Hall A event visualization in Python

Tyler Kutz
Stony Brook University

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Hall A/C software workshop
1. Introduction

2. Tools

3. Visualization code
Goal

Need a program to visualize events and detector response in the Hall A HRS

This requires tools to:

• Build and visualize detector geometry  (VPython)
• Read event data from ROOT files    (PyROOT)
• Visualize event and detector response (VPython)
VPython

VPython is the Python language plus the Visual 3D graphics module

Basics:

• Construct objects from set of simple volumes
  (sphere, box, cylinder...)

• More complex objects possible using extrusion

• Each object has a set of...
  • ...geometric attributes (pos, length, radius...)
  • ...optical attributes (color, opacity, material...)

```python
# create a red cube at origin with unit side length
from vpython import *
myBox = box(pos=vector(0,0,0), length=1, width=1, height=1)
myBox.color = color.red
```
Reading event data with PyROOT

Normal (C++) method for reading data from a ROOT tree T:

```c
double var;
T->SetBranchAddress("branch", &var);
T->GetEntry(i);
```

Python doesn’t have pointers! Python method is:

```python
T.GetEntry(i)
var = T.branch
```

But...our branch names have periods in them (e.g., R.tr.n). Python interprets this as the dot operator!

Cleanest solution I found:

```python
T.GetEntry(i)
ntr = getattr(T, "R.tr.n")
```

Alternate suggestions are welcome!
Structure of visualization code

Each detector is built its own file `detector.py`:

- Contains single function `build_detector` that constructs geometry
- Function must return object/array of objects composing that detector

Main function `event_vis.py`:

- Draws coordinate system axes
- Sets scene lighting, camera focus and initial angle
- Imports and executes all detector build functions
- Opens ROOT file (PyROOT) and loops over events
  - Draws electron track
  - Adjusts detector appearance to reflect detector response
Demonstration

• Current visualization contains the RHRS preshower/shower calorimeters
• VDC is shown as visual reference but does not respond to event data
• Tracks are shown as green lines
• Calorimeter blocks in shower cluster are colored red
  • Saturation adjusted based on ADC signal
Summary

• VPython is a simple tool allowing 3D graphics visualization

• PyROOT allows Python programs to directly access data from ROOT files

• Combining these tools allows visualization of detector geometry and event data

• Future improvements:
  • Define complete detector geometry
  • Implement more quantitative visualization of detector response
  • Create GUI for cycling events, displaying event parameters, etc.

Currently tracked in the `replay/scripts` directory of the tritium repository: [github.com/JeffersonLab/HallA-Online-Tritium](https://github.com/JeffersonLab/HallA-Online-Tritium)