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New Micromegas for axion searches in CAST

The CAST experiment is looking for axions coming from the Sun since 2002. Three of the four X-ray detectors currently used are Micromegas. In the first years of the experiment, one Micromegas was taking data looking at the sun during sunrise; the first generation of 2d-readout detectors had been showing good performance and stability. In 2007, an upgrade of the experiment allowed for changes in the micromegas systems: two more Micromegas were installed, replacing the older TPC detector on the sunset side, while the sunrise system was re-designed in a way to accommodate a shielding. The new detectors are of the Microbulk technology, which have attracted a lot of attention because of the advantages they present, like low material, high radiopurity and good energy resolution. The new construction technology of these micromegas detectors will be commented and their performance in the experiment the last year will be presented.

Summary (Additional text describing your work. Can be pasted here or give an URL to a PDF document):

Axions are hypothetical particles which could explain the strong CP problem. They could be produced in the centre of stars like the Sun via the Primakoff effect. The CAST experiment (CERN Axion Solar Telescope) has been looking for solar axions since 2002. It is using a decommissioned LHC-prototype 10 m long magnet which can reach a 9T magnetic field as a converter of axions coming from the Sun into detectable X-rays. In order to extend the search to a bigger range of axion rest masses, data has been acquired not only when the magnet bores were kept under vacuum but as well introducing inside them a buffer gas (first 4He and then 3He) which helped increase the detection sensitivity to higher masses.

The energy range of the expected signal is between 1 and 10 keV, and its rate is dependent on the very weak axion-photon coupling. Therefore, low background X-ray detectors are necessary for having a good experiment's sensitivity. The requirements for such detectors include radiopure detector components, shielding, good energy and space resolution to perform powerful offline rejection conditions and reduce backgrounds, as well as stability over long periods of operation.

In 2007 the CAST experiment was upgraded to the second part of Phase II, were 3He (instead of 4He which was the case until then) was to be used as a buffer gas inside the magnet bores. This change gave the opportunity for several upgrades regarding the detector systems. For the Micromegas detectors the upgrade was significant: on one hand, a new system was designed for the installation of two new Micromegas detectors in the sunset tracking side, which replaced the Time Projection Chamber that was sitting on that end since 2002. On the other, the sunrise system was re-designed in order to implement a new shielding of the detector as well as new controls for several parameters crucial for its monitoring.

In parallel, the Micromegas group had invested in efforts to improve the detectors' performance starting with its construction technique. Two new technologies were used to build the Bulk and Microbulk detectors. The improvement they presented is that the mesh is no longer suspended above the anode mechanically, as in the previous generation, but either glued above the active area (Bulk) or built together with the active area during the construction process (Microbulk). In this way, they provide better uniformity and therefore stability of operation. Detectors of both types were constructed, tested and installed in the experiment, achieving very good background rejection factors.

In particular the Microbulk Micromegas presents advantages of low intrinsic radioactivity and good energy and spatial resolution, important elements for a good background discrimination performance. In CAST, these detectors have achieved background rates as low as 4x10-6 cts keV-1s-2cm-2. Beyond this nominal operation, there have been several periods where the background has been reduced even down to a level of ˜2×10-7s-1cm-2keV-1, due to reasons which are under investigation, and which could be partially linked to variations in the radon concentration inside the shielding.

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