First LHCb Results

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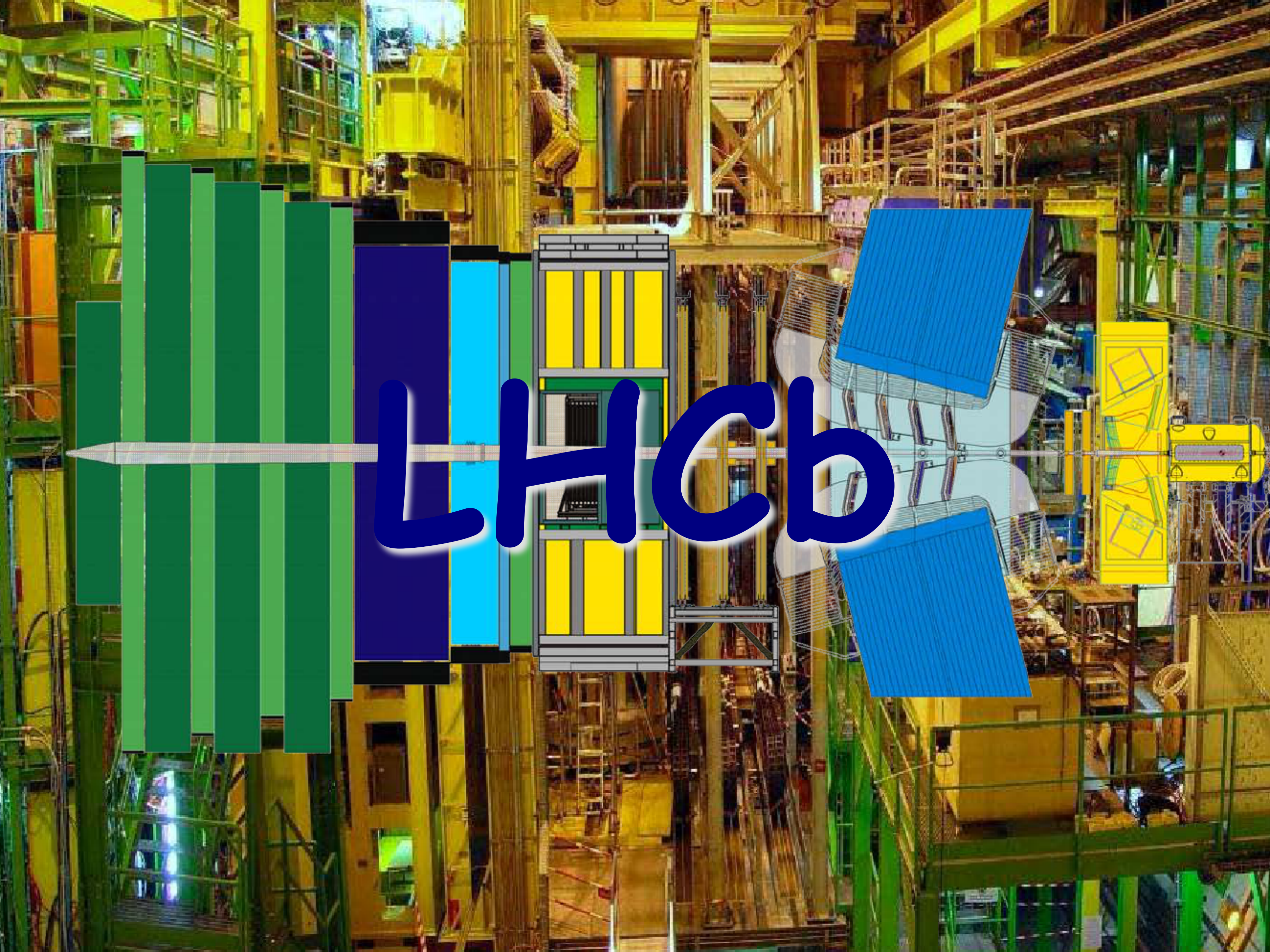
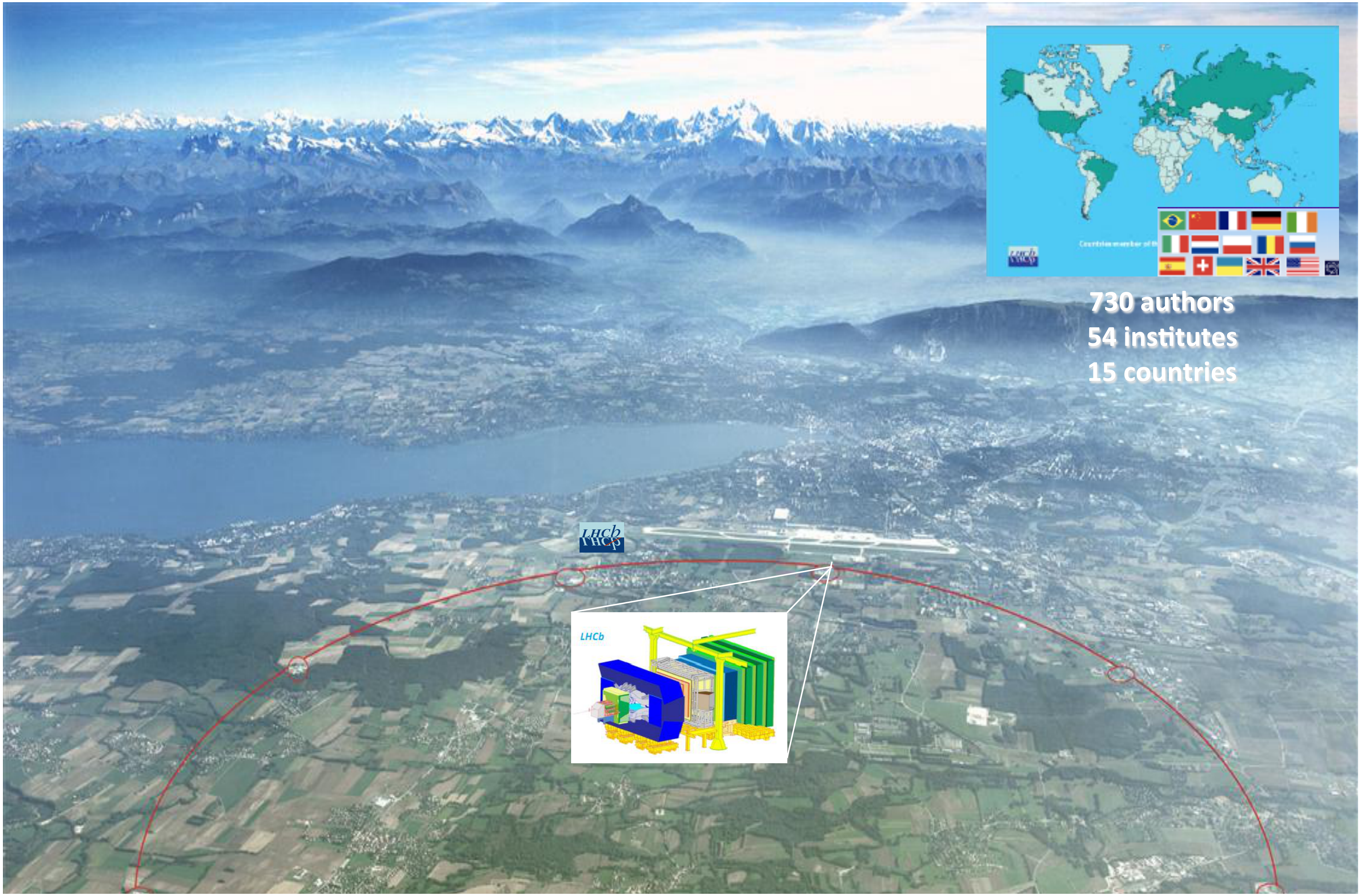
Overview

- LHCb: What is it, what makes it special and different from ATLAS/CMS?
- Status: Running experience from the first months of LHC operation
- First physics: Results from the 2010 data, published and preliminary
- Discovery potential: Plans for 2011 and beyond



LHCb

Overview



730 authors
54 institutes
15 countries

“Indirect” Search for NP

- LHCb performs precision measurements of CP violating phases and rare heavy-quark hadron decays

- New Physics enters through contributions from virtual heavy particles in loop-mediated processes

- sensitivity to New Physics is highest in processes that are strongly suppressed in the Standard Model

- discovery potential for New Physics extends to mass scales far in excess of the LHC centre-of-mass energy

- pattern of observed deviations from Standard Model predictions will hint at the nature of the New Physics

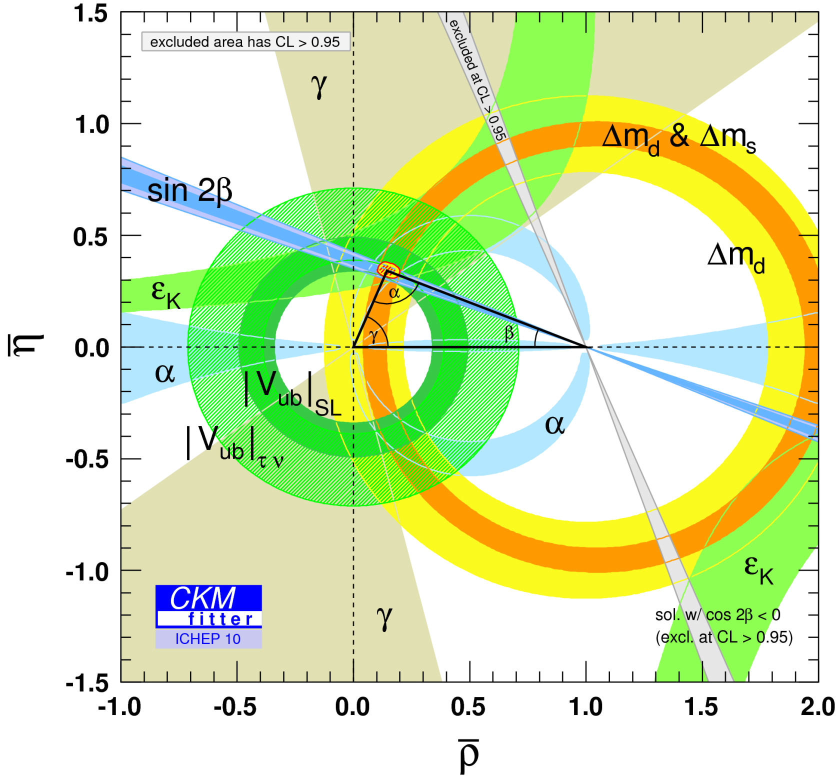
- in continuation of long history of “indirect discoveries”
  - suppression of FCNC → prediction of 2nd quark family
  - CP violation → prediction of 3rd quark family
  - strong BB mixing → prediction of large top-quark mass

New Physics in B decays

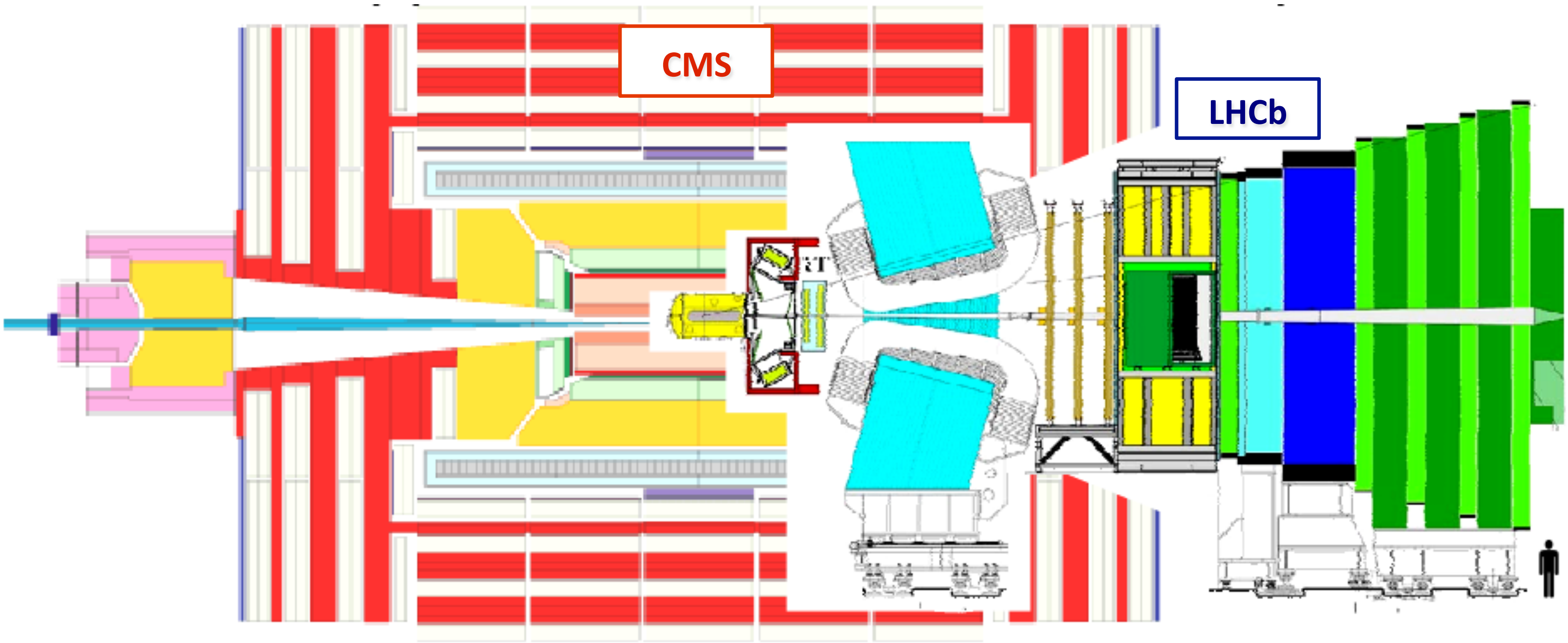
- explore FCNC processes with large sensitivity to New Physics, in particular b→s transitions

- improve measurements on CKM elements and challenge the Standard Model by over-constraining the unitarity triangles

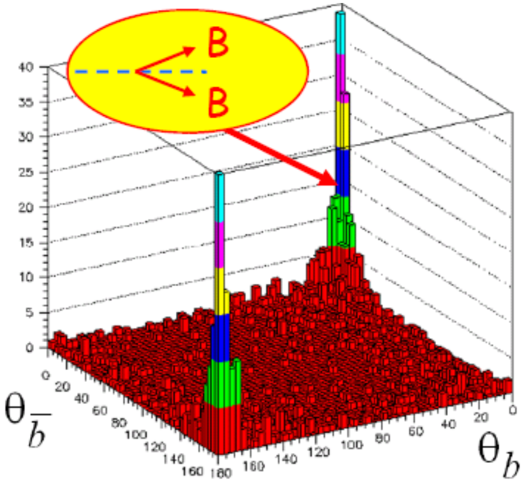
- LHCb roadmap document: [arXiv:0912.4179v2 [hep-ex]]
  - tree-level determination of CKM angle γ
  - charmless charged two-body B decays
  - B_s mixing phase ϕ_s from $B_s \to J/\psi\,\phi$
  - branching fraction of $B_s \to \mu^+\mu^-$
  - angular distributions in $B^0 \to K^*\mu^+\mu^-$
  - $B_s \to \phi\gamma$ and other radiative decays



LHCb = Forward Spectrometer

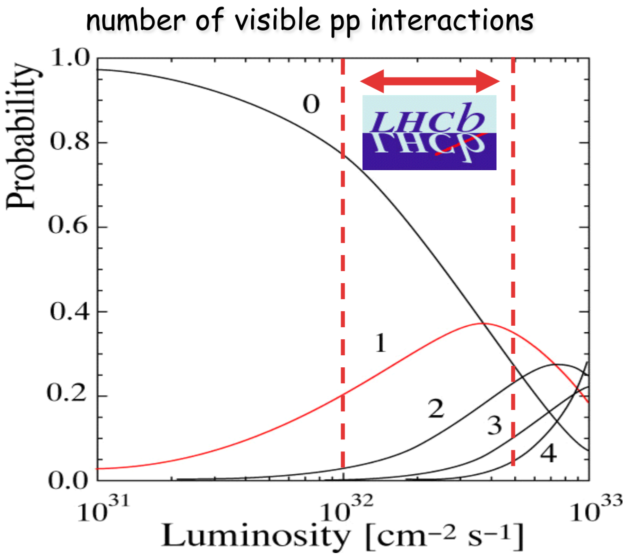


- LHCb covers forward region: $1.9 < \eta < 4.9$
- optimized for the strongly forward peaked heavy quark production at the LHC
- covers only ~4% of solid angle but captures ~40% of heavy-quark production cross section



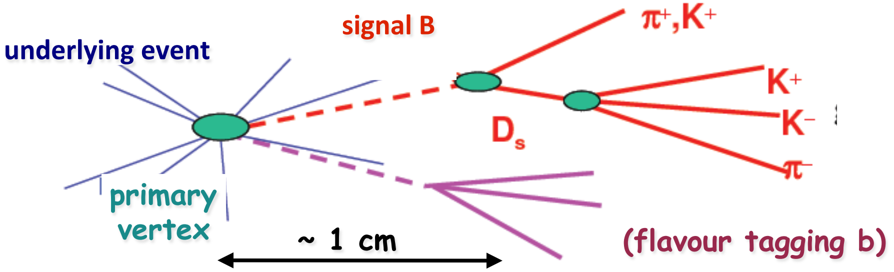
LHCb = “Day-1 Experiment”

- LHCb designed to operate at an instantaneous luminosity of 2 x 10^{32}cm^{-2}s^{-1}



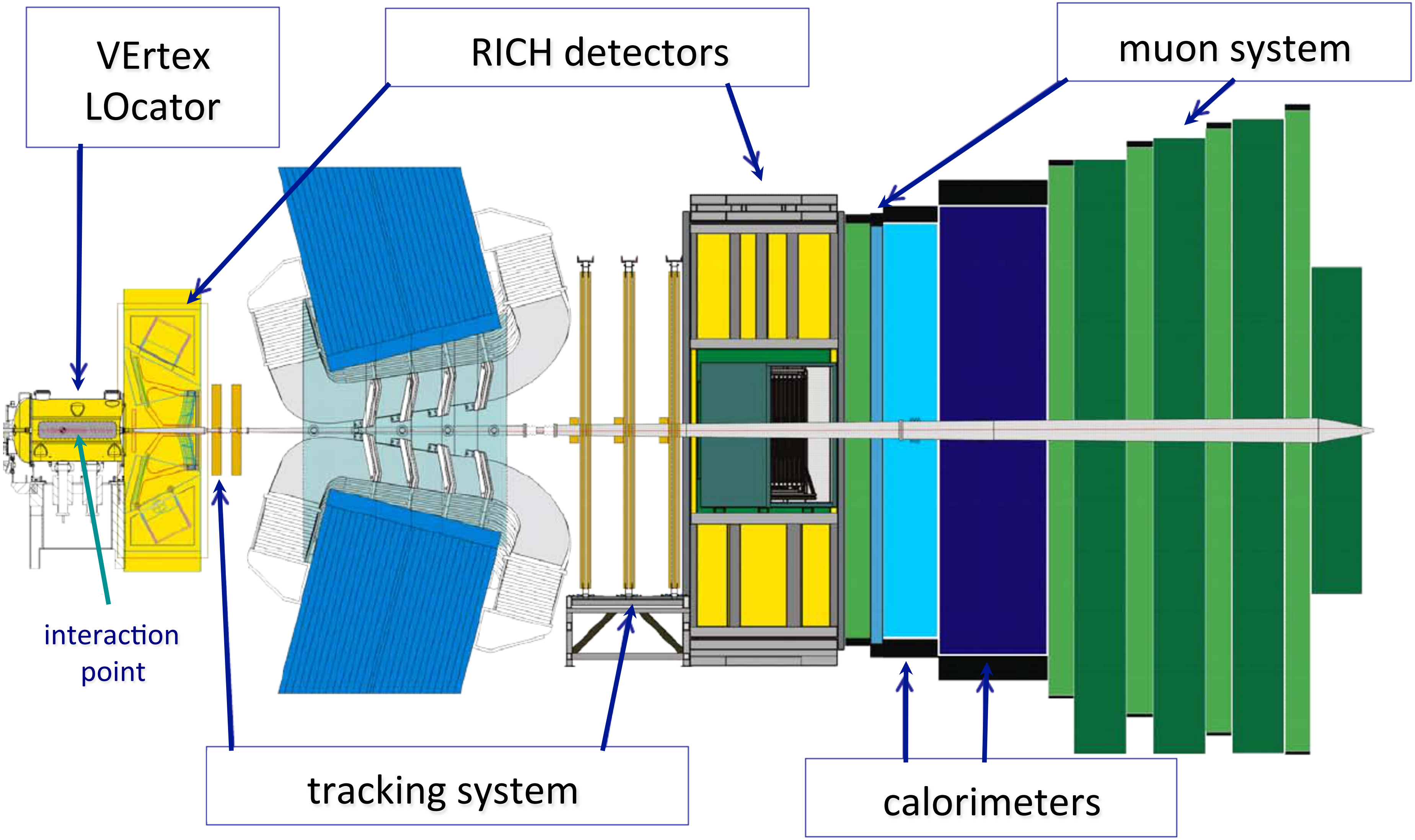
- corresponds to an average of 0.4 visible interactions per bunch-crossing, maximizes fraction of single-interaction bunch crossings (for nominal operation with 2622 colliding bunches)

- single primary vertex: no ambiguity associating B decay vertex to its production vertex (required e.g. for time-dependent CP asymmetries)



- for several of LHCb's core measurements expect first significant results from 2010/2011 LHC run

LHCb Detector


VErtex LOcator

RICH detectors

muon system

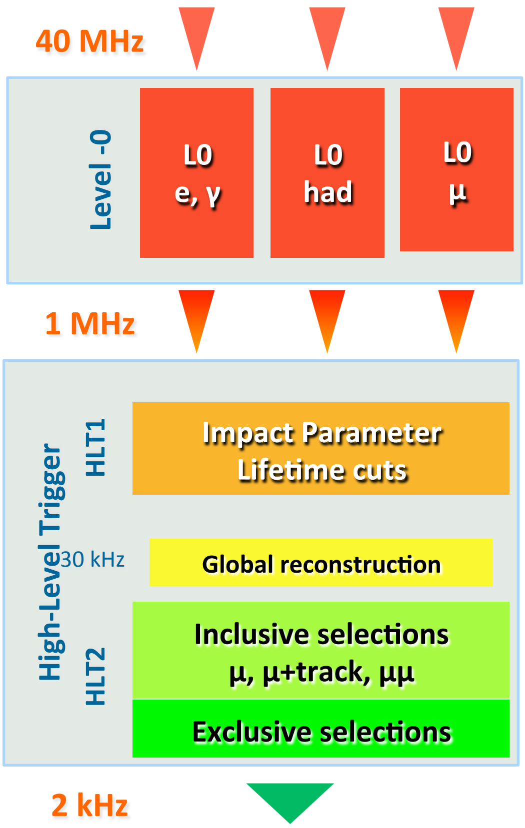
interaction point

tracking system

calorimeters

LHCb = Optimized Trigger

- $b\bar{b}$ cross section is less than 1 % of the total inelastic cross section
- interesting B decay channels have typical branching fractions of 10^{-5}
- exploit generic B decay signature: decay products with large p_T (“large” = few GeV) and high impact-parameter, well separated B decay vertex



Hardware level (L0):

- high-p_T μ, e, γ, or hadron candidates in muon system and calorimeters

Software level (HLT):

- multi-processor farm (14000 CPU cores)
- access to full detector data
- HLT1: cuts on impact parameter and lifetime
- HLT2: global event reconstruction + selections for specific channels

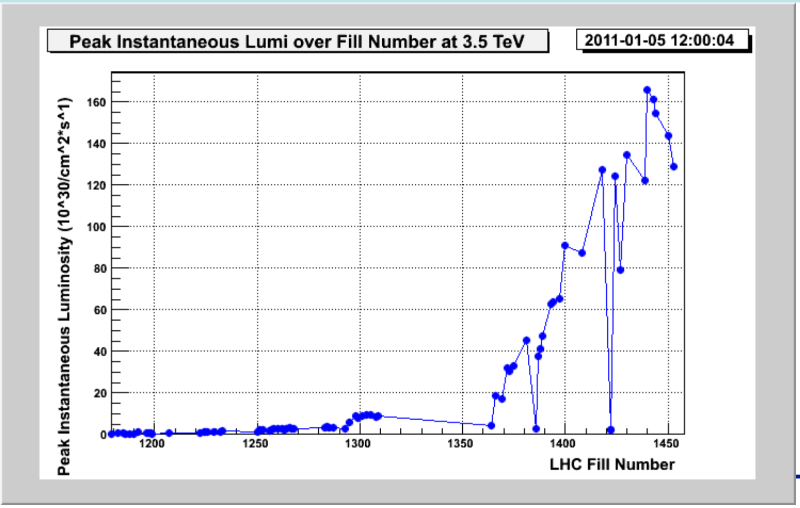
software trigger:
flexible → adjust
to running conditions

Running Experience

LHCb Running in 2010

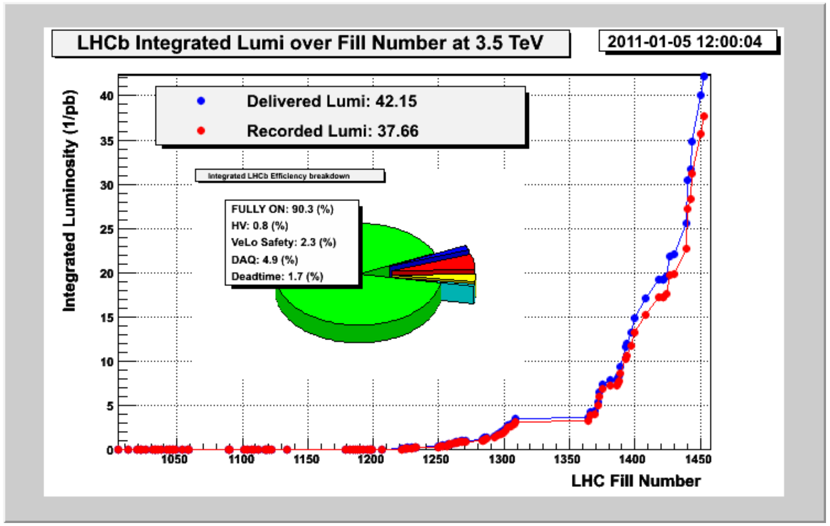
- Extreme conditions compared to design:

	Nominal @ LHCb	**2010**
Number of colliding bunches	2622	344
Instantaneous luminosity	2x10^{32} $cm^{-2}.s^{-1}$ (average)	1.7x10^{32} $cm^{-2}.s^{-1}$ (max)
Normalized emittance	3.75 mm	2.4 mm
β*	30 m	3.5 m
μ (number of visible interaction per crossing)	0.4	2.5
pile-up	1 interaction/bb event	3.1 interactions/bb event
Integrated luminosity	2 fb^{-1}/year	37.7 pb^{-1}

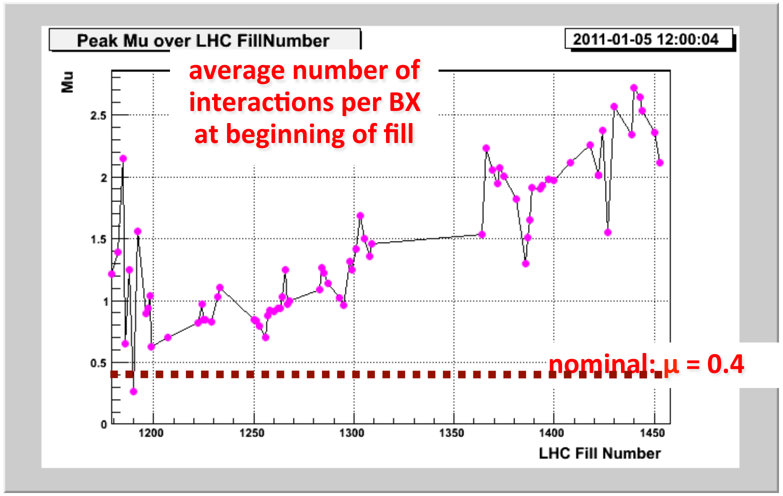


Data Taking & Running Conditions

- LHCb fully operational on first day of LHC collisions, running smoothly since
- recorded 37.7 pb^{-1} at $\sqrt{s} = 7$ TeV
- data taking efficiency > 90%



- at beginning of fill: up to more than 2.5 interactions per crossing on average
- significantly harsher conditions than design
  - multiple primary vertices
  - high occupancies, track multiplicities

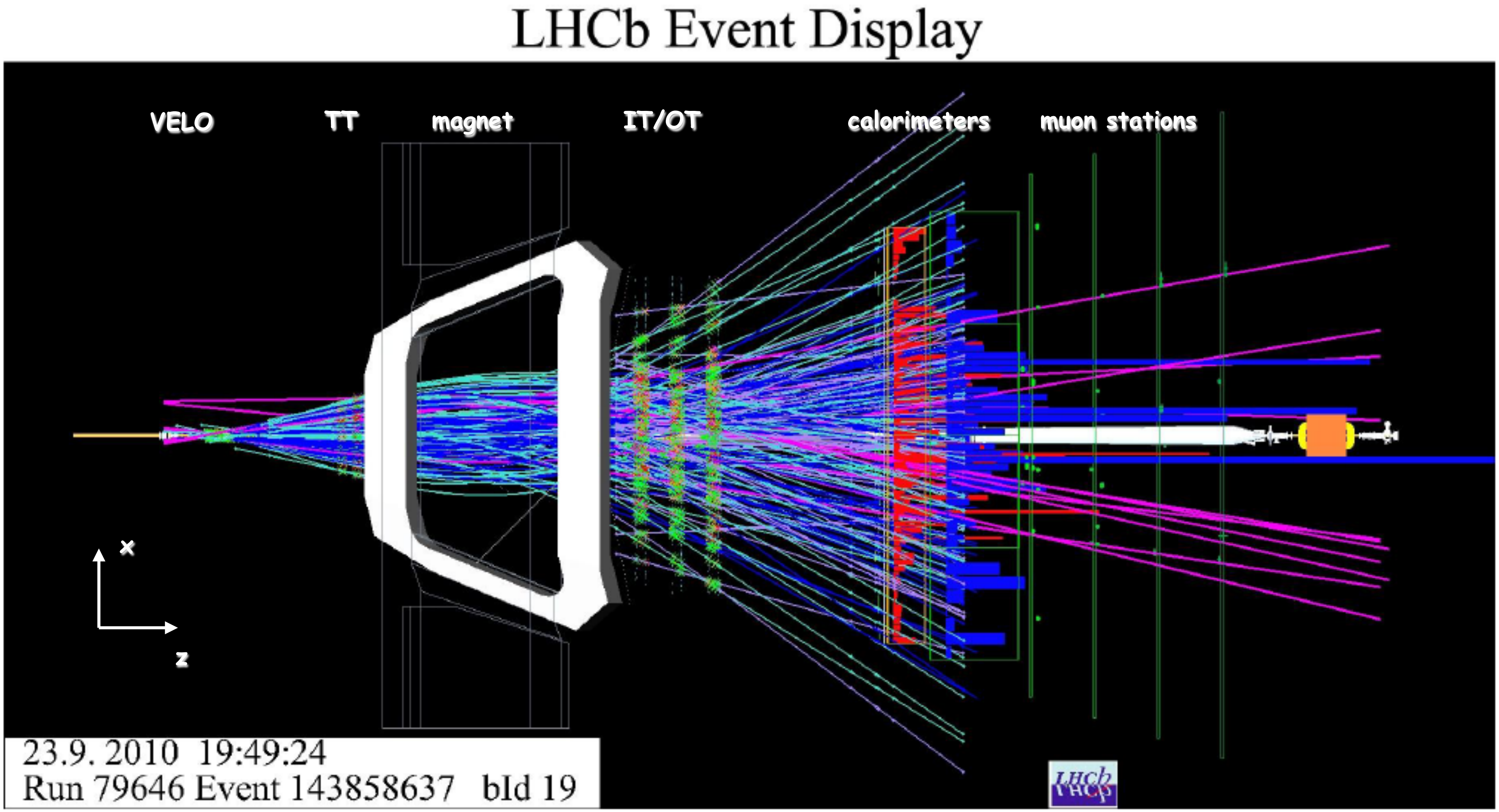


average number of interactions per BX at beginning of fill

nominal: μ = 0.4

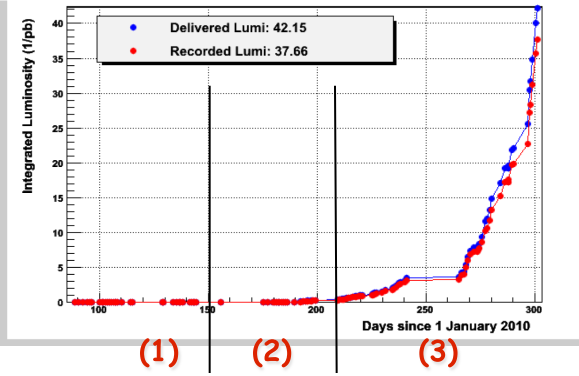
- detector & reconstruction cope better with these conditions than expected
  - main limitation found: HLT reconstruction time for very busy events

Typical Event at <μ> = 2.5



Trigger

- trigger settings continuously adapted to rapidly increasing luminosity and changing running conditions.
- early running (1): low intensity, small number of bunches:
  - *minimum bias trigger, require single track in VELO.*
- with increasing number of bunches and μ (2):
  - *loose p_T cuts at L0, start to use HLT, adjust settings to fully exploit available bandwidth and CPU.*
- at highest μ (3): give priority to muon triggers, reduce hadron trigger lines when needed:
  - *increase cuts on transverse momentum / energy*
  - *“global event cuts” on hit multiplicities to reject very busy events that require lots of CPU*
- trigger efficiencies determined on data using “tag-and-probe” methods
- results in good agreement with simulation



(1) loose L0 cuts, HLT in pass-through

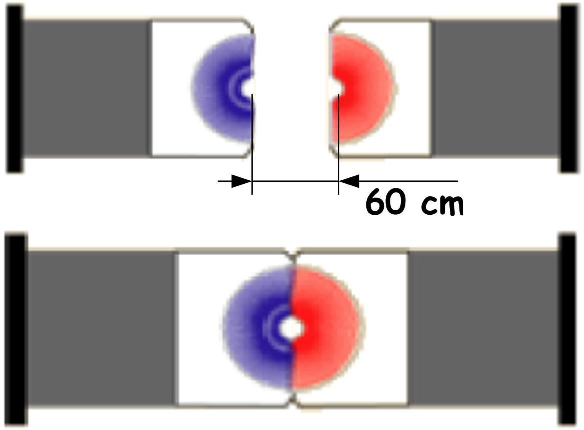
(2) L0 + HLT1

(3) full L0-HLT1-HLT2

	Muon Trigger (J/ψ)	Hadron Trigger (D^0, p_T>2.6 GeV)
Data	(94.9 ± 0.2) %	(60 ± 4) %
Simulation	(93.3 ± 0.2) %	66 %

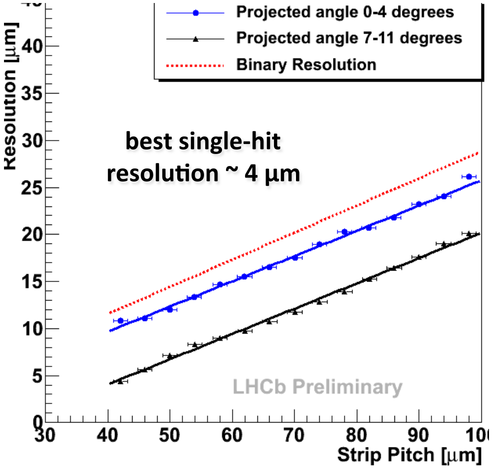
Vertex Reconstruction

- excellent vertex resolution crucial for high-level triggers and most physics analyses
- VELO detectors inside LHC vacuum pipe
- only 8mm from beam during data taking
- retracted by ±3 cm at end of each fill,
  re-inserted when stable beams declared



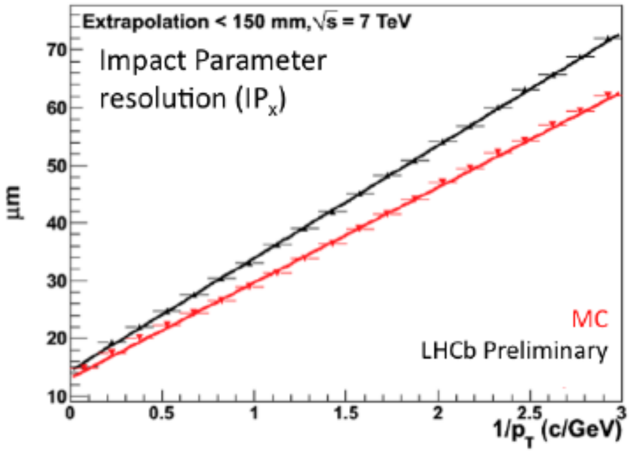
- internal alignment better than 5 µm, fill-to-fill variations also < 5 µm

single-hit resolution

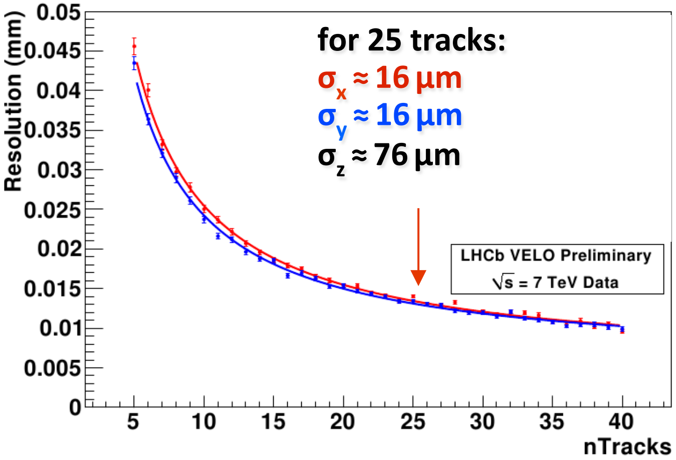


best single-hit resolution ~ 4 µm

impact-parameter resolution

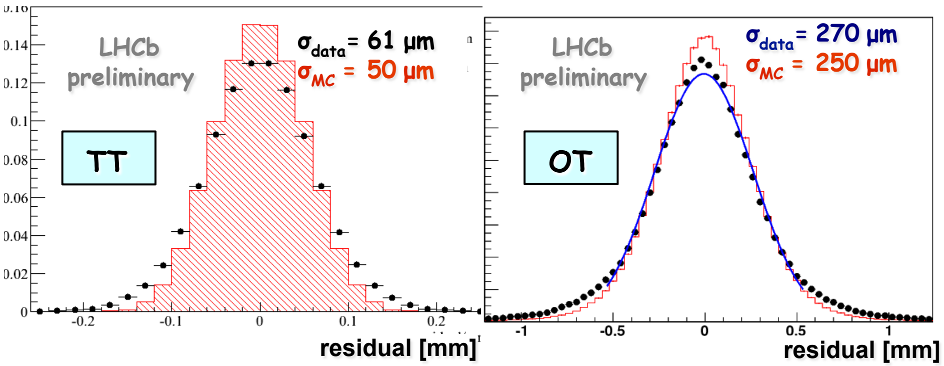


primary vertex resolution

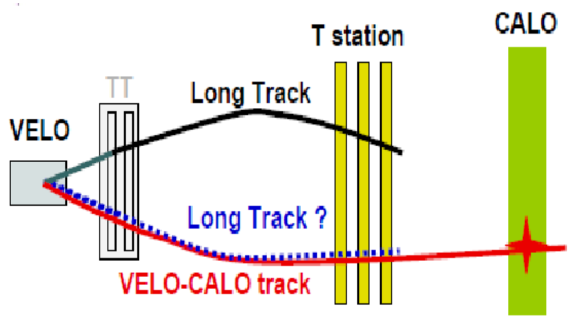


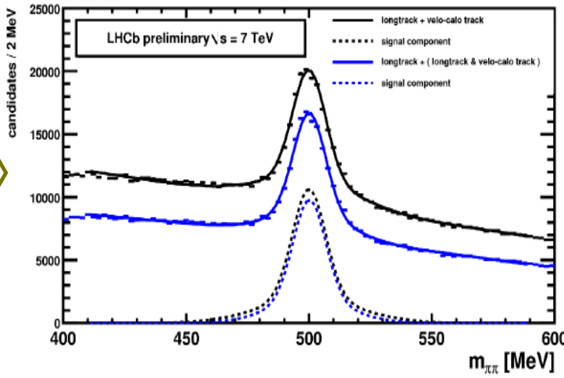
for 25 tracks:
$\sigma_x \approx 16\ \mu m$
$\sigma_y \approx 16\ \mu m$
$\sigma_z \approx 76\ \mu m$

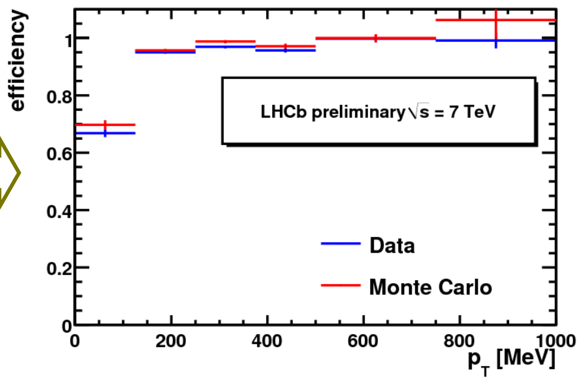
Tracking



- excellent momentum resolution for invariant mass resolution, rejection of combinatorial backgrounds
- spatial resolutions approaching values expected from simulation
- small differences remaining from residual mis-alignments
- *note: no alignment from cosmics (acceptance too small)*
- reconstruction efficiencies > 90 % for tracks above few GeV
- estimated using "tag-and-probe" methods on $K_S^0 \rightarrow \pi^+\pi^-$

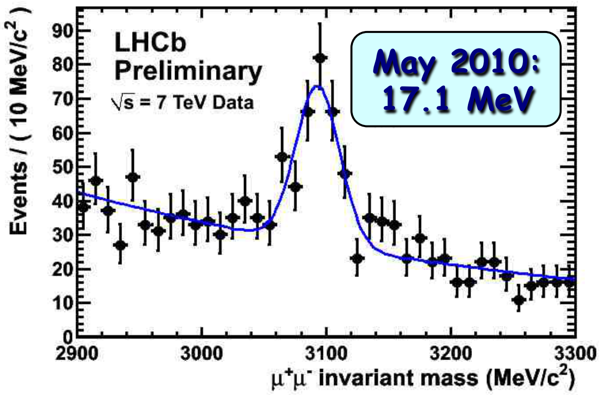


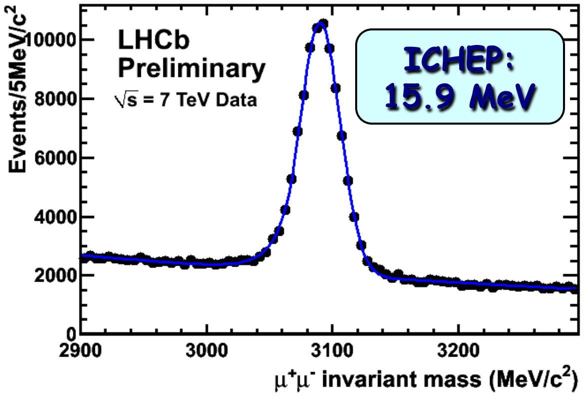


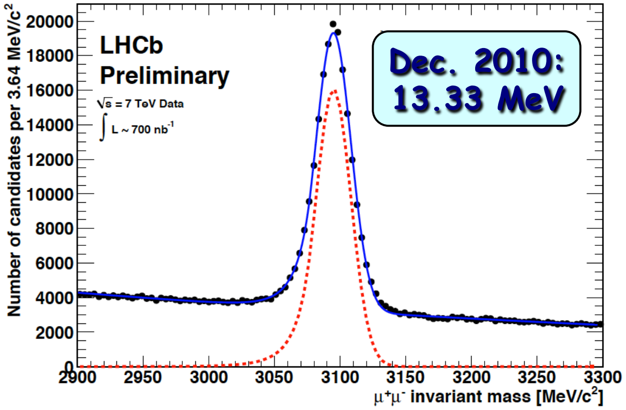


$\mu^+\mu^-$ Invariant Mass Resolutions

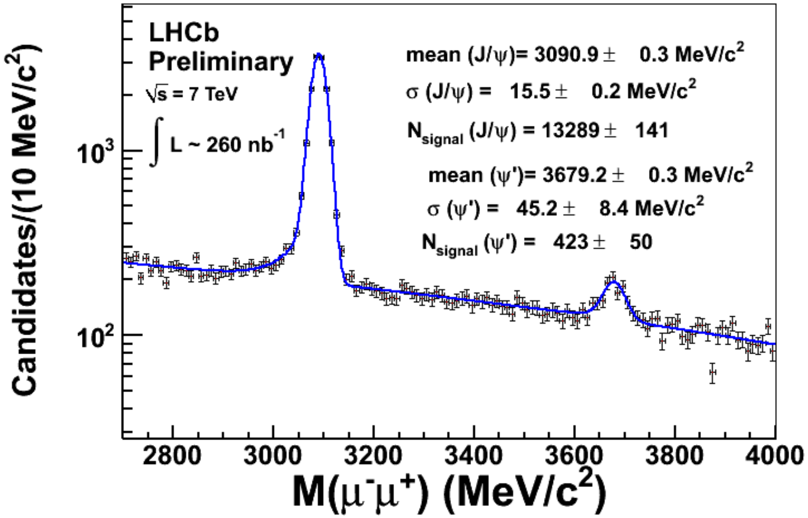
$J/\psi \rightarrow \mu^+\mu^-$ (Monte-Carlo: 12.1 MeV)



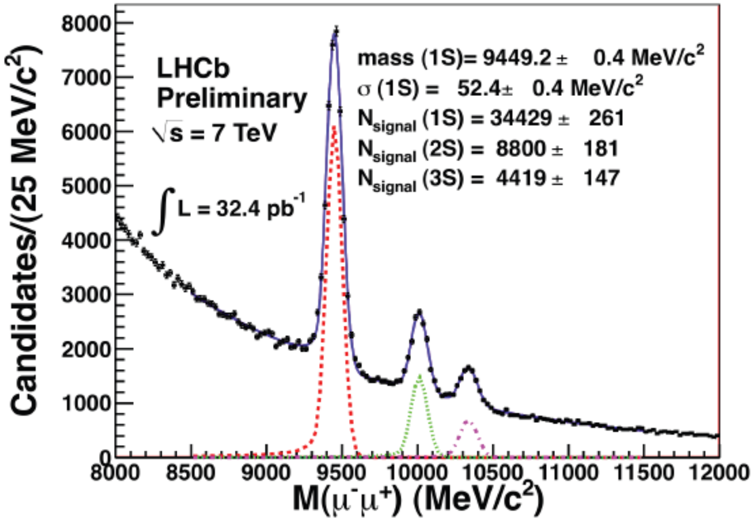




$\psi(2S) \rightarrow \mu^+\mu^-$

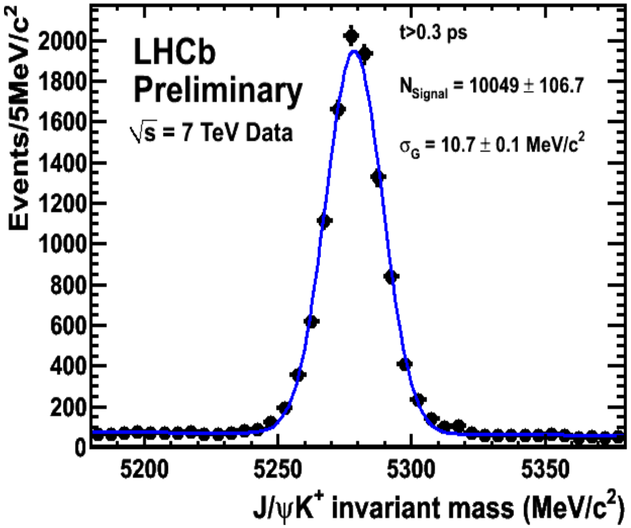


$\Upsilon(1S,2S,3S) \rightarrow \mu^+\mu^-$

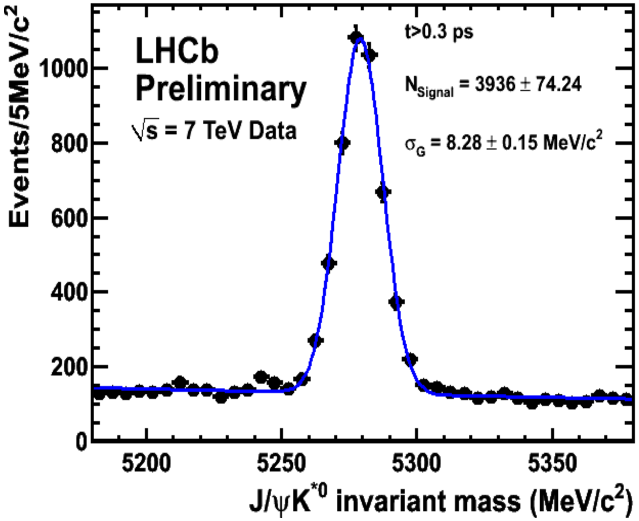


$b \to J/\psi\, X$ Signals (from 34 pb^{-1})

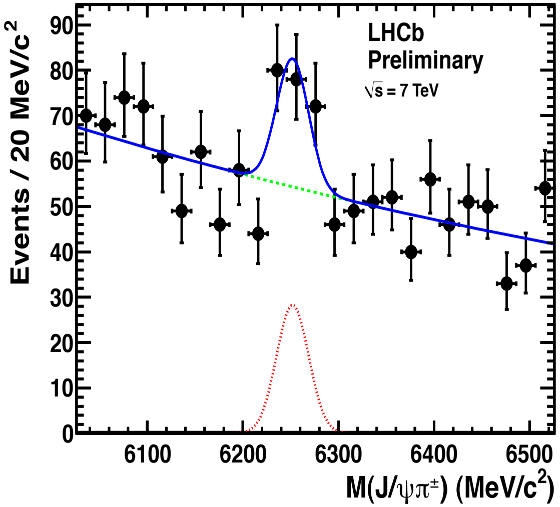
$B^+ \to J/\psi\, K^+$



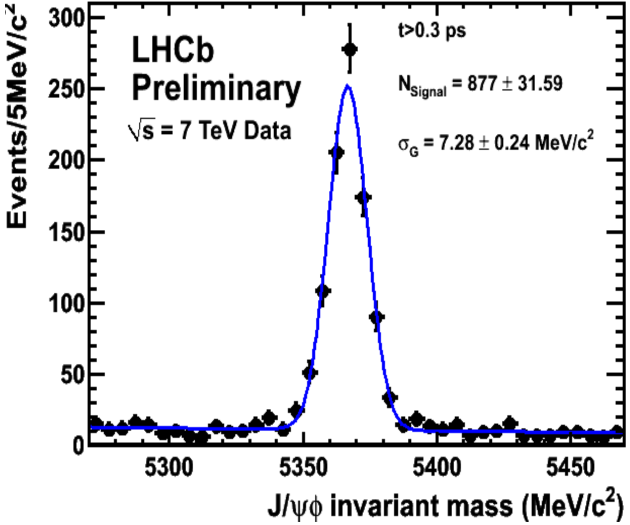
$B^0 \to J/\psi\, K^{*0}$



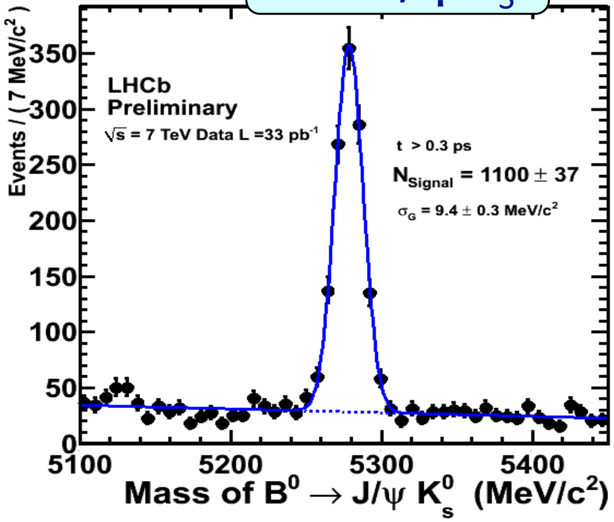
$B_c^+ \to J/\psi\, \pi^+$



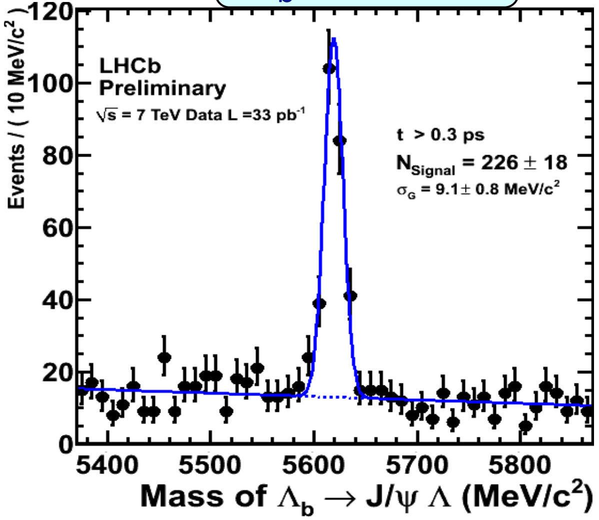
$B_s^0 \to J/\psi\, \phi$



$B^0 \to J/\psi\, K_S^0$

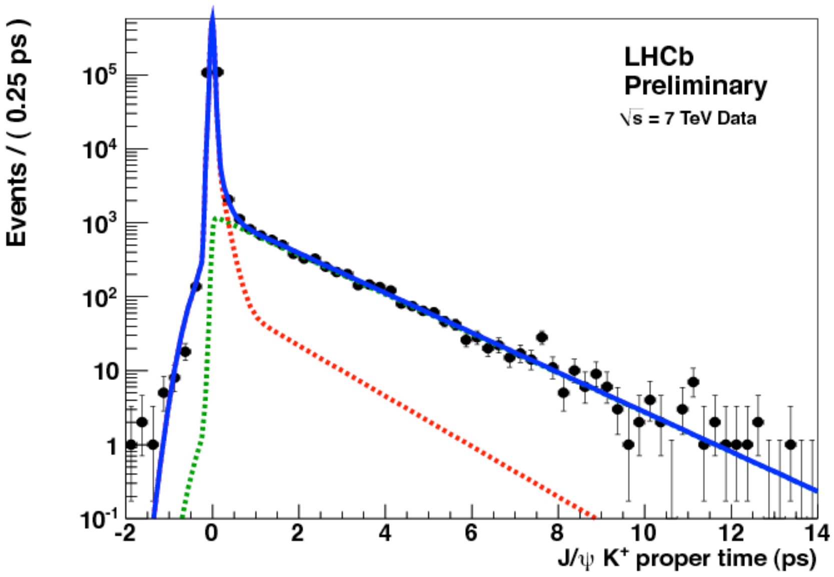


$\Lambda_b \to J/\psi\, \Lambda$



b → J/ψ X lifetime measurements

(from 36 pb^{-1})



- Already large samples available with very low background, using lifetime unbiased triggers.
- Very good proper-time resolution, ~50 fs.
- Conservative systematics assigned for the moment, dominated by time acceptance.
- Measurements compatible with PDG
- Indicates good understanding of the detector for time-dependant studies, like CP violation.

Channel	Yield	Lifetime (ps)	PDG (ps)
$B^+ \rightarrow J/\psi K^+$	6741 ± 85	1.689 ± 0.022 ± 0.047	1.638 ± 0.011
$B^0 \rightarrow J/\psi K^{*0}$	2668 ± 58	1.512 ± 0.032 ± 0.042	1.525 ± 0.009
$B^0 \rightarrow J/\psi K_S^0$	838 ± 31	1.558 ± 0.056 ± 0.022	1.525 ± 0.009
$B_s^0 \rightarrow J/\psi \phi$	570 ± 24	1.447 ± 0.064 ± 0.056	1.477 ± 0.046
$\Lambda_b \rightarrow J/\psi \Lambda$	187 ± 16	1.353 ± 0.108 ± 0.035	1.391 ± 0.038

b → J/ψ X mass measurements

(from 36 pb^{-1})

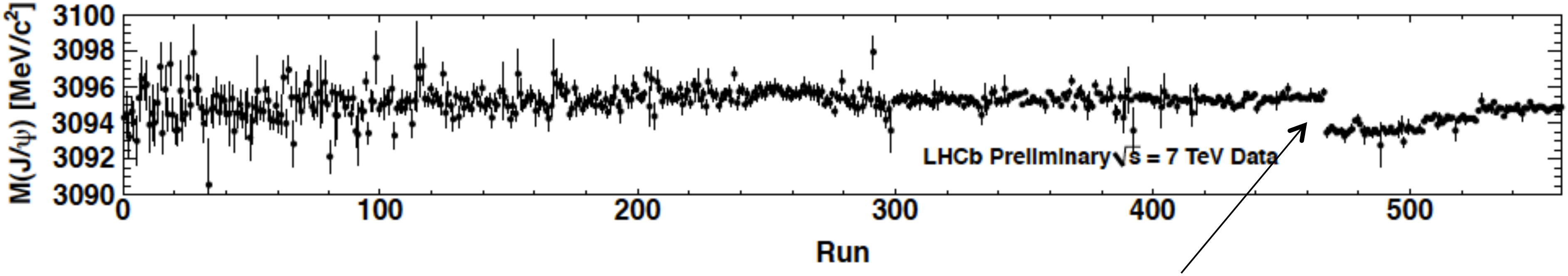
- Mass measurements are very challenging tasks
- Need to control precisely (at the per mille level to be competitive) :
  - Magnetic field / absolute field scale → momentum scale
  - Alignment of subdetectors
- Momentum scale calibration: done using J/ψ → $\mu^+ \mu^-$ decays, and checked on 2-body decays and ψ(2S)→ J/ψ $\pi^+ \pi^-$.

Decay Mode	Measured mass (MeV/c^2)	PDG average (MeV/c^2)
$\Upsilon \to \mu^+ \mu^-$	9459.90 ± 0.54	9460.30 ± 0.26
$\psi(2S) \to J/\psi\, \pi^+ \pi^-$	3686.12 ± 0.06	3686.09 ± 0.04
$J/\psi \to \mu^+ \mu^-$	3096.97 ± 0.01	3096.916 ± 0.011
$D^0 \to K^- \pi^+$	1864.75 ± 0.07	1864.83 ± 0.14
$K_S^0 \to \pi^+ \pi^-$	497.62 ± 0.01	497.61 ± 0.02

- Systematic uncertainty of 0.15 MeV/c^2 for B mass measurement.

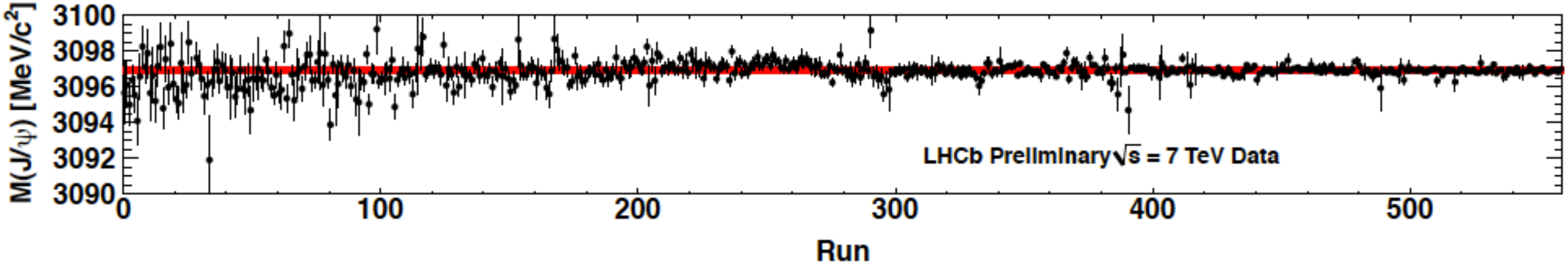
b → J/ψ X mass measurements

- Alignment: depend on a lot of parameters → time dependant alignment.
- Before alignment: (central value of J/ψ mass)



Change of operational temperature of TT detector (-5 to -15°C) causing movements of 400 μm, compared to 50 μm hit resolution.

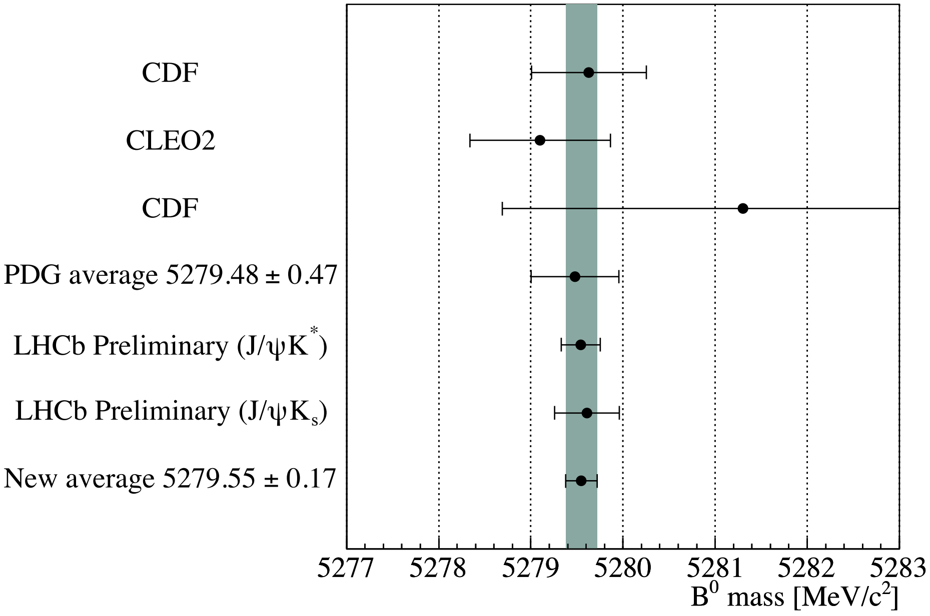
- After alignment:



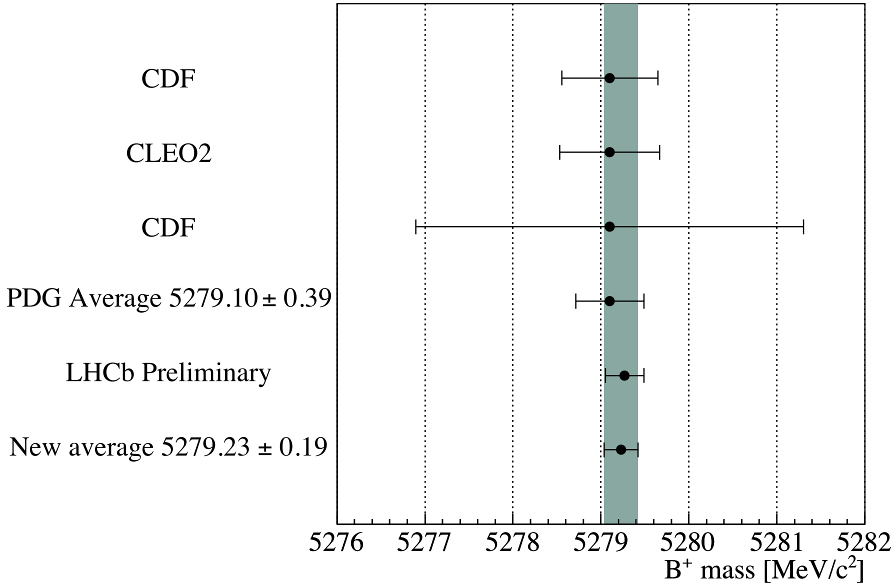
- Systematic uncertainty of 0.10 MeV/c^2 for B mass measurement

b → J/ψ X mass measurements

State	Measured mass (MeV/c^2)	PDG average (MeV/c^2)
B^0	5279.54 ± 0.15 ± 0.16	5279.48 ± 0.47
B^+	5279.27 ± 0.11 ± 0.20	5279.10 ± 0.39
B_s^0	5366.60 ± 0.28 ± 0.21	5365.97 ± 0.87
Λ_b	5619.49 ± 0.70 ± 0.19	5620.19 ± 1.60
B_c^+	6268.0 ± 4.0 ± 0.6	6277.13 ± 6.00

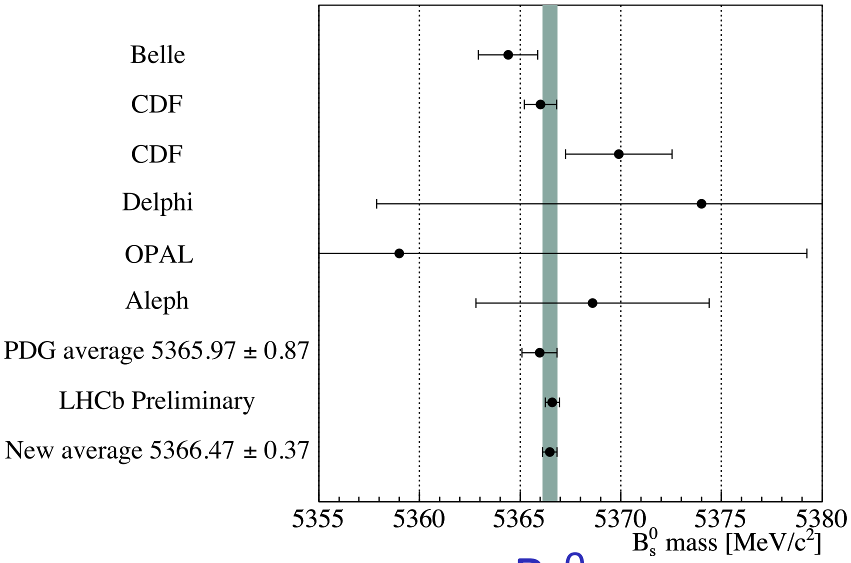


B^0

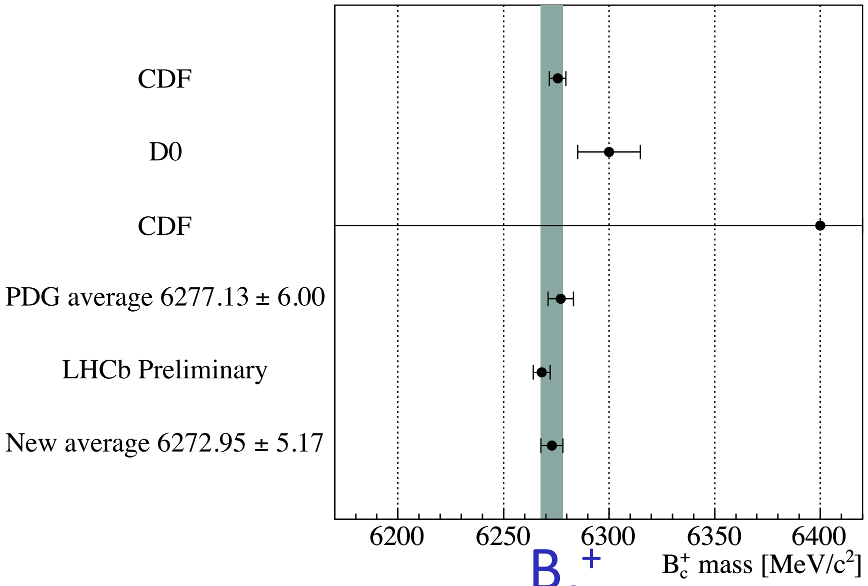


B^+

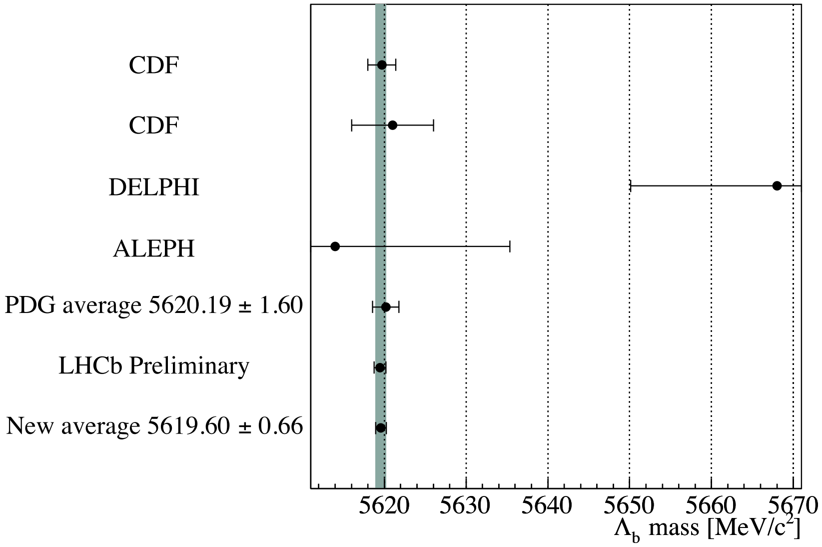
b → J/ψ X mass measurements



B_s^0



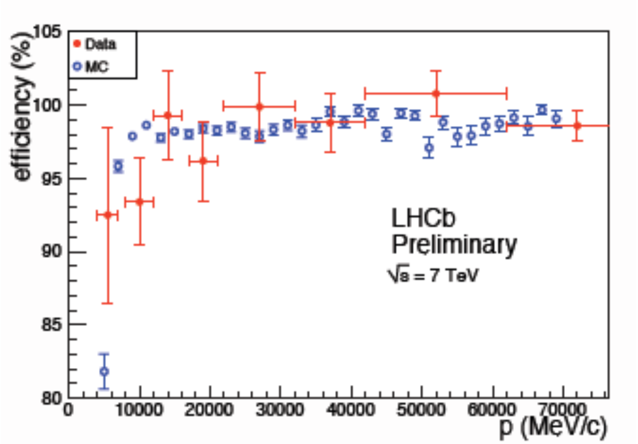
B_c^+

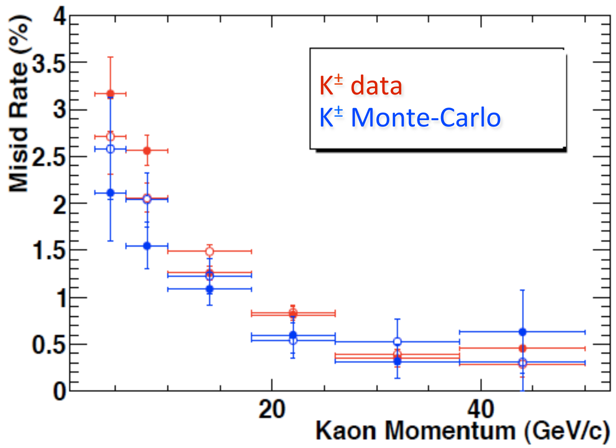


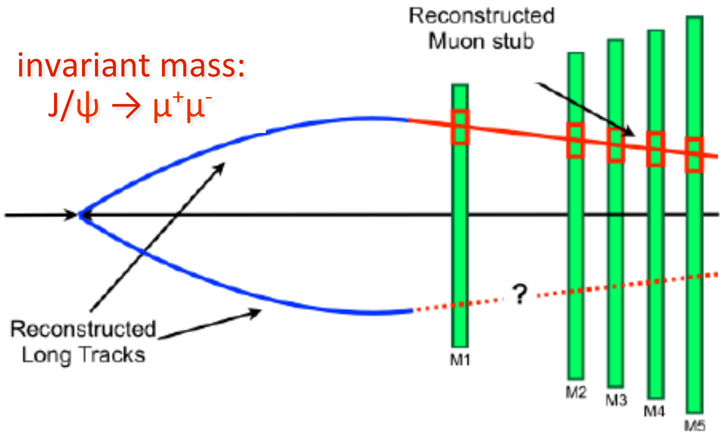
Λ_b

Muon Identification Performance

- efficiency determined from data using tag-and-probe method on $J/\psi \rightarrow \mu^+\mu^-$
- found to be > 90 % for p > 10 GeV
- mis-ID probabilities $K \rightarrow \mu$, $\pi \rightarrow \mu$, $p \rightarrow \mu$ determined from data using tag-and-probe method on $\phi \rightarrow KK$, $K_S \rightarrow \pi\pi$, $\Lambda \rightarrow p\pi$
- all found to be < 2 % for p > 10 GeV
- good agreement between data and simulation







invariant mass:
$J/\psi \rightarrow \mu^+\mu^-$

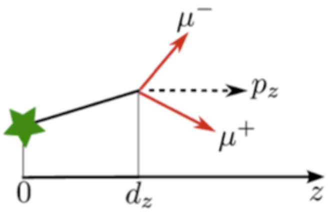
tagging
muon

probe
muon

J/ψ cross-section measurement

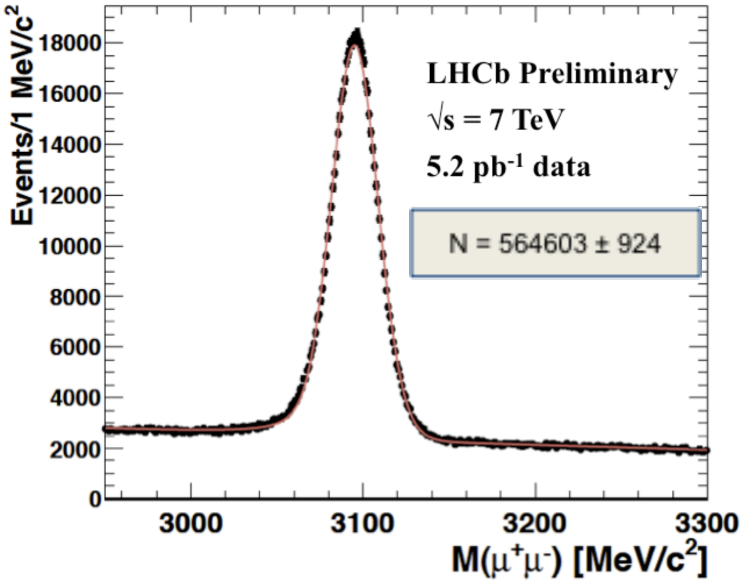
- Important calibration mode for LHCb, and proof of absolute cross-section / branching fractions capabilities.
- Measurement released in December, with 5pb^{-1}, accepted for publication in EPCJ (arXiv:1103.0423 [hep-ex]).
- Measure separately:
  - Prompt J/ψ (direct J/ψ + J/ψ from χ_c feeddown)
  - J/ψ from *b* decays,
- Using to separate them the J/ψ pseudo proper time:

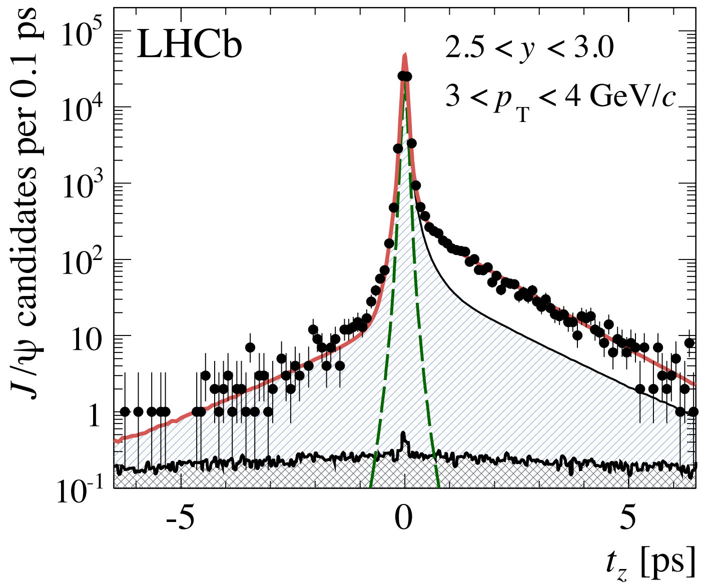
$$t_z(J/\psi) = \frac{d_z \times M_{J/\psi}}{p_z}$$



- Total $b\bar{b}$ cross-section:

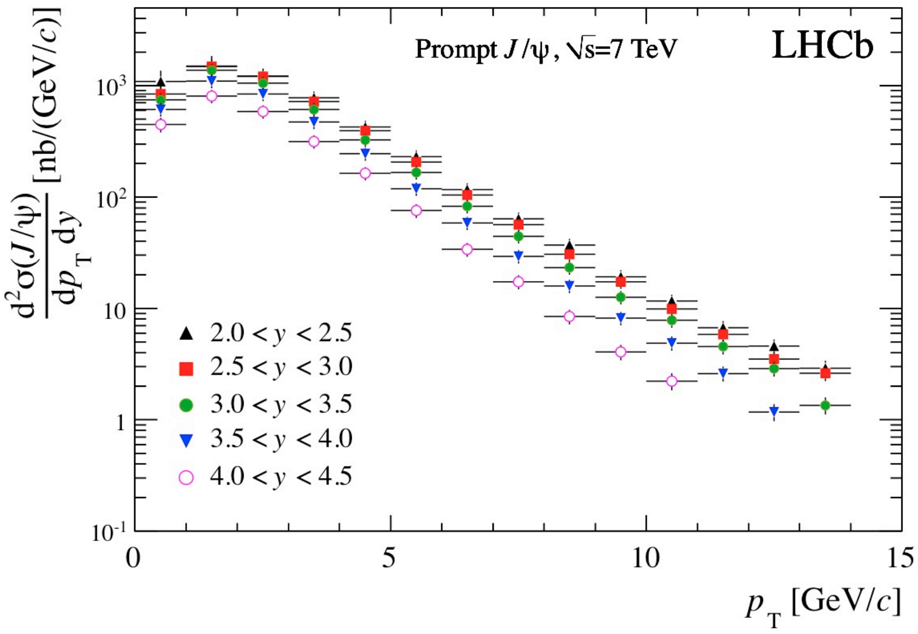
$$\boxed{\sigma(pp \to b\bar{b}X) = 288 \pm 4 \pm 48\ \mu\text{b}}$$



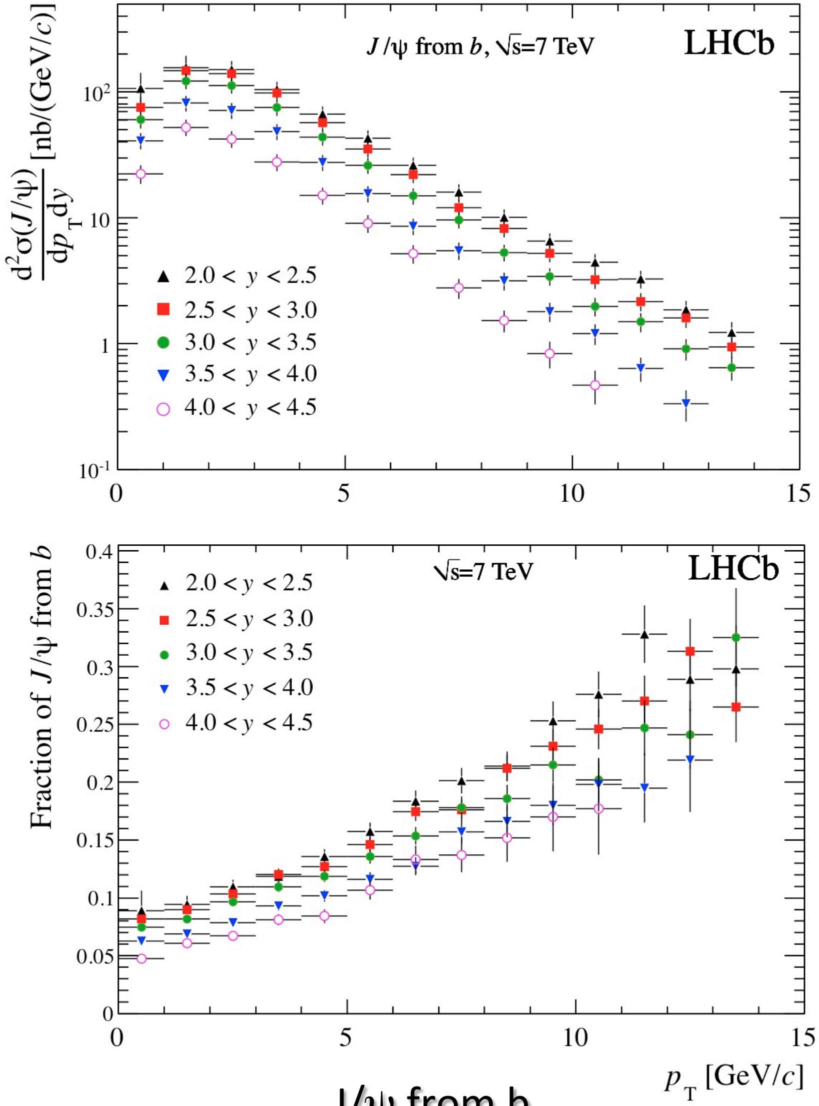


J/ψ cross-section measurement

- Differential cross-sections in 70 bins (p_T and rapidity, y)



Prompt J/ψ, assumed unpolarized

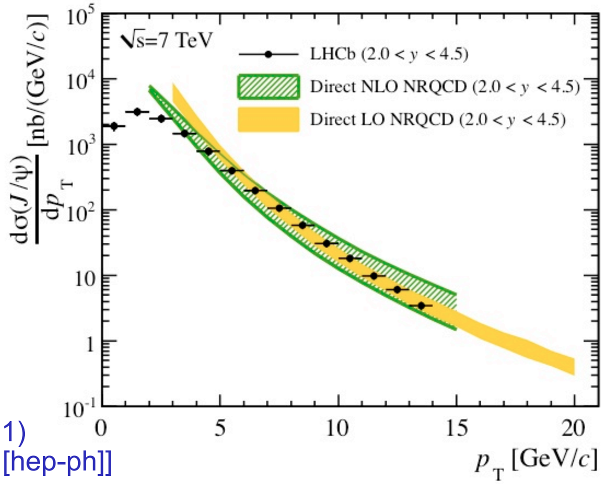


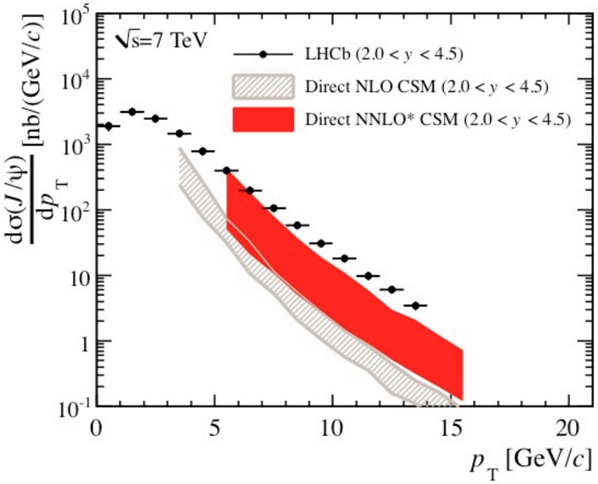
J/ψ from b

J/ψ cross-section measurement

Comparison with theory (prompt J/ψ):

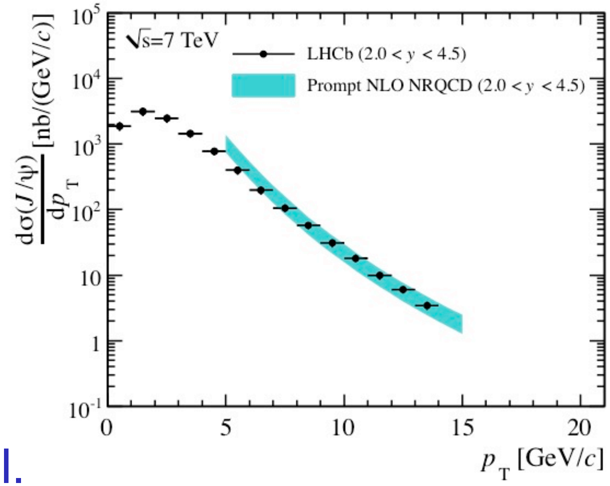
P. Artoisenet
[PoS ICHEP 2010 (2010) 192]



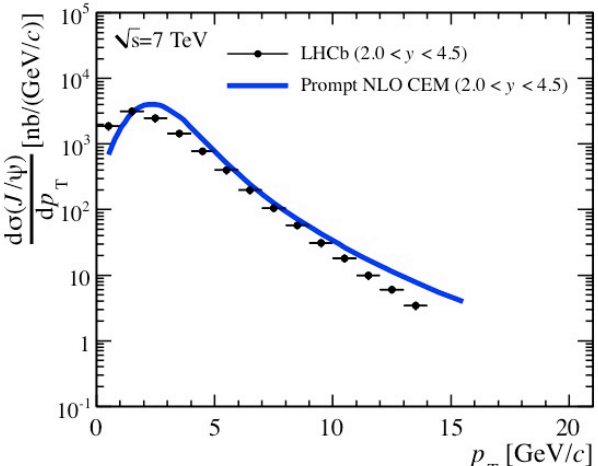


J.-P. Lansberg
[Eur. Phys. J. C 61 (2009) 693, arXiv:0811.4005 [hep-ph]]

M. Butenschön and B. Kniehl
[Phys. Rev. Lett. 106 (2011) 022301, arXiv:1009.5662 [hep-ph]]



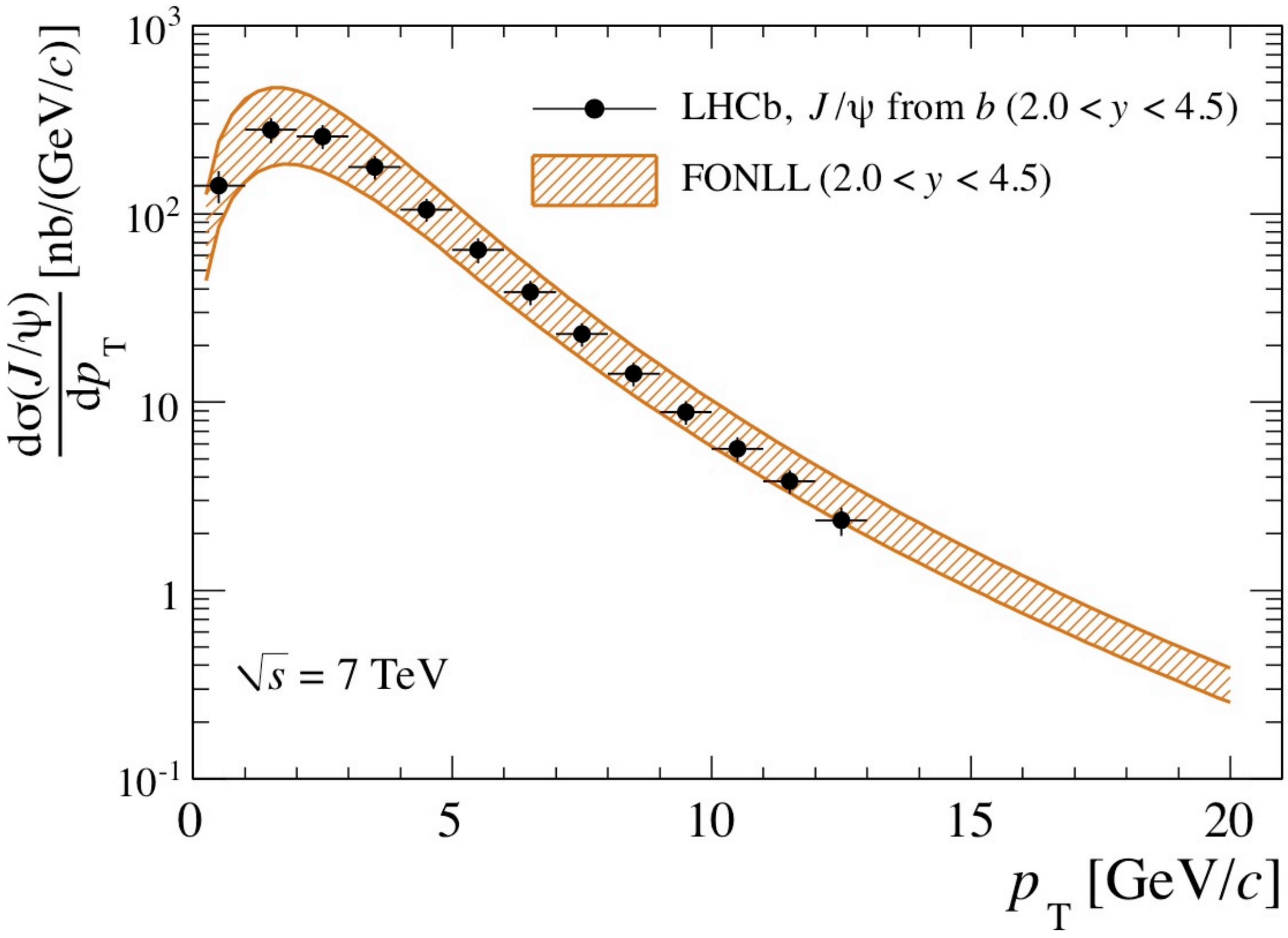
K. T. Chao et al.
[Phys. Rev. Lett. 106 (2011) 042002, arXiv:1009.3655 [hep-ph]]



R. Vogt
[Phys. Rep. 462 (2008) 125, arXiv:0806.1013 [nucl-ex]]

J/ψ cross-section measurement

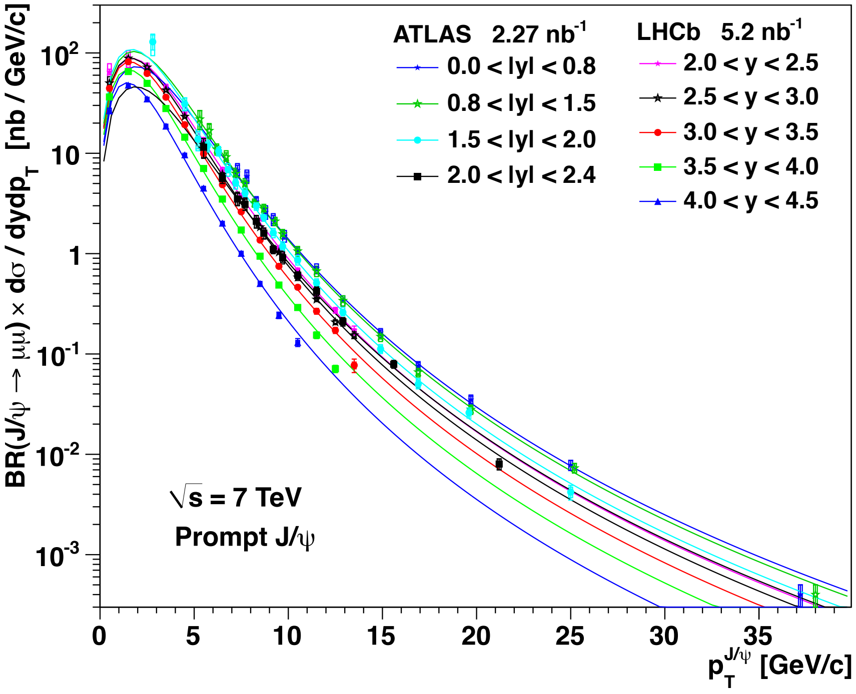
Comparison with theory (J/ψ from b):

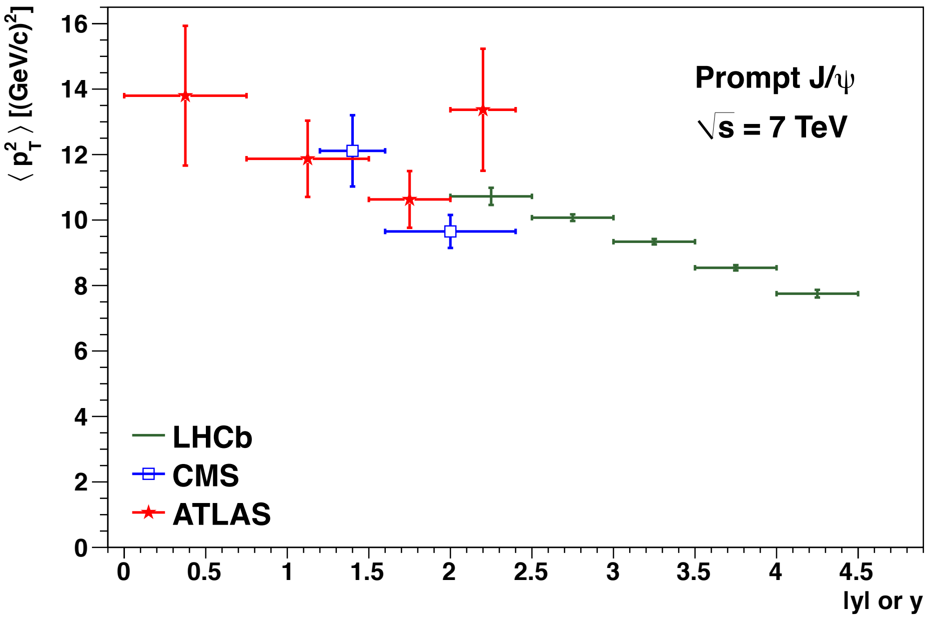


M. Cacciari

J/ψ cross-section measurement

Comparison with other experiments:



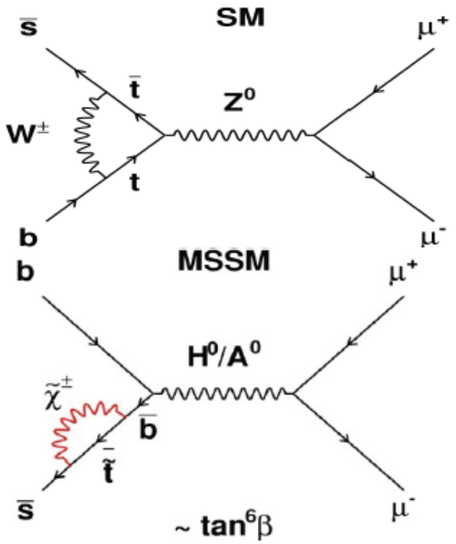


Search for $B_{d,s} \to \mu^+ \mu^-$ decays

- One of the early benchmark channels for LHCb (arXiv:1103.2465): search of New Physics entering in loops that would enhance the Branching fraction compared to Standard Model expectations (which are very small).
- These decay modes are very sensitive to new scalar and / or pseudo-scalar interactions. In the MSSM, the Branching fraction is proportional to $\tan^6\beta / M_A^4$.

$$BR(B_q \to l^+ l^-) \approx \frac{G_F^2 \alpha^2 M_{B_q}^3 f_{B_q}^2 \tau_{B_q}}{64\pi^3 \sin^4\theta_W} |V_{tb}V_{tq}^*|^2 \sqrt{1 - \frac{4m_l^2}{M_{B_q}^2}}$$

$$\left\{ M_{B_q}^2 \left(1 - \frac{4m_l^2}{M_{B_q}^2}\right) c_S^2 + \left[M_{B_q} c_P + \boxed{\frac{2m_l}{M_{B_q}}} (c_A - c_A') \right]^2 \right\}.$$



- Standard Model Predictions:

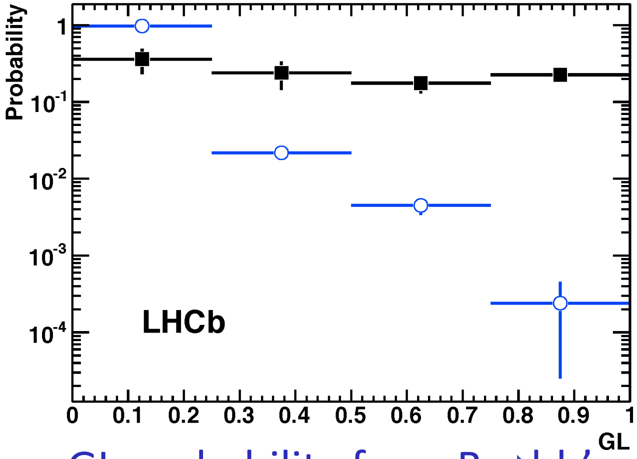
Mode	Branching Fraction
$B_s^0 \to \mu^+ \mu^-$	$(3.2 \pm 0.2) \times 10^{-9}$
$B^0 \to \mu^+ \mu^-$	$(0.10 \pm 0.01) \times 10^{-9}$

A. J. Buras
[arXiv:1012.1447]

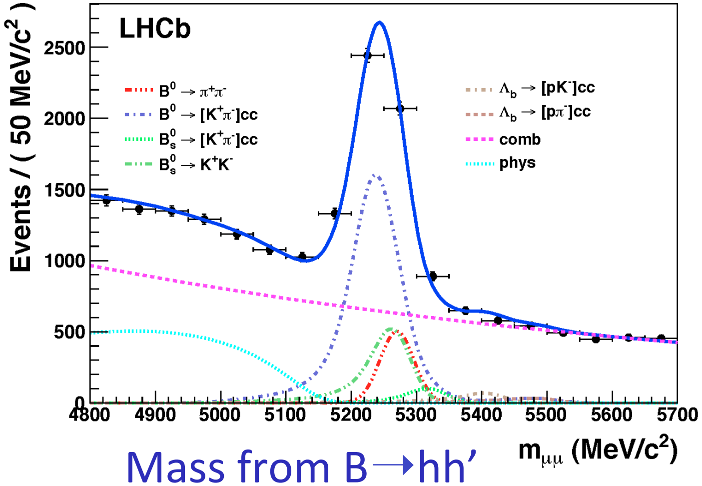
E. Gamiz et al.
[PRD80 (2009) 014503]

Search for $B_{d,s} \to \mu^+ \mu^-$ decays

- Signal and background candidates are discriminated by a 2D likelihood: **multivariate discriminant variable** (Geometrical Likelihood) and **invariant mass**, with both probabilities obtained from data ($B \to hh'$):

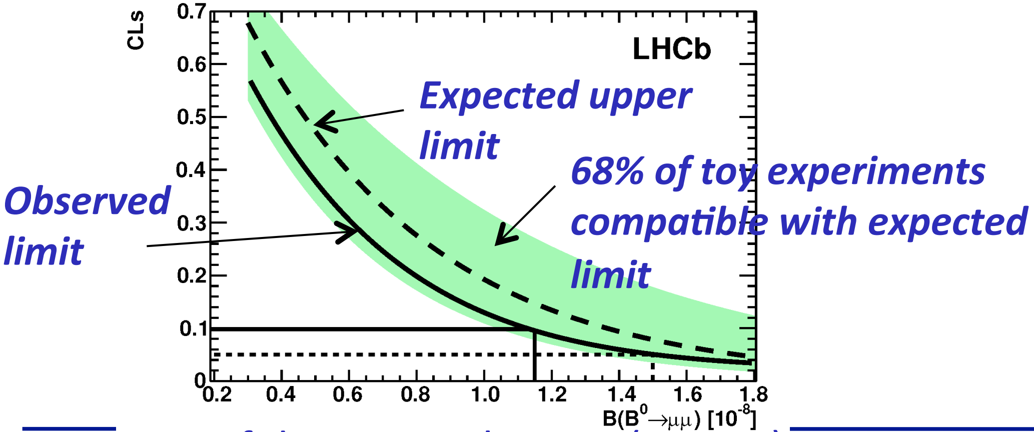


GL probability from $B \to hh'$



Mass from $B \to hh'$

- Three complementary normalization channels: $B^+ \to J/\psi\ K^+$, $B_s^0 \to J/\psi\ \phi$ and $B^0 \to K^+\pi^-$.



Expected upper limit

68% of toy experiments compatible with expected limit

Observed limit

Confidence Levels vs BR($B \to \mu\mu$)

LHCb results with 37pb^{-1}:

BR($B_s^0 \to \mu^+\mu^-$) < 5.6 x 10^{-8} @ 95% CL

BR($B^0 \to \mu^+\mu^-$) < 1.5 x 10^{-8} @ 95% CL

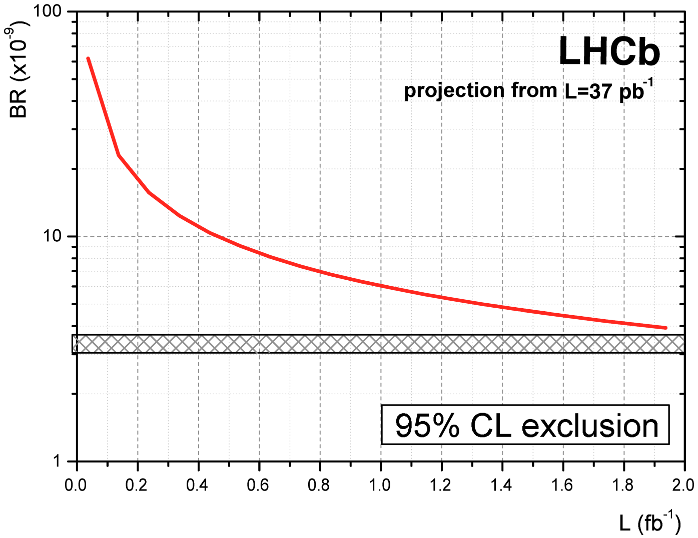
Close to best limits from CDF with 3.7fb^{-1}:

BR($B_s^0 \to \mu^+\mu^-$) < 4.3 x 10^{-8} @ 95% CL

BR($B^0 \to \mu^+\mu^-$) < 0.76 x 10^{-8} @ 95% CL

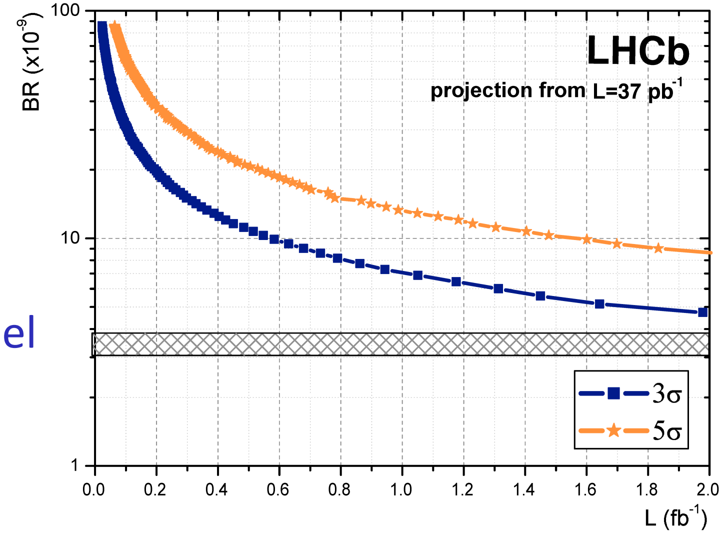
Search for $B_{d,s} \rightarrow \mu^+ \mu^-$ decays

- Prospects for 2011/2012 (expected luminosity from 500 pb^{-1} to 2 fb^{-1}):



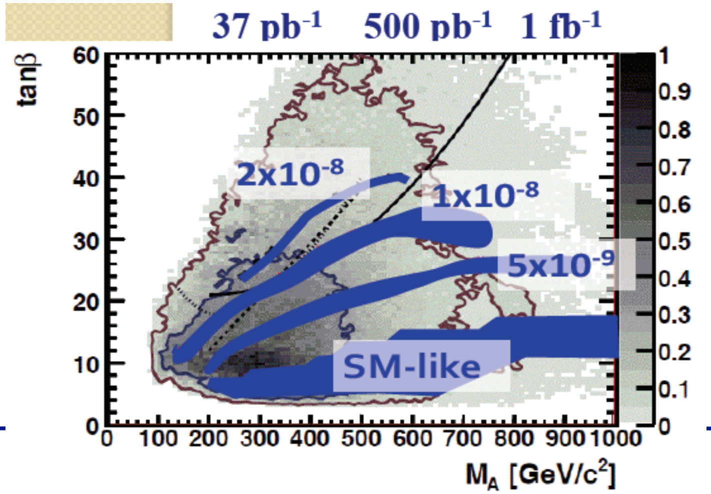
Exclusion @ 95% CL

Standard Model expectation

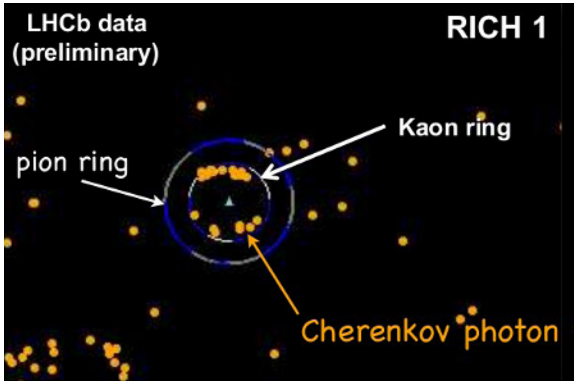


Observation

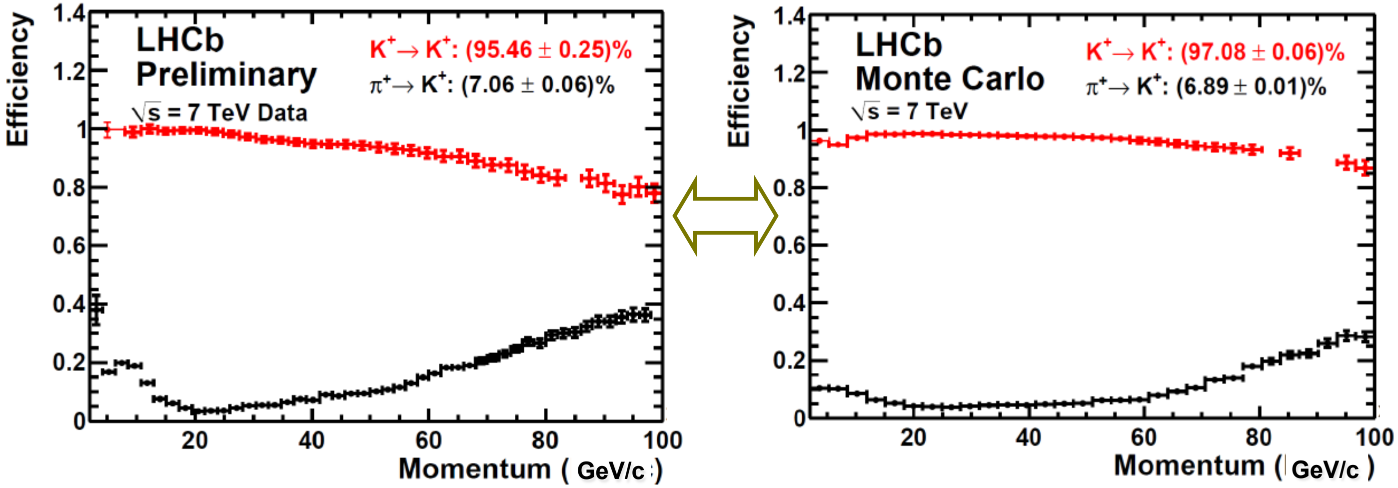
- LHCb will either find signs of NP or exclude most of the tanβ vs M_A plane with 2011/2012 data.



K/π Identification



- crucial for flavour tagging and for separation of B decays with identical topology, e.g.
  $B^0 \rightarrow \pi^+\pi^- \leftrightarrow B^0 \rightarrow K^\pm\pi^\mp \leftrightarrow B_s \rightarrow K^+K^-$
- two RICH detectors with three radiators
- efficiencies and mis-ID determined from data using tag-and-probe methods on $\phi \rightarrow KK$, $K_S \rightarrow \pi\pi$, $\Lambda \rightarrow p\pi$
- performance found to be close to simulation over full momentum range from few GeV (tagging) to 100 GeV (two-body hadronic decays)



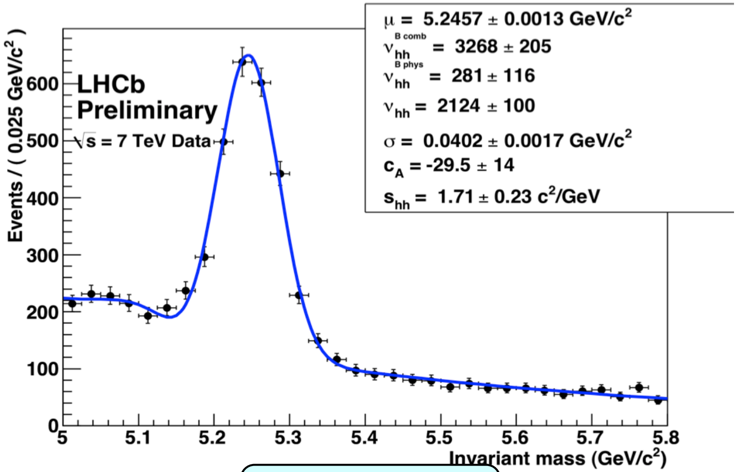
K/π Identification

(from 34 pb^{-1})

no PID, π mass assumed for both decay particles

↓

apply PID cuts

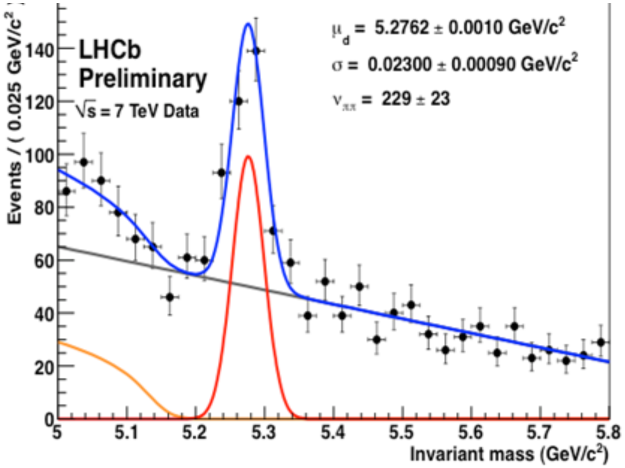


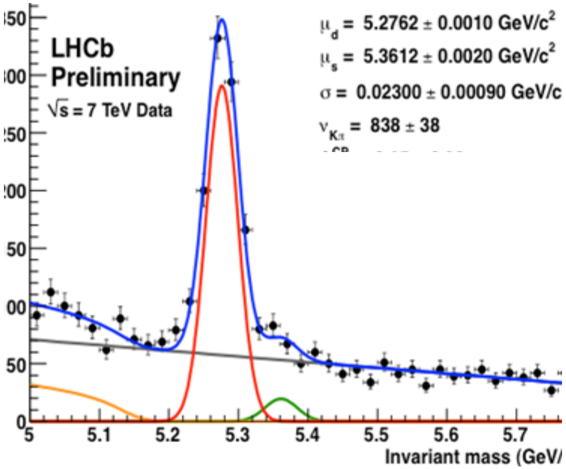
$B \rightarrow h^+h'^-$

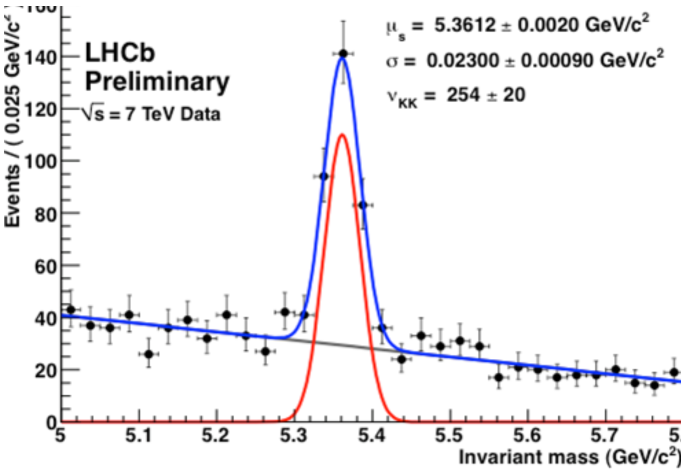
$B^0 \rightarrow \pi^+\pi^-$

$B^0 \rightarrow K^+\pi^-$, $B_s^0 \rightarrow K^+\pi^-$

$B_s^0 \rightarrow K^+K^-$

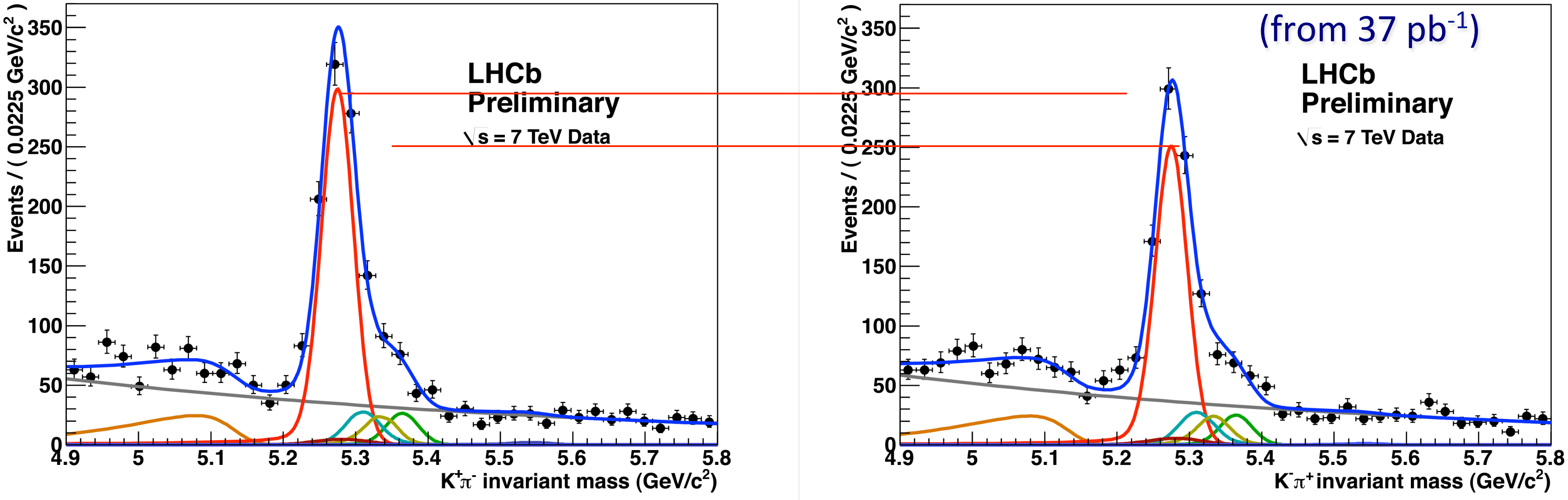






Study of direct CP violation in $B_{d,s} \rightarrow K\pi$

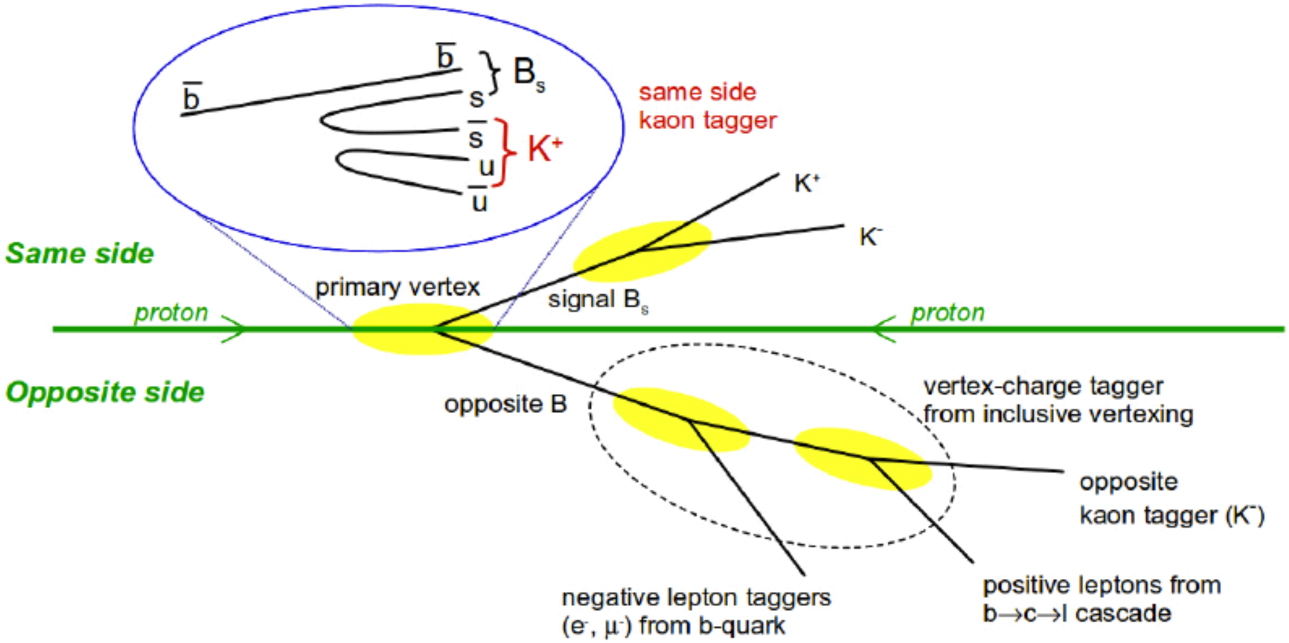
- Direct CP asymmetry in $B^0 \rightarrow K\pi$ is well established (9σ) but not yet significantly observed for $B_s^0 \rightarrow K\pi$.
- <u>Detector asymmetries</u>: controlled using clean samples of $D^{*+} \rightarrow D^0(\rightarrow K^-\pi^+)\,\pi^+$, comparing data taken with both magnet polarities: $\boldsymbol{A_D = -0.004 \pm 0.004}$.
- <u>Production asymmetries</u>: constrained using $B^+ \rightarrow J/\psi\, K^+$: $\boldsymbol{A_P = -0.024 \pm 0.016}$.



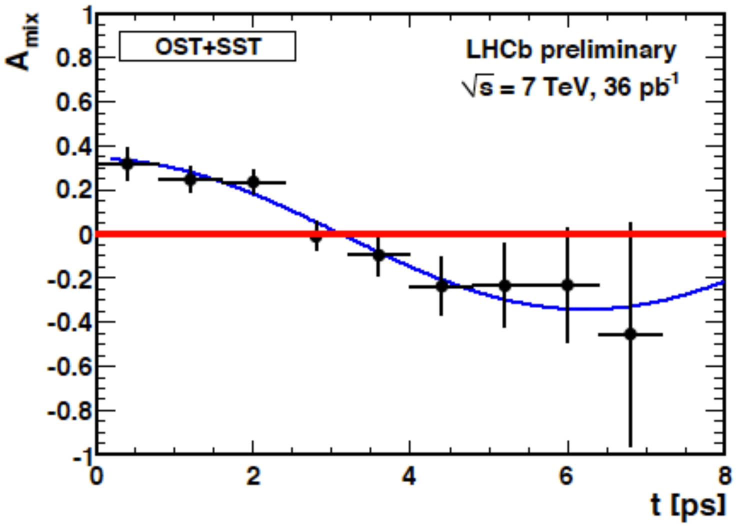
Decay mode	A_{CP} LHCb preliminary	HFAG Average
$B^0 \rightarrow K^-\pi^+$	-0.077 ± 0.033 ± 0.007	-0.098 ± 0.012
$B_s^0 \rightarrow K^-\pi^+$	0.15 ± 0.19 ± 0.02	0.39 ± 0.17

B^0, B_s^0 Mixing

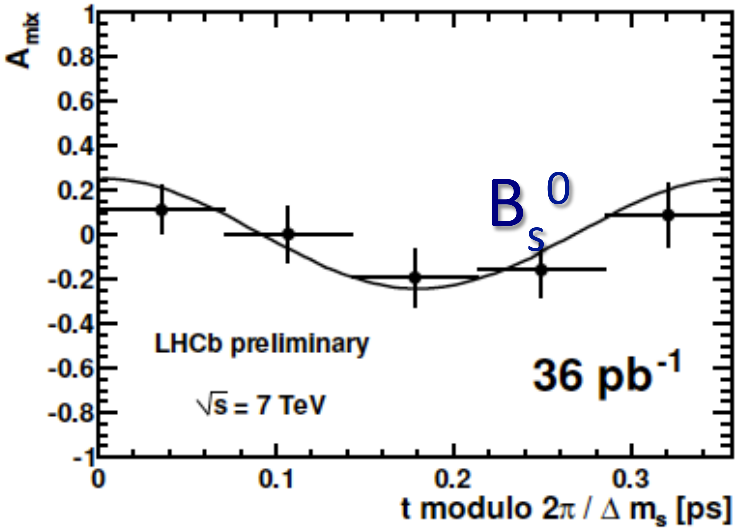
- Requires flavour tagging, several methods used:
  - Opposite Side Tagging: flag the flavour of the B opposite to the signal with sign of e, μ, K or the total inclusive charge of the secondary vertex.
  - Same Sign Tagging: charge of π or K coming from the same vertex than signal, exploiting hadronization process of the signal B or decays of excited $B^{**} \rightarrow B_{signal}\ \pi/K$
  - Performances: Mistag rate ω ~ 33%, Tagging power ε_{eff} ~ 2.5%.



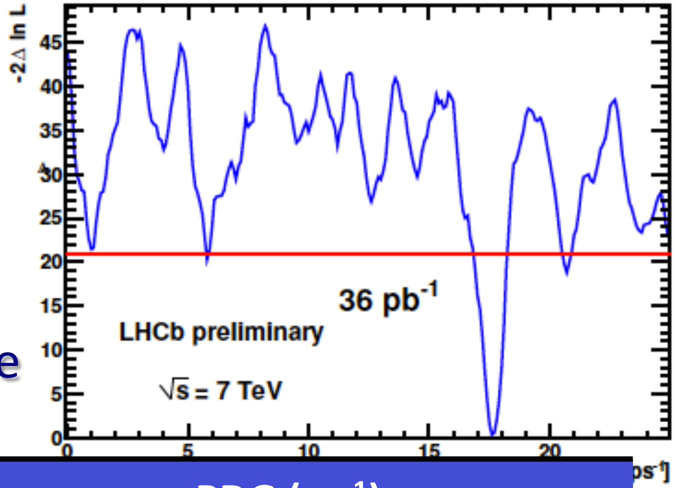
B^0, B_s^0 Mixing



B^0



4.6σ significance



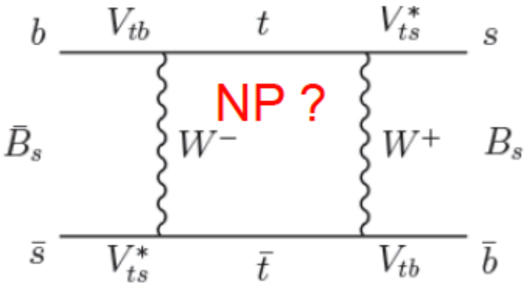
Mode	Δm (ps^{-1}) LHCb Preliminary	PDG (ps^{-1})
$B^0 \to D^- (\to K^+\pi^-\pi^-)\, \pi^+$	0.499 ± 0.032 ± 0.003	0.507 ± 0.005
$B_s^0 \to D_s^-(K^- K^+ \pi^-)\, \pi^+(\pi^+\pi^-)$	17.63 ± 0.11 ± 0.04	17.77 ± 0.10 ± 0.07

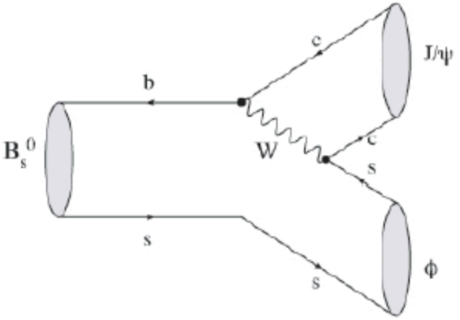
ϕ_s from $B_s^0 \to J/\psi\ \phi$

- One of the main LHCb first measurement, “golden mode” for CP Violation studies in the B_s system.
- Interference of mixing and decay: CPV phase $\phi_S = \phi_M + 2\phi_D$

$$\begin{tikzcd}
B_s^0 \arrow[rr, "\phi_D"] \arrow[dr, bend right, "\phi_M"'] & & J/\psi\phi \\
& \bar{B}_s^0 \arrow[ur, bend right, "-\phi_D"'] &
\end{tikzcd}$$

- In the Standard Model:





+ small penguin pollution

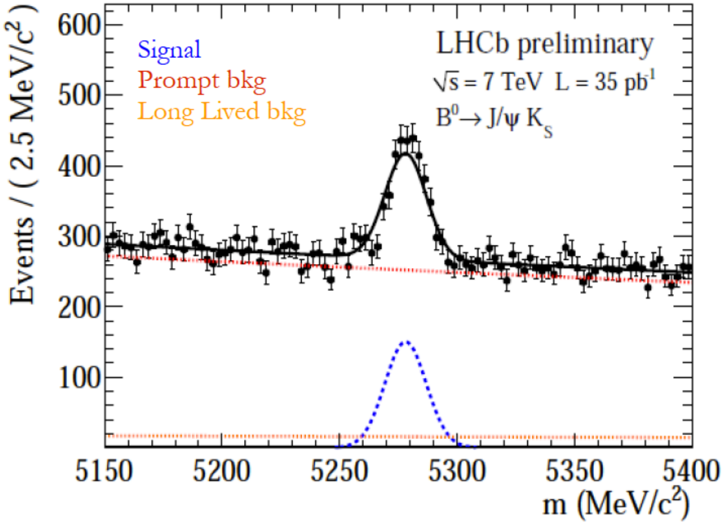
$$\phi_M^{SM} = -2\arg\left(V_{ts}V_{tb}^*\right) \approx -2\beta_s$$

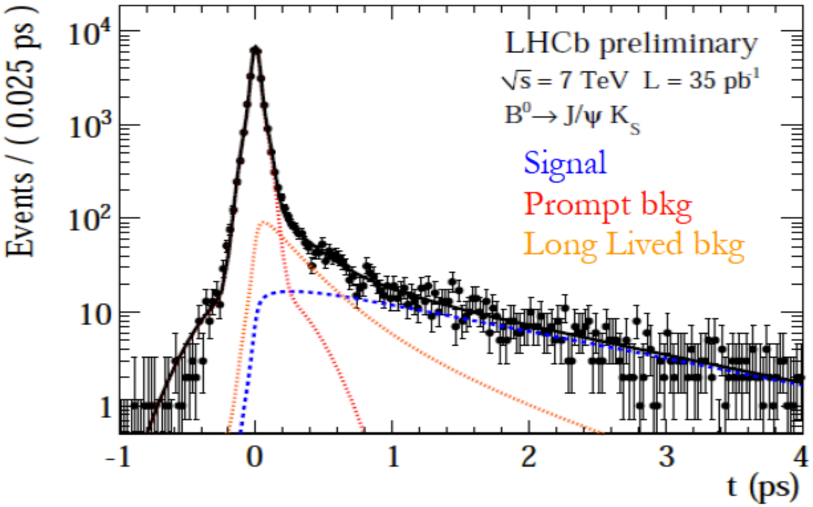
$$\phi_D^{SM} = -2\arg\left(V_{cs}V_{cb}^*\right) \approx 0$$

- Precise (and small) Standard Model prediction: $\phi_s^{SM} = -0.0363 \pm 0.0017$ rad
- Possible New Physics contribution: $\phi_s = \phi_s^{SM} + \Delta\phi_s^{NP}$
- Tagged, Time-Dependant, Angular analysis !

$\sin(2\beta)$ from $B^0 \rightarrow J/\psi\, K_S$

- Tagged, Time-Dependant analysis.
- Result can be compared to the very precise value from B-factories.
- Selection of 280 tagged $B^0 \rightarrow J/\psi\, K_S$ in $35\,pb^{-1}$ (only tagged events are sensitive to $\sin(2\beta)$)



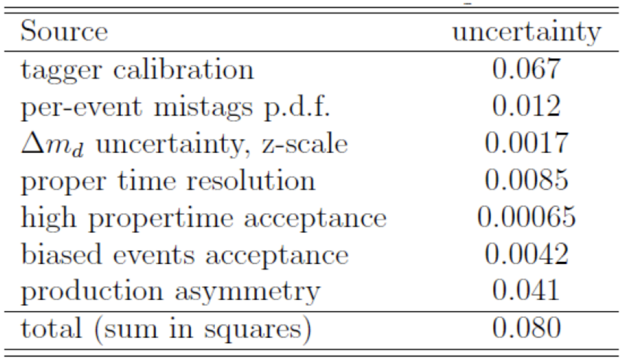


LHCb Preliminary:

$$\sin(2\beta) = 0.53^{+0.28}_{-0.29}(stat) \pm 0.08(syst)$$

World average:

$\sin(2\beta) = 0.673 \pm 0.023$

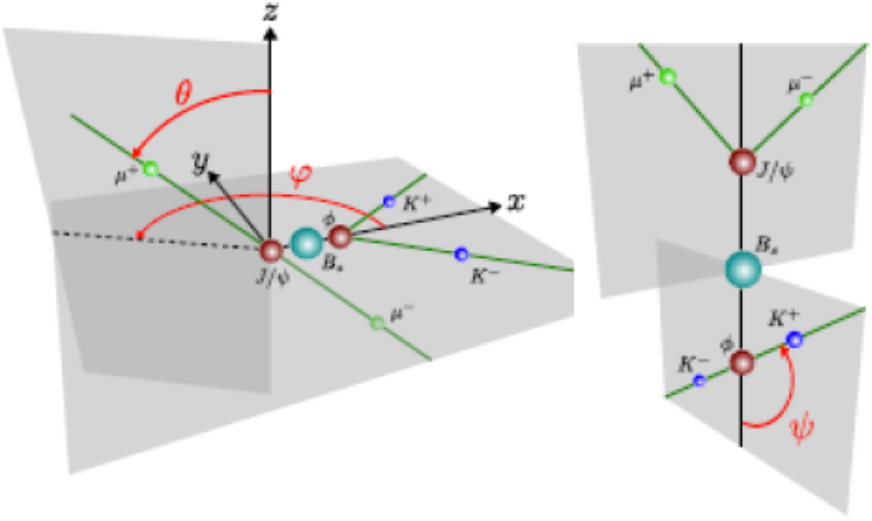


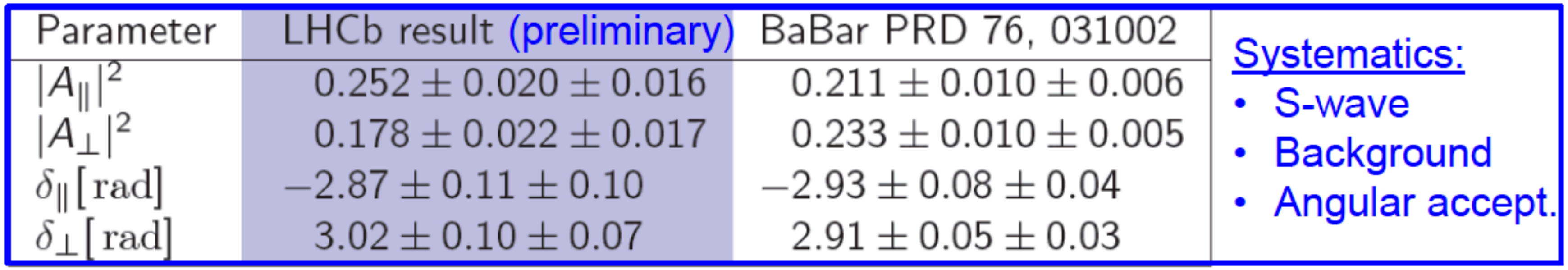
Source	uncertainty
tagger calibration	0.067
per-event mistags p.d.f.	0.012
Δm_d uncertainty, z-scale	0.0017
proper time resolution	0.0085
high propertime acceptance	0.00065
biased events acceptance	0.0042
production asymmetry	0.041
total (sum in squares)	0.080

Systematic uncertainties

Polarization amplitudes in $B^0 \to J/\psi\ K^{*0}$

- Angular analysis, in transversity basis:
- Measurement of the distributions of the 3 angles: θ, φ, ψ
- Detector geometry distorts efficiency to reconstruct these angles: 3-dimensional corrections obtained from full Monte Carlo simulation.
- 2668 ± 58 signal events.





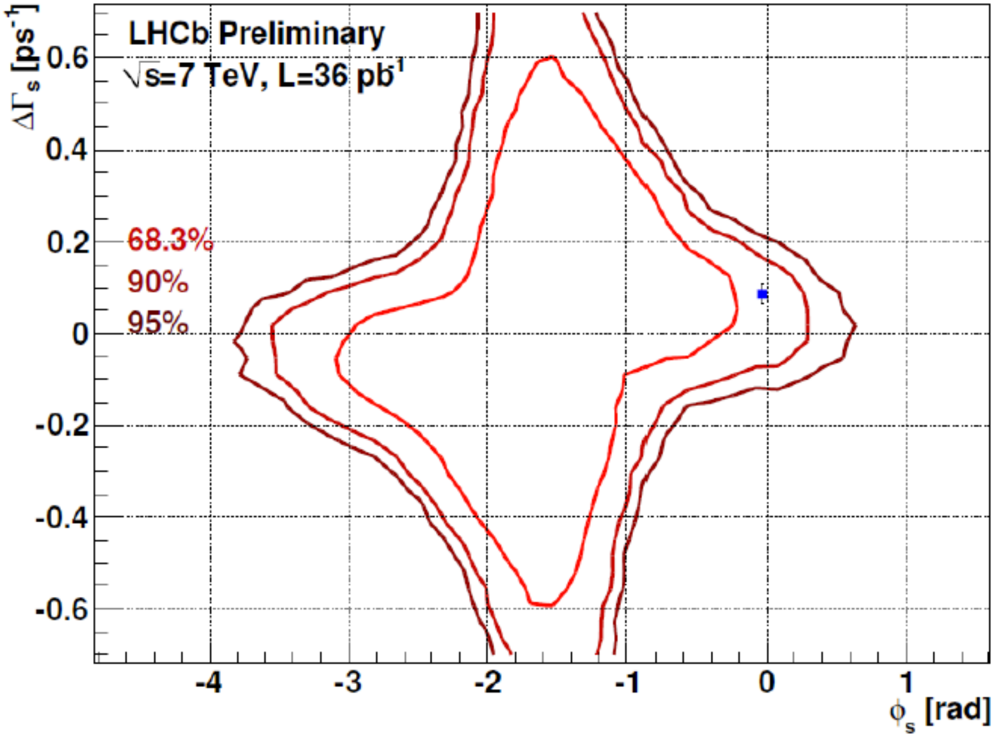
Parameter	LHCb result (preliminary)	BaBar PRD 76, 031002
$\lvert A_\parallel\rvert^2$	$0.252 \pm 0.020 \pm 0.016$	$0.211 \pm 0.010 \pm 0.006$
$\lvert A_\perp\rvert^2$	$0.178 \pm 0.022 \pm 0.017$	$0.233 \pm 0.010 \pm 0.005$
$\delta_\parallel\,[\mathrm{rad}]$	$-2.87 \pm 0.11 \pm 0.10$	$-2.93 \pm 0.08 \pm 0.04$
$\delta_\perp\,[\mathrm{rad}]$	$3.02 \pm 0.10 \pm 0.07$	$2.91 \pm 0.05 \pm 0.03$

Systematics:
- S-wave
- Background
- Angular accept.

- Good agreement with BaBar measurement
- But not yet competitive

ϕ_s from $B_s^0 \rightarrow J/\psi\ \phi$

- Tagged, Time-Dependant, Angular analysis.
- With 836 ± 60 tagged reconstructed candidates, not enough statistics to have a meaningful point-estimate : confidence contours using Feldman-Cousins method.
- Statistical errors only, but systematic effects are negligible at this point.

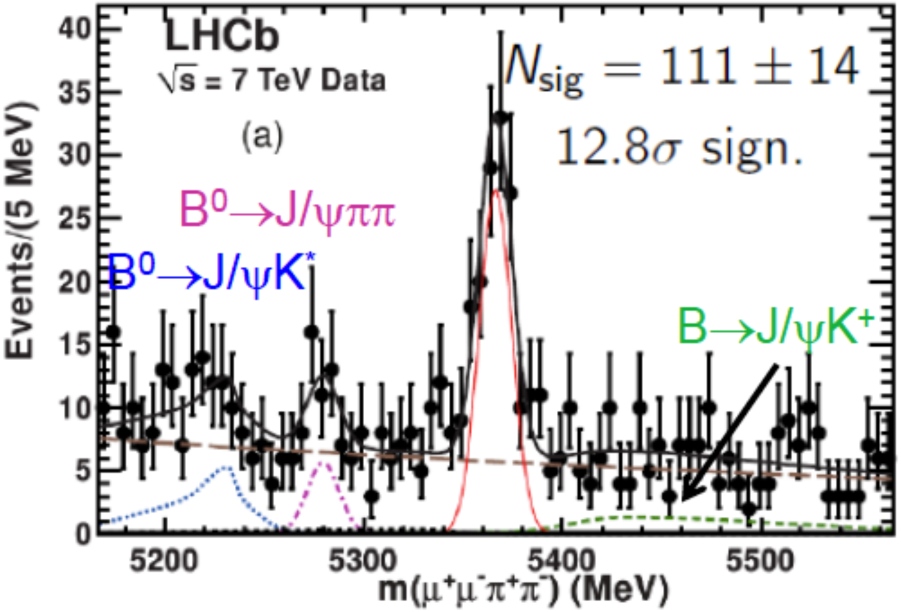


Standard Model P-value: 22%

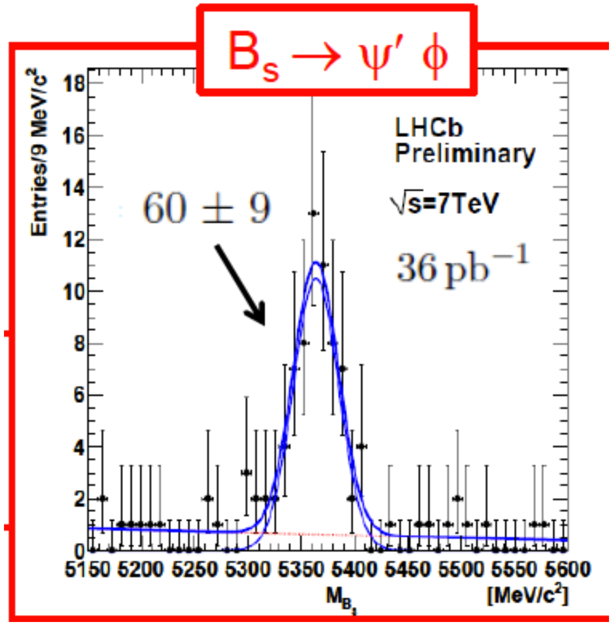
$\phi_s \in [-2.7,\ -0.5]$ rad at 68% CL
$\phi_s \in [-3.5,\ 0.2]$ rad at 95% CL

ϕ_s from $B_s^0 \to J/\psi\,\phi$

- Prospects for 2011/2012 running (500pb^{-1} to 2 fb^{-1} of data):
  - With current performances, and only using Opposite Side tagging, expected sensitivity on ϕ_S is 0.13 rad, assuming Standard Model ϕ_S value [will be world's best measurement already end of 2011].
  - Adding Same Side Tagging will improve the sensitivity significantly.
  - Adding other decay modes will also help:



$B_s^0 \to J/\psi\, f_0$



LHCb running plans for 2011-2012

- <u>From detector point of view</u>:

– Trigger Computer Farm for HLT will be upgraded to reach 1500 CPU nodes, additional data links will be needed to increase current bandwidth.

– LHCb has been designed to run for 10 years at 2-5x10^{32} cm^{-2}.s^{-1}: limit of the instantaneous luminosity that the detectors can support to have stable operation.

- <u>From trigger point of view</u>:

– Global event cuts have a large price on luminosity when μ is high.

– Crucial to improve CPU time consumption per event in the HLT.

- <u>From analysis point of view</u>:

– No significant gain when μ>2.5.

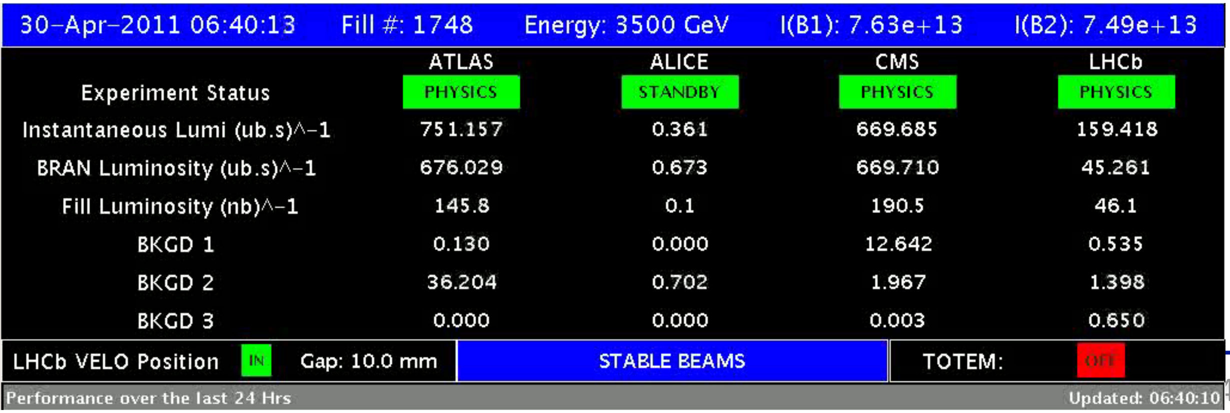
- Spill-over with 50 ns bunch spacing also add complexity !

- <u>LHCb future running strategy</u>:

– Maximum instantaneous luminosity: ~3x10^{32} cm^{-2}.s^{-1}

– Maximum μ of 2.5, lower than ATLAS/CMS

– LHC displace beams to reduce luminosity at beginning of fill and readjust them to follow beam lifetime, every hour.



30-Apr-2011 06:40:13 Fill #: 1748 Energy: 3500 GeV I(B1): 7.63e+13 I(B2): 7.49e+13

	ATLAS	ALICE	CMS	LHCb
Experiment Status	PHYSICS	STANDBY	PHYSICS	PHYSICS
Instantaneous Lumi (ub.s)^-1	751.157	0.361	669.685	159.418
BRAN Luminosity (ub.s)^-1	676.029	0.673	669.710	45.261
Fill Luminosity (nb)^-1	145.8	0.1	190.5	46.1
BKGD 1	0.130	0.000	12.642	0.535
BKGD 2	36.204	0.702	1.967	1.398
BKGD 3	0.000	0.000	0.003	0.650

LHCb VELO Position IN Gap: 10.0 mm STABLE BEAMS TOTEM: OFF

Performance over the last 24 Hrs Updated: 06:40:10

Conclusions

- LHCb has a unique potential for the

INDIRECT DISCOVERY

of New Physics

- the experiment is performing very well, under harsher conditions than it was designed for
- the good agreement between simulation and early measurements indicates that estimated physics reaches seem realistic
- in some areas we are already getting close to being competitive with exisiting results with only a small sample of data.
- A lot of other results not covered here.
- 2011 will see a lot of results from LHCb.