# T 42: Detector Systems 1

Time: Tuesday 16:15–18:00 Location: T-H27

T 42.1 Tue 16:15 T-H27

**R&D of Multidimensional Calorimetry for the SHiP SBT** — •Fairhurst Lyons for the SBT-Collaboration — ALU Freiburg

We present R&D towards a large-area detector for energy reconstruction and limited resolution tracking, which consists of many individual cells filled with liquid scintillator. Each cell is equipped with two wavelength-shifting optical modules (WOMs) that capture scintillation light and transfer it to silicon photomultipliers. This design could serve as the surrounding background tagger (SBT) of the proposed Search for Hidden Particles (SHiP) experiment, a general-purpose detector housed at the CERN SPS accelerator to search for light, feebly interacting particles. SHiP allows probing dark photons, dark (pseudo-)scalars, and heavy neutrinos, as well as the investigation of light dark matter, neutrinos, and flavour physics. The SBT studied here surrounds the vacuum decay vessel of SHiP to detect charged particles either entering the vacuum vessel from outside, or produced in inelastic interactions of muons and neutrinos in the vacuum vessel walls. We present studies of readout electronics and simulated individual detector cells investigating scintillator response.

T 42.2 Tue 16:30 T-H27

**Studies to improve the light absorption of wavelength-shifting optical modules in the SHiP experiment** — •Jakob Schmidt for the SBT-Collaboration — Humboldt-Universität zu Berlin, Berlin, Germany

The usage of wavelength-shifting optical modules (WOMs) as photon detectors was first proposed for the IceCube large-volume extension and then also for large-area liquid scintillator detectors as the SHiP surrounding background tagger (SBT). A WOM is a light-guiding tube coated with a UV light-absorbing paint that emits secondary photons in the visible spectrum. By total internal reflection inside the tube walls, these photons are guided to the actual photon detector, which in this case is made of a ring array of silicon photomultipliers that is coupled to one end of the tube. The light detection efficiency depends significantly on the light absorption in the wavelength shifter. This talk will present studies of coating methods to improve the light absorption in WOMs. This work is funded by the DFG.

T 42.3 Tue 16:45 T-H27

**Measurements of photon exit angles of Wavelength-Shifting Optical Modules used in a large-area liquid-scintillator detector** — •Florian Rehbein for the SBT-Collaboration — RWTH Aachen University, Aachen, Germany

This contribution presents first laboratory measurements of the optical characteristics and the quality of a Wavelength-Sifting Optical Module (WOM) as foreseen for a liquid-scintillator-based large-area detector. Measurements of the photon exit angle distribution have been taken with a DSLR camera on a test stand that was built specifically for this purpose. Further, it will be discussed how systematic measurements and comparisons to simulations will help to examine the properties of the module. WOMS combine a well-designed light guide with a wavelength-shifting coating, presenting a novel optical sensor for numerous applications, first proposed for the large-volume extension of the IceCube detector. WOMs are also foreseen as photon detectors in the Surround Background Tagger (SBT) in SHiP (Search for Hidden Particles), a proposed general-purpose fixed target experiment at the SPS accelerator of the CERN Facility. The SBT acts as a discriminator against external particle interactions and is composed of many cells utilizing liquid scintillator and tube-shaped WOMs made of PMMA to detect traversing particles. The coating of the WOMs absorbs the scintillation photons and re-emits wavelength-shifted photons, which are then detected by an array of SiPMs coupled to one end of the WOM. Supported by the DFG.

T 42.4 Tue 17:00 T-H27

**Position-dependent detector response of a liquid scintillation detector instrumented with wavelength-shifting optical modules and SiPMs using cosmic muons** — •Andrea Ernst for the SBT-Collaboration — Humboldt-Universität zu Berlin

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T 42.5 Tue 17:15 T-H27

**Impact of a reflector on the light yield of WOMs** — •Alexander Vagts for the SBT-Collaboration — Humboldt-Universität zu Berlin, Berlin, Deutschland

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T 42.6 Tue 17:30 T-H27

**Tracking of charged particles using an FE-I4B pixel telescope and moving emulsion films** — •Nikolaus Owtscharenko[1], Vadim Kostyukhin[1], Christopher Betancourt[2], Fabian Hügging[3], David-Leon Pohl[3], Antonia Di Crescenzo[4], Antonio Iuliano[4], and Markus Cristinziani[1] — [1]Center for Particle Physics Siegen, Experimentelle Teilchenphysik, Universität Siegen — [2]Universität Zürich — [3]Physikalisches Institut, Universität Bonn — [4]Sezione INFN di Napoli

The SHiP collaboration proposes a general purpose fixed-target experiment to search for hidden particles at the new beam-dump facility at CERN SPS. To estimate the charm production cross section in the experiment, which includes hadronic cascade production, several dedicated measurements have been proposed. A first run was performed in summer 2018. Protons from SPS interacted with a thick multilayer target, interleaved with tracking emulsion films. While the emulsion detector offered high spatial resolution, it did not provide timing information. For full event reconstruction a 6-plane telescope made of ATLAS IBL double-chip modules was assembled and placed downstream of the target to provide a high timing resolution. An occupancy limit on the emulsion films made a movement of the target during and in between spills necessary. Reconstruction of tracks and vertices in the pixel detector as well as matching of track and vertex candidates reconstructed in the moving emulsion detectors are presented.

T 42.7 Tue 17:45 T-H27

**The SHiP Surrounding Background Tagger** — •Annika Hollnagel for the SBT-Collaboration — JGU Mainz

Within the CERN Physics Beyond Colliders (PBC) initiative, the SHiP fixed-target experiment is a frontrunner proposal for the SPS Beam-Dump Facility (BDF). Making use of the high-intensity SPS beam with $4 \times 10^{19}$ protons on target per year, the experiment will combine the Search for Hidden Particles (SHiP) of masses up to 200 MeV/$c^2$ - such as Heavy Neutral Leptons (HNL) and Light Dark Matter (LDM) - with studies of tau neutrino physics.
The Hidden Sector Decay Spectrometer (HSDS) of the SHiP detector consists of a large evacuated volume followed by a magnetic spectrometer and particle identification system. To enable a background-free study of the decays of feebly-interacting particles, the reduction of beam-induced background heavily relies on the Surrounding Background Tagger (SBT) that envelops the 50 m-long decay vessel. The current baseline for the SBT is a segmented Liquid Scintillator (LS) detector of LAB and PPO that is instrumented with Wavelength-shifting Optical Modules (WOM) and read out via SiPMs. Since 2017, several test beam exposures of prototype detector cells have

been conducted, supported by laboratory measurements and simulations. This talk will give a general overview on the SBT, summarise the state of the ongoing R&D, and present our plans for the next period of test beam measurements.