KfB Workshop
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10-Year R&D Strategy for Beam-Driven Plasma Accelerators

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Beam-driven plasma accelerators offer technology path to high-average power and high energy applications

- **Technology for wakefield driver generation exists in principle that enables**
  - high energy (GeV to TeV) electron acceleration
  - high repetition rates (up to MHz)
  - high wall-plug efficiency (of order 1 to 10%)
  - high average power (kW to MW)
- **Particularly interesting for future high-energy physics or high-average power photon science applications**

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High avg. power/rep. rate/efficiency

FLASHFORWARD

DESY.

High energy

AWAKE

CERN

FLASHFORWARD roadmap covers major accelerator challenges for high-average power applications

2018 Beam plasma dechirper

2019 **Efficiency maximization & beam loading control**

Detection of slice properties with fs resolution

kHz to MHz plasma response

Drive depletion

Low-emittance beams from plasma

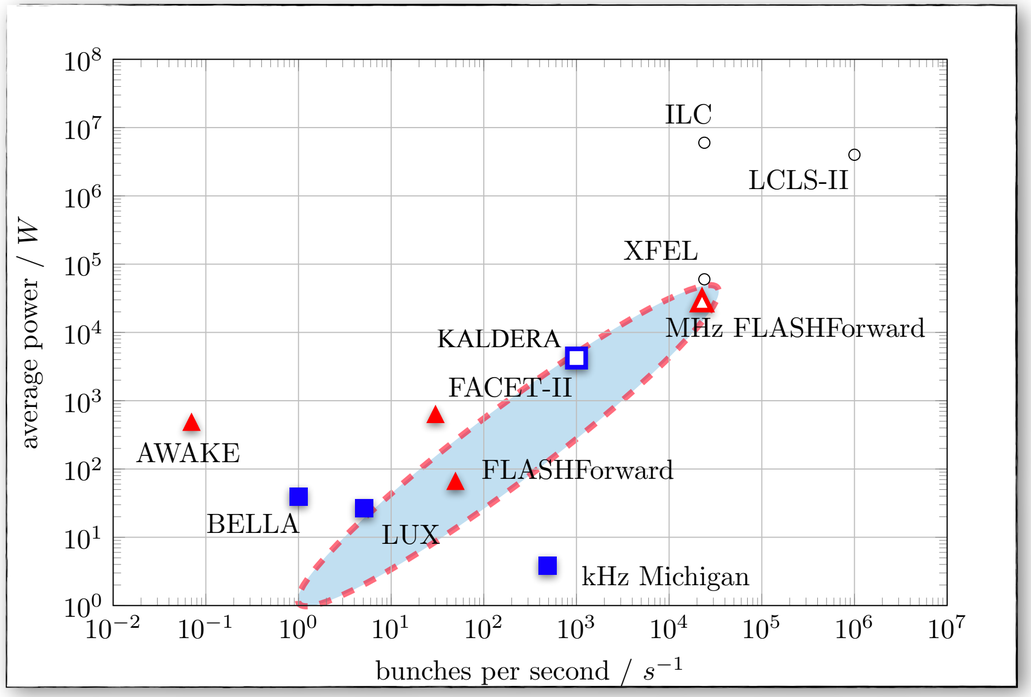
Emittance preservation

2022 FEL gain studies

2024 **10 kW avg. power operation**

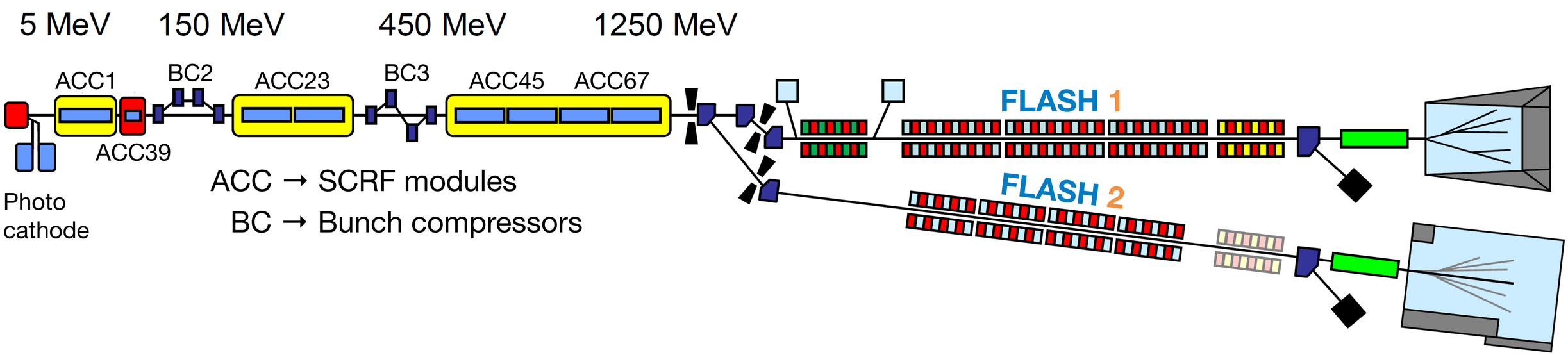
2026 **10 kW stage with 40% efficiency & witness property conservation**

2030



FLASH drives plasma accelerator research (and FELs)

SUPERCONDUCTING, HIGH-AVERAGE POWER SYSTEM FEEDS MULTIPLE BEAM LINES SIMULTANEOUSLY



> **FLASH** is an FEL user facility

- 10% of beam time (750 h / year) dedicated to generic accelerator research

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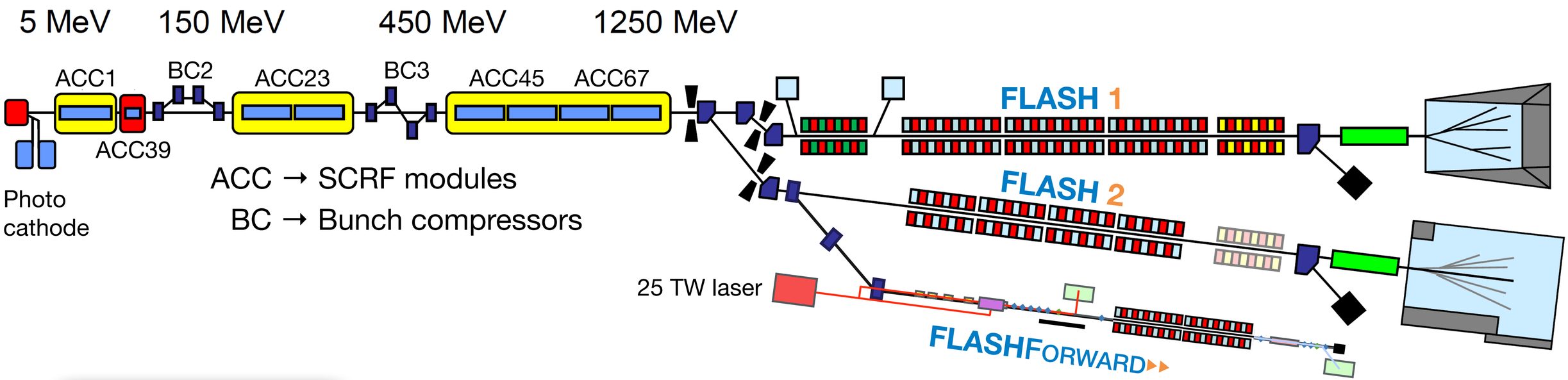

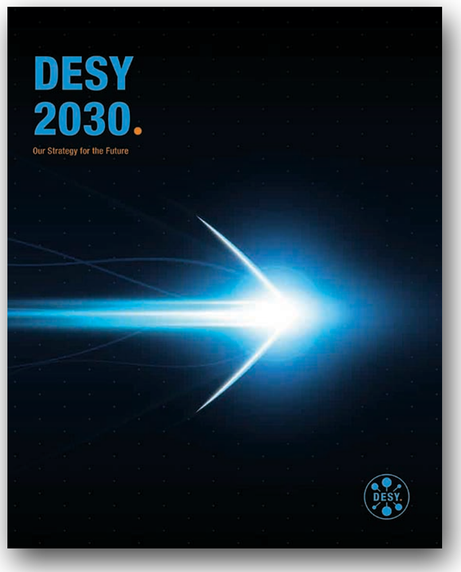

> **FLASH is an FEL user facility**

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> **FLASHForward is the pillar for PWFA research in the DESY 2030 strategy**

> **Superconducting accelerator based on ILC/XFEL technology. Typical beam parameters:**

- ≲ 1.25 GeV energy with a few 100 pC at ~100 fs rms bunch duration
- ~2 µm trans. norm. emittance

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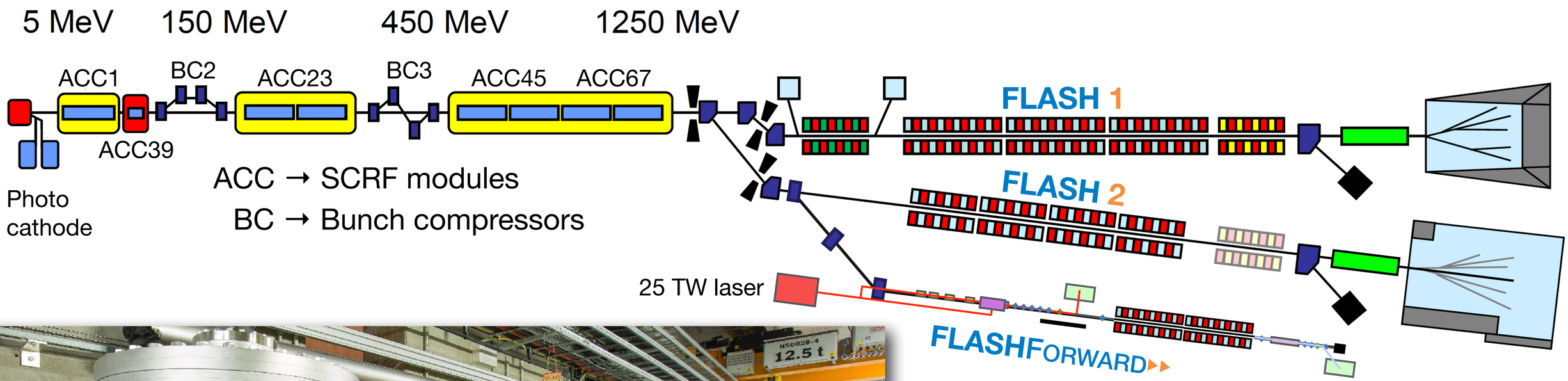

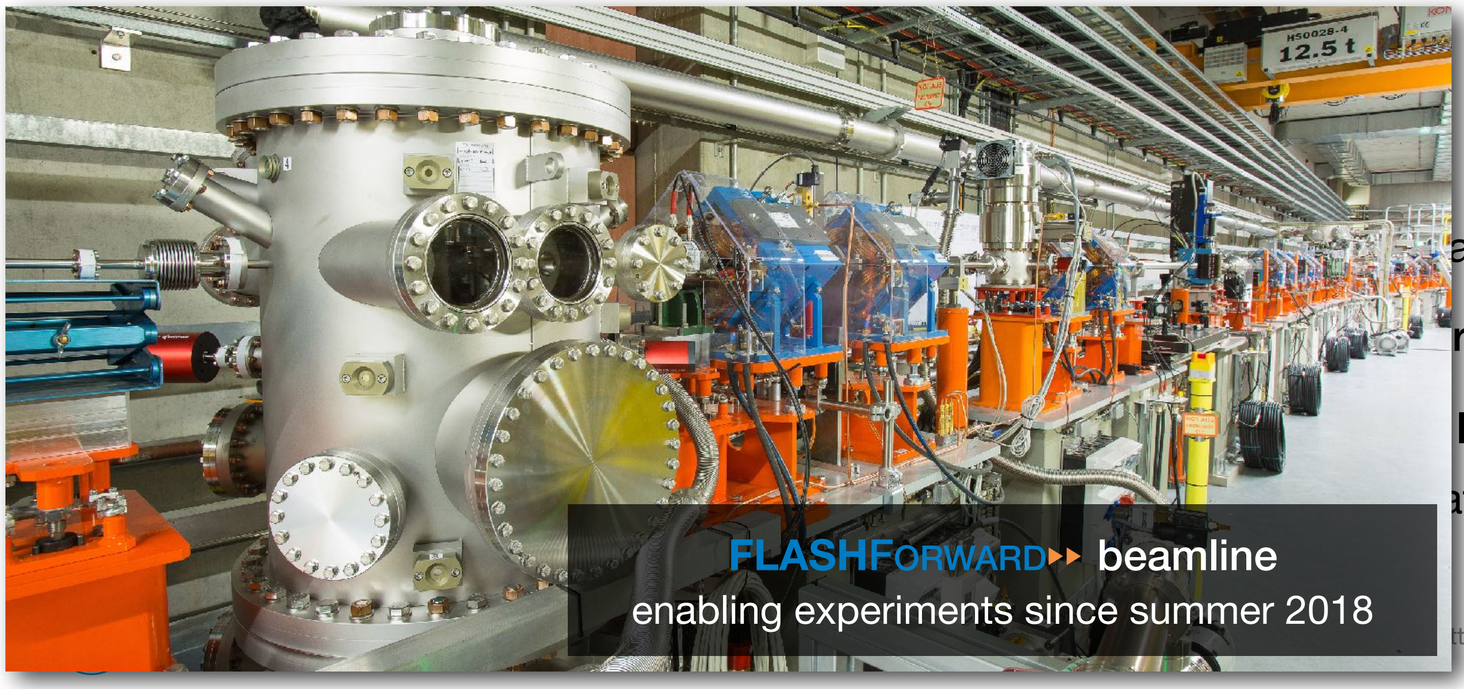

FLASHFORWARD beamline
enabling experiments since summer 2018

ated to generic accelerator research

research in the DESY 2030 strategy

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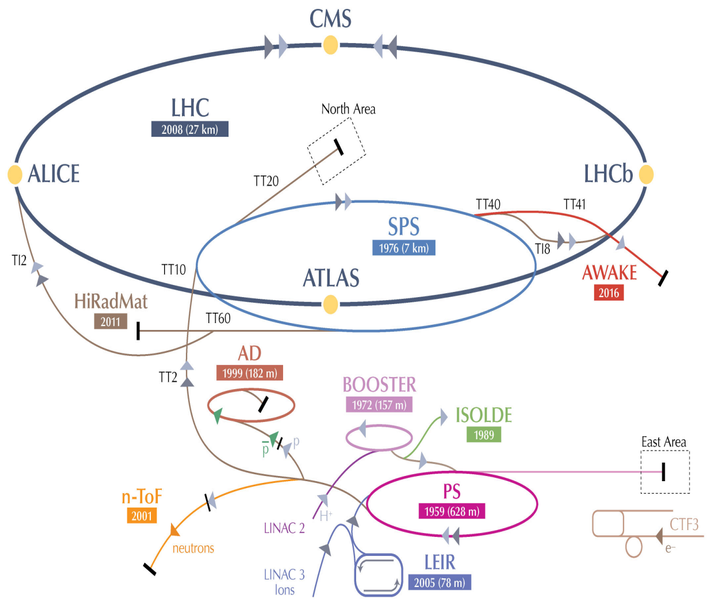
AWAKE targets high energy physics experiments

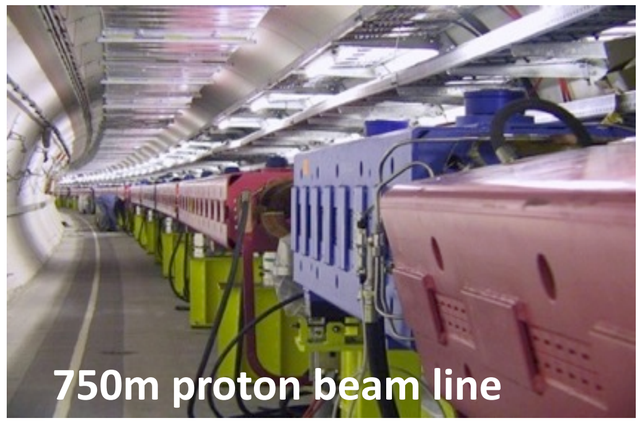


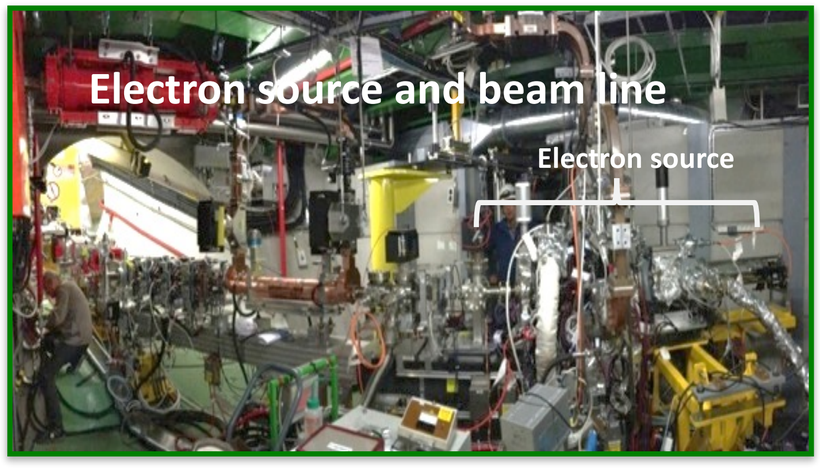
Advanced WAKEfield Experiment: Use protons beam as drive beam → powerful drivers at CERN, allow acceleration of electron to very high energies

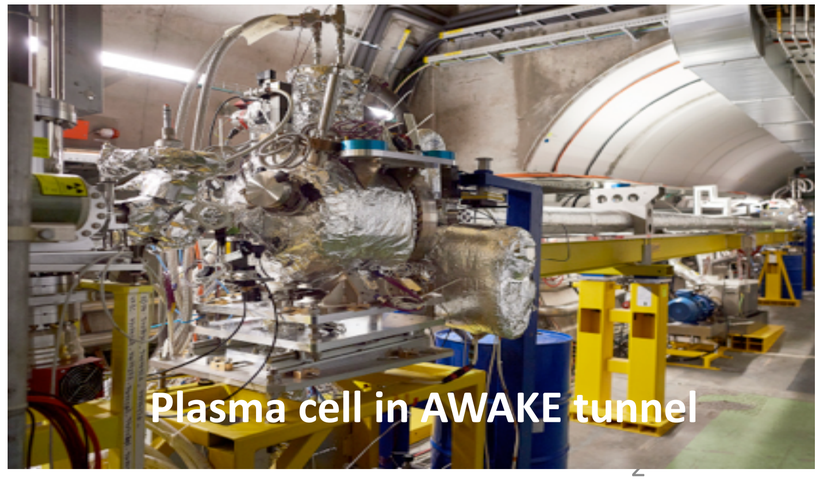
➔ **PWA experiment dedicated to high energy physics applications!**

International Collaboration: 20 collaborating institutes, 3 associate institutes

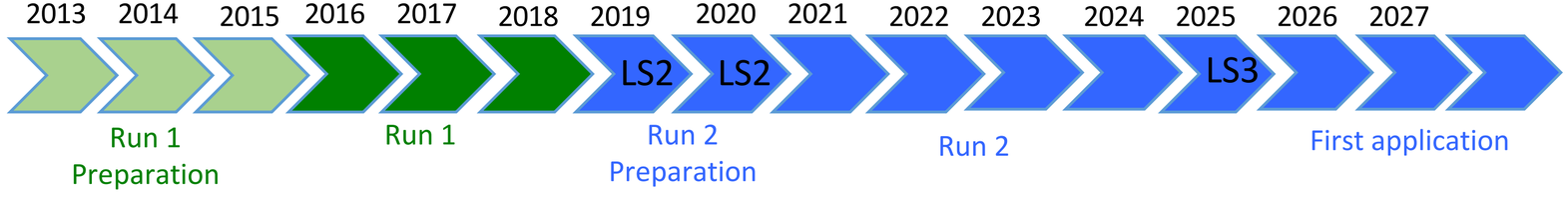
Timeline:
2013: Approved
2016-2018: AWAKE Run 1: proof-of-concept experiment: demonstrated seeded self-modulation of the proton bunch and acceleration of electrons
2020- LS3: AWAKE Run 2: Accelerate electrons to high energies while preserving beam quality
After Run 2: Particle physics applications kick-off







- contact E. Gschwendtner (CERN) or P. Muggli (MPP) for more info



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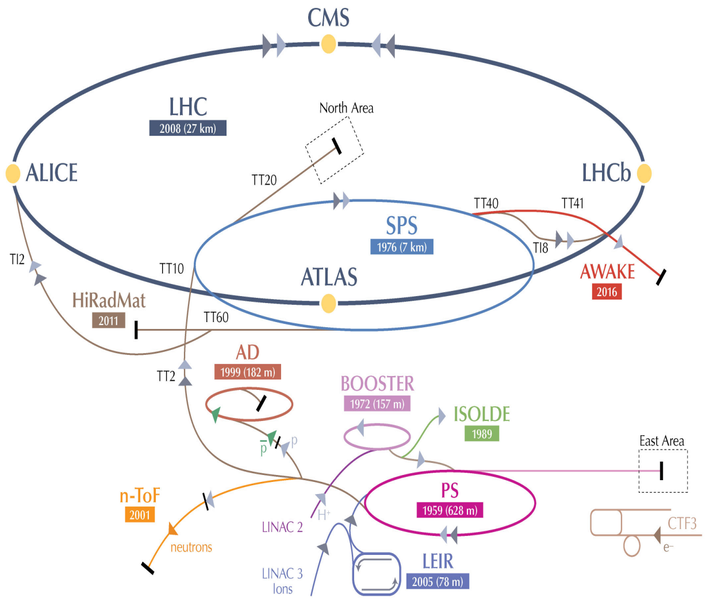

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Timeline:
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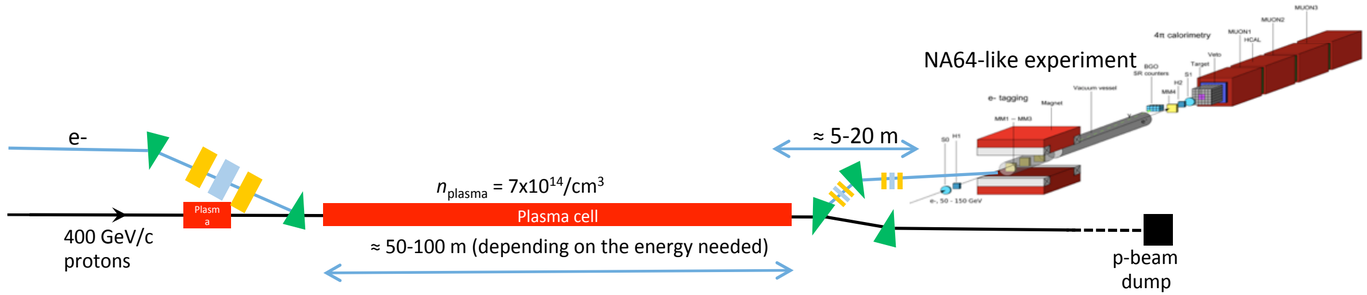
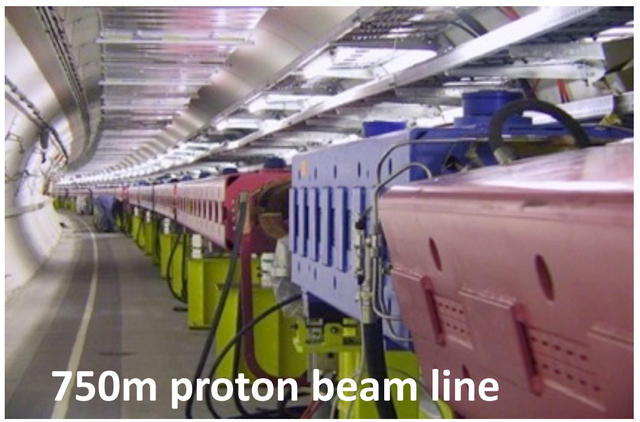
First Application:

→ **Fixed target test facility**: Use bunches from SPS with 3.5 E11 protons every ~5sec, → electron beam of up to O (50GeV), **3 orders of magnitude increase in electrons** (compared to NA64)

→ deep inelastic scattering, non-linear QED, **search for dark photons a la NA64**





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