PANAMA
Plasma Accelerators for Nuclear Applications and Materials Analysis
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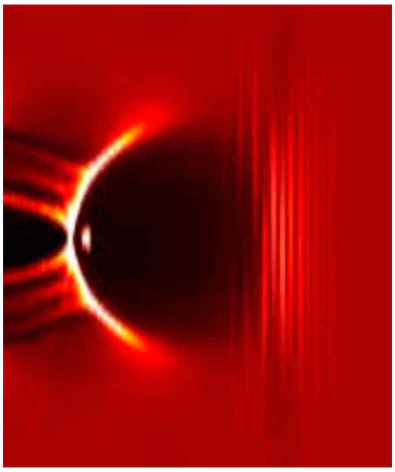
The PANAMA facility, based in the **Scottish Centre for the Application of Plasma Accelerators** (SCAPA) will provide state-of-the-art characterization and testing capabilities for nuclear materials from across the nuclear sector, from new build and fuel development and manufacture, to decommissioning, waste management and geological disposal.

Radiation shielding concrete door to Bunker A in SCAPA


Computer simulation of a micrometer-scale intense X-ray source (small bright blob to the left of centre) created in a laser-plasma accelerator

Capabilities being developed at PANAMA include:

- X-ray and γ-ray Computed Tomography (X-CT/γ-CT)
- γ-radiography imaging
- X-ray Absorption Spectroscopy (XAS)
- X-ray Diffraction
- Time-resolved diffraction & spectroscopy
- Radiation damage (particle beams, including protons and ^{4}He ions)
- Pump-probe on radiation damage combining particle beams with diffraction/ spectroscopy/imaging.

Laser-driven plasma accelerators derive their energy from a high intensity laser (generally a Ti:sapphire laser) that irradiates a low density plasma target with femtosecond light pulses. The light pulses produce a density wake in plasma thus separating the charge to produce accelerating fields 1000 times stronger than possible in conventional accelerators. The resulting self-injected electrons form ultra-short duration bunches, which can directly produce THz radiation, X-rays or gamma rays up to 10 MeV or through interacting with a secondary target or counter-propagating laser beam produce 100 s MeV photons. Radiation produced in laser-plasma interactions include: electrons, muons, protons, neutrons and light ion beams, and electromagnetic radiation pulses from the IR to gamma rays.

The SCAPA facility uses two state of-the-art Ti:sapphire lasers: a 40 TW (1.4 J, 35 fs; at 10 Hz) and a 350 TW (8.75 J, 25 fs; at 5 Hz) system, to generate:

Radiation pulses:

- High brightness THz and infra-red radiation;
- Partially coherent betatron (plasma wiggler) radiation in the X-ray to γ-ray (10 s of MeV) range;
- Coherent radiation from a free-electron laser (FEL) in the VUV-X-ray (sub-nm) range.

Particle beams:

- Monoenergetic electron beams of energy 100 MeV – 4 GeV;
- Proton and light ion beams of energy up to 100 MeV/c.

At the PANAMA beamline, these SCAPA capabilities will be exploited for advanced materials characterization. The high energy range of the produced X- and γ-rays (100 s of keV to MeV) can penetrate very dense (or very large) materials for detailed imaging of such materials. Additionally, the ultrashort duration of the high intensity hard X-ray pulses (e.g. 7-20 keV) can be utilized for time-resolved diffraction and spectroscopy at ultrashort timescales. Perhaps most important, the flexibility of the X- and γ-rays produced and the possibility to (nearly) simultaneously produce particle beams enables combining imaging, spectroscopy or diffraction with radiation damage on the same sample to enable *in-situ* real-time observations of the precise mechanism of damage relevant to the nuclear energy sectors, including structural materials, waste matrices, and cladding.

A new dedicated active lab will also enable safe manipulations of radioactive samples, including subsequent analysis at the PANAMA beamline.

Contact details

Please email **pieter.bots@strath.ac.uk** to discuss your potential project.

Availability

PANAMA is currently scheduled to be available for access by external users from Spring 2021 (for the X-CT in the first instance). Up-to-date information about availability, in light of the COVID situation, is available at **https://www.nnuf.ac.uk/panama**.

