



Collaboration Meeting March 2024

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MAX-PLANCK-INSTITUT
FÜR PHYSIK



✦ WELCOME...

❖ 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

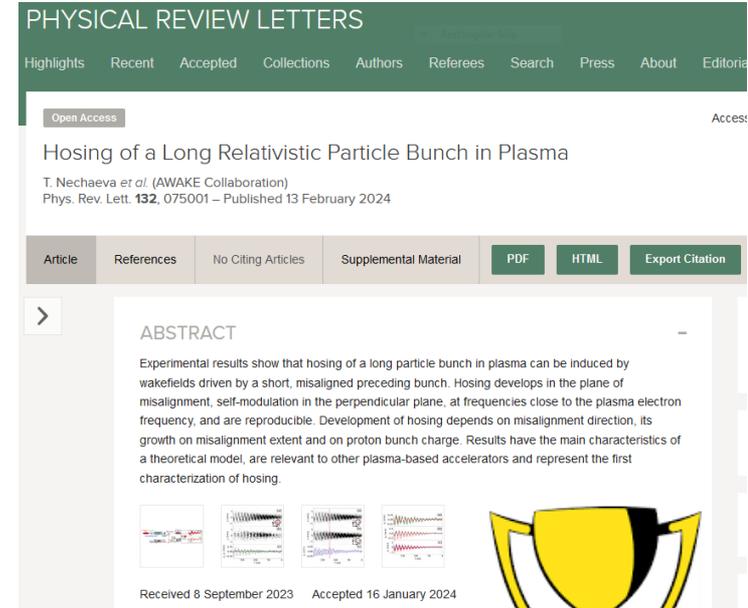
❖ C. Amoedo et al. (AWAKE Coll.), on SM in discharge plasma source

❖ First run 2b of 2024 will start on April 15

❖ 10 weeks

❖ 4 weeks SM

❖ 6 week acceleration, plasma density step



PHYSICAL REVIEW LETTERS

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Hosing of a Long Relativistic Particle Bunch in Plasma

T. Nechaeva *et al.* (AWAKE Collaboration)
Phys. Rev. Lett. **132**, 075001 – Published 13 February 2024

Article References No Citing Articles Supplemental Material PDF HTML Export Citation

ABSTRACT

Experimental results show that hosing of a long particle bunch in plasma can be induced by wakefields driven by a short, misaligned preceding bunch. Hosing develops in the plane of misalignment, self-modulation in the perpendicular plane, at frequencies close to the plasma electron frequency, and are reproducible. Development of hosing depends on misalignment direction, its growth on misalignment extent and on proton bunch charge. Results have the main characteristics of a theoretical model, are relevant to other plasma-based accelerators and represent the first characterization of hosing.

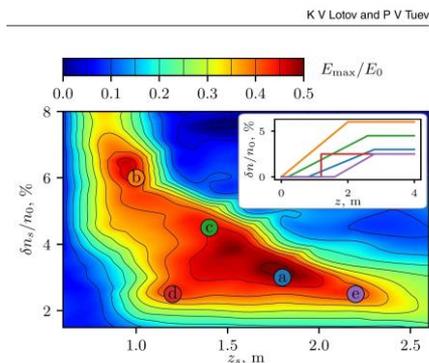
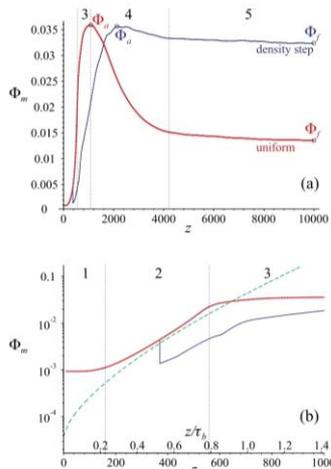
Received 8 September 2023 Accepted 16 January 2024



❖ QUITE SOME PROGRESS AND ACHIEVEMENTS ...

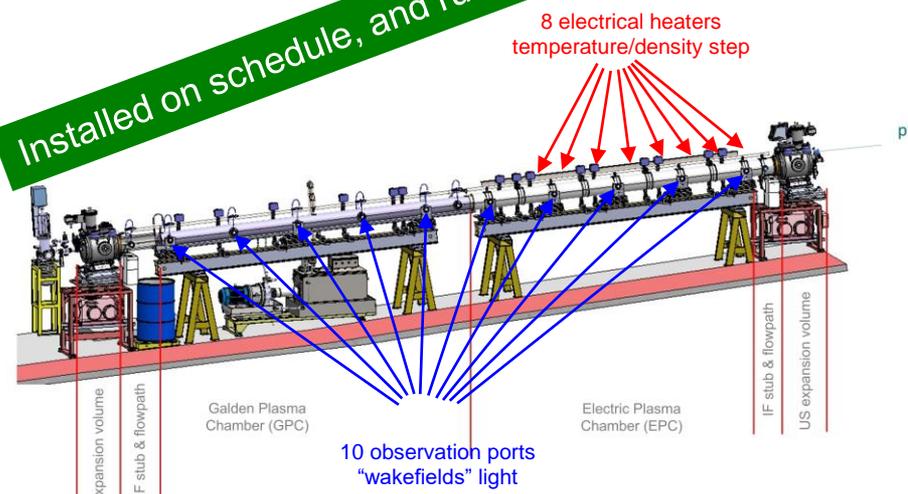
Purpose: impose temperature/plasma density step

- ✦ Explore the effect of a plasma density on
 - ✦ micro-bunch train
 - ✦ bunch halo
 - ✦ plasma light from dissipation of wakefields
 - ✦ ...



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

Installed on schedule, and running!

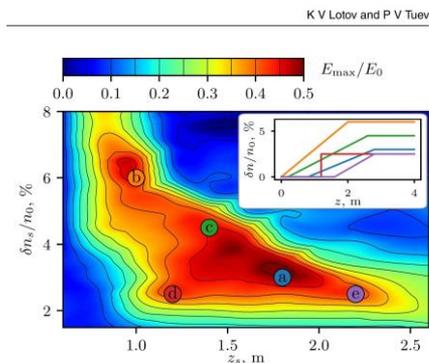
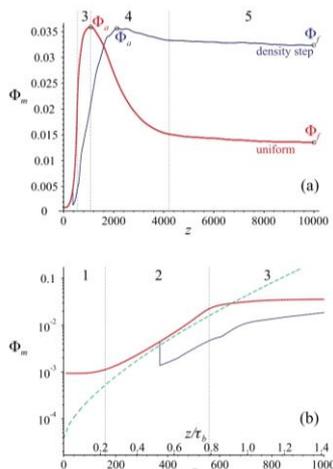


- ✦ Numerical simulation results:
 - ✦ Amplitude of wakefields larger w plasma density step
 - ✦ Optimum position and amplitude of the step

- ✦ New vapor source allows for imposing temperature step
- ✦ Temperature step is vapor/plasma density step

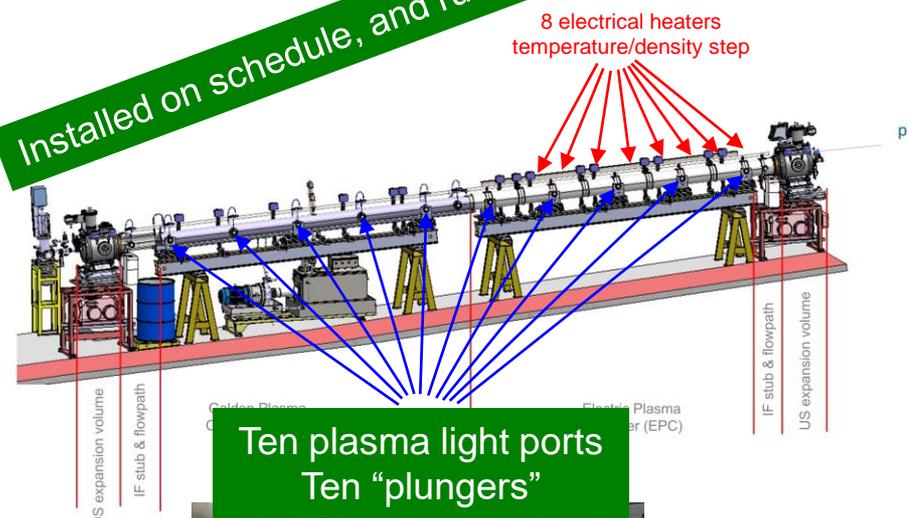
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Installed on schedule, and running!



Ten plasma light ports
Ten "plungers"

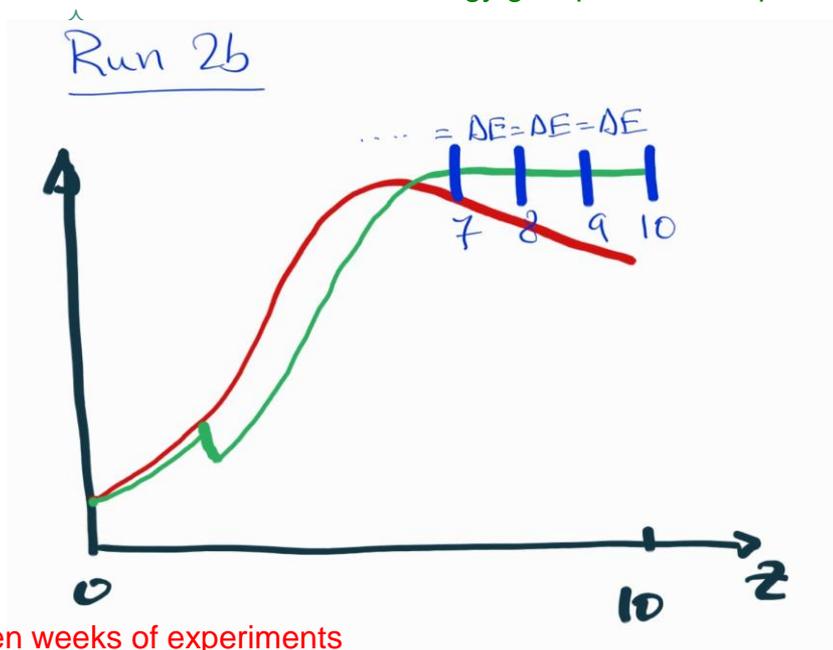


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Long term view:

- ✧ 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 ...

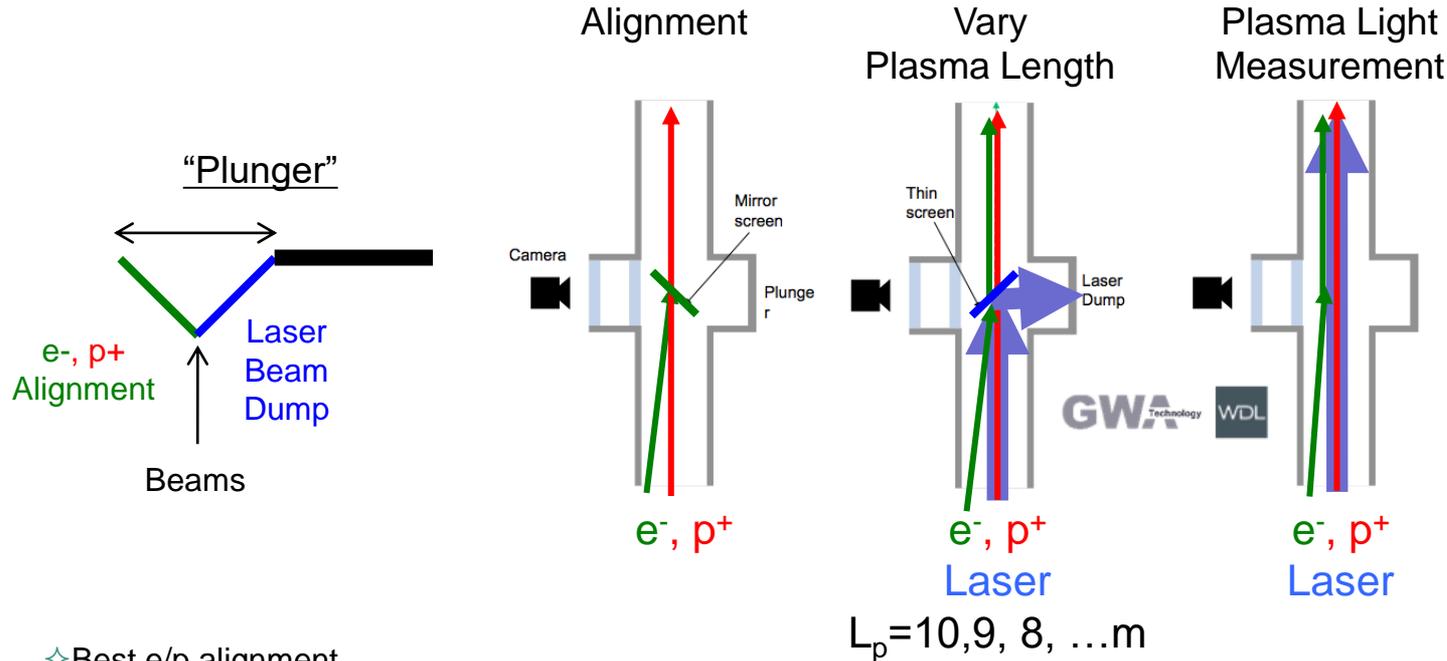


Ten weeks of experiments

- ✧ Four dedicated to SM
- ✧ Six dedicated to e-injection, acceleration, density step

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- ✦ 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 ...
 - ✦ ...



$$L_p = 10, 9, 8, \dots \text{m}$$

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

AWAKE Run 2c – Ongoing Studies

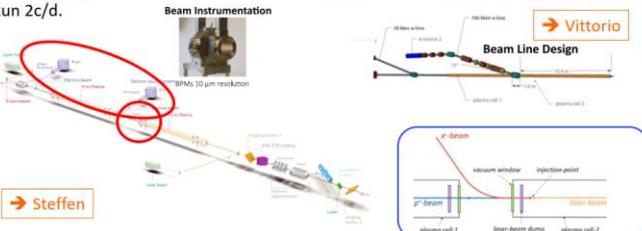


Acceleration and emittance control of externally injected electrons.

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



Injection area at conceptual design level. → Patric, John

Move from physics level to engineering level.

→ Challenges of external injection relevant for other PWFA

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

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



Development and demonstration of scalable plasma sources



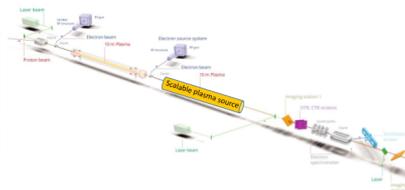
Scalable plasma source R&D program:

- Dedicated plasma source labs at CERN
- 5 collaborating institutes
- Addressing challenges of **density, uniformity, reproducibility, scalability**.

→ Alban, Patric

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

1m Helicon Plasma Source

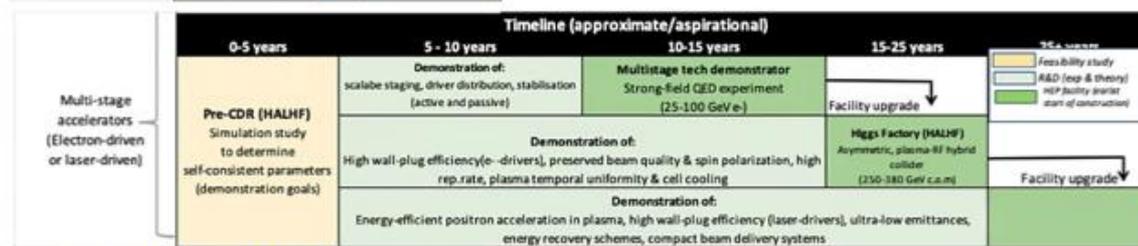
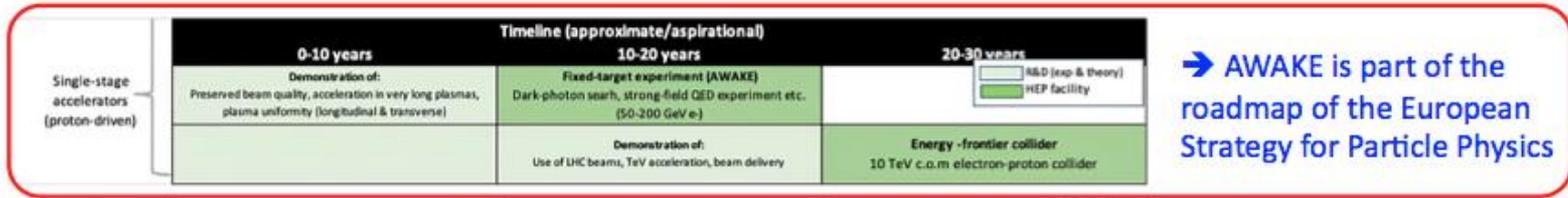


10m Discharge Plasma Source



- 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

AWAKE as Part of the European Strategy Roadmap



R. Pattathil, presented at EAAC 2023

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

✦ QUITTE SOME PROGRESS AND ACHIEVEMENTS ...

✧ CERN review

✧ AWAKE has a (clear) plan for Run 2c,d



✧ CERN decision: April 2024

✧ AWAKE has to do it!!!

✧ New opportunity

✧ New opportunities for major contribution

✧ Need a strong team at CERN, starting January 1, 2025

✧ First application of a plasma-based accelerator to particle physics

✧ AWAKE has a prominent position in the community

✧ AWAKE makes important contributions to the advanced accelerator community

✧ AWAKE can do more ...



✧ Need YOUR collaboration ... participation ...

13:00	Registration and Light Lunch	
14:00	Space four + five, The Spine 13:30 - 15:00	
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
16:00	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
17:00	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
18:00	Discussion	
	Space four + five, The Spine	17:55 - 18:15
20:00	Special Dinner	
21:00		
22:00		
23:00	The Philharmonic Dining Rooms 20:00 - 23:00	

PROGARM

Tue 12/03

10:00	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 Weber
	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
11:00	Clustering of macroparticles in PWFA simulations and solutions to this problem	Konstantin Latov
	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
12:00	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
13:00	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 Peltuca
	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
18:00		

✦ Busy, but ...
✦ Hope you will enjoy ...

Wed 13/03

09:00	Coach departs from Novotel Liverpool Paddington Village at 8:30 Novotel Liverpool Paddington Village 09:00 - 09:30	
10:00		
	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
12:00	LLRF for AWAKE Run 2c	Kevin Peplone
	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
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
15:00	Discussion / AOB	
	Atrium, Daresbury Laboratory	15:10 - 15:20
	Lab tour (optional)	
	Daresbury Laboratory	15:30 - 17:30
16:00		
17:00		



- ❖ Thank you to:
 - ❖ Carsten
 - ❖ Ricardo
 - ❖ The whole team ...