Summary of the Lepton Flavor Violation Session

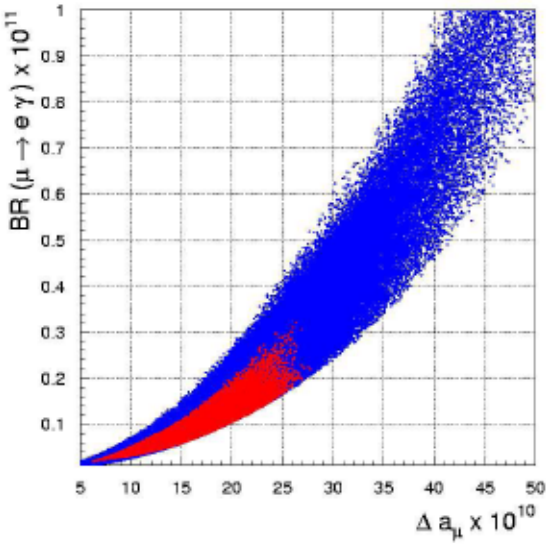
Giancarlo Piredda
INFN Sezione Roma - Sapienza

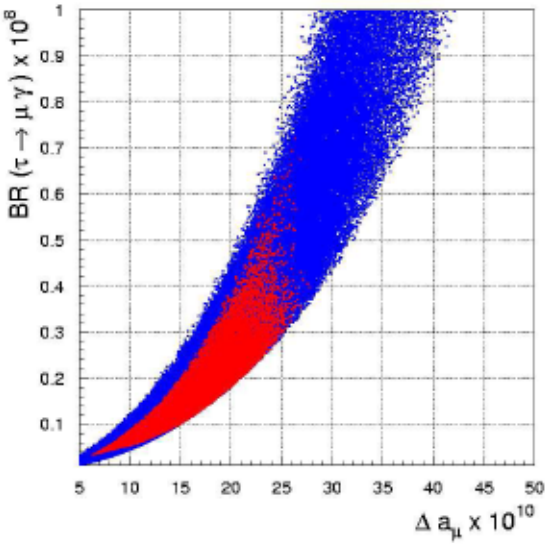
LFV(μ->eγ) vs muon g-2

Forbidden very well predicted

$(g-2)_\mu$ vs $\ell_i \to \ell_j \gamma$

P.Paradisi





$|\delta^{12}_{LL}| = 10^{-4}$ and $|\delta^{23}_{LL}| = 10^{-2}$,

[Isidori, Mescia, Paradisi & Temes, 07]

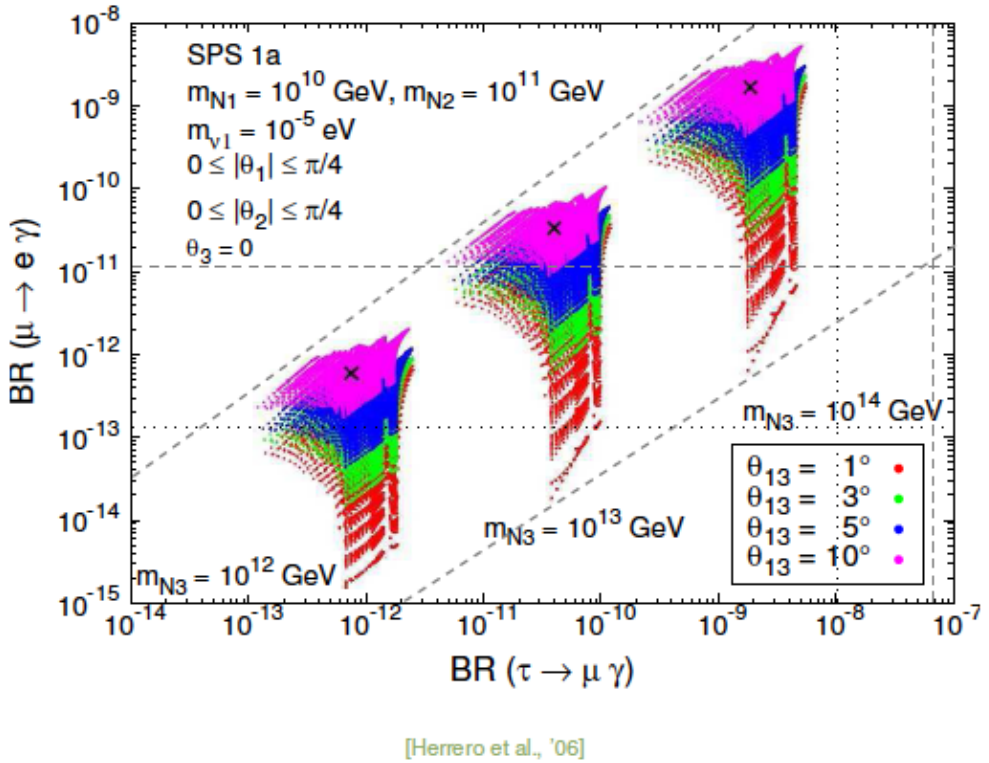
$$BR(\ell_i \to \ell_j\gamma) \approx \left[\frac{\Delta a_\mu}{20\times 10^{-10}}\right]^2 \times \left\{ \begin{array}{ll} 1\times 10^{-4} & |\delta^{12}_{LL}|^2 \quad [\mu \to e] \\ 2\times 10^{-5} & |\delta^{23}_{LL}|^2 \quad [\tau \to \mu] \end{array} \right\}$$

BNL E821 results $\Delta a_\mu \equiv a_\mu^{\exp} - a_\mu^{SM} = (297 \pm 79)\times 10^{-11}$

μ->eγ vs τ->μγ

P.Paradisi

$\mu \to e\gamma$ and $\tau \to \mu\gamma$ in SUSY see-saw



[Herrero et al., '06]

←Color code for θ_{13}

Correlation with ν-mixing θ_{13}

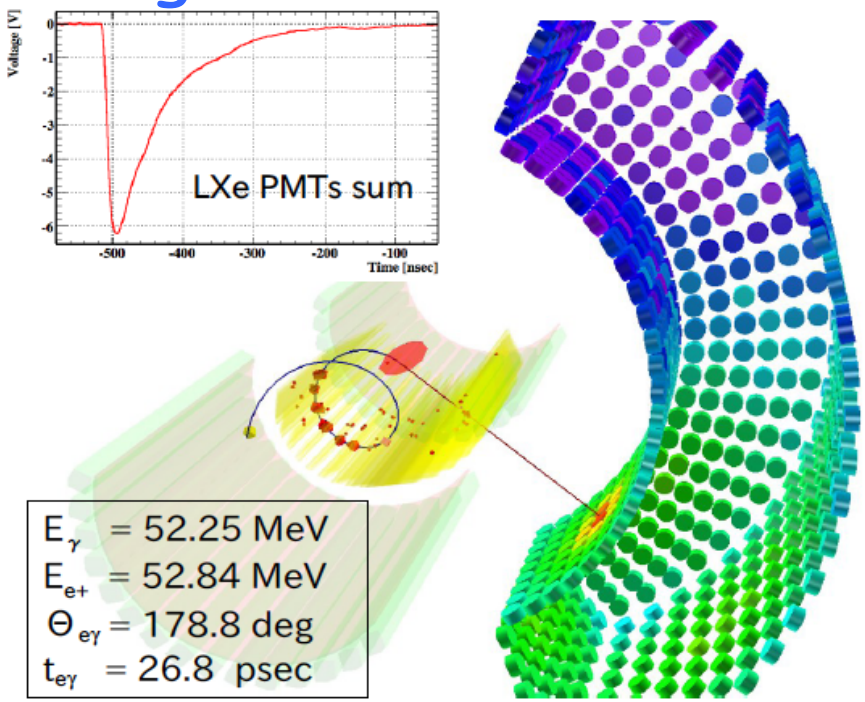
The MEG Experiment

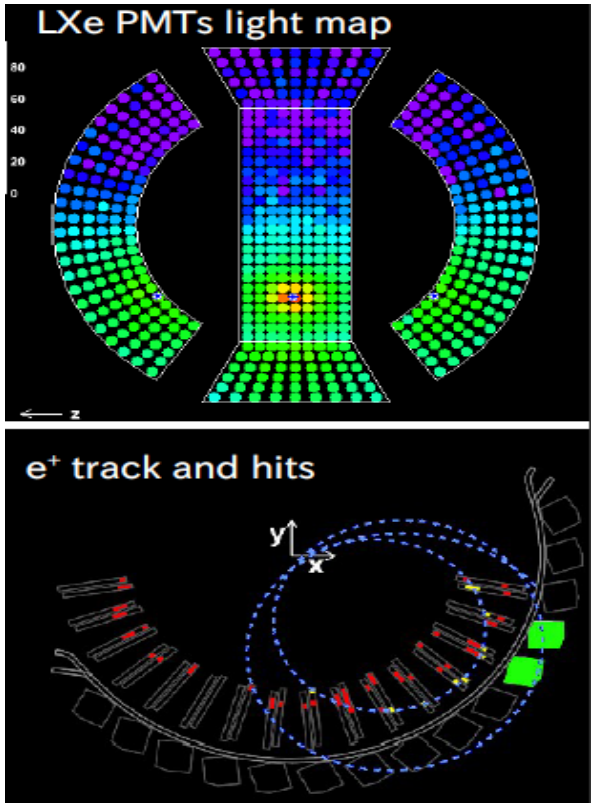
MEG
Mu-E-Gamma Collaboration

- World's most intense **DC muon beam** @ PSI
- High rate tolerable e^+ spectrometer with **gradient B-field**
- High performance γ-ray detector with **Liquid Xenon**

Y.Uchiyama

A signal-like event





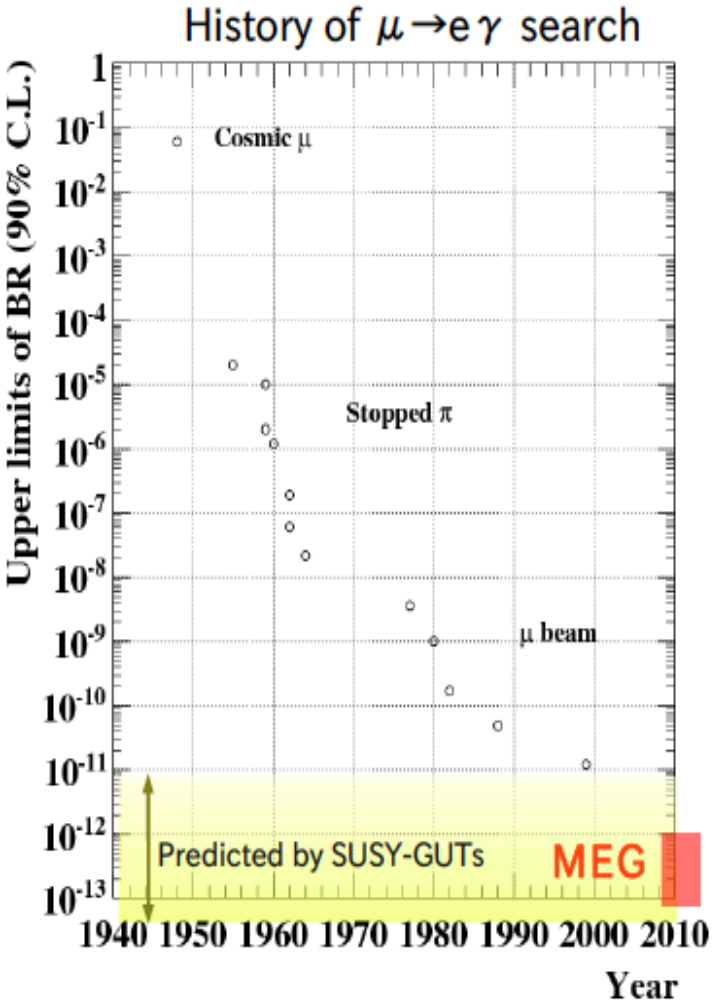
Y.Uchiyama

- **In 2009, MEG successfully carried out 2 months DAQ with stable detector operation**

- **Preliminary result from 2009 data**
  - **Sensitivity : 6.1 x 10^{-12}**
  - **90%CL-upper limit : 1.5 x 10^{-11}**
  - **N_{sig}=0 is in the 90%CL region**

- MEG is running
  - We resumed data taking since Augus
  - Will acquire x3 statistics in this year
  - Sensitivity will improve accordingly

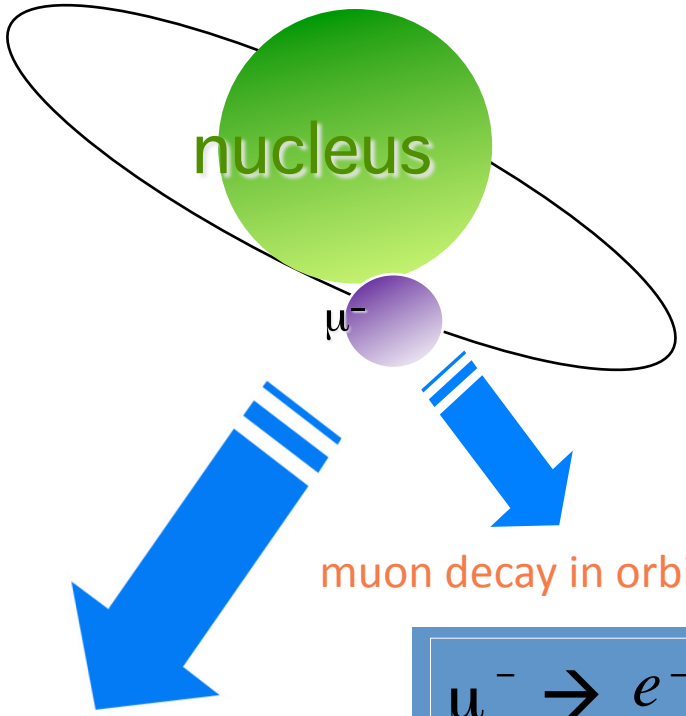
- We will run at least until 2012
  - Another two-year full run.
  - No clear schedule for further years
  - We will **clarify the situation (2009 result) by ourselves** with long term stable data taking



What is a μ-e Conversion ?

S.Mihara

1s state in a muonic atom



muon decay in orbit

$$\mu^- \rightarrow e^- \nu \bar{\nu}$$

nuclear muon capture

$$\mu^- + (A,Z) \rightarrow \nu_\mu + (A,Z-1)$$

Neutrino-less muon nuclear capture (=μ-e conversion)

$$\mu^- + (A,Z) \rightarrow e^- + (A,Z)$$

lepton flavors changes by one unit

$$B(\mu^- N \rightarrow e^- N) = \frac{\Gamma(\mu^- N \rightarrow e^- N)}{\Gamma(\mu^- N \rightarrow \nu N')}$$

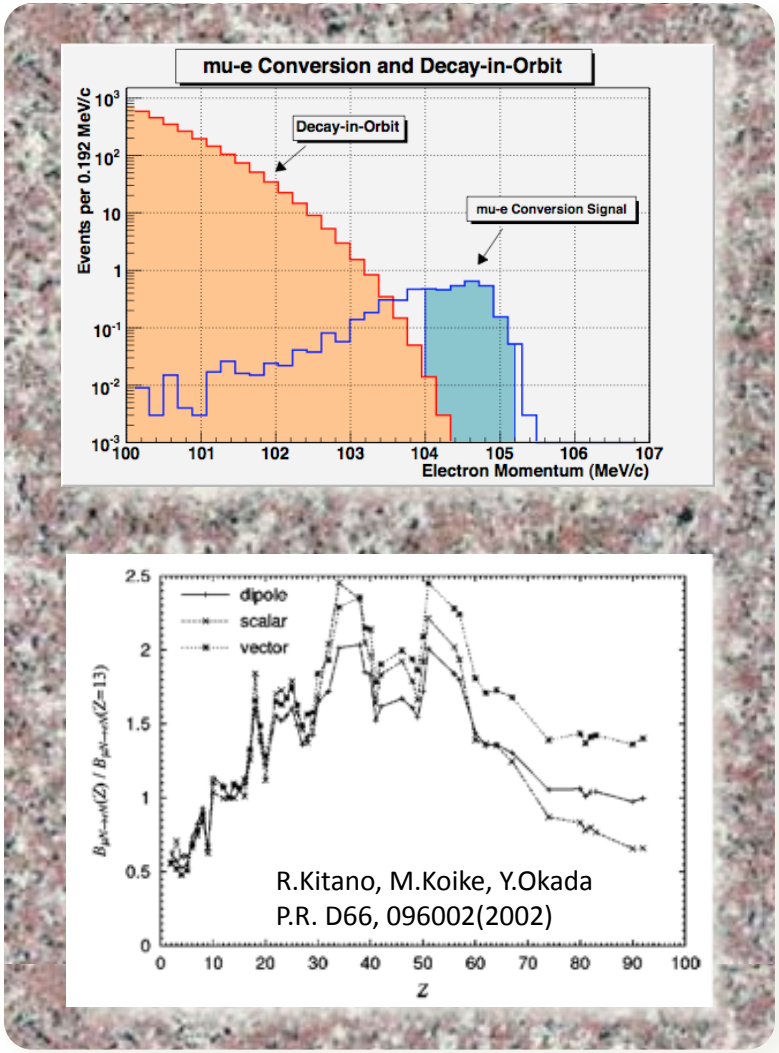
S.Mihara

μ-e conversion signal

- $E_{\mu e} \sim m_{\mu} - B_{\mu}$
  - B_{μ}: binding energy of the 1s muonic atom

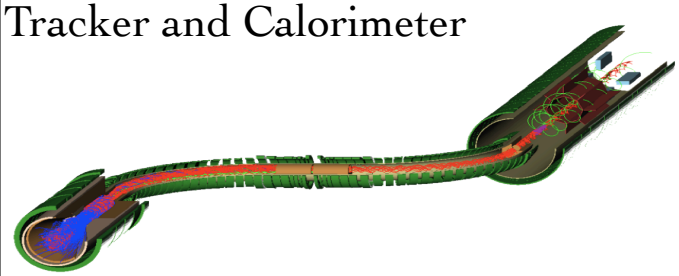
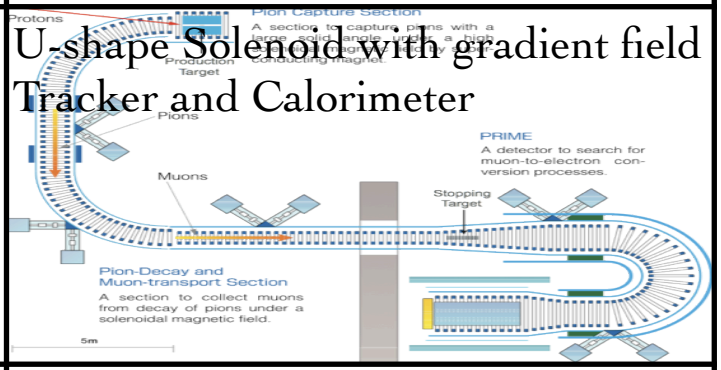
- Improvement of a muon beam is possible, both in purity (no pions) and in intensity (***thanks to muon collider R&D***). A higher beam intensity can be taken because of no accidentals.

- Potential to discriminate different models through studying the Z dependence



Mu2e (Fermilab) vs COMET(J-Parc)

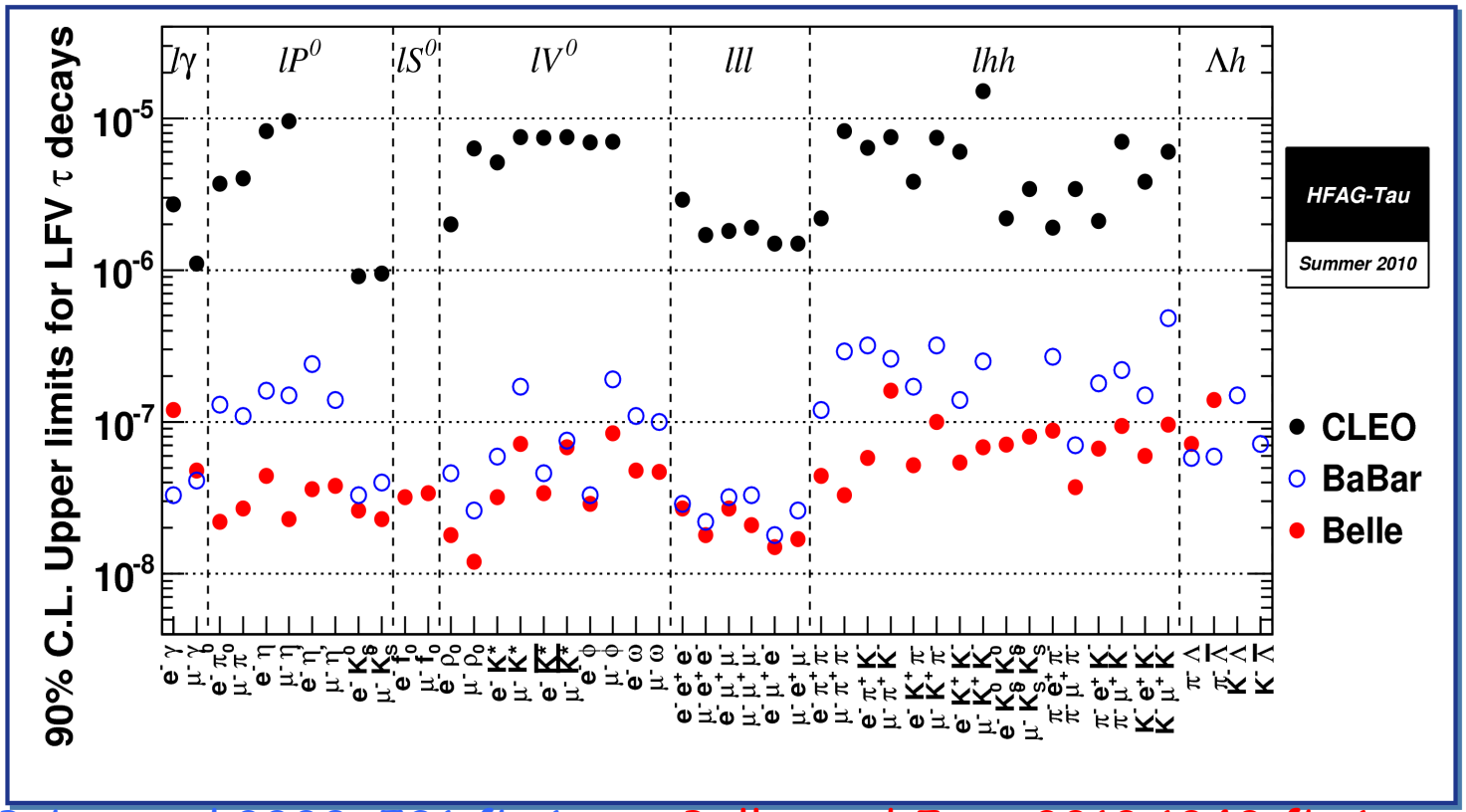
S.Mihara

	Mu2e	COMET
Proton Beam	8GeV, 20kW bunch-bunch spacing 1.69 μsec rebunching Extinction: 10^{-9}	8GeV, 50kW bunch-bunch spacing 1.18-1.76 μsec empty buckets Extinction: 10^{-9}
Muon Transport	S-shape Solenoid	U-shape solenoid
Detector	Straight Solenoid with gradient field Tracker and Calorimeter 	U-shape Solenoid with gradient field Tracker and Calorimeter 
Sensitivity	SES: 2.5×10^{-17} 90% CL UL: 6×10^{-17}	SES: 2.6×10^{-17} 90% CL UL: 6×10^{-17}

From the B-(and tau)factories

Tau LFV results status (by HFAG-Tau)

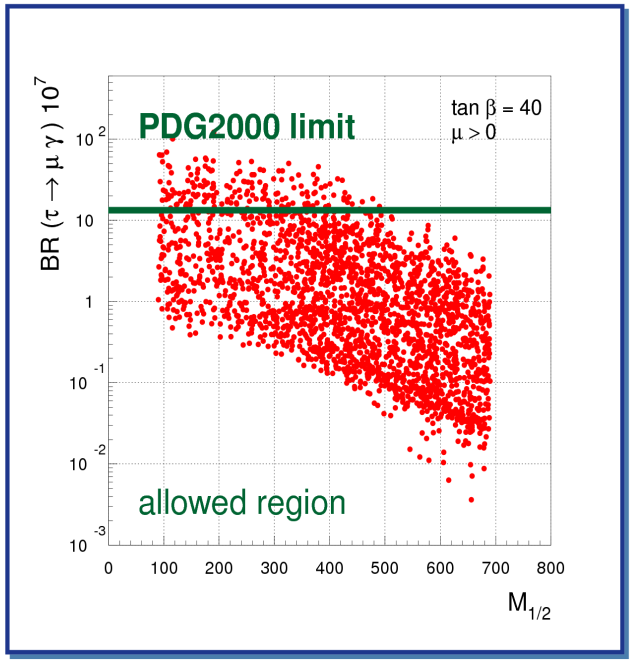
A.Lusiani

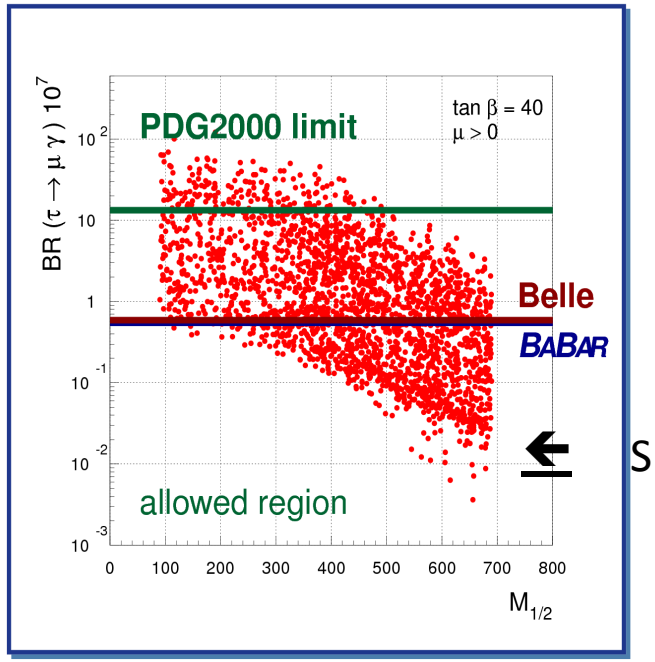


Babar end 2008, 531 fb-1 Belle, end June 2010 1040 fb-1

A.Lusiani

B-factories LFV searches do constrain the parameter space of NP models





SuperB

SUSY SO(10) + seesaw – Masiero et al., NJP 6 (2004) 202

A.Lusiani

Brief status of Lepton Flavor Violation searches

- tau LFV
  - past: CLEO explored up to BRs $\sim 10^{-6}$
  - **present: B-factories are completing exploration up to BRs $\sim 10^{-8}$**
  - future: Super Flavor Factories can explore up to BRs $\sim 10^{-10}$
  - **$\tau \to \mu\gamma$ is the most sensitive channel for most mainstream NP models**
- muon LFV
  - past: LAMPF, MEGA, BF($\mu \to e\gamma$) $< 1.2 \cdot 10^{-11}$ at 90% CL
  - past: SINDRUM II, BF($\mu \to e$ in nucleon field) $< 7 \cdot 10^{-13}$ at 90% CL
  - **present: MEG, BF($\mu \to e\gamma$) $< 1.5 \cdot 10^{-11}$ at 90% CL, (sensitivity $6 \cdot 10^{-12}$)**
  - future: MEG will soon reach sensitivity $\sim 10^{-13}$
  - future: Mu2E and COMET/PRISM can much increase reach on BF($\mu \to e$ in nucleon field)

Concluding Remarks

- Charged LFV can't be accomodated in the SM
- Is an unambiguous sign of New Physics
- The theoretical framework looks ready
- Just wait a little bit for the experimental results!
- and finally:
- Thank you to all the speakers
- And…last but not least to the Organizers!

2010 Super$B$ Physics Report, arXiv:1008.1541v1 [hep-ex]

- $\tau \to \ell\gamma$
  - **repeated** last published *BABAR* analysis at Super$B$ luminosity
  - estimated gains from improved tracking resolution & photon acceptance
- $\tau \to \ell\ell\ell$
  - **re-optmimized** last published *BABAR* result for Super$B$ luminosity
  - neglected expected gains from better tracking resolution
- $\sim 80\%$ electron beam polarization
  - increases experimental reach reach given the LFV interaction
  - facilitates determination of LFV interaction structure

Process	Expected 90% CL upper limit	3σ evidence reach
BF($\tau \to \mu\gamma$)	$2.4 \cdot 10^{-9}$	$5.4 \cdot 10^{-9}$
BF($\tau \to e\gamma$)	$3.0 \cdot 10^{-9}$	$6.8 \cdot 10^{-9}$
BF($\tau \to \ell\ell\ell$)	$2.3\text{–}8.2 \cdot 10^{-10}$	$1.2\text{–}4.0 \cdot 10^{-9}$