Searching for a new force at VEPP-3

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1 Goal of the experiment

We plan to search for the U-boson signal in the mass range 5-20 MeV. The projected result of this experiment corresponds to an upper limit on the square of coupling constant $|f_{eU}|^2 = 1 \cdot 10^{-8}$ with a signal-to-noise ratio of five to one.

2 Experimental setup

VEPP-3 is an accumulator ring, operating as an intermediate accelerator/storage ring of electrons and positrons for the VEPP-4 collider. The internal target is located in one of the two 12-meter-long straight sections of the VEPP-3 ring. In the same straight section there are also two RF cavities, one sextupole and four quadrupole lenses, and elements of beam injection and ejection. The space available for the internal target equipment is 217 cm long.

The physics program of the VEPP-3 internal target facility is concentrated on measurements of tensor target asymmetries in electro- and photoreactions on a tensor polarized deuteron [1]. Recently, a measurement of the cross-section ratio for the elastic scattering of the positron and electron on the proton was carried out [2]. That measurement demonstrated a reliable operation with the positron beam and the internal hydrogen target during a 4-month run at a luminosity of $\sim 1 \times 10^{32}$ cm^{-2}s^{-1}. Further improvement of the VEPP-3 performance is anticipated after the commissioning of the electron/positron injection complex is completed [3]. Besides an increase in the positron injection rate, this new injection scheme will allow up to 18 bunches in VEPP-3, which is essential for the reduction of the probability of accidental veto.

The layout of the proposed experiment at VEPP-3 is presented in Fig. 1. The particle detectors to be used in the proposed experiment and the arrangement of components in the internal target area differ substantially from those used in the previous internal target experiments at VEPP-3.

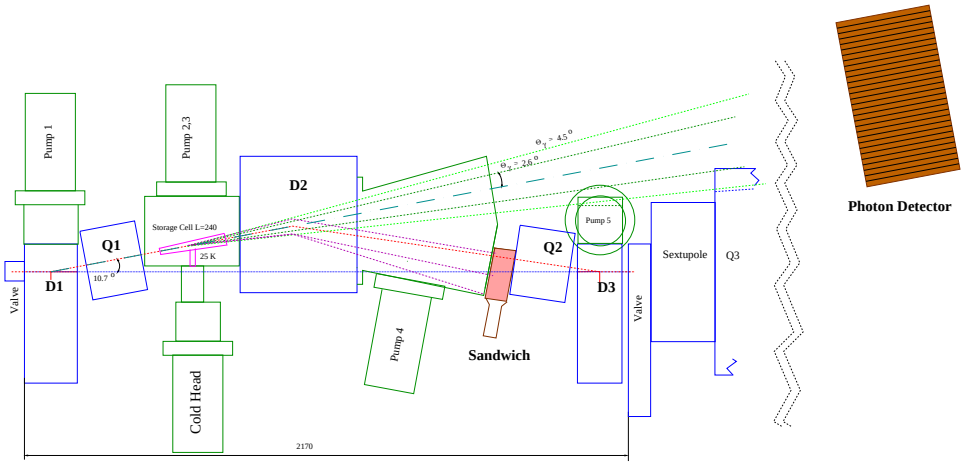

Figure 1: The layout of the proposed experiment at VEPP-3

3 Accelerator or Lab Facility

The experiment will run at the Budker Institute for Nuclear Physics, Novosibisrk, Russia. The 500 MeV positron beam in the storage ring VEPP-3 with an internal hydrogen target will be used. Projected results are based on an existing intensity of the beam and demonstrated luminosity.

4 Physics Reach

Figure 2 shows a plot of the coupling constant ratio α'/α versus the mass of the new boson m_U. A region which will be accessible for the search in the proposed experiment is outlined, together with some other completed and proposed measurements. (Note that $\alpha'/\alpha = |f_{eU}|^2/4\pi\alpha$).

5 Status and Schedule

The proposal will be presented to the Budker Institute in January/February 2012.

6 Future Plans

The scheduled upgrade of the positron injector at BINP will allow a ten-fold increase in experiment productivity.

7 Collaborating Institutions and Collaborators

This note presents a collaboration project with D. Nikolenko and I. Rachek of the Budker Institute of Nuclear Physics.

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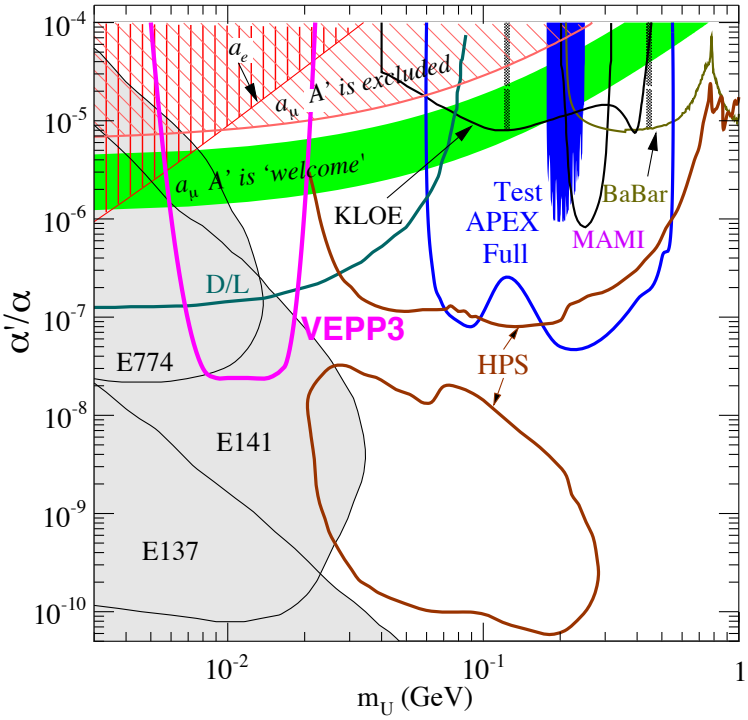

Figure 2: Existing and projected upper limits of a coupling constant of a new boson to lepton vs. its mass. The shaded areas are the results of the completed direct searches: beam dump experiments at SLAC: E137, E141, E774 [4, 5]; e^+e^- colliding beam experiments BaBar [6], KLOE [7]; fixed–target experiments MAMI [8], APEX Test run [9]. The hatched areas are regions excluded by the results of the measurements of anomalous magnetic moments of electron and muon [10]. The green band indicates a "welcome" area, where the consistency of theoretical and experimental values would improve to 2σ or less. Curves show areas of search of other proposed experiments: Full APEX [11], HPS [12], DarkLight [13] and the proposed experiment (VEPP3). Note that the beam dump experiments have sensitivity only for the processes with the visible decays of the U-boson. Therefore, they don't guarantee a total exclusion of a new boson, and the projected VEPP-3 results will provide explicitly new data even in the regions already checked by those measurements.