Gauge boson scattering at the CERN future collider

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Vector boson scattering (VBS) is a particularly important process to get new insight into the electroweak symmetry breaking mechanism (EWSB) and the origin of the Brout-Englert-Higgs (BEH) boson. The longitudinal component of the gauge bosons are in fact the Goldstone bosons associated with the EWSB. In the absence of the BEH boson, the scattering of longitudinal massive (weak) bosons diverges and ultimately violates unitarity for energies >~1 TeV. In the standard model (SM), the presence of the Higgs boson is expected to regularize this process by a delicate interference between the diagrams involving the Higgs and those involving trilinear and quartic gauge couplings. It is therefore essential to measure this scattering and in particular the VBS production of longitudinal weak bosons. The available data at the CERN LHC have already allowed the first observation of the VBS production in the WWjj channel, WZjj channel, as well as to see a first signal in the ZZjj channel. A first result on polarized WW scattering was published by the CMS collaboration at CERN this year. In the meanwhile, efforts are ongoing towards the design of detectors for a future machine at CERN that will allow to collide electrons and positrons at a centre of mass energy of up to 350 GeV. The internship goal is to assess the potential for observing the longitudinal ZZ scattering at such a machine.

The student will study the possibility to measure the longitudinal component in the VBS production of ZZ in the fully leptonic final state ee->ZZjj->4ljj. This decay channel is especially interesting because it is the only one in which the final state particles are fully reconstructed in the detector, allowing for a strong potential in the separation of the longitudinal and transverse components. The student will simulate signal and background events using the MadGraph Monte Carlo generator and the Delphes fast simulation package. He will look for discriminating variables to separate the longitudinal component from the transverse polarisation components, and will optimise the separation of the signal from the background. He will also study the impact of the angular coverage foreseen for FCC detectors.

The student will benefit from the expertise of the LLR CMS group in the di-boson measurements, vector boson scattering and polarisation measurements. The internship will be conducted within the FCC physics working group to which a presentation of the results will be given at the end of the internship. A short stay at CERN could be envisaged if the health situation allows for it.

Interested candidates should send an email to Claude Charlot (charlot@llr.in2p3.fr).