COMMISSIONING OF THE LYSO BASED INTERNAL POLARIMETER

Spokespersons: I. Keshelashvili, D. Mchedlishvili

CBAC 2019 #10 | Exp. No.: E002.7
OVERVIEW

Steps & achievements up to now

Exp. E002.1  March 2016
First test of:
- LYSO
- PMT
- SiPM
- FADC
- Scans
- ...

Exp. E002.3  March 2017
+ Ni, Sn

Exp. E002.5  May 2018
Test 1:
- 52x LYSO
- ΔE 20mm
- Mechanics
- 6x FADC
- Timing
- ...

Test of:
- 24x LYSO
- New SiPM
- ΔE 5mm
- Software
- Power supply
- ...

C, CH₂, Mg, Al, Si

Exp. E002.3  March 2017
Test of:
- Cross sections
- Software
- ΔE 10mm
- V readout
- ...

C, CH₂, Mg, Al, Si

Exp. E002.4
Exp. E002.5
Test 1:
- 52x LYSO
- ΔE 20mm
- Mechanics
- 6x FADC
- Timing
- ...

Test 2:
- Front Scans
- Tracker ΔE
- ...

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JEDI POLARIMETER @ COSY

Opposite side polarization monitoring
EXIT WINDOW

One of the most critical parts of the detector

The delay in delivering exit window caused canceling of commissioning beam time in spring 2019!

Parts from ZEA-1

COSY beam pipe

Exit window 0.8 mm
LABORATORY TESTS

Vacuum and mechanical components

- Mass spectrometer
- < 1mm deformation on Exit window
JEPO @ FORMER "EDDA" TARGET SECTION

Pictures from June 28th
DETECTOR SETUP

All 52 LYSO-SiPM modules + $\Delta E$ and DAQ will be tested

- 52 SiPM LYSO Modules with $\Delta E$
- Block target
  - Vertical & Horizontal
- Rogowski coils
  - both sides
- Fast FADC
  - 6x16ch system
NEW DATA ACQUISITION SCHEMATIC (TWO PARALLEL TS-TDC)

Standard JePo DAQ System

Left

Up

4x3 LYSO +4 Pl.Sci

SIS3316-250-14
16 channel
250 MSPS
14-bit

Figure

Right

Down

Analog Signals

Network Switch

E5-2637 v4
4-Core CPU
2x Intel Xeon

Polarimeter standard readout

Network

1 Gbit/s

10 Gbit/s

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July 1st, 2019

Slide 7/11
NEW DATA ACQUISITION SCHEMATIC (TWO PARALLEL TS-TDC)

Combined JePo and JEDI Time-stamping TDC

EDDA, WASA
Time stamping system

time stamping TDC readout are fed with OR signals from each polarimeter arm.

Polarimeter standard readout

Network Switch

E5-2637 v4
4-Core CPU
2x Intel Xeon

Standard JEDI spin tune / feedback analysis software
Asymmetry due to multiple scattering inside the target material
GEANT4 SIMULATION

Investigating the influence of different detector parts on $A_Y$

- No vacuum parts
- Exit window
- Beam pipe
- Large barrel
- Target chamber
- Barrel endcap
This work has been supported by

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"High-precision polarimetry for charged-particle Electric Dipole Moment (EDM) searches in storage rings"

- Mechanics: B. Klimczok, G. D’Orsaneo & D. Spölgen
- COSY Vacuum: J. Böker & G. Langenberg
- Electronics: Tanja Hahnraiths-von der Gracht & T. Sefzick
- DAQ & FEE: D. Mchedlishvili, & P. Wüstner
- Geant4: M. Abuladze (Master) , G. Macharashvili
- Ms.: G. Kvantrishvili, M. Gagoshidze
- PhD: F. Müller, D. Shergelashvili, O. Javakhishvili & N. Canale
BEAM TIME REQUEST FOR COMMISSIONING

- Internal $\bar{d}$ beam (former EDDA target station)
- Variable intensity and extraction rate
- RF-WF exp. beam momentum $P_d = 970$ MeV/c
- Commissioning of dual DAQ system
- MD+1 Week Autumn 2019 (commissioning)
- 1 Week with WF/Precursor in 2020 (measurement)

Executive summary for “COSY Test Beam Time”

For Lab. use
Exp. No.: E2.7
Session No. 10

Collaboration: JEDI

Spokesperson for test beam time: I. Keshelashvili (FZJ)
D. Mchedlishvili (HEPI TSU / SMART|EDM_Lab)

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

Phone: +49 2461 615603 Fax: __________________ E-mail: i.keshelashvili@fz-juelich.de

<table>
<thead>
<tr>
<th>Total number of particles and type of beam (p,d,polarization)</th>
<th>Momentum range (MeV/c)</th>
<th>Intensity or internal reaction rate (particles per second)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polarized deuterons</td>
<td>970 MeV/c</td>
<td>minimum needed: $10^8$, maximum useful: $10^10$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Experimental area</th>
<th>Safety aspects (if any)</th>
<th>Earliest date of installation</th>
<th>Total beam time (No.of shifts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>COSY internal beam</td>
<td>none</td>
<td>1.10.2019</td>
<td>(MD) +1 Week + 1 Week Total 2 Weeks</td>
</tr>
</tbody>
</table>

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)
Appendix
Contacting me via e-mail

Click here: i.keshelashvili@fz-juelich.de
GEANT4 SIMULATION

Expected track distribution
GEANT4 SIMULATION

Expected track distribution
GEANT4 SIMULATION

Expected track distribution
GEANT4 RESULTS

Expected distributions for the internal experiment

- **Elastic cut**
  - $h_{L2\ 3\ 5}$
  - Entries: $1.1\times10^8$
  - Mean: 170
  - Std Dev: 77.41

- **2cm block target shadow**
  - $h_{L1\ 2\ 3}$
  - Entries: $1.1\times10^8$
  - Mean: 192.1
  - Std Dev: 69.33

- **Block target effect**
  - $h_{L1\ 1\ 3}$
  - Entries: $1.1\times10^8$
  - Mean: 186.1
  - Std Dev: 73.13

- **only $\Delta E$**
  - $h_{L2\ 2\ 5}$
  - Entries: $1.1\times10^8$
  - Mean: 178
  - Std Dev: 73.68

- **Partial $\Delta E$ effect**
  - $h_{L1\ 1\ 3}$
  - Entries: $1.1\times10^8$
  - Mean: 186.1
  - Std Dev: 73.13
GEANT4 RESULTS

Expected distributions for the internal experiment

- 

\[ T_d \ [\text{MeV}] \]

\[ h2 \_dEvsL2 \_3 \_5 \]

\[ \text{Entries} \ 1.1 \times 10^8 \]

\[ \text{Mean x} \ 181.8 \]

\[ \text{Mean y} \ 12.83 \]

\[ \text{Std Dev x} \ 69.9 \]

\[ \text{Std Dev y} \ 1.702 \]

\[ h2 \_dEvsL1 \_2 \_3 \]

\[ \text{Entries} \ 1.1 \times 10^8 \]

\[ \text{Mean x} \ 245.4 \]

\[ \text{Mean y} \ 11.24 \]

\[ \text{Std Dev x} \ 16.04 \]

\[ \text{Std Dev y} \ 3.534 \]

\[ h2 \_dEvsL2 \_2 \_5 \]

\[ \text{Entries} \ 1.1 \times 10^8 \]

\[ \text{Mean x} \ 180.6 \]

\[ \text{Mean y} \ 12.64 \]

\[ \text{Std Dev x} \ 72.66 \]

\[ \text{Std Dev y} \ 1.644 \]

\[ h2 \_dEvsL1 \_1 \_3 \]

\[ \text{Entries} \ 1.1 \times 10^8 \]

\[ \text{Mean x} \ 248.9 \]

\[ \text{Mean y} \ 11.03 \]

\[ \text{Std Dev x} \ 16.41 \]

\[ \text{Std Dev y} \ 3.612 \]
GEANT4 RESULTS

2 cm graphite target on to of beam

Asymmetry due to multiple scattering inside the target material
SIGNAL SHAPES

Full signal shape vs 8 accumulator/integral region
DETECTOR MONITORING AND ARCHIVING SYSTEM

The EPICS based system

- COSY compatible EPICS CSS slow control system
- Monitoring of voltage, temperature, ...)

LYSO module internal temperature

Big Karl exp. hall (brown) temperature variation

Blue graph, the supply voltage for the same module

*The apparent correlation between all the values is evident.*
ONLINE ASYMMETRY MONITORING

Elastic $\bar{d}C \rightarrow dC$ scattering

$\Theta = 4^\circ \rightarrow 9^\circ$

$\Theta = 4^\circ \rightarrow 15^\circ$
VECTOR ANALYZING POWER

Elastic $\vec{d}C \rightarrow dC$ scattering

$T_{\vec{d}} = 270 \text{ MeV}$

$T_{\vec{d}} = 300 \text{ MeV}$