

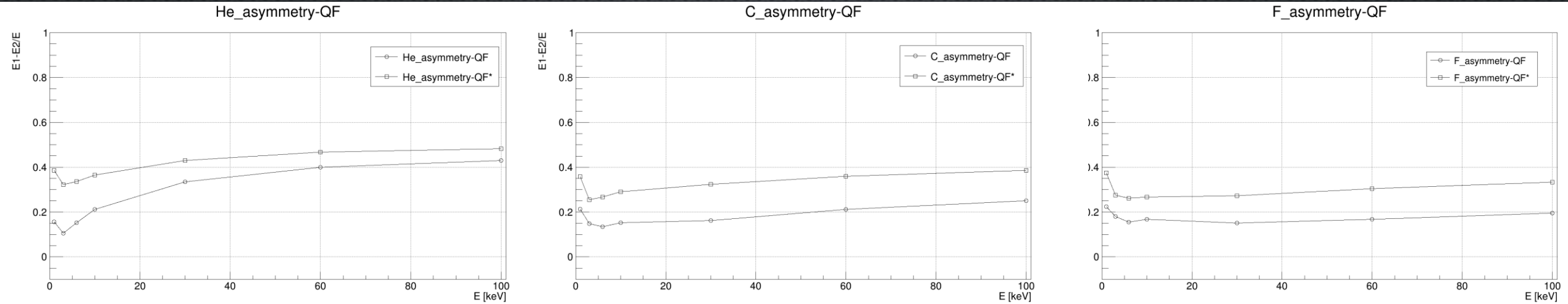
NUCLEAR RECOILS SIMULATIONS

CYGNO SIMULATION MEETING, 8/02/2021

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TRACK ASYMMETRY

The difference between the two proposed methods to reproduce the ionization energy deposit spatial distribution can be expressed by an asymmetry parameter $(E1-E2)/E$



TRACK ASYMMETRY

In order to check which method best describes an actual track, we propose to compare the data obtained from SRIM simulations with measurements

- LEMON data with AmBe source
- LEMON data taken at FNG

In both cases we know the position of the source and we could not only study the **head-tail** effect, but also the **directionality** of the tracks

What do you think?

SRIM SIMULATIONS

New simulations may be needed for the comparison with data + we are going to produce the high statistics samples for the MC

We planned to set SRIM on a computer at LNGS and set the connection to control it remotely with TeamViewer

This week we will start producing the sample of 3D ionization profile using the constant QF while we study the possible alternative approaches

Up to now we considered 1,3,6,10,30,60,100 keV; we could increase the number of values at low energy for the comparison with data - *what do you think?*

NEUTRON SIMULATIONS IN LIME AT LNGS

I started looking at the neutron simulation at LNGS with GEANT4

To retrieve the neutron spectrum we need to unfold the distribution of nuclear recoils

$$Y(E_{NR}) = \int_0^\infty R(E, E_{NR}) X(E) dE$$

$R(E, E_{NR})$ is the response function of the detector.

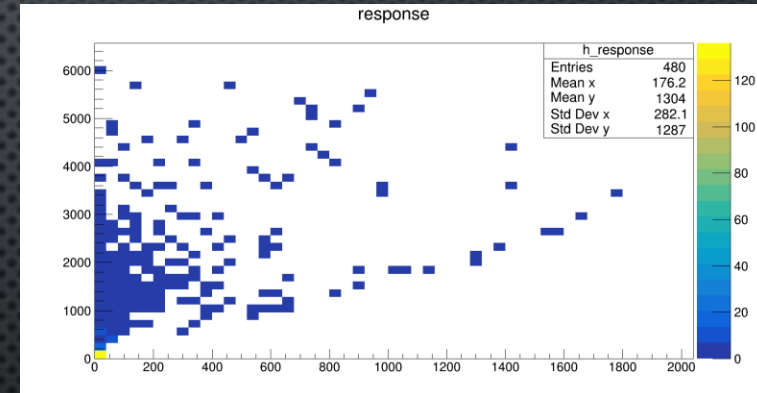
There are different methods to invert this expression, given that R is known.

The package **Roofold** seems a optimal tool to retrieve the input spectrum

ROOUNFOLD

Makes different unfolding methods available as Root/C++ classes

The response matrix can be passed as a 2D histogram – filled with $(x_{\text{meas}}, x_{\text{truth}})$ from MC simulation.
The training true distribution should be close to the expected data

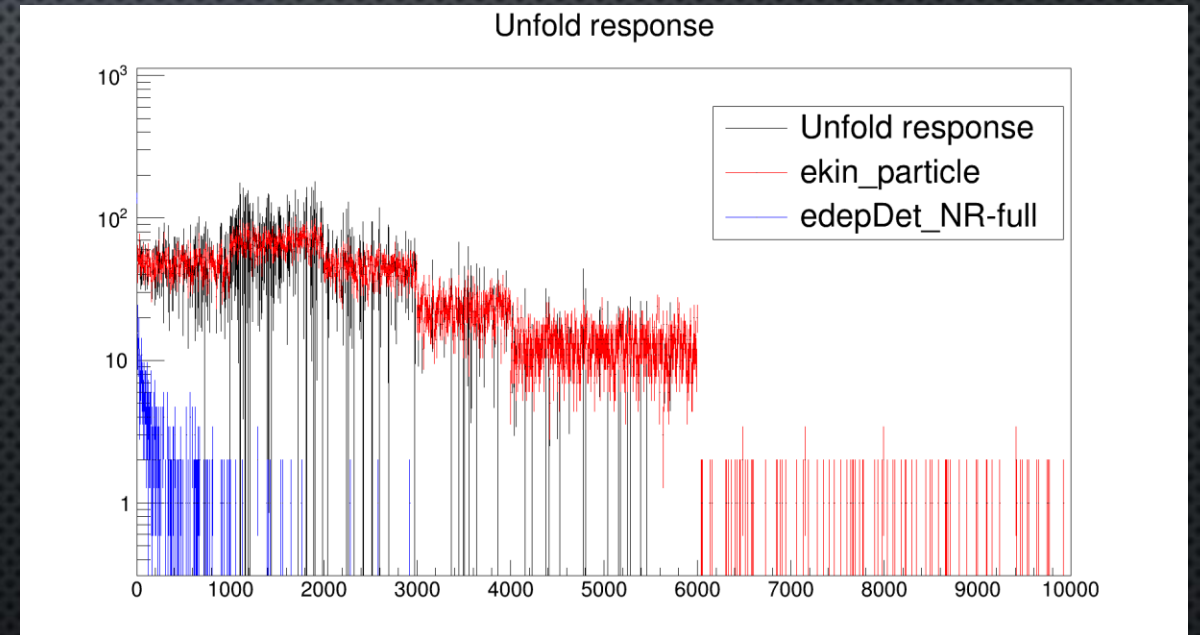


Once the response matrix has been constructed, the true distribution is returned as a histogram with errors
Some methods also support 2D distributions (e.g. energy+angle)

ROOUNFOLD – PRELIMINARY TEST

I tested RooUnfold with a training true distribution given by the kinetic energy distribution of neutrons expected underground at LNGS

With the RooUnfoldBayes method (iterative method proposed by D'Agostini) I used the NR recoil distribution as an input, and retrieved the correct original distribution



CONCLUSIONS AND FUTURE PLANS

- We can produce the 3D ionization profile of NR tracks from SRIM simulations
 - Two methods proposed to compute ionization spatial distribution: QF and F factor
 - Comparison with data may be necessary to choose the best one
- We plan to (re-)analyse LEMON data to study NR tracks (head-tail effect, directionality)
- Neutron response simulations in LIME at LNGS are about to start
- Unfolding methods are being considered to retrieve the neutron spectrum from the measured NR recoil spectrum with the RooUnfold package
 - Preliminary tests were made to check the performance of this method – it seems promising