Non-accelerator nuclear and particle physics at the Institute of Physics Belgrade

Ivan Aničin, IF Zemun, June 8. 2010

LOW-LEVEL LABORATORY FOR NUCLEAR PHYSICS

Manpower:

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In close collaboration with the similarly oriented NPLaboratory at the University of Novi Sad

ACTIVITIES

Past :

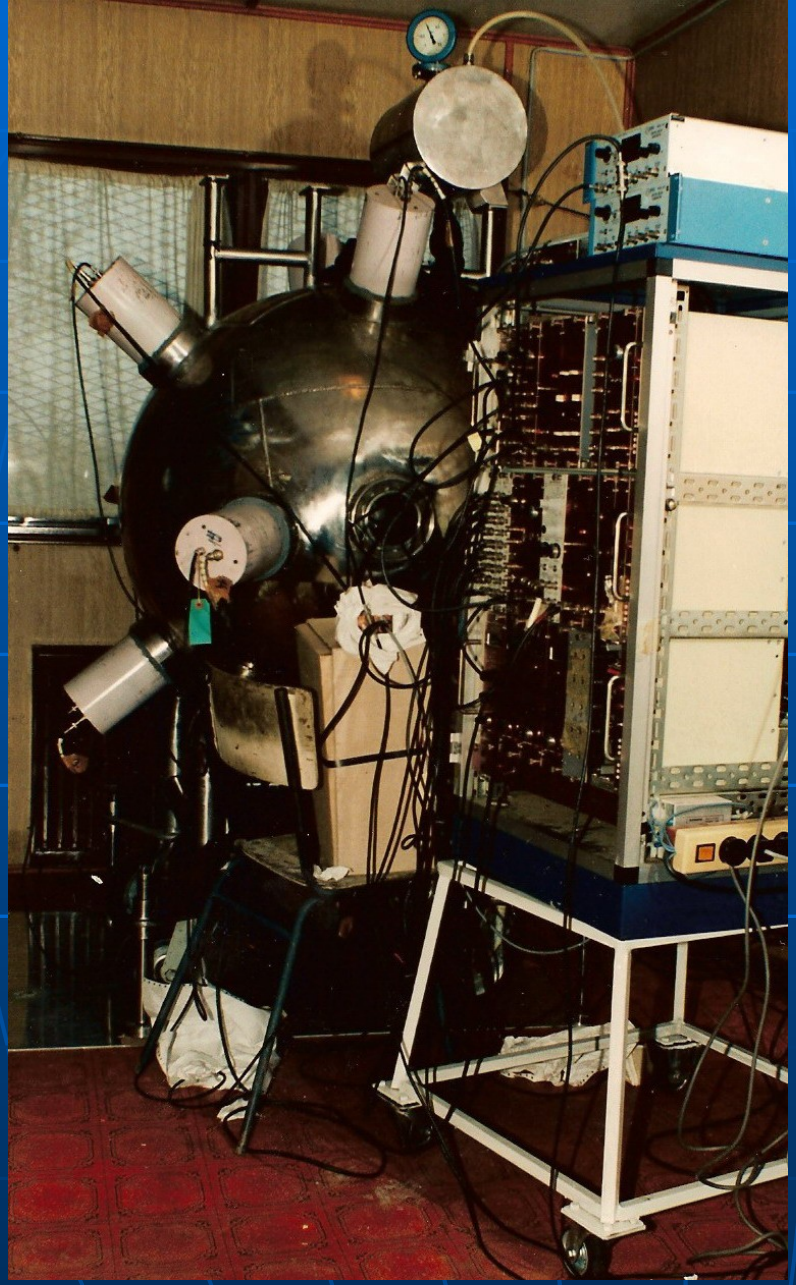
Nuclear structure studies by γ and β spectroscopy

γ -γ , γ -e directional angular correlations, nuclear orientations

- **Present:**

- Studies of rare nuclear and particle processes (low-probability decay modes, neutrinoless double beta decay, comprehensive studies of all components of background in high sensitivity experiments, CR muon induced signatures in low-energy detectors, continuous monitoring of CR muon intensity, etc)

- Expertise in low-level gamma-ray spectroscopy (coincidence and anticoincidence methods for fundamental and applied research, material radio-purity tests for uses in low bckg labs)



SOME PAST ACTIVITIES

Backgroundless search for element Z-113 (eka-thallium) in nature (conc<e-11g/g at 90%CL)

THE BIG Gd loaded LIQUID SCINTILLATOR SPHERE

In the past we measured the low activities remained in the old targets from HI reactions from GSI by the low-background gamma-ray spectroscopy, in search for low-yield and long-lived exotic species.

Reports on gamma-ray spectroscopy measurements of old GSI targets performed in the period from 1985 to 1990 by the Belgrade Group, and published in GSI Annual Reports:

1. R.Vukanović, A.Kukoč, I.Aničin and P.Adžic:

"Yields of Long-Lived Isotopes in 132Xe Interactions with Thick nat-Si at 8 and 14 MeV/u",

GSI Sci.Report 1985, Darmstadt 1986, p.73,

2. A.Kukoč, P.Adžić, I.Aničin, R.Vukanović and M.Župančić:

"Thin Target Yields from 74Ge + 197Au at 18.8 MeV/u",

GSI Sci.Report 1986, Darmstadt 1987, p.60,

3. D.Toprek, A.Kukoč, I.Aničin, P.Adžić, R.Vukanović and M.Župančić:

"Average Number of Neutrons from the Interaction of 16.2 MeV/u Nb with the thick Ta Target",

GSI Sci.Report 1987, Darmstadt 1988, p.54,

4. A.Kukoč, P.Adžić, I.Aničin, R.Vukanović:

"Thick Target Yields from 93 Nb + 181Ta at an Average 16.2 Mev/u", $\sigma\ (^{274}Sh_{114}[1y]) < 10\ \mu\ b$

GSI Sci.Report 1988, Darmstadt 1989, p.58,

5. I.Aničin, A.Kukoč, P.Adžić, D.Toprek, R.Vukanović, M.Župančić and Dj.Krmpotić:

"Nuclear Isomers Produced (and stopped) in a Thin Au Target by 74Ge at 18.8 MeV/u",

GSI Sci.Report 1989, Darmstadt 1990, p.44

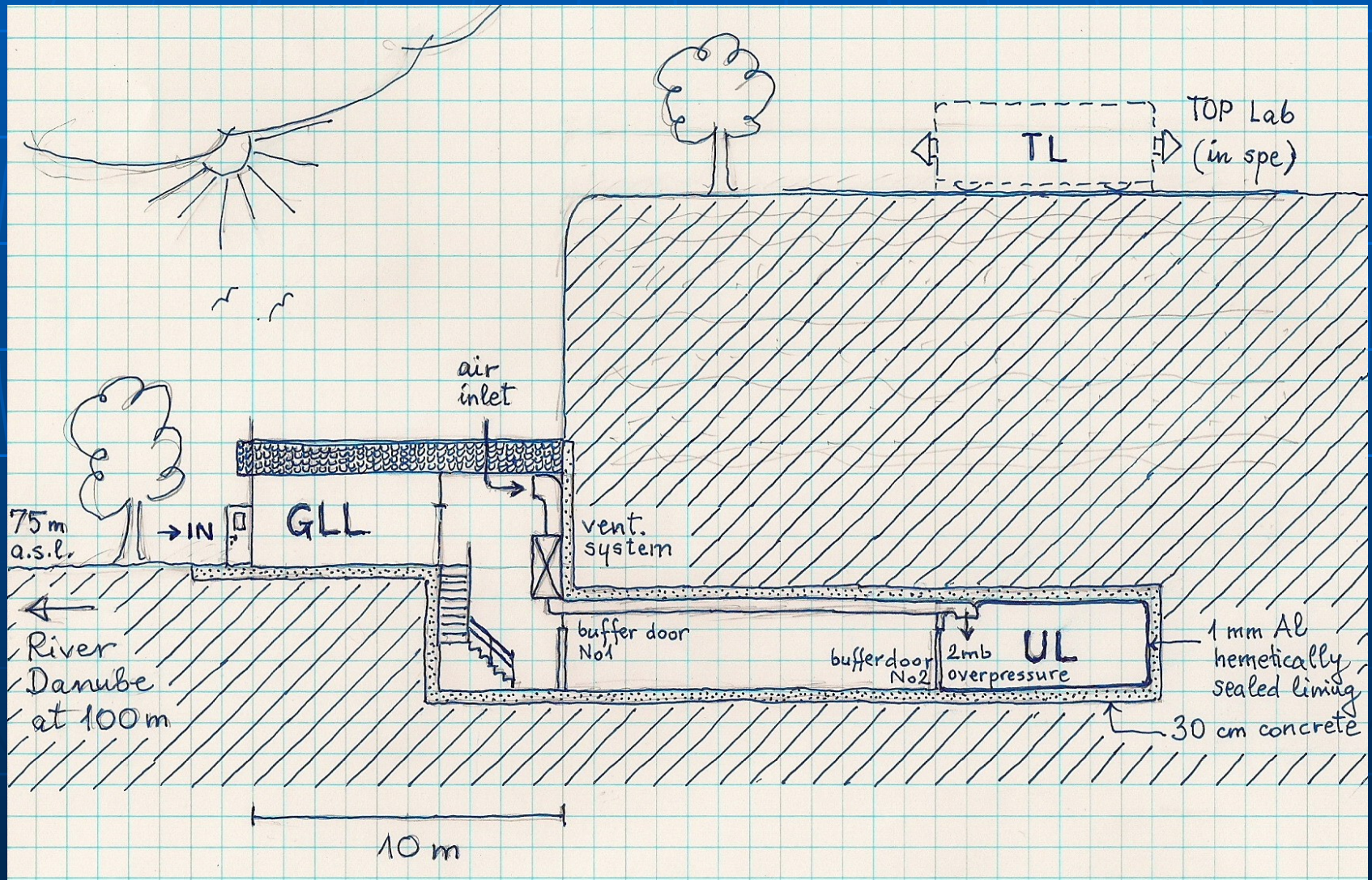
And we would gladly do similar kind of work again

(with targets from Isolde, or…)

For the last 25 years
we also participate in the realization of LOREX,
the only geochemical experiment to determine the average solar neutrino flux over the last 5 million years, via the neutrino capture by Tl-205. It has the lowest threshold among all the solar neutrino detectors, of 50 keV only, and it measures mostly the pp neutrinos.
First result is expected in 2015.

Sketch of the cross section of the Low-level Laboratory at IOP, Belgrade,

44°49'N, 20°28'E, vertical rigidity 5 MV



THE “ZEMUoN” SPECTROMETER SYSTEM

(Belgrade, Ground Level Laboratory & Underground Lab, 25 m.w.e.)

- UL hermetically sealed and over-pressurized against radon intrusion (~10 Bq/m^3) (“the biggest can in the Balkans”)
- 35% lo bg HPGe spectrometer
- 15% HPGe spectrometer (borrowed)
- Two 1 m x 1 m x 5 cm plastic scintillator detectors
- Two 50 x 25 x 5 cm plastic scintillators
- The background events from the six detectors are continuously recorded by their amplitude, and time stamped with the resolution of 10 ns, for off-line coincidence/anticoicidence analysis, producing altogether about 1 TB of data per year.

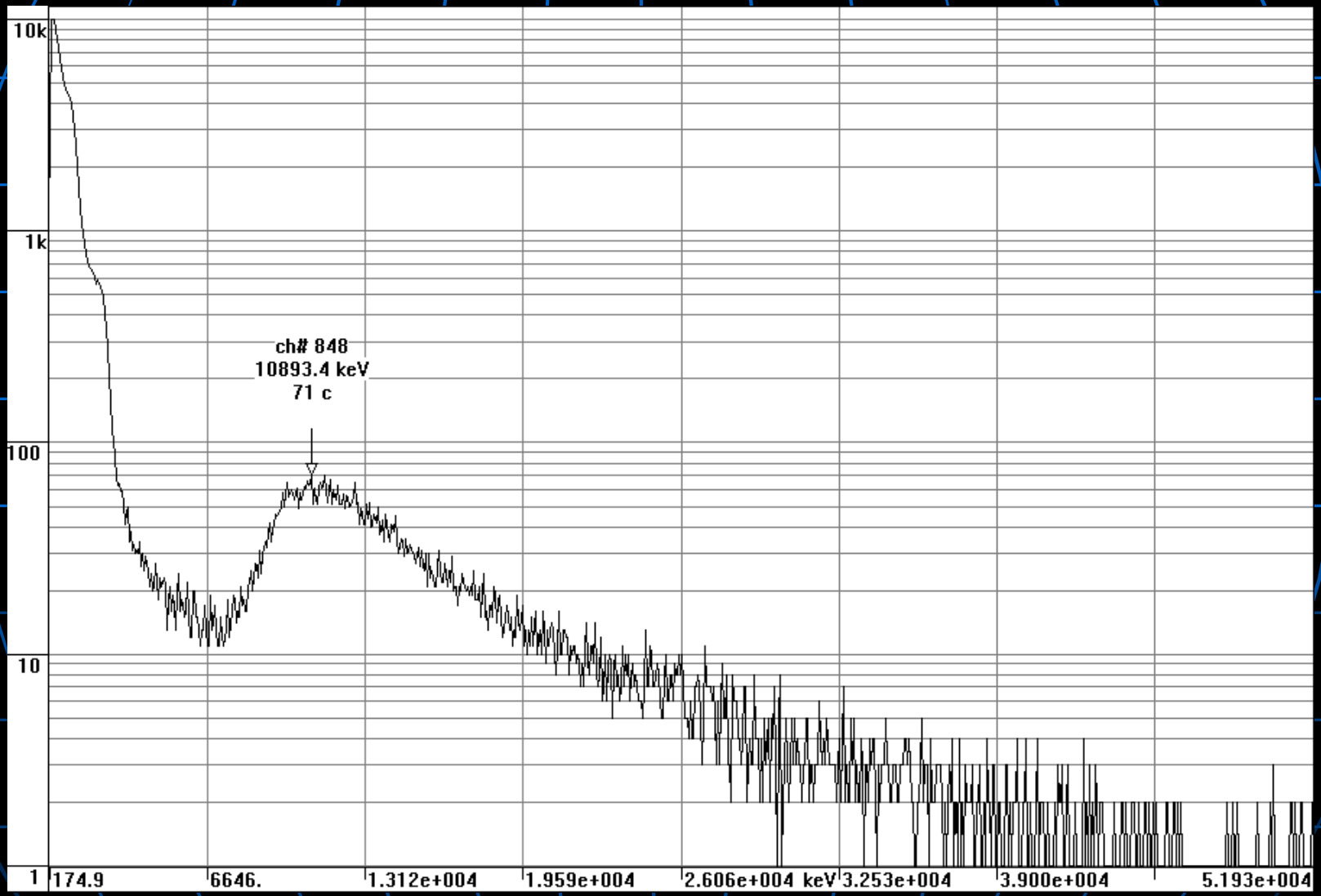
Ground Level Lab

Underground Lab

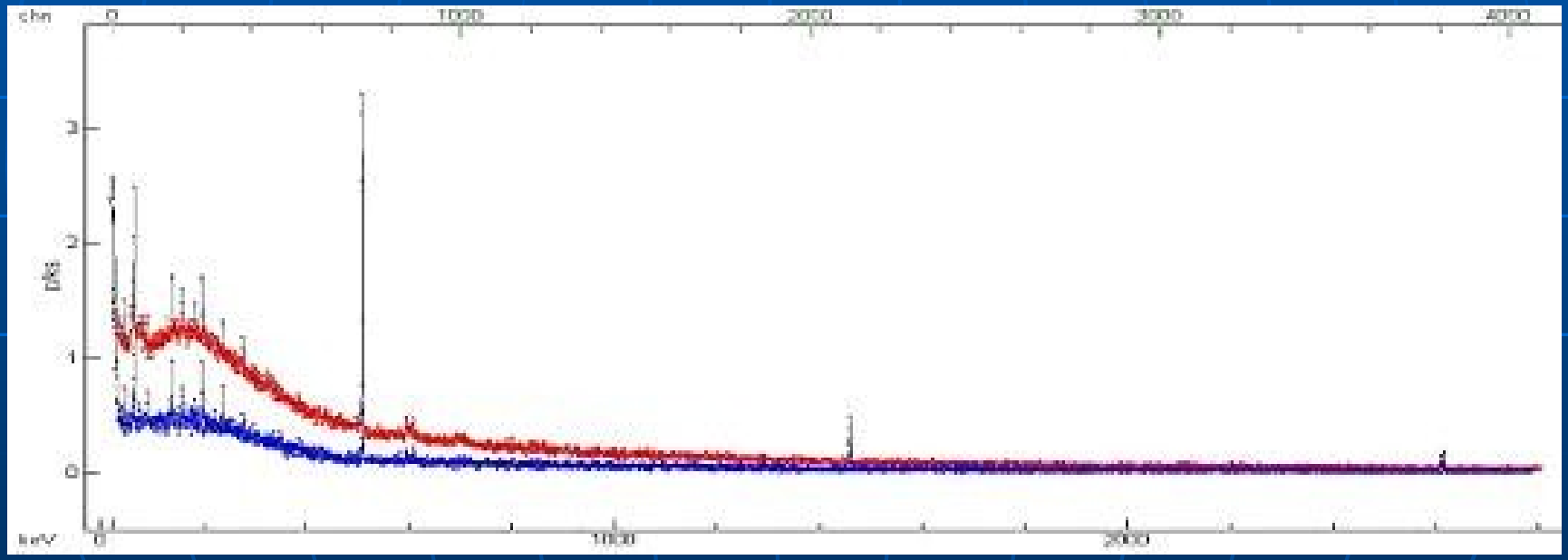
This is small scale CR physics
(or the poor man's HEP)
We compensate by trying to interpret every low-energy event induced by CR, which constitute background in searches for rare n&p events

with help from GEANT4, CORSIKA, FLUKA and our own PHOTON, etc

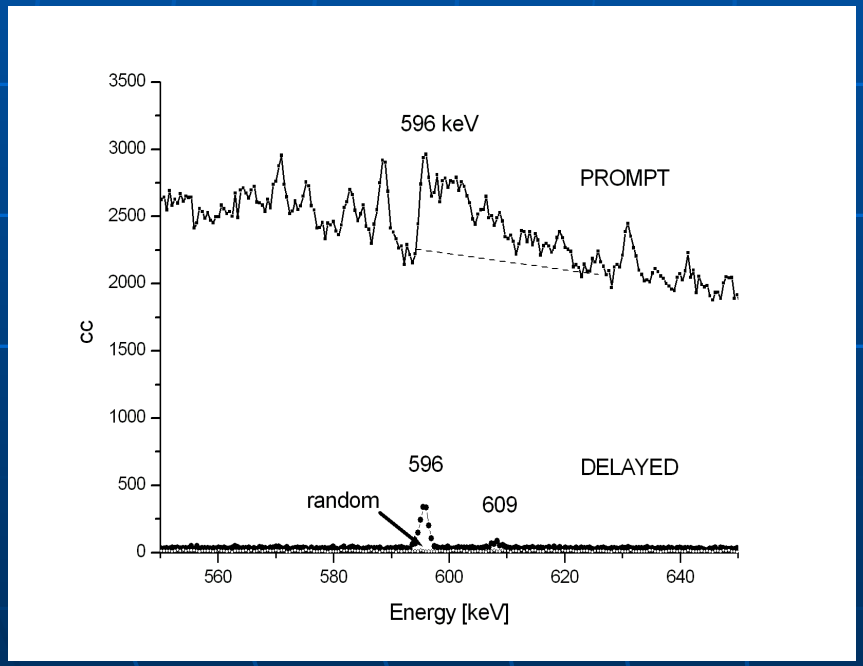
Typical CR muon Δ E spectrum in a horizontal plastic detector

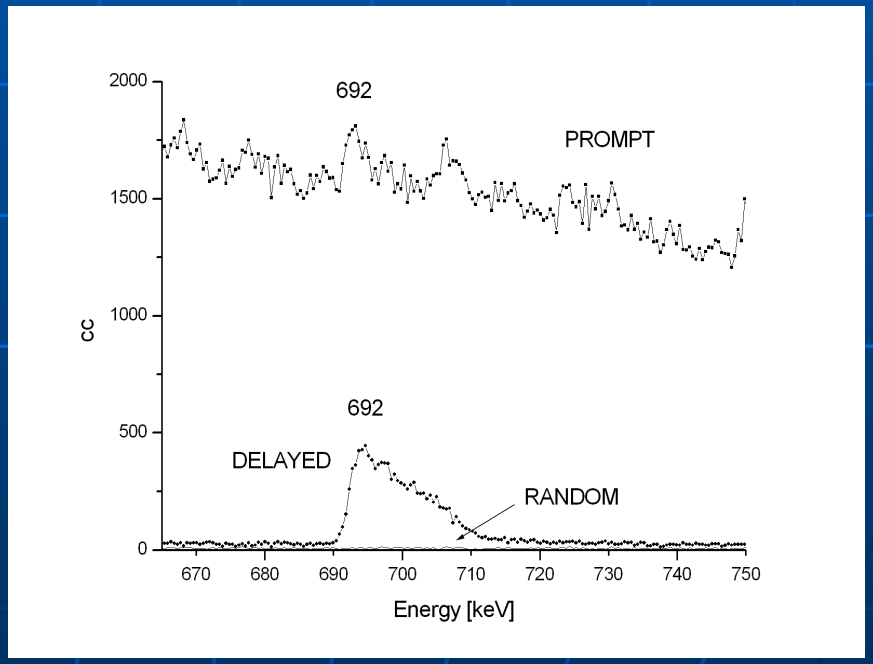


The direct (upper) and vetoed (lower) germanium spectrum



Coincidences with neutron source, which imitates the neutrons of CR origin





And some results for CR

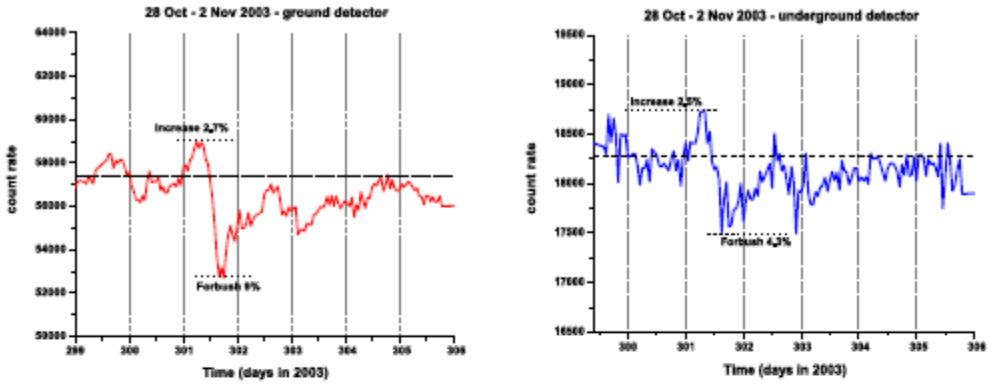


Figure 1: Forbush decrease on October 29 2003 recorded as sudden drop of counting rates of GD (left) and UD (right).

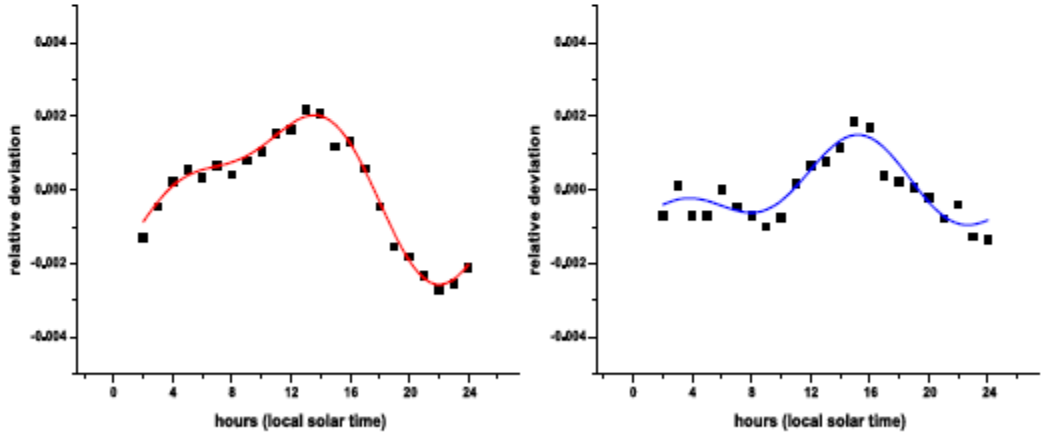


Figure 2: Diurnal and semi-diurnal anisotropy of surface (left) and underground (right) muons.

Absolute muon flux in Belgrade

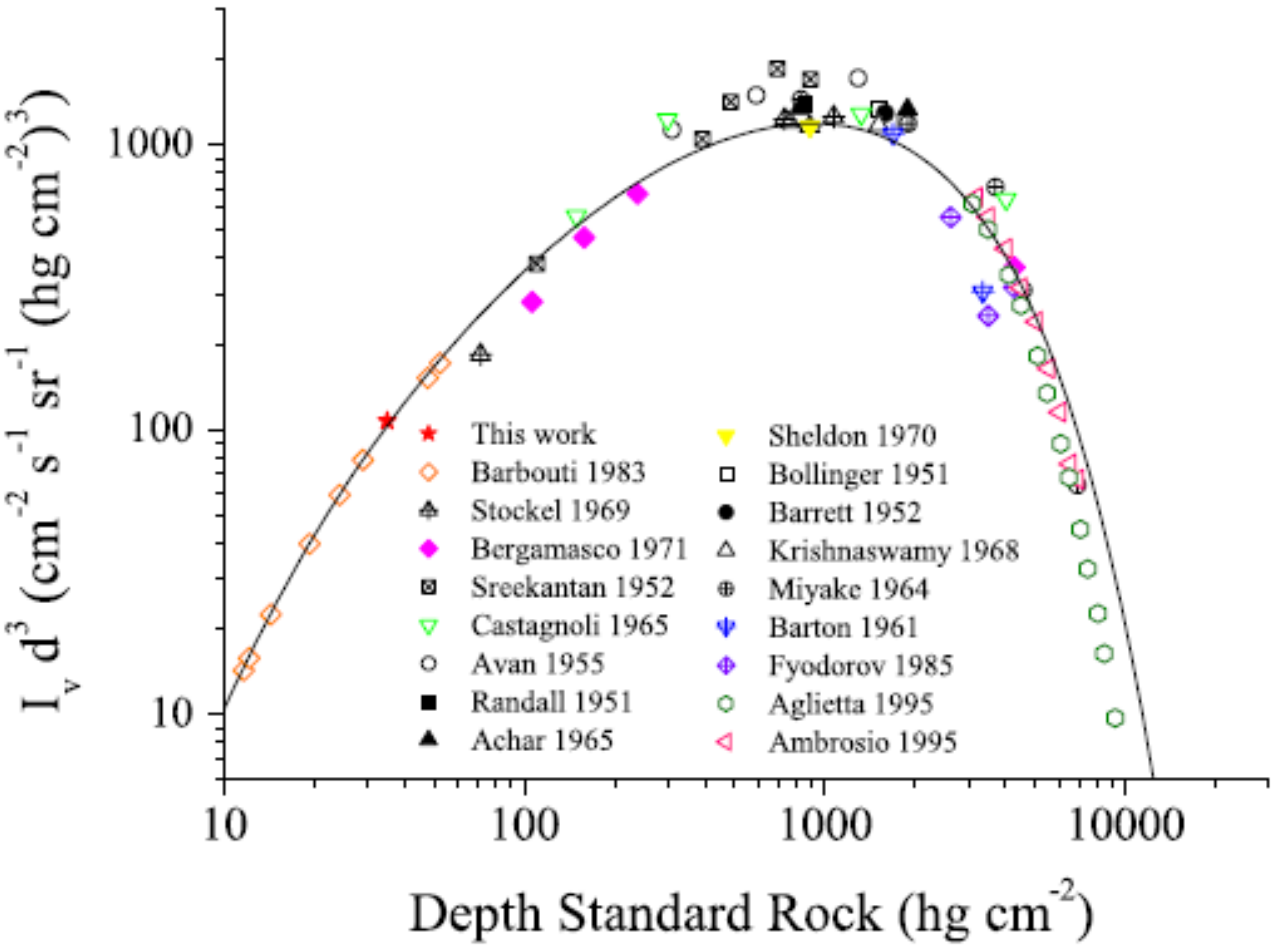


Fig. 4. Absolute vertical muon intensity vs. depth measured from the top of the atmosphere. The result of present measurement is indicated.

Muon time series

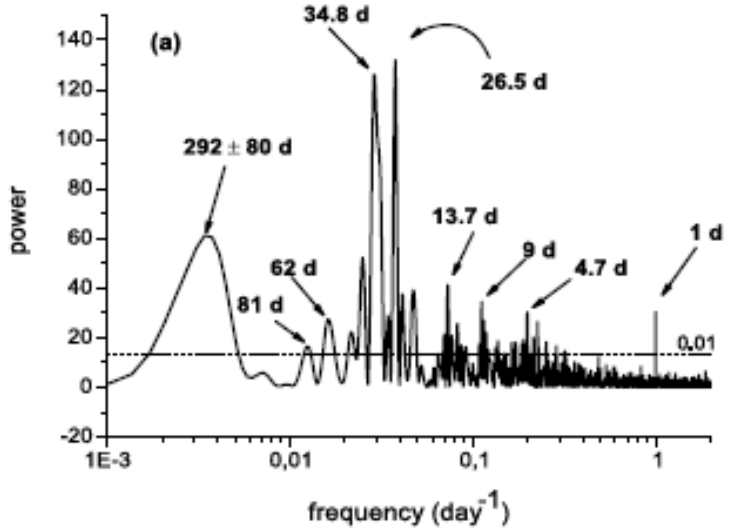


Fig. 1. Power spectral density of the underground detector time series: Lomb-Scargle periodogram (a); and CLEAN periodogram (b). Hourly averaged counting rates are used.

THANKS FOR YOUR ATTENTION