Argonne and Mu2e

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Physics Case and ANL's Role

- Craig Dukes made that case this morning
  - if Low Energy Supersymmetry at LHC, or order 40-50 events with background < 1
    - can use to help distinguish among models
  - if *no* observation, set limits on new physics up to 10^4 TeV
- Experiment is in Conceptual Design Stage and needs engineering help *now*
  - Fermilab is understaffed in a number of places where ANL can help greatly

CR Veto

- "Baseline" Design from MECO used scintillator
  - about 800 m^2, 9 km/2100 strips
  - we can extrude simple patterns at FNAL
  - ANL has more capability
  - no reason this "must" be done at FNAL
- Scintillator may not be the best choice
  - high neutron rate may "veto everything"
  - are RPC's a better choice?
- ANL might help in either case

Sources of Neutrons

- Bath of thermal neutrons from Production Target
  - these can end up in CR veto
- 2 neutrons produced per stopped muon
  - these can exit detector solenoid, stop in CR and "self-veto" event

DAQ and Software

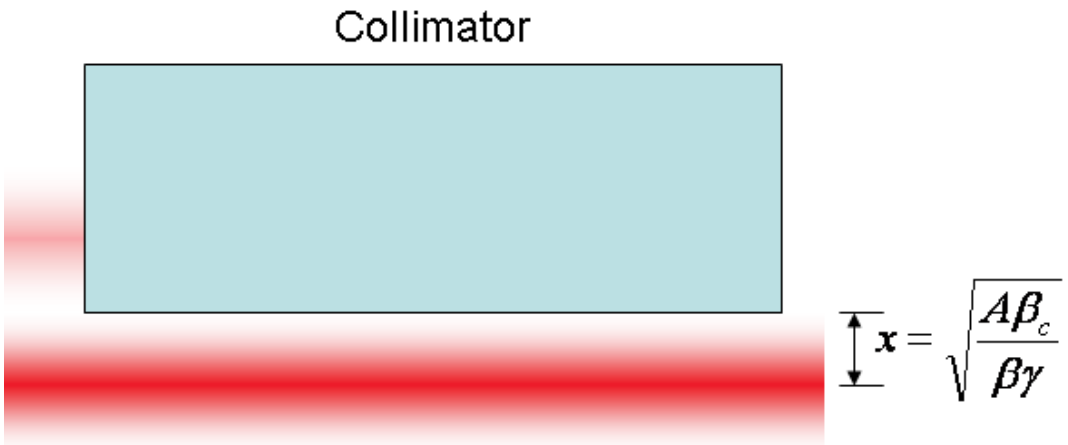
- Mu2e Offline is coming along
  - framework based on CMS
  - well-supported by FNAL CD
- Mu2e DAQ might be an opportunity
  - can we pipeline data directly into processors?
    - tracker ~150 kHz/wire * 2000 wires
    - calorimeter samples every ~25 nsec*2000 crystals
  - for example, have already written fast Hough Transform as pre-event selection for Kalman Filter

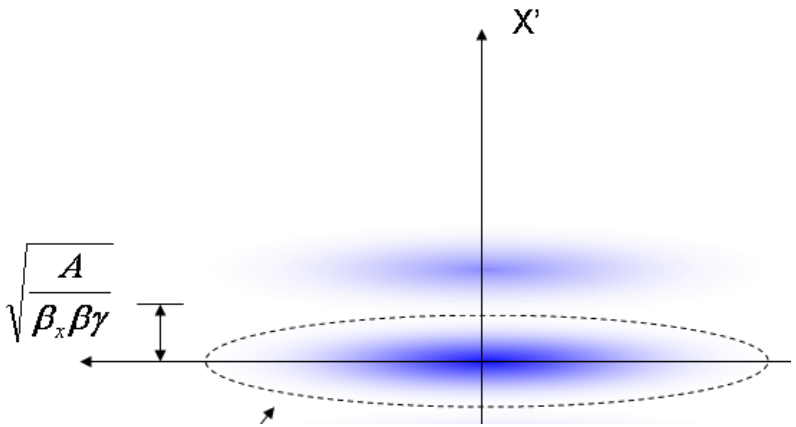
SIPMs and Extinction Monitor

- Generic Extinction:

At collimator:

Beam fully extinguished when deflection equals *twice* full admittance (*A*) amplitude





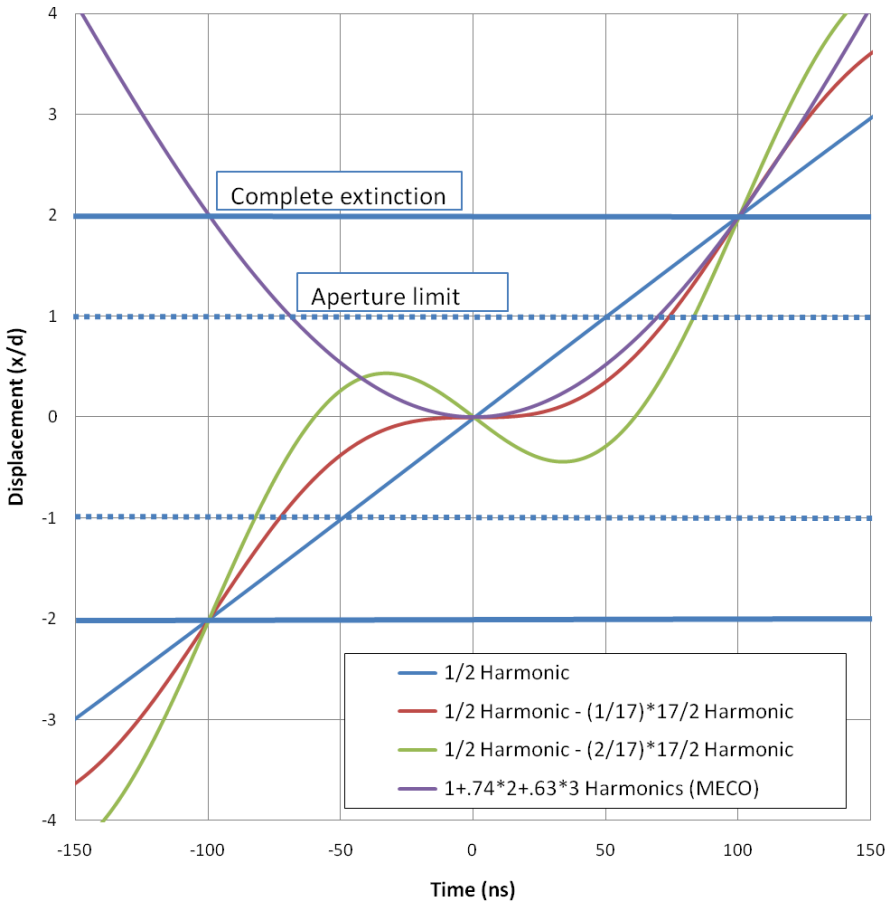
Angle to extinguish beam

$$\Delta\theta = 2\sqrt{\frac{A}{\beta_x\beta\gamma}}$$

Extinction Schemes

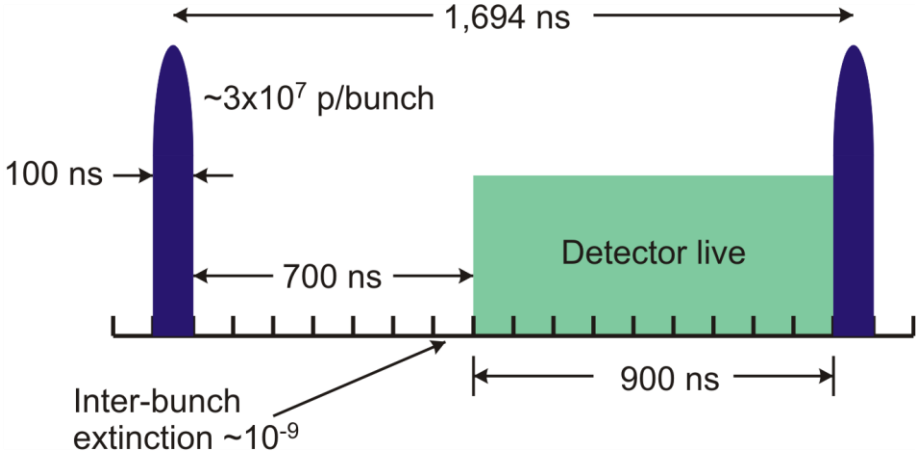
- Have a single dipole solution with two frequencies

In these schemes, second dipole not required!



Measurement of Extinction

- Must measure, cannot trust calculation
- Dynamic range:
- 3E7 p^+ in 100 nsec, need to detect 1 in the 700 nsec gap
- Will likely use Cerenkov counter in primary beam path
- Possible auxiliary monitor in Production Solenoid



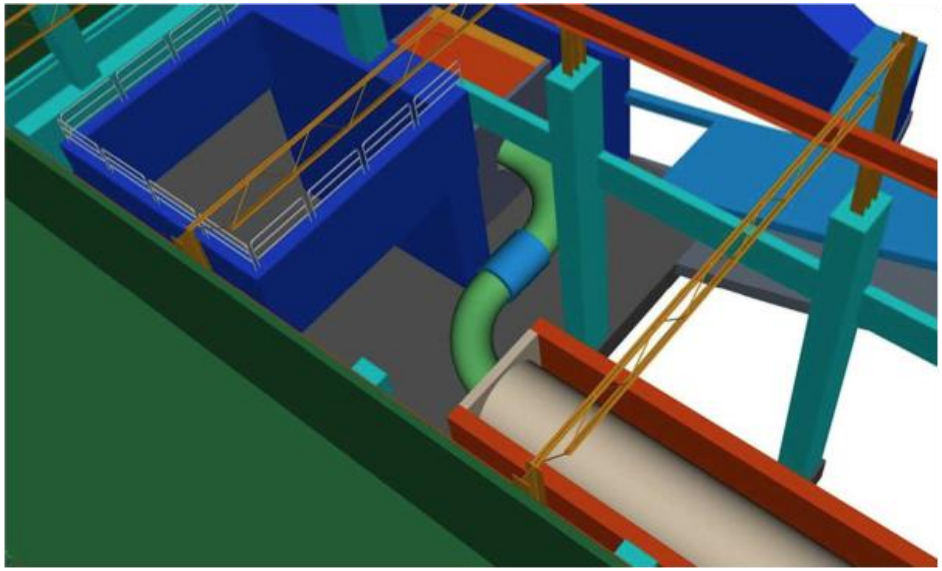
• therefore need a device which can be turned on/off in < 100 nsec

•PMT's have problems

•MCPs or SIPMs?

Repairs and Hot Handling

- Central piece is the sign-selecting collimator which must rotate
- Complicated area, therefore more likely to fail
- Also see next slide



Neutron Absorber

- Lines inside of Detector Solenoid
- About 20 Tons of 30% boron loaded polyethylene
- Needed to
  - keep neutrons from firing veto(get outside of bore, stop in hydrogen of CH_2 – hence RPC?)
  - rattle around in DS and fire straws
- Complicated arrangement driven by manufacturer (Thermo Electron)
- Can we do better?

Neutron Absorber (front view)

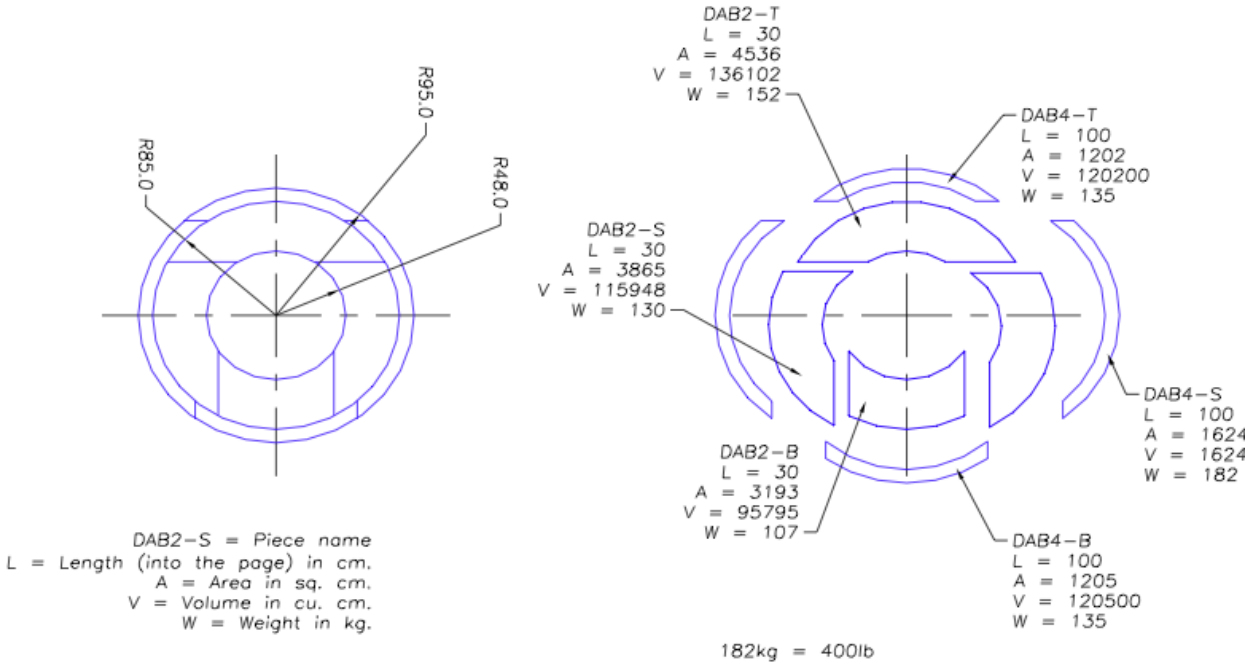
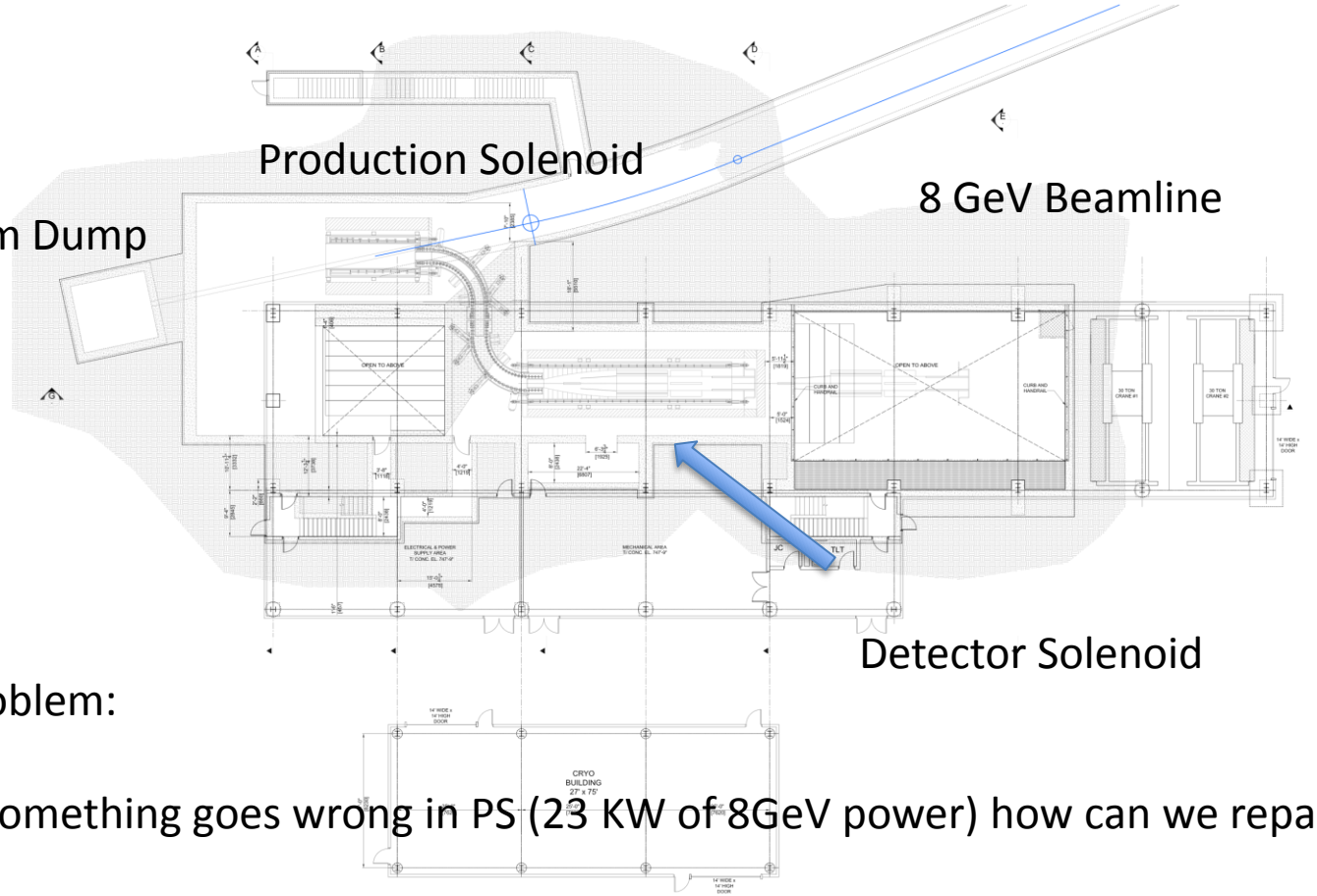


Fig. 4 End View of Neutron Absorbing Material
(Looking from upstream end of DS)

Mu2e Hall



Problem:

if something goes wrong in PS (23 KW of 8GeV power) how can we repair it?

Calibration and Resolution Measurement

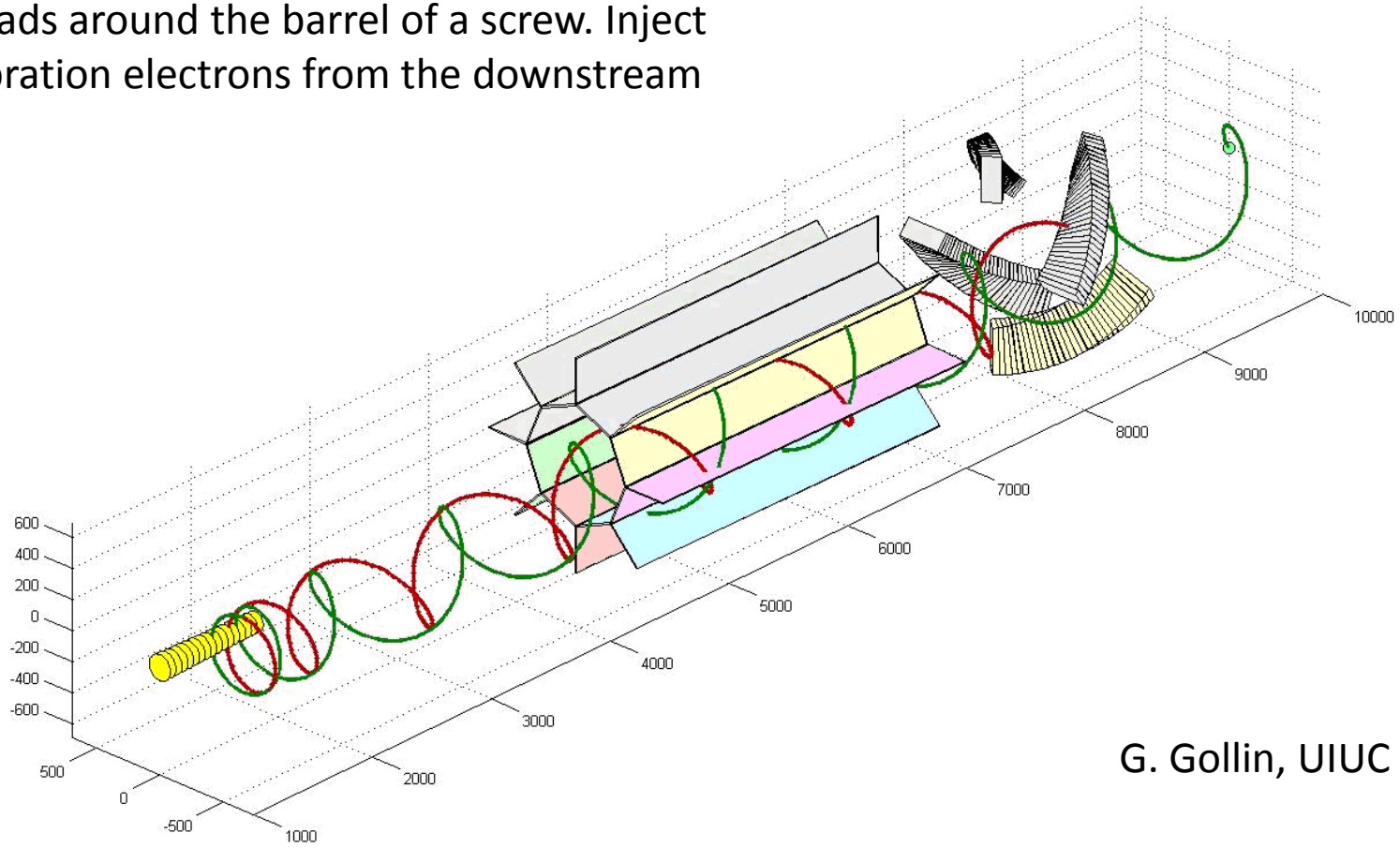
- Both “absolute scale” and understanding resolution are required
- Calibration:
  - absolute measurement of field
  - reverse central collimator which lets through positives: study pi^+ -> e^+ nu_e, monochromatic e^+ at ~70 MeV
    - different environment than data
    - opposite helicity from e^- signal

Resolution Measurement

- Desirable to have *in situ* measurement of resolution function: intrinsic resolution of tracker < 200 keV and we want to understand non-gaussian tails.
- Electron source at ~100 MeV?
  - absolute calibration not so important as long as it's reproducible and width small, understood
- Possible Idea: fire electrons into downstream end of Detector Solenoid
  - electrons then bounce off mirror and execute two helices
  - many problems with this
    - must reconfigure calorimeter or electrons will hit it
    - need to sweep through range of angles
    - plus non-trivial to build source, short beamline, optics, etc.

One Scheme

Consider reconfiguring calorimeter vanes to wrap around the spectrometer axis, like screw threads around the barrel of a screw. Inject calibration electrons from the downstream end.



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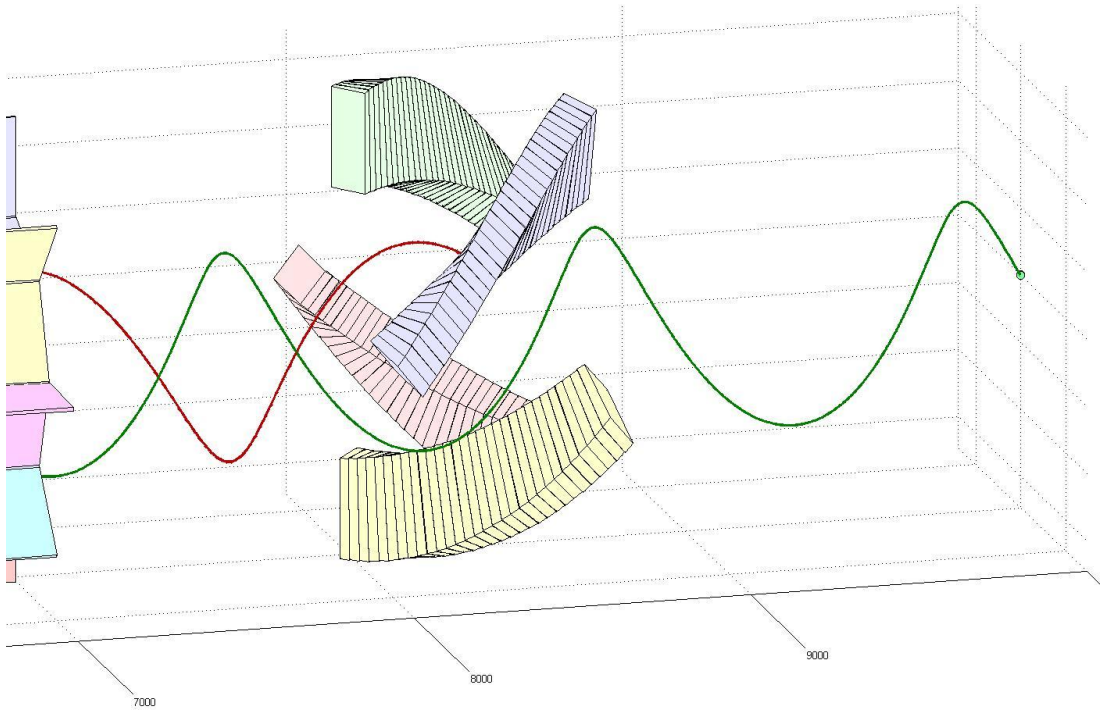
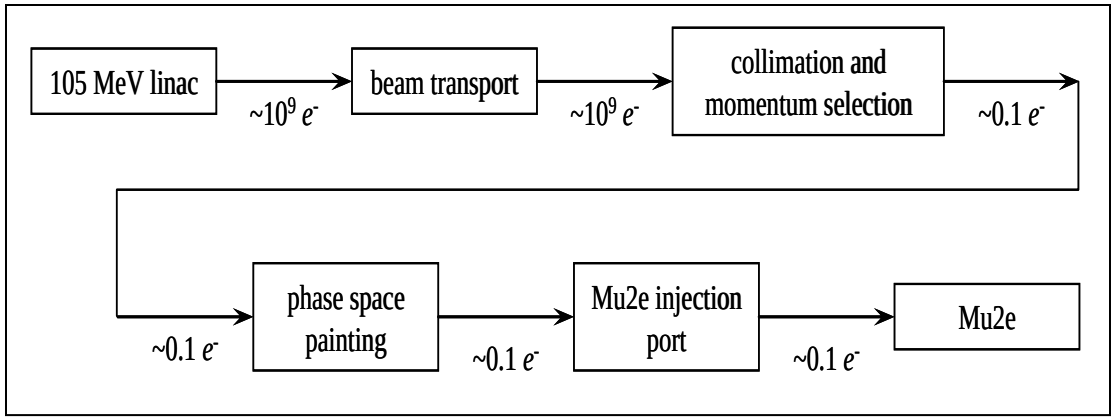
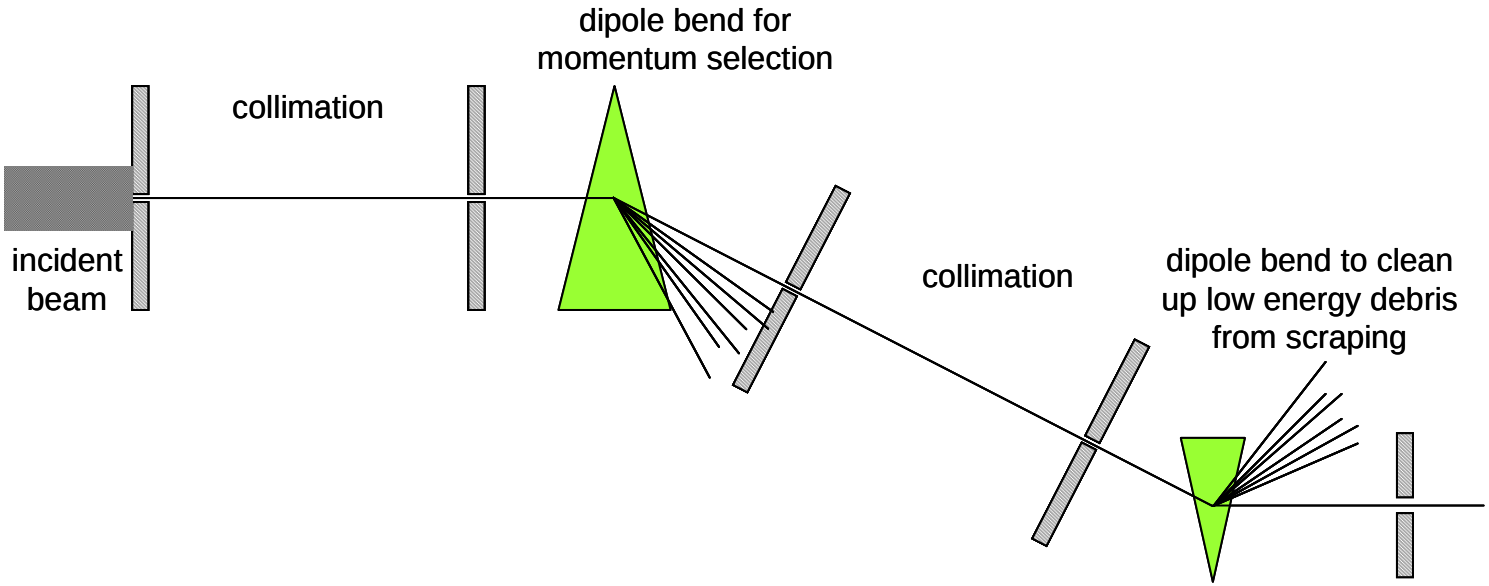
Blowup near calorimeter

- Non-Trivial configuration



Beamline is Complicated





Semi-Conclusions

- This would be great if it worked
  - Not an easy problem and could end up being expensive
  - perhaps just upstream injection, but would like to avoid stopping target and consequent energy loss
- Requires thought and commitment

Conclusions

- Any number of places where ANL could make a significant contribution
- Or possibly own a subsystem
  - neutron absorber
  - front end pipeline
  - hot handling system
  - calibration/resolution measurement
- Welcome participation of engineering and technical staff!
- And physicists too…