Remote handling design study developments for a new experimental facility at CERN – The Beam Dump Facility

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Introduction to the Beam Dump Facility

CERN has launched a study phase to evaluate the feasibility of a new multi-purpose high-intensity facility with the primary goal of exploring Light Dark Matter – the Beam Dump Facility (BDF). The new facility will require – among other infrastructures – a target complex in which a dense target/dump (referred to in the rest of this document as the "target") will be installed, capable of absorbing the entire energy of the beam extracted from the Super Proton Synchrotron (SPS) accelerator - 355 kW average beam power).

Remote handling and manipulation of the target, the surrounding shielding and adjacent beam line elements will be mandatory due to high residual radiation dose rates. The target complex design is therefore greatly influenced by remote handling considerations.

The target will be used to produce weakly interacting particles, to be investigated by a suite of particle detectors located downstream of the target complex. A new junction cavern and extraction tunnel will be built to house the new beam line taking the proton beam from the SPS to the BDF target area. A large experimental hall is located immediately downstream of the target complex (Figure 10).

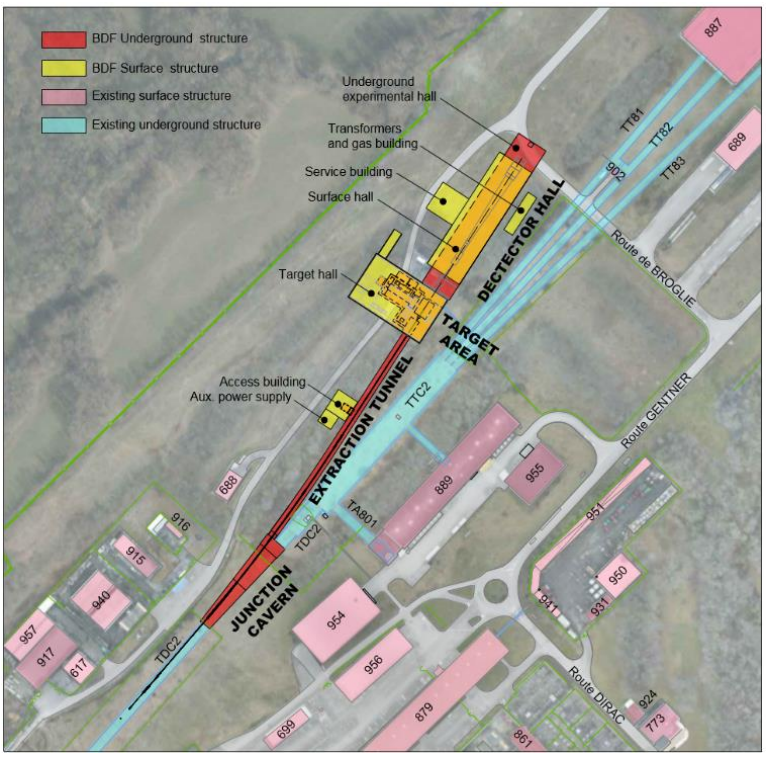

Figure 10: Plan view of the BDF extraction tunnel, target complex and detector hall next to the existing SPS "North Area" (North Area shown in blue).

The target complex. The target will be at the heart of the new facility. High levels of radiation (both prompt and residual) will be produced by the SPS beam hitting the target; a total cumulated dose near the target of around 500 MGy/year is expected. Residual dose rates near the target will be of the order of hundreds of Sv/hr. The target will be located in an underground area (to contain radiation as much as possible) located at about 15 metres below ground level.

The target will be surrounded by approximately 3700 tonnes of cast iron and steel shielding with outer dimensions of around 6.8 m x 9.5 m x 8 m high (the so-called hadron absorber) to reduce the prompt dose rate during operation and the residual dose rate around the target during shutdown. The target and its surrounding shielding will be housed in a vessel containing gaseous helium slightly above atmospheric pressure in order to reduce air activation and reduce the radiation accelerated corrosion of the target and surrounding equipment.

The target and the shielding immediately around it will be water cooled. All the shielding in the helium vessel will be built up of blocks; the layout and geometries of which are designed to avoid direct radiation shine paths and to minimise the number of block movements needed to allow exchange of failed equipment. The target complex design allows for removal and temporary storage of the target and shielding blocks in the cool-down area below ground level and includes dedicated shielded pits for storage of the highest dose rate equipment.

A 40-tonne capacity overhead travelling crane in the target complex building will be used for initial installation and will carry out the handling and remote handling of the shielding blocks and other equipment as needed for assembly and maintenance of the facility.

Target complex design methodology. After the initial work to determine the main requirements and basic layout of the target complex, the target complex design was further developed by going into more detail on the handling and remote handling operations required throughout the life of the facility. This work aimed to demonstrate the feasibility of the construction, operation, maintenance of the BDF target complex along with decommissioning of the key elements.

The study included the conceptual design of lifting, handling and remote handling equipment for the highly activated objects along with the necessary water, helium and electrical connections compatible with the radiation environment and remote handling constraints. These designs were then integrated in to the target complex as a whole.

The two remote handling concepts studied. Target complex designs based on two different handling concepts have been developed: the “crane concept” and the “trolley concept”. The crane concept relies on the overhead travelling crane in the target complex building for the movements of the target, shielding etc. during the life of the facility. The trolley concept has the target and its main services installed on a mobile trolley running on rails allowing quicker access to the target.

For both concepts the core elements are essentially the same and are common to the target complex designs produced for both concepts. The main differences between the crane and trolley concepts are in the way the target and water-cooled proximity shielding are supported, installed and removed from the helium vessel and how their services are connected and disconnected.

The presentation will briefly introduce the Beam Dump Facility then describe the two remote handling design concepts and the design study results.