Title: Upgrade of the CEDAR detectors for COMPASS experiment at CERN

The goal of this project is the upgrade of ChErenkov Differential counters with Achromatic Ring Focus type N (CEDARs) used in beam line of the COMPASS experiment at CERN. Two detectors of this type are located on beam axis, 30 m before the spectrometer target, and are used to identify and time-tag selected type of particles present in a beam. They are based on phenomenon of an emission of a Cherenkov light by a particle passing through the medium. For CEDAR detectors it is a ^{4}He gas contained at high pressure in a detector vessel. The light created by an interaction is reflected by a mirror and after passing through the optical systems consisting of chromatic aberration corrector, condenser and variable diaphragm it is registered by eight photomultipliers (PMT) placed on a ring. Selection of desired particle momentum is done by choosing proper gas density (a ratio of gas pressure to its temperature) and diaphragm opening position. Detection of a particle, whose interaction is seen as a ring on a PMTs plane requires a coincidence of signals coming from 6 to 8 of PMTs. CEDAR detectors were designed in 70s of last century and from 80s are in constant use, providing invaluable data for physics. Nowadays requirements arising from a scientific goals require usage of even more intense beams. Unfortunately the original design of the detectors limits their usage in new conditions. Apart from that the detectors lacks instrumentation for continuous performance monitoring and has problems with temperature stability and uniformity. This project will address all these issues to ensure proper operation under new conditions. First of all a new electronics chain will be designed consisting of a new voltage dividers for PMTs, new preamplifier circuit and replacement of a time to digital converter with an analog to digital converter with time detection algorithms implemented in an programmable logic (FPGA). A new detector monitoring system will be implemented, which will use a calibrated source of light pulses, fiberoptic splitter and a special light injection spacers to deliver light to the PMTs. As a result a constant, beam-independent monitoring of PMT gain and overall detector efficiency will be possible. Fixing the thermal problems of the detector requires installation of a new system to remove unwanted temperature gradients along the detector vessel. It will use a water flowing in close circuit with a system of pipes mounted along the detector. Along with installation of water system, the whole thermal shielding of the detector will be redesigned to provide better attenuation of daily ambient temperature changes.

All the changes are necessary to allow for a new physics program in the field of a hadron structure and hadron spectroscopy at COMPASS. Until now a lot of interesting programs were realized including: hadron spectroscopy, spin structure analysis, Primakoff effect studies, Deep Virtual Compton Scattering (DVCS) measurements, generalized parton distribution (GPD) and study of Drell-Yan process. In 2018 a new program for studying the latter is planned. Drell-Yan its a process where annihilation of quark and antiquark in two colliding hadrons occurs. As a result a virtual photon is created which then decays into two oppositely-charged leptons. Observation of this process provide an overview of a partons inside particles. For the next experimental period a new measurements will be made to explore the kaon parton distribution, angular distribution for kaon-induced Drell-Yan (first ever measurements of this kind), and not well known valence/sea quark separation for kaons with a special interest in strange quarks influence. This is just a beginning of a measurements with a high intensity beams at COMPASS.

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