

# Potential of A TeV Muon-Ion Collider at BNL

– The ultimate QCD frontier and a path toward a new energy frontier

*Based on*

- *Nucl. Instrum. Meth. A 1027 (2022) 166334*
- *arXiv:2203.06258, a whitepaper submitted to Snowmass 2021*
- *Muon Collider Forum Report: arXiv:2209.01318*

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## Why now as EIC is not built yet?

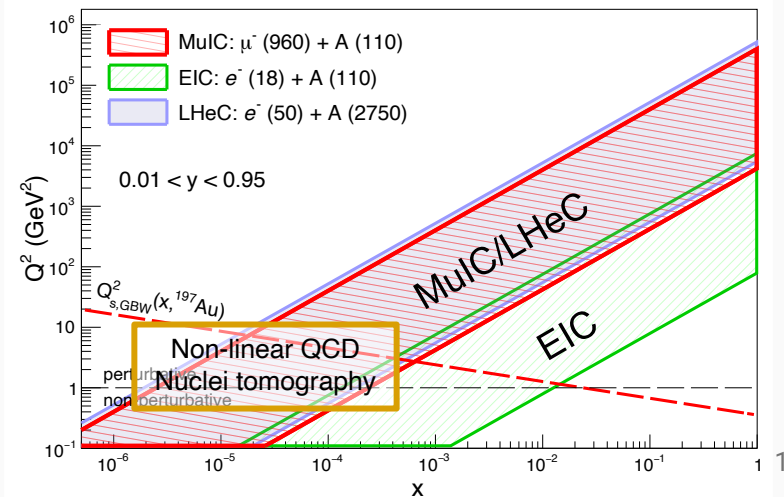
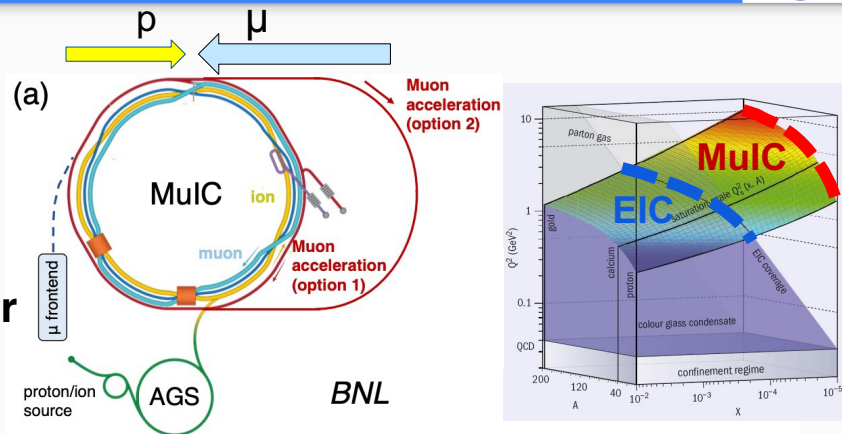
– It took 20+ years to develop the case for EIC. If the community wants an ambitious future beyond EIC, it is time to think NOW!

## A TeV HL-DIS machine – the ultimate QCD frontier

- $\sim 1$  TeV  $\mu$  beam could be hosted at EIC tunnel to collide with a 275 GeV hadron
- Luminosity up to  $5 \times 10^{33}/\text{cm}^2$
- Expands high  $Q^2$  and low  $x$  reach by 1–3 orders of magnitude over HERA/EIC

## MuIC will bring us deep into the nonlinear QCD regime and enable a wide range of opportunities:

- Spin physics down to  $x \sim 10^{-5}$
- Precision PDFs, EWK and QCD in new regimes
- Higgs production
- BSM searches with initial muon (e.g., CLFV, LQs)



# MuIC R&Ds and Synergies



**Muon Accelerator Program (MAP) in US for feasibility studies in 2011-2016**

**Growing interests in muon colliders in HEP community:**

- Formation of [International Muon Collider Collaboration \(IMCC\)](#) by CERN in 2021: consider **3 TeV  $\mu^+\mu^-$**  as an initial step
- Active discussion in Muon Collider forum from Snowmass 21 ([white papers](#))

**Many challenges to overcome but no obvious showstopper**

**MuIC – Opportunities and synergies for NP community**

- A demonstrator to support  $\mu$  collider R&Ds
- The first  $\mu$ -based collider sited in US
- Affordable: an “upgrade” to EIC by re-using existing facility
- Attractive to both particle and nuclear communities

**Recommendation: support R&Ds initiatives for novel accelerator technology by synergizing with other communities (e.g., HEP)**

**25 years to realize first muon collider!**

