



LYSO-based polarimeter

Towards the JEDI Polarimetry

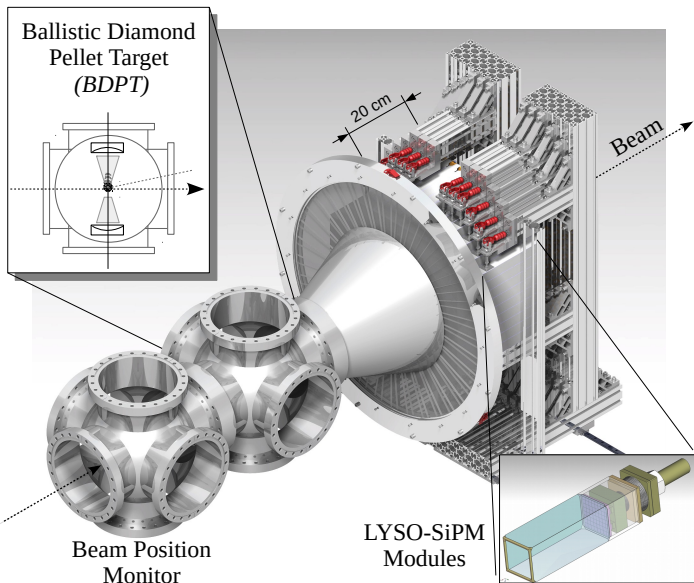
EDM kick-off meeting | CERN

March 13th, 2017 | Dr. Irakli Keshelashvili |

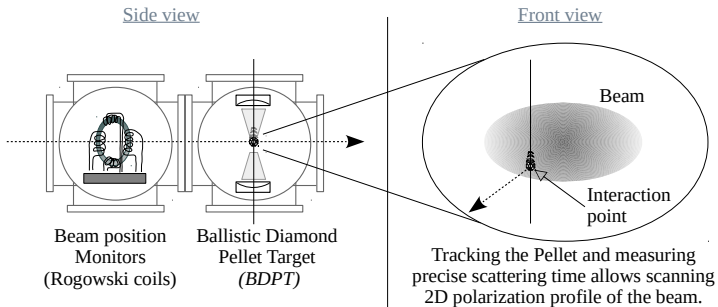


EDM – Precision Experiment !!!

- Reaction with Large A_y : Best $dC \rightarrow dC$!!!
- **Maximum** Detection & Data Taking Efficiency !!!
- **Full ϕ** in Reasonable **FOM(θ)** region !!!
- **No** Magnetic / Electric Field !!!
- **Stability** – Long / Short Term !!!



- Target capable to measure polarization profile
- Huge dynamic range in effective target thickness
- Non-invasive, no rest gas

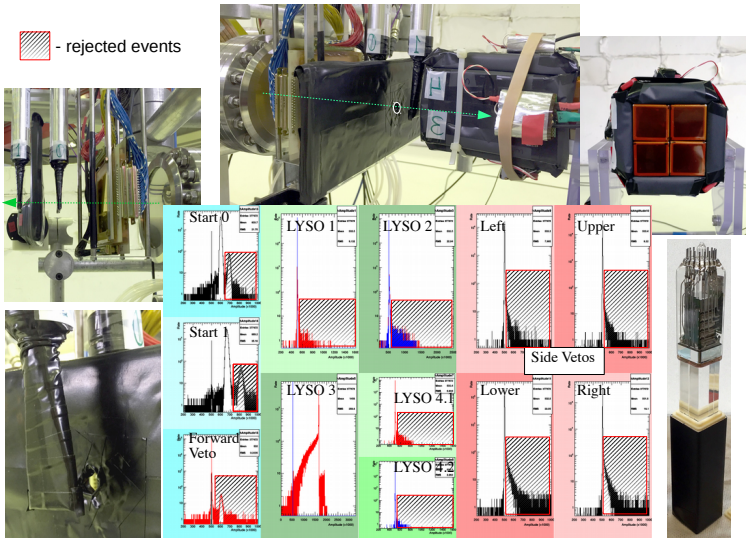


First Step: LYSO Crystal Test

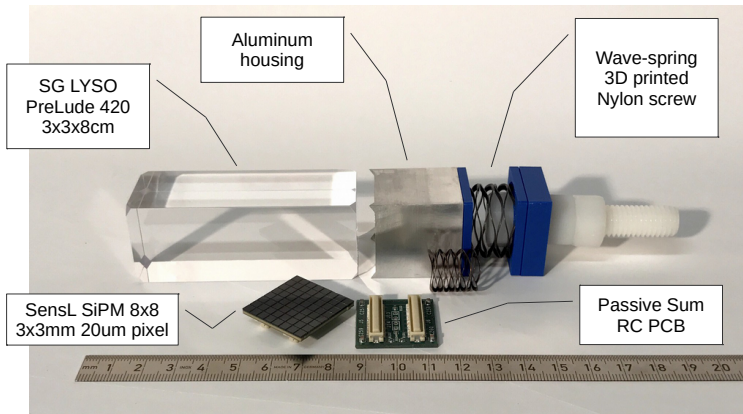
E-Linearity, E/T-Resolution, d-Efficiency, DAQ, Bragg Peak, Vendors,...



 - rejected events

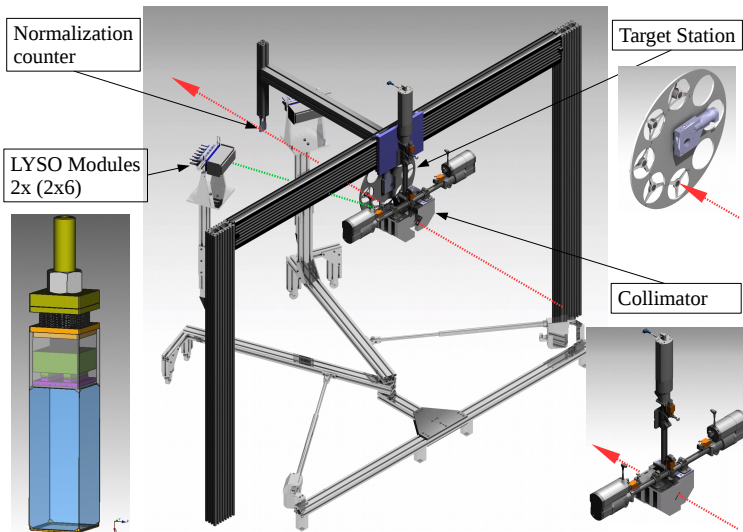


- Test of FADC (250 MS/s, 14-bit) 'dead-time less' **DAQ** system
Full signal shape were recorded
- Linearity of **particle energy** vs. **light output** up to **270 MeV**
- Energy Resolution ($\frac{FWHM}{Amp} \sim 1\%$), time resolution $\Delta t \sim 300ps$
- *d* detection/reconstruction eff. @ 270 MeV drops $\sim 70\%$
- Measuring Bragg-Peak by rotating split LYSO,
peak @ 6 cm @ 270 MeV \rightarrow crystal length 8 cm (can be flipped)
- Tests of Saint-Gobain and EPIC Crystals with **PMT & SiPM (C)**



Current Beam Time

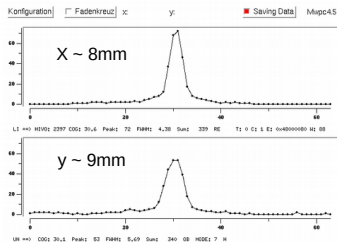
Asymmetry Measurements & Target Material Test



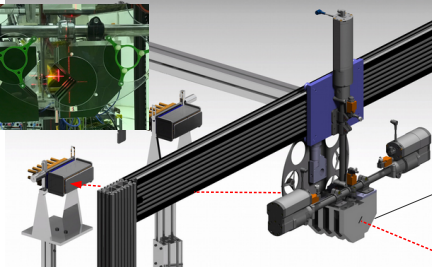
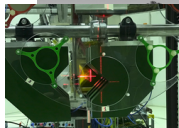
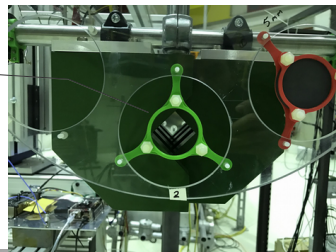
Member of the Helmholtz-Association

Collimator System

December 2016 Beam Time



Empty target holder

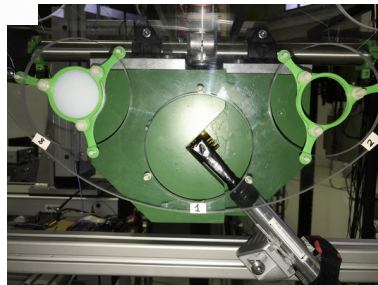
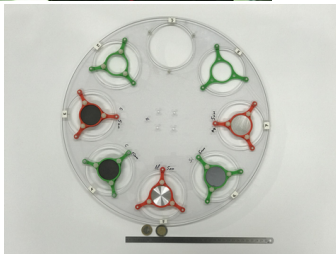
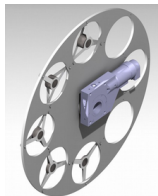
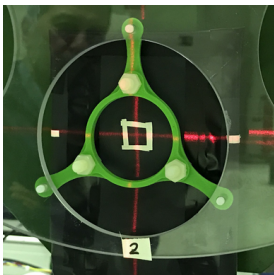


2D movement
Spot diameter

4x2.5cm Iron
collimator blades

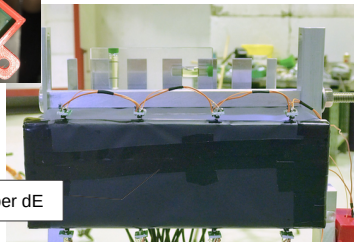
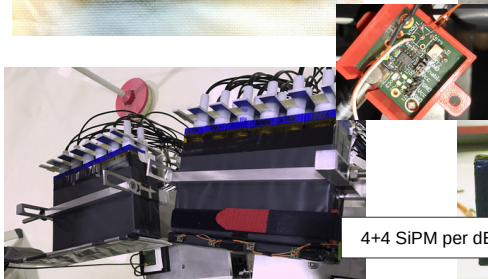
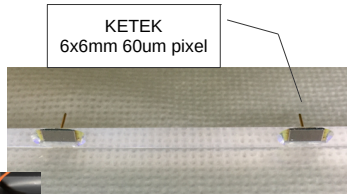
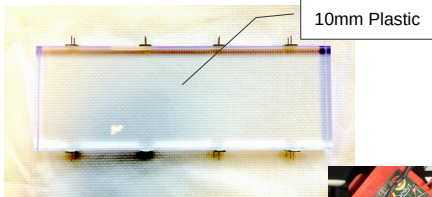
Target System + Start Counter

December 2016 Beam Time



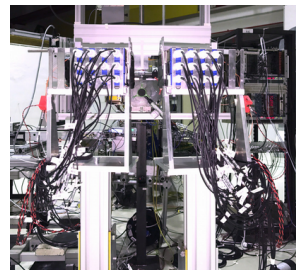
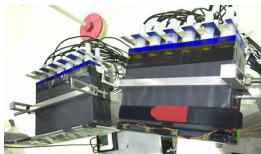
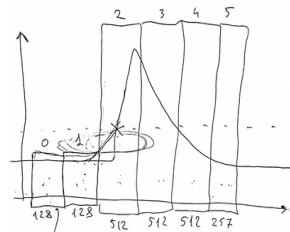
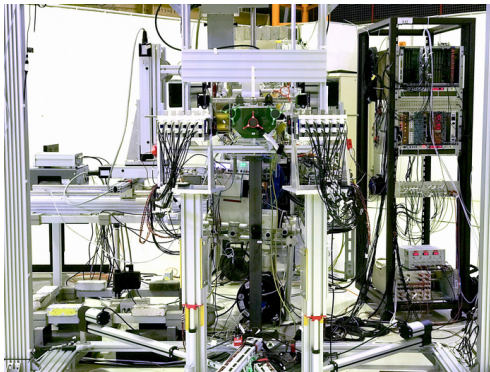
dE 10mm SiPM Scintillators

December 2016 Beam Time

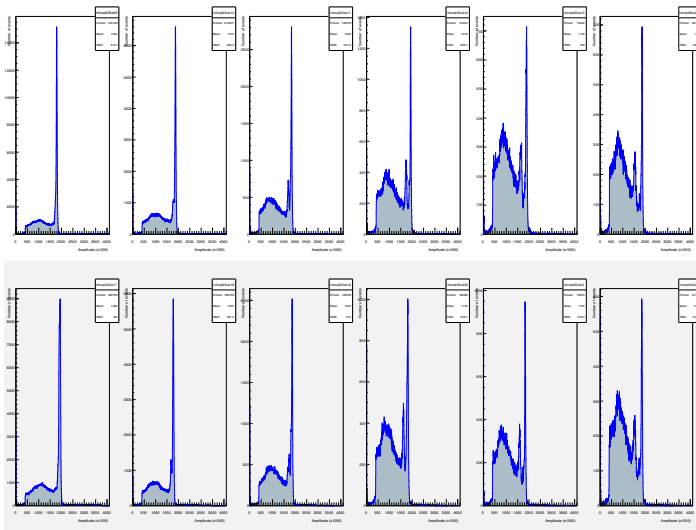


Different Configurations

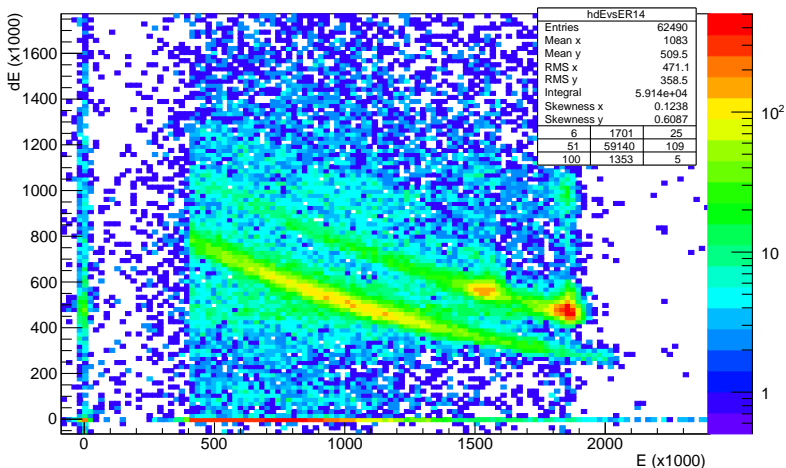
December 2016 Beam Time



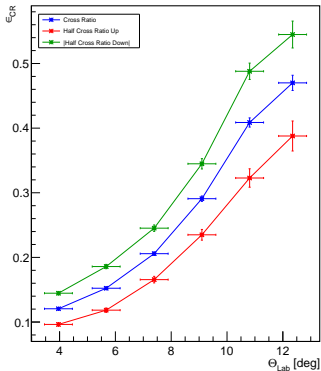
Measurement on CH_2 Polyethylene target



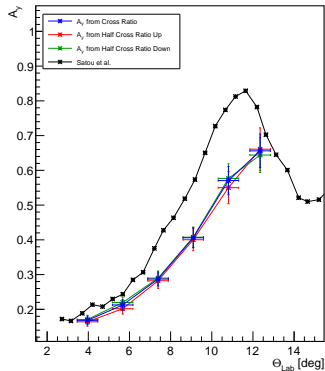
Measurement on CH_2 Polyethylene target



Asymmetry Cross Ratio



Vector Analyzing Power

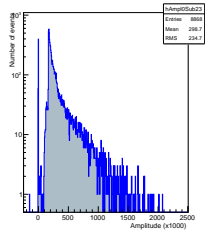
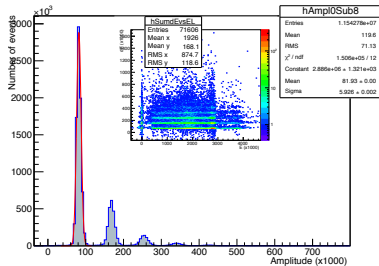
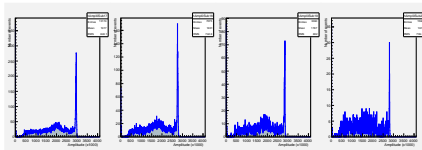
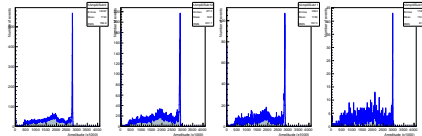
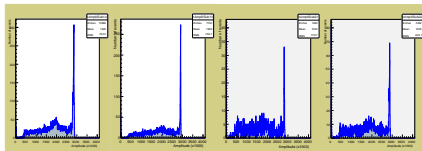


Preliminary results on $\frac{d\sigma}{d\Omega}$

Not yet done!

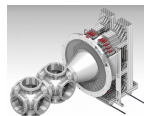
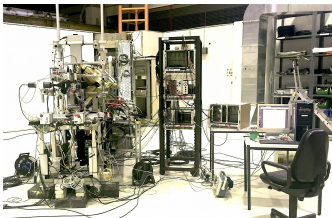
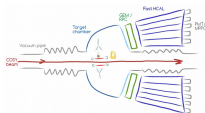


$$\vec{d}C \rightarrow dC \text{ at } T_d = 270 \text{ MeV}$$



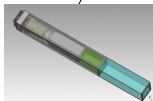
Time-line

Towards Precursor Experiment

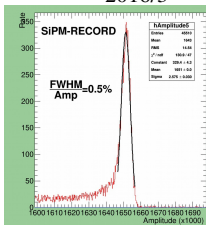


BIG/KARL

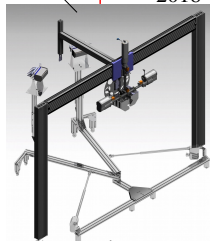
COSY



Lab tests

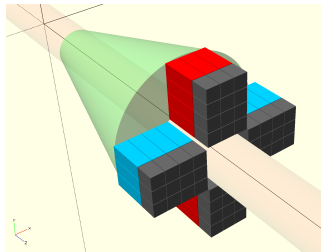


1 Week BT



Coming beam tests

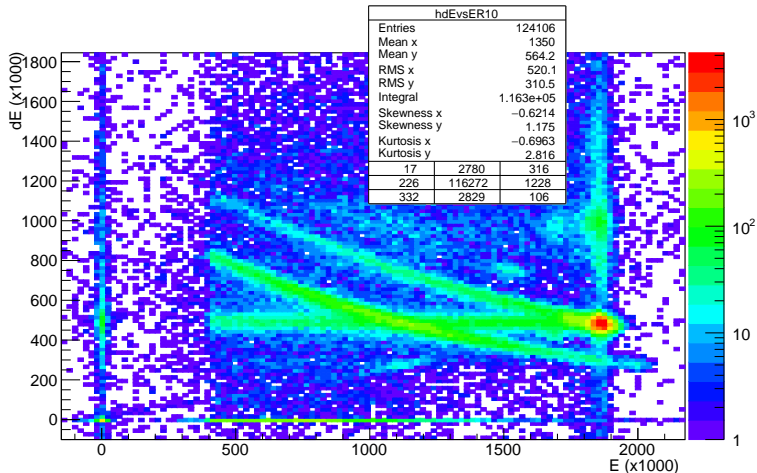
- 3 very successful beam times performed.
4th started today morning 😊
- $\Delta E(x)$ Plastic scintillator modules are under development...
- All 24 LYSO-SiPM modules performed well.
New 24 modules will be assembled and tested in 2017
in total 48 (4x12) Modules
- **Now we have universal external beam experimental setup with various measurement possibilities.**





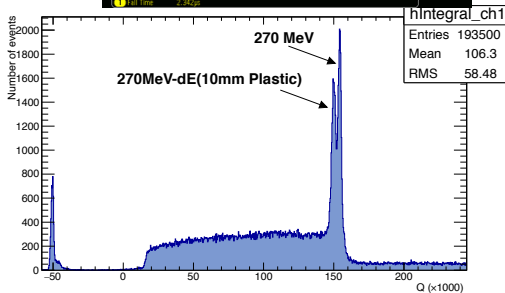
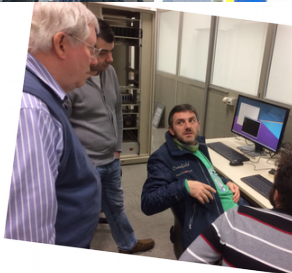
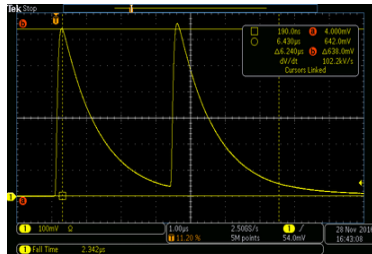
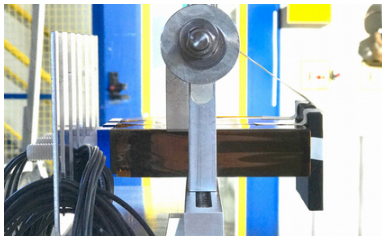
Appendix

Measurement on Carbon target



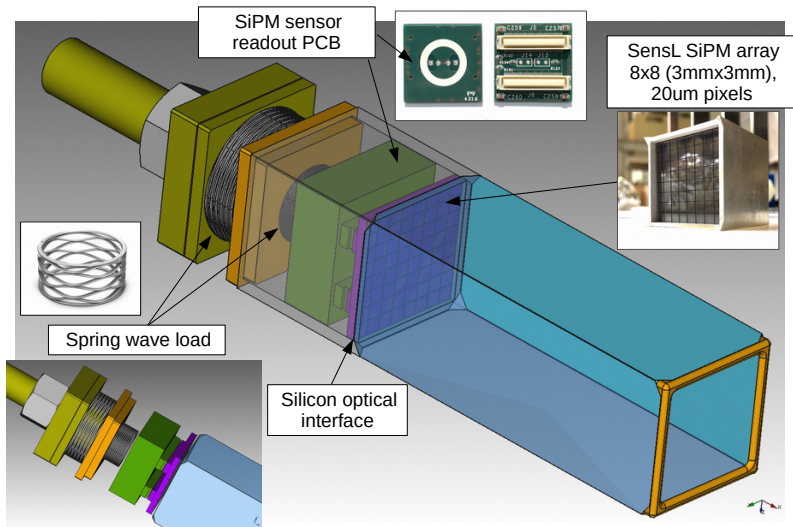
First Saturation Test

December 2016 Beam Time



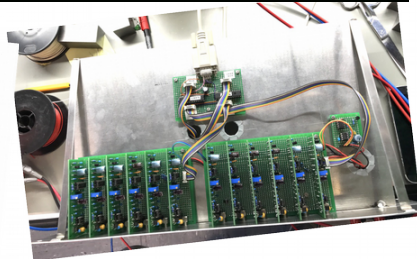
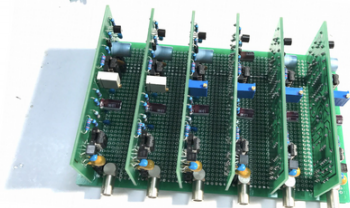
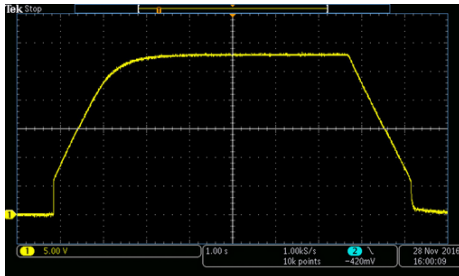
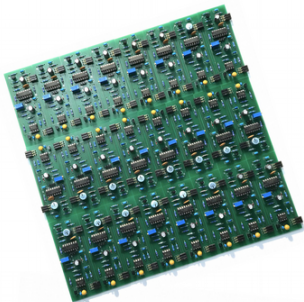
LYSO Modules

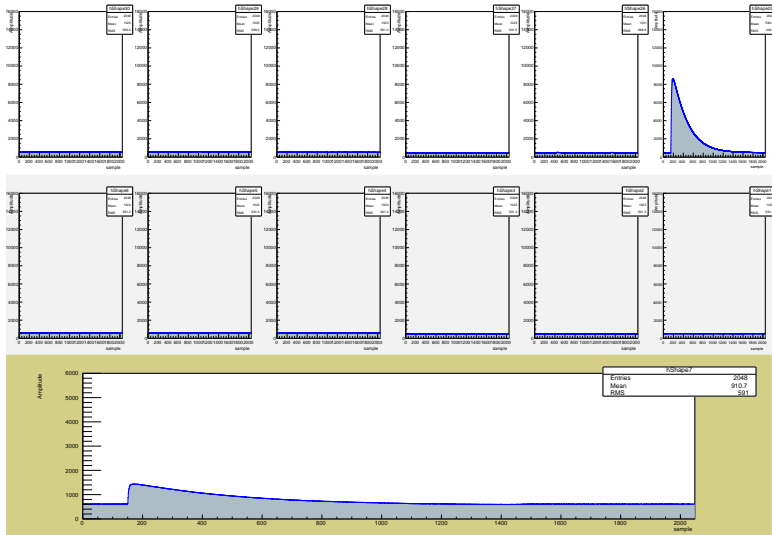
SiPM based LYSO module



SiPM Voltage Supply

December 2016 Beam Time





Slow Control System

December 2016 Beam Time



LYSD Beamtime II - Slowcontrol

ReloClaw Temperatures:

Arm Horizontal Controller	54.7 C
Aperture Horizontal Controller	54.8 C
Aperture Vertical Controller	49.8 C

Aperture & Normalisation:

Left Arm - Horizontal	0.8 deg	Aperture - Vertical	15.0 mm
Right Arm - Horizontal	0.0 deg	Aperture - Position	-4.0 mm
Left Arm - Vertical	0.0 mm	Aperture - Size	30.8 mm
Right Arm - Vertical	0.0 mm	Target Station	Carbon 10 mm

Left Modules:

Module 1 on	Module 2 on
Module 3 on	Module 4 on
Module 5 on	Module 6 on
Module 7 on	Module 8 on
Module 9 on	Module 10 on
Module 11 on	Module 12 on

Right Modules:

Module 1 on	Module 2 on
Module 3 on	Module 4 on
Module 5 on	Module 6 on
Module 7 on	Module 8 on
Module 9 on	Module 10 on
Module 11 on	Module 12 on

Target Power Control:

Beam	Beamline 5 mm
Target Power	Beamline 8 mm
Carbon 5 mm	Magnesium Beam
Carbon 10 mm	On/Off - Substructure

Enable / Disable LYSD Module - Left Side:

1	2	3	4	5	6	7	8	9	10	11	12
1	2	3	4	5	6	7	8	9	10	11	12

Enable / Disable LYSD Module - Right Side:

1	2	3	4	5	6	7	8	9	10	11	12
1	2	3	4	5	6	7	8	9	10	11	12

Left Arm - Horizontal Positions:

1	2	3	4	5	6	7	8	9	10	11	12
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Right Arm - Horizontal Positions:

1	2	3	4	5	6	7	8	9	10	11	12
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Left Arm - Vertical Positions:

1	2	3	4	5	6	7	8	9	10	11	12
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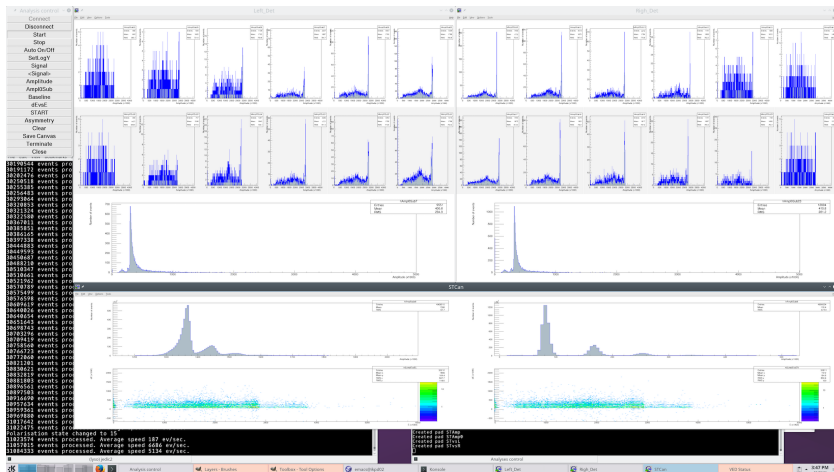
Right Arm - Vertical Positions:

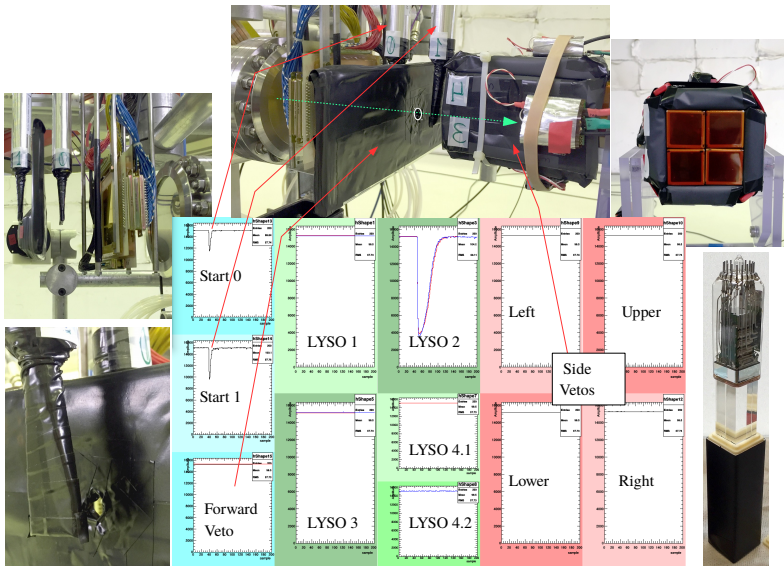
1	2	3	4	5	6	7	8	9	10	11	12
---	---	---	---	---	---	---	---	---	----	----	----

Aperture - Vertical: [-15 - 256 [mm]]

Aperture - Position: [-17 - 17 [mm]]

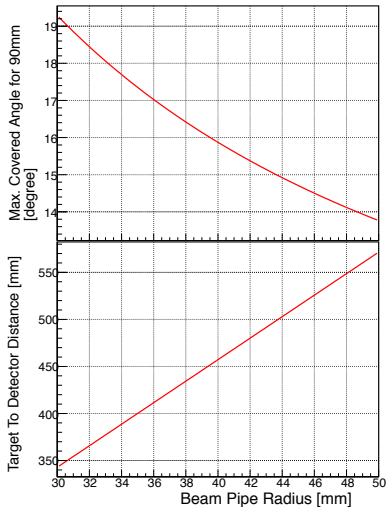
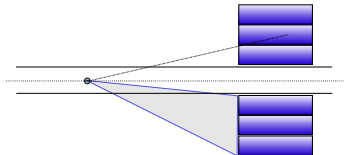
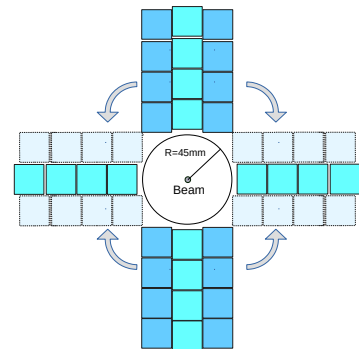
Aperture - Size: [12.8 - 216.8 [mm]]





Cross JEDI Polarimeter

48 crystals



Acknowledgment

People contributing to the experiment



- Mechanics: N. Giese, M. Maubach, G. D'Orsaneo & D. Spölgén
- Electronics: Tanja Hahnrahts-von der Gracht & T. Sefzick
- DAQ & FEE: D. Mchedlishvili, L. Barion & P. Wüstner
- G4: G. Macharashvili, P. Maanen & N. Lomidze
- **Ms & Bs: O. Javakhishvili, M. Gagoshidze**
- **PhD: F. Müller, S. Basile, & D. Shergelashvili**



Current Proposal

Production run !

*Polarized \vec{d} -beam on
Mg, C, CH₂, Si, Al-targets
at five different energies*

1 Week (+ MD) → March 2017 (2x PhD and 1 Ms Student)