MINERvA simu & reco status

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Dune 2x2 analysis workshop

YORK U

DUNE DEEP UNDERGROUND NEUTRINO EXPERIMENT

Minerva in the 2x2 context

Aim of the MINERvA planes:

- Detect escaping particles
- Tag upstream rock muons
- Use fast detection timing of MINERvA to help slow reco from Liquid Argon

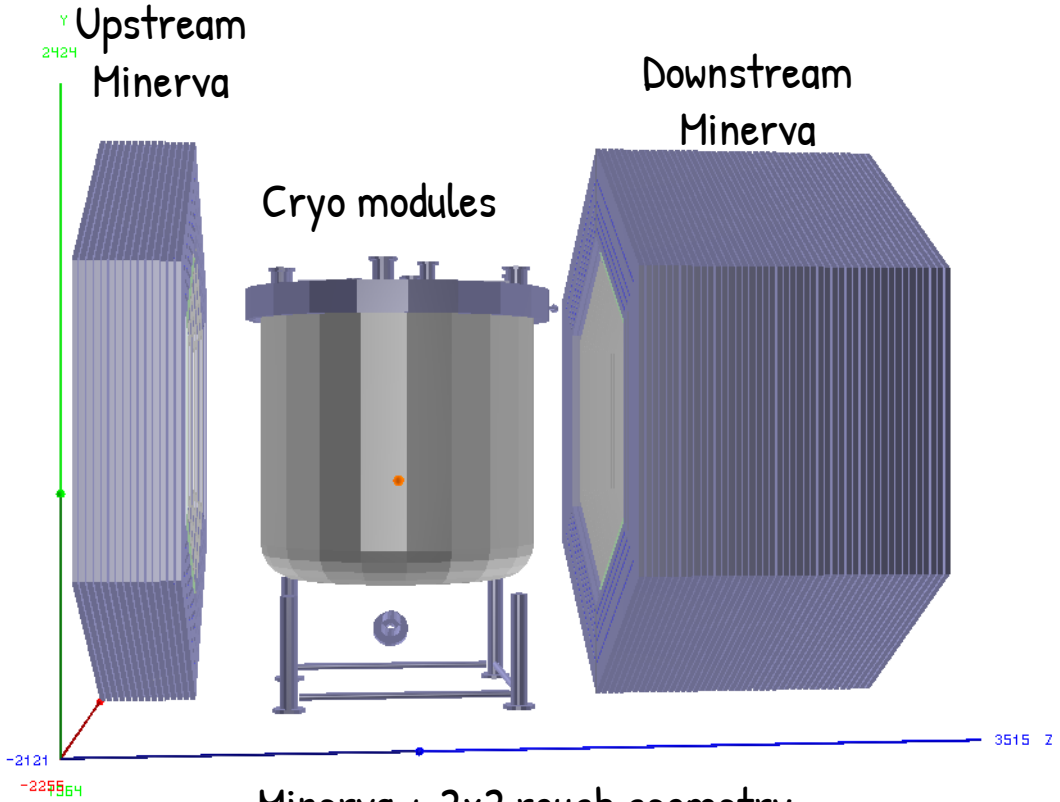
Upstream tracker :

10 Tracker modules (20 planes)

Downstream tracker :

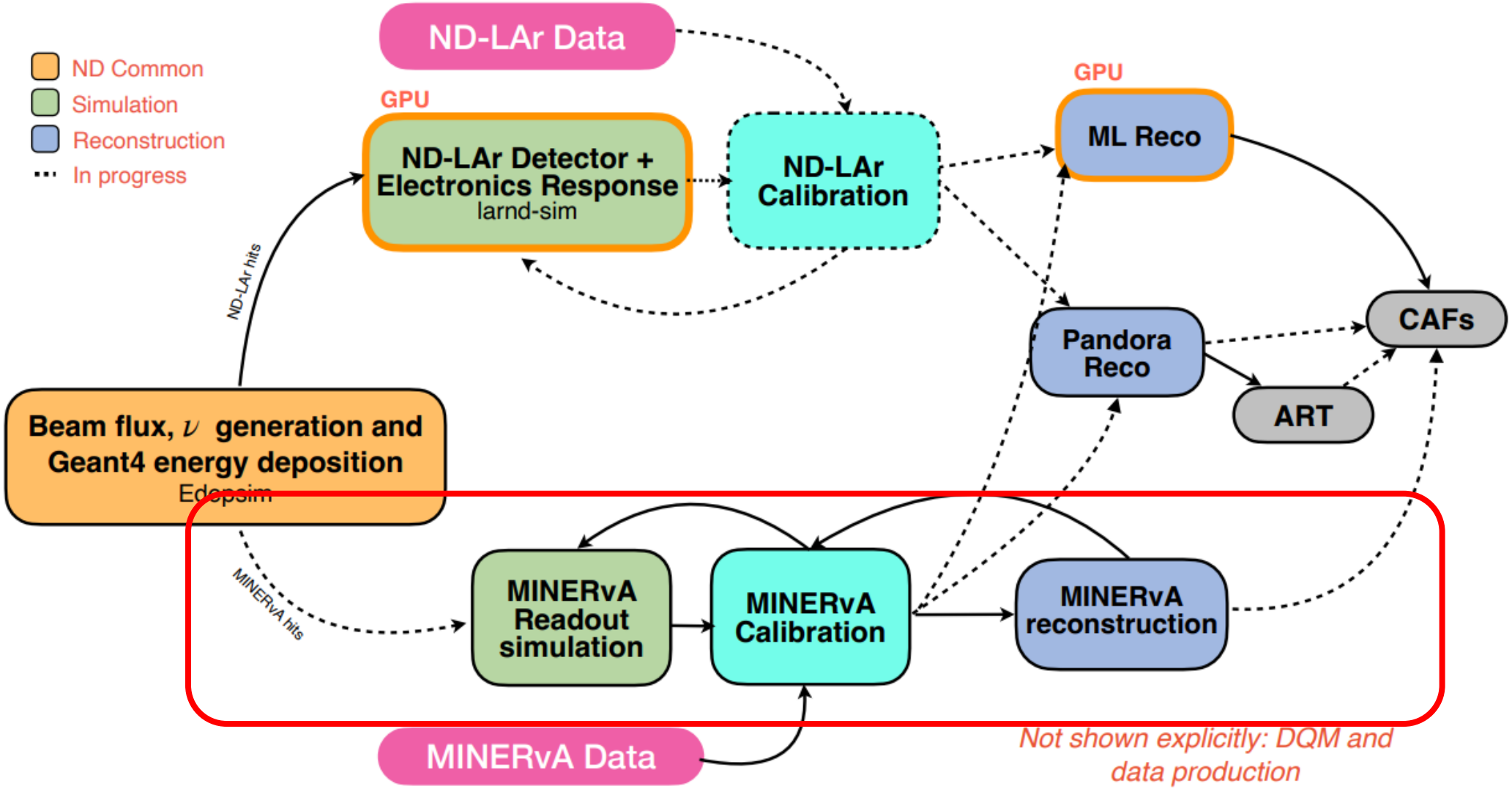
10 Tracker modules (20 planes)
10 Ecal Modules (20 planes)
12 Hcal modules (12 planes)

Tracker Module: 2 scintillator planes (1 vertical strips & one with tilted strips)
Ecal Module: 2 x scintillator planes + 2 x 0.2 cm thick lead plates
Hcal Module: 1 x scintillator plane + 1 x 2.54 cm thick lead plate



Minerva + 2x2 rough geometry

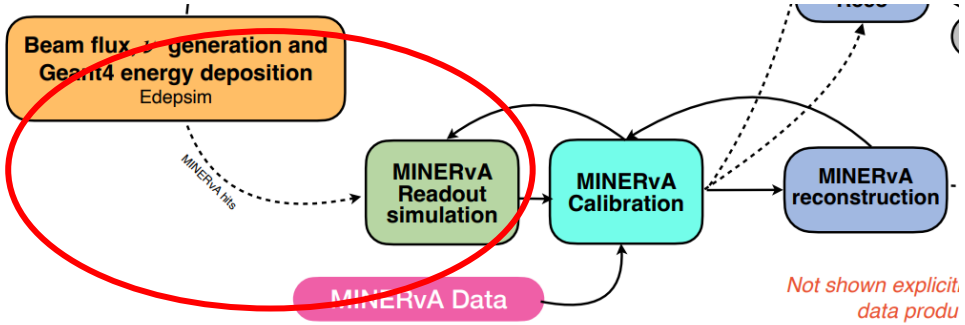
What's the plan?



Current setup

Input from Edepsim => Specific framework with

TG4PrimaryVertex
TG4TrajectoryPoint
TG4HitSegment



Readout simulation and reconstruction in MINERvA framework : **Gaudi based**

Much of the code was produced when Obama was still a senator and the world had not yet swayed to Gangnam Style!

Every modification to the MINERvA core framework can end up with crashes at some point where we do not expect it.

A lot of « class embeded root files » -> Difficult to check results before going through the whole chain.

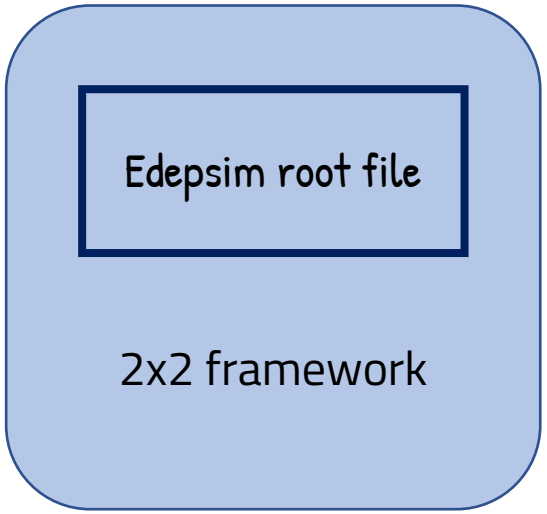
We still don't know how to directly read Edepsim files with the MINERvA framework.

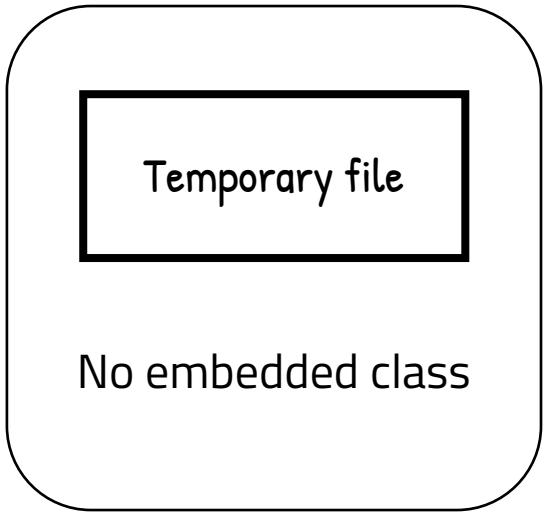
-> **Go through a temporary file « plain root file » with no embeded classes.**

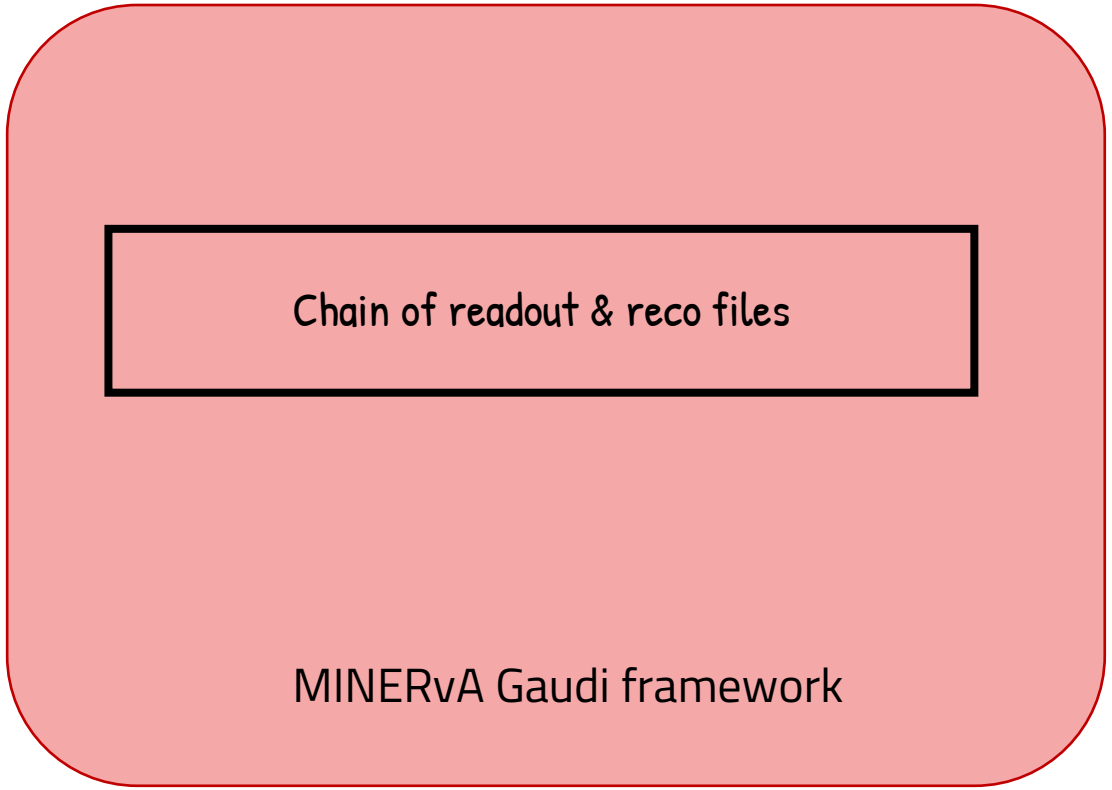
Adaptation “module”

Get the list of hits per events, for each event we get vectors of:

-> Start(X, Y, Z, T)
-> Stop (X, Y, Z, T)
-> Length of the hits
-> Track ID
-> energy deposited + Birks corrections



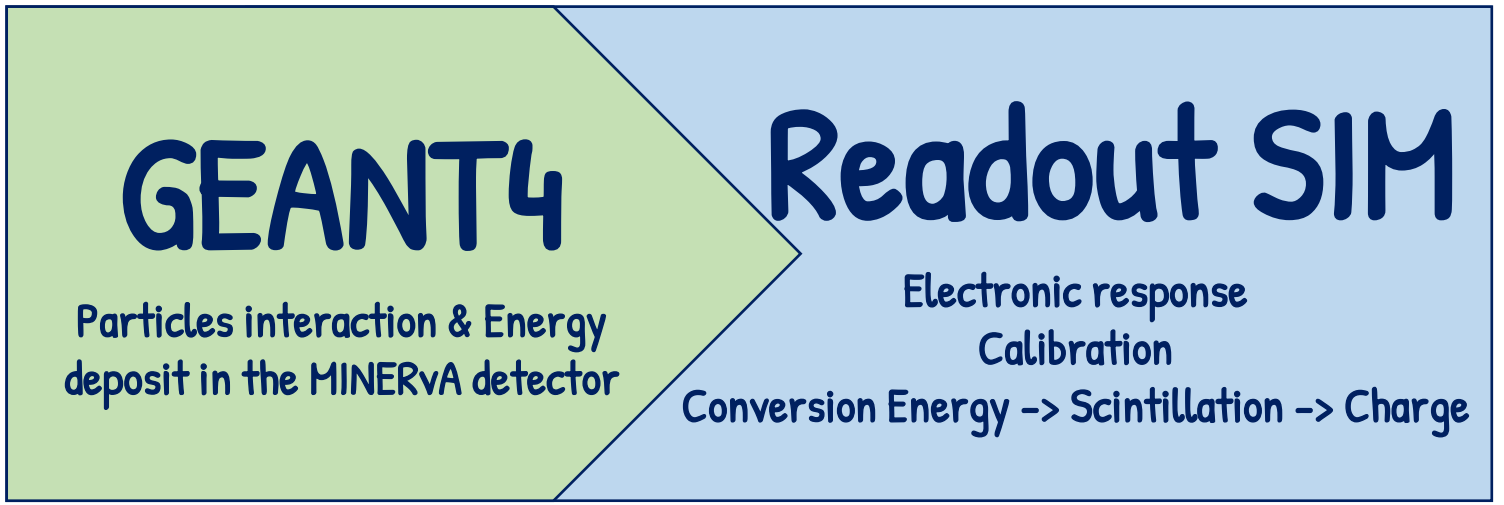




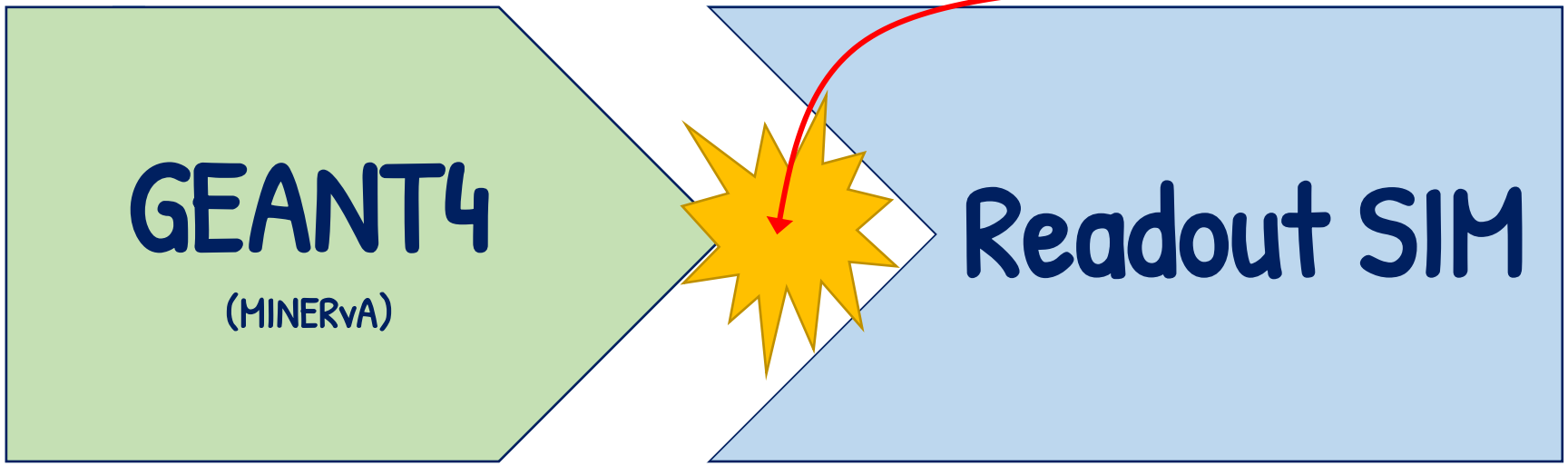
Quite crude way to do things, for now, no other « true » variables -> Really just a minimal input for the readout simulation to run

Then: Minerva simulation

Minerva simulation & generation



Find where to break the software to remove the GEANT4 part



Minerva simulation

Minerva
Readout sim

GEANT4

Particles interaction & Energy deposit in the MINERvA detector

Readout SIM

Electronic response
Calibration
Conversion Energy -> Scintillation -> Charge

Use the format adaptation to plug Edepsim to the Readout Sim

Minerva
Readout sim
Updated

Edepsim

Basic root file
(2x2 + Minerva)

Readout SIM

What detector model do we create ?

- 1st step is to reproduce 2x2 geometry as in Edepsim -> Bunch of xml files to modify with geometries & different distances/units

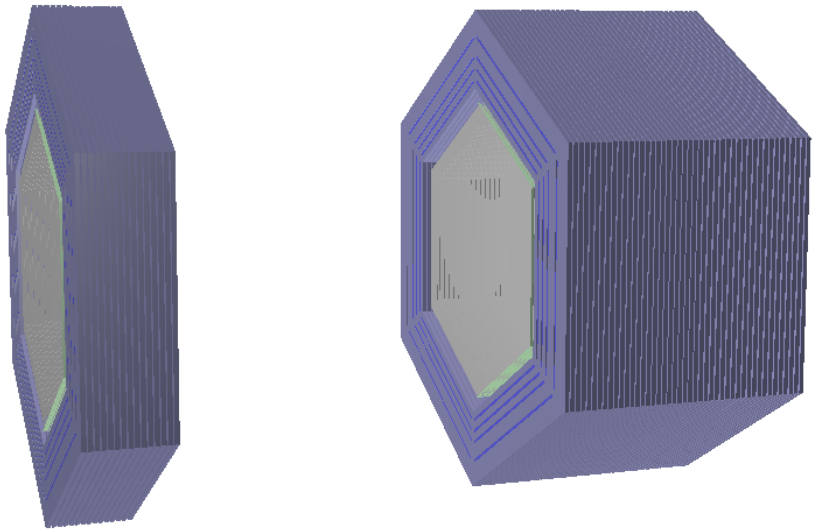
- Then use a plex model that matches the geometry (currently « random » model not matching the real PMT/plane repartition, will be updated once everything is settled)

- Remove the « veto » information needed for the simulation

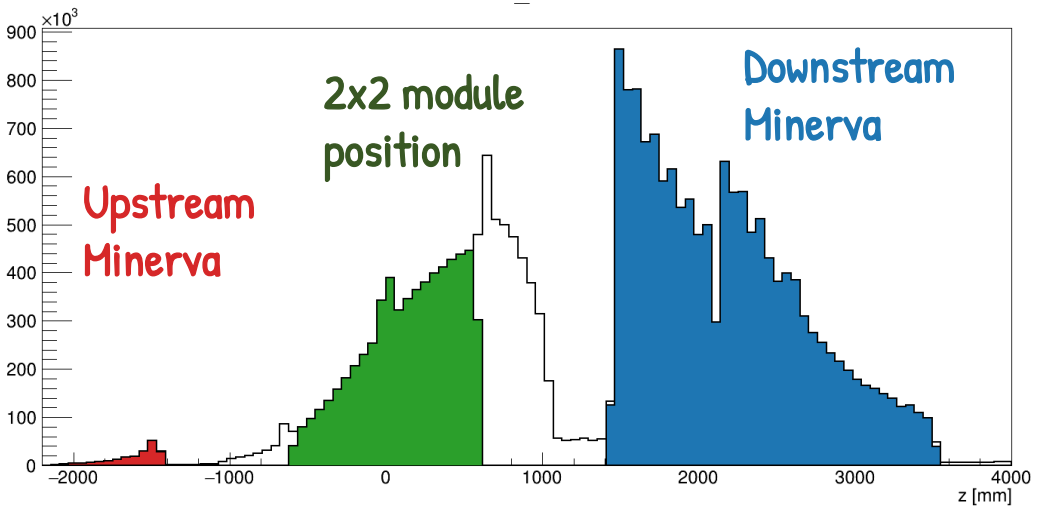
- Calibration on default values for now

Rough geometry that matches Edepsim
Upstream tracker :
15 Tracker modules (30 planes)

Downstream tracker :
15 Tracker modules (30 planes)
10 Ecal Modules (20 planes)
20 Hcal modules (20 planes)



What's the « 0 » : Z



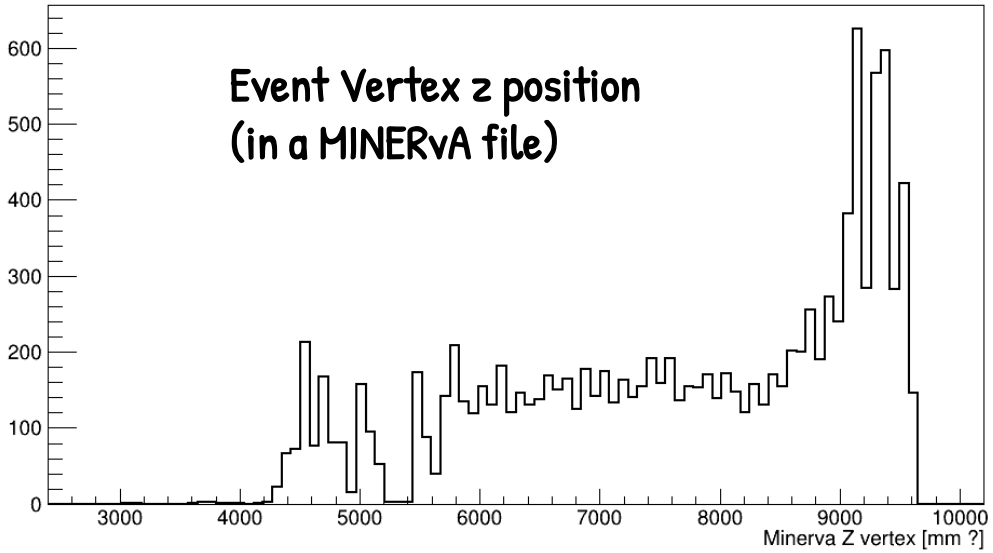
EDEPSIM HITS POSITIONS

(obviously) planes not placed in the same position in 2x2 compared to MINERvA.

Reference z point is also not the same.

2x2 centred around the cryogenic module.

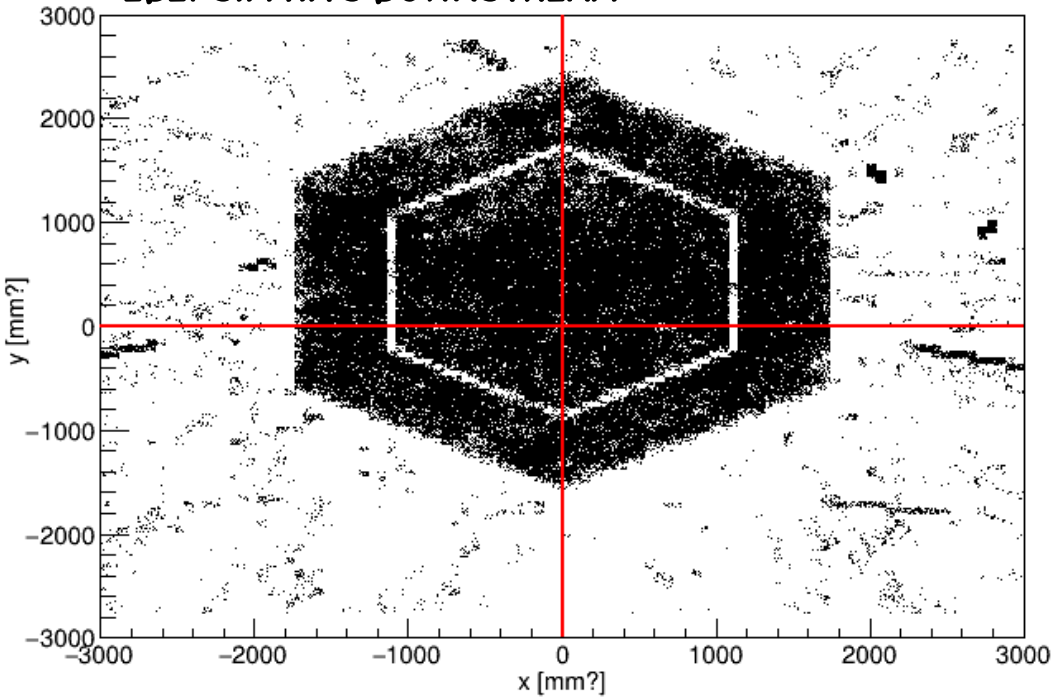
MINERvA z ref with respect to MINOS



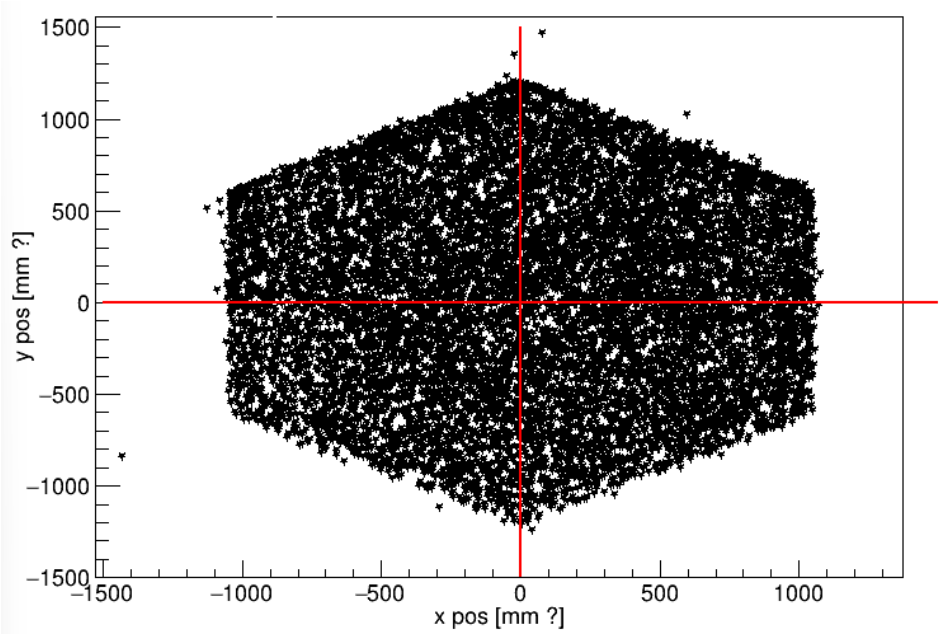
MINERvA DATA (from MINERvA processing)

What's the 0: (X,Y)

EDEPSIM HITS DOWNSTREAM



Minerva Vertex in Inner detector



Not same x,y reference point:

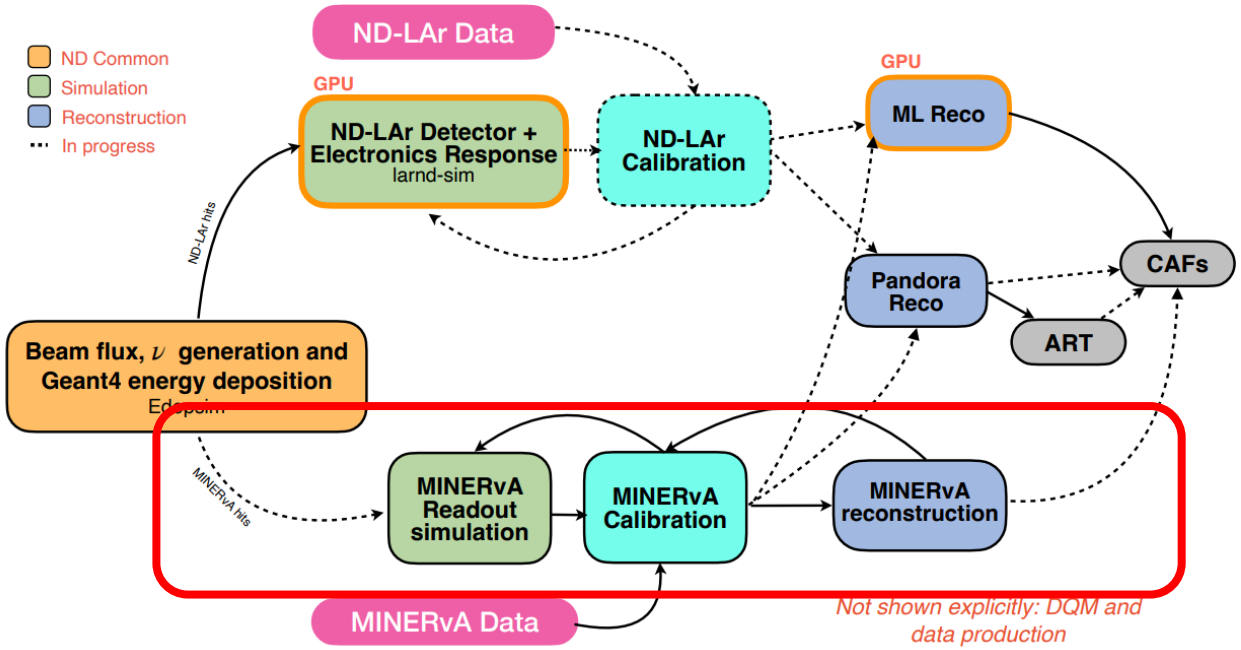
- **MINERvA model centered around the planes**
- **2x2 model centered in the middle of the LAr model**

Several options here

- Shift the reference point of Minerva detector model to match the 2x2 reference point.
  - Easier match between LarNDSim and MINERvA Sim
  - Changing the simulation reference point could (will ?) induce mismatch with the online MINERvA (2x2) data + could have some inner reconstruction issues with angles
- Shift the hit positions to change the reference point at the hit level and reshift everything after the reconstruction
  - Modifying the less possible the detector model will induce less errors
  - Need to shift all positions variables (input + output) & make sure we do not forget everything

Second option selected

What's the plan?



* Will need to be refined

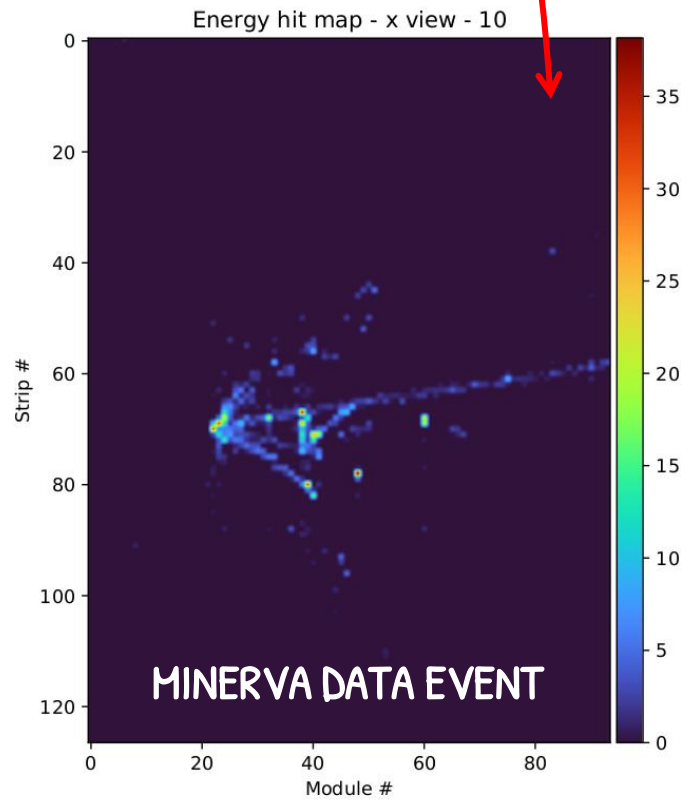
- **Give appropriate G4 geometry for simulation**

- **Take inputs from Edepsim**
- **Plain root file conversion ***
- **Pass the plain root file into the readout simulation**
- Use calibration data to apply necessary calibration (will need to explore with Chris & the calibration team)
- Reconstruct the necessary information and give those to the ND-LAr reco

Create custom release of MINERvA software to make it available and under control

What is needed for a (minimal) output?

- Simulated channel outputs : Channel ID, position, energy, timing
- List of tracked particles with point of entry, point of exit (if exists), reco energy & time
- Keep track of list of true variable
- Association between Channel & G4 particles
- Book keeping : best to try to match as much as possible Larndsim way



MINERvA Calibrated energy map

Conclusion

- Readout simulation runs OK with inputs from Edepsim
  - The plain root file will need to be refined if we keep using that method

- Still need to run the full reconstruction to make sure everything was well simulated
  - Under investigation

- Now what still needs to be added/improved:
  - Accurate geometry
  - Work on the reconstruction and its output
  - Making the simulation available for everyone and runs somewhere else than on fermilab clusters
  - File handling system (hopefuly we'll manage to load both Edepsim & MINERvA frameworks in one instance at some point)
  - Use an acurate calibration
  - Get an idea of the memory/time consumption we'll have