

Archiving last polarized $p + p$ data with streaming DAQ and AI

Physics need → Streaming DAQ → Real-time AI

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Coming RHIC runs : last of world's polarized $p + p$ collisions

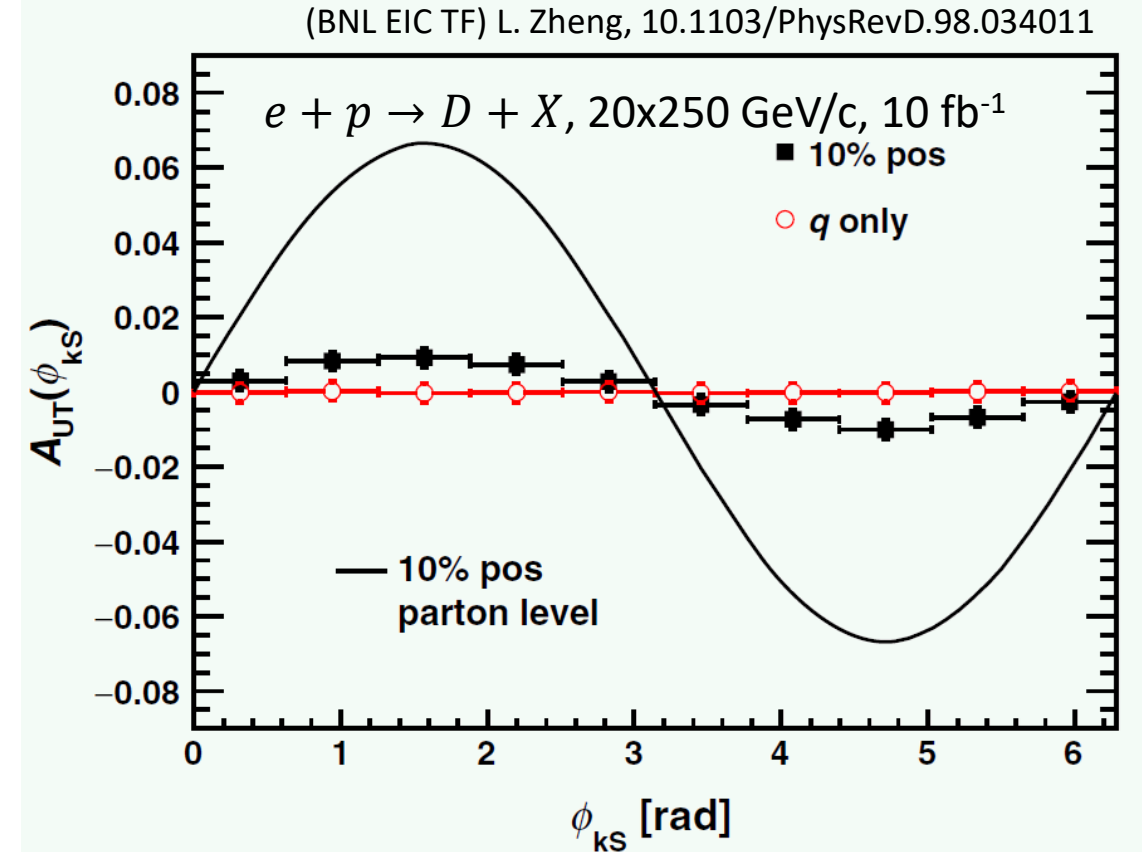
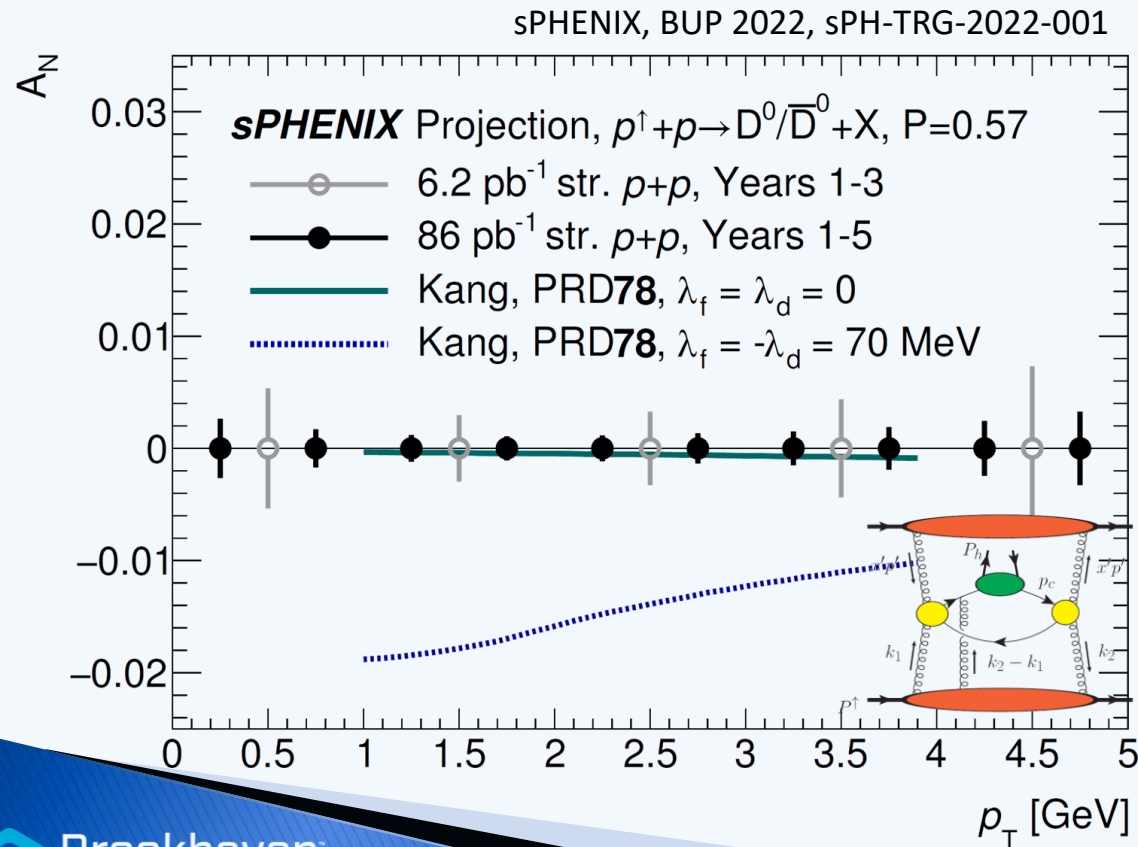
Critical for max preservation for future EIC comparison \rightarrow Streaming DAQ

Example: universality of Gluon Sievers effect, $p + p$ vs $e + p$

← Universality test on gluon Sievers eff. →

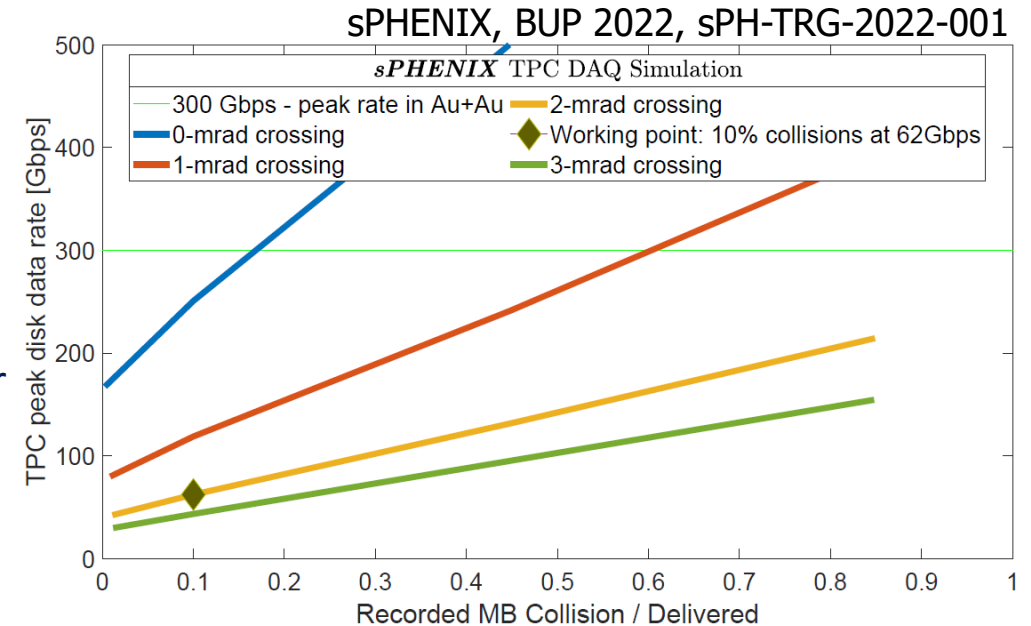
sPHENIX D^0 trans. spin asymmetry, $A_N \rightarrow$ Gluon Sievers via tri-g cor.

EIC SIDIS D^0 transverse spin asymmetry \rightarrow Gluon Sievers



Address the challenge: streaming readout at sPHENIX

- ▶ Many $p + p$ physics only accessible via un-triggered data, including D0, inclusive tracks, new observables for future
- ▶ Paradigm shift for streaming readout, for sPHENIX and EIC:
 - All three sPHENIX tracking detector uses streaming readout
 - Developed plan to take 10% streaming data for heavy flavor physics program commended by RHIC PAC.
 - Experience to be applied for EIC too
- ▶ Streaming DAQ calls for novel techniques for real-time data reduction at RHIC and EIC → Realtime AI



We commend sPHENIX for developing the continuous streaming readout option for the detector, which increases the amount of data that can be collected in Run-24 by orders of magnitude. In particular in the sector of open heavy flavor, this technique will give access to a set of qualitatively novel measurements that would otherwise not be accessible. Given the tight timeline for completing the RHIC physics program before construction of the EIC begins, this is a tremendous and highly welcome achievement.

RHIC PAC 2020 report

Physics driven need for Real-time AI applications for sPHENIX and EIC

- ▶ Real-time AI data reduction will enhance the physics output, see also BNL Physic-AI meetings [link to [my talk](#), [Maxim's talk](#)], e.g.
 - Lossy compression of data, noise filtering (LDRD 19-028)
 - Feature extraction: energy time extraction from ADC time-series (LDRD 21-023, NPPS)
 - Feature extraction: tracking, vertexing, HF signal selection (sPHENIX ML Open Data [[GitHub](#)]→SBIRs→sPHENIX demo. See BNL AIMS seminar D.T. Yu [[link](#)])
- ▶ Advanced hardware platforms for real-time AI computing under study:

In-memory computing at ASIC | DNN on FPGA | AI-chips w/ non-von-Neumann Architecture

