Chicane and Proton Absorber in the IDS-NF Front End

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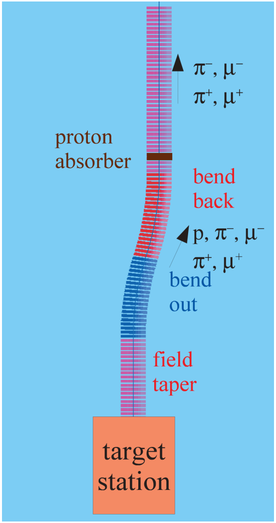
Muon Accelerator Program

Chicane and proton absorber



- The aim of the chicane is to remove the high energy protons.
- The aim of the absorber is to remove the remaining protons with relatively low energies.
- A single chicane is adequate for both signs as shown in a few slides.
- Magnetic field map of the chicane is produced by G4beamline.
- Particle distributions were generated in MARS (thanks to Nicholas Souchlas).
- Proton absorber: 10 cm of Be.
- Simulation results: the muon flux is not reduced significantly by going through the chicane + proton absorber, while there is virtually no proton flux downstream of the absorber.

MARS simulation of the target

- I start with the distribution 30 meters downstream of the target.
- Produced based on the recent update to the Study II channel target (IDS120h).
- The Hg pool from the Study II geometry is modified partially to allow protons from specific beam injection points to cover the longest path possible and lose as much energy as possible in the pool.
- The p–Hg interactions in the pool and the jet are simulated as liquid Hg at rest.
- p–Hg splashing effects are not simulated in MARS.

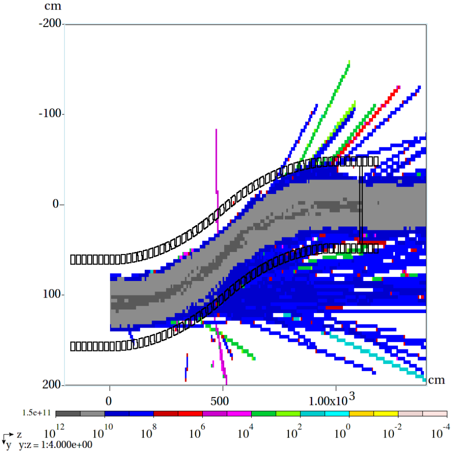
Single Chicane

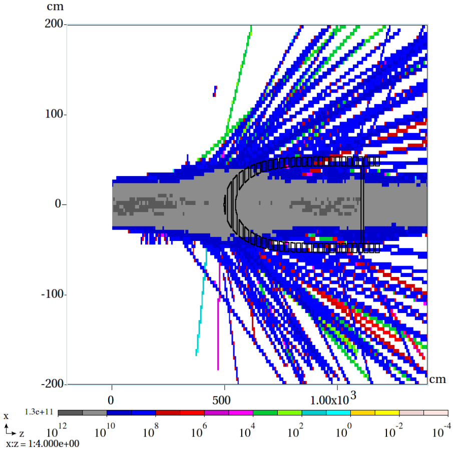
- Located close to the target to allow more drift downstream.
- Filters high energy protons.
- Central coils take a serious hit from high-energy particles going straight through.
- Chicane terminates with a 10 cm Be absorber aimed to remove the remaining low energy protons.
- Single chicane transmits particles of both signs.
- 1.25 degree rotation per cell (baseline configuration).

Simulation parameters

- Magnetic field on axis: 1.5 T
- Proton beam power: 4 MW
- Proton energy: 8 GeV
- Proton rate: 3.125e15 protons/s
- Coil geometry: inner radius = 43 cm, outer radius = 53 cm, length = 18 cm.

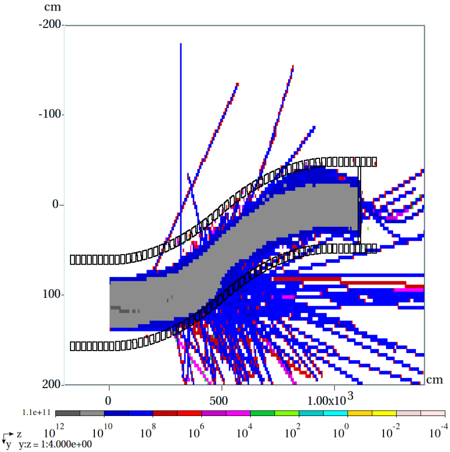
Muon flux (top/side view)

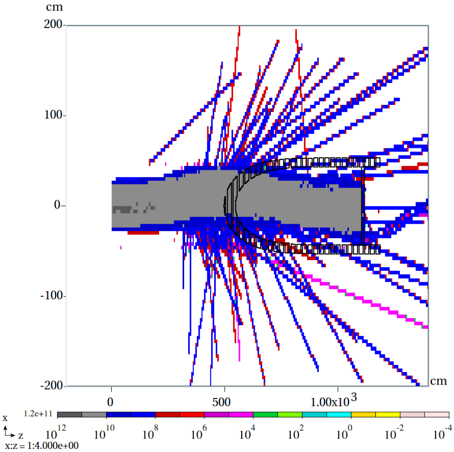




- Muons pass through Be with minor losses.
- Both signs are propagated; hence, the thickening in the middle.

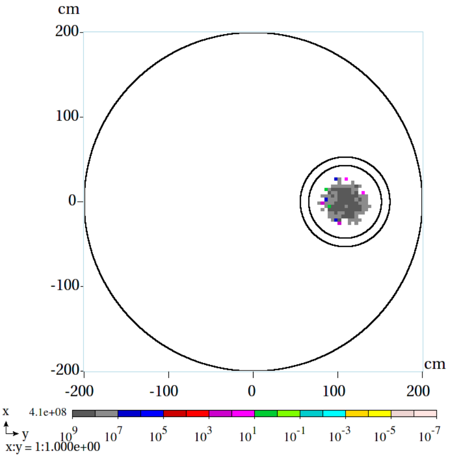
Proton flux (top/side view)

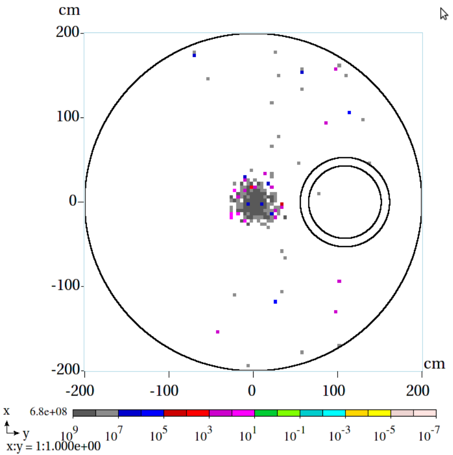




- High energy protons do not get past the chicane. Low energy protons are killed at the absorber.
- Protons are deflected up than down.

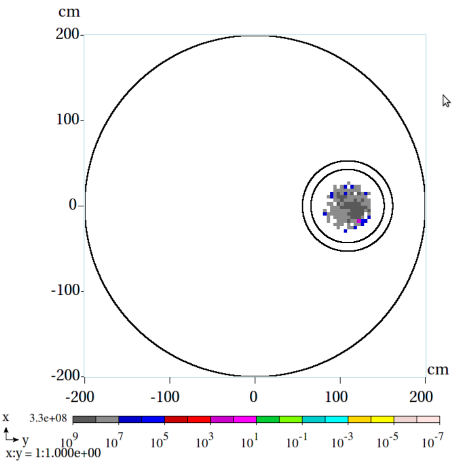
Muon flux (us/ds of the chicane)

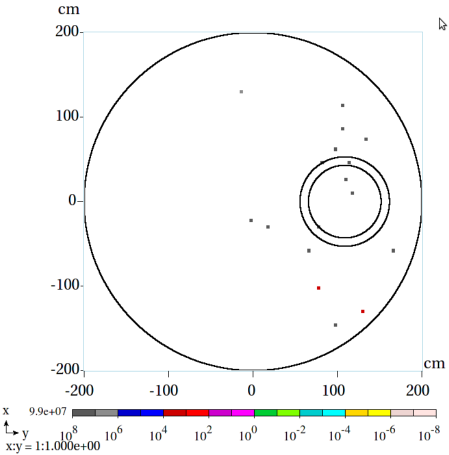




- Minimal loss in the chicane + Be absorber.

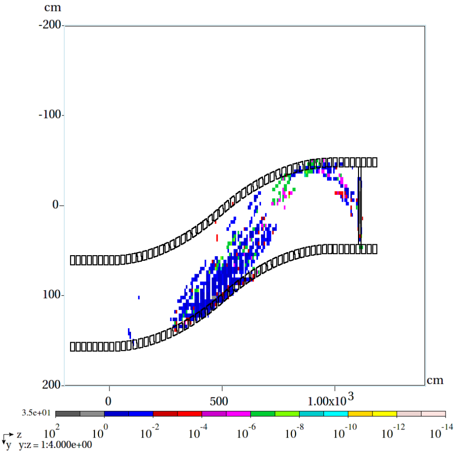
Proton flux (us/ds of the chicane)

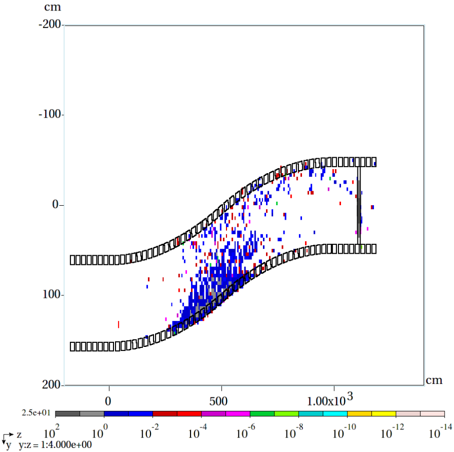




- Virtually no protons ds of the absorber.

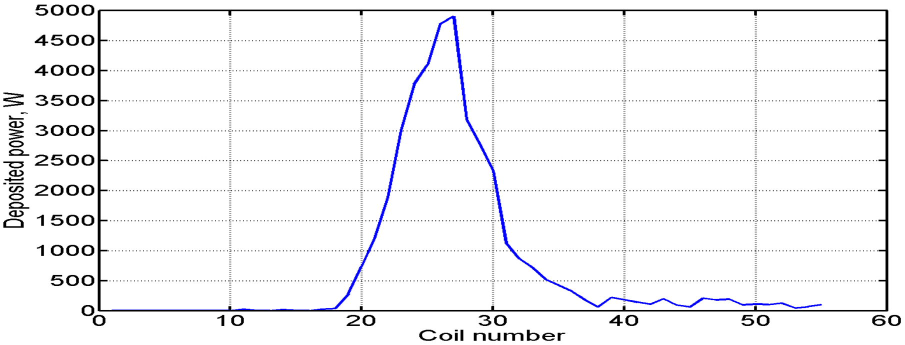
Muon vs proton power density (top view, mW/g)





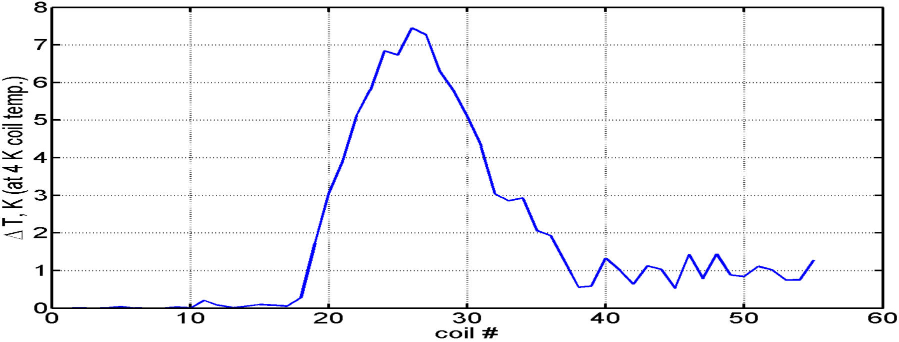
- Maximum power density is ≈35 mW/g, at the absorber.
- Power density at coils is ≈10 mW/g, mostly due to protons (two orders higher than the desired 0.15 mW/g).

Energy deposition in the coils



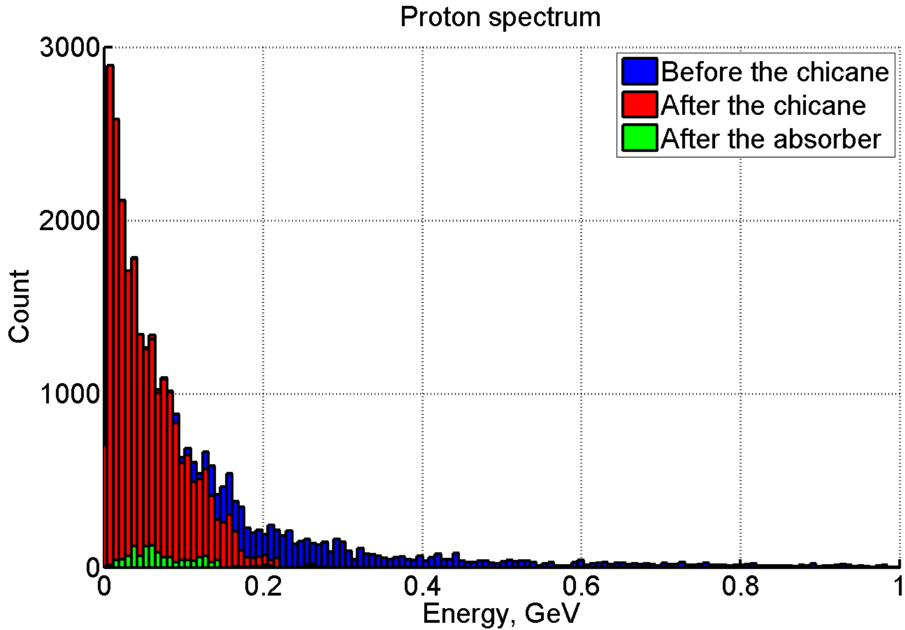
- As expected, the coils in the middle of the chicane take the most hit (from high energy protons not deflected by the chicane).
- Peak deposited power is 5 kW, or 28 kW/m in the central coil, or 13 mW/g.
- This is the total power (deposited by all particle types).

Temperature change in the coils

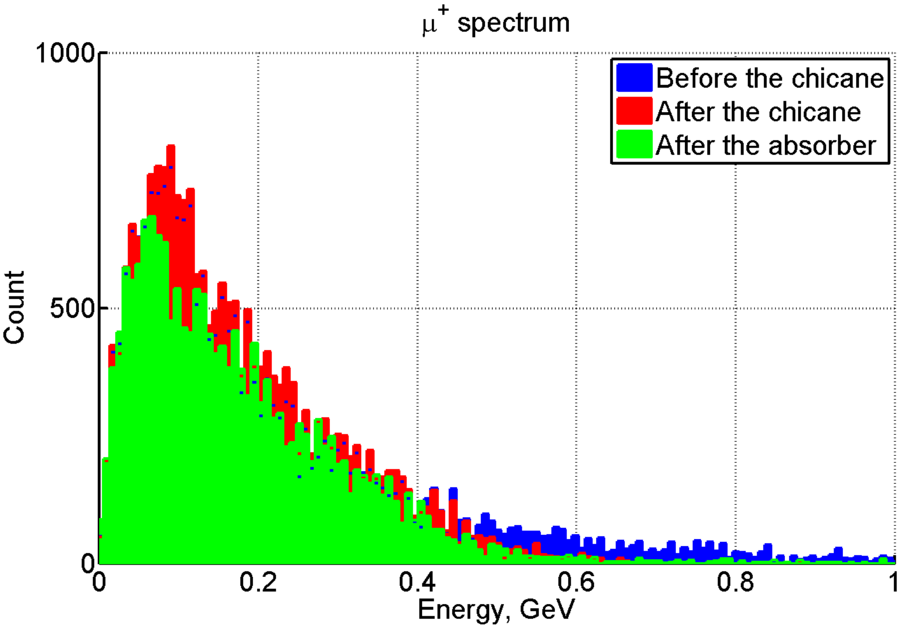


- Coil temperature change as calculated by MARS.
- The initial temperature is assumed to be 4 Kelvin.
- Max temperature change is about 7.5 Kelvin for the middle coil.

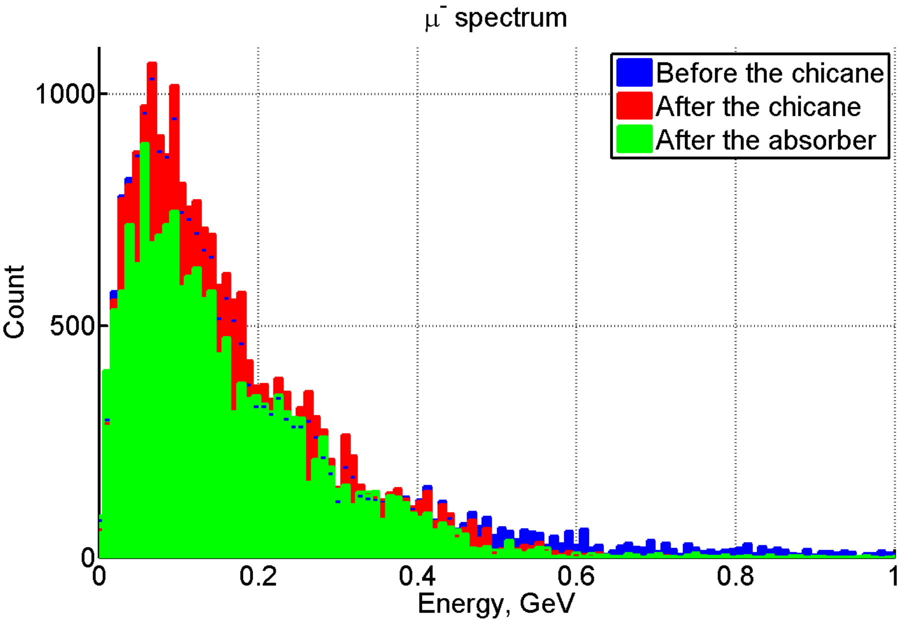
Proton spectrum us/ds chicane + absorber



μ^+ spectrum us/ds chicane + absorber



μ^- spectrum us/ds chicane + absorber



Summary

- A single chicane + proton absorber efficiently remove undesired particles.
- Energy deposition requires further shielding studies.
- Time-energy distribution of the beam is changed by the absorber $\Rightarrow$ need buncher and phase rotator re-optimization (reported by Neuffer).
- The price to pay is $\approx$10% extra muon losses compared to the baseline (no chicane, no absorber).