Mu2e-II Workshop Summary

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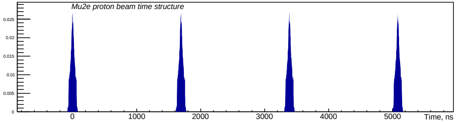
Summary of the summary

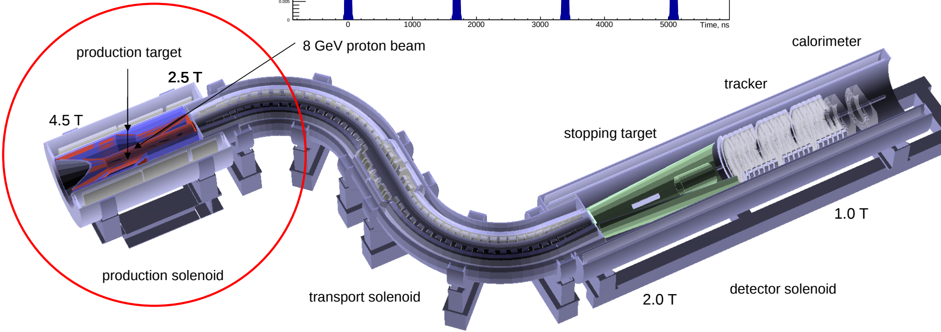
- Mu2e physics program , search for neutrinoless conversion $\mu A \rightarrow eA$ is unique, double charge exchange process is also of significant interest
- continuation makes sense in any scenario
- Mu2e-II workshop held on Dec 08 2017
- followed by MU2e-II EOI : https://arxiv.org/abs/1802.02599
- Mu2e-II : improve sensitivity by x10, to SES = 2.5x10^{-}18 use PIP-II 100 kW proton beam

Mu2e-II Workshop Goals

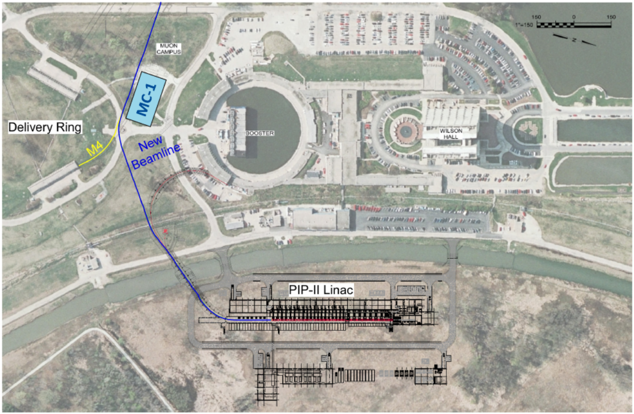
- what neds to be done to translate x10 in the beam power into x10 in the exp sensitivity
- Summarize the exp. challenges
- Brainstorm ideas to address the challenges
- identify the high-priority R&D
- make max use of the existing infrastructure
- upgrade : cost < cost of the Mu2e project

Mu2e experiment - roadmap





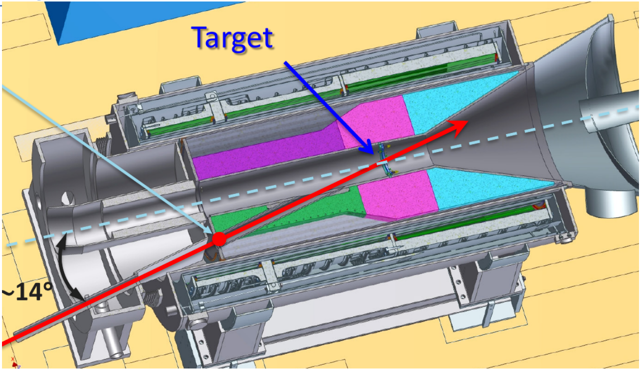
Accelerator



12/8/2017 S. Werkema | Accelerator R&D for Mu2e II

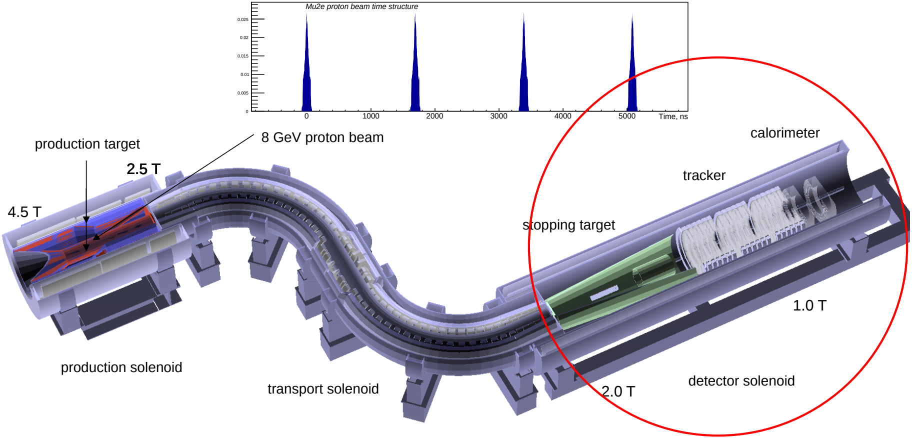
- 8 kW beam @ 8 GeV —> 100 kW PIP-II beam, 800 MeV
- PIP-II input: 2.1 MeV H- ions @ 162.MHz (6 ns),
- pulsed beam with 100 ns pulses : chop off part of the train
- can 800 MeV H- ions be transported? where to strip them?
- will shielding be sufficient to accommodate 100 kW beam?
- can extinction of $< 10^{-11}$ be achieved? - need C

Production target



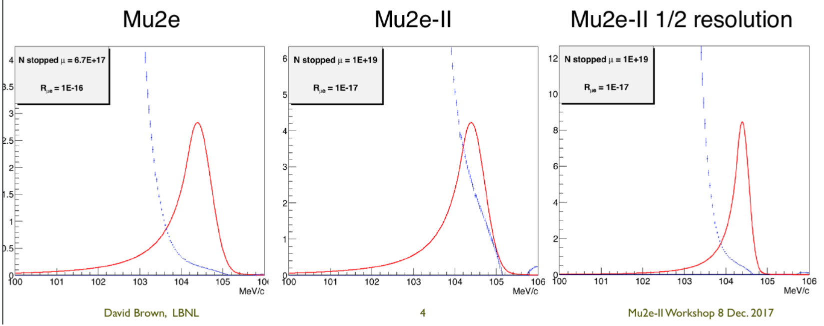
- D=6 mm W rod , vacuum $10^{-}5$ torr , B = 4 T
- power density at 8 kW –> 150 MW/m^3, comparable to NOva
- at 100+ kW, requirements for rad tolerance exceed current state of art
- need active cooling, conceptual design exists for water and helium cooled systems
- collaborate with RaDIATE consortium
- how to focus 800 MeV/c proton beam on target? - need a conceptual design for the beamline, including new PS

Detector



Mu2e proton beam time structure
0.025
0.02
0.015
0.01
0.005
0
0
1000
2000
3000
4000
5000
Time, ns
8 GeV proton beam
production target
2.5 T
4.5 T
calorimeter
tracker
stopping target
1.0 T
production solenoid
transport solenoid
2.0 T
detector solenoid

Tracker Resolution toy MC study

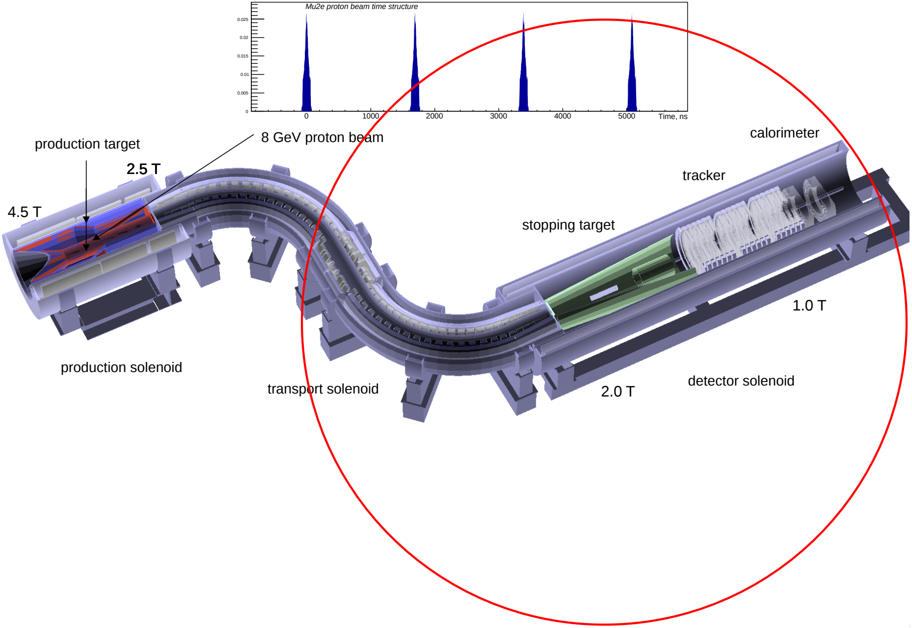


- straw tracker, 18 tracking stations, D=5mm straws, 15 um mylar (Al+Au), tungsten wires
- background from decays in orbit x10: 2 events
- experiment momentum resolution needs to be improved by x2
- resolution - large fraction from fluctuations of energy losses before the tracker
- occupancy : 2500 hits / proton pulse –> 10000 hits/pulse, non-uniform radially
- thinner straw walls 15um –> 8 um ? lower mass wires ?
- alternative technologies: an utra-low mass rad hard tracker would be of broad interest

Calorimeter

- Energy resolution : < 10%, timing resolution < 500 psec
- performance improvement is not required, however will need to suppress the pileup
- CsI crystals degrade fast after 100kRad
- Mu2e-II will need a faster calorimeter with improved radiation hardness
- most feasible option: BaF2 + fast readout based on UV-sensitive SiPM's.
  Considered as one of the options for Mu2e, R&D has already started
- why special SiPMs? compared to MEG (LXe), BaF2 has 10-20 times lower light yield
- R&D of interest: quantum dot (QD)-based wavelength shifting, yttrium doping of BaF2 to suppress the slow (600 ns) component of BaF2 emission, fast timing with QD-based detectors for PID

Cosmic ray veto system



The cosmic ray veto system

4 layers of scintillation counters with SIPM-based readout

challenges:

- need to maintain high cosmic muon rejection efficiency (99.9%) - the light yield requirement
  scintillator aging? - studies are already in progress
  one of the directions: improve the light collection with
- "dead time" due to the CRV veto: 5% , accidental coincidences scale quadratically with the beam intensity
  upgrade shielding?
  replace scintillators with RPC's in the high rate areas?

alternative technology of building a highly efficient cosmic ray veto system with low sensitivity to neutrons would be of general interest

Action Items

- form a task force to develop a conceptual design of the beam line and targeting to accommodate the 800 MeV H^- ions delivered by PIP-II
- collaborate with RaDIATE consortium - material R&D for the Mu2e-II production target
- engage funding agencies and labs in discusssions to identify support the Mu2e-II detector R&D.
- identify high priority simulation studies, start making progress on them