# Development of calibration system for a project of a new Baksan Large Neutrino Telescope

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## Abstract

We present results of the development of a calibration system for a project of a new Baksan Large Neutrino Telescope. The calibration system is based on fast blue and UV InGaN and AlGaN ultra bright and high power light emitting diodes (LEDs), a diffusing ball and fiber optics. Special fast electronic drivers for such LEDs were developed. The drivers are based on fast complementary pair of transistors and avalanche transistors. The diffusing ball is designed to provide uniform isotropic illumination of all photomultipliers of the detector. Thorough studies of timing and light yield parameters are done. Special emphasis is done on careful studies of compatibility of calibration system parts with liquid scintillator and ultra pure water.

## Introduction

A project of a new Large Baksan Neutrino Telescope (LBNT) is being presently under development [1]. The LBNT will be located at the Baksan Neutrino Observatory of INR RAS in the North Caucasus. The aim of the project is to build a large 1-10-kt liquid scintillator detector with high energy resolution. Among the main scientific goals of the project are the following:

− high precision measurements of solar neutrino fluxes, in particular $^{8}B$ neutrino fluxes;
− monitoring supernovae explosions in our Galaxy and its satellites;
− measurement of diffuse flux of neutrinos from supernovae explosions;
− studies of geoneutrino flux;
− measurements with powerful artificial neutrino sources
− measurements of proton decay with high sensitivity;
− dark matter searches;
− searches for magnetic monopoles, Q-balls, nuclearites and other exotics
− geophysics studies;
− etc.

High precision measurements of $^{8}B$ solar neutrino flux are of utmost importance. Such measurements will solve unequivocally and ultimately the problem of solar metalicity and neutrino mass eigenstates $m_1$ and $m_2$ hierarchy. To do so one need to have a large volume liquid scintillator detector with energy resolution better than 3%/MeV, or even of order 1%/MeV, if it will be feasible at al. The latter is undoubtedly experimental challenge for the project. Measurements of geoneutrino fluxes are another experimental challenge too.

## Detector project and prototypes

The detector project envisages several stages. The first stage is the development of a half ton (0.5-t) liquid scintillator detector to test all elements of the project: liquid scintillator, its transparency, light yield; engineering system for storing, filling, removing, safety issues connected with liquid scintillator; photomultipliers, evaluation of their performance (sensitivity, single photoelectron response, timing etc.), their encapsulations, water proofing, material compatibility etc.; detector electronics and DAQ system, data storage etc. It is also important to measure the level of radioactivity in the underground laboratory and screen all the detector materials for radioactivity and to test capabilities of veto (passive and active) systems. The first 0.5-t prototype of the project before filling by liquid scintillator and immersing into the water tank is shown in Fig.1.

**Figure 1**: The first 0.5 t prototype of the Large Baksan Neutrino Telescope project. The prototype is shown at the stage when all parts are assembled and fixed right before filling by 0.5-t liquid scintillator and immersing into water tank, seen behind the PMT array.

The second stage will be a 5-t prototype, shown in Fig.2 [2]. At this stage 5 t of liquid scintillator in acrylic sphere will be viewed by forty-two 10-inch Hamamatsu R7081-100 WA-S70 PMTs. Each PMT of the array will be equipped by a Winston cone to increase light yield of the detector. All areas of the acrylic sphere just outside of the Winston cones will be covered by non-transparent foil separating optically scintillator volume. The array will be surrounded by a stainless steel tank which will be filled with ultra pure water and equipped by twelve 8-inch Hamamatsu R5912-100WA water proof photomultiplier assembles.

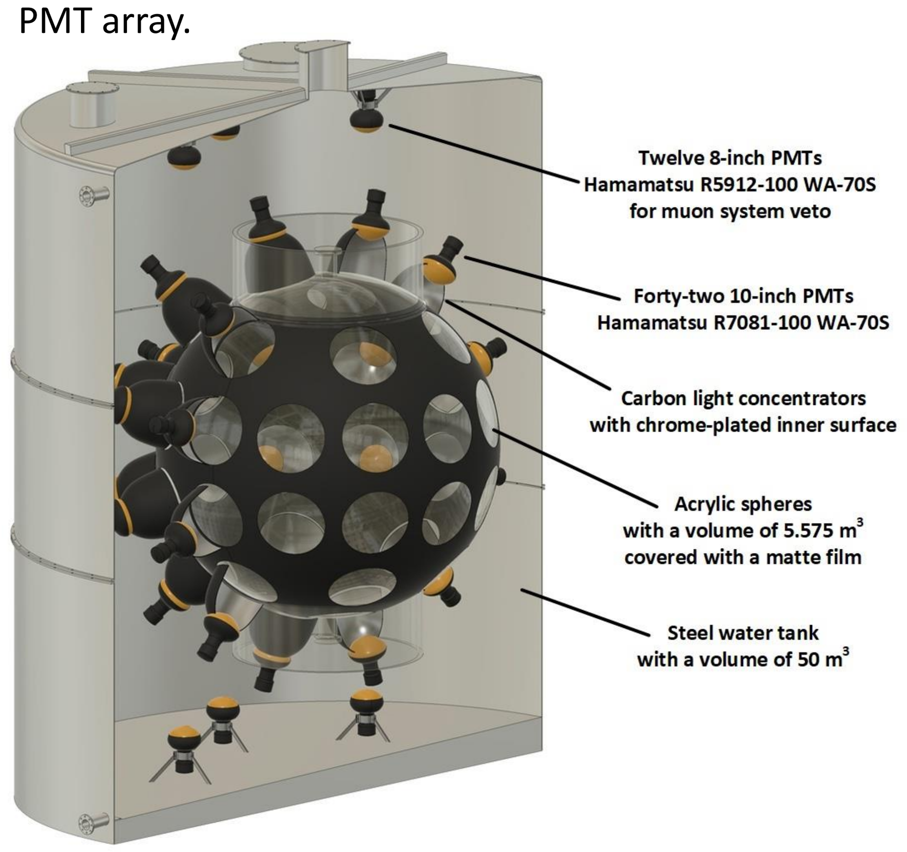


**Figure 2**: The second 5-t prototype of the Large Baksan Neutrino Telescope project. The prototype is shown at the stage when all parts are assembled and fixed right before filling by 5 t liquid scintillator and immersing into water tank, seen behind the PMT array.

## Light source, LED drivers

For the 0.5-t first stage of the project we developed photon calibration system based on a fast light pulses source and a plastic fiber system and a light pulses diffuser. The fast light pulses source is based on ultra bright InGaN/GaN blue LEDs and a fast LED driver [3, 4].
A stand-alone desktop module was developed too. This module, Fig.3 incorporates the fast LED driver PV board and specially designed system based on Arduino Nano v3 plate with 8-bit microcontroller AVR ATmega328P (Atmel).

**Figure 3**: Stand-alone desktop module of fast light pulses source for calibration of the 0.5-t prototype of the Large Baksan Neutrino Telescope project: front view and without cover.

## Diffuser

Comar FS 04 plastic optical cable with 1 mm PMMA core and black clad from PVC is used to deliver light pulses from the light source to a specially designed diffusing ball. The diffusing ball is shown in Fig.4.
The diffusing ball is made of a glass sphere with 5 cm in diameter and 1 mm thickness. The sphere is filled with a special mixture prepared in advance. The mixture is made of SilGel Wacker 612A silicone gel and S32 glass microspheres powder. The end cap of the fiber is fixed at the point of 5 mm above the geometrical center of the glass sphere and gel mixture is poured into the sphere. The diffuser does not deteriorate the light pulses width. The light level intensity is still enough to illuminate the whole array of photomultipliers in the wide dynamic range.

**Figure 4**: Diffusing ball.

## Conclusion

We developed calibration system for 0.5-t and 5-t prototypes of the Large Baksan Neutrino Telescope project. The system performance is adequate for the requirements of the project prototypes. The system can be served as a prototype of a calibration system of the whole project.

## References

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