**TG4: Issues to be Addressed in White Papers**

**and Final Report for Multi-TeV Colliders**

The Snowmass 2021 Accelerator Frontier Topical Group no. 4 – Multi-TeV Colliders, in collaboration with the Energy Frontier colleagues aims to explore the potential machine routes, timelines, R&D requirements, and common issues at the very high energy scale such as energy efficiency and cost.

This document outlines the proposed structure of White Papers and key aspects that will be summarized in the final working group report. The information gathered during the preparation of these reports will also assist in the communication with other Topical Groups on synergistic matters.

We expect that the bulleted lists below may not be comprehensive, so each whitepaper team can add topics that they view as relevant to their proposal.

Structure of White Papers

1. **Design Overview**

This section will contain a high-level summary of the proposed design. The list below represents general guidance on what we expect of the overview.

* 1. Status of Design

Possible classification categories include: concept-only, pre-CDR (with significant, but not end-to-end design work available), CDR, TDR, other.

* 1. Performance Matrix

Identify the key limiting physical and technological factors in the following main areas:

* Attainable Energy
  + Acceleration rate and RF power.
  + Magnet technology: conductor, field quality, quench protection, cost.
  + Power consumption
* Attainable Luminosity and Luminosity Integral
  + Beam brightness issues:
    - Focusing lattice design (most importantly, final focus or BDS).
    - Necessary beam emittance, beam generation and cooling technologies, instabilities and intrinsic heating mechanisms.
    - Vacuum system, machine precision and control (instrumentation).
  + Beam intensity/power issues: vacuum system, machine safety, collimation, background, MDI, cryogenics.
  + Luminosity integral: luminosity time evolution, leveling, MDI limitations, repetition rate, turnaround time and reliability.
* Injector and driver systems
  + Beam Sources: driver, targetry and front-end.
  + Injector complex: energy boostering, beam preparation (emittance, bunch population and spacing).
* Facility Scale
  + Site and tunnel size and feasibility.
  + Necessary conventional facilities.
* Power Requirements
  + Energy efficiency of beam acceleration.
  + Energy efficiency of magnet systems.
  + Energy efficiency of cryogenic systems.
  + Efficiency and power consumption of conventional systems.
  1. Design Summary
* Description and references for the detailed design as it presently exists.
  1. Design Challenges
* Beam physics
* Machine design
* Required key technologies
* Environmental Impacts

1. Technology Requirements\*
   1. Technology Readiness Assessment
   2. Required R&D
   3. Required and Desirable Demonstrators
2. Staging options and upgrades

Note: ITF would like each option listed separately

3.1 Energy upgrades

3.2 Luminosity upgrades

3.3 Experimental system upgrades

1. Synergies with other concepts and/or existing facilities

4.1 Synergies on machine technologies

4.2 Synergies on detector technologies

4.3 Synergies on conventional facilities and green power

4.4 Synergies for physics research

\*Notes: A list of technology R&D LOIs related to each machine concept is included. We ask the machine coordinators to integrate inputs from these LOIs into section 2 of the document.