

# WELCOME **AWAKE Collaboration** Meeting

Carsten P Welsch

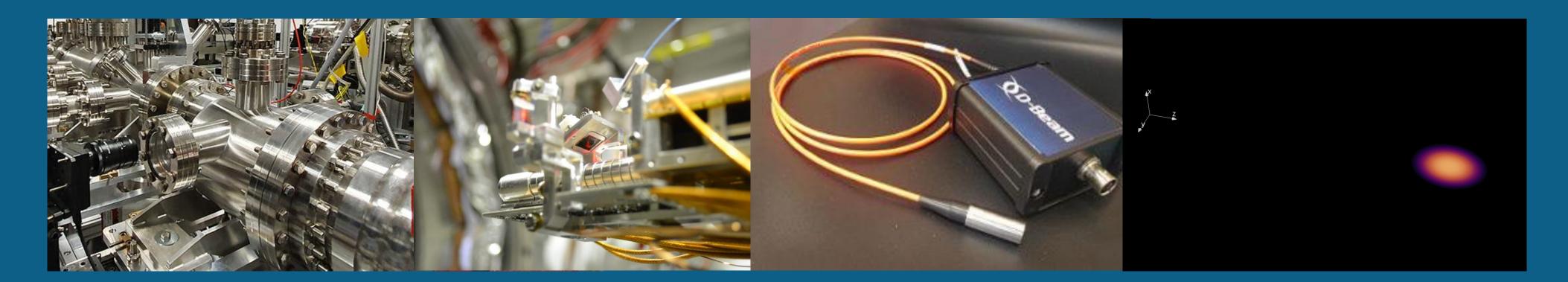




# QUASAR Group Research

Working across three strategic areas:

- Frontier Accelerators
- Novel Accelerators
- Accelerator Applications.



All work underpinned by R&D into Data Intensive Science.



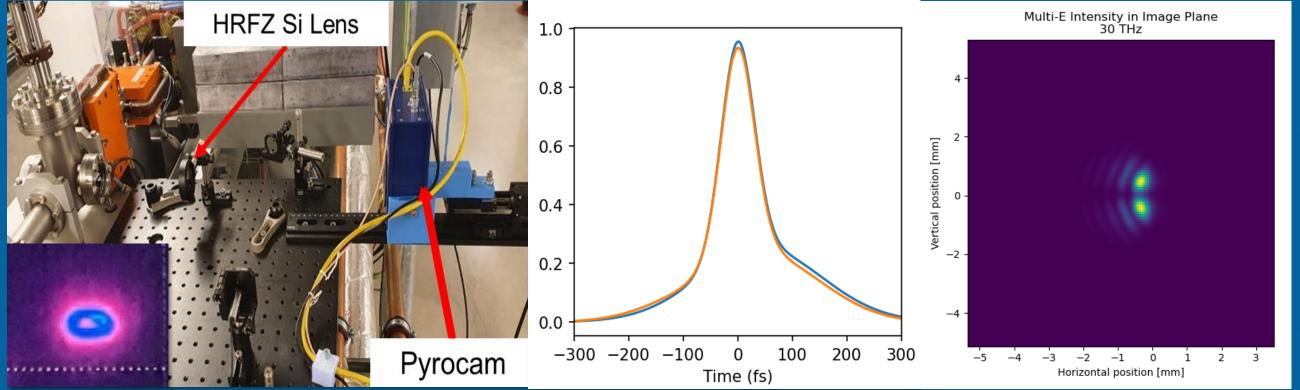




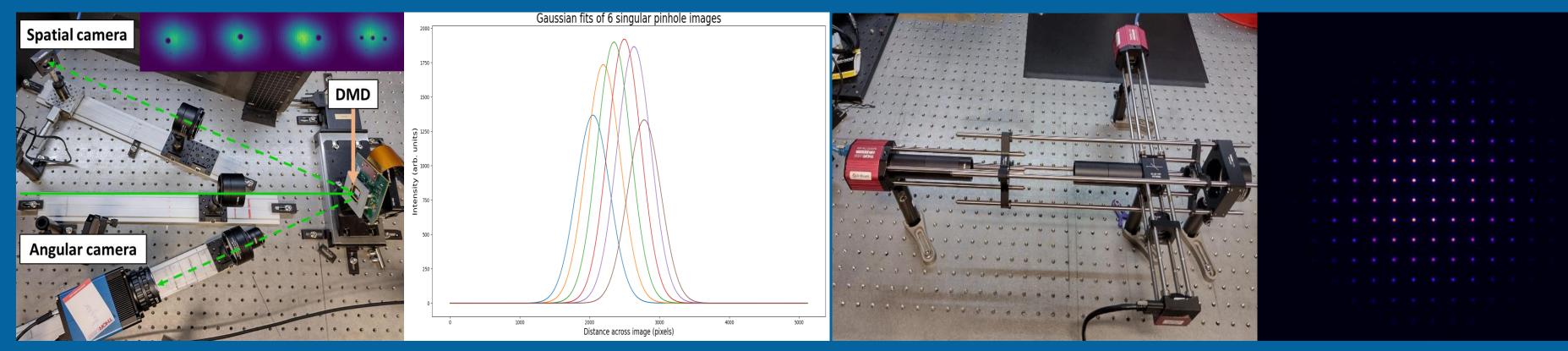


## R&D in AWAKE

### Longitudinal bunch profile – CTR/CSR Imaging with Machine Learning



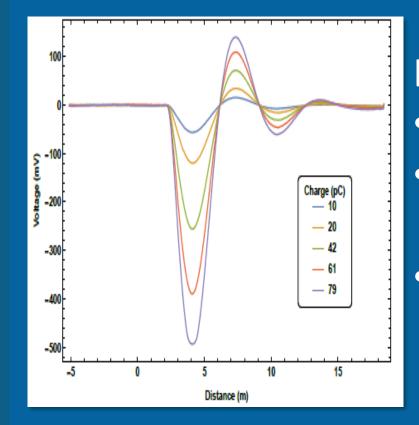
### **Emittance – DMD(multi-shot)/MLA(single-shot) Optical Pepper-pot**





- Pre and post acceleration e<sup>-</sup>
- Could use existing/planned TR screens or SR from spectrometer
- Compact breadboard

### **Optical fibre-based diagnostics**



Loss signals:

- Loss location
- Beam Alignment
- Energy/spread

- Both for pre-acceleration e<sup>-</sup>
- Existing/planned TR screens
- SR from spectrometer for MLA on post-acceleration e<sup>-</sup>
- Compact breadboard
- MLA just requires CMOS interface
- DMD already tested at AWAKE



## Future plans

- CTR/CSR imaging with Machine Learning •
  - $\bigcirc$
  - Leverage simulation work to apply machine learning analysis to experimental measurements  $\bigcirc$
- DMD/MLA Emittance diagnostics •
  - Test of method at CLEAR  $\bigcirc$
  - Full end-to-end simulation
  - Installation and optimisation at CLARA FEBE  $\bigcirc$
- Proton angular distribution imaging with DMD-masking  $\bullet$ 
  - Found potential solution to dispersion, plan to test at AWAKE this year  $\bigcirc$
- Optical fiber beam loss monitor (oBLM)  $\bullet$ 
  - Two PhD students started recently focused solely on oBLM (ERL and SPS/LHC)  $\bigcirc$
  - Test new prototype in research and industrial setting, concentrating on novel applications  $\bigcirc$
- Betatron radiation diagnostics



Extract bunch profile from measurements of CTR and CSR at MAX IV as part of existing collaboration

o Build on and expand existing collaboration with UCLA and U Manchester, looking at application to AWAKE

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FIAT LUX

Inda,



Science and Technology Facilities Council



## Data-driven research



- LIV.INNO focuses on innovation in STFC science and industry applications. •
- •
- Around 40 PhD students will be trained across at least three cohorts  $\bullet$
- Accelerator R&D is a core element of both CDTs, including AWAKE  $\bullet$
- $\bullet$



The center is based on LIV.DAT, a previous very successful CDT in Data Science

Wider impact achieved through placements, outreach symposium, and "DataAid"





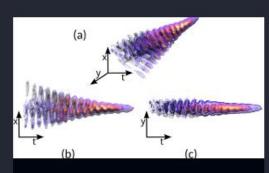
## AWAKE-UK Website

### www.awake-uk.org

- Science
  - Collaboration ullet
- Publications  $\bullet$
- News



#### Latest News, Updates and Events



Tackling instabilities in a plasma wakefield accelerator

Plasma wakefield accelerators are widely regarded as a promising alternative to conventional RF-based accelerators due .



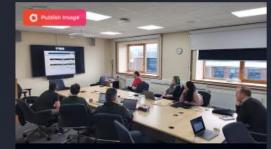
Mar 31, 2023

Feb 28

AWAKE researcher awarded prestigious Ernest Rutherford Fellowship

STFC has awarded an Ernest Rutherford Fellowship to Dr Morgan Hibberd from the University of Manchester, the first to be ...





#### Nov 23, 2023

#### AWAKE-UK members take the pulse on the project

A group of members and associates of the AWAKE-UK collaboration met online on Friday 10 November to discuss the..



#### Sep 20, 2023

Professor Peter Norreys recognised by the American **Nuclear Society** Oxford University's Professor Peter Norreys, a key member of the AWAKE-UK

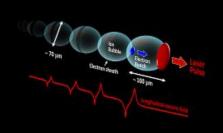
collaboration, has been awarded the.



#### May 12, 2023

#### AWAKE Collaboration meets in Uppsala

The Advanced Proton Driven Plasma Wakefield Acceleration Experiment (AWAKE) is proof-of-principle experiment ...



#### Apr 21, 2023

#### Surfatron brings the physics of plasma accelerators to the classroom

The online game Surfatron, designed by Ricardo Torres has proven a useful tool to convey the challenges of plasma wakefie.



#### Mar 30, 2023

#### AWAKE achieves first ever acceleration of electrons in a proton-driven plasma wave

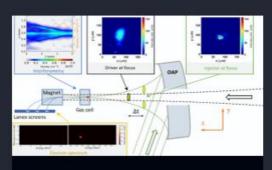
Novel scheme paves way for entirely new range of particle physics experiments In a paper published today in the journal...



#### Mar 22, 2023

#### AWAKE-UK Collaboration met in Liverpool

On 17 March 2023, the AWAKE UK collaboration held its bi-annual meeting at Novotel Liverpool Paddington Village to...



Mar 20, 2023

#### Paving the Way for Next-**Generation X-Ray Sources**

To build powerful but small particle accelerators, one requires both strong accelerating fields and particles in the rig...



#### Nov 16, 2022

#### **AWAKE Collaboration Meeting** held at CERN

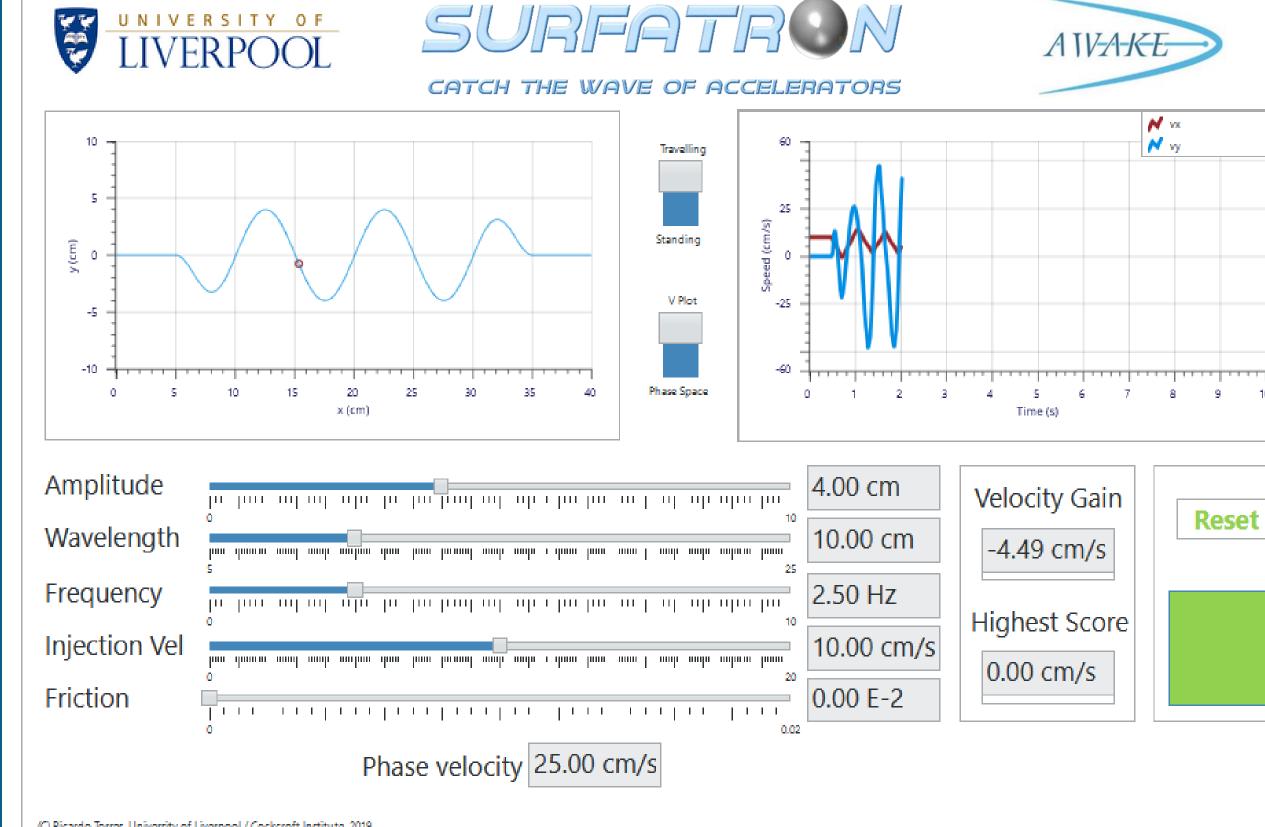
A collaboration meeting of the AWAKE project took place at CERN on 5 – 7 October 2022. These meetings bring.



Surfatron online www.awake-uk.org

- Plasma wave ightarrow
- Injection •
  - Synchronisation
- Dephasing ightarrow
- Tab with info about ightarrowAWAKE







(C) Ricardo Torres, University of Liverpool / Cockcroft Institute, 2019

Go Surfin'! Instructions The EuPRAXIA Project



## Communication & Outreach Surfatron

- Online game
- Mechanical device
- Demo video  $\bullet$
- Demonstrates some of the challenges of wakefield acceleration.
- Communicate the • science of AWAKE to wide audience.



ISSUE 62 - April 2023



### Surfatron: catch the wave of accelerators

**Ricardo Torres** 

Try your hand at Surfatron, a game that lets students experience the challenges faced by particle accelerator scientists while learning the physics of waves.

#### Introduction

Accelerator science is a constantly evolving field. New technological advances allow large colliders – like the Large Hadron Collider (LHC) - to reach higher energies and discover new particles. At the same time, particle accelerators that are used in hospitals for cancer treatment may offer a safer, more effective, and more affordable service.

New technology, which could revolutionize the field of accel erators, relies on the ability of scientists to inject a beam of particles with a well-defined energy into a suitable plasma wave to gain energy, much in the same way as a surfer catches a wave at sea to be pushed forward.

Surfatron Illustrates the same process, by simulating the motion of a ball on an undulating track. The purpose of the game is to get the ball – the surfer – to gain as much speed as possible by finding the optimum parameters of the wave (amplitude, wavelength, and frequency) and launching the ball at the right time with the appropriate initial speed.

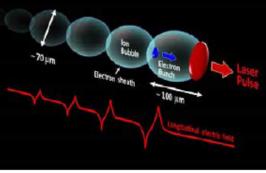
www.scienceinschool.org/article/2023/surfatron-catch-the-wave-of-accelerator



### Science in School

Topics Engineering-| Physics | Resources

a very high energy. Image courtesy of Ricardo Torre



A laser pulse travelling through a gas of ionized atoms creates a wake of plasma waves that can be used to accelerate electrons to

To play the game, students have to manipulate the ampli tude, wavelength, and frequency of a wave, helping them to understand intuitively the properties of waves and the basic working principles of linear particle accelerators, while learning to interpret velocity plots



### Surfatron - Bringing the science of plasma accelerators to the classroom

Online activity designed at the University of Liverpool proves successful in engaging schoolchildren with the physics of the novel plasma wakefield accelerator being investigated in AWAKE. 25 SEPTEMBER, 2023 | By Ricardo Torres (University of Liverpool)



AWAKE



## Communication & Outreach Exhibitions

- LINAC 2022, IPAC2024 •
- Daresbury Open Week 2023. More  $\bullet$ than 5,000 visitors.
- University of Liverpool Open Days •

### **Further outreach**

- Lymm summer festival ullet
- Physics of Star Wars at SWCE, • IPAC23, APS March meeting 2024







- Three issue circulated.
- Quarterly newsletter for partners of • AWAKE-UK.
- Collection of abstracts of published articles that are relevant to AWAKE.
- Facilitate the work of the  $\bullet$ researchers involved in AWAKE-UK.



## WAKE up



ISSUE 2

FOREWORD

ome to the first issue of

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BEAMLINES & APP

INSTRUMENTATI

THEORY & SIMU

RESEAR

To build powe

the right place

FACILITIES FUNDAMENTS .....

FOREWORD .. RESEARCH HIGHLIN

UK. WAKE up is a collection L

of the researchers is find it useful.

ISSUE 1

This is the second issue of with abstracts of publishe exhaustive and its purpo community. If you have a email to the address at t AWAKE project. Putting toge

#### CONTENT

FOREWORD

FOREWORD ..... FUNDAMENTALS PLASMA TECHNO DIAGNOSTICS..... BEAMLINES & AI THEORY & SIMU FACILITIES ..... EDUCATION .....

#### FUNDA

Photon Acce Sandberg, R. T.; PHYSICAL REVIE https://doi.org

The propagatin a process kno because of gr analytic solut the plasma d wake can be frequency s observed, l increases i velocity di intensity.



ISSUE 3

October 2023

#### FOREWORD

This is the third issue of the quarterly newsletter for members and friends of the AWAKE-UK collaboration, with abstracts of published articles that are relevant to the AWAKE project. The list is by no means exhaustive and its purpose is to facilitate your research and continue to strengthen the AWAKE-UK community. If you have any suggestion or an article that should be included in the next issue, please send an email to the address at the end of this newsletter.

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THEORY & SIMULATION	

#### **FUNDAMENTALS**

Progress in hybrid plasma wakefield acceleration

Hidding, B.; Assmann, R.; Bussmann, M.; Campbell, D.; Chang, Y.-Y.; Corde, S.; Couperus Cabadağ, J.; Debus, A.; Döpp, A.; Gilljohann, M.; Götzfried, J.; Foerster, F.M.; Haberstroh, F.; Habib, F.; Heinemann, T.; Hollatz, D.; Irman, A.; Kaluza, M.; Karsch, S.; Kononenko, O.; Knetsch, A.; Kurz, T.; Kuschel, S.; Köhler, A.; Martinez de la Ossa, A.; Nutter, A.; Pausch, R.; Raj, G.; Schramm, U.; Schöbel, S.; Seidel, A.; Steiniger, K.; Ufer, P.; Yeung, M.; Zarini, O.; Zepf, M.

PHOTONICS 10, 99 (JAN 2023) https://doi.org/10.3390/photonics10020099

Plasma wakefield accelerators can be driven either by intense laser pulses (LWFA) or by intense particle beams (PWFA). A third approach that combines the complementary advantages of both types of plasma wakefield accelerator has been established with increasing success over the last decade and is called hybrid LWFA→PWFA. Essentially, a compact LWFA is exploited to produce an energetic, high-current electron beam as a driver for a subsequent PWFA stage, which, in turn, is exploited for phase-constant, inherently lasersynchronized, quasi-static acceleration over extended acceleration lengths. The sum is greater than its parts: the approach not only provides a compact, cost-effective alternative to linac-driven PWFA for exploitation of PWFA and its advantages for acceleration and high-brightness beam generation, but extends the parameter range accessible for PWFA and, through the added benefit of co-location of inherently synchronized laser pulses, enables high-precision pump/probing, injection, seeding and unique experimental constellations, e.g., for beam coordination and collision experiments. We report on the accelerating progress of the approach achieved in a series of collaborative experiments and discuss future prospects and potential impact.

AWAKE

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## AWAKE Collaboration Meeting

- Welcome to the UK and to Liverpool!
- at Daresbury Lab on Wednesday.
- this meeting!) and to all who helped organize this event!



• Enjoy the scientific discussions and the environment at the Spine and

Many thanks to STFC for their support of the AWAKE-UK project (and



