"Introduction"

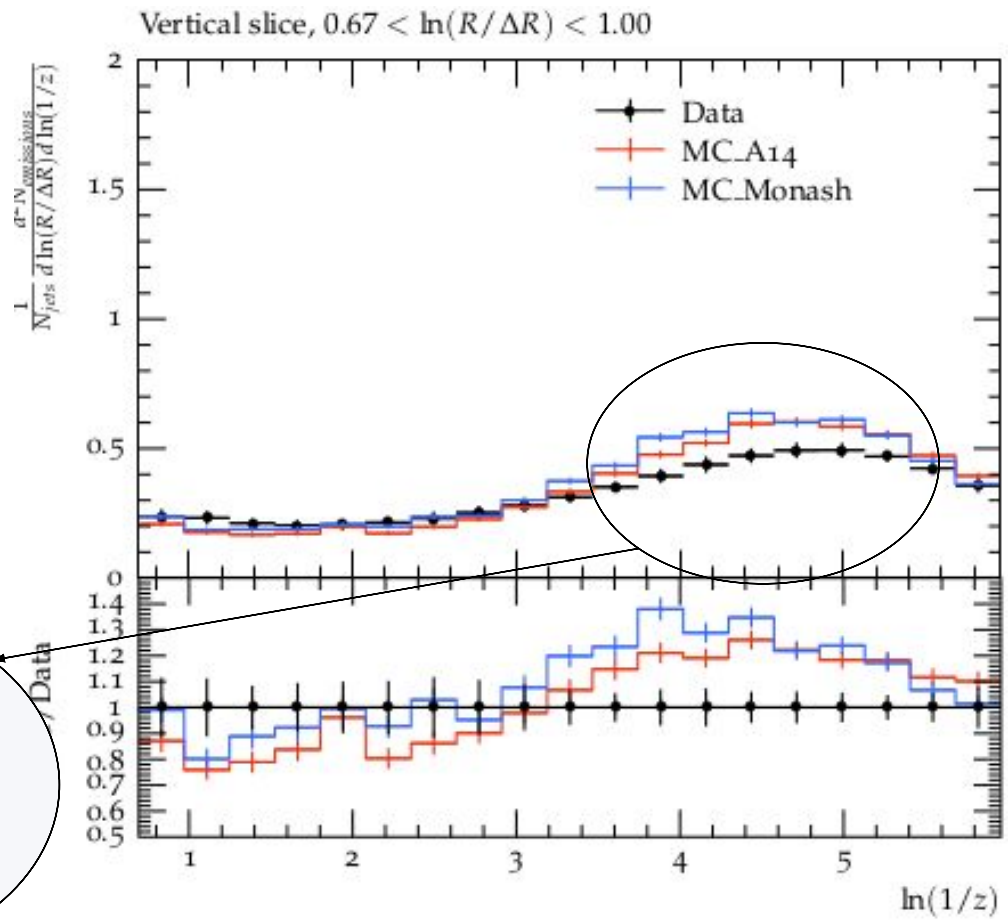
Herwig 7 tuning and KrkNLO implementation with spin correlations

Pratixan Sarmah

(PhD student at Jagiellonian University, Krakow)

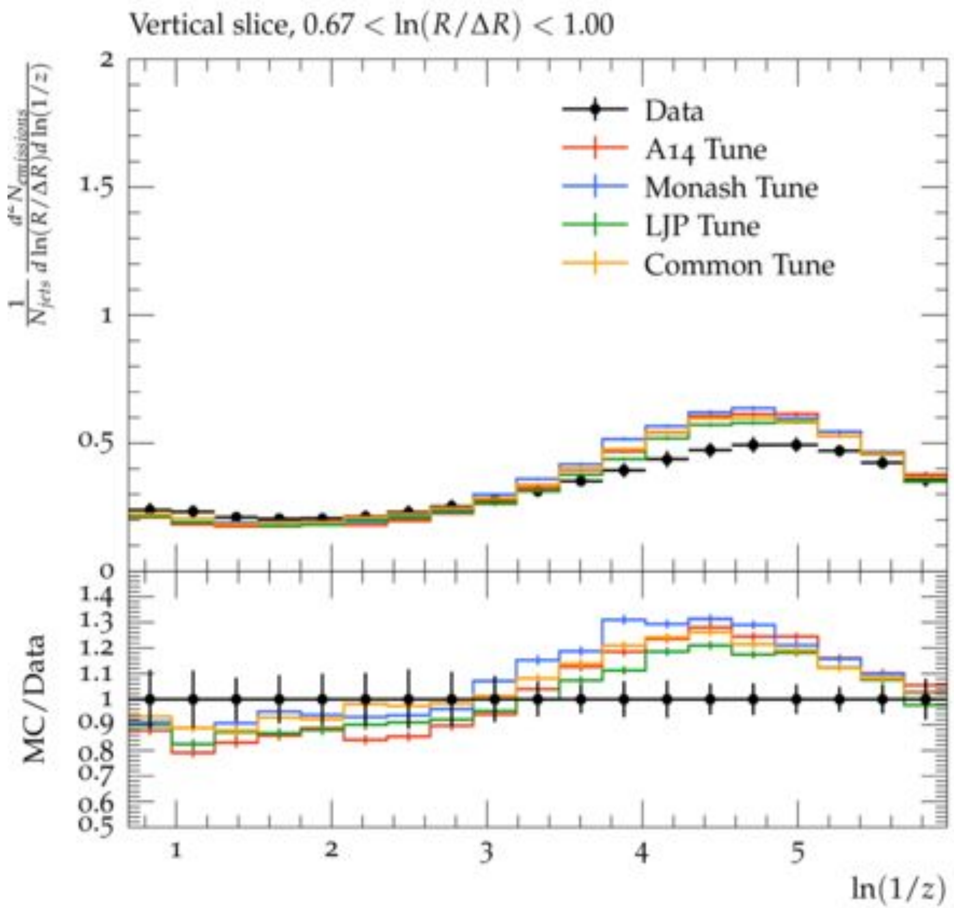
Background

- Completed my MSc. in India in 2021
- MSc. thesis on tuning FSR parameters in Pythia
- Looked at the effect of Jet Substructure measurements by ATLAS on the tune



TENSION between Data and MCEG modelling => Scope for improvement of the MCEG

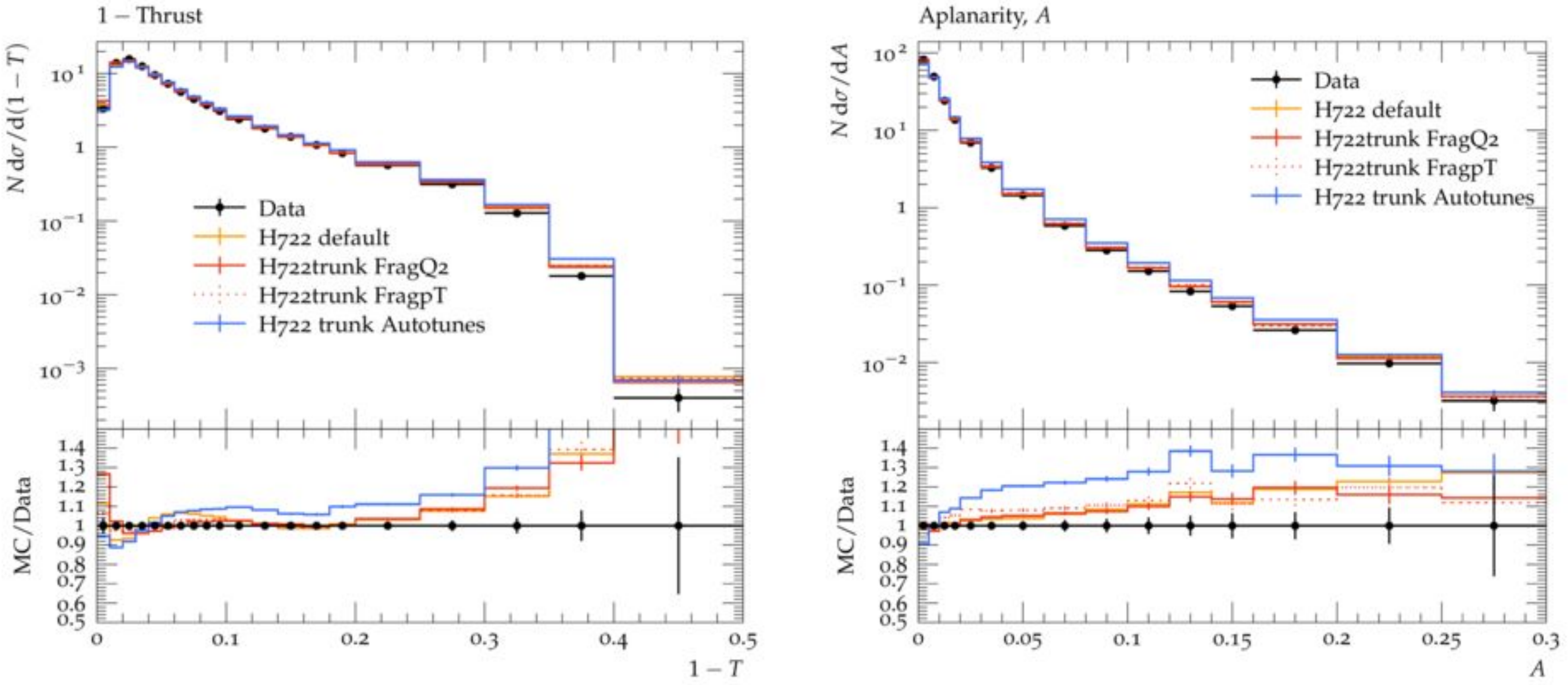
Plotted using data from published analysis : Measurement of the LJP using charged particles in 13 Tev p-p collisions with the ATLAS detector. https://arxiv.org/abs/2004.03540



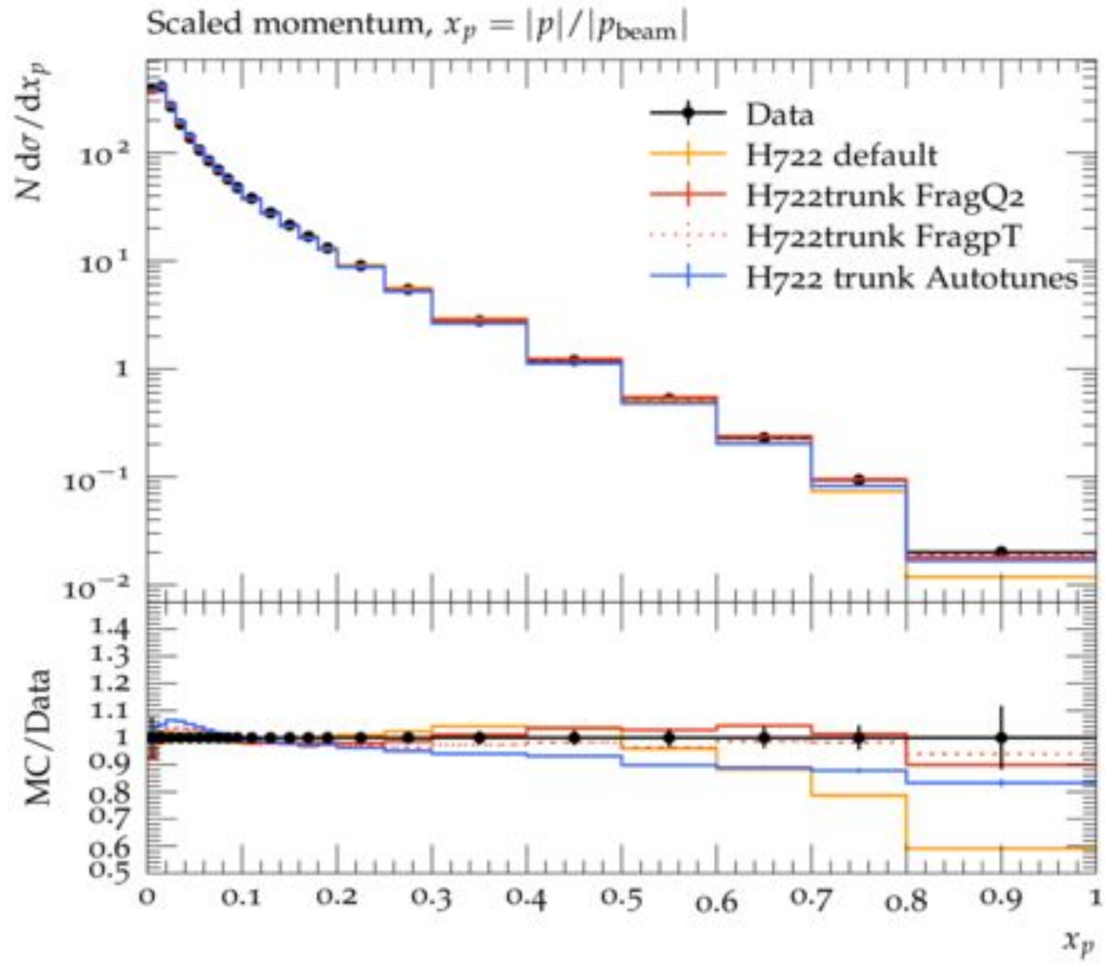
Link to the pre-print - https://inspirehep.net/literature/1842994

First year as a PhD

- Started where I left.. More tuning!
- Tuning of fragmentation parameters in the String model with Herwig
- TheP8I, written by L. Lonnblad allowed the internal use of Pythia 8-stings with Herwig 7 events.



Autotunes paper by Johannes Bellm and Leif Gellersen - https://inspirehep.net/literature/1751



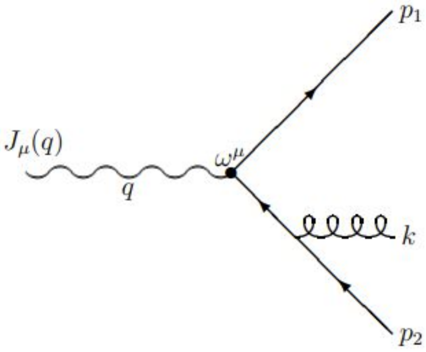
- **Next step** - Tuning to hadron hadron data

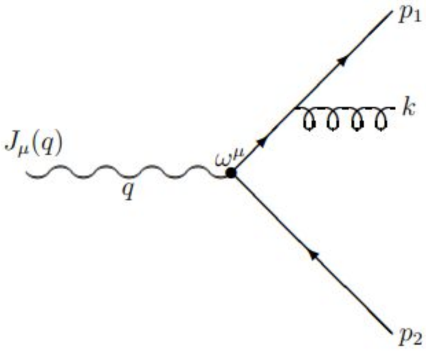
- NLO Matching with a new method - **KrkNLO method** (https://arxiv.org/abs/1503.06849): On the principle of using MC pdfs and reweighting (refer James' talk)
- LO and NLO Validations for Drell Yan and Higgs productions

Drell Yan production	**Cross section (pb)**	**Reference**
LO with MCDY pdf	737.2(7)	738
NLO using KrkNLO with MC pdf	1022.0(1)	1022.3(2)

Higgs production via gg fusion	**Cross section (pb)**	**Reference**
LO	5.572(4)	5.564(1)
NLO using KrkNLO with MC pdf	12.948(9)	12.939(2)

- First results for W-production with KrkNLO
- Spin correlations for Drell Yan and W productions
- Implementation guided by the paper - "**A Simple prescription for first order corrections to quark scattering and annihilation processes**" M.Seymour, 1994 (https://inspirehep.net/literature/378040)





Thank you!

Algorithm to implement spin correlation

$$d\sigma_3 = \frac{f_{q/1}(\xi_1) f_{\bar{q}/2}(\xi_2)}{f_{q/1}(\eta_1) f_{\bar{q}/2}(\eta_2)} \frac{C_{\mathrm{F}}\alpha_s}{2\pi} \; \frac{d\hat{s}d\hat{t}}{\hat{s}^2\hat{t}\hat{u}} \left\{ (Q^2 - \hat{u})^2 d\sigma_2 \frac{d\phi}{2\pi} + (Q^2 - \hat{t})^2 d\sigma_2 \frac{d\phi}{2\pi} \right\}.$$

1. Generate a parton model event according to the exact $\mathcal{O}(1)$ matrix element.
2. Generate $\hat{s}$ and $\hat{t}$ values according to $Q^4 d\hat{s}d\hat{t}/\hat{s}^2\hat{t}\hat{u} = Q^4 d\hat{s}d\hat{t}/\hat{s}^2\hat{t}(Q^2 - \hat{s} - \hat{t})$.
3. Construct momenta in the boson rest-frame corresponding to these values.
4. Choose parton 1 with probability $(Q^2 - \hat{u})^2 / \left((Q^2 - \hat{u})^2 + (Q^2 - \hat{t})^2 \right)$, and otherwise parton 2, and uniformly rotate about the chosen parton.
5. Boost the momenta back to the lab frame such that the boson's rapidity is the same as it was in the parton-model event.
6. Calculate a weight factor

$$w = \frac{C_{\mathrm{F}}\alpha_s}{2\pi} \frac{f_{q/1}(\xi_1) f_{\bar{q}/2}(\xi_2)}{f_{q/1}(\eta_1) f_{\bar{q}/2}(\eta_2)} \left\{ (1 - \hat{u}/Q^2)^2 + (1 - \hat{t}/Q^2)^2 \right\}.$$

7. Keep the event with probability proportional to w.