

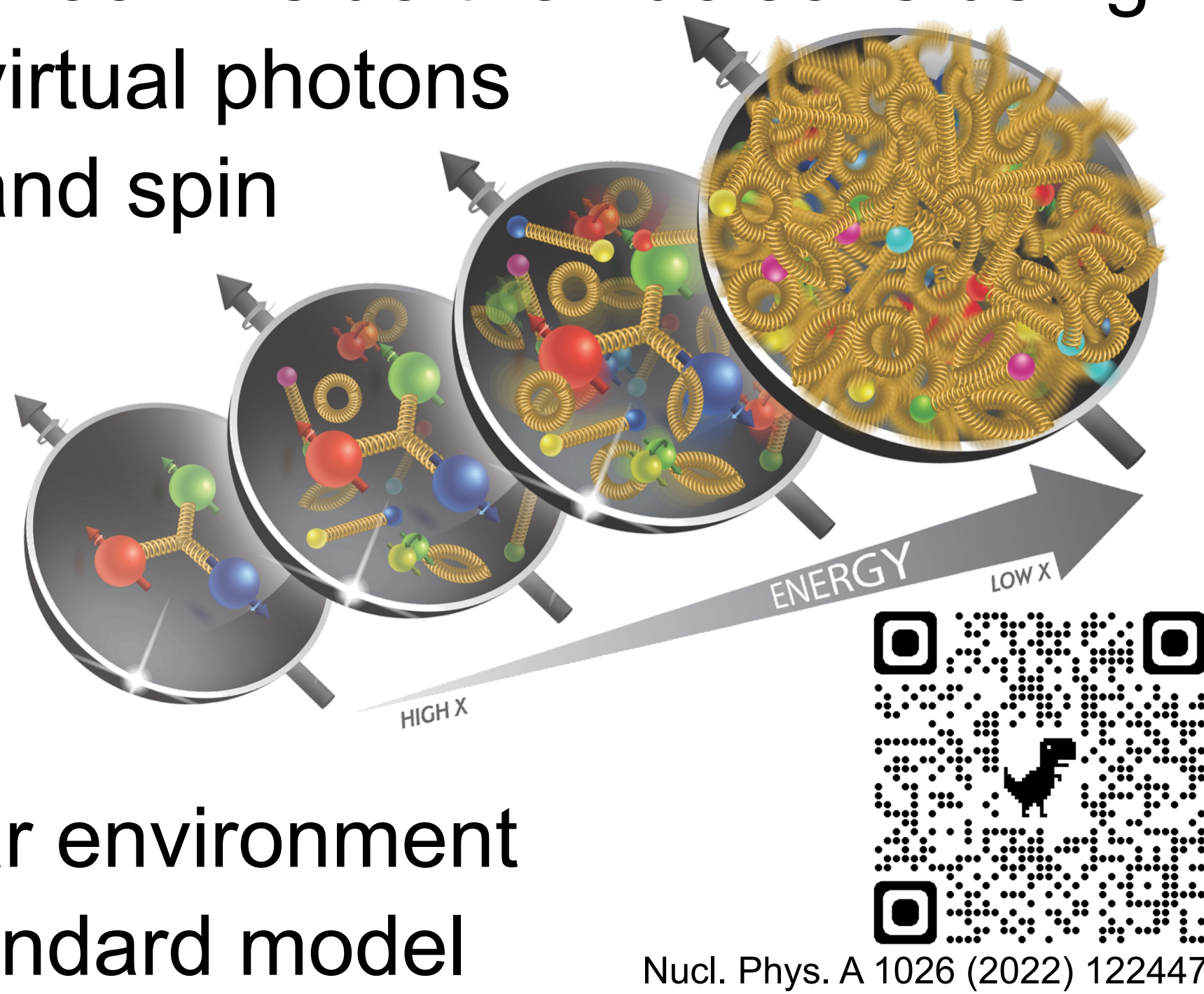
# Discovery through Complementarity

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BNL Day at SUNY OW, 04-10-2024

## 1. Electron-Ion Collider Physics

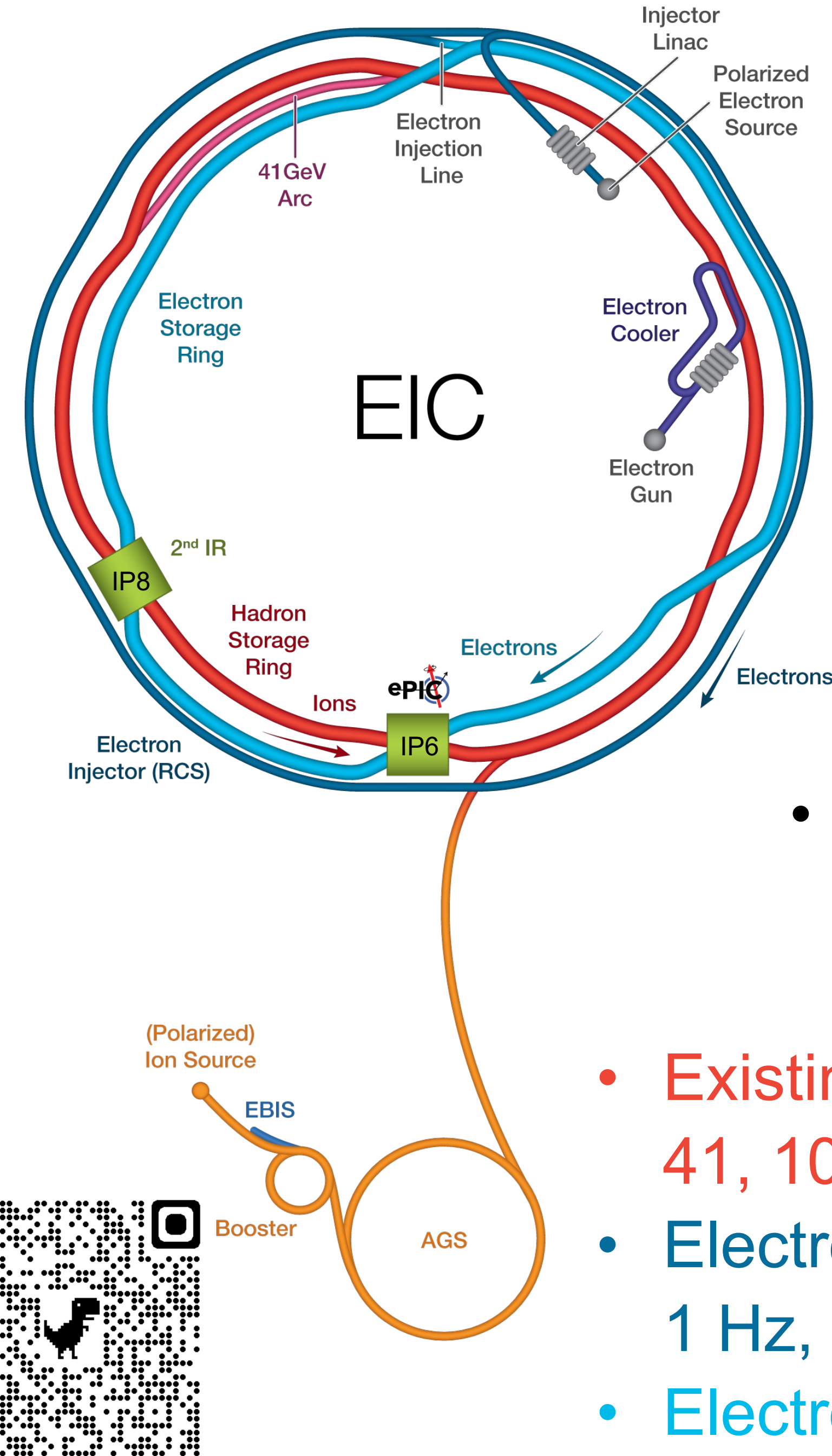
The **finest microscope** to look inside the nucleons using electromagnetic-induced virtual photons

1. Origin of proton mass and spin
2. Quark and gluon distributions in spatial and momentum space
3. Gluon saturation
4. Hadronization process
5. QCD in a dense nuclear environment
6. Physics beyond the standard model



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## 2. The Accelerator

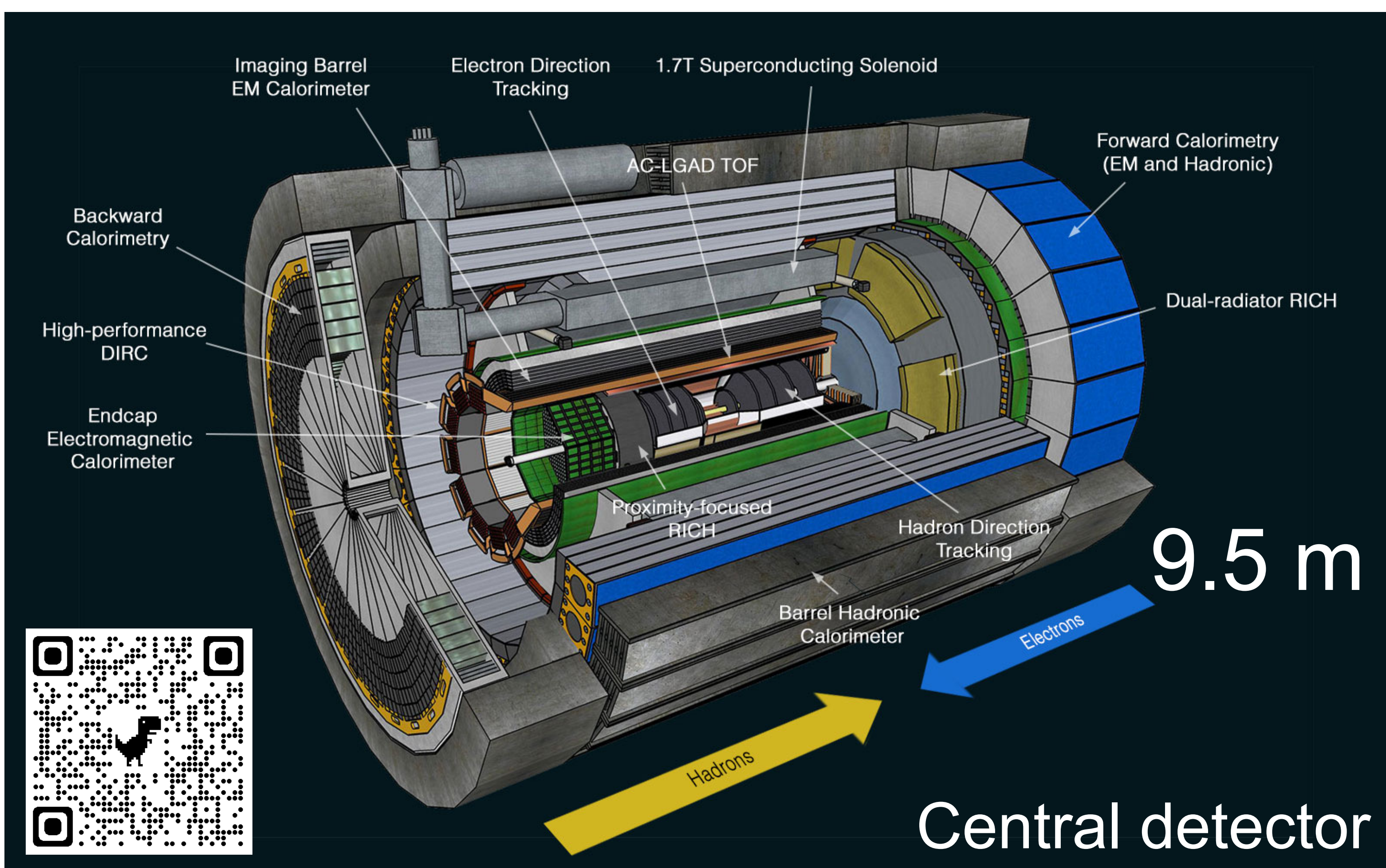


- High luminosity:  $10^{33} - 10^{34} \text{ cm}^{-2}\text{s}^{-1}$
- Variety of hadron / ion beams: p to Pb
- Wide center-of-mass energy ranging: 20-140 GeV
- High number of bunches: 1160, 10ns separation
- First collider that provides polarized electron and light ion beams

- Existing hadron storage ring 41, 100 – 275 GeV
- Electron rapid cycling synchrotron 1 Hz, 0.4 – 18 GeV
- Electron storage ring 5 – 18 GeV

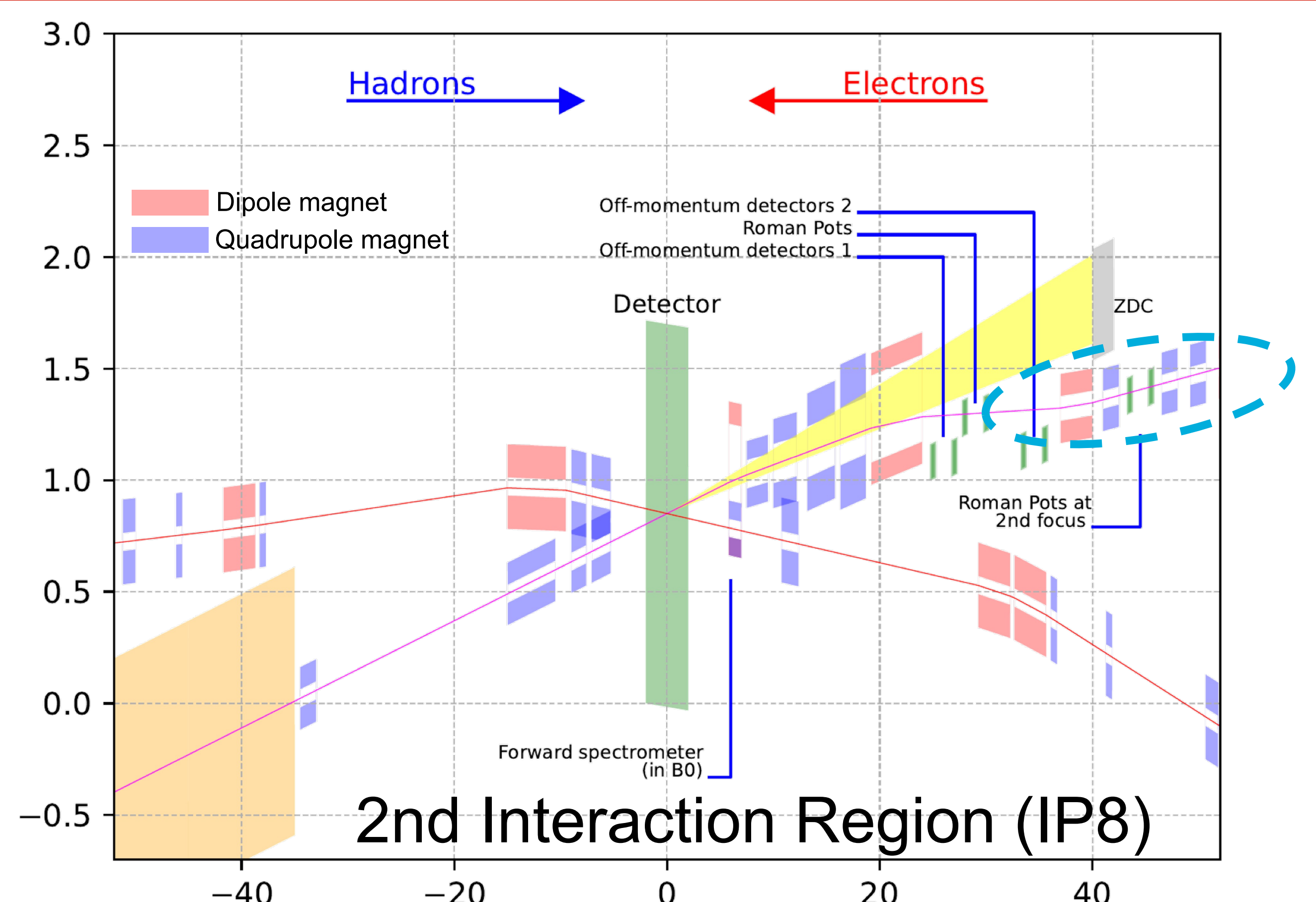


## 4. The ePIC Detector



- 16 subdetectors in the central region
- Far-forward and far-backward detectors for ion fragments and scattered electron measurements
- Using machine learning techniques on detector design, operations and data analysis
- 171 institutions from 24 countries and counting

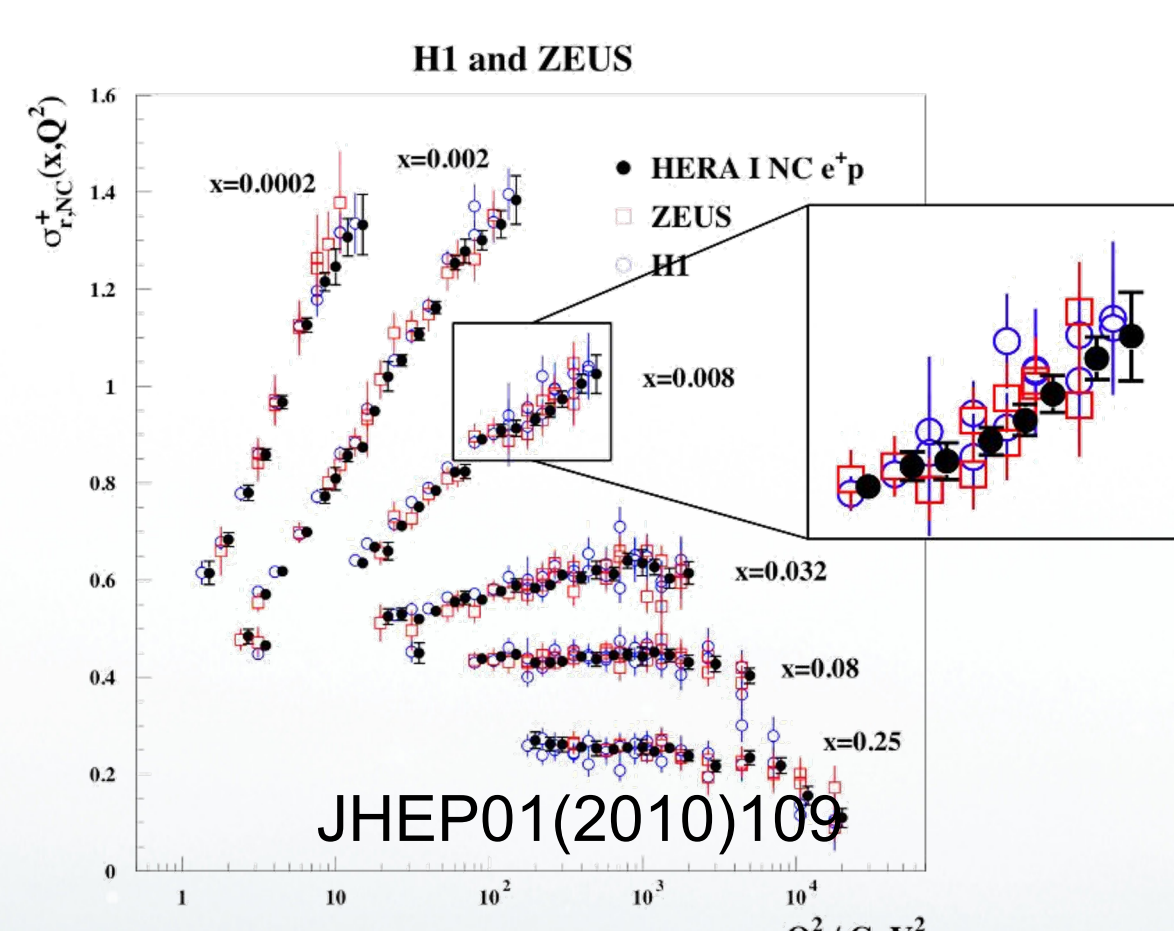
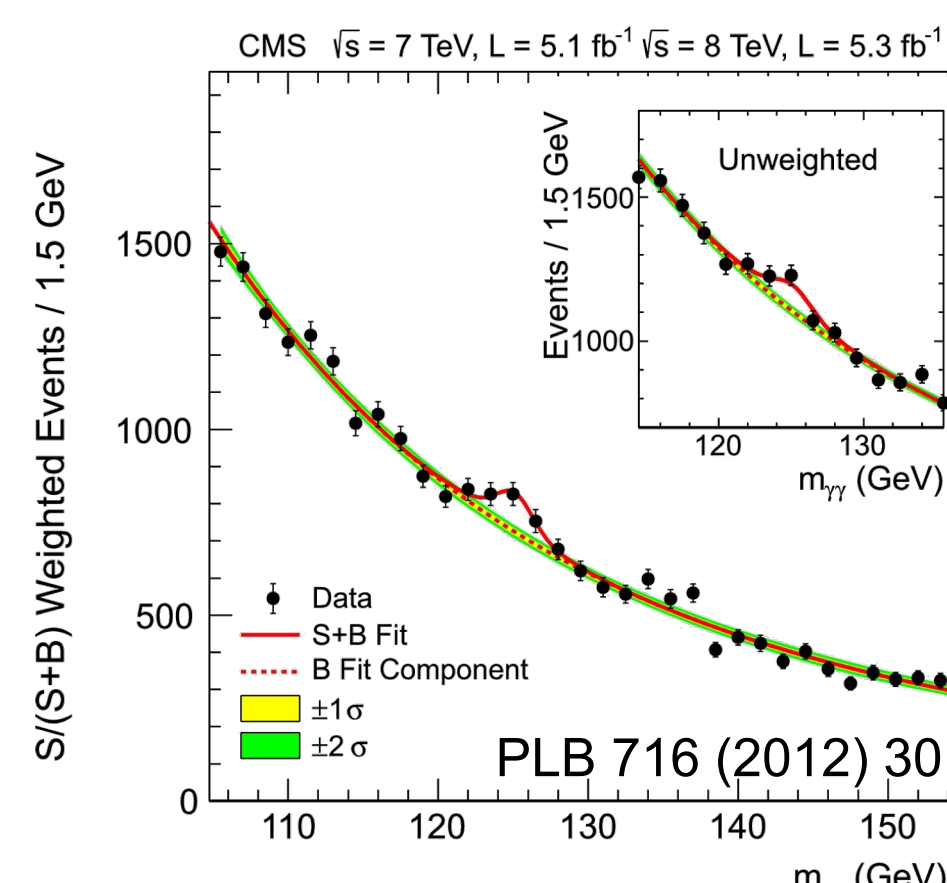
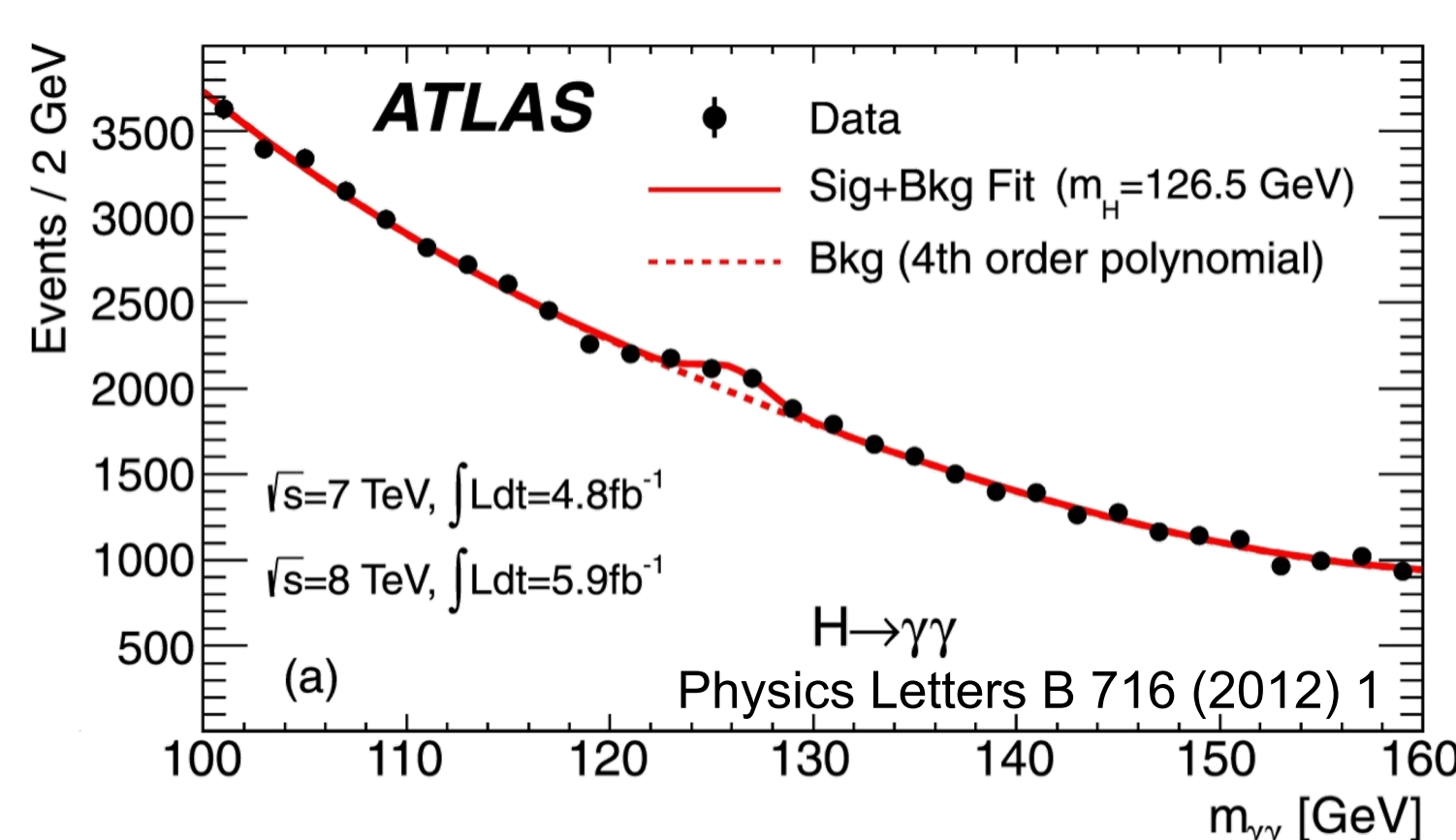
## 3. The Interaction Regions



- 25 mrad (35 mrad) crossing angle at the IP6 (IP8) → different blind spots
- Crab crossing → restore head-on collision of each bunch
- IP8 with a secondary beam focus → Improve low  $p_T$  ( $\sim 0 \text{ GeV}$ ) acceptance at far-forward region

## 5. The Complementarity of a Second Detector

- Cross-checking → validate discoveries



- Cross Calibration → gives beyond the simple  $\sqrt{2}$  statistical improvement
- Different physics focuses
- Technology Redundancy → mitigate risks
- Potential detector technologies
  - Muon Identification vs hadronic calorimeter
  - Mixed tracker technologies vs all-silicon tracker

## 6. Join Us

- Science Undergraduate Laboratory Internship (SULI) 10-week/semester-long internship at the national lab
- Work with us on physics/detector simulations and detector R&D



## Electron-Ion Collider

