(Anti)(hyper)nuclei and exotica measurements with the ALICE upgrade

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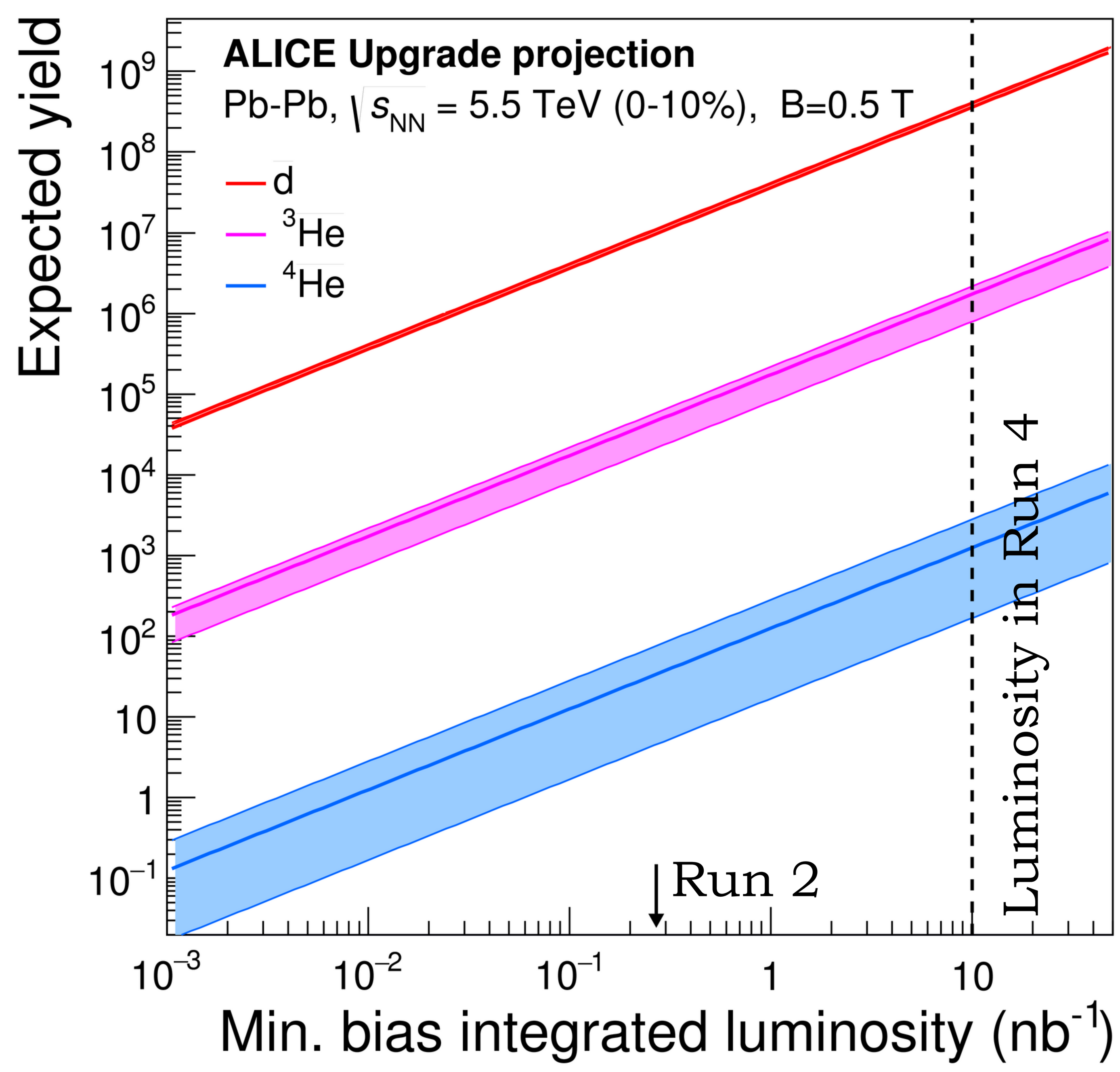
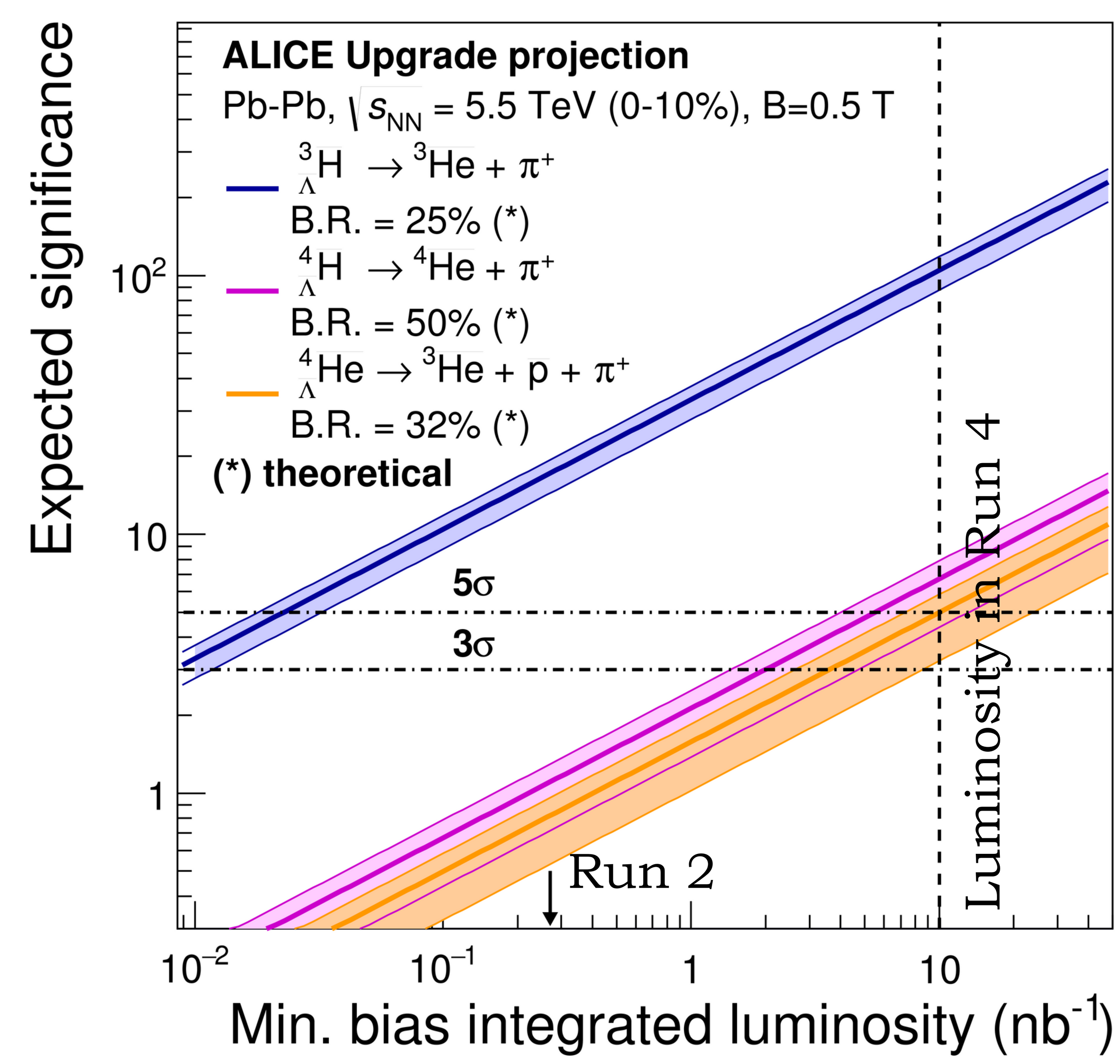
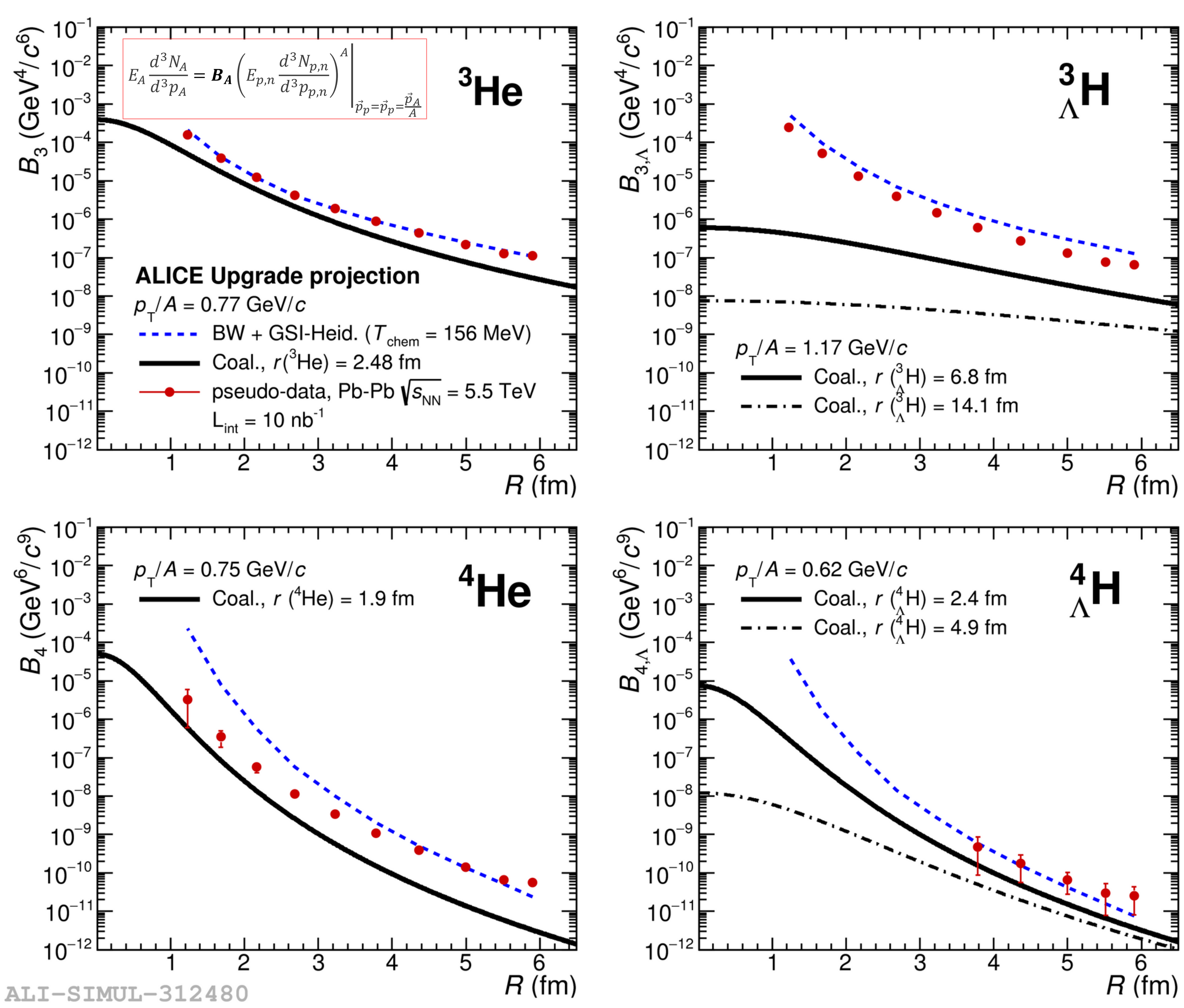
The unprecedented luminosities available at LHC in Run 3 and Run 4 (2021-2029) will offer a unique physics potential for the study of the formation of complex hadronic structures. In central ultrarelativistic heavy-ion collisions the light (hyper)nuclei formation is described by a thermal-statistical model which foresees that hadron abundances are produced when inelastic collisions stop, the chemical freeze-out, that occurs at the temperature $T_{chem} \approx 156$ MeV [1]. Below that temperature also elastic collisions cease, the kinetic freeze-out occurs, and the formation of (hyper-)nuclei and QCD exotic states can be modeled with an initial production of their constituents in a chemically equilibrated medium followed by the coalescence of such constituents into more complex systems [2][3].





Upper plots :the central line refers to a T_{chem} = 156 MeV, the upper line refers to T_{chem} = 158 MeV, the lower line uses the expectations from coalescence [4]. Below: R refers to the radius of the emitting source size.



The expected yield of (anti)(hyper)nuclei in 2 GeV/c < p_T <10 GeV/c in most central Pb–Pb collisions will allow :

- the measurement of the elliptic flow (v_2) of nuclei heavier than deuteron with a statistical precision better than 5%.
- the first precise measurement of the mass of nuclei with A = 3 allowing to test Charge Symmetry Breaking (CSB) in the (anti)nuclei sector.
- the discovery of the $^4_\Lambda\overline{\mathrm{H}}$ and $^4_\Lambda\overline{\mathrm{He}}$
- to disentangle the role of the thermal-statistical model from the coalescence model in nuclei production. The coalescence parameter of the $^3_\Lambda$H formation, in fact, differ by up to three orders of magnitude in the two cases [5], making the hypetriton very sensitive to the production process.

The predictions of thermal and coalescence models for exotic hadrons in central Pb-Pb collisions in the new luminosity regime [3] will allow for precise measurements of the $f_0(980)$ and N(1875) with estimated yields larger than 10^7 detected particles and a significance larger then 100. Their study will provide new insights into their nature (multiquark states or hadron molecules). Also dibaryon states such as NΩ, NΞ and $N\Lambda_c$, should these exist, will be abundantly produced (> 10^4) thus improving the understanding of the baryon-baryon potential as well as the nuclei bound state formation after the chemical freeze-out.

[1] ALICE Collaboration, Nucl. Phys. A 971 (2018) 1–20, arXiv:1710.07531 [nucl-ex].
[2] F. Bellini, A. P. Kalweit, Phys. Rev. C 99, 054905 (2019), arXiv:1807.05894[hep-ph]
[3] ExHIC Collaboration, S. Cho et al., Prog. Part. Nucl. Phys. 95 (2017) 279–322, arXiv:1702.00486 [nucl-th]
[4] Z. Citron et al. CERN-LPCC-2018-07, arXiv:1812.06772 [hep-ph]
[5] ALICE Collaboration, ALICE-PUBLIC-2019-001