First muon induced neutron yields from the NEMESIS experiment

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The EUL Project

Interreg Baltic Sea Region co-funded project Empowering Underground Laboratories network usage (EUL) continues the work done during the Baltic Sea Underground Innovation Network (BSUIN) project

Underground laboratories in the Baltic Sea region are not utilized to their full potential even though world-leading research organizations and industrial companies are nearby. In order to use the available underground space better, the BSUIN project has developed service concepts for the underground laboratories and an open-access platform that characterizes them. These concepts and the platform will be further tested, evaluated, and improved within the EUL project. Better information about the laboratories and their business opportunities is provided to regional development agencies and potential new customers from academia and business.

EMPOWERING UNDERGROUND LABORATORIES NETWORK USAGE

Interreg Baltic Sea Region

EUROPEAN UNION EUROPEAN REGIONAL DEVELOPMENT FUND

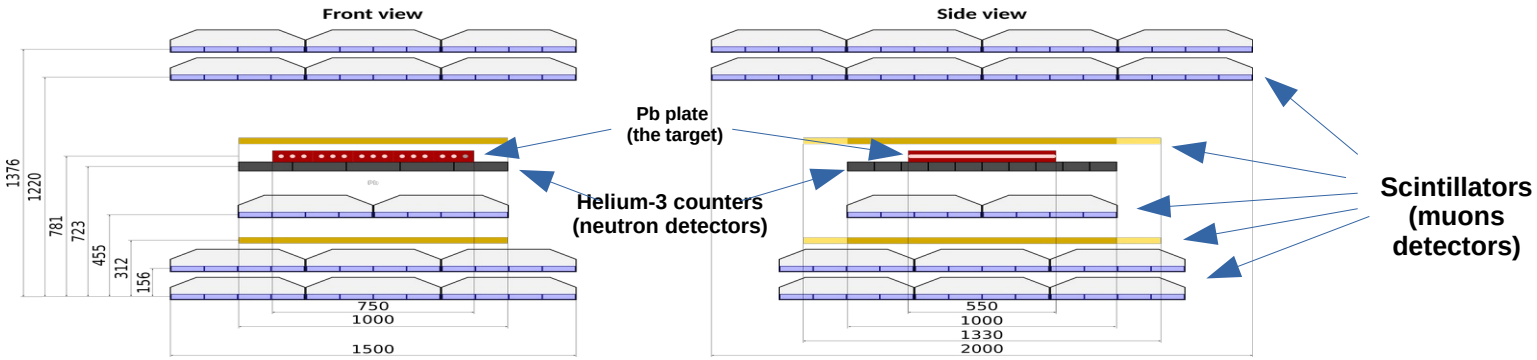
http://bsuin.eu

https://undergroundlabs.network/about/https://undergroundlabs.network/about/

Increasing capacity for innovations of the underground laboratory, case study: the NEMESIS experiment

- The collaboration was created thanks to contacts made during the work on the BSUIN project
- The experiment uses the infrastructure previously existing at the Pyhasalmi mine - the EMMA underground muon telescope, and a measurement set-up originally designed for pilot measurements for the BSUIN project
- But NEMESIS is not simply a combination of two existing apparatus is a new experiment pursuing their own goals

The NEMESIS experiment



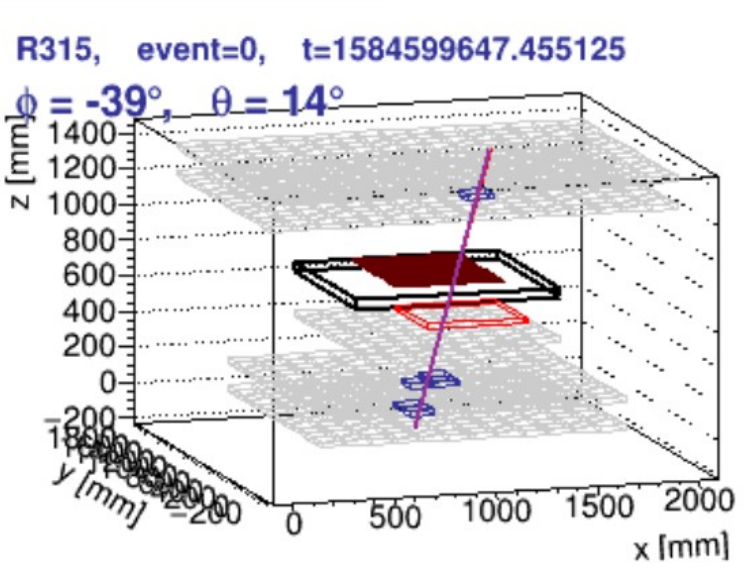
Idea:

- Pb target (plate 1m^2 x 5cm) in which muons of cosmic rays (or other particles) produce neutrons
- tray of detectors (helium counters) detecting the produced neutrons
- target and tray are surrounded by a telescope detecting cosmic muons

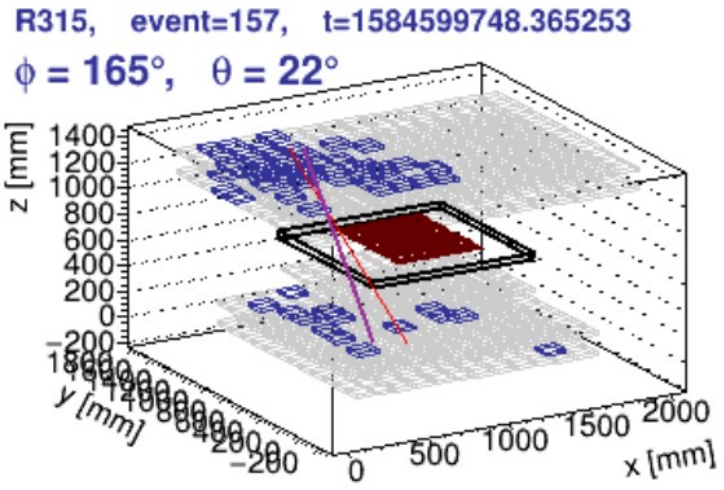
The experiment is located in the Pyhasalmi mine (Finland) at a depth of 75 m (240 m H_2O)

Average cosmic muons energy = 50 GeV

NEMESIS: Muon track reconstruction



reconstructable event



non-reconstructable event

In 52% of registered events, the muon track is successfully reconstructed.
Only successfully reconstructed were included into this analysis.

Neutron production yield: calculation procedure

$$Y=N_n/(N_\mu \epsilon_n X)$$

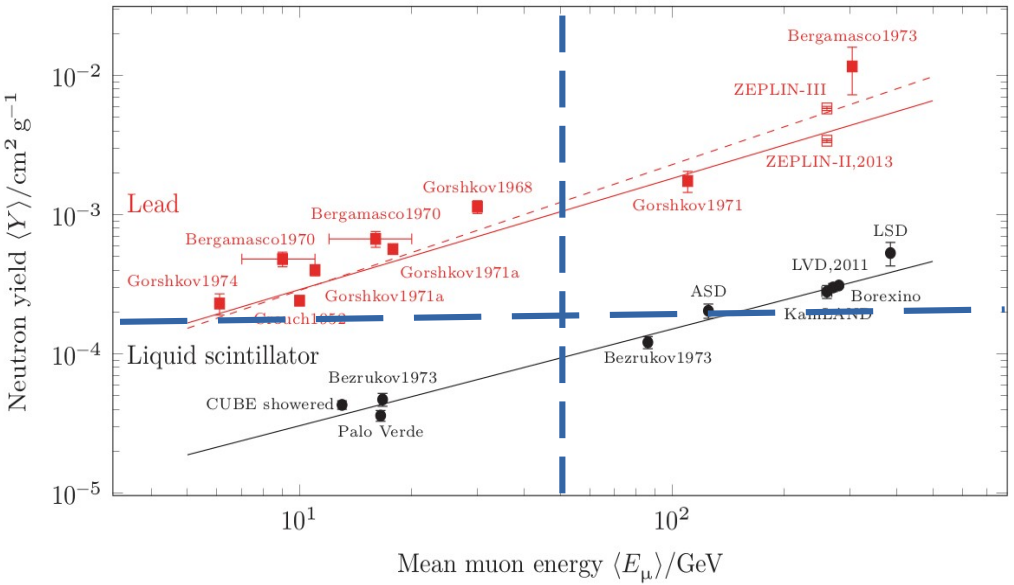
Y – Yield

N_n – registered neutron number

N_μ – muon number

X – target thick [g/cm^2]

ϵ_n – neutron registration efficiency



$Y=1.64\times10^{-4}$

neutron per muon per g/cm^2 Pb

Oryginal figure from H. M. Kluck „Measurement of the cosmic induced neutron yield at the Modane underground laboratory" PHD thesis