

# The new LHC event display

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In modern particle physics experiments the visualisation of experimental data - the event display - has a key role in many aspects.

The event display is basically a "photograph" of an event. By event we mean the information from the particles created from a collision of two beams or a beam on a fixed target. Particles are detected due to their interactions with the detector material, producing electrical signals which are processed and digitised; this digital information - the "raw" data - is recorded and then reconstructed, translated to the information conveyed by the detectors, which can be position, time, energy or particle identity. The superposition of the reconstructed information on the geometry of the detector generates the event display. Typically, the trajectories of charged particles are represented as lines, often with different colours, which can indicate the type of particle or its momentum; the energy deposited in calorimeters is represented as towers; jets are represented as cones.

Used in real time to visualise the data, the event display is a powerful tool: it gives an idea of how well the detectors work and helps debug the reconstruction software. In addition, event displays come in handy for outreach and educational purposes. By making visible all these invisible particles, event displays help the layman grasp what happens when accelerators and detectors are at work. Last but not least, these beautiful snapshots of collision events are a source of inspiration for artists.

Each LHC experiment has developed its own event display, in the framework of the analysis software used; these dedicated packages are continuously adapted and improved. As an example, for the ALICE experiment, the new event display is part of the  $O^2$  software, a new analysis framework common between online and offline. The event displays of today have evolved to a high degree of sophistication, showing details of the detectors or of different physics processes.

There have been efforts to develop a common tool. For example, for the CERN microcosm exhibition, a generic event display (called TEV, Total Event Display) has been developed, which can be used for any experiment, as long as the description of the detector geometry and the data are provided in a suitable format.

In recent years Phoenix, a web-based framework for event and geometry visualisation has been developed; the idea is that it can be used by different experiments (it is independent of the experiment's software) with a simplified version of the detector description and the data. Here one can see an example of an interactive event display from ATLAS done with Phoenix. CMS has also developed iSpy, a web-based application used for outreach and particle physics masterclasses, where high-school students analyze experimental data based on visual inspection of events.

The first heavy-ion run of Run3 of the LHC started on the 26 September 2023, producing beautiful event displays from lead collisions; we are looking forward to many more.



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