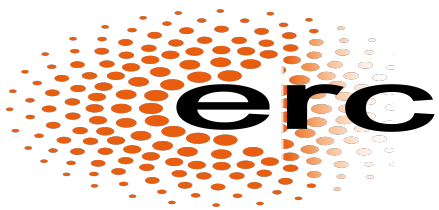
UPC/pPb/nPDF/low-x chapter for HL-LHC yellow report: activity summary and chapter status

Michael Winn



June 16, 2018

Outline

- collision energy
- chapter overview: authors, tables and figures
- *pp* reference samples
- luminosity requirements

pPb energy: top energy strongly preferred from physics

Top energy for PbPb $\sqrt{s_{NN}}$ =**5.5 TeV** vs. top energy pPb $\sqrt{s_{NN}}$=**8.8** TeV

- luminosities scale as $L \propto \sqrt{\gamma_{beam1}}\sqrt{\gamma_{beam2}}$
- larger statistical power for a fixed luminosity for a given observable for larger energy
  $\rightarrow$ most dramatic for top $\rightarrow$ factor ≈ 6 for σ_{incl}
- larger kinematic range in x, Q^2-plane at higher energy

$\rightarrow$ strong preference of working group to run at highest possible collision energy
$\rightarrow$ requires pp reference different w.r.t. PbPb, to be seen what can be done with available data at 8 TeV

Structure overview

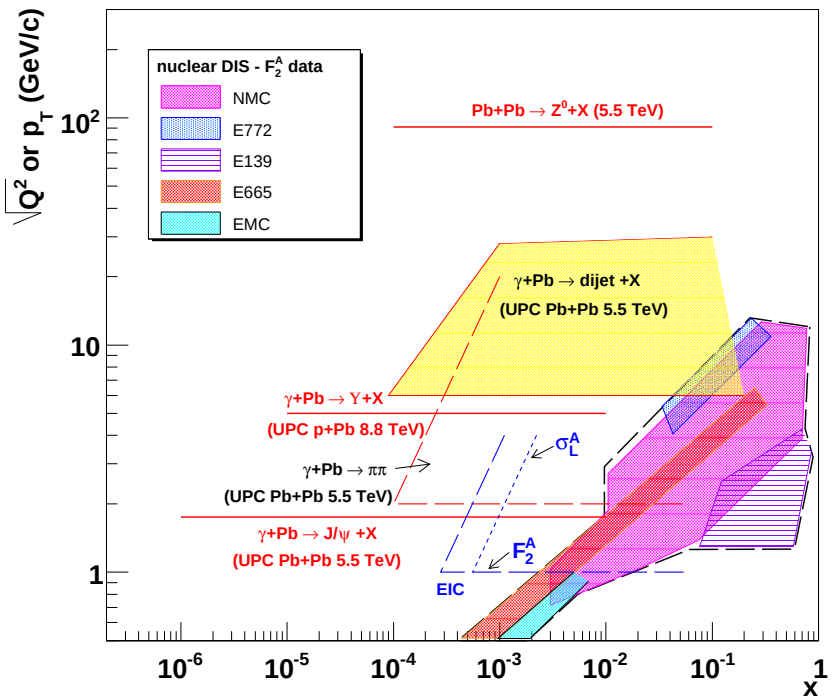
- introduction, about 1-2 pages
- UPC: experiment + theory, about 6 pages
- inclusive hadronic pA collisions: experiment + theory, about 6 pages
- nPDF constraints, about 5 pages
- *Lighter ions, about 2 pages*: reserved, to be filled with life depending on discussion today and at workshop

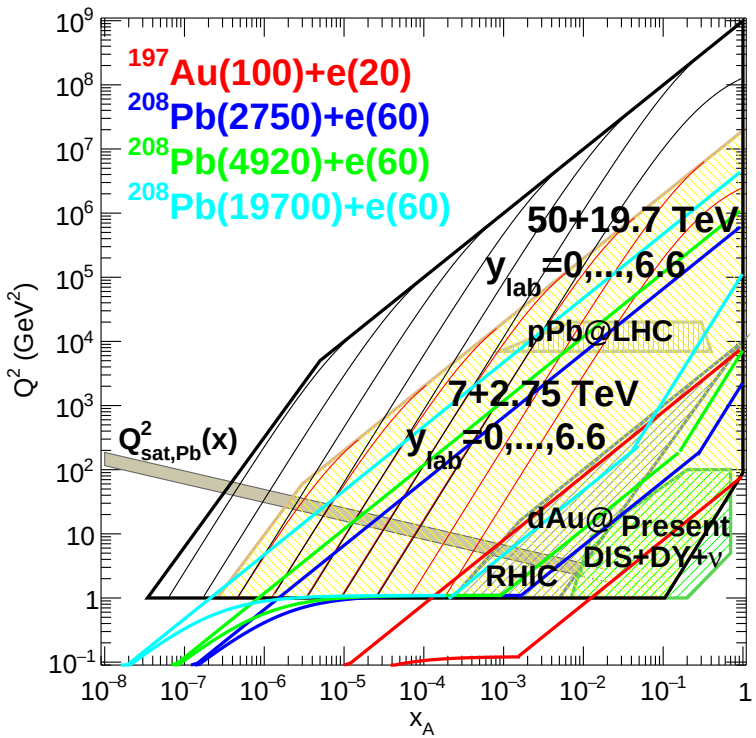
structure evolving in separate overleaf copy of central repository, where all authors have rights to write
will be merged at later stage

Intro

Author: Nestor Armesto

- intro high-energy QCD: partonic structure of nucleons and nuclei and particle production in heavy-ion
- present status of theory: collinear and beyond
- plots: kinematic planes for UPC and inclusive hadronic, placeholders see below

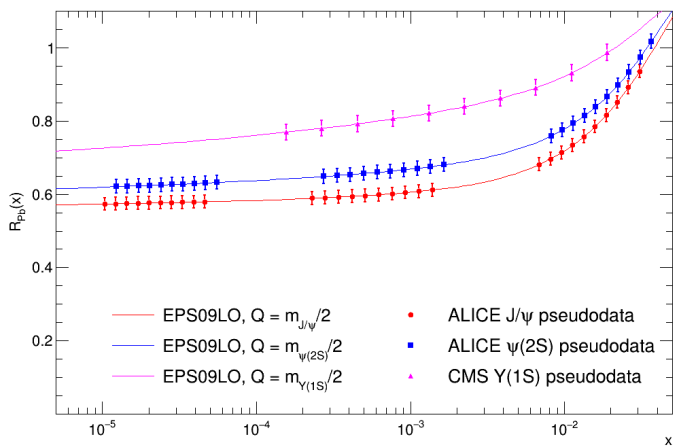




UPC: experiment

Authors: Christoph Mayer (ALICE), Evgeny Krishen (ALICE), Daniel Takaki (CMS), Zvi Citron (ATLAS), Michael Winn (LHCb)

- paragraph for each experiment explaining observables and capabilities
- large table summarising all observables in reach in all experiments with approx. avail. stat. and physics topic for Run 3,4
- mention beyond opportunities where appropriate and not covered by small systems, High-energy
- plots from detailed projections: 1 plot with nuclear suppression in UPC vector meson production combining all available projections, first draft plot by E. Kryshen, T. Takaki, C. Mayer



UPC: theory

Dijets *Authors: Mark Strikman and Vadim Guzey + Adrian Dumitru + Aaron Angerami*

- content: jets as novel probe of nuclear "common" and diffractive PDFs, theory status and predictions
- Plots: Feynman graphs for jets in UPC, 2 plots for x_A distributions for inclusive and diffractive case

Vector mesons *Authors: Mark Strikman and Vadim Guzey + Jesus Guillermo Contreras Nuno + Spencer Klein*

- intro, relation to geometry, coherent vs. incoherent in view of small-x access, overview of literature: general features and model-dependence and current data comparisons, predictions
- Plots: Feynman graphs for VM photoproduction in UPC, two-panel figure for pt2 distribution for light and heavy vector mesons

γ-induced reactions in hadronic inelastic collisions *Authors: Spencer Klein + Jesus Guillermo Contreras Nuno*

- to be seen how to separate w.r.t. other chapters

pA: experiment

Authors: Yen-Jie Lee (CMS), Marco van Leeuwen (ALICE), Zvi Citron (ATLAS), Michael Winn (LHCb)

- paragraph for each experiment explaining observables and capabilities
- table summarising all observables in reach in all experiments with approx. avail. stat. and physics topic for Run 3,4
- mention beyond opportunities where appropriate and not covered by small systems, High-Energy
- plots from detailed projections: 1 plot DY from LHCb, 1 plot Dijets from CMS, 1-3 plots W or Z(triple differential) ATLAS, 1 plot ccbar correlations LHCb (can be recombined in less number of Figures), ALICE Focal photons (tbc)

pA: theory

Authors: Cyrille Marquet (CGC/TMD), Francois Arleo (collinear)

- CM: ccbar and bbbar correlations: heavy mesons and dijets, general intro of framework, discussion on particular Transverse Momentum Dependent (TMD) pdfs appearance in massive case and saturation sensitivity
- FA: DY, photons, E-los, pt-broadening in pA, discrimination w.r.t. existing models with new data, general features in kinematics to be exploited
- one plot with with azimuthal ccbar correlations in pp vs. pA most central combined with LHCb projection

nuclear PDF: general

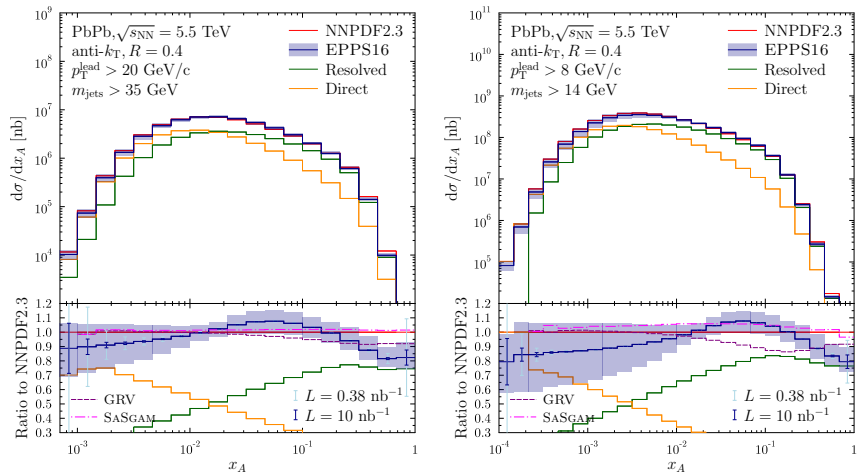
Authors: Fred Olsen, Aleksander Kusina, Ingo Schienbein, Hannu Paukkunen, Ilkka Helenius

- summary of "safe" input for fits at Run 3,4: W,Z, DY, dijets, top, photon
- input from experiment till end of July, crucial to know assumption of error bar sizes
- provide reweighted uncertainty band with pseudodata from previous experimental tables
- point out where also add. potential incl. caveats for low-x gluons: UPC vector mesons, charm/beauty in pPb
- demonstrative theory plot to be decided, probably gluon and quark pdfs before and after reweight with Run3,4 data

nuclear PDF: dedicated part with focus

UPC inclusive Dijets, *Authors: Ilkka Helenius*

- content: theoretical framework, optimal kinematical cuts to constrain certain x-regions
- plot with dijet distribution with ATLAS cuts and with softer pt-cut, see below, theory including also photon pdf uncertainties, show also ratio w.r.t. proton pdfs (pA measurement)



Top, *Authors: Hannu Paukkunen and David d'Enterria*

- plots pT reach for ttbar and constraints for nPDF
- probably lepton+jets, to be updated with EPPS16/nCTEQ15, see last meeting for procedure

"Ideal" pp references: naive thoughts on running time

- ideally: pp reference before/after pPb data taking: same detector configuration, better cancellation of systematic uncertainties
- statistical uncertainty of pp smaller statistical uncertainty pPb/Pbp: S/B and $\varepsilon \approx$ the same/better as pp (pile-up in pp)
- assumption in ALICE LOI for PbPb: statistical square $\Delta^{stat}_{pp} = \Delta^{stat}_{pPb}/\sqrt{2}$
- assume that most interesting modes have large S/B

"Ideal" pp reference: naive thoughts on running time

Assuming similar conditions in pp vs pPb and $R_{pPb} = 1$ and neglecting rapidity shift:

- $L_{int,pPb} = 1pb^{-1}$(ATLAS/CMS), $160nb^{-1}$ (LHCb) $500nb^{-1}$ (ALICE)
- $L_{int,pp-ref} = 2 \cdot 208 \cdot L_{int,pPb}$
  $\approx$ $416pb^{-1}(ATLAS/CMS), \approx$ $70pb^{-1}(LHCb), \approx$ $210pb^{-1}(ALICE)$
- ATLAS/CMS: luminosity at 8.8/5.5 TeV machine limited, fastest
- LHCb: $PU = 5$ as at top energy with full machine: $\approx$ 20h stable beams; opimistic, machine limitations?
  $\rightarrow$ still quite short
- ALICE: assuming 1 MHz read-out: about 200 days of stable beams

$\rightarrow$ rather little running time for ATLAS/CMS/LHCb
$\rightarrow$ to be evaluated what can be done with existing and with higher energy data depending on observable and experiment
$\rightarrow$ will also depend on observable focus, priorities at that time, would not assume that pp reference a limitation

Luminosity requirements

baselines discussed so far

- PbPb: 10 nb^{-1} per ATLAS/CMS/ALICE for UPC vector mesons and dijects, LHCb to be defined
- pPb: ATLAS/CMS 1 pb^{-1}, W,Z, Dijets, top
- pPb: ALICE UPC
- pPb: LHCb 160 nb^{-1} in run 3 (b-production, Z,W, ccbar correlations, photons); total integrated 460 nb^{-1} for precise pA Drell-Yan

Conclusion

- highest available energy strongly favoured
- range of observable exploited
- plan quite detailed: need to finalise all needed projections and get started with editing work
- next meeting during next week to fix priorities for nPDF exercise