Transforming the CNGS Facility into AWAKE: Status and Challenges

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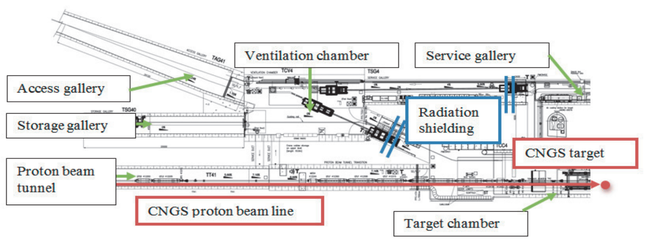
Abstract

The Advanced Proton Driven Plasma Wakefield Acceleration Experiment (AWAKE) is a proof-of-principle R&D experiment at CERN, installed in the former CNGS facility. It is the world's first proton driven plasma wakefield acceleration experiment, using a high-energy proton bunch to drive a plasma wakefield for electron beam acceleration. Modifying the CNGS underground high radiation area for AWAKE beam, expected at the end of 2016 (protons) and 2017 (electrons), requires challenging modifications in a complex intervention area. Dismantling of activated elements, separation of the highest activated areas and installation of shielding were followed by underground civil engineering works to create new tunnels and cores for AWAKE electron and laser beams. AWAKE services and infrastructure must be integrated within the existing radiation facility and at the same time be designed and installed to keep the radiation dose to personnel as low as possible. This poster shows the main challenges encountered in matters of integration, safety and coordination. It gives an overview of the dismantling and installation works completed, on-going and planned to ensure the timely start of a safe and technically reliable AWAKE facility.

History and Transformation

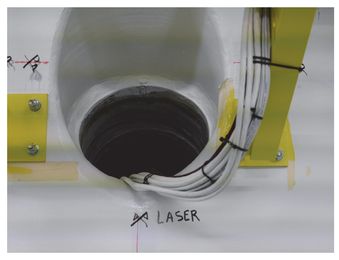
CNGS During Operation (Past)



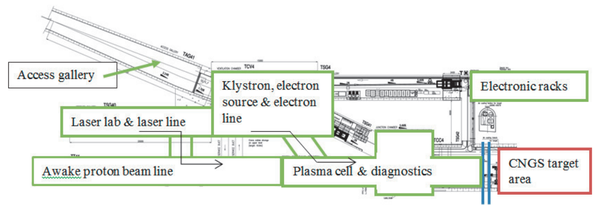
- CNGS = Limited Stay Radiation Area with remnant hot spots (target, collimator) years after proton beam stop
- Needs very little access, built for remote operation and remote handling/repair
- No access to CNGS during operation (90% of the year) and very limited access during shut-down
- Very low fuel load in-situ (mainly metal, concrete, magnets, …)

Before Civil Engineering Works

During Civil Engineering Works

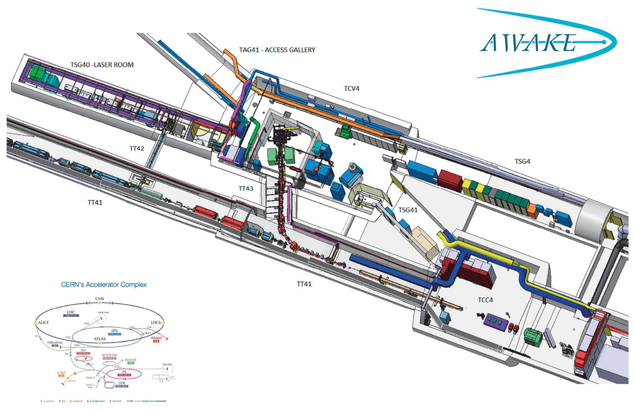


AWAKE During Operation (Future)



- AWAKE = Supervised Radiation Area already a few minutes after proton beam stop
- Needs regular access, built as stop-and-go (proof of principle), with local setting-up and upgrade.
- Controlled access to AWAKE 80% of the year (except when proton beam, which is 4x2 weeks per year)
- Higher fuel load in-situ (racks, plasma oil, klystron oil) and presence of Rubidium (plasma)

AWAKE Integration and Schedule

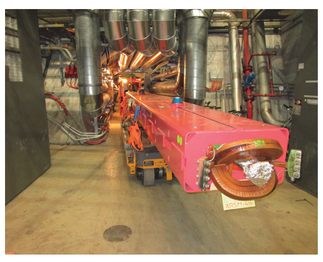


2014	Jan-Jun	CNGS Partial Dismantling
	Jul-Dec	Civil Engineering
2015	Jan-Jun	General Services Installation
	Jul-Dec	Magnets, Vacuum and Diagnostics Installation
2016	Jan-Jun	Laser, Plasma Cell and Controls Installation
	Jul-Dec	Commissioning and First Proton Beam to Plasma
2017	Jan-Jun	Electron Beam: E-source, E-magnets, E-services Installation
	Jul-Dec	Commissioning and First Electron Beam to Plasma
2018	Jan-Dec	AWAKE Proton and Electron Beam Physics (Estimated at 4x2 Weeks of Beam per Year)

Integrating and building a new facility in an existing geometry, originally designed for a very different purpose, creates significant challenges. AWAKE must be designed to fit into a very limited space, services must be adapted and safety issues re-assessed.

AWAKE Installation in Pictures

Proton beam magnet installation (TT41)



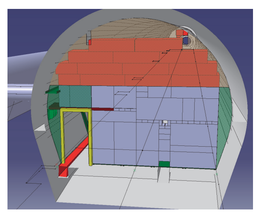
Magnet transport through tunnels

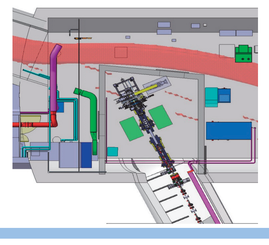
Magnet lowered through access pit

Safety: From CNGS to AWAKE

Radiation Environment in the AWAKE Facility: Actions Executed or Planned

- Installation of airtight TCC4 wall between AWAKE experimental area and CNGS target area and modification of ventilation system confines airborne radioactivity (from proton beam hitting the former CNGS target) outside of AWAKE
- Installation of TCC4 separation shielding protects people in AWAKE from the radiation of highly activated CNGS beam line elements (esp. target, collimators and horns)
- Exchange of CNGS target collimator (to clean, larger aperture collimator) to reduce dose in AWAKE during and after AWAKE beam (larger sigma) operation
- Future installation of TCV4 e-source shielding reduces gamma radiation created by the losses of the electron beam and allows people present in the AWAKE during e-source running



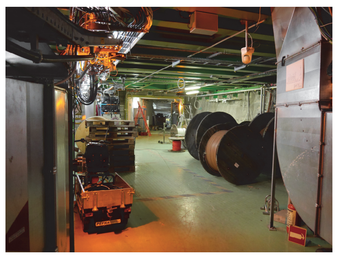


Fire Safety and Intervention in the AWAKE Facility: Actions Under Study

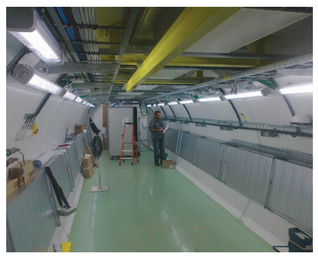
- Creation of fire zones → max. 400m between fire doors
- Fire risk assessment for higher risk or higher fuel load areas:
  - Laser room TSG40 (dead-end)
  - Klystron oil in TCV4
  - Plasma cell heating oil and Rubidium in TT41
- Fuel load calculation for entire underground area
- Detailed evacuation path study and signalization
- Dedicated AWAKE safety course

The TSG4 tunnel in CNGS times (left). Fire safety measures must be adapted for the modified TSG4 tunnel during AWAKE (right) as access will be more frequent and fuel load is higher than before.

AWAKE material access pit with cables and ducts (60m)



Cabling for services and equipment (TCV4)



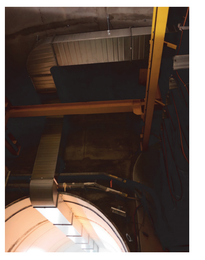
Cabling in laser room (TSG40)

New air treatment unit for laser room (TSG40)

CNGS magnets dismantled, cables for AWAKE magnets installed (TT41)

AWAKE element positions traced (TT41)

Cables for plasma cell and diagnostics (TCC4)



Modified ventilation ducts (TCC4)

Summary

The transformation of the CNGS facility into AWAKE facility is on track to have first AWAKE proton beam to the plasma cell by end 2016. Shielding was installed and elements dismantled or exchanged in order to turn the high-radiation, no-access CNGS facility into a supervised radiation area with safe regular access. Fire safety equipment and the access procedures will be modified following extensive fire risk assessments, in order to deal with the specific AWAKE access needs (a stop-and-go proof-of-principle experiment) and properties of the new equipment.

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