

# **RSVP Project and Program Overview**

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New York University**

**DOE Review of RSVP Activities at BNL**

**January 27-28, 2004**

# RSVP Participants



## MECO and KOPIO

### Scientific Collaborations –

Arizona State University  
Boston University  
Brookhaven National Laboratory  
University of California, Irvine  
University of Cincinnati  
University of Houston  
University of Massachusetts, Amherst  
Stony Brook University  
University of New Mexico  
New York University  
University of Pennsylvania  
Syracuse University  
Thomas Jefferson National Accel Facility  
University of Virginia  
Virginia Polytechnic Institute and State University  
College of William and Mary  
Yale University

### International Collaborators –

Canada  
Italy  
Japan  
Russia  
Switzerland

### Sponsoring agency –

National Science Foundation,  
Division of Mathematical and Physical  
Sciences, MREFC Program.

### Host Laboratory –

Brookhaven National Laboratory,  
Operated by Brookhaven Science  
Associates for the Department of Energy,  
Office of Science, Division of Nuclear  
Physics

# KOPIO- Measurement of $K_L \rightarrow \pi^0 \nu \bar{\nu}$



Uniquely determines  $\mathbf{J}_{CP}$ ,  
 the fundamental parameter of SM  
 CP-violation, with  $\sim 2\%$  precision  
 ( $\mathbf{J}_{CP} = 2 \times \text{area}$  of all unitary triangles)

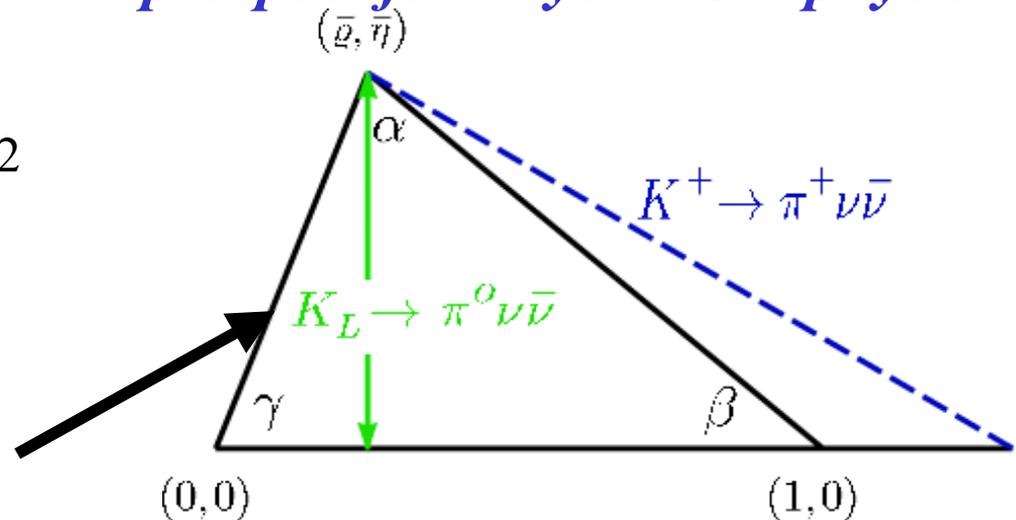


*Comparison with indirect measurement of  $\mathbf{J}_{CP}$  in the B-system offers a critical test of the SM and a vital prospect for Beyond-SM physics.*

$$\text{Br}(K_L \rightarrow \pi^0 \nu \bar{\nu}) \propto (V_{cb})^4 \eta^2$$

**KOPIO:  $\eta \pm 10\%$**

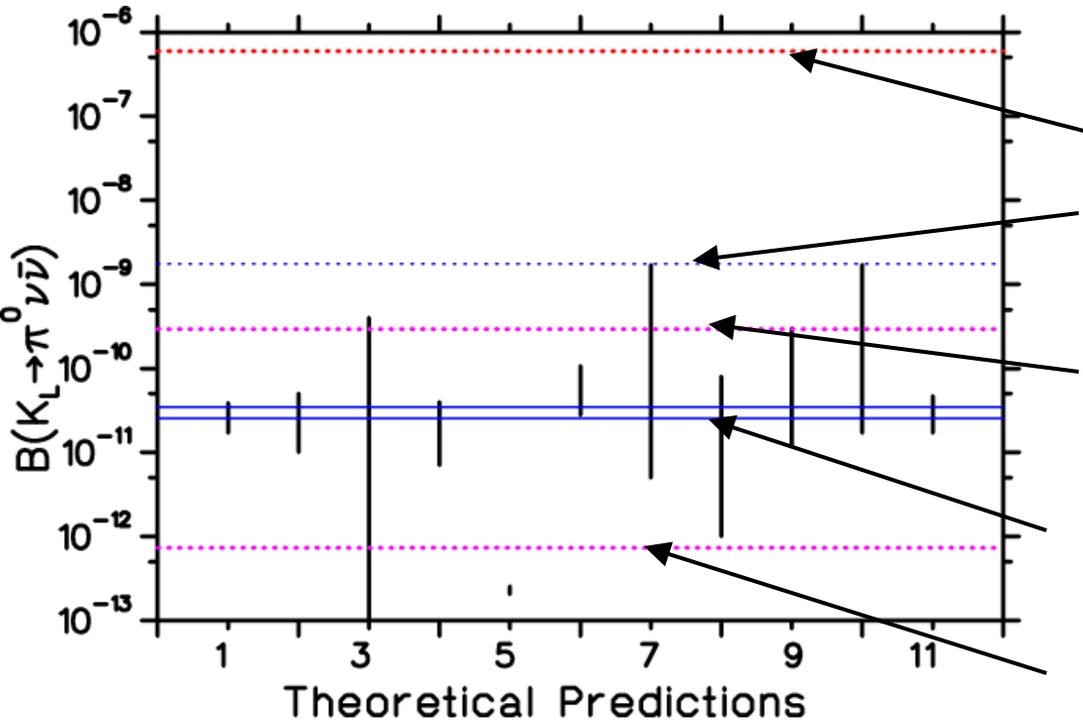
**Complete K-based  
 Unitary Triangle**



# KOPIO - A Window of Opportunity



$K_L \rightarrow \pi^0 \nu \bar{\nu}$  sensitivity  $< 10^{-12}$  :  $10^5$  improvement



Current experimental upper limit for BR is  $5.9 \times 10^{-7}$  (KTEV)

Theoretical upper bound using  $K^+ \Rightarrow \pi^+ \nu \bar{\nu}$  is  $1.7 \times 10^{-9}$  (Grossman-Nir)

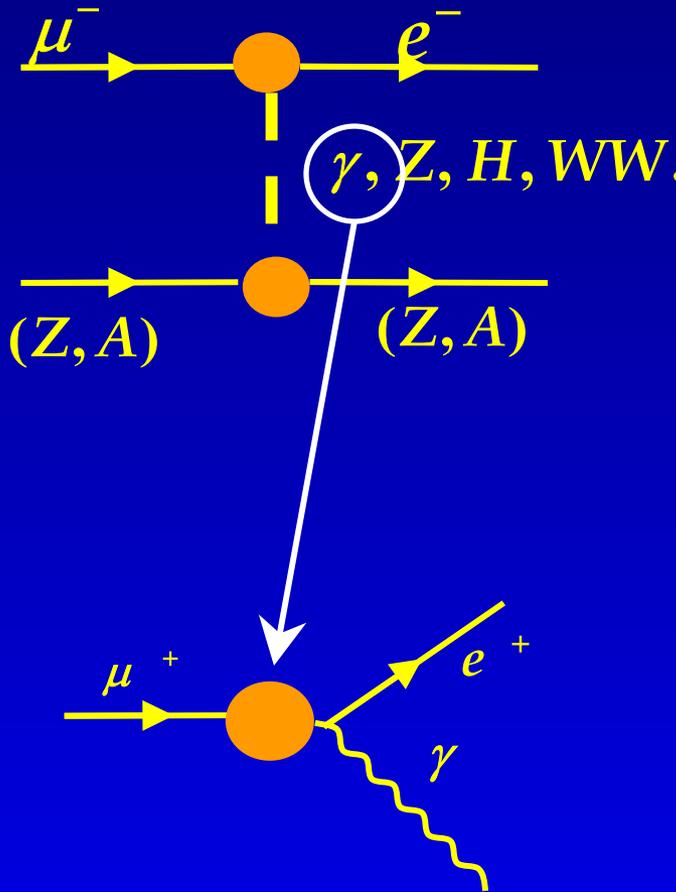
KEK39a proposes to reach single event sensitivity of  $3 \times 10^{-10}$

Standard Model predicts branching ratio (BR) of  $3 \times 10^{-11}$

KOPIO proposes to measure the BR with **40 events** at the Standard Model level; and with a single event sensitivity of below  $10^{-12}$

Almost a dozen theoretical models incorporating new physics predict BR's in this window

# Lepton flavor violating processes initiated by muons



$\gamma, Z, H, WW \dots$

## □ Muon to Electron Conversion (MECO)

- Unobservable in the Standard Model, even in minimal extensions that include light massive neutrinos.
- Distinctive signature, monoenergetic electron with energy  $\approx m_\mu c^2$
- Current limit  $6 \times 10^{-13}$
- MECO goal:  $R < 2 \times 10^{-17}$

## □ Muon decay at rest: $\mu \rightarrow e + \gamma$

- Back to back electron and gamma each with energy  $m_\mu c^2 / 2$
- Current limit B. R.  $1.2 \times 10^{-11}$  (MEGA)
- Goal:  $10^{-14}$  (MEG at PSI)

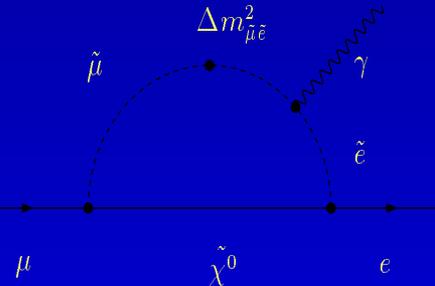
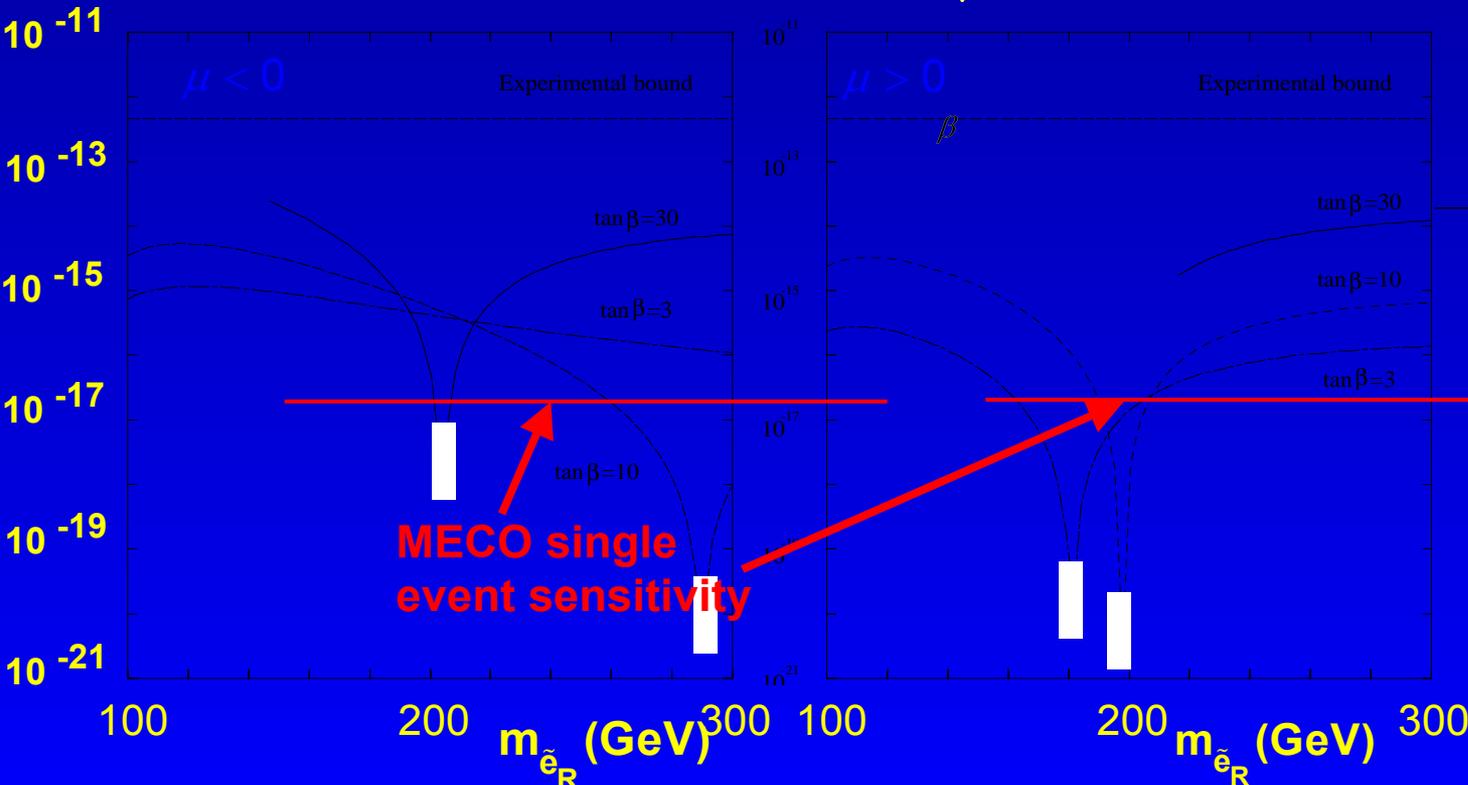
# Supersymmetry Predictions for $\mu \rightarrow e$



- From Hall and Barbieri
  - Large  $t$  quark Yukawa couplings imply observable levels of LFV in supersymmetric grand unified models
- Extent of lepton flavor violation in Supersymmetry related to quark mixing
- Other diagrams calculated by Hisano, et al.

Process	Current Limit	SUSY level
$\mu^- N \rightarrow e^- N$	$10^{-12}$	$10^{-15}$
$\mu^+ \rightarrow e^+ \gamma$	$10^{-11}$	$10^{-13}$
$\tau \rightarrow \mu \gamma$	$10^{-6}$	$10^{-9}$

$R_{\mu e}$



- LFV induced by slepton mixing
- Tan (beta) > 10 (LEP)

# RSVP History—External Reviews



- ❑ **Oct 1999** RSVP Proposal for MREFC submitted to NSF.
- ❑ **Nov 1999** NSF Panel review— scientific merit and technical feasibility. “Must do... They address the most fundamental questions in particle physics today....”
- ❑ **May 2000** **NSF MREFC Panel Recommends placing RSVP in highest category for funding in FY 2002 MRE account.**
- ❑ **July 2000** NSF Cost Review Panel. Verify costs at 10% level.
- ❑ **Nov 2000** NSF Panel Review. Focus on management and oversight for RSVP, magnet acquisition plan. Go ahead on conceptual design of magnet.
- ❑ **May 2001** BNL LOC Review. Technical Review.
- ❑ **June 2001** NSF RSVP Technical and Management Review. TDR’s, Draft Management Plans for MECO/KOPIO generated.
- ❑ **Sept 2001** **MIT Solenoid System Conceptual Design Interim Review.**
- ❑ **Feb 2002** **MIT Solenoid System Conceptual Design Final Review.**
- ❑ **Mar 2002** NSF RSVP R&D Budget Review.
- ❑ **Sept 2002** **MECO Magnet Acquisition Panel Review. Recommends developing a draft RFP by May 31, 2003 for magnet acquisition on a fixed price basis.**
- ❑ **Jan 2003** NSF RSVP Review. Focus on R&D Budget.

# Status--Funding



✓ Strong Support from the NSF Division of Mathematical and Physical Sciences:

“...RSVP is now the highest priority construction project from the Division of Mathematical and Physical Sciences.”

---- Letter from Director to RSVP PI 1/29/02

✓ R&D funding from NSF

	MECO	KOPIO
6/01—6/04	\$1.5M	\$1.2M
10/02—10/04	\$0.61M	\$0.61M
9/03—9/04	\$0.5M	\$0.5M

(In addition to NSF and DOE base support to RSVP university groups.)

✓ In the pipeline? FY2004 Consolidated Appropriations Conference Report includes language that would provide funding in the R&RA Account:

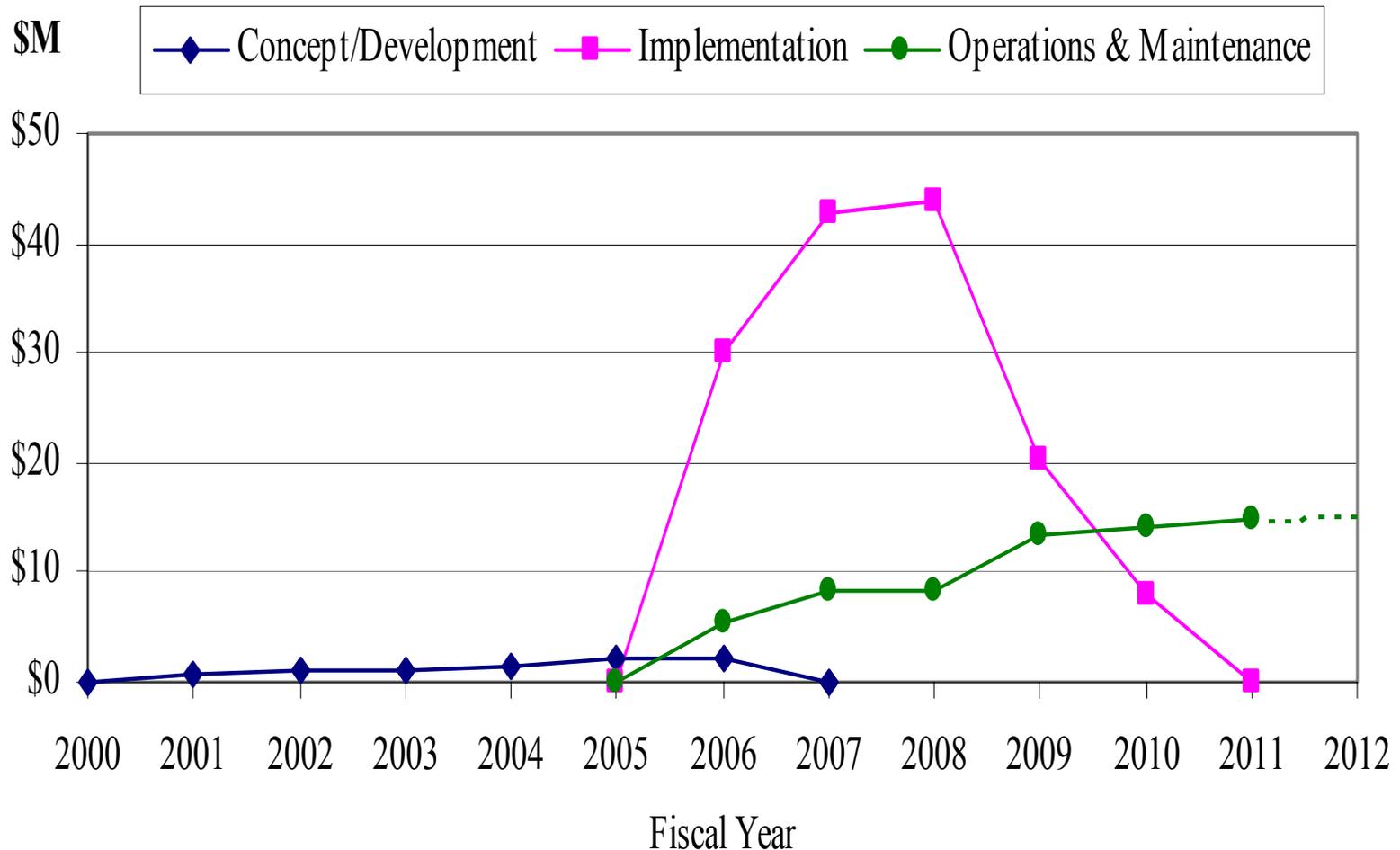
“The conferees recommend \$6,000,000 for continued advanced planning of the Rare Symmetry Violating Process project.”

✓ An RSVP project start in FY 2006 is in the President’s 2004 Budget Request to Congress.

# Status--Funding

NSF FY04 Congressional  
Budget Submission

## RSVP Funding, by Phase



# MECO Collaboration

RSVP

## Boston University

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# KOPIO Collaboration



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