HEP 2013
Stockholm
18-24 July 2013

Contribution ID: **401** Type: **Poster Presentation**

The active Neutron Detector for direct Dark Matter searches with the DarkSide-50 experiment at Gran Sasso

The existence of dark matter is known from gravitational effects, and although its nature remains undisclosed, there is a growing indication that the galactic halo could be permeated by WIMPs with mass on the order of 100GeV. Among diverse and complementary ongoing dark matter searches, direct observation of WIMP-nuclear collisions in a laboratory detector plays a key role in this search. However, it poses at the same time significant challenges, as the expected signals are low in energy (below 100keV) and very rare (a few interactions per year per ton of target). DarkSide is a project for direct observation of WIMPs in a liquid argon time-projection chamber (TPC) that can meet these challenges with a high sensitivity and an ultra-low background detector. A limiting background for all dark matter detectors is the production in their active volumes of nuclear recoils from the elastic scattering of neutrons. Instead of passive shielding, a superior method for their suppression is the use of an active detector in which neutrons from both internal and external sources are detected with very high efficiency. DarkSide-50 is equipped with a high-efficiency liquid scintillator, doped with Boron, which is used as a neutron detector. The neutron detector's tank is a 4m diameter sphere instrumented with 110 low background 8" PMTs deployed in a water Cherencov detector which will serve both as a passive shield and as a veto of cosmic-ray muons. In order to acquire the PMT signal we have developed custom front-end amplifiers with built-in trigger capabilities and a DAQ system based on high-resolution fast digitizers.

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Track Classification: Astroparticle Physics