Modern Photodetectors and Their Applications

Introduction

The project aims to advance photodetector technologies, focusing on Silicon Photomultipliers (SiPMs) and their applications. With over 15 years of experience, Dr. Nikolay Anfimov's group specializes in this area, addressing the scientific and applied challenges associated with low light sensing technologies. SiPMs, as cutting-edge solid-state devices, offer unique advantages such as single photon sensitivity, compactness, and immunity to magnetic fields. They are revolutionizing fields like medical imaging, radiation protection, and high-energy physics through applications such as positron emission tomography (PET), Time-of-Flight (TOF) PET, and Time-Domain Diffuse Optics (TD-DO).

Main Part

Participants will gain knowledge in photodetectors methodology, focusing on SiPMs. They will learn about the operational principles, advantages, and limitations of SiPMs compared to traditional photomultiplier tubes (PMTs). The project will provide hands-on experience in evaluating SiPMs for various applications, including medical applications, and guide students through the process of SiPM performance evaluation.

Description of the Work on the Project

- **Installation:** The project will utilize a setup designed to test SiPMs
- **Photo and diagram:** (pdf is attached)

- **Measurement Procedure:** Students will be tasked with setting up the SiPMs, performing measurements, and analyzing data related to dark count rate, timing performance, gain, and energy resolution. Time-of-flight measurements will be conducted to assess the timing resolution of SiPM.
- **Form of Presentation:** Students will compile their findings into a report that includes quantitative data, diagrams, and analysis. Presentations of results will be required at the conclusion of the project, summarizing key insights and proposing potential applications for the findings.

Requirements for the Student's Level of Training

The project is intended for master's and PhD students with a background in physics, electronics, or related fields. Familiarity with photodetectors, basic electronics, and data analysis is beneficial but not mandatory.

Recommended Literature

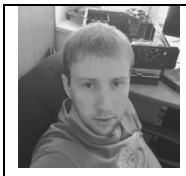
1. Gundacker, Stefan & Heering, Arjan. (2020). The silicon photomultiplier: Fundamentals and applications of a modern solid-state photon detector. Physics in Medicine and Biology. 65. 10.1088/1361-6560/ab7b2d.
2. https://hub.hamamatsu.com/us/en/technical-notes/mppc-sipms/physics-and-operation-of-the-MPPC-silicon-photomultiplier.html

Number of Project Participants

The project can accommodate 2 to 3 students, working either individually or as a team.

JINR Project Managers

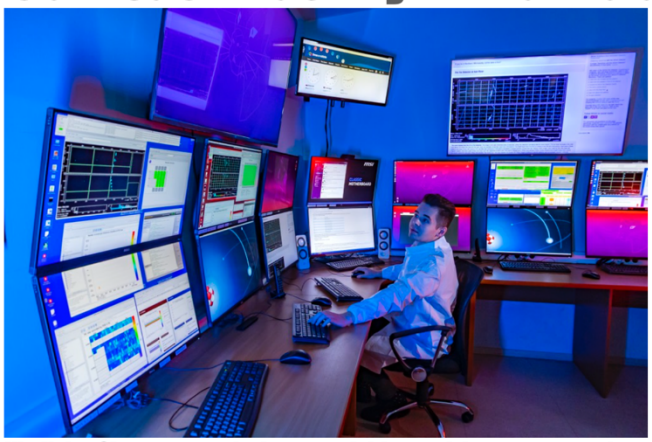
Dr. Nikolay Anfimov
Head of the Sector of Experimental Methods,
Experimental Department of Particle Physics,
Dzhelepov Laboratory of Nuclear Problems.



Selyunin Alexandr
Substitute Head of the Sector of Experimental Methods,
Experimental Department of Particle Physics,
Dzhelepov Laboratory of Nuclear Problems.

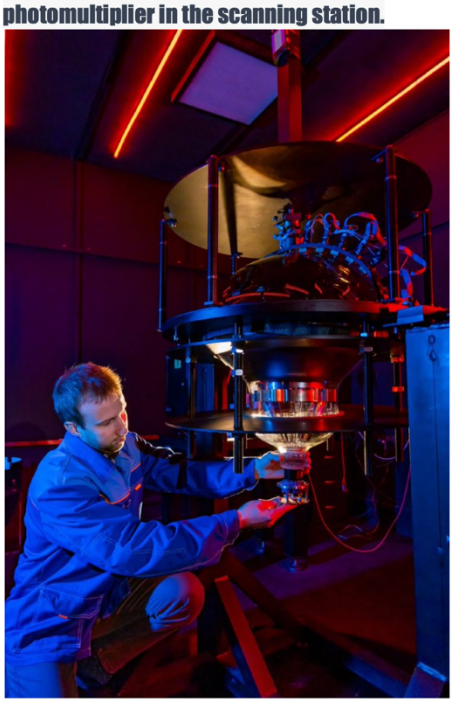
In 2014, a decision was made to enhance the facilities at DLNP. The creation of a sophisticated laboratory was intentional, aiming to test large 20"-PMTs for JUNO experiment and offer a diverse range of methodical activities for the advancement of modern detectors (NOvA, DUNE, TAO)

The GreenLab
is a modern facility with a vibrant team of young scientists



Vladislav Sharov controls data acquisition and detector operations at the NOvA experiment remote control center.

Alexander Selyunin is operating the large photomultiplier in the scanning station.



Dr. Nikolay Anfimov leads a group of 12 bright scientists and engineers. Together, they are engaged in developing state-of-the-art methods and detectors for flagship international experiments.

The cutting-edge facility significantly impacts productivity and creativity

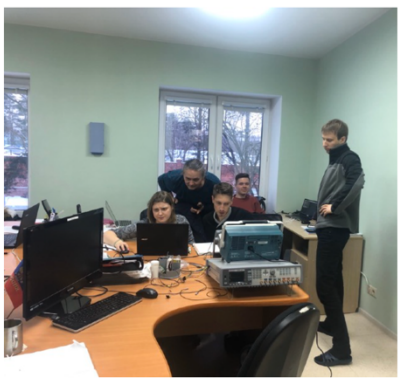
The instruments are the key to discovery

The lab is equipped with cutting-edge tools such as cryogenics, electronics, and machinery.

Cryogenic equipment

Precision Machinery Hall

Experimental Hall



Office

These advanced instruments enable groundbreaking research by allowing scientists to conduct precise measurements and produce intricate components for experimental setups.