POETIC6: 6th International Conference on
Physics Opportunities at an ElecTron-Ion Collider
Ecole Polytechnique, Palaiseau, September 7th 2015

Small-x Physics at the LHeC

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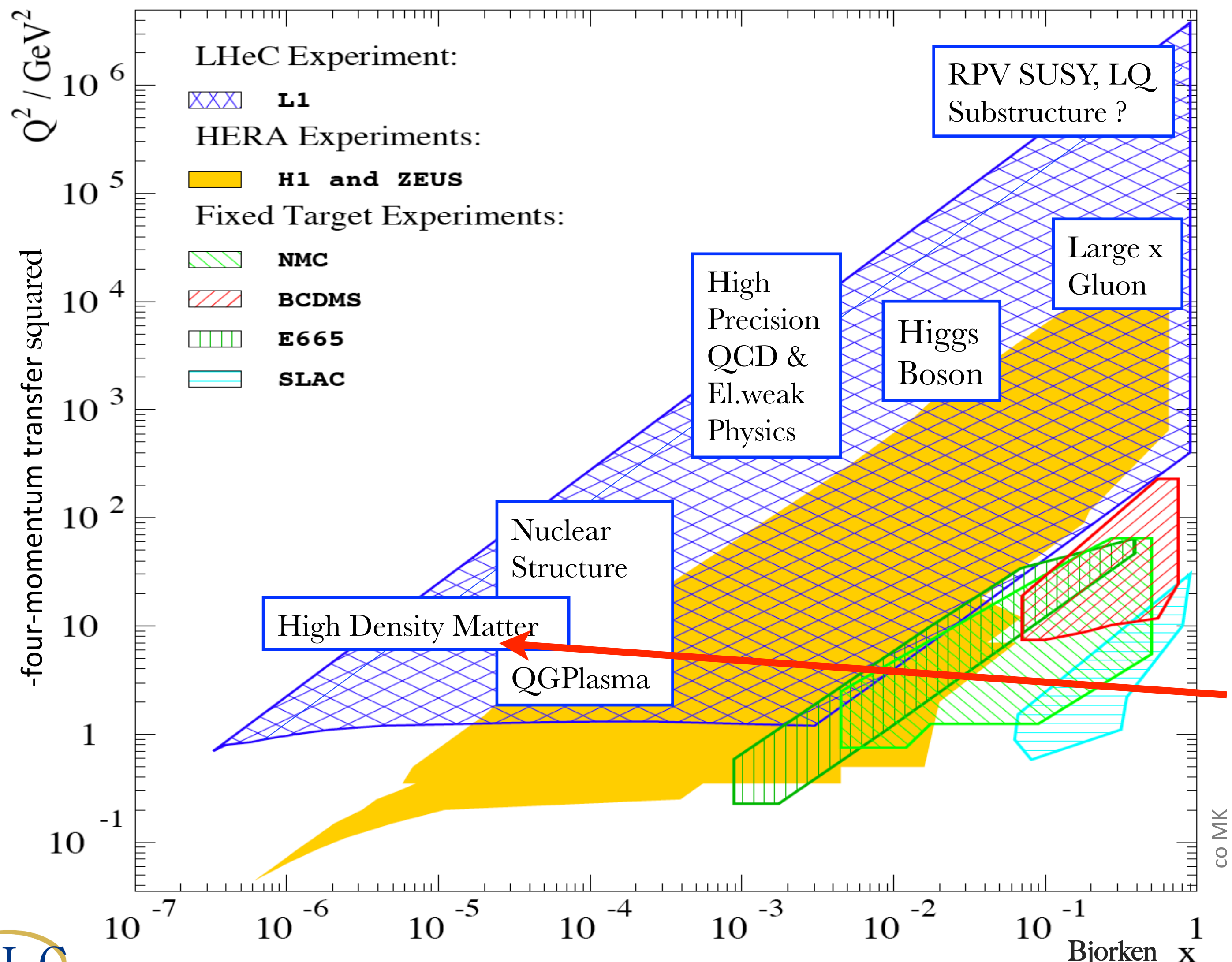
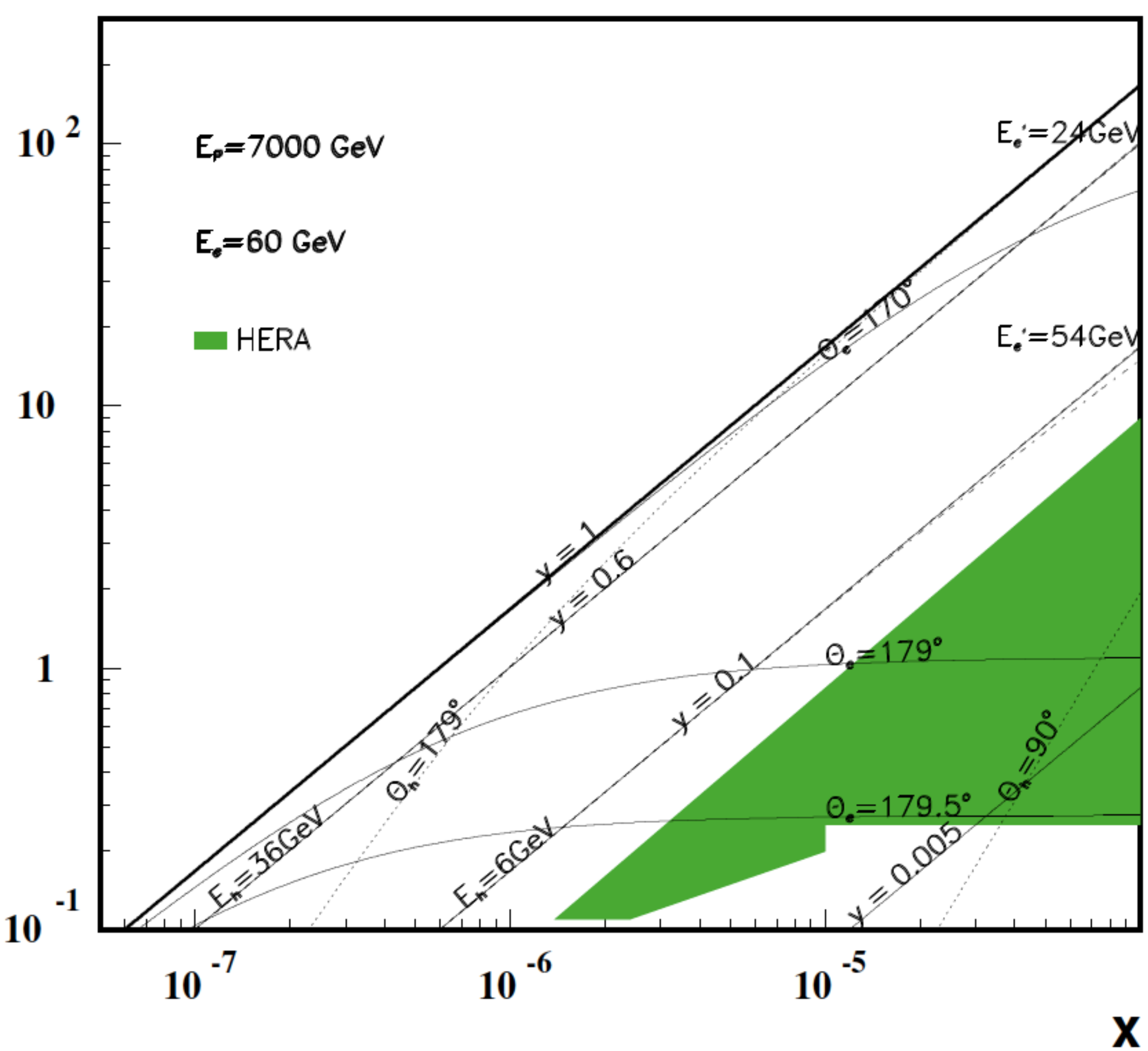
Physics goals:

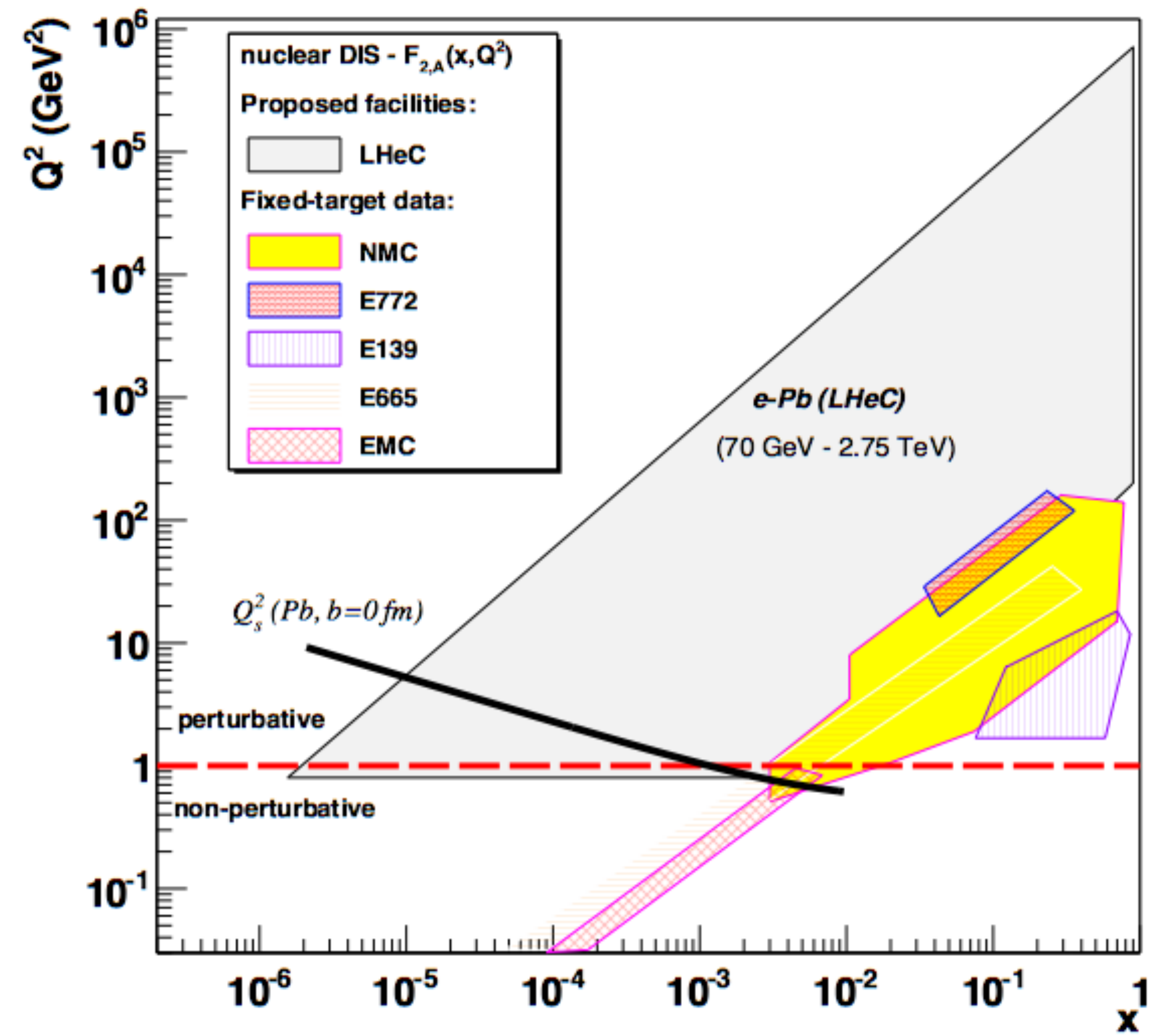


- Proton structure to a few 10^{-20} m: Q^2 lever arm.
- Precision QCD/EW physics.
- Higgs physics.
- High-mass frontier (lq, excited fermions, contact interactions).
- Unambiguous access, in ep and eA, to a qualitatively novel regime of matter predicted by QCD.
- Substructure/parton dynamics inside nuclei with strong implications on QGP search.

Kinematics:

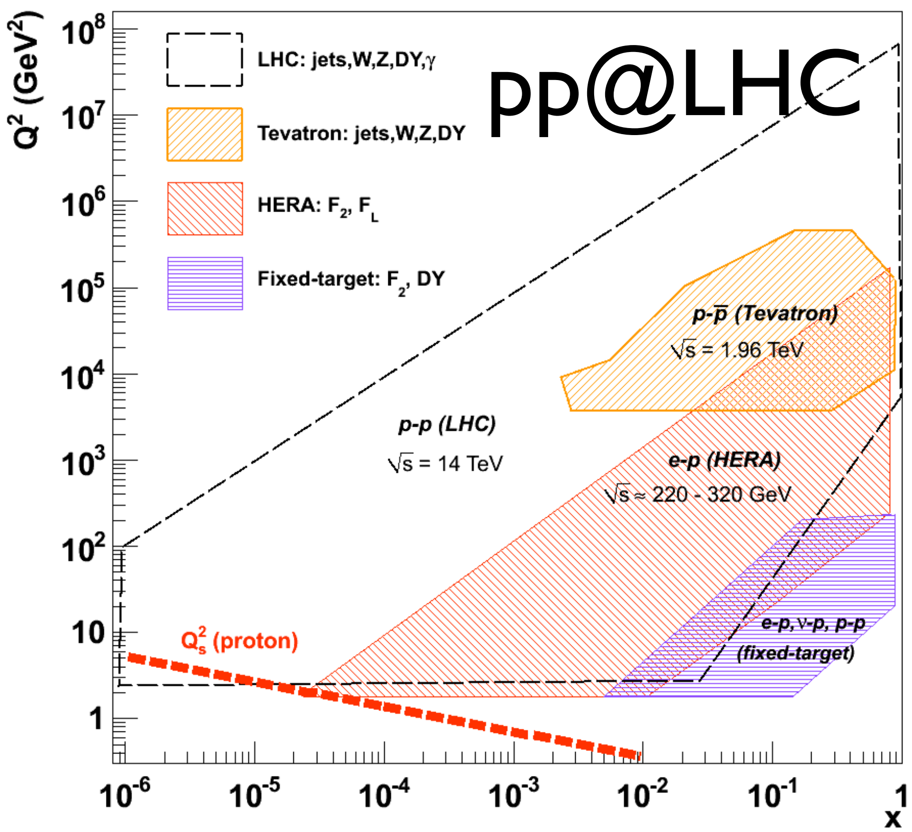
LHeC - Low x Kinematics

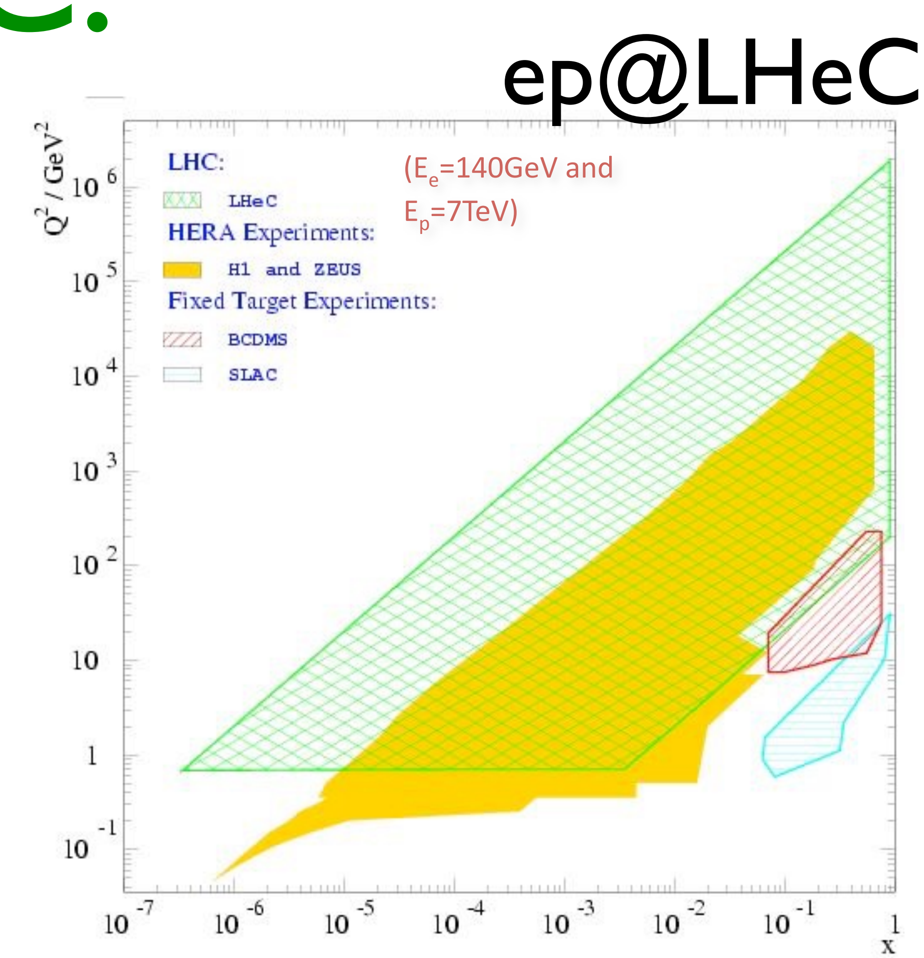


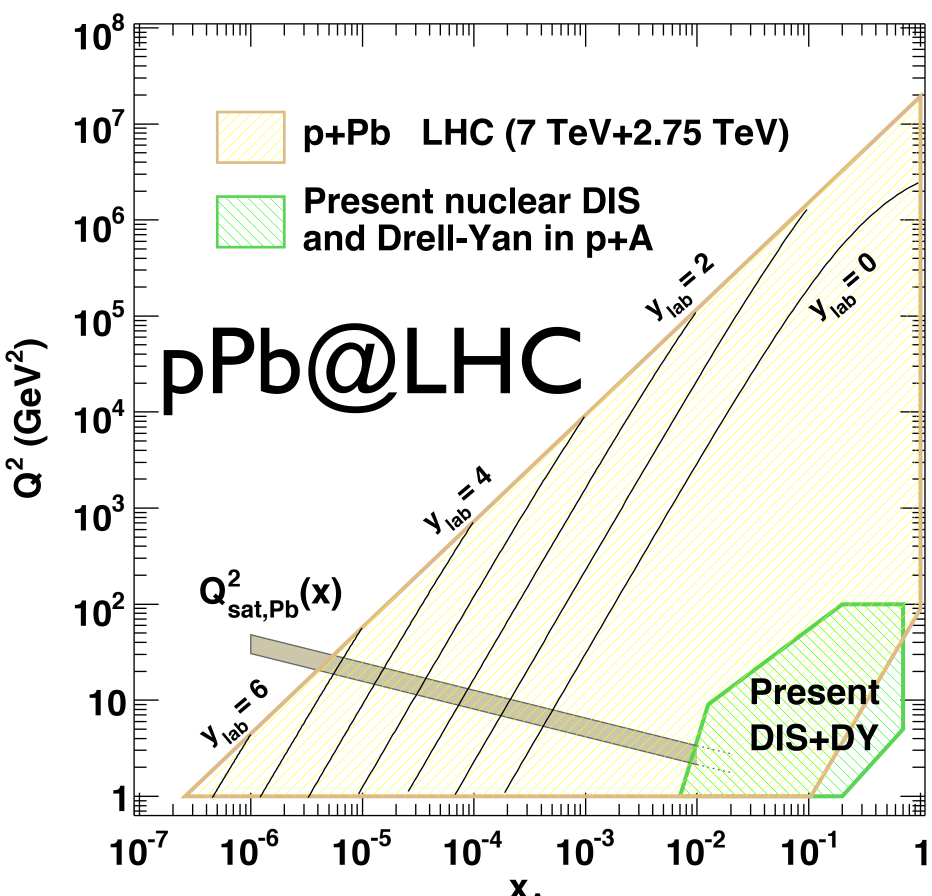


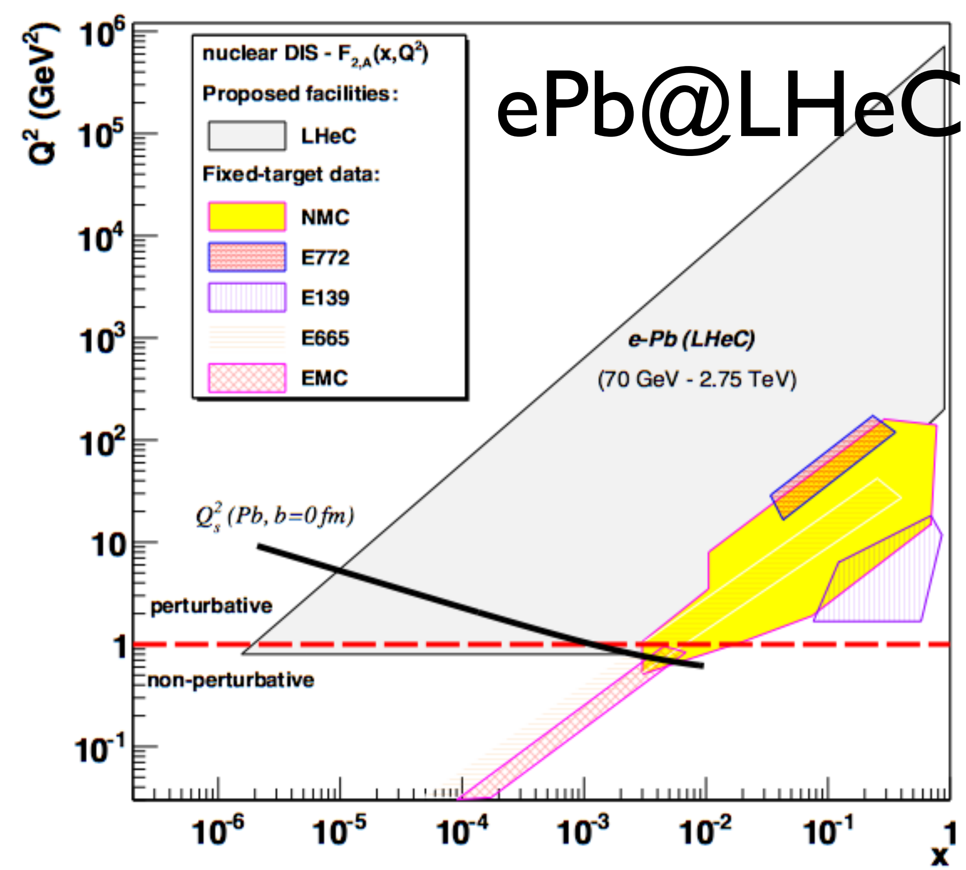
- Small-x demands 1 degree acceptance. This gets worse with increasing electron energy.
- Higher luminosity would benefit high-x and Q^2 studies: linked to small x via DGLAP evolution (see HERA final analysis).

LHC vs. LHeC:

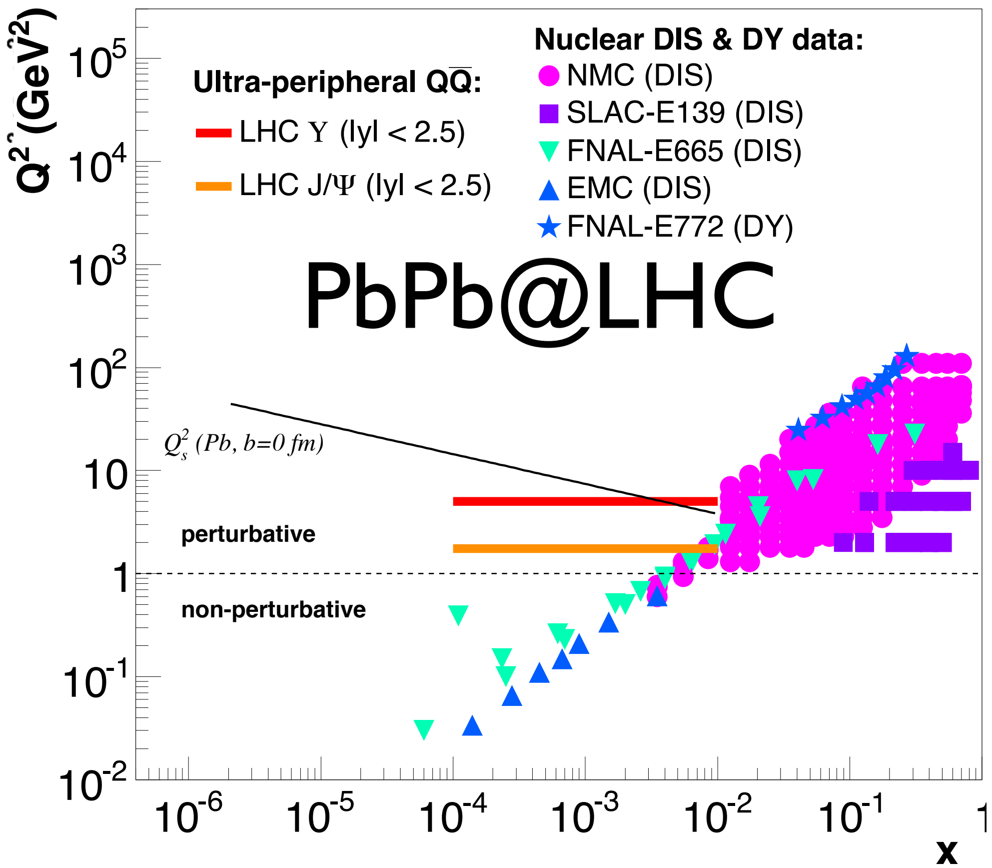

pp@LHC
LHC: jets,W,Z,DY,γ
Tevatron: jets,W,Z,DY
HERA: F2, FL
Fixed-target: F2, DY
p-p̄ (Tevatron)
√s = 1.96 TeV
p-p (LHC)
√s = 14 TeV
e-p (HERA)
√s ≈ 220 - 320 GeV
e-p, ν-p, p-p
(fixed-target)
Qs2 (proton)
Q2 (GeV2)
x

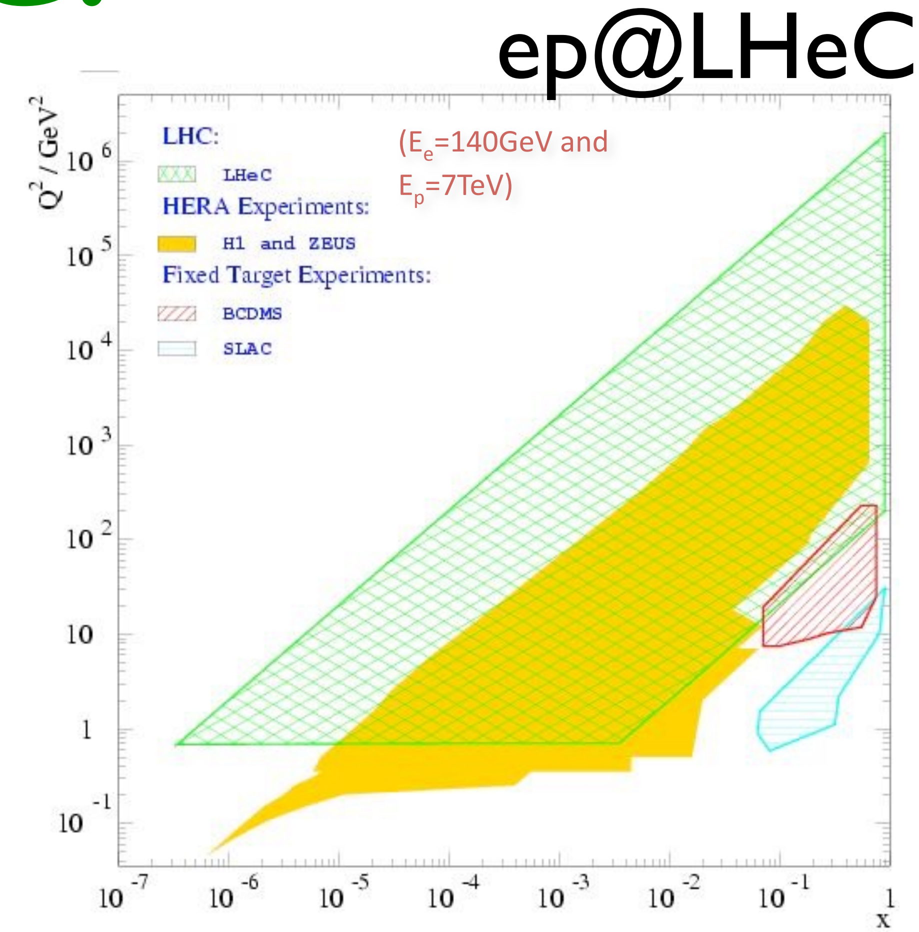

ep@LHeC
LHC:
LHeC
HERA Experiments:
H1 and ZEUS
Fixed Target Experiments:
BCDMS
SLAC
(Ee=140GeV and
Ep=7TeV)
Q2 / GeV2
x


pPb@LHC
p+Pb LHC (7 TeV+2.75 TeV)
Present nuclear DIS
and Drell-Yan in p+A
y lab = 2
y lab = 0
y lab = 4
y lab = 6
Q2 sat,Pb(x)
Present
DIS+DY
Q2 (GeV2)
xA


ePb@LHeC
nuclear DIS - F2,A(x,Q2)
Proposed facilities:
LHeC
Fixed-target data:
NMC
E772
E139
E665
EMC
e-Pb (LHeC)
(70 GeV - 2.75 TeV)
Qs2 (Pb, b=0 fm)
perturbative
non-perturbative
Q2 (GeV2)
x

LHC vs. LHeC:


PbPb@LHC
Nuclear DIS & DY data:
NMC (DIS)
SLAC-E139 (DIS)
FNAL-E665 (DIS)
EMC (DIS)
FNAL-E772 (DY)
Ultra-peripheral QQ̄:
LHC Υ (|y| < 2.5)
LHC J/Ψ (|y| < 2.5)
Q_s^2 (Pb, b=0 fm)
perturbative
non-perturbative
Q^2 (GeV^2)
x


ep@LHeC
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Fixed Target Experiments:
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(E_e=140GeV and E_p=7TeV)
Q^2 / GeV^2
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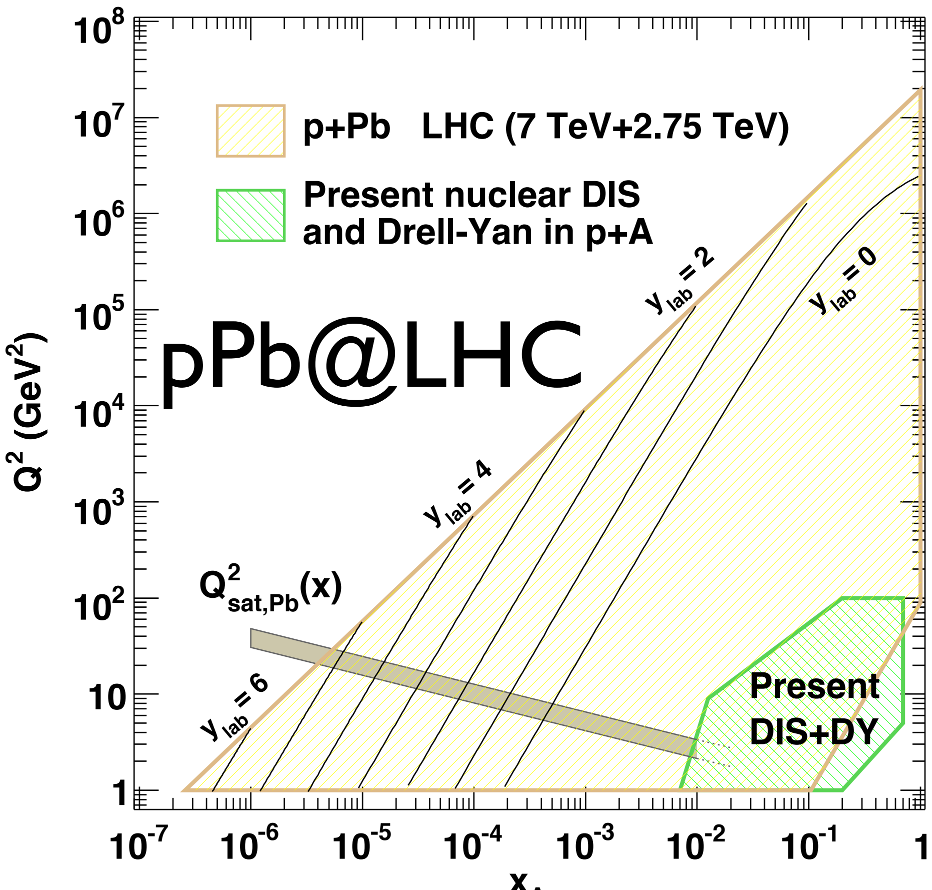
pPb@LHC
p+Pb LHC (7 TeV+2.75 TeV)
Present nuclear DIS and Drell-Yan in p+A
y_{lab} = 2
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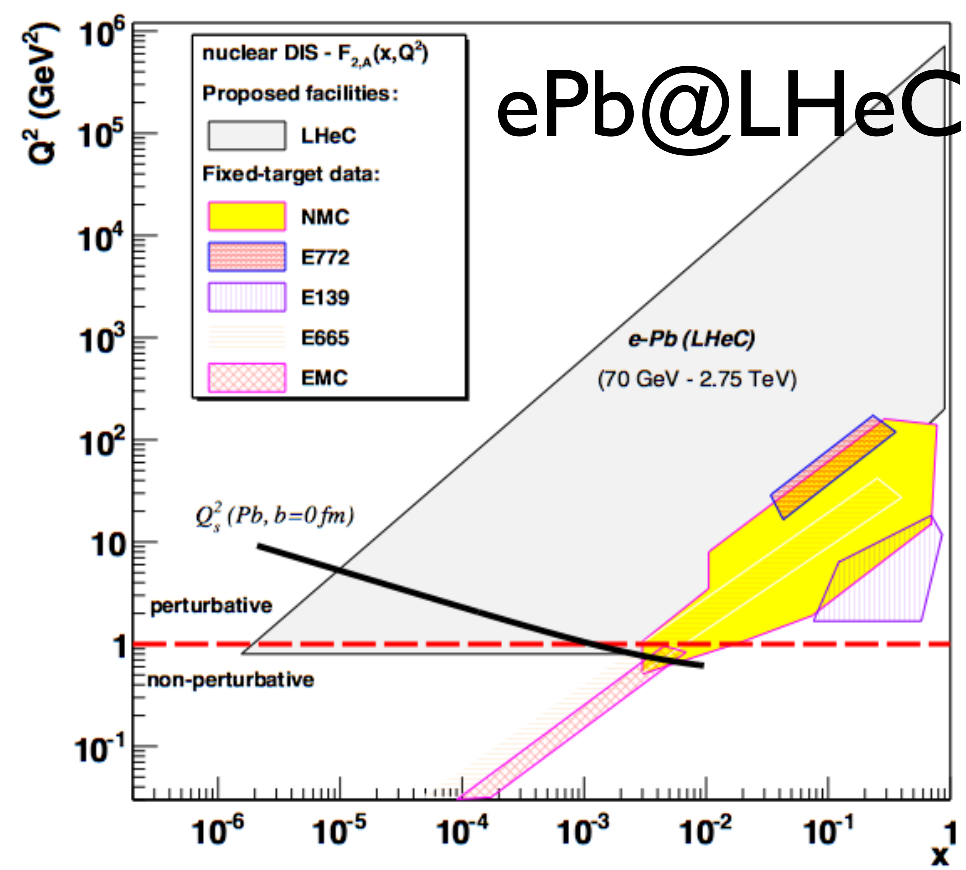
y_{lab} = 6
$Q^2_{sat,Pb}(x)$
Present DIS+DY
Q^2 (GeV^2)
x_A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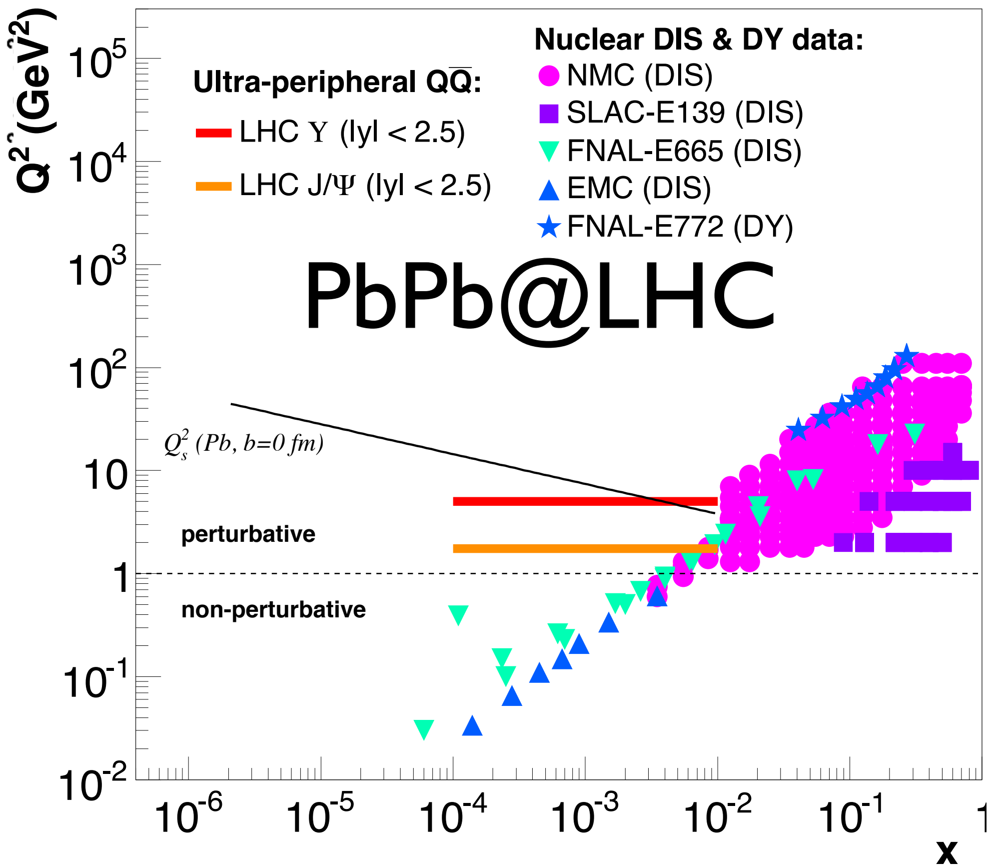
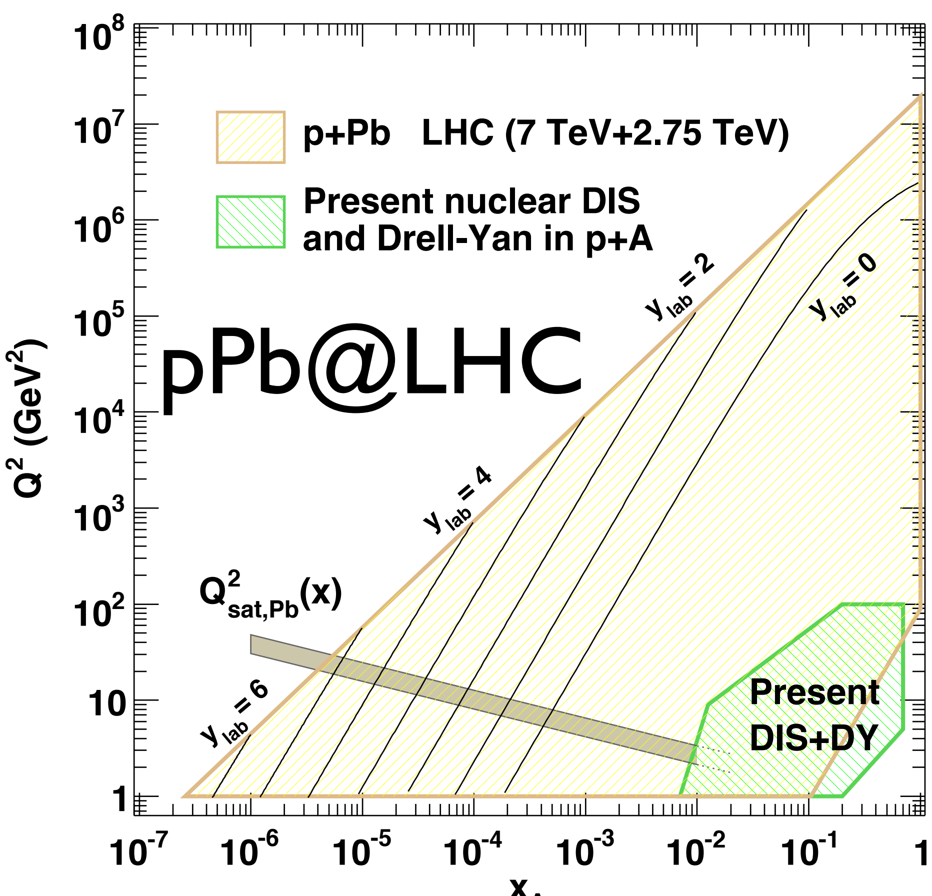
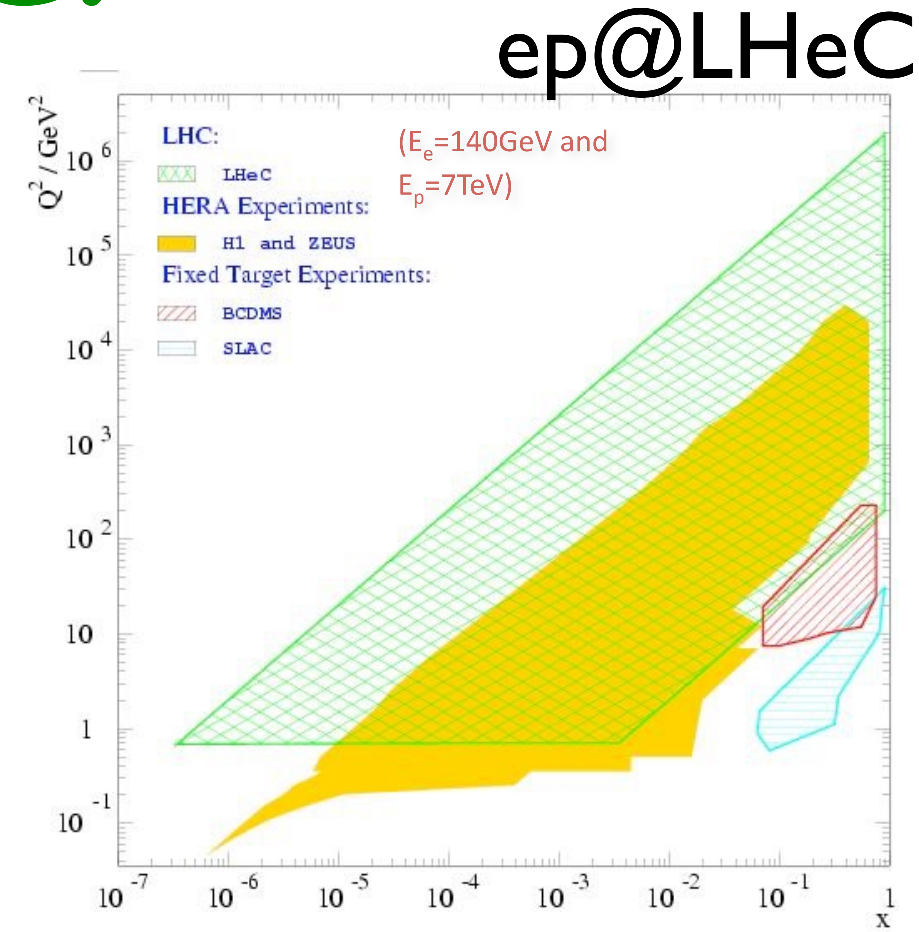
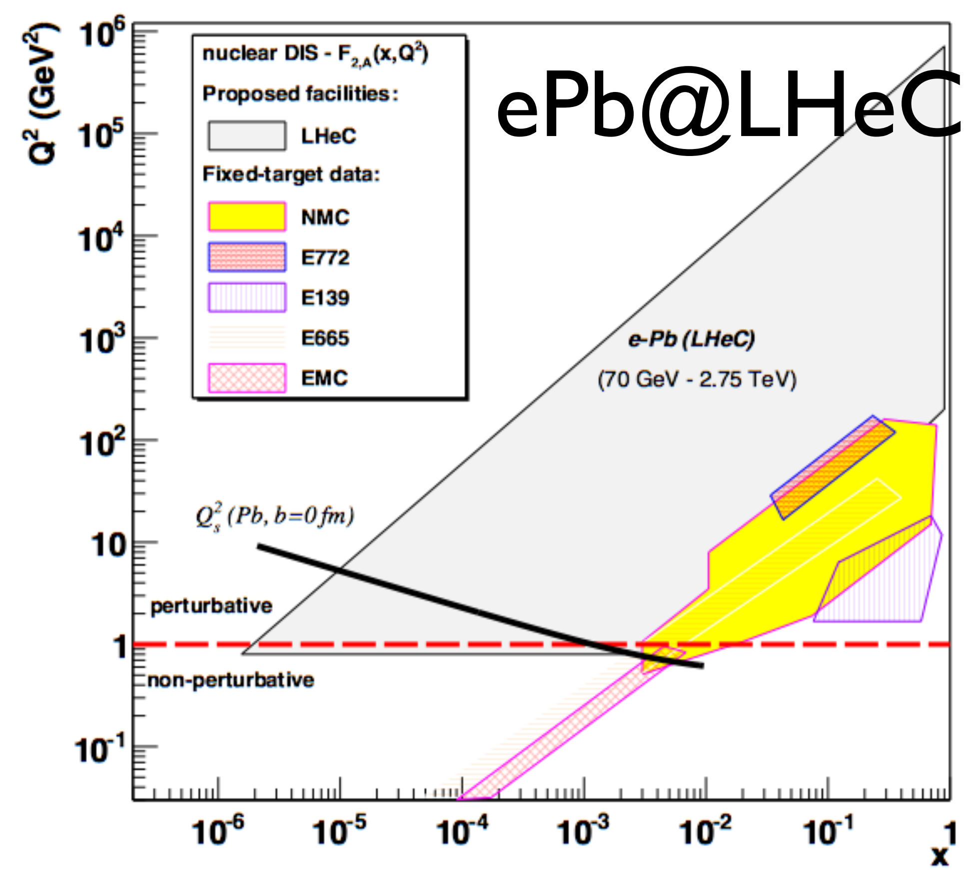




- The LHeC will explore a region overlapping with the LHC:
  ➜ in a cleaner experimental setup;
  ➜ on firmer theoretical grounds.





Contents:

1. Status and motivation.

2. Inclusive measurements at low x.

3. Diffractive and exclusive measurements at low x.

4. Summary.

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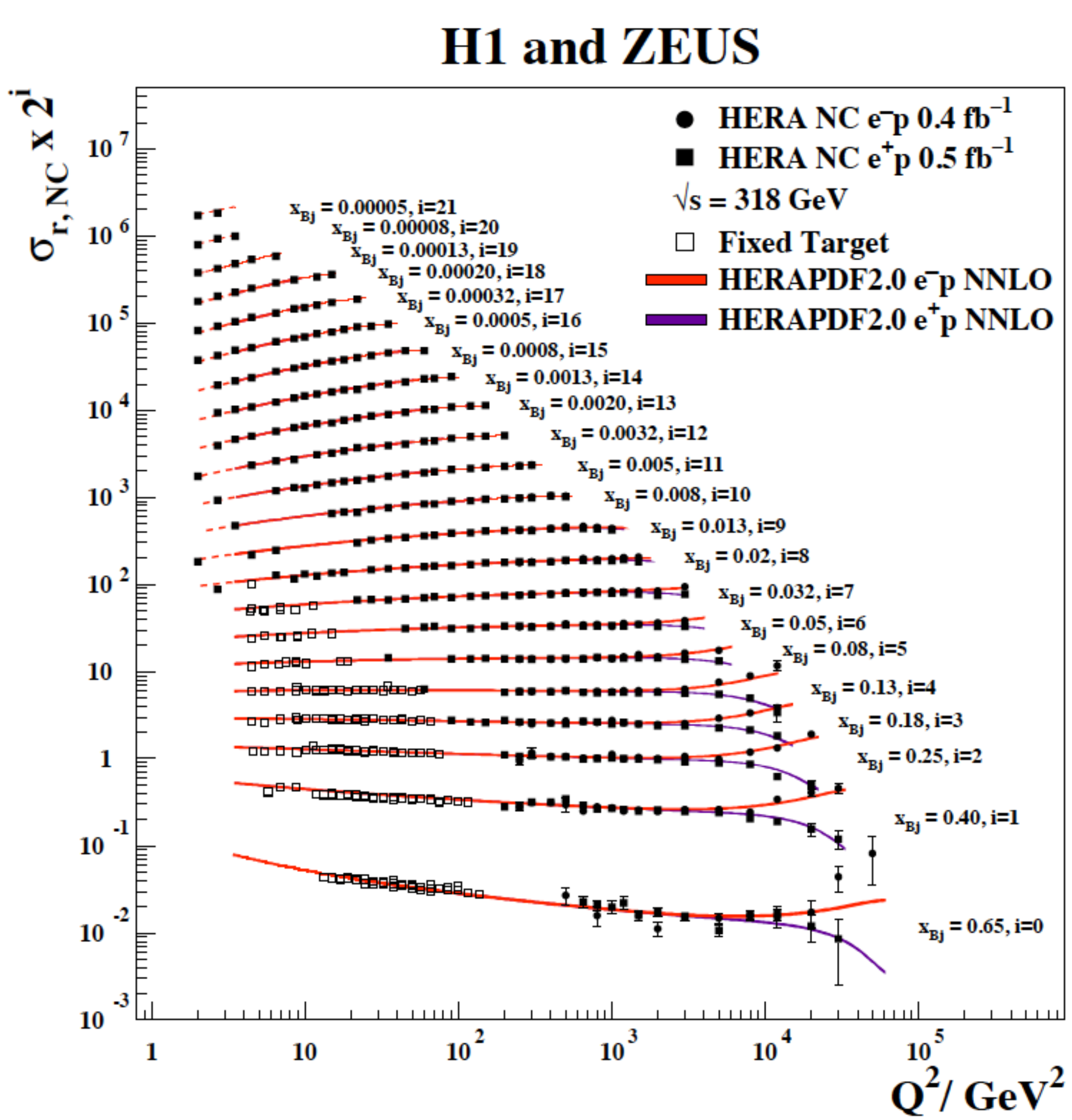
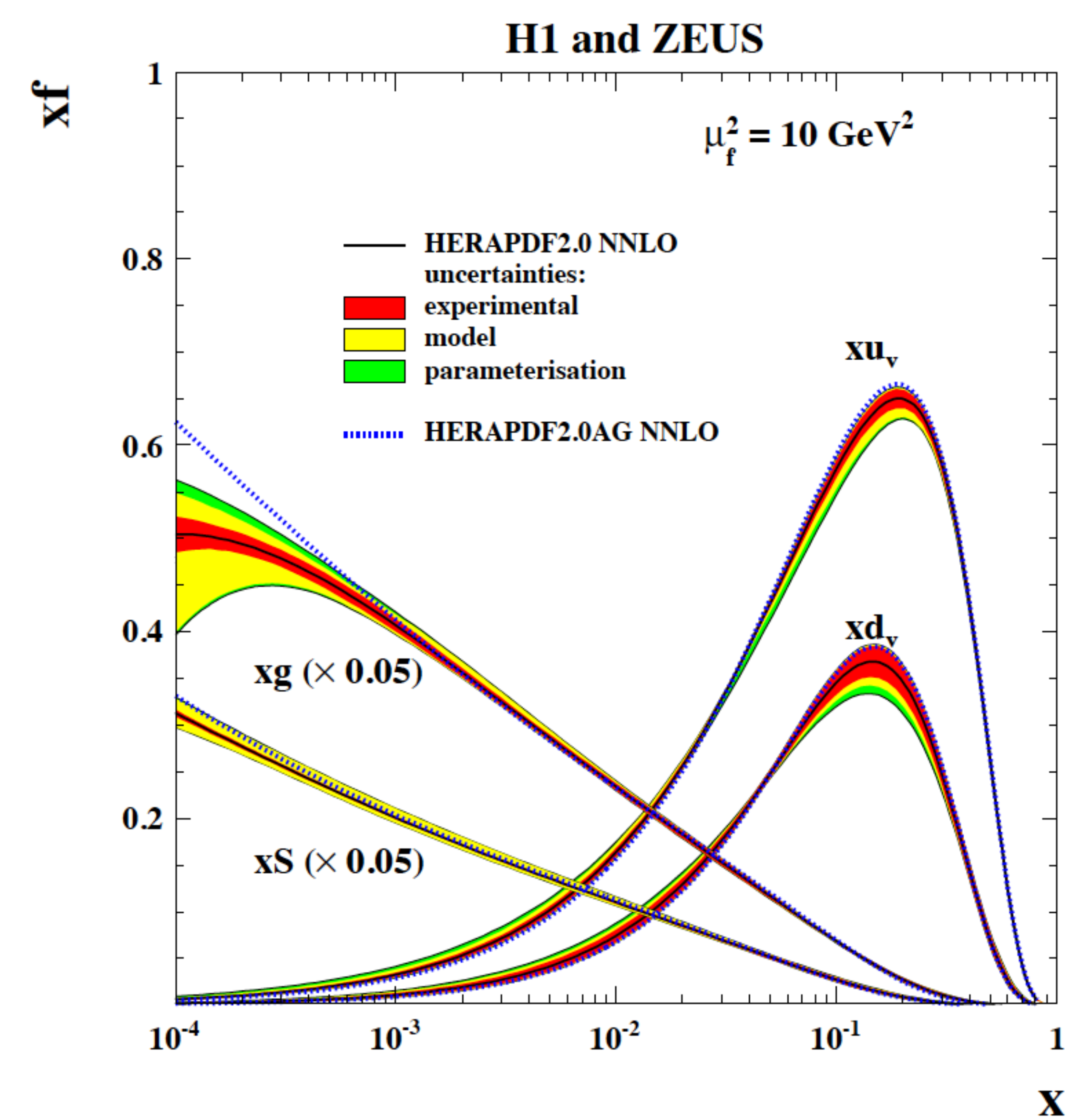
arXiv:1211.4831; arXiv:1211.5102;
2015 LHeC Workshop http://indico.cern.ch/event/356714/;
See the talks by Paul Newman, Claire Gwenlan and Max Klein.

Legacy from HERA:

- Structure functions in an extended x-Q^2 range, xg $\propto 1/x^\lambda$, $\lambda>0$.
- Large fraction of diffraction $\sigma_{diff}/\sigma_{tot}\sim 10\%$.
- But: no eA/eD, kinematical reach at small x, luminosity at high x / for searches (odderon,...), flavour decomposition, TMDs,...





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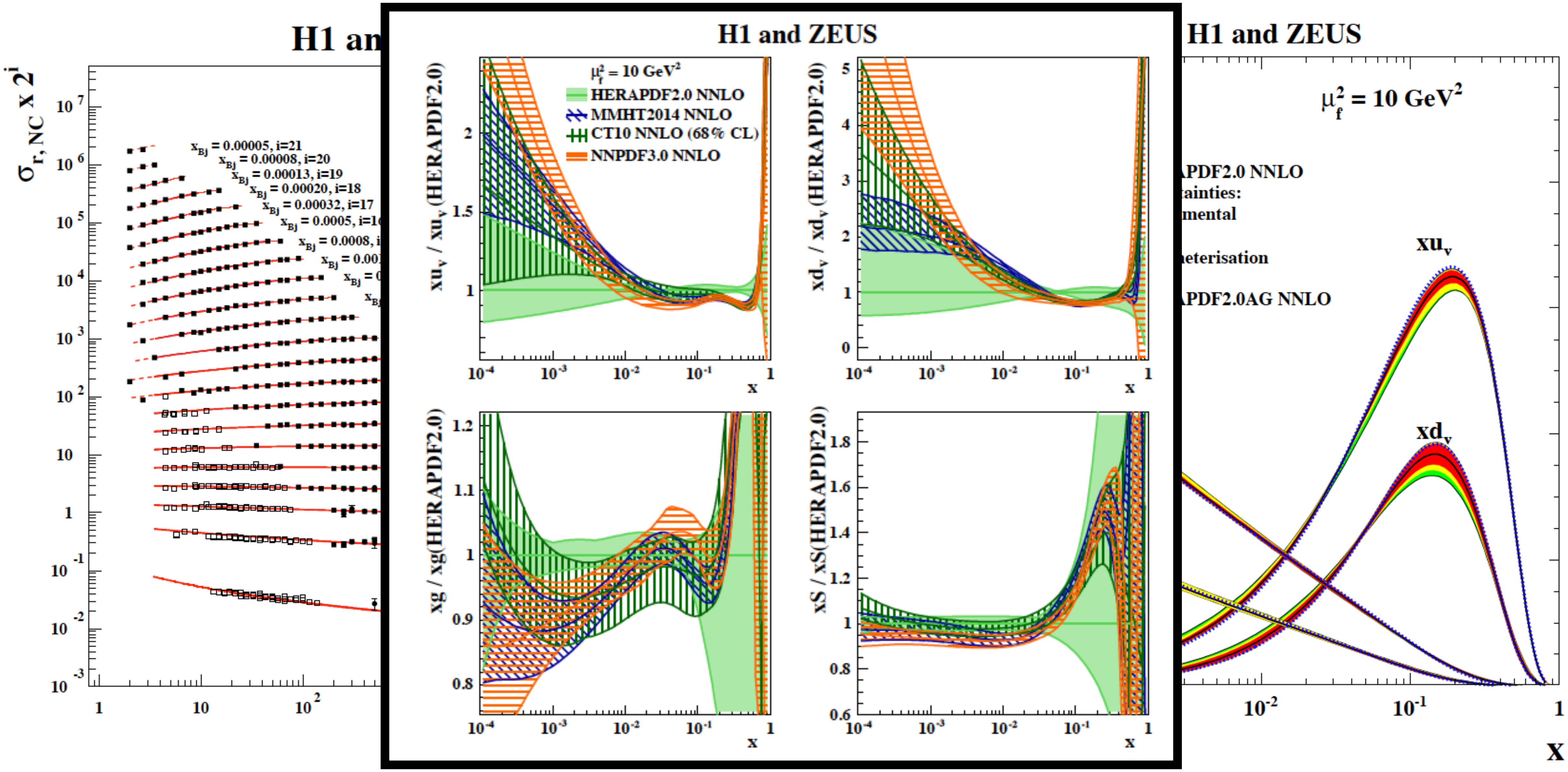
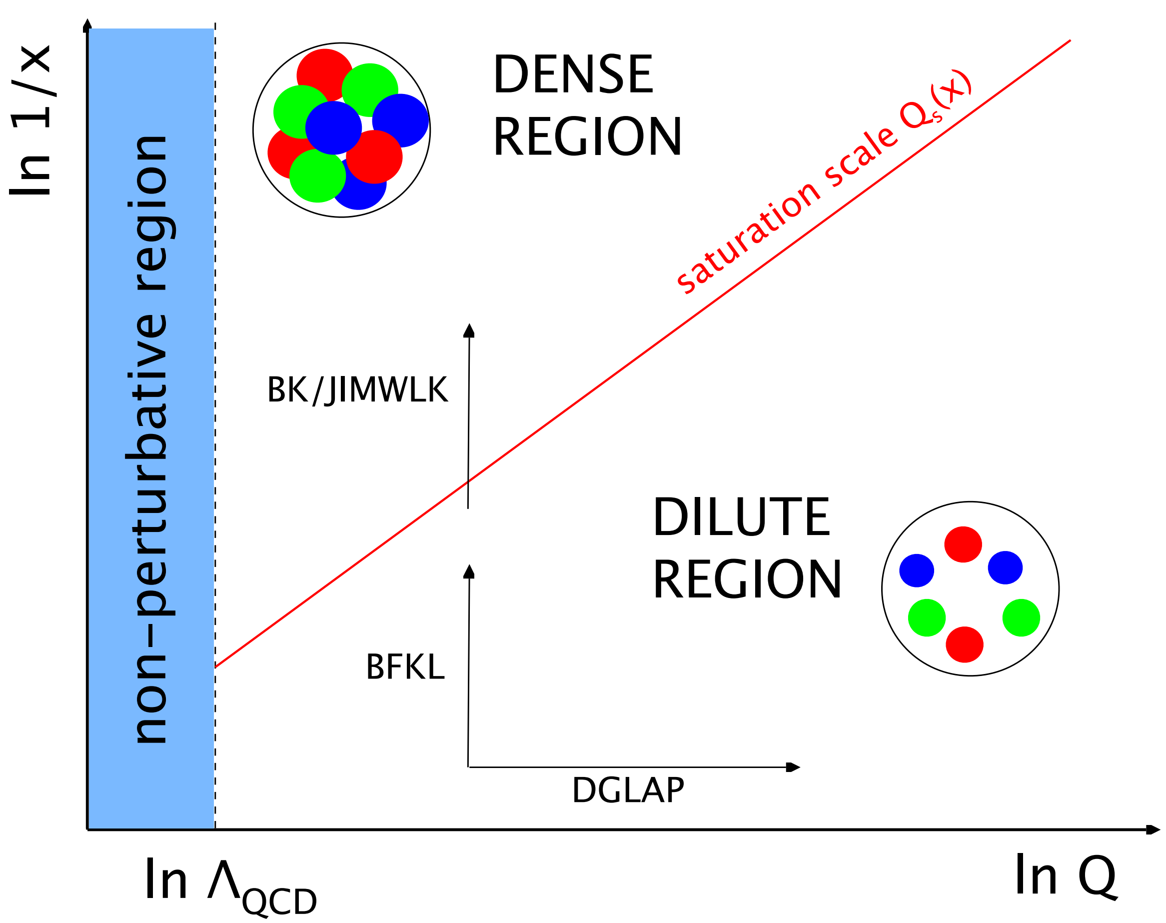
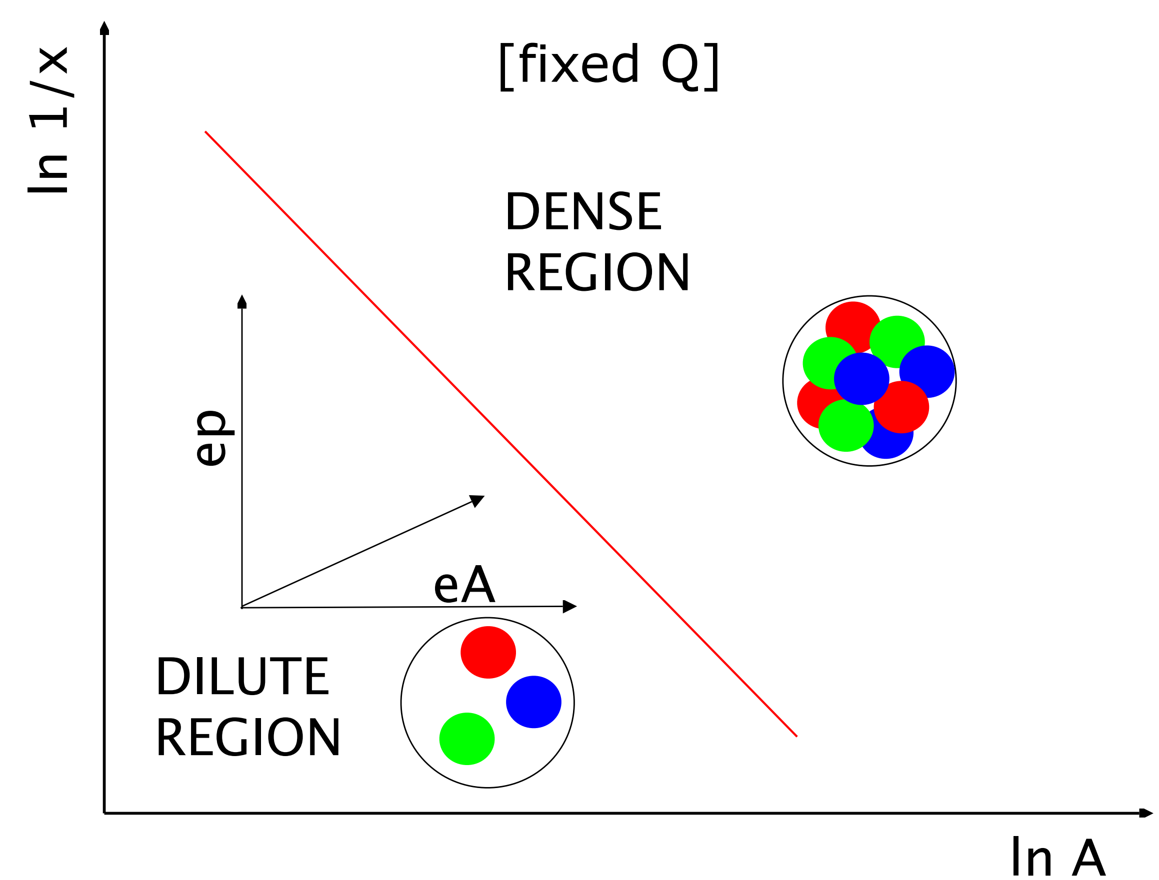


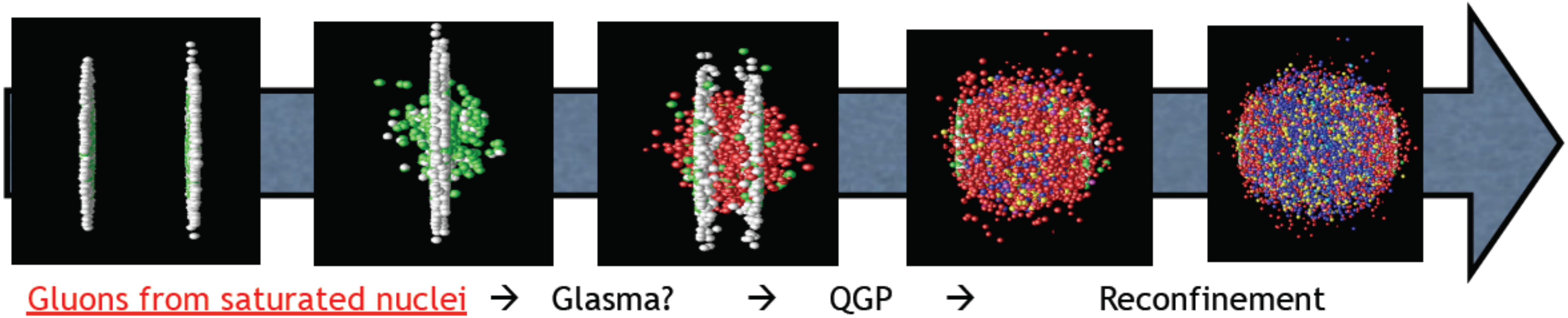
Status of small-x physics:

- Three pQCD-based alternatives to describe small-x ep and eA data (differences at moderate $Q^2(>\Lambda^2_{QCD})$ and small x):
  - ➜ DGLAP evolution (fixed order perturbation theory).
  - ➜ Resummation schemes: BFKL, CCFM, ABF, CCSS.
  - ➜ Saturation (CGC, dipole models).
- **Non-linear effects** (unitarity constraints) are density effects: where? ⇒ **two-pronged approach at the LHeC**: ↓ x / ↑ A.





Relevance for the HI program:



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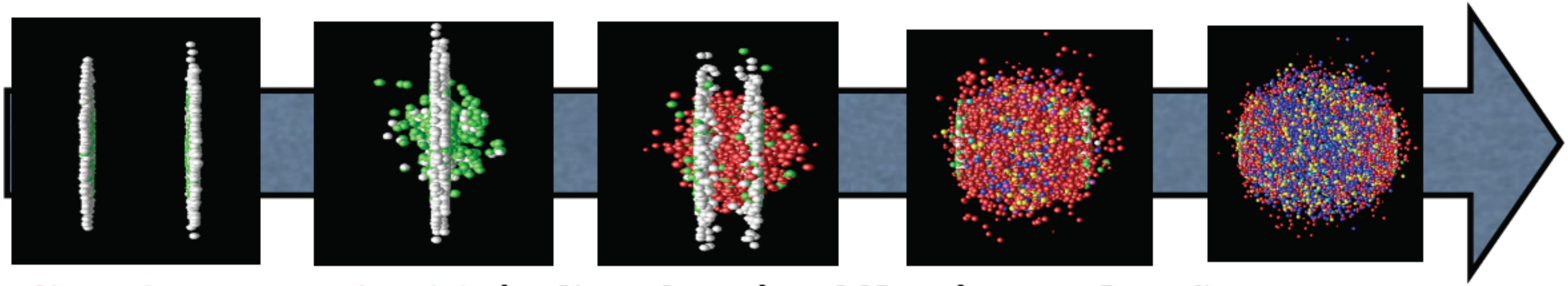

Gluons from saturated nuclei → Glasma? → QGP → Reconfinement

- Nuclear wave function at small x: nuclear structure functions.

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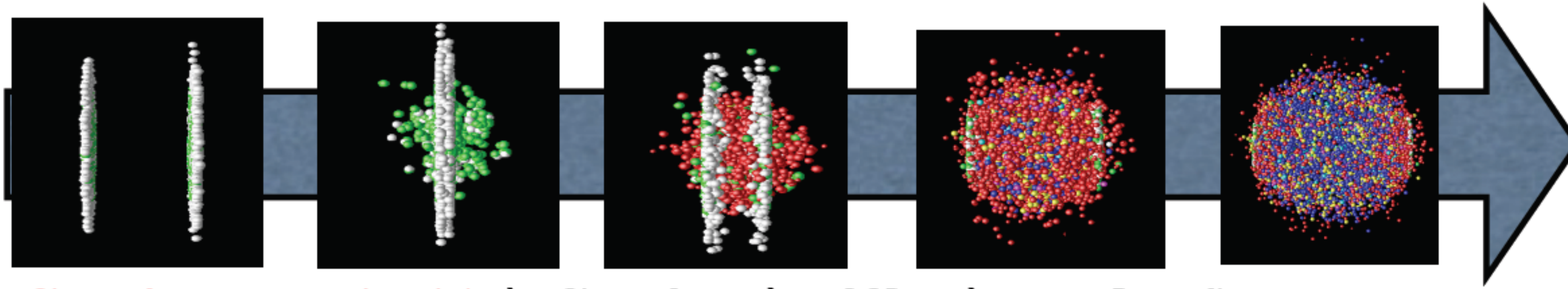

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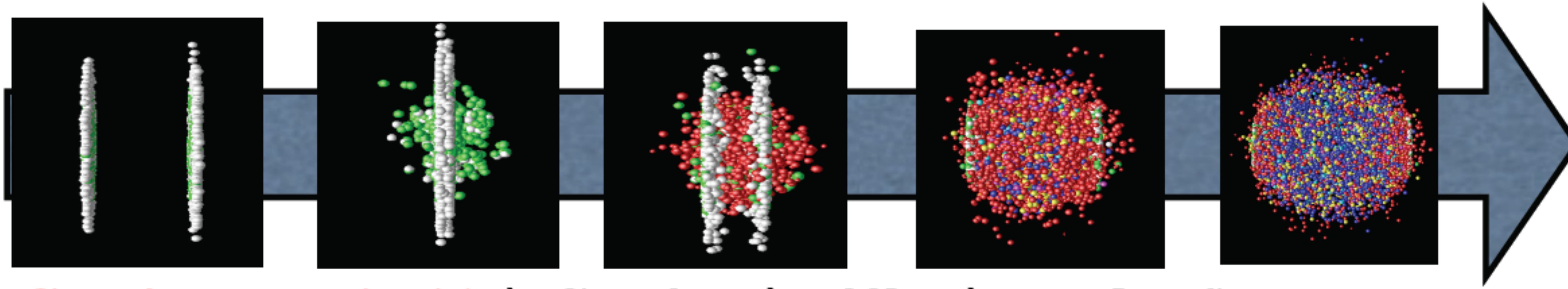
- Nuclear wave function at small x: nuclear structure functions.

- Particle production at the very beginning: which factorisation in eA?

- How does the system behave as ~ isotropised so fast?: initial conditions for plasma formation to be studied in eA.

Relevance for the HI program:



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- Probing the medium through energetic particles (jet quenching etc.): modification of QCD radiation and hadronization in the nuclear medium.

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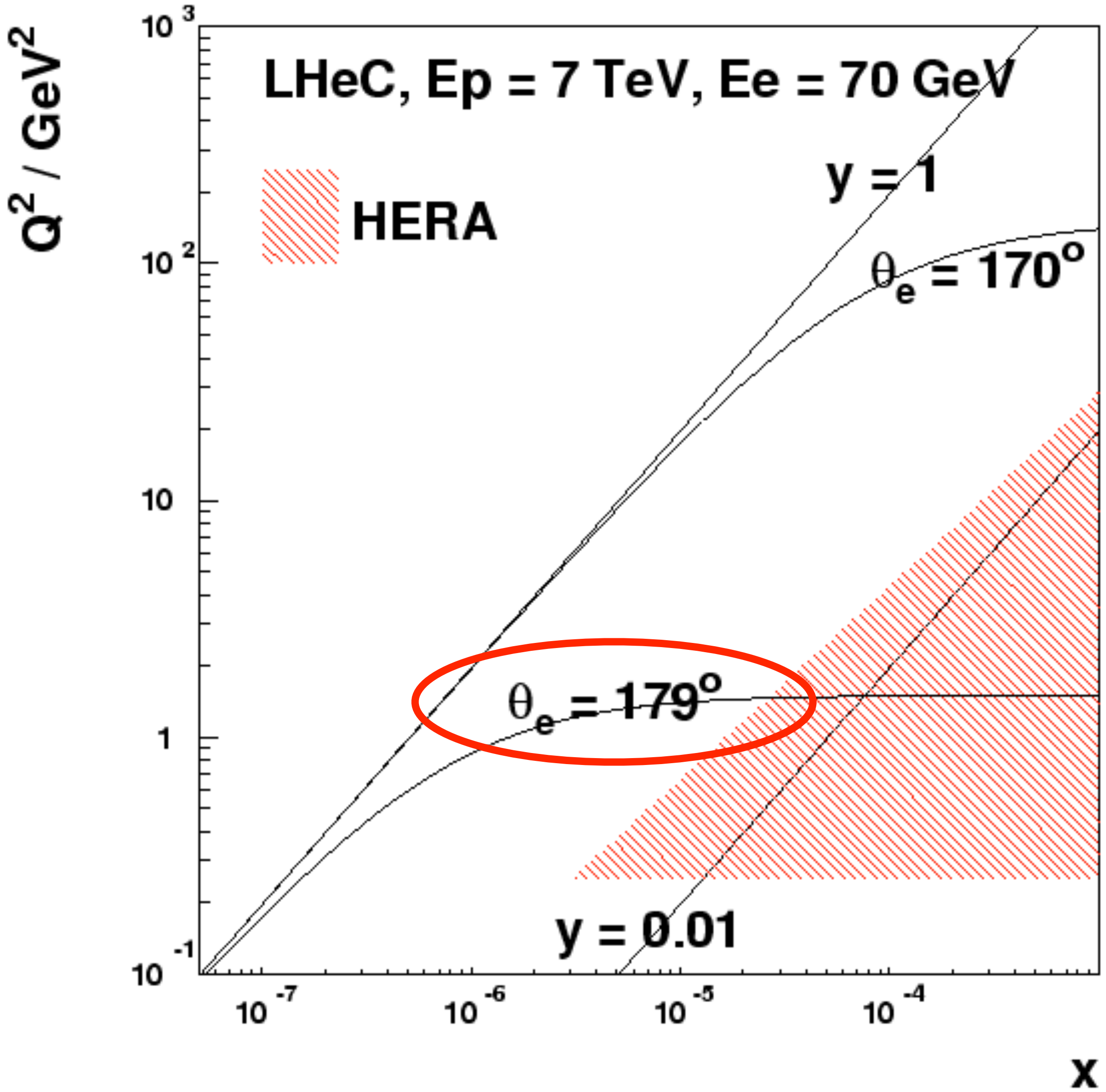
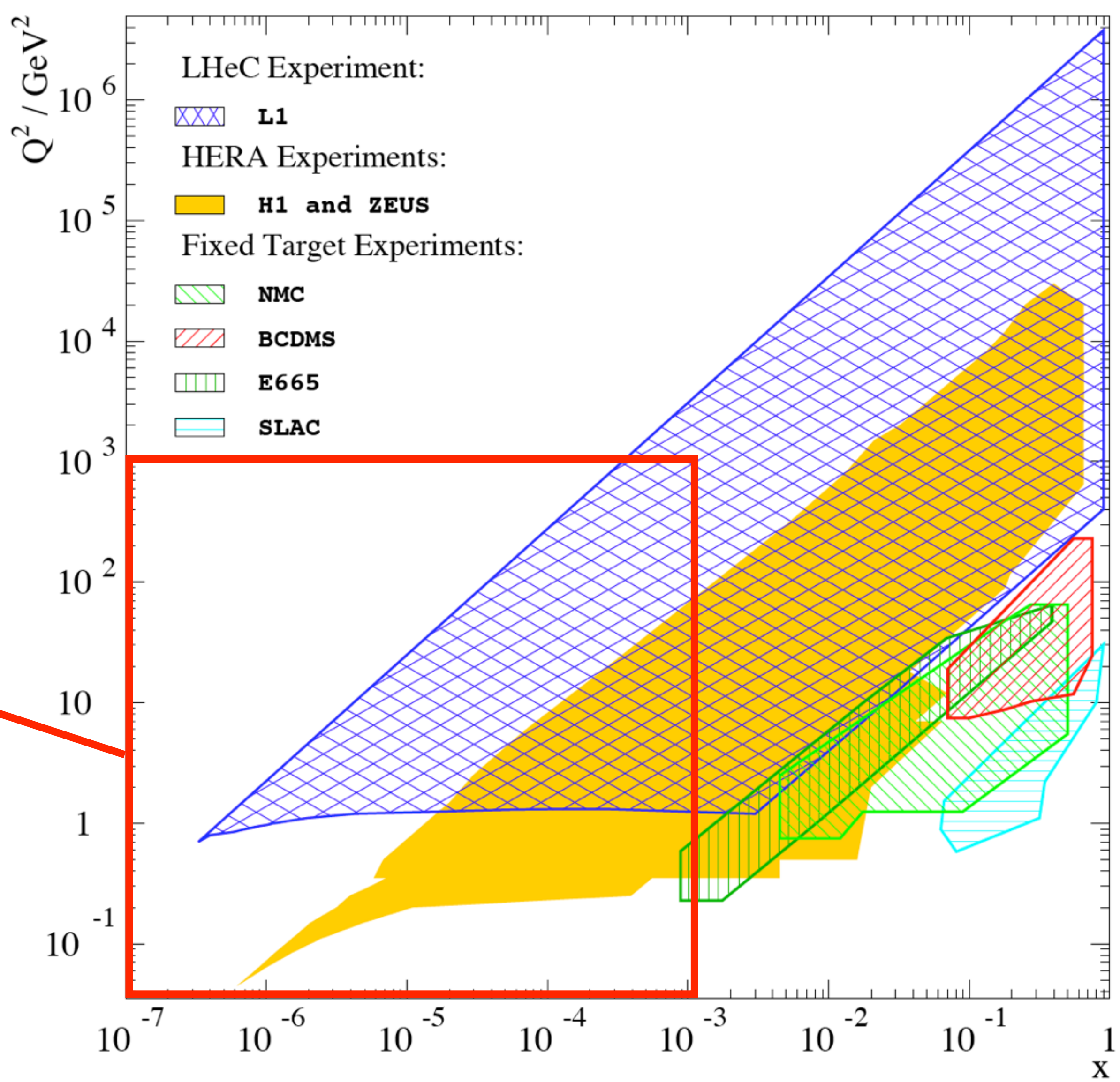
Proton PDFs at small x:

- Parton densities poorly known at small x and small to moderate Q^2: uncertainties in predictions.
- LHeC will substantially reduce the uncertainties in global fits: F_L and heavy flavour decomposition most useful.





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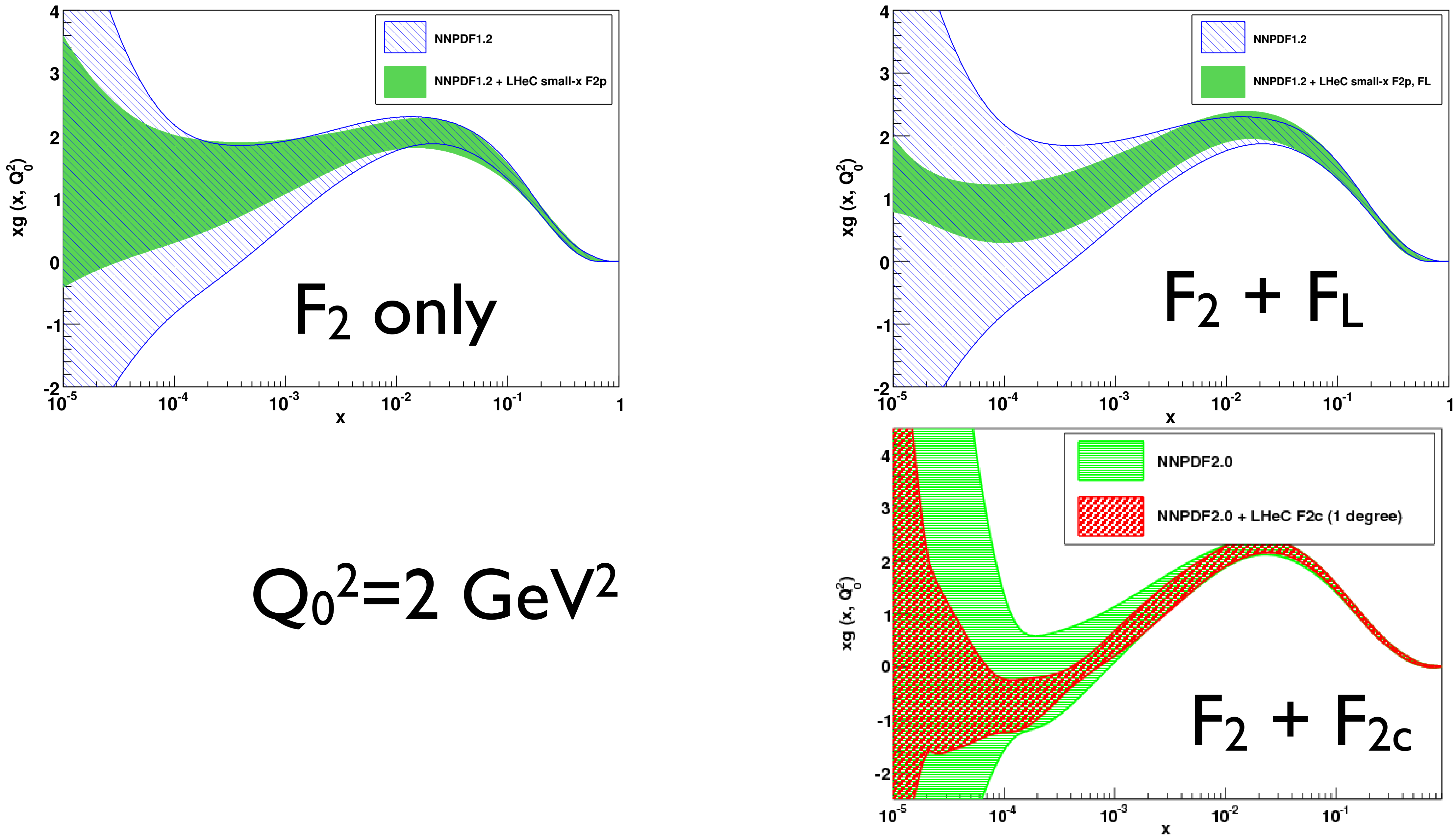
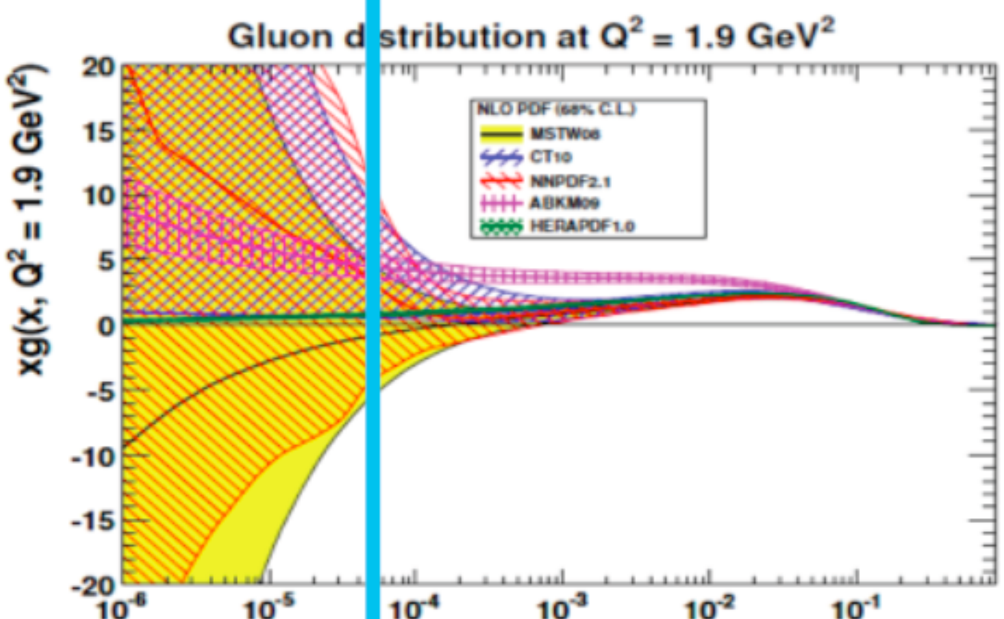


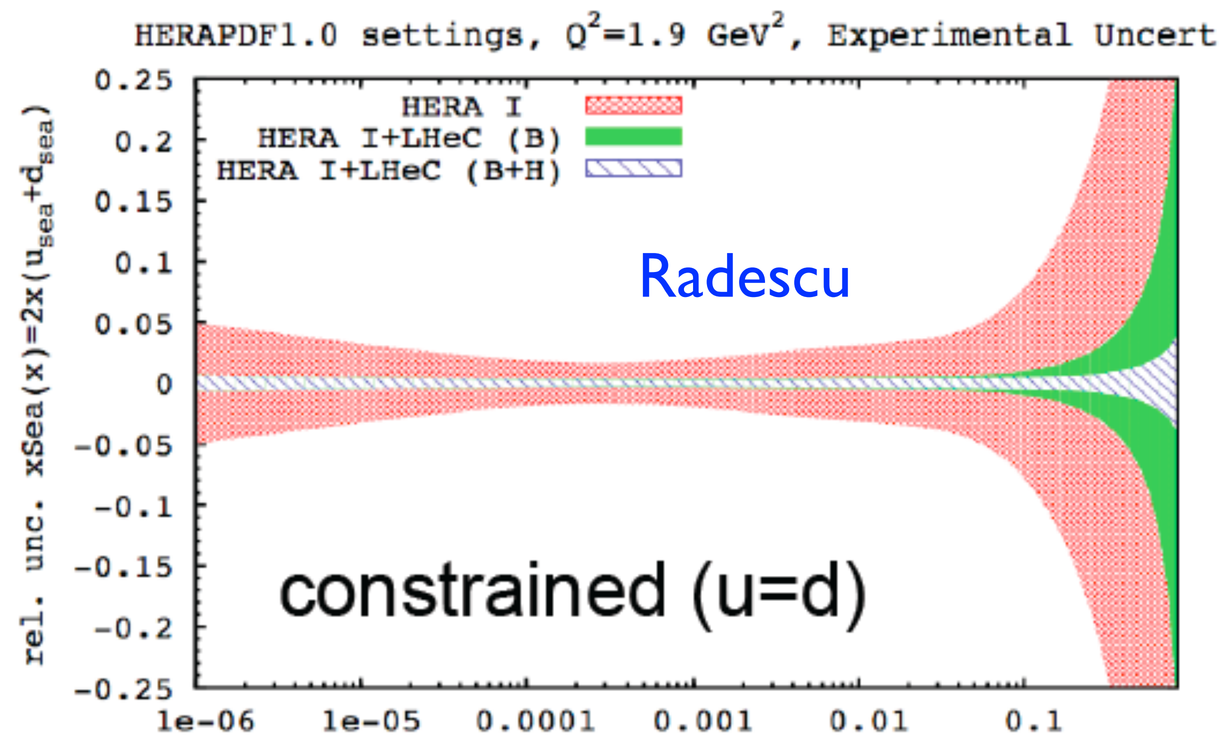
Proton PDFs at small x:

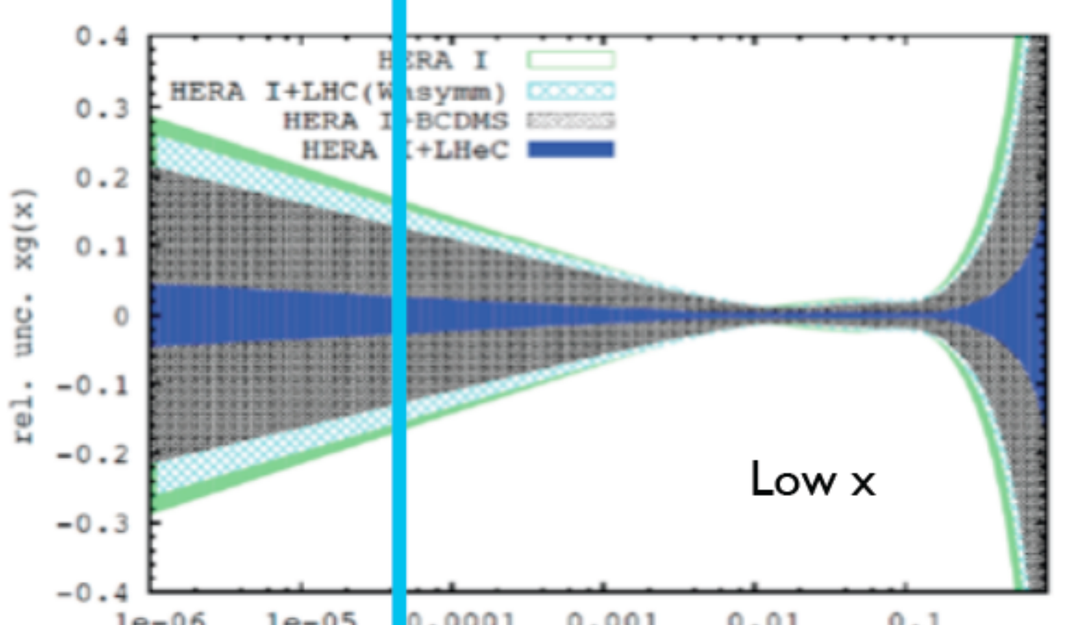
- Parton densities poorly known at small x and small to moderate Q^2: uncertainties in predictions.
- LH

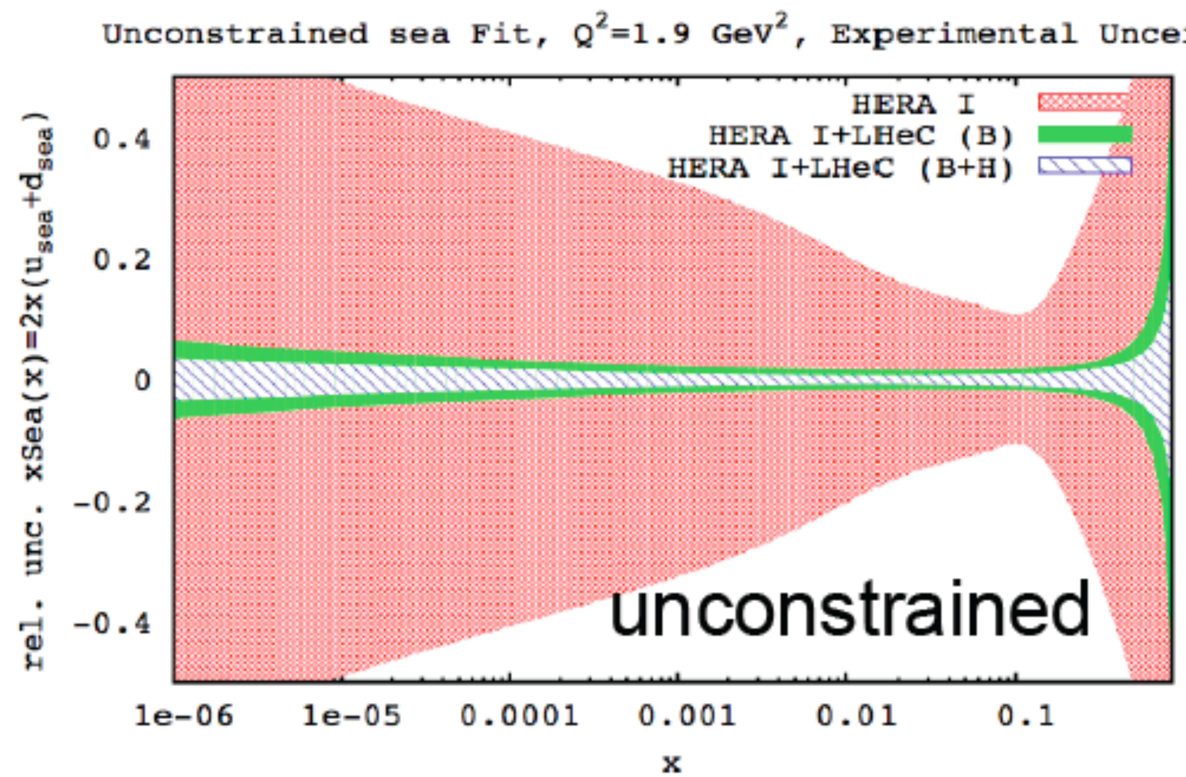
and

F_L







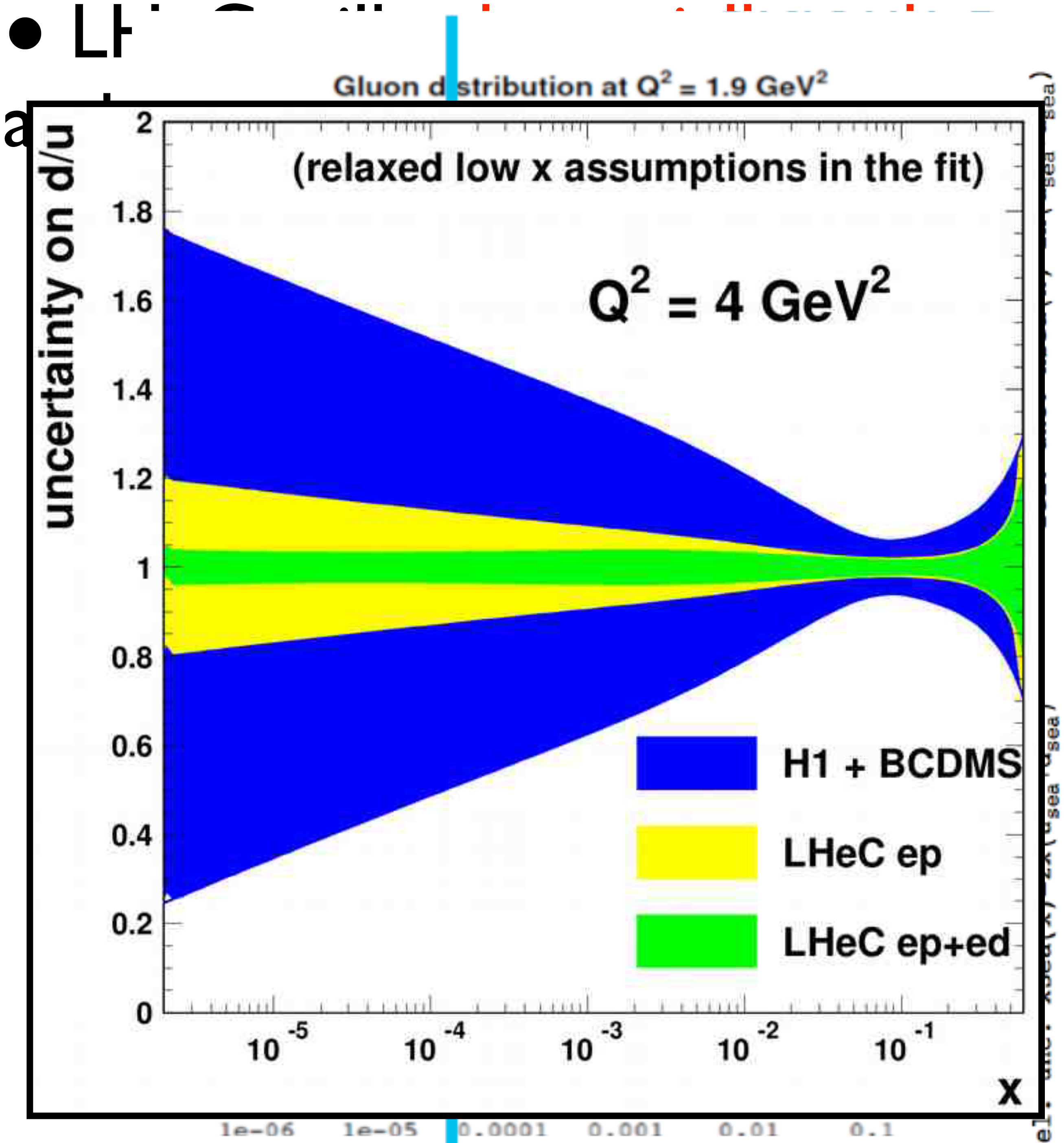


→ This is where HERA

Proton PDFs at small x:

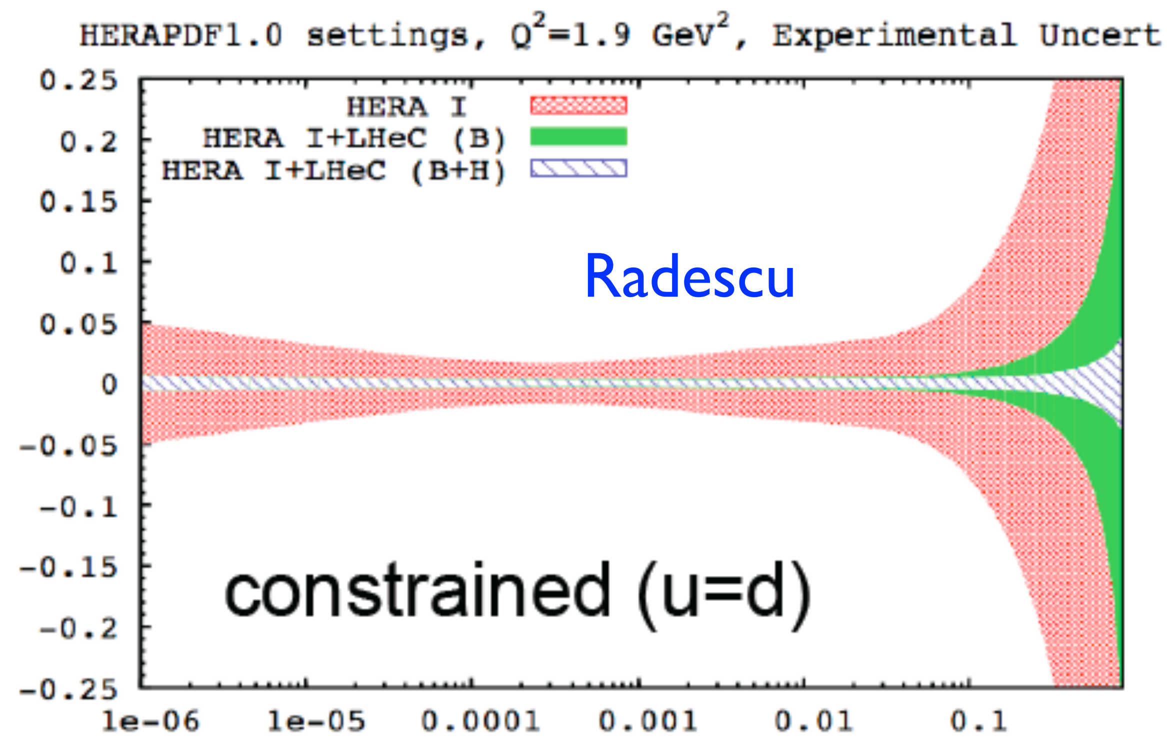
- Parton densities poorly known at small x and small to moderate Q^2: uncertainties in predictions.
- LH...

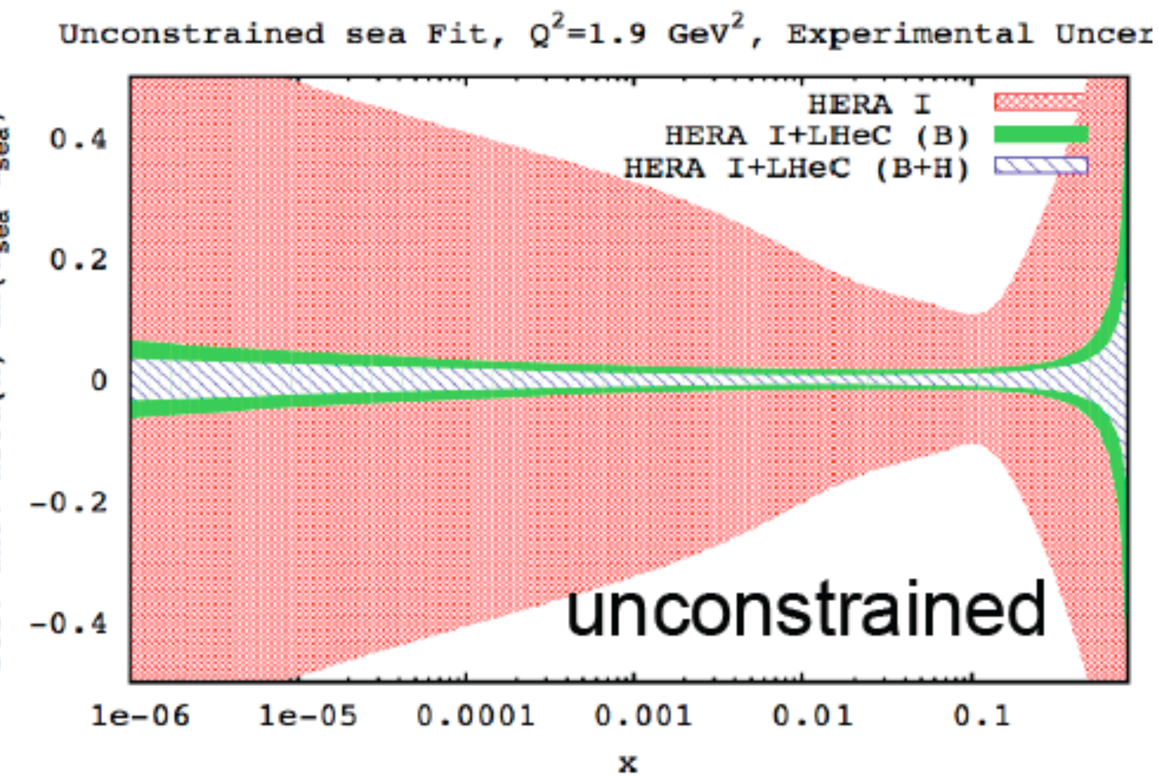
a...



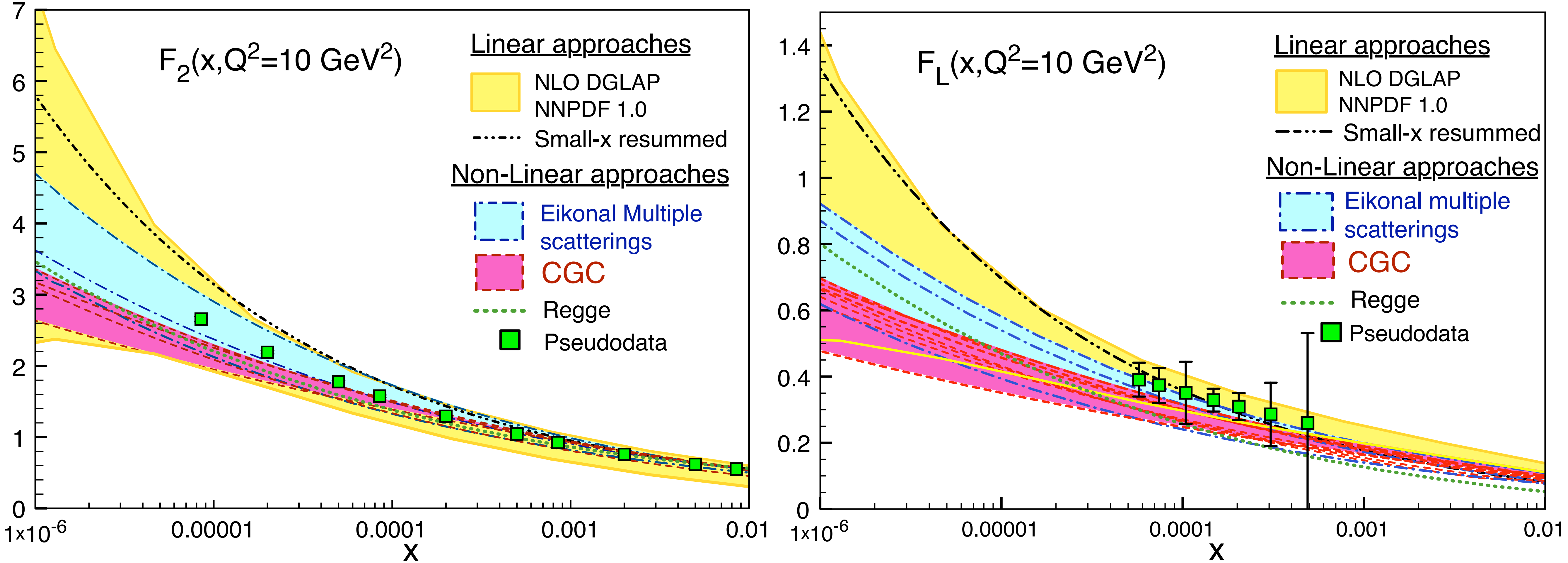
→ This is where HERA

F_L





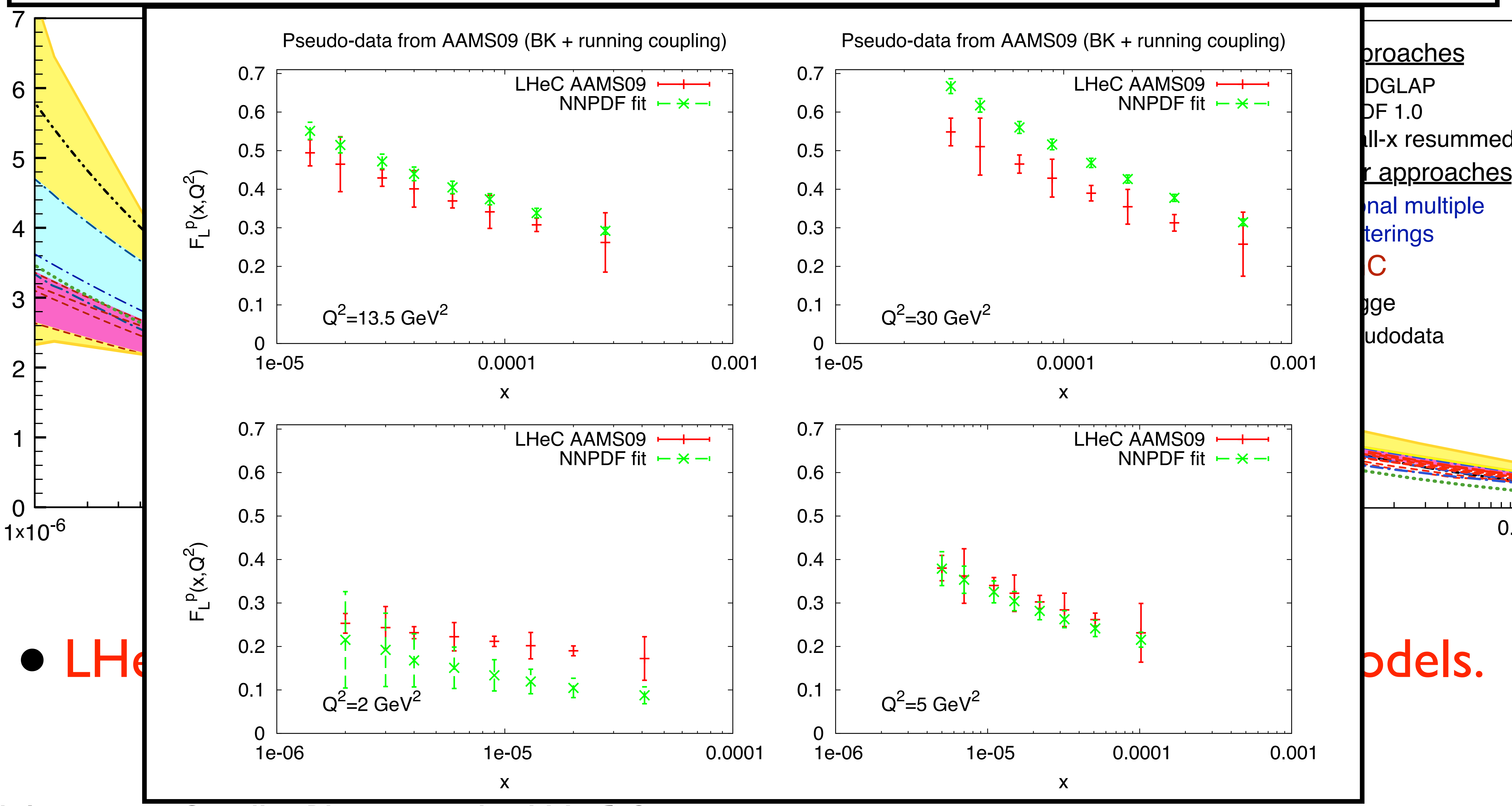
Effects beyond DGLAP?



- LHeC F_2 and F_L data will have discriminatory power on models.

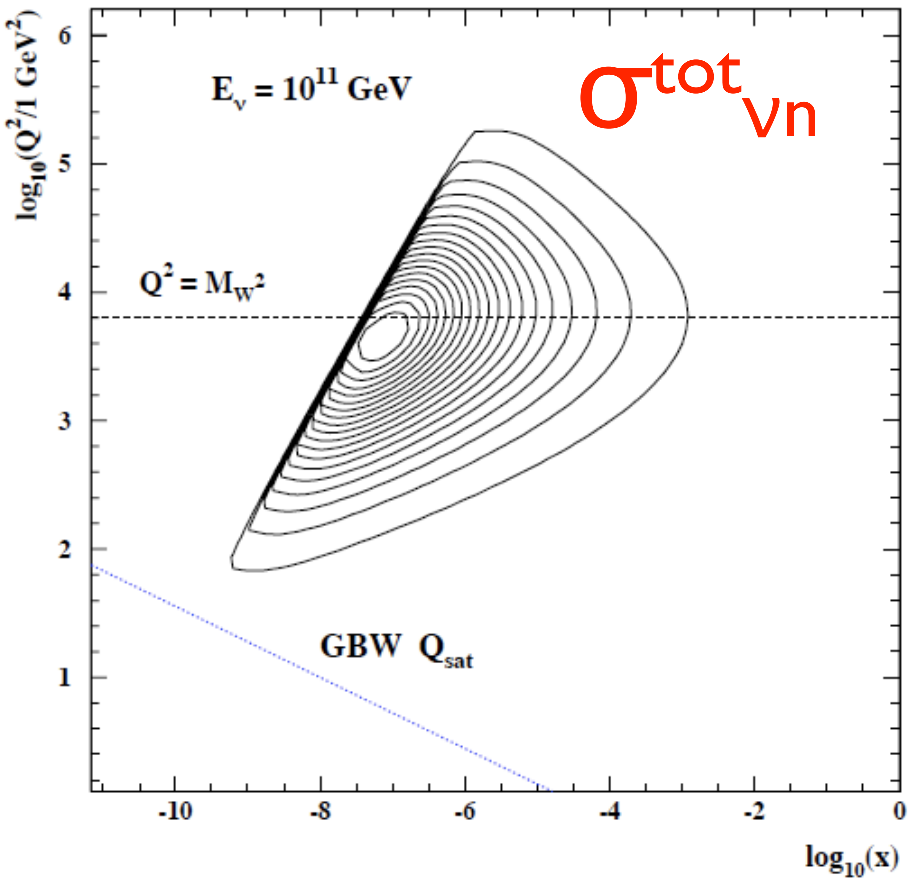
Effects beyond DGLAP?

- NLO DGLAP cannot simultaneously accommodate LHeC F_2 and F_L data if saturation effects included according to current models ⇒ two observables required: (F_2, F_L), (F_2, F_{2c}),….



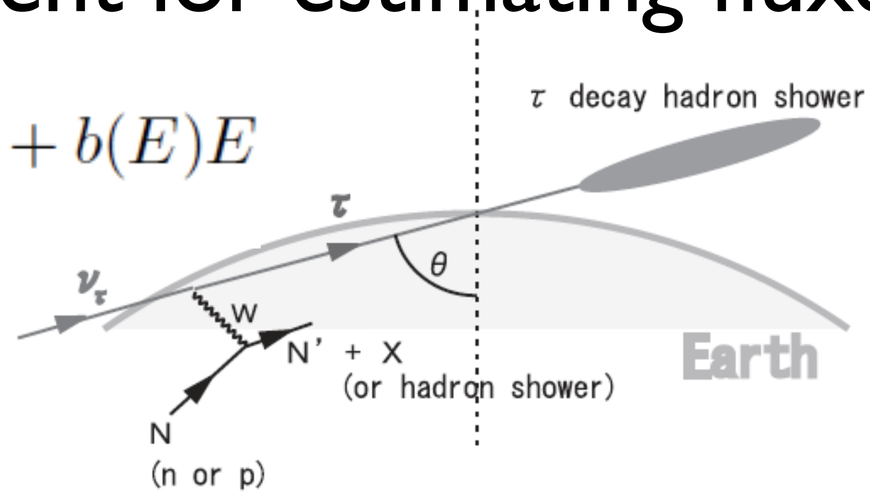
- LHe… odels.

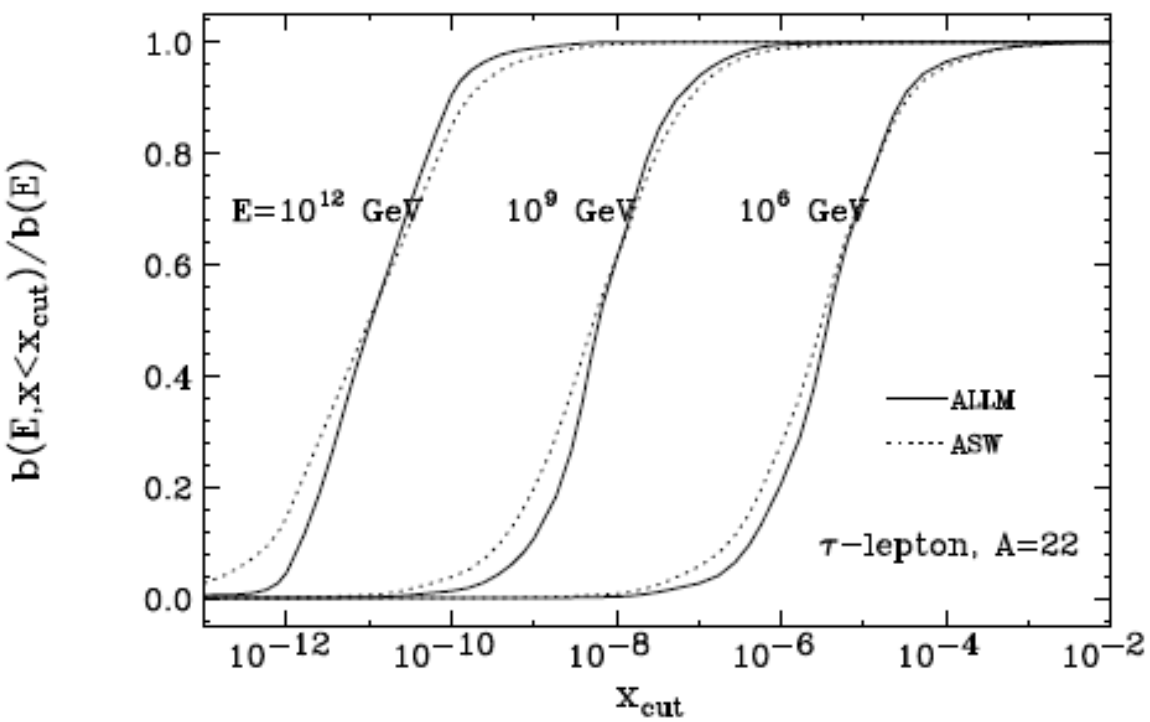
Implications for UHEν's:

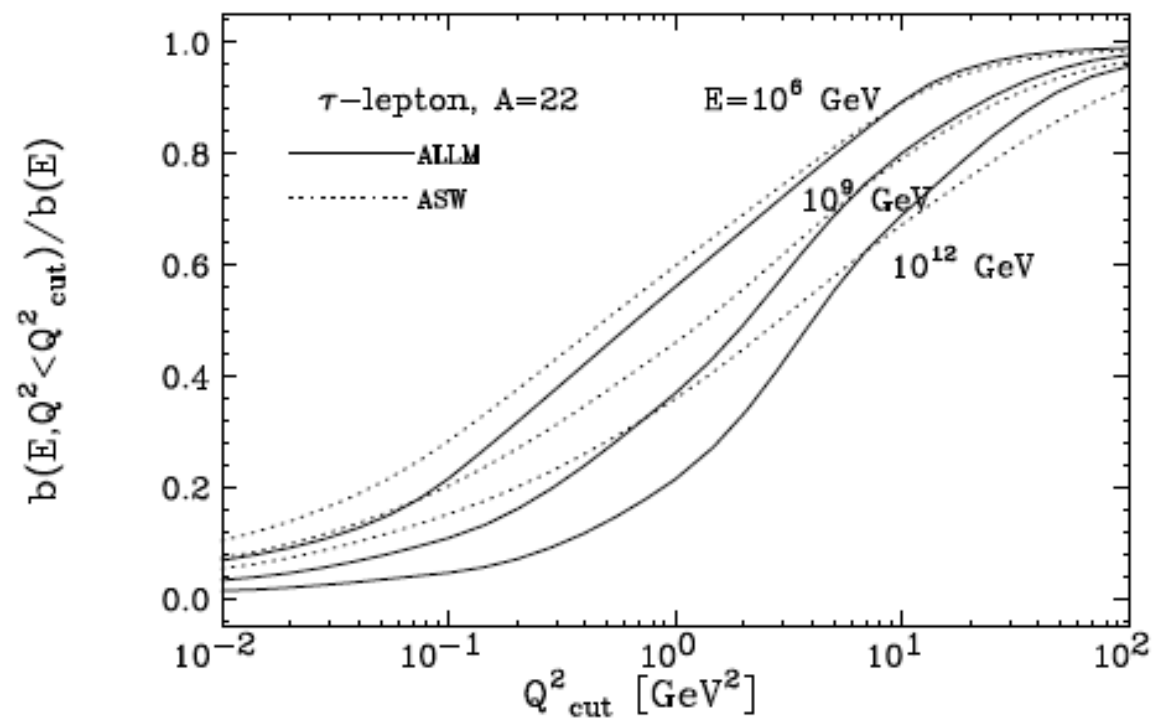


- ν-n/A cross section (τ energy loss) dominated by DIS structure functions / (n)PDFs at small-x and large (small) Q^2.
- Key ingredient for estimating fluxes.

$$-\left\langle \frac{dE}{dX} \right\rangle = a(E) + b(E)E$$



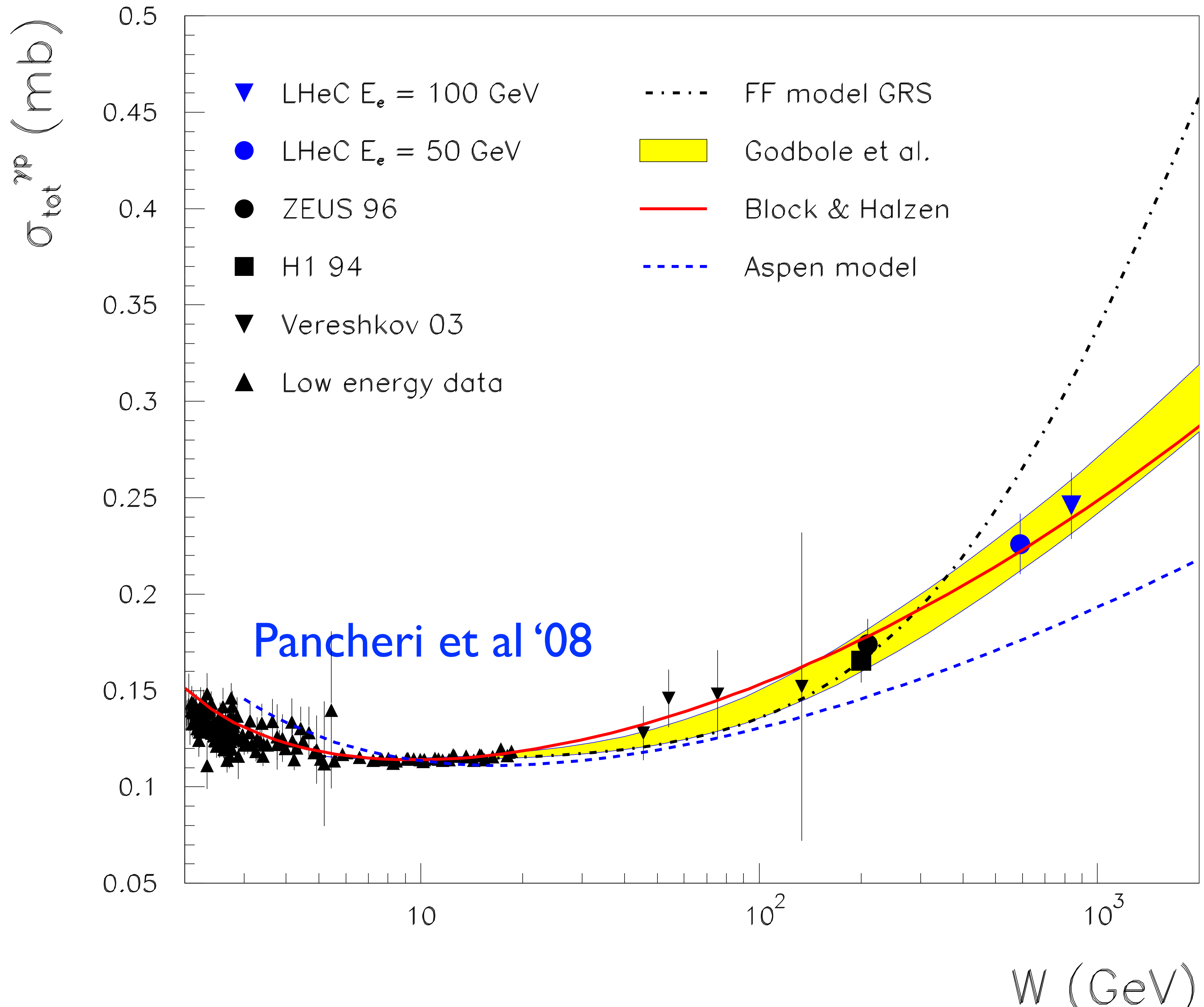




Photoproduction cross section:

- Small angle electron detector 62 m far from the interaction point: $Q^2<0.01$ GeV, $y\sim0.3 \Rightarrow W\sim0.5\sqrt{s}$.

- Substantial enlarging of the lever arm in W.



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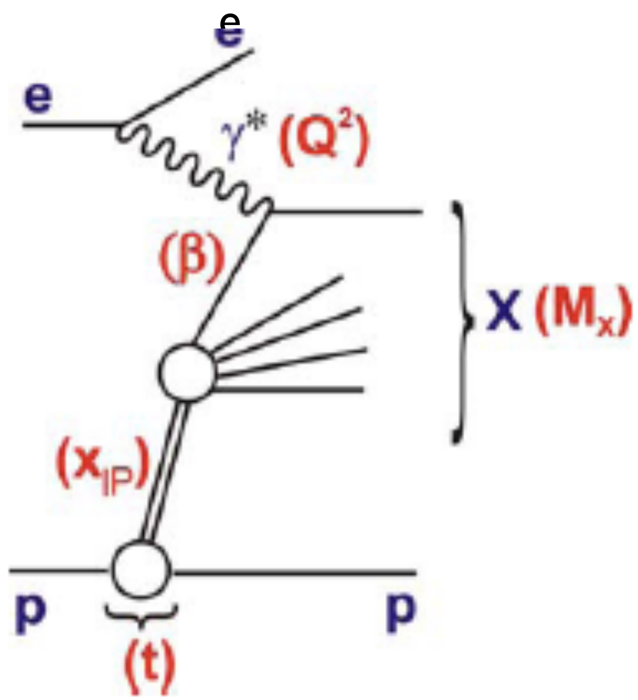
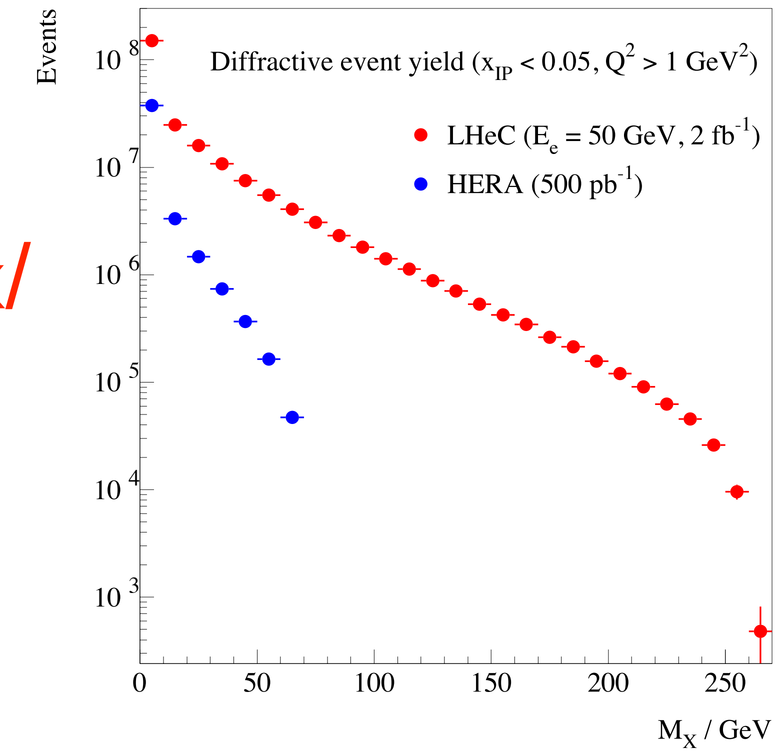
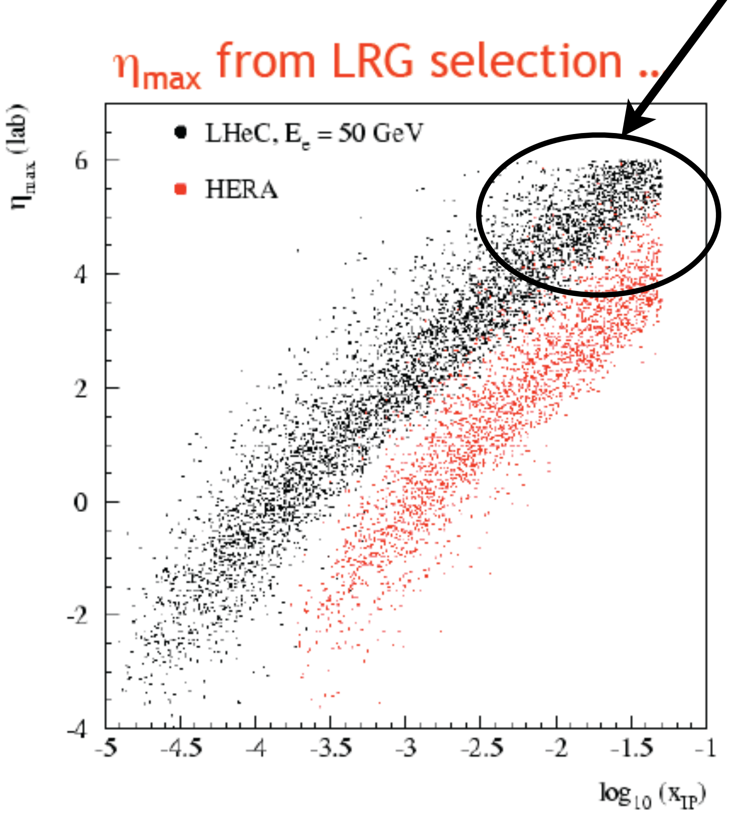
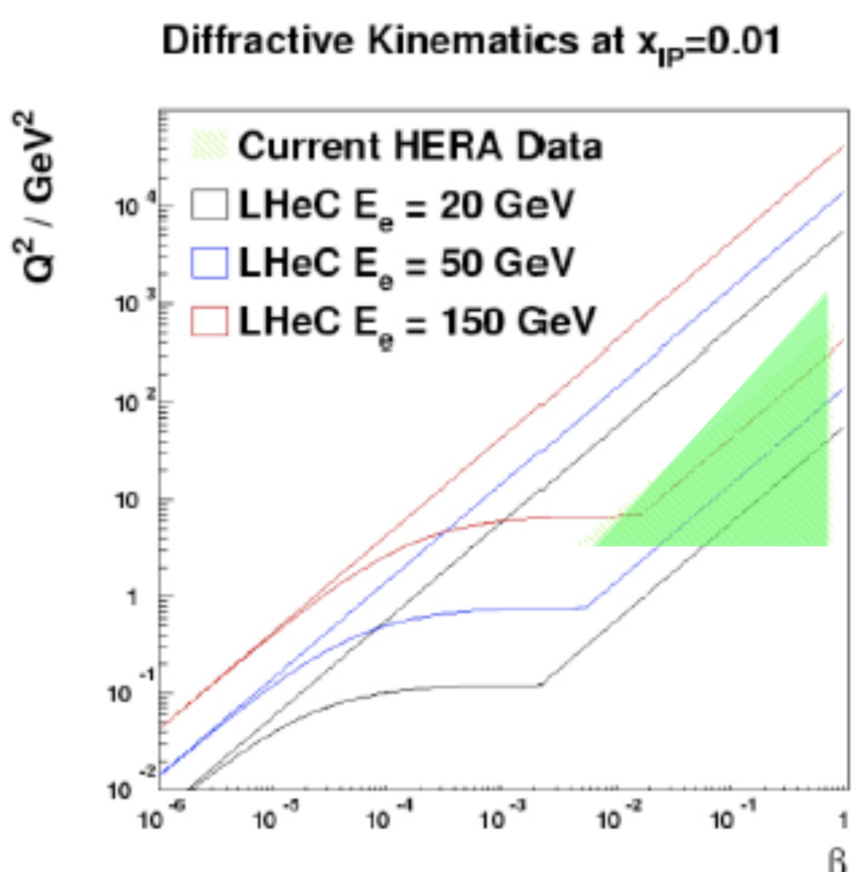
Diffraction:

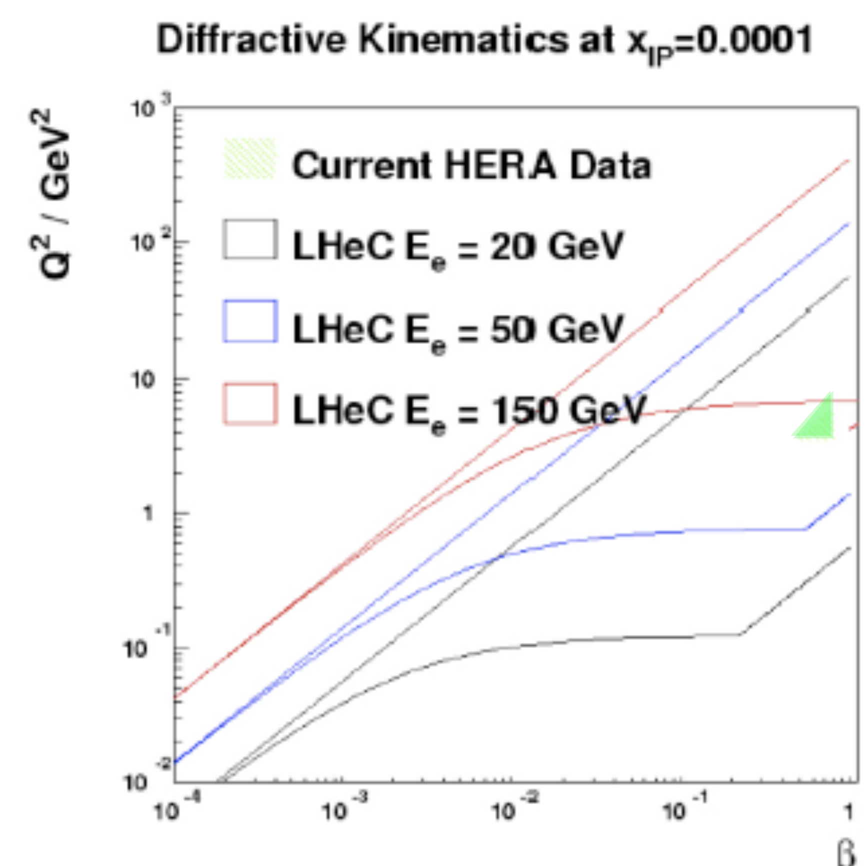


- Large increase in the M^2, $x_P=(M^2-t+Q^2)/(W^2+Q^2)$, $\beta=x/x_P$ region studied.
- Possibility to combine LRG and LPS.

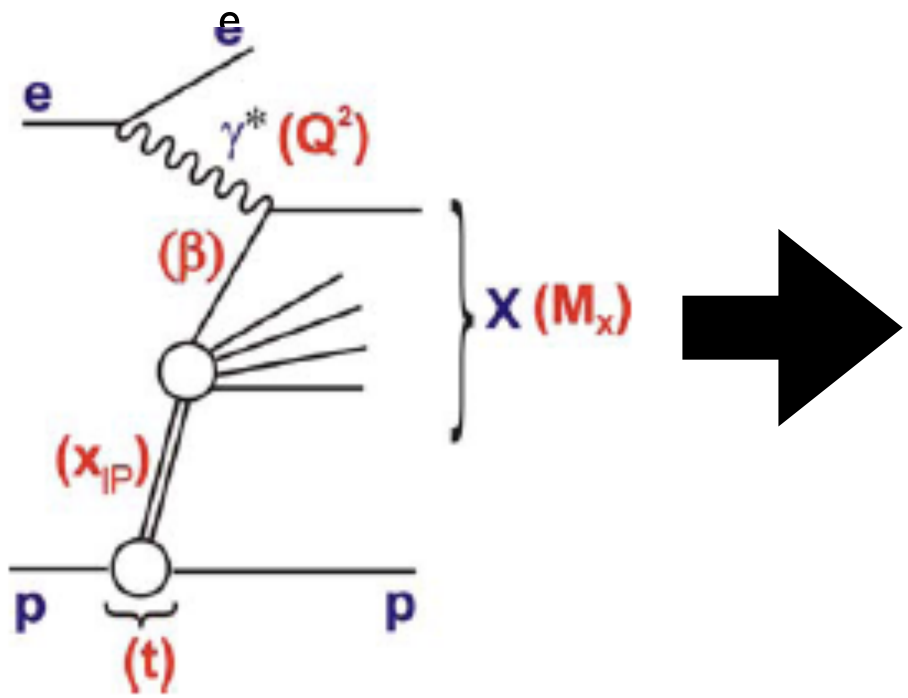


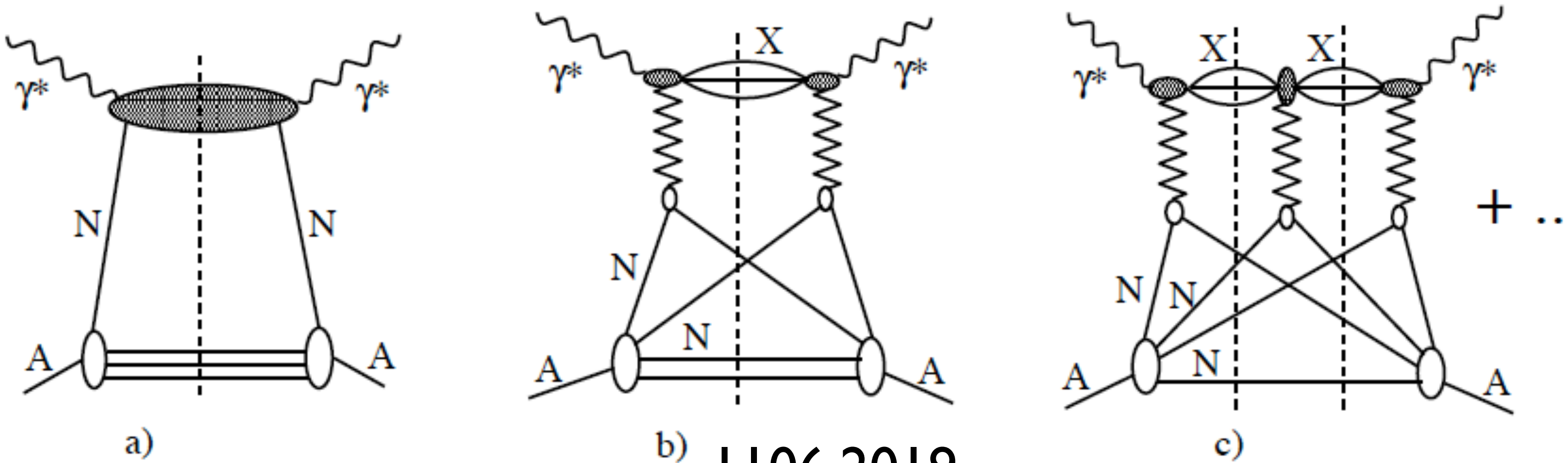






Diffraction in ep and shadowing:





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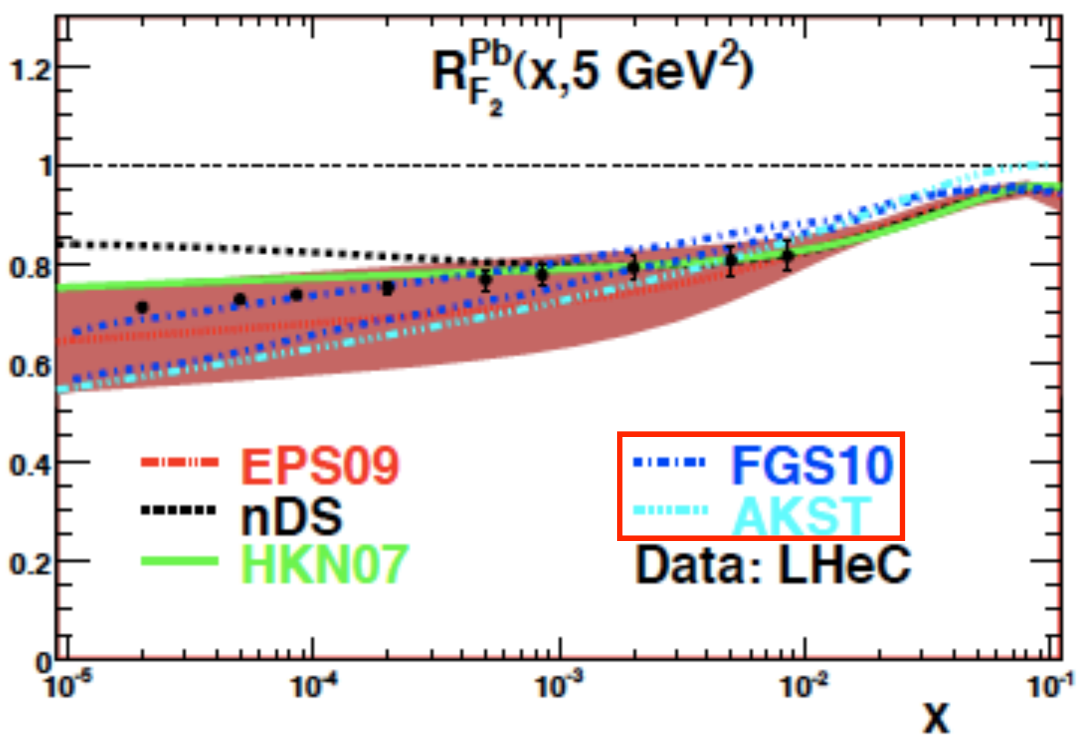
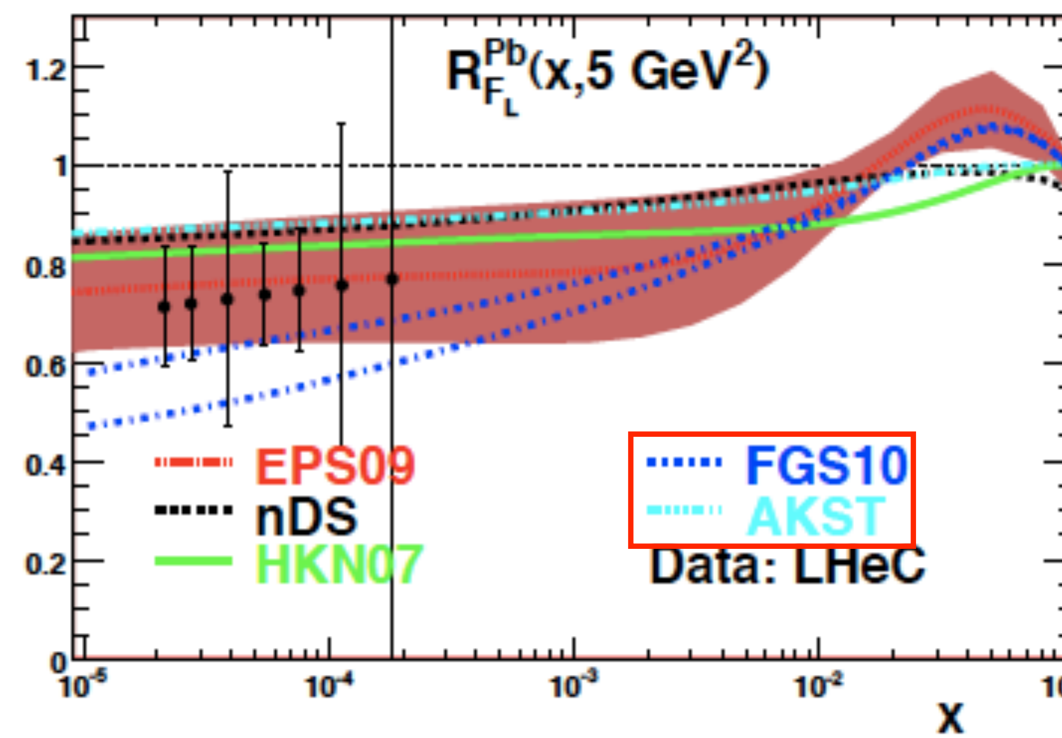
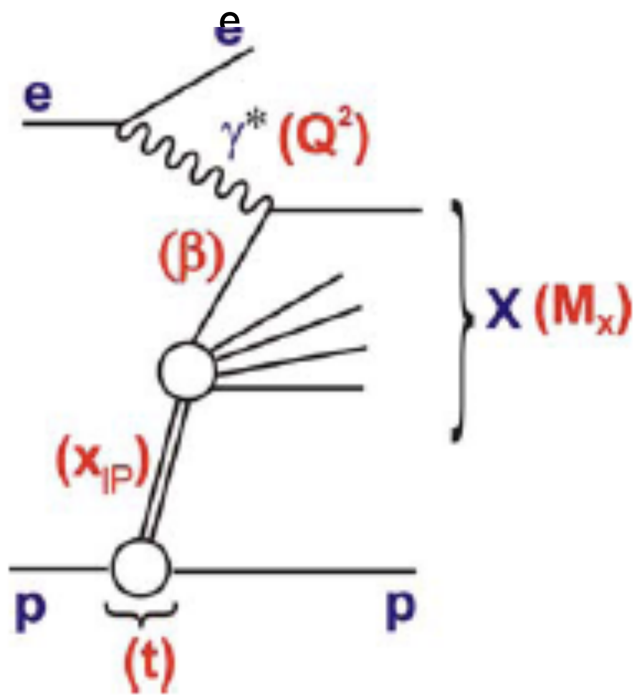
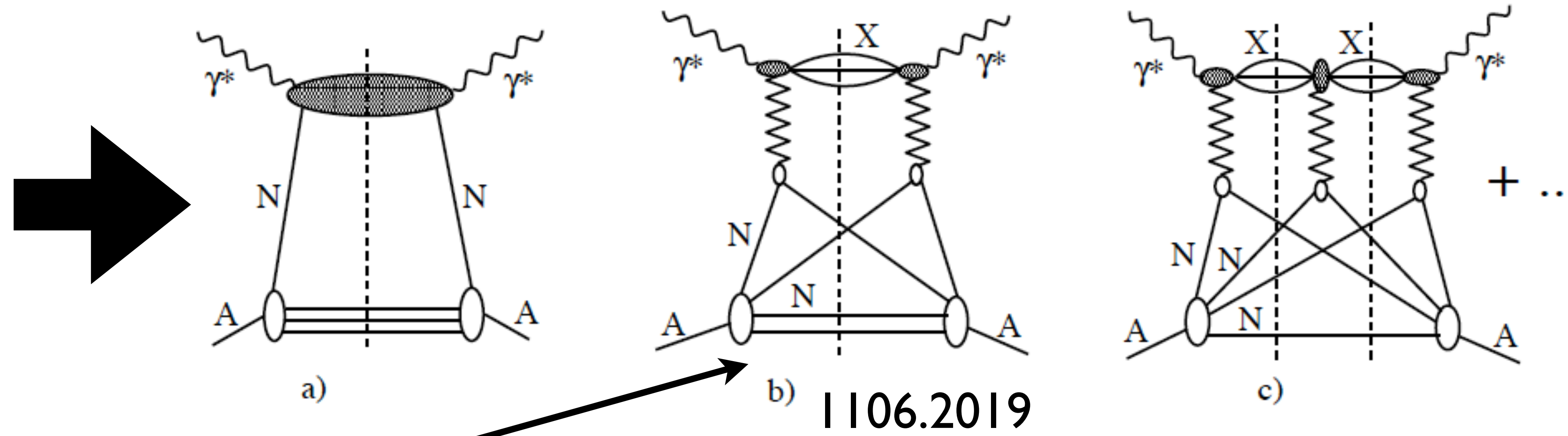
- Diffraction is linked to nuclear shadowing through basic QFT (Gribov): eD to test and set the 'benchmark' for new effects.



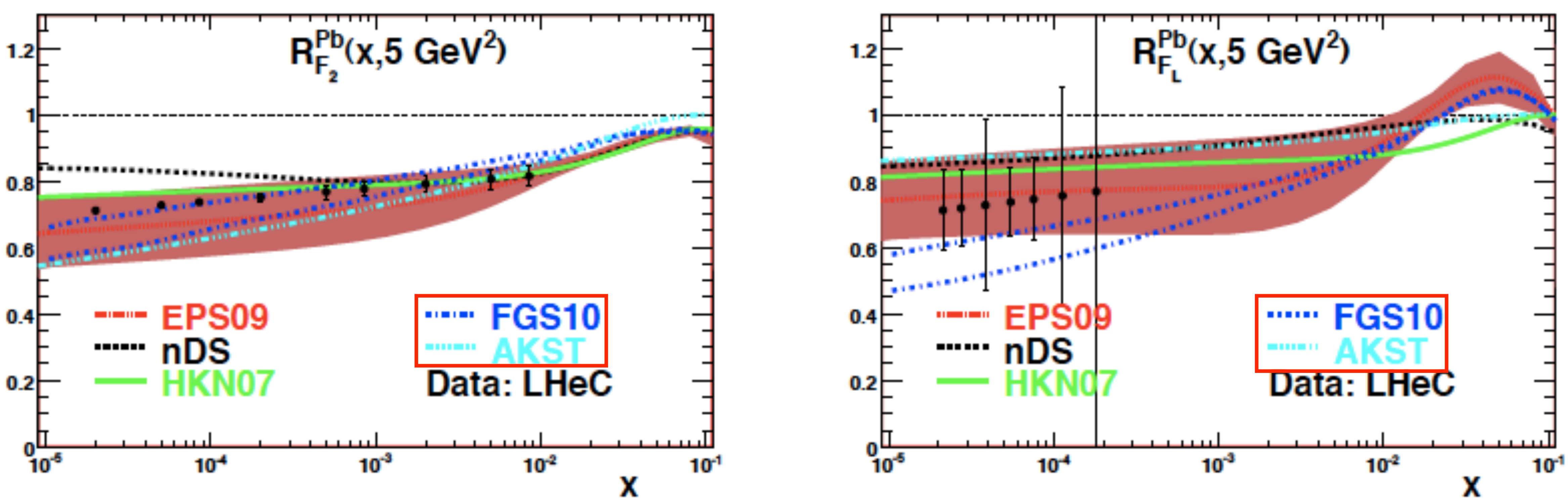


Diffraction in ep and shadowing:

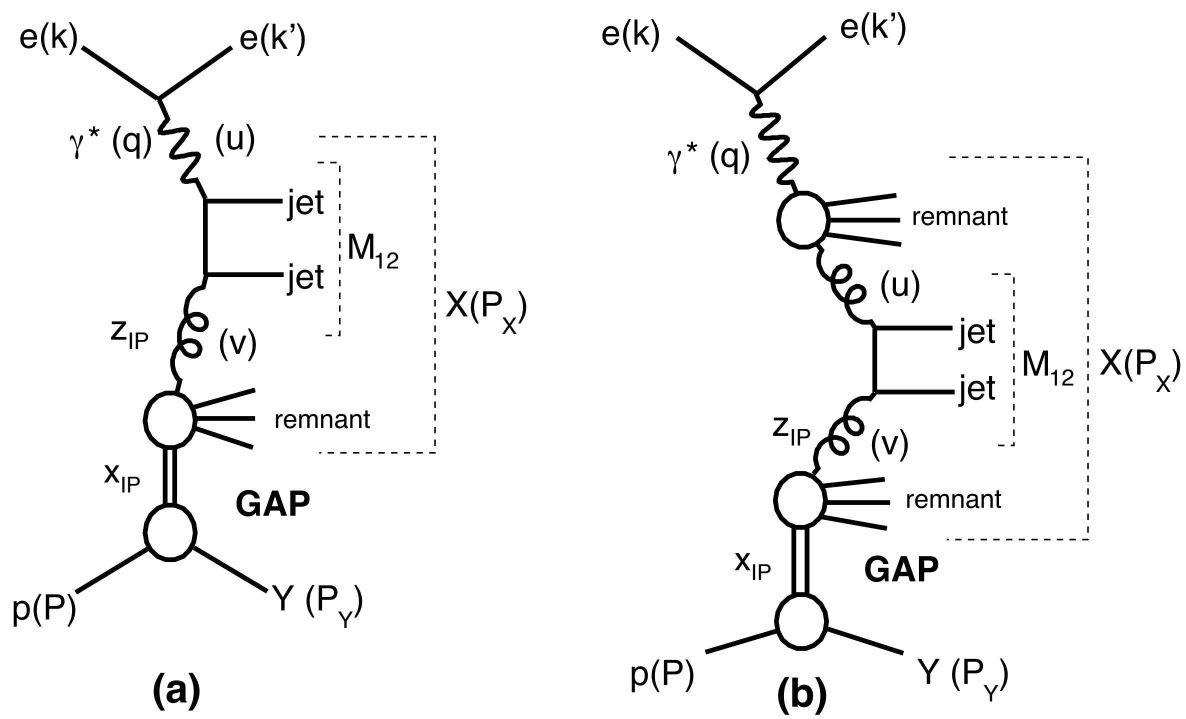


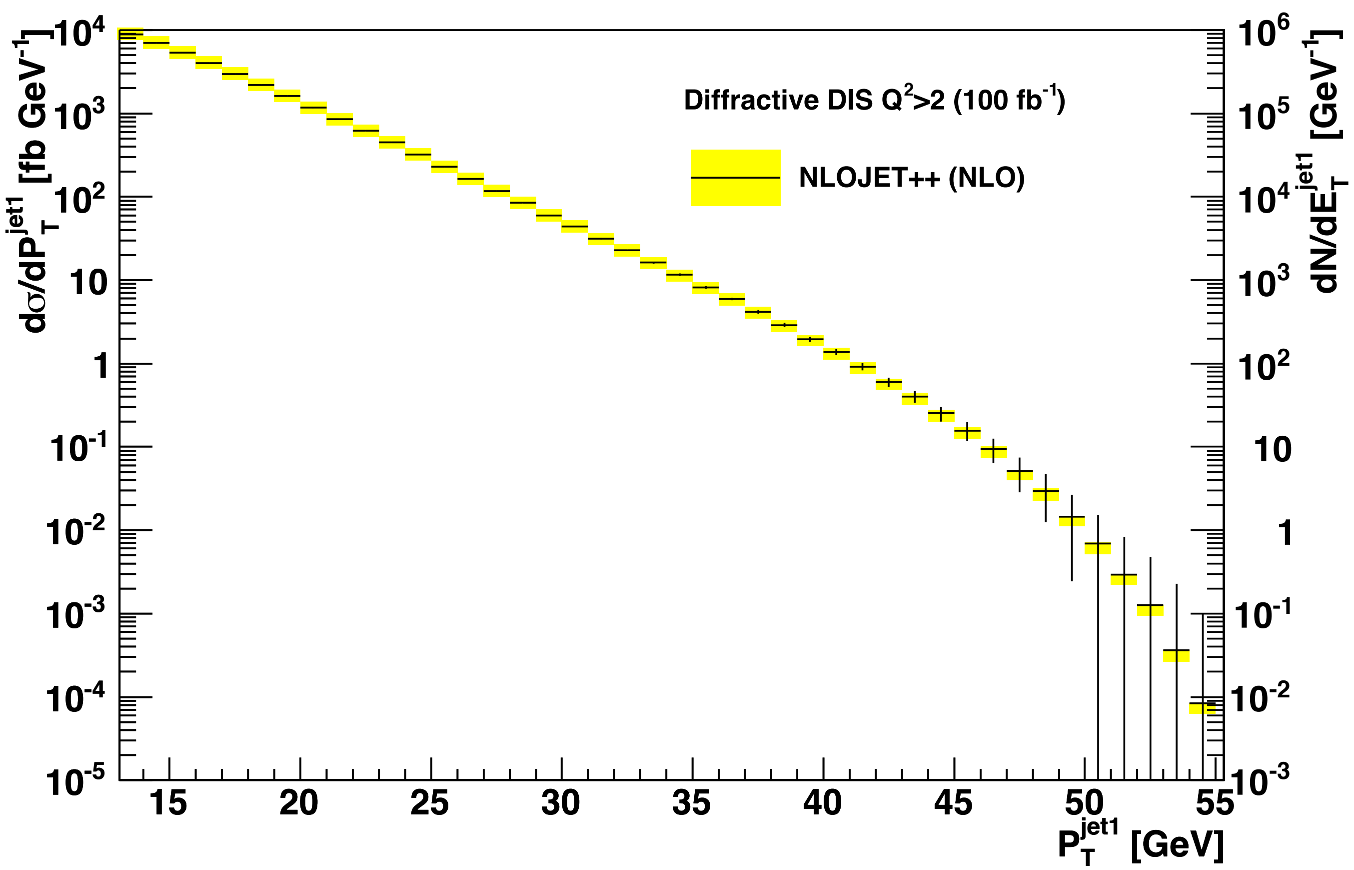


- Diffraction is linked to nuclear shadowing through basic QFT (Gribov): eD to test and set the ‘benchmark’ for new effects.



Diffractive dijets:



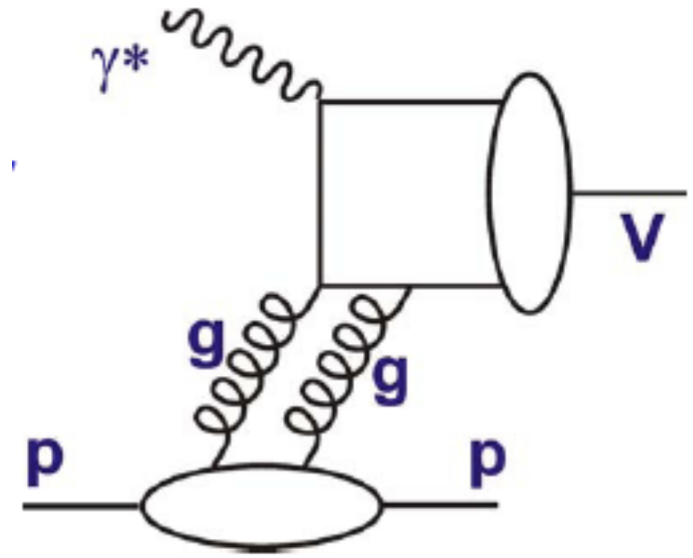


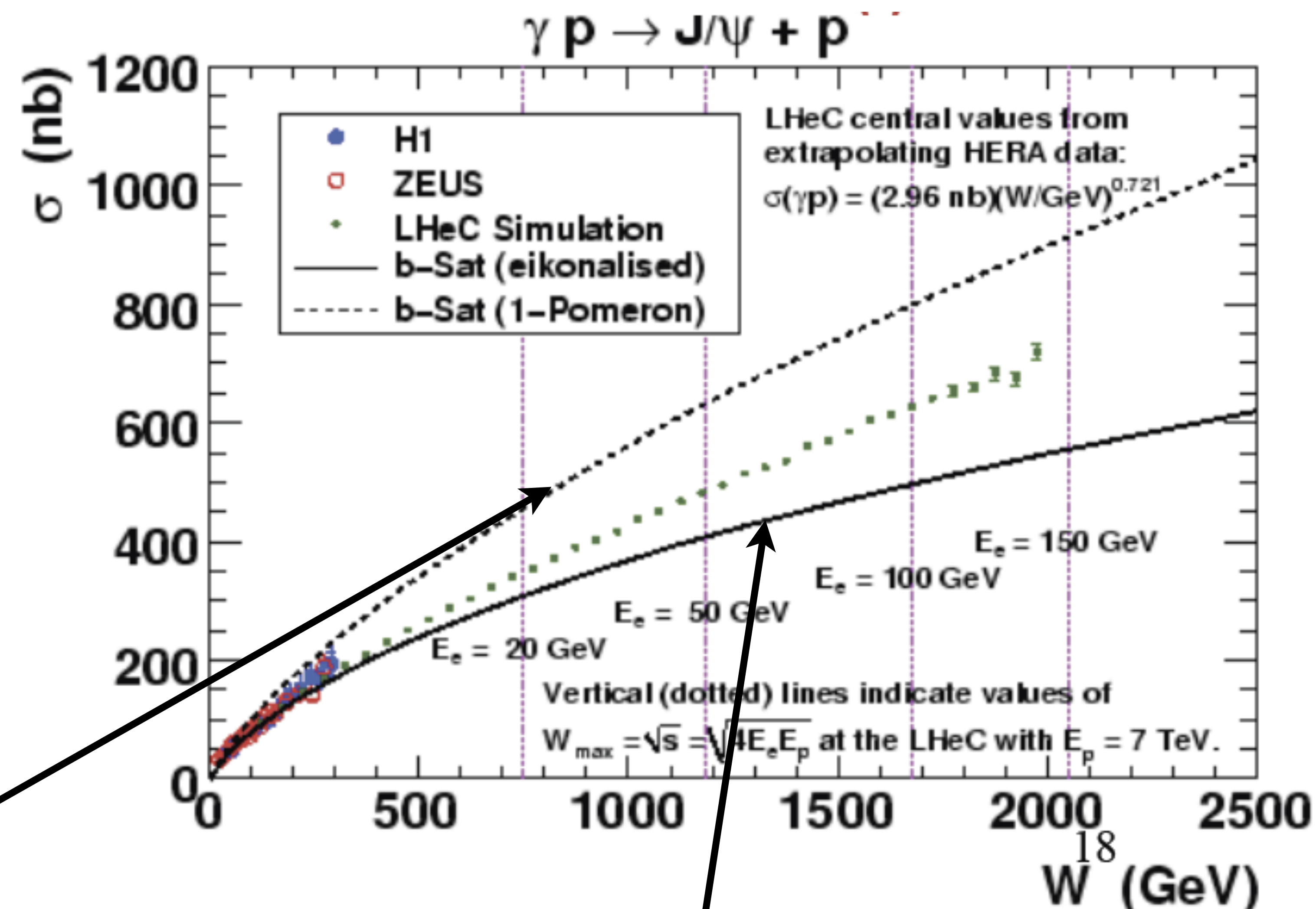
- Diffractive dijet and open heavy flavour production offer large possibilities for:
  - ➜ Checking factorization in hard diffraction.
  - ➜ Constraining DPDFs.

- Large yields up to large p_T^{jet}.

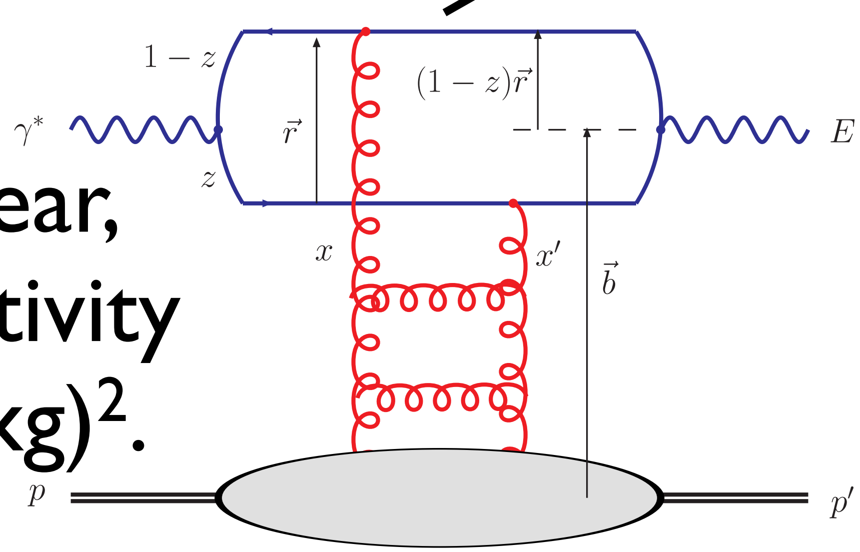
- Direct and resolved contributions: photon PDFs.

Elastic VM production in ep:

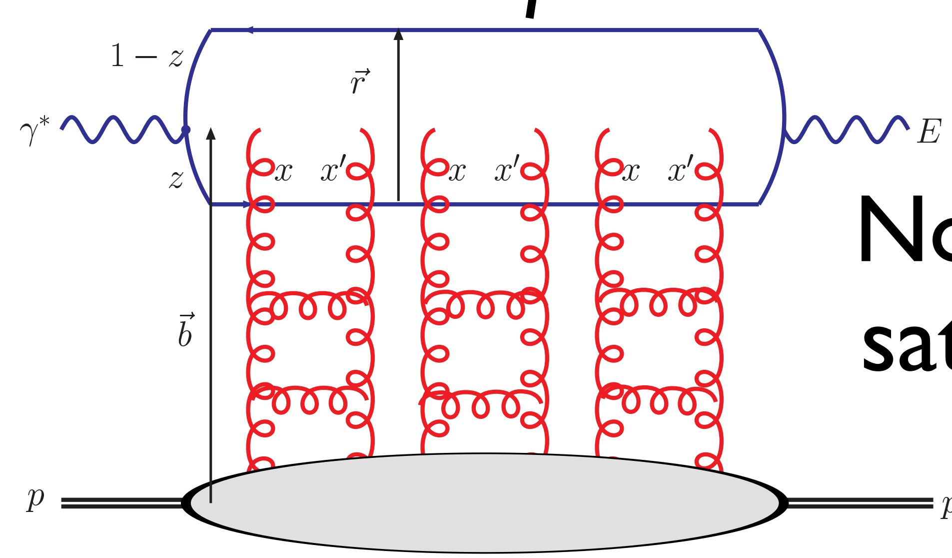




- Elastic J/ψ production appears as a candidate to signal saturation effects at work.



Linear, sensitivity to $(xg)^2$.

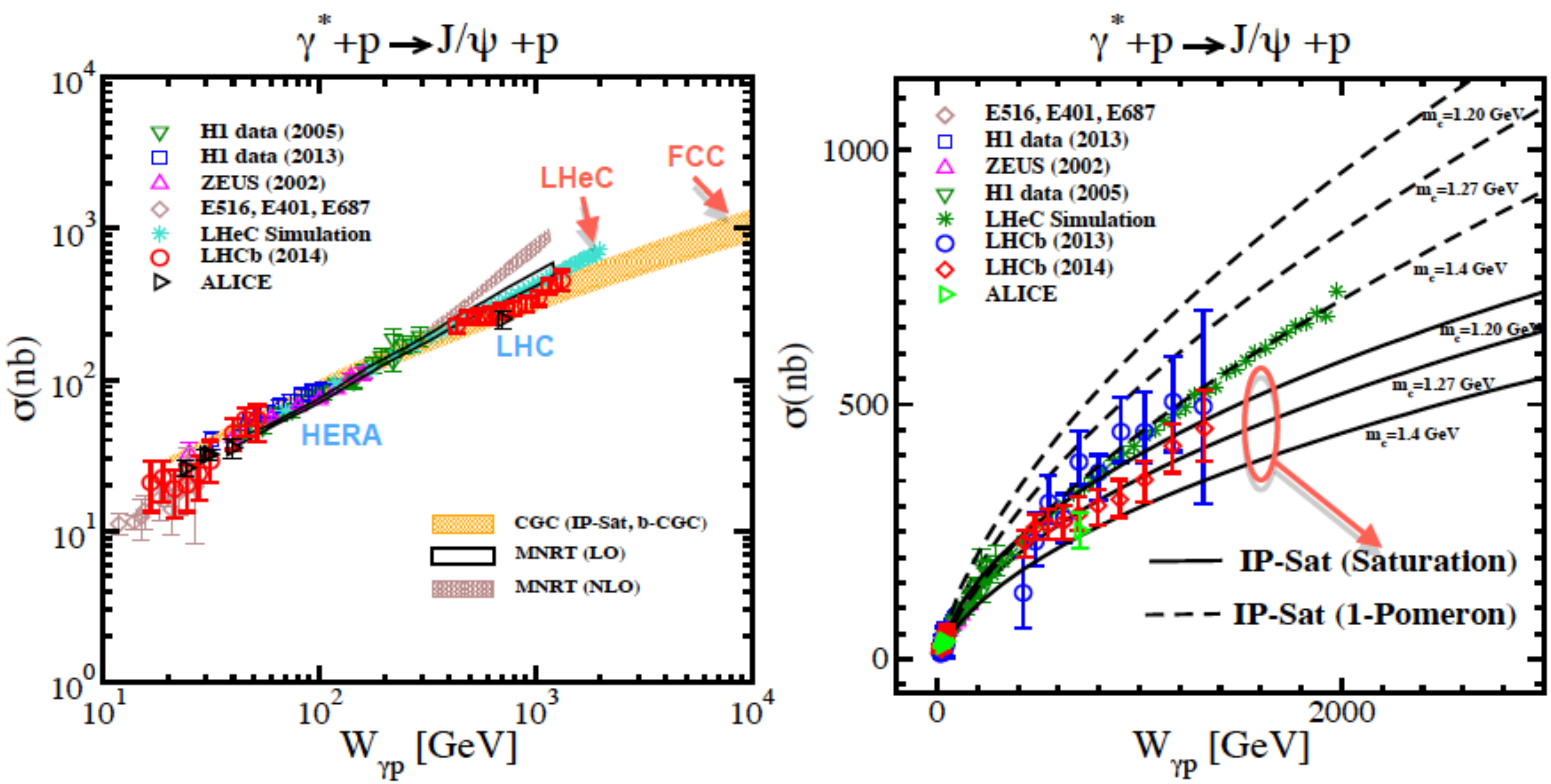


Non-linear, saturation.

Elastic VM production in ep:

- UPCs at the LHC and beyond are a (less precise) alternative.

Armesto and Rezaeian, arXiv:1402.4831



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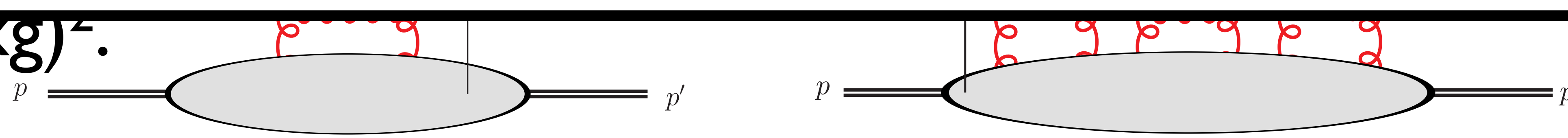
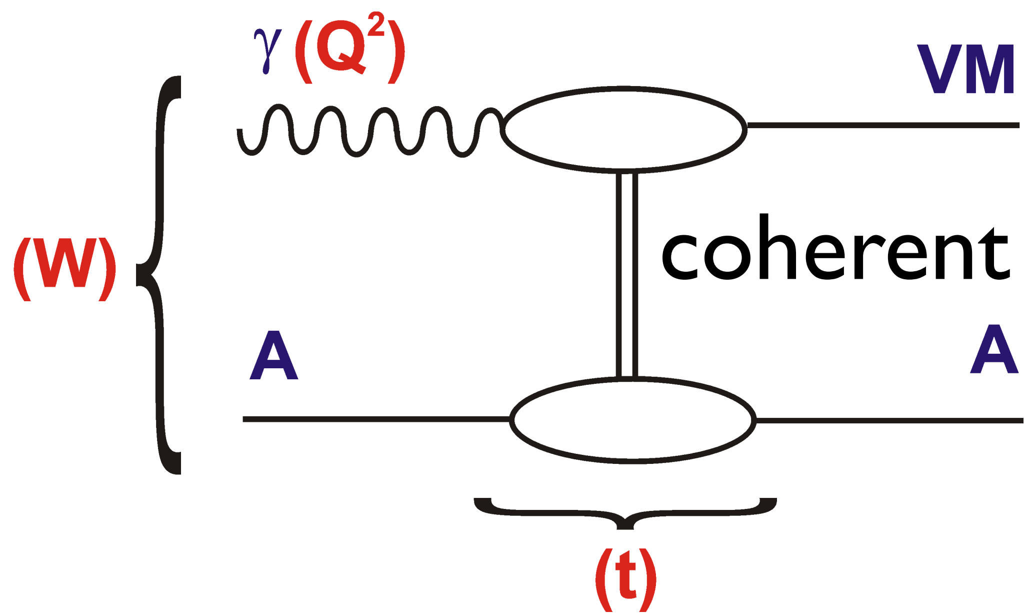
to $(xg)^2$.

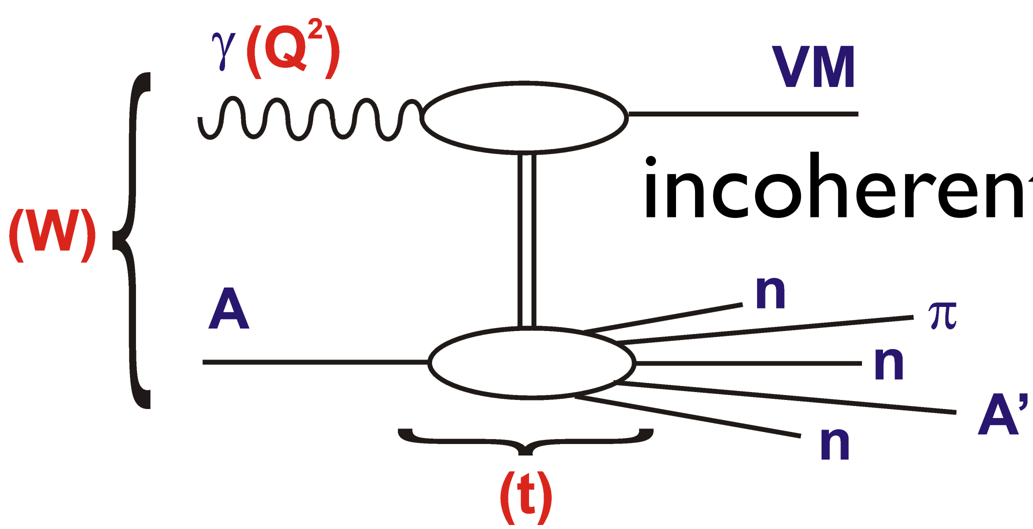


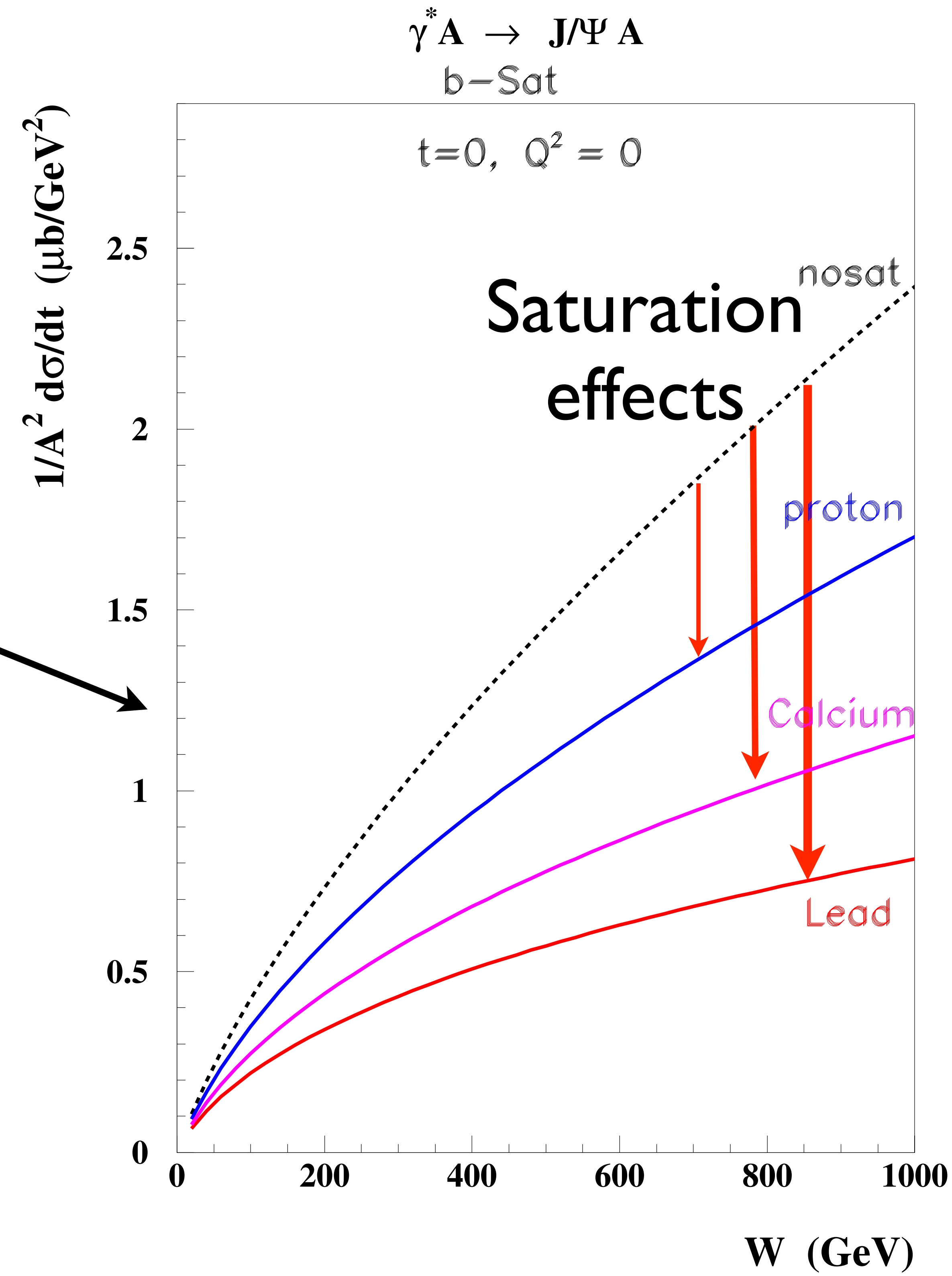
Elastic VM production in eA:



- For the coherent case, predictions available.

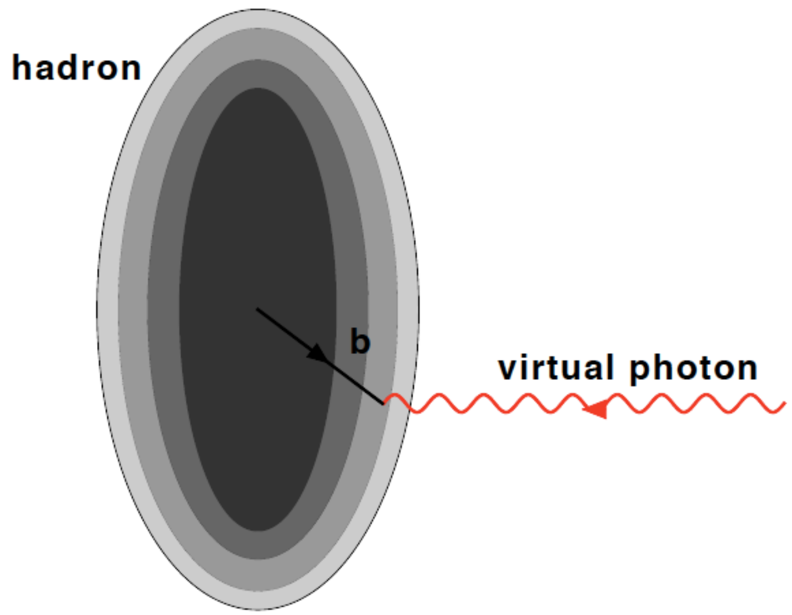
- Challenging experimental problem.

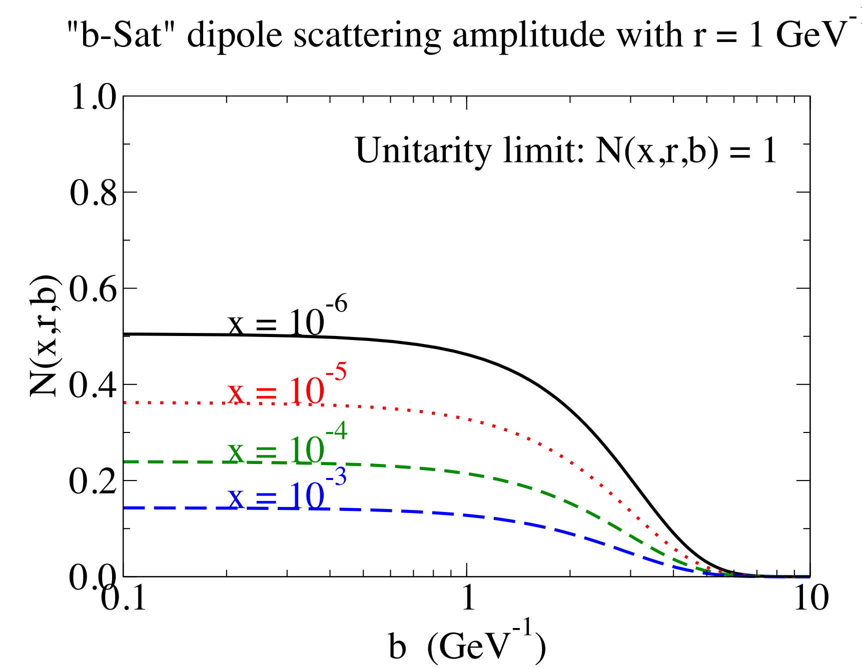


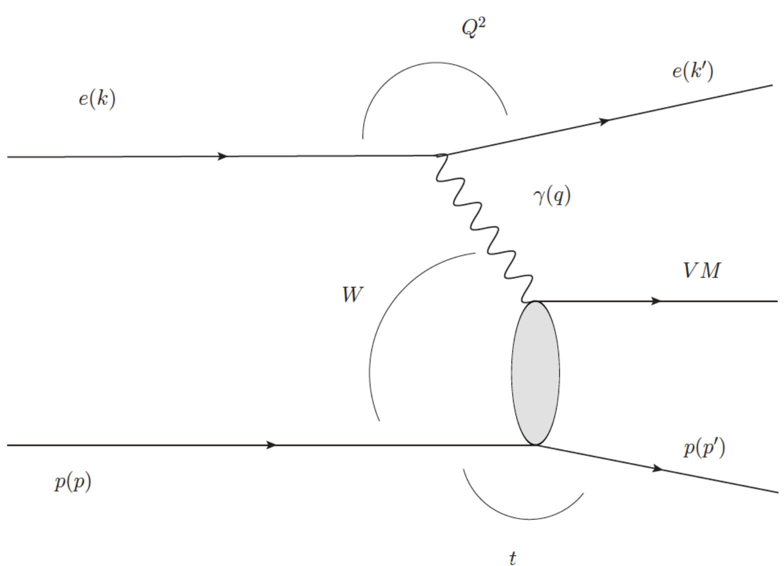


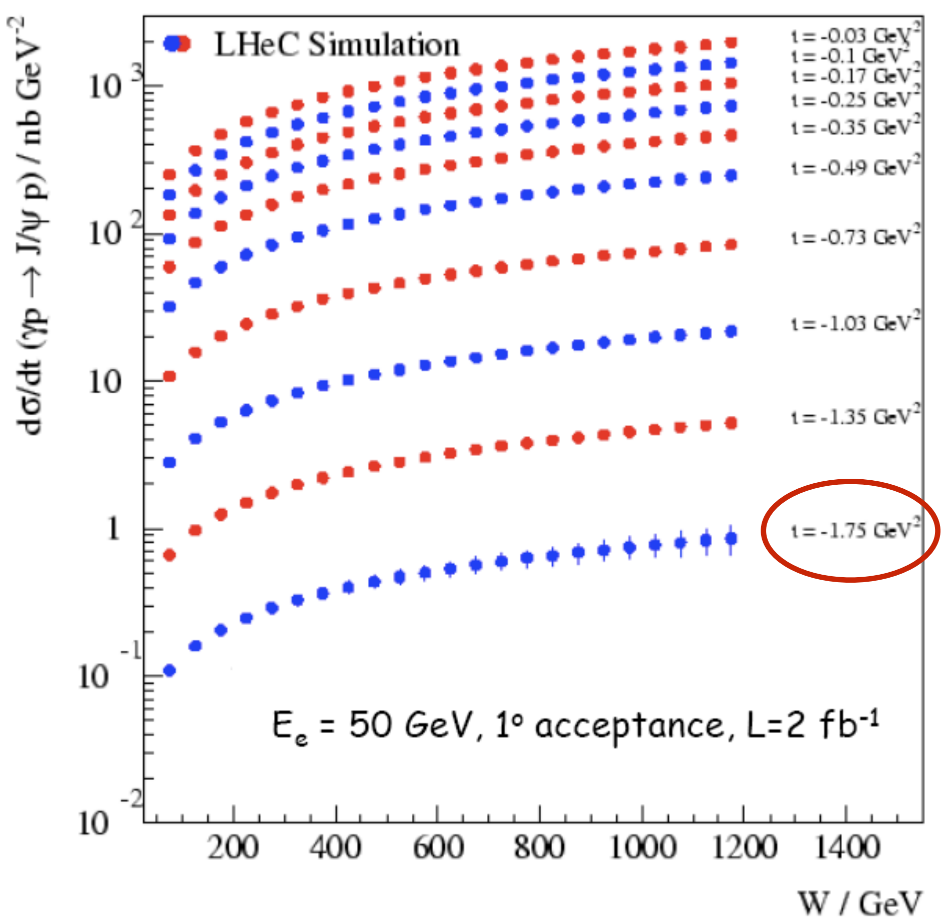
Transverse scan: elastic VM

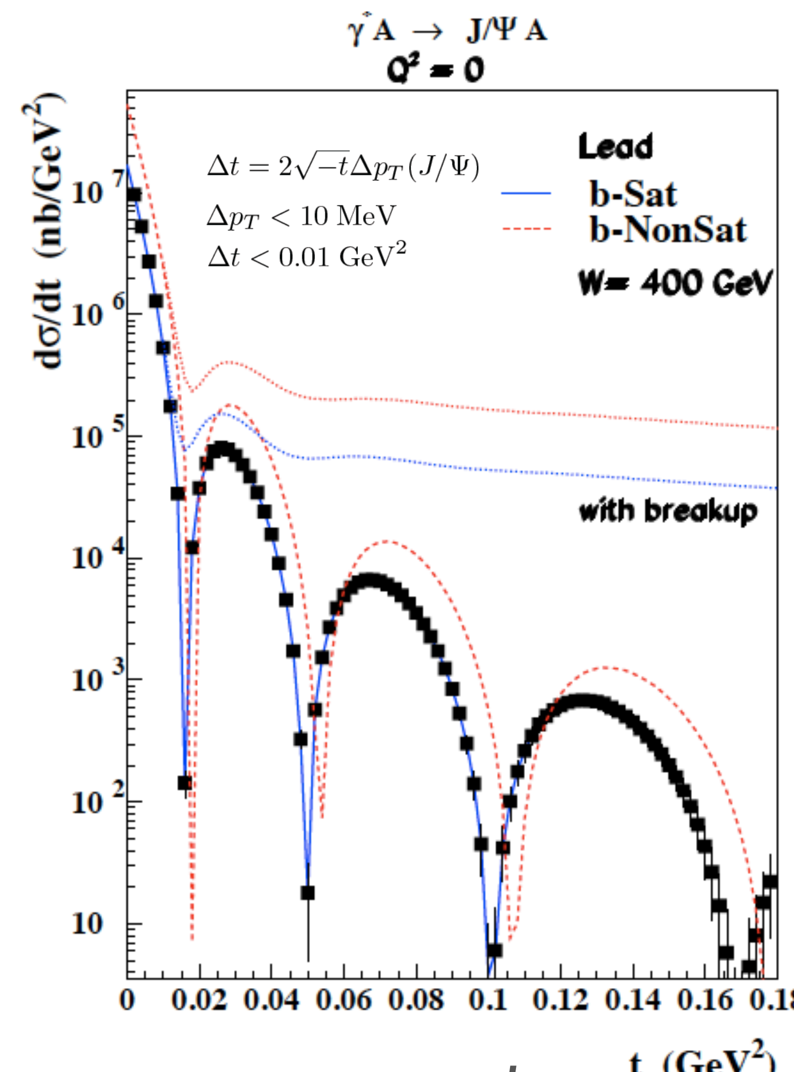
- t-differential measurements give a gluon tranverse mapping of the hadron/nucleus.











Transverse scan: elastic VM

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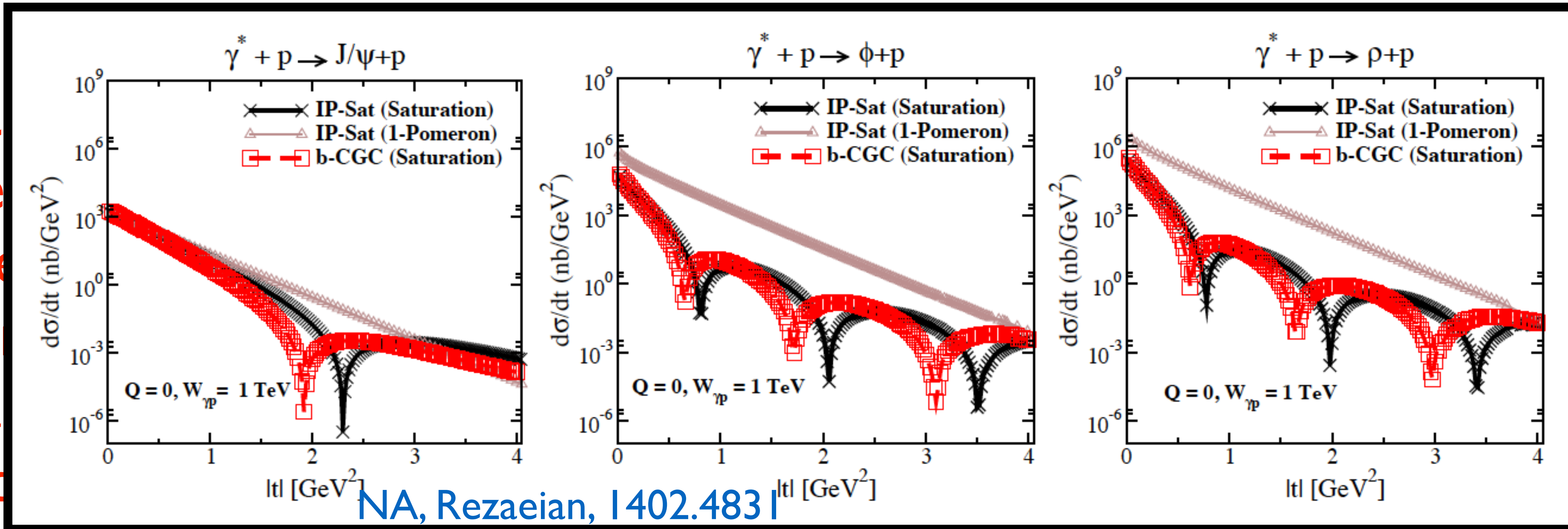
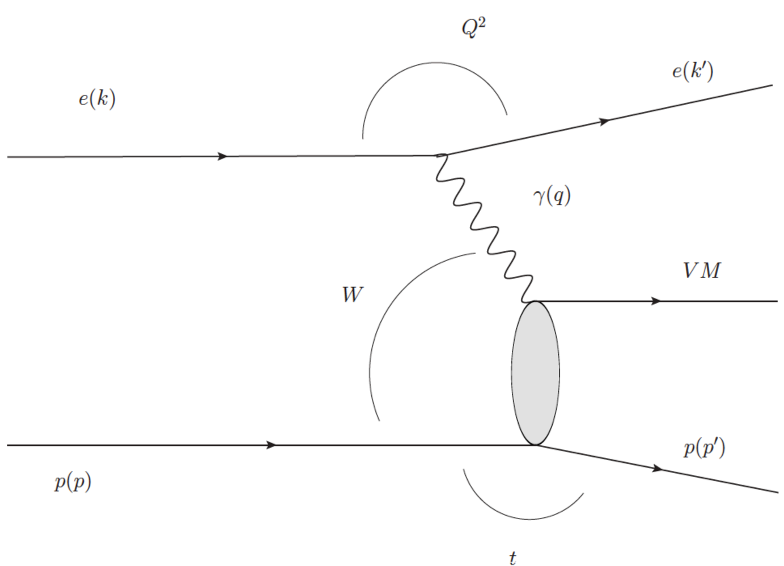
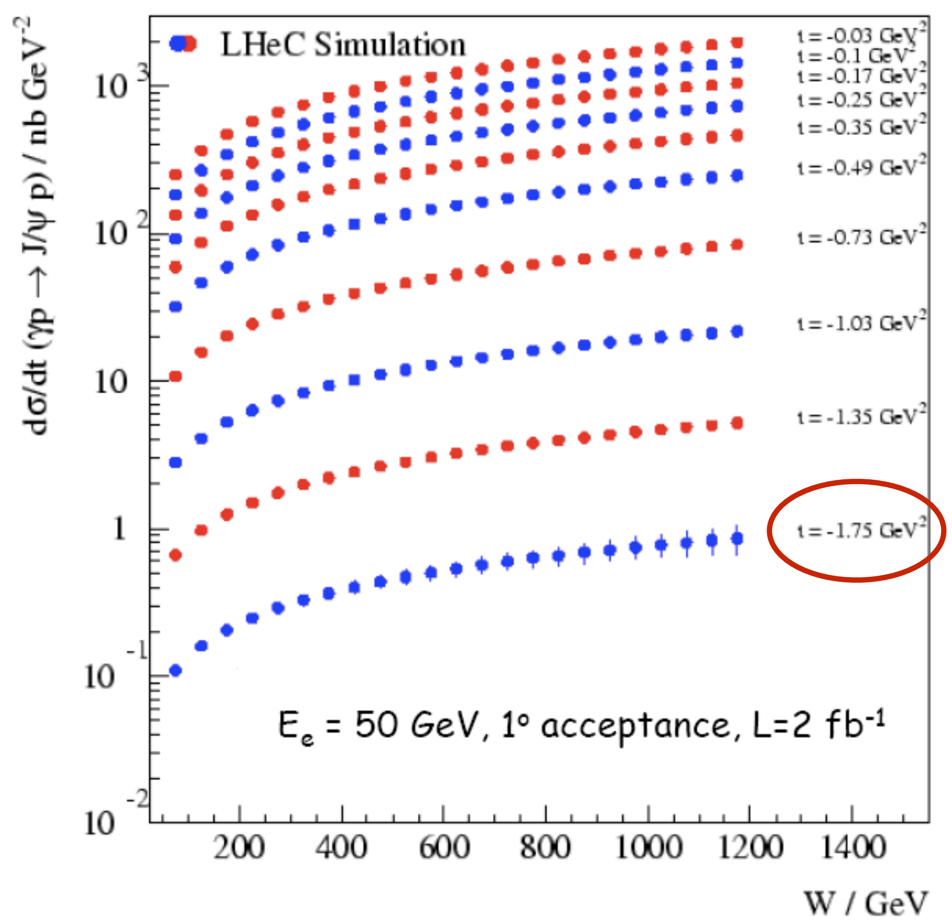
eV^{-1}

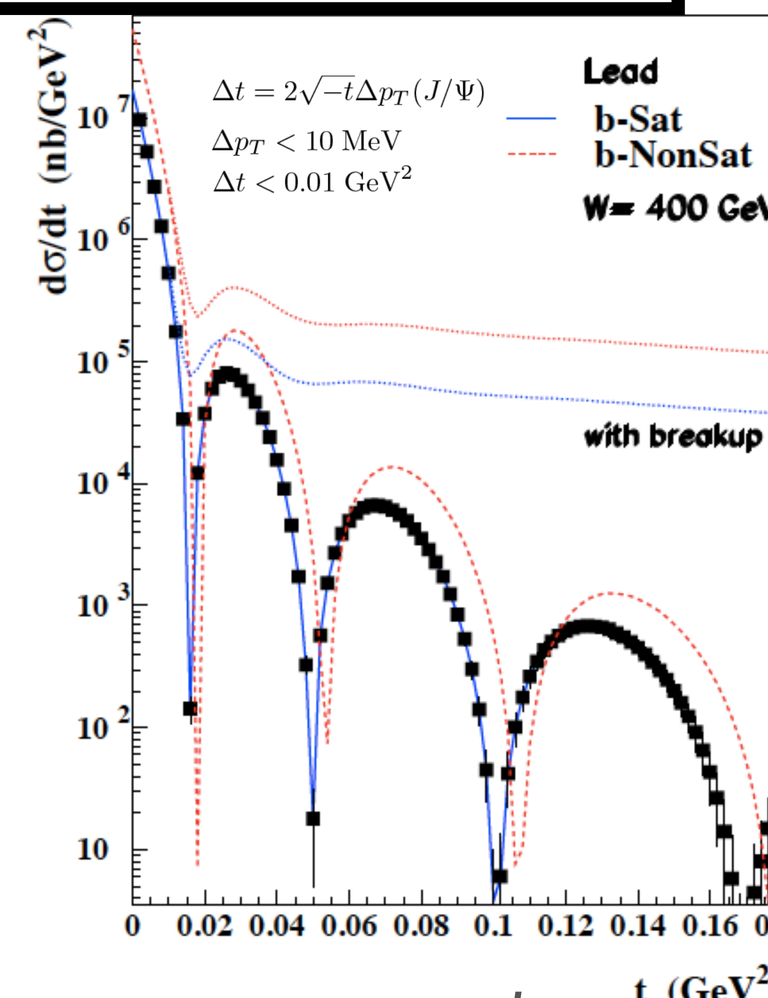
0



NA, Rezaeian, 1402.4831

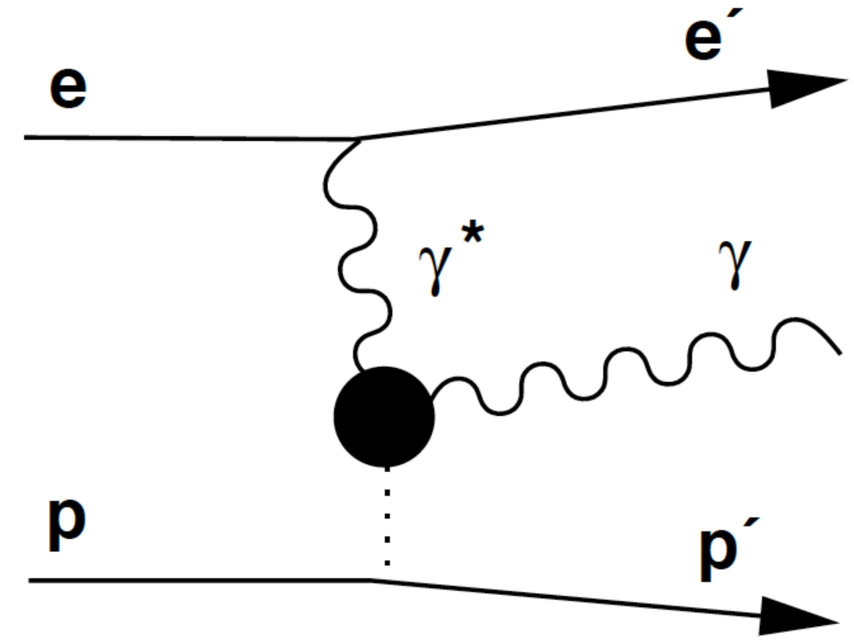




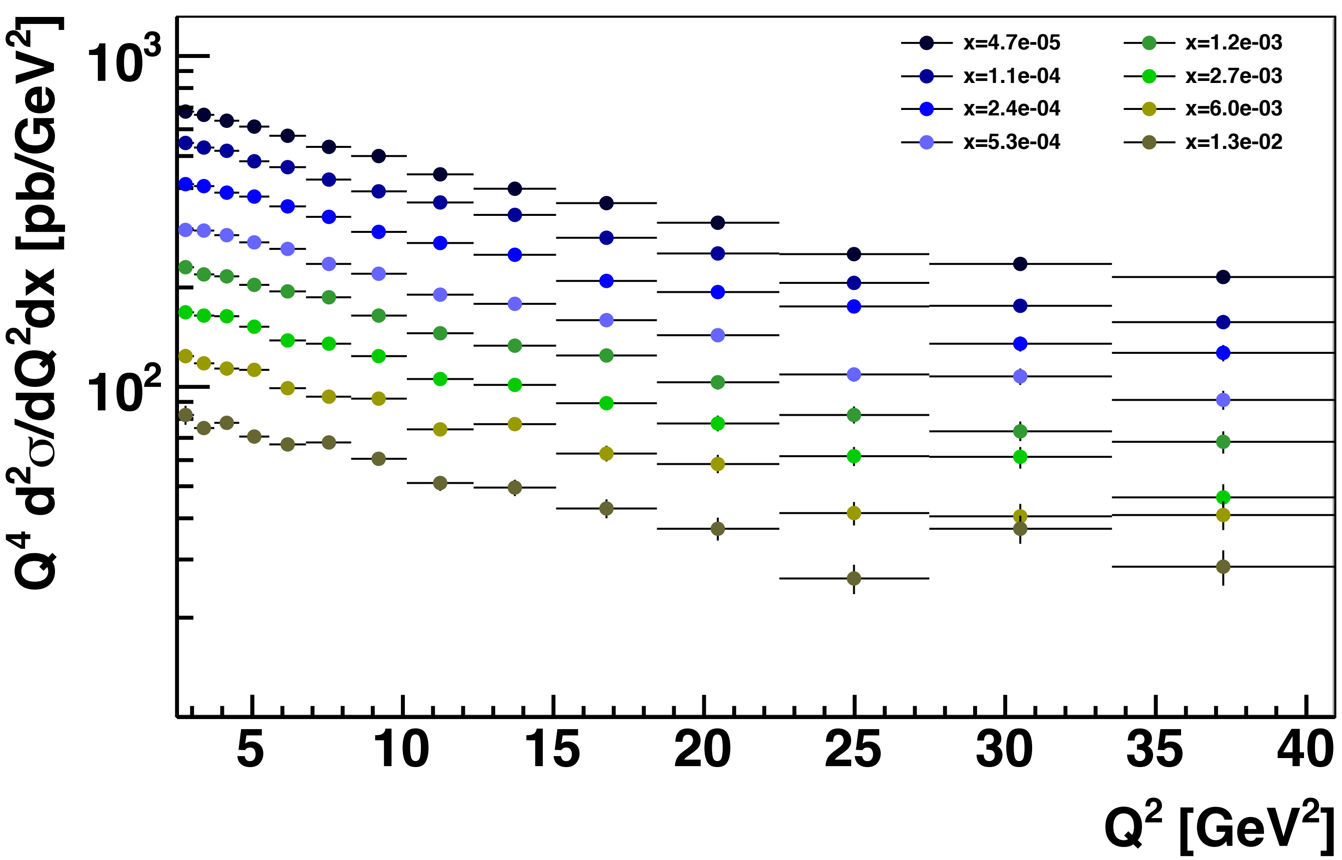


DVCS:

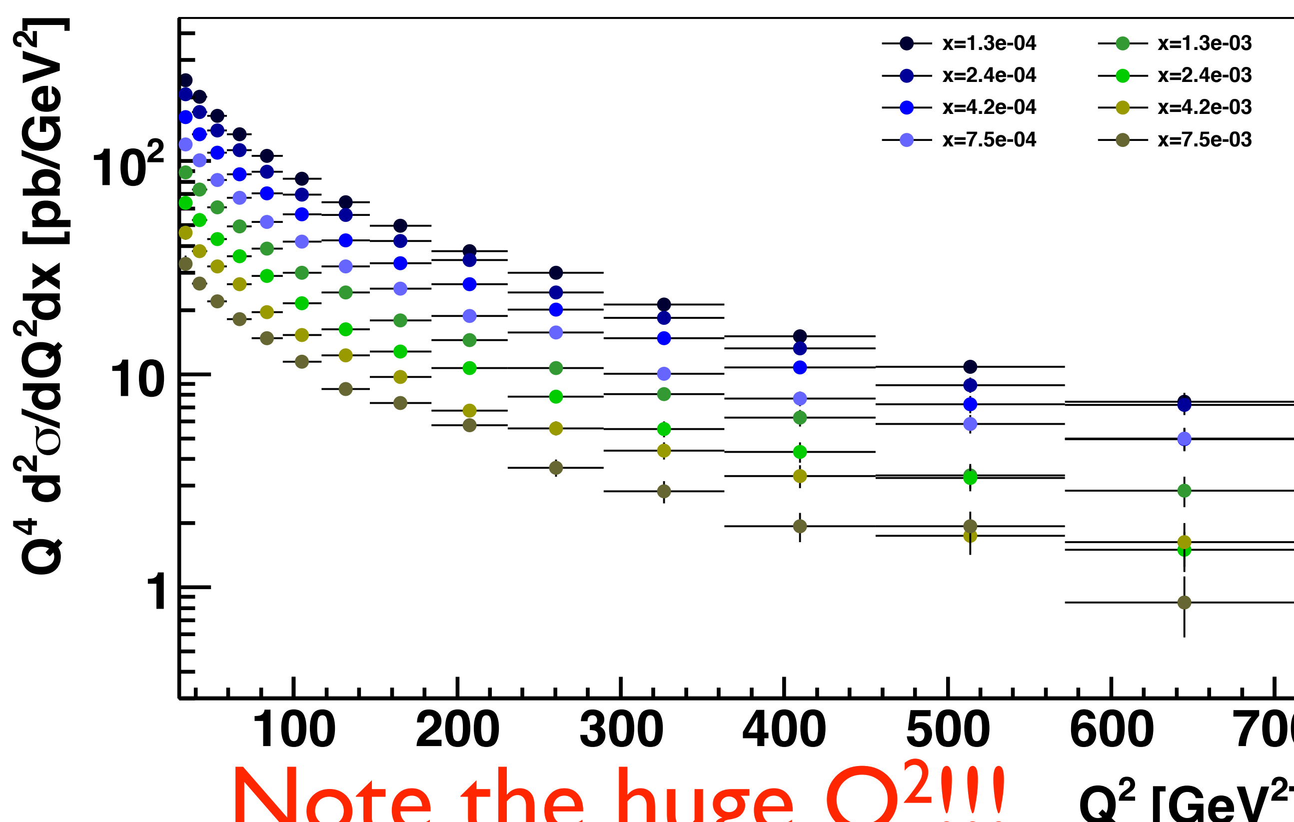
- Exclusive processes give information about GPDs, whose Fourier transform gives a tranverse scan of the hadron: DVCS sensitive to the singlet.
- Sensitive to dynamics e.g. non-linear effects.



DVCS, E_e=50 GeV, 1°, $p_T^{\gamma,cut}$=2 GeV, 1 fb^{-1}



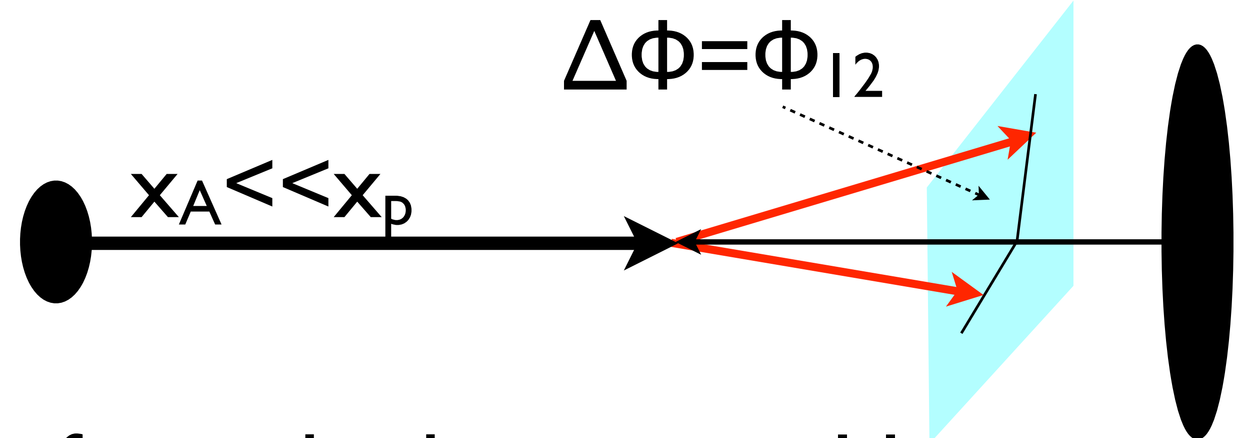
DVCS, E_e=50 GeV, 10°, $p_T^{\gamma,cut}$=5 GeV, 100 fb^{-1}



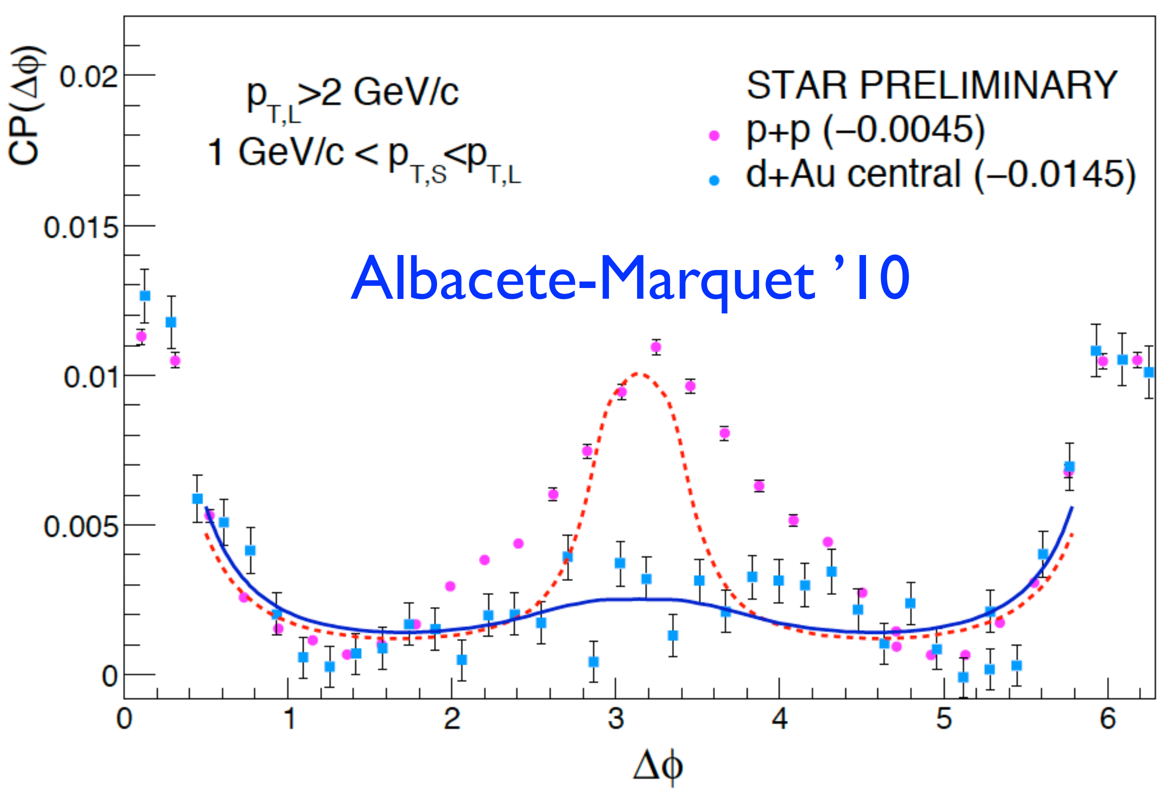
Note the huge Q^2!!!

Dihadron azimuthal decorrelation:

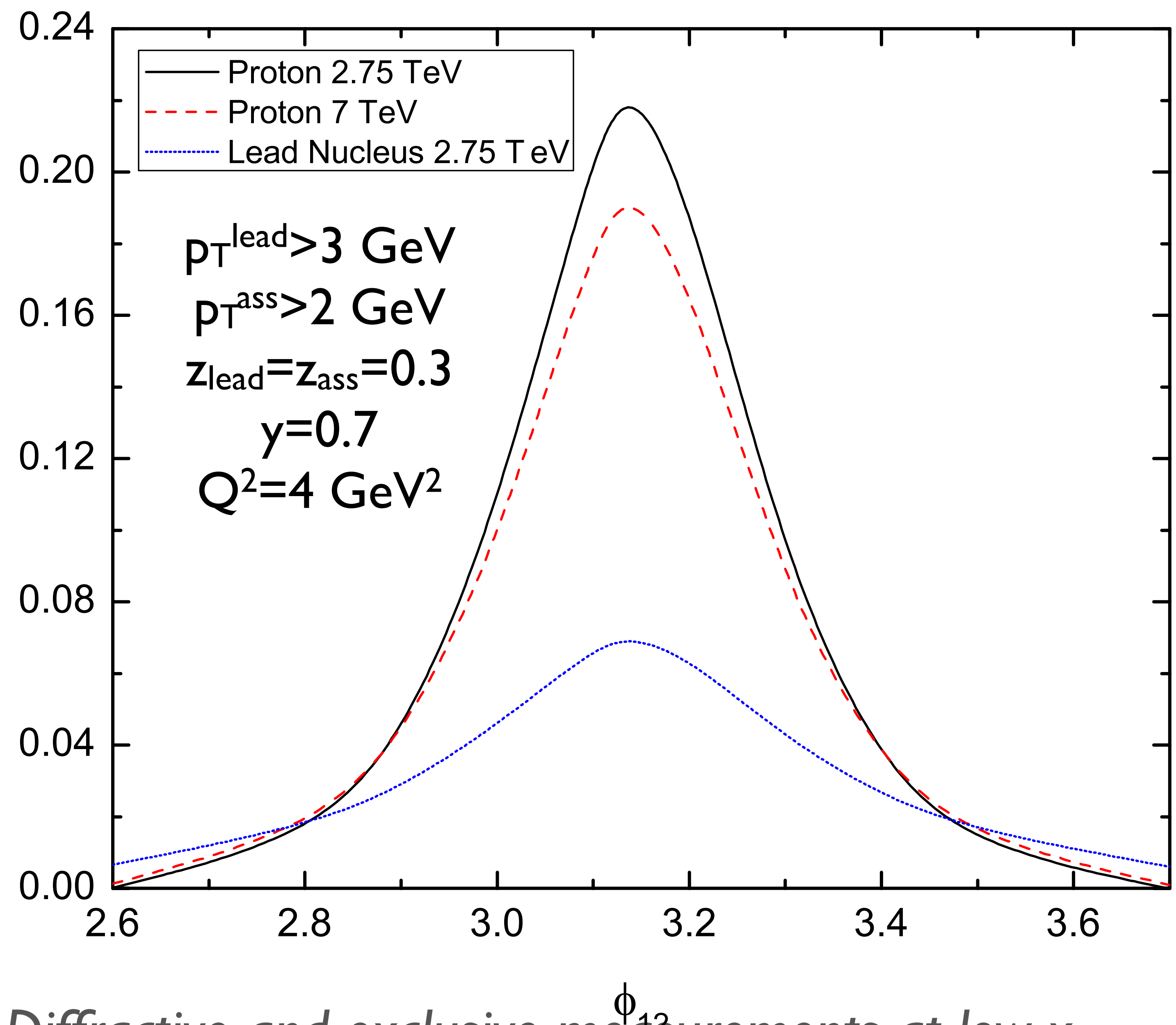
- Dihadron azimuthal decorrelation: currently discussed at RHIC as suggestive of saturation.



- At the LHeC it could be studied far from the kinematical limits.



$$C(\phi_{12}) = \frac{1}{\frac{d\sigma(\gamma^* N \to h_1 X)}{dz_{h1}}} \frac{d\sigma^{\gamma^* N \to h_1 h_2 + X}}{dz_{h1} dz_{h2} d\phi_{12}}$$



Dijet azimuthal decorrelation:

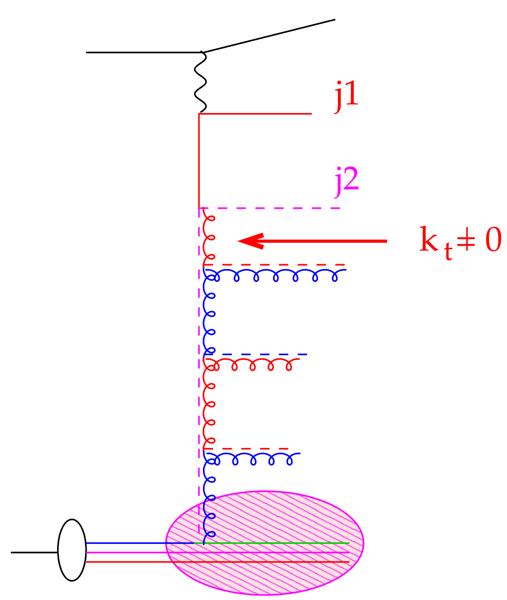
- Studying dijet azimuthal decorrelation or forward jets ($p_T \sim Q$) would allow to understand the mechanism of radiation:

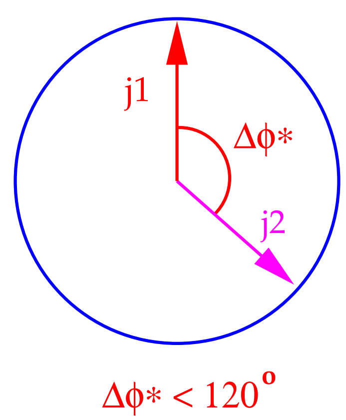
➜ k_T-ordered: DGLAP.

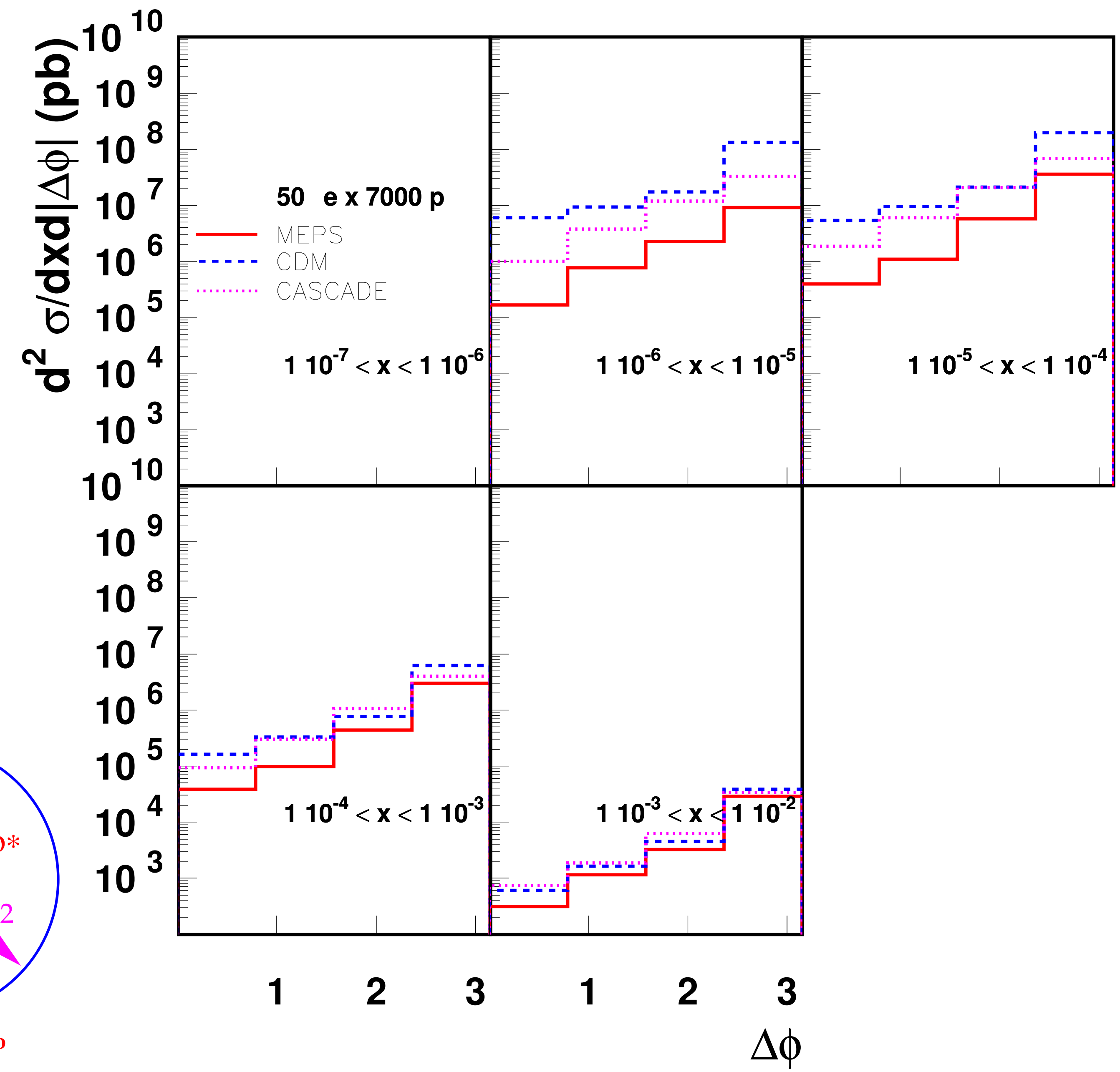
➜ k_T-disordered: BFKL.

➜ Saturation?

- Further imposing a rapidity gap (diffractive jets) would be most interesting: perturbatively controllable observable.







Forward jets:

- Studying dijet azimuthal decorrelation or forward jets ($p_T \sim Q$) would allow to understand the mechanism of radiation:

➜ k_T-ordered: DGLAP.

➜ k_T-disordered: BFKL.

➜ Saturation?

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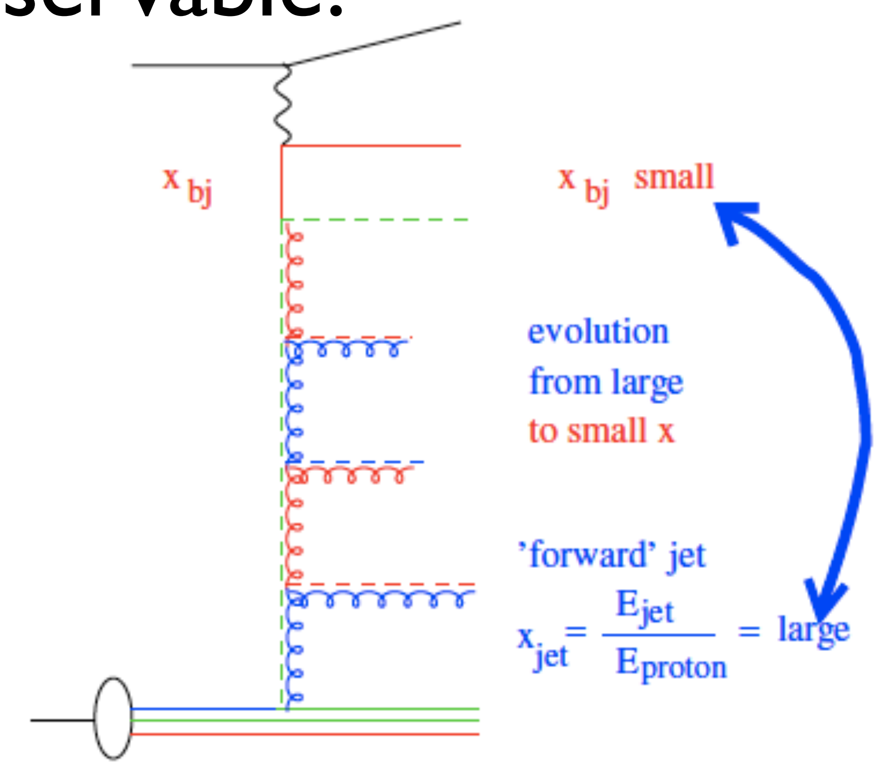
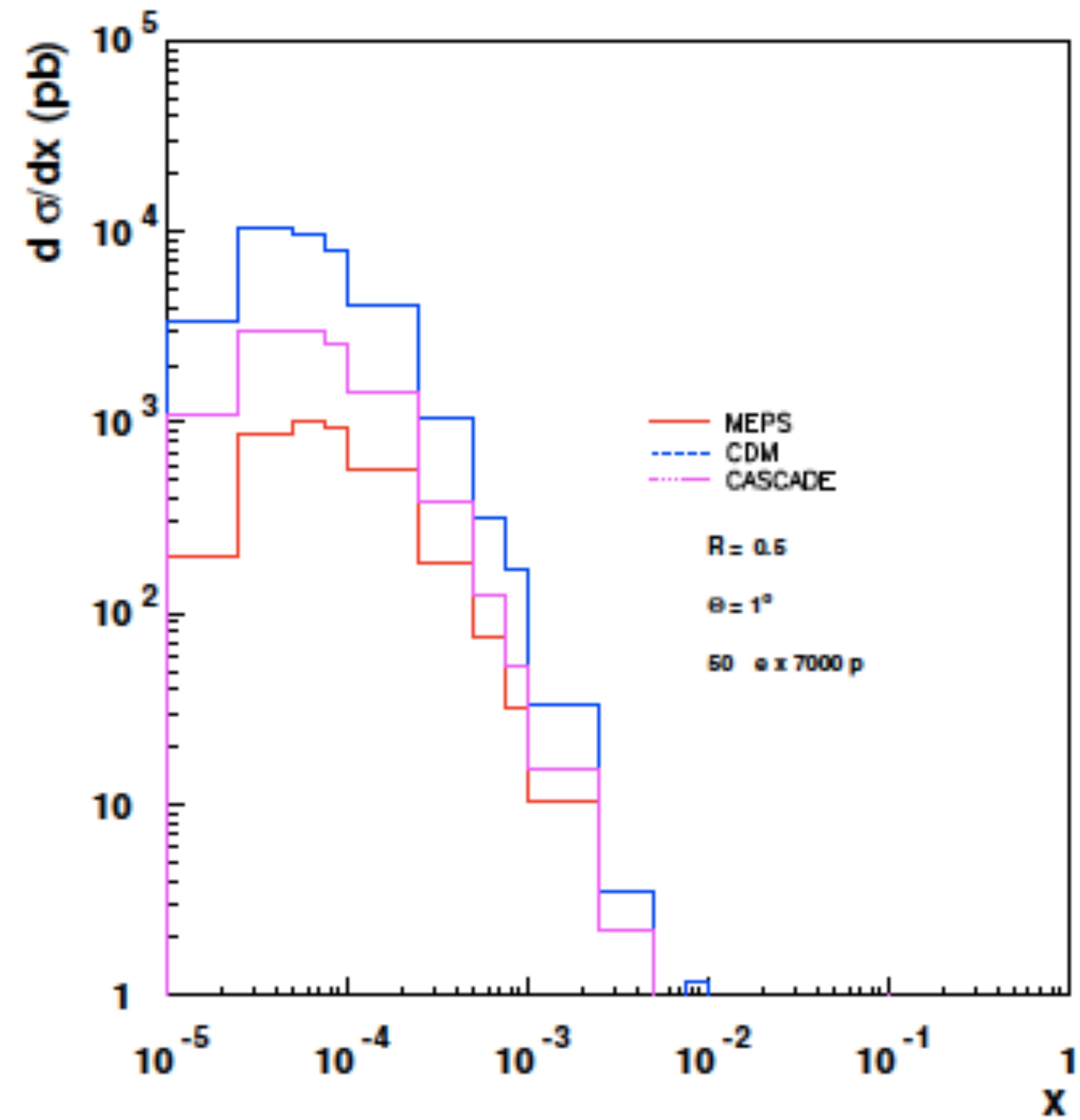


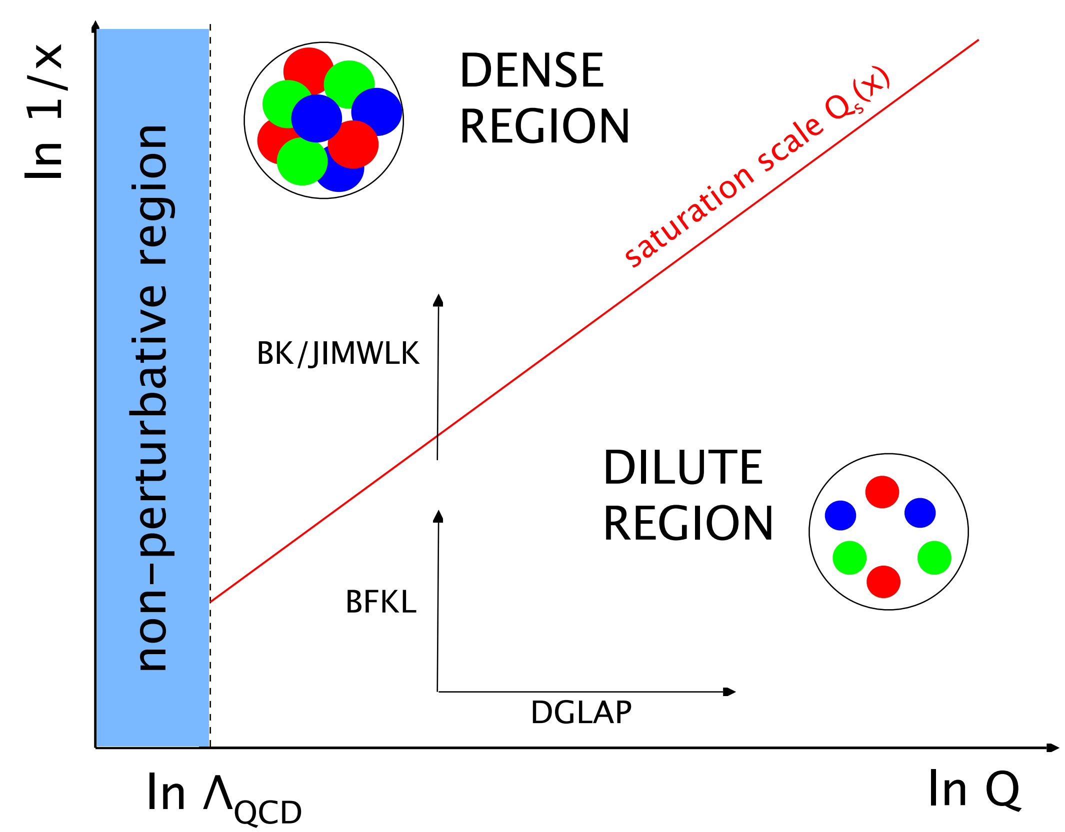


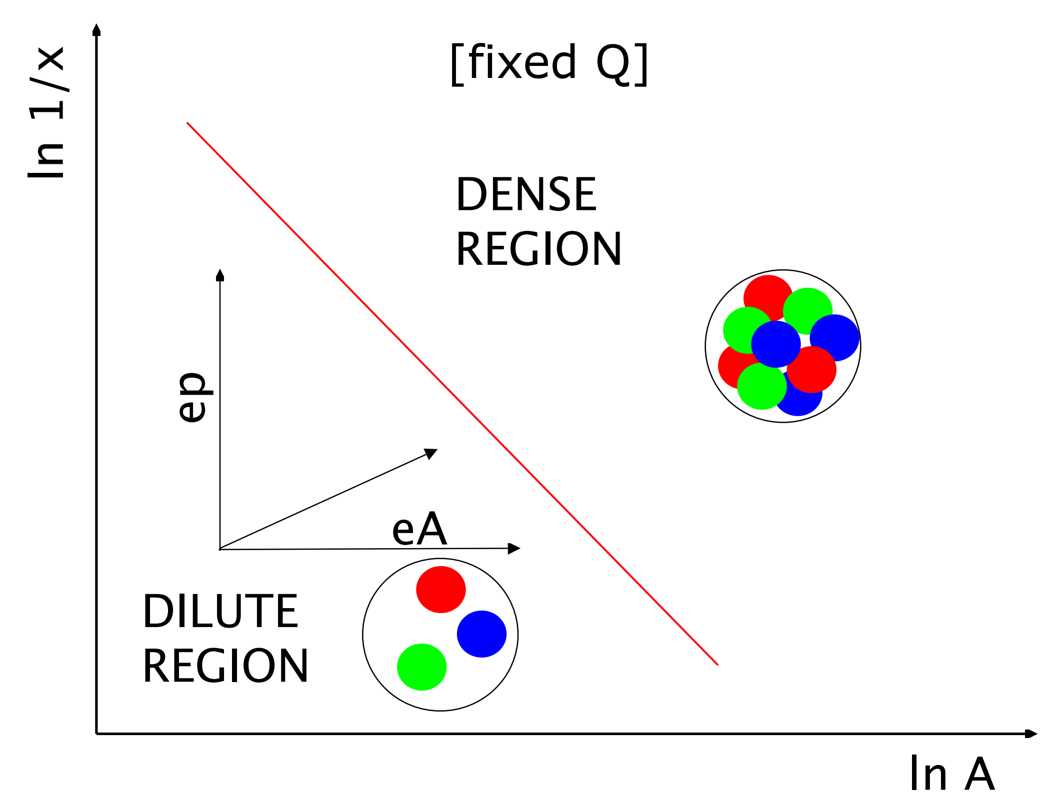
Summary:

- ***At an LHeC@CERN***:
  - ➜ High-precision tests of collinear factorization(s) and determination of PDFs.
  - ➜ Unprecedented access to small x in p and A.
  - ➜ Novel sensitivity to physics beyond standard pQCD.
  - ➜ Stringent tests of QCD radiation and hadronization.
  - ➜ Transverse scan of the hadron/nucleus at small x.

  ... with implications on our understanding of QGP.

- **The LHeC will answer the question of saturation/ non-linear dynamics. For that, ep AND eA essential!!!**





Future plans:

- **Next: follow CERN mandate and go towards a TDR.** This requires a further elaboration of the physics case:

  ➜ diffraction: studies on DPDFs and nDPDFs.

  ➜ GPDs: complementarity of exclusive VM production and DVCS, also in the nuclear case.

  ➜ complementarity with the LHC, both ep/pp and eA/pA.

  ➜ ...

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➜ ...

Everybody is welcome to contribute!!!

Thank you very much for your attention!!!

Backup:

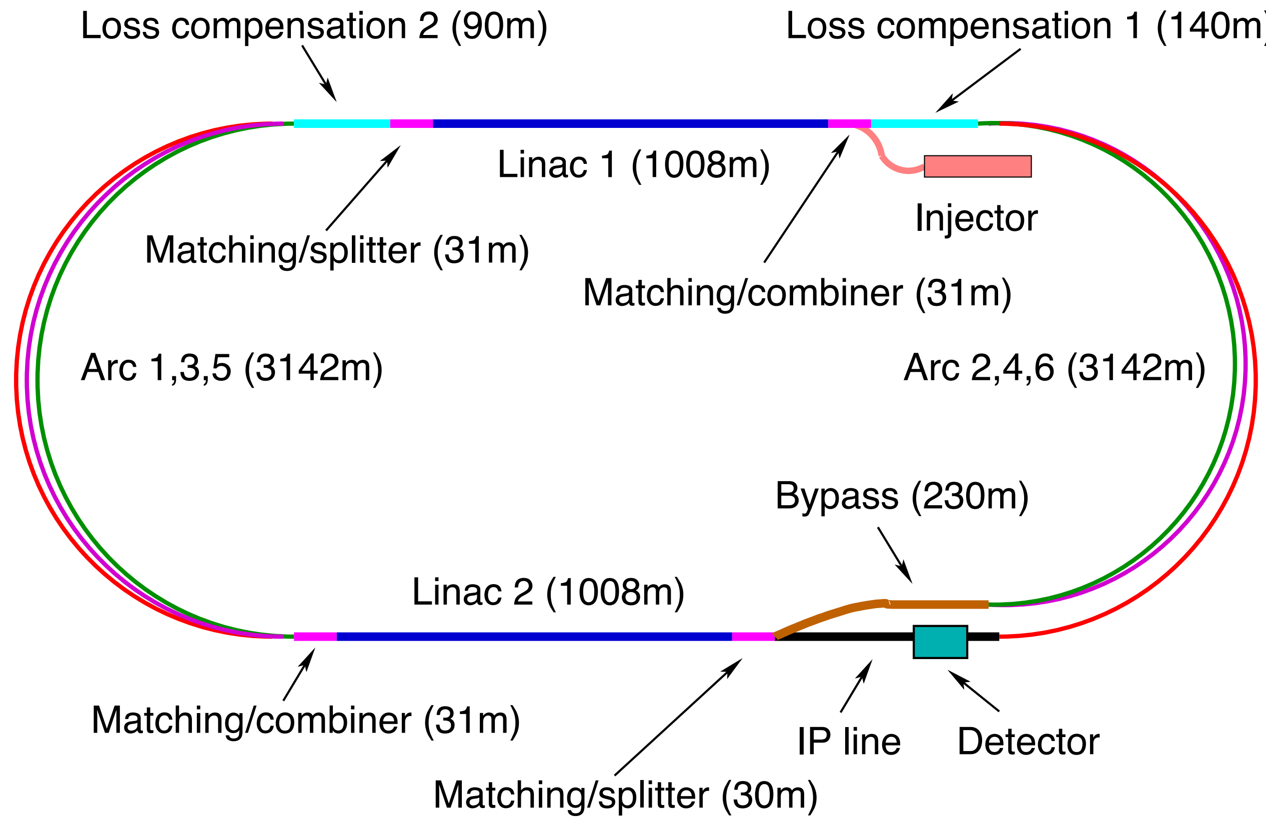
Accelerator:

$\sqrt{s} \simeq 0.8\text{-}1.2$ TeV/nucleon

Design considerations:

- $L \sim 10^{33}$ cm^{-2} s^{-1}.
- Power < 70 MW.
- Synchronous pp/ep.

E_e=60 GeV (benchmark).



10^{34} cm^{-2} s^{-1} Luminosity reach	PROTONS	ELECTRONS	PROTONS	ELECTRONS
Beam Energy [GeV]	7000	60	7000	60
Luminosity [10^{33}cm^{-2}s^{-1}]	16	16	1	1
Normalized emittance $\gamma\varepsilon_{x,y}$ [μm]	2.5	20	3.75	50
Beta Funtion $\beta^{*}_{x,y}$ [m]	0.05	0.10	0.1	0.12
rms Beam size $\sigma^{*}_{x,y}$ [μm]	4	4	7	7
rms Beam divergence σ□$^{*}_{x,y}$ [μrad]	80	40	70	58
Beam Current @ IP[mA]	1112	25	430 (860)	6.6
Bunch Spacing [ns]	25	25	25 (50)	25 (50)
Bunch Population	$2.2*10^{11}$	$4*10^{9}$	$1.7*10^{11}$	$(1*10^{9})$ $2*10^{9}$
Bunch charge [nC]	35	0.64	27	(0.16) 0.32

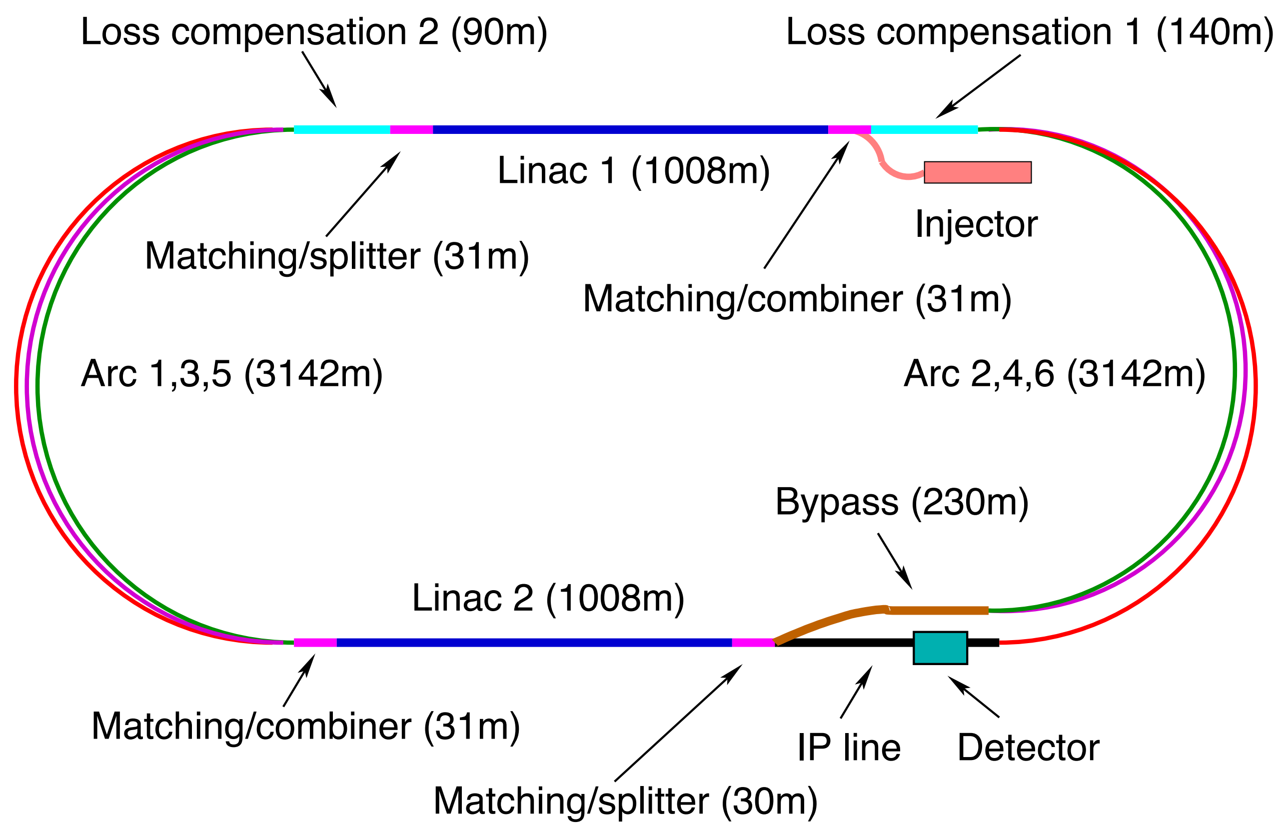
Accelerator:

$\sqrt{s} \simeq 0.8\text{-}1.2$ TeV/nucleon

Luminosity per nucleon

$$L_{eN} = \begin{cases} 9 \times 10^{31}\ \text{cm}^{-2}\text{s}^{-1} & \text{(Nominal Pb)} \\ 1.6 \times 10^{32}\ \text{cm}^{-2}\text{s}^{-1} & \text{(Ultimate Pb)} \end{cases}$$

eD: $L_{eN} = AL_{eA} > \sim 3\times10^{31}$



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LHeC

Accelerator:

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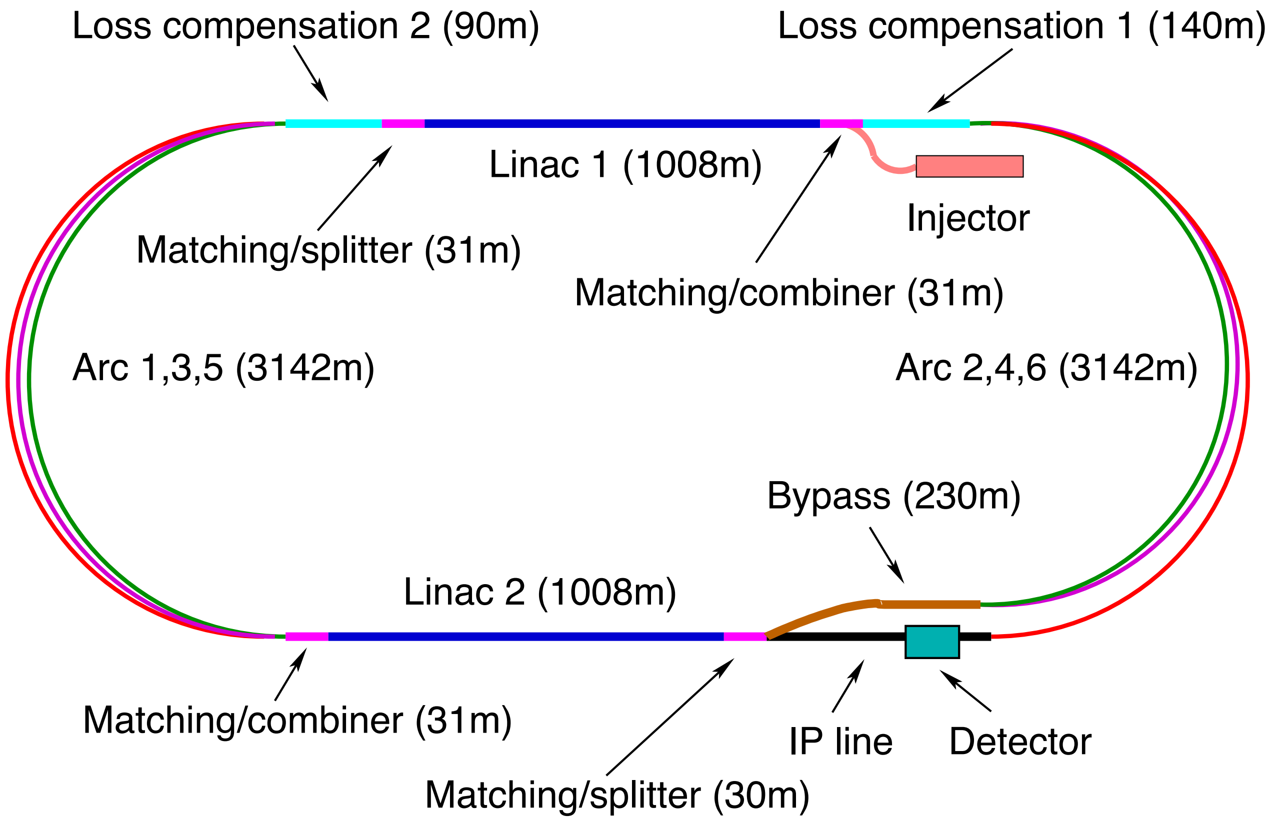

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CDR numbers

Accelerator:

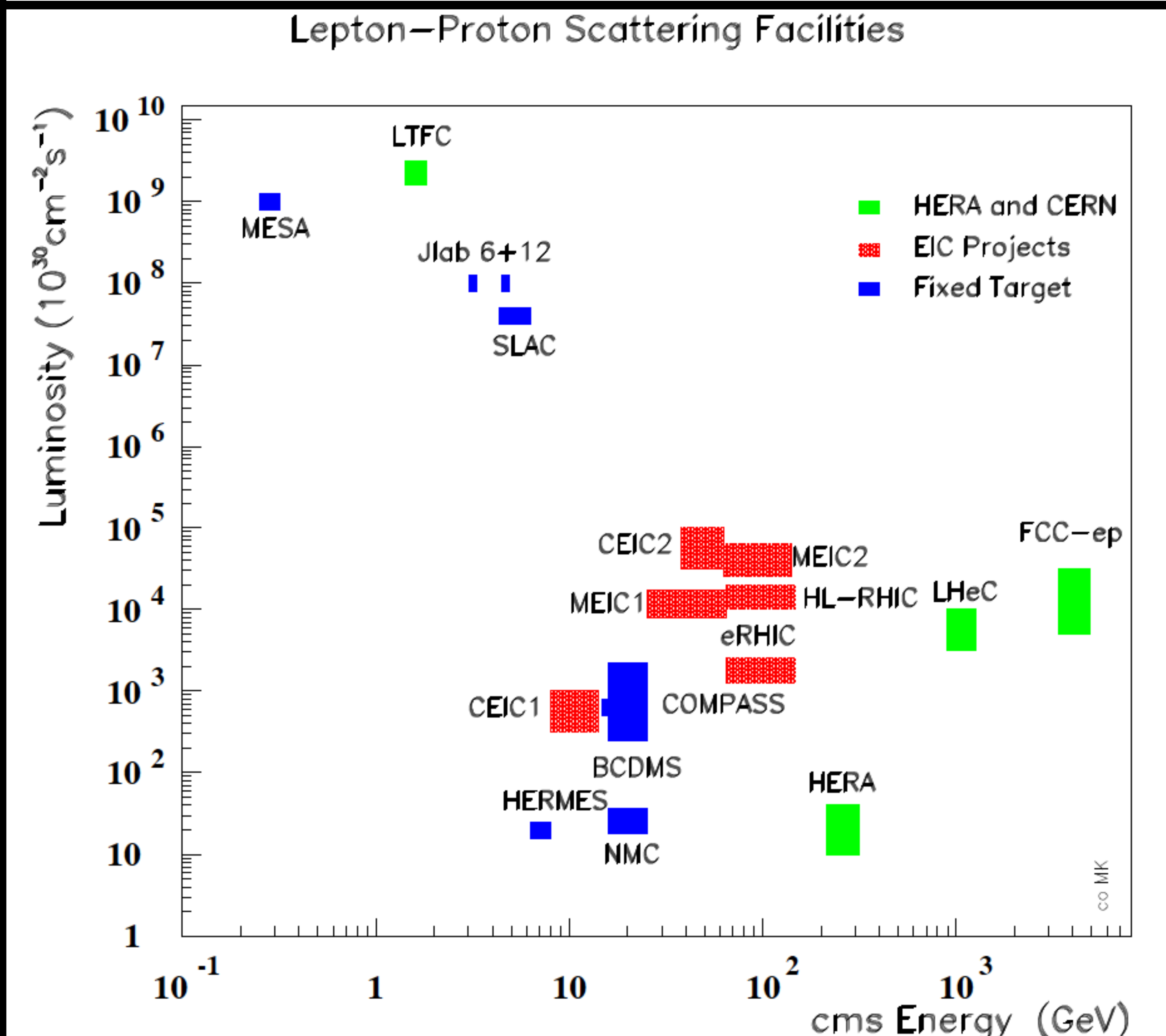
$\sqrt{s}\simeq 0.8\text{-}1.2$ T...

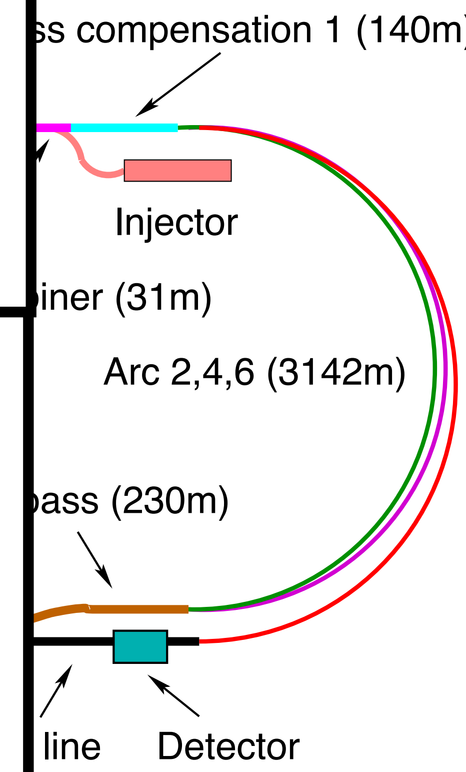
Luminosity

$L_{eN} = \begin{cases} 9\times10^{31}\ \text{cm}\ldots \\ 1.6\times10^{32}\ \text{c}\ldots \end{cases}$

eD: $L_{eN}=AL_{e}\ldots$

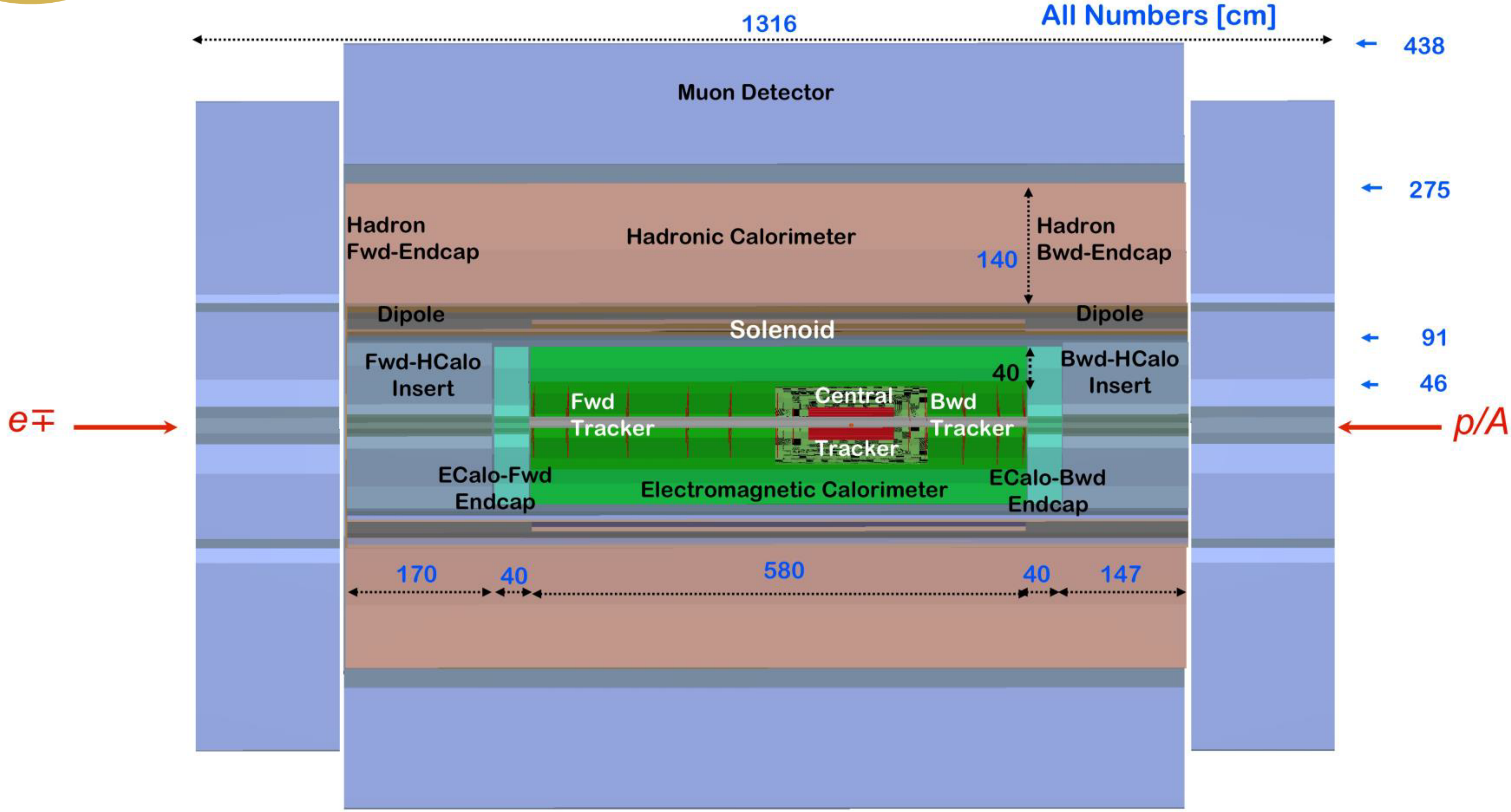
- With HL-LHC parameters, luminosities around 10^{34} cm^{-2}s^{-1} are within reach: 1 ab^{-1} in 10 years!!!



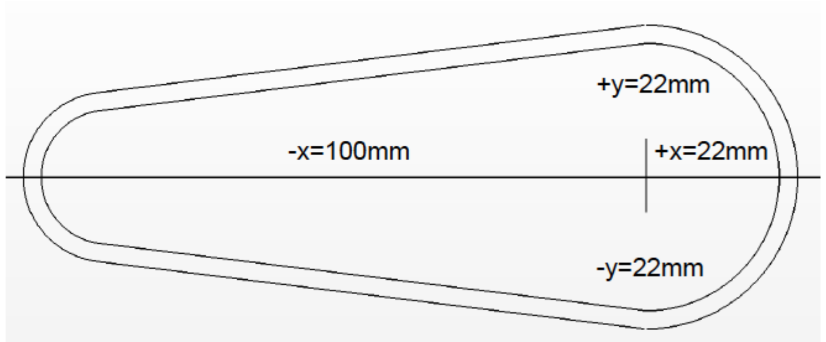


10^{34} cm^{-2} s^{-1}...	ELECTRONS
Beam Ener...	60
Luminosity...	1
Normalized...	50
Beta Funtio...	0.12
rms Beam s...	7
rms Beam ...	58
Beam Curre...	6.6
Bunch Spac...	25 (50)
Bunch Popu...	...$*10^9$) $2*10^9$
Bunch char...	(0.16) 0.32

Detector:

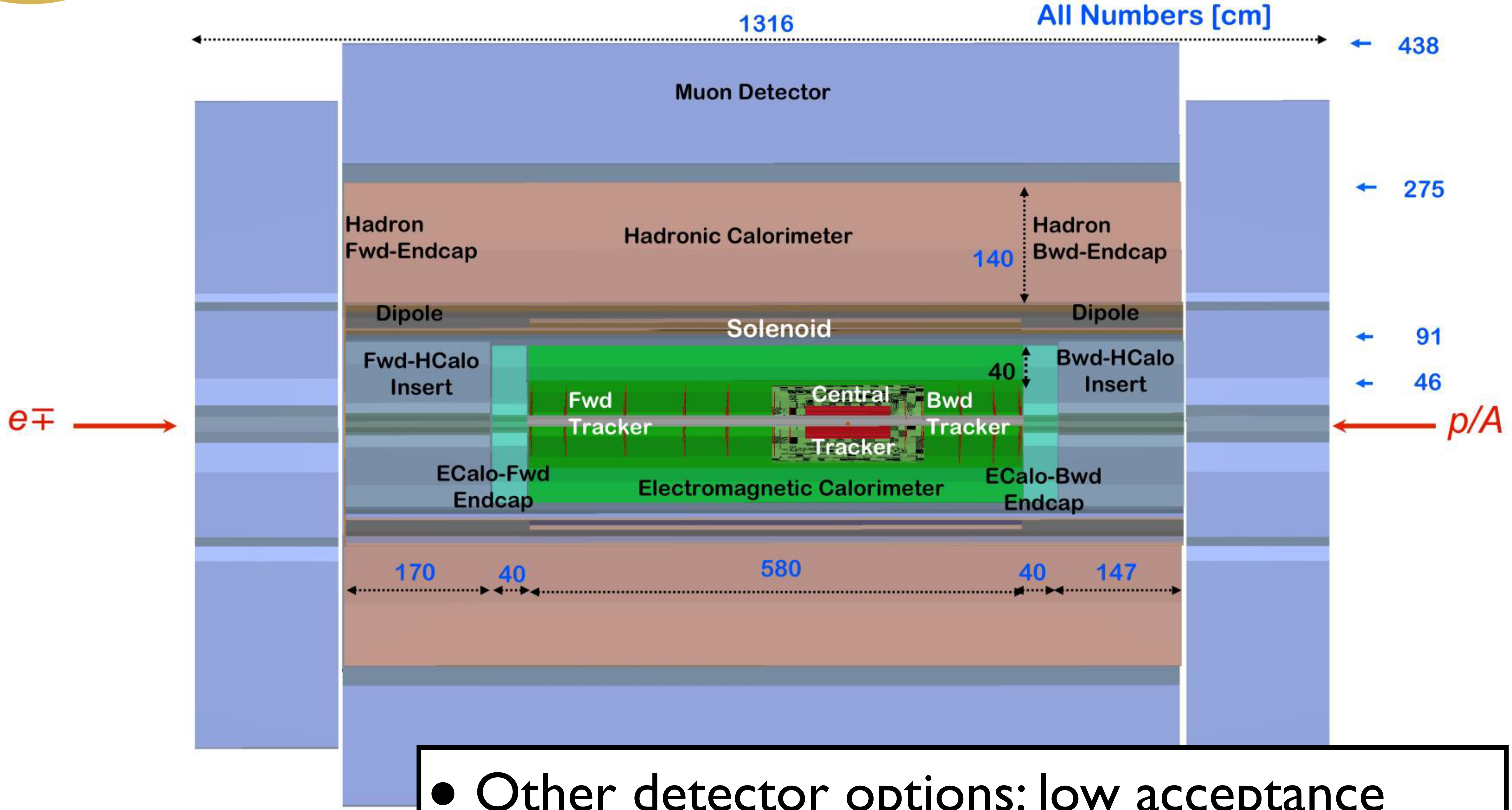


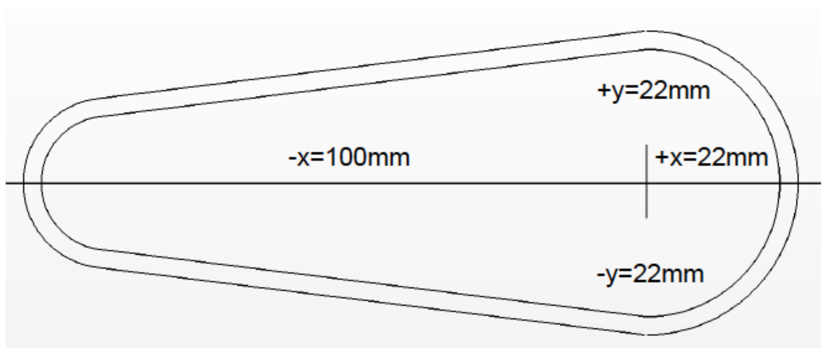
All Numbers [cm]
1316
438
275
91
46
Muon Detector
Hadron
Fwd-Endcap
Hadronic Calorimeter
140
Hadron
Bwd-Endcap
Dipole
Solenoid
Dipole
Fwd-HCalo
Insert
40
Bwd-HCalo
Insert
Fwd
Tracker
Central
Tracker
Bwd
Tracker
e∓
p/A
ECalo-Fwd
Endcap
Electromagnetic Calorimeter
ECalo-Bwd
Endcap
170
40
580
40
147



+y=22mm
-x=100mm
+x=22mm
-y=22mm

Detector:

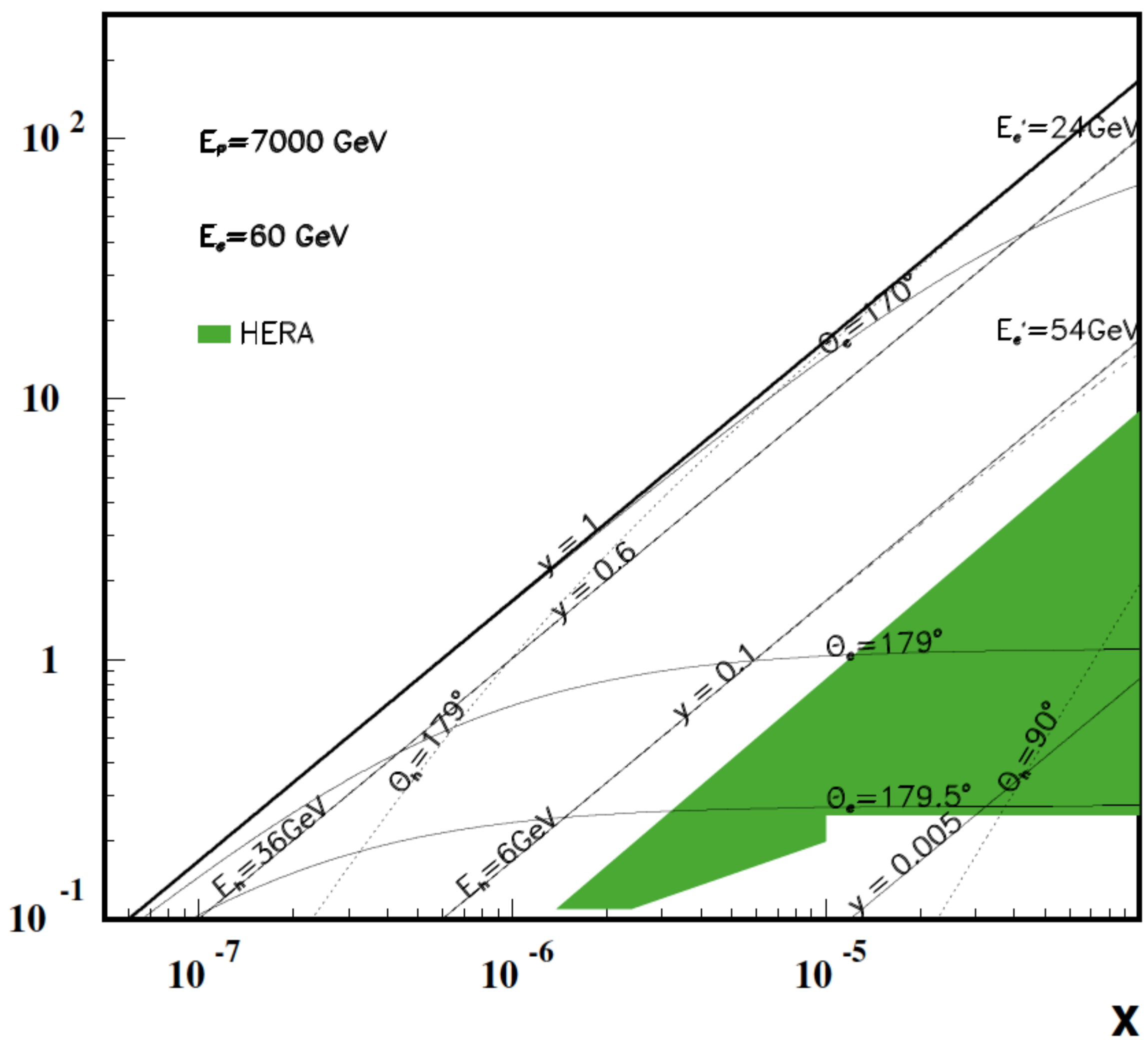




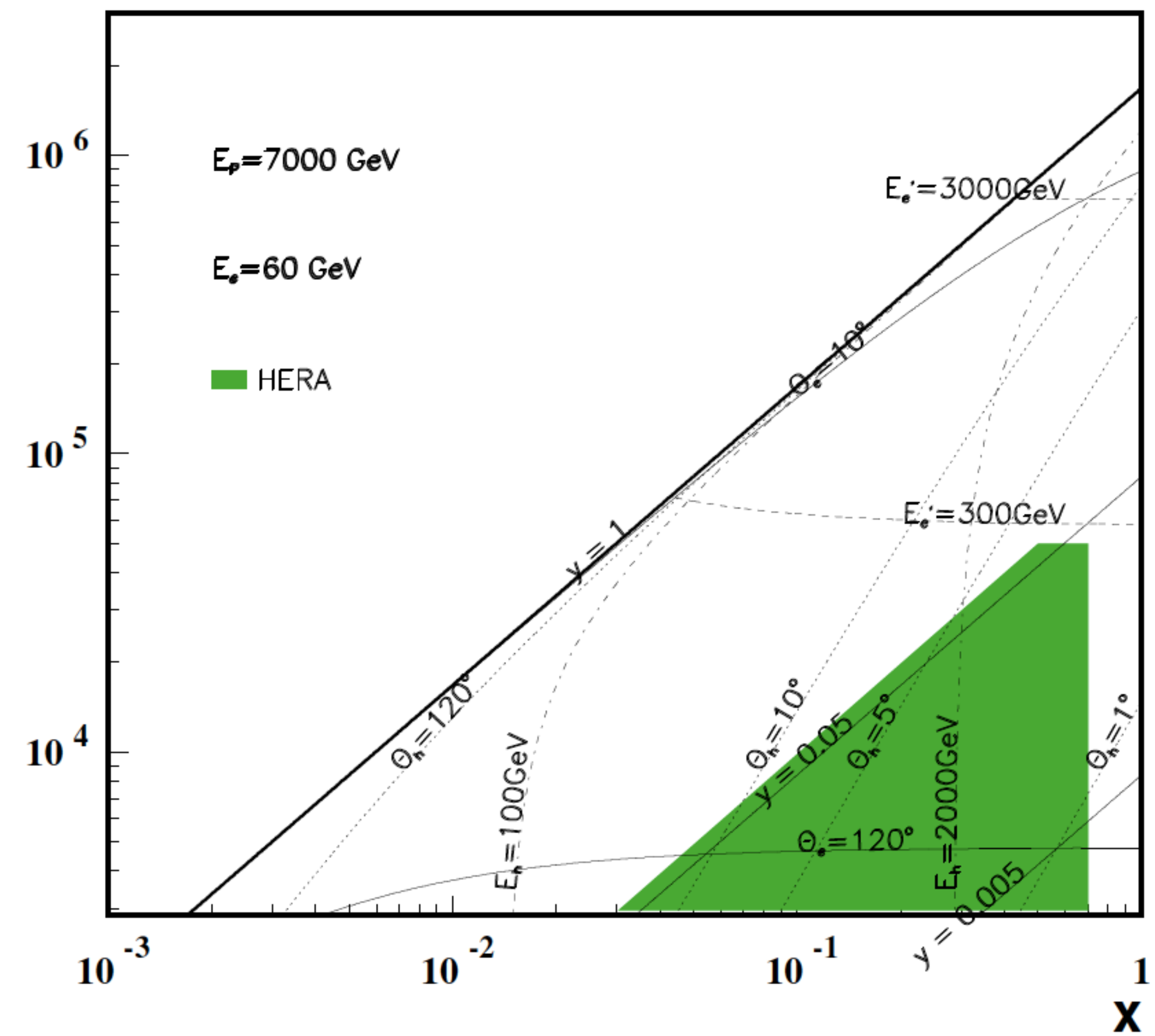
- Other detector options: low acceptance (8°-172°), solenoid outside, also considered.
- Plus luminosity detector, electron tagging, polarimeter, ZDC and leading proton detector.

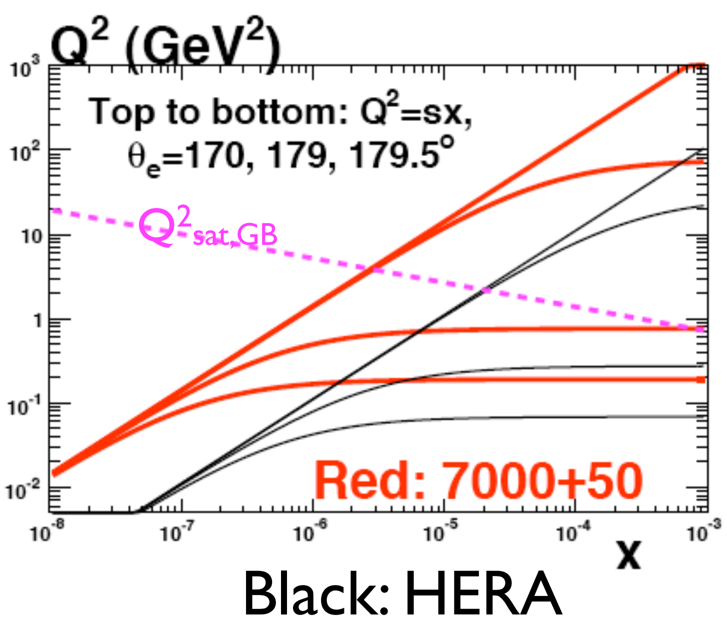
Kinematics:

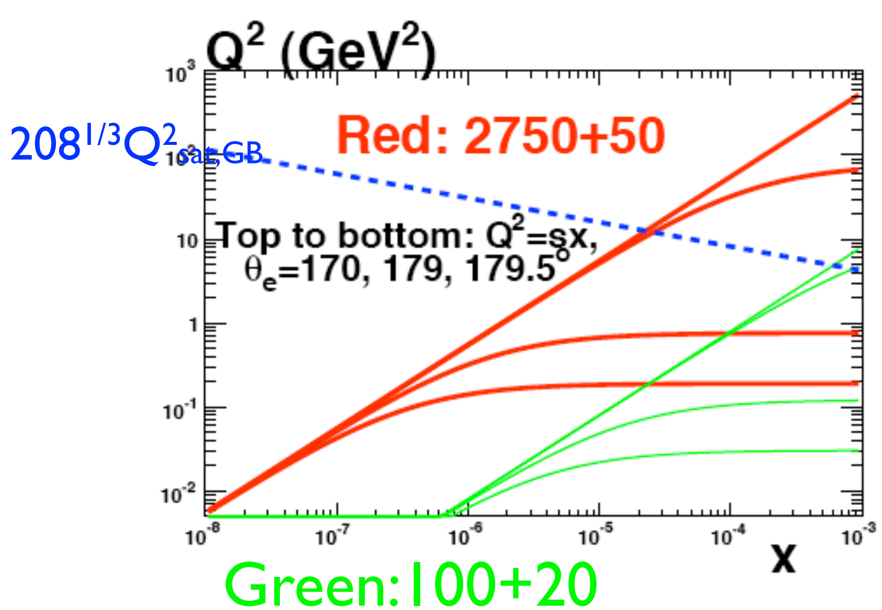
LHeC - Low x Kinematics



LHeC - High Q^2 Kinematics

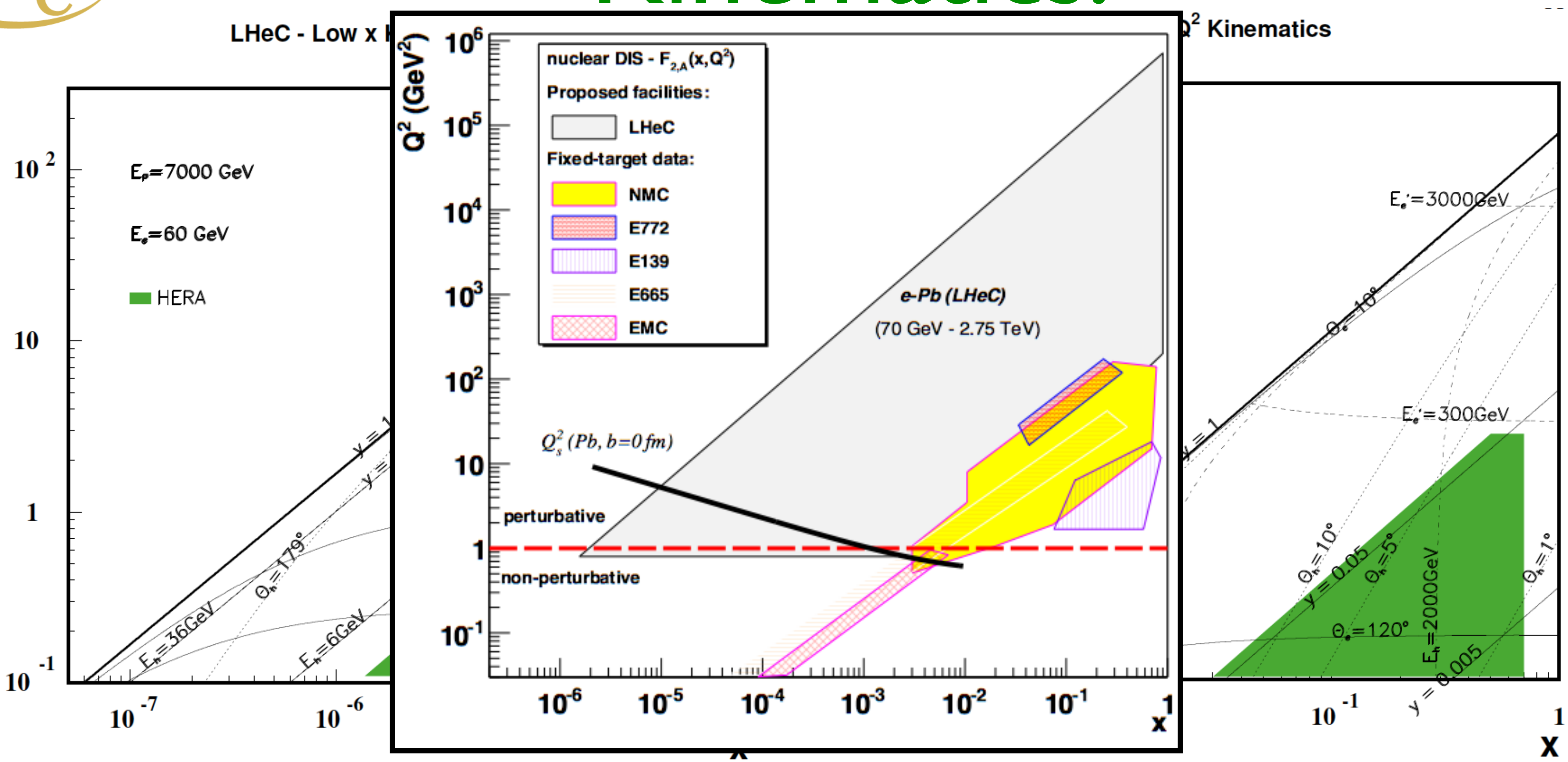


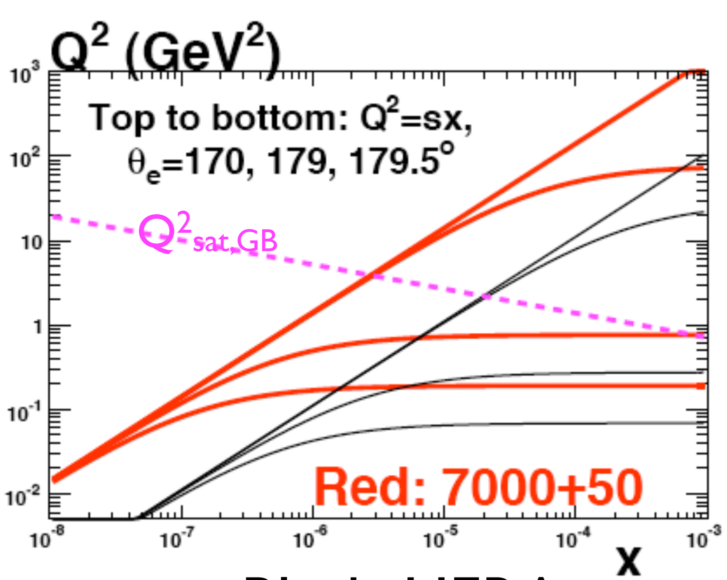




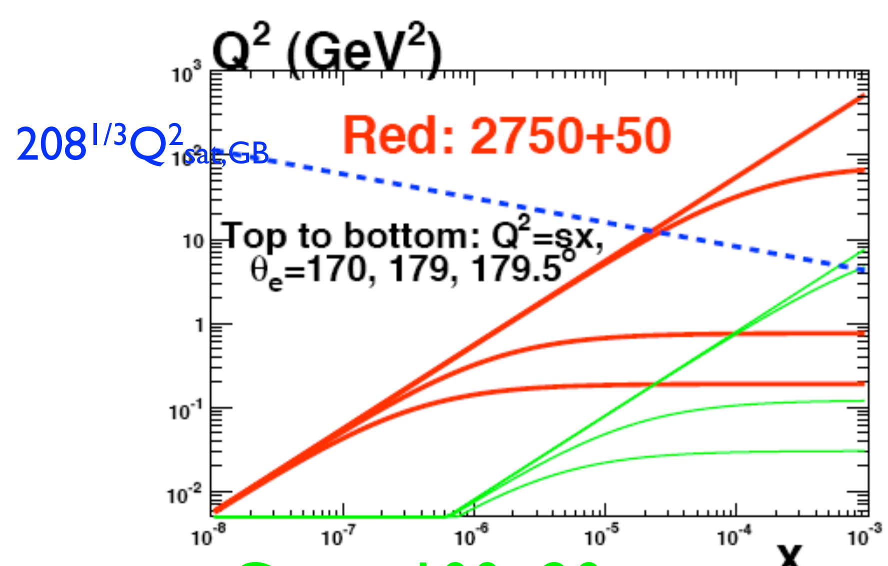
- Small-x demands 1 degree acceptance.
- Higher luminosity would benefit high-x and Q^2 studies.

Kinematics:





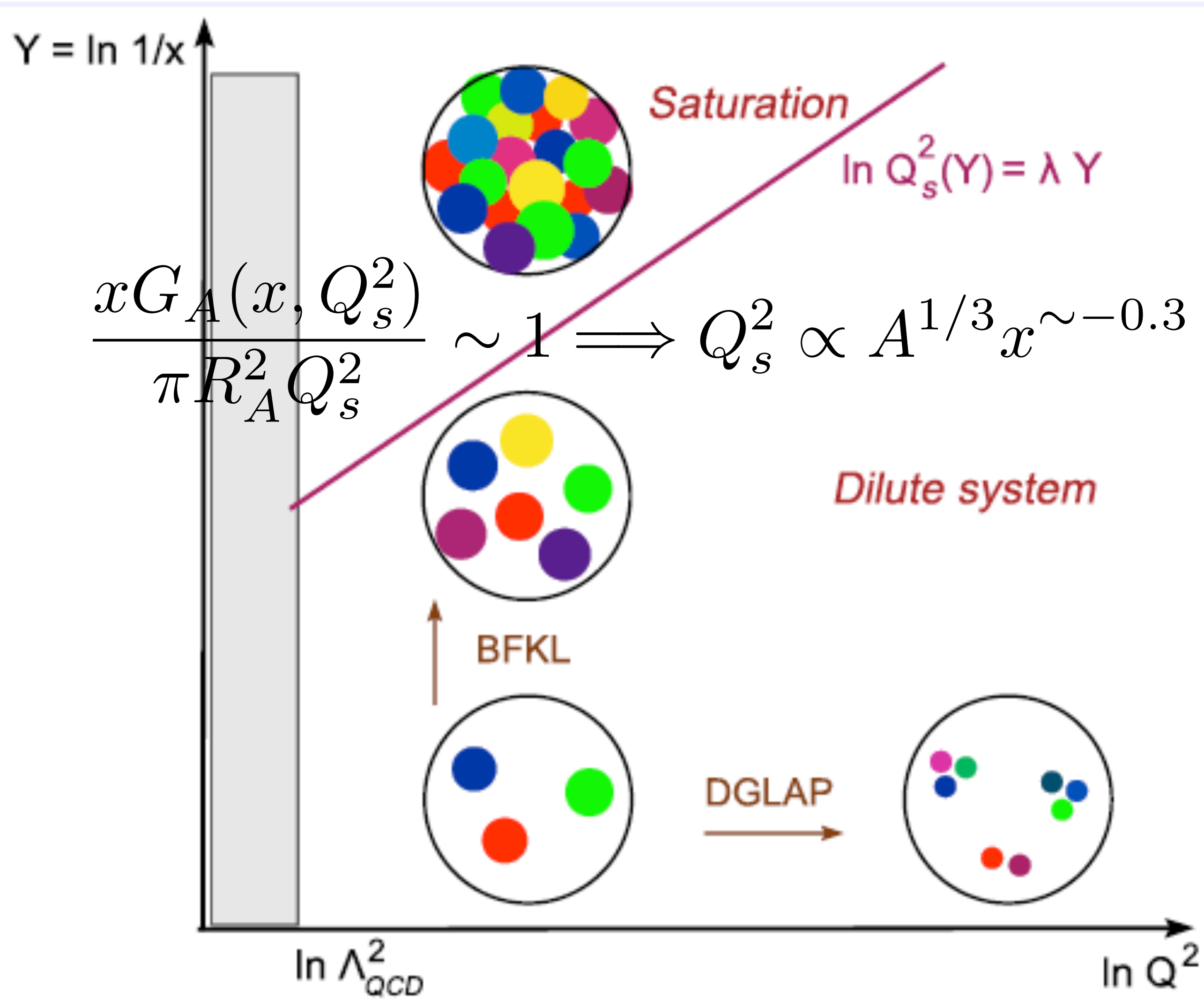
Black: HERA



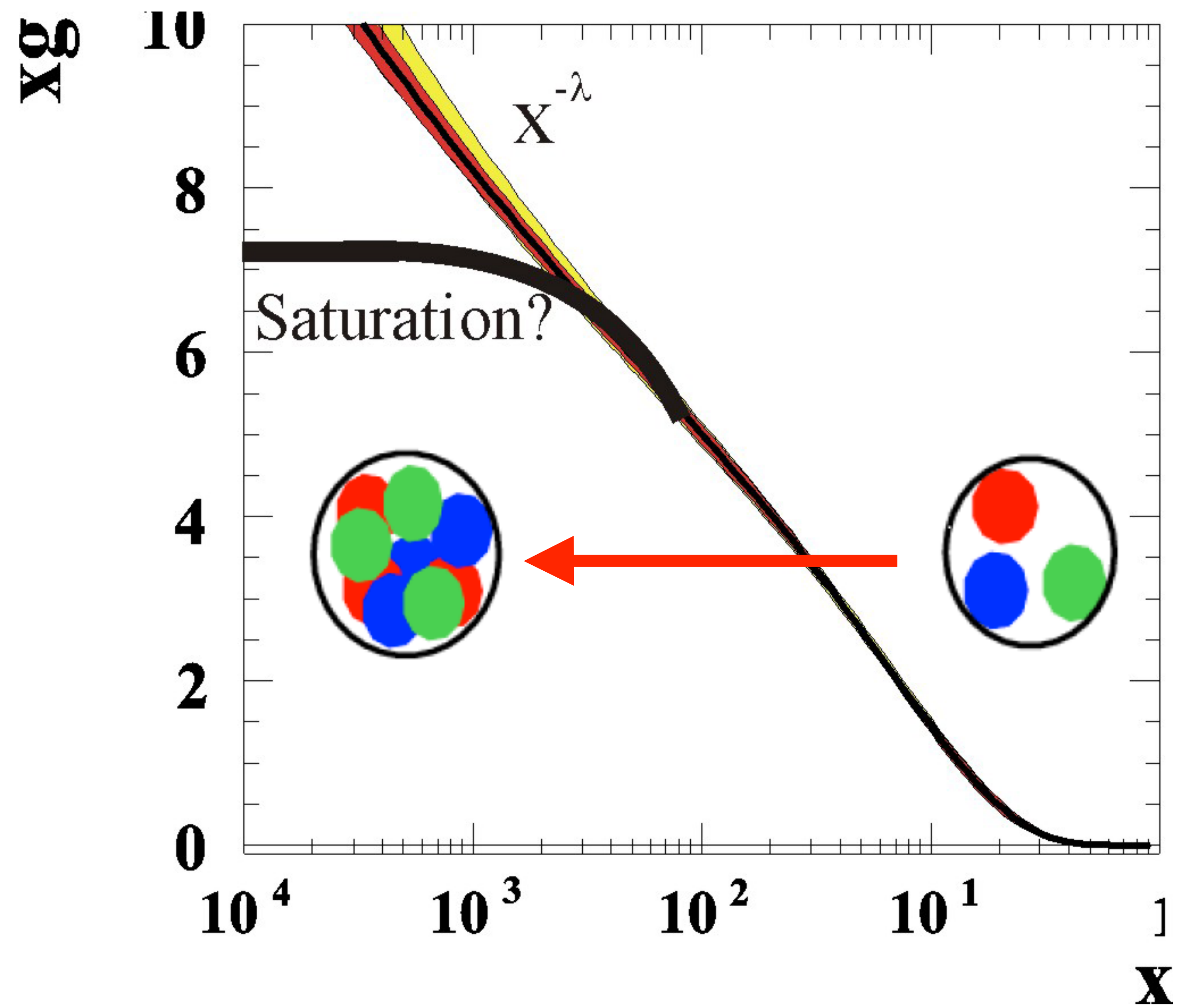
Green:100+20

- Small-x demands 1 degree acceptance.
- Higher luminosity would benefit high-x and Q^2 studies.

Small x and saturation:



$$\frac{xG_A(x, Q_s^2)}{\pi R_A^2 Q_s^2} \sim 1 \Longrightarrow Q_s^2 \propto A^{1/3} x^{\sim -0.3}$$



- QCD radiation of partons when x decreases leads to a large number of partons (gluons), provided each parton evolves independently (linearly, $\Delta[xg] \propto xg$).
- This independent evolution breaks at high densities (<u>small x or high mass number A</u>): non-linear effects ($gg \to g$, $\Delta[xg] \propto xg - k(xg)^2$).

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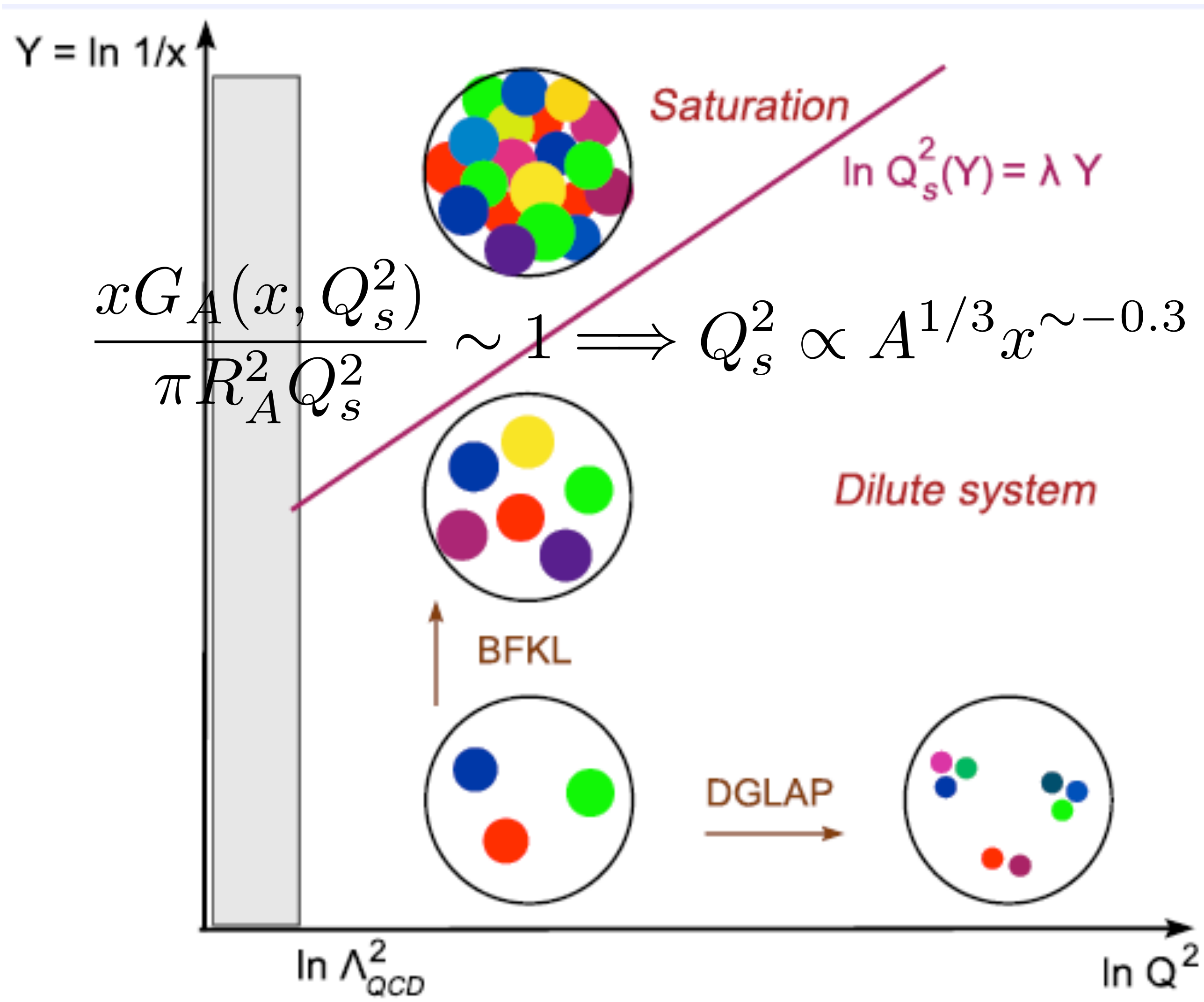

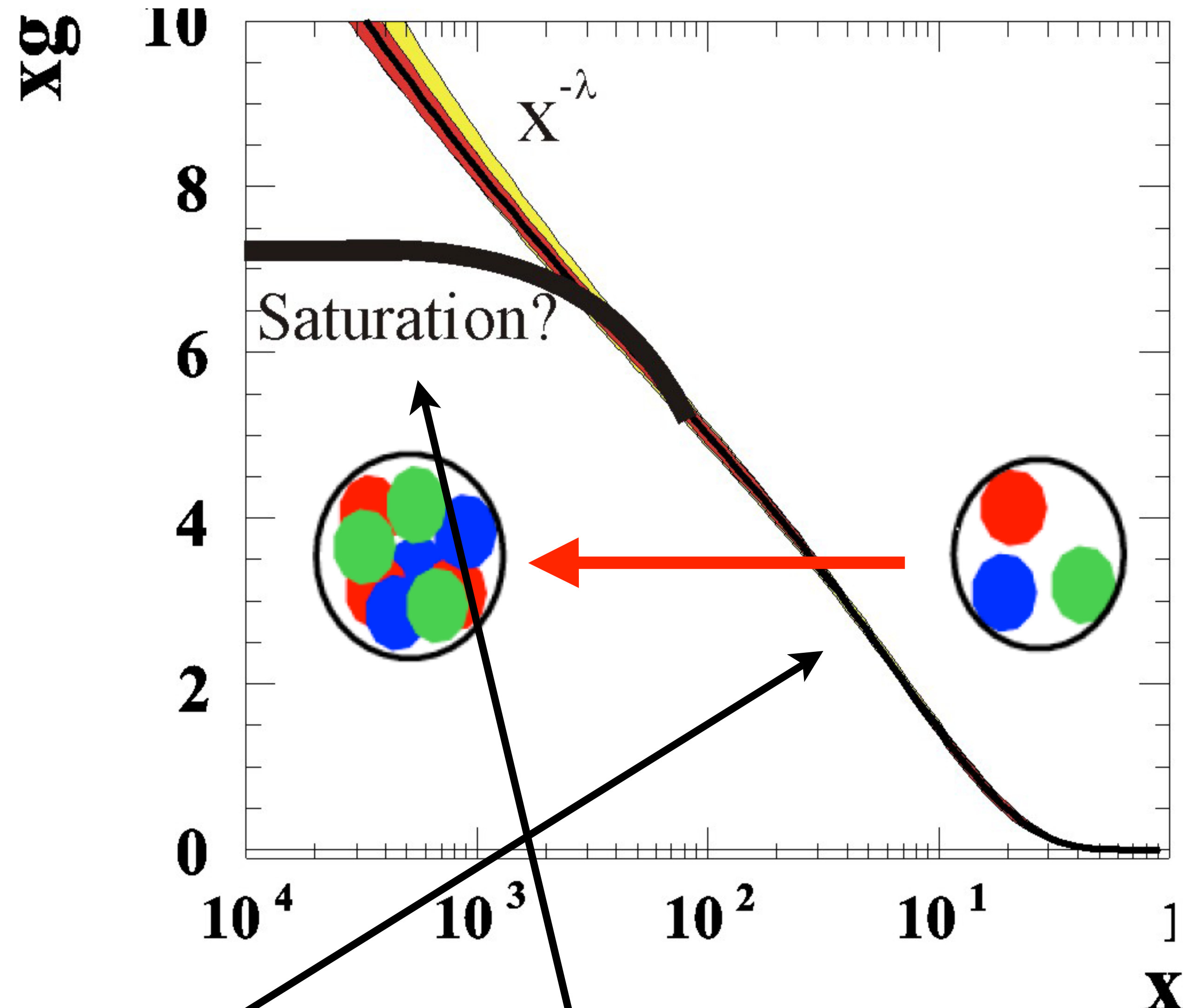

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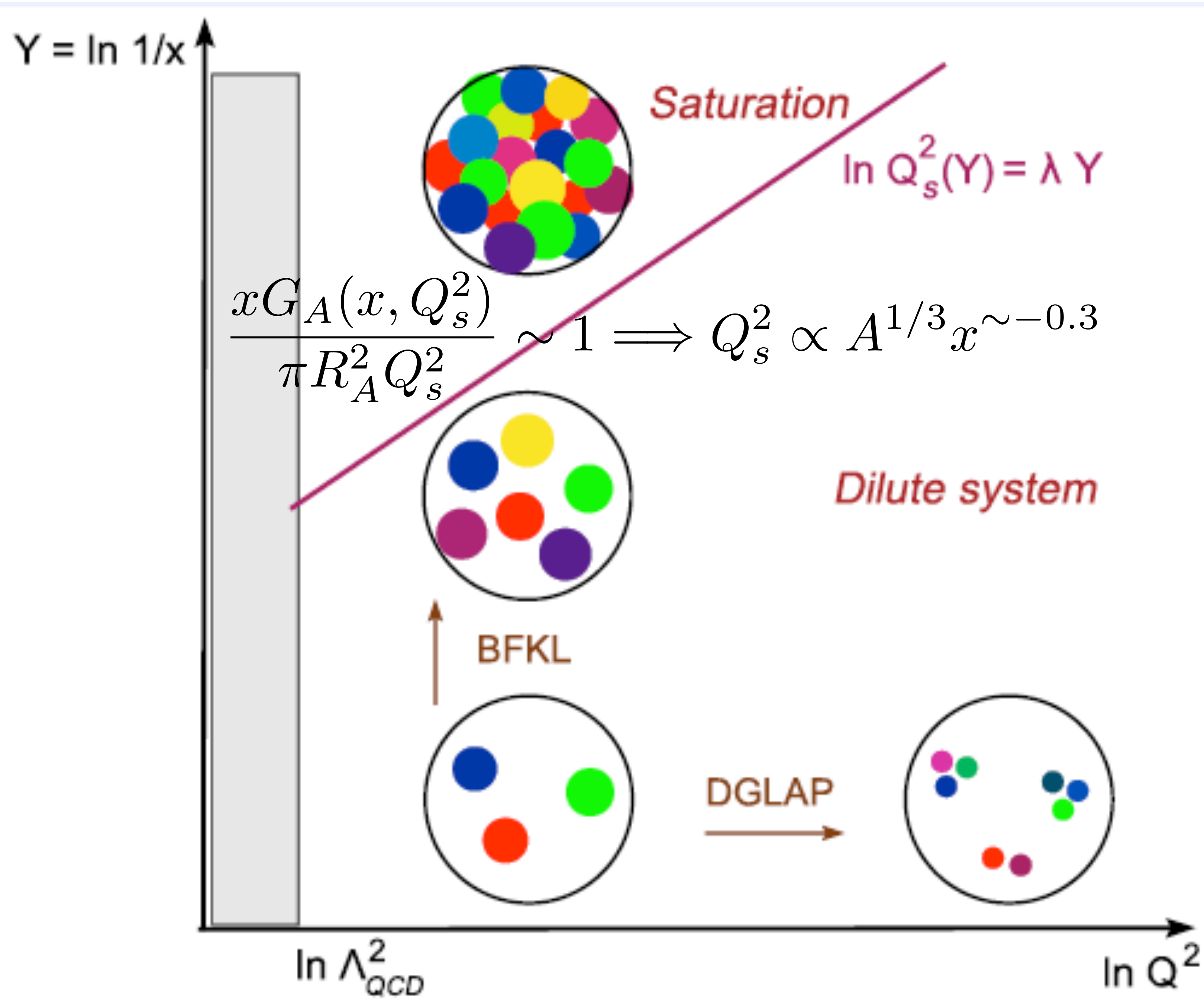
The 'QCD phase' diagram:

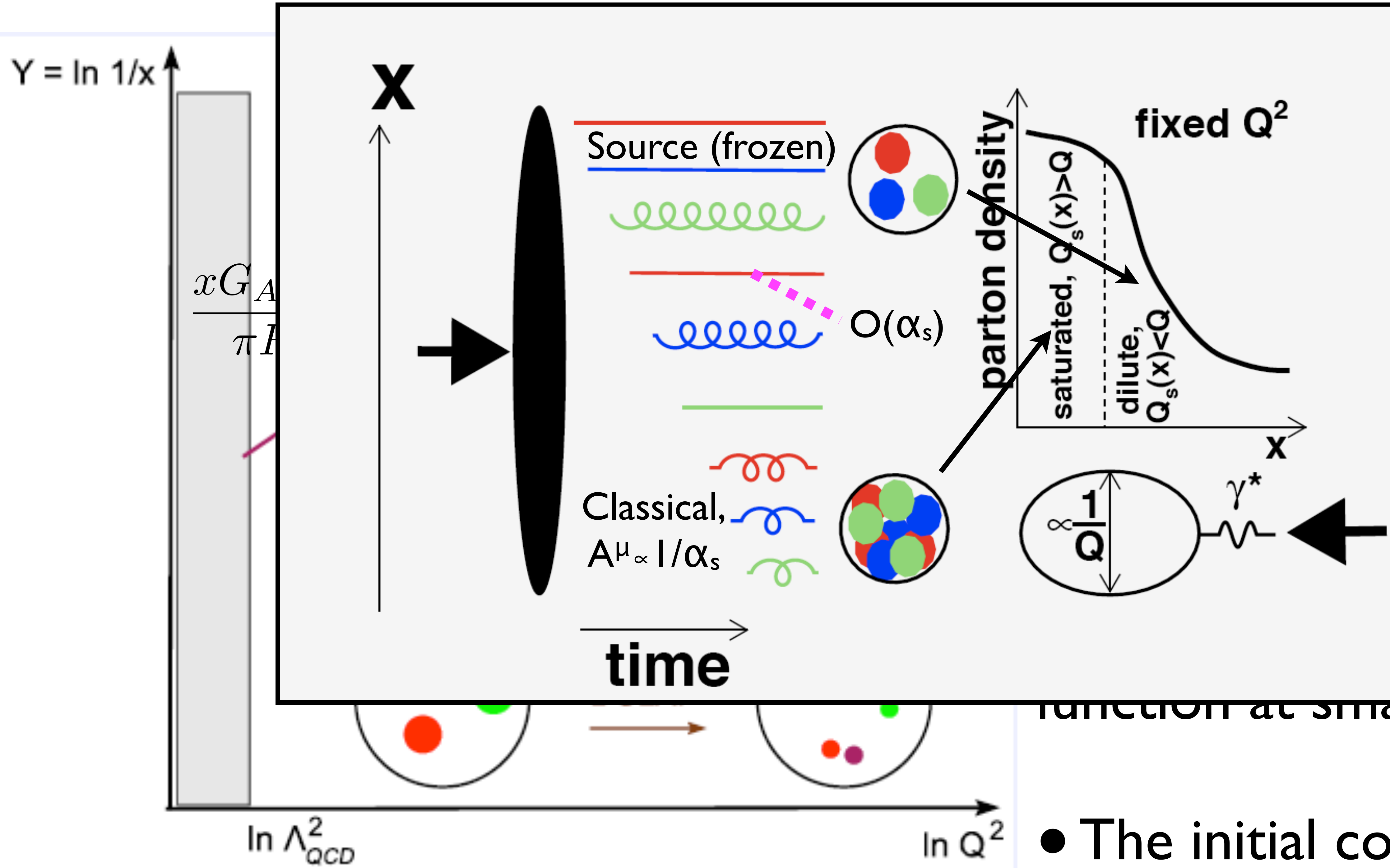


Origin in the early 80's: GLR, Mueller et al, McLerran-Venugopalan.

Our aims: understanding

- The implications of unitarity in a QFT.
- The behaviour of QCD at large energies.
- The hadron wave function at small x.
- The initial conditions for the creation of a dense medium in heavy-ion collisions.

The ‘QCD phase’ diagram:



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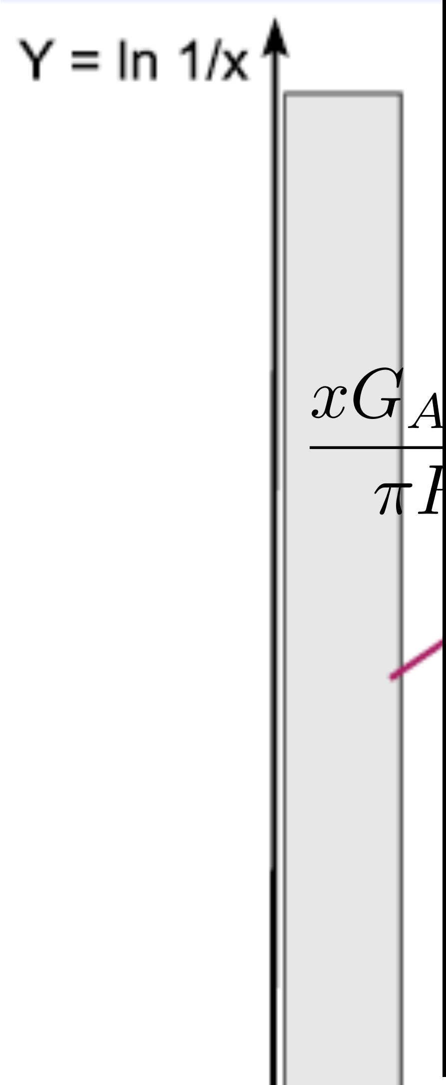

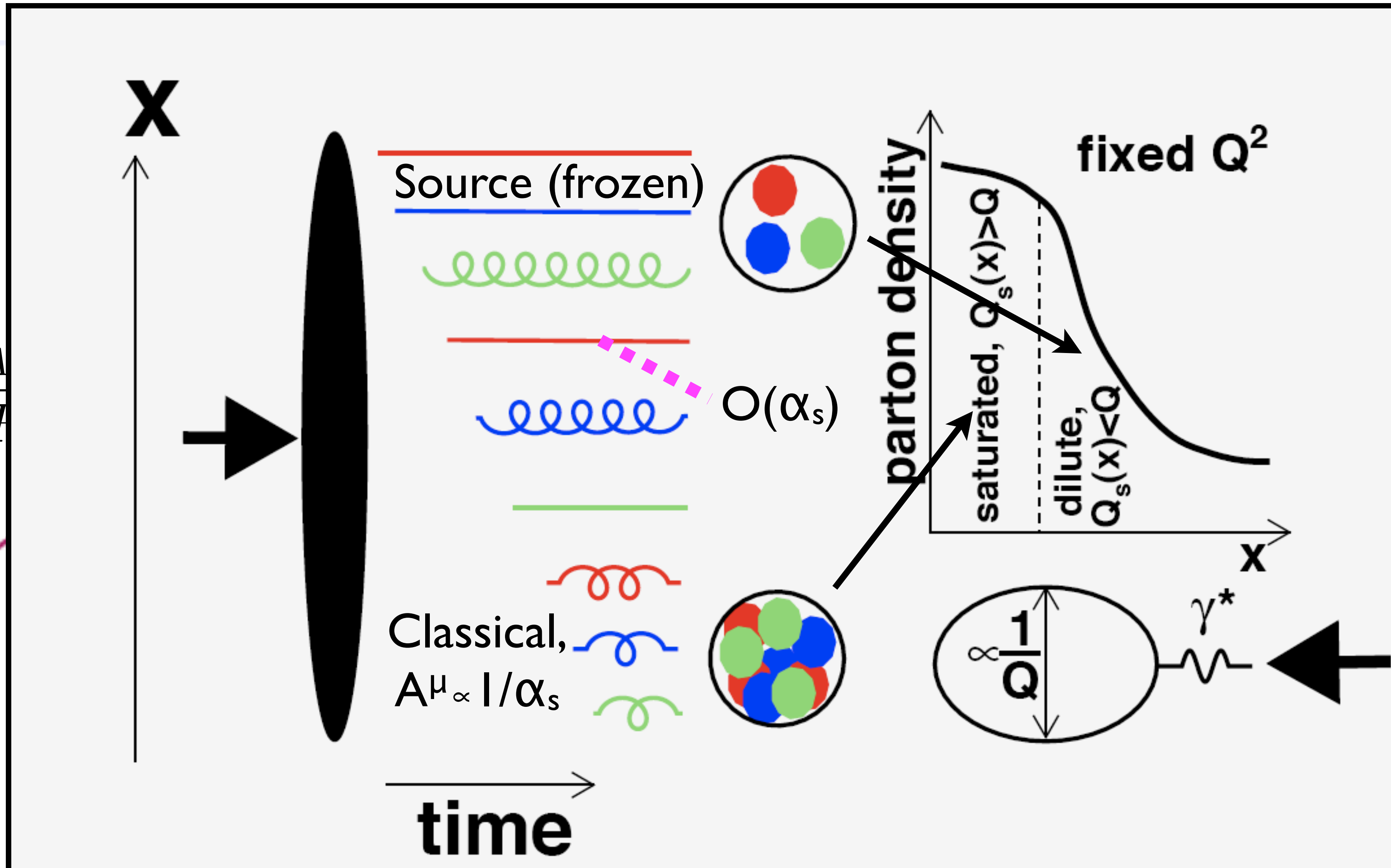

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Questions:

- **Theory**: can the dense regime be described using pQCD techniques? Or non-perturbative - Regge, AdS/QCD,...? Which factorisation is at work?
- **Experiment**: where do present/future experimental data lie?

LHeC scenarios:

For F_2

config.	E(e)	E(N)	N	$\int L(e^+)$	$\int L(e^-)$	|Pol|	$L/10^{32}$	P/MW	years	type
A	20	7	p	1	1	-	1	10	1	SPL
B	50	7	p	50	50	0.4	25	30	2	RR hiQ^2
C	50	7	p	1	1	0.4	1	30	1	RR lo x
D	100	7	p	5	10	0.9	2.5	40	2	LR
E	150	7	p	3	6	0.9	1.8	40	2	LR
F	50	3.5	D	1	1	--	0.5	30	1	eD
G	50	2.7	Pb	10^{-4}	10^{-4}	0.4	10^{-3}	30	1	ePb
H	50	1	p	--	1	--	25	30	1	lowEp
I	50	3.5	Ca	$5 \cdot 10^{-4}$		?	$5 \cdot 10^{-3}$	?	?	eCa

- For F_L: 10, 25, 50 + 2750 (7000); $Q^2 \leq sx$; Lumi=5,10,100 pb^{-1} respectively; charm and beauty: same efficiencies in ep and eA.

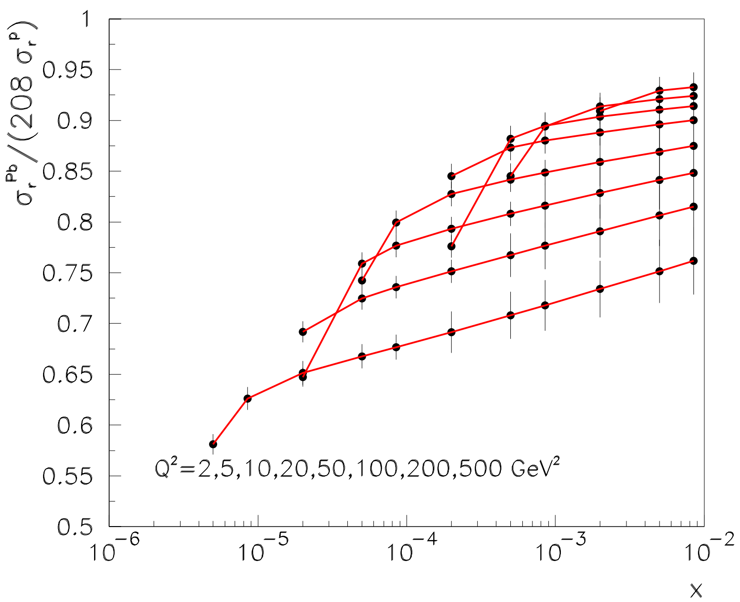
Note: F_L in eA

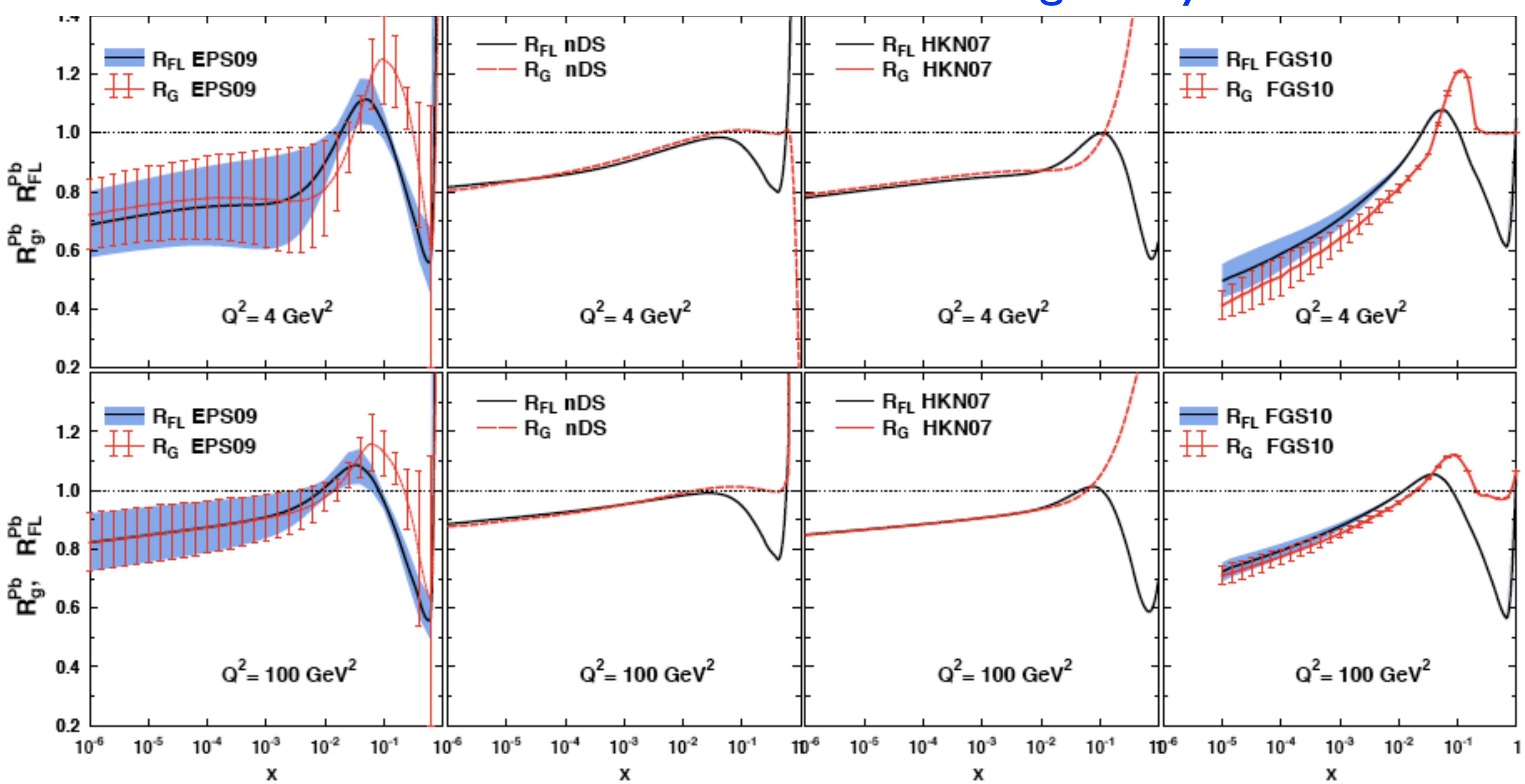
$$\sigma_r^{NC} = \frac{Q^4 x}{2\pi\alpha^2 Y_+}\frac{d^2\sigma^{NC}}{dx dQ^2} = F_2\left[1 - \frac{y^2}{Y_+}\frac{F_L}{F_2}\right], \qquad Y_+ = 1 + (1-y)^2$$

- F_L traces the nuclear effects on the glue (Cazarotto et al '08).
- Uncertainties in the extraction of F_2 due to the unknown nuclear effects on F_L of order 5 % (larger than expected stat.+syst.) ⇒

measure F_L or use the reduced cross section (but then ratios at two energies...).

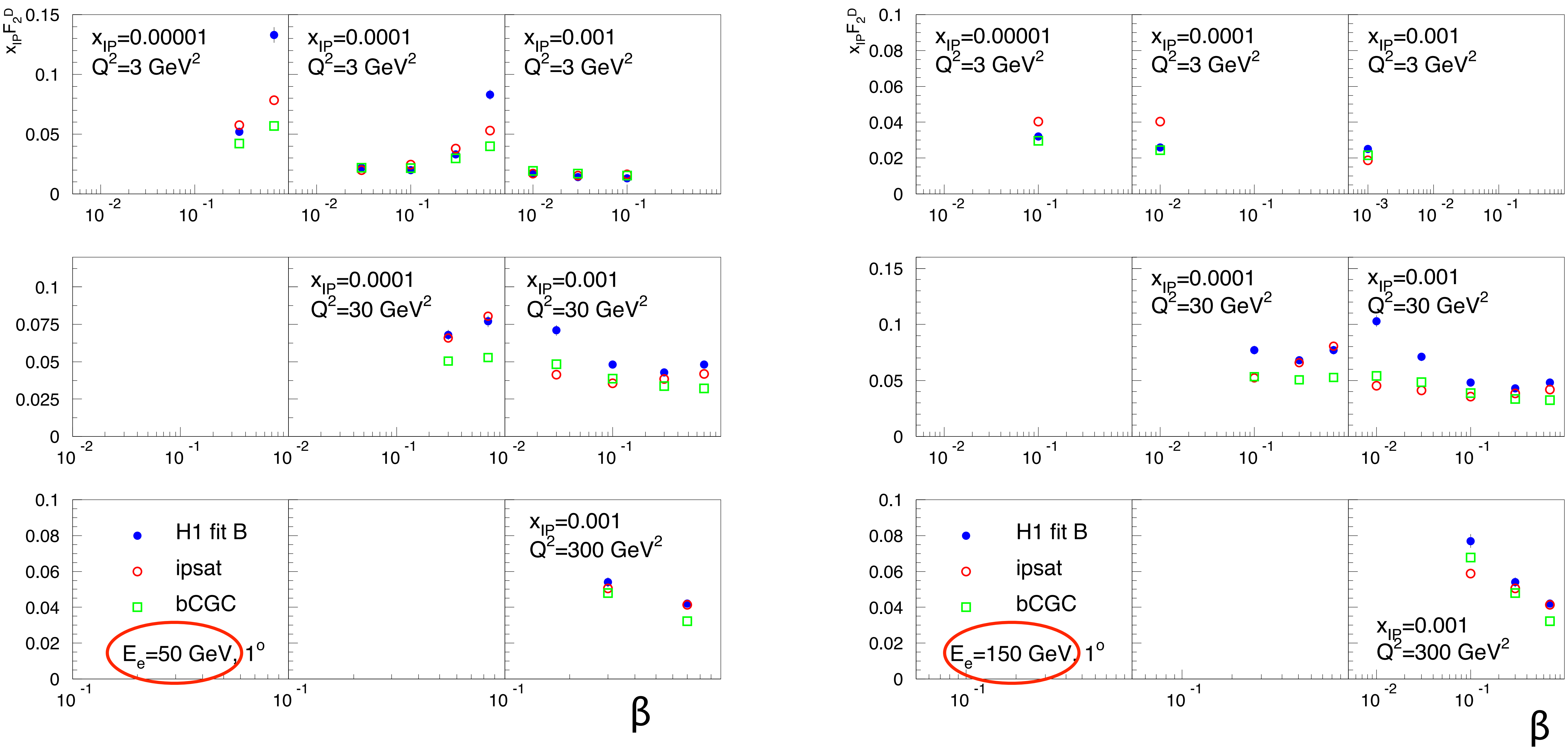
NA, Paukkunen, Salgado, Tywoniuk, '10



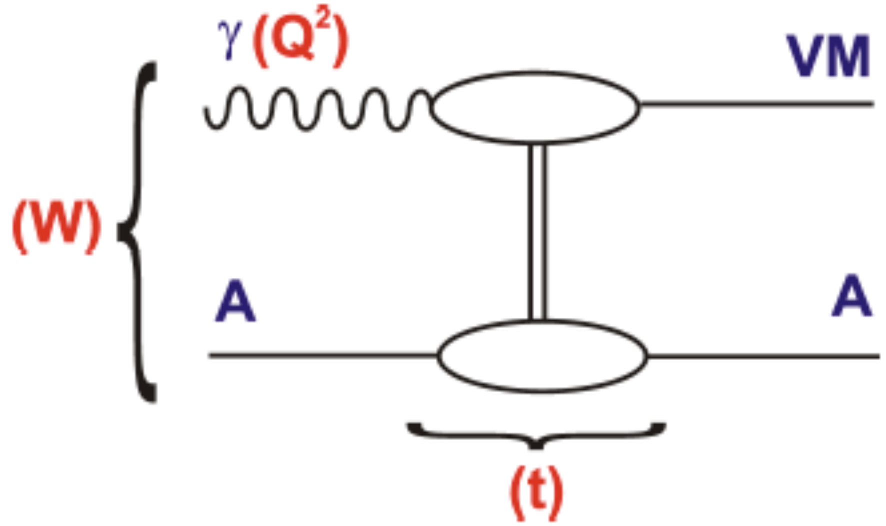


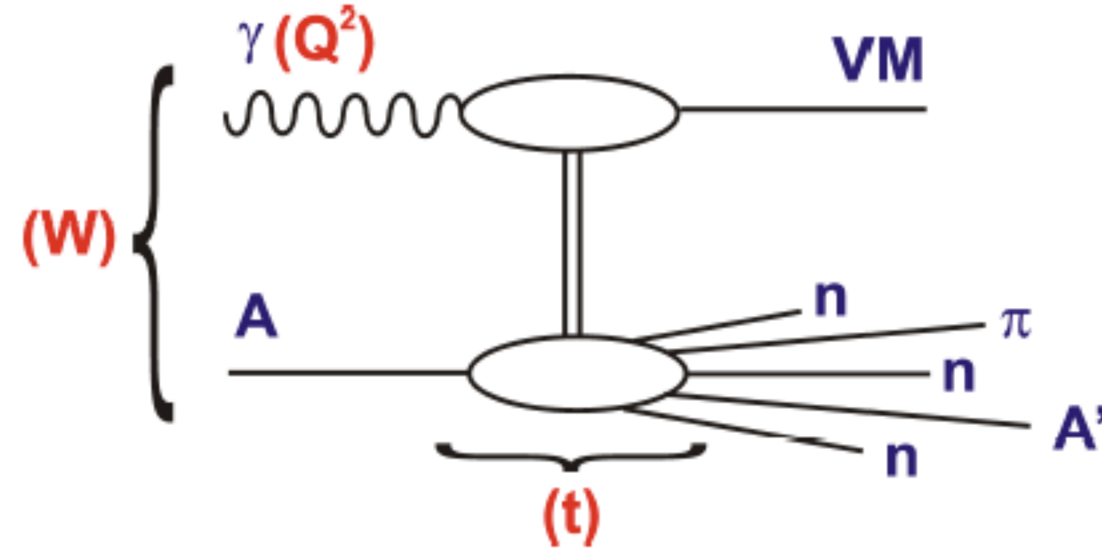
LHeC Diffraction and non-linear dynamics:

- Dipole models show differences with linear-based extrapolations (HERA-based dpdf's) and among each other: possibility to check saturation and its realization.



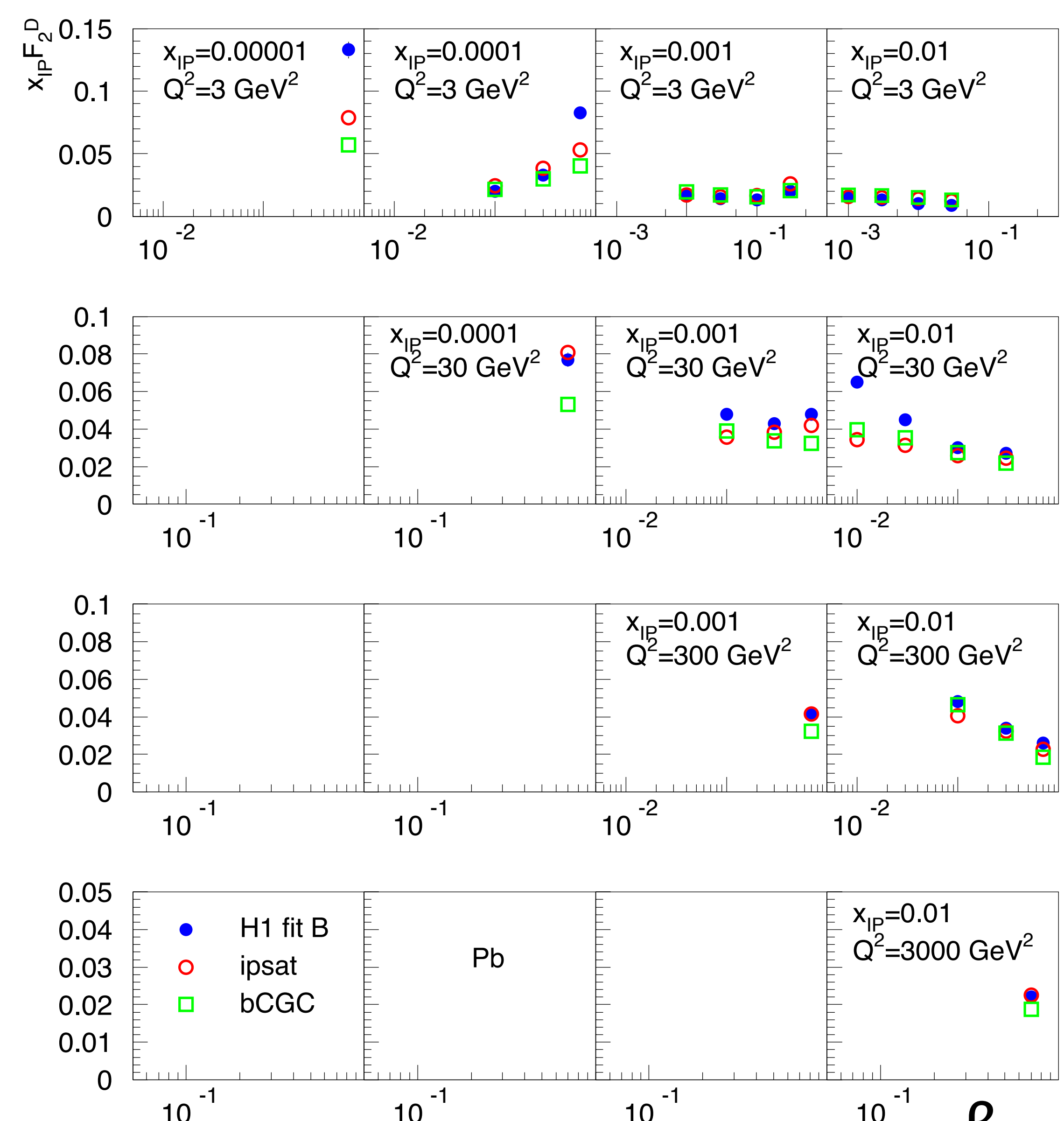
Diffractive DIS on nuclear targets:





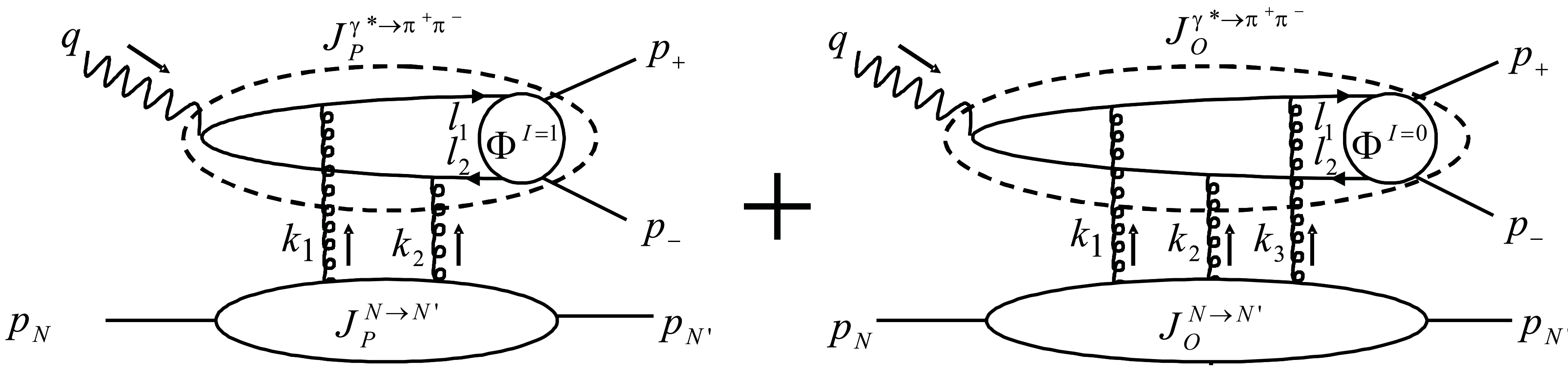
- Challenging experimental problem, requires Monte Carlo simulation with detailed understanding of the nuclear break-up.

- For the coherent case, predictions available.



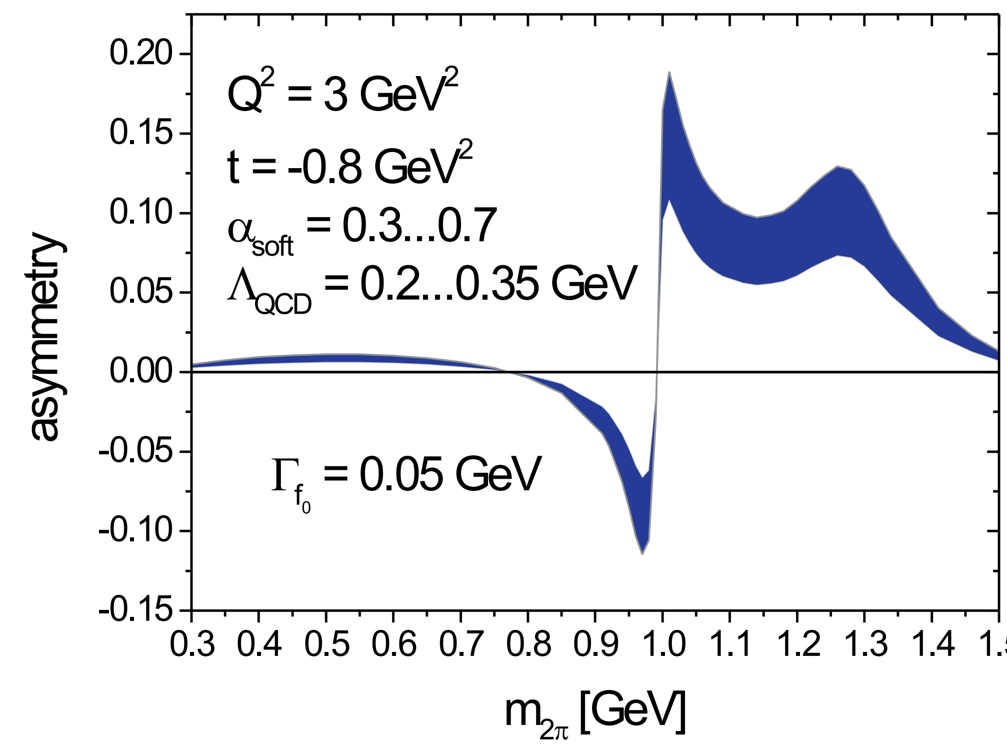
Odderon:

- Odderon (C-odd exchange contributing to particle-antiparticle difference in cross section) seached in $\gamma^{(\star)} p \to Cp, \text{ where } C = \pi^0, \eta, \eta', \eta_c \ldots$ or through O-P interferences.



$$A(Q^2,t,m_{2\pi}^2) = \frac{\int \cos\theta \, d\sigma(W^2,Q^2,t,m_{2\pi}^2,\theta)}{\int d\sigma(W^2,Q^2,t,m_{2\pi}^2,\theta)} = \frac{\int_{-1}^{1} \cos\theta \, d\cos\theta \, 2 \, \mathrm{Re}\left[\mathcal{M}_P^{\gamma_L^*} (\mathcal{M}_O^{\gamma_L^*})^*\right]}{\int_{-1}^{1} d\cos\theta \left[|\mathcal{M}_P^{\gamma_L^*}|^2 + |\mathcal{M}_O^{\gamma_L^*}|^2\right]}$$

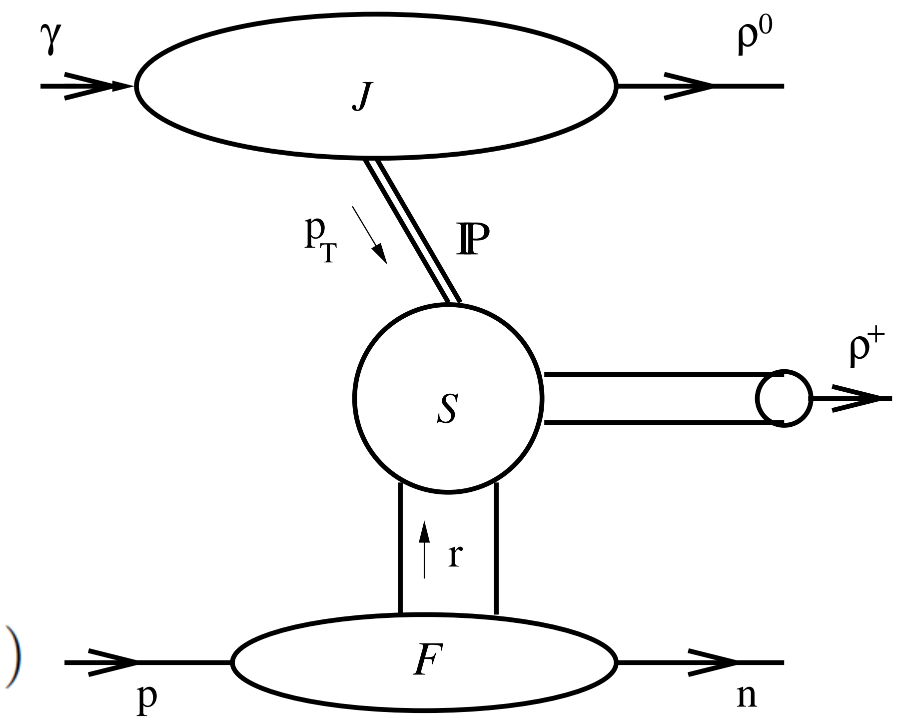
- Sizable charge asymmetry, yields and reconstruction pending.



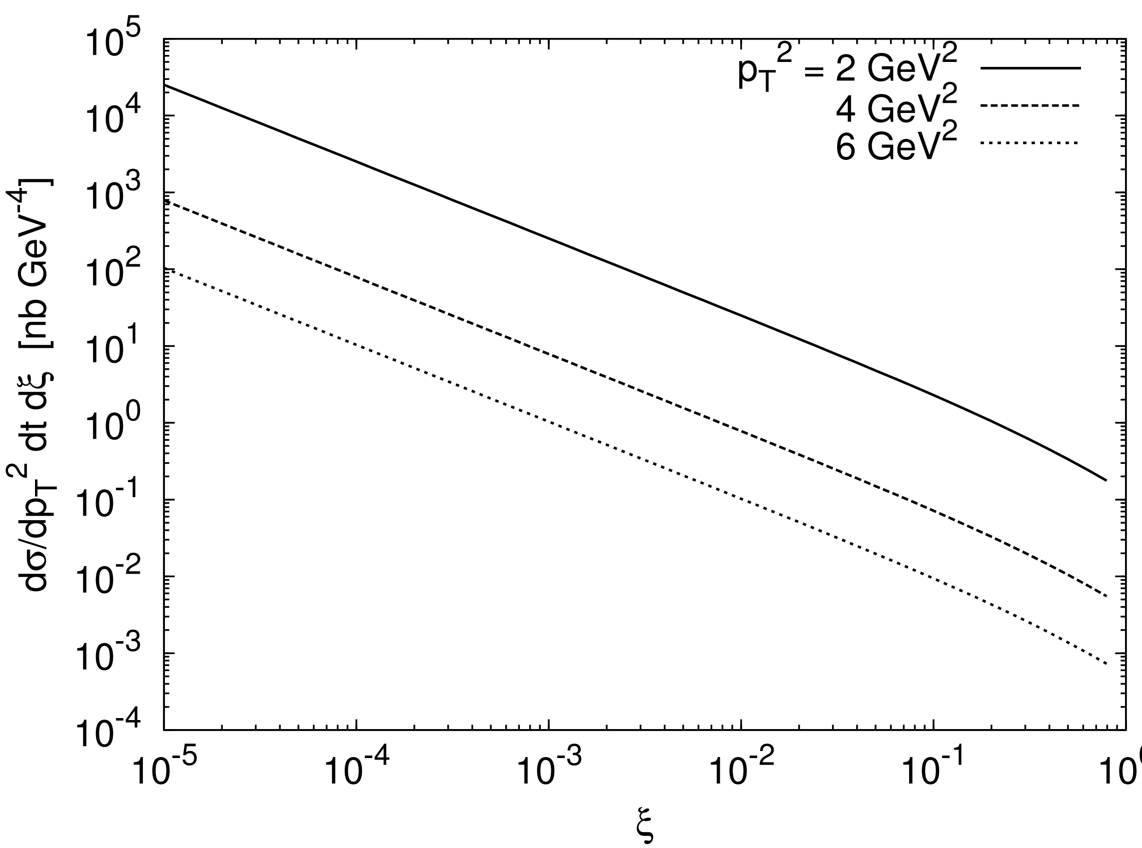
Transversity GPDs:

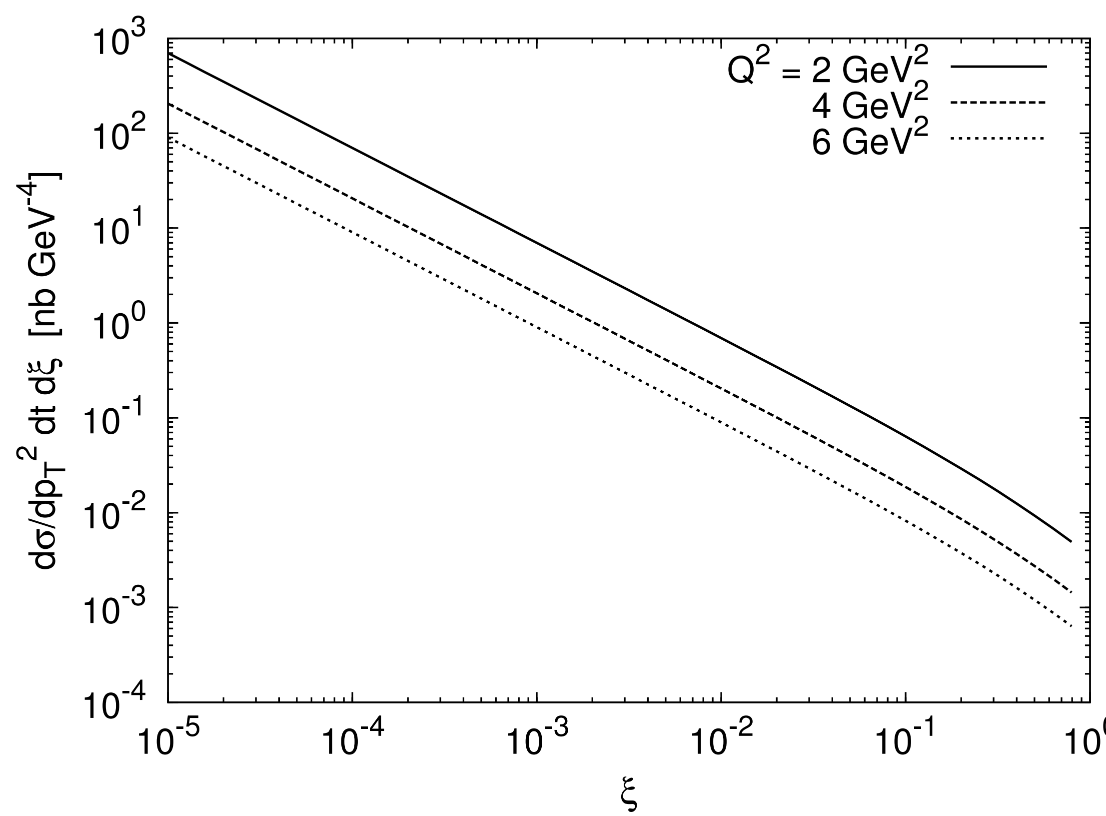
- Chiral-odd transversity GPDs are largely unknown.

- They can be accessed through double exclusive production:



$$ep(p_2) \to e'\gamma^{(*)}_{L/T}(q)\ \ p(p_2) \to e'\rho^0_{L,T}(q_\rho)\ \ \rho_T(p_\rho)\ N'(p_{2'})$$





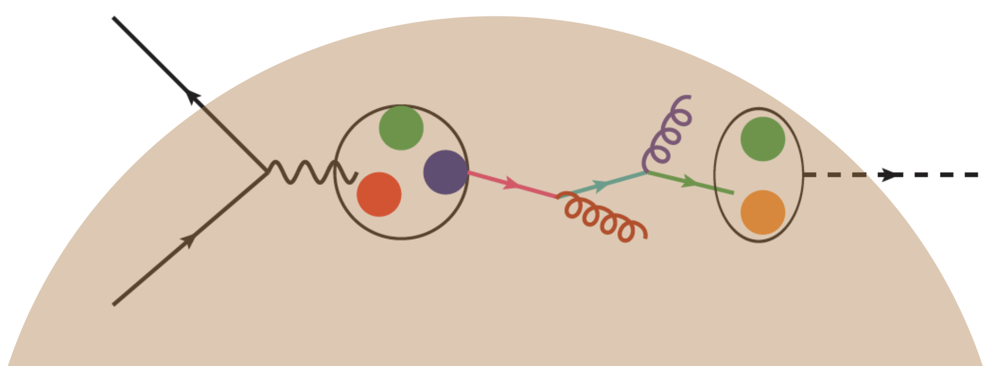
$$\xi \approx x_B/(2 - x_B)$$

Radiation and hadronization:

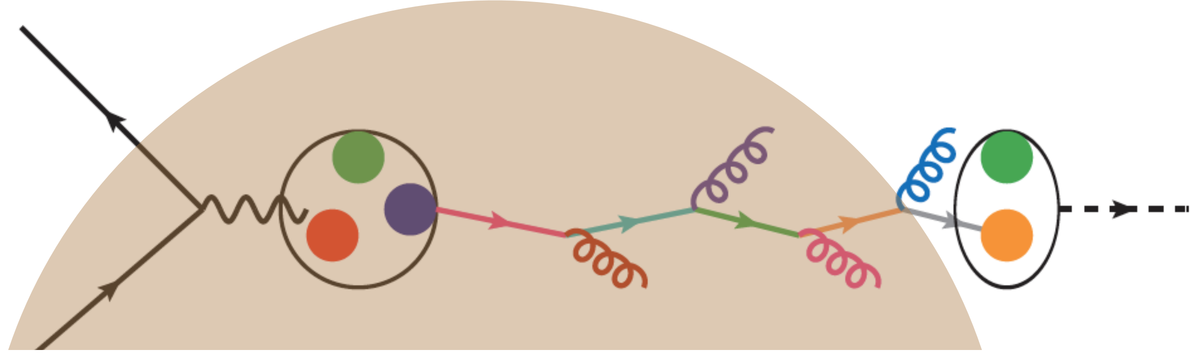
- LHeC: dynamics of QCD radiation and hadronization.
- Most relevant for particle production off nuclei and for QGP analysis in HIC.

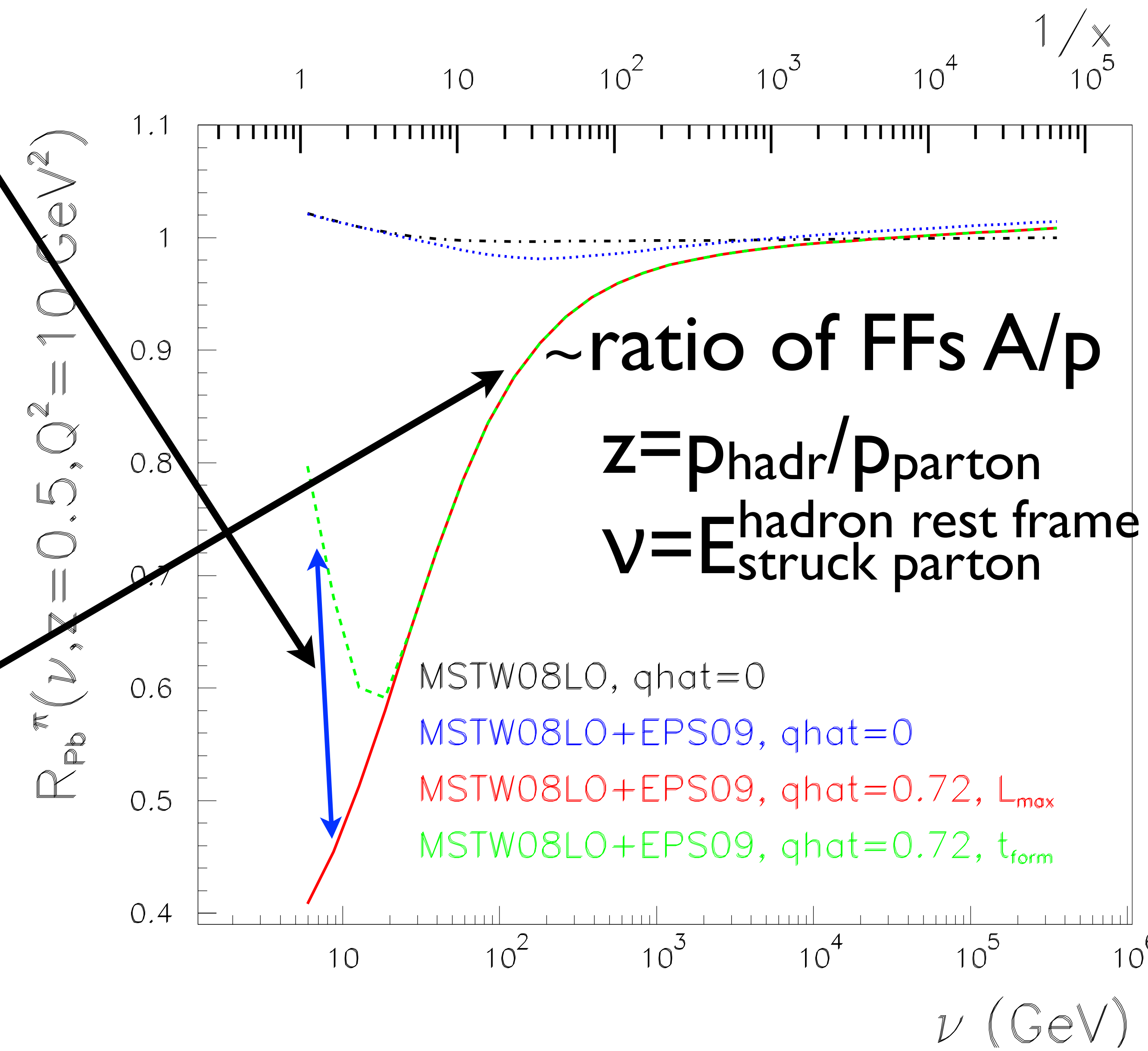
$$R_A^h(z,\nu) = \frac{1}{N_A^e}\frac{dN_A^h(z,\nu)}{d\nu\, dz} \Bigg/ \frac{1}{N_D^e}\frac{dN_D^h(z,\nu)}{d\nu\, dz}$$

- Low energy: hadronization inside → formation time, (pre-)hadronic absorption,...



- High energy: partonic evolution altered in the nuclear medium.





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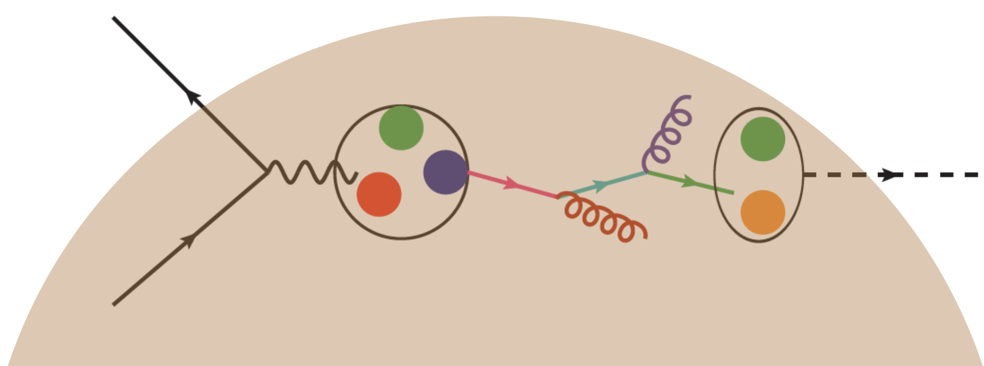

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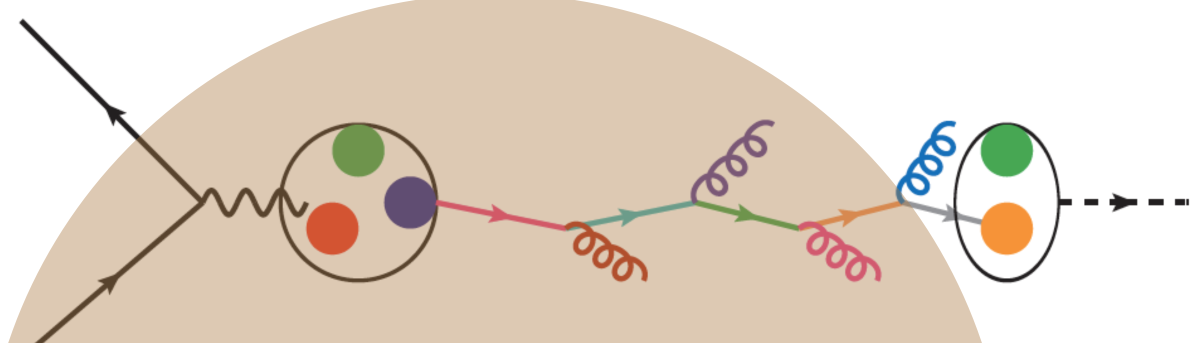
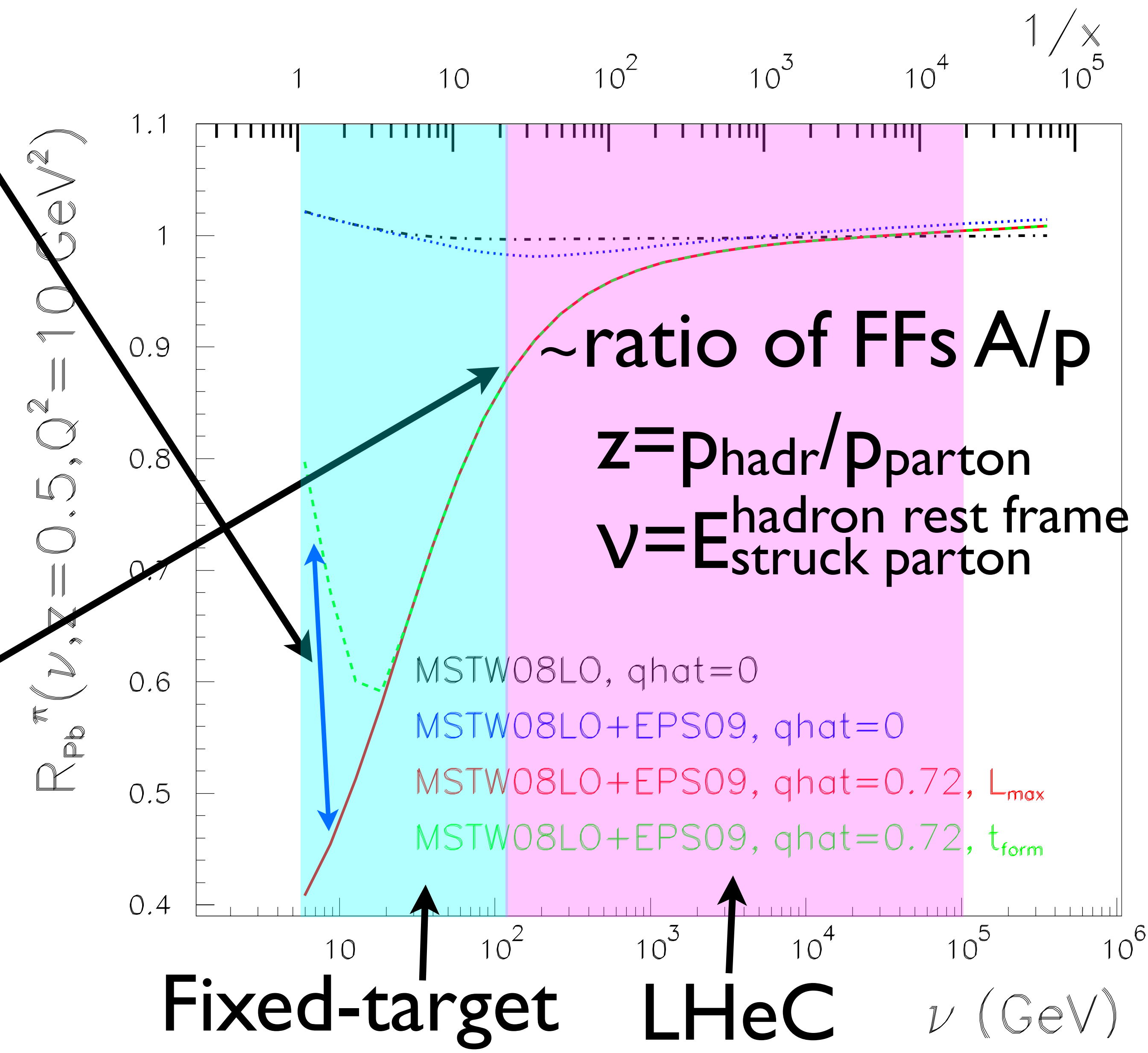
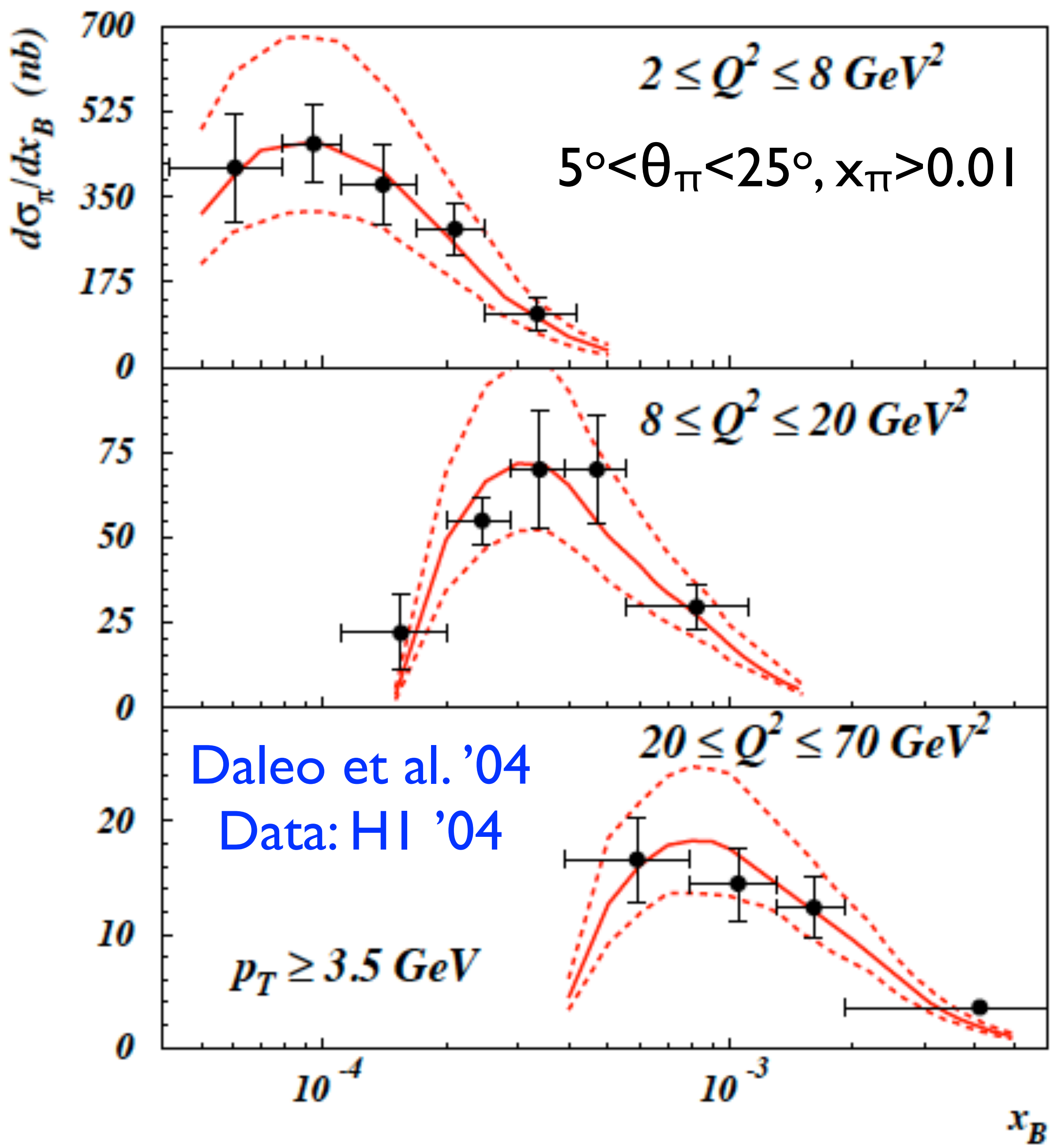




Radiation and hadronization:

- Large (NLO) yields at small-x (H1 cuts, 3 times higher if relaxed).
- Nuclear effects in hadronization at small ν (LO plus QW, Arleo '03).



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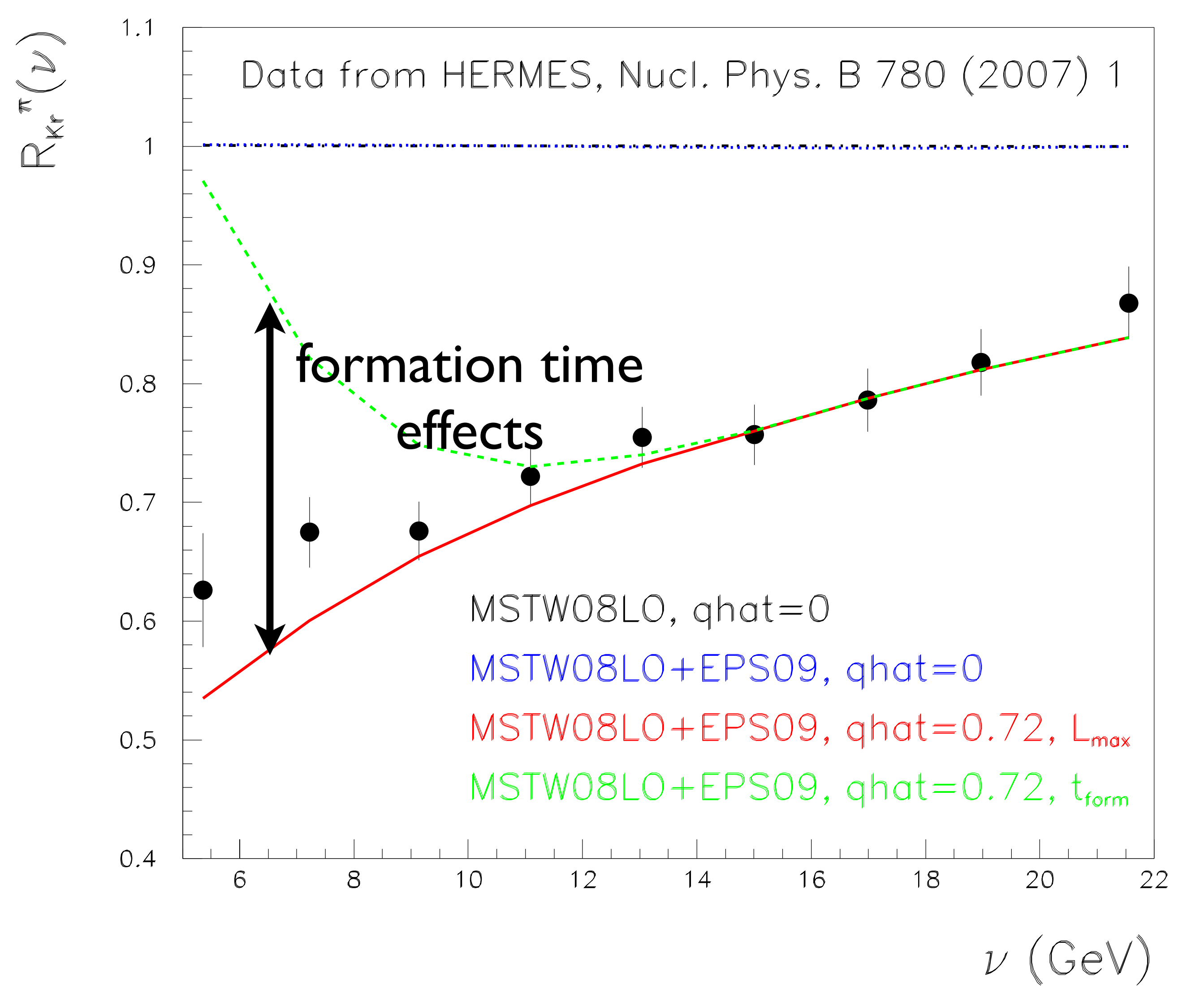

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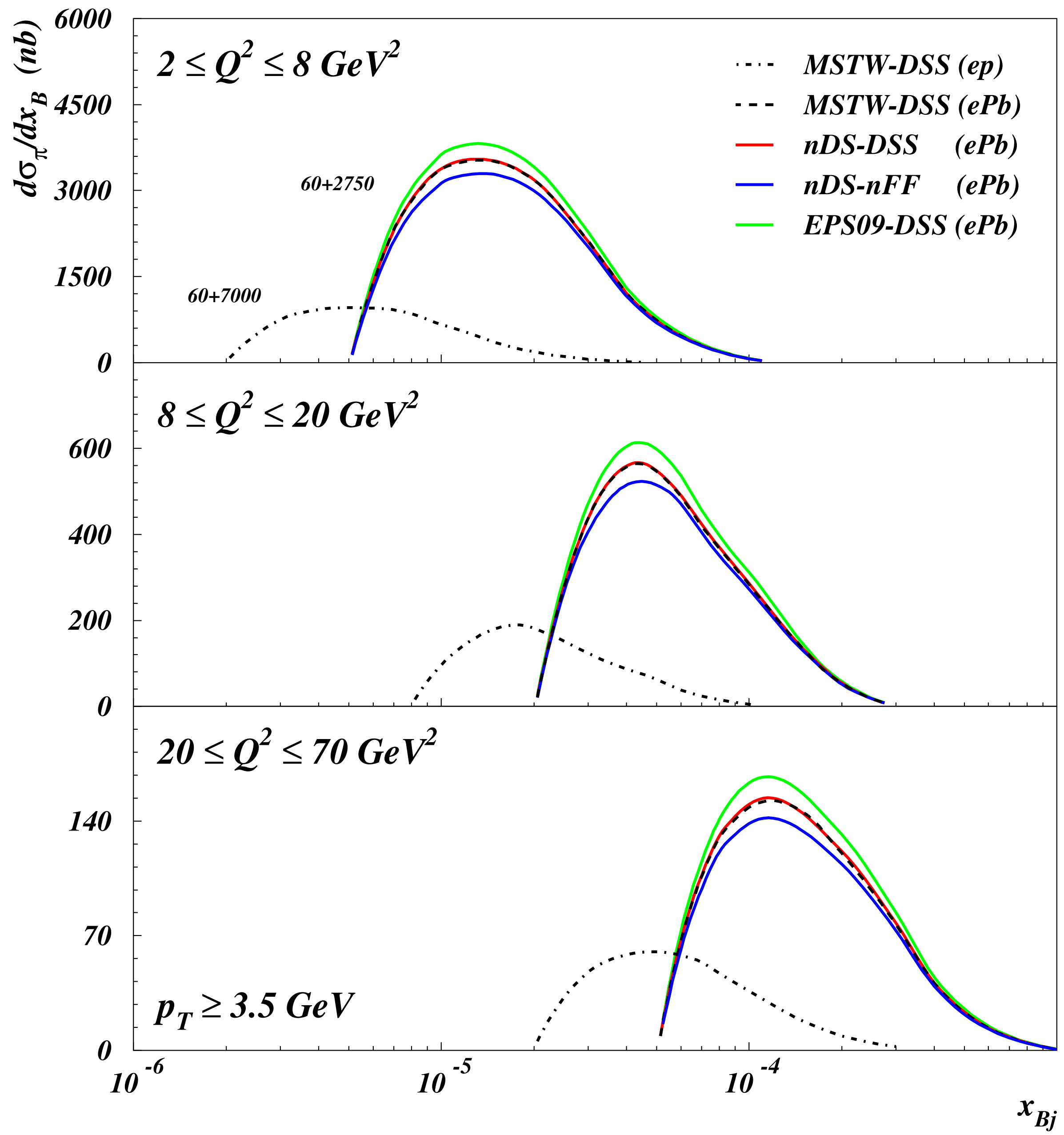

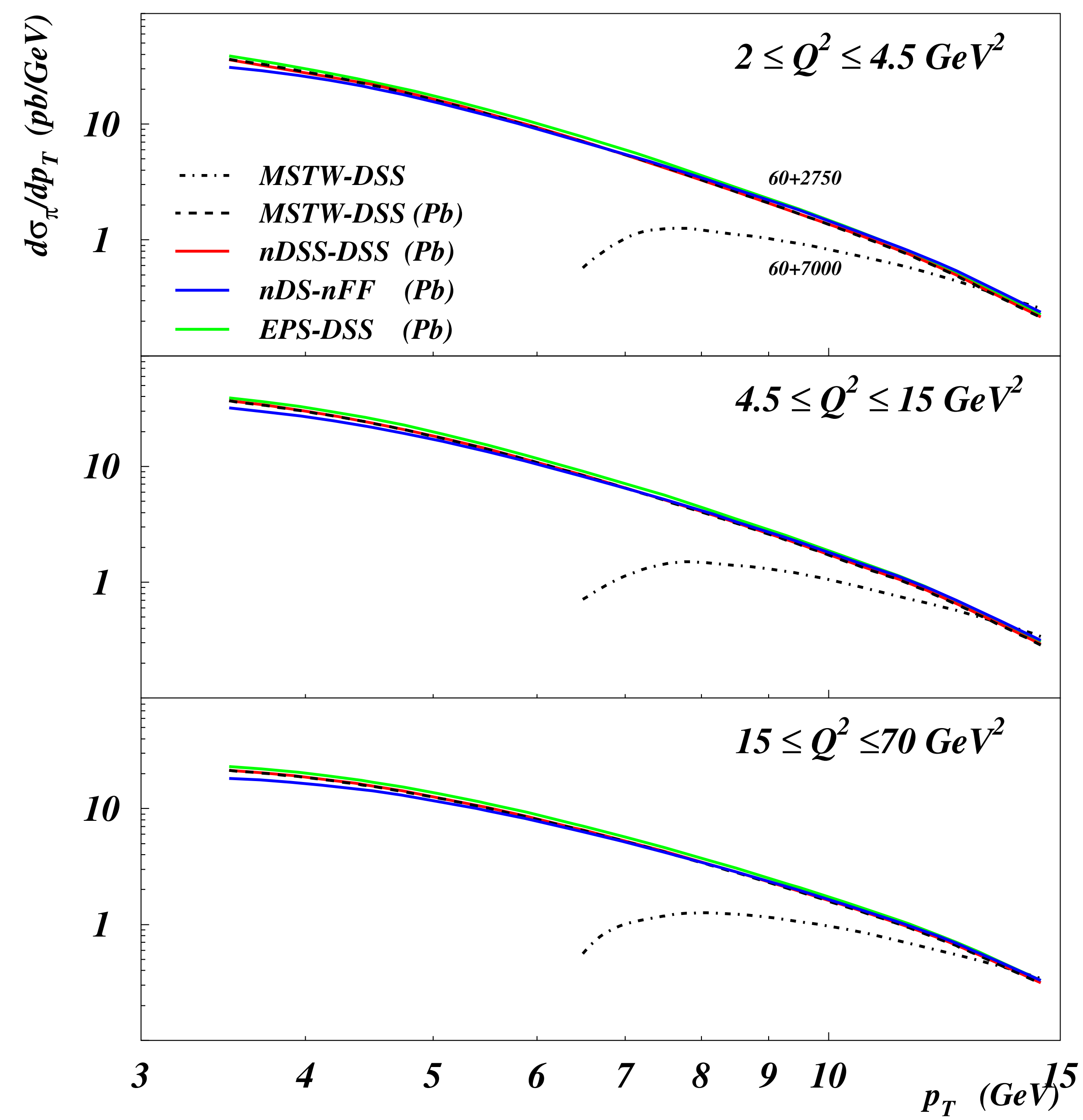

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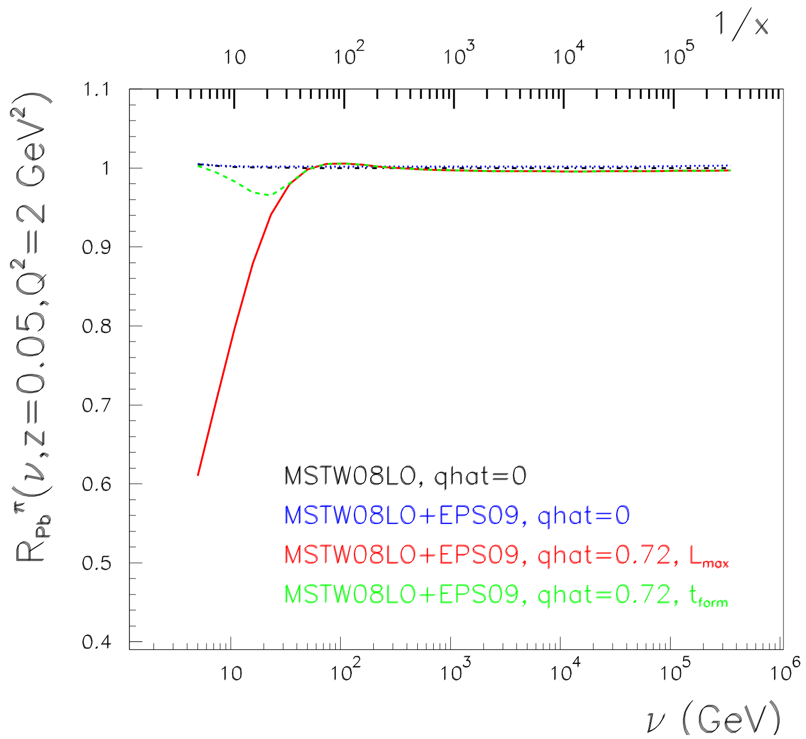

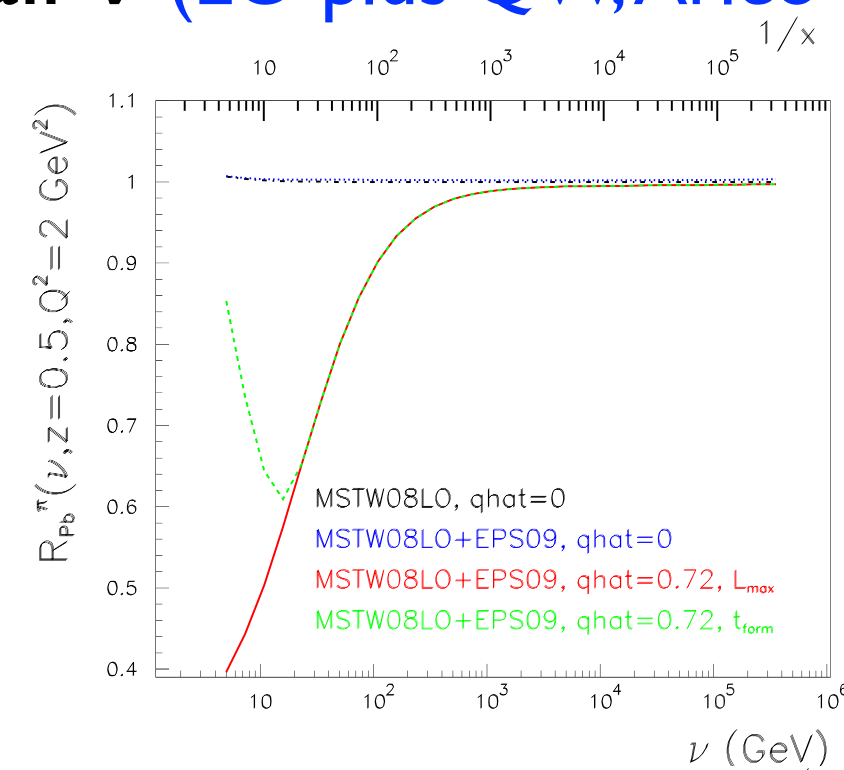

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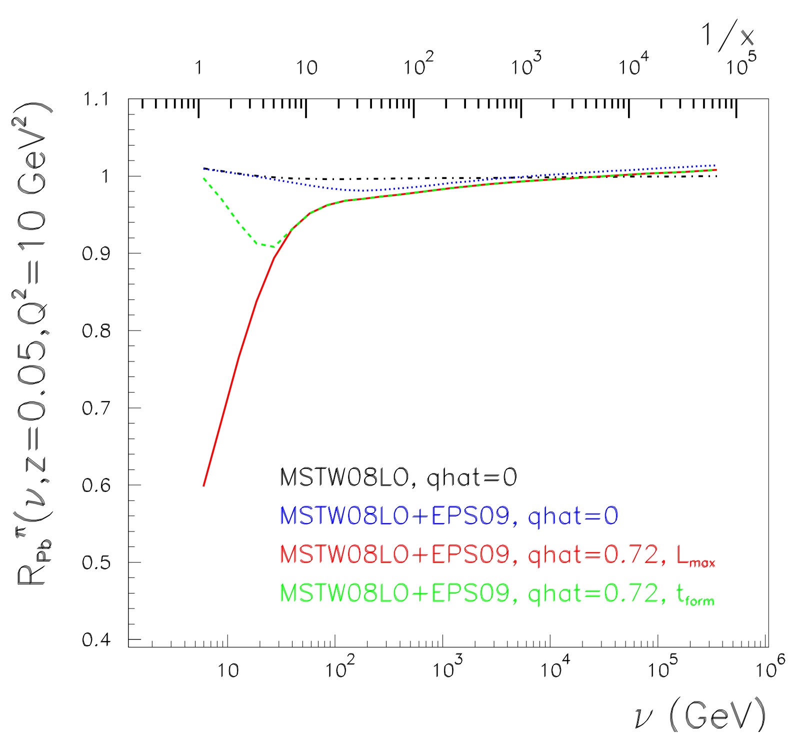
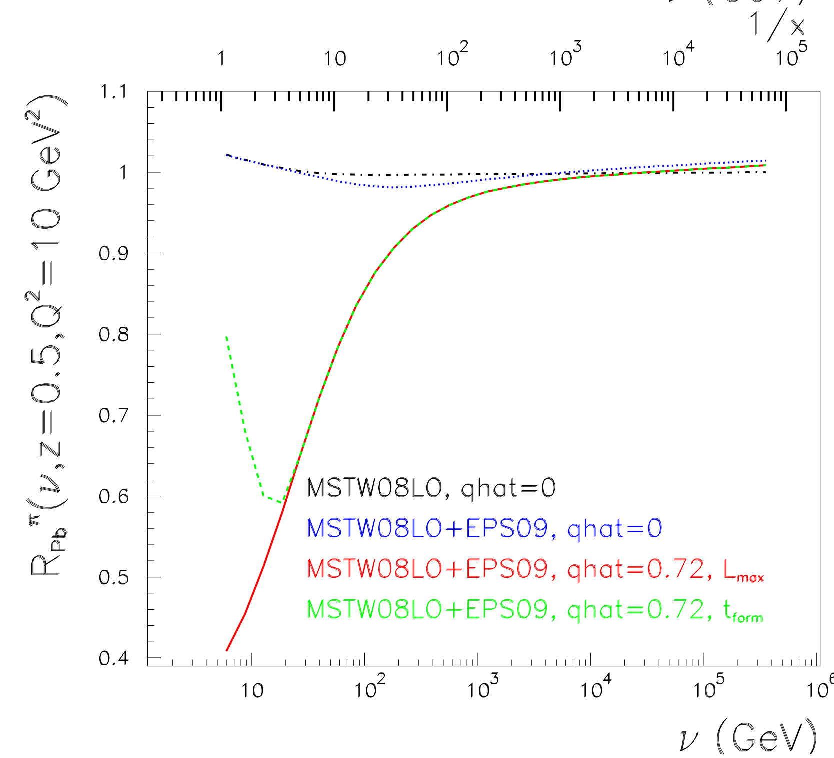
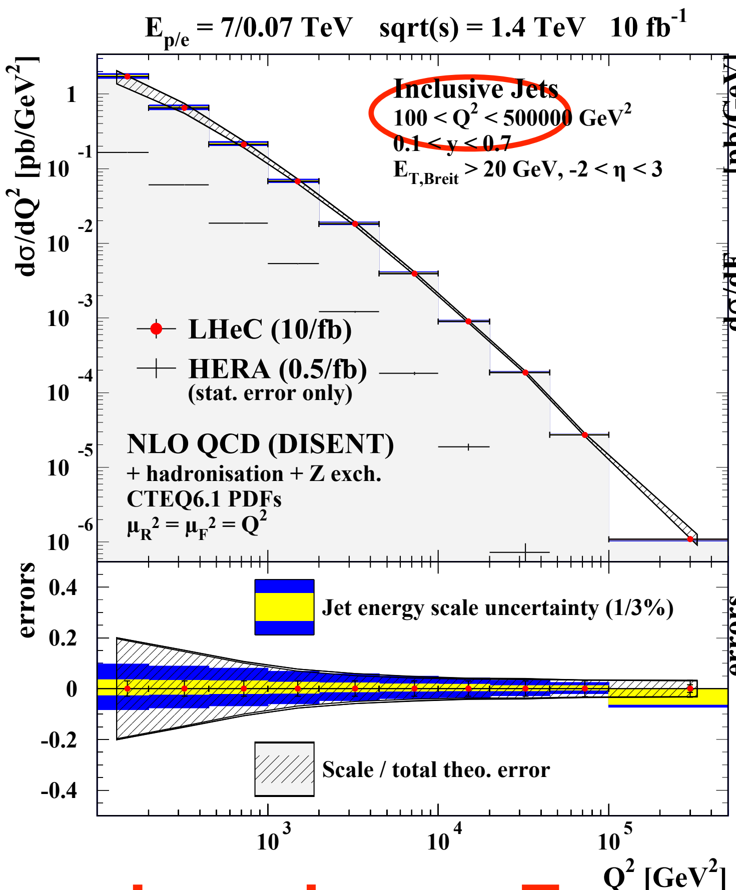
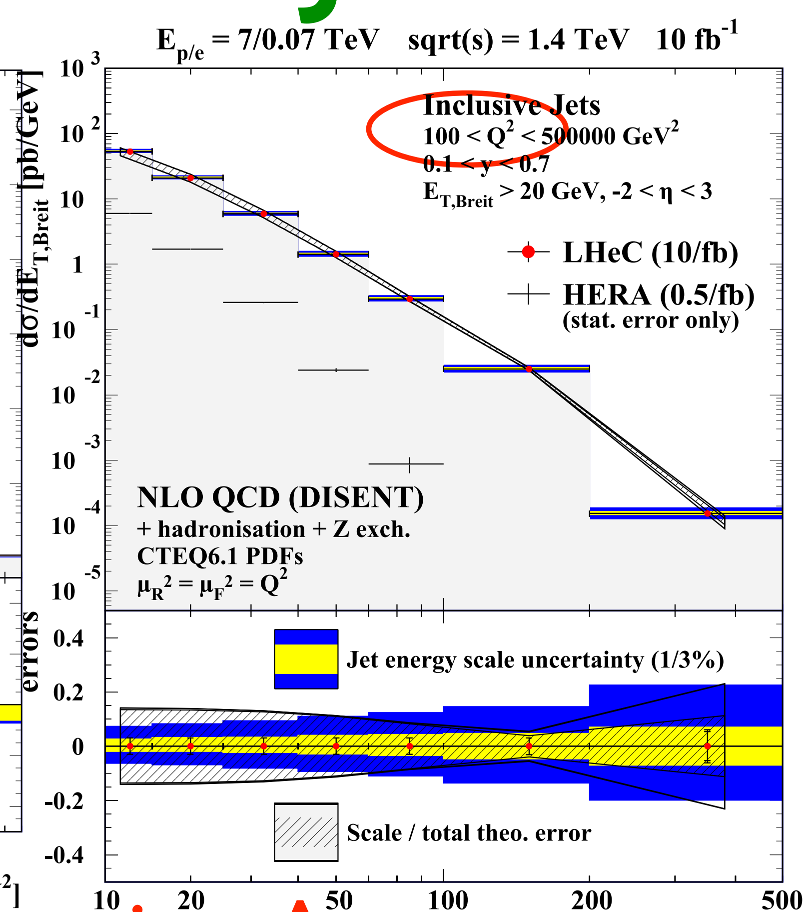
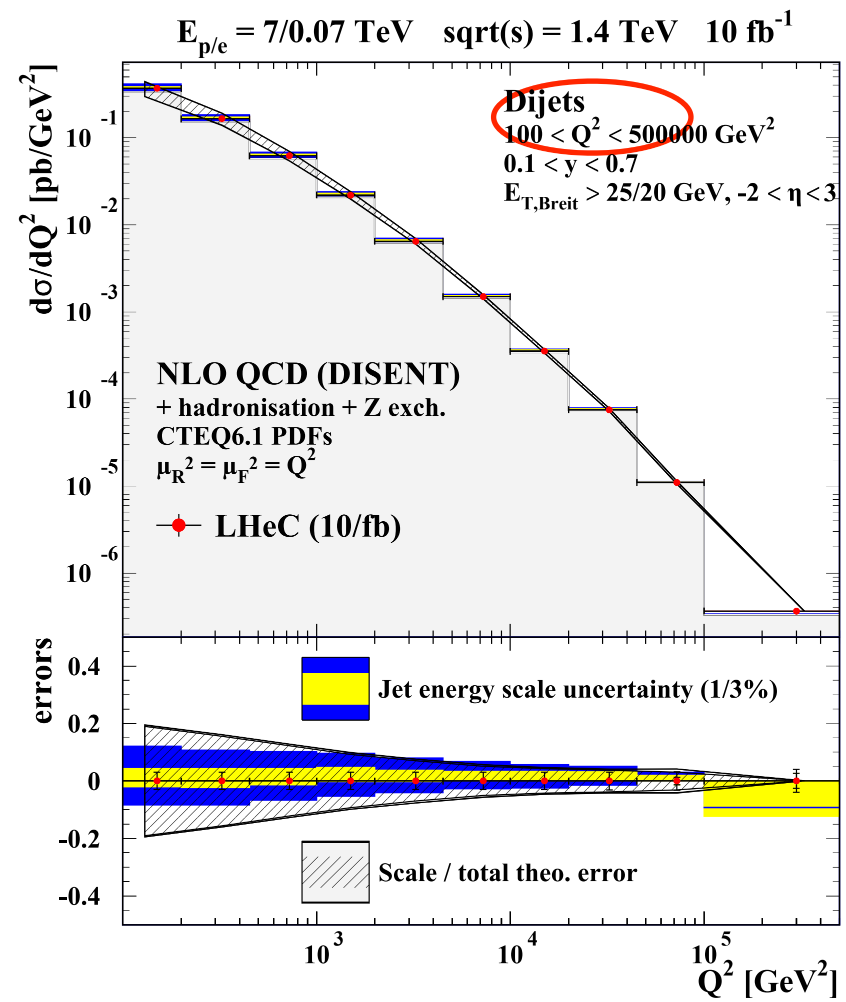




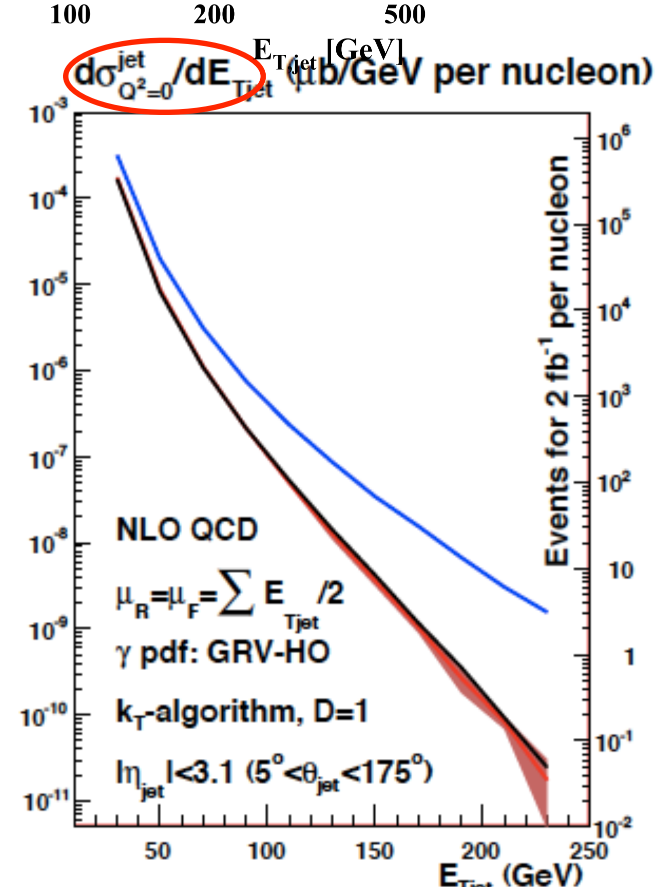
Jets:

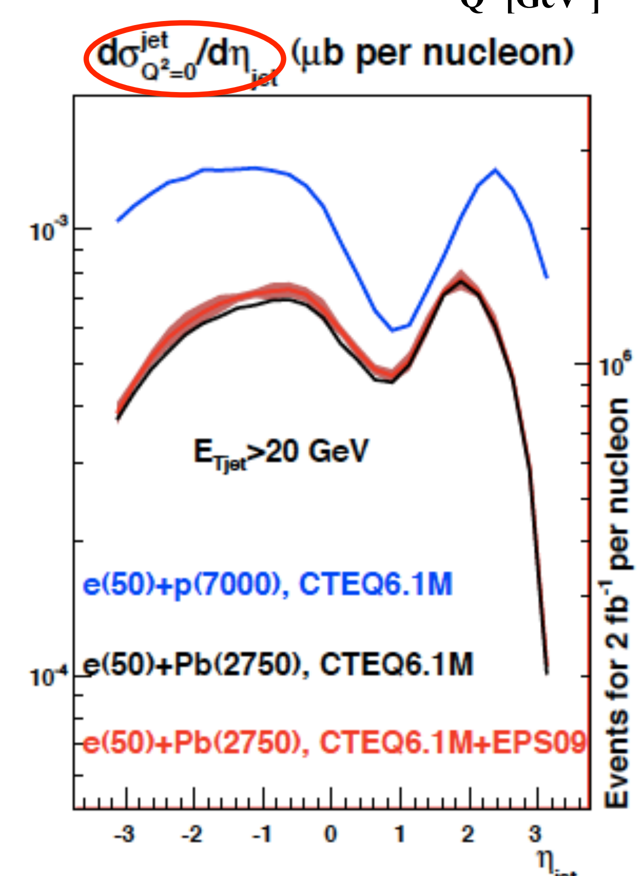






- Jets: large E_T even in eA.
- Useful for studies of parton dynamics in nuclei (hard probes), and for photon structure.
- Background subtraction, detailed reconstruction pending.





Future plans:

- **Next: follow CERN mandate and go towards a TDR.** This requires a further elaboration of the physics case:

➜ diffraction: studies on DPDFs and nDPDFs.

➜ GPDs: complementarity of exclusive VM production and DVCS, also in the nuclear case.

➜ complementarity with the LHC, both ep/pp and eA/pA.

➜ ...

Any collaboration is more than welcome!!!

Future plans:

• **Ne**

TDR ... **sics**

case:

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aft Report

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2007: Invitation by SPC to ECFA and by (r)ECFA to work out a design concept

Report

The LHeC Study Group
http://cern.ch/lhec

2008: First CERN-ECFA Workshop in Divonne (1.-3.9.08)

2009: 2nd CERN-ECFA-NuPECC Workshop at Divonne (1.-3.9.09)

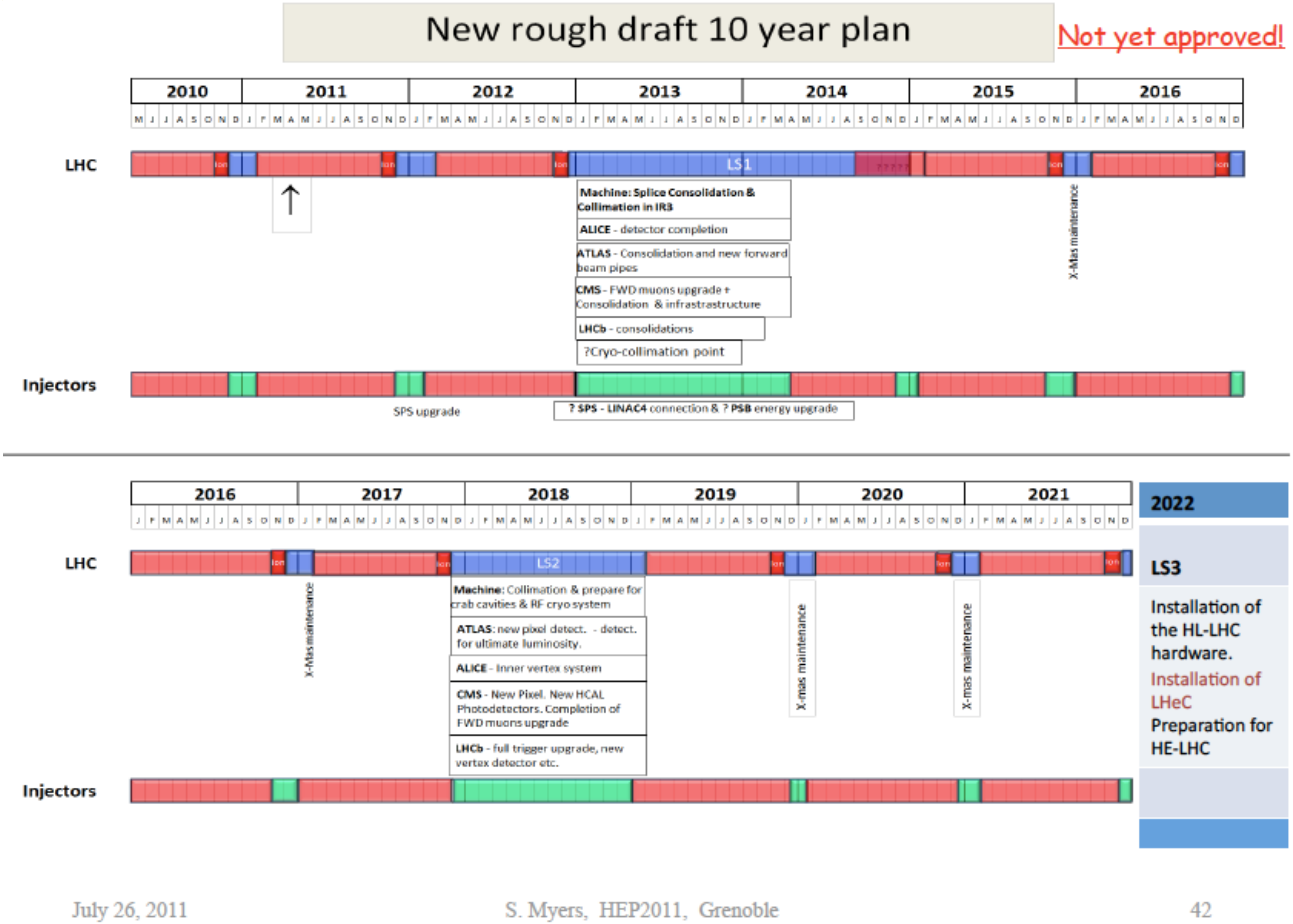
2010: Report to CERN SPC (June)
3rd CERN-ECFA-NuPECC Workshop at Chavannes-de-Bogis (12.-13.11.10)
NuPECC puts LHeC to its Longe Range Plan for Nuclear Physics (12/10)

2011: Draft CDR (530 pages on Physics, Detector and Accelerator) (5.8.11)
being refereed and updated

2012: Publication of CDR – European Strategy
New workshop June 14-15 2012

Goal: TDR by 2015
Perspective: Operation after LS3 (synchronous with pp/pA/AA)

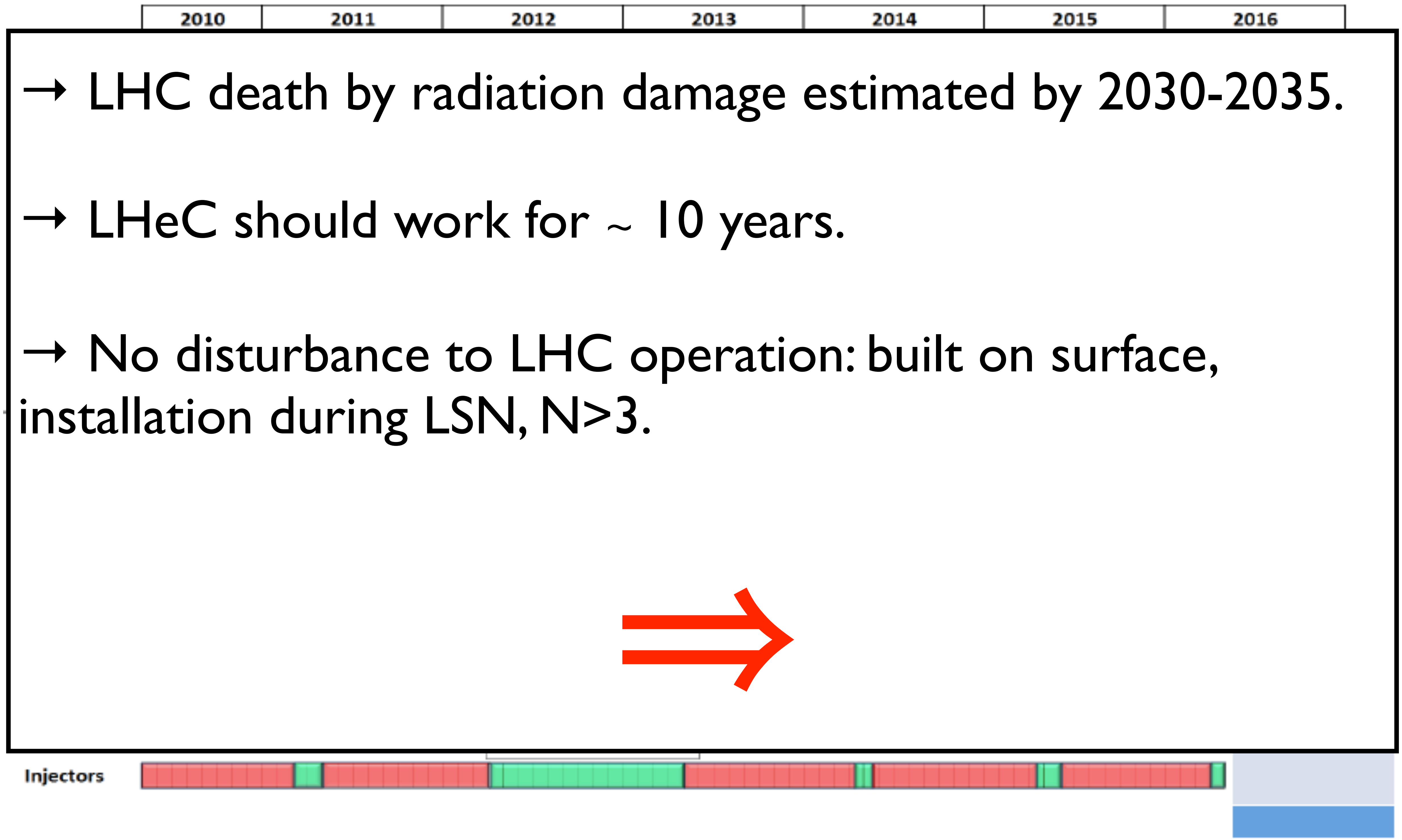
Tentative timeline:



Tentative timeline:

New rough draft 10 year plan

Not yet approved!



→ LHC death by radiation damage estimated by 2030-2035.

→ LHeC should work for ~ 10 years.

→ No disturbance to LHC operation: built on surface, installation during LSN, N>3.

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Tentative timeline: