



LYSO-based polarimeter

*Towards the JEDI Polarimetry*

*EDM kick-off meeting | CERN*

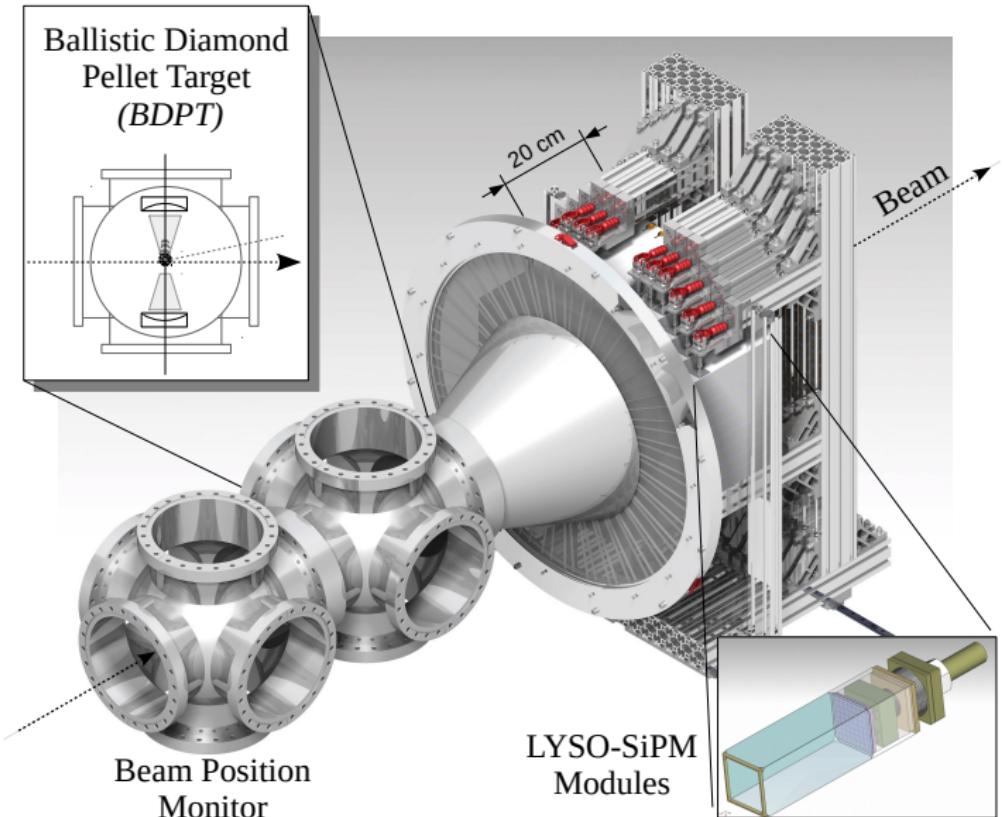
March 13<sup>th</sup>, 2017 | Dr. Irakli Keshelashvili |

### EDM – Precision Experiment !!!

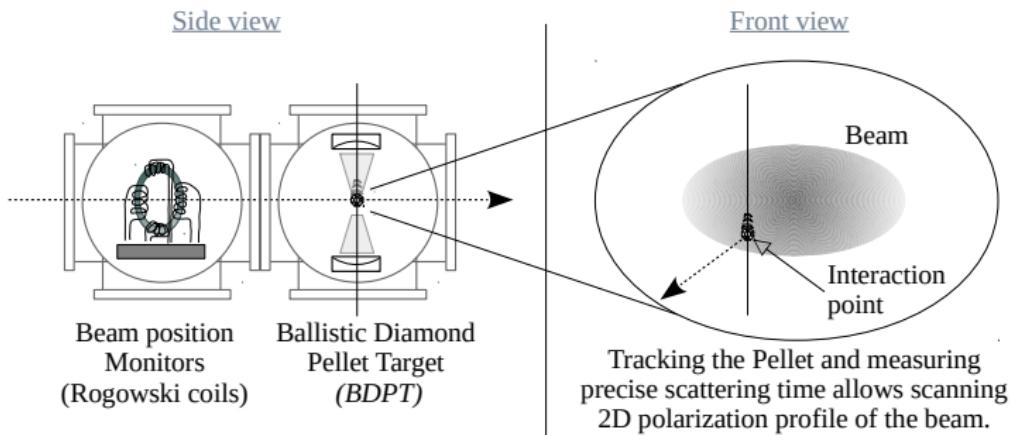
- Reaction with Large  $A_y$ : Best  $dC \rightarrow dC$  !!!
- Maximum Detection & Data Taking Efficiency !!!
- Full  $\phi$  in Reasonable FOM( $\theta$ ) region !!!
- No Magnetic / Electric Field !!!
- Stability – Long / Short Term !!!

# JEDI Polarimeter

Current Design



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

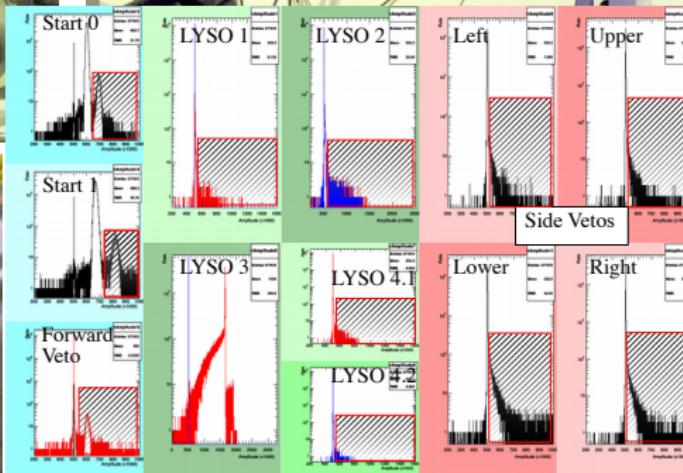
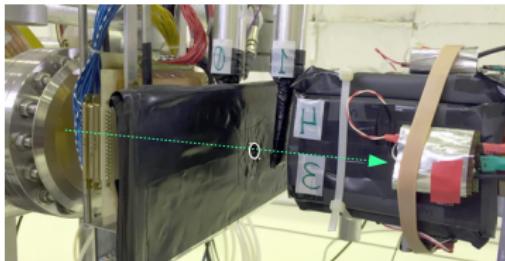


# First Step: LYSO Crystal Test

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



- rejected events



# Results of LYSO Tests

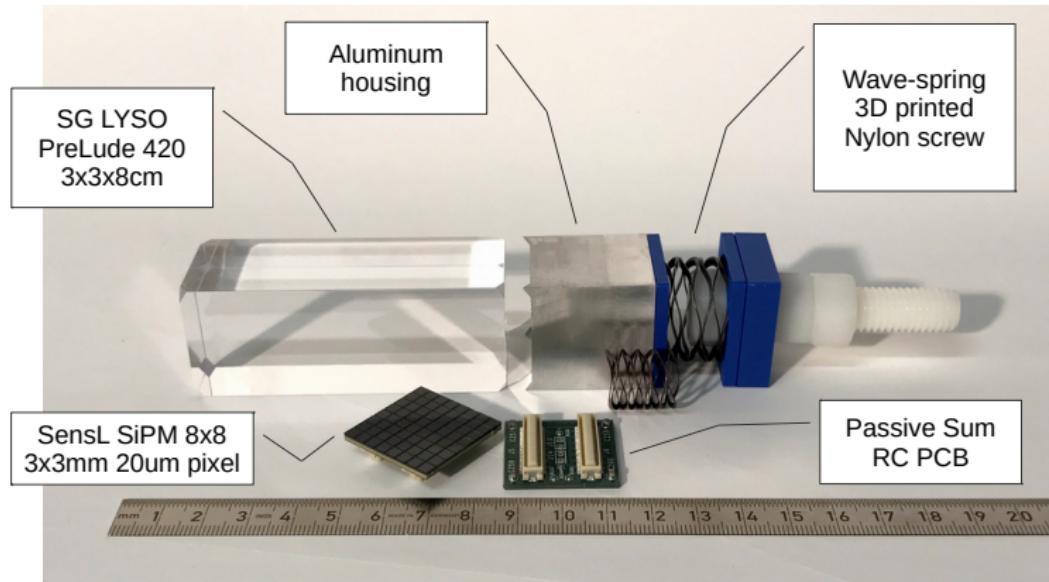
Investigating LYSO material properties



- 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** → crystal length **8 cm** (can be flipped)
- Tests of Saint-Gobain and EPIC Crystals with **PMT & SiPM (C)**

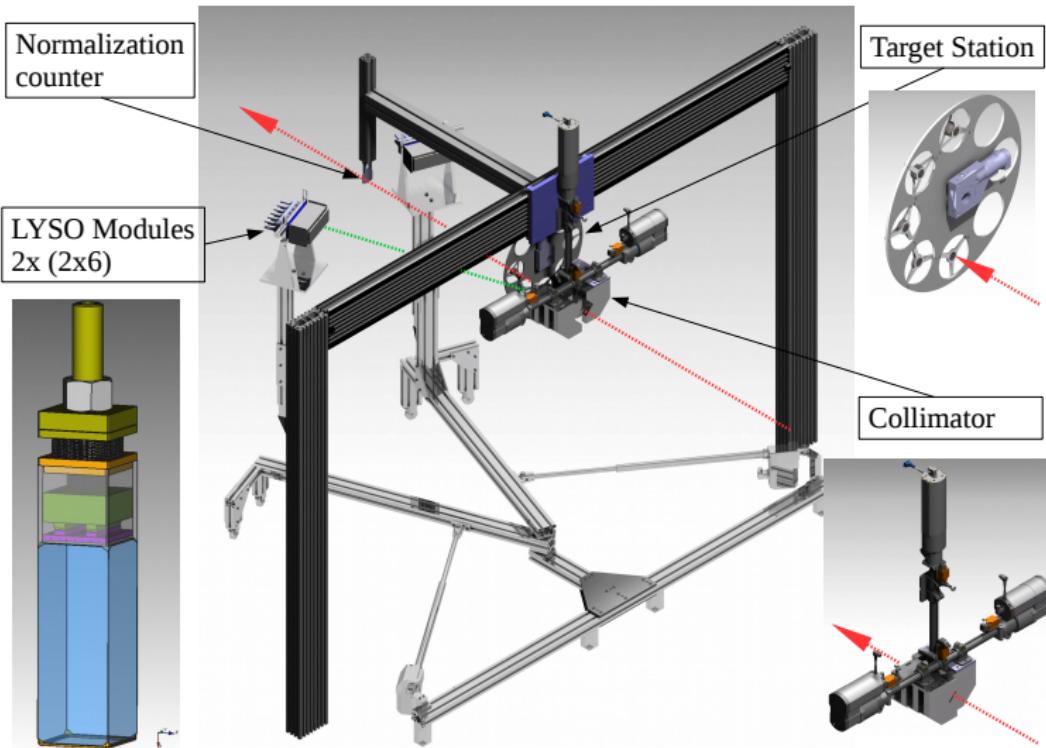
# LYSO Module

December 2016 Beam Time



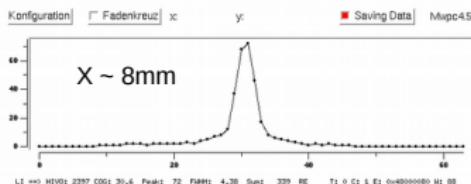
# Current Beam Time

Asymmetry Measurements & Target Material Test

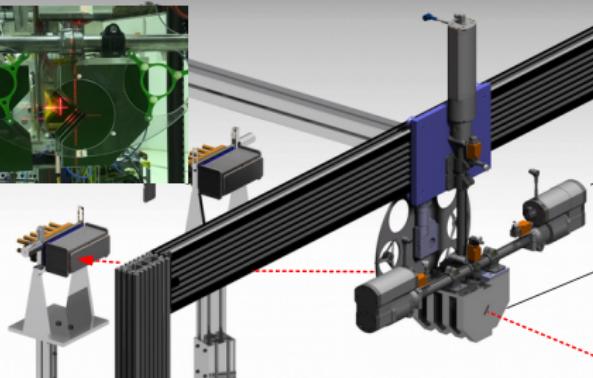
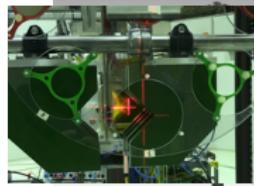
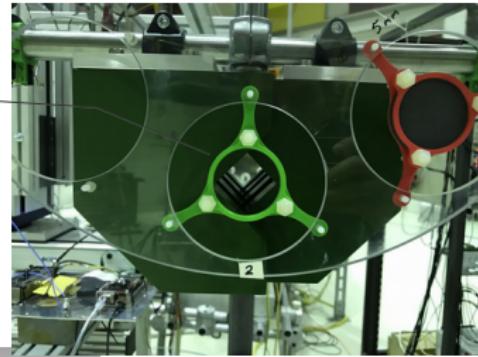
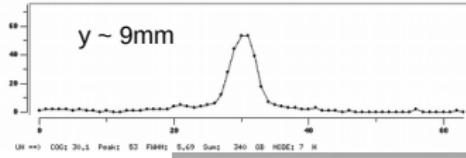


# Collimator System

December 2016 Beam Time



Empty target holder

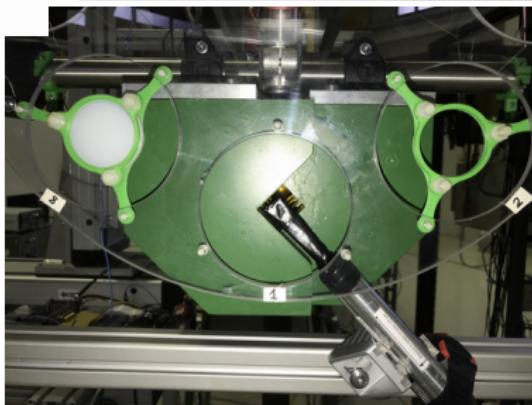
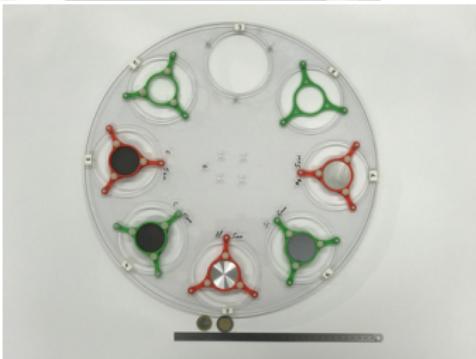
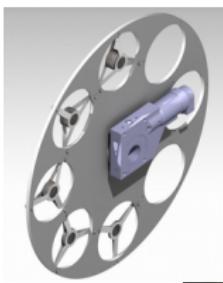
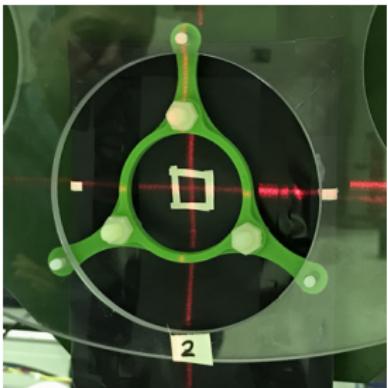


2D movement  
Spot diameter

4x2.5cm Iron  
collimator blades

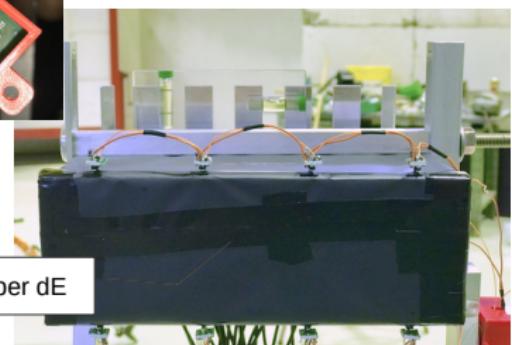
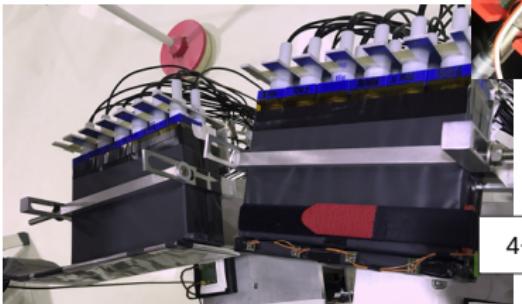
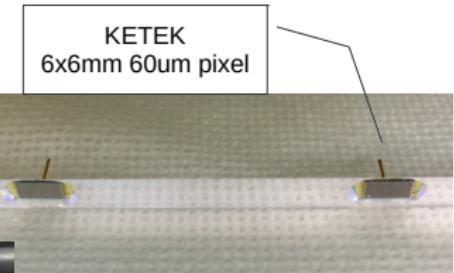
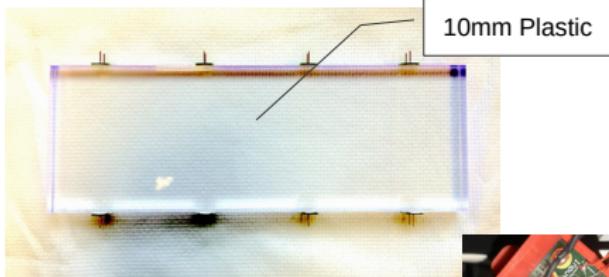
# Target System + Start Counter

December 2016 Beam Time



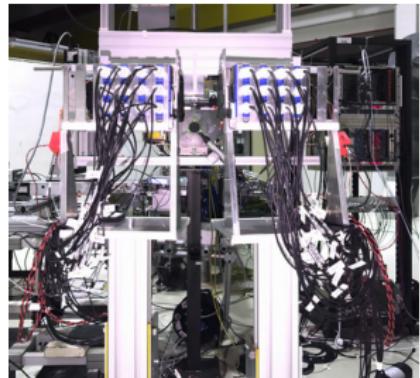
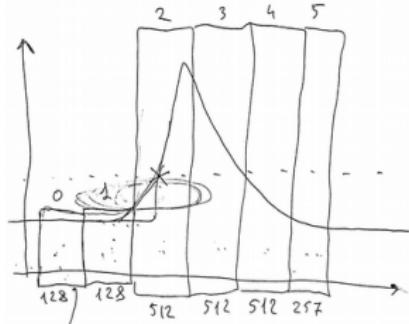
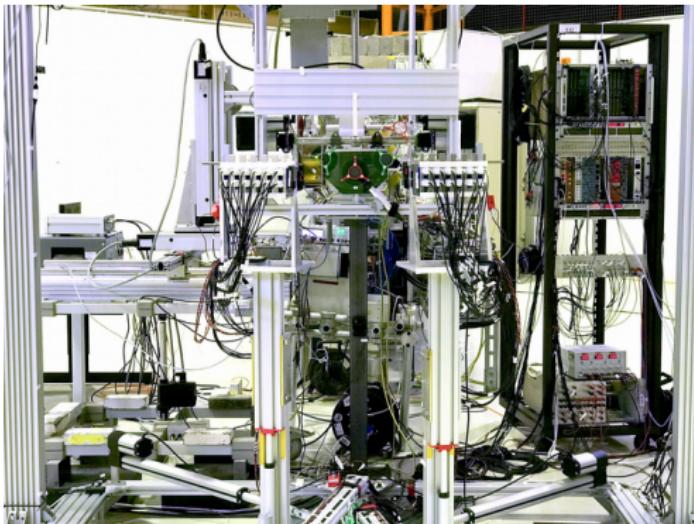
# dE 10mm SiPM Scintillators

December 2016 Beam Time



# Different Configurations

December 2016 Beam Time

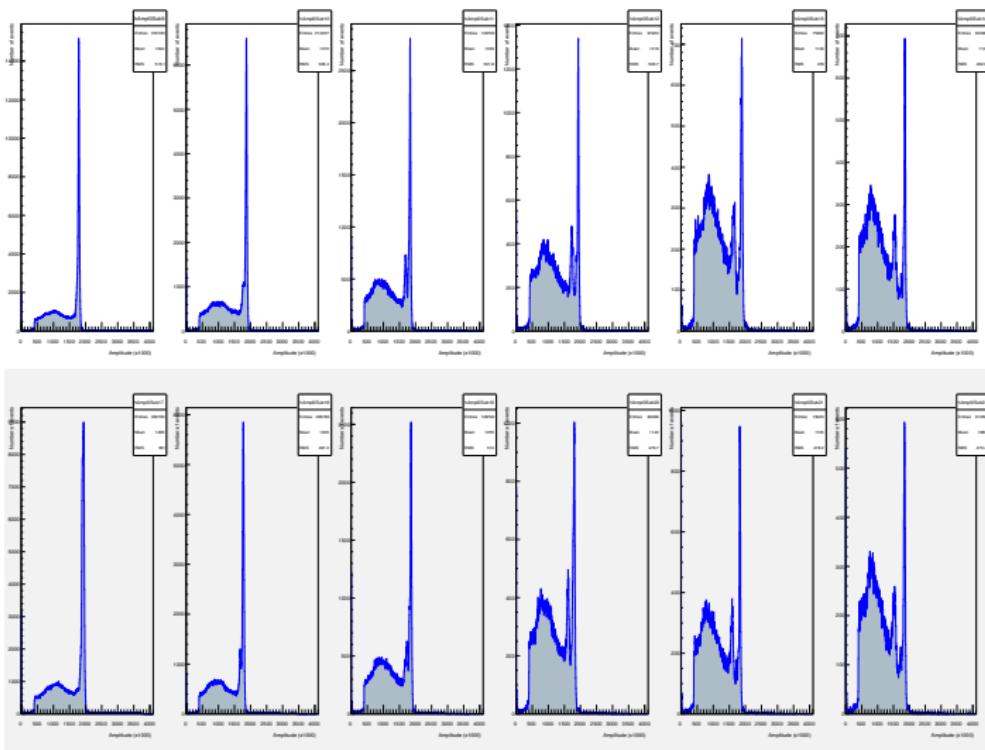


# Preliminary results

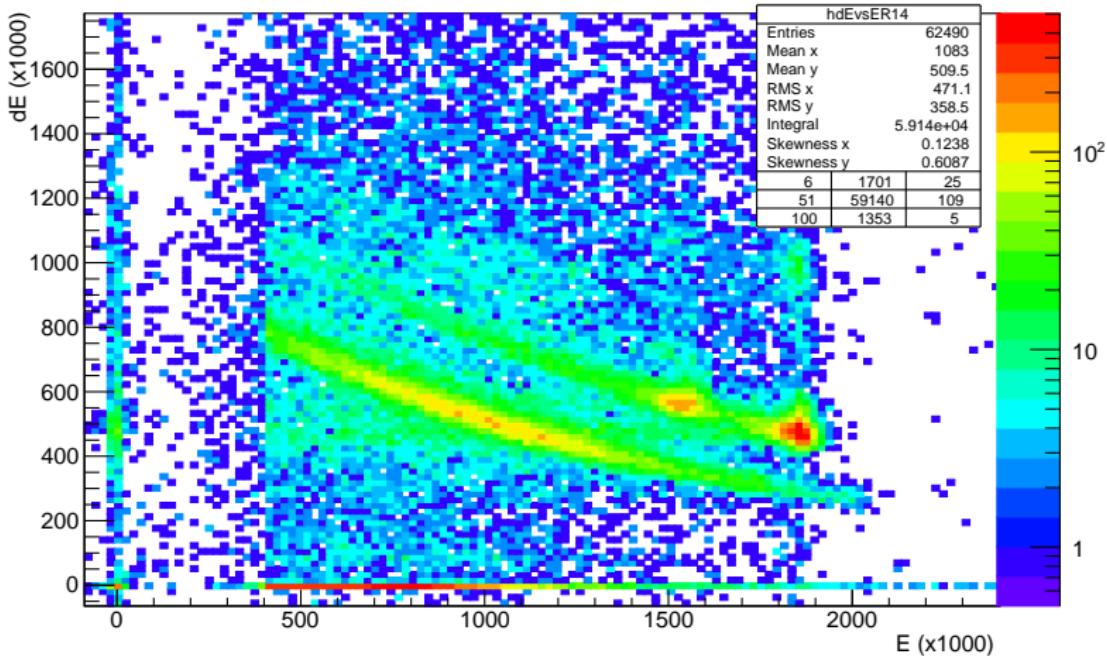
December 2016 Beam Time



## Measurement on $CH_2$ Polyethylene target



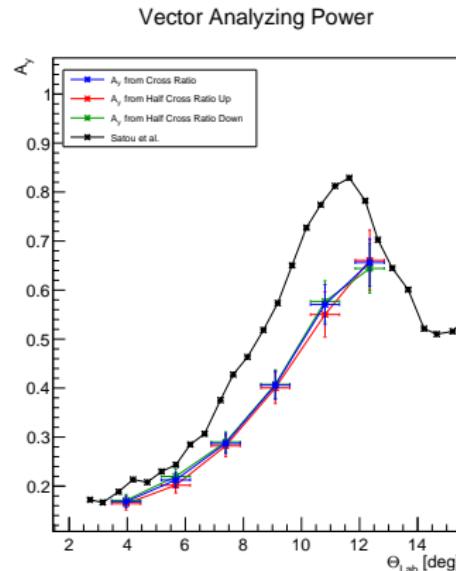
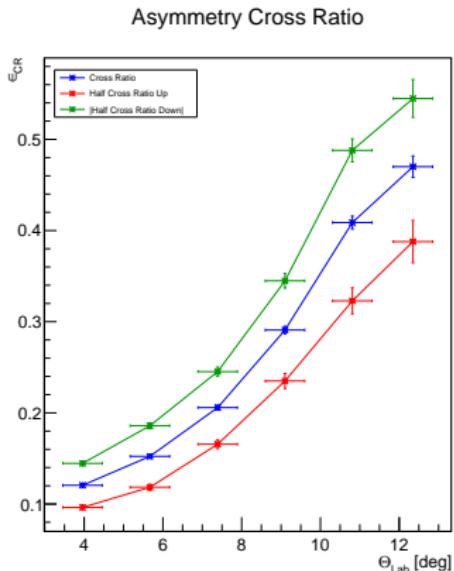
## Measurement on $CH_2$ Polyethylene target



# Preliminary results on $A_y$



Asymmetry: Cross-Ratio

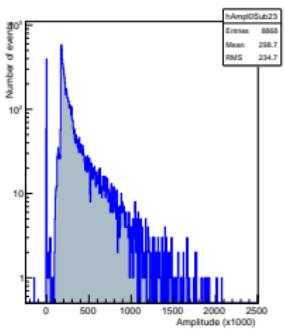
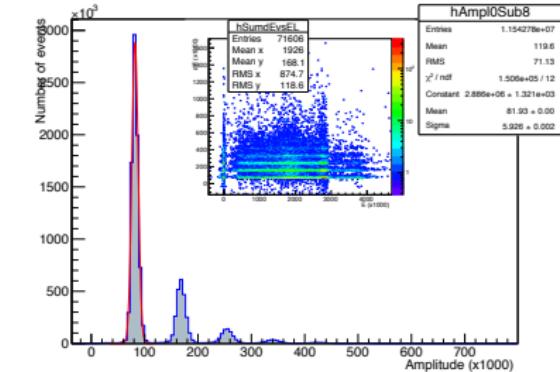
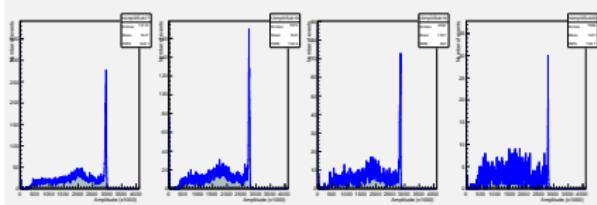
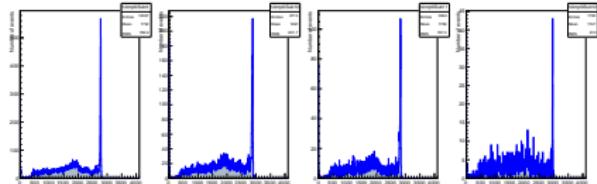
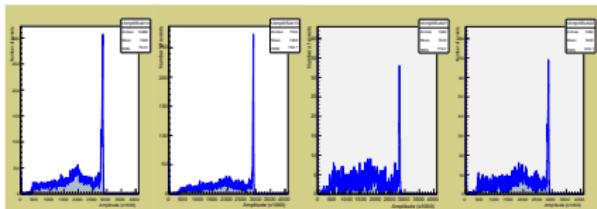


# Preliminary results on $\frac{d\sigma}{d\Omega}$



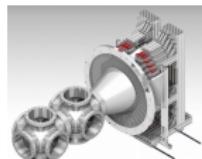
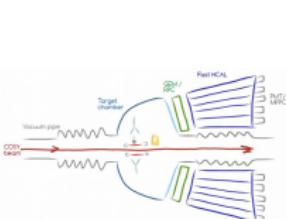
Not yet done!

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

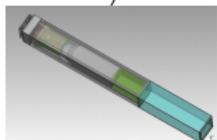


# Time-line

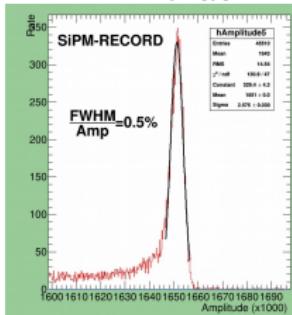
## Towards Precursor Experiment



2014/9 → 2015



Lab tests

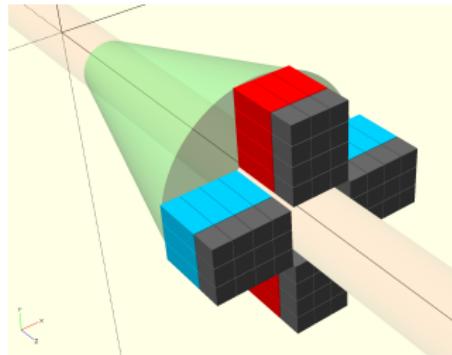


1 Week BT



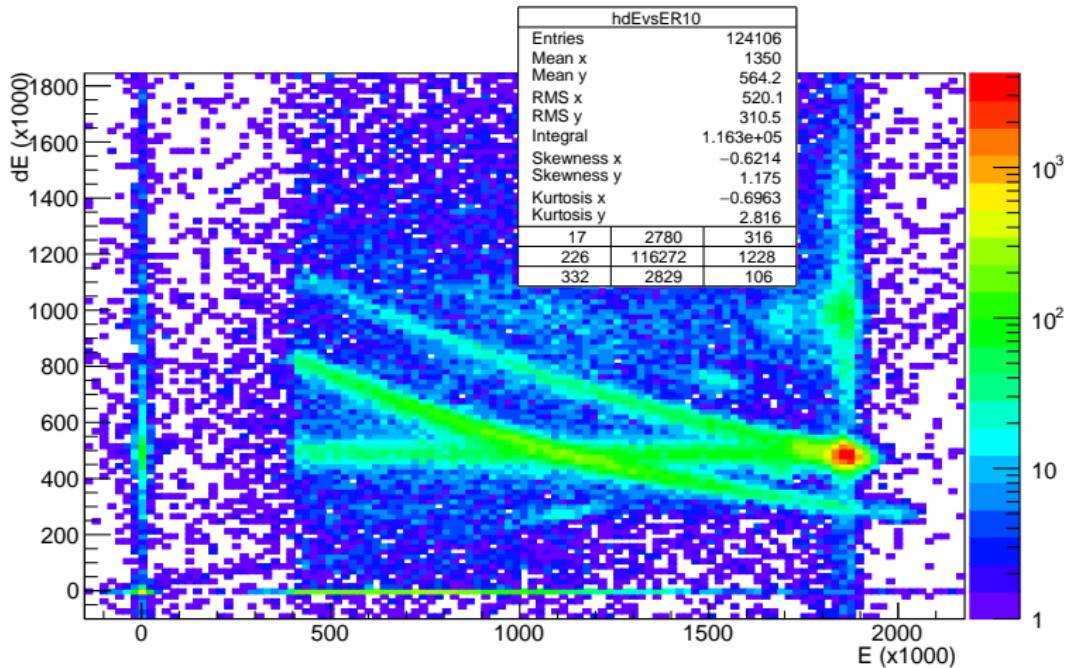
Coming beam tests

- 3 very successful beam times performed.  
 $4^{\text{th}}$  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.



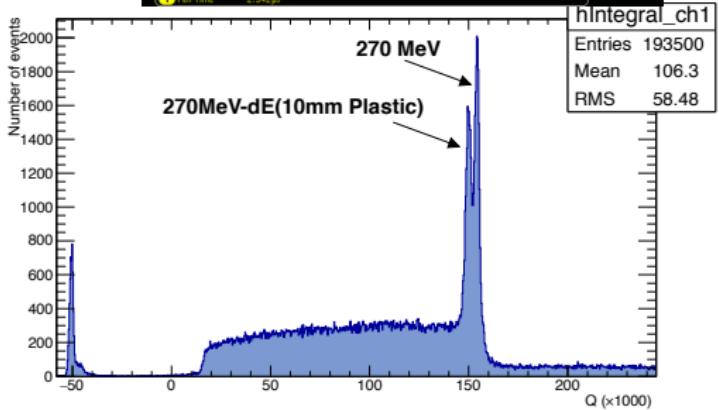
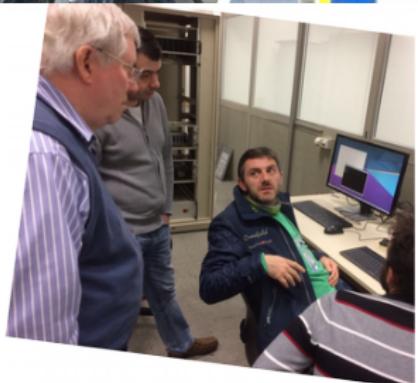
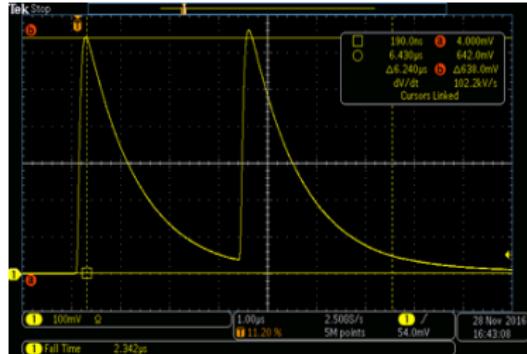
# Appendix

## Measurement on Carbon target



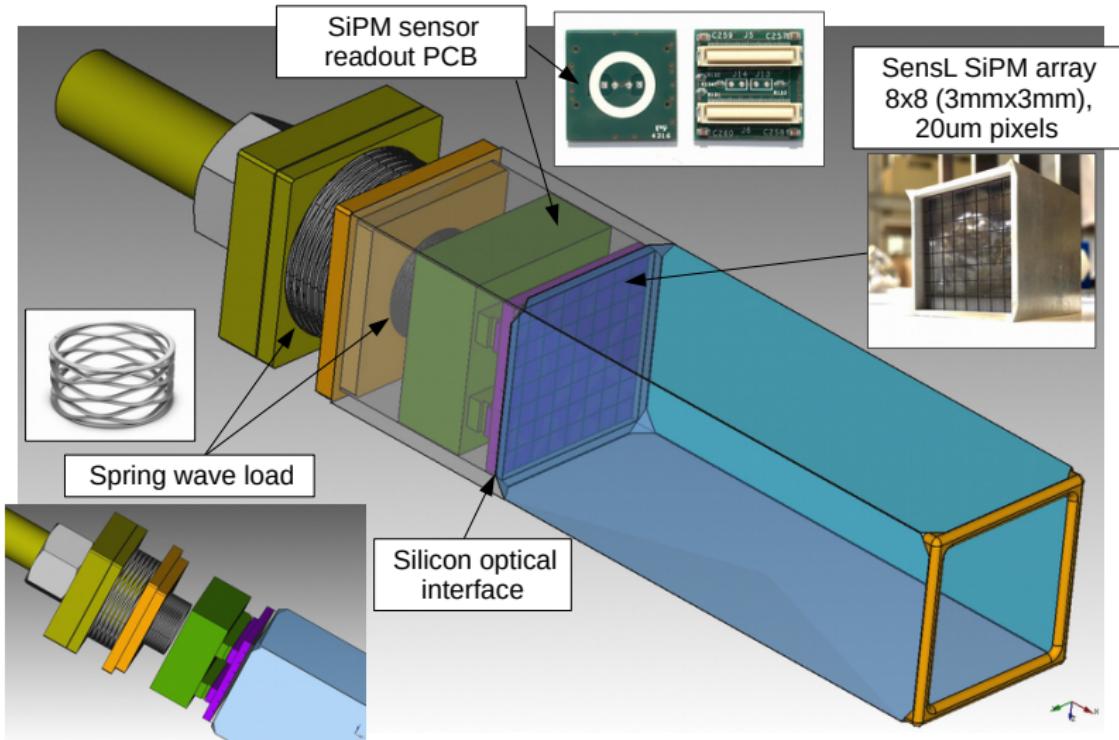
# First Saturation Test

December 2016 Beam Time



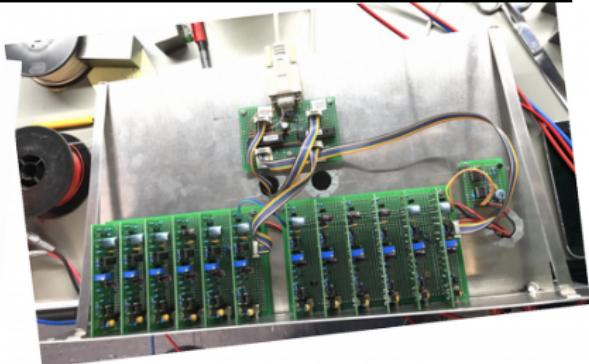
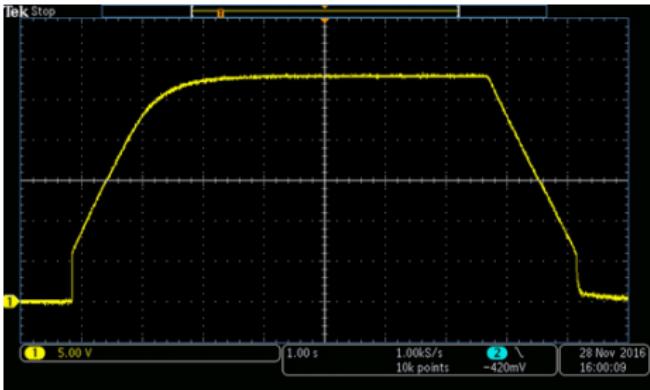
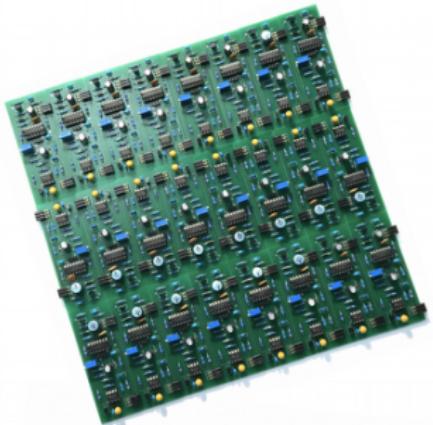
# LYSO Modules

SiPM based LYSO module



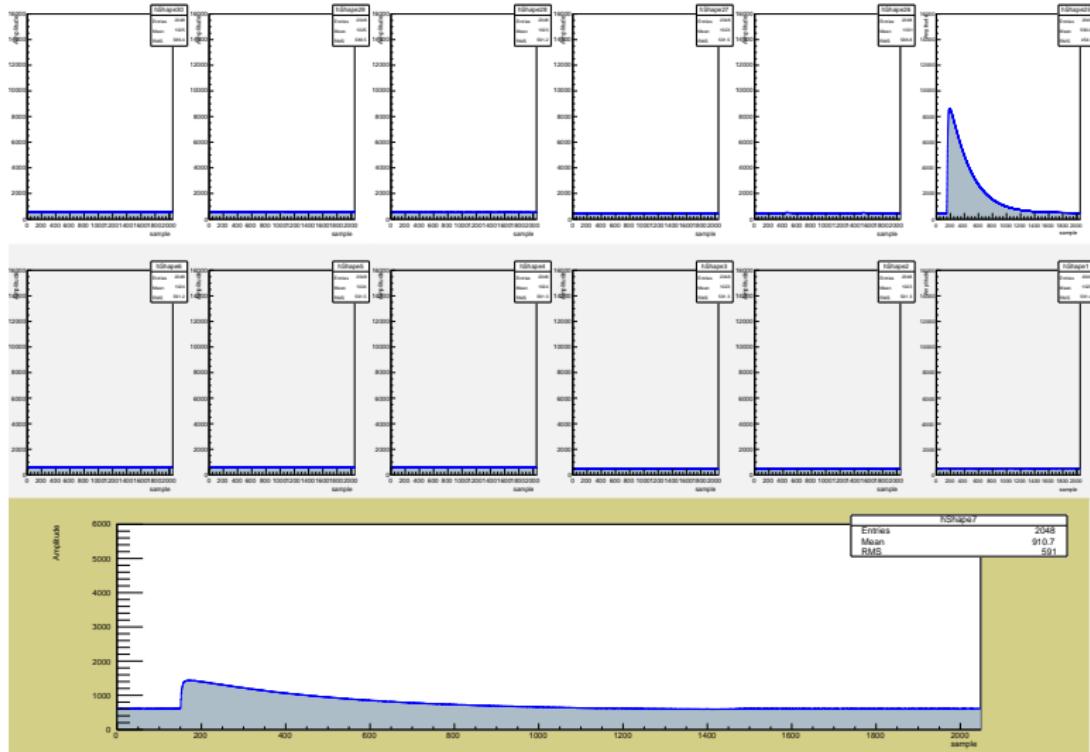
# SiPM Voltage Supply

December 2016 Beam Time



# Online Monitoring

December 2016 Beam Time



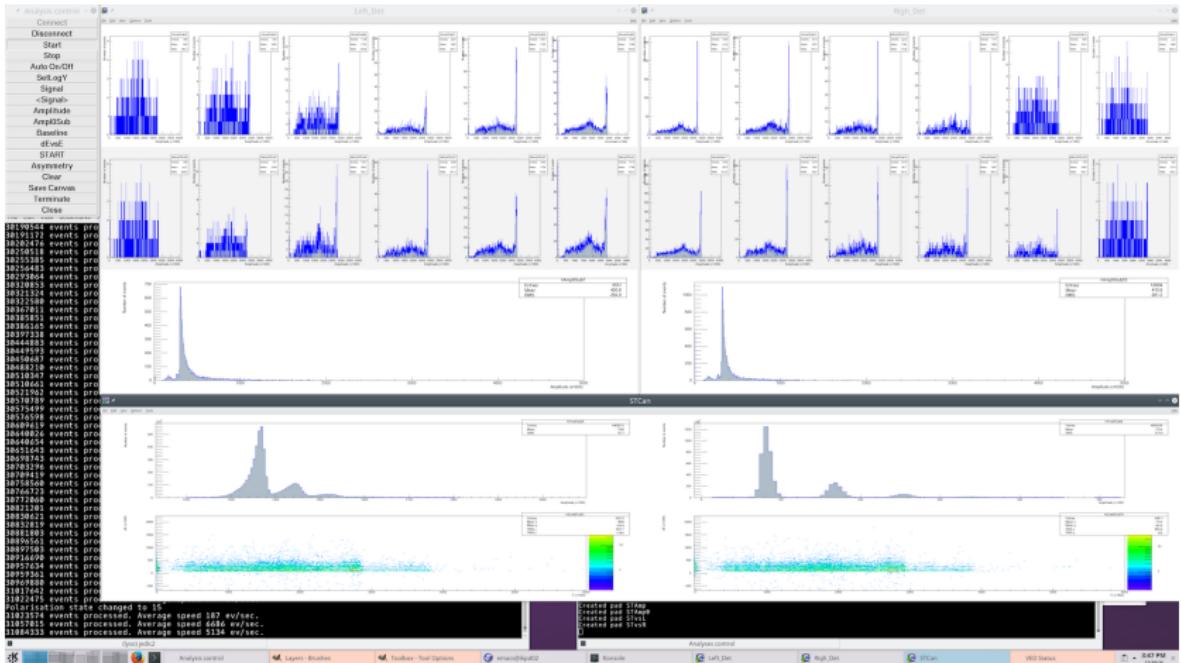
# Slow Control System

December 2016 Beam Time

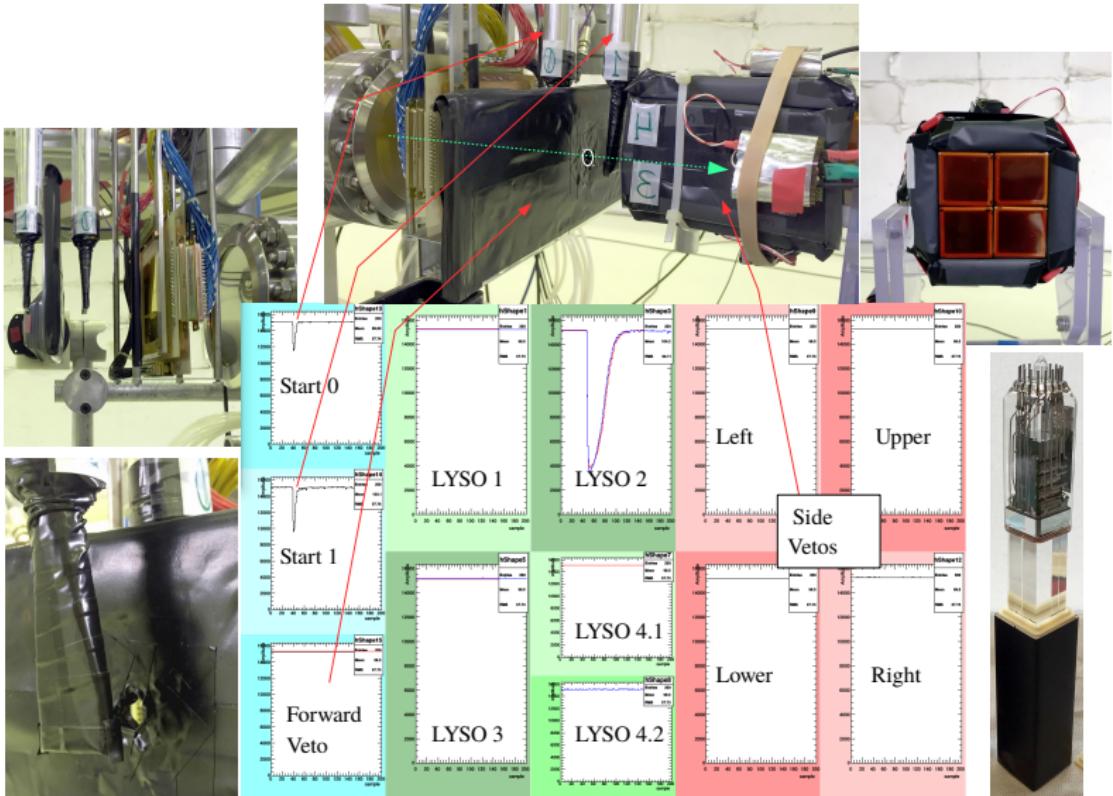


# Online Analysis Software

December 2016 Beam Time

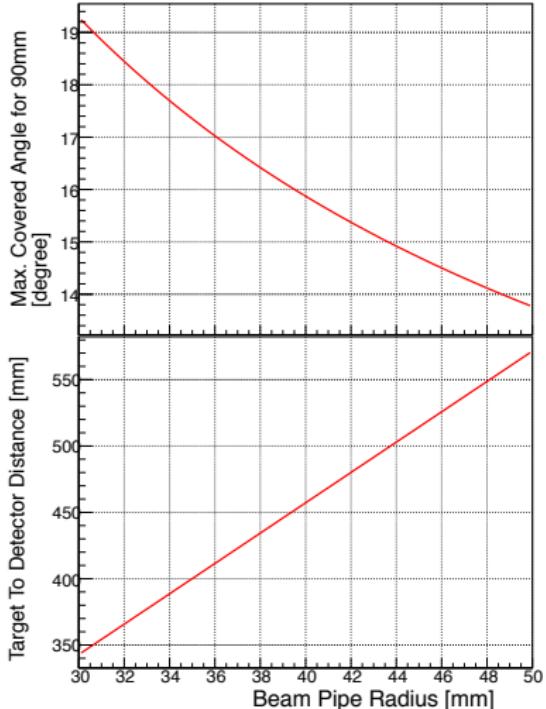
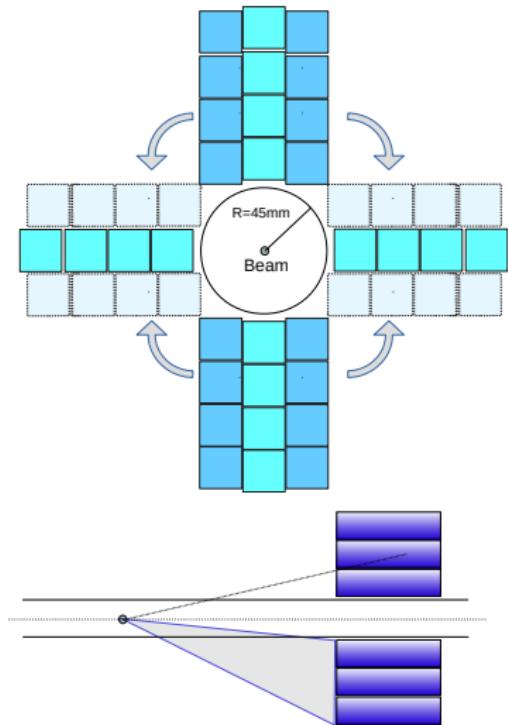


Signal shapes Struck FADC: 14 bit, 250 MS/s, 200 samples



# Cross JEDI Polarimeter

48 crystals



# Acknowledgment

People contributing to the experiment



- Mechanics: N. Giese, M. Maubach, G. D'Orsaneo & D. Spölgen
- Electronics: Tanja Hahnrats-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

P r o d u c t i o n   r u n !

*Polarized  $\vec{d}$ -beam on  
 $Mg, C, CH_2, Si, Al$ -targets  
at five different energies*

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