The Carpet-3 EAS array

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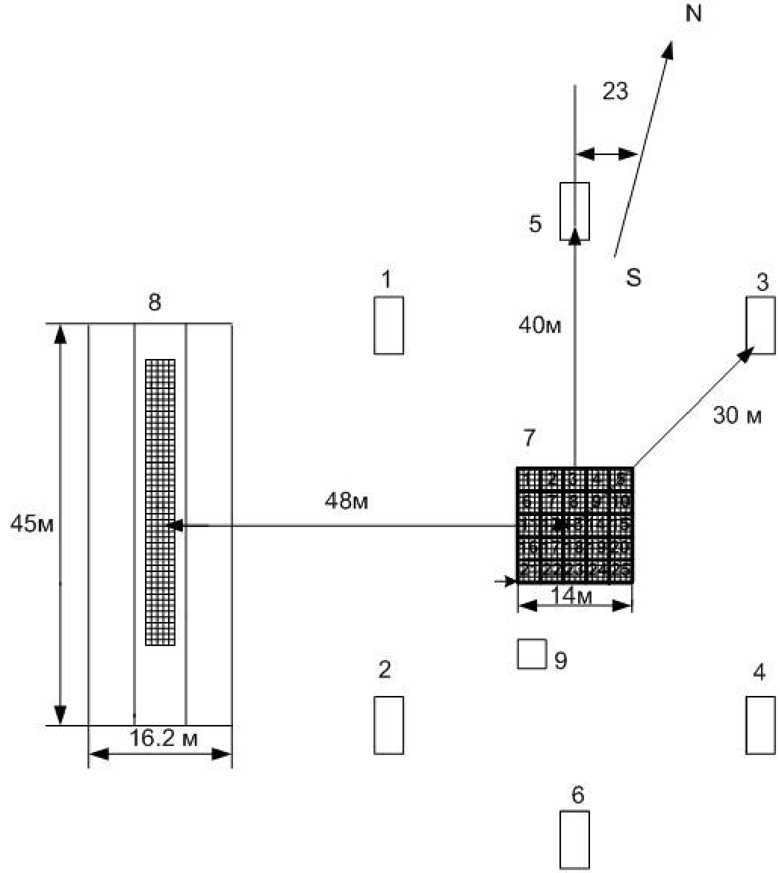
The Carpet-3 EAS array :
1) is the further development of the Carpet-2 EAS array



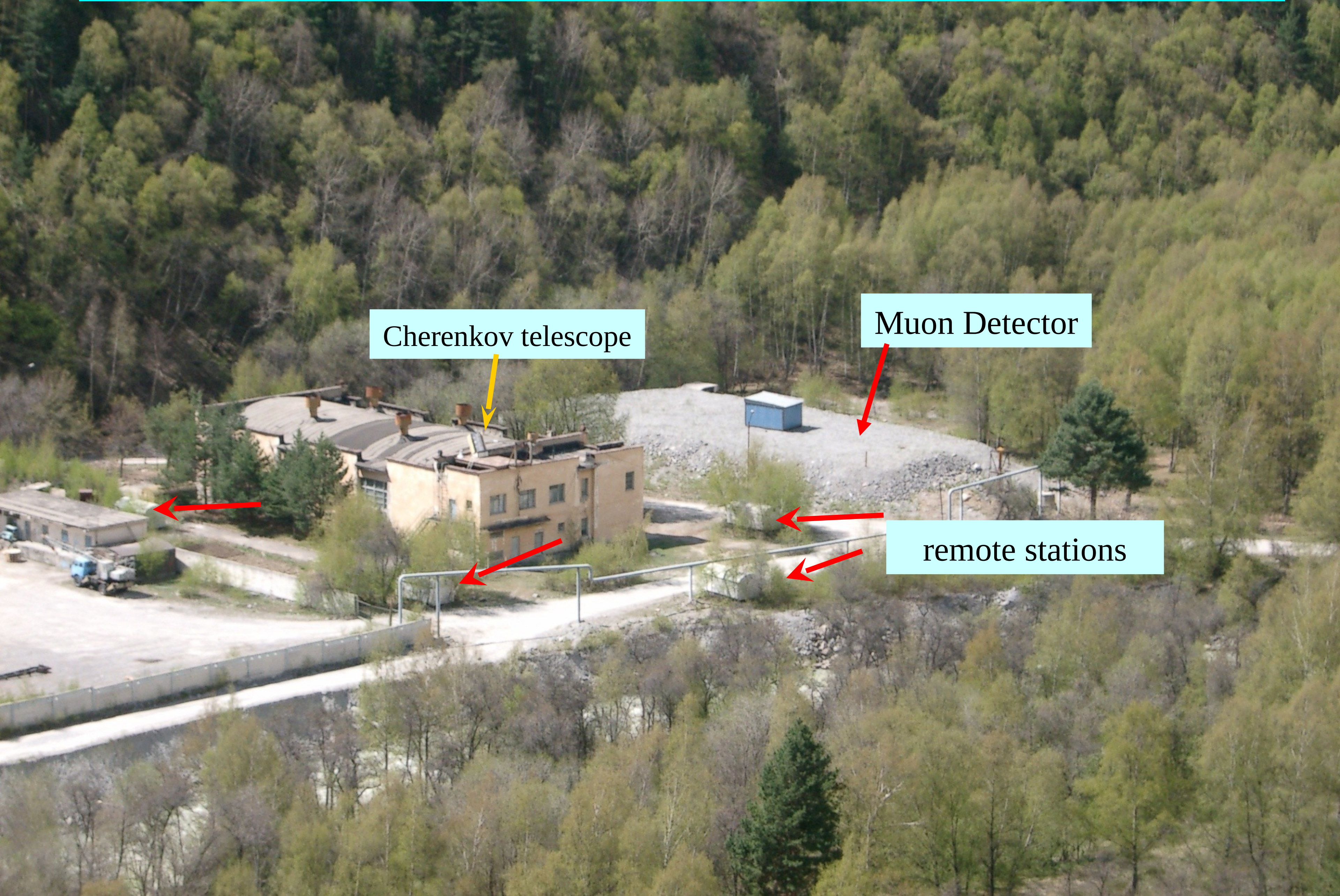
The "Carpet-2" array.
1-6 - outside detectors , 7 - "Carpet", 8 - muon detector,
9 - neutron monitor.

Carpet-2 air shower array

The Carpet proper: continuous area ≈ 200 m^2
(400 liquid scintillation counters)

$\Delta X = \Delta Y = 0.7$ m

“Carpet-2” EAS Array



1st stage of the Muon Detector (MD) - 175 m^2 - in operation since 1999

The Carpet-3 EAS array :
2) is intended to be a multi-component and multi-purpose array

Multi-component:
electron-photon, muon (with a threshold energy of 1 GeV),
hadron (hadrons with energies more than 30 GeV and thermal neutrons)

A number of parameters (x_1, x_2, ..., x_k,...) can be measured for each EAS and the multiple parameter method is assumed to allow determination of both energy and type (atomic number) of a primary particle with good enough accuracy.

$$(x_1, x_2, ..., x_k, ...) \rightarrow (A_i, E_0)$$

$$\{ A_0 = \gamma; A_1 = p, A_2 = He, ..., A_{56} = Fe, ... \}$$

The Carpet-3 EAS array

Examples of measurable parameters:

1) $x_1 = N^C_{ch}$ - the number of charged particles in the Carpet;

2) $x_2 = n_\mu$ - the number of muons (E_μ > 1 GeV)in the MD;

3) $x_3 = n_h$ - the number of hadrons (E_h > 30 GeV) in the MD;

After the processing of measured data :

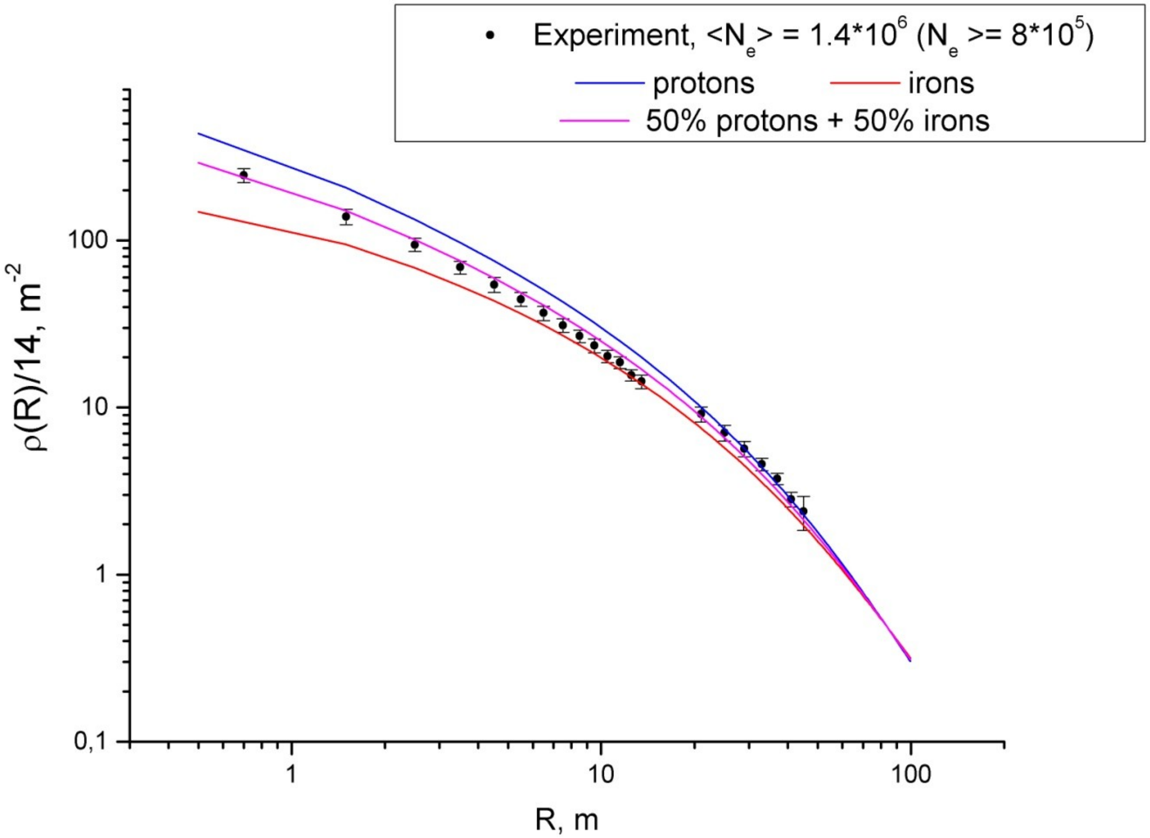
$N_{r.p.}$ (or N_e) - shower size (total number of charged particles in the EAS);

f(r) - lateral distribution function (LDF);

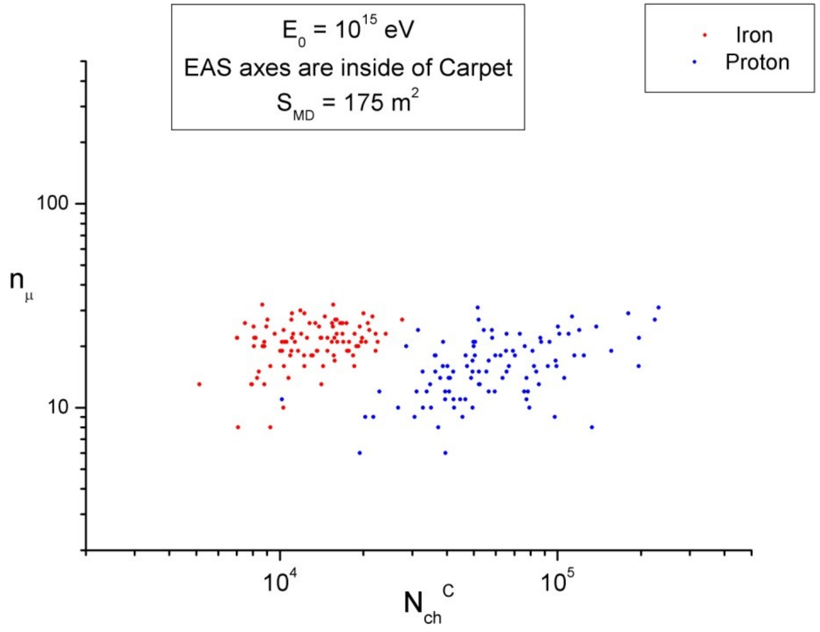
(θ, φ) - arrival direction

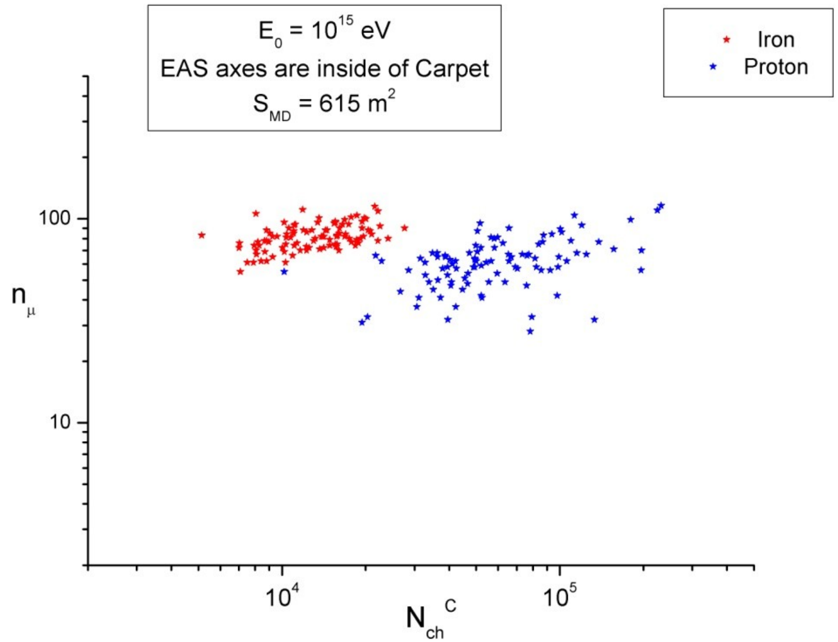
and so on

EASs with axes well inside the Carpet: the accuracy of the axis position for such events is ~ 0.2 m. This gives a possibility to perform fine-resolution measurements of the lateral distribution function (LDF) and its fluctuations near the EAS core.



Primary composition: better separation for large area of Muon Detector

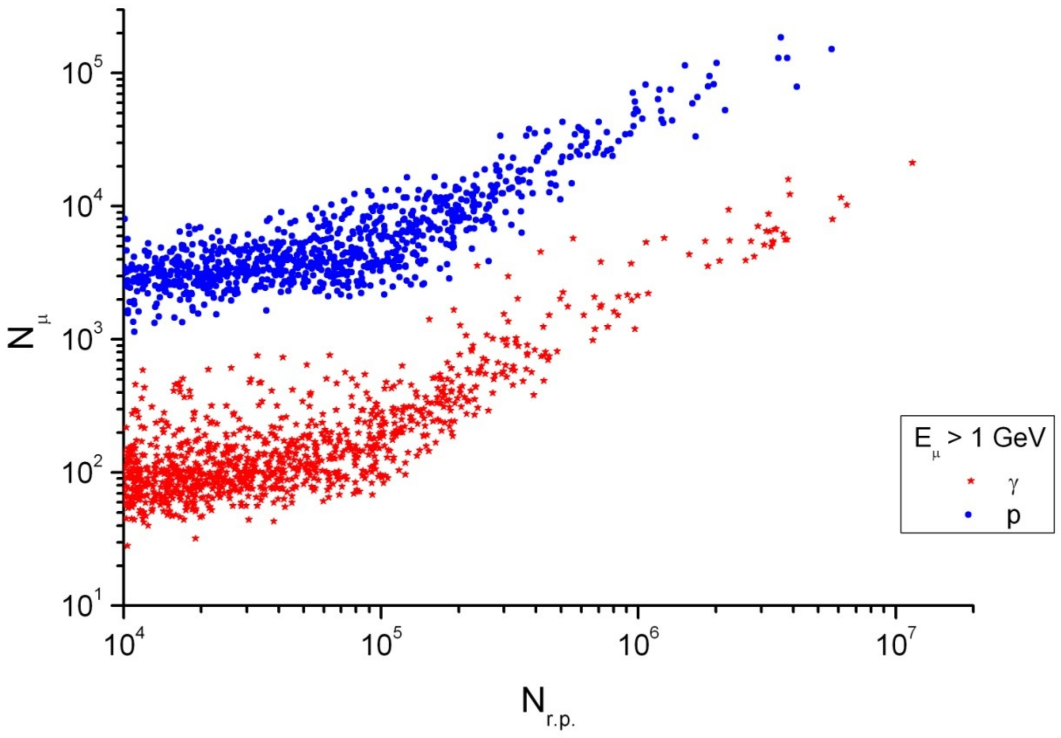




Search for primary γ-rays: γ-ray air showers are muon-poor

N_μ – total number of muons, $N_{r.p.}$ – reconstructed shower size

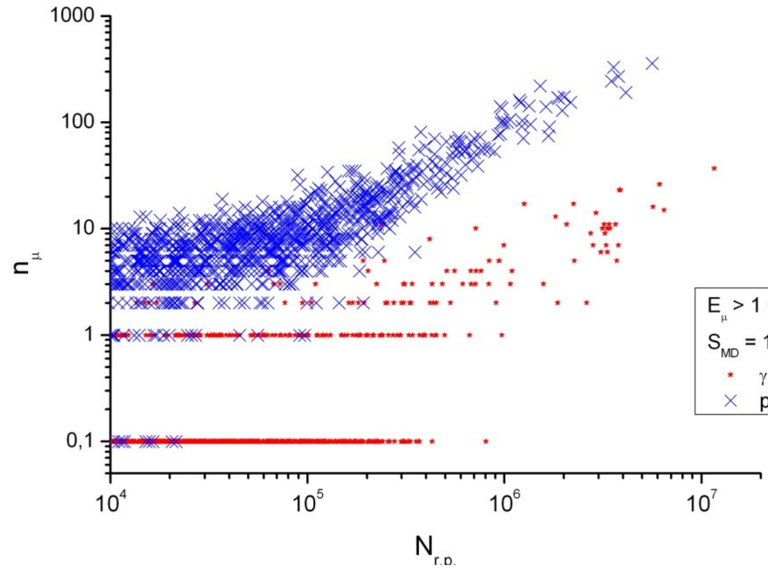
$N_{r.p.} = f(E_0)$

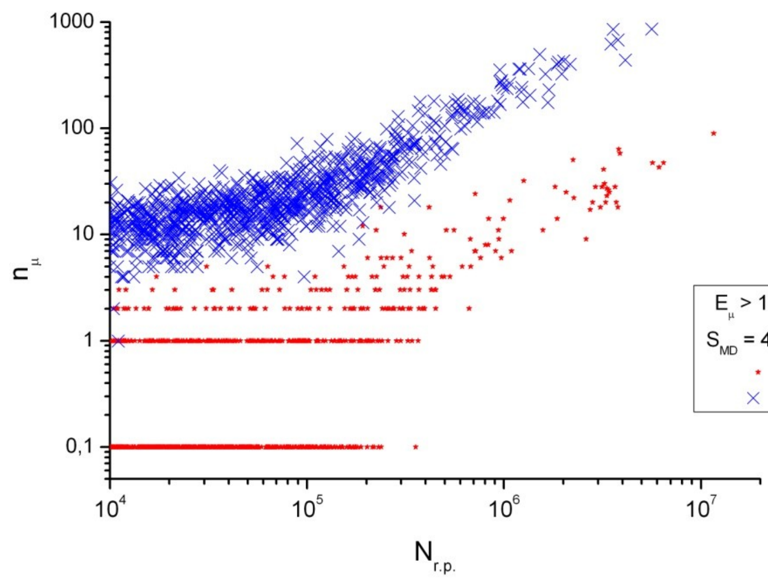


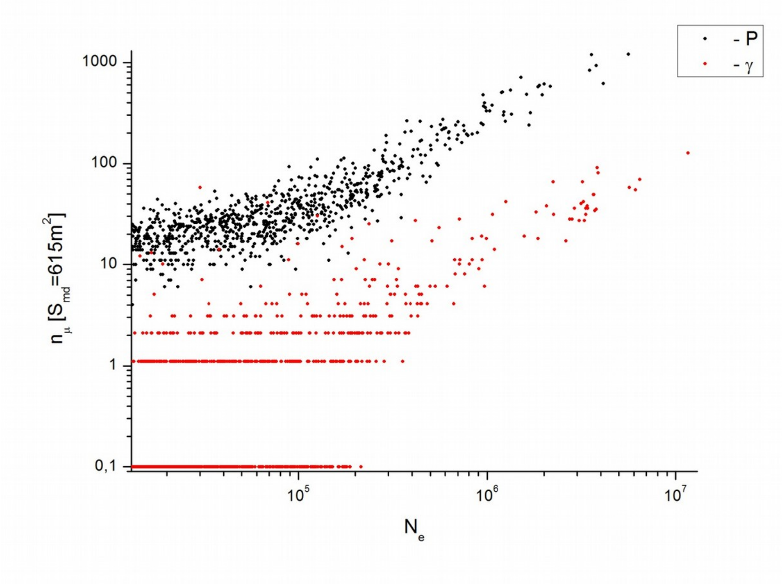
Simulated showers

Simulated showers

$N_{r.p.}$ – reconstructed shower size, n_μ – the number of muons in the MD



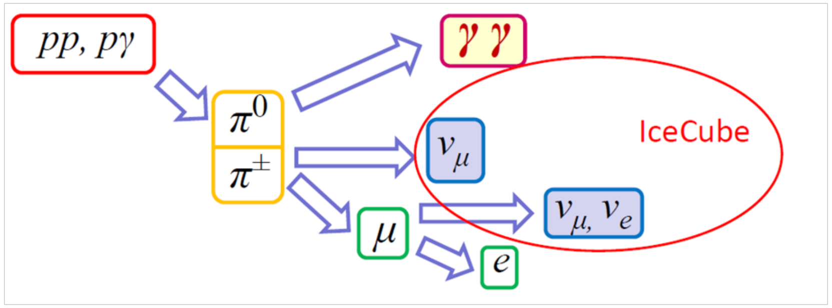


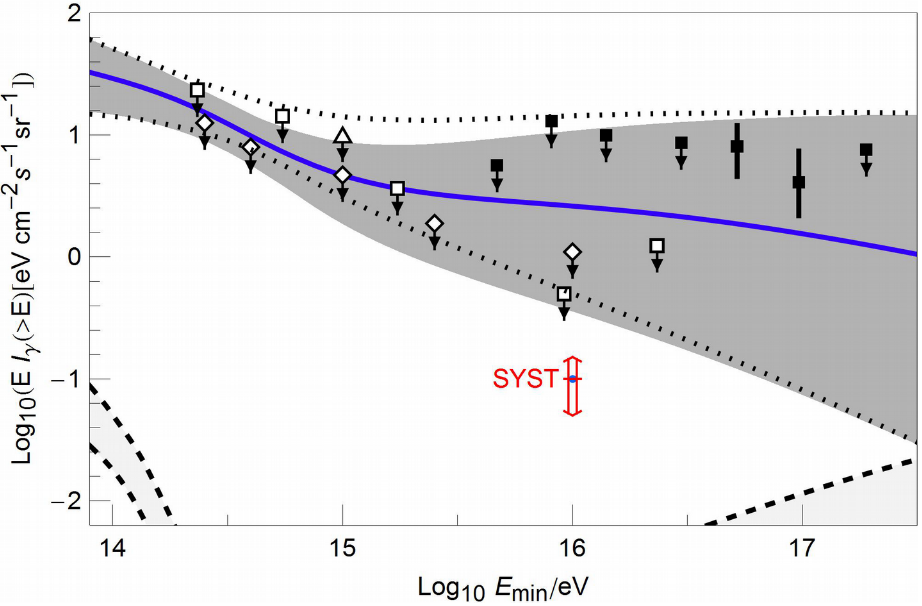


S_{MD} = 615 m²

Search for diffuse cosmic gamma rays associated with Ice Cube neutrino events

gamma-rays and neutrino:



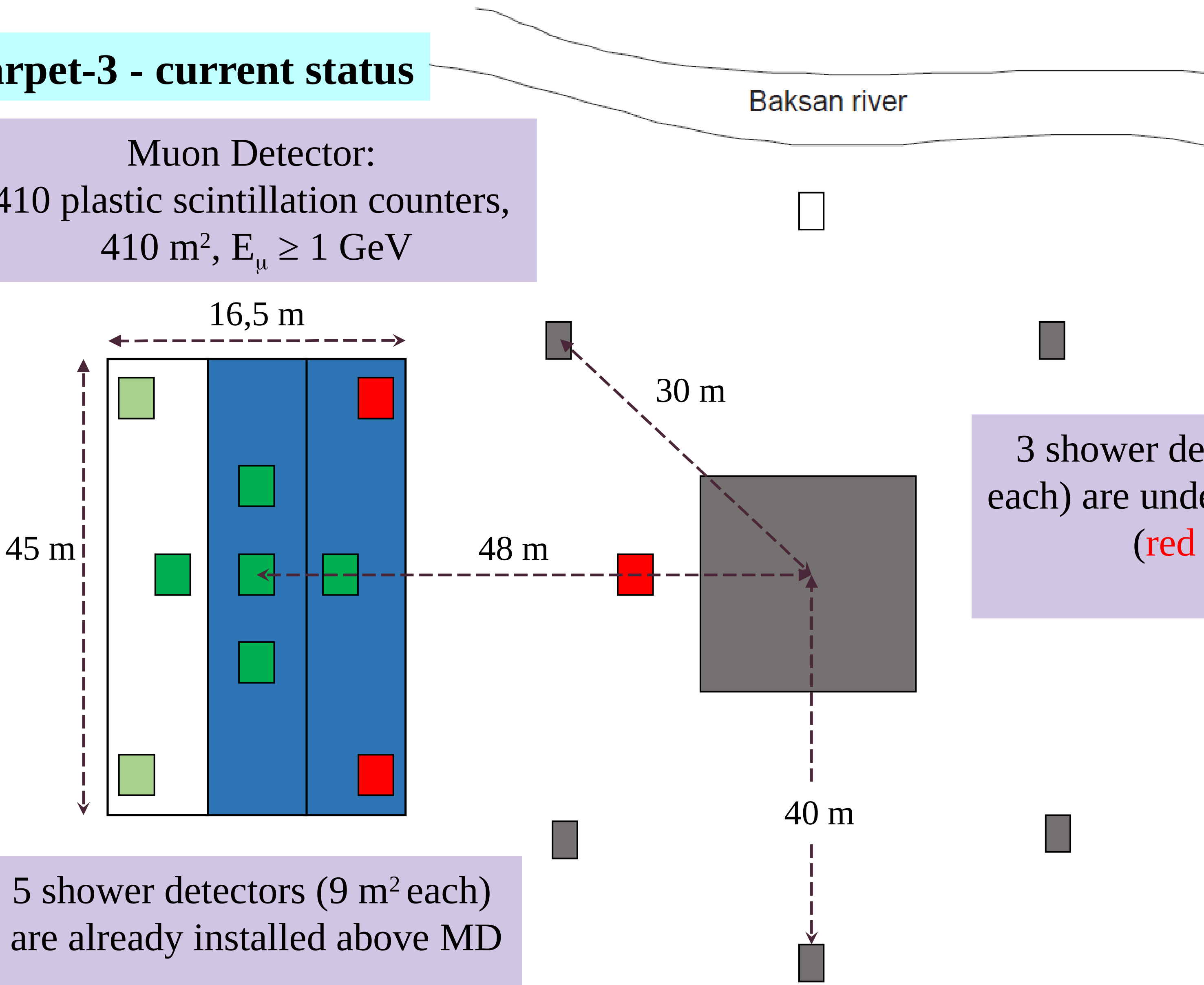


The curve represents a theoretical prediction (shaded region - model uncertainty related to neutrino spectrum) for the model in which photons and neutrinos are produced in cosmic-ray collisions with the hot gas surrounding our Galaxy, assuming the best Ice Cube observed neutrino spectrum.

IceCube astrophysical neutrinos without a spectral cutoff and (10^{15} – 10^{17}) eV cosmic gamma radiation.
O. Kalashev, S. Troitsky, arXiv:1410.2600

Carpet-3 - current status

Muon Detector:
410 plastic scintillation counters,
410 m^2, $E_\mu \geq 1$ GeV

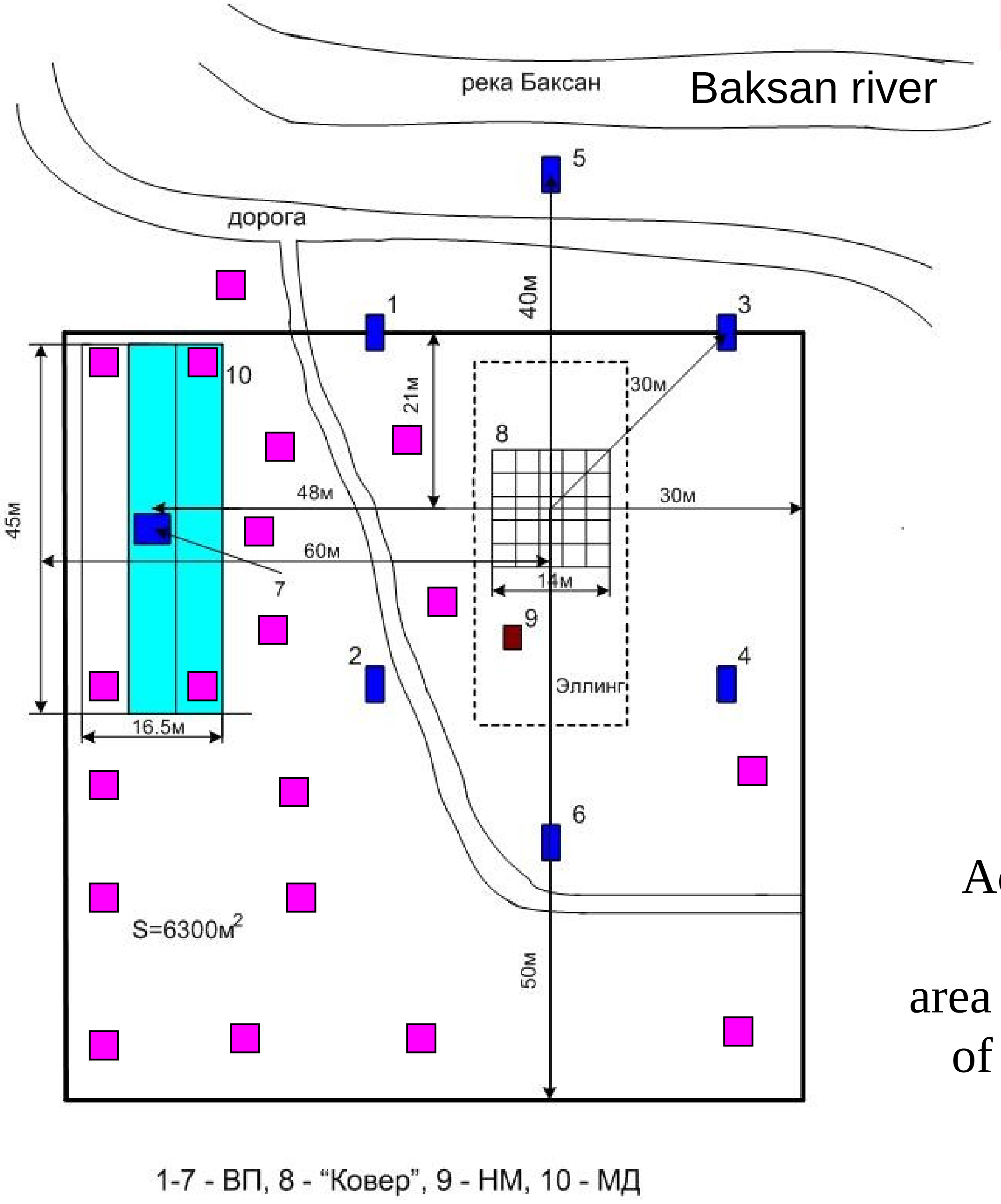


3 shower detectors (9 m^2 each) are under construction (red box)

5 shower detectors (9 m^2 each) are already installed above MD

(green box)

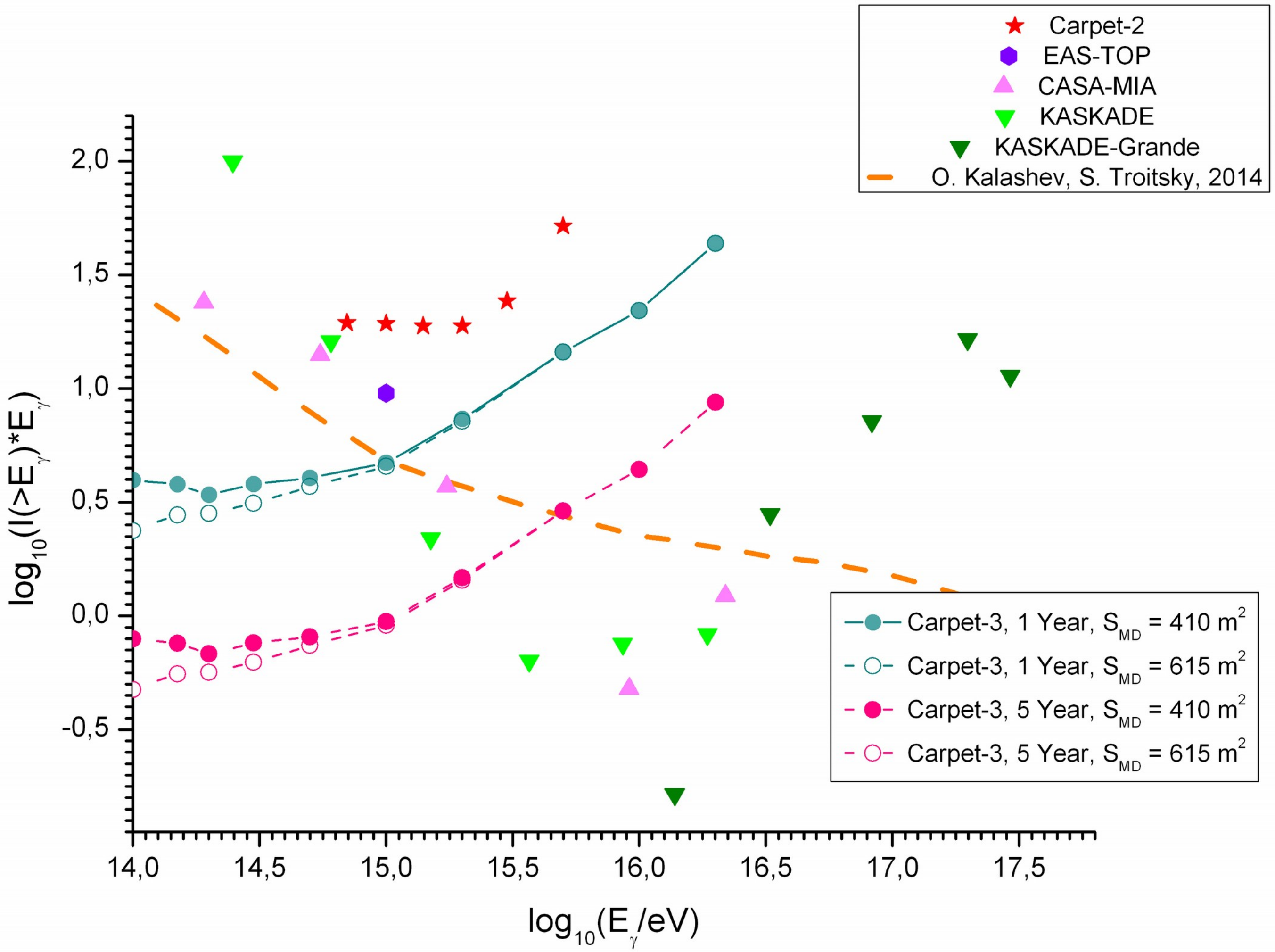
Carpet-3 - prospects



Muon Detector 410 m^2

Additional 20 - 25 modules of surface detectors of 9 m^2 area (9 plastic scintillation counters of area of 1 m^2 in each module)

Carpet-3 sensitivity to the flux of diffuse cosmic gamma rays



Conclusions

1) The Carpet-3 air shower array is under construction at the Baksan Neutrino Observatory by step-by-step upgrade and extension.

2) The principal goal now is to study diffuse gamma-ray background at energy above 100 TeV.

3) After final accomplishment of this array it can be competitive in its class and will have a chance to get the world-best limit on the flux of gamma rays of cosmic origin. This will allow one to solve the problem of origin of high-energy astrophysical neutrinos detected by IceCube.