

A1/MAMI and MESA
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1 Goal of experiment

The goal of the planned experiments in Mainz is a search for the Dark Photon over a wide range of masses and couplings. We concentrate on the parameter range, which has been discussed to be relevant for the discrepancy presently seen in the anomalous magnetic moment of the muon as well as possibly for dark matter physics. We plan to perform these measurements in three steps:

- Step 1: Use A1 high-resolution spectrometers at Mainzer Microtron MAMI. A first publication has already been achieved (*Phys. Rev. Lett.* **106** 2011) 251802). This programme is similar to JLAB/APEX plans and allows to cover the mass range above 50 MeV/ c^2 for relatively large couplings α' .
- Step 2: We will try to use A1 together with a displaced vertex technique to get access to lower couplings. The physics reach seems to be similar to JLAB/HPS.
- Step 3: Construct a low-energy high-intensity accelerator MESA: dedicated experiment to cover low-mass region below 50 MeV. These plans are similar to the plans at the JLAB-FEL.

2 Experimental setup

The setup at A1 for step 1 is essentially ready. We plan to improve the efficiency of the method which already lead to a publication. Activation of air was a major issue at the four days pilot run. For step 2 dedicated simulations are needed to verify the method. It is for instance important to study the background levels in the proposed experimental setup. Step 3 is for the intermediate future. Funding for acclerator and experiment are under review at present.

3 Accelerator or Lab Facility

The Mainz Microtron MAMI is providing a maximum beam energy of 1.6 GeV with beam currents of up to 140 microamps. Not only beam intensity, but also beam stability are world class. The A1 spectrometers feature very high momentum resolution (10^{-4}) as well as excellent timing resolution. MESA plans foresee to combine a high-intensity electron accelerator with beam energies up to 200 MeV with the ERL technique.

4 Physics Reach

Fig. 1 shows the physics reach for step 1 (A1/MAMI without modifications) and step 3 (MESA plans) in the well known 2dim plot coupling $\epsilon = \alpha'/\alpha_{\text{QED}}$ versus dark photon mass m_γ . So far the physics reach for step 2 has not been definitely defined, but couplings down to $\epsilon = 10^{-4}$ or even lower should be in reach.

5 Status and Schedule

More physics runs for Step 1 are foreseen for the coming months.

6 Future Plans

Improve efficiency of measurement in phase 1 (A1 spectrometers) by means of improved target configuration, shielding of target region, higher beam current.

7 Collaborating Institutions and Collaborators

A1 collaboration, s. wwwa1.kph.uni-mainz.de/A1/members.html

8 Written Materials (e.g. references)

- First publication A1, phase 1: Phys. Rev. Lett. **106** (2011) 251802
- A1 homepage: <http://wwwa1.kph.uni-mainz.de/A1/Welcome-2009-01-14.html>
- http://www.jlab.org/conferences/boson2010/Monday/jlab10_denig.pdf

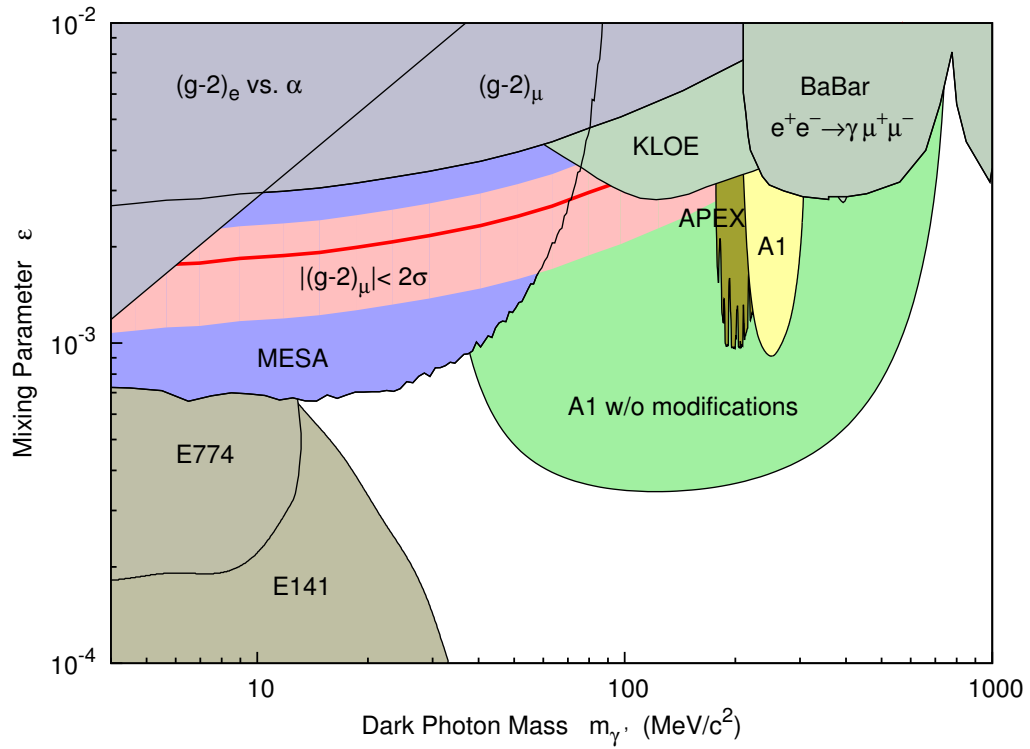


Figure 1: Exclusion limits expected in phase 1 (A1) and phase 3 (MESA) of the Mainz programme together with existing limits from dark photon and axion searches.

- MESA accelerator (phase 3), not up-to-date:
<http://www.fe.infn.it/PST2009/body/talks/aulenbacher.pdf>