Beam Simulation Group Plans

Laura Fields and Paola Sala

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Outline

- Purpose of our group
- Near term plans

Purpose of Our Group

- Collaborate with Beam Interface WG and Beam Optimization Task Force to build tools needed for and to execute beam optimization and other beam studies

- Provide beam flux simulations and systematic uncertainties that are the starting point of beam-based physics studies

Our group's responsibility is DUNE's beam simulation software for physics studies, but we will work closely with the MARS team (which develops the beam simulation used for LBNF radiological and energy deposition studies)

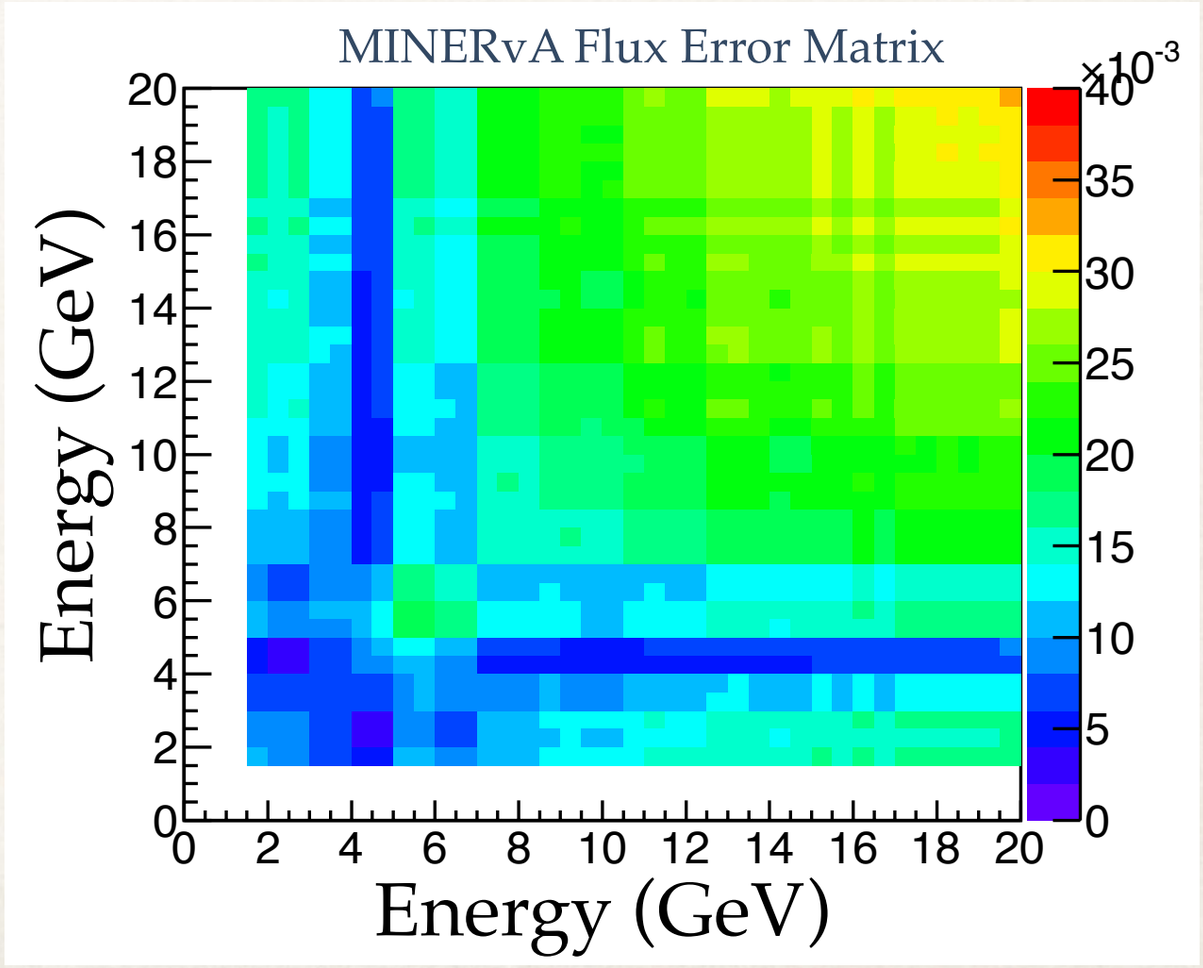
Near Term Plans

- An urgent need of the Near Detector Optimization Task Force is a priori flux uncertainties and bin-to-bin correlations (inputs to near detector fits):
  - There is currently no good estimate of these for DUNE

Zeroth Order Plan:

Borrow NuMI Uncertainties

Specifically, MINERvA's



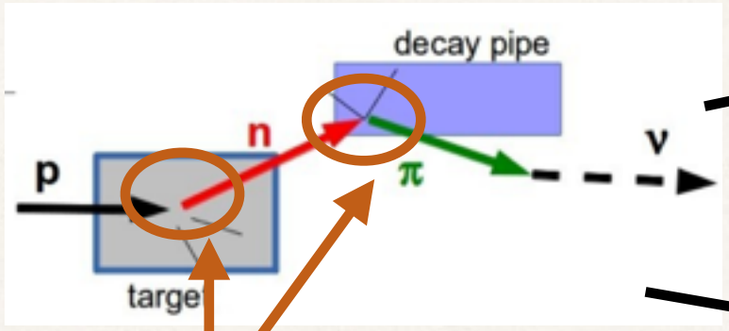
Near Term Plans

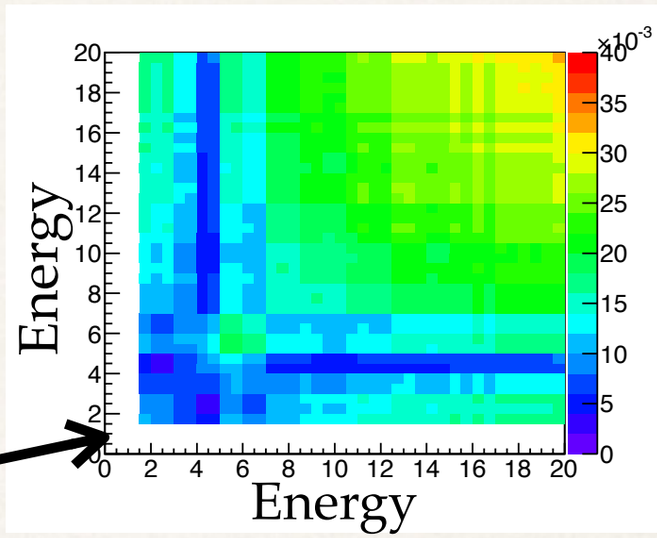
- Next step in producing flux uncertainties and correlations: use external data constraints, leaning heavily on infrastructure already developed by NuMI:

A. Bashyal & H. Schellman of OSU will apply MINERvA's procedure to DUNE

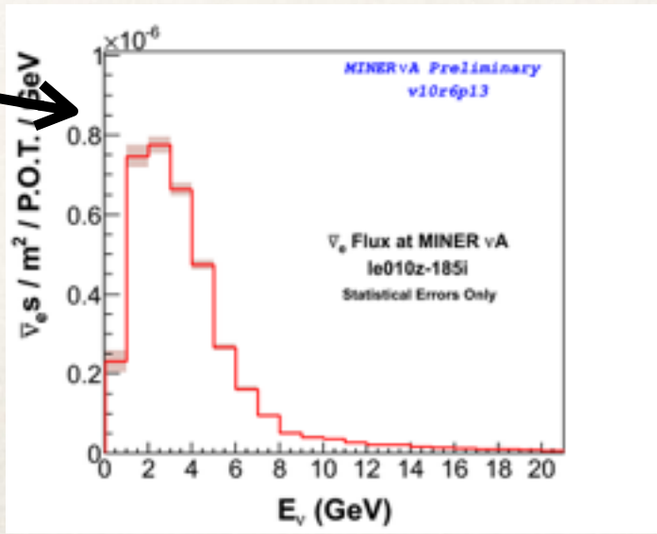
Others welcome (especially those familiar with alternative methods e.g. BMPT parameterization)

Flux event record





Each interaction in the ancestry list is adjusted and an uncertainty assigned using external data constraints (or very large uncertainty assumptions where data is unavailable)

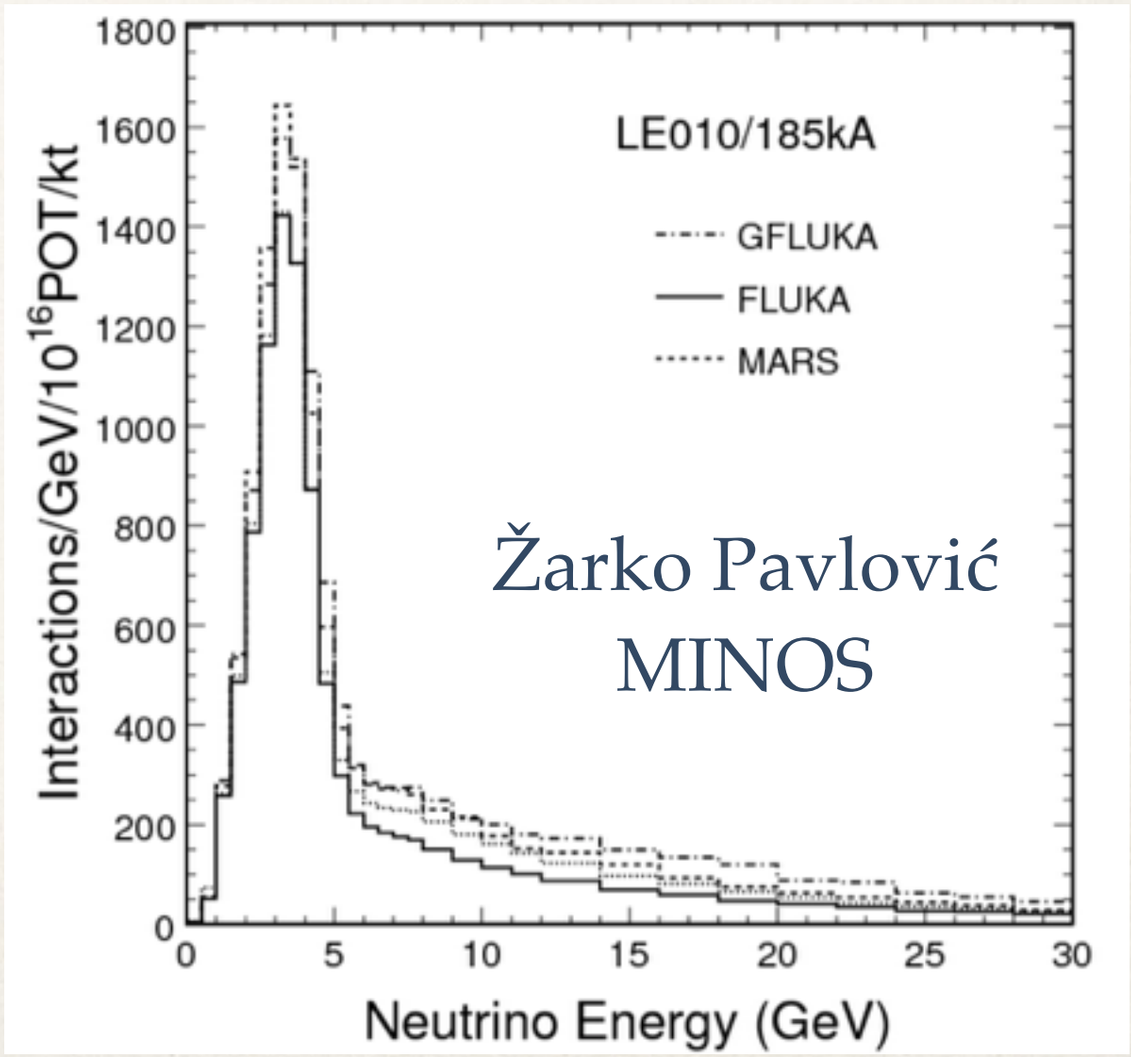


Near Term Plans

- Another important component in understanding systematic uncertainties: the ability to run with many different hadron production models:

P. Sala plans to add a full-FLUKA option to the DUNE beam simulation

Important for understanding flux uncertainties; also an important cross-check of GEANT4 implementation of geometry



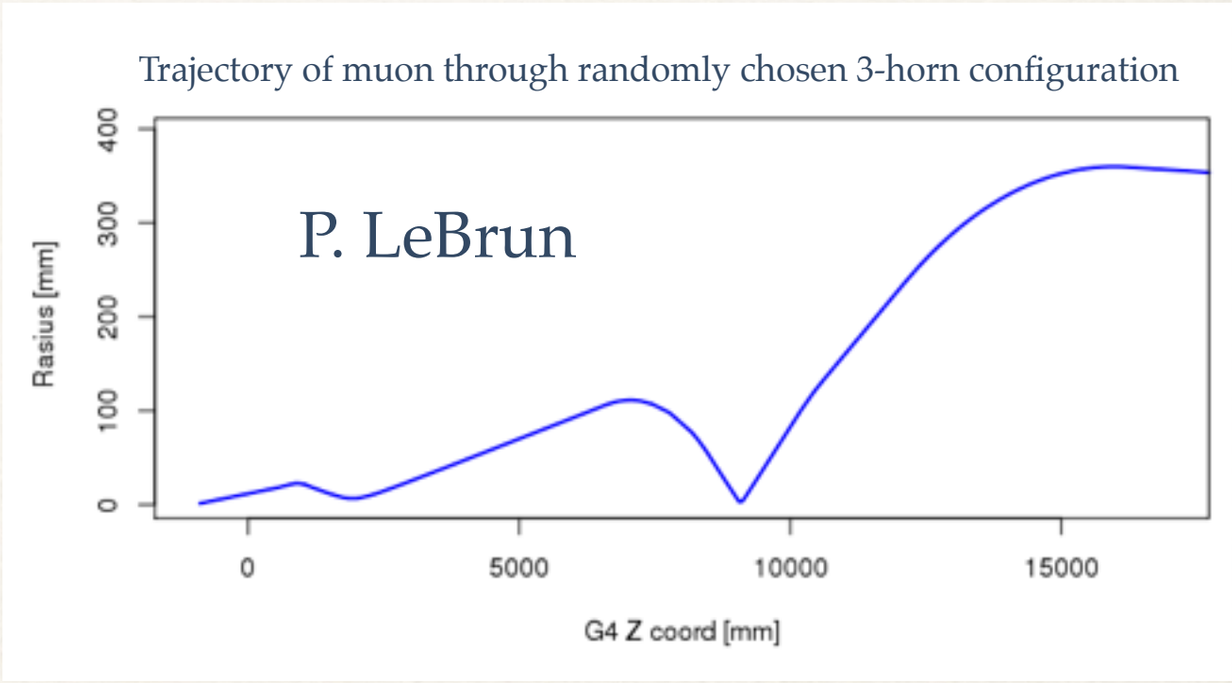
Žarko Pavlović
MINOS

Near Term Plans

- Another goal of the group: facilitate beam design optimization

P. LeBrun has implemented an option with three (or more!) configurable horns

More options to come:
sphere-array target?
target wings?
parabolic horn shapes



Near Term Plans

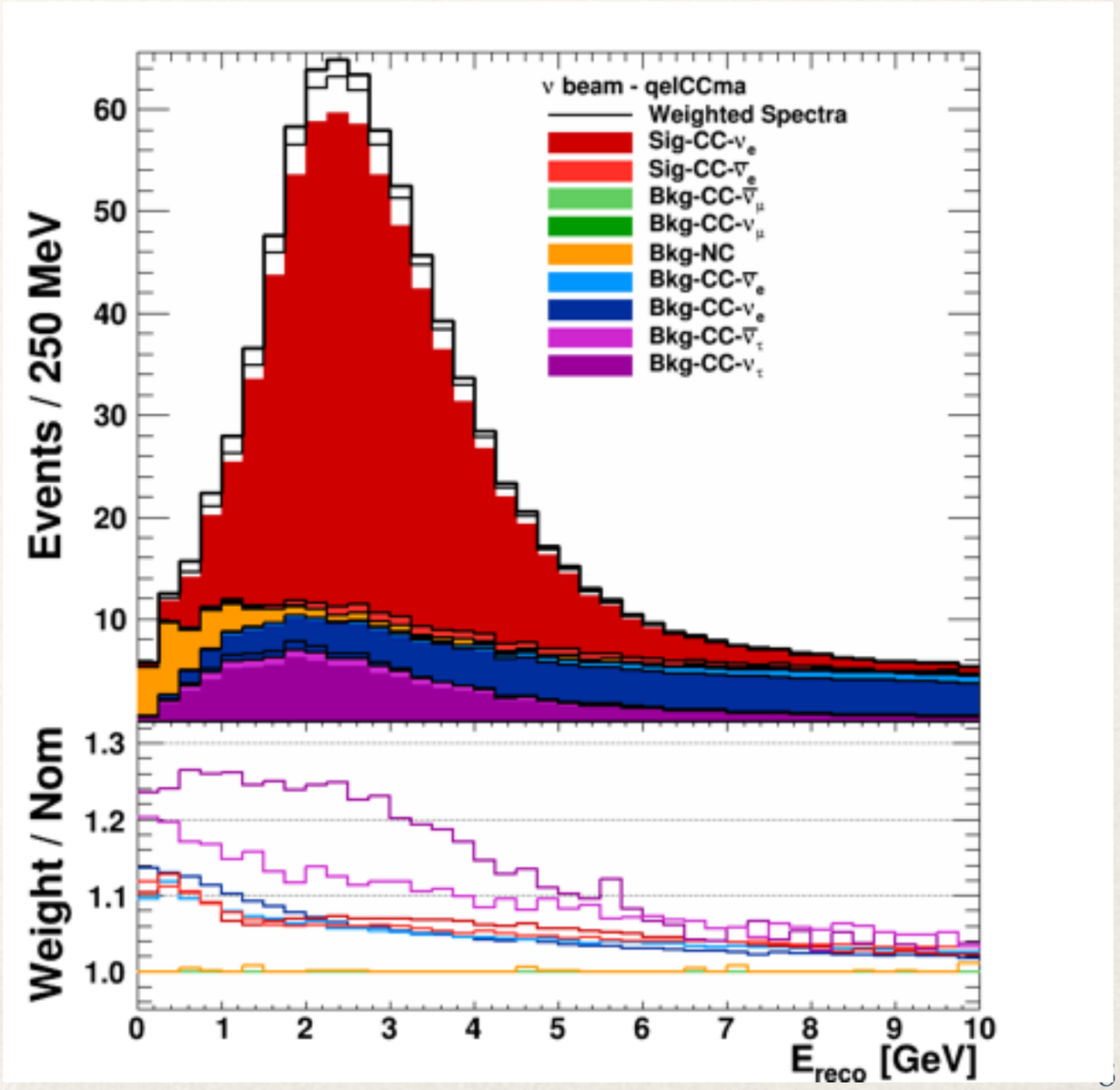
- Another high priority activity: Fast MC Interface

All DUNE Fast MC studies begin with a beam simulation

Many other physics/reco efforts (e.g. FD reconstruction) piggyback on Fast MC files

We need help developing this interface

Coming soon: Flux histogram -> Flux driver transition



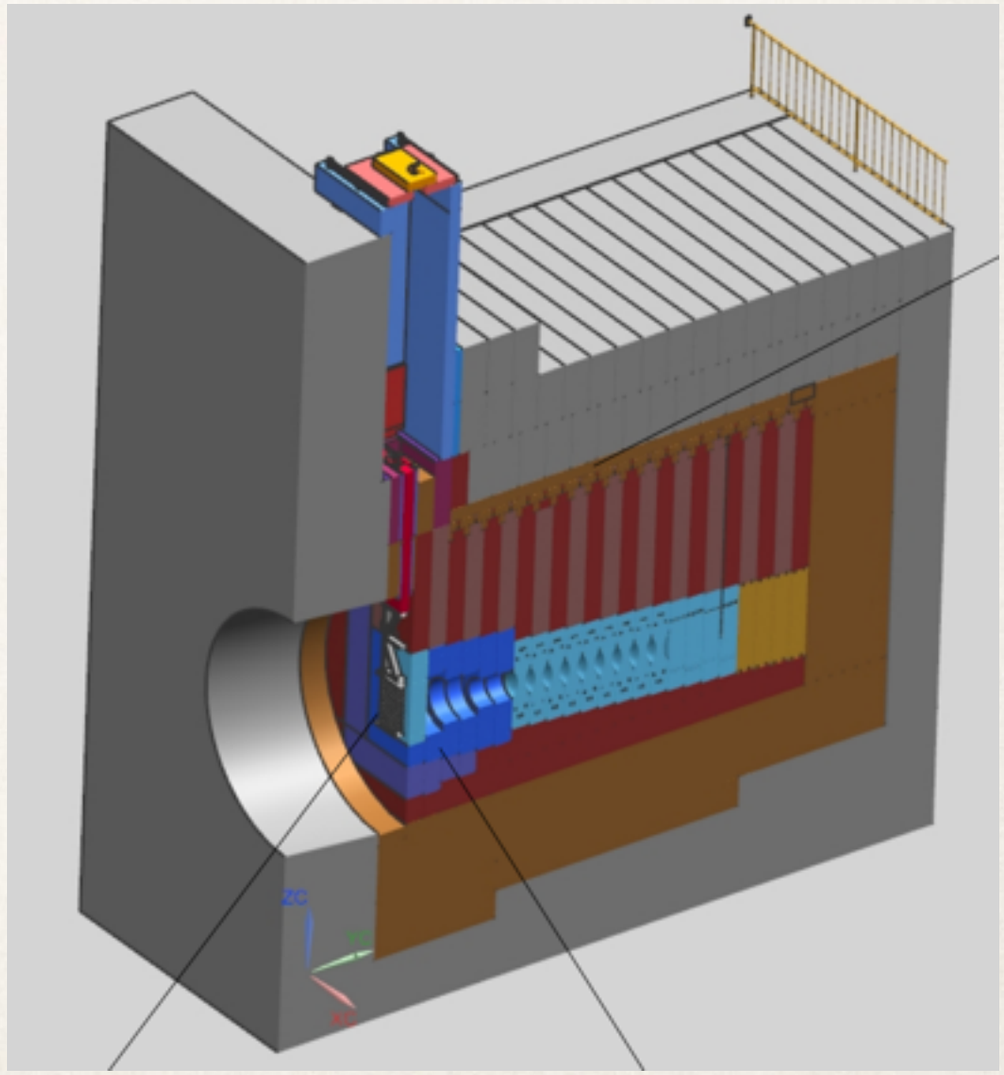
Near Term Plans

- Another active project: HA, instrumentation studies

P. LeBrun has also implemented a sculpted hadron absorber design in Geant4

Basic first steps towards implementation of hadron and muon monitor simulations have been taken

Much more work needed before we have a full simulation of monitors and an understanding of their impact on physics.



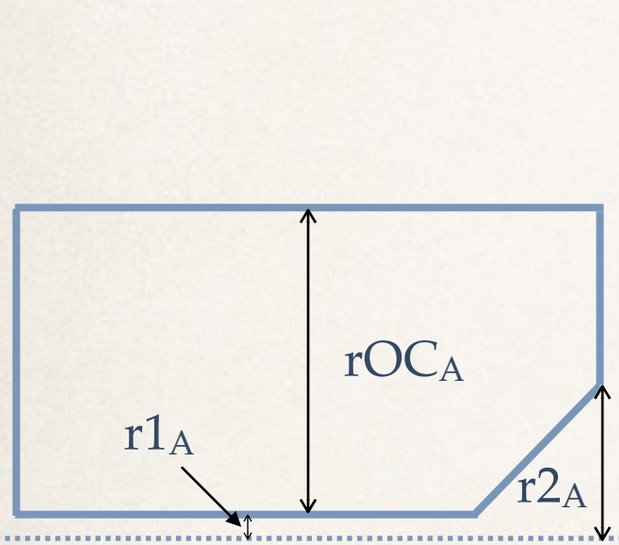
Near Term Plans

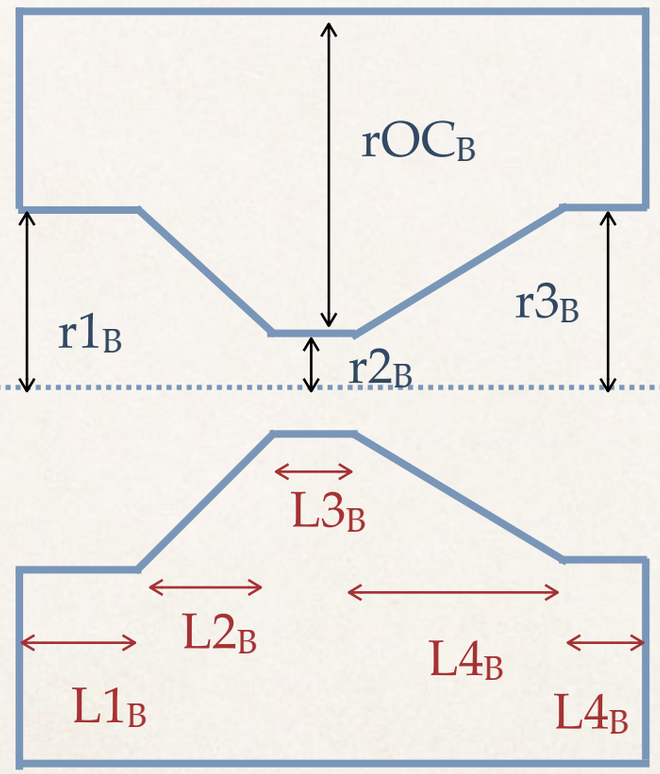
- Simulation studies
  - Downstream high-Z target
  - Off-axis angles in optimized beam
  - Parabolic version of optimized horn
  - Update & refinement of optimization metric
    - Fast estimator of CP & MH sensitivity -> may be of use outside of beam group
- Estimates of focusing uncertainty and alignment tolerances for optimized beams
- Impact of target material and dimensions on optimized flux (P. Sala?)
- Impact of magnetic field inside horn (if target not electrically separated from horn)
- Target sag alignment tolerance
- Magnetic field distortions at the edges of the horn
- Energy deposition in optimized design (N. Mokhov + Team)

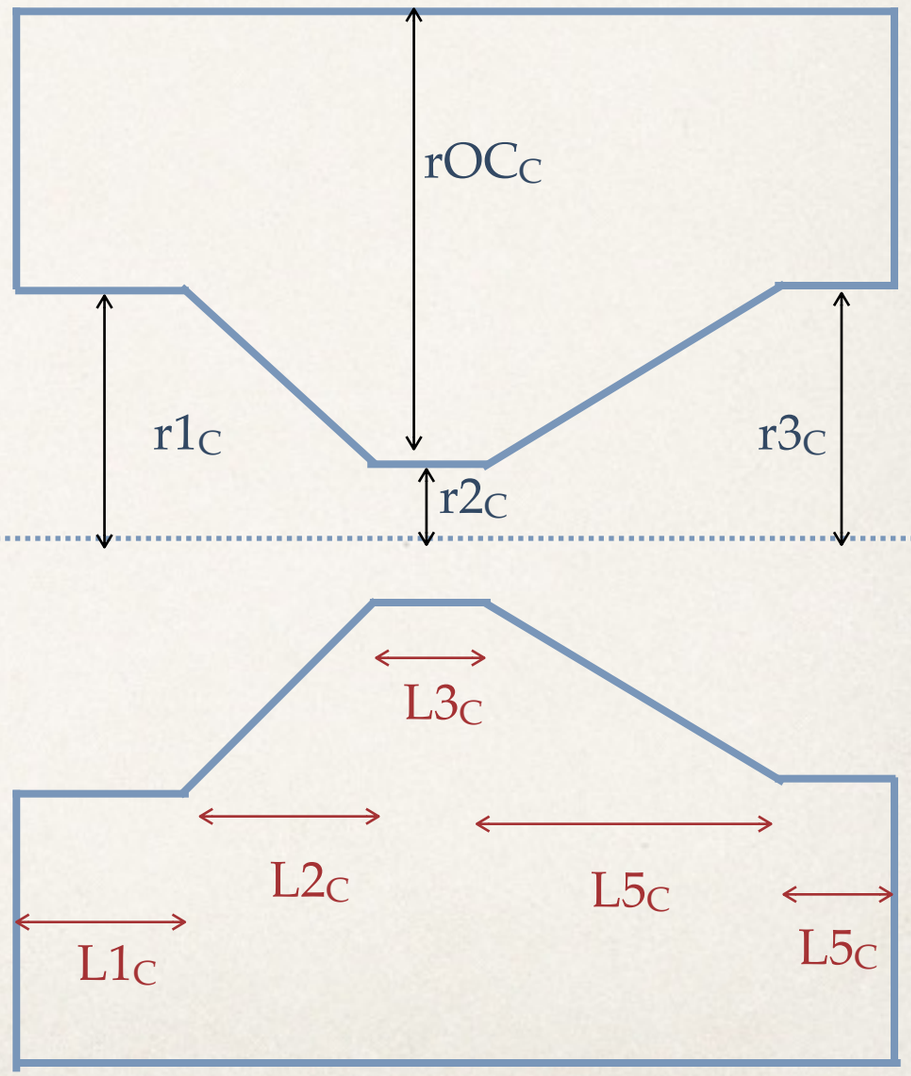
Most of these do not yet have proponents. An excellent place for new people to get involved.

Optimization Plan

- I'm planning to start a new optimization soon
  - These things take weeks to months to converge, so have to carefully consider what we want to vary
  - I propose to use three horns:







Optimization Plan

- Other Parameters:
  - Horn Current 150-300 kA
  - Proton energy 60-120 GeV, with power scaling according to PIP II estimates
  - Target length and radius
    - vary beam spot size with radius again, or separate?
  - Off-axis angle?
  - Fin spacing?
  - Perhaps do two optimizations, with Beryllium and Carbon targets
- Limits and other considerations
  - Limit outer conductor radii to 65 cm (similar to T2K, so can be fabricated)
  - Limit length of horns? 4 m? 3.5 m?
  - Limit target length to 1.75 m
  - Conductor thickness proportional to their radii
    - 2mm for 200 mm radii or less
    - Add 0.5 mm for ever 100 mm increase beyond that
    - One thickness for entire inner conductor determined by largest IC radius

} **Based on input from C. Crowley**

Optimization Plan

- Not part of the optimization itself, but an important study:
  - Need to understand how much a realistic material description changes the optimized flux
    - Welds, ribs, spider supports
    - More cooling?
    - Material at endcaps?

The End