Diffraction in DIS

With prospects at EIC

Anna Stasto

PennState
Eberly College of Science

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Outline

- Introduction: diffraction in optics
- Diffraction in hadronic collisions. Example: elastic vector meson production
- Inclusive diffraction
- Prospects for EIC

EIC Yellow Report, 2103.05419
EIC White paper 1212.1701
Armesto, Newman, Slominski, Stasto 1901.09076
W. Slominski, 2nd Yellow Report Workshop, Pavia, 2021

Note: I will focus on ep/eA. Not pp.

Diffraction in optics


PHYSICO-MATHESIS
DE LVMINE.
COLORIBVS. ET IRIDE.
ALIISQVE ADNEXIS
LIBRI DVO.
In quorum Primo afferuntur Noua Experimenta, & Rationes ab iis deductæ pro Substantialitate Luminis.
In Secundo autem dissoluuntur Argumenta in Primo adducta, & probabiliter sustineri posse docetur Sententia Peripatetica de Accidentalitate Luminis.
QVA OCCASIONE
AVCTORE
P. FRANCISCO MARIA GRIMALDO
SOCIETATIS IESV.
OPVS POSTHVMVM.
BONONIÆ. M.DC.LXV.

Francesco Maria Grimaldi
1618-1663

Jesuit priest from Bologna


1

PROPOSITIO I.

Lumen propagatur seu diffunditur non solùm Directè, Refractè, ac Reflexè, sed etiam alio quodam Quarto modo, DIFFRACTE'.

Triplex diffusio luminis hactenus cognita.

HActenus nonnisi tribus modis exerceri luminis diffusionem Optici communiter agnouerunt, Directè scilicet, Refractè, ac Reflexè. Certissimis namq; experimentis obseruatum est, lumen per lineam quidem rectam propagari, seu diffundi, donec medium, per quod diffunditur, maneat idem: mutare verò lineam, seu viam suæ diffusionis, eamq; cum fractione radij inclinare ad vnam partem, statim ac transit ab vno medio ad aliud, densitatem habens diuersam à densitate medij prioris, si tamen in illud incurrat obliquè: ac tandem suum cursum retro conuertere per reflexionem, quotiescunq; incidit in corpus illi resistens, nec permittens vlteriorem progressum.

Directa.

2 Exempli gratiâ à luminoso A descendat lumen per radium AB, obliquè incidentem superficiei planæ, ac politæ corporis alicuius diaphani, quæ sit CD: erit enim diffusio luminis per radium AB. rectissima, quia ille totus transit per vnicum medium. At quia deinde mutatur medium, idem lumen non perget ampliùs rectâ per radium ABE, si corpus diaphanum de nouo occurrens diuersam habuerit densitatem ab ea, quam habet corpus item diaphanum, per quod radius AB. descendit. Quin immò si transitus fiat à medio rariore ad densius, radius refringetur versùs perpendicularem, hoc est versùs lineam rectam, quæ concipiatur educi per punctum ingressûs B, ita vt faciat cum superficie CD. angulos omnes æquales. At si transitus fiat à medio densiore ad rarius, radius flectetur, seu refringetur ad partes contrarias, magis recedendo à prædicta perpendiculari.

Refracta.

3 Ponamus iam corpus CDG, in quod radius incidit, esse crystallum, aërem verò esse illud medium prius, per quod defluit radius AB: & quia crystallum est quidem diaphanum, densius tamen quam aër; propterea lumen relicta via BE, aliam instituet viciniorem lineæ perpendiculari BH, & procedet per BI. E contrariò si corpus CDG ponatur esse rarius, quàm medium CDA, radius AB. alioqui rectâ iturus per BE, perget per rectam BL remotiorem à prædicta perpendiculari BH, & ipse passus refractionem, hoc est obliquationem à rectitudine viæ, quam priùs tenebat. Cæterùm si radius perpendiculariter incideret superficiei CD, vt facit recta MB, tenderet absq; vlla refractione per viam semper rectam in H.

Tum in medio densiore,

Tum in rariore,

4 Iam verò fingamus corpus CDG esse opacum, ac lumini imperuium: idem enim lumen incidens superficiei CD, cùm non possit vllo modo vlteriùs progredi, cogetur flecti retrorsum aliquatenus contra luminosum A. Et si quidem inciderit perpendiculariter, vt facit radius MB reflectetur in se ipsum per eandem viam, qua venit: Si verò obliquè inciderit, vt facit radius AB, reflectetur ad partes oppositas

Et Reflexa.

A per

‘Light propagates and diffuses not only directly, refractively and reflectively, but also, somehow, in a fourth manner, that is DIFFRACTIVELY.’

Theory of diffraction

Christiaan Huygens
1629-1695

Augustin Fresnel
1788-1827

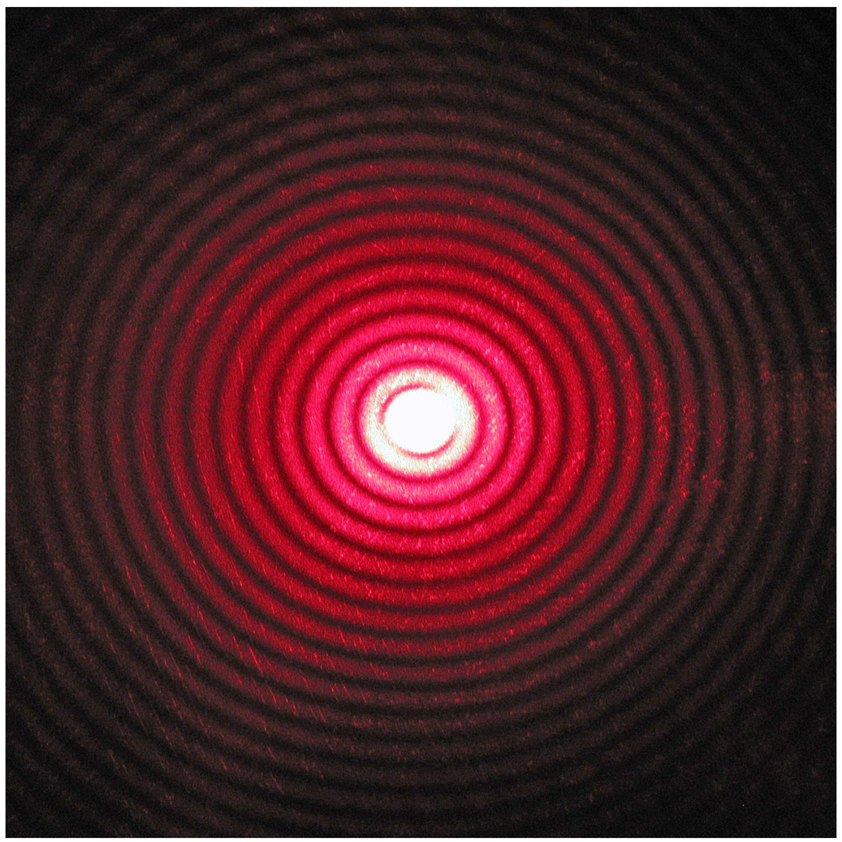
Gustav Kirchhoff
1824-1887

Geometrical optics: applicable in the limit when the wavelength is infinitely small

Diffraction phenomena: deviation from geometrical optics due to finite wavelength

Diffraction : occurs when a wave (for example light) encounters an obstacle or an opening. Most pronounced when the dimensions of obstacle/opening are comparable to wavelength

Laser light passing through a circular aperture



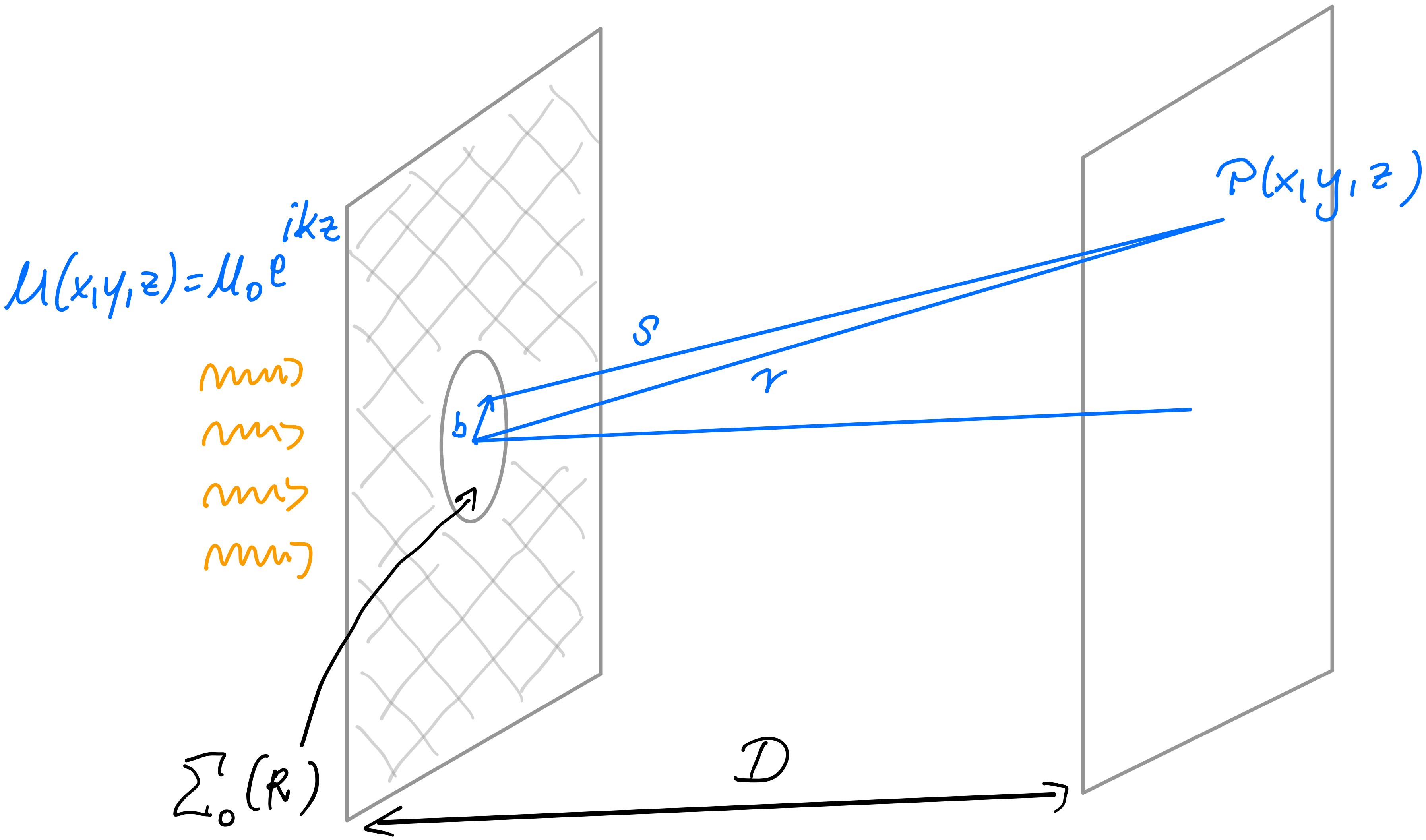
Source: Wikipedia
Author: Wisky

Water waves passing through small entrance

Source: Wikipedia
Author: Verbcatcher

In quantum theory:
hadronic and nuclear diffractive scattering

Kirchhoff theory



$$P \equiv (x, y, z)$$

$$k = 2\pi/\lambda$$

Wave number

U Amplitude

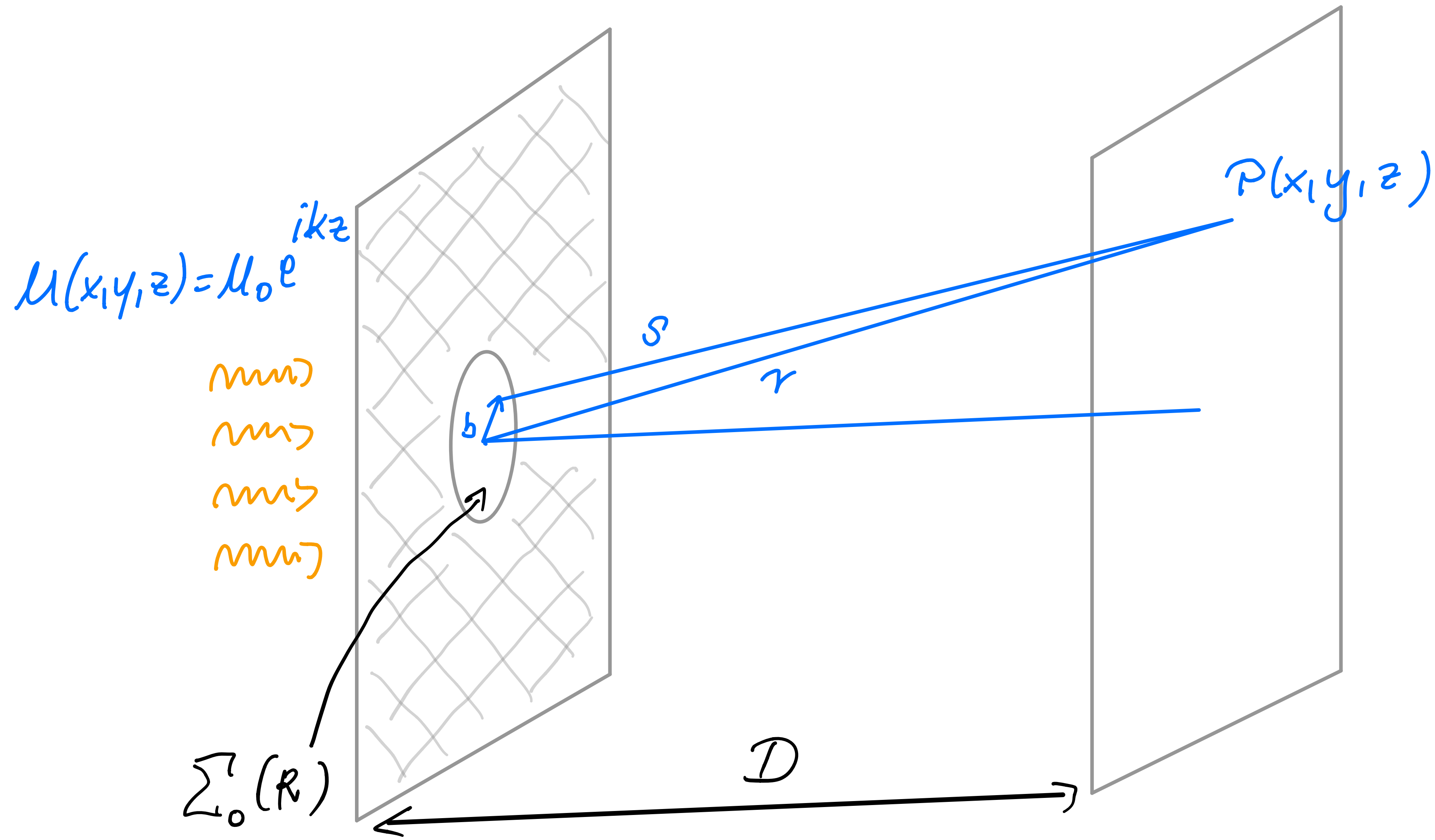
$$\phi(x,y,z,t) = U(x,y,z)e^{-i\omega t}$$

$$(\nabla^2 + k^2)U = 0$$ Helmholtz equation

Short wave length limit (kR>1)

$$U(x,y,z) = -\frac{ik}{2\pi}U_0 \int_{\Sigma_0} d^2\mathbf{b}\,\frac{e^{iks}}{s}$$

Fresnel-Kirchhoff integral



Geometrical optics: $$kR^2/D \gg 1$$

Fresnel diffraction: $$kR^2/D \approx 1$$ Near field

Fraunhofer diffraction: $$kR^2/D \ll 1$$ Far field

Relevant for hadronic physics

Fraunhofer diffraction

For the hole in the screen:

$$U(x,y,z) = -\frac{ik}{2\pi} U_0 \frac{e^{ikr}}{r} \int d^2\mathbf{b}\, \Gamma(\mathbf{b})\, e^{-i\mathbf{q}\mathbf{b}}$$

$$\mathbf{q} \approx \mathbf{k}' - \mathbf{k}$$ Momentum transfer (2 dimensional vector)

$\mathbf{k}$ Incoming wave vector

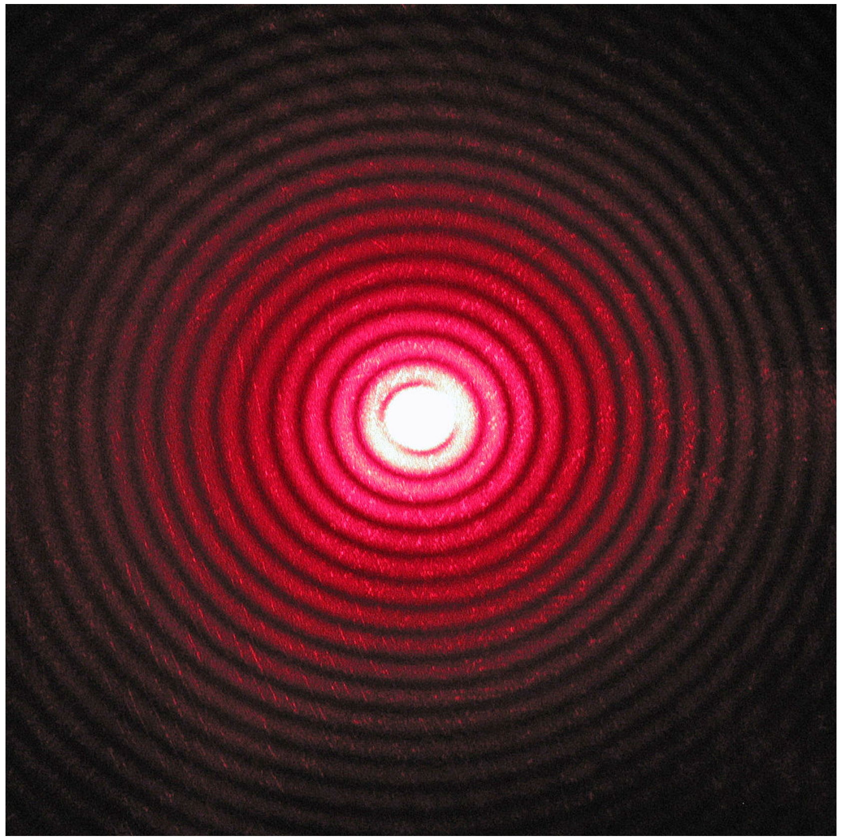
$\mathbf{k}'$ Outgoing wave vector

$\Gamma(\mathbf{b})$ Profile function

For the hole:

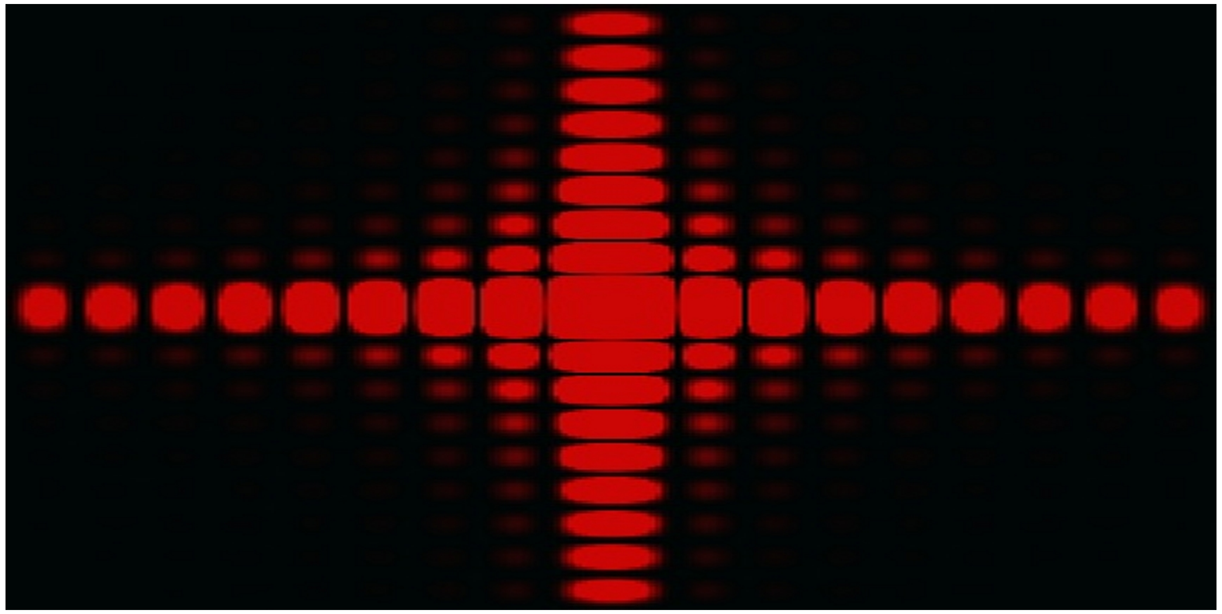
$$\Gamma(\mathbf{b}) = \begin{cases} 1, & \text{on } \Sigma_0 \\ 0, & \text{outside } \Sigma_0 \end{cases}$$

Diffraction patterns



Source: Wikipedia
Author: Wisky

Circular aperture



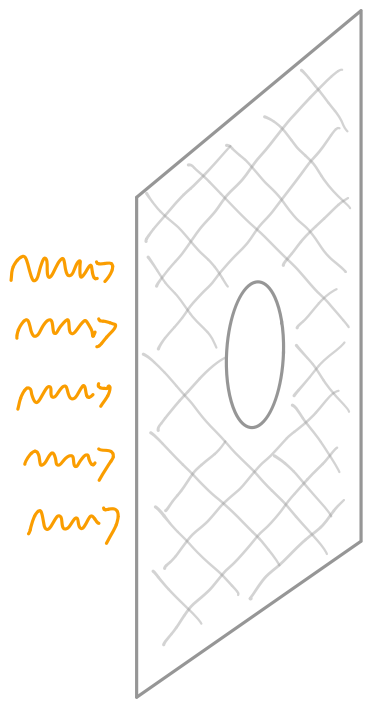
Source: Wikipedia
Author: Epzcaw

Rectangular aperture

In Fraunhofer regime the diffraction pattern (far field) is a Fourier transform of the apertured field.

Diffraction off an obstacle

Babinet's principle:



S1 Screen with a hole

S2 Obstacle with the same size and shape as a hole

Waves diffracted by a hole S1 and obstacle S2 must combine to reconstruct the incident wave front.

Diffraction patterns away from incident direction are the same for screen with hole and complementary obstacle.

Diffraction off an obstacle

$$U(x,y,z) = U_{\text{inc}} + U_{\text{scat}}$$

$$U(x,y,z) = U_0 (e^{ikz} + f(\mathbf{q})\frac{e^{ikr}}{r})$$

Scattering amplitude

$$f(\mathbf{q}) = \frac{ik}{2\pi}\int d^2\mathbf{b}\,\Gamma(\mathbf{b})\,\mathbf{e}^{-\mathbf{iq\cdot b}}$$

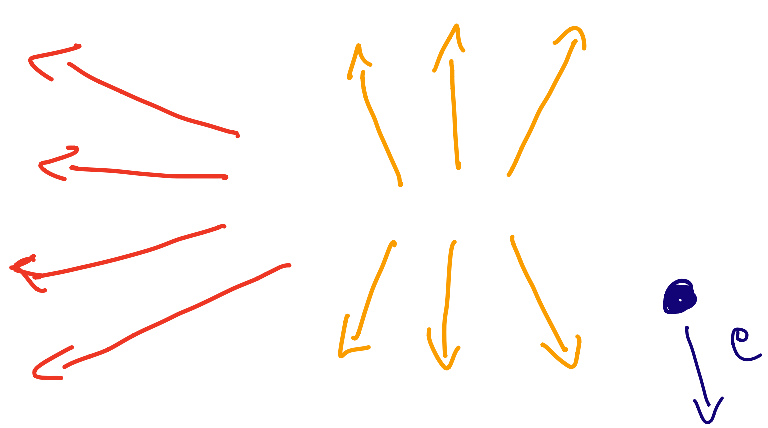
$$\Gamma(\mathbf{b}) = \frac{1}{2\pi ik}\int d^2\mathbf{b}\,f(\mathbf{q})\,e^{i\mathbf{q\cdot b}}$$

Scattering amplitude is Fourier transform of the profile function.
Profile function is inverse Fourier transform of the scattering amplitude.

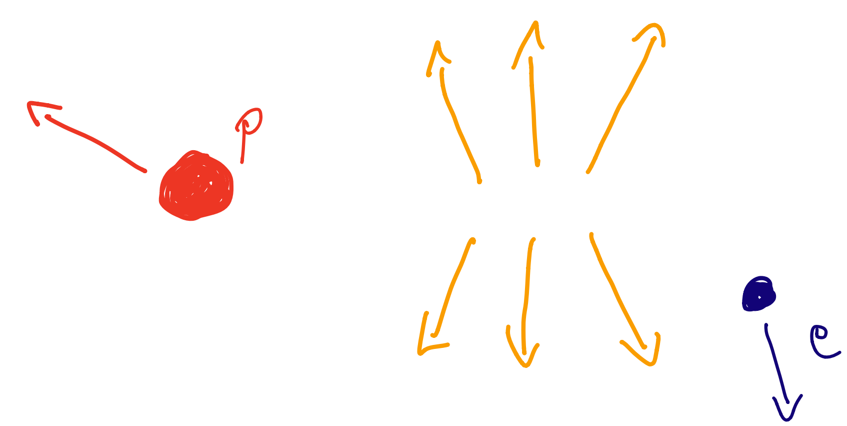
Diffraction in hadronic / nuclear physics

In quantum physics: propagation and interaction of particles as an absorption of the various components of their wavefunction

Electron - hadron(nucleus) scattering (like at EIC)



Proton is fragmented



Target(proton) is intact
No activity in vicinity

Scattering at ep collider HERA

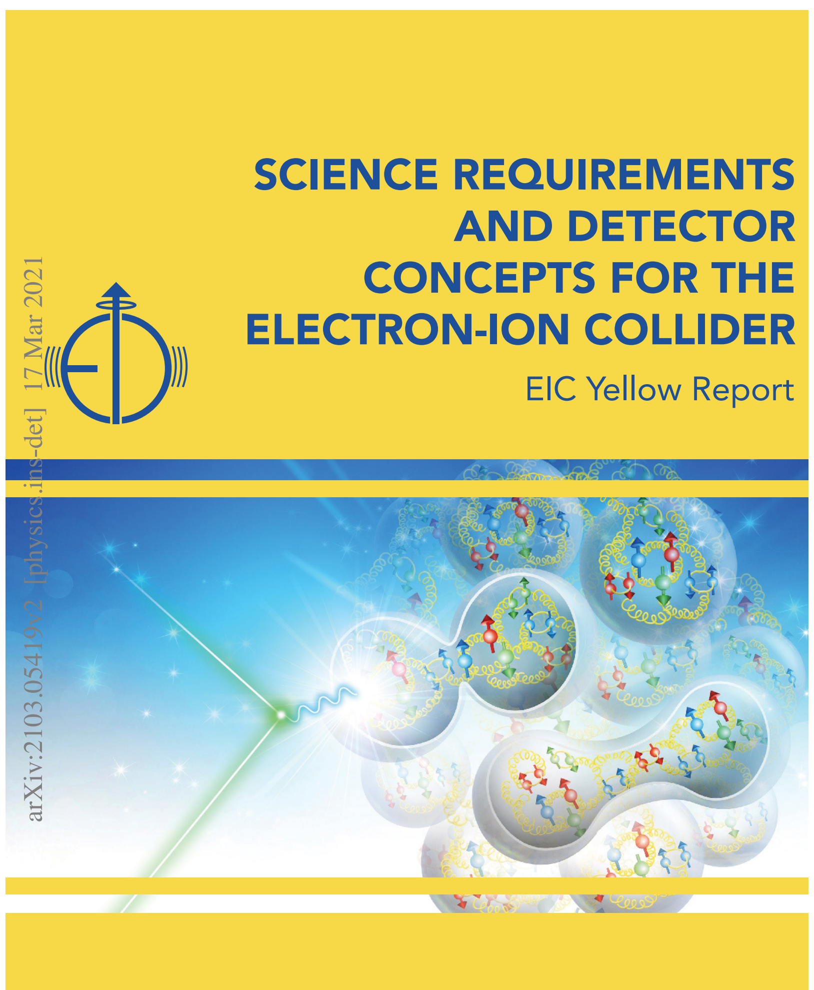
HERA: (1992-2007)
27.5 GeV electrons/positrons
820/920 GeV protons
318 GeV CoM energy
Lumi: 10^{31} cm^{-2} s^{-1}
Electrons, positrons and protons

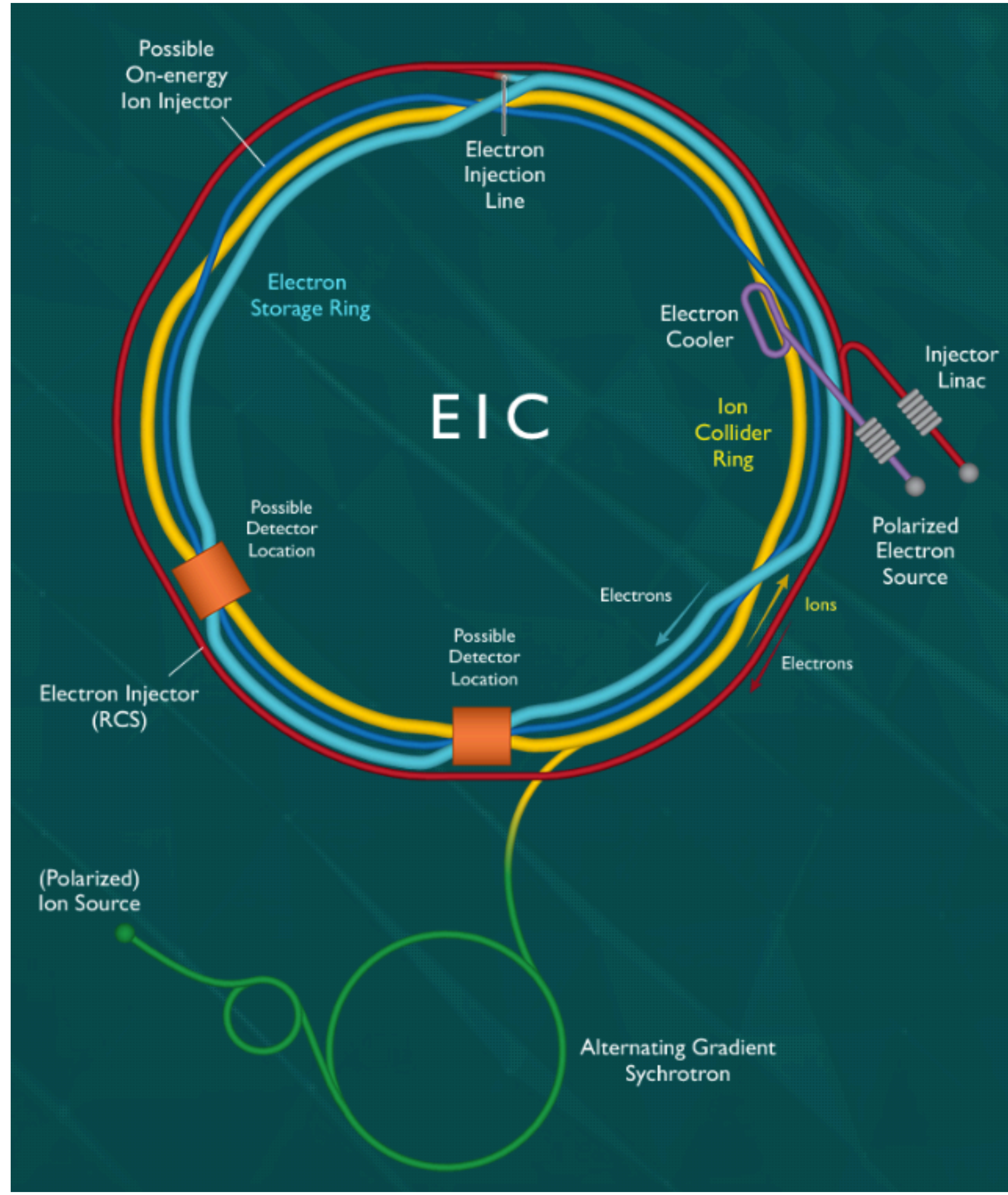
Physics:
Structure functions
Parton density functions
Established growth of gluon with decreasing Bjorken x
Measurement of coupling constant
Diffraction
Jets, heavy quarks
BSM searches

Low luminosity/limited statistics, no nuclei, no polarized beams

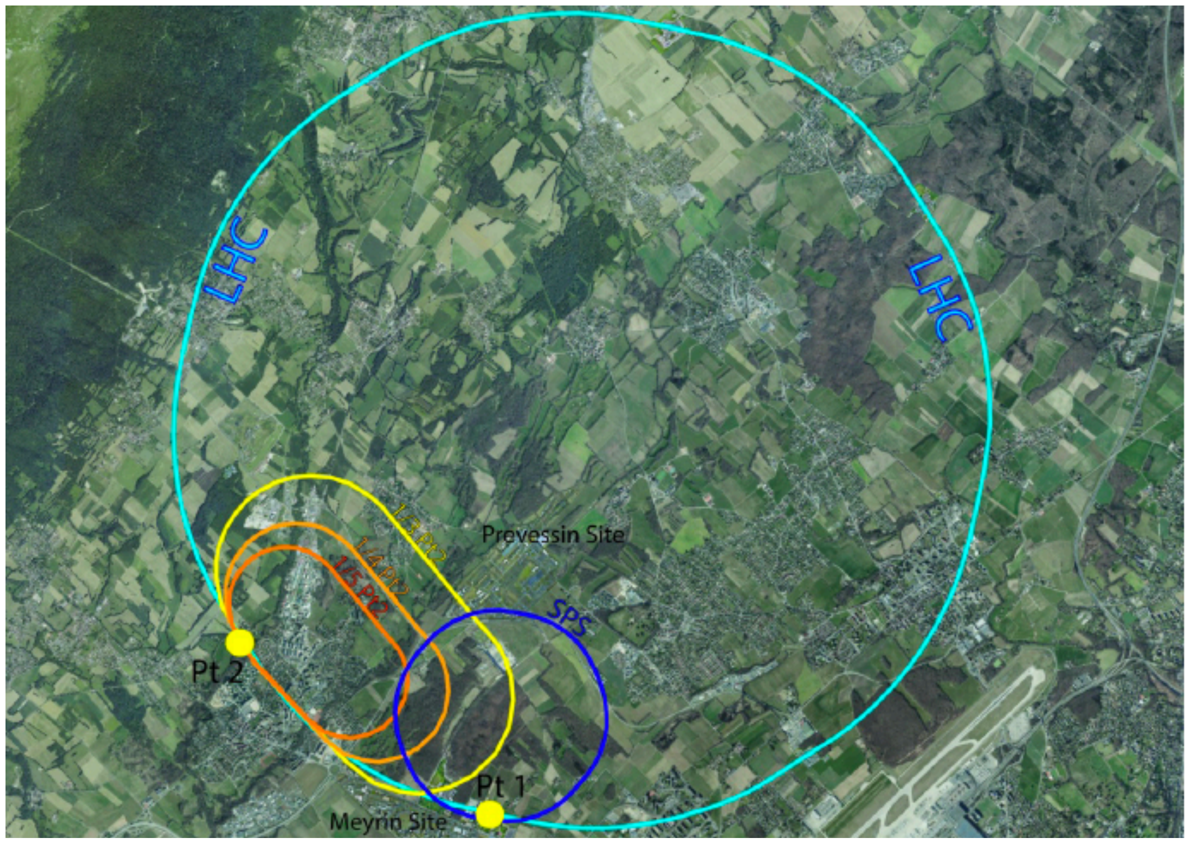
Future DIS machines EIC

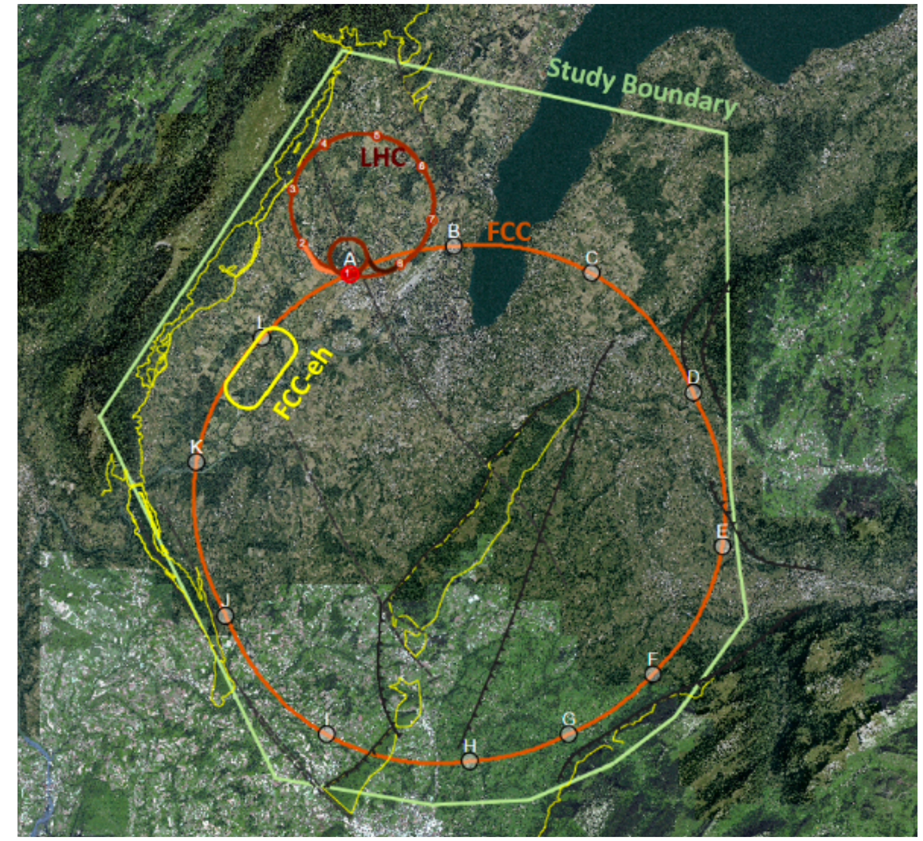
EIC: 5-20 GeV electrons
20-140 GeV CoM energy
Lumi: 10^{34} cm^{-2} s^{-1}
Polarized e,p,d,^3He
Wide range of nuclei





Future DIS machines LHeC, FCC-eh at CERN



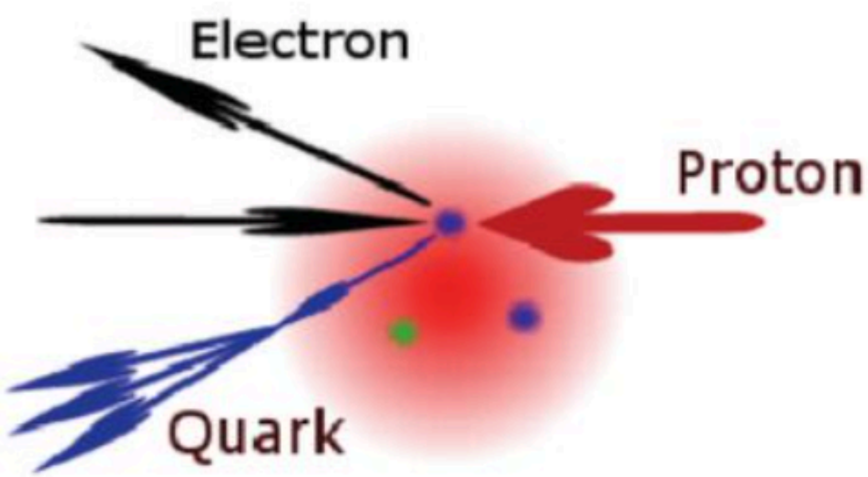


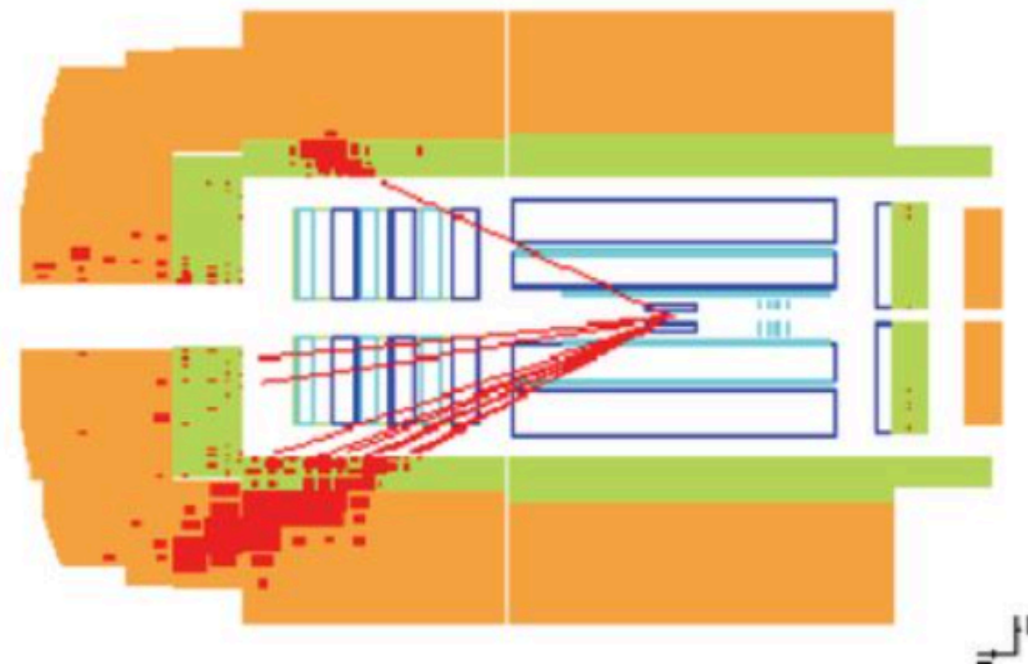
LHeC: 60(50) GeV electrons x LHC protons and ions
1.3 TeV CoM energy for ep
812 GeV CoM for ePb
Lumi: 10^{34} cm^{-2} s^{-1}
Simultaneous running with ATLAS and CMS in HL-LHC period

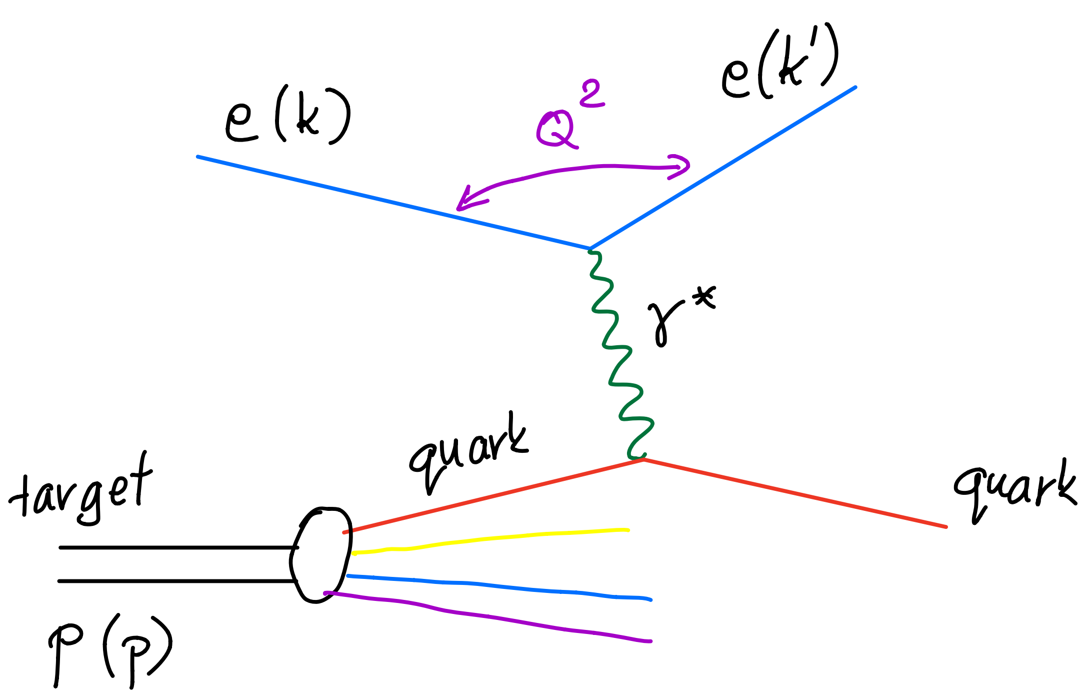
FCC-ep: 60(50) GeV electrons x 50 TeV protons from FCC, lead beams 19.7 TeV/per nucleon
3.5 TeV CoM energy for ep
2.2 TeV CoM for ePb
Lumi: 10^{34} cm^{-2} s^{-1}

Scattering at ep collider HERA

Non-diffractive DIS event







$$Q^2 = -q^2 = -(k - k')^2$$ 4 momentum transfer at a lepton vertex

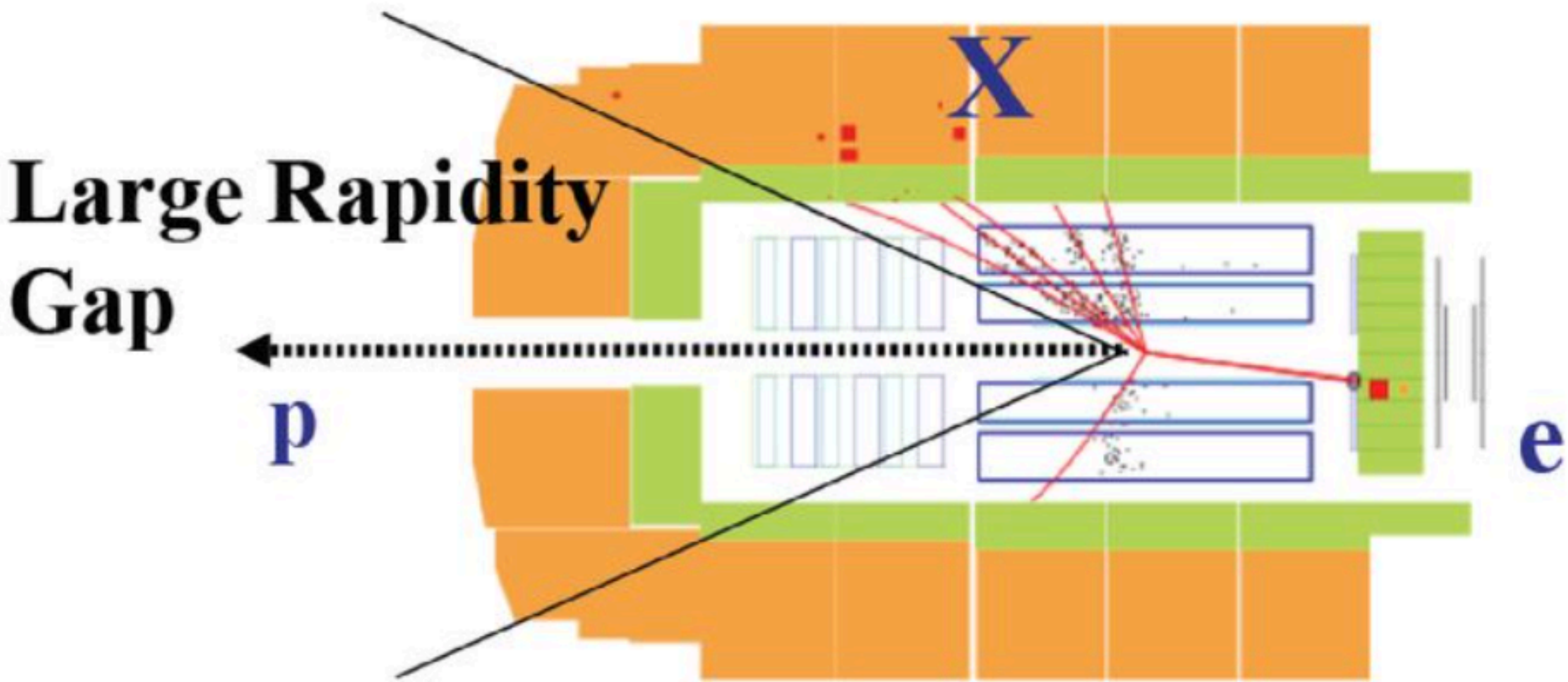
$$W^2 = (q + p)^2$$ Photon-proton cms energy squared

$$s = (k + p)^2$$ Electron-proton cms energy squared

$$x = Q^2/2p \cdot q$$ Longitudinal momentum fraction of the target carried by the struck quark (in infinite momentum frame)

$$y = q \cdot p/k \cdot p$$ Inelasticity

Diffraction at HERA



10% events at HERA were of diffractive type

Large portion of the detector void of any particle activity: **rapidity gap**

Proton stays intact despite undergoing violent collision with a 50 TeV electron (in its rest frame)

Rapidity: recap

$$p^\mu = (E, \vec{p}_T, p_z) \qquad y = \frac{1}{2}\ln\frac{E+p_z}{E-p_z} \qquad \frac{E}{p_z} = \tanh y$$

Under boosts in z direction rapidity transforms additively

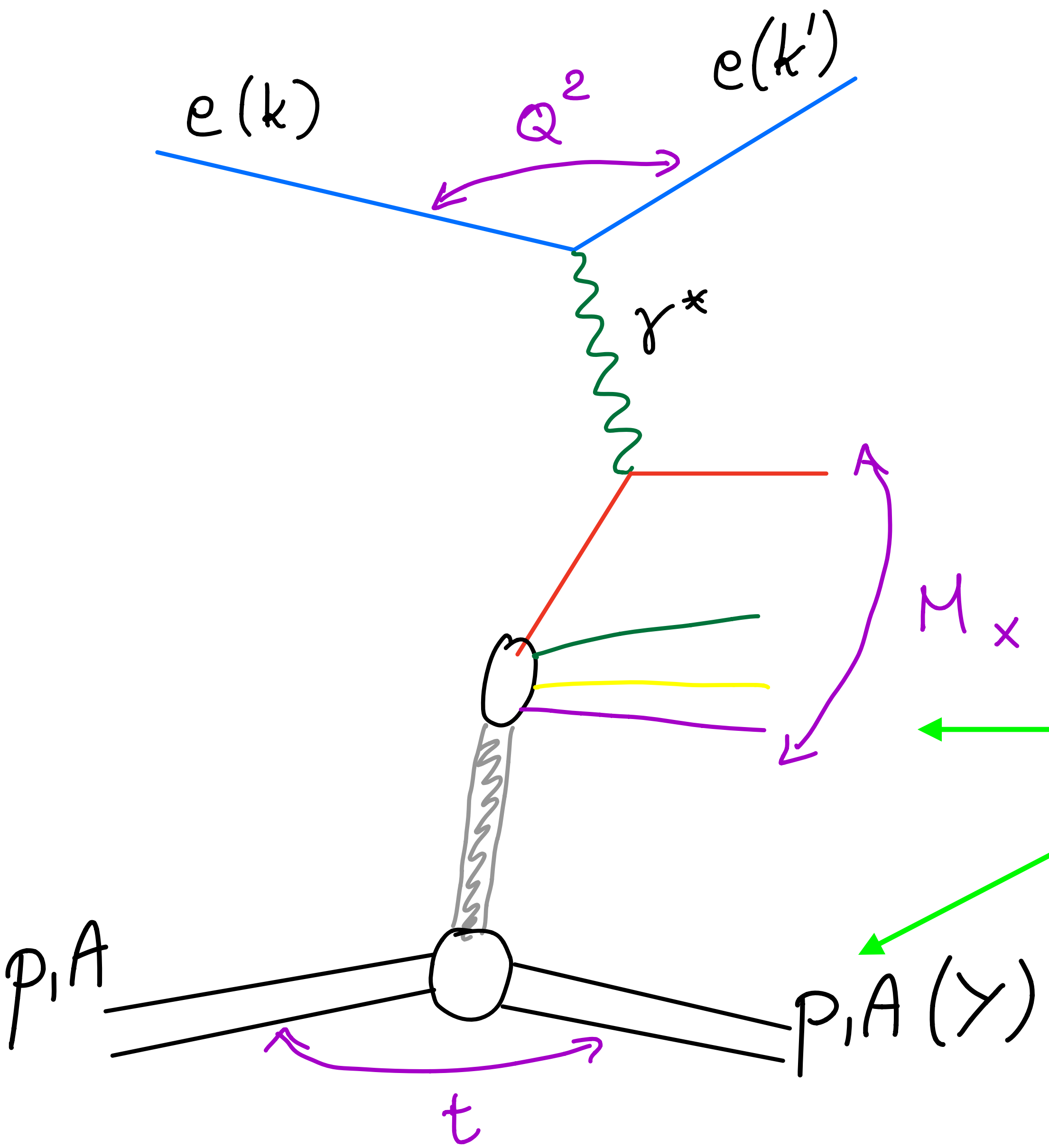
$$\begin{pmatrix} p_z \\ E \end{pmatrix} = \begin{pmatrix} \cosh\phi & \sinh\phi \\ \sinh\phi & \cosh\phi \end{pmatrix} \begin{pmatrix} p'_z \\ E' \end{pmatrix}$$

Then $y = y' + \phi$

Pseudorapidity $\eta = -\ln\tan\frac{\theta}{2}$ Angle between 3-momentum and z-axis

When $m \ll \vec{p}_T$ then $y \to \eta$

Diffraction in electron - proton(nucleus)



t Momentum transfer at the proton vertex (target recoil)

X Diffractive system with mass M_x

Rapidity gap

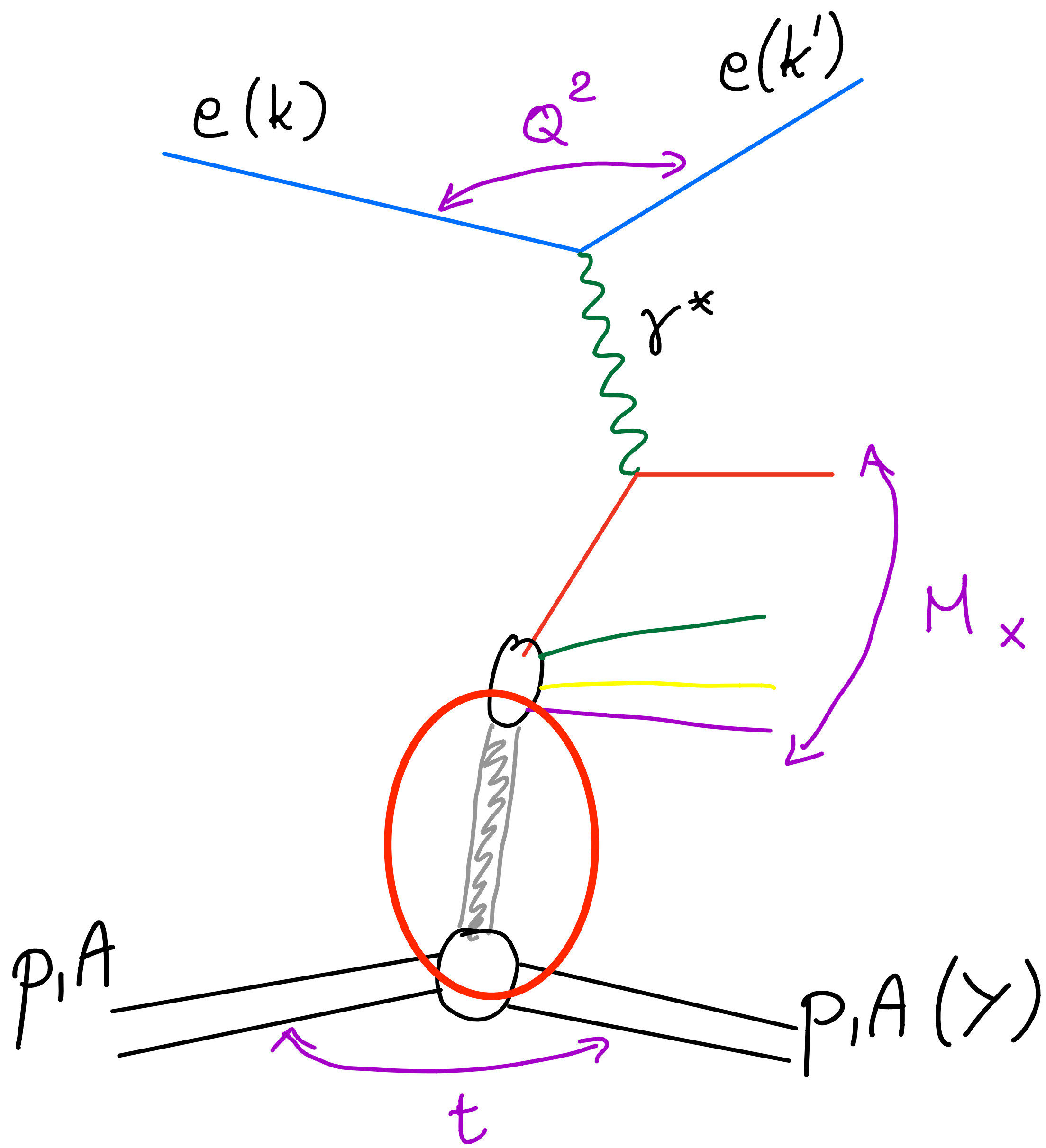
Target is scattered elastically: elastic scattering

It can also dissociate into a state Y with the same quantum numbers, but still separated from the rest of particles

In order for the rapidity gap to exist it needs to be mediated by the *colorless* exchange

Diffraction: a reaction characterized by a large rapidity gap in the final state

Diffraction and the Pomeron



In order for the rapidity gap to exist it needs to be mediated by the *colorless diffractive exchange*

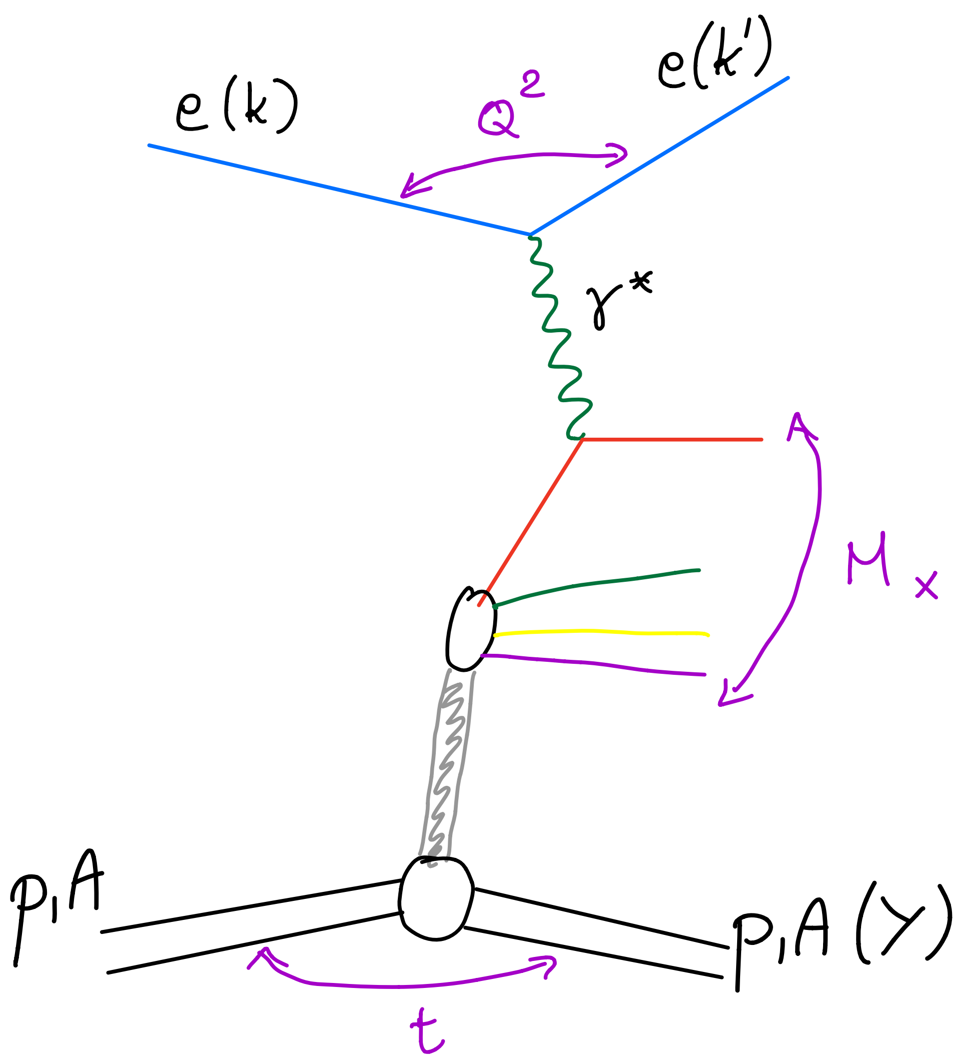
But what is this *diffractive exchange* ?

Usually referred to as the *Pomeron.* Quantum numbers of the vacuum

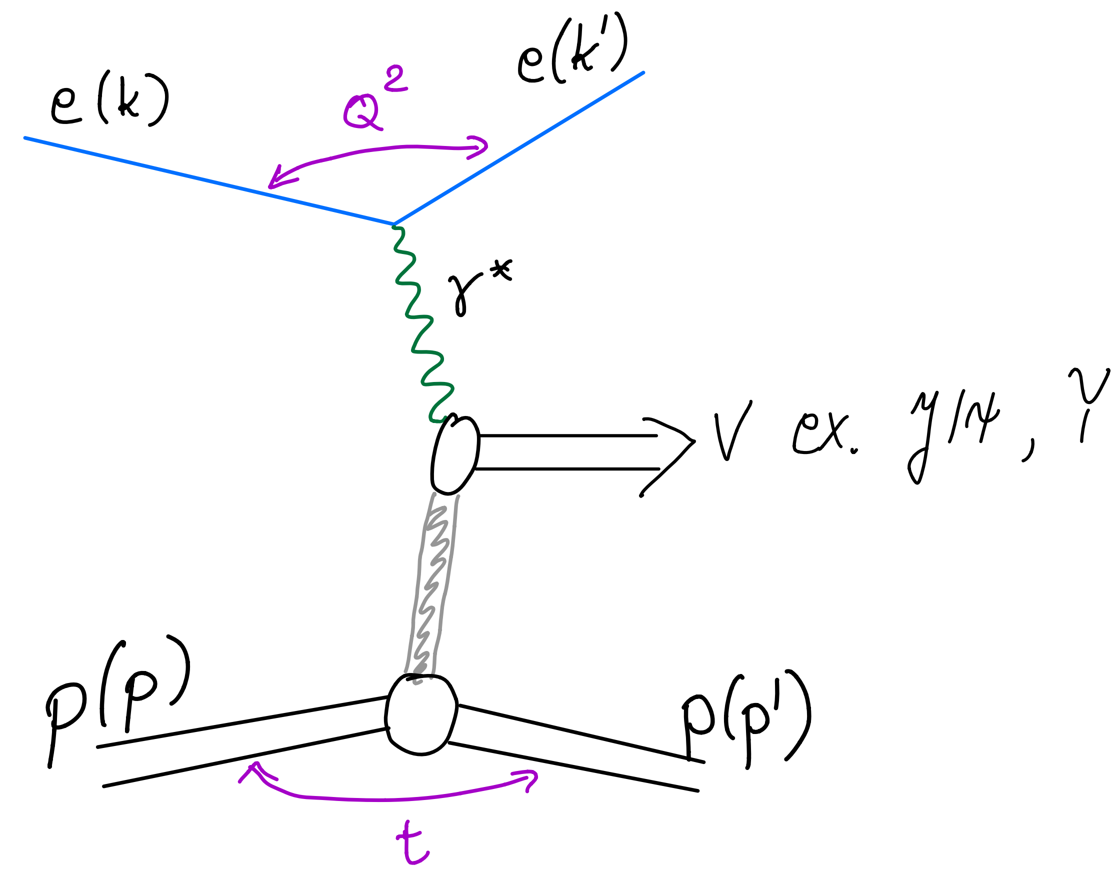
Modeled as a composite system of gluons and/or quarks.

Studying diffractive processes can shed light onto properties of this intriguing object.

Example : elastic vector meson production



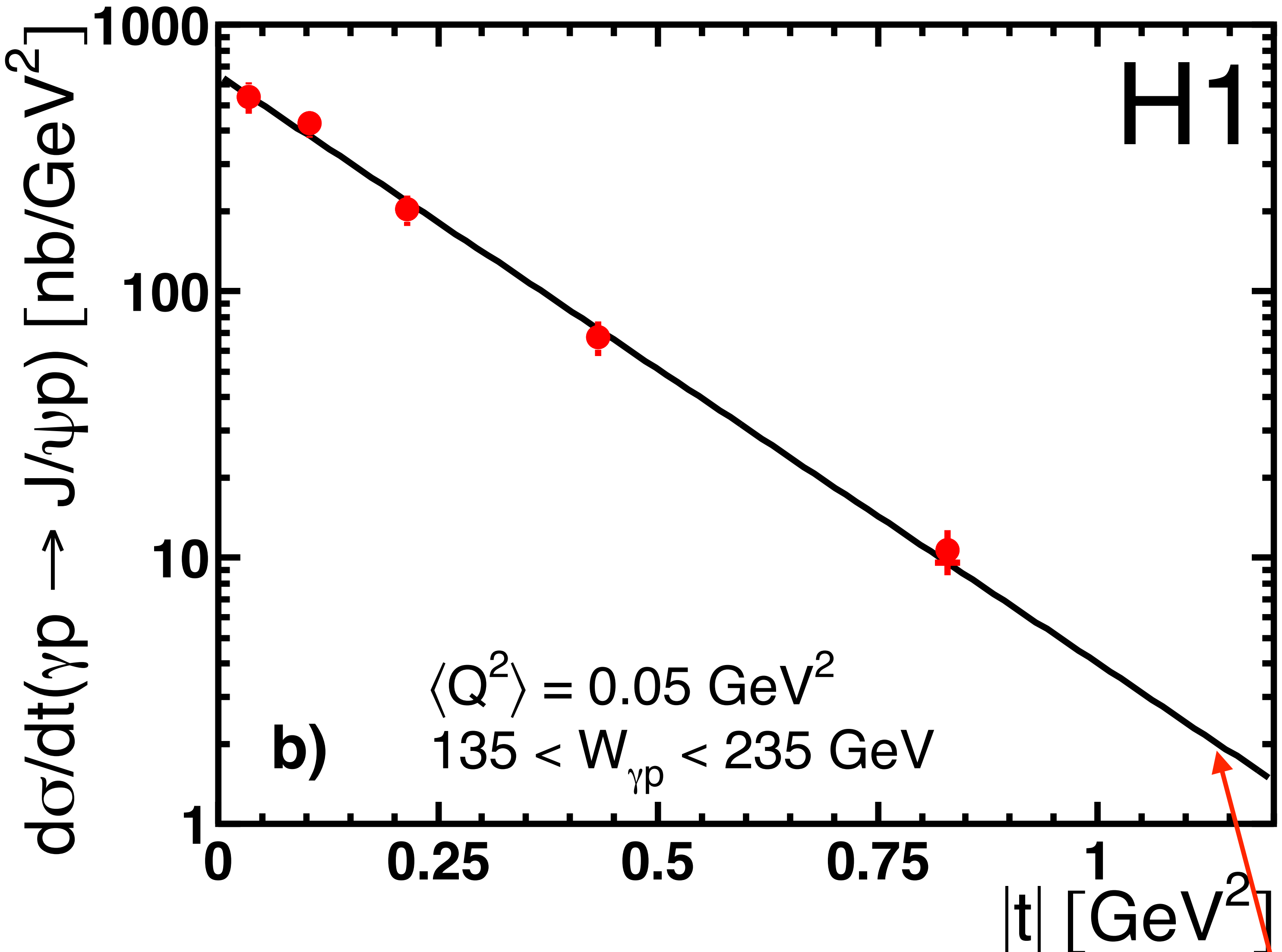
Final state contains only vector meson, scattered lepton and proton

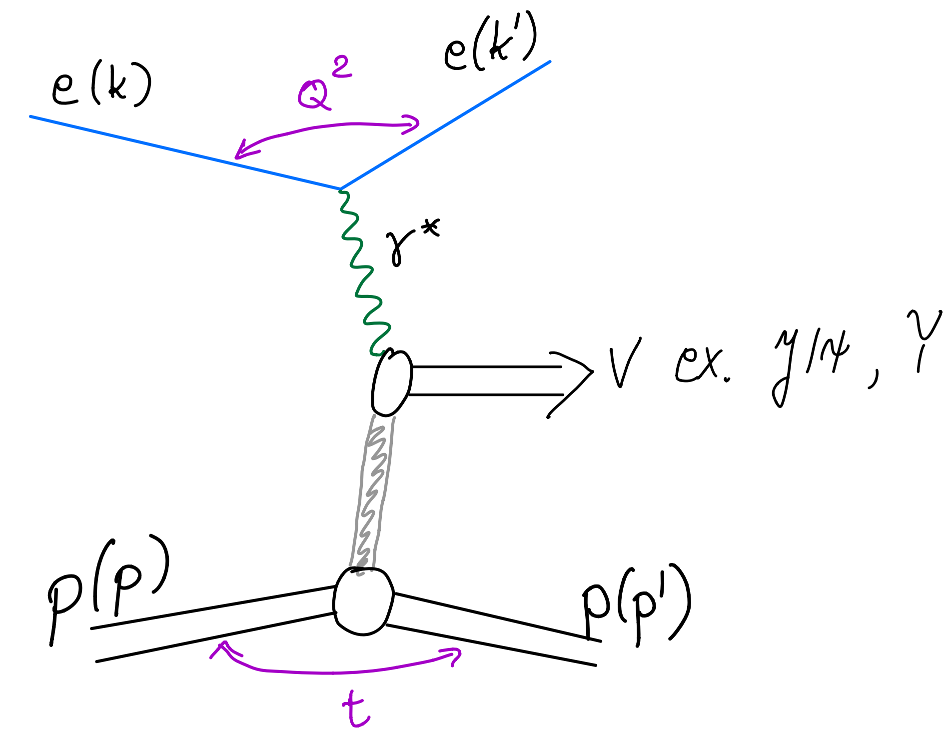


J/ψ vector meson: charm -anti charm system $m = 3.09\ \mathrm{GeV}$

Upsilon vector meson: bottom - anti bottom system $m = 9.46\ \mathrm{GeV}$

Elastic vector meson production



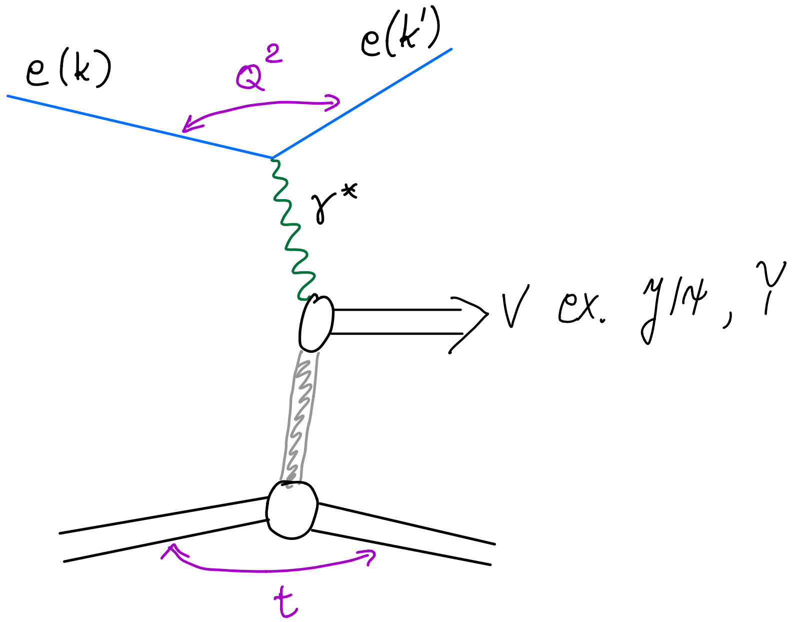


$$t = (p - p')^2 < 0$$

momentum transfer at the proton vertex

$$\frac{d\sigma}{dt} \sim e^{bt}$$

Exponential fit



$$\frac{d\sigma}{dt} = \frac{1}{16\pi}|\mathcal{M}(\Delta)|^2$$

$$\mathcal{M}(\Delta) = \langle \psi_{\gamma^*} | A(\Delta) | \psi_V \rangle$$

Momentum transfer $t = -\Delta^2$

$\mathcal{M}$ amplitude for vector meson process

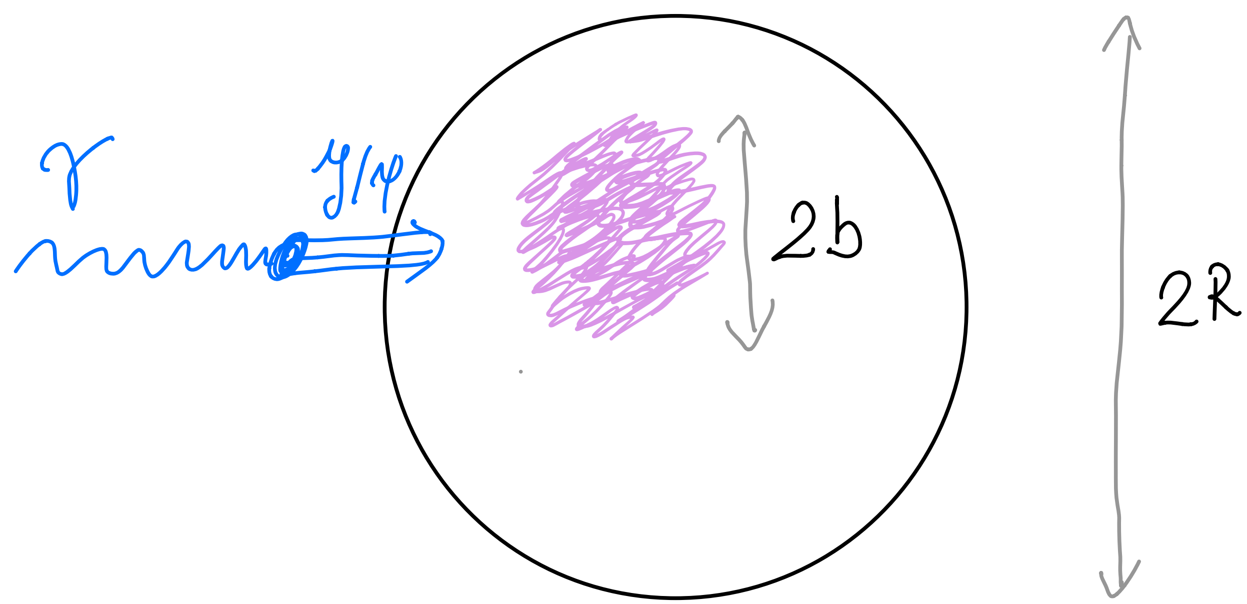
A elementary (quark dipole) amplitude

$$A(\Delta) = \int d^2\mathbf{b}\, e^{i\Delta\cdot\mathbf{b}} \tilde{A}(b)$$

$$\boxed{\langle \tilde{A}(b) \rangle} = \frac{\langle \psi_{\gamma^*} | \tilde{A} | \psi_V \rangle}{\langle \psi_{\gamma^*} | \psi_V \rangle} = \frac{\boxed{\int d^2\Delta e^{-i\Delta b} \sqrt{\frac{d\sigma}{dt}}}}{\pi^{3/2} \langle \psi_{\gamma^*} | \psi_V \rangle}$$

t-dependence of the elastic cross section provides information about the profile of the target

Diffractive elastic vector meson production as a way to study nucleon structure



Radius measured in diffractive scattering of vector mesons

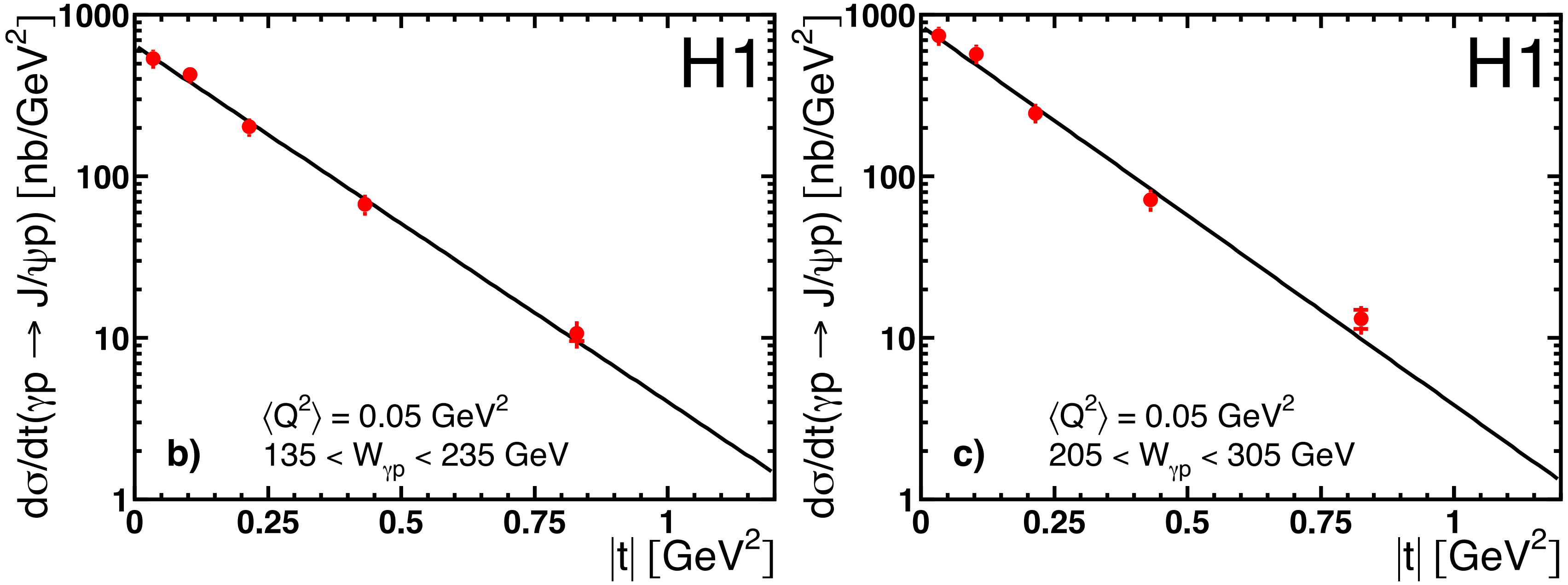
$$b \approx 0.5 \div 0.6 \text{ fm}$$

Proton charge radius

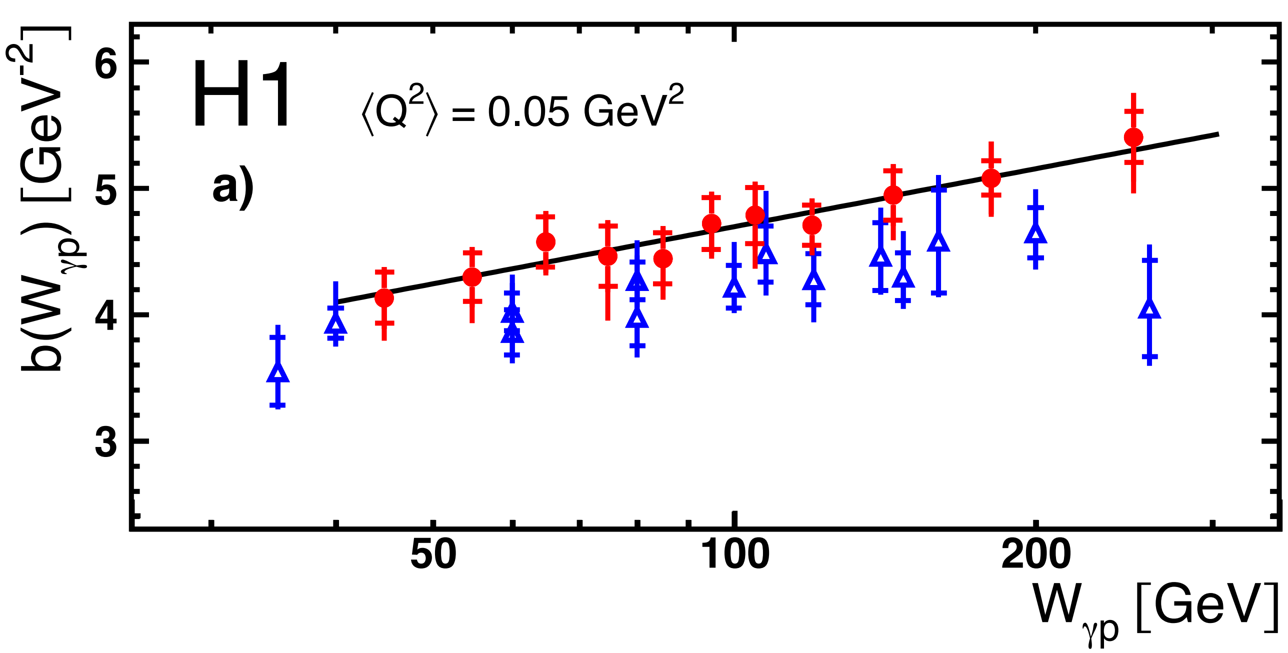
$$R \approx 0.84 \div 0.87 \text{ fm}$$

Experiments on elastic VM production suggest gluons are concentrated in smaller regions than quarks

Growth of the target size with energy



$$\frac{d\sigma}{dt} \sim e^{bt}$$

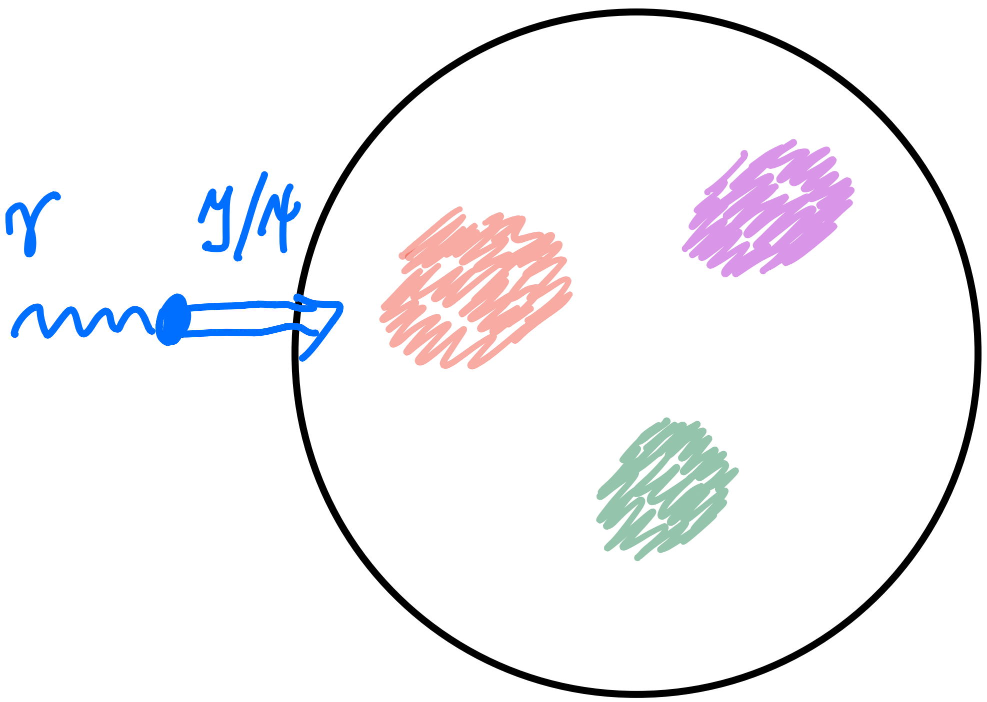


The slope growths with energy

$$b(W) = b_0 + 4\alpha' \ln(W_{\gamma p}/W_0)$$

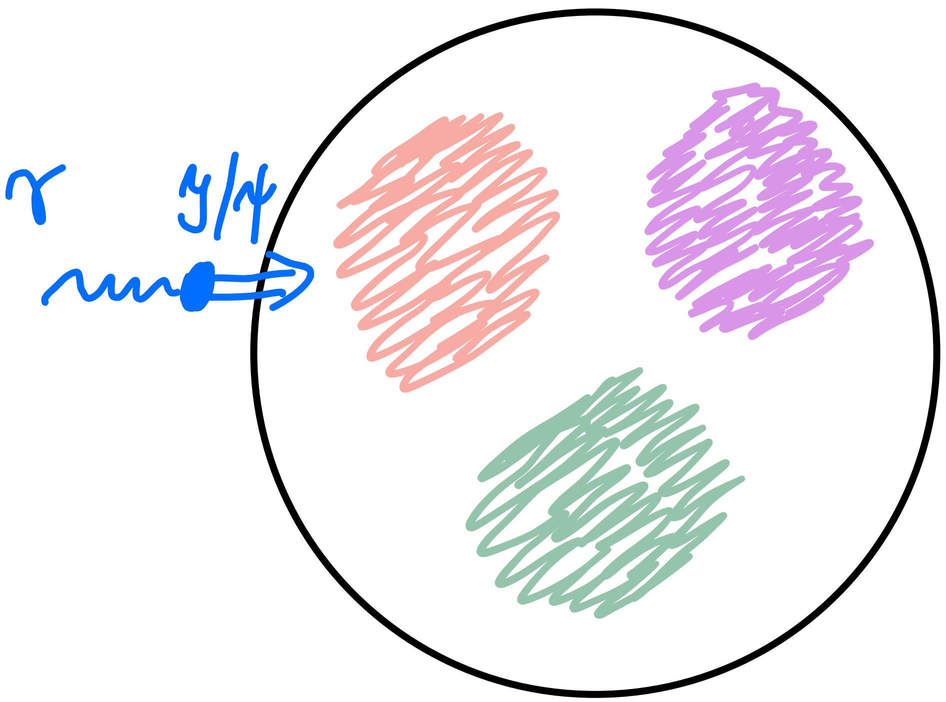
Growth of the target size with energy

Small energy



Target

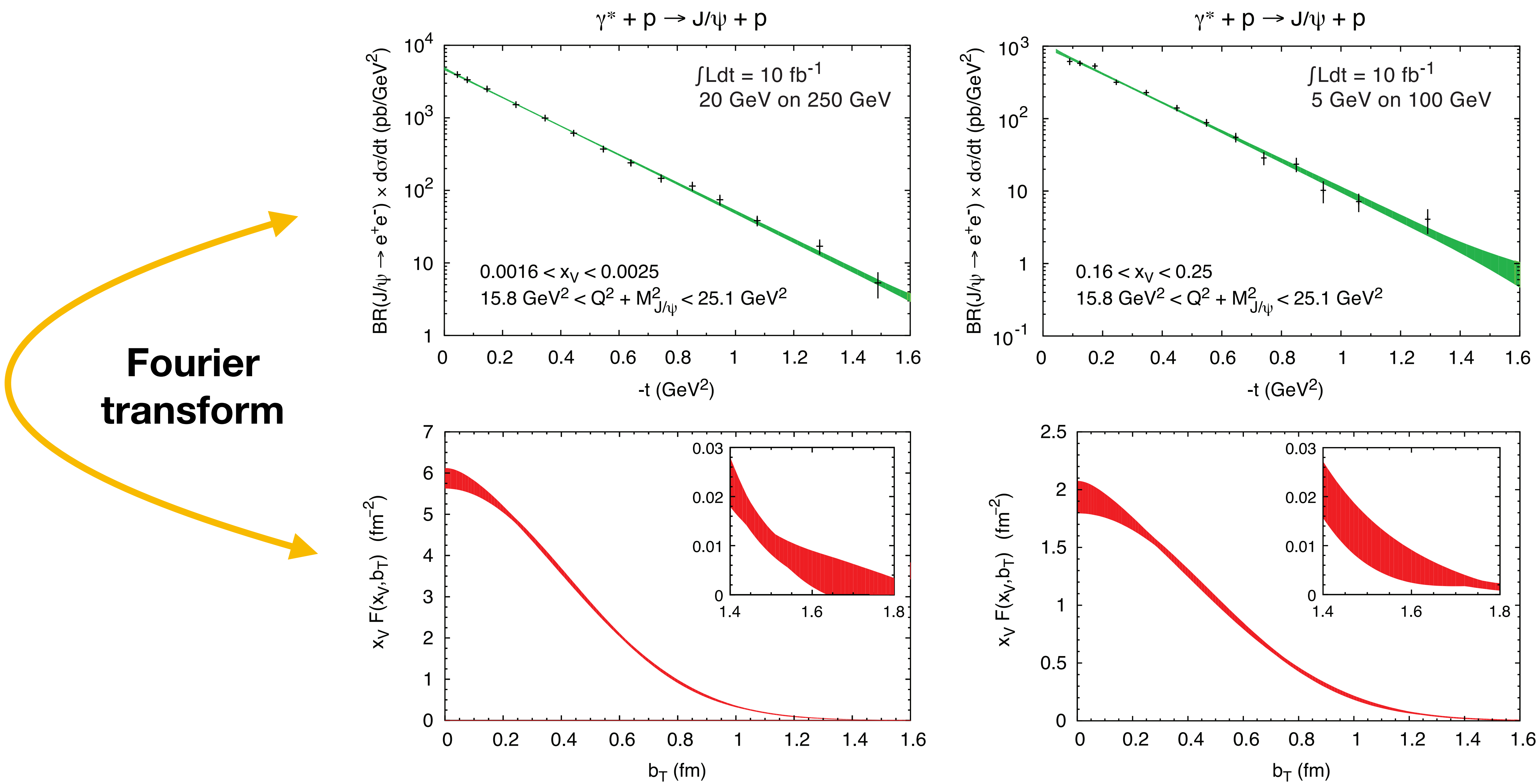
Large energy



Target

The target size, i.e. the region of gluon density probed by the vector meson increases with energy

Elastic vector meson production at EIC



EIC, White paper

EIC: lower energy than HERA, different kinematics.
Very high statistics, high precision

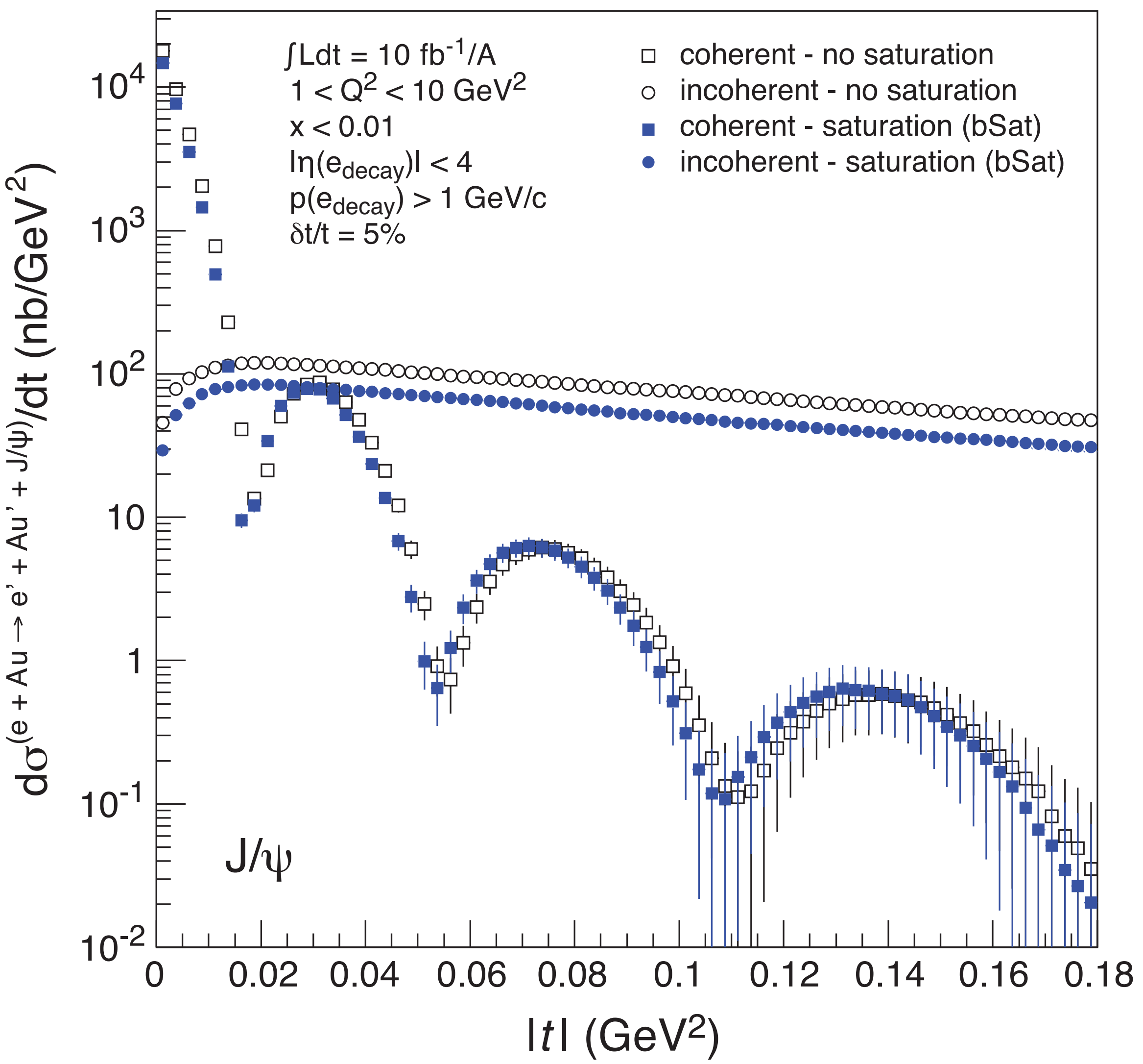
Elastic vector meson production at EIC: Nuclei

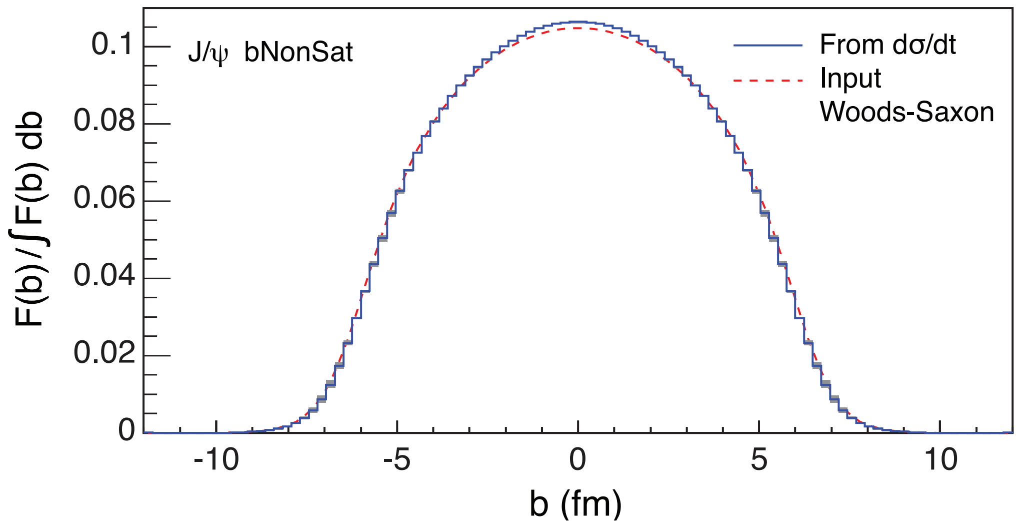
EIC, White paper

Nuclear target: Au

$$e + Au \to e + Au + J/\psi$$

Characteristic 'dips' in t-distribution

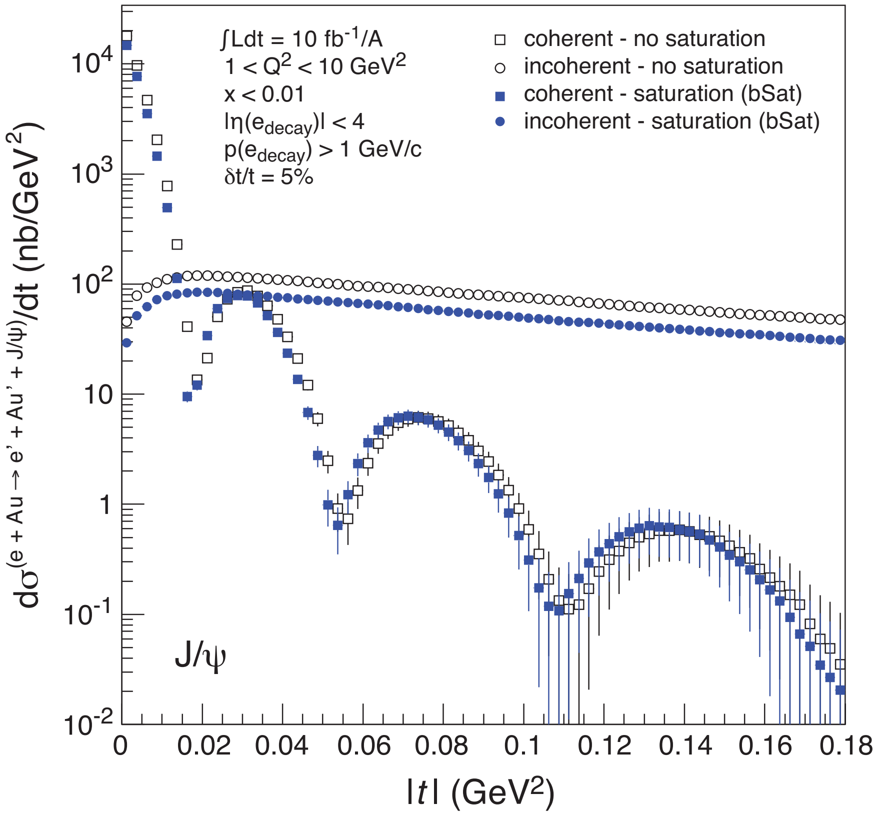




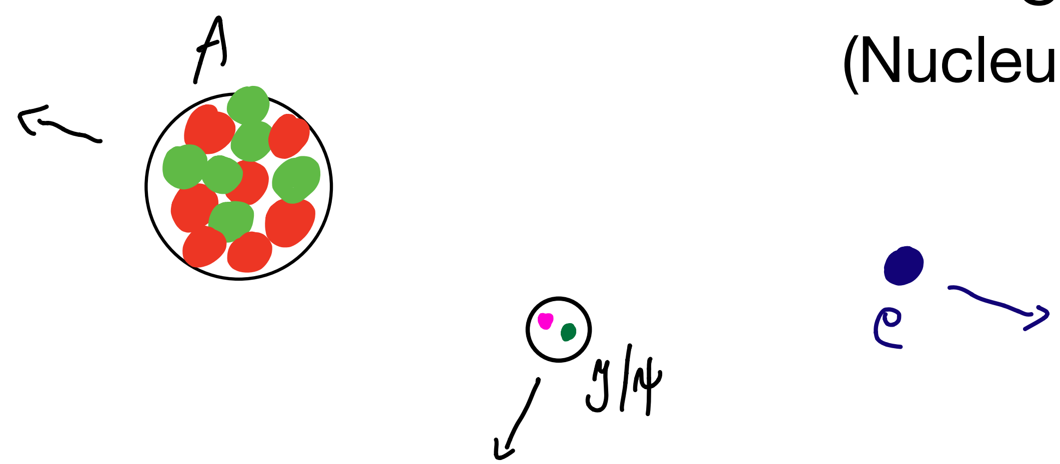
$$F(b) = \int_0^\infty \frac{q\,dq}{2\pi} J_0(qb) \sqrt{\frac{d\sigma_{\mathrm{coherent}}}{dt}}$$

$$t = -q^2$$

Coherent vs incoherent



Coherent
(Nucleus stays intact)

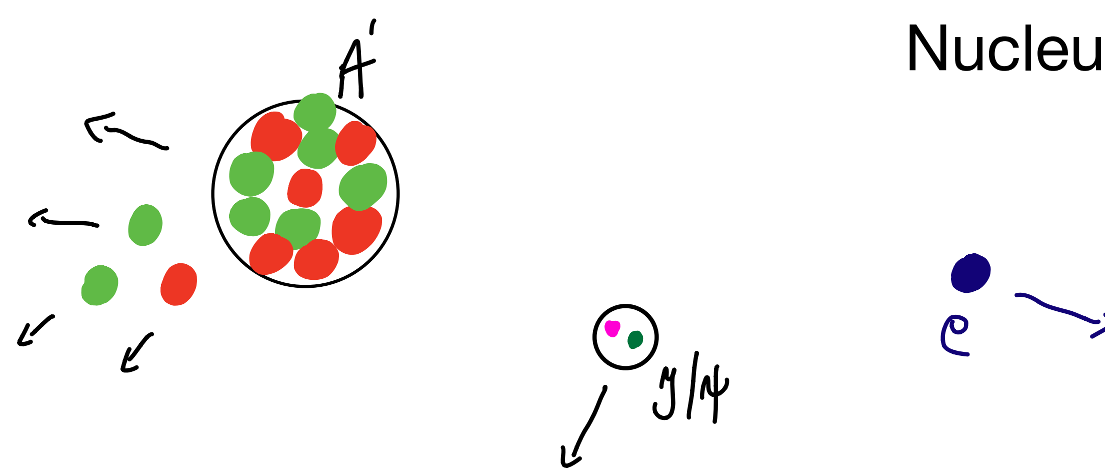


Coherent:
Depends on the shape of the source, average distribution

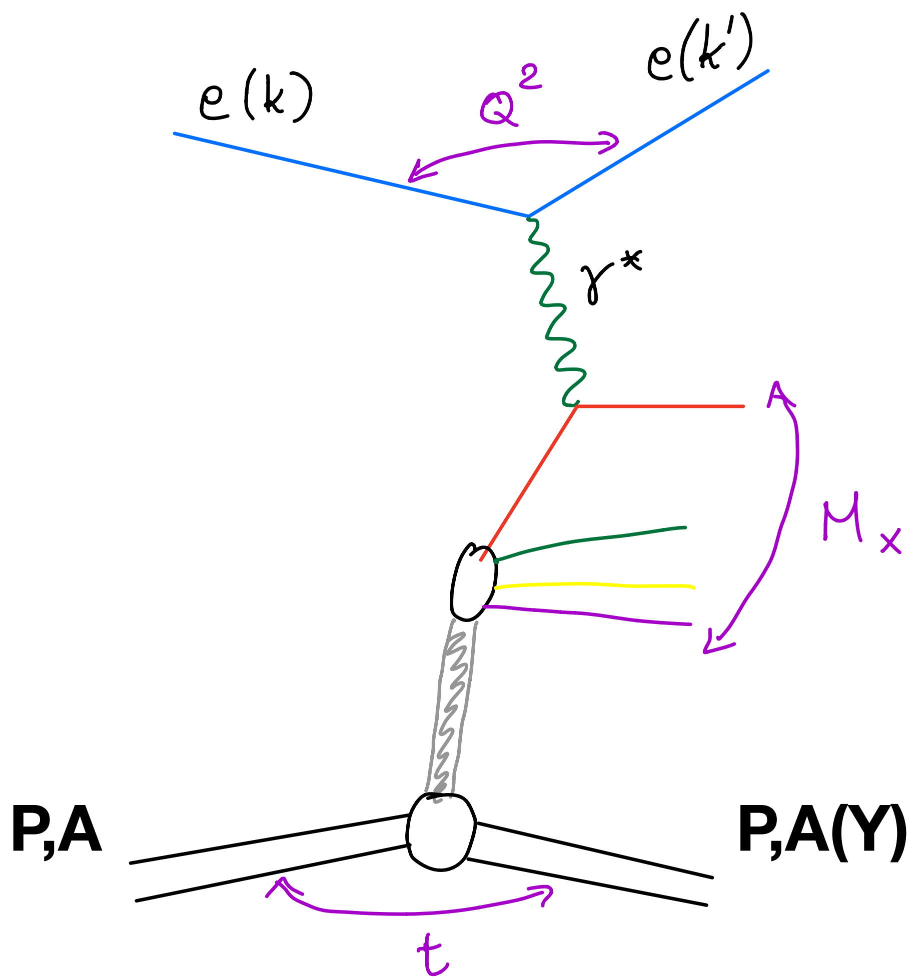
Incoherent:

Provides information about the fluctuations or lumpiness of the source

Incoherent
Nucleus breaks up



Inclusive Diffraction in e p(A)



t 4-momentum transfer squared

$$x_{\rm Bj} = \frac{Q^2}{2p\cdot q}$$ Bjorken x

$$Q^2 = -q^2$$ (minus) photon virtuality

$$\xi \equiv x_{IP} = \frac{Q^2 + M_X^2 - t}{Q^2 + W^2}$$ momentum fraction of the Pomeron w.r.t hadron

$$\beta = \frac{Q^2}{Q^2 + M_X^2 - t}$$ momentum fraction of parton w.r.t Pomeron

$$x_{Bj} = x_{IP}\beta$$

Rapidity gap $\ln 1/x_{IP}$

Inclusive diffraction: system X can contain anything (jets, heavy quarks),
Can learn about structure of the diffractive exchange

Diffractive structure functions

$$\boxed{\frac{d^3\sigma^D}{dx_{IP}\,dx\,dQ^2} = \frac{2\pi\alpha_{\rm em}^2}{xQ^4}\,Y_+\,\sigma_r^{D(3)}(x_{IP},x,Q^2)}$$

3 variables

$$Y_+ = 1+(1-y)^2$$

Reduced diffractive cross section depends on two structure functions :

$$\boxed{\sigma_r^{D(3)} = F_2^{D(3)} - \frac{y^2}{Y_+}F_L^{D(3)}}$$

Transverse photon polarization and longitudinal polarization

For y not to close to unity we have: $\sigma_r^{D(3)} \simeq F_2^{D(3)}$

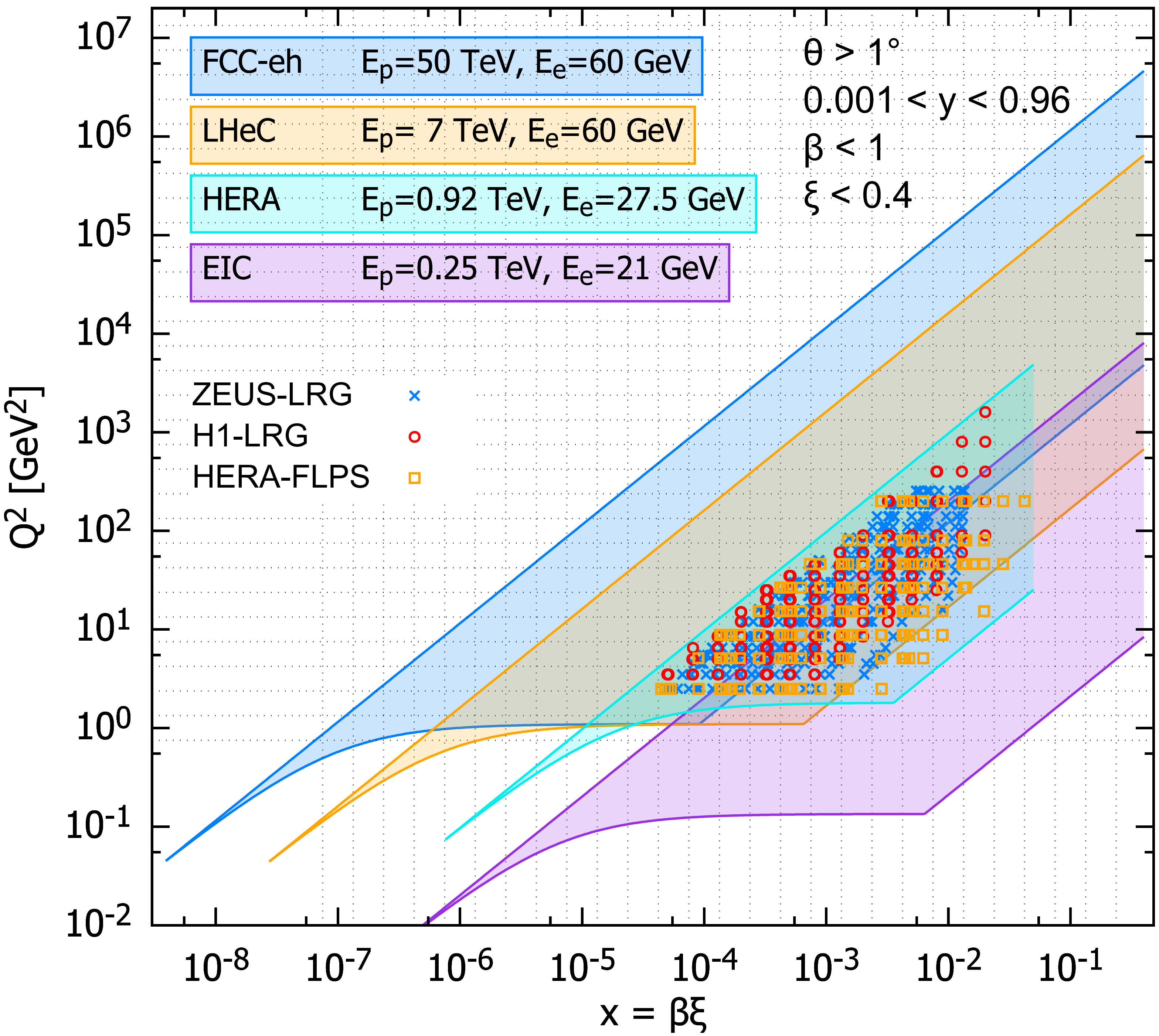
Integrated vs unintegrated structure functions over t:

$$F_{T,L}^{D(3)}(x,Q^2,x_{IP}) = \int_{-\infty}^{0} dt\, \boxed{F_{T,L}^{D(4)}(x,Q^2,x_{IP},t)}$$

4 variables

$$F_2^{D(4)} = F_T^{D(4)} + F_L^{D(4)}$$

Phase space of HERA and future colliders

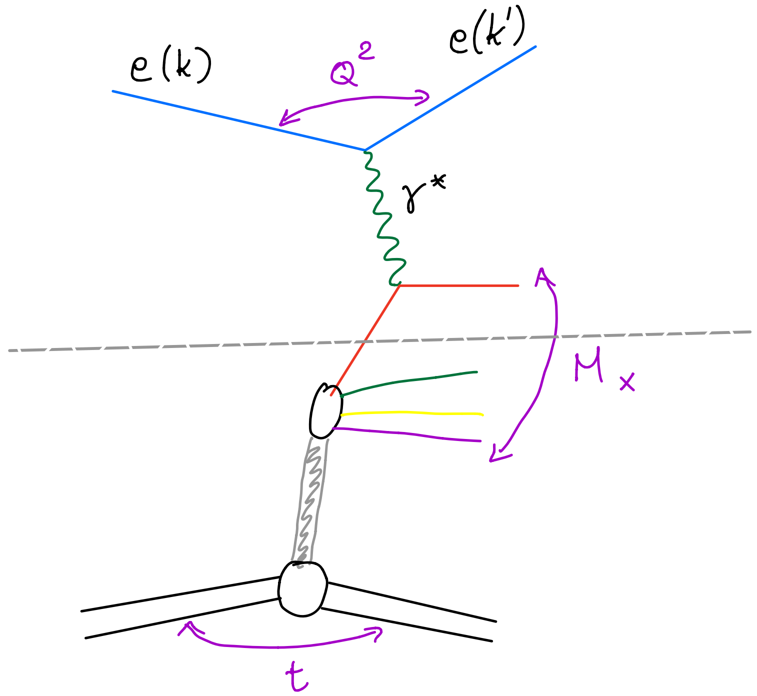


EIC: large x, up by factor 10, small / moderate Q^2

LHeC: small x, xmin down by factor 20, wide range of Q^2,up by factor 100

FCC-eh: very small x, down by factor 200, Q^2 up by factor 1000

Collinear factorization in diffraction



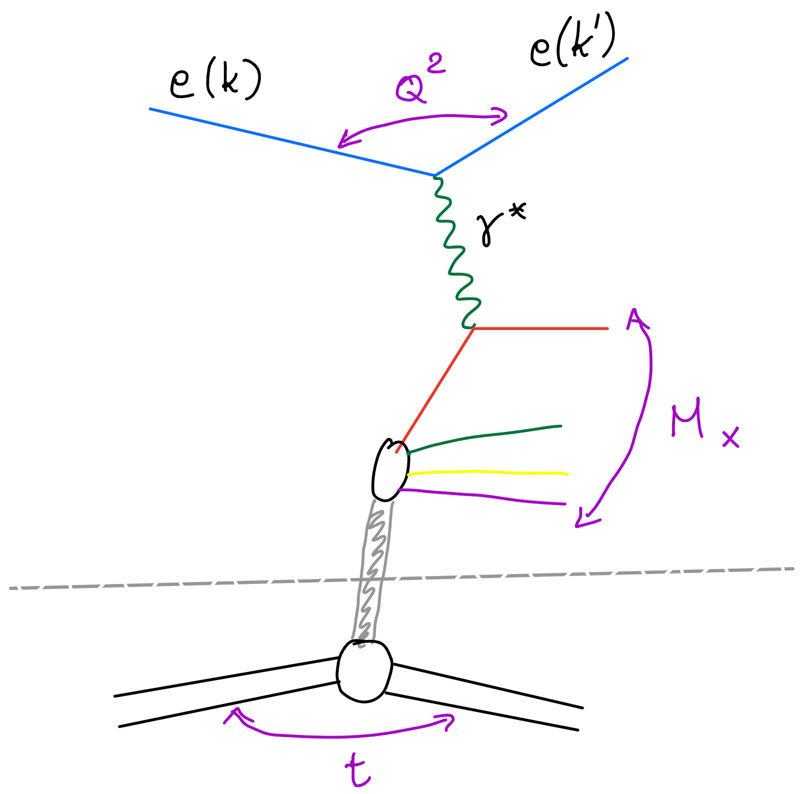
Collins

Collinear factorization in diffractive DIS

$$d\sigma^{ep\to eXY}(\beta,\xi,Q^2,t) \;=\; \sum_i \int_\beta^1 dz\; d\hat{\sigma}^{ei}\left(\frac{\beta}{z},Q^2\right)\; f_i^{\mathrm{D}}(z,\xi,Q^2,t)$$

- Diffractive cross section can be factorized into the perturbatively calculable partonic cross sections and diffractive parton distributions (DPDFs).
- Partonic cross sections are the same as for the inclusive DIS.
- The DPDFs represent the probability distributions for partons *i* in the proton under the constraint that the proton is scattered into the system Y with a specified 4-momentum.
- Factorization should be valid for sufficiently(?) large Q^2 (and fixed t and x_{IP}).

DPDF parametrization



Regge factorization (additional assumption)

$$f_i^D(x, Q^2, x_{IP}, t) = f_{IP/p}(x_{IP}, t)\, f_i(\beta = x/x_{IP}, Q^2)$$

Pomeron flux is parametrized as

$$f_{IP/p}(x_{IP}, t) = A_{IP} \frac{e^{B_{IP} t}}{x_{IP}^{2\alpha_{IP}(t)} - 1}$$

$$\alpha_{IP}(t) = \alpha_{IP}(0) + \alpha'_{IP} t$$

parton distributions in the Pomeron, evolved with DGLAP evolution and initial conditions

$$f_k(z) = A_k z^{B_k} (1-z)^{C_k}$$

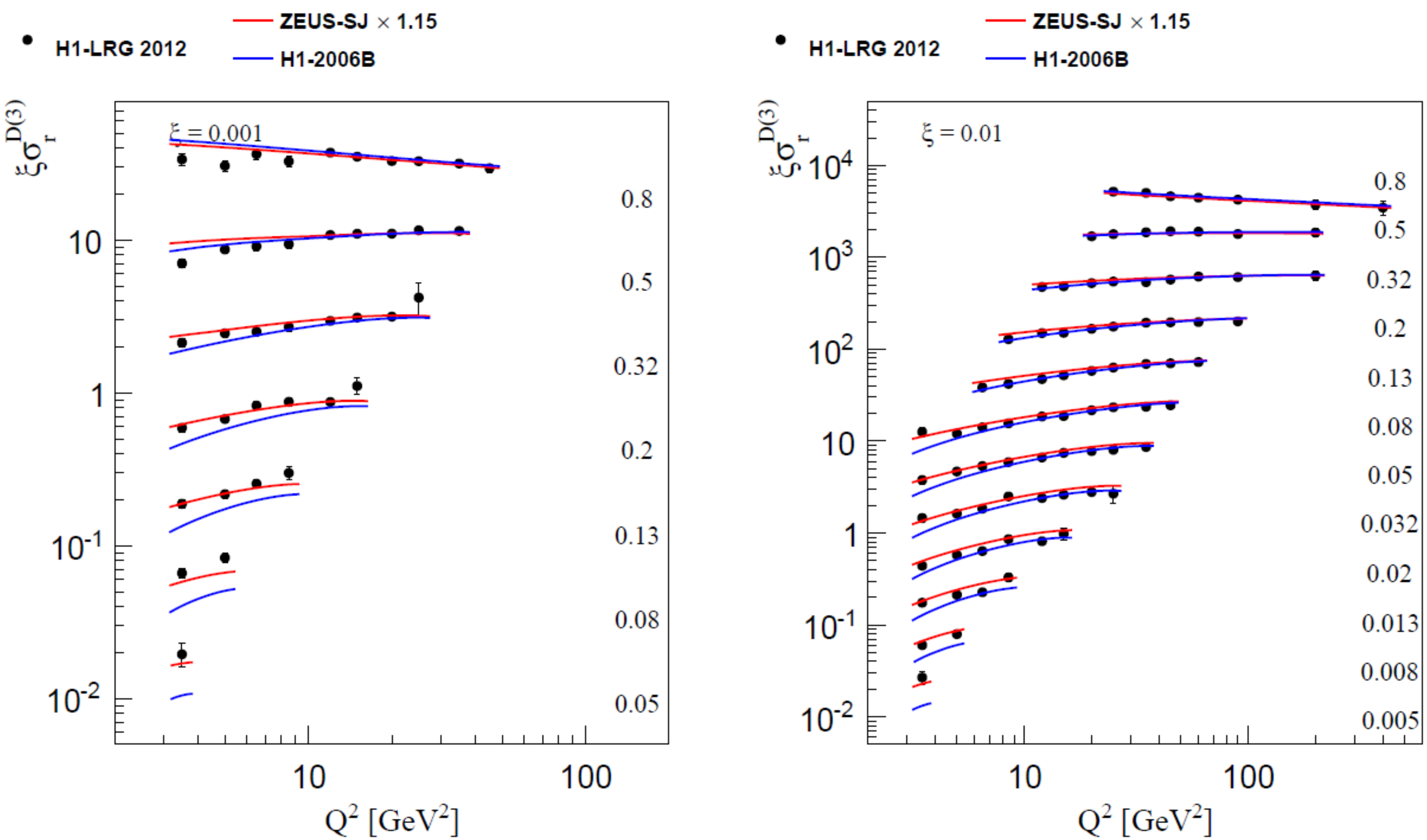
where k=g,d. Light quarks equal u=d=s.

For good description of the data usually subleading Reggeons are included

$$f_i^D(x, Q^2, x_{IP}, t) = f_{IP/p}(x_{IP}, t)\, f_i(\beta, Q^2) + n_{IR} f_{IR/p}(x_{IP}, t)\, f_i^{IR}(\beta, Q^2)$$

Diffractive fits

$\xi = x_{IP}$ Example of the DGLAP fit to the diffractive data

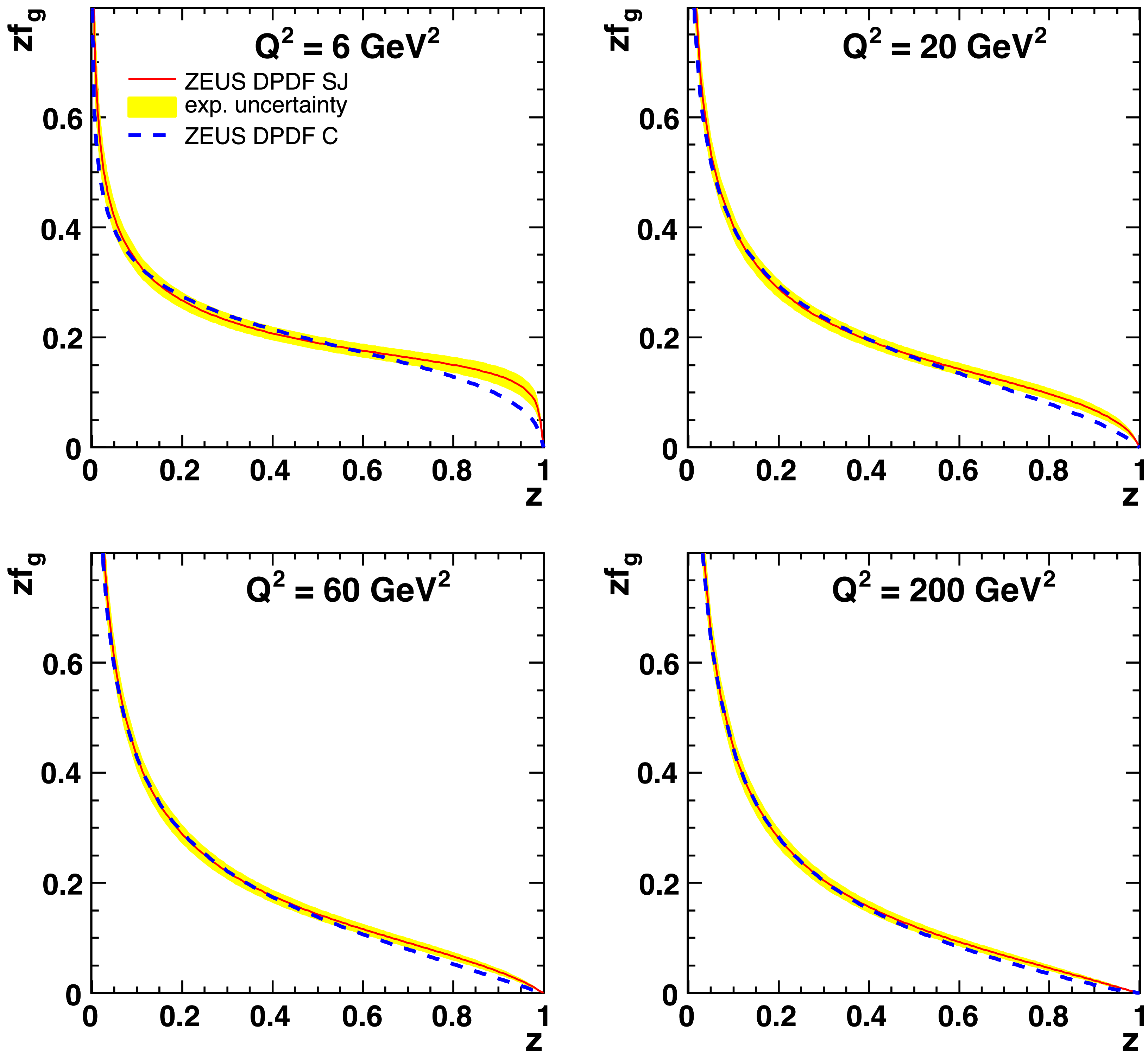


Comparison of H1-2006B and ZEUS-SJ fits to the H1-LRG 2012 data
ZEUS-SJ fit seems to better describe the data in the low β region

DPDFs

Gluon

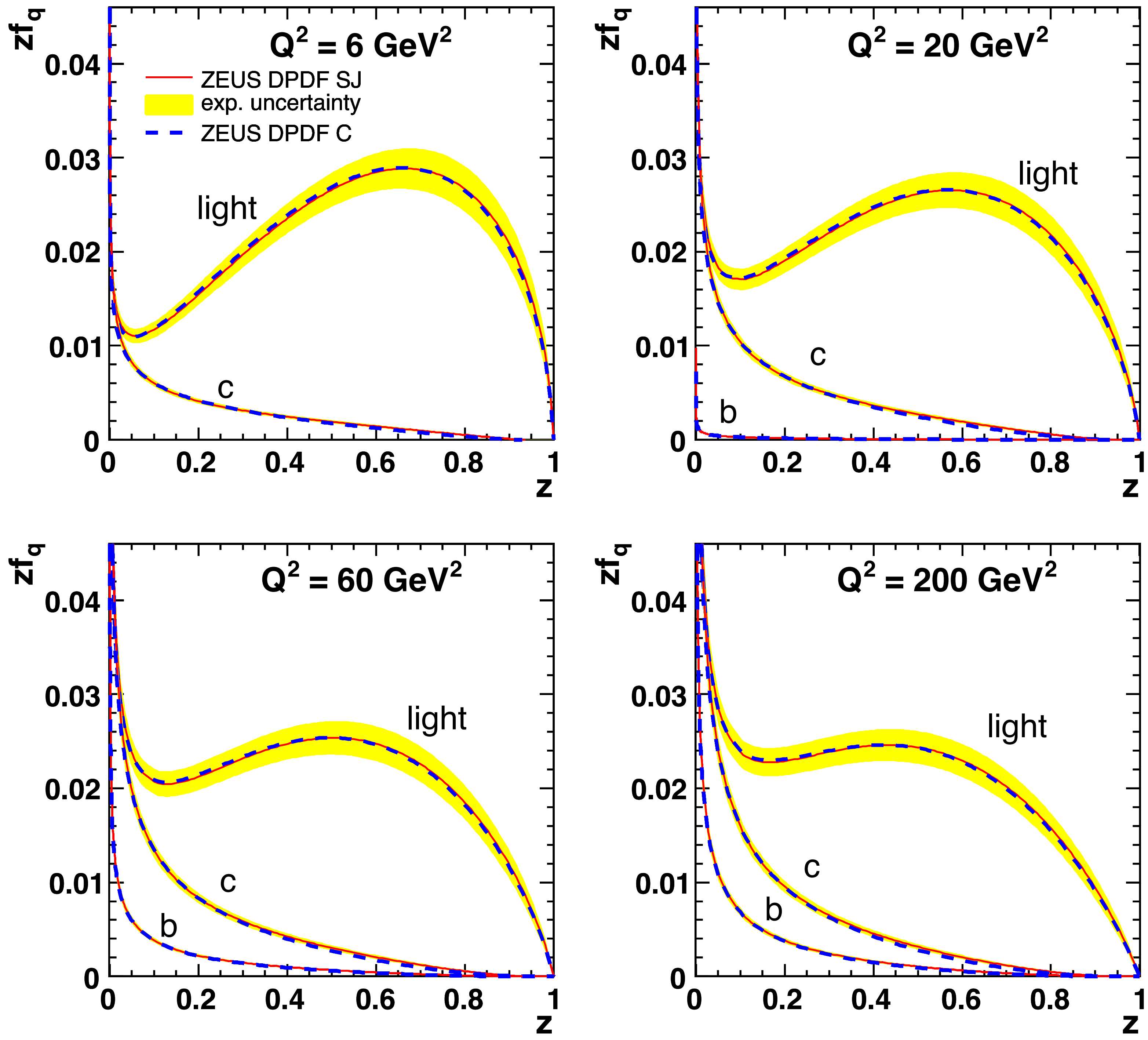
$$f_i^D(x, Q^2, x_{IP}, t) = f_{IP/p}(x_{IP}, t)\boxed{f_i(\beta = x/x_{IP}, Q^2)}$$



DPDFs

Quark

$$f_i^D(x, Q^2, x_{IP}, t) = f_{IP/p}(x_{IP}, t)\boxed{f_i(\beta = x/x_{IP}, Q^2)}$$



Inclusive diffraction possibilities at EIC

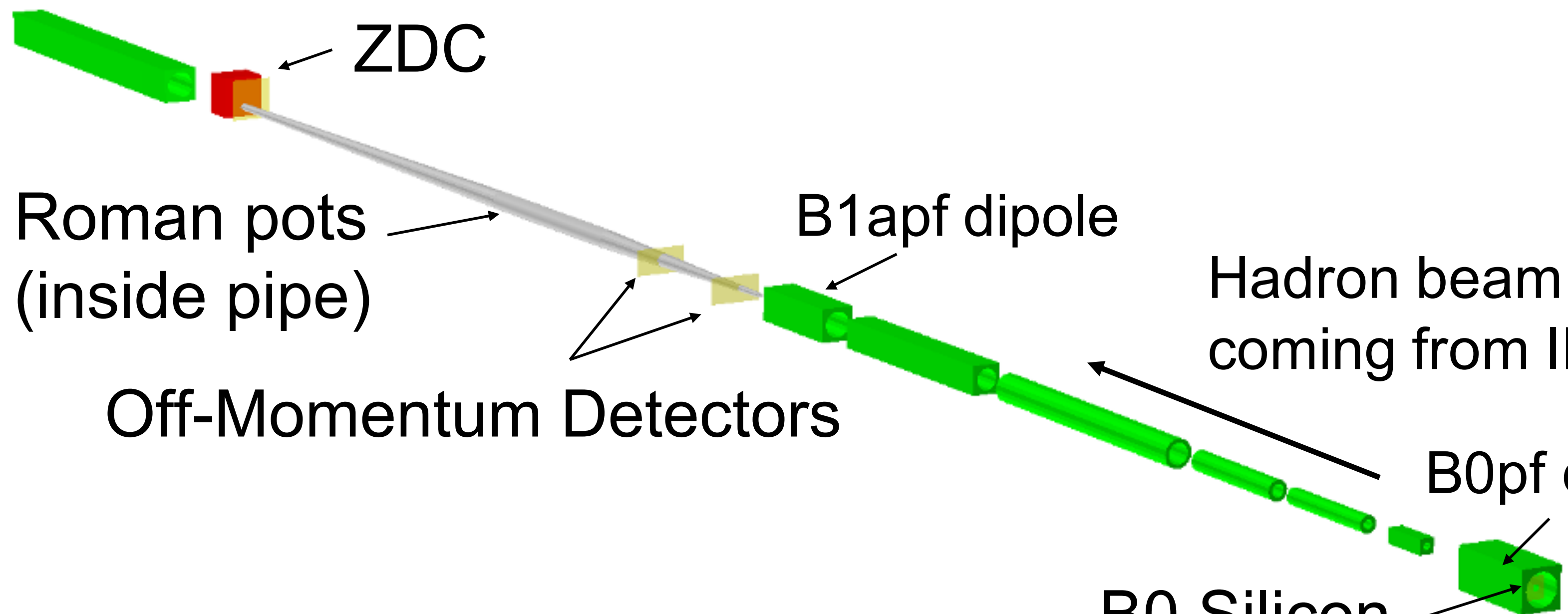
Physics with protons

- Precision measurement of $\sigma_{\mathrm{red}}^{D(3)}, \sigma_{\mathrm{red}}^{D(4)}$
- Access to large $\xi = x_{IP}$
- Possibility of disentangling Pomeron and Reggeon components
- Precise measurements of diffractive parton densities at large z
- Measurements of the diffractive longitudinal structure function F_L^D

Physics with nuclei

- Measurements of $\sigma_{\mathrm{red}}^{D(3)}, \sigma_{\mathrm{red}}^{D(4)}$
- First extraction of the nuclear diffractive parton distribution functions
- Simultaneous measurements of shadowing and diffraction in the same experimental setup

Forward instrumentation at EIC

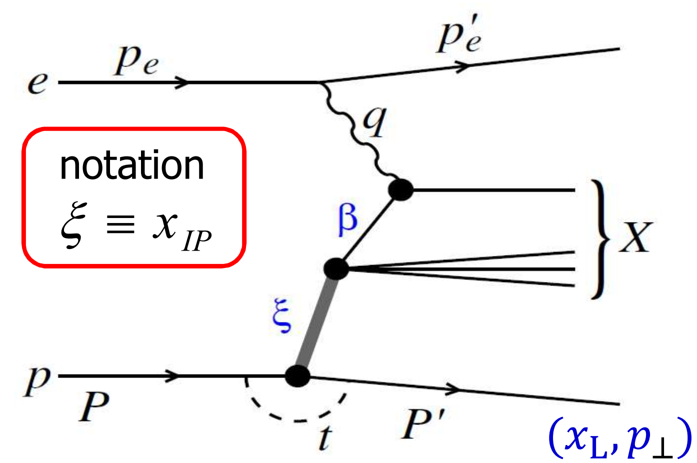


Detector	**(x,z) Position [m]**	**Dimensions**	**θ [mrad]**	**Notes**
ZDC	(0.96, 37.5)	(60cm, 60cm, 2m)	$\theta < 5.5$	$\sim$4.0 mrad at $\phi = \pi$
Roman Pots (2 stations)	(0.85, 26.0) (0.94, 28.0)	(25cm, 10cm, n/a)	$0.0 < \theta < 5.5$	10 σ cut.
Off-Momentum Detector	(0.8, 22.5), (0.85, 24.5)	(30cm, 30cm, n/a)	$0.0 < \theta < 5.0$	$0.4 < x_L < 0.6$
B0 Spectrometer	(x = 0.19, 5.4 < z < 6.4)	(26cm, 27cm, n/a)	$5.5 < \theta < 13.0$	$\sim$20 mrad at ϕ=0

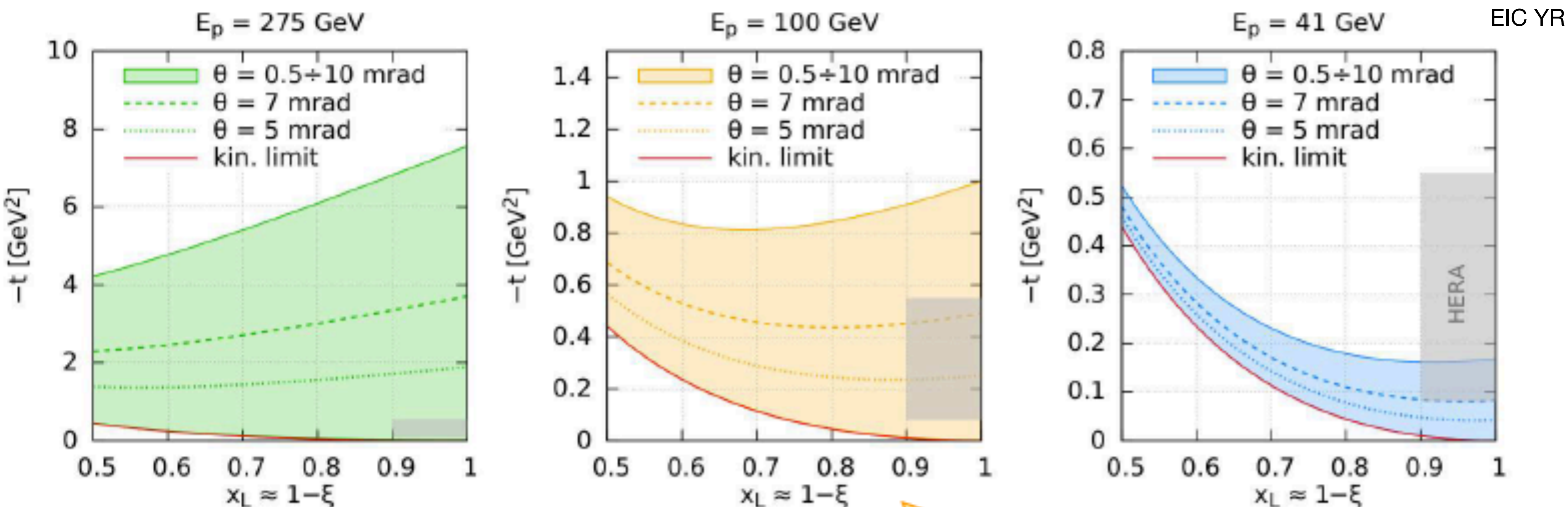
Excellent capabilities in the forward region for t measurement of the scattered proton

Possibilities at EIC: proton tagging

$$\xi \equiv x_{IP} = \frac{Q^2 + M_X^2 - t}{Q^2 + W^2}$$



- EIC can tackle large $\xi \cong 1 - x_L$ regions beyond HERA
- The coverage depends on the angular acceptance



$$t = -\frac{p_\perp^2}{x_L} - \frac{(1-x_L)^2}{x_L} m_p^2 - \frac{1-x_L}{x_L}(M_Y^2 - m_p^2)$$

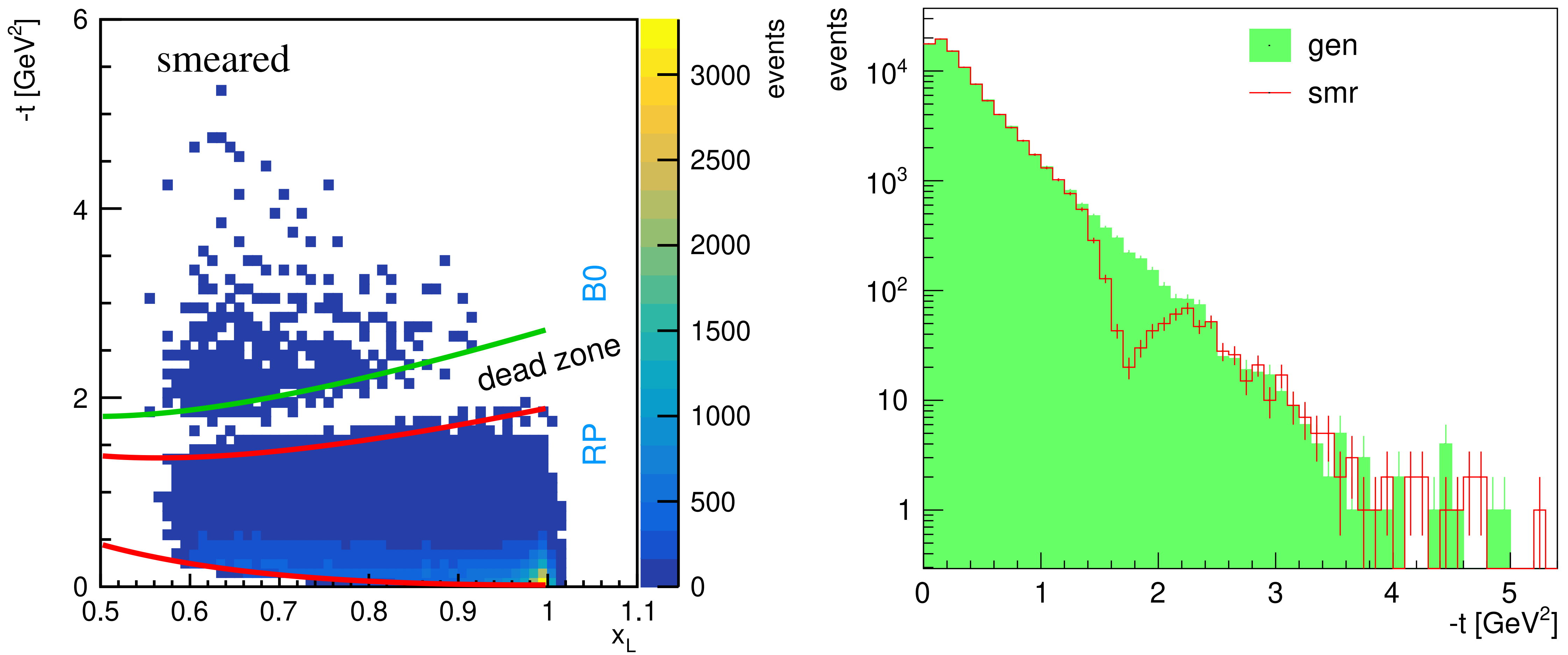
$x_L, p_\perp, \theta$ measured in
LAB = collinear(e,p) frame

$|t|$ measured up to ~ 2 GeV², is very interesting,
e.g. for determination of the t-dependence of the secondary exchange.

Inclusive diffraction in ep: extended range in t and x_L

RAPGAP MC simulation

EIC YR



Gap in acceptance between Roman pots and B0 detectors, at relatively large value of t

Gap moves to lower t for smaller energies

Could be mitigated in the design with two EIC detectors, and different forward instrumentation in the second case.

Inclusive diffraction in ep: secondary exchange

Regge factorization works at low

At higher values need additional term : Reggeon terms

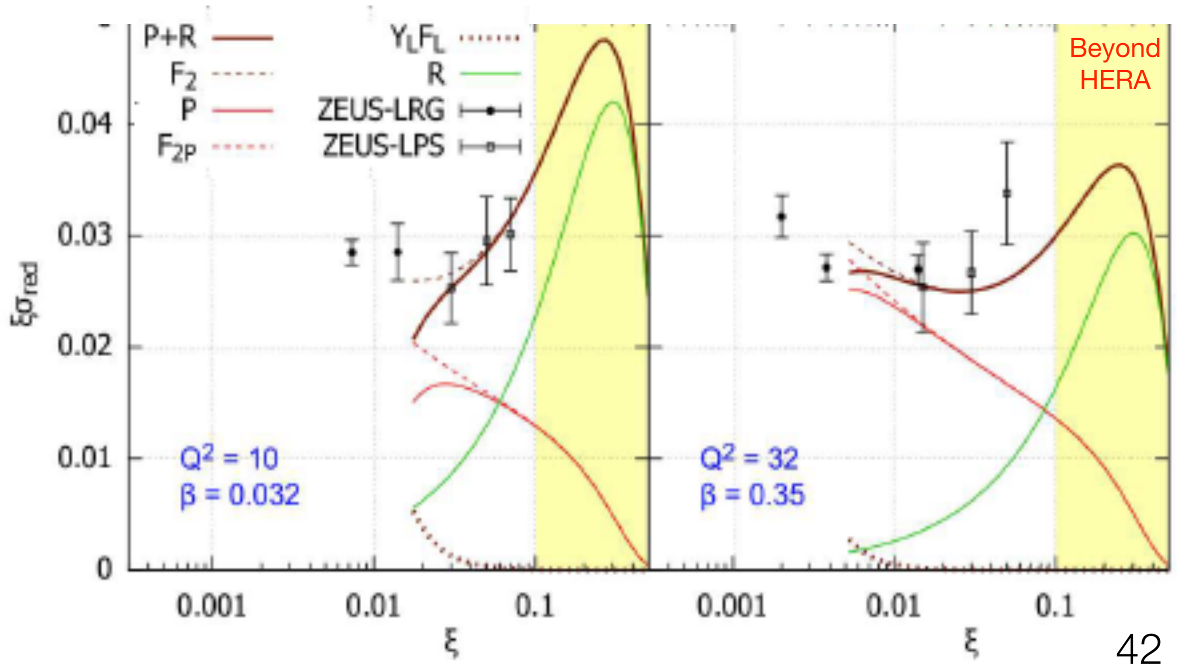
$$f_i^D(x, Q^2, x_{IP}, t) = f_{IP/p}(x_{IP}, t)\, f_i(\beta, Q^2) + n_{IR} f_{IR/p}(x_{IP}, t)\, f_i^{IR}(\beta, Q^2)$$

Pomeron flux is parametrized as

$$\boxed{f_{IP/p}(x_{IP}, t) = A_{IP} \frac{e^{B_{IP} t}}{x_{IP}^{2\alpha_{IP}(t)} - 1}}$$

$$\xi \phi_P(\xi, t) \propto \xi^{-0.22}\, e^{-7|t|}$$
$$\xi \phi_R(\xi, t) \propto \xi^{0.6+1.8|t|}\, e^{-2|t|}$$

$$\alpha_{IP}(t) = \alpha_{IP}(0) + \alpha'_{IP} t$$

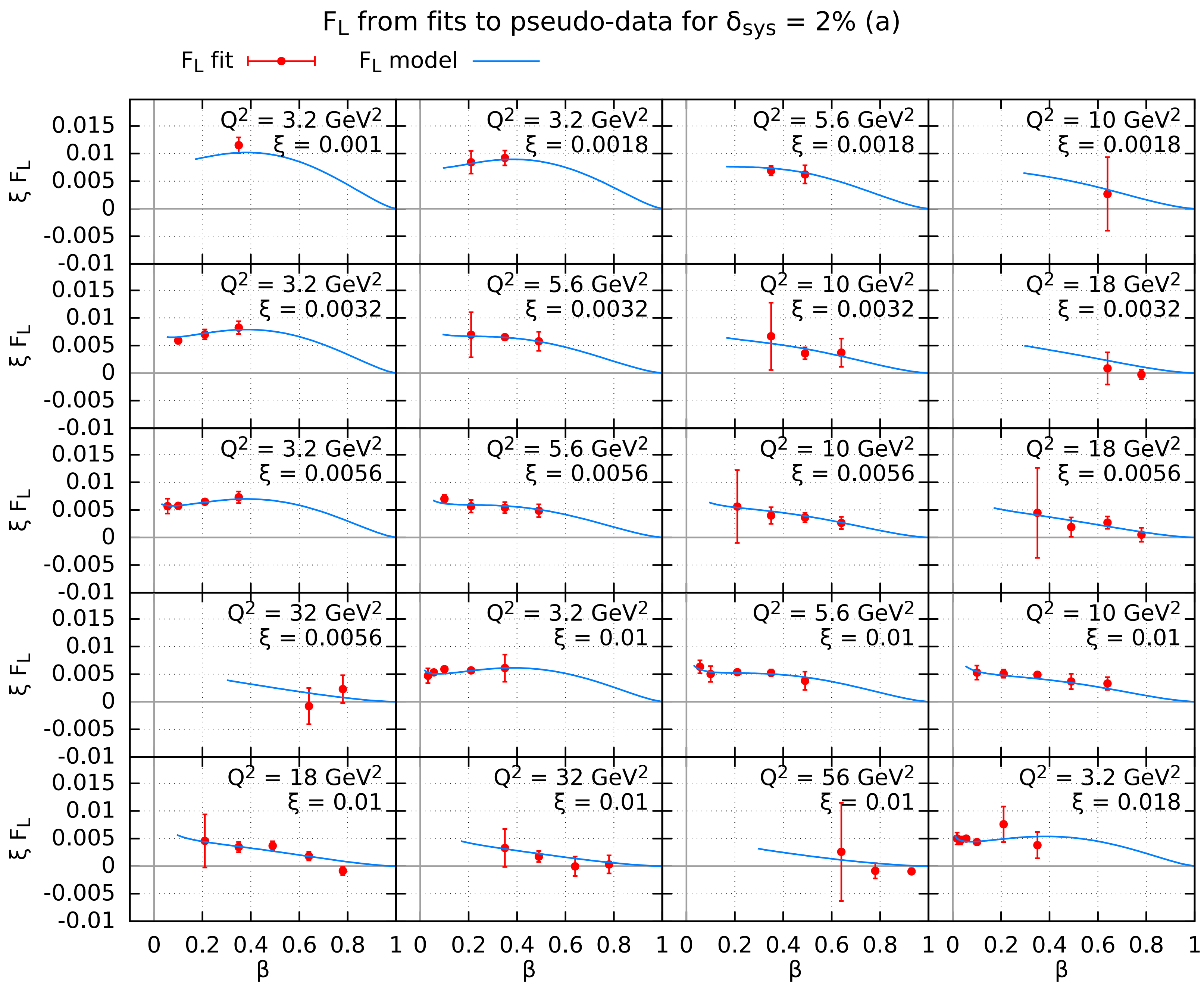


- $\mathbb{R}$ contribution grows with ξ
  - High ξ required for the determination of subleading "Reggeon" term
- Significant F_L component, ~30 times higher than at HERA
  - However, some intermediate beam energy settings needed for F_L measurements

Inclusive diffraction in ep: F_L^D

The pseudo-data are fitted to $\sigma_{\rm red} = F_2 - Y_L(y) F_L$ $\quad Y_L(y) = \frac{y^2}{1+(1-y)^2}$

F_2 and F_L are free parameters in the fit



Systematic error 2%

18 beam setups

469 bins selected such that they are common to at least four beam setups

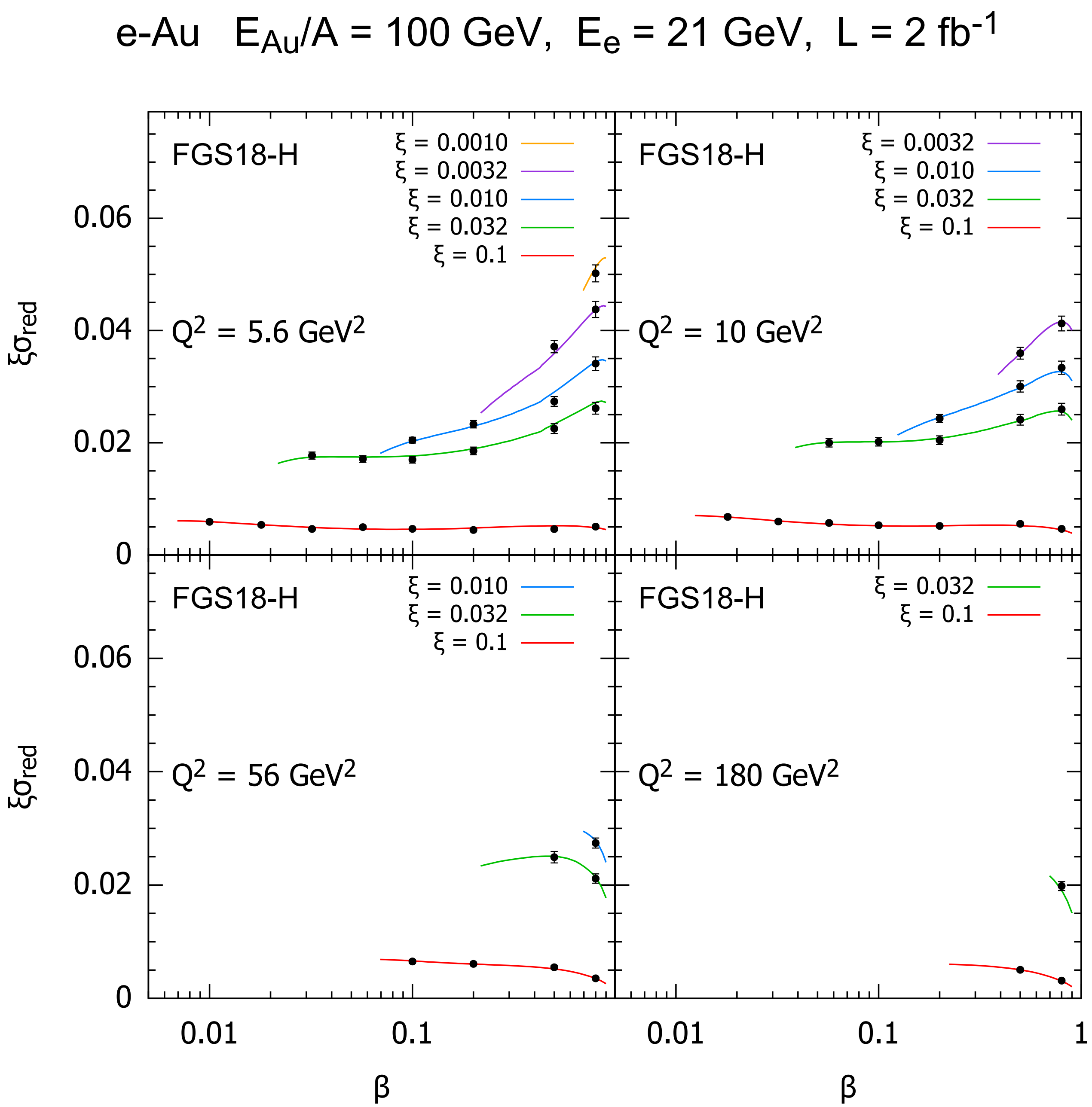
Nuclear cross sections: EIC

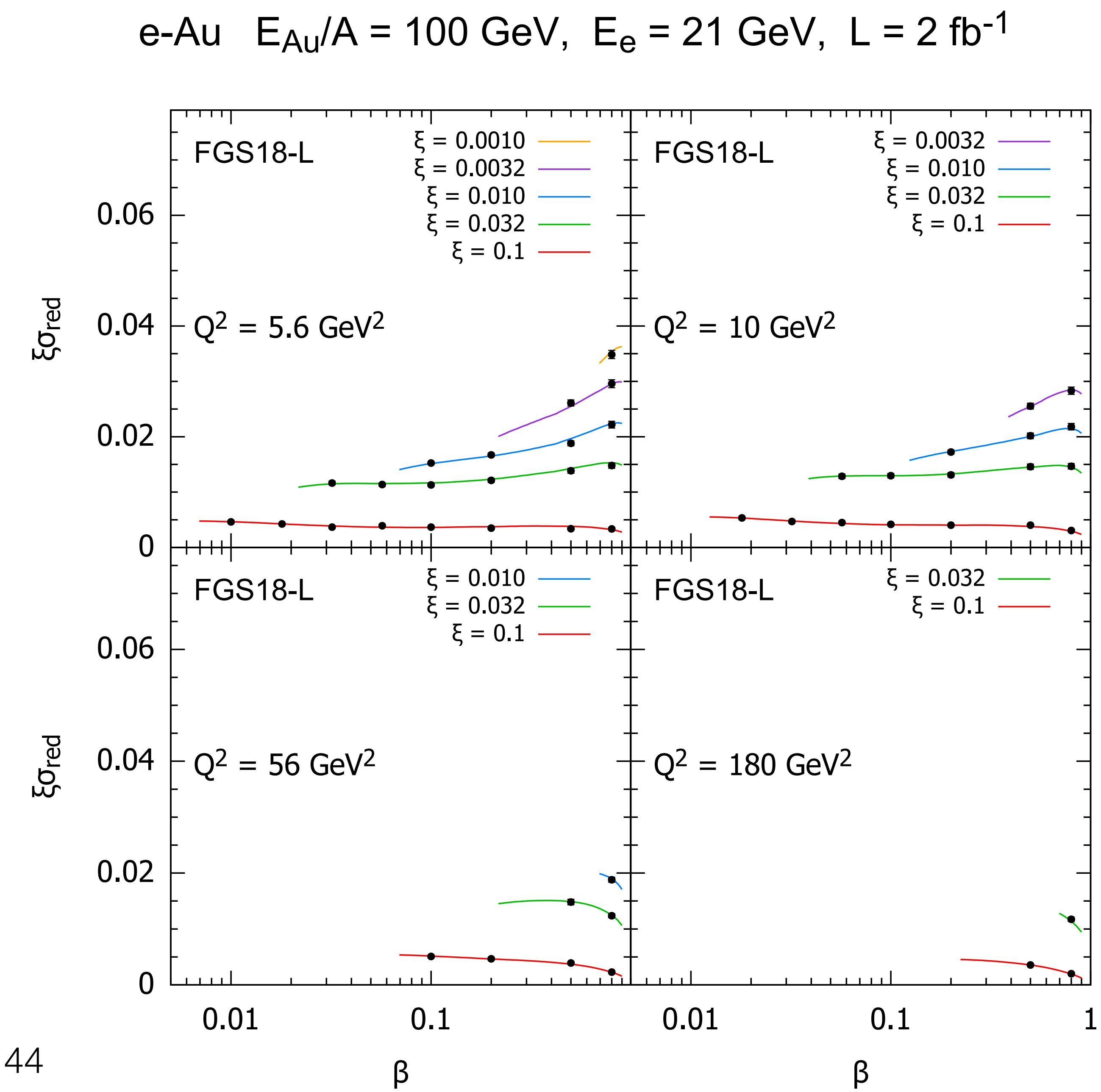
Frankfurt, Guzey, Strikman model: high and low shadowing model predictions

Pseudodata simulated under the same assumptions: 5% systematics, luminosity 2 fb^{-1}

Illustration of the possible reach in (Q^2,β,ξ) kinematics

Reduced cross section





Summary

- Diffraction observed in hadronic collisions (ep,pp …)
- Provides important information about nucleon/nuclear structure
- Sensitive to the nature of the Pomeron
- EIC can provide precise measurements on:
    - Reduced cross sections, particularly with t-dependence and with nuclei
    - Exclusive processes, i.e. with vector mesons in the final state
    - Longitudinal diffractive structure function
    - Explore relation between the diffraction and nuclear shadowing
    - Many more…