T 92: Detektorsysteme V

Zeit: Donnerstag 16:00–18:35 Raum: S03

Gruppenbericht T 92.1 Do 16:00 S03

The SHiP Liquid Scintillator-Based Surrounding Background Tagger — •Julian Schliwinski for the SHiP LScin SBT-Collaboration — HU Berlin, Berlin, Deutschland

SHiP is a proposed general-purpose beam dump experiment at the CERN SPS North Area. It is desigend to combine the Search for Hidden Particles (SHiP), e.g. Heavy Neutral Leptons (HNL), with the search for light dark-matter particles and studies of tau neutrino physics.

Proton-proton Collisions with the SPS' 400 GeV beam on the fixed target may create very weakly interacting new particles with a mass between 0.1 GeV - 10 GeV. Hadrons from these collisions are absorbed and muons redirected through a magnet system. This leaves only neutrinos as well as other neutral particles to decay in the 50 m long decay volume, which is followed by a magnetic spectrometer and calorimeter. The decay volume will be surrounded by scintillating liquid (Surrounding Background Tagger - SBT) to reduce background. The scintillation photons may be detected using wavelength-shifting optical modules coupled to large-area silicon photomultipliers.

This talk will give an overview of the current design and ongoing R&D on the SBT. Results of test beam measurements with a new and improved liquid-scintillator detector will be presented with a focus on readout electronics and the SiPM photo sensors.

T 92.2 Do 16:20 S03

Simulation of light guidance in scintillating fibres for the LHCb upgrade — •Martin Bieker, Robert Ekelhof, Ole Gerber, and Robin Manderfeld — Experimentelle Physik 5, TU Dortmund

During the current long shutdown of the LHC the LHCb detector will undergo a comprehensive upgrade. An important part of this upgrade is the replacement of the current downstream tracking stations by a detector made of scintillating fibres. These fibres are wound and glued to form mats with a length of 2.5 m. Charged particles crossing the scintillator emit light which is then guided by total internal reflection towards silicon photo multipliers at the end of the mat.

The amount of light observed at the end of the fibre is an important predictor for the performance of the system. This so called light yield is among other things affected by irradiation damage of the fibres. Hence it is important to understand and quantify these effects in order to predict the performance of the tracker during its life time.

In this talk several approaches to the simulation of scintillating fibres are presented. Special emphasis is put on the development of effective models from simulation studies and measurements of single fibres.

T 92.3 Do 16:35 S03

Metal-Loaded Liquid Scintillators for Neutrino Physics — Christian Buck, Benjamin Gramlich, Manfred Lindner, Christian Roca, and •Stefan Schoppmann — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany

Liquid scintillators have become a well established detection medium in the context of neutrino experiments. They offer good transparency and light yield while allowing for geometrical flexibility of the fiducial volume at low costs. By loading the scintillators with metal compounds, effectiveness of neutron detection can be highly increased making them suitable for applications e.g. in reactor neutrino physics.

Depending on the respective usage-case, additional scintillator properties such as particle identification and vertex resolution become beneficial. We report the development of scintillator in the context of the STEREO experiment which allows for good particle identification by exploiting light pulse shape discrimination. In addition we present the current status of a LAB-based scintillator aiming for improved spatial resolution.

T 92.4 Do 16:50 S03

Reflectance of vacuum ultraviolet-sensitive silicon photomultipliers in liquid xenon — •Michael Wagenpfeil[1], Tobias Ziegler[1], Denny Schulte[2], Lutz Althueser[2], Thilo Michel[1], and Christian Weinheimer[2] — [1]Universität Erlangen-Nürnberg, ECAP — [2]Universität Münster, Institut für Kernphysik

Silicon Photomultiplier (SiPMs) are pixelated semiconductor photosensors with single photon resolution and a strong candidate for the ultimate low light-level detector due to their compact robust geometry, low power consumption, insensitivity to magnetic fields and easy scalability. Vacuum ultraviolet-sensitive SiPMs are innovative SiPM modifications suitable for detecting scintillation photons from liquid noble gases as used in various astroparticle physics detectors e.g. for neutrinoless double beta decay or dark matter searches.

SiPMs need to be characterised extensively focussing on their optical and electronic behaviour to determine the SiPM operation parameters which influence the energy resolution of such detectors. Many astroparticle groups plan to use SiPM-based photosensor systems directly within the liquid noble gas detector material so SiPM parameters need to be measured within the same environments for reliable results.

We present results from the first reflectance studies with SiPMs in liquid xenon and for vacuum ultraviolet photons. Such reflectance studies are important to determine the angular dependence of the SiPM photon detection efficiency as well as the optical influence of the complex SiPM surface microstructure required for the pixelation of the sensor.

T 92.5 Do 17:05 S03

Geant4 simulation of a detector prototype for neutron radiography — Christoph Günther, •Nina Höflich, Oliver Pooth, Christian Teichrib, and Simon Weingarten — III. Physikalisches Institut B, RWTH Aachen University, D-52056 Aachen

At the Physics Institute III B, a detector for fast neutron radiography measurements is under development. Neutron radiography allows for the discrimination of different materials in heterogeneous probes and is especially sensitive to light elements.

For this purpose, a neutron camera prototype made of 16 stilbene scintillator crystals coupled to a 4×4 pixel SiPM array is constructed. A radioactive AmBe source is used for detector tests with neutrons of energies up to 11 MeV.

In this talk, a Geant4 simulation of the detector prototype is presented. The focus lies on the simulation of the fast neutron interactions and the scintillation process as well as the propagation of the scintillation light inside the detector. Also, the interaction of neutrons with different test materials is simulated.

T 92.6 Do 17:20 S03

Development and test of a fast neutron camera — •Christoph Günther, Nina Höflich, Oliver Pooth, Christian Teichrib, and Simon Weingarten — III. Physikalisches Institut B, RWTH Aachen University, D-52056 Aachen

We are developing a prototype of a scintillator based camera for fast neutron radiography. The camera consists of 4×4 pixels with a size of $5\,\text{mm} \times 5\,\text{mm}$ per pixel. Each pixel consists of a stilbene crystal whose scintillation light is read out by an SiPM. As a neutron source we use an $^{241}\text{Am}/^{9}\text{Be}$ source that emits neutrons with energies up to 11 MeV. So far, optimization studies have been carried out with one pixel in order to achieve a good gamma-neutron discrimination and to maximize the number of detected neutrons.

In this talk the further development of the camera and first measurements with the 4×4 pixel array are presented. To be able to capture images of larger size, measurements with a XY-table will be carried out.

T 92.7 Do 17:35 S03

Detector Response of a Liquid-Scintillator Detector Prototype with WOM and SiPM Readout — •Linus Shihora for the SHiP LScin SBT-Collaboration — HU Berlin, Berlin, Deutschland

SHiP is a proposed beam dump experiment at CERN to search for very weakly interacting new particles with a mass between 0.1 GeV - 10 GeV. Hadrons from proton-proton collisions are absorbed and muons redirected through a magnet system. This leaves only neutrinos and other neutral particles to decay in the 50m long decay volume. This decay volume will be surrounded by scintillating liquid (Surrounding Background Tagger = SBT) to reduce background. The scintillation photons will be detected using wavelength-shifting optical modules coupled to an array of silicon photomultipliers.

This talk will analyse and discuss the detector-response of a new and improved liquid-scintillator detector, tested at the CERN PS accelerator in 2018, and compare the results to previous measurements

performed in 2017 with a smaller liquid-scintillator detector.

T 92.8 Do 17:50 S03

The intelligent PMTs for OSIRIS — Feng Gao, •Florian Kiel, Tim Kuhlbusch, Achim Stahl, Jochen Steinmann, Christopher Wiebusch, and Christian Wysotzki — III. Physikalisches Institut B, RWTH Aachen University

For the next generation of liquid scintillator detectors, a novel concept for the readout of the Photomultiplier-Tubes has been developed. In the intelligent PMT concept all necessary electronics are mounted at the back of the PMT. The electronics is able to digitize and process the measured signal. Thereby, the high computing power of the FPGA offers the possibility of a low-level waveform reconstruction. Based on the analyzed data, the operational parameters of the PMT, e.g. applied voltage, are regulated autonomously. Since the iPMT will be connected via digital signals only, the performance does not decrease with long cables. The concept can be easily adapted from the laboratory to any size of detector, since the PMTs operate independent. The iPMTs will be deployed in the OSIRIS detector in order to demonstrate the concept as well as testing the performance.

T 92.9 Do 18:05 S03

Dynamic gain optimization for large-area PMTs for OSIRIS — •Feng Gao, Florian Kiel, Tim Kuhlbusch, Achim Stahl, Jochen Steinmann, Christopher Wiebusch, and Christian Wysotzki — III. Physikalisches Institut B, Aachen RWTH

Photomultiplier-Tubes are photodetectors with good single photon resolution. For the optimal photon reconstruction the PMT gain is required to 1E7 e- per electron. The gain of the PMT depends exponentially on the applied high voltage. By regulating the high voltage, the gain can be tuned and stabilized. By using the presented technique it is possible to simply connect all PMTs to the readout system, without characterizing the gain and the correct HV beforehand. By using the charge of dark counts there is no need for a special light source in the detector for implementing this procedure. Potential changes of the PMT gain can be compensated during runtime. This concept will be implemented and tested in the OSIRIS detector.

T 92.10 Do 18:20 S03

Entwicklung eines Messstandes zur Qualitätsprüfung der Szintillationseigenschaften von PEN — •Isabelle Schilling, Jens Weingarten, Kevin Kröninger und Philipp Hellmann — TU Dortmund, Lehrstuhl für Experimentelle Physik IV, 44227 Dortmund

Polyethylennaphtalat (PEN) ist ein thermoplastischer Kunststoff, welcher nach Anregung beim Durchgang energiereicher Teilchen oder Photonen szintilliert und im Zuge dessen sichtbare Strahlung im optimalen Funktionsbereich herkömmlicher Photomultiplier emittiert. Er ist günstig herzustellen, individuell formbar und könnte die Verwendung von Wellenlängenschiebern überflüssig machen. Um PEN beispielsweise in Experimenten als Veto-System einzusetzen, oder als Detektorkomponente zur Qualitätssicherung in der Strahlentherapie, sind detaillierte Kenntnisse über dessen Szintillationseigenschaften unverzichtbar.
Am kalibrierten Messstand werden Emissionsspektren und Rastermessungen bei Bestrahlung der PEN-Proben mit einer ^{207}Bi-Quelle aufgenommen, um Rückschlüsse auf die vom Herstellungsprozess der Probe abhängigen Materialeigenschaften ziehen zu können. Die Selbstabsorption des Szintillationslichtes, sowie die Lichtausbeute sind hierbei von besonderem Interesse.