# Doctoral INPhINIT - INCOMING Fellowship Programme 2019 Call for applications

**Position**: Search of the nature of neutrinos with the NEXT-100 detector at the Underground Laboratory of Canfranc

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## Centre description

The Galician Institute for High Energy Physics (Instituto Galego de Física de Altas Enerxías, IGFAE) is a joint research institute of the University of Santiago de Compostela and Xunta de Galicia (the Galician Autonomous Government). It was officially created on July 2, 1999. The main goal of the Institute is to coordinate and foster the scientific and technical research in the field of High Energy Physics, Particle and Nuclear Physics and related areas as Astrophysics, Medical Physics and Instrumentation. Of primary importance is the planning and promotion of the relation with large experimental facilities, especially with CERN, GSI/FAIR and the Pierre Auger Observatory at present.

The experimental groups at IGFAE coordinate the Spanish participation in the LHCb Collaboration at CERN, the Spanish participation in the Pierre Auger Observatory, as well as the Spanish participation in the GSI/FAIR nuclear facility. Members of the Institute have a relevant participation in the LHCb upgrade planning, in the LHeC project development and planning, etc. In the last couple of years, a new line has also been open with the building of a new facility (LaserPET) at the University of Santiago de Compostela aiming to produce radioisotopes for medical use by a laser-induced plasma accelerator. Moreover, the theory section of the Institute holds an excellent international reputation, with participation in different international committees, invitations to plenary talks and large-impact publications.

## Research project and research line description

The nature of the neutrino, if the neutrino is or not its own anti-particle, is one of the most relevant open questions in Physics. Its answer has profound consequences in Particple

Physics and Cosmology. Neutrinos are one of the most abundant, and mysterious, elemental particles of our Universe. The question of the nature of the neutrino is intricate with its mass, and with the fact that the neutrinos oscillates while propagating (which discovery was granted with the Nobel Price 2015). The Neutrino Physics is the only probe so far that the Standard Model of Particle Physics is incomplete, in addition, knowledge of nature of the neutrino could uncover why the Universe is made of matter and not anti-matter.

NEXT is an international collaboration, leaded by Spanish groups, IFIC, DIPC, IGFAE, with a strong USA contingent, Texas U., Harvard U., Fermilab, which is building a 100 kg High Pressure 136Xenon Time Projection Chamber, TPC, with Electro-luminescence readout. The detector will be installed at the Underground Laboratory of Canfranc (LSC), in the Spanish Pyrenees, in 2021. This project is financed by European (ERC), national and autonomically funds. Actually, there is a large-scale prototype, called NEXT-White, operating at LSC. NEXT uses a novel technique, an optical TPC, with excellent energy resolution and tracking capabilities which reach surpasses its direct competitors (EXO and KamLand-ZEN).

## Job description

The main objective of the research project is the search of the hypothetical double beta decay of 136Xenon nuclei in NEXT-100. The student will participate in the commissioning and operation of the NEXT-100 detector. The main part of the project is the analysis of the data, which includes the calibration of the detector, the measurement of the energy spectrum, the development and validation of tracking and electron identification algorithm, and finally measuring (or setting a limit) to the lifetime of a double-beta neutrino less decay in 136Xenon. The candidate will also participate also in our R+D program at the University of Santiago, dedicated to the improvement of the optical TPC of next and the application of the NEXT detector to the search for dark matter.

The IGFAE is involved in NEXT since 2012. There are two main researches, J. A. Hernando, professor at the Universidad de Santiago, responsible of the software and analysis of NEXT, and D. Gonzalez, a Ramon y Cajal fellow, who is responsible of the TPC laboratory at the IGFE, and the development of optical TPCs for neutrino and dark matter physics. The student will participate in an international and collaborative environment. The work will be carried out at the laboratory and installations of IGFAE and at Canfranc Laboratory. The project includes

stays at other institutions of the collaboration, IFIC, DIPC (Spain) and Fermilab or Harvard U. (USA).

The only practical way to unveil the nature of the neutrino, is via the possible discovery of an hypothetical rare decay that could happen in certain nuclei, a double beta decay (two electrons), without emission of neutrinos. The signature of this decays are two electrons which carry all the energy of the decay. The detector must be massive, as the decay is very rare, less than one time in 10^25 years. It must have an excellent energy resolution and a very low radio-active background. NEXT has in addition have excellent tracking capabilities.