PROCEEDINGS OF SCIENCE

The INFN-LNF Bruno Touschek Visitor Centre: a hub for public engagement activities

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The Bruno Touschek Visitor Centre is a permanent exhibition dedicated to the evolution of particle physics, playing a central role in the popularization of science initiatives conducted at INFN Frascati National Laboratory (LNF). The centre was conceived as a public engagement hub to involve people with the main discoveries and the latest developments in technology and research fields investigated by INFN. Since its opening in 2018, it has been the scene where researchers, citizens, students, teachers, policy makers and different stakeholders share the importance of the evolution of science and its applications. In the itinerary path, the history of accelerator machines starting from AdA, the first storage ring accelerating matter and antimatter, designed and realized in Frascati, up to the future perspectives in particle acceleration, the development of particle detectors and the applications of research and technology-based outcomes in everyday life are presented. The exhibition features the exposition of instruments, interactive exhibits and immersive elements that will be described in this contribution. The centre is part of the LNF diffused museum that includes a Cockcroft-Walton accelerator, a section of the Adone storage ring, the KLOE experiment, lately enriched by a digital installation based on video mapping and NAUTILUS, a gravitational waves detector. Close to the exhibition hall, a laboratory named EduLab has recently been realized and it is devoted to hands-on activities and science demonstrations addressed to pupils of Primary and Middle Schools. The Bruno Touschek Visitor Centre and EduLab are hosting both formal and informal science education events, held either in person or virtually, providing, in this latter case, online resources that extend the accessibility of LNF outreach projects and enhance lifelong learning. The Visitor Centre itinerary path, the related public engagement activities and their societal impact are here presented.

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1. INFN LNF Educational program

The Frascati National Laboratory (LNF) of INFN Italian National Institute for Nuclear Physics fosters the scientific literacy through a wide program of science education and popularization of science events addressed to students, teachers and general public to bridge science and society[1]. These activities are carried out either inside or outside the LNF site, also in collaboration with other research centres and universities. The main missions are to engage the public with science, to inform about the latest issues in research conducted by INFN-LNF and the collaborations as well as the applications in other disciplines and in everyday life, to enhance the valorization of scientific heritage and to build network with the society[2]. More than 10000 people every year used to visit LNF before the pandemics.

2. The Bruno Touschek Visitor Centre

The LNF Visitor Centre[3] is a permanent exhibition of 150 m^2 realized after a renewal of an exiting facility. It was opened in 2018 and recently named after the physicist Bruno Touschek[4].

Figure 1: The Bruno Touschek Visitor Centre main building.

The centre plays a major role in the LNF popularization of science initiatives being a place where past, present and future of the research at INFN are presented by interactive exhibits and immersive elements. The centre was designed to be the welcome door of LNF and a multifunctional pole of public engagement, serving as a scene where to connect science and society. It was meant to be a place to share knowledge, where formal and informal education initiatives can be carried out, where to chronicle the history of LNF, with a focus on particle accelerators and detectors, and where

to preserve the historical-scientific heritage of the laboratory[5]. The Visitor Centre is a section of the LNF diffused museum that includes also a Cockcroft-Walton accelerator, a segment of the Adone storage ring, the KLOE experiment and NAUTILUS, a gravitational waves detector. Lately the building was enlarged to include another facility converted into a didactic laboratory, named EduLab, where hands-on Physics education activities can be realized combining them to the visit. The main exhibition combines the exposition of objects and interactive elements. The visit can be performed both individually or guided. In the latter case, tours are conducted by LNF personnel representing a strong point to make people and scientists share knowledge (see fig.1).

2.1 The itinerary visit

The visit path is divided in four areas and one central room that houses an art installation. Each area is devoted to a specific theme: *Accelerating particles, Seeing the invisible, Listening to the Cosmos* and *Future accelerators*. The itinerary follows the chronicle of the history of particle physics with a connection to the main experiments, conducted either at or in collaboration with LNF, to investigate the fundamental constituents of matter, the matter-antimatter asymmetry, dark energy and dark matter, the evolution of the Universe. The narration constantly illustrates the applications of discoveries and related technology to everyday life.
In the first section *Accelerating particles*, the machines to study the building block of matter are presented. The historical dimension of the progress in particle accelerators is deepened by a video that displays the timeline from 1954, when LNF was built, up to now. The trailer shows historical pictures of the LNF facility and its accelators starting from AdA, the first matter anti-matter storage ring, to Adone[6] and Dafne[9], the collider in operation at LNF since 1997.
This section hosts the AdA mockup and the Dafne interaction point (see fig.2).

Figure 2: The AdA mockup and on the right the Dafne interaction point. Picture by D.Lanzilao

AdA (Anello di Accumulazione), namely storage ring, is a milestone in the History of Science since it proved in 1961 the possibility to collide, inside the same magnet, electrons and positrons circulating in opposite directions.This technique allowed to reach higher energies compared to those available with a single beam impinging on a fixed target.
The Dafne interaction point is a five meter long section composed by two arms and a central sphere made of an aluminum-beryllium alloy, showing the region where particle beams collide.
Seeing the invisible is the second part of the itinerary visit where particle detectors are described with a focus on the specific role each of them plays in identifying particles and on their main features. While a video mapping is running to visualize what happens when particle beams collide, the exposition area houses parts of different types of detectors displaced as in a real experiment.

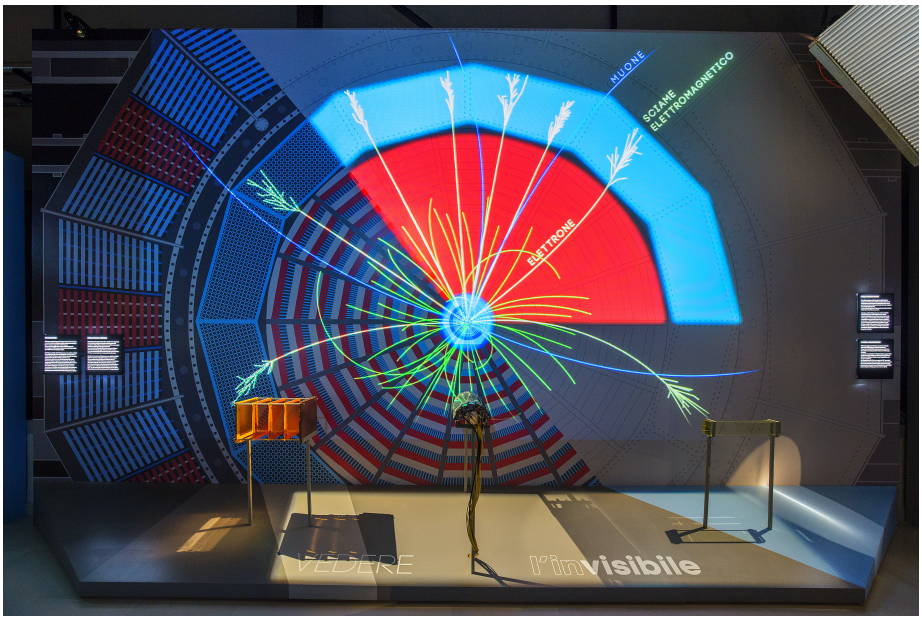

Figure 3: The video mapping showing the collision between particle beams Picture by D.Lanzilao

The idea was to compose a detector with elements from different experiments. Starting from the centre, one can see the vertex locator of the Aleph experiment (CERN) and the triple GEM LHCb detector, displayed as an example of tracking system. To show the instruments that serve to collect the energy deposited by particles, a module of the KLOE experiment calorimeter and a module of the HERMES calorimeter are presented. As in real experiments, the last component is the muon detection system, thereby a module of the Monitored Drift Tube of the ATLAS experiment is showed.
The visit is enriched by an art installation called *The gift of mass* that is an immersive/interactive-based element in which a system of motion sensors and projectors let the visitor experience what happens when a massless particle interacts with the Higgs field, gaining its mass.
As suggested by the name *Listening to the cosmos* is the section dedicated to the main protagonists to investigate the Universe, cosmic rays and gravitational waves. A spark chamber and a cloud chamber are therefore showed to introduce the topic of radioactivity and, in particular, the cosmic radiation.

Concerning the study of gravitational waves, the Tiga (Truncated Icosahedral Gravitational wave Antenna) prototype and the Nautilus[8] experiment are presented. The resonant-mass detector Nautilus (in operation in Frascati from 1995 to 2017) is a 2300 kg cylinder, placed outside the Visitor Centre. The evolution in the investigation of gravitational waves and the related technology developed to detect them is presented. A mockup of an interferometer is showed to illustrate how gravitational waves have been discovered by Ligo and Virgo.
The final section *Future accelerators* is devoted to the future perspective in particle acceleration techniques. In particular the Plasma Wakefield Acceleration (PWA) and the EuPraxia[10] project are presented. The PWA is a technique based on the use of plasma that will lead to build accelerators 100 times smaller than the existing ones. LNF and other facilities around the word (laboratories in USA and Germany, CERN) work in the development of this technique whose success could allow the realization of low cost, portable and ultra compact particle accelerators that could be used in medicine, industry and research in fundamental physics. A capillary used in the Plasma Wakefield Acceleration is showed in this section to explain this technique.
In addition to the tour at the Visitor Centre, people can also visit the Cockcroft-Walton accelerator and the KLOE experiment[11], placed in the dedicated experimental hall, where a video mapping called *The perfect asymmetry* has been realized to introduce, using the language of art, the concept of symmetry.

2.2 Public outreach activities

Since its opening, the Bruno Touschek Visitor Centre has been playing a key role in public outreach events like guided visits for students (from Primary school to University), teachers, the general public, politicians and policy makers. It was the scene for several footages and documentaries as well. From November 2018 to February 2020 it hosted more than 7000 visitors. Due to the Covid-19 emergency, starting from March 2020 the LNF science education activities have been adapted and carried out online (in Italian and English). In this context, the Visitor Centre played once again a central role, since virtual guided tours were periodically organized and these kind of events enlarged our reachability. EduLab was the scene for many video tutorials and video lectures in which LNF researchers realized Physics experiments tailored to Primary, Middle and High School students to support the experimental aspect in teaching/learning in a period when the laboratory-based activities were precluded. Presently the in person events have restarted but we have planned to pursue also virtual events to allow more people to access digital contents.

3. Conclusions and perspectives

The Bruno Touschek Visitor Centre is a hub for the public engagement activities carried out by LNF to raise awareness towards science and its applications and to bridge science and society. It also serves as a place where to preserve and collect the historical-scientific heritage of LNF.
For the near future we foresee to increase the number of events (also in blended modality) to enhance our engagement, moreover we have planned to implement, inside the itinerary visit,innovative and alternative digital tools, like virtual and augmented reality exhibits, to show for instance the working principles of particle accelerators as a support to the traditional narration.

References

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[10] EuPraxia @SparcLAB web site bit.ly/3ESpWbm

[11] KLOE web site https://www.lnf.infn.it/kloe2/

[12] The perfect asymmetry web site https://vimeo.com/760330191

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