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DUNENDGGD: A Geometry Generator for DUNE Near Detector Design

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The Deep Underground Neutrino Experiment (DUNE) is a long-baseline neutrino oscillation experiment aiming at measuring the CP-violation phase in an unprecedented precision. A liquid argon time projection chamber (TPC) far detector and a near detector system are considered. The near detector complex will consist of various components since we are aiming at a good phase space coverage of the neutrino events. A geometry generation tool, DUNENDGGD, is developed based on the general geometry description (GeGeDe). DUNENDGGD has a great flexibility to generate different detector and tracker combinations, therefore, the tool has been widely used in the DUNE near detector working group to design the DUNE near detector.

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The DUNE near detector is considered to be a hybrid detector with a liquid argon system and some numbers of tracking systems. In order to provide substantial flexibility for the near detector design study, a geometry generator is needed. A package, DUNENDGGD, is built targeting at evaluating different near detector configurations. DUNENDGGD is a general geometry generator and its output is in the gdml format, which is largely used in GEANT4 and ROOT. Users can easily change the detector dimensions, positions, materials and technologies. The package is located at https://github.com/gyang9/dunendggd. A package named GeGeDe (https://github.com/brettviren/gegede) will be needed in order to run DUNENDGGD. GeGeDe is a software system to generate a description of a constructive solid geometry. It is based on Python and relies on to enforce consistent usage of units.

In DUNENDGGD, the geometry hierarchy is:

- DUNE near detector.
- Sub detectors such as the fine grain detector, liquid argon time projection chamber (TPC), gas argon TPC, electromagnetic calorimeter (ECAL), magnets and so on.
- Components such as scintillator plane, wire plane, resistive plate chamber (RPC) plane and so on, an example of the RPC is shown in Fig. 1.
- Active volumes such as the straw tube, rectangular scintillator bar and so on.

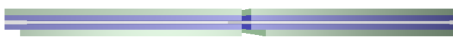

Figure 1: A resistive plate chamber. The outer layers are honeycomb insulators, middle layers are bakelite resistive plates and the inner part is filled with mixed gas.

An example shown in Fig. 2 is a detector complex consisting of a liquid argon TPC detector in the front and a multi-purpose tracker behind the liquid argon TPC detector. The detector on the left side is a liquid argon detector named ArgonCube and the one on the right is a magnet volume containing ECALs and a gas argon TPC.

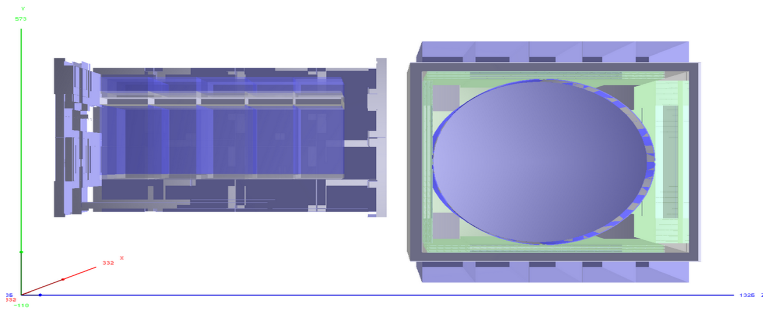

Figure 2: An example geometry generated with DUNENDGGD. On the left, it is the ArgonCube detector and on the right, a box shpaed magnet and ECAL cover a gas argon TPC.

DUNENDGGD can be used to build complicated detector systems with various technologies. Physics studies based on those detectors can be done afterward. DUNENDGGD is widely used in the DUNE near detector working group.