



Max-Planck-Institut für Physik
(Werner-Heisenberg-Institut)



Letter of Intent #68, AF6



For the AWAKE Collaboration

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MAX-PLANCK-GESELLSCHAFT
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AWAKE LOI



AWAKE opportunity: high energy proton bunches **available today as wakefields driver**

- ✧ CERN SPS: 400GeV, $3 \times 10^{11} p^+$ \Leftrightarrow 19kJ
- ✧ CERN LHC: 6.5TeV, $1 \times 10^{11} p^+$ \Leftrightarrow 104kJ

Drive \sim GV/m accelerating fields in a single, km-long plasma

AWAKE applications to HEP (AF6 LOI “high energy physics applications of the AWAKE acceleration scheme”):

- ✧ **Search for dark photons (beam dump experiments)**
- ✧ Strong field quantum electrodynamics
- ✧ High-energy electron-proton collisions
- ✧ Compact electron injector using the RHIC-EIC proton beam

Rapid progress has been made by the AWAKE experiment at CERN (first experiments Dec. 2016):

- ✧ Controlled self-modulation (SM) long p^+ bunch
- ✧ Acceleration of externally injected e^- to 2GeV
- ✧ Development of plasma sources: laser ionized rubidium vapor (10m), discharge, helicon



AWAKE has a clear roadmap towards early application for HEP

Within the next 5 years (2021-2025):

- ✧ Demonstration of seeding of the SM process with an e^- bunch, optimization of the modulation process using a plasma density step with multi-GeV e^- acceleration.

Within the next 10 years (2021-2030):

- ✧ Demonstration of acceleration of an electron witness bunch to ~ 10 GeV with preservation of incoming emittance (mm-mrad level) and percent energy spread.
- ✧ Development of scalable plasma sources (1 to 10m), helicon and discharges to replace the second plasma source. These can in principle be made as long as necessary since they are based on a modular scheme that that can be tailored for reaching the desired energy.
- ✧ Development of accelerator plasma source 50-100m long.
- ✧ Demonstration of acceleration in a scalable plasma source (helicon or discharge), acceleration to 10 to 50 GeV, with bunch quality.

Starting in 2029:

- ✧ Application to beam dump experiments (AF6 LOI), 50-100 GeV electron bunch.





Planned experiments address many of the challenges all plasma-based accelerators face

- ✧ external injection
- ✧ beam quality generation
- ✧ large energy gain
- ✧ reproducibility
- ✧ plasma source quality (laboratory at CERN)
- ✧ etc.

Naturally complements other existing programs geared towards HEP applications.

- ✧ Suitable proton bunches and infrastructure available at CERN for the R&D program
- ✧ AWAKE is already an international collaboration that includes experts in all required fields (experiment, simulation, theory, accelerators).
- ✧ High-energy physics programs that could use high-energy electron beam produced by the AWAKE scheme have been clearly identified and some are already active at CERN (dark photon searches) => possible early applications

Besides the expertise in plasma-based acceleration, plasma sources, beam physics and HEP, one the strengths of AWAKE is that it is embedded in the high-energy physics laboratory that can both support its development and benefit from its applications.





Just do it!