JÜLICH
FORSCHUNGSZENTRUM

Towards the JEDI Polarimetry

for the JEDI Collaboration

September 15, 2015 | Irakli Keshelashvili |

- Introduction
- JEDI Polarimetry Concept
- MC Simulations
- Laboratory Tests
- Outlook
- Summary

JEDI – Jülich Electric Dipole moment Investigation

S1: M. Bai

S1: E. Stephenson

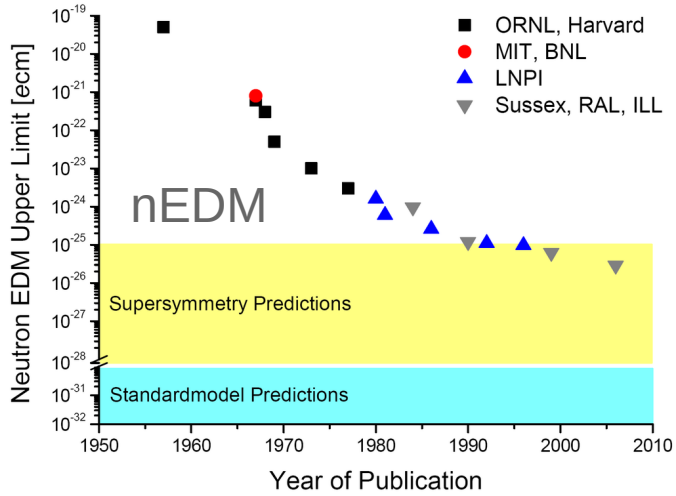
S11: J. Pretz

JEDI

Baryo genesis

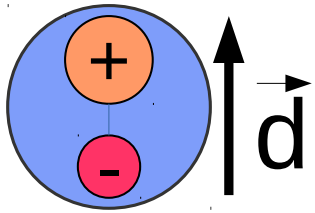
Standard Model

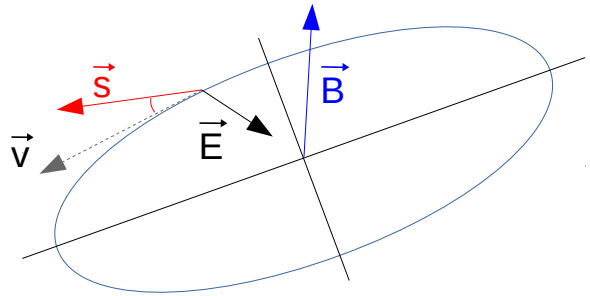
- not enough CP violation



Why Storage Ring?

Measuring EDM for Charged Pericles





$$\frac{d\vec{s}}{dt} = \vec{d} \times \vec{E} + \vec{d} \times (\vec{v} \times \vec{B})$$

- Store Polarized Deuterons (COSY)
- Interact with an E-field
- Analyze Polarization Build-up (this talk)

S5: N. Hempelmann

S6: S. Mey

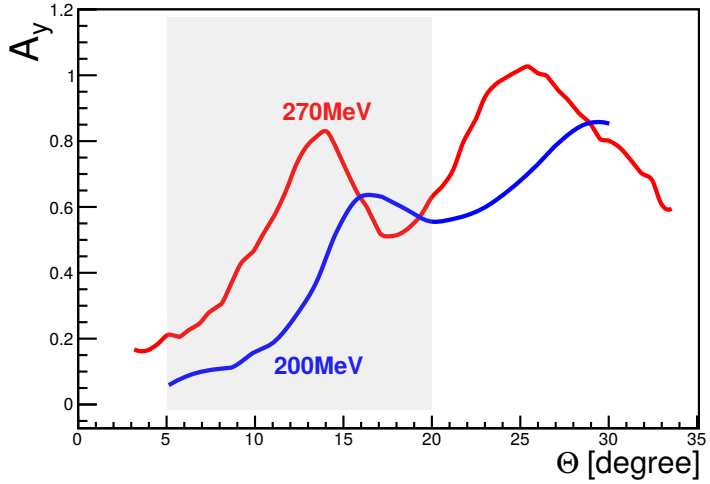
S6: J. Slim

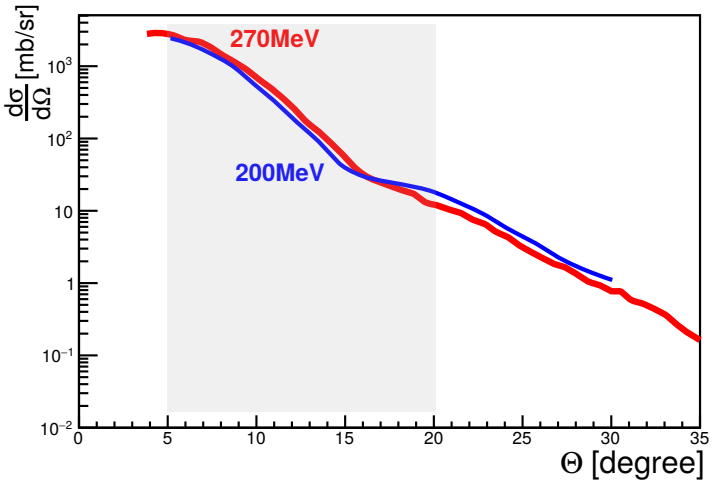
EDM – *Precision Experiment !!!*

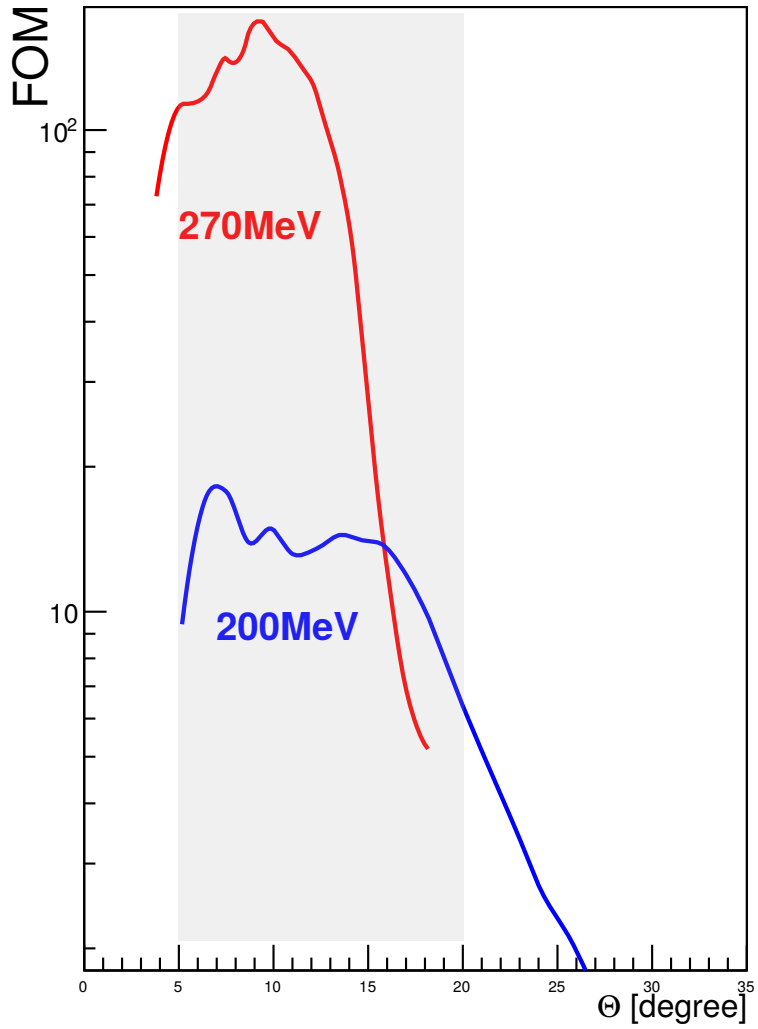
- Reaction with Large A_y: Best $dC \rightarrow dC$!!!
- Maximum Detection & Data Taking Efficiency !!!
- Full ϕ in Reasonable FOM(θ) region !!!
- No Magnetic / Electric Field !!!
- Stability – Long / Short Term !!!

$dC \rightarrow dC$ Elastic Scattering @ 270 *MeV*

Y. Satou et al., Phys. Lett. B 549, 307 (2002).

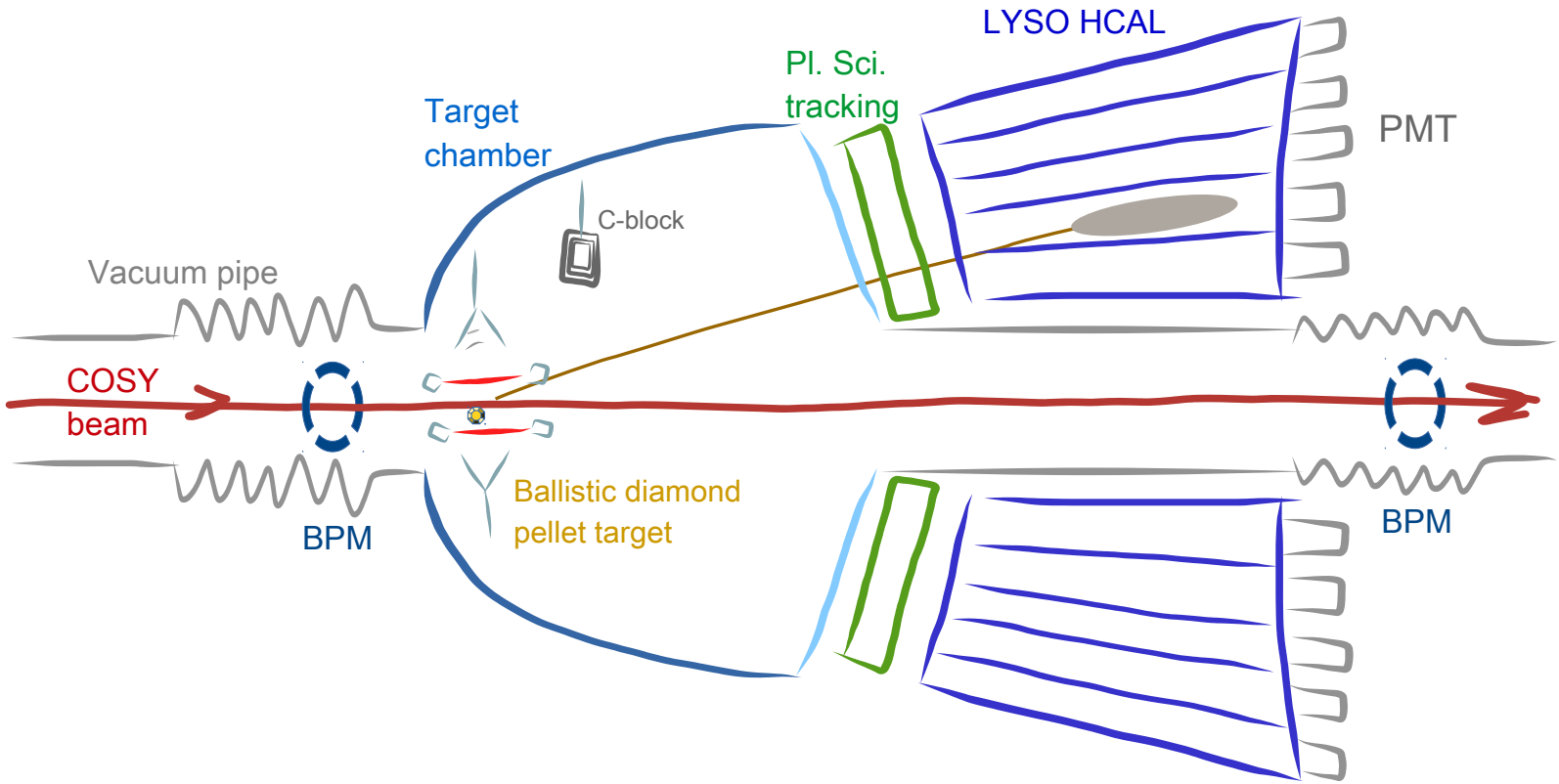






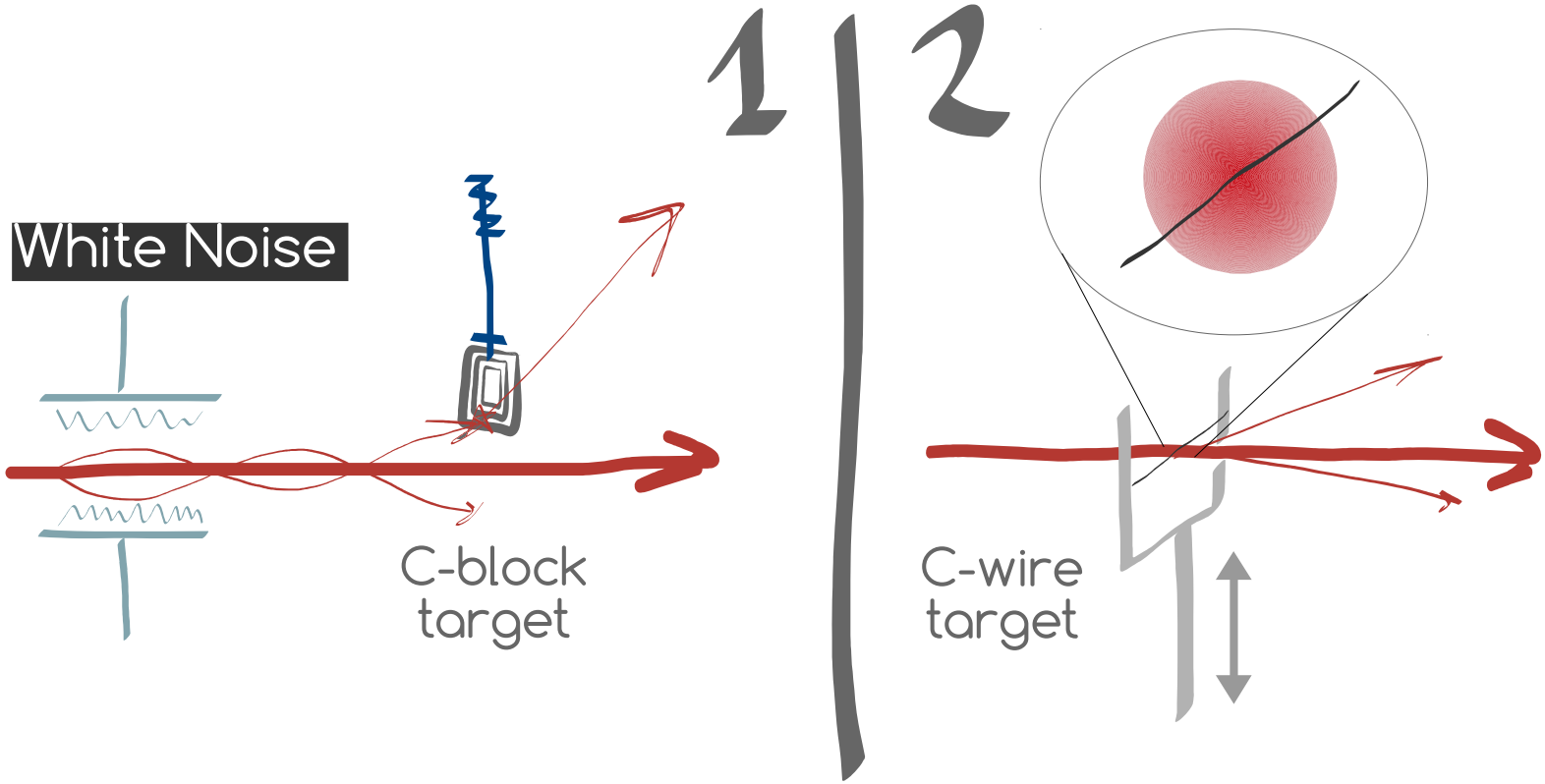
JEDI Polarimetry Concept

Optimized for $dC \rightarrow dC$ Reaction



EDDA@COSY Targets

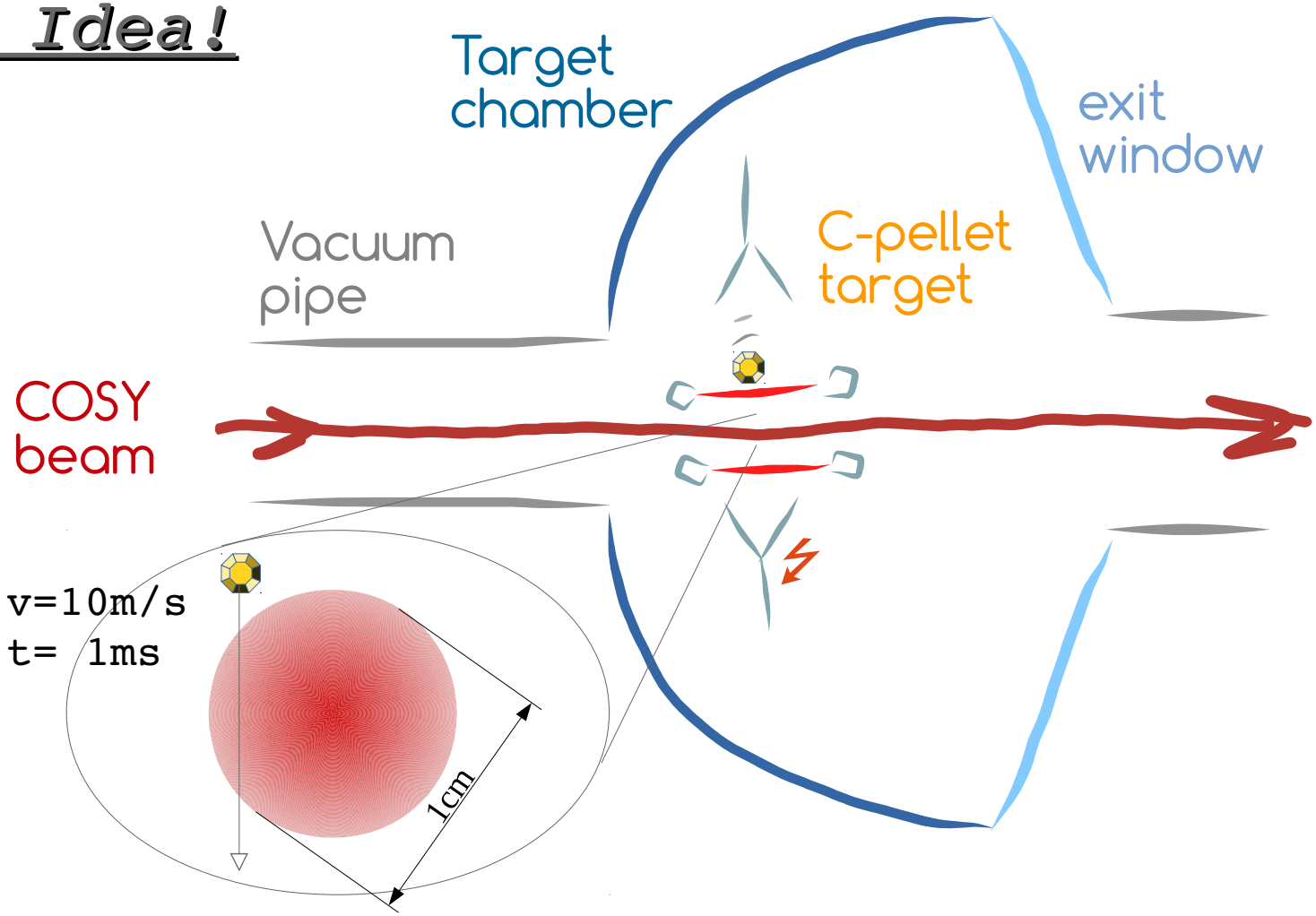
Optimized for $dC \rightarrow dC$ Reaction



JEDI Polarimetry Concept

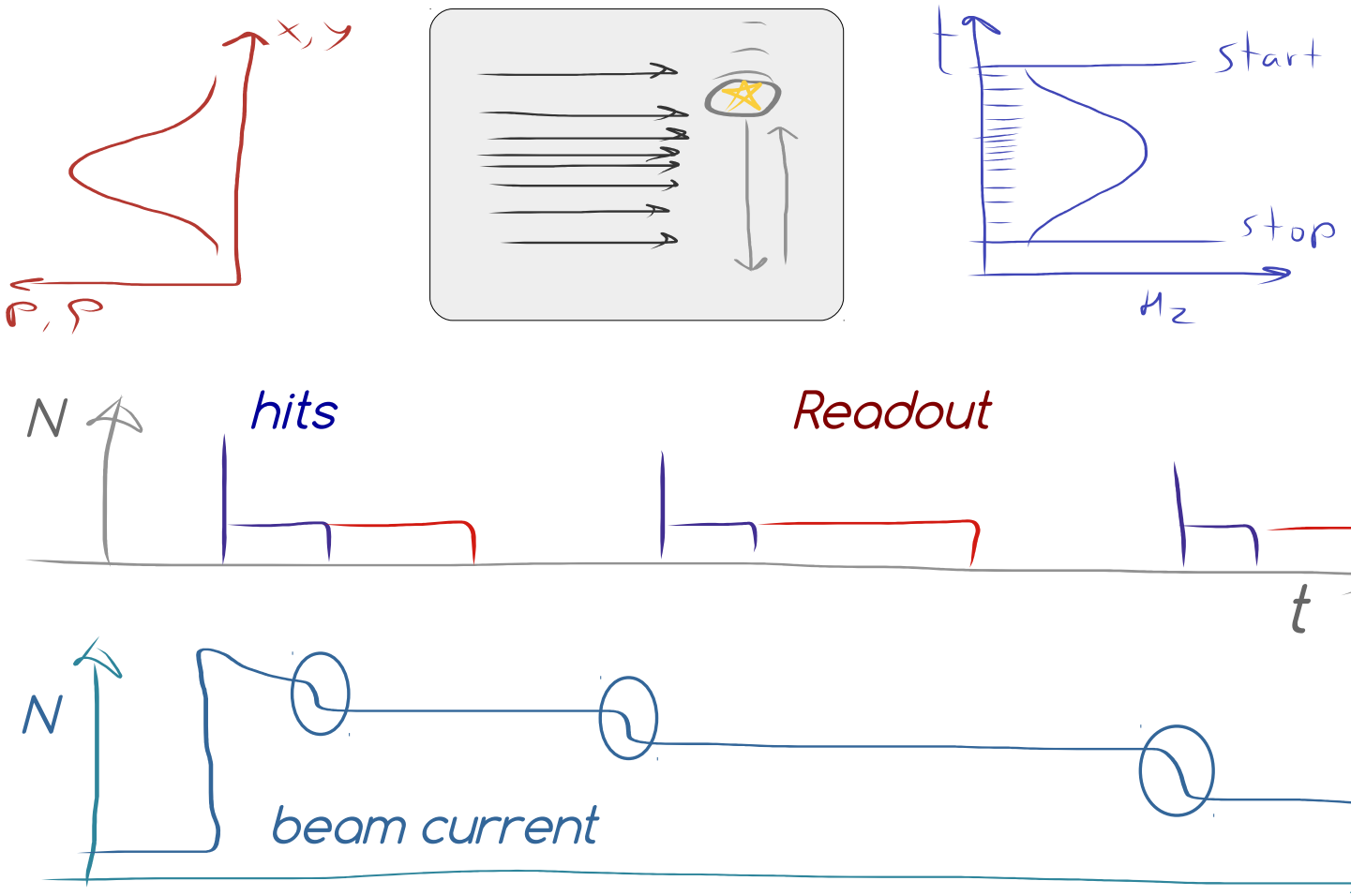
JüDiT – Jülich "Ballistic" Diamond Pellet Target

New Idea!



JEDI Polarimetry Concept

Variable Effective Target Thickness

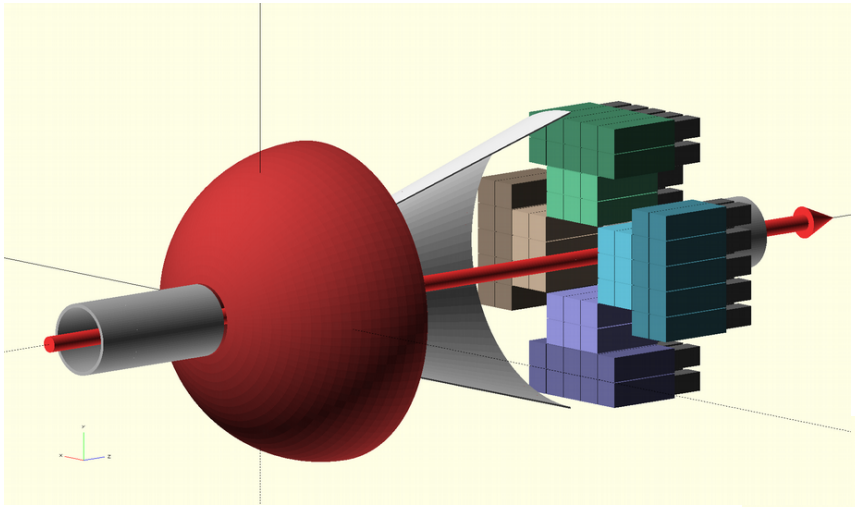


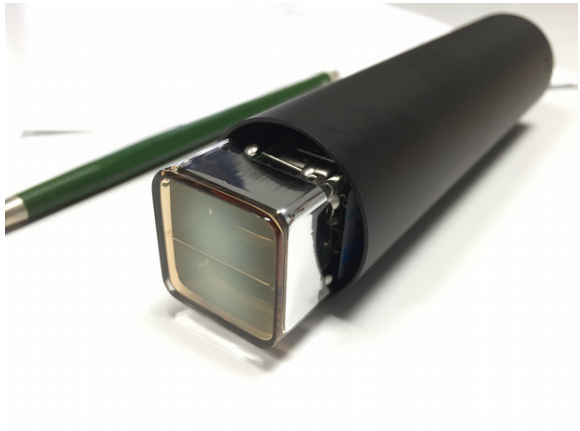
Proposed Detector Concept: Layout

Modular Setup

First Version

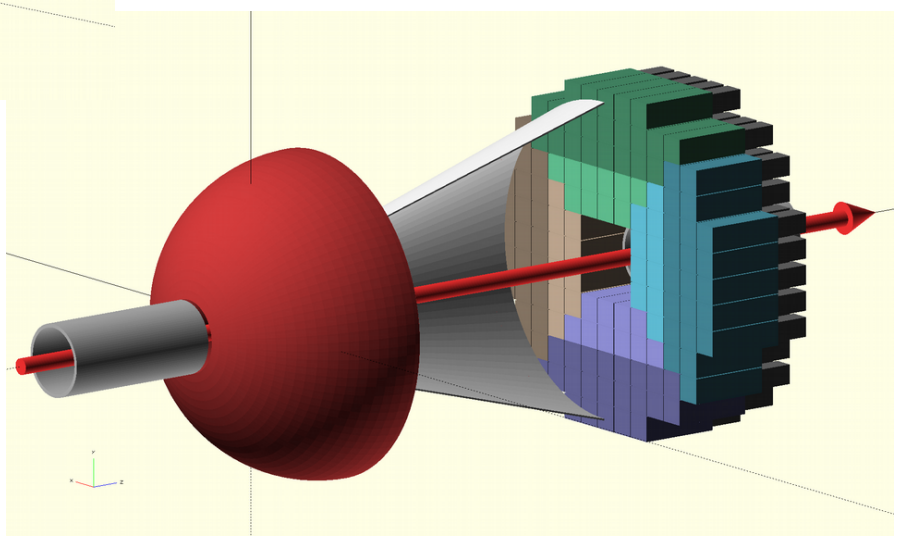
4x6=24 LYSO
4x10=40 BGO





Final Version

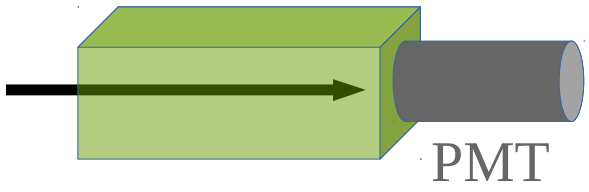
LYSO & BGO



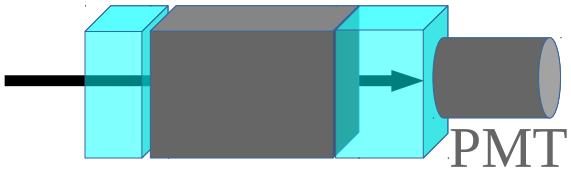
Hadron Calorimeter Concept

Possible Scintillation Materials

LYSO / BGO



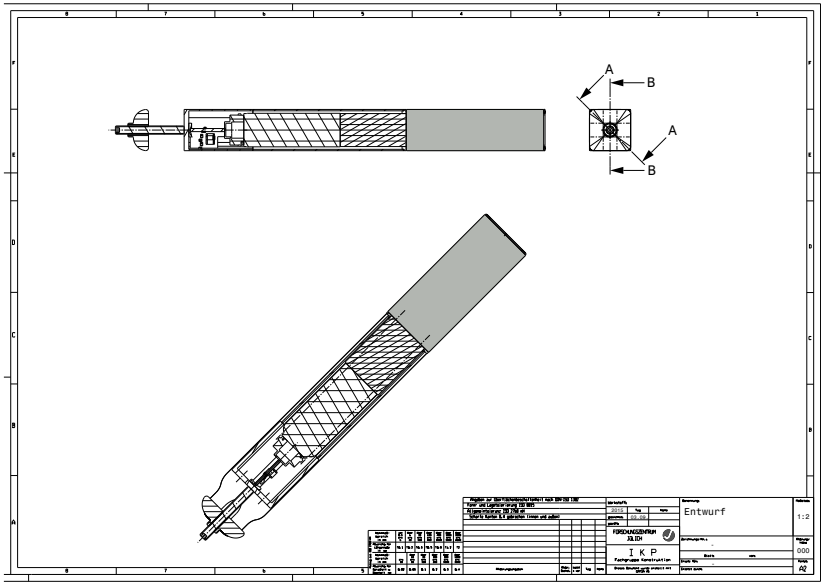
Sci. + W + Sci.

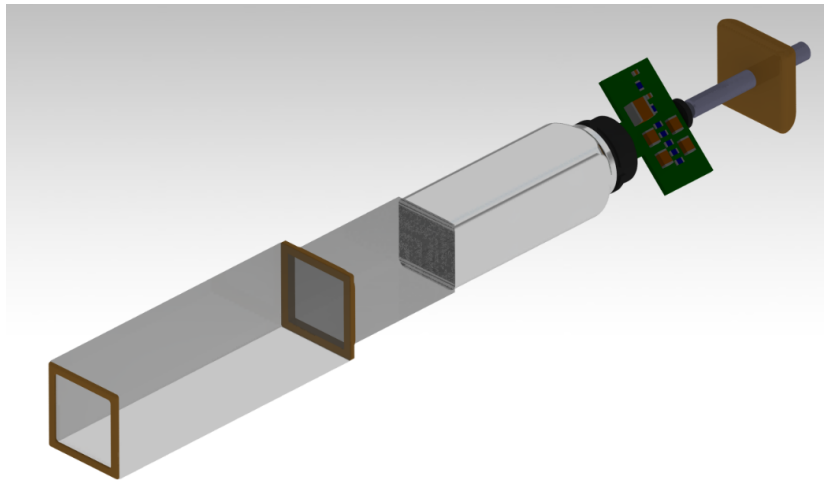


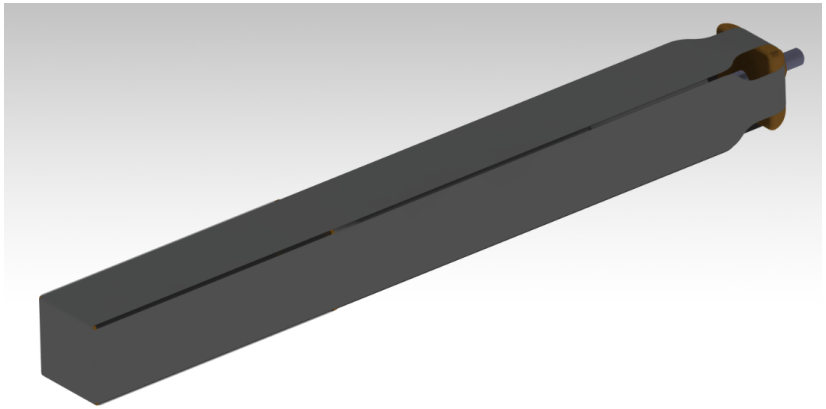
	LYSO	BGO	Plastic
[g/cm^3]	7.1	7.1	1.05
Devay [ns]	40	300	2.4
L. Y. % NaI(Tl)	75	25	25
S. Peak [nm]	420	480	420
n-index	1.82	2.15	1.58
Melt. ^{O}C	2050	1050	75
Hygrosc.	No	No	No
Radioact.	Yes	No	No

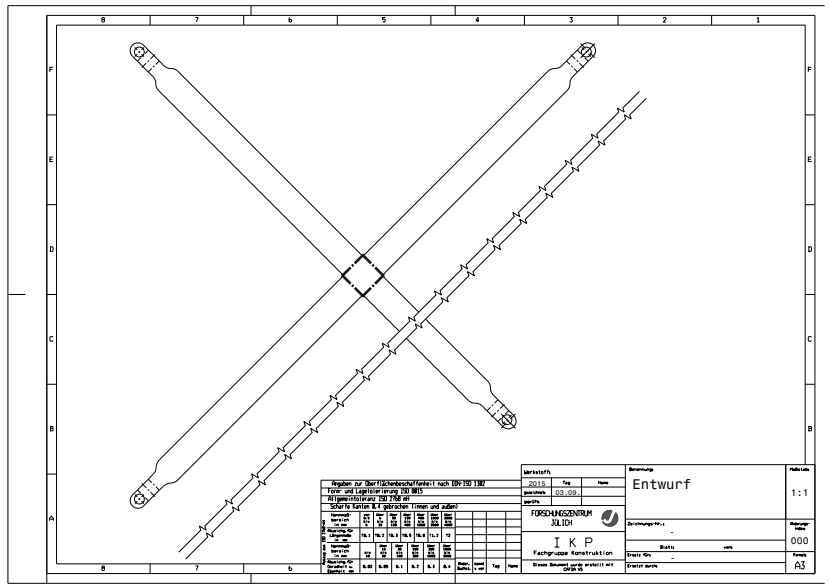
LYSO Module

N. Giese



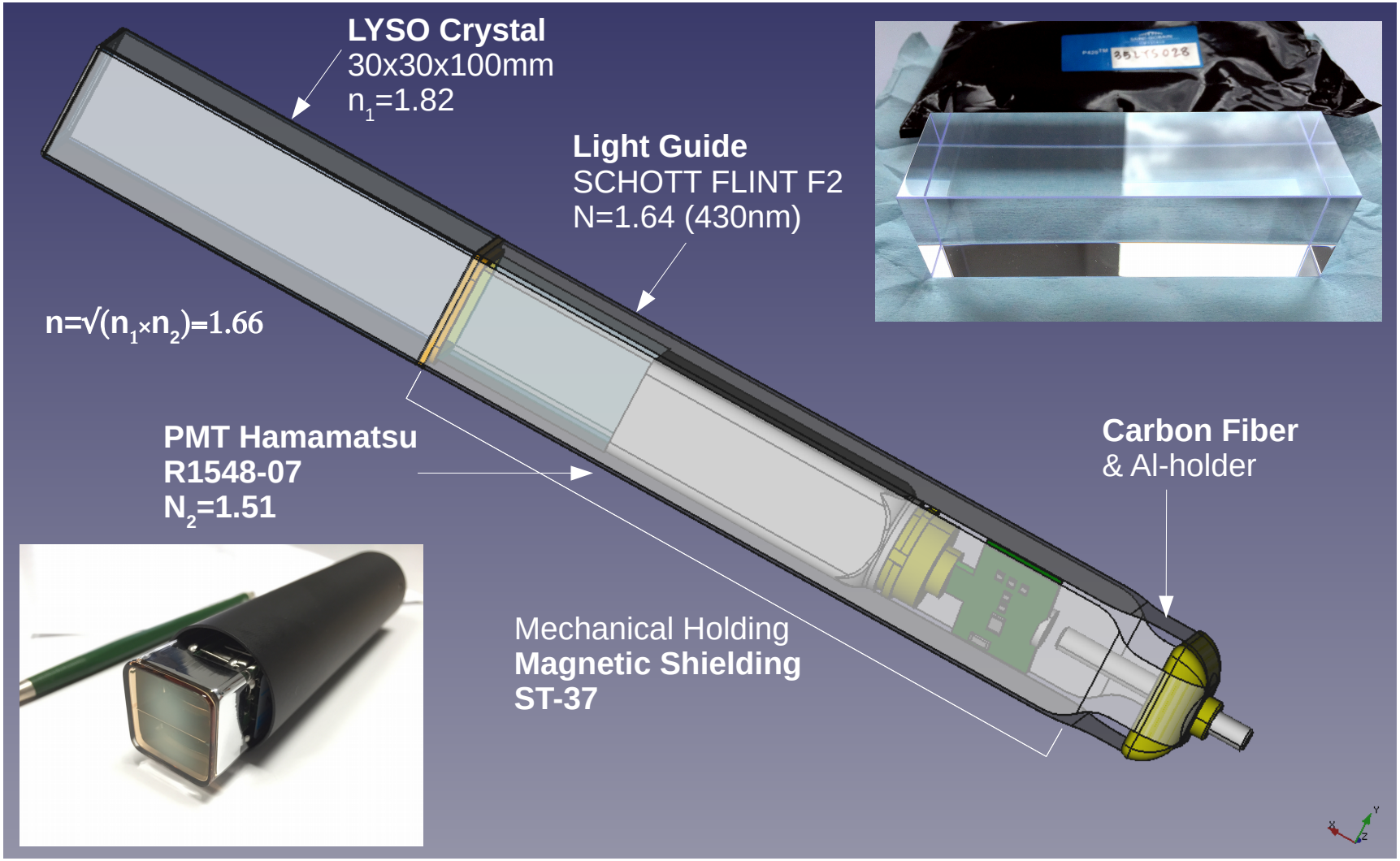






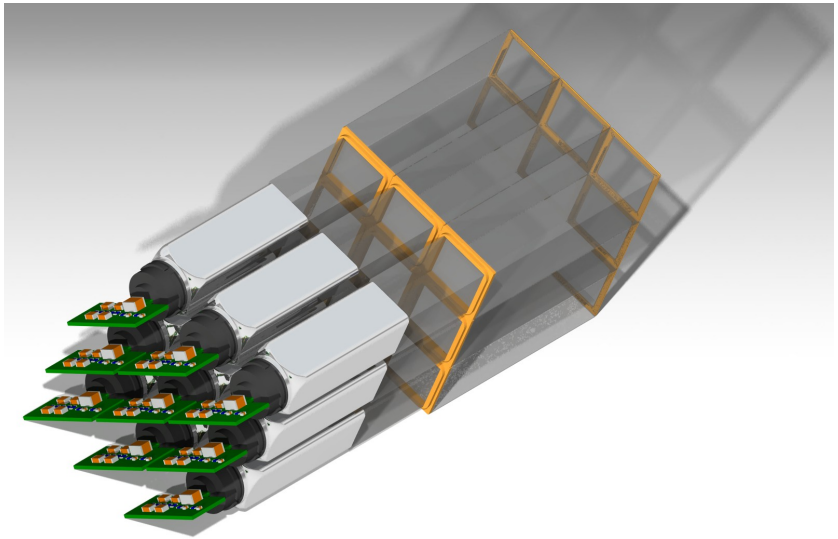
LYSO Module Prototype

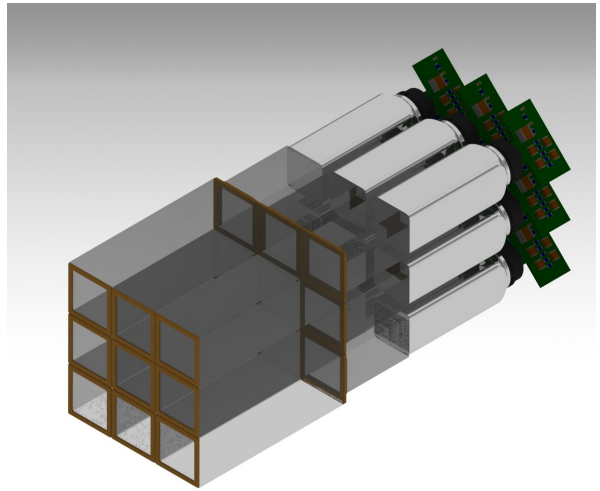
N. Giese

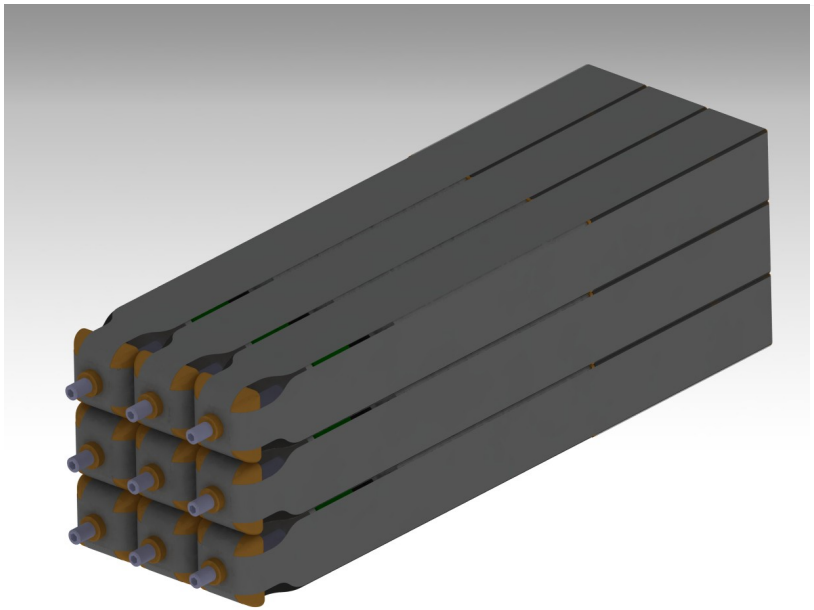


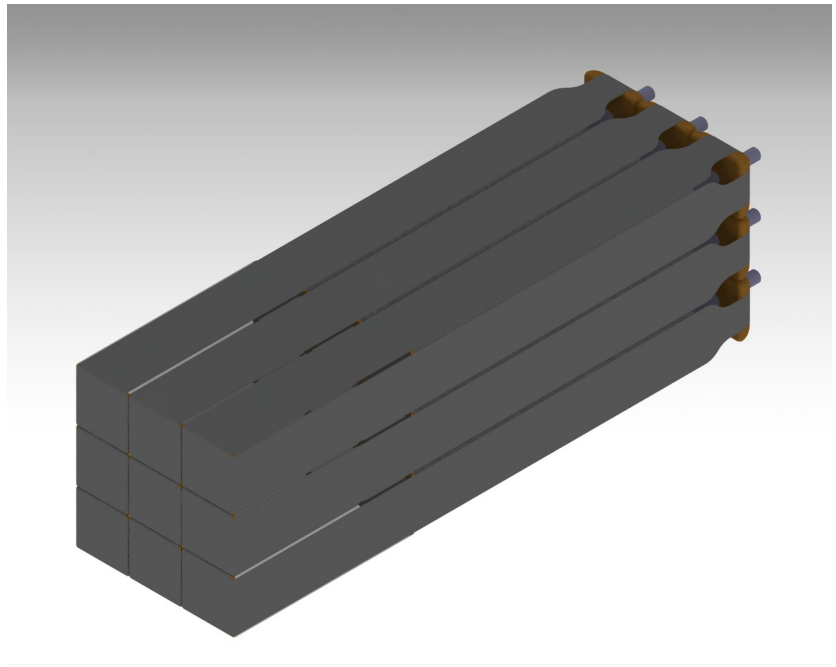
Prototype: Proto 9

N. Giese



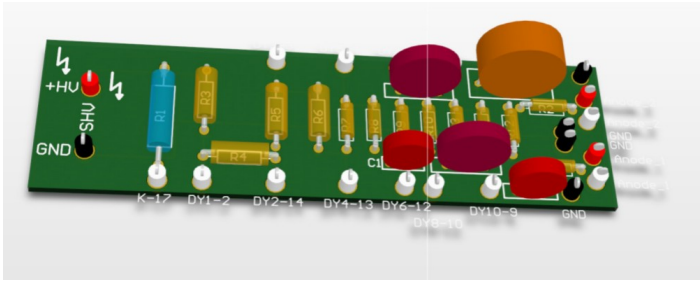


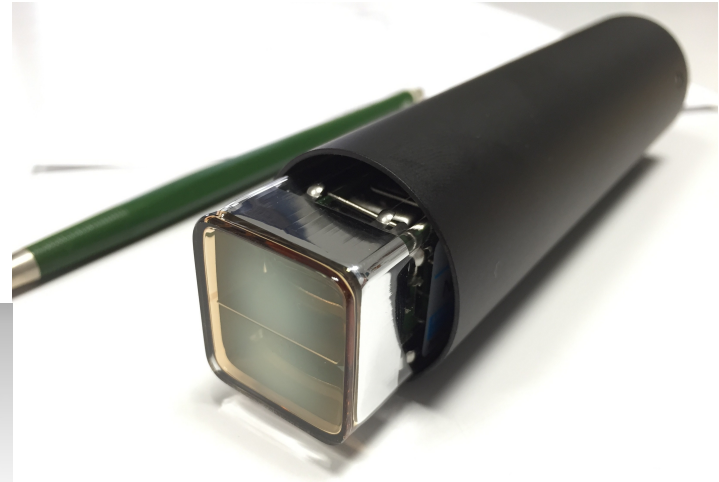


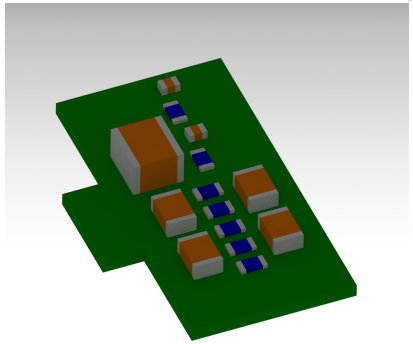


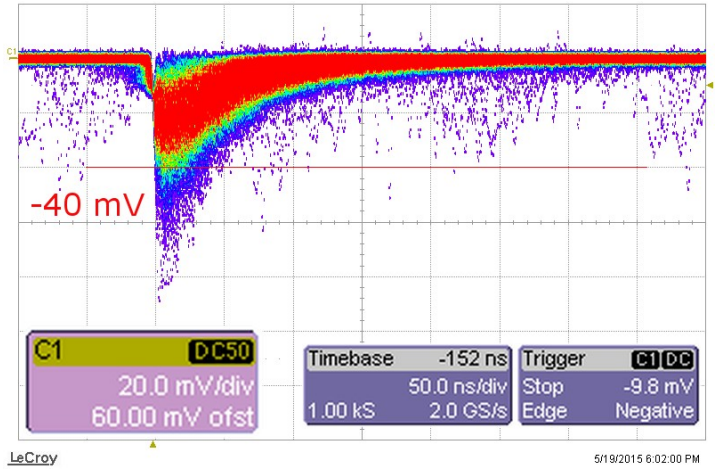
Hardware Progress

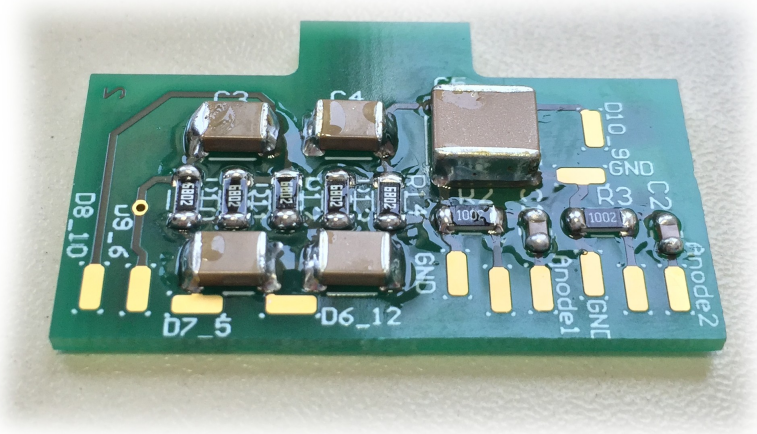
Tanja Hahnraths-von der Gracht & T. Sefzick





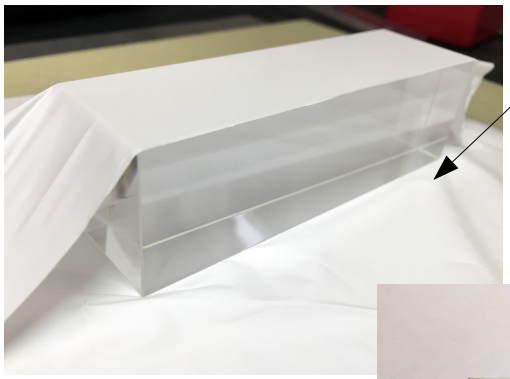






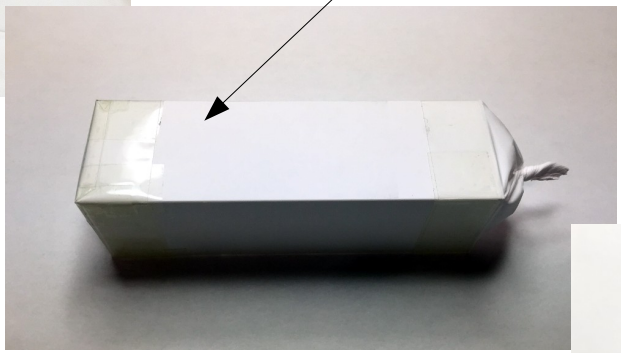
LYSO Crystal Wrapping

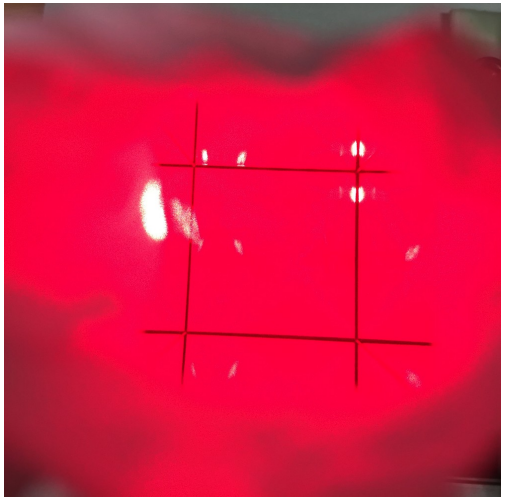
RWTH Bs. C. Dziwok

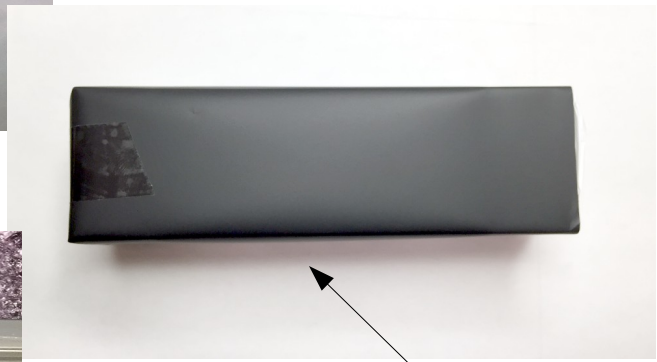


50µm Teflon

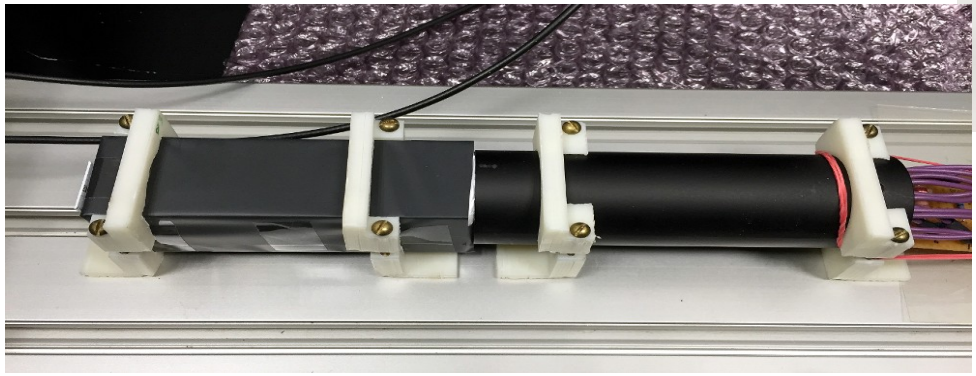
Double Layer Teflon





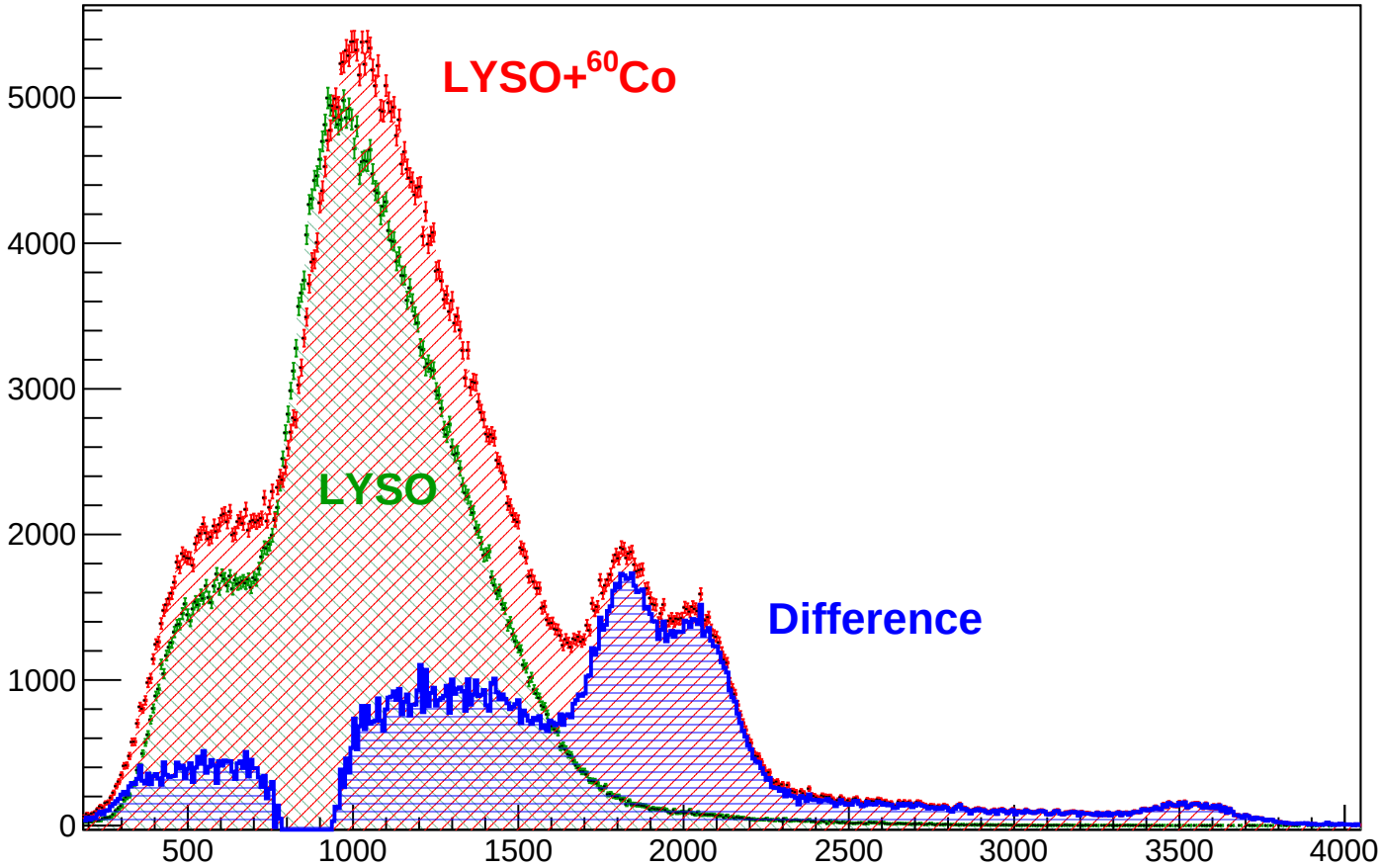


50µm Redlar



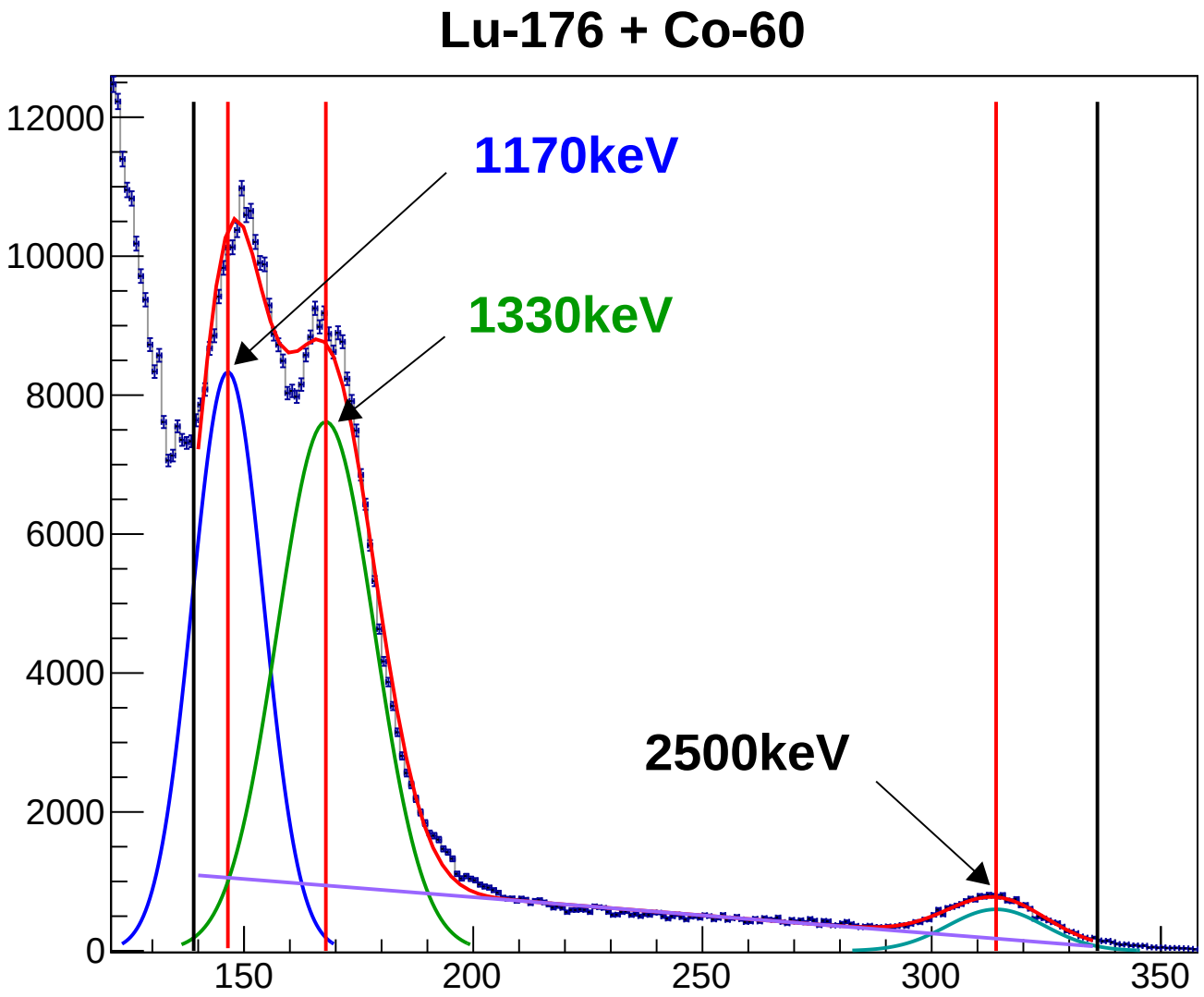
LYSO (^{176}Lu) Vs. ^{60}Co Tests

K. Nowakowski



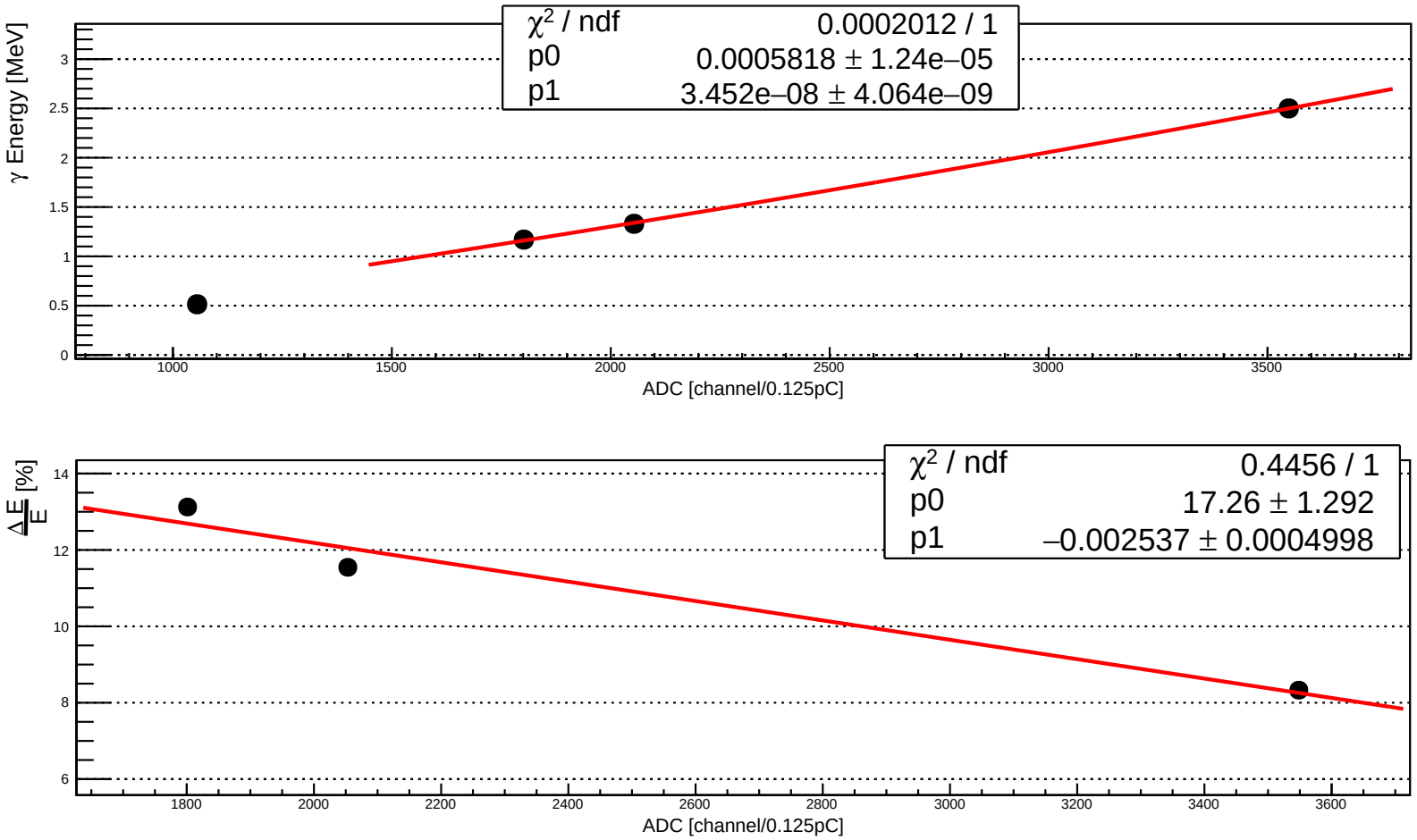
^{60}Co Tests

K. Nowakowski, C. Dziwok



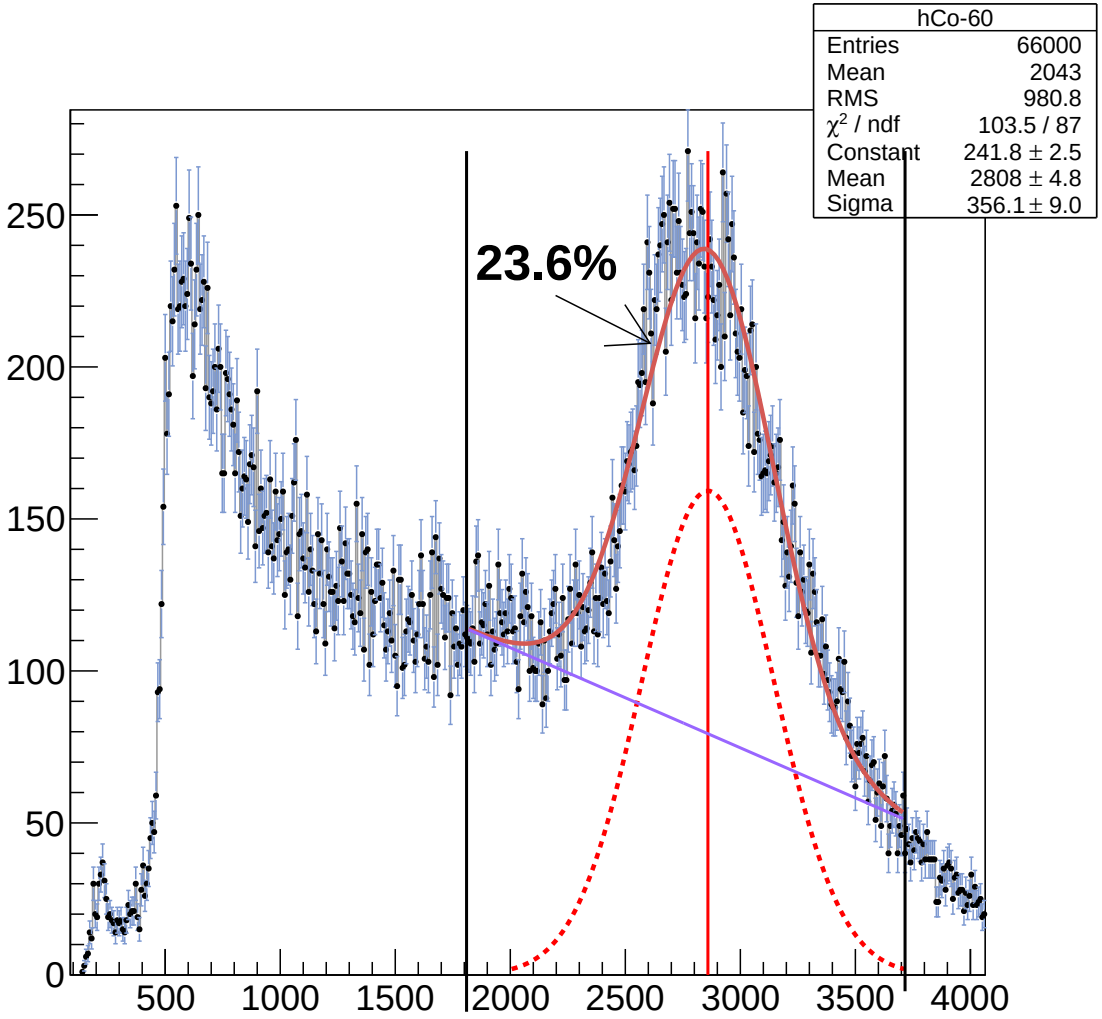
Energy Resolution

K. Nowakowski



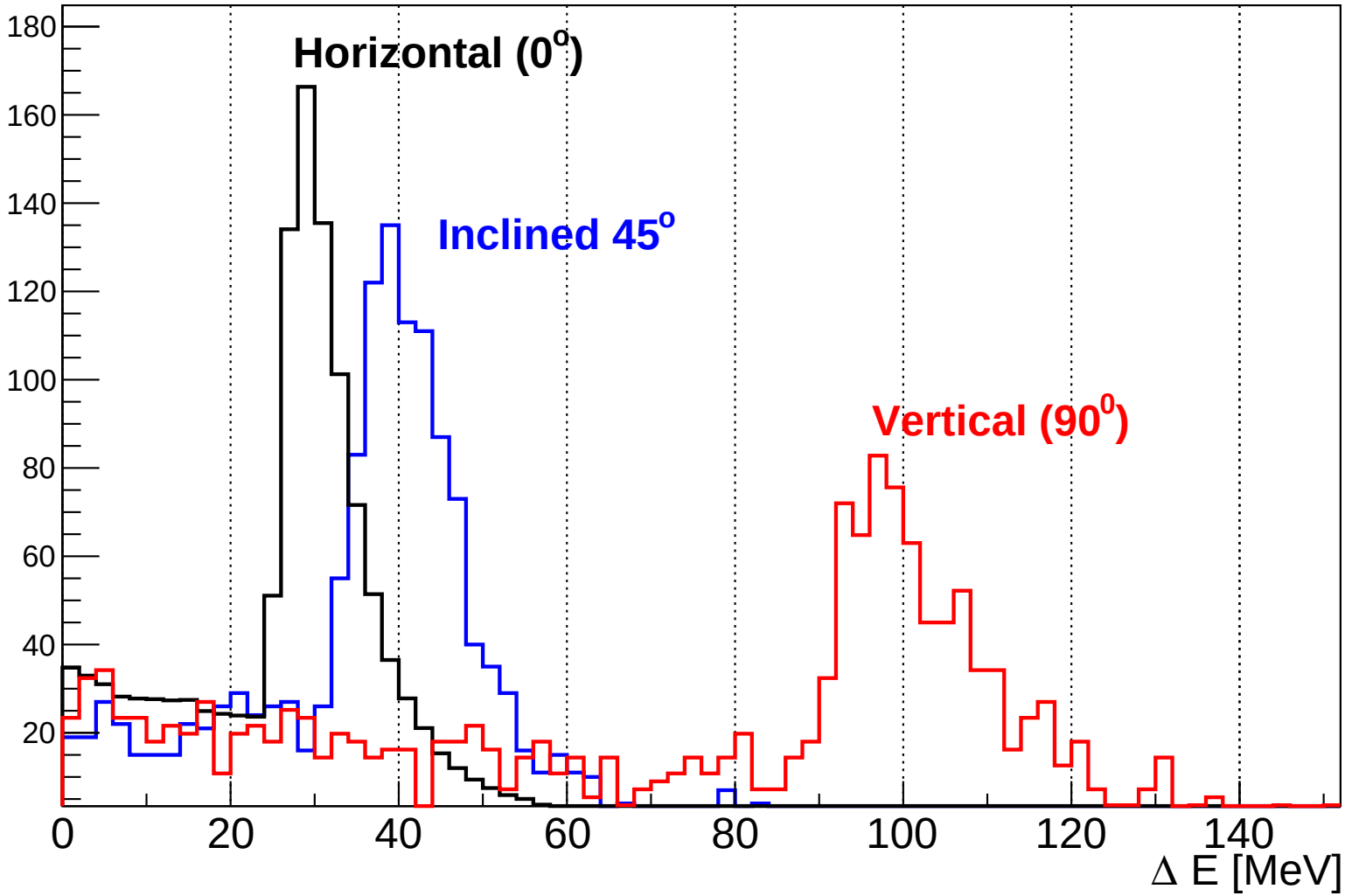
Cosmic Calibration

K. Nowakowski, C. Dziwok



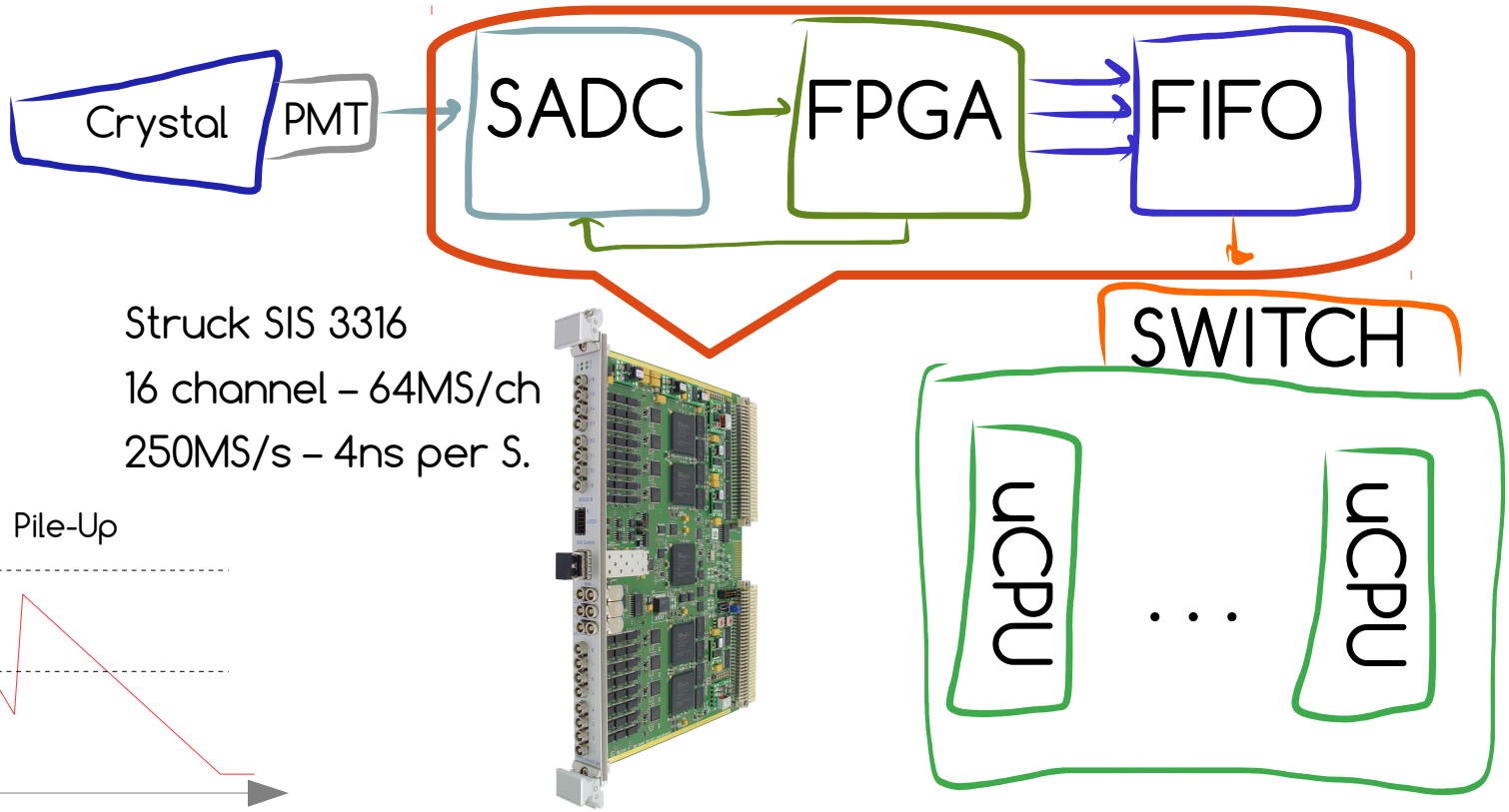
G4: Cosmic Simulation

P. Maanen, LYSO $30x30x100mm$ **with** 0^o, 45^o, 90^o



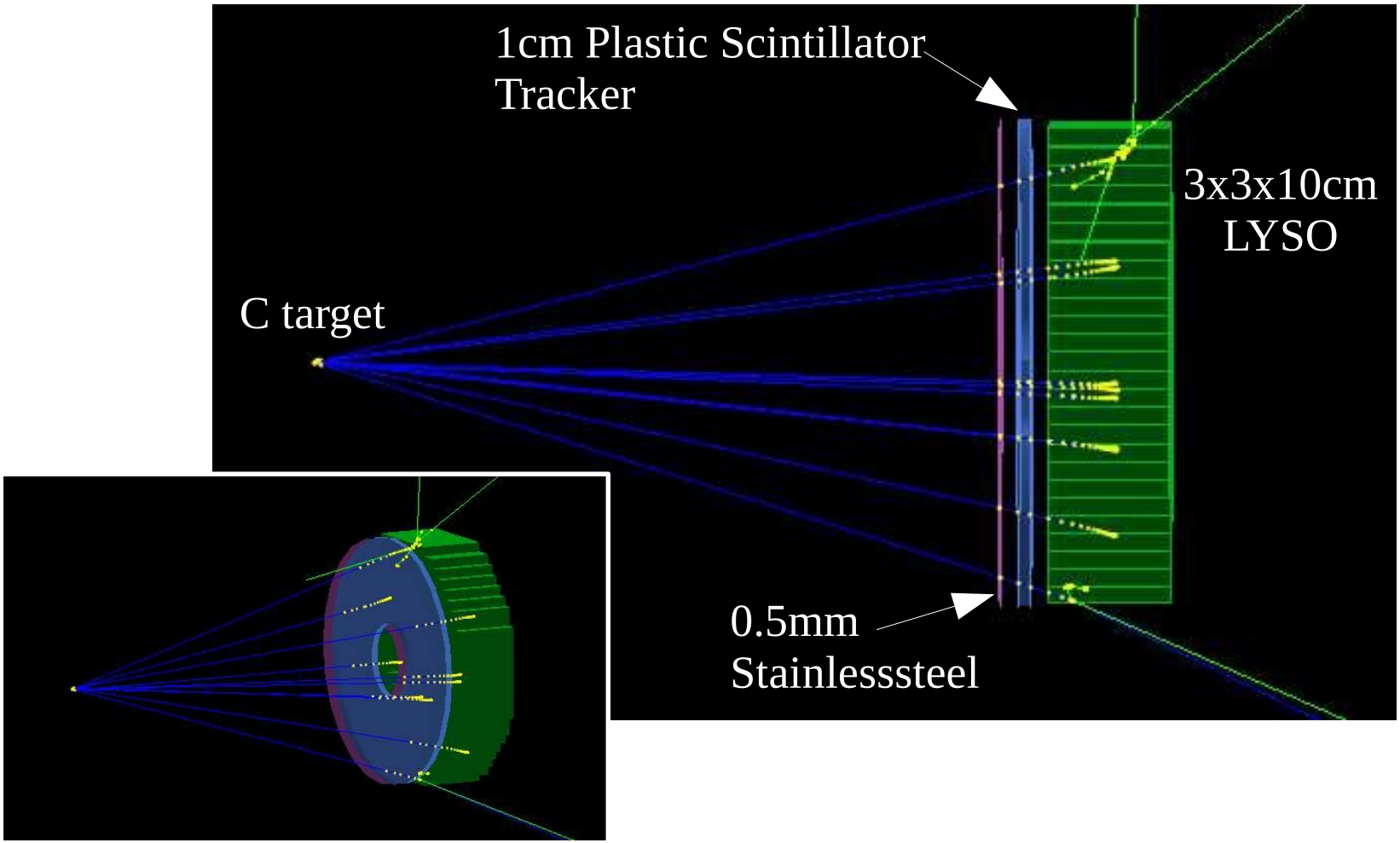
DAQ

100 % Data Taking Efficiency



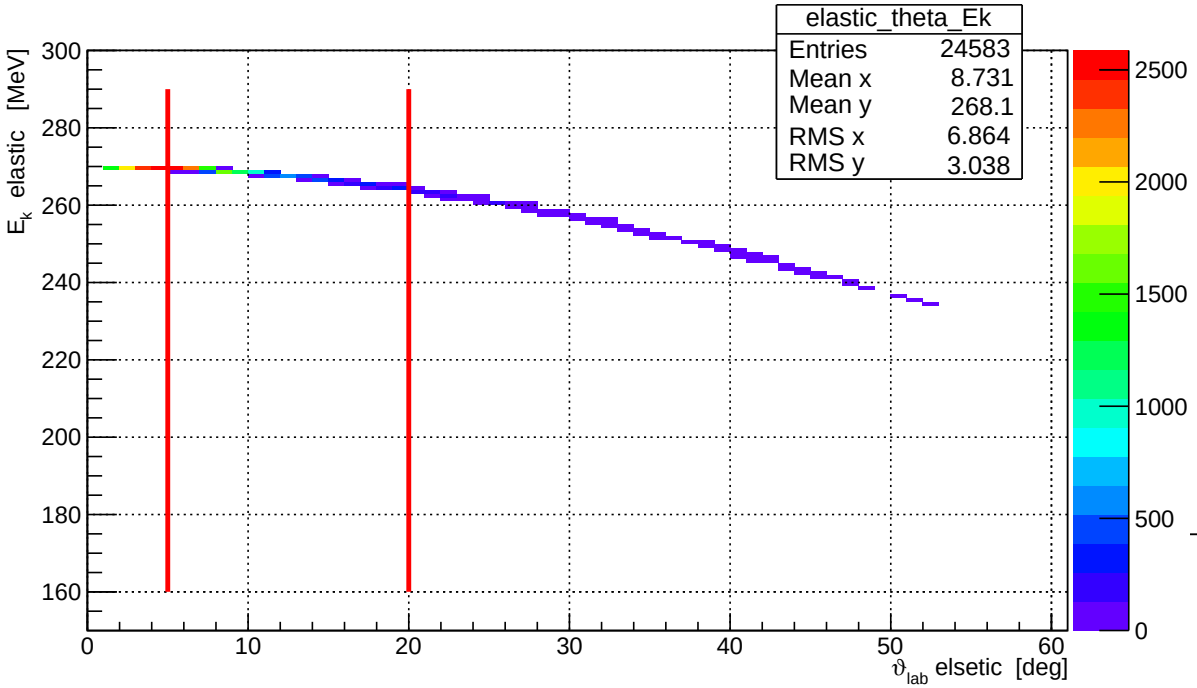
MC Simulation (GEANT4)

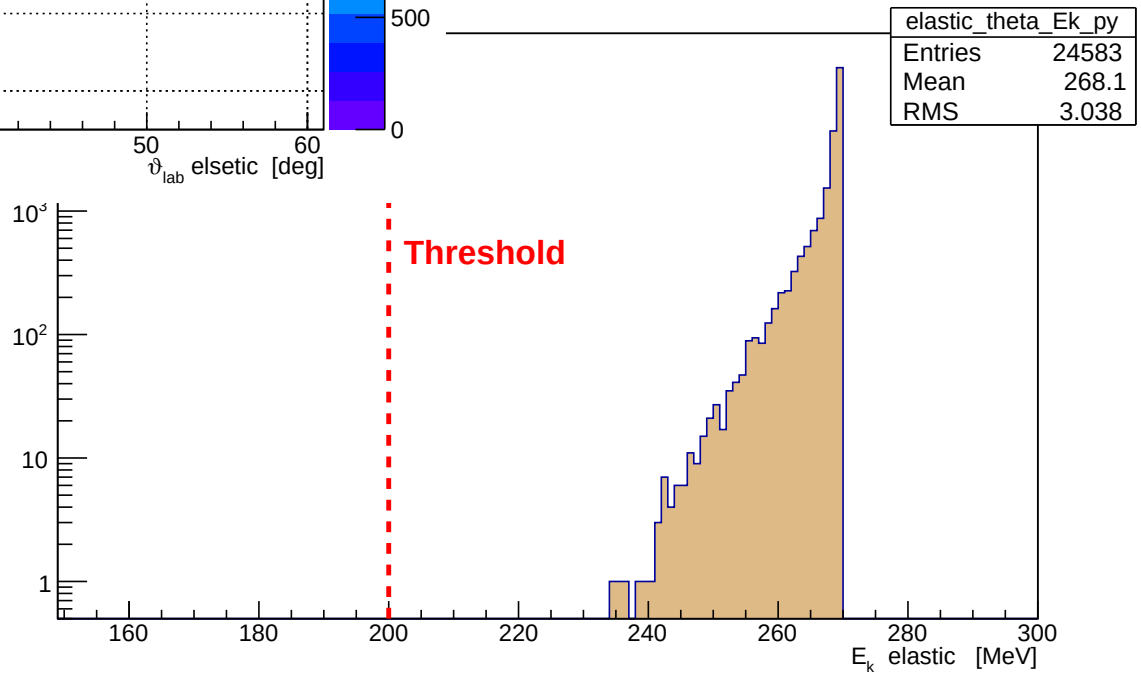
G. Macharashvili & N. Lomidze



G4: Elastic $dC \rightarrow dC$ Scattering

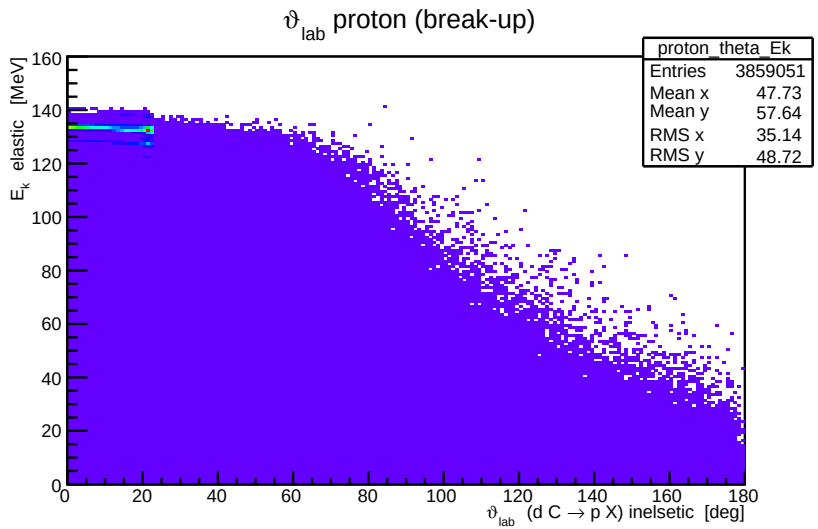
Very Clear Signature

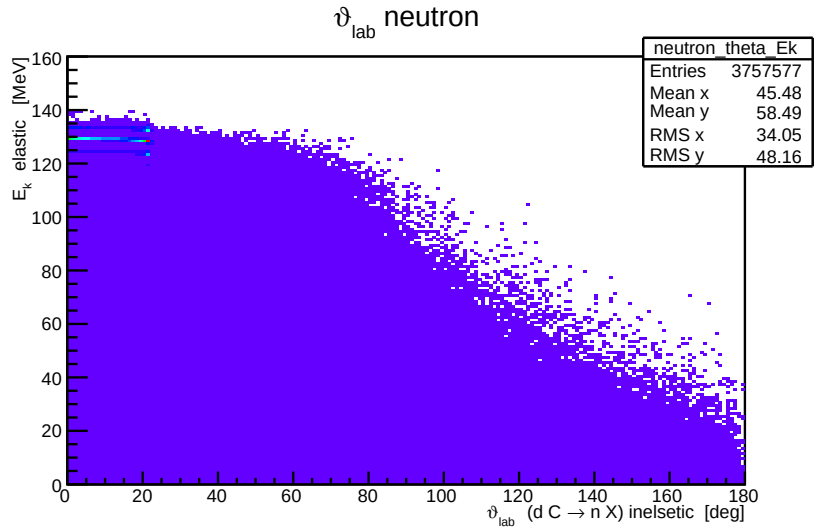


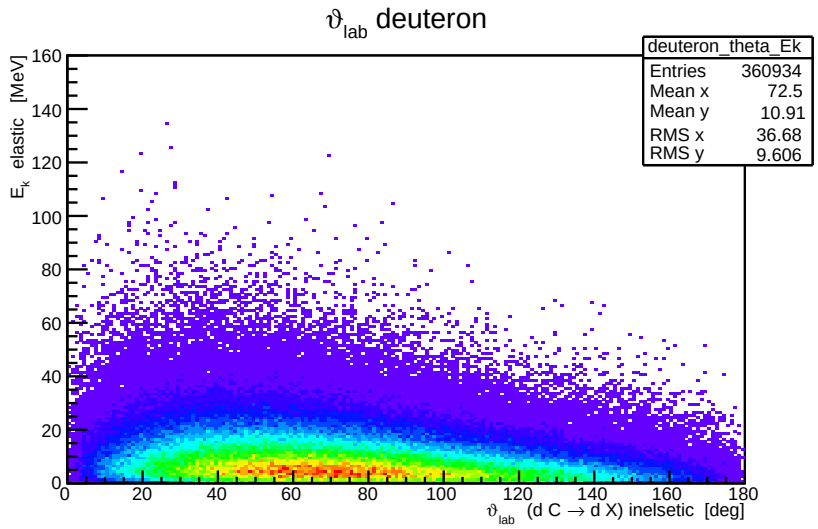


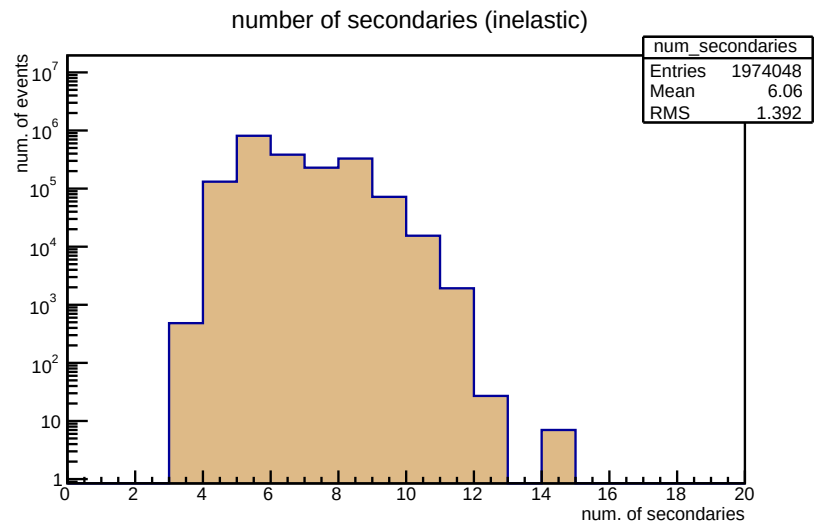
G4: Inelastic $dC \rightarrow X$ Simulation

Far Below Elastic E-Spectrum



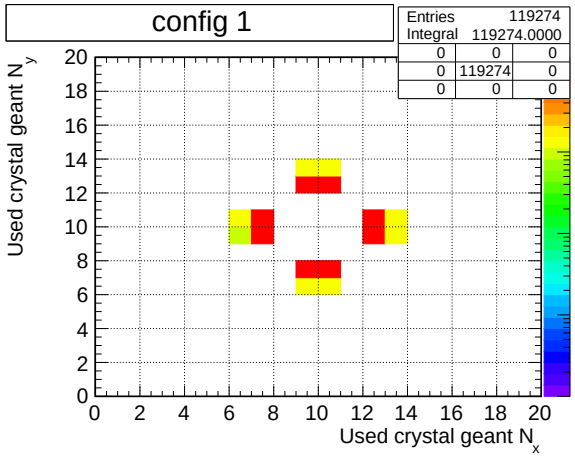


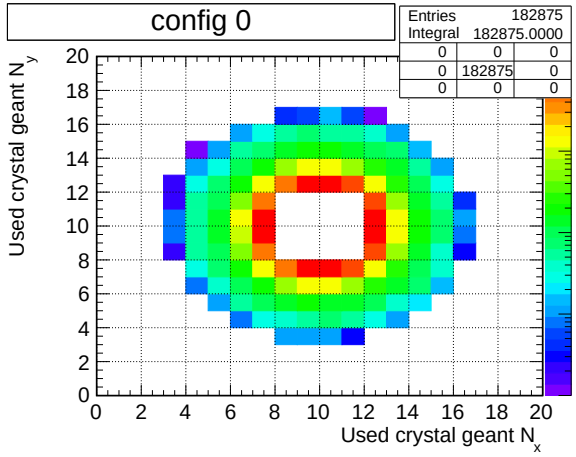


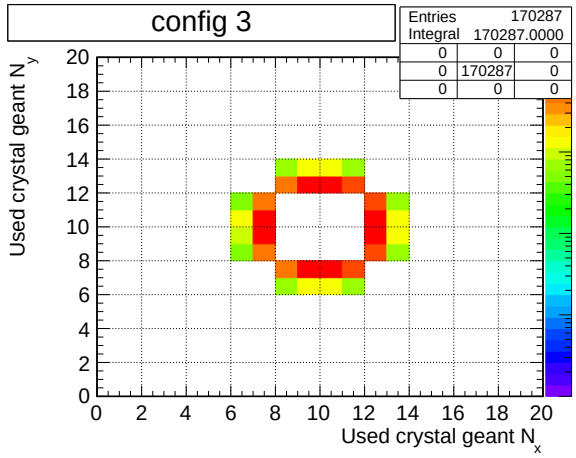


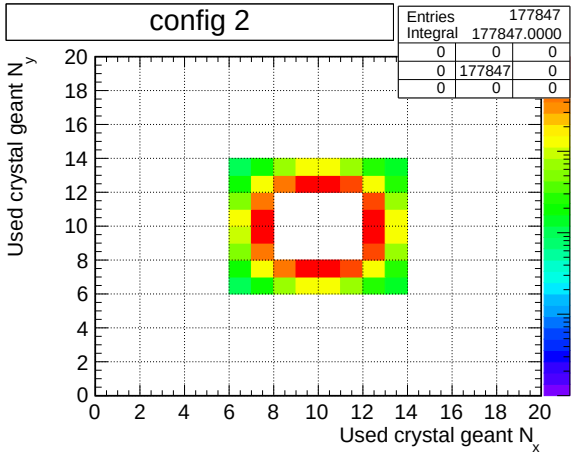
G4: Studied Detector Configurations

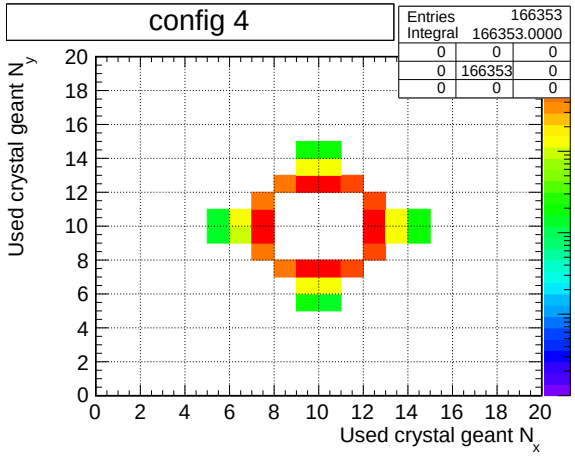
N. Lomidze





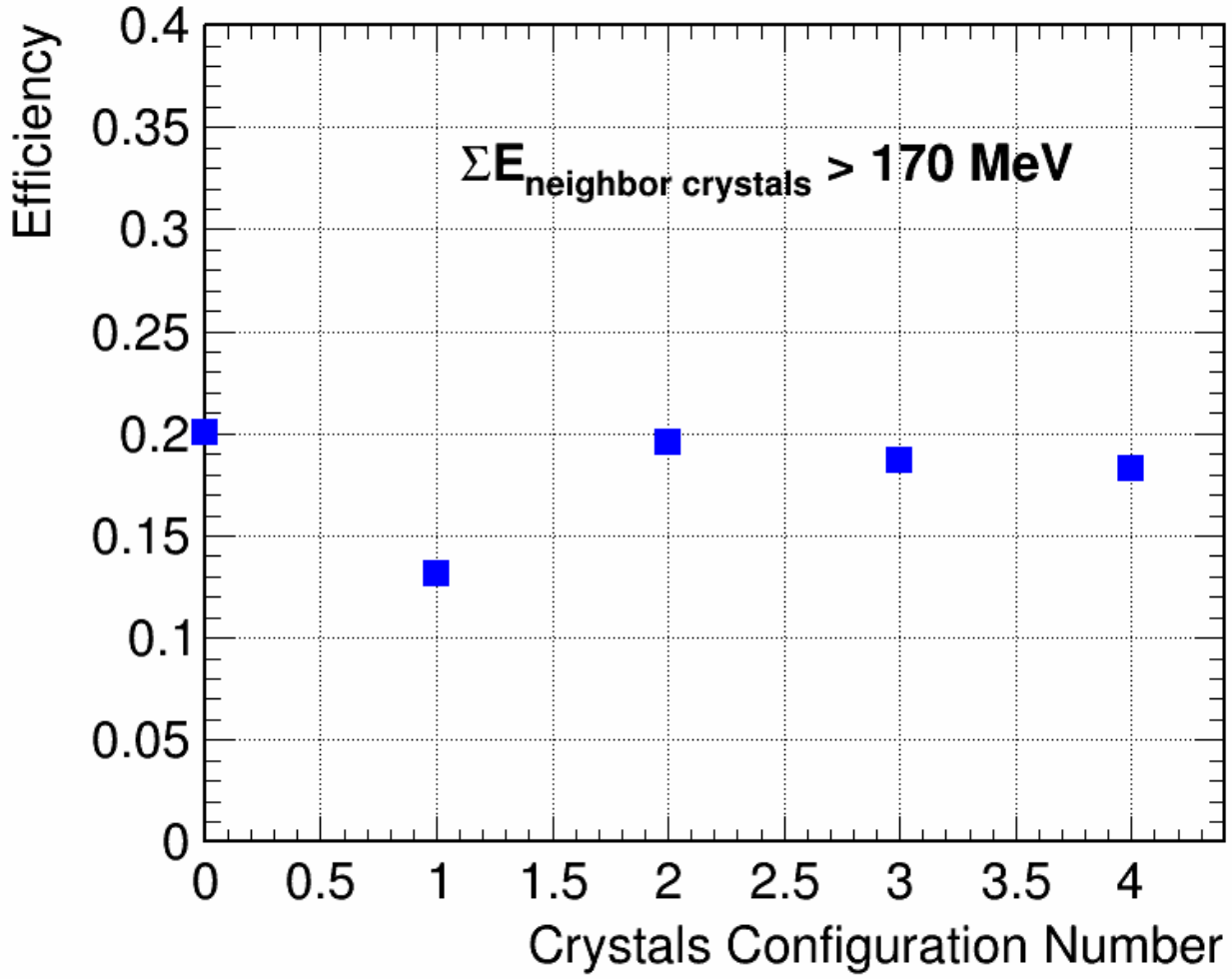






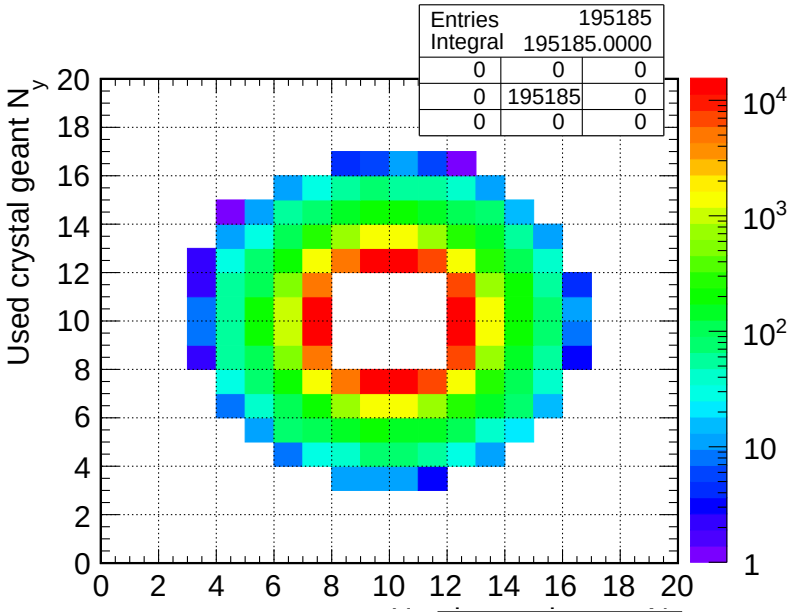
G4: Efficiency Vs. Detector Configuration

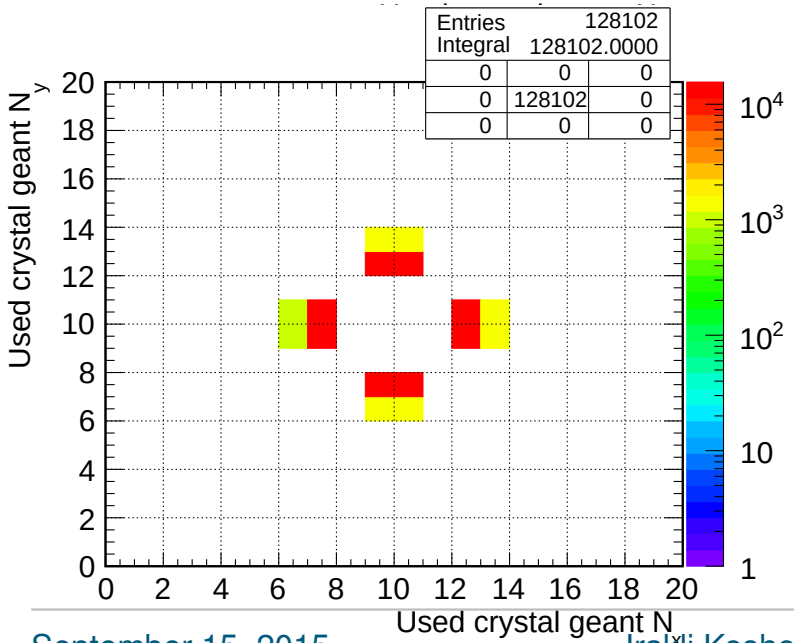
Small θ is very Important

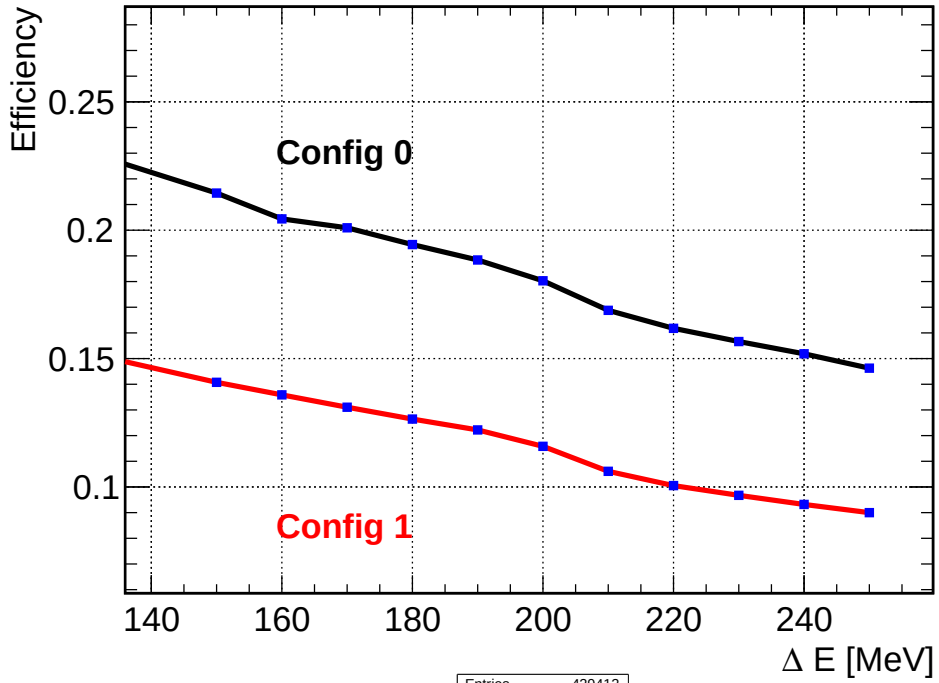


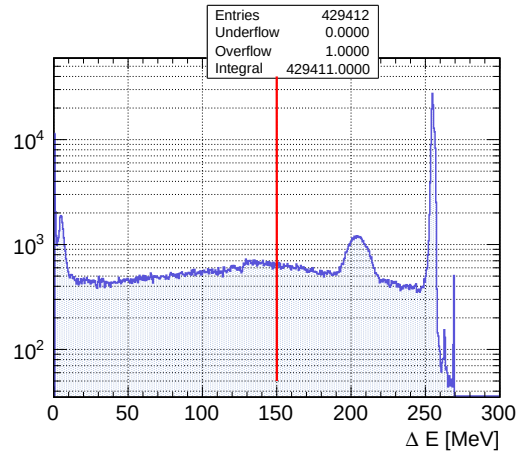
G4: Efficiency Vs. ΔE Threshold

N. Lomidze



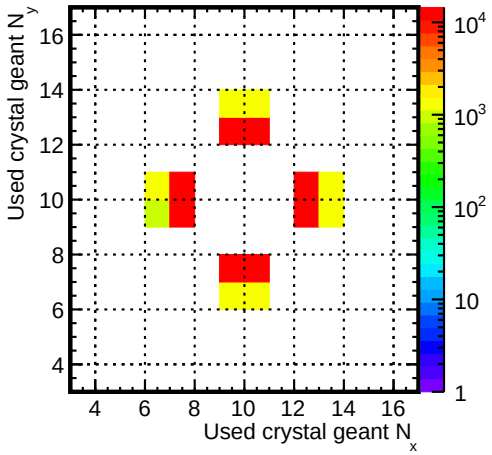


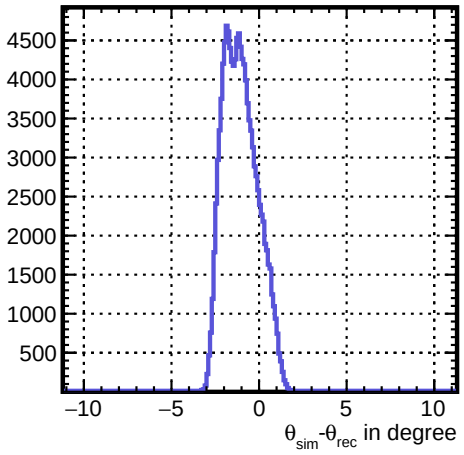


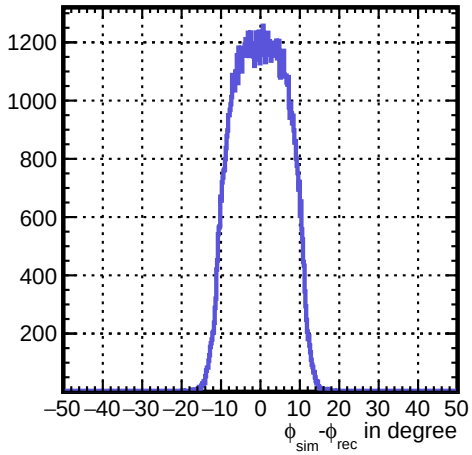


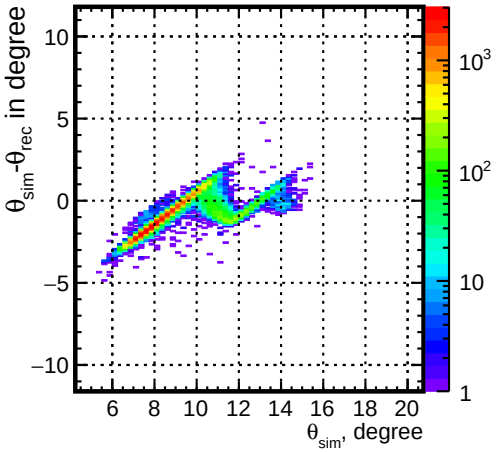
G4: Angular Distributions

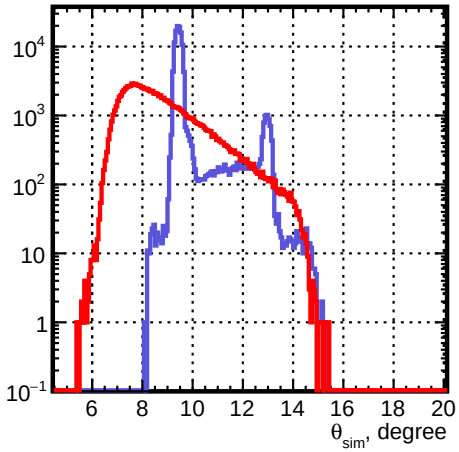
N. Lomidze

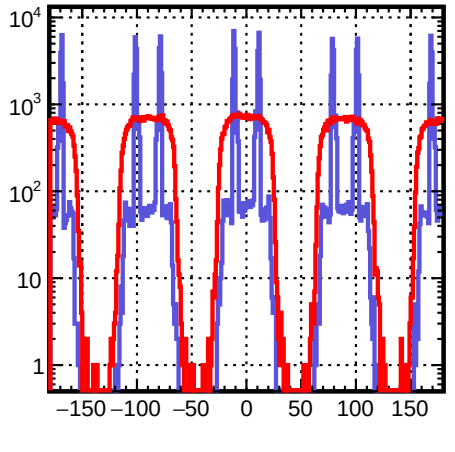






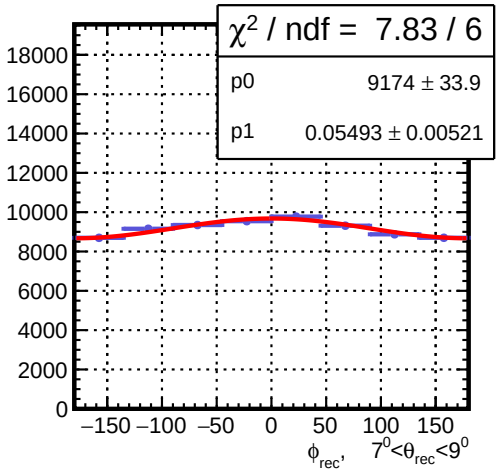


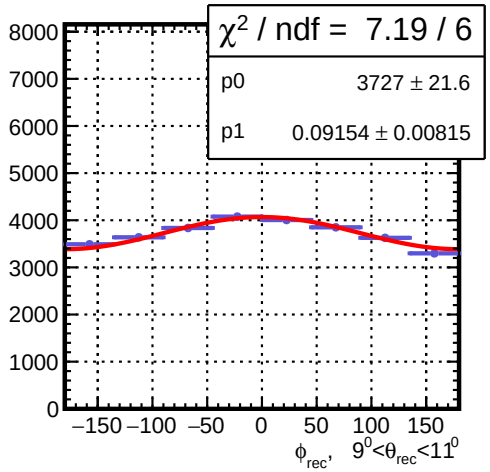


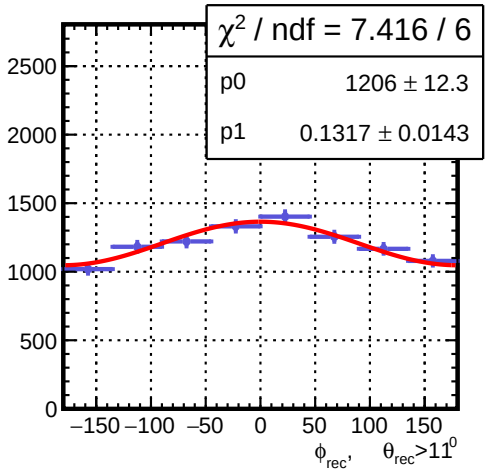


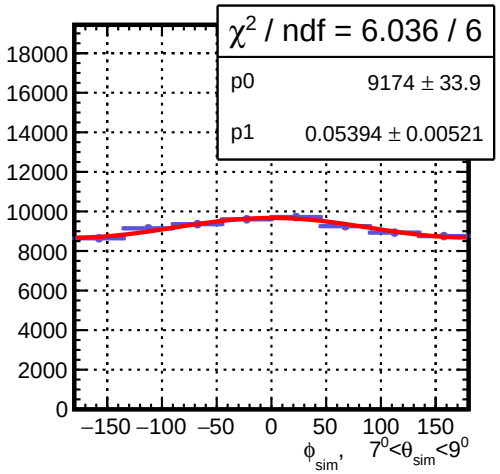
G4: Reconstructing Asymmetry

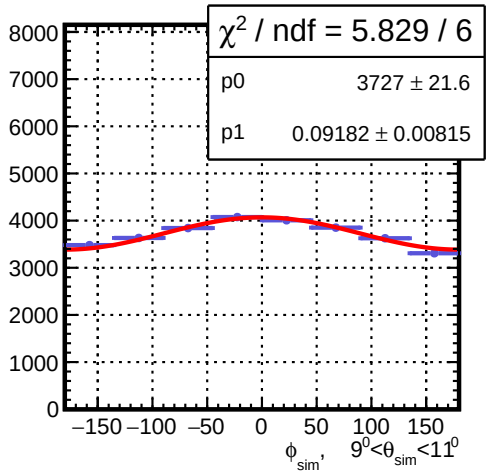
N. Lomidze

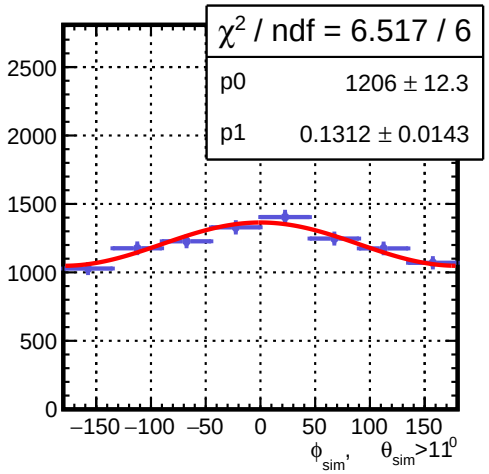












Outlook

Accepted Proposal

COSY Beam Time Request

For Lab. use

Exp. No.:	Session No.
E2	**2**

Collaboration: JEDI

Towards the EDM Polarimetry

Spokespersons for the beam time: **Irakli Keshelashvili (Jülich)**, **Bernd Lorentz (Jülich)**

Spokespersons for the collaboration: **Andreas Lehrach (Jülich)**, **Jörg Pretz (Aachen)**, **Frank Rathmann (Jülich)**

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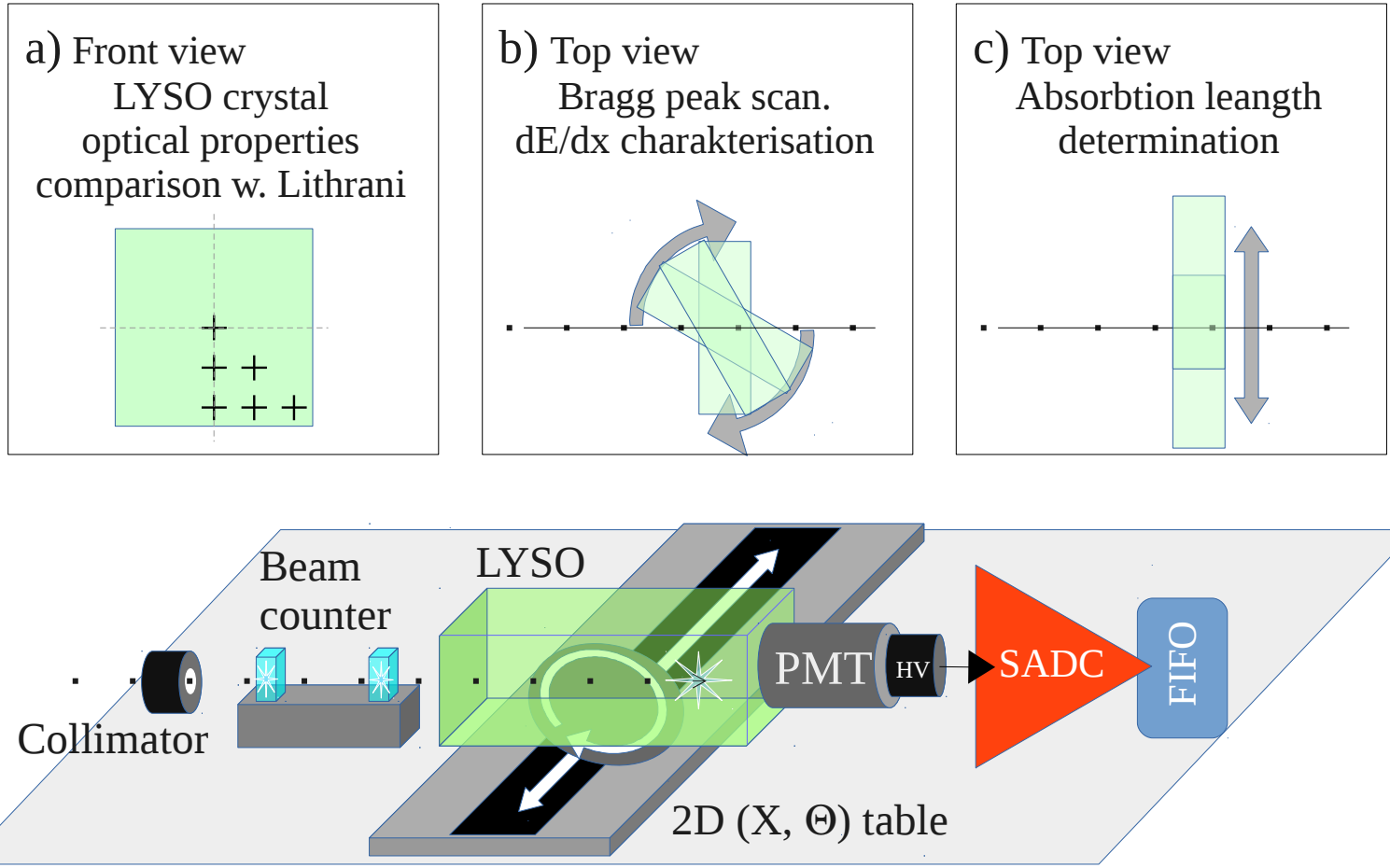
Forschungszentrum Jülich
52428 Jülich
Phone: **+49 2461 615603** Fax: **+49 2461 613930**

E-mail: **a.lehrach@fz-juelich.de**, **pretz@physik.rwth-aachen.de**, **f.rathmann@fz-juelich.de**, **i.keshelashvili@fz-juelich.de**, **b.lorentz@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 unpolarized deuterons	**100, 150, 200, 250, 270 MeV**	**10^3**	**10^7**
Experimental area	Safety aspects (if any)	Earliest date of installation	Total beam time (No.of shifts)
LYSO crystals at external BIG KARL area	**none**	**1st November 2015**	**1 week (+ MD)**

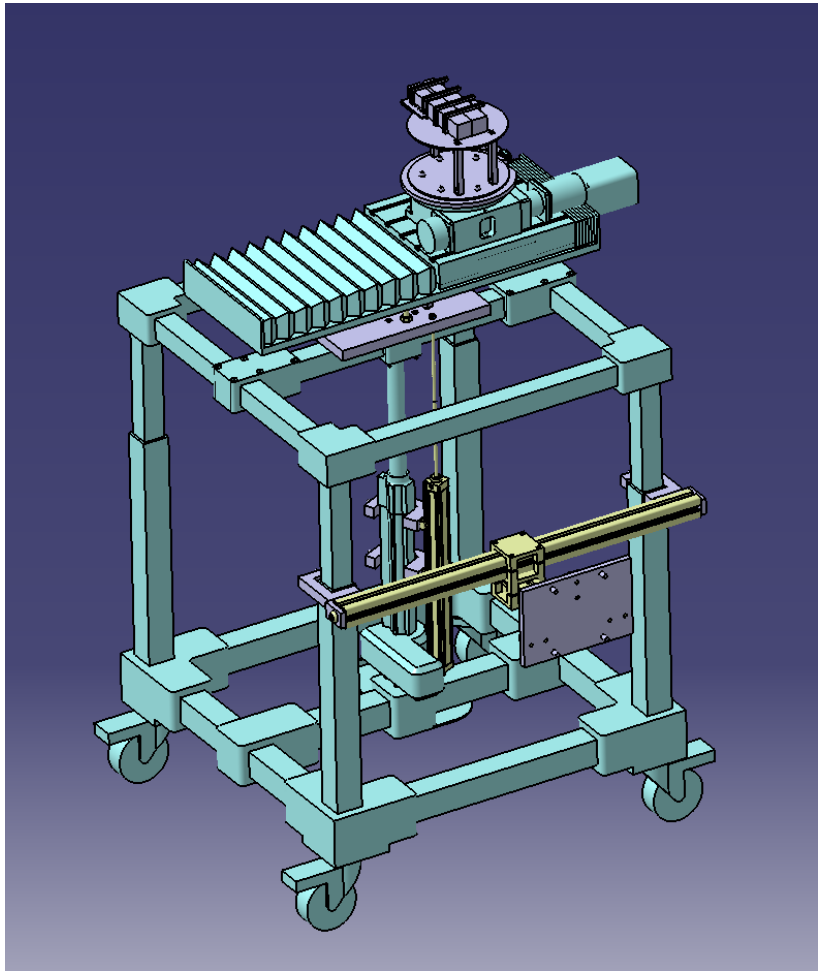
Prototype Test – BIG KARL Area

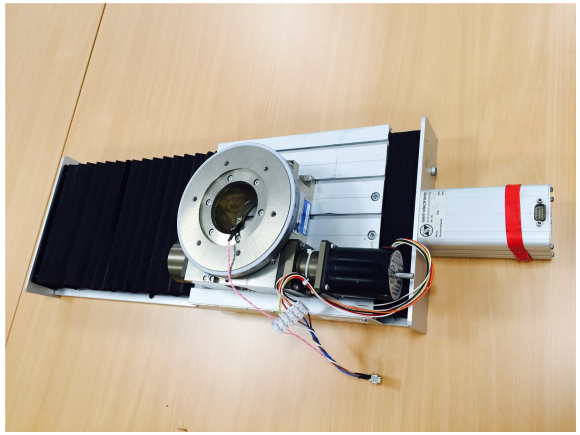
M. Maubach

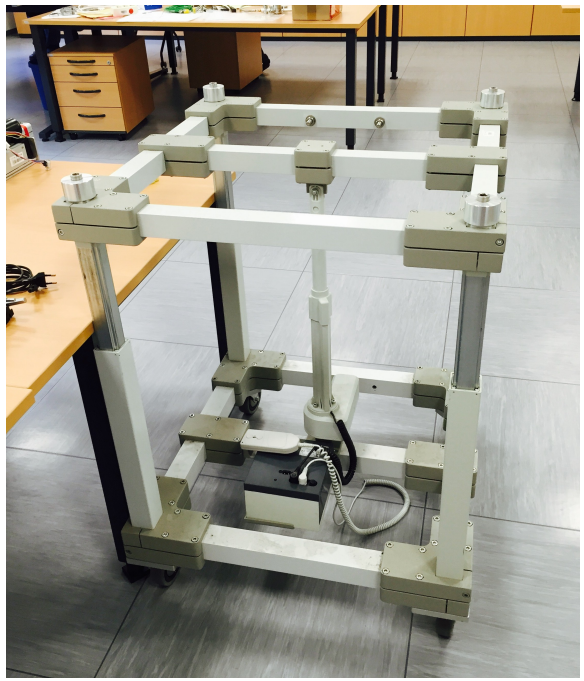


Prototype Test – BIG KARL Area

M. Maubach



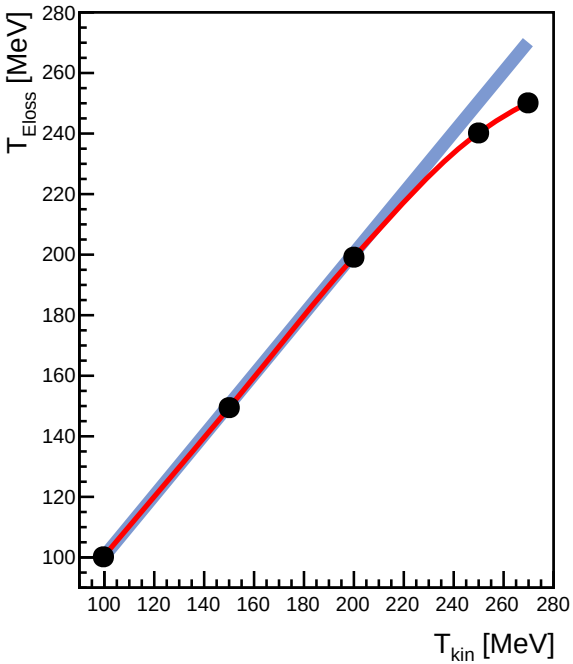


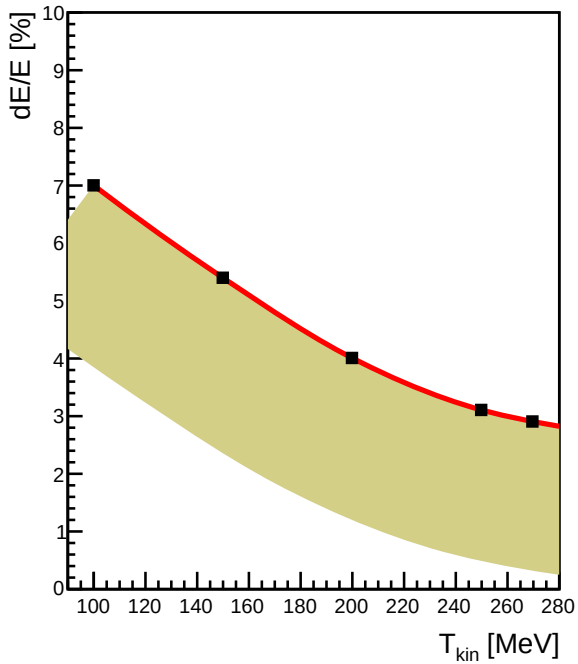


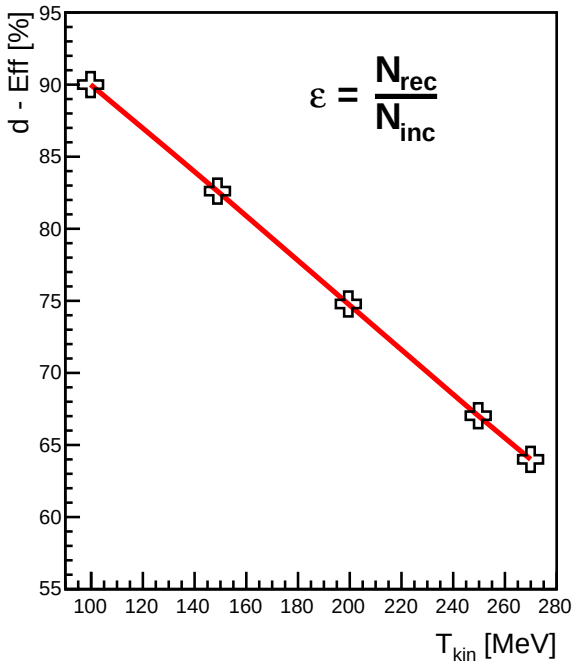
Prototype Characterization

Using External Beam

- Incident *vs* Reconstructed $d - T_{kin}$
- Reconstructed Energy Resolution *vs* Incident $d - T_{kin}$
- Deuteron Identification Efficiency
- Bragg Peak, Absorption λ, Radiation Hardness

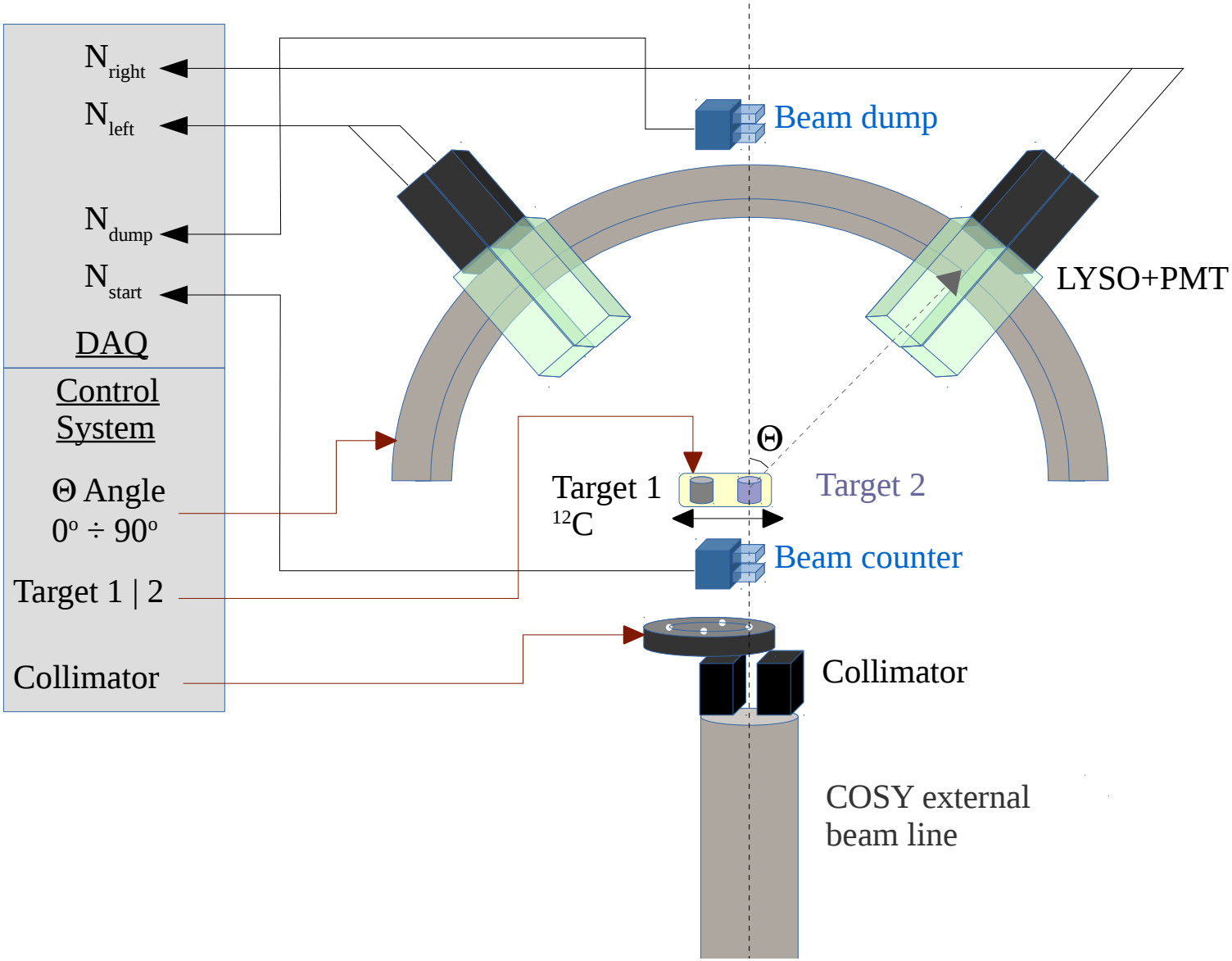






Next Step (Next BT Request)

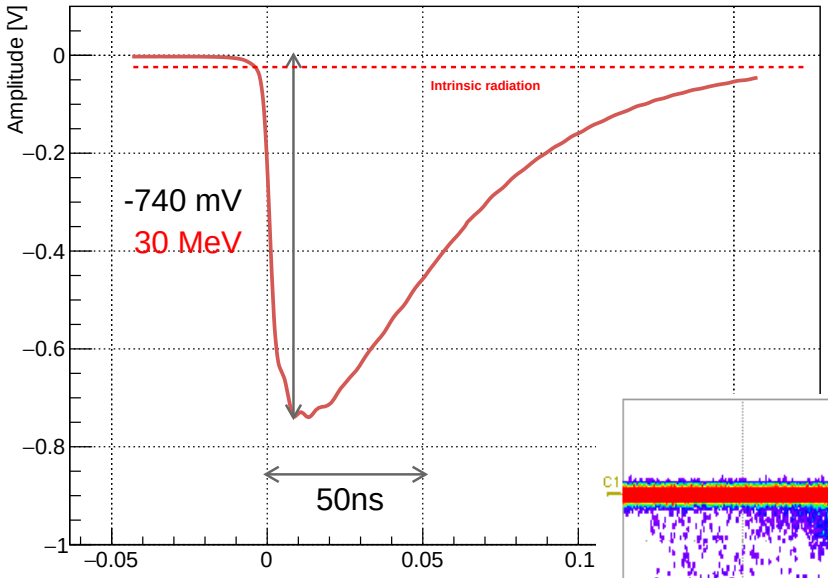
Asymmetry Measurements & Target Material Test

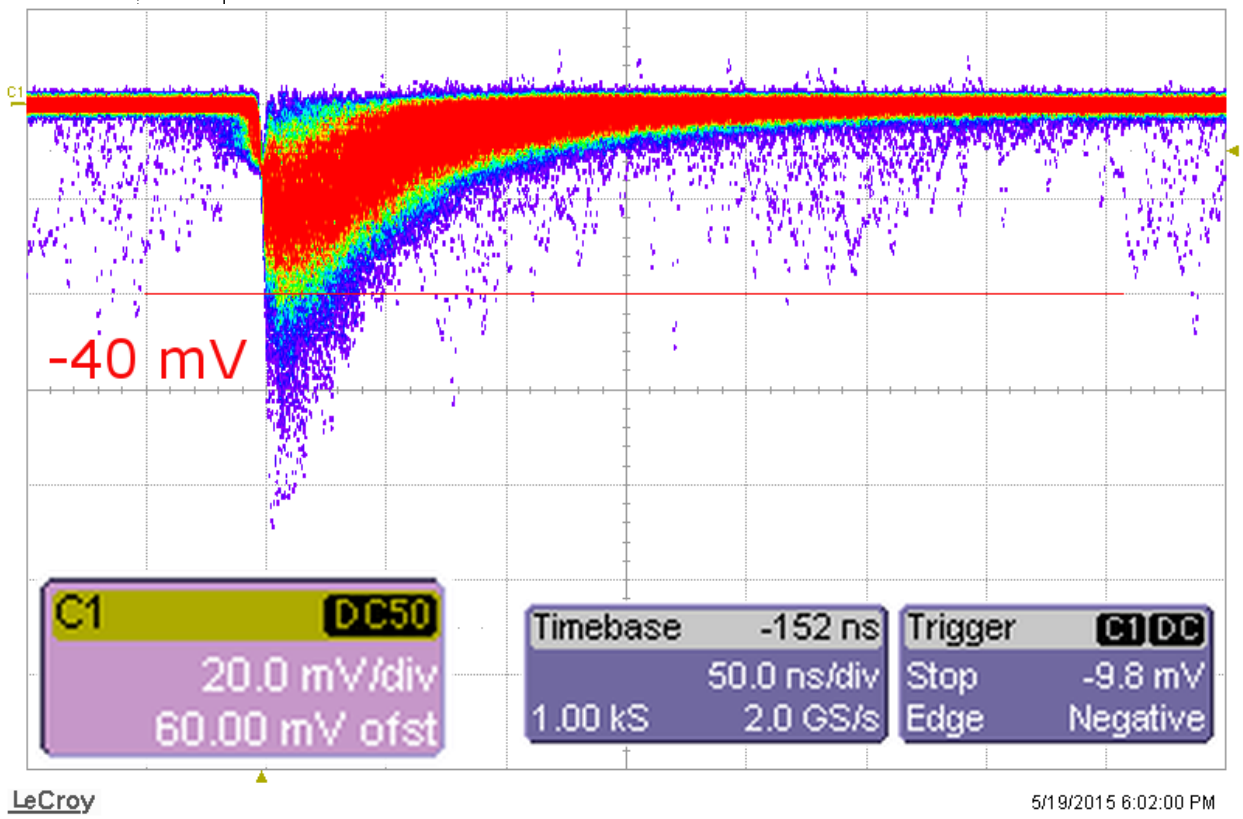


Summary

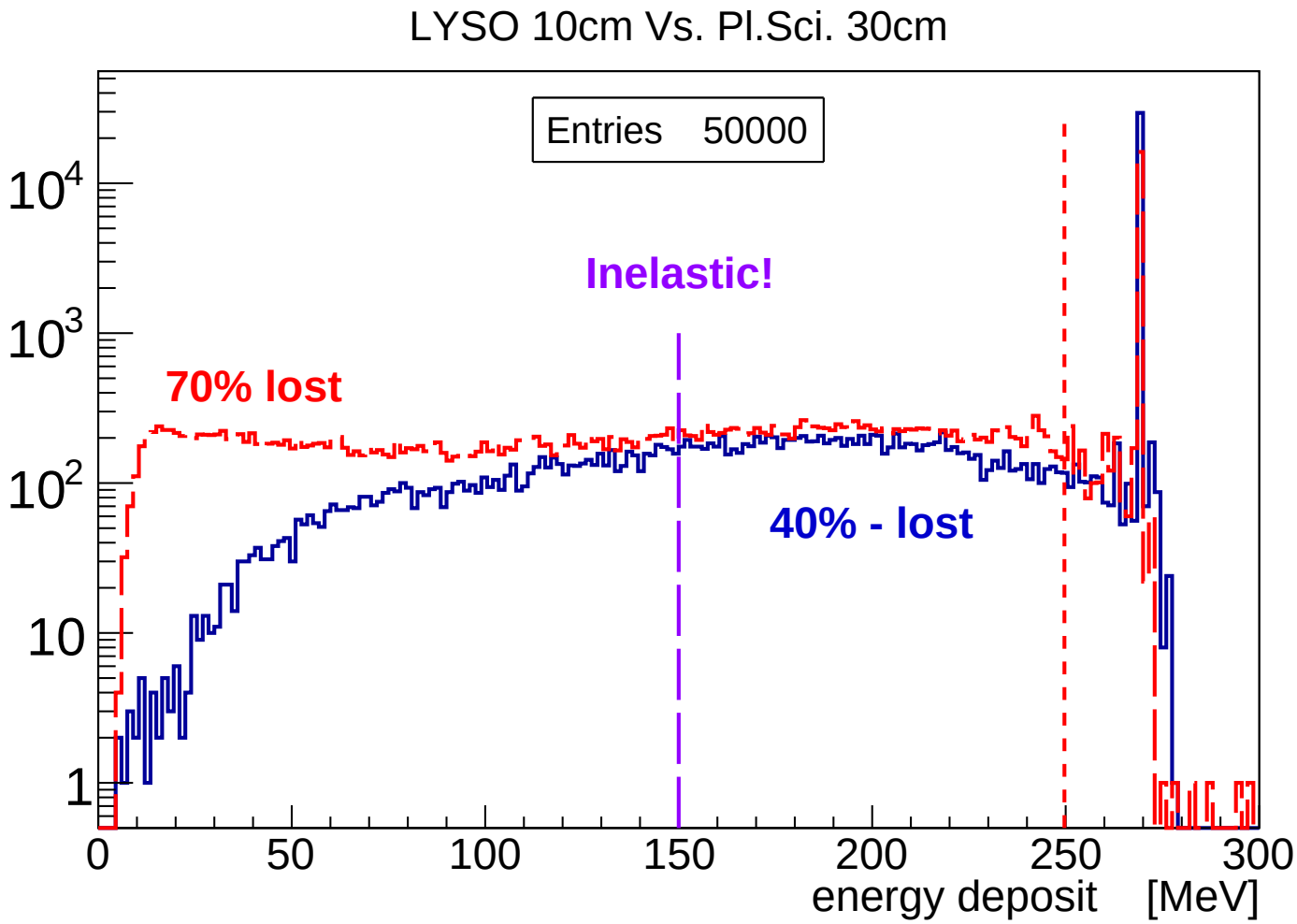
- Proposal approved, 3 Weeks (1+2) Beam time planned
  Unpolarized deuteron and proton
- Hardware development and support construction:
  LYSO (2 types), PMT (2 types)
- PI. Scintillator *pizza* – *wall* under investigation:
  Possible readout using MPPC (KETEK, SensL)
- **2 (+2)** LYSO crystals will be tested:
  Saint–Gobain (EU) 2x(30x30x100mm)
  EPIC–Crystals (China) 1x(30x30x100mm)
  Saint–Gobain 1x(15x30x100mm)

Cosmic Signal vs Intrinsic Radiation

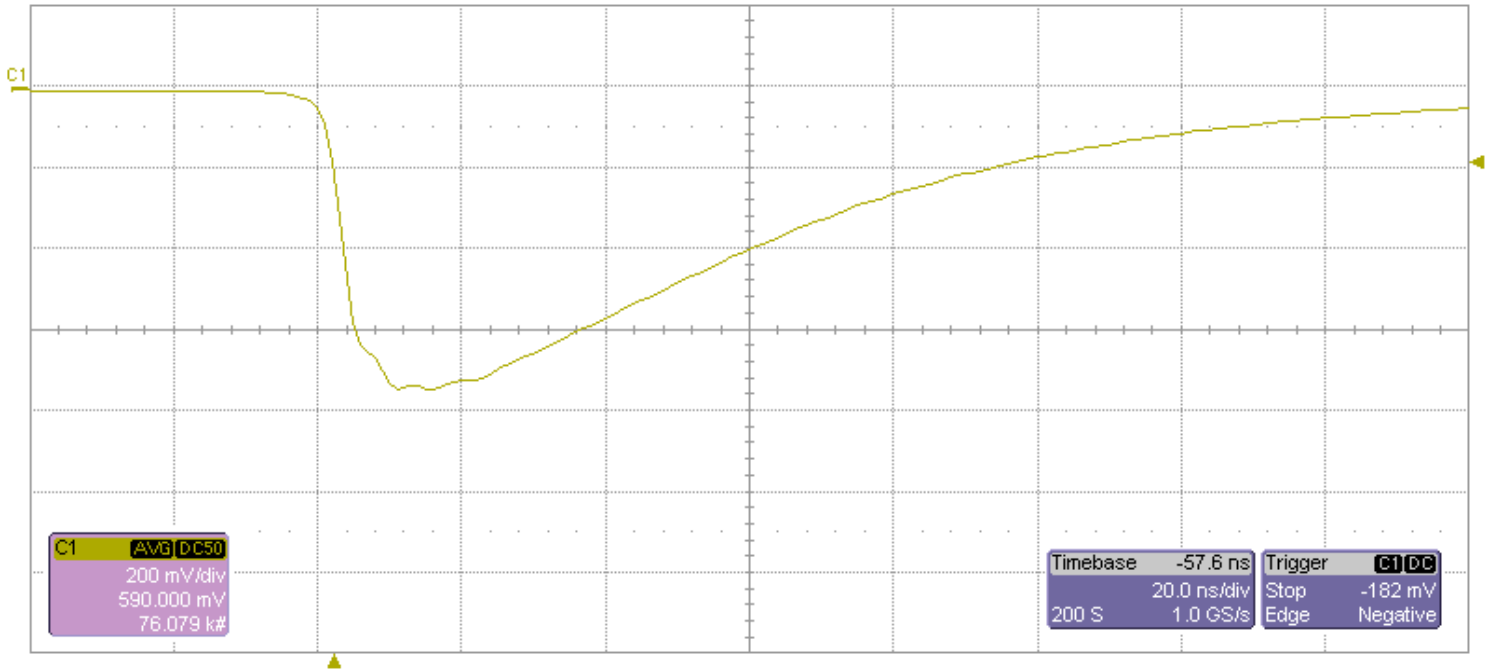




Comparison of LYSO Vs. Plastic Sci.



Cosmic Signal



Measure	P1:pkpk(C1)	P2:pkpk(C2)	P3:fall(C1)	P4:area(C1)	P5:- - -	P6:- - -
value	695.23 mV	677.26 mV	6.95 ns	-24.659260 nVs		
mean	695.2309 mV	677.2567 mV	6.9487 ns	-24.65925980 nVs		
min	695.23 mV	677.26 mV	6.95 ns	-24.659260 nVs		
max	695.23 mV	677.26 mV	6.95 ns	-24.659260 nVs		