

Muon Physics

at BNL

William Morse

DOE HEP Review

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Vernon W. Hughes 1921-2003



The Muon (g-2) Collaboration

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[Y. Orlov](#) - **Cornell University**

D. Winn - **Fairfield University**

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B. Bunker, [P.T. Debevec](#), W. Deninger, [F. Grav](#), [D.W. Hertzog](#), T.D. Jones, [C.J.G. Onderwater](#), C. Polly, S. Sedykh, [M. Sossong](#), D. Urner - **University of Illinois**

U. Haeberlen - **MPG für Med. Forschung**

M.A. Green - **Lawrence Berkeley National Laboratory**

[B. Bousquet](#), [P. Cushman](#), [L. Duong](#), [S. Giron](#), [J. Kindem](#), [I. Kronqvist](#), [R. McNabb](#), D. Miller, C. Timmermans, T. Qian, D. Zimmerman - **University of Minnesota**

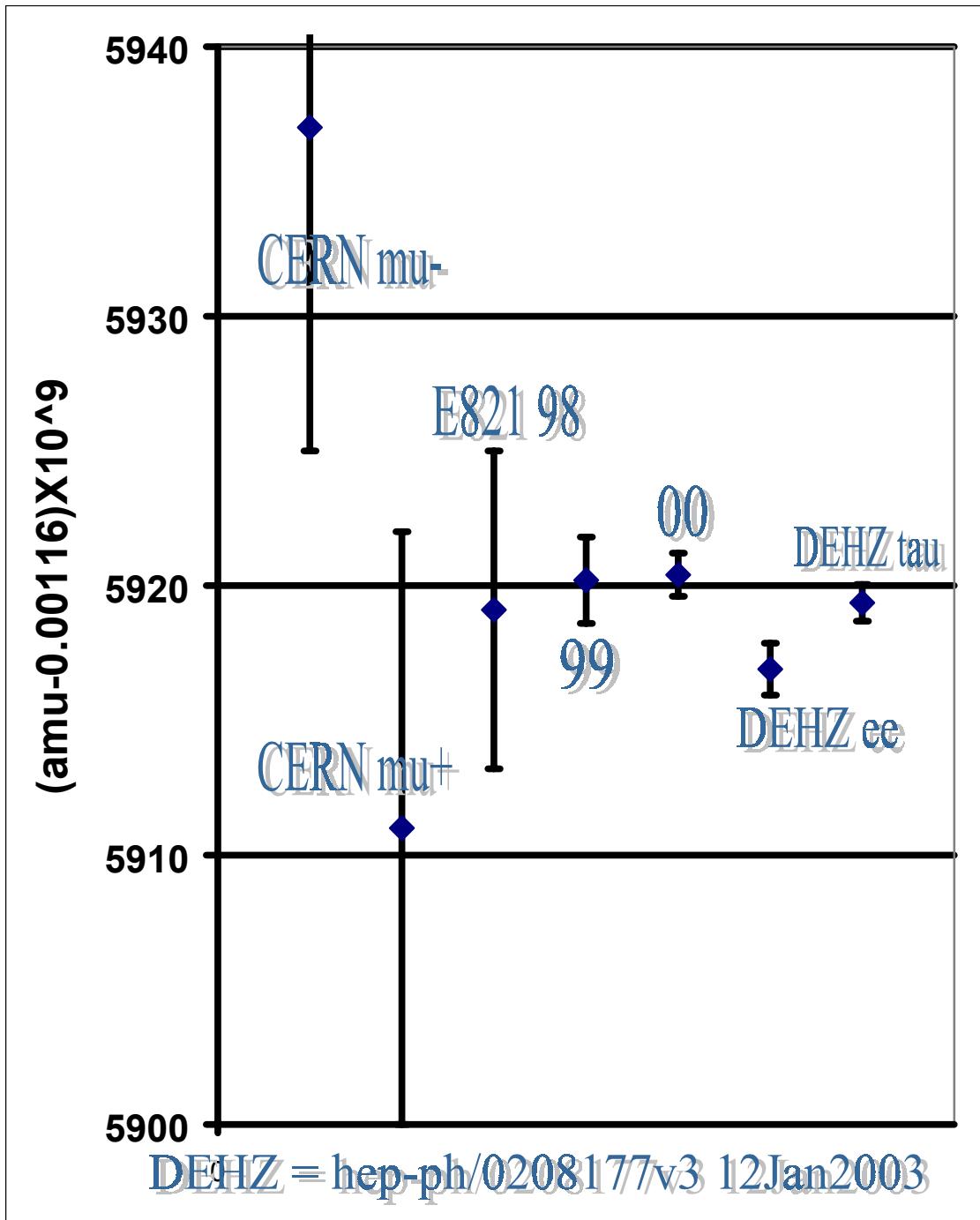
A. Chertovskikh, V.P. Druzhinin, G.V. Fedotovich, D. Grigoriev, V.B. Golubev, B.I. Khazin, A. Maksimov, Yu. Merzliakov, N.M. Ryskulov, S. Serednyakov, Yu.M. Shatunov, E. Solodov - **Budker Institute of Nuclear Physics, Novosibirsk**

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H.E. Ahn, [M. Deile](#), H. Deng, S.K. Dhawan, A. Disco, F.J.M. Farley, X. Fei, M. Grosse-Perdekamp, V.W. Hughes, D. Kawall, J. Pretz, S.I. Redin, E.P. Sichtermann, A. Steinmetz - **Yale University**

E821 a(μ^+) Results



New e^+e^- data from CMD2, KLOE, BaBar and Belle (2003).

Calculate hadronic correction to a_μ on the lattice (2004-5).

CMD3 (2006).

Standard Model Theory

$$a_\mu(\text{QED}) = 116584703 (03) \times 10^{-11}$$

$$a_\mu(\text{Had}_a) = \approx 7000 (70) \times 10^{-11}$$

$$a_\mu(\text{Had}_b) = -100 (06) \times 10^{-11}$$

$$a_\mu(\text{Had}_{ll}) = 85 (25) \times 10^{-11}$$

$$a_\mu(\text{EW}) = 154 (04) \times 10^{-11}$$

BNL E821 Physicists

G. Bennett - electrostatic quadrupoles

H. Brown - beamline

G. Bunce - project manager

G. Danby - storage ring magnet

Y.Y. Lee - kicker and beam dynamics

W. Meng - inflector magnet

W. Morse - resident spokesman, systematic error czar

Y. Semertzidis - electrostatic quadrupoles, analysis coordinator, chair of publications committee

Improvements?

- Now analyzing 2001 run $a(\mu^-)$ data.

Result by early summer with accuracy $\approx 0.7\text{ppm}$.

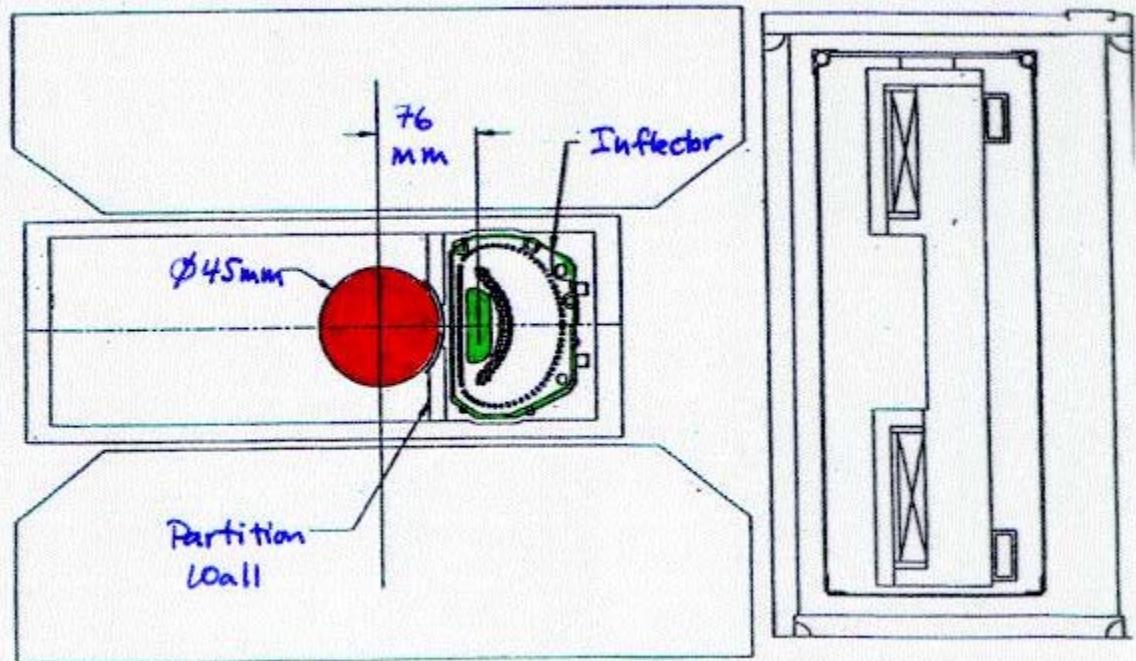
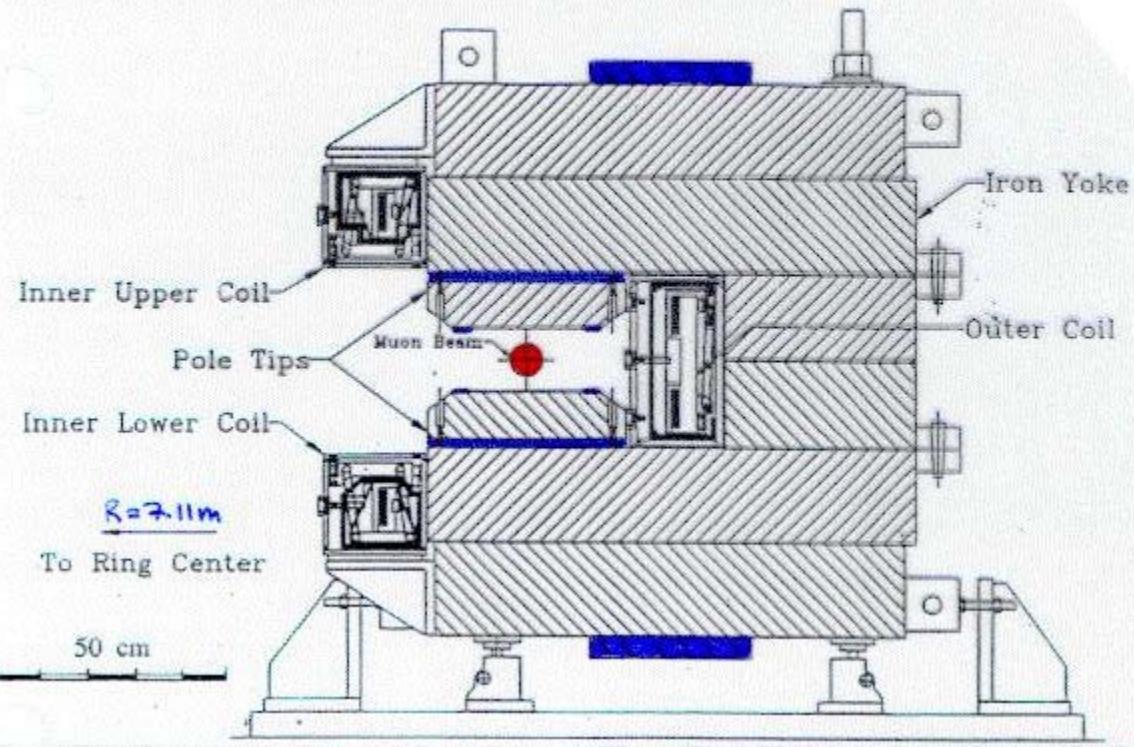
- 10X at JPARC?

- 0.9MW (JPARC) vs. 0.15MW (AGS)
- Larger inflector aperture? (W. Meng - study)
- Larger emittance beamline?
- SM hadronic contribution?

JPARC LOI January, 2003.

Lee Roberts spokesman.

STORAGE RING CROSS SECTION



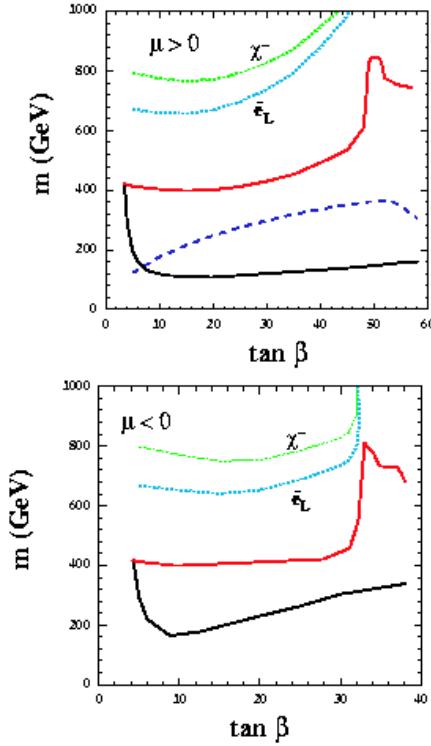


Figure 3: The ranges of m_χ allowed by cosmology and other constraints, for (a) $\mu > 0$ and (b) $\mu < 0$. Upper limits without (red solid line) and with (blue dashed line) the $g_\mu - 2$ constraint are shown for $\mu > 0$: the lower limits are shown as black solid lines. Note the sharp increases in the upper limits for $\tan \beta \gtrsim 50, \mu > 0$ and $\tan \beta \gtrsim 35, \mu < 0$ due to the rapid-annihilation funnels. Also shown as dotted lines are the \tilde{e}_L and χ^\pm masses at the tips of the coannihilation tails.

Electric Dipole Moment of the Muon

<http://www.bnl.gov/edm/>

- New idea by Y.S. (BNL) makes sensitive search to 10^{-24} e-cm possible: radial E field to cancel g-2 precession. 10^5 improvement!
- Standard Model prediction unambiguous: $d_\mu \approx 10^{-35}$ e-cm.
- An observation implies new physics T violation.
- K. Babu, B. Dutta, and R. Mohapatra
“Enhanced EDM of the Muon in the Presence of Large Neutrino Mixing”; Phy. Rev. Lett. **85**, 5064(2000):
 $a_\mu \approx 10^{-9}$ $d_\mu \approx 5 \times 10^{-23}$ e-cm $d_e \approx 10^{-28}$ e-cm
- JPARC LOI January, 2003. Yannis Semertzidis (BNL) and Jim Miller (B.U.) spokesmen. Y. Kuno (Osaka) resident spokesman.

Muon Momentum	0.5 GeV/c
dp/p acceptance of FFAG ring	$\pm 30\%$
acceptance of muon edm ring	0.8π m-mrad
yield of unpolarized μ/p (50GeV)	0.040%
yield of polarized μ/p (50GeV)	0.016%
Muon polarization (Longitudinal)	60%
Expected NP ² per 10^7 s.	5×10^{16}

Stat. sensitivity 10^{-24} e-cm requires $NP^2 \approx 10^{16}$.

Systematic errors $< 10^{-24}$ e-cm and quickly mapped with deuterons.

J-PARC Letter of Intent: Search for a Permanent Muon
Electric Dipole Moment at the $10^{-24} \text{ e} \cdot \text{cm}$ Level.

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January 9, 2003

* Spokesperson, # Resident Spokesperson

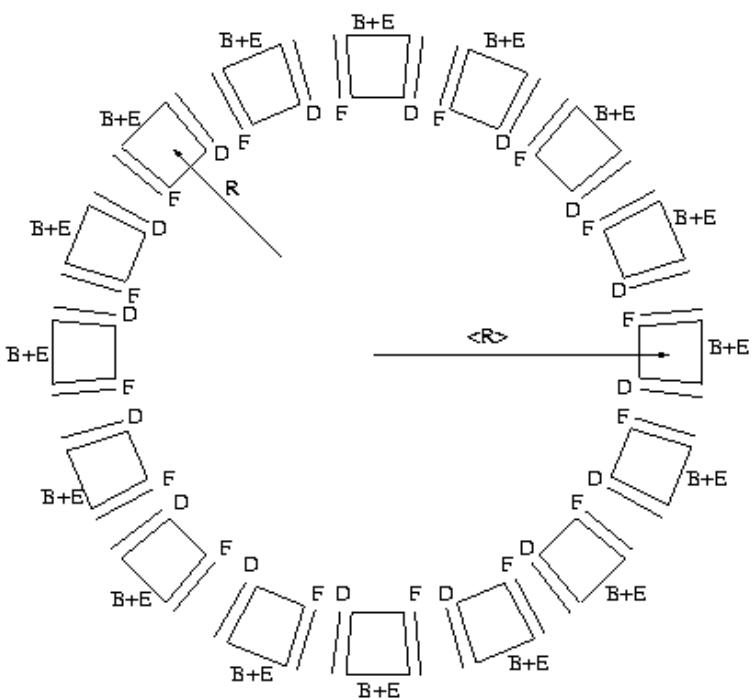


Figure 9: A schematic of the lattice (not to scale) of the EDM ring for the 0.5 GeV/c momentum case. $R \approx 6.5$ m, while the average radius around the ring, including regions with no dipole magnetic field, is $\langle R \rangle \approx 11$ m.

Muon Electron Conversion E940

<http://meco.ps.uci.edu>

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BNL MECO Physicists

K. Brown - proton beamline.

M. Brennan - beam extinction between AGS bunches.

W. Marciano - “If the muon collider guys can get 10^{20} muons per year, why can’t anyone do a better muon-electron conversion experiment?” circa 1996.

W. Meng - magnetic field calculations.

W. Morse - muon beamline.

Y. Semertzidis and P. Yamin - neutron backgrounds.

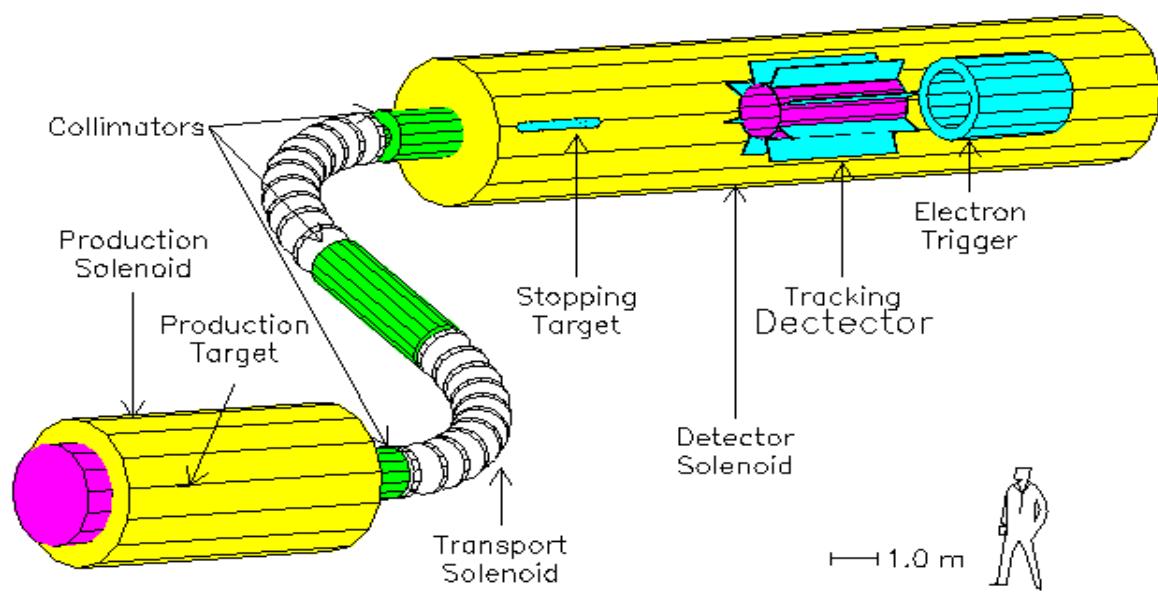
- Observation would mean physics beyond the standard model.
- 1000-fold increase in rate of the μ^- stops.
- Muon beamline that minimizes contamination while maximizing yield.
- Improved detector acceptance, high rate capability, and good resolution.

RSVP Presidents Budget (NSF in 10^6 \$)

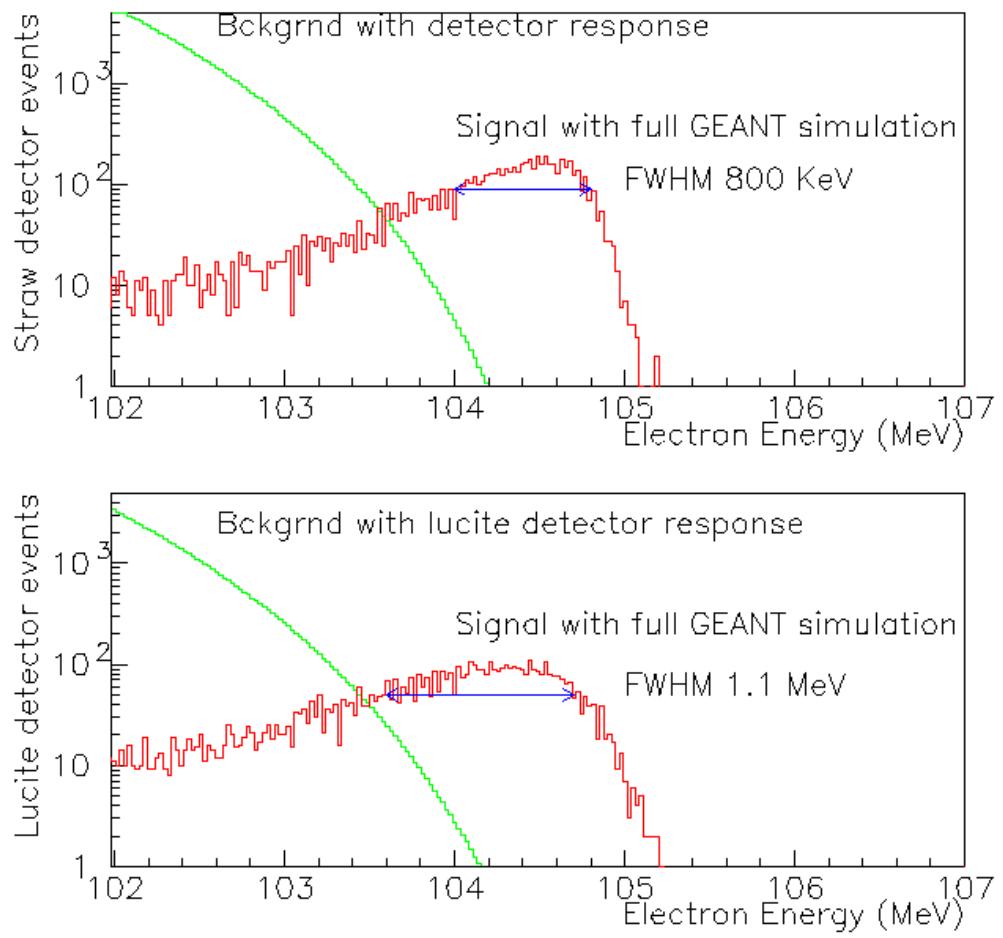
FY	R&D	Implementation	Operations
2003	1.2		
2004	1.5		
2005	2.0		
2006	2.0	30	5
2007		43	8
2008		44	9
2009		20	14
2010		8	14
2011			15
Total	8.8	145	65

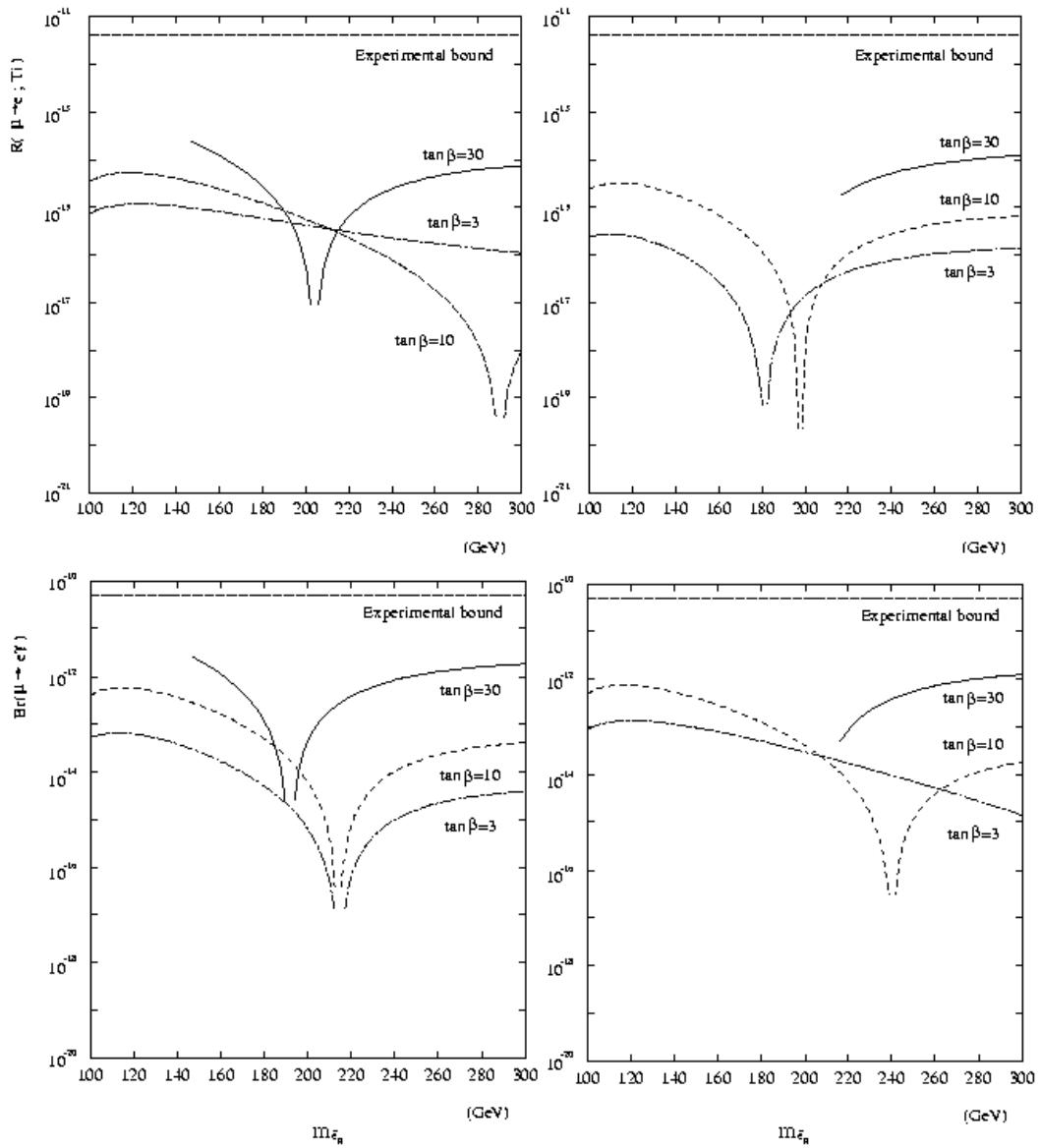
We need strong support from DOE for research part!

MECO E940



MECO - E940





Muon physics is still exciting and is sensitive to physics beyond the standard model. We need your support for physics research at BNL.