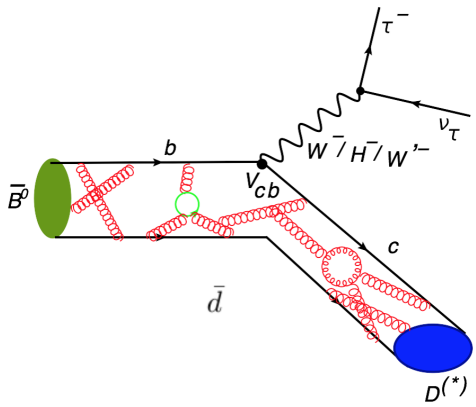
Test of Lepton Flavour Universality in LHCb using semileptonic decays of the B_s meson



Measurements performed at B-Factories and LHCb, show an hint of violation of Lepton Flavour Universality (LFU) from the comparison of the B --> D(*) τ ν_τ (semi-tauonic) and B --> D(*) μ ν_μ mu nu_mu (semi-muonic) decay widths. If these hints would be confirmed by other measurements it will clearly signal Physics Beyond the Standard Model. It is of paramount importance to study semi-tauonic decays in other b-hadron species both to check the presence of large LFU violation in alternative environments, and to explore different kinematic variables aiming to pin down the kind of New Physics than explains the observed anomalies in the LFU.

The LHCb group in Frascati is deeply involved in the study of semileptonic decays of B_s mesons. The B_s mesons (constituted by an anti-b quark and s quark instead of an u- or d-quark which constitute a B meson) are interesting because have advantages compared with the B mesons. A crucial one is that they allow to overcome one the most important background that affects the semi-tauonic decays of the B mesons. Moreover, semileptonic B_s decays offer many interesting kinematic observables that can be exploited to constrain various plausible New Physics scenarios.

The student will be deeply involved on key points of the data analysis. Depending on his/her interests and when he/she will be with us, the work can focus on:

Study of backgrounds relevant to semi-tauonic decays B_s --> D_s(*) τ ν_τ
The double charm decays B_s-->D_s(*)D_s X are an important source of background to semi-tauonic decays B_s --> D_s(*) τ ν_τ . We propose to study the rate of production of these decays which are not known with enough precision. Machine learning approach would be crucial to study these decays.

Developments of novel algorithms to control soft photon efficiency
The soft photon efficiency is crucial to reconstruct D_s* --> D_s γ decays and suppress backgrounds in B_s --> D_s τ ν_τ decays. We propose the development of a control sample of photons using partially reconstructed charm mesons. The tool developed will be of general usage in other LHCb analyses.

Machine learning for the improvements of the resolution of B_s --> D_s(*) τ ν_τ kinematic
Improvements of the resolution of the decay kinematics help in improving signal sensitivity. A novel technique that uses machine learning approaches will applied for such goal.

Marcello Rotondo (marcello.rotondo@lnf.infn.it)
Barbara Sciascia (barbara.sciascia@lnf.infn.it)