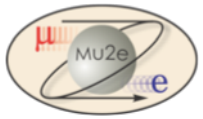
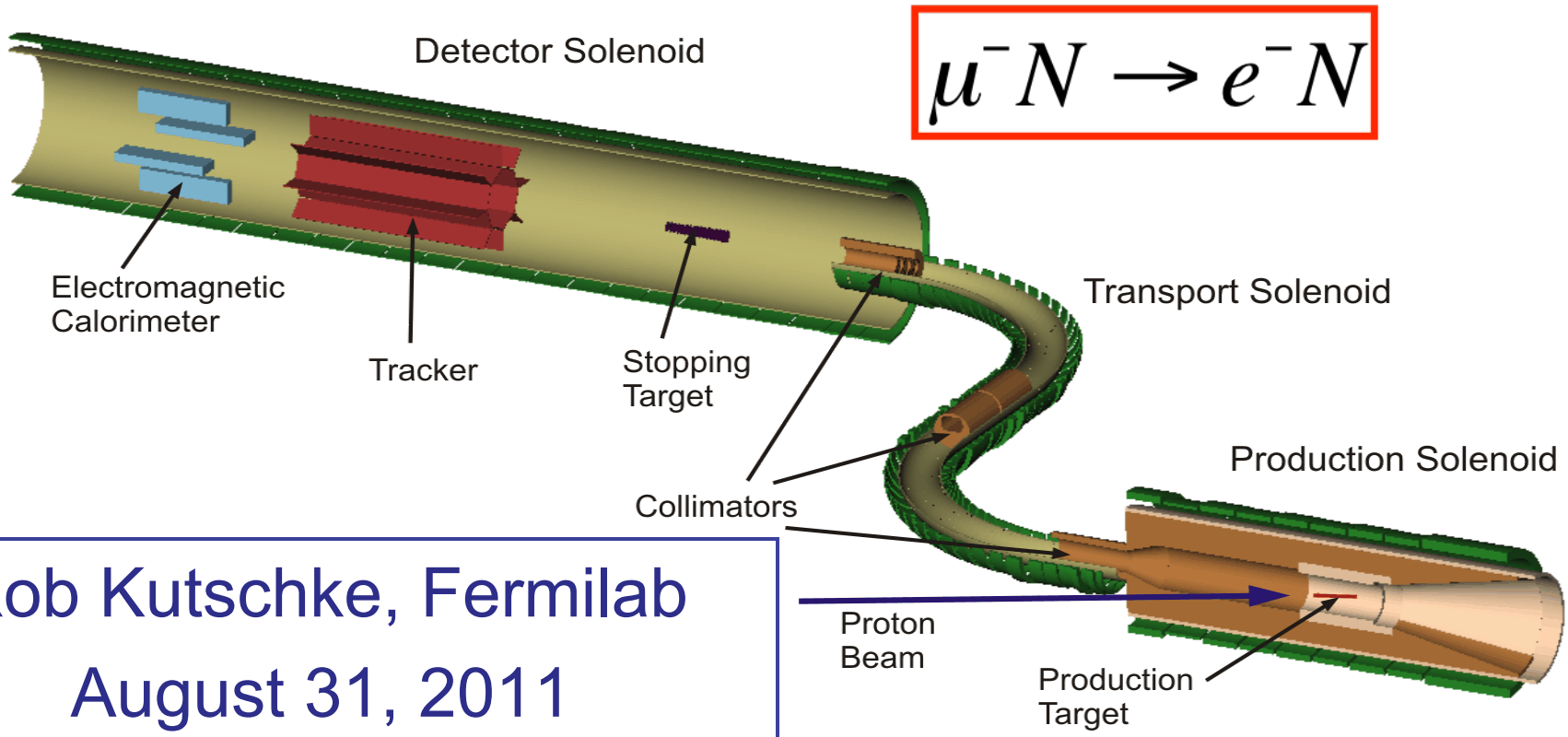


Mu2e-doc-1841-v1

The Mu2e Experiment at Fermilab



Rob Kutschke, Fermilab

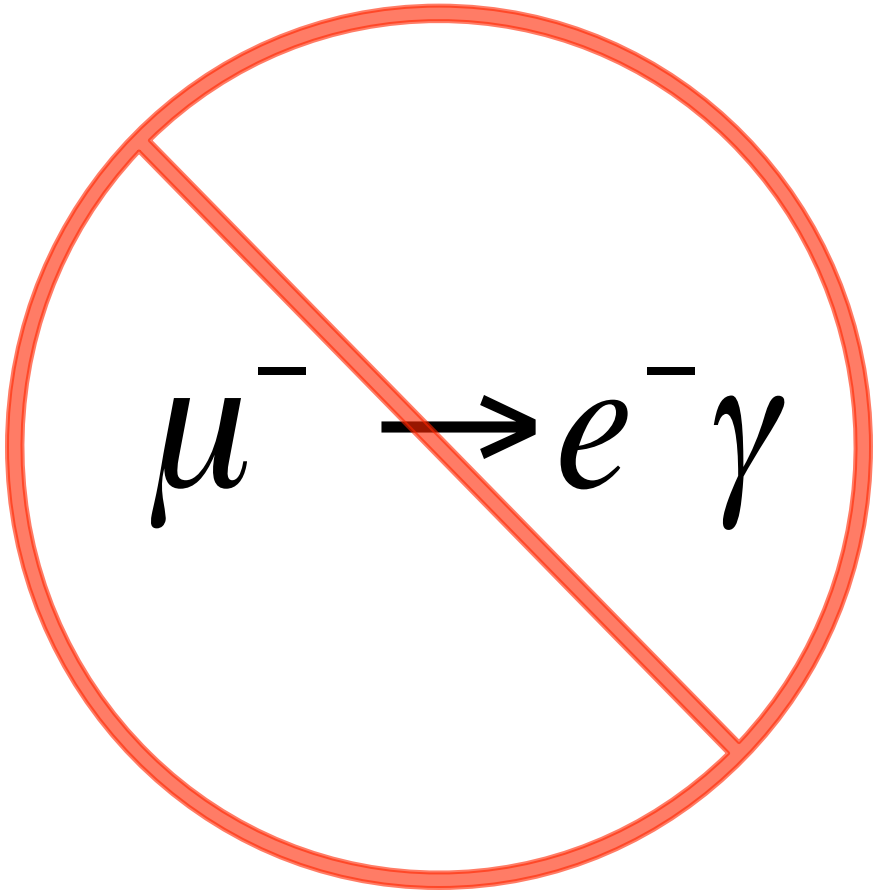
August 31, 2011

Physics in Collision

Vancouver, BC

http://mu2e.fnal.gov

What we are not doing …



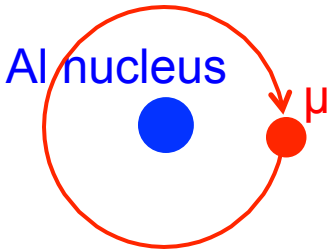
- MEG is underway:
  - http://meg.web.psi.ch
- Previous best:
  - MEGA in SPIRES
- Mu2e is doing:

$$\mu^- N \rightarrow e^- N$$

μ to e Conversion at Mu2e

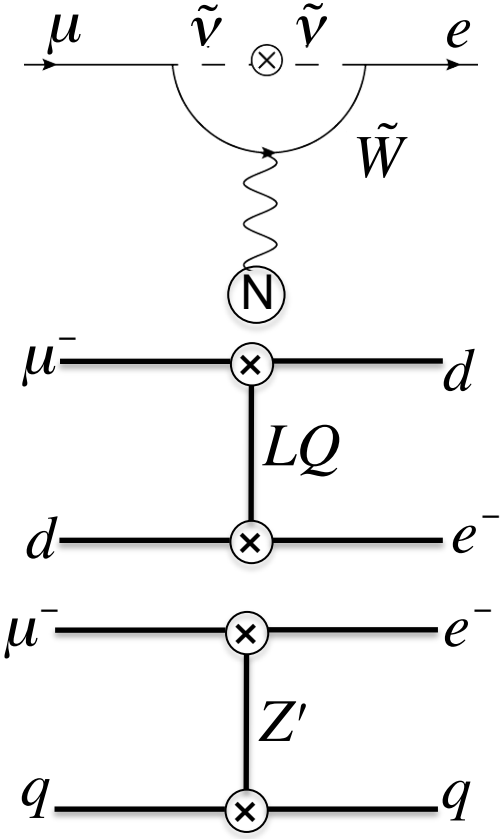
Initial State

- Muonic aluminium



- Bohr radius: ≈ 20 fm
- Nuclear radius: ≈ 4 fm
- Lifetime: 864 ns

New Physics



Final State

- No neutrinos
- 2-body
- Recoiling, intact, unobserved nucleus
- Mono-energetic e^-
  - E=104.97 MeV

- Coherent = no nuclear breakup!

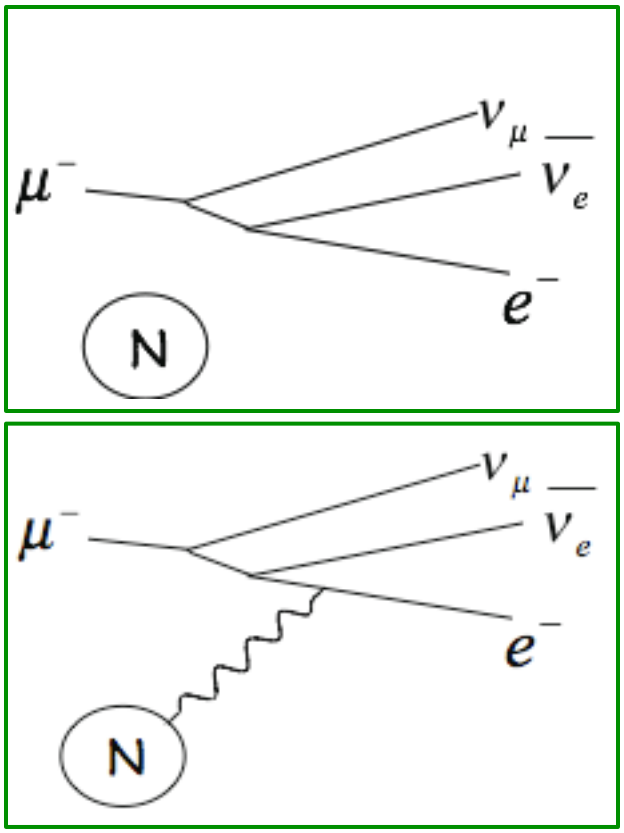
What do We Measure

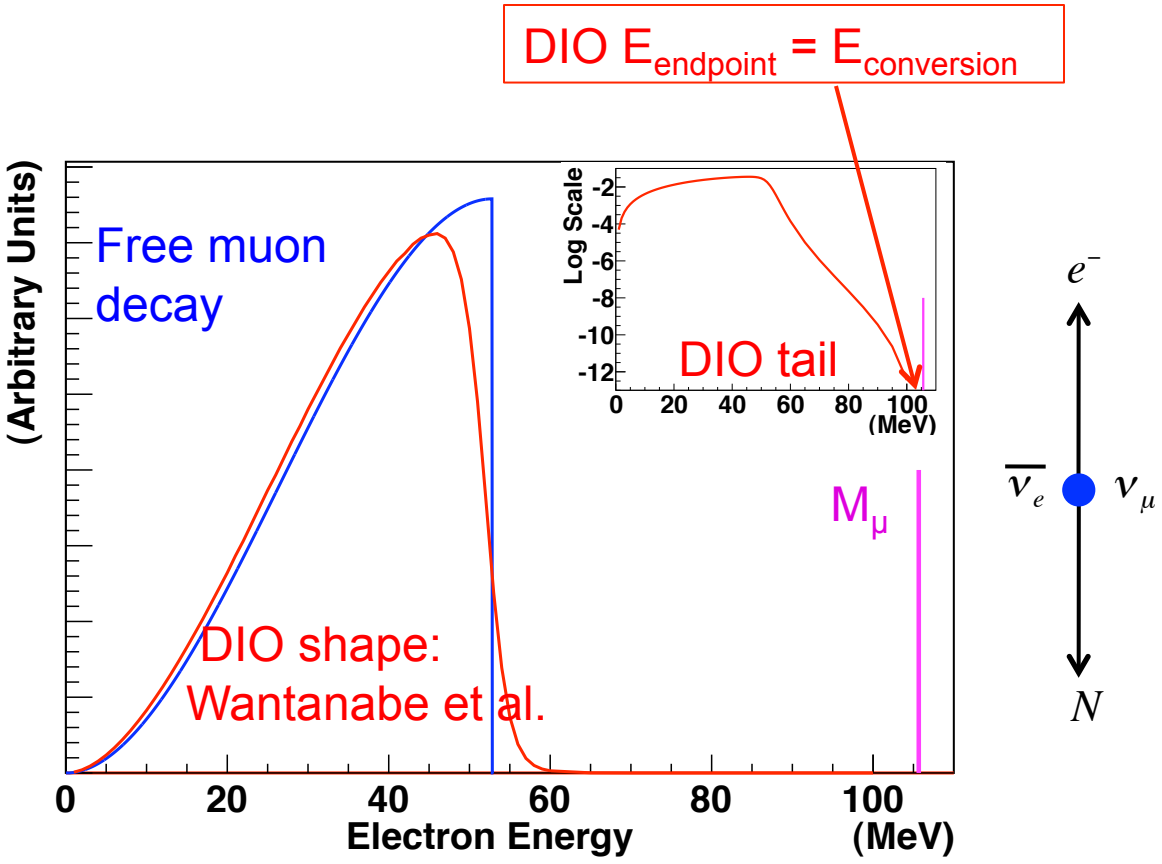
$$R_{\mu e} = \frac{\Gamma(\mu^- + (A,Z) \rightarrow e^- + (A,Z))}{\Gamma(\mu^- + (A,Z) \rightarrow \nu_\mu + (A,Z-1))}$$

- Denominator: normal muon nuclear capture.
  - Count the number of stopped muons, using muonic X-ray lines.
- SM rate is non-zero but is immeasurably small.
- Any observation is evidence for physics beyond the Standard Model.
  - Sensitive to new mass scales up to O(10,000 TeV).
- Previous best: Sindrum II
- An earlier experiment: TRIUMF-104 (TRIUMF TPC)

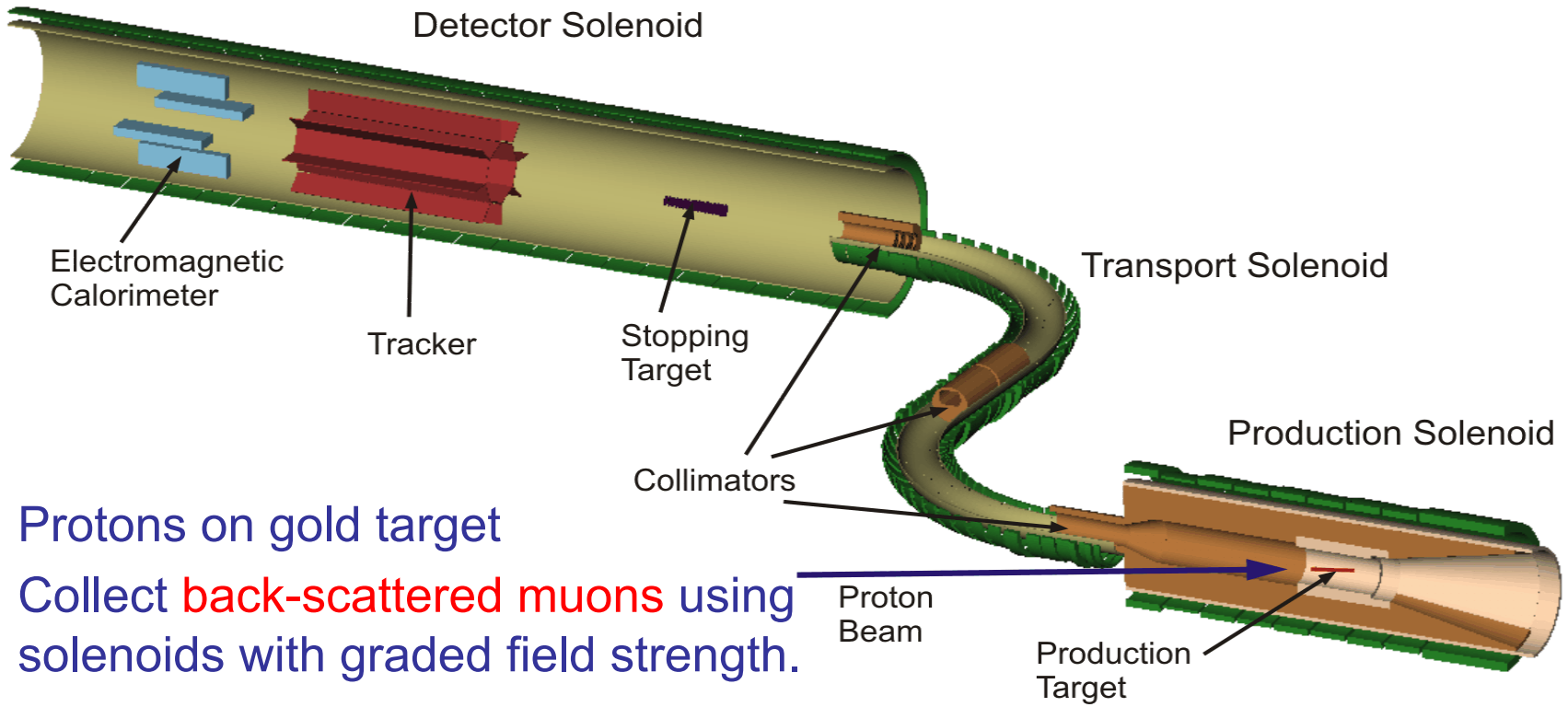
Decay-in-Orbit: Irreducible Background

Decay of muonic aluminium:
40% decay in orbit (DIO)





Making Muonic Al



- Protons on gold target
- Collect back-scattered muons using solenoids with graded field strength.
- Transport muons to thin foils stopping targets.
- Many non-muons arrive in time with muons: prompt backgrounds.
- Lifetime of muonic aluminium is 864 ns
  - Wait for prompt backgrounds to decay!

A Cartoon of Mu2e

1) Make a low momentum muon beam.
2) Shoot it at target of many thin Al foils.
3) Some muons will range out in the first foil, some in the next foil, …
4) Stopped muons will be captured to form muonic atoms.
5) Wait until the prompt backgrounds decay away.
6) Measure the energy spectrum of electrons that escape the foils.
   - Using standard HEP techniques: straw tracker and crystal calorimeter
7) Is there an excess at the DIO electron endpoint energy?
8) Measure/estimate backgrounds.
9) Systematics, Systematics and more systematics.

Sensitivity, Schedule …

- For a 2 year run:
  - Expect < 0.17 ± 0.7 background events in the signal region.
  - $R\mu e \approx 2.3 \times 10^{-17}$ single event sensitivity.
  - $R\mu e < 6 \times 10^{-17}$ limit at 90% C.L.
  - 10,000 × better than previous limit (SINDRUM II).
  - Sensitive to masses up to O(10,000 TeV).
  - For SUSY visible at the LHC: $R\mu e \approx O(10^{-15})$
    - Expect 40 events on a background of 0.17 ± 0.7
- Working schedule:
  - CD-1 review this fall
  - Start data taking in 2018.
- See the poster.
- Stay tuned: http://mu2e.fnal.gov.