Proton Absorber – Feasibility Study

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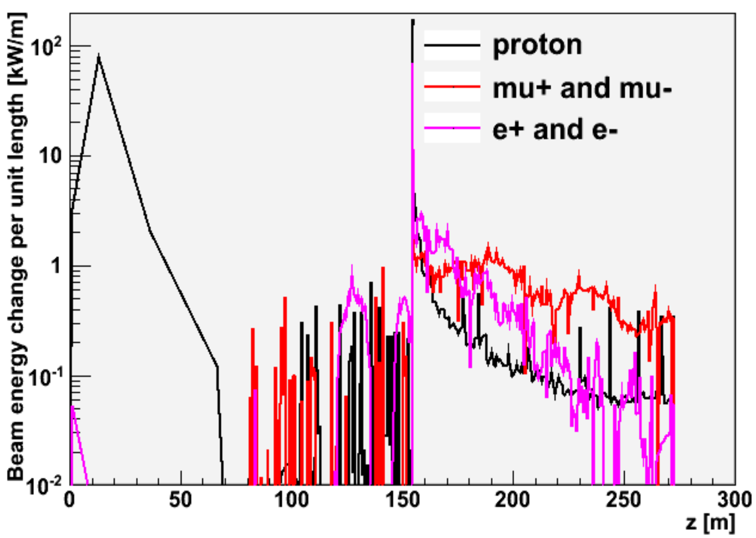
Overview

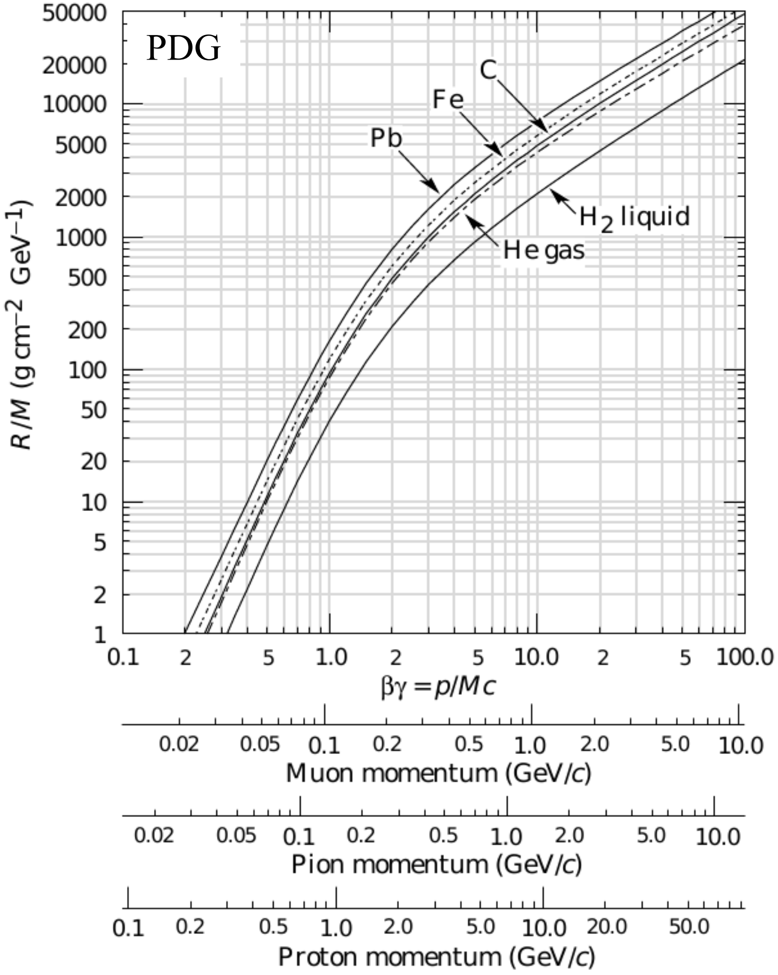
- We have a problem with secondary protons in the front end
- Deposit significant energy on the hardware
  - Especially RF windows and LiH absorbers
- Probably these become far too active
  - Need remote handling (ouch)
- One way to fix this is using a proton absorber

Change in beam power/length along beamline



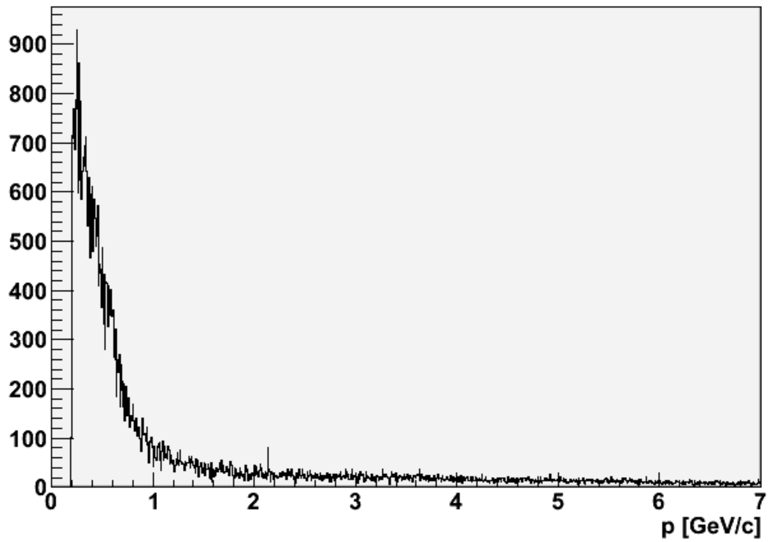
Proton absorber – design principle

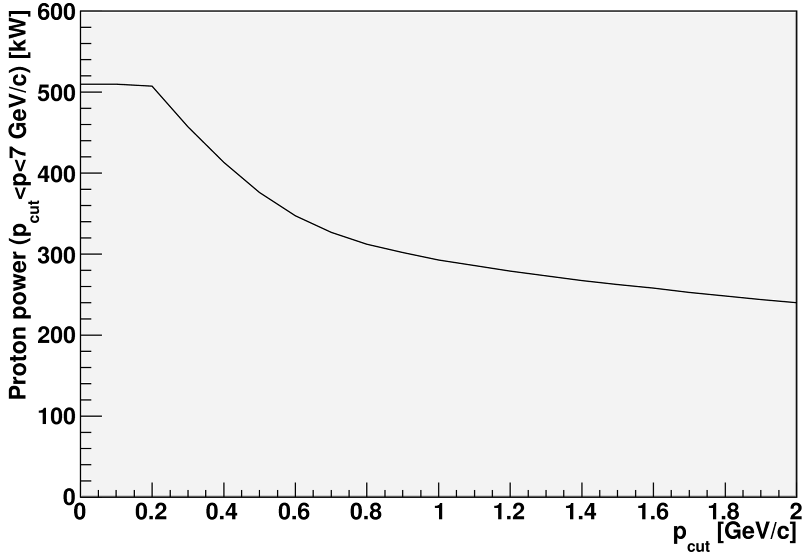
- Low p protons lose more energy in material than muons, pions
  - dE/dx goes with relativistic βγ
  - Bγ = p/m
  - m of protons is >> m of muons, pions



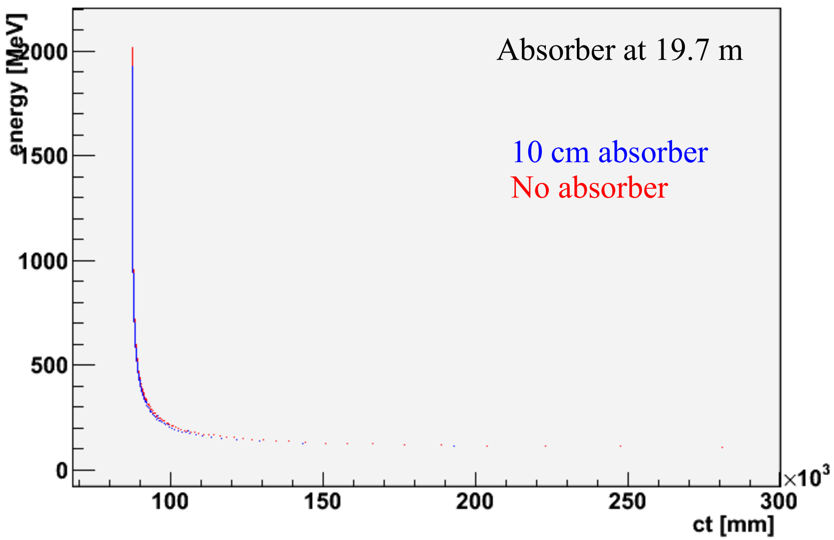
Momentum Distribution of protons

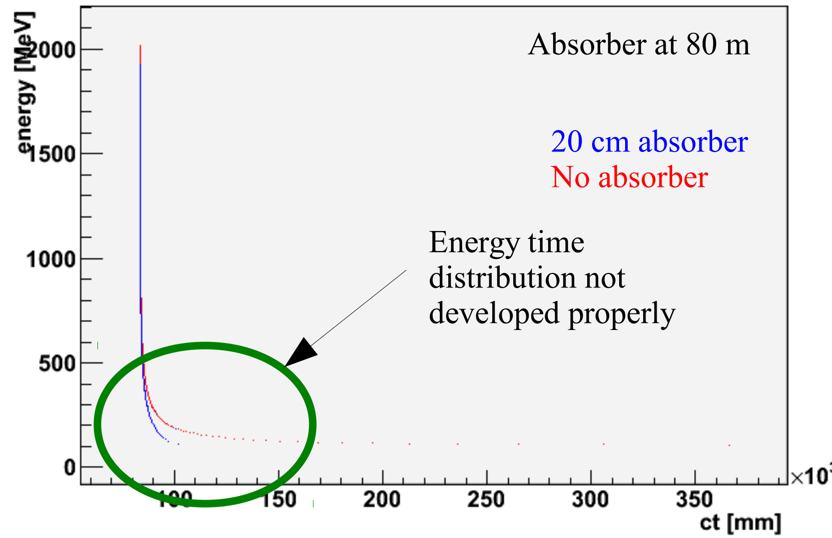
- Proton momentum distribution of beam at target
  - Most protons have p < 1 GeV/c
  - Nb no protons with p < 0.2 GeV/c (MARS cut-off?)
- Proton power distribution of beam at target
  - Plot is power in beam vs minimum cut-off
  - e.g. P_{cut} = 1 GeV/c => power of all protons with 1 < p < 7 GeV/c
    - Upper cut is to get rid of primaries
  - About 50% of proton power is in protons with p > 1 GeV/c





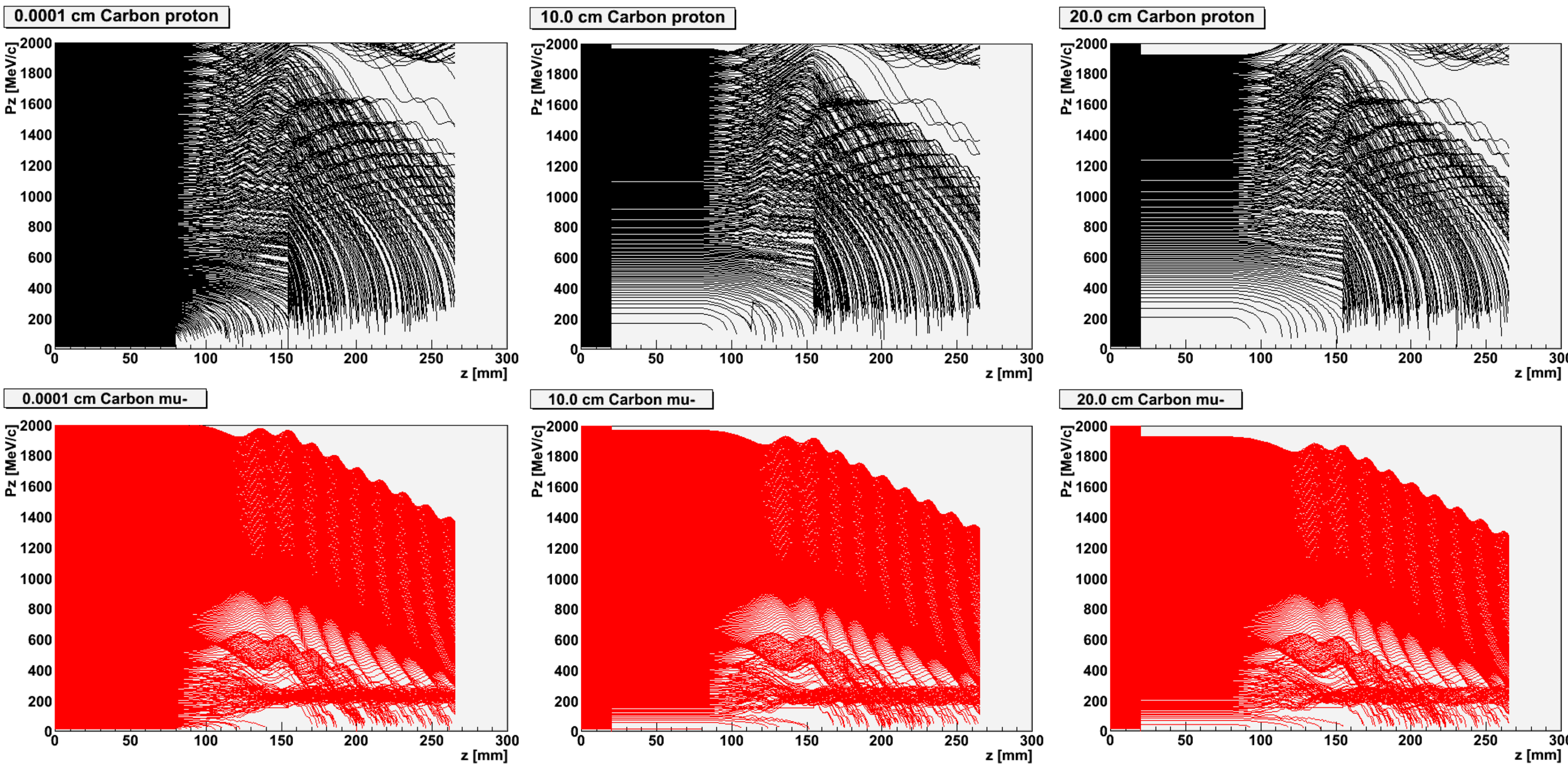
Proton absorber - z-position





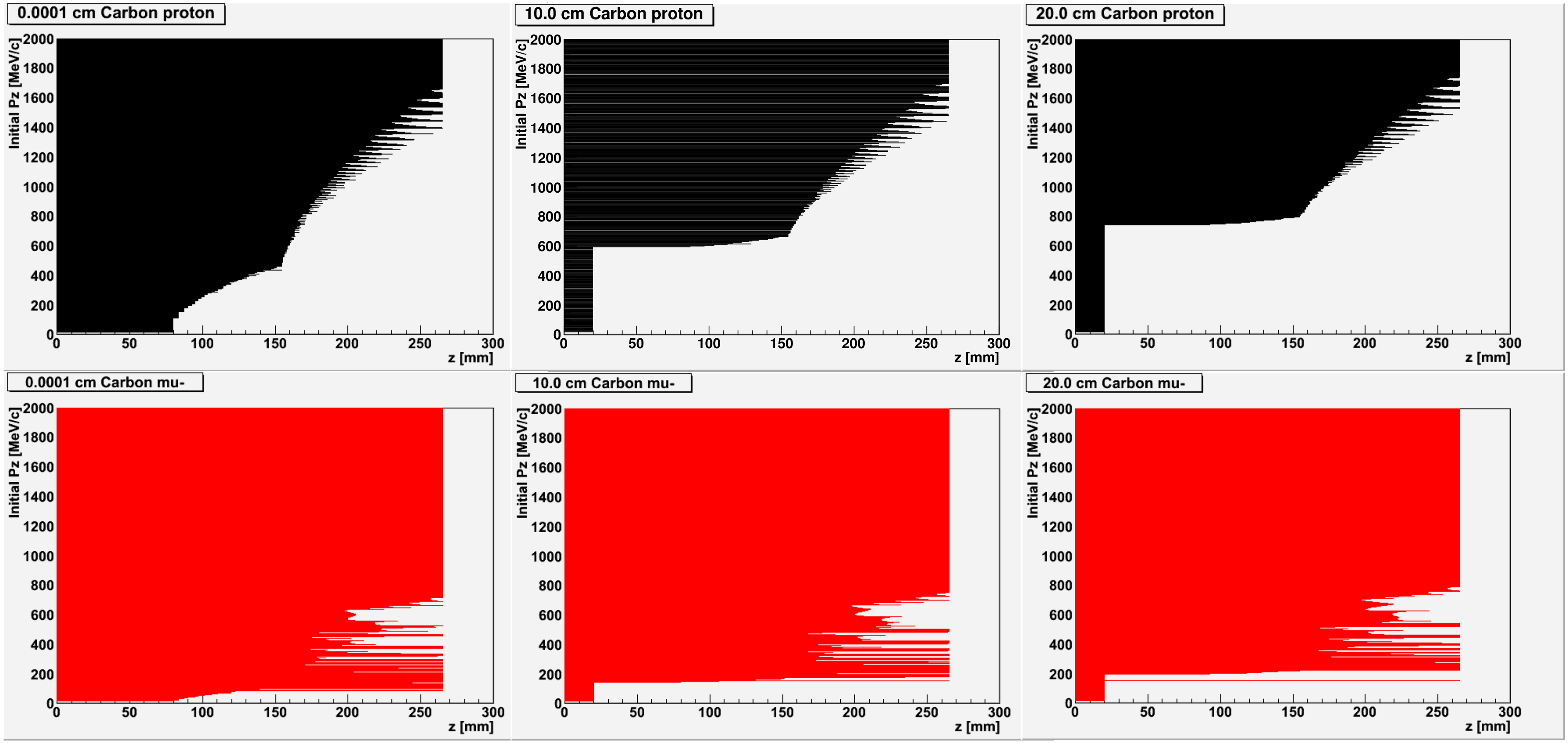
- Take a naive distribution (t=0, energy=square distribution)
- Plot energy-time at z=90 m
- Try for absorber near target and absorber at end of drift
- If we put the absorber at end of drift, energy-time distribution does not develop properly
- But this is required for the buncher to operate
- Therefore put proton absorber near to target

Proton absorber - thickness



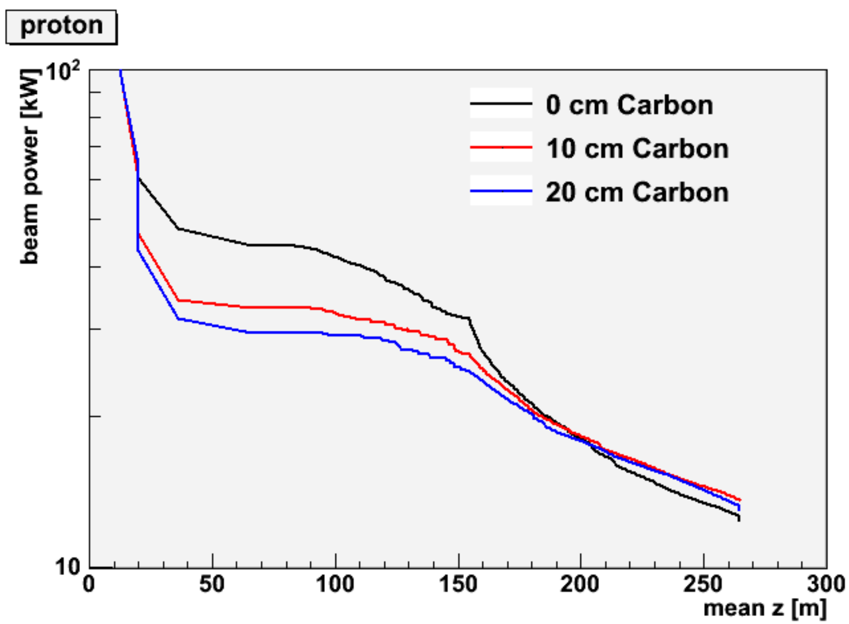
- Look at pz vs z
  - No stochastic physics processes, axial beam
- For different proton absorbers, get different set of particles captured

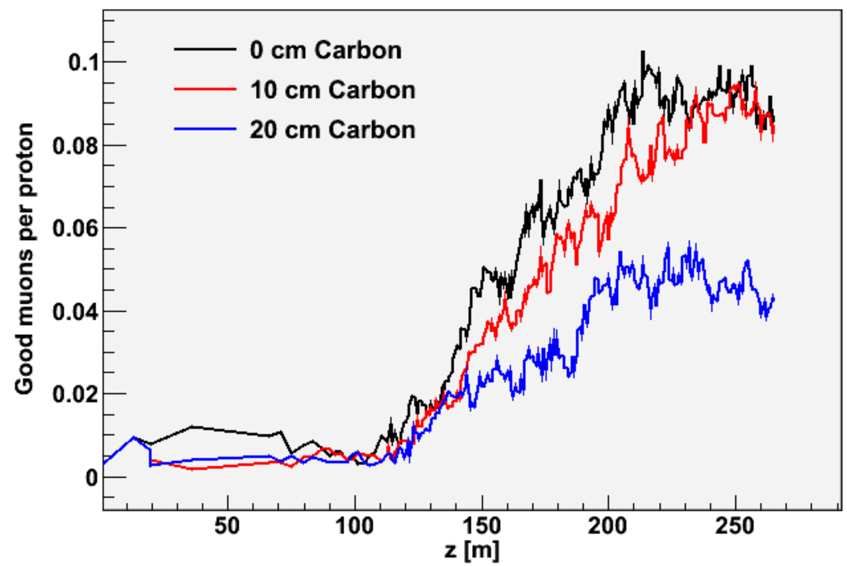
Proton absorber – thickness 2



- Now look at initial momentum vs z
- How much material is appropriate?
  - More material ruins muon rate but gets rid of more protons

Proton absorber – thickness 3





- Now take a realistic simulation (5k particles)
  - Not much difference between 10 cm and 20 cm in terms of proton beam power reduction
  - Both take out about 30-40% of proton beam power
- Big difference between 10 cm and 20 cm in terms of muon rate
  - 10 cm is ~ comparable with baseline
  - 20 cm is much worse

Discussion with target group

- Discussion with target group:
  - They already have a Mercury containment window
  - If it can be thicker that is advantageous
  - Beryllium is the preferred material
  - Will probably need active cooling
- But if we need a chicane, this must go before the proton absorber

Conclusions

- We remove about 30% of the proton beam power with a ~10 cm proton absorber
  - This is nowhere near enough – needs to be 99.9%!
- A chicane could remove the high energy protons
  - Chicane should go before proton absorber
    - Else we knock protons into chicane acceptance with proton absorber
  - Chicane should remove all particles with pz > 500 MeV/c or so
- Then come back to proton absorber
- Aim was to have feasible system in place by IDR
  - Looks unlikely
  - High-acceptance achromatic chicane design ~ 3-6 months work
  - Start with “tilted solenoid” style design
  - Later try “helical solenoid” style design
  - Expect a significant drop in acceptance