

AD Infrastructures and Experimental Areas Evolutions in the Context of ELENA Development

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(Received May 26, 2016)

With the ongoing installation of the ELENA machine in the CERN AD facility, the AD infrastructures must be adapted to support 20 more years of exploitation of the facility with improved conditions for most experiments.

The first stage of improvements has been completed in 2015 (new control room building with cafeteria and conference room, annex building with storage space for experiments and cleaning room), together with an improved circuit to welcome visitors to this very popular place at CERN.

The second stage of improvements will be presented, detailing the enlargement of existing experimental areas (ALPHA, ASACUSA and BASE), installation of new experimental areas (for GBAR and possibly AEGIS 2) and maximization of usage of AD ground floor space for physics.

KEYWORDS: CERN, Infrastructure, ELENA, Antiprotons, AD, Experimental Areas

1. Introduction

The ELENA synchrotron [1] currently being installed at CERN AD is to be considered in the wider context of the consolidation of the antiprotons deceleration complex. ELENA will lower the energy of AD antiprotons from 5 MeV to 100 keV, thus increasing by a factor of up to 100 the number of antiprotons exploitable by the experiments [2]. The AD infrastructures must be adapted to cope with another 20 years of low energy antiproton physics. The insertion of this new machine, together with related infrastructure (shielding, access structures, ion source, transfer lines, power supplies, controls, safety systems etc.) and the new experiment GBAR, requires an important modification of the layout of the AD environment, and a consolidation of existing facilities. The main steps of this work include three aspects:

1. Consolidate the AD machine
2. Generate space and adapt infrastructure to enable ELENA and GBAR installation
3. Improve existing experimental areas and control rooms, plus increase space for experiments, preparation and hardware storage.

The AD machine consolidation will not be described here as it would deserve a publication in itself. Only the two latter points will be detailed in the subsequent chapters.

2. Adapt AD environment for ELENA and GBAR

2.1 New buildings

Two new buildings have been erected at CERN in the framework of the AD complex development: building 93 is now the home of the experiments control rooms, with adapted facilities (meeting room, cafeteria etc.), and building 393 houses a shared cleaning room and storage space for all experiments, in addition to a shared mechanical workshop and the AD/ELENA kicker generators. These buildings are now completely finished and operational (see Fig.1).



Fig. 1: The two new buildings erected in the AD complex.

2.2 AD facility visits

The reorganization of the AD facility provided the opportunity to develop a completely new visit itinerary to satisfy the large demand, allowing about 5000 visitors every year to tour the CERN “Antimatter Factory”. The visit circuit includes views over the ELENA machine being assembled and the GBAR experimental area under construction, through the AD machine during the winter shutdown period and over all the other experiments, with the exception of BASE. A screen displaying a webcam and online results of the BASE antiproton trap is installed on the platform to compensate for the fact that this experiment is not visible from the viewing platform.

2.3 Allocation of space inside the AD hall

The ELENA machine, despite being the smallest synchrotron at CERN with only 30.4 m in circumference, had to be shoehorned inside the AD hall, together with its corresponding infrastructure (power supplies, control electronics, access control systems, shielding, ion source etc...).

The relocation of the kicker generators was the key for generating space for the installation of the ELENA machine (see Fig. 2), the commissioning of which is expected to commence by summer 2016. With the approval of the GBAR experiment, the construction of Building 393 was decided, where the kicker generators have been relocated. This rearrangement is now complete: the access and circulation situation is

satisfactory both from a safety and practicability perspective, and space has been generated for a possible additional experiment.

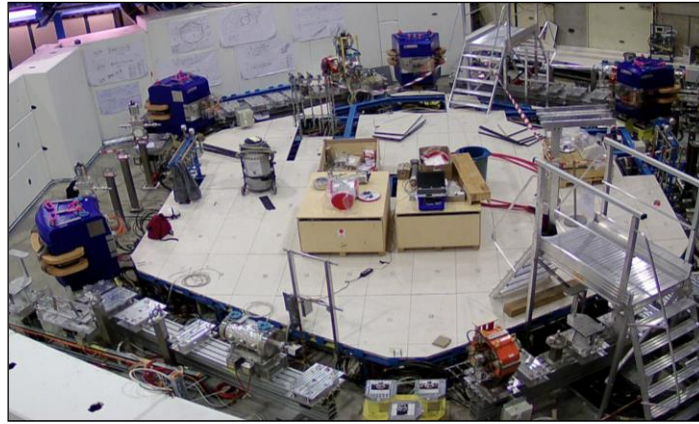


Fig. 2: ELENA machine installation in AD hall (May 2016).

Ground floor has been cleared for the GBAR experiment and in particular for its positron LINAC. When in operation at full repetition rate, the 10 MeV GBAR electron LINAC beam hitting the tungsten target generates radiation levels of $3 \cdot 10^3$ Sv/h at 1 m distance from the target and a contact dose up to 10^6 Sv/h. This requires the installation of a massive bunker to attenuate radiations. Economical constraints have been integrated by recycling about 1000 tons of former LEP (Large Electron Positron collider) magnet yokes for this shielding (see Fig.3). The impact of this huge mass, only 5 m away from the AD machine (currently in operation), is being monitored online and has remained well within acceptable limits to date, with a sink smaller than $150 \mu\text{m}$, measured on AD quadrupoles.



Fig. 3: GBAR LINAC bunker assembly in AD hall (May 2016).

In parallel, the design and integration effort continues for the electrostatic transfer lines from the ELENA machine to the existing and future experiments inside the AD hall.

3. Future improvements for existing experimental areas

The upgrade of existing experimental areas is being pursued, in order to allow continuation of the physics program in the best possible conditions and allow expansion of the experimental set-up. Notably, both ALPHA and ASACUSA experimental areas are planned to be enlarged during 2016-2017 YETS (Year-End Technical Stop), see Fig.4. This will allow ALPHA to develop measurement for antigravity, and ASACUSA to prepare for a second beam line parallel to the existing one, in the ELENA era. The existing control room of ALPHA will also be modified to conform to new regulations during 2017-2018 YETS.

There is also an interest to relocate the AEGIS experiment during LS2 (long shutdown for major LHC modifications and upgrades of the LHC injectors during 2019-2020), to a larger experimental area located near GBAR (see Fig.4). This major change will necessitate altering the shape of the ASACUSA laser room and designing new preparation and storage space for the experiments. At the same time, the ASACUSA control room will be modified to conform to new regulations.

When ELENA comes into operation, ASACUSA's decelerating system (RFQD) won't be needed anymore and all the corresponding racks and cubicles will be removed. This will free some space for the extension of the BASE experimental area. This re-arrangement is currently planned for LS2 (2019-2020).

The project to distribute liquid helium and liquid nitrogen directly in the experimental areas via a cryogenic line from a large external dewar is inscribed in the Medium Term Plan, but although this would be a major improvement both in terms of convenience and safety, a definite date has not yet been agreed.

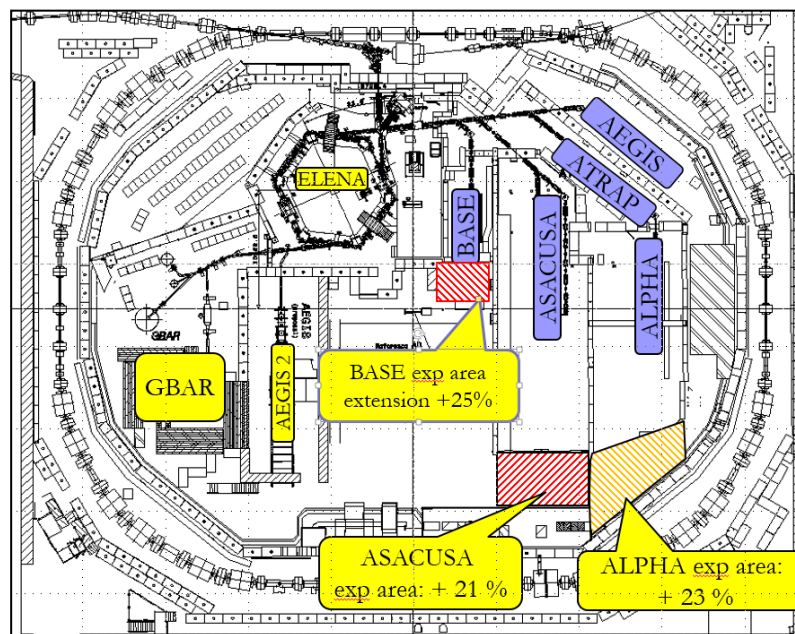


Fig. 4: Projected enlargement of experimental areas

4. Conclusion

Over the past few years, the AD facility has grown into a substantial complex in the CERN environment, encompassing no less than four buildings, one workshop, one fixed target, two synchrotrons (AD and ELENA), seven experiments, some 150 m of injection or ejection transfer lines, one ion source for 100 keV H^+ and H^- , one e^-/e^+ LINAC.

The AD facility has become an important and integral part of the diverse research program at CERN and a popular visit place for the numerous tourists in the Geneva region interested in science.

A number of major improvements are planned in the near future to accompany the development of ELENA and enter a new era for antimatter physics.

References

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