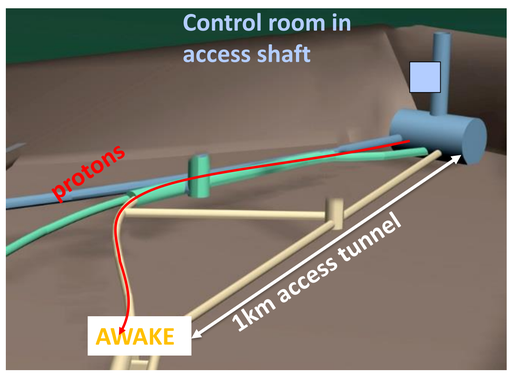
Installation and infrastructure for big PWA facilities: Lessons from AWAKE Run 1 and ideas for AWAKE Run 2.

A. Pardons for the AWAKE Integration, Infrastructure & Installation Coordination Package
CERN, Geneva, Switzerland

Abstract

The design, installation and operation of AWAKE Run1 infrastructure and equipment took place from 2013 until 2019. This was the first PWA facility of such large scale, and this scale influences many choices regarding infrastructure and design. Run 1 configuration, as well as lessons learnt from designing, installing and running the AWAKE facility's infrastructure are shown, and are extrapolated to show how they could be implemented for the upcoming AWAKE Run2.

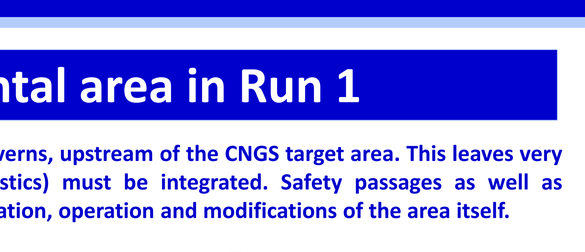
Fact: using protons means you will be far away



AWAKE has only a single access point, and this is via a 1km long, 6% slope tunnel, 60-120m underground. Fire safety and evacuation are therefore crucial elements in design and operation of the area and lone working is forbidden. For radiation safety reasons, access to the underground area is forbidden during operation with protons. As a consequence, the AWAKE control room is more than a kilometer away from the experimental area, meaning remote monitoring and regulating of equipment is essential.

Working in the underground radiation area requires many safety considerations (pictograms below) as well as careful planning and coordination of all activities.

A complex access system is necessary to separate the different beam areas (laser, electron, proton). Patrols of the entire area are needed to ensure absence of persons so beam can be sent.



Free access
Laser experts
Emergency evacuation
Access forbidden

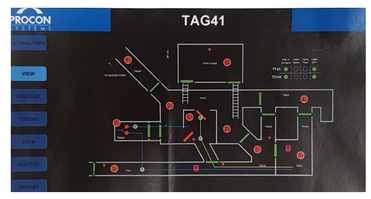
New AWAKE Access System

AWAKE ‘s access system, combined with permanent radiation shielding ensures a maximum extent of accessible areas during each AWAKE operation phase.

Access doors are interlocked with proton, laser and electron beam safety elements. If a door into a forbidden or limited access area is forced, the interlocks ensure that the beam is interrupted, creating safe access conditions.

A new access system is being installed and will be operational for AWAKE Run 2.

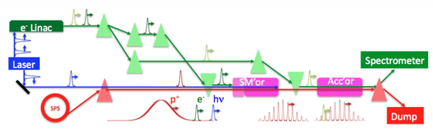
Using feedback from AWAKE operation, amongst others, the system should simplify access and patrols, and give the AWAKE users more independence from the CERN operation group.



Lesson: you will always need more space for your experiment

AWAKE Run 1 has one e-source, one plasma cell, one e-beamline, laser line and proton beam line. First schematics for the run 2 layout show possible needs for two e-sources, two e-lines, two laser lines, two plasma cells and a longer diagnostics area.

As a consequence, the currently inaccessible and highly radioactive “CNGS target area” downstream of run 1 elements will be dismantled, allowing an extension of up to 80 m length for Run 2. However, the works need large resources (cost, time, personnel) and very specific radiation safety measures during the execution.



AWAKE experimental area in Run 1

AWAKE Run 1 is installed upstream in the former CNGS caverns, upstream of the CNGS target area. This leaves very little flexibility in case new elements (services, diagnostics) must be integrated. Safety passages as well as evacuation routes become complex and as does the installation, operation and modifications of the area itself.

Run 1 Layout

Passage under electron / proton merging point

Lesson: make control room more a living space

In order to have the control room as close as possible to the experimental area and to save money, the Run 1 control room is located underground, in the access shaft. As this area is part of a radiation area, drinking and eating is forbidden. There is no natural light in the room and evacuation in case of fire is climbing 50m of stairs up to the surface.

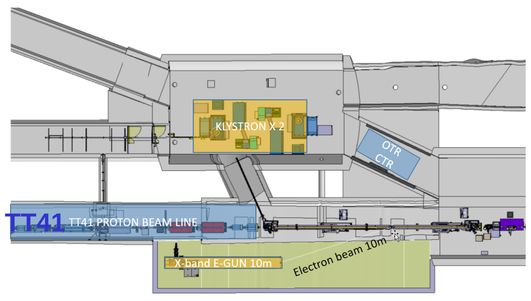
While it represents a significant financial investment, the Run 2 control room should be designed and built as follows:

- In a non-designated area (no radiation), with an area for eating/drinking
- On the surface (natural light and safer evacuation)
- Large enough and with desk stations to comfortably house 40 people
- Still as close as possible to the experimental area and with remote monitoring in place for all major elements.

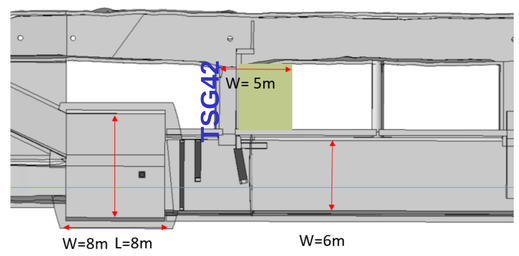
AWAKE experimental area ideas for Run 2

In order to allow for flexibility and future upgrades or extensions, the entire CNGS target area will be emptied, adding 80m length to the Run 1 experimental area.

Additionally, several studies are on-going (see below), to assess whether additional tunnels or caverns are needed to house the Run 2 experiment, notwithstanding the significant cost and the time needed to execute such civil engineering works.



Enlarging proton beamline tunnel TT41 to house X-band electron source



Enlarging cross-tunnel TSG42 to house Klystron(s)

Using enlarged TSG42 and emptied CNGS target area to house two plasma cells, two electron beam lines and two electron sources.

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