Concluding Remarks

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Hadron-China2017, Nanjing University University, July 24-28, 2017

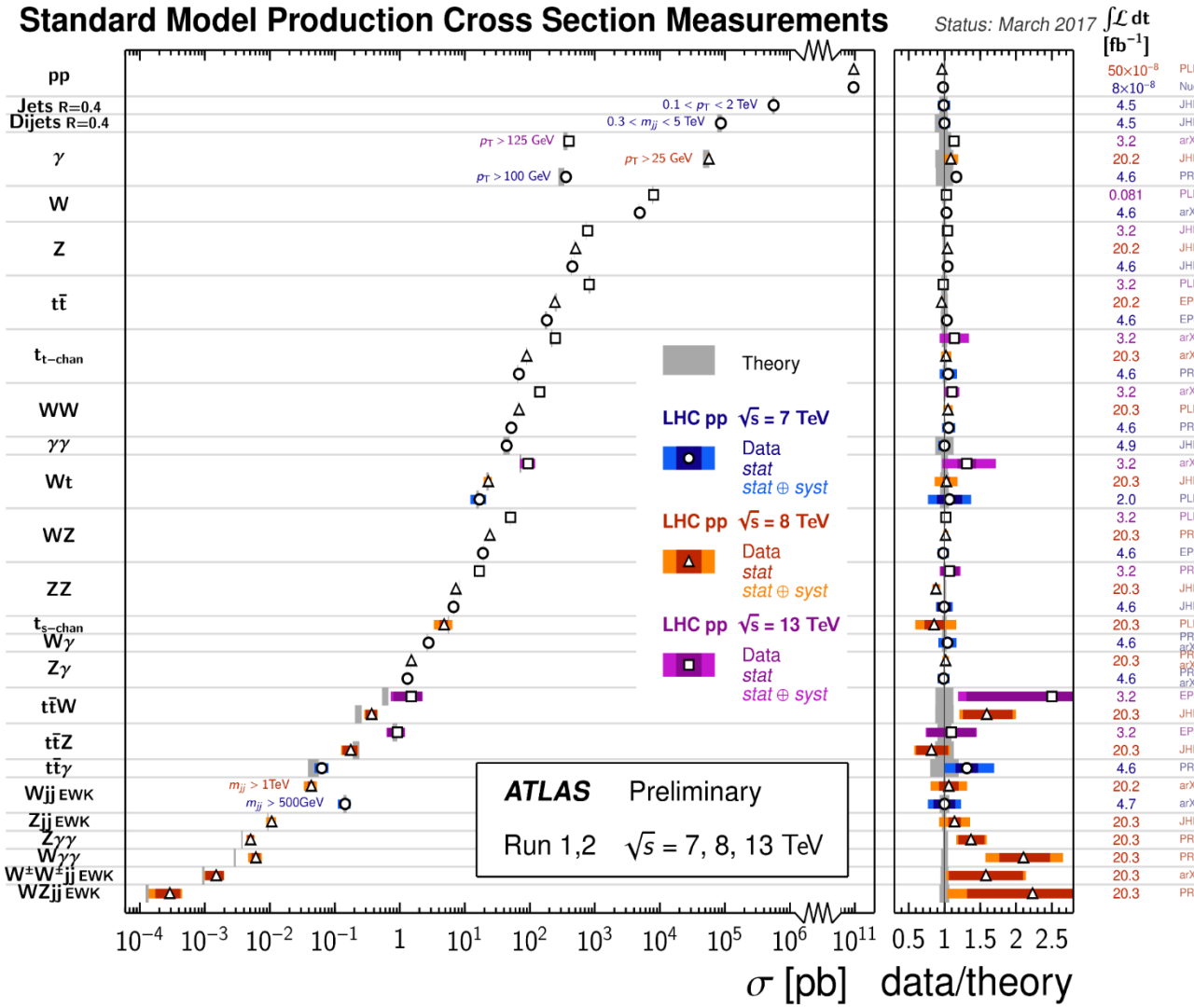
- Strong QCD/Hadron Phsyics is the last frontier in Standard Model
- Numerous highlights in experimental hadron physics studies
- Impressive theoretical progress: LQCD, D-S, Holographic QCD, Models, …
- New opportunities/facilities worldwide
- Emerging opportunities in China
- Longer-term Future - Electron Ion Collider, in US and China

X. JI

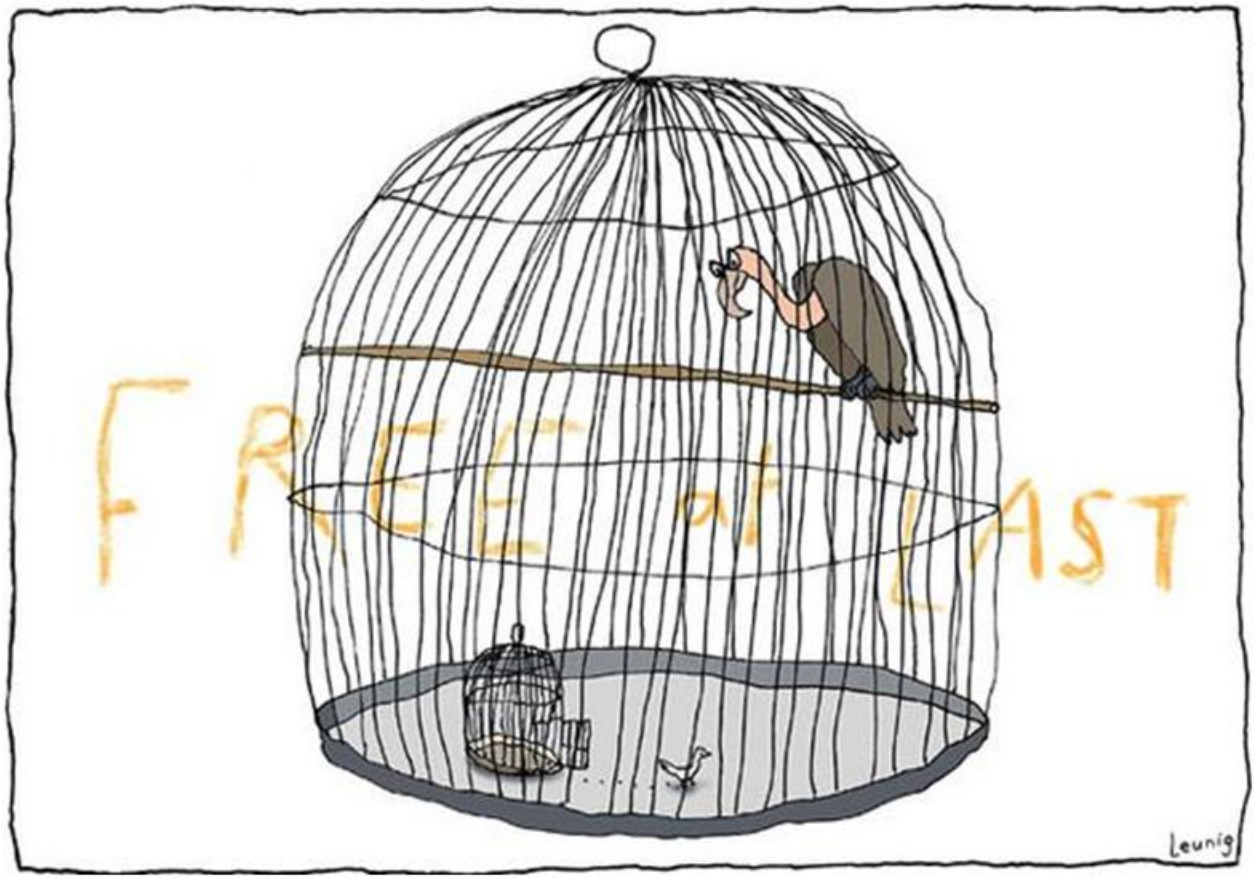
Standard model successes:

- The standard model itself has been hugely successful in explaining many physics phenomena
  - Electroweak processes
  - High-energy QCD processes

Perturbation theory works!（LHC）



C. Roberts



Confinement is dynamical

Z. Meziani

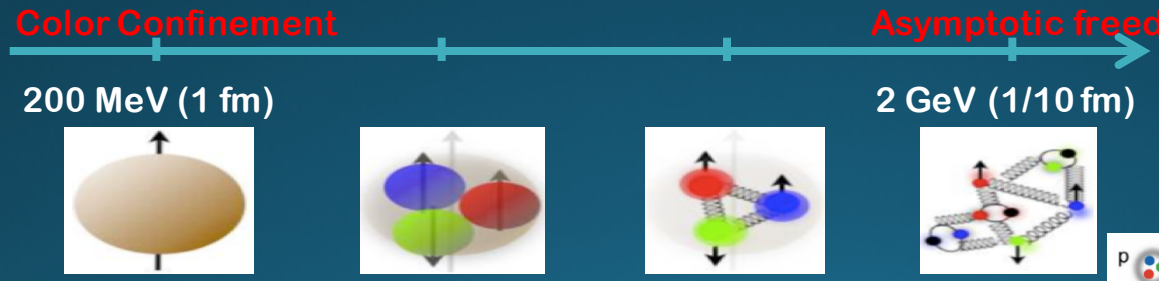
The next QCD frontier

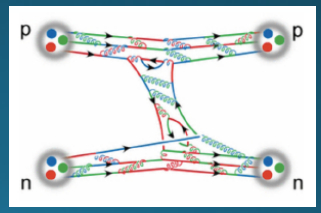
- What is the role of QCD in the evolution of the universe?

- How hadrons emerge from quarks and gluons?
- How does QCD make up the properties of hadrons?

  Their mass, spin, magnetic moment, …

- What is the QCD landscape of nucleon and nuclei?





- How does the nuclear force arise from QCD?

We have to understand the role of glue!

Z. Meziani

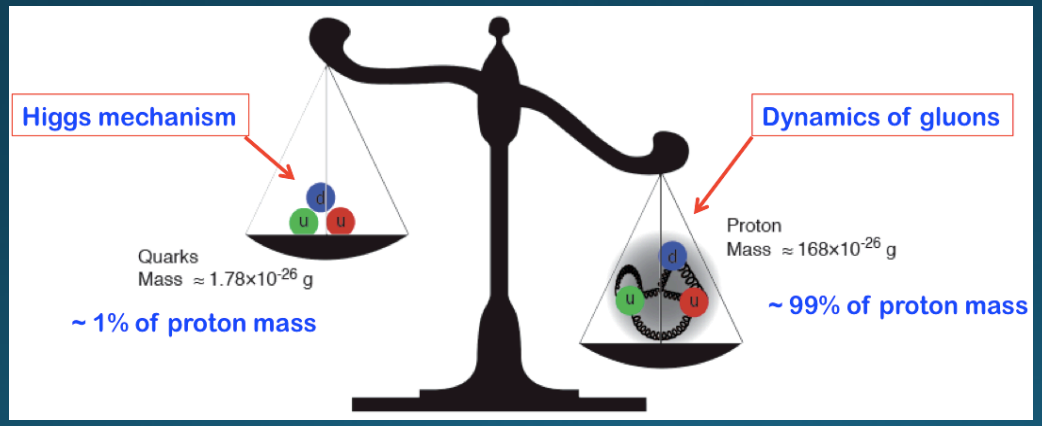
How does QCD generate its Mass & Spin?

"…QCD takes us a long stride towards the Einstein-Wheeler ideal of mass without mass

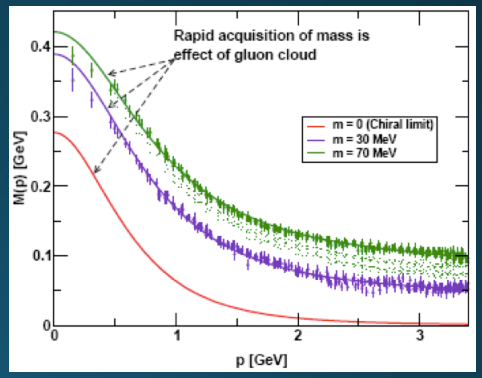
Frank Wilczek (1999, Physics Today)

Close examples in nature: proton, blackhole

✧ ***Massless, yet, responsible for nearly all visible mass***



"Mass without mass!"

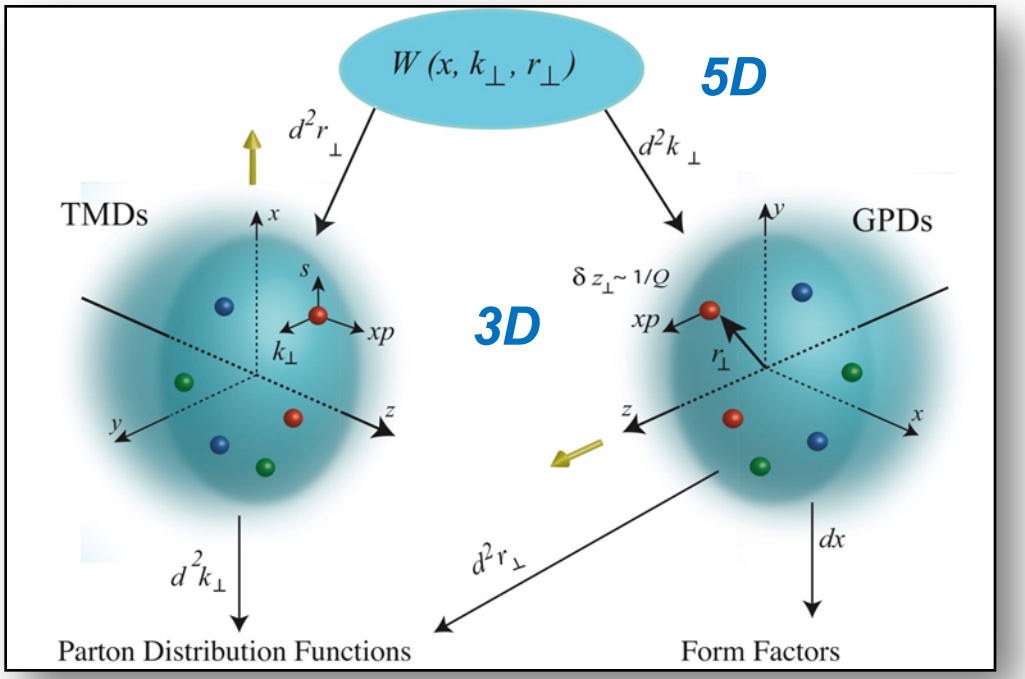


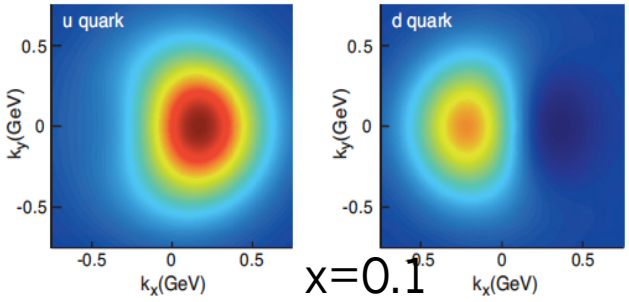
Bhagwat & Tandy/Roberts et al

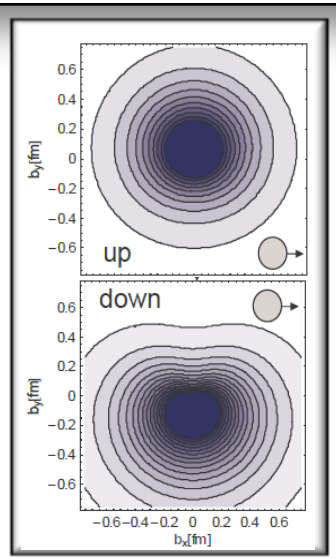
What Susskind has to say about proton mass and the Higgs mechanism.

- https://youtu.be/JqNg819PiZY?t=2403

Nucleon Landscape (Tomography)







- *Transverse Momentum Dist. (TMD)*
  - *Confined motion in a nucleon (semi-inclusive DIS)*
- *Generalized Parton Dist. (GPD)*
  - *Spatial imaging (exclusive DIS)*
- *Requires*
  - *High luminosity*
  - *Polarized beams and targets*
  - *Sophisticated detector systems*

Major new capability with JLab @ 12 GeV COMPASS, … and EIC

Highlights from experiments

- Hadron Spectroscopy: exotics particle search

  4-q (XYZ): BESIII (X. Shen, C. Shen), 5-q: LHCb, 6-q: STAR (J. H. Chen)

  hybrid: GlueX (B. Zihlmann), mesonic decays: COSY/MAMI (L. Heijkenskjold)…
- Proton Radius (H. Gao)
- Spin Structure: JLab (K. Slifer), RHIC-Spin (J. Zhang)
- 3-d (TMDs): COMPASS (W. Zhang, T. Iwata), CLAS12 (B. Seitz)
- Nuclei: SRC (A. Schmidt), Global polarized Lambda (Z. Liang)
- Parity Violation (X. Zheng)
- …
- Cutting-eddg Technology R&D

Rapid Developments from Theory

- LQCD (H. Lin, K. Liu), quais-PDF (X.Ji, …)
- S-D (C. Roberts, S. Qin)
- Models for multi-q states (E. Hiyama, Y. Yamaguchi, J. Ping, H. Chen …)
- Hadron /QCD theroy devlopment in other aspects (B. Ma, Z. Liang, X. Chen, Y. Zhao, I. Danilkin, S. Wang,...)
- BSM theories: Z. Liu, Y. Wu, Y. Zhou, B. Zhang...

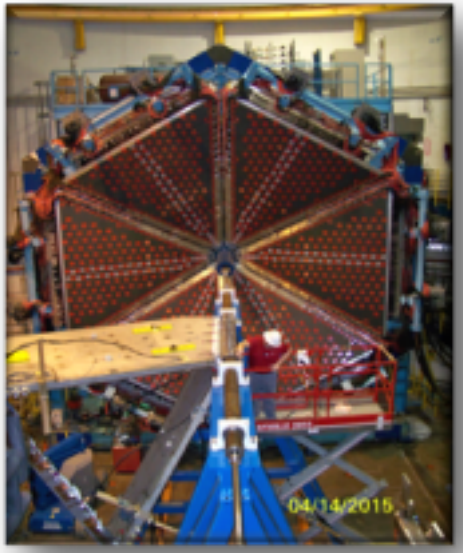
Facilities/oppurtunities in the World (outside China)

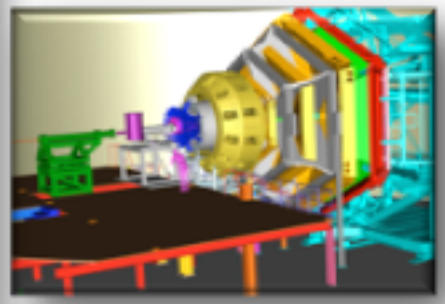
- RHIC/sPHENIX (B. Mueller, J. Huang)
- COMPASS (M. Perdekamp)
- J-PARC (S. Sawada)
- JLab (J.P. Chen)
- EIC in US (Z. Mezinia)

12 GeV Scientific Capabilities

J. P. Chen

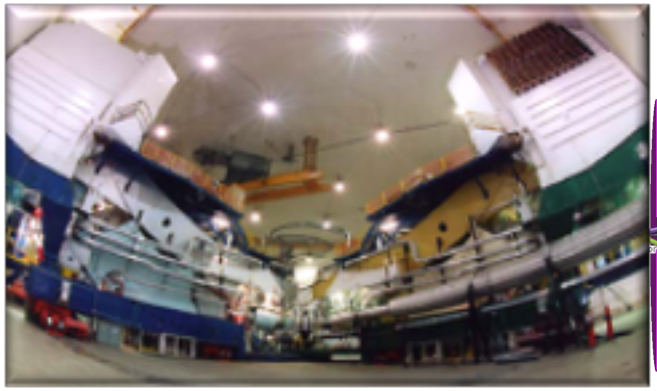
Hall B – understanding nucleon structure via generalized parton distributions

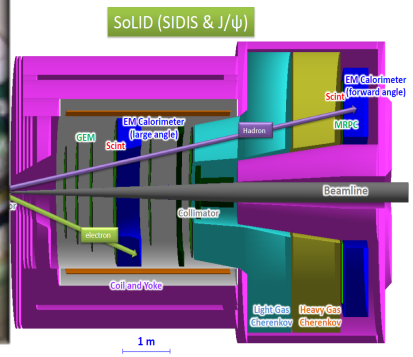




Hall D – exploring origin of confinement by studying exotic mesons

Hall A – form factors, future new experiments (e.g., SoLID and MOLLER)



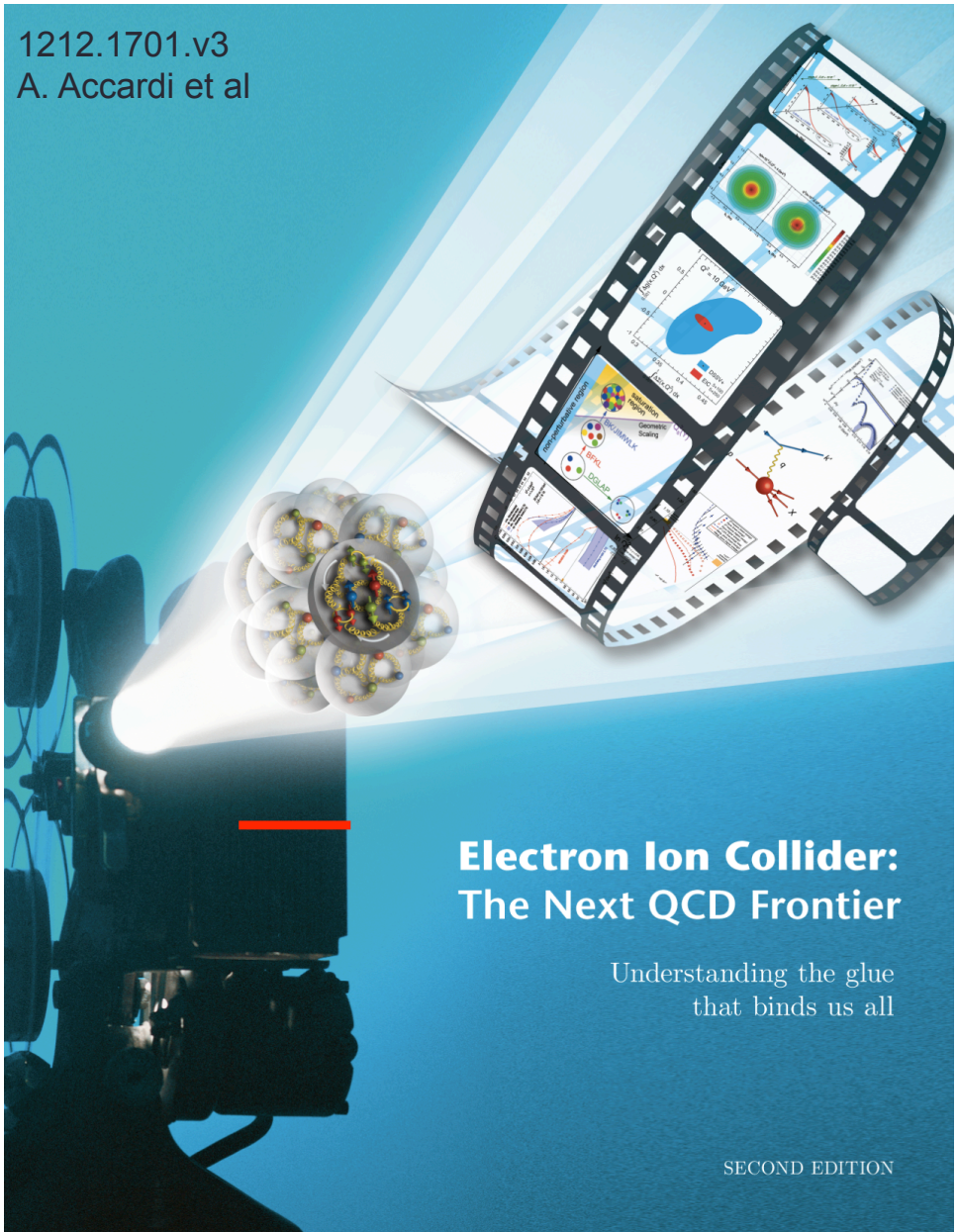


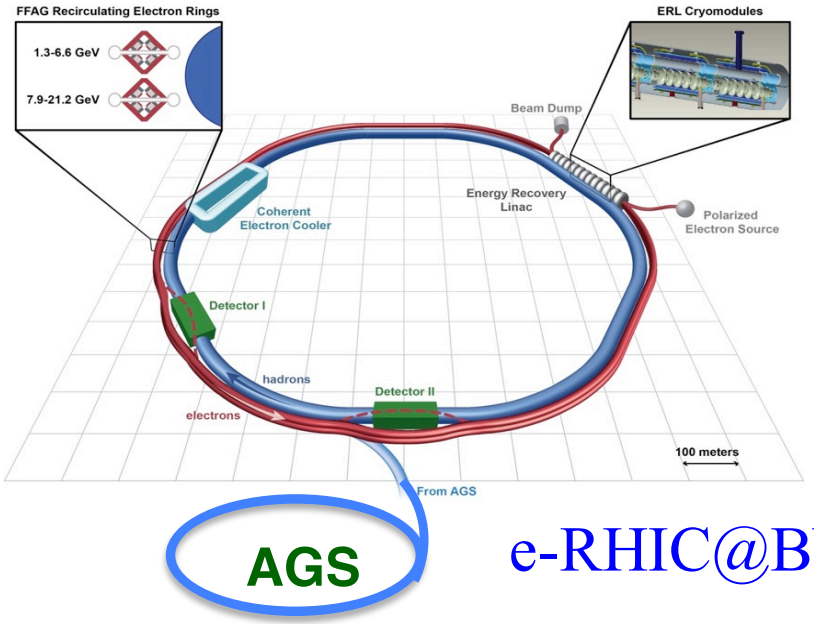
Hall C – precision determination of valence quark properties in nucleons/nuclei

The Electron Ion Collider

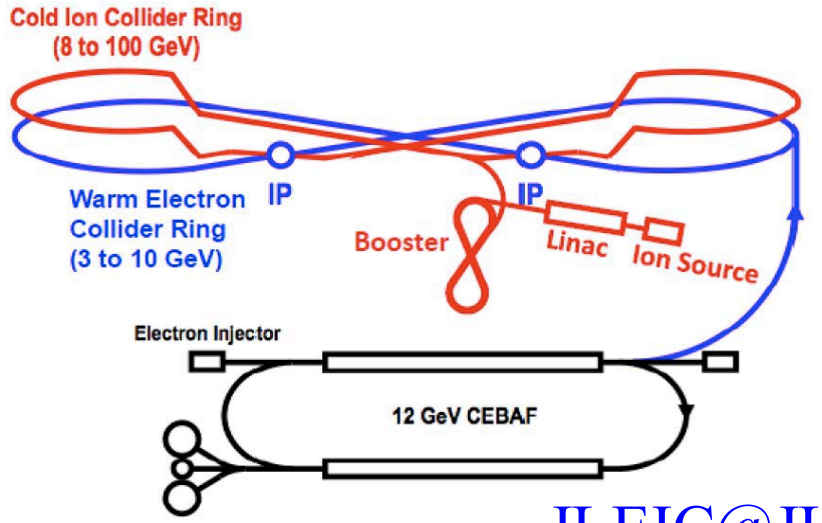
Z. Meziani

Two proposals for realization of the Science Case





e-RHIC@BNL



JLEIC@JLab

Opportunities/Facilities in China

- BESIII (X. Shen)
- Shanghai light sources / electron and photon beams (Y. Ma)
- Future HE collider: CEPC(HIGS-Z) /SPPC (Y Wang, Z. Zhang)
- High intensity hadron facilities (N. Xu, A. Sun)
- Underground: JPLab/PandaX (C. Fu, Y. Wang)
- Cosmic/Space: PAMDE/… (J. Chang, Y. Wu, Y. Wang)
- EIC @ China

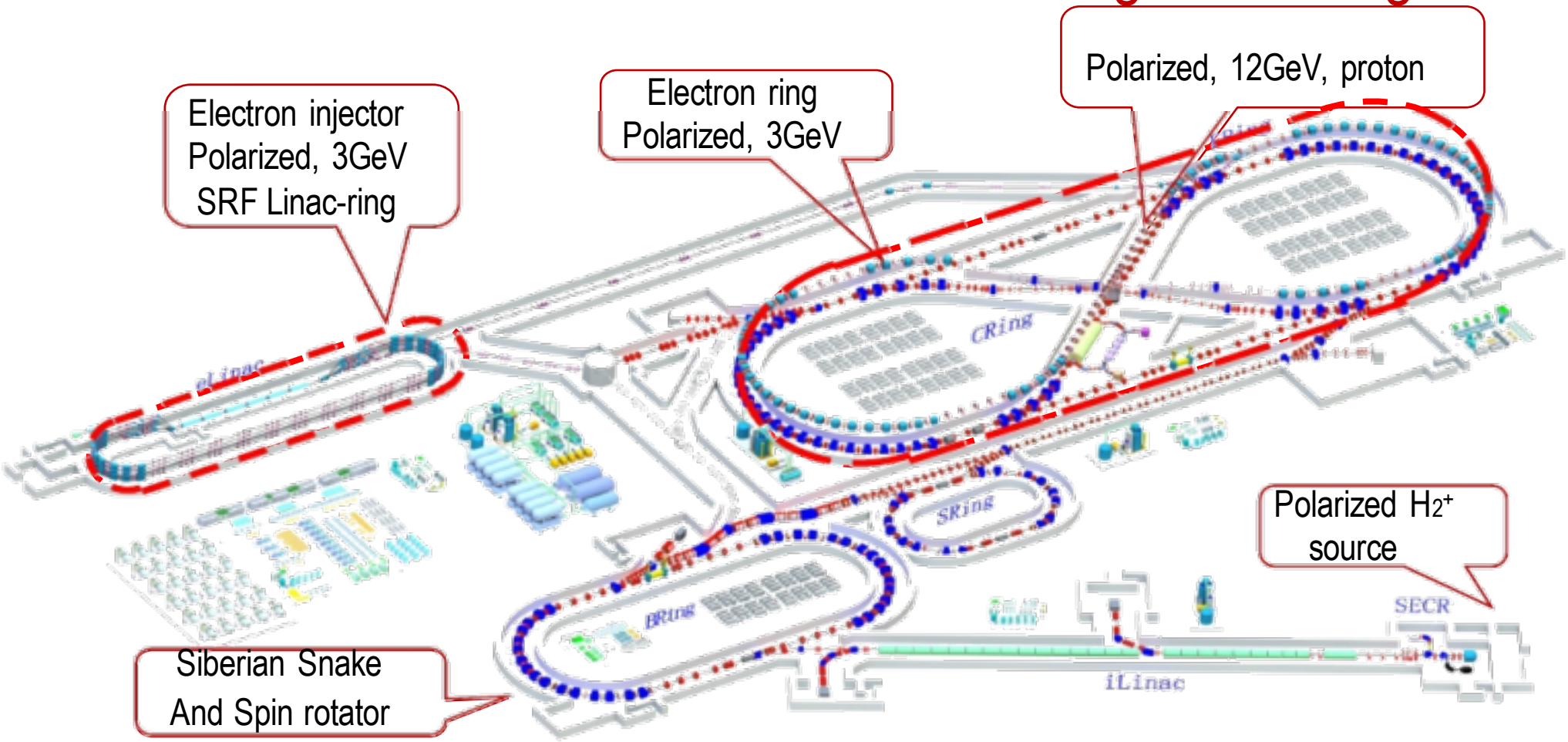
Second phase for HIAF: EIC (3 x 12 GeV) in China

- HIAF design maintains a well defined path for EIC
- **In HIAF I: EIC Ion pre-Booster $10^{14\sim15}$ ppp → Lower energy EIC (Update +ERL)**

See W. L. Zhan's talk@The 8th Workshop on Hadron Physics in China and Opportunities Worldwide (2016)

Luminosity : ~10^{33} cm^{-2} s^{-1}

figure-8 design



Thank You!

Welcome All to Our Next Workshop
Hadron-China2018
Will be hosted by Shandong University
Qingdao (青岛) or Weihai （威海）

Thank the Local Organizers

Thank Prof. Wang who tirelessly worked to make this workshop a nice successful workshop.

Thank Zuowei Liu (Scientific Secretary)
Zhu-Fang Cui and Shu-Sheng Xu
(Conference Secretary)
and a big team of students volunteers
Who provided excellent support