

#### Pellet target development for the EDM search experiment at storage ring COSY

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### **Overview**

1) Introduction

2) Polarimeter concept

- 3) Target systems
- 4) Pellet target
  - 1) System design
  - 2) Triggrting and TOF
  - 3) Image processing
  - 4) Some tests
- 5) Summary



# **EDM – Electric Dipole Moment**

- fundamental property of particles (like magnetic moment, mass, charge)
- permanent separation of positive and negative charge

For all *EDM* experiments Interaction of *d* with *E* is necessary!

Method:

- a) Store longitudinally polarized particles in storage ring
- b) Interact with a radial E-field
- c) Analyze Polarization Build-up





 $\frac{d\vec{s}}{dt} \propto d \cdot \vec{E} \times \vec{s}$ 

### **COSY storage ring**



Internal and external beams

High polarization (p, d) Spin manipulation !!!



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# **Polarimeter concept**

- ► Reaction with Large FOM  $(\sigma A_y^2) \& (\sigma_{ela}/\sigma_{tot})$ : Best dC→dC
- Maximum Detection & Data Taking Efficiency
- ≻ Full Φ in Reasonable FOM(θ) region





# LYSO calorimeter modules

.52 independent LYSO modules .Each module is tested and calibrated separately

Silicon layer **Optical coupling** Mechanical stability

> Cut corners for mechanical fixation





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## **LYSO calorimeter modules**





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Slide 9

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### **Different target systems**

- 1. Carbon block extraction Strong EM influence on beam
- 2. Wire target inefficient, even with very thin wire the dencity is still too high



### **Carbon block target used in JePo**



target driver system

carbon block target 2x2x3cm





hardware interlock system



Horizontal and vertical targets in the target chamber



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# **Carbon block target (working principle)**

- 1. Industry standart G-code interface
- 2. EPICS based network controll
- 3. Several level safety systems
- 4. Automatic position search
- 5. Automatic controll mode





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# **JUDIT - Juelich Ballistic Diamond Pellet Target**

- Target capable to measure 2D/3D polarization profile
- Huge dynamic range in effective target thickness
- "quasi" Non-invasive, no rest gas
- small size 10-100 µm diamond pellets







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### **Pellet target system (realisation)**







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# **Pellet TOF (time of flight) measurement**







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#### **Test beanch fot TOF measurement**











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#### **TOF test results**

JDP Setup	Serial	TC	P Client   TCP Ser	ver UDP
eceived/Se	ent data			
current	time	->	103.250824	ms
urrent	time	->	103.250824	ms
urrent	time	->	103.250827	ms
urrent	time	->	103.250824	ms
current	time	->	103.250824	ms
current	time	->	103.250824	ms
urrent	time	->	103.250824	ms
current	time	->	103.250824	ms
current	time	->	103.250824	ms
current	time	->	103.250824	ms
urrent	time	->	103.250824	ms
urrent	time	->	103.250822	ms
urrent	time	->	103.250824	ms
urrent	time	->	103.250824	ms
current	time	->	103.250822	ms
current	time	->	103.250824	ms
current	time	->	103.250822	ms
current	time	->	103.250824	ms
Modem line	25			*
Send				





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#### **FPGA design**



#### **FPGA image processing core**





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### Image processing hardware



667 MHz dual-core Cortex-A9 processorHigh-bandwidth peripheral controllers: 1G Ethernet, USB 2.0, SDIO1 GB DDR3L RAM

FPGA - XC7Z020-1CLG400C Look-up Tables (LUTs) 53,200 Flip-Flops 106,400



5MP color system-on-chip image sensor

Dual lane MIPI CSI-2 image sensor interface

Supports QSXGA@15Hz, 1080p@30Hz, 720p@60Hz, VGA@90Hz and QVGA@120Hz

Output formats include RAW10, RGB565, CCIR656, YUV422/420, YCbCr422, and JPEG compression



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#### **FPGA image processing tests**

Image from custom linux running on FPGA board

Test using color invert and Sobel filter

Test using Pewitt filter

.





Test using canny edge detect ad standalone firmware with SD card frame grabber





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#### **FPGA image processing tests**





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# Summary

- JePo has been installed at COSY ring and successfully used in several EDM experiments.
- Carbon block target control, monitoring and safety systems has been developed and tested.
- Pellet target (JUDIT) concept has been suggested.
- TOF system is developed and tested on test bench.
- Different parts for pellet target system has been developed, includeing interfacing with camera and HDMI.
- The object detection and tracking IPs has been created and demonstrated with simulations.

# Outlook

- Apropriate mechanical system must be developed to demonstrat the whole concept of JUDIT.
- Better and faster camera sollution must be found to have more precise tracking.
- User side software has to be developed to control target from remote location.

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# **Thank You**



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