Introduction

Andy Hocker and Karie Badgley

Mu2e-II Workshop Solenoids Session

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The solenoid system in Mu2e-II

- Mu2e-II: ~100 kW vs 8 kW
- Detector Solenoid
  - No upgrades
- Transport Solenoid
  - Additional rad/heat load not likely an issue
  - Recall Mu2e proton beam line goes through TSu
- Production Solenoid
  - Rad damage to Al stabilizer is limiting factor on beam power (RRR degradation)
  - Don't want to anneal (thermal-cycle) Al every month
  - Re-design PS to remove this limiting factor

Some numbers

- 4-6 e-05 DPA drives Al down to RRR=100 (time to anneal)
- From Pronskikh et al. (arXiv:0612.08931)
  - Current Mu2e configuration: ~4-6 e-06 DPA/yr per kW for 1-8 GeV beam
  - Tungsten HRS can reduce this by a factor of ~four

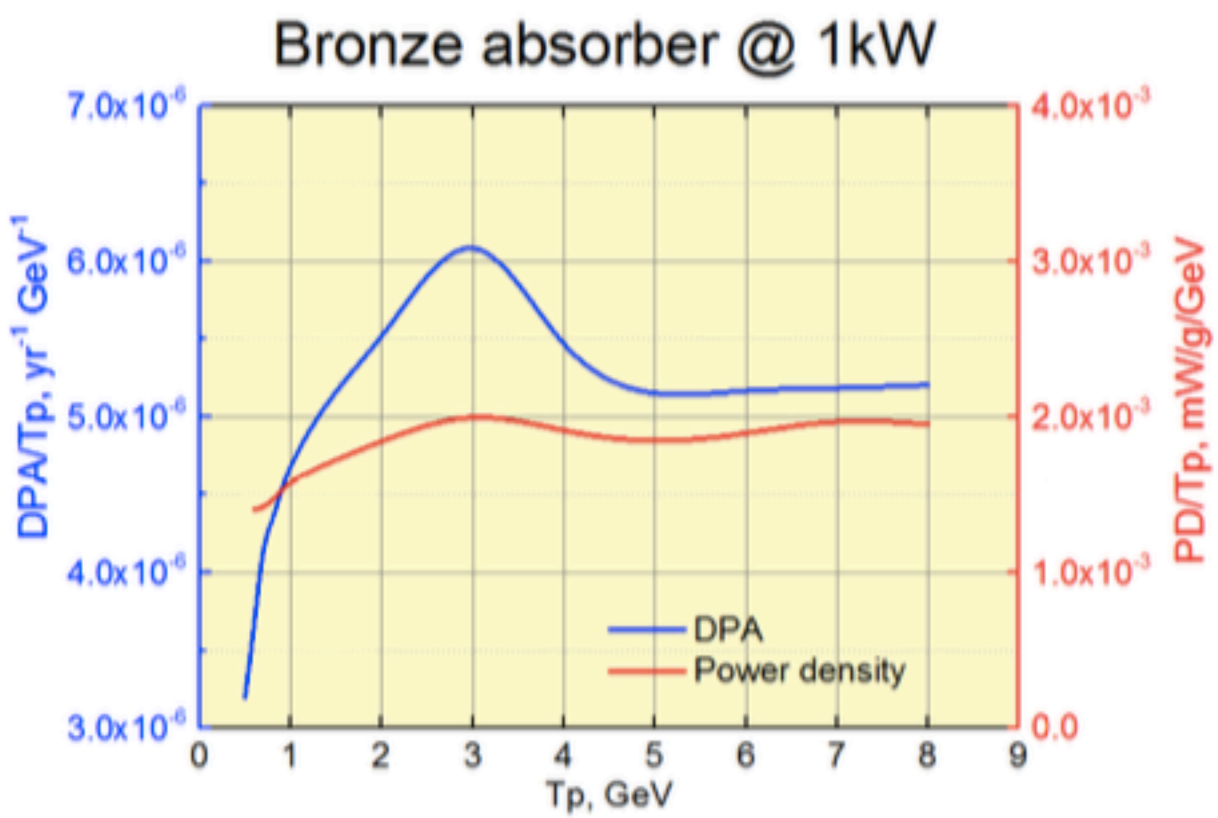
- Current PS critical temperature is 6.5 K
  - 1.5 K temperature margin — keep peak coil temp at ~5 K
  - Design allows for peak power density 16 μW/g
  - Again from Pronskikh et al.
    - Current Mu2e configuration: ~1.5-2 μW/g per kW for 1-8 GeV beam
    - Tungsten HRS can reduce this by a factor of ~six
  - Dhanaraj, Peterson, Kashikhin:
    - Recover temperature margin by pre-cooling LHe to 3.7 K
      - Peak coil temp = 4.9 K for 100 kW beam

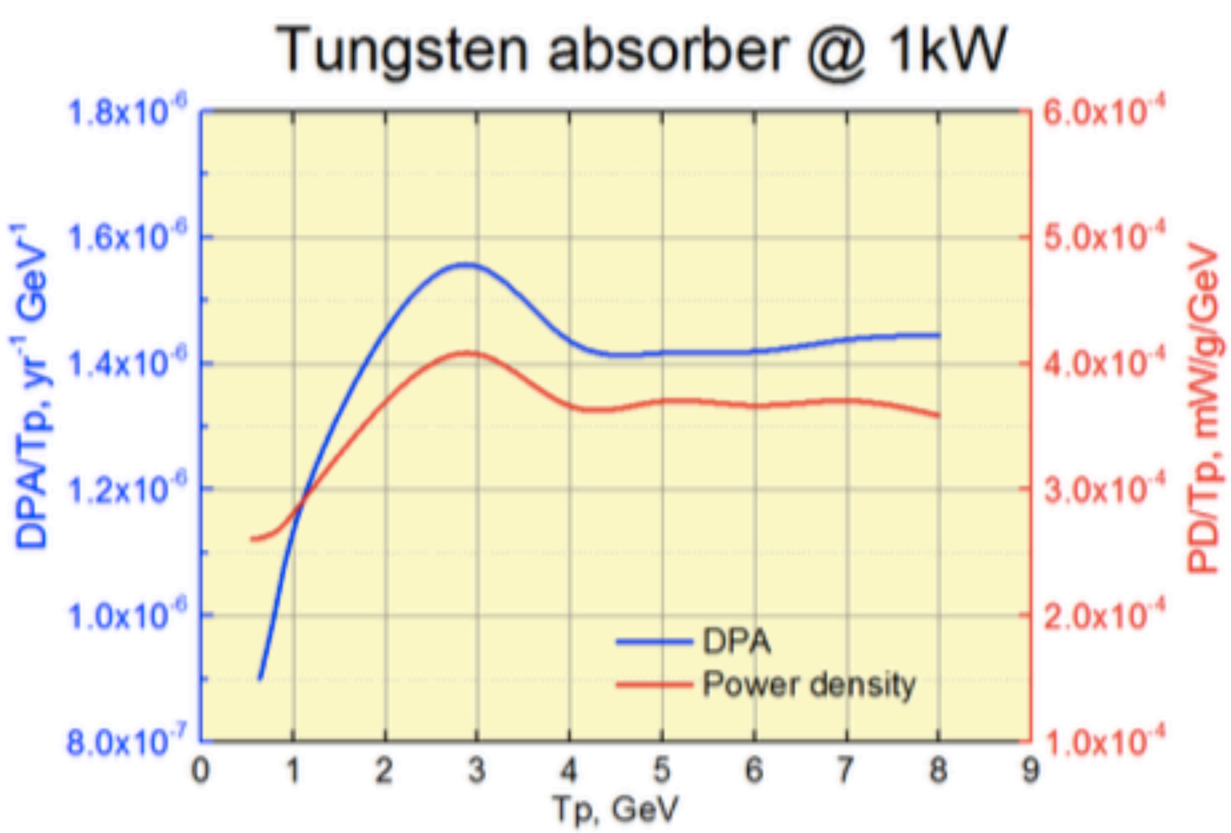
R&D

- Number one topic is more rad-resistant PS conductor
  - See Vadim’s talk
- Will need to develop a conductor design AND vendor(s)
  - Recall: Mu2e conductor fabricated by Furukawa and Hitachi
    - Hitachi (now SH Copper) is out of the superconductor game
    - Furukawa is out of the Al-stabilized cable game (but we’re pushing them)
    - Mysterious Russian vendor being developed for PANDA experiment
  - Is there an existing conductor design that would be suitable?
- Depending on conductor design, winding R&D?
  - cf. Toshiba coil

- Pre-cooling requires design work but not R&D (done in TeVatron)
- Any TS mods requires design work but not R&D
  - But conductor vendor development required here too

Supporting figures





Pronskikh et al. arXiv:0612.08931

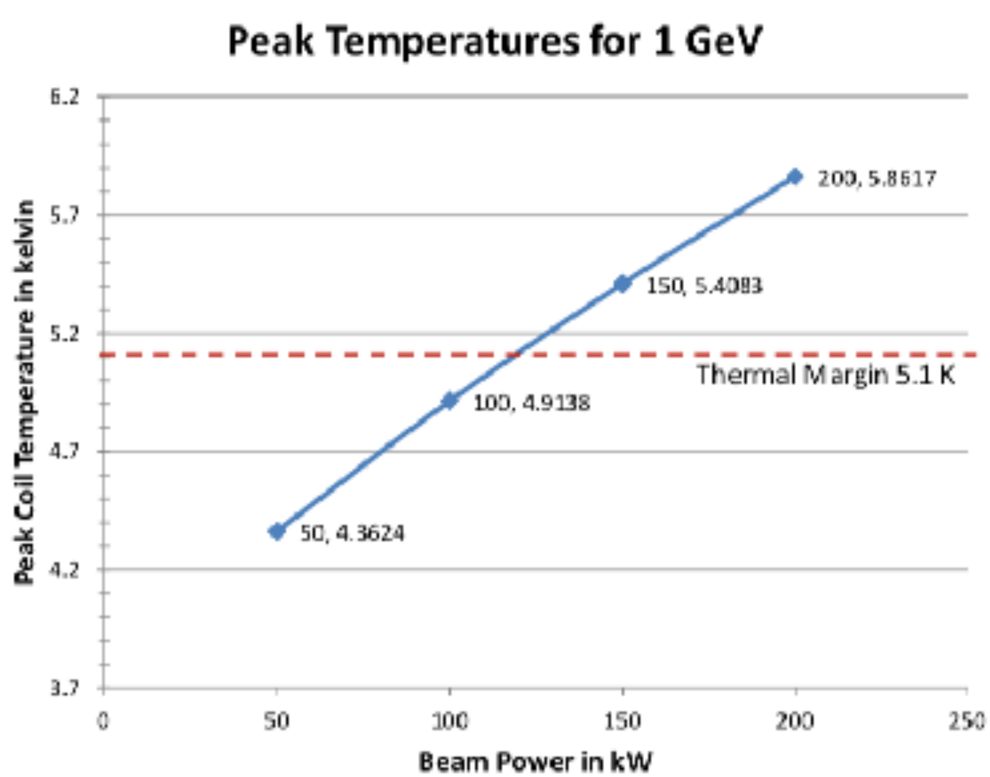
Beam Power in kW	Peak Power Density in the coil in W/m^3	Peak Power in the coil in W/Kg (µW/g)
50	56.679	0.016 (16)
100	113.36	0.031 (31)
150	170.04	0.047 (47)
200	226.71	0.062 (62)

← Already comparable to present

- **From Vitaly's RESMM15 paper 100kW→ 29 µW/g**

Beam Power in kW	Coil Peak Temperature in kelvin	Total Magnet Heat Load in watts
50	4.3624	89.61
100	4.9138	155.31
150	5.4083	221.02
200	5.8617	286.72

Helium Temperature assumed 3.7 K



Lamm, DocDB 6806

Proton beam line and TS (Roberts, DocDB 6810)

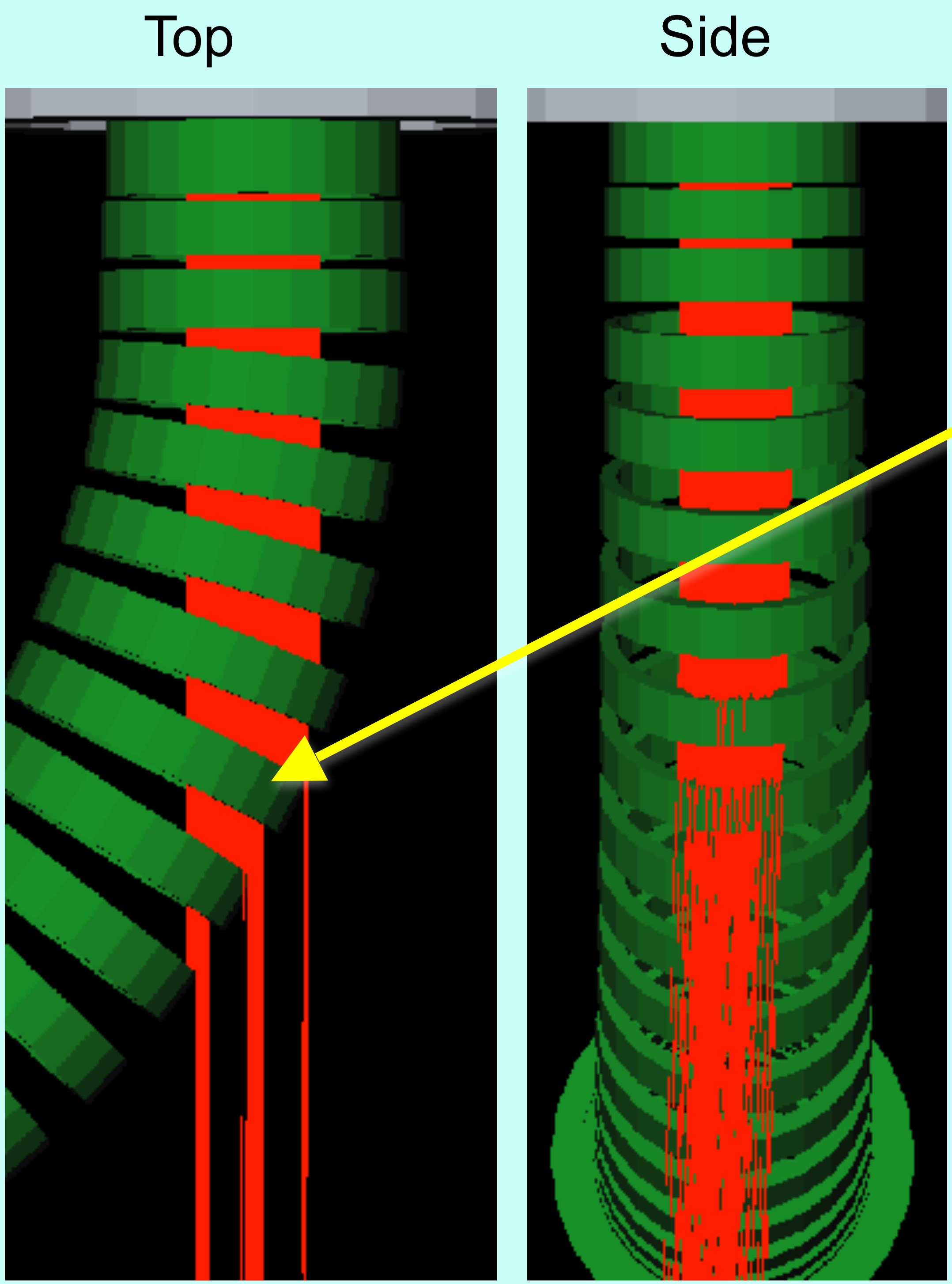
Muons, Inc.

Summary
800 MeV Beam on Target

- The “No Changes” and “Minimal Changes” approaches do not work.
- It looks to me like there is probably an approach with “Modest Changes”:
  - Drill a second beam hole in the Heat and Radiation Shield.
  - Re-route the water pipes for the HRS.
  - Re-work the interface between the beam pipe and the PS cryostat.
  - Move the beamline ~100 mm closer to the TS, slight angle.
  - Move the target (probably not much).
  - Move the beam dump.
- Establishing that this actually works will require more effort.

Doing this would be A LOT less effort than any other approach I have found.

Modest Changes
800 MeV Beam



By removing one TS coil, two of these gaps would be combined into one gap about 20 cm wide.

This might work.

This would have the advantage of working for both 800 MeV and 8 GeV beams.