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

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Outline

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Introduction

• 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, cont'd.

- 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.
- Start with the chicane, use the same technique downstream to study the buncher and phase-rotator sections.
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.
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
Non-uniform 30 and 40 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
Current MARS simulations

• New target parameters:
  – 8 GeV => 6.75 GeV
  – 4 MW => 1 MW
  – $3.125 \times 10^{15}$ protons/sec => $0.925 \times 10^{15}$ protons/sec
  – new particle distribution
  – need to re-run MARS

• The hope is that the new parameters help reduce the amount of shielding required
New results

Muon flux, top view  
Muon flux, side view
New results 2

Proton flux, top view

Proton flux, side view
New results 3

Deposited power density, mW/g,

- top view

Deposited power density, mW/g,

- side view
New results 4

Deposited power density, mW/g
segmented coil analysis

Deposited power density, mW/g
averaged
Other codes

- Can G4beamline or ICOOL be used for energy loss/deposition calculations?
- Back in 2010 I did a comparison of the two codes for IDR:
Summary

• Simulations of the new 1 MW graphite target are underway, first results presented.
  – power density > 0.1 mW/g only in a handful of central coils, very low everywhere else;
  – definitely do not need 35 cm of tungsten.

• Action item: implement a more sophisticated geometry (elliptical cross-section following the profile of the beam).
  – this will allow to significantly reduce the amount of W used for shielding.

• MARS is the main tool, although G4beamline and ICOOL can also be used for some analyses.
Thank you!