EIC Detector R&D Progress Report *and Proposal*
Reporting Period: From May 2013 to January 2014

Project Name: 2012-5 Physics Simulations

Project Leader: Thomas Ullrich

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Past

What was planned for this reporting period?

1. We planned to finish the unintegrated gluon fit with CASCADE and use it to extend CASCADE to *e*A-collisions. We planned to implement CASCADE into the framework of the existing *e*A-hybrid between DPMJetIII and Pythia, using nuclear uPDFs in CASCADE for matrix-elements and parton evolution, Pythia for hadronization (standard in CASCADE), and FLUKA (in DPMJetIII) as an afterburner for hadronic energy-loss in a cold medium and nuclear breakup and evaporation.

2. We planned to continue to not only maintain but improve the Sartre event generator and keep the documentation up to date.

What was achieved?

We have made great progress in adding inclusive diffractive processes to the Sar*t*re event generator. These processes constitute a generalisation of the exclusive vector meson and DVCS processes which are currently fully implemented in Sar*t*re 1. This was deemed necessary at an earlier stage than first envisioned, since it was agreed in the EIC community that we need an improved set of graphs for inclusive diffraction in the next updated version of the EIC White Paper. The current predictions are based on analytical calculations in the Dipole model by Cyrille Marquet, which do not allow us to study kinematic and acceptance constraints. We have implemented the necessary cross-sections for both ep and eA, and successfully describe available data, and we reproduce the results of previous calculations.

We have submitted a technical description of the Sar*t*re program to Computer Physics Communications. It is also available on the archive (arXiv:1307.8059).

We have, with the help of the PhD student Liang Zheng started a grid computing project to extend the phase-space of Sar*t*re from EIC energies to LHC, and LHeC energies. This we do so that Sar*t*re may serve a larger HEP community in the near future. The Sartre user community is slowly growing and the program is used by several colleagues in the US and users in China and Europe.

What was not achieved, why not, and what will be done to correct?
We have not made headway with the promising project of adding eA to CASCADE. This was because the implementation work on inclusive diffraction have become more urgent. We will do this in the near future instead.

Future

What is planned for the coming months and beyond? How, if at all, is this planning different from the original plan?

We plan to take the next steps to fully implement inclusive diffraction into a new version of Sar*t*re (version 2). For this, we first need to generate inclusive events. As a second step, we will need to link Sartre with Pythia to generate fully exclusive final states.

We will continue to keep the documentation up to date.

We plan to finish the unintegrated gluon fit with CASCADE and use it to extend CASCADE to *e*A-collisions. We plan to implement CASCADE into the framework of the existing *e*A-hybrid, using our nuclear uPDFs in CASCADE for matrix-elements and parton evolution, Pythia for hadronization (standard in CASCADE), and FLUKA (in DPMJetIII) as an afterburner for hadronic energy-loss in a cold medium and nuclear breakup and evaporation.

With our dipole model, saturation is inherent for small x in the nuclear initial state. Given time, we also have plans to include perturbative saturation in the CCFM-evolution in CASCADE.

We plan to release an updated version of Sar*t*re 1, including amplitude look-up tables covering the phase-space of the LHC and the future LHeC, together with Liang Zheng.

This is different from the original plan, since we previously envisioned working on CASCADE before implementing the inclusive diffractive processes in Sar*t*re.

What are critical issues?

Maintain man power past the current R&D effort to maintain and possibly extend the developed event generators for the EIC community.

Proposal for 3 month extension of the R&D program

The R&D program ends May 2, 2014 (check) and with it the appointment of Dr. Tobias Toll who was hired with the R&D funds to work on this effort. Two items remain to be completed, which are (i) to write, test, and prepare version 2 of Sartre, which includes the inclusive processes, and (ii) finalizing the work on CASCADE.
This is not feasible in the currently remaining time.

Tobias has the likely prospect for a junior professorship. However, this appointment, if realised, starts earliest in July 2014. This opens an opportune window to complete the outstanding tasks. Therefore, **I request an extension of the R&D program by 3 month.** This moderate extension would on the one hand allow us to finish the remaining tasks that are urgently needed for the preparation for the NSAC Long Range Plan and on the other would bridge Tobias's employments allowing for a

smooth transition. Tobias will continue to work on the EIC project in his new position although his teaching duties will certainly at the beginning limit the amount of time he can spend on the continuation of our project.