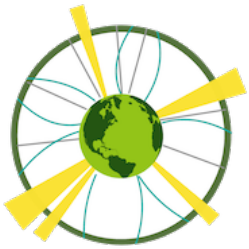

Contribution ID: **82** Type: **EITHER 15 minute talk or 5 minute 'flash' talk**

A Methodology for Calculating the CO2 Emissions from the Construction of an LHC Detector Upgrade Using Full Simulation

Monday 12 May 2025 20:00 (5 minutes)

The construction of detectors for the Large Hadron Collider (LHC) have substantial resource demands. As a case study, we examine LHCb Upgrade II, a major replacement of the LHCb detector planned for the 2030s. LHCb estimated Scope I and II carbon emissions for its Framework Technical Design Report, a first of its kind study. A brief overview of these results is given.
In this work, we propose a methodology for determining the Scope III emissions for this project and other future systems. Assessing the Scope III emissions of large detector systems, namely the impact of raw materials, presents greater challenges due to complex supply chains and indirect impacts. With around ten individual bespoke large subdetector systems, contributions from more than twenty countries and over a thousand scientists, an approach that tracks individual procurement orders is not realistic. Instead, we propose utilising the full simulation description of the detector to make an initial estimate, combined with the standard approach of Life Cycle Assessment (LCA). Outside High Energy Physics such a detailed simulation is often referred to as a "digital twin". We extract an inventory of post-processing materials from particle simulations, and implement automated cradle-to-gate impact calculations using the popular database software OpenLCA.
The process is based on the LHCb simulation, which uses GDML data, as part of the standard DD4HEP software framework. This is a widely used geometry markup language, and the main concepts are transferable to alternative geometry descriptions of other detector systems. This simulation serves as the input to our framework for a complete profile of LCA results for LHCb Upgrade II. This allows straightforward identification of materials and components with the most dominant contributions. We investigate limitations on the accuracy of the LCA, its applicability to alternative scenarios, and outline steps to improve the quality of the results.

Author: Mr GRAHAM, Dominic (University of Manchester)

Presenter: Mr GRAHAM, Dominic (University of Manchester)

Session Classification: Flash Talks