

# FD Geometry Generation Should be Better.



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FD Sim/Reco Meeting

# What To Discuss

- ◆ **Required Capabilities throughout DUNE lifetime**
- ◆ **Potential problems**
- ◆ **Multiple Modes of Geometry**
  - Root Version, No-Wires G4 Version, “workspaces”
- ◆ **Version Control**
  - This needs to Change
- ◆ **Maximizing transparency to current users**
- ◆ **GDML Generation**
  - Currently single Perl script (many copy-paste versions)
  - This needs to Change

# Required Capabilities

## ◆ **Early Stage of DUNE (Now)**

- Prototype or R&D Geometries (Real-life detectors)
- Sensitivity studies exploring different FD designs
- Workspace Geometries

## ◆ **Middle Stage**

- One module constructed and taking data
- Other modules in development (different tech!)
  - FD Geometry *must* remain flexible for many years to come
- Production file metadata
  - keeping geo versions in sync with *MC* and *Reco* files

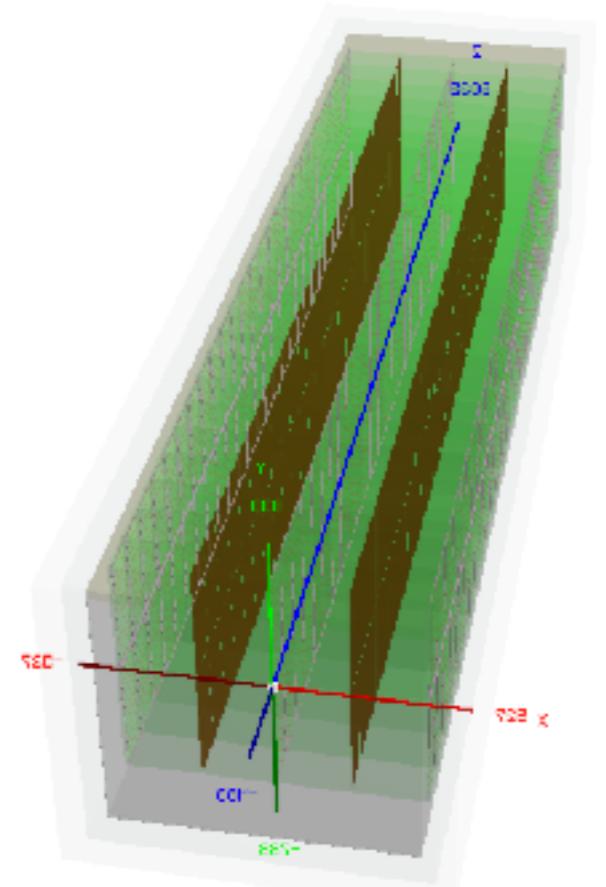
## ◆ **Late Stage**

- Alignment Issues (Not necessarily always a GDML solution)
- Materials Improvements (LAr hard to get wrong, but dirt etc.)

# Workspace Geometries

## ◆ Full Geometry is a massive simulation

- Geant: **MC Particles**
  - scales with number of “volTPCActive”s
- Geant+LarSoft: **Energy Depositions** (IDEs)
  - scales with physical dimensions
- DetSim: **Digitized Waveforms** (RawDigits)
  - scales with number of channels
  - noise sim complicates things



Full 10kt

## ◆ Restrict “number of APAs” for efficient simulation

- Don't need all APAs for the vast majority of studies
- Could have been done better (whoops)

# Workspace Geometries

## ◆ No such thing as an APA in LArSoft

- TPC volumes linked by sorted numbering and a channel map
- APA frame volumes (should) stay regardless of what is done with TPC volumes

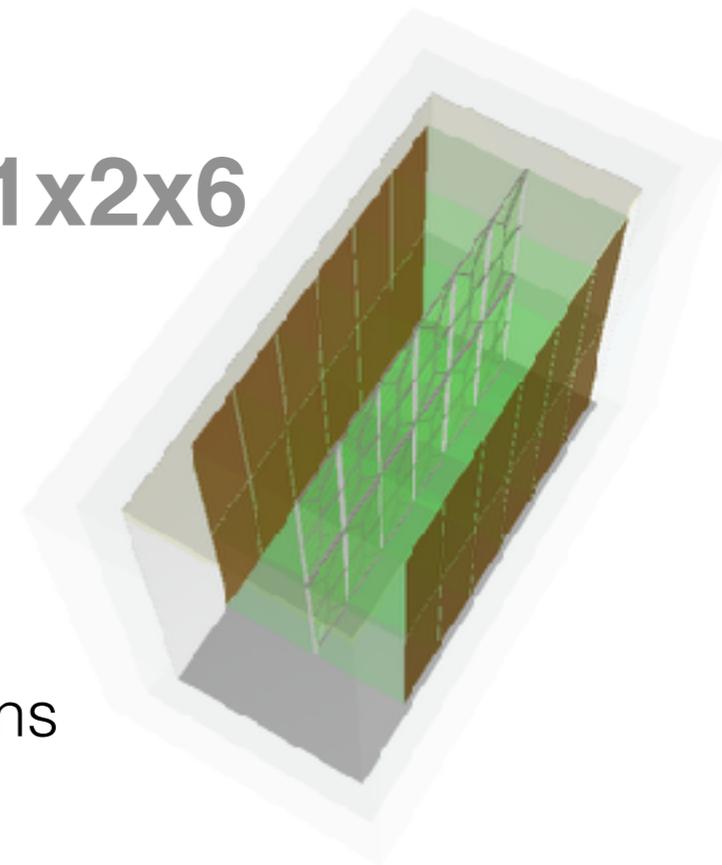
## ◆ Ways to make Sim more efficient without changing LArSoft

- Remove “volTPC”s from GDML (removes wire planes, which aren't in G4 anyway)
  - Fewer IDEs and MCParticles
- Use artificially smaller cryostat dimensions
  - Fewer digitized waveforms

## ◆ LArSoft could also be improved

- LArG4 off-switch per TPC (Leave TPCs in GDML)
  - Also makes the edge APAs more natural to simulate
- Dropping MCParticles we don't need for geometry reasons
  - Radiologicals Studies example

1x2x6



# Radiological Workspace

- ◆ **1x2x6 not realistic enough for radiological backgrounds**

- When positions of APAs relative to cryostat edge matter
- Neutron bkgd studies at Sussex (Aran Borkum, Pierre Lasorak)

- ◆ **Full Cryostat, fewer volumes configured to be active**

- Raw data and Depositions not a problem
- All MC Particles will still be saved
  - Not always a problem in underground FD sim
  - **Could become standard workspace**
- Pick corner, edge, and a chunk of center APAs?

- ◆ **We will make this**

# GDDL Generation

Should be....

## ◆ **Modular**

- Parallel development easier — Photon Detectors and TPCs
- Safer proliferation of design versions
  - Single source for things that should be identical (detector hall, or cryostat...)
  - Fixes/improvements make it into all design version that they should

## ◆ **Flexible / Configurable**

- Design Studies
- Version for each separate 10kt module
- No Wires Version

## ◆ **Versionable**

- Avoid version shears between MC/Reco processing and source geometry

## ◆ **Easy to Learn and Use**

- New experts inevitably needed, even late into data-taking

## ◆ **Testable**

- In-situ testing upon generation (overlaps, densities, key volumes...)

## ◆ **Aware of ROOT vs Geant4 Subtleties**

- There are actual differences capability, rules should be enforced (certain volumes, units, etc..)

# General Geometry Description

By Brett Viren

## ◆ Modular

- Python “Builder” classes, owning “Subbuilders”, each with their own defining file
- Naturally enforces LArSoft Geometry hierarchy

## ◆ Flexible / Configurable

- Easy to reconfigure a builder at any level in the hierarchy
- Easy to define a new builder if something is fundamentally different and can't be solved by a new config
  - Wires vs Pixels. SP vs DP.

## ◆ Versionable

- Save duneggd version number and few-KB config file to each art root file.

## ◆ Easy to Learn and Use

- If you know python and the volume hierarchy LArSoft wants, you're good to go
- Use GGD framework instead of single custom script
  - enforces developments to progress in a clean, easy-to-understand way

## ◆ Testable

- Easy to include in-situ testing as an option in the “gegede-cli” executable

## ◆ Aware of ROOT vs Geant4 Subtleties

- GGD begins to enforce these rules, and is a good way to continue to formally do that

### Documentation

[Overview](#)

[Builders](#)

# Dune GGD

By Tyler Alion

◆ **duneggd** repository on top of GGD

◆ **Documented** (hyperlinks)

- Extremely easy to get started
- Easy to configure

◆ **Used By ND groups**

- I added a LArND which is very much like the FD workspace
- FGT example: Easy to make a very complicated geometry
  - Parallel development, outside of MRB and LArSoft dependencies

◆ **Auxiliary tools**

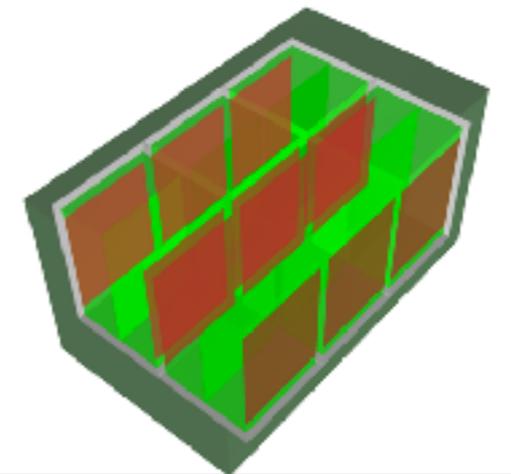
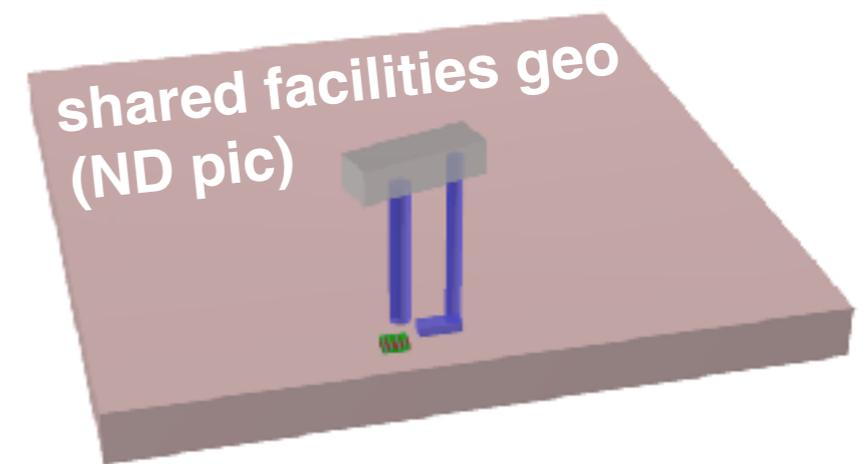
- I've committed testing and drawing scripts, can link to the executable

◆ **Can package separately (with GDML)**

- Save duneggd version number and few-KB config file to each art root file.
- Then dependency on another repo just becomes a matter of UPS versioning

◆ **Single Source** for Detector Hall, Material definitions Near and Far, etc...

- and for all of the different versions
- SP, DP, various designs, various 10kt modules, Workspaces!



# Dune FD with GGD

- ◆ **I need to proactively share geometry expertise**

- Most natural way to do it is at my institution

- ◆ **Interested folk at Sussex**

- Me, Aran Borkum (Simon Peeters' PhD student), Pierre Losak

- ◆ **I propose to make a GGD FD**

- Next couple of months, I already started this years ago.
- Mostly me and Aran, Keep others at Sussex in the loop

- ◆ **I propose to make this the standard approach to geometry moving forward**

- What do you think?

- ◆ **Backwards compatibility not an issue**

- Existing Perl and GDML is not going anywhere

Backup

- Neutron capture position in the whole 10kT.
  - You can see the wall, argon gas etc.
  - The CPA, APA are \*not\* there, you would expect different capture rate there.
- We are investigating this, for now, with the 1x2x6:
  - Generated 100k isotopic muons, recorded dEdx of every GEANT4 step... not very conclusive for now.
- I checked the geometry file (gdml), and didn't find what I was looking for (APA/CPA steel volumes).

