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Performance of the new measuring system of multipurpose Cherenkov water detector NEVOD

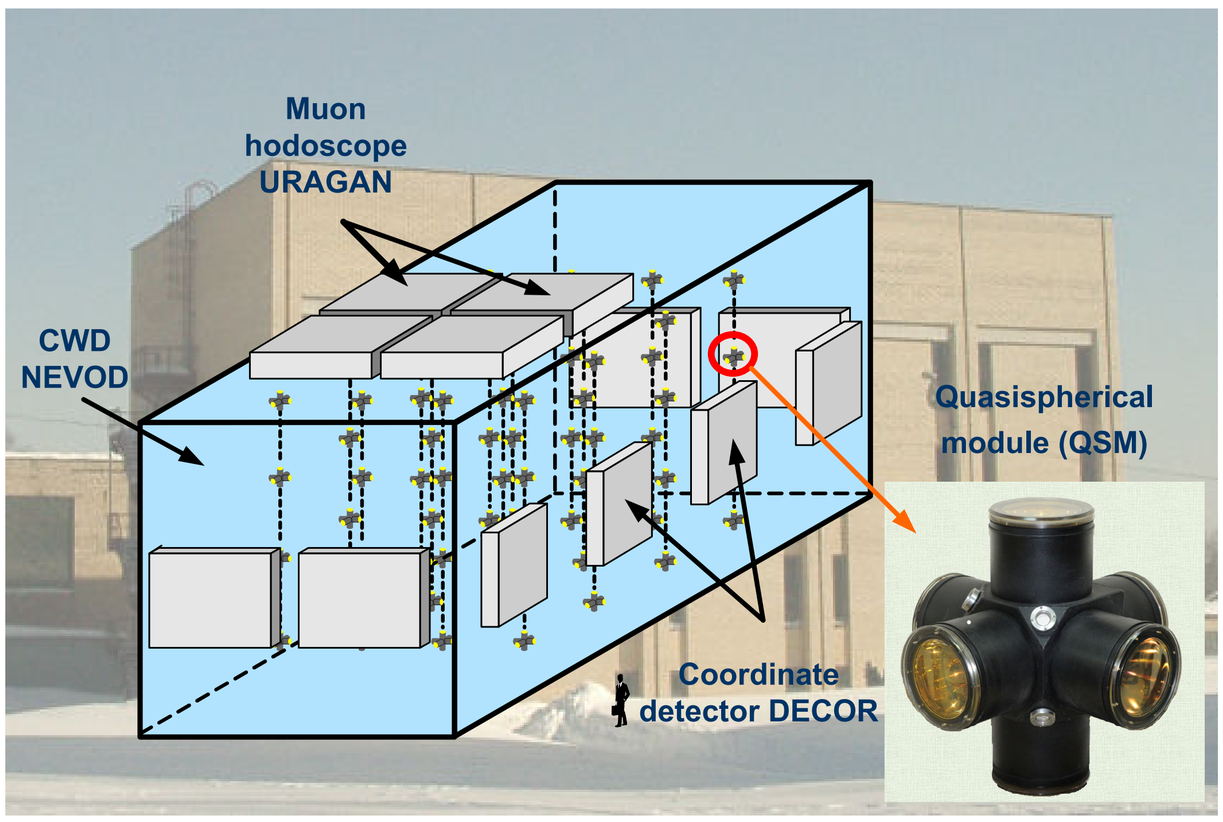
http://nevod.mephi.ru

S.S.Khokhlov[1], M.B.Amelchakov[1], V.V.Ashikhmin[1], I.A.Vorobiev[1], V.G.Gulyi[2], E.A.Zadeba[1], I.S.Kartsev[2], V.V.Kindin[1], K.G.Kompaniets[1], M.A.Korolev[2], A.A.Petrukhin[1], I.A.Shulzhenko[1], V.V.Shutenko[1], I.I.Yashin[1]

[1] National Research Nuclear University MEPhI, Moscow 115409, Russia; SSKhokhlov@mephi.ru

[2] SNIIP-Plus, Moscow 123060, Russia.

The experimental complex NEVOD



Cherenkov water detector (CWD)

- detector volume – 2000 m^3 of purified water;
- optical detector – quasi-spherical module (QSM) has equal sensitivity to any direction of particle arrival;
- detection system – a spatial lattice of quasi-spherical measuring modules.

Characteristics of the new measuring system

- hierarchical structure of data processing with the lower trigger level on the string (cluster) of QSMs;
- includes inner-module electronics, blocks of electronics of the cluster (BEC), system of external trigger formation and DAQ units;
- provides digitizing of PMT signals; generation of trigger signals for each QSM; storage of data and asynchronous exchange with external electronic systems by means of **BEC**;
- 91 QSM in 25 strings (clusters): 9 strings with 3 QSM and 16 strings with 4 QSM;
- 546 low noise 12-dynode photomultipliers FEU-200 (Russia) (15 cm diameter);
- program controlled threshold from 0.25 to 6 photoelectrons;
- signal readout from the 12th and 9th dynodes of PMT;
- dynamic range of PMT from 1 to 10^5 photoelectrons;
- 1092 spectrometric channels.

Operation modes

- calorimetric mode – for analysis of events with powerful energy deposits in the CWD (cascade showers) and to study the events generated by very-high and ultra-high energy particles (EAS cores, muon bundles with large multiplicity, etc.);
- hodoscopic mode – for detection of single particles and reconstruction of their tracks on the basis of amplitude response of QSM (without time-of-flight technique);

Autonomous and combined operation modes (with other detectors of experimental complex, DECOR and URAGAN) are foreseen.

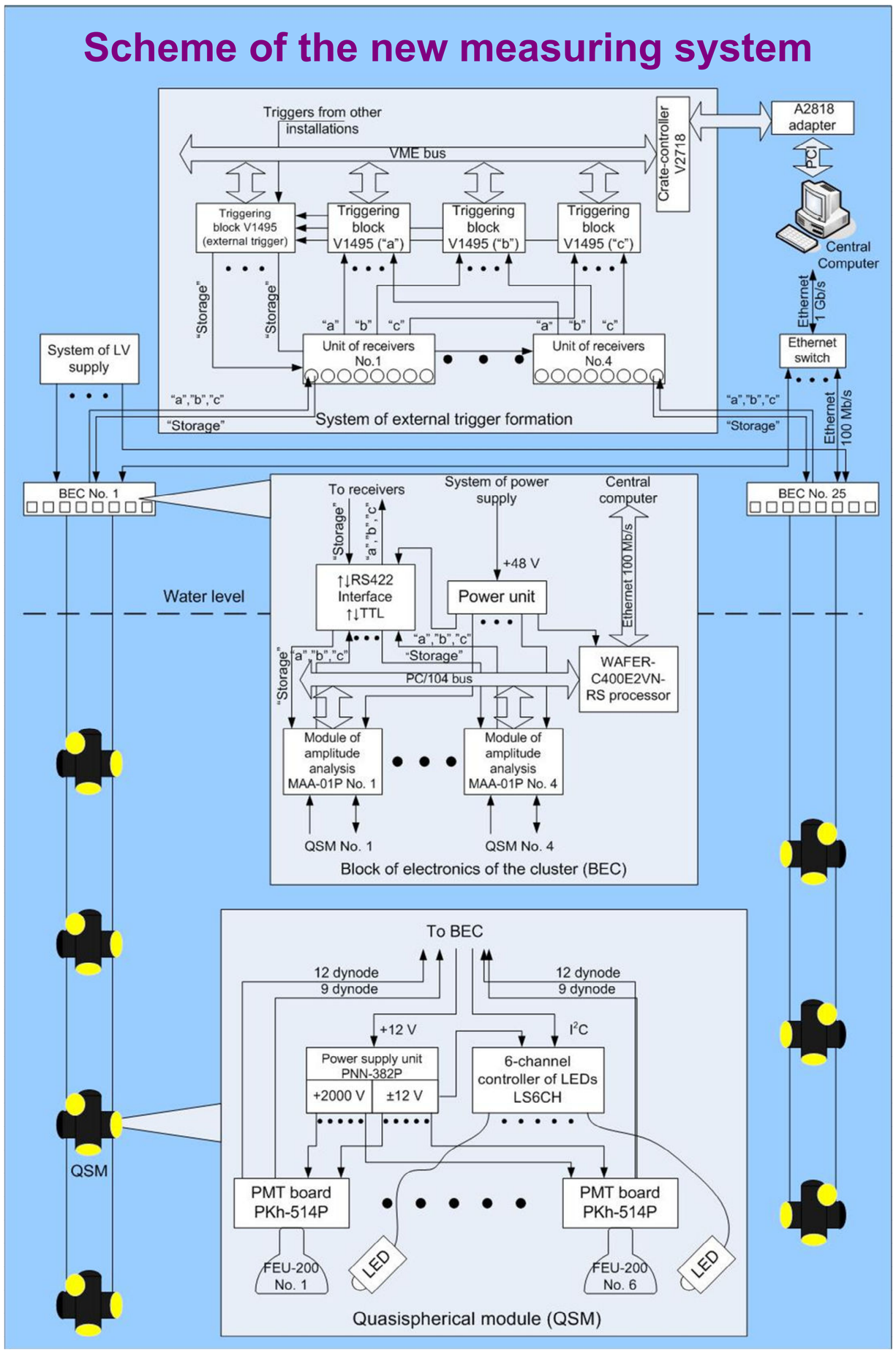
Cluster level triggers

"a" (any) – logical "OR" of six signals from 12th dynodes of QSM PMTs for detecting single muons;

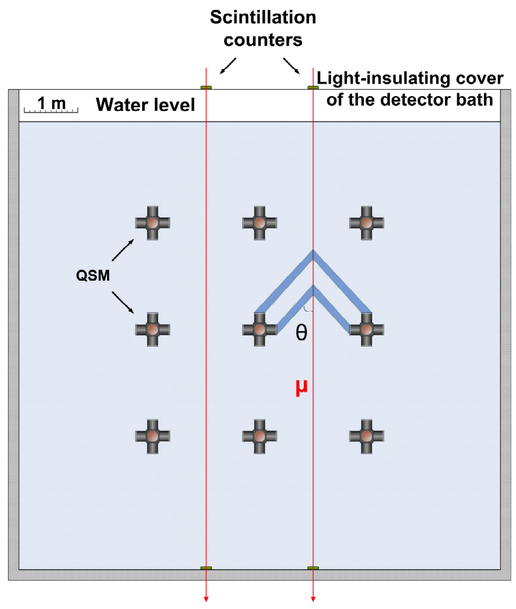
"b" (bottom) – signals from downward directed PMTs for registering muons from the bottom hemisphere;

"c" (coincidence) – coincidence of signals from any two PMTs (except those oppositely directed) for selection of events with large energy deposit in the detector volume.

Scheme of the new measuring system

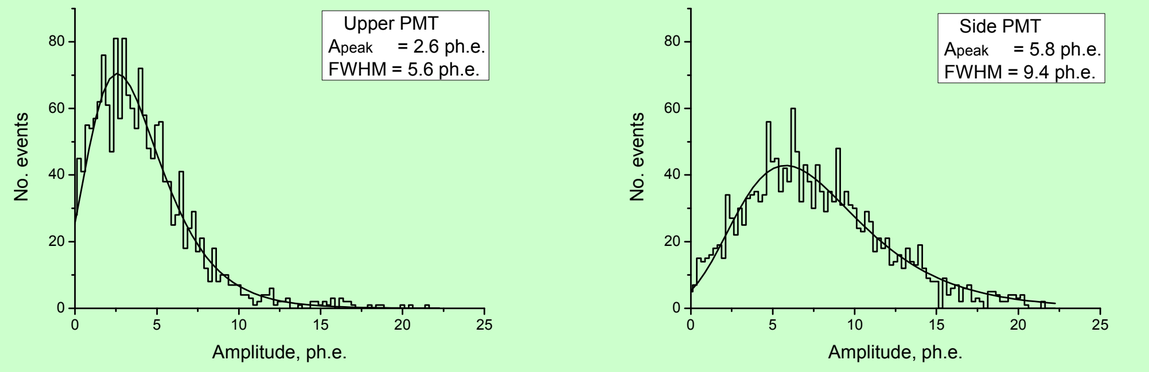


QSM calibration by means of vertical muons



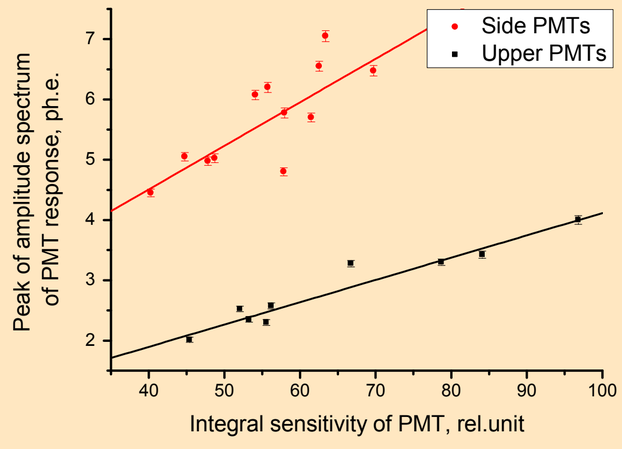
- first part of measuring system (3 strings, 9 QSMs) was calibrated;
- optical modules form the vertical plane of the spatial lattice of CWD with distances between the QSMs of 2.0 m across the detector and in the depth.
- muon separation is provided by means of the system of calibration telescopes (4 scintillation counters);
- size of the counters 40x20x1 cm^3;
- precision of track location is better than 2°;
- axes of telescopes are located between the axes of strings with 1 m distances:
- threshold energy of muons E_0 = 2 GeV;
- duration of the experiment 130 h;
- every telescope detected ~2000 muons;
- efficiency of muon detection by PMT about 90 - 95 %.

Amplitude spectrum of QSM PMT response for vertical muons



Results of calibration

Peaks of amplitude spectrum of PMT response are proportional to their integral sensitivity which was measured on test facility. The number of photons detected in the upper PMT is about twice less than in the side one. This effect is explained by different length which passes the Cherenkov radiation from the track to PMT (1.50 m to upper and 1.08 m to the side one). The results will be used for optimization of algorithms of single muon track reconstruction in CWD.



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