Jet and heavy flavour at the EIC

CFNS EIC Summer School 2022

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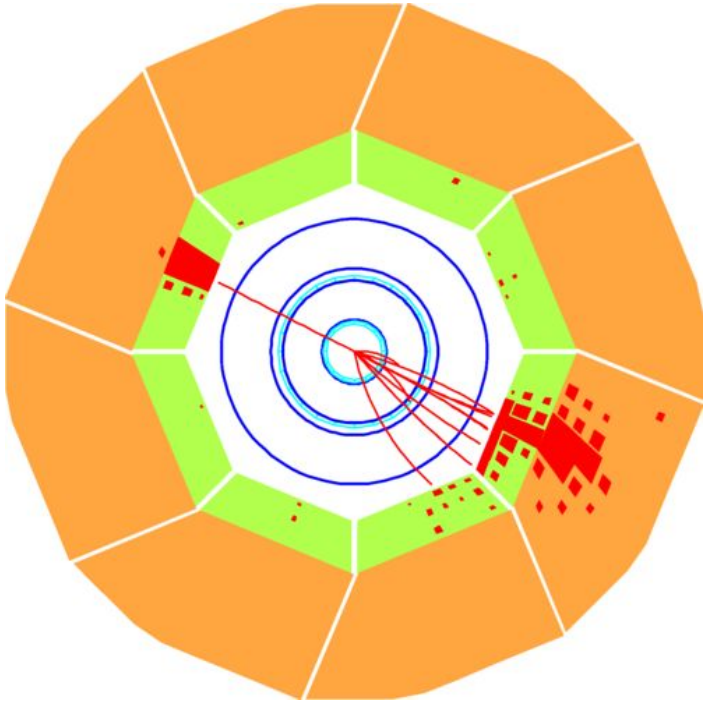
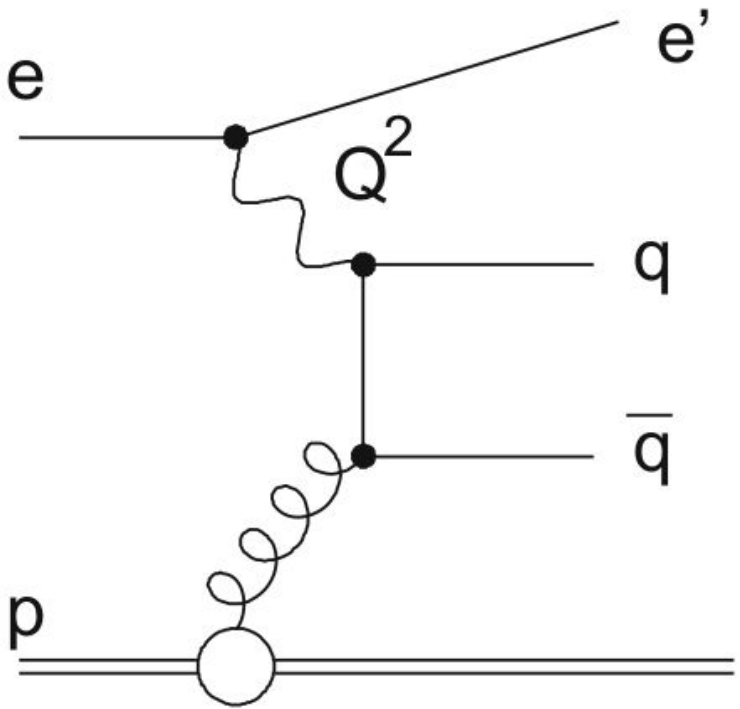
UC RIVERSIDE

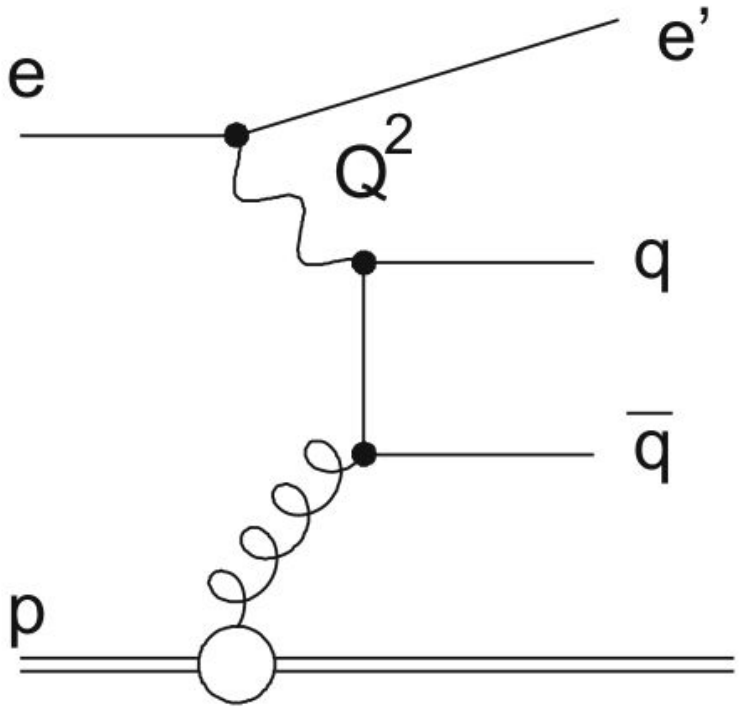


Why heavy flavour at the EIC?

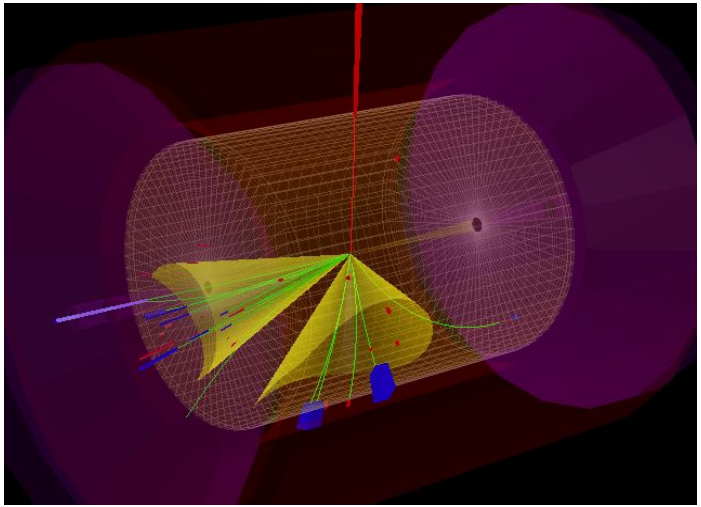
Excellent proxy for gluons

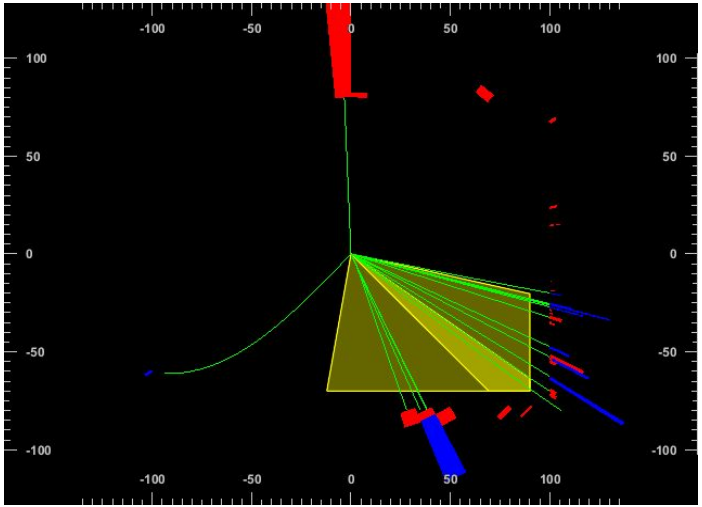


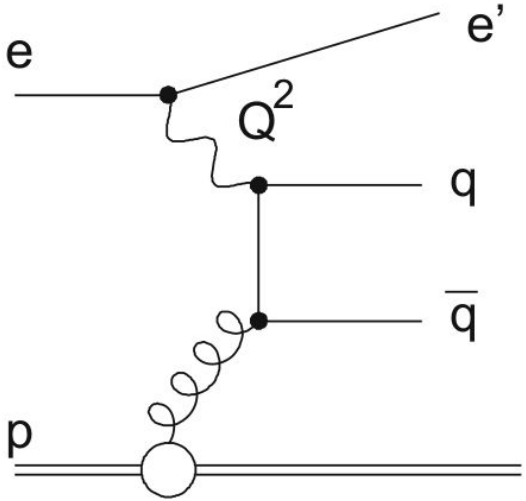
How do you measure Heavy flavour?

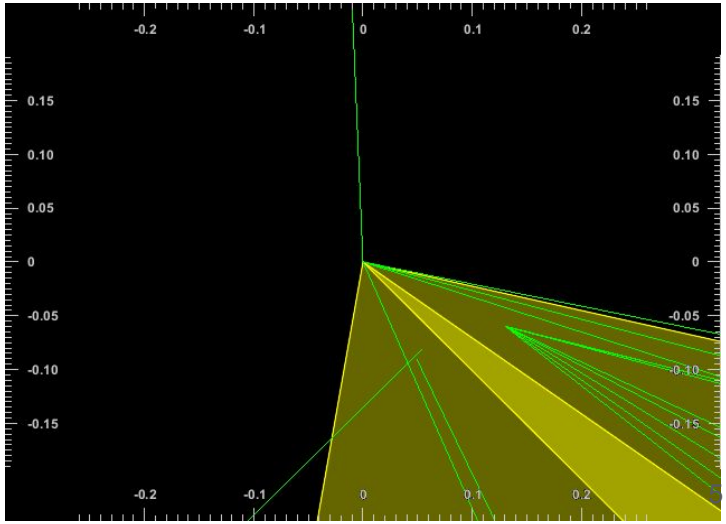


Double charm jet events









Displaced vertices

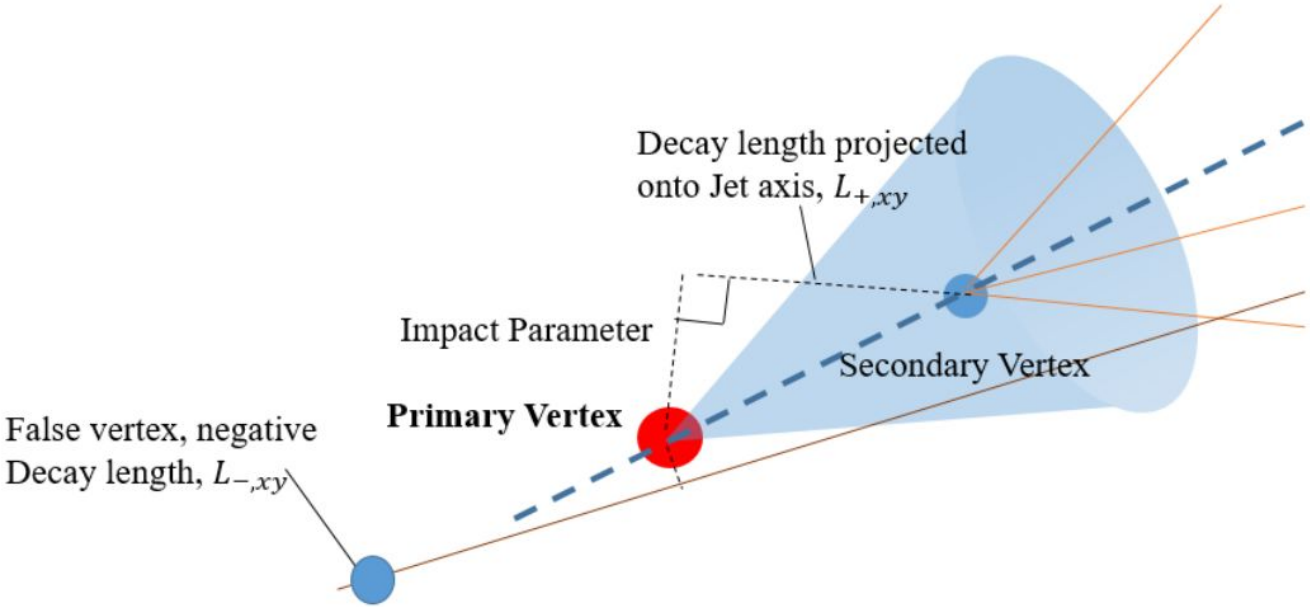


Fig from https://doi.org/10.1063/1.5040209

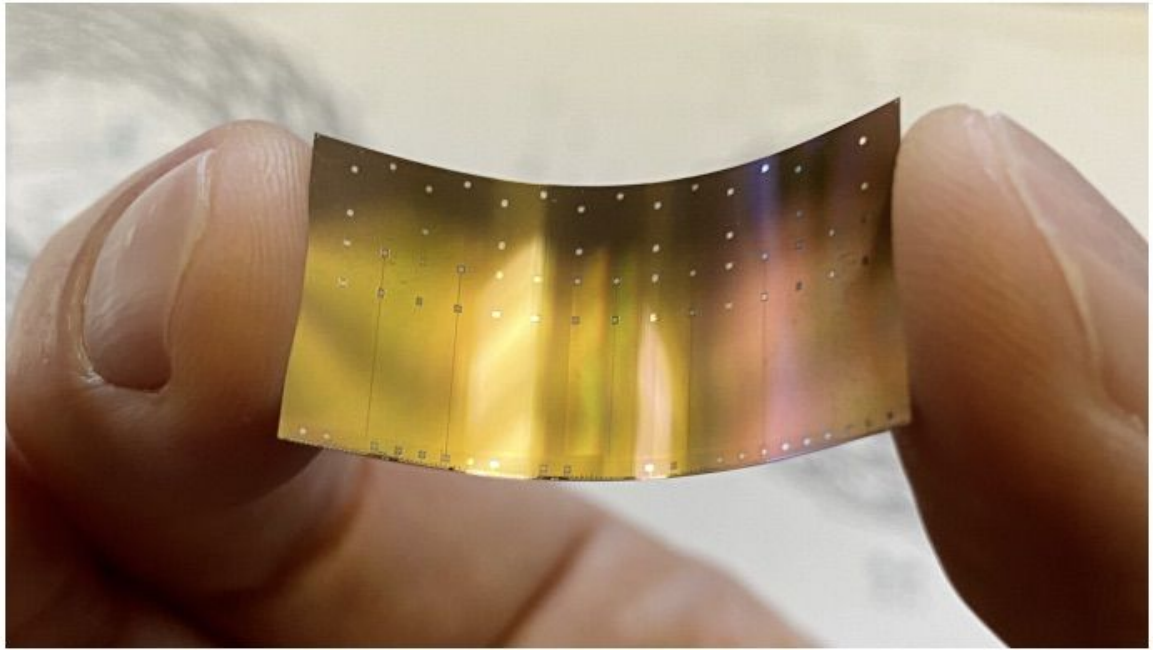
Outstanding progress in silicon tracker technology

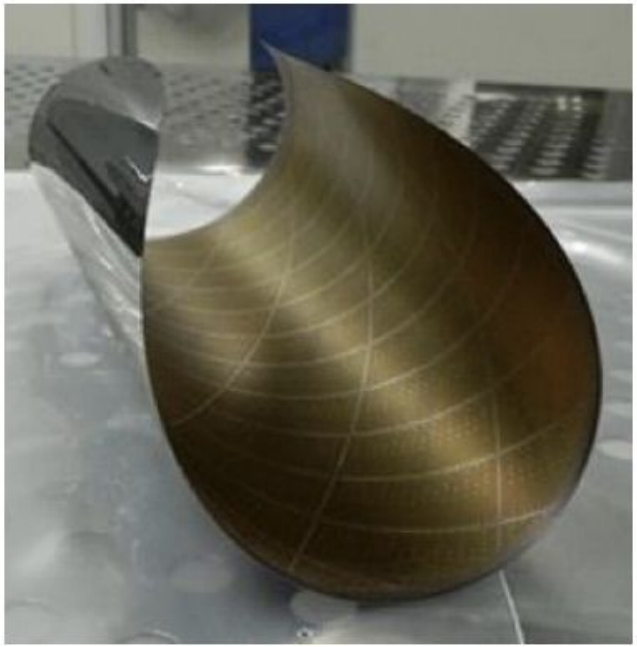
State of the art in 1989
(wire drift chamber used in H1 at HERA)

Figures from H1 collaboration

*H1 was later with a silicon tracker

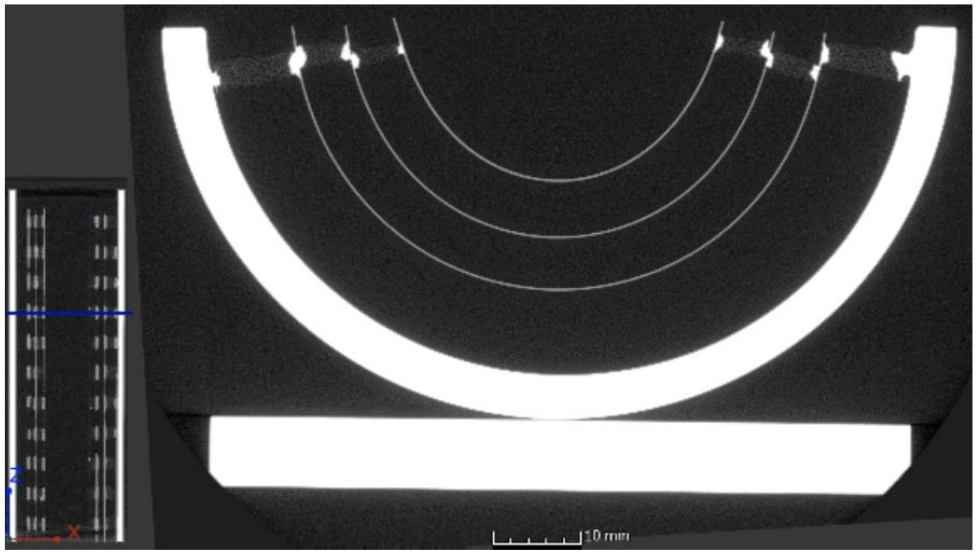
State of the art for the EIC





https://alice-collaboration.web.cern.ch/menu_proj_items/ITS-3

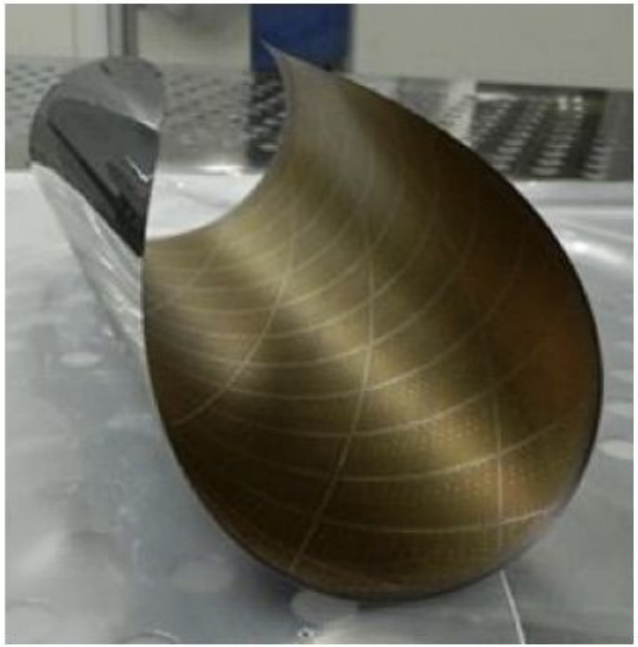
State of the art for the EIC



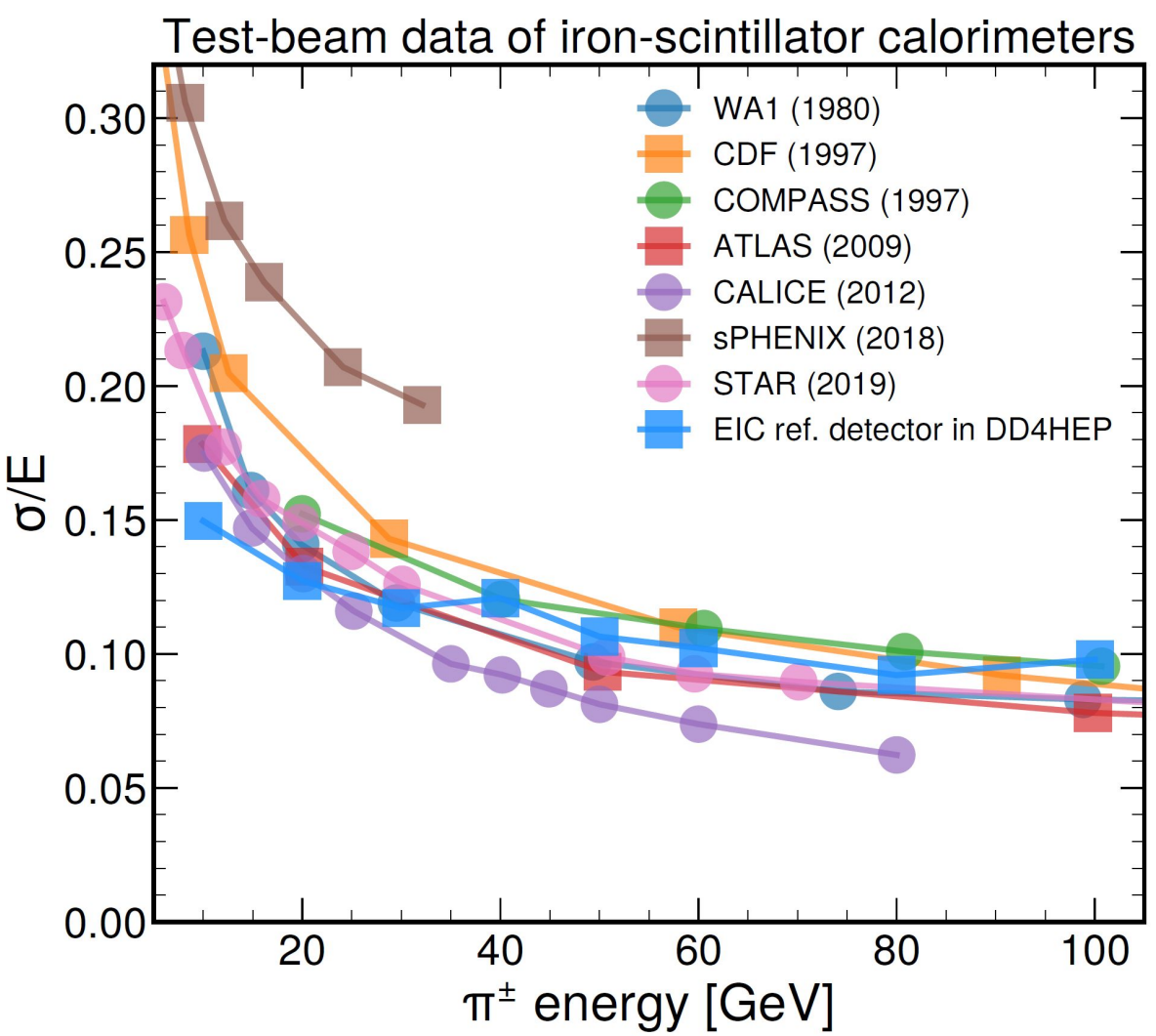
https://ep-news.web.cern.ch/content/alice-its3-clears-major-milestone

Silicon sensors have driven tracking to new limits

- Ultra-low material
- 10 um granularity
- Low power consumption



Compare that to the situation for HCALs, where we are stuck in the 80's



Moreover, EIC detector will have superb PID (practically non-existing in HERA experiments)

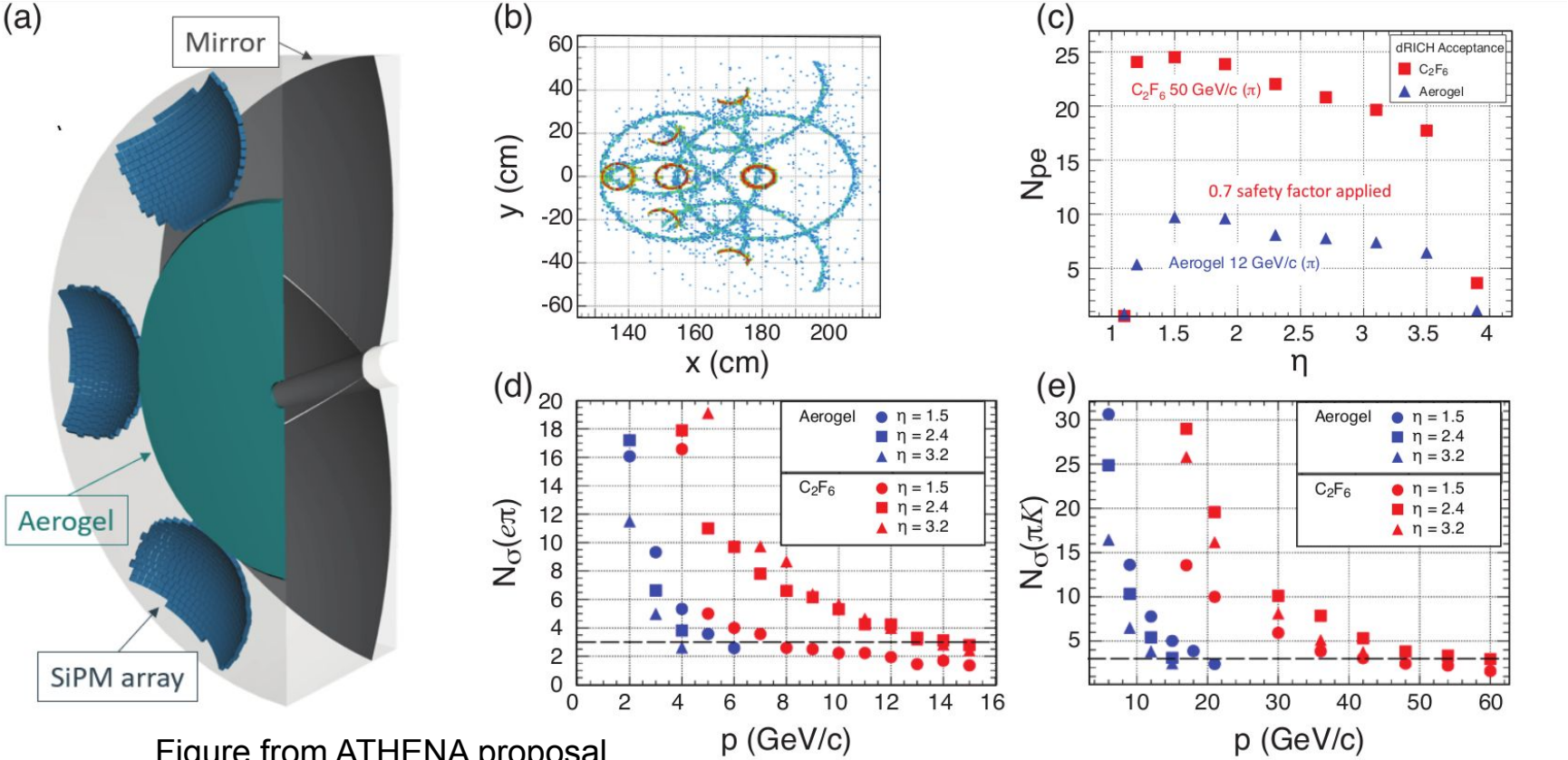


Figure from ATHENA proposal

Charm mesons
With ZEUS@HERA

https://arxiv.org/abs/1308.3368

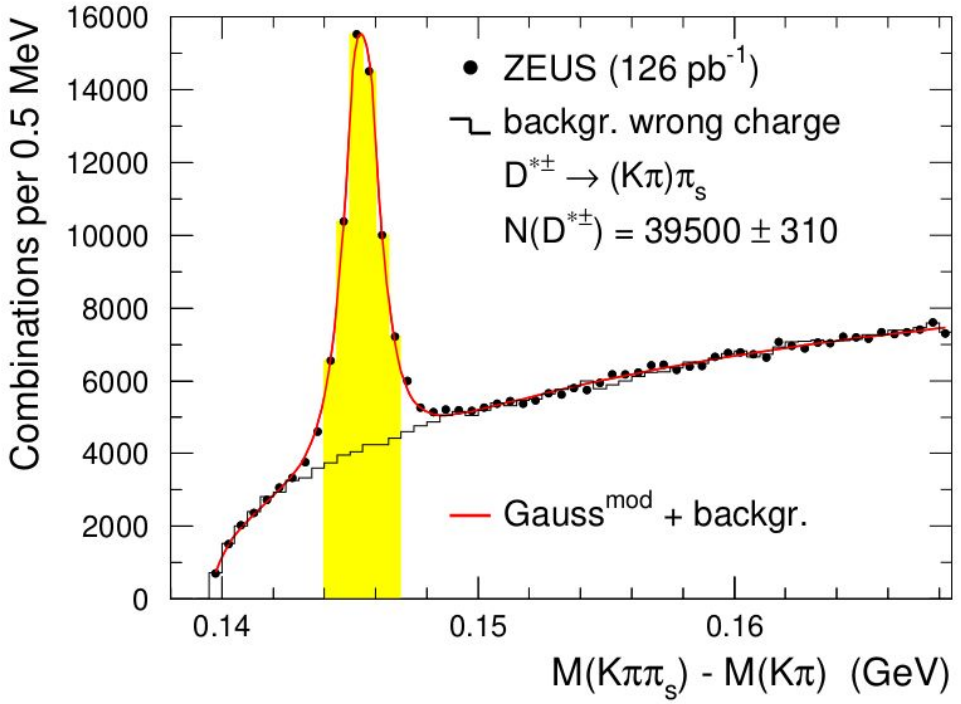


FIG. 3 The distribution of the mass difference $m(D^*) - m(D^0)$ for D^* candidates and a background estimate. From (Chekanov *et al.*, 2009i).

D* mesons with H1@HERA

https://arxiv.org/abs/1308.3368

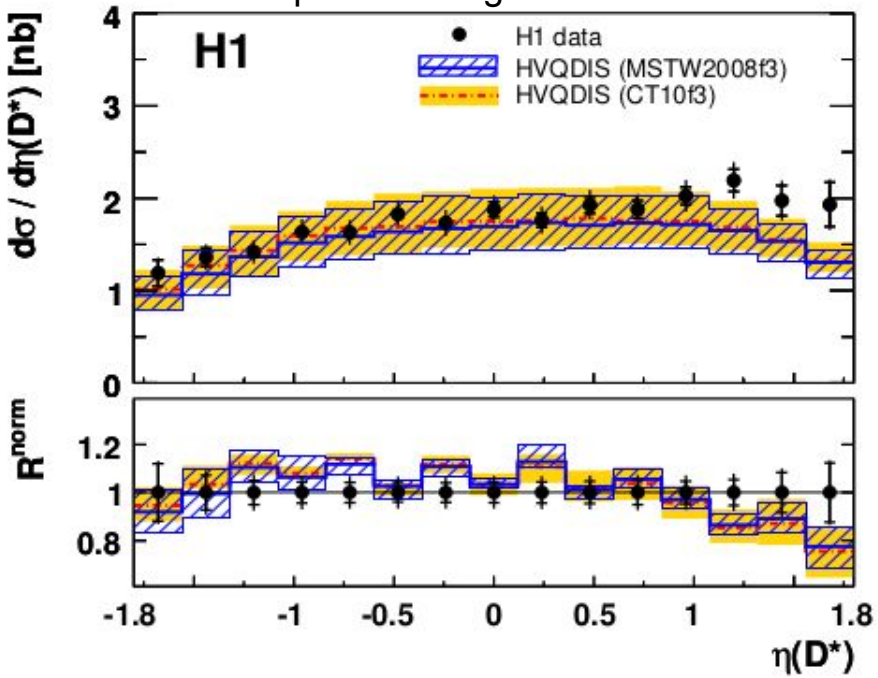
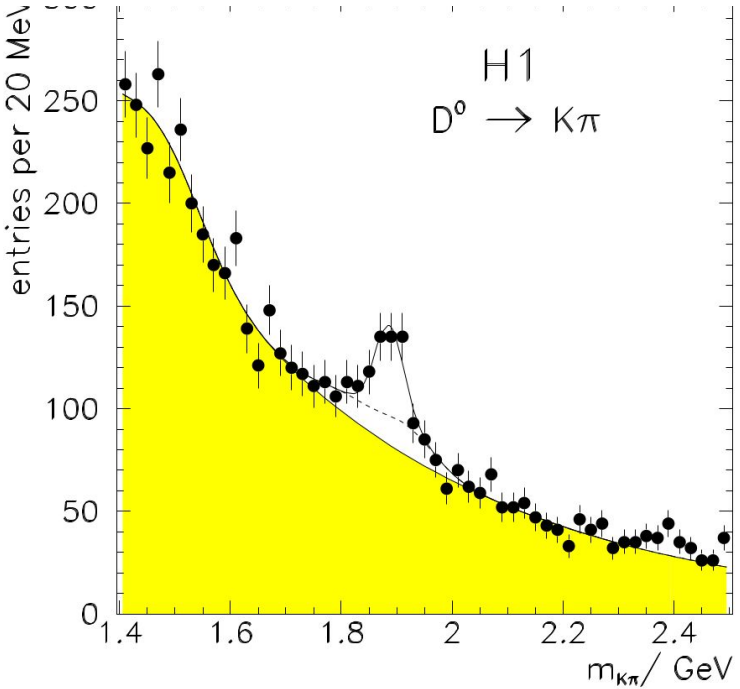
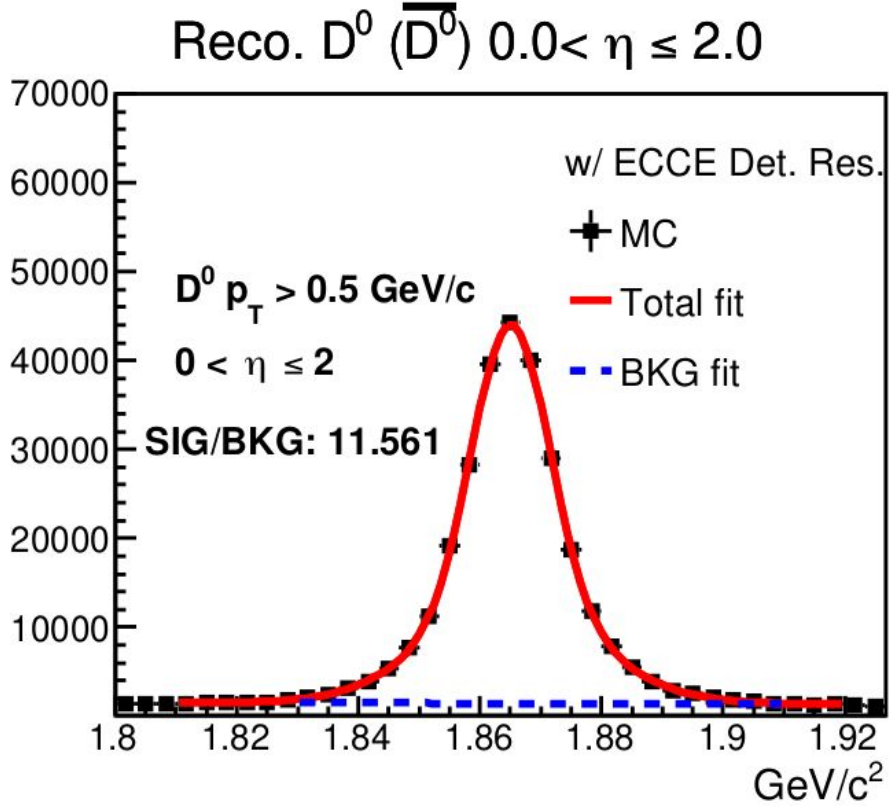


FIG. 17 Measurements of cross-sections $d\sigma/dp_T^{D^*}$ and $d\sigma/d\eta^{D^*}$ for D^* production in DIS compared with NLO QCD predictions using two different proton PDFs. The lower plot for each variable shows the ratio of theory to data where each is first normalised to its corresponding total cross section. From (Aaron *et al.*, 2011b).

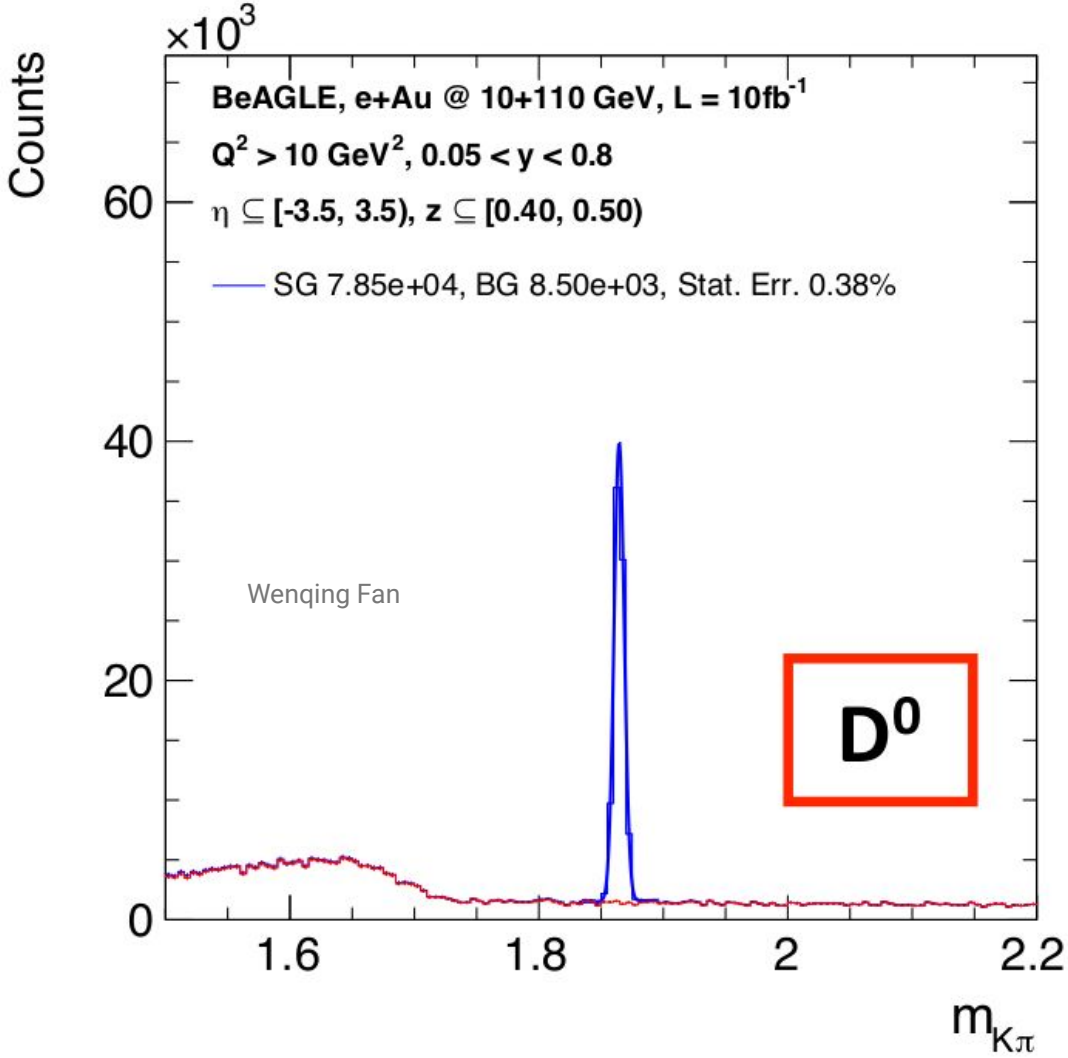
D0 mesons in H1@HERA and ECCE@EIC



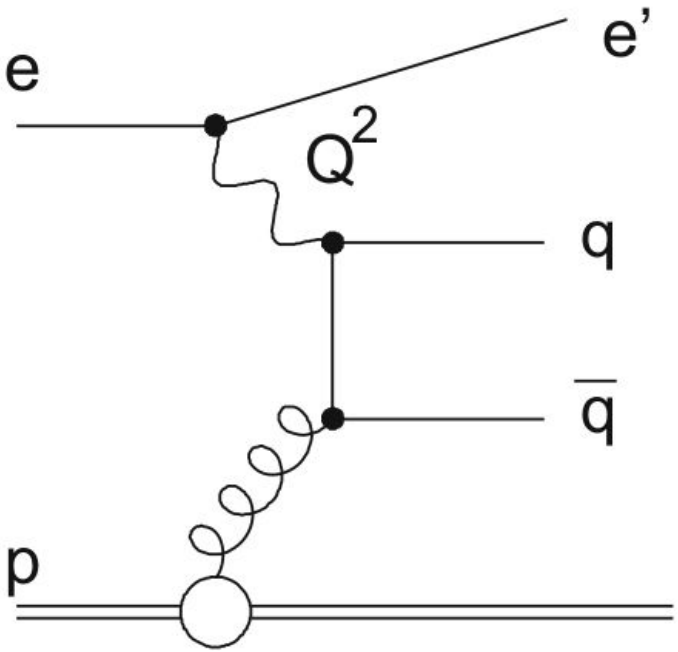
hep-ex/9607012

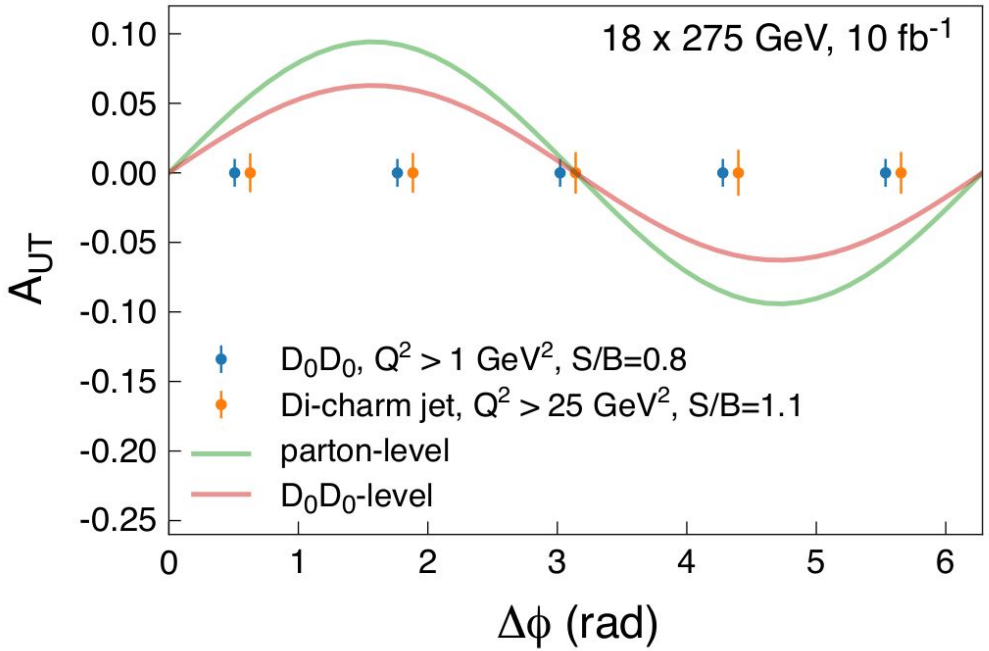


https://arxiv.org/abs/2207.10632

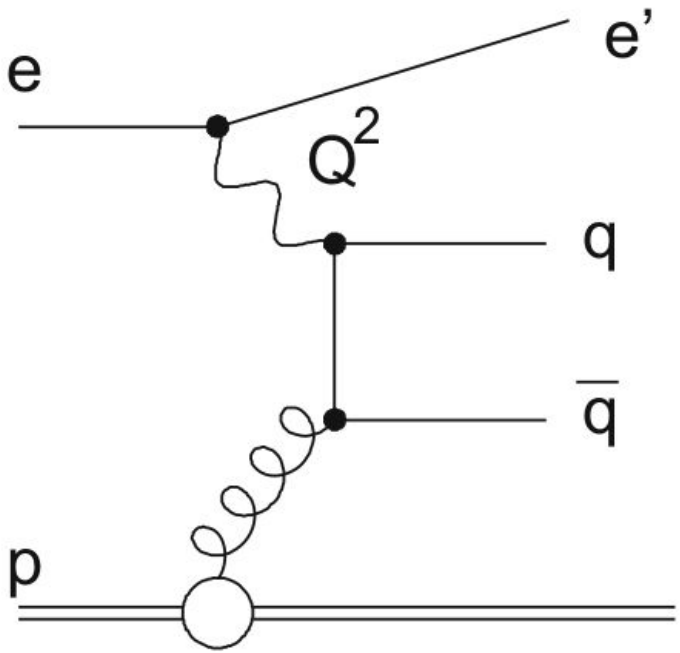

×10^3
Counts
BeAGLE, e+Au @ 10+110 GeV, L = 10fb^-1
Q^2 > 10 GeV^2, 0.05 < y < 0.8
η ⊆ [-3.5, 3.5), z ⊆ [0.40, 0.50)
SG 7.85e+04, BG 8.50e+03, Stat. Err. 0.38%
Wenqing Fan
D^0
60
40
20
0
1.6
1.8
2
2.2
m_Kπ

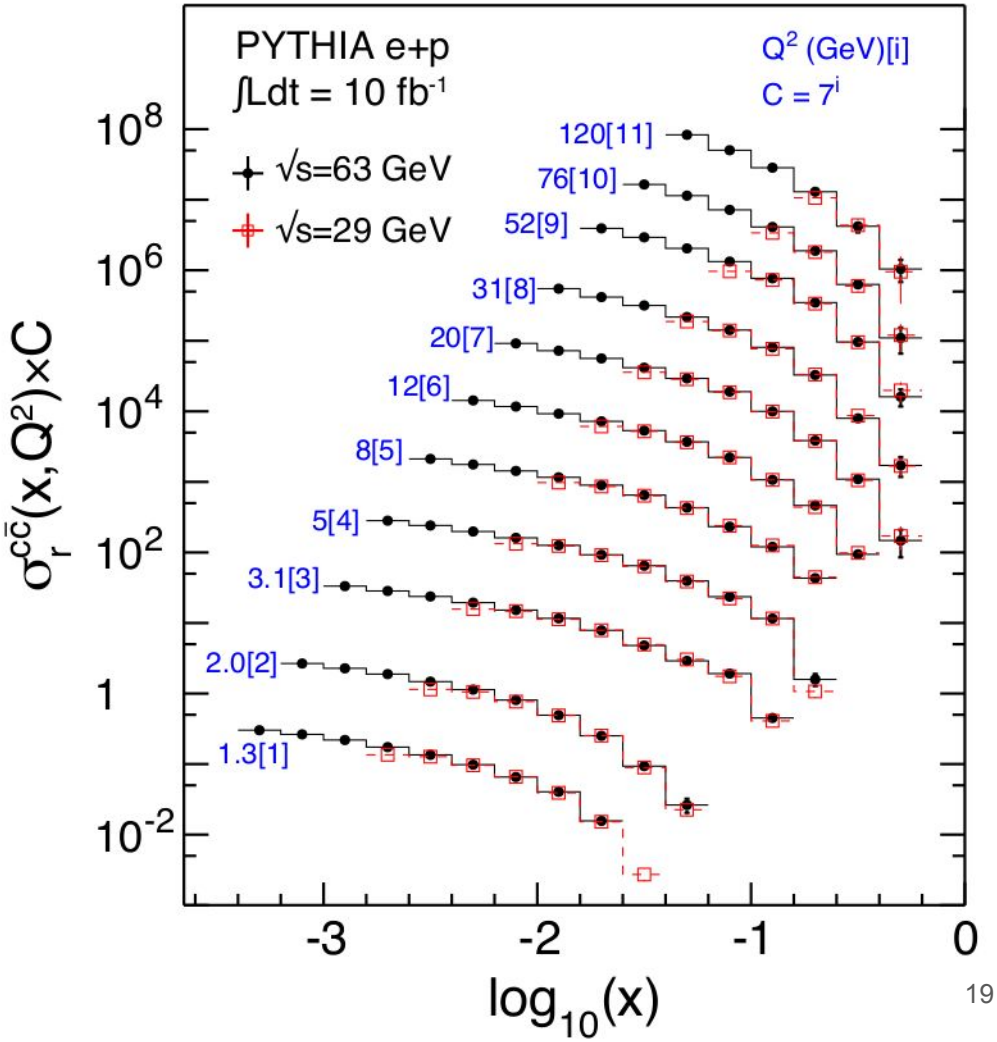
Gluon TMDs


e
e'
Q^2
q
$\overline{q}$
p

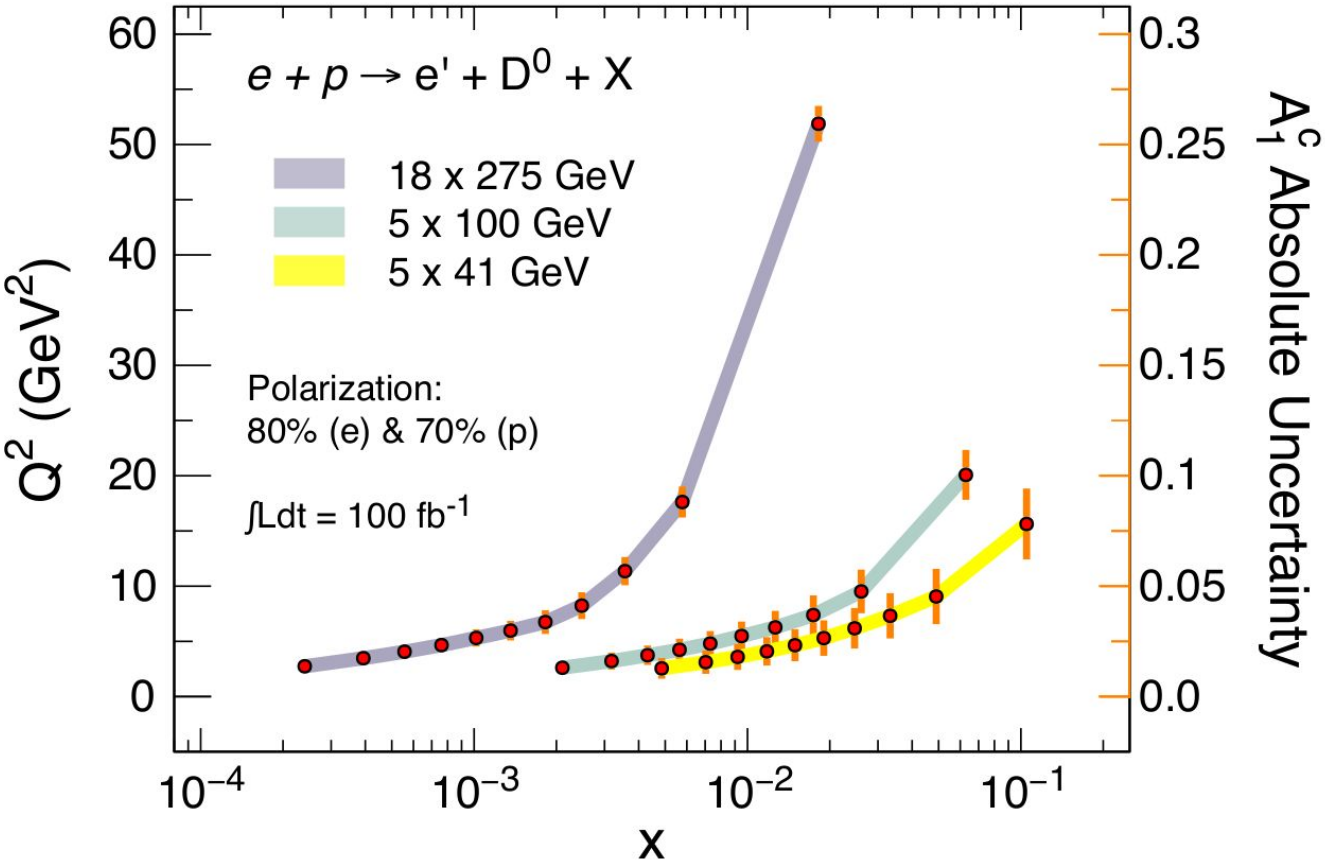

18 x 275 GeV, 10 fb^{-1}
A_{UT}
0.10
0.05
0.00
-0.05
-0.10
-0.15
-0.20
-0.25
0
1
2
3
4
5
6
$\Delta\phi$ (rad)
D_0D_0, $Q^2 > 1$ GeV^2, S/B=0.8
Di-charm jet, $Q^2 > 25$ GeV^2, S/B=1.1
parton-level
D_0D_0-level

Gluon PDFs

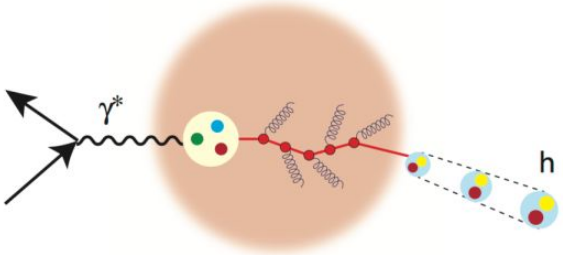

e
e'
Q²
q
q̄
p

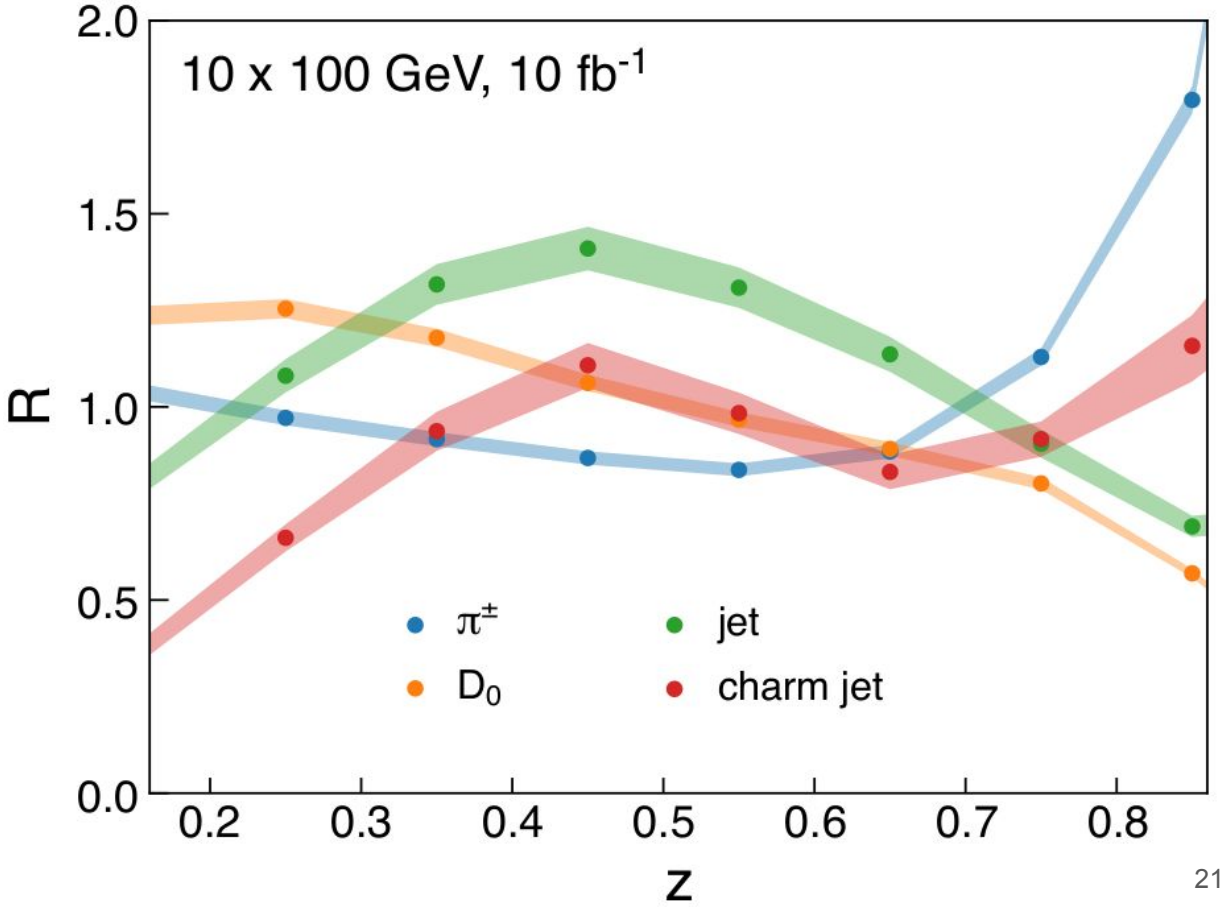

PYTHIA e+p
∫Ldt = 10 fb⁻¹
√s=63 GeV
√s=29 GeV
Q² (GeV)[i]
C = 7^i
120[11]
76[10]
52[9]
31[8]
20[7]
12[6]
8[5]
5[4]
3.1[3]
2.0[2]
1.3[1]
$\sigma_r^{c\bar{c}}(x,Q^2)\times C$
10^8
10^6
10^4
10^2
1
10^{-2}
-3
-2
-1
0
$\log_{10}(x)$

Gluon helicity



Quark propagation In nuclei





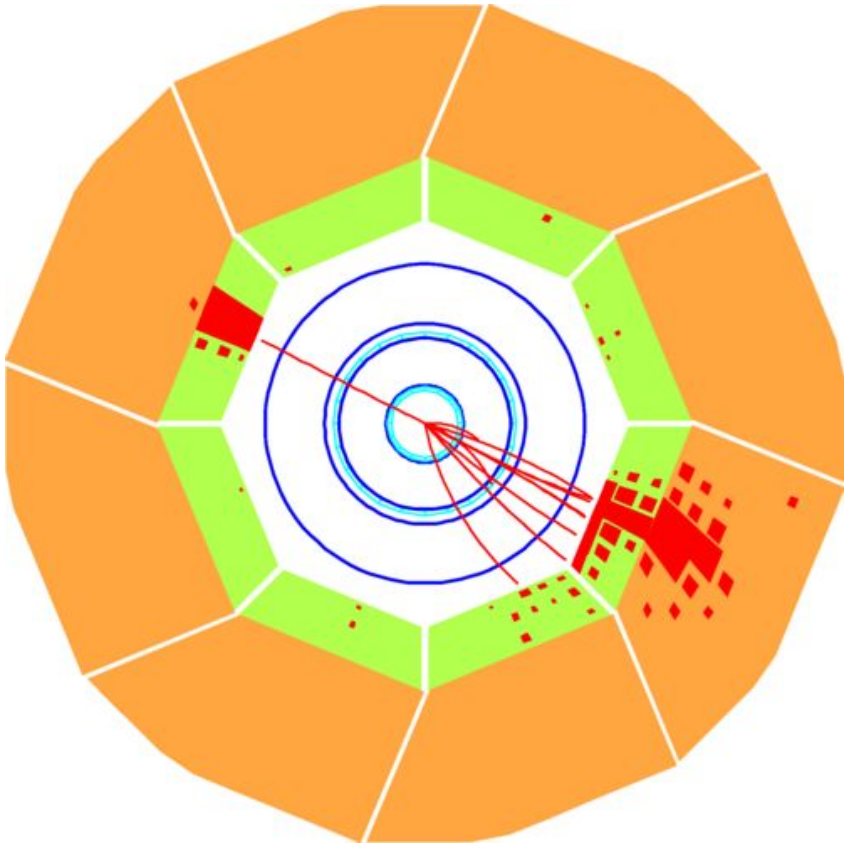
Summary

Why heavy flavour at the EIC?

Because they are sensitive to gluons (helicity, TMDs, PDFs)

How will we measure Heavy flavour at the EIC?

With superb tracking, and PID



The end

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