Slides of the talk "LFVs in Experiments"

decay	experimental upper bound
$\mu \to e\gamma$	$1.2 \cdot 10^{-11}$
$\mu^- \to e^- e^+ e^-$	$1.0 \cdot 10^{-12}$
$\mu\text{Ti} \to e\text{Ti}$	$4.3 \cdot 10^{-12}$
$\tau \to e\gamma$	$1.1 \cdot 10^{-7}$
$\tau \to \mu\gamma$	$4.5 \cdot 10^{-8}$
$\tau^- \to e^- e^+ e^-$	$2.0 \cdot 10^{-7}$
$\tau^- \to \mu^- \mu^+ \mu^-$	$1.9 \cdot 10^{-7}$
$\tau^- \to e^- \mu^+ \mu^-$	$2.0 \cdot 10^{-7}$
$\tau^- \to \mu^- e^+ e^-$	$1.9 \cdot 10^{-7}$
$\tau^- \to \mu^- e^+ \mu^-$	$1.3 \cdot 10^{-7}$
$\tau^- \to e^- \mu^+ e^-$	$1.1 \cdot 10^{-7}$
$\tau \to \mu\pi$	$4.1 \cdot 10^{-7}$
$\tau \to e\pi$	$1.9 \cdot 10^{-7}$
$\tau \to \mu\eta$	$1.5 \cdot 10^{-7}$
$\tau \to e\eta$	$2.4 \cdot 10^{-7}$
$\tau \to \mu\eta'$	$4.7 \cdot 10^{-7}$
$\tau \to e\eta'$	$1.0 \cdot 10^{-6}$
$\pi^0 \to \mu^- e^+$	$3.4 \cdot 10^{-9}$
$K_L \to \mu e$	$4.7 \cdot 10^{-12}$
$K_L \to \pi^0 \mu e$	$6.2 \cdot 10^{-9}$
$B_d \to \mu e$	$1.7 \cdot 10^{-7}$
$B_s \to \mu e$	$6.1 \cdot 10^{-6}$
$B_d \to \tau e$	$1.1 \cdot 10^{-4}$
$B_d \to \tau \mu$	$3.8 \cdot 10^{-5}$
$Z \to \mu\gamma$	$1.5 \cdot 10^{-5}$

Upper bounds on LFV decay branching ratios. Most part of the table can be found in hep-ph/0702136 together with the reference to the experiments.

Place	Year	$\Delta E_e/E_e$	$\Delta E_\gamma/E_\gamma$	$\Delta t_{e\gamma}$	$\Delta\theta_{e\gamma}$	Upper limit
SIN	1977	8.7 %	9.3 %	1.4 ns	–	$< 1.0 \times 10^{-9}$
TRIUMF	1977	10 %	8.7 %	6.7 ns	–	$< 3.6 \times 10^{-9}$
LANL	1979	8.8 %	8 %	1.9 ns	37 mrad	$< 1.7 \times 10^{-10}$
LANL	1986	8 %	8 %	1.8 ns	87 mrad	$< 4.9 \times 10^{-11}$
LANL	1999	1.2 %*	4.5 %*	1.6 ns	17 mrad	$< 1.2 \times 10^{-11}$
PSI	≈ 2007	0.8 %	4.0 %	0.15 ns	19 mrad	$< 1 \times 10^{-13}$

Figure 1: *Resolutions of the various experiments. Taken from P. Cei, Lepton flavor violation: Present and future experiments, Nucl.Phys.Proc.Suppl.154:62-79,2006.*

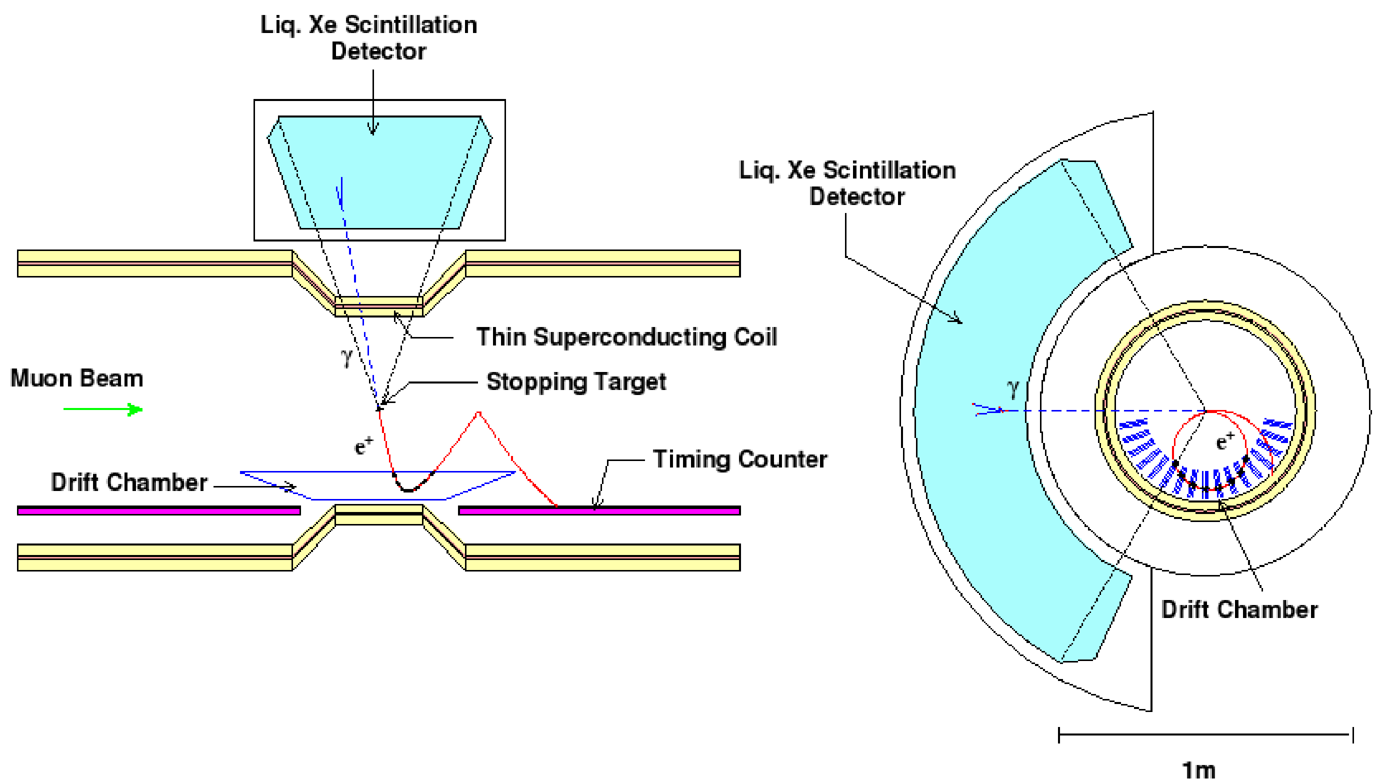

Figure 4. Layout of the MEG experiment.

Table 2
A summary of the level of background from various sources, calculated for a sensitivity of 5 events for $R_{\mu e} = 10^{-16}$.

Source	Events
μ decay in orbit	0.29
Radiative μ capture	<< 0.05
μ decay in flight	< 0.003
μ decay in flight	0.004
Radiative π capture	0.007
Radiative π capture	0.014
π decay in flight	<< 0.001
Beam electrons	< 0.002
Cosmic ray induced	0.004
Total background	0.37

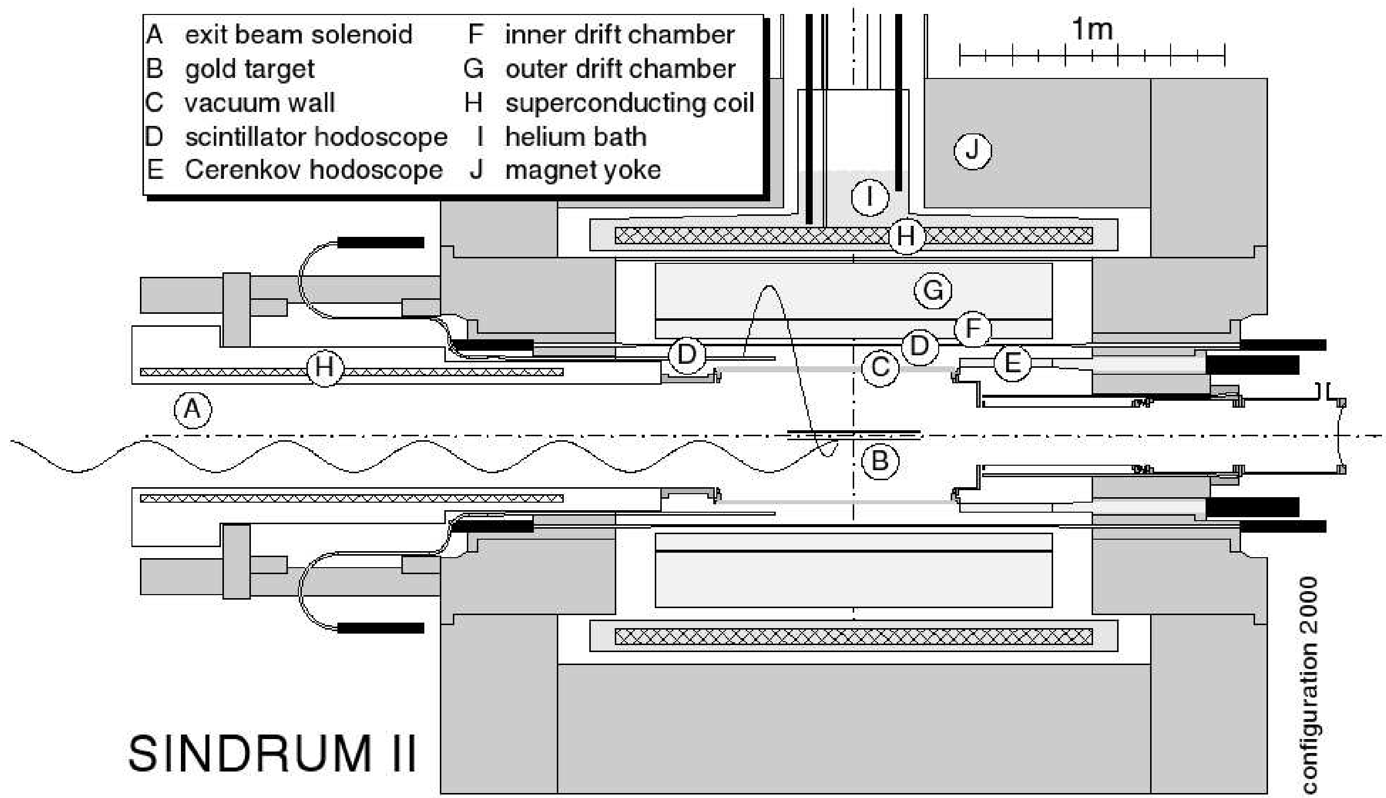

Figure 1. The SINDRUM II spectrometer.

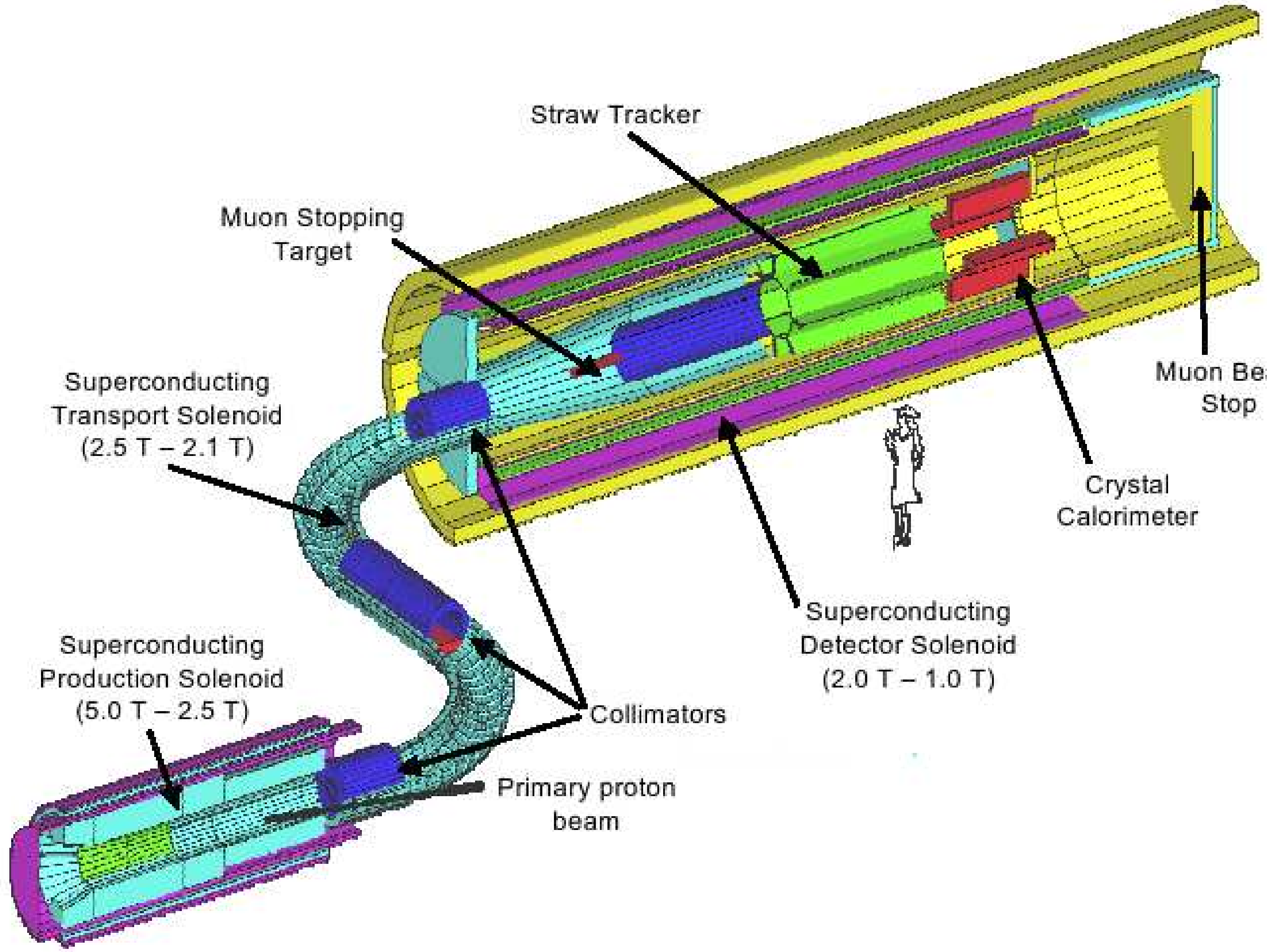

Figure 7. Layout of the MECO experiment.

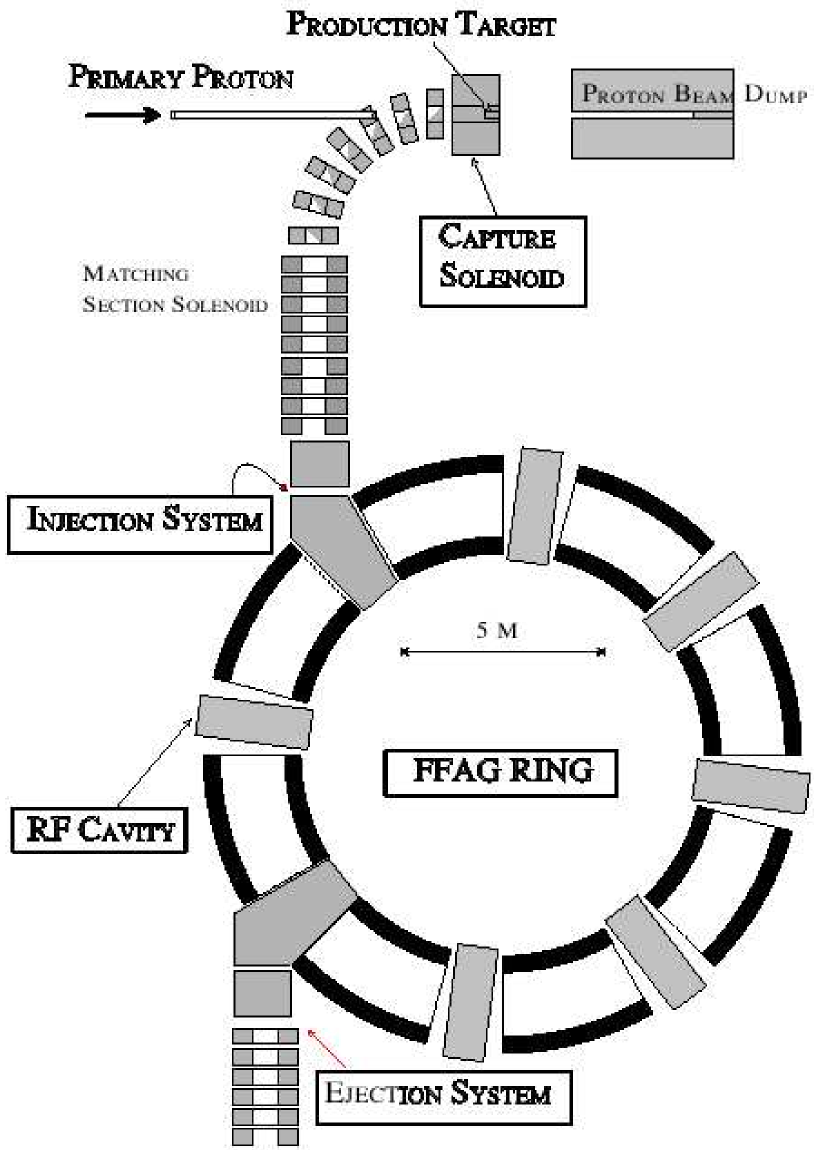

Figure 8. Layout of the PRISM experiment.

Fig.2

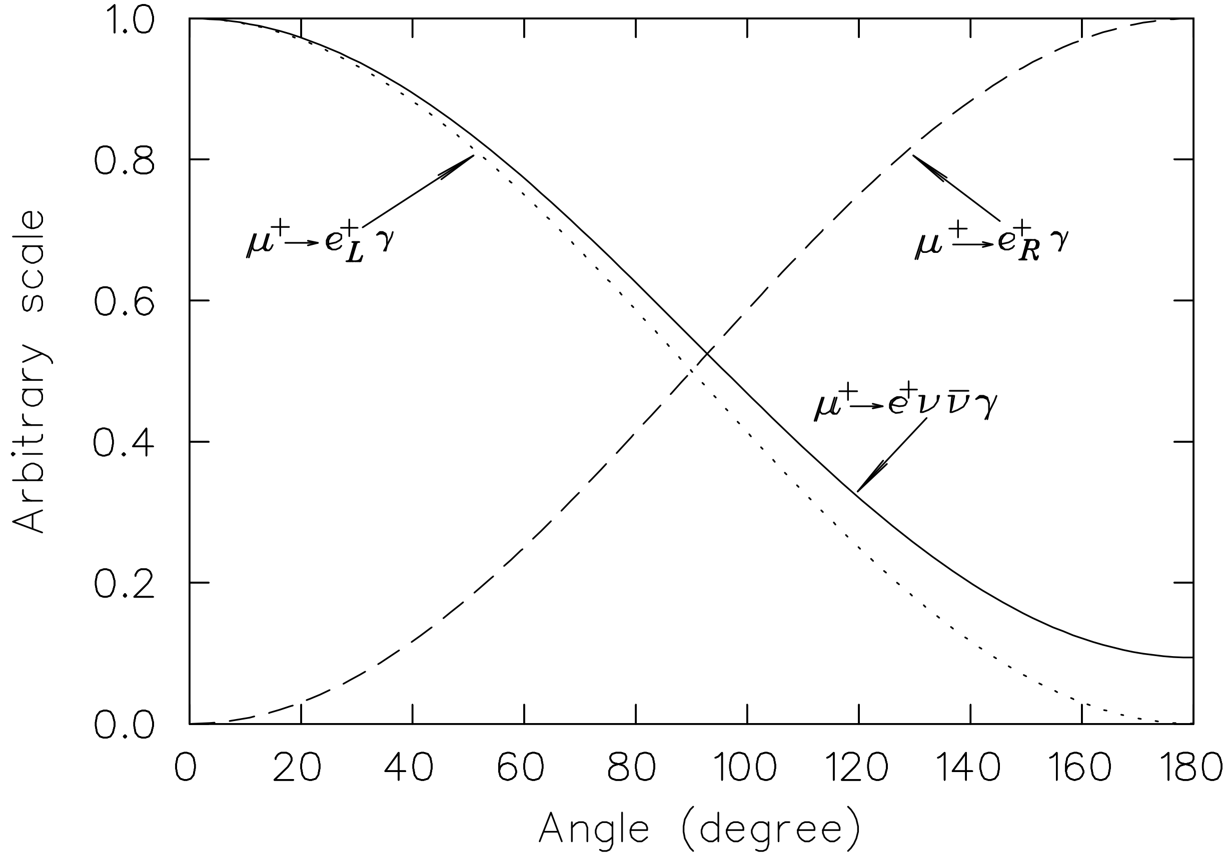

Figure 2: *Angular distribution of e^+ in radiative μ decay with finite detector resolution ($\Delta E_{e^+} \ll \Delta E_\gamma$) [solid line]. The angular distribution of $\mu^+ \to e_L^+ \gamma$ is shown as dotted line and of $\mu^+ \to e_R^+ \gamma$ in dashed line. The angle θ is between the μ^+ spin direction and the e^+ direction. Taken from hep-ph/9604296.*

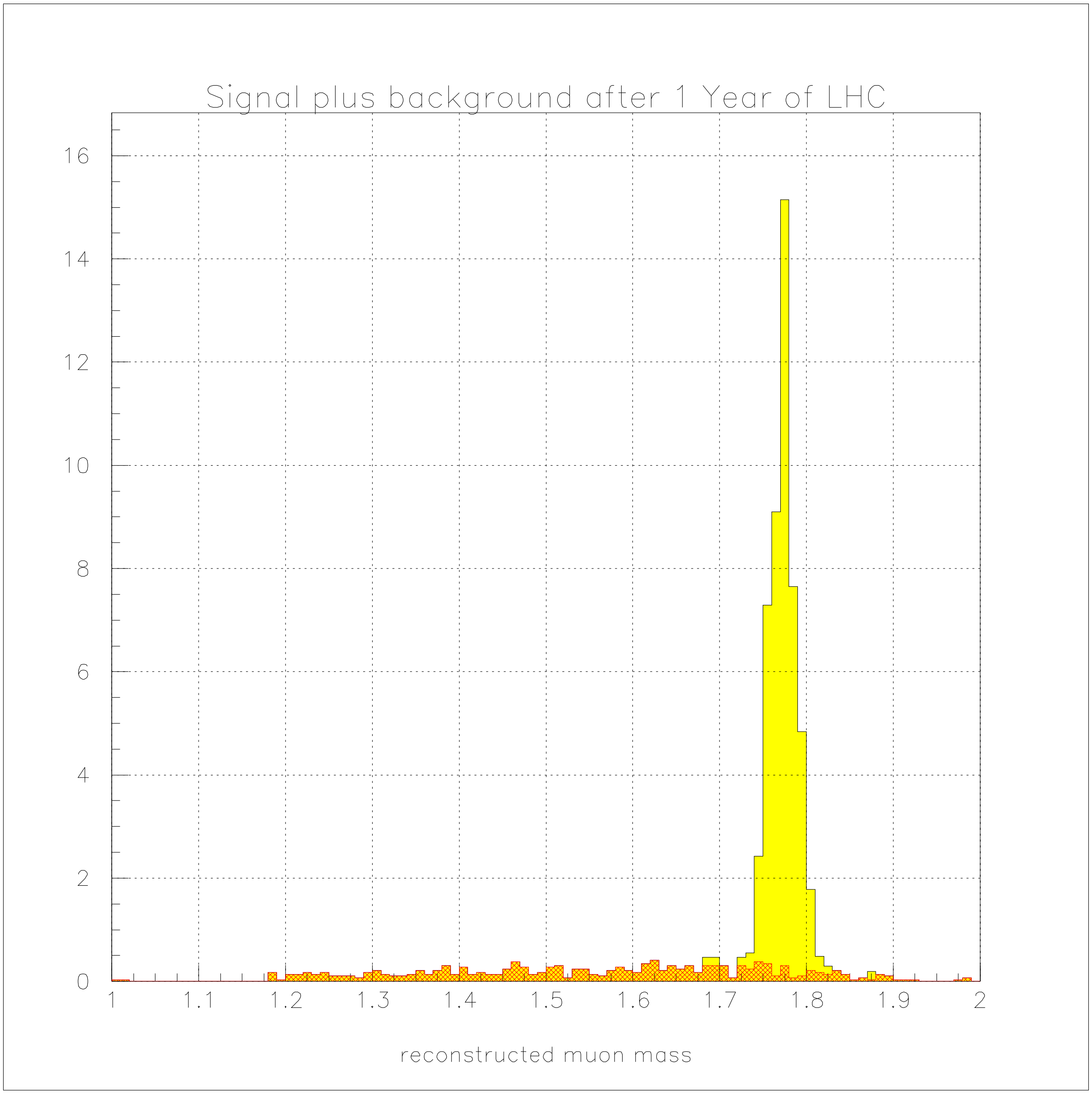

Figure 3: *Invariant mass reconstruction from $\tau \to \mu\mu\mu$ in CMS. τs originate from W decays, the SM background is the darker dashed area. Taken from hep-ex/0505030.*

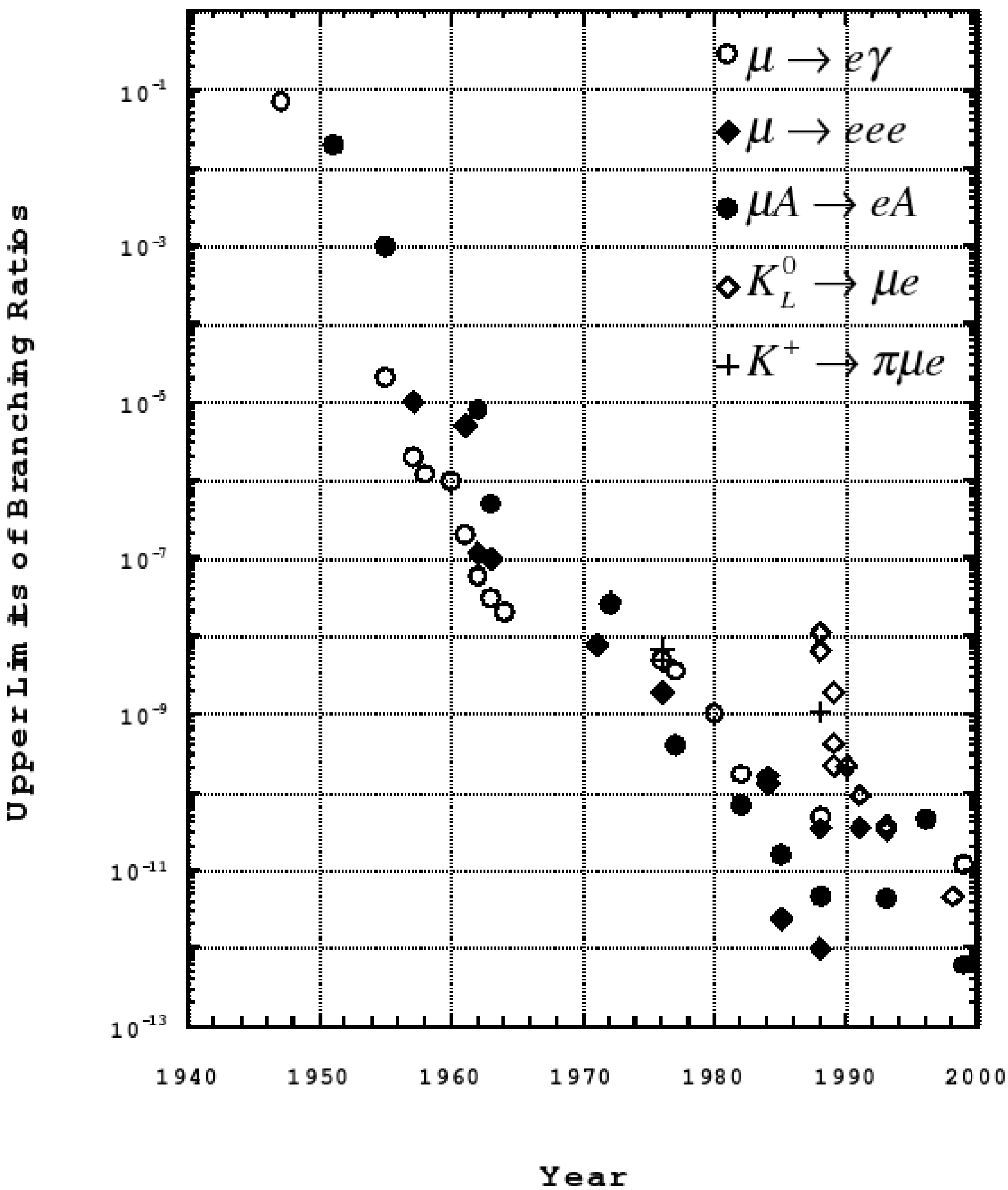

Figure 4: *Experimental limits for branching fractions of LFV processes involving muons as a function of time. Taken from P. Cei, Lepton flavor violation: Present and future experiments, Nucl.Phys.Proc.Suppl.154:62-79,2006.*

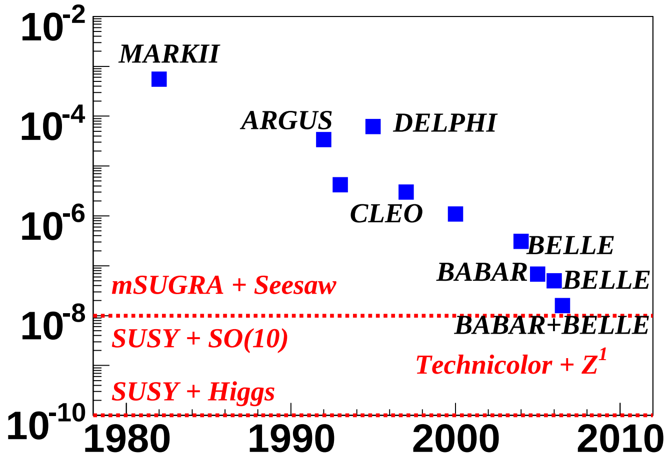

Figure 5: *Experimental limit for branching ratio of LFV process $\tau \to \mu\gamma$ as a function of time and some theoretical predictions. Taken from hep-ex/0702017.*

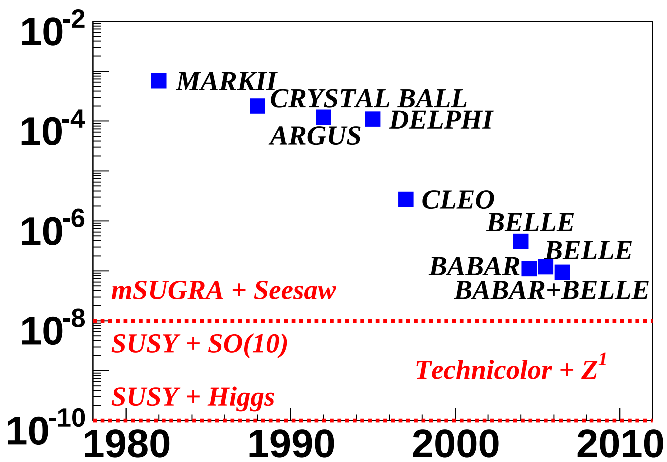

Figure 6: *Experimental limit for branching ratio of LFV process $\tau \to e\gamma$ as a function of time and some theoretical predictions. Taken from hep-ex/0702017.*

Literature on Experiments measuring LFVs

- T.S. Kosmas et al., *Lepton Flavor Non-Conservation*, Prog. Part. Nucl. Phys., **33**, 397 pp., (1994): quite old, but still good paper which explains the basics of LFV experiments.
- papers/ talks whose topic is a certain experiment:
  1. A.v.d. Schaaf, *SINDRUM II*, J. Phys. G: Nucl. Part. Phys. **29**, 1503 pp., (2003): as the title says: contains a short description of the SINDRUM II experiment and a figure of the experimental setup.
  2. M. L. Brooks et al., *New Limit for the Family-Number Non-Conserving Decay* $\mu^+ \to e^+\gamma$, hep-ex/9905013: contains results and a more detailed description of the MEGA experiment.
  3. W. Molzon, *The MECO Experiment to Search for* $\mu^- N \to e^- N$ *with* 10^{-17} *Sensitivity*, Nucl. Phys. B (Proc. Suppl.) **111**, 188 pp., (2002): description of the MECO experiment; although it has never been built, the description of its setup shows the main features needed to perform a $(\mu - e)$ conversion experiment.
  4. A. Baldini, *Status of the MEG experiment*, presented at *Neutrino Factories and Superbeams: 5th International Workshop*: some short description of the MEG experiment together with a figure of the experimental setup.
  5. Y. Kuno, *PRISM/PRIME*, Nucl. Phys. B (Proc. Suppl.) **149**, 376 pp., (2005): a short description of the PRISM/PRIME experiment and its new features compared to other existing/proposed $(\mu - e)$ conversion experiments.
- Y. Kuno, Y. Okada, $\mu \to e\gamma$ *Search with Polarized Muons*, hep-ph/9604296: treats the idea of a measurement with polarized μs together with the theoretical as well as the experimental advantages, points out the necessities which have to be fulfilled in order to perform such an experiment.
- M. Aoki, *Lepton Flavor Violation - Experimental*, Nucl. Phys. B (Proc. Suppl.) **143**, 64 pp., (2005): short overview over μ LFV decays, explains the principles of these measurements, mainly concentrating on the experiments MEG, MECO and PRISM/PRIME.
- F. Cei, *Lepton Flavour Violation: present and future Experiments*, Nucl. Phys. B (Proc. Suppl.) **154**, 62 pp., (2006): good overview over the principles of experiments as well as the experiments MEG, MECO and PRISM/PRIME, furthermore also some comments on $\mu \to 3e$ as well as τ LFV decays and their principles of measurement. This paper contains some nice plots which I used in my talk.
- T. Mori, *Lepton Flavor Violating Decays - Review and Outlook*, hep-ex/0605116: treats the same topics as the paper mentioned before, shows also some figures of the machines and some simulation of the MEG experiment.
- S. Banerjee, *Searches for the lepton flavor violating decays* $\tau^\pm \to l^\pm\gamma$, $\tau^\pm \to l^\pm P^0$ *(where* $l^- = e^-, \mu^-$ *and* $P^0 = \pi^0, \eta, \eta'$*) at B-Factories: Status and Combinations*, hep-ex/0702017: short overview over the Belle and BaBar experimental results and the principles of measurement, first paper which tries to perform a combined analysis of the Belle and BaBar data.

- `N.G. Unel`, *Lepton Flavor Violation at LHC*, hep-ex/0505030: treats LFV τ decays at the LHC, shows results of the simulations of the ATLAS and CMS group, gives furthermore some results for LFVs involving non-SM particles (SUSY, 2HDM).

- `L. Calibbi et al.`, *Lepton Flavour Violation from SUSY-GUTs: Where do we stand for MEG, PRISM/PRIME and a Super Flavour factory*, hep-ph/0605139: a theory paper which contains an elaborated analysis of a SUSY $SO(10)$ model with a detailed comparison to the experimental upper bounds expected for the upcoming experiments.