Search for the neutrinoless double beta decay of Xe-136 with the NEXT experiment

Research Project / Research Group Description:
The only practical way to determine whether neutrinos are Majorana particles, identical to their own antiparticles, is to observe neutrinoless double beta decay. This is a nuclear transition in which a nucleus with Z protons decays into a nucleus with Z+2 protons and the same mass number A, without emitting neutrinos.

The NEXT experiment is developing the technology of high-pressure xenon gas detectors to search for the neutrinoless double beta decay of Xe-136 . The first phase of the program included two prototypes, NEXT-DEMO and NEXT-DBDM, with xenon masses ~1 kg and operated at IFIC and LBNL (USA), respectively. The prototypes demonstrated the robustness of the technology, its excellent energy resolution and its unique topological signature. The NEXT-White demonstrator, deploying 5 kg of xenon and currently taking data at the Laboratorio Subterraneo de Canfranc (LSC, Spain), implements the second phase of the program. NEXT-White is assessing the NEXT background model, and will measure the two-neutrino double beta decay of Xe-136 in 2019. NEXT-100, to be commissioned in 2020, constitutes the third phase of the program. It is a radiopure detector deploying 100 kg of xenon at 15 bar. In addition to a physics potential for neutrinoless double beta decay searches which is competitive with the best current experiments, NEXT-100 can be considered as a large scale demonstrator for detector masses in the ton-scale.

The NEXT group at IFIC is one of the founding groups of the Collaboration, and continues to have major responsibilities within NEXT. Concerning NEXT-100 construction and operation, NEXT-IFIC is responsible for the mechanics and the slow controls. Concerning NEXT software and analysis, NEXT-IFIC is in charge of physics analysis coordination, background characterization, and of the development and maintenance of software tools. Concerning NEXT R&D, NEXT-IFIC is responsible of gas mixture R&D with the recently refurbished NEXT-DEMO detector at IFIC.

Job position description:
The researcher will contribute to commissioning, data analysis and R&D activities during his/her PhD at IFIC. Frequent trips to the LSC are envisaged. Stays at other NEXT institutions in Spain and abroad are foreseen.

The NEXT-100 detector will be commissioned at the LSC during 2020. During the 1st year, the researcher will contribute to NEXT-100 commissioning using radioactive sources (Kr-83m, Th-228). This phase will be essential to calibrate the detector response and to assess the detector performance. It is expected that the researcher will become fully familiar with NEXT detector instrumentation and software during this time.

At the beginning of the 2nd year of the fellowship, the NEXT-100 low-background run with Xe-136 gas will commence. The researcher will take a leading role in the flagship analysis of the experiment, namely the search for the neutrinoless double beta decay of Xe-136. It is expected that the researcher will focus in the understanding and mitigation of backgrounds for this search (radioactivity from detector components and laboratory walls, radon, cosmogenics), as well as on the optimal reconstruction of the double-electron signature in xenon gas. The analysis will extend until the end of the 3-yr fellowship.

In parallel, the researcher will gain first-hand hardware experience with the NEXT-DEMO prototype at IFIC. R&D solutions to upgrade NEXT-100, or to be adopted in future ton-scale xenon gas detectors, will first be tested in NEXT-DEMO. The researcher will be involved in this effort during the 2nd and 3rd years of the fellowship. He/she will study xenon gas mixtures in NEXT (with either molecular or other noble gas additives) to be used as an alternative to pure xenon operation for improved detector performance. The researcher will also gain experience with the photo-detectors (silicon photomultipliers, photomultipliers) employed in the NEXT detection concept, and study possible upgrades for the NEXT optical readout.

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Research project/Research Group website
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