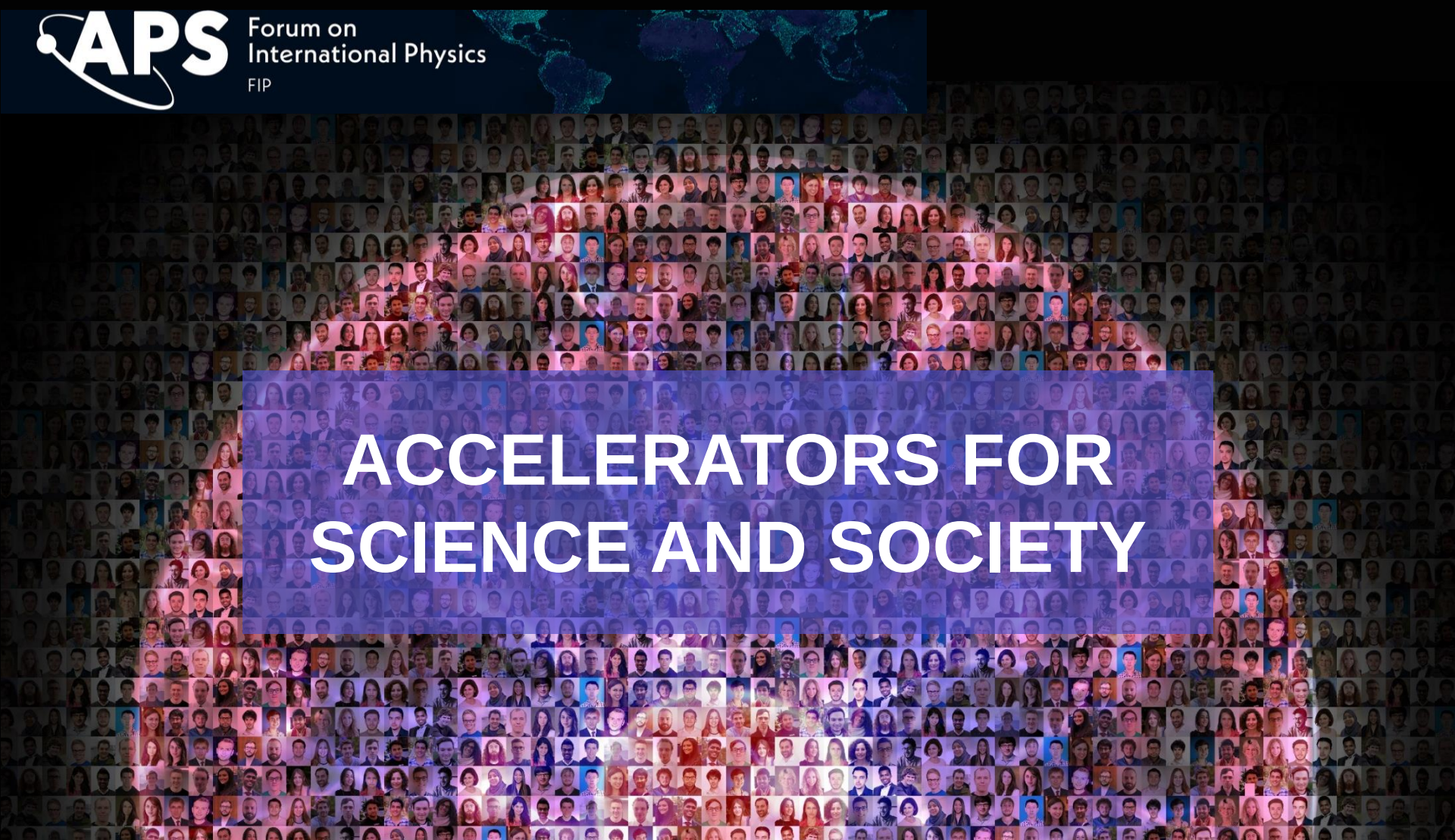
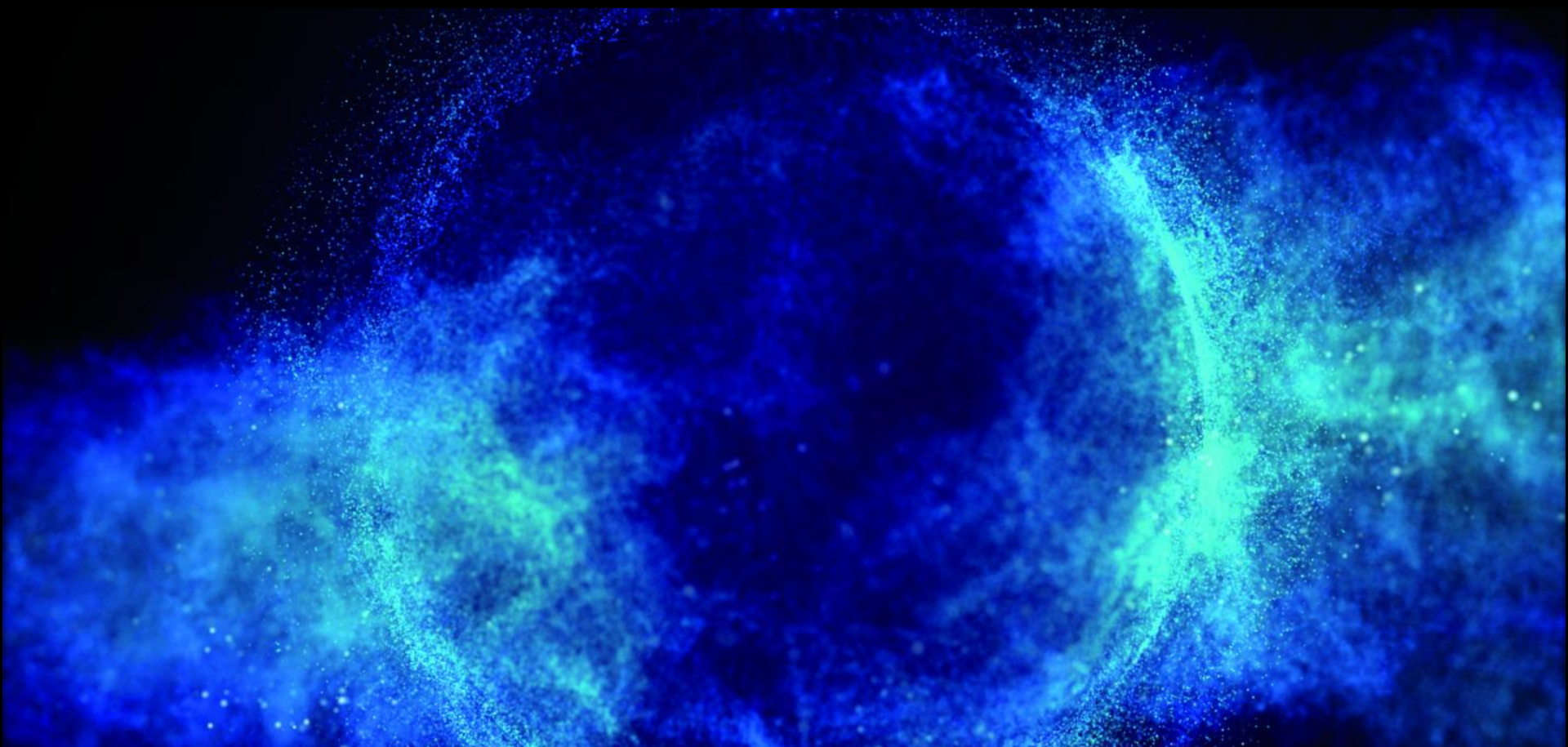


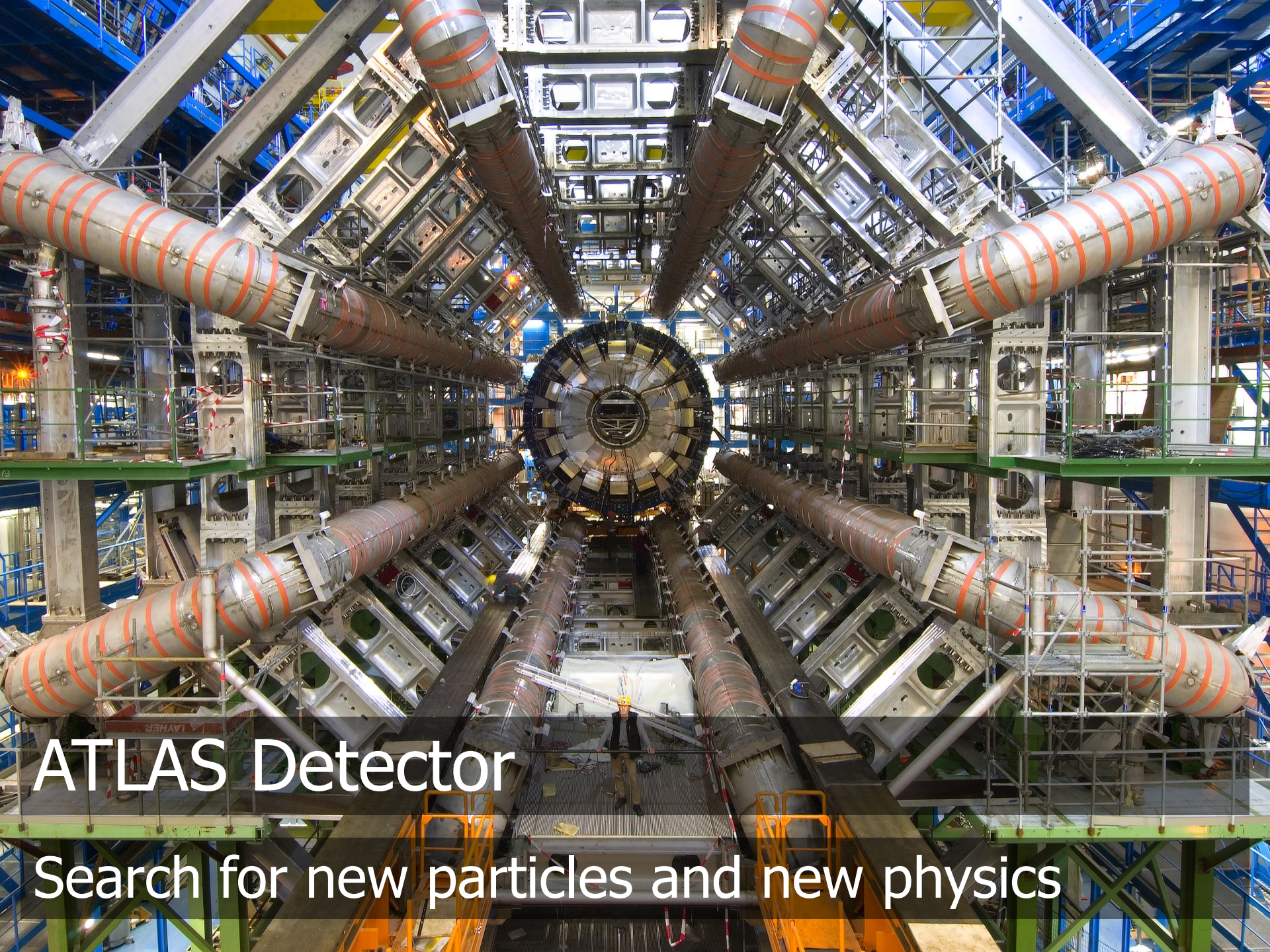
The background of the slide is a large, dense mosaic of many small, square portrait photographs of people from various backgrounds, creating a textured, grid-like effect. The colors of the portraits are muted and blend into each other.

ACCELERATORS FOR SCIENCE AND SOCIETY



Fundamental research

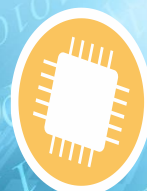
Key to understanding the world around us



ATLAS Detector

Search for new particles and new physics

LIV.INNO



Science and
Technology
Facilities Council







Grid computing

ML/AI to optimize beam and experiment



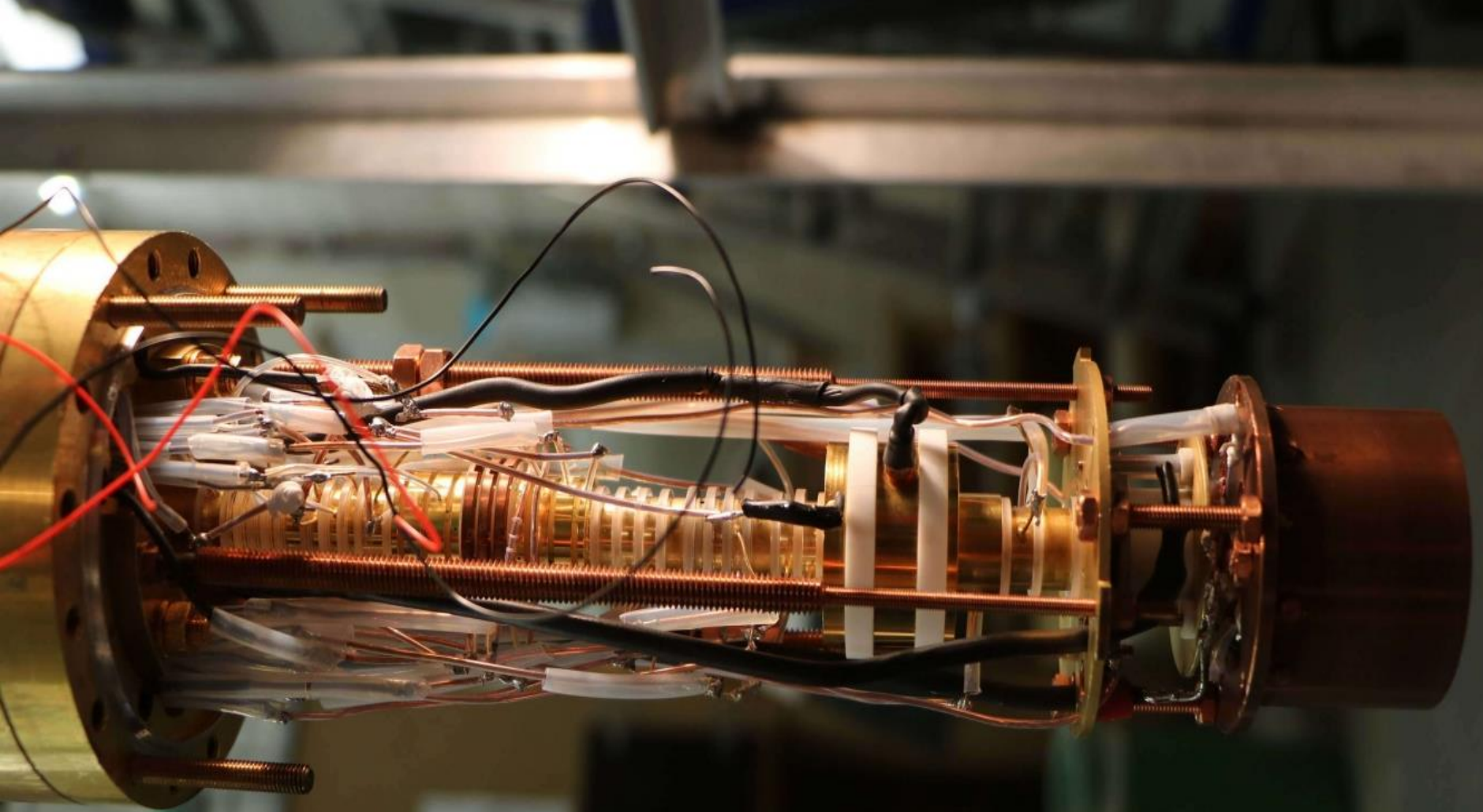
ACCELERATORS
VALIDATING
ANTIMATTER
PHYSICS





New opportunity: ELENA

How to provide and measure cold beams?



Trapping antiparticles

Can we optimize the way we catch/trap?



Positron Emission Tomography

Using antimatter in clinical practice

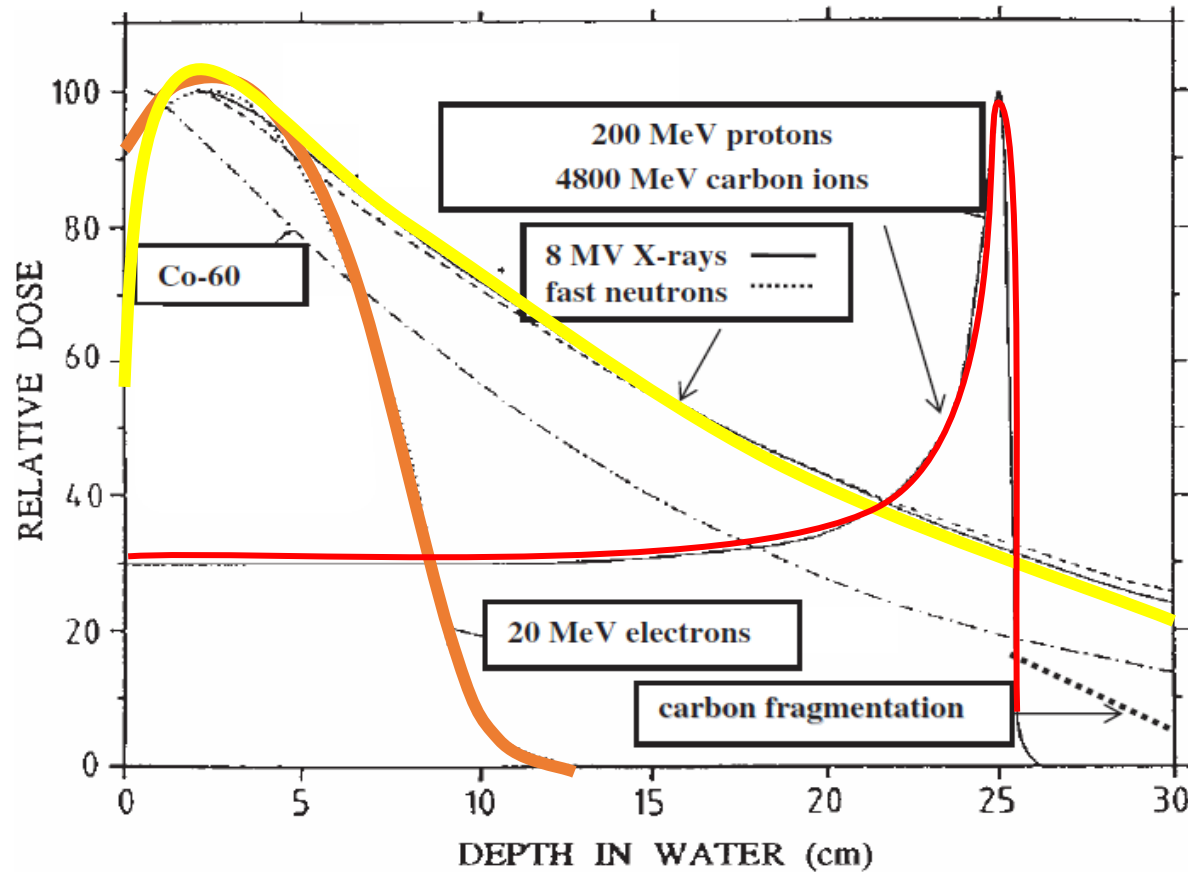


UNIVERSITY OF
LIVERPOOL

Ion Beam Therapy

Beating cancer sooner

© Thomas Kästenbauer



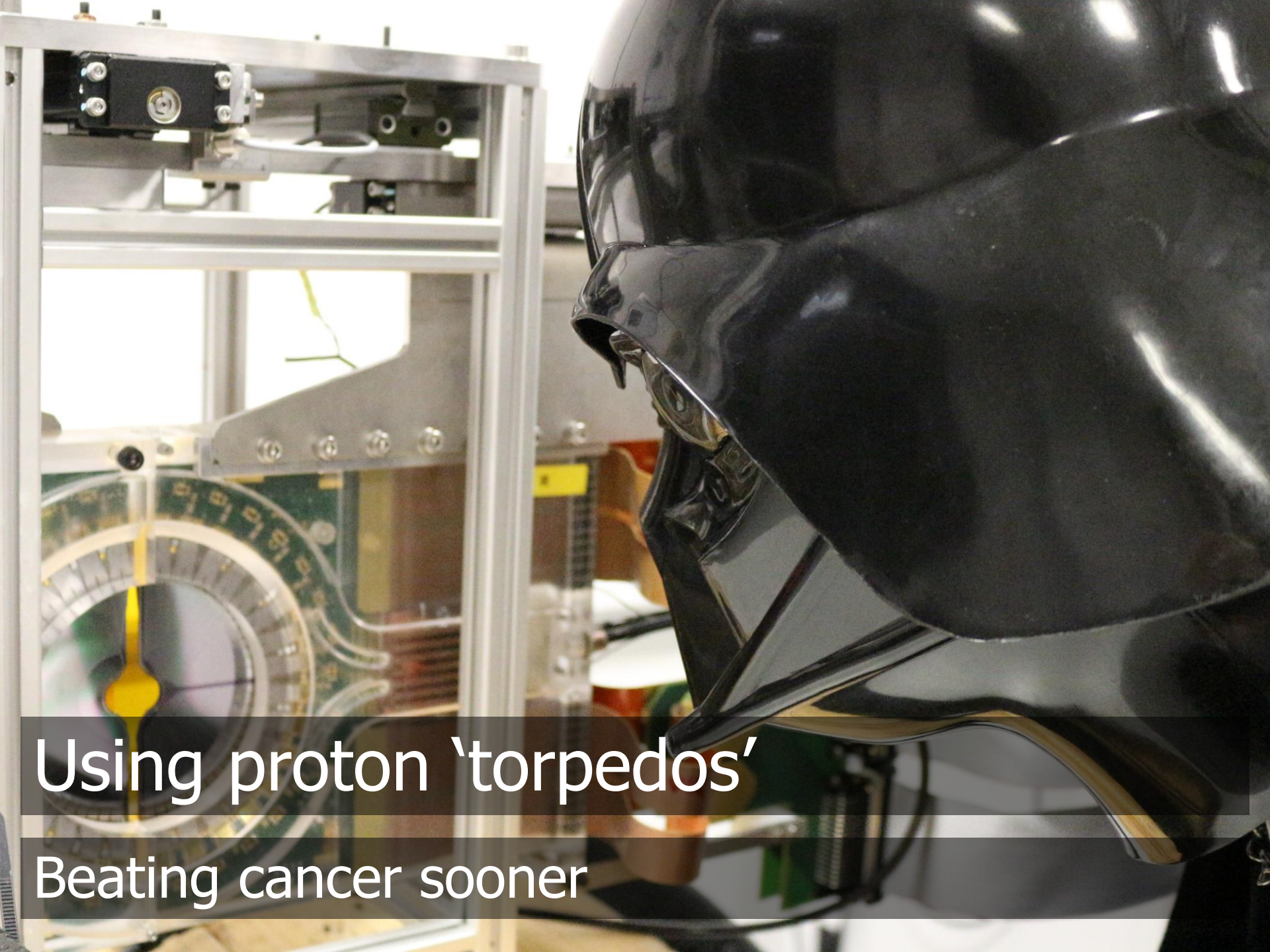
Ion Beam Therapy

Beating cancer sooner



Optimization of Medical Accelerators





Using proton 'torpedos'

Beating cancer sooner

On a campus not so far, far away



Themed demonstrations



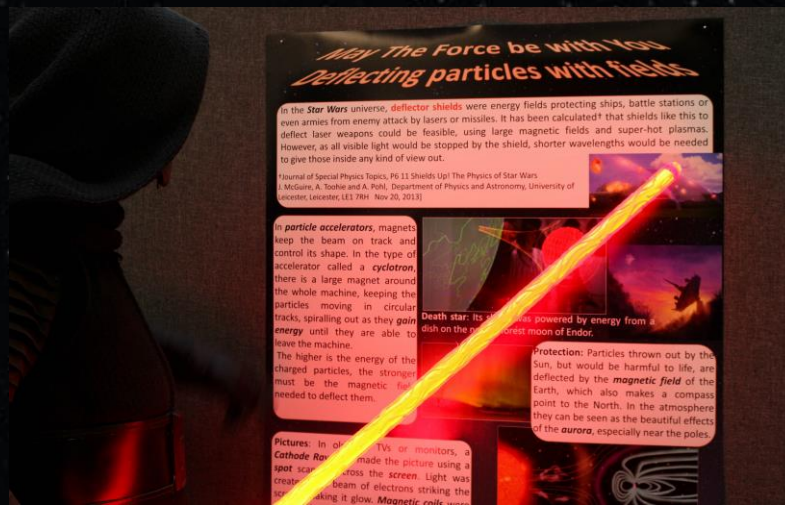
Themed demonstrations



Themed demonstrations



Posters about accelerator R&D



BENDING THE BEAM

Kylo Ren's lightsaber is equipped with focusing crystal activators that slice the *plasma* beam into three parts, two of which are bent sideways to create the cross guard blades.

Particle accelerators found in hospitals, factories, customs and of course those that span tens and thousands of meters in length need to slice and/or bend their beam at some point in the beam line.

Septum and kicker magnets separate or inject particles from/into the beam by "pushing" them away/towards the beam using the Lorentz Force. Magnetic dipoles bend the beam as a whole using the same principle.

The magnetic field has to be at an angle different than 0 or π relative to the beam direction for all those magnets to do their job.

Septum and kicker magnets:

- Inject an accelerated beam into a storage ring.
- Eject part of a beam towards an experiment.

Magnetic dipoles:

- Maintain the beam trajectory in a storage ring
- Bend the beam towards the patient in a medical linear accelerator (LINAC) or towards a dense target to create X-rays in cargo imaging LINACS.

Circular accelerators are fitted with multiple dipoles along their circumference in order for the beam to circulate in them.

This means that the beam passes through the accelerating cavities in every loop and each time it gains more and more energy.

More energy does not require a longer accelerator, just more loops. A clear benefit against LINACS.

UNIVERSITY OF LIVERPOOL
The project has received funding from the ERC under grant agreement No 101019151

Enhancing physics education

Creative Teaching & Learning

The Science Of Star Wars: Creative Physics Learning In A Galaxy That Isn't Far Far Away

Physicist and Star Wars fan Professor Carsten P Welsch explains how Star Wars fiction can help students to better understand the developments happening in accelerator science.



"Much to learn, you still have" are the famous words of Jedi master Yoda to Count Dooku when he faces his old Padawan in *Attack of the Clones*.



Science in School

The European journal for science teachers

ISSUE 54 | 01/09/2021

Topics Engineering | Physics | Science and society | Careers in STEM

The physics of Star Wars: introducing accelerator science

Carsten P Welsch

Science fiction can be an engaging starting point for scientific discussions. Learn how one research group is using Star Wars to introduce students to accelerator science.

Films and books create the chance to explore new experiences and science fiction is a great opportunity to create an environment in which to ask questions such as 'what if ...?' and 'how could you do that?'

These science questions emerge naturally out of discussion about the film and may even encourage the quiet film buff at the edge of the group to voice an opinion!

A number of TV series and films may have enthused your own interest in science. For us at the University of Liverpool, it has been *Star Wars*. Although strictly science fantasy rather than science fiction, there are a number of memorable scenes in the *Star Wars* films that we have used as analogies to introduce groups of young people to the concepts behind cutting-edge accelerator research.

As part of our outreach program, we created a themed workshop event with hands-on experiments and characters in costume to facilitate the discussions. The concept has worked well for all ages and abilities. We have run this as an event for several years and plan to use this winning formula again.

To capture the excitement of these 'big science' experiments, we have also created some [films](#) of our own, which

www.scienceinschool.org/2021/Issue54/the-physics-of-star-wars



The Cockcroft Institute

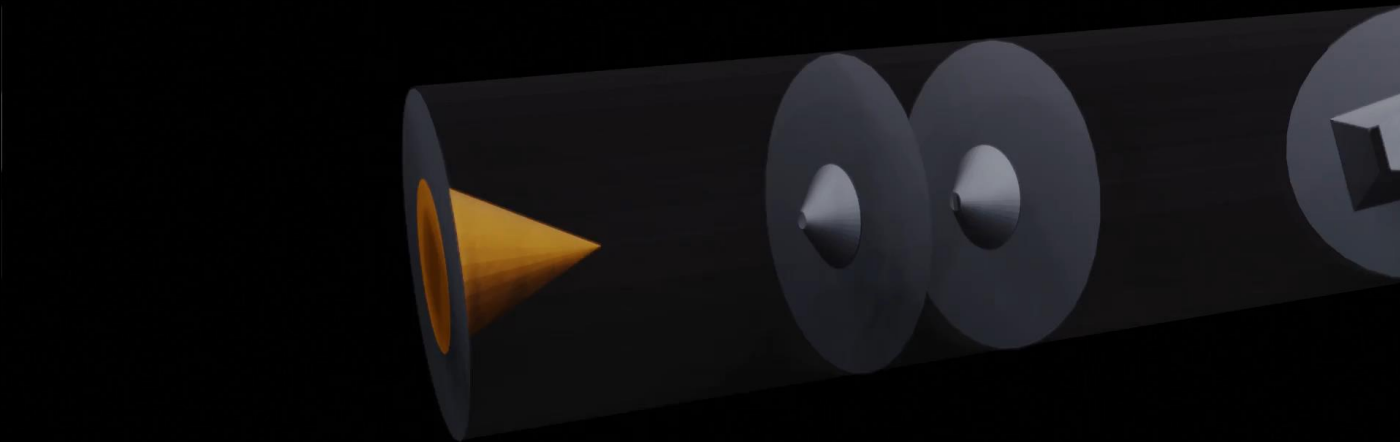
focus on the people behind the science, in particular, young researchers from across the world. This diversity increases the chance that young people will see someone like themselves involved in research.

This could be replicated on a smaller scale – clips from the films are readily accessible and can be used with certain caveats: the films cannot be used to promote the event, the event must not be for-profit, and there can be no indication that the event was endorsed by Lucasfilm or Disney.

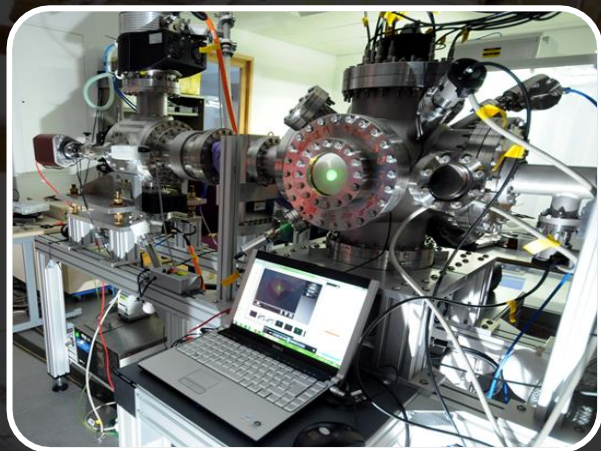


High Luminosity LHC

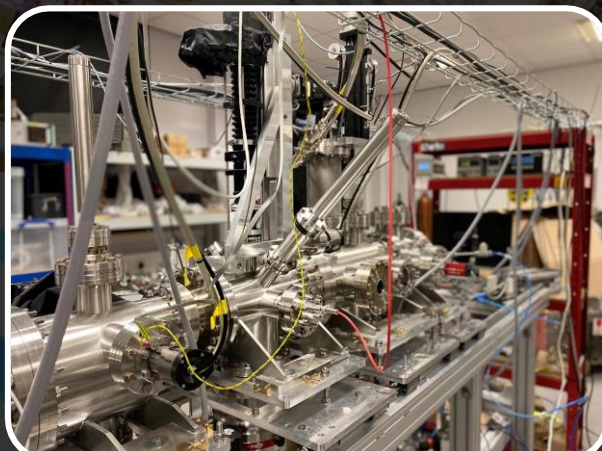
A critical update



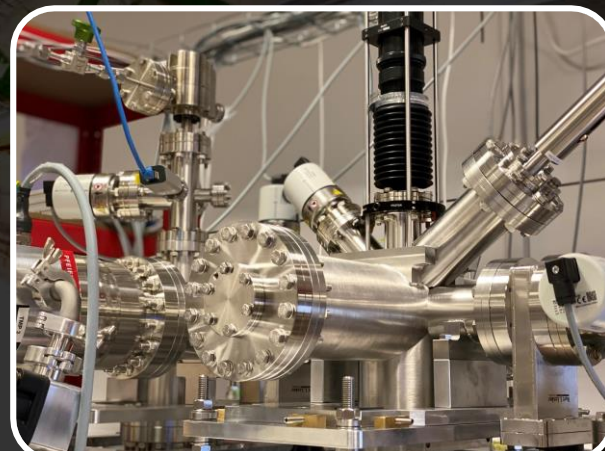




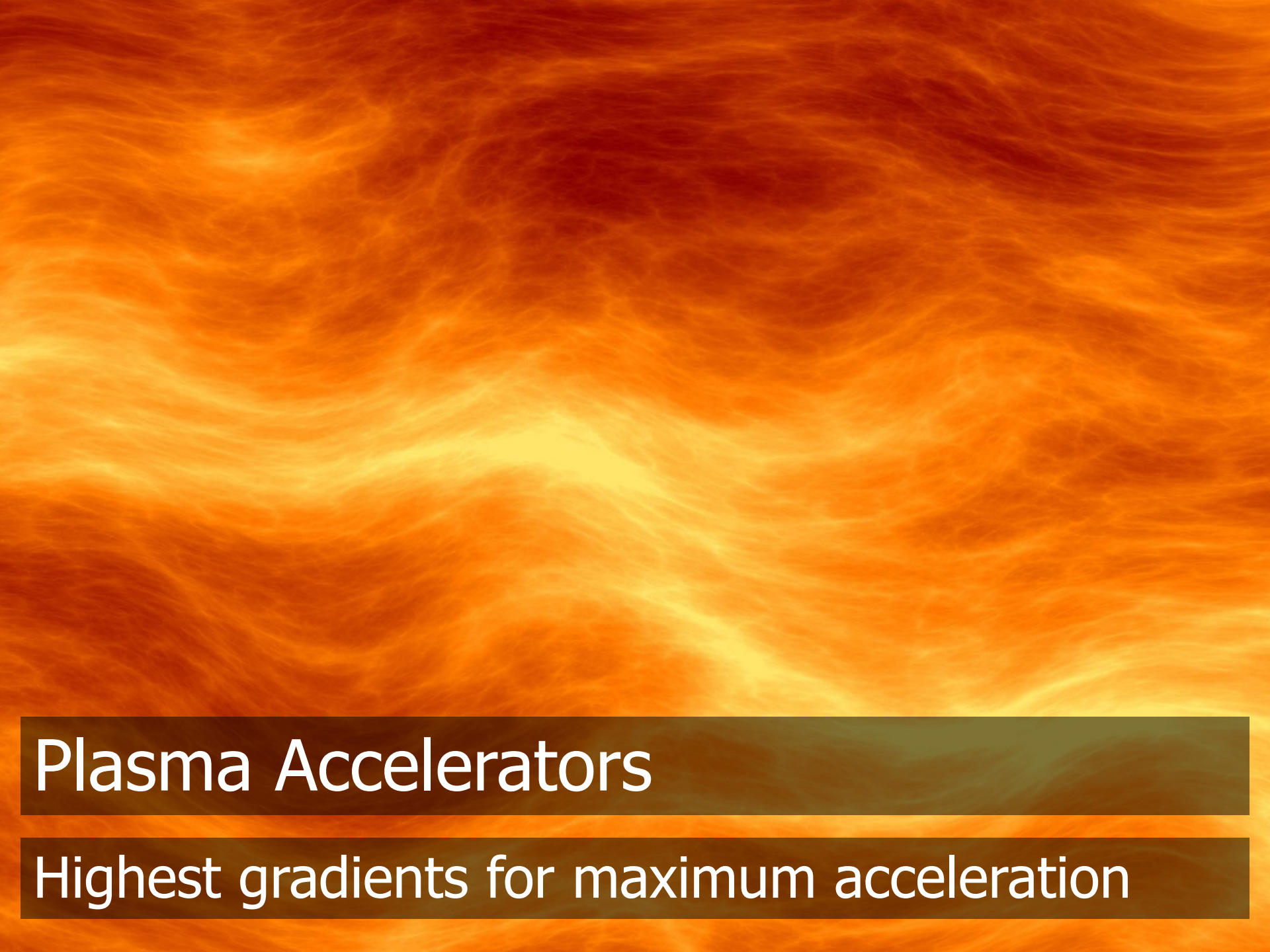
Monitor for keV beams



HL-LHC prototype

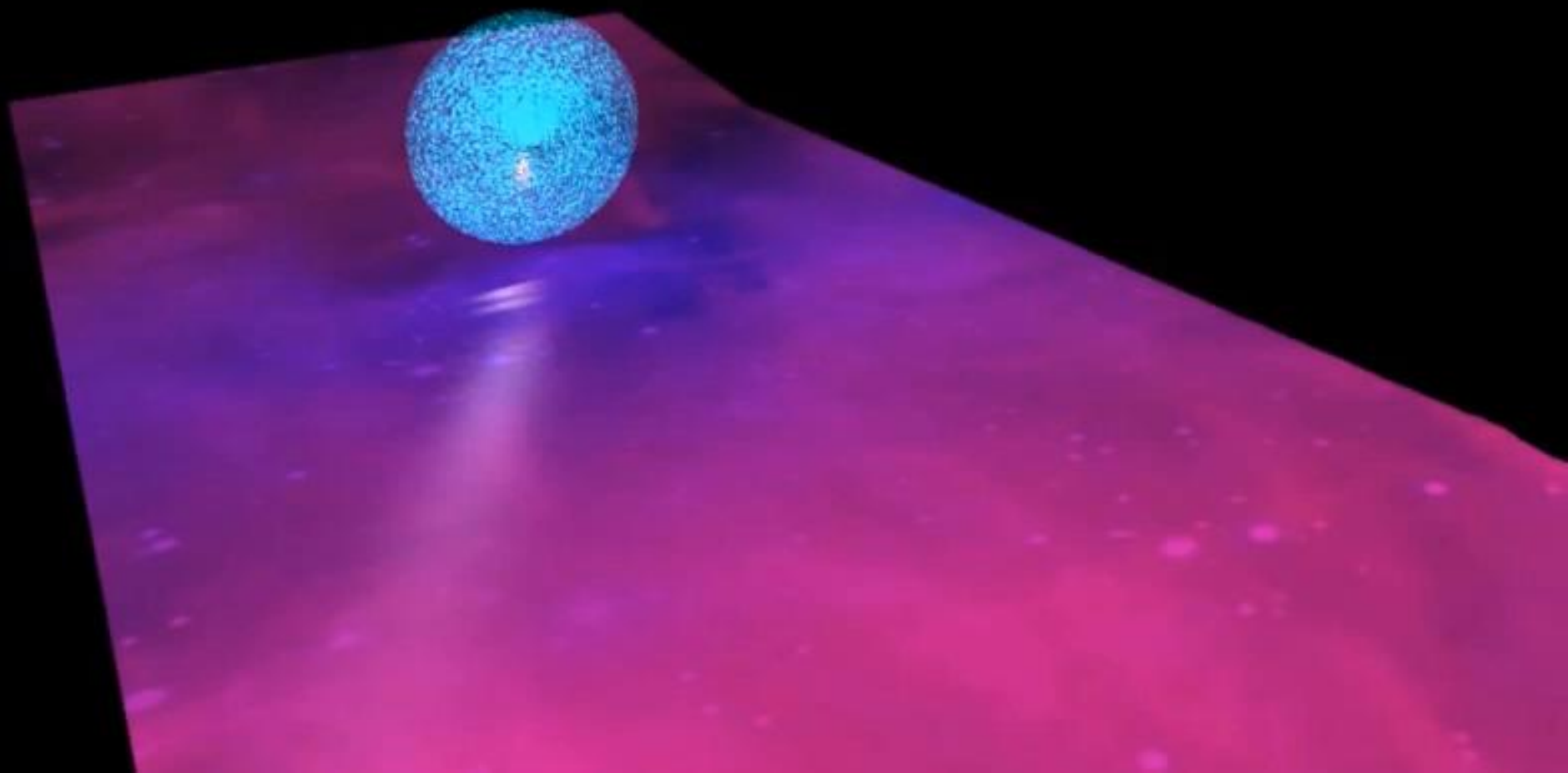


HL-LHC working instrument



Plasma Accelerators

Highest gradients for maximum acceleration





NOT-AUS
EMERGENCY
OFF

NOT-AUS
EMERGENCY
OFF

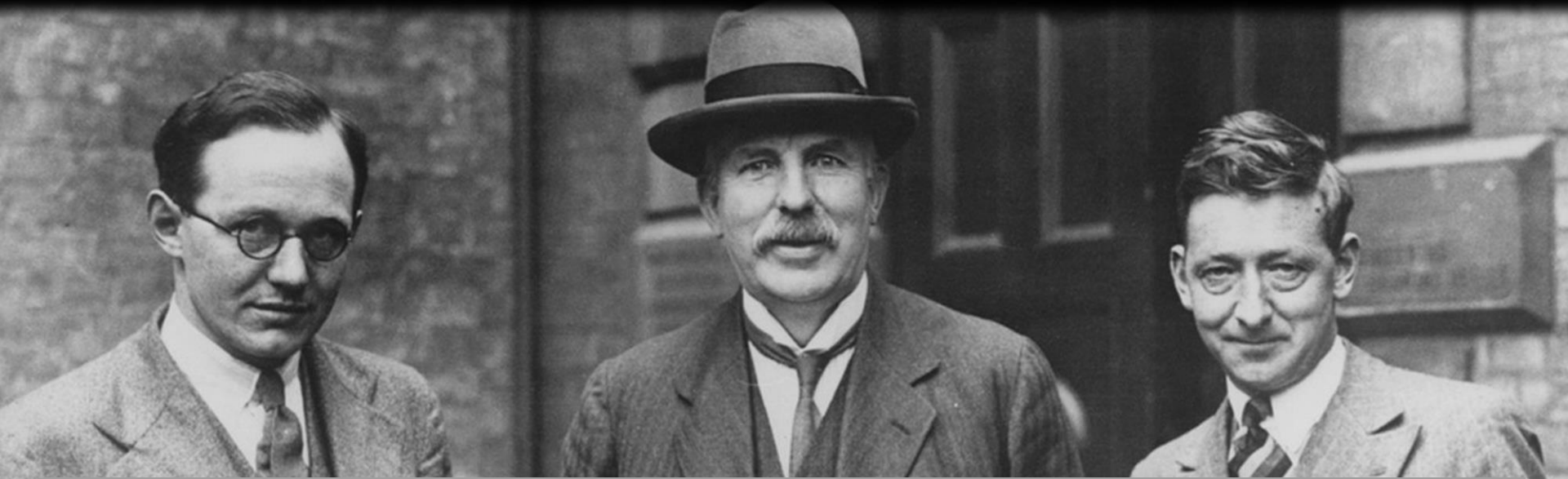
EuPRAXIA

Unleashing the power of plasma



This nation should commit itself to achieve the goal, before this decade is out, of landing a man on the moon and returning him safely to earth.

J.F. Kennedy



What we require is an apparatus to give us a potential of the order of 10 million volts which can be safely accommodated in a reasonably sized room and operated by a few kilowatts of power. We require too an exhausted tube capable of withstanding this voltage. (...) I see no reason why such a requirement cannot be made practical.

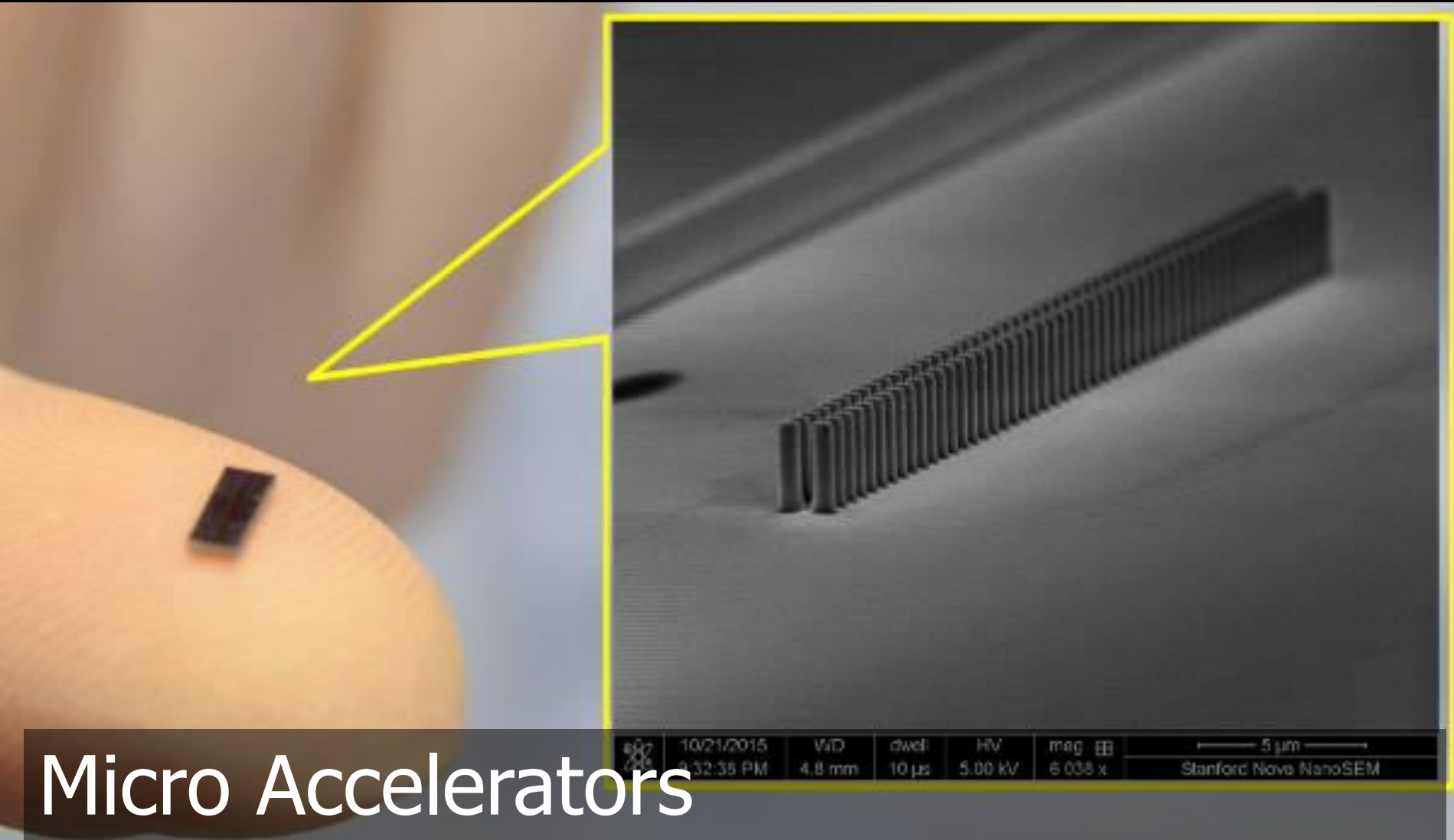
World's first accelerator for science



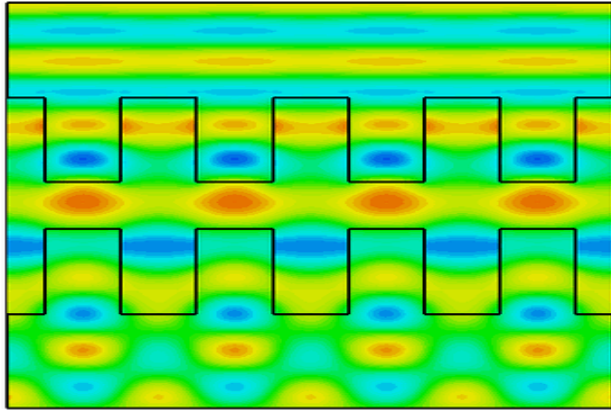
What we require is the design and construction of a laser capable of delivering pulses with a duration of 100 femtoseconds and an energy of 100 joules, at a repetition rate up to 100 Hertz and a user facility build around this technology in this decade.

EuPRAXIA

Accelerating Innovation

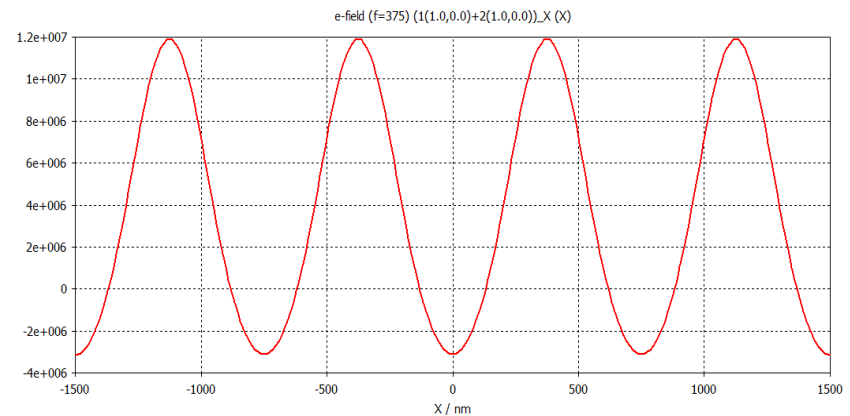
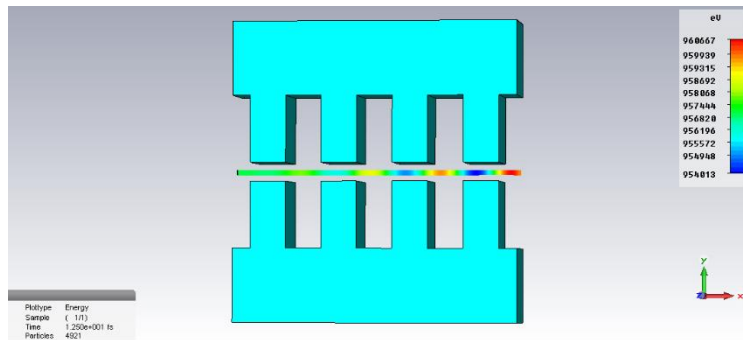


Using CNT/DLA technologies



Challenges

- Structure geometry
- Field distribution
- Optimization of accelerating gradient
- Understanding and optimization of output beam quality



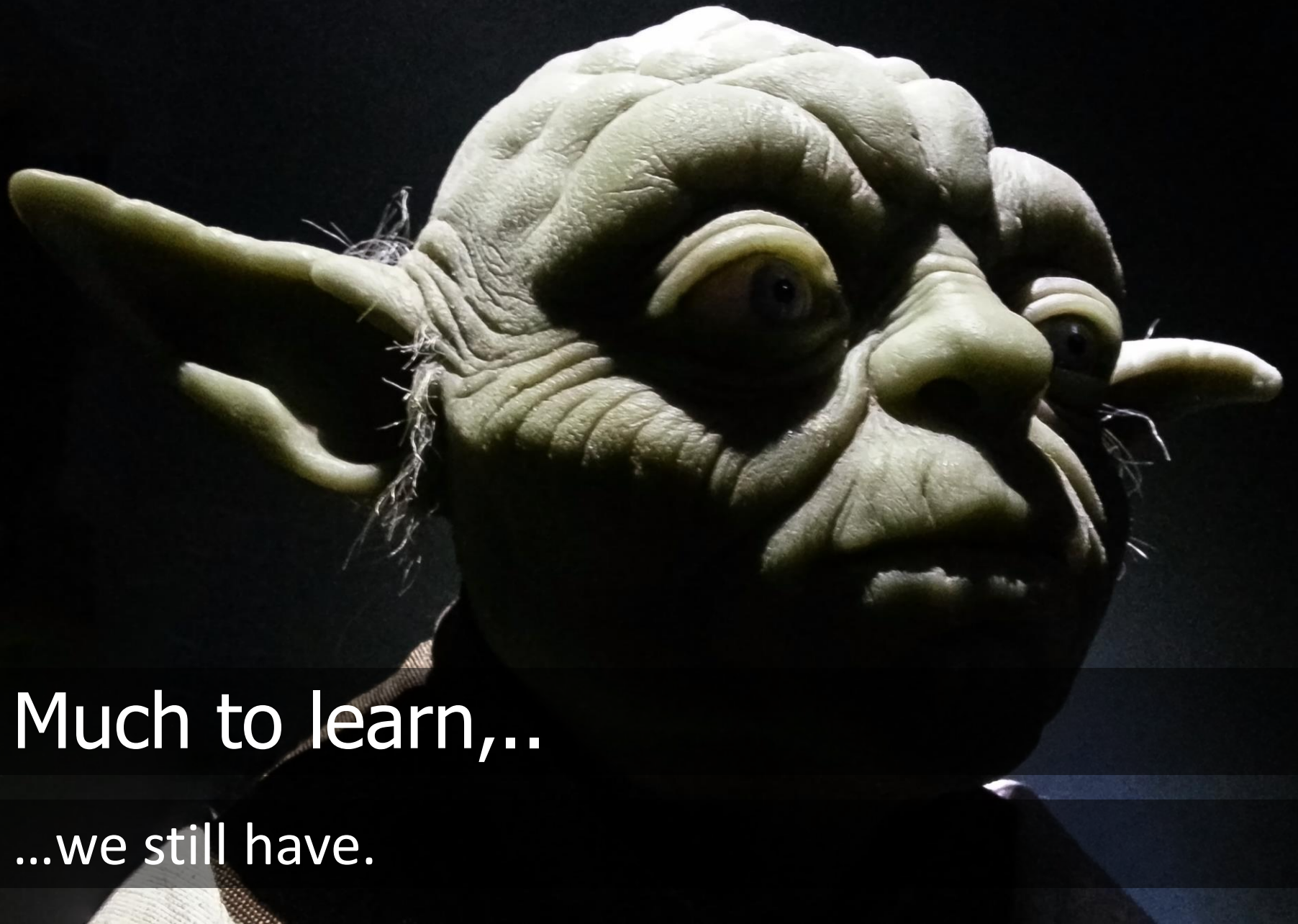


Accelerating innovation

Collaboration is key

**The Cockcroft
Institute**

**Accelerator Research
for sCIence and soCIety**



Much to learn,..

...we still have.



www.quasar-group.org



Forum on
International Physics
FIP

