

# Short Minutes of the BVR 44

## Meetings of January 14 – 16, 2013

### 1 Meetings of the Committee

closed meetings:	Tuesday, January 15, from 9:00 – 12:30 Wednesday, January 16, from 8:30 – 12:00
present:	G. Colangelo B. Filippone G. Greene C. Hoffman (chair) P. Kammel St. Passaggio J. M. Pendlebury M. Pohl (Tue) M. Ramsey-Musolf A. Signer (secretary)
beam time coordinator:	C. Petitjean
ex officio:	K. Clausen (Wed) K. Kirch
apologies:	D. Bryman A. Ceccucci M. Pohl (Wed) U. Straumann

### 2 New Proposals

The Committee is very pleased to have received five new proposals and one letter of intent. The proposals are all of high quality and the Committee would like to see them run at PSI.

In view of this activity, the reduction of beam operations from 8 to 6 months in 2014 and 2015 has a serious adverse effect and it is important that the beam runtime be increased to the usual 8 months in 2016 and beyond. In addition, increased particle physics time in  $\pi E1$  is needed to carry out this program.

#### **R-99-05.2: Search for $\mu^+ \rightarrow e^+\gamma$ (MEG upgrade proposal)** (T. Mori, A. Baldini *et al.*)

There was a detailed technical review of the MEG experiment and the proposed upgrade on Monday. There will be a separate detailed report from the MEG subcommittee. The collaboration has made substantial improvements in their data analysis. This was checked by reanalyzing the 2009/10 data where the new improved analysis gives results consistent with the previous analysis, but with an improved sensitivity.

The Committee endorses the proposed 3.5 month run in 2013 to complete data taking before the upgrade and hopes that the envisaged sensitivity of  $6 \times 10^{-13}$  for the branching

ratio  $\text{BR}(\mu \rightarrow e\gamma)$  will be reached. The Committee urges the collaboration to consider the possibility of using some of this beam time to test aspects of the upgrade (such as running with higher intensity, testing an active target, and testing a counter to detect inner-bremsstrahlung photons).

The physics goal of the proposed upgrade of the MEG experiment is to improve the sensitivity by an order of magnitude to  $\text{BR}(\mu \rightarrow e\gamma) \sim 6 \times 10^{-14}$ . The collaboration has identified the three most important aspects (the drift chamber, the scintillation counters and the front face of the LXe detector) for this upgrade and has shown that each can be significantly improved. This should result in better suppression of the accidental background and a clear path to a factor ten improvement in sensitivity.

The upgrade proposal is strongly endorsed from a scientific and technical point of view. It will ensure that PSI keeps its world leadership in the study of this process. The Committee approves the upgrade proposal and expects that, after the upgrade is successfully completed, MEG will be given the highest priority in  $\pi\text{E5}$ . The Committee is pleased that funding from Italy and Japan has been secured for this upgrade and hopes that the experiment can be completed successfully and in timely fashion, hopefully by 2018.

The Committee encourages the collaboration to make provisions to enable fast turnover between experiments in  $\pi\text{E5}$ .

There will be a detailed technical review of the MEG upgrade on January 27, 2014.

**R-12-01.2: Studying the “Proton Radius Puzzle” with  $\mu p$  elastic scattering (MUSE)**  
(R. Gilman *et al.*)

The collaboration proposes to study  $e^\pm p$  and  $\mu^\pm p$  scattering at low  $Q^2$  in order to get further insights into the proton radius puzzle. This experiment addresses an important physics problem and, as the issue came to light as a result of the Lamb shift experiment at PSI, it would be fitting if it were solved at PSI.

The Committee is pleased by the progress made by the collaboration since the last review in July 2012 and approves the experiment. The collaboration is encouraged to make further beam tests to confirm that the beam line  $\pi\text{M1}$  is adequate for the experiment. Furthermore, there is some concern about the level of understanding of the radiative corrections: more reliable calculations are needed.

The Committee requests a detailed technical design report which will be reviewed in conjunction with the BV 45 meeting in January 2014. A satisfactory outcome of this review will be a prerequisite for this experiment receiving significant beam time.

**R-12-03.1: Search for the decay  $\mu^+ \rightarrow e^+ e^- e^+$  (Mu3e)** (A. Schoening, St. Ritt *et al.* )

The ultimate aim of this experiment is to study the flavour violating decay  $\mu^+ \rightarrow e^+ e^- e^+$  to the unprecedented sensitivity of  $\text{BR}(\mu \rightarrow 3e) \sim 10^{-16}$ . A positive signal would be clear evidence of physics beyond the Standard Model, while the absence of a signal would impose extremely stringent constraints on extensions of the Standard Model. Such a measurement would be an improvement of several orders of magnitude compared to the current limit,  $\text{BR}(\mu \rightarrow 3e) < 1.0 \times 10^{-12}$ , obtained by SINDRUM in 1988, but would require a new high intensity muon beam (HiMB) at PSI. With the existing beam line ( $\pi\text{E5}$ ) a sensitivity of  $\text{BR}(\mu \rightarrow 3e) \sim 10^{-15}$  can be reached.

The science case for this experiment is compelling as it provides important information that is complementary to that obtained from studying the  $\mu \rightarrow e\gamma$  decay. Muon physics has emerged as a cornerstone of the high intensity frontier. Successful completion of the proposed experiment would cement PSI's world-leading role in this field and the Committee is keen to facilitate this experiment. In this context the Committee also recommends that the PSI management undertake a detailed study of a new high-intensity muon beam HiMB.

The Committee likes the staged approach of this experiment with successive improvements in the sensitivity to  $\text{BR} \sim 10^{-15}$  in phase I and possibly further improvements to  $\text{BR} \sim 10^{-16}$  at later stages, if HiMB is realized at PSI. The fact that progress is mainly made by detector upgrades and the experiment does not require unduly long run times is beneficial given the expected tight constraints on available beam time in  $\pi\text{E5}$ . It appears that Mu3e and MEG can be set up at the same time, with the beam being switched from one experiment to the other. The collaboration is encouraged to make provisions for efficient switching between experiments.

The schedule proposed by the collaboration is very aggressive. The experiment needs further design and development (cooling, cabling, mechanical support, detector development, for example). There will be a detailed technical review of the Mu3e experiment on January 27, 2014. It is expected that there will be subsequent periodic technical reviews with milestones to help the collaboration achieve their ambitious goal.

**R-13-01.1: Laser spectroscopy of pionic helium atoms (PiHe)** (M. Hori *et al.*)

In this experiment a novel metastable bound state of a  $\pi^-$  and an  $e^-$  with a helium nucleus  $\text{He}^{2+}$  is to be formed and atomic transition frequencies are to be measured. Apart from an unambiguous proof of the existence of such bound states, this experiment would determine the pion mass with unprecedented accuracy and test QED in a new domain. As a side product it would provide the best lower limit of the muon-neutrino mass from laboratory experiments (although limits from cosmological considerations are considerably more stringent).

The Committee thinks this is a worthwhile experiment that addresses important physics, in particular a better measurement of the pion mass. The Committee also appreciates that funding is already secured and wants to ensure that the experiment can be run at PSI.

Unfortunately, due to competition from other experiments, it is highly unlikely that there will be enough beam time available to accommodate this experiment at  $\pi\text{E5}$  after 2014. Thus an alternative suitable beam line has to be found. The collaboration is urged to consider whether the experiment could successfully run at  $\pi\text{E1}$ . PSI is willing to try to accommodate this experiment in  $\pi\text{E5}$  for the next 2 years and to give assistance to the collaboration in studying whether  $\pi\text{E1}$  is appropriate for this experiment.

**R-13-03.1: Study of muon capture for  $\mu \rightarrow e$  conversion experiments (AlCap)** (P. Kammel, Y. Kuno *et al.*)

The Mu2e and COMET collaborations have joined forces to obtain crucial input for the planned  $\mu \rightarrow e$  conversion experiments at Fermilab and J-PARC, respectively. This proposal consists of three work packages. In WP1 the collaboration aims to measure charged particle emission after muon capture in  $\pi\text{E1}$  in 2013. This process is an important background for the  $\mu \rightarrow e$  conversion experiments and there is currently not sufficient information available. In 2014  $\gamma$  and X-ray emission (WP2) and neutron emission (WP3), respectively are to be

measured.

The Committee recognizes the importance of these measurements and approves this experiment. It is important that these measurements are done in timely fashion to facilitate the Mu2e and COMET experiments. To this end 4 weeks of beam time at  $\pi E1$  have been allocated at the end of 2013.

### 3 Letters of Intent

#### **R-13-02.0: Search for muonium decay $\mu^+ e^- \rightarrow \bar{\nu}_\mu \nu_e$ (MUTON) (S. Gninenko *et al.*)**

The collaboration wants to measure the branching ratio  $\text{BR}(\mu^+ e^- \rightarrow \bar{\nu}_\mu \nu_e)$  and hopes to be able to observe the Standard Model value  $\text{BR} = 6.6 \times 10^{-12}$  for this branching ratio with a significance of  $3\sigma$  after running for three months. In a second phase with six months of data taking an observation at the  $5\sigma$  level could be made.

The Committee thinks this is an intriguing idea. The Standard Model value gives a useful benchmark for this experiment. However there are many open questions (e.g. what contamination in the beam is acceptable, what beam rate is required, how to determine the level of background rejection). The proponents are encouraged to submit a full proposal that addresses these questions.

### 4 Progress Reports and Beam Requests

#### **R-05-03.1: Measurement of the neutron EDM (W. Heil, K. Kirch *et al.*)**

There was a separate technical review of this experiment on Monday, January 14 and there will be a detailed report from the EDM subcommittee.

While the UCN flux still needs improvement, the Committee recognizes that substantial progress has been made by the collaboration and that they now have a more sensitive experiment than the published Sussex-Ral-ILL experiment. The Committee is pleased to see clear experimental improvements in several areas, in particular the mercury magnetometer.

It is clear that the improvement of the UCN flux will require a long term effort and in such projects it is often unrealistic to expect immediate success. The collaboration is encouraged to set up and carry out a clear diagnostic plan, even if this requires a substantial amount of time.

#### **R-08-01.1: Muon capture on the deuteron (MuSun) (P. Kammel, C. Petitjean, A. Vasilyev *et al.*)**

The Committee obtained a written progress report with a request for three 4-week periods of beam time at  $\pi E1$  in 2013. The experiment is in a very solid position and the Committee is happy to approve the request.

**R-98-03: Lamb shift in muonic atoms (CREMA)** (F. Kottmann, R. Pohl *et al.*)

The Committee acknowledges the written progress report and approves the requested beam time of 12 weeks at  $\pi E5$  at the end of 2013, with a production run expected at the start of the 2014 run.

## 5 Miscellaneous

Due to the large number of new proposals there was no time for oral progress reports during the Open Users Meeting on Tuesday afternoon. A. Signer (PSI) gave an invited talk on “Effective Test of the Standard Model” in the Open Users Meeting before the presentations of the proposals and the letter of intent.

## 6 Next Meeting

The next meeting (BV 45) is again planned as a 3-day meeting from Monday through Wednesday, and will take place January 27 – 29, 2014. The deadline for submission of new proposals and beam requests is January 6, 2014. The first day of the meeting will be devoted to a review of MEG and Mu3e (half a day each) and in parallel a one-day review of the neutron EDM experiment.

February 3, 2013

C. Hoffman, A. Signer