Exploring server/web-client event display for CMS

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Content

• Review of functionality of current CMS event display, Fireworks, and ROOT EVE
• Motivation to “change”
• Preliminary exploration with JSROOT and Fireworks
• EVE modernization
• Future work plan
CMS event display

- Fireworks application – CMS data exploration tool
- Based on ROOT
  - Data stored in ROOT format (CMS EDM)
  - All 2D/3D graphics is done with ROOT EVE + GL
- Physics Analysis oriented
  - Primary users
    - Physics analysers, MET scanners, Particle Flow algorithm developers, new detector geometry developers
    - Simplified information presentation is favored over exact 3D presentation for primary users
Essential Features

Fireworks only:

• Ability to access and interact with data collections, physics objects and experiment data model
  – Event filtering
  – Collection selection, item filtering
  – Table view where column value can be an arbitrary expression

Used from EVE:

• Primitives & Algorithms for Physics oriented event Display:
  – Multi-view / multi-scene support
  – Geometry access and drawing
  – Flexible track propagator accepting trajectory guides; magnetic field representation
  – Automatic non-linear (fish-eye) and scaling transformations

• Object selection and highlighting across multiple views
Motivations for change

1. Long term maintainability
   - GUI and GL components are becoming really old
     • Increasing number of issues with system level support for GL and remote GL
     - OpenGL being deprecated in general and on OSX in particular

2. On client side, support as many platforms as possible
   - Windows and future versions of OSX
   - Allow access from phones and tablets
   - Easier client side customization with usage of standard libraries

3. ROOT is moving to web based interface in version 7
Preliminary exploration with JSROOT

• Embed THttpServer into Fireworks
  – Wrote a simple client based on JSROOT / OpenUI-5 / THREE.js
  – Client commands get translated into Fireworks signals to initiate change:
    • Event navigation, rebuild table view content, EVE scenes, …
  – Draw / display what was relatively easy to stream:
    • Table view, simple shapes, tracks, and hits
  – Did not do:
    • Streaming and client rendering for more advanced EVE classes (jets, calos)
    • Interaction with EVE elements
    • Projections

• **Goal:** learn about new technologies, evaluate existing code in view of what should be done a true web-based display.
First test – simple Fireworks client: Screenshot of web browser window
Second Step: the Web Entanglement

• The first step – declare success!
  – Technology available and easy to use.
  – Staying with ROOT / close to ROOT makes the most sense.

• The problem – what to do next?
  – We did not know enough to estimate the exact needed time (rough guess 4 FTE).

• The solution:
  • Minimal refactoring of EVE for server – web-client operation.
  • Forego any changes on Fireworks side – but think how some of its features could be transplanted into EVE.
  – This effort was supported by the ROOT team:
    • Considered as prototype of ROOT-7 EVE ➔ EVE-7 or FireEve
  – This phase has actually just concluded (Jun 2018).
EVE ↔ EVE-7 prototype

- Strip away all GUI / GL functionality
- Implement:
  - Object identification
  - Serialization for Eve classes (JSON for meta-data, binary for tesselations/points)
  - Mechanism to execute client commands as object function calls through interpreter
  - Subscription scheme so clients can receive only parts of the available content
    - This is a multi-clinet event display where different clients have different view types
- Reuse:
  - RhoPhi / RhoZ projection and Track Propagator code
  - Scene & Object change / update protocol
- Port only a subset of EVE classes (skip calorimeters, digit classes, etc).
Eve-7 client in Chrome browser
Physics collections in EVE-7

• Old EVE had no support for management & display of experiment specific physics collections
  – EVE objects were always just visual representations of physics objects.
• Concepts of Physics Collections and Event Items are essential to Fireworks data management and display.
• We realized the Physics Collection concept can be implemented in EVE-7! Benefits:
  • Provide **filtering** of physics objects on the level of physics collection.
  • Support **Table views** with arbitrary expressions for each column.
  – Use CLING and lambdas for compilation of filtering and column expressions.
TParticle collection in EVE-7
Conclusion

• Web based event display is attainable solution for the next decade.

• CMS is committed to support development of EVE-7 and modernization of Fireworks.
  – Chosen solution for Physics oriented event display from Run 3 onwards.

• Expected workplan:
  – Evolve EVE-7 to contain basic features
  – Port Fireworks to EVE-7
  – Work on advanced features of Fireworks and EVE-7

• BoF session today from 2 to 4pm