Energy deposition for intense muon sources (chicane + the rest of the front end)

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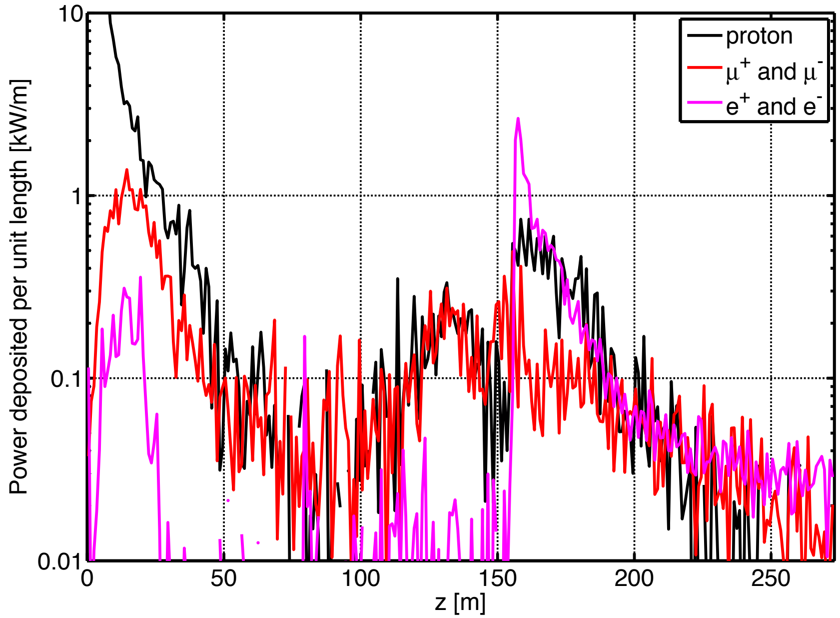
Outline

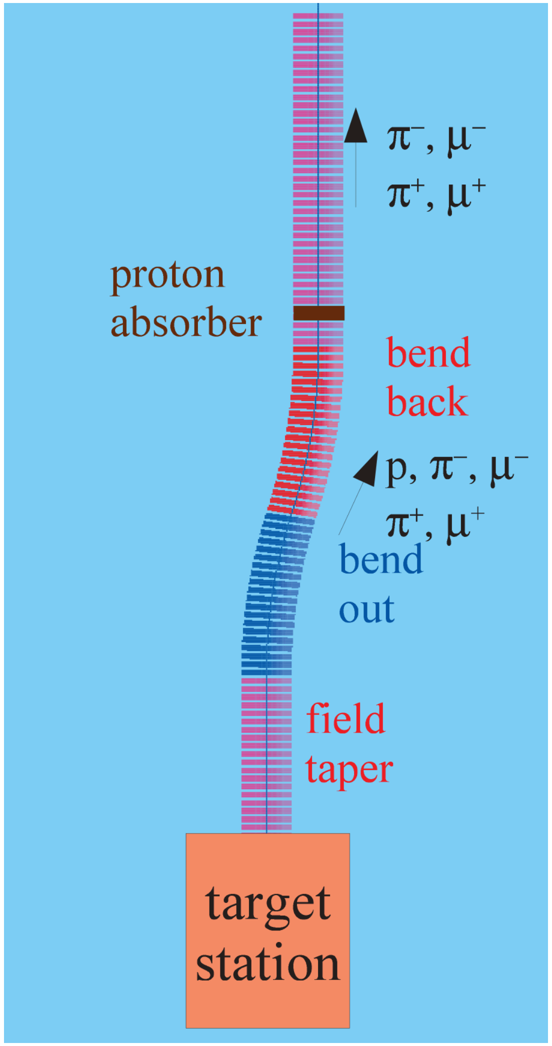
- Introduction
- History
- Current MARS simulations
  - based on the hybrid channel ICOOL lattice
- Summary

Introduction



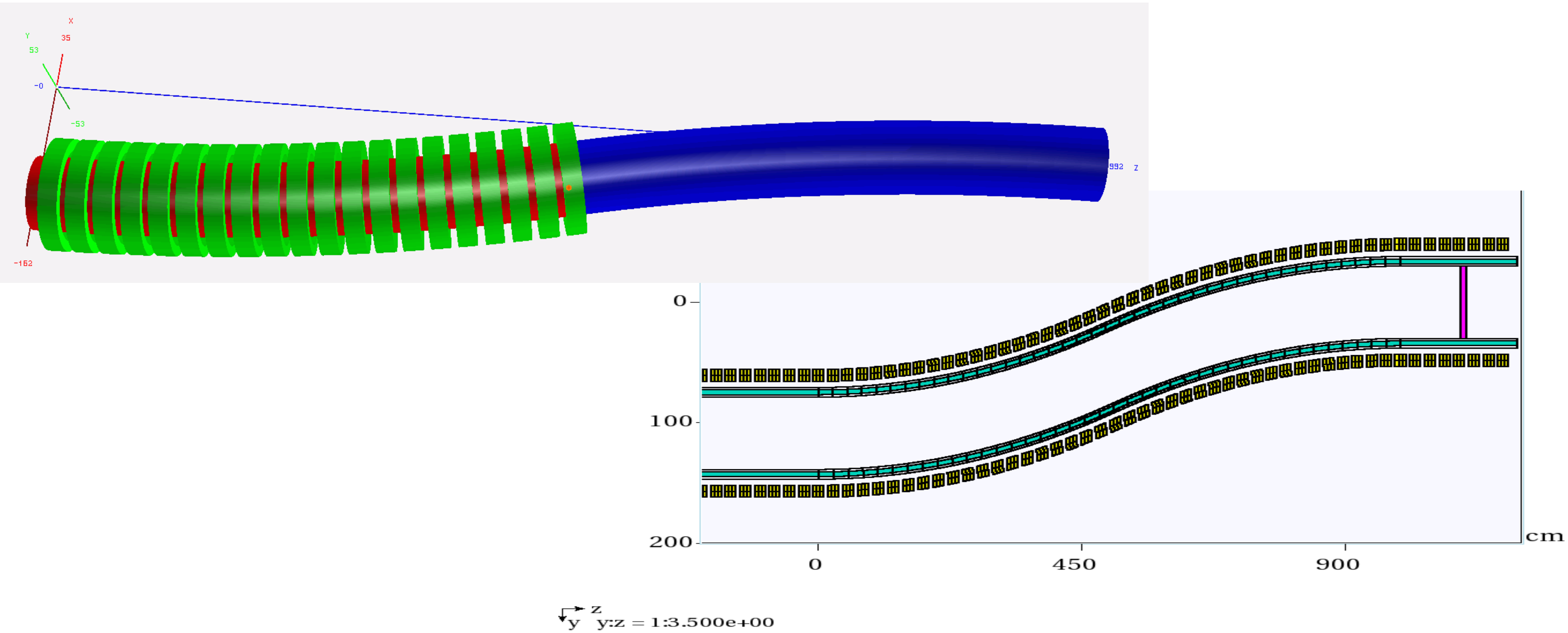
- In high-intensity sources muons are produced by firing high energy ***p*** onto a target to produce ***π***.
- ***π*** decay to ***μ*** which are captured and accelerated.
- Significant background from ***p*** and ***ē***, which may result in
  - heat deposition on superconducting materials;
  - activation of the machine preventing manual handling.

Introduction, contd.



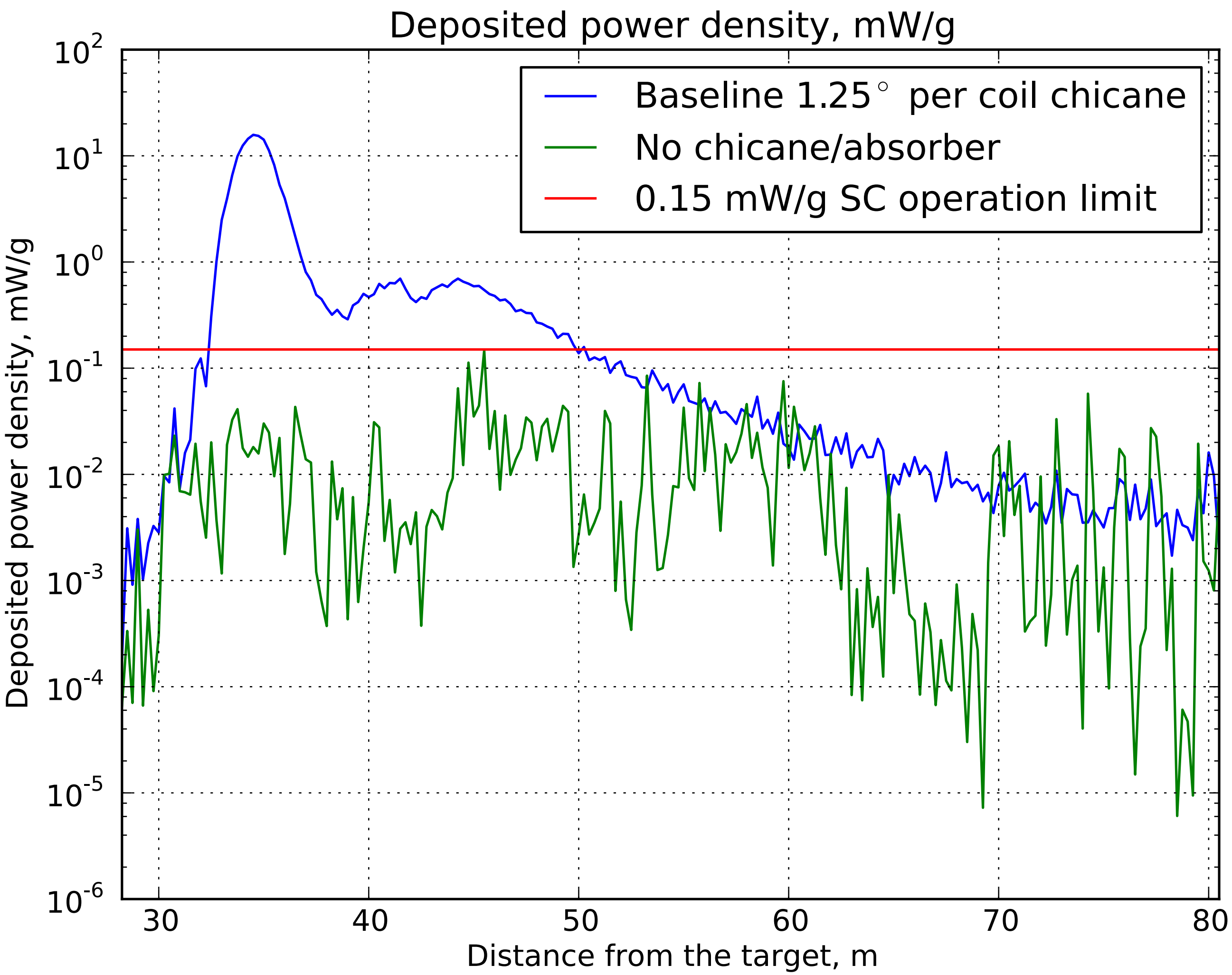
- Need a secondary particle handling system for a megawatt class solid C target
  - solenoidal chicane
  - followed by a proton absorber.
- Challenges of optimization and integration of the system with the rest of the muon front end.
- Main study tool – MARS, some analysis and validation by using ICOOL and G4beamline.
- Use the same technique to study the buncher/phase-rotator/cooler for the hybrid channel.

History: MARS simulations



- ROOT-based geometry
- 12.5° single bend, Z=0 corresponds to 19 m downstream of the target
  - consistent with RDR (IDS-NF).
- W density reduced to 60% to take into account packing fraction for beads.

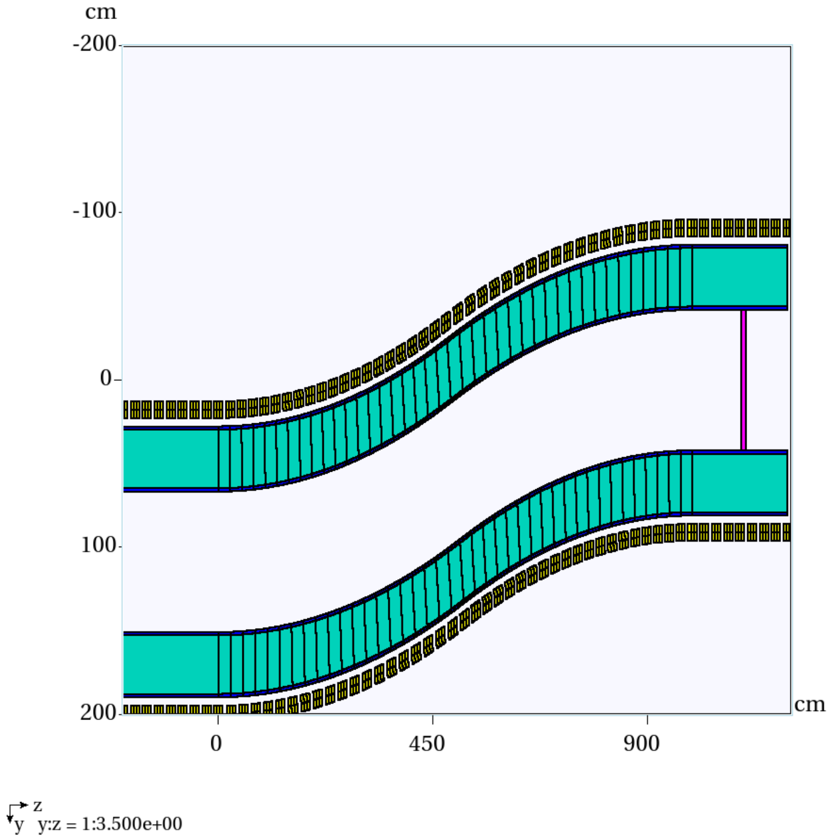
Reference: no shielding



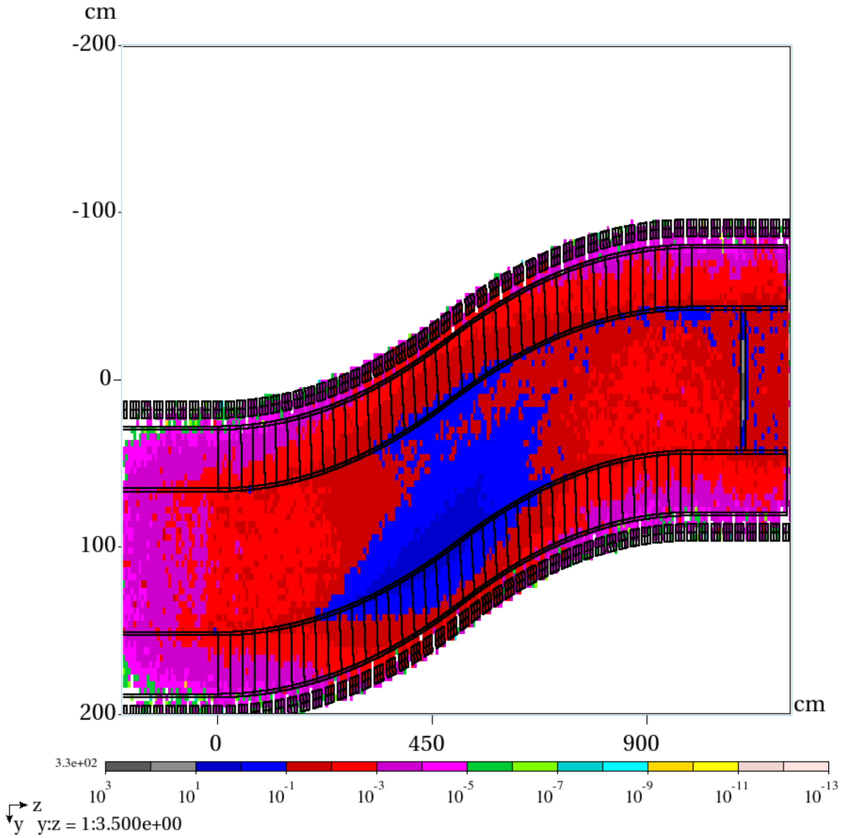
DPD peaks at 15.8 mW/g, that translates into 42.6 kW/m for Cu coils or 33.3 kW/m

for SC coils.

Uniform 35 cm shielding

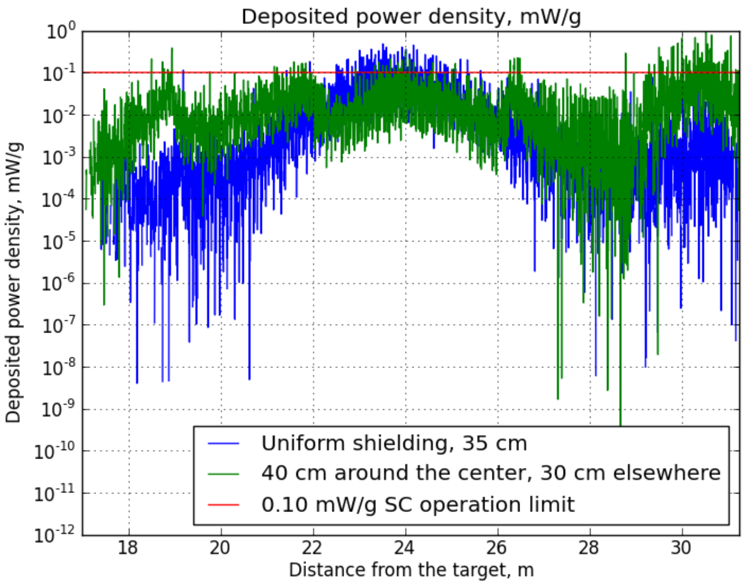


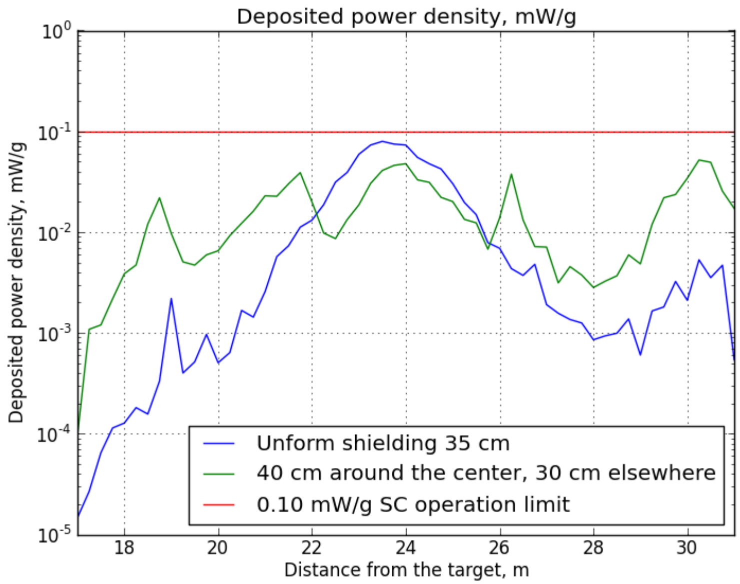
Empty channel



PD total, mW/g

Overall DPD per coil/segment





Segmented coil analysis, total DPD, mW/g

Average DPD per coil, mW/g

In both cases red line corresponds to 0.1 mW/g SC limit

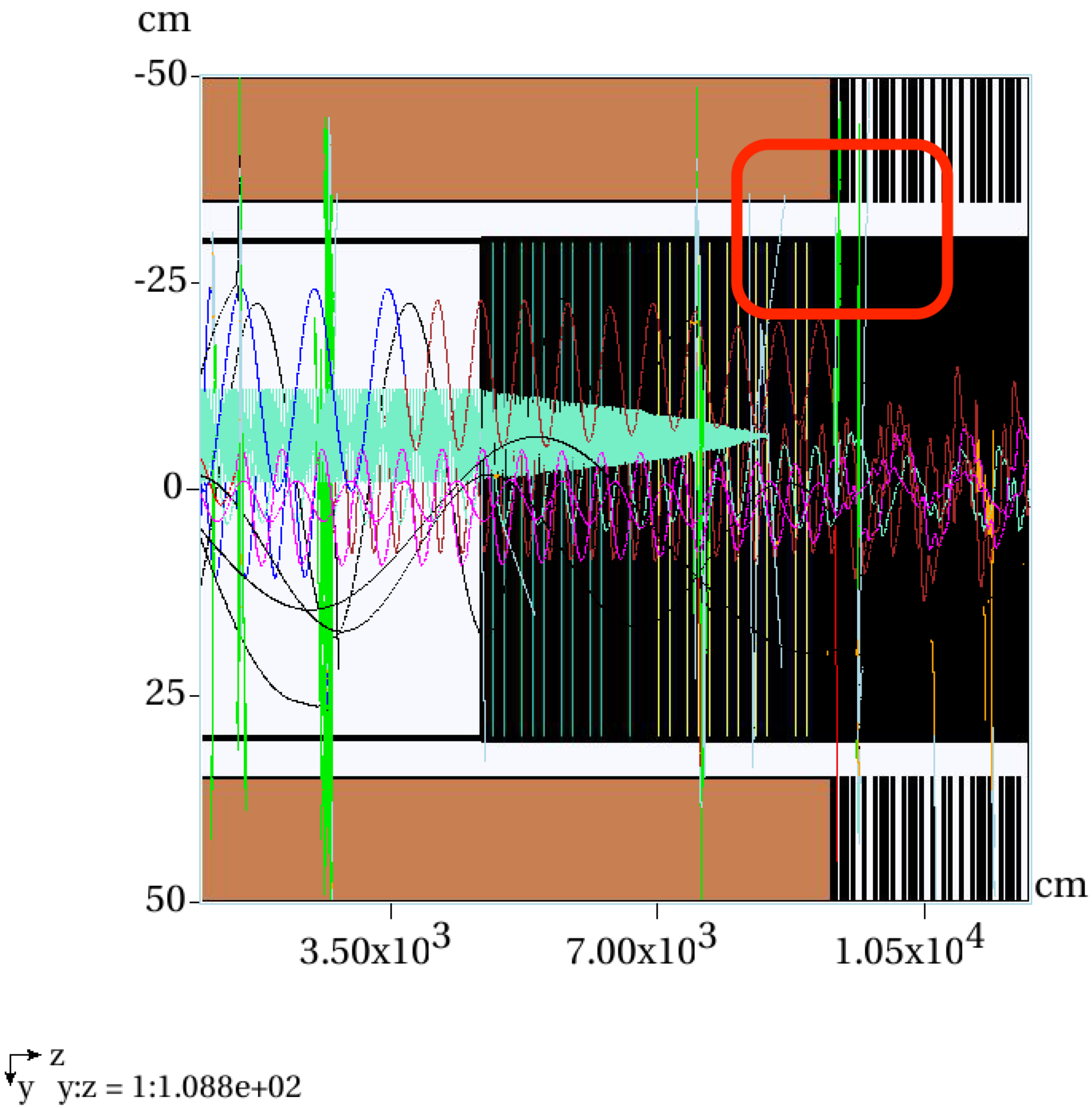
Ongoing MARS simulations

- New target parameters:
  - 8 GeV => 6.75 GeV
  - 4 MW => 1 MW
  - 3.125e15 protons/sec => 0.925e15 protons/sec
  - new particle distribution
- New ICOOL lattice file
  - hybrid channel
- Looking downstream of the chicane
  - buncher
  - phase rotator
  - matcher/cooler

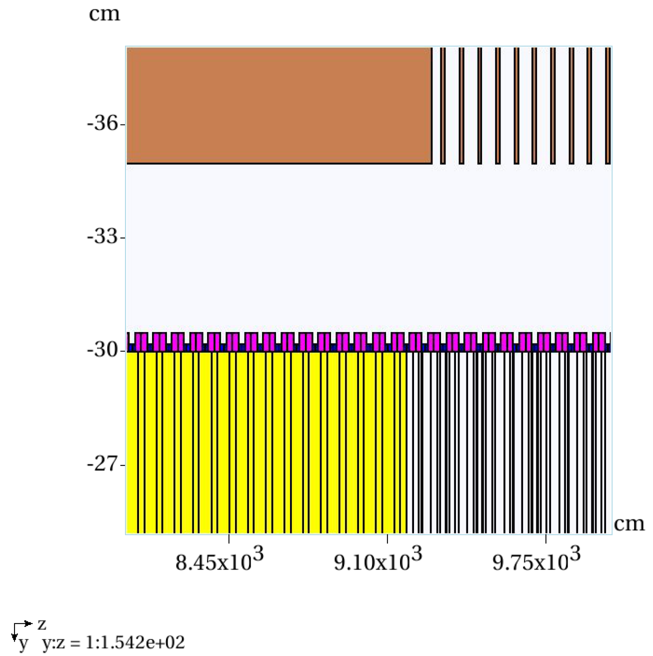
MARS RF Challenge

- Stationary magnetic fields are straightforward…
- Time-dependent electric field in the RF cavities is not.
  - Ended up using a combination of the two user routines in MARS m1514.f intended for other purposes:
    - MFILL = meant for producing data for histograms, knows when a region boundary is crossed.
    - KILLPTCL = meant for killing particles under certain conditions, here one can change the energy/momentum of the particle
  - RF is a kick approximation (at the center of the cavity).
- Use MARS extended geometry, and while it is sufficient, ROOT geometry would be much more convenient given the length and regularity of the structure.

MARS RF, first results

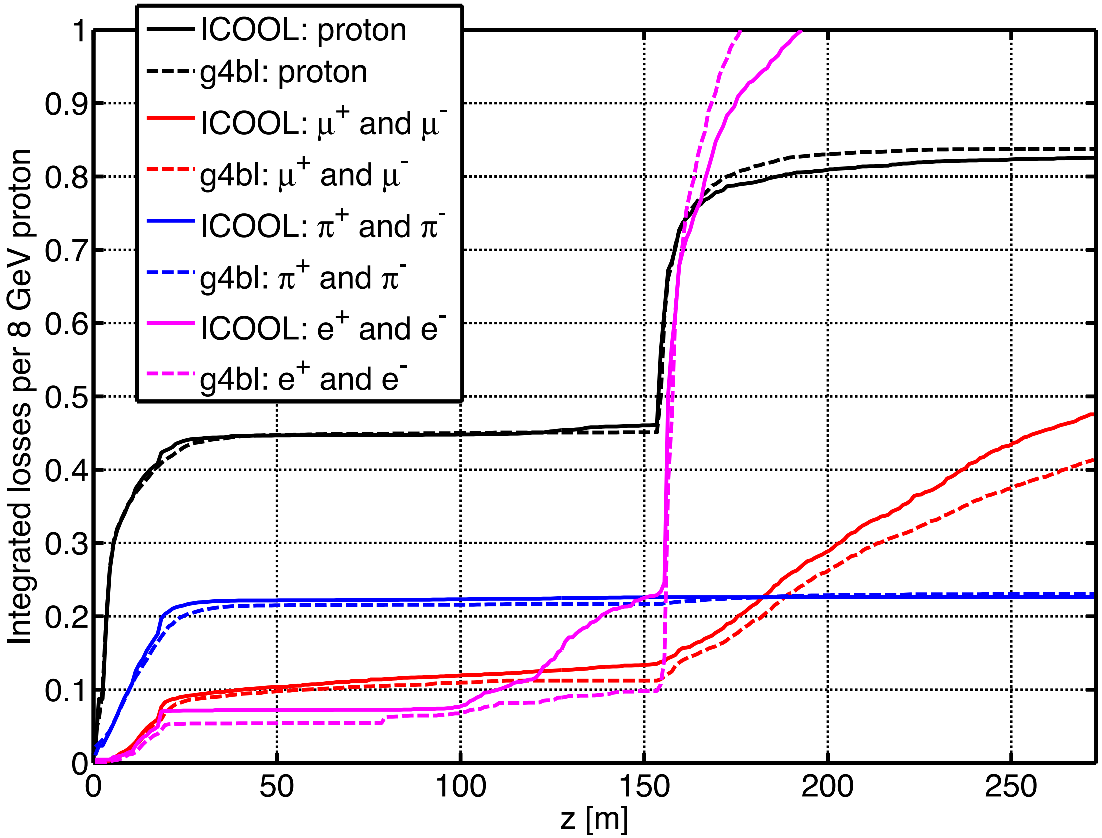


- A few tracks running through buncher/rotator/cooler.
- Magnetic field is a field map imported from G4beamline.
- Tracks lose energy in absorbers and gain energy when they cross the center of a cavity.



Other codes

- Once MARS lattice is up and running, the plan is to compare results with G4beamline/ICOOL energy loss calculations
- Back in 2010 I did a comparison of the two codes for IDR:



Summary

- Buncher/rotator/cooler are in MARS now.
  - More input on a more precise geometry for coils and cavities is appreciated.
- Kick approximation is used for RF cavities at the moment…
  - “workaround” style, something more straightforward and permanent would be good;
  - information on phasing is taken directly from ICOOL, no reference particle(s) tracking in MARS.
- MARS is the main tool, although G4beamline and ICOOL are also used for some analyses, could be used for validation.

Thank you!