WG4 Summary: Heavy flavour and hadronic final states

Ilkka Helenius
Laure Massacrier
Giovanni Stagnitto

09:00
Precise phenomenology at the LHC: state of art in perturbative QCD — *Luca Buonocore*
Maison MINATEC, Grenoble, FRANCE 09:00 - 09:30

Open bottom production at hadron colliders at NNLO+NNLL — *Terry Generet*
Maison MINATEC, Grenoble, FRANCE 09:30 - 09:50

Recent results on open heavy flavor production (pp, pPb, PbPb) from LHCb — *Chenxi Gu*
10:00
Maison MINATEC, Grenoble, FRANCE 09:50 - 10:10

Recent heavy-flavour results from ATLAS — *Semen Turchikhin*
Maison MINATEC, Grenoble, FRANCE 10:10 - 10:30

Coffee break
Maison MINATEC, Grenoble, FRANCE 10:30 - 11:00

11:00
Recent heavy-flavor measurements from RHIC — *Veronika Prozorova*
Maison MINATEC, Grenoble, FRANCE 11:00 - 11:20

Reacent heavy flavour measurements from ALICE — *Jonghan Park*
Maison MINATEC, Grenoble, FRANCE 11:20 - 11:40

Charm total cross sections and extraction of QCD parameters — *Achim Geiser*
Maison MINATEC, Grenoble, FRANCE 11:40 - 12:00

12:00
PineAPPL grids of open heavy-flavor production in the GM-VFNS — *Jan Wissmann*
Maison MINATEC, Grenoble, FRANCE 12:00 - 12:20

14:00
Strangeness production and polarization at LHCb — *camilla de angelis*
Maison MINATEC, Grenoble, FRANCE 14:10 - 14:30

From short to long-distance QCD with archived ALEPH e+e- at LEP1 and LEP2 — *Gian Michele Innocenti*
Maison MINATEC, Grenoble, FRANCE 14:30 - 14:50

Reconstructing, classifying and calibrating hadronic objects in ATLAS — *Pierre-Antoine Delsart*
15:00
Maison MINATEC, Grenoble, FRANCE 14:50 - 15:10

Quarkonium fragmentation in a variable-flavor number scheme: Towards NRFF1.0 — *Francesco Giovanni Celiberto*
Maison MINATEC, Grenoble, FRANCE 15:10 - 15:30

Coffee break
Maison MINATEC, Grenoble, FRANCE 15:30 - 16:00

16:00
Complete one-loop study of exclusive J/ψ and Υ photoproduction — *Dr Saad Nabeebaccus*
Maison MINATEC, Grenoble, FRANCE 16:00 - 16:20

One-loop QCD corrections to inclusive production of J/ψ and Υ in e^+e^- annihilation — *Maxim Nefedov*
Maison MINATEC, Grenoble, FRANCE 16:20 - 16:40

Recent progress in the calculation of the N3LO splitting functions — *Giulio Falcioni*
Maison MINATEC, Grenoble, FRANCE 16:40 - 17:00

17:00
A general mass variable flavor number scheme for Z boson associated with a heavy quark production at hadron collide
MARCO GUZZI

Measurement of jet production in deep inelastic scattering and NNLO determination of the strong coupling at ZEUS
Florian Lorkowski

Measurement of the 1-jettiness event shape observable in deep inelastic electron-proton scattering at HER
Johannes Hessler

18:00
Energy Energy correlators in DIS — *Haitao Li*
Maison MINATEC, Grenoble, FRANCE 18:00 - 18:20

Simultaneous Determination of Fragmentation Functions and Test on Momentum Sum Rule — *Jun Gao*
Maison MINATEC, Grenoble, FRANCE 18:20 - 18:40

8+6+10+4+6+5 = 39 talks in WG4
\+ 6 talks in WG1+WG4

many topics: bottom/charm fragmentation, top physics, jet substructure, MC generators for DIS, UPC & nuclei & correlations, hadronization, quarkonia…

Thanks to all the speakers of WG4!

Thanks to the organizers!

09:00
- **Precision calculations for groomed event shapes at HERA** — *Daniel Reichelt*
  Maison MINATEC, Grenoble, FRANCE 08:50 - 09:10
- **First measurement of groomed event shape observables in deep-inelastic electron-proton scattering at HERA**
  Henry Klest
- **High-purity gluon jet showers from secondary Lund jet planes** — *Cristian Baldenegro*
  Maison MINATEC, Grenoble, FRANCE 09:30 - 09:50

10:00
- **Measurements of jet substructure using the CMS detector** — *Jelena Mijuskovic*
  Maison MINATEC, Grenoble, FRANCE 09:50 - 10:10
- **Jet substructure measurements and precision measurements of multijet production with the ATLAS experiment**
  Zdenek Hubacek
- **Coffee break**
  Maison MINATEC, Grenoble, FRANCE 10:30 - 11:00

11:00
- **Precision boson-jet azimuthal decorrelation at hadron colliders** — *Bin Wu*
  Maison MINATEC, Grenoble, FRANCE 11:00 - 11:20
- **Theoretical predictions for $t{\bar t}W$ cross sections at approximate N^{3}LO** — *Nikolaos Kidonakis*
  Maison MINATEC, Grenoble, FRANCE 11:20 - 11:40
- **Linear power corrections to top quark production processes** — *Melih OZCELIK*
  Maison MINATEC, Grenoble, FRANCE 11:40 - 12:00

12:00
- **Top-Bottom Interference Contribution to Fully-Inclusive Higgs Production** — *Tom Schellenberger*
  Maison MINATEC, Grenoble, FRANCE 12:00 - 12:20
- **Measurements of γ from tree-level decays at LHCb** — *Alessandro Bertolin*
  Maison MINATEC, Grenoble, FRANCE 12:20 - 12:40

- **Measurements of W and Z boson production in association with jets in ATLAS** — *Camilla Vittori*
  Maison MINATEC, Grenoble, FRANCE 14:10 - 14:30
- **Combining NNLO QCD corrections with parton showers for Higgs production in bottom-quark fusion** — *Aparna Sankar*
  Maison MINATEC, Grenoble, FRANCE 14:30 - 14:50

15:00
- **Partial N3LL + NNLO Resummed Predictions for the Drell-Yan Process in Rapidity Dependent Jet Veto Observables**
  Thomas Clark
- **Six-jet production via triple parton scatterings in p-p and p-Pb collisions at the LHC** — *Marina Maneyro*
  Maison MINATEC, Grenoble, FRANCE 15:10 - 15:30
- **Coffee break**
  Maison MINATEC, Grenoble, FRANCE 15:30 - 16:00

16:00
- **di-jet production and signatures of collectivity in multiparticle photoproduction in UPC with the ATLAS detector**
  Martin Spousta
- **Dijet photoproduction and transverse-plane geometry in ultra-peripheral nuclear collisions** — *Petja Paakkinen*
  Maison MINATEC, Grenoble, FRANCE 16:20 - 16:40
- **Dependence of two-particle azimuthal correlations on the forward rapidity gap width in pPb collisions at 8.16 TeV**
  Moises Leon Coello

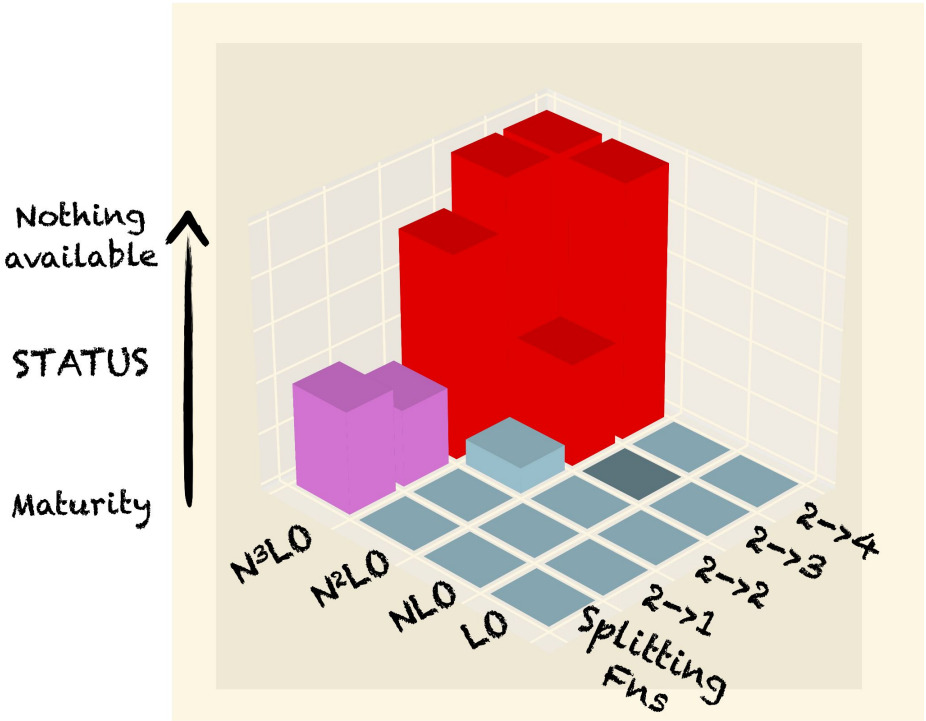
17:00
- **Di-hadron Correlations in eA scattering in the CLAS experiment** — *Sebouh Paul*
  Maison MINATEC, Grenoble, FRANCE 17:00 - 17:20
- **Cold Nuclear effects on azimuthal decorrelation in heavy-ion collisions** — *Florian Cougoulic*
  Maison MINATEC, Grenoble, FRANCE 17:20 - 17:40
- **STUDY OF PROTON-NUCLEUS INTERACTIONS IN THE DSTAU/NA65 EXPERIMENT AT THE CERN-SPS** — *Emin Yuksel*
  Maison MINATEC, Grenoble, FRANCE 17:40 - 18:00

18:00

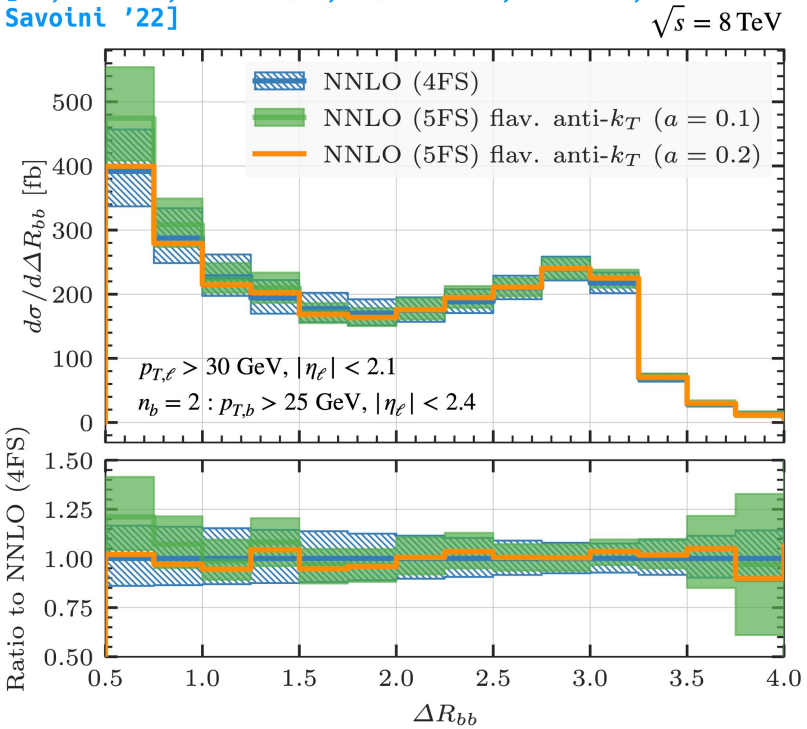
09:00
- **Extensions of MadGraph5 aMC@NLO for QCD studies** — *Laboni Manna*
  Maison MINATEC, Grenoble, FRANCE 08:50 - 09:10
- **The azimuthal correlation between the leading jet and the scattered lepton in deep inelastic scattering at HERA**
  Jae Nam
- **Multi-Jet Merging in Deep Inelastic Scattering with Pythia** — *Joni Laulainen*
  Maison MINATEC, Grenoble, FRANCE 09:30 - 09:50

10:00
- **Observation of events with an empty hemisphere in the Breit frame and differential cross section measurement**
  Zhiqing Zhang
- **A POWHEG generator for DIS** — *Andrea Banfi*
  Maison MINATEC, Grenoble, FRANCE 10:10 - 10:30

State of the art in perturbative QCD Luca Buonocore

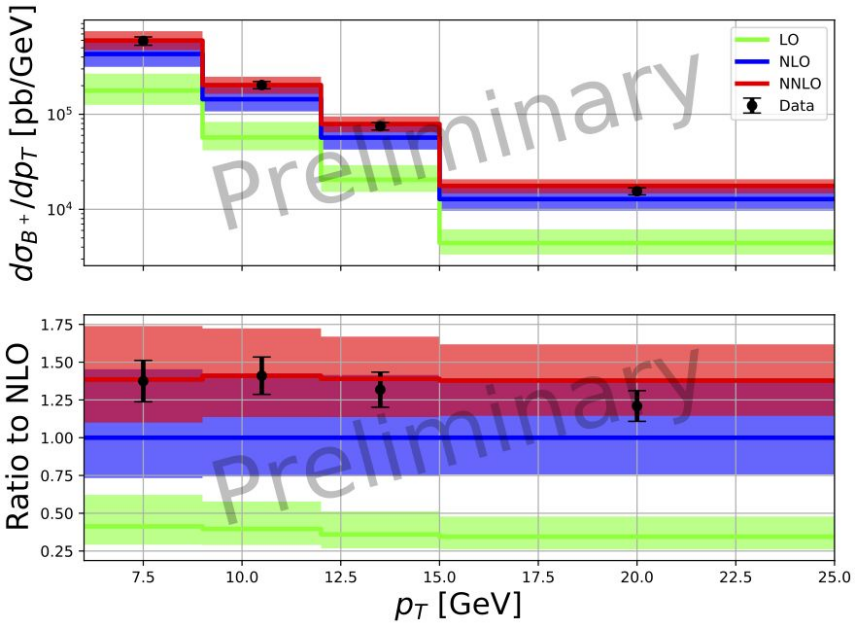


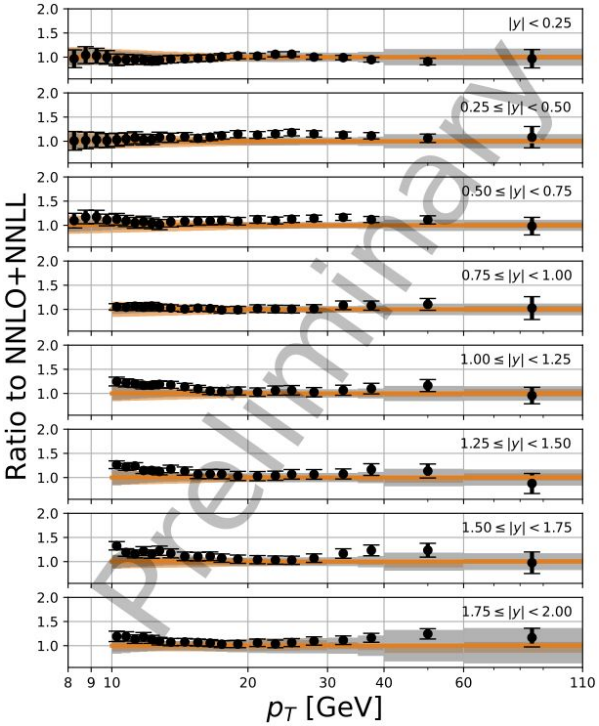
[LB, Devoto, Kallweitt, Mazzitelli, Rottoli, Savoini '22]



- Theoretical progress improves accuracy in phenomenology

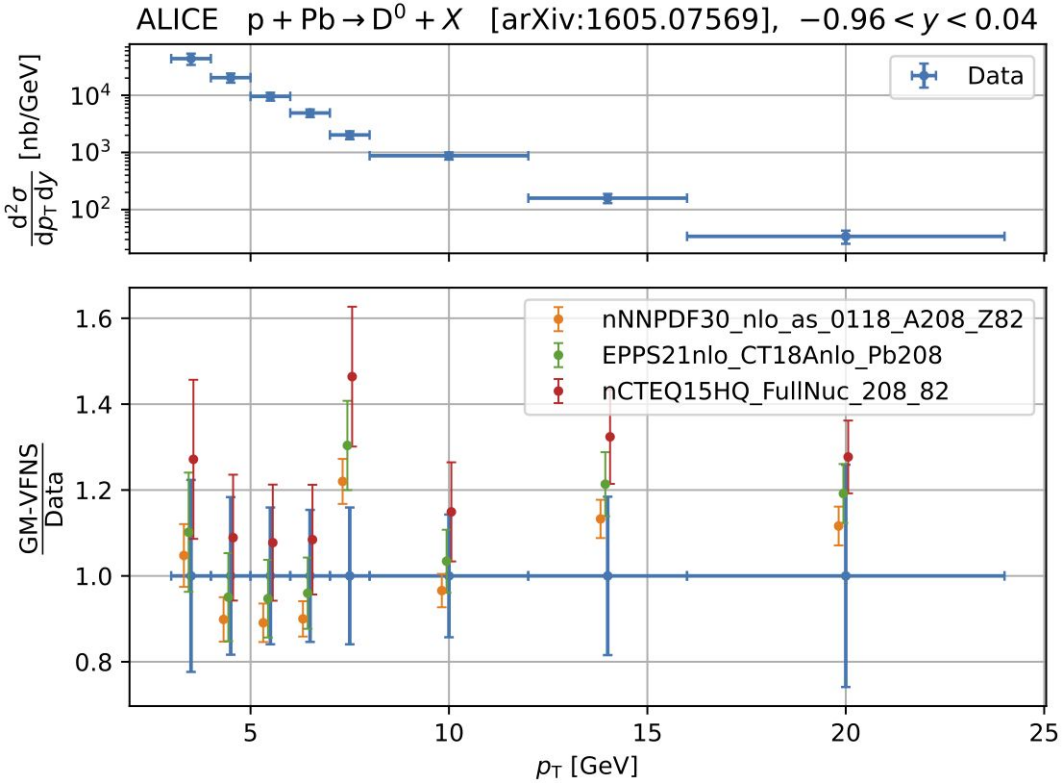
Open bottom production at NNLO+NNLL Terry Generet





- NNLO Improves description of CDF B+ data
- Good agreement also with LHCb data for J/Psi from B meson decays

PineAPPL grids for a GM-VFNS for open heavy flavour



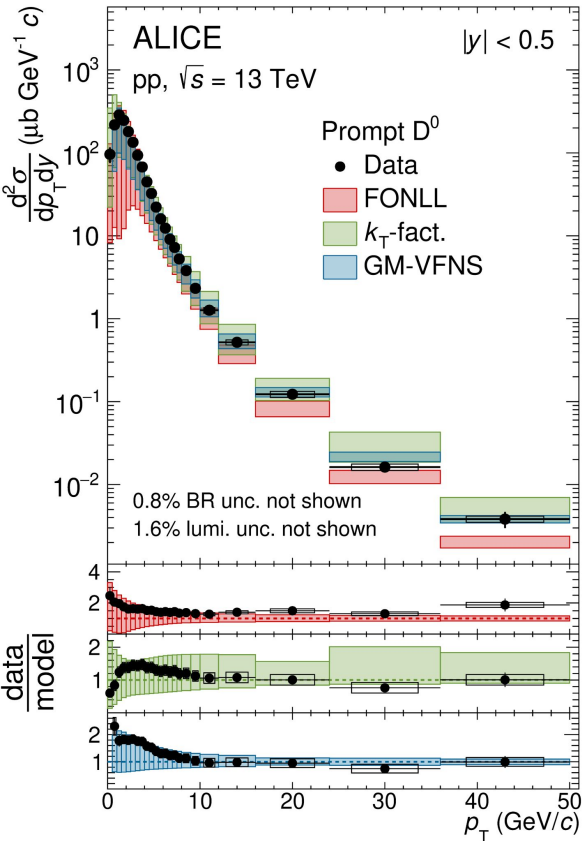
Jan Wissmann

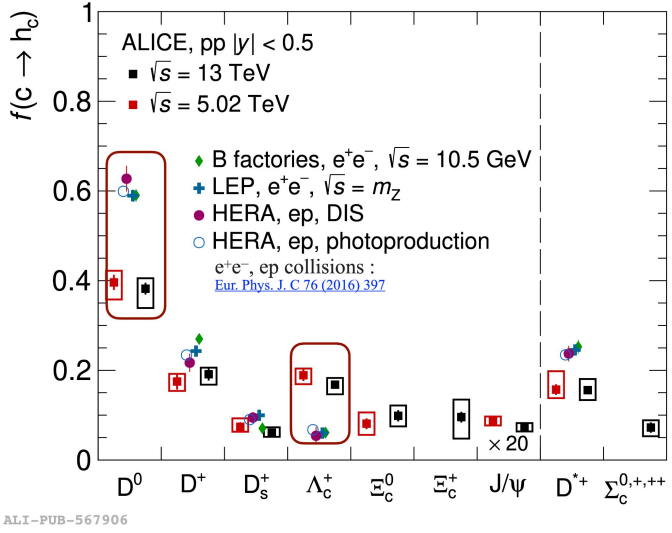
$$d\sigma_{FFNS} \xleftarrow{m_Q \leftarrow p_T} d\sigma_{GM-VFNS} \xrightarrow{p_T \gg m_Q} d\sigma_{ZM-VFNS}$$

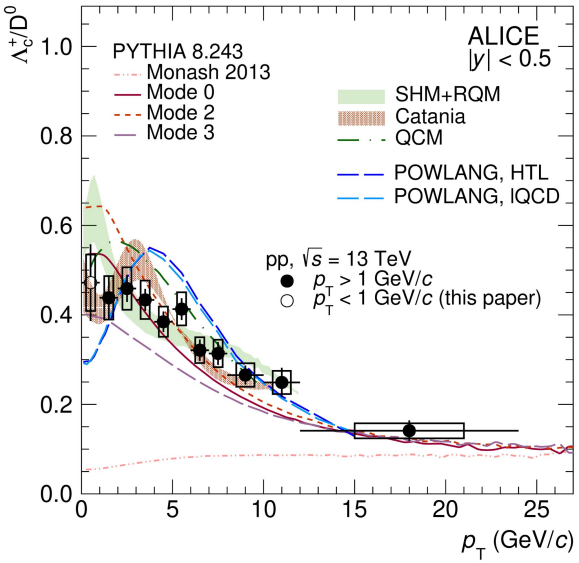
- Couple GM-VFNS calculation with PineAPPL
- Grids to allow efficient estimation of PDF uncertainties
- Good agreement with ALICE and LHCb data in p+p and p+Pb
- Enable usage of these data in (nuclear) PDF analyses

Open charm production in ALICE

Jonghan Park



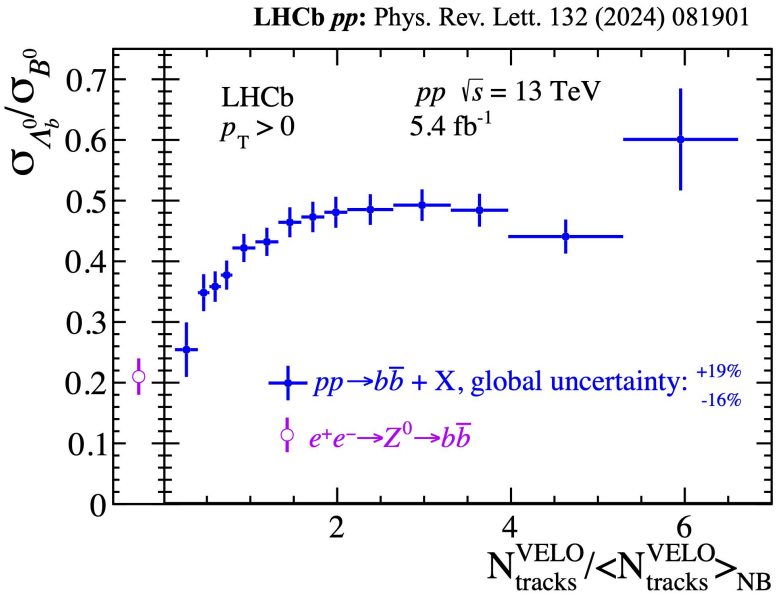




- Open charm pT spectra in line with theoretical expectations
- However, observation of non-universal fragmentation ratios
- Baryon-to-meson ratios enhanced at pT < 15 GeV

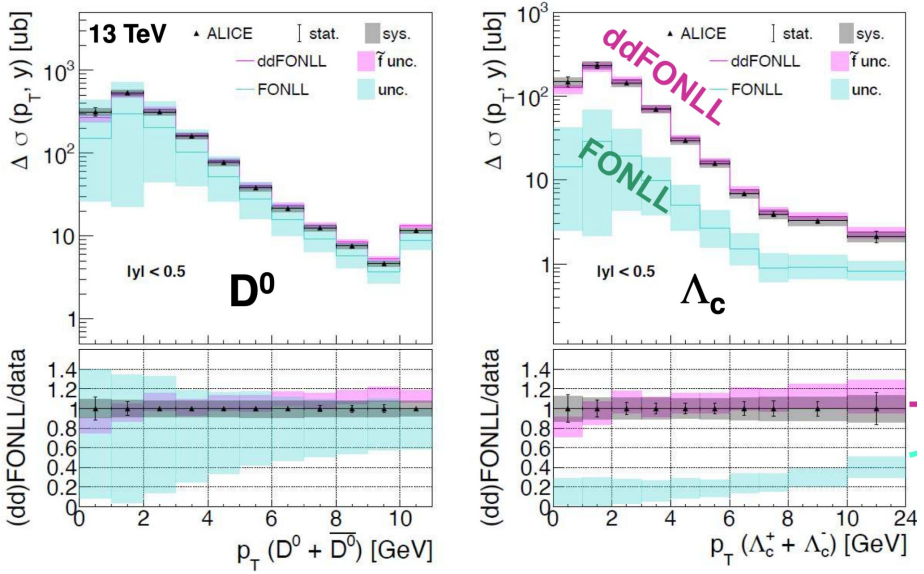
Fragmentation non-universality

Chengxi Gu



- Multiplicity dependent fragmentation ratios
- Converges to e+e- ratios at low multiplicity

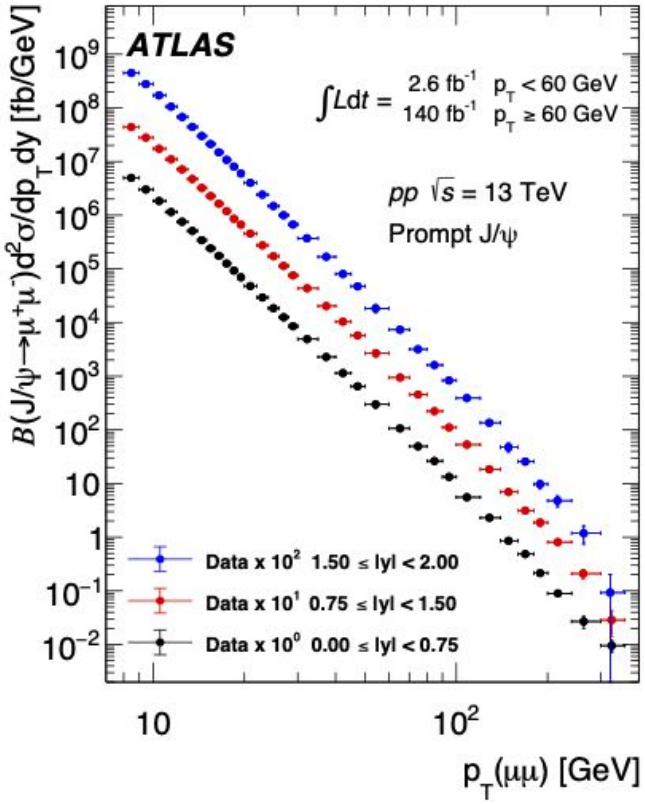
Achim Geiser



- Non-universality addressed with pT dependent fragmentation fractions (data-driven FONLL)

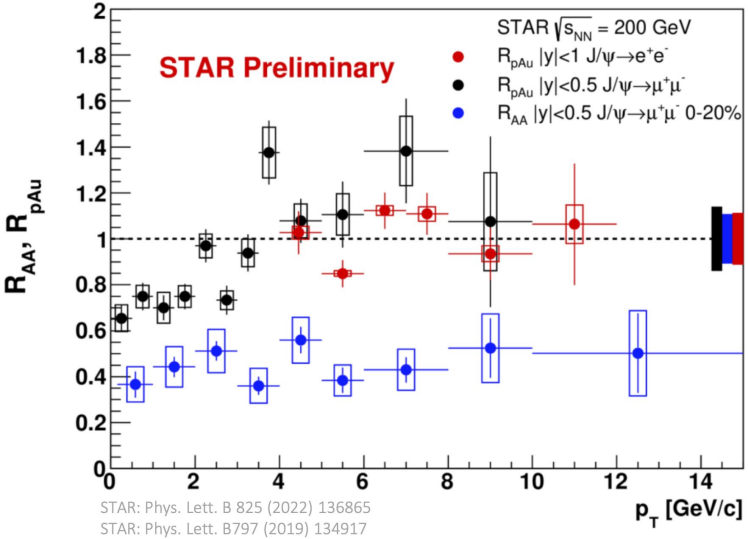
Quarkonia production

Semen Turchikhin



- Widest pT range so far for J/Psi
- Non-prompt fraction increases at low pT
- Data also for Psi(2s)
- Good agreement with other data at overlapping kinematics

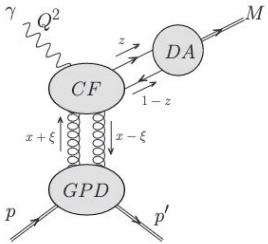
Veronika Prozorova



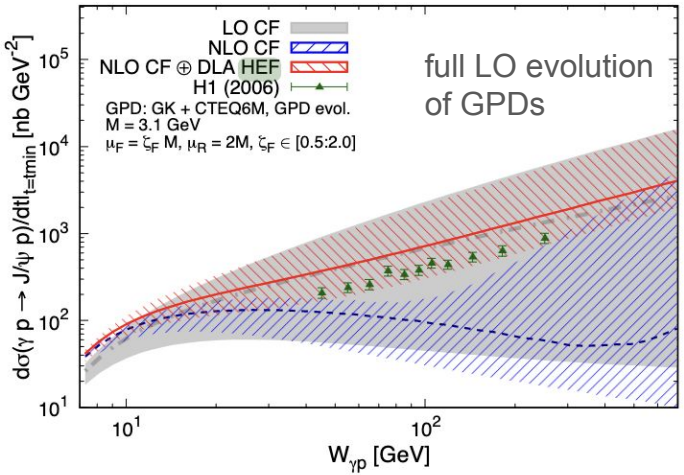
- Significant cold nuclear matter effects at low pT
- Large suppression in AA due to hot medium effects

Quarkonium photoproduction

Saad Nabeebaccus **γp**

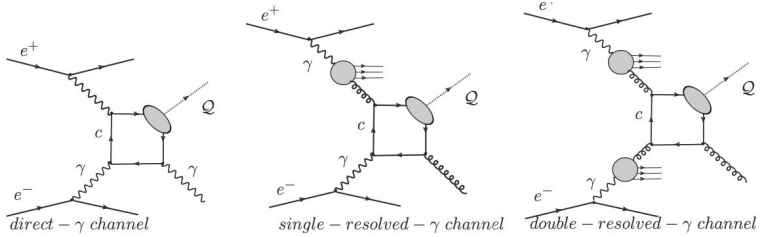


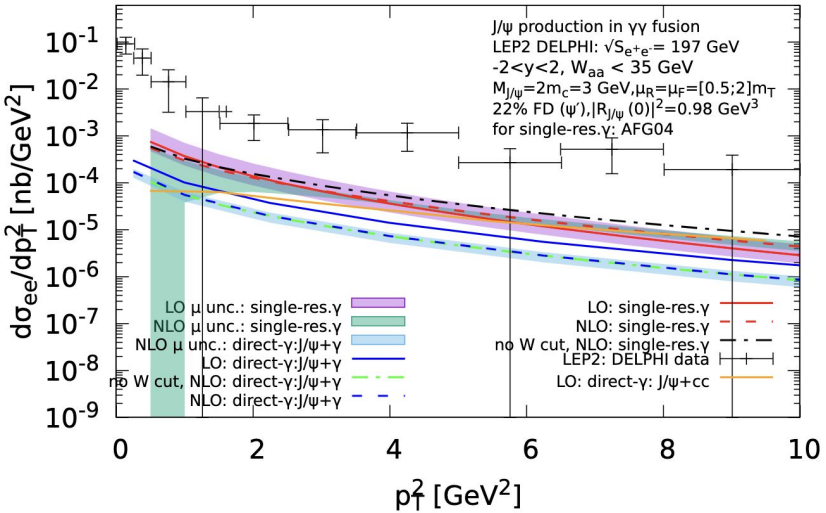
- Complete 1-loop study of exclusive J/ψ photoproduction with full GPD evolution
- Perturbative instabilities at NLO at large $W_{\gamma p}$ "patched" with high energy resummation



Maxime Nefedov **e^+e^-**

- At NLO in α_s-order, NRQCD CS+CO not able to reproduce DELPHI LEP2 data
- First computation of CS-1 loop QED direct **γ** predictions → relevant contribution at low p_T

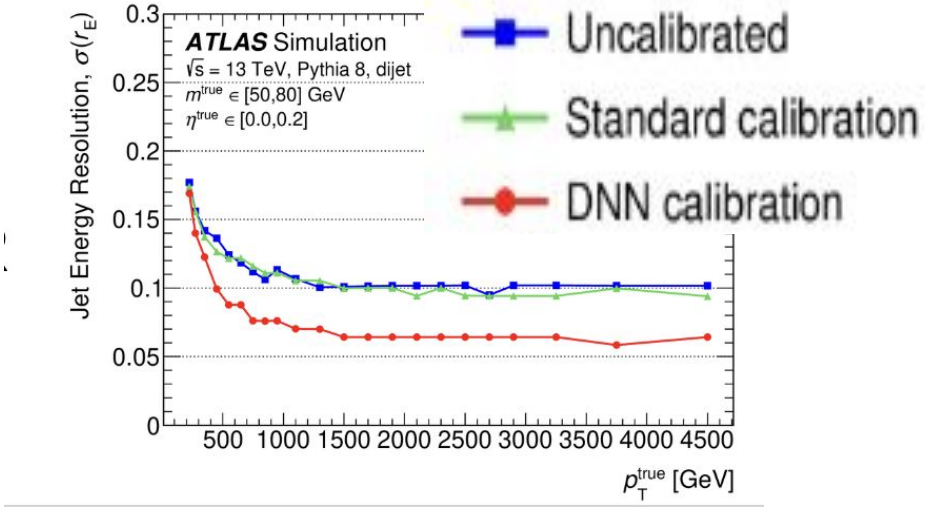




Hadronization

Pierre-Antoine Delsart

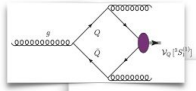
- Continuous work in ATLAS to optimize
  - energy, mass scale and resolution of hadronic jets
  - uncertainties on E and Mass
  - Discrimination between different types of jets
- Performed at every level from low-level cluster calibration to reduced jet uncertainties
- Using extensively ML tools

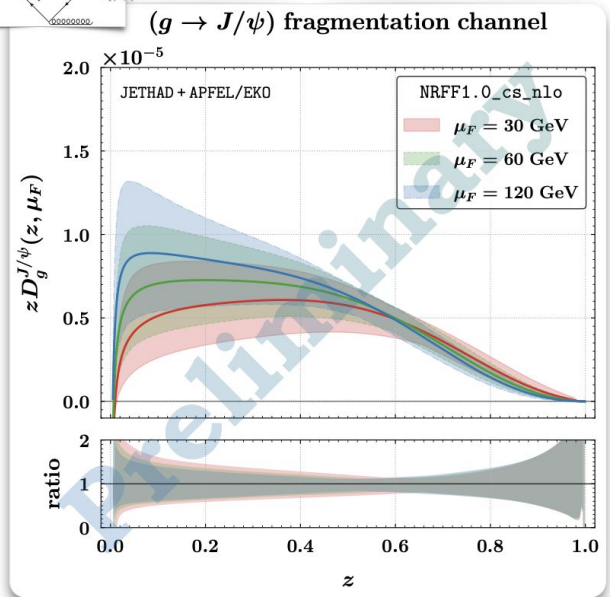


Francesco Celiberto

- Combined NRQCD and DGLAP evolution
- Obtain scale-dependent quarkonium fragmentation functions

Vector J/ψ

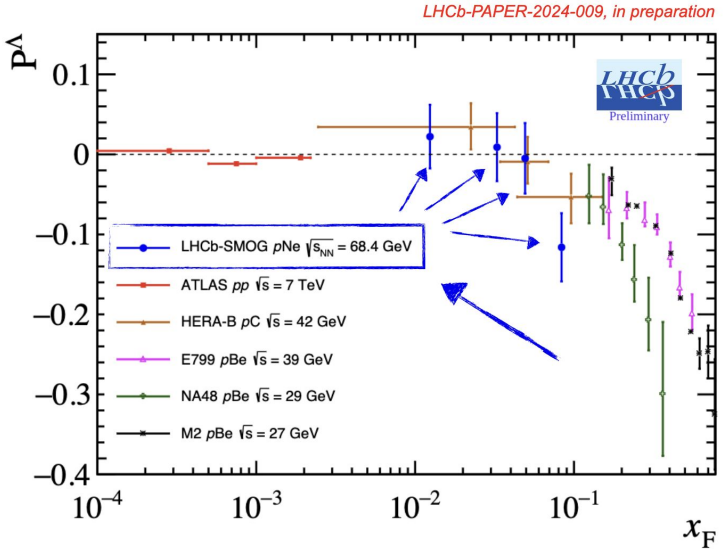




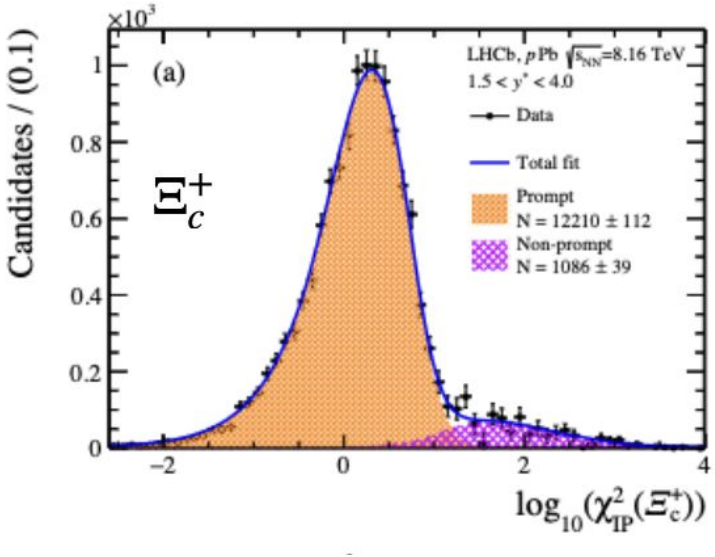
Hadronization

Camilla de Angellis

- Λ^0 (transverse) polarization in fixed target pNe collisions at LHCb
- Transverse polarization explained via phenomenological approaches (Polarizing TMD fragmentation functions: fragmentation of an unpolarized quark into a transversely polarized hadron)
- Complementary measurement to available data (kinematics, collision system) gives consistent picture



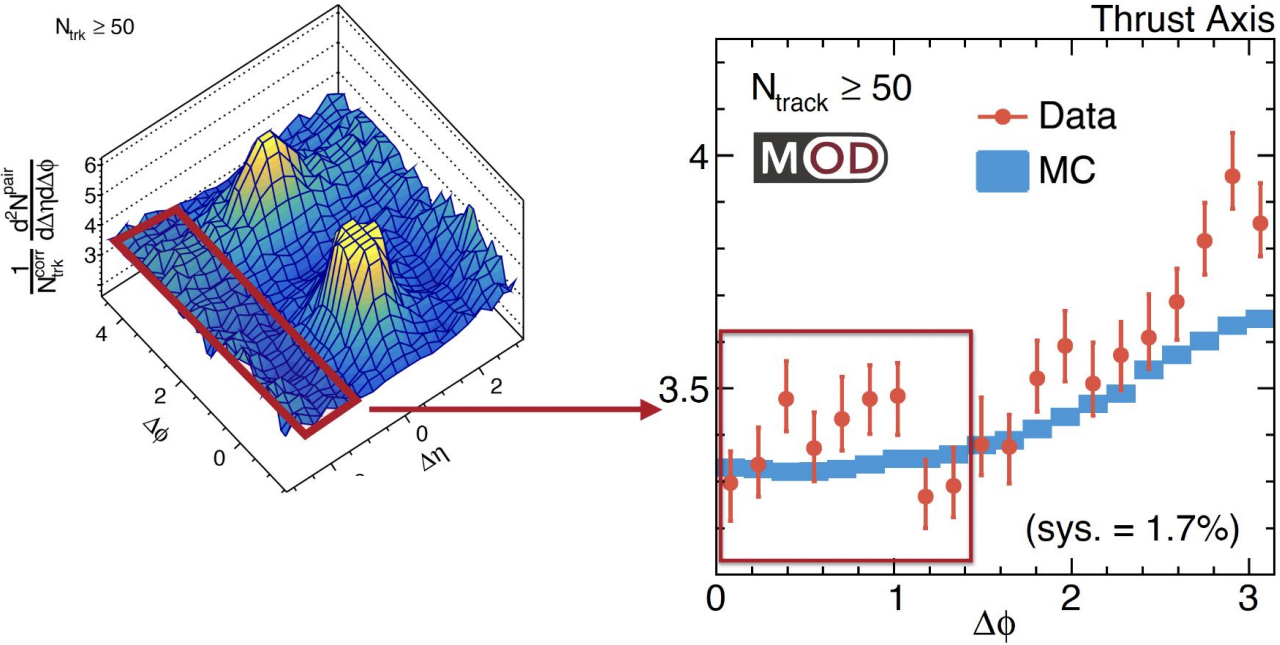
- New inputs for hadronization of strangeness
- First measurement of Ξ_c^+ by LHCb in pPb



Hadronization

Gian Michele Innocenti

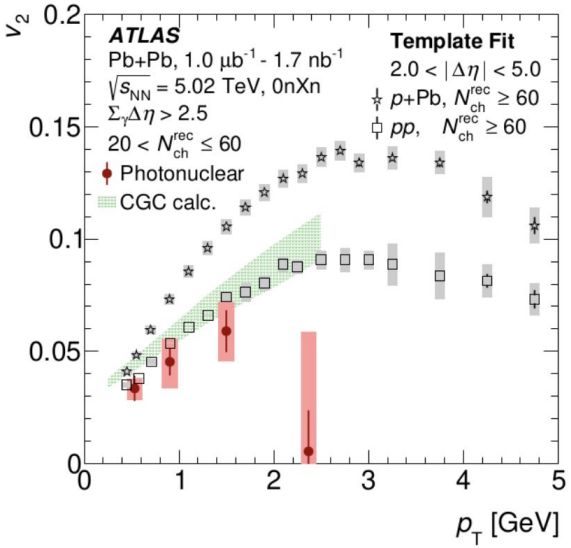
- Revisiting of ALEPH LEP2 e^+e^- data to look for the emergence of the ridge in small collision systems
- Helps in understanding the origin of the “heavy-ion like” ridge in small system : initial state effects? MPI? mini-QGP?
- Long-range near side structure also shows up in high-multiplicity LEP2 data



Heavy ions (UPC Pb-Pb, correlations)

Martin Spousta

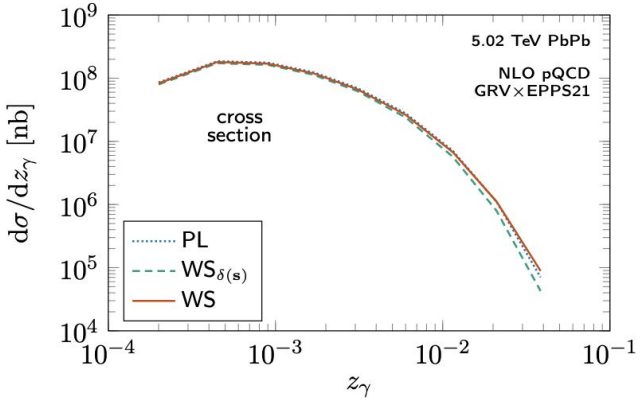
- Two-particle correlations studied in Pb-Pb UPC by ATLAS
- Long range angular correlation measured in high-multiplicity small systems. Similar behaviour for ***γ***Pb?



- Significant v_2 observed, smaller than in pPb and pp
- Theory predicted v_2 based on hadronic fluctuation in ***γ*** interacting with Pb

Petja Paakkinen

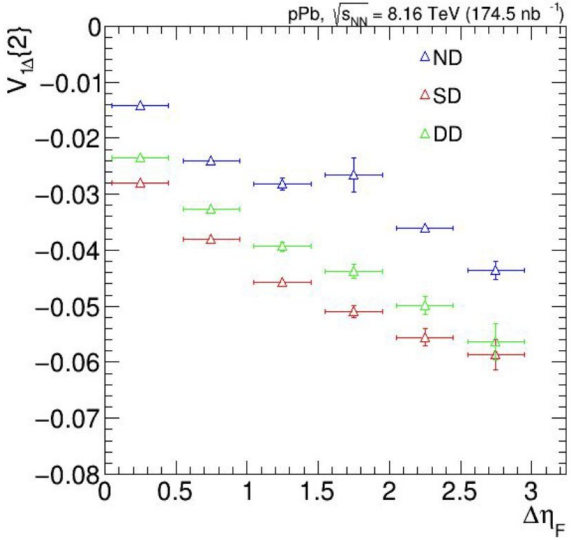
- NLO predictions for inclusive di-jet production in UPC
- WS: accounts for nuclear form factor and density of target nucleus (previous calculation PL)



Heavy ions (pPb/eA, correlations)

Moises Coello

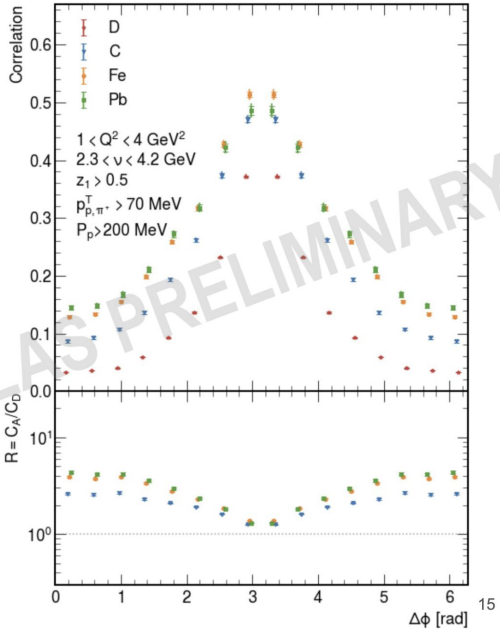
- Two particle azimuthal correlation as a function of forward rapidity gap in pPb with CMS
- MC study using Pythia8 with sample including Pomeron-Pb, γ-Pb and Non diffractive interactions



- No obvious way to differentiate diffractive classes using v_1 (or v_2)

Sebouh Paul

- Di-pion and proton-pion correlations measured at CLAS in eA scattering (A=D,C,Fe,Pb) → unique insights into how hadronization is affected by the presence of nuclear matter

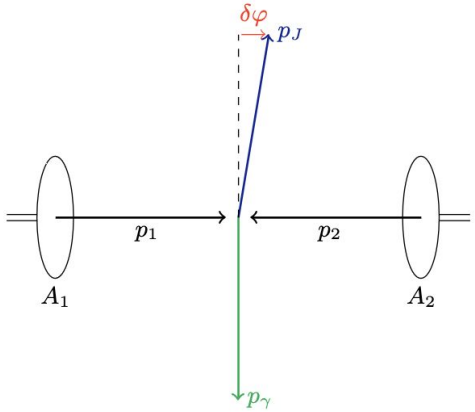


proton-pion correlation : wider correlation function for heavy nuclei than D

Heavy ions (pA/PbPb)

Florian Cougoulic

- Study factorization for DY and γ-jet in AA collisions
- Look at azimuthal decorrelation/momentum imbalance
- Compute LO corrections in α_s to the azimuthal decorrelation due to cold nuclear matter effects

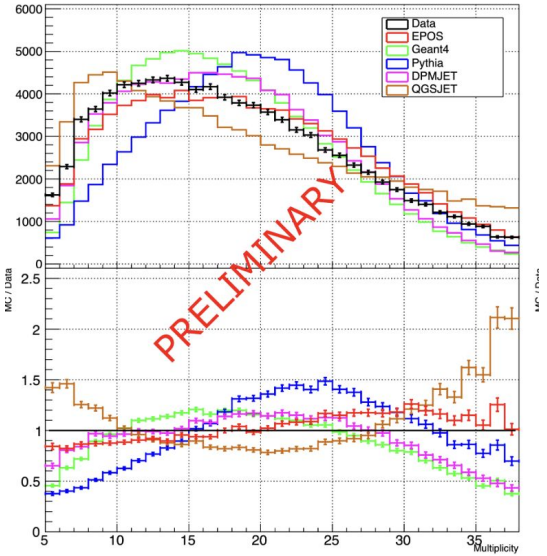


- Work in progress computations

Emin Yuksel

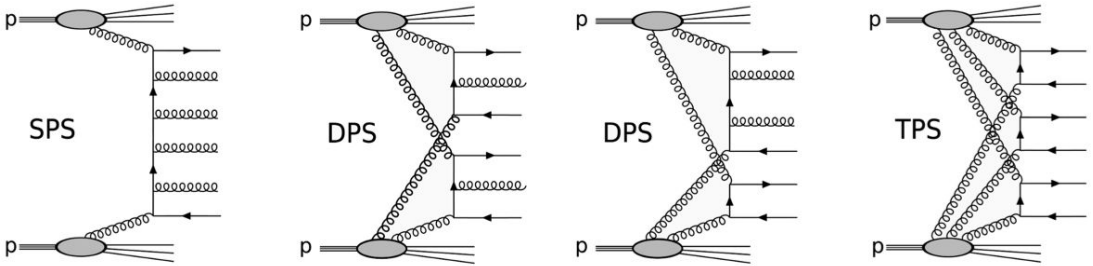
- Study υ_τ production (via D_s decay) in pW interactions (NA65/Dstau)
  - test of lepton universality in neutrino scattering
- Pilot data used to study proton interactions in W as a first step

Charged Track Multiplicity

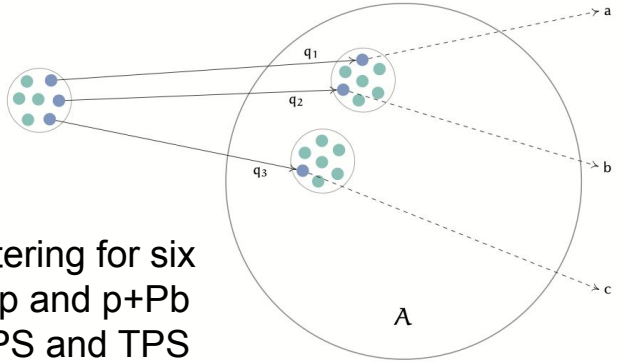


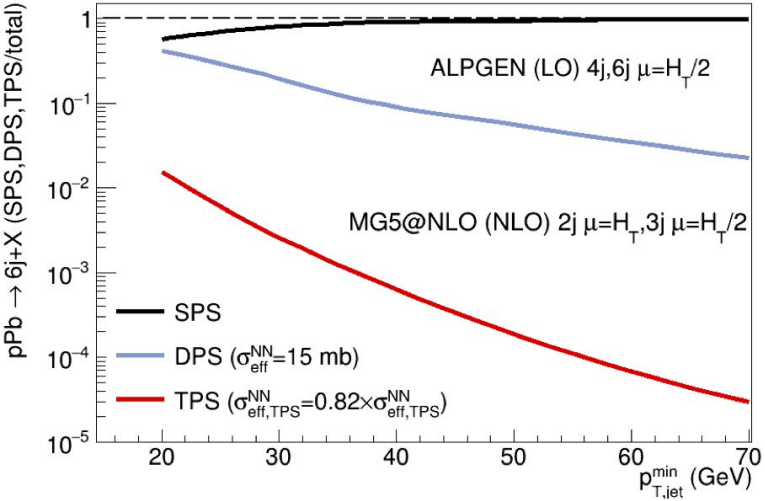
Six-jet production as a probe for TPS in LHC

Marina Maneyro



$$\sigma^{\mathrm{TPS},2}_{\mathrm{pA}\to abc} = \sigma^{\mathrm{TPS}}_{\mathrm{pN}\to abc} \cdot 3\,\frac{\sigma^{2}_{\mathrm{eff,TPS}}}{\sigma_{\mathrm{eff,DPS}}}\,\mathrm{F}_{\mathrm{pA}}$$



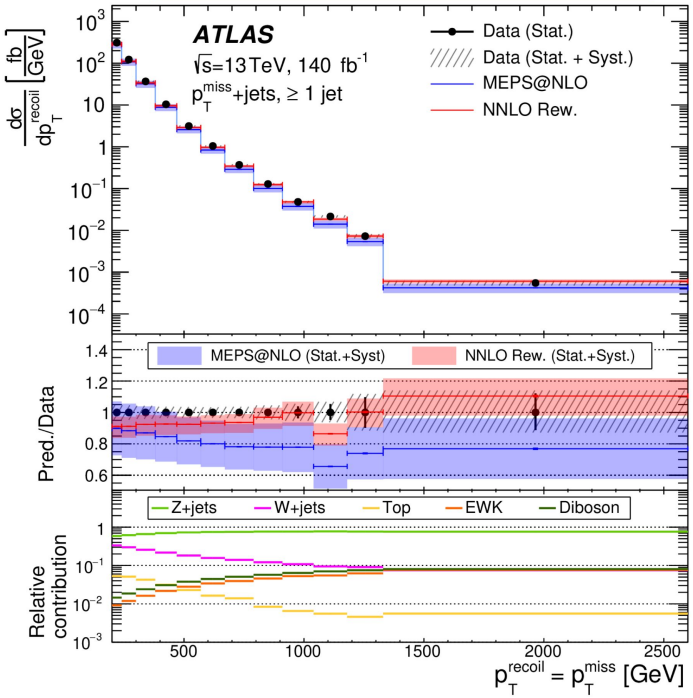


- Triple-parton scattering for six jet production in pp and p+Pb
- Combine SPS, DPS and TPS using geometrical factors
- TPS enhanced with nuclear target
- Kinematical cuts can enhance the TPS contribution

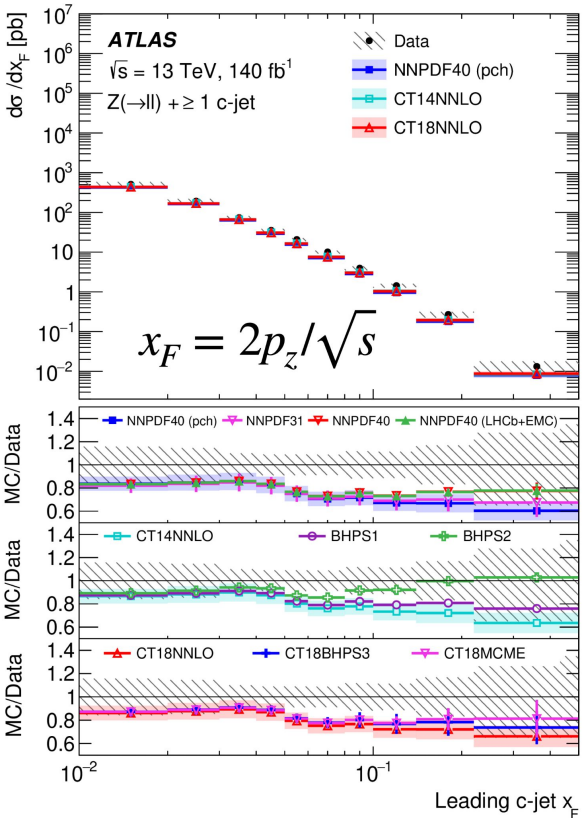
Z-boson production in association with jets

Camilla Vittori

p_T^{miss} + jets, inclusive

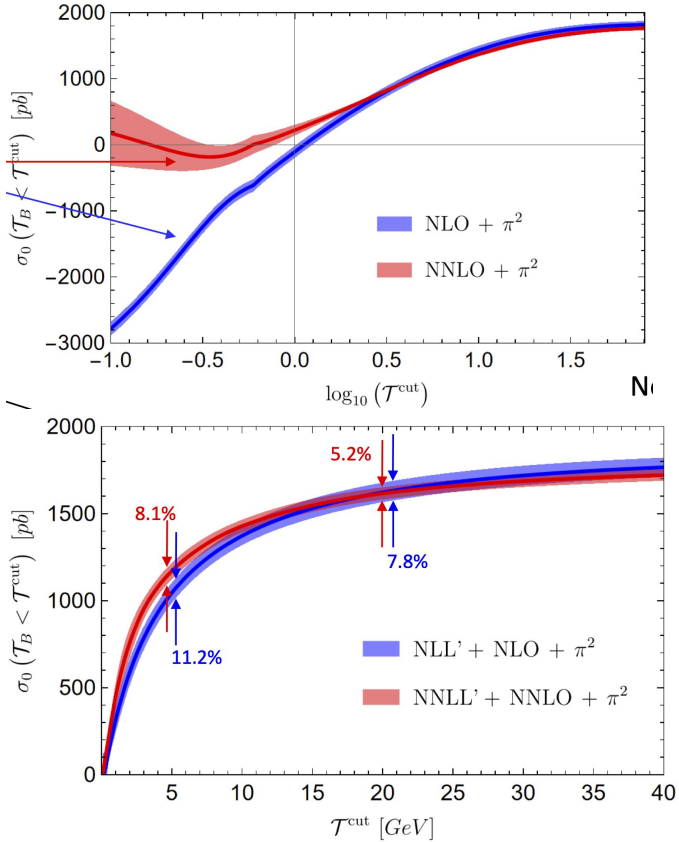


- Missing pT potentially sensitive to BSM and dark matter candidates
- Results consistent with SM, Z + jet(s) largest contribution
- Z+HF-jets can probe intrinsic charm in PDFs
- Marginal improvement from realistic scenarios



NNLO + partial N3LL for Jet Veto observables in DY

Thomas Clark



- Jet vetoes are used to eg. to reduce contribution from background processes
- Rapidity-dependent vetoes allow for finer control

$$\tau_f^{jet} = \underset{j \in J}{Max} \mid p_{Tj} \mid f(Y, y_j)$$

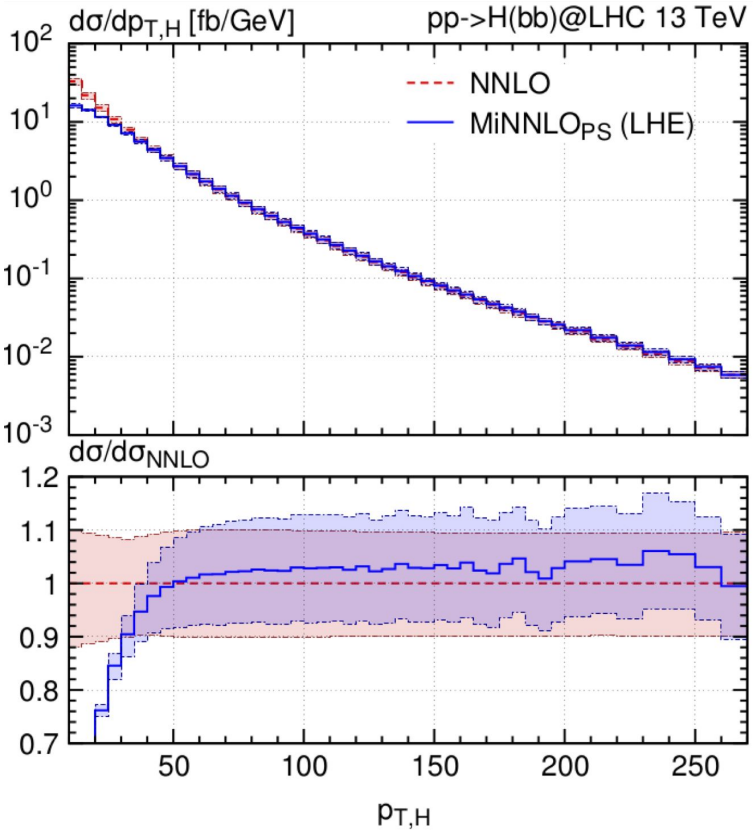
Rapidity of hard system — Rapidity of jet

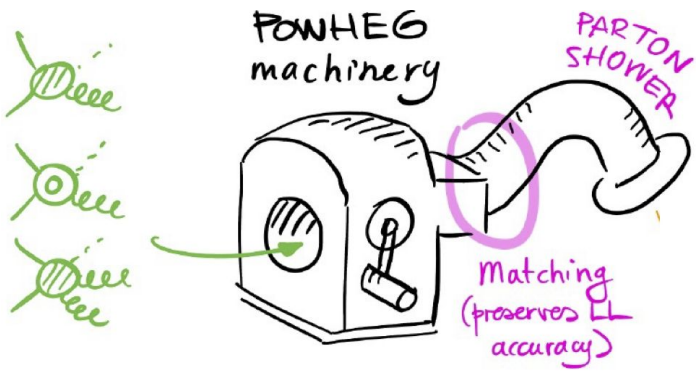
$$\tau_B : f_B(Y, y_j) = e^{-|y_j - Y|}$$

- Leads to large logarithms in FO calculations
- Need to apply resummation for physical results

NNLO-PS for Higgs production in bottom fusion

Aparna Sarkar

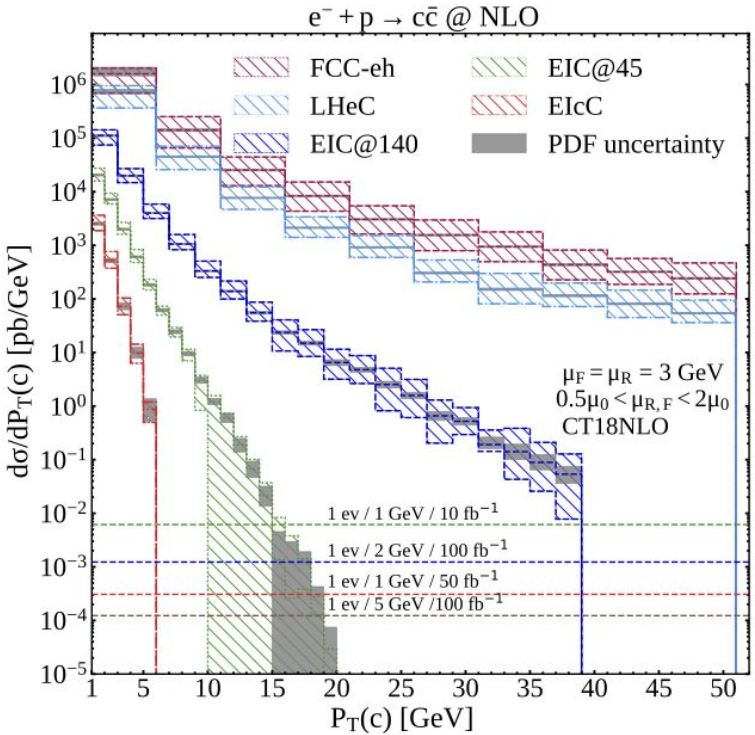




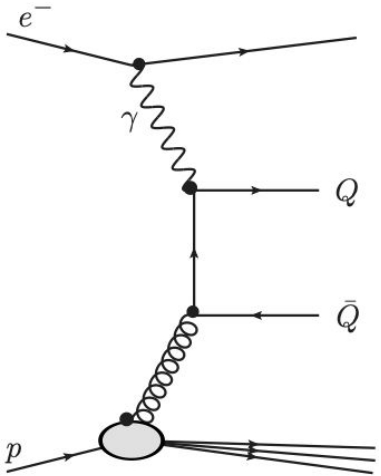
- Matching with Powheg method in MiNNLO-ps framework
- Agreement with fixed-order calculation at high pT
- Finite results at pT -> 0 limit
- Combine with 4FS calculation to account mass effects at low pT

Extensions of MadGraph5_aMC@NLO for QCD studies

Laboni Manna



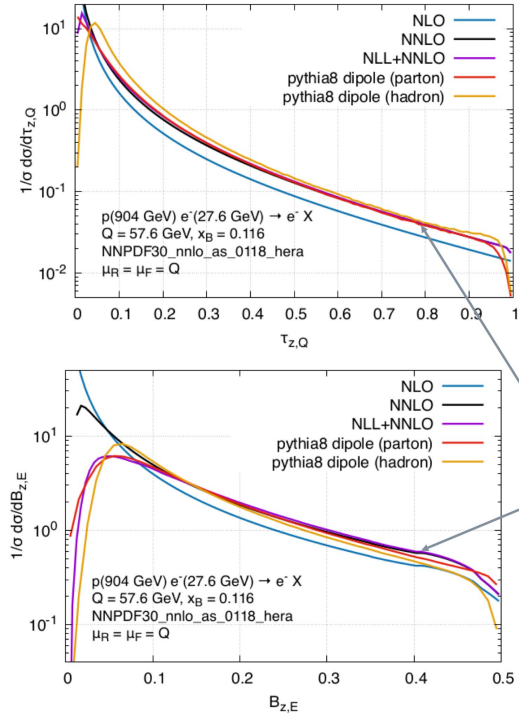
- Photoproduction implemented into MG5, NLO validated against FMNR for heavy-quark pair production
- Calculations for different experimental configurations
- Also nuclear modification factors for EIC with nuclear PDFs



Monte Carlo event generator developments for DIS

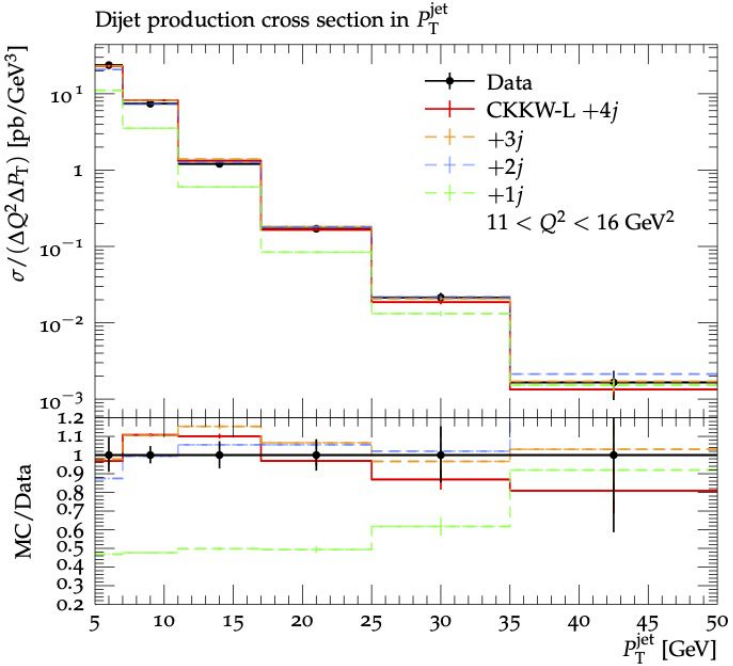
Andrea Banfi

Joni Laulainen



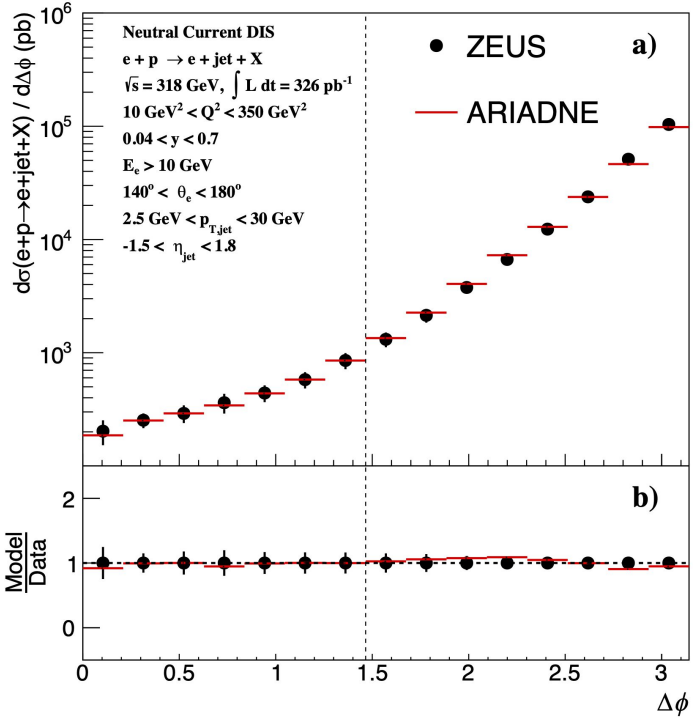
- A new NLO Powheg setup for DIS with Pythia dipole shower
- Very good agreement with NLL+NNLO calculation
- Similarly for events shapes from H1

- Multi-jet merging in DIS in Pythia 8.3 with Vincia
- Good description of H1 dijet and trijet data
- Also UMEPS merging



New DIS analyses from HERA experiments

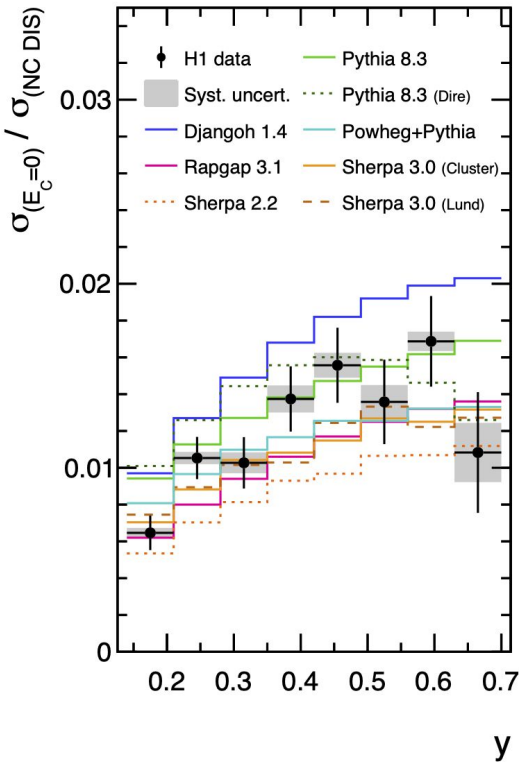
Jae D. Nam



- ZEUS analysis for azimuthal correlations between leading jet and scattered lepton
- Probes soft and hard QCD effects
- Good description with NNLO calculations and applied MC generators

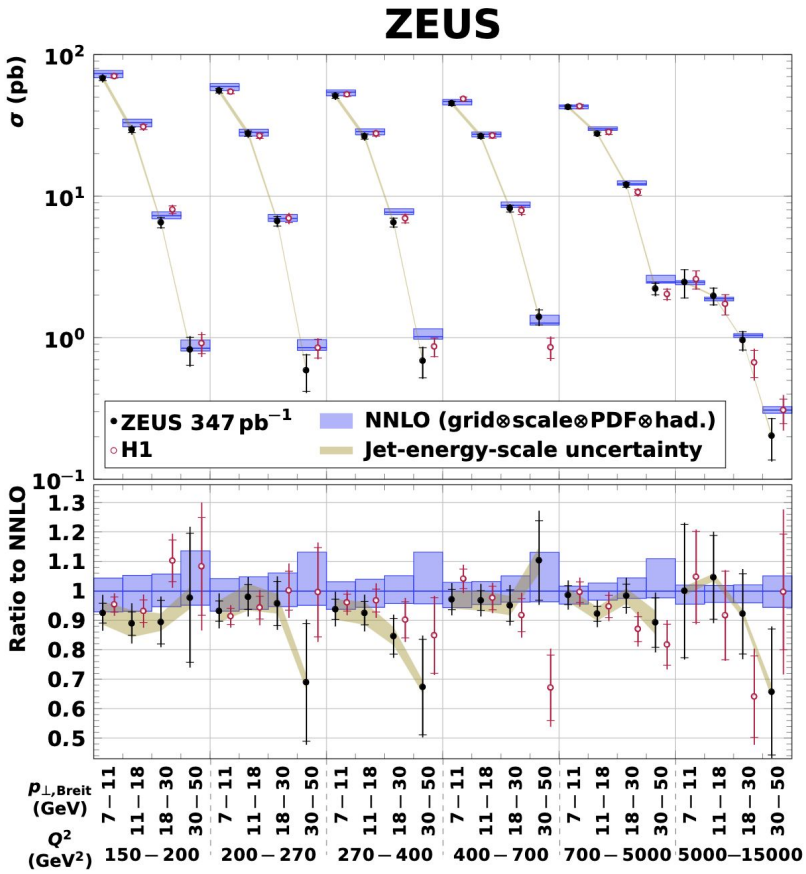
- H1 analysis for empty hemisphere events
- Large spread between different MC generators

Zhiqing Zhang



Jet production in DIS at ZEUS and fit of α_s

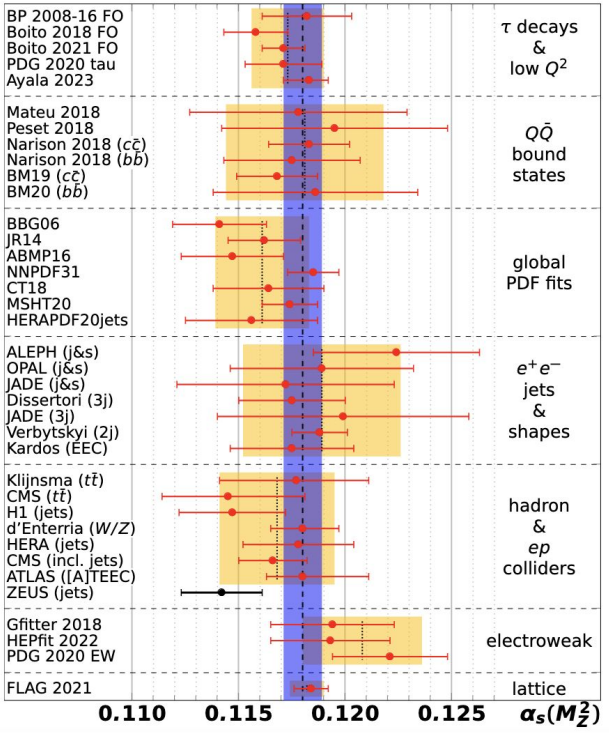
Florian Lorkowski



Inclusive jet cross section with more than 70% of the entire luminosity at ZEUS

Measurement compatible with H1 and nice agreement with NNLO theory calculations

Dataset used for measurement of α_s (with restriction to high-Q2 data in the fit)

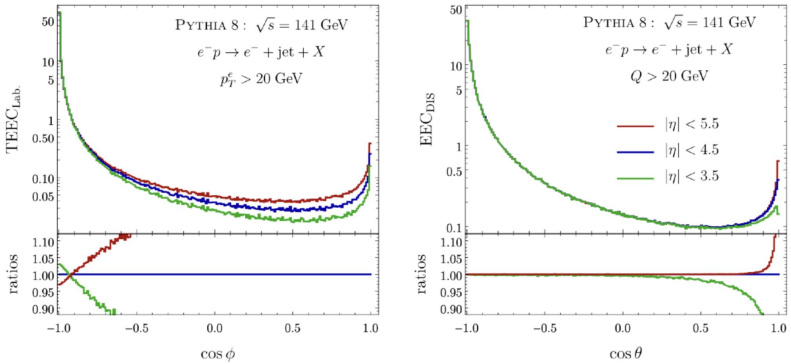


$$\alpha_s(M_Z^2) = 0.1143 \pm 0.0017\ (\text{exp./fit})\ ^{+0.0006}_{-0.0007}\ (\text{model/param.})\ ^{+0.0012}_{-0.0005}\ (\text{scale})$$

Energy-energy correlators in DIS

Haitao Li

Observables useful to check the universality of TMD factorization and study TMD PDFs and FFs.

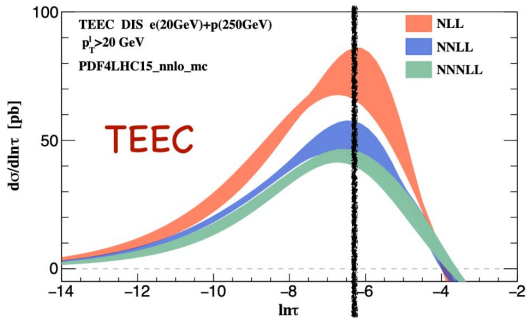


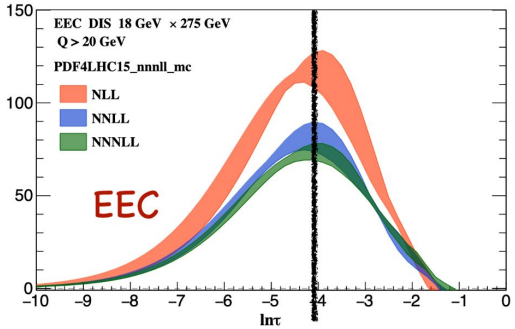
in Lab frame

$$\text{TEEC} = \sum_a \int d\sigma_{lp\to l+a+X} \frac{E_{T,l} E_{T,a}}{E_{T,l} \sum_i E_{T,i}} \delta(\cos\phi_{la} - \cos\phi)$$

in Breit frame

$$\text{EEC} = \sum_a \int d\sigma_{lp\to l+a+X} \left(\frac{p \cdot p_a}{\sum_i p \cdot p_i} \right) \delta(\cos\chi - \cos\theta_{ap})$$





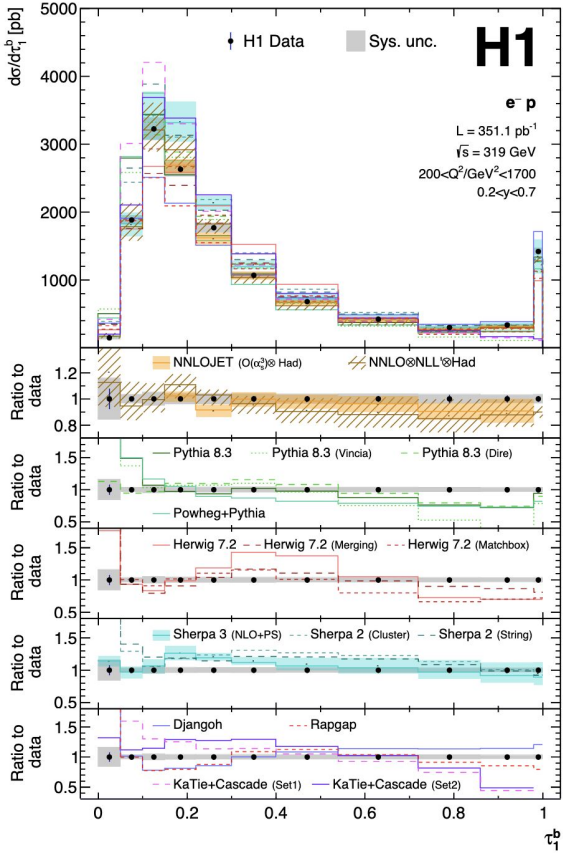
New observable: EEC for DIS

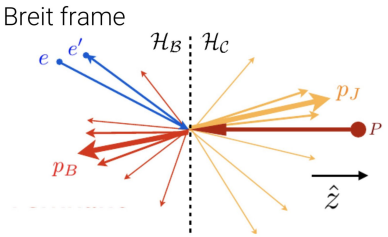
Advantages over TEEC:

- independent on the $|\eta|$ cuts
- more stable perturbative behaviour
- smaller NP corrections

1-jettiness event shape in DIS at H1

Johannes Hessler





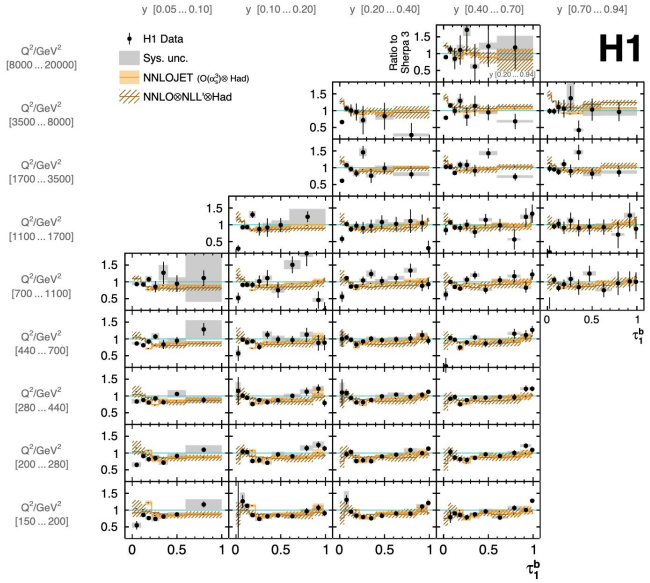
$$\tau_1^b = 1 - \frac{2}{Q}\sum_{i \in H_C} P_{z,i}^{Breit}$$

manifestly *global*
(but well measured particles give dominant contribution)

15 models compared to data, precise data useful for tuning

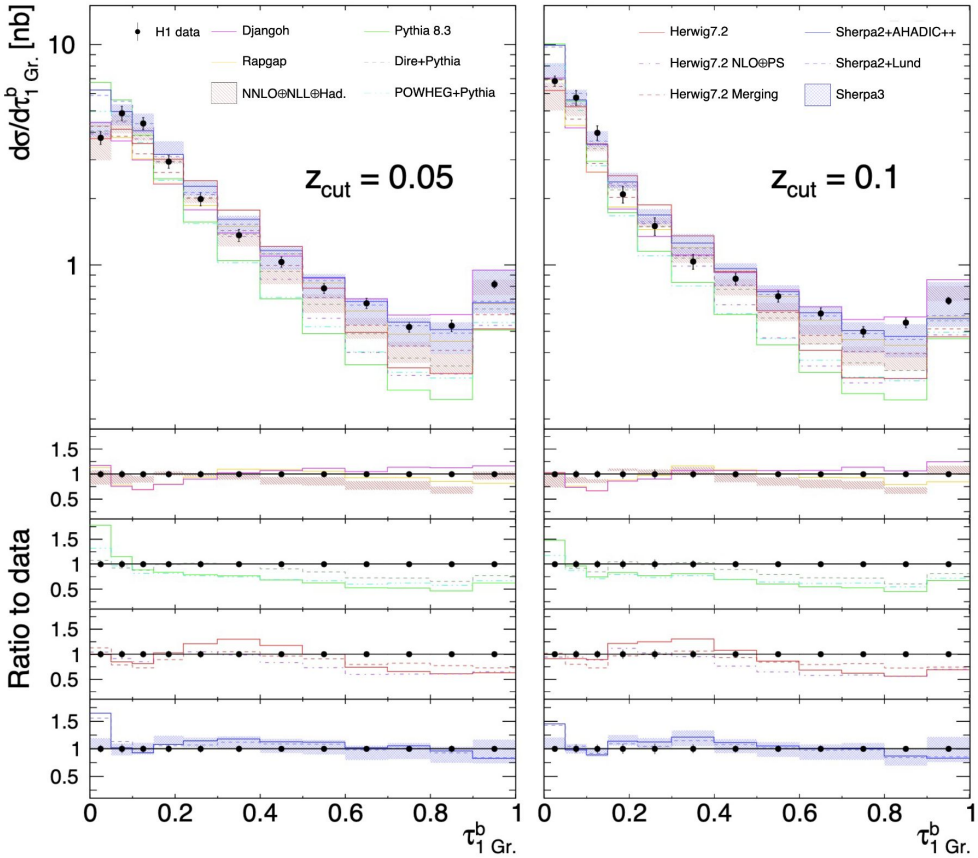
Also 3D measurement in Q^2, y, τ^b_1

By integrating, one get inclusive DIS cross section, which can be used as a cross check



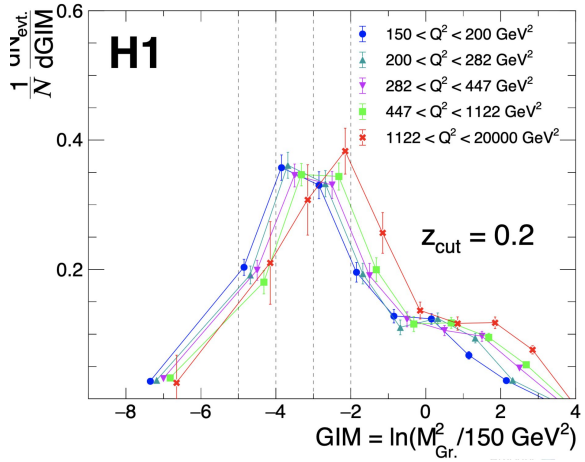
Groomed event shapes in DIS at H1

Henry Klest



Grooming with Soft Drop (remove soft wide-angle radiation), based on Centauro measure (keep radiation hard and/or collinear to current direction in Breit frame)

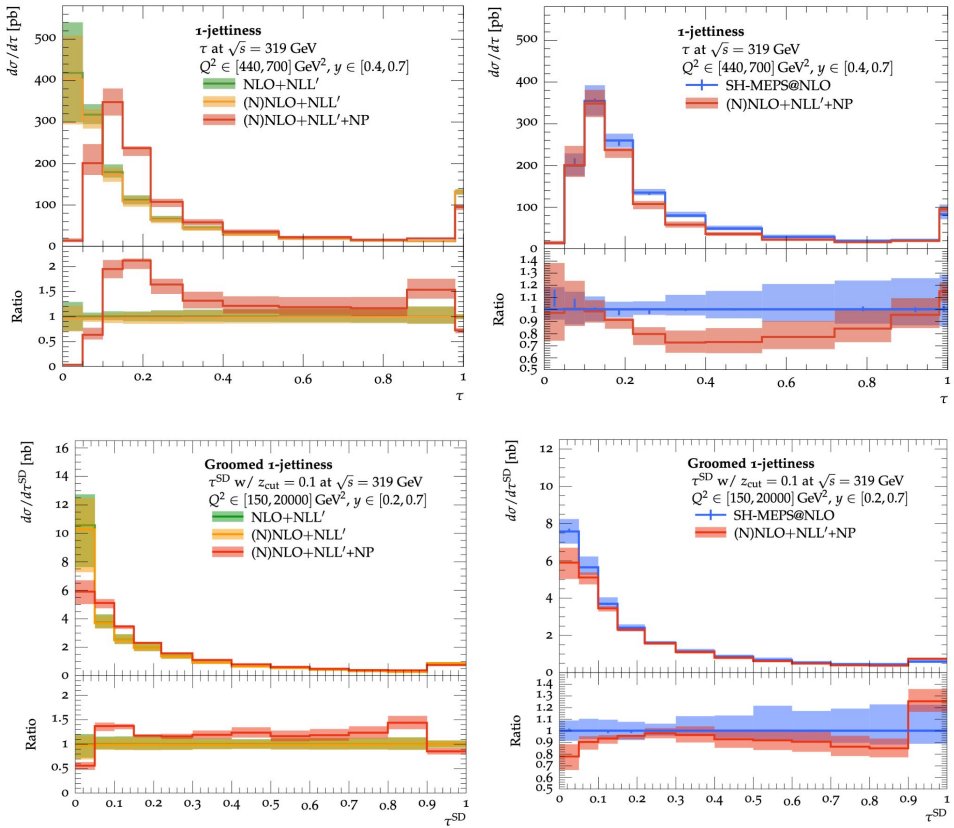
Focus on **groomed 1-jettiness $\tau^{b}_{1\ Gr.}$** and **groomed invariant mass $M_{Gr.}$**



Almost Q2-independence predicted by SCET!

Calculations for (groomed) event shapes

Daniel Reichelt



Two calculations within Sherpa:

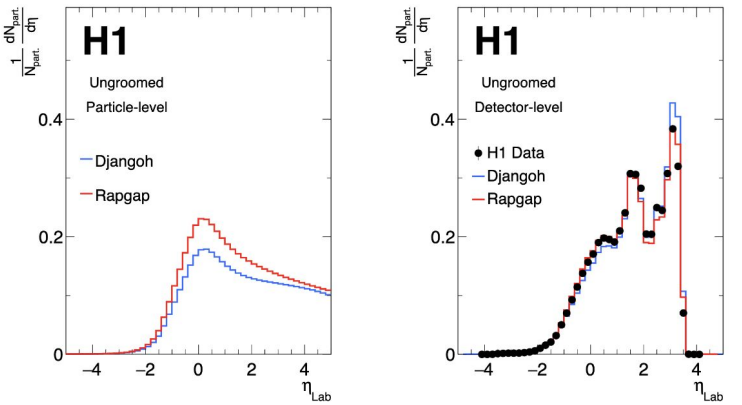
- at (N)NLO+NLL’(+NP) resummation with CAESAR formalism
- at MEPS@NLO with MC@NLO + CKKW (“SHERPA3” on previous slides)

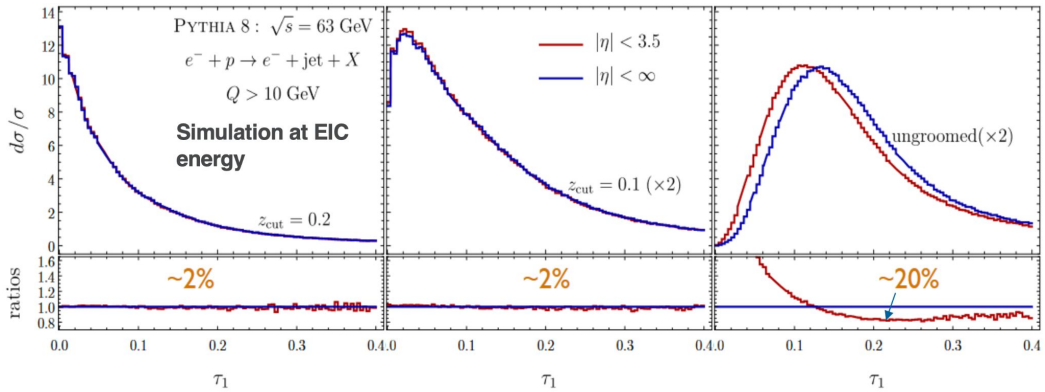
$$e^- p \to e^- + 1,2\,j\,@\,\mathrm{NLO} + 3,4\,j\,@\,\mathrm{LO}$$

Grooming beneficial:

- reduction of NP corrections
- better agreement between two calculations

Calculations for (groomed) event shapes



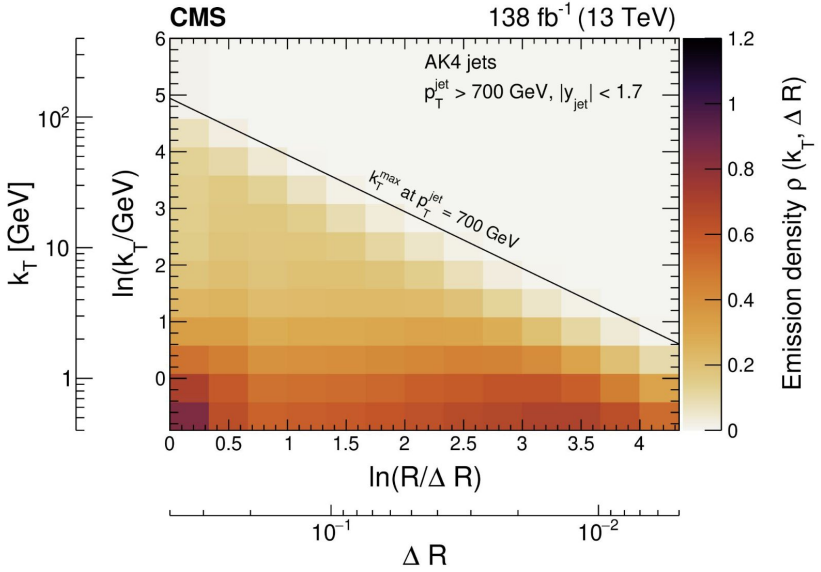


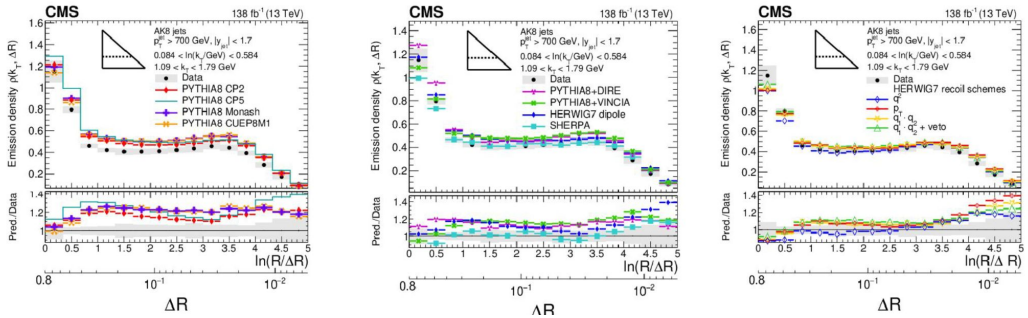
Grooming beneficial:

- reduction of NP corrections
- better agreement between two calculations
- better agreement between particle-level and detector-level
- less dependence on acceptance cuts

Jet substructure at CMS

Jelena Mijuskovic

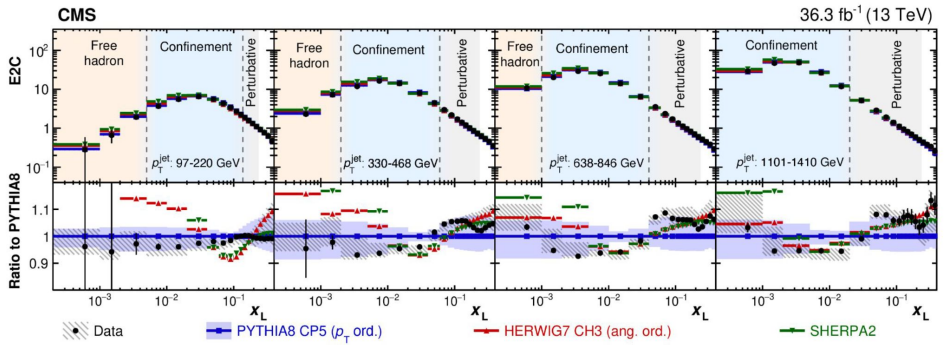




Lund jet plane density
clear separation of regions
important for comparisons between generators

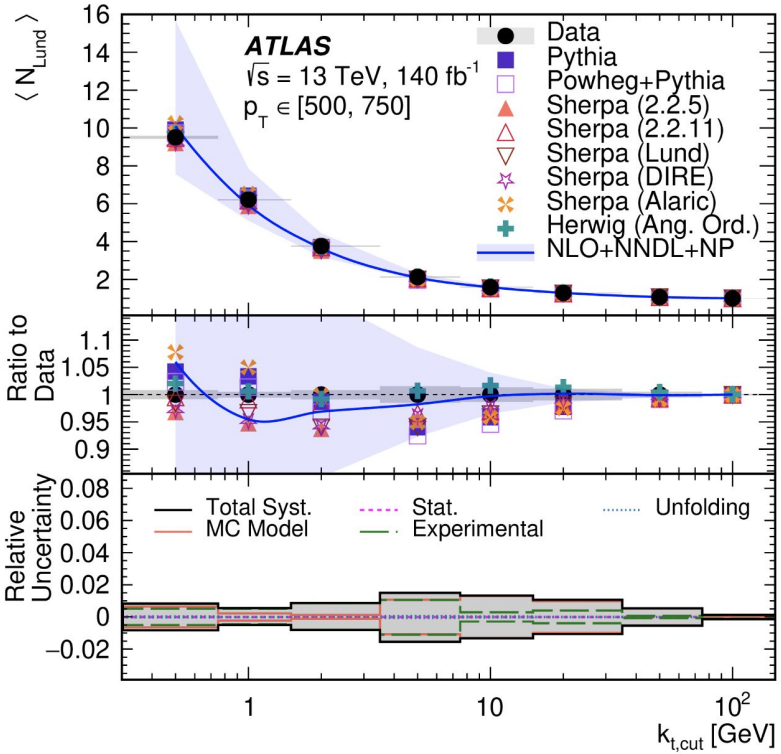
Energy correlators
different stages of jet formation

$$E2C = \sum_{i\,i}^{3} \int d\sigma \frac{E_i E_j}{E^2} \delta(x_L - \Delta R_{i,j})$$



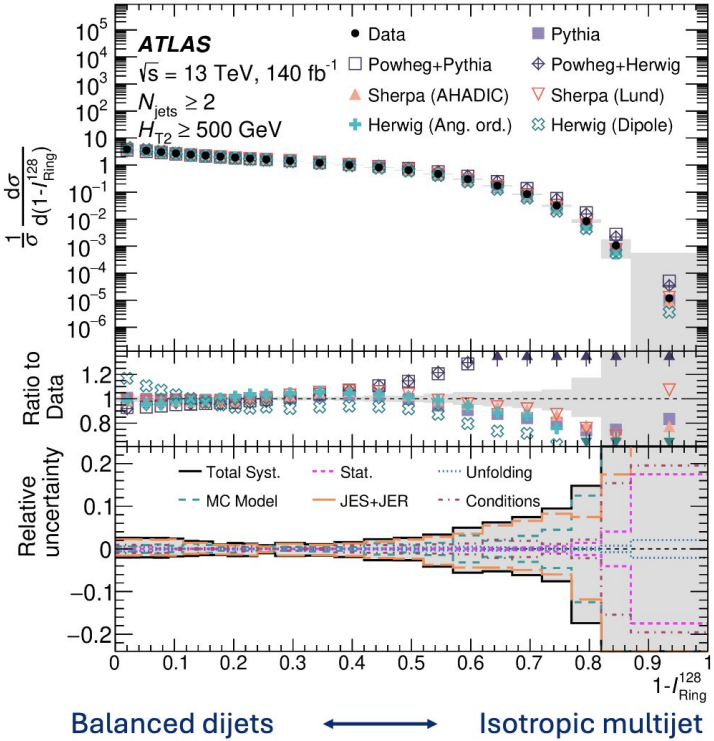
Jet substructure at ATLAS

Zdenek Hubacek



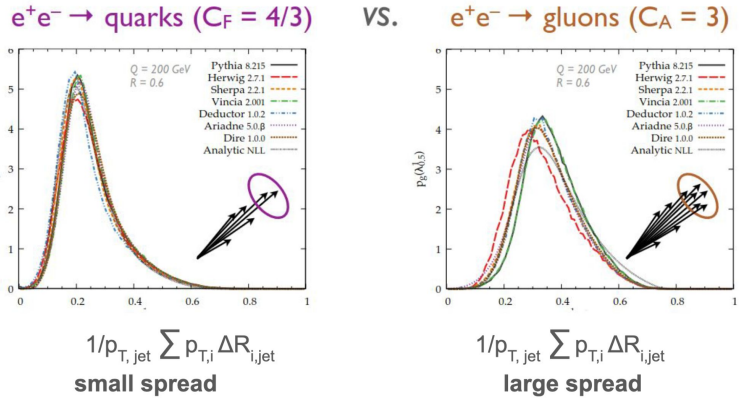
Average subjet multiplicity above $k_{t,cut}$
both generators and analytical calculation

Event isotropies
how far is a collider event from a symmetric configuration

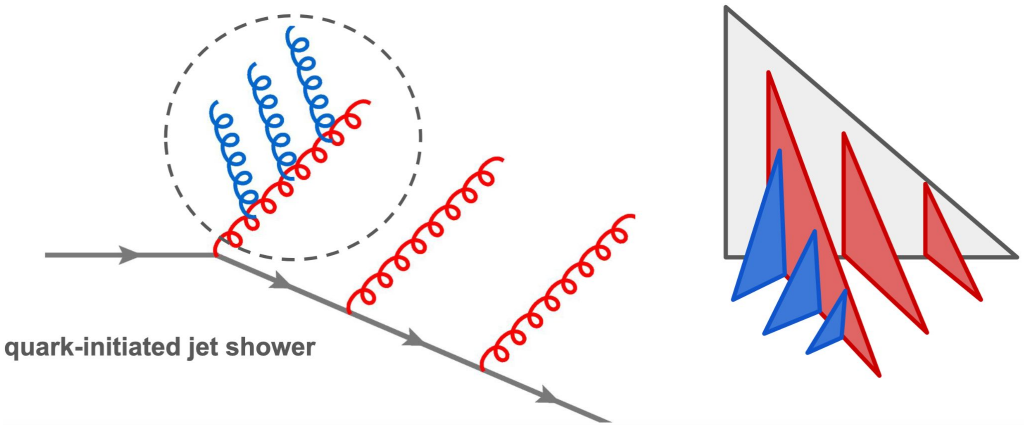


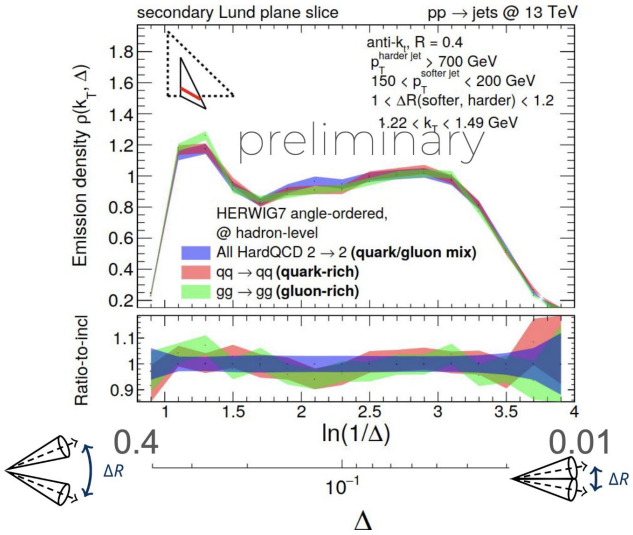
High-purity gluon jets from secondary Lund jet planes

Cristian Baldenegro



Gluon jets not much constrained!
(tuning on LEP data, which are mostly quark jets).
How to obtain a high-purity gluon jet sample?
Idea: **exploit secondary Lund planes generated from particular regions of the primary Lund plane** (to have "gluon-domination" in the secondary plane)



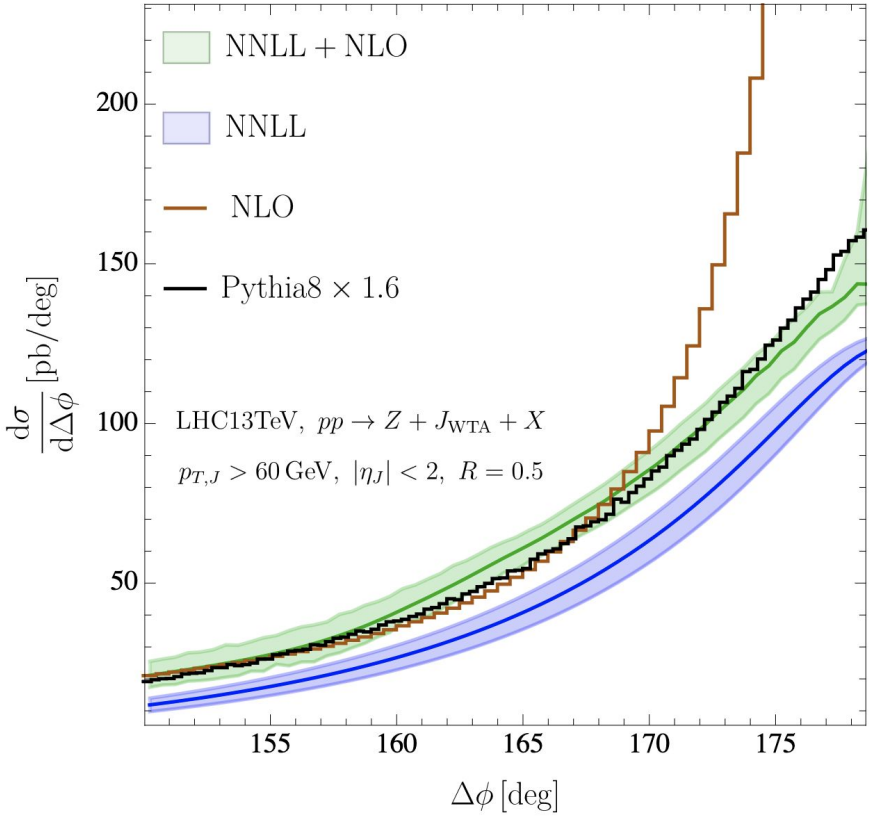


Independence from hard scattering process!

$$\Delta\phi \equiv |\phi_V - \phi_J| \ (\delta\phi \equiv \pi - \Delta\phi)$$

Precise boson-jet azimuthal decorrelation at LHC

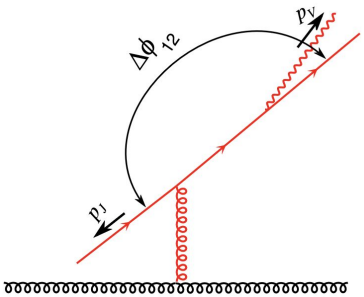
Bin Wu



New resummed calculation at NNLL in SCET, thanks for the usage for Winner-Take-All axis (it removes nasty non-global logarithms)

WTA axis also insensitive to hadronization and the underlying event and facilitates track-based jet definitions.

Surprisingly large non-singular corrections even at large $\Delta\phi$ (i.e. small $\delta\phi$): traced back to collinear boson emission off dijets

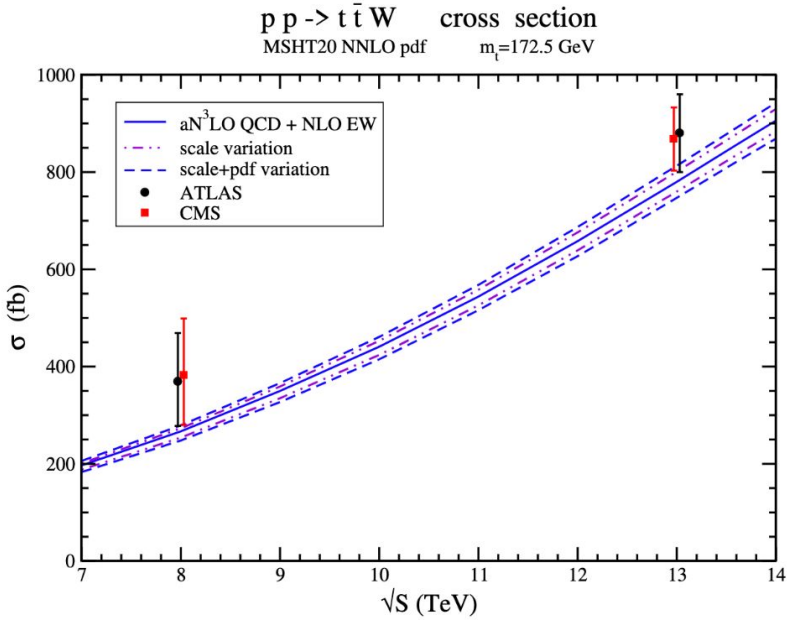


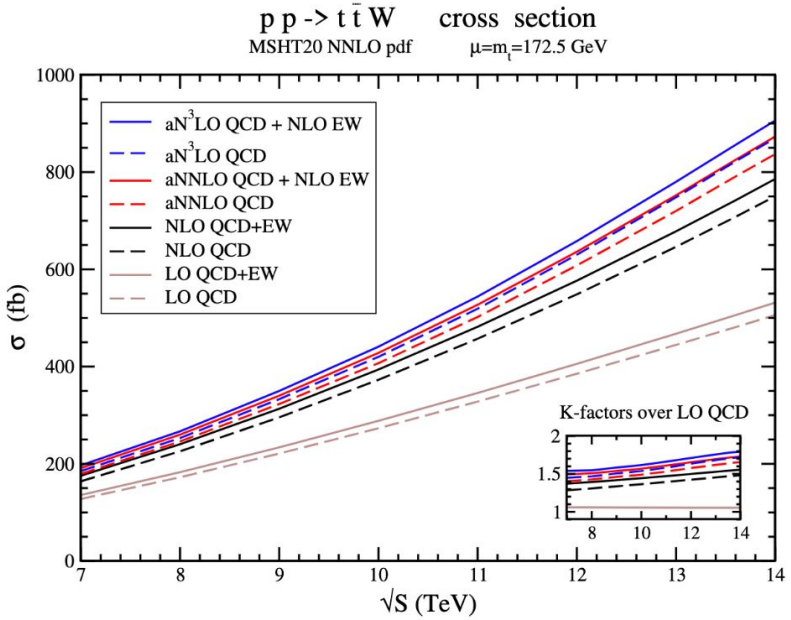
Predictions for ttW cross sections at aN3LO

Nikolaos Kidonakis

Approximate higher-order corrections (aNNLO and aN3LO) by considering soft-gluon resummation and expanding to fixed order (in this way ambiguities related to inverse Laplace transform are avoided)

Goodness of approximation estimated by comparing aNLO and aNNLO to known NLO and NNLO results





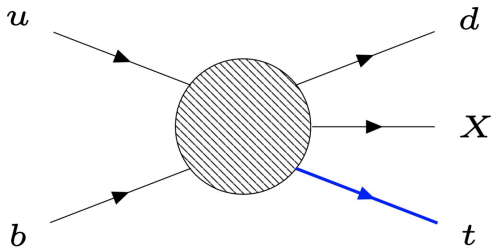
Linear power corrections to top quark processes

Melih OZCELIK

$$d\sigma = d\sigma_{\rm LO} + \underbrace{\left(\frac{\alpha_s}{\pi}\right) d\sigma_{\rm NLO}}_{10\%} + \underbrace{\left(\frac{\alpha_s}{\pi}\right)^2 d\sigma_{\rm NNLO}}_{1\%} + \underbrace{\left(\frac{\alpha_s}{\pi}\right)^3 d\sigma_{\rm N^3LO}}_{0.1\%} + \ldots$$

$$+ \underbrace{\left(\frac{\Lambda_{\rm QCD}}{Q}\right) d\sigma^{\rm NP}_{\rm linear}}_{0.1\%-1\%} + \ldots \qquad \text{with } \Lambda_{\rm QCD} \sim 300 \text{ MeV}, \quad Q \sim 30 - 100 \text{ GeV}$$

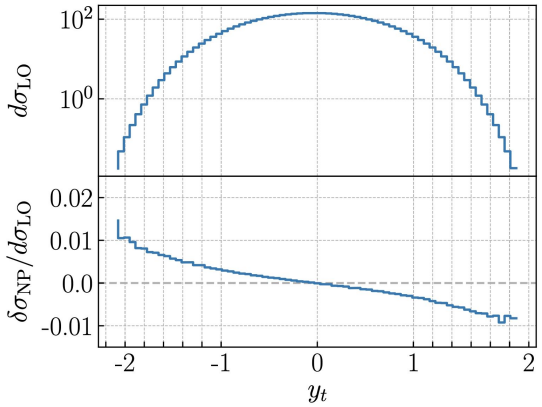
Non-perturbative corrections may become relevant for percent level precision!
Focus here on processes with tops:



By means of renormalon calculus, one concludes that:

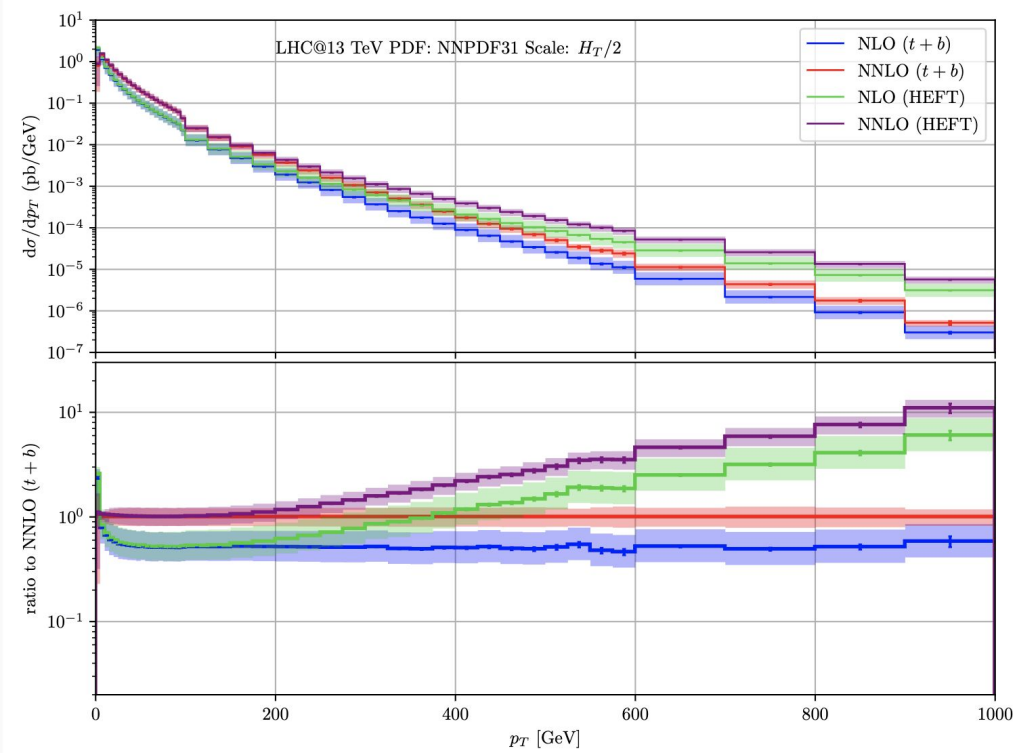
- for top quark production processes, **there are no linear power corrections** to total cross-sections within the short-distance mass scheme ($\overline{\rm MS}$-scheme)
- however for observables ($p_{t\perp}$, y_t, $s_{t\bar{t}}$), **there are linear power corrections** within the short-distance mass scheme ($\overline{\rm MS}$-scheme)

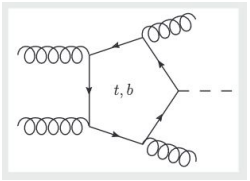
(focus on MS mass, as the pole mass suffers from renormalon ambiguity, so it is problematic from the very beginning)

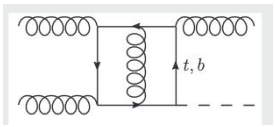


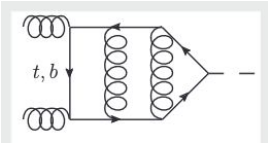
Quark Mass Effects in Higgs Production

Tom Schellenberger









Addressing one important source of theory uncertainty in predictions for gg -> H

LHC@13 TeV, PDF NNPDF31, Scale $m_H/2$

Preliminary

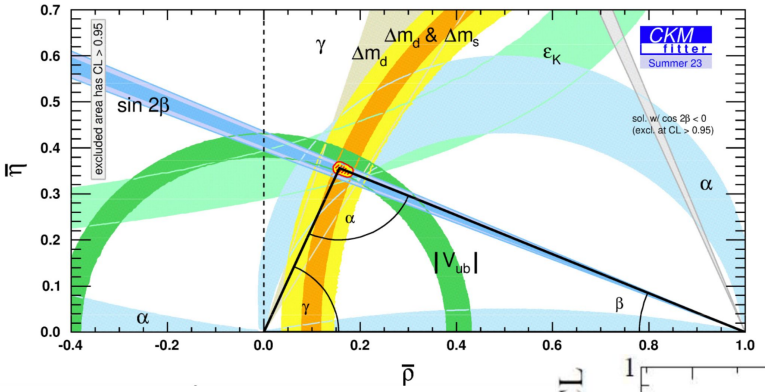
$$\sigma_{gg-\text{fusion}} = \underbrace{48.81^{+0.65}_{-2.02}}_{\text{HEFT}} \underbrace{-0.16^{+0.13}_{-0.03}}_{\text{finite } t} \underbrace{-1.74^{+0.13}_{-0.01}}_{t-b \text{ int.}} \text{ pb}$$

- $m_b(m_b) = 4.18$ GeV
- $m_t = 173.05$ GeV
- $m_H = 125$ GeV

Good agreement of results in 4FS and 5FS (with MSbar scheme for the masses)

Measurements of CKM ɣ from tree-level decays at LHCb

Alessandro Bertolin

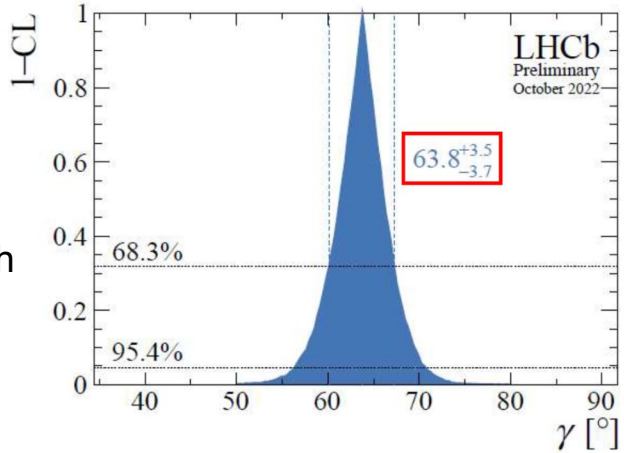


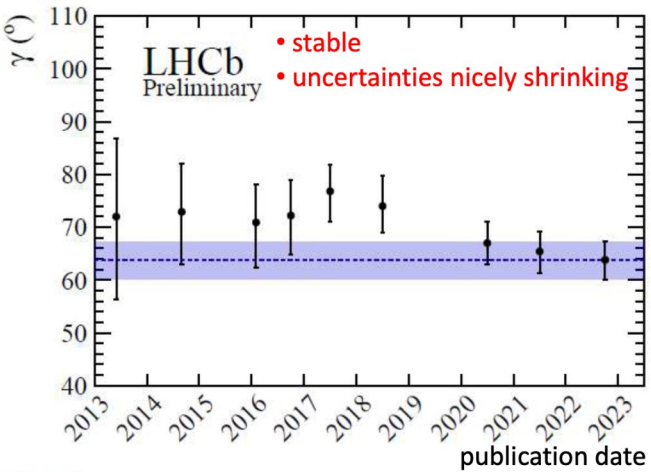
The ɣ angle is a smoking gun for new physics
if direct measurement != global fit value
(experimentally accessible in tree level decays, with negligible theory uncertainty)

many B mesons and D mesons decay modes

> 10 input measurements that can cross check each other

This new result is with 9 fb^-1: with additional 14 fb^-1 after 2025 an accuracy in the range 1.7 - 2.3 is expected





• most precise determination from a single experiment

Thanks for your attention