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
• In high-intensity sources muons are produced by firing high energy $p$ onto a target to produce $\pi$.
• $\pi$ decay to $\mu$ which are captured and accelerated.
• Significant background from $p$ and $\bar{e}$, 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
- $12.5^\circ$ 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.
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!