Faculty of Physics
WARSAW UNIVERSITY OF TECHNOLOGY

AFTER @ LHC

A fixed-target programme at the LHC for heavy-ion, hadron, spin and astroparticle physics

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AFTER@LHC Study group: http://after.in2p3.fr/after/index.php/Current_author_list

A Fixed-Target Programme at the LHC: Physics Case and Projected Performances for Heavy-Ion, Hadron, Spin and Astroparticle Studies

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e-Print: arXiv:1807.00603 [hep-ex] | PDF

Why a fixed-target experiment at the LHC?

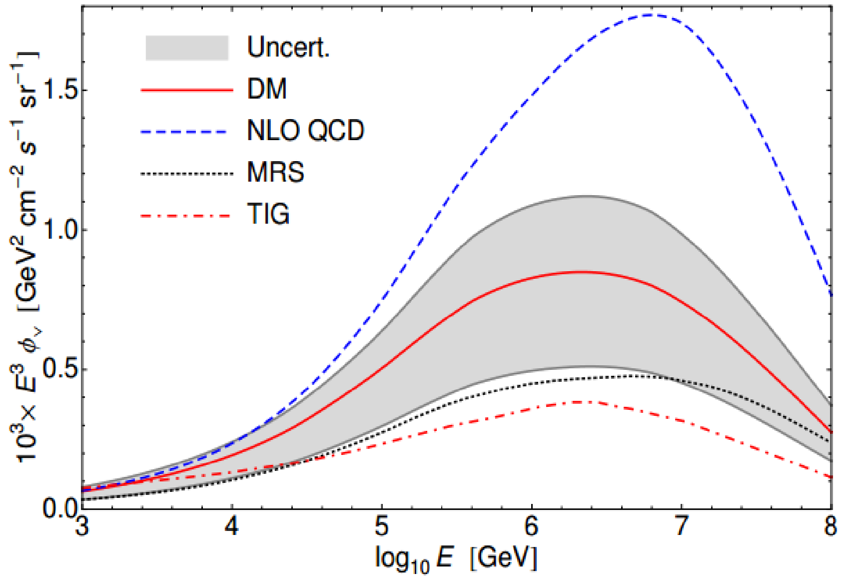
- High luminosities → access to rare probes (heavy quarks)
- High precision Heavy-Ion program between SPS and RHIC top energy
- Access to high Feynman x_F domain ($|x_F| = |p_z|/p_{z\,max} \rightarrow 1$)
- Variety of atomic mass of the target,
- Large kinematic coverage
- Polarization of the target → spin physics at the LHC

Physics program

High-x frontier

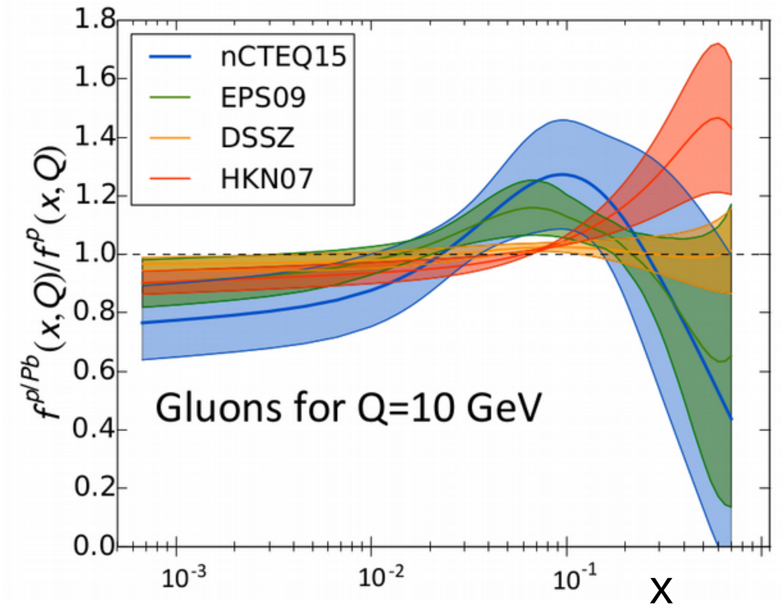
- Advance our understanding of high-x gluons, antiquark and heavy-quark content in the nucleon & nucleus
- AFTER@LHC data → reduce uncertainties on PDFs, astrophysics calculations

Energy spectrum of neutrino flux



Phys.Rev.D78:043005,2008

Gluon nuclear PDFs



Phys. Rev. D 93, 085037 (2016)

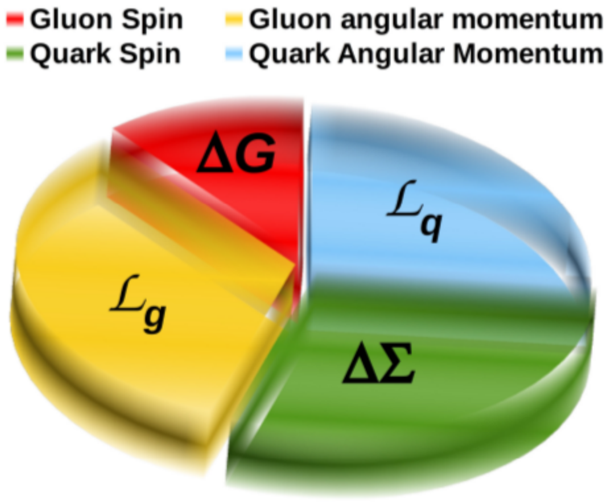
The Spin Physics Program

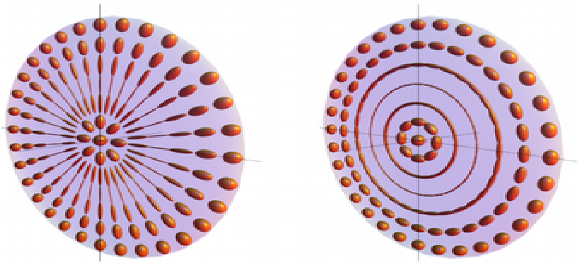
3D mapping of the parton momentum:

- Missing contribution to the proton spin: Gluon and Quark Orbital Angular Momentum L_q and L_g

  p+p↑ → (indirect) access to quark L_q, gluon L_g and gluon transverse-momentum dependent PDF

- Determination of the linearly polarized gluons in unpolarized protons





Phys. Rev. Lett. 112, 212001

Heavy-ion collisions

AFTER@LHC

Heavy-ion collisions at

$\sqrt{s_{NN}}$ = 72 -115 GeV

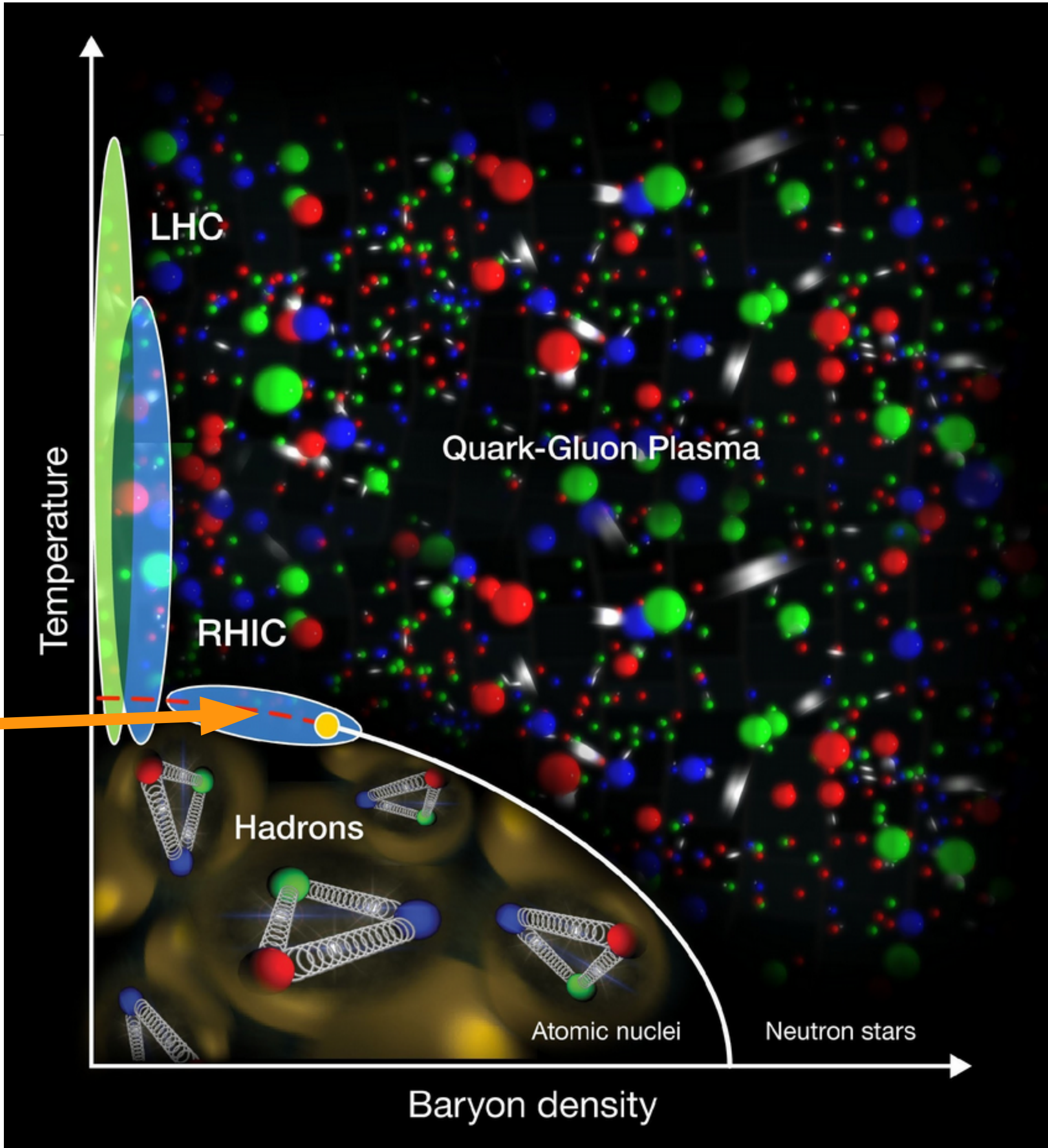
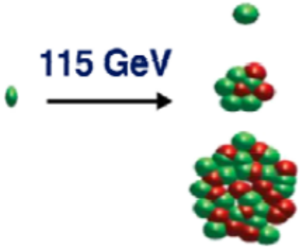


Figure courtesy of Brookhaven National Laboratory

Fixed-target collisions at LHC

Kinematics

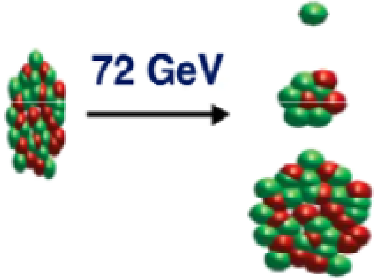
- p+p or p+A with a 7 TeV p on a fixed target



$$\sqrt{s} = \sqrt{2 m_N E_p} \approx 115\, GeV$$

$$y_{CMS} = 0 \rightarrow y_{Lab} = 4.8$$

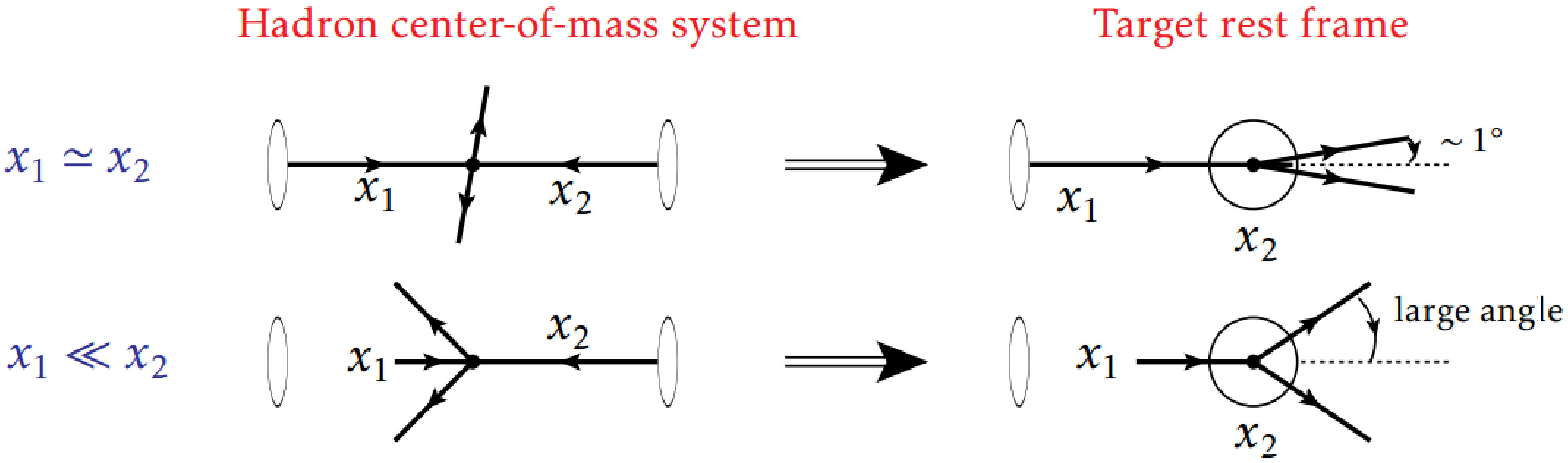
- A+A collisions with a 2.76 TeV Pb beam



$$\sqrt{s} \approx 72\, GeV$$

$$y_{CMS} = 0 \rightarrow y_{Lab} = 4.3$$

Boost effect → access to backward physics

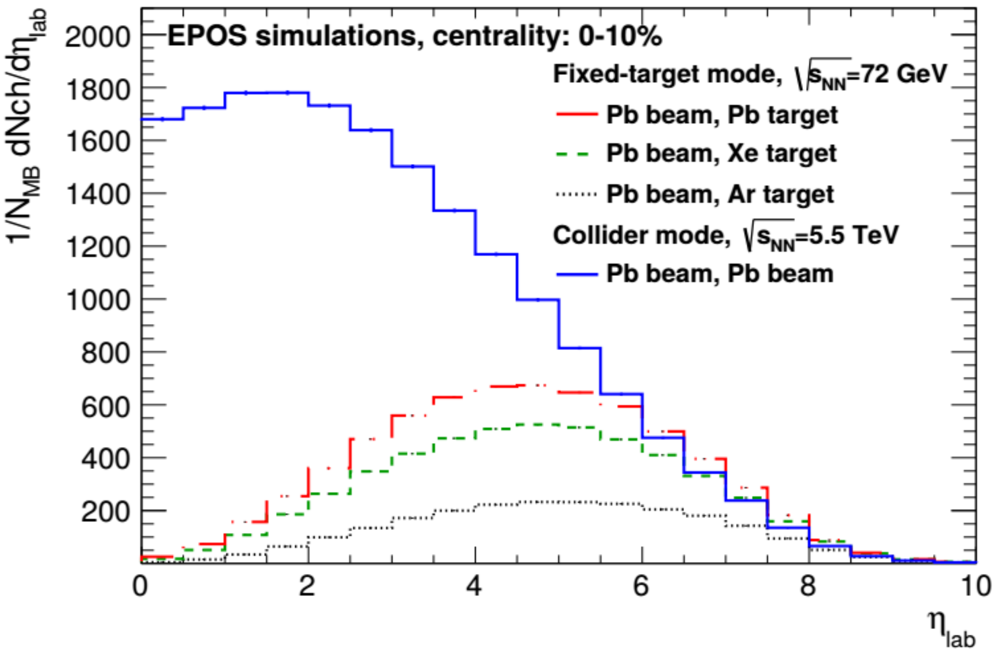


backward physics = large-x_2 physics ($x_F < 0 \rightarrow$ large x_2)

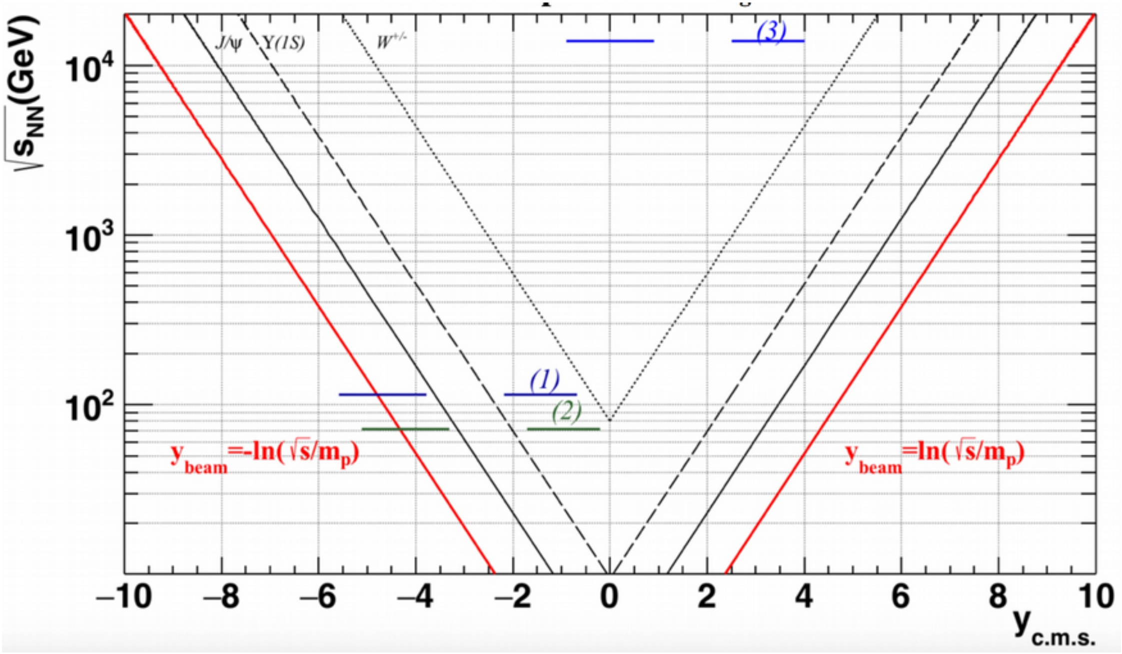
Detector requrements

- Wide rapidity coverage with PID and vertexing capabilities
- Readout rate similar as LHC collider: up to 40 MHz in pp, 300 MHz in pA and 200 kHz in PbA
- Heavy-ion: good detector performance in high-multiplicity events, up to 600 charged tracks per unit of rapidity at η_{lab} ~4

L. Massacrier et al.,
Adv.Hi.En.Phys. (2015) 986348



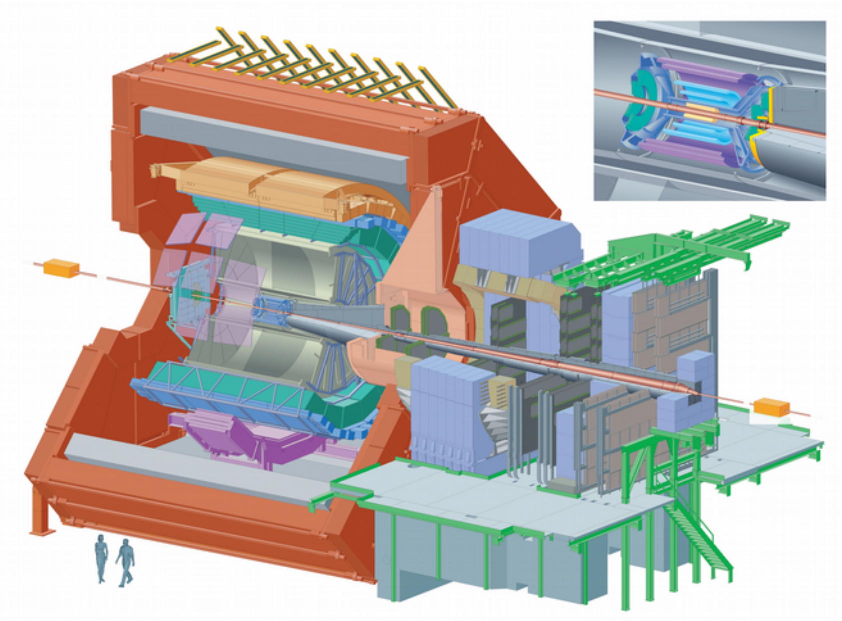
Kinematic coverage: collider vs fixed target



ALICE: Muon Det.: $2.5 < \eta^{lab} < 4$,

TPC: $|\eta^{lab}| < 0.9$

ALICE detector

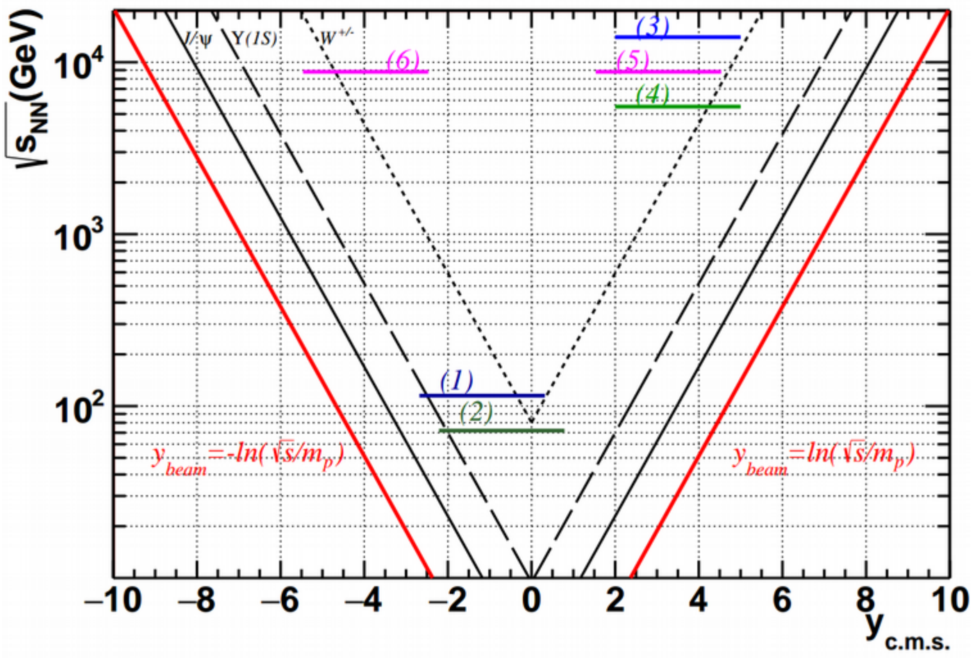


http://aliceinfo.cern.ch

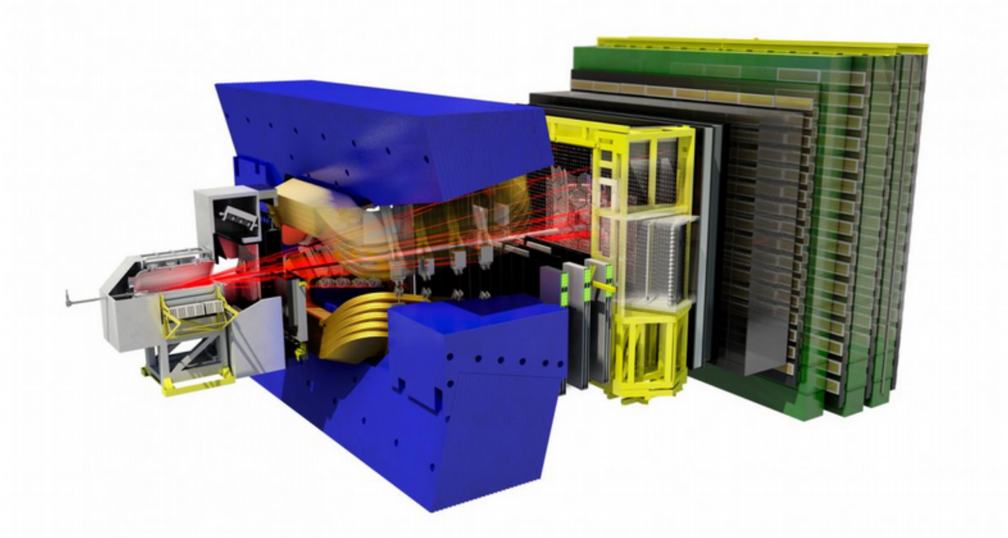
(1) fixed target, $\sqrt{s_{NN}}$ = 115 GeV; (2) fixed target, $\sqrt{s_{NN}}$ = 72 GeV;
(3) collider mode, $\sqrt{s}$ = 14 TeV;

for $Z_{target} \sim 0$

Kinematic coverage: collider vs fixed target



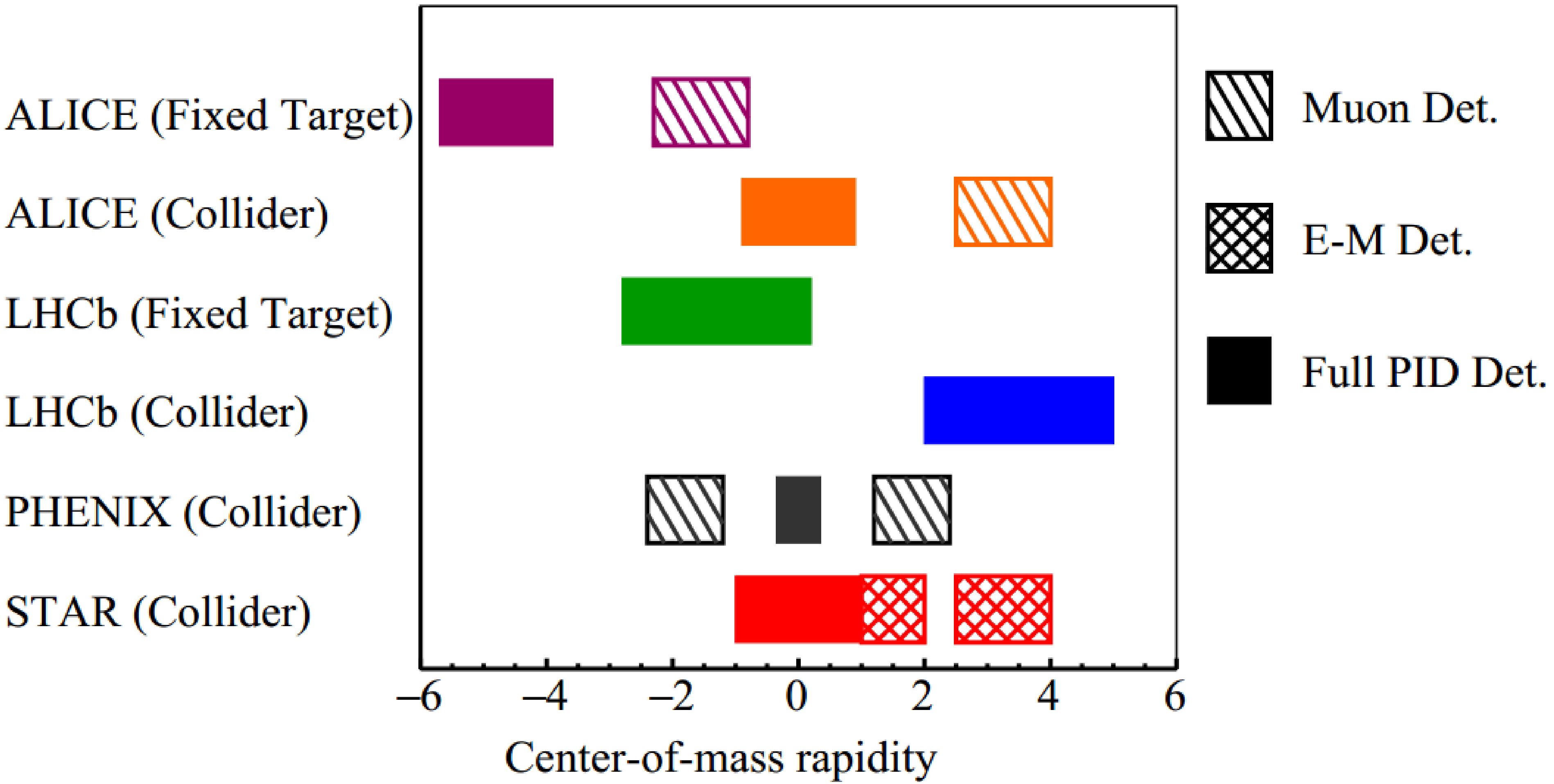
LHCb detector



https://lhcb.web.cern.ch/lhcb

LHCb: $2 < \eta^{lab} < 5$

(1) fixed target, $\sqrt{s_{NN}}$ = 115 GeV; (2) fixed target, $\sqrt{s_{NN}}$ = 72 GeV;
(3) collider mode, $\sqrt{s}$ = 14 TeV; (4) collider mode, $\sqrt{s_{NN}}$ = 5.5 TeV, (5),(6) $\sqrt{s_{NN}}$ = 8.8 TeV



ALICE (Fixed Target)
ALICE (Collider)
LHCb (Fixed Target)
LHCb (Collider)
PHENIX (Collider)
STAR (Collider)
Muon Det.
E-M Det.
Full PID Det.
−6
−4
−2
0
2
4
6
Center-of-mass rapidity

How to make fixed-target collisions with the LHC beams?

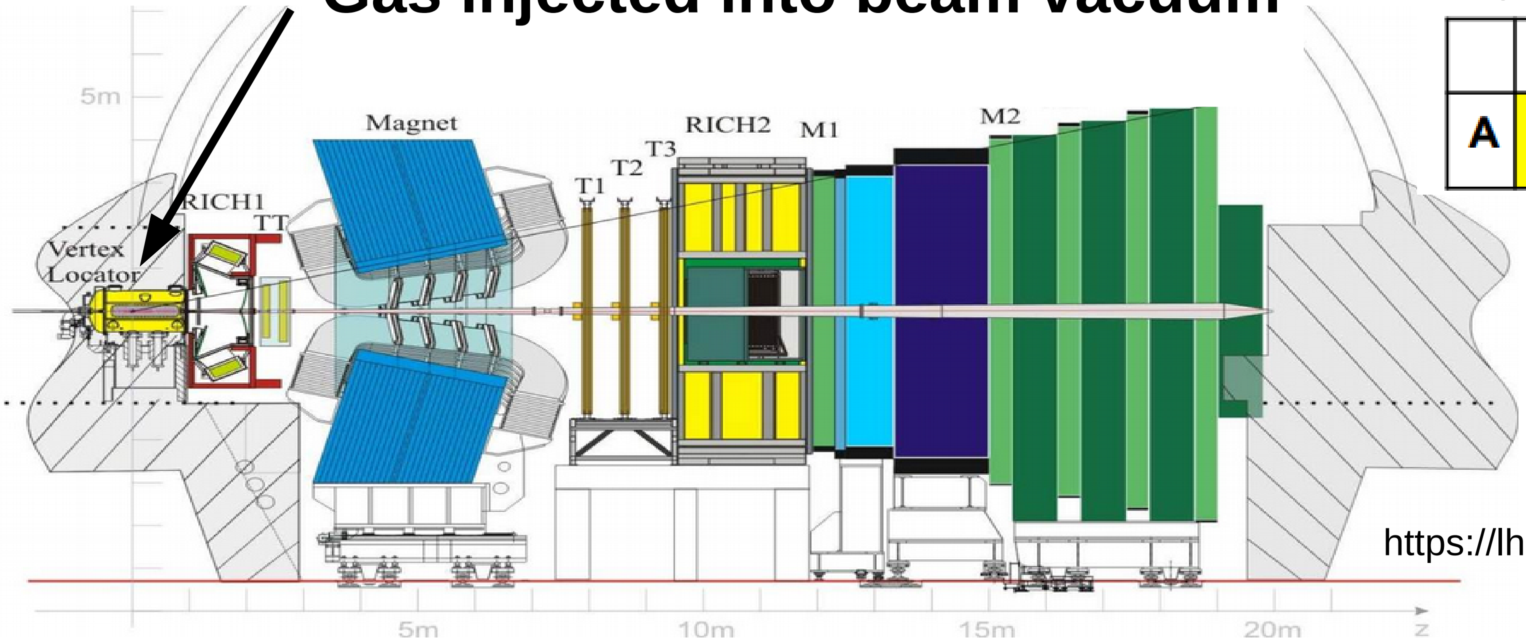
- Internal (solid or gas) target + existing detector
  - gas target (unpolarized/polarized) and full LHC beam
  - beam splitting by bent-crystal + internal (solid, pol.?) target
  - internal Wire/Foil target (directly in the beam halo)
- Beam extraction by bent-crystal
  - new beam line + new experiment

Under study within the Physics Beyond Collider working group (https://pbc.web.cern.ch)
S. Redaelli et al. Proceedings of IPAC2018
Physics Beyond Collider Working Group meeting June 2018: https://indico.cern.ch/event/706741/

SMOG-LHCb: the demonstrator of a gas target

System for Measuring Overlap with Gas

Gas injected into beam vacuum



Target gas: only noble gases

	He	Ne	Ar	Kr	Xe
A	4	20	40	84	131

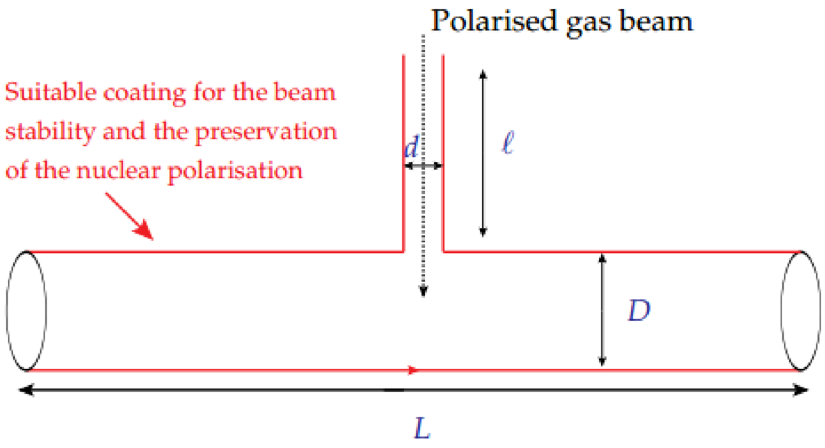
https://lhcb.web.cern.ch/lhcb

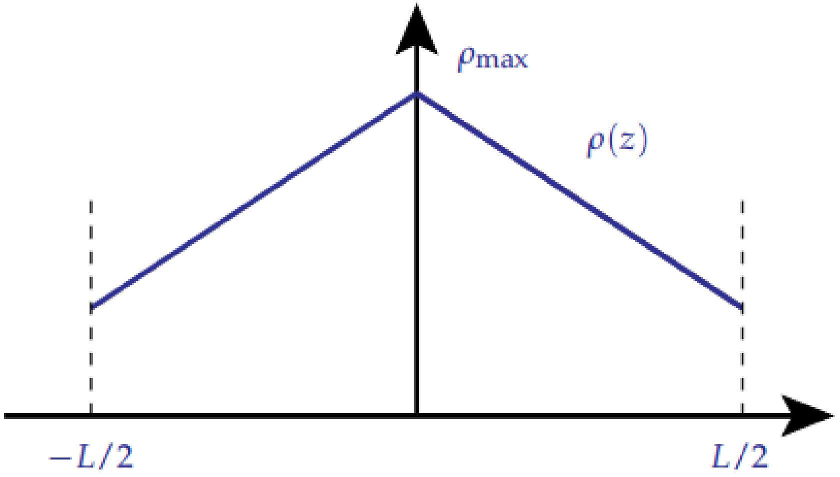
Successful p+Ne, p+Ar, p+He, Pb+Ar data taking

Limitations: Limited luminosities; no p+p baseline; no heavy nuclei yet

Gas target: storage cell

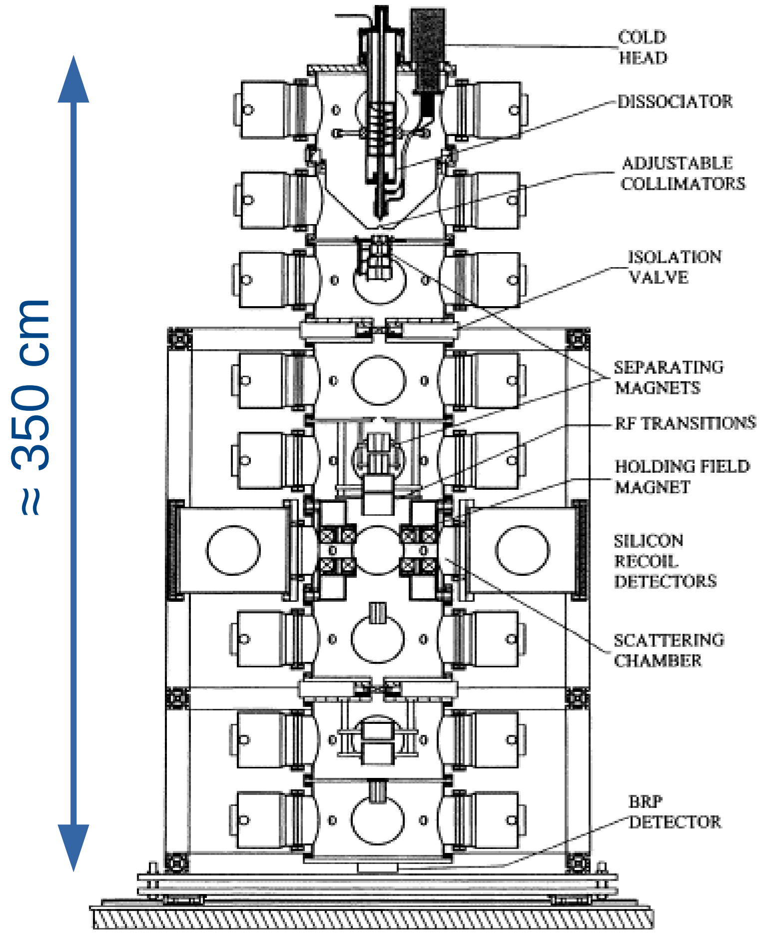
- Dedicated pumping system
- Polarized $H^{\uparrow}$ and $D^{\uparrow}$ injected in open-end storage cell with polarization P ~80% **(requires additional polarized gas target)**
- Possible polarized $^{3}He^{\uparrow}$ or unpolarized heavy gas (Kr, Xe)
- Expected L_{int} over a year (for 1 m cell):
  - p-H $\sqrt{s_{NN}}$ = 115 GeV, L_{int} ~ 10 fb^{-1}
  - Pb-H $\sqrt{s_{NN}}$ = 72 GeV, L_{int} ~ 100 nb^{-1}
  - Pb-Xe $\sqrt{s_{NN}}$ = 72 GeV, L_{int} ~ 30 nb^{-1}





The hydrogen jet polarimeter

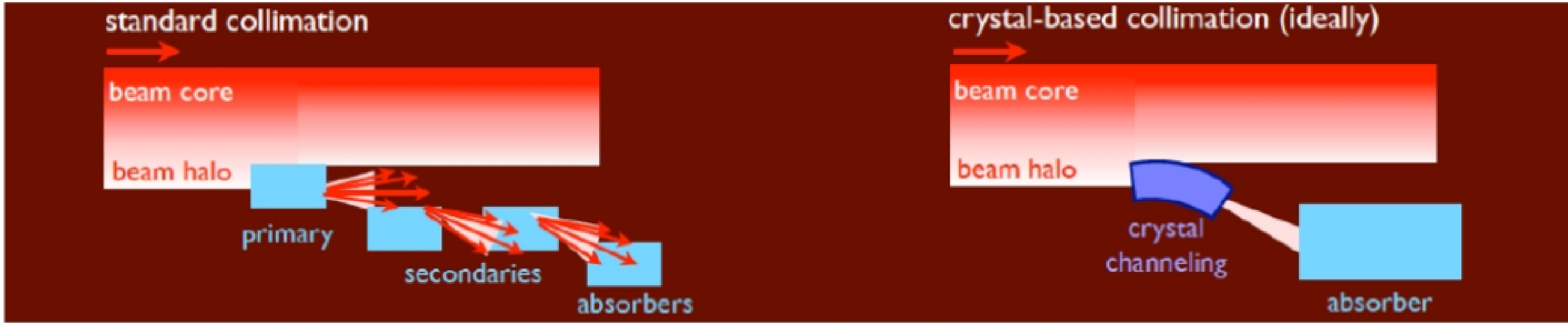
- Used to measure the proton beam polarisation at RHIC
- 9 vacuum chambers, 9 stages of differential pumping
- Polarised free atomic beam source (ABS)
- L_{int} (pH) ~ 50 pb^{-1} per year



NIM A 536 (2005) 248

Beam splitting by bent-crystal

Motivation: beam collimation



Standard collimation today

W. Scandale et al., JINST 6 T10002 (2011)

Crystal-based collimation
- UA9 (@SPS)
- LUA9 (@LHC)

To beam extraction
- CRYSBEAM (@SPS then LHC)
- AFTER@LHC

→Deflecting the beam halo at 7σ distance to the beam, reduces beam loss

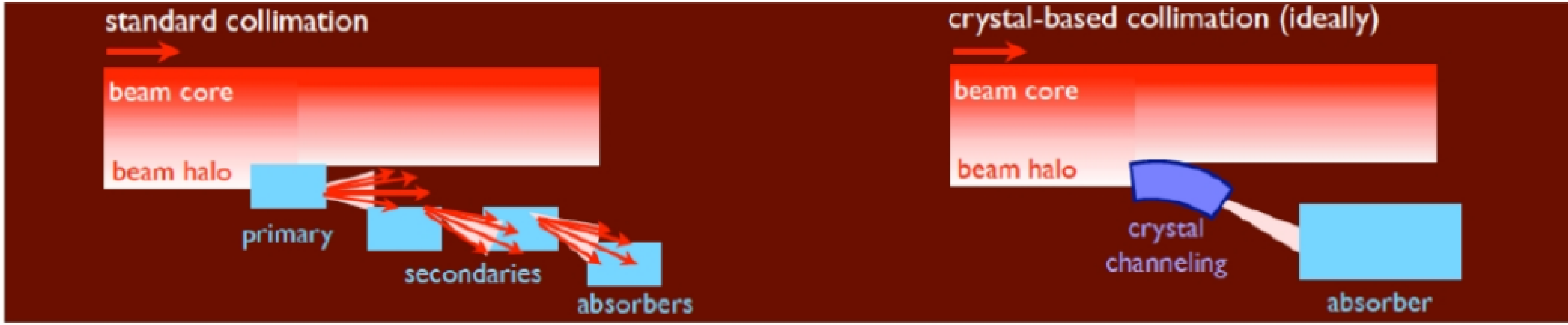
→Beam extraction: civil engineering required, new facility with 7 TeV proton beam

→Beam splitting: intermediate option, could be used with existing experiment

W. Scandale, PBC workshop 2016, https://indico.cern.ch/event/523655/contributions/2284521/

Beam splitting by bent-crystal

Motivation: beam collimation



Standard collimation today → Crystal-based collimation
- UA9 (@SPS)
- LUA9 (@LHC)

→ To beam extraction
- CRYSBEAM (@SPS then LHC)
- AFTER@LHC

W. Scandale et al., JINST 6 T10002 (2011)

Typical integrated luminosity over a year (for 5 mm-thick targets):
- p-C collisions at $\sqrt{s}_{NN}$ = 115 GeV, L_{int} ~ 6 nb^{-1}
- Pb-W collisions at $\sqrt{s}_{NN}$ = 72 GeV, L_{int} ~ 3 nb^{-1}

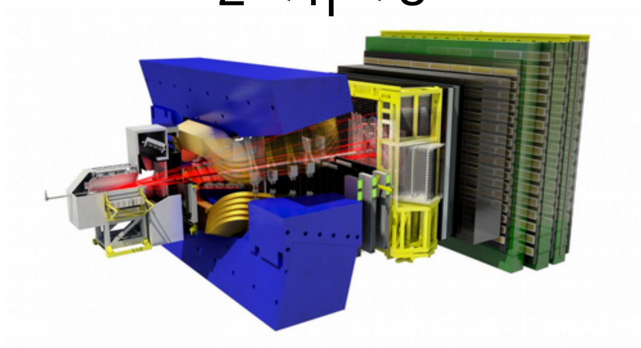
A selection of performance studies

Sensitivity studies - assumptions

LHCb-like

$\sqrt{s_{NN}}$ = 115 GeV, L_{int} (p-H) = 10 fb^{-1} / year
$\sqrt{s_{NN}}$ = 115 GeV, L_{int} (p-Xe) = 100 pb^{-1} / year
$\sqrt{s_{NN}}$ = 72 GeV, L_{int} (Pb-Xe) = 30 nb^{-1} / year
(Ref at same energy:
L_{int} (p-H) = 250 pb^{-1} L^{int} (p-Xe) = 2 pb^{-1})

$2 < \eta < 5$

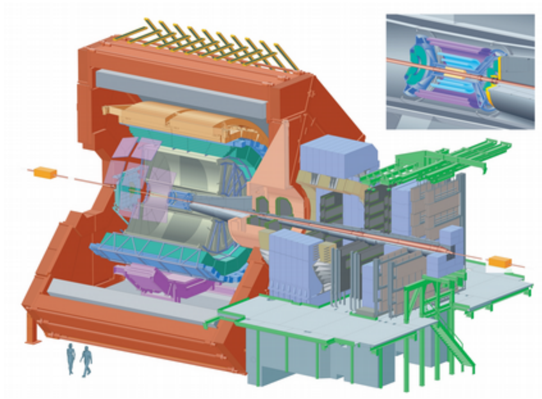


Target Z = 0, microvertexing, particle ID, μ ID

ALICE-like

$\sqrt{s_{NN}}$ = 72 GeV, L_{int} (Pb-Pb) = 1.6 nb^{-1} / year
$\sqrt{s_{NN}}$ = 115 GeV, L_{int} (p-H) = 45 pb^{-1} / year

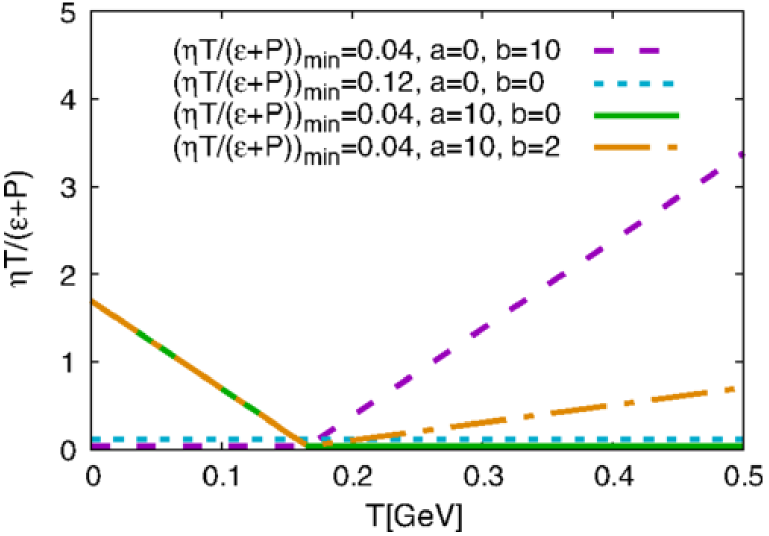
$-0.9 < \eta^{TPC} < 0.9$



Bent crystal + internal solid target:
Z ~ 0 + ALICE-like acceptance

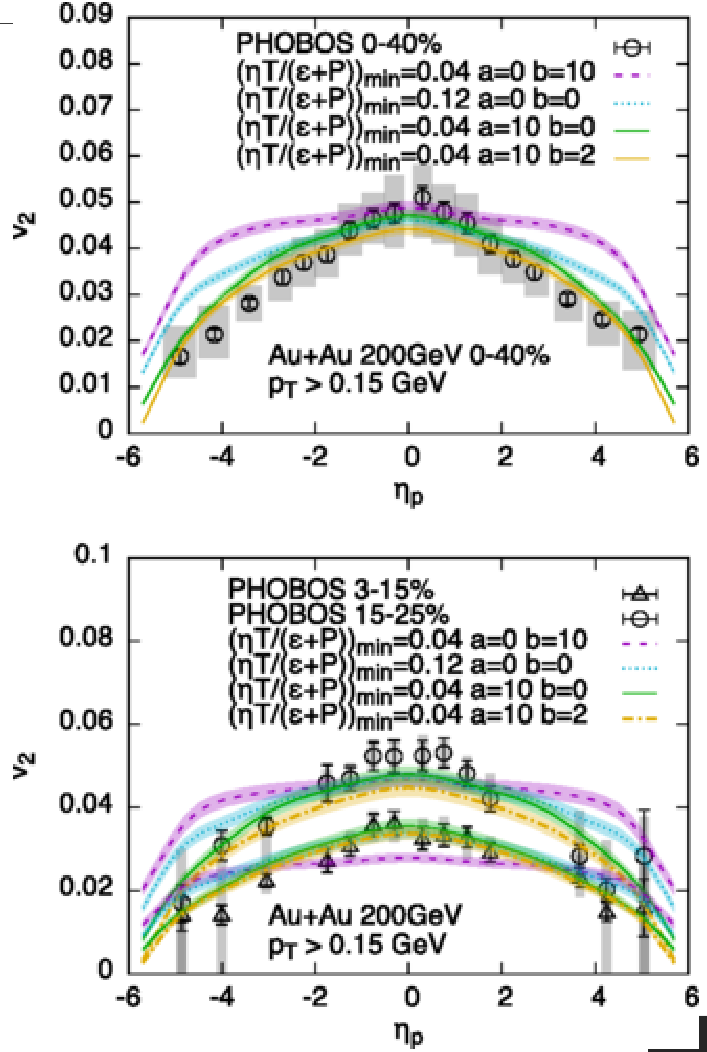
Heavy-Ion collisions

Heavy-ion collisions: toward large rapidities



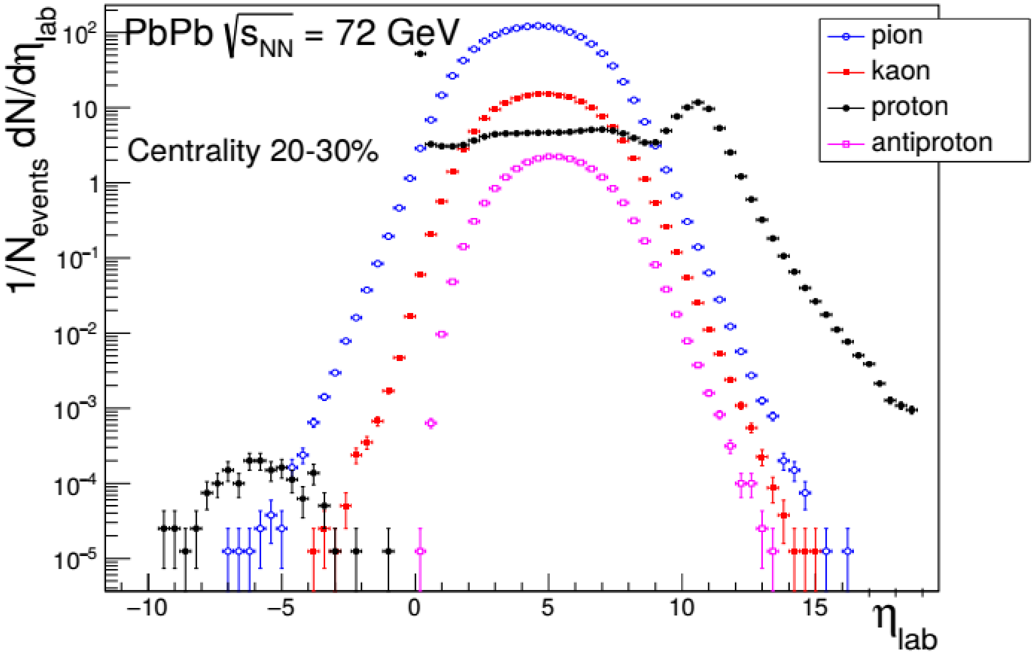
The four scenarios of temperature dependent $\eta T/(\epsilon+P)$,
G. Denicol et al, PRL. 116, 212301

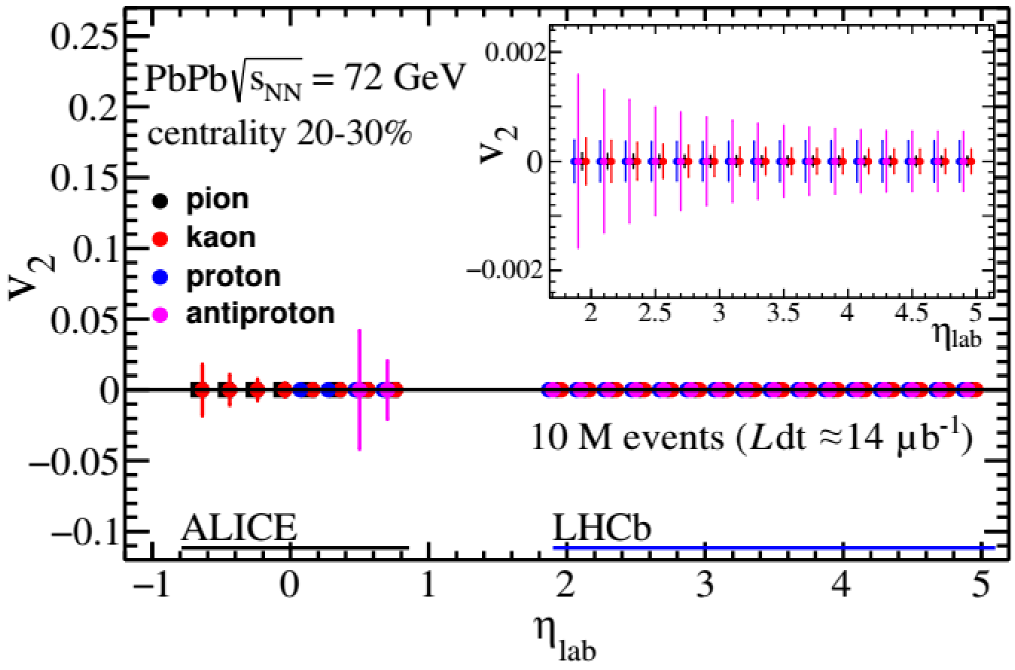
Particle yields and v_N at large rapidities → powerful tool to constrain the temperature dependence of the medium shear viscosity



G. Denicol et al, PRL. 116, 212301

Heavy-ion collisions: toward large rapidities



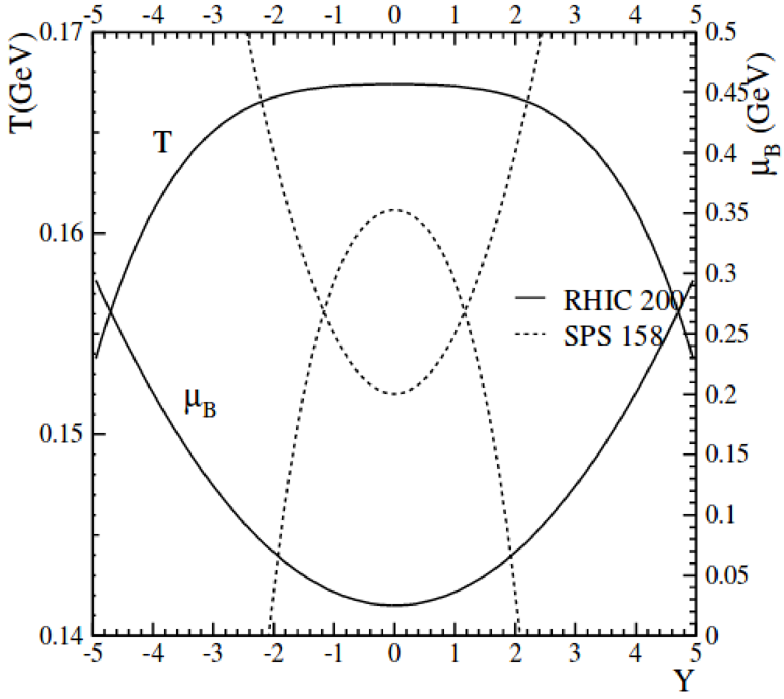


Particle yields and v_N at large rapidities → powerful tool to access the medium shear viscosity and temperature

Rapidity scan of the QCD phase diagram

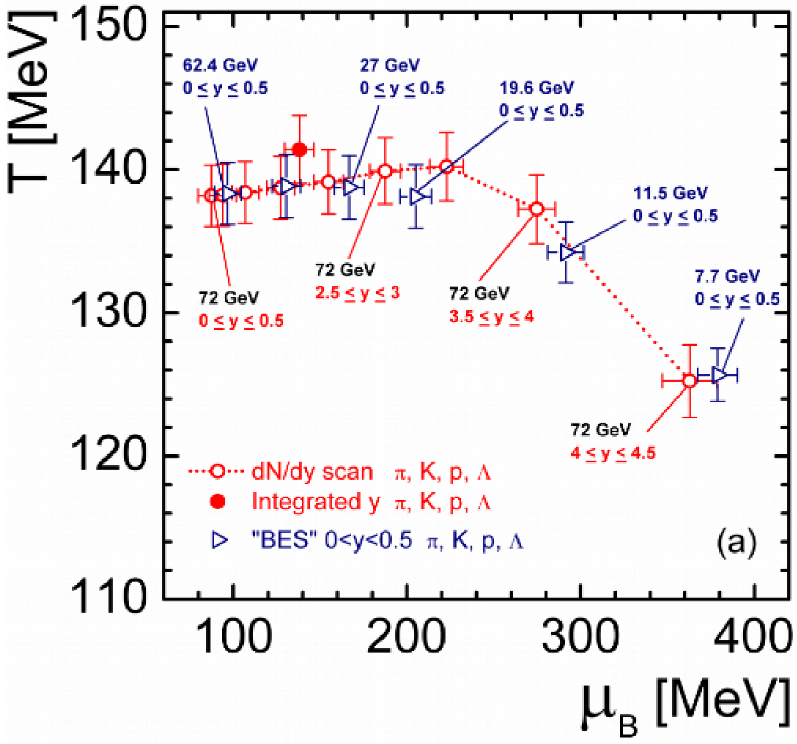
Larger rapidity → larger baryon chemical potential μ_B

AFTER@LHC: Comparable μ_B range to the RHIC Beam Energy Scan



F. Becattini, J. Cleymans, J.Phys.G34:S959-964,2007

Pb+Pb $\sqrt{s_{NN}}$ = 72 GeV, 0-10%

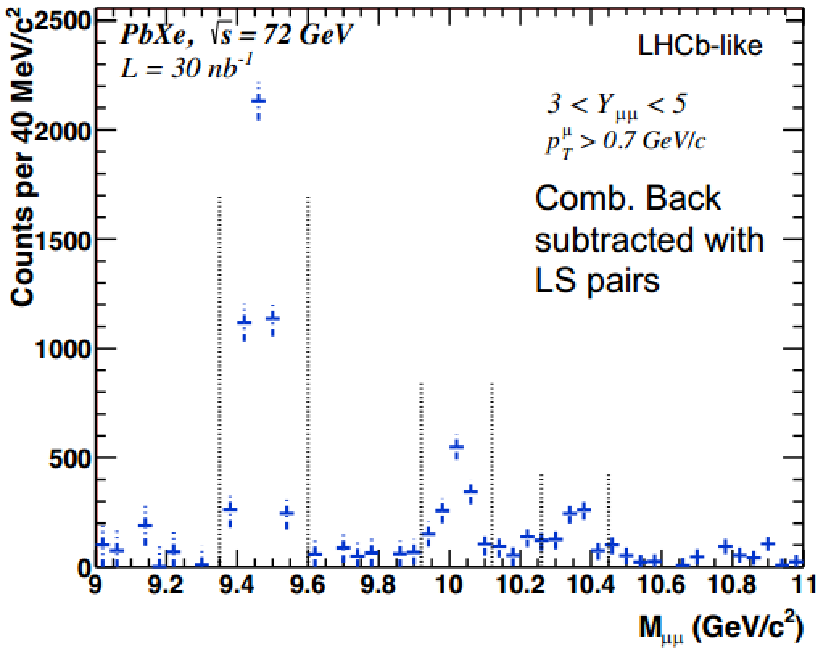


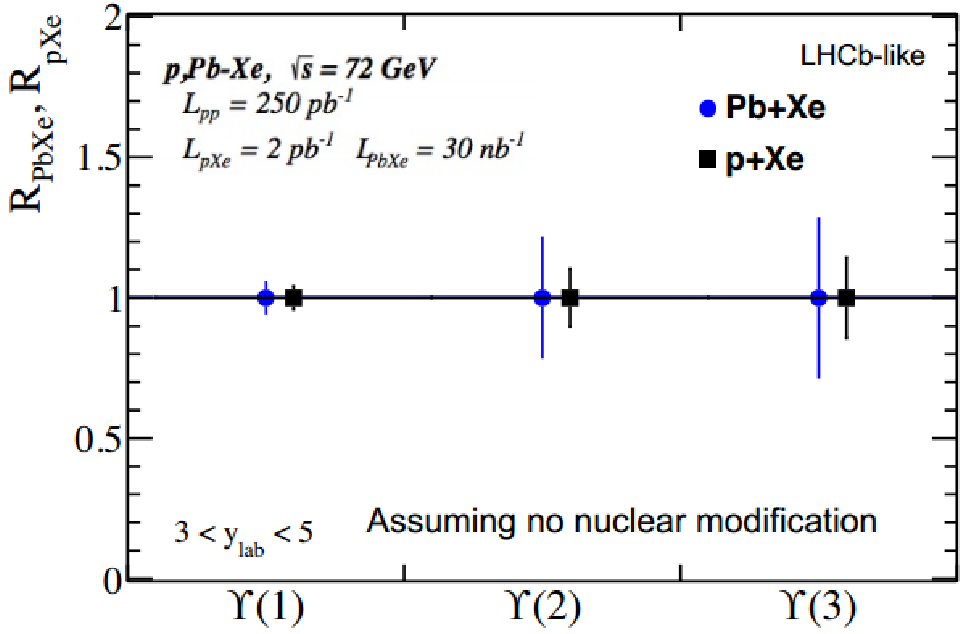
Hadron Resonance Gas model fit to UrQMD simulations, V. Begun et al, PRC98 (2018) 3, 034905

Quarkonium in “cold” and “hot” mater studies

Determination of thermodynamic properties of QGP + cold nuclear matter effects with ϒ(nS) production in pp, pA, AA

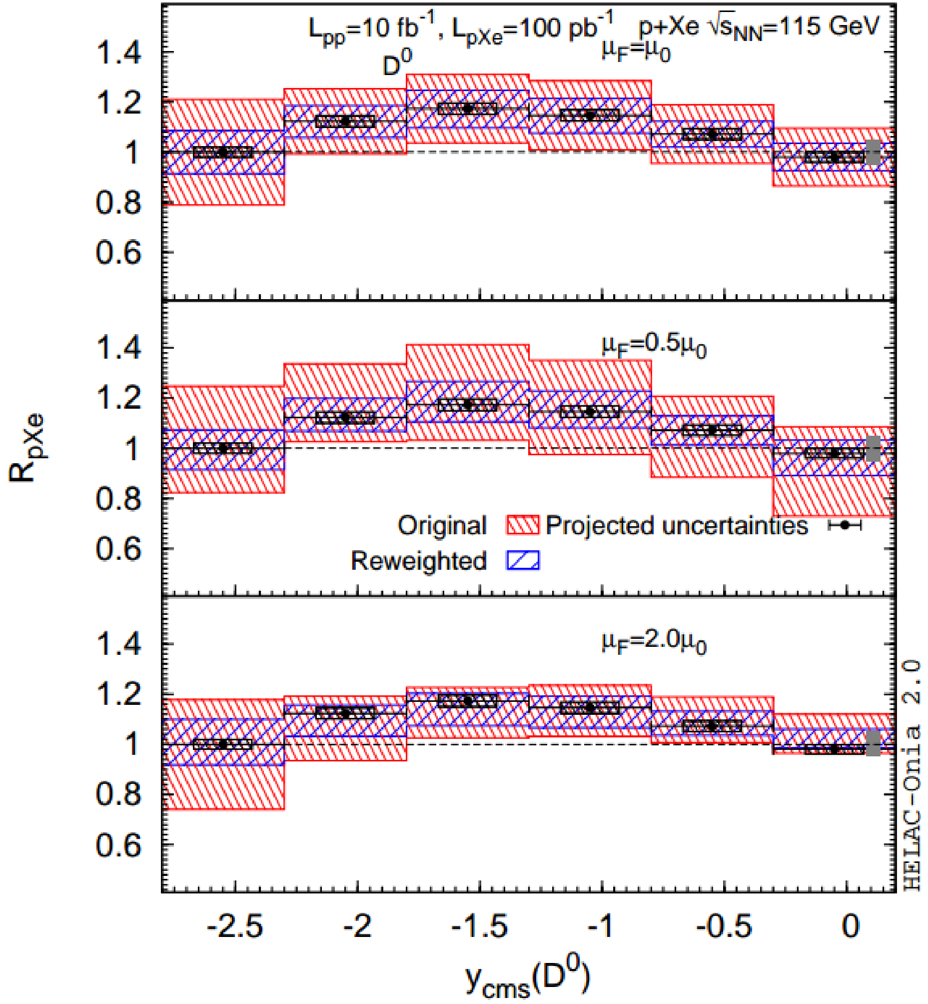
Few Body Syst. 58 (2017) no.5, 148





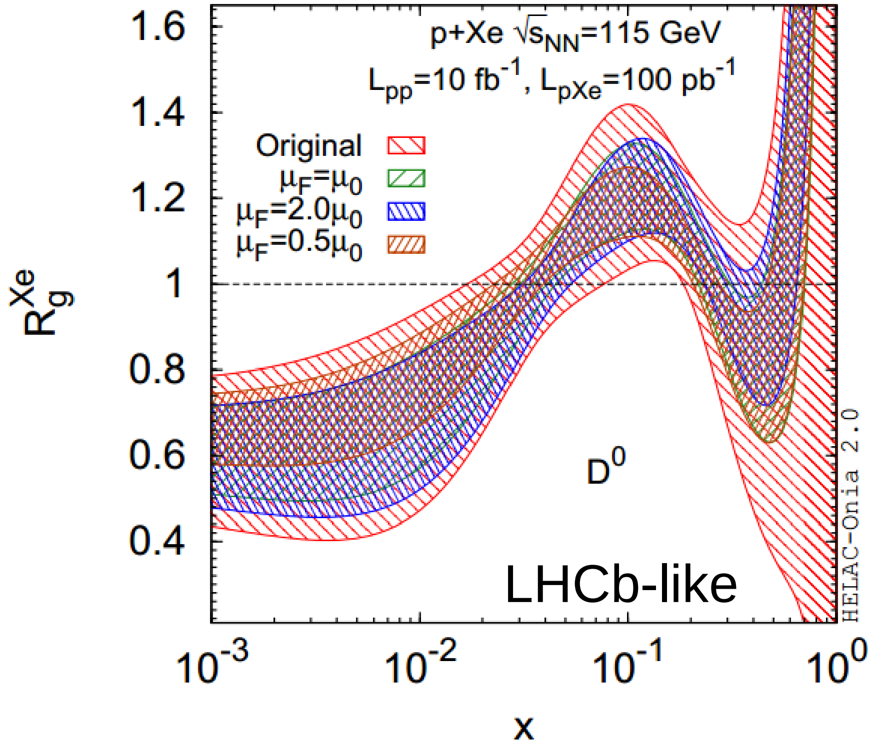
Probing the nuclear structure

Constraining gluon nPDF with heavy quarks



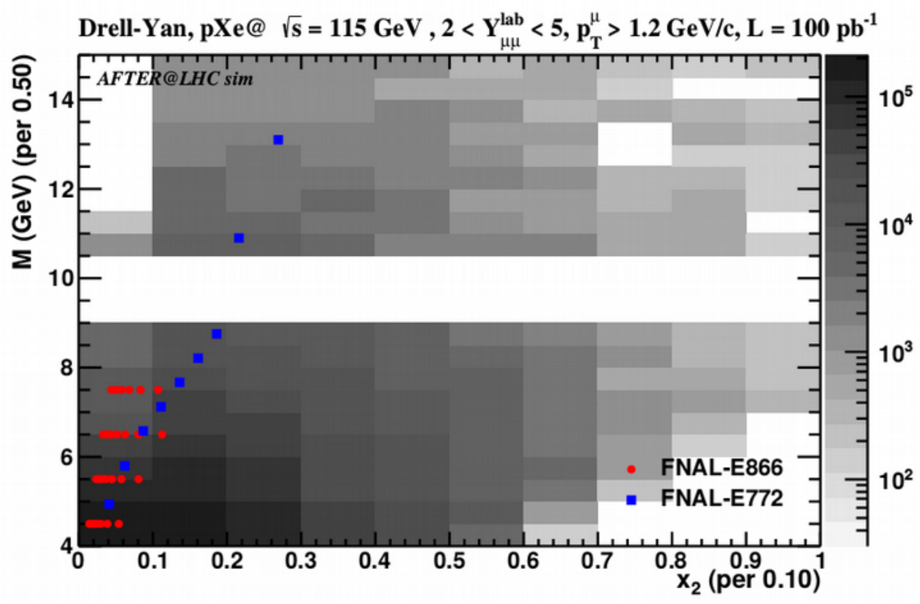
$$R_{pA} = \frac{dN_{pA}}{\langle N_{\rm coll}\rangle dN_{pp}}.$$

*) There are also other CNM effects in R_{pA}



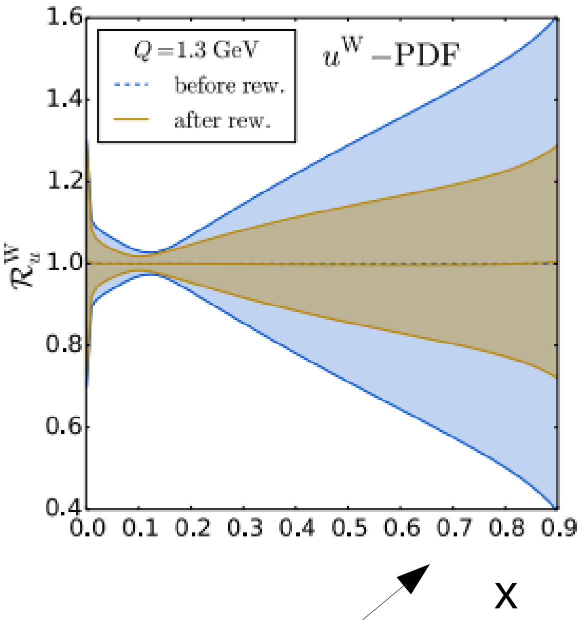
Constraining quark nPDF with Drell-Yan

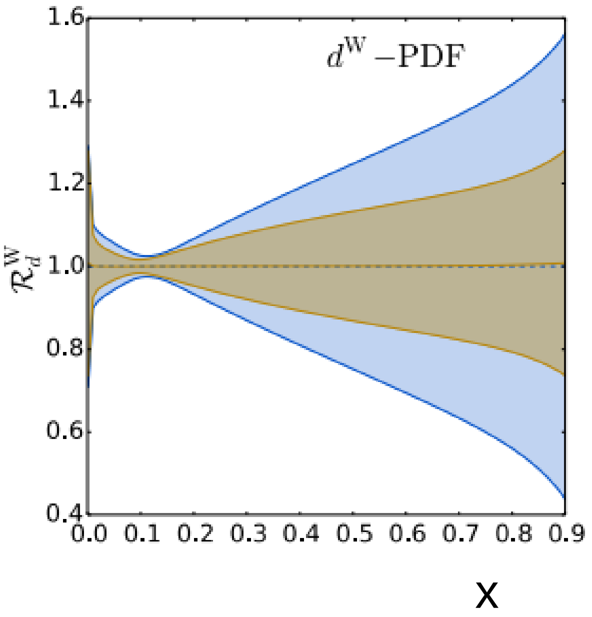
Large Drell-Yan yields, wide kinematic reach ($x_2 \rightarrow 1$), various targets



Few Body Syst. 58 (2017) no.4, 139

LHCb-like





Expected improvement with AFTER@LHC data

Also: ideal test of the extrapolation of initial state effects in pA to AA

Orbital angular momentum of quarks and gluons

$$A_N = \frac{1}{P}\frac{\sigma^{\uparrow} - \sigma^{\downarrow}}{\sigma^{\uparrow} + \sigma^{\downarrow}}$$

Possible sources of the asymmetry: **Sivers mechanism** → correlation between spin and parton k_T

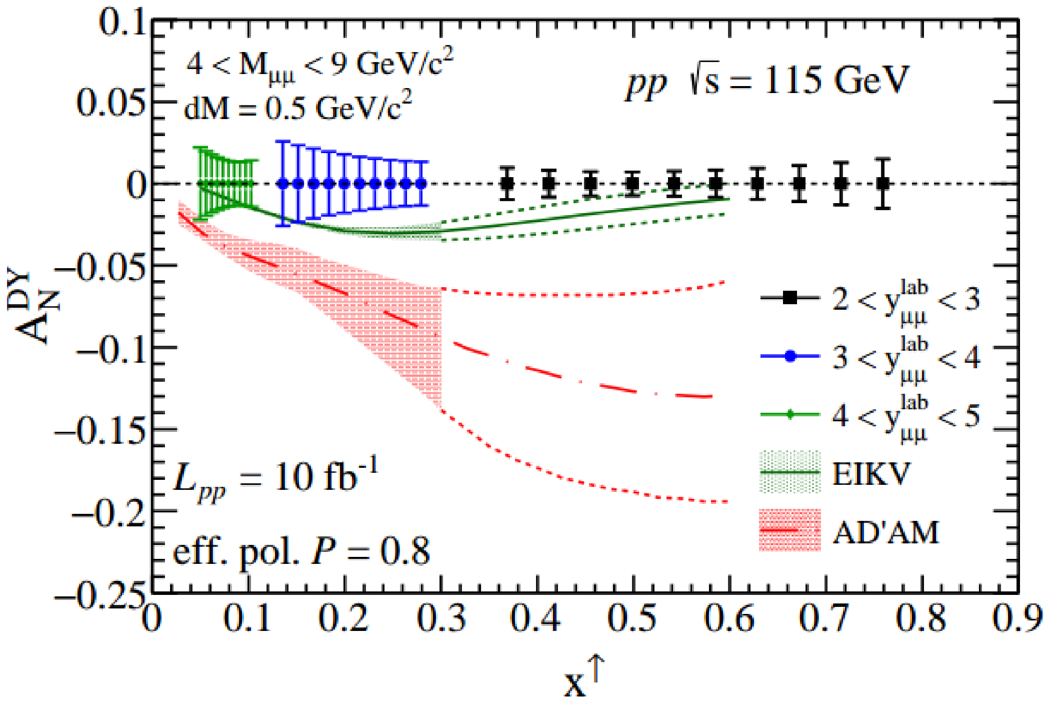
- **$A_N \neq 0$** → non-zero quark/gluon Sivers function → **non-zero quark/gluon OAM**
- Drell-Yan → access to $f_{1T}^{\perp q}(x, \vec{k}_{\perp}^{2})$

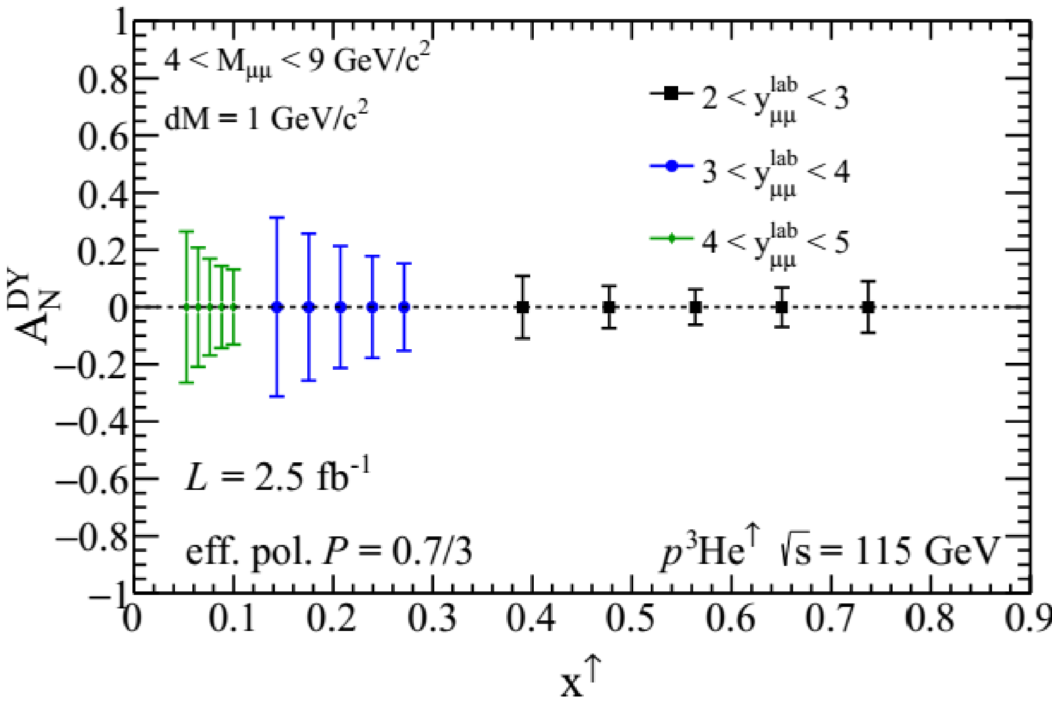
$$f_{1T}^{\perp q}(x, \vec{k}_{\perp}^{2})_{Drell-Yan} = -f_{1T}^{\perp q}(x, \vec{k}_{\perp}^{2})_{Semi-Inclusive\,DIS}$$

- Gluon Sivers effect → access via single spin asymmetry of open charm & quarkonia, J/ψ-J/ψ, $J/\psi+\gamma$

Drell-Yan A_N in AFTER

- Precision study of the quark Sivers function with Drell-Yan over a wide kinematic range





AD'AM → M. Anselmino, U. D'Alesio, and S. Melis, Adv. High Energy Phys. 2015 (2015) 475040
EIKV → M. G. Echevarria, A. Idilbi, Z.-B. Kang, and I. Vitev, Phys. Rev. D89 (2014)

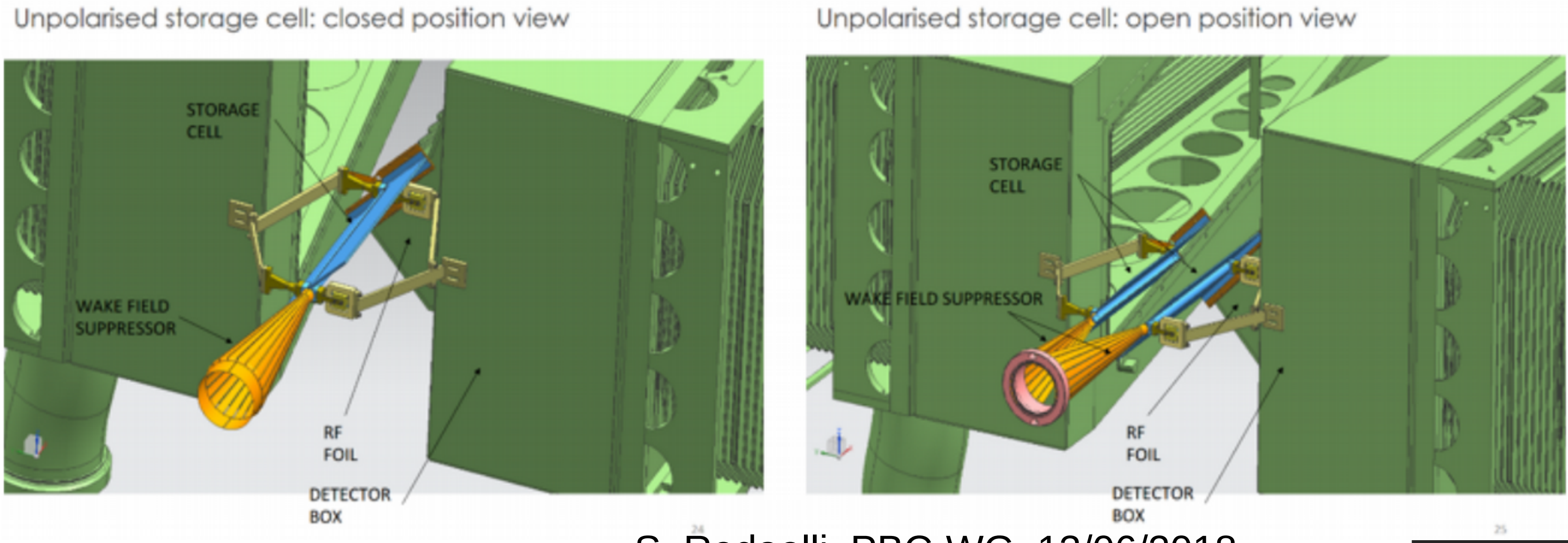
Implementation options under investigation

- **LHCb**
  - Beam splitting and internal W solid target (with a second crystal) for Electromagnetic Dipole Moment of charmed baryons
  - Polarized storage cell gas target for spin physics
  - Unpolarized storage cell gas target (SMOG2)

- **ALICE**
  - Beam splitting and internal solid targetsolid target

SMOG2 internal storage cell target

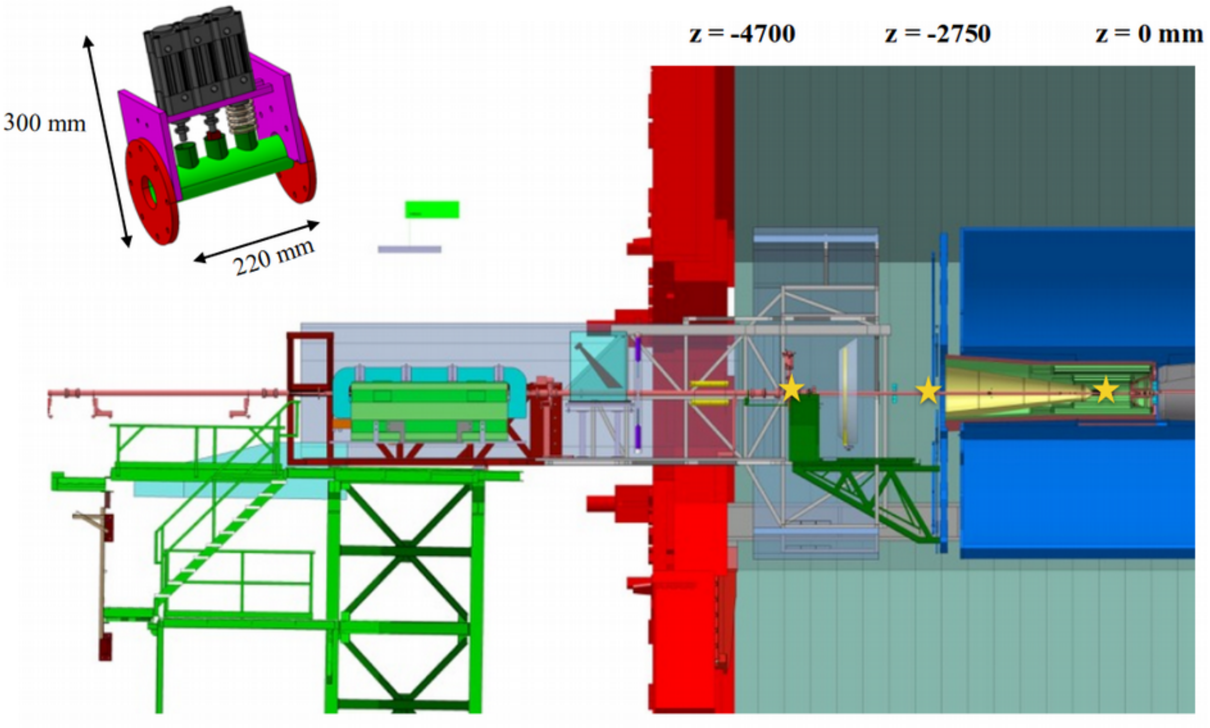
Openable storage cell of 20 cm long attached to the VELO
Unpolarized gas via capillary: gas feed tube in the cell center
Gas pressure up to 100 × SMOG: P ~ 10^{-5} mbar,
Formal approval expected this fall, installation in LS2
Luminosties: $\mathcal{L}_{p\text{-}H}$@115GeV = 10/pb, $\mathcal{L}_{p\text{-}D}$@115GeV = 10/pb, $\mathcal{L}_{Pb}$-Ar@72GeV = 5/nb



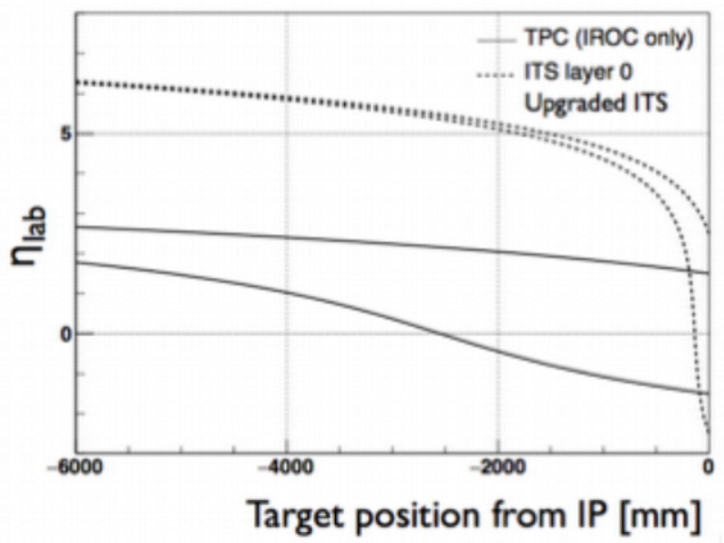
S. Redaelli, PBC-WG, 13/06/2018

Fixed-target setup investigated in ALICE

Beam splitting and internal solid target
- Inside the L3 solenoid
- Pneumatic motion system with two positions (IN and OUT of the beam pipe)



C. Hadjidakis, Annual Workshop PBC, June 2018



geometrical consideration using reduced track length in TPC

Status and summary

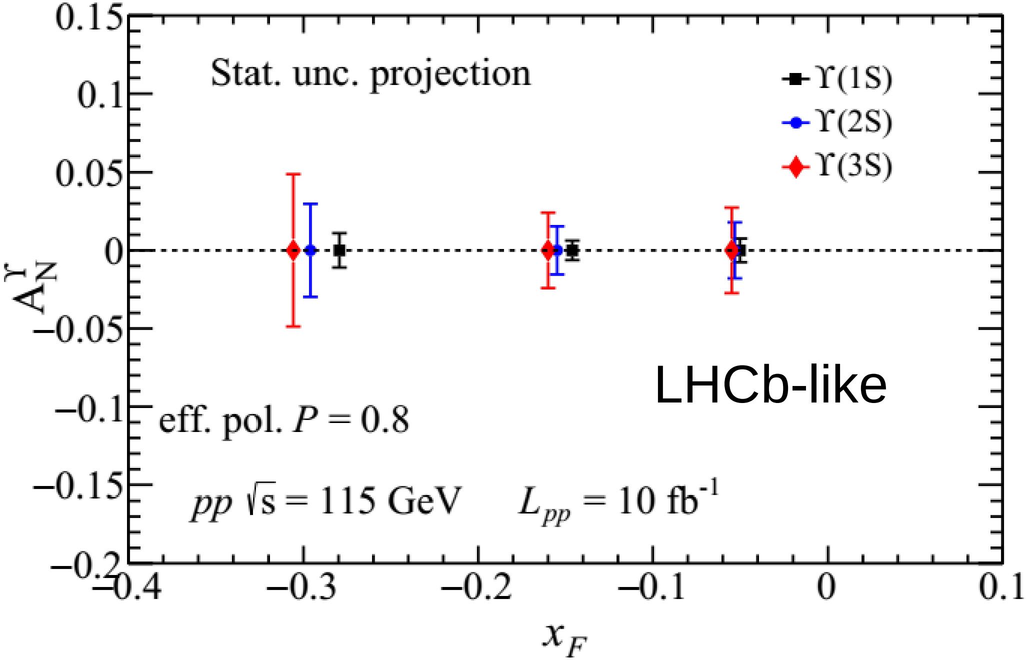
- Reach and unique physics program: **large-x frontier, heavy-ion collisions, spin physics program at the LHC**
- A fixed-target program at the LHC can be implemented without interfering with the other experiments
- Topic of the Physics Beyond Collider study http://pbc.web.cern.ch/ → **LHC fixed target** working group
- Ongoing feasibility studies for FT collisions with ALICE and LHCb detectors
- AFTER@LHC Study Group: http://after.in2p3.fr

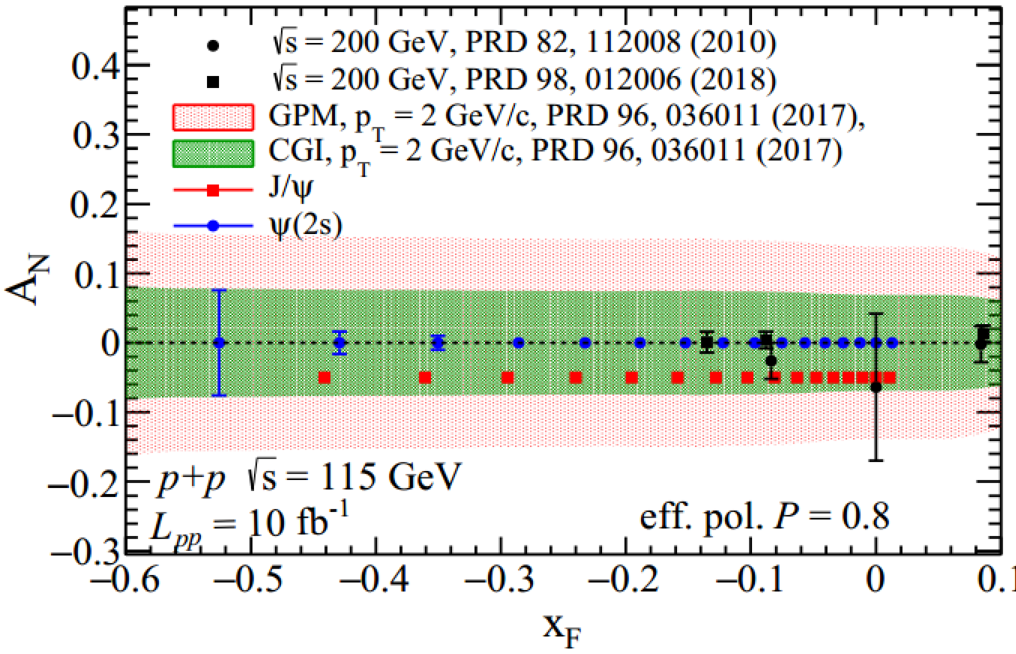
Backup

J/ψ and ϒ in p+p

$$A_N = \frac{1}{\mathcal{P}_{\rm eff}} \frac{\sigma^\uparrow - \sigma^\downarrow}{\sigma^\uparrow + \sigma^\downarrow}$$

- Typically 10^9 charmonia, 10^6 bottomonia per year
- Unique access to C-even quarkonia ($\chi_{c,b}$, η_c) + associated production
- A_N for all quarkonia (J/ψ, ψ', χ_c, ϒ(nS), χ_b & η_c) can be measured

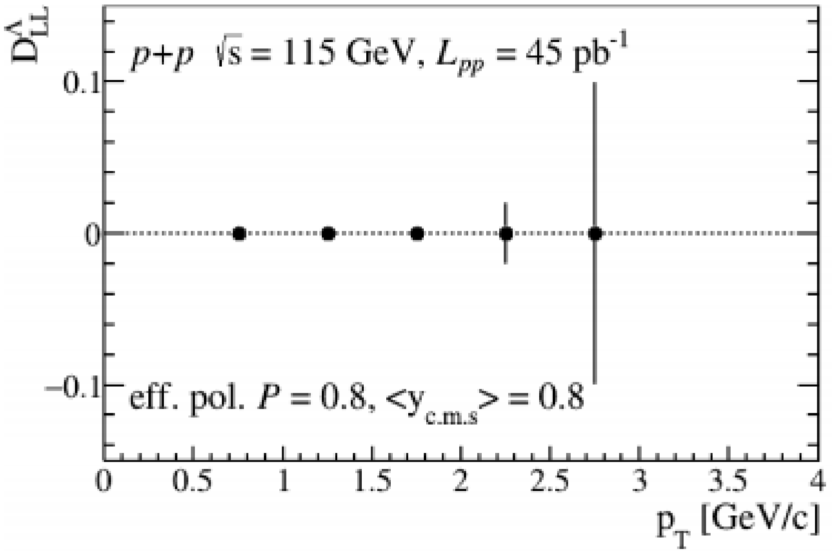




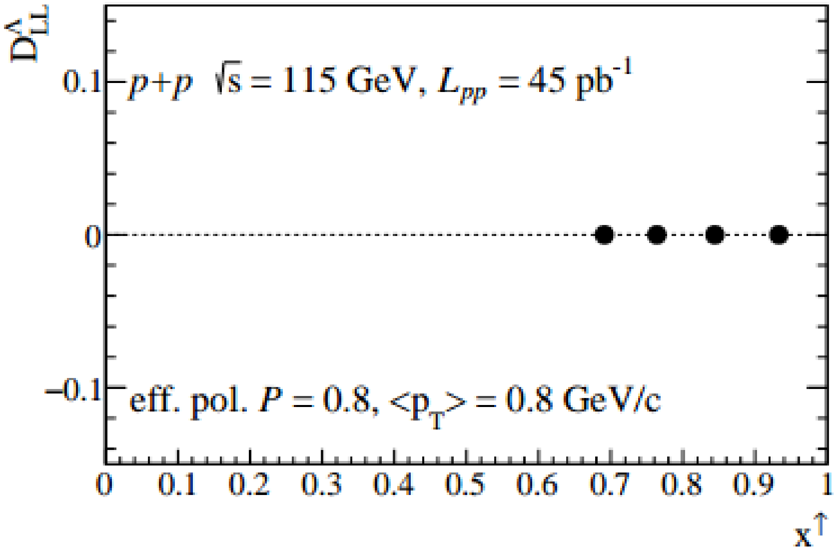
Longitudinal spin transfer D_{LL} to Λ baryons

- Unique rapidity coverage with the ALICE central barrel
- Access to the strange quark polarized PDF at x→1

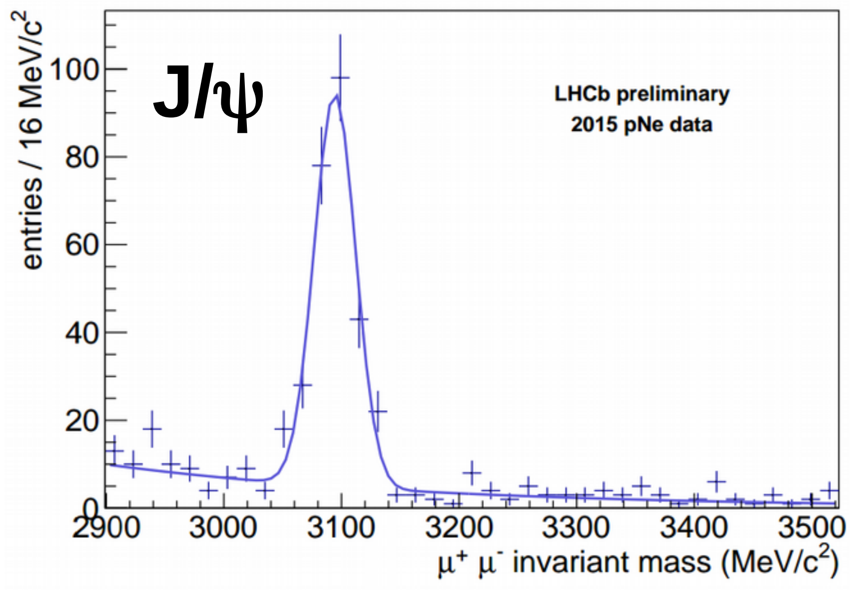
$$D_{LL} \equiv \frac{\sigma_{pp^+\to\Lambda^+} - \sigma_{pp^+\to\Lambda^-}}{\sigma_{pp^+\to\Lambda^+} + \sigma_{pp^+\to\Lambda^-}}$$

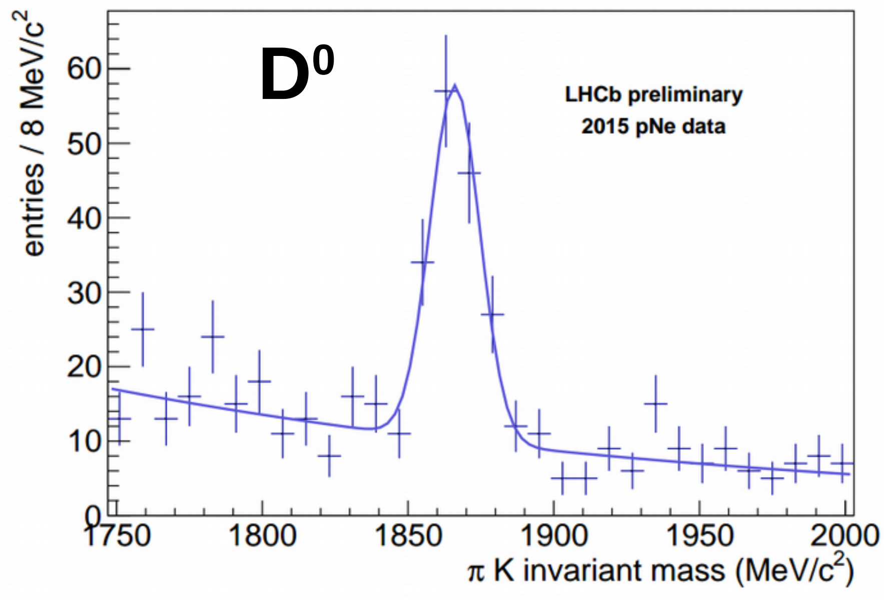


ALICE-like, Z_{target} ~ 0



SMOG-LHCb: the perfect demonstrator





Successful p+Ne, p+Ar, p+He, Pb+Ar data taking, good resolution, low BG

Limitations: Limited luminosities; no p+p baseline; no heavy nuclei yet

https://twiki.cern.ch/twiki/bin/view/LHCb/LHCbPlots2015

Available Luminosities

ALICE

Target			ALICE: proton beam ($\sqrt{s_{NN}}$ = 115 GeV)				Pb beam ($\sqrt{s_{NN}}$ = 72 GeV)			
			$\mathcal{L}$ [cm^{-2} s^{-1}]	σ_{inel}	Inel rate [kHz]	$\int \mathcal{L}$	$\mathcal{L}$ [cm^{-2} s^{-1}]		[kHz]	
Internal gas target	Gas-Jet	$H^{\uparrow}$	4.3×10^{30}	39 mb	168	43 pb^{-1}	5.6×10^{26}	1.8 b	1	0.56 nb^{-1}
		H_2	2.6×10^{31}	39 mb	1000	0.26 fb^{-1}	2.8×10^{28}	1.8 b	50	28 nb^{-1}
		$D^{\uparrow}$	4.3×10^{30}	72 mb	309	43 pb^{-1}	5.6×10^{26}	2.2 b	1.2	0.56 nb^{-1}
		$^3He^{\uparrow}$	8.5×10^{30}	117 mb	1000	85 pb^{-1}	2.0×10^{28}	2.5 b	50	20 nb^{-1}
		Xe	7.7×10^{29}	1.3 b	1000	7.7 pb^{-1}	8.1×10^{27}	6.2 b	50	8.1 nb^{-1}
	Storage Cell	$H^{\uparrow}$	2.6×10^{31}	39 mb	1000	0.26 fb^{-1}	2.8×10^{28}	1.8 b	50	28 nb^{-1}
		H_2	2.6×10^{31}	39 mb	1000	0.26 fb^{-1}	2.8×10^{28}	1.8 b	50	28 nb^{-1}
		$D^{\uparrow}$	1.4×10^{31}	72 mb	1000	140 pb^{-1}	2.2×10^{28}	2.2 b	50	22 nb^{-1}
		$^3He^{\uparrow}$	8.5×10^{30}	117 mb	1000	85 pb^{-1}	2.0×10^{28}	2.5 b	50	20 nb^{-1}
		Xe	7.7×10^{29}	1.3 b	1000	7.7 pb^{-1}	8.1×10^{27}	6.2 b	50	8.1 nb^{-1}
Internal solid target with beam halo	Wire Target	C (500 μm)	2.8×10^{30}	271 mb	760	28 pb^{-1}	5.6×10^{26}	3.3 b	1.8	0.56 nb^{-1}
		Ti (500 μm)	1.4×10^{30}	694 mb	971	14 pb^{-1}	2.8×10^{26}	4.7 b	1.3	0.28 nb^{-1}
		W (184 μm)	5.9×10^{29}	1.7b	1000	5.9 pb^{-1}	–	–	–	–
		W (500 μm)	–	–	–	–	3.1×10^{26}	6.9 b	2.1	0.31 nb^{-1}
Beam splitting	E1039	$NH_3^{\uparrow}$	2.6×10^{31}	39 mb	1000	0.26 fb^{-1}	1.4×10^{28}	1.8 b	25	14 nb^{-1}
		$ND_3^{\uparrow}$	1.4×10^{31}	72 mb	1000	140 pb^{-1}	1.4×10^{28}	2.2 b	30	14 nb^{-1}
	Unpolarised solid target	C (658 μm)	3.7×10^{30}	271 mb	1000	37 pb^{-1}	–	–	–	–
		C (5 mm)	–	–	–	–	5.6×10^{27}	3.3 b	18	5.6 nb^{-1}
		Ti (515 μm)	1.4×10^{30}	694 mb	1000	14 pb^{-1}	–	–	–	–
		Ti (5 mm)	–	–	–	–	2.8×10^{27}	4.7 b	13	2.8 nb^{-1}
		W(184 μm)	5.9×10^{29}	1.7b	1000	5.9 pb^{-1}	–	–	-	–
		W(5 mm)	–	–	–	–	3.1×10^{27}	6.9 b	21	3.1 nb^{-1}

FT Luminosities comparable with nominal LHC luminosities

Available Luminosities

LHCb

Target			LHCb							
			proton beam ($\sqrt{s_{NN}}$ = 115 GeV)				Pb beam ($\sqrt{s_{NN}}$ = 72 GeV)			
			$\mathcal{L}$ [$cm^{-2}\ s^{-1}$]	σ_{inel}	Inel rate kHz	$\int \mathcal{L}$	$\mathcal{L}$ [$cm^{-2}\ s^{-1}$]	σ_{inel}	Inel rate kHz	$\int \mathcal{L}$
Internal gas target	Gas-Jet	$H^{\uparrow}$	4.3×10^{30}	39 mb	168	43 pb^{-1}	5.6×10^{26}	1.8 b	1	0.56 nb^{-1}
		H_2	1.0×10^{33}	39 mb	40000	10 fb^{-1}	1.18×10^{29}	1.8 b	212	118 nb^{-1}
		$D^{\uparrow}$	4.3×10^{30}	72 mb	309	43 pb^{-1}	5.6×10^{26}	2.2 b	1.2	0.56 nb^{-1}
		$^3He^{\uparrow}$	3.4×10^{32}	117 mb	40000	3.4 fb^{-1}	4.7×10^{28}	2.5 b	118	47 nb^{-1}
		Xe	3.1×10^{31}	1.3 b	40000	0.31 fb^{-1}	2.3×10^{28}	6.2 b	186	23 nb^{-1}
	Storage Cell	$H^{\uparrow}$	0.92×10^{33}	39 mb	35880	9.2 fb^{-1}	1.18×10^{29}	1.8 b	212	118 nb^{-1}
		H_2	1.0×10^{33}	39 mb	40000	10 fb^{-1}	1.18×10^{29}	1.8 b	212	118 nb^{-1}
		$D^{\uparrow}$	5.6×10^{32}	72 mb	40000	5.6 fb^{-1}	8.82×10^{28}	2.2 b	194	88 nb^{-1}
		$^3He^{\uparrow}$	1.3×10^{33}	117 mb	40000	13 fb^{-1}	8.25×10^{28}	2.5 b	206	83 nb^{-1}
		Xe	3.1×10^{31}	1.3 b	40000	0.31 fb^{-1}	3.0×10^{28}	6.2 b	186	30 nb^{-1}
Internal solid target on beam halo	Wire Target	C (500 μm)	2.8×10^{30}	271 mb	760	28 pb^{-1}	5.6×10^{26}	3.3 b	1.8	0.56 nb^{-1}
		Ti (500 μm)	1.4×10^{30}	694 mb	972	14 pb^{-1}	2.8×10^{26}	4.7 b	1.3	0.28 nb^{-1}
		W (500 μm)	1.6×10^{30}	1.7 b	2720	16 pb^{-1}	3.1×10^{26}	6.9 b	2.1	0.31 nb^{-1}
Beam splitting	E1039	$NH_3^{\uparrow}$	7.2×10^{31}	39 mb	2808	0.72 fb^{-1}	1.4×10^{28}	1.8 b	25	14 nb^{-1}
		$ND_3^{\uparrow}$	7.2×10^{31}	72 mb	5100	0.72 fb^{-1}	1.4×10^{28}	2.2 b	30	14 nb^{-1}
	Unpol-arised solid target	C (5 mm)	2.8×10^{31}	271 mb	7600	280 pb^{-1}	5.6×10^{27}	3.3 b	18	5.6 nb^{-1}
		Ti (5 mm)	1.4×10^{31}	694 mb	9720	140 pb^{-1}	2.8×10^{27}	4.7 b	13	2.8 nb^{-1}
		W (5 mm)	1.6×10^{31}	1.7 b	27200	160 pb^{-1}	3.1×10^{27}	6.9 b	21	3.1 nb^{-1}

Physics opportunities in AFTER @ LHC

Physics opportunities of a fixed-target experiment using LHC beams

Physics Reports 522 (2013) 239

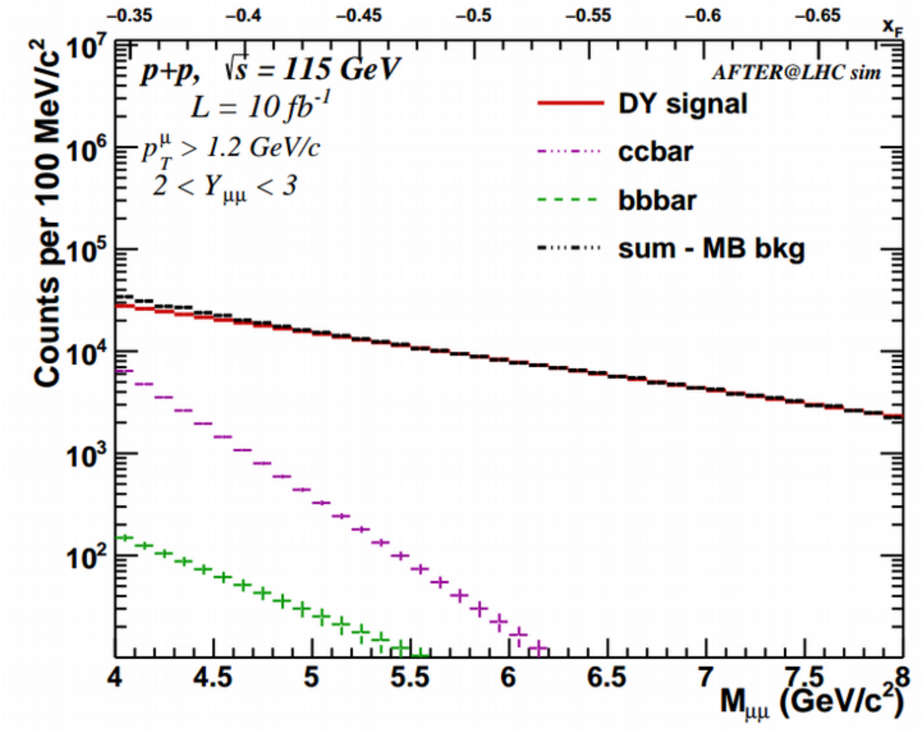
Ideas for a fixed target experiment at LHC in a Special Issue in Advances in High Energy Physics:

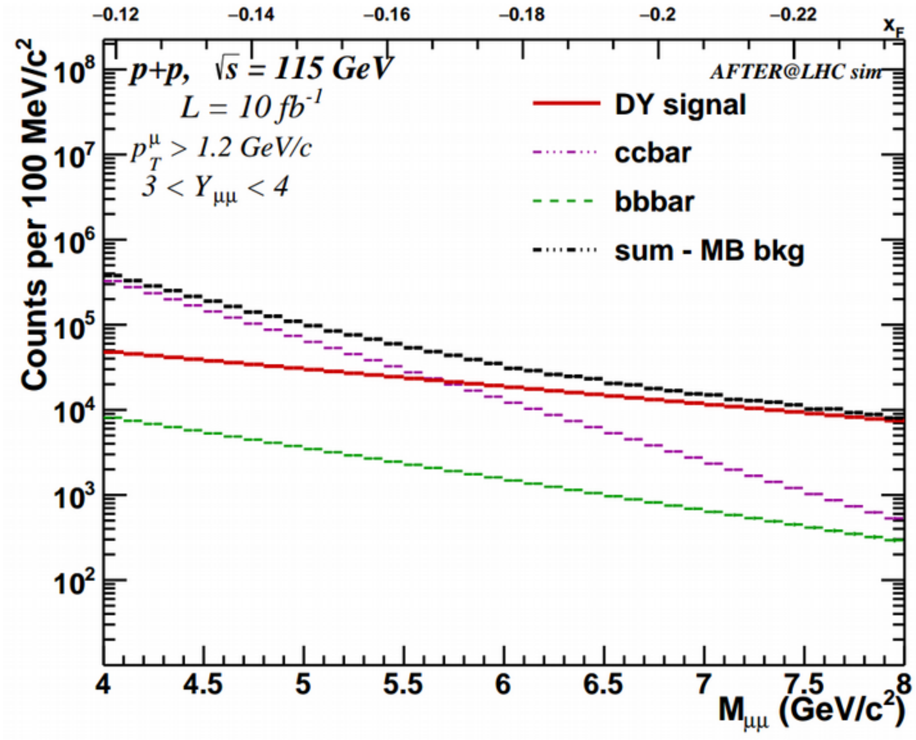
Advances in High Energy Physics, Volume 2015 (2015)

- **Heavy-ion physics**
- **Exclusive reactions**
- **Spin physics studies**
- **Hadron structure**
- **Feasibility study and technical ideas**

Drell-Yan production

LHCb-like



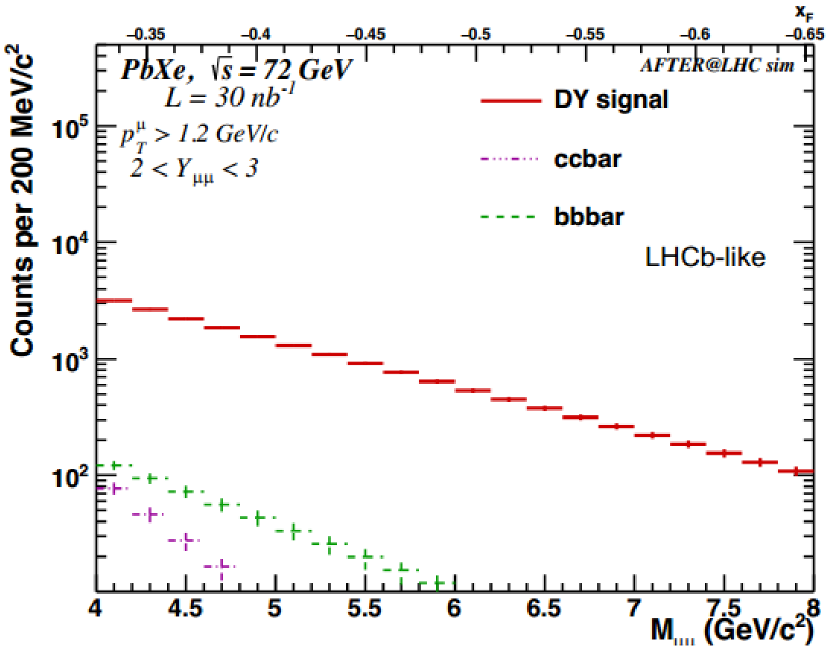


Test o factorization of initial state effects in A+A

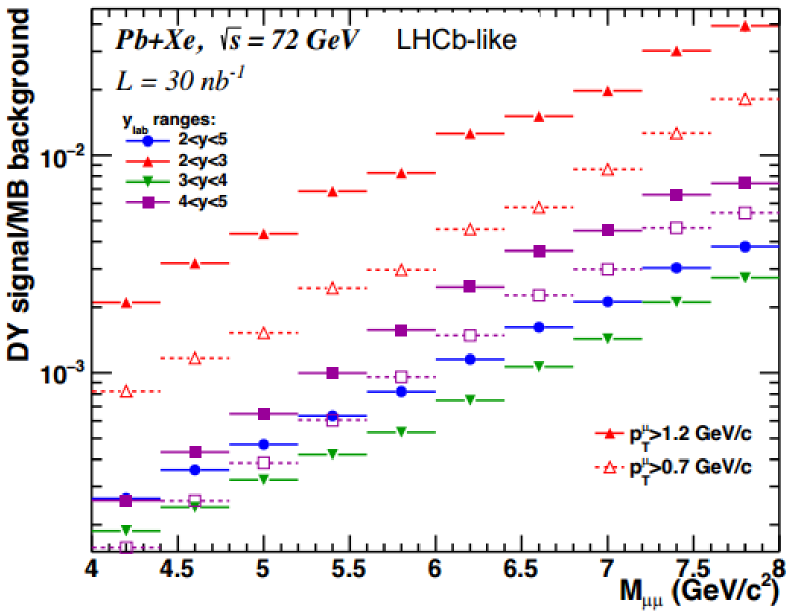
Drell Yan:

Few Body Syst. 58 (2017) no.4, 139

- initial state production, not significant interaction with nuclear medium
- ideal test of the extrapolation of initial state effects in pA to AA



Few Body Syst. 58 (2017) no.5, 148

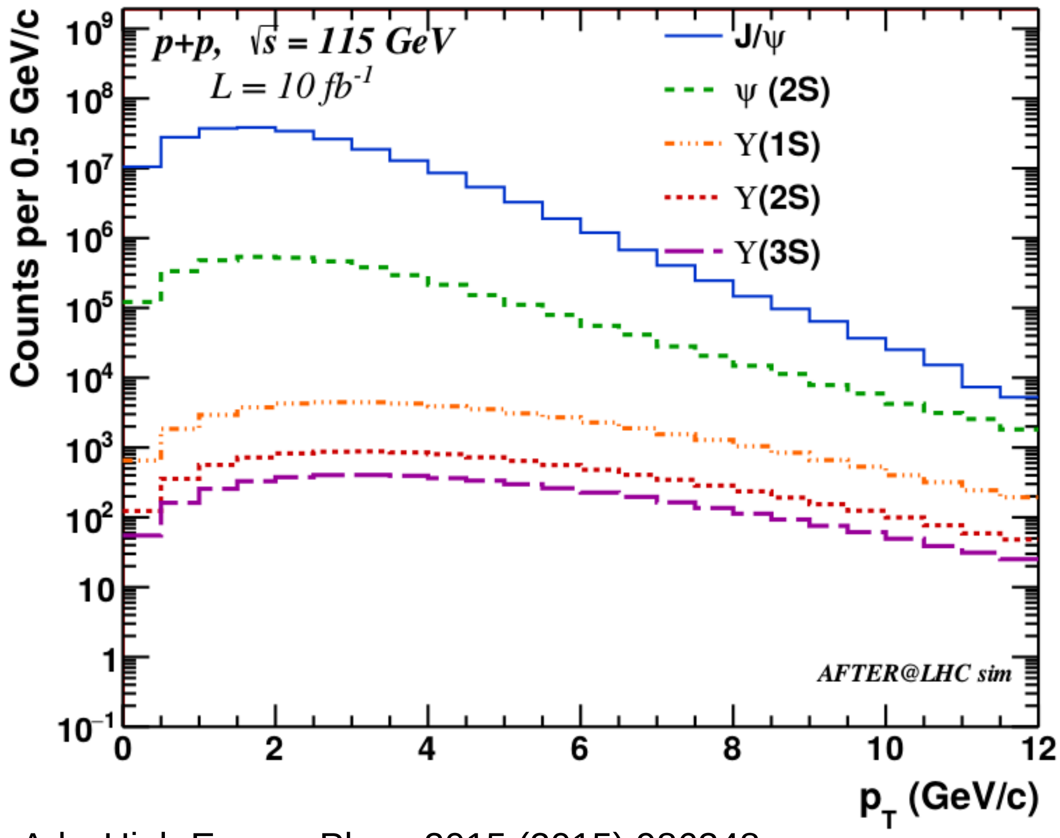


LHCb-like

J/ψ and ϒ yields

Typically 10^9 charmonia, 10^6 bottomonia per year

LHCb-like

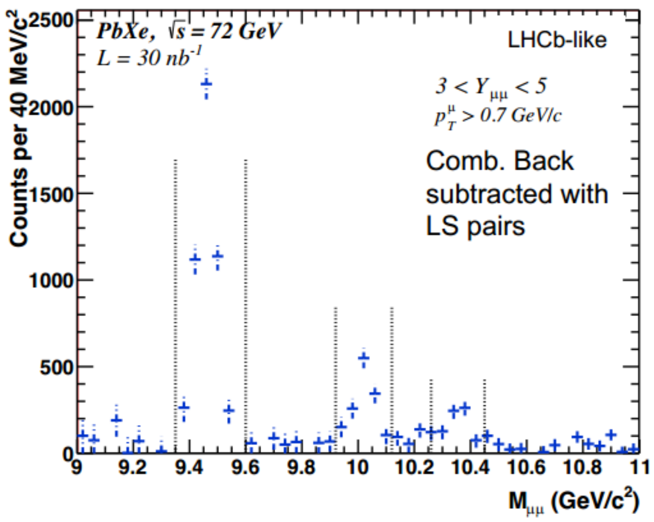


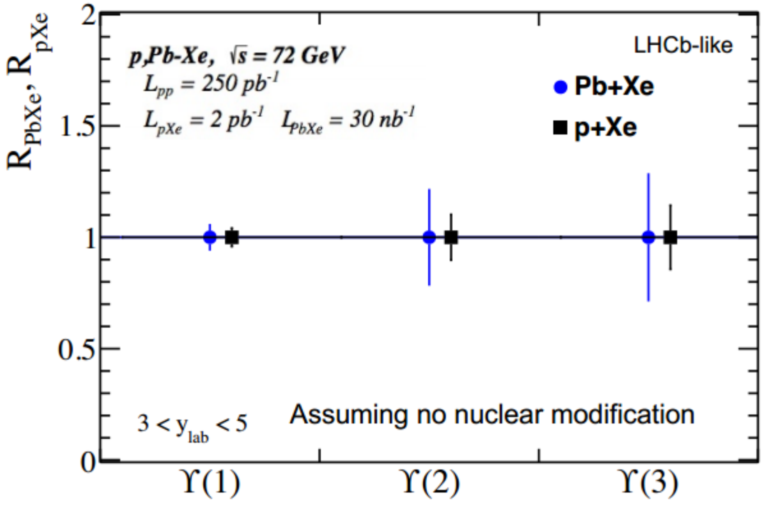
Adv. High Energy Phys. 2015 (2015) 986348

Quarkonium in “cold” and “hot” mater studies

Determination of thermodynamic properties of QGP + cold nuclear matter effects with Υ(nS) production in pp, pA, AA

Few Body Syst. 58 (2017) no.5, 148





Yields		signal	S/B
$\Upsilon(1S)$	pp	1.33×10^3	29.0
	pXe	1.39×10^3	7.8
	PbXe	4.33×10^3	1.8×10^{-1}
$\Upsilon(2S)$	pp	2.92×10^2	8.2
	pXe	3.06×10^2	2.2
	PbXe	9.56×10^2	5.0×10^{-2}
$\Upsilon(3S)$	pp	1.37×10^2	10.3
	pXe	1.44×10^2	2.8
	PbXe	4.49×10^2	6.2×10^{-2}

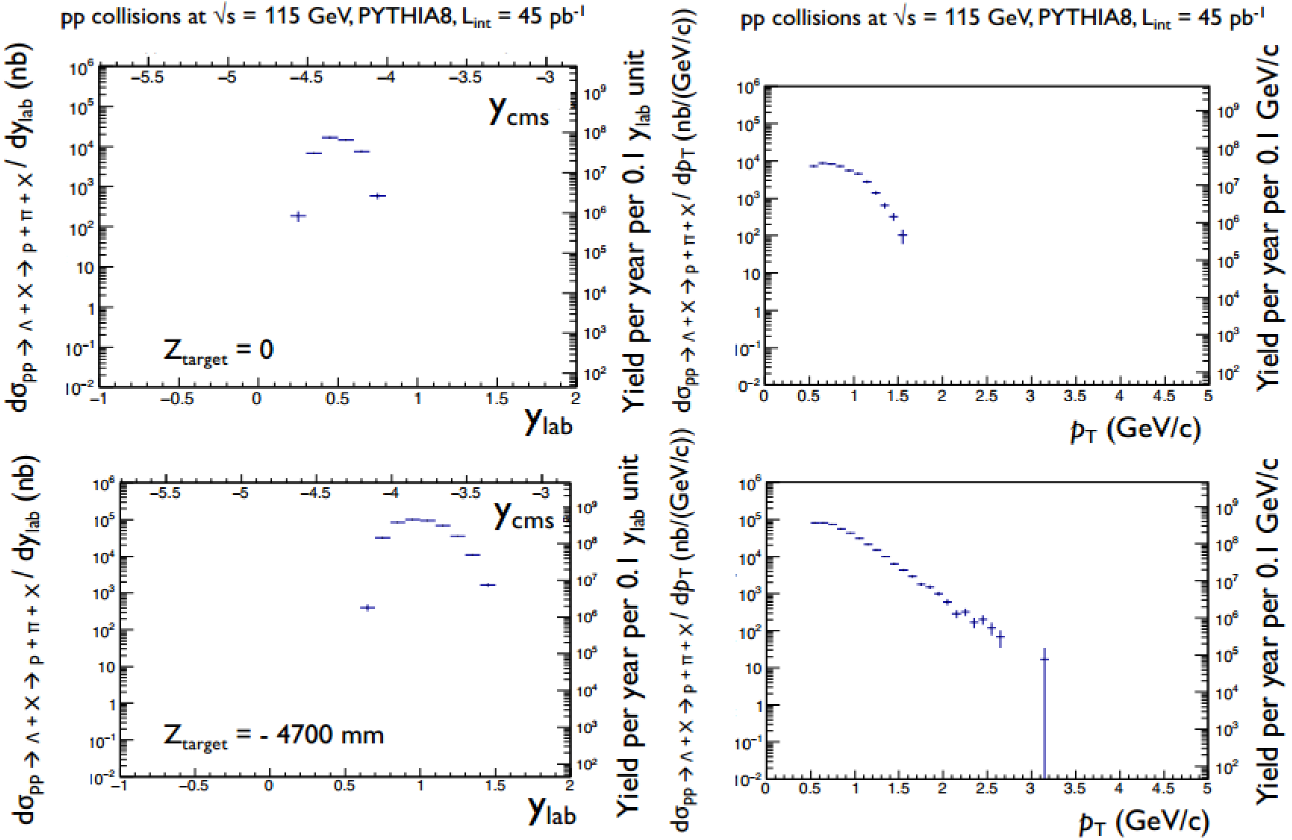
LHCb-like

STRANGENESS SIMULATED PERFORMANCE

ALICE

- Strangeness in the central barrel (Λ production)

- Pythia8 minbias simulation, pp collisions, $\sqrt{s}$ = 115 GeV
- L_{int} = 45 pb^{-1} with polarised H (1 year of data taking) Additional factor 10 if unpolarised H_2
- 10 x 10^6 events generated
- PID &Tracking inefficiencies + decay product geometrical acceptance not accounted for
- Pseudo-rapidity of the Λ within TPC (IROC only) + TOF coverage
- $p_T(\Lambda)$ > 0.5 GeV/c



Very large yields of Λ produced in the central barrel acceptance (to be converted into an uncertainty on D_{LL})

*caveat the tracking performances of the TPC and effect of material budget for large negative Z has still to be studied

L. Massacrier, Physics Beyond Colliders annual workshop, CERN, 2017, https://indico.cern.ch/event/644287/contributions/2724478/