Exploring Gluon Saturation at a Moderate-Energy Electron Ion Collider

Principal Investigator(s): *Rongrong Ma*

List of the proposal participants and their organizations:

Bjoern Schenke (BNL), Kong Tu (BNL)

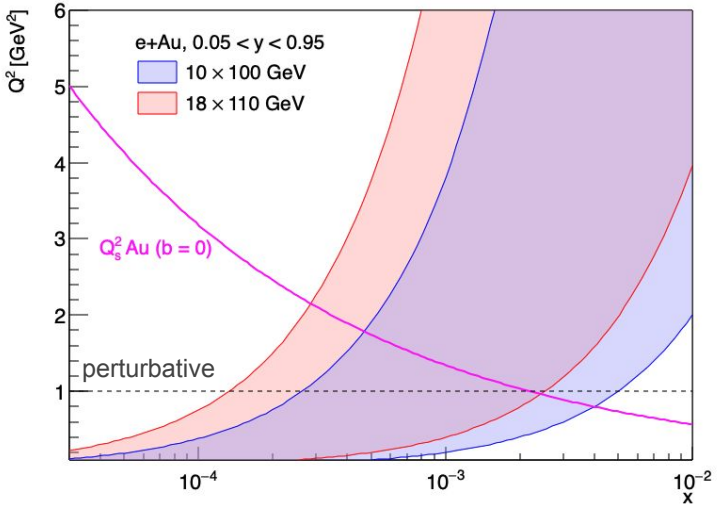
Thomas Ullrich (BNL), Yoshitaka Hatta (BNL)

Proposal term from: 10/2026 to: 10/2029

Annual funding: FY27-29 $600k/year

THE CHALLENGE: LIMITED ELECTRON ENERGY

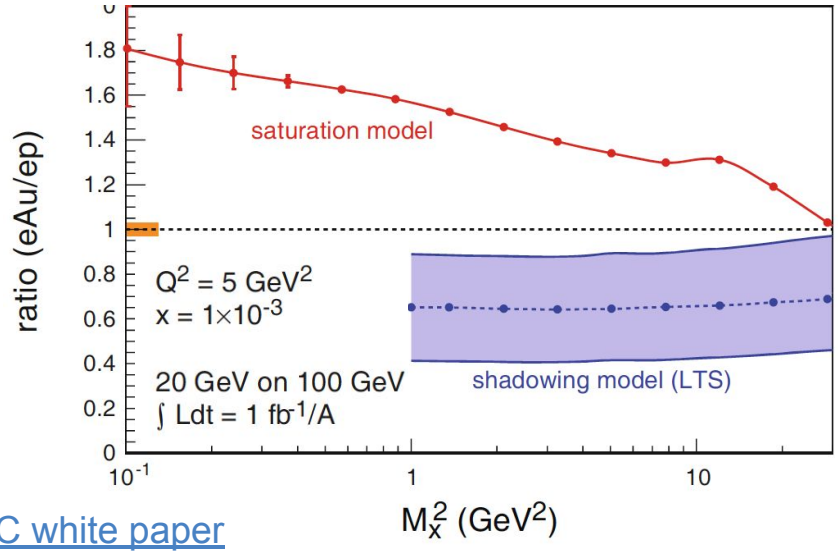
- A key scientific goal of EIC is to **establish and understand gluon saturation,** a novel regime of nuclear matter**.** It directly contributes to lab's mission **of exploring the Constituents of Matter.**
- Saturation effect grows with decreasing *x*, which motivated 18 GeV electron beam



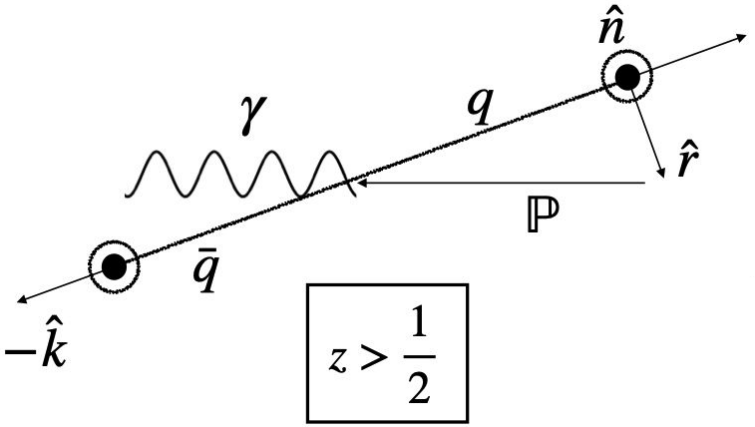
- *Recent news on funding constraints: electron energy limited to 10 GeV*
  - *Factor ~2 shrink in x reach*
- This proposal aims at addressing this critical challenge from both theoretical and experimental aspects

PROPOSAL OBJECTIVES

- With state-of-art theoretical frameworks (e.g. CGC), **re-evaluate sensitivity** of various observables for 10 GeV electron beam and explore **leverage from nuclear size dependence**
- **Implement** gluon saturation into eA **Monte-Carlo program**
- **Feasibility studies** with ePIC detector simulation
- **Explore new observables**, such as those connected to entanglement



EIC white paper



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HOW DOES THE PROPOSED RESEARCH ENHANCE THE LAB STRATEGY

- EIC is the top priority for BNL for the next decade, and understanding gluon saturation is key to EIC's success.
  - Saturation is one of five EIC scientific pillars identified by NSAC

- This proposal **directly advances BNL's strategic planning**
  - Evaluates feasibility of gluon saturation measurements under current energy constraints
  - Informs detector optimization, analysis strategies, and upgrade planning
    - Reduces strategic risk to BNL's future flagship facility
  - Enables broader physics opportunities at EIC

- Strengthens BNL's Leadership in Nuclear Physics

THE RESEARCH TEAM

Rongrong Ma (BNL, PI)
- Convener of Jets & HF working group in ePIC

Bjoern Schenke (BNL, Co-PI)
- Leading theorist in gluon saturation, Color Glass Condensate

Kong Tu (BNL, Co-PI)
- Convener of Exclusive, Diffractive and Tagging WG in ePIC

Thomas Ullrich (BNL, Collaborator)
- Experimental expert in saturation physics

Yoshitaka Hatta (BNL, Collaborator)
- Theoretical expertise in small-*x* physics, entanglement

1 theoretical and 1 phenomenological/experimental postdocs

1 student collaborator

WHY BNL

BNL is uniquely positioned to lead this effort

- **Host laboratory for the EIC**
  - BNL is responsible for delivering the EIC and ensuring its core science goals are met
  - Gluon saturation is a *flagship objective* of the EIC identified in the NSAC Long Range Plan

- **Birthplace of saturation physics; in-house experts**
  - World-leading theory expertise in saturation and CGC
  - Leading experimentalists in ePIC to study saturation observables
  - Maintain BNL's leadership in this area

Draft LDRD Funding Table

	Year 1	Year 2	Year 3
Ma	15% salary*	15% salary	15% salary
Tu	5% salary	5% salary	5% salary
Schenke	5% salary	5% salary	5% salary
Postdoc 1	$200k	$200k	$200k
Postdoc 2	$200k	$200k	$200k
Student	$50k	$50k	$50k
Others (travel, workshop et. al.)	$50k	$50k	$50k

* Assuming salary of $400k/year with overhead