B-Physics at ATLAS and CMS

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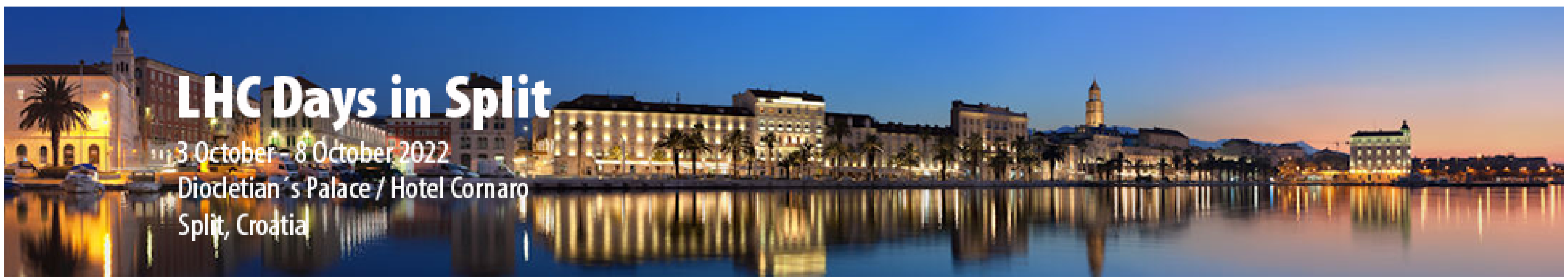
on behalf of the ATLAS and CMS Collaborations



Contents

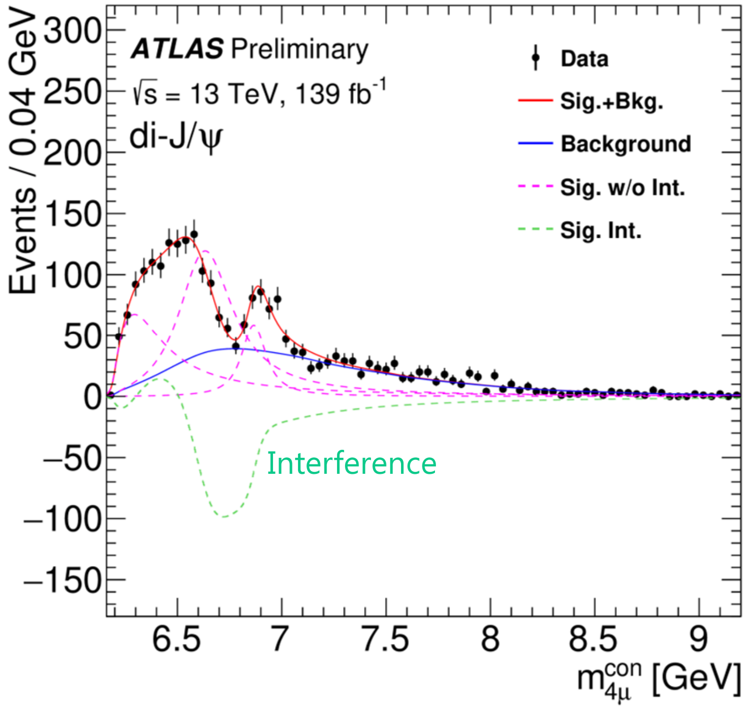
- Studies of J/ψ pair production at ATLAS and CMS: di-charmonium exotics
- Triple J/ψ production at CMS;
- Pentaquark and tetraquark studies in B-hadron decays at ATLAS;
- Differential cross-section of J/ψ production at ATLAS and CMS;
- Measurement of the CP-violating phase in $B_s \to J/\psi\phi$ decays at ATLAS and CMS;
- Combination of LHCb, ATLAS, CMS results for $B_s \to \mu\mu$, $B^0 \to \mu\mu$ rare decays;
- Summary of B_c results;
- Observation of $B^0 \to \psi(2S)K_s^0\pi^+\pi^-$ and $B_s \to \psi(2S)K_s^0$ decays at CMS;
- Angular analysis of B-meson decays at ATLAS and CMS;
- Observation of $\Xi^-_b(6100)$ excited bottom-strange baryon state in $\Xi^-_b\pi\pi$ decay channel

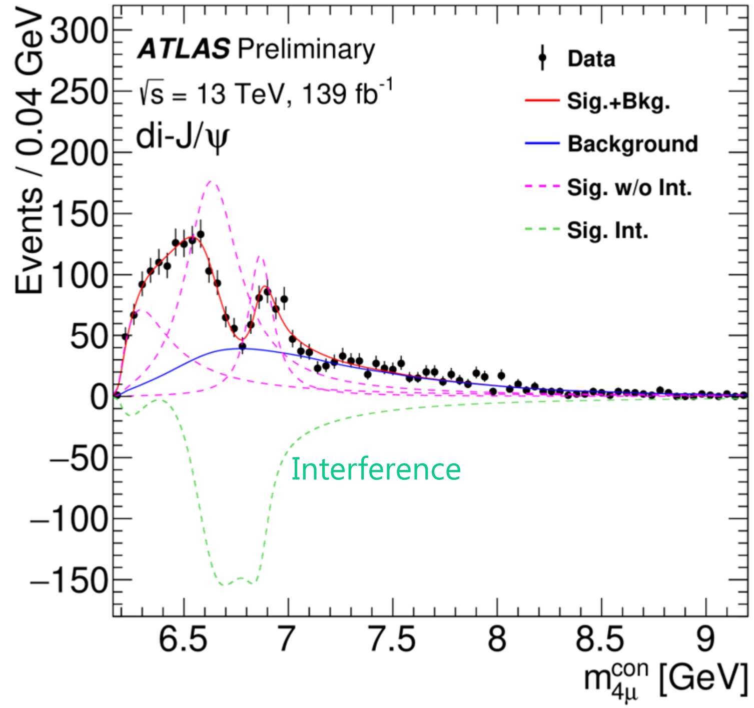
J/ψ pair production studies at ATLAS and CMS: exotic states

ATLAS-CONF-2022-040

Studies were motivated by LHCb discovery of resonant-like signal X(6900) in di-J/ψ spectrum: [Science Bulletin 65 (2020) 1983-1993]

ATLAS and CMS also studied di-J/ψ spectrum near production threshold:



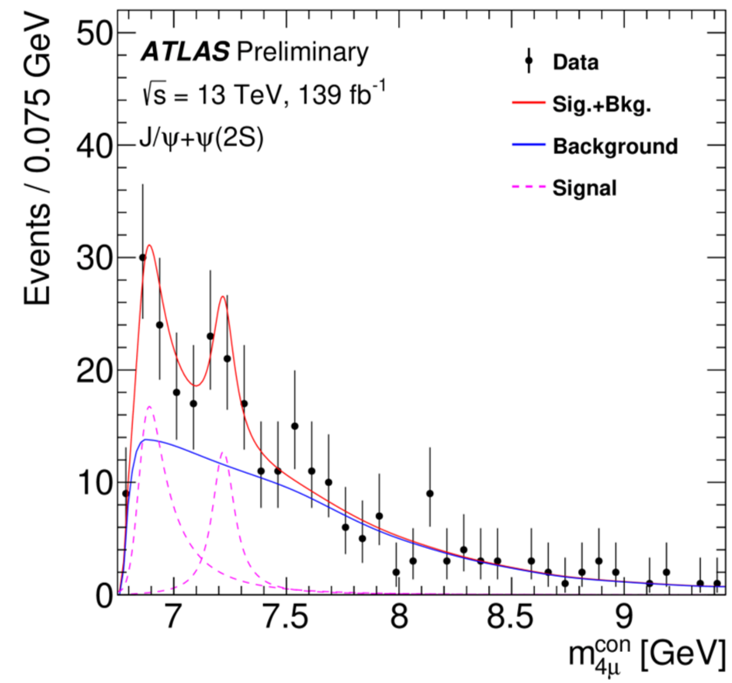


Two degenerate solutions for di-J/ψ mass spectrum are obtained by ATLAS with different interference contribution:

di-J/ψ	M, GeV	Γ, GeV
X(6900)	$6.87\pm0.03^{+0.06}_{-0.01}$	$0.12\pm0.04^{+0.03}_{-0.01}$
BW_1	$6.22\pm0.05^{+0.04}_{-0.05}$	$0.31\pm0.12^{+0.07}_{-0.08}$
BW_2	$6.62\pm0.03^{+0.02}_{-0.01}$	$0.31\pm0.09^{+0.06}_{-0.11}$

ATLAS studies of J/ψ+ψ(2S) spectrum shows hint on the additional signal at 7.2GeV

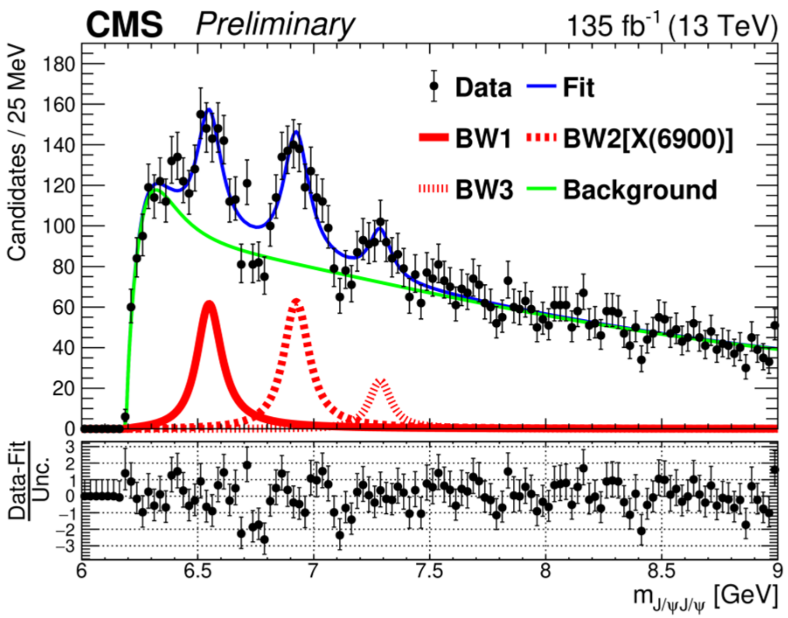
J/ψ+ψ(2S)	M, GeV	Γ, GeV
BW_4	$7.22\pm0.03^{+0.02}_{-0.03}$	$0.10^{+0.13+0.06}_{-0.07-0.05}$

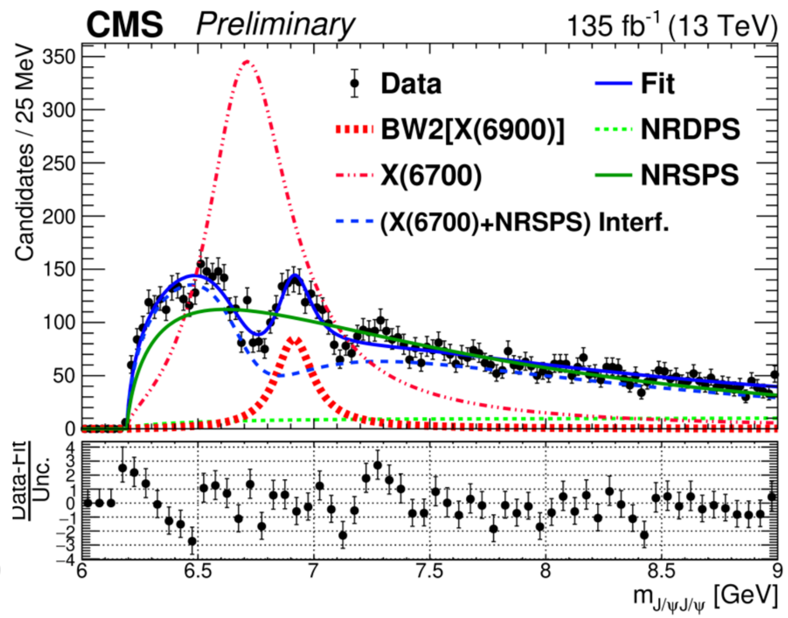


 CMS-PAS-BPH-21-003

Studies were motivated by LHCb discovery of resonant-like signal X(6900) in di-J/ψ spectrum: Science Bulletin 65 (2020) 1983-1993

ATLAS and CMS also studied di-J/ψ spectrum near production threshold:





Plots show fit solutions with and without interference for CMS data:

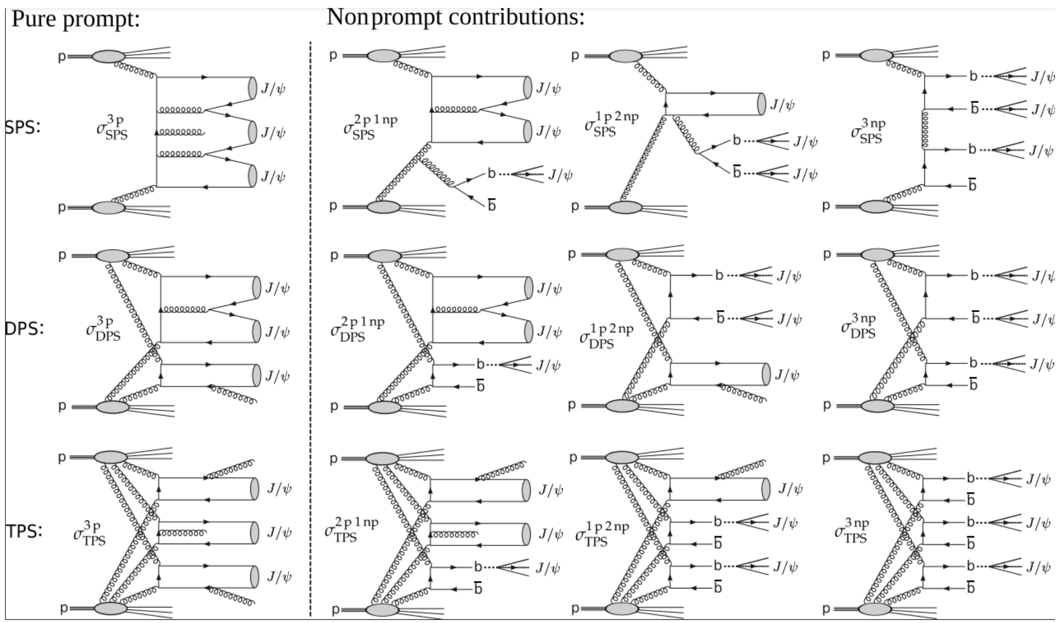
di-J/ψ	M, GeV	Γ, GeV
X(6900)	6.927±0.009±0.005	0.122±0.022±0.019
BW_1	6.552±0.010±0.012	0.124±0.029±0.034
BW_2	7.287±0.019±0.005	0.095±0.046±0.020

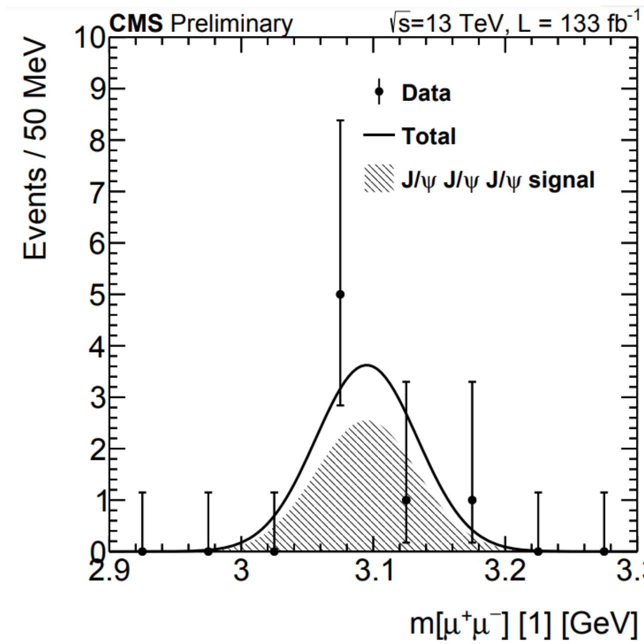
Hint on the signal at 7.3GeV is more prominent in CMS data.

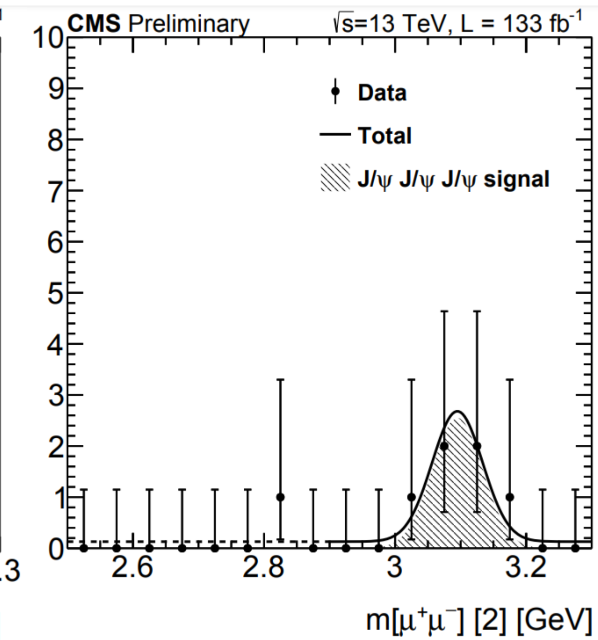
Precise analysis of di-J/ψ spectrum (including angular information) is needed to shed light on structure of the threshold signals as well as exotic nature of X(6900) and X(7300) candidates.

Triple J/ψ production at CMS

CMS-PAS-BPH-21-004
Submitted to Nature Physics



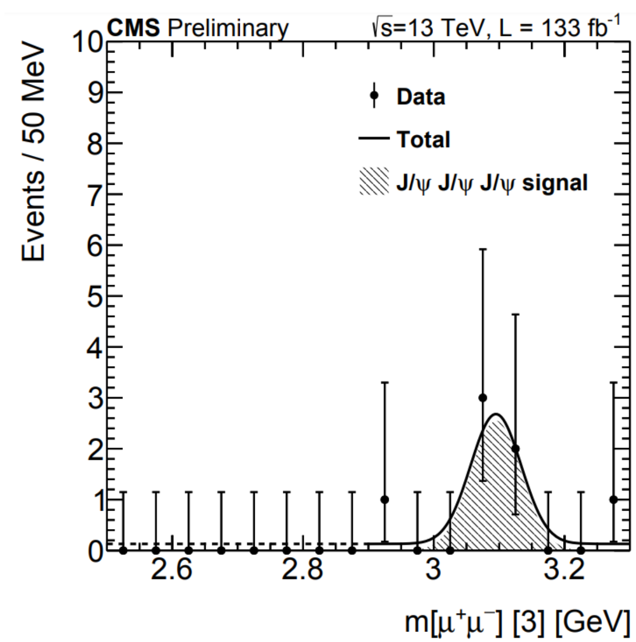




- Cross section of the triple-J/ψ production is measured at CMS.

$$\sigma(pp\rightarrow J/\psi\ J/\psi\ J/\psi\ X) = 272^{+141}_{-104}(\text{stat})\pm17(\text{syst})\ \text{fb}$$

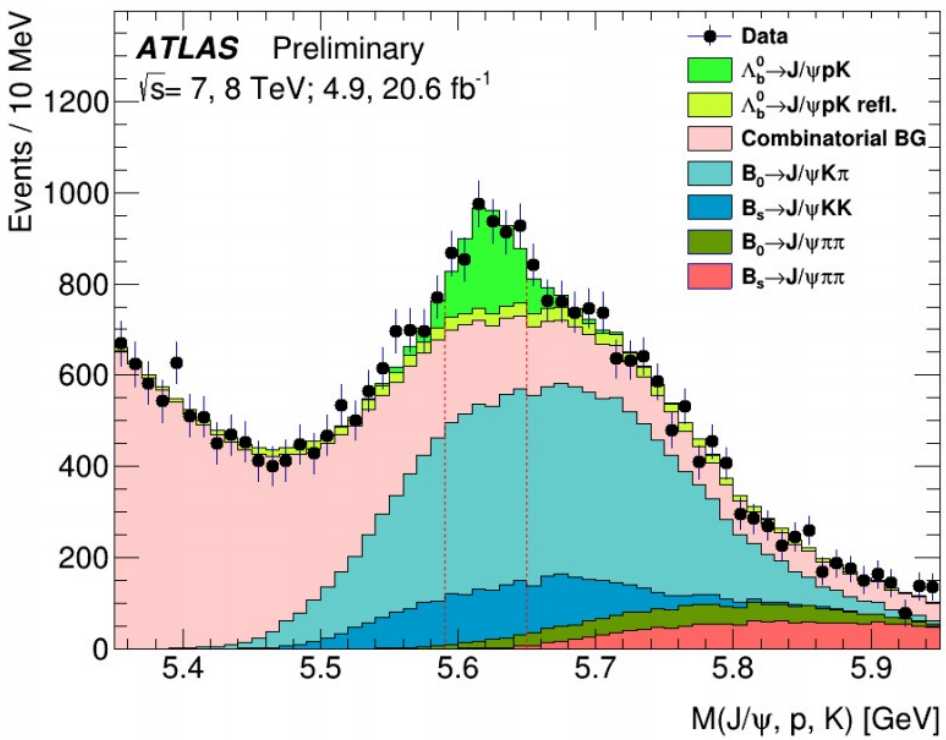
- Result is in general compatible to theoretical expectations for SPS(~6%), DPS(~74%) and TPS(~20%)
- Result is interesting wr.t. studies of multiple hard processes in pp-collisions

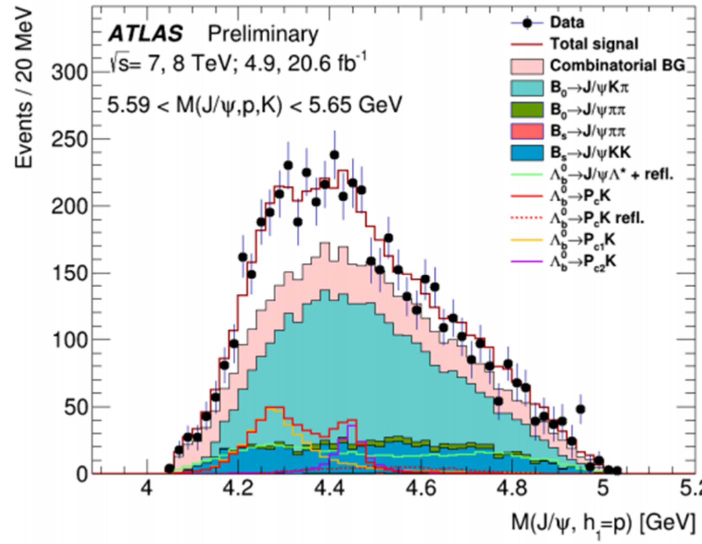


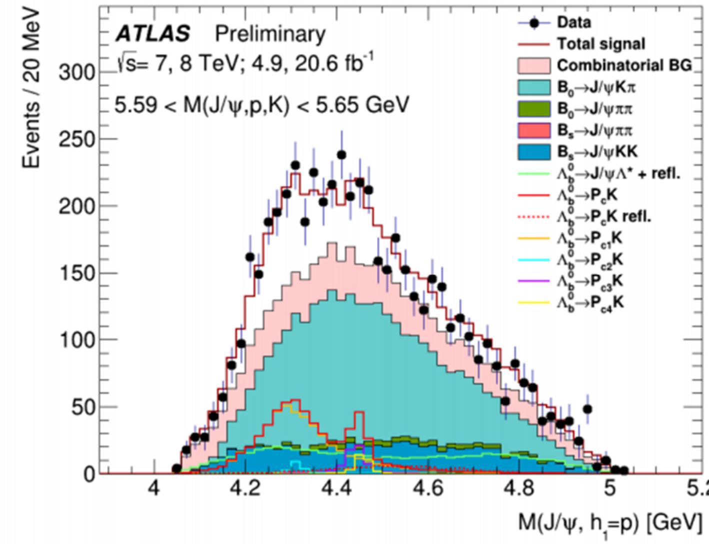
Pentaquarks decaying into $J/\psi p$ at ATLAS

ATLAS-CONF-2019-048

Following the discovery by LHCb, the $\Lambda_b \to J/\psi pK$ decays in the region of high pK system masses were analyzed in ATLAS data.



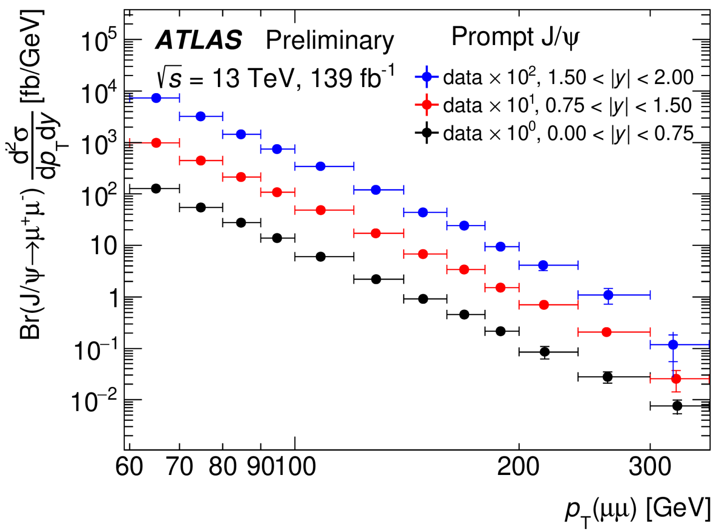


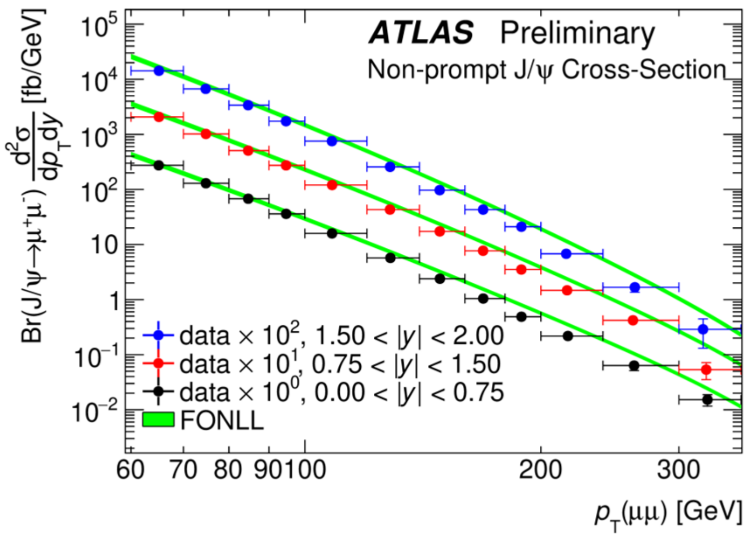


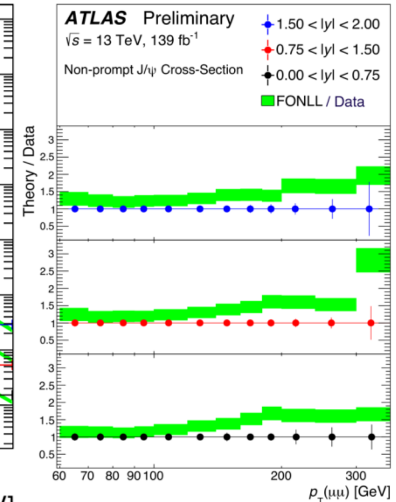
Parameter	Value	LHCb value [5]
$N(P_{c1})$	$400^{+130}_{-140}(\text{stat})^{+110}_{-100}(\text{syst})$	–
$N(P_{c2})$	$150^{+170}_{-100}(\text{stat})^{+50}_{-90}(\text{syst})$	–
$N(P_{c1}+P_{c2})$	$540^{+80}_{-70}(\text{stat})^{+70}_{-80}(\text{syst})$	–
$\Delta\phi$	$2.8^{+1.0}_{-1.6}(\text{stat})^{+0.2}_{-0.1}(\text{syst})$ rad	–
$m(P_{c1})$	$4282^{+33}_{-26}(\text{stat})^{+28}_{-7}(\text{syst})$ MeV	$4380 \pm 8 \pm 29$ MeV
$\Gamma(P_{c1})$	$140^{+77}_{-50}(\text{stat})^{+41}_{-33}(\text{syst})$ MeV	$205 \pm 18 \pm 86$ MeV
$m(P_{c2})$	$4449^{+20}_{-29}(\text{stat})^{+18}_{-10}(\text{syst})$ MeV	$4449.8 \pm 1.7 \pm 2.5$ MeV
$\Gamma(P_{c2})$	$51^{+59}_{-48}(\text{stat})^{+14}_{-46}(\text{syst})$ MeV	$39 \pm 5 \pm 19$ MeV

The ‘no-exotic contribution’ hypothesis is excluded at the level of p-value = $9\cdot 10^{-3}$.
Data are consistent with 4-pentaquark hypothesis reported by LHCb in 2019. Further studies are ongoing.
Analysis with Run II data is ongoing…

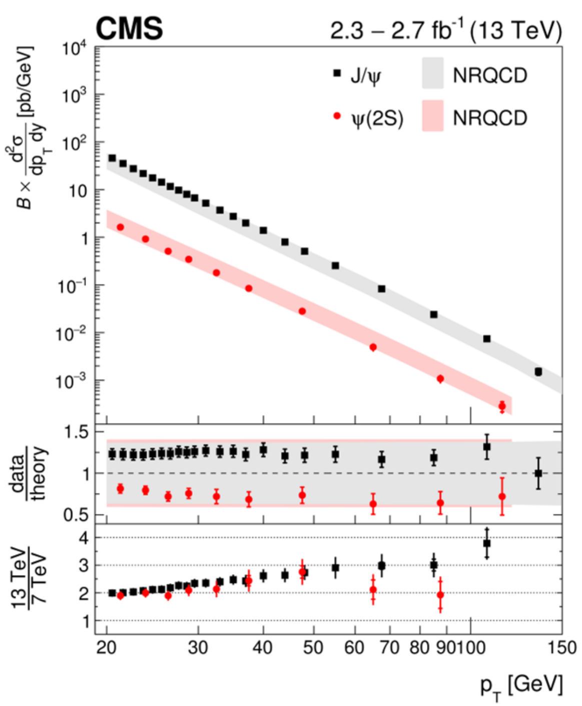
Differential cross sections of quarkonia production at ATLAS and CMS

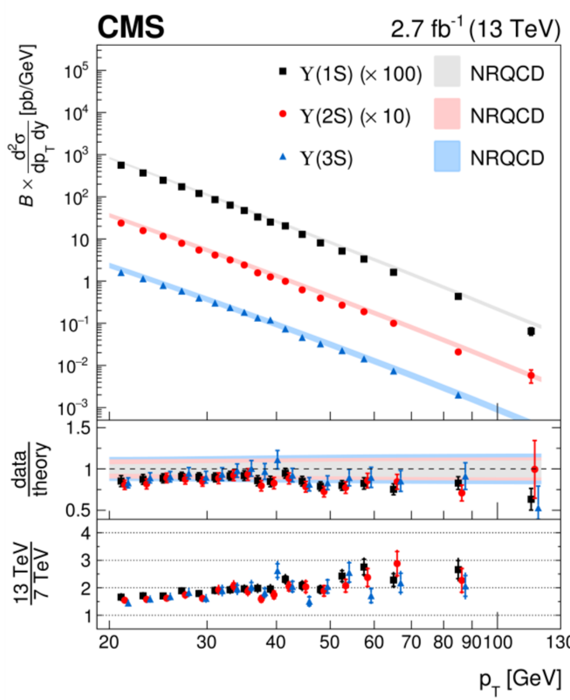






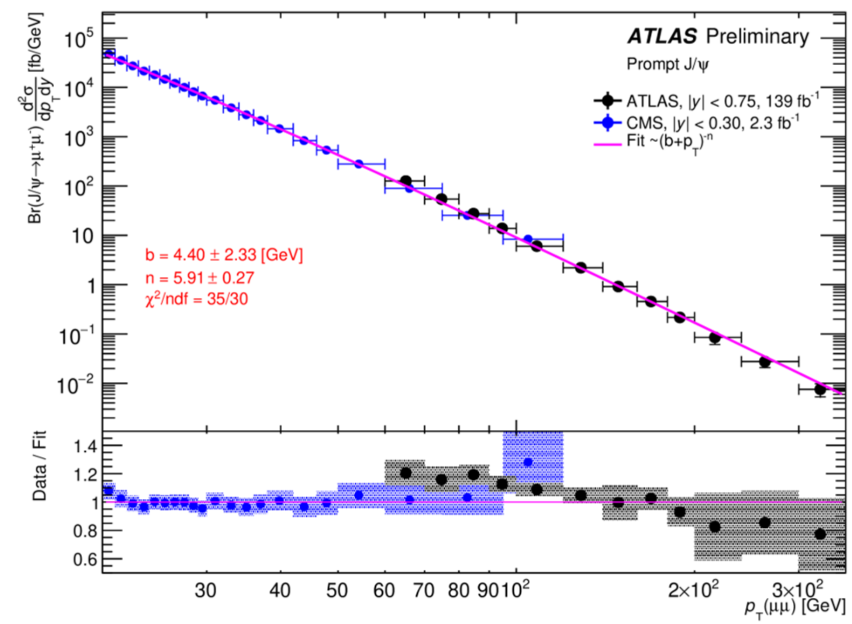
- Measurements of the prompt and non-prompt differential cross sections are compared to the FONLL calculations; prediction is too high at high p_T
- Understanding of the prompt production mechanisms is still to be achieved; plot below shows comparison of ATLAS and CMS results for the prompt *J/ψ*-s;





PLB 780 (2018) 251

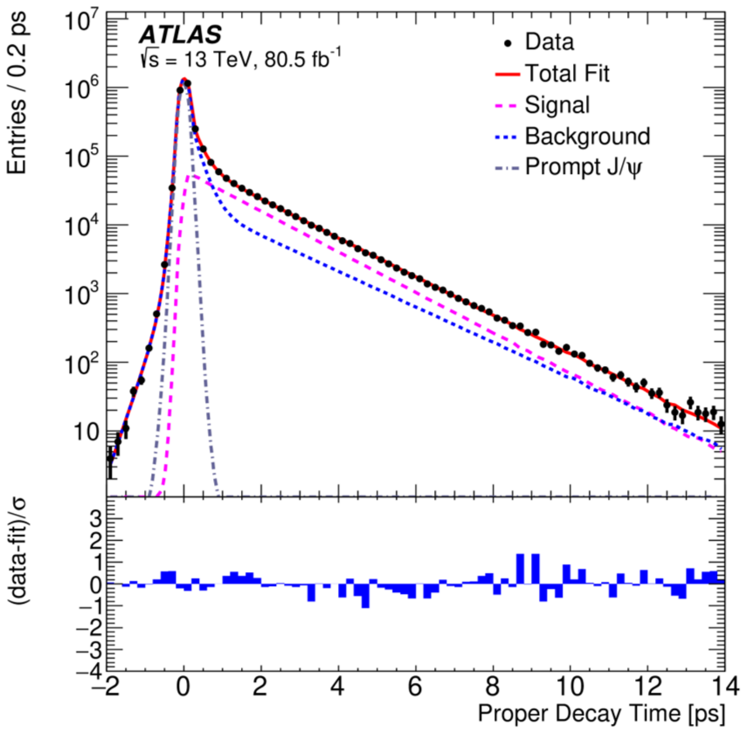
ATLAS-CONF-2019-047



Measurement of the CP-violating phase in $B_s \to J/\psi\phi$ decays

The measured parameters include the CP-violating phase φ_s, the width difference $\Delta\Gamma_s$ between the B^0_s meson mass eigenstates and the average decay width Γ

"Tension" between different experimental results is observed…

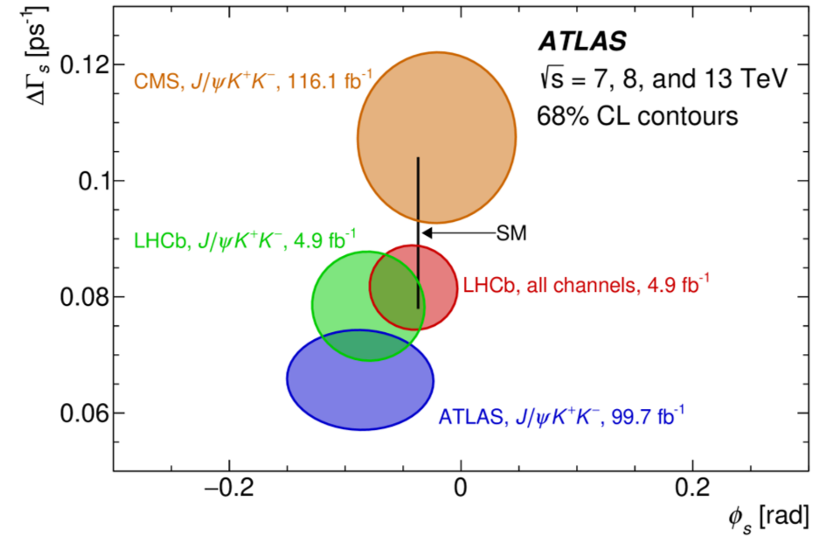


Parameter	Value	Statistical uncertainty	Systematic uncertainty
ϕ_s [rad]	−0.081	0.041	0.022
$\Delta\Gamma_s$ [ps^{-1}]	0.0607	0.0047	0.0043
Γ_s [ps^{-1}]	0.6687	0.0015	0.0022
$\lvert A_\parallel(0)\rvert^2$	0.2213	0.0019	0.0023
$\lvert A_0(0)\rvert^2$	0.5131	0.0013	0.0038
$\lvert A_S(0)\rvert^2$	0.0321	0.0033	0.0046
$\delta_\perp - \delta_S$ [rad]	−0.25	0.05	0.04

Parameters from ATLAS Run II data analysis

Parameter	Fit value	Stat. uncer.	Syst. uncer.
ϕ_s [mrad]	−11	±50	±10
$\Delta\Gamma_s$ [ps^{-1}]	0.114	±0.014	±0.007
Δm_s [$\hbar$ps^{-1}]	17.51	$^{+0.10}_{-0.09}$	±0.03
$\lvert\lambda\rvert$	0.972	±0.026	±0.008
Γ_s [ps^{-1}]	0.6531	±0.0042	±0.0024
$\lvert A_0\rvert^2$	0.5350	±0.0047	±0.0048
$\lvert A_\perp\rvert^2$	0.2337	±0.0063	±0.0044
$\lvert A_S\rvert^2$	0.022	$^{+0.008}_{-0.007}$	±0.016
$\delta_\parallel$ [rad]	3.18	±0.12	±0.03
$\delta_\perp$ [rad]	2.77	±0.16	±0.04
$\delta_{S\perp}$ [rad]	0.221	$^{+0.083}_{-0.070}$	±0.048

Parameters from CMS Run II data analysis



Eur. Phys. J. C 81 (2021) 342

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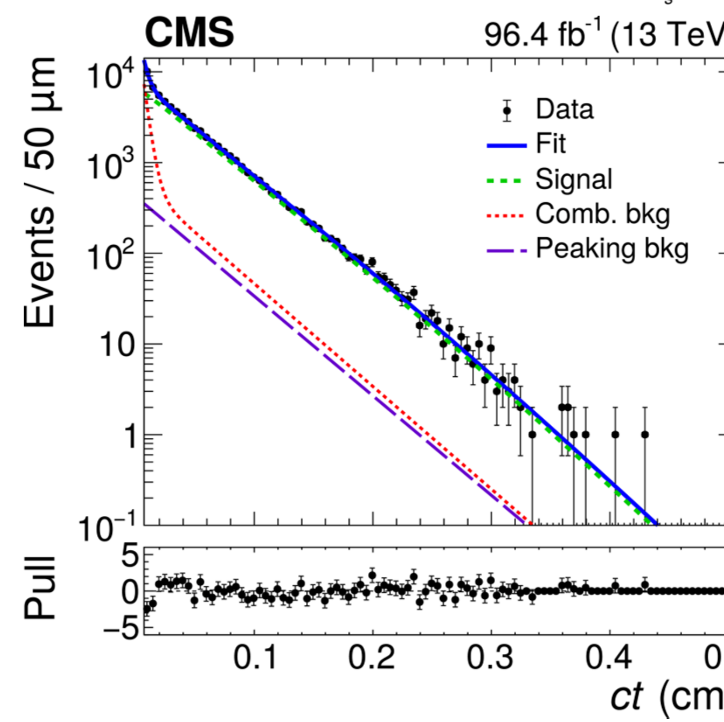
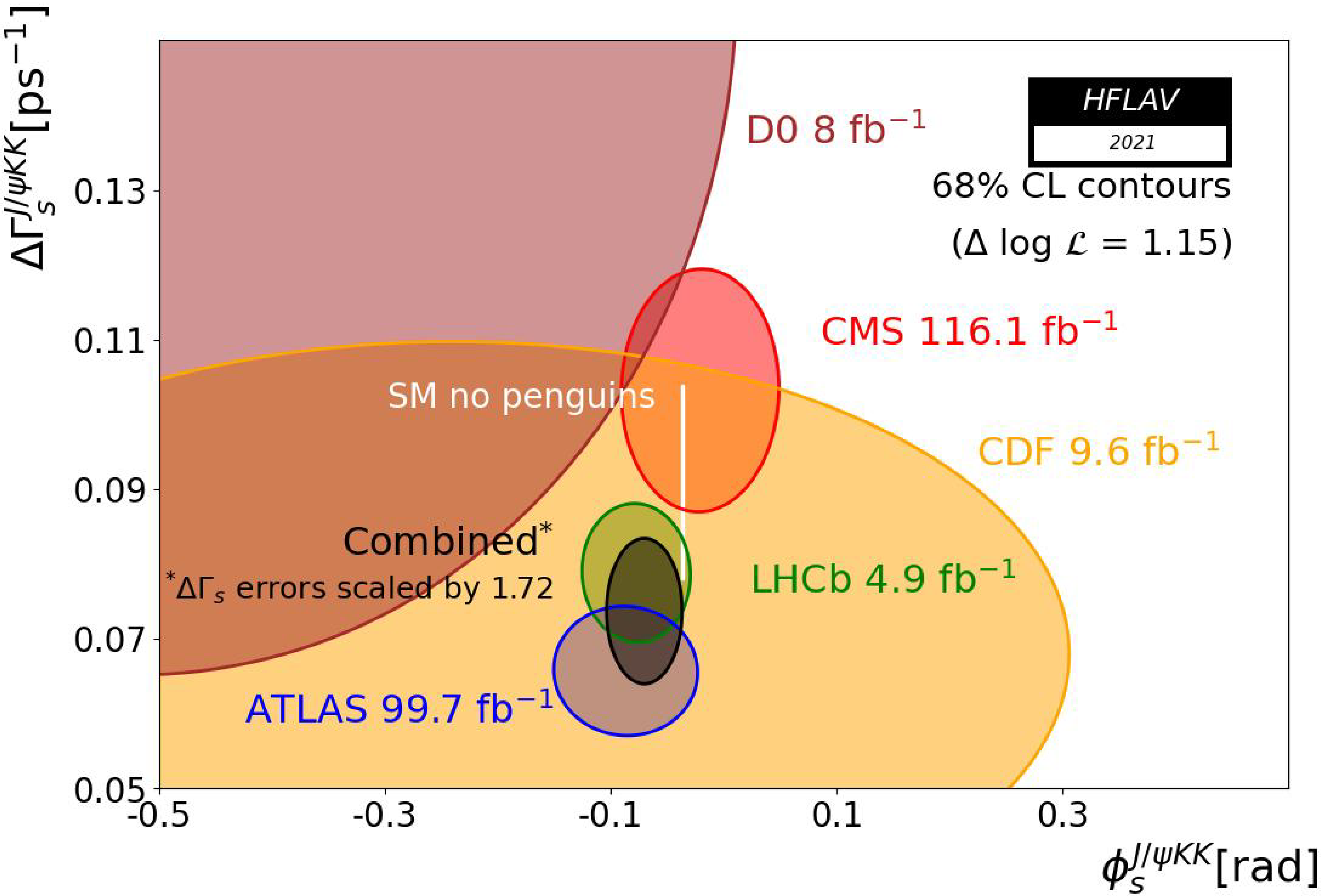
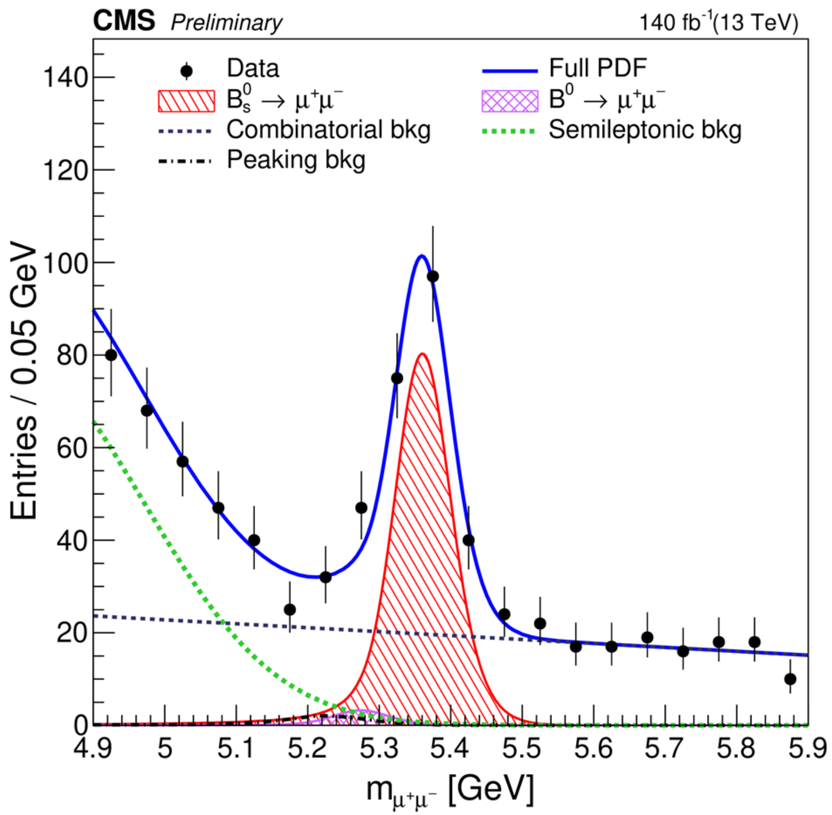


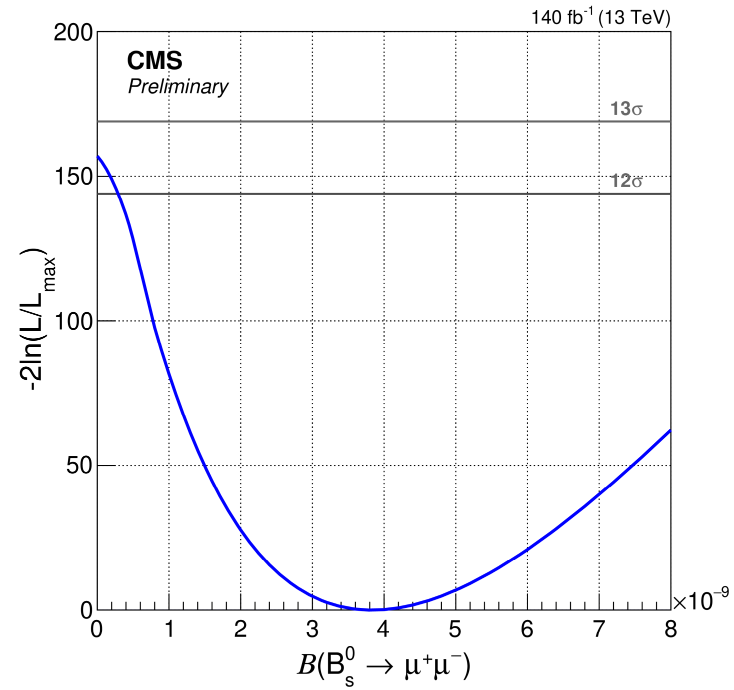
Measurement of the CP-violating phase: combination

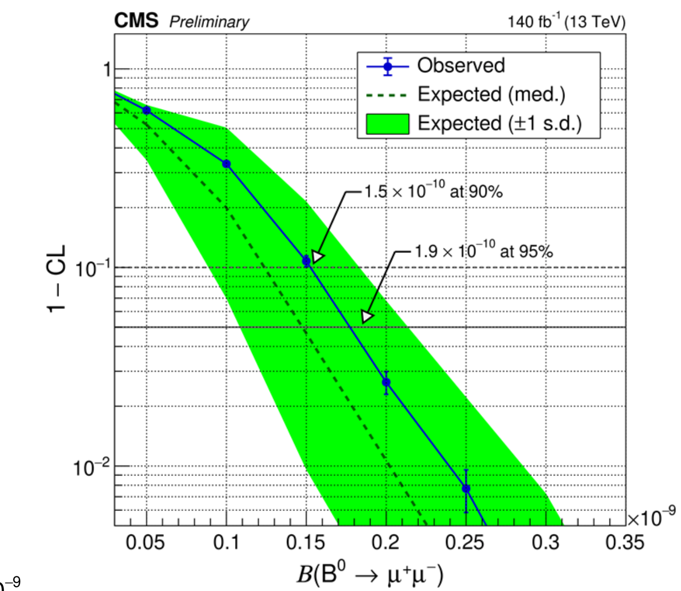


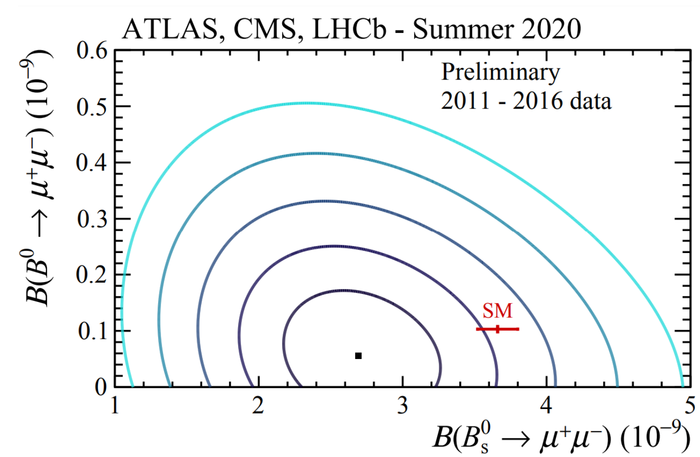
$B_s \to \mu\mu$ results from ATLAS and CMS

CMS-PAS-BPH-21-006 ; LHCb-CONF-2020-002 ; ATLAS-CONF-2020-049





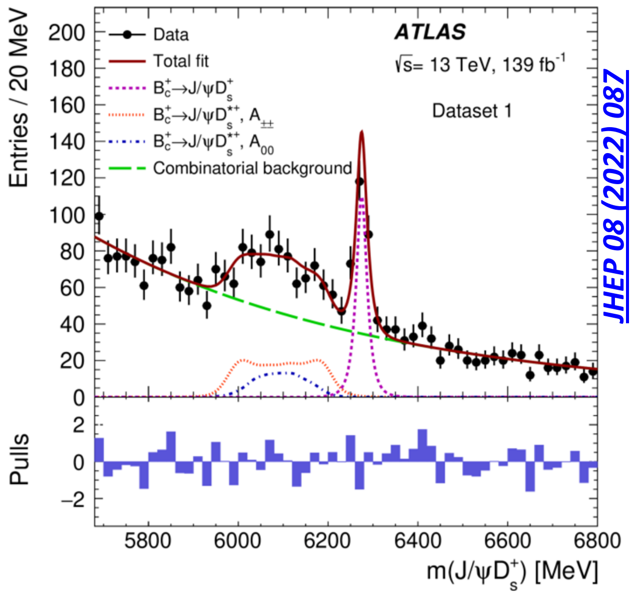




- A combination of ATLAS, CMS, LHCb results for rare decays $B_s \to \mu\mu$ and $B^0 \to \mu\mu$ has been performed;
- Branching fraction $\mathcal{B}(B_s \to \mu\mu) = (2.69^{+0.37}_{-0.35})\text{x}10^{-9}$
- Effective lifetime $\tau(B_s \to \mu\mu) = 1.91^{+0.37}_{-0.35}$ ps
- Limit is set for $\mathcal{B}(B^0 \to \mu\mu) < 1.9\text{x}10^{-10}$ at 95% CL
- With the latest results, combined measurement is going to move closer to SM prediction

B_c results from ATLAS and CMS

Study of $B_c \to J/\psi D_s^{(*)}$ at ATLAS

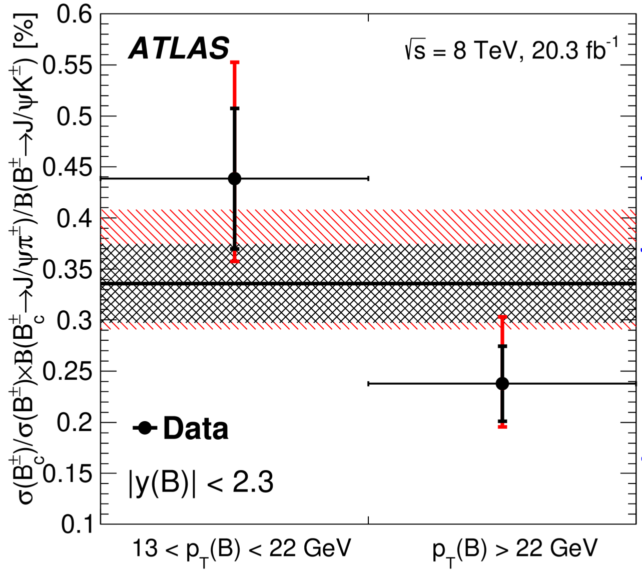


JHEP 08 (2022) 087

Parameter	Value
$m_{B_c^+}$ [MeV]	6274.8 ± 1.4
$\sigma_{B_c^+}$ [MeV]	11.5 ± 1.5
$r_{D_s^{*+}/D_s^+}$	1.76 ± 0.22
$f_{\pm\pm}$	0.70 ± 0.10
$N^{\mathrm{DS1}}_{B_c^+\to J/\psi D_s^+}$	193 ± 20
$N^{\mathrm{DS2}}_{B_c^+\to J/\psi D_s^+}$	49 ± 10
$N^{\mathrm{DS1}}_{B_c^+\to J/\psi D_s^{*+}}$	338 ± 32
$N^{\mathrm{DS1\&2}}_{B_c^+\to J/\psi D_s^+}$	241 ± 28
$N^{\mathrm{DS1\&2}}_{B_c^+\to J/\psi D_s^{*+}}$	424 ± 46

$R_{D_s^+/\pi^+}$	$R_{D_s^{*+}/\pi^+}$	$R_{D_s^{*+}/D_s^+}$	$\Gamma_{\pm\pm}/\Gamma$
2.76 ± 0.47	5.33 ± 0.96	1.93 ± 0.26	0.70 ± 0.11

Relative B_c/B^+ production at ATLAS



Phys. Rev. D 104 (2021) 012010

Analysis bin	$\sigma(B_c^\pm)/\sigma(B^\pm) \times \mathcal{B}(B_c^\pm \to J/\psi\pi^\pm)/\mathcal{B}(B^\pm \to J/\psi K^\pm)$
$p_\mathrm{T}(B) > 13$ GeV, $\lvert y(B)\rvert < 2.3$	$(0.34 \pm 0.04_{\mathrm{stat}}\ {}^{+0.06}_{-0.02}{}_{\mathrm{syst}} \pm 0.01_{\mathrm{lifetime}})\%$
$13 < p_\mathrm{T}(B) < 22$ GeV, $\lvert y(B)\rvert < 2.3$	$(0.44 \pm 0.07_{\mathrm{stat}}\ {}^{+0.09}_{-0.04}{}_{\mathrm{syst}} \pm 0.01_{\mathrm{lifetime}})\%$
$p_\mathrm{T}(B) > 22$ GeV, $\lvert y(B)\rvert < 2.3$	$(0.24 \pm 0.04_{\mathrm{stat}}\ {}^{+0.05}_{-0.01}{}_{\mathrm{syst}} \pm 0.01_{\mathrm{lifetime}})\%$
$p_\mathrm{T}(B) > 13$ GeV, $\lvert y(B)\rvert < 0.75$	$(0.38 \pm 0.06_{\mathrm{stat}}\ {}^{+0.05}_{-0.04}{}_{\mathrm{syst}} \pm 0.01_{\mathrm{lifetime}})\%$
$p_\mathrm{T}(B) > 13$ GeV, $0.75 < \lvert y(B)\rvert < 2.3$	$(0.29 \pm 0.05_{\mathrm{stat}}\ {}^{+0.07}_{-0.02}{}_{\mathrm{syst}} \pm 0.01_{\mathrm{lifetime}})\%$

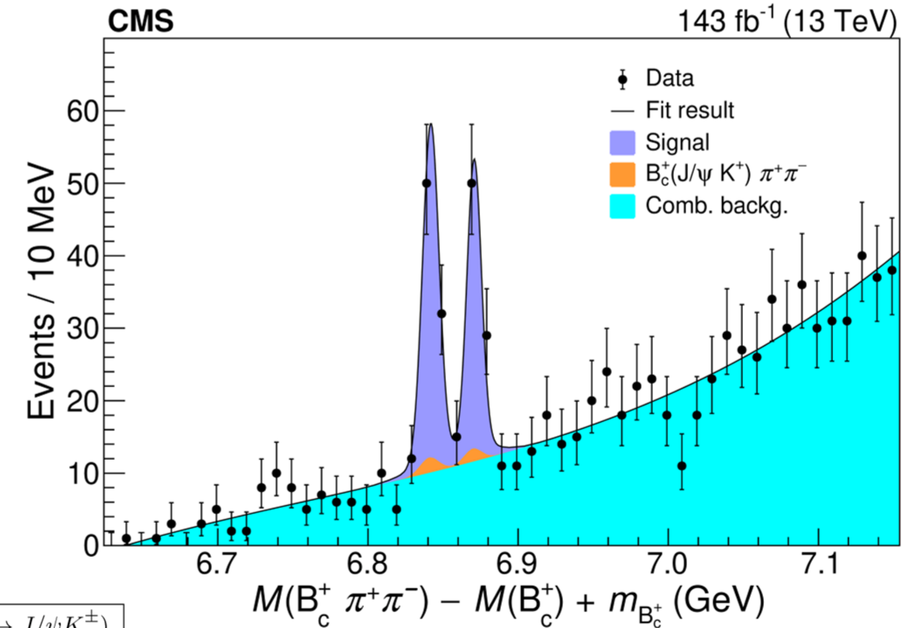
0.683 ± 0.018 ± 0.009 — **pT < 20 GeV**, 2.0 < |y| < 4.5 — LHCb at 8 TeV

0.48 ± 0.05 ± 0.03 ± 0.05 — **pT > 15 GeV**, |y| < 1.6 — CMS at 7 TeV

0.44 ± 0.07 $^{+0.09}_{-0.04}$ ± 0.01 — **13 < pT** < 22 GeV, |y| < 2.3 — ATLAS at 8 TeV

0.24 ± 0.04 $^{+0.05}_{-0.01}$ ± 0.01 — **pT > 22 GeV**, |y| < 2.3 — ATLAS at 8 TeV

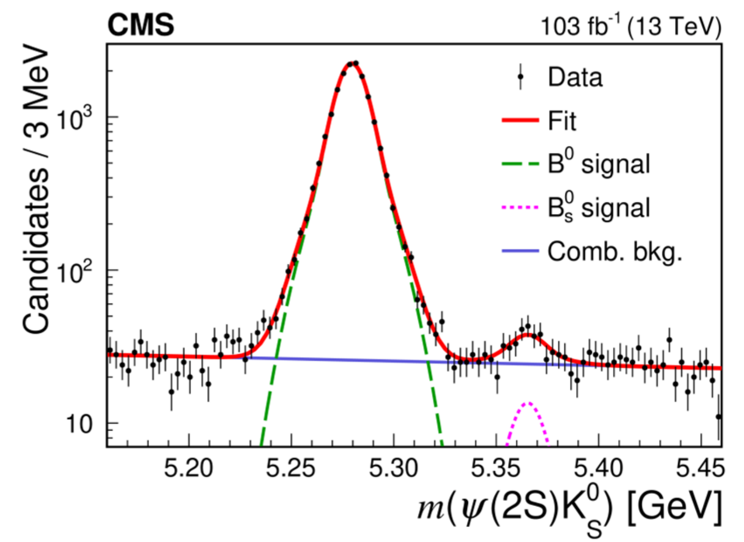
$B_c(2S)$, $B_c(2S)^*$ study at CMS



PRD 102 (2020) 092007

$$R^+ = (3.47 \pm 0.63\ \text{(stat)} \pm 0.33\ \text{(syst)})\%$$
$$R^{*+} = (4.69 \pm 0.71\ \text{(stat)} \pm 0.56\ \text{(syst)})\%$$
$$R^{*+}/R^+ = 1.35 \pm 0.32\ \text{(stat)} \pm 0.09\ \text{(syst)}$$

Observation of $B^0\to\psi(2S)K_s^0\pi^+\pi^-$ and $B_s\to\psi(2S)K_s^0$ decays at CMS

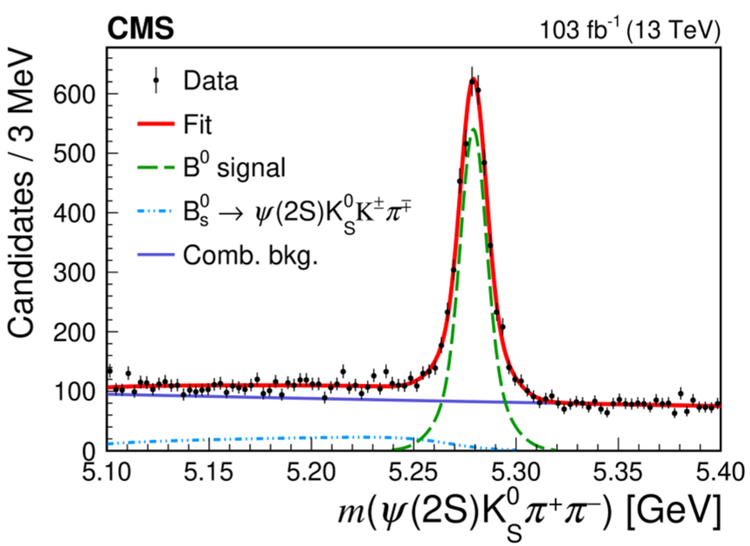


- $B^0\to\psi(2S)K_s^0\pi^+\pi^-$ and $B_s\to\psi(2S)K_s^0$ decays are observed;
- Branching fractions are measured:

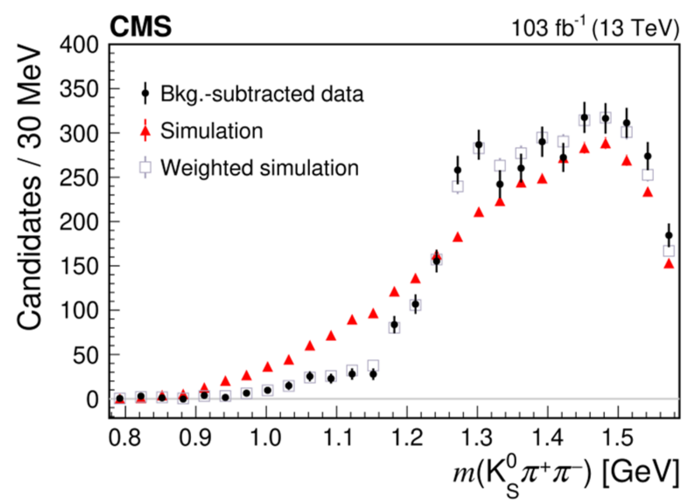
$\mathcal{B}(B_s\to\psi(2S)K_s^0)/\mathcal{B}(B^0\to\psi(2S)K_s^0)$ = $(3.33 \pm 0.69(stat) \pm 0.11(syst) \pm 0.34(f_s/f_d))\times10^{-2}$

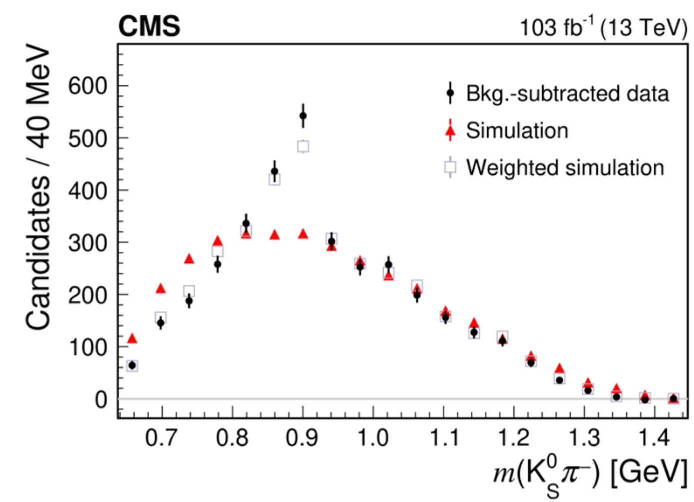
$\mathcal{B}(B^0\to\psi(2S)K_s^0\pi^+\pi^-)/\mathcal{B}(B^0\to\psi(2S)K_s^0)$ = $0.48 \pm 0.013(stat) \pm 0.032(syst)$

- Future analysis is intended to study dynamics of the intermediate states in $B^0\to\psi(2S)K_s^0\pi^+\pi^-$ chain:



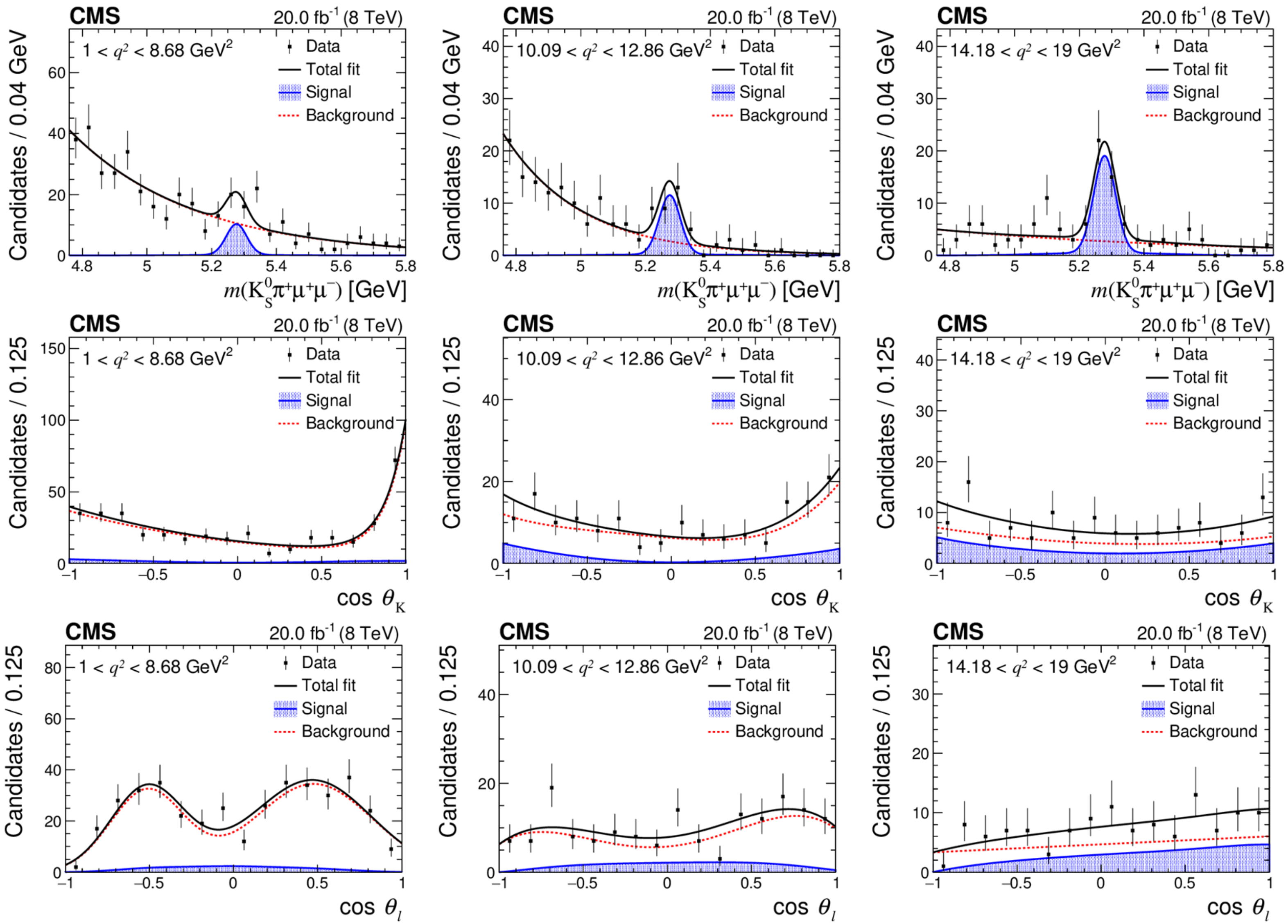
Eur. Phys. J. C 82 (2022) 499





Angular analysis of $B^+ \to K^*(892)^+\mu^+\mu^-$ at CMS

JHEP 04 (2021) 124



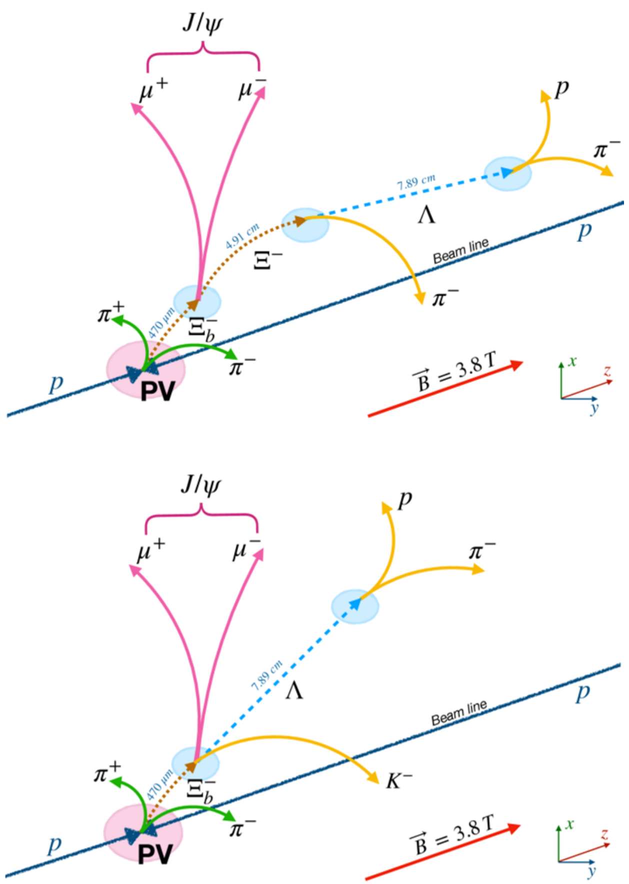
- The first angular analysis of the $B^+ \to K^*(892)^+\mu^+\mu^-$ decay is performed;
- In three bins of the dimuon invariant mass squared (q^2), a 3D fits are performed;
- The muon forward/backward asymmetry (A_{FB}) and $K^*(892)^+$ longitudinal fraction (F_L) are consistent with SM predictions;

q^2 (GeV^2)	Y_S	A_{FB}	F_L
1 – 8.68	22.1 ± 8.1	$-0.14^{+0.32}_{-0.35} \pm 0.17$	$0.60^{+0.31}_{-0.25} \pm 0.13$
10.09 – 12.86	25.9 ± 6.3	$0.09^{+0.16}_{-0.11} \pm 0.04$	$0.88^{+0.10}_{-0.13} \pm 0.05$
14.18 – 19	45.1 ± 8.0	$0.33^{+0.11}_{-0.07} \pm 0.05$	$0.55^{+0.13}_{-0.10} \pm 0.06$

- ATLAS earlier performed similar analysis of $B^0 \to K^*\mu^+\mu^-$ decays

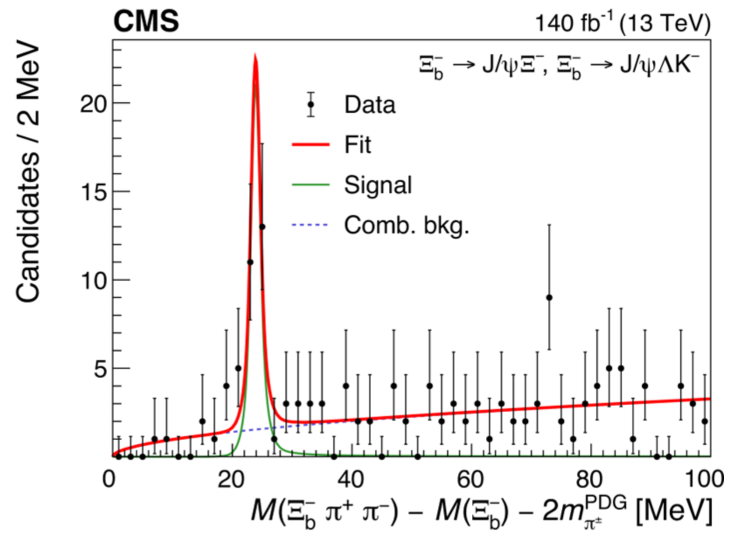
JHEP 10 (2018) 047

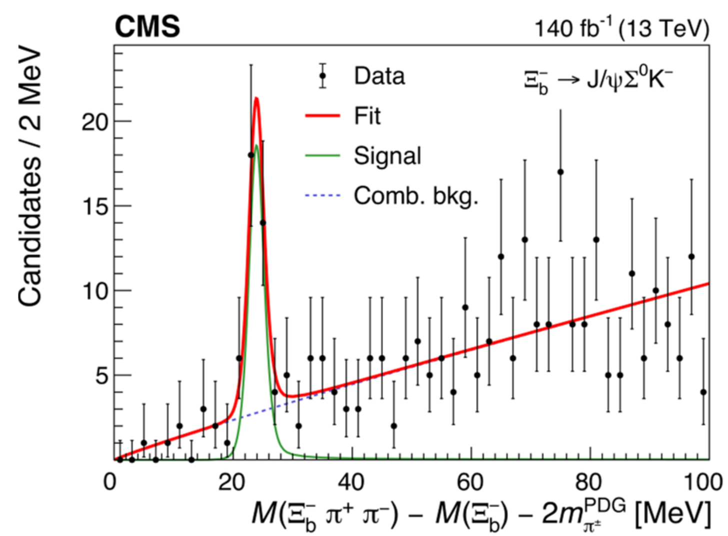
Observation of new bottom-strange baryon $\Xi^-_b(6100)$ in $\Xi^-_b\pi^+\pi^-$ channel at CMS



Topologies with different Ξ^-_b decay channels

Phys. Rev. Lett. 126 (2021) 252003





- A narrow resonance $\Xi^-_b(6100)$ is observed at a $\Xi^-_b\pi^+\pi^-$ invariant mass of:

  M = 6100.3 ±0.2(stat)±0.1(syst) ±0.6(Ξ^-_b)

- Results are consistent between fully reconstructed channels and partially reconstructed channel with $\Sigma^0 \rightarrow \Lambda\gamma$
- Upper limit is set 1.9MeV on a natural width of the new state (95% CL)
- New state is consistent with orbitally excited Ξ^-_b baryon with spin/parity of $3/2^-$.

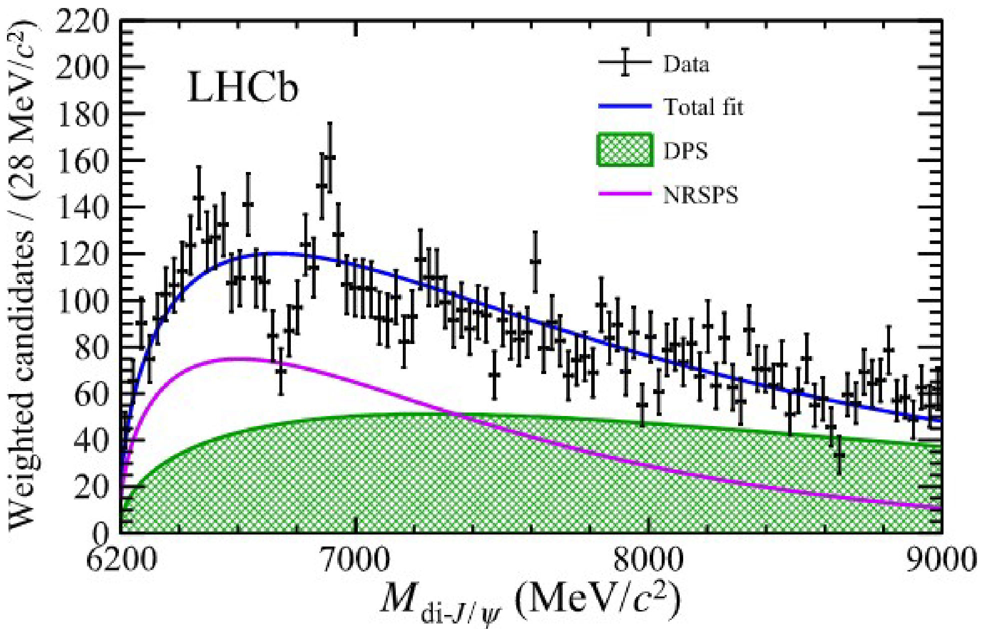
Conclusions

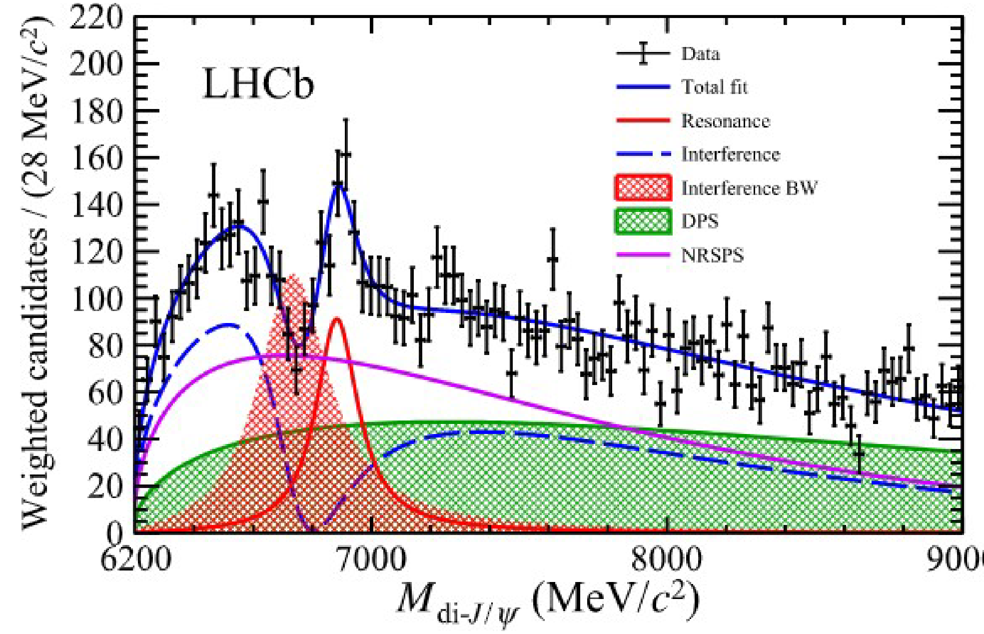
- Studies of J/ψ pair production revealed potential new physics contributions;
  - X(6900) and X(7300) are potential exotic 4c candidates;
  - Properties of these states along with nature of threshold signals are going to be obtained from future precise analyses;
- Triple-J/ψ production is observed at CMS;
- Pentaquark and tetraquark studies in *B*-hadron decays are ongoing at ATALS featuring advanced amplitude analysis methods involved…
- Precise measurements of quarkonia production cross-sections is an important input for various analyses and searches, in particular, those related to B-physics;
- A strong probes of SM come from B-meson decays (rare decays, CP-violating processes);
- Spectroscopy of heavy states: Ξ^{-}_{b}(6100) observation;
- More studies are ongoing using experience we have in pursue of new discoveries;

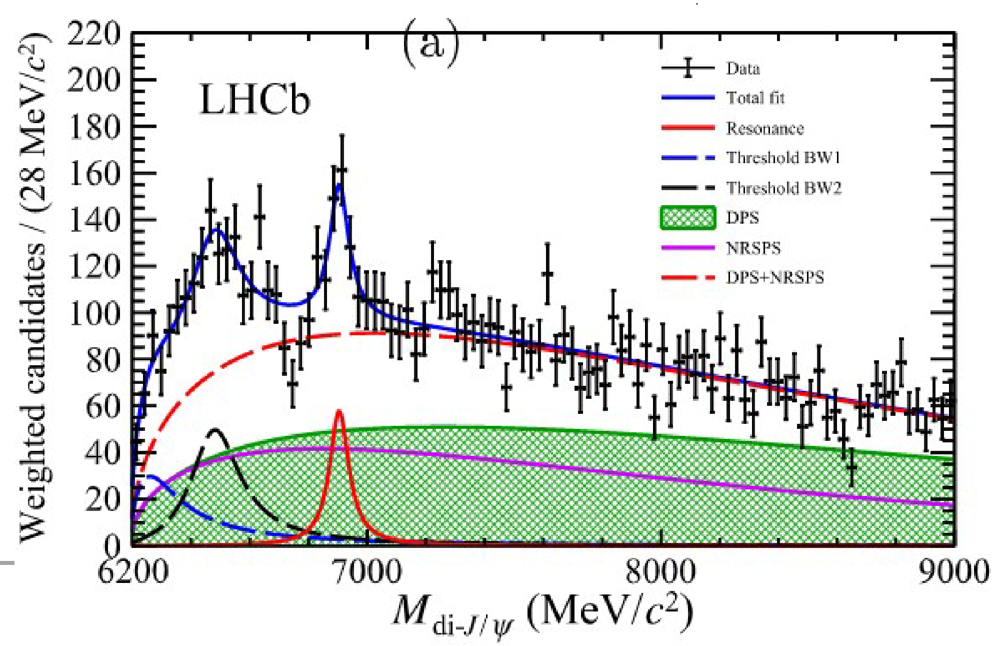
- In some cases, high-energy pp-collisions provide better potential for quarkonia studies in comparison to other types of experiments;

BACKUP

Resonant J/ψ pair production observed by LHCb





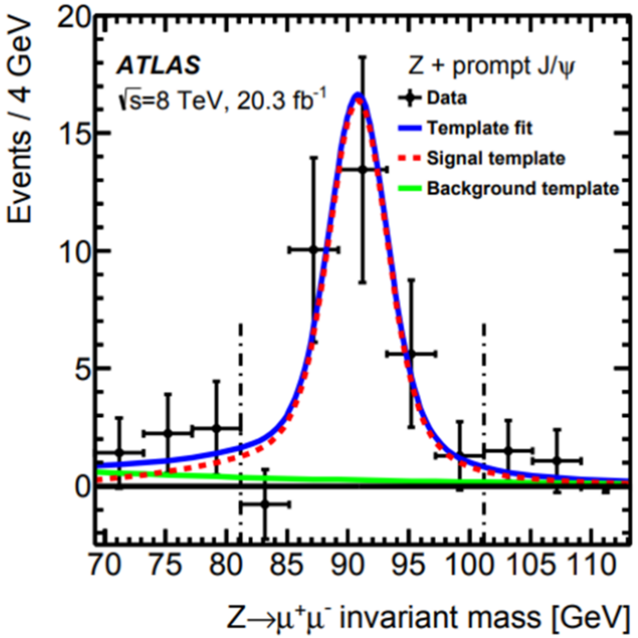


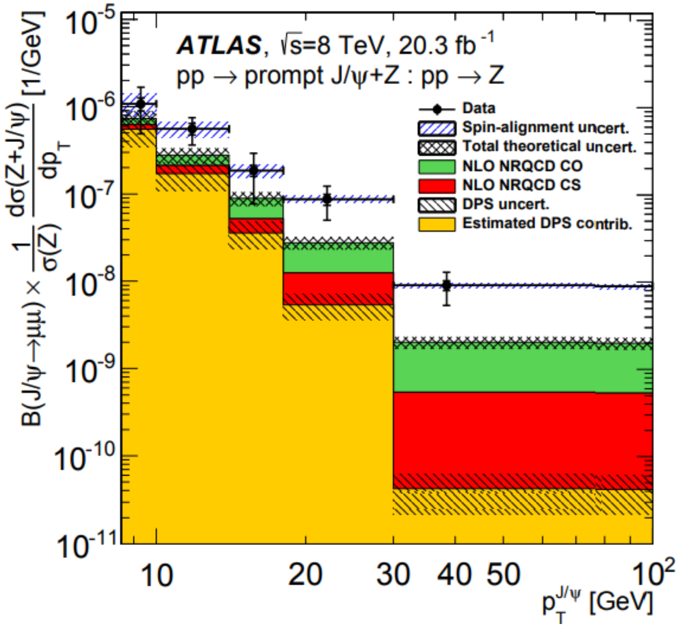
- *J/ψ* pairs production has been studies by LHCb near the threshold. Signal of possibly resonant nature observed at m=6.9GeV;
- Interference effects potentially play a significant role;
- Signal is consistent with 4c tetraquark hypothesis, further studies are ongoing;
- ATLAS plans to study this kinematic region;

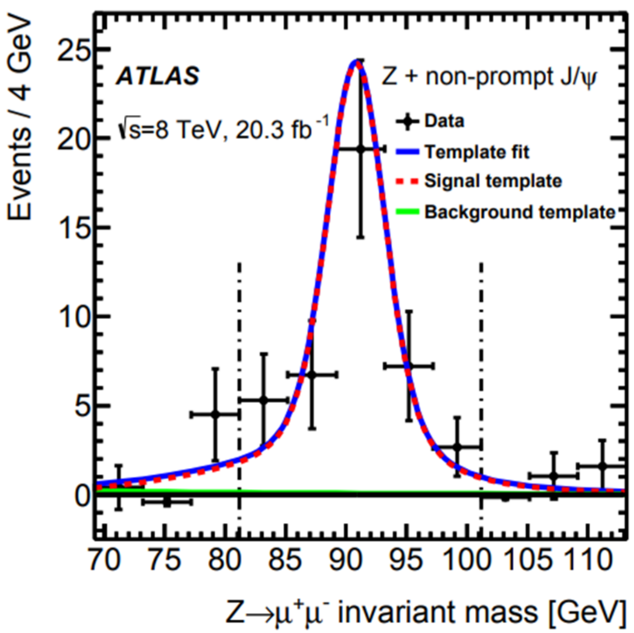
Science Bulletin 65 (2020) 1983-1993

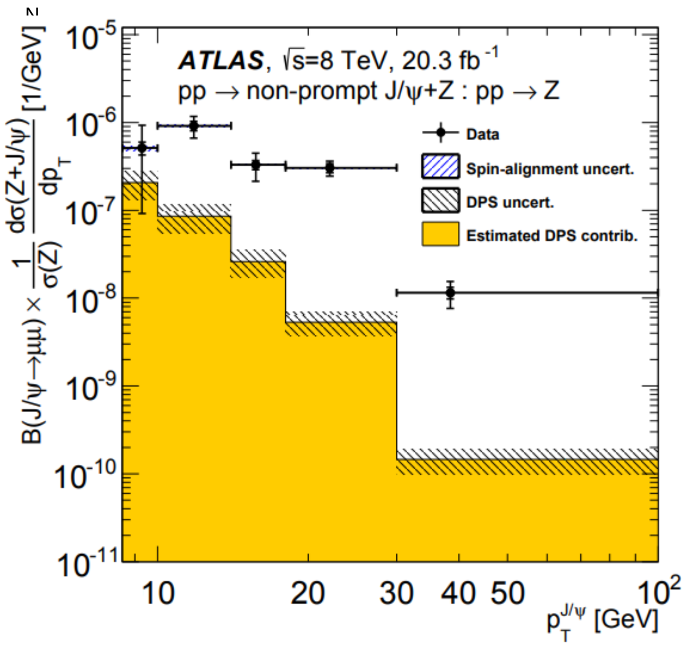
Observation and measurement of J/ψ + Z production

[Eur. Phys. J. C75 (2015) 229]





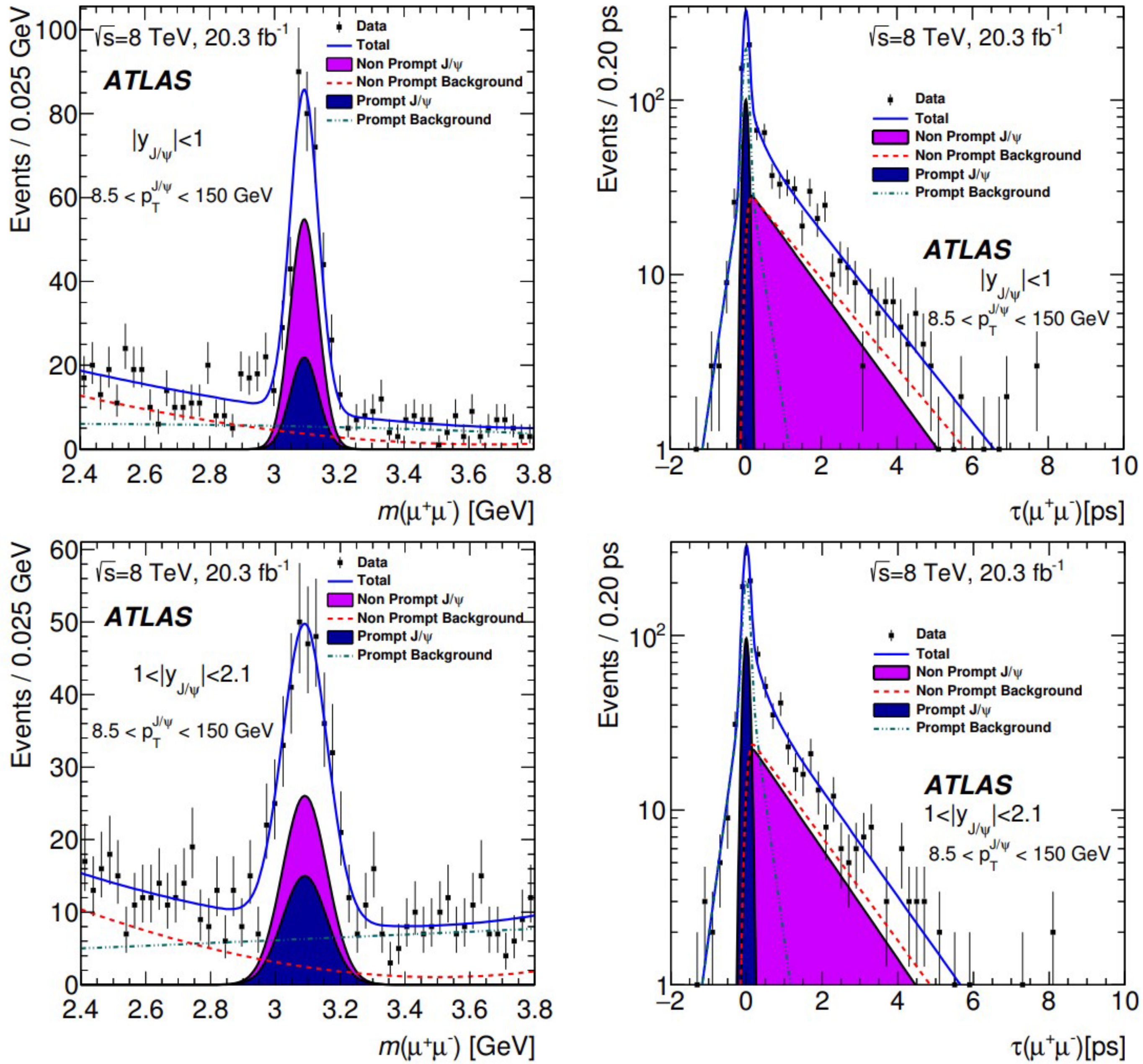




- *J/ψ* production associated with vector bosons is a probe of QCD on the edge between perturbative and non-perturbative regimes;
- *J/ψ* production associated with *Z*-boson has been observed with 5σ and 9σ significance for prompt and non-prompt *J/ψ* candidates, respectively;
- Production ratio (relative to inclusive Z production) for prompt and non-prompt *J/ψ* are measured to be: $(36.8\pm6.7\pm2.5)\times 10^{-7}$ and $(65.8\pm9.2\pm4.2)\times 10^{-7}$ respectively;
- SPS and DPS contributions studied; larger SPS yield is observed compared to predictions…
- A lower limit of 5.3 (3.7) mb at 68 (95)% confidence level is placed on the effective cross-section regulating double parton interactions;

Measurement of J/ψ + $W^{\pm}$ production;

JHEP 01 (2020) 095



J/ψ production associated with *W*-boson has been studied for prompt and non- prompt *J/ψ*;

The final prompt $J/\psi+W^{\pm}$ signal yields after the application of the *J/ψ* acceptance and muon efficiency weights are:

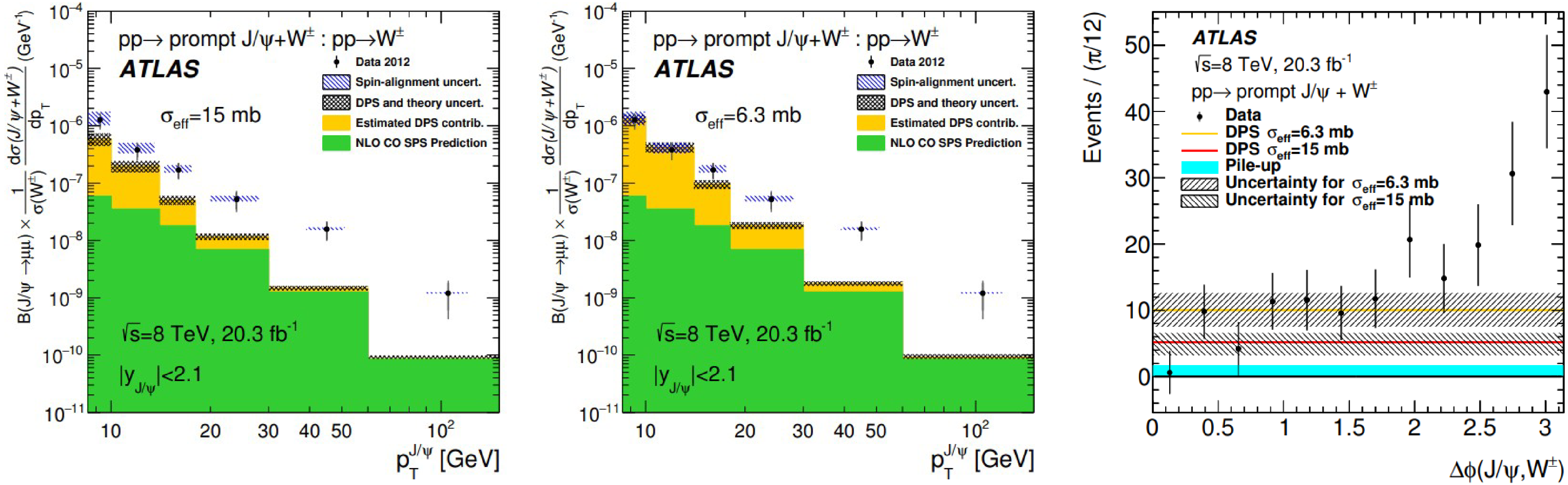
222 ± 37(stat) for the central region;
195 ± 33(stat) for the forward region;

The fully corrected inclusive production cross-section ratio, in which the *J/ψ* acceptance and the unknown *J/ψ* spin-alignment are taken into account :

$(5.3\pm0.7\pm0.8+1.5-0.7)\times10^{-6}$

Additional measurements are made by subtracting the estimated DPS contribution in each rapidity and p_T interval from the inclusive cross-section ratio;

Measurement of J/ψ+W± production;

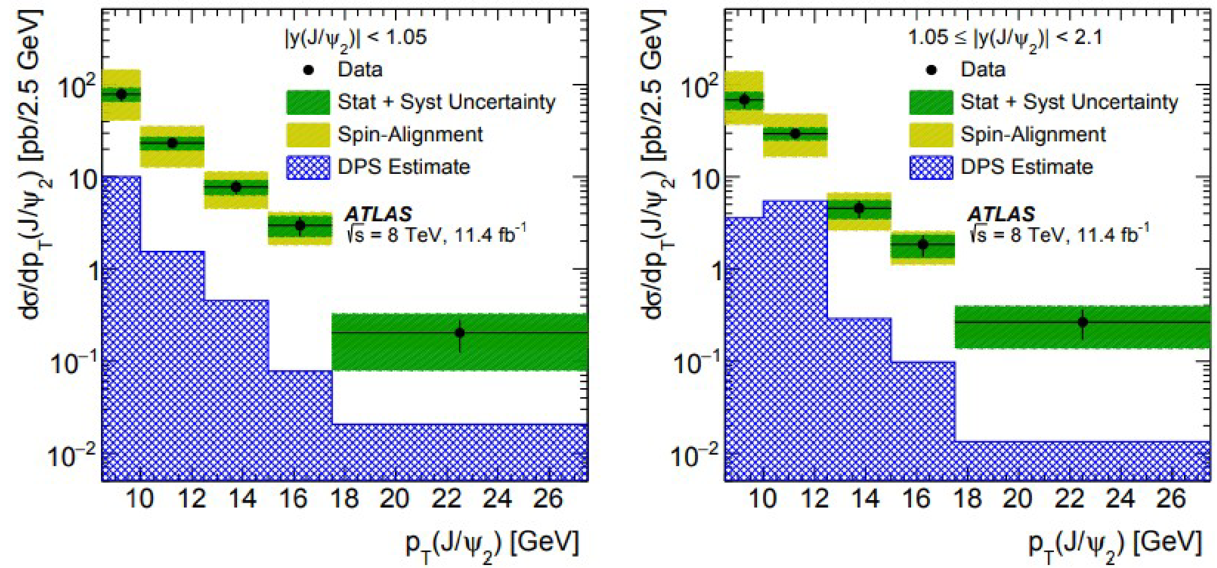


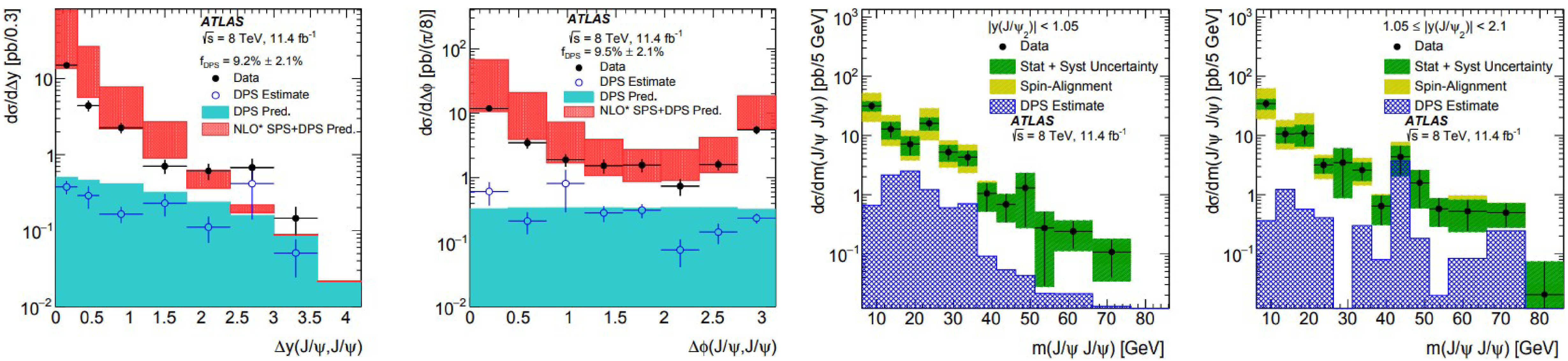
- Plots show differential cross-sections of *J/ψ+W* production w.r.t. p_T (for different DPS contributions)and Δφ between *J/ψ* and *W*.
- The measured prompt *J/ψ + W* production rates are compared with a theoretical prediction at NLO for colour-octet prompt production processes;
- Larger SPS yield is observed compared to predictions, which may indicate significant contributions from SPS color-singlet mechanism.

Prompt J/ψ pair production

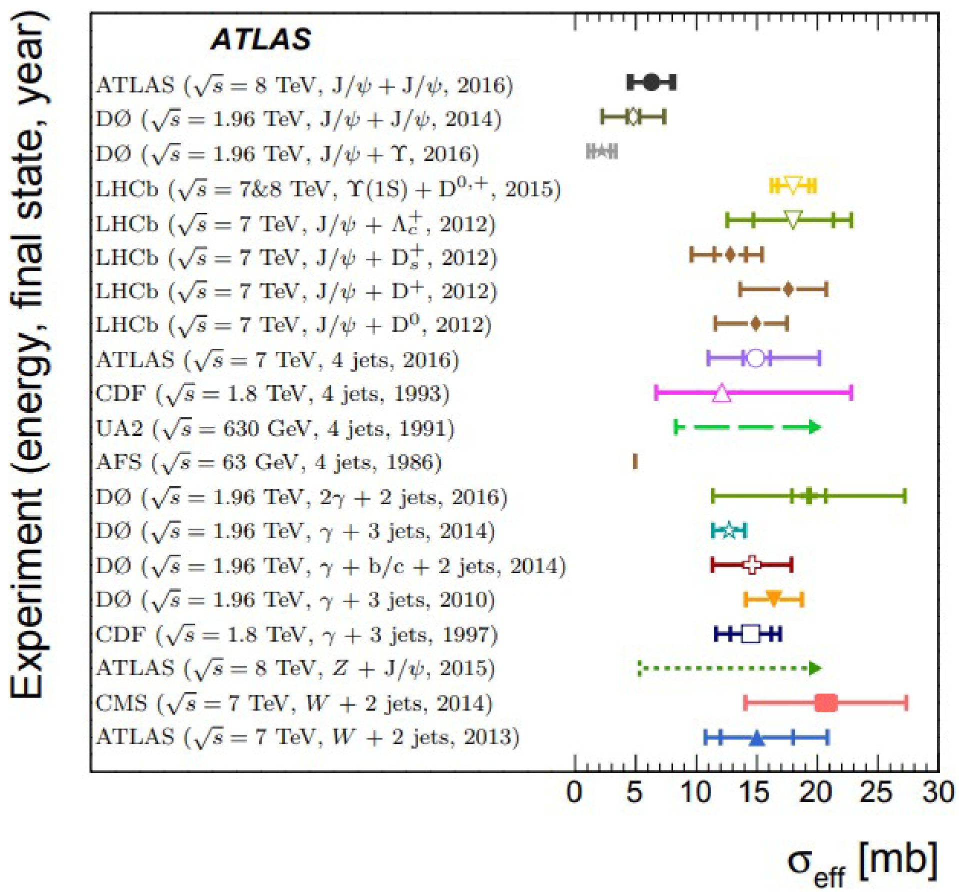
[Eur. Phys. J. C77 (2017) 76]

- *J/ψ* pairs are produces via SPS and DPS mechanisms;
- The differential cross-section, assuming unpolarised *J/ψ* production, is measured as a function of the transverse momentum of *J/ψ* meson, di-*J/ψ* p_T and mass, the difference in rapidity between the two *J/ψ* mesons, and the azimuthal angle between the two *J/ψ* mesons;
- The effective cross-section of double parton scattering is measured to be σ_{eff} = **6.3±1.6(stat)±1.0(syst) mb**;





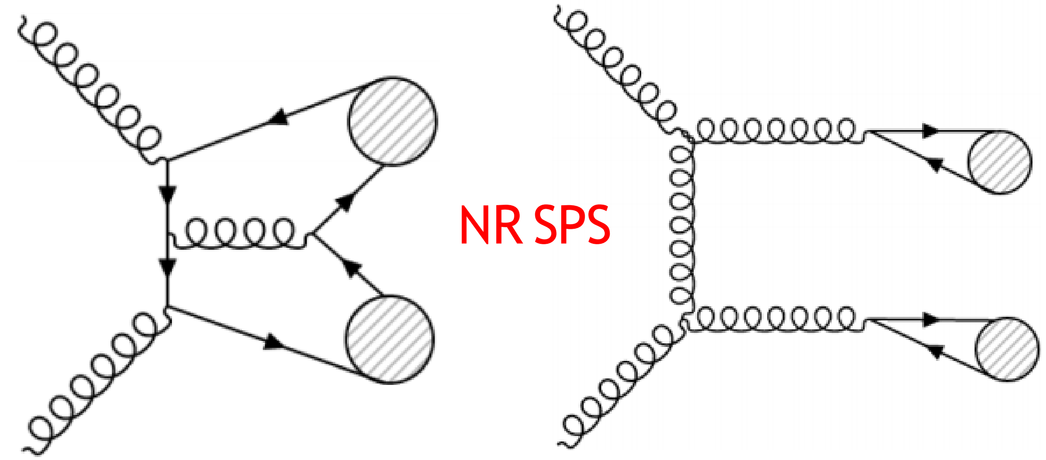
J/ψ production cross-sections



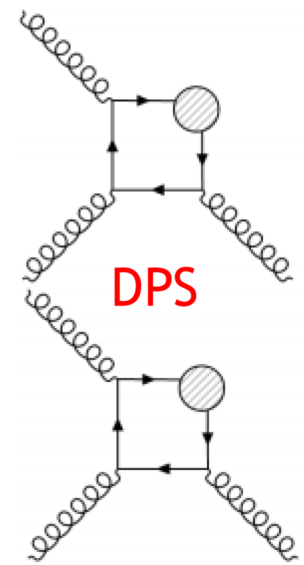
Eur. Phys. J. C77 (2017) 76

The cross-sections of the various J/ψ production channels at different energies measured by different experiments;

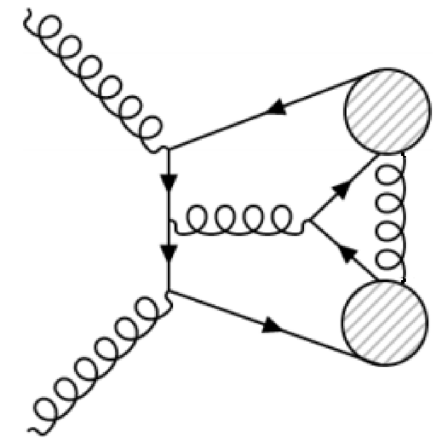
J/ψ pair production mechanisms



NR SPS



DPS



Resonant SPS?

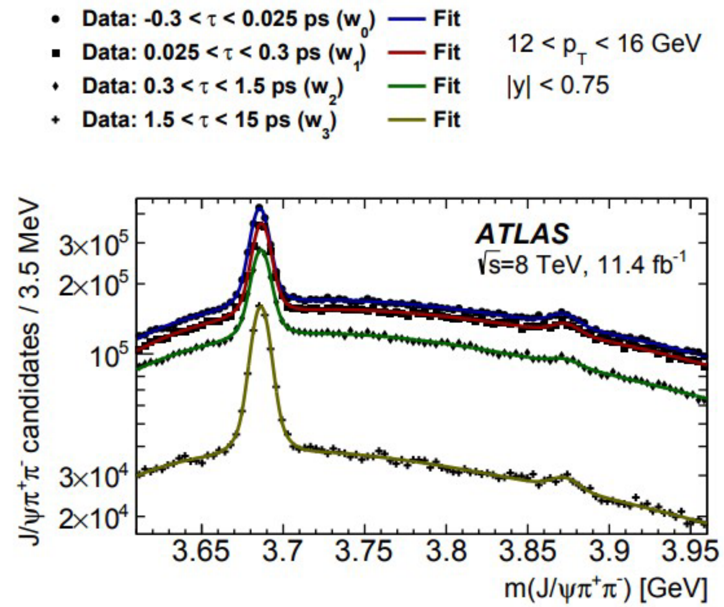
ψ(2S) and χ_{c1} (3872) studies

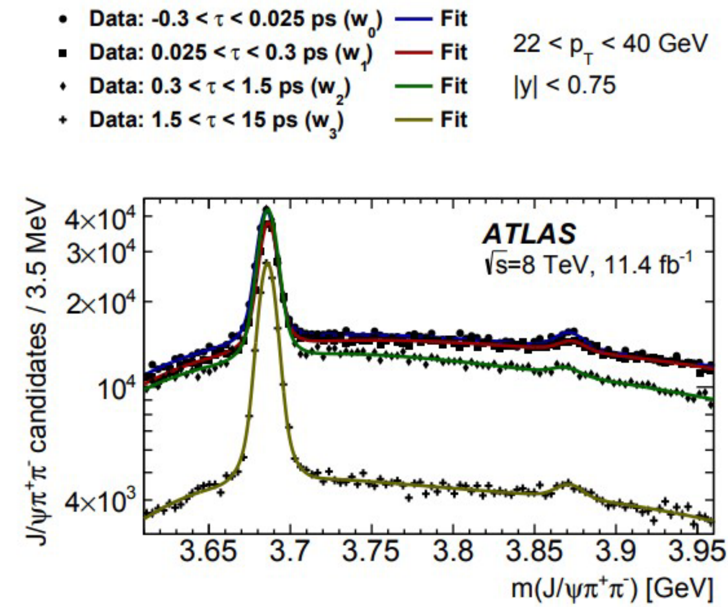
Differential cross sections are measured for the prompt and non-prompt production of the hidden-charm states χ_{c1}(3872) and ψ(2S), in the decay mode $J/\psi\pi^+\pi^-$.

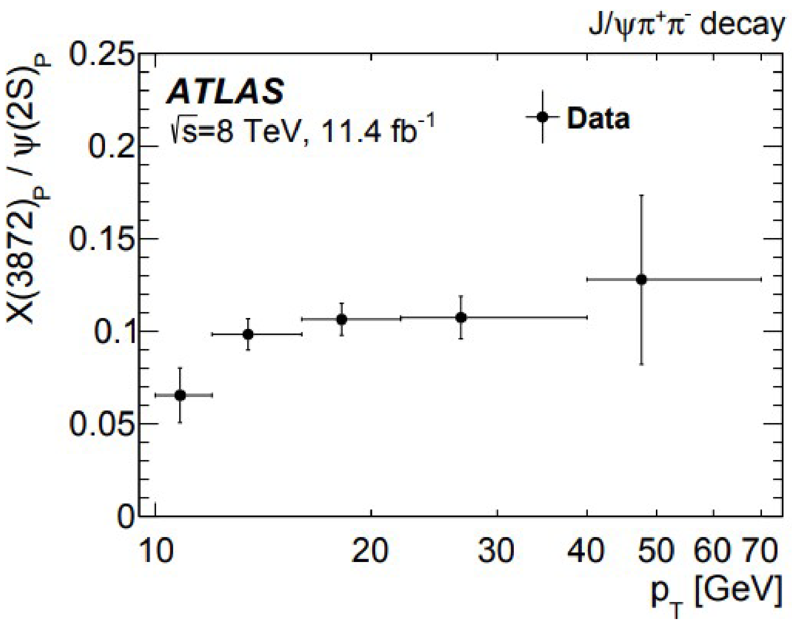
Fraction of the non-prompt χ_{c1}(3872) is measured to be :

25±13(stat)±2(sys)±5(spin) %

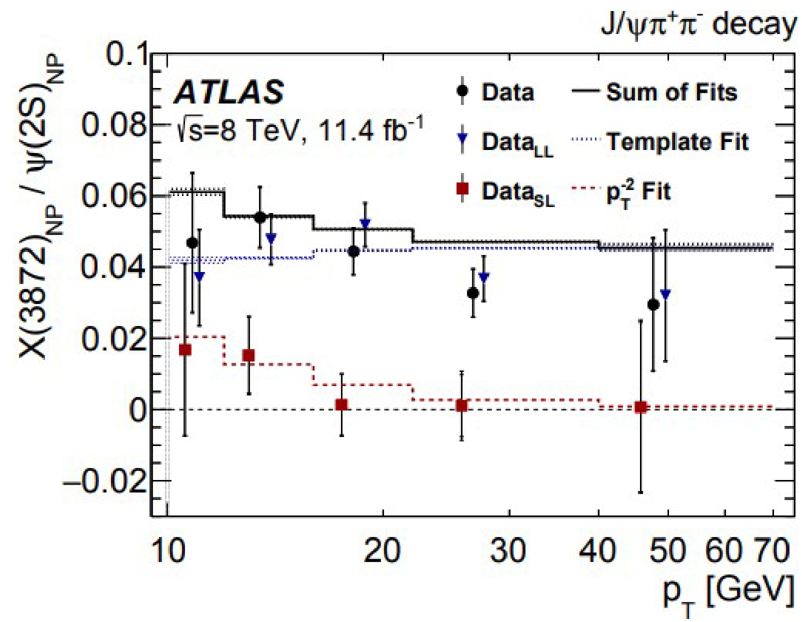
$\pi^+\pi^-$ distributions are also studied

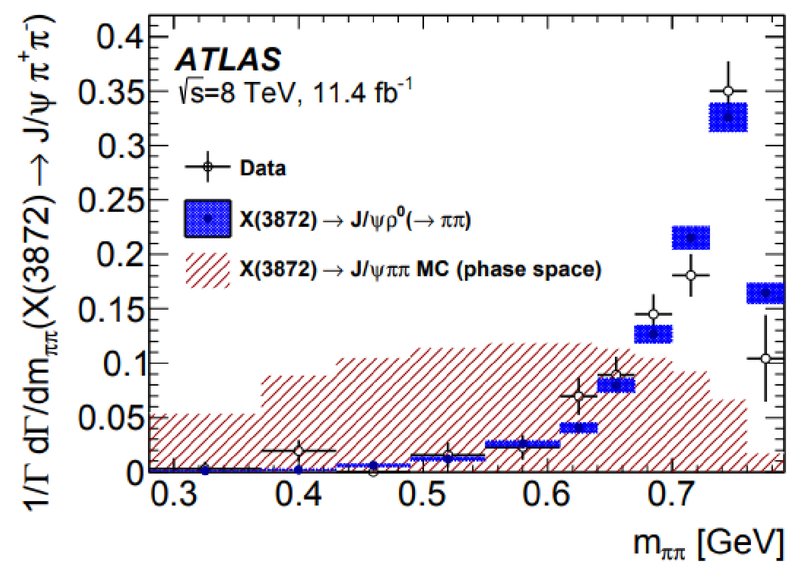






JHEP 01 (2017) 117



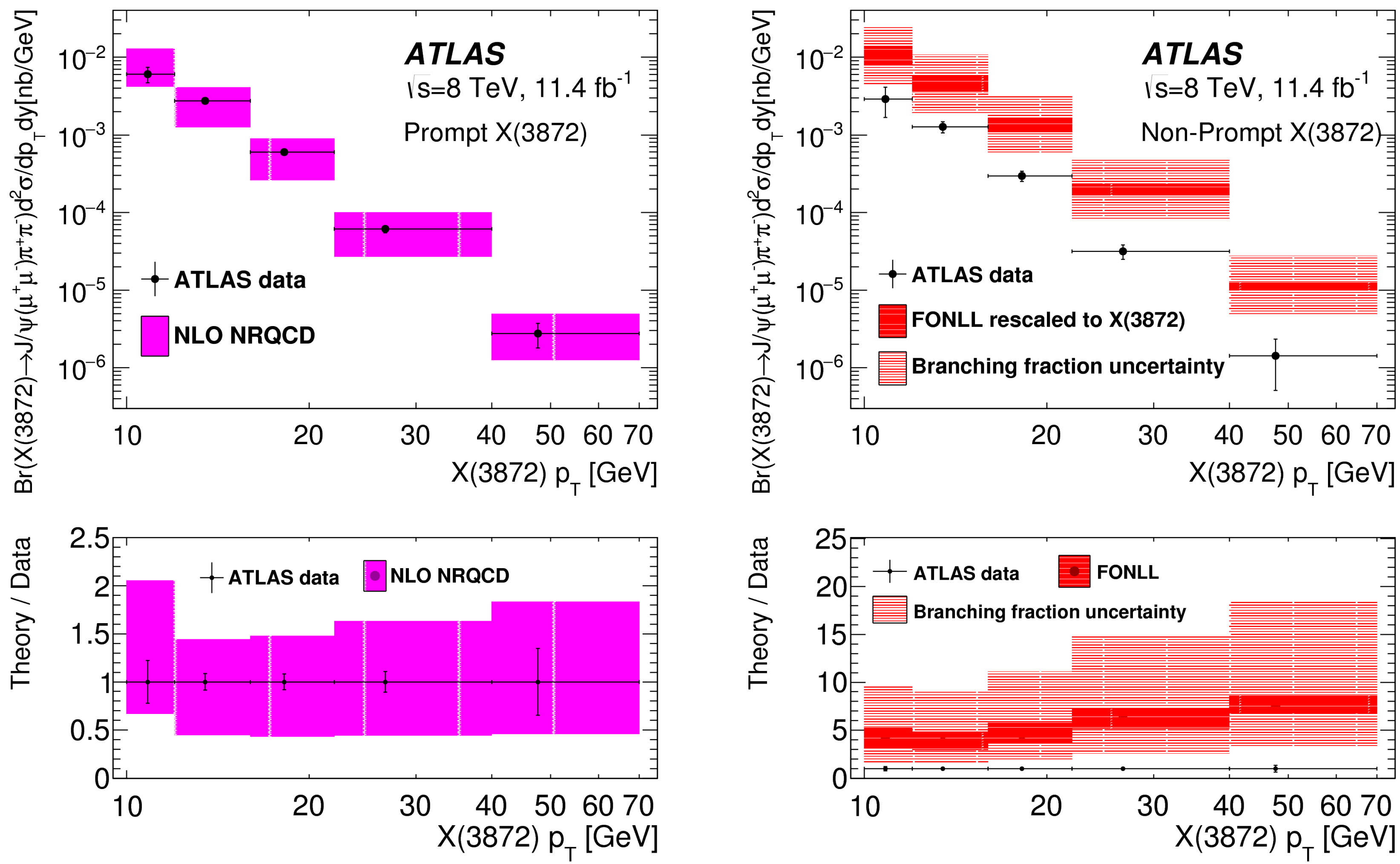


Cross-section ratio is measured for prompt and non-prompt production:

$$R_B = \frac{\mathcal{B}(B\to X(3872) + \text{any})\mathcal{B}(X(3872)\to J/\psi\pi^+\pi^-)}{\mathcal{B}(B\to\psi(2S) + \text{any})\mathcal{B}(\psi(2S)\to J/\psi\pi^+\pi^-)} = (3.95 \pm 0.32(\text{stat}) \pm 0.08(\text{sys})) \times 10^{-2}$$

$\psi(2S)$ and $\chi_{c1}(3872)$ studies at ATLAS

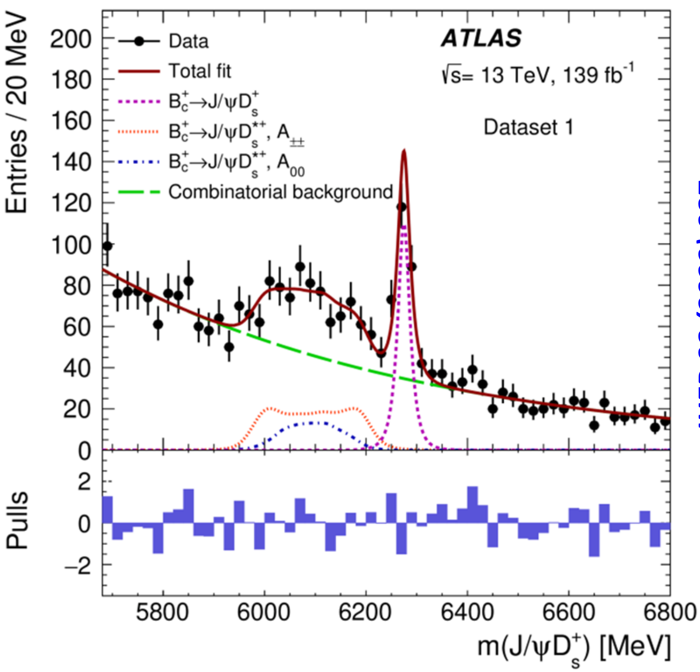
Measured cross section times branching fractions as a function of p_T for prompt $\chi_{c1}(3872)$ compared to NLO NRQCD predictions with the $\chi_{c1}(3872)$ modelled as a mixture of $\chi_{c1}(2P)$ and a D^0-anti-D^{*0} molecular state (left), and non-prompt $\chi_{c1}(3872)$ compared to the FONLL model prediction, recalculated using the measured earlier branching fraction;



JHEP 01 (2017) 117

B_c results from ATLAS and CMS

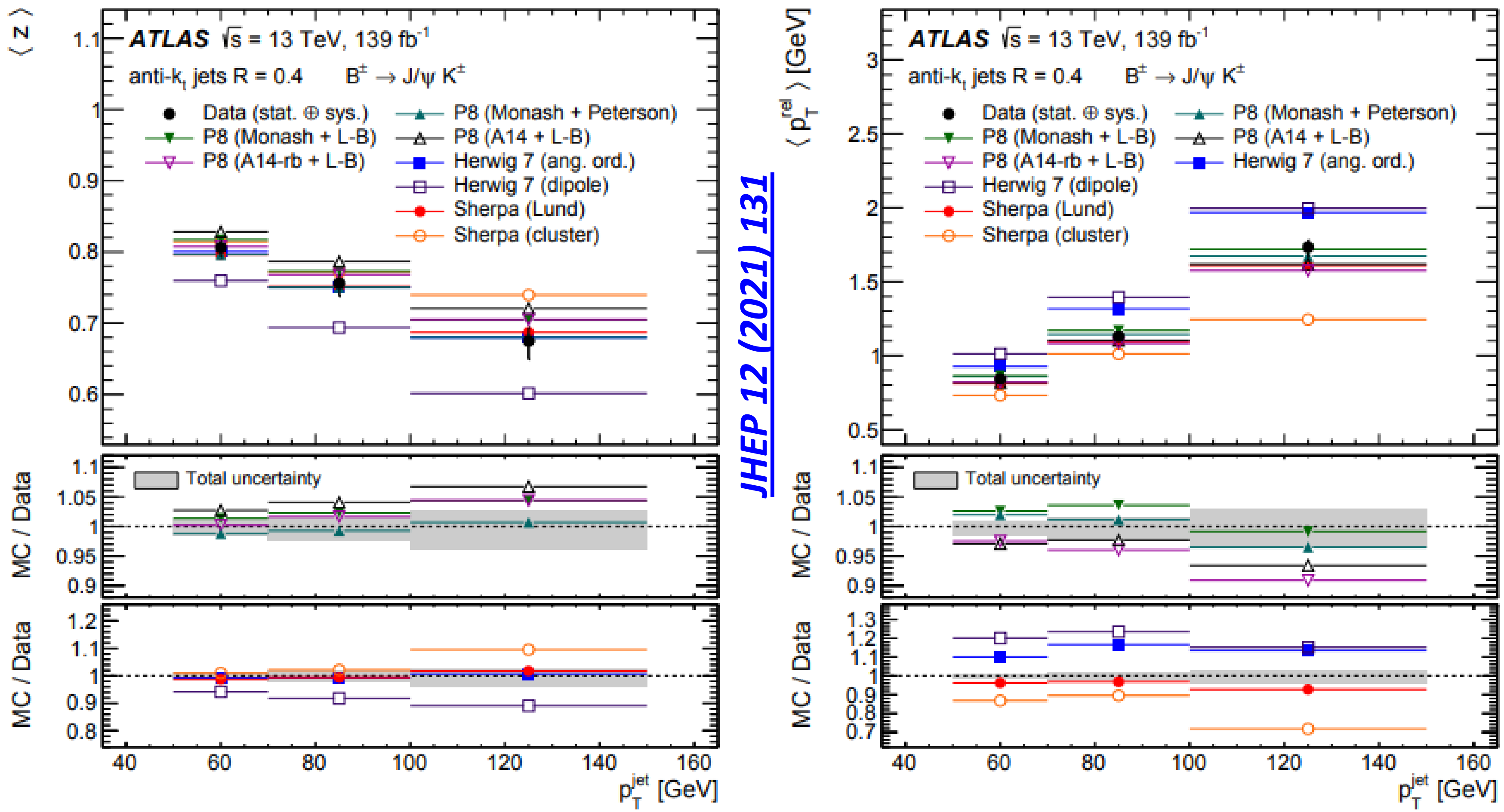
Study of $B_c \to J/\psi D_s^{(*)}$ at ATLAS



JHEP 08 (2022) 087

$R_{D_s^+/\pi^+}$	$R_{D_s^{*+}/\pi^+}$	$R_{D_s^{*+}/D_s^+}$	$\Gamma_{\pm\pm}/\Gamma$	Reference
2.76 ± 0.47	5.33 ± 0.96	1.93 ± 0.26	0.70 ± 0.11	ATLAS Run 2
2.90 ± 0.62	—	2.37 ± 0.57	0.52 ± 0.20	LHCb Run 1 [1]
3.8 ± 1.2	10.4 ± 3.5	$2.8^{+1.2}_{-0.9}$	0.38 ± 0.24	ATLAS Run 1 [2]
2.6	4.5	1.7	—	QCD potential model [3]
1.3	5.2	3.9	—	QCD sum rules [4]
1.29 ± 0.26	5.09 ± 1.02	3.96 ± 0.80	0.46 ± 0.09	CCQM [6]
2.2	—	—	—	BSW [7]
2.06 ± 0.86	—	3.01 ± 1.23	—	LFQM [8]
$3.45^{+0.49}_{-0.17}$	—	$2.54^{+0.07}_{-0.21}$	0.48 ± 0.04	pQCD [9]
3.7832	—	—	0.410	RIQM [10, 11]
3.257 ± 0.293	—	—	—	FNCM [12]
1.67 ± 0.36	3.49 ± 0.52	2.09 ± 0.52	—	$B^+ \to \bar{D}^{*0} D_s^{(*)+} / \bar{D}^{*0}\pi^+$ [25]
2.92 ± 0.42	6.46 ± 0.60	2.21 ± 0.35	0.48 ± 0.05	$B^0 \to D^{*-} D_s^{(*)+} / D^{*-}\pi^+$ [25]
—	7.2 ± 2.1	—	0.94 ± 0.18	$B_s^0 \to D_s^{*-} D_s^+ / D_s^{*-}\pi^+$ [25]
—	—	1.402 ± 0.083	0.396 ± 0.023	$B^+ \to J/\psi K^{(*)+}$ [25]
—	—	1.425 ± 0.065	0.429 ± 0.007	$B^0 \to J/\psi K^{(*)0}$ [25]
—	—	—	0.4774 ± 0.0034	$B_s^0 \to J/\psi \phi$ [25]

Study of b-quark fragmentation properties in jets using $B^{\pm} \to J/\psi K^{\pm}$



Average values of the longitudinal profile hzi and of the transverse profile hp rel T i as a function of the jet pT, compared with MC predictions by Pythia 8, Sherpa and Herwig 7. The points are in the bin centre. The vertical error bars represent the total experimental uncertainties. The lower panels show the ratios of MC predictions to the data, where the gray bands represent the total uncertainties

Topologies with different Ξ^{-}_{b} decay channels