An experiment to search for mu-e conversion at J-PARC MLF in Japan, DeeMe experiment





Muonic atom and mu-e conversion

Normal reactions

Our target





- Charged Lepton flavor violating (CLFV) process.
 Not yet discovered.
- Standard Model: Br=0

SM+v-oscillation: Br<10⁻⁵⁴

- Several BSM predicts just below current experimental limit (Br(for Au)<7x10⁻¹³, Br(for Ti) < 4.3x10⁻¹² (SINDRUM II), 4.6x10⁻¹² (TRIUMF))
 - Clear Evidence of NP

Muon physics and the physics scale

originally from Andre de Gouvea (2013)



Our strategy for mu-e conversion search

- **SINDRUM II** Br(μ -e conv. Au) < 7×10⁻¹³
- DC beam, heavy nuclei
- O(1) probably beam B.G.





Our approach

 $v \rightarrow e^+e^-$ etc.

- Pulsed beam, delayed signal window, light but not too light nucleus (DeeMe selects C or SiC)
 - Heavier nucleus, larger overlap with muon wave function, but shorter lifetime (τ_(Au)~0.07μs, τ_(C)~2.0μs, τ_(Si)~0.76us)
 - Need more intense beam

Experimental site: J-PARC MLF



Design of DeeMe



- Pion production by accelerated proton hits on target
- 2 $\pi^- \rightarrow \mu^- + v_\mu$
- 3 μ⁻ trapped by a nuclear. Muonic atom formation
- Particles emitted from muonic atom
- 5 Extract electron via secondary beam line and measure the momentum

Backgrounds and expected sensitivity

Expected backgrounds

- Radiative π/μ capture backgrounds (π⁻/μ⁻ + (A,Z) → (A, Z-1)*, γ → e+e⁻):
 <0.0009 in delayed signal window
- Decay in orbit (DIO): 0.09
- Delayed proton induced backgrounds (From delayed proton measurement. 0 in principle): < 0.027
- Cosmic ray induced backgrounds (MC simulation):
 e: < 0.018, μ: < 0.001
- Anti-proton (MC simulation): 0

Single Event Sensitivity

- C target case: 8x10⁻¹⁴ (1 year data taking)
- SiC target: 2x10⁻¹⁴ (1year), 5x10⁻¹⁵ (4 years)



Delayed proton rate = 10⁻¹⁹

Design of DeeMe

- Advantage of design of DeeMe
 - Less Delayed-proton/Cosmic/Anti-proton induced B.G.
 - No need to construct dedicated beam line.
- Issue
 - Huge prompt burst particles (~70GHz at beam center, detector position)

Space charge effect disables normal wire chamber to detect delayed signal electron.

HV switching **MWPC**



HV switching MWPC



Spectrometer magnet



- Dipole magnet which was used for PIENU in TRIUMF is transported to J-PARC
- Operation in J-PARC was successful. Measured field is compared with calculated one.
- 0.4T operation for 105 MeV/c electron tracking.

Preparation status: Beamline





DeeMe will run in H-line in MLF J-PARC which is now under construction

DIO measurement (Middle momentum region)





- Checked the actual chamber operation with Decay in orbit background measurement.
- Successful several days of data taking.
- Analysis on going

Waveform analysis

Noise of HV switching has always the same shape. Template subtraction eliminate baseline vibration by the HV switching.



- Mu-e conversion is a good probe for the new physics beyond the Standard Model.
- DeeMe starts to search for mu-e conversion with graphite target with S.E.S. of 8x10⁻¹⁴. Improving the sensitivity with SiC is under investigation.
- DIO background measurement was done with actual chambers. Analysis on going.
- DeeMe will start soon after completing the H-line construction.



Backups



Wire pitch vs gain control power

Special geometry is needed for dynamic gas gain control with potential wire HV switching



Discharge voltage vs wire pitch



 pitch 0.7mm, Ar/C2H6=50/50 enough separation between discharge-nominal voltage





Switching period

