Accelerator Cluster

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What are particle accelerators

Source: https://www.iaea.org/newscenter/news/what-are-particle-accelerators

Members

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- Dr. Bharat Rawat
- Dr. Benjamin Rienacker
- Dr. Milaan Patel

Cockcroft Institute

- Named after Nobel Prize laureate John Cockcroft.
- Four universities
  - Liverpool
  - Lancaster
  - Manchester
  - Strathclyde
- One STFC partner
  - ASTeC

Research Strategy for Quasar group

Frontier Accelerators

In the next decade we will focus on the **LHC** at CERN, where we lead the development of gas jet monitors for the high luminosity upgrade, and other collider options; on the exploitation of the **CLARA** facility on Daresbury campus to explore next-generation FEL technologies; on the development and exploitation of the new facilities **PERLE and RUEDI**; and on the optimization of low energy beam transport and efficient injection into traps at the Antiproton Decelerator, in particular contributions to **AEgIS**.

Novel Accelerators

As part of **AWAKE**, we will continue our efforts on novel (high gradient) acceleration techniques. Following the successful demonstration of proton-driven wakefield acceleration in 2018, we are leading the development of novel diagnostics that will give more detailed insight into the physics of the acceleration process and also benefit other large scale plasma accelerator projects such as **EuPRAXIA**. We will also expand simulation and experimental studies into **micro-accelerators using** carbon nanotubes and dielectric structures.

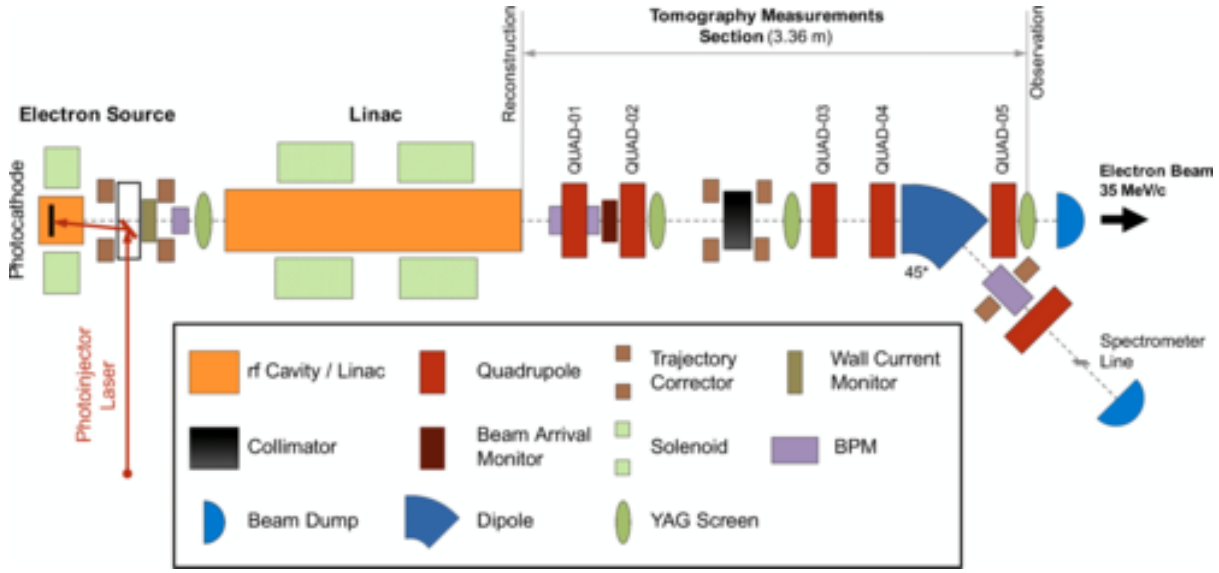
Accelerator Applications

For impact, we will carry out R&D into least invasive **beam and dose monitors**, to help improve patient treatment and medical accelerator operation; continue to develop and optimize **novel low dose 3D X-ray imaging systems** with Adaptix; drive **quantum technologies** for accelerator applications; grow our **spinout company D-Beam**, targeting a product portfolio that benefits accelerator facilities around the world.

A backbone of all areas will be our continued leadership in **Data Intensive Science** through LIV.DAT and LIV.INNO.

Frontier Accelerators: Daresbury Lab

- CLARA facility (UK-XFEL)



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Transverse phase space tomography in an accelerator test facility using image compression and machine learning

A. Wolski, M. A. Johnson, M. King, B. L. Militsyn, and P. H. Williams

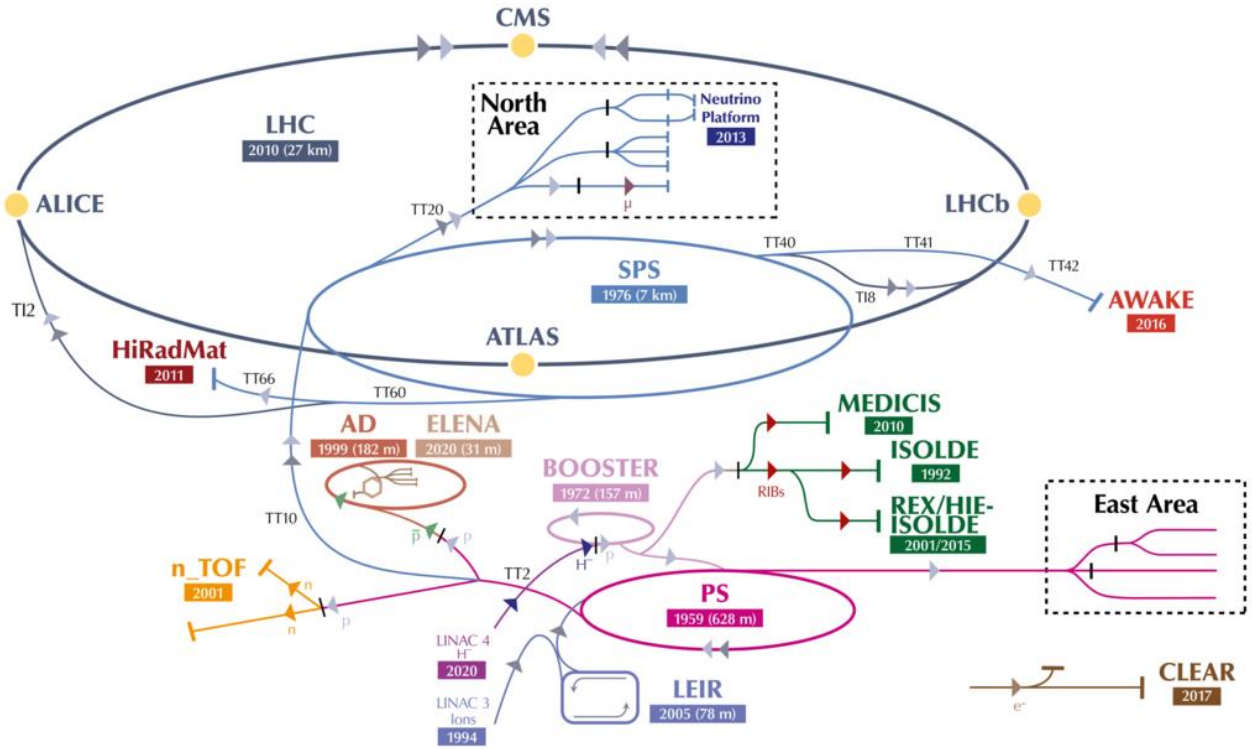
Phys. Rev. Accel. Beams **25**, 122803 – Published 15 December 2022

Article References Citing Articles (3) PDF HTML Export Citation

ABSTRACT

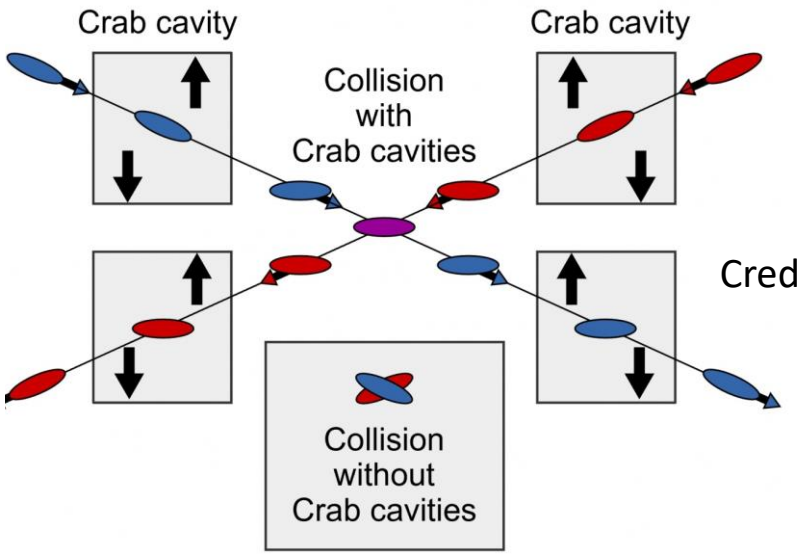
We describe a novel technique, based on image compression and machine learning, for transverse phase space tomography in two degrees of freedom in an accelerator beamline. The technique has been used in the CLARA accelerator test facility at Daresbury Laboratory: results from the machine learning method are compared with those from a conventional tomography algorithm (algebraic reconstruction) and applied to the same data. The use of machine learning allows reconstruction of the 4D phase space distribution of the beam to be carried out much more rapidly than using conventional tomography algorithms and also enables the use of image compression to reduce significantly the size of the data sets involved in the analysis. Results from the machine learning technique are at least as good as those from the algebraic reconstruction tomography in characterizing the beam behavior, in terms of the variation of the beam size in response to variation of the quadrupole strengths.

Frontier Accelerators: CERN



Credit: CERN

HLLHC project

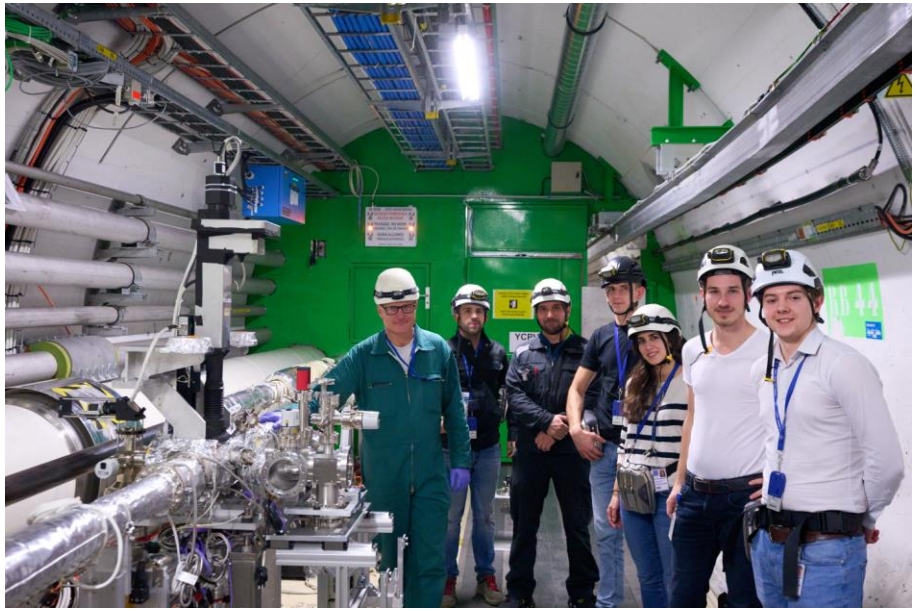


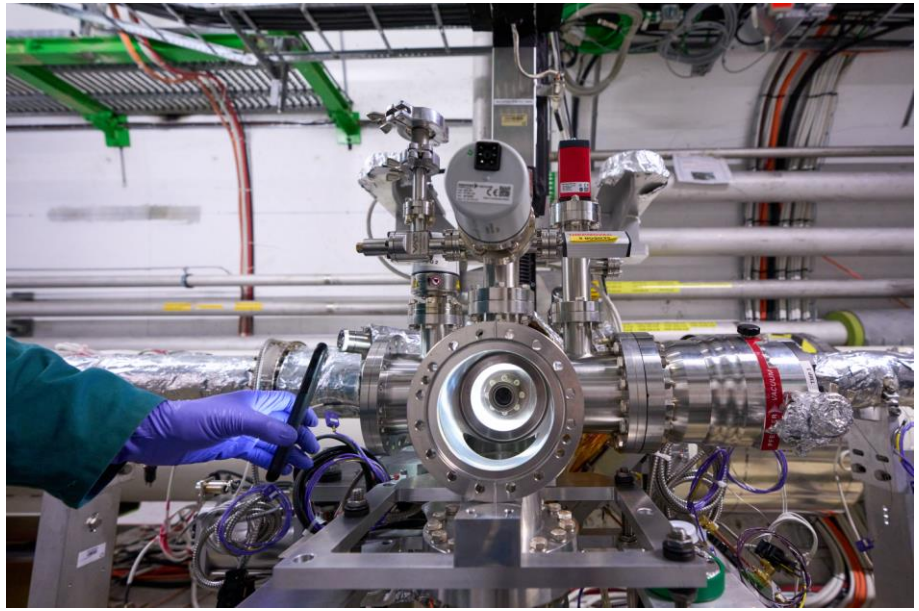
Credit: CERN

ıb cavity development and beam dynamics.

Frontier Accelerators: HLLHC project

Beam Gas Curtain profile monitor

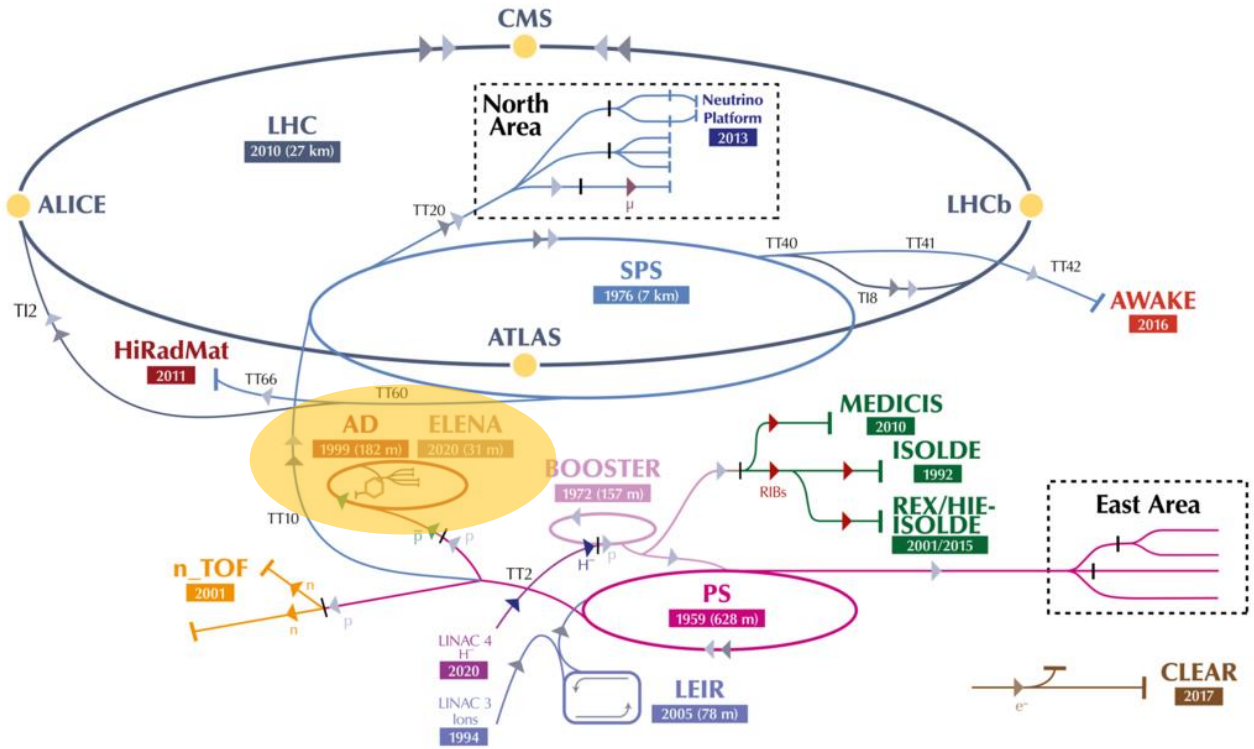




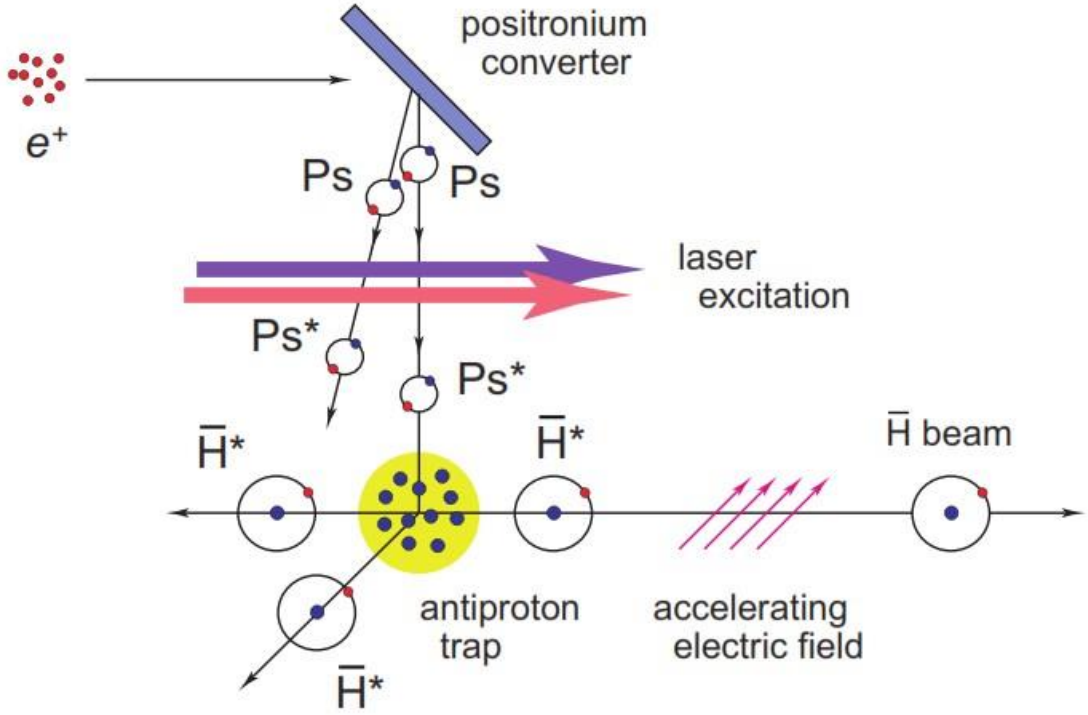
Credit: Accelerating news

Installed into the LHC and began to measure beam profile this year.

Frontier Accelerators: Antimatter facility



Beam dynamic Task: Optimization of low energy beam transport and efficient injection into traps at the Antiproton Decelerator

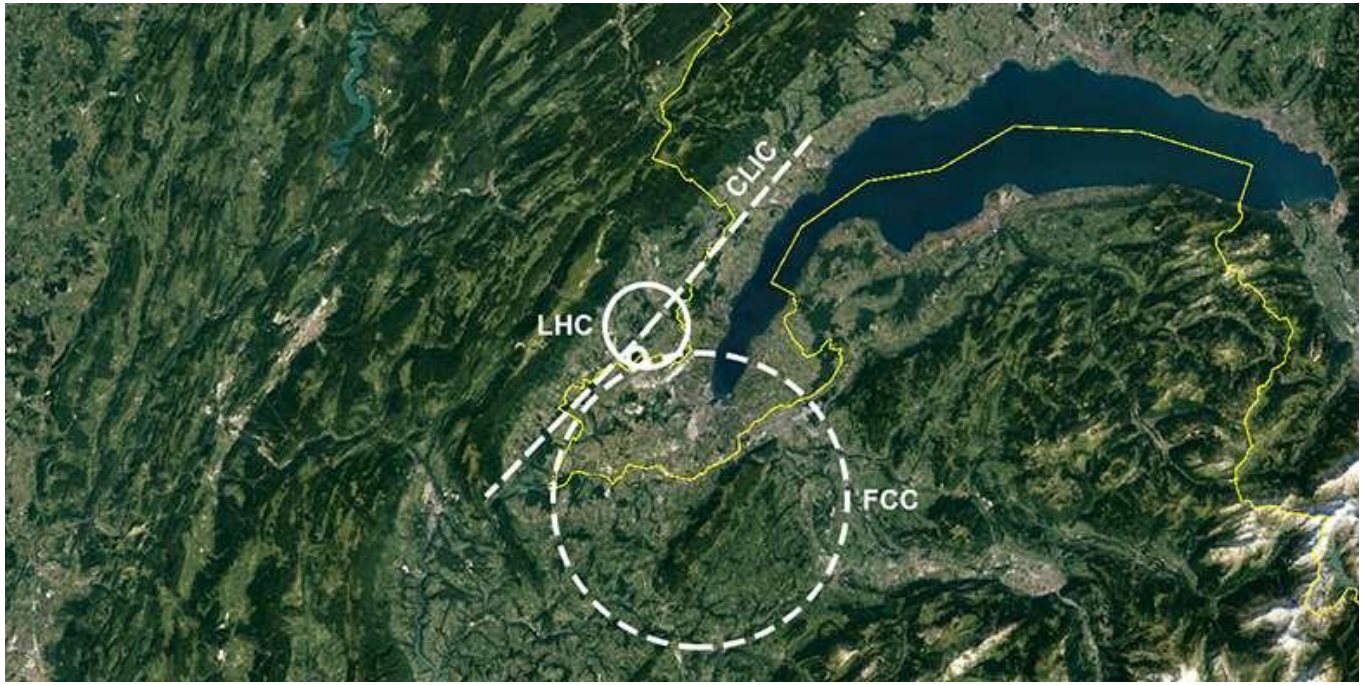


Credit: AEgIS collaboration.

Future mega facilities?

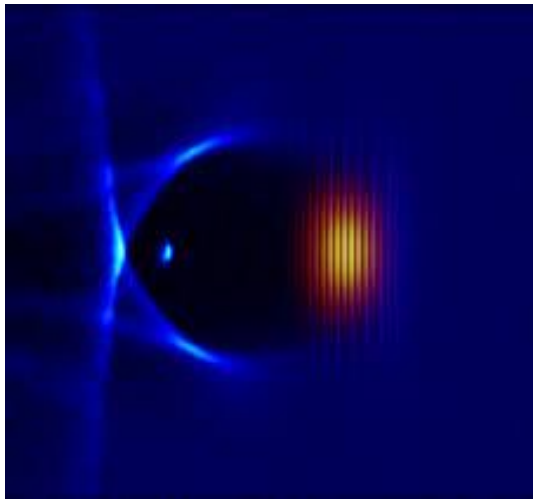
- The International linear collider (ILC at Japan?)
- The Compact Linear Collider (CLIC at CERN?)
- FCC-ee, FCC (CERN) VS CEPC (China)
- Muon collider

- So many other facilities
  - 4th generation light source
    - Diamond upgrade
    - UK-XFEL
  - ISIS upgrade



Laser Plasma Wakefield Acceleration

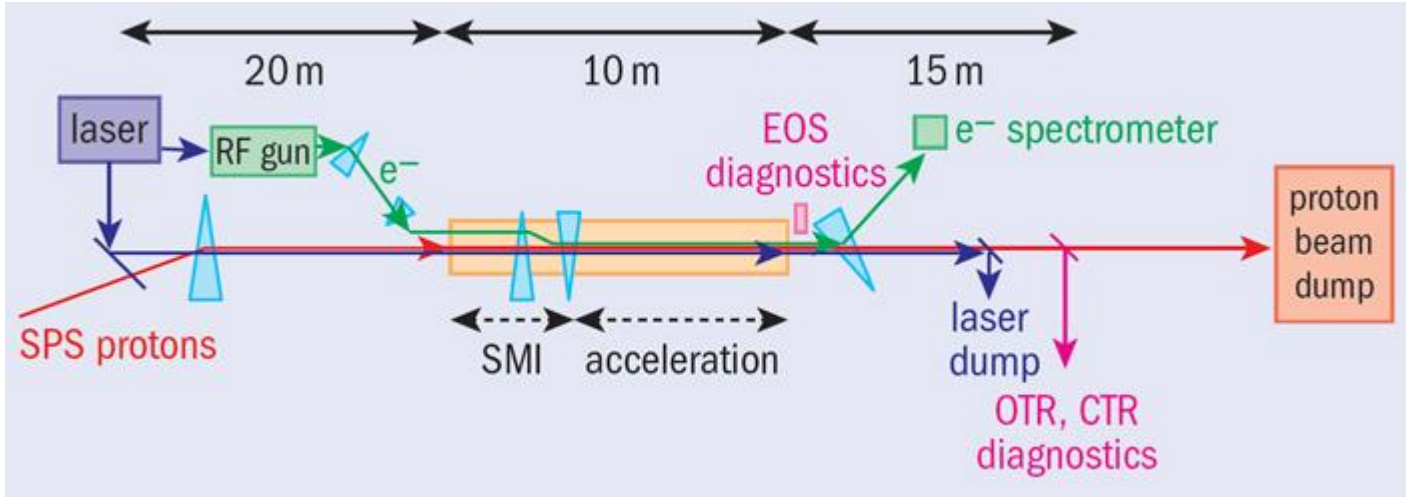
Credit: Nature 2004



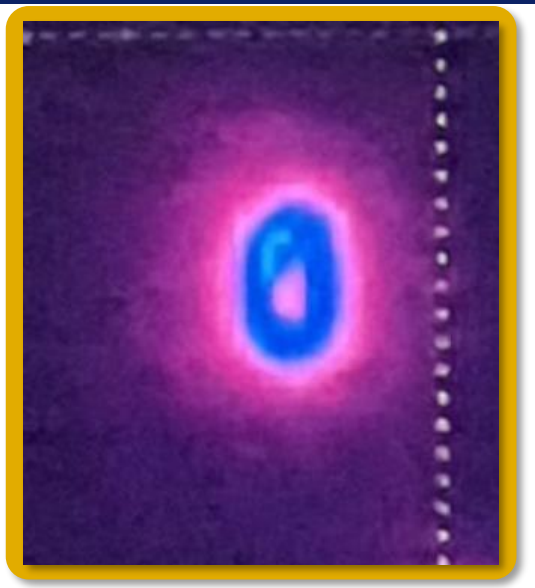
Credit: CAS

Credit: Laura Corner from CLF experiment RAL

Novel Accelerators: AWAKE Project

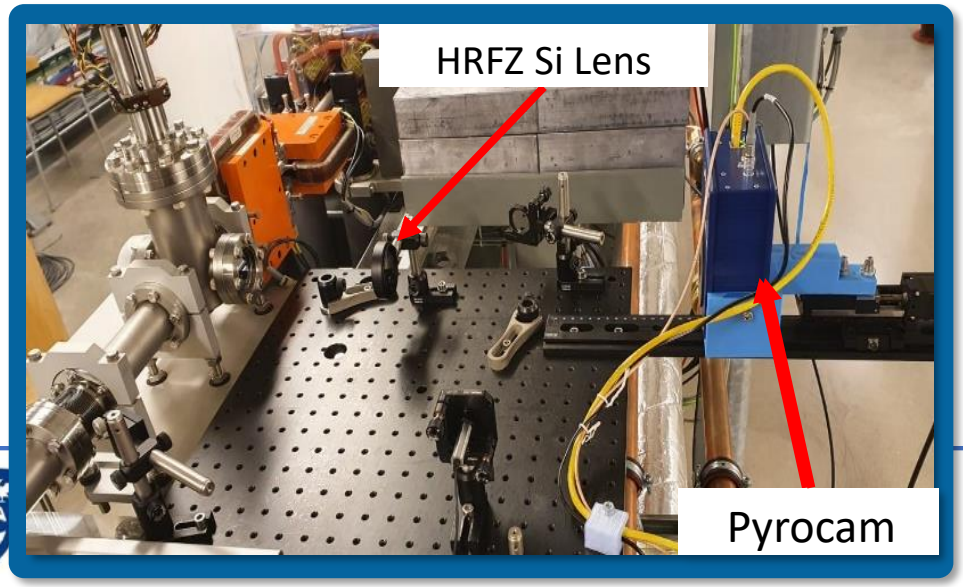


Credit: CERN courier

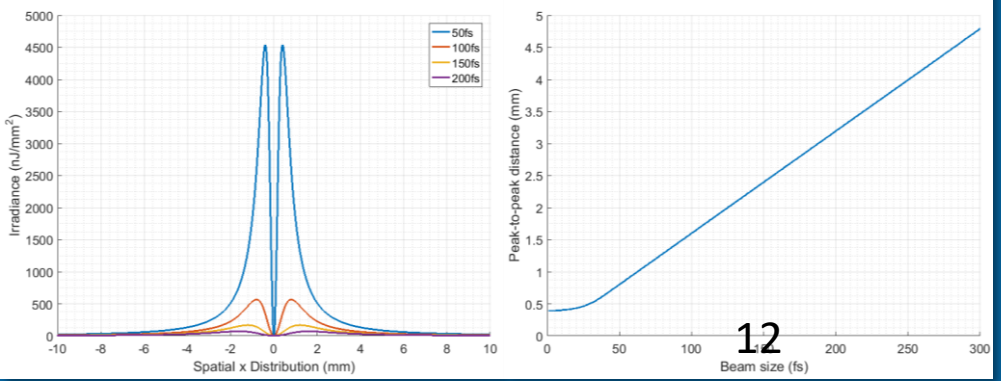


Credit: Joseph Wolfenden

CTR imaging bunch length monitor

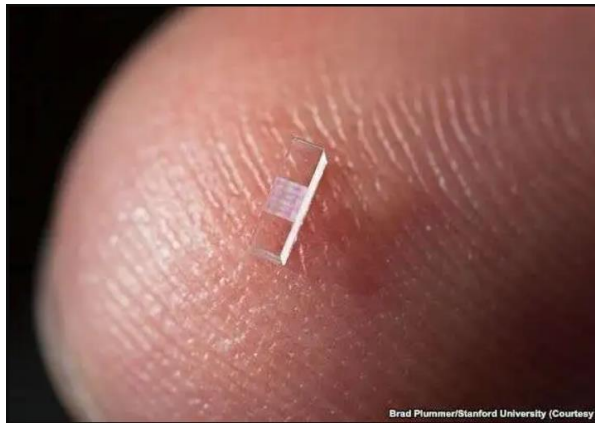


$$\frac{dI^i_{bunch}}{dr} \approx N_e^2 \int_{\Delta\omega} \frac{d^2 I^i_e}{d\omega dr} |F_z(\rho(z), \omega)|^2 d\omega$$

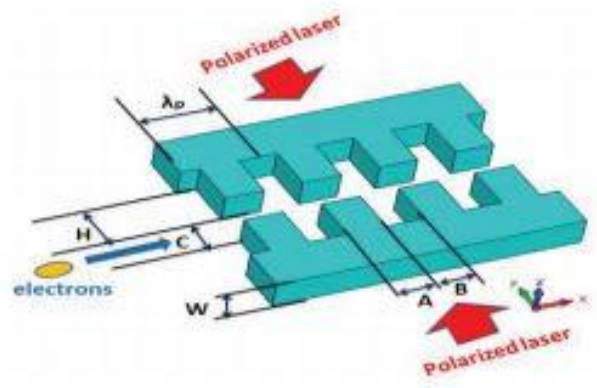


Micro-accelerators

- Dielectric laser accelerators

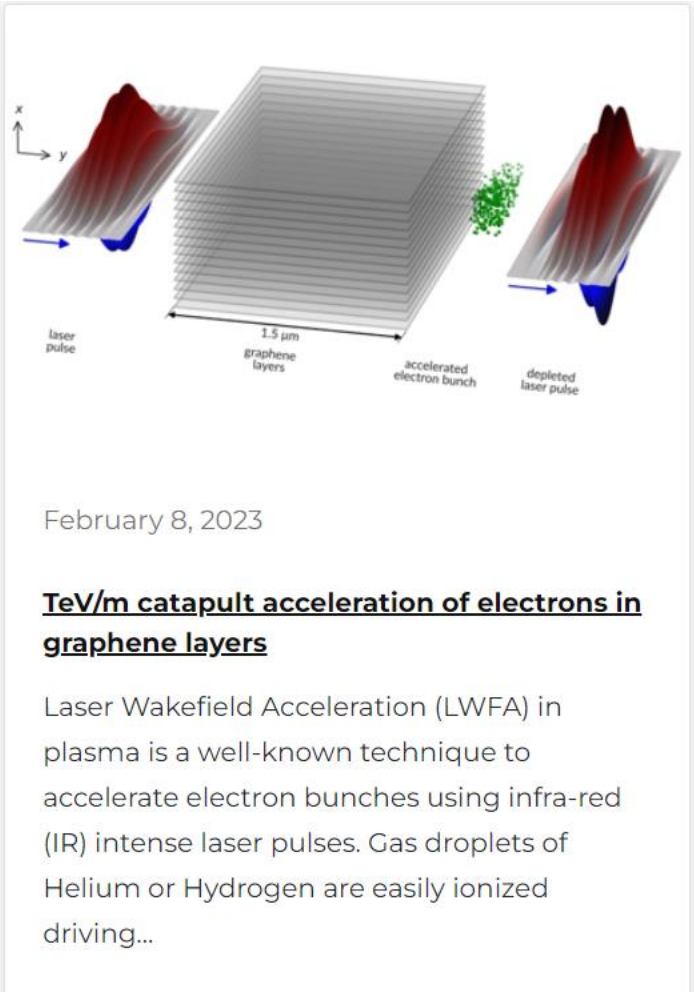


Credit: SLAC



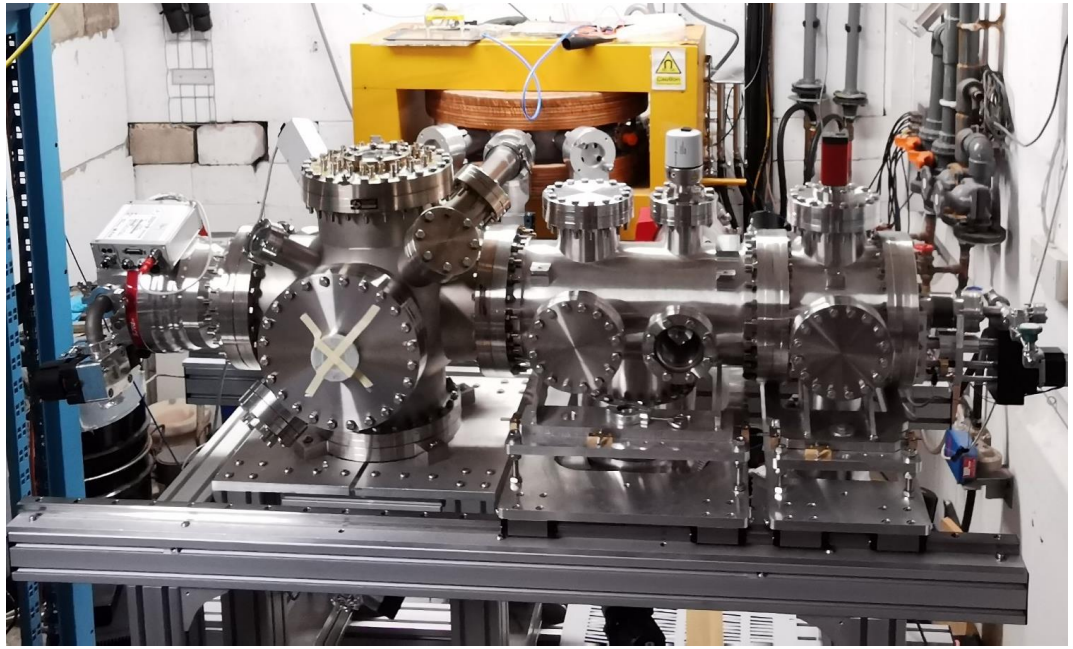
Credit: Y. Wei

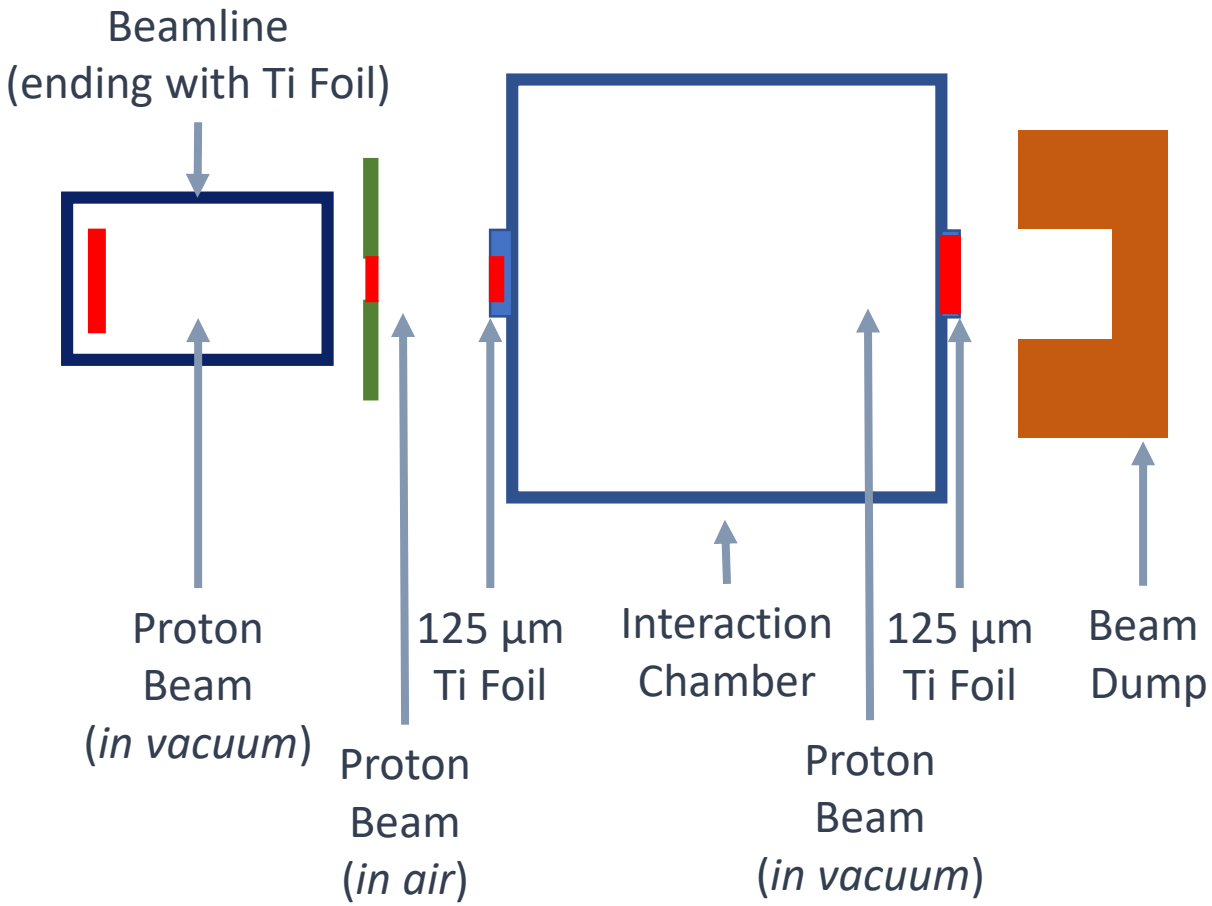
- Graphene layer for laser accelerator



Credit: C. Bontoiu

Accelerator Applications: JetDose



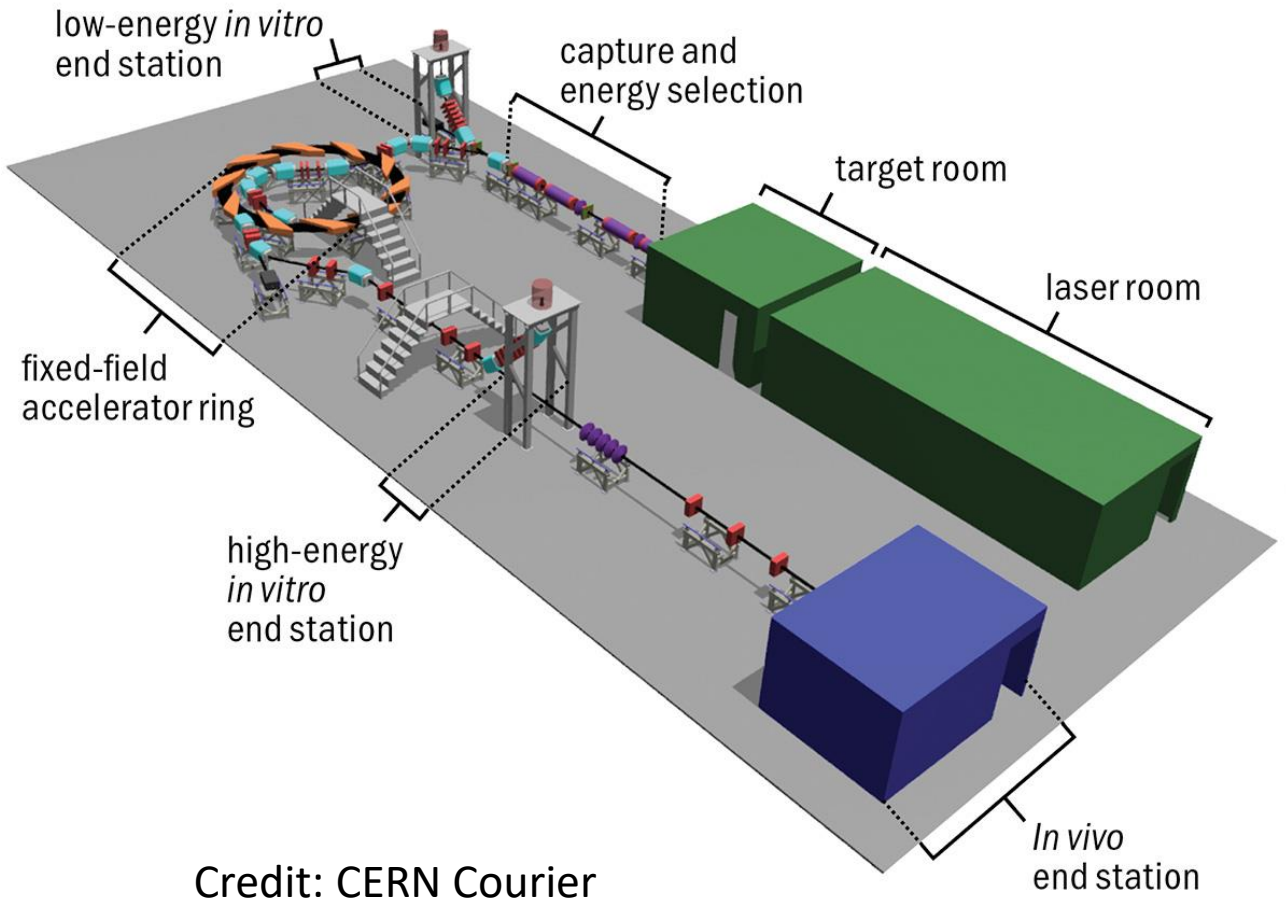


Beam Parameters

Beam Species:	***Proton***
Beam Energy:	***28 MeV***
Beam Current:	***150-750 nA (on FC1)***
Beam Collimator Area:	***4-100 mm²***

Credit: N. Kumar

Accelerator Applications: Lhara



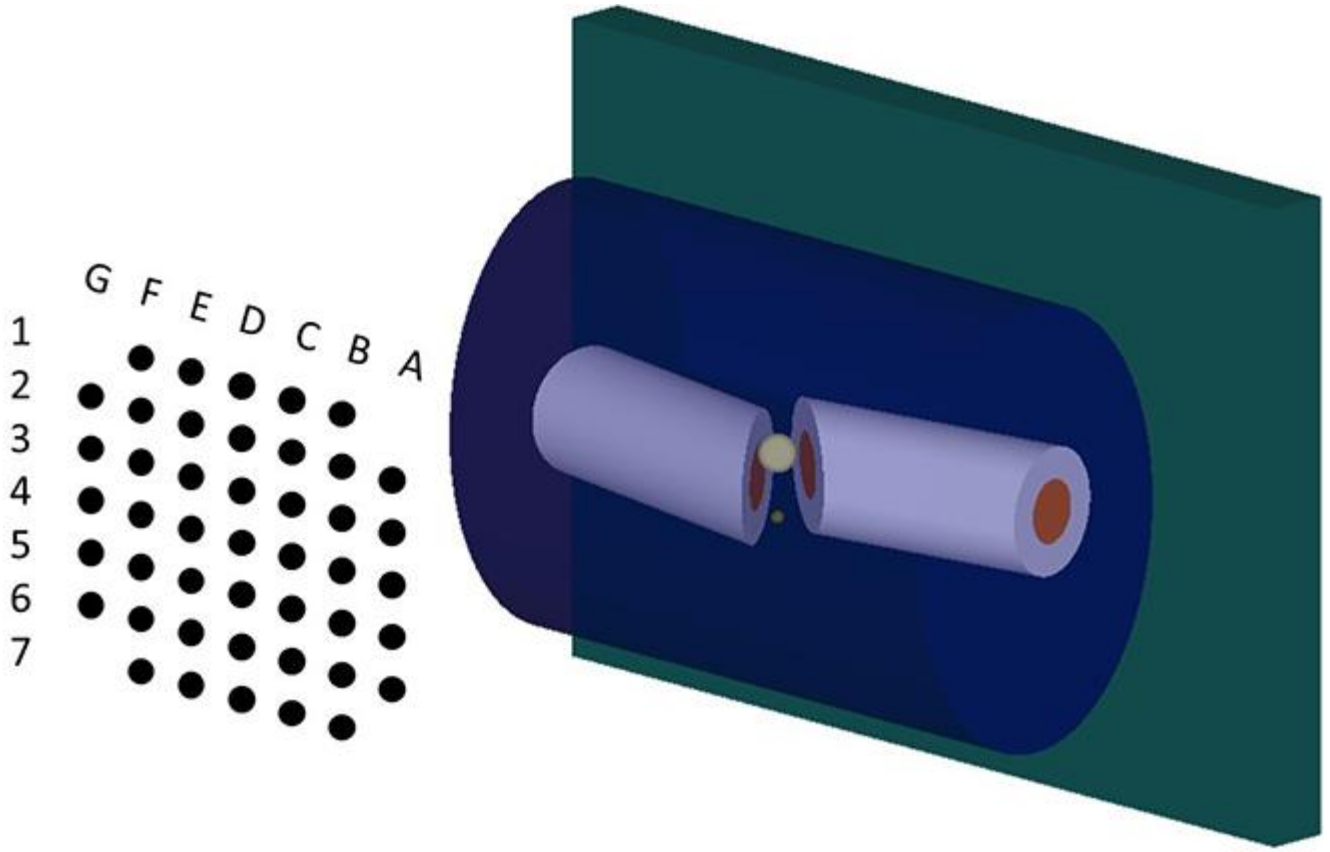
Credit: CERN Courier

Clearly identified clinical benefits – opening opportunities for novel cancer treatment modalities such as LhARA, FLASH and improved ways to operate existing and future facilities;

Project will be realized by consortium with long-standing collaborative links who are recognized leaders in their respective area;

Exceptional international network for collaboration and dissemination established through OMA leadership.

Accelerator Applications: Adaptix



Credit: T. Primidis

Personal taste

- Particle physicist used to be good at both Particle physics and accelerator physics historically.
- Good combination between physics and engineering.
- Nowadays, large accelerators is too big to be afford by a university lab. Collaboration is a must.
- New accelerating concepts are emerging, and new techniques were welcomed by the accelerator communities.
- Applications of accelerators are expanding.

Questions?