Semester Report 3

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Introduction

This semester was very research-heavy. Whilst I did take a course and attend a research school, the majority of my time was spent continuing the research from the summer. A lot of this work was focused on running checks on the main computation of our project and then investigating any mismatches that were identified. Overall, the term had a strong focus on validation and refinement: running calculations, comparing outputs, and digging into the details whenever something looked inconsistent.

Courses

Experimental Methods in Particle Physics 2

This semester I took the follow-up course to last semester's Experimental Methods in Particle Physics 1. This course had a stronger focus on data interpretation and the limitations of different methods, rather than just the techniques themselves. I found this challenging, as it is a type of physics I am not accustomed to; however, it was a rewarding experience and has helped me become a more well-rounded physicist.

Schools

Terascale Monte Carlo School 2025

This term I attended a five-day school held at the DESY institute in Hamburg, Germany. It covered Monte Carlo methods for high-energy particle physics, with lectures on topics including NLO and NNLO fixed-order calculations, PDFs, resummation, NLO showers, matching and merging, and negative weighted events. It also had very hands-on tutorials using the parton shower event generator programs `PYTHIA`, `HERWIG`, and `Sherpa`. All of this is directly relevant to my studies, and the tutorials in particular taught me skills I will likely be using soon in my research.

Research

Over the semester I built a check for our cross-section calculation using an analytic form from the paper [1]. At LO, this was fully analytic and then integrated numerically. For NLO, we used a list of values of the NLO DIS coefficient functions, made this into a continuous function, and converted that to a cross-section by integrating it numerically as well. This was then used to produce several histograms, so we could directly compare shapes and normalisations across different regions.

These checks showed mismatches in certain regions of phase space, which then needed a lot of investigation. Most of the work was figuring out exactly where the differences come from and whether they are numerical or from how things are implemented. We hope to publish preliminary results soon.

Conclusion

This semester was overall very productive. I made progress both on the research side (through implementing and using cross-checks) and on the broader background needed for the project through the course and the Terascale Monte Carlo school. The main outcome is that we now have clearer validation tools in place, and a more concrete understanding of what still needs to be resolved going forward.

References

[1] W. L. van Neerven S. Riemersma, J. Smith. Rates for inclusive deep-inelastic electroproduction of charm quarks at hera. 1994.