Gnumi Migration

Giving features of gnumi to g4numi

Introduction

- Gnumi
  - NuMI beamline simulation program
  - Very simple, flexible geometry
- G4numi
  - Successor of gnumi
  - Very detailed, rigid geometry
- Need a more flexible version of g4numi…
  - Useful for more applications
  - Easier batch processing

gnumi vs g4numi

- Uses GEANT3
- Written in FORTRAN
- Simple geometry
- Flexible layout
- Layout input from a text file at run time

- Uses GEANT4
- Written in C++
- Detailed geometry
- Rigid layout
- Layout hard-coded in a C++ file

What I've done so far…

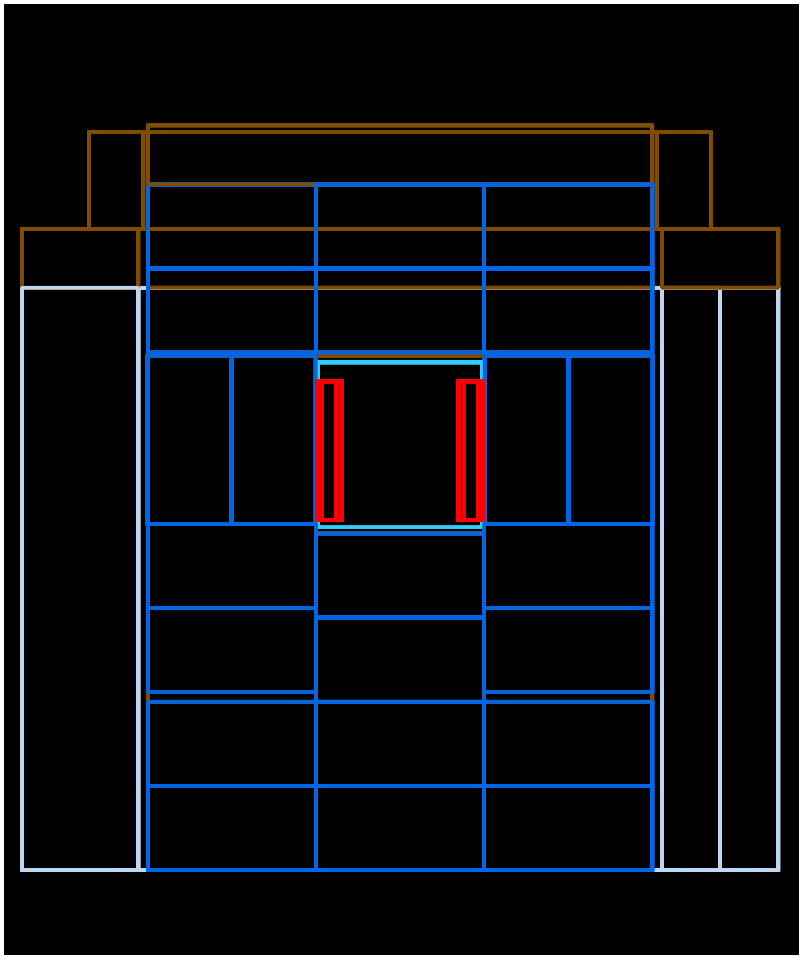
- Obtained gnumi code and got it to run
- Obtained g4numi code and got it to run
  - Will post instructions for how I did this on the LBNE wiki
- Wrote a parser in C++ to read gnumi-style input files
- Partially integrated this parser into g4numi, allowing g4numi to read certain variables from an input file
  - An optional command-line argument, preceded by --input, specifies the input file
  - An optional environment variable G4NUMI_INPUT_DIR may be set to specify the base directory to look for input files. This is analogous to gnumi.
- Obtained and learned to use HepRApp
  - 3-D visualization tool, successor of Wired3
  - Used to view .heprep files, which g4numi can output
  - Can be used for debugging, making sure the volumes are in the right places
- Replaced certain detailed geometries with simpler gnumi-style geometries, allowing more variables to be read from the input file
  - Target
  - Budal monitor
  - Decay pipe
  - Target hall
  - Hadron absorber

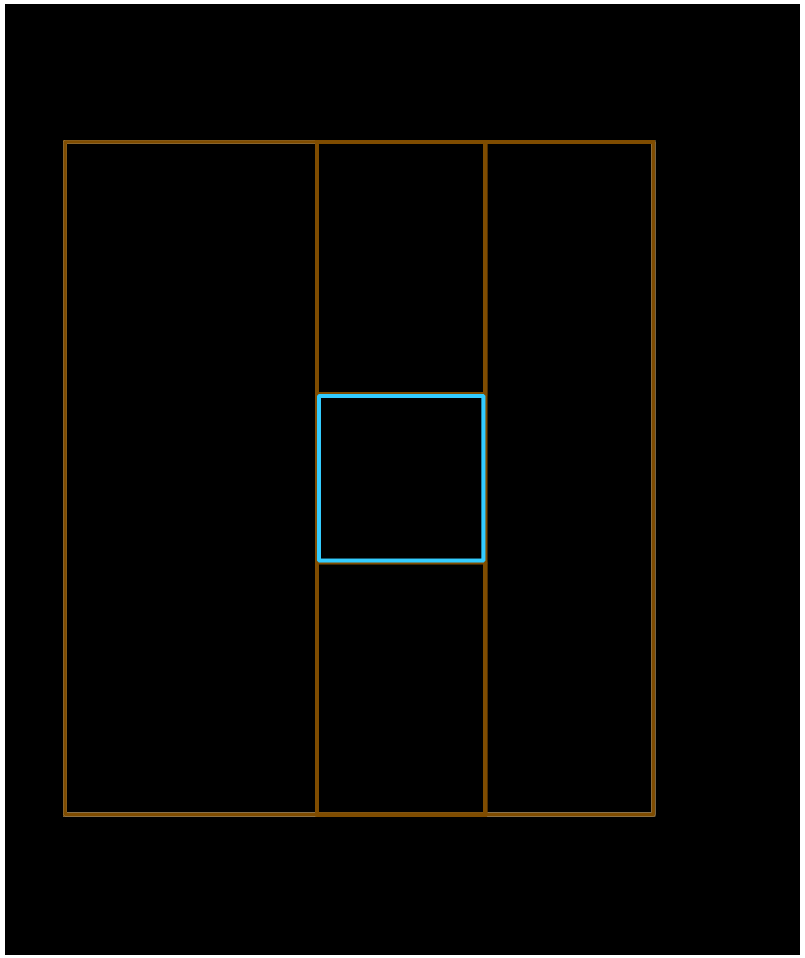
Part of a gnumi input file (le.input)

```
...
Beam         1
C=====================================================================
C
C BeamOnTarget = FALSE -> beam starts in front of baffle, do not C
C automatically transport to target face C
C
BeamOnTarget FALSE
BeamX0      0.0
BeamY0      0.0
BeamZ0     -3.05
BeamSigx    1.0E-3
BeamSigy    1.0E-3
BeamMaxx    5.0E-3
BeamMaxy    5.0E-3
BeamDx      0.0
BeamDy      0.0
BeamSigdx   26.0E-6
BeamSigdy   26.0E-6
BeamMaxdx   130E-6
BeamMaxdy   130E-6
BeamP       120.93

BlockNblock 14
C=====================================================================
C Target area shielding
C
BlockX0        1=  1.3970  -1.39700  0.       0.        0       0
BlockY0        1=  0.8707   0.8707  -1.4153   1.3665    1.3792  1.3665
BlockZ0        1= -4.0     -4.0     -4.0     -4.0       9.0     15.0
BlockDxdz      1=  0.0      0.0      0.0      0.0       0       0
BlockDydz      1=  0.0      0.0      0.0      0.0       0       0
BlockLength    1=  49.28    49.28    49.28    13.0      6.0     30.279
BlockHdx       1=  0.8128   0.8128   2.2098   0.5842    0.5842  0.5842
BlockHdy       1=  1.8232   1.8232   0.4628   1.0109    0.9982  1.0109
BlockGeantmat  1=  10       10       10       10        10      10
C
C Absorber
C
BlockX0        7= 1.651  -1.3208 0.      0.3302   0.     0.    0.
BlockY0        7= 0.0     0.    0.      0.      0.    -1.651  1.651
BlockZ0        7= 723.48  723.48 726.4772 728.7632 723.48  723.48 723.48
BlockDxdz      7= 0.0     0.    0.      0.      0.     0.    0.
BlockDydz      7= 0.0     0.    0.      0.      0.     0.    0.
BlockLength    7= 5.2832  5.2832 2.2860  0.9144  2.4384 2.9972 2.9972
BlockHdx       7= 0.9906  0.6604 0.6604  2.3114  0.6477 0.6604 0.6604
BlockHdy       7= 2.6416  2.6416 2.6416  2.6416  0.6477 0.9906 0.9906
BlockGeantmat  7= 10      10     10      17      9      10     10
C
C Target budal monitor
C
BlockX0       14= -7.5E-3
BlockY0       14= 0.0
BlockZ0       14= -51.72E-2
BlockDxdz     14= 0.0
BlockDydz     14= 0.0
BlockLength   14= 20.0E-3
BlockHdx      14= 17.5E-3
BlockHdy      14= 3.2E-3
BlockGeantMat 14= 18

...
```

Detailed (left) and simple (right) hadron absorber

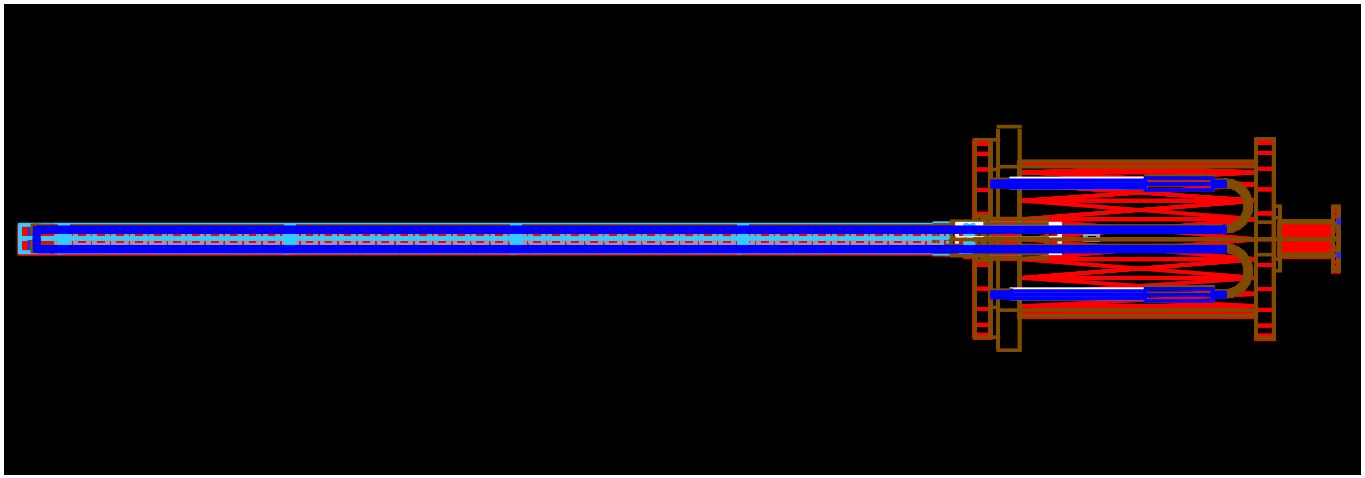
(generated with HepRApp)

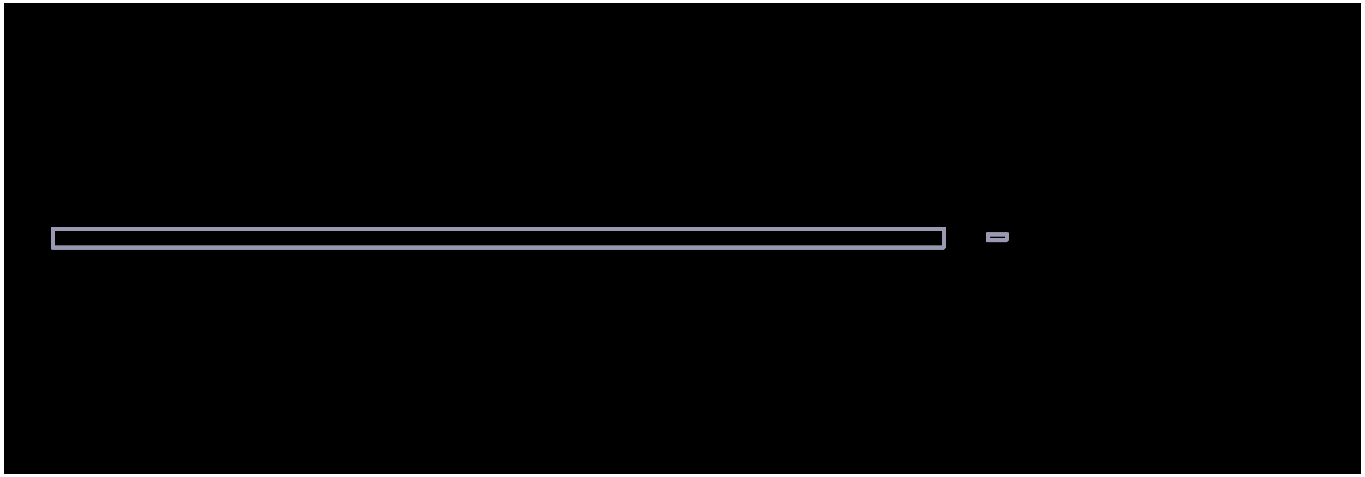




Detailed (top) and simple (bottom) target and budal monitor

(generated with HepRApp)





Typical gnumi components

- Rock: rock formation containing all other volumes
- Beam: primary proton beam
- TargetArea: primary target hall
- Blocks:
  - 1-6: target area shielding
  - 7-13: primary absorber
  - 14: budal monitor
- HPBaffle: horn protection baffle
- Target: primary target
- Phorn: horn 1 and horn 2 definitions
- Tunnel: decay tunnel
- DecayPipe: decay pipe
- Shield: decay pipe shielding
- FluxArea: Neutrino flux weighting parameters
  - Specifies near and far detector locations and radii

What remains to be done…

(note: since I will be leaving in a few weeks, this project may need to be passed on to someone else before it is finished)

- Finish replacing detailed geometries with simpler ones that can read input
  - Horn 1 and horn 2
  - Hadron absorber shield?
  - Muon monitor alcoves?
- Add any important functionality from gnumi that may still be missing
- Make sure all of the variables can be read from input
- Perform tests to ensure g4numi beamline simulation runs as expected
- Write documentation
  - Section in LBNE wiki
  - Readme file
  - Comments in source code
- Create a branch in the g4numi CVS repository where this code will be accessible
- Clean up source code to better match the new design
- Possibly allow for more input formats than just the original gnumi-style input (xml, for example)