

# Mu2e-II Tracker Workgroup and Detector Requirements

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# Tracker Working Group:

**Conveners :** Gianfranco Tassielli, INFN  
Dan Ambrose, UMN

**Members :** Brendan Casey, FNAL  
Mete Yucel, FNAL  
Manolis Kargiantoulakis, FNAL  
Dave Brown, LBNL  
**Jim Popp, York CUNY**

**Join the list serve : [MU2EII-TRACKER@fnal.gov](mailto:MU2EII-TRACKER@fnal.gov)**

**Meeting Schedule : Bi-weekly Tuesdays 11:00 AM CST. Next one is Jan 5<sup>th</sup>.  
Zoom link sent through list-serv**

**We would gladly welcome more interested people.**

**Please contact ([giovanni.tassielli@le.infn.it](mailto:giovanni.tassielli@le.infn.it) ), [me\(ambr0028@umn.edu\)](mailto:me(ambr0028@umn.edu)), or come to the workgroup meeting**

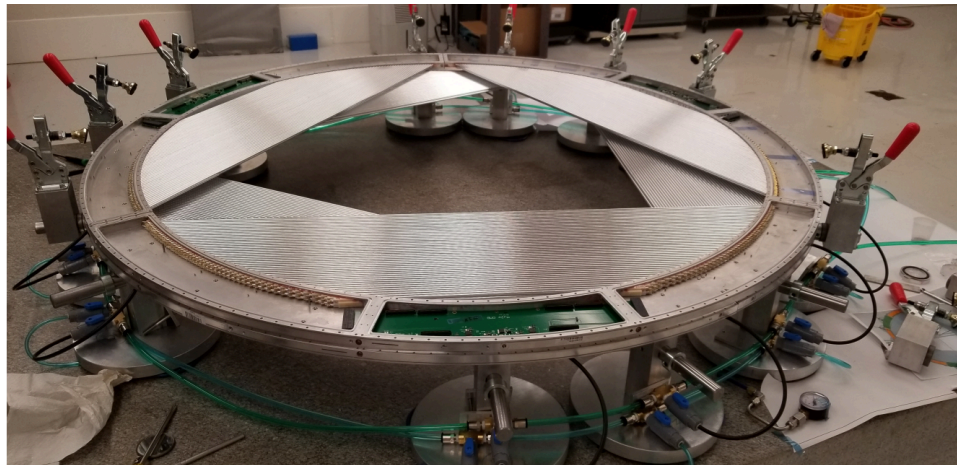
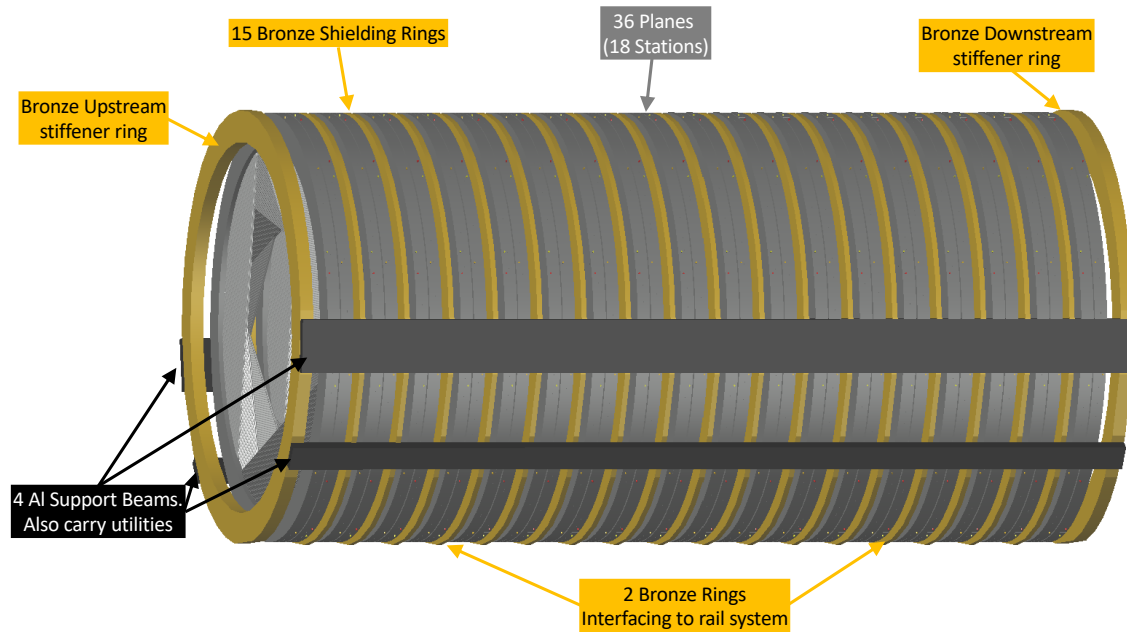
# Mu2e-II Tracker Workgroup Goals

**In process of mapping out an R&D plan for the next few years**

- **Explore limits of what can be done in tracking with current technology**
- **Starting long term studies**
- **Produce results needed for next year's Snowmass white paper**

**Snowmass LOI([link](#)) outlines many tests and technologies we are looking into.**

# Mu2e Tracker



## Design Features:

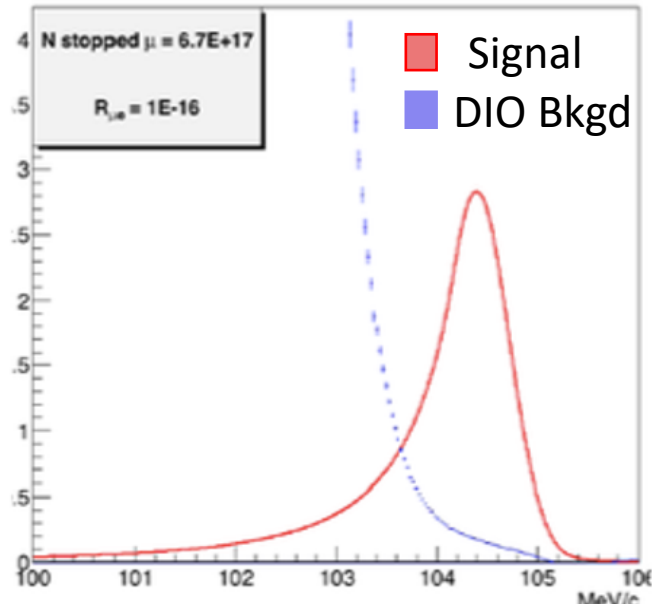
- Made from 20,736 Proportion Drift Tubes
- Gap through middle to blind to low momentum background and avoid much of the beam flash.
- Detection region is low mass
- Structural components, electronics and shielding in outer cylinder.

## Requirements:

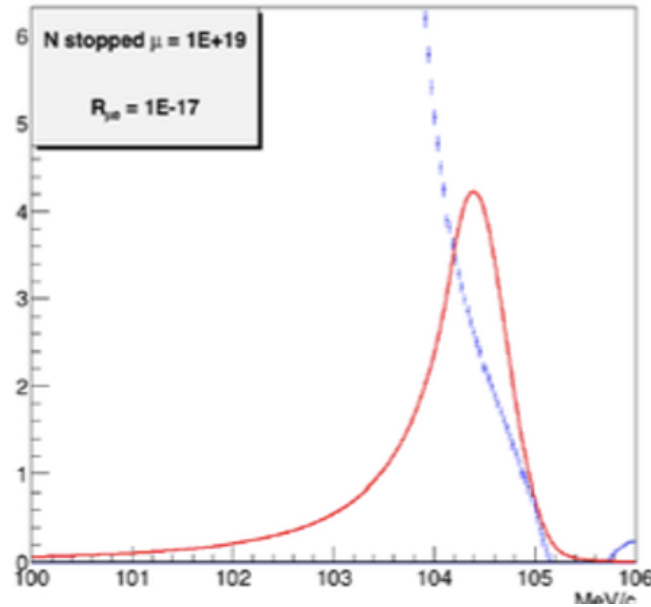
- Core momentum resolution  $< 180$  keV/c at 105 MeV/c
- Efficiency for the combined acceptance and reconstruction of 105 MeV/c electron tracks around 20%
- Leak plus outgassing rate below 6 sccm
- Operates without access to the detector train for repairs more frequently than once per year
- Handle a hit rate of up to 5MHz/straw, 500 ns after the peak of the proton bunch reaches the production target

The Tracker requirements are described in DocDB #22804

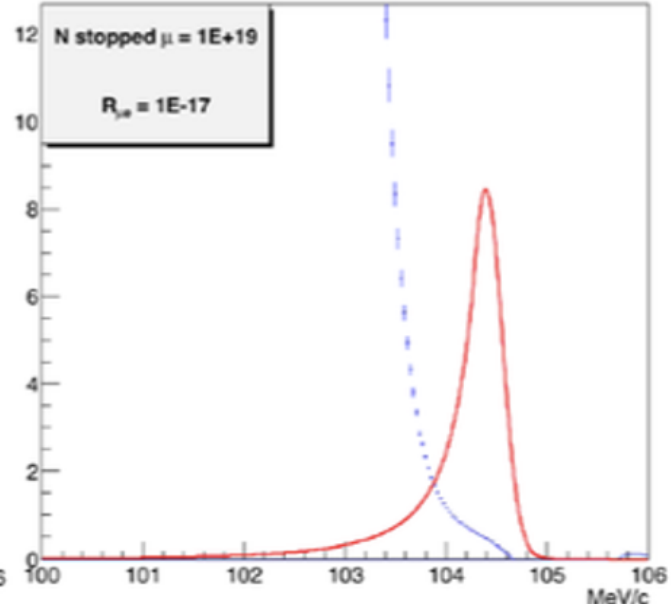
# Would the same tracker work in Mu2e-II Environment?



Mu2e Rate and Background



Mu2e-II Rate and Background  
With Mu2e Tracker  
(15  $\mu\text{m}$  wall straws)



Mu2e-II Rate and Background  
With Lower Mass Tracker  
(8  $\mu\text{m}$  wall straws)

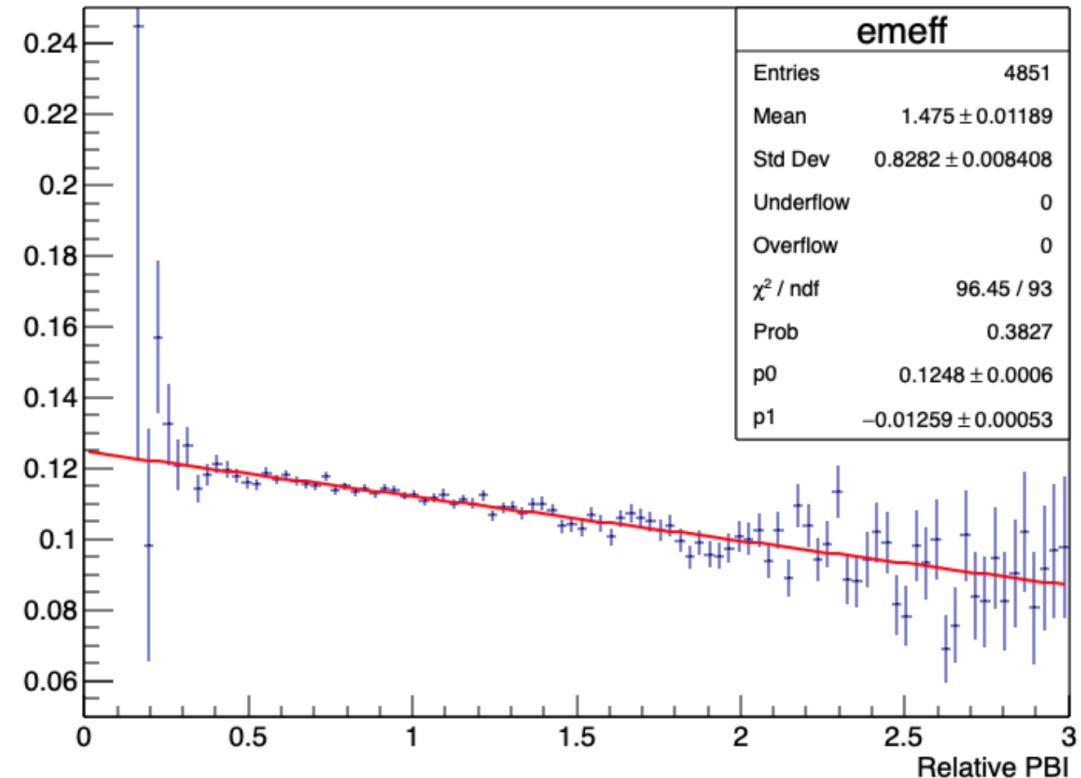
Toy MC from  
Dave Brown

- The reuse of the Mu2e tracker would exceed allowed background budget of Mu2e-II which is 1 event
- Biggest concerns:
  - DIO background
  - Increased aging effects from radiation
  - Increased hit occupancy and timing window

# Mu2e-II Tracker Requirements

- **Lower mass**
  - To meet Mu2e-II momentum resolution/background separation goals
  - Looking into :
    - Thinner straws
    - Different Geometry
    - Lower mass gas or sense wires(molybdenum)
    - Pursuing alternative new technologies
- **Survive the increased charge deposition and beam flash radiation :**
  - Develop radiation-resistant front-end electronics
    - ASICs
    - DC-DC converter
    - Optical components
- **Increased hit occupancy and timing window**
  - 4x increase in Proton bunch intensity reduces reconstruction efficiency by 30% (extrapolated)
  - Current design and software is capable of this

Efficiency for  $\mu^+ \rightarrow e^+$  vs PBI



MDC2018, Dave Brown  
Docdb# 28281

# Investigating Tracker Options

## Similar tracker design :

- Could use much of the existing Mu2e infrastructure and apparatus.
- Similar design, production tooling, and electronics allows us to capitalize on current expertise and save money.

## Exploring other tracking technologies and geometries:

- Estimates have shown improvement over a straw tube tracker
- Possible solution to insurmountable issues are encountered with lower mass straws and/or readout in higher radiation fields
- Exploration could advance the “Ultra-low mass/power rad-hard silicon detectors” Grand Challenge identified by the detector R&D community. [CPAD]<sup>[1]</sup>

**[1]** [arXiv:1802.02599](https://arxiv.org/abs/1802.02599)

# Today's agenda :

**Research into 8  $\mu\text{m}$  wall thickness prototype straws –Brendan Casey and LDRD group**

**Discussion Software and Simulations – Dave Brown and Gianfranco Tassielli**

**Discussion on Radiation Studies – Mete Yucel**

**Tracker Construction Ideas –Dan Ambrose**

**We hope this workshop will be a useful platform to express and brainstorm ideas.**



# Conclusion

- **New Detector is needed to accomplish Mu2e-II's goals**
- **Major difficulties:**
  - **Improve momentum resolution**
  - **10x integrated radiation dose**
  - **Increased hit occupancy and timing window**
- **Thank you for coming to the workshop!**
  - **You are welcome to join us. Plenty of room for new people and new ideas.**