise RF signal generation.

It is designed to control and stabilise the amplitude and phase of short RF pulses operating at 11.424 GHz, supporting the demanding requirements of high-gradient X-band LINACs. Previous laboratory characterisation demonstrated amplitude stability of approximately 0.01% RMS and phase stability better than 0.01° RMS.

The prototype was subsequently tested at the TEX facility of INFN-LNF in Frascati, Italy, under operational X-band RF conditions. Building on these results, the new experimental campaign at SLAC will investigate the performance of the preliminary industrialised version under realistic accelerator operating conditions.

The planned measurements include pulse-to-pulse amplitude and phase stability, phase noise, timing stability, and the influence of different RF pulse repetition rates on system performance. The team will also assess RF stability at the klystron output and compare the results with previous laboratory and experimental measurements to identify potential limitations and opportunities for further improvement.



Preliminary industrialised version of the X-band Low-Level RF (LLRF) system.

The experiments represent an important step towards validating the developed technology for practical accelerator applications. In particular, the results could contribute to the further development of RF control and diagnostic systems for the EuPRAXIA@SPARC_LAB linac at INFN-LNF and other future X-band accelerator facilities.

Congratulations to Phani on this achievement!

EuPRAXIA-DN highlighted at IBIC 2026



Ana presenting her talk at IBIC 2026. (Image credit: IBIC 2026)

The 15th International Beam Instrumentation Conference (IBIC 2026) was held in Whistler, Canada this year.

Dedicated to exploring the physics and engineering challenges of beam diagnostic and measurement techniques for particle accelerators worldwide it attracted almost 170 delegates from all over the world.

EuPRAXIA-DN Fellow Ana Maria Guisao Betancur contributed to the scientific programme as invited speaker.

She presented a talk titled 'Femtosecond-resolution longitudinal bunch profile monitor using coherent transition radiation imaging'. She introduced a single-shot approach for longitudinal beam diagnostics based on broadband spatial imaging of coherent transition radiation in the THz region, combined with data-driven analysis. The diagnostic system has been installed at the MAX IV Short-Pulse Facility, where extensive experimental data have been collected and analysed.

One of the highlights of the conference was the presentation of the Faraday Cup Award. The award recognises outstanding innovation in particle beam diagnostics and instrumentation, celebrating developments that have demonstrated and published their performance.

Professor Carsten P. Welsch, EuPRAXIA-DN coordinator and leader of the University of Liverpool's QUASAR Group, received the award in recognition of his work on the Beam Gas Curtain (BGC) monitor. This innovative diagnostic instrument was developed through a long-standing collaboration between the University of Liverpool, CERN in Switzerland, and the GSI Helmholtz Centre for Heavy Ion Research in Germany.



Carsten P. Welsch (second from right) with representatives of the BGC collaboration from CERN and GSI, alongside Kevin Jordan (right) who presented the award. (Image credit: IBIC 2026)

Phani Deep Meruga awarded Best Student Poster Prize at LINAC 2026



Phani during the award ceremony.

We are pleased to announce that EuPRAXIA-DN Fellow Phani Deep Meruga was awarded Best Student Poster Prize in recognition of his outstanding poster presentation at the 33rd Linear Accelerator Conference (LINAC 2026). The 2026 edition of the conference took place from 16 - 21 August 2026 at the Daejeon Convention Centre in Daejeon, Korea.

The LINAC conference series is the premier biennial gathering for the worldwide community of linear accelerator experts. It provides a unique opportunity to learn about the most recent advances in research, development, and applications of linear accelerators for both hadron and lepton beams.

Phani, who is based at Instrumentation Technologies in Slovenia and is in the final year of his PhD at Sapienza University of Rome, Italy, presented his research on experimental validation of an X-Band LLRF prototype for high-gradient linear accelerators. Developed within the EuPRAXIA-DN project for the EuPRAXIA@SPARC_LAB LINAC at INFN-LNF in Italy, the system is designed to precisely control and stabilise the amplitude and phase of short, ~100 ns X-band RF pulses, supporting reliable operation of compact, high-gradient linear accelerators.

Phani said:" I'm very honoured to receive this award. It was a wonderful opportunity to present my research, and I was also very happy to briefly present the EuPRAXIA project to the audience. Overall, it was a wonderful experience for me, and I feel it was a memorable way to mark the conclusion of my doctoral studies."

Congratulations!

EuPRAXIA-DN Fellow brings particle accelerator physics to life at the Victoria Gallery & Museum

EuPRAXIA-DN Fellow Ana Maria Guisao Betancur joined members of the University of Liverpool's QUASAR Group for a vibrant outreach session at the University of Liverpool's Victoria Gallery & Museum (VG&M) on 4th August 2026. The free event welcomed school children and families, providing an engaging opportunity to discover the fascinating world of accelerator physics through fun, interactive, hands-on activities.



Ana explaining the principles of optics.

The programme was divided into two parts, allowing the team to adapt their engagement to different audiences. The first part was a public drop-in session, which attracted a wide range of visitors, particularly families, interested to learn about the science behind modern technology.

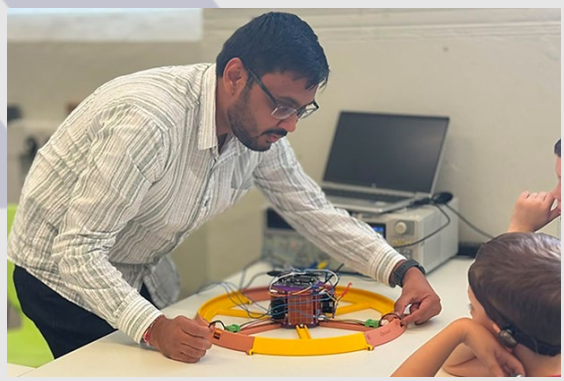
This was followed by an hour-long session of mini workshops for Year 6 students, who took part in small groups during the second half of the afternoon.

The team presented three different working models, each designed to make abstract scientific concepts understandable:

Imaging Outreach Demo: Ana Maria exhibited an interactive experiment, exploring the principles of optics, a fundamental concept in everything from cameras to projectors. She showed how lenses focus and defocus light, with an analogy for how particle beams are focused inside accelerators. The activity helped visitors understand how precise control of beams is essential for modern accelerator science.

Tabletop Ball Bearing Accelerator: The next hands-on display explained how we can accelerate particles over short distances, simplifying the complex machines that power cutting-edge research. Milaan Patel introduced visitors to particle accelerators and their different applications, using magnetic ball bearings accelerated around a circular track via solenoid coils while illustrating how a circular accelerator works.

Schlieren Imaging: The final station was a visual demonstration allowing visitors to see the invisible, an optical technique showing how density variations in air can be captured and visualized. Led and demonstrated by Debdeep Ghosal with optical imaging setups, it explained how scientists can reveal challenging hidden phenomena used for beam quality checking in particle accelerators.



Milaan Patel demonstrating how scientists accelerate particles with the 'Tabletop Ball Bearing Accelerator'.

Both the "Tabletop Ball Bearing Accelerator" and the "Schlieren Imaging" activities were developed by EuPRAXIA-DN Fellows during a week-long training at the Cockcroft Institute this summer. Videos showcasing the demonstrations and underlying science can be found on the EuPRAXIA YouTube channel

After the public session, the team hosted around 30 Year 6 schoolchildren. Giving them the opportunity to explore the exhibits, ask questions and see the physics in action, the hands-on workshops helped spark their curiosity and interest in science and engineering.

This outreach event highlighted the innovative research being carried out at the University of Liverpool through EuPRAXIA-DN and the QUASAR Group and showed the importance of science communication in inspiring the next generation of scientists and engineers.

>>> Selected Publications

Combined tools for particle-in-cell simulations performed with transversely asymmetric chirped lasers

I. Moulanier, F. Massimo, T. L. Steyn, and B. Cros

PHYSICS OF PLASMAS 33, 073105 (JULY 20 2026)

https://doi.org/10.1063/5.0333754

Accurate modelling of realistic laser fields is important for particle-in-cell simulations of laser wakefield acceleration, particularly when experimental laser profiles include transverse asymmetries and temporal spectral chirp. This work introduces the Asymmetric Chirped Electric field reconstruction (ACE) toolbox, a suite of algorithms for reconstructing realistic laser transverse distributions together with their chirped temporal profiles and implementing them in cylindrical and Cartesian particle-in-cell simulations. The approach provides a practical framework for incorporating experimentally measured laser characteristics into high-fidelity plasma accelerator simulations.

Plasma dechirper and lens for electron beams from laser wakefield acceleration in a tailored density profile

T. L. Steyn et al.

PHYSICAL REVIEW ACCELERATORS AND BEAMS 29, L080501 (AUGUST 31 2026)

https://doi.org/10.1103/fdkn-8hpg

Electron beams produced by laser wakefield acceleration can exhibit significant energy chirp and divergence, limiting their suitability for applications such as free-electron lasers. This work experimentally demonstrates the simultaneous use of plasma dechirping and plasma lensing in a tailored plasma density profile. The results show how a combination of density down-ramp and low-density plasma regions can reduce energy spread while providing strong focusing, offering a compact approach to beam manipulation for advanced accelerator applications.

Laser wakefield acceleration in a capillary gas cell to produce high-quality GeV-scale electron beams

S. Maity, F. Massimo, A. Whitehead, P. Sasorov, and A. Molodozhentsev

PHYSICAL REVIEW ACCELERATORS AND BEAMS 29, 093601 (SEPTEMBER 9 2026)

https://doi.org/10.1103/l8b2-j67x

This work presents a computational study of laser wakefield acceleration in a capillary gas-cell configuration designed to produce high-quality GeV-scale electron beams. Hydrodynamic simulations are used to model the gas target and provide plasma density profiles for subsequent particle-in-cell simulations. The proposed configuration combines a short helium-nitrogen injection region with a longer pure-helium acceleration section, enabling control of injection and beam evolution. The simulations predict electron beams with mean energies above 1 GeV and properties relevant to upcoming laser wakefield acceleration experiments at ELI Beamlines within the EuPRAXIA framework.

>>> Selected Publications

Meter-Scale Discharge Capillaries for Plasma-Based Accelerators

L. Crincoli, R. Demitra, V. Lollo, D. Pellegrini, M. Ferrario, and A. Biagioni

APPLIED SCIENCES 16, 3291 (MAR 28 2026)

https://doi.org/10.3390/app16073291

Gas-filled discharge capillaries are widely used in the field of plasma-based particle accelerators, due to their compactness, cost-effectiveness and versatility for different applications. Technological improvement of such Plasma sources is necessary to enable high energy gain acceleration at the meter scale, as required for next generation particle colliders and light sources. Beam quality preservation within such an acceleration length involves accurate tuning of the plasma properties. In particular, precise tailoring of the plasma density distribution is required to control the emittance growth of particle bunches during the acceleration process.
In this context, this paper presents a scalable and versatile approach for the design of meter-scale discharge capillaries, aimed at achieving fine tuning of the plasma density distribution, with the possibility of locally controlling the density profile by acting on the source geometry. Forty-centimeter-long capillaries are designed using numerical fluid dynamics simulations and tested in a dedicated plasma module. Different arrangements of the gas inlets are tested, with their number and diameter varied, to assess the effect of the capillary geometry on the plasma properties. Plasma density measurements show that a higher number of inlets with variable diameter along the plasma formation channel provides an enhancement in the homogeneity of the electron plasma density distribution. Longitudinal density plateaus are observed along most of the plasma channel length, with a center-to-end density uniformity of up to 80%. The experimental results highlight the proposed approach's capability to modulate the longitudinal plasma density distribution by acting on the capillary geometry, thus providing uniform density profiles over the meter scale, as required for plasma-based acceleration experiments.

A structured plasma profile for an optimized laser-driven accelerator of quality enhanced very high energy electrons (VHEE)

F. Avella, P. Tomassini, L. Labate, and L. A. Gizzi

PHYSICS OF PLASMAS 33(4), 043101 (APR 1 2026)

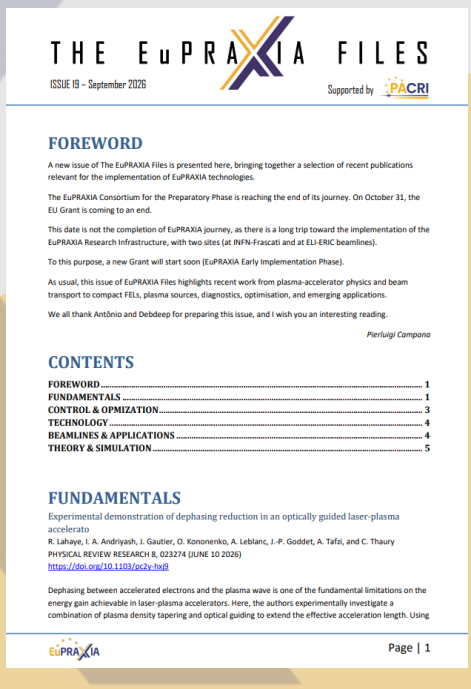
https://doi.org/10.1063/5.0315070

We present a numerical study on a structured plasma target to simultaneously improve the energy spread and divergence of a laser-driven very high energy electron (VHEE) beam designed for VHEE-radiotherapy (RT) application. The main concept to obtain such an enhanced quality beam is to localize the injection, acceleration, and extraction of the electrons by tailoring the plasma target density profile. The injection space is truncated by spatially confining the ionization-injection dopant, while the rest of the target is filled with He atoms. In order to reduce the emittance growth during the bunch extraction, an optimized density downramp profile is adopted. By using a 100 TW class Ti:Sa laser system and an ionization-injection scheme in the blow-out regime, a relatively high charge (≥120 pC) beam with mean energy ≥200 MeV, rms energy spread ≤6%, and normalized emittance $\varepsilon_{nx} < 4$ mm mrad can be obtained. This combination of bunch specification enables an efficient transport and focusing of the particles, thus making the beam of particular interest for VHEE-RT.

The EuPRAXIA Files

The EuPRAXIA Files is a collection of publicly available abstracts of published articles that are relevant to the EuPRAXIA project. Putting together the latest research in plasma accelerators, the aim is to facilitate the work of the many researchers involved in EuPRAXIA and to highlight the scientific outcomes of the various projects supporting the initiative.

The latest EuPRAXIA Files Issue 19 and previous issues can be accessed here:
https://www.eupraxia-pp.org/research-resources



THE EuPRAXIA FILES

ISSUE 19 – September 2026

Supported by PACRI

FOREWORD

A new issue of The EuPRAXIA Files is presented here, bringing together a selection of recent publications relevant for the implementation of EuPRAXIA technologies.

The EuPRAXIA Consortium for the Preparatory Phase is reaching the end of its journey. On October 31, the EU Grant is coming to an end.

This date is not the completion of EuPRAXIA journey, as there is a long trip toward the implementation of the EuPRAXIA Research Infrastructure, with two sites (at INFN-Frascati and at ELI-ERIC beamlines).

To this purpose, a new Grant will start soon (EuPRAXIA Early Implementation Phase).

As usual, this issue of EuPRAXIA Files highlights recent work from plasma-accelerator physics and beam transport to compact FELs, plasma sources, diagnostics, optimisation, and emerging applications.

We all thank Antônio and Debdeep for preparing this issue, and I wish you an interesting reading.

Pierluigi Campana

CONTENTS

FOREWORD 1
FUNDAMENTALS 1
CONTROL & OPMIZATION 3
TECHNOLOGY 4
BEAMLINES & APPLICATIONS 4
THEORY & SIMULATION 5

FUNDAMENTALS

Experimental demonstration of dephasing reduction in an optically guided laser-plasma accelerato

R. Lahaye, I. A. Andriyash, J. Gautier, O. Kononenko, A. Leblanc, J.-P. Goddet, A. Tafzi, and C. Thaury

PHYSICAL REVIEW RESEARCH 8, 023274 (JUNE 10 2026)

https://doi.org/10.1103/pc2y-hxj9

Dephasing between accelerated electrons and the plasma wave is one of the fundamental limitations on the energy gain achievable in laser-plasma accelerators. Here, the authors experimentally investigate a combination of plasma density tapering and optical guiding to extend the effective acceleration length. Using

EuPRAXIA Page | 1

EuPRAXIA YouTube Channel

The EuPRAXIA YouTube Channel features a variety of content, including interviews with leading experts and episodes of the EuPRAXIA Seminar Series.

The EuPRAXIA seminar series will cover the role of simulations and diagnostics in developing plasma accelerators, the principles and applications of free electron lasers, innovative linac technologies, the advantages of beam-driven plasma wakefield acceleration and key applications of plasma accelerators beyond conventional technologies.

The YouTube Channel can be accessed here https://www.youtube.com/@EuPRAXIA-facility

>>> Job Opportunities

University of Liverpool / The Cockcroft Institute

Research Coordinator in Accelerator Science

The University of Liverpool is offering a permanent position as Research Coordinator in the Accelerator Science cluster.

We are looking for an outstanding accelerator scientist to make important contributions to the cluster's research and training programme. Your research will involve leadership in one are several of the following areas: accelerator design and optimization, sustainable accelerator technologies including AI, novel acceleration techniques, sensor and beam instrumentation development, and accelerator applications.

The role will be based at the Cockcroft Institute on Daresbury Science and Innovation Campus and make substantial contributions to the research portfolio of the pan-European QUASAR Group. It will focus on the development and experimental exploitation of particle accelerators and light sources, and we are looking for an outstanding accelerator expert to strengthen our team and complement our existing expertise.

Applicants are expected to have an internationally recognized researcher profile and make major contributions to the cluster's world-class research programme in accelerator science.

More information and how to apply can be found here

>>> Notice Board

EuPRAXIA Doctoral Network

Selection of Events	
23-24 November 2026	EuPRAXIA-EIP Kick-off Meeting and Workshop on EuPRAXIA Implementation Status and mid-term strategy, INFN, Frascati, Italy
15-18 February 2027	PACRI Annual Meeting, Camogli, Italy
23-28 May 2027	18th International Particle Accelerator Conference (IPAC'27), Detroit, USA
6-10 September 2027	16th International Beam Instrumentation Conference (IBIC2027), Chiang Mai, Thailand

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

EuPRAXIA-DN
Project Coordinator

Prof Carsten P. Welsch
carsten.welsch@lnf.infn.it

This project has received funding from the European Union´s Horizon Europe research and innovation programme under grant agreement no. 101073480 and the UKRI guarantee funds. The information herein reflects only the views of its authors, and the Research Executive Agency is not responsible for any use that may be made of the information contained.