MANCHESTER 1824

The University of Manchester

Cosmics Simulation in LArIAT

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Premise

- It has been suggested (G. Garvey, R. van de Water), that the high amount of light seen by uBooNE might be due to positive ions left-over from ionization event recombining later (at the cathode?).
- This could be problematic for the SBN detectors – on surface, high amount of ions – high rate of extra photons in PMTs.

Courtesy of Andrzej and Will Fo

What's that got to do with LArIAT?

- The positive ions drift on the order of minutes – hard to measure on scale of single event frames.
- For a constant source of charge (cosmics) – we should get a constant effective increase of single phel “noise” in the PMTs.
- The amount of this extra light should depend on the electric field – at 0 electric field there are no ions to drift, so no extra light. At high field – many ions left over = lots of noise.
- The drift from the wires to cathode of positive ions is ~60 seconds.

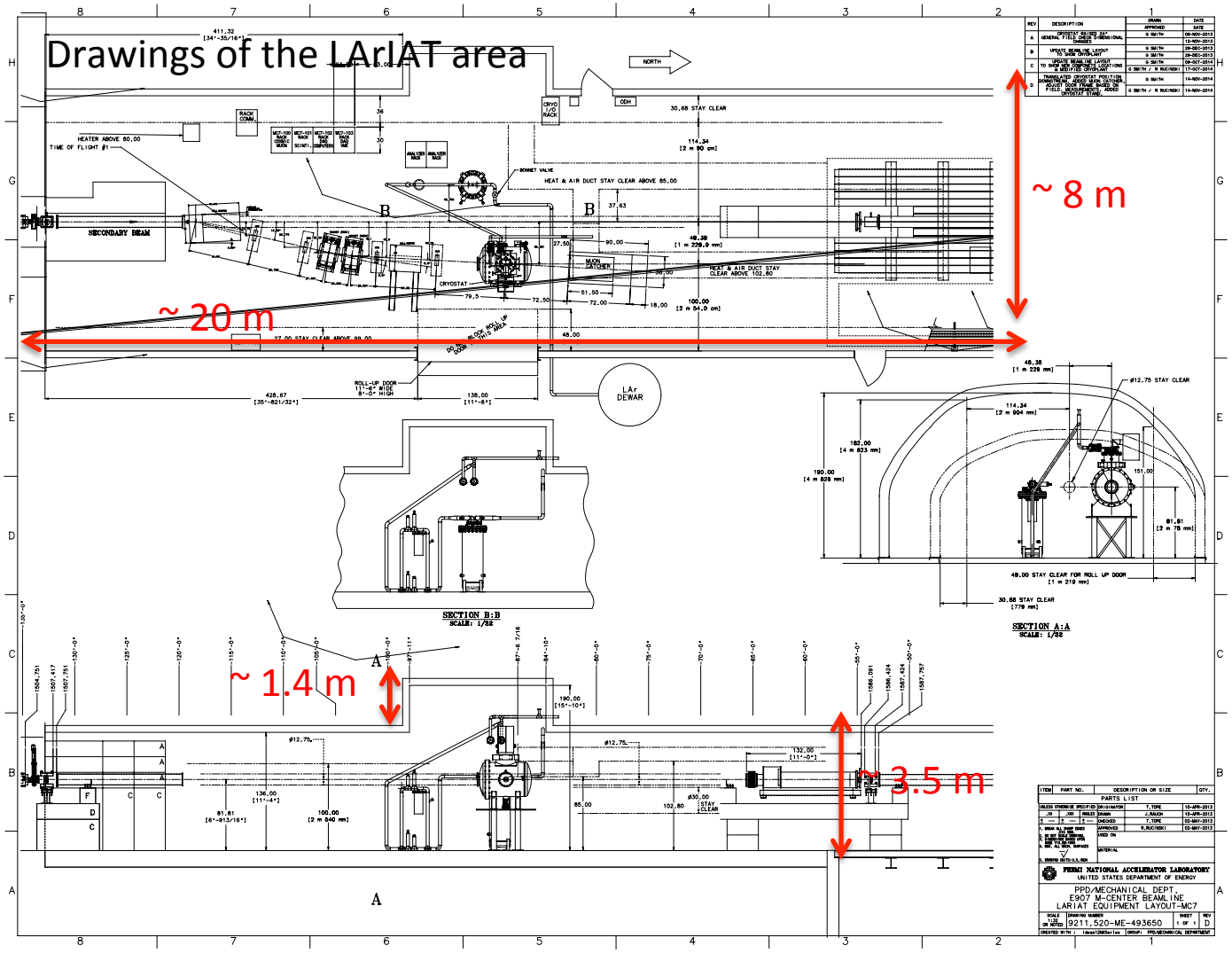
Courtesy of Andrzej and Will Fo

The data set

- Throughout the week of July 24th we took a number of data sets to test the delayed ion hypothesis.
- We have taken pulser data @20Hz throughout the beam spill at 56 seconds – needed fixing the rawdigit code to account for this (Johnny H. made this happen).
- We took no beam data sets at 0,100,200,300,400,450,500, 600! and 700!!V/cm.
- We took data with three different beam instensities: 1e9, 1e10 and 7e10 at 0,300 and 500V. (600V didn't happen because of beam enclosure flooding :( ).
- I have started looking at the with beam data to see if we see any effects.

Courtesy of Andrzej and Will Fo

Cosmics simulation: The building

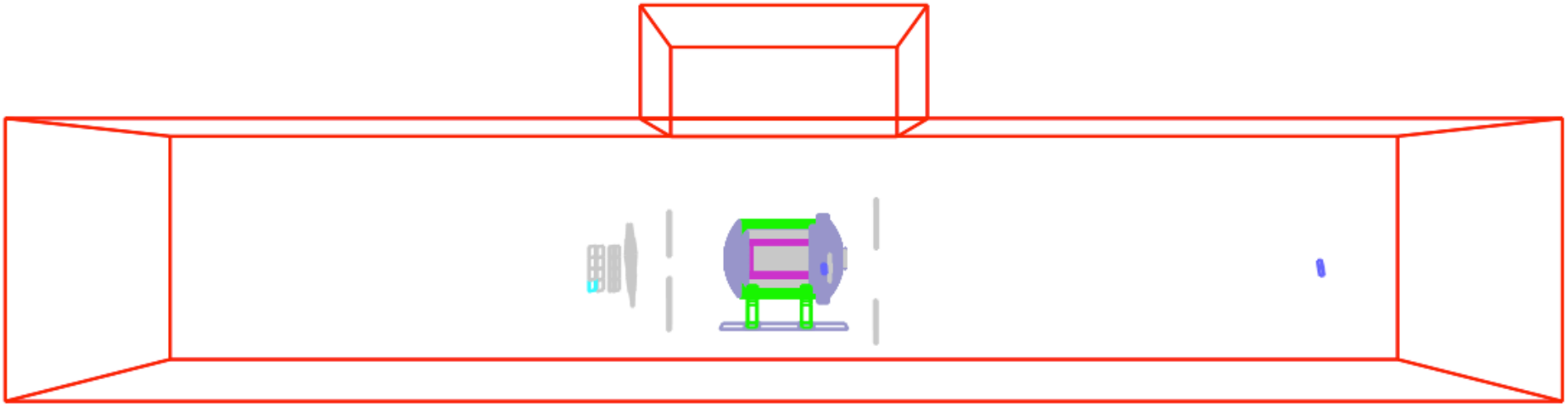


The thickness of the panels appear to be 16 gauge galvanized steel with a thickness of about 0.064 inches (Eugene E Schmidt Jr)

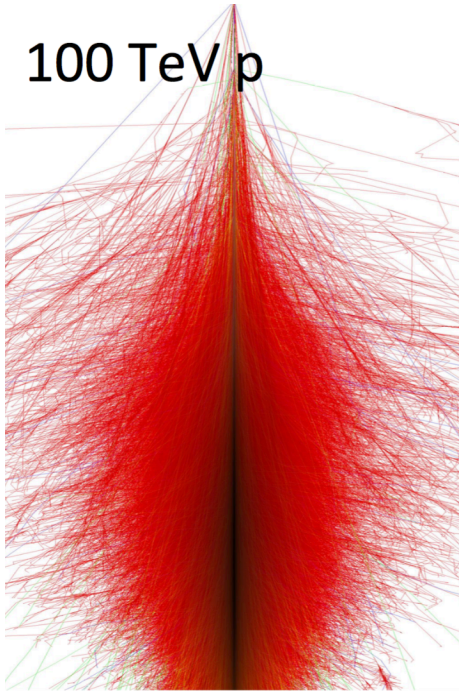
Cosmics simulation: The gdml file

Very simple approximation to the building (boxes), but trying to preserve:

- Dimensions (length, height and depth)
- Thickness
- Material



CORSIKA integrated in LArSoft (by Matt Bass)



- **CORSIKA** simulates extensive air showers initiated by cosmic ray particles

→ State-of-art **(before only CRY)**

- New **CorsikaGen module** developed to:

1- Resample from pre-generated Corsika samples so no need for users to have Corsika/Fluka installations

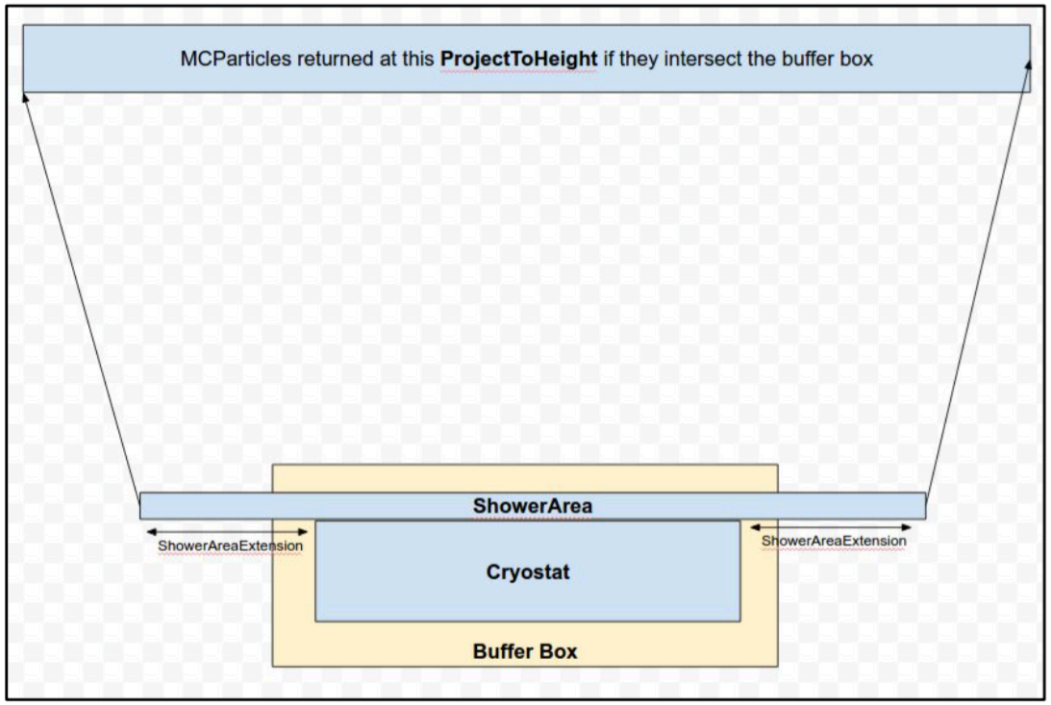
2- Use databases to store the particle information from Corsika

3- At run time, assemble an event by randomly sampling from shower tables and arranging the particles in space/time via: $I_N(E) = 1.8 \times 10^4 \, (E/1 \text{ GeV})^{-\alpha}$ nucleons/m^2 s sr GeV

- Module lives in larsim/EventGenerator/CORSIKA

Standard fcl file should work as a start for all experiments

CORSIKA integrated in LArSoft (by Matt Bass)



More about how it works:

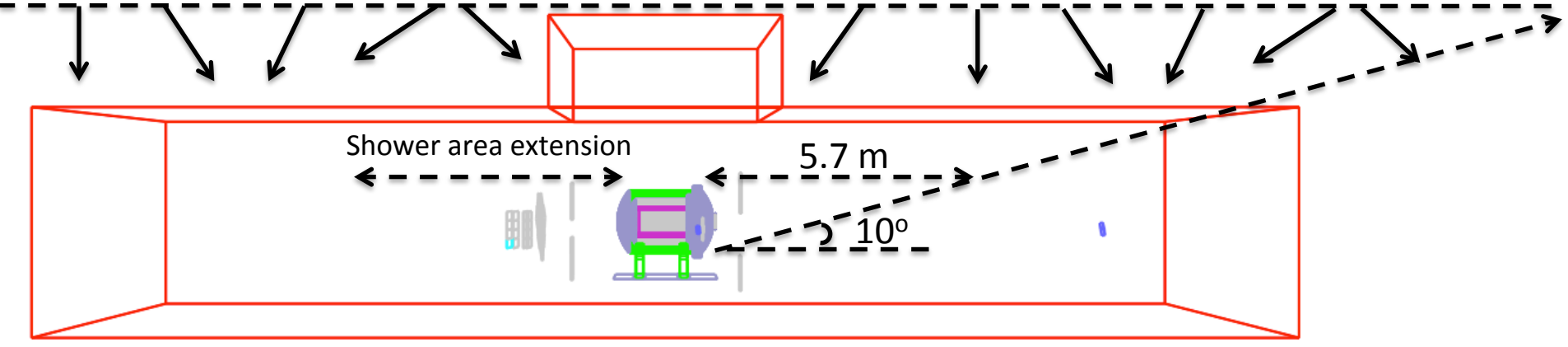
1- Random sample of showers queried from the database and distributed at **ShowerArea** position/time

2- Particles kept if they will intersect the **BufferBox**

3- Particles backwards propagated to ProjectToHeight

All these “parameters” can be modified (in fcl files)

Cosmics simulation parameters in LArIAT




```
#integration time in seconds->2 x NumberTimeSamples(3072)xSamplingTime(128ns)
physics.producers.generator.SampleTime: 0.786432e-3
physics.producers.generator.TimeOffset: -0.393216e-3 # 3072x128ns
#height to which particles are projected [cm] -> ceiling at ~140cm
physics.producers.generator.ProjectToHeight: 140
#list of buffer box extensions to cryo volume in each dimension/dir (-x,+x,-y,+y,-z,+z)
physics.producers.generator.BufferBox: [ 0.0,0.0,0.0,0.0,0.0,0.0 ]
#amount to extend the shower area beyond the cryo dimensions->cryo_heigh(~100cm)/tg10deg
physics.producers.generator.ShowerAreaExtension: 570.0
#amount to randomly shift shower start point in x & z [cm]
physics.producers.generator.RandomXZShift: 570.0
```

.fcl file

list of sqlite dbs with corsika showers: **/pnfs/lariat/persistent/Cosmics_FluxFiles/CORSIKA/**

Number of cosmics

1 time window = Time samples x Sampling time = 3013 x 128 ns = 393.216 µs

1 hour of cosmics: 60 min x 60 s/min x 1 time window/393.216 µs

→ about 9.2 x 10^6 time windows (events)

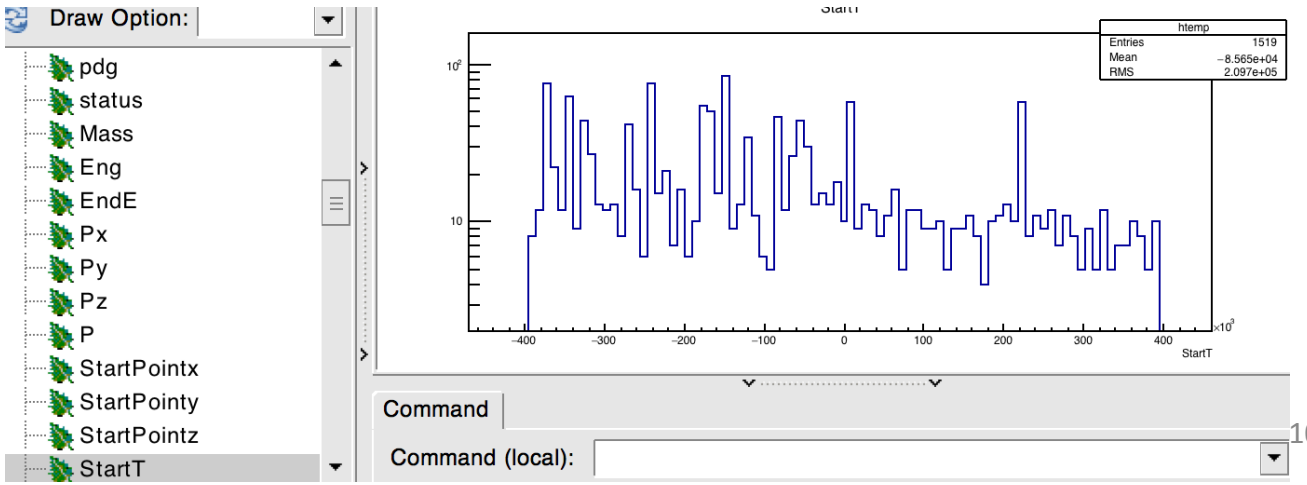
Fermilab Grid: running (already done the 75 %)

Interested only in the Geant4 (true) information:

```
SaveGeantInfo:          true
```

Using the AnalysisTree_module from MicroBooNE to switch off all the other information (is it possible in lariatsoft?)

Example of analysis tree:



Summary

- A precise simulation of the cosmic rays in LArIAT is important to study the “delayed ion theory”.
- We are using Corsika (EventGenerator_Corsika) for doing this.
- We are simulating 1 hour of cosmics in LArIAT. Jobs are finishing and very soon we will be able to produce our first results.