INFN
Istituto Nazionale di Fisica Nucleare
Laboratori Nazionali di Frascati

REGIONE LAZIO

SICURA

Development of a portable and integrated low cost probe for applications in radioprotection and anti-terrorism

CONTENTS OF THIS CONTRIBUTION

- **What, Why and Where**
- **Design**
  - Detectors
  - Electronics
  - Mechanical assembly
- **First results**
  - Detectors characterization
- **Simulations**
  - MCNP6

SICURA

SICUrezza RAdiologica (Radiation Security)

What

- Multi-detector radiation probe for radiation protection
- Radiological safety
- Radioactive meterial traficking fight
- Easy-to-use
- Low cost

Where

- National Labs of Frascati, Rome (Italy)
- Funded by the Lazio region

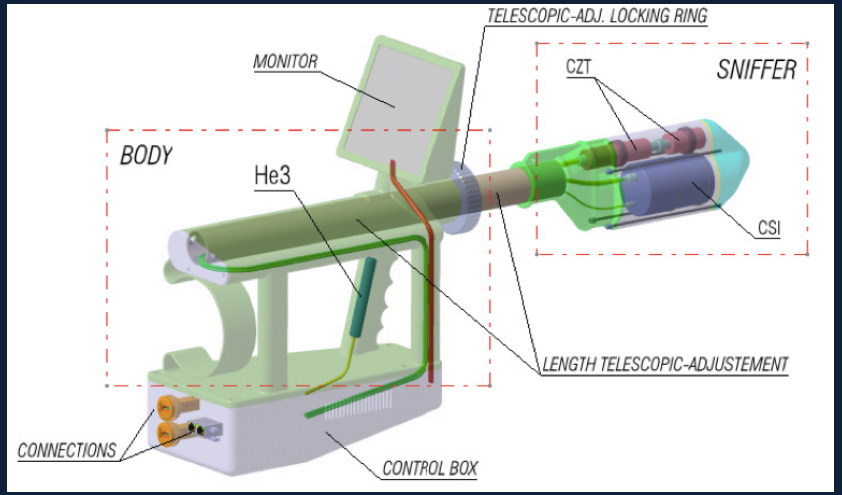
Why

- Provide border police with a tool able to detect radioactive surces emitting gammas and/or neutrons

Probe design

Multi-detector probe:

- **Gamma detectors:**
  - Alarm detector CsI(Tl)
  - Isotope identification CdZnTe -> CZT
- **Neutron detector:**
  - ^{3}He
- **Dedicated electronics**
- **User interface - monitor**
- **One hand and telescopic**
- **All the mechanical structure is 3D printed**

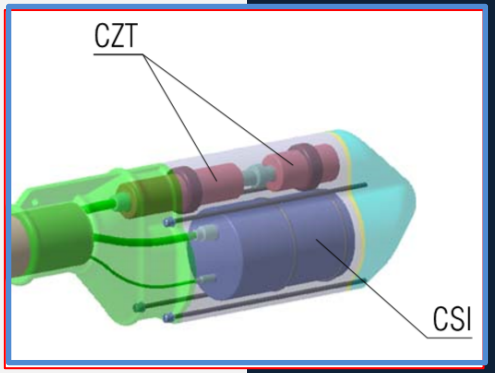


Gamma Detectors

Alert Stage

High detection efficiency

Low sensitivity to background



Identification

High resolving power

Large sensitive volume

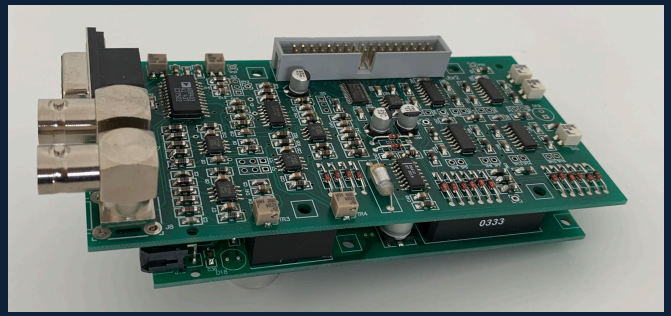
- Non hygroscopic and insensitive to temperature variations
- Portable
- Low cost
- Compliant to International Standards

CsI(Tl)

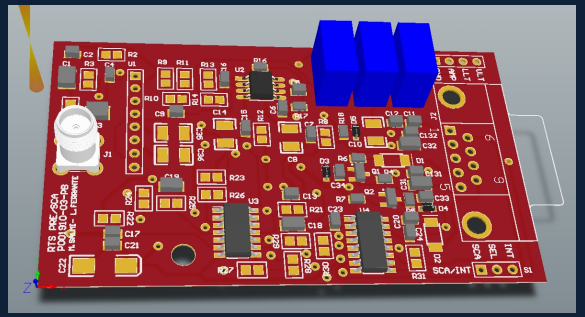
CZT

Analog Electronics

1. MCA (2 ch) with AMPLIFIER & SHAPER



2. SCA (1 ch) with PREAMPLIFIER & SHAPER



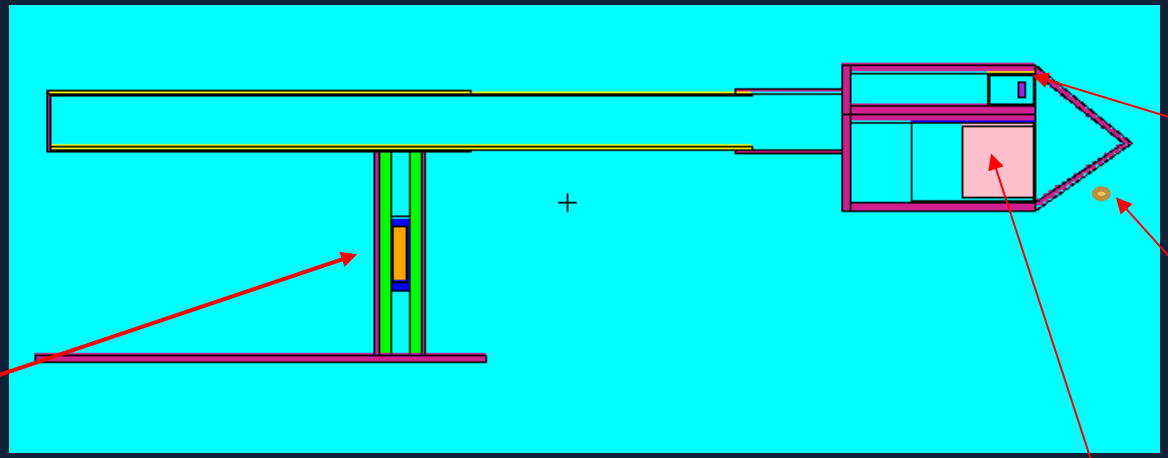
AMPLIFIER / SHAPER

Input: STEP, TAIL, DIFFERENTIAL PULSE
Shaping: Active Semi-Gaussian Shaping
Gain: Coarse and Fine Gain
Output: Unipolar or Bipolar

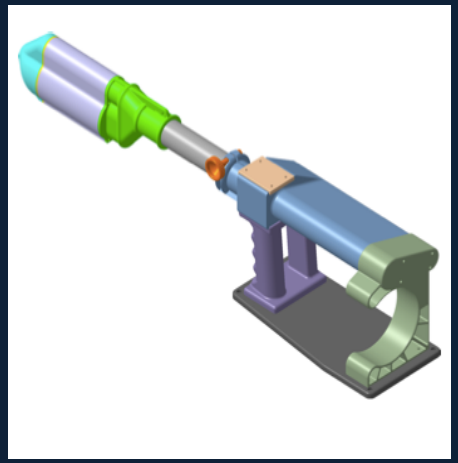
MCA

Channels: 2048 ch.
LLT/ULT: Settable
Memory: 32 bit / ch
Conv. T: 8 us
uController: 8-bit microcontroller, 29.5 MHz

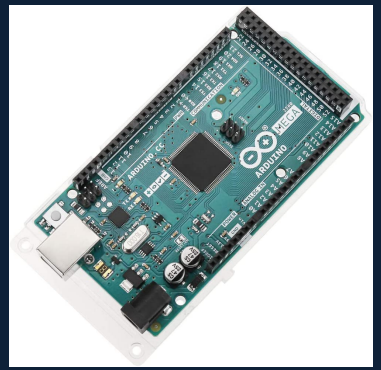
MCNP6 Simulation



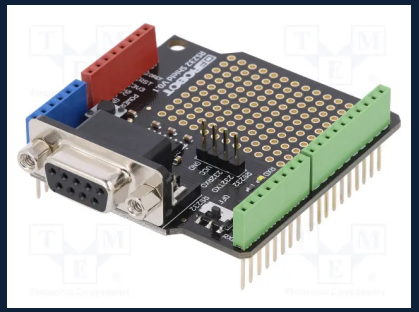
due to the pandemic we were unable to take measurements with the 3He



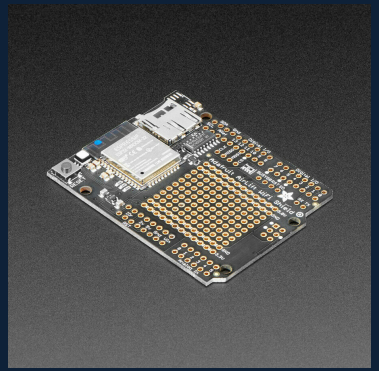
Spectrum readout and online analysys :



Arduino MEGA



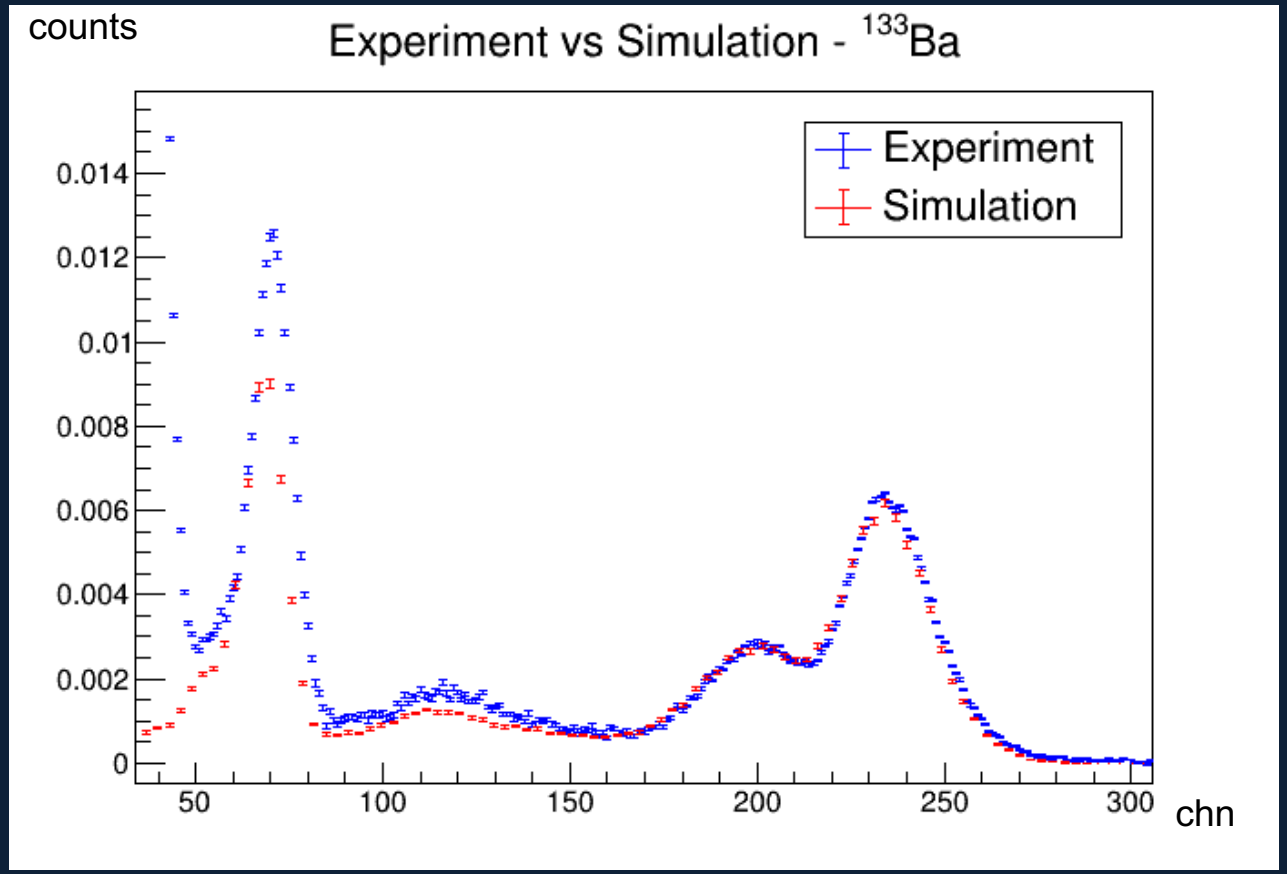
DFRobot 0258
RS232 shield



Adafruit AirLift WiFi shield with integrated microSD

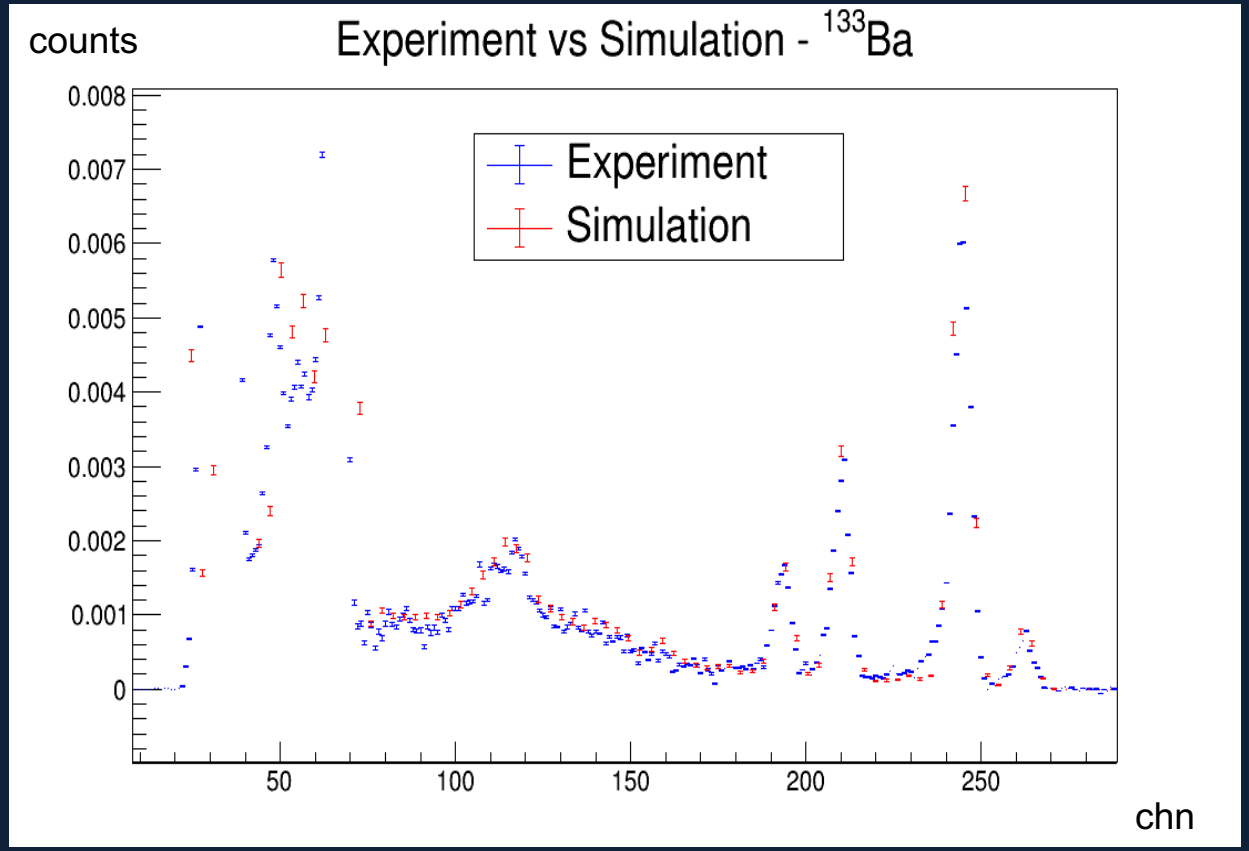
- RS232 Comunication with the Detectors Readout Electronics (MAB)
- Data sent to a private webpage via WiFi protocol
- Main analysis tool developed to operate on the client hardware (html, php, java on any mobile, tablet, etc)
- Data and codes stored on the integrated microSD
- No need of licensed softwares
- Low cost and power consumption

MCNP6: 133Ba – CsI(Tl)



E [keV]	Yield (%)
383,85	8,94
356,02	62,05
302,85	18,33
276,40	7,16

MCNP6: 133Ba - CZT



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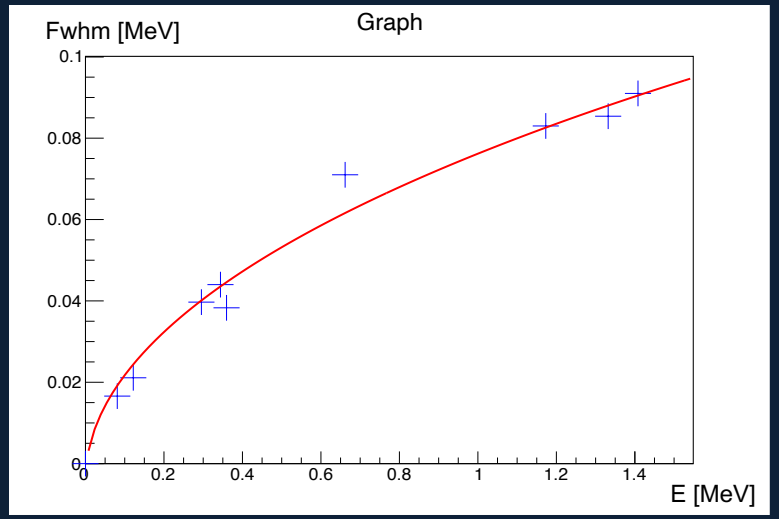
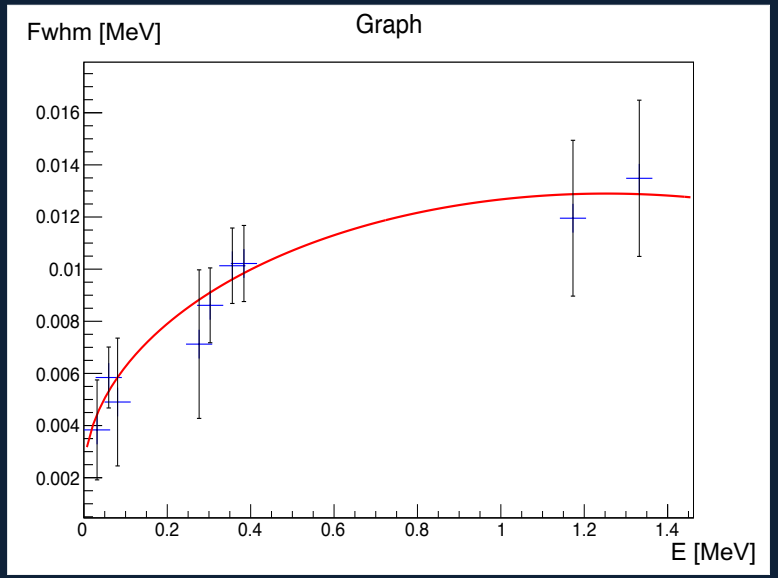
GEB: gaussian energy broadening





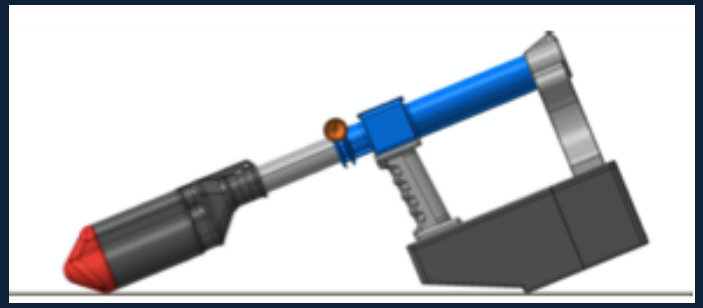
$$FWHM(E[MeV]) = p0 + p1 \cdot \sqrt{E + p2 \cdot E^2}$$

p0	=	-0.00400168	+/-	0.00439372
p1	=	0.0815424	+/-	0.0111387
p2	=	-0.0329177	+/-	0.155531

1	p0	1.99711e-03	1.79430e-03	4.26650e-07	-2.28950e-02
2	p1	1.37732e-02	4.50634e-03	9.00942e-07	-1.2620 02
3	p2	-3.99055e-01	2.32545e-01	1.07501e-04	-2.2 05

Conclusions

- Optimal compatibility between data and simulations
- High sensibility for γ, χ (tens eV -> MeV) (CZT + CsI(Tl)
- High sensibility for thermal neutrons (0,025 eV)
- Low cost
- Easy to use
- in the next few weeks we will perhaps be able to carry out the neutron measurements and complete the assembly of the probe



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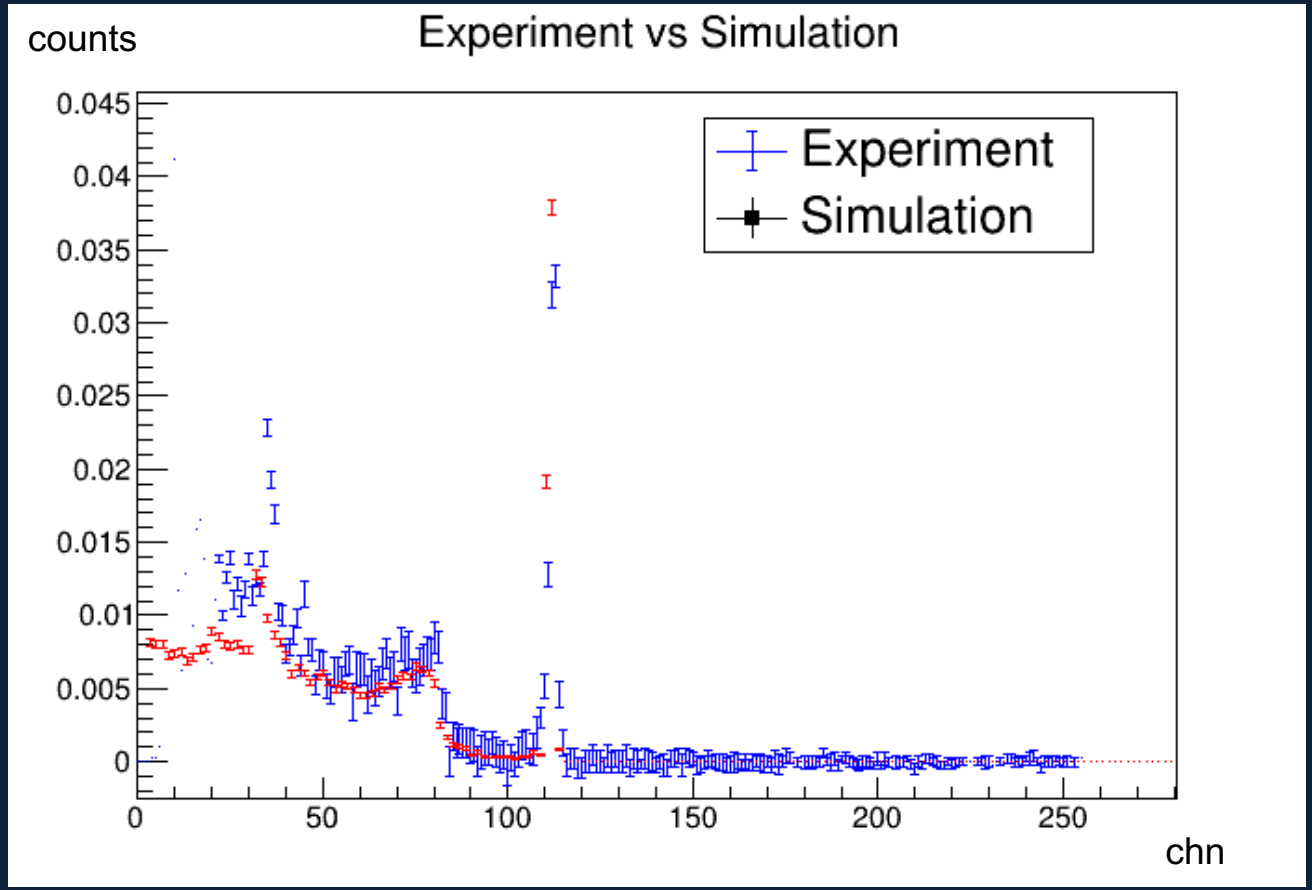
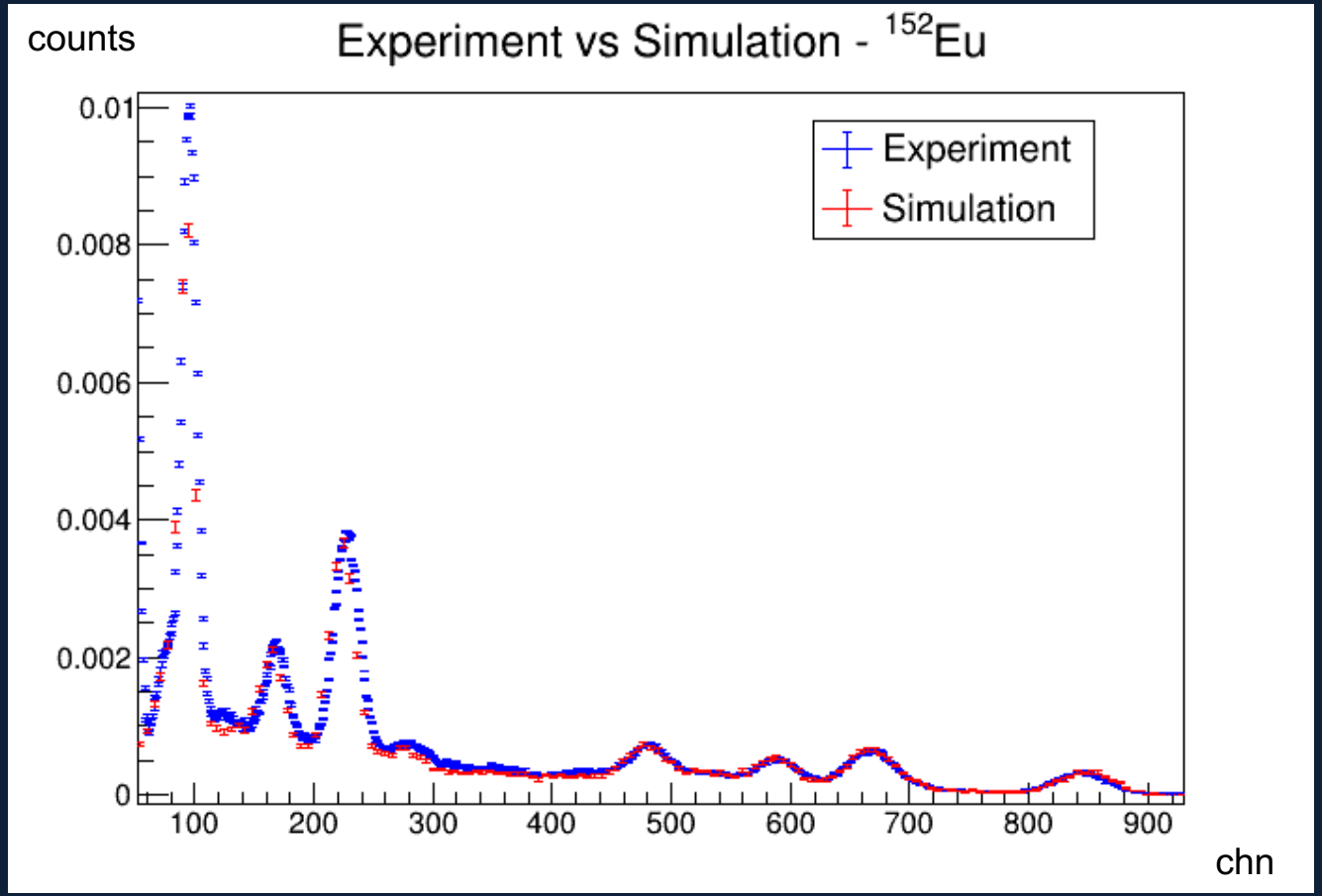
Thanks for your attention!!

MCNP6: 137Cs - CZT



MCNP6: 152Eu – CsI(Tl)



MCNP6: 60Co – CsI(Tl)