Fixed target program at the LHC

Pasquale Di Nezza

In collaboration with: V.Carassiti, G.Ciullo, R.Engels, P.Lenisa, L.Pappalardo, M.Santimaria, E.Steffens, G.Tagliente

29 Sep 2023

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SMOG2 LHCb

unpolarised gas target

→

LHC spin

polarised (+unpolarised) gas target

The LHCb detector

- LHCb is a general-purpose forward spectrometer, fully instrumented in $2 < \eta < 5$, and optimised for c and b hadron detection
- Excellent momentum resolution with VELO + tracking stations:

$$\sigma_p/p = 0.5 - 1.0\,\% \;\; (p \in [2{,}200]\ \mathrm{GeV})$$

- Particle identification with RICH+CALO+MUON

$\epsilon_\mu \sim 98\,\%$ with $\epsilon_{\pi\to\mu} \lesssim 1\,\%$

- Low momentum muon trigger:

$$p_{T_\mu} > 1.75\ \mathrm{GeV}\ (2018)$$

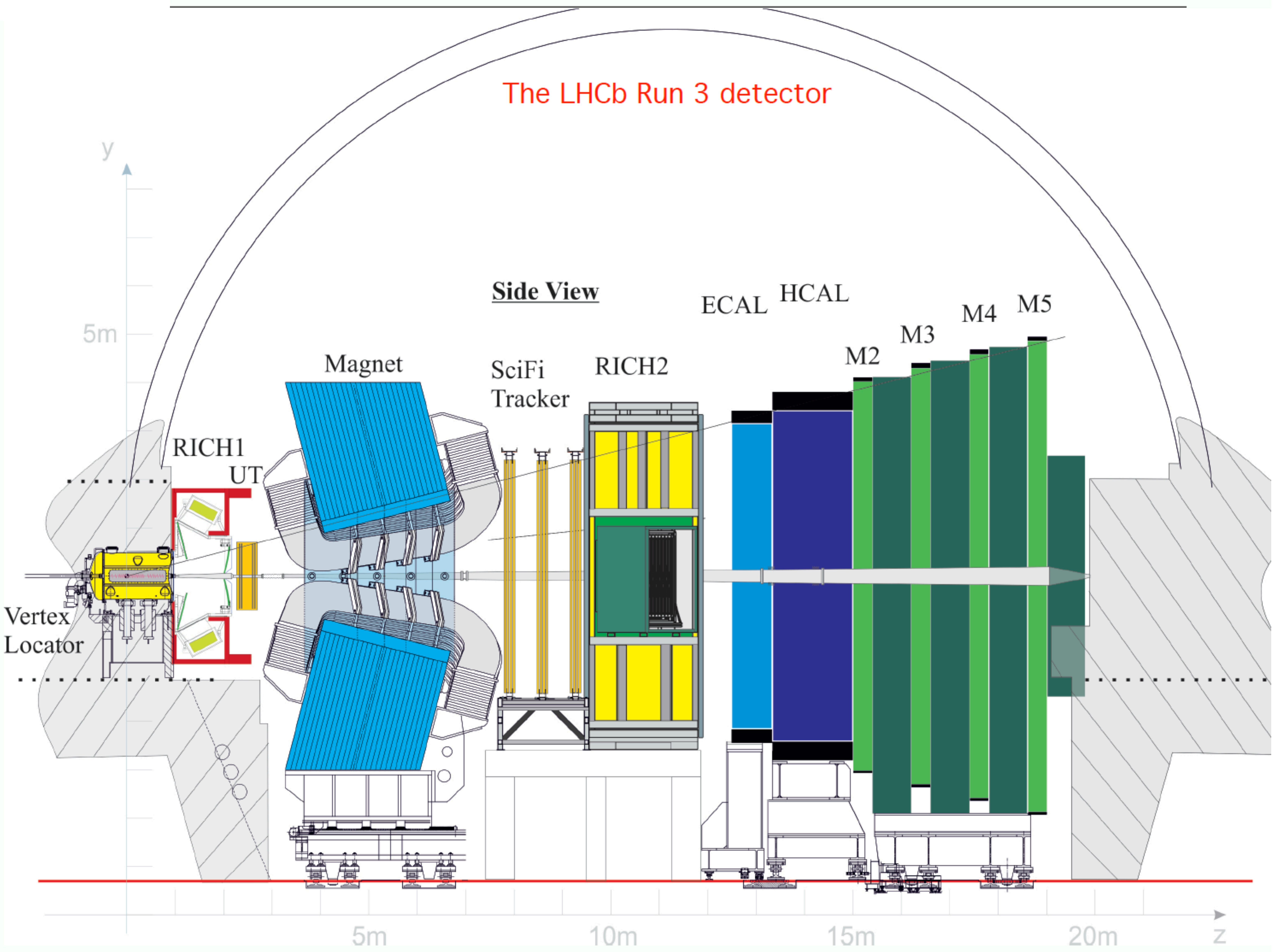
will be reduced thanks to the new fully-software trigger

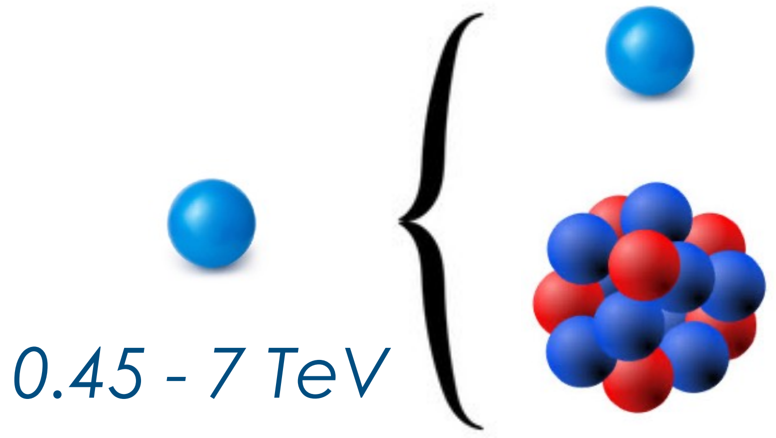
- Major detector upgrades performed during LS2 for the Run 3 (5x luminosity)

[JINST 3 (2008) S08005]

[IJMP A 30, 1530022 (2015)]

[Comput Softw Big Sci 6, 1 (2022)]

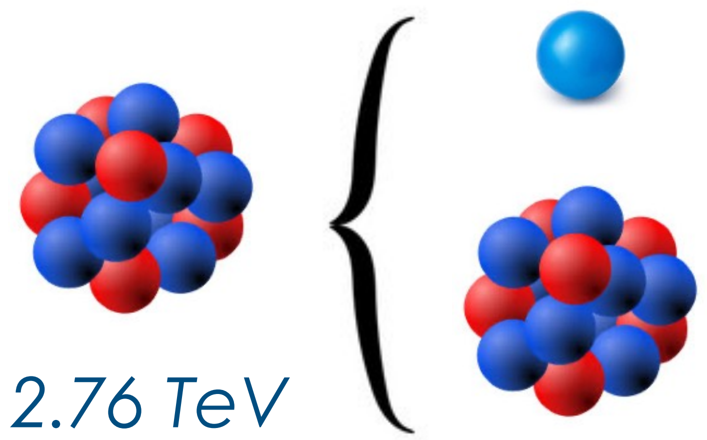




pp or pA collisions: 0.45 - 7 TeV beam on fix target

$$\sqrt{s} = \sqrt{2 m_N E_p} \simeq 41 - 115\ GeV$$

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



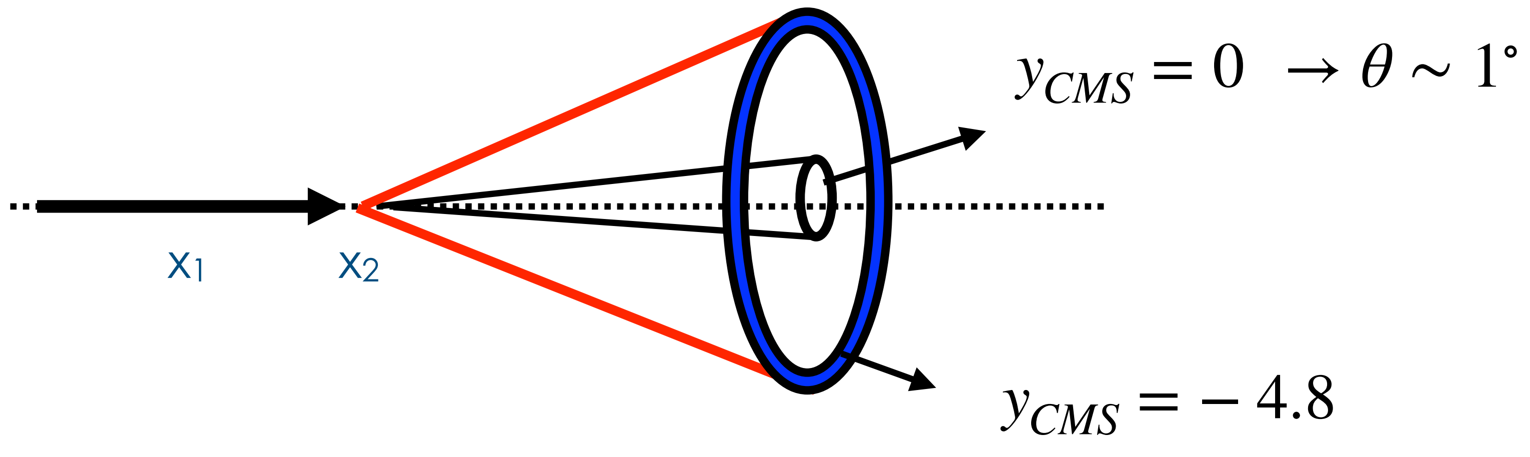
AA collisions: 2.76 TeV beam on fix target

$$\sqrt{s_{NN}} \simeq 72\ GeV$$

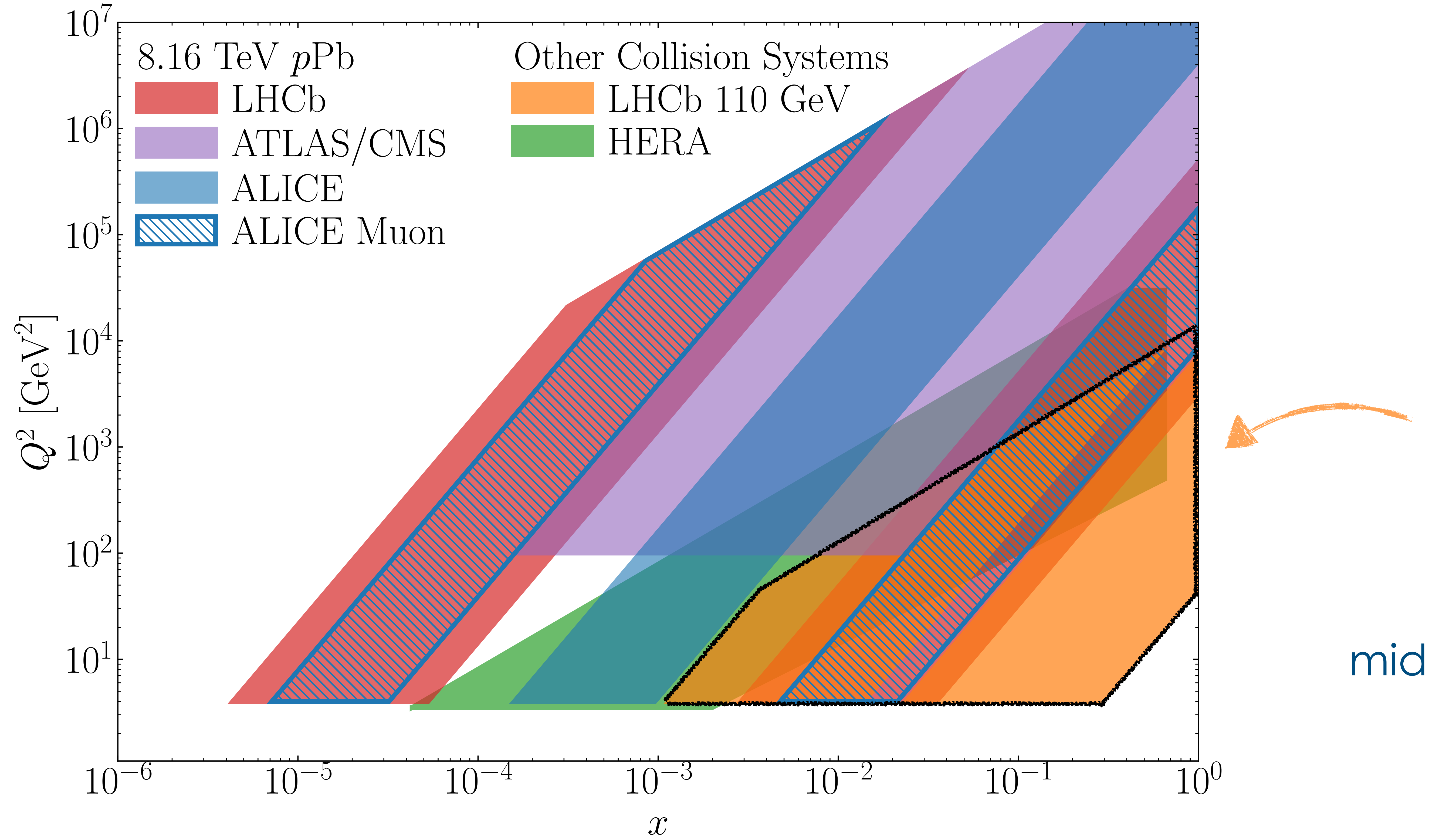
$$y_{CMS} = 0 \ \rightarrow \ y_{lab} = 4.3$$

1: beam; 2: target

Large CM boost, large x_2 values (x_F<0) and small x_1



$$\gamma = \frac{\sqrt{s_{NN}}}{2 m_p} \simeq 60$$



Broad and poorly explored kinematic range

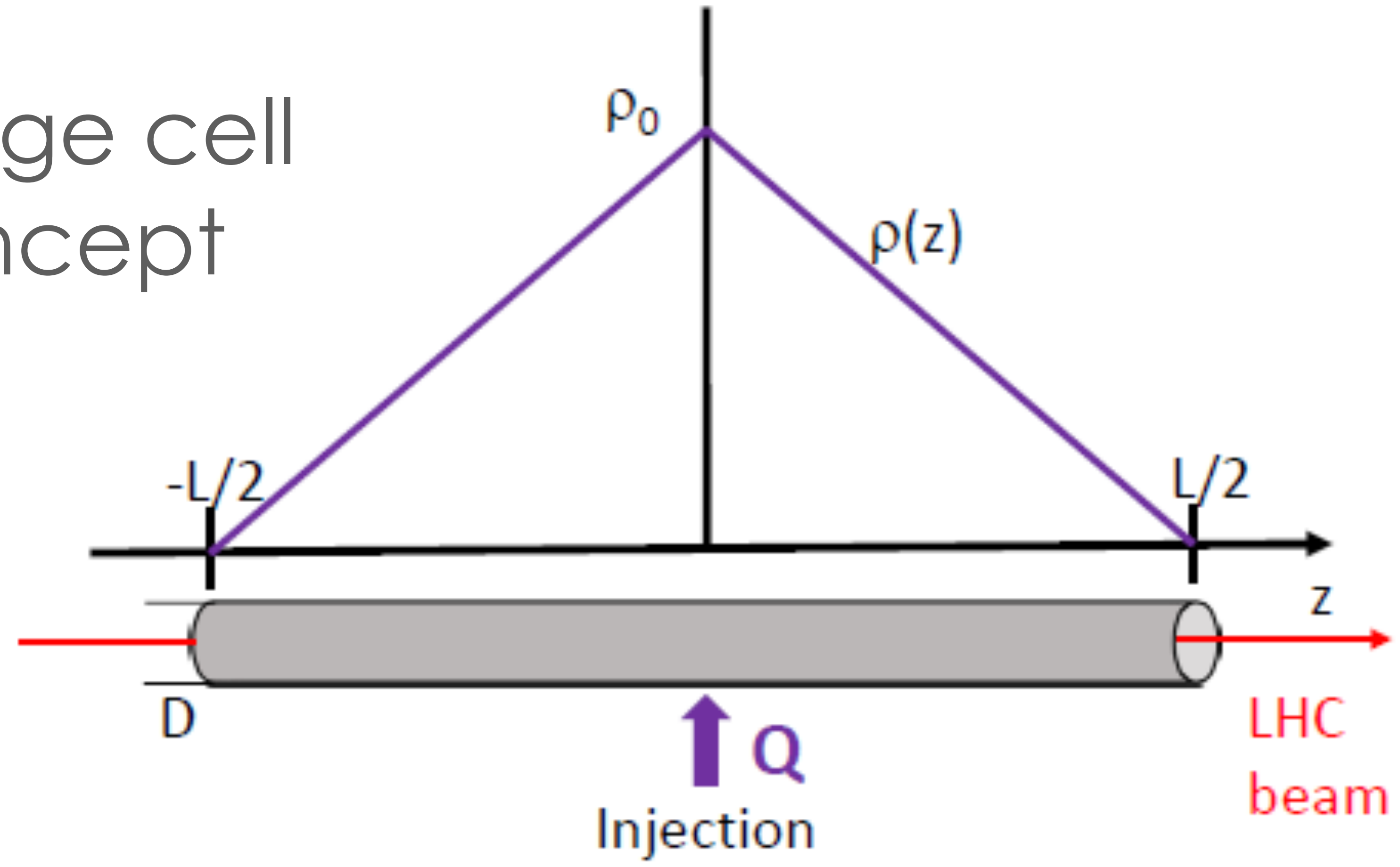
mid-to-large x_{Bj} at intermediate Q^2 and negative x_F

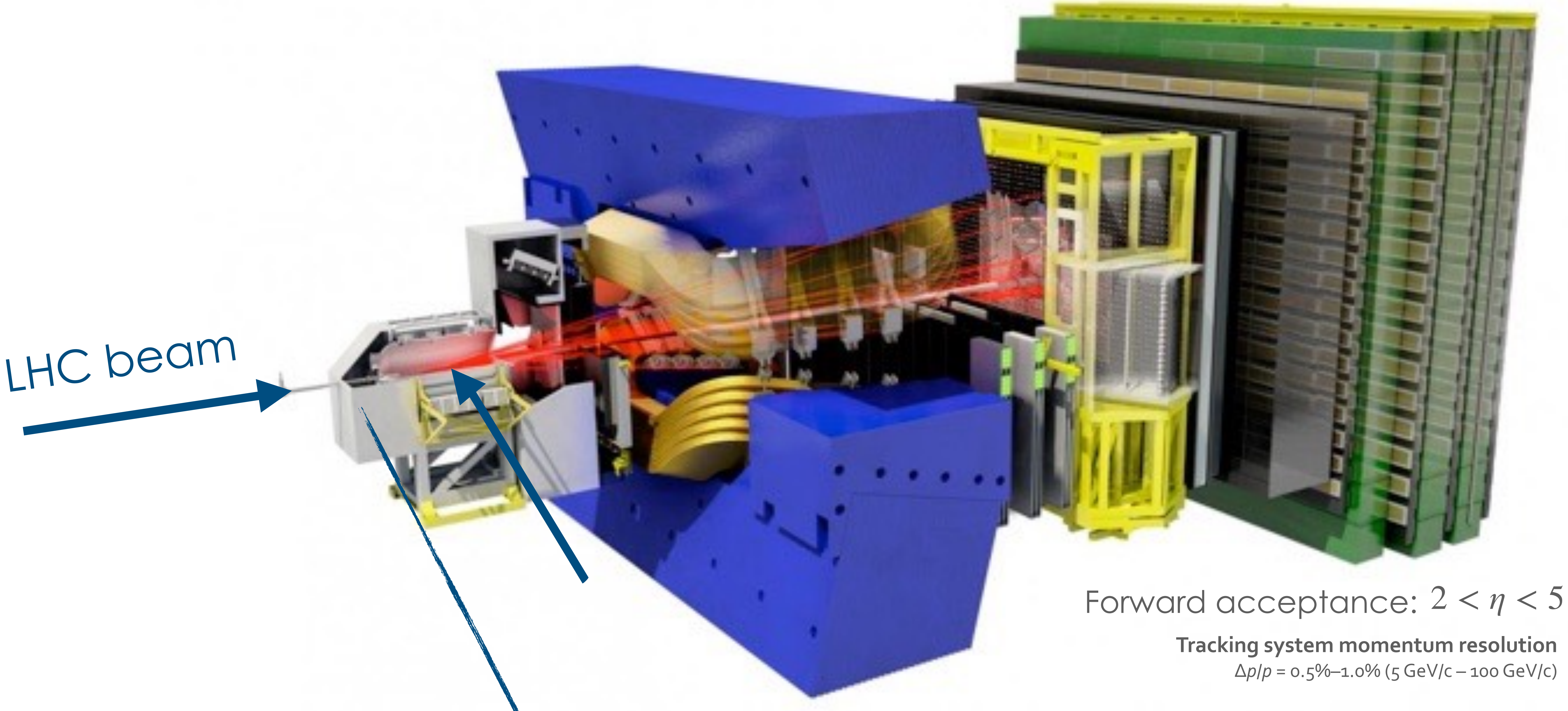
SMOG2 an unpolarised target at LHCb

CERN-LHCC-2019-005 ; LHCB-TDR-020

JINST 3 (2008) S08005
IJMPA 30 (2015) 1530022

Storage cell concept

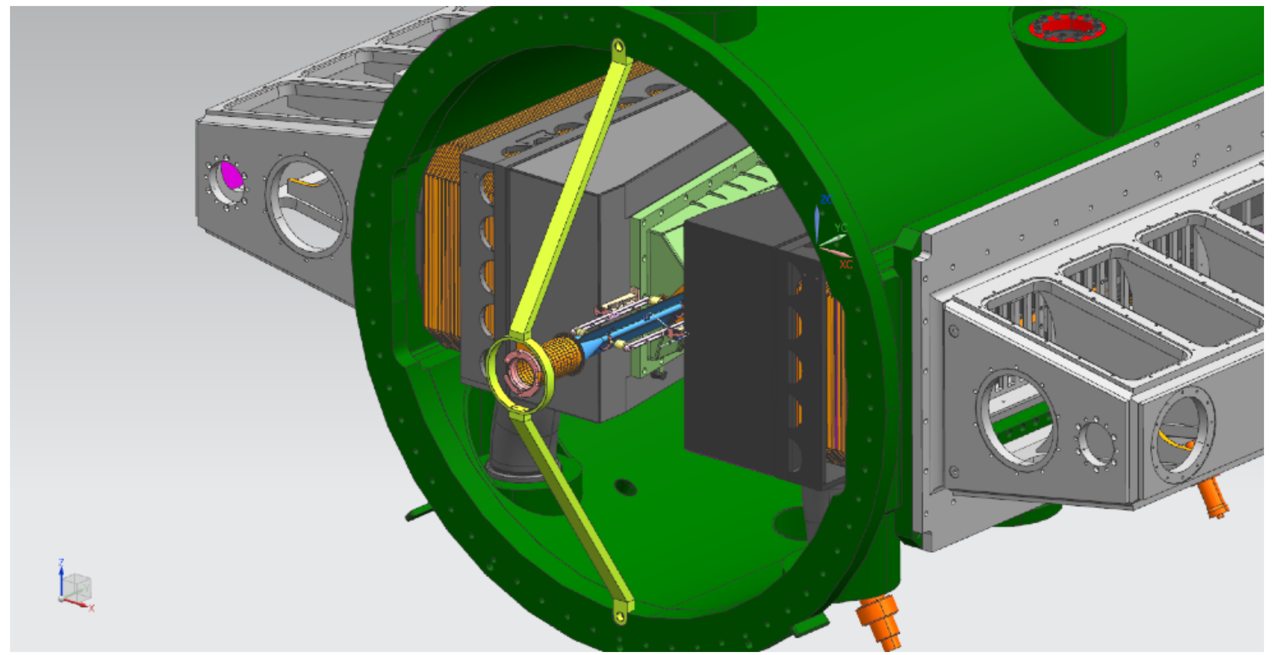




Forward acceptance: $2 < \eta < 5$

Tracking system momentum resolution
$\Delta p/p$ = 0.5%–1.0% (5 GeV/c – 100 GeV/c)

beam-beam collisions



UNpolarised target (beam-gas)

CERN-LHCC-2019-005 ; LHCB-TDR-020

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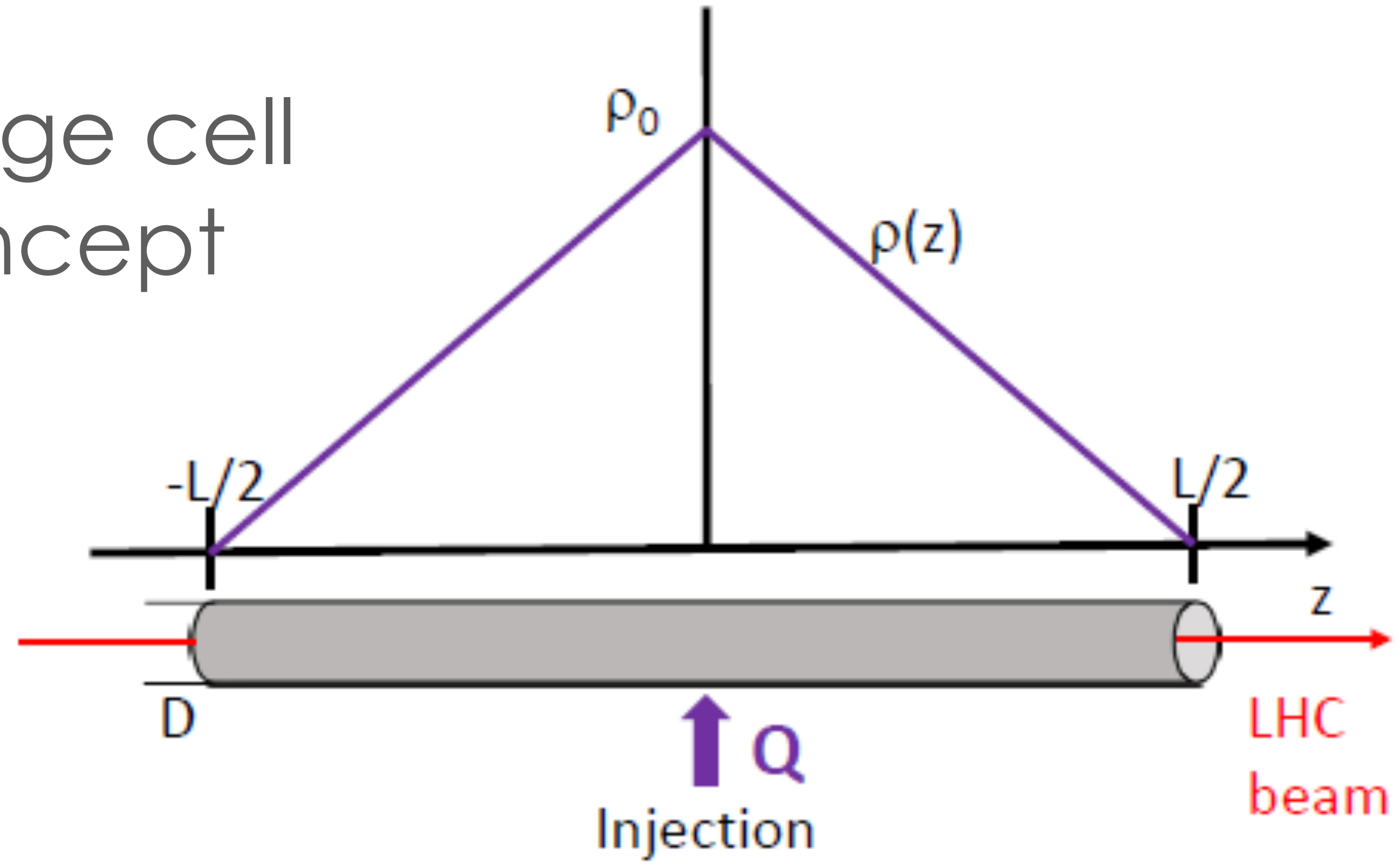
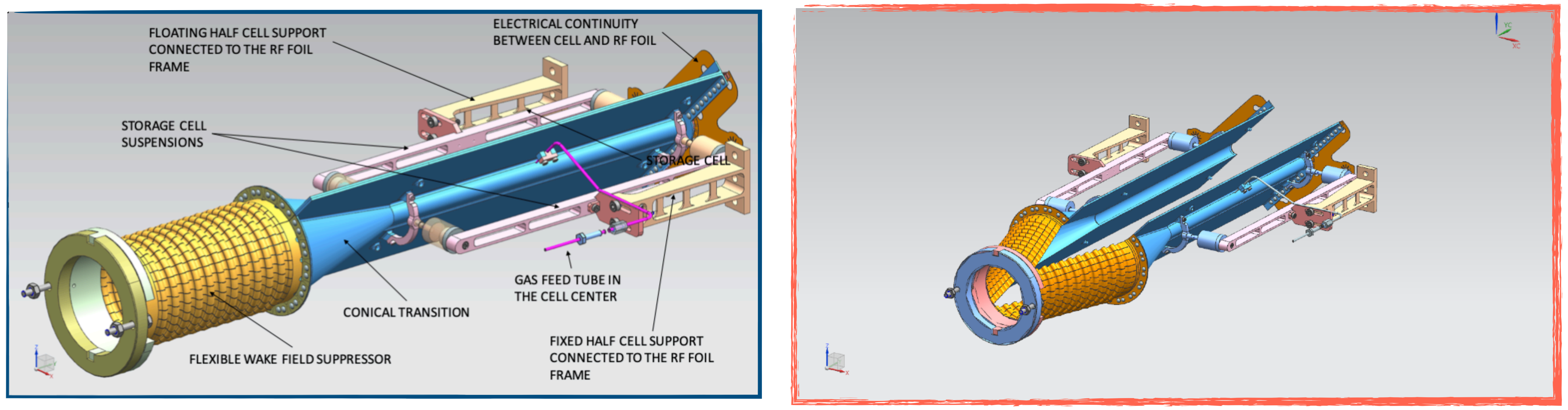
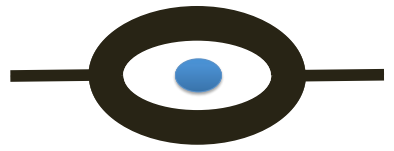


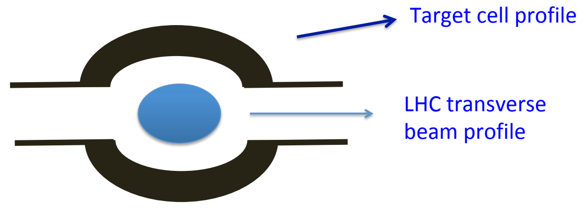
Openable cell



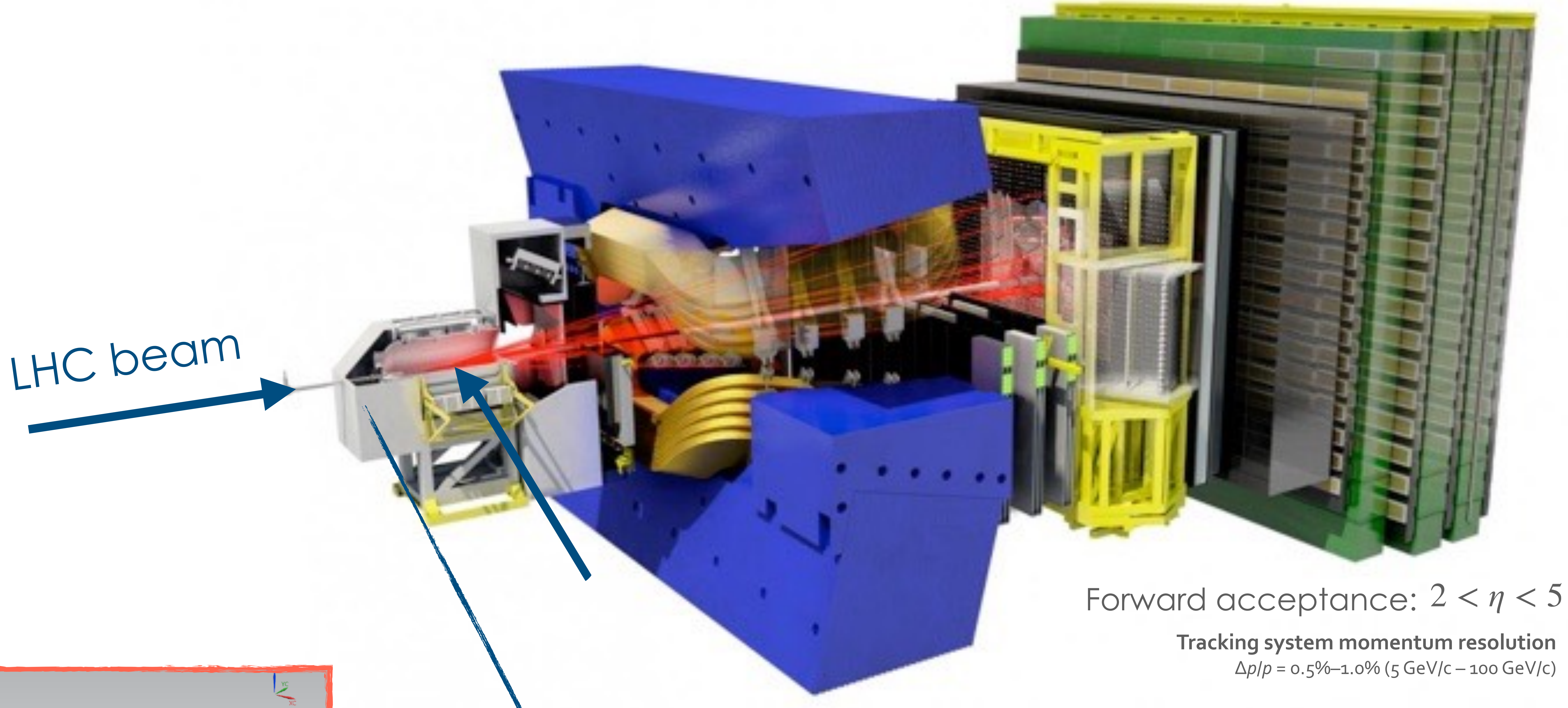


at Lumi Run
(7000 GeV)

5 mm radius x 200 mm length



at injection
(450 GeV)



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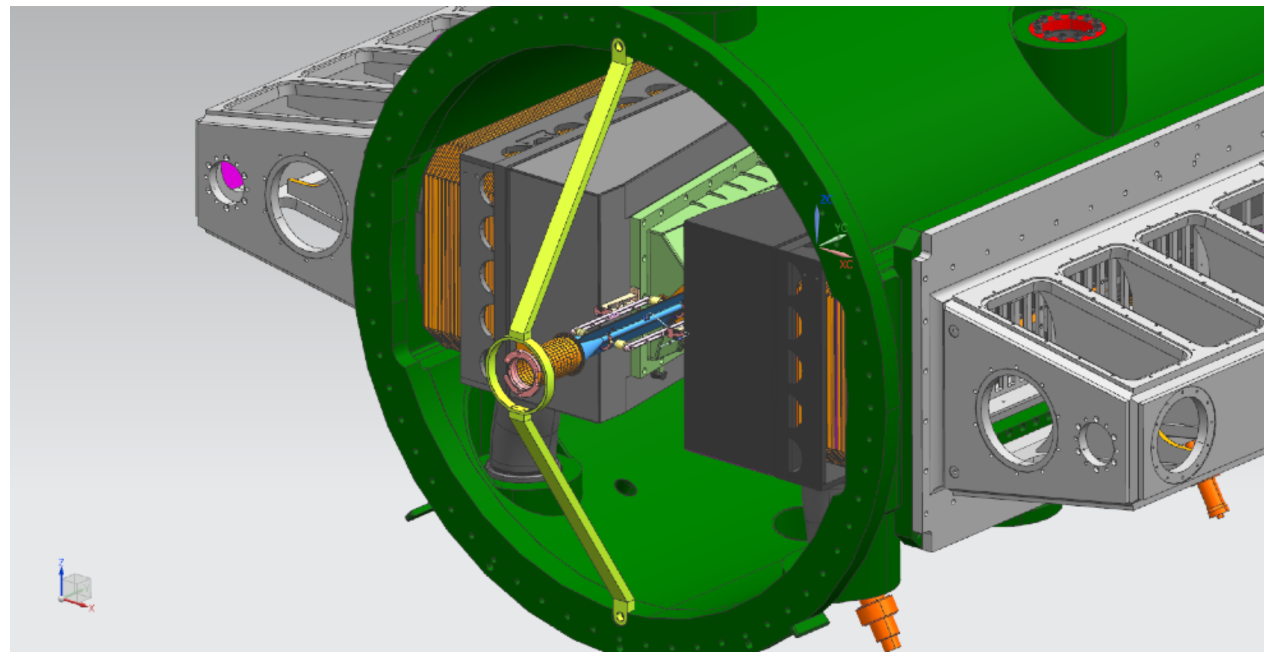

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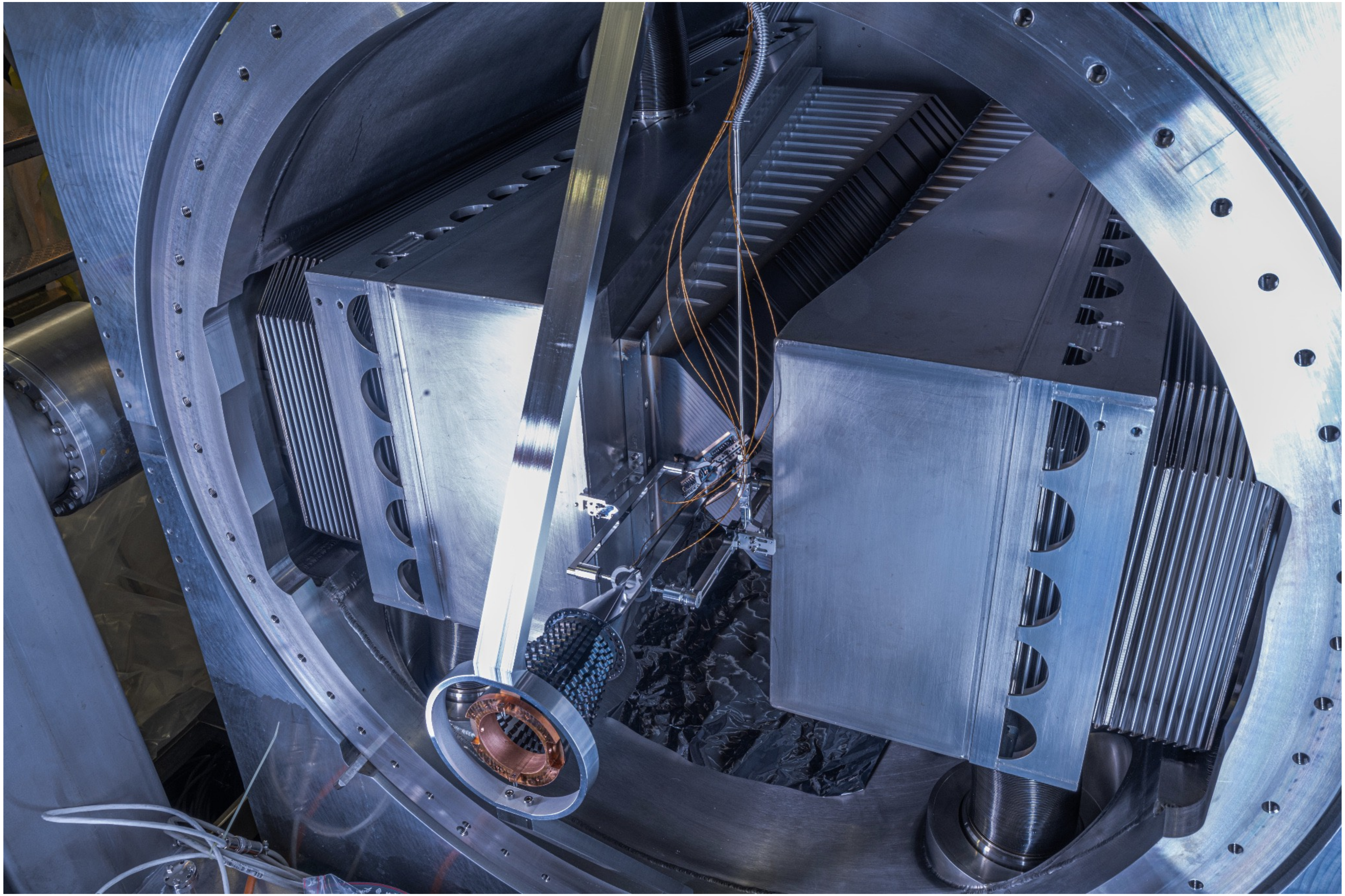
SMOG2



It is the only system present in the LHC primary vacuum

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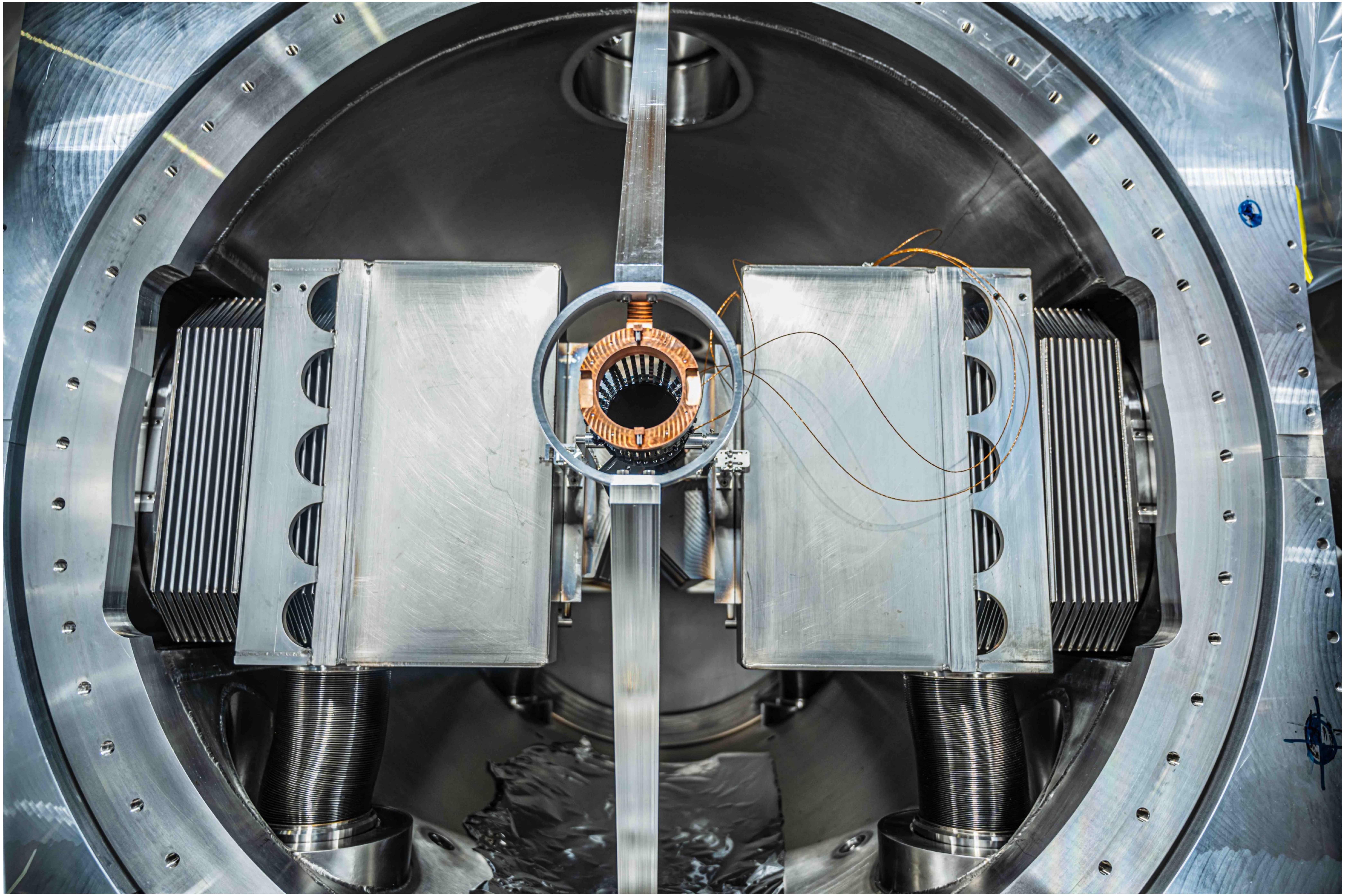
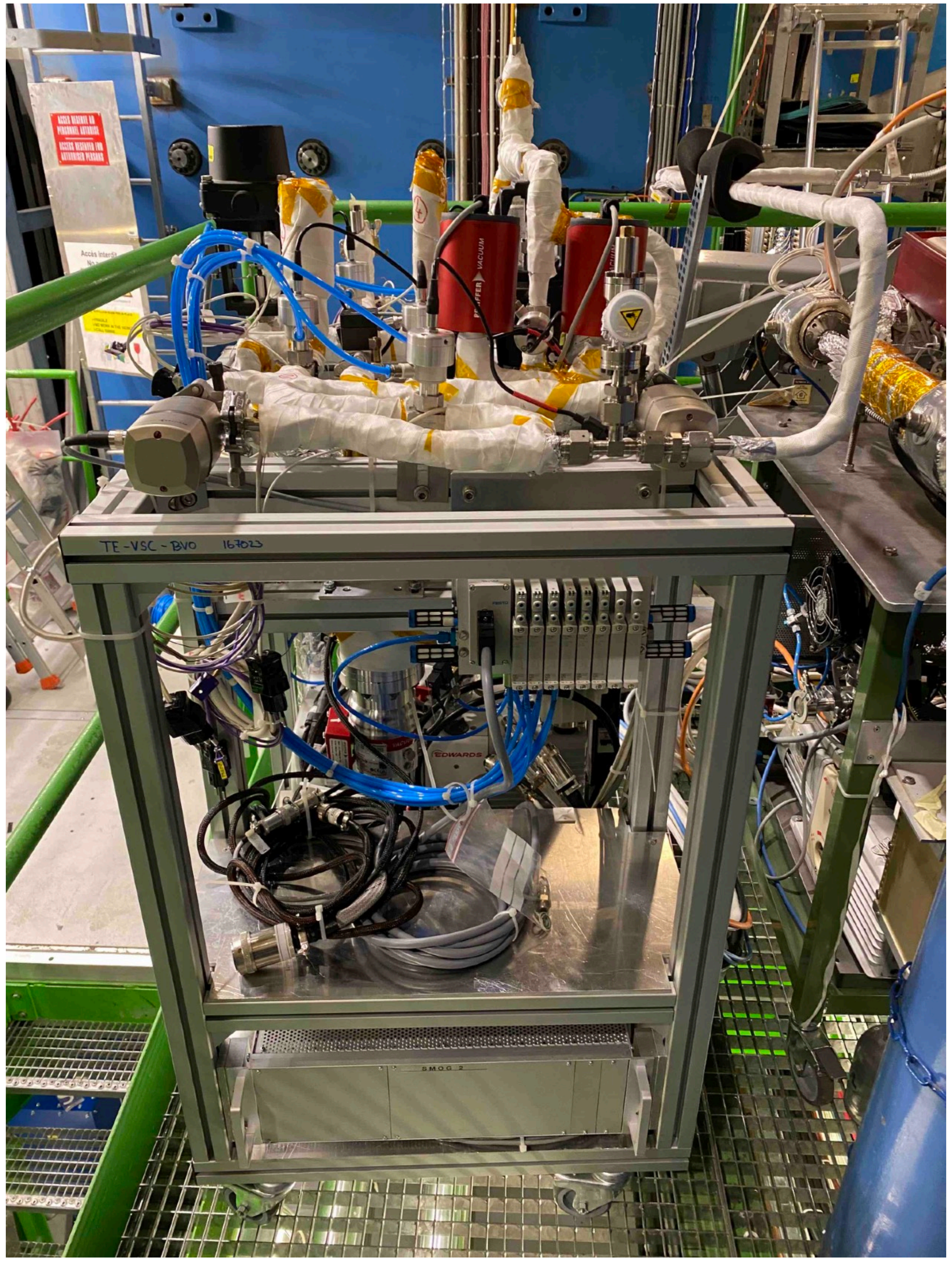


It is the only system present in the LHC primary vacuum

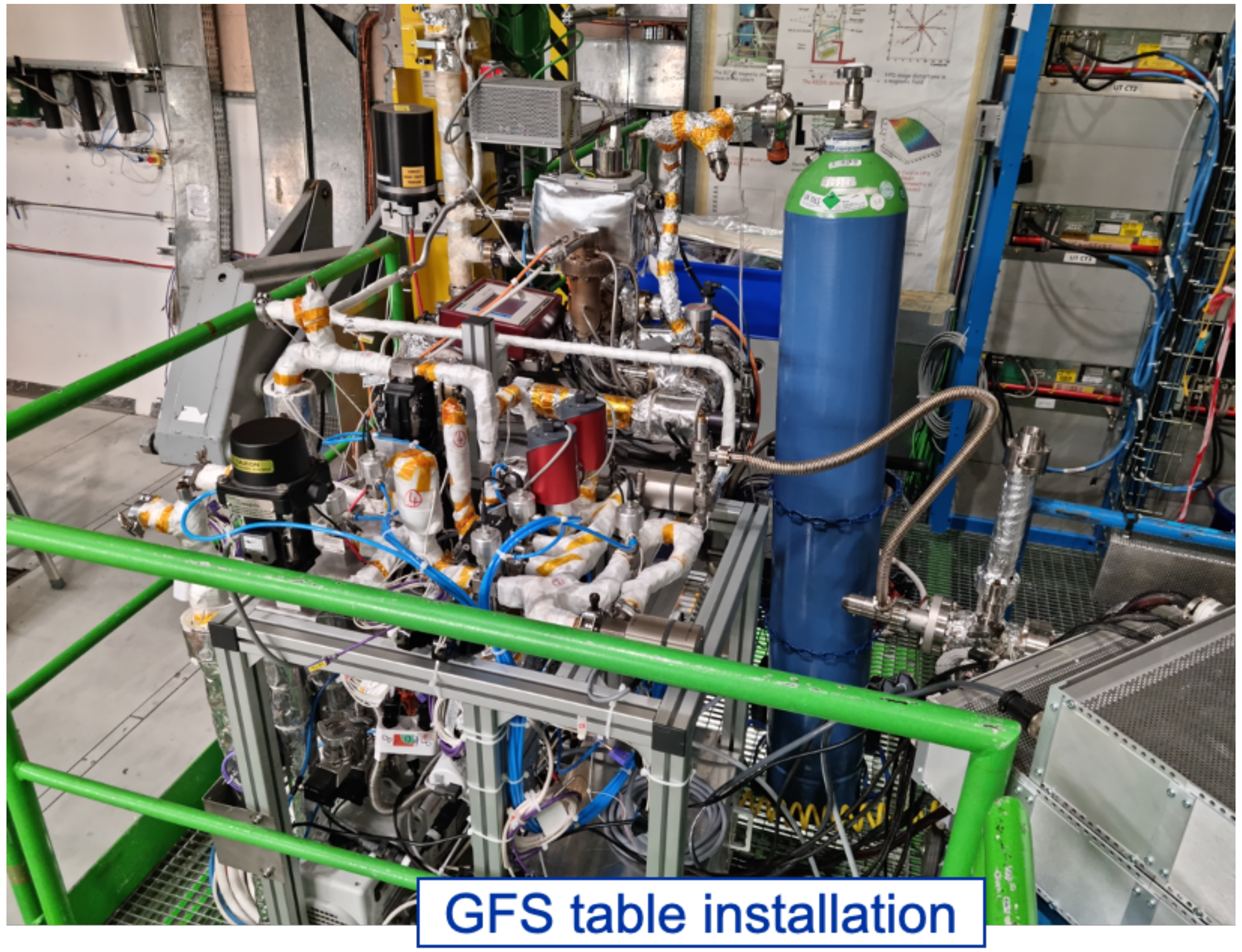
SMOG2

- Negligible impact on the beam lifetime ($\tau^{p-H_2}_{beam-gas} \sim 2000$ days , $\tau^{Pb-Ar}_{beam-gas} \sim 500$ h)
- Injectable gases (6 reservoirs): H_2, D_2, N_2, O_2, He, Ne, Ar, Kr, Xe
- Flux known with $1\,\%$ precision, measured relative contamination 10^{-4}

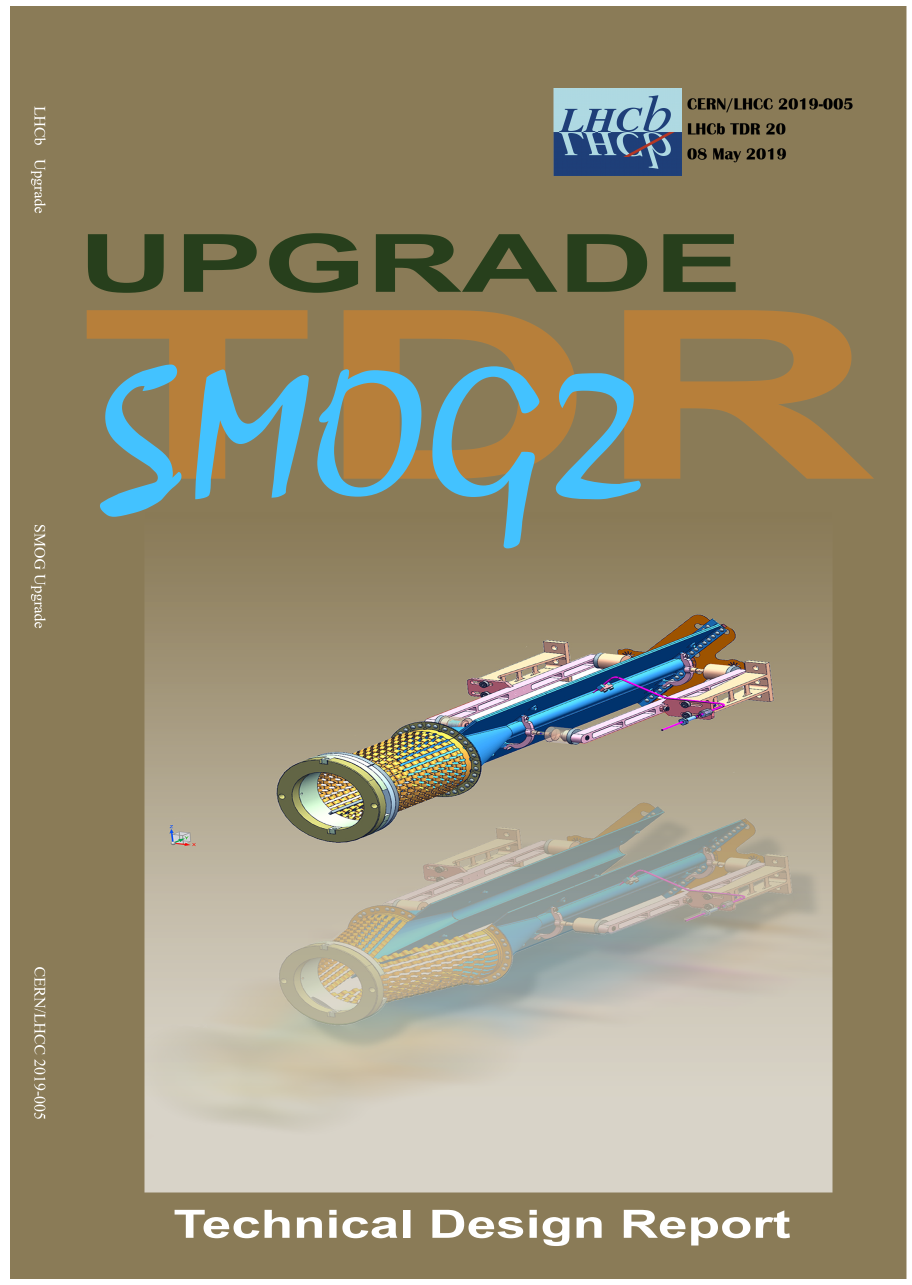
CERN-LHCC-2019-005 ; LHCB-TDR-020



Luminosity determination with 1.5% of accuracy



GFS table installation

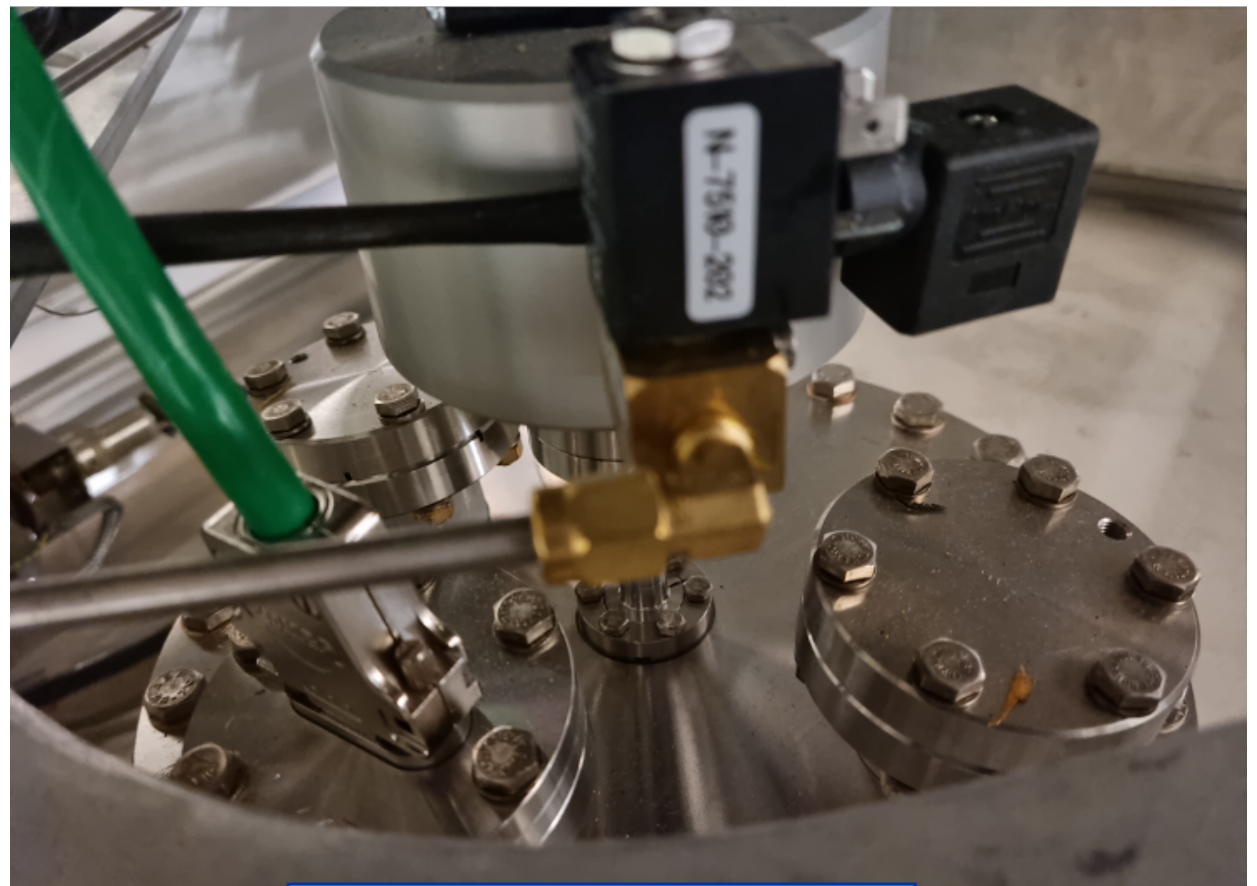


CERN/LHCC 2019-005
LHCb TDR 20
08 May 2019

UPGRADE TDR

SMOG2

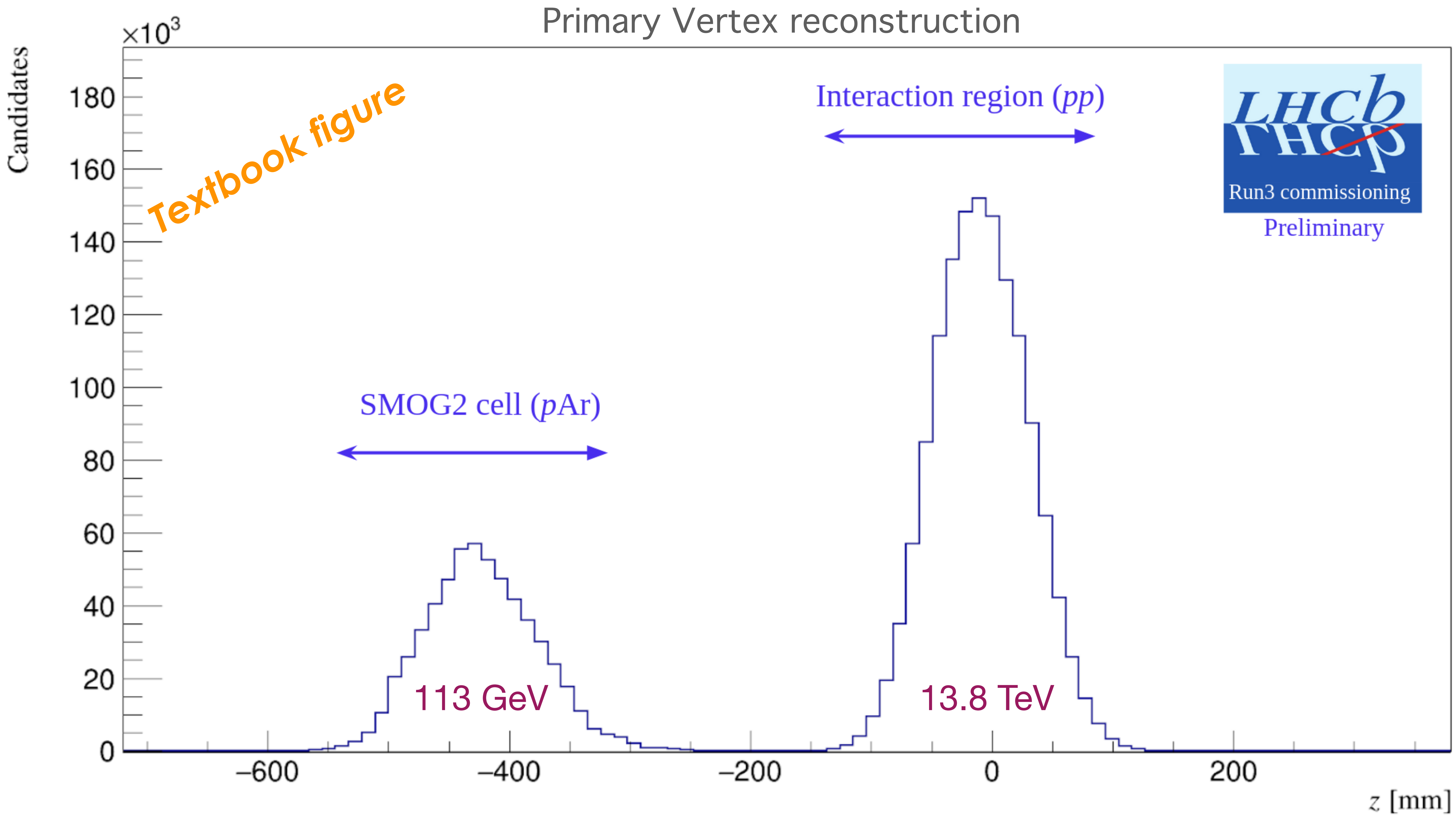
Technical Design Report



Injection valve PV611

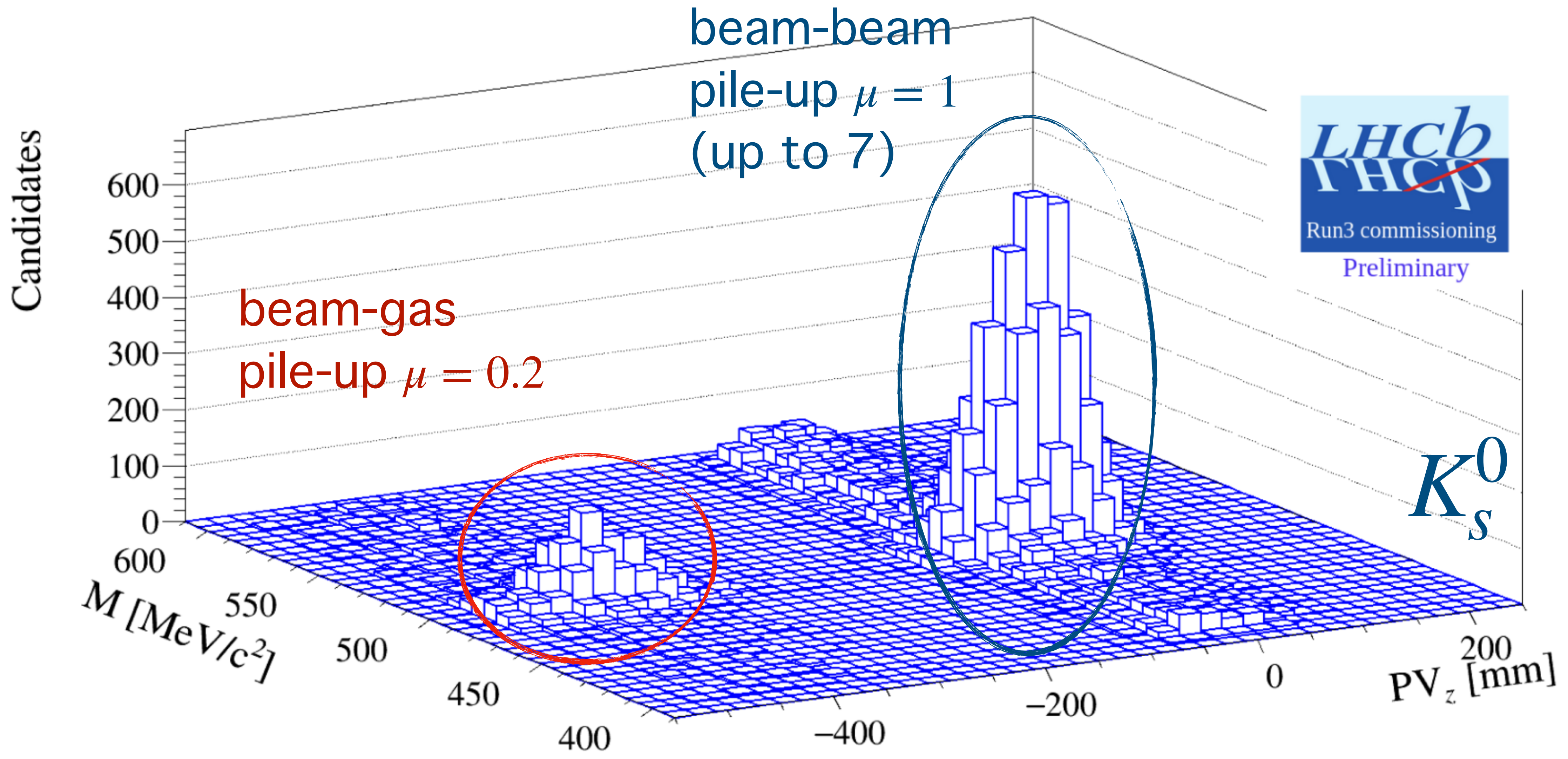
https://cds.cern.ch/record/2673690/

SMOG2 … wow-factor!

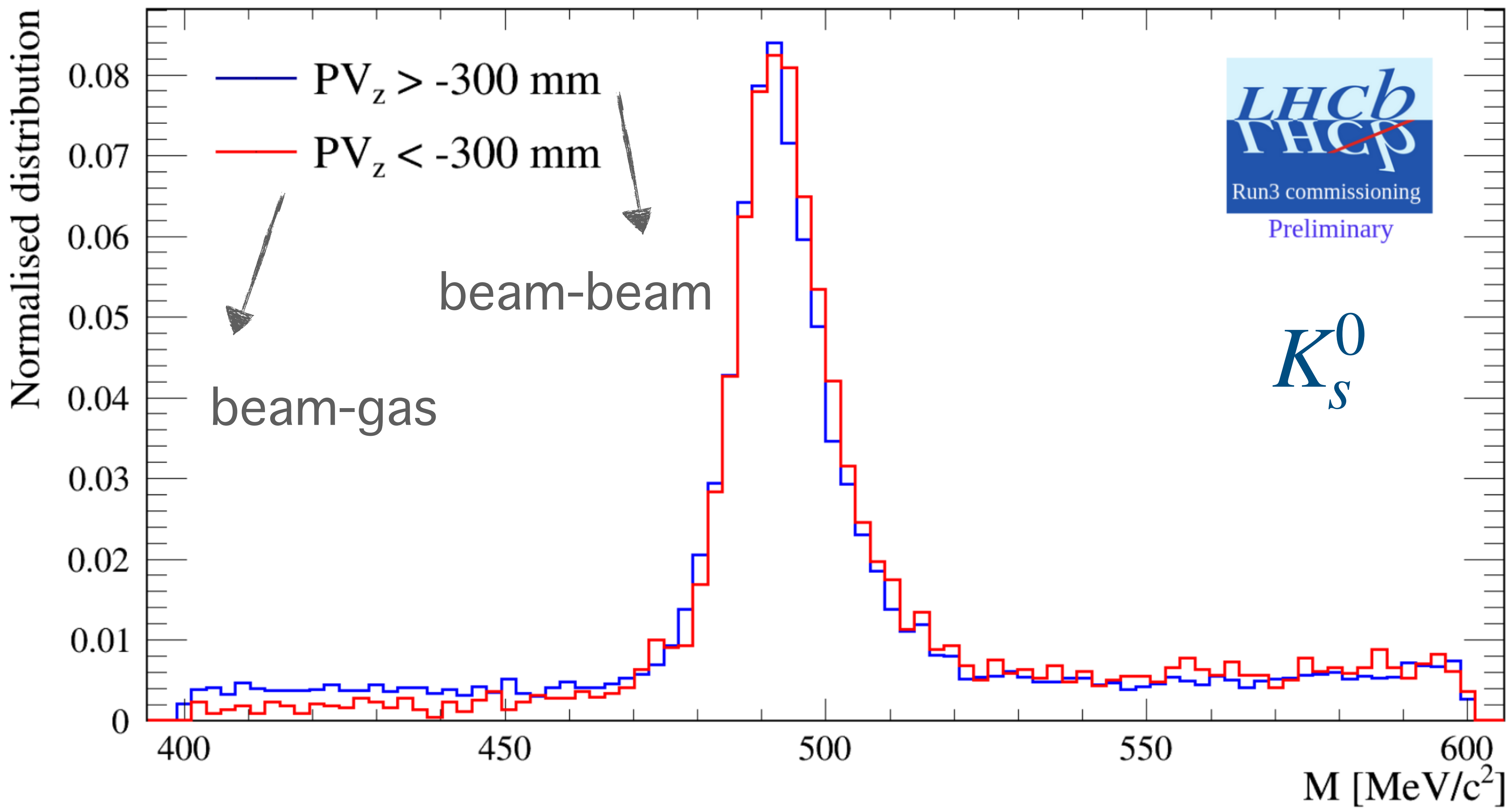


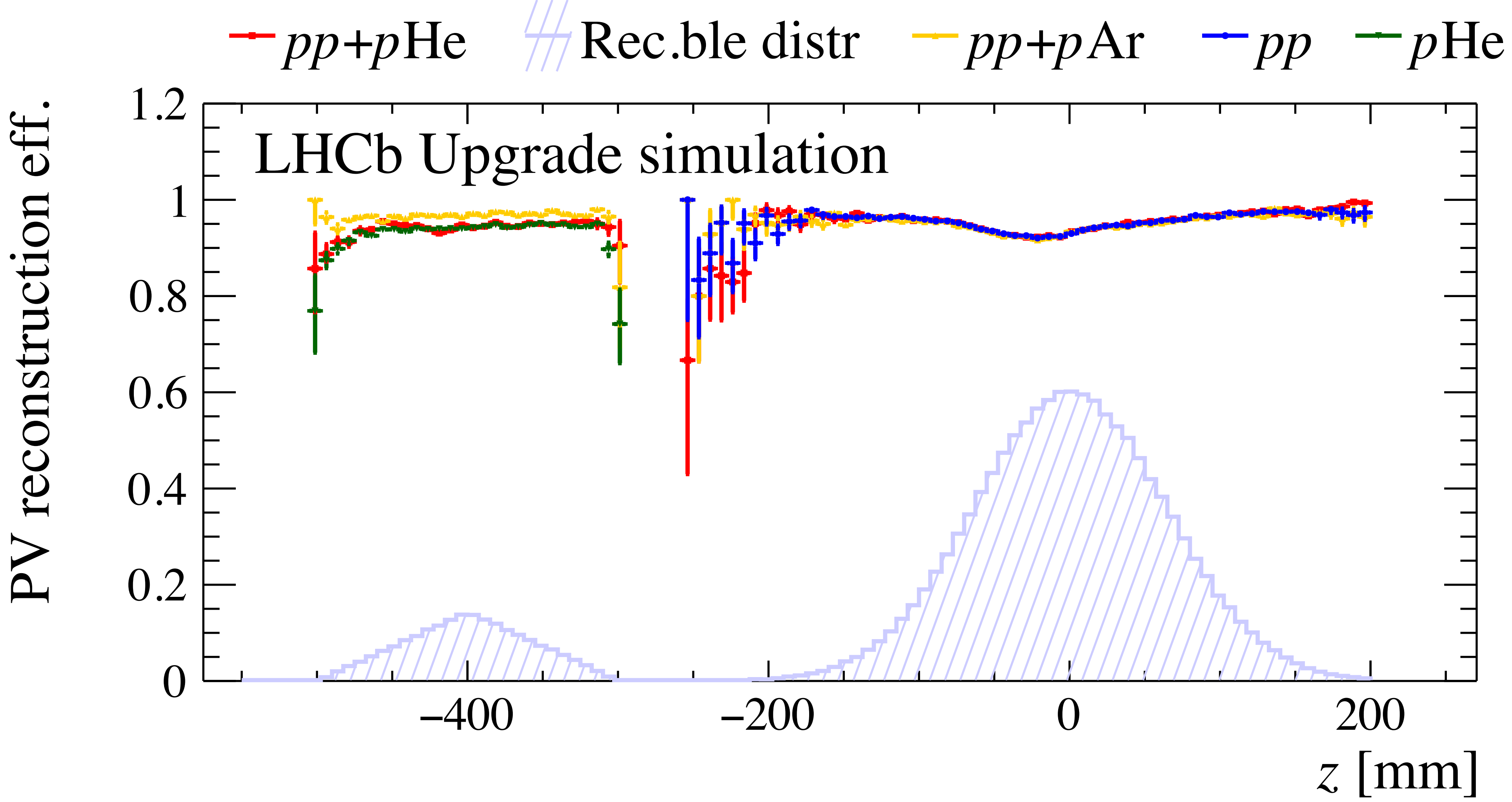
Two well separated and independent Interaction Points working simultaneously

SMOG2 ... wow-factor!



LHCb-FIGURE-2023-001



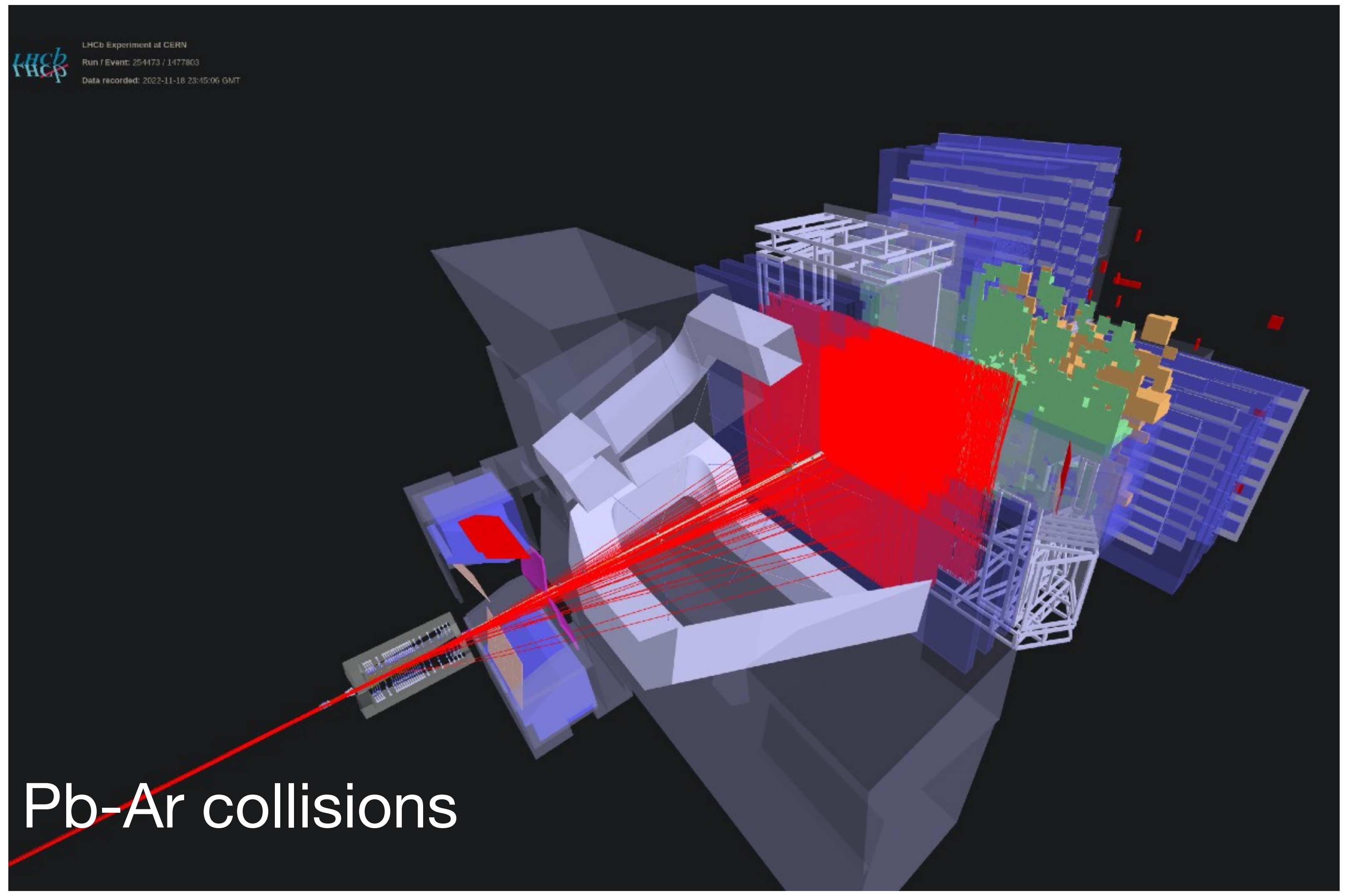


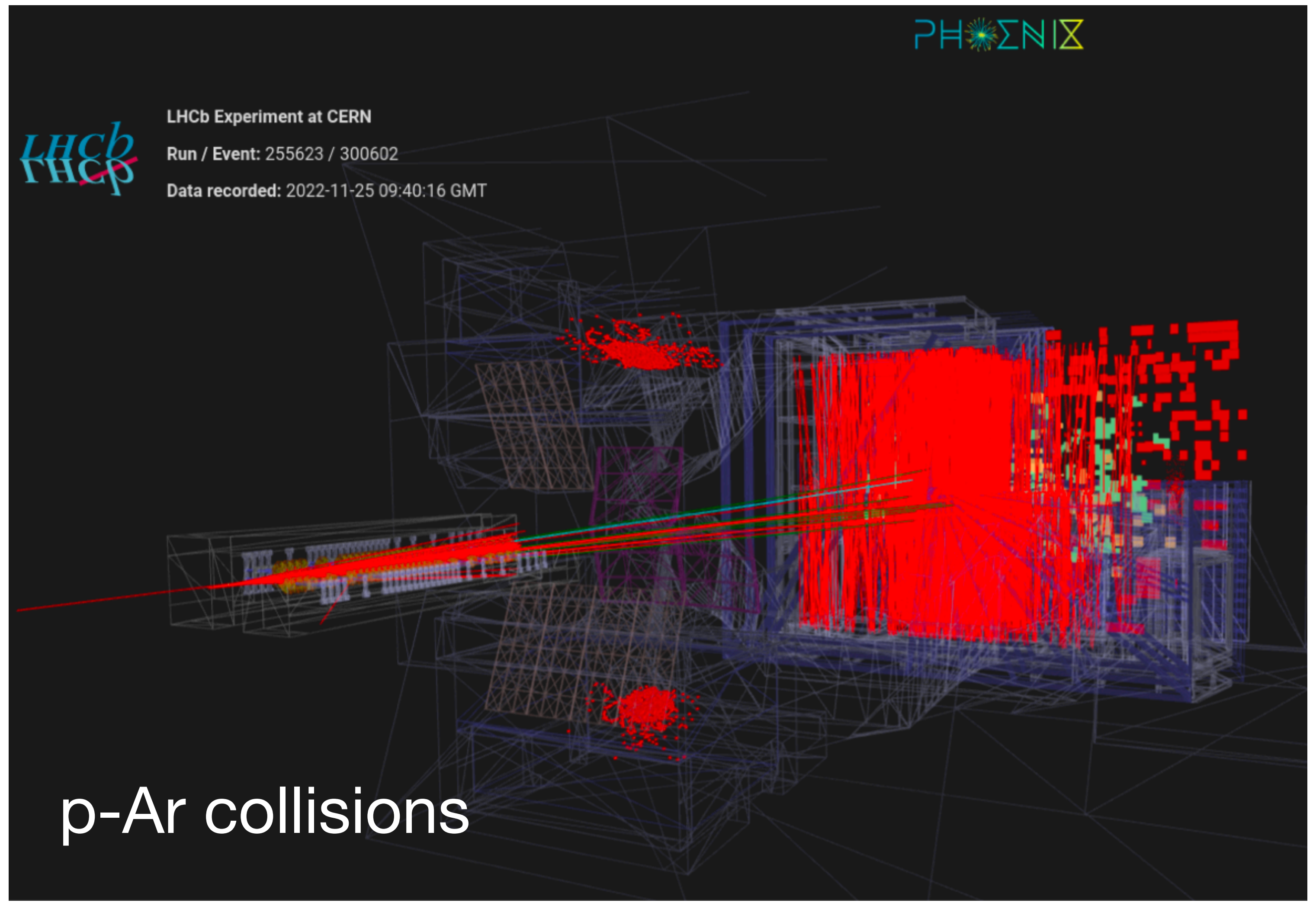
- beam-beam and beam-gas interactions are well detached
- same resolution for beam-gas and beam-beam collisions
- negligible increase of multiplicity small impact in the LHCb reconstruction sequence. Data flow increase of ~1%

LHCb is the only experiment able to run in collider-and fixed-target mode simultaneously!

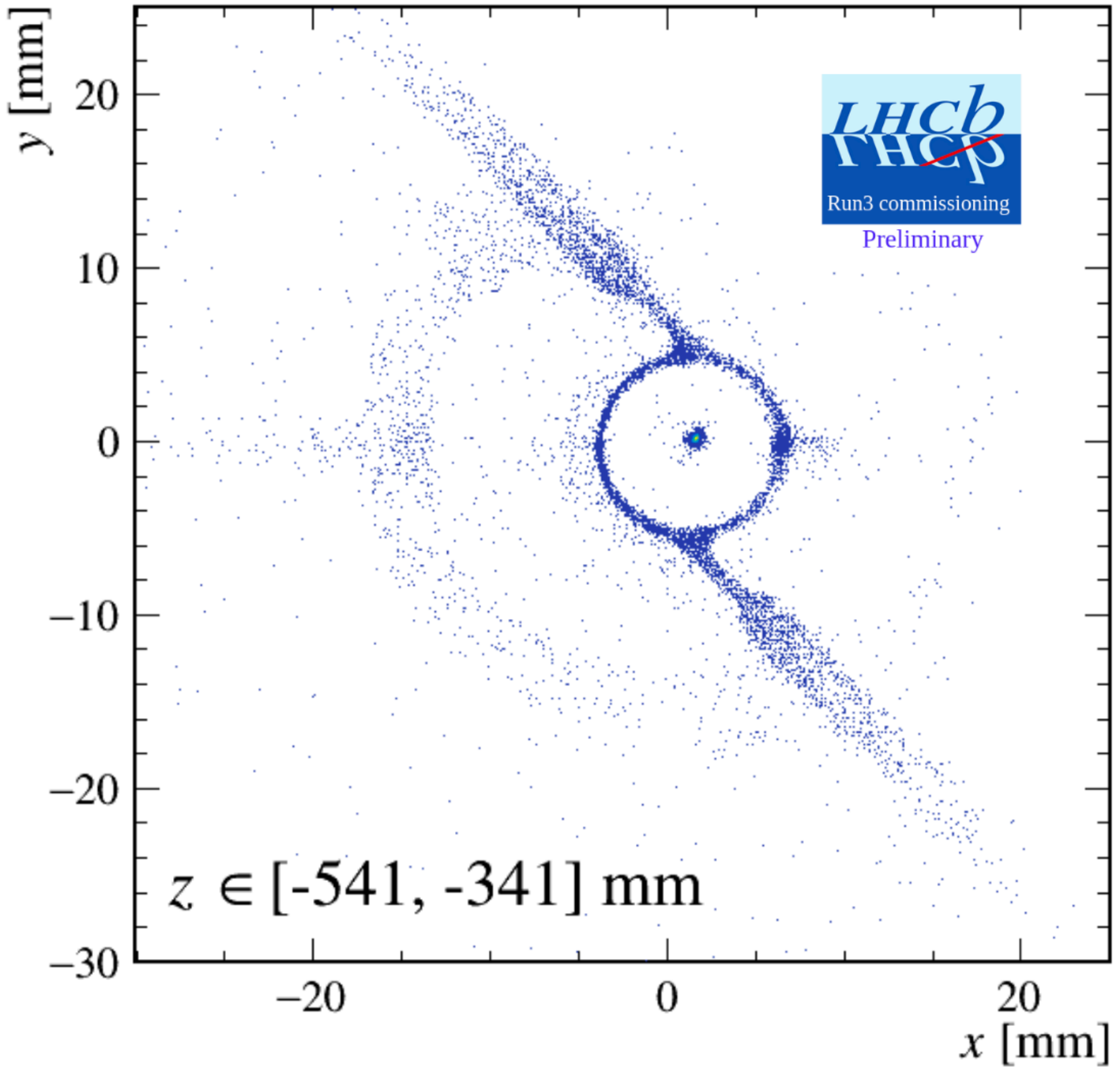
LHCb-FIGURE-2023-001

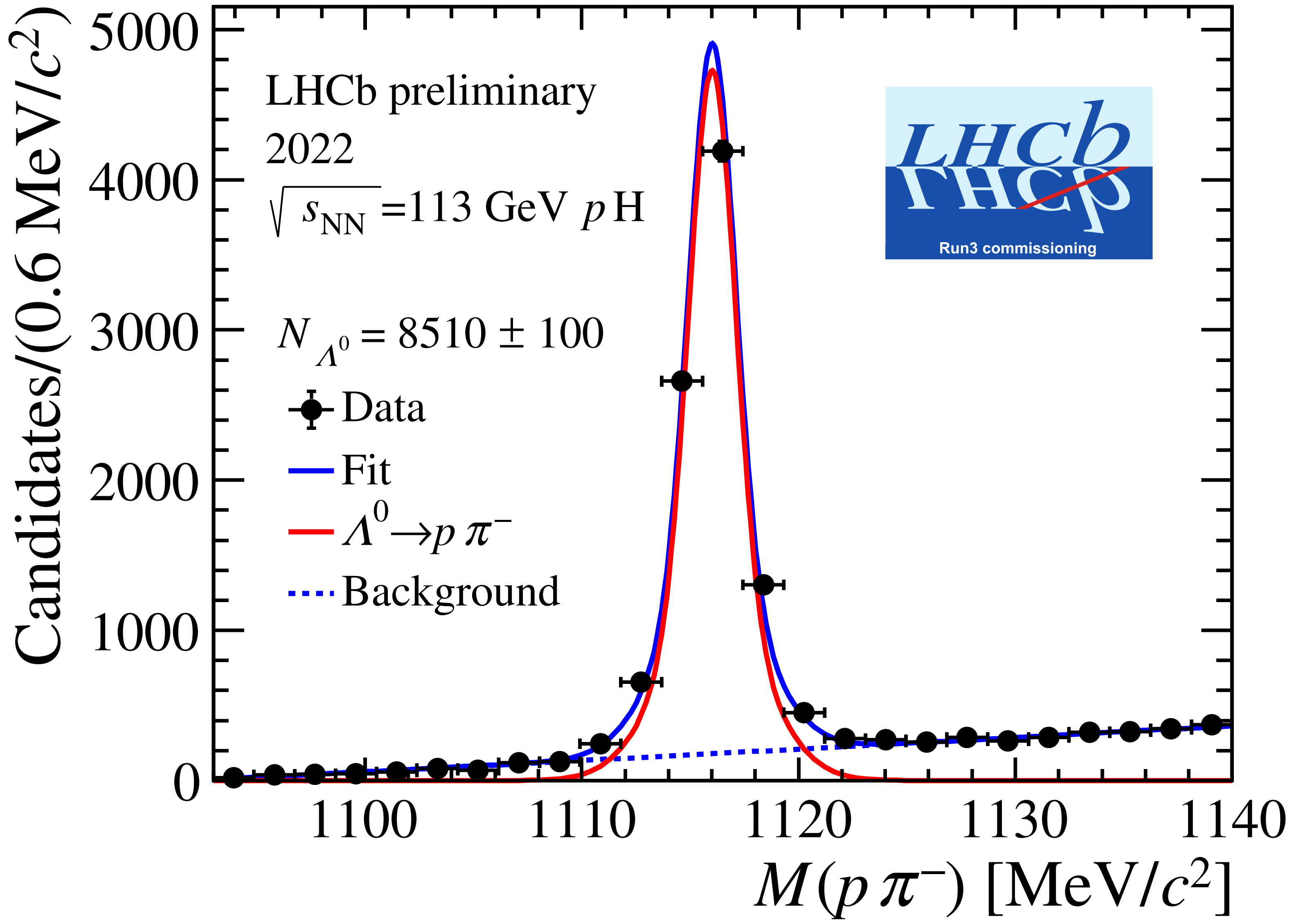
SMOG2 early data

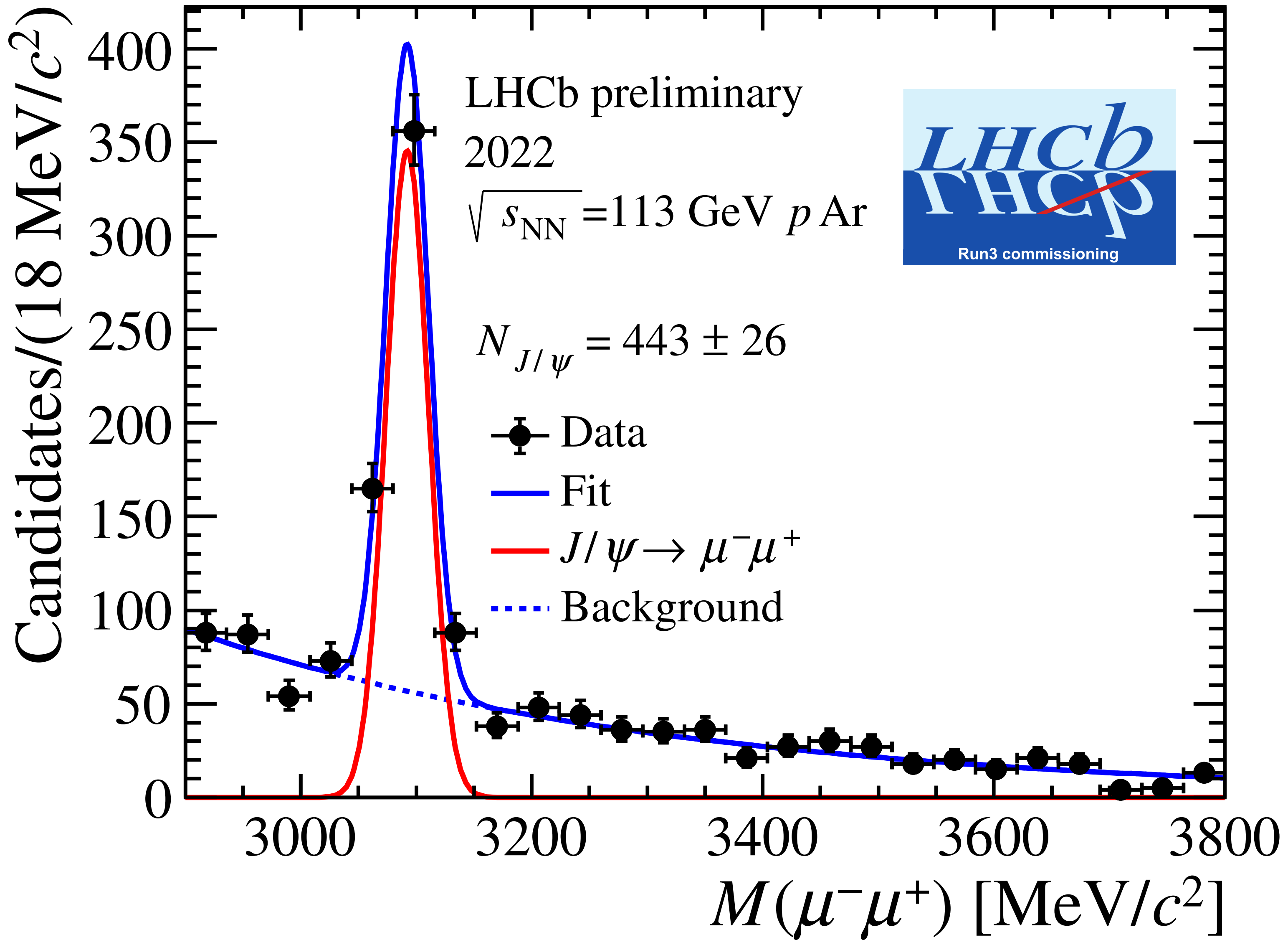




tomography of the cell from residual gas & secondary interactions







LHCb-FIGURE-2023-008

excellent results in ~10 minutes of data taking, albeit low gas pressure & preliminary sub-detector performance as we were commissioning them

SMOG~~2~~ … few of the several results

demonstrator, no storage cell

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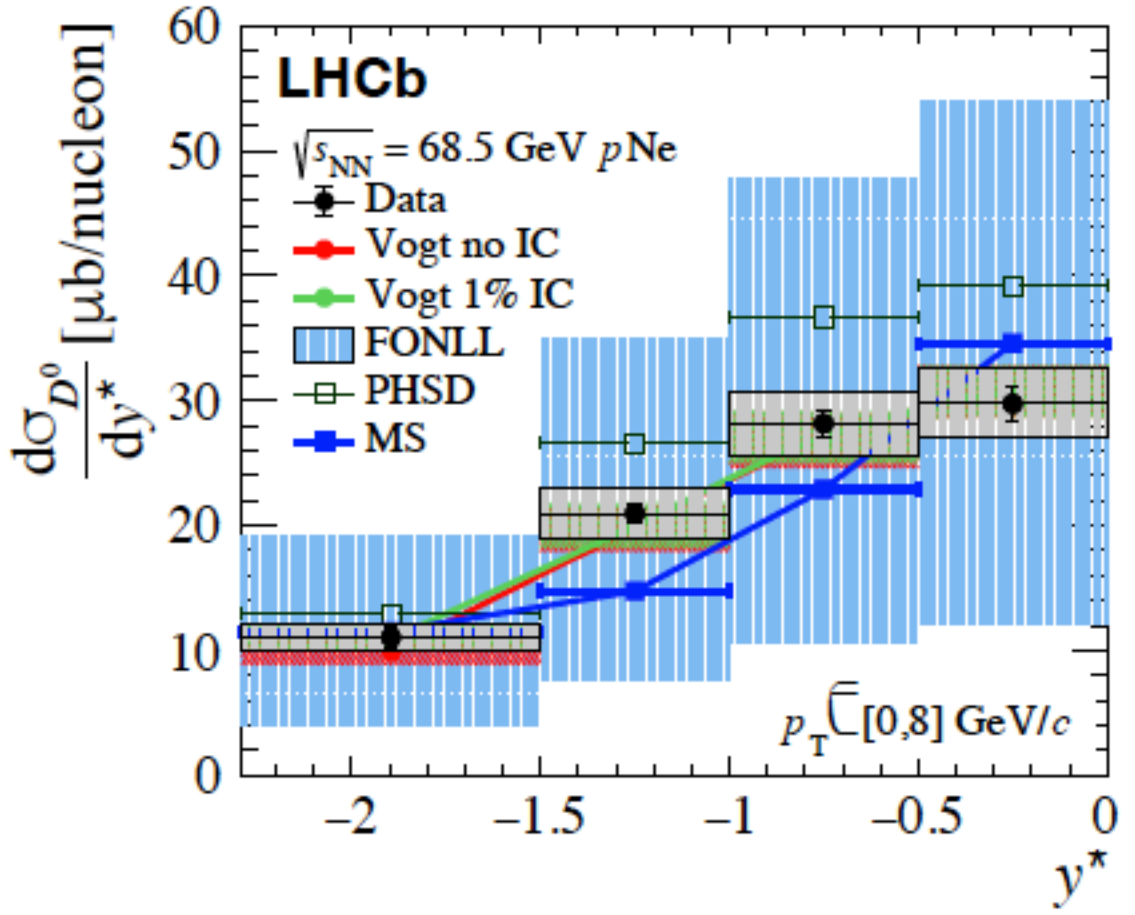
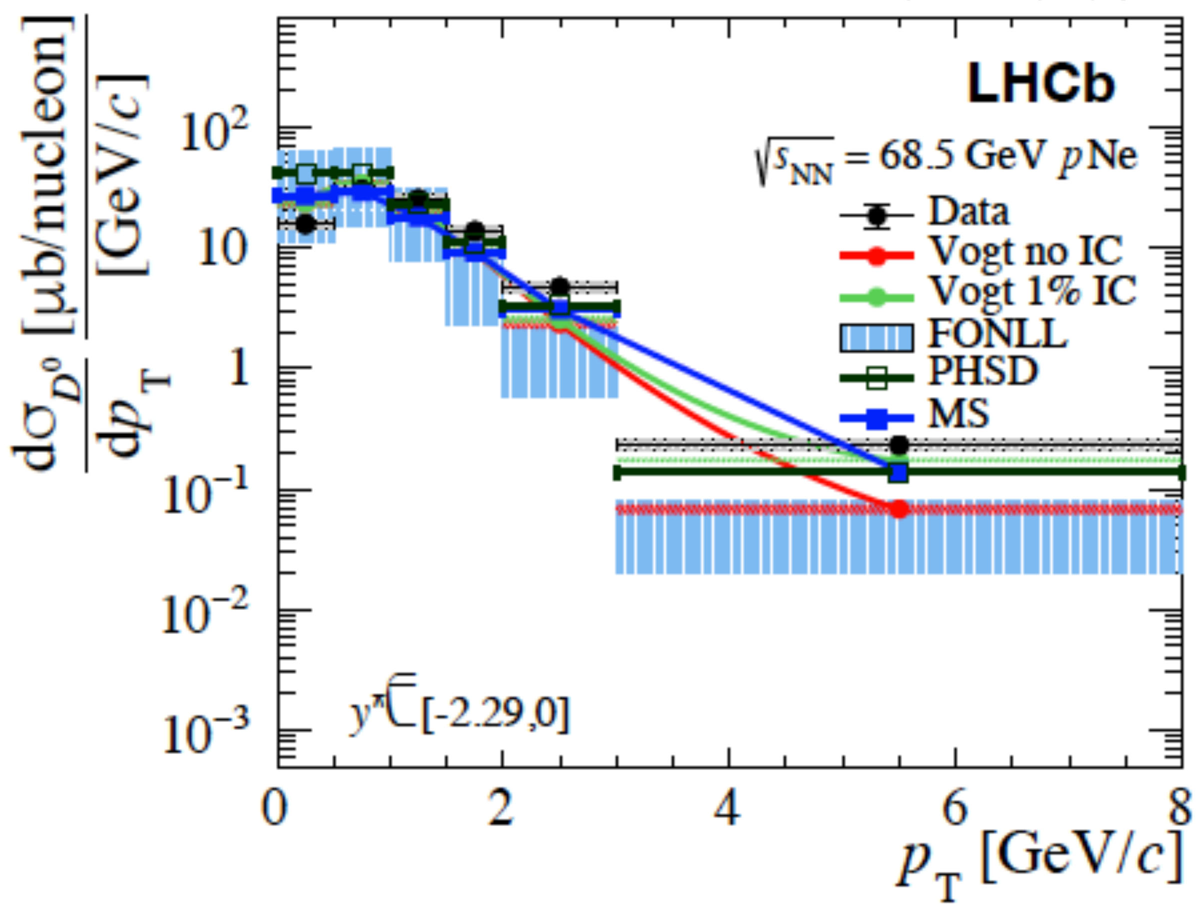
p → Ne 68.5 GeV

D^0 differential cross sections

EPJC 83 (2023) 541

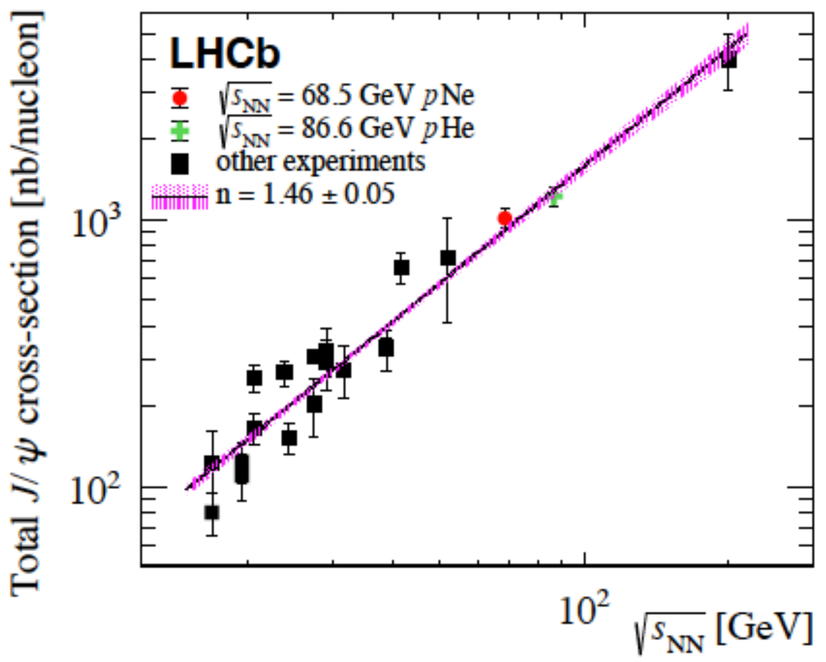


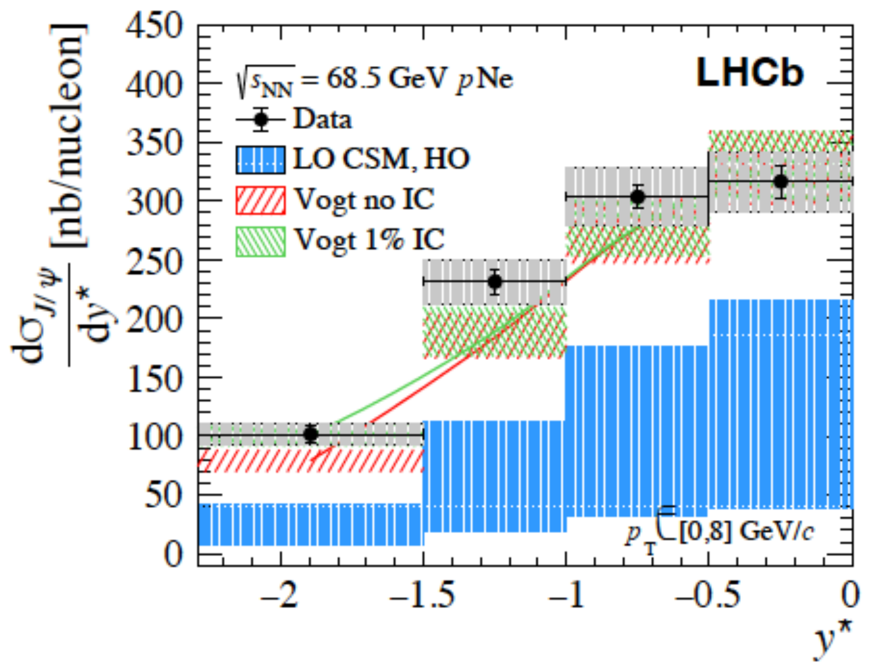


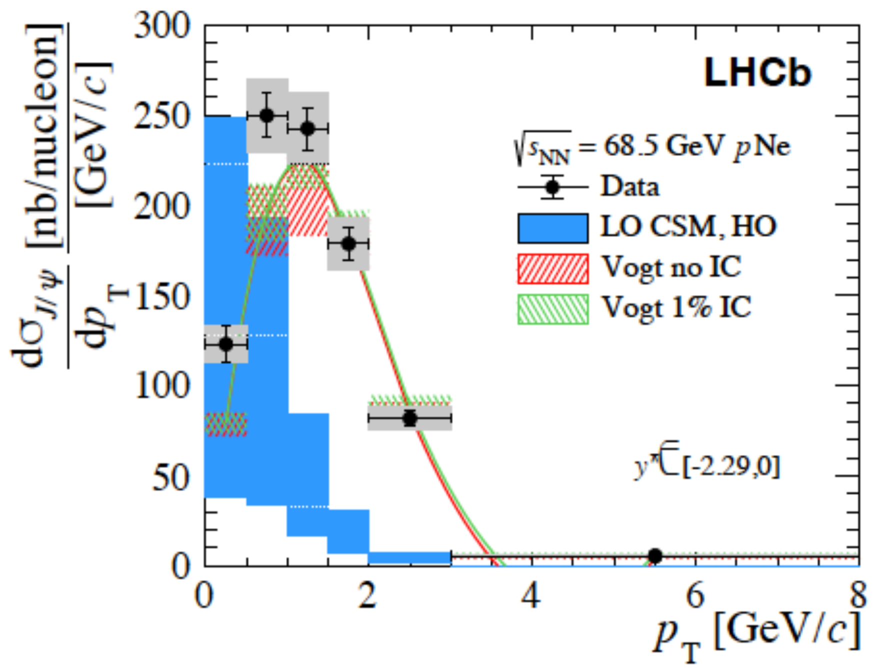
p → Ne 68.5 GeV

p → He 86.6 GeV

EPJC 83 (2023) 625





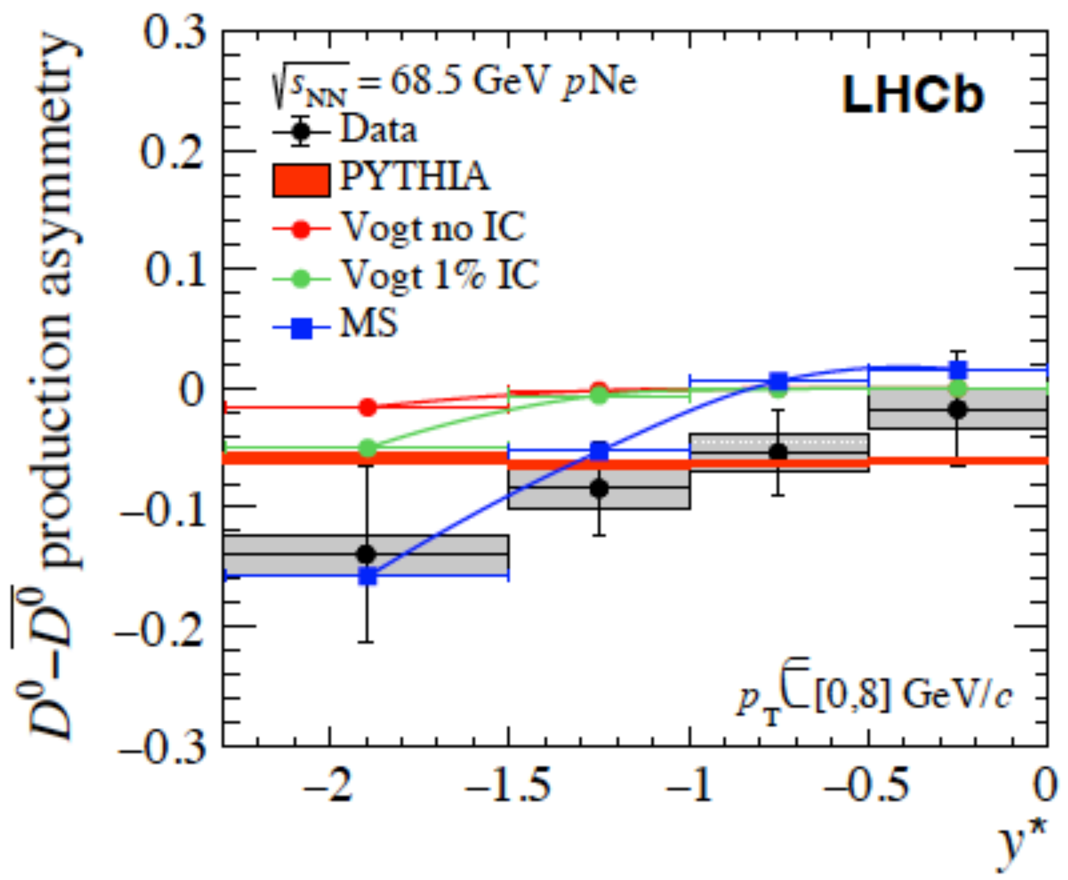


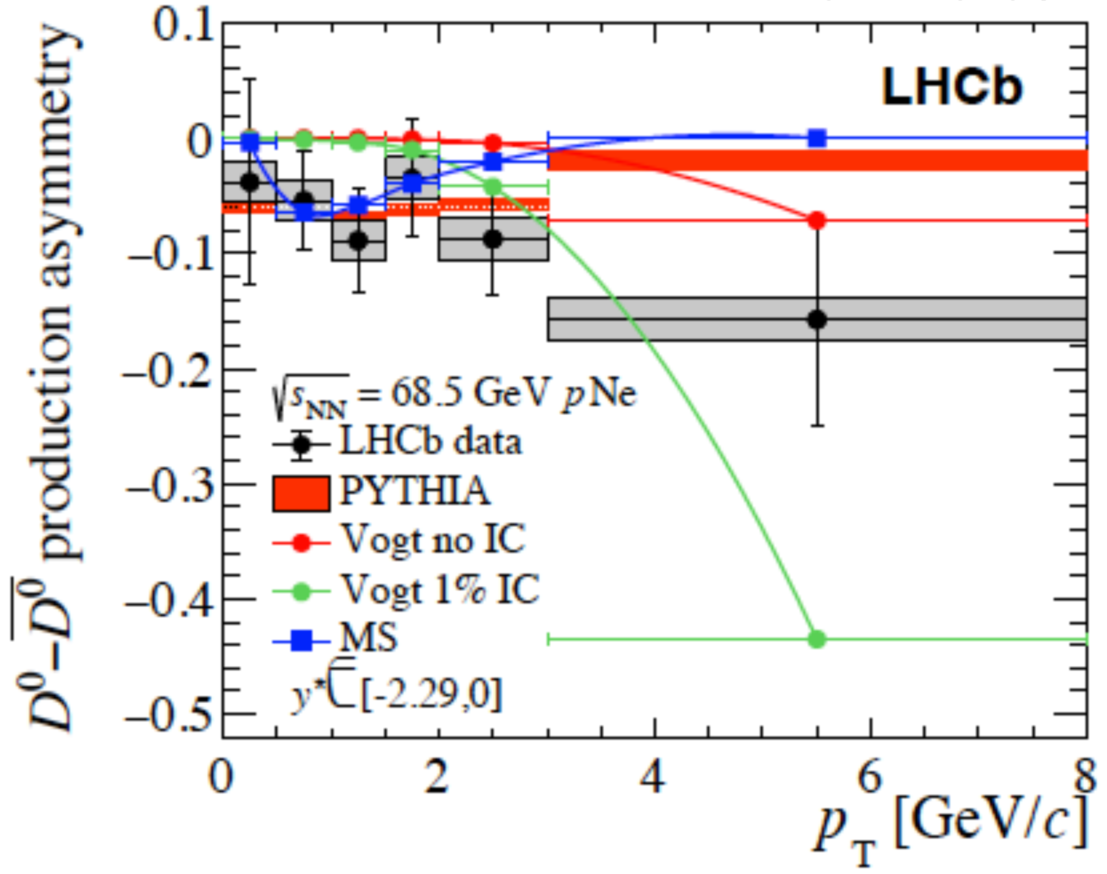
J/ψ cross section

D^0 Production Asymmetry

p → Ne 68.5 GeV

EPJC 83 (2023) 541





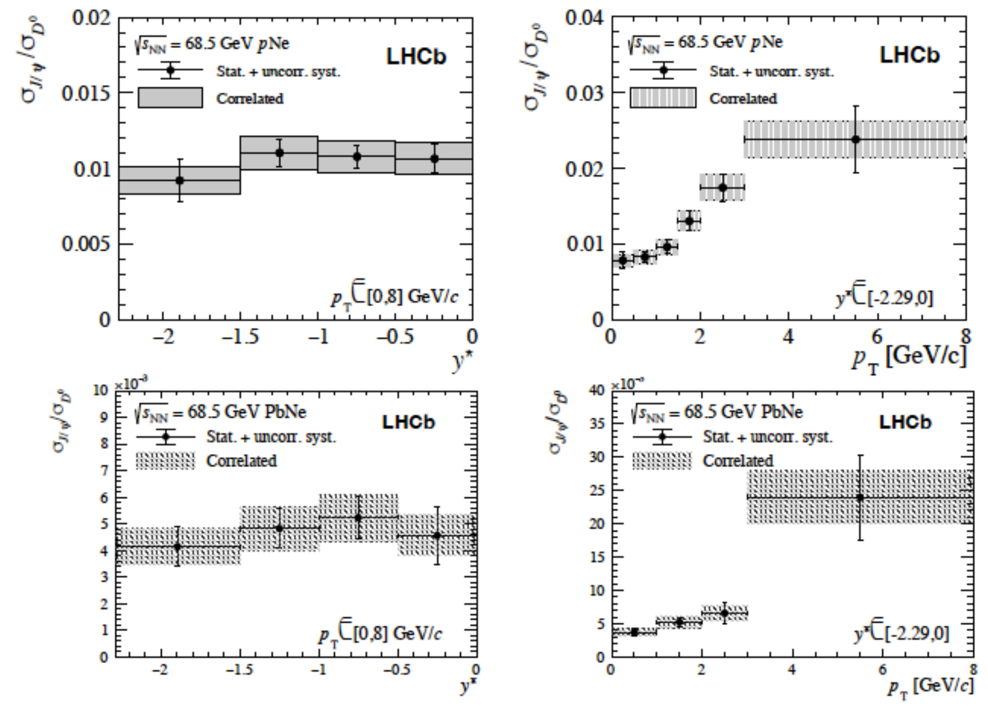
Cross section ratios of J/ψ and D^0 production in PbNe and pNe collisions

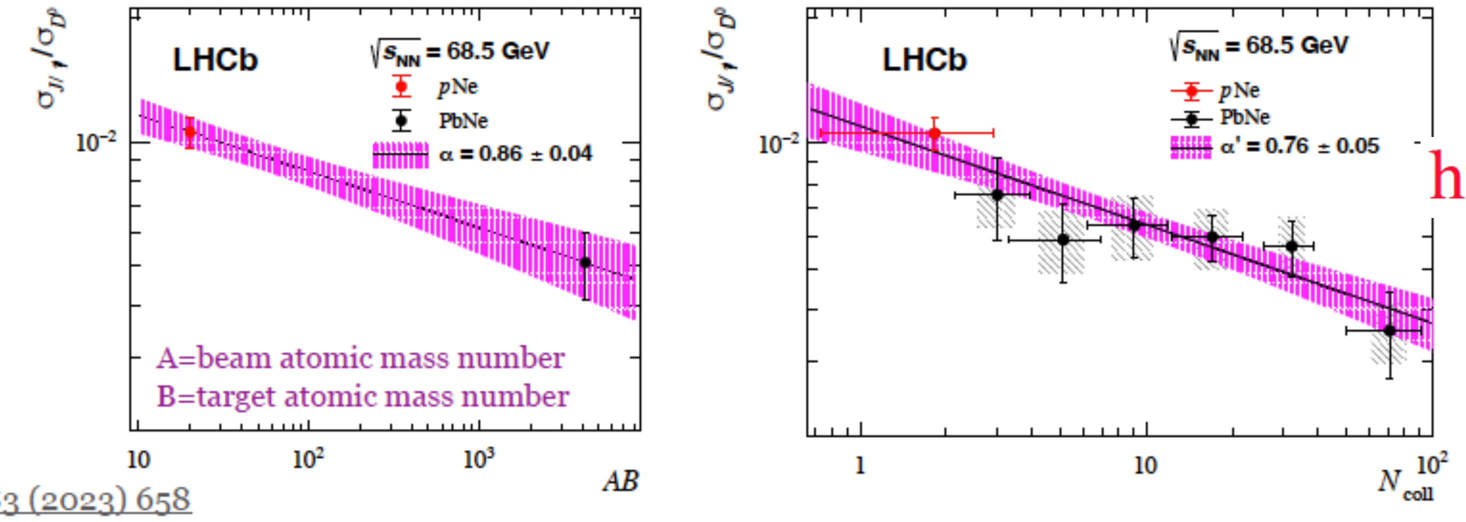
p → Ne

EPJC 83 (2023) 625

EPJC 83 (2023) 658

Pb → Ne





PbNe: EPJC 83 (2023) 658
pNe: EPJC 83 (2023) 625

Nuclear effects on hidden vs open charm

some of the highlights

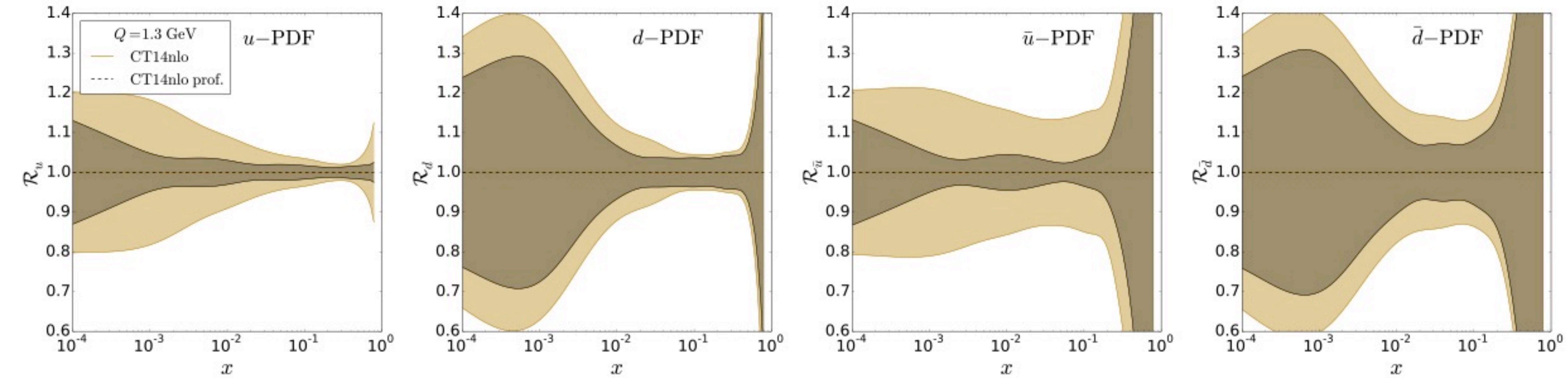
SMOG2 some of the highlights

http://cds.cern.ch/record/2649878/files/

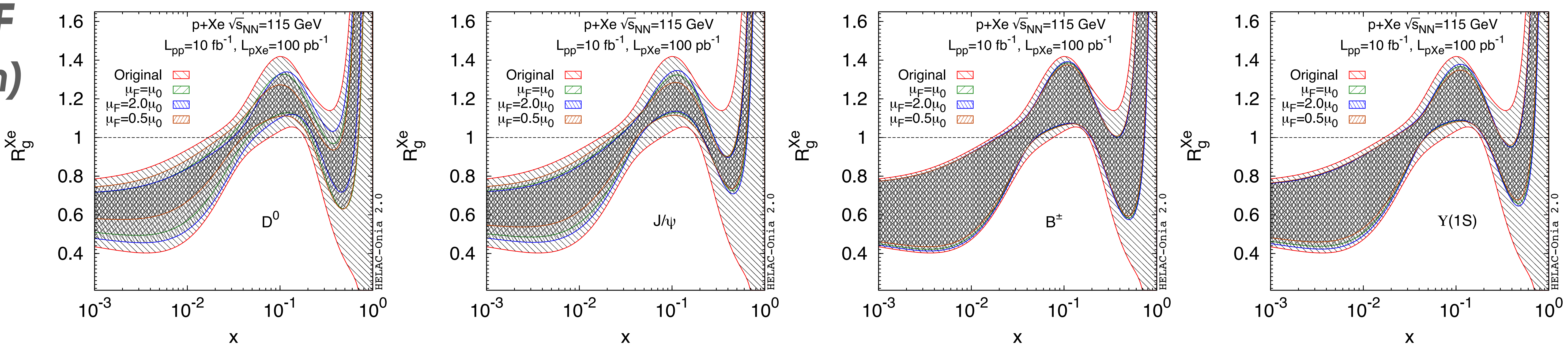
PDF

estimation with 10 fb^{-1}

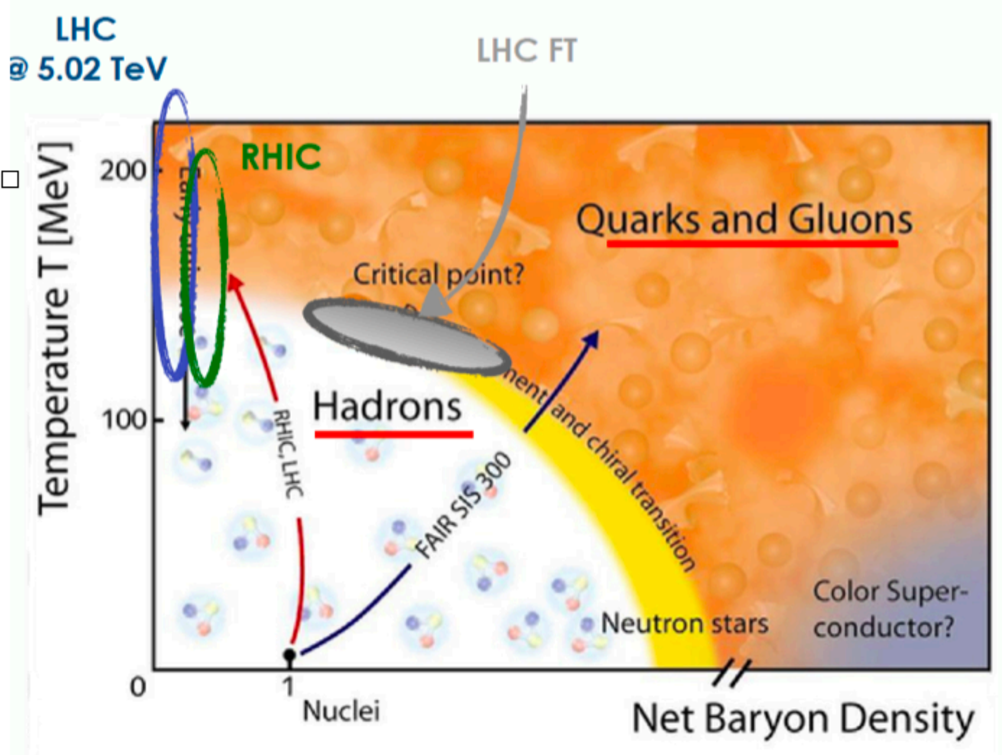
arXiv:1807.00603

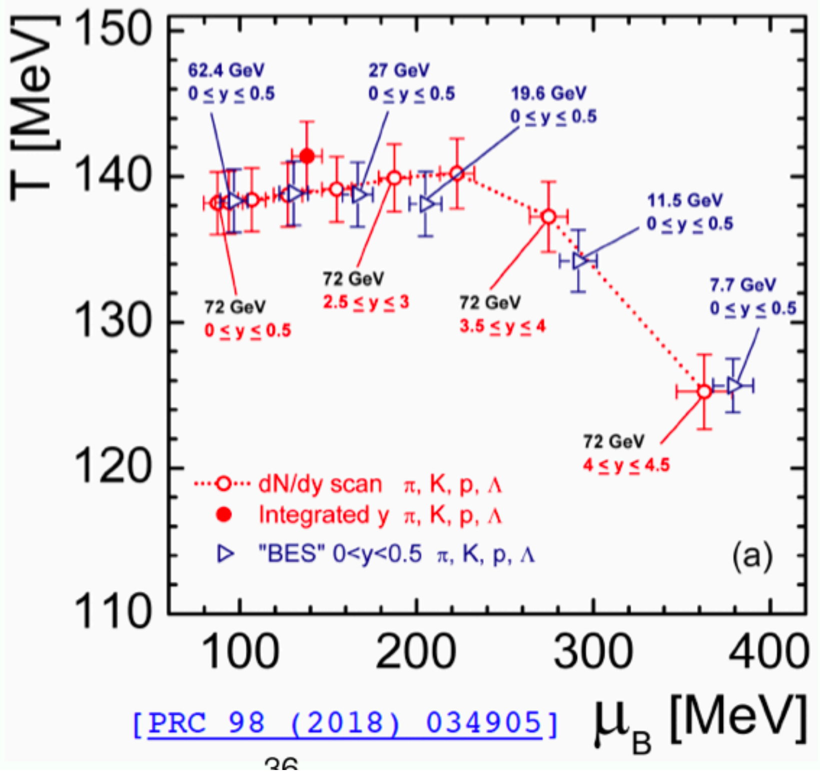


nPDF (gluon)



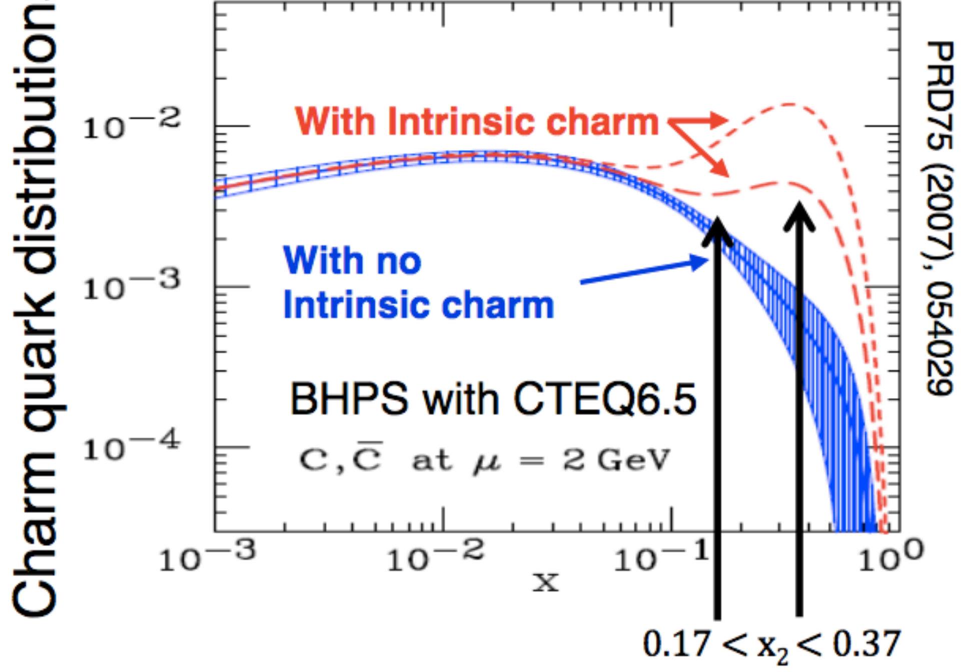
Heavy-Ion and QCD phase space





[PRC 98 (2018) 034905]

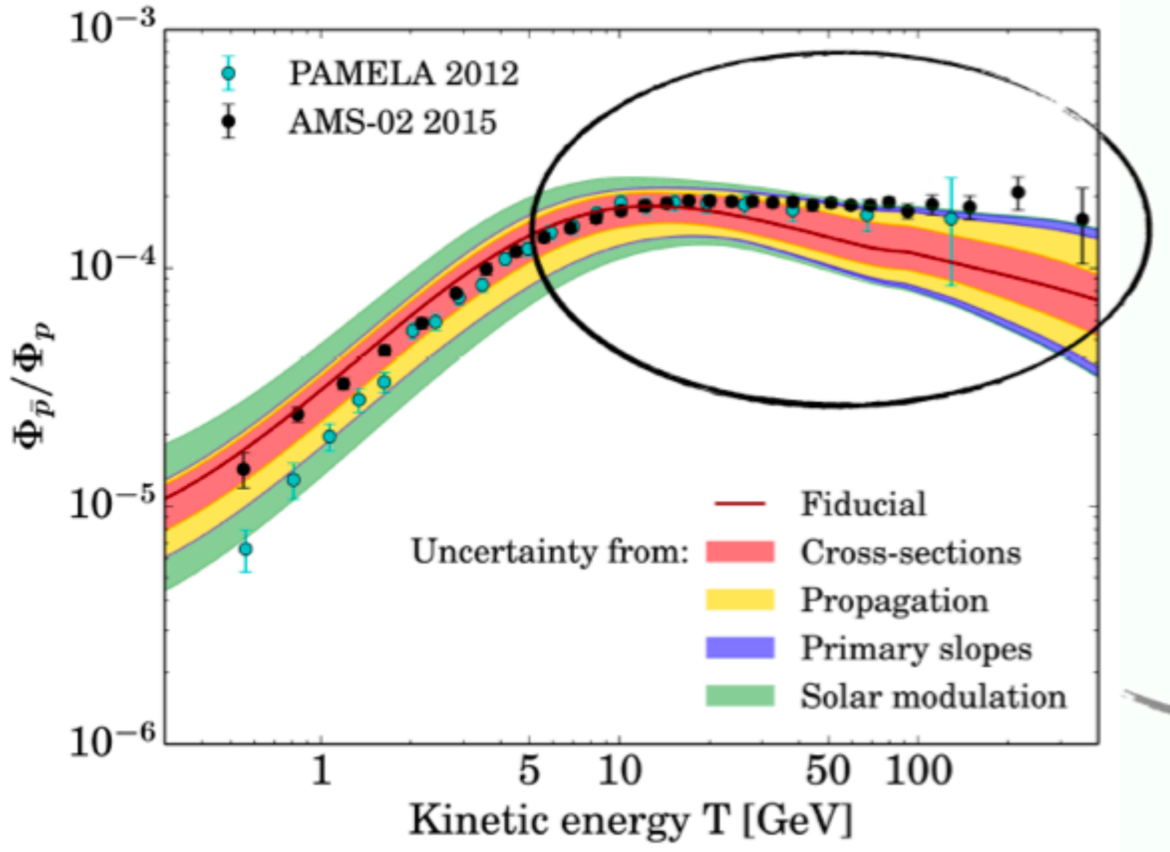
Intrinsic charm



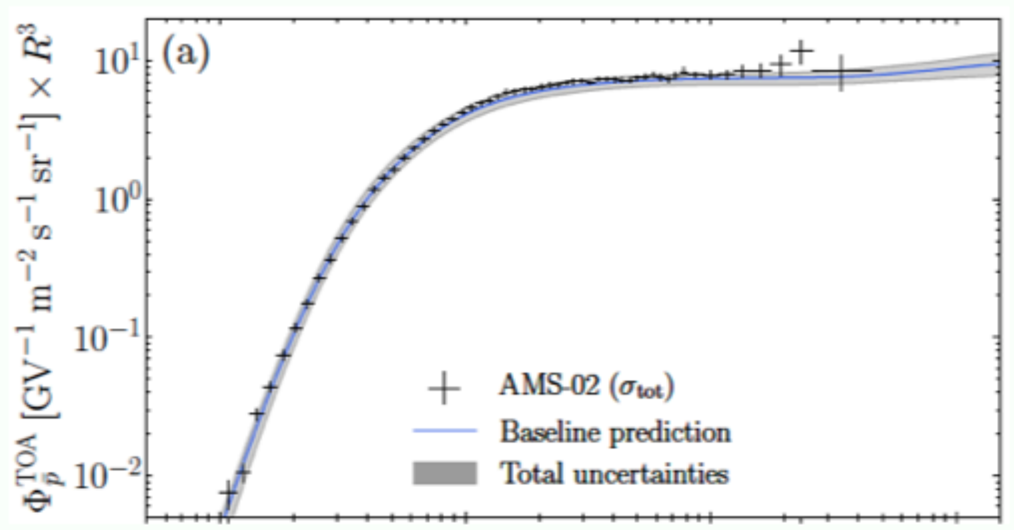
PRD75 (2007), 054029

Astroparticle (DM and CR)

[JCAP09 (2015) 023]

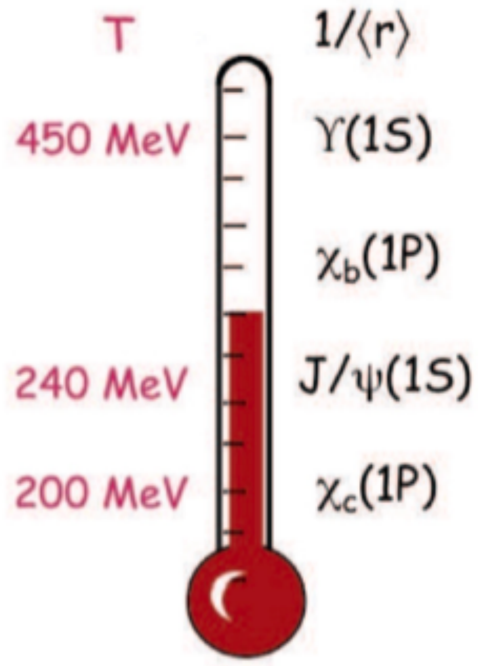


[ArXiv:1906.07119]



- Main uncertainty still due to cross sections!

$c\bar{c}$ bound states



Special Runs

$^{16}O + p \rightarrow \bar{p} + X$ and $^{16}O + ^{4}He \rightarrow \bar{p} + X$ [CERN-LPCC-2018-07]

SMOG2 some of the highlights

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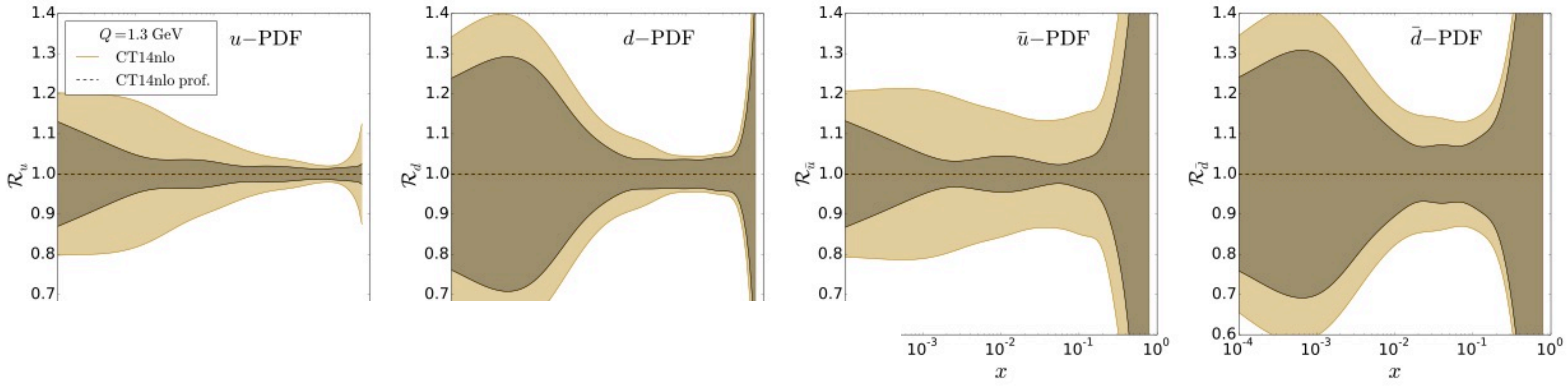
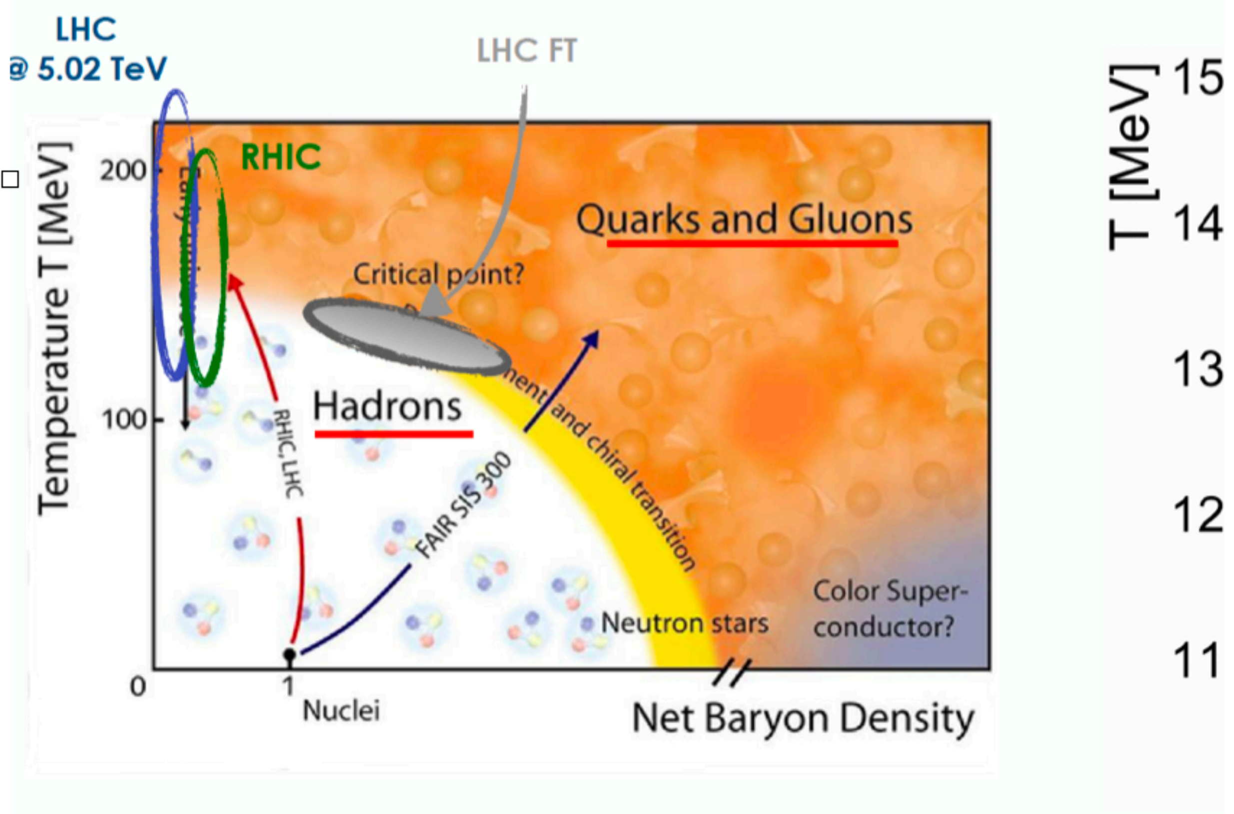


Heavy-Ion and QCD p



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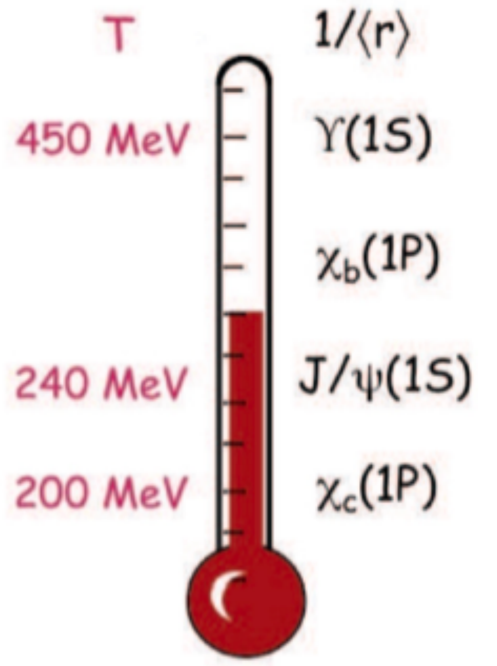
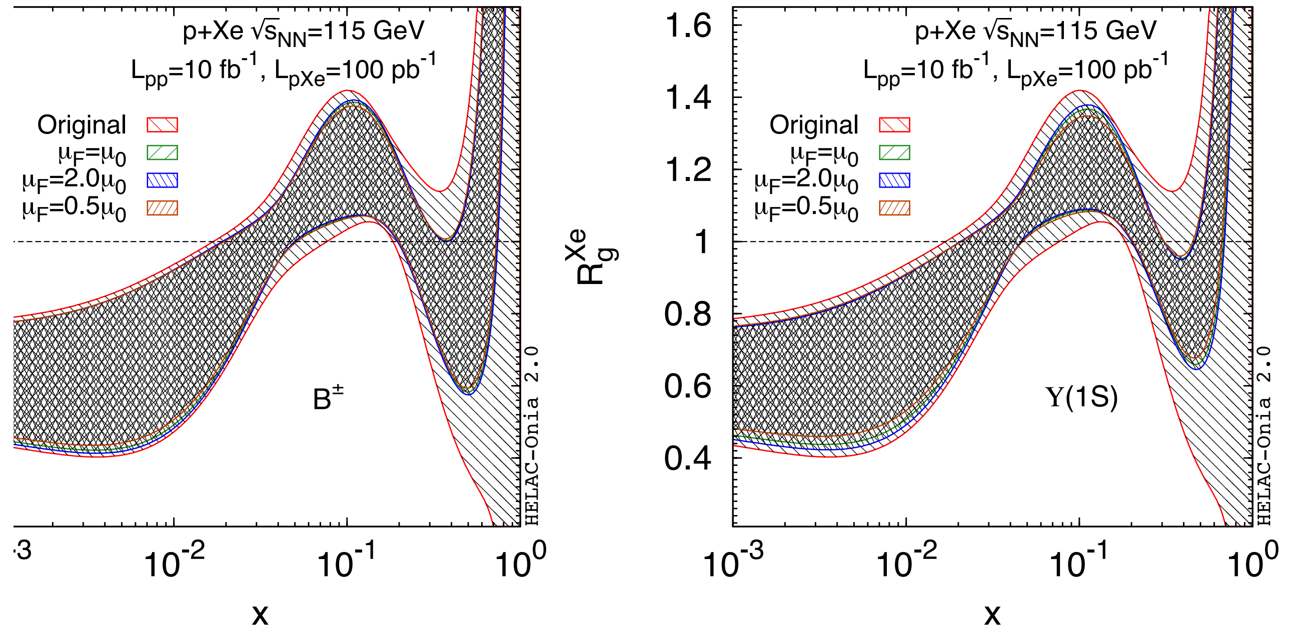


We can already enter in the field of the polarized physics

f_1^q	$h_1^{\perp,q}$	Boer-Mulders TMD
f_1^g	$h_1^{\perp,g}$	linearly-polarized gluon TMD



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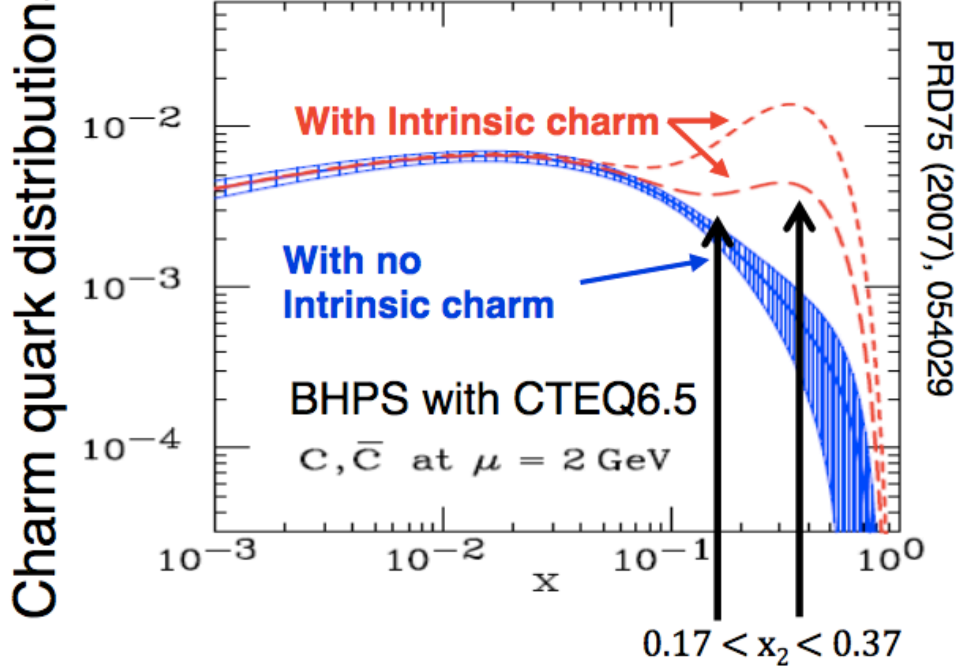

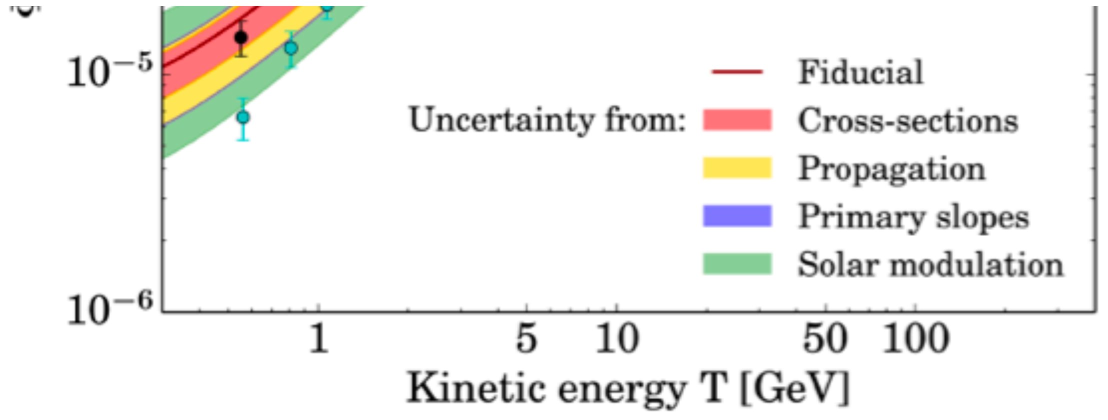

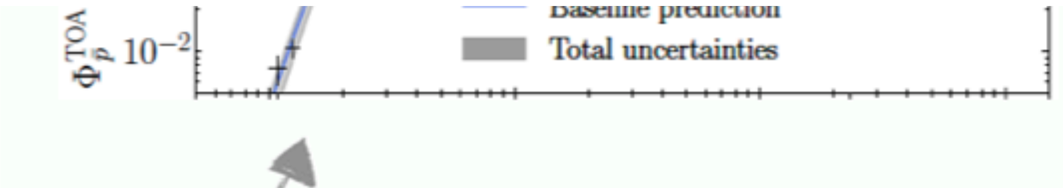

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LHCspin the polarised target project

SMOG2 is not only a unique project itself,

but also a great playground for LHCspin

LHCspin the polarised target project

arXiv:1901.08002
Acta Phys.Polon.Supp. 16 (2023) 7
PoS PSTP2022 (2023) 001

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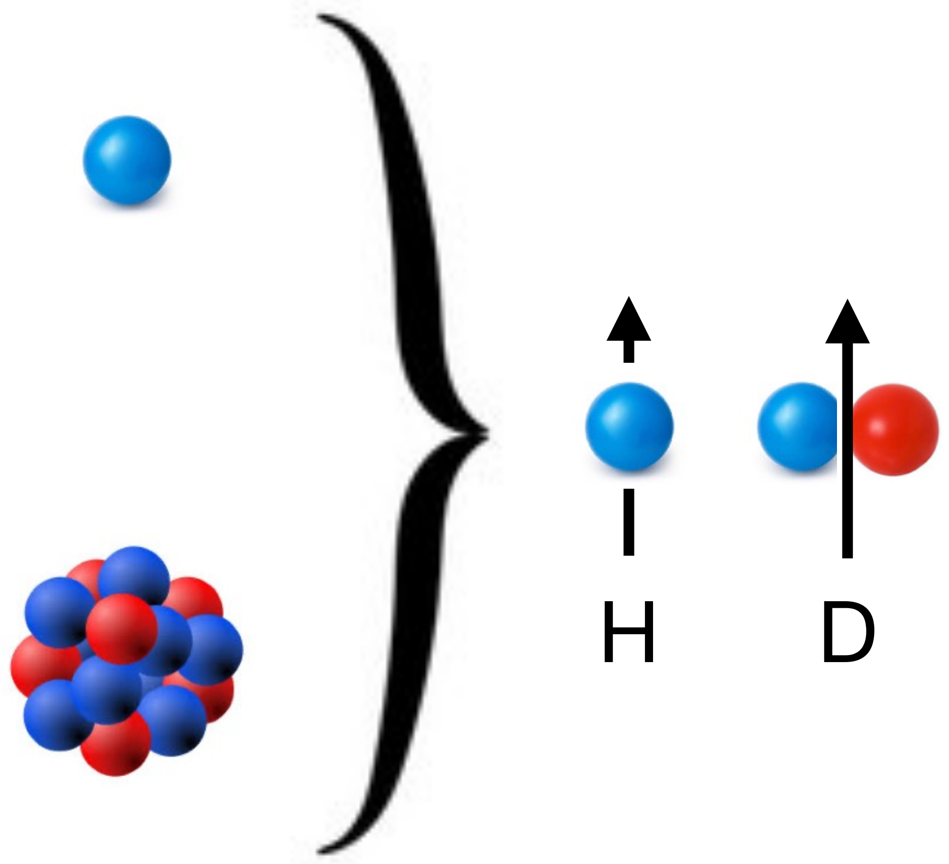
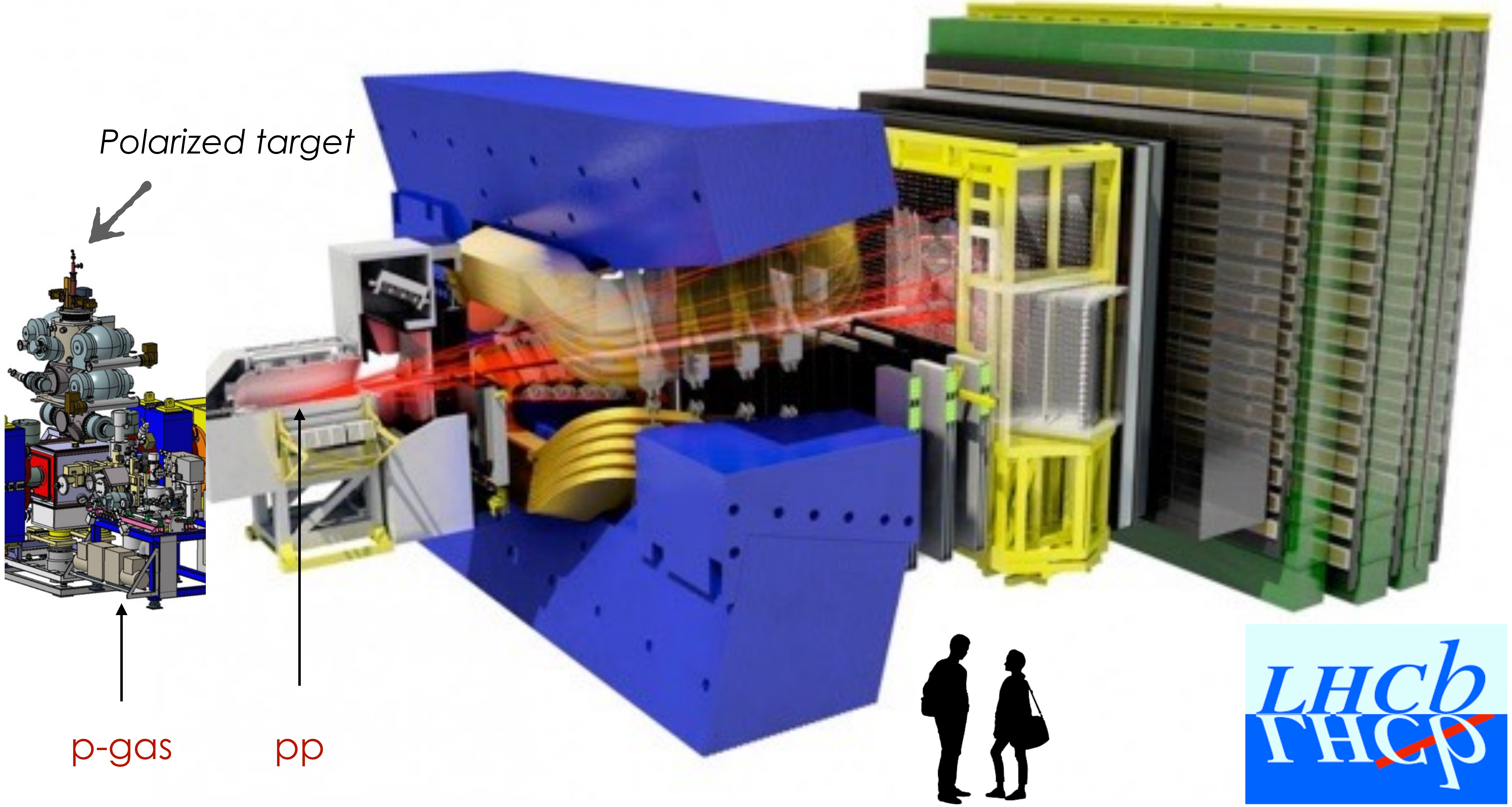


Successful technology based on HERA and COSY experiments

Challenge: develop a new generation of polarized targets

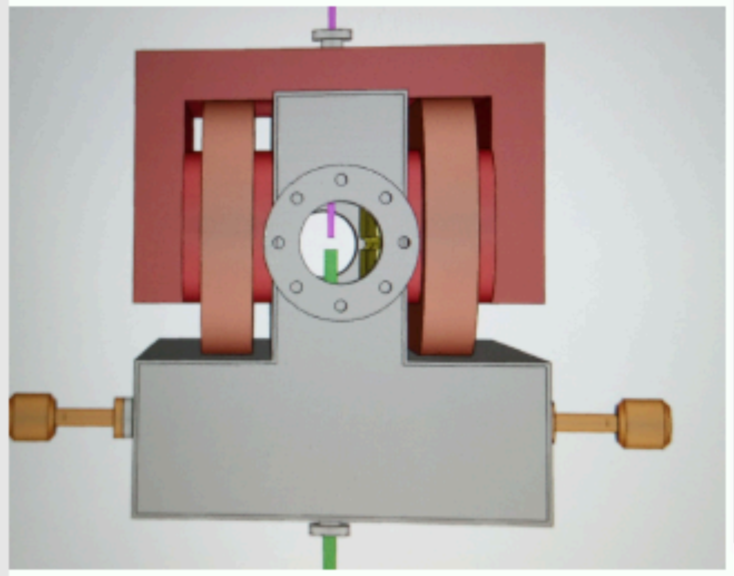


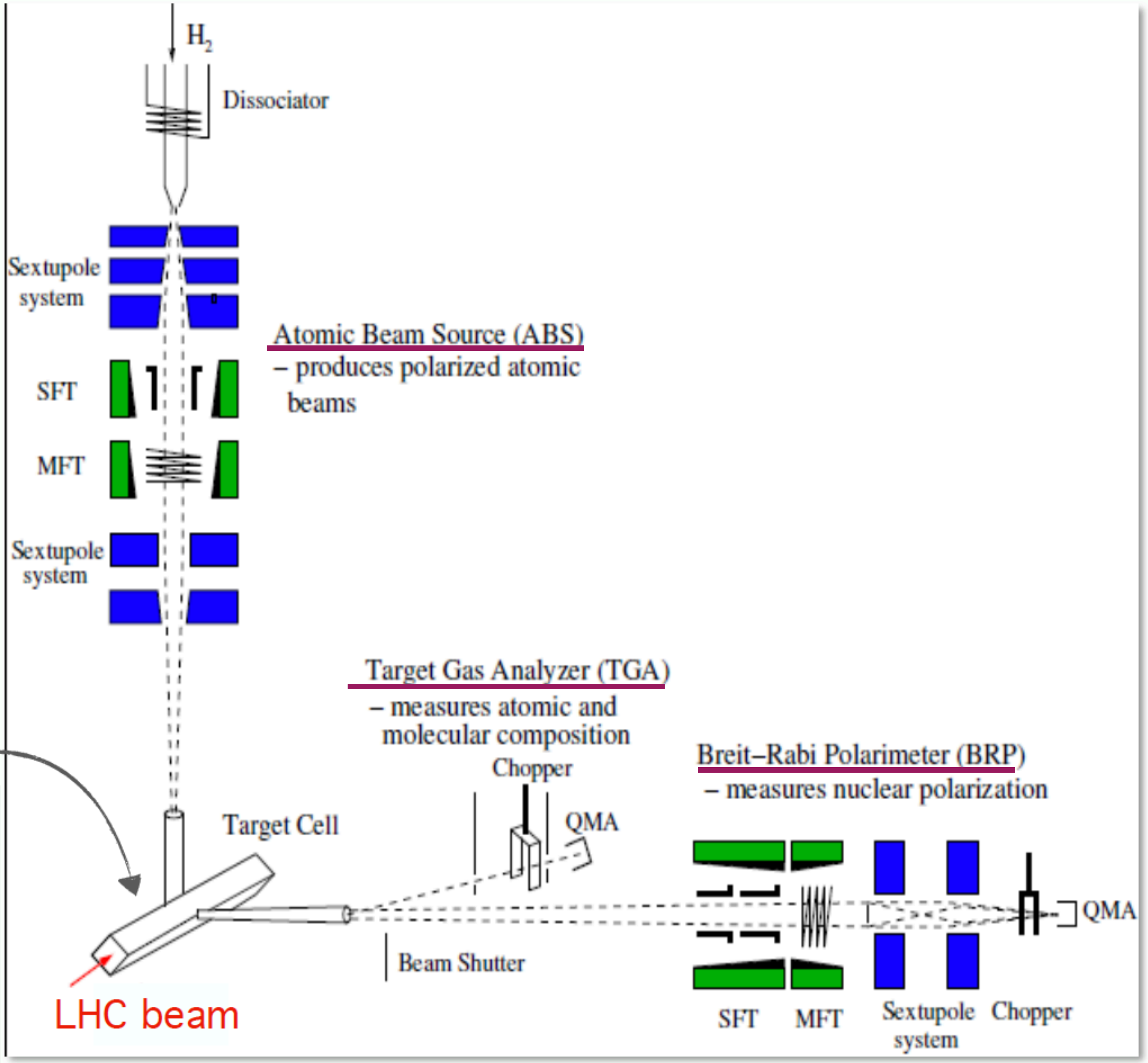
LHCspin experimental setup

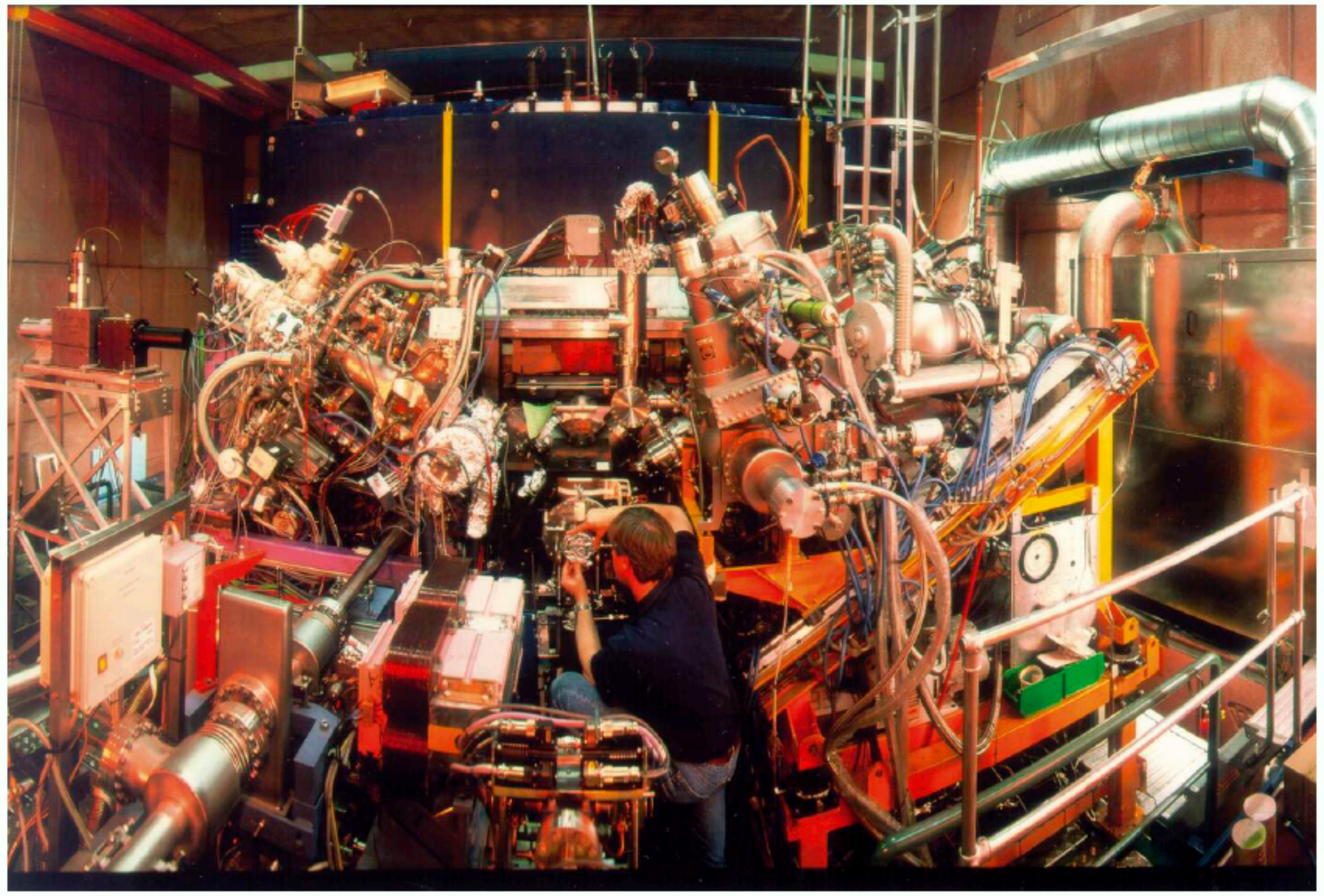
Target density (H) = 7 x 10^{13} cm^{-2}
LHC beam (Run4) = 6.8 x 10^{18} p s^{-1}

$$\boldsymbol{L_{pH} = 8 \times 10^{32}\ \mathrm{cm^{-2}\ s^{-2}}}$$

dipole



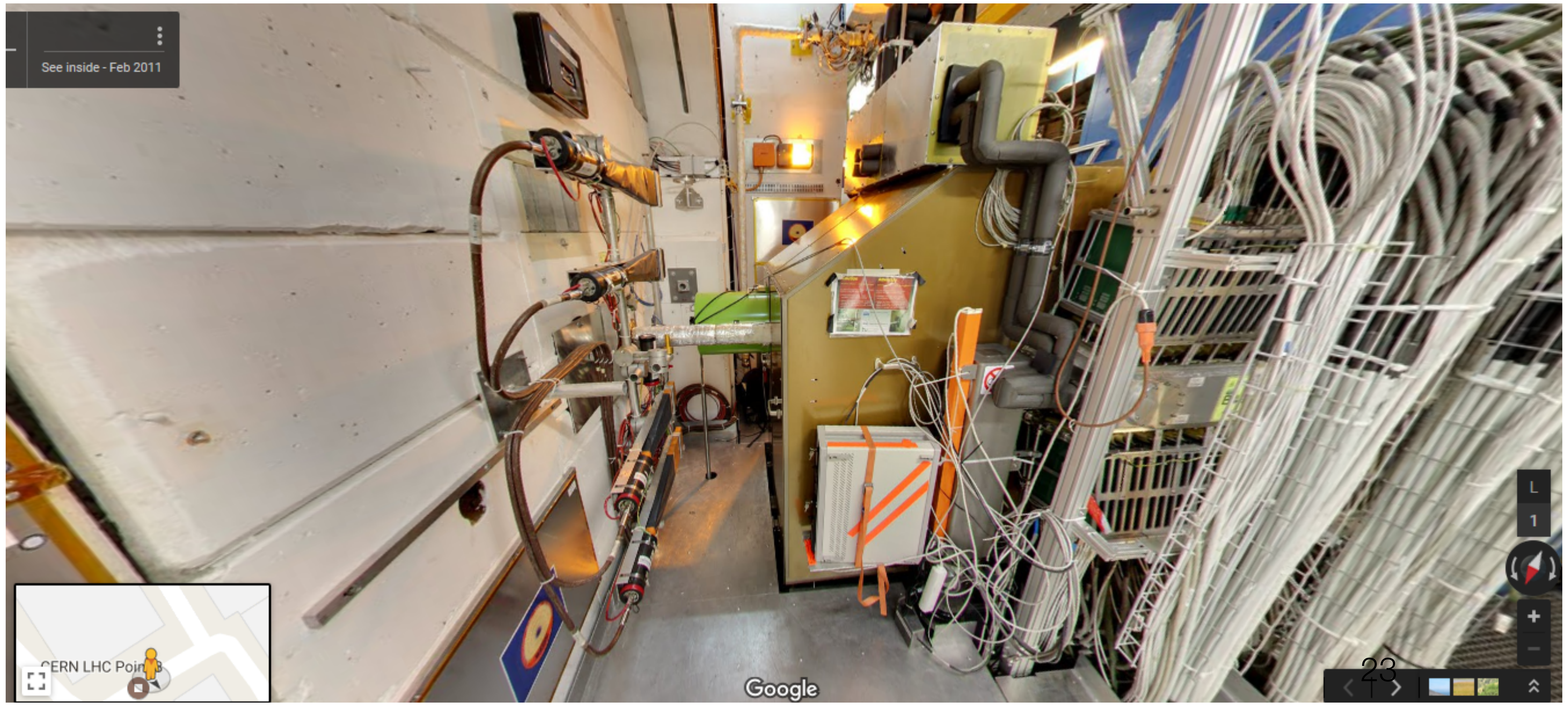




[NIMA 540 (2005) 68-101]

HERMES PGT

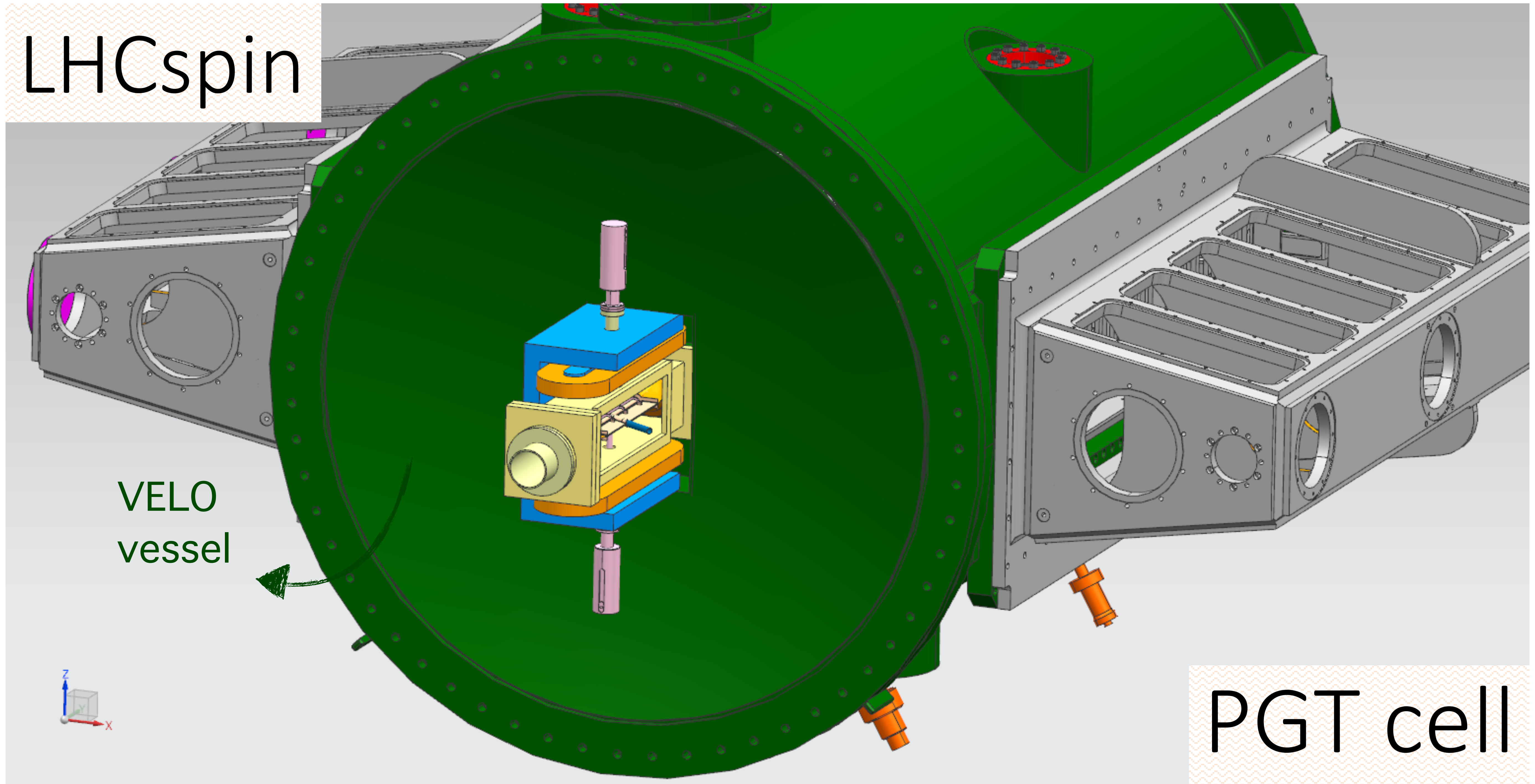
From there to here

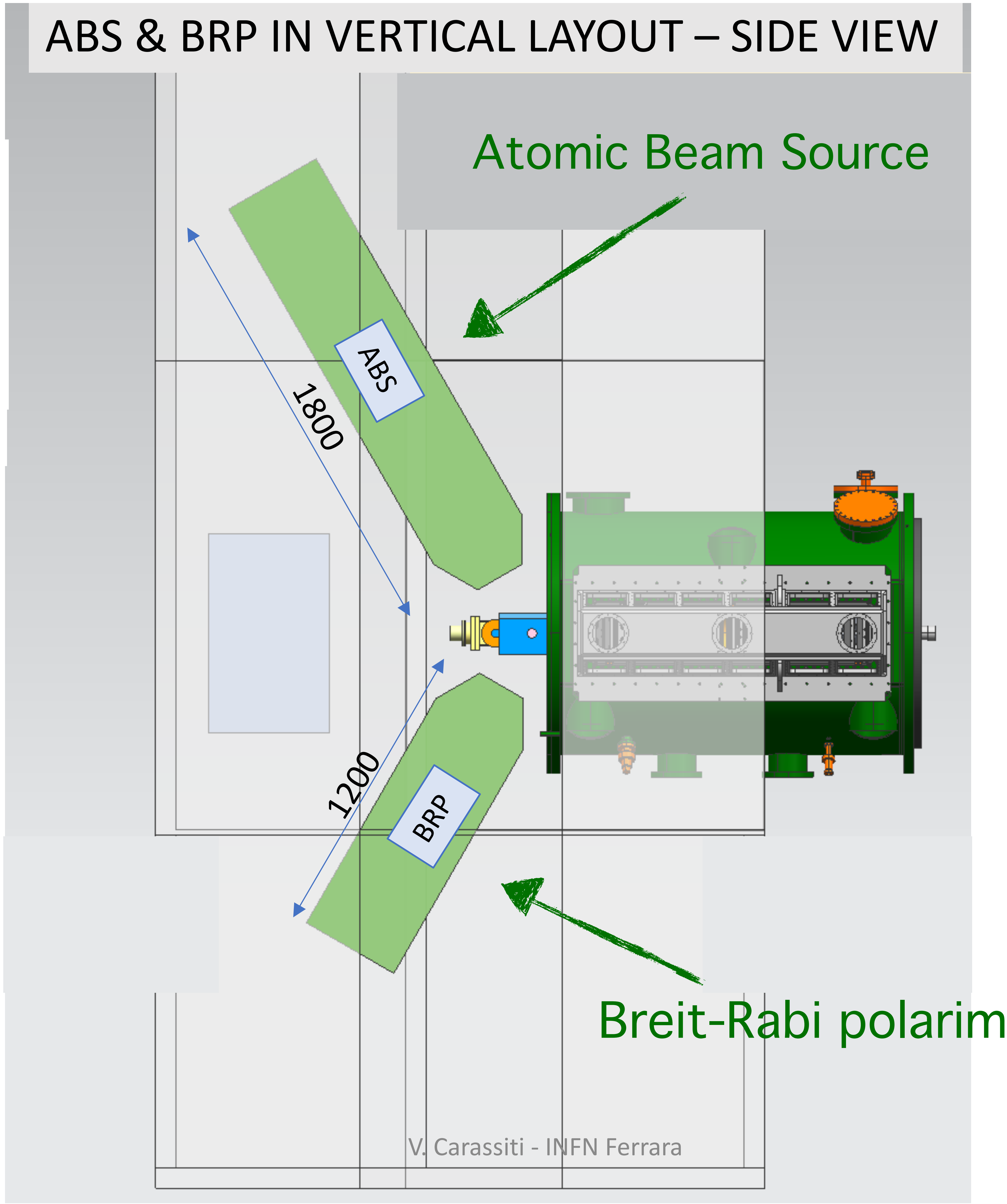


Space available in front of LHCb

PGT implementation into LHCb

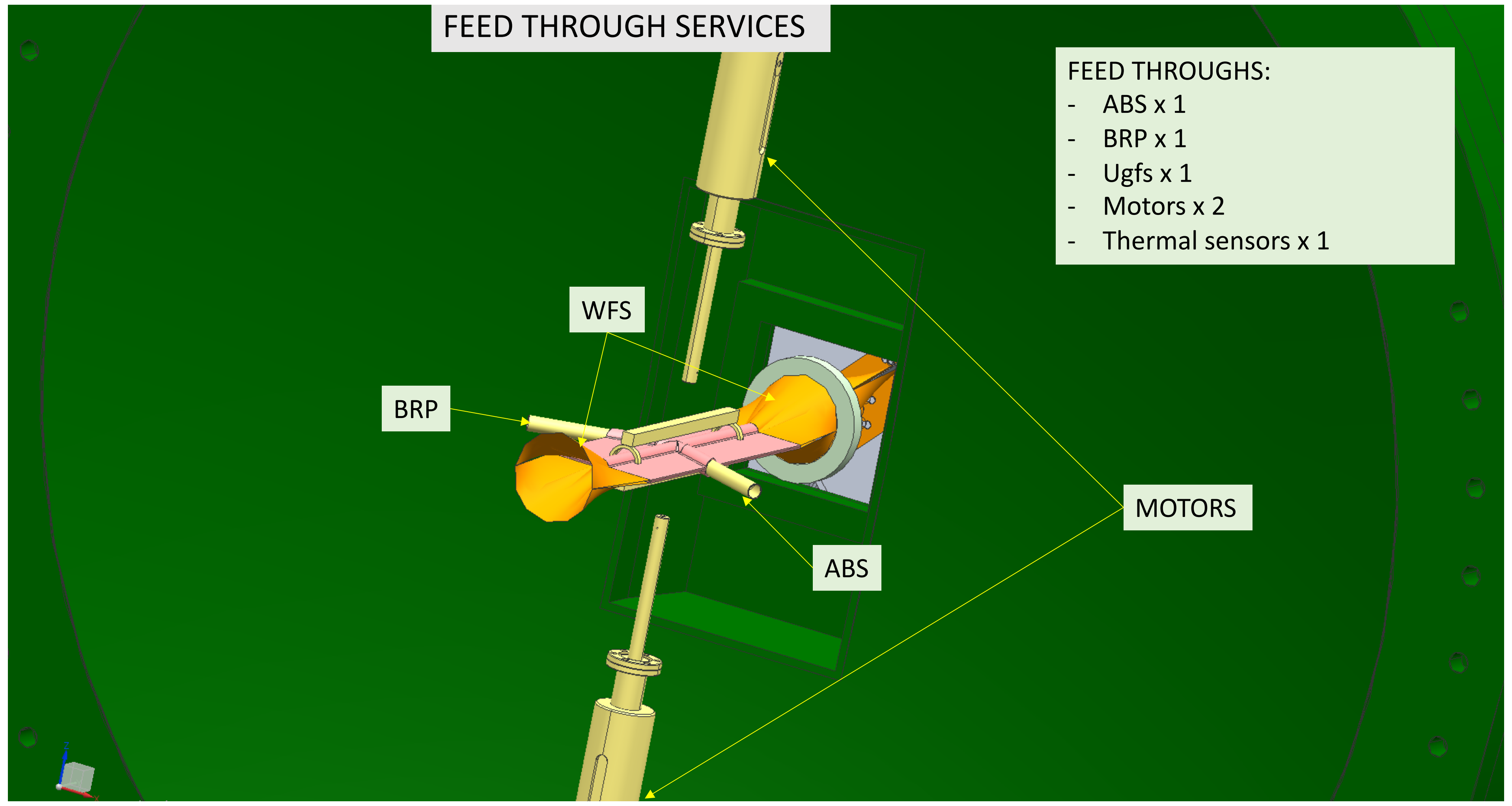
- Cylindrical target cell with SMOG2 dimensions: $L = 20\ \mathrm{cm}$ and $D = 1\ \mathrm{cm}$
- Full LHCb simulations show broader kinematic acceptance & higher efficiency in the same position of the SMOG2 cell





PGT implementation into LHCb

- Inject polarised gas via ABS and unpolarised gas via UGFS

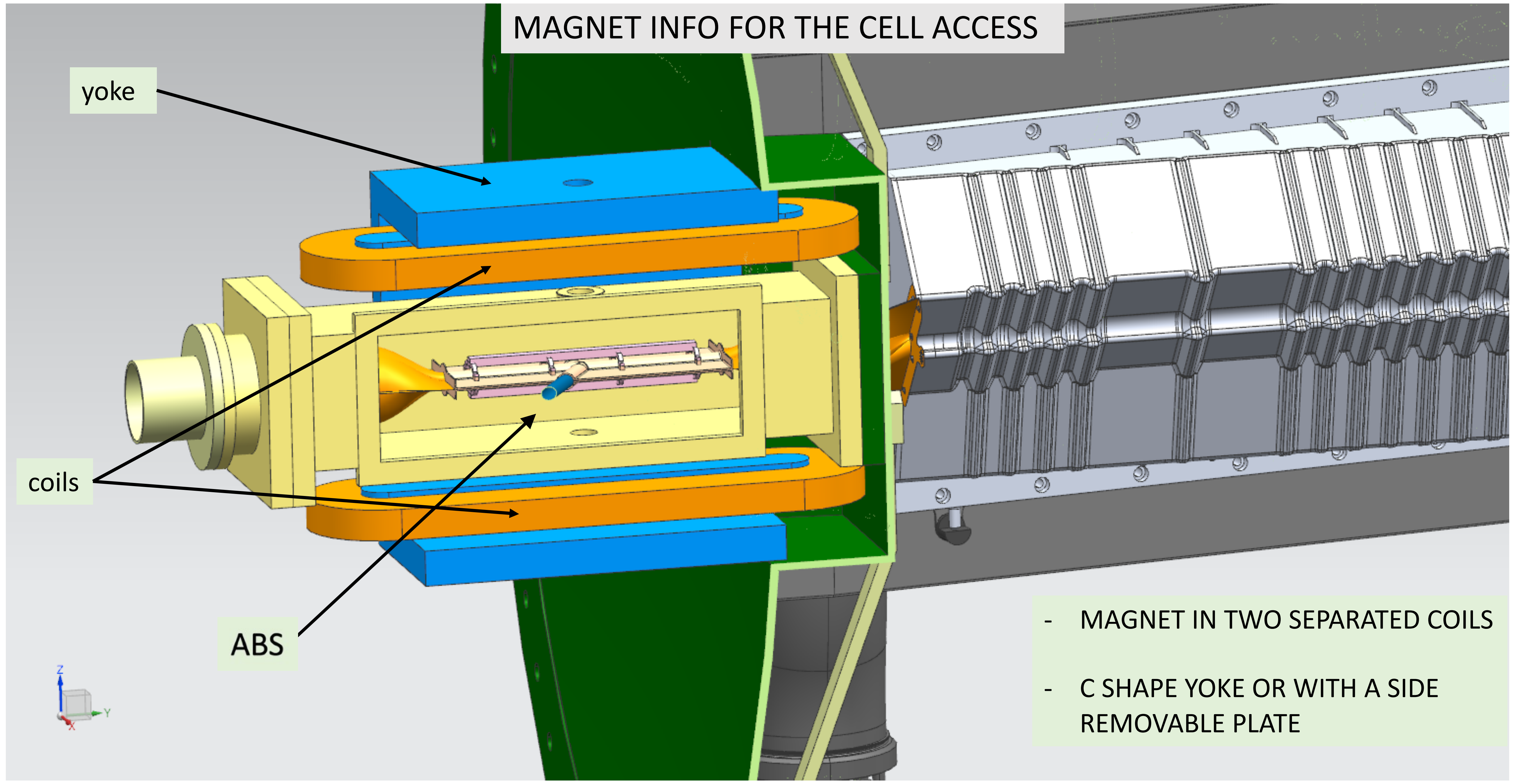


FEED THROUGHS:
- ABS x 1
- BRP x 1
- Ugfs x 1
- Motors x 2
- Thermal sensors x 1

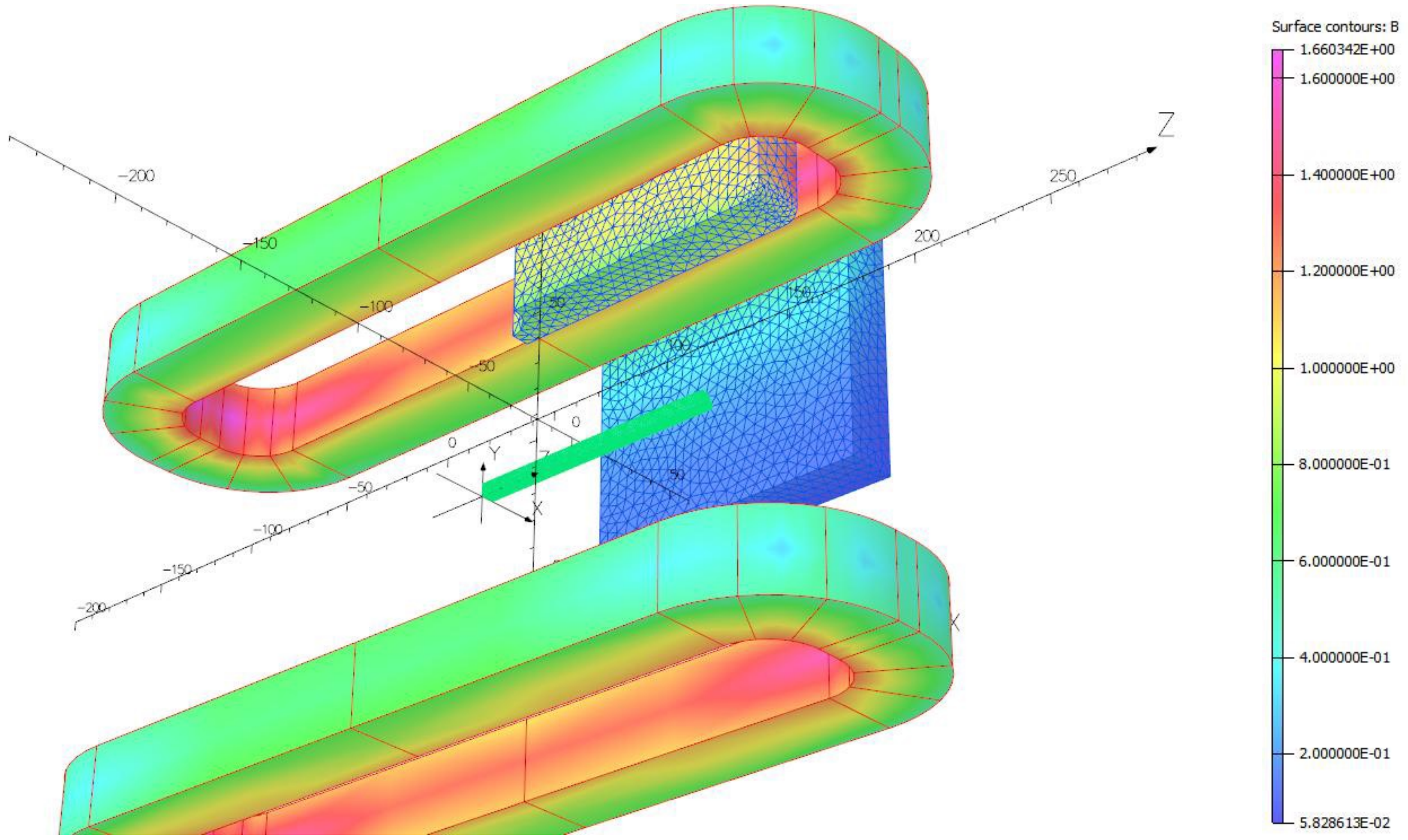
- Compact dipole magnet → static transverse field
- Superconductive coils + iron yoke configuration fits the space constraints
- $B = 300\ \mathrm{mT}$ with polarity inversion, $\Delta B/B \simeq 10\,\%$, suitable to avoid beam-induced depolarisation [PoS (SPIN2018)]

Possibility to switch to a solenoid and provide longitudinal polarisation

Transverse polarisation

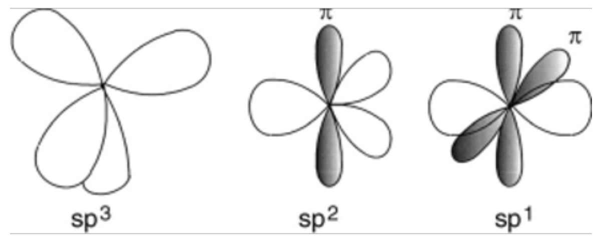


- MAGNET IN TWO SEPARATED COILS
- C SHAPE YOKE OR WITH A SIDE REMOVABLE PLATE



Role of the storage cell coating

Carbon thin films



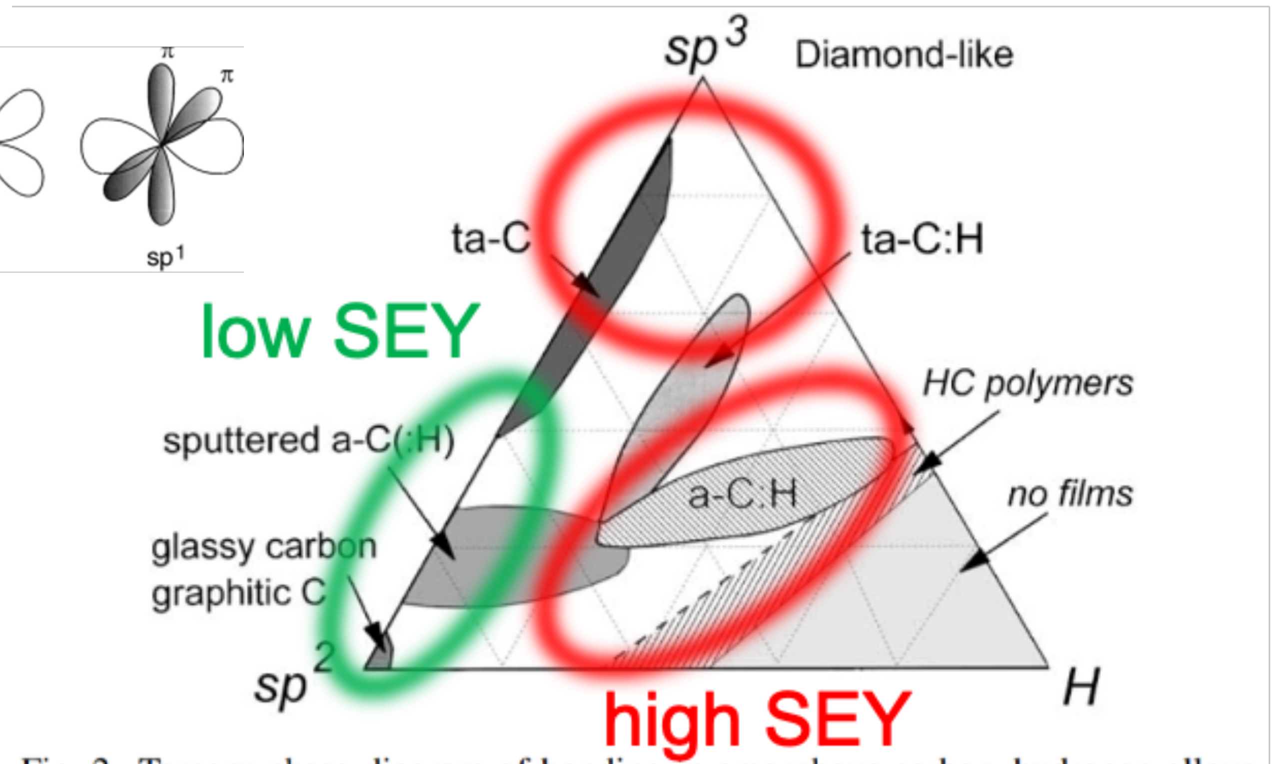
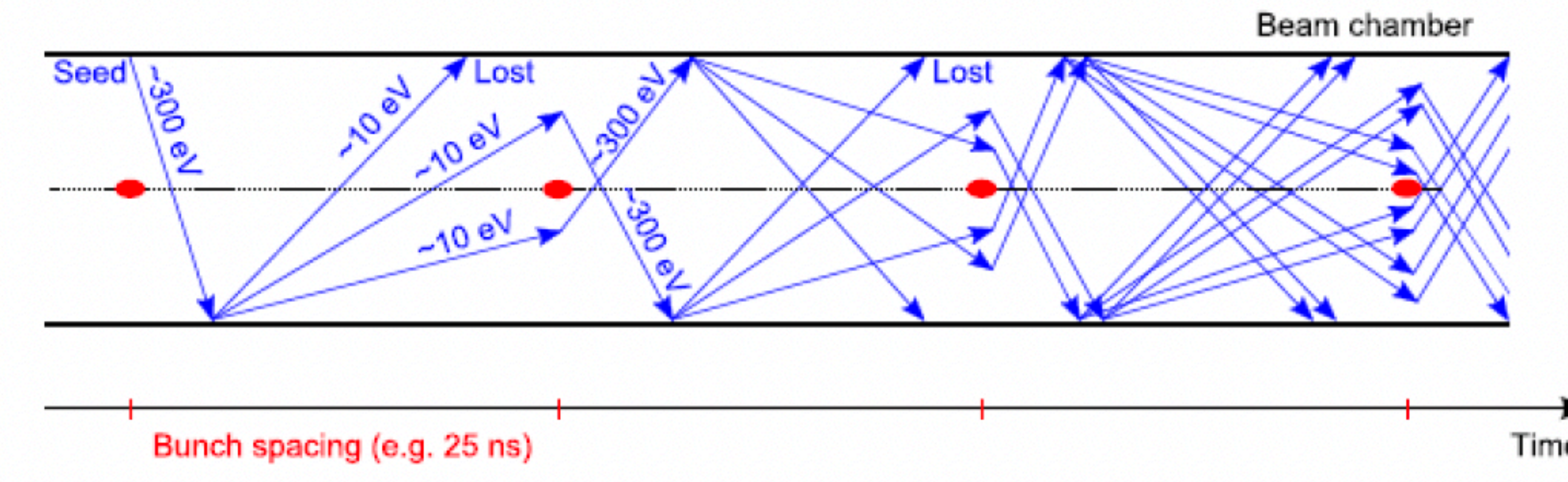


Fig. 2. Ternary phase diagram of bonding in amorphous carbon–hydrogen alloys.

J. Robertson/Materials Science and Engineering R 37 (2002) 129–281



The material of the cell walls must have a low Secondary Electron Yield (e-cloud)

As for SMOG2, Amorphous Carbon is ok. Has it a low H recombination as well?

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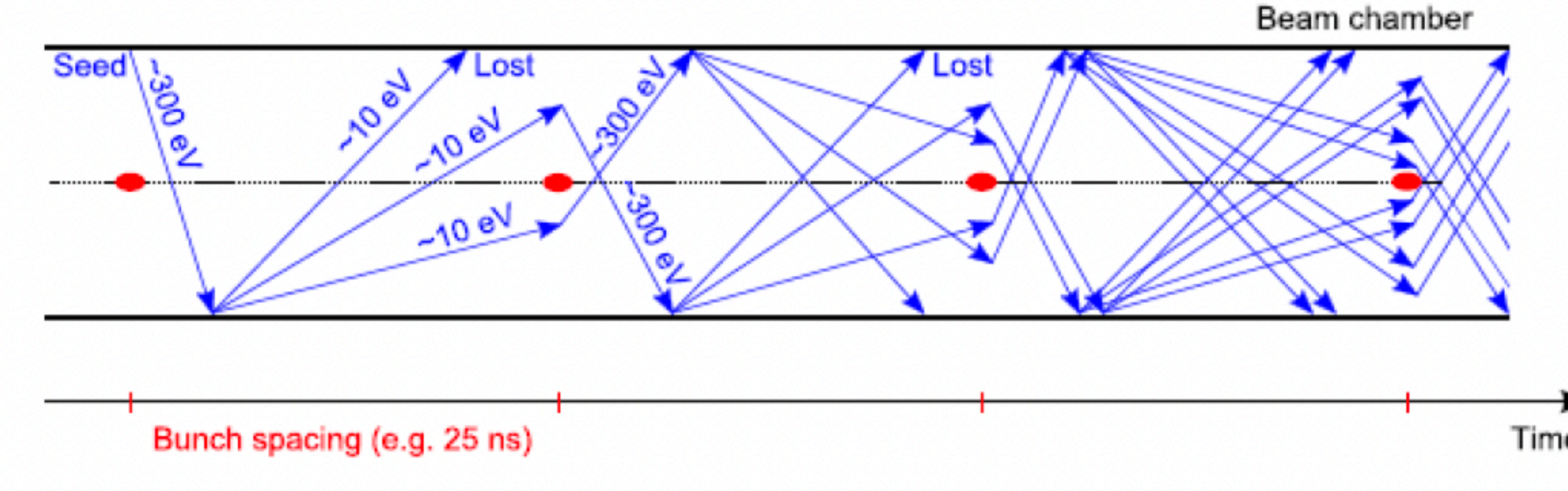

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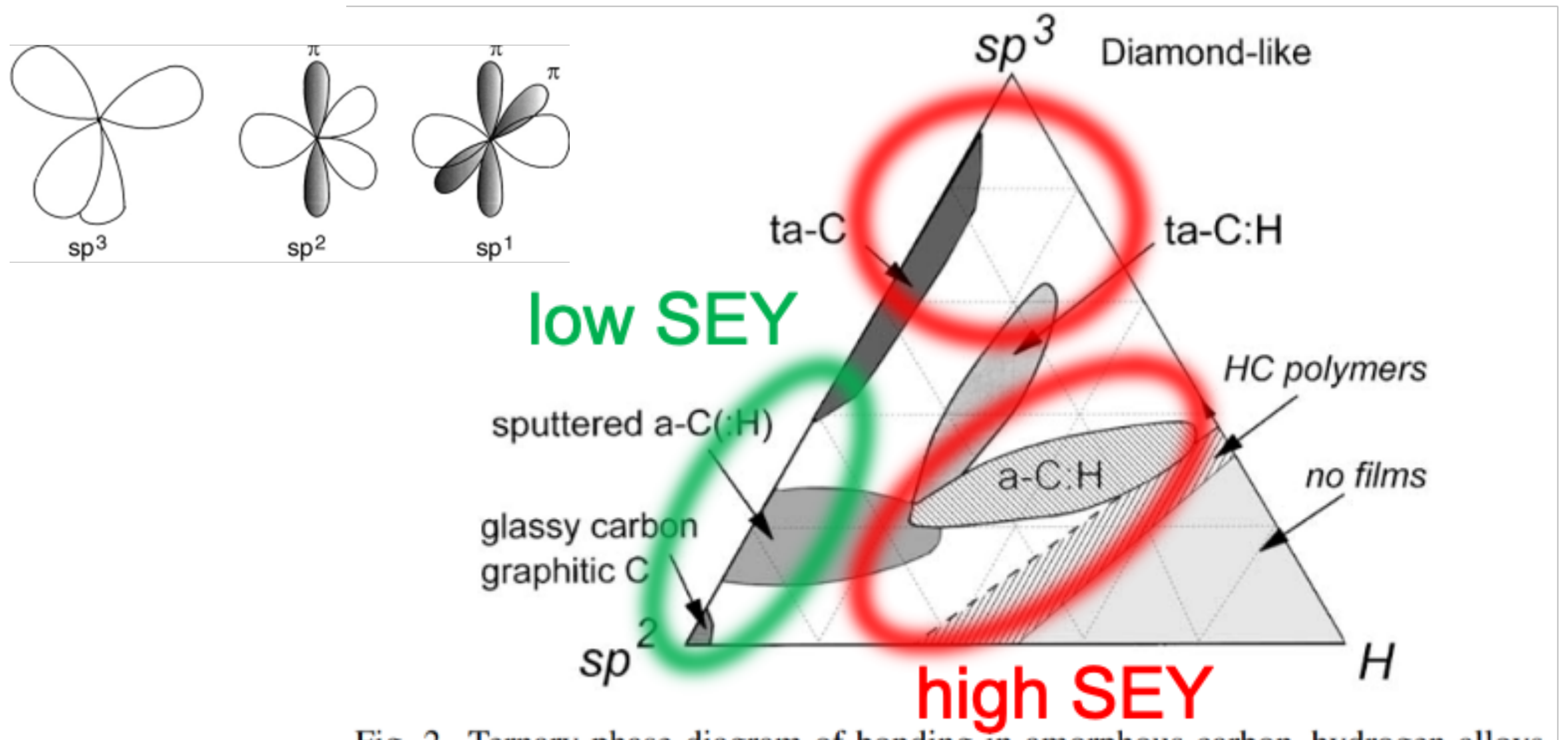

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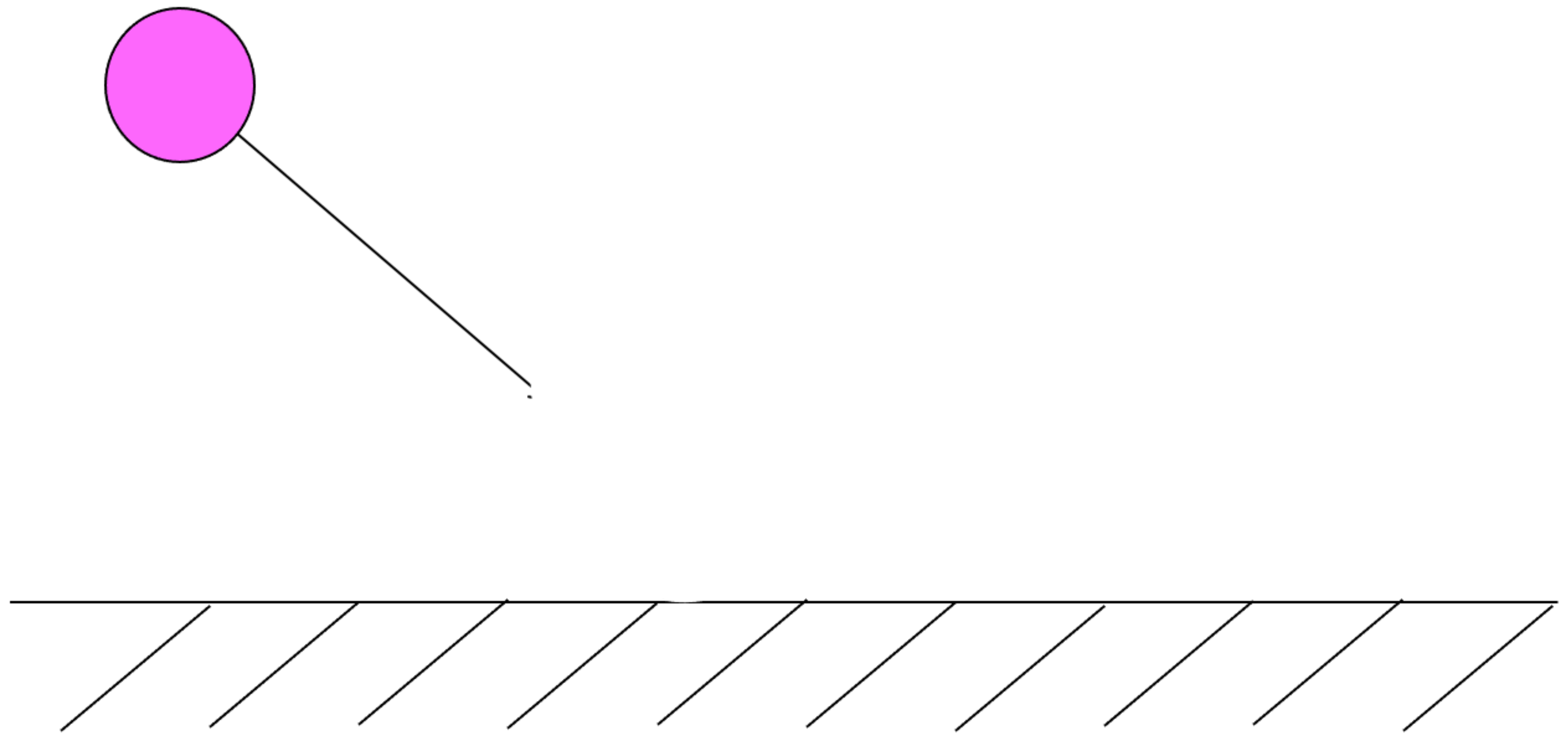
Eley-Rideal Mechanism



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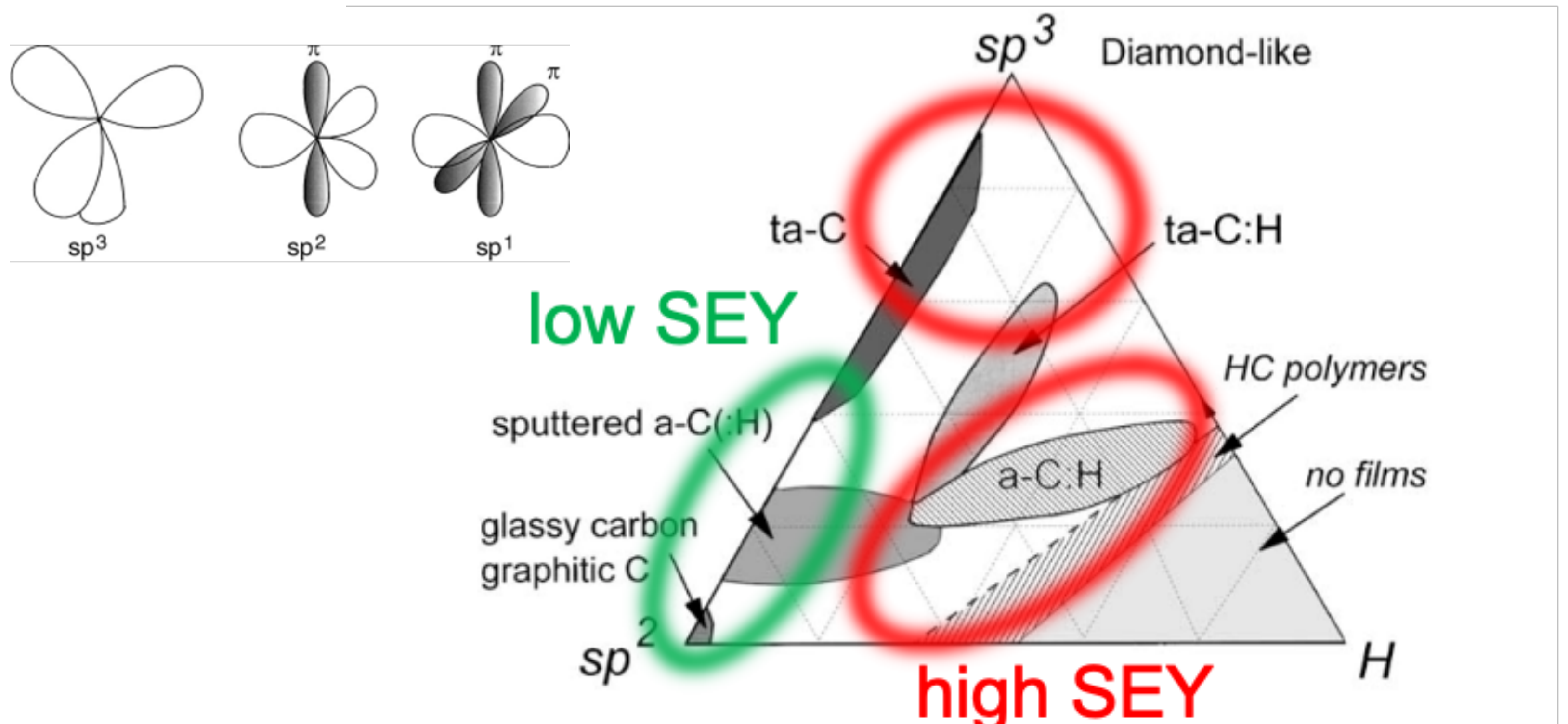

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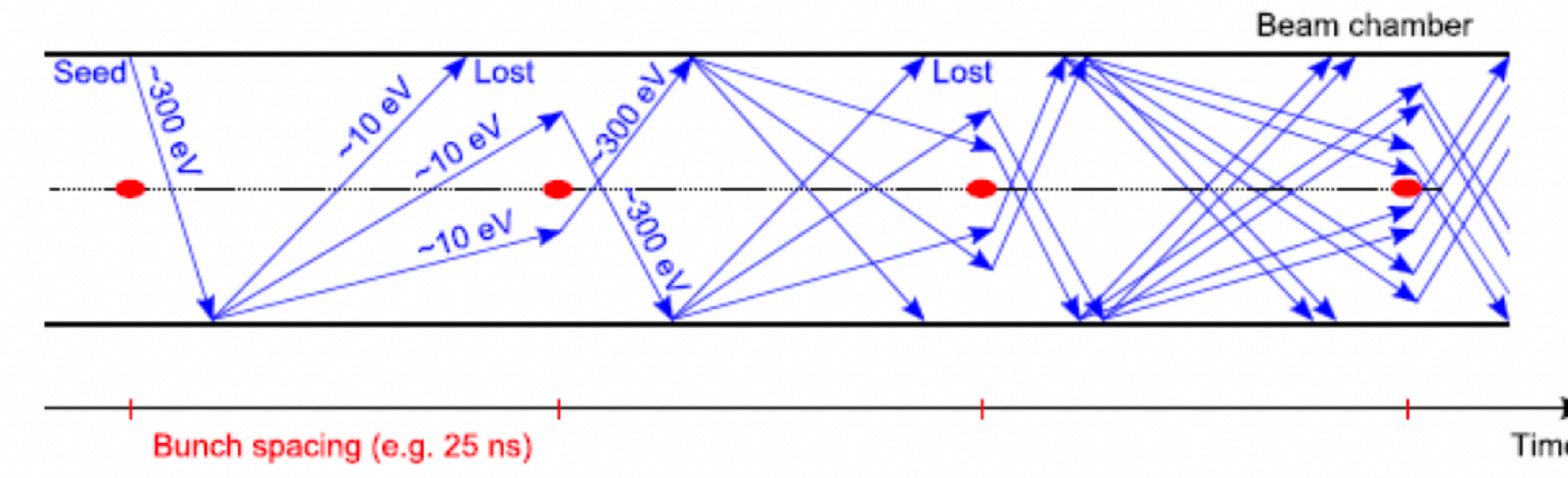

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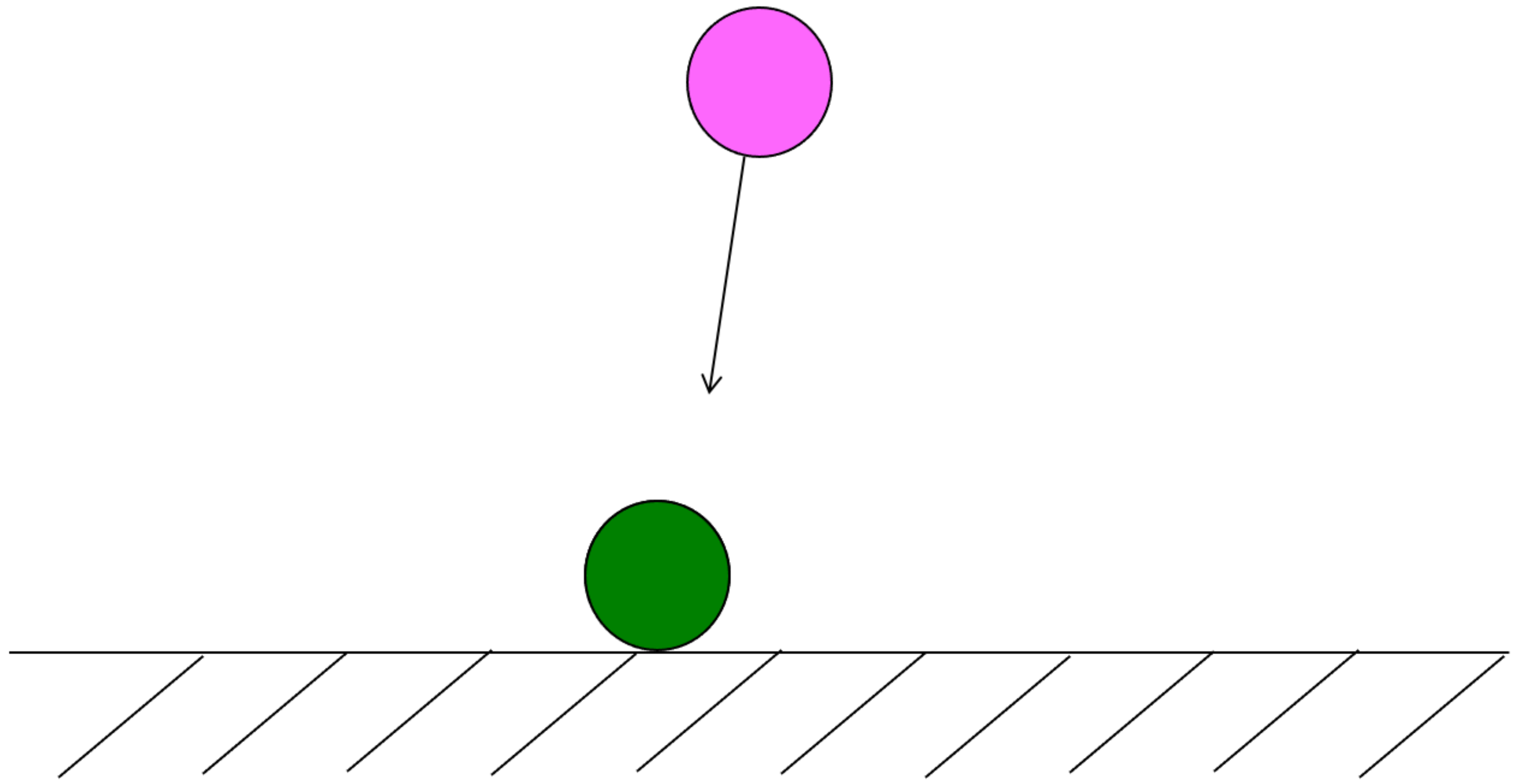

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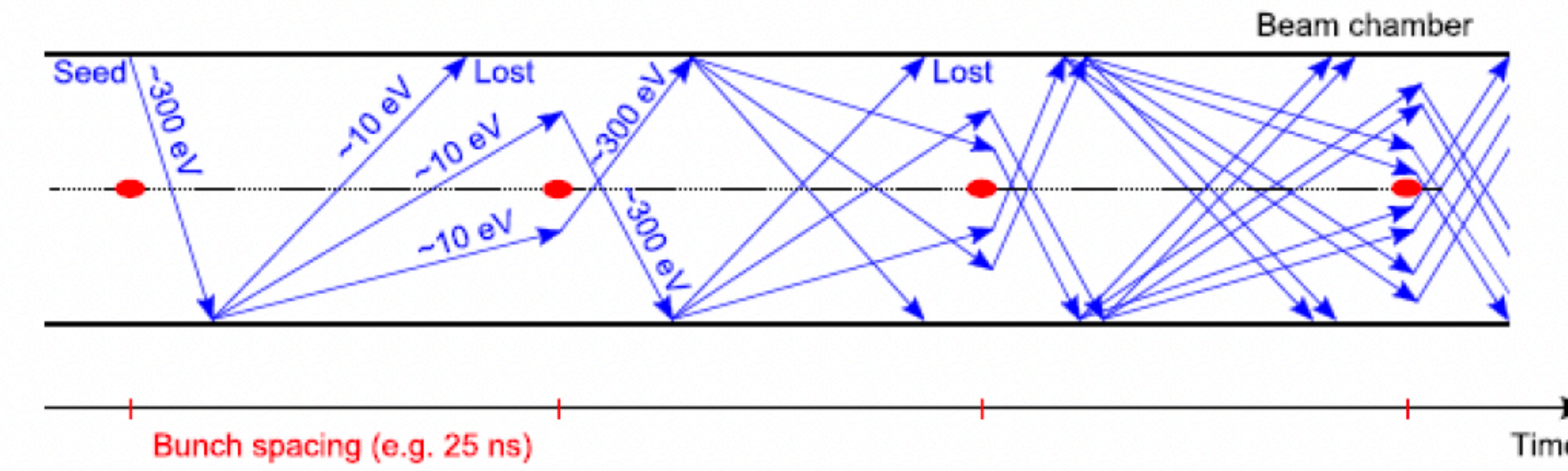

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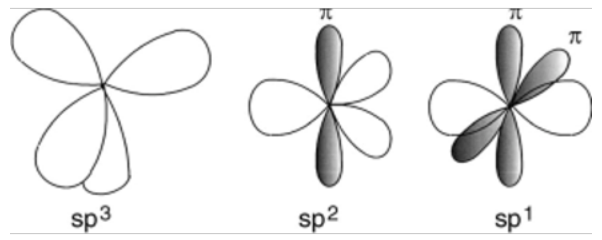

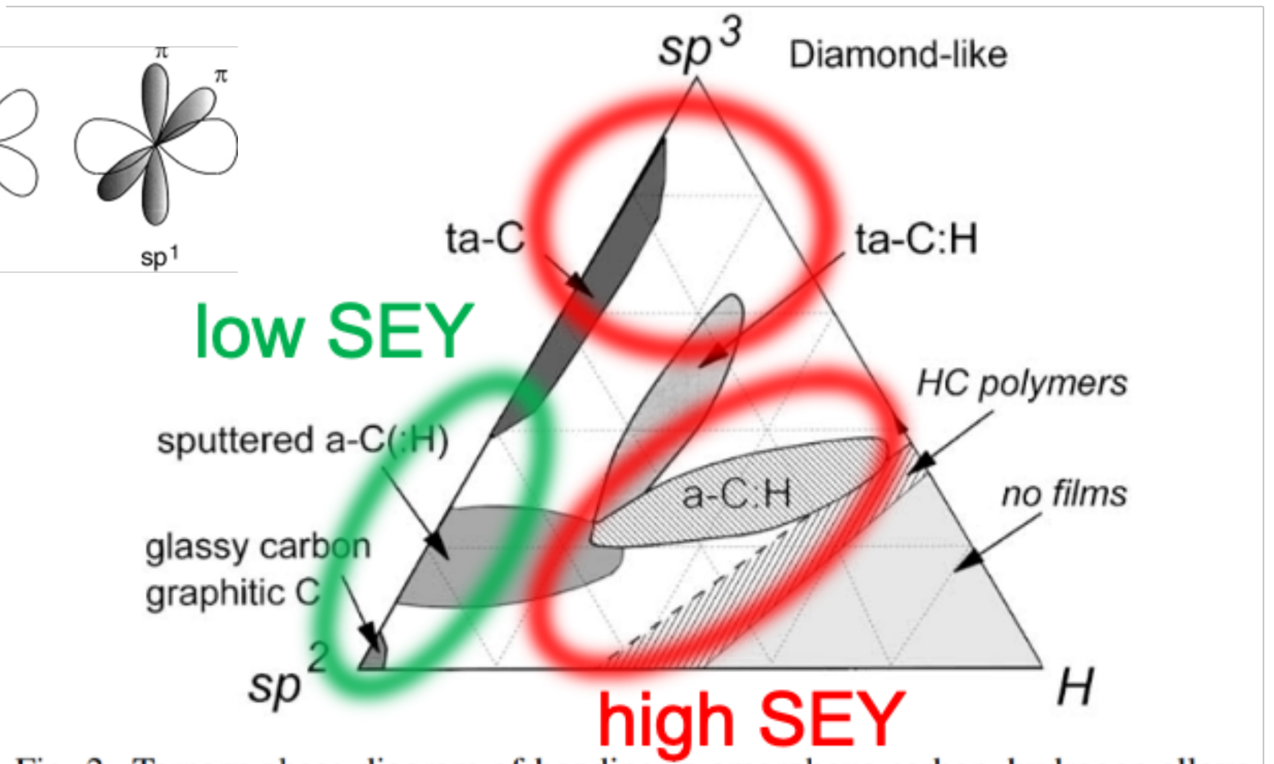

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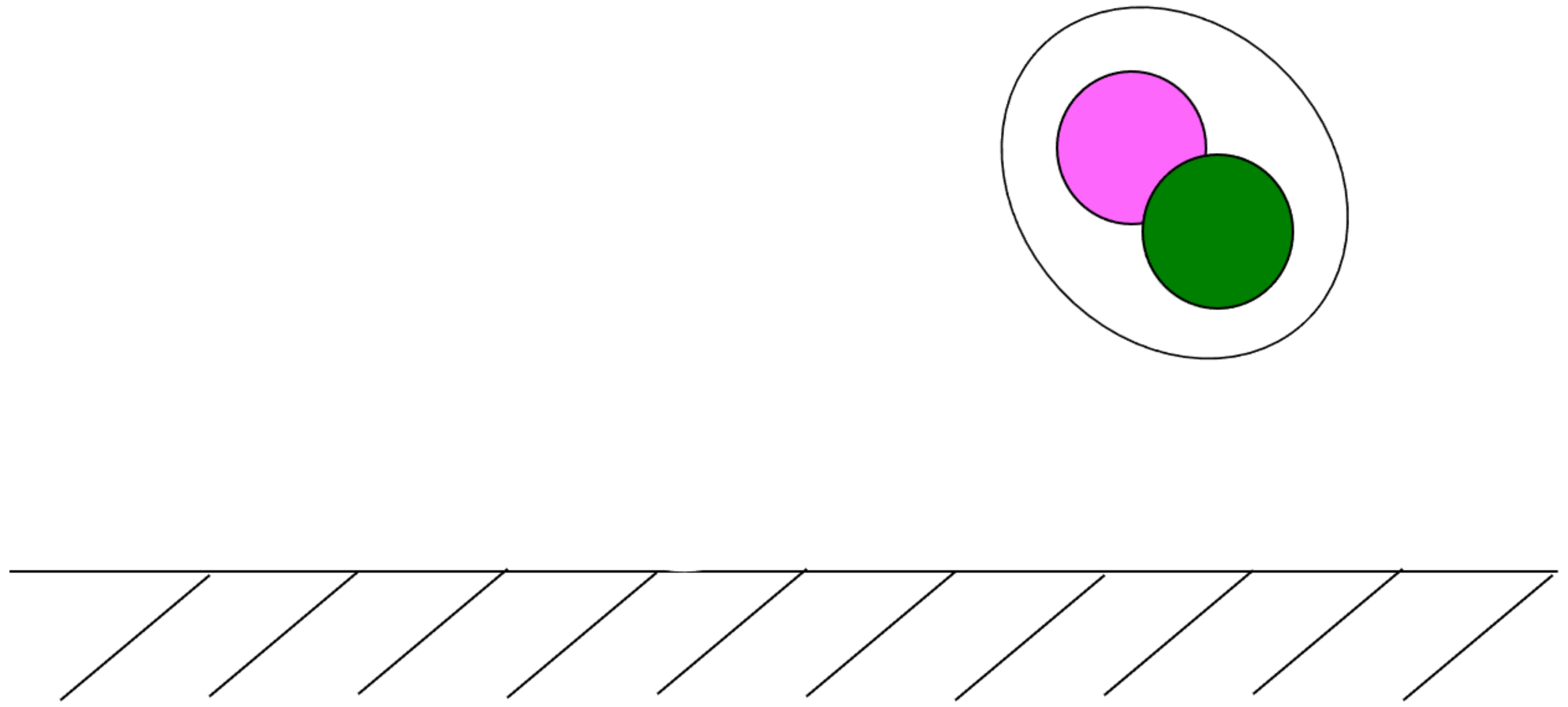
Eley-Rideal Mechanism

$P_m = 0.5 P_a$



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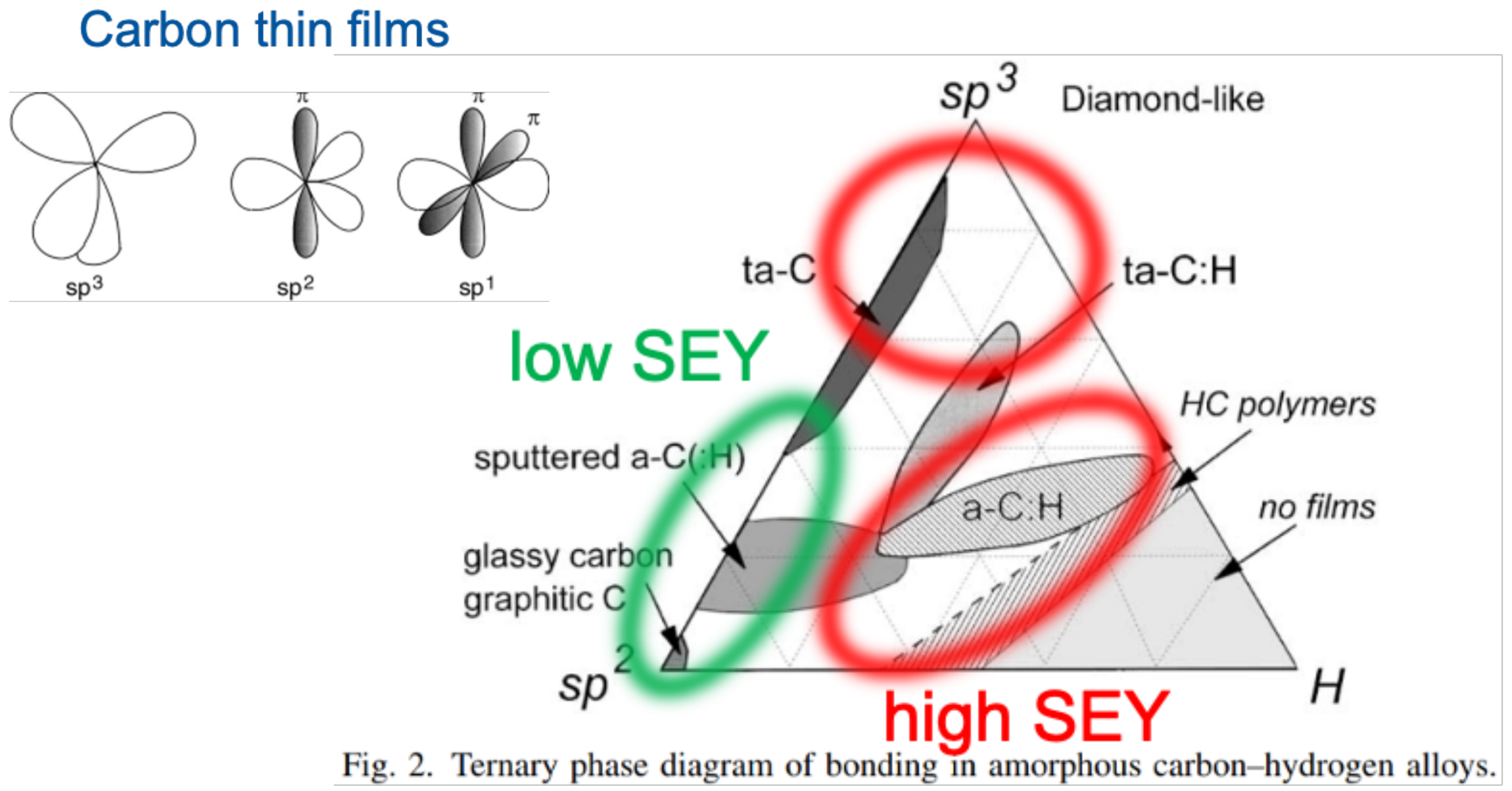

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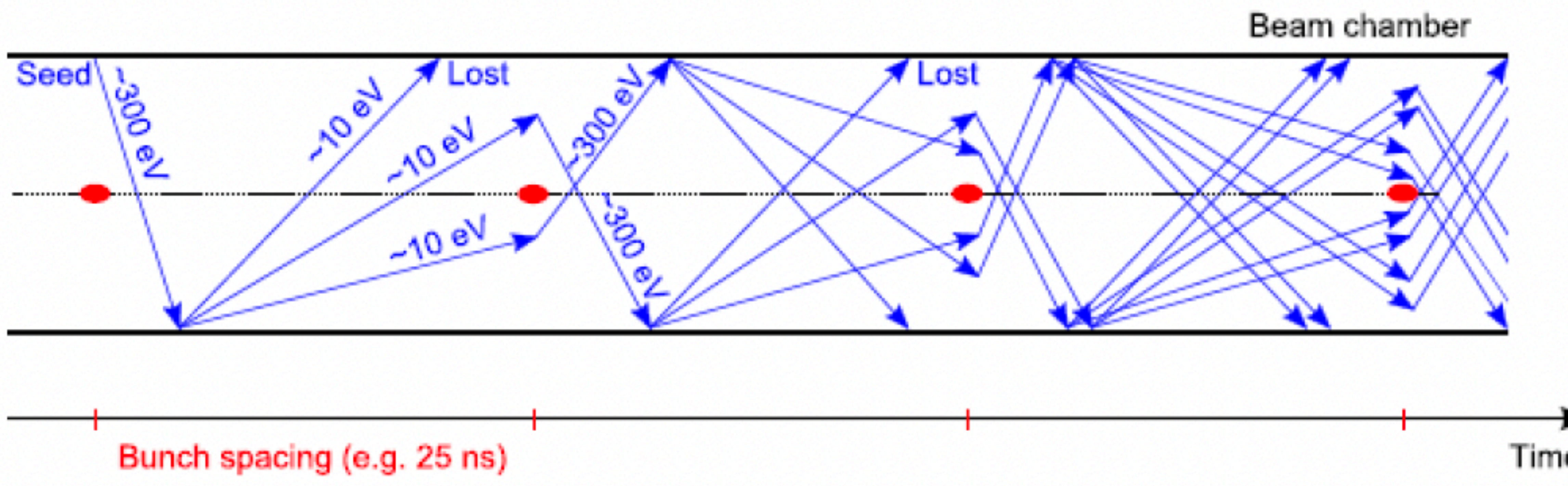
J. Robertson / Materials Science and Engineering R 37 (2002) 129–281



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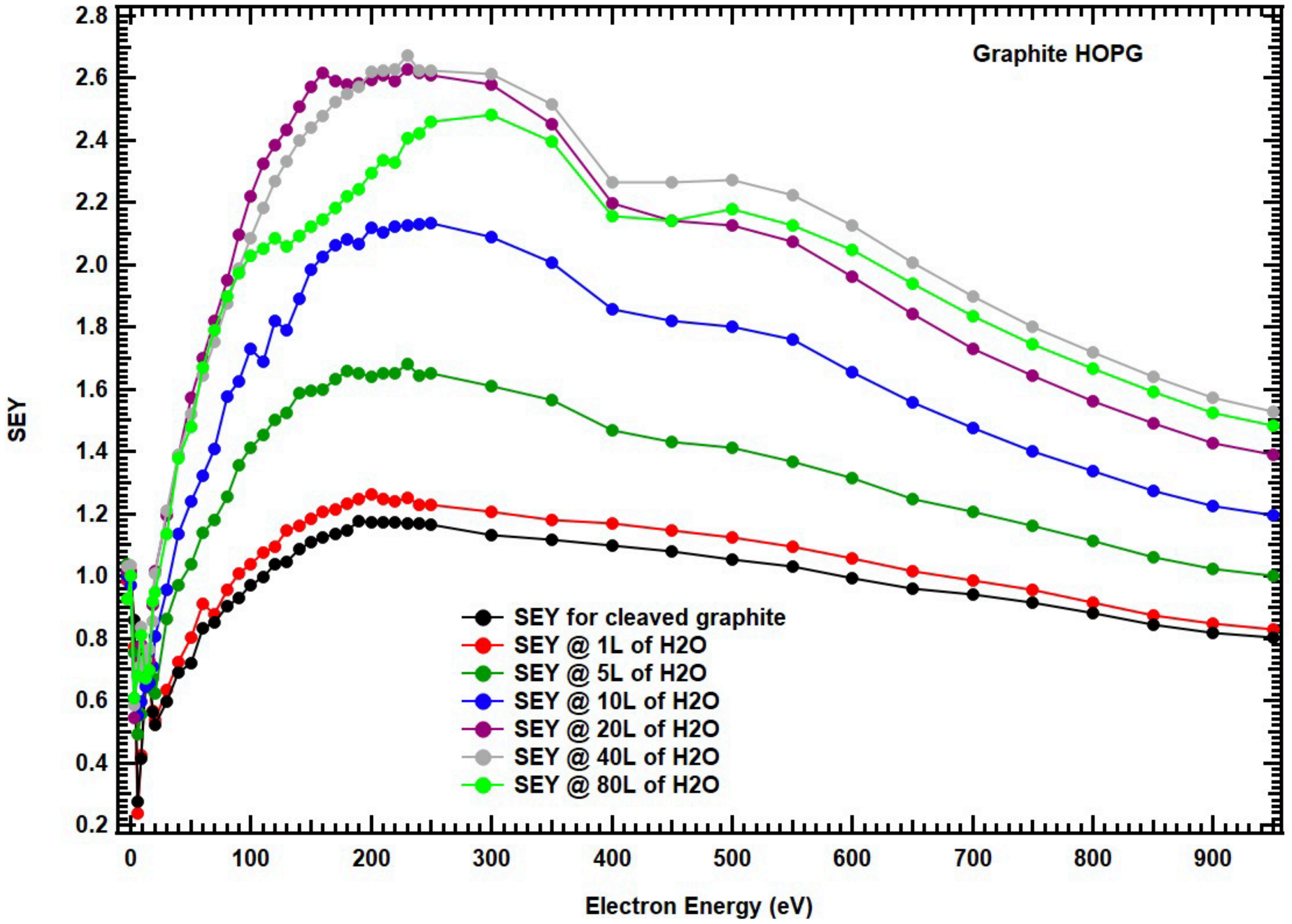


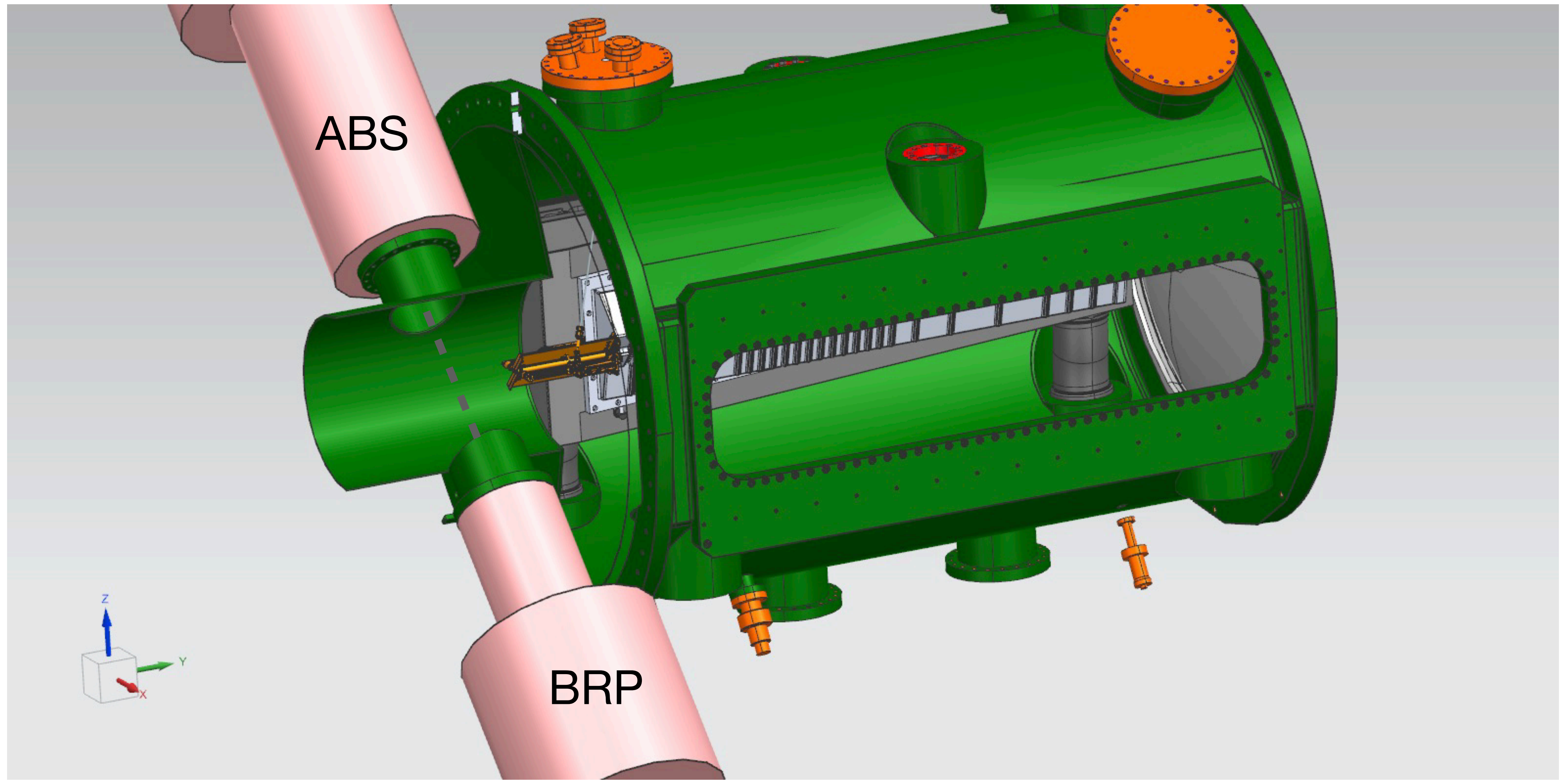
Ongoing studies aim to determine whether special films with a low Secondary Electron Yield can meet the required recombination rate of polarized hydrogen atoms injected into the storage cell

… or follow the HERMES experience to have an ice coating (low SEY, low H recombination)

Alternative solutions being investigated

Alternative solutions being investigated

Jet target



- this provides lower density ~10^{12} atoms/cm^2 (a factor 40 less wrt the cell solution)
- high polarisation degree (up to 90%)
- low systematics on the pol. determination

Alternative solutions being investigated

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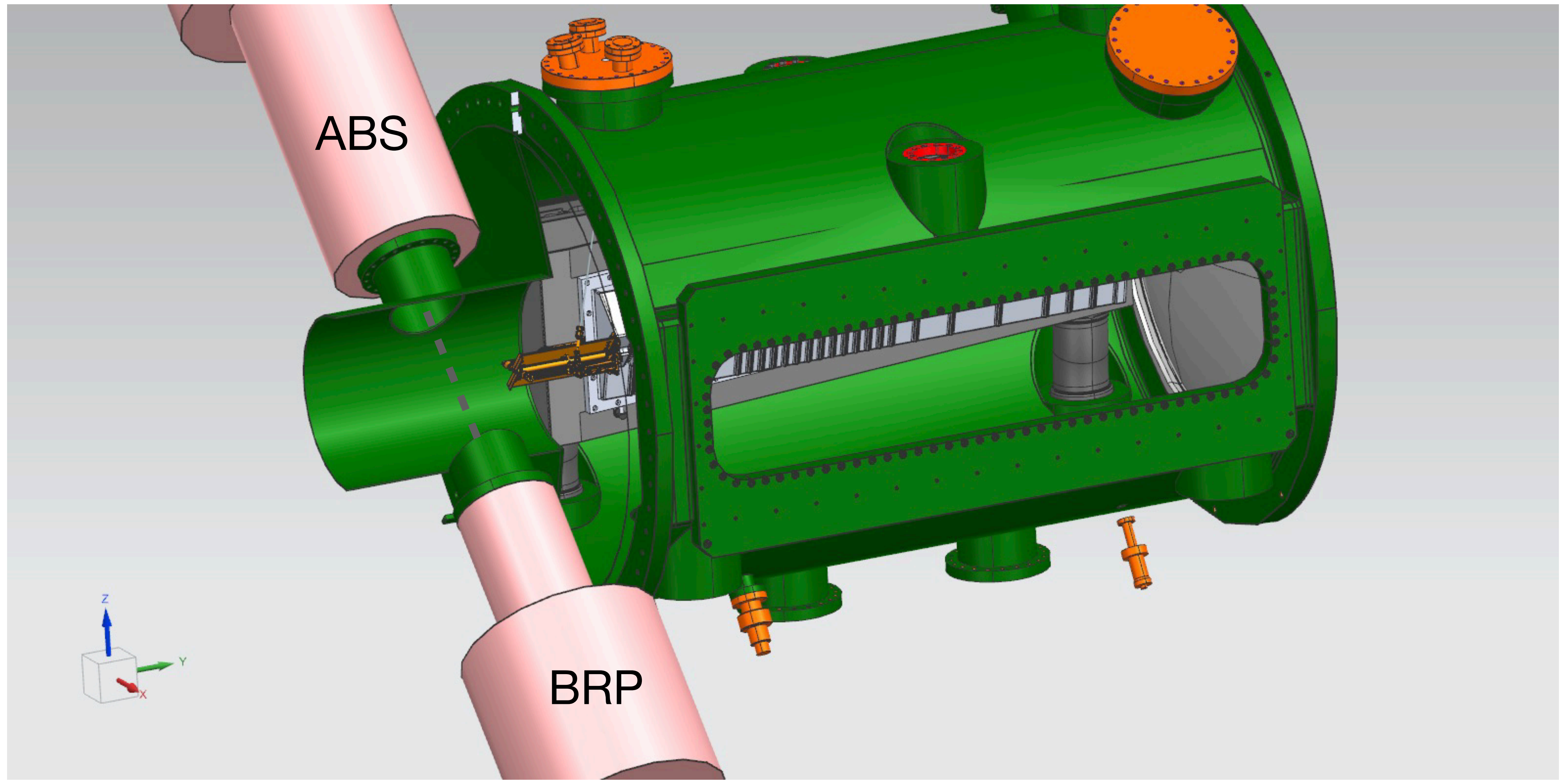

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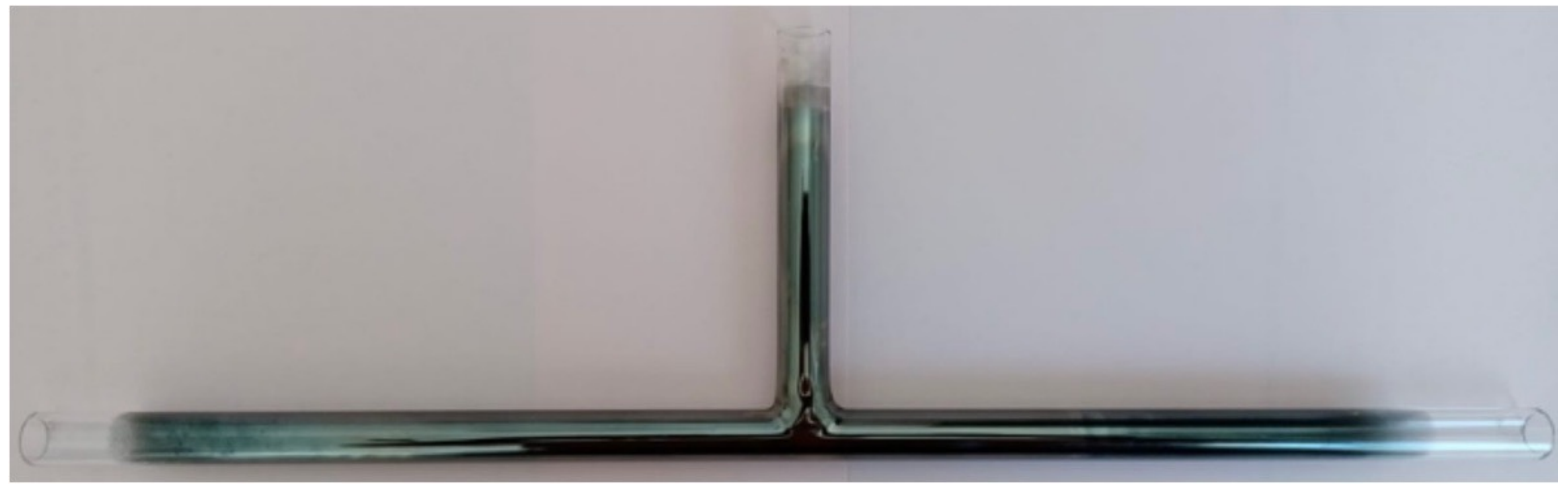
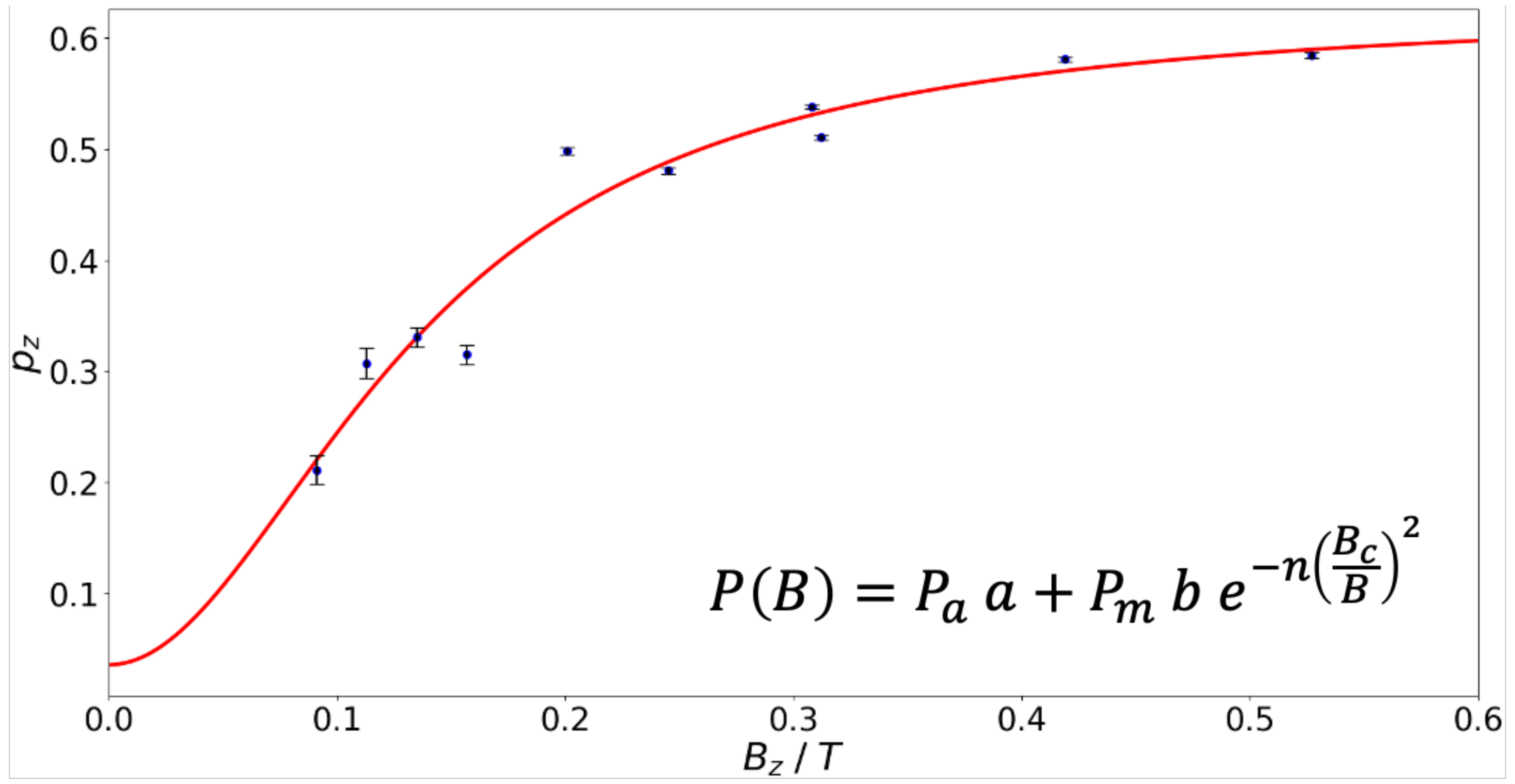
Storage Cell again, but using polarised molecules



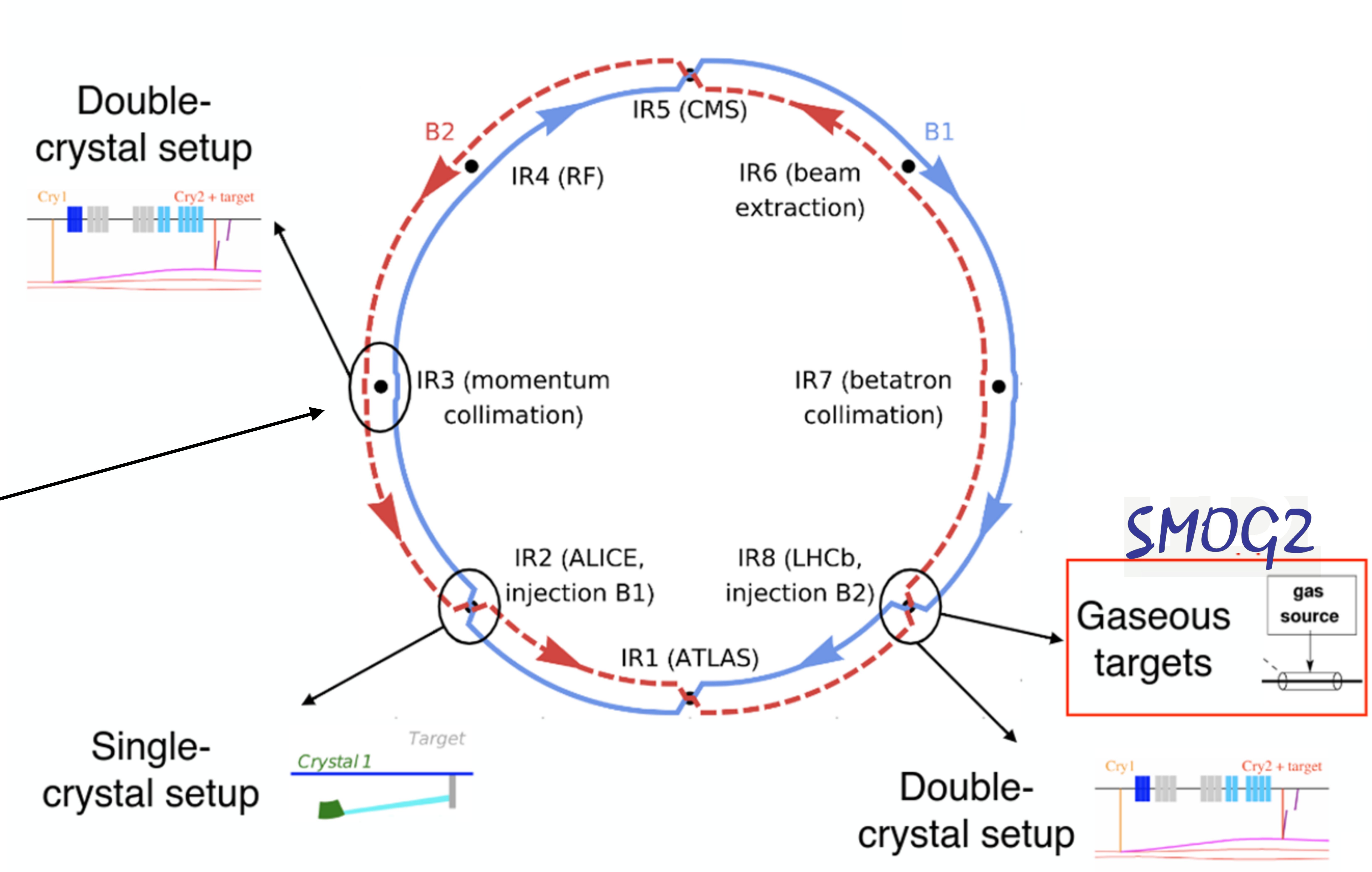
Tests performed at FZ-Julich on Storage cell amorphous carbon coated shows full atomic recombination

PoS PSTP2022 (2023) 036



- high density
- dilution factor for the polarisation degree (~54%)
- new polarimeter needed

The LHC Interaction Region 3



S. Redaelli, PBC General WG, 02/12/2021

R&D

IR3 is a great opportunity to perform R&D (and not only) on beam:

still a proposal

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still a proposal

-to develop a new generation target system

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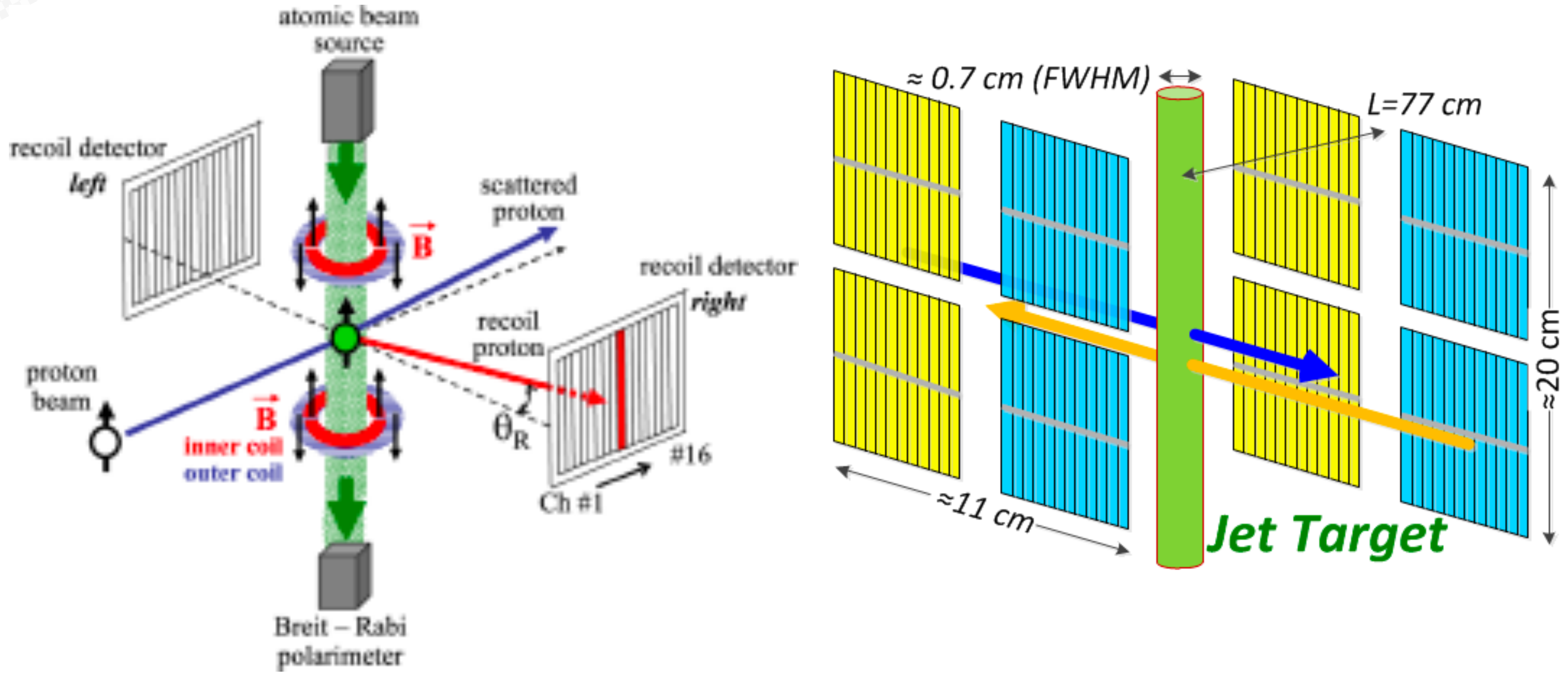
-to develop a new polarimeter

e.g. similar to the RHIC/EIC hadronic polarimeter



APet al., Nucl. Instrum. Meth. A **976**, 164261 (2020)

A.A. Poblaguev's talk @SPIN2023

requires also R&D for chip detectors in the LHC vacuum, interesting for many other projects

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still a proposal

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-to conduct interesting g physics measurements, such as inclusive hadron production in

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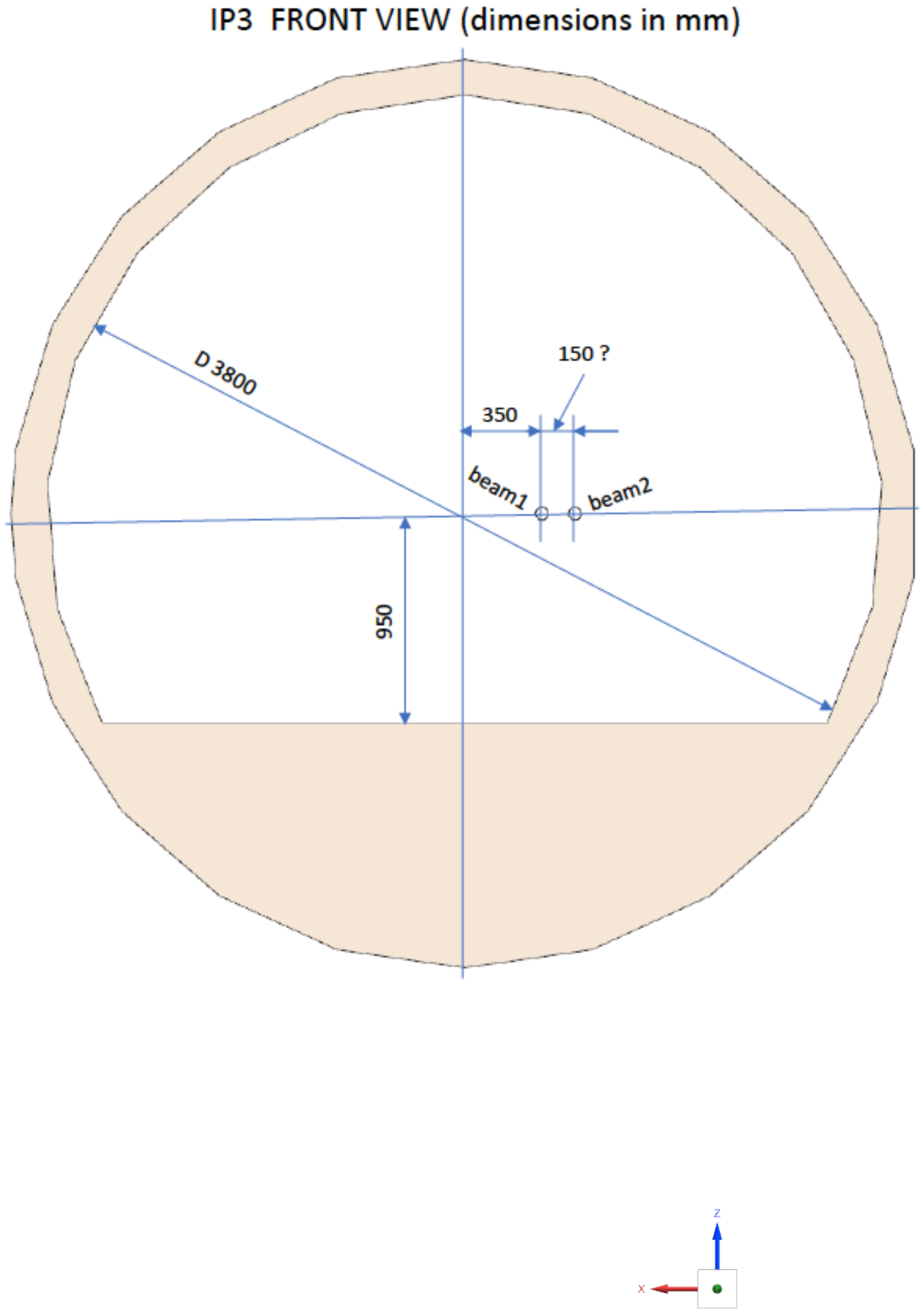
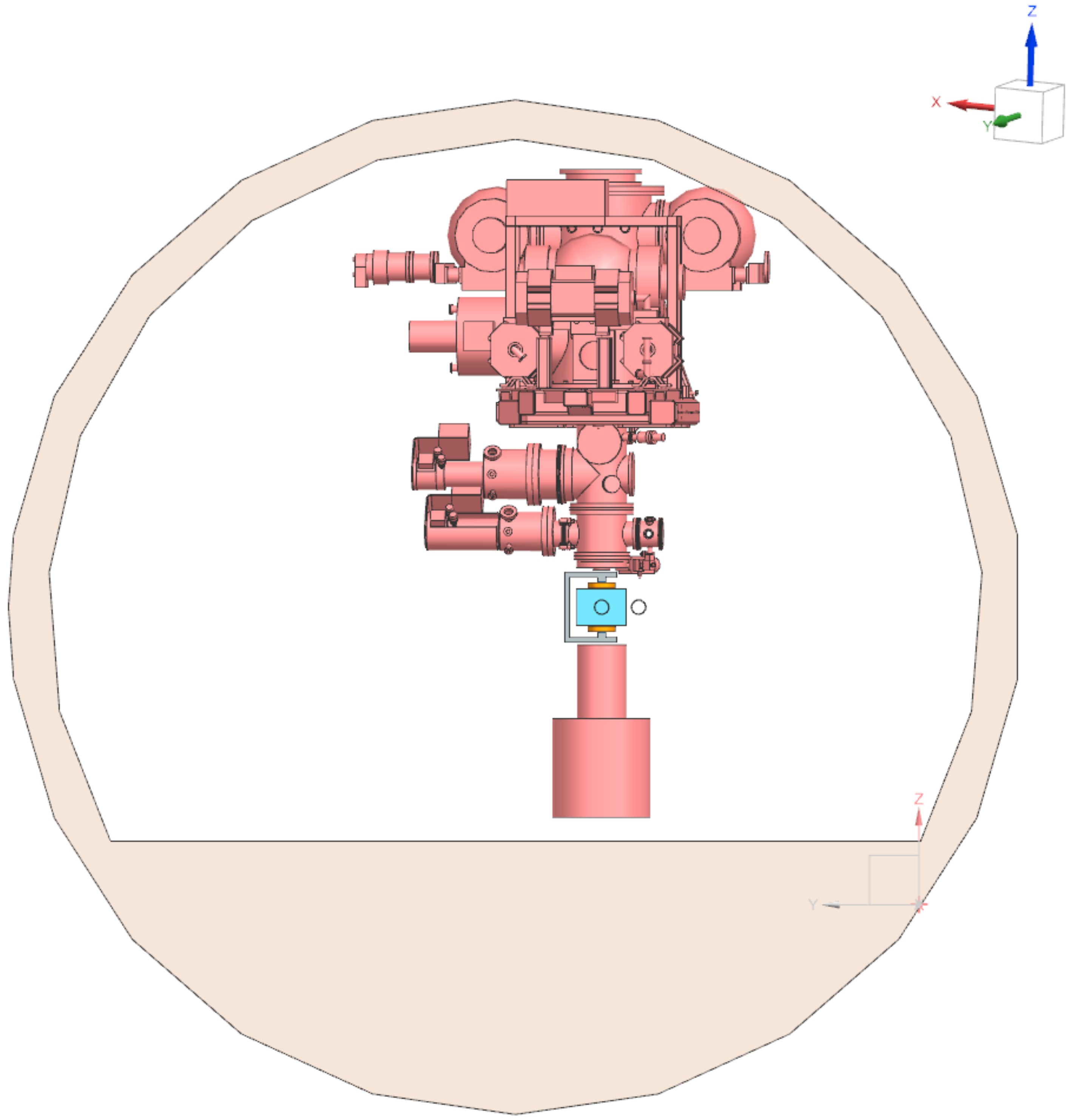
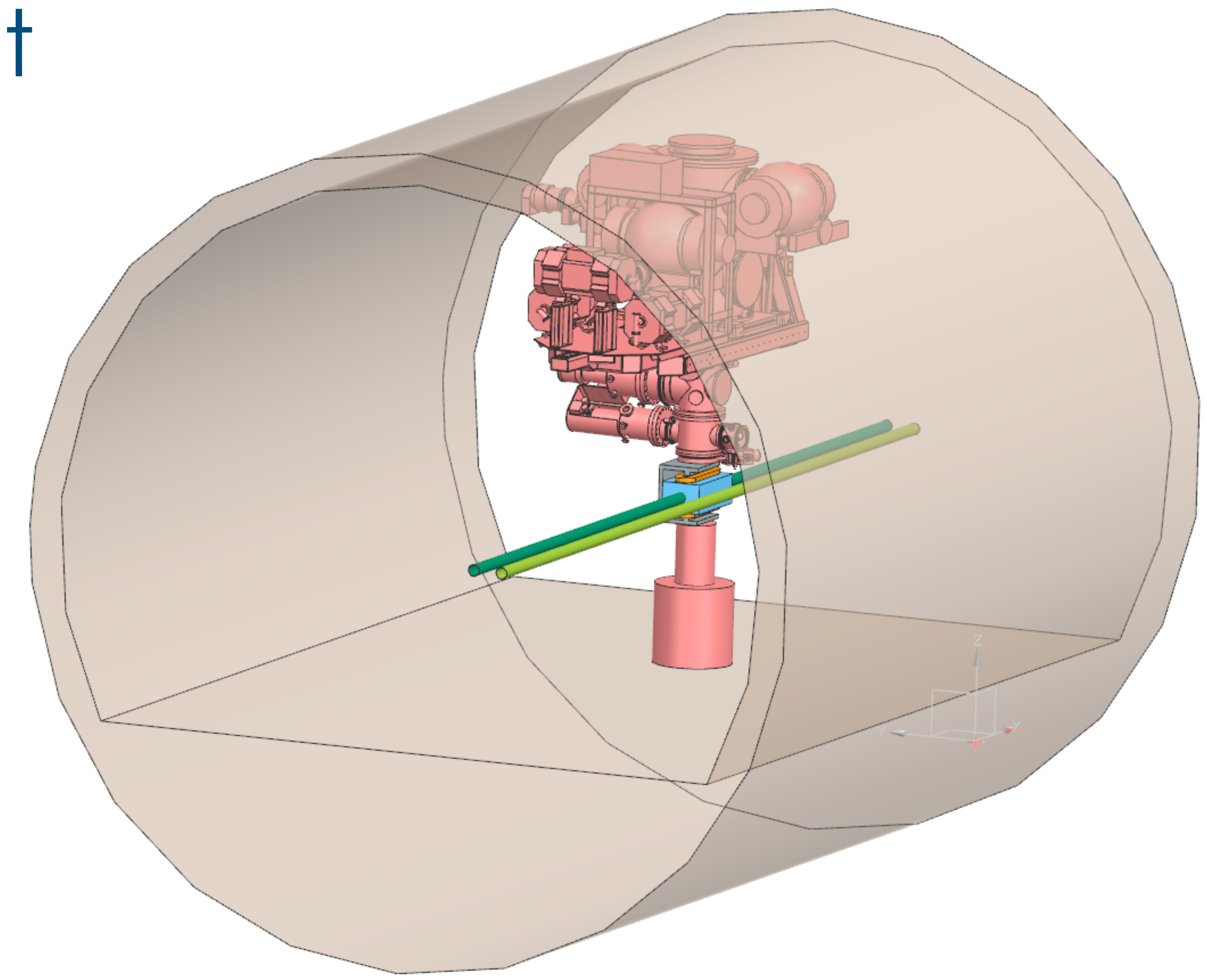
LHCspin@ IR3 will operate as an independent collaboration, welcoming participants regardless of their affiliation with LHCb

The LHC Interaction Region 3

Working on the implementation of an existing target



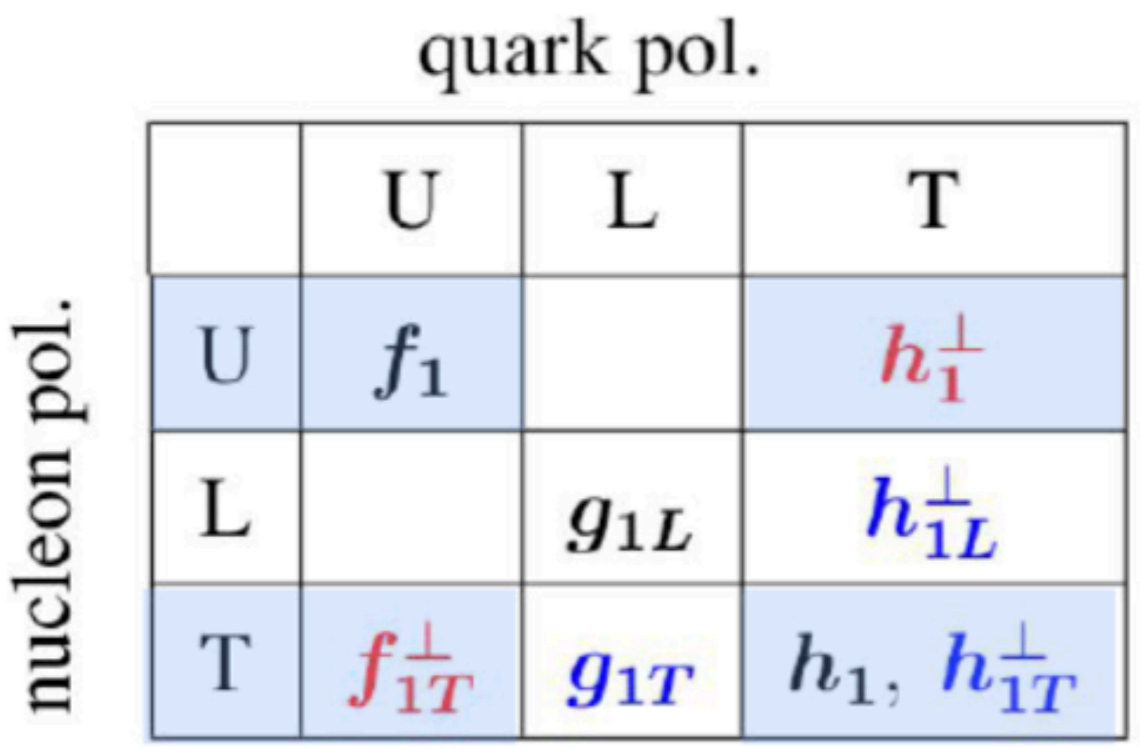




The physics goals of LHCspin … just a quick overview

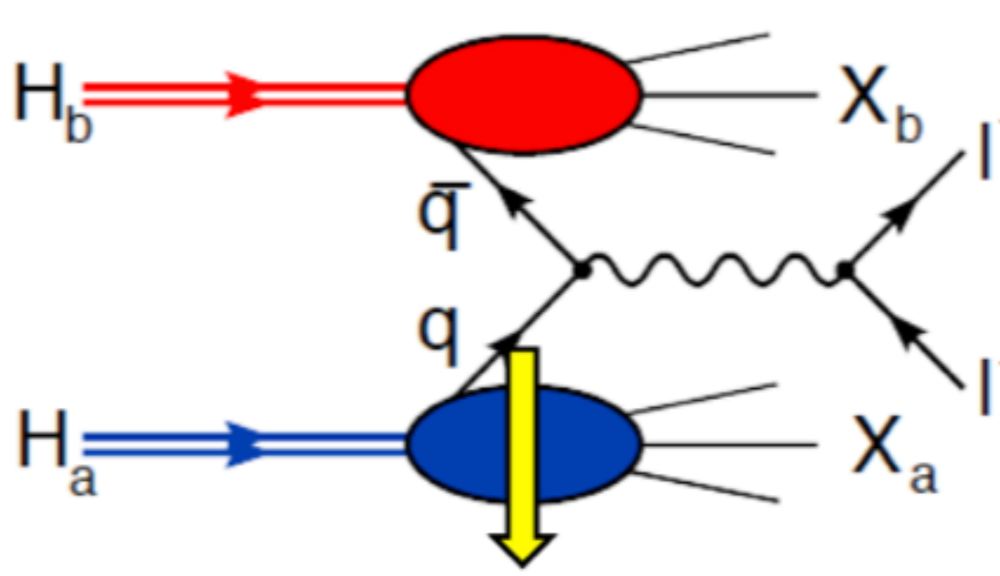
- Multi-dimensional nucleon structure in a poorly explored kinematic domain
- Measure experimental observables sensitive to both **quarks and gluons TMDs**
- **Make use of new probes (charmed and beauty mesons)**
- Complement present and future SIDIS results
- Test non-trivial process dependence of quarks and (especially) gluons TMDs
- Measure exclusive processes to access GPDs

Quark TMDs

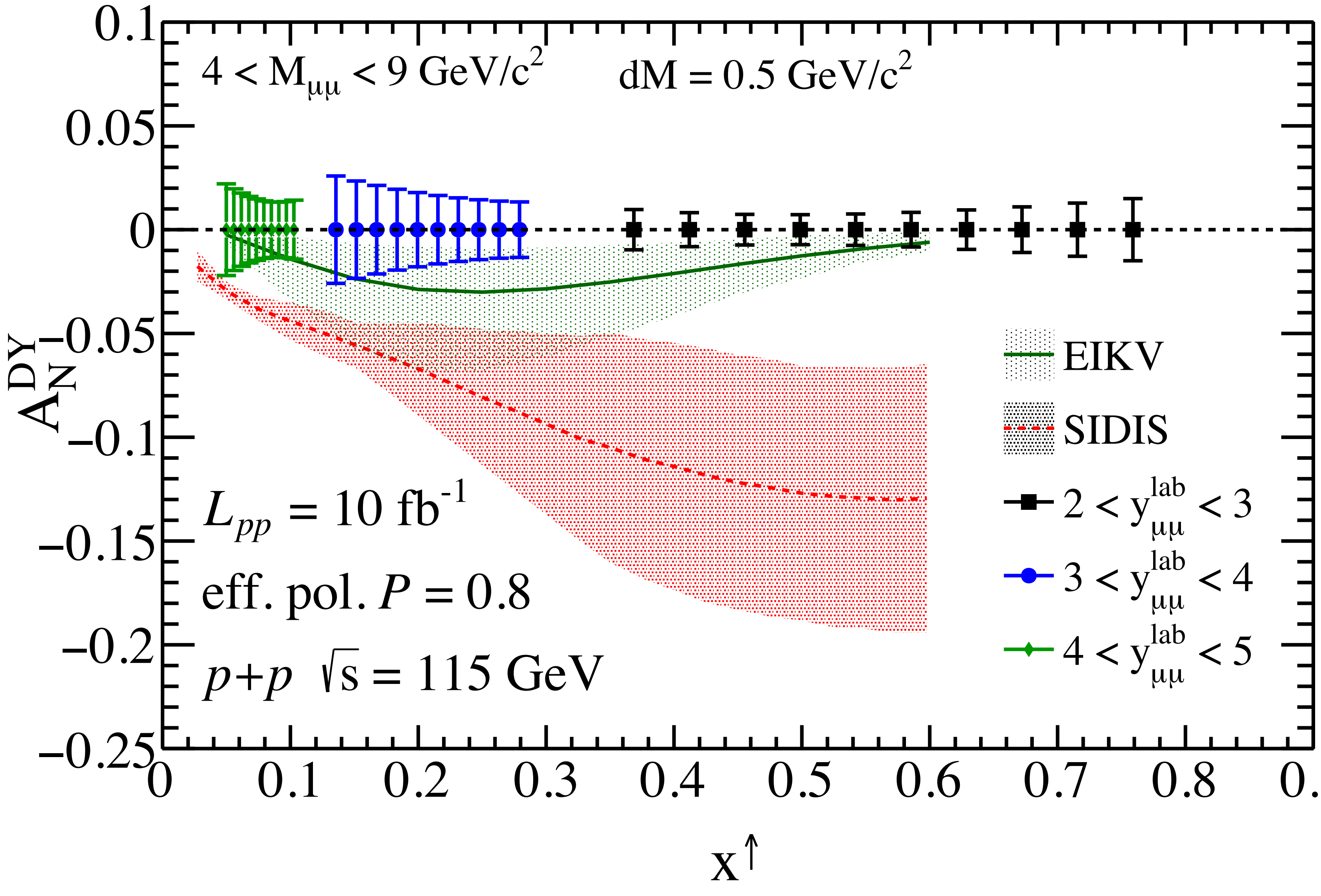


		quark pol.		
		U	L	T
nucleon pol.	U	f_1		$h_1^{\perp}$
	L		g_{1L}	$h_{1L}^{\perp}$
	T	$f_{1T}^{\perp}$	g_{1T}	h_1, $h_{1T}^{\perp}$

Transv. polarized Drell-Yan



Golden Channel



[arXiv:1807.00603]

- **Sensitive to quark TMDs through TSSAs**

$$A_N^{DY} = \frac{1}{P}\frac{\sigma_{DY}^{\uparrow} - \sigma_{DY}^{\downarrow}}{\sigma_{DY}^{\uparrow} + \sigma_{DY}^{\downarrow}} \Longrightarrow \quad A_{UT}^{\sin\phi_S} \sim \frac{f_1^q \otimes f_{1T}^{\perp q}}{f_1^q \otimes f_1^q}, \quad A_{UT}^{\sin(2\phi-\phi_S)} \sim \frac{h_1^{\perp q} \otimes h_1^q}{f_1^q \otimes f_1^q}, \ldots$$

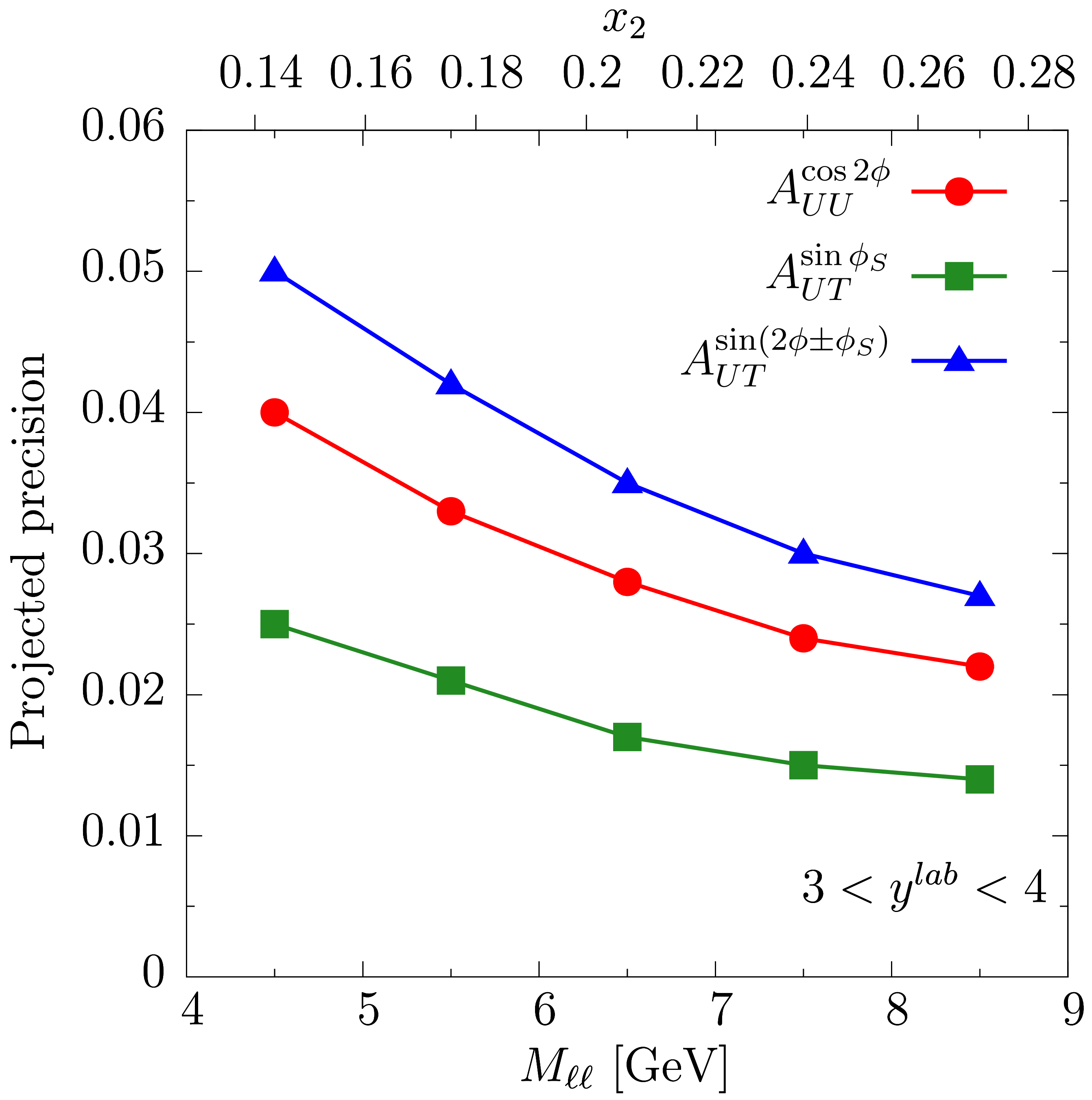
(ϕ: azimuthal orientation of lepton pair in dilepton CM)

LHCb has excellent μ-ID & reconstruction for $\mu^+\mu^-$ →

dominant: $\bar{q}(x_{beam}) + q(x_{target}) \rightarrow \mu^+\mu^-$

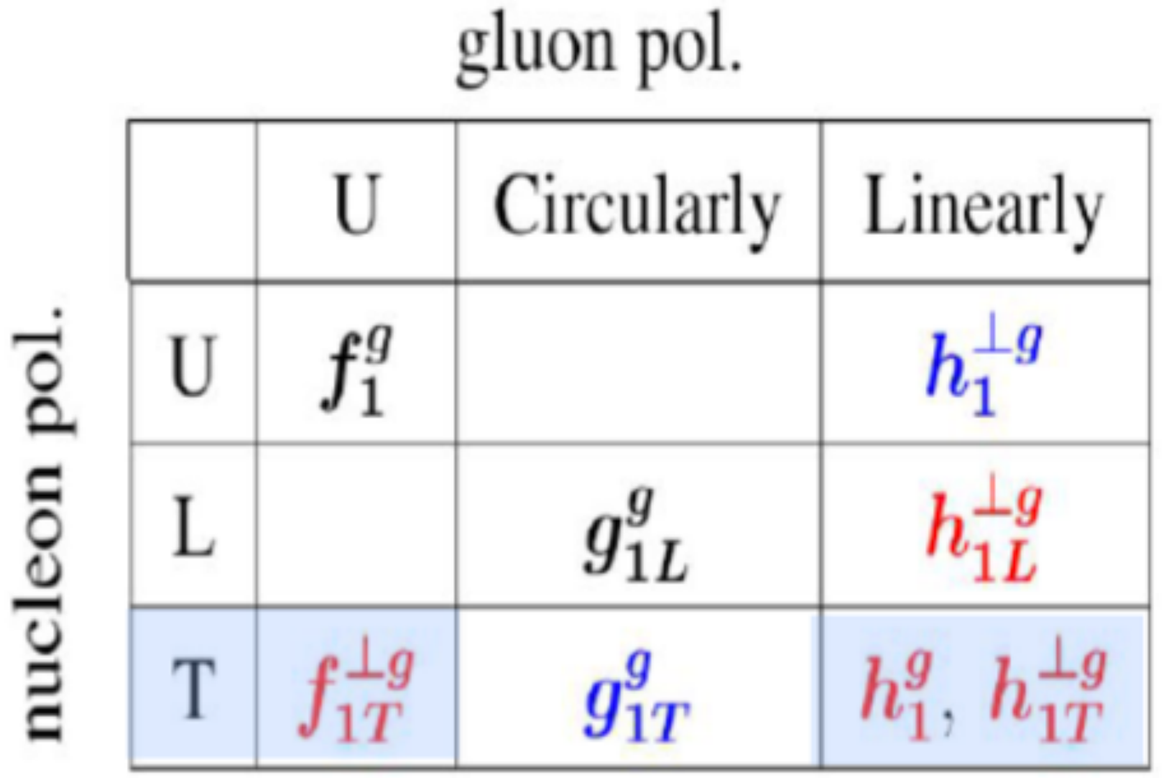
suppressed: $q(x_{beam}) + \bar{q}(x_{target}) \rightarrow \mu^+\mu^-$

- Extraction of qTMDs does not require knowledge of FF
- Verify sign change of Sivers function wrt SIDIS $f_{1T}^{\perp}|_{DY} = -f_{1T}^{\perp}|_{SIDIS}$
- Test flavour sensitivity using both H and D targets



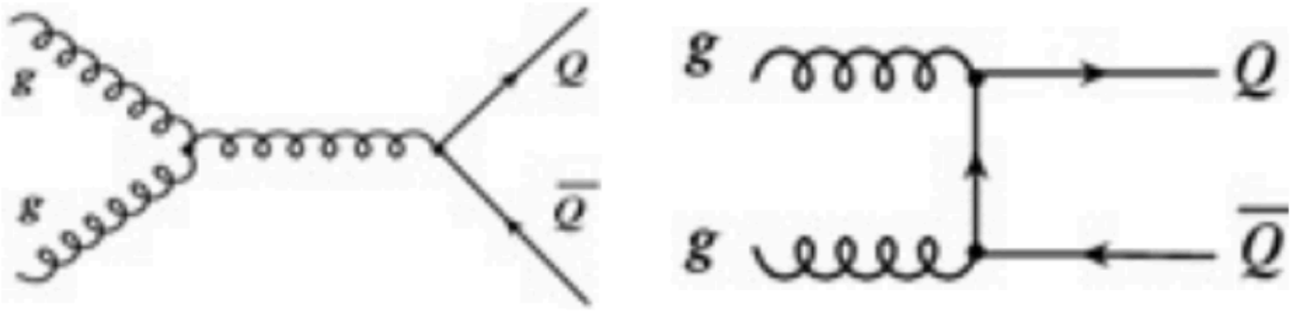
[arXiv:1807.00603]

Gluon TMDs

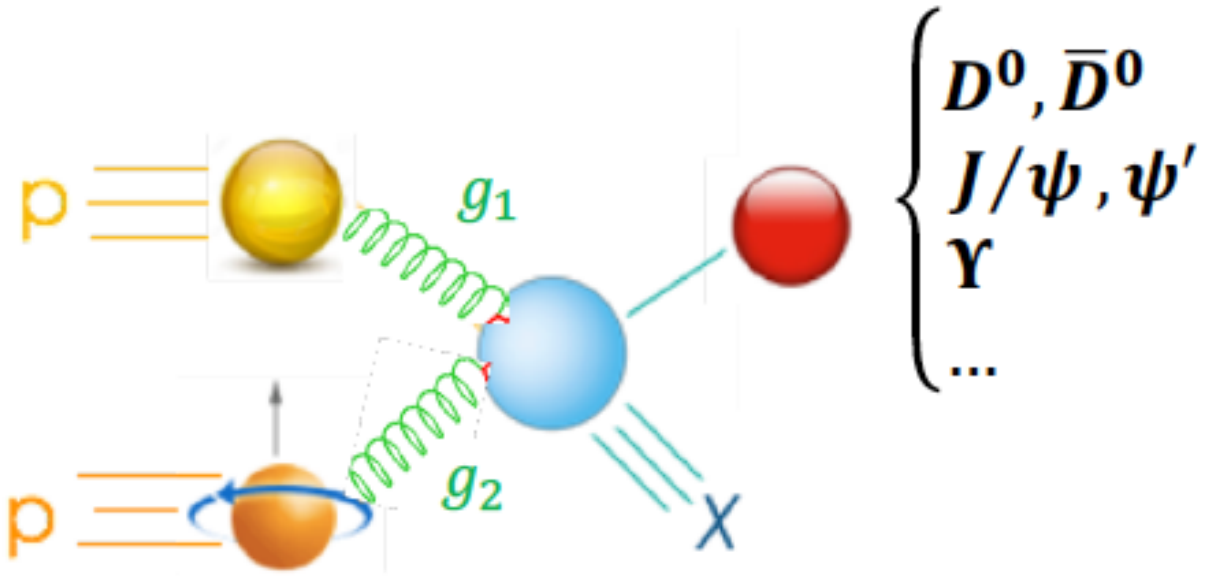


		gluon pol.	
nucleon pol.	U	Circularly	Linearly
U	f_1^g		$h_1^{\perp g}$
L		g_{1L}^g	$h_{1L}^{\perp g}$
T	$f_{1T}^{\perp g}$	g_{1T}^g	h_1^g, $h_{1T}^{\perp g}$

Theory framework well consolidated, but experimental access still extremely limited



The most efficient way to access the gluon dynamics inside the proton at LHC is to measure heavy-quark observables.
At LHC heavy quarks are produced by the dominant gg fusion process



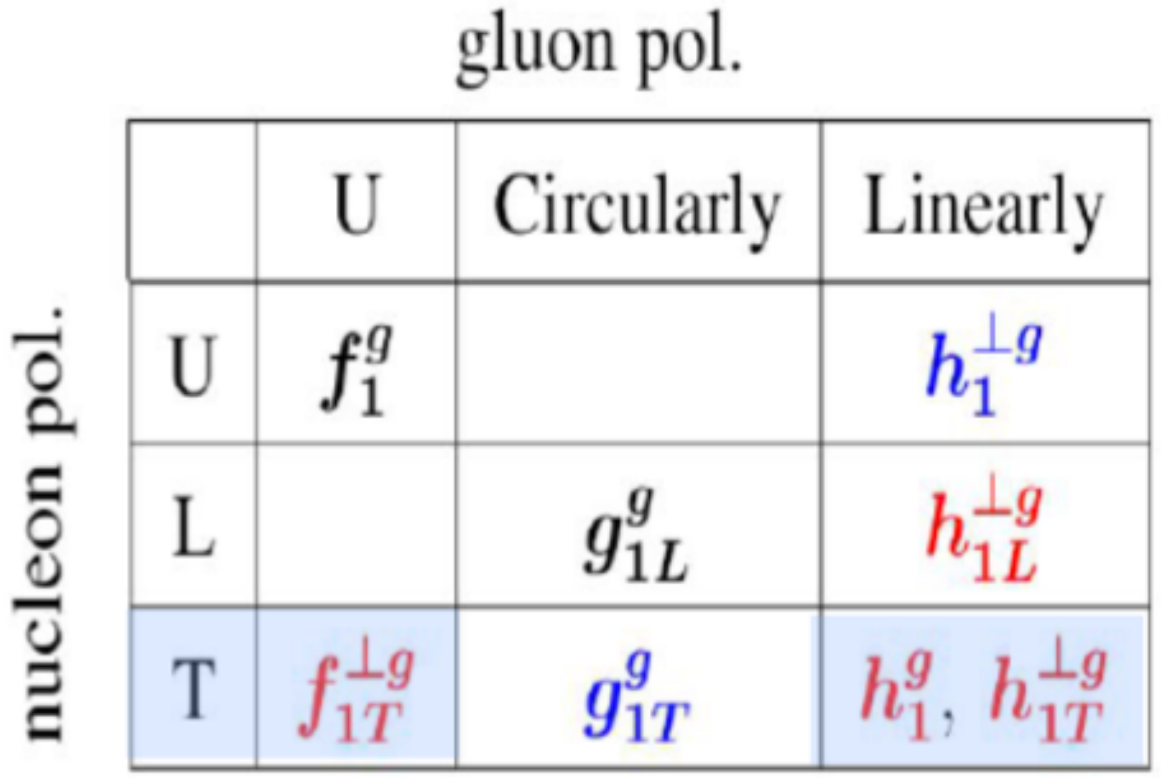
Inclusive quarkonia production in (un)polarized pp interaction turns out to be an ideal observable to access gTMDs

TMD factorisation requires $q_T(Q) \ll M_Q$:

- Can look at associate quarkonia production, where only relative q_T needs to be small (e.g. $pp^{(\uparrow)} \rightarrow J/\Psi + J/\Psi + X$)
- Due to the large masses, easier in case of bottomonium where factorisation can hold at large q_T

Gluon TMDs

Theory framework well consolidated, but experimental access still extremely limited



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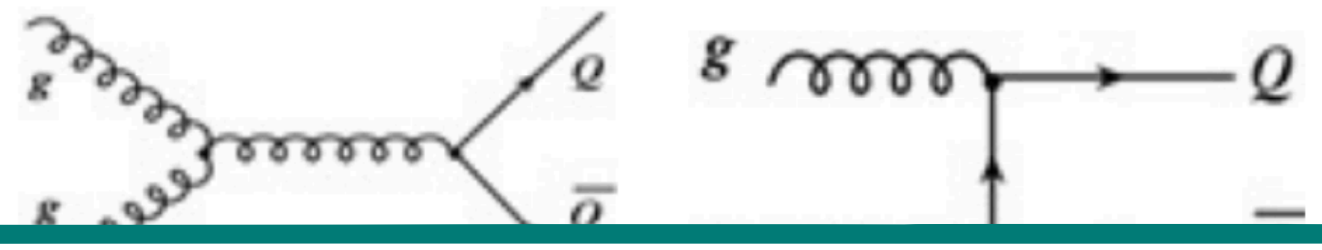
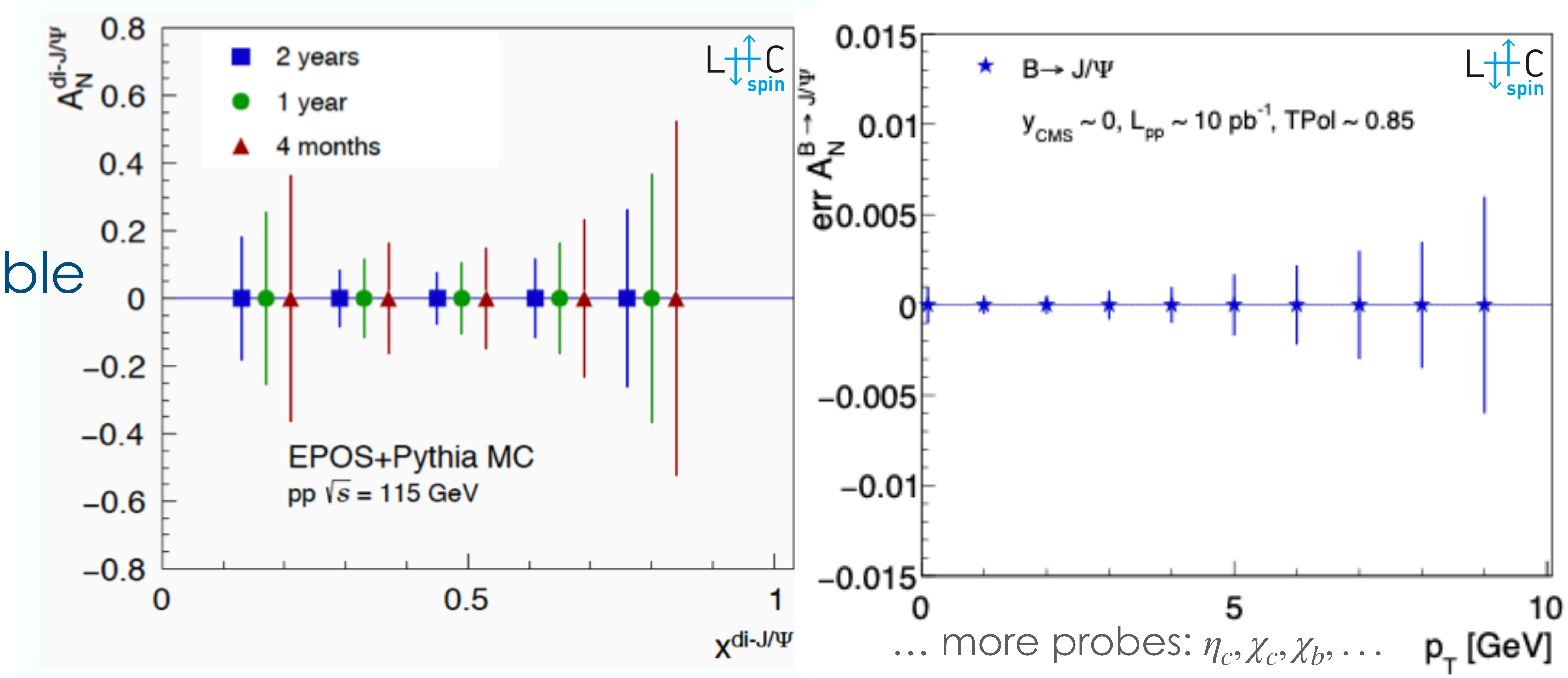


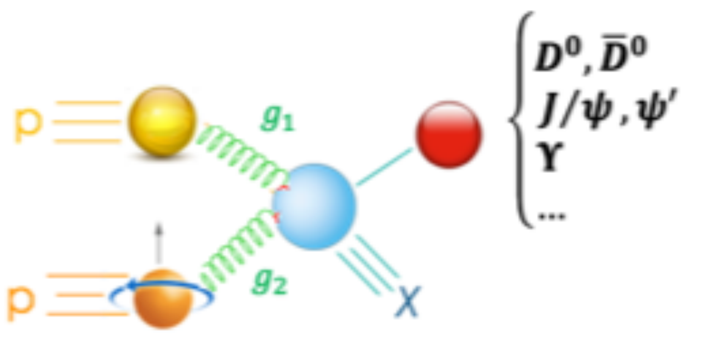
Gluon-induced asymmetries (unconstrained $h_1^{\perp g}$ + f_1^g) accessible by, e.g., $di-J/\Psi$ or Υ production

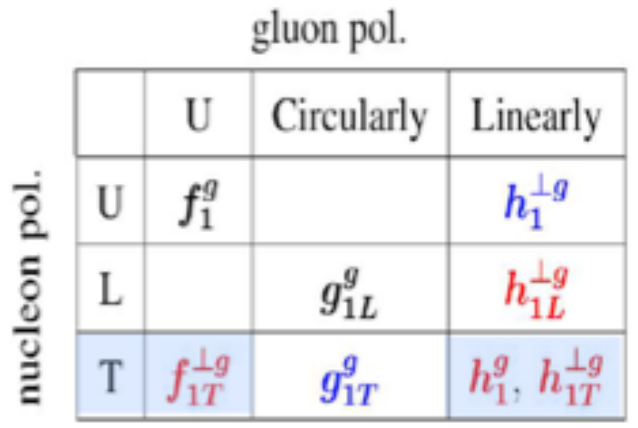


… more probes: $\eta_c, \chi_c, \chi_b, \dots$

factorisation can hold at large q_T

Probing the Sivers function





		gluon pol.		
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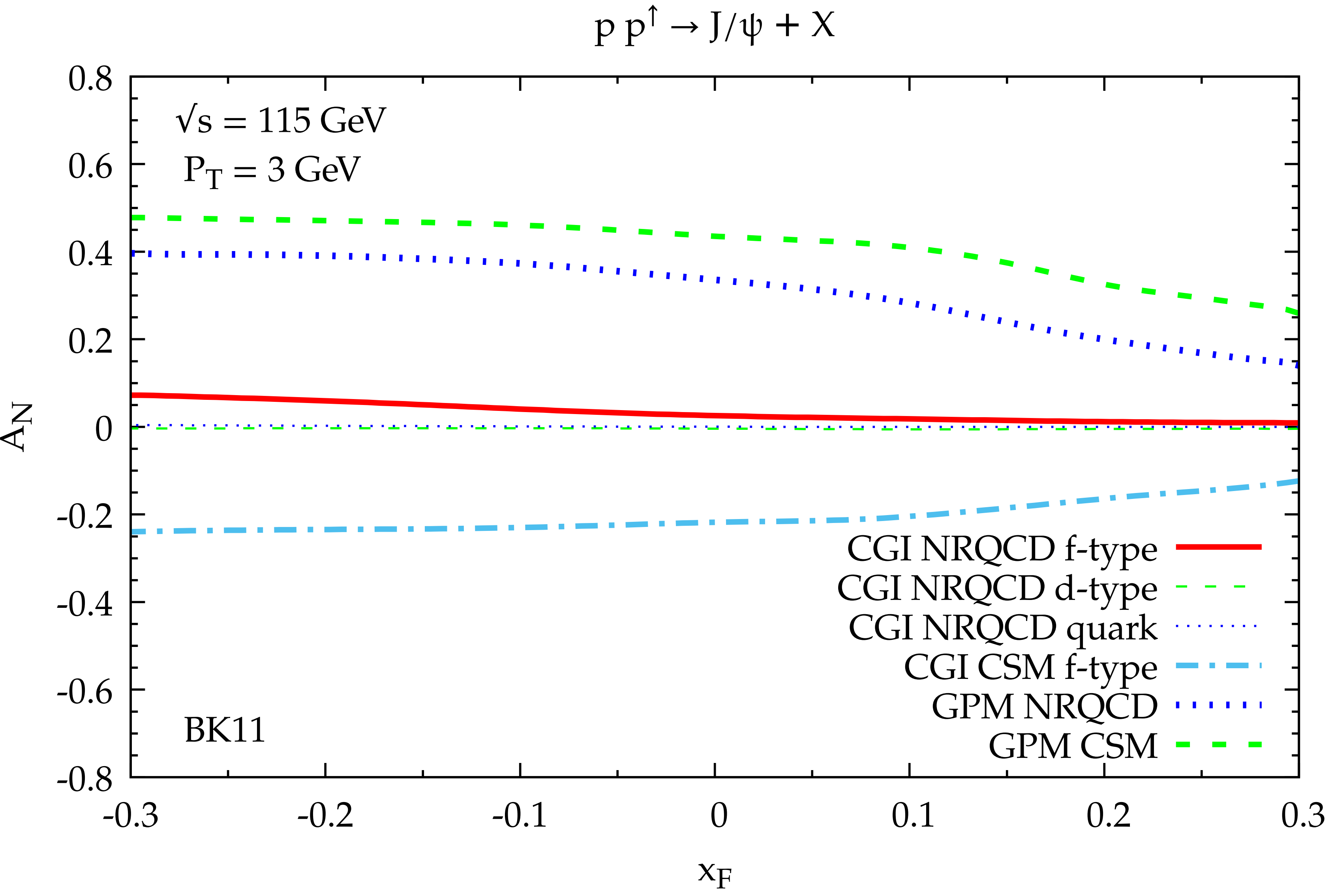
nucleon pol.	U	f_1^g		$h_1^{\perp g}$
	L		g_{1L}^g	$h_{1L}^{\perp g}$
	T	$f_{1T}^{\perp g}$	g_{1T}^g	h_1^g, $h_{1T}^{\perp g}$

Can be accessed through the Fourier decomposition of the TSSAs for inclusive meson production

$$A_N = \frac{1}{P}\frac{\sigma^\uparrow - \sigma^\downarrow}{\sigma^\uparrow + \sigma^\downarrow} \propto \left[\underline{f_{1T}^{\perp g}(x_a, k_{\perp a})} \otimes f_g(x_b, k_{\perp b}) \otimes d\sigma_{gg \to Q Q g}\right] \sin\phi_S + \cdots$$

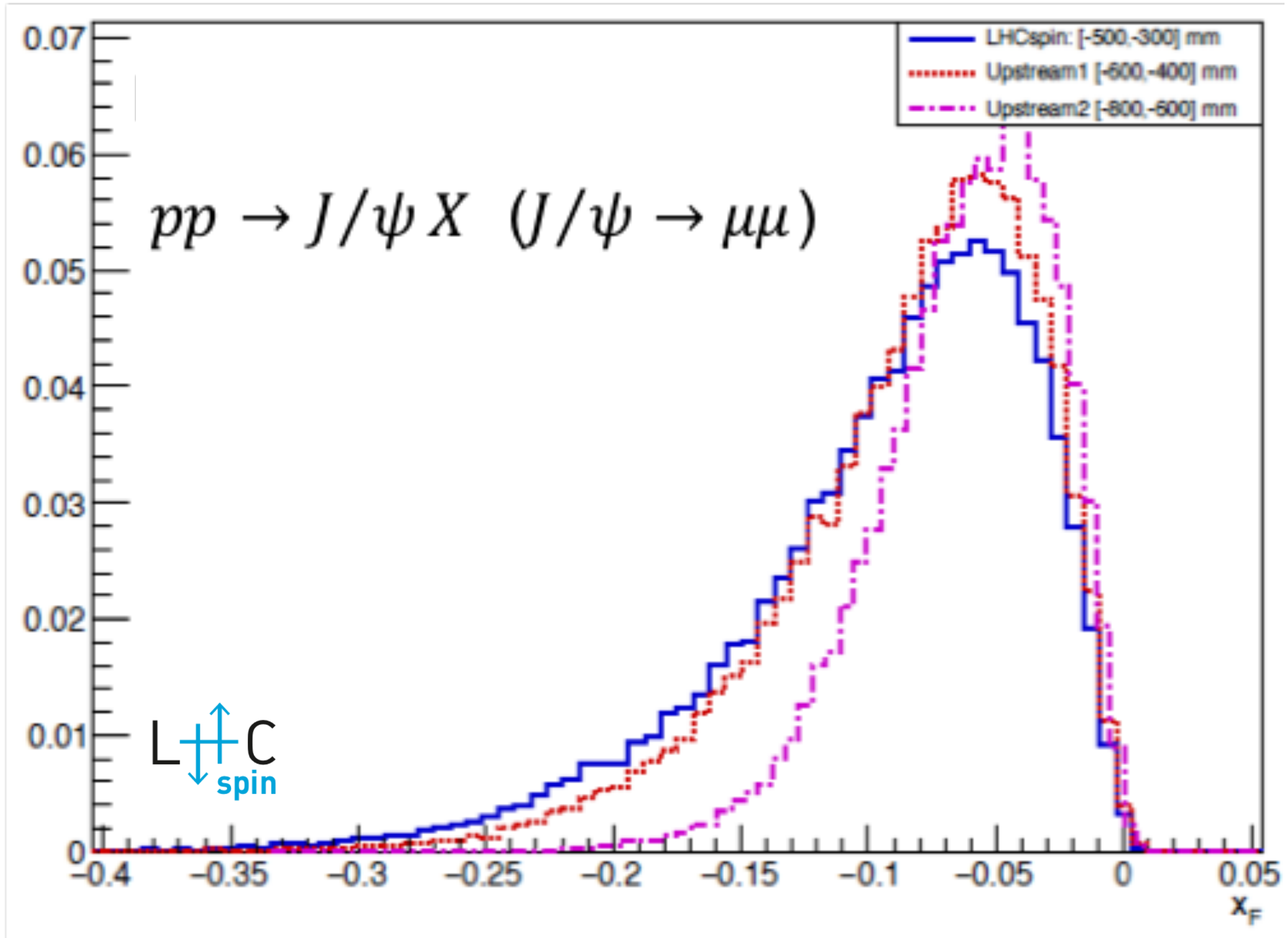
Sensitive to color exchange among IS and FS, and gluon OAM

Shed light on spin-orbit correlation of unpolarized gluons inside a transversely polarized proton



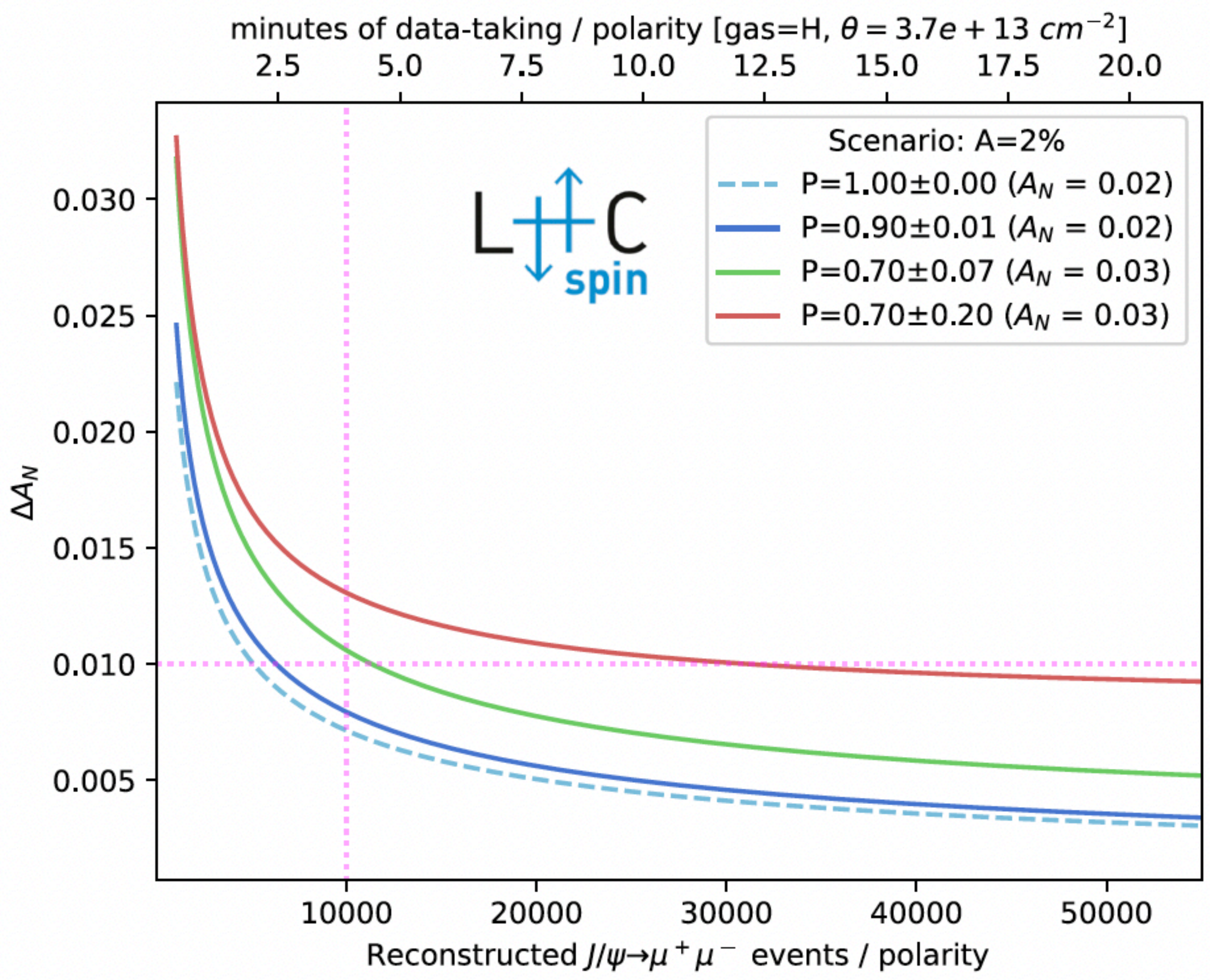
Phys. Rev. D 102, 094011 (2020)

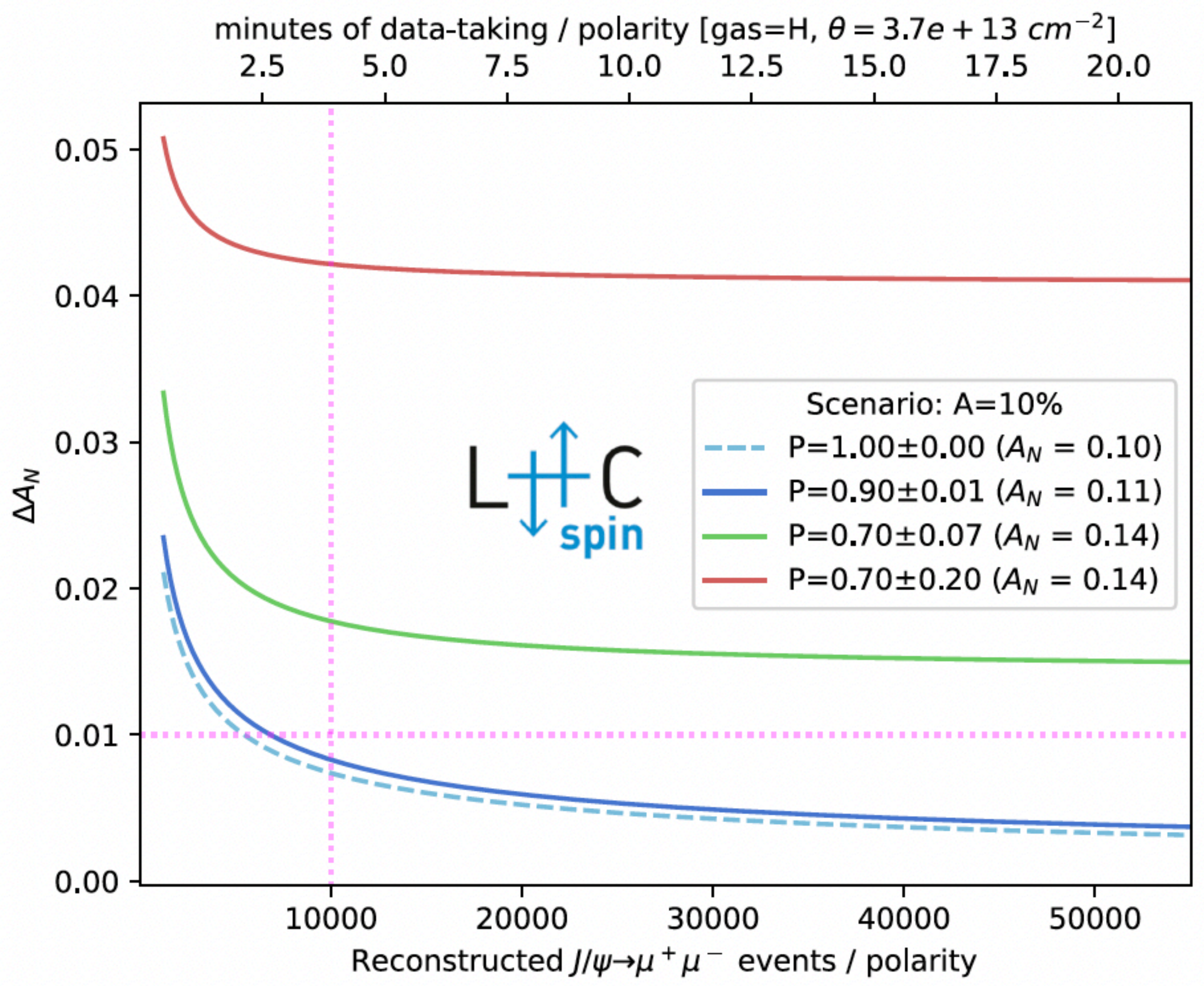
Predictions for J/Ψ production based on GPM & CGI-GPM Expected amplitudes could be very large in the $x_F < 0$ region



LHCspin event rates

Precise spin asymmetry on $J/\Psi \rightarrow \mu^+\mu^-$ and $D^0 \rightarrow K^-\pi^+$ for $pH^\uparrow$ collisions in just few weeks with Run3 luminosity!
Statistics further enhanced by a factor 3-5 in LHCb upgrade II





reconstructed particles

LHCspin event rates

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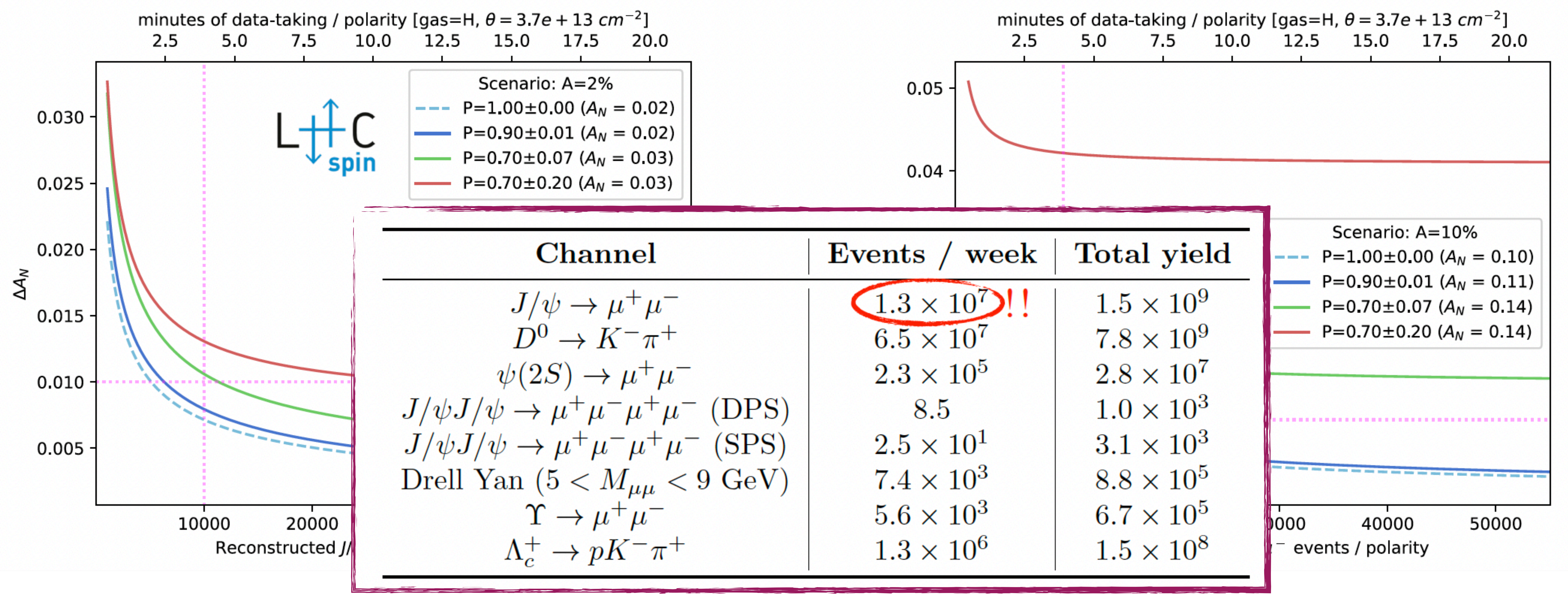


Channel	Events / week	Total yield
$J/\psi \to \mu^+\mu^-$	1.3×10^7 !!	1.5×10^9
$D^0 \to K^-\pi^+$	6.5×10^7	7.8×10^9
$\psi(2S) \to \mu^+\mu^-$	2.3×10^5	2.8×10^7
$J/\psi J/\psi \to \mu^+\mu^-\mu^+\mu^-$ (DPS)	8.5	1.0×10^3
$J/\psi J/\psi \to \mu^+\mu^-\mu^+\mu^-$ (SPS)	2.5×10^1	3.1×10^3
Drell Yan ($5 < M_{\mu\mu} < 9$ GeV)	7.4×10^3	8.8×10^5
$\Upsilon \to \mu^+\mu^-$	5.6×10^3	6.7×10^5
$\Lambda_c^+ \to pK^-\pi^+$	1.3×10^6	1.5×10^8

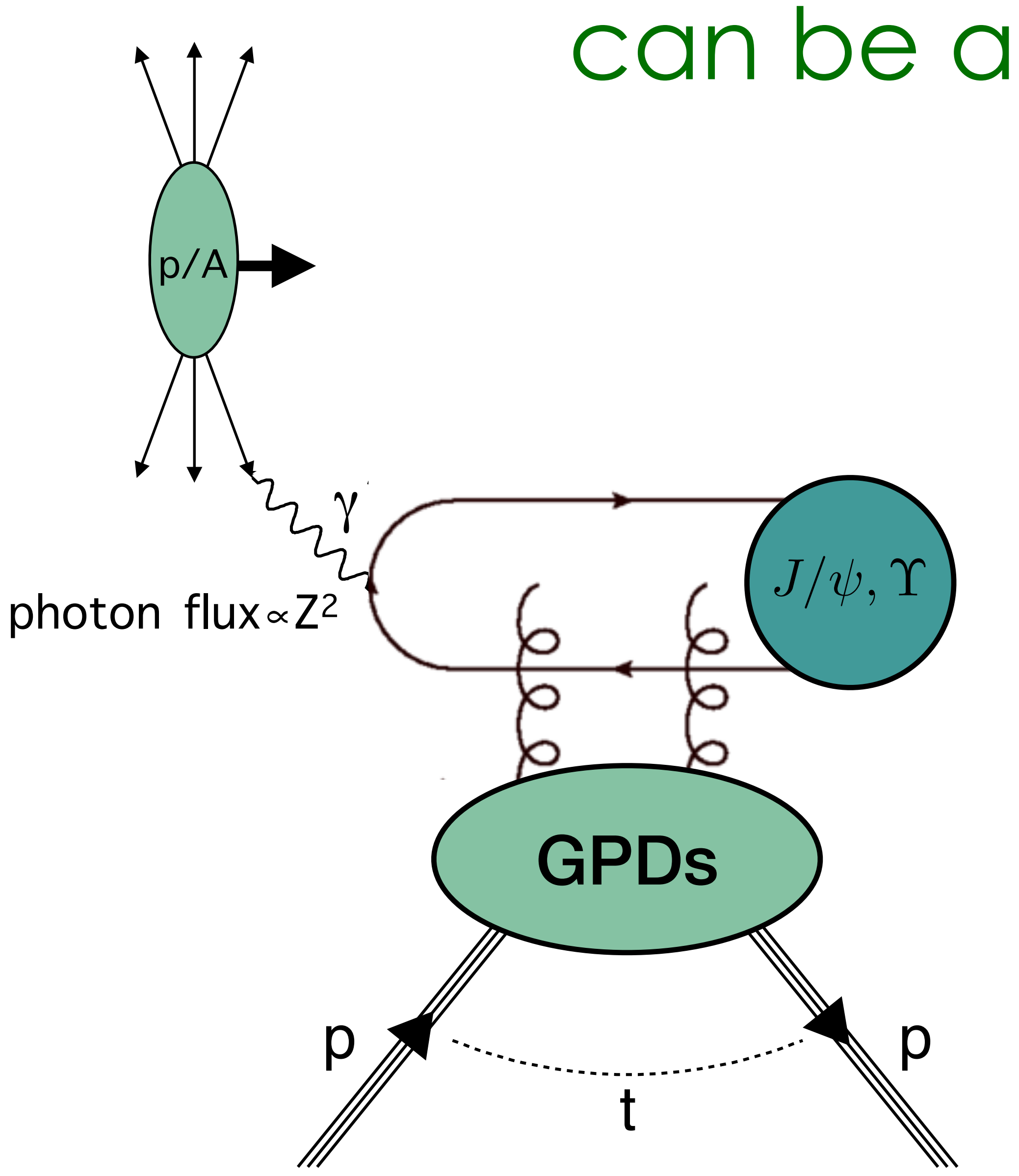
reconstructed particles

UPC and gGPDs

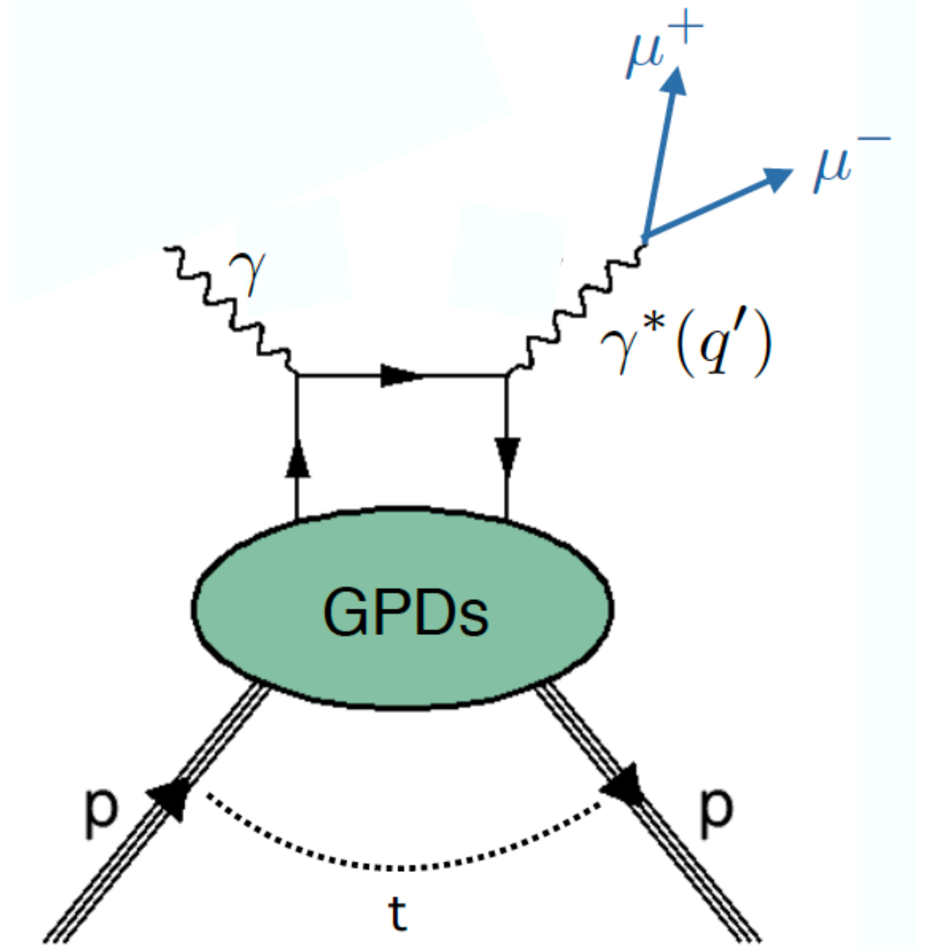
Accessible already with SMOG2
for the unpol part

can be accessed at LHC in Ultra-Peripheral collisions (UPC)

Recall:
-barely explored high-x_B region
-moderate Q^2



Exclusive meson production
hard scale = quark mass



Timelike Compton scattering (TCS)
(access via angular modulation)
hard scale = large q^2 (in practice few GeV²)

- Impact parameter larger than sum of radii
- Process dominated by EM interactions
- Gluon distributions probed by pomeron exchange
- Exclusive quarkonia prod. sensitive to gluon GPDs

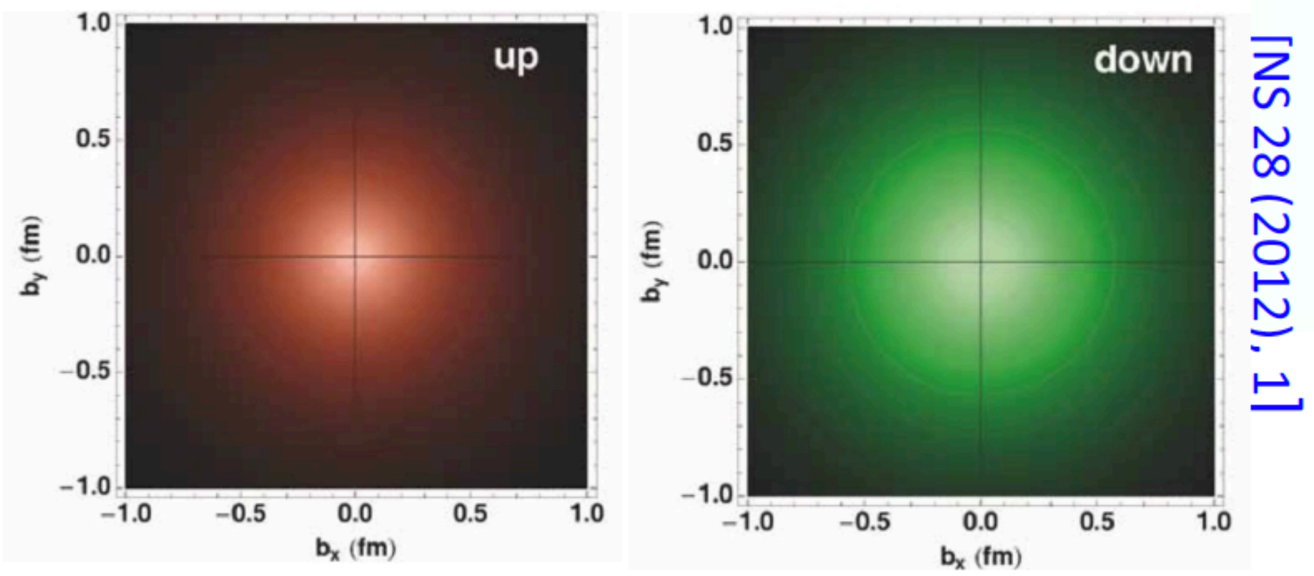
[PRD 85 (2012), 051502]

LHCspin could allow to access the GPD E^g (a key ingredient of the Ji sum rule)

$$J^g = \frac{1}{2}\int_0^1 dx\Big(H^g(x,\xi,0) + E^g(x,\xi,0)\Big)$$

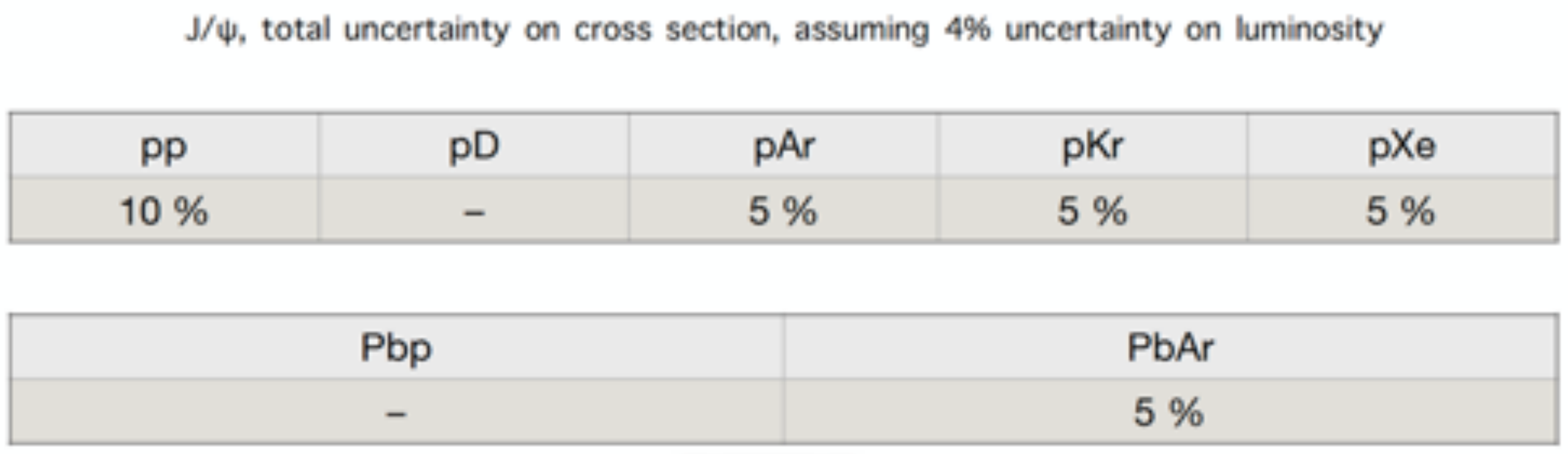
GPD	U	L	T
U	H		$\mathcal{E}_T$
L		$\tilde{H}$	$\tilde{E}_T$
T	E	$\tilde{E}$	$H_T,\ \tilde{H}_T$

3D maps of parton densities in coordinate space



[NS 28 (2012), 1]

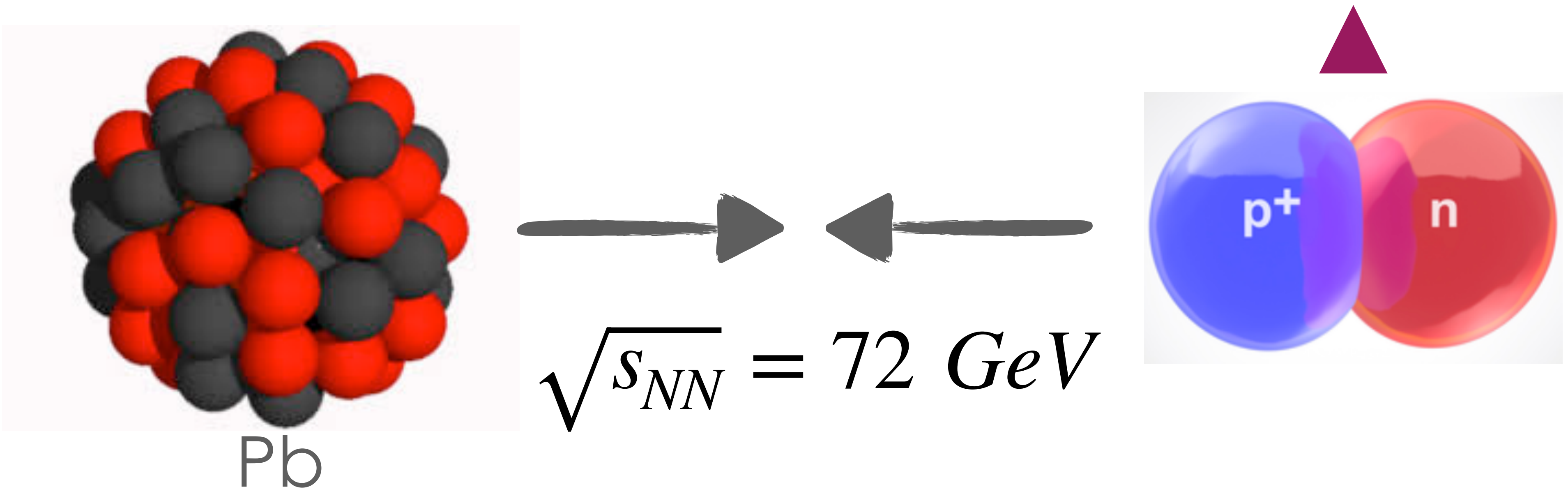
J/ψ, total uncertainty on cross section, assuming 4% uncertainty on luminosity



pp	pD	pAr	pKr	pXe
10 %	–	5 %	5 %	5 %

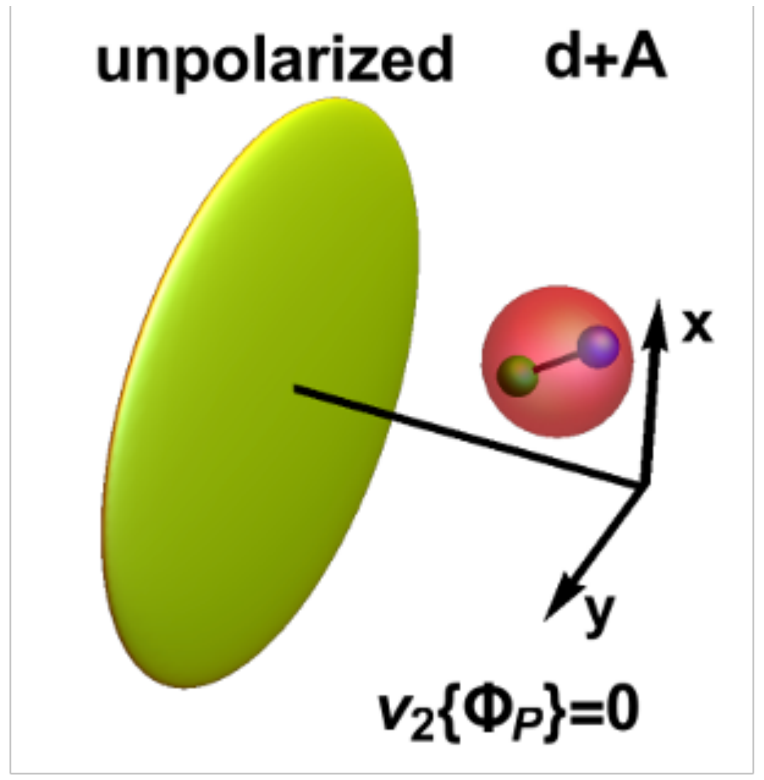
Pbp	PbAr
–	5 %

Spin physics in heavy-ion collisions

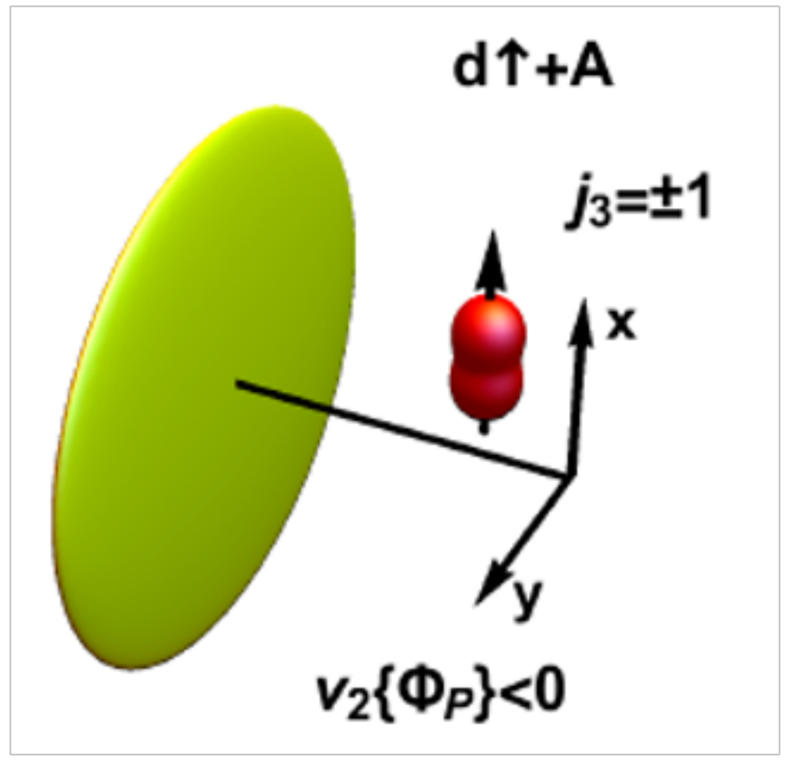


- probe collective phenomena in heavy-light systems through **ultra-relativistic collisions of heavy nuclei with trasv. pol. deuterons**

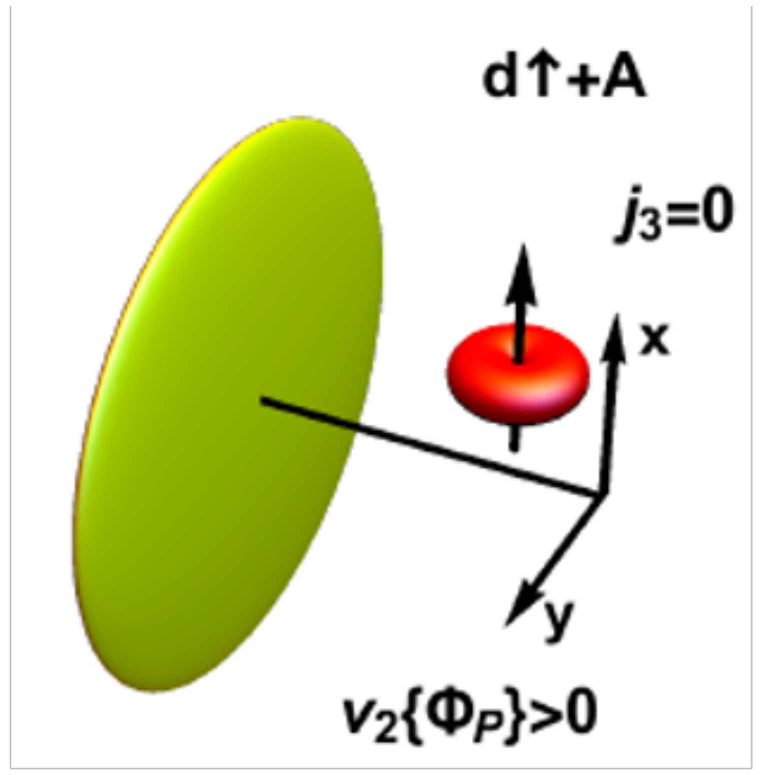
- polarized light target nuclei offer a unique opportunity to control the orientation of the formed fireball by measuring the **elliptic flow** relative to the polarization axis (**ellipticity**).



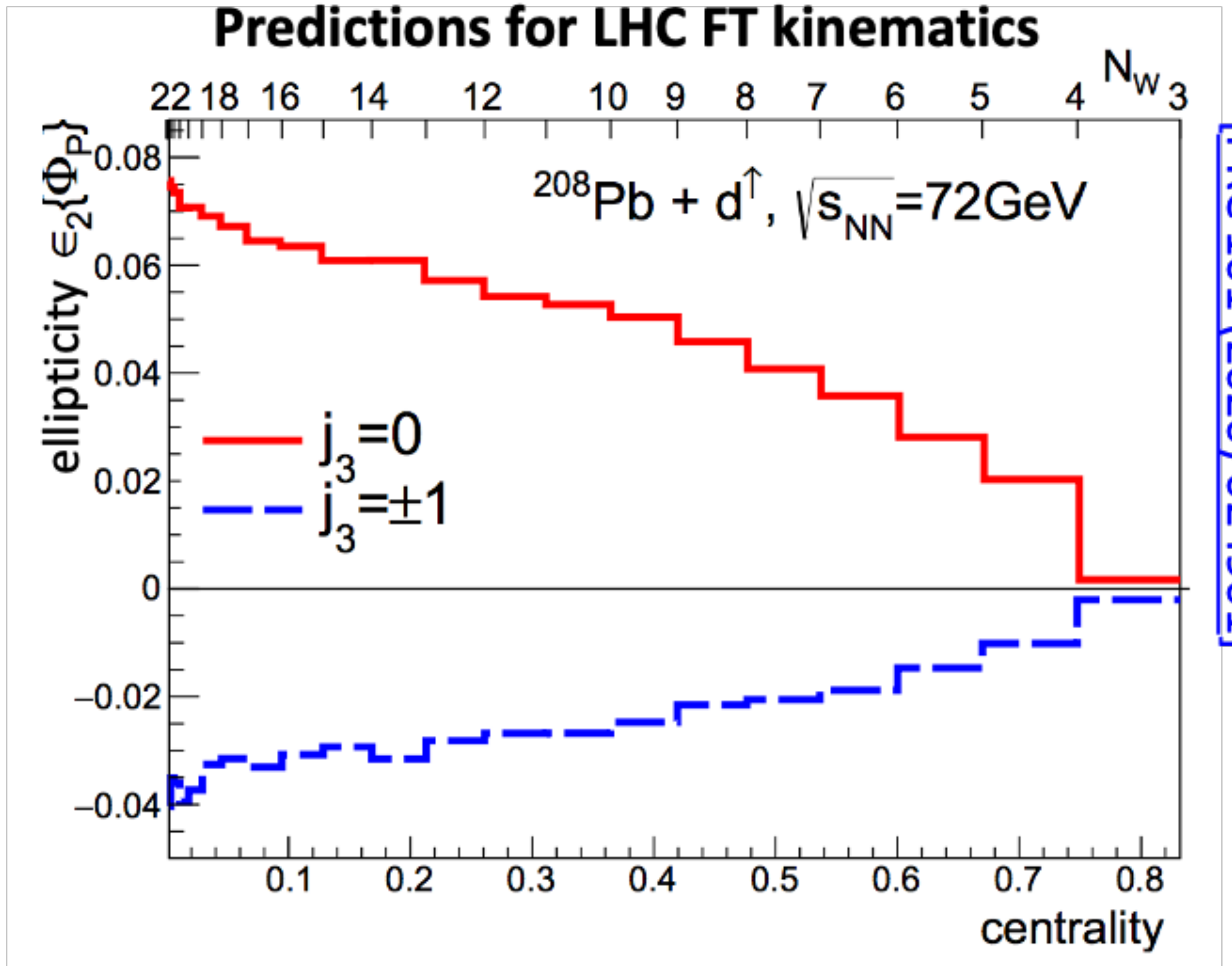
Unpol. deuterons: the **fireball is azimuthally symmetric** and $v_2 \approx 0$.



$j_3 = \pm 1$ → **prolate fireball** stretched along the pol. axis, corresponds to $v_2 < 0$



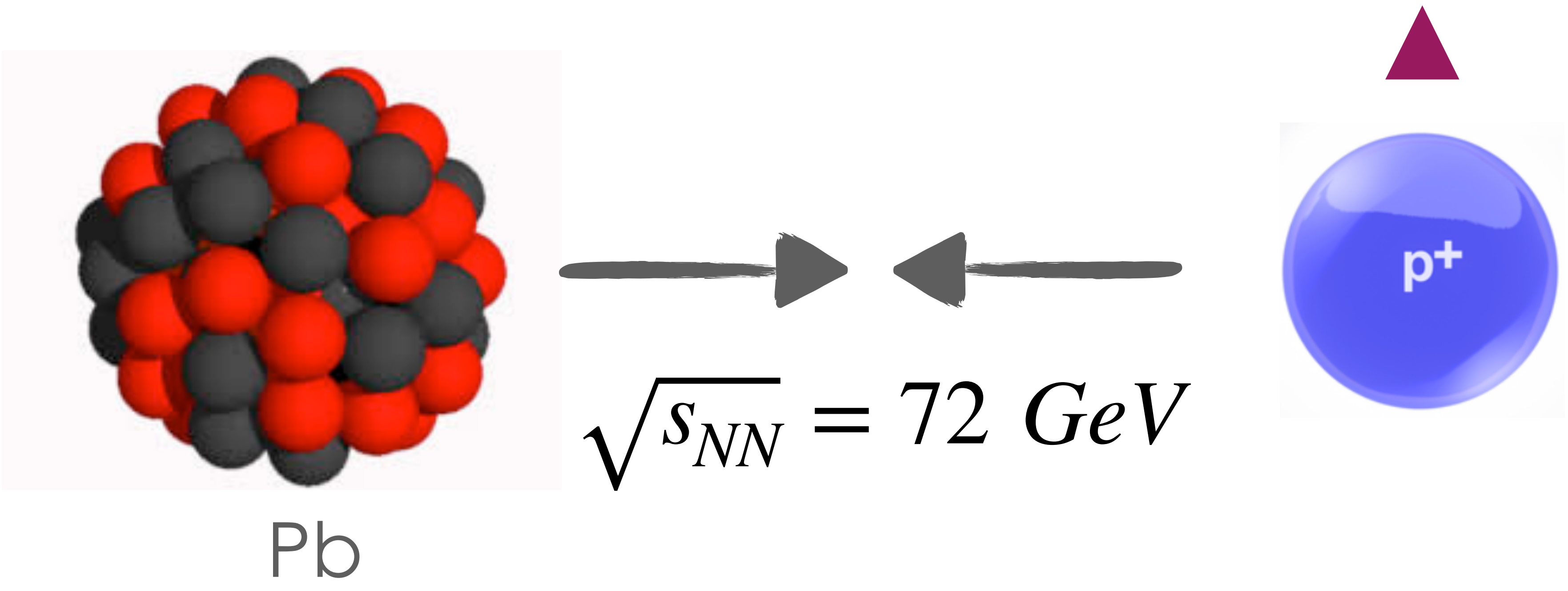
$j_3 = 0$ → **oblate fireball** corresponds to $v_2 > 0$



[PRC 101 (2020) 024901]

Wojciech Broniowski, Piotr Bozek

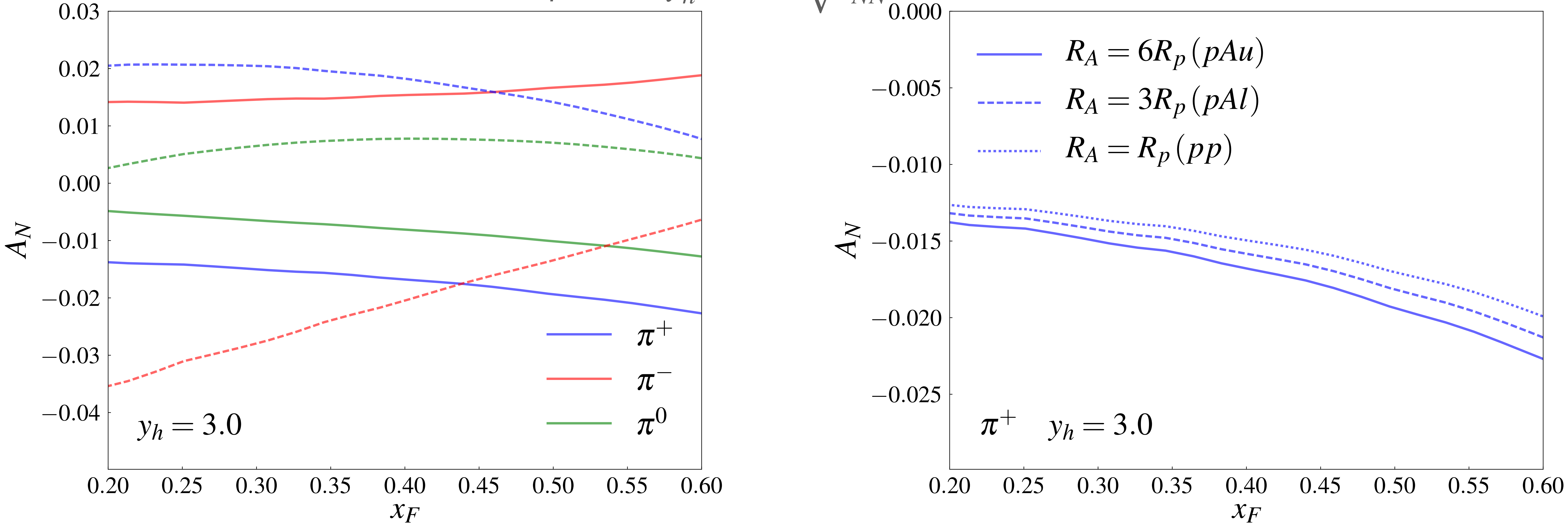
Spin physics in heavy-ion collisions



Single spin asymmetries in ultra-peripheral $p^{\uparrow}A \to hAX$ collisions

to test the assumed dominance of the contribution from twist-three fragmentation functions

p+Au, $y_h = 3.0$, $\sqrt{s_{NN}} = 200\ GeV$



Phys. Rev. D98, 094025 (2018)

kinematic region and required precision well fit the LHCspin potentialities

International framework and feedback

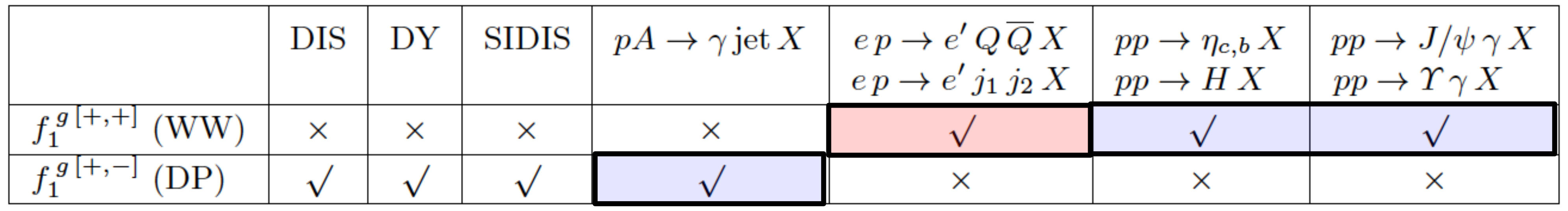
Several experiments dedicated to spin physics, but with many limitations:

very low energy, no rare probes, no ion beam, … → LHCspin is unique in this respect

LHCspin is complementary to EIC

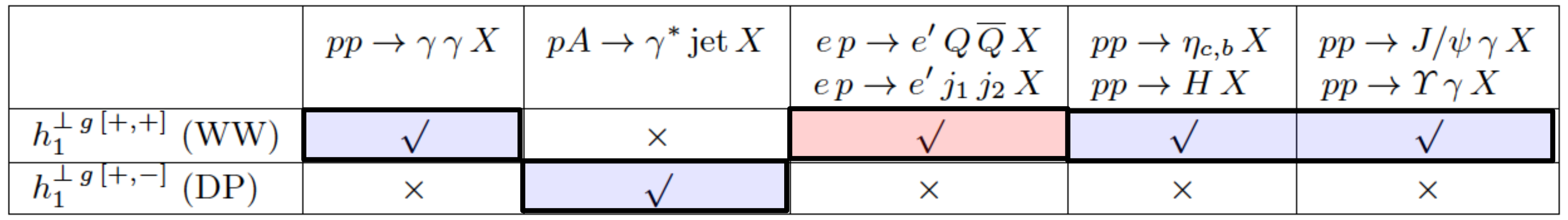
[D. Boer: arXiv:1611.06089]

unpolarized gluon TMD



	DIS	DY	SIDIS	$pA \to \gamma\,\text{jet}\,X$	$e\,p \to e'\,Q\,\overline{Q}\,X$ $e\,p \to e'\,j_1\,j_2\,X$	$pp \to \eta_{c,b}\,X$ $pp \to H\,X$	$pp \to J/\psi\,\gamma\,X$ $pp \to \Upsilon\,\gamma\,X$
$f_1^{g\,[+,+]}$ (WW)	×	×	×	×	√ 🟥	√ 🟦	√ 🟦
$f_1^{g\,[+,-]}$ (DP)	√	√	√	√ 🟦	×	×	×

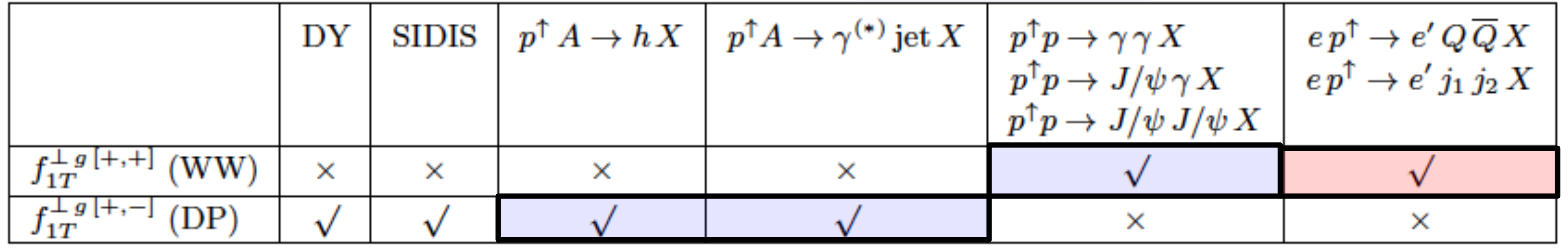
linearly polarized gluon TMD



	$pp \to \gamma\,\gamma\,X$	$pA \to \gamma^*\,\text{jet}\,X$	$e\,p \to e'\,Q\,\overline{Q}\,X$ $e\,p \to e'\,j_1\,j_2\,X$	$pp \to \eta_{c,b}\,X$ $pp \to H\,X$	$pp \to J/\psi\,\gamma\,X$ $pp \to \Upsilon\,\gamma\,X$
$h_1^{\perp\,g\,[+,+]}$ (WW)	√ 🟦	×	√ 🟥	√ 🟦	√ 🟦
$h_1^{\perp\,g\,[+,-]}$ (DP)	×	√ 🟦	×	×	×

TMDs (Sivers)

[D. Boer: arXiv:1611.06089, D. Boer et al. HEPJ 08 2016 001]



	DY	SIDIS	$p^\uparrow\,A \to h\,X$	$p^\uparrow A \to \gamma^{(*)}\,\text{jet}\,X$	$p^\uparrow p \to \gamma\,\gamma\,X$ $p^\uparrow p \to J/\psi\,\gamma\,X$ $p^\uparrow p \to J/\psi\,J/\psi\,X$	$e\,p^\uparrow \to e'\,Q\,\overline{Q}\,X$ $e\,p^\uparrow \to e'\,j_1\,j_2\,X$
$f_{1T}^{\perp\,g\,[+,+]}$ (WW)	×	×	×	×	√ 🟦	√ 🟥
$f_{1T}^{\perp\,g\,[+,-]}$ (DP)	√	√	√ 🟦	√ 🟦	×	×

$f_{1T}^{\perp g[+,+]}$ (Weizsacker-Williams type or “**f-type**”) → antisymmetric colour structures

$f_{1T}^{\perp g[+,-]}$ (Dipole s type or “**d-type**”) → symmetric colour structures

🟥 Can be measured at the Electron Ion-Collider (EIC)

🟦 Can be measured at LHCspin

“Ambitious and long term LHC-Fixed Target research program. The efforts of the existing LHC experiments to implement such a programme, including specific R&D actions on the collider, deserve support“ (European Strategy for Particle Physics)

“This would be unique and highly complementary to existing and future measurements in lepton-proton collisions, because the asymmetries in question have a process dependence between pp and lp that is predicted by theory” (CERN Physics Beyond Collider)

Recognised relevance

Fixed target physics at the LHC is an exciting reality

Fixed target physics at the LHC is an exciting reality

SMOG2 already operative and taking unpolarised data

LHCspin is an innovative and unique project conceived to bring polarized physics at the LHC. It is exceptionally ambitious in terms of both its potential for advancing physics and its technical complexity. Moreover, it can be implemented within a realistic timeframe (during LHC Run 4, starting in 2029) and limited budget

Fixed target physics at the LHC is an exciting reality

LHCb {

- SMOG2 already operative and taking unpolarised data
- LHCspin is an innovative and unique project conceived to bring polarized physics at the LHC. It is exceptionally ambitious in terms of both its potential for advancing physics and its technical complexity. Moreover, it can be implemented within a realistic timeframe (during LHC Run 4, starting in 2029) and limited budget

LHCspin @IR3 has great potentialities for R&D, early measurements, … all in a small group of research (you are welcome to join us)