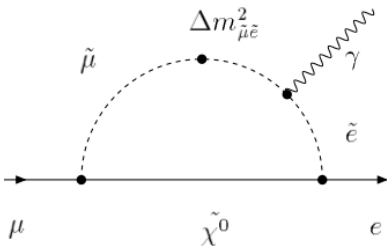
A Concept to Search for $\mu \rightarrow e\gamma$ Decays with High Intensity Muon Sources

Complementary to $\mu \rightarrow e$ Conversion



Challenge: Background from electron-photon coincidence

Signal scales as R_μ
Background scales as R_μ^2

R_μ = Muon stopping rate

Progress requires
- Increased R_μ
- Improved resolution to reject accidental coincidences

Effective Branching Ratio of Background

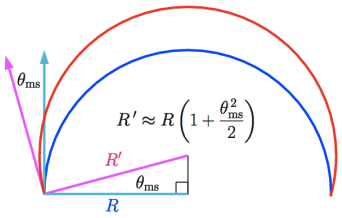
$$B_{acc} = \left(\frac{R_\mu}{d}\delta t_{e\gamma}\right) \text{ timing, duty cycle}$$
$$(\delta x) \quad e^+ \text{ energy resolution}$$
$$\left(\frac{\delta y}{15}\right)^2 \quad \gamma \text{ energy resolution}$$
$$\left(\frac{\delta\theta^2_{e\gamma}}{4}\right) \quad \text{opening angle}$$
$$\left(\frac{(2\delta\theta_z L_{\gamma T})^2}{A_T}\right) \quad \text{traceback angle}$$

Kuno, Okada, RMP73,151 (2001)
MEGA Collaboration, PRD65,112002 (2002)

Existing Branching Ratio Limits

MEGA: < 1.2 x 10^{-11} (1999)
Using converted photons
6% duty cycle

MEG: < 2.4 x 10^{-12} (2010)
Using LXe calorimeter
Expects to reach few x 10^{-13}



Concept for Future: Return to Converted Photons

- Photon detectors placed out of range of positrons, with pixel tracking
- High-rate pixel detectors for positron tracking
- Tracking measurements 180° apart to minimize effects of multiple scattering.
- Resolution dominated by energy loss in converter, tracker

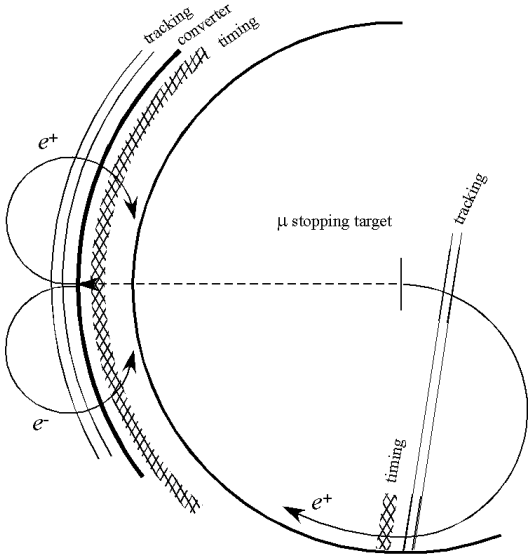
DeJongh, Fermilab-TM-2292-E (2005)

Thickness of Photon converter (t) Plays Critical Role

Signal increases as t

B_{acc} increases as t^3
(affects photon energy resolution, traceback angle resolution).

Strategy:
- Increase R_μ
- Decrease converter thickness



Projections: Scale to MEGA

Assume detector with:
- Same live-time, 100% duty cycle
- 10% of MEGA coverage (3% of 4π)
- BTEV style pixels, 900 μm thick
- Half the converter thickness
- 160 psec FWHM tof res. (10x better)
- X1000 R_μ (1.5 x 10^{10} / sec)

1-event sensitivity: 4 x 10^{-14}
B_{acc} : 1 x 10^{-14}

Further improvements:
- Monolithic pixels, 100 μm thick
- Reduce converter another x2
- 50% of MEGA coverage
- Increase R_μ another x20
- 5x live-time (4 x 10^7 sec)

1-event sensitivity: 2 x 10^{-16}
B_{acc} : 2 x 10^{-16}

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