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Getting the public closer to the experimental facilities: How Virtual Reality helps High Energy Physics experiments engage public interest

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For many High Energy Physics experiments the experimental area is difficult to access for visitors. That brings the necessity of engaging the public in other ways, both for educational purposes and for outreach and media events. The use of the latest technologies in Virtual Reality, Augmented Reality, and 360° visualisation helps the experiments in getting the public closer to their research. By virtually entering the experimental area the public can visit the different facilities in an immersive and autonomous way; also, by getting closer to the detector, people can get a feeling of the size and the complexity of the experiment itself. In the following, we present different software applications developed within the ATLAS Collaboration and based on the aforementioned technologies. We also describe how they have been used successfully in presentations to funding agencies and in a number of public events to educate the public about the ATLAS experiment at the Large Hadron Collider and to generally engage the public in High Energy Physics fundamental research.

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1. Introduction

Science communication is a crucial mission for the whole field of physics. At the European Organization for Nuclear Research (CERN), a dedicated group of people manages the complex visits calendar to enable hundreds of thousands people every year to visit exhibitions, former accelerators and the famous detectors of the Large Hadron Collider (LHC). However, the access to the experimental areas is difficult: the access is in fact allowed only when the experiments are not taking data and regulated by strict safety restrictions. In addition to that, due to the peculiar nature of the experimental sites and the safety procedures ruling them, the access is allowed to small groups of people and often not granted to people with disabilities or in vulnerable health conditions. As a result, only a few people, compared to the total number of visitors, can visit the experimental areas.

The situation can be improved by offering to the public a tool to visit and explore the experimental areas remotely, by leveraging the possibilities offered by the modern virtual reality and interactive visualisation technologies. With such tools, people can explore the experimental sites autonomously and in an immersive way, without leaving their home or through the participation at public events where activities using our virtual applications are available. With that, not only can we let many more people visit the experimental sites than scheduling would normally permit, but we can also let people who would normally be excluded (for disabilities, health conditions, among other causes) to visit. Another important limitation (and perhaps the most common one) is the necessity to travel to CERN to have the chance to see the experiments. Additionally, being able to get closer to the experimental areas and detectors or even to inaccessible parts of the inner-most sub-detectors, people can get a feeling of the size and the complexity of the experiment itself with the possibility to see real collisions and the representation of their resulting particles measured through the full detector.

In the following sections, we present distinct applications profiting from different tools focusing on the ATLAS detector [1] and its experimental areas where:

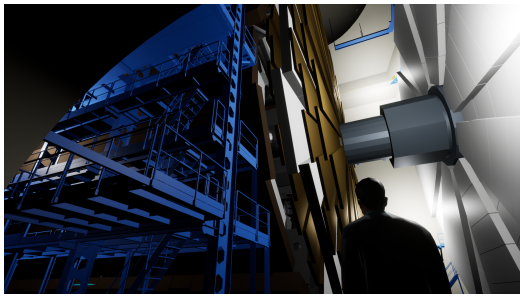
- The experiment is presented to the visitor in different outreach and social events, making use of the latest technologies in Virtual Reality (VR) through the ATLASRift application [2], Augmented Reality (AR) with the ATLAS In Your Pocket application [3] (one of the first ATLAS applications, developed to explore the technology), and 360° visualisation available from LHCPanoramas software [4];
- The public can travel from the control room to the experimental cavern, having a complete immersive experience where all infrastructure and sub-detectors of the ATLAS detector can be seen;
- Interaction points are strategically placed enabling a 360° photograph of the surroundings where the visitor can compare real photos of the ATLAS cavern and its virtual representation.

2. ATLASRift: a brief description

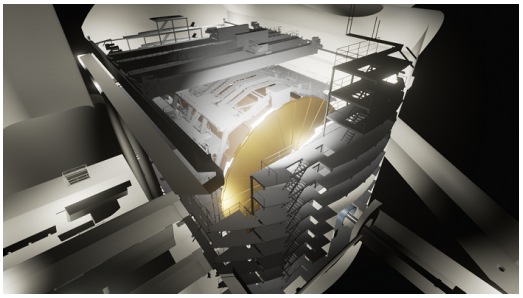
A virtual reality software called ATLASRift [2] has been developed on top of the "Unreal Engine" framework [5]. ATLASRift can be used with all major VR headsets, but it has been

customized for the "Oculus Rift" [6]. The application has three virtual spaces for visitors to explore:

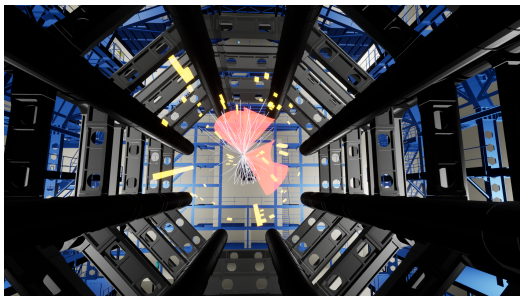
- The experimental cavern with a complete representation of all the ATLAS sub-detectors, accesses and catwalks;
- The ATLAS control room where the most enthusiastic visitors can learn more about subjects such as data taking and physics analyses;
- The CERN Globe of Science & Innovation with a summary of the history of CERN and the ATLAS Collaboration presented through virtual posters and videos.



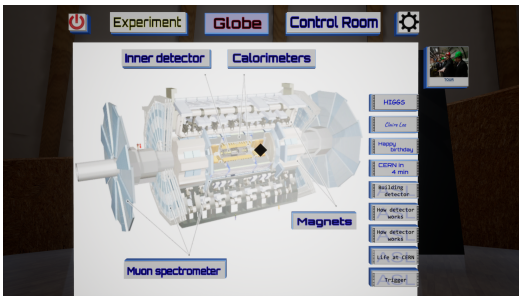
(a) View from inside the cavern.



(b) View from "outside" the cavern.



(c) Real event display visualisation.



(d) Display menu available to be controlled by the public.

(e) Exhibition at the CERN Globe of Innovation virtual space with sub-detectors represented.

(f) ATLAS control room virtual space with the display of webpages and videos.

Figure 1: Collection of screenshots of the spaces available with the ATLASRift application.

A collection of screenshots from the ATLASRift application presenting the different spaces can be found in Figure 1.

To best profit from the application, there are some hardware specifications that need to be fulfilled: a computer equipped with a good graphics card (standard computers are not sufficient - with them 3D graphics is not smooth enough and people tend to get motion sickness) and a VR headset (maximum immersion effect can be achieved with the Oculus Rift, but ATLASRift can also be run with other VR sets, like the HTC vive). Even when VR headsets are not available, AtlasRift can still be used at public events to engage people. Connected to an external large screen and a game controller, or a mouse, it enables people to navigate the ATLAS cavern in a game-like mode.

From the participation at different outreach events, it was concluded that the addition of a screen helps to attract more attention and involvement for a larger audience and lets the visitors waiting in line see what the person playing with the application is experiencing.

3. Additional applications

Besides the ATLASRift, the LHCPanoramas application [4] using Oculus Go [7] (a standalone version of the aforementioned Oculus Rift) is also used to admire the ATLAS detector through 360° visualisations. Its use is also possible with other VR tools such as Google Cardboard [8]. This application is the outcome of a joint outreach project with the CMS Collaboration and provides a unique experience since they were obtained by taking 360° photographs at strategic points of the cavern where the general public is not allowed to visit. Being a standalone device, the usage of the Oculus Go is very helpful during crowded events - while in the queue, the public can have an idea of what it will experience in the next minutes. A detailed 360° virtual tour to the ATLAS cavern is also available [9].

4. Feedback

Since the release of the first version of the software in 2015, a continuous improvement has been possible due to the participation of the ATLASRift in several events:

- Meeting of the Division of Particles & Fields 2015 in Michigan, United States of America;
- USA Science and Engineering Festival 2016 in Washington DC, United States of America;
- Fete de la Science 2016 in Geneva, Switzerland;
- ATLAS Christmas Party 2017 at CERN;
- CHEP 2018 Conference in Sofia, Bulgaria;
- Relay race 2019 at CERN;
- LMU 2019 in Munich, Germany;
- Hardronic 2019 Music Festival at CERN;
- European Night of the Researchers 2019 in Braga, Portugal.

From the experience of these events, we observe that interest from all ages is very considerable, and it is always one of the most crowded stands. The infinite curiosity of children is also perceptible, especially at events where more families are around. The public at the types of events targeted usually has some scientific background and general interest in science and particularly enjoy the

interaction with the detectors and the possibility of freely exploring the experimental cavern as well as the other infrastructure and galleries. It is also great to have occasions where even the ATLAS members can have a real size notion of their own detector for the first time. Besides that, sharing experiences with the other HEP collaborators developing VR applications is very fruitful.

From the organisation of public events and the participation of the public in our activities, lessons were learned and a guide of the best pratices compiled:

- **Motion sickness:** Most of the participants were using a VR application for the first time. Therefore, the guide should mention the possibility of motion sickness during this experience. From the feedback received, the seasickness was not felt by many people, but the guide should be aware of any indication on the contrary and try to resolve it by suggesting another activity. In this aspect, the LHCPanoramas application is more user-friendly and a possible alternative for ATLASRift.

- **Usability:** So far, public events used only one VR station. In the context of large events, this can cause a long waiting line since the guide must explain the basics of the application and then give the participants time to discover the ATLAS experiment by themselves. Another interesting usage of ATLASRift is the possibility to guide virtual visits. The precise representation of the ATLAS cavern and access infrastructure presents a great motivation and introduction to a future "real" virtual visit.

- **Intuition:** An explanation of the commands to navigate through the cavern needs to be performed before the usage of the application by the public. In general, the visitors are more focused on travelling through the cavern in order to have different points of view and a real feeling of the cavern size. Due to the several virtual spaces and tools in each of them, it is usual (and natural) to be confused by the menu options during the first minutes of the experience.

- **More practical terms:** In terms of hygiene, the use of shared headsets can pose problems in public events. This was not a concern at past events, but will be important in future ones, due to the pandemic situation. The use of a disposable cap for the visitor (as done for the ATLAS cavern visits) and a frequent disinfectation of the VR headset should be required for upcoming events.

Future improvements are always on the mind of the collaborators and developers and one such idea is the addition of sounds during the virtual visit. The noises of the ventilation, the racks, the pumps and the people working in the experimental cavern are a very strong part of the experience of the underground visitors. The combination of the visual aspect with sound can bring the ATLASRift application a step closer to the authentic experience and is one of the next planned upgrades to the experimental cavern virtual space.

The current pandemic situation has imposed many constraints on large public events. Fortunately, there is an upside to these restrictions: a growing community of citizens have their own equipment and are able to enjoy the ATLASRift experience from their homes. Taking this into account, additional features can be added to facilitate self-learning by the general public and the organisation of online public events where this community can be guided through the application by a physicist is an interesting possibility for future events.

5. Conclusions

The use of VR applications for practical explanations of the particle-physics detector world proves to be a great opportunity to engage the public both for educational purposes and for outreach and media events. Besides that, the current difficulties in visiting the experimental areas of the LHC and constraints on travelling have underscored the need for this new type of outreach activities. The feedback received from the use of ATLAS VR applications at several events demonstrates the consistent interest from all the participants. In addition to the real representation of the ATLAS detector and the corresponding infrastructure in the experimental areas, the ATLAS control room and the CERN Globe of Science & Innovation virtual spaces bring new ways to complement the experience while elucidating the complicated aspects of data taking and physics analyses. As always, further improvements to enrich the experience are in progress and participation at future outreach and social events will be restarted as soon as possible.

References

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[5] Unreal Engine website: https://www.unrealengine.com/en-US/

[6] Oculus Rift website: https://www.oculus.com/rift-s/

[7] Oculus Go website: https://support.oculus.com/go/

[8] Google Cardboard website: https://arvr.google.com/cardboard/

[9] 360° virtual tour to the ATLAS experiment: https://www.youtube.com/watch?v=On1WbLKP8DA&feature=youtu.be