

Expectations for LArIAT contributions to Geant4 and what do you expect from Geant4?

Hans Wenzel

LArIAT Collaboration Meeting
July 10th 2014

Outline

- Who are we?
 - about myself
- What are the planned measurements
- Tool we are working on
 - Geant 4 validation repository
 - Artg4tk
 - Modular physics lists/factories
 - Numi beam line

•Expectations

The PDS Group

Group leader: Daniel Elvira

Deputy: Krzysztof Genser

Geant 4: Robert Hatcher, Julia Yarba, Hans Wenzel, Krzysztof

Summer student: Kelly Barnett

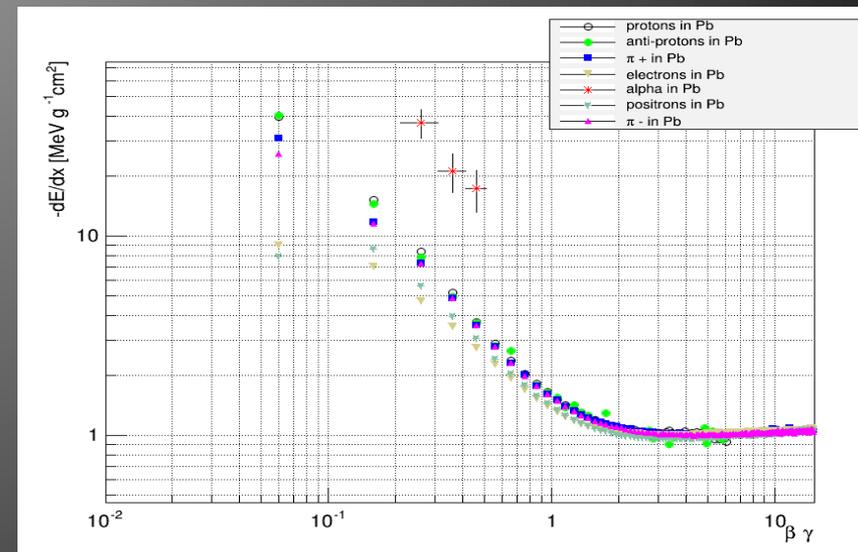
Genie: Gabriel Perdue, Tomasz Golan, Robert, Julia

Working on calorimeter R&D (specifically homogeneous, total absorption dual readout calorimeter (hhcal)). arg4tk/CaTs were developed as modular frameworks for fast prototyping allowing to make complete use of geant4. We instrumented the simulation so that we could study the particles/processes contributing to the signal. Understand the mechanism of compensation in a DR calorimeter. Guide for test beam studies.

	Hhcal (PbWO)	LArTPC
homogeneous	yes	yes
Total absorption	yes	(yes)
Dual readout	Yes (Sz + Cerenkov light)	Charge + Sz
Radiation length(cm)	0.89	14.0
Interaction length	20.7	83.
Density [g/cm ³]	8.29	1.4

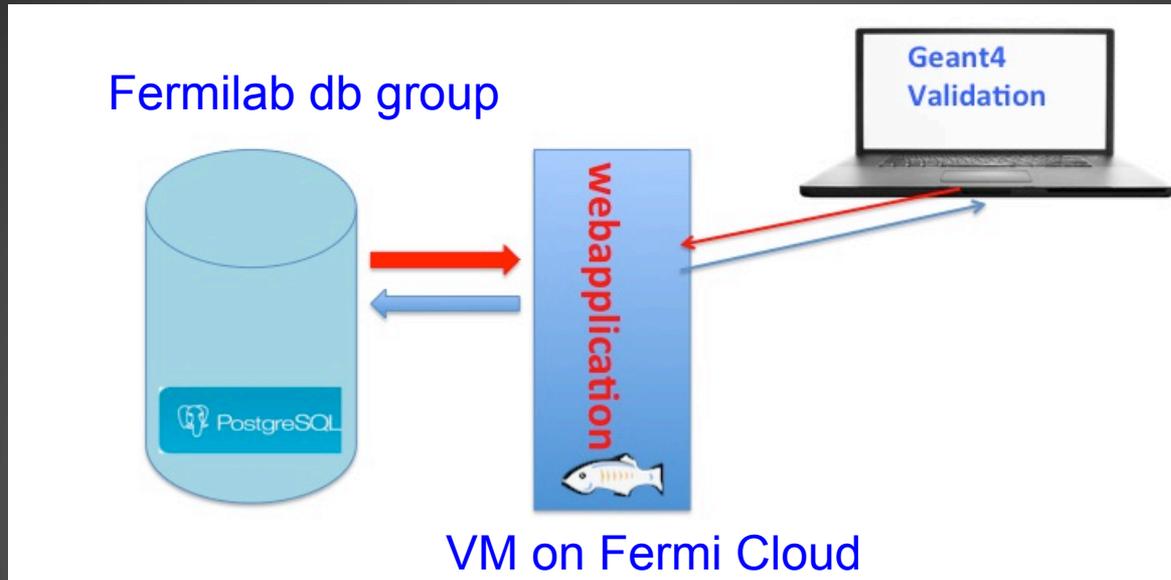
LARIAT Planned measurements

- Visible energy calibration dE/dx , Birks etc.
- PID methods
- e/gamma shower separation
- Muon sign determination
- Antiproton stars (why not spallation processes?)
→ Got excited: All looks interesting and looks like we could contribute expertise and look in detail how geant 4 performs.



The geant 4 Validation repository

The tool



<http://g4validation.fnal.gov:8080/G4ValidationWebApp/>

Central repository (Database) of tests, where a test is a comparison of experimental data with simulation.

Test and experimental data are stored as plots (blobs), data arrays or histograms with metadata (tags, testdes, publications...) in the data base. The web application allows to View the tests. We distinguish what can be seen by the public and by collaborators

Geant4 Physics Validation - Mozilla Firefox

File Edit View History Bookmarks Tools Help

Geant4 Physics Validation

g4validation.fnal.gov:3080/G4ValidationWebApp/

Most Visited Latest Headlines Getting Started G4Validation Geant 4 Personal ILC CMS Fermilab CERN Search CVS My Projects UbuntuScience - Com... Ubuntu - ne

Geant 4

Home > Results & Publications > Physics Validation and Verification

Home Validation Overview Release Highlights Electromagnetic Hadronic LHC-feedback Expert

Welcome to the Geant4 Validation Repository
Please make your selection from the menu on the top

Database statistics

Number of test setups	21
Number of test results (public and internal)	18128

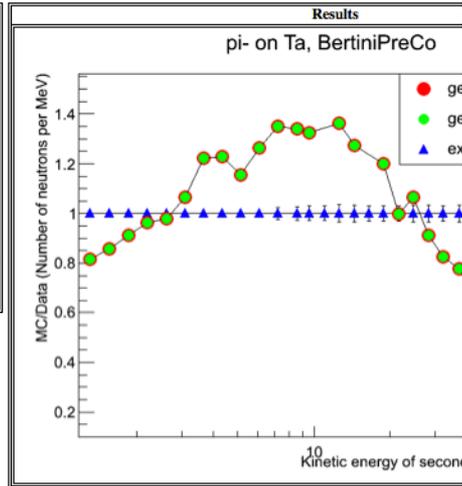
List of Tests

Name	Description	Working Group
ATLAS	shower characteristics of ATLAS Calorimeters	LHC-feedback
CMS	shower characteristics of CMS Calorimeters	LHC-feedback
Hadrion	Test of Physics Lists (thick targets, ion beams)	hadronic
HadrXS	Test of Physics Lists (cross sections)	hadronic
Hadrcap	is an analogous to Hadr00, with advanced features.	hadronic
IAEA	IAEA Benchmark of Nuclear Spallation Models	hadronic
Ndata	Test concerning developments of new nXS, it is calling HP XS as well as HPW XS.	hadronic
Testfragm	Test of hadronic generators (thin targets, ion beams)	hadronic
atlasbar	Test of ALTAS barrel type em calorimeter, determines response, resolution, and CPU performance	electromagnetic
placeholder	Dummy testdes	hadronic
simplifiedCalo	Test of Shower shapes using selected simplified calorimeter setups.	hadronic
test19	high energy test, provides comparison with NA61 (31GeV/c proton beam) and NA49 (158GeV/c proton beam) data sets.	hadronic
test22	Testing of the FTF model and comparison with experimental data for a wide energy region	hadronic
test30	Test of hadronic generators of inelastic processes	hadronic
test35	Test of hadronic generators of inelastic processes, based on results of HARP collaboration, Experiment PS214 at CERN.	hadronic
test37	Test against Sandia data, electron beam in semi-infinite media.	electromagnetic
test41	Comparison with MUSCAT experiment for multiple scattering validation	electromagnetic
test45	Test of hadronic generators of inelastic processes on thick targets.	hadronic
test47	Intermediate energy validation is done by comparing Monte Carlo predictions vs experimental data.	hadronic
test48	Stopping particle test Monte Carlo predictions are compared to experimental data.	hadronic
test75	test of gamma-nuclear interactions	hadronic

Name of the Test:	test48
Responsible:	J. Yarba (Fermilab)
Description:	Stopping particle test Monte Carlo predictions are compared to experimental data.

Geant4 Version:	geant4-9.6-p02
Observable:	kinetic energy of secondary neutrons
Reaction:	pi- on Ta
Status:	public

Test Conditions	
Name	Description
last-modified	2013-09-13 17:44:44 CDT
Target	Ta
Particle	pi-
Comment	Bertini is using PreCompound to handle evaporation
Model	Bertini: 4.9.6-p02, 4.9.6-p01
Reference	C. Amstler, Rev. Mod. Phys. 70, 1293 (1998)
Reference	C.B. Dover et al., Prog. Part. Nucl. Phys., Vol.29, pp.87-173 (1992)
Reference	R. Madey et al., Phys. Rev. C 25, 3050-3067 (1982)
Reference	K.D.Larson et al., Phys.Rev.D47(3), p.47, 1993
Reference	PSinger, Springer Tracts in Modern Physics, 71, 39 (1974)
Reference	R.M.Sundelin et. Al., Phys.Rev.Lett., Vol.20, Number 21, 11
Reference	M.Goossens et al., in Low and Intermediate energy physics ((Riedel, Holland, 1980, p.243)
Score:	passed
Type:	expert



List of hadronic Tests

- HadrIon
- HadrXS
- IAEA
- Testfragm
- simplifiedCalo
- test19
- test22
- test30
- test35
- test45
- test47
- test48
 - geant4-9.6-b01
 - geant4-9.6-p01
 - geant4-9.6-p02
 - geant4-9.6-p02
 - pi- on Pb
 - pi- on Ta
 - pi- on Cu
 - pi- on Al
 - pi- on O
 - pi- on N
 - pi- on C
 - Sigma- on H
 - K- on H

Menus don't allow to refine the selection
Only (test/reaction)

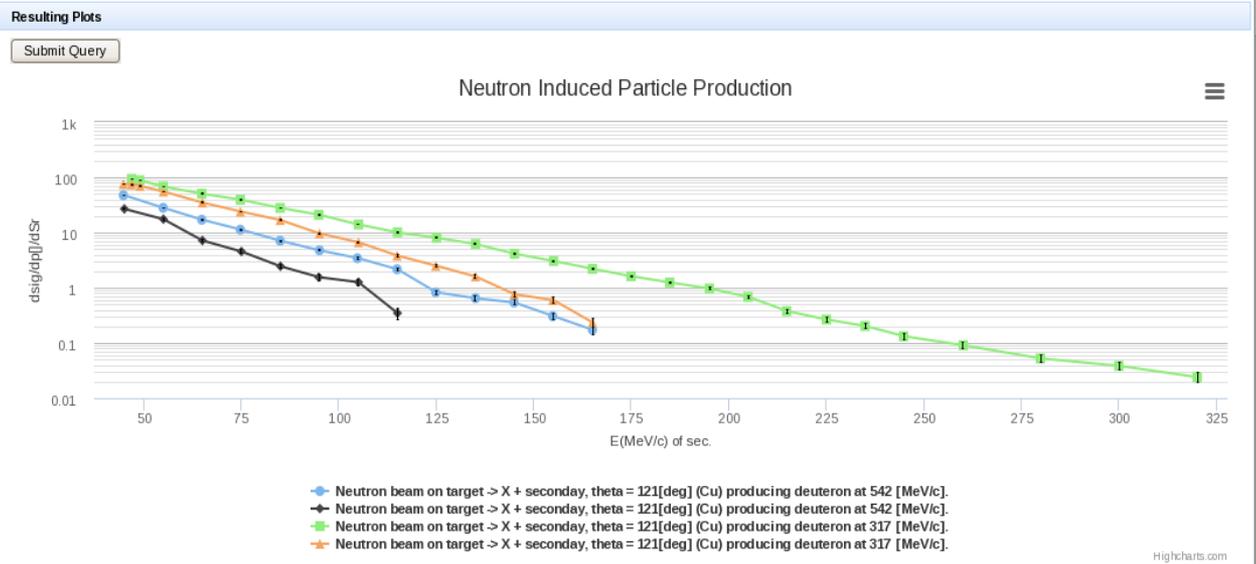


Geant 4 overlay web application demo

- Left
- Demos and Resources
- Test48 exp. data
 - NA49 exp. data
 - NA61 exp. data
 - Franz exp. data
 - Franz kelly
 - try high
 - try high1
 - XML upload
 - faces upload
 - Display some database statistic
 - Display Tag Cloud
 - panel Menu
 - test 47
 - DisplayTest
 - MultiSelectListBox
 - Single exp. data curve
 - Static overlay demo for given target
 - Static overlay demo
 - Pie Demo

Description Neutron-induced production of protons, deuterons and tritons in Copper and Bismuth.
 Reference Nuclear Physics A510 (1990) 774-802 (Franz, et. al.)

Targets Secondarys Reactions Beam Energy



Reaction	Target	Beam Energy or Momentum	Name	Secondary Produced	Table Data
----------	--------	-------------------------	------	--------------------	------------

Allows to select by :
 target
 secondarys
 reaction
 beamenergy

Geant 4 overlay web app

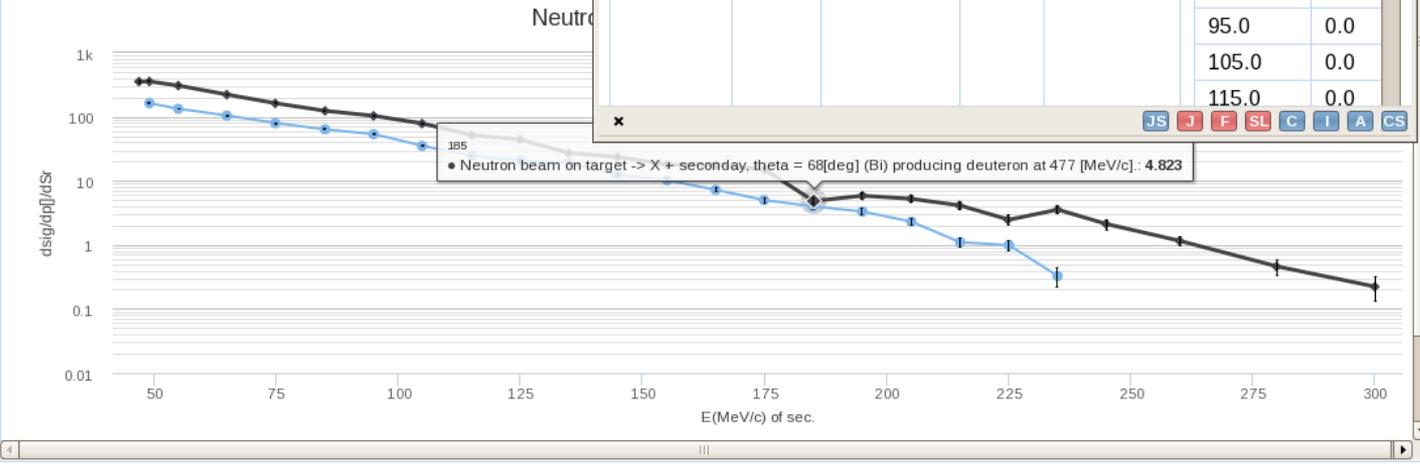
- Left
- Demos and Resources
- Test48 exp. data
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 - Static overlay demo

Description Neutron-induced production of protons, deuterons
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Click to display chart data in a table.
 [Display]

Targets [v] Secondaries [v] Reactions [v] Beam Energy [v]

Resulting Plots
 [Submit Query]



Resulting Data - Mozilla Firefox

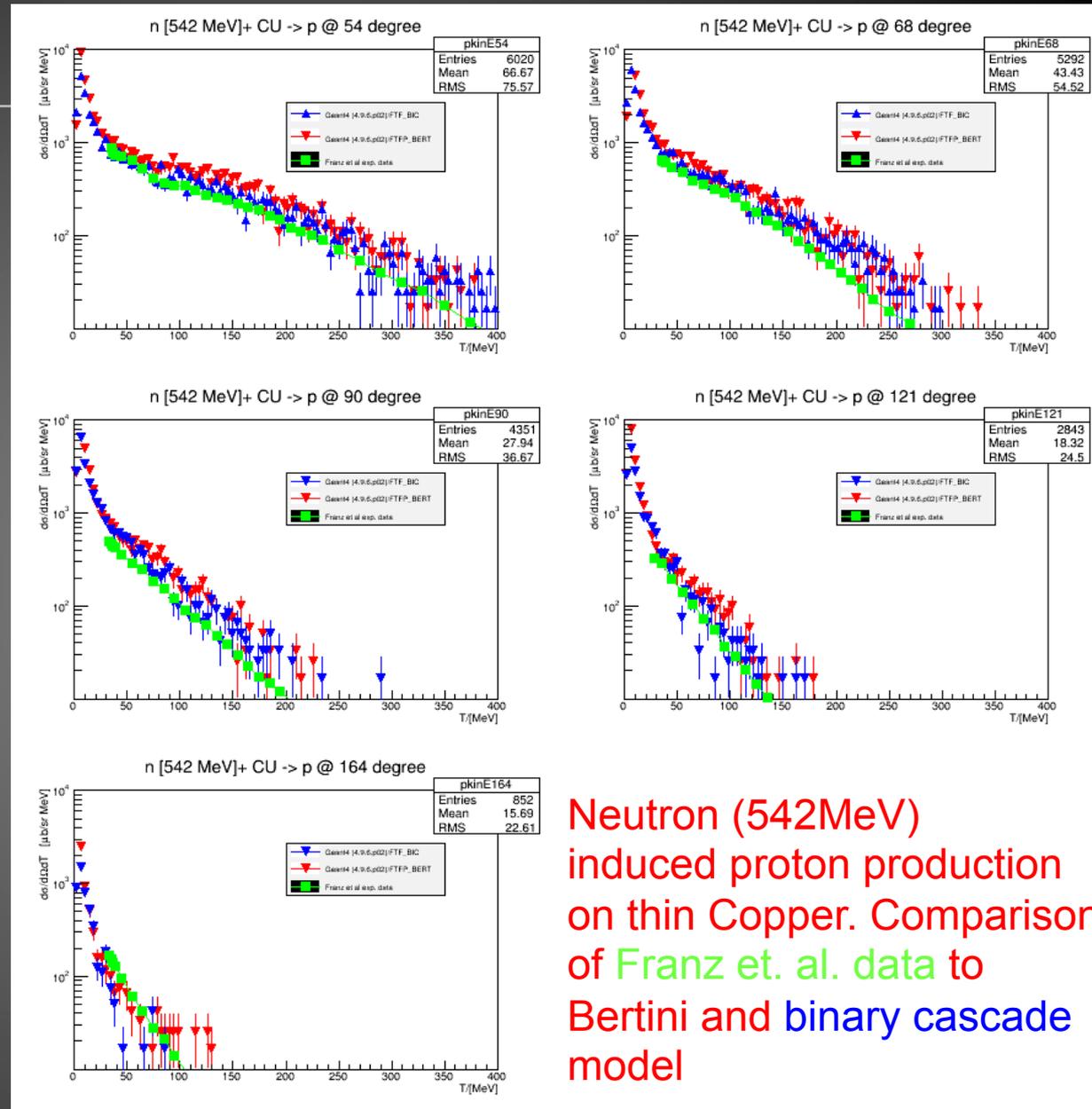
localhost:8080/primefaces/faces/handle.xhtml

Reaction	Target	Beam Energy or Momentum	Name	Secondary Produced	X Value E(MeV/c) of sec.	Error in X
beam on target -> X + seconday, theta = 68[deg]	Cu	477 [MeV/c]	franz	deuteron	49.0	0.0
					55.0	0.0
					65.0	0.0
					75.0	0.0
					85.0	0.0
					95.0	0.0
					105.0	0.0
					115.0	0.0

Expectation:

Tell us what processes are important to you → tailor physics list to your needs

e.g. Steve Dytman proposed that we look at various experimental data sets relevant to neutrino detector response. Used Artg4tk to implement test. → Very useful will present the plots to the experts in geant 4 hadronic working group. → will add more tests. → Results and exp. data will be stored in validation repository



Neutron (542MeV) induced proton production on thin Copper. Comparison of Franz et. al. data to Bertini and binary cascade model

Motivation: Modular system

build detector from predefined components,
geometry sensitive detectors described in ext. gdml,

Currently implemented
PhotonSD
TrackerSD
CalorimeterSD
DRCalorimeterSD
InteractionID

Particle ID

Cerenkov
Radiator

Tracker

EM

Hadronic

μ

BeamDump

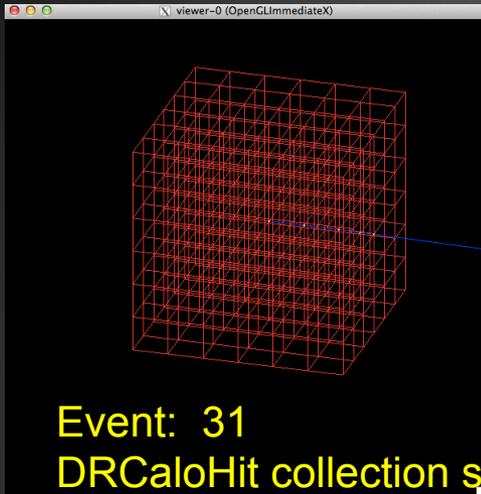
PhotonSD
produces ArtPhotonHits

TrackerSD
produces ArtTrackerHits

DRCalorimeterSD
produces ArtDRCalorimeterHits

StoppingCalorimeterSD
Pro. ArtCalorimeterHit

Instrumented to analyze contribution by particle/process



Event: 31

DRCaloHit collection size: 3196

Particle: ETot 8847.8 MeV

Particle: Fragment 1.37509 %

Particle: alpha 0.604975 %

Particle: deuteron 0.0952639 %

Particle: e+ 15.5078 %

Particle: e- 44.0526 %

Particle: gamma 2.62586 %

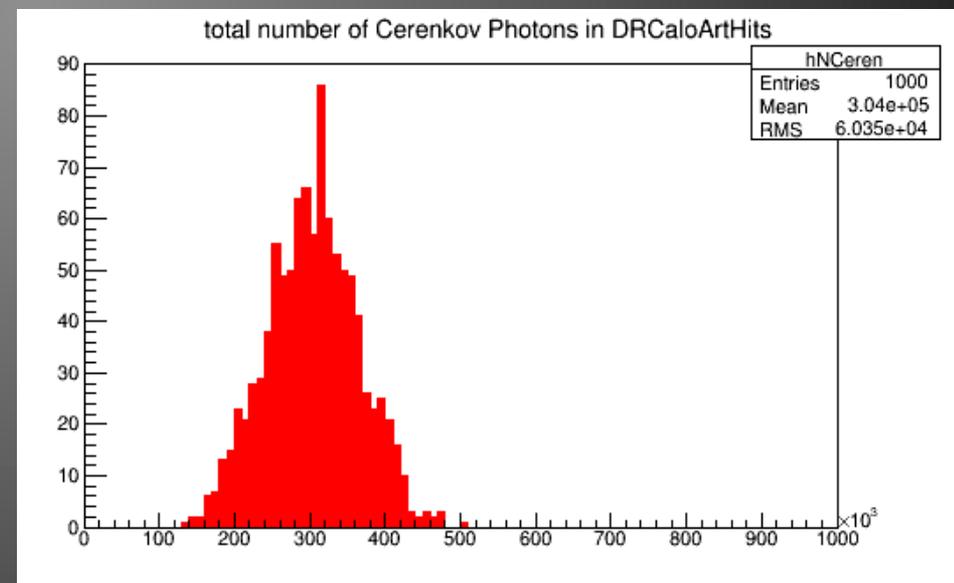
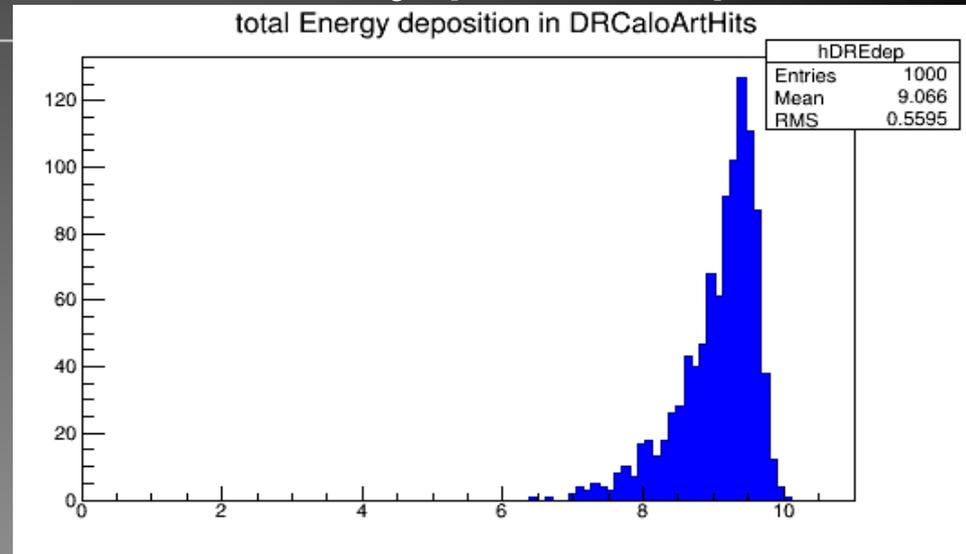
Particle: neutron 0.505972 %

Particle: other 0 %

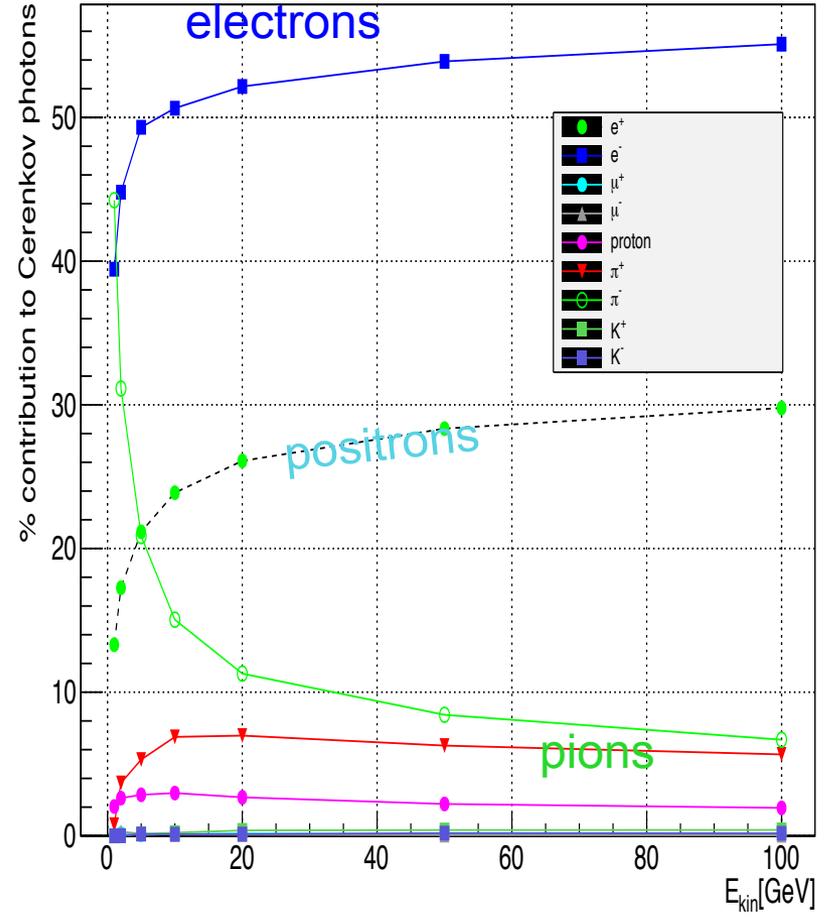
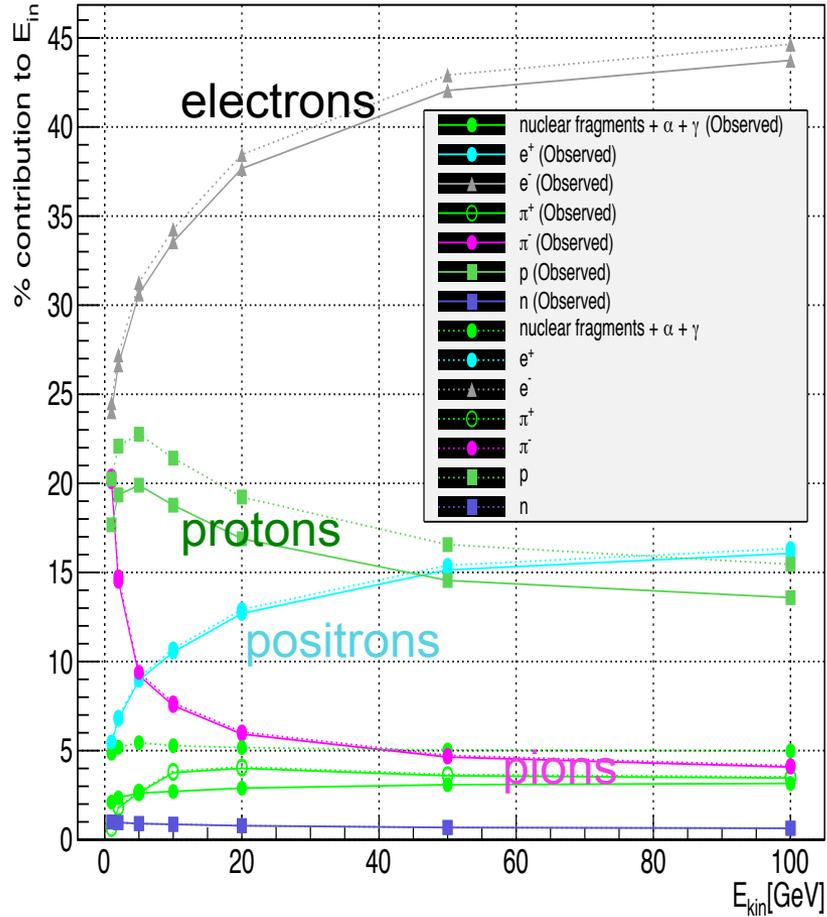
Particle: pi+ 0.715708 %

Particle: pi- 7.14516 %

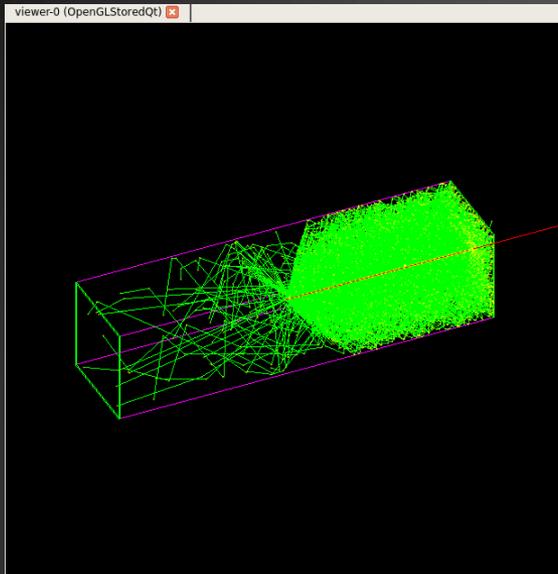
Particle: proton 27.3716 %



Composition of Ionization and Cerenkov response in π^- showers



Cerenkov light in PbF2 Crystal

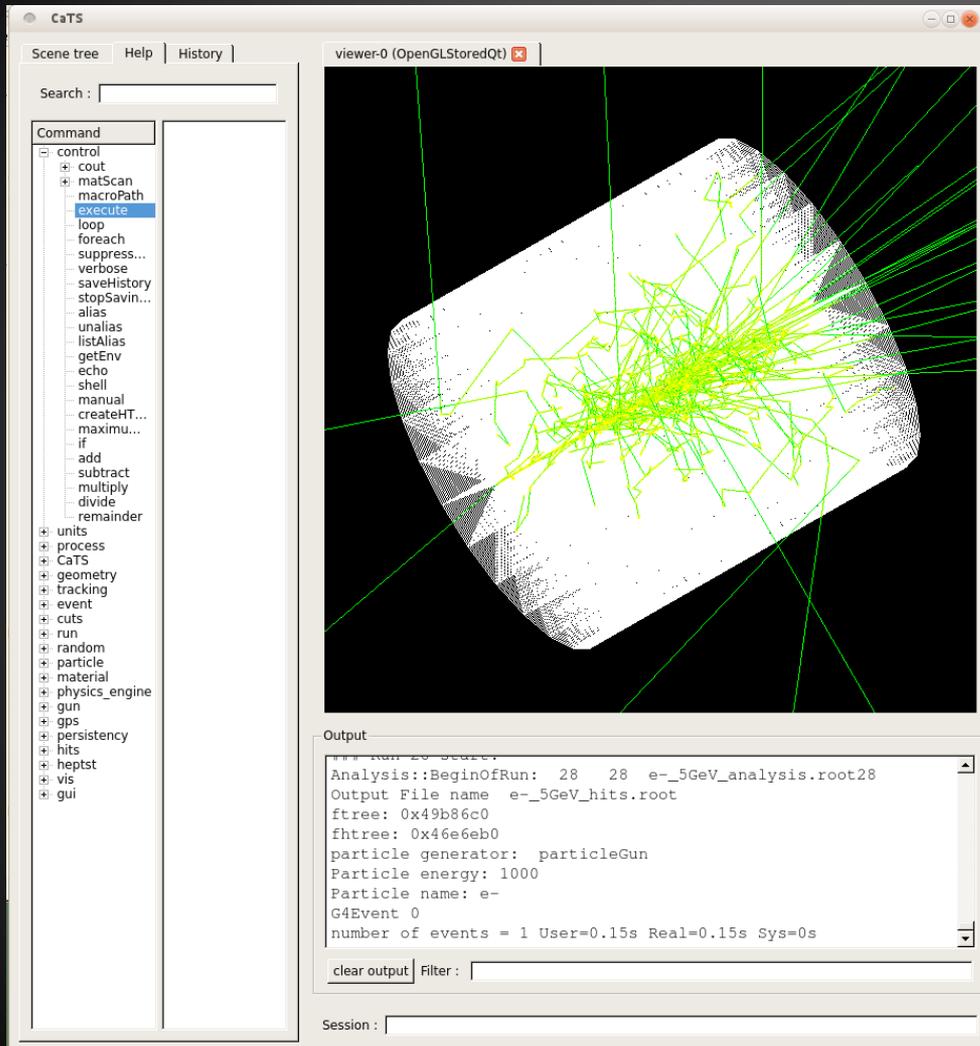


PbF2: no scintillation,
Good Cerenkov radiator,
used for em calorimeters

```
ParticleGunAction: {  
  name: "ParticleGun"  
  NParticle: 1  
  Name: "proton"  
  Direction: [ 0, 0, 1 ]  
  Energy: 10.  
  Position: [ 0, 0, -10. ]
```

```
PhysicsListHolder: {}  
PhysicsList: {  
  PhysicsListName: "FTFP_BERT"  
  DumpList: false  
  enableCerenkov: true  
  enableScintillation: false  
  enableAbsorption: true  
  enableRayleigh: false  
  enableMieHG: false  
  enableBoundary: true  
  enableWLS: false  
}
```

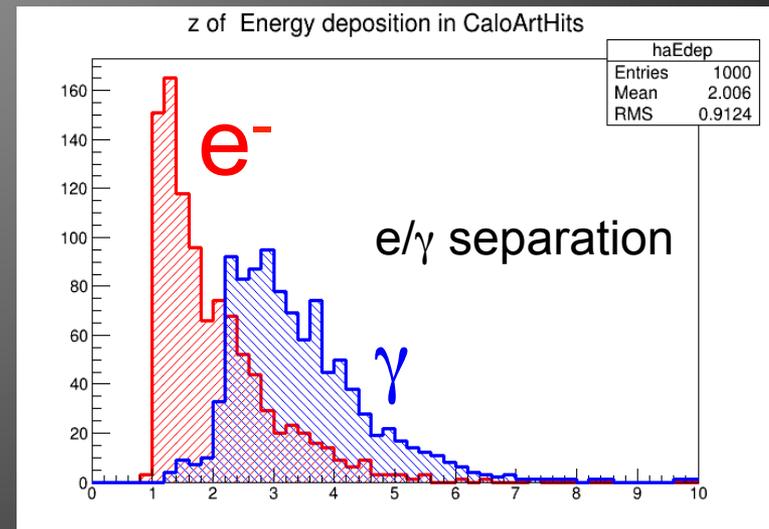
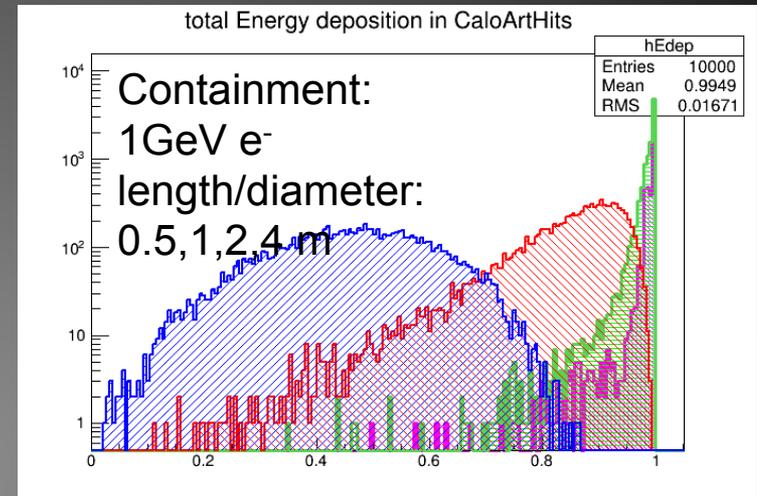
Liquid Argon in artg4tk



The screenshot shows the artg4tk software interface. On the left is a 'Command' list with various options like 'control', 'matScan', 'macroPath', 'execute', 'loop', 'foreach', 'suppress...', 'verbose', 'saveHistory', 'stopSavin...', 'alias', 'unalias', 'listAlias', 'getEnv', 'echo', 'shell', 'manual', 'createHT...', 'maximu...', 'if', 'add', 'subtract', 'multiply', 'divide', 'remainder', 'units', 'process', 'CaTS', 'geometry', 'tracking', 'event', 'cuts', 'run', 'random', 'particle', 'material', 'physics_engine', 'gun', 'gps', 'persistence', 'hits', 'hepst', 'vis', and 'gui'. The main window displays a 3D visualization of a detector structure with green lines representing particle tracks. Below the visualization is an 'Output' window showing the following text:

```
*** Run 28 Start ***
Analysis::BeginOfRun: 28 28 e-_5GeV_analysis.root28
Output File name e-_5GeV_hits.root
ftree: 0x49b86c0
fhrtree: 0x46e6eb0
particle generator: particleGun
Particle energy: 1000
Particle name: e-
G4Event 0
number of events = 1 User=0.15s Real=0.15s Sys=0s
```

At the bottom, there is a 'Session' field.



Expectations

- Good collaboration, be included in discussions, access to data
- Let us know what measurement you want to do → we can figure out how to contribute.
- Let us know what processes/experimental data are important to you → validate geant 4 → add to test suite/ validation repository
- Let us know what help you need from us e.g. tailored physics list for detector response/particle production....

Backup slides

Data base schema for exp. Data

