PROCEEDINGS OF SCIENCE

Engaging Adults – Education and Outreach for ages 16+

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The ATLAS Collaboration has developed a number of highly successful programmes featuring educational content for schools and universities, as well as communication strategies to engage the broader public. The ATLAS Open Data project has successfully delivered open-access data, simulations, documentation and related resources for education and outreach use in High Energy Physics and related computer sciences based on data collected in proton–proton collisions at 8 TeV and 13 TeV. These resources have found substantial application worldwide in schools, universities and other public settings. Building on this success and in support of CERN's Open Data Policy the ATLAS experiment plans to continue to release 13 TeV data for educational purposes and – for the first time – also for research purposes. The ATLAS Communication Programme prepares substantial web content through online press statements, briefings that explain topical result releases to the public, video content (interviews with analysers, tours and live Q&As), and social media engagement.

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1. Introduction

The ATLAS Collaboration has developed a wide range of outreach and engagement resources appropriate for a broad range of adult audience. The Collaboration mainly aims to: attract interest and provoke curiosity in High Energy Physics (HEP)/ATLAS achievements, inform the general public about the basic research (and possibly get their support) and educate/inspire the next generation of scientists. The communication strategy is directed towards the general public, media, policy makers and active (hands-on) engagement of high-school students, STEM teachers, citizen scientist volunteers and university students. One of the main responsibilities of the ATLAS Collaboration at CERN, in addition to research and development, is to share the excitement of scientific exploration and discovery with the public through many science communication and educational activities.

2.The available resources

Various aspects of engagement are discussed in this document, including the ATLAS public website, on-site visits of the new ATLAS Visitors Centre at CERN and the highly-successful Virtual Visit program bringing CERN and the ATLAS experiment to tens of thousands of people. An overview of ATLAS contributions to International Masterclasses and the ATLAS Open Data project which has successfully delivered open-access data for education and outreach use in HEP, is presented. Finally, a brief reference is given to showcase resources such as presence in social media platforms and live videos on YouTube.

2.1 The ATLAS public website

The ATLAS public website [1] is the primary portal which gives public visibility of the ATLAS Collaboration. Its public content communicates the goals and successes of the experiment and has many resources for the general public to learn more about the Collaboration, science and scientists. The web content is divided into four main tabs (as shown on Figure 1):

- ABOUT: contains a general explanation of the experiment and its goals
- DISCOVER: holds more detailed information about the detector components with the possibility of taking a Virtual Walk through the detector
- RESOURCES: catalogs all ATLAS-related outreach materials, such as images, videos and brochures
- UPDATES: contains online press statements, briefings that explain topical result releases to the public, video content (interviews with analysers, tours and live Q&As), and social media engagement.

In addition, ATLAS occasionally collaborates with the CERN communication team to feature ATLAS news and briefings on the main CERN website [2], which helps attract more viewers to the ATLAS website.

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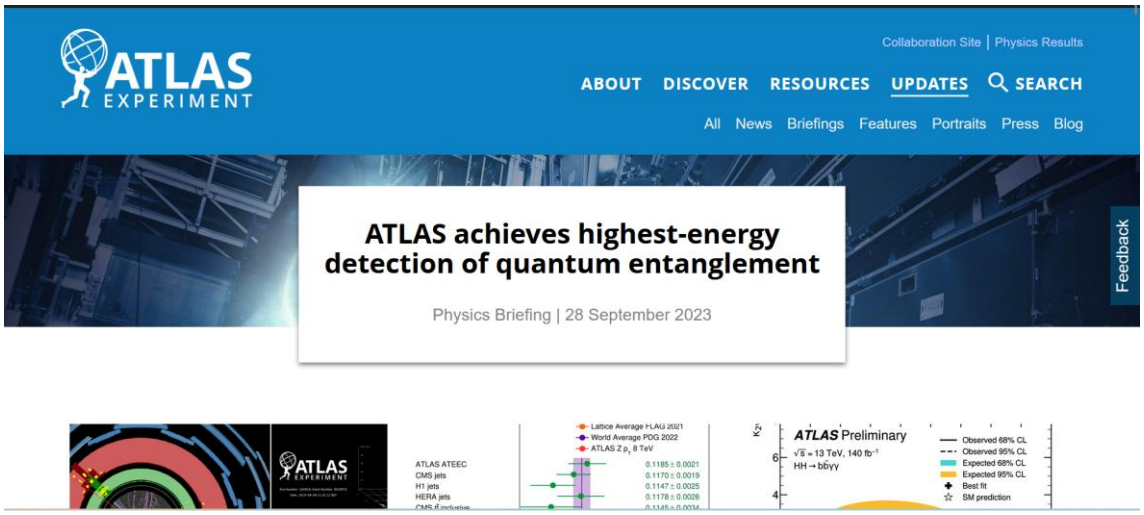

Figure 1: The "UPDATES" section of the ATLAS public website.

2.2 The International Masterclasses

The International Masterclasses (IMC) program [3] is the flagship of the International Particle Physics Outreach Group (IPPOG), inviting high-school students in collaboration with physicists from different experiments to "become physicists for a day". In 2023, in its 19th edition, it engaged 13,000 high school students, gathering in more than 200 different locations from over 55 countries around the world. The students visit one nearby university or research institution, get informed about the methods of basic research, and HEP in particular, and perform hands-on measurements on data offered by a wide range of experiments. All four LHC experiments have created their own masterclass exercises using recorded real data.

ATLAS has two very popular exercises: the "W path" and the "Z path". In both paths the students visually inspect selected samples of real ATLAS events collected from proton-proton collisions and learn how to identify the signatures of the collision products. In "W path", they use the MINERVA display tool [4] and look for leptonic decays of Ws. Then they form the ratio of positively to negatively charged Ws in order to investigate the structure of the proton. In the "Zpath", the students use the HYPATIA display tool and look for leptonic decays of Zs as well as for Higgs boson decays to two Zs and/or two photons. They investigate the relevant invariant mass spectra, look for resonances and differentiate decays to muons or electrons as well. ATLAS physicists from CERN (or Fermilab) moderate the video conference (at the end of the day) and discuss the students' findings from different schools with the use of web-based video tools. The "Z path" exercise is very popular and consisted of about half of all four LHC experiments' CERN based video conferences. The HYPATIA event analysis tool exists in two different versions: an offline one [5] and a simpler online one [6], shown on Figure 2. This online version is also used in shorter masterclasses when the ATLAS physicists visit the schools upon their invitation.

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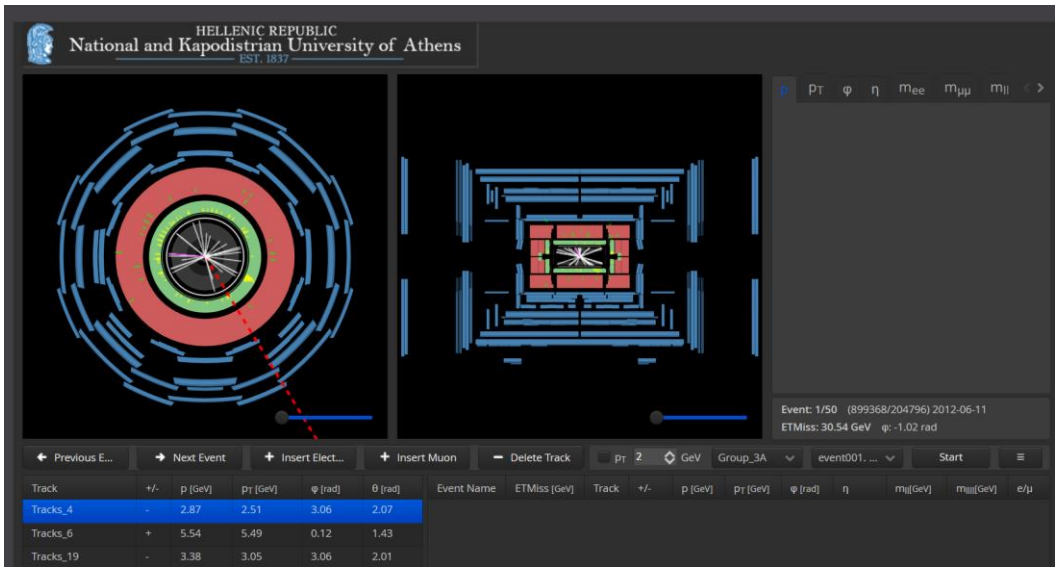

Figure 2: The online HYPATIA event analysis visual tool.

2.3 The ATLAS visits

The on-site visit at the ATLAS Visitor Center (AVC), located close to the main entrance of CERN on the Meyrin site, is one of the most-visited guided itineraries in the CERN visit program. For visitors who are not physically at CERN there is also the Virtual Visit program which brings ATLAS and CERN to the students' classrooms and public spaces. The visits aim to give students, teachers and the public, an overview of CERN and the ATLAS experiment, as well as their physics programs, goals, and operation.

2.3.1 The ATLAS Visitor Center

The AVC has been renovated between 2018 and 2021. In the AVC there are many installations and interfaces to support the guides on their tour, including a large full HD video wall, and three interactive touchscreens to give detailed information about the main sub-detectors. In addition, there is an ATLAS model made of LEGO pieces to illustrate the size and complexity of the detector. Visitors are guided through the different sections, where the installations highlight all the features of the experiment, focusing on its physics program and goals as well as on the Collaboration. The AVC is separated from the adjacent ATLAS Control Room (ACR) by an opaque window, as shown on Figure 3, which can be made transparent by a touchscreen to allow visitors to observe the shift crew monitoring the detector and recording data inside the ACR.

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Figure 3: Left: View of the AVC with the opaque window on the back of the photo, Right: the view of the control room through the transparent window [7][8].

2.3.2 ATLAS Virtual visits

Since its introduction in 2010, the ATLAS Virtual Visit (VV) program [9] has given opportunities to the audiences from all over the world to explore the experiment without coming to CERN. Using a combination of video conferencing, webcasts, and video recording, the project allows for live interactions between the remote audiences and members of the Collaboration. When the LHC is in open access (shutdowns, maintenance etc) the VV takes place at the underground ATLAS cavern where the guide is provided with a video camera and a Zoom connection to show the audience around, as if they were walking with him/her. When the VV cannot take place in the cavern, a dedicated separate area is available inside the AVC, with improved equipment, connectivity and lighting for visit hosts. Each visit typically hosts between 10 and 600 participants. Often when there is a visit with a large audience, it is livestreamed on YouTube, TikTok, and other social media platforms**.** In 2022, 121 Virtual Visits were conducted, for 36 countries on all continents and 8 different languages. In the first seven months of 2023 about 50 VVs took place and half of them were performed from the cavern.

We often receive enthusiastic feedback from the audience. As an example, after a VV for three girls' high-schools in Sri Lanka last November at 8 a.m. (right after the floods!), their teacher sent the card shown below (Figure 4).

Figure 4: Feedback card sent from a teacher in Sri Lanka after the VV

2.4 The ATLAS open data

The ATLAS Open Data project [10] aims to deliver access to data resources for education and outreach in HEP and related computer sciences. It is an open platform providing easy access to ATLAS real data, software and tools with documentation in the form of step-by-step instructions for users (mainly high-school and undergraduate students).The ATLAS Collaboration has so far released 1 fb^{-1} of 8 TeV proton-proton data (2016) and 10 fb^{-1} of 13 TeV proton-proton data (2020). Both datasets are accompanied by the relevant simulation datasets, tools and software of varying technical difficulty to analyze them.

The most basic tool is the "histogram analyzer" (shown on Figure 5), which is an interactive web application demonstrating the principles of a cut-and-count analysis without requiring any coding. There is also a visual analysis of events available using HYPATIA. For users who wish to learn about programming while analyzing the data, a variety of Jupyter notebooks are provided in C++ or Python. In addition, virtual machines are available if users want to work in a specific environment.

These resources have found substantial application by high school or undergraduate students for labs or research projects and were found to be a particularly good option for remote learning during the pandemic. As an example, in the University of Athens, the 3rd year physics labs were designed for event analysis using HYPATIA in batch mode. The open data project provided great help in involving students from countries in various geographic locations. In addition, countries that are not part of the ATLAS Collaboration used them.

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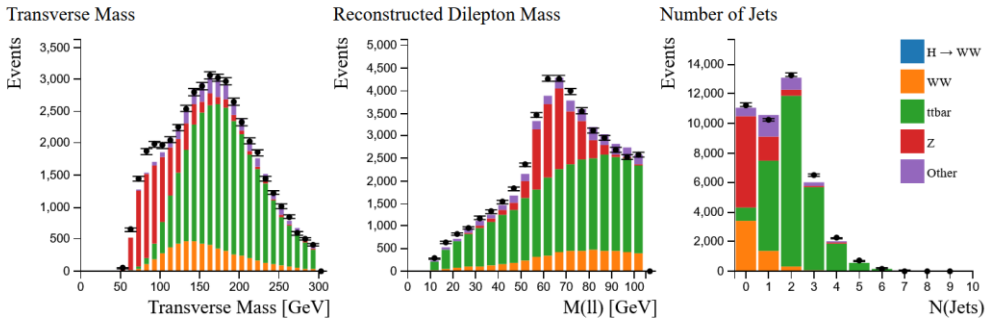

Figure 5: Examples of the histograms available for further simple analysis

Building on this success and in support of CERN's Open Data Policy, the ATLAS experiment plans to enhance the 13 TeV data with a new release for educational purposes and – for the first time – also for research purposes in 2024.

2.5 ATLAS presence on social media

Social media provides an opportunity to reach a wider and more diverse audience than the website alone. ATLAS is the leading LHC experiment in all social media platforms and has official accounts on all major platforms: Twitter/X, Instagram, Facebook, TikTok, YouTube, and LinkedIn. At the time of this contribution, the platform with the largest number of followers was Twitter, with more than 98,000. Additionally, the Collaboration is in the process of accessing newer social media like Threads, Mastodon, Hive, Flickt etc

2.6 ATLAS YouTube Live videos

ATLAS has recently posted new live YouTube long-videos. Recent ones, include ACR operations (Run-3 start), underground tours, and lectures all with interactive public Question and Answer session. The audience response has been excellent and an increased audience retention has been observed, mainly due to the interactive session.

3. Conclusion

The ATLAS Collaboration has developed many resources to communicate its science to the adult general public. A wide audience is reached through tailored content on a variety of platforms, in particular the ATLAS website, official ATLAS social media accounts, educational printable resources, Virtual Visits, Physics Masterclasses and the ATLAS Open Data and associated tools. All of these efforts are aimed at engaging more people in the excitement of search and discovery.

References

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