Collaboration Meeting
March 2024

Patric Muggli AWAKE collaboration
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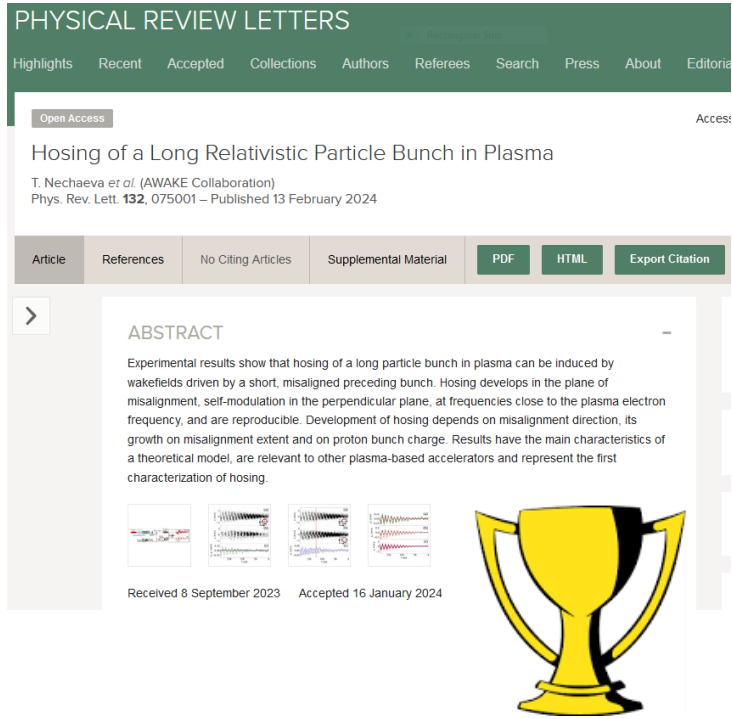
MAX-PLANCK-INSTITUT FÜR PHYSIK

✧WELCOME…

NOTABLY SINCE CERN 2023

- Outcome of experimental Run in October
  - Evidence for the effect of the plasma density step
- SPSC review (November)
  - Positive report
- Review of the science program requested by CERN (February) (see Edda's and Patric's talks)
  - Glaring review report
  - CERN decision for AWAKE Run 2c,d expected in April???
- Publications:
  - T, Nechaeva et al., (AWAKE Coll.), published in PRL
  - L. Verra (AWAKE Coll.), submitted to PRE, favorable review
  - and more ...
- Progress on manuscripts
  - M. Turner et al., (AWAKE Coll.) on ion motion
  - C. Amoedo et al. (AWAKE Coll.), on SM in discharge plasma source
- First run 2b of 2024 will start on April 15
  - 10 weeks
    - 4 weeks SM
    - 6 week acceleration, plasma density step



- QUITE SOME PROGRESS AND ACHIEVEMENTS …

EXPERIMENTS THIS YEAR

Purpose: impose temperature/plasma density step

- ✧Explore the effect of a plasma density on
  - ✧micro-bunch train
  - ✧bunch halo
  - ✧plasma light from dissipation of wakefields
  - ✧Energy gain
  - ✧…

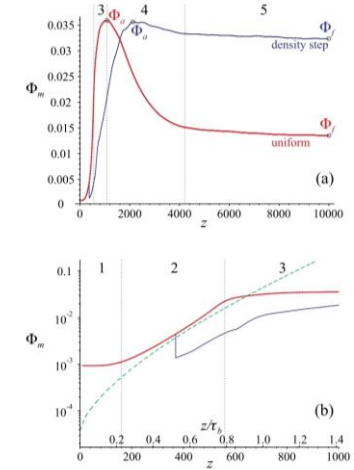
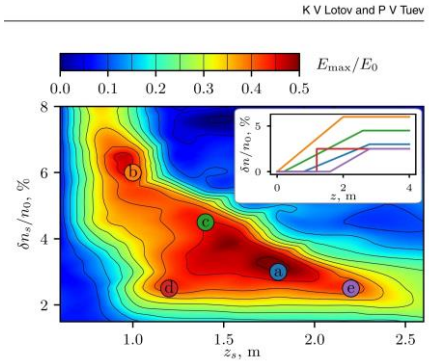
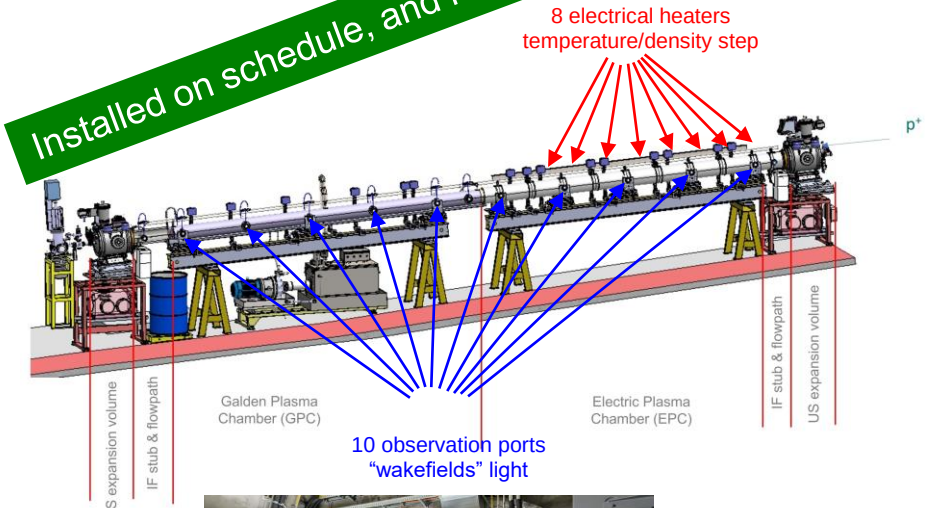


FIG. 2. The maximum wakefield amplitude Φ_m as a function of propagation distance z for the uniform plasma (red lines) and the plasma with the optimum density step (blue lines) in normal (a) and enlarged semi-logarithmic (b) scales. The green dashed line in (b) shows the theoretically predicted growth. The numbers and vertical lines indicate stages of beam evolution in the uniform plasma. Circles in (a) show points of absolute maximum Φ_u and established amplitude Φ_f.



K V Lotov, Physics of Plasmas 22, 103110 (2015)
K V Lotov and P V Tuev
2021 PPFC ***63 125027***

Installed on schedule, and running!



- ✧Numerical simulation results:
  - ✧Amplitude of wakefields larger w plasma density step
  - ✧Optimum position and amplitude of the step
- ✧New vapor source allows for imposing temperature step
- ✧Temperature step is vapor/plasma density step

Experiments This Year

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- ✧Explore the effect of a plasma density on
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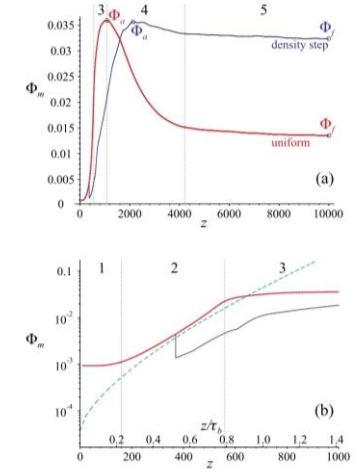

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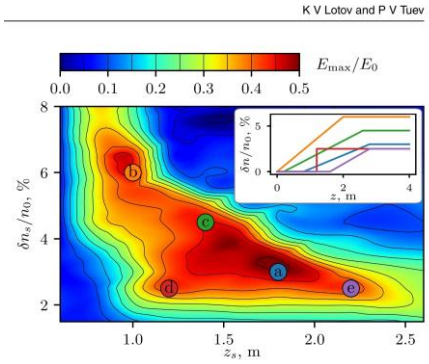

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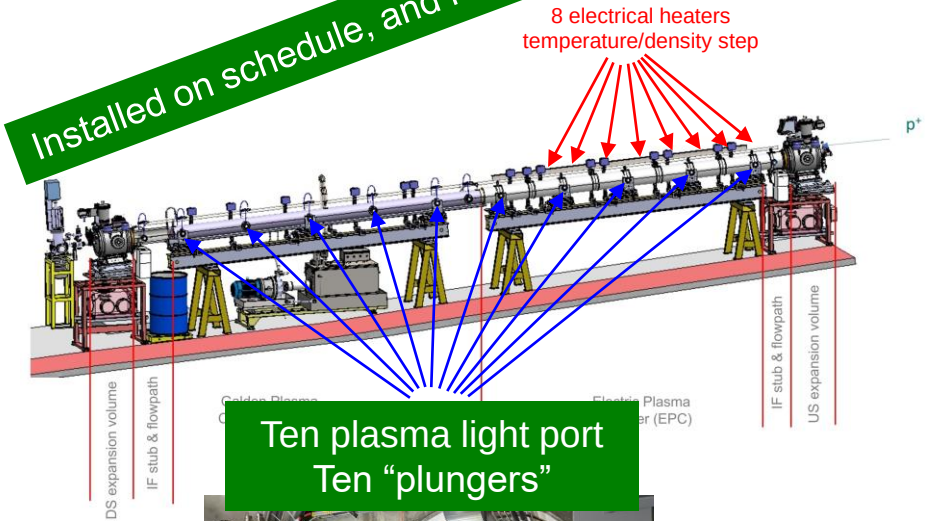
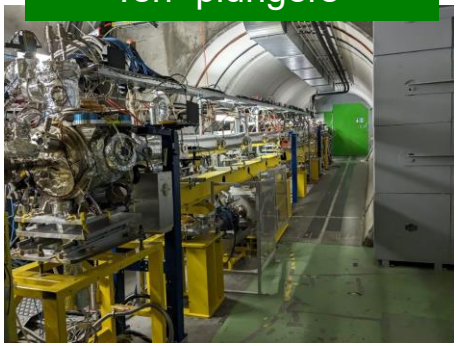


Ten plasma light port
Ten “plungers”



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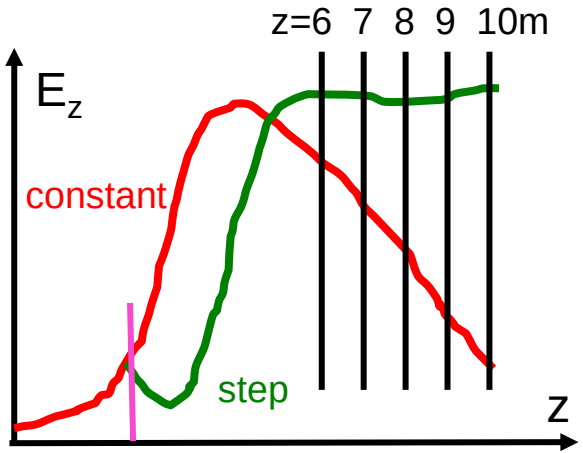
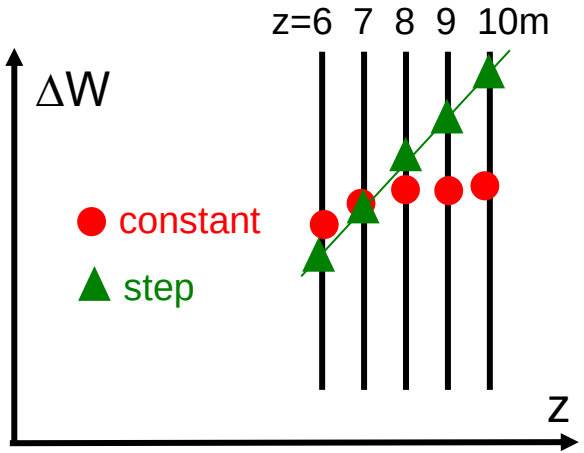
Run 2b Goal

Long term view:

- Demonstrate that a density step can make the wakefield amplitude constant and at high amplitude
  - Operate with a density step
  - Demonstrate that the amplitude of the wakefields is constant over the last x-meters of the plasma
  - Demonstrate that the energy gain per meter of plasma by test electrons is constant over the last …
  - …





Energy gain increases less then linearly with distance
Energy gain per meter is not constant
Energy gain increases linearly with distance
Energy gain per meter is constant

Run 2b Improvovement

Long term view:

- Demonstrate that a density step can make the wakefield amplitude constant and at high amplitude
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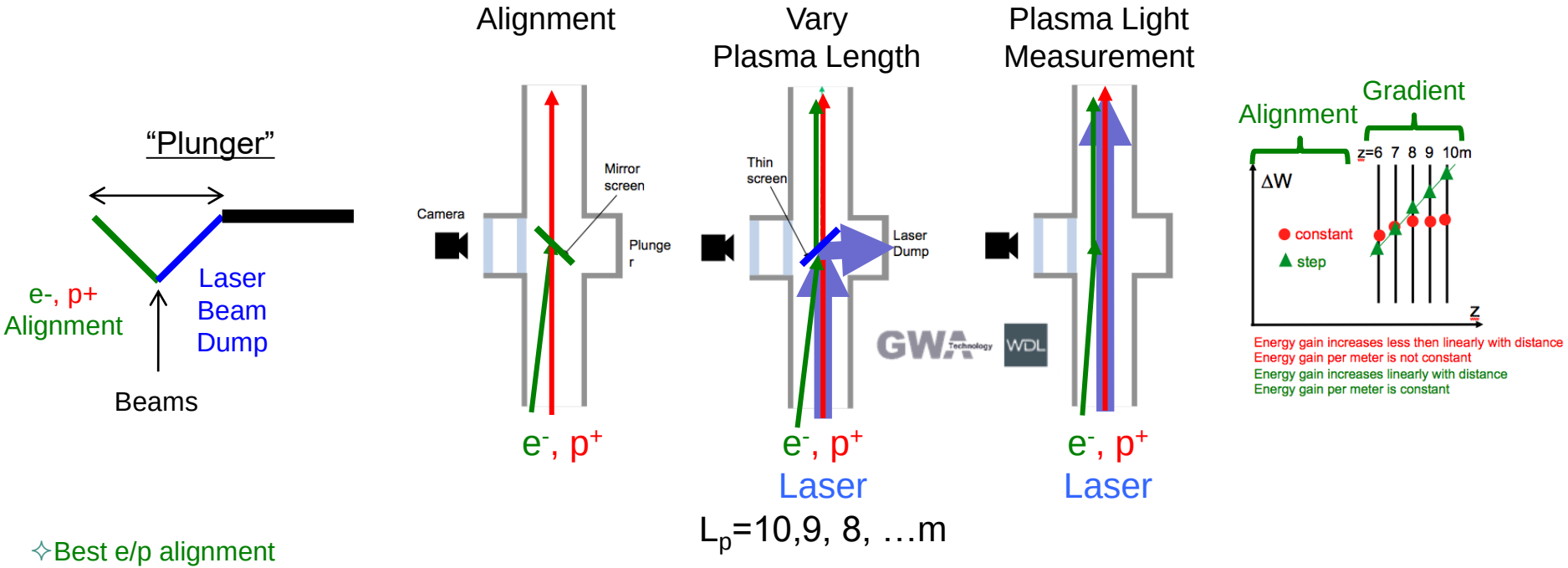


- Best e/p alignment
- Vary plasma length
- Measurement of accelerating gradient!

PROGRESS TOWARDS RUN 2c

AWAKE Run 2c – Ongoing Studies

Acceleration and **emittance control** of **externally injected** electrons.

Studies, design and prototyping already advancing well for several experimental elements of Run 2c/d.

New electron-source:
→ S-band e-gun with X-band accelerator, Prototyping with CLIC/CLEAR

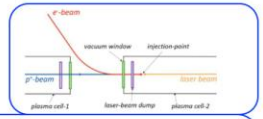
→ Steffen

Beam Instrumentation

BPMs 10 µm resolution

→ Vittorio

Beam Line Design



→ Strong synergy with CERN and the institutes.
→ CERN acquires additional expertise needed for other future electron facilities/colliders.

Injection area at conceptual design level.
Move from physics level to engineering level.

→ Patric, John

→ Challenges of external injection relevant for other PWFA

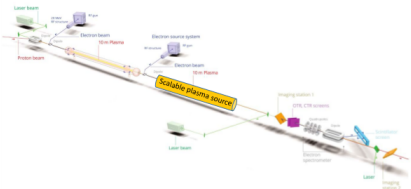
AWAKE Run 2d: Scalability – Towards First Particle Physics Experiments

Development and demonstration of scalable plasma sources

Scalable plasma source R&D program:
→ Dedicated plasma source labs at CERN
→ 5 collaborating institutes
→ Addressing challenges of **density, uniformity, reproducibility, scalability**.

→ Alban, Patric

1m Helicon Plasma Source



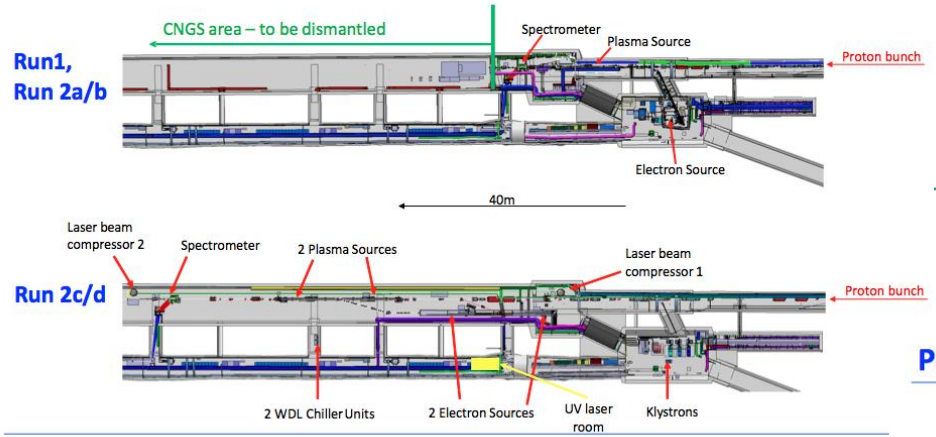
10m Discharge Plasma Source

→ R&D of scalable long plasma sources added in ESPP as experimental demonstration R&D milestone
→ Relevant for e+/e- collider designs based on PWFA

- ✧Design
- ✧Integration
- ✧e-gun, transport line
- ✧Scalable plasma sources
- ✧…
- ✧See Edda's talk ..

PROGRESS TOWARDS RUN 2c

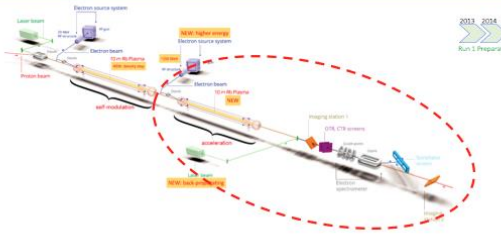
AWAKE Run 2 – Integration



Edda Gschwendtner, CERN AWAKE External Review, 5/2/2024

✧CNGS dismantling will occur

Preparing for AWAKE Run 2c/d during LS3



CNGS area content (~600m³):
- **~500 large shielding blocks** (0,05-0,6 mSv/h)
- A few **high dose-rate elements** (50mSv/h)
- 70-meter-long aluminum **He-tank**
- **Various** supports, ducts…

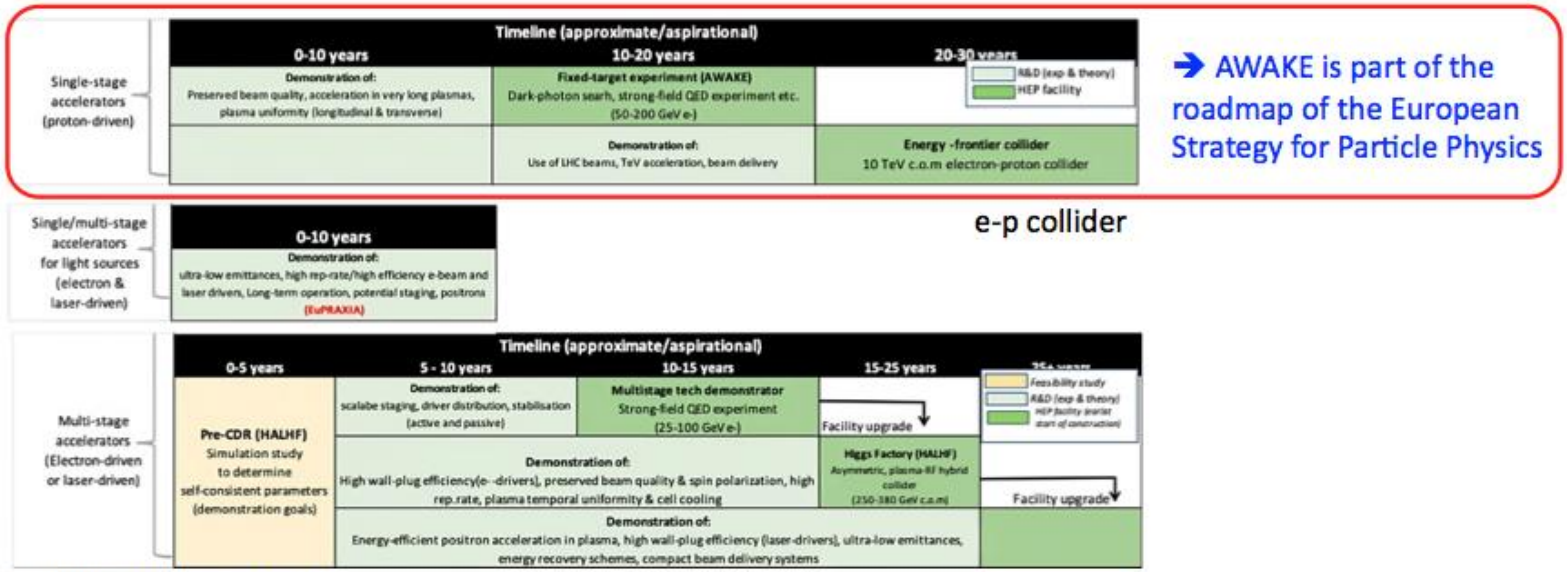
AWAKE program: start Run 2c in 2028 right after LS3
→ **CNGS dismantling: end 2024 – mid 2026**
→ **Run 2c installation: mid 2026– mid 2028**

→ Leverage CERN resources outside LS3 for CNGS dismantling
→ Ensure resources during LS3 for installation

Edda Gschwendtner, CERN AWAKE External Review, 5/2/2024 3

✧Ans' talk

AWAKE as Part of the European Strategy Roadmap



➔ AWAKE is part of the roadmap of the European Strategy for Particle Physics

e-p collider

R. Pattathil, presented at EAAC 2023

➔ AWAKE allows to bridge the gap between the PWFA development in general and a e+/e- collider.

NEW SEASON FOR AWAKE

- CERN review
  - AWAKE has a (clear) plan for Run 2c,d 
- CERN decision: April 2024
- AWAKE has to do it!!!
- Experiments in 2028, after CERN LS3
- New opportunity
- New opportunities for major contribution
  - Need a strong team at CERN, starting January 1, 2025
  - Message to the CB, discussed in the CB meeting
- First application of a plasma-based accelerator to particle physics
- AWAKE plays a prominent position in the community
- AWAKE makes important contributions to the field of advanced accelerator community
- AWAKE can do more …

- Need YOUR collaboration … participation …

MAX-PLANCK-INSTITUT FÜR PHYSIK

PROGARM

AWAKE

Mon 11/03

- **Registration and Light Lunch** — *Space four + five, The Spine* — 13:30 - 15:00
- **Welcome** — Carsten Peter Welsch — *Space four + five, The Spine* — 15:00 - 15:10
- **Introduction** — Patric Muggli — *Space four + five, The Spine* — 15:10 - 15:20
- **AWAKE: An Experiment at CERN with an International Collaboration and a Well-Defined Program of Work** — Edda Gschwendtner — *Space four + five, The Spine* — 15:20 - 15:55
- **The Next AWAKE Runs: Technological Advancements, Scientific Merit and Expected Parameter Reach** — Patric Muggli — *Space four + five, The Spine* — 15:55 - 16:25
- **Review Report** — Edda Gschwendtner — *Space four + five, The Spine* — 16:25 - 16:35
- **Group Photo - Coffee Break** — *Space four + five, The Spine* — 16:35 - 16:55
- **Update on the analysis of ion motion** — Marlene Turner — *Space four + five, The Spine* — 16:55 - 17:15
- **A statistical method to analyze streak camera images** — Allen Caldwell — *Space four + five, The Spine* — 17:15 - 17:35
- **Update on emittance measurements of the accelerated electron bunch** — David Andrew Cooke — *Space four + five, The Spine* — 17:35 - 17:55
- **Discussion** — *Space four + five, The Spine* — 17:55 - 18:15
- **Special Dinner** — *The Philharmonic Dining Rooms* — 20:00 - 23:00

Tue 12/03

- **A hosing mitigation experiment** — Mariana Moreira — *Space four + five, The Spine* — 10:00 - 10:20
- **Current filamentation of underdense beams after saturation of the transverse two-stream instability** — Erwin Walter — *Space four + five, The Spine* — 10:20 - 10:40
- **LCODE 3D: A New Open-Source Tool for 3D PWFA simulations** — Mr Nikita Okhotnikov — *Space four + five, The Spine* — 10:40 - 11:00
- **Clustering of macroparticles in PWFA simulations and solutions to this problem** — Konstantin Lotov — *Space four + five, The Spine* — 11:00 - 11:30
- **Discussion** — *Space four + five, The Spine* — 11:30 - 11:50
- **Coffee Break** — *Space four + five, The Spine* — 11:50 - 12:10
- **Preparing for Run 2b** — Giovanni Zevi Della Porta — *Space four + five, The Spine* — 12:10 - 12:30
- **Upgrades of the Rb Vapour Source** — Dr Michele Bergamaschi — *Space four + five, The Spine* — 12:30 - 12:50
- **Optimizing the electron injection into the plasma** — Nikita van Gils — *Space four + five, The Spine* — 12:50 - 13:10
- **Discussion** — Fern Pannell — *Space four + five, The Spine* — 13:10 - 13:30
- **Lunch** — *Space four + five, The Spine* — 13:30 - 14:30
- **Electron spectrometer measurements and resolution** — Fern Pannell — *Space four + five, The Spine* — 14:30 - 14:50
- **Recent updates on the Run 2b diagnostics** — Collette Pakuza — *Space four + five, The Spine* — 14:50 - 15:10
- **ChDR BPMs** — Bethany Spear — *Space four + five, The Spine* — 15:10 - 15:30
- **Getting the laser ready for the 2024 run** — Lucas Alexei Ranc — *Space four + five, The Spine* — 15:30 - 15:50
- **Discussion** — *Space four + five, The Spine* — 15:50 - 16:10
- **Coffee Break** — *Space four + five, The Spine* — 16:10 - 16:30
- **Collaboration Board** — *Space four + five, The Spine* — 16:30 - 18:00

Wed 13/03

- **Coach departs from Novotel Liverpool Paddington Village at 8:30** — *Novotel Liverpool Paddington Village* — 09:00 - 09:30
- **Betatron emission studies** — Hossein Saberi — *Atrium, Daresbury Laboratory* — 10:30 - 10:50
- **Getting ready for Run 2c** — Eloise Guran — *Atrium, Daresbury Laboratory* — 10:50 - 11:10
- **CNGS dismantling** — Ans Pardons — *Atrium, Daresbury Laboratory* — 11:10 - 11:30
- **The new electron source, prototype and first results** — Steffen Doebert — *Atrium, Daresbury Laboratory* — 11:30 - 11:50
- **Coffee Break** — *Atrium, Daresbury Laboratory* — 11:50 - 12:10
- **LLRF for AWAKE Run 2c** — Kevin Pepitone — *Atrium, Daresbury Laboratory* — 12:10 - 12:30
- **Laser lines for Run 2c** — Miguel Martinez Calderon — *Atrium, Daresbury Laboratory* — 12:30 - 12:50
- **Reliability improvements of the photocathode production** — Ralf Erik Rossel — *Atrium, Daresbury Laboratory* — 12:50 - 13:00
- **Update on the BPM study for Run 2c** — Laurence Stant — *Atrium, Daresbury Laboratory* — 13:00 - 13:20
- **Update on the development of scalable plasma sources at CERN** — Alban Sublet — *Atrium, Daresbury Laboratory* — 13:20 - 13:40
- **Discharge plasma source R&D at IST** — Nelson Lopes — *Atrium, Daresbury Laboratory* — 13:40 - 14:00
- **Lunch** — *Atrium, Daresbury Laboratory* — 14:00 - 14:30
- **Report from the Publication Committee** — Giovanni Zevi Della Porta — *Atrium, Daresbury Laboratory* — 14:30 - 14:50
- **Summary from the Collaboration Board** — Allen Caldwell — *Atrium, Daresbury Laboratory* — 14:50 - 15:10
- **Discussion / AOB** — *Atrium, Daresbury Laboratory* — 15:10 - 15:20
- **Lab tour (optional)** — *Daresbury Laboratory* — 15:30 - 17:30

✧Busy, but …

✧Hope you will enjoy …

✧Thank you to:

- ✧Carsten
- ✧Ricardo
- ✧The whole team …