

Mandate for the FCC-WG5

“QCD and $\gamma\gamma$ physics” conveners

1. Physics Objectives

- a. Understand the experimental & theoretical precision with which the **strong coupling constant** can be measured/ constrained from QCD event shapes (thrust), multi-jet production, the ratio of leptonic-to-hadronic ratios of Z decays, W decays, τ decays. Explore other methods to perform this measurement with 10^{12} Z, 10^8 W pairs, 2×10^6 H, and 10^6 top pairs.
- b. Explore the experimental & theoretical possibilities for **high-precision QCD studies with multi-jets $N_{\text{jets}} > 4$** events (fractal structure, scale breaking, power corrections, color coherence, subleading color corrections, subleading logs, mass corrections, spin correlations, n-loop corrections, IR limits, ...), and **parton-to-hadron fragmentation functions** (baryon production, heavy-quark at low and high z, rare/exotic hadrons, ...).
- c. Evaluate the possibilities provided by Equivalent Photon Approximation (EPA) fluxes of the colliding e^\pm in order to study potentially-interesting **two-photon fusion ($\gamma\gamma$) processes** sensitive to e.g. anomalous triple/quartic gauge couplings, anomalous e.m. τ moments, $\gamma\gamma \rightarrow$ Higgs, ...
- d. Set constraints on the performance and the relevance of the various **sub-detectors (in particular in the very forward direction** where e^\pm double tagging maybe needed for $\gamma\gamma$ studies), as well as on the experimental environment, to make the experimental precision match or approach the expected statistical accuracy.
- e. Define the **experimental and phenomenological software needs** to make possible these measurements and their interpretation with the required precision (MC generators, detector simulation, online and offline reconstruction, high-level data analysis, global fits, ...).
- f. Help evaluating the impact of QCD on the other measurements of TLEP. In particular, provide the design study with **“background” event generators, for QCD and $\gamma\gamma$ processes.**

2. Managerial objectives

- a. Define and start the activities of the group with a global vision, seeking for international collaboration. Synergies with other e^+e^- (linear or circular) collider studies will have to be exploited whenever deemed relevant and useful.
- b. Attract people for the studies relevant to the group. The list of TLEP subscribers with a declared interest in the study of QCD and $\gamma\gamma$ physics is compiled in mailing list (e-group) TLEP-QCD@cern.ch. One of the roles of the convener is to extend this list as much as possible (and ask new interested people to subscribe to the study through <http://tlep.web.cern.ch>).
- c. Maintain a high level of contacts with the other groups of the studies, in particular “Detector Designs”, “Offline software”, “Online Software”, “Electroweak Physics at the Z pole”, “Diboson Physics and W Mass Measurement”, “H(125) properties”, or “Top Quark Physics”. It is highly advisable to have group members participate to the more technical (and more urgent) activities of the other groups, especially if relevant to achieve the scientific objectives of the group.
- d. Create adequate sub-groups to match the group scientific objectives (if deemed useful), and suggest appropriate sub-conveners, possibly starting with a high-profile convener for each of the sub-groups.
- e. This physics group is a joint “experiment-phenomenology” group. A theory convener is to be nominated soon. Find, within about a year, one experimentalist associate to work as co-convener, and able to take over the convener task after two years or thereabout (although of prolongation of the mandate of the first convener until the end of the study is not excluded, of course). The same will be done on the phenomenology side.
- f. Appoint editors towards the production of intermediate reviews and a final yellow report. (See “Timescale and deliverables below.”)
- g. Report progress to the physics coordination of the study and at regular TLEP physics meetings (held monthly for the time being).

3. Timescale and deliverables

The Working Group “QCD and $\gamma\gamma$ Physics” is part of the physics coordination of the TLEP design study, itself part of the FCC (Future Circular Collider Design Study at CERN). The FCC study consists of three phases:

- a first phase, called “Exploration” until March 2015 or thereabout, which will serve exploring all possible options and potential studies, and identifying requirements and constraints;
- a second phase, called “Analysis” until September 2016 or thereabout, where the identified baselines are conceptually studied in detail and in an integrated fashion;
- a third and last phase, called “Elaboration”, expected to last until the end of 2017, which delivers all information required for the final Conceptual Design Report (CDR) of the study.

Each phase will conclude with a workshop and a review milestone that will layout the directions of the next phase. It would therefore be instrumental to foresee an interim written reports of the work of the group after the first two phases. A final yellow report, which will be part of the FCC CDR, is to be delivered at the beginning of 2018, and will document the scientific achievements of the group, expected to match or exceed the objectives set in the first section.

The “Phase 0” for TLEP physics studies, called “Preparation” is happening now. It should be concluded within a few weeks by the delivery, from the group convener to the physics coordinator, of a document describing in some details the “scope” for the group, with work areas, deliverables, and timeline, at least for Phase 1.