This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement No 730871.

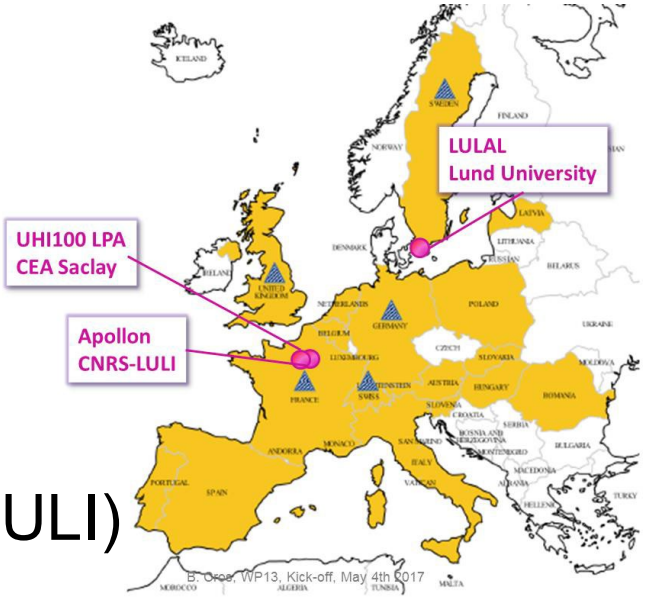
WP13: Access to Plasma Beam testing facilities

July 15th, 2022/ Final Review

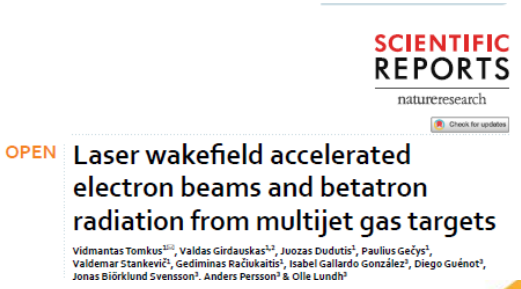
Brigitte CROS / CNRS - LPGP

Overview

- 3 facilities offering TA in WP13:
  - LULAL (Lund University)
  - UHI100 LPA (CEA LIDYL)
  - APOLLON MUST-LPA (CNRS LULI)



- Access provided: 1146 hours, 47 users
  - 2 projects at UHI100 LPA
  - 4 projects at LULAL
  - 1 project at APOLLON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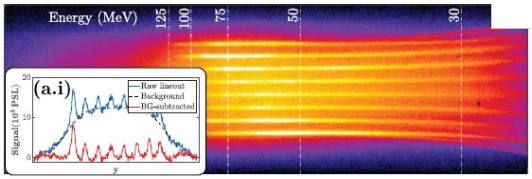
Laser wakefield accelerated electron beams and betatron radiation from multijet gas targets

Vidmantas Tomkus[1✉], Valdas Girdauskas[1,2], Juozas Dudutis[1], Paulius Gečys[1], Valdemar Stankevič[1], Gediminas Račiukaitis[1], Isabel Gallardo González[2], Diego Guénot[2], Jonas Björklund Svensson[2], Anders Persson[2] & Olle Lundh[2]

Access to UHI100-LPA (CEA Saclay)

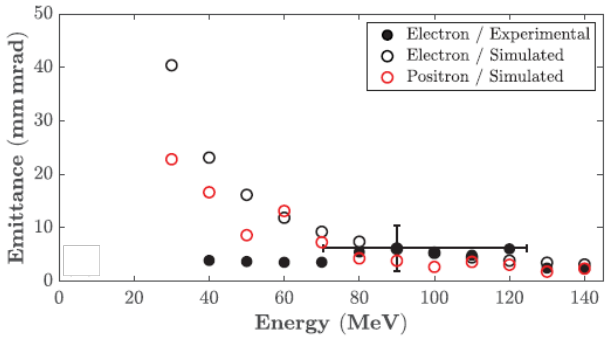
S. Dobosz Dufrénoy- Facility coordinator

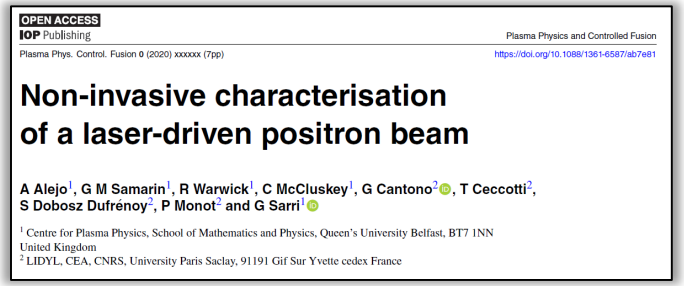
Secondary electron signal through pepper-pot W mask and dipole



Campaign n°1: *ARIES-CEA-LIDyL-2017-01*
(Janv-Fev 2018 /152 Units)

Emittance characterisation of laser-driven positron beams for injection in conventional accelerators





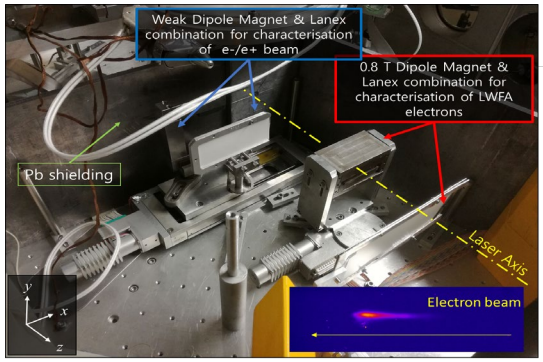
OPEN ACCESS
IOP Publishing
Plasma Physics and Controlled Fusion
Plasma Phys. Control. Fusion 0 (2020) xxxxxx (7pp)
https://doi.org/10.1088/1361-6587/ab7e81

Non-invasive characterisation of a laser-driven positron beam

A Alejo[1], G M Samarin[1], R Warwick[1], C McCluskey[1], G Cantono[2], T Ceccotti[2], S Dobosz Dufrénoy[2], P Monot[2] and G Sarri[1]

[1] Centre for Plasma Physics, School of Mathematics and Physics, Queen's University Belfast, BT7 1NN United Kingdom
[2] LIDYL, CEA, CNRS, University Paris Saclay, 91191 Gif Sur Yvette cedex France

published, 2020



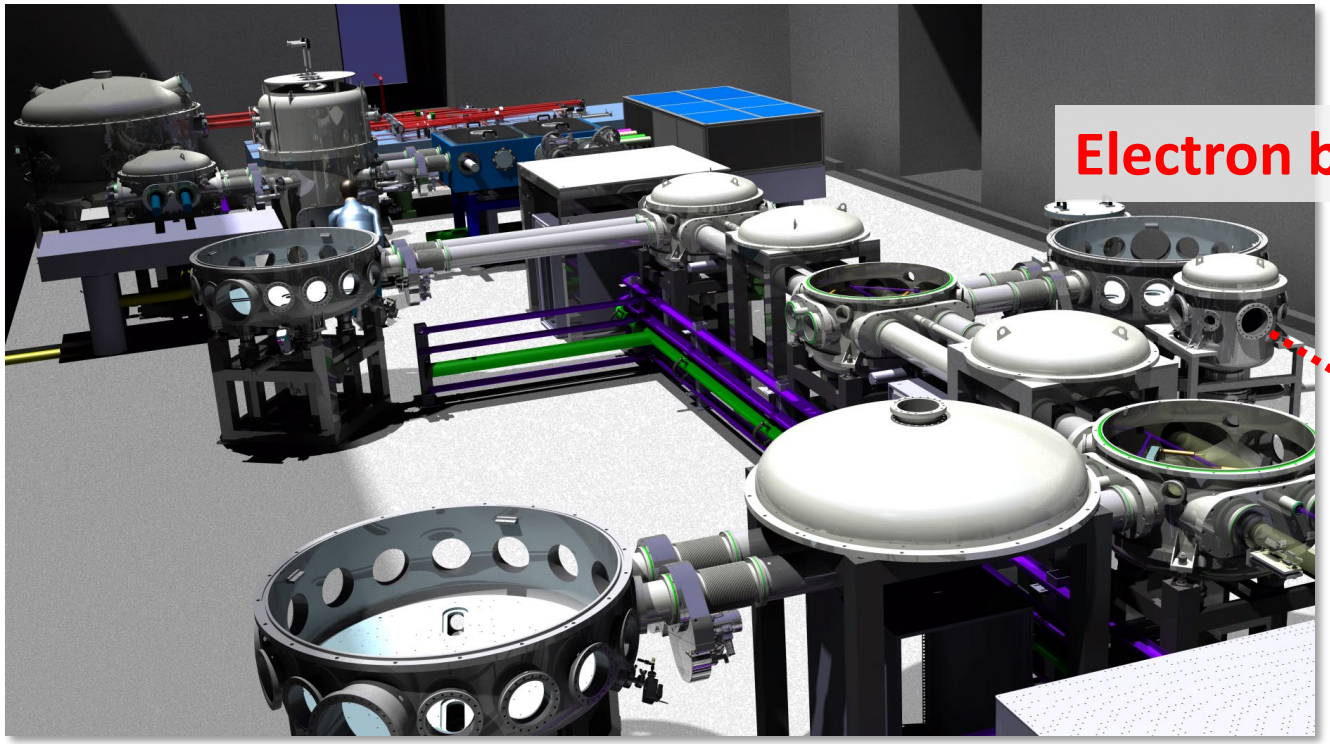
Campaign n°2: *ARIES-CEA-LIDyL-2018-01*
(Feb-March 2019 /176 Units)

Laser-driven low-energy positrons for high-resolution non-disruptive inspection of materials – G. Sarri and coll. (Queen's University – Belfast)

Upgraded facility implemented at CEA

Orme des Merisiers

New redesigned experimental facility in a completely refurbished area (few km away from CEA-Saclay)



New laser beam diagnostics, two laser beams available, 40% more energy on one beam in « single beam configuration »

Increase of electron beam energy and charge are expected

Upgraded facility implemented at CEA

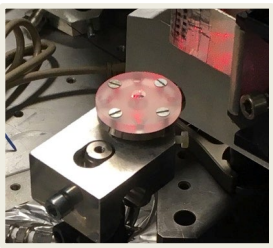
Orme des Merisiers

New redesigned experimental facility in a completely refurbished area (implementation now completed after long delays due to covid restrictions and lockdowns)

Commissioning of experimental area in Progress:
Waiting for permission to operate from ASN

Access to LULAL

4 experiment campaigns completed (30 users, 788 units)



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Laser wakefield accelerated electron beams and betatron radiation from multijet gas targets

Vidmantas Tomkus[1,2], Valdas Girdauskas[1,2], Juozas Dudutis[1], Paulius Gečys[1], Valdemar Stankevič[1], Gediminas Račiukaitis[1], Isabel Gallardo González[3], Diego Guénot[3], Jonas Björklund Svensson[3], Anders Persson[3] & Olle Lundh[3]

Olle Lundh, olle.lundh@fysik.lth.se

- Multistage Laser and Beam Driven Plasma Accelerator,

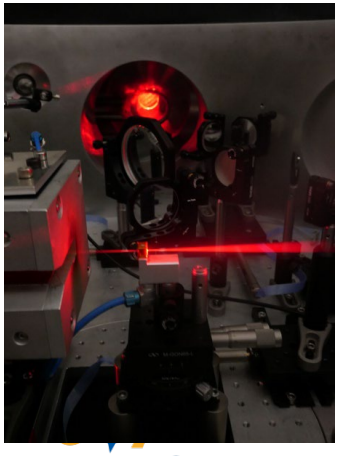
  PI : G. Raciukaitis (FTMC), Vilnius, Lithuania

Understanding the breakup and atomization of fuel sprays is essential for improving e.g. engine efficiencies.

- Spray imaging with laser driven X-ray

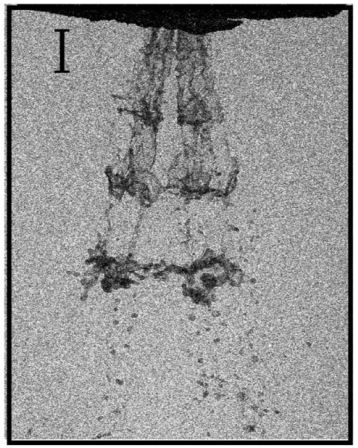
  PI: Lars Zigan (FAU), Erlangen-Nürnberg, Germany

LWFA X-ray source

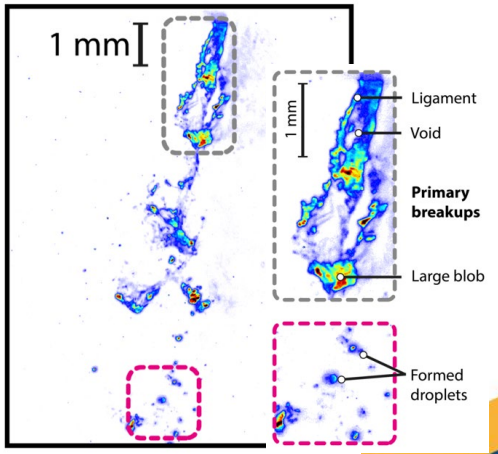


Fuel injection spray

LWFA X-ray image



Laser-induced fluorescence

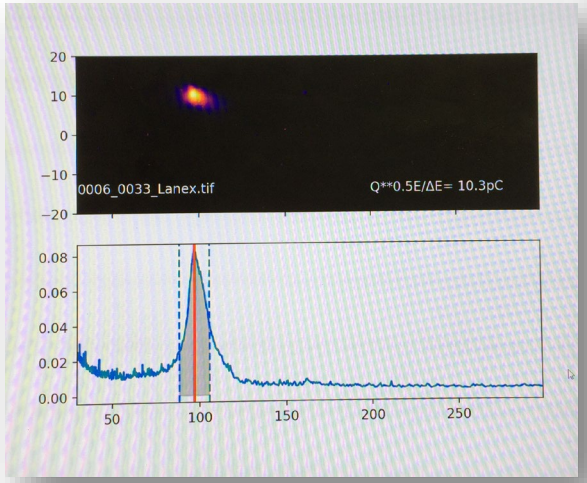


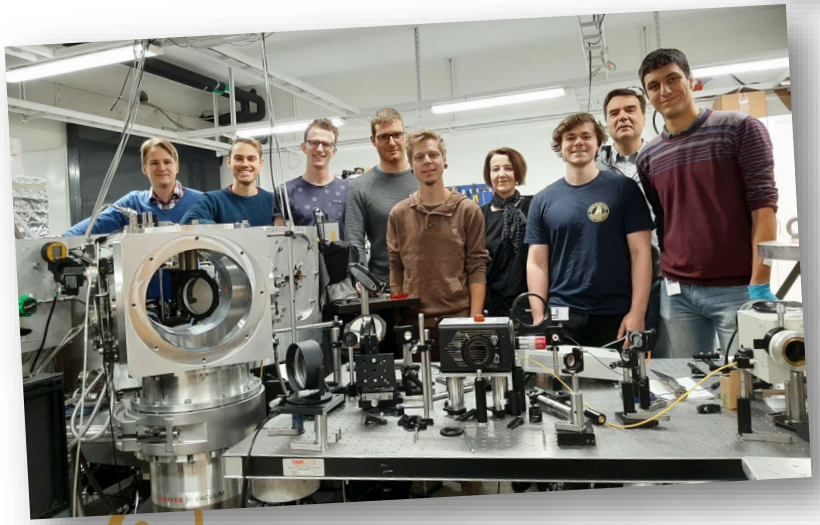
Access to LULAL

Testing plasma accelerator source for EuPRAXIA 1 & 2

Quantitative detailed study of the impact of laser properties on electron beam properties.

Automated online optimization of the electron beam





2 TNA projects (Nov-Dec 2019 and 2021)

4+4 weeks access,

20 visiting users,

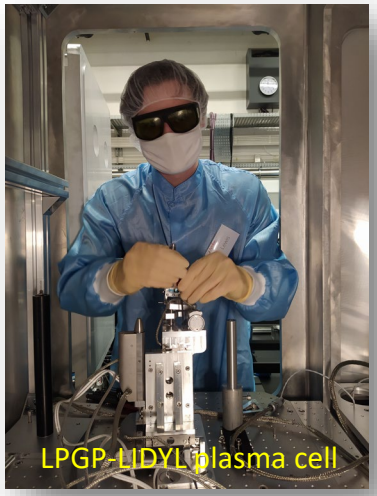
10 participating institutes, 5 countries

Imperial College (UK), University of York (UK), Oxford University (UK), CLF (UK), CNRS (FR), U Paris-Saclay (FR), CEA-Saclay (FR), ENEA (IT), IST (PT), Lund University (SE)

Commissioning experiments at Apollon


Overview of F2 experimental area

- PI B. Cros (CNRS LPGP) with teams from CEA LIDYL (S.Doboz), CNRS LLR (A. Specka) and CNRS IJCLAB (N. Delerue), supported by Apollon technical teams
- April 2021
- Apollon F2 beam focussed by a 3m focal lens optic, in a gas cell, electron spectrometer and on axis diagnostics


LPGP-LIDYL plasma cell


LLR spectrometer

- H2+1%N2 plasma, 2 to 20mm long were explored,
- 4.5 J laser energy at cc
- Electron spectra observed in the detection window: 200 MeV – 1.6 GeV (lanex + yag detectors)
- Results in agreement with PIC simulations

Access to Apollon

Generation of laser-driven GeV-scale high-quality positron beams

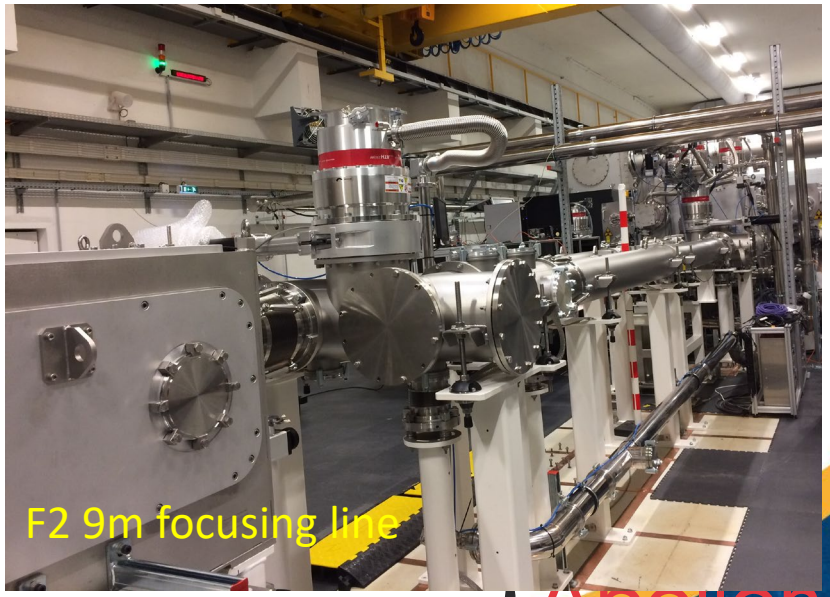
TNA March 14 to April 8 2022


M. Streeter (QUB) during implementation of experiment

Project selected by the Apollon program committee following the 2021 call for proposals, and by the WP13 User Selection Panel

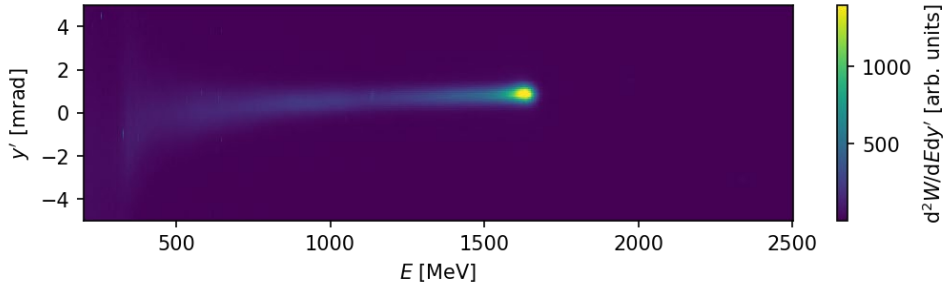
- PI G. Sarri

  Queen's University Belfast
- Supported by the commissioning team: B. Cros (CNRS LPGP), S.Doboz-Dufrénoy (CEA LIDYL) A. Specka (CNRS LLR) and Apollon technical teams


F2 9m focusing line

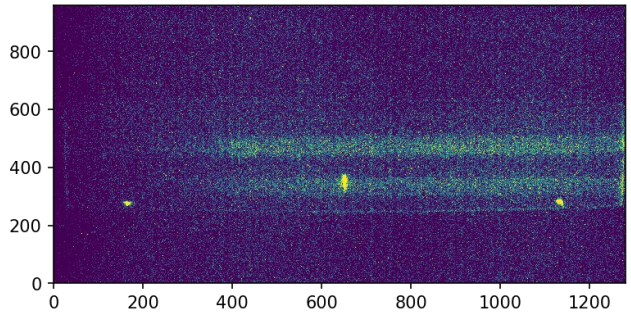
Preliminary results vs. objectives

- Generation of > GeV electron beams from laser-wakefield generation



Max. energy: 1.7 – 1.9 GeV
Overall charge: 0.3 – 0.6 nC
Divergence: 0.9 mrad

- Production of GeV-scale positron beams of high spatial quality



Max. energy: ~ 1GeV
Overall charge: ~ 3 pC
emittance and source size measured (*to be analysed*)

- Testing of a gamma-ray spectrometer for high-flux and ~ GeV gamma-ray beams
  gamma-ray spectrometer successfully tested and showing expected ~% level energy resolution. Results currently being analysed.

- Detection of muons from a laser-driven configuration
  detectors currently being etched for analysis...

ARIES

Apollon experiment

Apollon

Gianluca Sarri
g.sarri@qub.ac.uk

Summary

- Access to electron bunches driven by laser in plasma was provided at **UHI100 LPA and LULAL and APOLLON** facilities for various applications:
  - physics of plasma accelerators,
  - generation of secondary particles or radiation,
  - use of secondary radiation for imaging.

- Promising results for future use of plasma accelerators:
  - Large range of parameters can be delivered,
  - Flexibility of set-ups and environments for users
  - Reliability and stability can be improved through the development of dedicated facilites and specific beamlines

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement No 730871.

ARIES

Thank you for your attention