

Doctoral INPhINIT - INCOMING Fellowship Programme 2021 Call for applications

Position: Challenges and possibilities of the LHCb experiment at CERN

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Centre description

The Galician Institute of 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 2nd 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, the Pierre Auger Observatory and LIGO at present.

The experimental groups at IGFAE coordinate the Spanish participation in the LHCb Collaboration at CERN (being the third group in size in the Collaboration), in the Pierre Auger Observatory, and in the GSI/FAIR nuclear facility. Members of the Institute have relevant participation in the LHCb upgrade planning and the HL-LHC activities. Besides, they are involved in the design of future facilities like in the EIC and FCC physics cases, the LHeC project development and planning, etc. In the last years, a new line has also been opened with the building of a new facility (L2A2) 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, with groups working on QCD, string theory and, more recently, on BSM, holds an excellent international reputation, with participation in many international committees, invitations to plenary talks in top conferences and large-impact publications. The institute holds two ERC grantees, one StG and one StG+AdG.



Research project and research line description

The High Energy Group at the Instituto Galego de Física de Altas Enerxías (IGFAE) of the University of Santiago de Compostela (USC), Spain, is a member of the LHCb Collaboration at CERN, the European Organization for Nuclear Research. LHCb is one of the four big experiments operating at the Large Hadron Collider (LHC), originally designed to make precise measurements of CP violation and rare decays in the B meson system to understand the origin of the matter-antimatter difference in the Universe. Nowadays the LHCb physics program is much wider and covers also general quark-flavor physics, hadron spectroscopy, electroweak physics and heavy-ion proton collisions. Recent hints of lepton universality violation have been confirmed at LHCb and are being actively investigated. The group is very involved in the ongoing upgrade of the LHCb spectrometer, which will enable the detector to run at luminosities greater than $2 \times 10^{33} \text{ cm}^{-2}\text{s}^{-1}$ and explore New Physics effects in the beauty and charm sector with unprecedented precision. Santiago has focused his contribution to the upgrade in the Vertex Detector, an ultra-light hybrid pixel detector capable of reading out data at 5 Tbit/s.

The USC group is currently integrated by 7 research staff, 6 postdoctoral fellows, 7 PhD students, 2 engineers and one technician, and is involved in a large variety of physics analyses of the LHCb data.

Job description

The candidate is expected to participate in one or more of the following IGFAE-LHCb group research lines:

- Upgrade of the LHCb Vertex Detector. The group is working in the development of the detector readout system: readout chain, ASIC and module testing with radiation sources, lasers and beams, FPGA firmware development, detector assembly, installation and commissioning. The group has other research lines of potential interest for the candidate such as the development of Inverse Low Gain Avalanche Detectors (ILGAD) for the HL-LHC.
- Tests of Lepton Flavor Universality in semitauonic b-hadron decays are sensitive to new particles that preferentially couple to the third generation of leptons. The world



average for $R(D^*)$, the ratio of B_0 branching fractions into final states containing taus and muons, deviates from the prediction of the SM by 4 standard deviations. LHCb has measured this ratio with leptonic and hadronic tau final states. The latter measurement was proposed by the IGFAE LHCb group. The selected candidate can have an active role in the update this measurement including LHC run-2 data and in other sensitive measurements such as $R(\Lambda_c^*)$ and $R(D^+)$ using tau leptonic decays.

- The nuclear modification factor, $R_{pPb}(pT)$, in the region of pseudorapidity covered by LHCb, is a principal heavy ions physics objective. The candidate would be expected to determine the R_{pPb} for different particle species (pions, kaons and protons). The proposed research could provide checks of collinear factorization that is known to work for low parton densities and large scales or test the eventual breakdown of collinear factorization and existence of a new non-linear regime of QCD whose weak coupling realization is the Color Glass Condensate.

The candidate will join the LHCb collaboration with frequent travels to CERN. He/she will be in contact with top researchers of other international laboratories through visits and participation in conferences, courses and schools.