First A-dependent projections of ALICE 3 HF performance

Giuseppe Bruno
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Credits for the work presented today to:

F. Colamaria, M. Mazzilli, A. Palasciano and C. Terrevoli
V. Greco, V. Minnisale, S. Plumari and Yifeng Sun
J. Aichelin, P.B. Gossiaux, K. Werner and J. Zhao
F. Antinori, A. Dainese and A. Rossi
David Dobrigkeit Chinellato

Krakow - October the 8th 2024

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Outline:
- Context
- Motivations
- Recent theoretical advances
- First projections for ALICE 3
- Conclusions & outlook

Krakow - October the 8th 2024

Context

- Activity triggered and supported by the networking activity HF-QGP of the STRONG-2020 project (concluded in July this year)
  - Strict collaboration with theory groups:
    - V. Greco et al. (Catania)
    - J. Aichelin et al. (Nantes)

- Analyses steered in dedicated meetings of the ALICE 3 HF WP convened by D.Chinellato and A.Uras
  - https://indico.cern.ch/event/1355218/
  - https://indico.cern.ch/event/1366560/
  - https://indico.cern.ch/event/1395234/
  - https://indico.cern.ch/event/1430997/

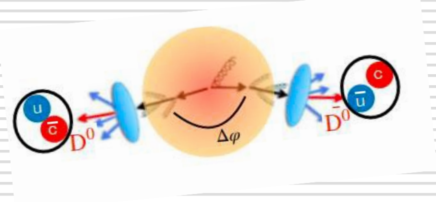
Motivations

- Lighter systems like Ar-Ar, Kr-Kr or Xe-Xe
  - smaller size and shorter lifetime of the QGP
  - can offer nice opportunities, e.g.:
    - Study the approach of HF quarks to thermal equilibration with lighter partons of the QGP
    - Emergence of decoherence in DDbar angular correlation
    - test-bench for hadronization mechanisms
      - Multi-charmed baryons, B_C, strange HF hadrons
- Very light system like O-O
  - Bridge between pp (and p-Pb) and heavy ions
    - onset of energy-loss effects in small colliding systems, which has not been observed yet
    - Signatures from the glasma?
- Better experimental conditions

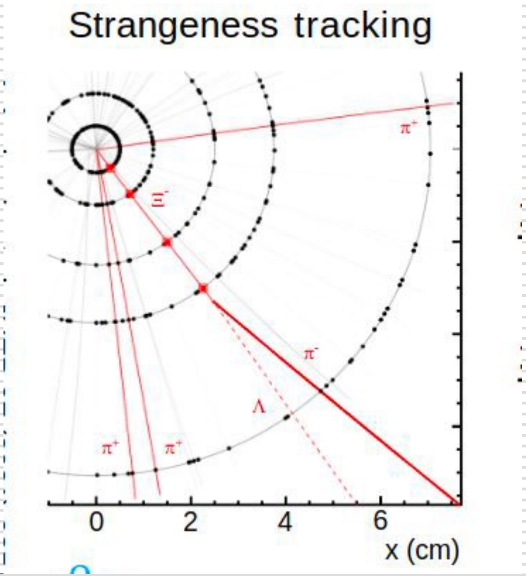
→ Discussed since long, see e.g. arXiv:1812.06772

Focus on two HF observables

- Azimuthal angular correlations between fully reconstructed D and Dbar mesons

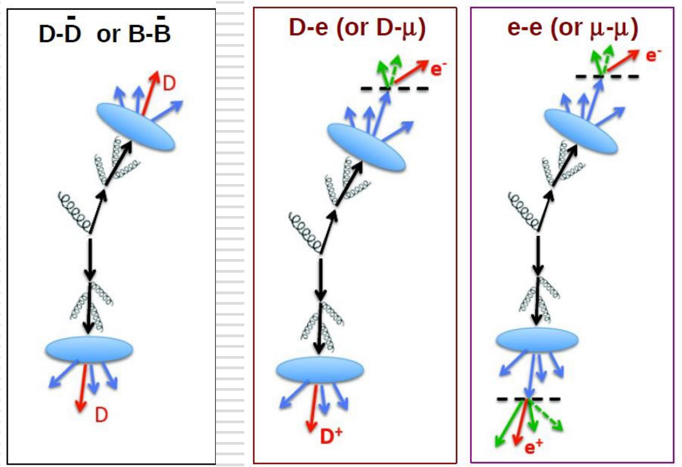


- Multi-charmed baryon production
  - $\Xi_{cc}^{++} \rightarrow \Xi_c^{+}\pi^{+} \rightarrow \Xi^{-}\pi^{+}\pi^{+}\pi^{+}$
  - $\Omega_{cc}^{+} \rightarrow \Omega_c^{0}\pi^{+} \rightarrow \Omega^{-}\pi^{+}\pi^{+}$
  - Ω_{ccc} studies ongoing

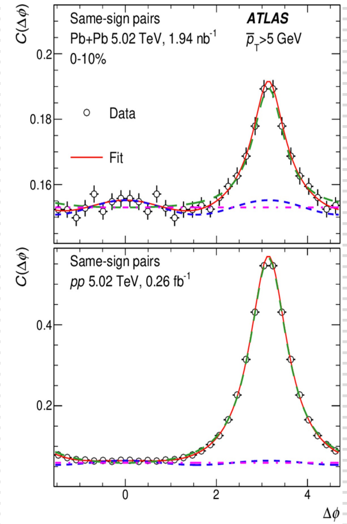


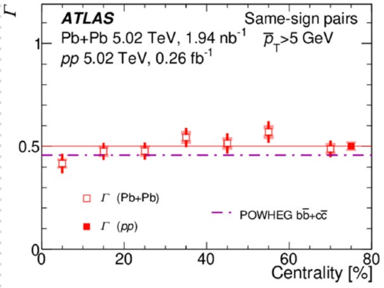
Angular correlations

- **Characterise energy-loss** of heavy quarks in QGP medium, with sensitivity to specific ΔE mechanisms
- D-Dbar correlation sensitive to parton-level angular correlation
- Correlation using HF leptons → quite indirect
- D-Dbar correlation: a very tough measurement
  - huge combinatorial background in Pb-Pb
  - out of reach with fully reconstructed hadron decay in LHC run3&4



ATLAS @ HP 2024



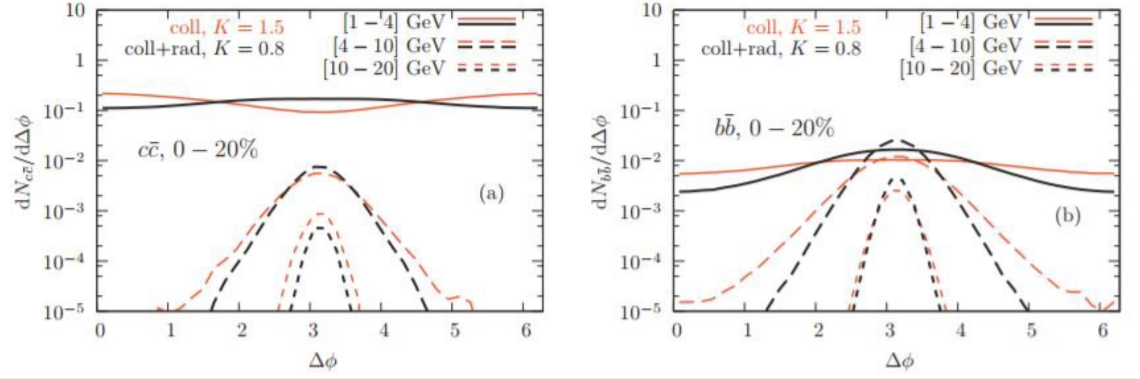


Angular correlations

- For LOI the only theory prediction dated back to 2014
  - M. Nahrgang et al. PRC 90 (2014) 024907

Pb-Pb @ 2.76 TeV, LO only
→ Initial distrib.: Δφ=π

PRC 90 (2014) 024907



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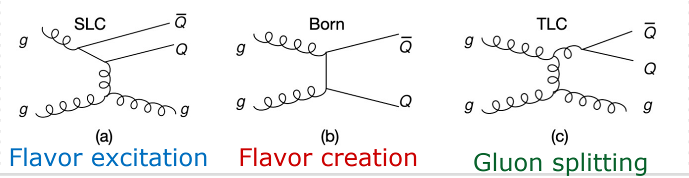
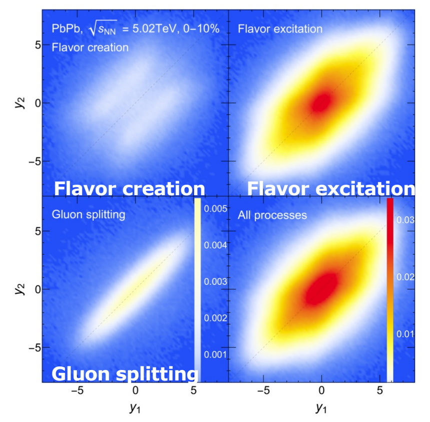
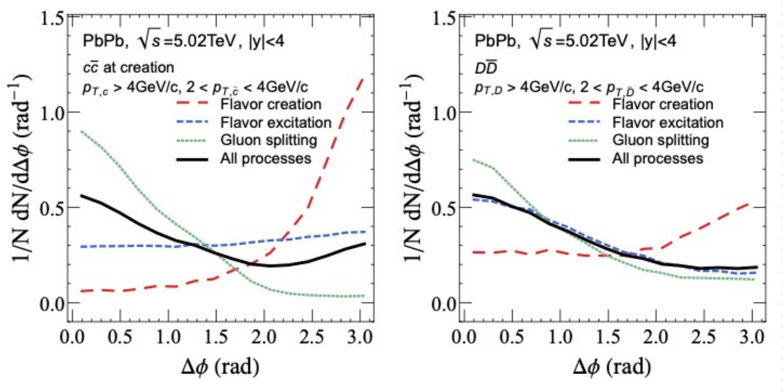
- New work by the Nantes group
  - J.Zhao et al. arXiv:2407.20919

Presented by Jiaxing at our ALICE 3 days in June this year
link to presentation







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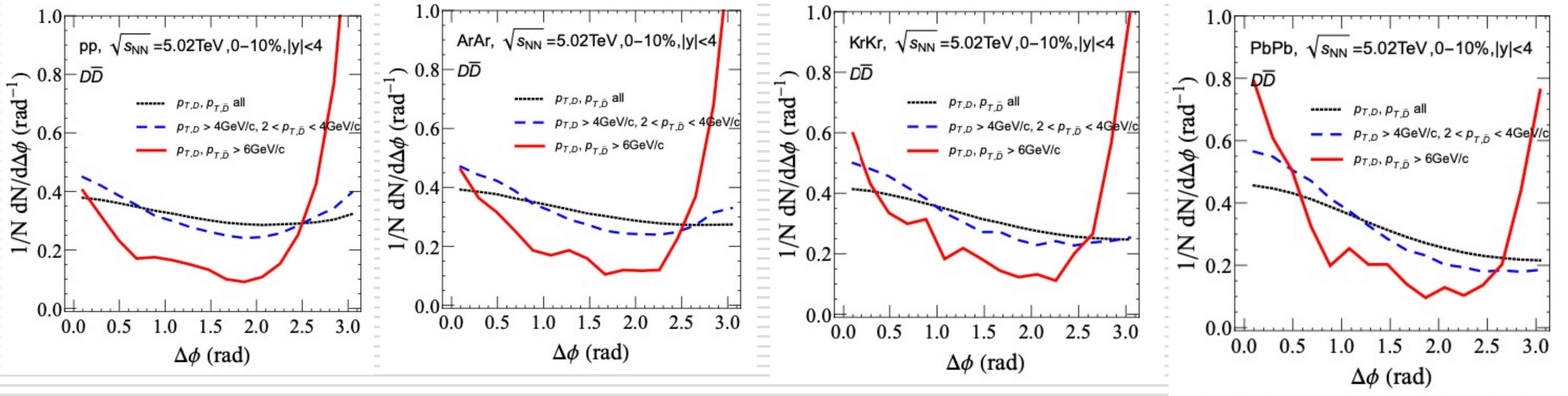
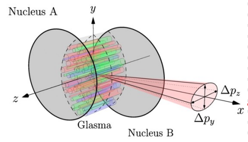


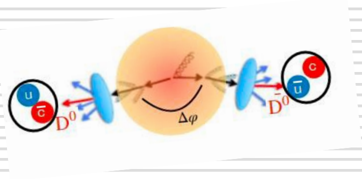
Glasma impact on angular $Q\bar{Q}$

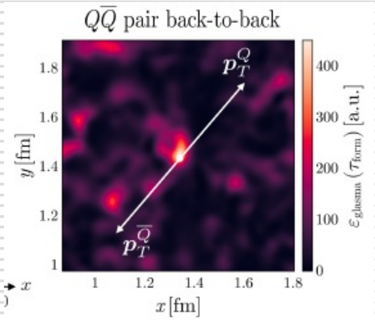


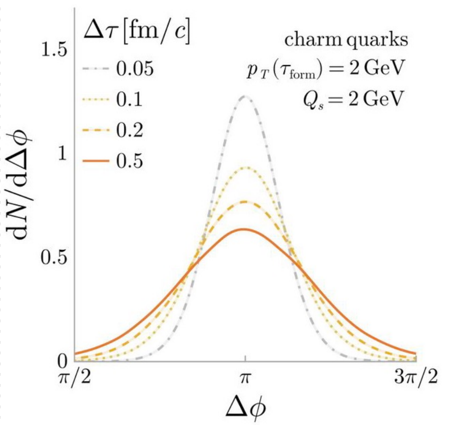
D. Avramescu, V. Greco et al., arXiv:2409.10565 [hep-ph]

large decorellation in only 0.2 fm/c

Significant effect of glasma on HQ!







Nearly identical for bottom despite mass smaller t_{form}

pA (and OO) collisions should keep memory of it especially correlating with R_{AA}, v_n:

- Identify Glasma phase
- quantify in medium Eloss $D_s(T)$
- solve the puzzle of R_{pA} ~1 and v_2 large

Calculation in SU(3) +longitudinal expansion

Multi-charmed baryons

Eur. Phys. J. C (2024) 84:228
https://doi.org/10.1140/epjc/s10052-024-12571-6

THE EUROPEAN PHYSICAL JOURNAL C

Regular Article - Theoretical Physics

Multi-charmed and singled charmed hadrons from coalescence: yields and ratios in different collision systems at LHC

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S. Plumari invited to the first ALICE 3 Meeting (Oct. 2020)
link to the agenda

Then V. Greco in March 2022
link to agenda

Multicharm production in different systems

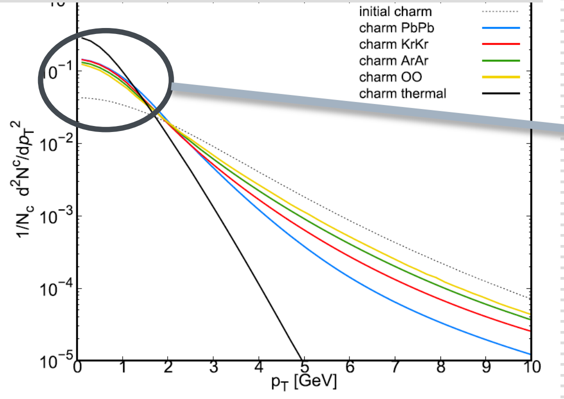
$\Xi_{cc}^{+,++}$, Ω_{scc}, Ω_{ccc}

Baryon		
$\Xi_{cc}^{+,++} = dcc, ucc$	3621	$\frac{1}{2}(\frac{1}{2})$
$\Omega_{scc}^{+} = scc$	3679	$0(\frac{1}{2})$
$\Omega_{ccc}^{++} = ccc$	4761	$0(\frac{3}{2})$

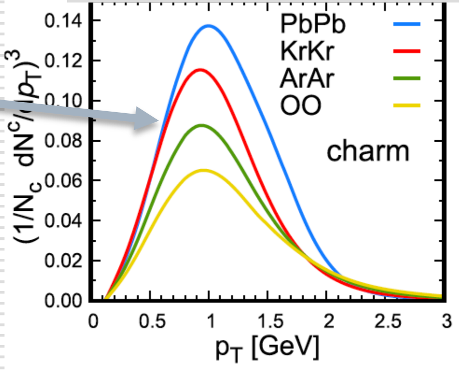
- Observation of a new particles quite relevant in itself
- Understand HQ in medium hadronization:
  [pure recombination , no fragmentation]
- Ω_{ccc} very sensitive (to cubic power) to dN_{charm}/dp_T

A system size scanning is like looking to see ΔE vs. L → dE/dx

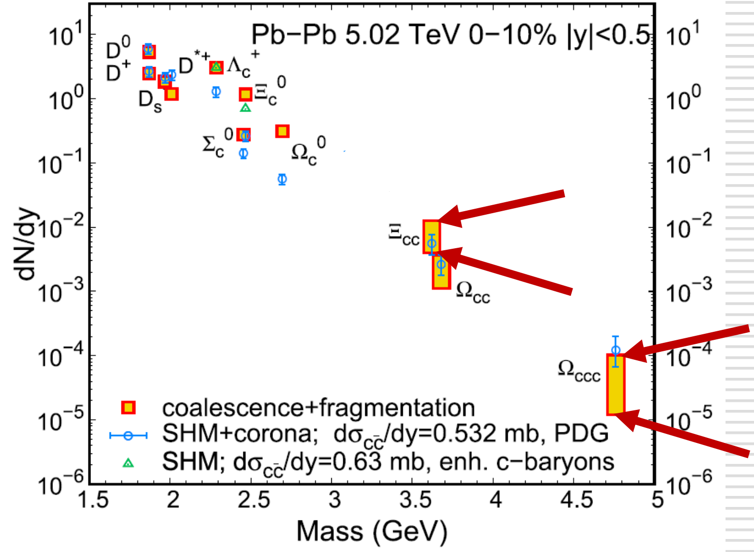
Evolution of p_T charm vs system size



cubic of charm p_T distrib.



Yields in Pb-Pb from coalescence vs SHM



- Both Statistical model (SHM) & a naïve coalescence should lead to a scaling with

$V\left(\frac{N_c}{V}\right)^c = N_c\left(\frac{N_c}{V}\right)^{c-1}$ c= #of charm

- Ω_{ccc} yield depends on $\left(\frac{dN_c}{dp_T}\right)^3$ + fragmentation contribution negligible

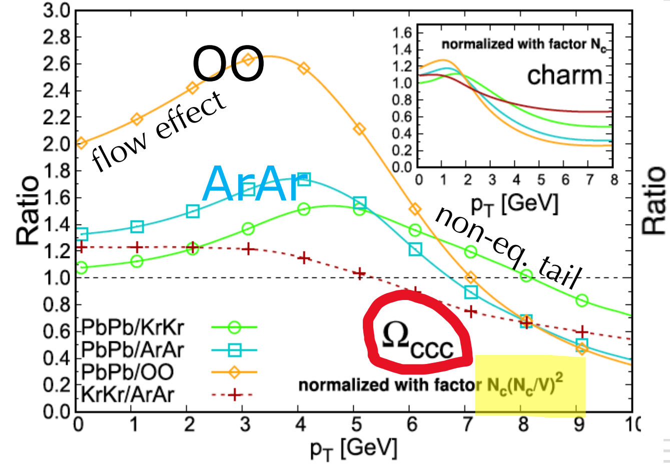
thermal full $dN_{charm}/dp_T \sim$ SHM

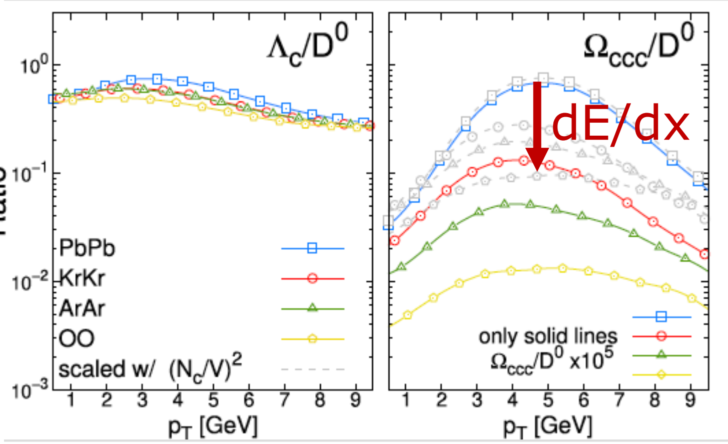
realistic dN_{charm}/dp_T from $D_s(T)$

❖ Makes a I order of magnitude difference depending on degree of equilibirum, while very small effect on D, Λ_c also due to charm # conservation & confinement

Ω_{ccc} p_T evolution from PbPb to OO

Minissale et al., EPJC84(2024)





Deviation from scaling $N_c \left(\frac{N_c}{V}\right)^2$ due to different final p_T-charm distribution wrt PbPb

Ω_{ccc} p_T spectrum evolution with system size unveil direct information of charm dN_c/dp_T with much larger sensitivity w.r.t. D^0 or Λ_c → precise info on interaction $D_s(T)$

First estimates for ALICE 3

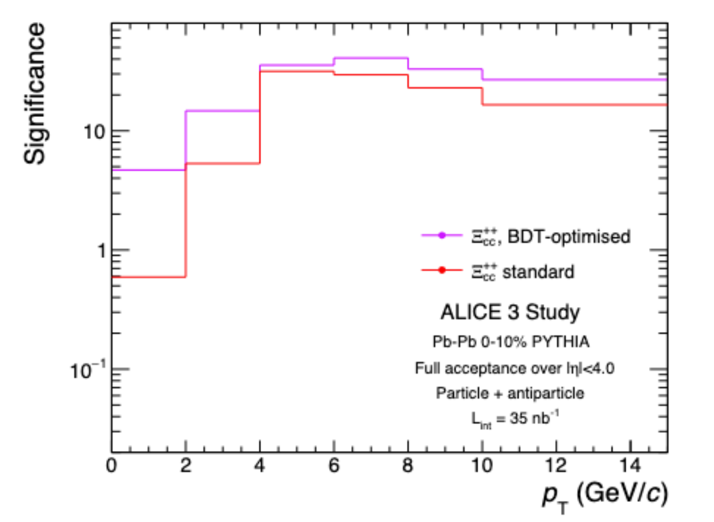
Estimate in **signal gain** with basic scaling assumptions

		O–O	Ar–Ar	Ca–Ca	Kr–Kr	Xe–Xe	Pb–Pb
	A	16	40	40	78	129	208
	$L_{\rm int}$ (nb^{-1}/month)	1600	340	310	84	26	5.6
	$\sigma_{\rm inel}$	1.41	2.6	2.6	4.06	5.67	7.8
	G events/month	2250	880	810	340	150	44
Light part.	$S_{\rm AA}/S_{\rm PbPb}$ for $A^{5/3}$ scaling	4.0	3.9	3.5	2.9	2.1	1
D & tot c	$S_{\rm AA}/S_{\rm PbPb}$ for A^{2} scaling	1.7	2.2	2.0	2.1	1.8	1
Ξ_{cc}	$S_{\rm AA}/S_{\rm PbPb}$ for $A^{7/3}$ scaling	0.7	1.3	1.2	1.5	1.5	1
Ω_{ccx}	$S_{\rm AA}/S_{\rm PbPb}$ for $A^{8/3}$ scaling	0.3	0.7	0.7	1.1	1.3	1

For the study of multi-charm baryons, more refined estimate of the scaling of S and bkg (light part.) has been performed (discussed later)

Other assumption (very conservative):
same selection efficiency of signal as for Pb-Pb in the ALICE 3 LOI

Ξ^{++}_{cc}: performance in 0-10% Pb-Pb collisions

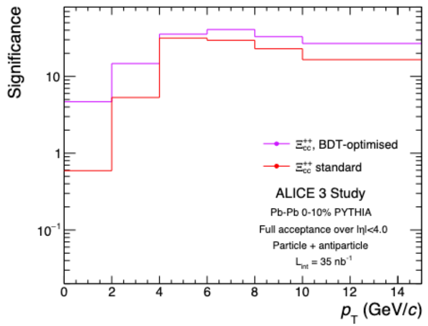


Ξ^{++}_{cc} significance in 0-10% Pb-Pb collisions at $\sqrt{s_{NN}}$ = 5.52 TeV with a 2.0 T field, studied as a function of p_T **with ML techniques** + strangeness tracking

LOI https://arxiv.org/abs/2211.02491

Ξ^{++}_{cc}: performarmance in smaller collision systems

same selection efficiency of signal as for Pb-Pb in the ALICE 3 LOI



+

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Ξ^{++}_{cc} significance in smaller collision systems:

- **relative to the integrated luminosity of one month of data taking**
- and to **detailed Pb-Pb performance studies as a function ot p_T.**

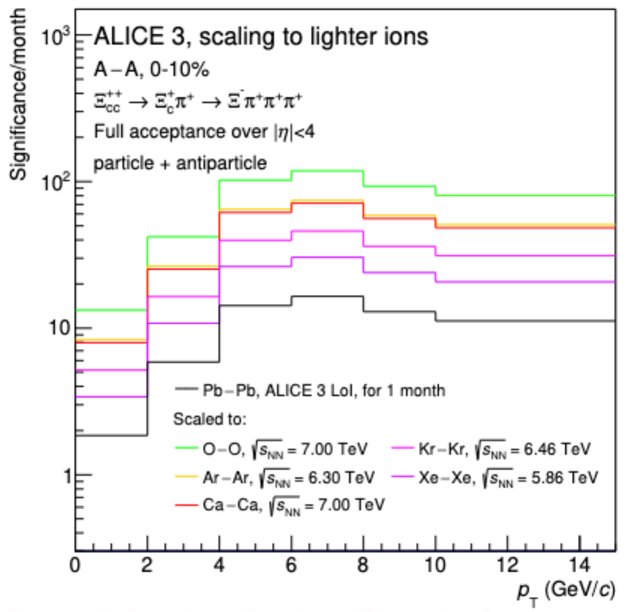
Basic assumptions, based on simple N_{ch} scaling:

$$B/ev \sim (dN_{ch}/dy)^4 \sim A^4 \quad S/ev \sim A^{4/3}$$

Significance relative to Pb–Pb	O–O	Ar–Ar	Ca–Ca	Kr–Kr	Xe–Xe	Pb–Pb
per $\sqrt{N_{ev}}$	5.5	3.0	3.0	1.9	1.5	1
per month	39.7	13.6	13.0	5.4	2.5	1

Ξ^{++}_{cc}: performarmance in smaller collision systems

same selection efficiency of signal as for Pb-Pb in the ALICE 3 LOI



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A-A & centrality dependence

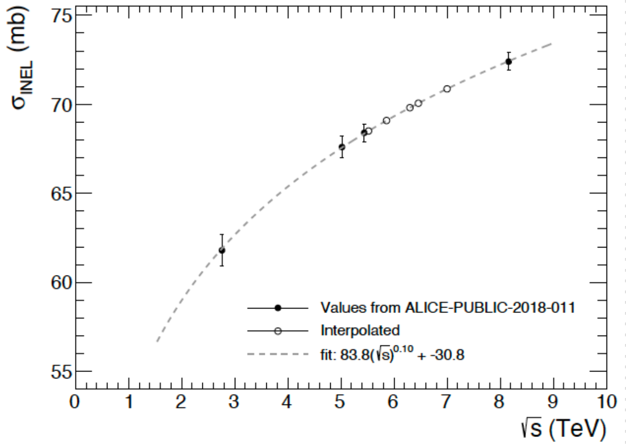
- Signal scaling → N_{coll} from Glauber MC
- Bkg scaling → $dN_{ch}/d\eta$ from PYTHIA Angantyr simulations

→ Bkg/evt $\propto N_{ch}^{4}$ $\Xi_{cc}^{++} \to \Xi_{c}^{+}\pi^{+} \to \Xi^{-}\pi^{+}\pi^{+}\pi^{+}$

Interpolation of σ_{INEL} (input for Glauber MC)

Table 2: Inelastic cross-section σ_{INEL} for various energies.

$\sqrt{s_{NN}}$ (TeV)	σ_{INEL} (mb)
2.76	61.8 ± 0.9
5.02	67.6 ± 0.6
5.44	68.4 ± 0.5
8.16	72.4 ± 0.5
	Interpolated:
5.52	68.5
5.86	69.1
6.46	70.1
6.30	69.8
7.00	70.9

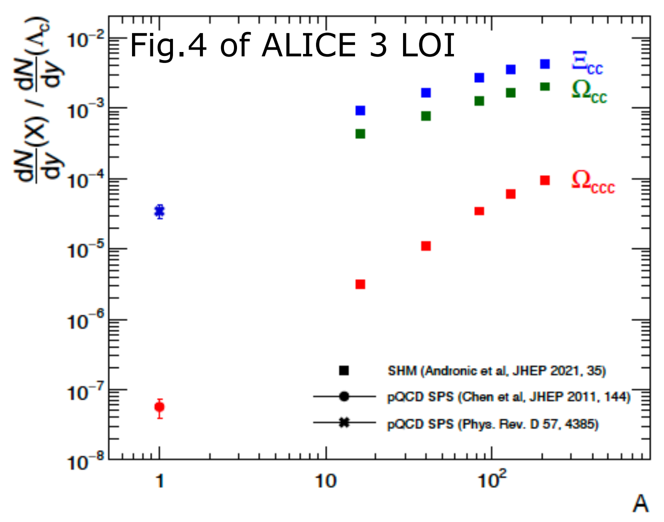


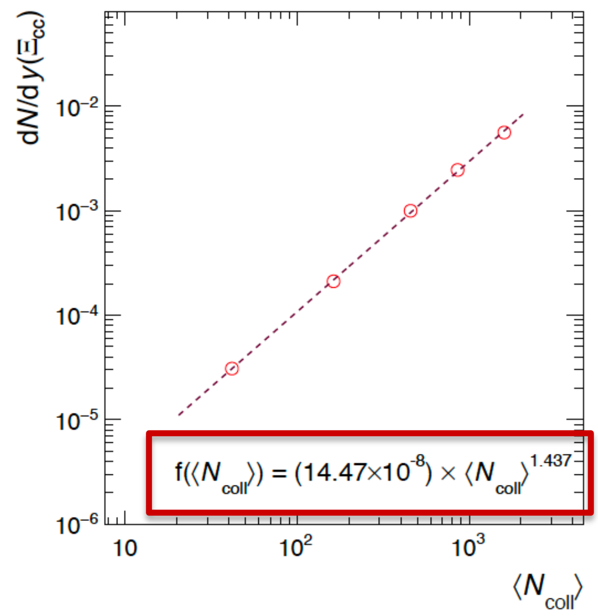
A-A & centrality dependence

- Signal scaling → N_{coll} from Glauber MC

statistical hadronisation model calculation
A. Andronic et al. JHEP 07 (2021) 035

0-10% , $\sqrt{s_{NN}}$=5.02 TeV





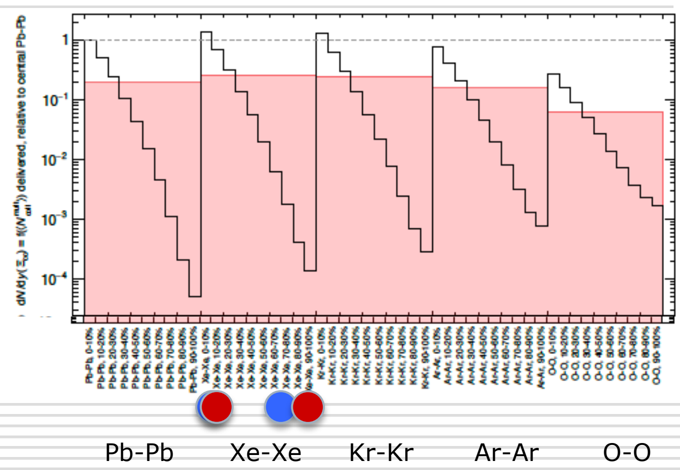
A-A & centrality dependence

- Signal scaling → N_{coll} from Glauber MC & $S = 14.47 \times 10^{-8} \times \langle N_{coll} \rangle^{1.437}$
- Bkg scaling → $dN_{ch}/d\eta$ from PYTHIA Angantyr simulations

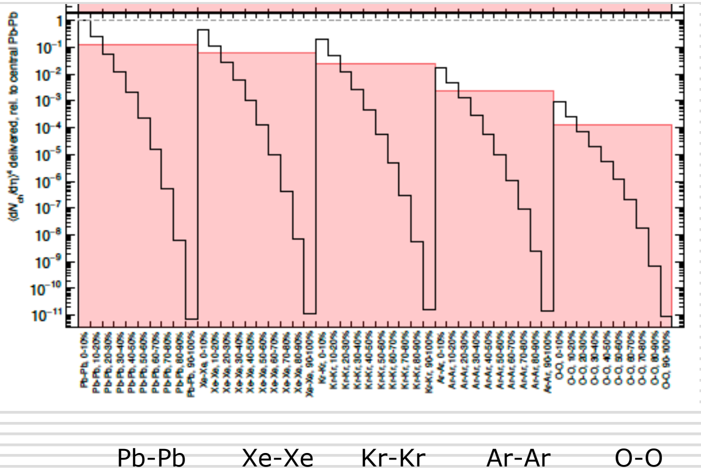
Bkg/evt $\propto N_{ch}^4$

$\Xi_{cc}^{++} \rightarrow \Xi_c^+ \pi^+ \rightarrow \Xi^- \pi^+ \pi^+ \pi^+$

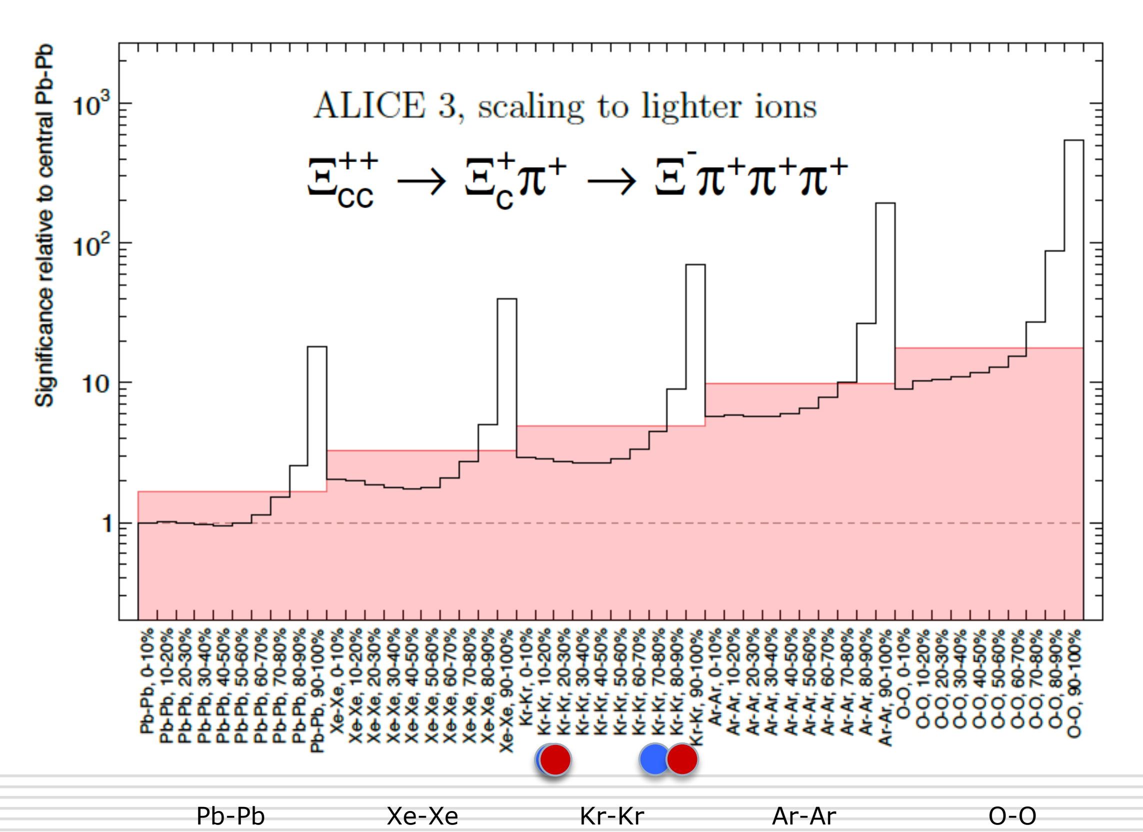
S per month relative to Pb-Pb 0-10%



Bkg per month relative to Pb-Pb 0-10%



A-A & centrality dependence



DDbar correlations in different systems

Two source of bkg: (i) true D from a **different hard scattering** and (ii) fake D

- Pythia simulations (FONLL parameterization) with proper N_{coll} to obtain **true signal** and **background from different hard scattering** component (the largest contribution to bkg)
  - Signal → Number of **D mesons from FONLL** scaled according T_{AA} and L_{int} foreseen for smaller systems
- Fake_D/N_{events} scales as the square of the ratio of the charged particles multiplicity that pass the cuts selection:

$$B/ev \propto (dN_{ch}/d\eta)^2$$

  - $dN_{ch}/d\eta$ obtained from $\frac{2}{N_{part}}\frac{dN_{ch}}{d\eta}$ vs $\sqrt{s_{NN}}$,
    - e.g. $dN_{ch}/d\eta$ in O-O for 0-10% (0-5%) with N_{part}= 23.5 (25.6) is ~ 132 (140)

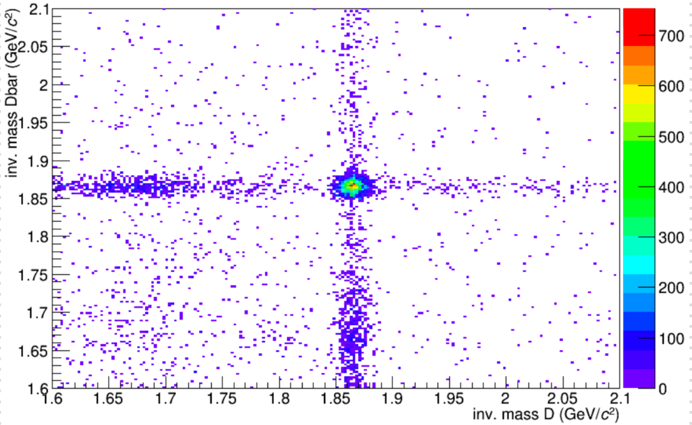
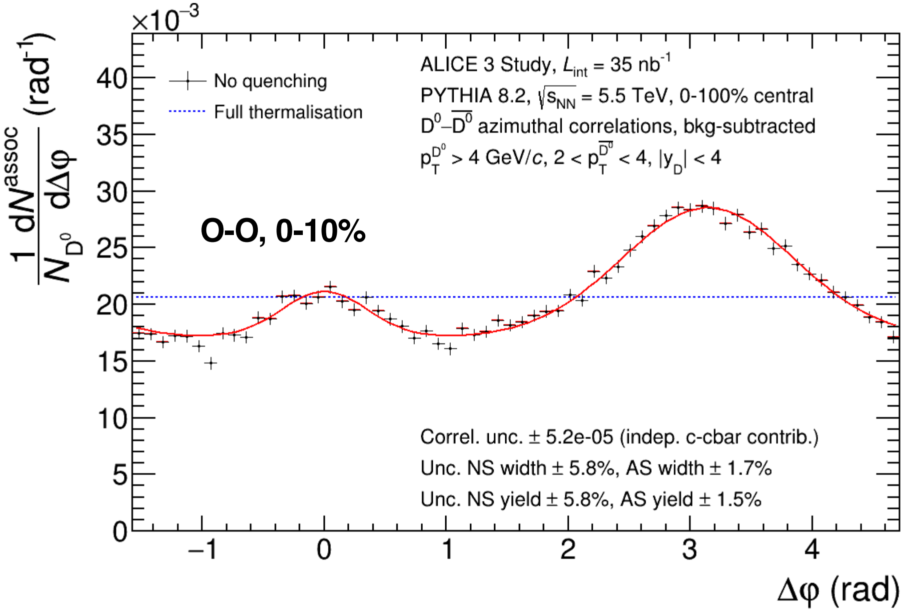
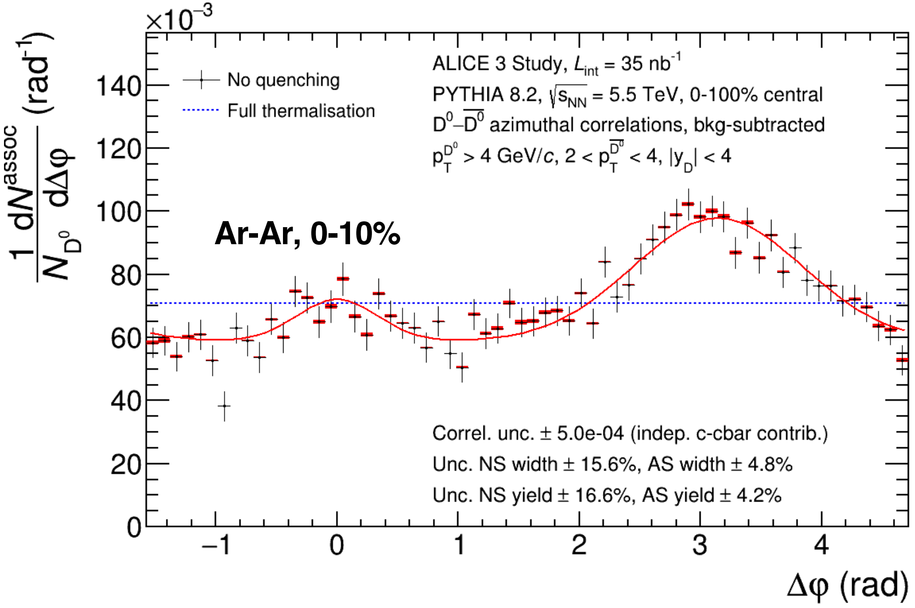


FIG. 2D invariant mass distribution of **D0, D0bar candidates**

- Tot combinatorial: sig-bkg / bkg-sig / bkg-bkg , where bkg=true $D_{\_diff\ hard\ scat.}$ + fake D

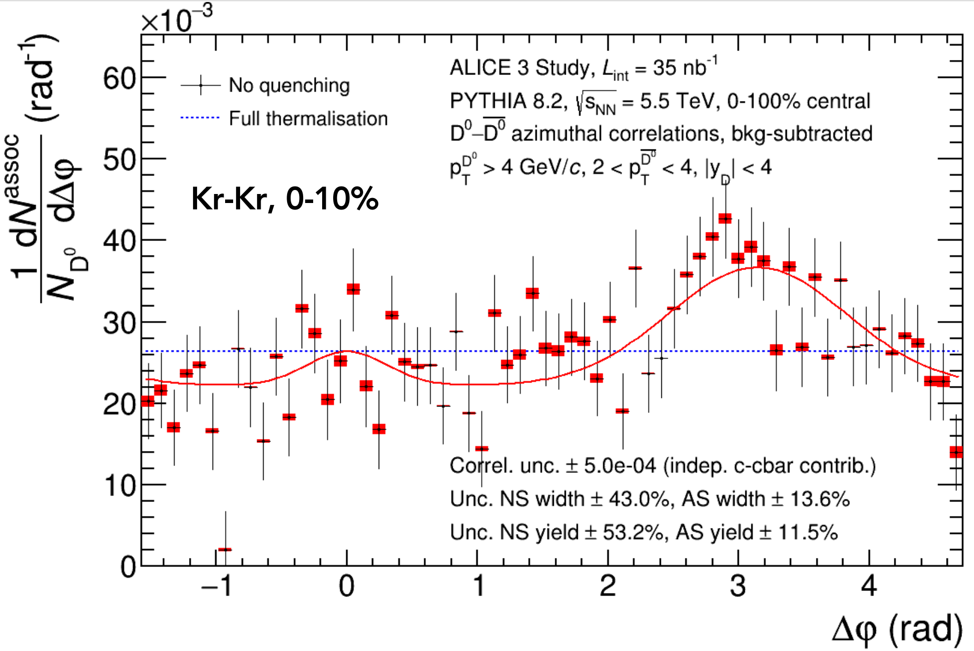
DDbar correlations in different systems

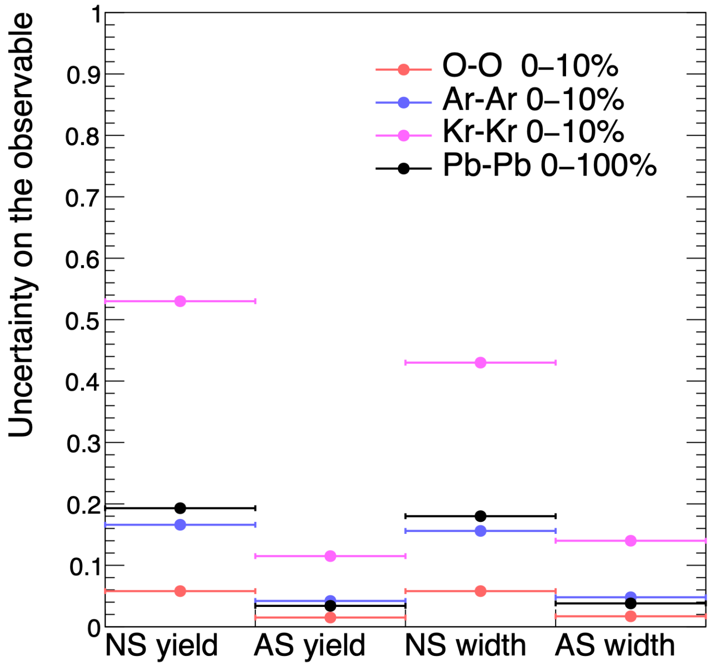




- DDbar azimuthal correlation distribution in central (0-10%) O-O, Ar-Ar and Xe-Xe were obtained with the described recipe and compared with **MB Pb-Pb** (from LOI studies)

DDbar correlations in different systems





- ☐ Gain in statistical precision with lighter system as expected
- ☐ main observable: modification of the properties of correlation-peak wrt pp collisions.
  - —> eventually milder modification for lighter colliding nuclei

Conclusions and outlook

- Preliminary studies in lighter colliding systems completed with reasonable scaling assumptions for Ξ_{cc} production and DDbar correlation
  - Assumption of same selection efficiency as in Pb-Pb very conservatice for Ξ_{cc} , quite ok for DDbar correlation

- This work has stimulated interest by theoretical groups

- Machinery for on-the-fly simulation developed

  → *Hyperloop* MGEN
  - Optimization of selection criteria (ML training) for different systems

EXTRA

From ALICE 3 LOI

Quantity	pp	O–O	Ar–Ar	Ca–Ca	Kr–Kr	In–In	Xe–Xe	Pb–Pb
$\sqrt{s_{NN}}$ (TeV)	14.00	7.00	6.30	7.00	6.46	5.97	5.86	5.52
L_{AA} ($cm^{-2}s^{-1}$)	3.0×10^{32}	1.5×10^{30}	3.2×10^{29}	2.8×10^{29}	8.5×10^{28}	5.0×10^{28}	3.3×10^{28}	1.2×10^{28}
$\langle L_{AA} \rangle$ ($cm^{-2}s^{-1}$)	3.0×10^{32}	9.5×10^{29}	2.0×10^{29}	1.9×10^{29}	5.0×10^{28}	2.3×10^{28}	1.6×10^{28}	3.3×10^{27}
$\mathcal{L}_{AA}^{month}$ (nb^{-1})	5.1×10^{5}	1.6×10^{3}	3.4×10^{2}	3.1×10^{2}	8.4×10^{1}	3.9×10^{1}	2.6×10^{1}	5.6
$\mathcal{L}_{NN}^{month}$ (pb^{-1})	505	409	550	500	510	512	434	242
R_{max} (kHz)	24 000	2169	821	734	344	260	187	93
μ	1.2	0.21	0.08	0.07	0.03	0.03	0.02	0.01
$dN_{ch}/d\eta$ (MB)	7	70	151	152	275	400	434	682

For the heavy-ion programme, the optimal running scenario will depend on the luminosities achievable with the various species. In this letter, we show projections for the most challenging environment, i.e. Pb–Pb collisions. Based on the current luminosity estimates, Xe–Xe could be the better option providing twice the nucleon–nucleon luminosity with a relatively large collision system. Runs with smaller collision systems, as well as p–A runs, are also being considered. The

System	$\mathcal{L}^{month}$	$\mathcal{L}^{Run5+6}$
pp	$0.5\,fb^{-1}$	$18\,fb^{-1}$
pp reference	$100\,pb^{-1}$	$200\,pb^{-1}$
A–A		
Xe–Xe	$26\,nb^{-1}$	$156\,nb^{-1}$
Pb–Pb	$5.6\,nb^{-1}$	$33.6\,nb^{-1}$

Table 2: Integrated luminosities for different collision systems

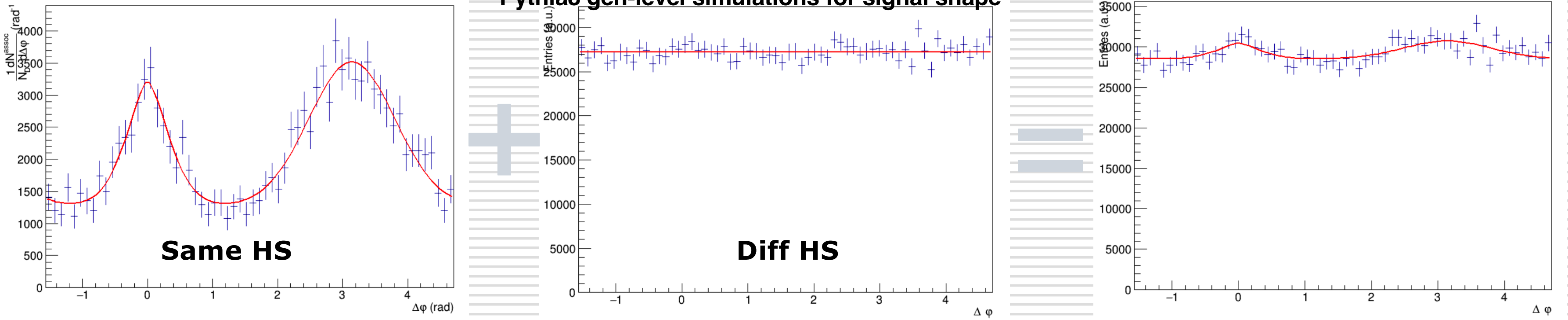
DDbar correlations - procedure

Input ingredients

- ☐Amount of expected D0, D0bar signal by **FONLL predictions**, properly rescaled
- ☐**D0, D0bar efficiency** and reconstruction performance from HF enriched **ALICE 3 MC** sample
- ☐D0-D0bar **signal Δφ shape** from **Pythia8** simulations SoftQCD:inelastic, merging <Ncoll>$_{0\text{-}100\%}$= 382 collisions
  - Includes 'signal' contribution from sameHS, and flat (dominant) contribution from uncorrelated HS

Combinatorial background and **S/B factor** under signal peak from **MB ALICE 3 simulation**

Pythia8 gen-level simulations for signal shape



A side comment

- Past experience with the Xe-Xe run
  - October the 12th 2017: $\sqrt{s_{NN}}$=5.44 TeV
  - ~ 1 day operation
  - 1 fill

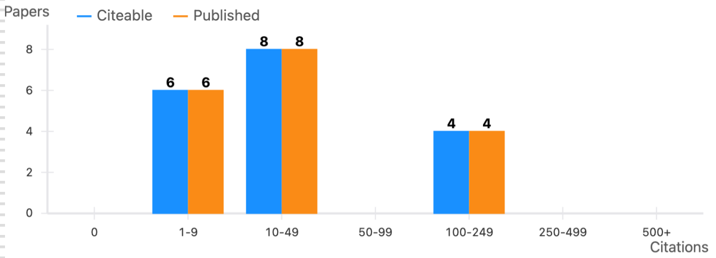
Very productive physics output:

→ 18 papers (500 in tot) → 3.5%

Citation Summary

☐ Exclude self-citations ⓘ

	Citeable ⓘ	Published ⓘ
Papers	18	18
Citations	812	812
h-index ⓘ	11	11
Citations/paper (avg)	45.1	45.1



ALICE Xe-Xe publications 1/2

1. **Event-by-event fluctuation of mean transverse momentum in pp, Xe–Xe and Pb–Pb collisions** t o be submitted (round 2 closed 26th of Sept.)
2. **Exploring nuclear structure with multiparticle azimuthal correlations at the LHC** arXiv:2409.04343
3. **Skewness and kurtosis of mean transverse momentum fluctuations at the LHC energies** Phys.Lett.B 850 (2024), 138541
4. **System size dependence of hadronic rescattering effect at LHC energies** Phys. Rev. C 109 (2024), 014911
5. **Measurement of the production and elliptic flow of (anti)nuclei in Xe-Xe collisions at Vs_NN = 5.44 TeV** ArXiv:2405.19826
6. **Pseudorapidity dependence of anisotropic flow and its decorrelations using long-range multiparticle correlations in Pb-Pb and Xe-Xe collisions** Phys.Lett.B 850 (2024), 138477, Phys.Lett.B 853 (2024), 138659 (erratum)
7. **Multiplicity dependence of charged-particle production in pp, p-Pb, Xe-Xe and Pb-Pb collisions at the LHC** Phys.Lett.B 845 (2023), 138110
8. **Characterizing the initial conditions of heavy-ion collisions at the LHC with mean transverse momentum and anisotropic flow correlations** Phys. Lett. B 834 (2022) 137393
9. **Search for the Chiral Magnetic Effect with charge-dependent azimuthal correlations in Xe-Xe collisions at -Vs_NN=5.44 TeV** Phys.Lett.B 856 (2024), 138862

ALICE Xe-Xe publications 2/2

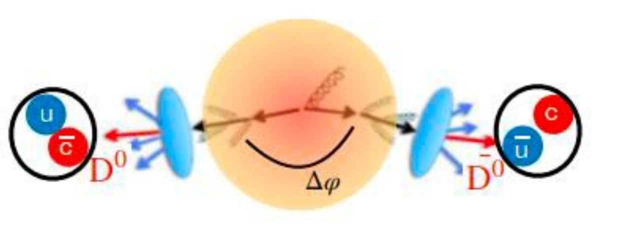
10. Elliptic flow of charged particles at midrapidity relative to the spectator plane in Pb-Pb and Xe-Xe collisions Phys.Lett.B 846 (2023), 137453
11. Anisotropic flow of identified hadrons in Xe-Xe collisions at √s_NN = 5.44 TeV JHEP 10 (2021), 152
12. Production of pions, kaons, (anti-)protons and ϕ mesons in Xe-Xe collisions at √s_NN = 5.44 TeV Eur.Phys.J.C 81 (2021) 7, 584
13. First measurement of coherent ρ_0 photoproduction in ultra-peripheral Xe-Xe collisions at √s_NN=5.44 TeV Phys.Lett.B 820 (2021), 136481
14. Inclusive heavy-flavour production at central and forward rapidity in Xe-Xe collisions at √s_NN=5.44 TeV Phys.Lett.B 819 (2021), 136437
15. Centrality and pseudorapidity dependence of the charged-particle multiplicity density in Xe-Xe collisions at √s_NN =5.44TeV Phys.Lett.B 790 (2019), 35-48
16. Transverse momentum spectra and nuclear modification factors of charged particles in Xe-Xe collisions at √s_NN = 5.44 TeV Phys.Lett.B 788 (2019), 166-179
17. Inclusive J/ψ production in Xe-Xe collisions at √s_NN = 5.44 TeV Phys.Lett.B 785 (2018), 419-428
18. Anisotropic flow in Xe-Xe collisions at √s_NN = 5.44}$ TeV Phys.Lett.B 784 (2018), 82-95

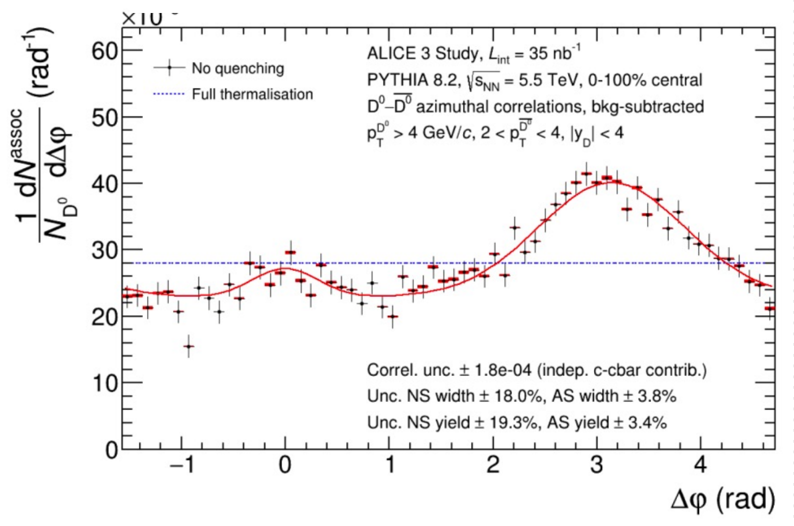
ALICE 3: physics performance

$D^0 - \overline{D}^0$ azimuthal correlation

- measure angular (de)correlation
  - direct probe of HF interaction with the QGP
- Strongest signal at low p_T
- Very challenging measurement:
  - good purity, efficiency and η coverage

In heavy-ion collisions doable only with ALICE 3





ALICE 3 LOI arXiv:2211.02491

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 824093.

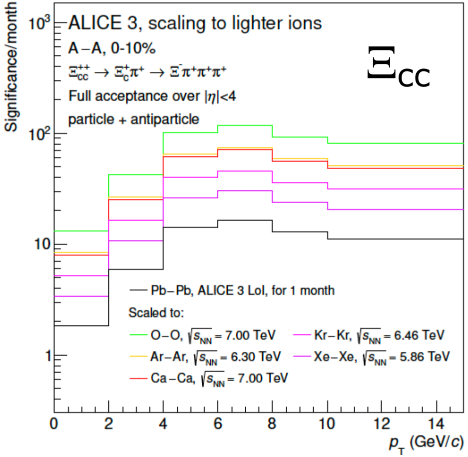
Not just p and Pb at the LHC!

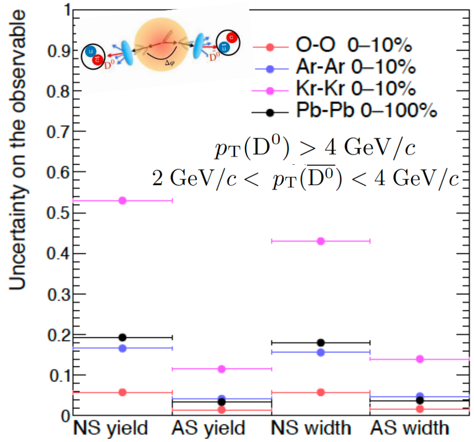
Estimate in **signal gain** with basic scaling assumptios

	O–O	Ar–Ar	Ca–Ca	Kr–Kr	Xe–Xe	Pb–Pb
A	16	40	40	78	129	208
$L_{\text{int}}(\text{nb}^{-1}/\text{month})$	1600	340	310	84	26	5.6
σ_{inel}	1.41	2.6	2.6	4.06	5.67	7.8
G events/month	2250	880	810	340	150	44
$S_{\text{AA}}/S_{\text{PbPb}}$ for $A^{5/3}$ scaling	4.0	3.9	3.5	2.9	2.1	1
$S_{\text{AA}}/S_{\text{PbPb}}$ for A^{2} scaling	1.7	2.2	2.0	2.1	1.8	1
$S_{\text{AA}}/S_{\text{PbPb}}$ for $A^{7/3}$ scaling	0.7	1.3	1.2	1.5	1.5	1
$S_{\text{AA}}/S_{\text{PbPb}}$ for $A^{8/3}$ scaling	0.3	0.7	0.7	1.1	1.3	1

Light part.
D & tot c
Ξ_{cc}
Ω_{ccx}

Assuming same selection efficiency as for Pb-Pb





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Federico’s scalings

The A-dependences I consider are:

- $\sigma \sim A^{5/3}$ bulk processes, such as charged particle production ($dN/dy \sim A$).
- $\sigma \sim A^{2}$ hard processes, such as heavy flavour production ($dN/dy \sim A^{4/3}$).
  A good approximation also for thermal radiation IN CASE $dN/dy \sim A^{1.4}$
- $\sigma \sim A^{7/3}$ e.g. double charm hadrons from statistical hadronisation if
  $dN/dy \sim A^{5/3} = A^{4/3}$ (charm yield) $\times A^{1/3}$ (charm to light quark density).
  For Pb/Kr, that would be about a factor 5 in the yields, consistent with an estimate by pbm et al for the ratio of the X(3872) yields between Pb and Kr in the statistical hadronisation model.
- $\sigma \sim A^{8/3}$ e.g. triple charm hadrons if:
  $dN/dy \sim A^{6/3} = A^{4/3}$ (charm yield) $\times A^{2/3}$ (charm to light quark density)^2

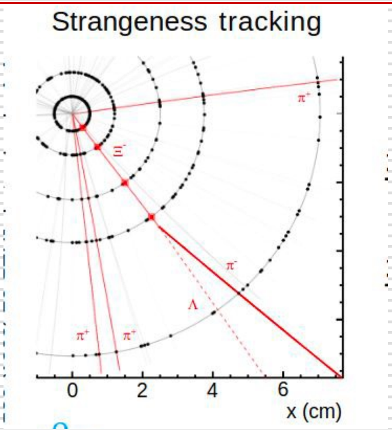
Federico's scalings vs. $dN_{ch}/d\eta$

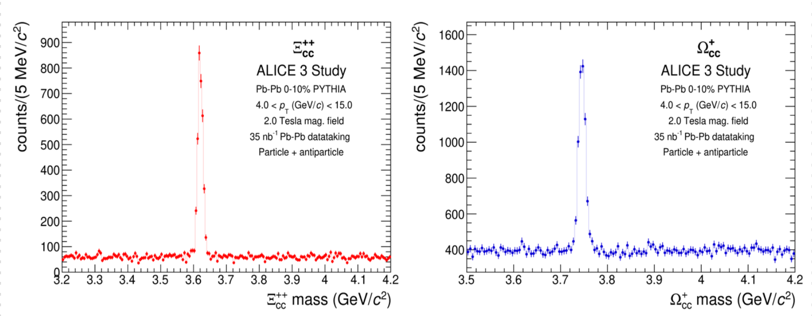
	pp	O-O	Ar-Ar	Ca-Ca	Kr-Kr	Xe-Xe	Pb-Pb	
Lint/month		1600	340	310	84	26	5.6	
evt/month (10^9)		2256	884	806	341.04	147.42	43.68	
A/Pb A^5/3		3.97520657	3.890021342	3.54678416	2.92511788	2.09409291	1	
A/Pb A^2		1.69061708	2.245350803	2.04723161	2.109375	1.7858216	1	
A/Pb A^7/3		0.71900316	1.29603408	1.18167813	1.52112259	1.52293089	1	
A/Pb A^8/3		0.30578512	0.748081027	0.68207388	1.0969192	1.29874031	1	
dN_ch/deta (MB)	7	70	151	152	275	434	682	As in the LOI
light particle		5.30115046	4.480868594	4.11255411	3.14826303	2.14772727	1	

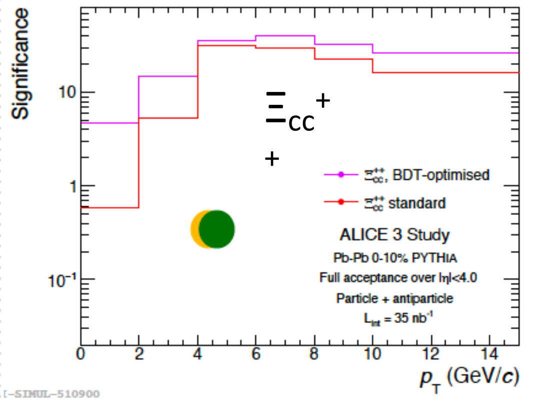
ALICE 3: physics performance

Multi-charm baryons

- Ξ_{cc}^{++} reconstructed in the channel: **$\Xi_{cc}^{++} \rightarrow \Xi_c^+\pi^+ \rightarrow \Xi^-\pi^+\pi^+\pi^+$**
- Ω_{cc}+ reconstructed in the channel: **$\Omega_{cc}^+ \rightarrow \Omega_c^0\pi^+ \rightarrow \Omega^-\pi^+\pi^+$**
- Performance for Ω_{ccc} studies ongoing







ALICE 3 LOI arXiv:2211.02491

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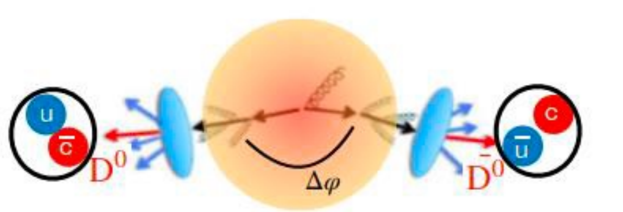
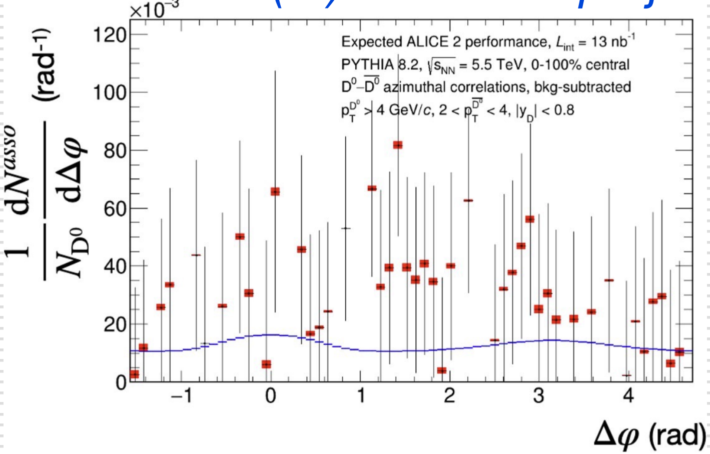
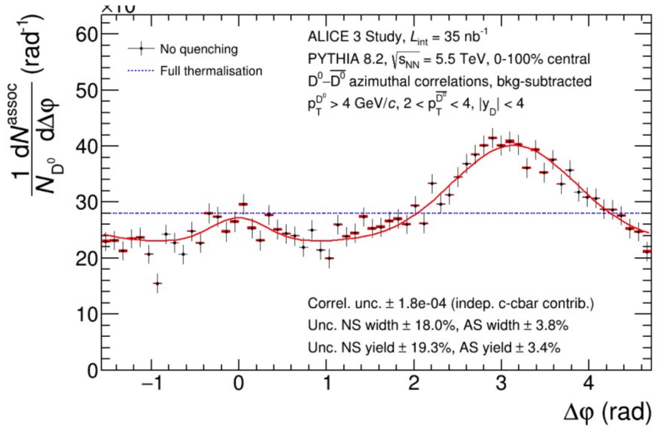
ALICE 3: physics performance

$D^0 - \overline{D}^0$ azimuthal correlation



ALICE 2(.1) Run 3 + 4 projection





In heavy-ion collisions doable only with ALICE 3

ALICE 3 LOI arXiv:2211.02491

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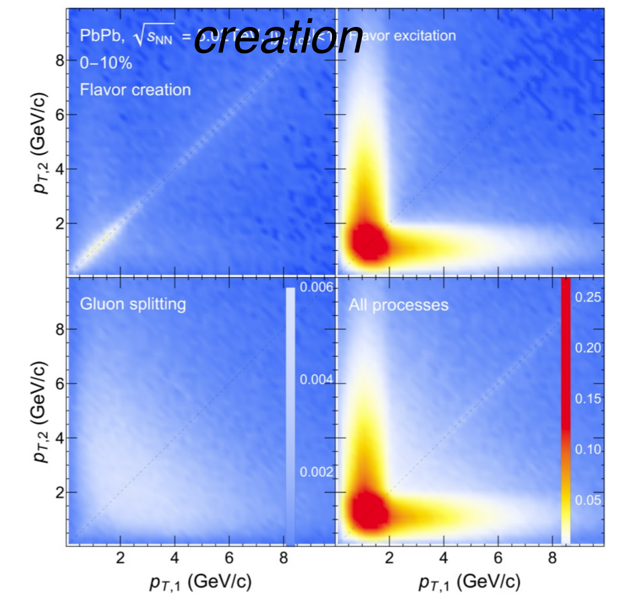
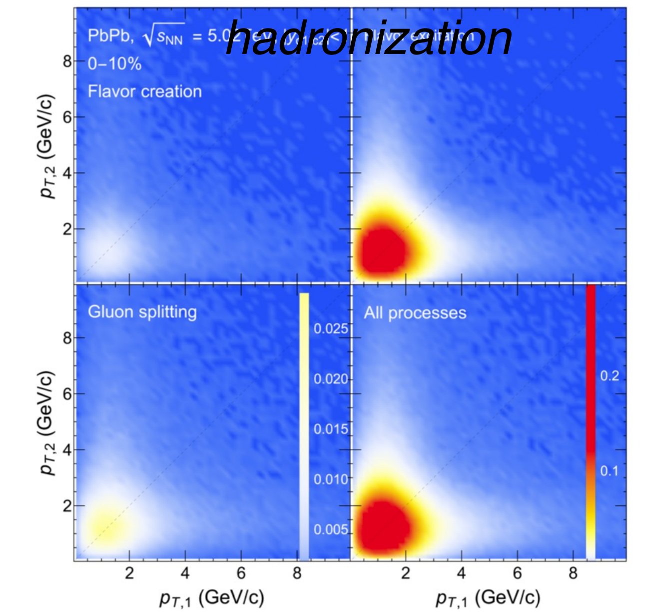
at creation



Before hadronization



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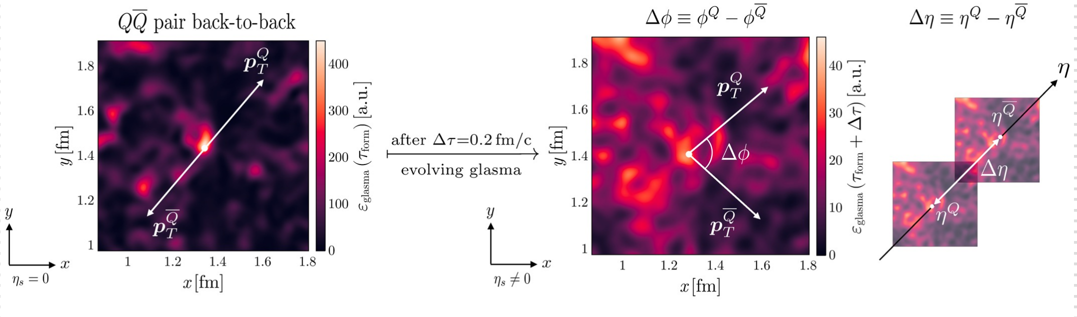
$\Delta\phi > 5\pi/6$	Flavor creation	Flavor excitation	Gluon splitting
$p_{T,D}, p_{T,\bar{D}}$ all	13.6%	81.3%	5.1%
$p_{T,D} > 4, 2 < p_{T,\bar{D}} < 4$ GeV	38.3%	54.6%	7.1%
$p_{T,D}, p_{T,\bar{D}} > 6$ GeV	64.3%	30.6%	5.1%
$\Delta\phi < \pi/6$	Flavor creation	Flavor excitation	Gluon splitting
$p_{T,D}, p_{T,\bar{D}}$ all	1.4%	70.8%	27.8%
$p_{T,D} > 4, 2 < p_{T,\bar{D}} < 4$ GeV	1.9%	35.9%	62.2%
$p_{T,D}, p_{T,\bar{D}} > 6$ GeV	1.9%	23.7%	74.4%

TABLE I. The fractions of $D\bar{D}$ are from different processes when did the selection, $\Delta\phi > 5\pi/6$ and $\Delta\phi < \pi/6$, in p-p collisions with $\sqrt{s_{\rm NN}} = 5.02$ TeV.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 824093.

arXiv:2409.10565



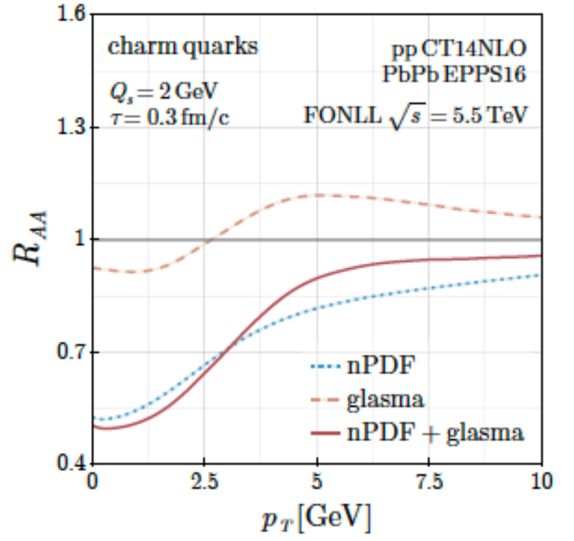


FIG. 2. Nuclear modification factor R_{AA} for charm quarks calculated by including only the nuclear PDF effects (*nPDF*) or interactions in the glasma stage (*glasma*), or both (*nPDF + glasma*).

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