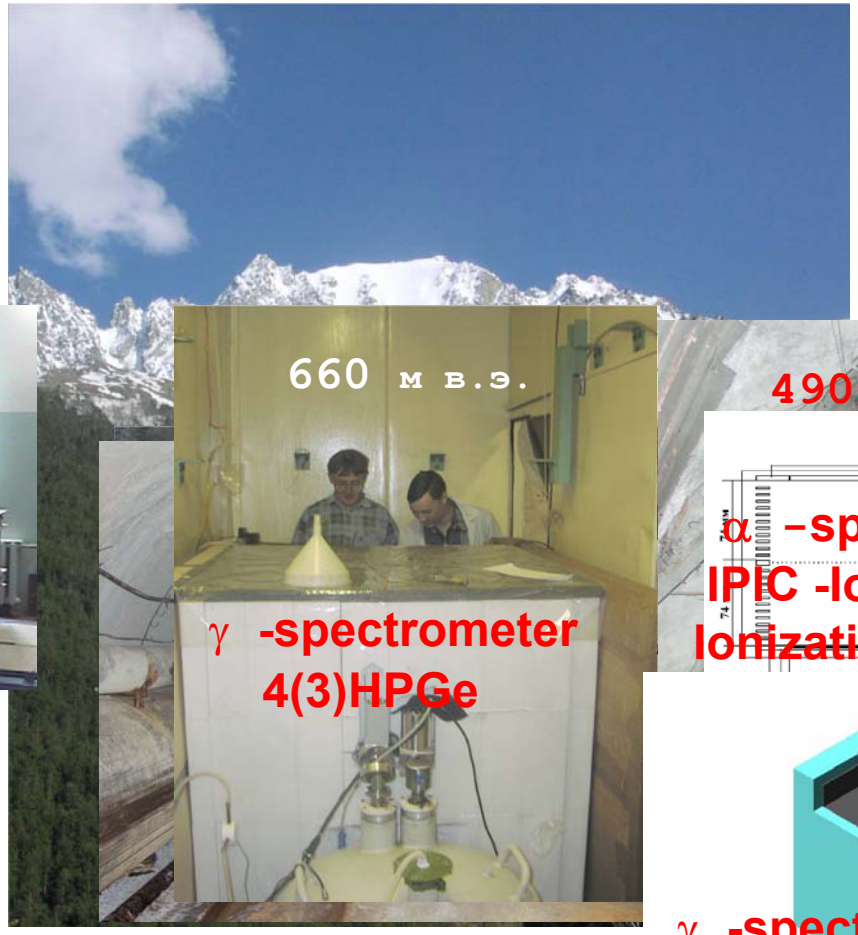
Task group TG11- material screening, measurements at Baksan and Dubna

Laboratory for Low Background Experiments

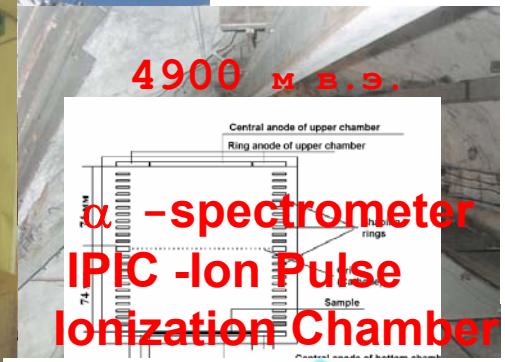
BNO INR

JINR, Dubna

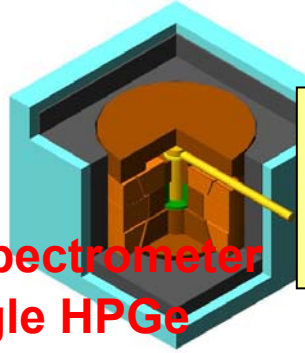
γ –spectrometer single HPGe



γ -spectrometer 4(3)HPGe



α –spectrometer IPIC -Ion Pulse Ionization Chamber



γ -spectrometer single HPGe

Construction will be finished soon (April – May 2006)

Measurements of the samples for GERDA at Baksan

1. **The Cu/P pellet sample – has been measured during 2005 year**

2. **Reference sample (0.5 l HCl solution) –**
from Institute for Reference Materials and Measurements of the EUROPEAN COMMISSION "EUROATOM" (Belgium)-
-delivered in January 2006 – in hands,
has been measured

Next samples:

3. **VM 2000 reflector foil (about 400 g) – in hands**

α -spectrometer
γ -spectrometer (s)

4. **Cu for GERDA cryostat (about 10 - 20 kg) – will be delivered soon**

The Cu/P pellet sample – has been measured during 2005 year

Sample

- Chemical compound Cu(90%)P(10%)
- Sample mass is 2.8 kg
- The sample has cylindrical shape with diameter 7.5 cm and height 11 cm, and placed between 3 detectors
- Sample density $\rho_{eff} = m/V_{eff} = 5.77$ g/cm^3

Cu/P and background measurements

The Cu/P pellet sample has been placed between 3 detectors of the Four HPGe Set Up and was measured during 69.71 days (1673 h). The background (with no sample) was accumulated during 70.42 days (1690 h). Analysis of the Cu/P and background spectra gives the excesses of events within 4 region of interest (ROI – under the peaks), namely

ROI (gamma-peak)	Number of counts in Cu/P spectrum for 69.71 days (Detector № 3)	Number of counts in background spectrum for 70.42 days (Detector № 3)
1460.83 keV (^{40}K)	94.26 ± 13.74	23.70 ± 6.67
2614.53 keV (^{208}Tl)	28	11
583.19 keV (^{208}Tl)	25.57 ± 8.04	3.34 ± 5.79
911.20 keV (^{228}Ac)	45	29

Cu/P measurement results

Measured radionuclide	Activity, mBq/kg
^{228}Ac (911 keV)	≈ 0.99 ± 0.54
^{228}Th (583 keV in ^{208}Tl)	0.96 ± 0.42
^{228}Th (2615 keV in ^{208}Tl)	0.81 ± 0.49
^{228}Th (weighted average)	0.90 ± 0.32
^{40}K (1461 keV)	11.42 ± 2.43

- **Contamination of ^{228}Th in CuP pellets has been found on the level ≈ 1 mBq/kg.**

- **We continue our measurements with CuP sample up to now - to improve our results**

and

to control stability of Rn level inside the set up

.

2. Current measurements and the nearest plans

Material Description	Sample weight [kg]	Method Laboratory	Date	Counting time [d]	Remarks
Cu(90%)-P(10%) pellets	2.8 kg	γ- 3 detectors Baksan	April 2005 – February 2006	ongoing	The measurement is continued up to now aimed to increase accuracy of the obtained results.
Reference Sample from JRC-IRMM (HCl solution)	0.5 l	γ –Ge JINR Dubna	February 2006	6 days (per each geometry)	RESULTS to be reported by Sergey Vasil'ev in the TG11 Will be discussed inside TG11
Reference Sample from JRC-IRMM (HCl solution)	0.5 l	γ- 3 detectors Baksan	End of February 2006	To be measured	Will be measured soon in different geometry of measurements
Reflector foil VM-2000	~ 10 g	α - spectrometer Baksan	February 2006	ongoing	Measurements of surface α - activity
Reflector foil VM-2000	~ 300 g	γ- 3 detectors Baksan	March 2006	To be measured for 1 month	
Reflector foil VM-2000	~ 100 g	γ- Ge (well-type detector)	March 2006	To be measured for 1 month	
Copper for Cryo-vessel	20 – 30 kg	γ- 3 detectors Baksan	Start from May 2006	To be measured for 3 months	Not yet delivered

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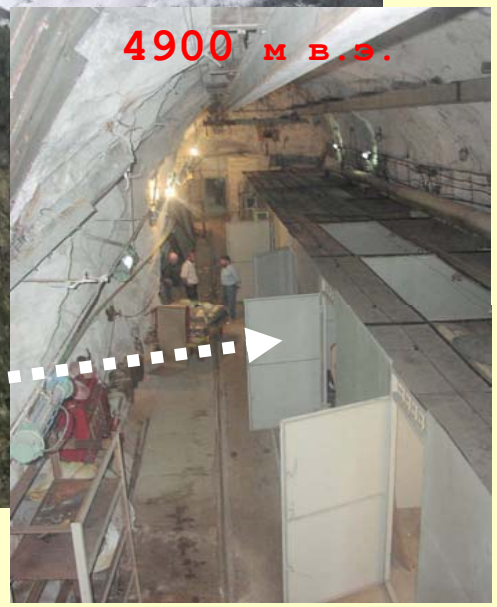
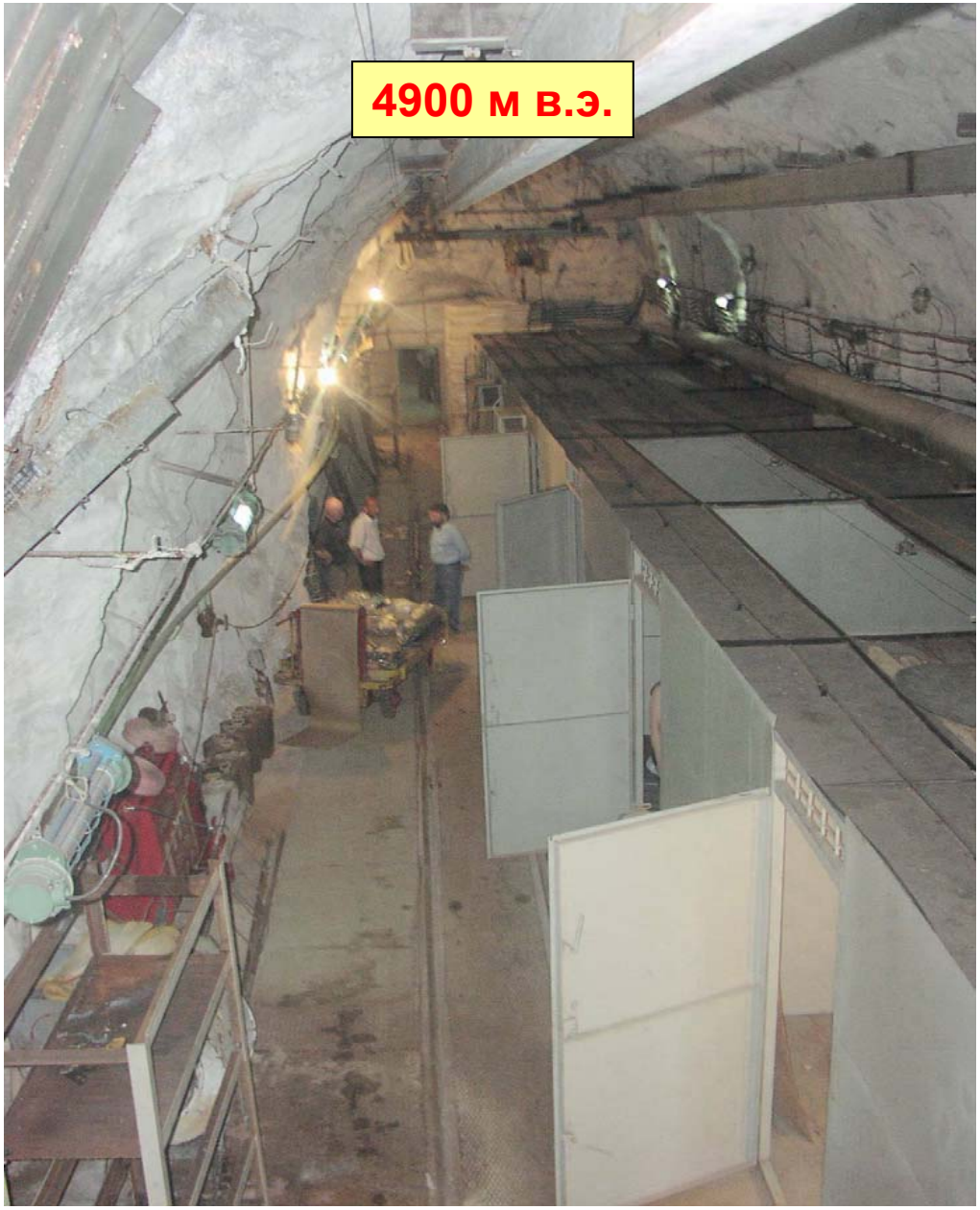


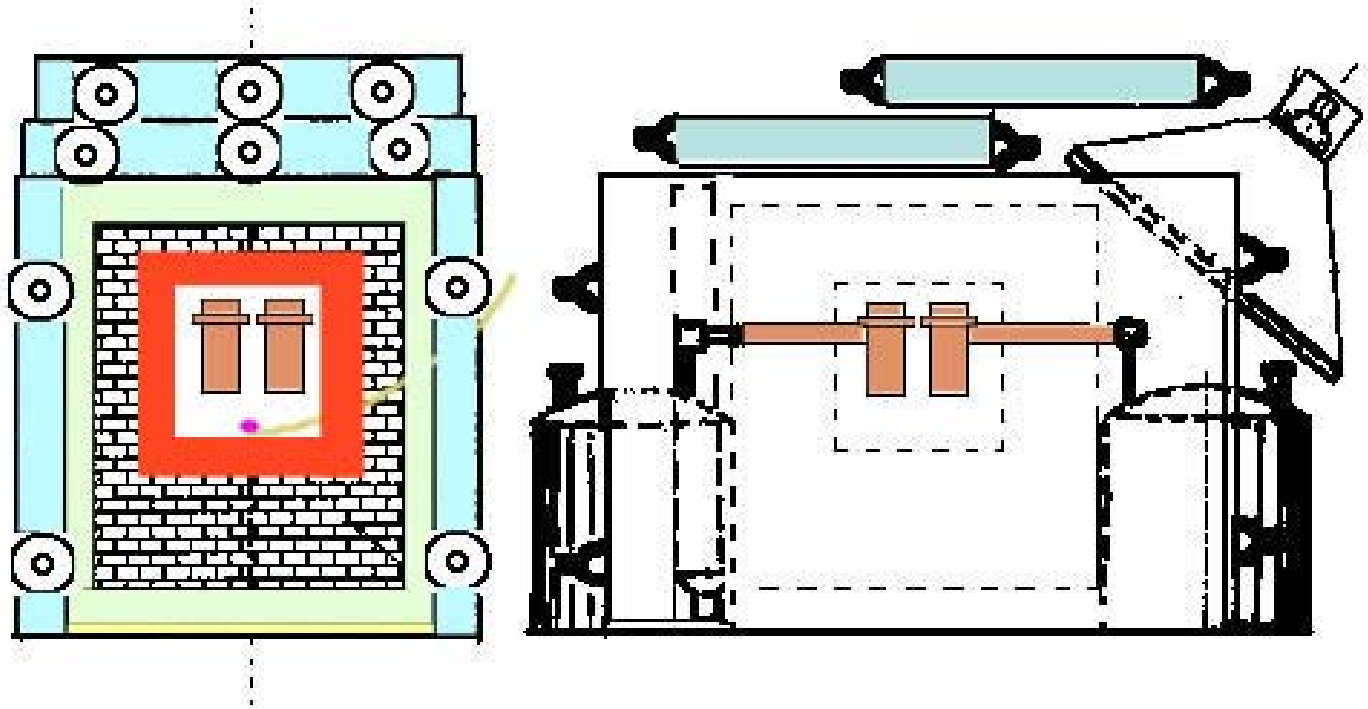

Баксанская нейтринная обсерватория ИЯИ РАН
гора Андырчи
A - Сцинтилляционный телескоп
B - Галлий-германиевый нейтринный телескоп
D-3 - Дальняя низкофоновая лаборатория
A
D-1
D-2
B
D-3
Поток мюонов (см -2 сек -1)
10-2
10-3
10-4
10-5
10-6
10-7
10-8
10-9
4200
3700
3200
2700
2200
1700
Высота над уровнем моря (м)
1000
2000
3000
4000 м
река Баксан
Расстояние от входа в штольню (м)


4900 м в.э.

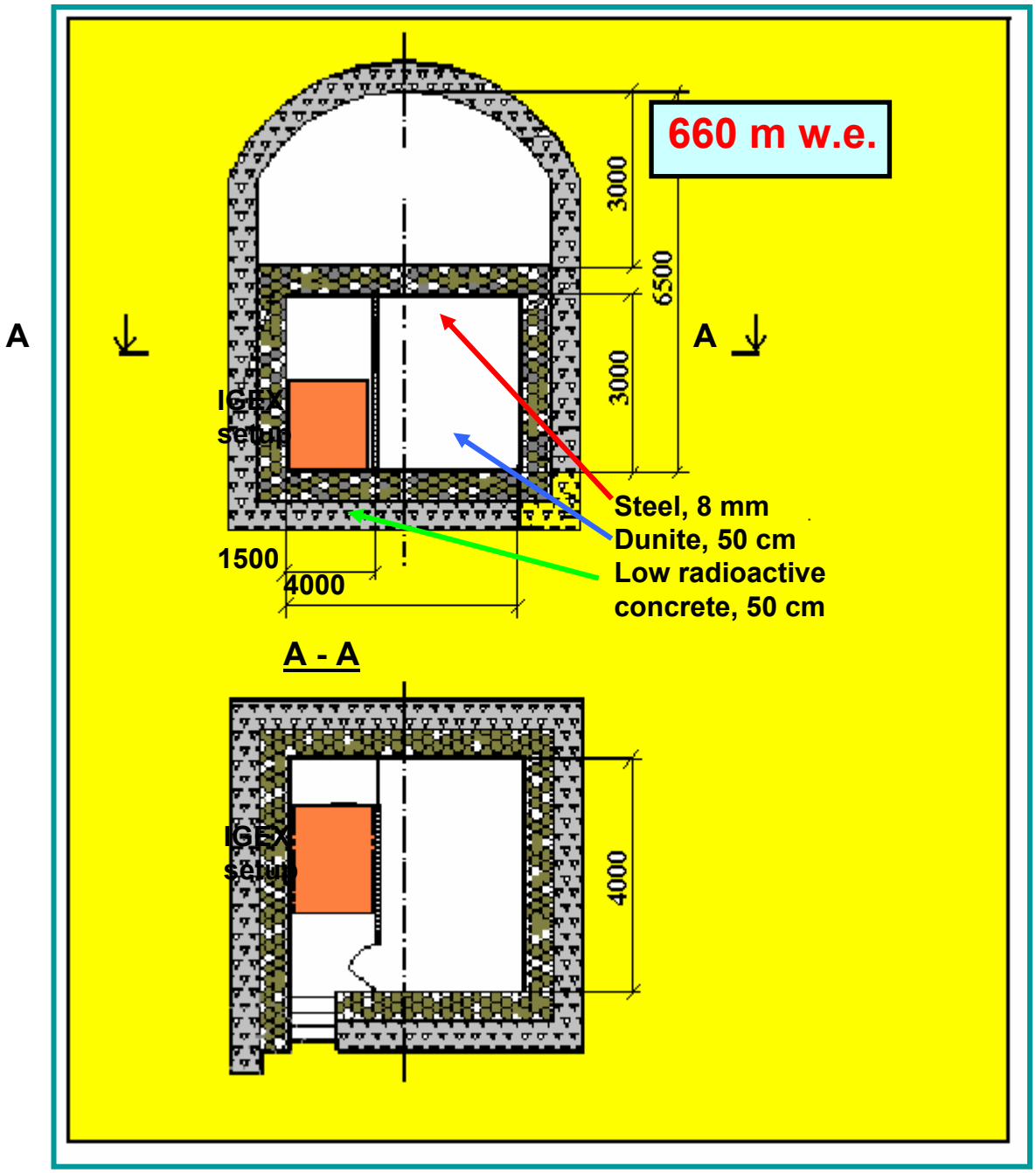
The IGEX/Baksan Four HPGe set up

This spectrometer is usually assembled from 4 ultra low background HPGe detectors of 1 kg each and operates up to now in the specially constructed low background facility of the Baksan Neutrino Observatory at the 660 m w.e. depth. The walls of the low background chamber are composed from 50 cm low radioactive concrete, 50 cm dunite and 0.8 cm steel [1]. Thus, gamma background inside the chamber is reduced by factor 200 in comparison with surrounding rocks. All detectors are placed in a common passive shield which consists of 12 cm of copper, 6 cm of lead sheets, 15 cm of lead bricks, and 8 cm of borated polyethylene. The cosmic ray muon flux at this depth is reduced by factor 2000, nevertheless, liquid scintillator active shield is used for additional background reduction. The active shield efficiency was defined as 93 %. To protect the spectrometer against radon gas penetration hermetical door closed facility is used. In addition the inner volume of the shield is permanently flushed with nitrogen. Conventional NIM electronic devices controlled by computer permit to have complete information about each event in the detection system, namely, amplitude of a signal from each Ge detector, time of event and active shield trigger signal came in 20 μsec time window.

Four HPGe Set Up operates at background level of the IGEX Ge-76 double beta decay experiment. Such ultra low background gives us a possibility to measure Th and U contamination in screening materials with sensitivity up to 10^{-12} g/g. Additional advantages of this spectrometer is the large sample volume (30 x 30 x 30 cm) and possibility to detect cascade gammas by several detectors in coincidence.



IGEX / Baksan


660 m w.e.
3000
6500
3000
A
A
IGEX
setup
1500
4000
Steel, 8 mm
Dunite, 50 cm
Low radioactive
concrete, 50 cm
A - A
IGEX
setup
4000

γ -spectrometer single HPGe

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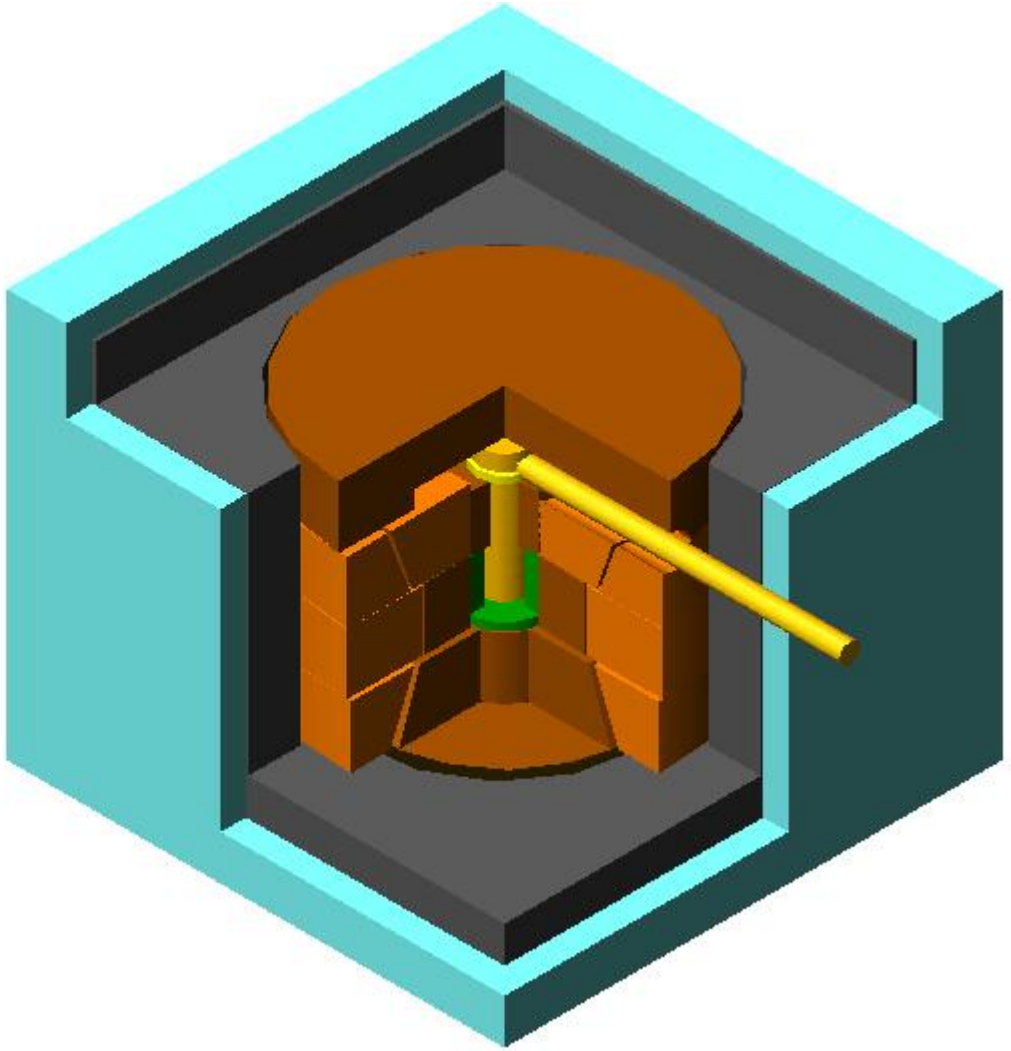
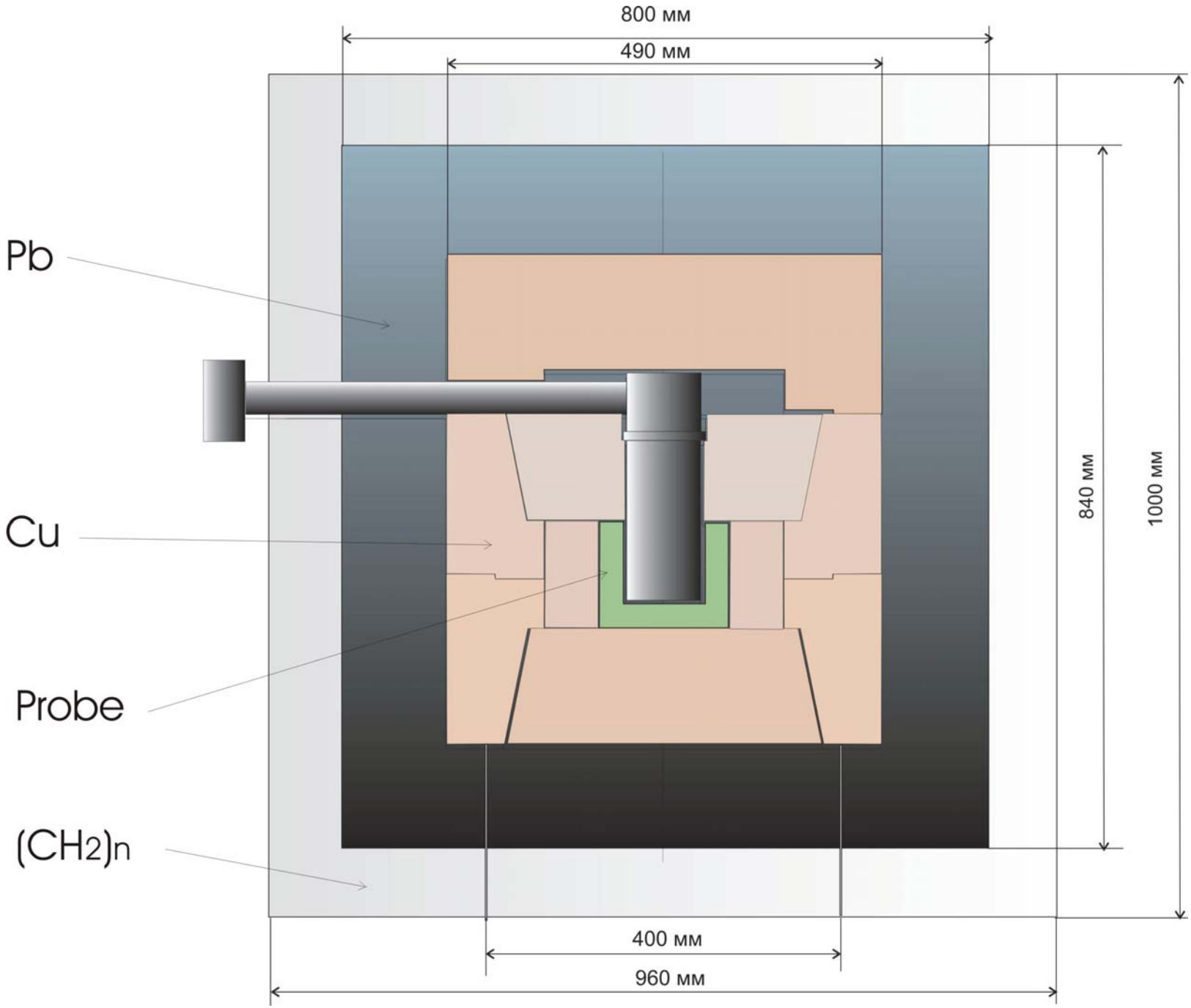
γ –spectrometer
single HPGe

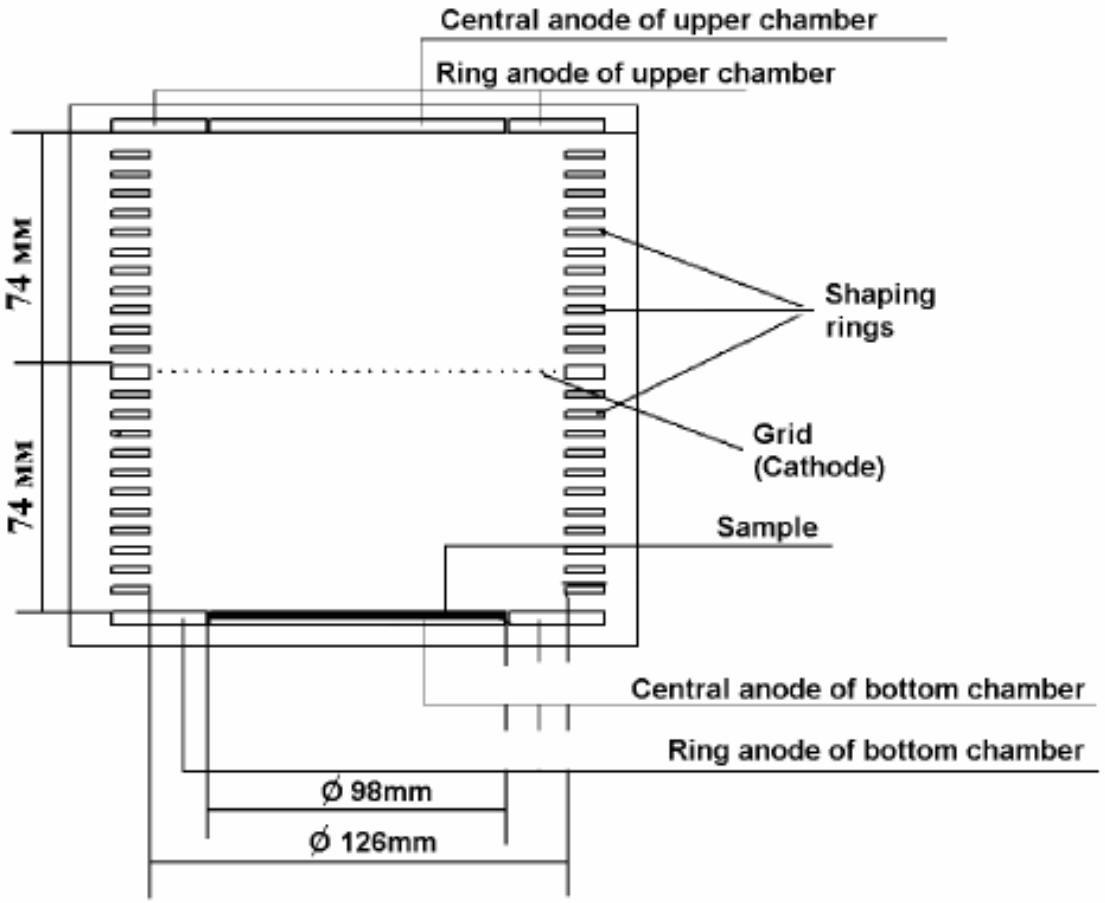
4900 м в.э.

Construction will be finished soon (April – May 2006)




800 мм
490 мм
Pb
Cu
Probe
(CH2)n
840 мм
1000 мм
400 мм
960 мм

The scheme of the IPIC



Materials with ultra low radioactive background are need for preparation of detectors for investigation of rare processes. (2β-decay, WIMP-events…). The part of this radioactive elements emit α-particles. The control of this α-activity could be done by using of IPIC with uniform electric field. Simultaneous collection of positive and negative ionization components allows to find different parameters of the α-track.

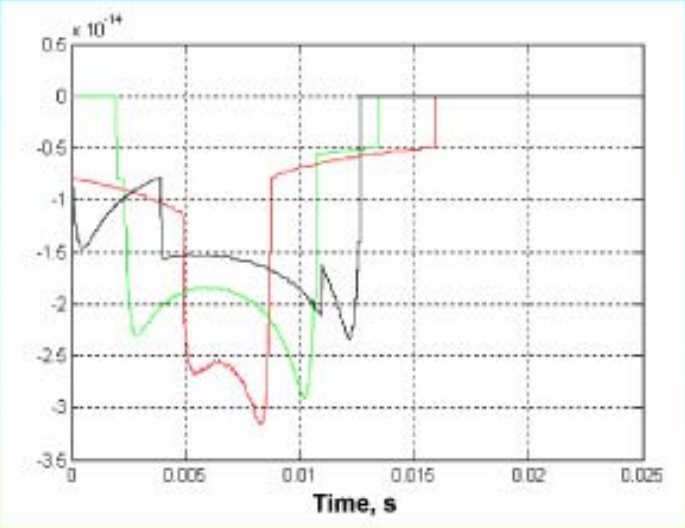
- position of the track

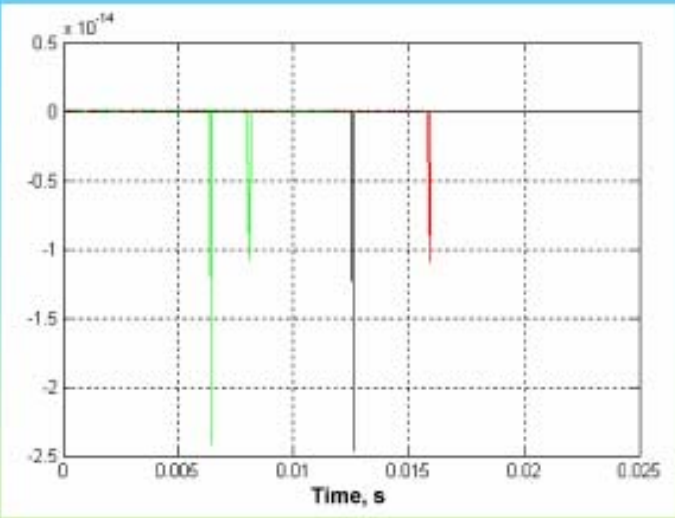
- track orientation

- track length projection on the drift axis

- distribution of ion density along the projection

Differentials of the sum current pulses (O_2)





A) angle 90^0; B) angle 0^0

(--) – track from sample, (–) track in the middle of IPIC, (-) track's "head" on the grid cathode, E = 6 MeV, P = 620 torr

A background of the IPIC with Cu-sample was found to be equal ~ 0.002 alphas/(cm^2*h) in the anticoincidence mode with veto without pulse shape selection.

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Well type NaI gamma spectrometer