Development of the Browser-based 3D Visualisation Approach for the ATLAS Outreach Applications

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Abstract

Outreach & Education in High Energy Physics (HEP) profits greatly from 3D visualization and advanced VR (Virtual Reality), AR (Augmented Reality), and MR (Mixed Reality) technologies to easily explain detector facilities and visualize various physical events. While browser-based applications based on gaming engines best fit the requirements for visualization, their real-time code interpretation and data downloading from servers can limit performance. The paper discusses methods of simplifying complex 'as-built' geometry descriptions, which are essential for the performance of browser-based applications and the quality of visualization, and the AR/VR applications developed based on this simplified geometry.

Methods

Developing web-based 3D tracer applications involves challenges due to the complexity and volume of graphical data, leading to high rendering times and data loading latency.

Challenges:

- Geometry Complexity: Detailed geometries increase GPU load and reduce performance
- Data Loading Latency: Loading large datasets over the web can be slow, impacting user experience, especially for educational tools that need to be accessible and responsive

To mitigate these issues, we employ several strategies:

- Geometry Simplification: Reducing triangles and optimizing detail based on visibility lowers GPU load

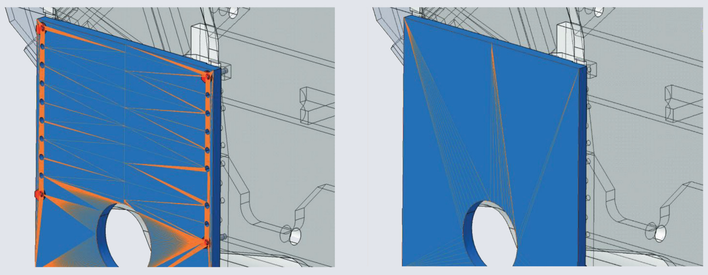


Figure 1. Facet-based representation of the Feet plates

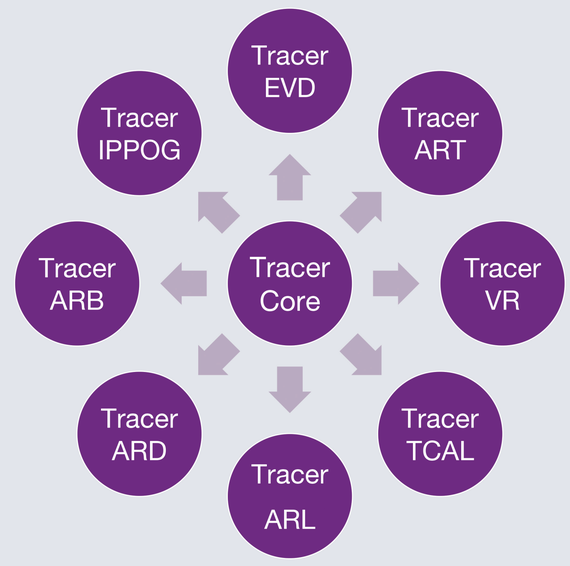
- Efficient Data Architecture: Using optimized data structures and efficient loading mechanisms, leveraging WebGL for better performance
- Adaptive Techniques: Adjusting the level of detail based on zoom level and viewpoint to balance performance and visual quality.

When developing web-based 3D tracer applications, Three.js, a popular JavaScript library for creating 3D graphics, is a strong choice due to its lightweight design, versatility, and efficient WebGL compatibility. Its efficient rendering capabilities make it ideal for a variety of applications.

Tracer Framework

The Tracer Framework is built on a modular architecture centered around the Tracer Core, ensuring flexibility, scalability, and maintainability.

The Tracer Framework includes several specialized applications:



tracer.web.cern.ch

1. EVD (Event Display Application): Provides a 3D view of particle collision events in the ATLAS detector
2. ART (Augmented Reality Table): Brings the ATLAS detector to life on a discussion table using AR technology
3. ARB (Augmented Reality Book): Extends paper documents into 3D visualizations.
4. VR (Virtual Reality Application): Delivers a realistic VR experience of the ATLAS Detector

Figure 2. Tracer ART

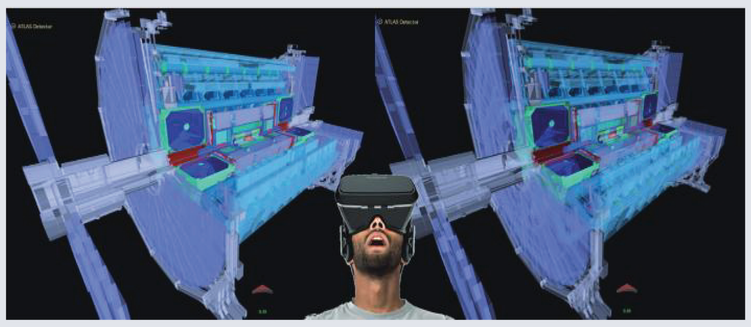
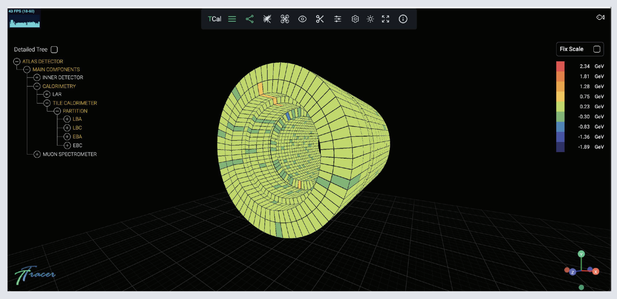


Figure 3. Tracer VR for organizing the virtual tours of the ATLAS detector

5. EVD MC (Masterclasses Event Display): Tailored for the IPPOG Masterclasses to display event data
6. ARD (Augmented Reality Door): Augmented reality door for navigation inside of the ATLAS Detector
7. TCAL (Tile Calorimeter): Offers an interactive 3D display of the Tile Calorimeter

Figure 4 TCAL
Users can explore its hierarchical geometry, visualize cell energies and other parameters, and manipulate the structure for detailed analysis.



8. ARL (Augmented Reality Landscape): Augmented reality landscape for visualizing the ATLAS Detector in its real scale and environment.

Conclusion

Developing 3D browser-based Tracer applications requires careful consideration of tools and methods. Simplifying geometry and optimizing data management ensure smoother user experiences, leading to more accessible and impactful visualizations across various fields.

References

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[3] The ATLAS Collaboration. “Performance of the Muon Alignment System in 2011 Data with Release 17” / ATLAS-Plot-Muon-2011-003