EuPRAXIA-DN Camp III: Innovation

Report of Contributions

Contribution ID: **1** Type: **not specified**

Welcome / admin & logistics

Monday 6 October 2025 09:00 (30 minutes)

Presenters: WELSCH, Carsten Peter; Prof. KOMÓCSI, András (University of Pécs); Prof. ALMÁSI, Gábor (University of Pécs)

Contribution ID: **2** Type: **not specified**

Putting it all toghether / Discussion

Tuesday 7 October 2025 16:00 (15 minutes)

Contribution ID: **3** Type: **not specified**

High-Brightness X-rays for Biology/Chemistry

Monday 6 October 2025 09:30 (1 hour)

Presenter: HIDDING, Bernhard (HHU)

Session Classification: Session 1: High-Brightness X-rays for Biology/Chemistry

Contribution ID: **4** Type: **not specified**

Medical Applications of Plasma Accelerators

Monday 6 October 2025 14:00 (1 hour)

Presenter: GERLACH, Sonja (LMU Munich)

Session Classification: Session 2: Medical Applications of Plasma Accelerators

Contribution ID: **5** Type: **not specified**

An analytic solution for plasma expansion into a vacuum

Monday 6 October 2025 15:30 (30 minutes)

Presenter: Dr BARNA, Imre Ferenc (Wigner Research Center for Physics)

Session Classification: Session 2: Medical Applications of Plasma Accelerators

Contribution ID: **6** Type: **not specified**

Betatron radiation –Applications

Tuesday 7 October 2025 09:00 (1 hour)

Presenter: NAJMUDIN, Zulfikar (Imperial College London)

Session Classification: Session 3: Betatron radiation –Applications

Contribution ID: **7** Type: **not specified**

Terahertz Pulse Sources

Tuesday 7 October 2025 10:00 (30 minutes)

Presenter: KRIZSÁN, Gergő (University of Pécs)

Session Classification: Session 3: Betatron radiation –Applications

Contribution ID: **8** Type: **not specified**

High-impact Beamlines for R&D Hubs

Tuesday 7 October 2025 14:00 (1 hour)

Presenter: PACEY, Thomas (STFC Daresbury Laboratory)

Session Classification: Session 4: High-impact Beamlines for R&D Hubs

Contribution ID: **9** Type: **not specified**

Configurations of targets and detectors for femtosecond laser-driven acceleration and fusion

Tuesday 7 October 2025 15:00 (30 minutes)

Presenter: ALADI, Mark (Wigner RCP)

Session Classification: Session 4: High-impact Beamlines for R&D Hubs

Contribution ID: **10** Type: **not specified**

Terahertz driven electron acceleration using a parabolic mirror or a paraboloid ring

Tuesday 7 October 2025 11:00 (30 minutes)

Presenter: PÁLFALVI, László (University of Pécs)

Session Classification: Session 3: Betatron radiation –Applications

Contribution ID: **11** Type: **not specified**

Spectral interferometry with high harmonics, isolated attosecond pulses from laser plasmas on solid targets

Tuesday 7 October 2025 11:30 (30 minutes)

Presenter: FÖLDES, István B (Wigner)

Session Classification: Session 3: Betatron radiation –Applications

Contribution ID: **12** Type: **not specified**

Simulation and Feasibility Analysis of a Compact, Non-invasive Re-entrant Cavity based Bunch Charge Monitor

Monday 6 October 2025 11:00 (30 minutes)

Accurate, non-invasive charge measurement is essential for high-precision beam experiments, especially at low bunch charge and low repetition rate. Interceptive devices such as Faraday cups and microchannel-plate detectors can suffer charge loss, which is a critical concern for low charge beams. This work presents a simulation-based feasibility study of a compact, material loaded re-entrant cavity Bunch Charge Monitor (BCM) for non-relativistic antimatter beams. Three-dimensional electromagnetic simulations were used to evaluate the cavity response and key RF parameters relevant to single-shot charge measurement in the few-pC range. As an initial check, a cavity tuned for nanosecond-scale pulses was simulated, offering a reference for other bunch durations. Preliminary findings indicate that dielectric loading can reduce cavity size while maintaining suitable RF performance. Limitations and next steps are outlined, with attention to coupling and signal extraction. The concept is motivated by low-energy antiproton studies like AEgIS at CERN and, with appropriate tuning, may also be adapted to plasma accelerator environments such as EuPRAXIA with low bunch repetition rates.

Author: CHANDRAN, Sruthy (University of Liverpool)

Co-authors: RIENACKER, Benjamin (University of Liverpool); RAWAT, Bharat (University of Liverpool); WELSCH, Carsten Peter; KUMAR, Narender (University of Liverpool)

Presenter: CHANDRAN, Sruthy (University of Liverpool)

Session Classification: Session 1: High-Brightness X-rays for Biology/Chemistry

Contribution ID: **13** Type: **not specified**

Development of the L2-DUHA dual output front end at ELI-ERIC

Tuesday 7 October 2025 15:30 (15 minutes)

The 100 TW DPSSL-OPCPA L2-DUHA laser system is under development at ELI-ERIC, with the goal of being the driver for the Laser Plasma Accelerator (LPA) of the LUIS-beamline, an incoherent Extreme Ultraviolet (EUV) radiation setup under development at ELI-ERIC, aiming to produce the high-quality electron beam required for a LPA-based Free Electron Laser (FEL).

The L2-DUHA broadband front-end is based on a 2kHz Yb:YAG thin disk regenerative amplifier-pumped OPCPA seeded by a supercontinuum. It will provide a 1mJ near Infrared (NIR) beam for seeding a high energy OPCPA chain, which will be used as the driver for the laser-plasma accelerator in the LUIS-beamline. In addition, a multi-mJ, synchronized mid IR auxiliary beam for high harmonic generation is under development. Both outputs are generated via supercontinuum in YAG crystals and are passing through pre-amplification OPA stages using Barium Borate (BBO) crystals.

In this presentation, we present the first characterization of the dual output L2-DUHA broadband front-end.

Authors: WHITEHEAD, Alex Johannes; Dr MOLODOZHENTSEV, Alexander (ELI-Beamlines); INDRA, Lukáš (ELI - Beamlines); GREEN, Tyler (ELI - Beamlines)

Presenter: WHITEHEAD, Alex Johannes

Session Classification: Session 4: High-impact Beamlines for R&D Hubs

Contribution ID: **15** Type: **not specified**

Prospects of dielectric terahertz-driven accelerators in medicine.

Monday 6 October 2025 15:15 (15 minutes)

Throughout the last century, the field of medicine has greatly benefited from particle accelerator technologies. Thanks to the advances in accelerator science in the last decades, accelerators have become important tools in modern medicine. The most common uses of accelerators are oncological treatment, advanced imaging, isotope production, and sterilization. Although conventional accelerators have proven to perform their job quite well, there are still certain limitations in the machinery and gaps that need to be addressed to further improve the performance of accelerators in medicine. It must also be taken into account that the introduction of new technologies and improved systems in medicine is not only related to performance, but also to economic, infrastructural, and administrative aspects.

New accelerators based on novel accelerating concepts are currently under development to overcome some of the issues posed by conventional accelerators. The most popular among them are laser-plasma accelerators, terahertz-driven LinAcs, and dielectric laser-driven accelerators (DLAs). The relatively new sub-field of dielectric terahertz-driven accelerators (DTAs), combining terahertz (THz) technology and DLA, has also gained relevance in recent years.

In this talk, the applications of DTAs and their related technologies in the medical field are explored. Thanks to the shorter wavelengths employed by DTAs, a significant size reduction can be achieved in several radiotherapy facilities, while also providing a more cost-effective solution. Furthermore, the shrinkage of the accelerator could potentially transform the field of intraoperative radiation therapy (IORT). The acceleration concept used in dielectric accelerating structures enables the acceleration of positively charged particles, such as protons, helium, carbon, and heavier ions. Therefore, the extension of these accelerators could also be transformative for hadrontherapy.

Regarding imaging techniques, THz radiation, also known as T-rays, could provide high-brilliance, compact X-ray sources and improve inverse-Compton scattering (ICS)-based compact light sources. Thanks to the development of high-intensity THz sources and detection systems, the field of THz imaging is also becoming of great interest for medical applications. Lastly, both electron beam sterilization techniques and radiobiology could benefit from terahertz-driven structure-based accelerators.

Author: LEIVA GENRE, Andrés

Presenter: LEIVA GENRE, Andrés

Session Classification: Session 2: Medical Applications of Plasma Accelerators

Contribution ID: **17** Type: **not specified**

Laser-Driven Proton Therapy: Innovations in Beam Diagnostics

Monday 6 October 2025 15:00 (15 minutes)

Laser-driven accelerators are emerging as compact and potentially cost-effective alternatives to conventional cyclotrons and synchrotrons for proton therapy. Their ability to generate ultra-short, high-intensity pulses at extremely high dose rates creates opportunities for innovative treatment modalities such as FLASH radiotherapy. At the same time, the distinctive structure of laser-plasma beams such as broad energy spectra, high peak currents, and strong shot-to-shot variations introduces significant challenges in stability, reproducibility, and control.

These challenges place unprecedented demands on beam diagnostics. Unlike conventional systems, diagnostics for laser-driven beams must be capable of handling extremely high instantaneous dose rates, while remaining minimally invasive to preserve beam quality. Reliable, online monitoring is essential to ensure continuous monitoring while treatment or beam delivery. Emerging approaches such as gas-jet monitors provide a promising solution, offering continuous beam characterization without significantly interfering with the primary beam.

The Laser-hybrid Accelerator for Radiobiological Applications (LhARA) exemplifies this paradigm. In its first phase, LhARA is expected to deliver 12–15 MeV protons for in-vitro radiobiology, with later development aiming to extend to 33.4 MeV/u ion beams and 15–127 MeV protons. The integration of advanced diagnostics, such as gas-jet monitoring will help to establish the reliability needed to investigate FLASH radiotherapy, where precise control of ultra-high dose rates is critical.

By tackling the diagnostic challenges of high-intensity laser-driven beams, initiatives such as LhARA, within the broader EuPRAXIA context, demonstrate how accelerator innovation and medical science can be brought together to shape the future of proton therapy.

Author: Mrs MADA PARAMBIL, Farhana Thesni (University of Liverpool/ Cockcroft Institute)

Co-authors: Prof. WELSCH, Carsten (University of Liverpool/ Cockcroft Institute); Dr PATEL, Milaan (University of Liverpool/ Cockcroft Institute); Dr KUMAR, Narender (University of Liverpool/ Cockcroft Institute)

Presenter: Mrs MADA PARAMBIL, Farhana Thesni (University of Liverpool/ Cockcroft Institute)

Session Classification: Session 2: Medical Applications of Plasma Accelerators

Contribution ID: **18** Type: **not specified**

Development of a Marx Generator Discharge Circuit for High-Current Plasma Capillary Discharges

Monday 6 October 2025 12:00 (15 minutes)

In the context of plasma-based accelerators, one of the main advantages lies in their compactness and lower overall cost compared to conventional machines. Beyond acceleration, plasma can also be used to focus (plasma lens) and bend particle beams within compact structures such as discharge-based plasma capillaries.
Beam bending in such devices requires a tailored capillary geometry and a dedicated discharge circuit capable of delivering high currents —typically above 10 kA —through the plasma. In this work, we present the development of a new type of discharge system based on a Marx generator, specifically designed to deliver more than 50 kV and 15 kA into a 20 cm-long capillary.
Several discharge configurations have been tested to optimize the setup for this application. Additionally, numerical simulations were conducted to estimate the resulting magnetic field distribution, and beam dynamics studies were performed to evaluate the guiding effect on a charged particle beam.

Author: DEMITRA, Romain (Istituto Nazionale di Fisica Nucleare)

Presenter: DEMITRA, Romain (Istituto Nazionale di Fisica Nucleare)

Session Classification: Session 1: High-Brightness X-rays for Biology/Chemistry

Contribution ID: **19** Type: **not specified**

Achieving Tight Synchronization in Plasma Wakefield Accelerators at EuPRAXIA@SPARC_LAB

Tuesday 7 October 2025 15:45 (15 minutes)

Plasma wakefield acceleration (PWFA) is the most promising candidate for next-generation compact accelerators. An efficient and reproducible operation of a plasma wakefield accelerator facility relies largely on a tight synchronization among all the accelerator sub-systems impacting the beam longitudinal phase-space and time-of-arrival. One of the big disturbances affecting the beam characteristics is the RF power station phase noise. An effective solution is using a fast feedback loop to stabilize its phase. SPRAC_LAB had implemented this technique since 2008 and recently several innovations have been realized on this feedback loop to achieve extremely stable synchronization for PWFA. The experimental results demonstrate the phase jitter of RF line is successfully reduced to 15 fs RMS with respect to the reference master oscillator. This marks a notable improvement over the original setup and makes a meaningful step toward meeting the strict RF stability requirements of advanced plasma accelerators.

Author: FANG, Xianghe (LNF-INFN)

Presenter: FANG, Xianghe (LNF-INFN)

Session Classification: Session 4: High-impact Beamlines for R&D Hubs

Contribution ID: **20** Type: **not specified**

Superradiance in non-linear Thomson scattering

Monday 6 October 2025 11:30 (30 minutes)

Plasma-based accelerators provide a compact and efficient means of generating ultra-relativistic particles [1], making them strong candidates for next-generation light sources. One of the most consolidated X-ray source configurations in plasma accelerators is based on nonlinear Thomson scattering [2]. Here, relativistic electrons from a plasma-based accelerator interact with a counter or copropagating, intense laser pulse. Temporal coherence and superradiance are highly sought features in this context because the peak brightness increases very favourably with the number of light-emitting particles squared [3]. This is in stark contrast with temporally incoherent sources, where the peak intensity grows linearly with the number of emitters.

This work presents results on the generation of superradiant emission from electron bunches interacting with an azimuthally polarised laser pulse. We investigate how this interaction evolves at varying electron densities and examine the collective effects that lead to enhanced, superradiant radiation. In addition, further analysis to gain deeper insight into the bunching mechanism and the underlying radiation process were also conducted, the results of which are also presented in this work.

References

[1] T. Tajima and J. M. Dawson, Phys. Rev. Lett. 43, 267 (1979).

[2] E. Esarey et al., Phys. Rev. E 48, 3003 (1993).

[3] J. Vieira et al., Nature Physics 17, pages 99–104 (2021).

Author: THAKUR, Bhushan (Instituto Superior Tecnico, Lisbon)

Presenter: THAKUR, Bhushan (Instituto Superior Tecnico, Lisbon)

Session Classification: Session 1: High-Brightness X-rays for Biology/Chemistry

Contribution ID: **21** Type: **not specified**

Energy Bunching from Sub-Cycle Ionization Injection in Laser Wakefield Acceleration

Monday 6 October 2025 12:15 (30 minutes)

Electron energy spectra featuring multiple quasi-monoenergetic peaks with uniform, narrow spacing are observed when a few-cycle (~9 fs), multi-terawatt laser pulse is used to drive laser wakefield acceleration in a helium–nitrogen gas mixture. This comb-like energy structure results from periodic ionization injection triggered by successive half-cycles of the laser electric field. Crucially, the evolving carrier-envelope phase (CEP) during laser propagation through the plasma enables this sub-cycle injection process. Our experimental findings provide the first direct observation of CEP-driven energy bunching in a plasma accelerator, establishing a scheme where electron injection and beam shaping can be precisely synchronized to the laser's optical waveform. This work opens a new pathway toward attosecond-scale control in laser-plasma acceleration.

Author: D SOUZA, Flanish Ashley

Presenter: D SOUZA, Flanish Ashley

Session Classification: Session 1: High-Brightness X-rays for Biology/Chemistry