Executive summary for “COSY Test Beam Time”

For Lab. use

Exp. No.: E2.7	Session No. 10

Collaboration_____**JEDI**_____

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Is support* from the LSF program of the EU requested?

Yes ~~No~~

Total number of particles and type of beam (p,d,polarization)	Momentum range (MeV/c)	Intensity or internal reaction rate (particles per second)	
		minimum needed	maximum useful
Polarized deuterons	970 MeV/c	10^8	10^10
Experimental area	Safety aspects (if any)	Earliest date of installation	Total beam time (No.of shifts)
COSY internal beam	**none**	**1.10.2019**	(MD) +1 Week + 1 Week **Total 2 Weeks**

What equipment, floor space etc. is expected from Forschungszentrum Jülich/IKP?

***EU-Support:**
The European Commission is planning to support access of new users from member and associated states to COSY. As soon as the grant negotiations are complete, travel and subsistence costs can be financed in the frame of the program Access to Large Scale Facilities (LSF).

Description of request (motivation, milestone(s), goals; maximum 5 pages)

JEDI Beam Time Request for the next period

Towards EDM Polarimetry:

Commissioning of the internal polarimeter based on LYSO crystals at COSY

for the JEDI collaboration

http://collaborations.fz-juelich.de/ikp/jedi

May 20, 2019

Abstract

This beam time request is based on the proposal for **E2.6** considered during CBAC-9. That proposal described a polarimeter installation at the ANKE location. Due to technical issues with the vacuum enclosure and interference with an existing experiment, the installation site has been shifted to the location of the EDDA detector, which will be removed this summer. The plan is to commission the polarimeter and its DAQ system, comparing its performance with the WASA Forward Detector now used as a polarimeter. Improvements in selectivity and analyzing power are expected. **We request one week of beam time with a week of machine development utilizing vertical beam polarization for the purpose of quantifying performance relative to WASA. In addition we request and additional week of horizontal polarization scheduled in conjunction with the precursor experiment to commission the DAQ for horizontal polarization measurements and feedback applications.**

1 Introduction

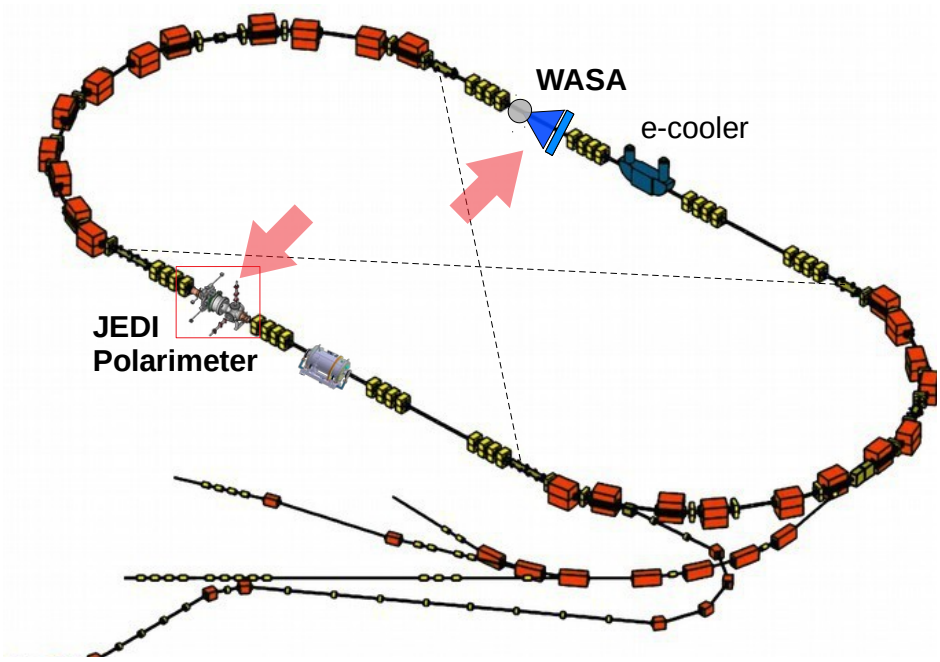

Figure 1: A new JEDI polarimeter and the WASA detector are indicated as opposite side polarization monitoring instruments at the COSY facility.

During the past few years, we have developed several new experimental methods and adopted advanced instrumentation in preparation for a storage ring EDM search. One of the main elements is precise monitoring of the polarization precession in the horizontal plane of the storage ring. At the beginning of the JEDI project, the EDDA detector was used very successfully. But it was limited in solid angle for forward-angle d+C elastic scattering. As a next step, we have adopted the WASA Forward Detector as a second-generation internal polarimeter. Unlike EDDA, it has a modern readout system but features a complex geometry with multiple layers that must provide fast and clean online triggering. Like EDDA, WASA is also not designed to act as a fast online polarimeter. The WASA detector has a much larger scattering angle acceptance than EDDA, but no simple way to select the best operating angle range. Figure 1 shows the location of the new polarimeter in the COSY ring. This was the former EDDA detector section.

In the opposite side of the accelerator ring, the WASA detector location is also indicated.

The future experimental activities within the JEDI collaboration will include the EDM precursor experiment at COSY. Based on acquired experience we have designed a new polarimeter which will be superior to both for the online elastic scatatering identification in the angle range of greatest benefit. During the last years, we have developed and tested different parts of the new LYSO-SiPM based polarimeter, including LYSO modules, targets, and a plastic scintillator dE-tracker system. The next important step is to install the new detector as an internal polarimeter for COSY. We are planning to use this new detector as the main polarimeter for the JEDI experiment and test several new ideas. One idea is a new method of simultaneous vertical end horizontal beam extraction into separate, dedicated target systems. This would enable a new idea proposed by Prof. Andrzej Magiera. His idea, "Distinguishing EDM and misalignment effects with fourier analysis," [3] can be tested where the polarization vector precession needs to be simultaneously measured and compared in two opposite side of the COSY accelerator ring.

2 Setup

After changing the plan (due to technical problems) of installing the JEDI Polarimeter (JePo) at the ANKE section, we quickly redesigned the setup. In addition, we designed and built a new support table for the detector fitting in EDDA section. The EDDA detector will be removed and the new polarimeter will be permanently inserted. Figure 2 shows the current assembly as a first phase test setup. It will consist of:

- All 52 LYSO crystals arranged into four arms.
- 2 cm thick plastic scintillator ΔE in front of each arm.
- Final mechanical support and vacuum parts.
- Vertical and horizontal block targets.

The standard COSY-JEDI type Rogowski coil holders are included in the plan. In the future, the internal degrader will be installed into the vacuum chamber. But in the next step, the triangular plastic scintillators will measure ΔE and position, improving our track reconstruction. The cross flange

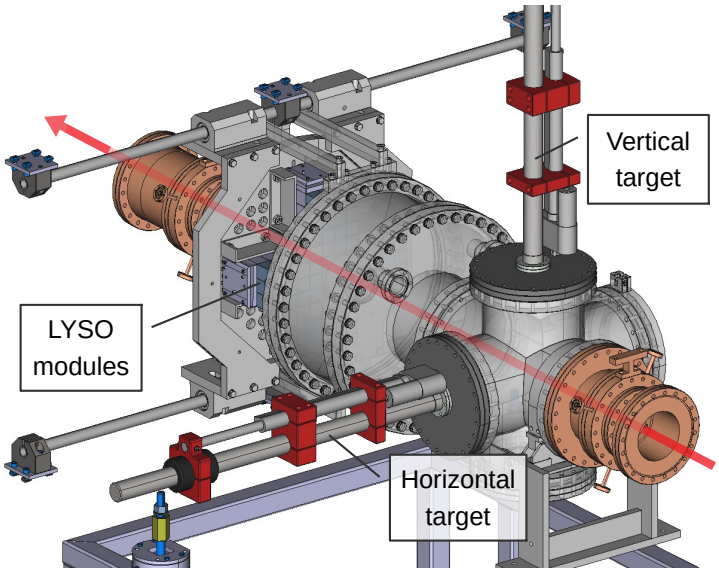

Figure 2: An artistic drawing of the new JEDI polarimeter shown in figure 1.

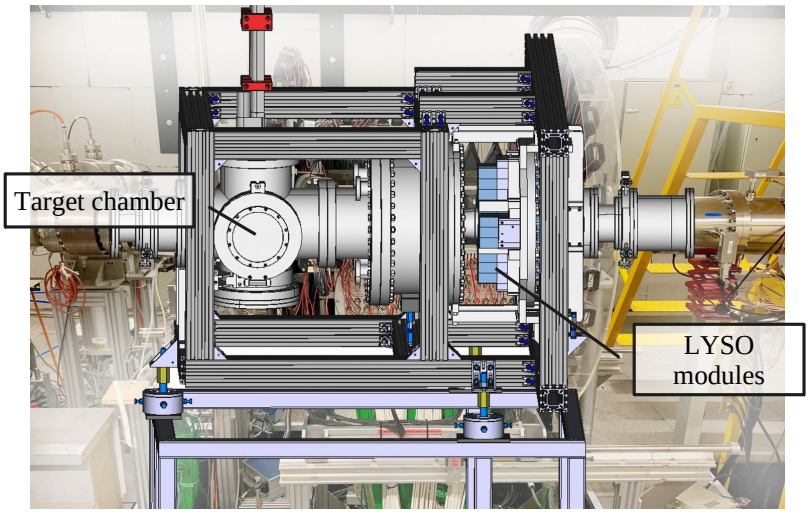

Figure 3: JEDI polarimeter installation inside the COSY tunnel at the EDDA detector location.

can also host the diamond pellet target after it successfully completes laboratory tests in an identical flange. Figure 4 shows the polarimeter orientation and size compatibility in the new section. In the current setup, the standard COSY BPM system will help to steer the beam precisely on target before the Rogowski coils are inserted.

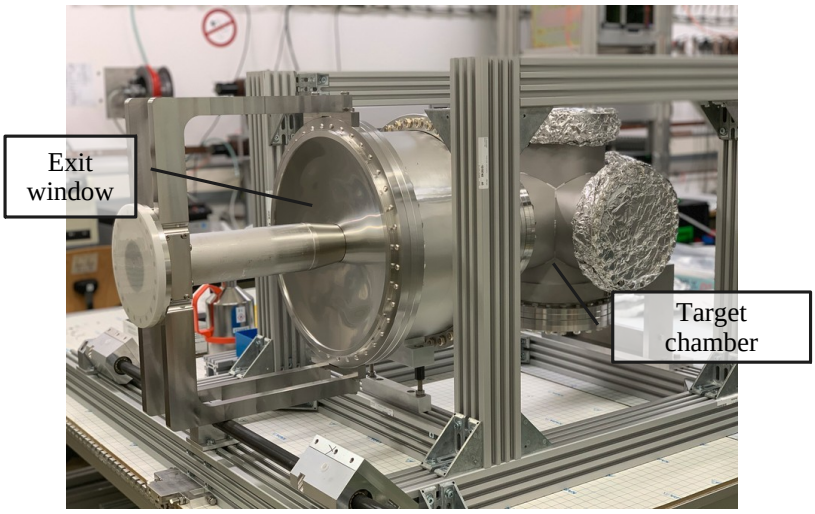

Figure 4: The vacuum chamber prepared for the ultra-high vacuum tests in the laboratory.

The Geant4 Monte Carlo simulation is progressing with the new assembly inserted in the beam line. We are currently investigating the influence of different parts on our asymmetry measurement. As expected, the most significant asymmetry is generated due to the 2 cm thick high-density graphite target block. All the rest (exit window, vacuum chamber) has azimuthal symmetry by design and does not influence the asymmetry measurement.

3 Data acquisiton system

In this beam time, special emphasis will be placed on the analysis software. For one readout, the combined OR signal from each arm will be generated using individual thresholds, selecting only elastic events. The output signal will be provided to the already tested EDDA / WASA time stamping readout, which can be used for the usual feedback system. In parallel with this readout

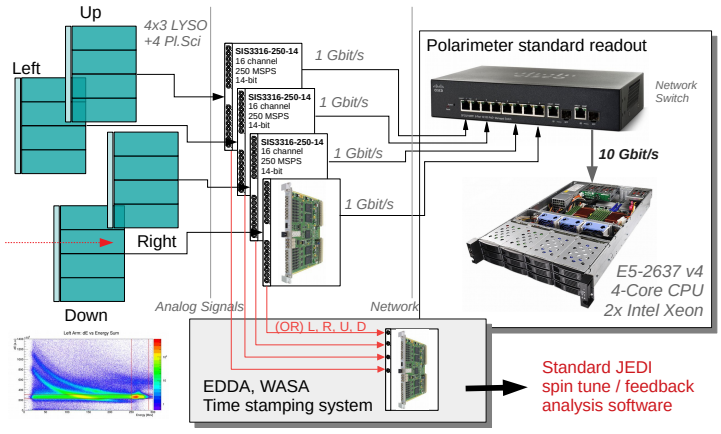

Figure 5: Schematic of the planned data acquisition system. Two parallel readouts will be used. The standard polarimeter readout and the EDDA / WASA time stamping TDC readout are fed with OR signals from each polarimeter arm.

(see Fig. 5), the usual polarimeter DAQ will be running. In fact, the system based on sampling readout [4] also produces time stamps for each trigger, which makes possible an even more efficient system then is available with WASA. Each elastic event can be separated using full energy deposition vs energy loss in 2 cm plastic scintillator bars in front of the LYSO crystals. This gives us excellent precision for the elastic event selection and can be used in an online analysis.

4 Beam Time Request

In order to finalize this very successful development, we ask the CBAC committee to grant us **two separate weeks** of polarized deuteron (P_d = 970 MeV/c) beam time in the second half of the 2019.

References

[1] Towards EDM Polarimetry
http : *//collaborations.fz−juelich.de/ikp/jedi/documents/proposals.shtml*

[2] Last proposal
http : *//collaborations.fz−juelich.de/ikp/jedi/public_files/proposals/*
JEPO_*01.2019.pdf*

[3] DISTINGUISHING EDM AND MISALIGNMENT EFFECTS WITH FOURIER ANALYSIS
http : *//collaborations.fz − juelich.de/ikp/jedi/private_files/*
*collaboration_meeting/magiera_v*3*.pdf*

[4] SIS3316-250-14 16 channel 250 MSPS 14-bit.
(*http* : *//www.struck.de/sis*3316*.html*)