“MEG” in this workshop

- 1st meeting, (Nov., 2005)
  - “LFV, status and prospects”, by T.Mori (Tokyo) - plenary -
  - “Improving the sensitivity, MEG and beyond”, by A.Baldini (INFN-Pisa) - WG3 -
- 2nd meeting, (Feb., 2006)
  - no presentation
- 3rd meeting (this time)
  - updates after the 1st meeting and the newest schedule, prospects
CONTENTS

• MEG experiment

• current status
  - beam line & target
  - photon detector
  - positron spectrometer
  - trigger & electronics
  - software & analysis

• schedule & prospects

• conclusion
MEG experiment
search for $\mu \to e\gamma$ decay

- quark mixing (B-factories, etc.)
- neutrino oscillation (SK, KamLAND, etc.)
- charged lepton must also mix
  - but not observed yet
- $\mu \to e\gamma$ decay is the most sensitive, exploring GUT/seesaw via SUSY
  - current experimental limit: $\text{Br}(\mu \to e\gamma) = 1.2 \times 10^{-11}$ (MEGA, PRL83(’99)p83)
  - $\text{Br}(\mu \to e\gamma) = 10^{-11} \sim 10^{-14}$ are predicted
  - predicted branching ratios are within the reach of the next experiments

MEG @ PSI, starts in this year
\( \mu \rightarrow e \gamma \) Signal and Background

- **Signal**
  - \( E_e = E_\gamma = m_\mu/2 = 52.8\text{MeV} \)
  - \( \theta = 180\text{deg.} \)
  - time coincidence

- **Background**
  - radiative muon decay
  - accidental overlap

Clear 2-body kinematics

use \( \mu^+ \) to avoid capture inside stopping target

Background dominated by Accidental overlap
- lower muon beam rate is better
- DC muon beam is the best

Current Status
Current Status

Beam line commissioning

- 2005
  - beam transport solenoid (BTS) commissioning
  - B-field mapping
  - phase space measurements up to end of BTS
  - commissioning BTS with Cryo-plant
  - phase space measurements inside COBRA magnet

- 2006
  - final beam commissioning with degrader
  - control system test

2.5~3.5x10^7 μ/sec (normal)
~1.2x10^8 μ/sec available

US flange  DS flange

Target system

- Material
  - Rohacell form / CH$_2$ combination
  - Complete Rohacell
  - Ch$_2$ or polystyrene target + wire frame

- Support
  - from DC frame, rotatable or translational
  - prototype is investigated

- position monitoring
  - idea of using several holes in target $\rightarrow$ x,y,z
Current Status

photon detector, Cryostat

- R&D with prototype completed 2004
- test, calibration, construction phase
- cryostat construction in progress in Italy
- completed soon and several tests will be performed in the factory
- delivery in July
- PMT installation and setup after that
- ready in September as a whole photon detector system
Current Status

photon detector, PMTs and holder

- PMT test
  - all PMTs (>1000) were tested in LXe before installing to the detector
    - Pisa LXe PMT test facility
    - Xenon detector large prototype
  - QE, gain, response linearity

- PMT support holder
  - assembly is progressing now
Current Status

**e^+ spectrometer, Drift Chamber**

- prototype R&D completed
- construction study in 2005
- final production started
- front-end elec./ pressure system
- beam test is being performed now

- 4 DCs are ready (16DCs we need)
- ~ 2 DC / week
- final production will be completed beginning of this summer
- September, we will start commissioning run with TC, target
Current Status

e^+ spectrometer, Timing Counter

- counter test completed
- PMTs
  - tested, selected
- APD electronics
  - prototypes ready
- TC bag, getting ready
- calibration laser, ordered
- mass-pro. is progressing
- installation test
  - tested by mockup construction
trigger electronics

- PCB production finished
- board mounting in progress
- ready to install in June
Current Status

DAQ, waveform digitizer

- all channel read out by waveform digitizer, DRS (Domino Ring Sampler)
- all channel ready in June.
- DAQ(trigger and readout) electronics ready to start in June.
• ROME based analysis tools are under developing ([http://meg.web.psi.ch/wiki/index.php/MEG_Software](http://meg.web.psi.ch/wiki/index.php/MEG_Software))

• ROME : see [http://midas.psi.ch/rome/](http://midas.psi.ch/rome/)

• same analysis framework for experiment/simulation.

• offline software is developed in 2 parts
  • bartender
  • analyzer
Software (simulation)

- Geant3 based MC simulation
  - event generator
  - signal event
  - Michel decay
  - radiative muon decay
  - Annihilation in Flight
  - muon beam and related
  - calibration event (RI source, gamma beam, LED, laser)

- detector simulation
  - detector geometry and material
  - physics processes
  - scintillation ray-tracing and initial waveform simulation (w/o electronics simulation) for PM

- developer’s preview released, public release will be soon.
Software (event display)
Analysis preparation with MC

- BG source study
  - A.I.F.
  - Bremsstrahlung
  - beam related
Current Status

Analysis preparation with MC - cont.

- waveform analysis and pileup rejection study
  - pileup rejection algorithm is progressing
  - use waveform information

- megbartender (post-processor for MC) generates waveform outputs
  - using this tool, waveform analysis is developing

Data (ave.)

Simulated
now, we can reject many of pileups by 3 different way,

- using waveform
- using timing info
- using light dist.
Prospects predicted by theory are shown on a graph. Past experiments are marked with green dots, while the current limit is represented by a dashed line. Predictions made by theory are indicated with a shaded area. The graph shows data points from 1950 to 2010 with values ranging from $10^{-15}$ to $10^{-1}$. Significant progress is indicated by the MEG experiment.
### Schedule in 2006

**MEG beam time**: April-June, August-December

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**Ready to start MEG commissioning RUN in November**
Expected Background and Reachability

- background rate is being estimated by the newest MC data
- BG related part needs careful tuning (ex. radiative decay spectrum, AIF process etc)
- very preliminary sensitivity estimation
  - beginning 1 month
    - \(10^7 \mu^+/\text{sec} \rightarrow \text{Br(90\%CL)} \sim 2 \times 10^{-12}\)
  - 2 year RUN
    - \(10^7 \mu^+/\text{sec} \rightarrow \text{Br(90\%CL)} \sim 2.1 \times 10^{-13}\)
    - \(3 \times 10^7 \mu^+/\text{sec} \rightarrow \text{Br(90\%CL)} \sim 1.2 \times 10^{-13}\)
    - \(10^8 \mu^+/\text{sec} \rightarrow \text{Br(90\%CL)} \sim 1.5 \times 10^{-13}\) → this should be improved by our detector and analysis algorithm enhancements.
Conclusion

• MEG is search experiment for $\mu \rightarrow e\gamma$ decay
• Beam line commissioning and photon/positron detectors are getting ready
• Online/Offline softwares are also developing
• MEG will start data taking this year
• According to the newest detector simulation, the sensitivity will reach $\sim 10^{-13}$ by 2 years running (2 order improvement than current limit)
• Even if 1 month running, we will be able to reach $\sim 2 \times 10^{-12}$ (1 order improvement than current limit)