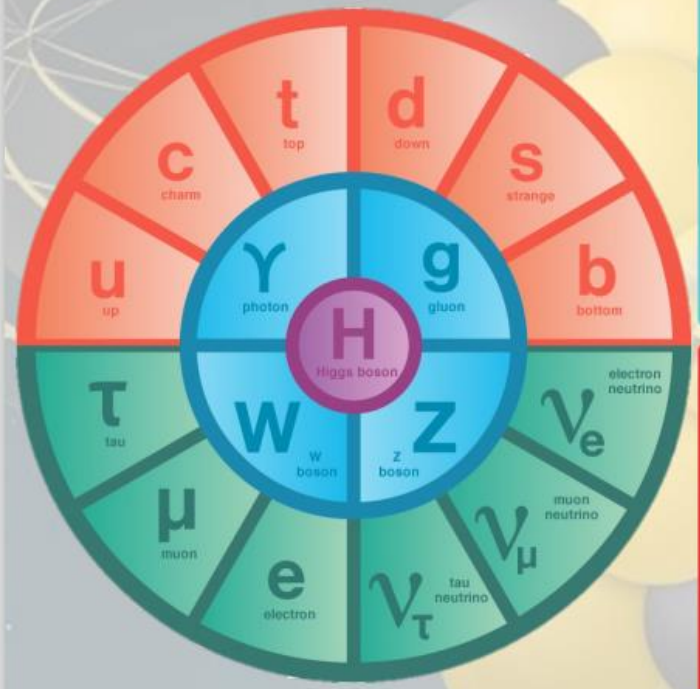
Standard Model of Particle Physics



Low energy (nuclear physics)
- Properties of proton, neutron
- QCD
- Dark matter
- ...

TEXONO, ADMX,...

Intermediate energy (high energy nuclear physics)
- QCD
- QED
- ...

RHIC, FAIR,...

High energy
- SM
- BSM
- ...

LHC, Tevatron...

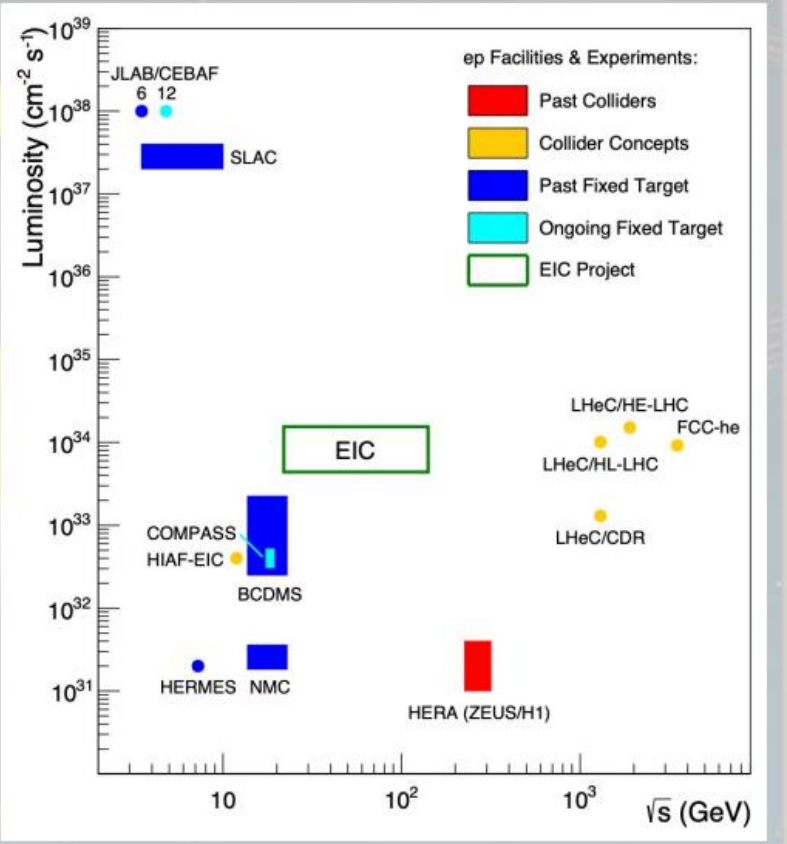
Ultra-high energy
- Cosmic ray
- Neutrino
- Dark matter
- ...

AMS, IceCube, ...

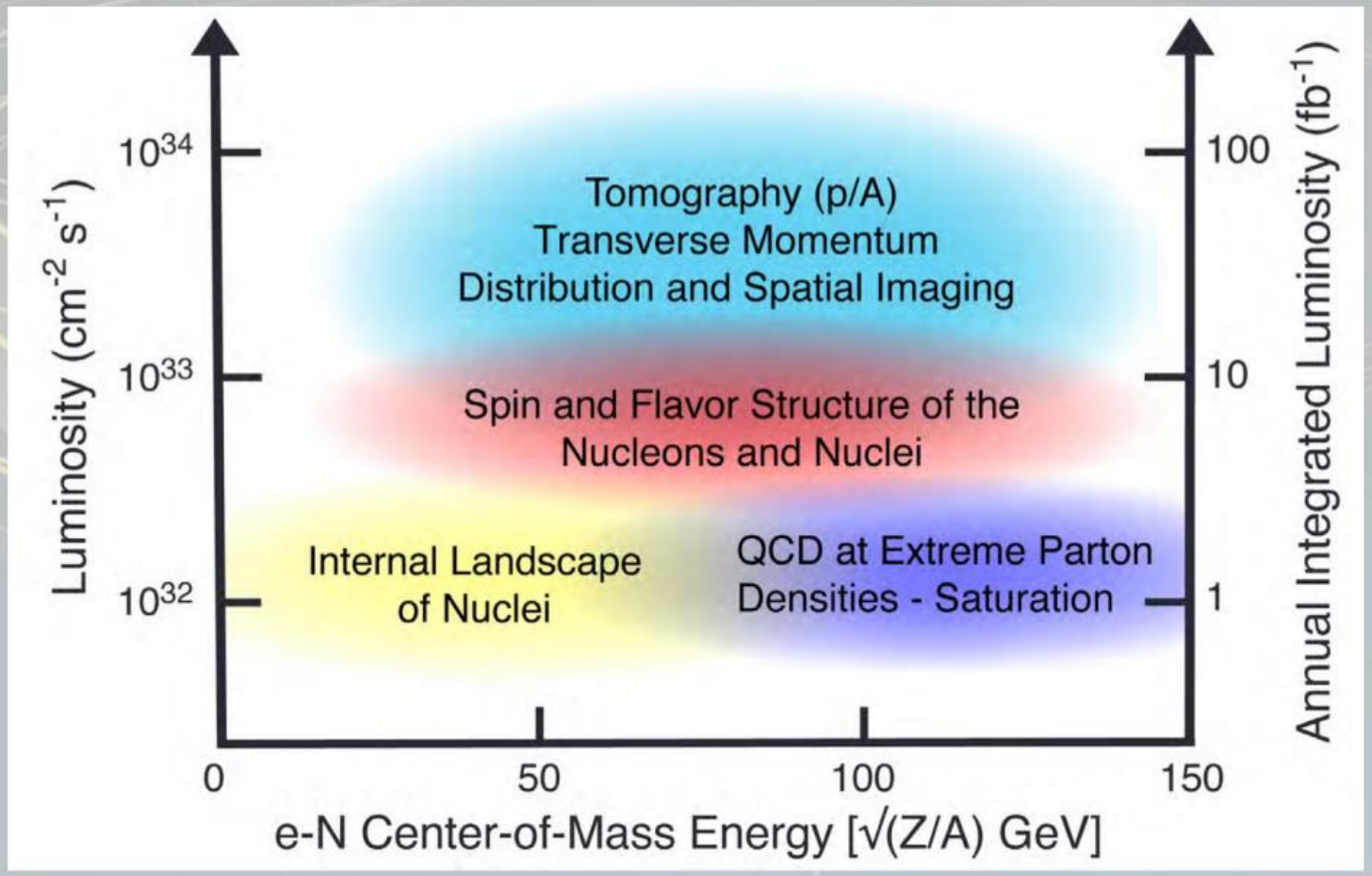
https://www.symmetrymagazine.org/standard-model/

Uniqueness of EIC

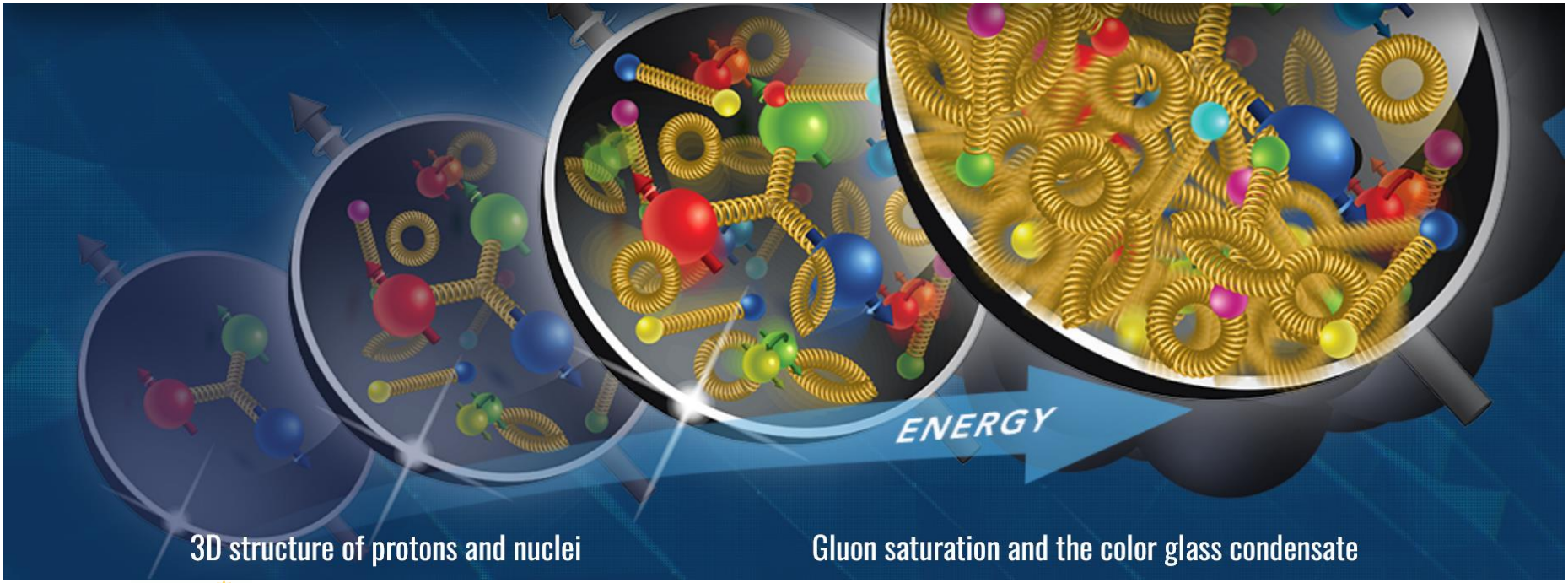
- **World's first polarized electron-proton/light ion and electron-Nucleus collider**
- **For e-N collisions at the EIC:**
  - Polarized beams: e, p, d/^{3}He
  - e beam 5-10(20) GeV
  - Luminosity L_{ep} ~ $10^{33\text{-}34}$ cm^{-2}sec^{-1} (100-1000 times HERA)
  - 20-100 (140) GeV Variable CoM
- **For e-A collisions at the EIC:**
  - Wide range in nuclei
    Luminosity per nucleon same as e-p
  - Variable center of mass energy



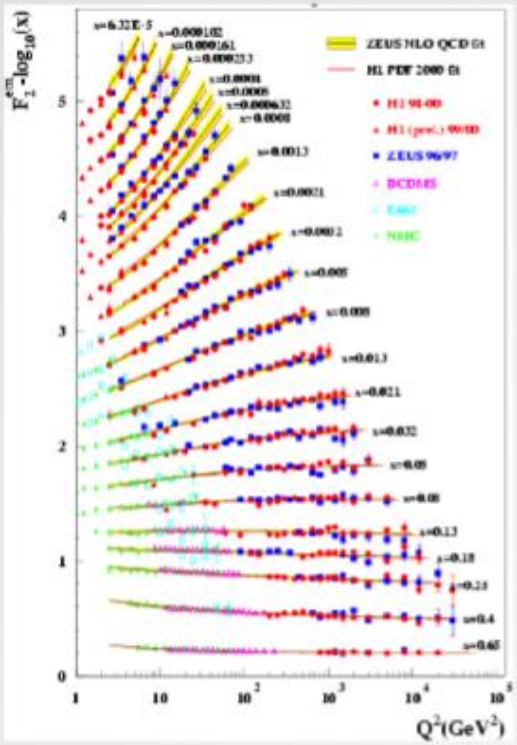
EIC Physics


Luminosity (cm^{-2} s^{-1})
10^{34}
10^{33}
10^{32}
Tomography (p/A)
Transverse Momentum
Distribution and Spatial Imaging
Spin and Flavor Structure of the
Nucleons and Nuclei
Internal Landscape
of Nuclei
QCD at Extreme Parton
Densities - Saturation
0
50
100
150
e-N Center-of-Mass Energy [√(Z/A) GeV]
100
10
1
Annual Integrated Luminosity (fb^{-1})

The Electron-Ion Collider will keep America at the forefront of the international nuclear physics and particle accelerator communities.

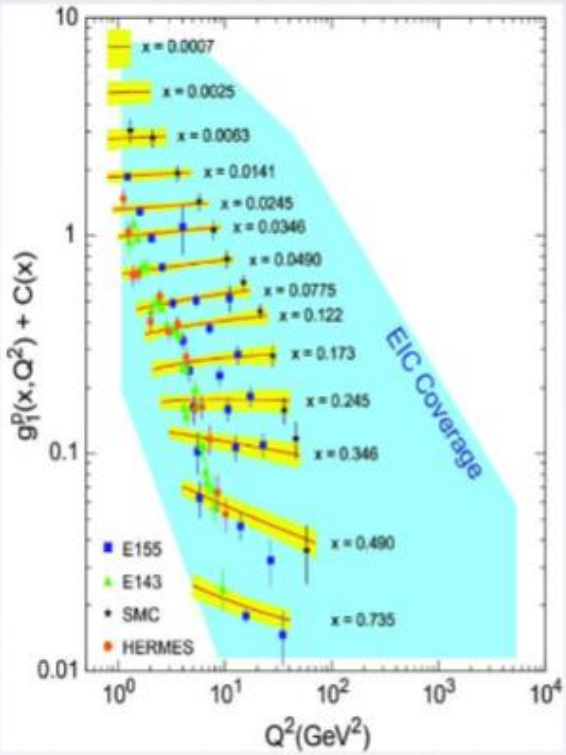


World data for F_2^p



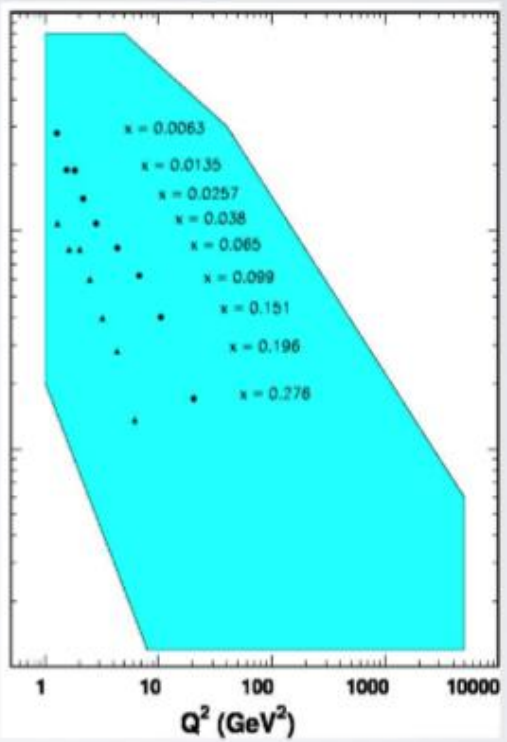
$\mathbf{f_1}$ from fits of **thousands** data

World data for g_1^p



$\mathbf{g_1}$ from fits of **hundreds** data

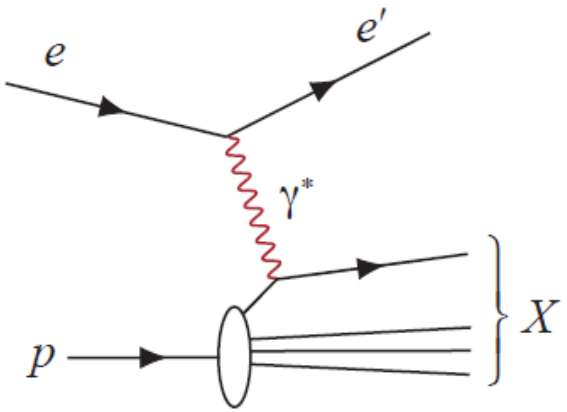
World data for $\mathbf{h_1}$



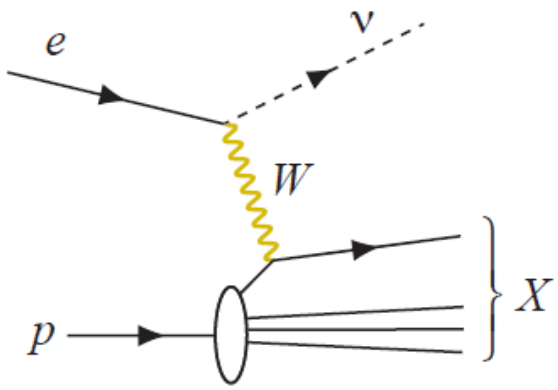
$\mathbf{h_1}$ from fits of **tens** data

What EIC will do?

Neutral-current Inclusive DIS: $e + p/\mathrm{A} \longrightarrow e' + X$; for this process, it is essential to detect the scattered electron, e', with high precision. All other final state particles (X) are ignored. The scattered electron is critical for all processes to determine the event kinematics.

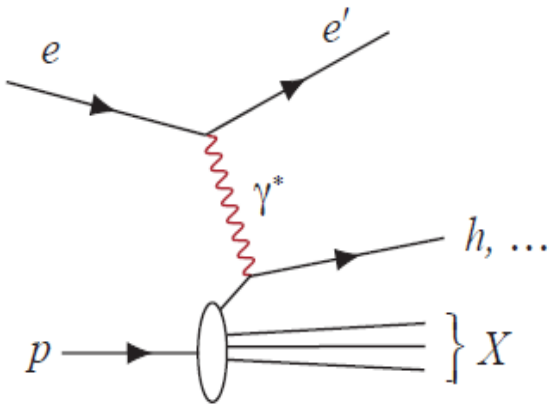


Charged-current Inclusive DIS: $e + p/\mathrm{A} \longrightarrow \nu + X$; at high enough momentum transfer Q^2, the electron-quark interaction is mediated by the exchange of a $W^{\pm}$ gauge boson instead of the virtual photon. In this case the event kinematic cannot be reconstructed from the scattered electron, but needs to be reconstructed from the final state particles.

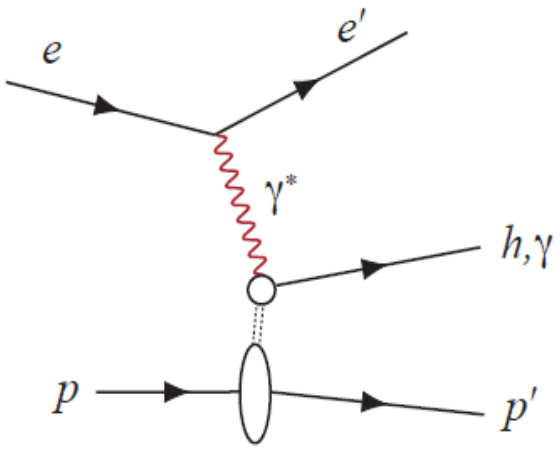


What EIC will do?

Semi-inclusive DIS: $e + p/\mathrm{A} \longrightarrow e' + h^{\pm,0} + X$, which requires measurement of *at least one* identified hadron in coincidence with the scattered electron.



Exclusive DIS: $e + p/\mathrm{A} \longrightarrow e' + p'/A' + \gamma/h^{\pm,0}/VM$, which require the measurement of *all* particles in the event with high precision.

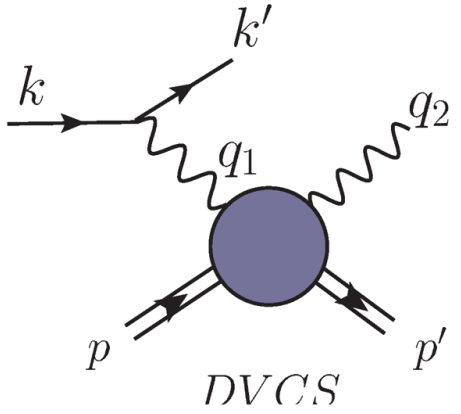


What EIC will do?

Deeply Virtual Compton Scattering:

$$\gamma^* + p \to \gamma + p$$

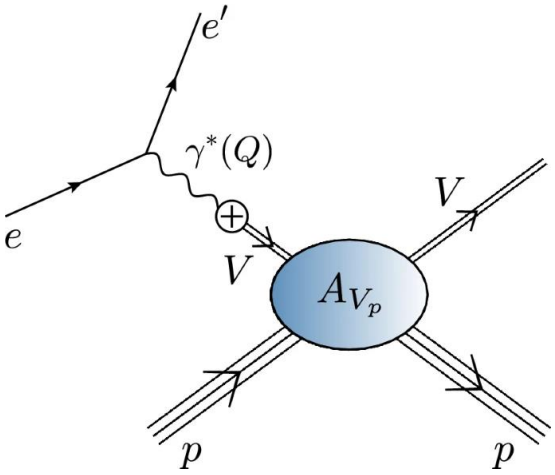
Exclusive process, whoch requires to measure all the particles in the final state.



Electrproduction of vector meson

$$\gamma^* + p \to V + p$$

Exclusive process, whoch requires to measure all the particles in the final state.



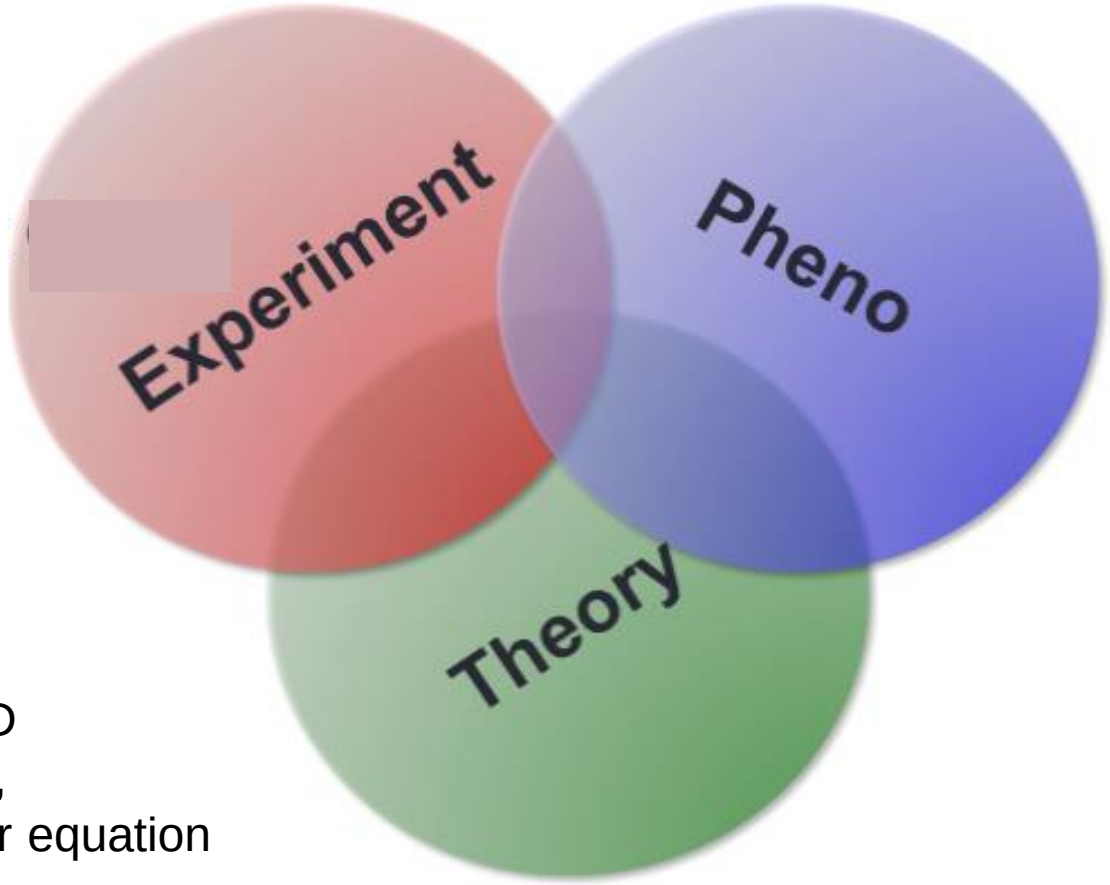
What makes EIC special?

The EIC machine designs are aimed at achieving

- Highly polarized ($\sim 70\%$) electron and nucleon beams
- Ion beams from deuteron to the heaviest nuclei (uranium or lead)
- Variable center of mass energies from $\sim 20 - \sim$100 GeV, upgradable to $\sim$140 GeV
- High collision luminosity $\sim 10^{33-34}$ cm^{-2}s^{-1}
- Possibilities of having more than one interaction region

Three ways are all necessary!

Dell-Yan
DIS
...

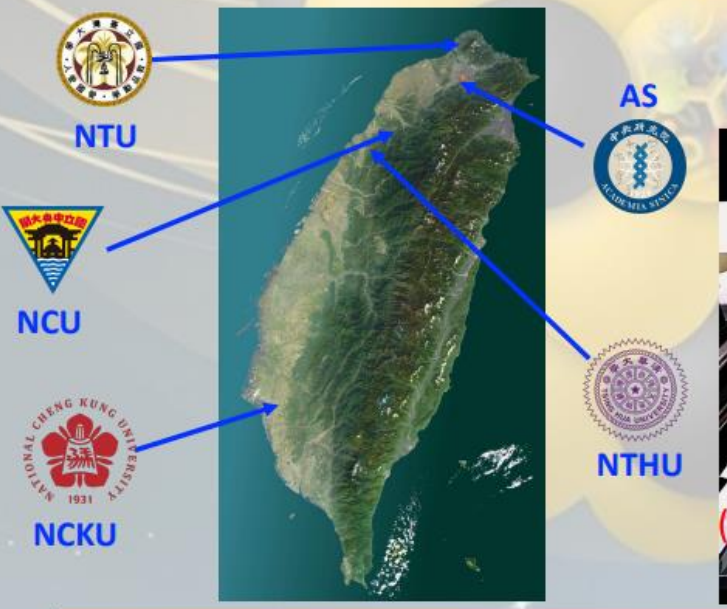


Parametirzations
GRS,SMAS
Global fit
JAM

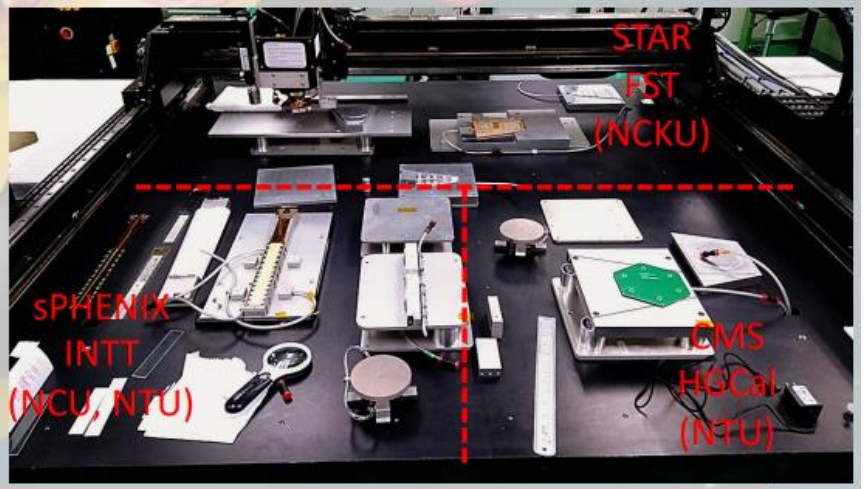
Lattice QCD
Perturbative QCD
NJL type Models,
Dyson-Schwinger equation

Electron-Ion Collider @ Taiwan

- 5 institutes (AS, NCU, NTHU, NCKU, NTU) in Taiwan have the consensus to form a strong team to participate the EIC in the coming future
- Mainly focus on physics, silicon-based detector (sensor development and mechanical structure design)



TIDC



Working Groups

	WG	Conveners			
Transversal WGs	Global Detector Optimization	Richard Milner	Jin Huang	Thomas Ullrich	Silvia Dalla Torre
	Simulation production and QA	Joe Osborn	Wenliang (Bill) Li	Zhoudunming (Kong) Tu	Wouter Deconinck
	Computing and Software	Cristiano Fanelli	David Lawrence	Sylvester Joosten	Andrea Bressan
	DAQ / Electronics / Readout	Chris Cuevas	Jo Schambach	Alexandre Camsonne	Landgraf Jeff
Detector WGs	Tracking	Xuan Li	Kondo Gnanvo	Laura Gonella	Francesco Bossu
	Calorimetry	Friederike Bock	Carlos Munoz Camacho	Oleg Tsai	Paul Reimer
	PID Cherenkov	Xiaochun He	Grzegorz Kalicy	Tom Hemmick	Roberto Preghenella
	PID ToF	Wei Li	Constantin Loizides	Franck Geurts	Zhenyu Ye
	Far Forward	Michael Murray	Yuji Goto	Jentsch Alex	John Arrington
	Far Backward	Igor Korover	Nick Zachariou	Krzyzstof Piotrzkowski	Adam Jaroslav
Physics WGs	Inclusive Physics	Tyler Kutz	Claire Gwenlan	Barak Schmookler	Paul Newman
	Jets and Heavy Flavor	Cheuk-Ping Wong	Wangmei Zha	Miguel Arratia	Page Brian
	Exclusive, Diffraction, & Tagging	Axel Schmidt	Rachel Montgomery	Spencer Klein	Daria Sokhan
	Semi-Inclusive Physics	Ralf Seidl	Charlotte Van Hulse	Anselm Vossen	Marco Radici
	BSM & precision EW	Xiaochao Zheng	Sonny Mantry	Furletova Yulia	Ciprian Gal

Mailing list: https://lists.bnl.gov/mailman/listinfo/

Conclusions

- EIC represents a major opportuniy for nuclear/particle physicists in Taiwan
- Building upon the experience and expertise from other previous research, the Taiwan group can readily explore related and compelling physics at this major future facility
- A staged approach with on-going and near-future projects at RHIC (sPHENIX, STAR), JLab, J-PARC, CERN (AMBER) converging on EIC would be very attractive
- Research related to EIC physics offers an excellent opportunity to form strong collaboration between experimentalists and theorists in Taiwan

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Summary & Discussion

- Goal of this workshop:
  - Uniqueness of EIC; EIC physics subjects
  - Status of EIC project
  - *Bring interested people together!*
- "A staged approach with on-going and near-future projects at RHIC (sPHENIX, STAR), JLab, J-PARC, CERN (AMBER)"
  – Prof. Jen-Chieh Peng
- **TIDC** provides a nice framework of making hardware contributions.
- Experimentalists and theorists work coherently on focused physics topics. For example, **TQCD** meeting: EIC session.
- Things to discuss and decide:
  - "Primary Contact" of Taiwan EPIC team
  - Working groups of EPIC to join
  - Joint 2023 NSTC proposal
  - Next EIC workshop
  - …