

GEANT4 Simulation of the MeV Mott Polarimeter:

A Tutorial

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Overview

- What you need
- Checking out, configuring, and compiling
- Running in interactive mode
- Running in batch mode
- Output Files
- Where do I make changes?
- Assignments
- Resources

What You Need: ifarm usage

- Computer on the internet
- Access to the JLab ifarm computing clusters
- Access to the GitHub JlabMottGroup repository

There is a working version maintained at:

```
/u/group/mottgrp/MottG4
```

To use this version, you must have:

```
source /site/env/syscshrc.alt
```

```
setenv MOTTG4DIR /u/group/mottgrp/MottG4
```

```
source /site/12gev_phys/production.csh
```

or their bash/zsh equivalents in your startup scripts.

What You Need: local box Usage

- GEANT4 installed and able to compile and execute the included examples :)
 - <http://geant4.web.cern.ch/geant4/UserDocumentation/UsersGuides/InstallationGuide/html/>
- cmake version 2.8 or more recent

Note: GEANT4 is rather sensitive about it's running environment. It's not trivial to get and keep running.

Checking Out & Compiling

- To checkout a version to develop, login to ifarm then:

```
> cd /path/to/directory/ (wherever you want MottG4)
> git clone https://github.com/JLabMottGroup/MottG4.git MottG4
> setenv MOTTG4DIR /path/to/directory/MottG4
```

- To compile:

```
> cd MottG4/Mott_Polarimeter/
> cd build/
> cmake ..
> make
```

Running Interactively

- To Run:

```
> cd build/
```

```
> ./mott
```

The screenshot displays the mott application interface. On the left, a 'Scene tree' panel lists various components such as control, units, process, geometry, tracking, event, cuts, run, random, particle, Target, Stepping, PhysicsList, Beam, PrimaryGenerator, gun, Analysis, EventAction, material, hits, vis, and gui. The main area is a 3D viewer titled 'viewer-0 (OpenGLStoredQt)' showing a dark scene with a central yellow and grey object. Below the viewer is an 'Output' panel containing a log of simulation parameters and a 'clear' button. At the bottom, there is a 'Session:' label and an empty input field.

Running Interactively

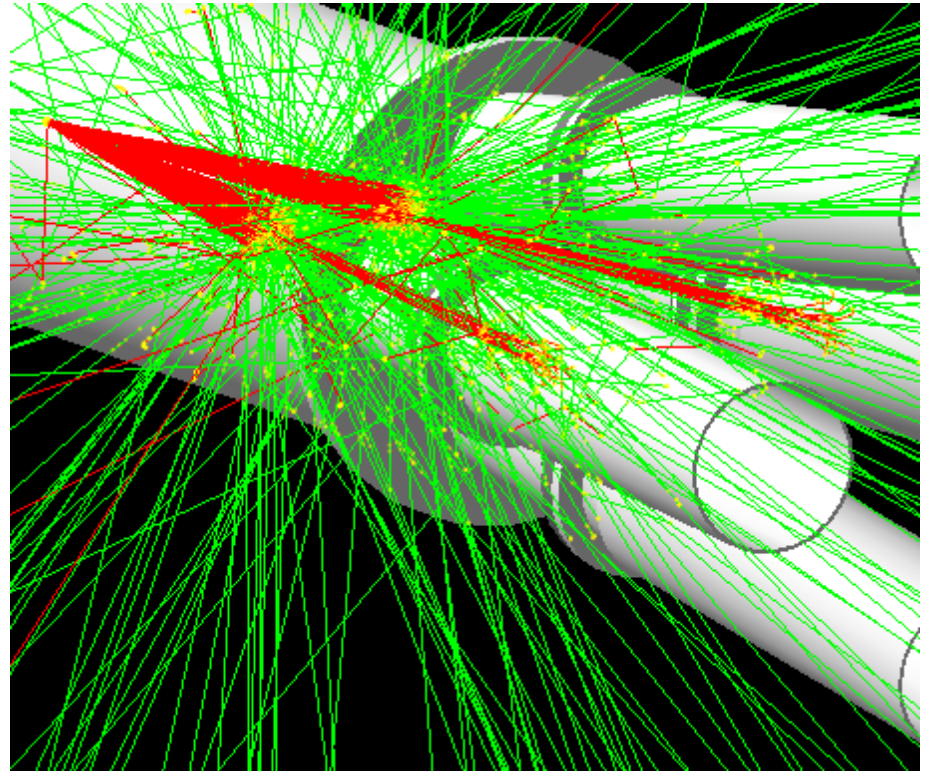
- To make a run we can analyze:

```
> /EventAction/StoreAllEvents 1  
> /run/beamOn 1000
```

- Can manipulate viewer w/ mouse ->

- To look at that run, close the sim, then:

```
> cd ..  
> root -l MottSim.root  
> Mott->Draw("Left_E", "Left_E>0", "");
```



Running in Batch Mode

- Make a macro for 4 runs:

```
> cd /path/Mott_Polarimeter/  
> vi macros/myAsym.mac
```

- To run:

```
> cd MottG4/Mott_Polarimeter/  
> ./build/mott macros/myAsym.mac
```

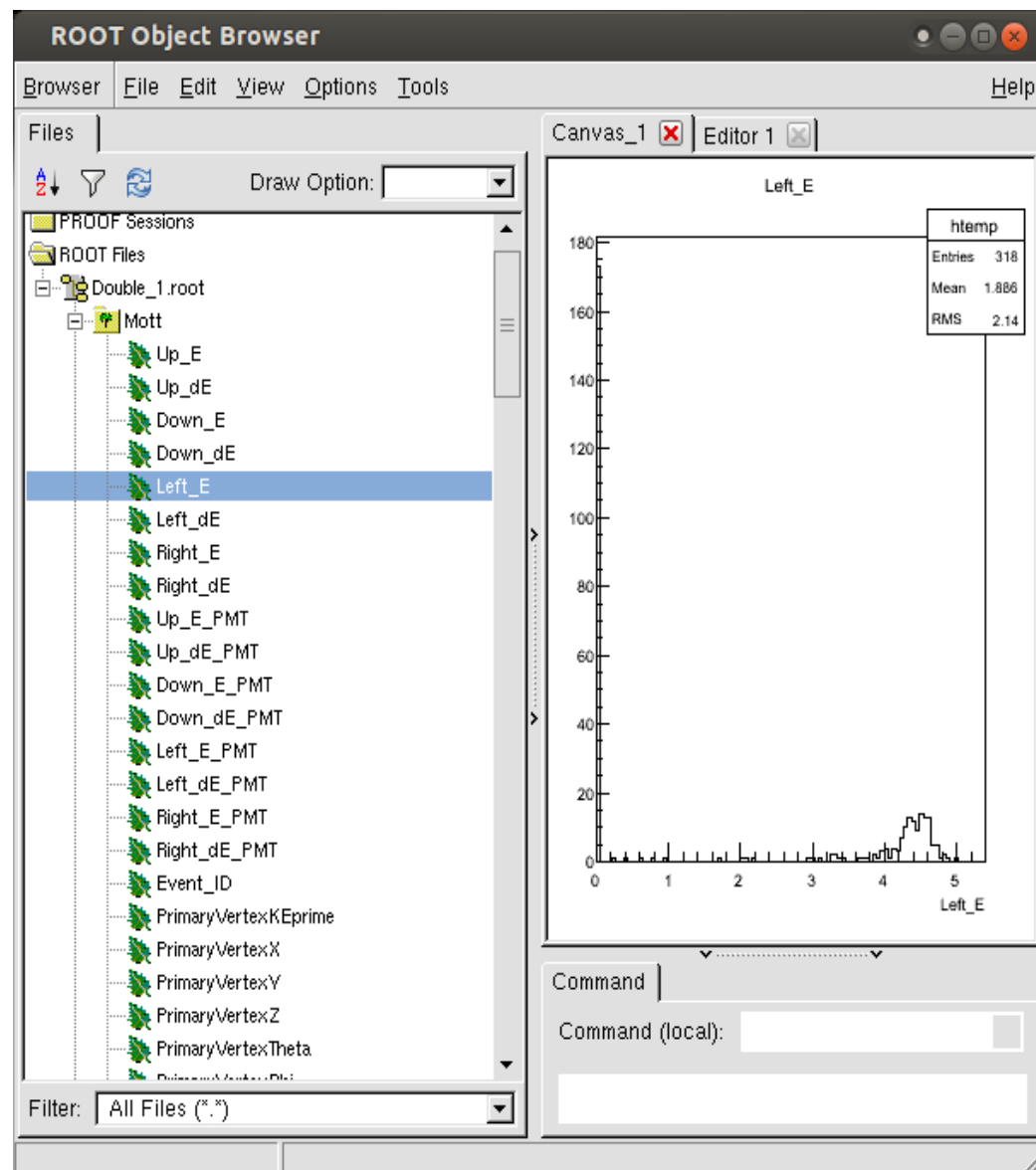
- Macro contents:

```
/Target/SetTargetLength 0.100 um  
  
/PrimaryGenerator/EventType 3  
/Analysis/RootFileName Single_1.root  
/run/beamOn 1000  
  
/PrimaryGenerator/EventType 4  
/Analysis/RootFileName Double_1.root  
/run/beamOn 1000  
  
/Target/SetTargetLength 0.200 um  
  
/PrimaryGenerator/EventType 3  
/Analysis/RootFileName Single_2.root  
/run/beamOn 1000  
  
/PrimaryGenerator/EventType 4  
/Analysis/RootFileName Double_2.root  
/run/beamOn 1000
```

Breakout: Look at output rootfiles

ROOTfile Structure

- Energy deposited in detectors
- PMT response (OFF BY DEFAULT)
- Kinematics:
 - Angle
 - polarization
- Scattering Dynamics:
 - Cross sections
 - Spin functions
- To see the structure:
 - > `root -l Single_1.root`
 - > `Mott->Print()`



Structure of MottG4: Where do I make changes?

- `Mott.cc`: Boilerplate file, contains `main()`
- `src/MottRunAction.cc`: Creates ROOTfile for output, called at the start of each run.
- `src/MottDetectorConstruction.cc`: Contains the geometry of all objects and assigns sensitive volumes.
- `src/MottPrimaryGeneratorAction.cc`: Loads in Xavier's Mott physics, throws electrons based on this physics and user inputs.
- `src/Mott_____Messenger.cc`: Allows the user to interact with the _____ class through command line and macro interfaces.
- Xavier's files are in the directory: `/MottG4/NewMottPhysics/`
- Additional info can be found in the user's guide I wrote:
https://wiki.jlab.org/ciswiki/images/4/42/Mott_Geant4_User_Guide.pdf

Correcting the Scattering Angle

- **Joe Reported:** $\text{Theta} = 172.71^\circ$
- **Lets put that in:**

```
> vi src/MottDetectorConstruction.cc
```

```
Find: G4double ScatteringAngle = 172.6*deg;
```

```
Save
```

```
> cd build/ && make
```

Pushing Changes to Repository

- Check where you are w.r.t. Github:
 - > `git diff master origin/master`
- If it looks good:
 - > `git push origin master`

Assignments

- Analyze your rootfiles you generated today to see the asymmetries, look at scripts included if you need to
- Check my to-do list on the mott wiki.
- Ask me any questions you can think of!