JÜLICH
FORSCHUNGSZENTRUM

Towards the EDM Polarimetry

Spokespersons: I. Keshelashvili, D. Mchedlishvili, B. Lorentz

CBAC 2017 #6 | Exp. No.: E002.4

June 26th, 2017 | Irakli Keshelashvili |

Outline

- Introduction
  - goal of the next experiment and appropriate setup
- Latest Results
  - Hardware test, Software development, DAQ optimization,
- Proposed Beam Time

Polarimeter Setup @ COSY
Plans for 2018

Energy range (min.-- max.):

0.045 – 2.8 GeV (p)

0.023 – 2.3 GeV (d)

Max. momentum ~ **3.7 GeV/c**

Electron & ***Stochastic*** cooling

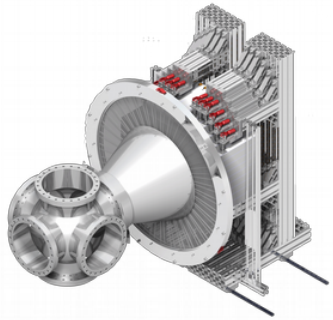
Feed-forward machine

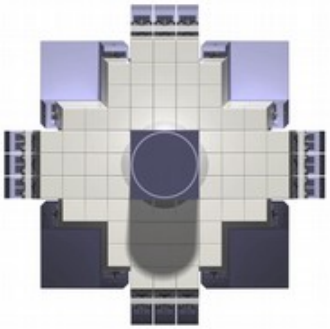
Internal and **external** beams

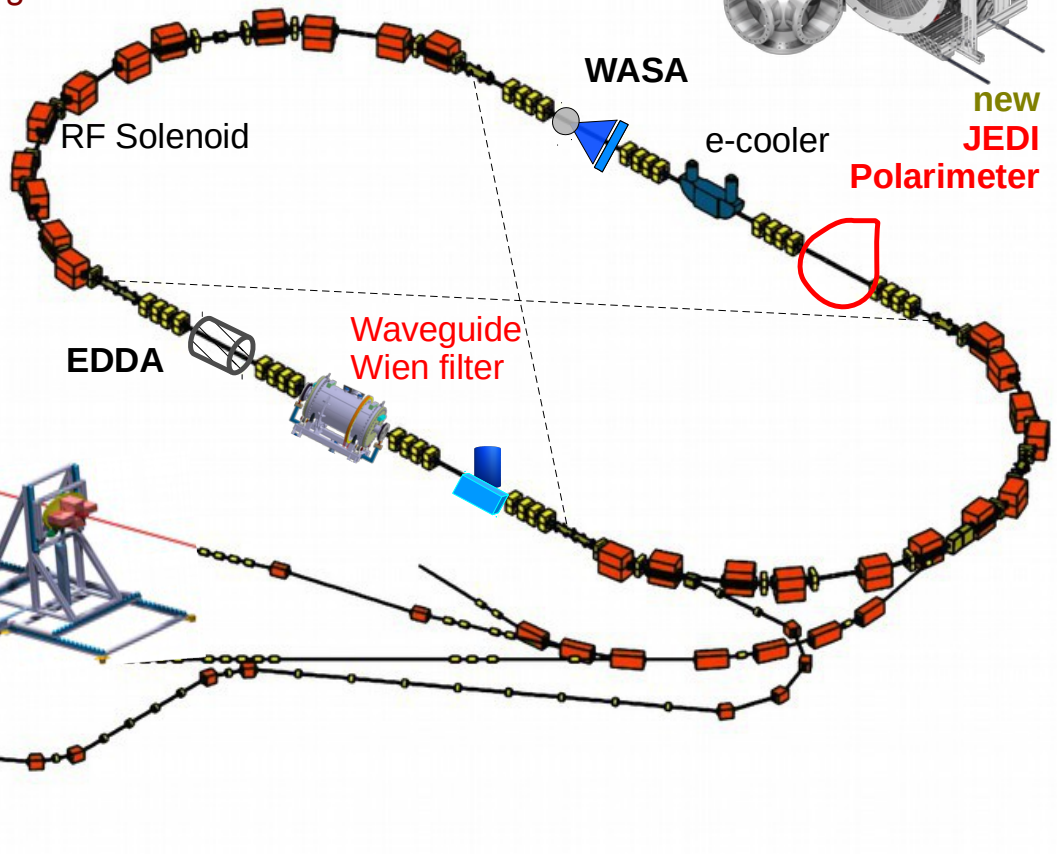
High **polarization** (***p, d***)

Spin manipulation !!!

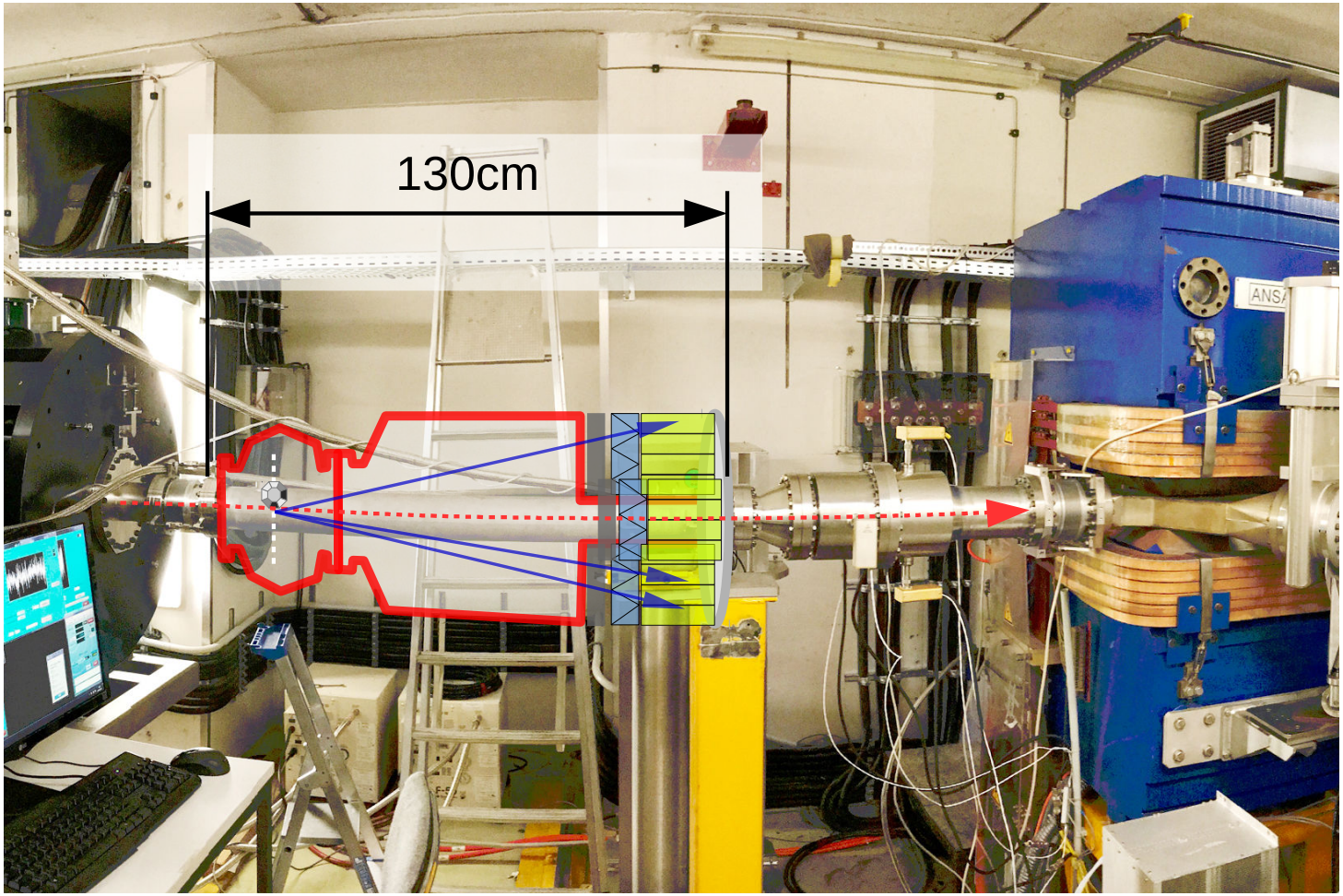
RF ExB Wien filter



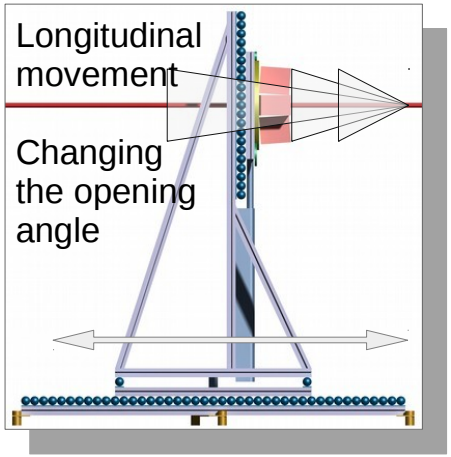


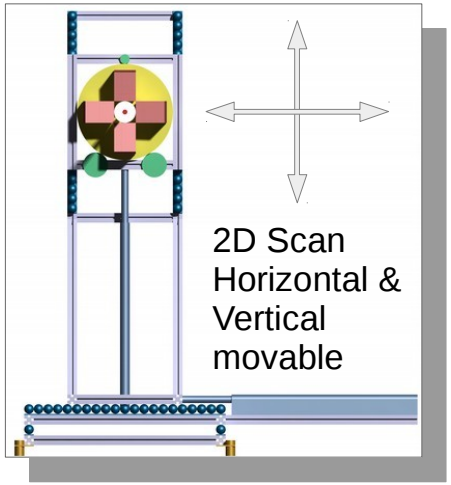


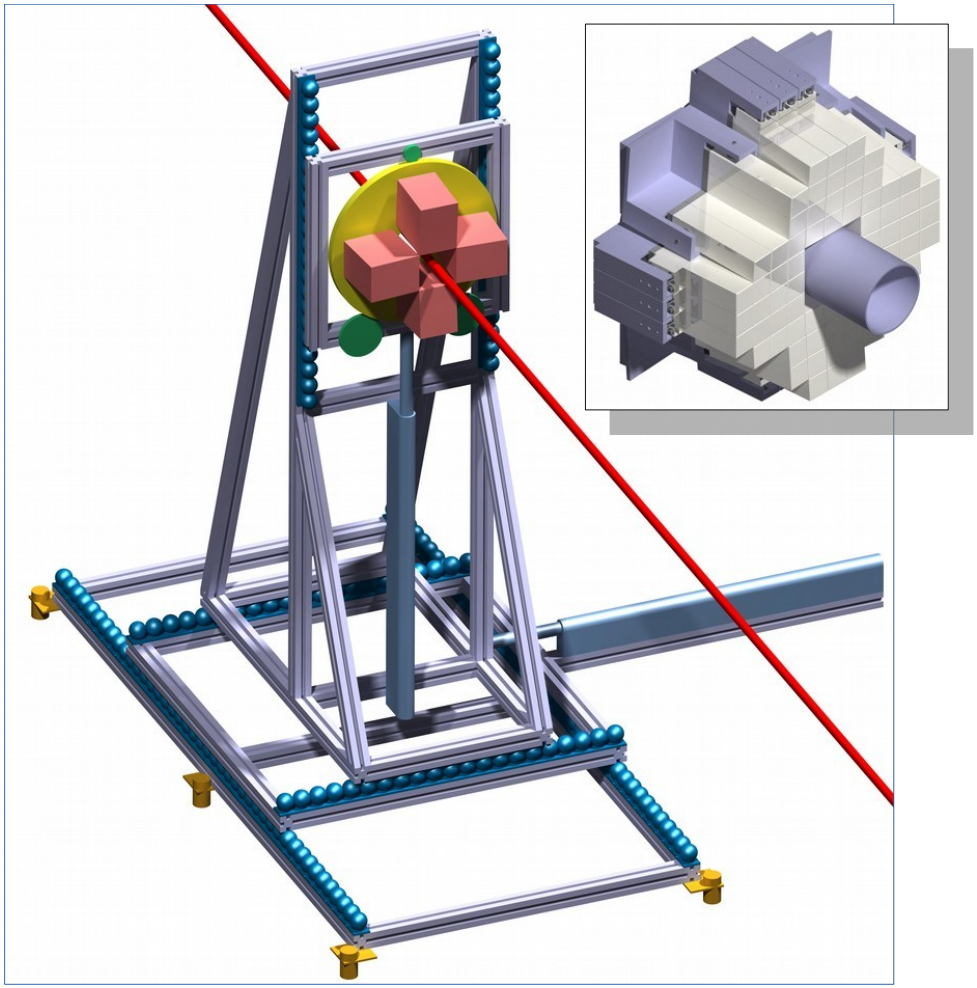
Polarimeter Setup @ ANKE
Plans for 2018



Polarimeter Test
Prototype of the Calorimeter Part



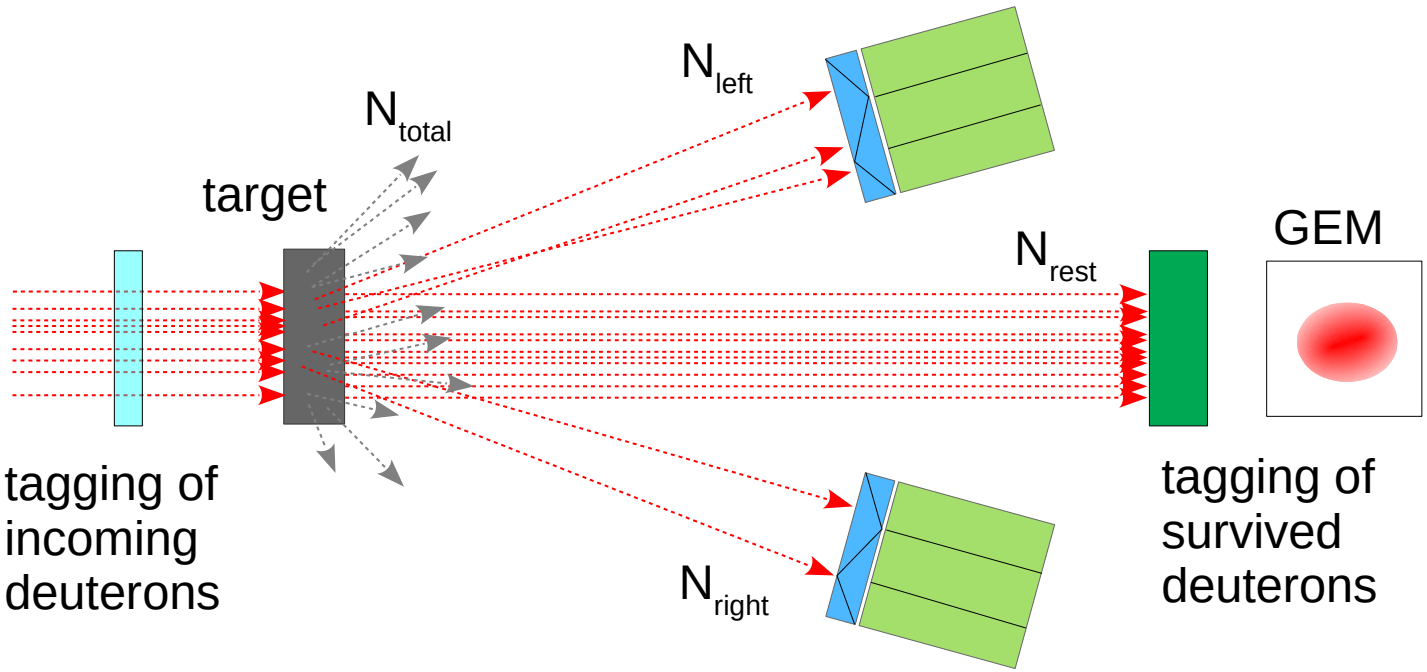




Inelastic Cross-Section Measurement

Beam particle loss measurement

$$N_{lost} = N_{scattered} + N_{Eloss} + N_{acc} \qquad (1)$$



$$N_{scattered} = L \times \sigma_{tot} = N_{el} + N_{inel} = N_{incoming} - N_{rest} \qquad (2)$$

Objectives of Beam Time

- **Test of 52 LYSO-SiPM Moduls!!!**
- Combined test of the read-out electronics with the detector modules to verify the performance of the whole prototype system

  FEE, DAQ, HV, FADC, Count-rate, ...
- Measurement / cross-check in $\vec{d}C \rightarrow dC$ of $\frac{d\sigma}{d\Omega}(\Theta)$, $A_y(\Theta)$

  Comparison to WASA datebase results.
- Plastic scintillator placed in front of LYSO modules testing the **dE**/**E** and count-rate
- **Direct measurement of** $\frac{\sigma_{el}}{\sigma_{tot}}$ **(**$dC \rightarrow dC$ **over** $dC \rightarrow X$**)**

  Complete FOM and Background estimation.

24 x LYSO+SiPM Module

Tested December 2016/March 2017 Beam Time

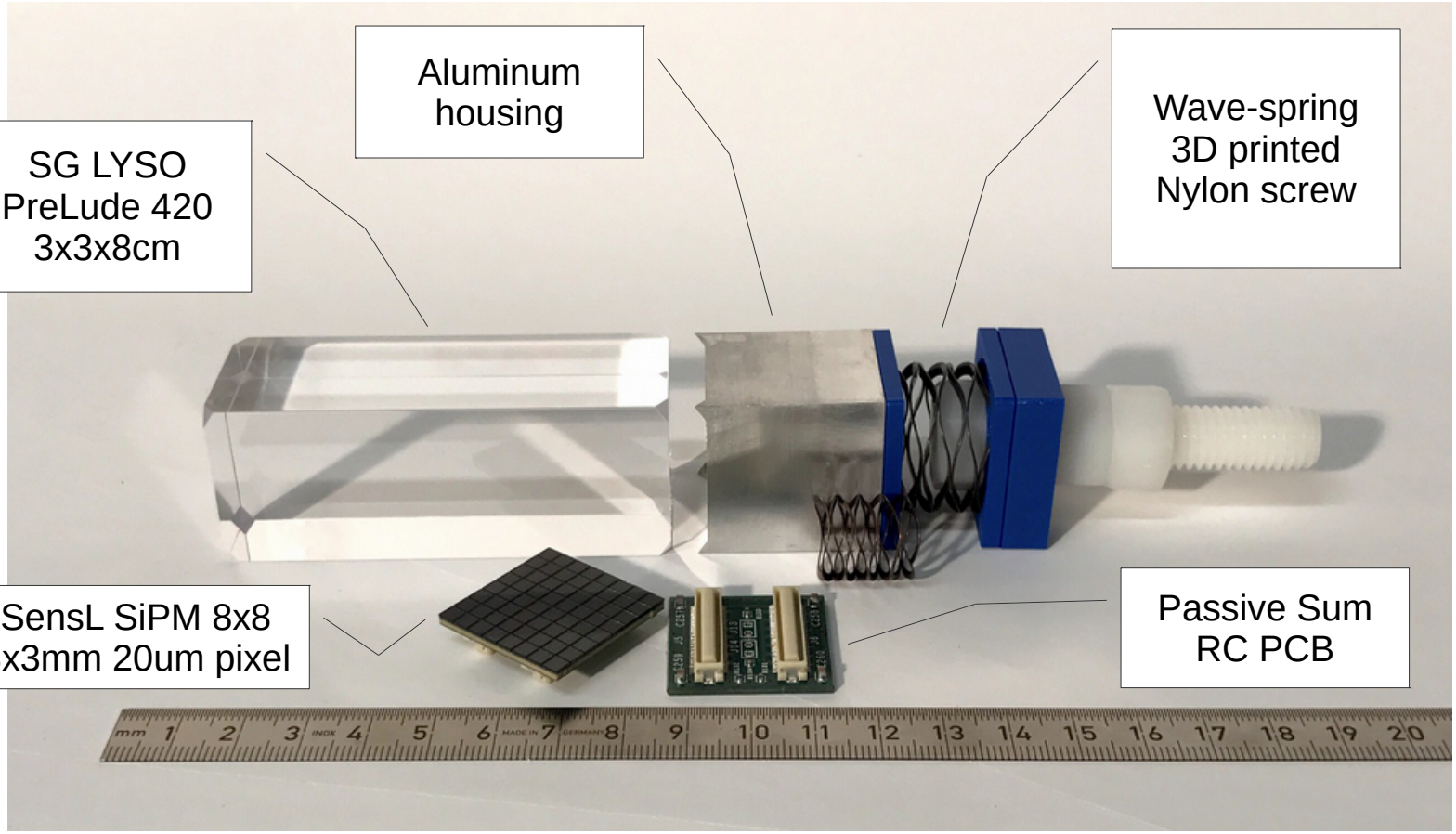
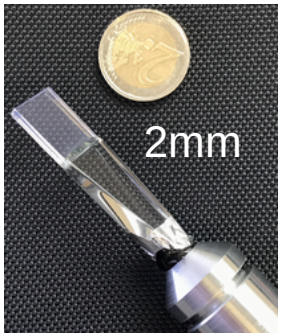
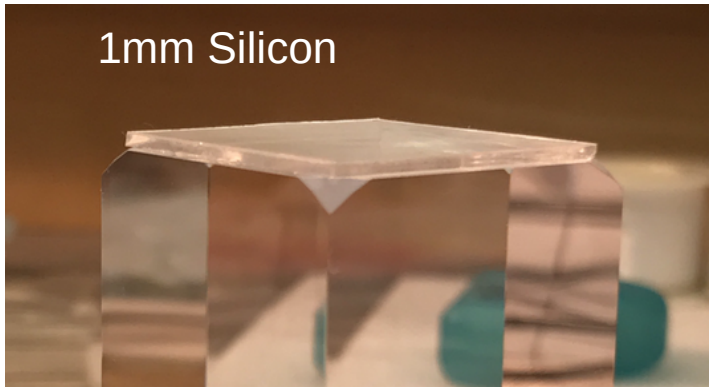
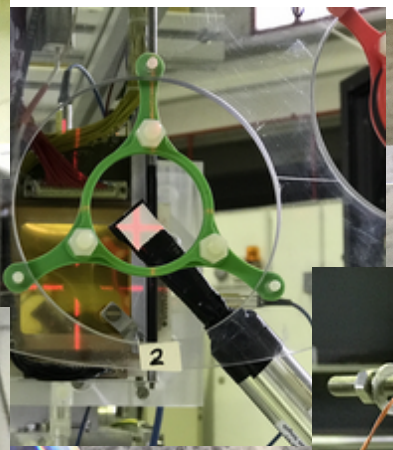
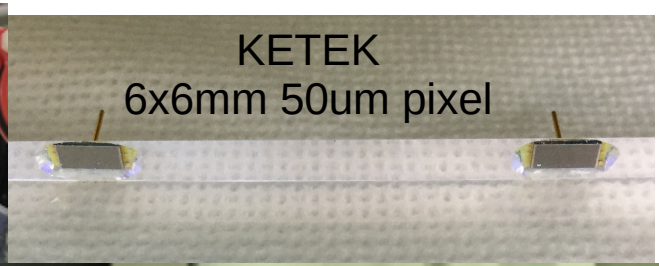


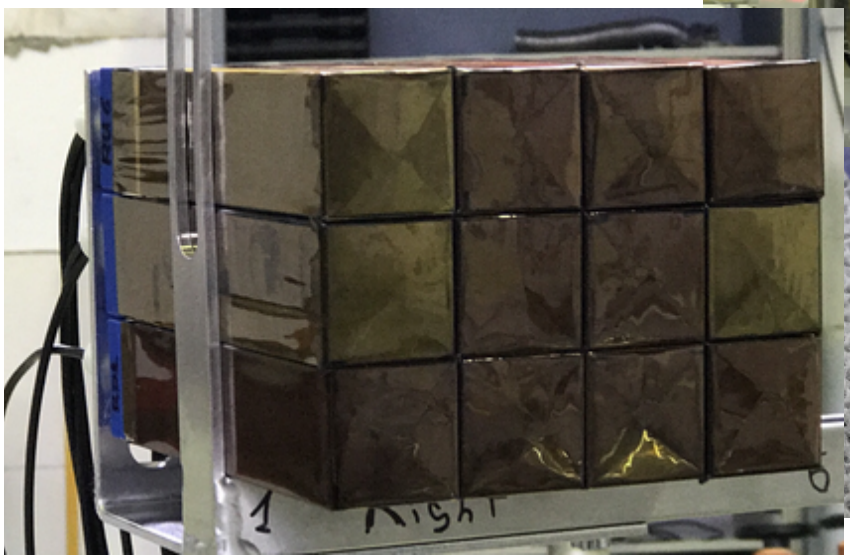
Photo Gallery

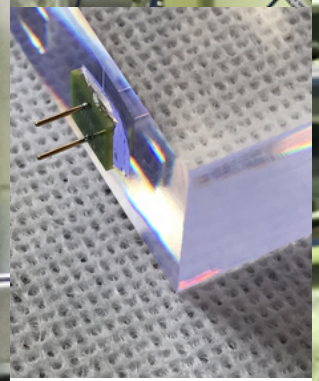


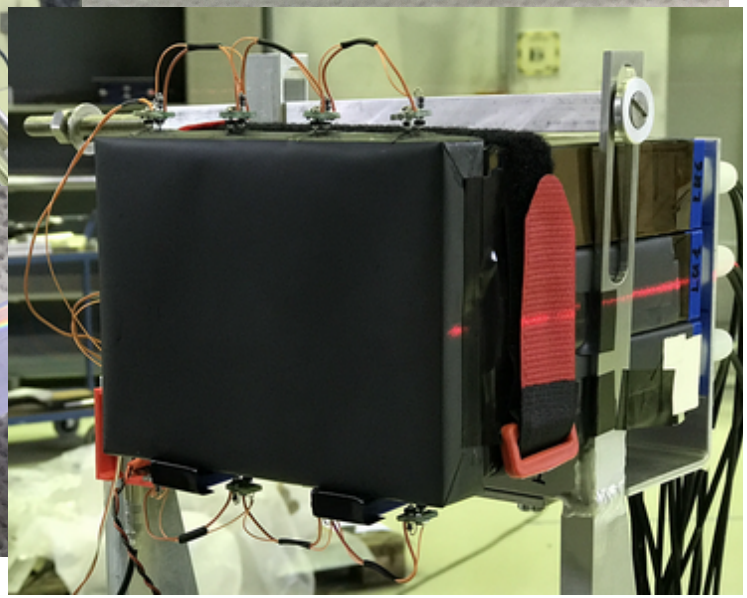








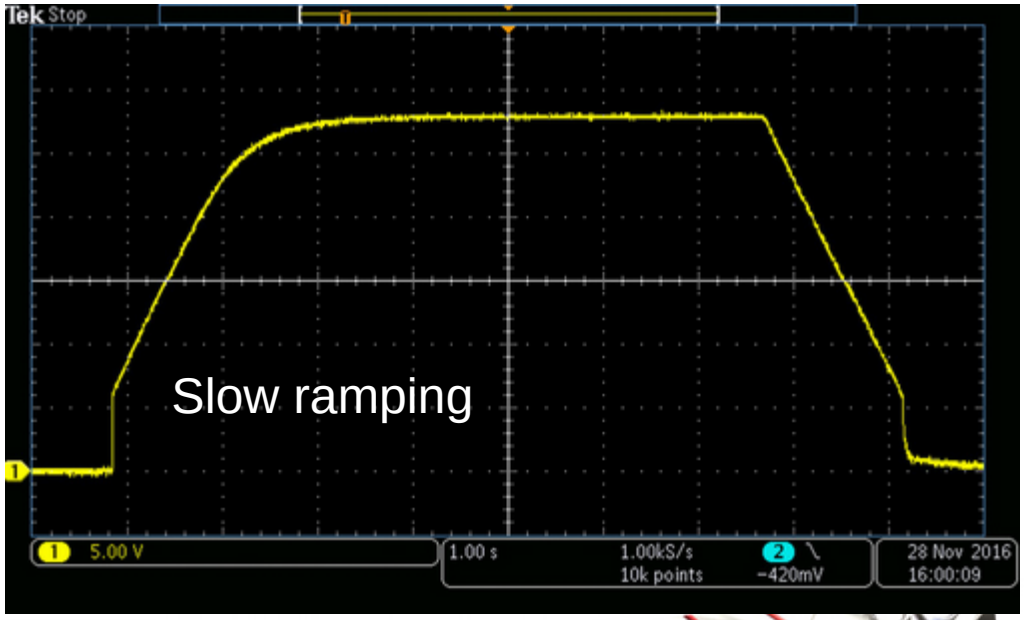


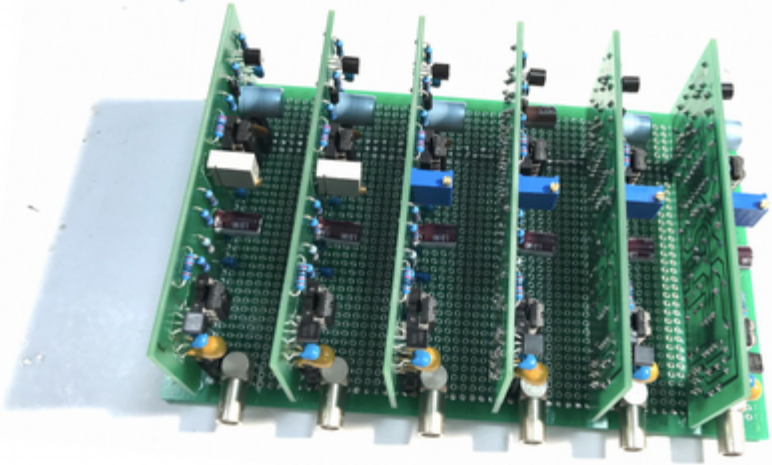


SiPM Voltage Supply

Very Good Long Term Stability ~ $1\mu V_{pp}$

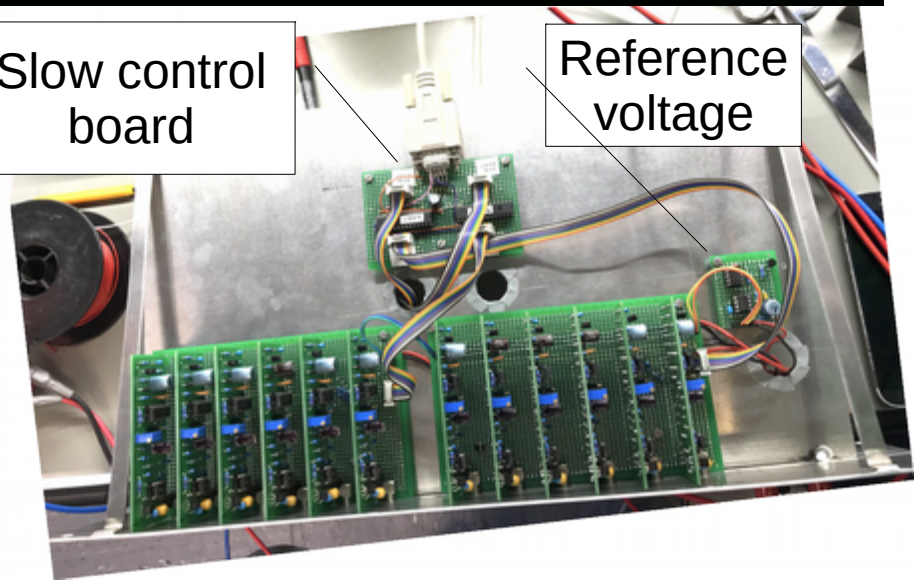
24 Channels



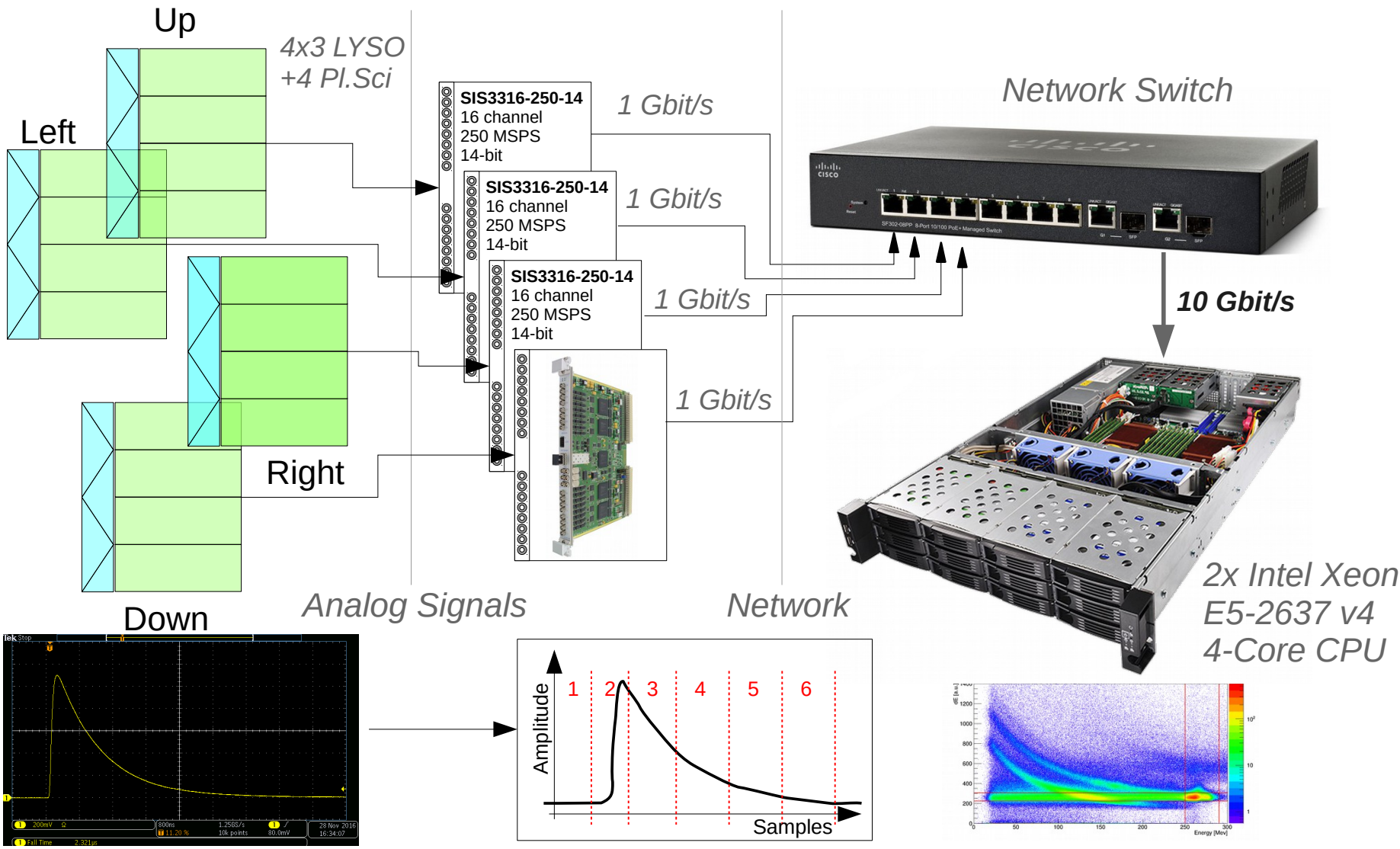


Slow control board

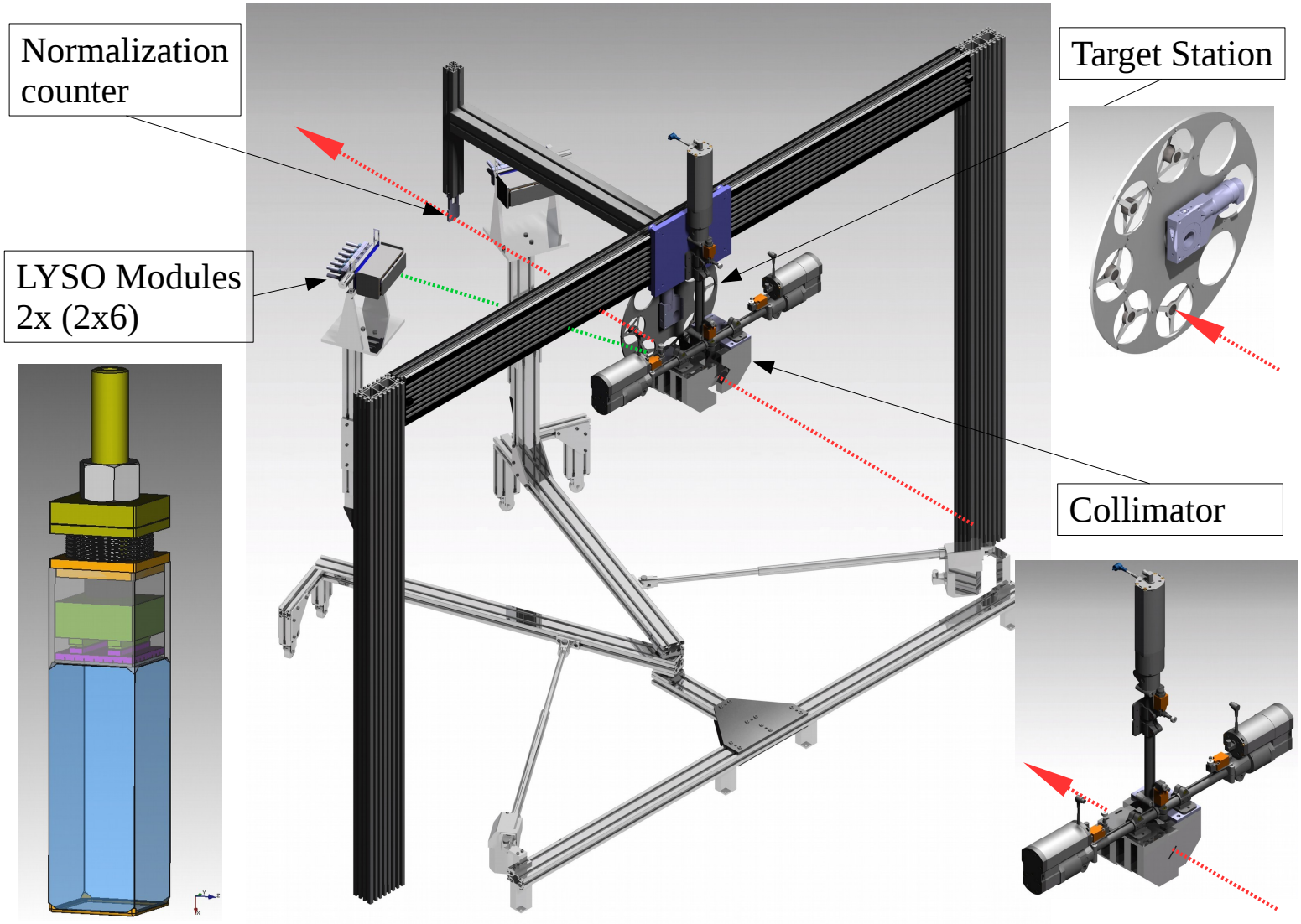
Reference voltage



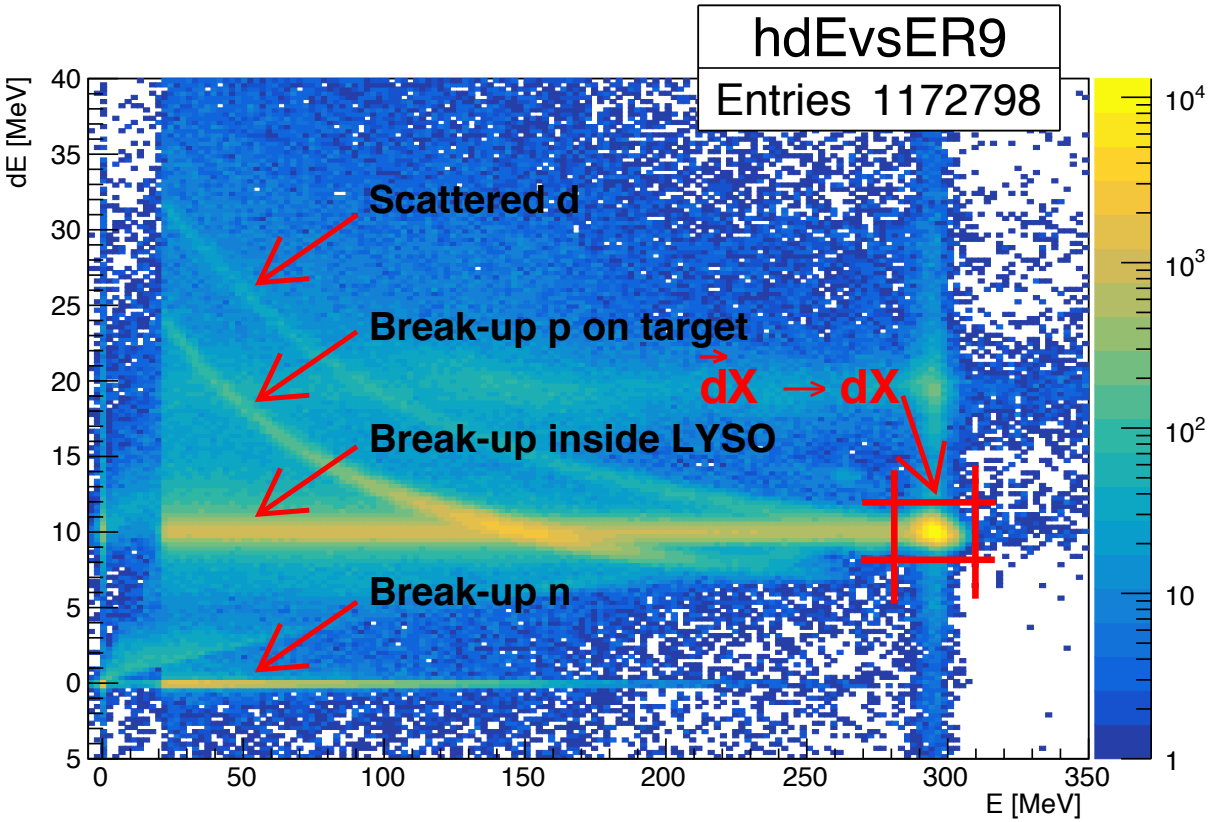
Data Acquisition System
Flash ADC Based System



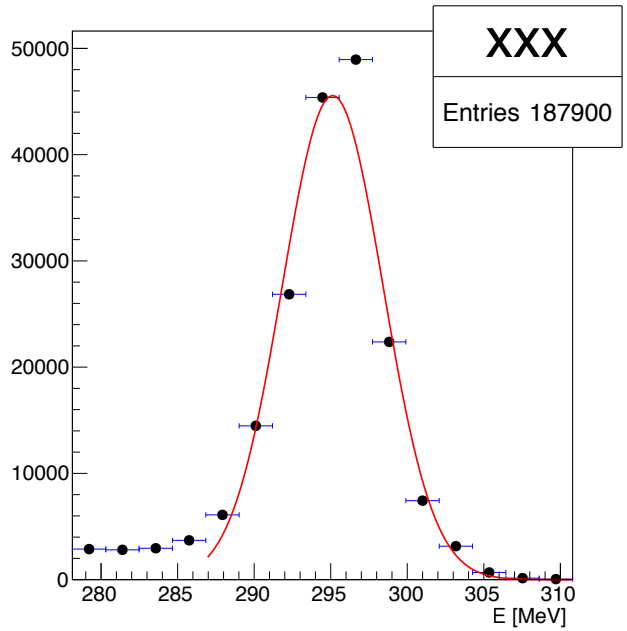
Experimental Setup
Asymmetry Measurements & Target Material Test



Event Selection
Online cuts



$$A_y(\theta) = \frac{\sigma^{\uparrow}(\theta) - \sigma^{\downarrow}(\theta)}{\sigma^{\uparrow}(\theta) + \sigma^{\downarrow}(\theta)}$$

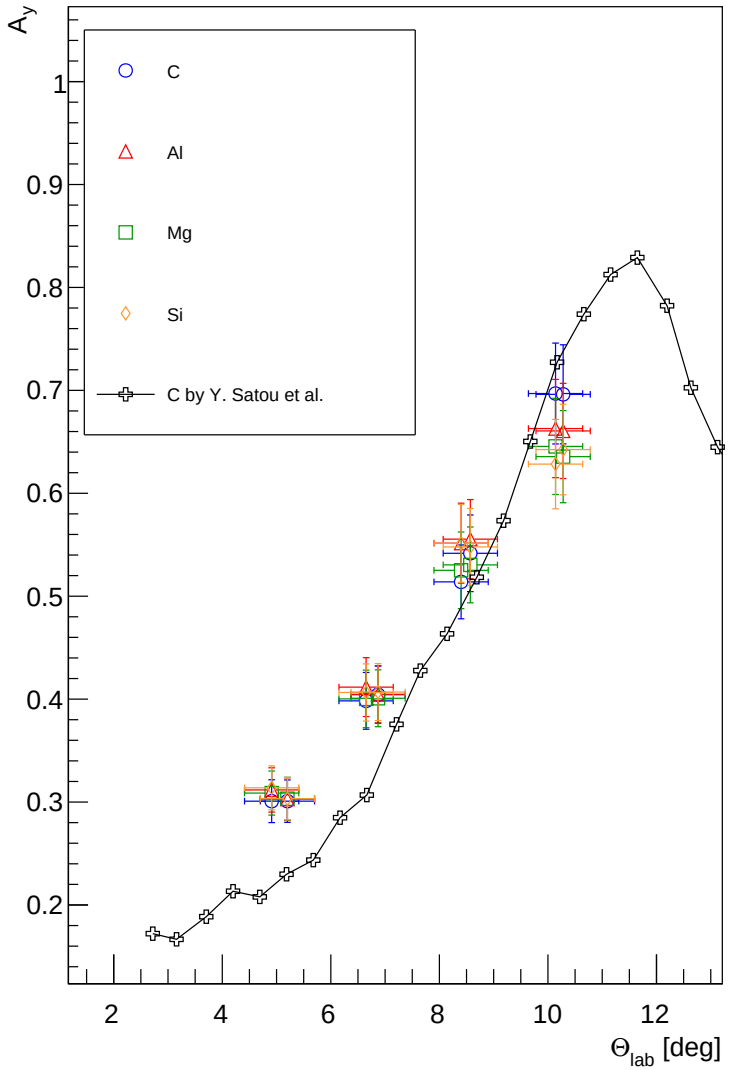


$$\sigma^{pol}(\theta, \phi) = \sigma_0(\theta)[1 - \frac{3}{2} P A_y(\theta) \sin\phi]$$

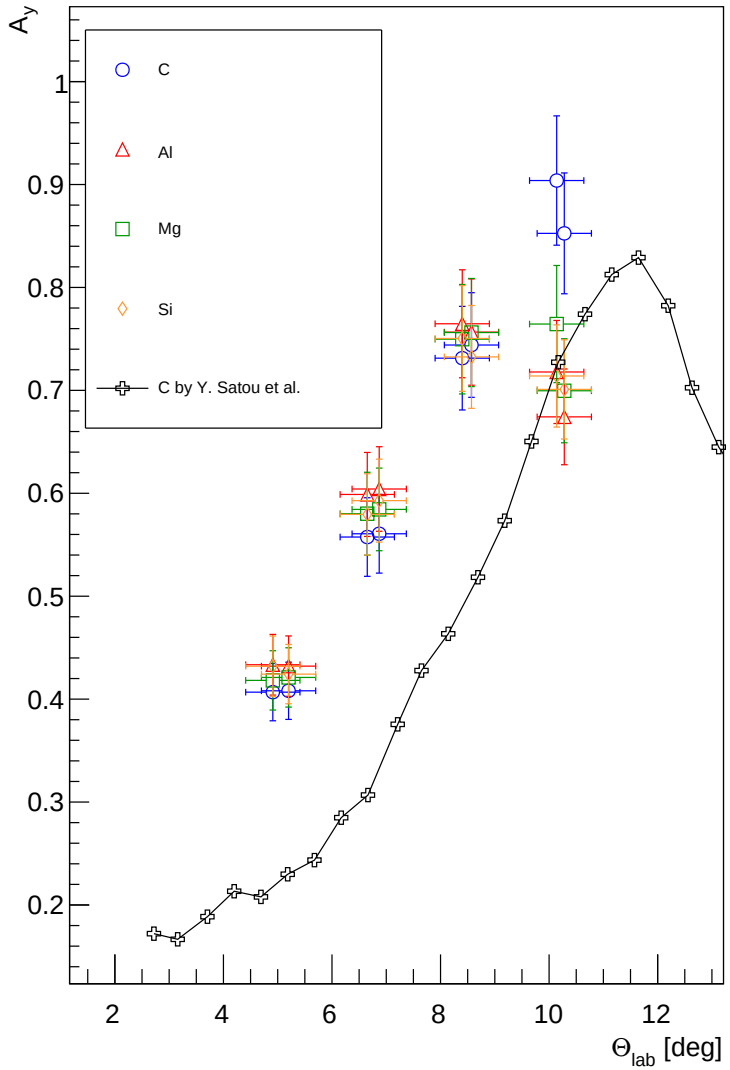
Preliminary Results

PhD: Fabian Müller $A_y(\Theta)$ $\vec{d}C \to dC$

Vector Analyzing Power, Deuteron Scattering at 270 MeV

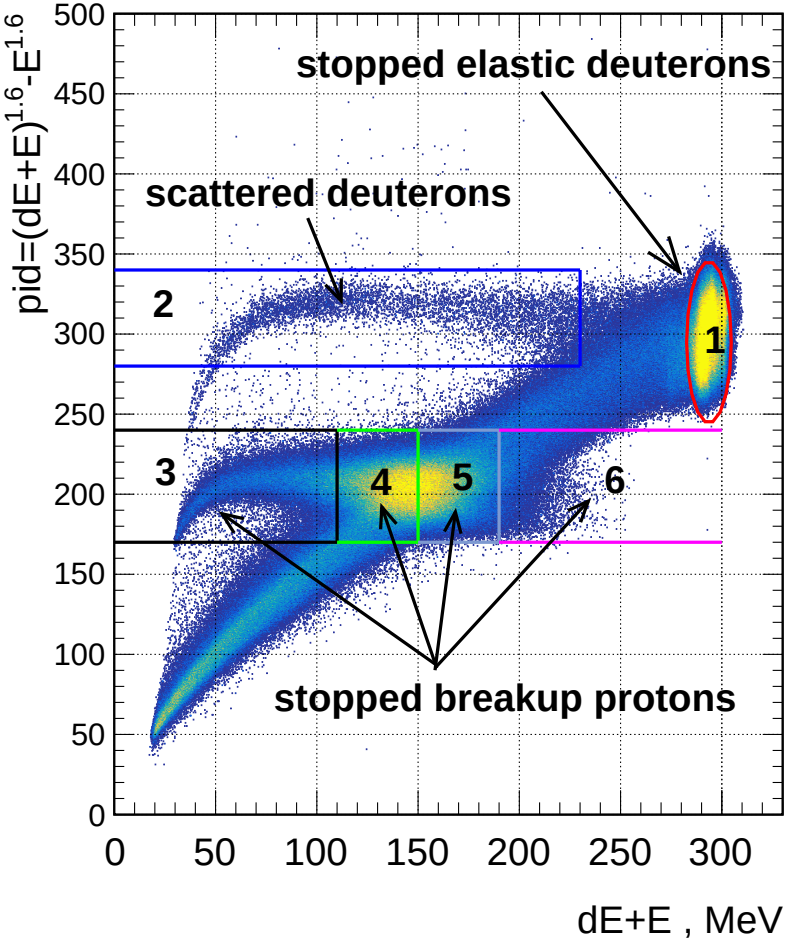


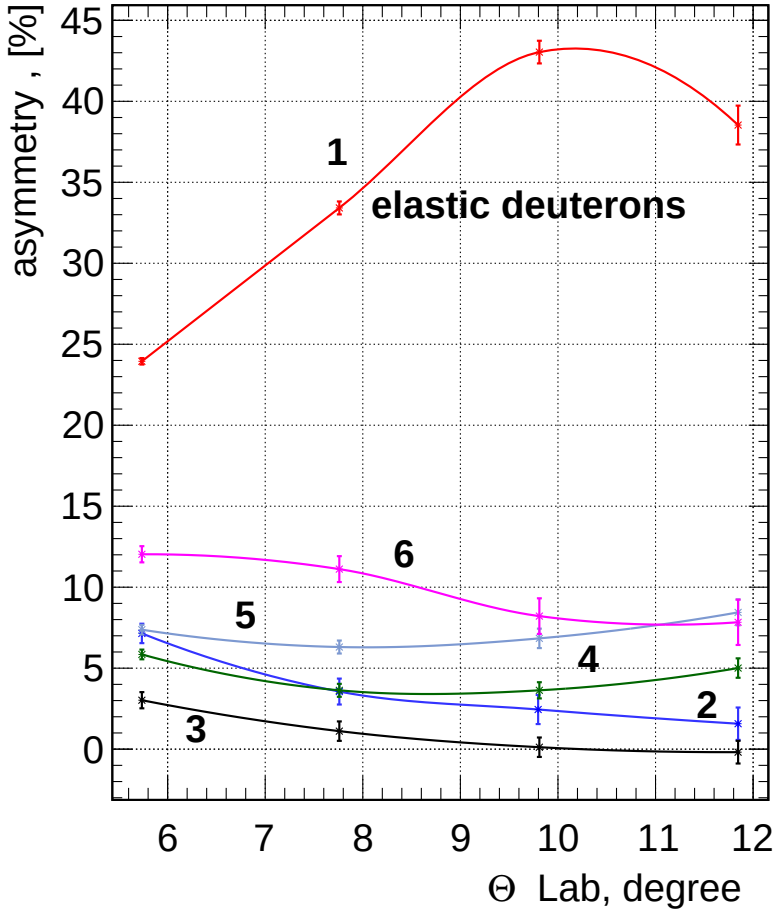
Vector Analyzing Power, Deuteron Scattering at 300 MeV



Preliminary Results

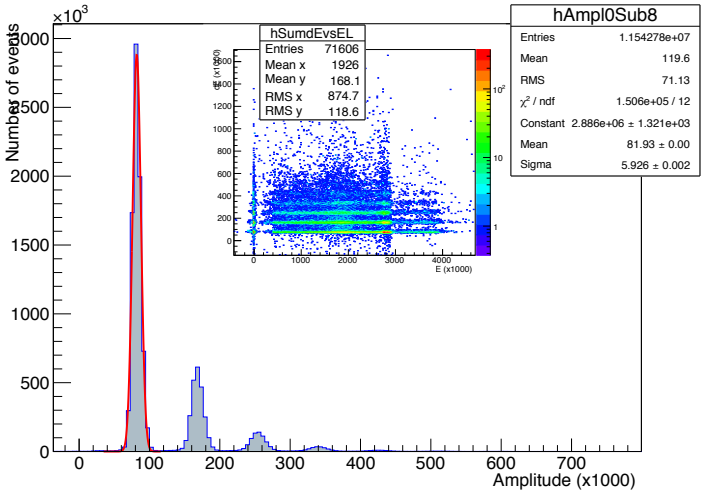
PhD: D. Shergelashvili $A_y(\Theta)$ $\vec{d}C \to pnC$

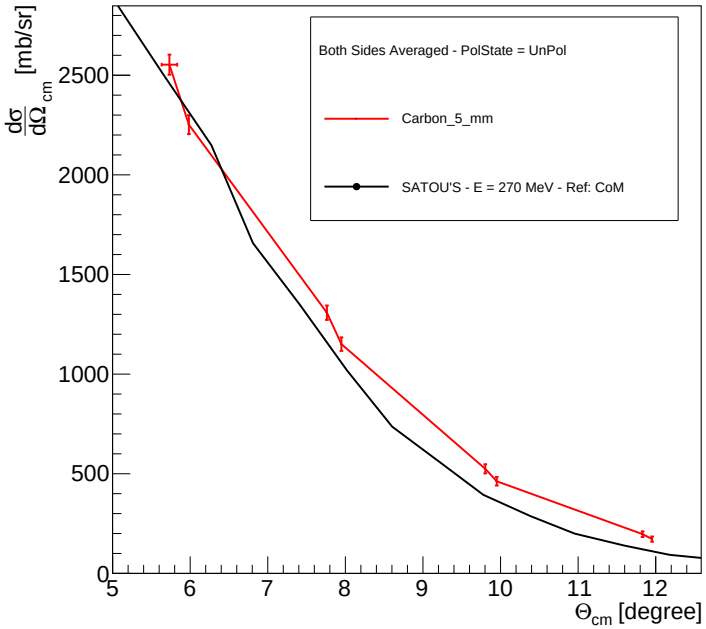




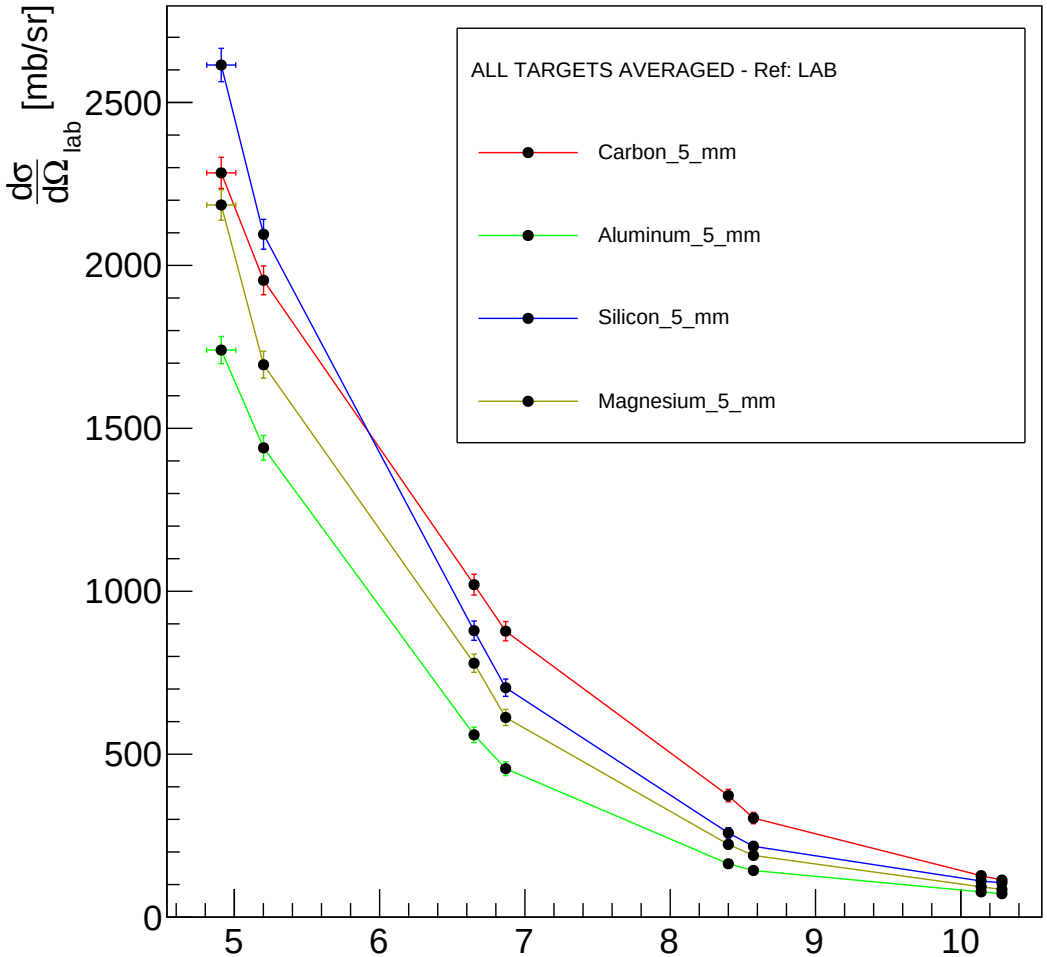
Preliminary Results

PhD: Simone Basile





$\vec{d}X \rightarrow dX$ at $T_d = 300\ MeV$



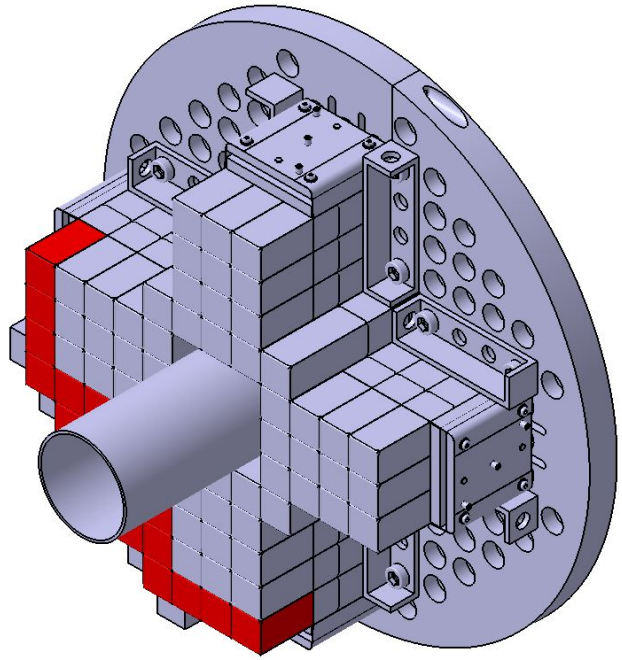
$$FOM(\theta) = \sigma(\theta) \times A_y^2(\theta)$$

Acknowledgment

People contributing to the experiment

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

Summary



- We had 3 very successful beam times. Preparing 4th, end of 2017 ☺
- LYSO-SiPM - Excellent Performance
- $\Delta E(x)$ Plastic scintillator modules are under development...
- New 24+4 modules will be assembled and tested in 2017 **in total 52 (4x12+4) Modules**
- **Now we have universal external beam experimental setup with various measurement possibilities.**

Beam Time

LYSO module / DAQ / Software optimization

- Extracted beam (BIG KARL)
- Polarized deuterons
- 5 energies of T_d =

  100, **150**, **200**, 235, **270** *MeV*
- Low count rate

  ~ 1 ÷ 50 *kHz*
- 1 Week end of 2017

  (1+1 Weeks next year →request for next CBAC)

COSY Beam Time Request

For Lab. use

Exp. No.:	Session No.
E2.4	**6**

Collaboration: JEDI

Towards the EDM Polarimetry

Spokespersons for the beam time: **Irakli Keshelashvili (Jülich)**, **Bernd Lorentz (Jülich)**, **David Mchedlishvili (HEPI TSU)**

Spokespersons for the collaboration: **Jörg Pretz (Jülich)**, **Paolo Lenisa (Ferrara)**

Address:
Institut für Kernphysik
Forschungszentrum Jülich
52428 Jülich
Germany

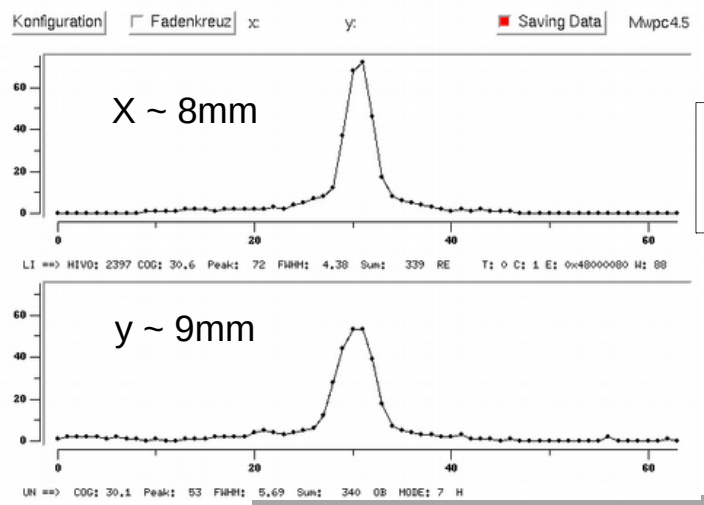
Phone: **+49 2461 615603** Fax: **+49 2461 613930** E-mail: **j.pretz@fz-juelich.de**, **lenisa@fe.infn.it**, **i.keshelashvili@fz-juelich.de**, **b.lorentz@fz-juelich.de**, **d.mchedlishvili@fz-juelich.de**

Total number of particles and type of beam (p,d,polarization)	Kinetic energy (MeV)	Intensity or internal reaction rate (particles per second)	
		minimum needed	maximum useful
Extracted beam of polarized deuterons	**200, 270, 300 MeV**	**10^3**	**10^7**
Experimental area	Safety aspects (if any)	Earliest date of installation	Total beam time (No.of shifts)
Set-up with LYSO crystals at BIG KARL area	**none**	**1st November 2017**	**1 week (+ MD)**

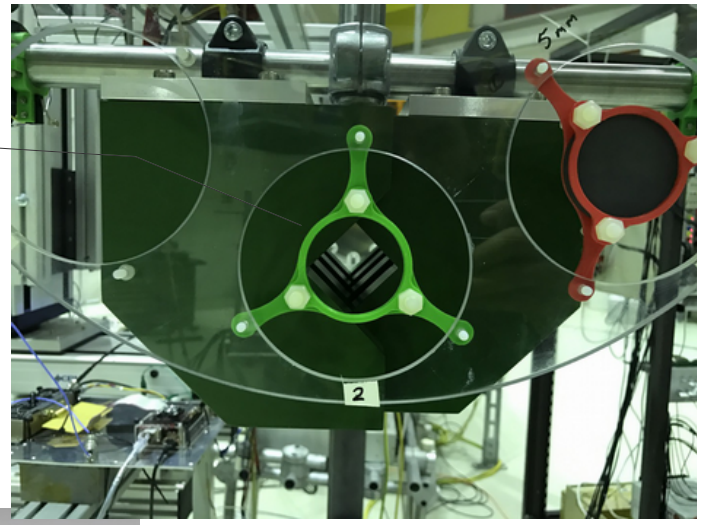
Appendix

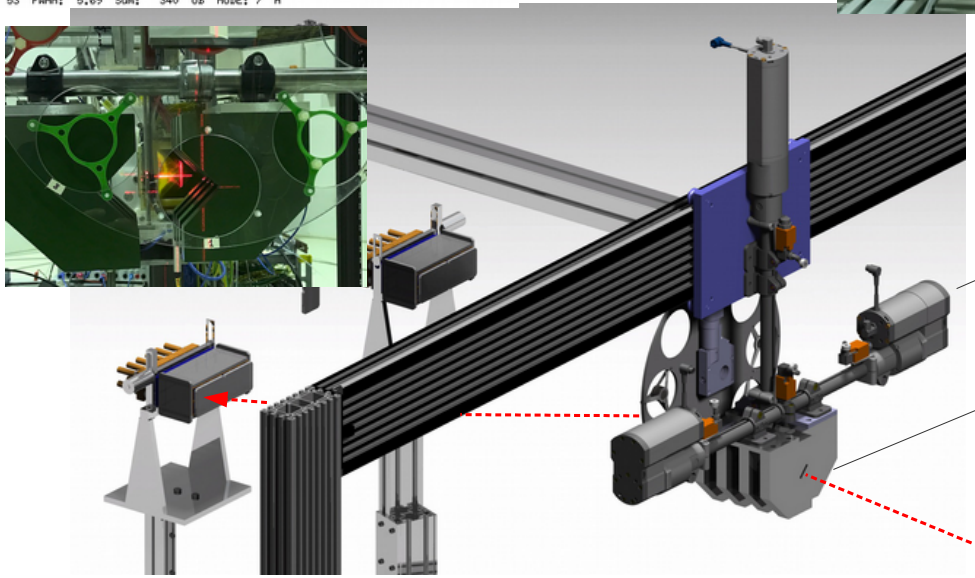
Collimator System

December 2016 Beam Time



Empty target holder





2D movement
Spot diameter

4x2.5cm Iron collimator blades