Mu2e-II Tracker Workgroup White paper outline

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Sept 15, 2021

Tracker White Paper Outline

- Description
- Critical Issues
- Anticipated Requirements
- R&D
  - Results
  - Future Plans

Description :

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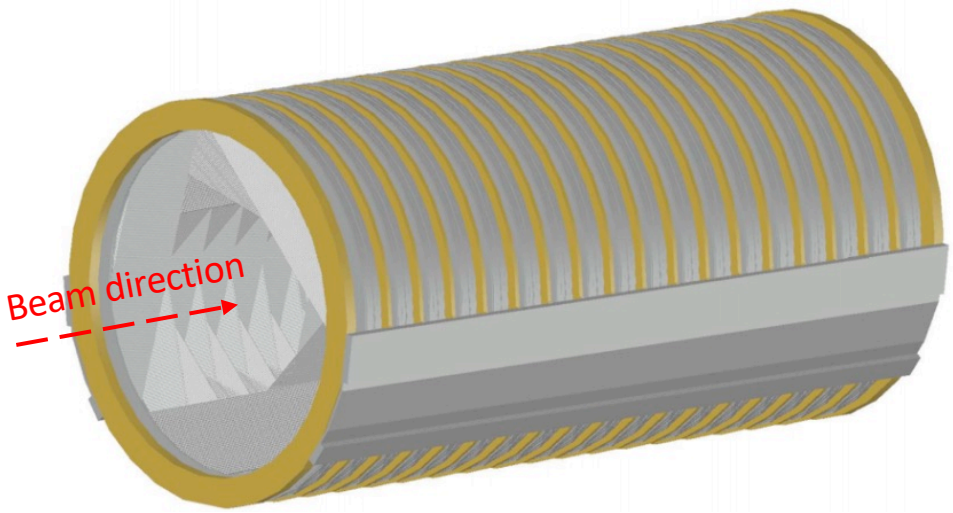
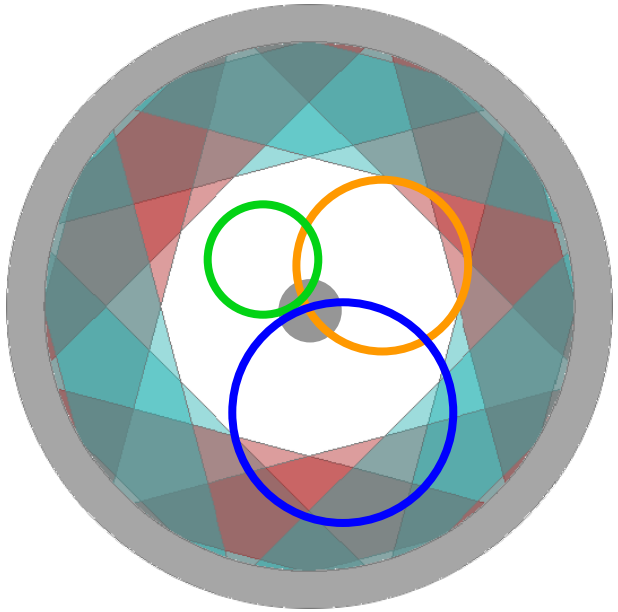
Similar read-out geometry to Mu2e :

- **Blinding to low energy DIO electrons**
- **Sensitivity to 100 MeV electrons**

Other geometries or detector types feasible.





beam's-eye view of the tracker

Mu2e Tracker Design: Straw drift tubes measure track curvature through a 1 T magnetic field.

- **Segmentation to minimize occupancy**
- **Thin walls minimize multiple scattering**
- **No support structure in tracking region**
- **High radiation survival (structure & electronics)**

Critical Issues :

Introduce the issues that will determine the requirements of the tracker.

Momentum Resolution :

- To keep DIO background low, resolution must improve.
- Toy MC suggests a factor of 2 resolution improvement needed for similar DIO background

Increased Occupancy :

- Expecting tracker occupancy ~4x higher than Mu2e
- Reducing material upstream to improve resolution could further increase occupancy

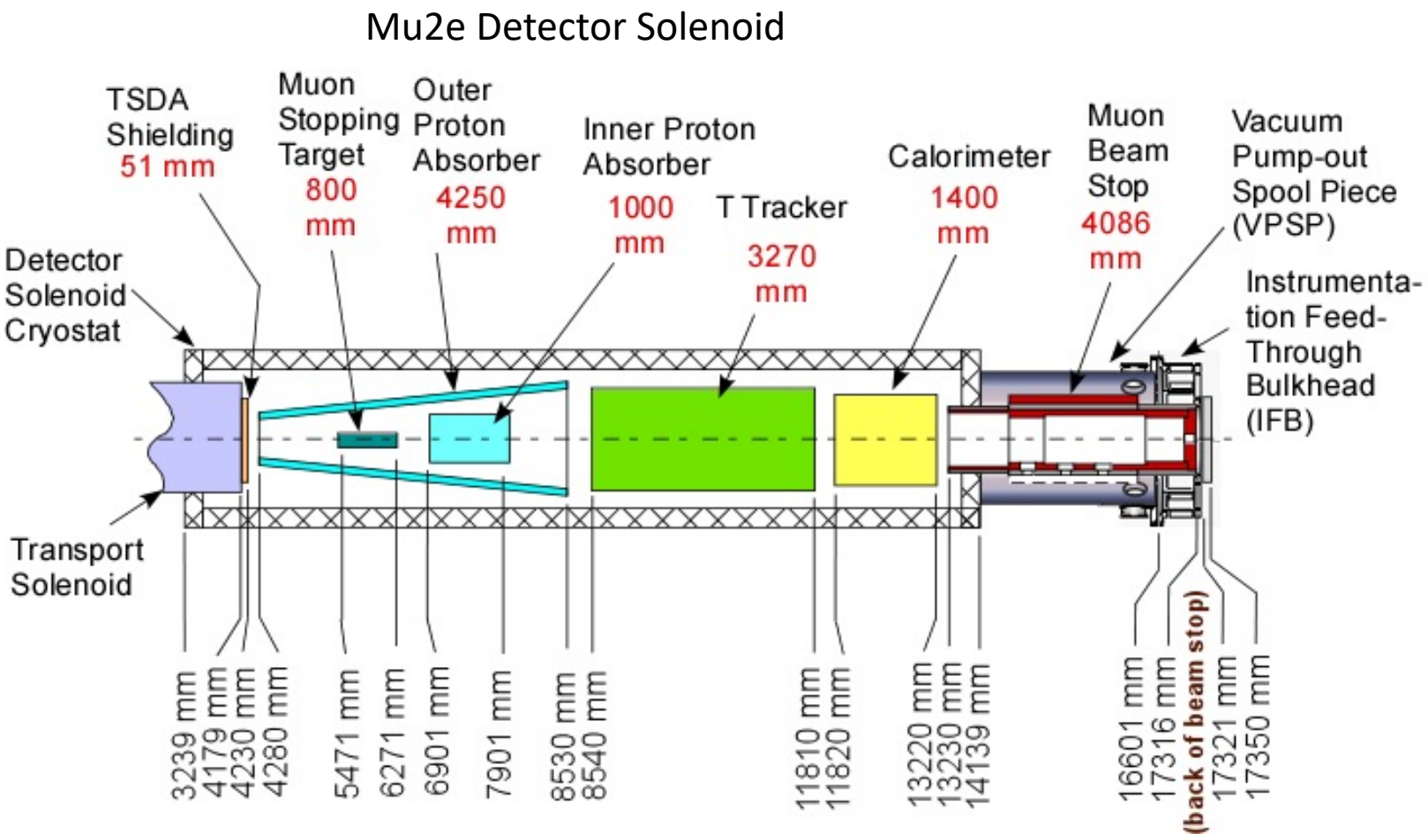
Radiation :

- Radiation levels expected to be large (could be an order of magnitude larger)

Beam electrons :

- Difference from Mu2e 8 GeV proton beam and Mu2e-II's 800 MeV

Momentum Resolution Issue :

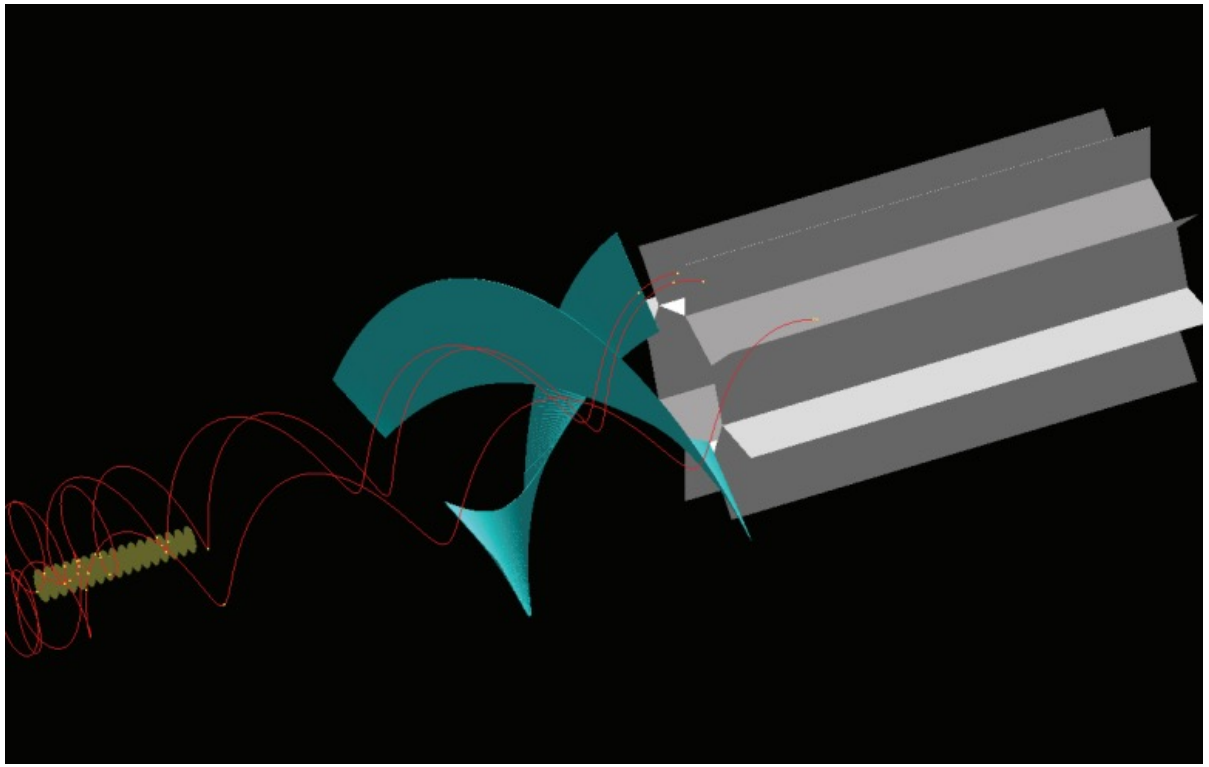


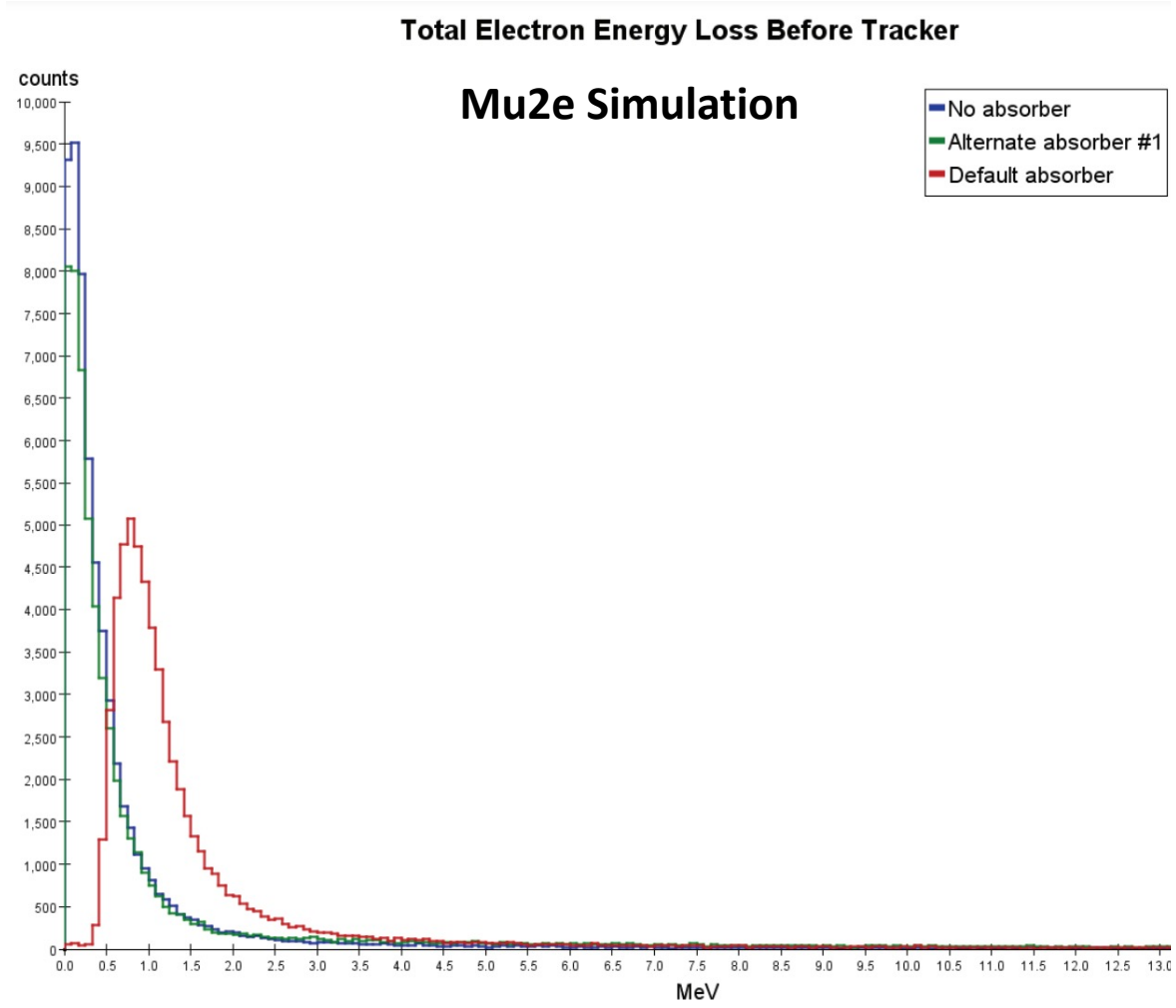
(Old Numbers needs updating)
~0.15 protons emitted per muon capture

Without Inner Proton Absorber, 9% of protons would contribute to single hits in tracker.
With IPA, 0.13% leave hits in the tracker.

*Vadim Rusu Docdb-1197

Alternative Inner Proton Absorber Design





Raymond Clay
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For total energy loss at tracker For total energy loss at tracker

- **FWHM for alternate geometries is ~0.33 MeV**
- **FWHM for default geometry is ~0.68 MeV**

***Mu2e Simulation**

Is a total 50% improvement to momentum resolution feasible?

Improved Tracker only, no improvements to the Muon stopping target and IPA :

- No. Tracker improvements could only improve resolution ~10%

Improved Tracker and improvements to the Muon stopping target and IPA:

- Probably, studies need to be completed to show.

Expected Requirements :

Mu2e Requirements

- **Electron momentum resolution: < 180 keV/c at 105 MeV/c**
- **Efficiency for acceptance and reconstruction of 105 MeV/c electron tracks: >20%**
- **Work in vacuum: operation limits for outgassing rate : < 6 sccm**
- **Hit rate: > 5MHz/channel, 500 ns after proton bunch hits production target**
- **Access : < once per year**
- **Operation time: > 10 yrs**

Additional requirements of Mu2e-II:

- **Lower mass**
  - **In conjunction with the IPA, Stopping target**
  - **Description of Mu2e-II momentum resolution/background separation goals**
- **Increased hit occupancy and timing window**
  - **Faster gas, IPA shielding**
- **Survive the increased charge deposition and beam flash radiation**

R&D Plan

Simulations :

- **Different geometries (including IPA and Stopping Target)**
- **Increased Occupancy Estimations**
- **Detailed simulation of Beam electrons (Beam profiles, Timing)**
  - **Need to talk to simulation/target groups about what they have done**
  - **@ 800 MeV electrons (Transit time different)**
- **Faster gasses/partial pressure (timing improvements, reduces rate/improves resolution)**

Lower mass protypes:

- **Thinner straws**
- **IPA design and tracker interaction**
- **Pursuing alternative tracking technologies**
- **Pursuing alternative geometries**

Rad hard equipment :

- **Discuss outlook for off-the-shelf radiation-resistant electronics in ~2030**
  - **Possibly use electronics developed for HL-LHC**
- **Develop radiation-resistant front-end electronics**
  - **ASICS**
  - **DC-DC converter**
  - **Optical components**

Currently have results

Looking to have some results in 6 months

Discussion but no results.

R&D Results to date :

- 8 μm thin-walled straw's material studies
- Tracker Construction Techniques
- Tracker Geometry simulations

Summary

- Top priority moving forward is simulating the momentum resolution of the tracker in conjunction with the muon stopping target and inner proton absorber.
- Additional work is being done on possible geometries, prototype straws, and processes for tracker construction
- Most work in the next 6 months will be on simulations