The eRHIC project

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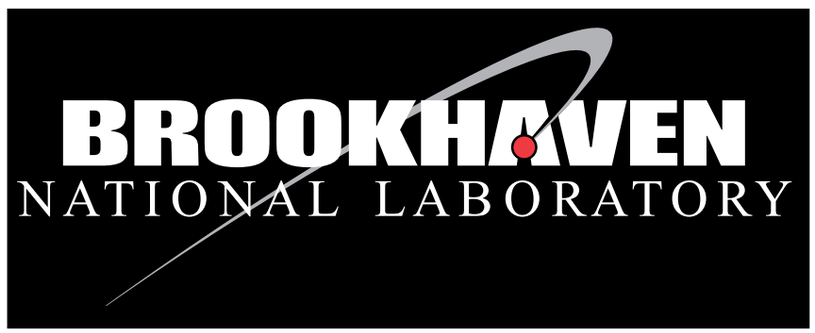
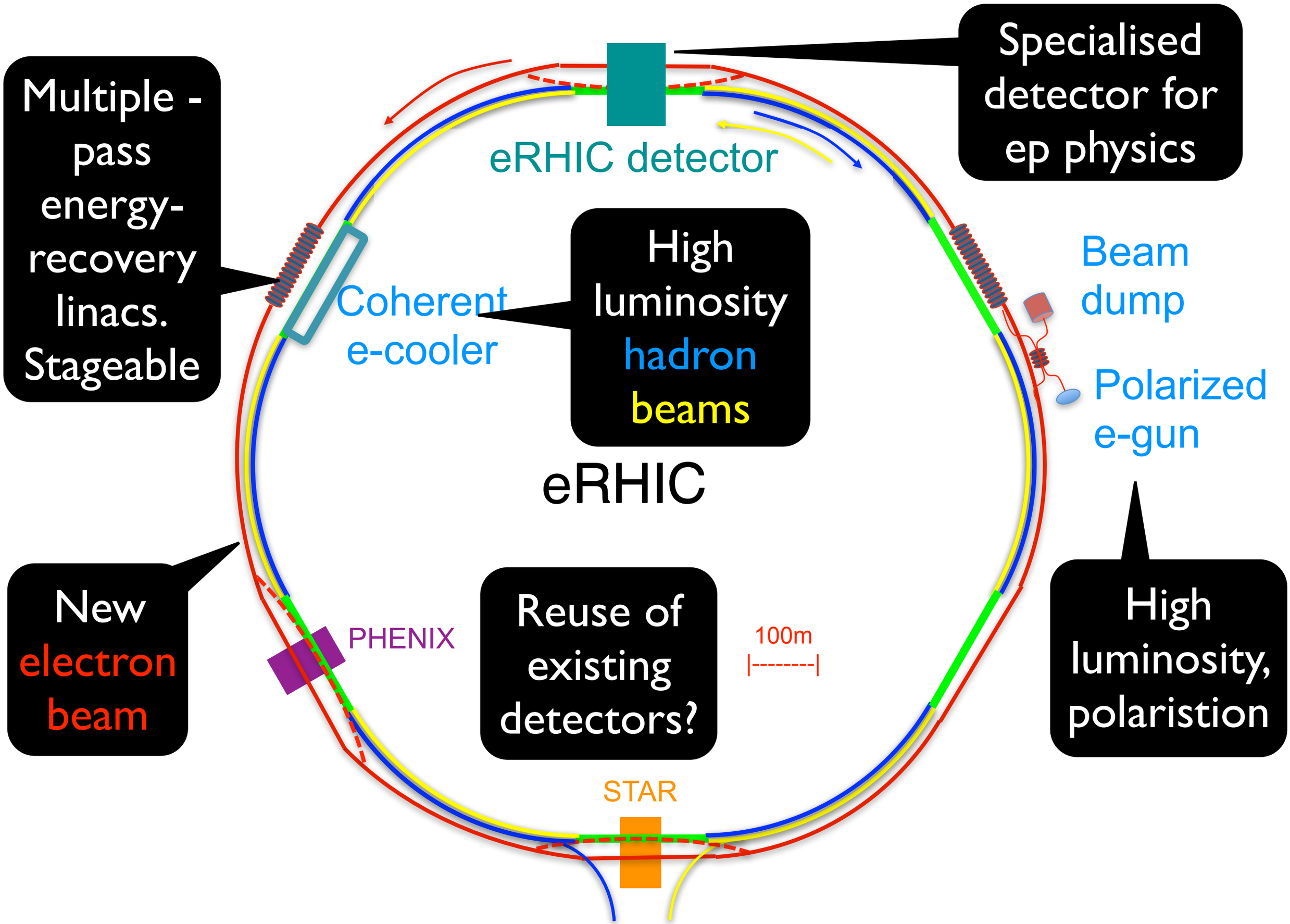
International Conference on Frontiers in Physics

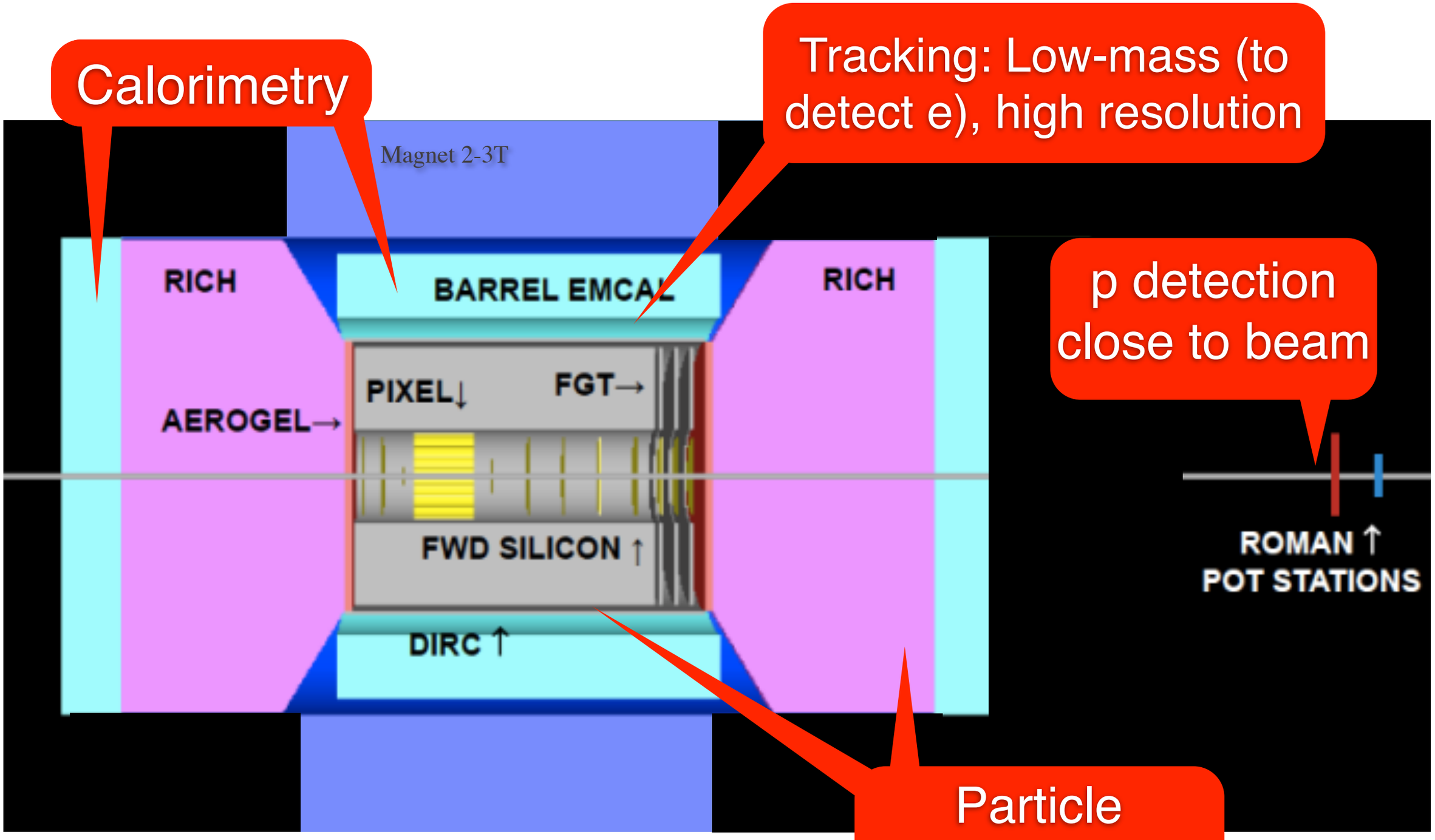


The **eRHIC** project

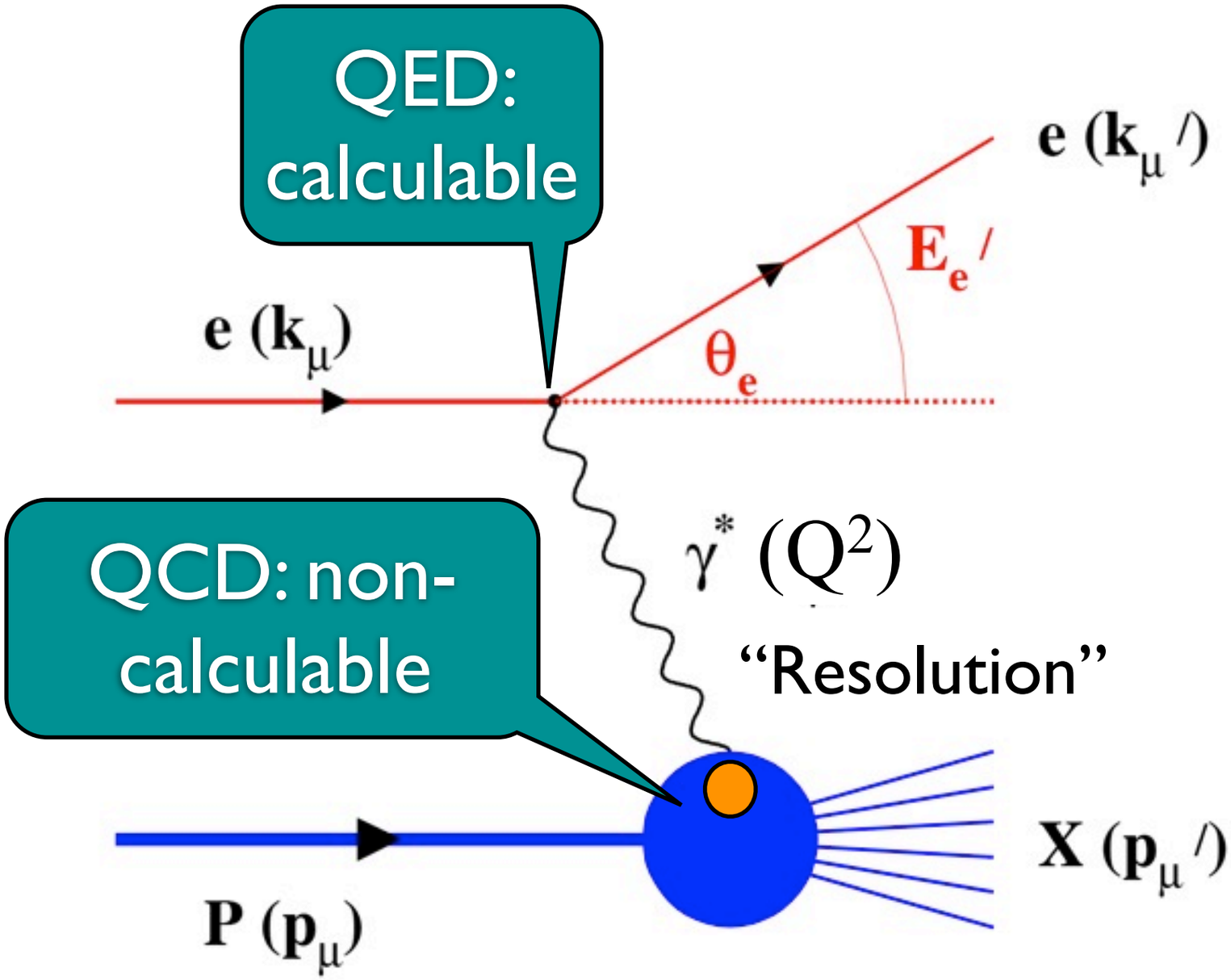
- BNL's proposal for an **Electron-ion-collider (EIC)**
- Next-gen facility for nucle(on/ar) structure
  - Extreme luminosity ~ 10^{34} $cm^{-2}s^{-1}$
  - Variable energy [e 5-20, p 100-250, Au 50-100]
  - Multiple ion species: p to U
  - Polarised beams [e, p, He^3]


Multiple - pass energy-recovery linacs. Stageable
Specialised detector for ep physics
eRHIC detector
Coherent e-cooler
High luminosity hadron beams
eRHIC
Beam dump
Polarized e-gun
New electron beam
Reuse of existing detectors?
High luminosity, polaristion
PHENIX
100m
|--------|
STAR

Detector: compact & hermetic



Probing hadrons: **DIS**



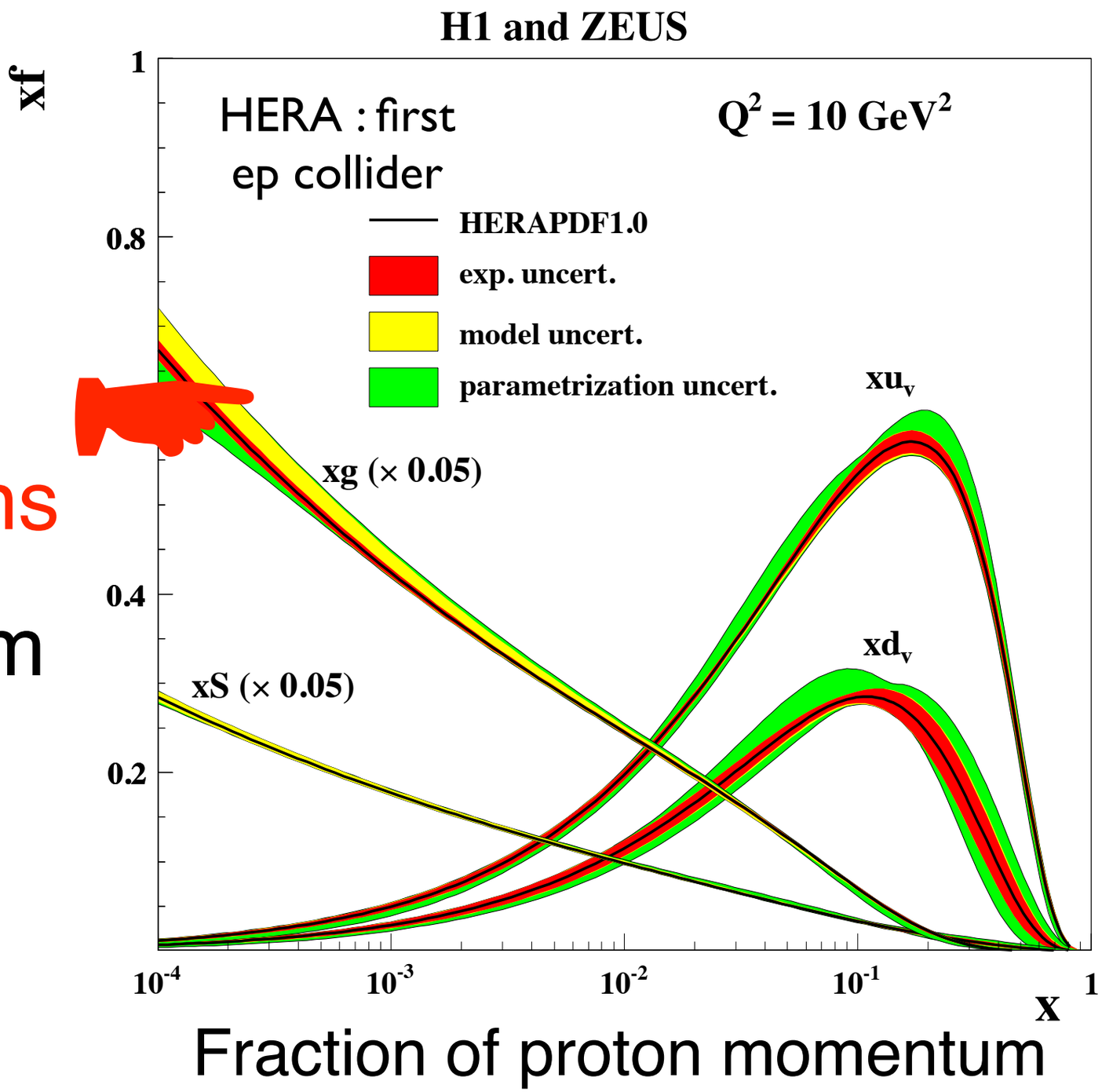
Deeply
Inelastic
Scattering

- Photon interacts with **quark** not **proton**
- "QCD femtoscope"

Proton structure

$$\sigma_r = F_2(x, Q^2) - \frac{y^2}{1 + (1 - y)^2} F_L(x, Q^2)$$

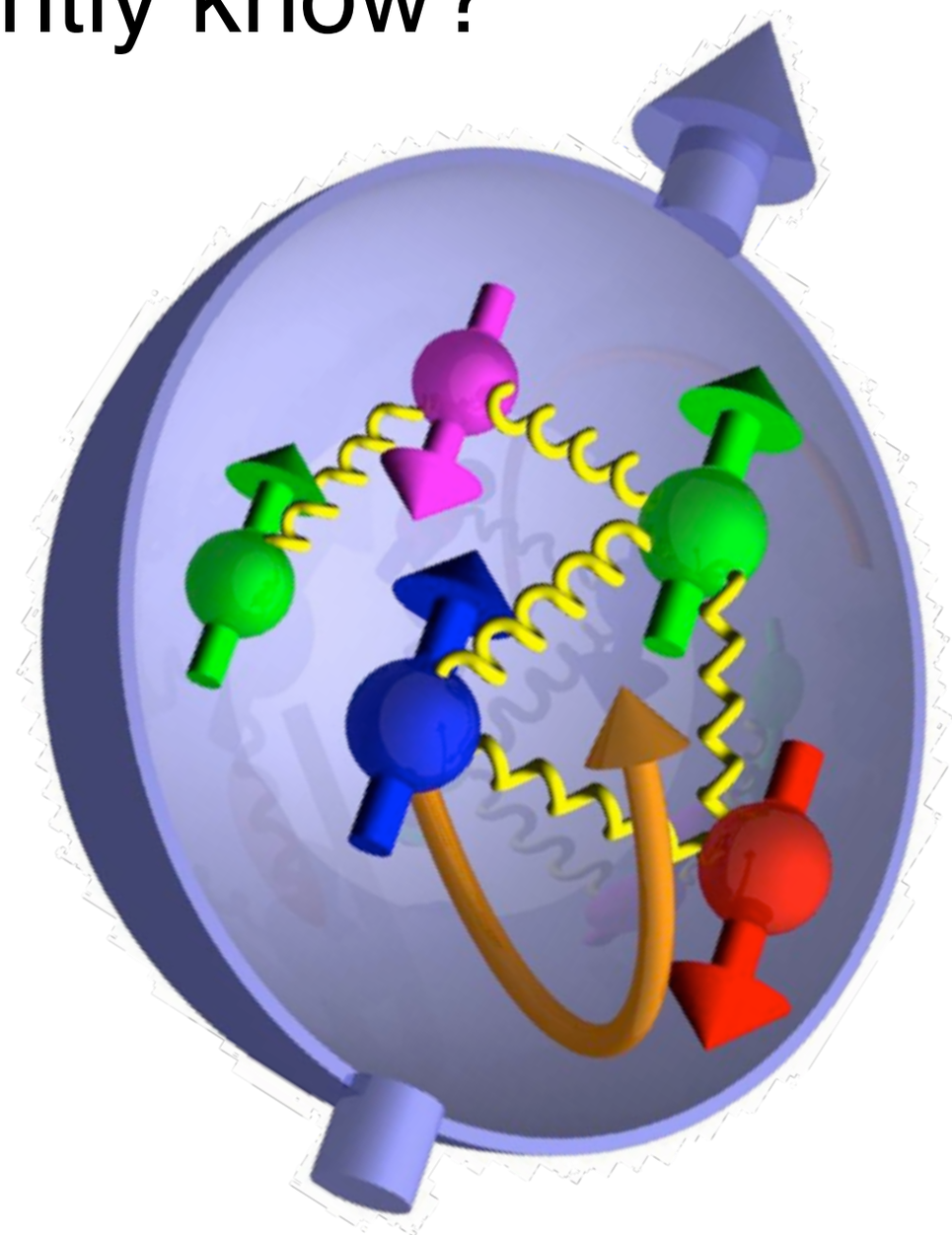
- Describable with structure functions
- Relate to parton distribution functions
  - parton momentum inside proton



1: Spin physics

DIS with **polarised** beams

Allows study of nucleon spin
What do we currently know?



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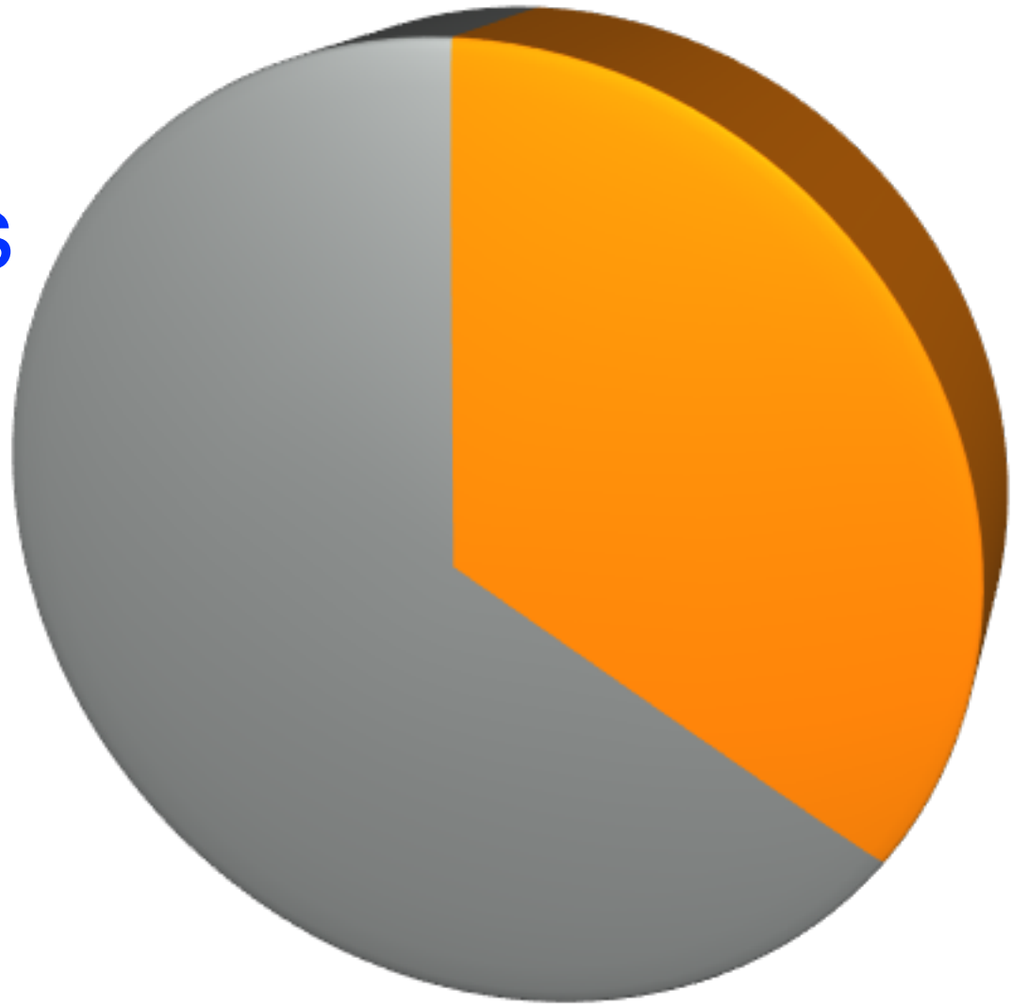
- **Not** from 3 spin ½ quarks
- Only ⅓ from quark spin
- Remainder unclear



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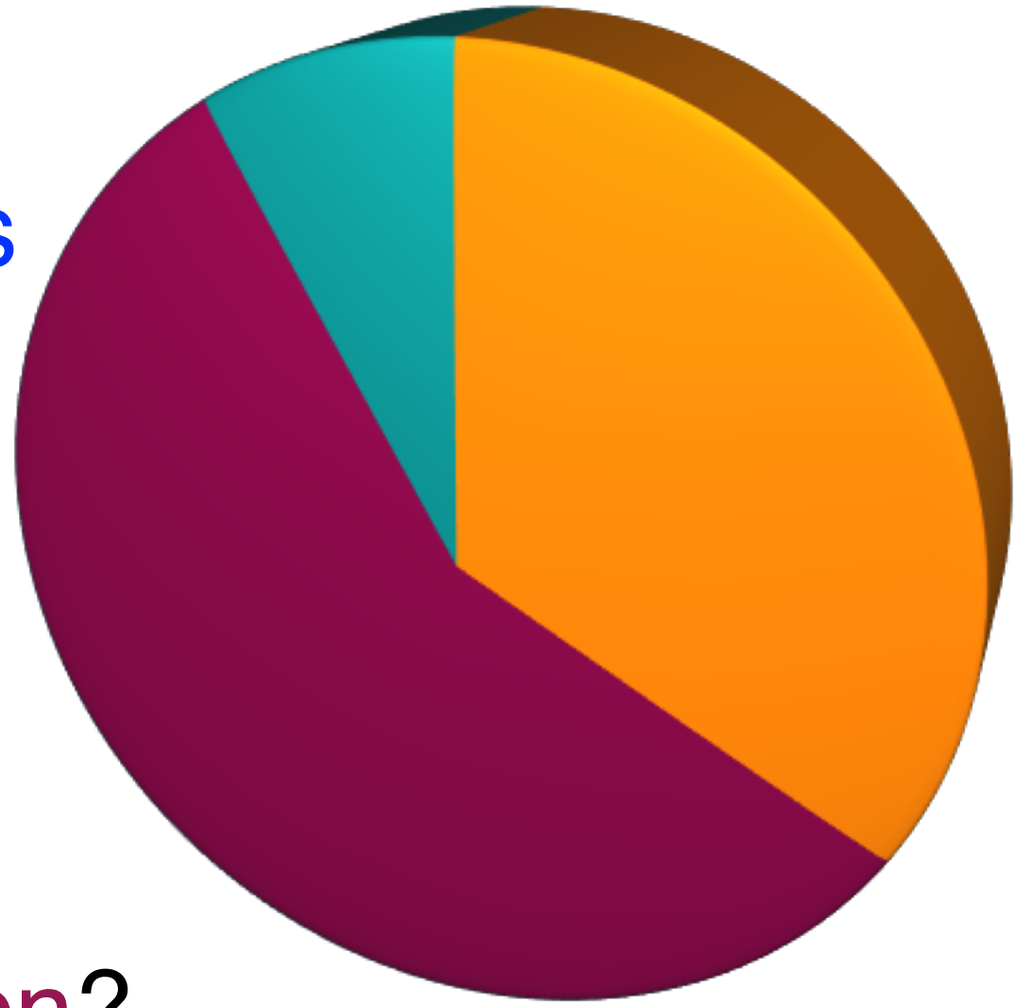

- **Not** from 3 spin ½ quarks
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  - How much gluon spin?
  - How much orbital motion?

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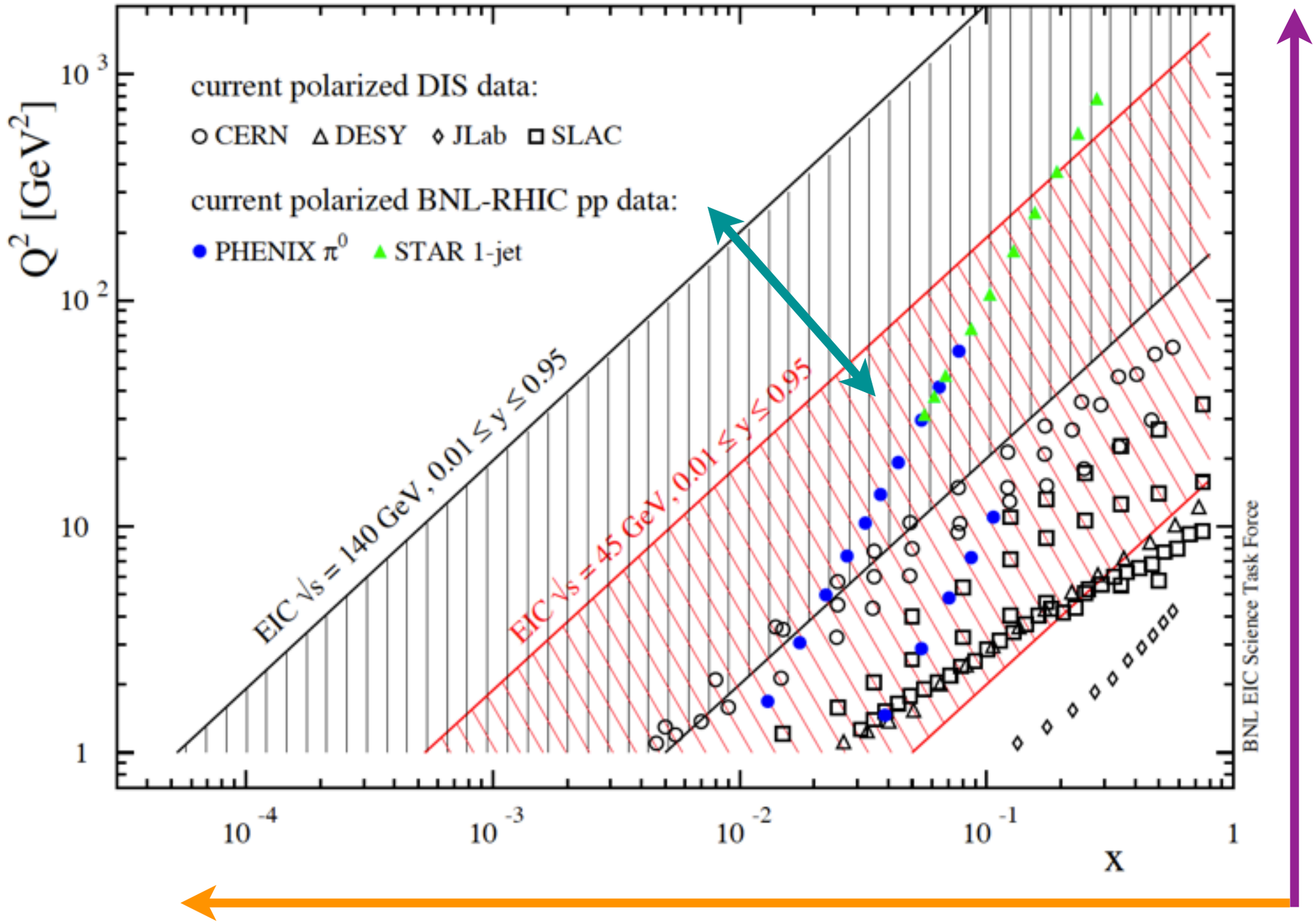
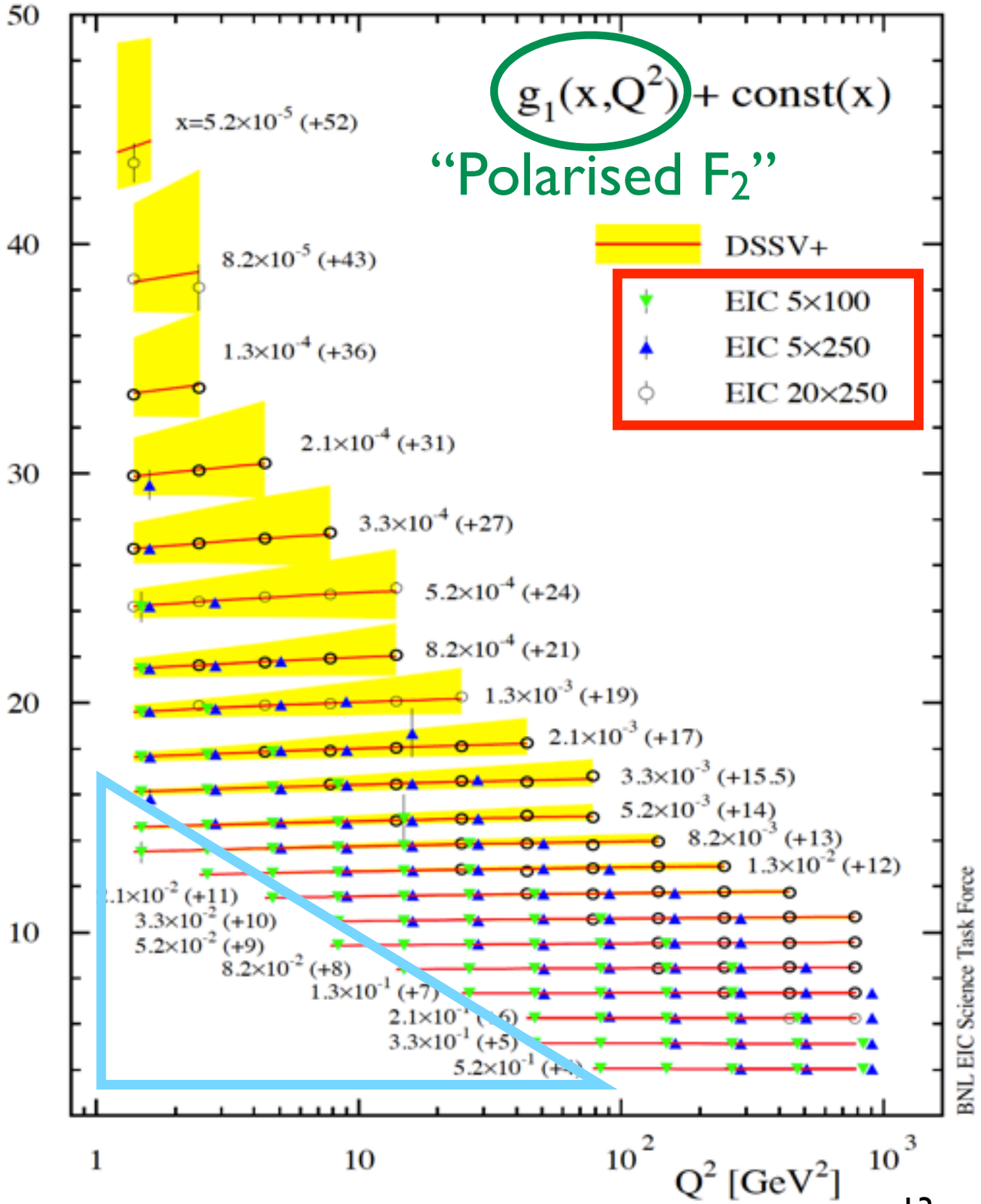
eRHIC **kinematics**



Variable E
→ scan
x-Q^2 plane

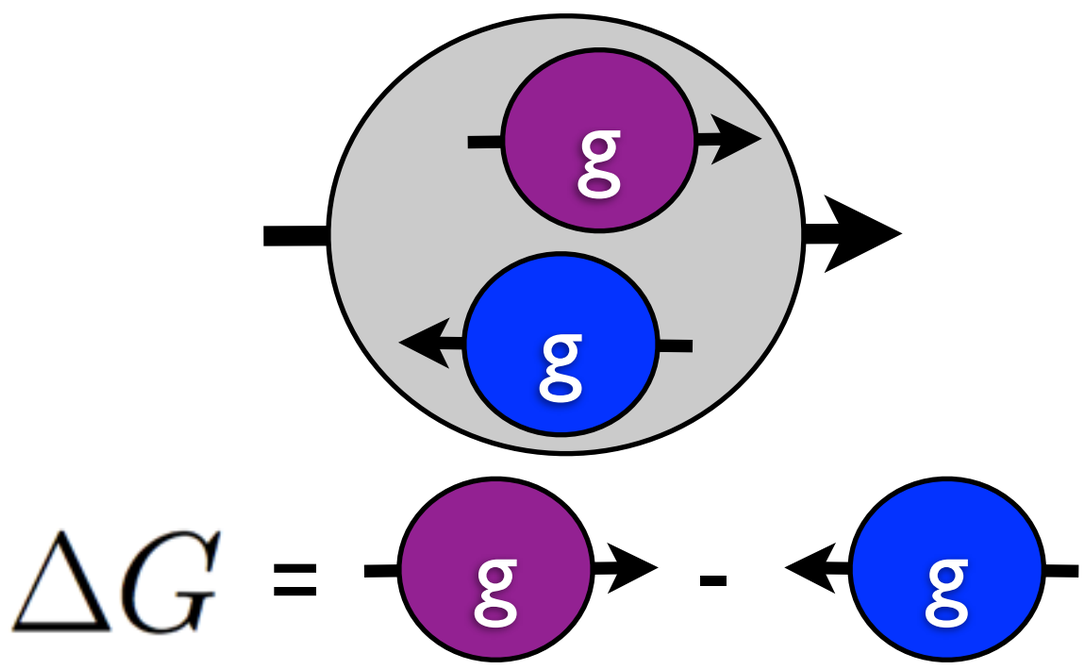
Greatly extended reach to both low x & high Q^2

DIS with **polarised** beams

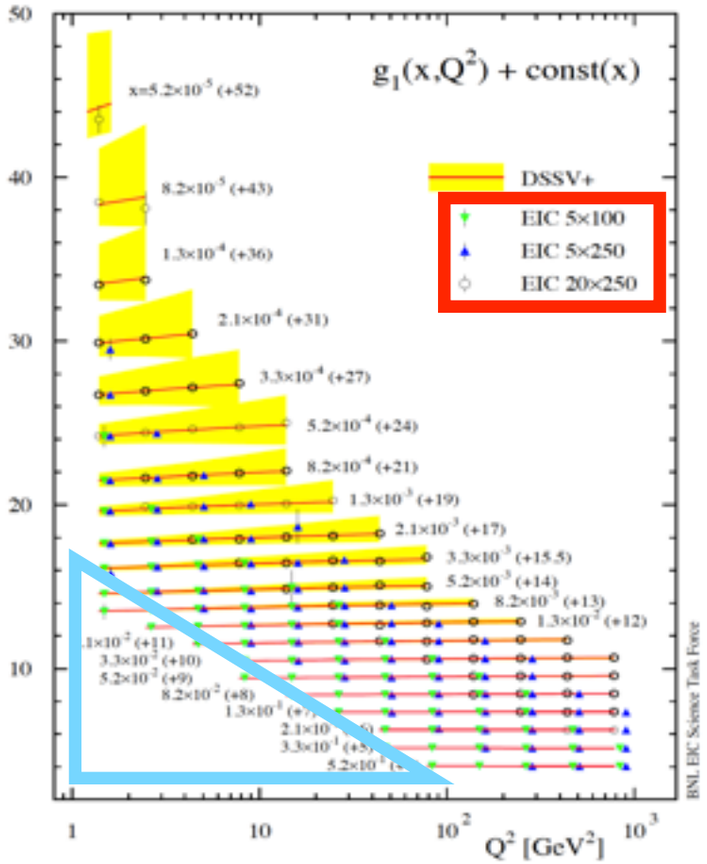


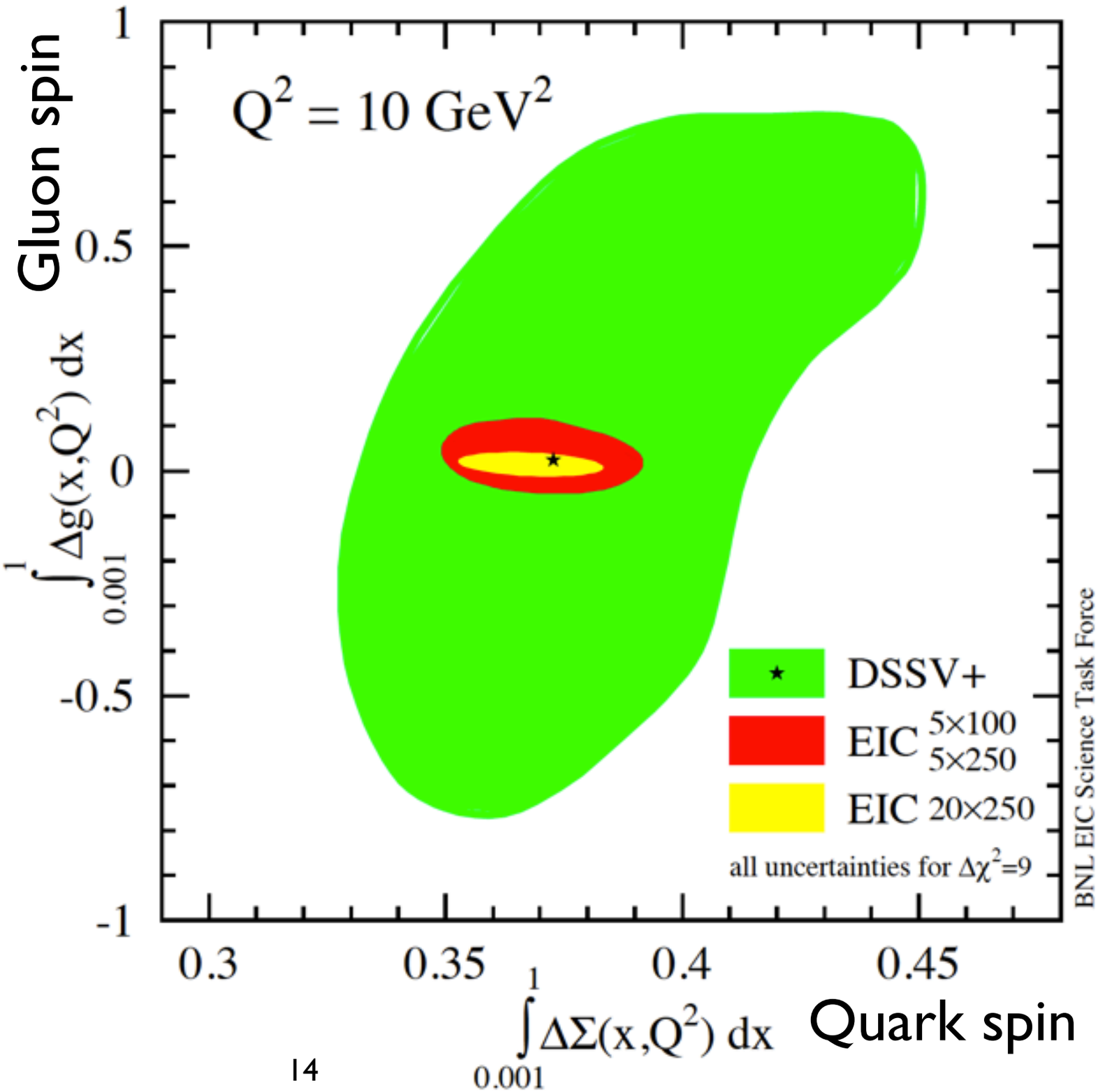
- eRHIC impact?
  - Perform global fit of existing data + eRHIC "data"

$$\Delta G \propto -\frac{dg_1}{d\log Q^2}$$



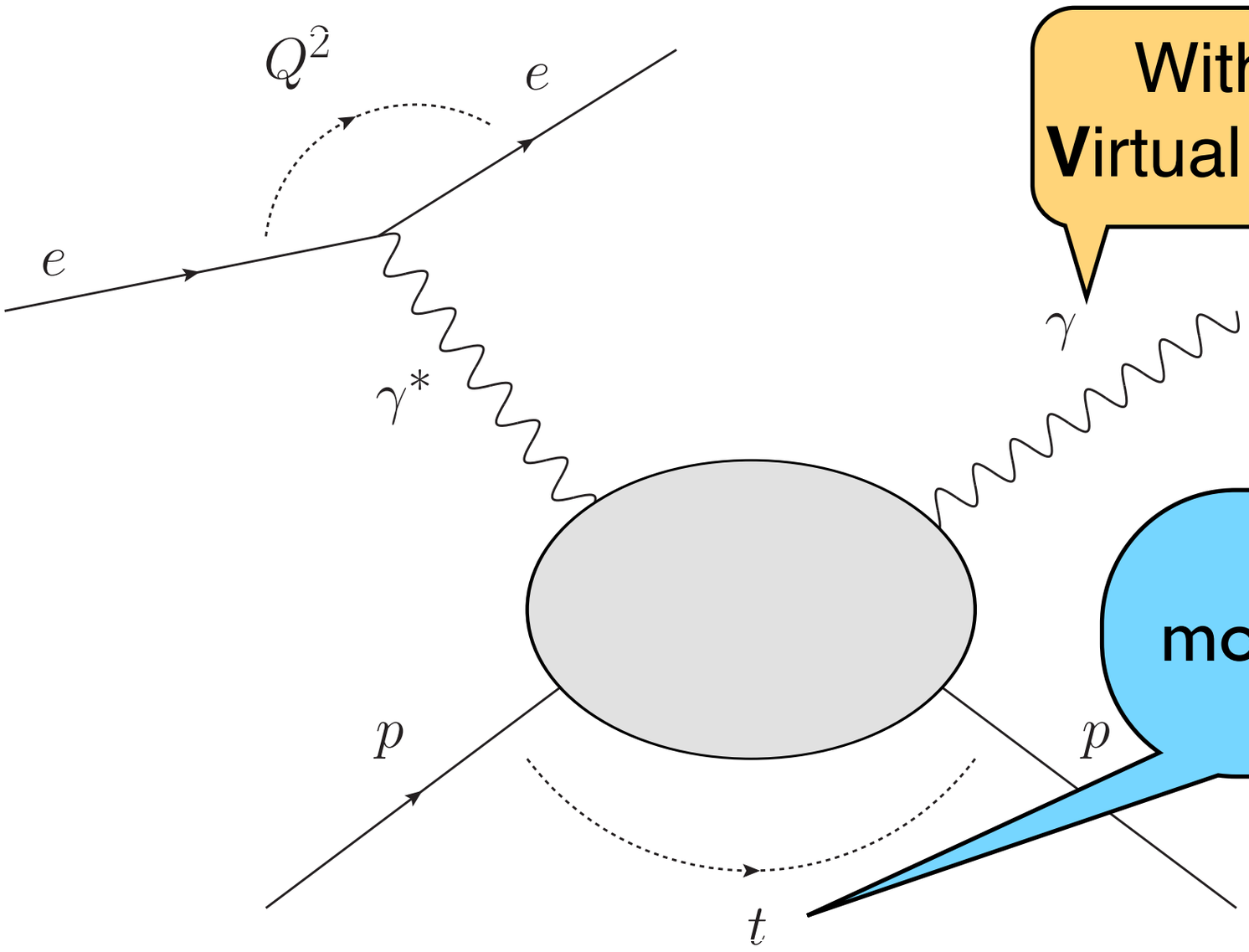
DIS with **polarised** beams





2: Imaging protons & nuclei

Exclusive Diffractive Scattering



With γ, called "**D**eeply **V**irtual **C**ompton **S**cattering"

or vector meson

Depends on momentum transfer to proton, t

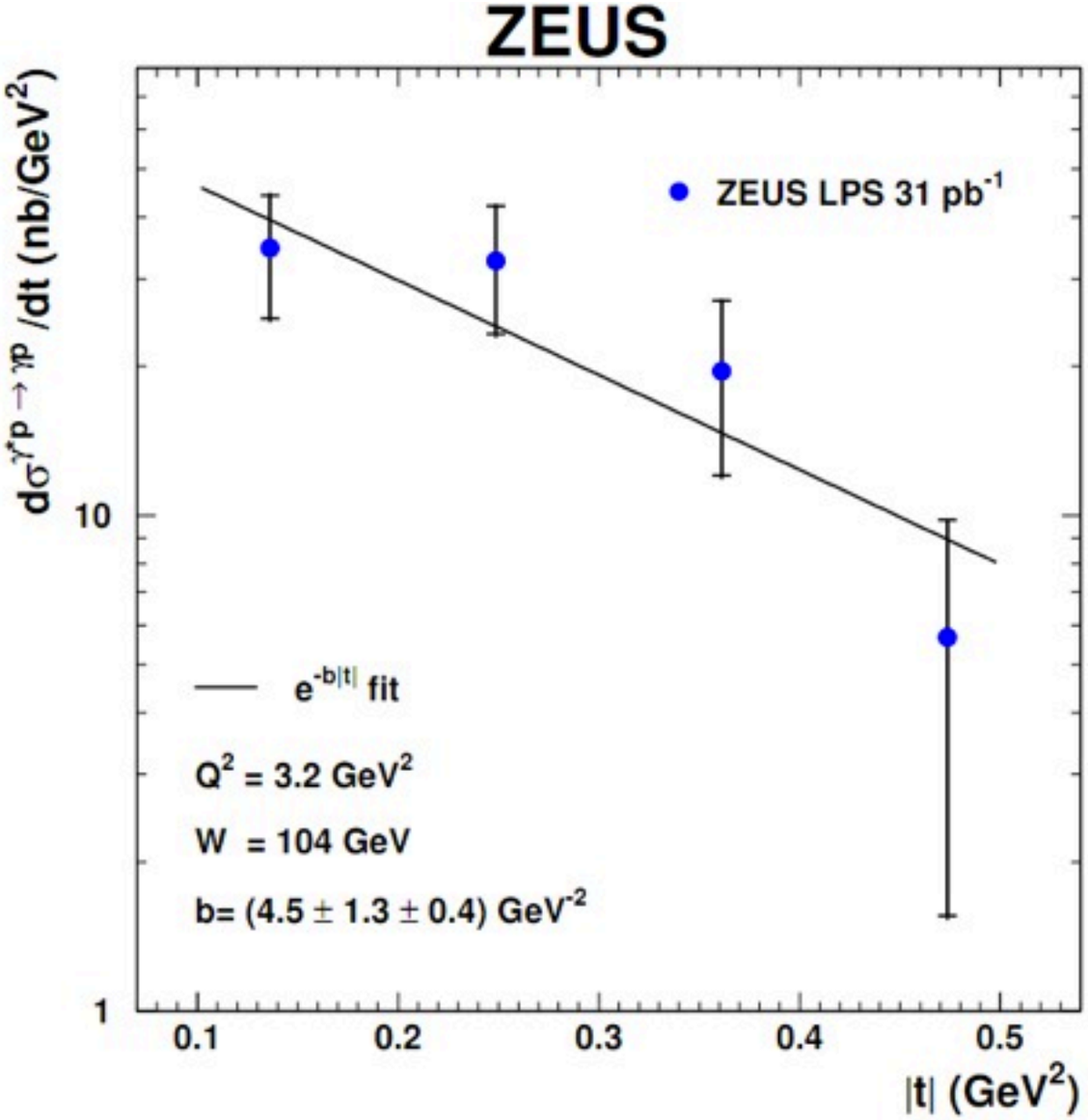
Fourier transform

exclusive diffractive cross section vs .t →

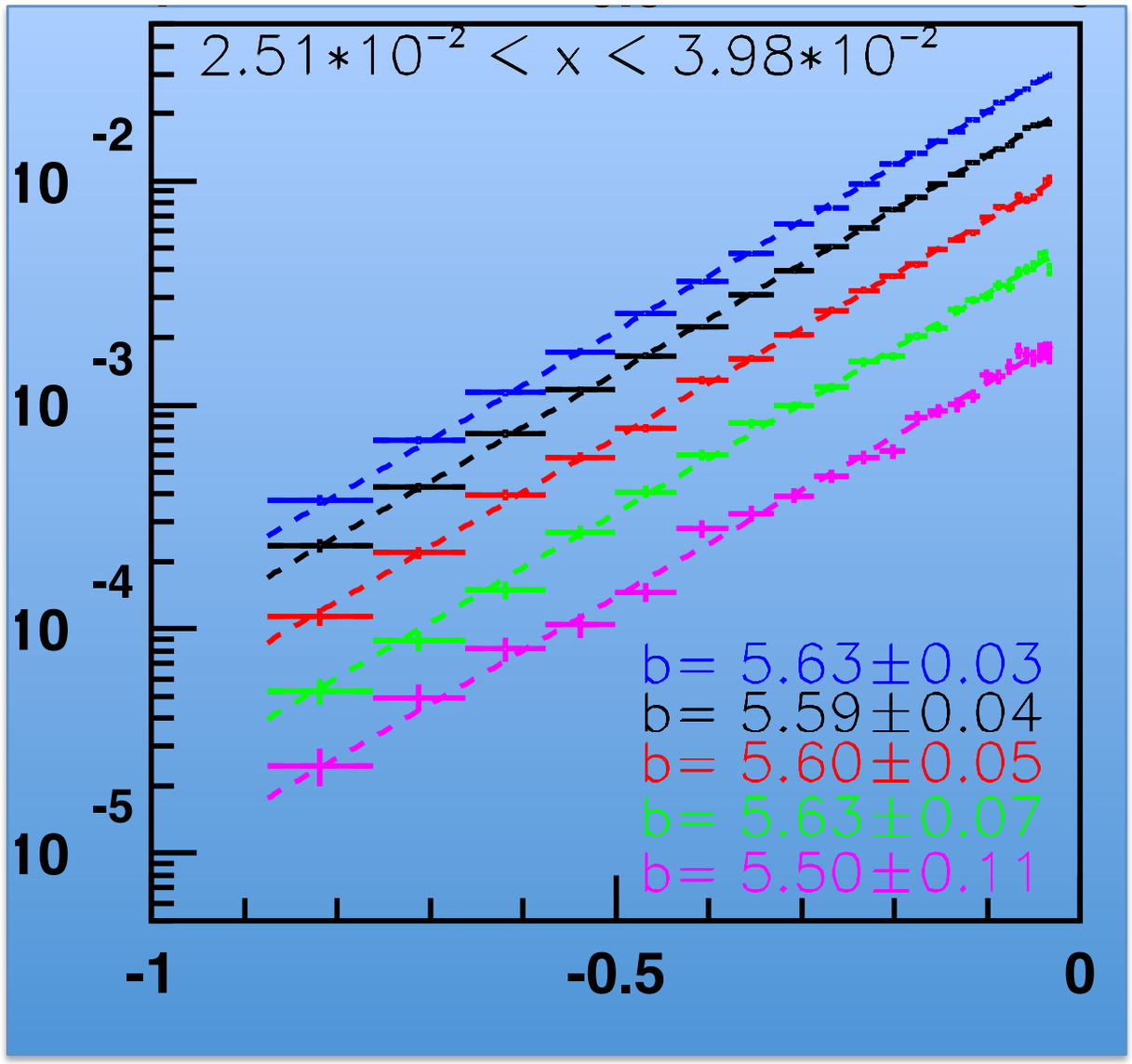
transverse spatial distribution:

tomographic imaging

Deeply Virtual Compton Scattering

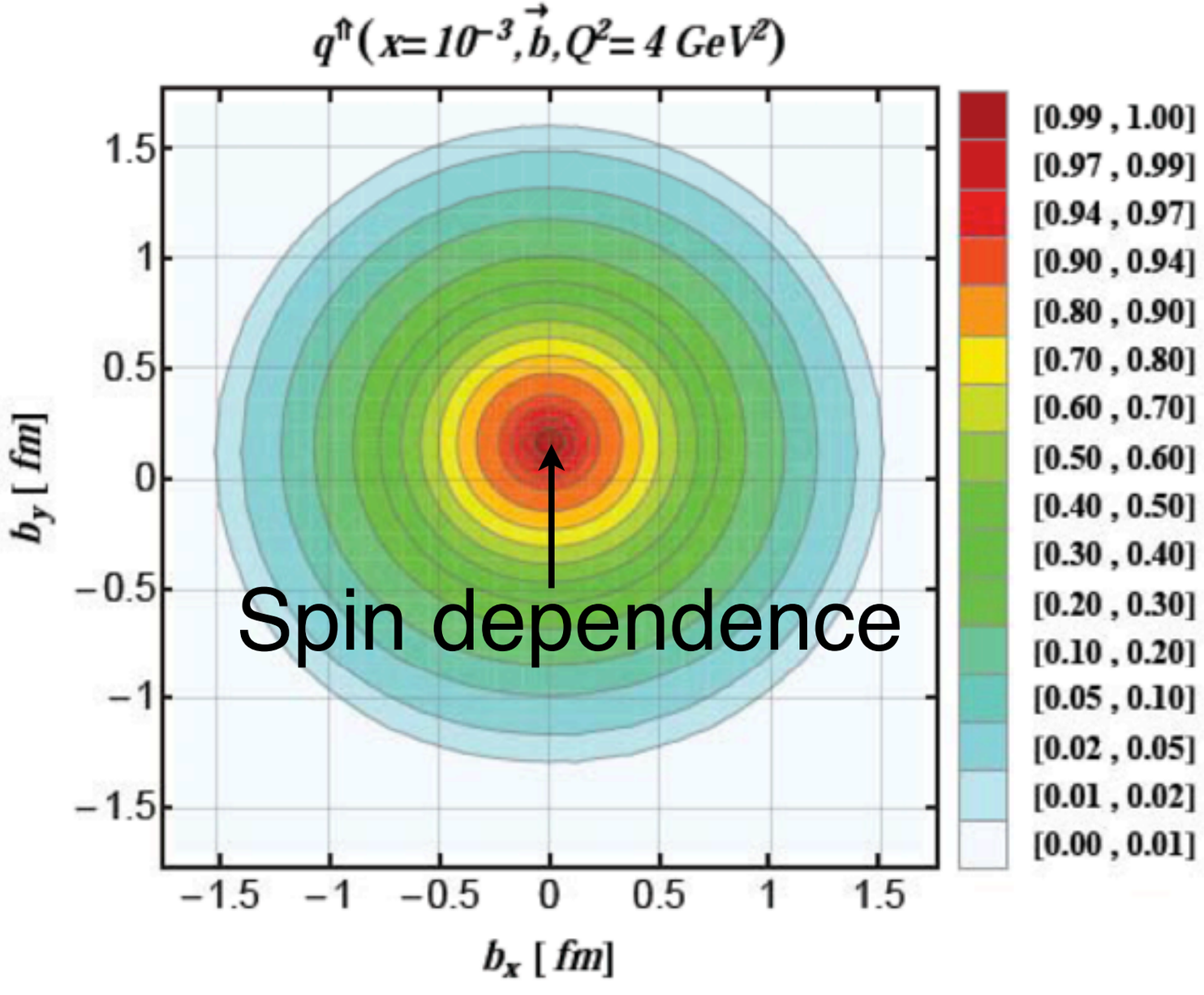


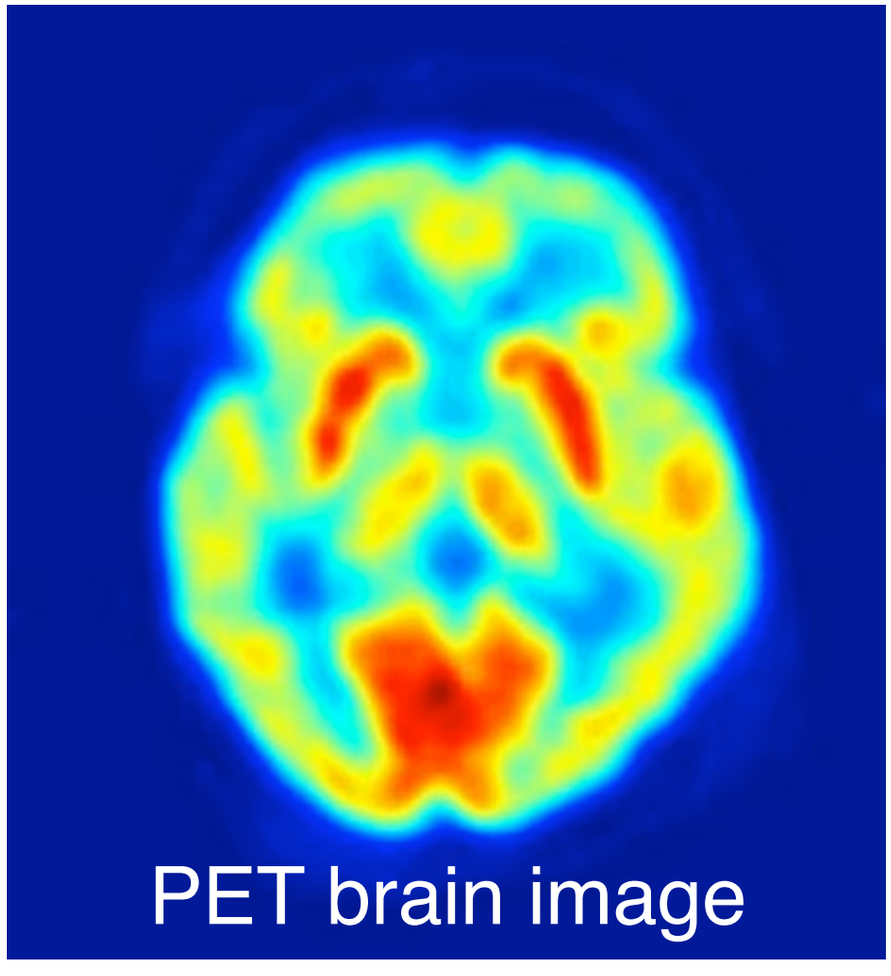
Existing HERA data



eRHIC: high luminosity gives precision & fine binning

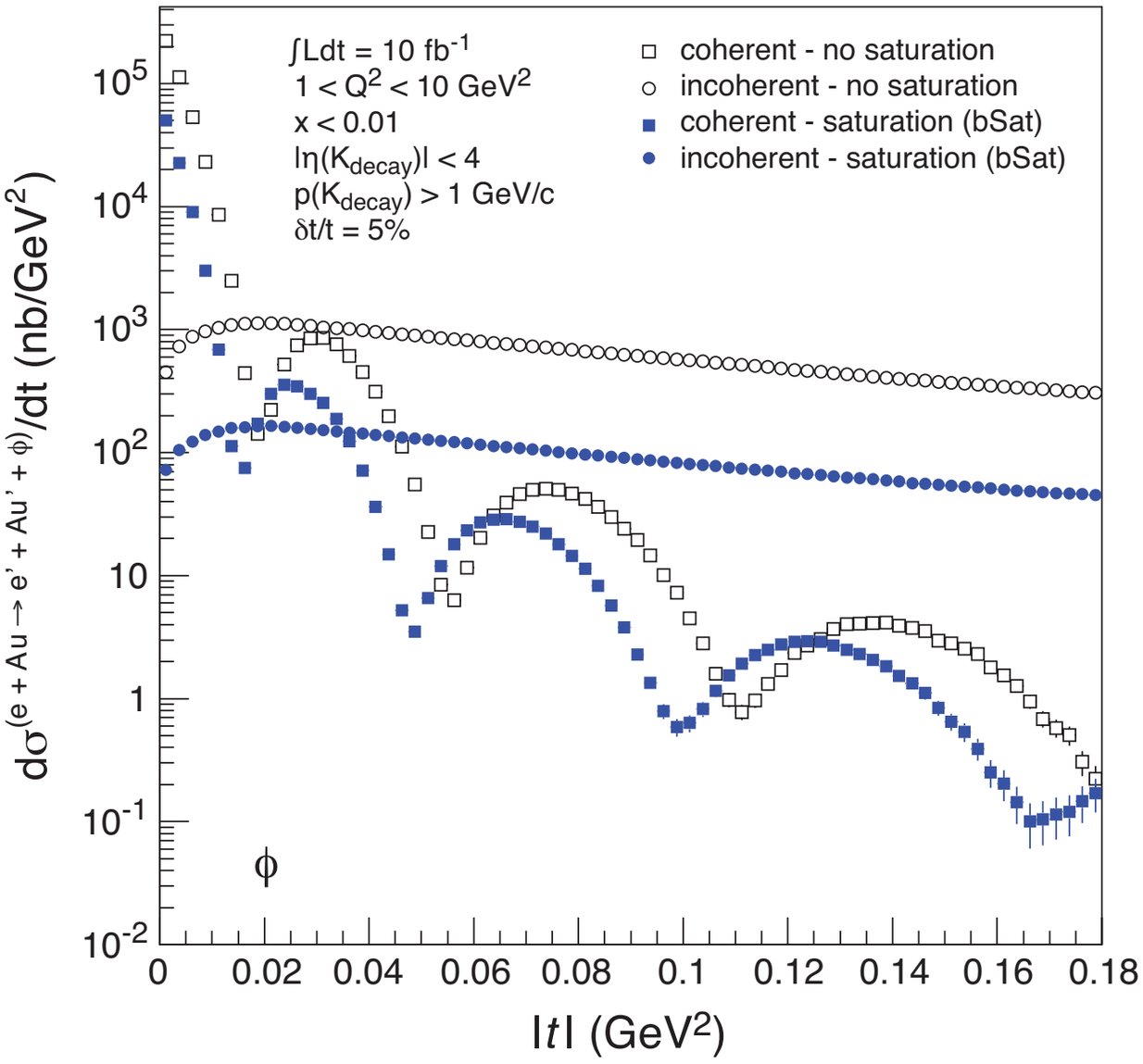
Nucleon **tomography**





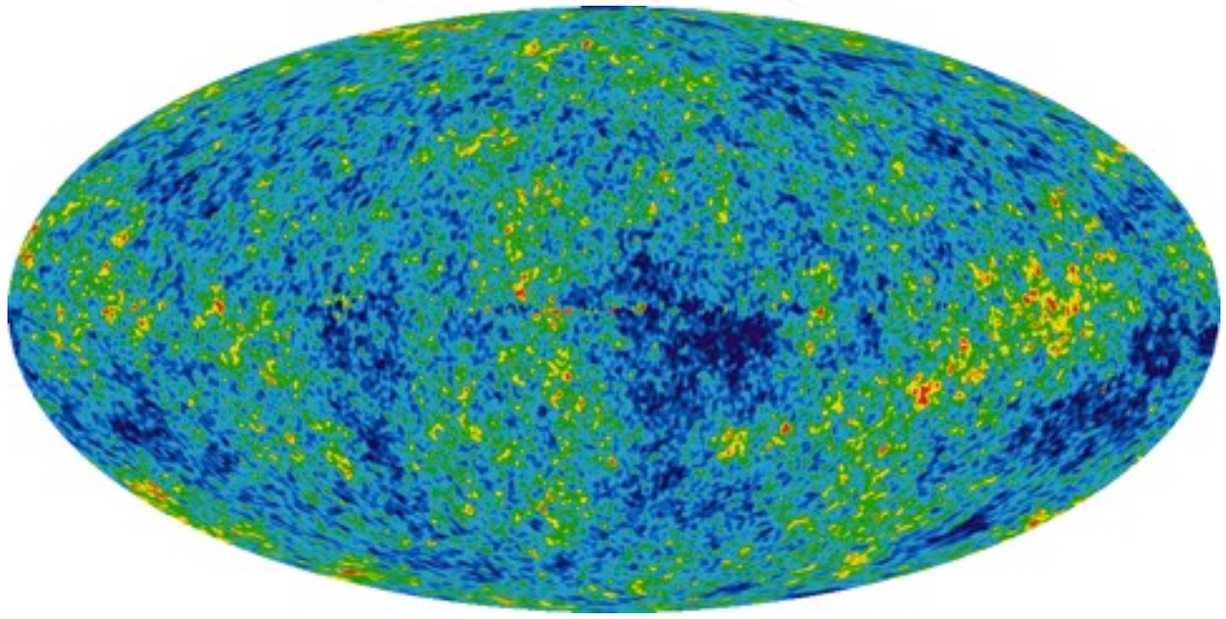
3: Strong colour fields

Nuclear diffraction



Coherent: nucleus intact
Incoherent: nucleus breaks up

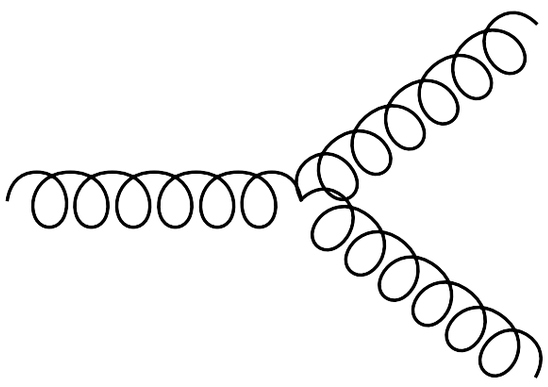
- dσ/dt → b-density



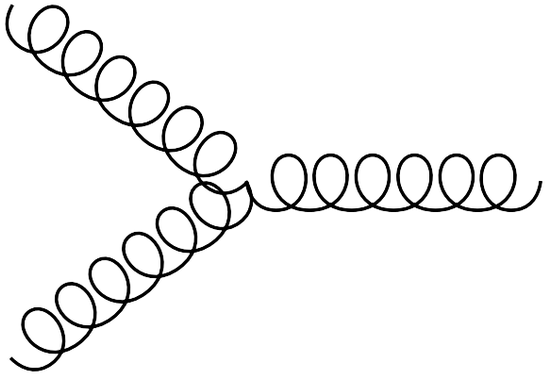
- Initial fluctuations in density analogous to fluctuations in early universe
- Sensitive to ***saturation***

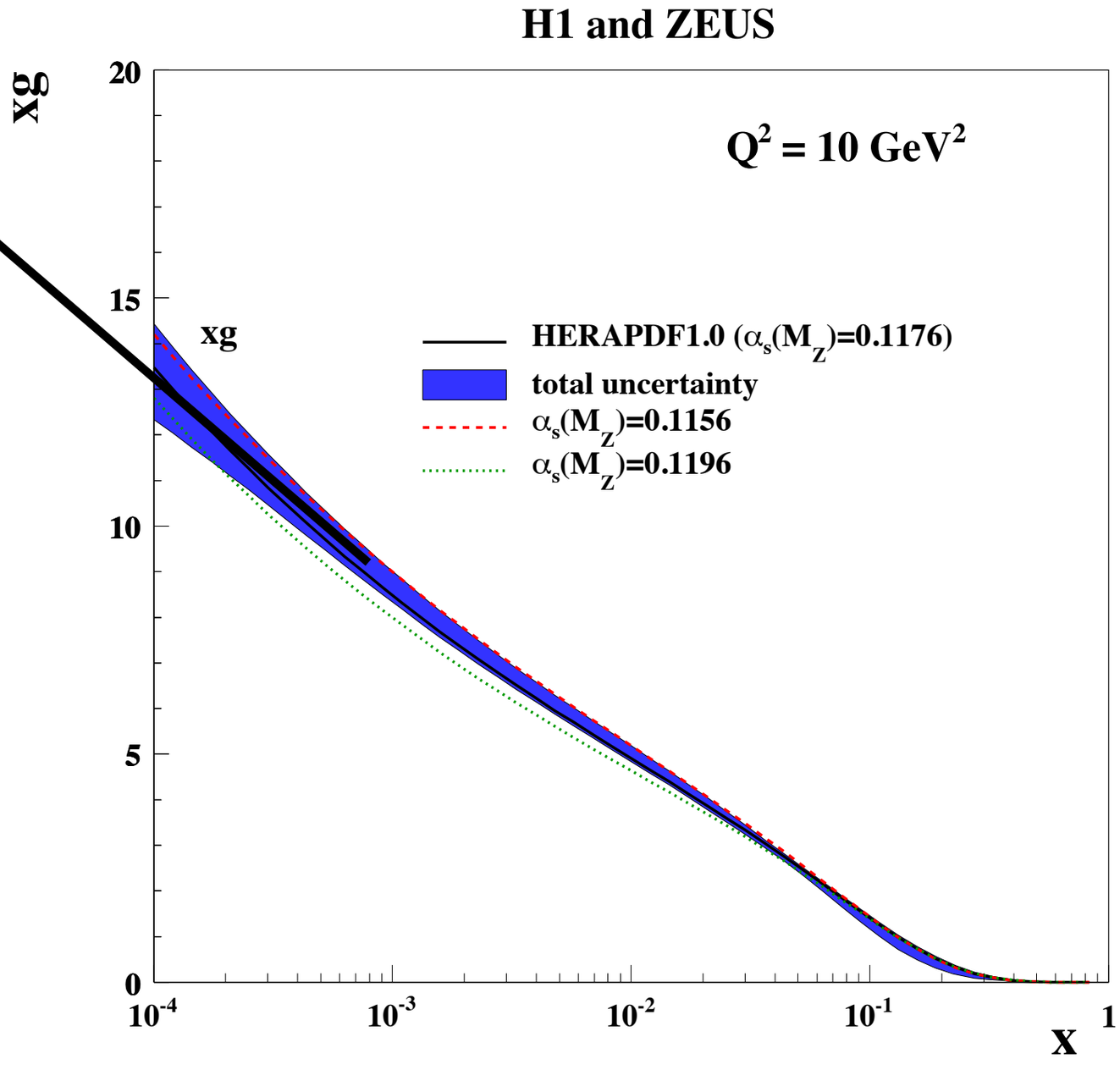
What is **Saturation**?

- Can't rise forever
- At some point density so high



balanced by



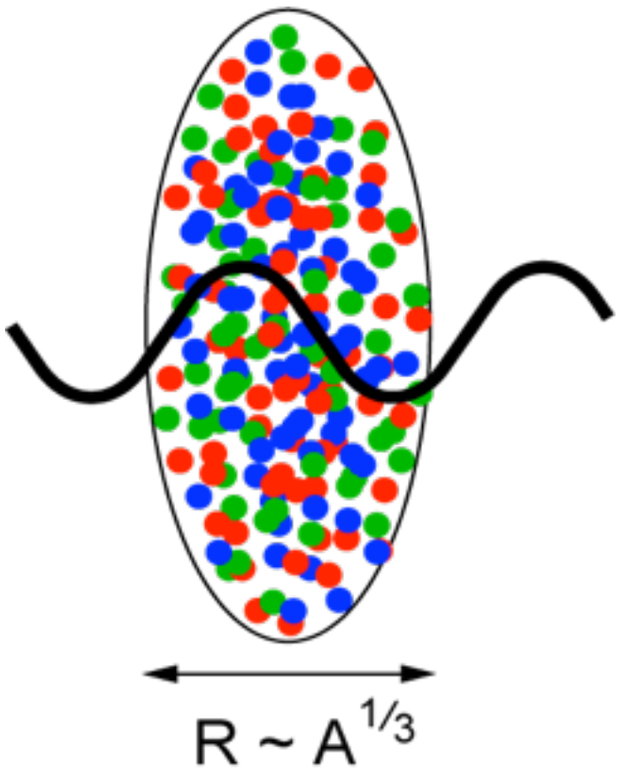


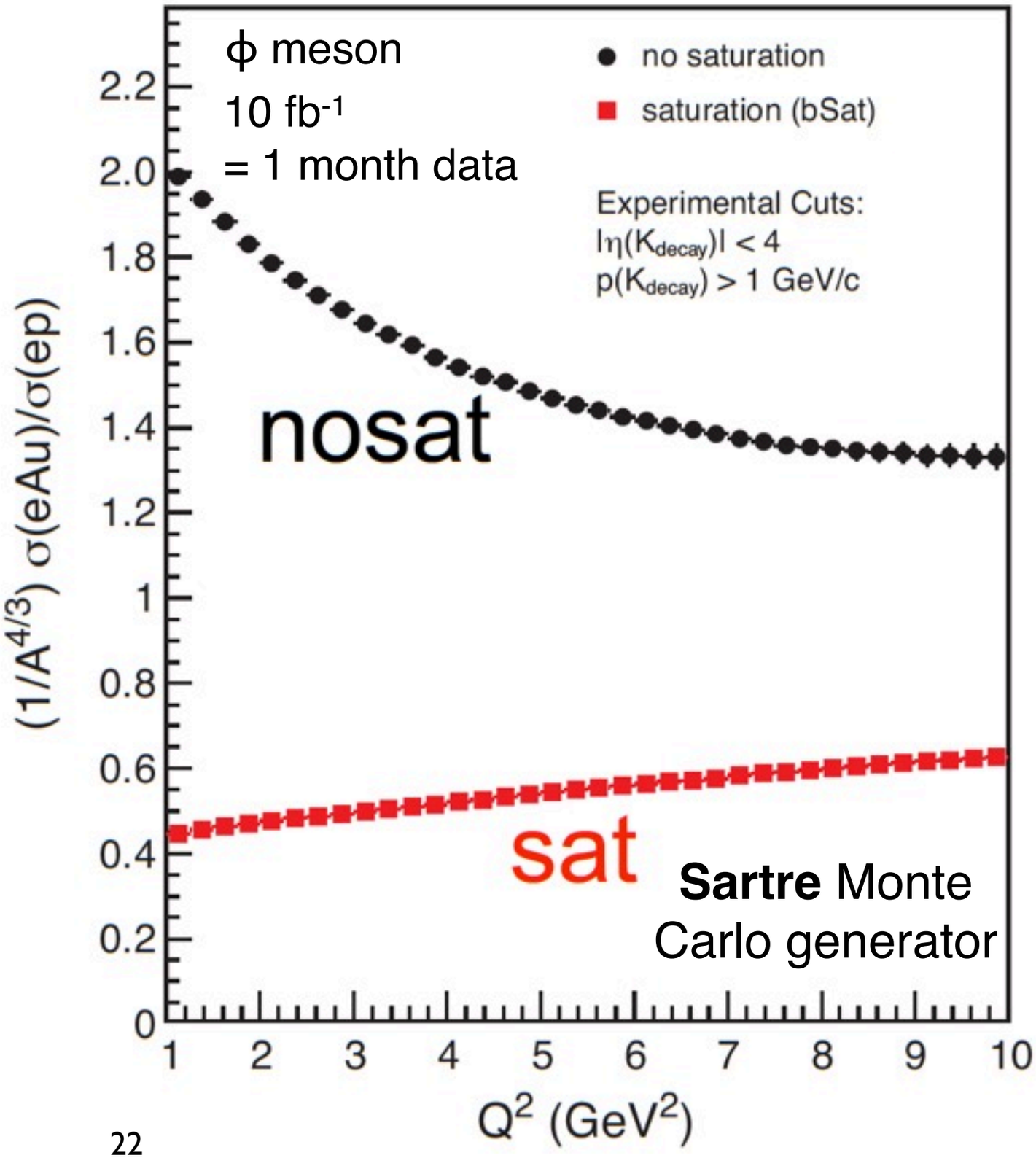
"Saturation"

Exclusive Vector Meson Production

$$e + A \rightarrow e' + A' + VM$$

- Nuclei are an ideal laboratory for saturation
  - higher g density





Summary

- eRHIC will provide

  ✓ A broad, compelling physics programme

  - Much more than discussed here!

  ✓ A state of the art detector

  ✓ A cost-effective route to an EIC

- http://arxiv.org/abs/1108.1713: 500+ pages of details
- https://wiki.bnl.gov/eic/index.php/Main_Page