E821 Muon (g-2) Results

William Morse

BNL

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Measurement of the Negative Muon Anomalous Magnetic Moment to 0.7 ppm

G.W. Bennett,[2] B. Bousquet,[9] H. N. Brown,[2] G. Bunce,[2] R. M. Carey,[1] P. Cushman,[9] G. T. Danby,[2] P. T. Debevec,[7] M. Deile,[11] H. Deng,[11] S. K. Dhawan,[11] V. P. Druzhinin,[3] L. Duong,[9] F. J. M. Farley,[11] G. V. Fedotovich,[3] F. E. Gray,[7] D. Grigoriev,[3] M. Grosse-Perdekamp,[11] A. Grossmann,[6] M. F. Hare,[1] D. W. Hertzog,[7] X. Huang,[1] V. W. Hughes,[11,*] M. Iwasaki,[10] K. Jungmann,[5] D. Kawall,[11] B. I. Khazin,[3] F. Krienen,[1] I. Kronkvist,[9] A. Lam,[1] R. Larsen,[2] Y. Y. Lee,[2] I. Logashenko,[1,3] R. McNabb,[9] W. Meng,[2] J. P. Miller,[1] W. M. Morse,[2] D. Nikas,[2] C. J. G. Onderwater,[7] Y. Orlov,[4] C. S. Özben,[2,7] J. M. Paley,[1] Q. Peng,[1] C. C. Polly,[7] J. Pretz,[11] R. Prigl,[2] G. zu Putlitz,[6] T. Qian,[9] S. I. Redin,[3,11] O. Rind,[1] B. L. Roberts,[1] N. Ryskulov,[3] Y. K. Semertzidis,[2] P. Shagin,[9] Yu. M. Shatunov,[3] E. P. Sichtermann,[11] E. Solodov,[3] M. Sossong,[7] L. R. Sulak,[1] A. Trofimov,[1] P. von Walter,[6] and A. Yamamoto[8]

(Muon ($g-2$) Collaboration)

[1]*Department of Physics, Boston University, Boston, Massachusetts 02215, USA*
[2]*Brookhaven National Laboratory, Upton, New York 11973, USA*
[3]*Budker Institute of Nuclear Physics, Novosibirsk, Russia*
[4]*Newman Laboratory, Cornell University, Ithaca, New York 14853, USA*
[5]*Kernfysisch Versneller Instituut, Rijksuniversiteit Groningen, NL 9747 AA Groningen, The Netherlands*
[6]*Physikalisches Institut der Universität Heidelberg, 69120 Heidelberg, Germany*
[7]*Department of Physics, University of Illinois at Urbana-Champaign, Illinois 61801, USA*
[8]*KEK, High Energy Accelerator Research Organization, Tsukuba, Ibaraki 305-0801, Japan*
[9]*Department of Physics, University of Minnesota, Minneapolis, Minnesota 55455, USA*
[10]*Tokyo Institute of Technology, Tokyo, Japan*
[11]*Department of Physics, Yale University, New Haven, Connecticut 06520, USA*
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The anomalous magnetic moment of the negative muon has been measured to a precision of 0.7 ppm (ppm) at the Brookhaven Alternating Gradient Synchrotron. This result is based on data collected in 2001, and is over an order of magnitude more precise than the previous measurement of the negative muon. The result $a_{\mu^-} = 11\,659\,214(8)(3) \times 10^{-10}$ (0.7 ppm), where the first uncertainty is statistical and the second is systematic, is consistent with previous measurements of the anomaly for the positive and the negative muon. The average for the muon anomaly is $a_\mu(\text{exp}) = 11\,659\,208(6) \times 10^{-10}$ (0.5 ppm).

2001 E821 Negative Muon Data

Statistical error: ±0.7ppm from 4×10^9 decays.

Systematic uncertainties (ppm) for the ω_p analysis.

Absolute calibration of standard probe	0.05
Calibration of trolley probe	0.09
Trolley measurement of B_0	0.05
Interpolation with fixed probes	0.07
Uncertainty with muon distribution	0.03
Others[a]	0.10
Total	**0.17**

[a] Higher multipoles, trolley temperature and voltage response, eddy currents from the kicker, and time-varying stray fields.

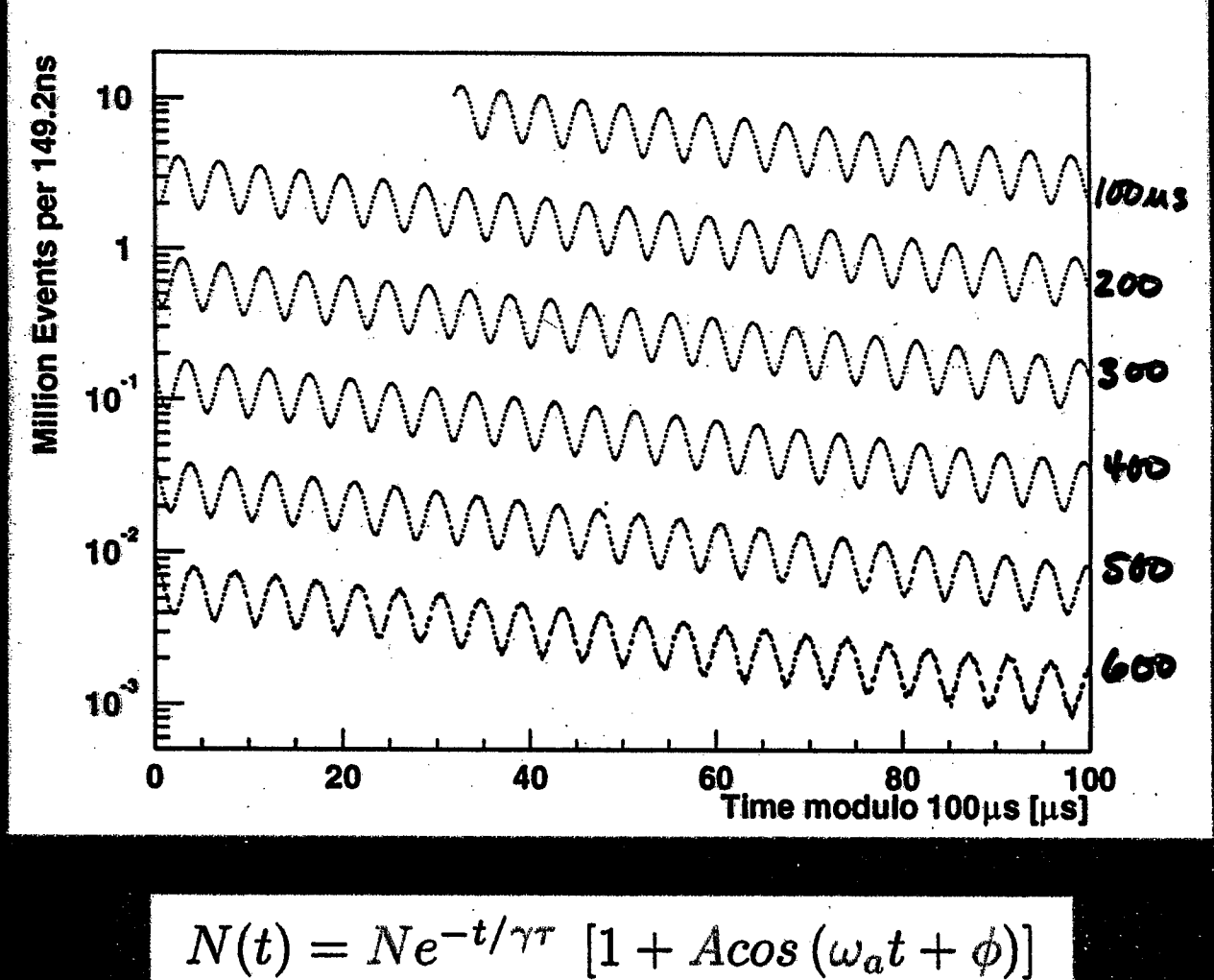
Systematic uncertainties (ppm) for the ω_a analysis.

Coherent betatron oscillations	0.07
Pileup	0.08
Gain changes	0.12
Lost muons	0.09
Others[b]	0.11
Total	**0.21**

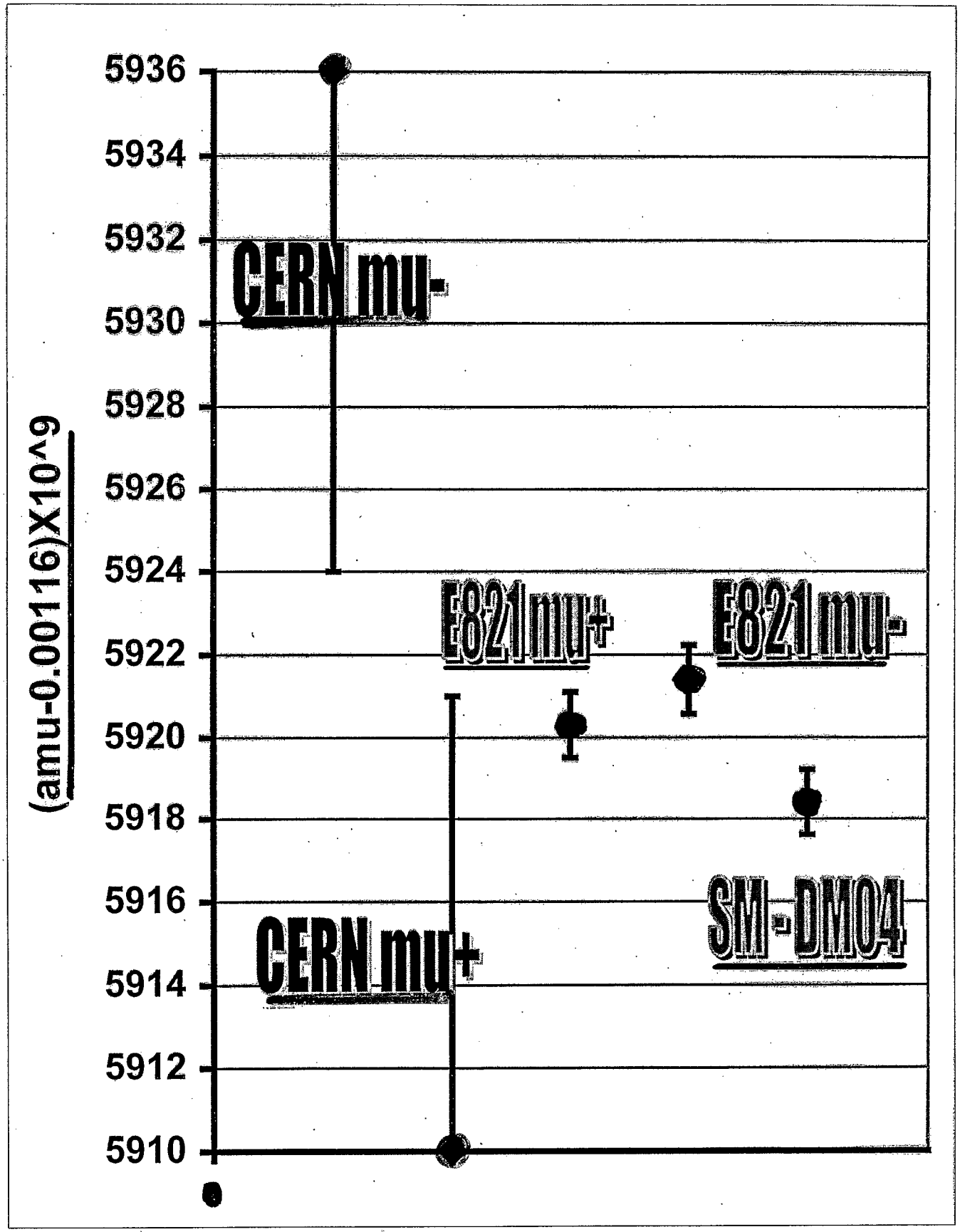
[b] AGS background, timing shifts, E field and Vertical oscillations, beam debunching/randomization, binning, and fitting procedure.

The 2001 ω_a data

4×10^9 events with $t > 32\mu$s, $E > 1.8$ GeV



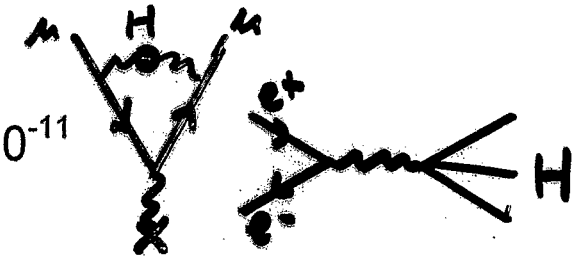
$$N(t) = Ne^{-t/\gamma\tau}\ [1 + A\cos(\omega_a t + \phi)]$$


(amu-0.00116)X10^9
5936
5934
5932
5930
5928
5926
5924
5922
5920
5918
5916
5914
5912
5910
0
CERN mu-
E821 mu+
E821 mu-
SM-DM04
CERN mu+

a_μ Standard Model Calculation[1]

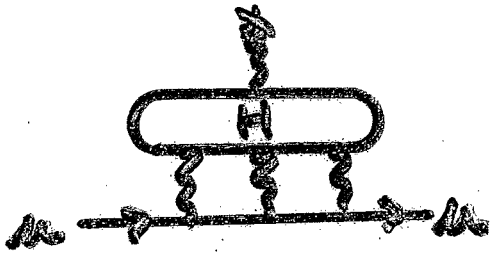
a_μ (QED) = 116584721(1) $\times 10^{-11}$

a_μ (Had_a) = 6944 $(62)_{exp}$ $(36)_{rad} \times 10^{-11}$



a_μ (Had_b) = -98 (1) $\times 10^{-11}$

a_μ (Had_{ll}) = 120 (35) $\times 10^{-11}$



a_μ (EW) = 154 (2) $\times 10^{-11}$

a_μ (SM) = 11659184.1 $(7.2)_{VP}(3.5)_{LBL}(0.3)_{EW,\ QED}$ 10^{-10}

$a(\mu^{\pm})$ (exp) = 11659208 (6) $\times 10^{-10}$

$\Delta a_\mu = 24\ (10) \times 10^{-10}$

1. M. Davier and W. Marciano, Annual Rev. Nucl. and Part. Physics (2004).

S. Ghozzi and F. Jegerlehner
Phys. Lett. B583, 222 (2004).

Improvements in Standard Model Calculation?

Bill Marciano's Guesstimate...

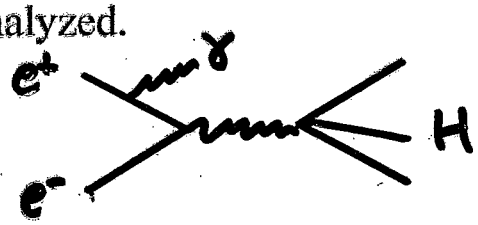
Short term (2 years)

1. Had_a: $\pm (72 \times 10^{-11}) \rightarrow \pm (35 \times 10^{-11})$?

- More CMD2 e^+e^- data are now being analyzed.

$m_H < 1.4 GeV$

- KLOE (A. Denig et al., hep-ex/0311012) and B Factory (M. Davier et al., hep-ex/0312063) radiative return e^+e^- data are now being analyzed.



$m_H < 1.0 GeV$ KLOE

$10 GeV$ $B\bar{B}$

- Had_v on the Lattice (T. Blum, hep-lat/0310064)

2. Had_{II}: $\pm (35 \times 10^{-11}) \rightarrow \pm (15 - 20 \times 10^{-11})$?

- New approach: K. Melnikov and A. Vainshtein, hep-ph/0312226

3. Total theory: $\pm (40 \times 10^{-11})$ in two years?

Improvements in Experimental Measurement?

- New proposal for Fall BNL Physics Advisory Committee:

$\pm 6 \times 10^{-10} \rightarrow \pm 3 \times 10^{-10}$ in 2-3 years?

More muons:

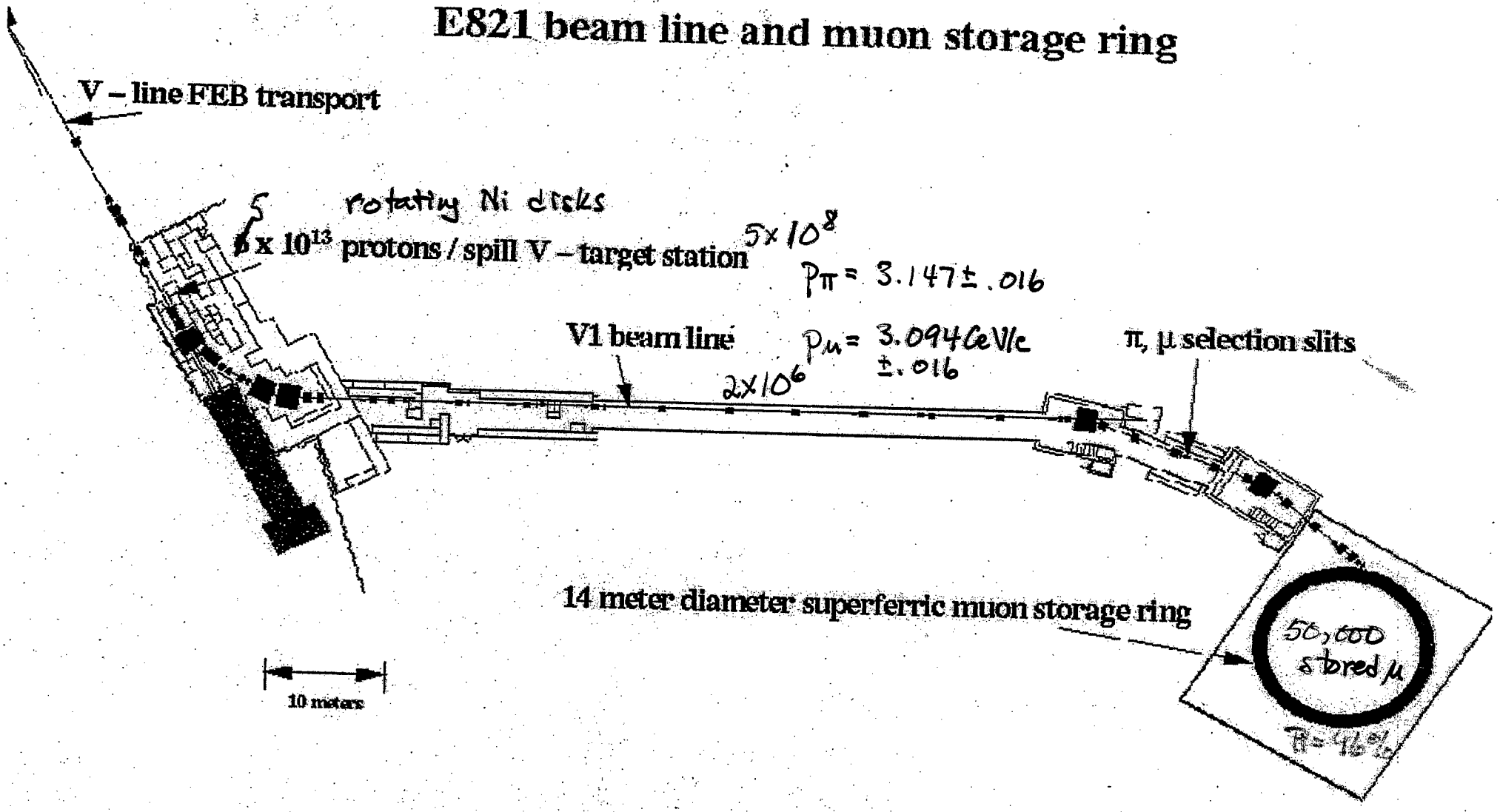
$\times$ 4 with beamline upgrade

$\times$ 2 with inflector upgrade

Upgrade detector/DAQ to handle the rates

5 month run gives a factor of two in da_μ .

E821 beam line and muon storage ring



Conclusions

- da_μ is still dominated by statistical error

- SM da_μ is expected to decrease

- A modest investment in an upgraded experiment would have great physics reach.