



Preview of AWAKE talk at JAPW

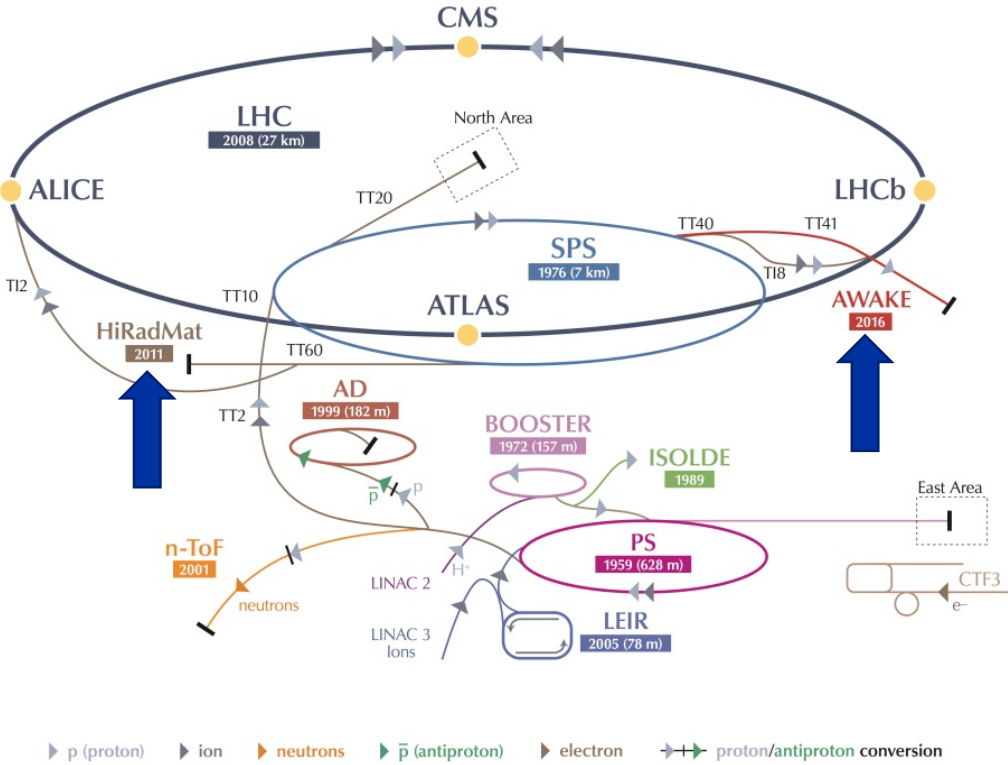
G. Zevi Della Porta

2 December 2022, Special PS/SPS User Meeting: End of Year, Wrap-Up & Feedback Session

HiRadMat and AWAKE: fast extraction at SPS

HiRadMat at TT66:

Facility for beam tests of accelerator components



AWAKE at TT41:

Accelerator R&D experiment for proton-induced plasma wakefield acceleration of electrons

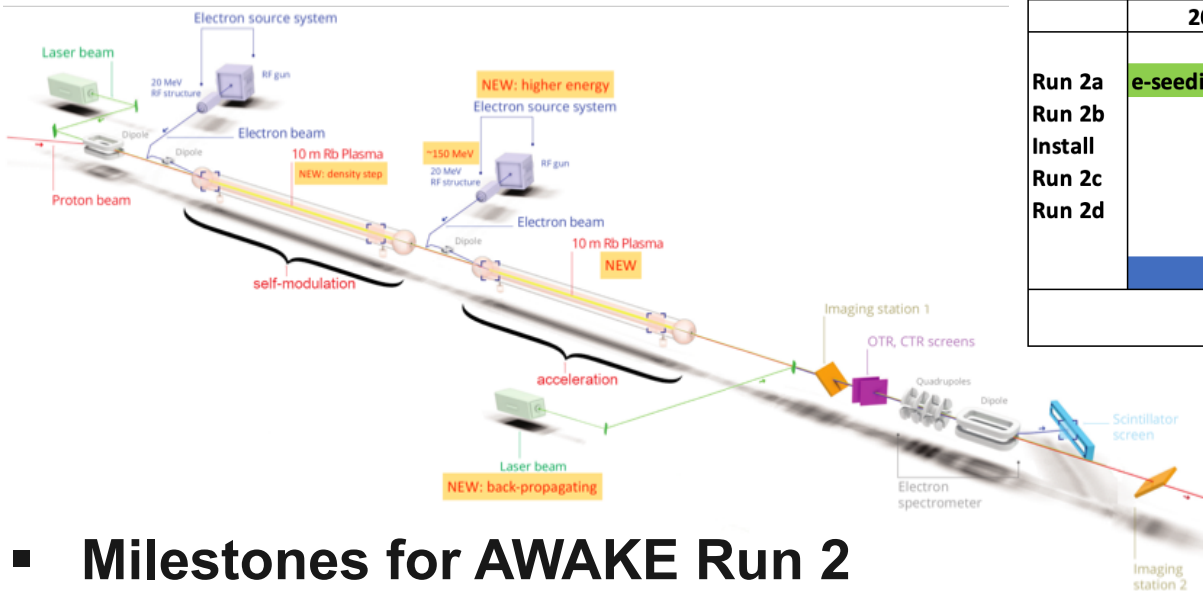
LHC Large Hadron Collider SPS Super Proton Synchrotron PS Proton Synchrotron

AD Antiproton Decelerator CTF3 Clic Test Facility AWAKE Advanced WAKEfield Experiment ISOLDE Isotope Separator OnLine DEvice

LEIR Low Energy Ion Ring LINAC LINear ACcelerator n-ToF Neutrons Time Of Flight HiRadMat High-Radiation to Materials



AWAKE Run 2 (2021 – 2030): Towards an Accelerator



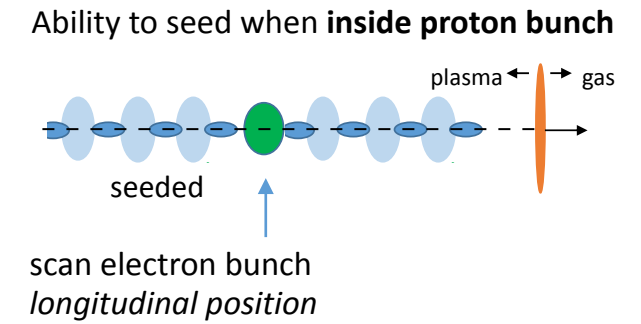
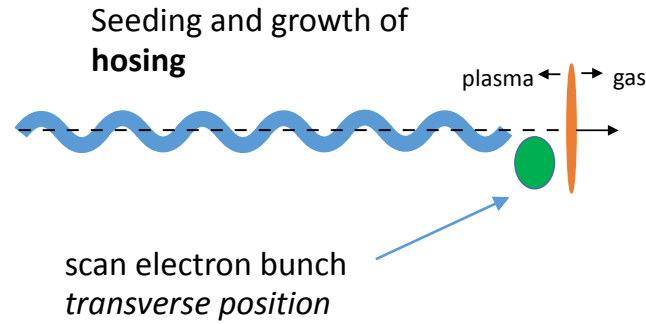
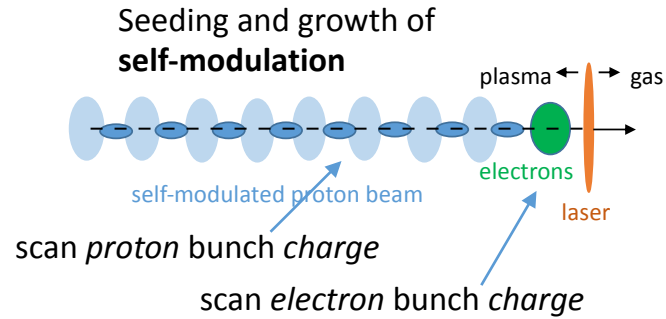
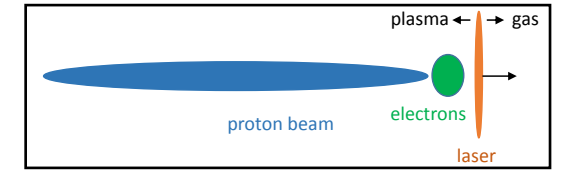
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Run 2a	e-seeding					CERN Longshutdown 3					
Run 2b			discharge source	density step							
Install				area extension, installation							
Run 2c							external injection				
Run 2d									scalable plasma accel.		
	design, prototyping of S/X-band electron source, beam line, laser system										
	scalable plasma source development										
											HEP Application

■ Milestones for AWAKE Run 2

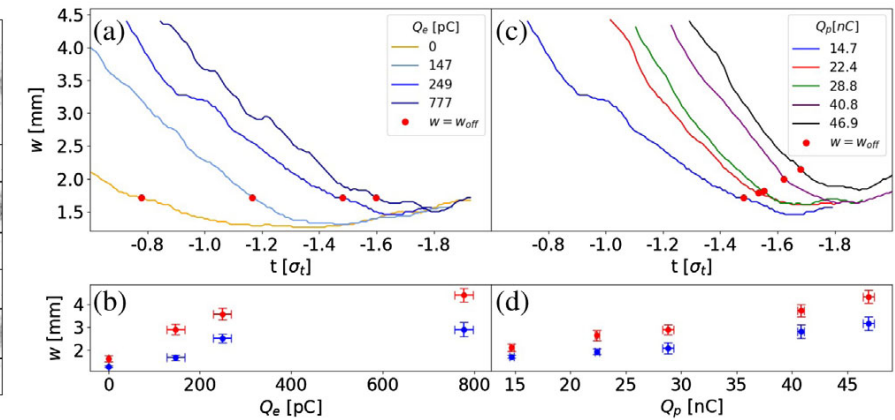
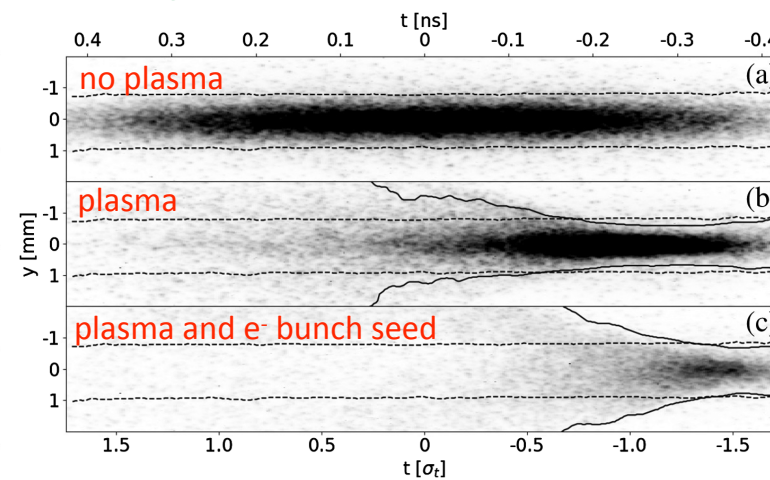
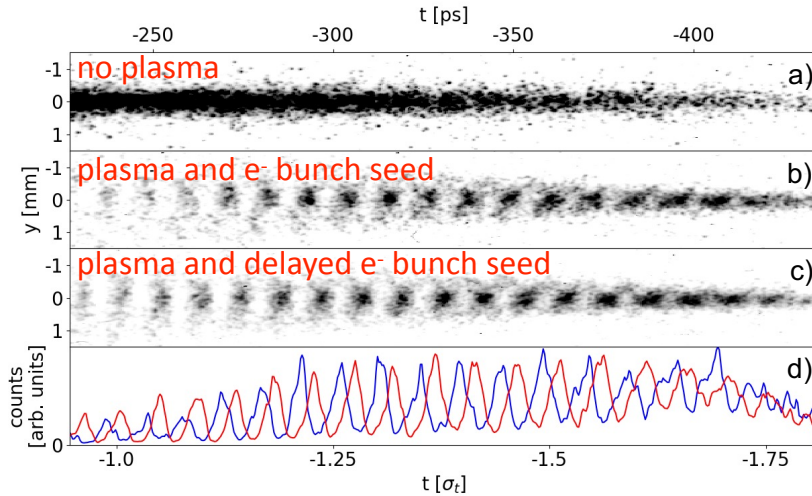
- Run 2a (2021/22): demonstrate the seeding of the self-modulation of the entire proton bunch with an electron bunch
- Run 2b (2023/24): maintain large wakefield amplitudes over long plasma distances by introducing a step in the plasma density
- CNGS dismantling and installation of Run 2c (2025/26/27)
- Run 2c (after LS3, 2028/29): demonstrate electron acceleration and emittance preservation of externally injected electrons
- Run 2d (2029/30..): development of scalable plasma sources to 100s meters length with sub-% level plasma density uniformity
- → Propose first applications for particle physics experiments with 50-200 GeV electron bunches!

AWAKE Highlights 2022

- 11 Weeks of proton beam
- Study proton bunch self-modulation using electron bunch to seed instabilities



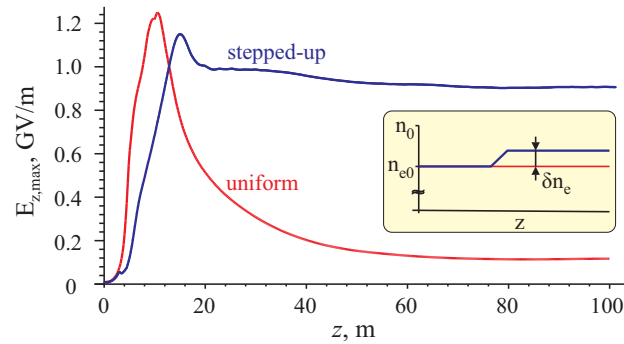
- Run 2a Milestone : Demonstrated the seeding of the self-modulation of the entire proton bunch with an electron bunch



L. Verra, et al. (AWAKE Collaboration), "Controlled Growth of the Self-Modulation of a Relativistic Proton Bunch in Plasma", *Phys. Rev. Lett.* 129, 024802 (2022)

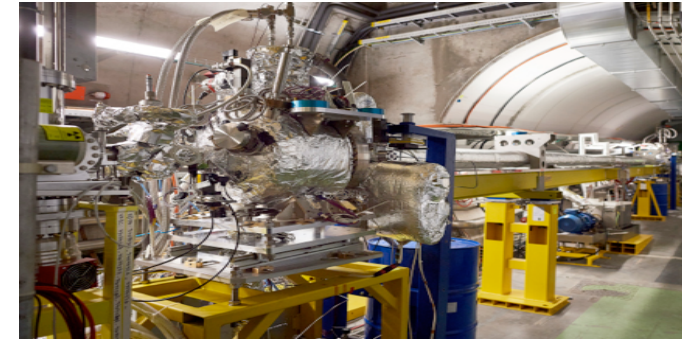
AWAKE Program 2023

- Run 2b (2023-2024): new plasma sources
- Discharge plasma
 - Candidate for O(100)m acceleration plasma in Run 2d (2028+)
- Plasma density step
 - Required to stabilize proton-driven wakefields to \sim GeV/m over O(100)m
- Dense installation/run schedule



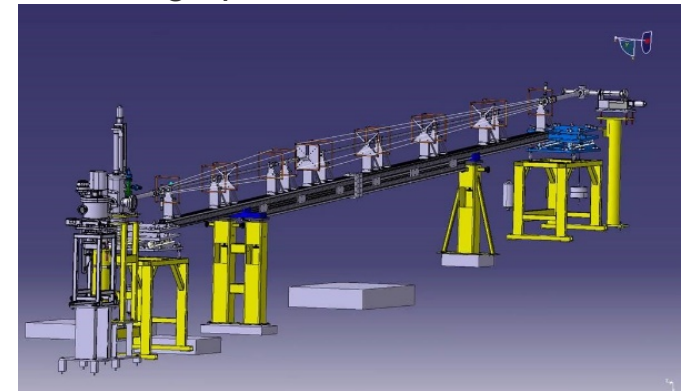
Current

Density-gradient vapor source



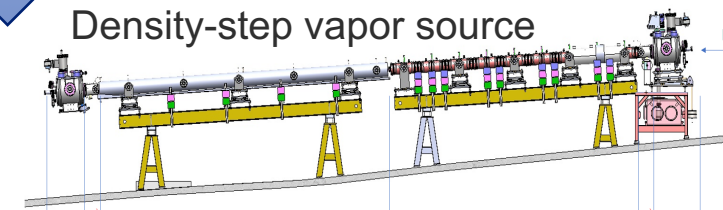
May 2023

Discharge plasma source



July 2023

Density-step vapor source



	2022							2023																									
	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.													
Run 2a																																	
Decommissioning run 2a vapor source								7 wks		10/02/2023																							
Transport operations (current vapor source)								13/02/2023		2 wks																							
Discharge plasma source										20/03/2023		8,5 wks																					
Transport, Installation & commissioning														19/05/2023																			
Test																																	
Decommissioning DPS																																	
Step density vapor source (run 2b)										15/03/2023		8 wks		transport		25/07/2023																	
Pre-build														9 wks																			
Installation & commissioning																																	
Operation Run 2b																																	
YETS 2022/23								12th Dec.				27th Mar.				AWAKE #1 (*)				AWAKE #2: wk 31/32 (31/07 -> 13/08)													

*wk 17/18/19 requested by AWAKE

AWAKE: Progress, Issues and Feedback for 2022

- We are very happy of the support from all technical groups involved in the experiment infrastructure and from the SPS operation team!
- We run for 2 out of 3 shifts and get out of the cycle as soon as there is an issue
- Improvements on precision and speed of Laser and Electron beam alignment
 - Further precision improvements require addressing subtle effects: BTV angle motion, magnet hysteresis
- Only showstopper from SPS: RF settings for $3E11p$ bunch
 - Longitudinal instabilities (mid-cycle and end-cycle) identified in June run: resolved during July run
- Best data collected when NA/LHC were off in late July/August
 - Higher repetition rate (7s instead of the usual 20s), fewer interruptions (no LHC fills)
 - We should find a way able to take good data even when NA and LHC are running

AWAKE: Progress on IEFC 2021 Feedback/Requests

- Four issues highlighted in 2021 IEFC. Progress made on most of them
- **1. Proton ALIGNMENT**
 - AWAKE moved from BPM- to BTV-based calculation for faster correction (higher resolution)
 - At least one supercycle lost every correction to mask FE Interlock. Could it be masked during alignment?
- **2. Beam STABILITY**
 - AWAKE improved speed of laser/e/p alignments (now <1h) to recover from p⁺ interruptions
 - **Still observed longitudinal p⁺ instabilities (next slide)**
- **3. Beam to AWAKE during LHC FILLING**
 - Confirmed that it is not possible for now . Not an issue when LHC is stable and fills are few and short
 - Difficult/impossible to take data when LHC is commissioning or suffering from any issues
- **4. FLEXIBILITY**
 - AWAKE/SPS/LHC communication improved: granted occasional flexibility to complete

AWAKE Desiderata

- 1. Stable beam with higher repetition rate in dedicated periods**
 - Example: 8 hours of stable beams with higher repetition rate (1/10-1/15s)
 - For reference: 1/22s (2 NA + 2 AW), 1/18s (1 NAions + 3 AW), 1/11s (4 AW July 30)
- 2. Continue maintaining availability of laser and electron beams during YETS**
 - Maintenance, optimization and technical upgrades on different subsystems
- 3. [LS3] Upgrade of power converter to reduce proton beam jitter**
 - Upgrade to Class 3 performance for 9 converters in TT40/TT41 and MSE (synergy with SPS-CONS)
 - From 3% to 30% usable proton shots in Run 2c

