Results of the tests of detectors for photon detection

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We report on a design and primary tests results of two trial detectors of gamma-quantum executed on the basis of scintillating baric glass SCGL-1 type

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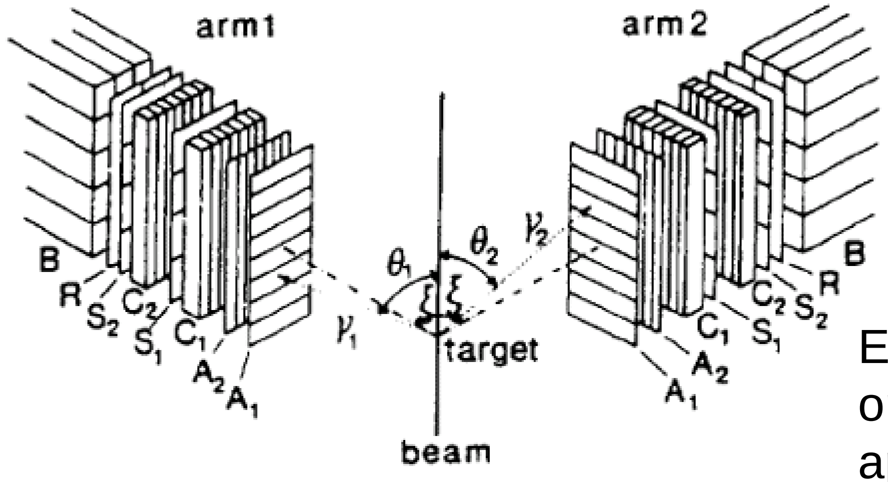
History

During second half 1980 - first half 1990 years on the accelerator SATURN were carried out the physical measurements of the eta-meson production in a proton - proton and a proton - nuclear collisions at energies up to 2 ГэВ. A line of interesting results has been received (E. Chiavassa et al.). After end of physical program (in 1999 approx.), part of detectors of a spectrometer have been handed to INR of the Russian Academy of Science for sharing on accelerators JINR.



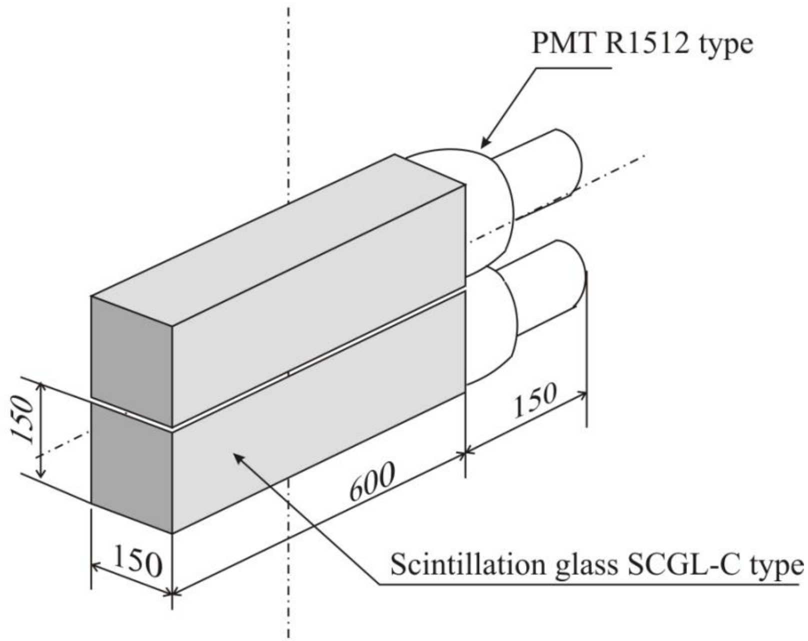
Schematic view of the PINOT spectrometer

The base of the spectrometer is two modules electromagnetic calorimeters **B** consisting of a scintillating glasses SCGL-C type.

Electromagnetic calorimeter of such type, on the basis of a baric glasses, not was applied earlier in JINR experimental technique, therefore it was necessary to carry out measurements of the basic parameters in our conditions.

What features?

Structure of one module of the gamma - quantum detector



SCGL-C glass parameters

1. Mass %
   - BaO - 43.4
   - SiO_2 - 42.5
   - Ce_2O_3 - 1.5
2. Density $\rho = 3.49\ g/cm^3$
3. Radiation length $X_0 = 4.12$ cm
4. Molier radius $R_M = 3.9$ cm
5. Critical energy $E_{cr} \sim 15$ MeV
6. Expected photon number (for $E\gamma$=70MeV) $\sim 10^4$
7. Expected photoelectron number $\sim 10^2$
8. Avalanche depth ~ 6 cm

Two components of light are expected to contribute to the observed signal : a fast pulse due to Cherenkov radiation and slower component due to scintillation light. Both components are observed as shown by the signal detected with an oscilloscope. The narrow spike is due to Cherenkov radiation followed by an exponential decay of the scintillation light with a lifetime of 87 ± 5 ns .

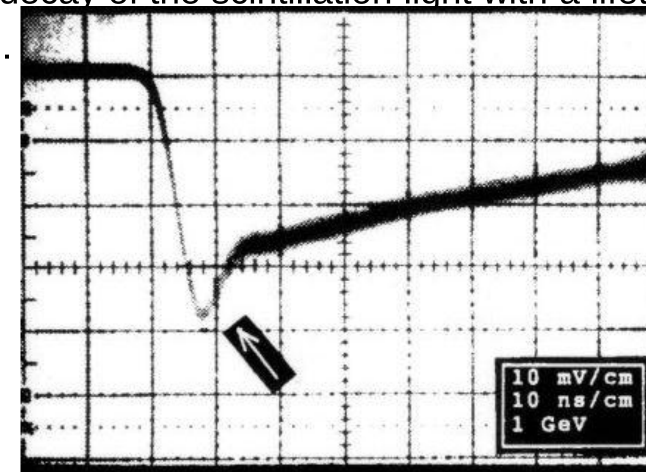
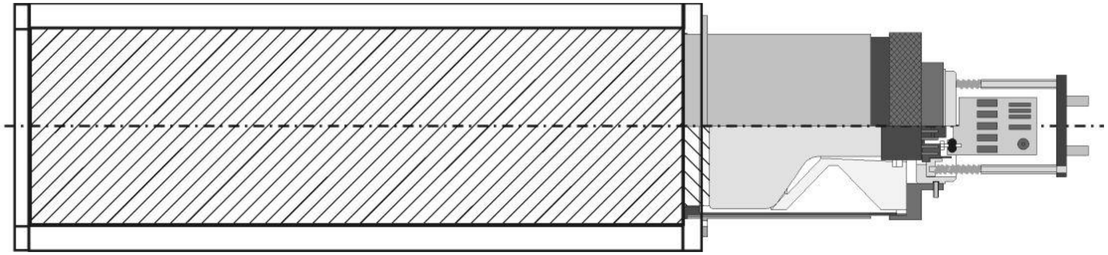


Fig. 4. Scintillation pulse recorded with an oscilloscope.

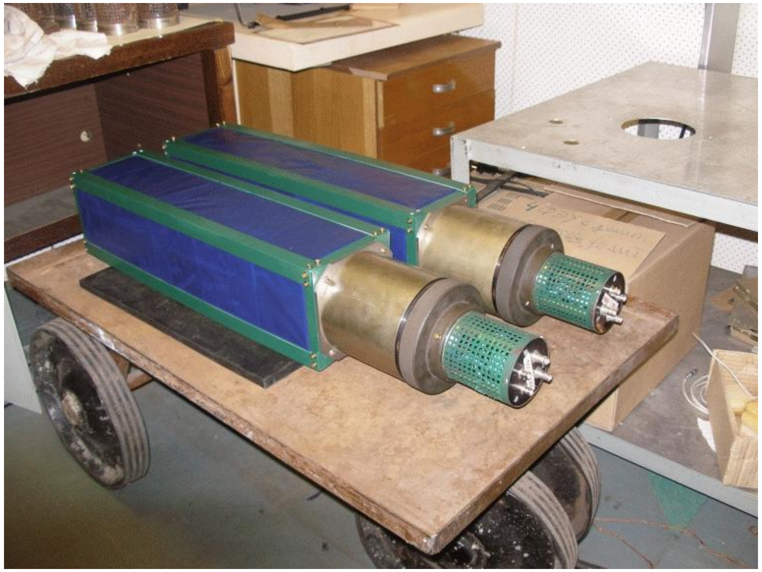
Properties of different counter materials

	HED-1	SCGL-C	SF2	SF5	CsI(Tl)
p [g/cm3]	3.44	3.49	4.07	5.18	4.53
Xo [cm]	4.12	4.12	2.55	1.70	1.85
RM [cm]	3.9		3.17	2.70	3.8
e, [MeV]	22.0		16.9	13.1	10.2
n (587.6 nm)	1.609		1 .673	1.805	
decayconst. [ns]	87+5	70		1000	
Peak [nm]	435	430			
n Pe/MeV	12.5±1 .2	3±0.2 [13]	0.6+0.05	0.9+0.1	
N Pe/MeV	330±42	100±20			4.5 x104

Detector construction



The scheme of the detector module

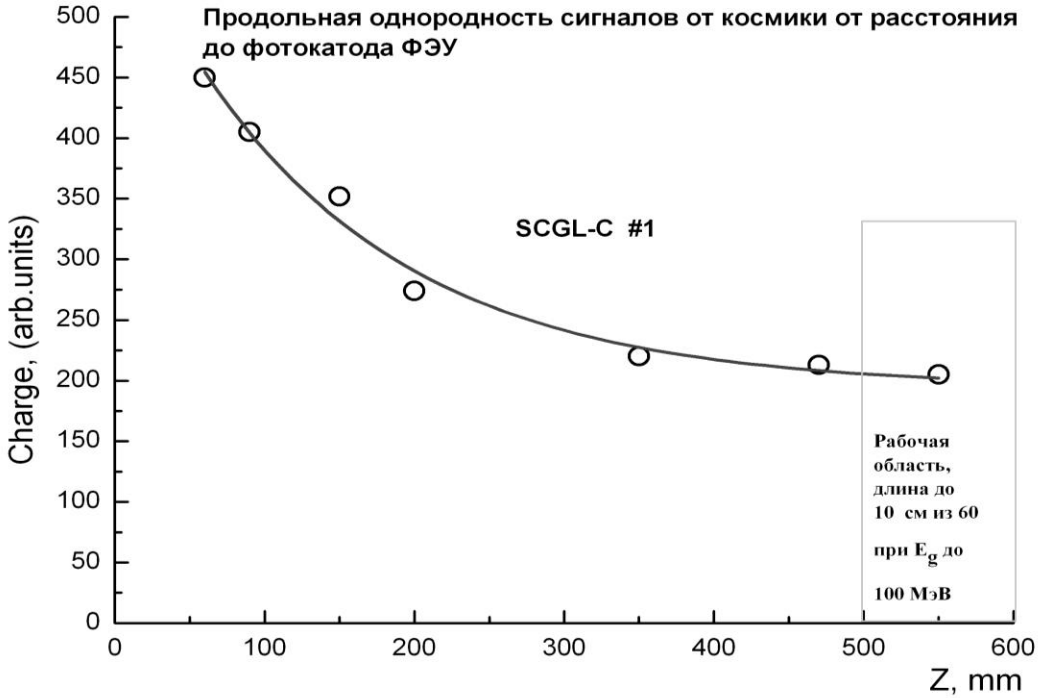


Common view of two detectors prepared for tests

General view of the stand for detectors tests on the space radiation rays

The main characteristics

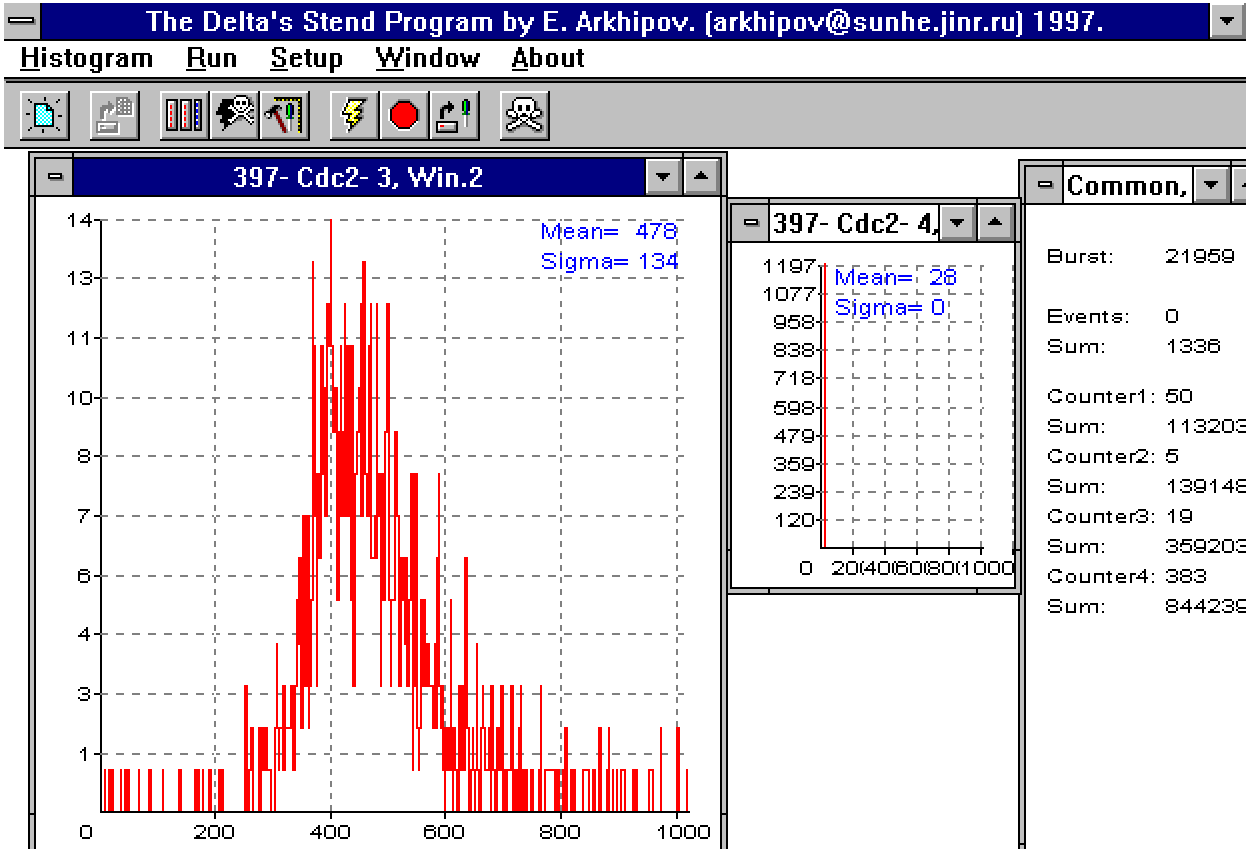
1. Were spent measurements of longitudinal uniformity of amplitudes from space muons at different distances from the photocathode.



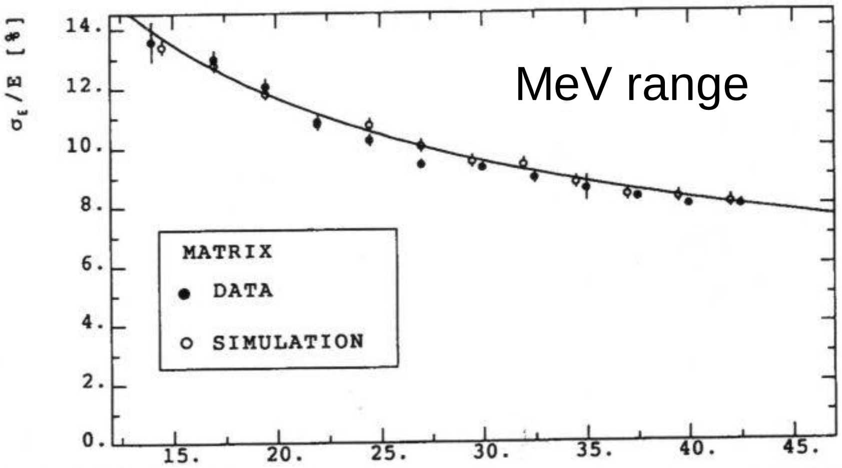
Light collection as a function of the distance from the photomultiplier for the scintillation signal component .

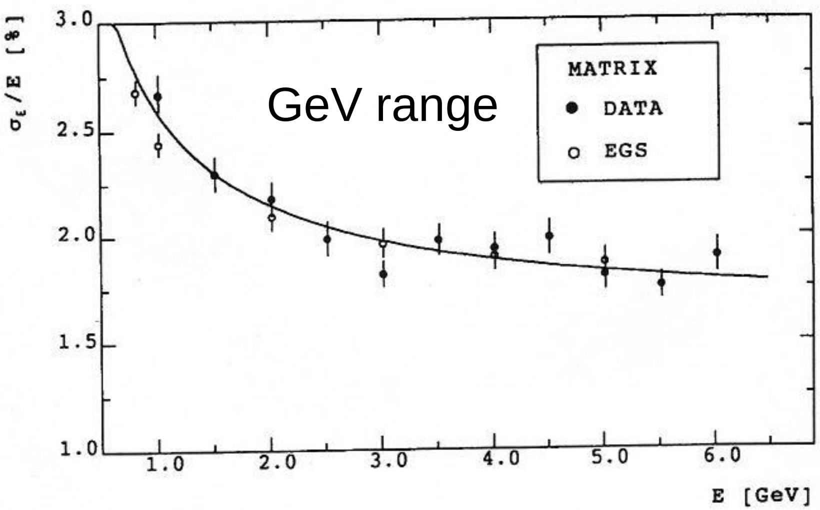
2. Measurement of the relative amplitudes of the scintillation and cherenkov components of light was spent at detectors work with space muons pass on a direction along a longitudinal axis on a direction "from" (scintillation) and "on" (scintillation + cherenkov components) on entrance PMT window. The relative amount of light about 1:2 is measured, i.e. components give approximately identical contribution.

Example of a signal peak distribution from the detector for space radiation muons. A cross-section arrangement of the detector (only scintillation signal componentl). Energy loss in the detector about 120 MeV. View on the operator screen.



The energy resolution for electromagnetic shower





. Energy resolution as a function of the electron energy (black circles) and the EGS prediction (open circles). The line shows the parametrization (4) described in the text.

$$\sigma_E/E(\%) = 1.6 \pm (0.08)/\sqrt{E(\text{GeV})}$$

$$14.7\,\text{MeV} < E < 6000\ \text{GeV}$$

Conclusions:

- **We have built and tested of 2 scintillating glass blocks with an area of 15 X 15 cm2 and a length of 60 cm each . The response of this electromagnetic calorimeter to cosmic ray muons has been studied.**

- **Scintillating glasses are potentially capable of yielding in the energy region of interest (from tens up to hundreds MeV) with a resolution comparable to CsI(TI) and BGO at a much lower price.**

Acknowledgements

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