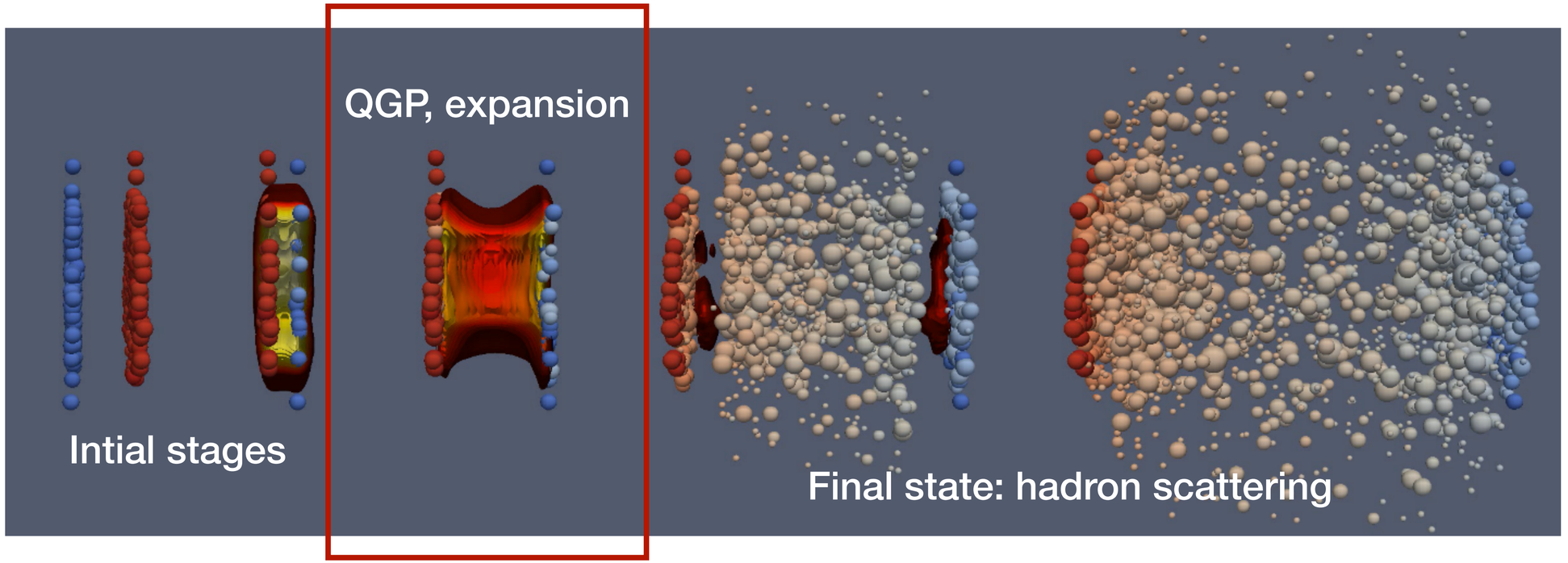
High-density QCD at FCC-hh



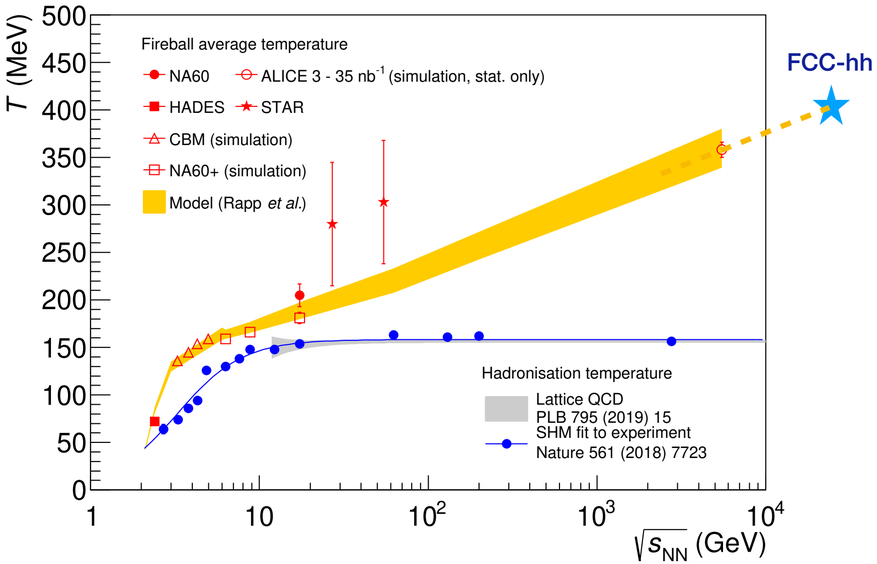
- Increase in temperature/density and life time compared to LHC
- Availability of new probes: e.g. top decays
- Increase of density in pp: study density effects in ‘small systems’

+ bonus slide on LHeC/FCC-eh

More details in: FCC-hh heavy-ion report, overview talk at 2018 FCC week

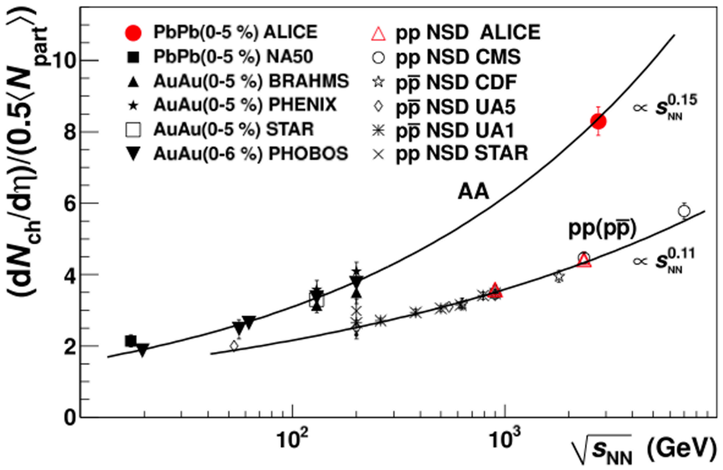
Increased temperature/density

Temperature vs collision energy



FCC-hh

Multiplicity vs energy



Early-stage temperature ~ 400 MeV at LHC

Hadronic probes reflect phase transition:
no increase beyond ~ SPS energies

$\frac{dN_{\mathrm{ch}}}{d\eta}$ increases by factor 1.8

$\epsilon \propto T^4$ $\quad$ $n \propto T^3$

Expect increase of T by factor 1.2
+ faster thermalisation/formation?

Increased temperature/density

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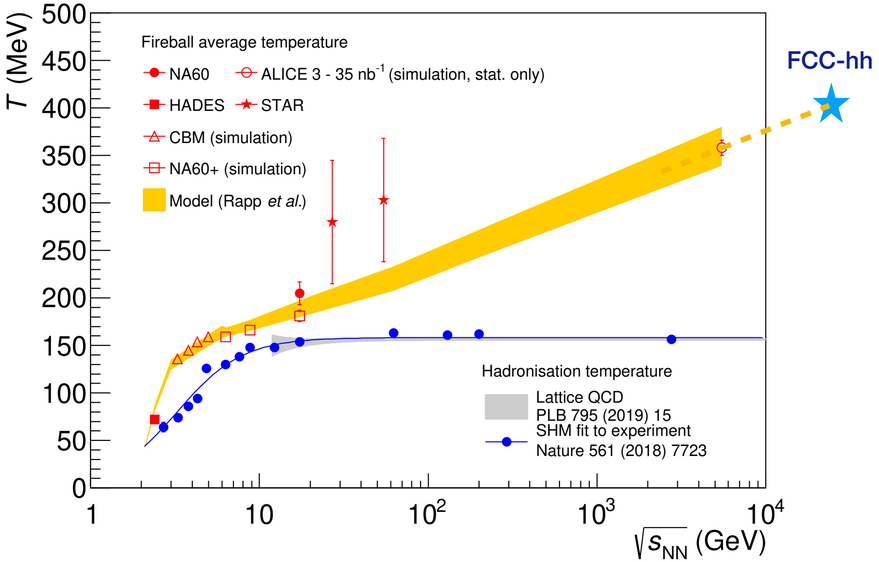

FCC-hh

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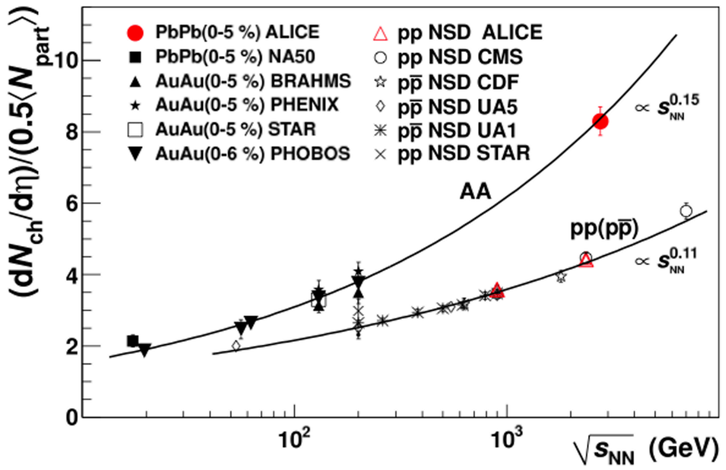

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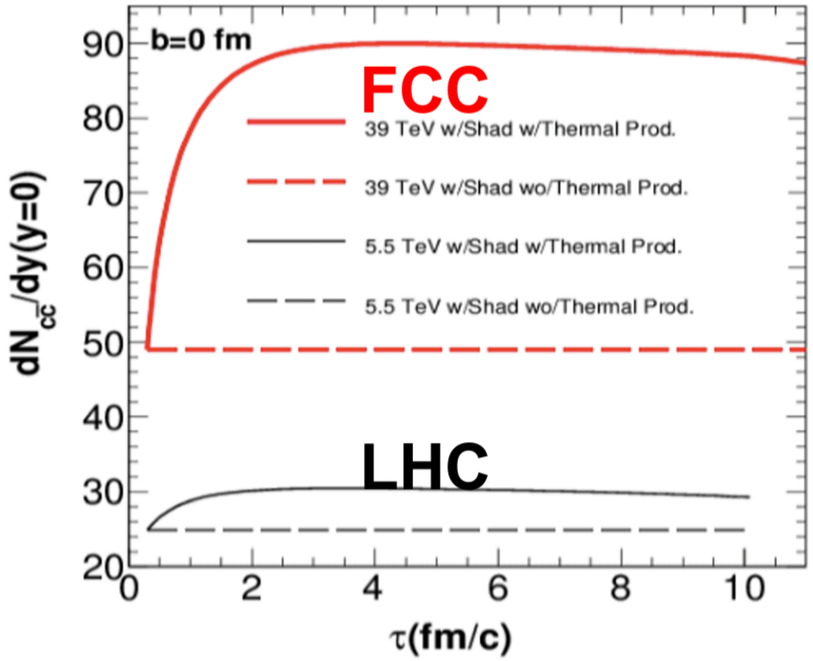
Initial + thermal charm production



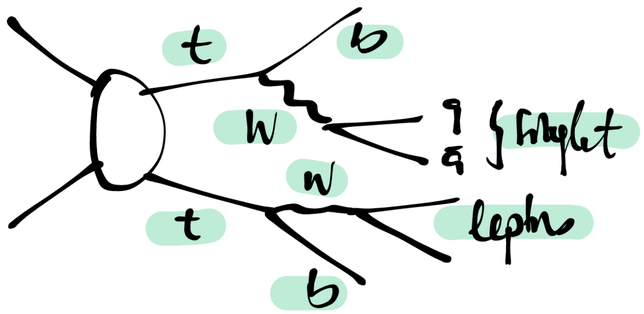
K. Zhou et al., arXiv:1602.01667
C.M. Ko, Y. Liu, arXiv:1604.0120

**For sufficiently high temperature:
thermal charm production**

+ much more: melting of bottomonia, increased thermal radiation, full thermalisation of beauty?

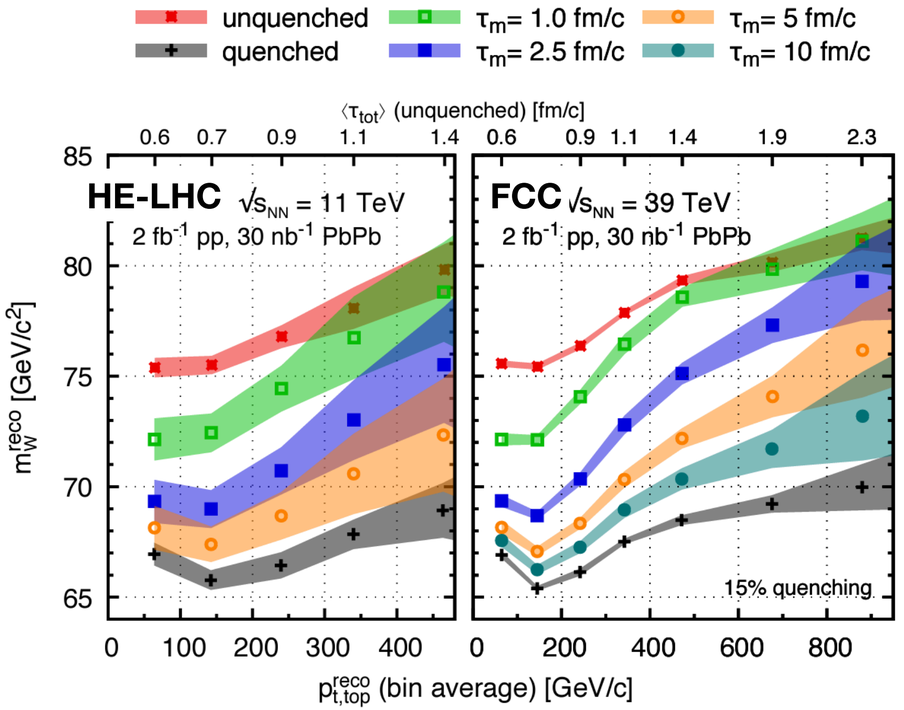
New probes of the QGP: top decays

Main idea:



Use W decays to switch off strong interactions

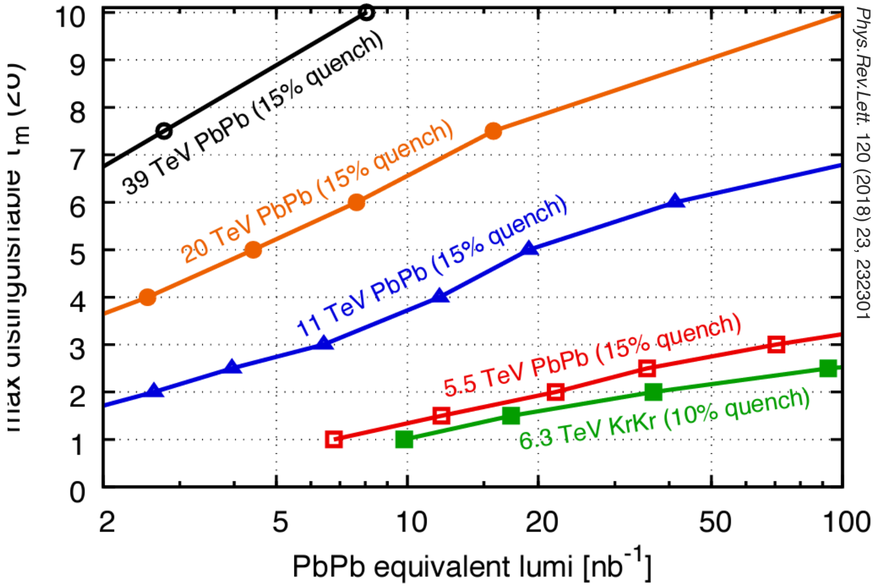
Vary time by varying boost



Observable:
Apparent mass of hadronic W decay

Energy loss effect decreases
at large p_T due to boost

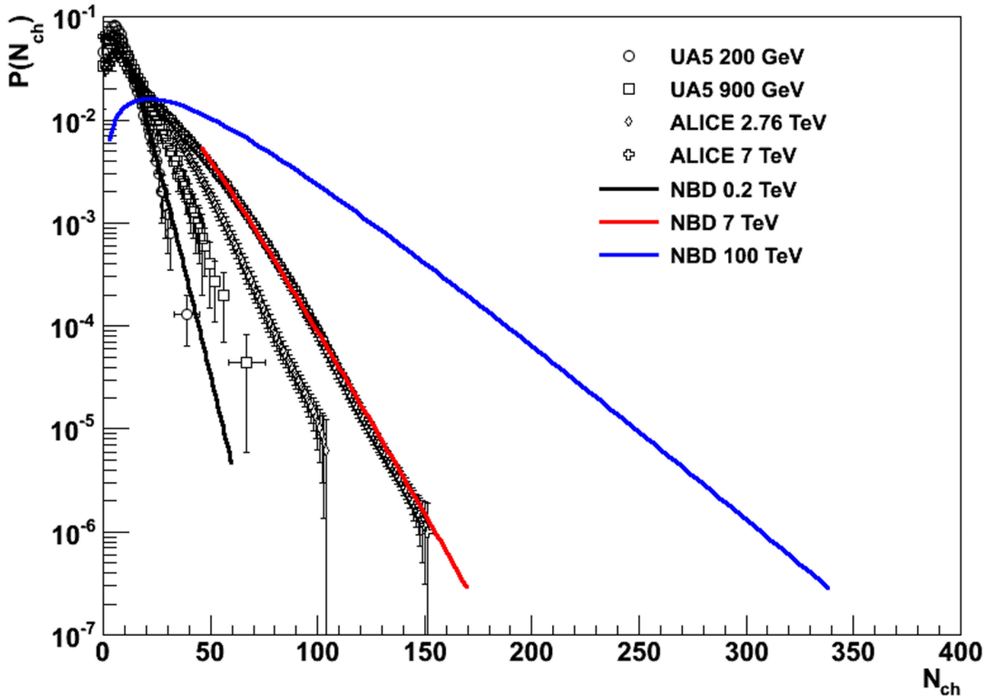
Sensitivity limits to max quenching time



Need large statistics and large boost
for a measurement
in the relevant range (5-10 /fm)

Increased density in ‘small’ systems

pp: multiplicity distribution



Proton-proton collisions occasionally produce (very) large multiplicity

Density effects already seen at LHC
long-range correlations (flow)
strangeness enhancement

FCC gives access to (much) larger multiplicities in pp (and e^+e^- ?)

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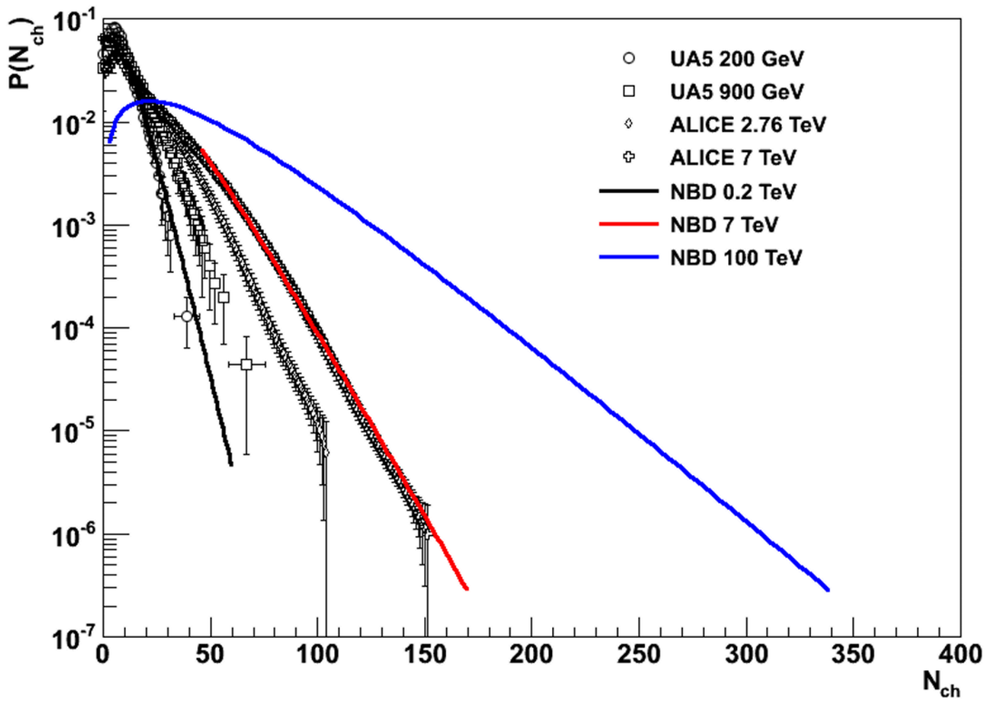

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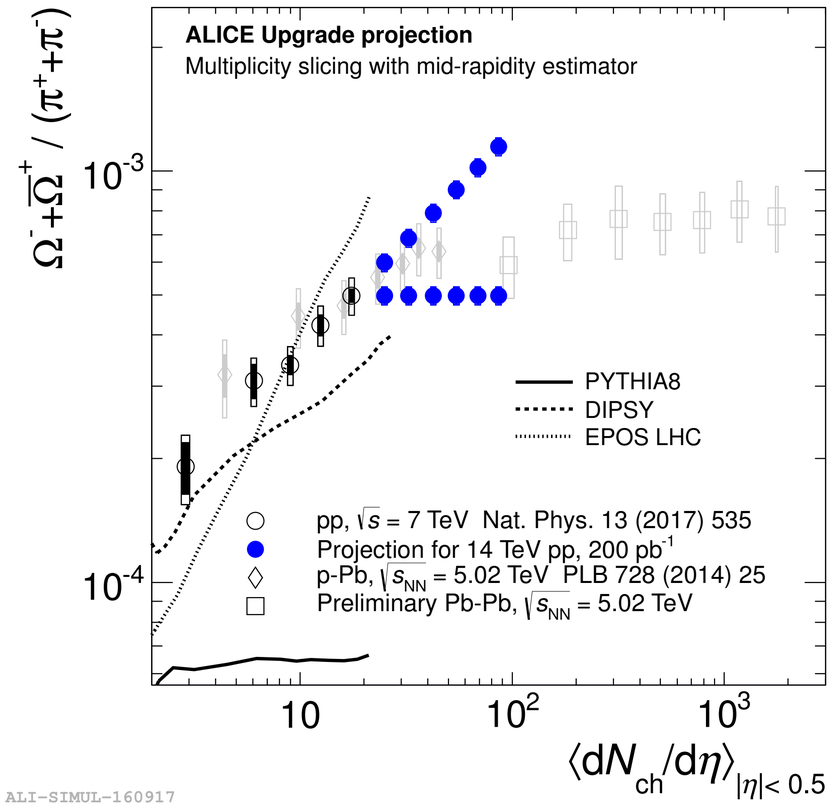
Ω/π ratio



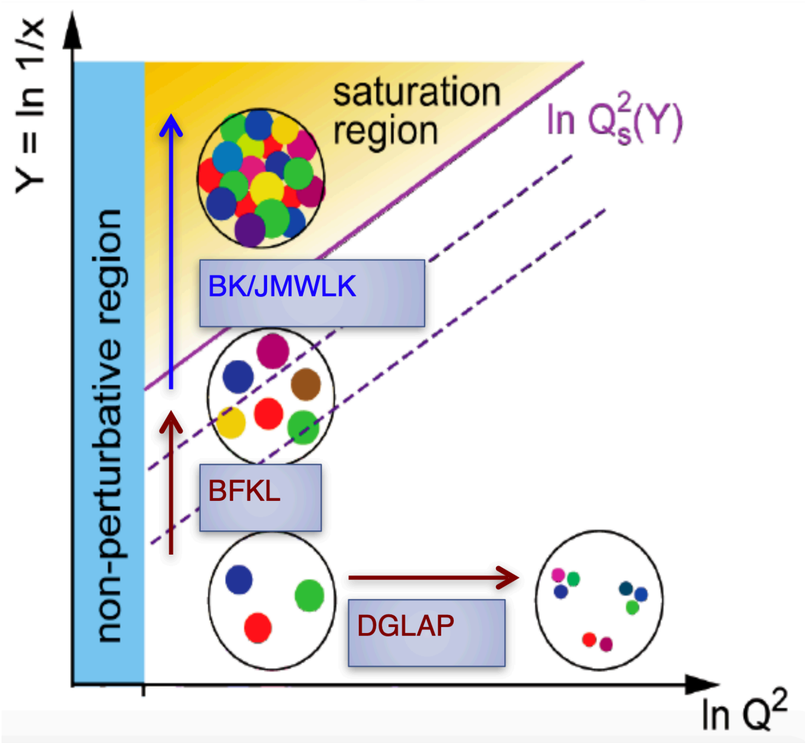
Test equilibration dynamics in small systems:

e.g. does Ω/π saturate at thermal equilibrium levels?

Increase beyond would indicate dynamics dominant, e.g. more color ropes

Small-x physics at FCC-hh and LHeC

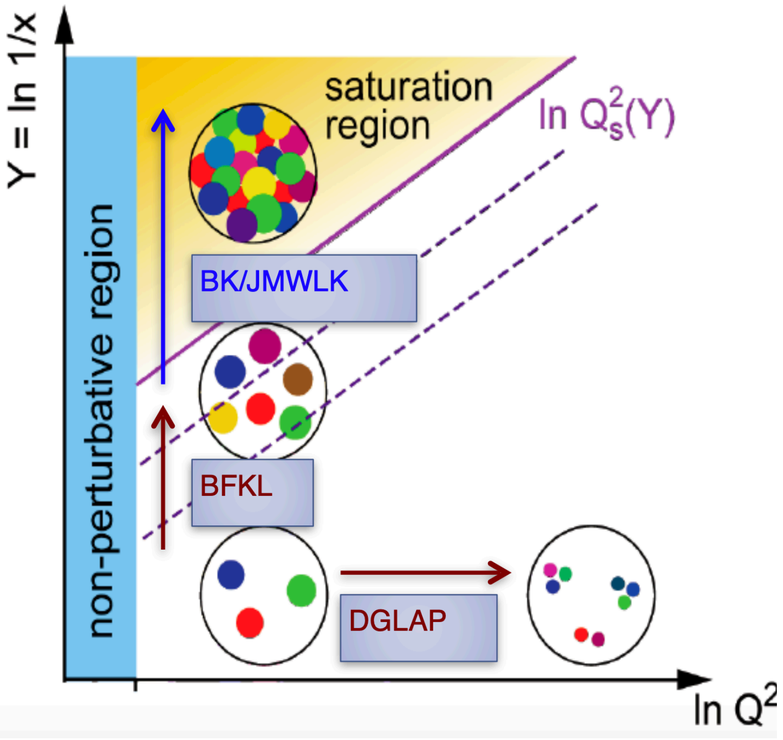
small-x: large gluon density



Expect non-linear evolution of gluon density at very small x:
new regime

Small-x physics at FCC-hh and LHeC

small-x: large gluon density



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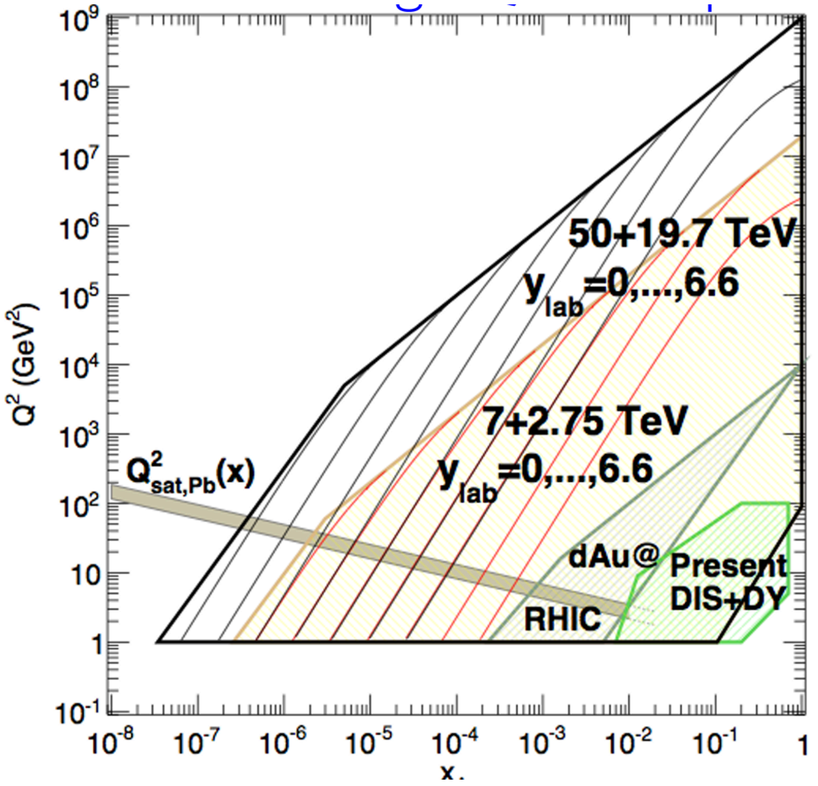
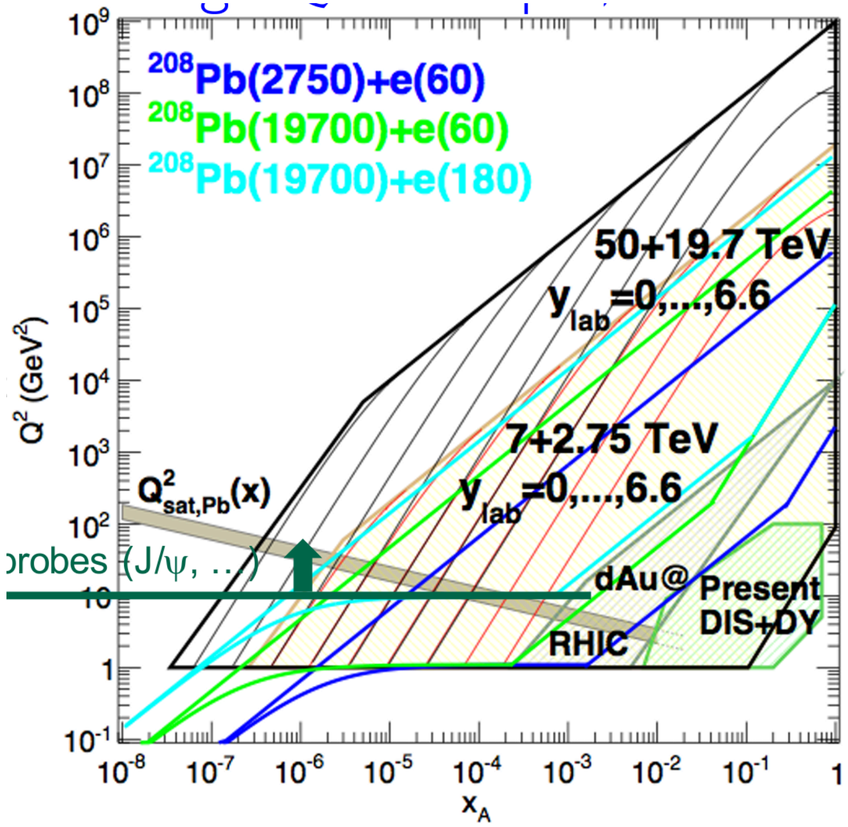
x-Q coverage in pA (including FCC)



x-Q coverage in LHeC, FCC-eh



LHCeC gives access to $x \approx 5\ 10^{-7}$ at $Q^2 \sim 10$ GeV