

# 360 DEGREE PANORAMIC PHOTOGRAPHS DURING THE LONG SHUTDOWN 2 OF THE CERN MACHINES AND FACILITIES

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## Abstract

Studies and preparation of activities are key to the success of short technical stops and longer shutdowns in CERN's accelerator complex. The 'Panorama' tool offers a virtual tour of our facilities, and thanks to integration with other CERN tools, further complementary information can be easily retrieved, including layout information, equipment detail, and a history of changes.

The tool was used to support the preparation and the execution of works during the Long Shutdown 2. It helped to optimise machine (accelerator/decelerator) interventions and hence reduce potential radiation exposure, as well as to ease integration studies. Thanks to its user friendliness, the tool is now also used for educational and outreach activities.

The current instantiation of the 'Panorama' tool and related processes is presented, alongside the benefits that the tool can bring to the accelerator complex community. A particular focus is on the Long Shutdown 2. Future planned developments and improvements are also described.

## INTRODUCTION

Photographs of CERN machines (accelerators/decelerators) and facilities have been captured throughout their lifecycles. They have been used for recording installations, planning future works, and for publicity and advertising. In the past, photographs at CERN were captured informally and stored in different locations or databases. Consequently, many areas of facilities and machines were either not captured, or the information could not be easily retrieved. Furthermore, photographs were not always retaken following changes, and so records were often misleading or obsolete. To address these issues, the Panorama project was set-up in 2013 by the Configuration Management team [1].

Initially, the project scope covered only regions of machines considered of most interest, due to limited resources. Over time, this scope grew to cover additional areas, and today most of the CERN machines are included. Most recently, it was decided to include panorama images of surface buildings, offices and experimental areas, to expand the usage of the tool beyond the primary beamlines. This was done in collaboration with the Site and Civil Engineering department (SCE) and the Experimental Areas team in the Beams department (BE-EA).

The Long Shutdown 2 (LS2) was an 18-month time period during which CERN machines were stopped in order to perform maintenance activities and significant upgrades linked to the LHC injectors upgrade project (LIU) [2].

## PANORAMA APPLICATION

The Panorama application was developed to facilitate the display of 360 x 180 degree immersive panoramic images, and to allow navigation between them. Each panorama is assigned an X, Y, Z value in the CERN coordinate system corresponding to its location in three-dimensional space. This location is also used to assign the panorama to a region, the name of which is displayed in the interface. The region is a defined part of a machine or building. Panoramas are also orientated, by defining the north direction in each one. They are linked together with arrows, which are automatically generated using a specific algorithm that relies on the coordinate position and orientation of each panorama. Furthermore, a 'floors' tab is available to allow navigation between panoramas that have similar X and Y coordinates but different Z coordinates, indicating that they are above or below one another.

A date of capture is assigned to each panorama, so its validity is known. The user interface includes a 'versions' tab to facilitate navigation between panoramas at the same location, but with different capture dates. Functionality is also provided to view multiple versions simultaneously, in order to make comparisons.

The application allows zooming in and out, and there is an information button providing additional details on the specific panorama. It is also integrated with the CERN GIS mapping system [3], to ease navigation for users, and with the CERN Layout Database [4]. Figure 1 shows an example of the panorama interface.

Access to view a specific panorama is managed within the application, in order to restrict access when necessary. In general, however, panoramas are viewable by anyone with a CERN user account. To protect privacy, any personally recognisable objects in panoramas, including people, are blurred before the panorama is published.

From the technical side, the Panorama application is a typical three-tier web application. Its data storage tier is composed of a file repository with the panoramic images, together with an Oracle relational database. The database contains all the panorama metadata as well as auxiliary data such as functional position and region location data.

The business logic tier uses a structured Spring Boot Java Server. Along with distributing the frontend code, this server provides REST endpoints, not only for providing the application data, but also for its management.

The presentation tier uses JavaScript, alongside libraries like React, Redux and Material-UI to improve the flexibility and maintainability of the code.



Figure 1: Panorama application interface, showing a panorama from region PR.SD01 of the PS Ring taken during LS2.

## PROCESS

Panoramas are captured using a Digital Single Lens Reflex (DSLR) camera with a fish-eye lens. Four photographs, taken at 90 degree intervals, are stitched together using commercial software to form each 360 degree panorama. During the capture process, a geo-location application is used on a tablet computer to identify the location of the panorama on a map of the CERN site. This assigns an X, Y, Z position in the CERN coordinate system to the panorama so that it can be later uploaded to the Panorama application at the correct location, and viewed.

The Configuration Management team at CERN provides a representation of a machine or a facility at a given point in time [5] by using a variety of tools and databases, strongly complemented by panoramas. Most recently, the team has been working on the post-LS2 configuration, to take into account the many changes that were made during the shutdown. It is important to ensure that panoramas represent the real on-site situation, and so photographs must be re-captured following any changes. The Configuration Management team processes and manages all engineering change requests (ECR), and so is informed whenever changes take place in the machines and facilities. As such, the team can effectively plan and undertake the capture and update of panoramas.

## USAGE AND BENEFITS

The Panorama application is used by many groups and teams across CERN. During operational periods, machines and certain technical infrastructure are not accessible. When planning future upgrade or maintenance works, such as those carried out during the LS2, it is therefore necessary for CERN groups to collect all pertinent information prior to the closure. Panoramas provide an even more immersive view than simple photographs, giving the user an idea of

the surrounding environment. This reduces the risk of errors in upgrade work planning and can help to minimise the time spent on preparation activities, as visits to the machines can sometimes be avoided.

Many CERN machines and facilities are radioactive. It is therefore important to plan and undertake works in a way that reduces potential radiation exposure to people, following ALARA (As Low As Reasonably Achievable) principles. Panoramas is contributing to ALARA, as they may provide sufficient information to avoid on-site visits.

A major user of the Panorama application is the Integration team, who is responsible for creating and maintaining 3D CAD models of the CERN machines and facilities. This team uses panoramas daily to check that 3D models accurately represent the real on-site situation. The panoramas were used to prepare and check integration models in advance of, and during, the LS2. Following the completion of on-site works during the shutdown, approximately 4,300 new panoramas were taken of the CERN technical facilities, experimental areas, and beam-lines. These were used to verify that integration models were updated correctly.

## EDUCATIONAL USAGE

The Configuration team quickly realised that the panoramic images of the CERN machines could be a useful educational resource. The team decided to develop a separate 'Outreach' Panorama application version [6] for the 2019 CERN Open Days, to showcase the tool to the wider public. This 'Outreach' version shows a sub-set of panoramas of the most interesting machines, areas and facilities of CERN for visualisation by the public. The interface was modified to improve usability for this different audience. For example, versions, floors, and links to other tools are not available, as these are not useful or interesting for the public. Furthermore, a clear navigation page, shown in Fig. 2, was developed to make the tool more user friendly.

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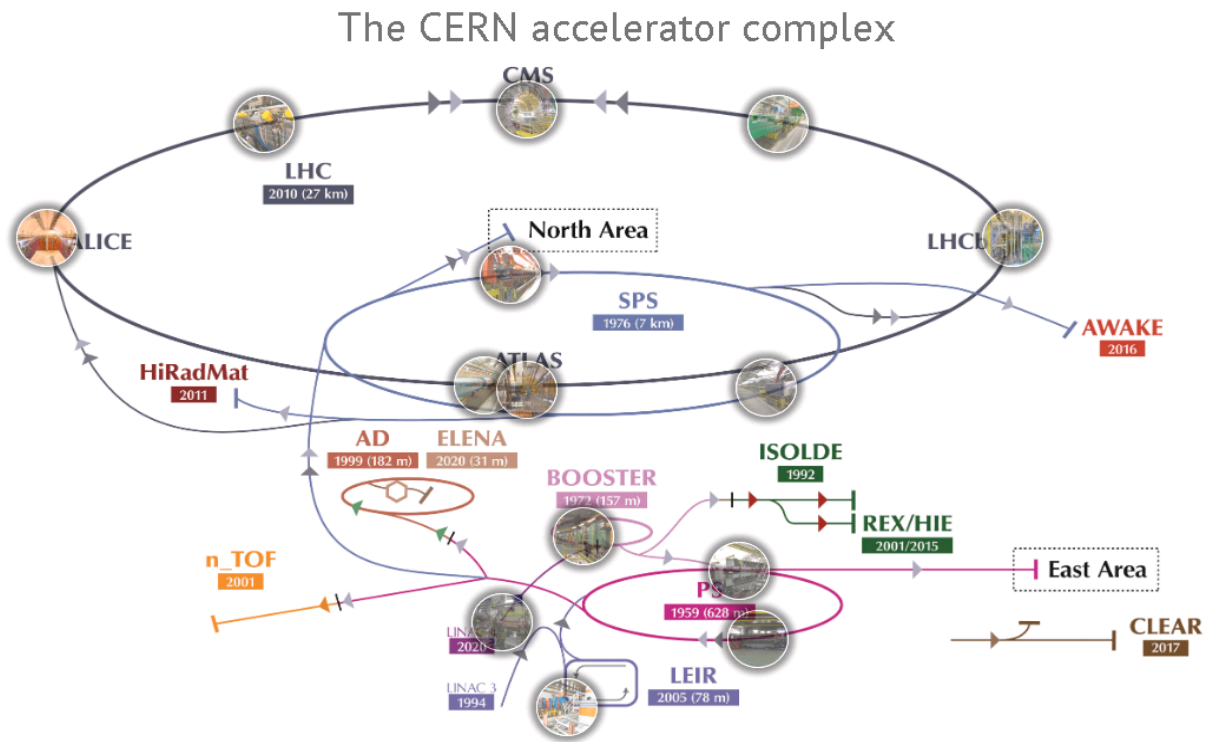


Figure 2: Outreach version navigation page. The CERN accelerator complex is schematically represented with clickable circular thumbnails where panoramas are available.

The CERN outreach team acknowledged the potential of this tool for the public. As a consequence, since December 2019, the outreach version is available on the CERN home website [6] and receives an average of about 75 visitors per day.

### FUTURE DEVELOPMENTS

Improvements to the Panorama tool and process are planned in the short and long term. The algorithms that are used to place the arrows that link panoramas together and determine versioning and floors will be updated. These algorithms were developed at the early stage of the project before the scope grew to include surface buildings and offices. As such, in some cases, this can contribute to navigation difficulties for users. By adapting the algorithms to be more appropriate for the current panorama project scope, it is expected that usability can be improved.

In recent years, advances have been made in commercial panorama cameras. The capture methodology will therefore be reviewed in the short-term to assess if panoramas could be captured more efficiently, whilst still maintaining a high quality. Using the experience gained during the LS2 campaign, potential improvements to increase the efficiency of the post-processing activities to make panoramas available in the application will also be studied.

Following feedback on the outreach version of the application, many users find it extremely interesting but would like to get information about the equipment they are looking at (e.g. name, function, characteristics, ...). Information buttons will be placed on key equipment shown in

the panoramas to address this. Investigations will be undertaken to see if this work could be done semi-automatically by reading data from other tools and databases, such as the Layout Database.

### SUMMARY

The Panorama application at CERN is presented and the various benefits discussed, in addition to the planned future developments. It is shown that the tool can serve as a useful support in the preparation and study of upgrade and maintenance works, notably following the ALARA radio-protection principles. Moreover, the public outreach version has been introduced as a useful additional educational resource.

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