LYSO modules for the JEDI polarimeter: production, laboratory tests and results of first measurements

October 19, 2017 – 17th PSTP

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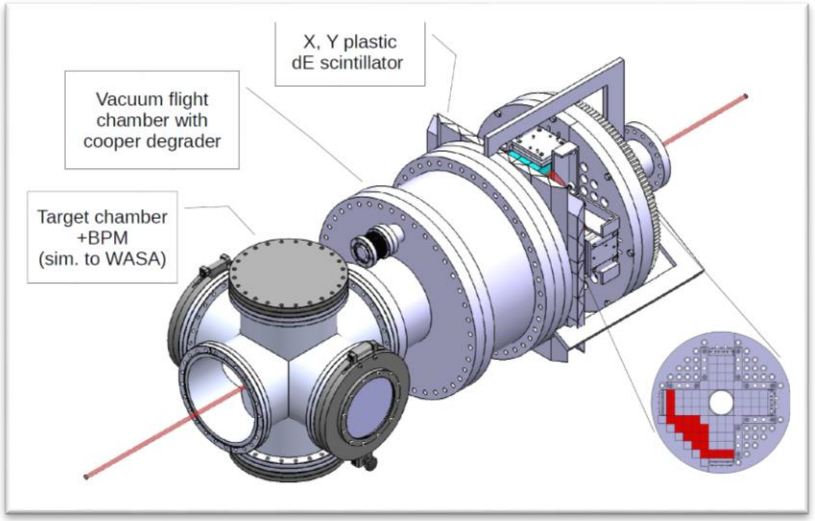
Supv: Dr. Davit Mchedlishvili @ TSU; Dr. Irakli Keshelashvili @ FZJ

Talk overview

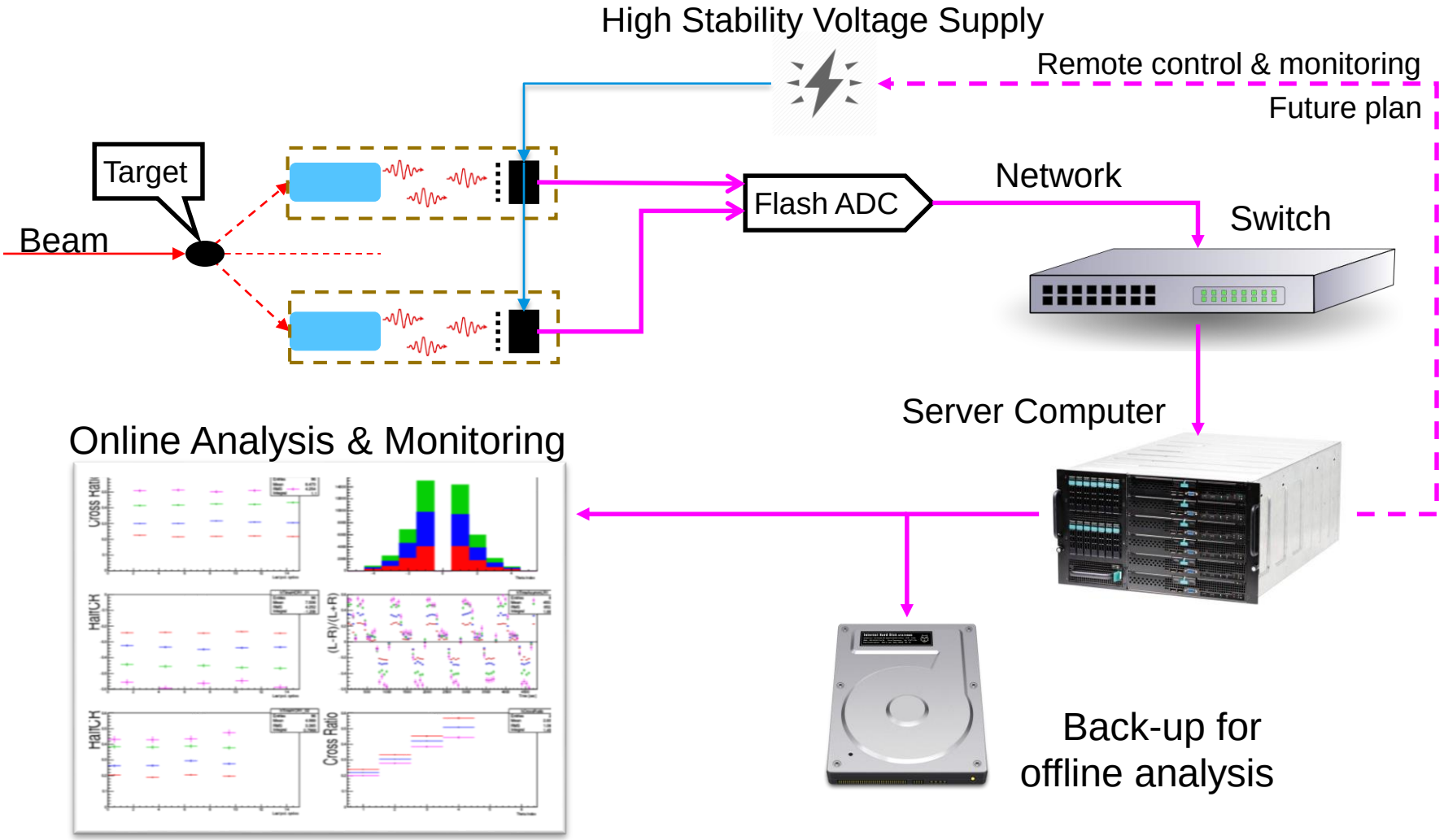
- Objective
- LYSO Module Assembling
- Module Inspection and Tuning in the Lab
- Energy Resolution & Linearity Tests Results
- COSY Tests
- Summary & Outlook

New concept of the JEDI Polarimeter

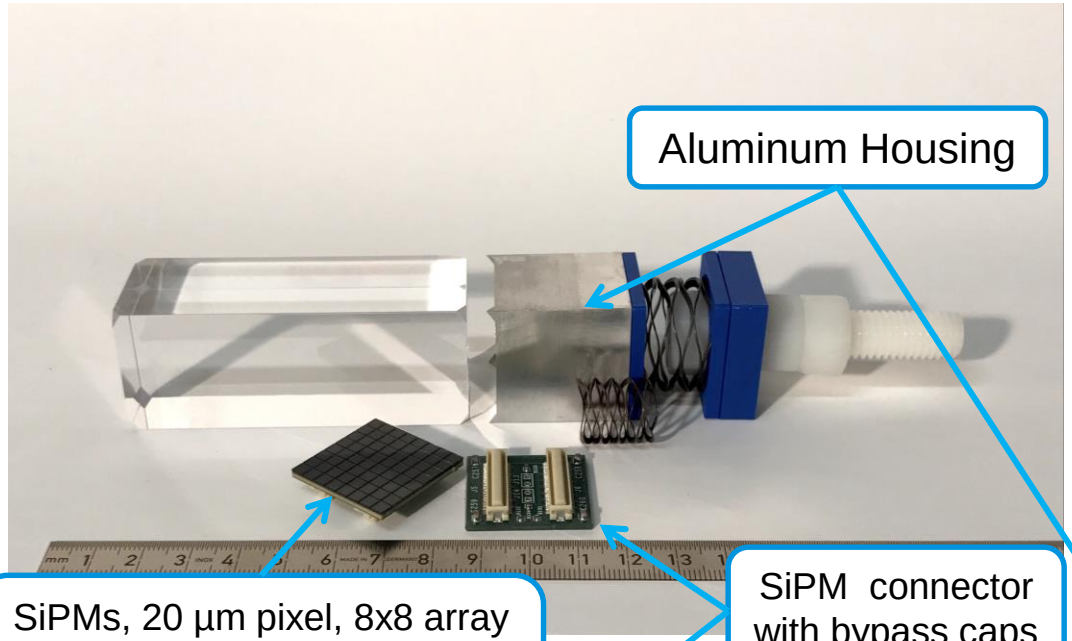


Goal: 10^{-29} e cm

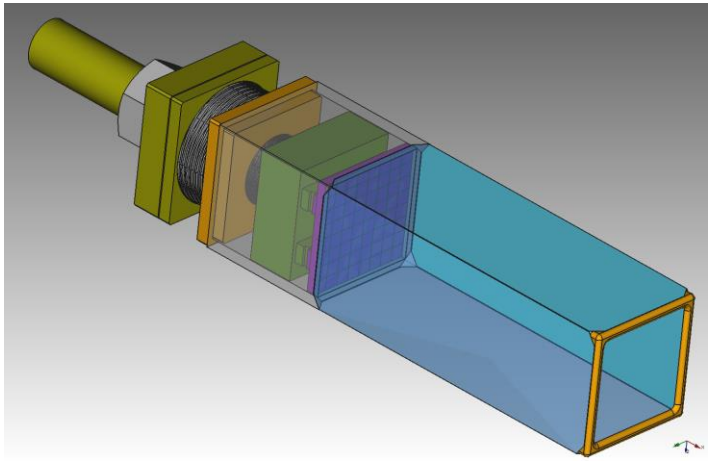
Polarimetry Overview

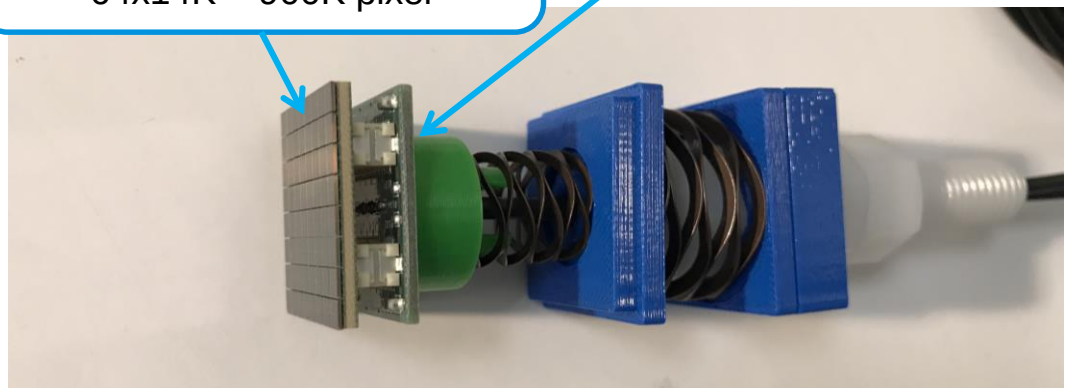


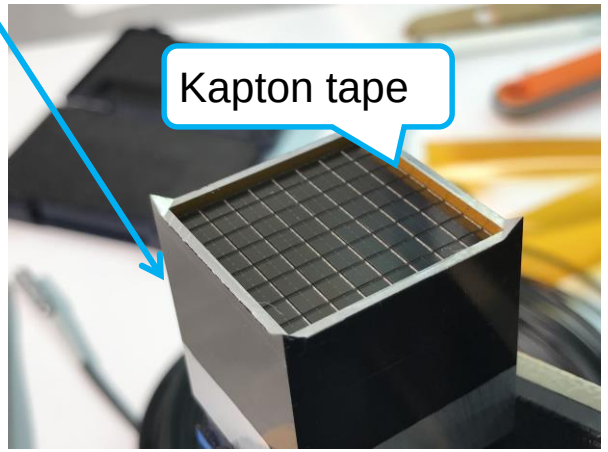
LYSO Modules Assembling



3D drawing of the module







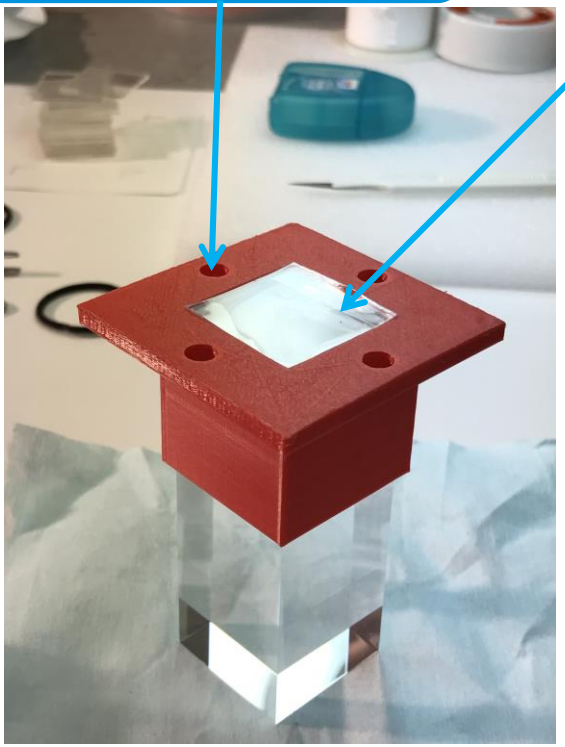
LYSO Modules Assembling

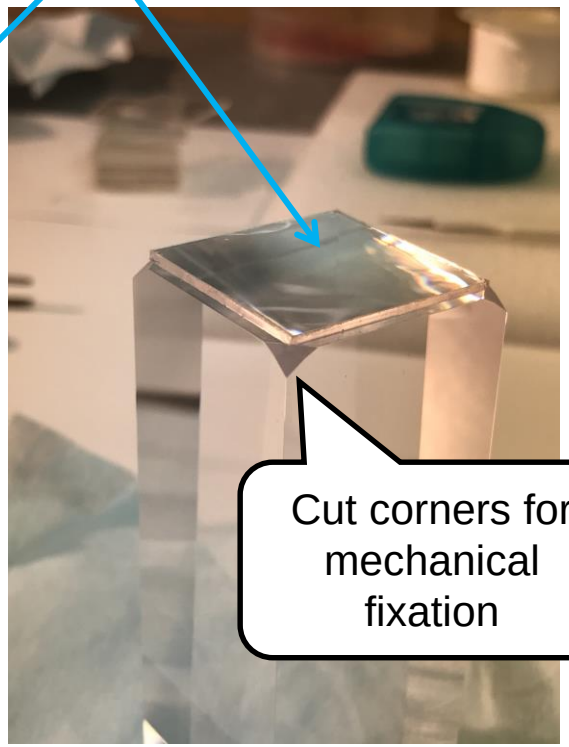
Two layers of foils:
I - Four different inner layers (reflector)
II - Tedlar (outer) foil (light tightness)

1. Teflon – 50 µm
2. Tyvek ~ 100 µm
3. Smooth Mylar - 25 µm
4. Wrinkled Mylar - 25 µm

3D printed plastic for centering silicon

Silicon layer

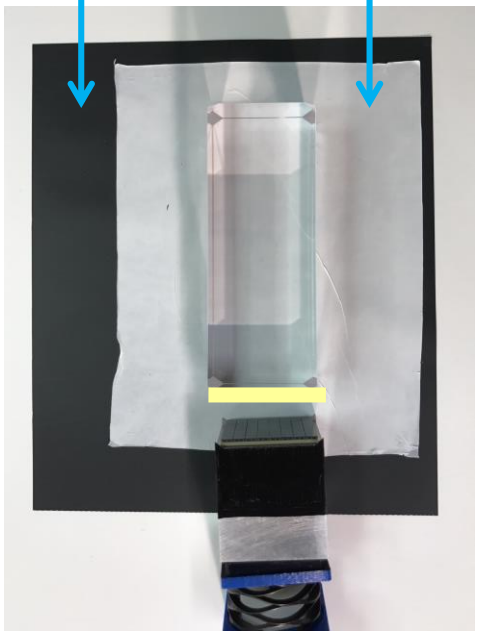




Cut corners for mechanical fixation

Tedlar 50 µm

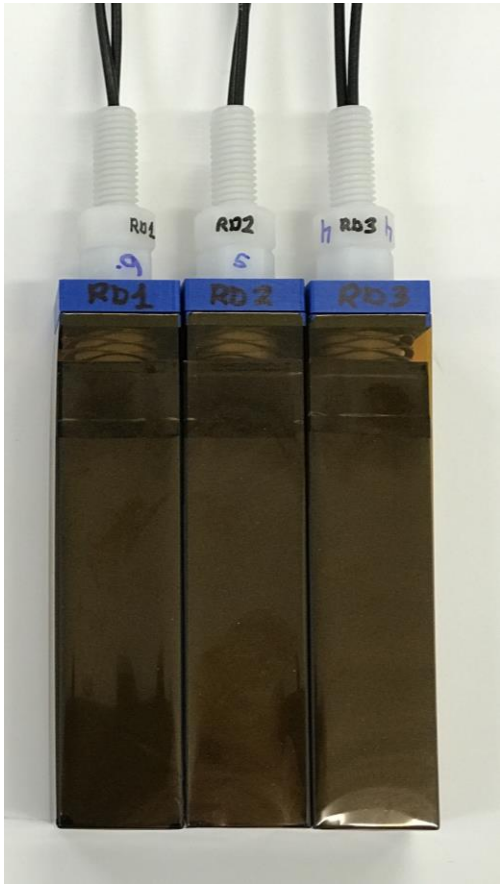
Teflon

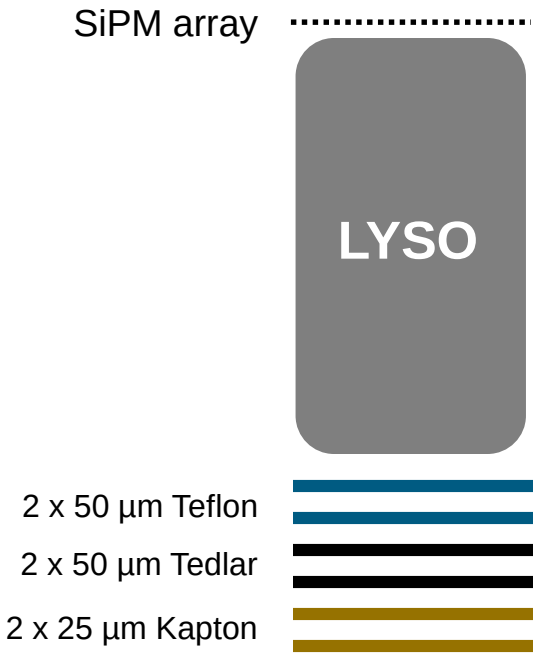


LYSO Modules Assembling

3rd hand during assembling

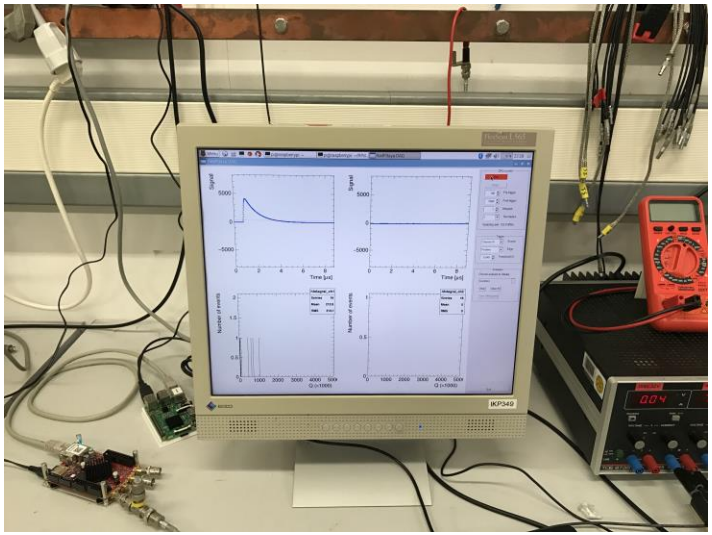
Ready for test



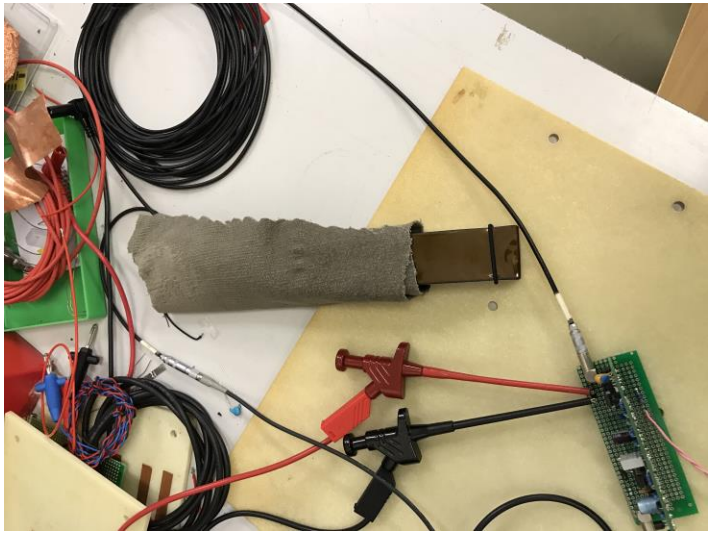


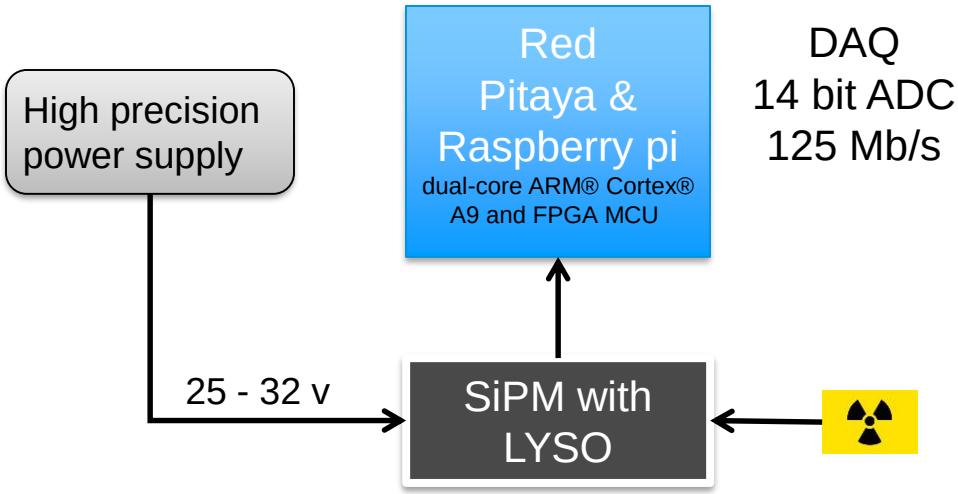
Energy loss can be estimated

LYSO Modules Lab Tests

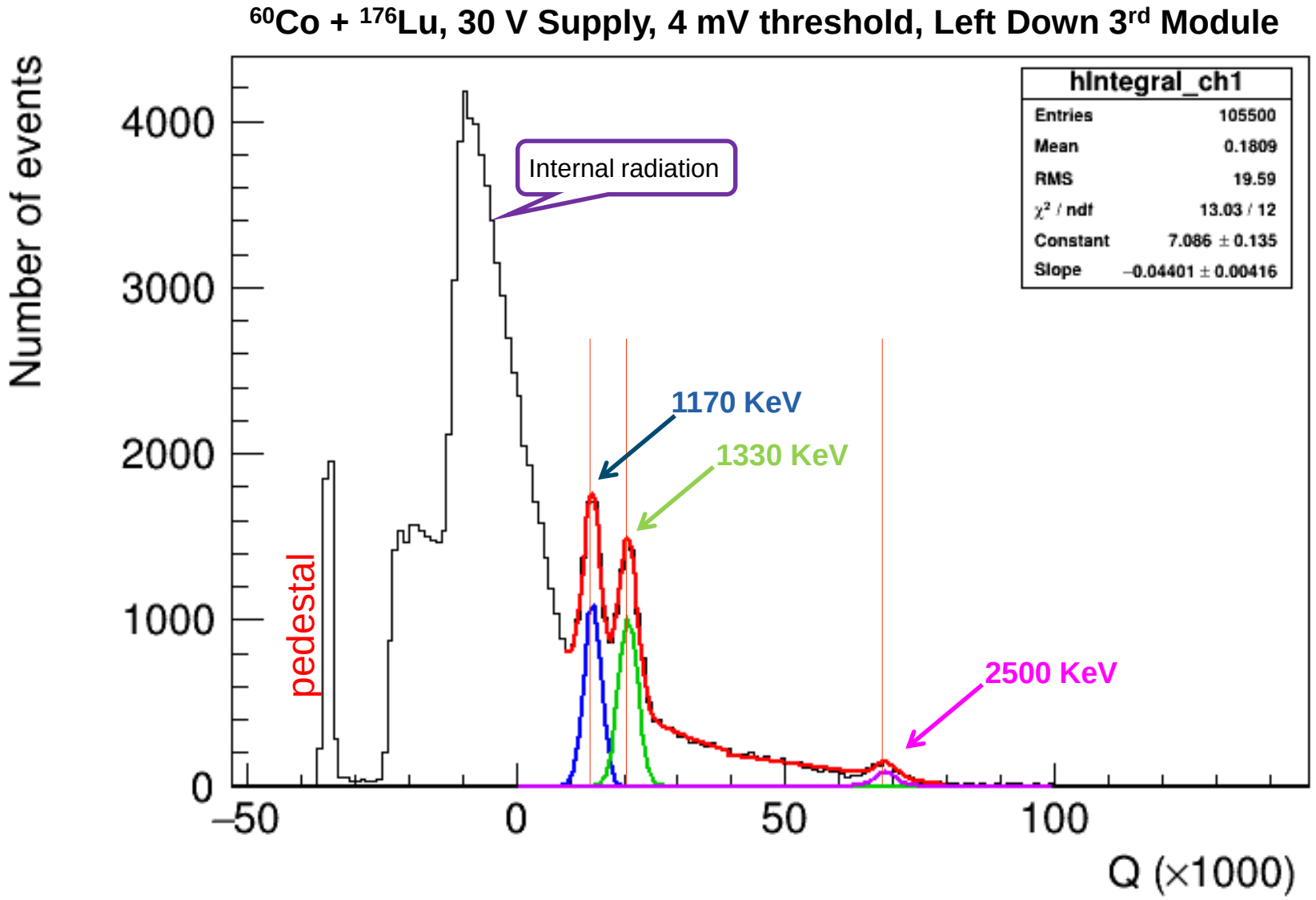


- Light Tightness
- Measurements of ^{22}Na, ^{60}Co, ^{176}Lu (internal)
- Optimal supply voltages
- Signal offset (current leakage)

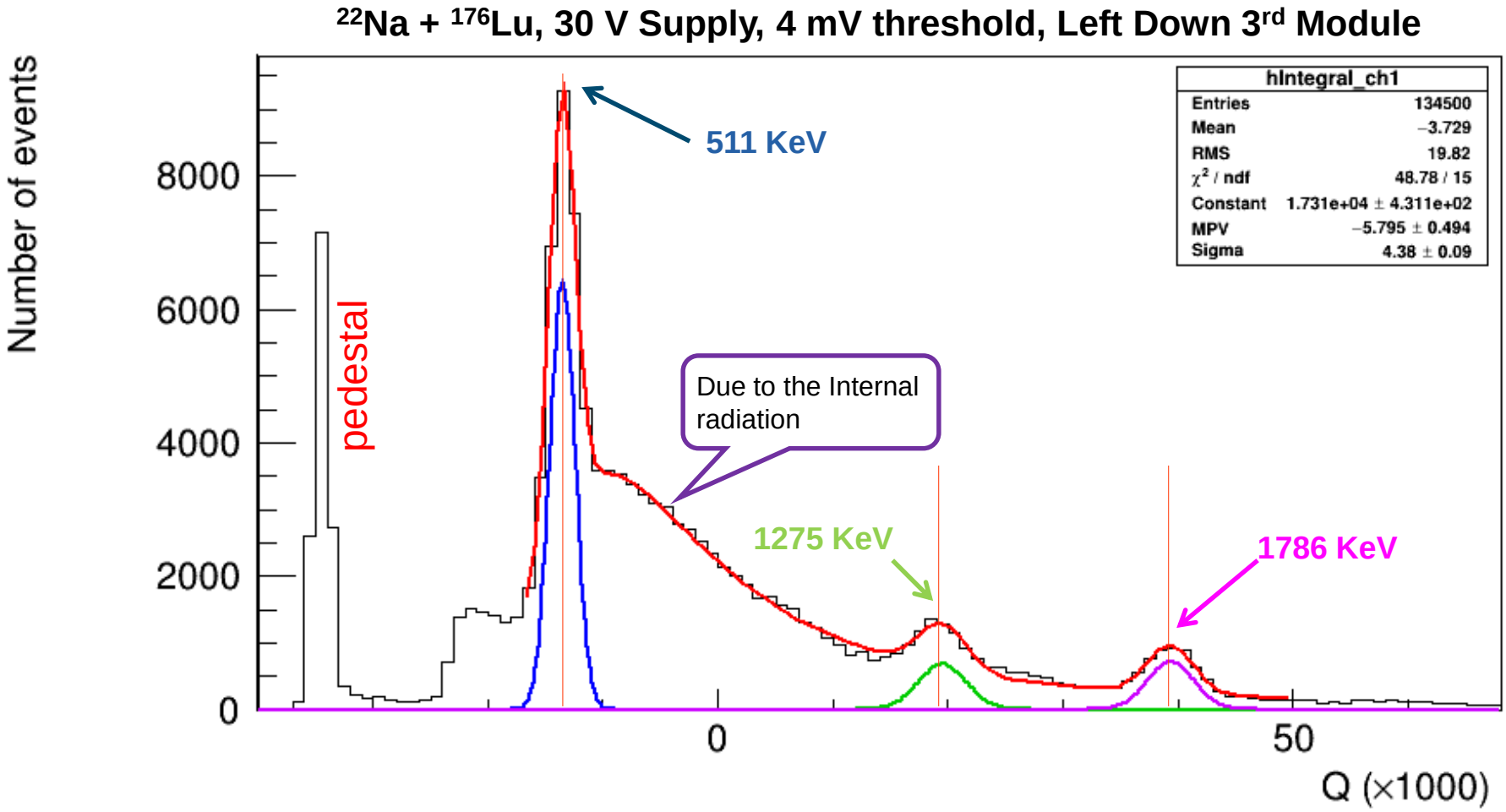




LYSO Modules Lab Tests Analysis

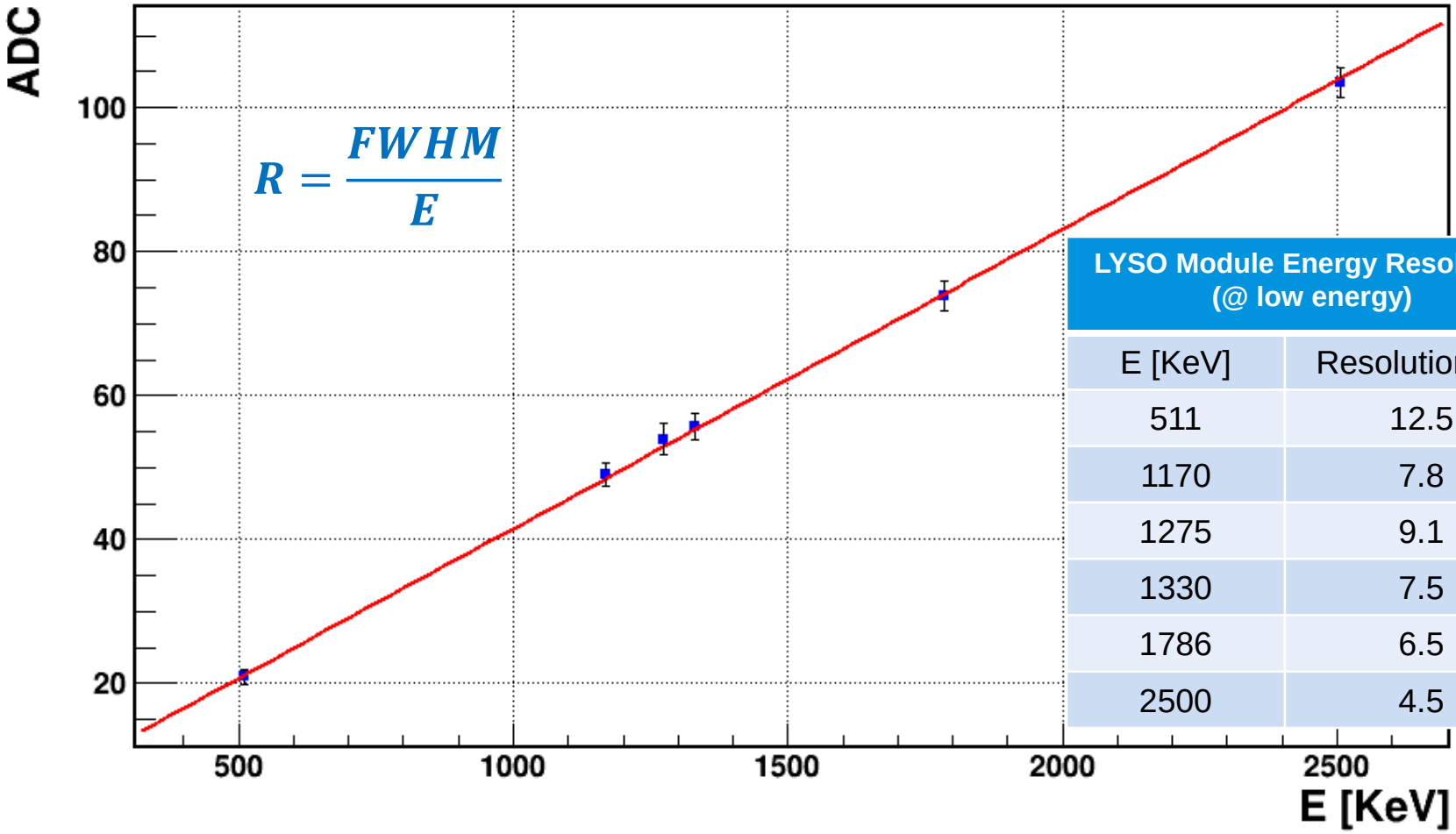


LYSO Modules Lab Tests Analysis



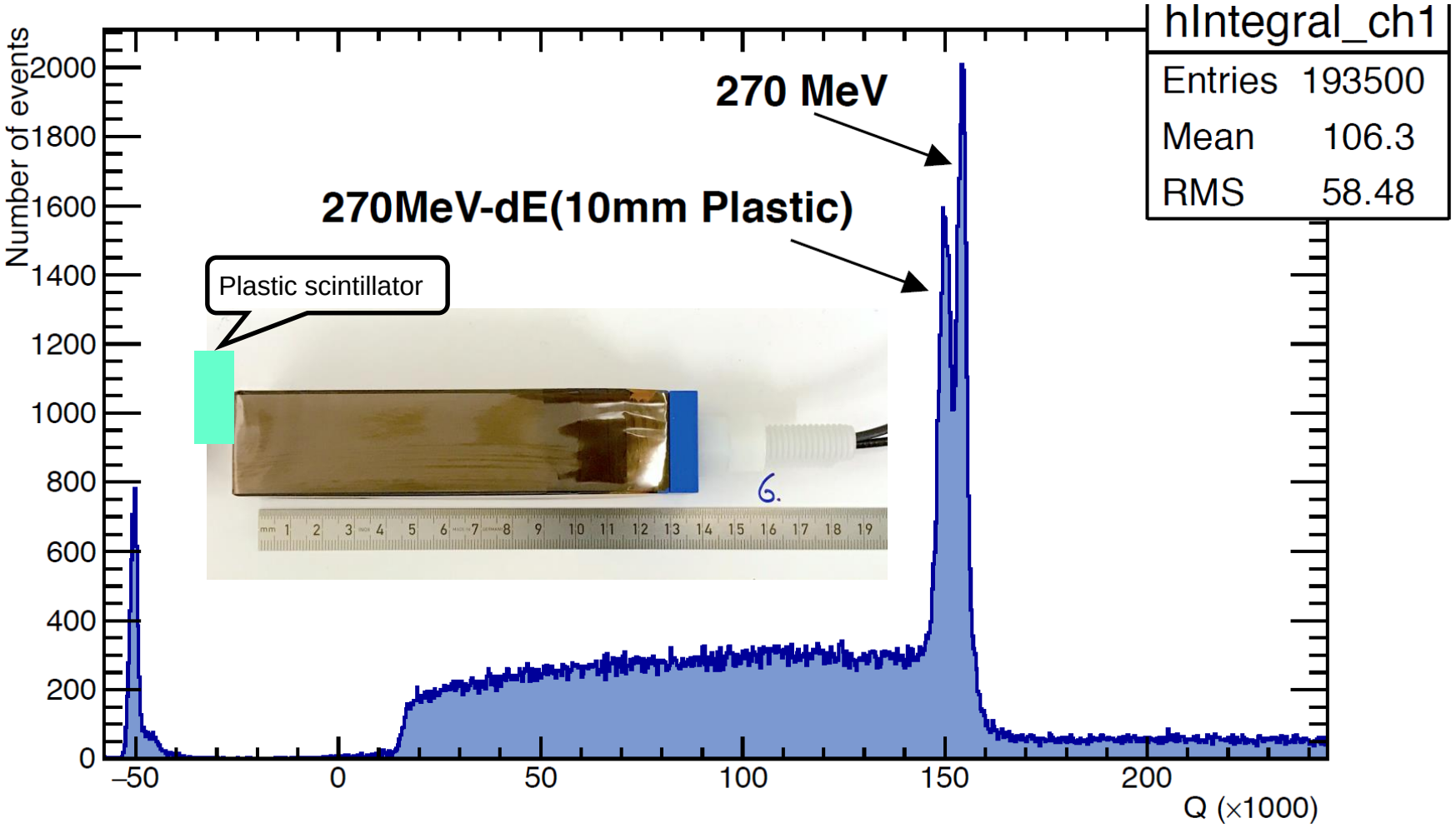
LYSO Modules Lab Tests Analysis

LYSO Module Linearity (@ low energy !)



LYSO Module Energy Resolution (@ low energy)	
E [KeV]	Resolution [%]
511	12.5
1170	7.8
1275	9.1
1330	7.5
1786	6.5
2500	4.5

Saturation Test on LYSO & SiPM



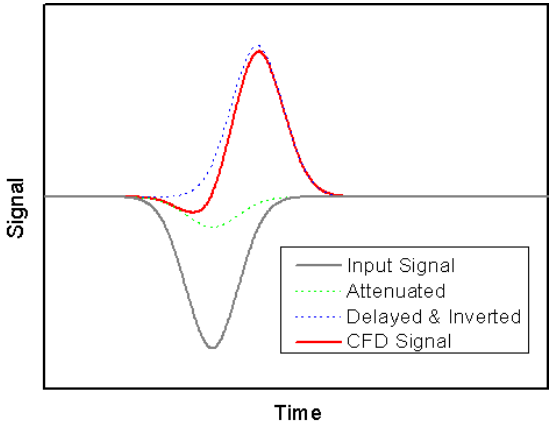
Time Resolution Analysis

Struck innovation system:
SIS3316 flash ADC

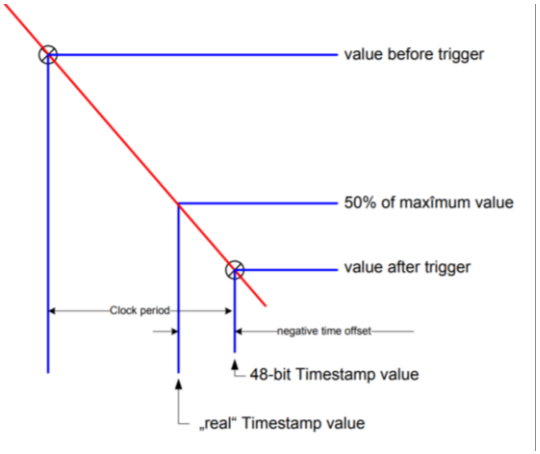
Features/Properties:

- 16 channels
- 250 MS/s per channel = 4ns between timestamps
- 14-bit resolution
- 64 MSamples memory/channel
- ...

1. Software based Constant Fraction Discriminator (CFD)

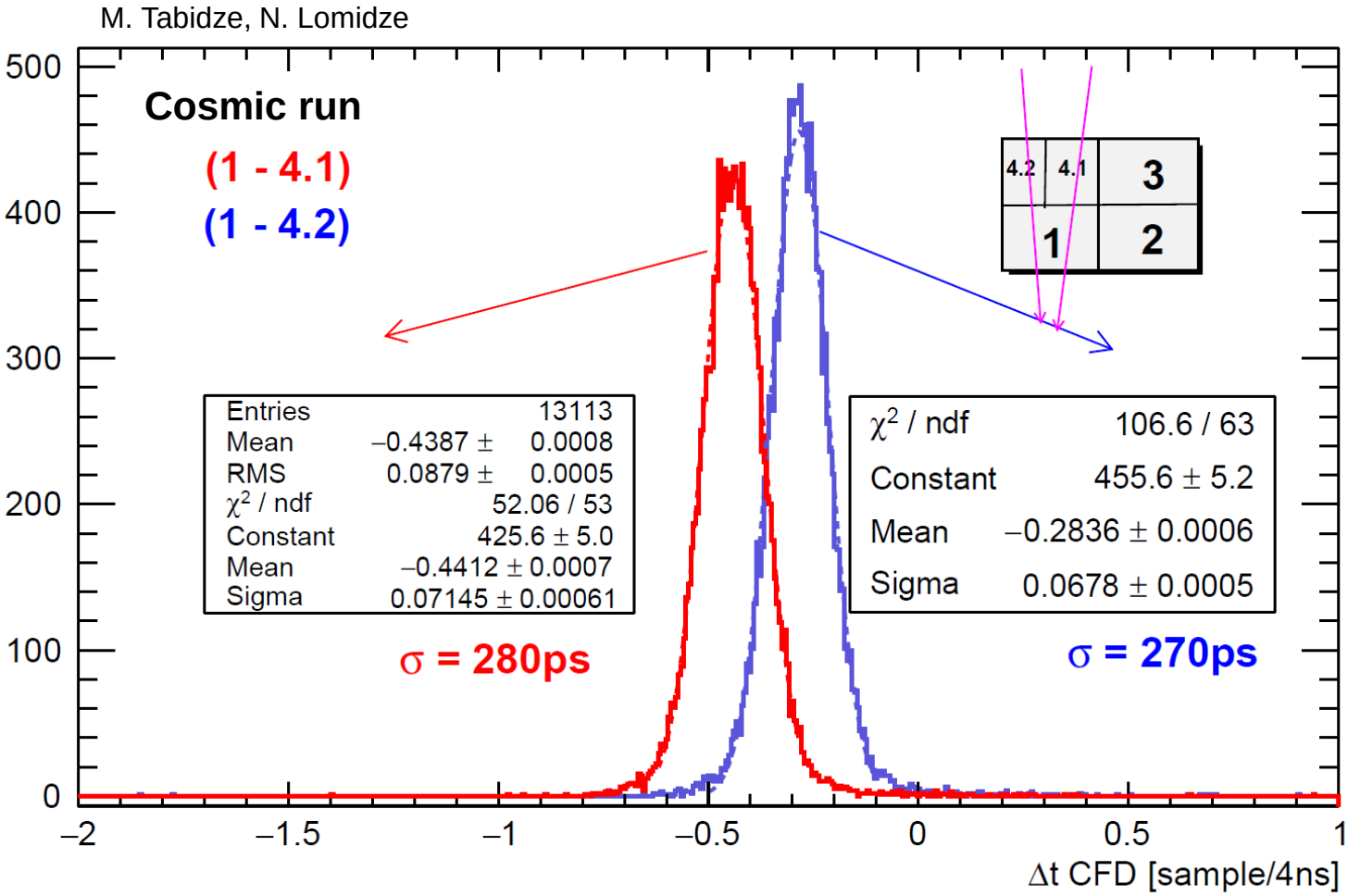


2. Built-in feature (Hardware CFD)



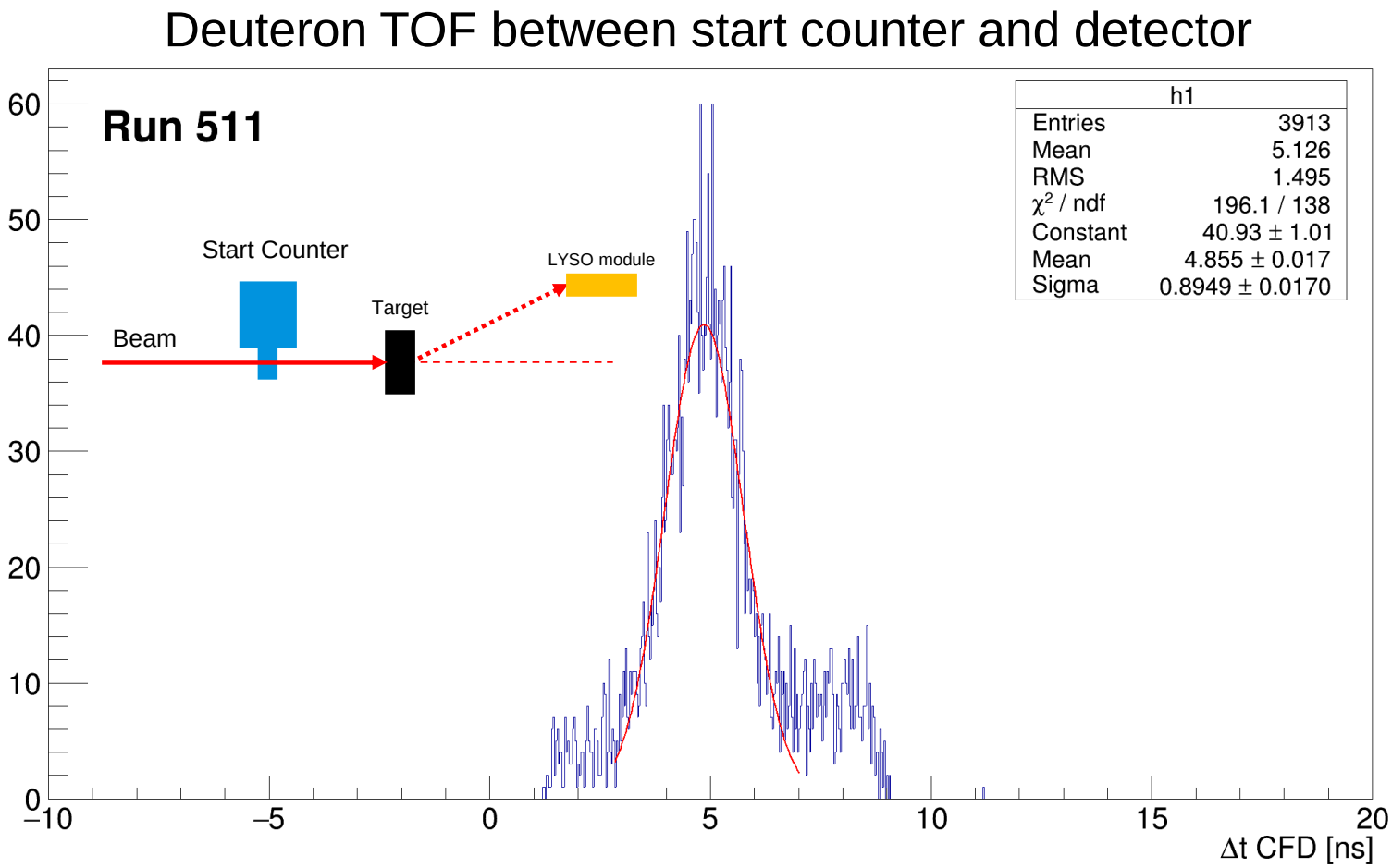
Time Resolution Analysis (SW CFD)

Cosmic Run with PMT & LYSO

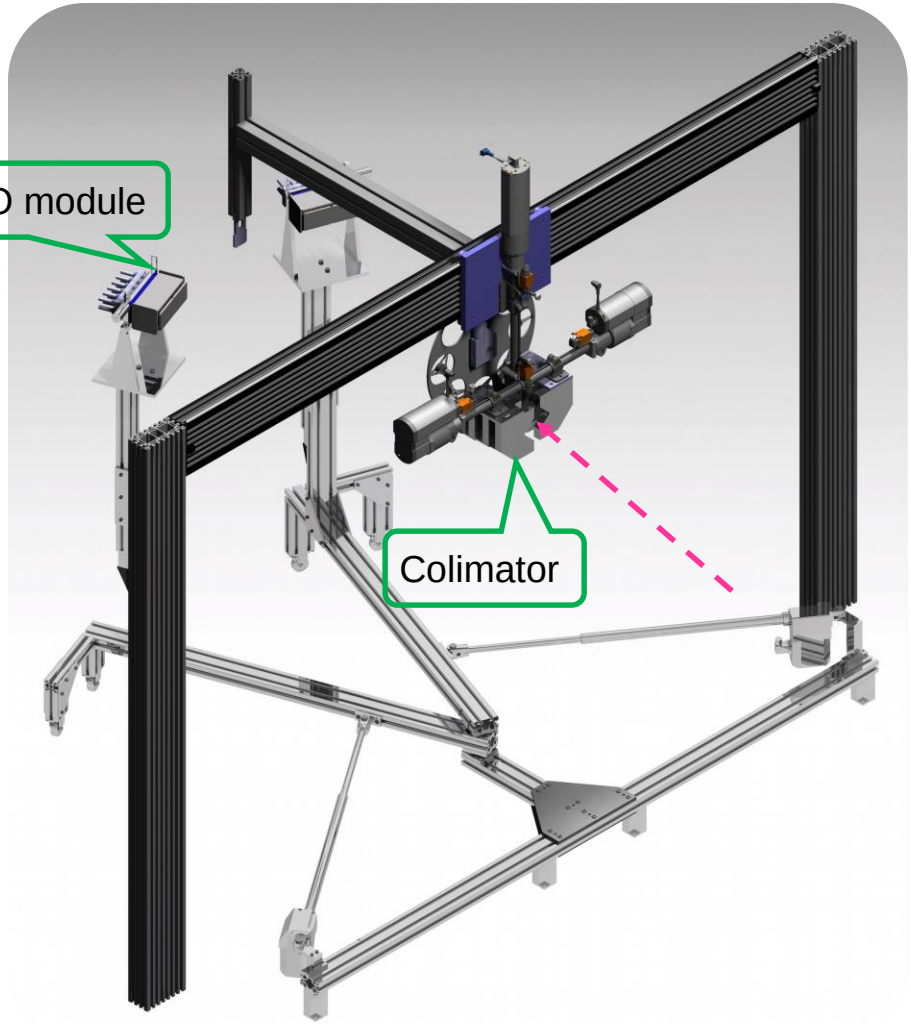


Time Resolution Analysis (HW CFD)

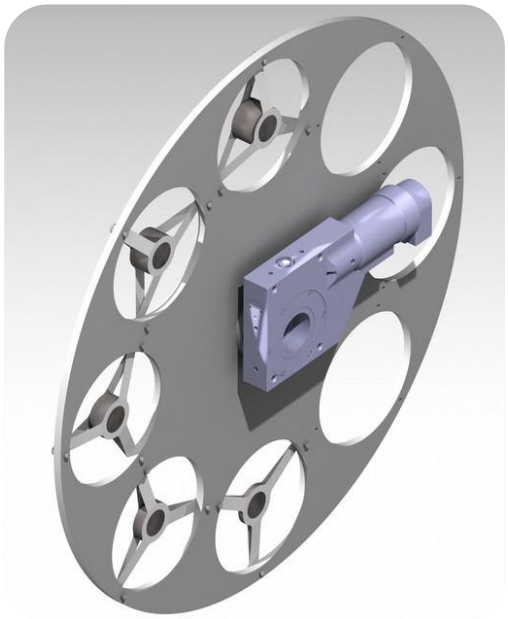
March 2017 beam time data



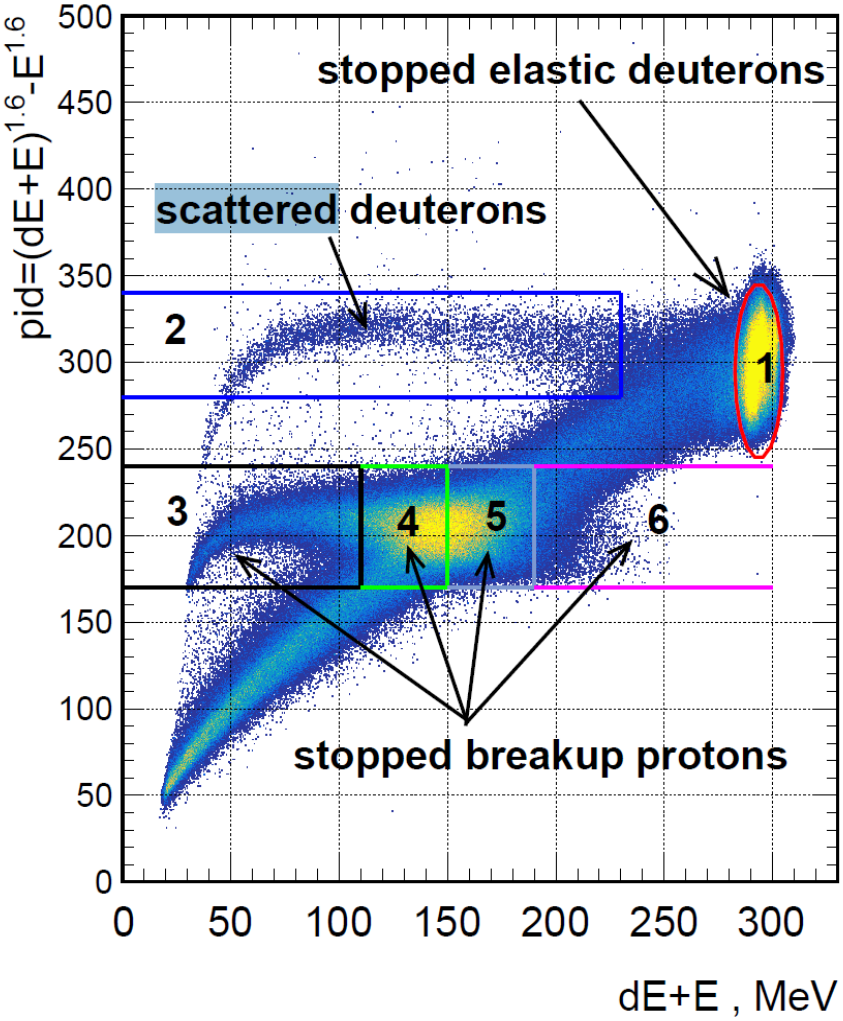
2nd Set-up for COSY Beam Time

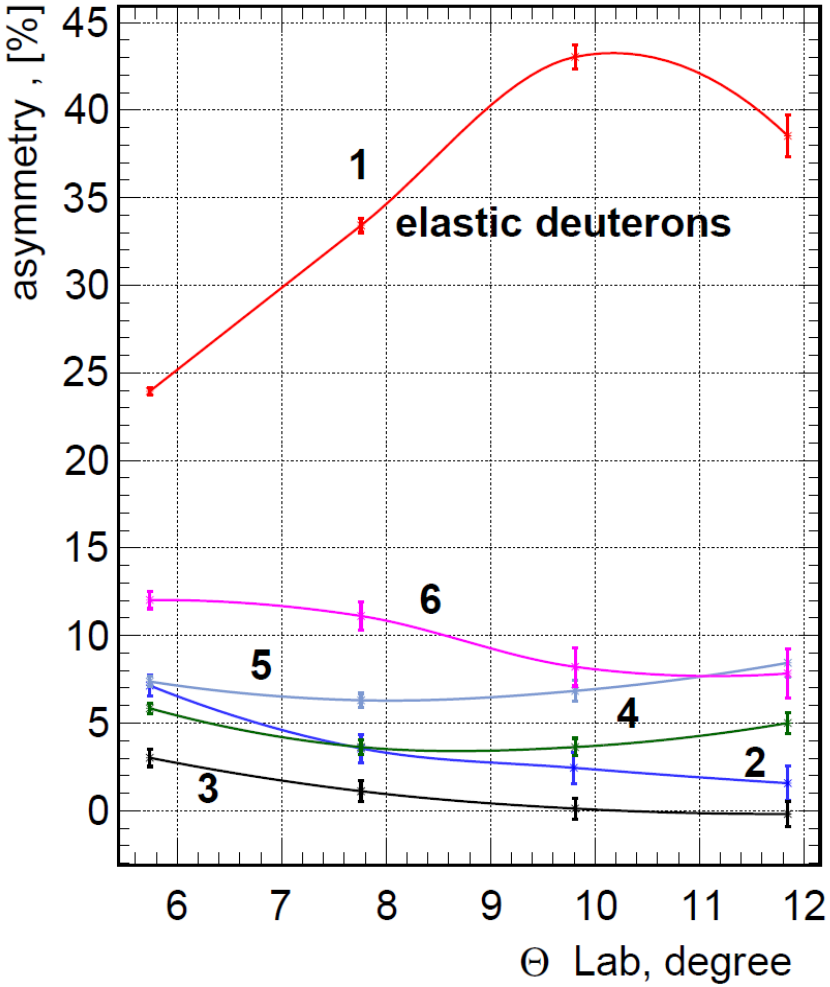


Target wheel



A_y (Θ) dC → pnC


stopped elastic deuterons
scattered deuterons
stopped breakup protons
1
2
3
4
5
6
pid=(dE+E)^1.6-E^1.6
dE+E , MeV


asymmetry , [%]
1
elastic deuterons
6
5
4
3
2
Θ Lab, degree

Summary

- ✓ LYSO module **assembling** and **testing** procedure
- ✓ Analyzing of the deuteron break-up reaction dC → **p**nC
- ✓ CFD for higher time resolution (need more investigation for SiPMs)

Outlook

Getting ready for the next polarimetry beam time in Dec, 2017

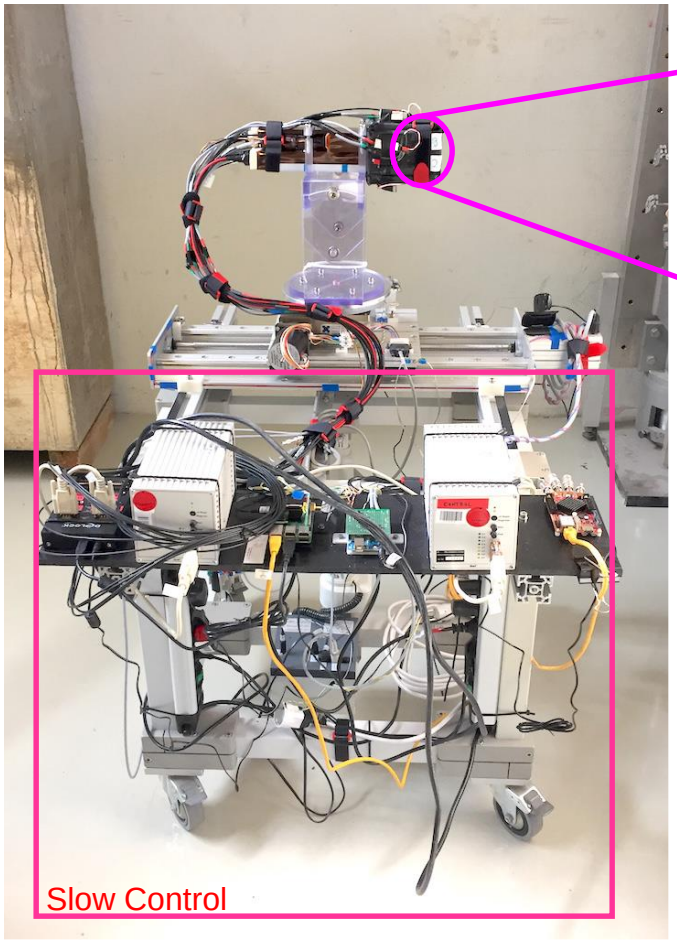
- ❑ Assembling the new 46 modules and lab tests
- ❑ Upgrade HW/SW packages for the read out system
- ❑ Development of power supply with monitoring option

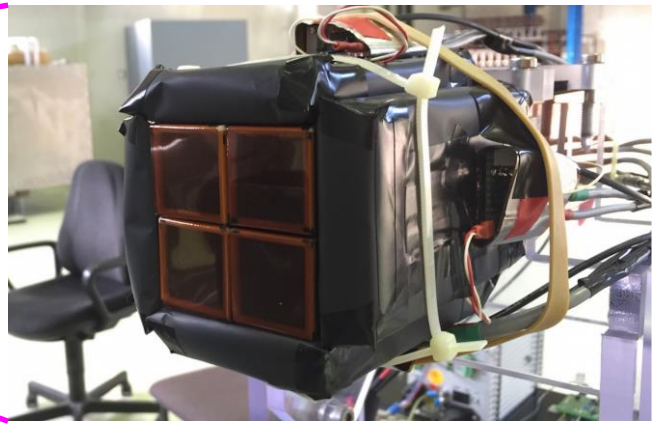
This work was supported by the Shota Rustaveli National Science Foundation (SRNSF)


Thank You

Appendix

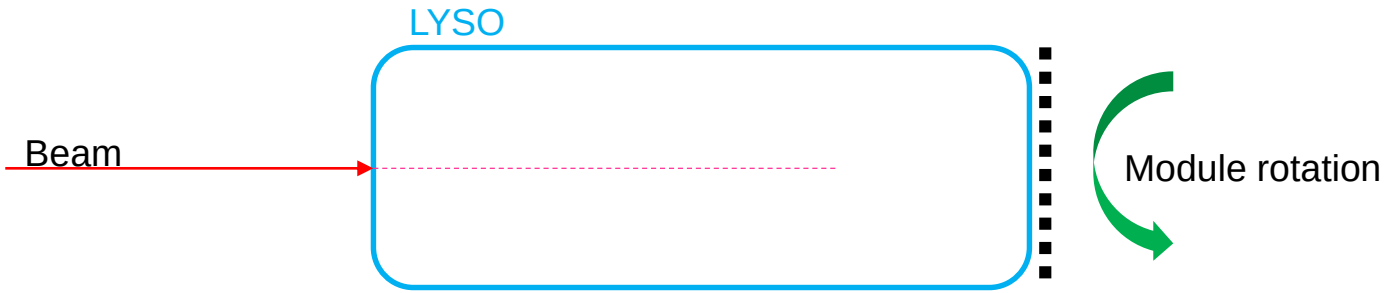
1st Set-up for COSY Beam Time



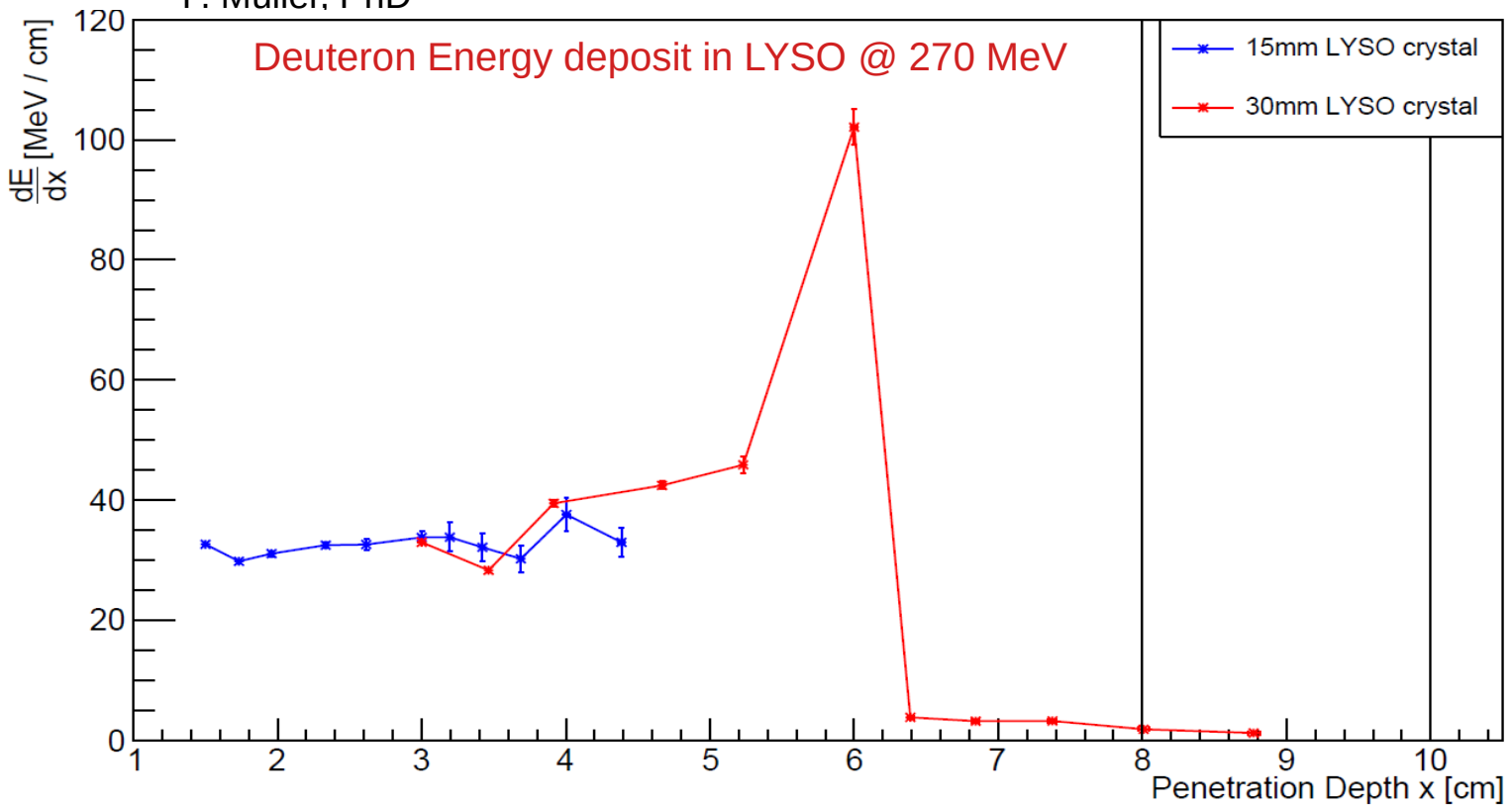


4.1	4.2	3
1		2

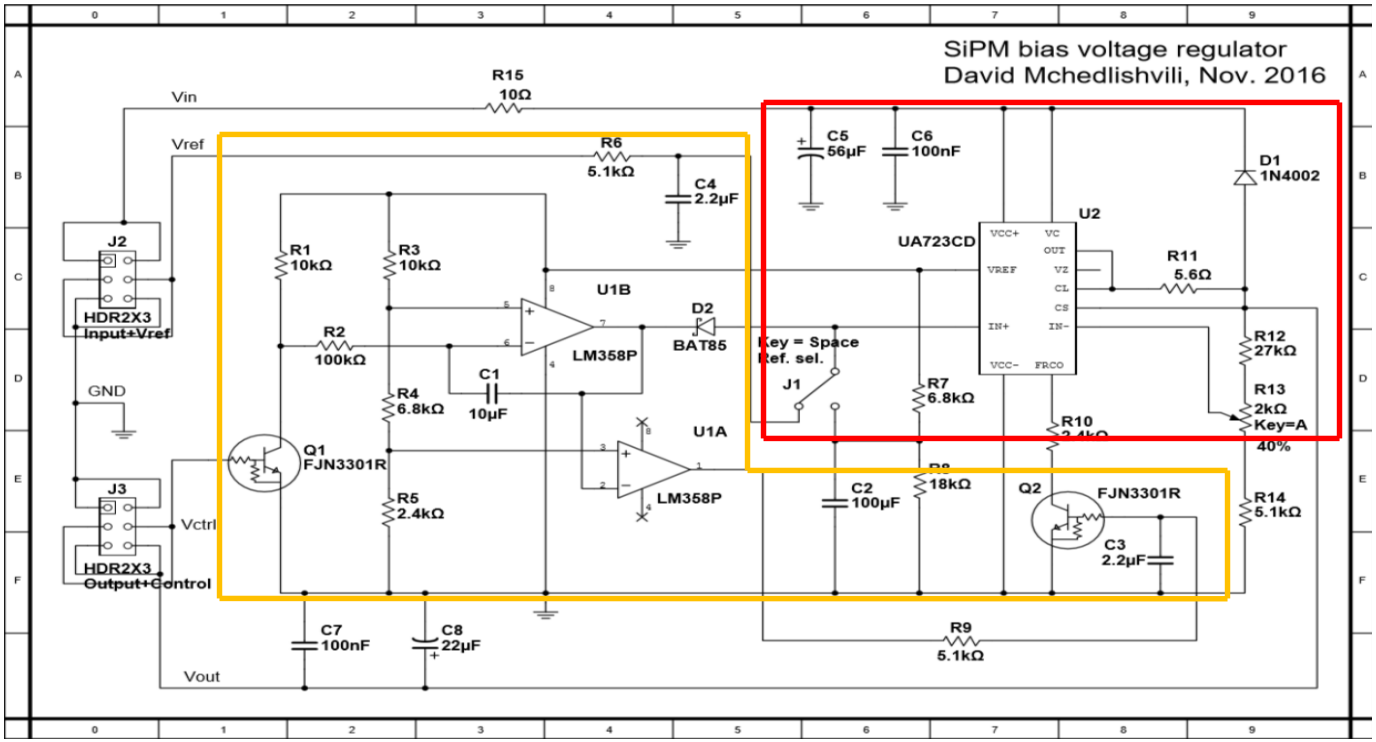
First Test on LYSO – Bragg peak



F. Müller, PhD

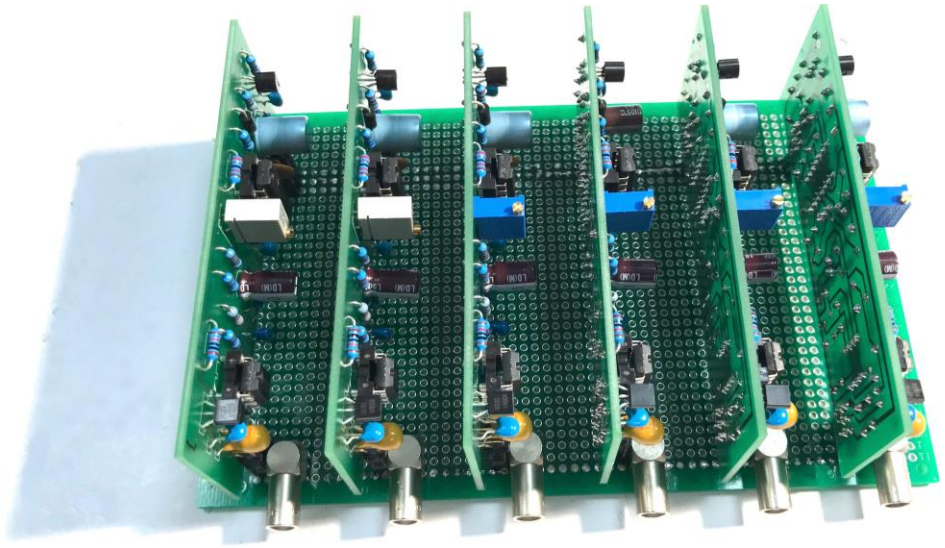


SiPM Power Supply Schematic

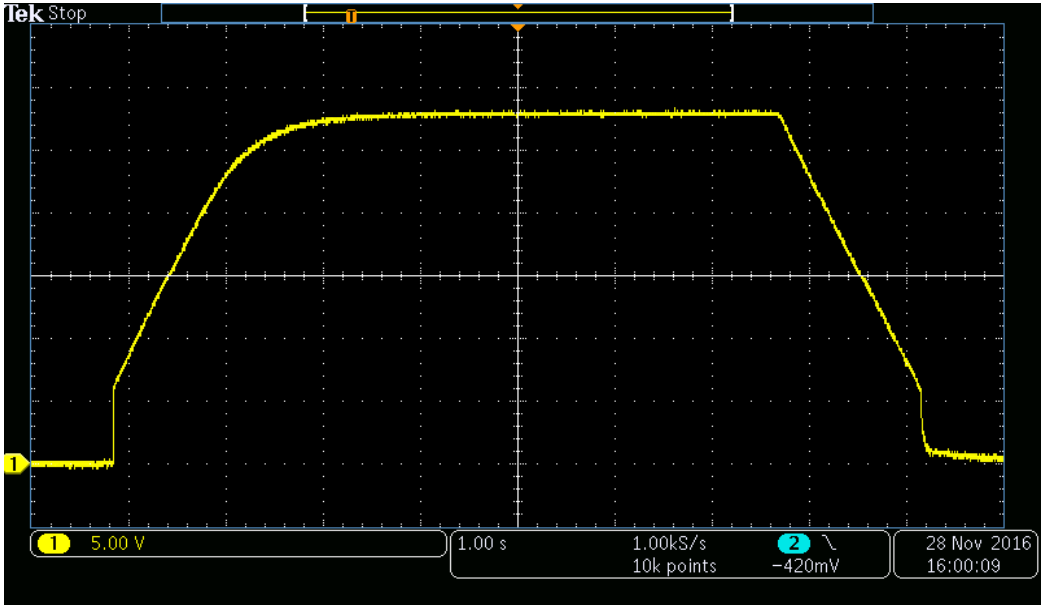


- Linear voltage regulator part
- Ramp generator and on/off part

Power Supply for SiPM

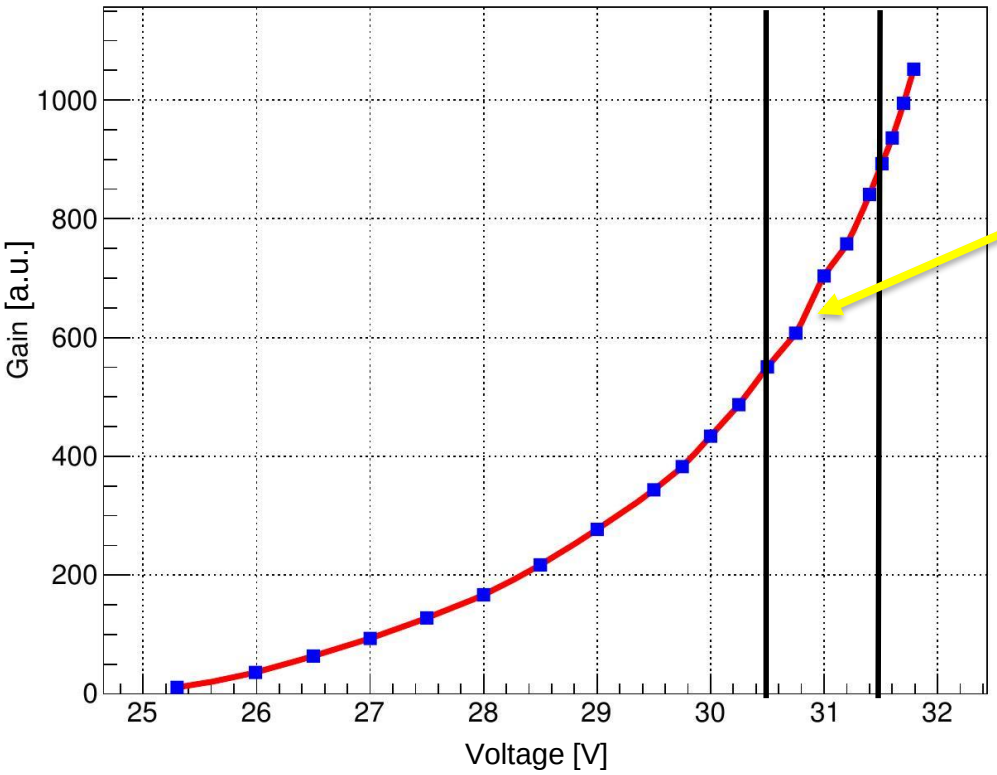


First prototype board on a test bench *(using internal voltage reference)*



Output on/off curve with voltage ramp

SiPM Gain *vs* Bias Voltage



1mV variation ~ 0.02…0.05 % in gain

Gain variation is directly related to energy resolution

LYSO energy resolution ~ 1%

Max. accepted ΔV ~ 10mV