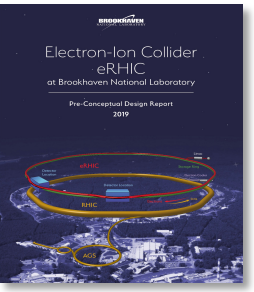
Center for Frontiers in Nuclear Science

Center for Frontiers in Nuclear Science (CFNS)

- What is the Electron Ion Collider (EIC)?
- CFNS: history, vision and recent activities & successes
- Synergy with the Inter-American Network of Networks of QCD Challenges

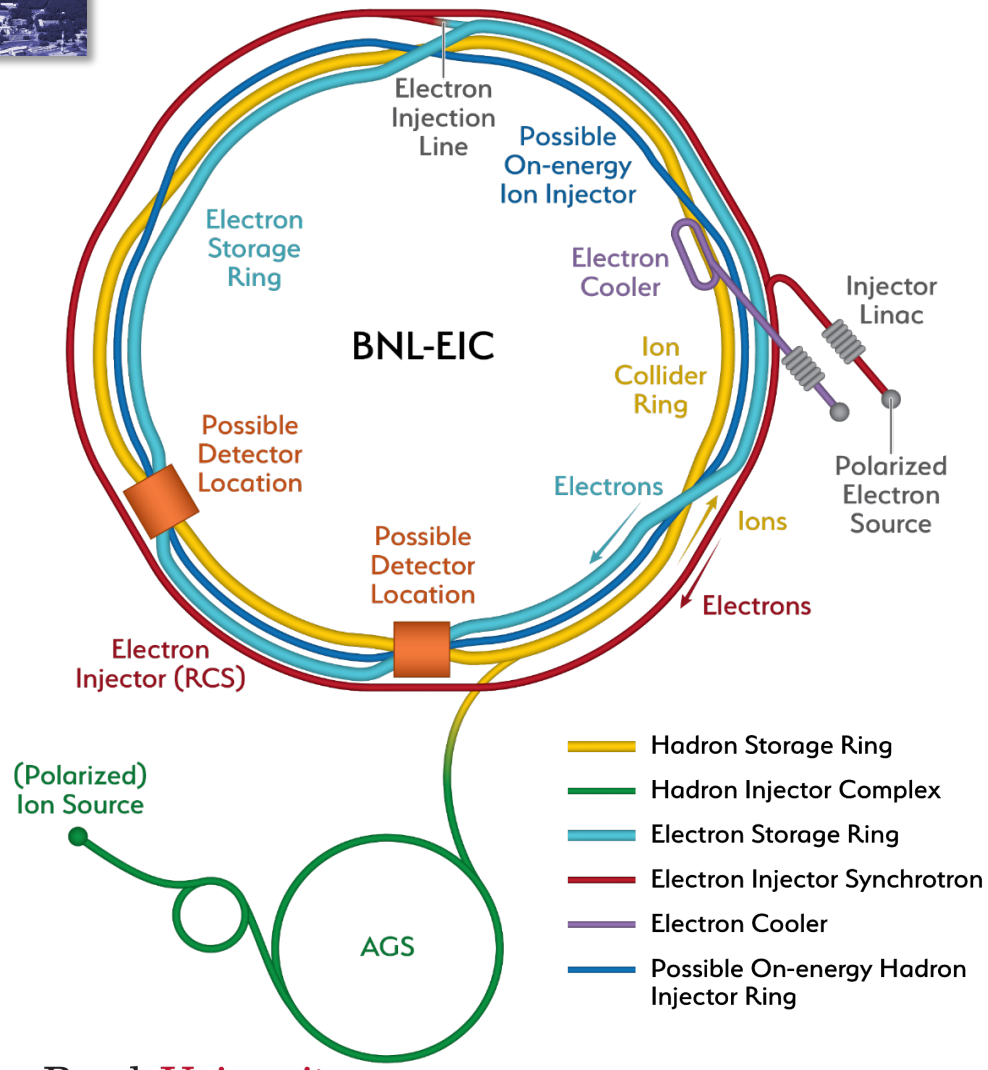
Abhay Deshpande
Stony Brook University
Brookhaven National Laboratory

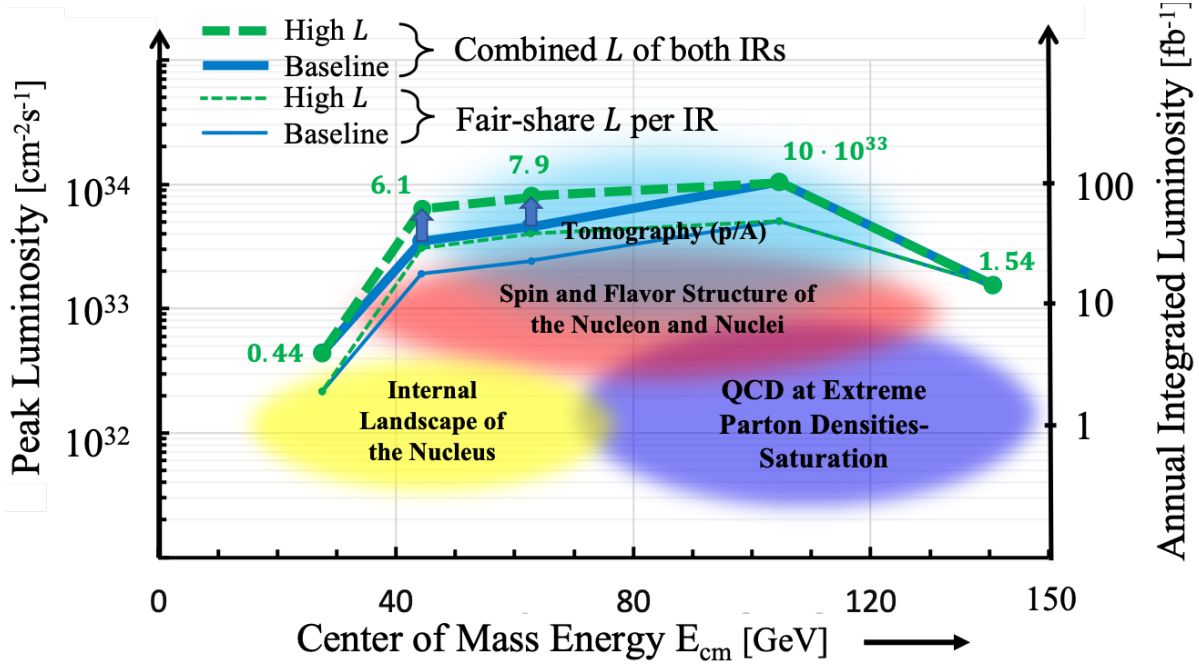


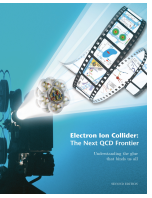
EIC Accelerator Design

Plan to be ready in 10 years

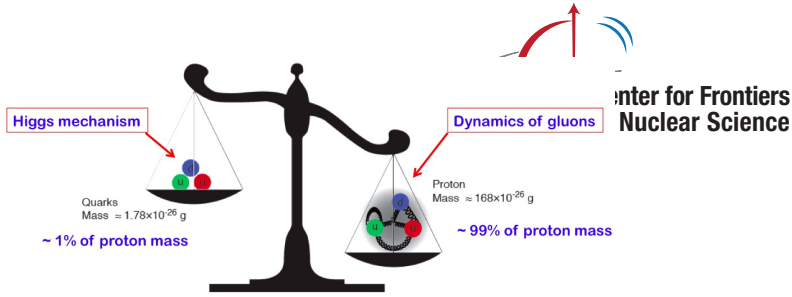
Center of Mass Energies:	20GeV - 140GeV
Luminosity:	10^{33} - 10^{34} $cm^{-2}s^{-1}$ / 10-100fb^{-1} / year
Highly Polarized Beams:	70%
Large Ion Species Range:	p to U
Number of Interaction Regions:	Up to 2!





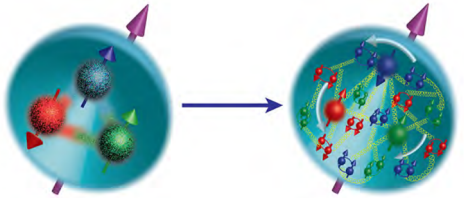


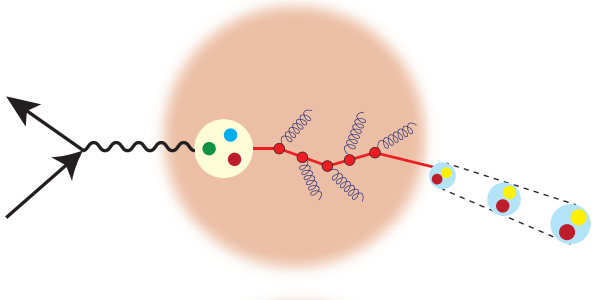
EIC Physics at-a-Glance



How are the sea quarks and gluons, and their spins, distributed in space and momentum inside the nucleon?

How do the nucleon properties (mass & spin) emerge from their interactions?





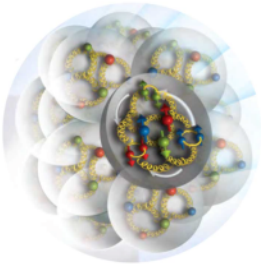
How do color-charged quarks and gluons, and colorless jets, interact with a nuclear medium?

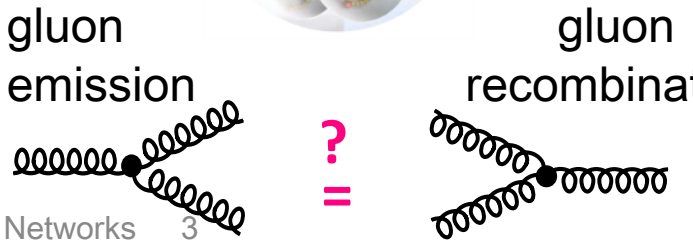
How do the confined hadronic states emerge from these quarks and gluons?

How do the quark-gluon interactions create nuclear binding?

How does a dense nuclear environment affect the quarks and gluons, their correlations, and their interactions?

What happens to the gluon density in nuclei? Does it saturate at high energy, giving rise to a gluonic matter with universal properties in all nuclei, even the proton?





Vision:

Center for Frontiers in Nuclear Science

https://www.stonybrook.edu/cfns/

Founded in September 2017

Simons Foundation support till 2027
+ NY State : Renovations at Stony Brook
+ BNL : Renovations at BNL (Seminar Room)

A Center for all scientists interested in the US Electron Ion Collider (& Nuclear Science)

A “home” for

- scientific discourse and
- attract & support young scientists → EIC/QCD
- help seed future detector & theory collaborations

Work with the EIC Users Group & BNL+ JLab & DOE to help realize the US Electron Ion Collider.

Then… expand the scientific scope beyond EIC

CFNS Activities

- SBU-BNL Joint Seminars : Twice a month broadly on QCD (Thursday 4:00PM)
  - Organized by Center's post docs, conducted on Zoom, recorded.
- CFNS Workshops and Adhoc Meetings
  - An external Workshop Program Committee selects ~8 workshops/year & Ad-Hoc meetings
  - Solicitation in February: application deadline in May/June – Selection process through June/July
- CFNS post-doctoral fellow program
  - Post doctoral fellows at Stony Brook, BNL and a Joint CFNS-Remote Institution Fellow Program
  - 3-5 BNL/Stony Brook CFNS Fellows, and 6-8 Joint Fellows with remote universities
- Short- & long-term visitor program: ~7 days - ~ 30-90 days
- CFNS QCD summer school: International participation
- Edward Bouchet Initiating to support under-represented minorities (URMs)

Total of 750-1000 visitors at the Center through the remote activities

Center for Frontiers in Nuclear Science

CFNS Workshops:

Open call for workshops in February, Deadline June,

Workshops selected by July 1st with the help of the CFNS Program advisory committee consisting of

M. Diehl (DESY, Chair), C. Keppel (Jlab), K. Kumar (Umass), P. Shanahan (MIT) & F. Yuan (LBNL)

2021-2022 CFNS Workshop and Ad-hoc workshops

https://www.stonybrook.edu/cfns/activities/conferences

Center for Frontiers in Nuclear Science

Date	Recent Events
September 7-10, 2021	**Workshop:** AI4EIC-Ex-Experimental Applications of Electron Ion Collider **Location:** Stony Brook University (online) **Organizers:** A. Boehnlein (Jlab) C. Fanelli (MIT), T. Hori
September 27-29, 2021	**Workshop:** The 2nd Workshop on Jets for 3D Imaging **Location:** Stony Brook University (in person + online) **Organizers:** Miguel Arratia(UC Riverside, Chair), Rene Zhongbo Kang (UCLA/CFNS), Brian Page(CFNS/BNL), Berks), Felix Ringer (LBNL)
October 25-27, 2021	**Ad-Hoc Meeting:** Physics Opportunities with Heavy **Location:** Stony Brook University (online) **Organizers:** Jin Huang(BNL), Xuan Li(LANL), Fred Olne Christian Weiss(JLab)
November 1-5, 2021	**Conference:** Chirality, vorticity and magnetic field in **Location:** Stony Brook University (in person + online) **Organizers:** D. Kharzeev Chair(SBU+ BNL), A. Florio(S Teaney(SBU), S.Shi(SBU), Z.Xu(BNL), R. Lacey(SBU), M Mukherjee(BNL), B. Schweid(SBU), S.Voloshin(Wayne
November 18-19, 2021	**Workshop:** MC4EIC: Monte Carlo event simulation fo **Location:** Stony Brook University (online) **Organizers:** Stefan Hoeche (FNAL), Elke Aschenauer ((JLab), Cynthia Keppel (JLab), Pavel Nodolsky (SMU)

Date	Upcoming Events
December 16-17, 2021	**Workshop:** Inter-American Network of Networks of QCD Challenges **Location:** Stony Brook University (online. in person by invitation only) **Organizers:** Abhay Deshpande (Stony Brook University), Carlos Bertulani, Christine Aidala (Michigan), Daniel Tapia Takaki (University of Kansas), Jean Delayen (Old Dominion University)
February 9-11, 2022	**Ad-hoc Meeting: Novel approaches to target fragmentation and diffraction with UPC and EIC** **Location:** Online only **Organizers:** Abhay Deshpande (Stony Brook University/CFNS & BNL), Marta Ruspa (U. Piemonte Orientale Novara & INFN Torino, Italy), Michael Murray (U. Kansas), Mark Strikman (Penn State U.), Chritian Weiss (JLab)
TBD	**Workshop: Exotic heavy meson spectroscopy and structure with EIC** **Location:** Stony Brook University (TBD) **Organizers:** Derek Glazier(U. Glasgow,UK), Astrid Hiller Blin (JLab), Jin H (BNL), Alessandro Pilloni (U. Messina, Italy), Justin Stevens(William & Ma Szczepaniak (Indiana U), Christian Weiss(JLab)
March 23-25, 2022	**Workshop: Helicity, Transversity and Tomography of the Nucleon-Spi towards the EIC era and memorial symposium of George Igo** **Location:** UCLA **Organizers:** Miguel Arratia(UCR), Kenneth Barish(UCR), Abhay Deshpan (CFNS/SBU/BNL), Matthias Grosse Perdekamp (UIUC), Huan Zhong Hua Zhongbo Kang (UCLA/CFNS), Joanna Kiryluk (CFNS), Astrid Morreale (L Sichtermann (LBNL), Stephen Trentalange(UCLA)
May-June 2022, TBD	**Workshop: Hera-4 EIC-Workshop @ CFNS** **Location:** Stony Brook University **Organizers:** Miguel Arratia (UC Riverside/Jlab), Daniel Britzger(MPP), Yu Furletova (Jlab), Z.Tu (BNL/CFNS), Felix Ringer (LBNL), Bernd Surrow (Te
May-July 2022, TBD	**Workshop: Jet Physics: From RHIC/LHC to EIC** **Location:** Stony Brook University **Organizers:** Megan Connors(Georgia State), Zhongbo Kang (UCLA/CFNS), Yacine Mehtar-Tani(BNL/RBRC/CFNS), Brian Page (BNL/CFNS), Xin-Nian Wang (LBNL)
Summer 2022, TBD	**Workshop: High Luminosity-EIC (EIC-Phase II)** **Location:** Stony Brook University **Organizers:** Mei Bai (SLAC), Martha Constantinou (Temple), Abhay Deshpande(CFNS/SBU/BNL), Ciprian Gal(CFNS), Pavel Nadolsky(SMU), Alexey Prokudin(Penn State), Rosi Reed(Lehigh), Xiaochao Zheng (UVa)
August 2022, TBD	**Workshop: Precision QCD predictions for ep Physics at the EIC** **Location:** Stony Brook University **Organizers:** Daniel de Florian (UNSAM), Werner Vogelsang (Teubingen)
September-October 2022, TBD	**Workshop: Future Trends in Nuclear Physics Computing** **Location:** Stony Brook University **Organizers:** Amber Boehnlein(JLab), Graeme Steward (HSF), Grahm Hayes (JLab), Kolja Kauder(BNL,CFNS), Mark Ito(Jlab), Markus Diefenthaler (Jlab), Ofer Rind (BNL), Paul Laycock (BNL), Torre Wenaus(BNL)

Theory, Experiment & Accelerators

Solicitation driven process
External committee evaluation

Cycle from Sept-Aug every year

Post Doctoral & student Program 2018/19-2020/21

*Mentors in (brackets), graduations in **bold***

- Post doctoral fellows @ BNL in 2020 (5)
  - **Kolja Kauder (TU), Alba S. Ontoso(RV), Abha Rajan (YH), Kong Tu (TU), Renaud Boussarie (RV)**

- Post doctoral fellows @ Stony Brook in 2020/21 (4)
  - Barak Schmookler (ALD), Mriganka Mondal (ALD), Esha Roli (AD)
  - New: Zuhal Demiroglu(ALD), Charles-Joseph Naim (ALD), Wenliang Li (ALD)

- Joint CFNS-Remote institutions (PI's propose, Director & SC evaluate, opportunities)
  - **Dingyu Shao (Z. Kang, UCLA),** Andrei Tarasov (Y. Kovchegov, OSU), **Vitali Baturin** (C. Hyde, ODU), **Caryn Palatchi** (K. Paschke, UVa), **Yang-Ting Chien (G. Sterman, SBU/YITP)**
  - Others: B. Jacak (UCB), X. Ji (UMD), R. Milner (MIT) S. Dalla Torre (INFN), A. Mukherjee (IITB, India), Y.T.Chien (OSU), S. Park (Mississippi State)

- Graduate students at Stony Brook supported:
  - **Ph.D.: Kaushik Roy (RV), Farid Salazar** (BS)
  - **MA Sr. Thesis Athira K.V. (ALD)**

ALD : Abhay D.
AD : Axel Drees
RV : Raju V.
BS. : Bjoern Schenke
YT : Yoshitaka Hatta
TU. : Thomas U.

The three proposals + White Paper: 2nd IR Physics

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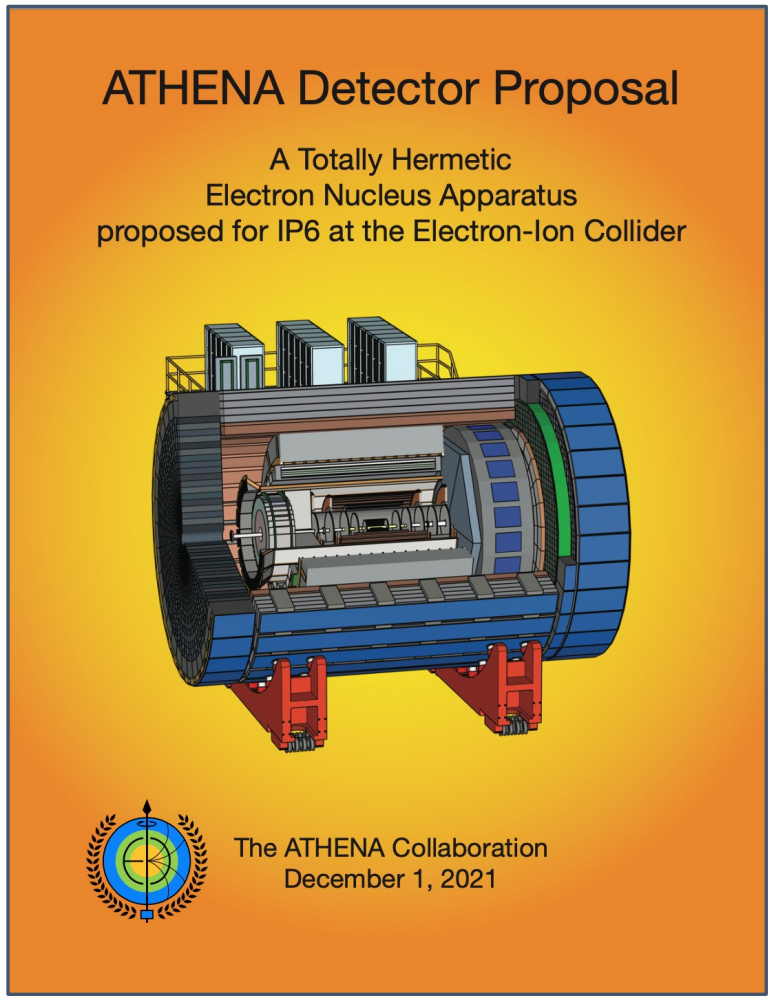
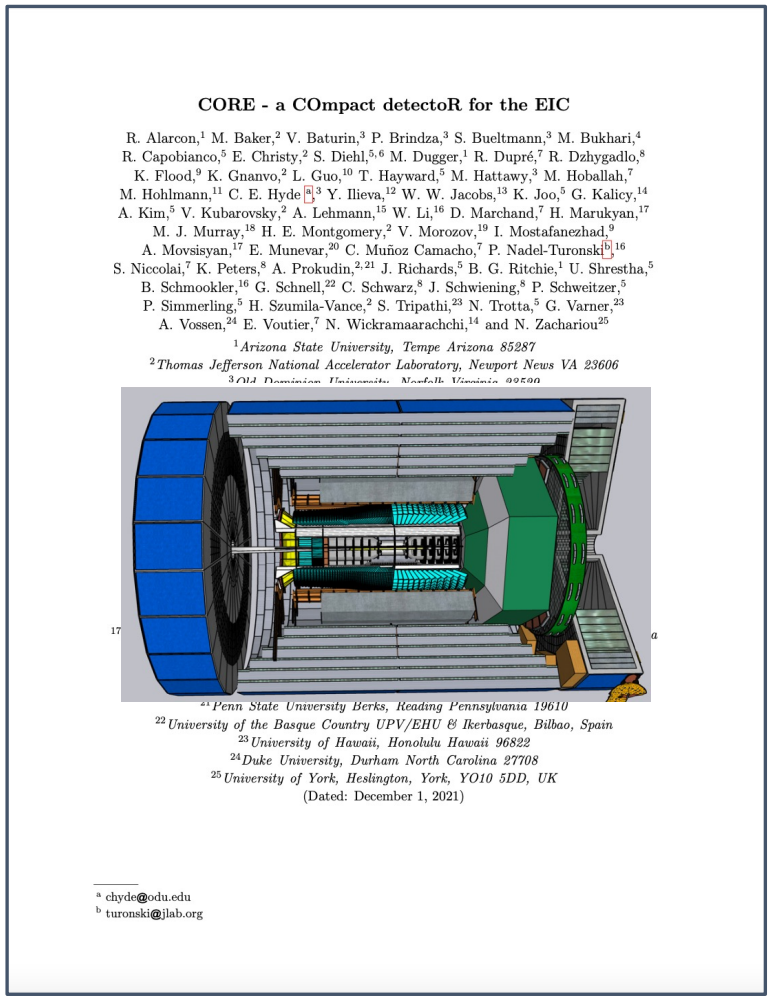
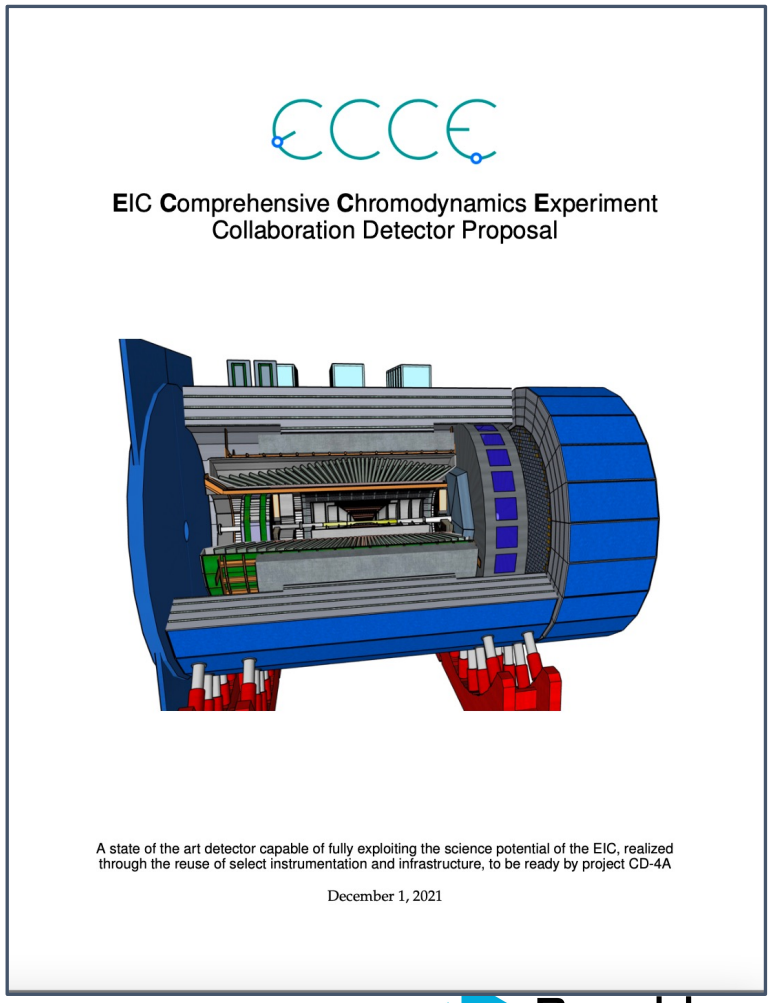
CFNS helped all three & the 2nd IR White Paper

Expect EIC Advisory Panel's recommendation by March 2022







Summary of scientific output 2020

by post-docs and students supported by CFNS

Center for Frontiers in Nuclear Science

Publications including submitted papers:

- 85 publications in a variety of international journals:
- PRL, PRD, PRC, NIM, Hadr. Sp.& Str., EPJC, JHEP, PLB, Nature, Science, Chin. Phy. C

Talks given:

- 55 talks (25 contributed, 22 seminars, 8 invited/plenary) @ national and international meets and departmental seminars

Workshops organized:

- 9 workshops/conferences organized

Edward Bouchet Initiatives for under-represented minorities

Edward Bouchet Initiative for QCD: NSF/DOE Traineeship for graduate students (MS and PH.D.)

- Seven minority serving institutions: CUNY, Florida A&M U., Hampton U., Howard U., Navajo Tech., Texas Southern, and U. of Puerto Rico
- BNL, Jefferson Lab, LBNL and MIT, UC Berkeley, UMass Amherst, UVa, Yale and Stony Brook/CFNS) (Deshpande: PI)
- MA/MS/MSI at SBU. Research, including potential Ph.D., with Co-PI's at above institutions
- Proposal made through all-but final hurdle. Unsuccessful so far, but constructive comments by reviewers, will apply again for 2021.

BNL-URM Fellowship Program for Research Excellence in NP for undergraduate students DOE

- Source: Florida A&M, Howard U., Morgan State, Texas Southern, U. of Puerto Rico
- Students come to BNL for summer research & continue for two more semesters, optionally take 2 advanced UG courses at Stony Brook, which may not be available at their institutes: CFNS will pay tuition if not affordable.
- M. Chiu (PI), A. Deshpande (Co-PI)+ ~8 scientists at BNL in different aspects of nuclear physics

Other CFNS initiatives in infancy

EIC HERA Research Initiatives : Data analysis of HERA data

- H1 and ZEUS collaborations welcome young EIC-oriented scientists getting involved in analyses of their data and get them published.
- Ideal analyses & experience for Masters & Ph.D. students & post docs interested in EIC
- CFNS could partially support such an initiative (currently 1@BNL & 2@SBU CFNS post docs involved, this will grow) – broader interests and activities at UCR, Yale, Temple

New Center for Nuclear Femtography at SURA

- With Xiangdong Ji as its Director & supported by the state of Virginia and SURA, the Center is aimed at bringing experts in NP theorists, Computing, mathematics and visualization together.
- Ideas for possible collaboration between CFNS and CNF are being explored: "2nd Interaction Region at the EIC"

Teaching initiatives with EIC^2 @ JLab

- Prepare pedagogical lecture (core set of lectures) and EIC Simulation Software tutorials
- Lectures aimed at general & Specific needs: (M. Diefenthaler, D. Higinbothom & A. Deshpande)

CFNS Governance

- **International Advisory Committee (Review Center Operations)**
  - A. Caldwell (MPI), L. Elouadrhiri (Jlab), B. Jacak (UCB/LBNL), X. Ji (UMD/CNF), Y. Kovchegov (OSU), Z.-E. Meziani (ANL), R. Milner (MIT, Chair), B. Mueller (Duke), W. Nazarewicz (MSU), P. Newman (Birmingham), B. Pasquini (Pavia), F. Pilat (ORNL), J. Qiu (Jlab), G. Sterman (SBU/YITP), W. Vogelsang (Tubingen)
  - Ex. Officio: R. McKeown (JLab), Dmitri Denisov (BNL), B. Surrow (Chair, EICUG-SC)
  - Optional rotation of 1/3 committee in 2021

- **Program Advisory Committee (Review/recommend Workshops)**
  - M. Diehl (DESY), C. Keppel (JLab), K. Kumar (U. Mass.) P. Shanahan (MIT), F. Yuan (LBNL)
  - Optional rotation of 1/3 committee in 2022

Governance and day-to-day operation

- **Director:** Abhay Deshpande
- **Scientific Coordinators:** Ciprian Gal (SBU) & J.H. Lee (BNL)
- **CFNS Steering Committee** (Help implement IAC's advice & run local activities)
  - A. Deshpande (SBU/BNL, Chair)T. Hemmick (SBU), D. Kharzeev (SBU/BNL), J. Kiryluk (SBU), L Ruan (BNL), T. Ullrich (BNL), R. Venugopalan (BNL, Co-Chair), Ex officio: C. Gal (SBU) & J. H. Lee (BNL)
- **Seminar Coordinators:**
  - Sanghwa Park (SBU), Yong Zhao (BNL>ANL), Jinlong Zhang (SBU>SDU), Adrian Florio (SBU)
- **Administrative Assistants:**
  - Socorro Delquaglio (SBU), Rachel Inguenta (BNL) Marlene Vera-Vitteri (SBU)

CFNS & Inter-American Network of Networks for QCD Challenges

Center for Frontiers in Nuclear Science is always happy to welcome you if you want to get involved in EIC or related High Energy QCD physics.

Many existing tools and programs such as Joint post doctoral fellows, Workshops, short/long term visitors for establishing contacts within the EIC (theory, experiment and accelerator) – could be used as tools. If you have other good ideas, we are eager to listen to good suggestions.

We hope to be an enthusiastic participant in the IANNQCDC's activities.

Let me end this introduction to CFNS with a warm welcome to you all again and open invitation to participate and lead activities at CFNS.