Development of simulation workflows for BSM LLPs at LHCb.

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1 Project Summary

1.1 Introduction

The LHCb detector is at present, during its Run3, taking data at an unprecedented rate of 30 MHz, thanks to the new trigger paradigm based on Real Time Analysis in new hardware architectures, in particular to the execution of the full first stage of the trigger in Graphic Processors Units (GPUs) [1]. The recent implementation of new fast tracking algorithms at this HLT1 level, inside the Allen framework, allow direct access to Downstream and T tracks from HLT1 selections, largely improving the LHCb ability to reconstruct long lived particles (LLP). This opens a window for new physics models that contain particles with high lifetimes, which have not been observed before in HEP experiments due to the restrictions of the trigger systems [2].

The main objective of this project is to study, simulate, and analyze new physics models in the context of the HEP experiments, and in particular inside the LHCb and Allen framework. New workflows have to be developed with high flexibility to be possible to modify new physics properties like masses of the involved particles and lifetimes. A high level of parallelism is important to be able to produce large data samples in short time.

1.2 Methodology

For data samples production a number of LHCb frameworks should be used: Gauss (The LHCb simulation framework which manages the creation of simulated events by interfacing to multiple external applications, such as Pythia, EvtGen, Geant4), Boole (the simulated hits making in the virtual detector converting to signals that mimic the real detector) and Moore (the High-level trigger application.). All these application can be run on Dirac, which is the LHCb distributed computing grid infrastructure for Monte Carlo (MC) production and analysis. Its architecture is based on a set of distributed collaborating services. Ganga is a system for job submission to different backends.

1.3 Specific goals

1. Understanding of the different physics scenarios that include LLPs.
2. Deep understanding of the LHCb generation framework.
3. Development of a flexible and fast framework that can be used to generate different models with different properties. Model parameters (couplings, particle masses, lifetimes, etc...) have to be modifiable.
4. Study of the simulation output inside the Allen framework.
5. Selection and optimization of the output, development of a ”finder” algorithm for new physics.

1.4 Timeline

- **Week 1-2:** Study of new physics scenarios with LLPs.
- **Week 3-5:** Study the DIRAC framework and ganga in deep. Designing workflows for fast and flexible simulations.
- **Week 6-7:** Develop and test workflow with an example: Dark Boson production and testing several decay channels. Algorithm testing.
- **Week 8:** Data samples testing using HLT1 (Allen). Adding improvement to simulation workflow.
- **Week 9-10:** Algorithm creating and testing for extra channels. Selection and Optimization.
- **Week 11-12:** Preparation of structured documentation for the developed modules. Creation of the final presentation for the project.

References

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