Welcome and Introduction

LPCC MCWG Tuning Forum

22nd September 2026

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Tuning Forum Conveners

- Lorenzo Bernardinis (ALICE)
- Tom Hadavizadeh (LHCb)
- Leif Lönnblad (PYTHIA)
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Feedback and comments

- Recipe for how to try and estimate the **uncertainties** of the non-perturbative parameters
- Repository defining mappings between **datasets, generators, models,** and **methods**
- Mapping, which observables are **sensitive** to which parameters and which they are not sensitive to
- Define a minimum requirement for what is needed to deem a tune “reproducible”:
  - A weights file for Professor
  - A GoF measure
  - The set of parameters to be varied (and others that are fixed)
  - Generator settings/configs/cards
  - Observables and bins used
- Collect a list of **observables** (Rivet routine + histogram [+ bin range]) that are useful. For each generator specify which parameters are sensitive/targeted.
- Do we need a side entrance to Rivet to analyse non-event-based generator output such as cross sections as a function of collision energy?
- Monthly (bi-weekly?) shorter tuning forum meetings with one or two talks and discussions.
- It would have been nice if we could find a common set of observables that would define a common (preferably reproducible) base tune for LHC for all generators.

Feedback and comments

- Set up a central **tune registry**, where all published or presented tunes are stored with their generator version, cards, observables, and validation material.
- Encourage **students** and **early-career researchers**, who often do the hands-on tuning work, to attend the forum and present their practical experience, challenges, and lessons learned.
- Explore the possibility of organising a **tuning-focused school or tutorial** series to train new people in modern MC tuning tools and workflows.
- Introduce discussions on **ML-based tuning approaches** and on the possibility of shipping reusable tuning frameworks or benchmark setups alongside event generators.
- Encourage closer **collaboration** between **experimental groups** and **generator developers**, so that the large tuning efforts already carried out by experiments can feed into better physics-motivated tunes, validated jointly by experiment and theory, and eventually shipped with the generators for broad community use.
- Compare tuning to certain subclasses of observables as a means of assessing **tuning systematics** from a theoretical point of view and to disentangle sensitivity to different model components.
- Tune at different values of the infrared parton shower cutoff to assess the **consistency of the factorization between shower and hadronization**

Feedback and comments

- Retune at meaningful **parton shower variations** to assess what the true residual uncertainty from these variations is. Variations in the shower alone need to be used carefully due to an unavoidable cross-talk to hadronization in a factorized context.
- Extrapolate tunes between different energies and cross check that evolution from different points give consistent results.
- Regular discussions of best practices and approaches.
- Forum for idea dissemination, introduction of students.
- Way to determine **correlation between parameters** to tune. Professor returns this information for example, but it is strongly dependent on the order of the polynomial and on the number of the sampled points. It can provide very different values. I think that a more robust way to define correlation between parameters can help in the choice of the parameters to tune together, since often the number of parameters is of the order or 6 or more, it is convenient to factorize the tuning procedure in different steps.
- Common procedure to assign **statistical/systematic errors** to the tuned parameters.
- Explore possibilities of different functions to be minimized in order to find best parameter values? One possible example was discussed during the PYTHIA Week 2024 (Link to the contribution: https://indico.global/event/12626/#14-errors-on-errors)

Feedback and comments

- Longer-term outcome of these discussions could be drafting a public note (similar to other LHC WG notes) with best practices and approaches in tuning; a **tuning 'handbook'**. This would not particularly deal with the details of the **tools** (since Professor may now be the standard tool but not necessarily in 5 years from now) or specific areas that need to be tuned (discrepancies in the data evolve over time with new generators and physics understanding), but rather the approaches to obtain tunes that are most useful for the community as a whole. The idea would be that, by focusing on strategy rather than actual results, this might guide the overall tuning effort well within HL-LHC too. For instance:
  - Assessment of uncertainties
  - Factorized or simultaneous tuning?
  - Validation strategy
  - Reproducibility
  - Tuning should typically focus on non-perturbative aspects, but in which cases tuning of perturbative parameters (e.g. α_s) could be acceptable from a theoretical point of view as well?