Experimental Particle Physics

Part I: Contributions to hadronic cross sections at LHC

1. Partonic process: \( e^+ e^- \rightarrow \gamma \rightarrow \mu^+ \mu^- \), \( e^+ e^- \rightarrow \) hadrons. Partonic process: \( e^+ e^- \rightarrow \) hadrons. QCD Lagrangian. Running of the strong coupling constant, \( \alpha_S \). Ratio \( R \) in \( e^+ e^- \) collisions. Evidences of colour charge. Drell-Yan process \( pp \rightarrow \gamma \rightarrow l^+ l^- + X \ l = e, \mu \). Drell-Yan process in EW (hints).

2. Perturbative QCD: bremsstrahlung process \( e^+ e^- \rightarrow f \bar{f} + \gamma \) (in a nutshell). Infrared and collinear singularities. Process \( e^+ e^- \rightarrow q \bar{q} + g \). Infrared cancellation in QED/QCD. \( e^+ e^- \rightarrow 3 \) jets cross section. Infrared safe observables (jet algorithms, hints).


4. Uncertainties from missing higher orders in pQCD: factorization and renormalization scales.

5. Parton Density Functions. How they are extracted, their evolution and universality (slides from P. Nadolsky and M. Ubiali). PDF+\( \alpha_S \) uncertainty contribution in the hadronic cross section (hints).

Part III: QCD and event simulation for the LHC (F. Maltoni and M. Zaro)

1. Perturbative QCD at LHC. Fixed order computation at higher order, parton shower and their merging/matching.

2. Applications to Higgs and top-quark physics relevant for the next LHC run.

3. Tutorials on the web-based package MadGrap5_aMC@NLO.

Part IV: Experimental techniques at LHC (A. Negri and S. Franchino)
Bibliography