Thoughts on Theory Needs for a Muon Ion Collider

- Honestly our focus has been on building a case for a MuIC, as an alternative and novel facility for DIS measurements, EF physics, and nuclear physics.
- Additionally we have started looking at the associated experimental challenges that may differ from an electron-proton machine
  - Thus the science case probably will not hinge on e.g. higher order terms in the calculations, though of course the measurements will!
- That said, suggestions on which topics could take advantage of such a facility and the needs from theory to maximize the science extraction are welcome!
  - e.g. electroweak corrections
- Ultimately a serious physics potential report (CDR/TDR) must use the state-of-the-art
- Anyway most of our calculations were done with Madgraph, and generally at LO, though NLO is most likely possible
- SM particle production (incl. Higgs) proceeds generally through Vector Boson Fusion
  - So uncertainties on those predictions in DIS would be relevant
  - Perhaps particularly for cross section and mass measurements of single W and top (?)

One Particular Theory Need for LHC

- Higgs width measurement at the LHC via a measurement of the ratio of off-shell to on-shell production (ZZ, WW)
  - The on-shell pole piece has only the width in the propagator
  - The $qq \rightarrow ZZ^* \rightarrow 4l$ background features an uncertainty in the NLO EW corrections applied to the simulation, which are significant at higher m4l values. This becomes the dominant systematic uncertainty in this measurement and the evolution of the uncertainty against m4l [15% at 1 TeV]