Testing the SM and Studying the Higgs at the Energy Frontier (+Mu2e)

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The Standard Model
SM Flaws and Omissions

Dark Matter Candidate

Higgs Mass problem

Do the RC cancel the bare mass to >20 orders of magnitude?

Too many free parameters?

Unification of strong force with electroweak?
CERN Accelerator Complex

LHC: Last step in a series of accelerators responsible for bringing protons from 450 GeV to 3.5 TeV (and soon 7 TeV)

Circular accelerator: benefit of “seeing” the protons more than once at the cost of magnets to keep the protons on the circular path
Yale ATLAS Group

Keith Baker  Sarah Demers  Paul Tipton
Yale ATLAS Group

Transition Radiation Tracker
Higgs to four leptons
Axions
New Physics

Trigger
Taus
Polarization Upgrade
Higgs Bosons

Inner Tracker Upgrade
Multi-higgs search
ttH search
New Physics

Keith Baker
Sarah Demers
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Mu2e: The Motivation

Looking for evidence of charged lepton flavor violation: muon conversion to an electron without a neutrino.

Mu2e looks for this in the field of the nucleus

\[ R_{\mu e} = \frac{\mu^- + A(Z,N) \rightarrow e^- + A(Z,N)}{\mu^- + A(Z,N) \rightarrow \nu_\mu + A(Z-1,N)}. \]

Physics Motivation: rate of direct conversion < $10^{-50}$ in the standard model

Enhancements predicted in
- MSSM with right-handed neutrinos
- R-parity violating SUSY
- models with leptoquarks
- models with large extra dimensions
- models with new gauge bosons
- models with a non-minimal Higgs Sector
Mu2e: The Experiment

- Production Solenoid: 12 ft long, 4.5 Tesla
- Proton Beam
- Transport Solenoid: 40 ft along the curve, 2 Tesla
- Detector Solenoid: 30 ft long, ~1 Tesla
- Production Target
- Tracker
- Calorimeter
Yale Undergraduates at the Discovery Announcement