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Timepix background studies for double beta decay experiments

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The double beta decay (Beta-Beta) is very challenging subject of today's physics. It can be used as a powerful tool to test neutrino properties (e.g. Dirac or Majorana type of neutrino) and lepton number conservation. There are various experimental approaches, e.g. GERDA [1], COBRA [2] (source=detector); SuperNEMO (tracking and calorimetric detector) [3] or CUORE (low temperature detector) [4]. In contrast to such big experiments devoted mainly to the Beta- Beta- decay, the search for 2-neutrino EC/EC decay (collaboration TGV [5]) is also important. This decay has not been observed yet in direct measurements (the only positive result is given by geochemical experiment [6] for 130Ba as (2.2 ± 0.5) x 10ˆ21 years). All above mentioned general Beta- Beta- experiments are on the road towards setups with ˜100 kg of isotope which could reach the sensitivity on the level of neutrino mass ˜50 meV (depending on nuclear matrix element calculations). To be able to improve the experimental sensitivity there is a necessity to develop new experimental approach. One of the promising directions is the use of pixel detector techniques. Such R&D is running within the TGV (Si pixel detectors) and COBRA (CdTe pixel detectors) collaborations.
We are performing intensive R&D towards the use of pixel detectors, TimePix [7] in the Beta-Beta (EC/EC) decay. The TimePix device, operated in time over threshold (TOT) mode, provides spectroscopic capabilities in each individual pixel. The main advantage of such detector is its ability to identify and reject background signals (e.g. tracks made by electrons, alpha particles, muons) and would efficiently recognize the signal of Beta-Beta decay processes (e.g. two X-rays with the energy of ˜21 keV in two isolated pixels for 2-neutrino EC/EC) or two electron tracks with sum energy equal to Q beta-beta value for neutrinoless Beta-Beta). Two pixel detectors, Si (pixel size 55 x 55 umˆ2) and CdTe (pixel size 110 x 110 umˆ2) in surface laboratory as well as in underground laboratories (Modane underground Laboratory, LSM; Gran Sasso underground laboratory, LNGS) were tested from the point of view of intrinsic background. We had presented the idea of silicon pixel telescope (SPT) based on stacked silicon pixel detectors and initial background study results at the iWoRID2010 conference [8].
Final aim in both research areas (TGV, COBRA) is to build a multi-detector system based on the TimePix detectors working in coincidence mode. The quad detector should be used to increase the detector area in the case of SPT. For the purpose of COBRA the detector thickness should be optimized to maximize the amount of investigated isotopes. The first prototype of coincidence apparatus of two pixel detectors (face-to-face arrangement) has been constructed and tested. The results of long term background measurements (performed in LSM with the Si TimePix device and in LNGS with CdTe TimePix device) will be presented, as well as the results of test with coincidence apparatus. Also future plans with hardware developments will be presented.

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