LHCb status report

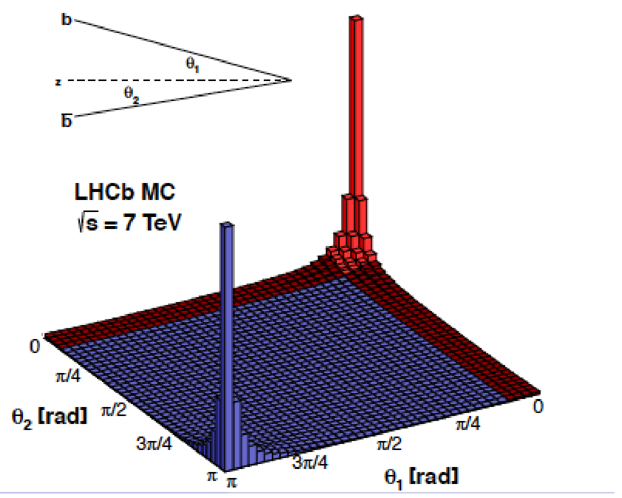
Yasmine Amhis

On behalf of the LHCb Collaboration

LHCC Open session – September 26 th 2012

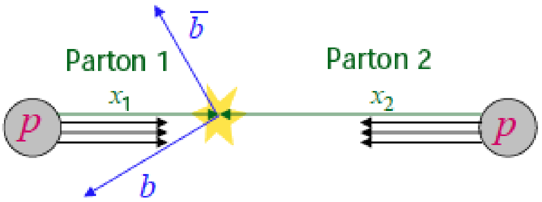
LHC a Flavour Factory

- Large cross sections @ 7 TeV :
  - σ^{inel}_{pp} ~ 60 mb [JINST 7 (2012) P01010
  - σ^{inel} (pp → charm) ~ 6 mb [LHCb-CONF-2010-013]
  - σ^{inel} (pp → beauty) ~ 0.3 mb [PLB 694 (2010) 209]

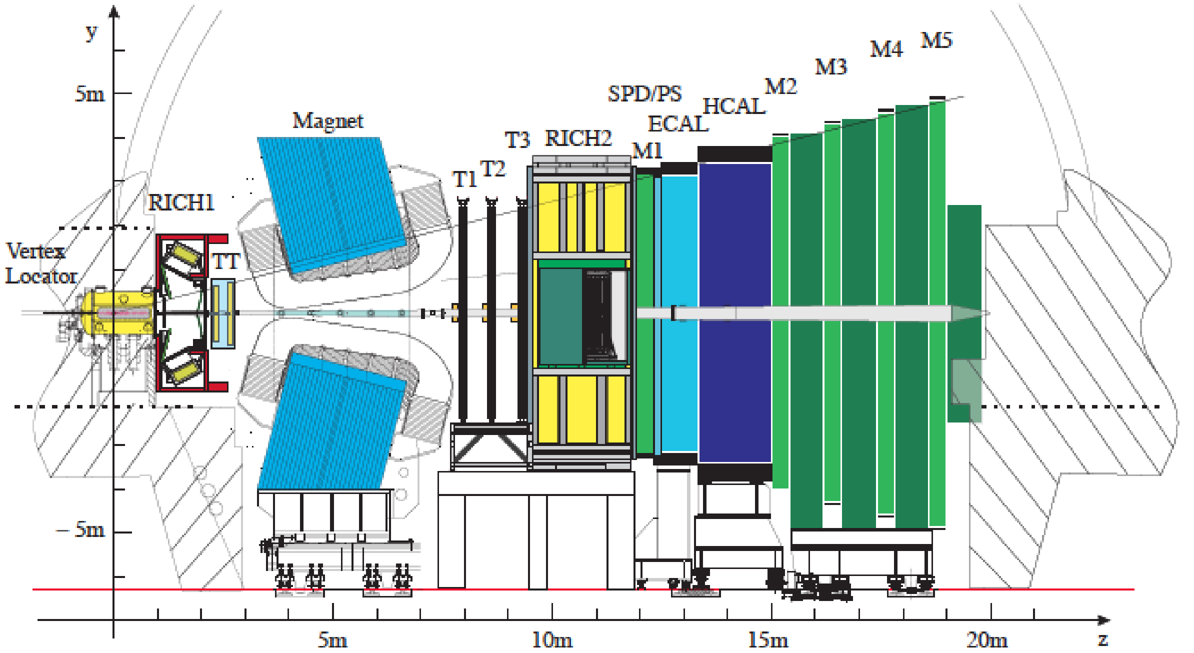


Initial motivation for the design

In high energy collisions, bb/cc pairs are produced predominantly in the forward or backward directions

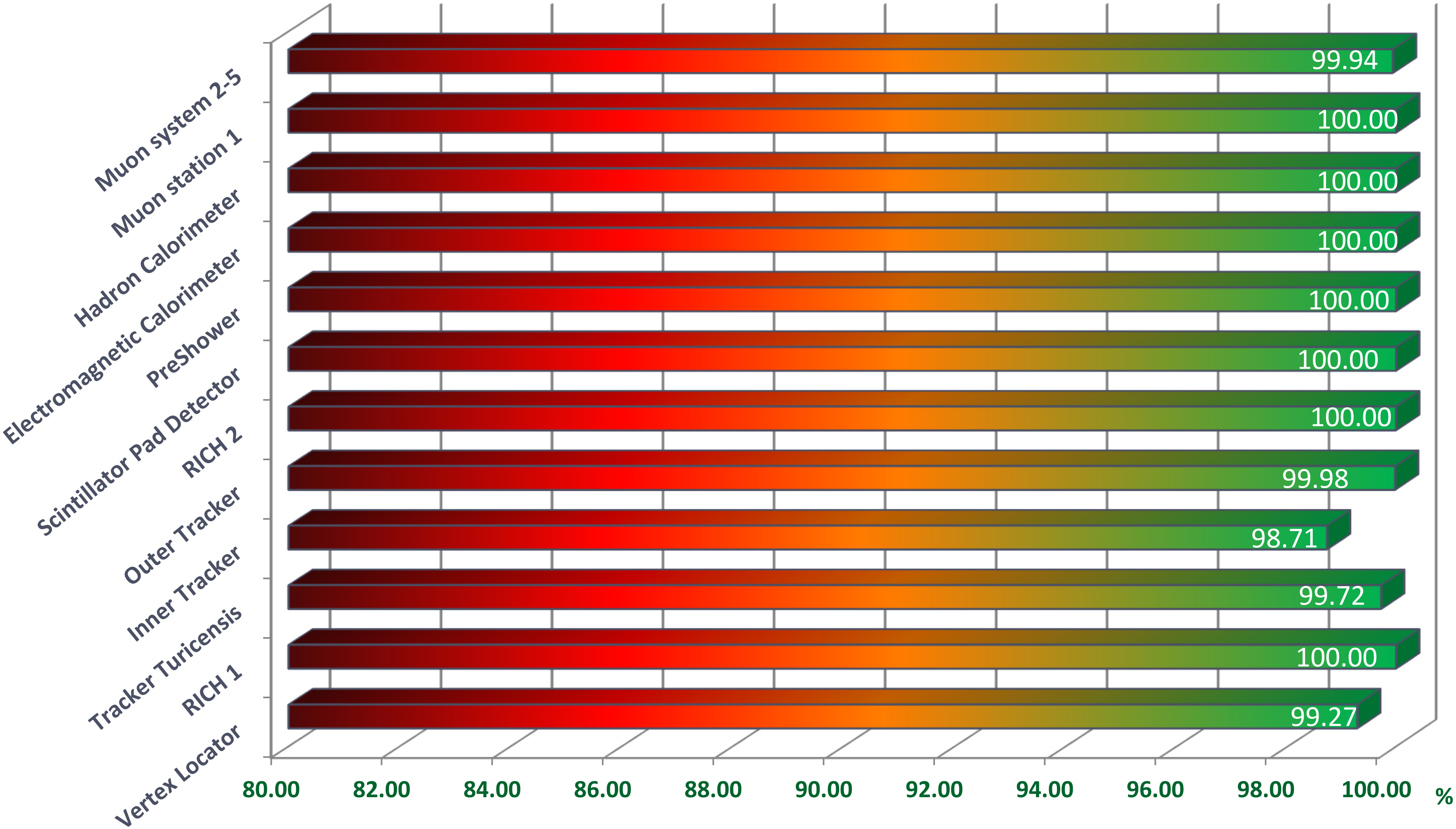


The LHCb detector

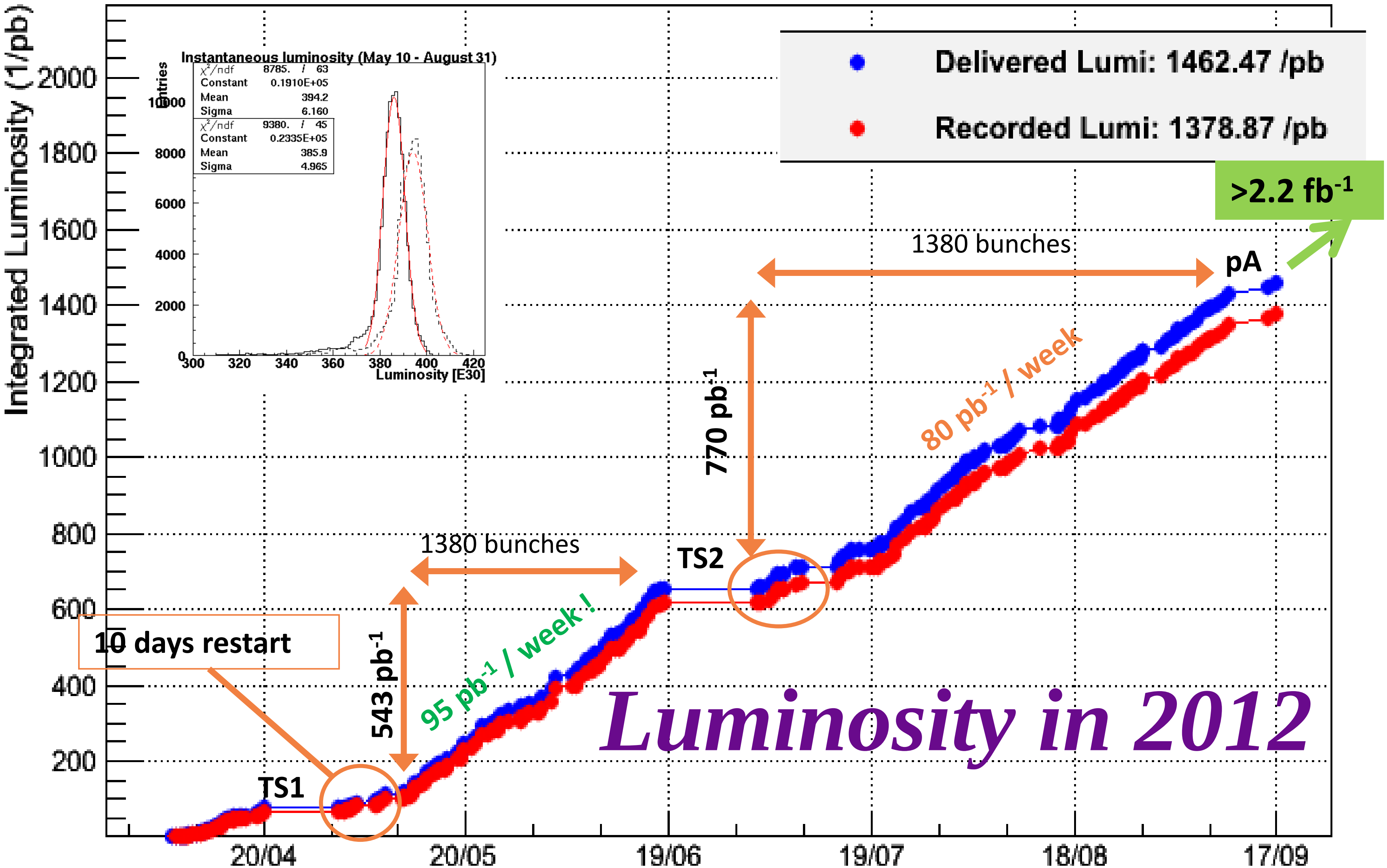


Vertex Locator	$\sigma_{\mathrm{PV},x/y} \sim 10\ \mu\mathrm{m}$, $\sigma_{\mathrm{PV},z} \sim 60\ \mu\mathrm{m}$
Tracking (TT, T1-T3)	$\Delta p/p$: 0.4% at 5 GeV/c, to 0.6% at 100 GeV/c
RICHs	$\varepsilon(K \to K) \sim 95\%$, mis-ID rate $(\pi \to K) \sim 5\%$
Muon system (M1-M5)	$\varepsilon(\mu \to \mu) \sim 97\%$, mis-ID rate $(\pi \to \mu) = 1 - 3\%$
ECAL	$\sigma_E/E \sim 10\%/\sqrt{E} \oplus 1\%$ (E in GeV)
HCAL	$\sigma_E/E \sim 70\%/\sqrt{E} \oplus 10\%$ (E in GeV)

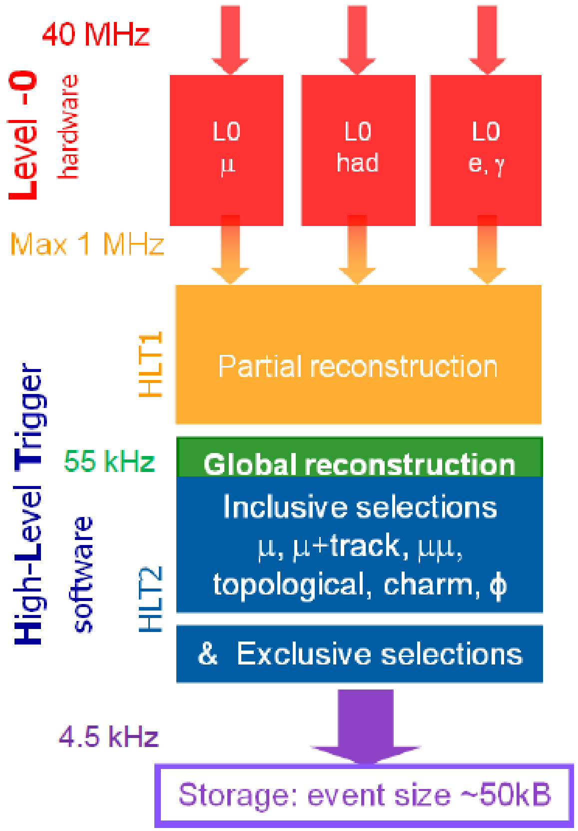
LHCb detectors efficiency



Luminosity in 2012

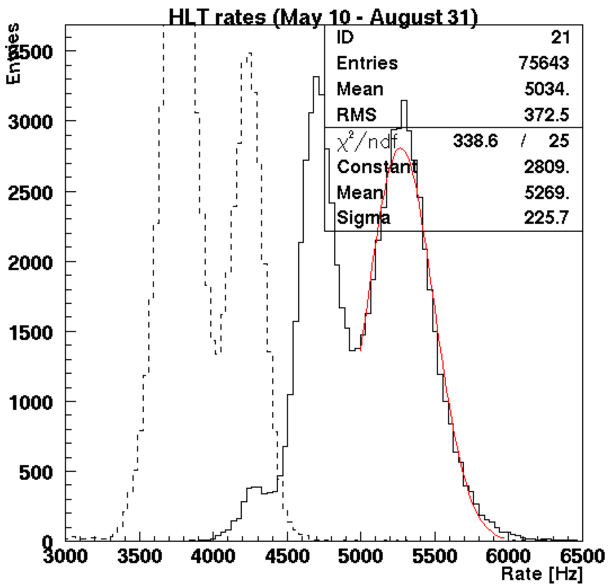


Trigger System in 2012



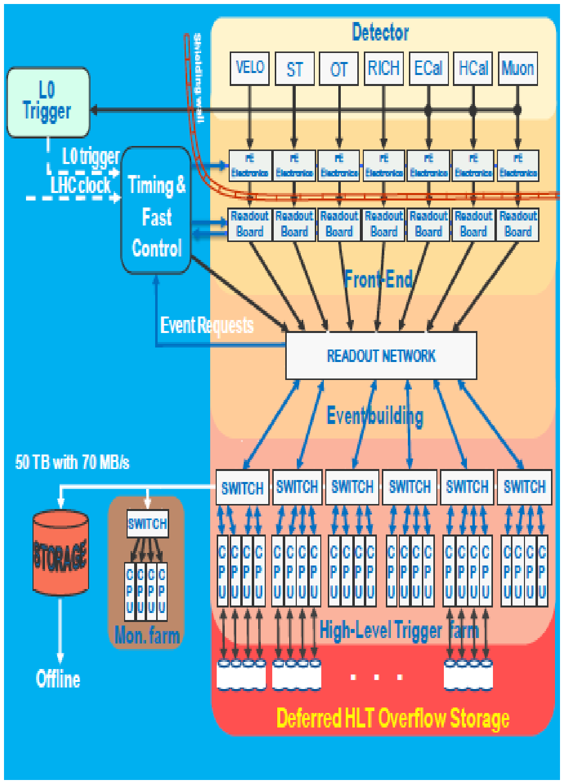
Different running condition w.r.t 2011 :

- Energy $\sqrt{s}$ = 8 TeV was $\sqrt{s}$ = 7 TeV.
- 10 % more CPU.
- HLT1 input rate 950 kHz was 850 kHz.
- HLT2 output rate 4.5 kHz was 3 kHz.
- Now using Deferred HLT.



Note : Due to the excellent perfomances of the LHC and longer data taking, we are very sqeezed in disk !

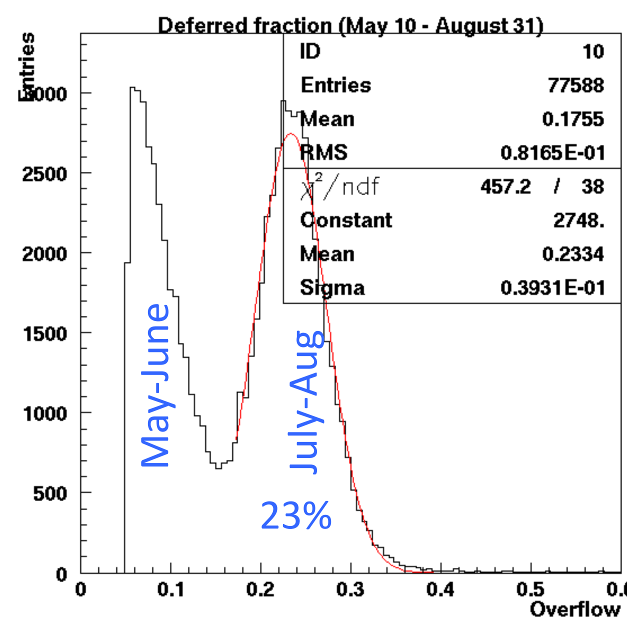
Deferred Trigger System in 2012



- Delay the HLT triggering for 20% of the L0 rate.

- When the event builder detects that the HLT cannot process all the incoming events, they are written to the hard disk of the nodes in the EFF. Between fills, these events will be processed.

- Equivalent 20% gain in CPU (but cheaper than buying 20% more CPU's)



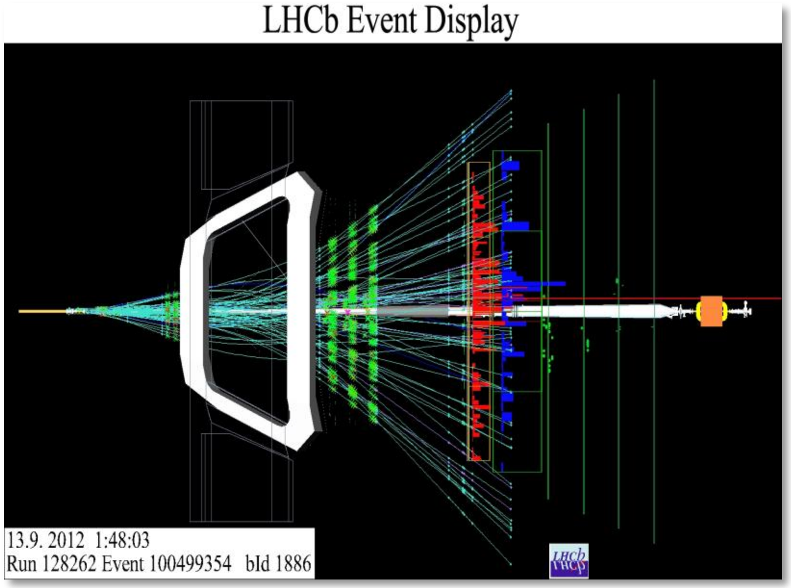
Data reprocessing

Reprocessing of 2012 data started last Monday

Data taken until September's technical stop

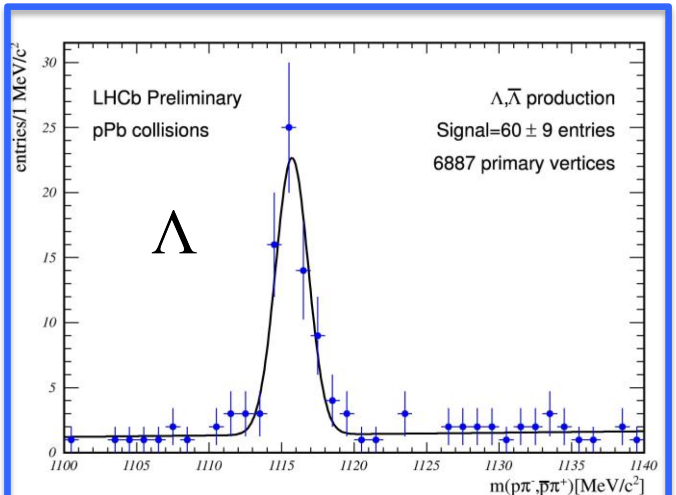
should be reprocessed by mid-December

Proton - Lead ion collision pilot run



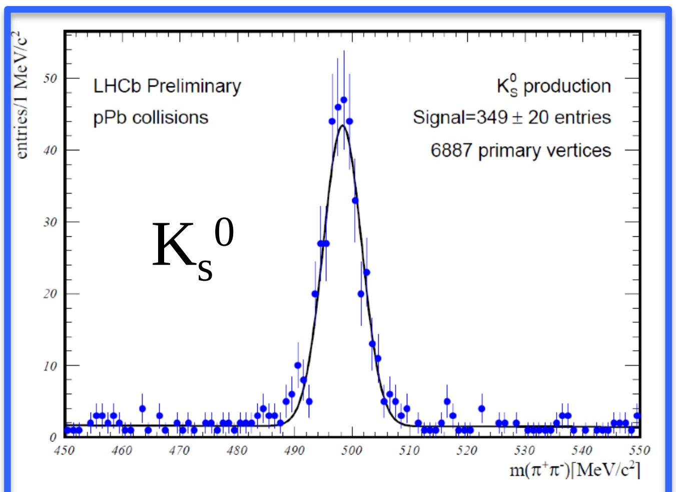
- September 13th, 2012 at 1h26 the LHC declared stable beams.
- Occupancy was lower enough to not saturate the detector .
- 1h15 without SMOG.
- Trigger rate was 160 Hz.
- 1 hour with SMOG for beam imagining studies.

Proton - Lead ion collision Physics from pilot run



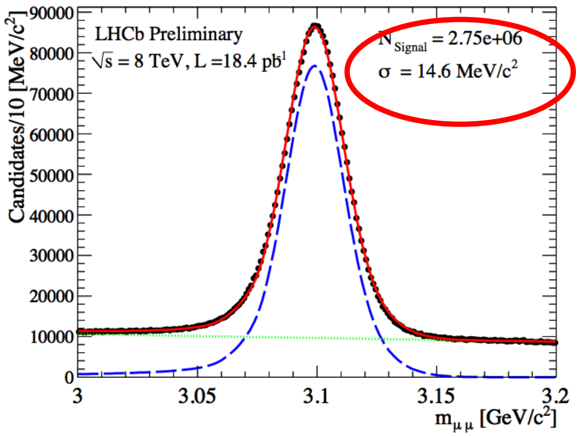
Record data to prepare the 2013 run where

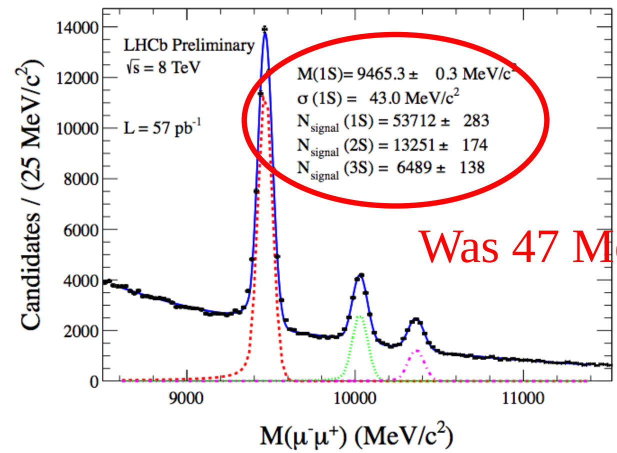
→ Measurement of J/ψ cross-section.



And also strangeness and charm production.

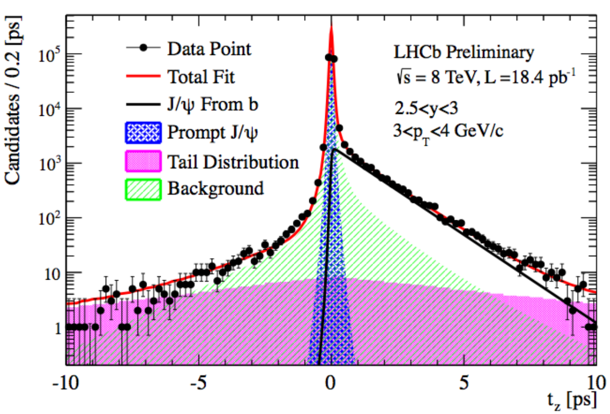
J/ψ, ϒ(1S), ϒ(2S) and ϒ(3S) @ 8 TeV

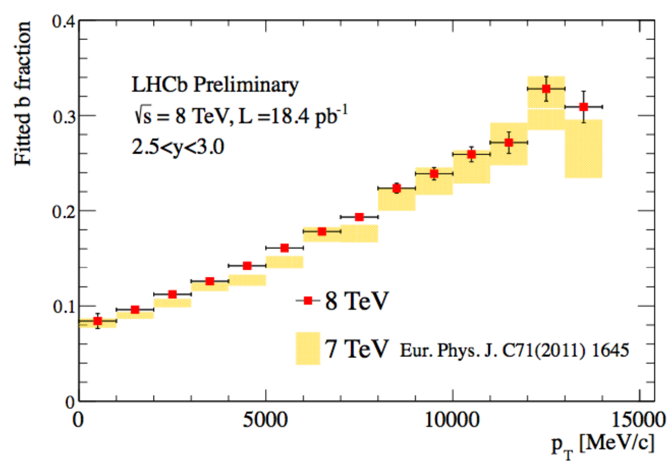




Was 47 MeV/c^2 in 2011

Measure the J/ψ from *b* quarks :





LHCb-CONF-2012-025

Physics papers since June

- Study of D_{sJ} decays in pp collisions **arXiv:1207.6016**
- Measurement of the B_s effective lifetime in the $J/\psi f_0(980)$ final state **arXiv:1207.0878**
- $B_s \rightarrow KK$ lifetime **arXiv:1207.5993**
- Observation of $B \rightarrow DKK$ **arXiv:1207.5991**
- Measurement of $B_s \rightarrow J/\psi K^*$ **arXiv:1208.0738**
- Measurement of $B_s \rightarrow \phi \gamma$ **arXiv:1209.0313**
- Measurement of χ_b cross section **arXiv:1209.0282**
- Search of the rare decay $K_S \rightarrow \mu\mu$ **arXiv:1209.4029**
- Differential branching fraction and angular analysis of the $B^+ \rightarrow K^+ \mu^+ \mu^-$ decay **arXiv:1209.4284**
- The B_c production and mass paper **arXiv:1209.5634**
- Model Independent Dalitz analysis $B \rightarrow DK$ **LHCb-PAPER-2012-027**

We have currently 67 published papers !

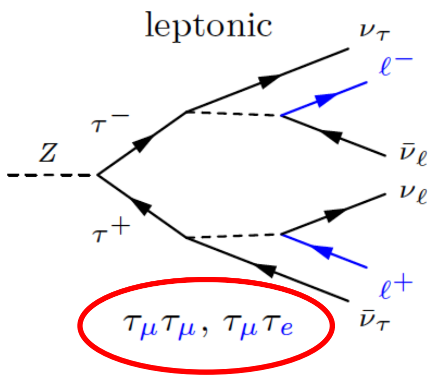
Conference Reports Since June

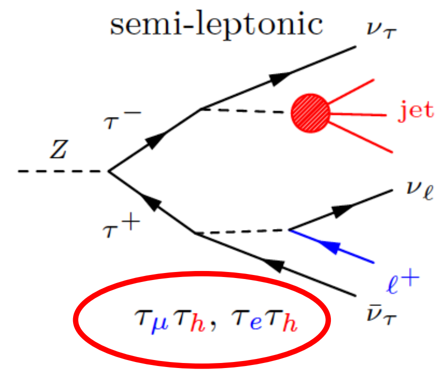
- Performance of flavour tagging algorithms optimised for the analysis of $B_s \to J/\psi\ \phi$ **LHCb-CONF-2012-026**
- Production of J/ψ and $Y(1S)$, $Y(2S)$ and $Y(3S)$ mesons at $s\sqrt{=8}$ TeV **LHCb-CONF-2012-025**
- Measurement of CP observables in $B^0 \to DK^{*0}$ with $D \to K^+K^-$ **LHCb-CONF-2012-024**
- Branching fraction measurements of $B^0_{d,s}$ decays to $K^0_S h^\pm h'^\mp$ final states, including first observation of $B^0_s \to K^0_S K$ **LHCb-CONF-2012-023**
- Measurement of the flavour-specific CP violating asymmetry a^{sl}_s in B_s decays **LHCb-CONF-2012-022**
- First observation of $B^- \to D^0 K^- \pi^+ \pi^-$ Decays to CP even final states **LHCb-CONF-2012-021**
- Observation of the $\chi_b(3P)$ state at LHCb in pp collisions at $s\sqrt{=7}$ TeV **LHCb-CONF-2012-020**
- Search for CP violation in $D^0 \to \pi^-\pi^+\pi^+\pi^-$ **LHCb-CONF-2012-019**
- Evidence for CP violation in $B^\pm \to K^\pm \pi^+ \pi^-$ and $B^\pm \to K^\pm K^+ K^-$ decays **LHCb-CONF-2012-018**

Electroweak

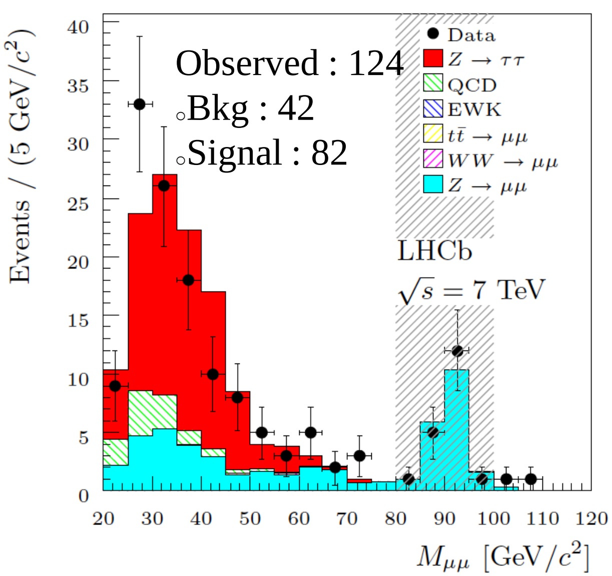
$Z \to \tau\tau$ cross section

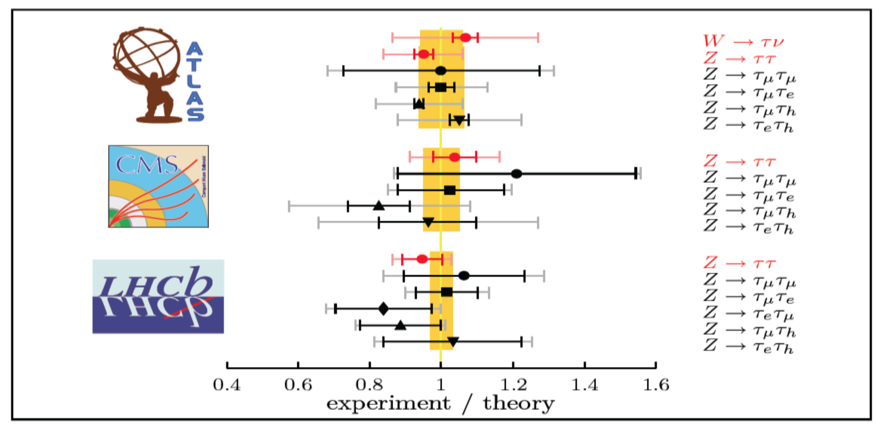
- Signal topologies and channels





LHCB-PAPER-2012-029



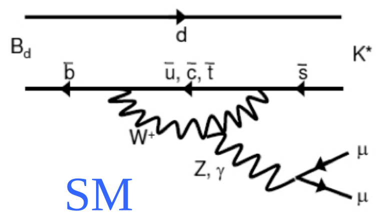


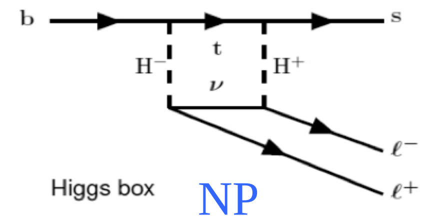
ATLAS : ATLAS-CONF-2012-006
ATLAS : Phys. Rev. D84 (2011) 112006
CMS : JHEP 08 (2011) 117

Flavour Changing Neutral Current

Differential branching fraction of $B^+ \to K^+\mu^+\mu^-$

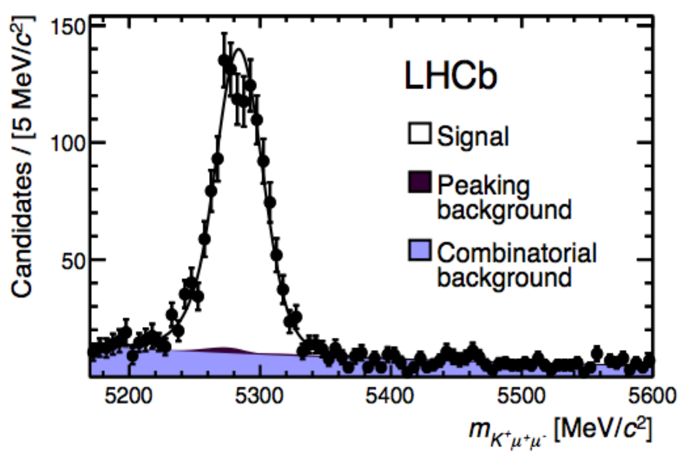
Flavour Changing
Neutral Current
(FCNC)

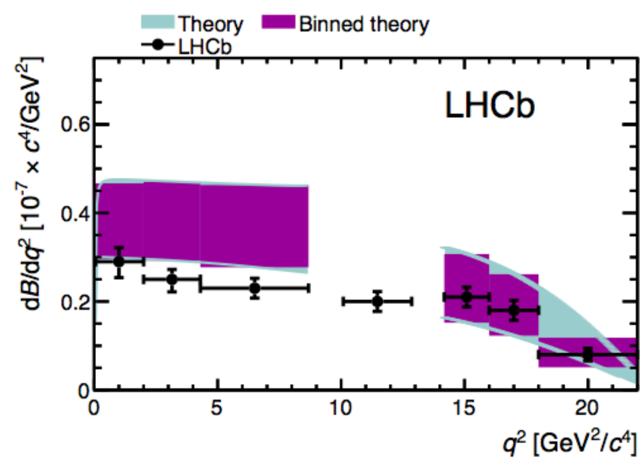




- Measure the differential branching fraction :

$$\frac{\mathrm{d}\mathcal{B}}{\mathrm{d}q^2} = \frac{1}{q^2_{\mathrm{max}} - q^2_{\mathrm{min}}} \frac{N_{\mathrm{sig}}}{N_{K^+J/\psi}} \frac{\varepsilon_{K^+J/\psi}}{\varepsilon_{K^+\mu^+\mu^-}} \times \mathcal{B}(B^+ \to K^+J/\psi) \times \mathcal{B}(J/\psi \to \mu^+\mu^-) \ .$$





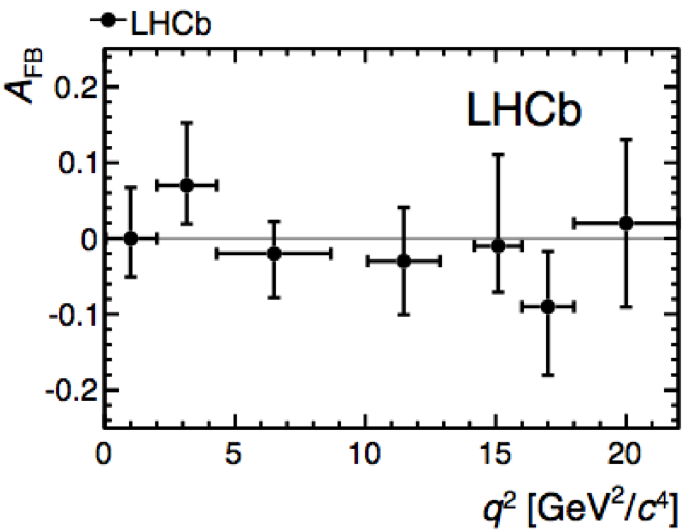
arXiv:1209.4284

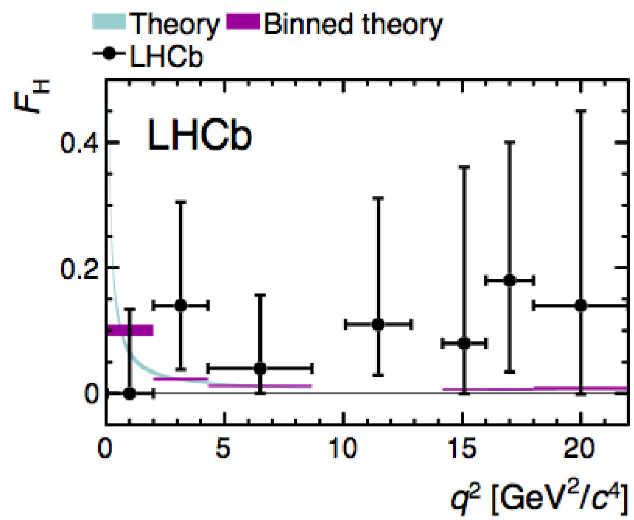
Event yield 1232 ± 40 of $B^+ \to K^+\mu^+\mu$ in 1.0 fb^{-1} and normalise to $B^+ \to J/\psi\, K^+$

Angular analysis $B^+ \to K^+\mu^+\mu^-$

$$\frac{1}{\Gamma}\frac{\mathrm{d}\Gamma[B^+ \to K^+\mu^+\mu^-]}{\mathrm{dcos}\,\theta_l} = \frac{3}{4}(1 - F_\mathrm{H})(1 - \cos^2\theta_l) + \frac{1}{2}F_\mathrm{H} + A_\mathrm{FB}\cos\theta_l$$

Both the F_H and the Forward Backward asymetry A_{FB} are expected to be null in the SM





arXiv:1209.4284

If muons were massless, F_H would be proportional to the contributions from (pseudo-)scalar and tensor operators to the partial width, Γ.

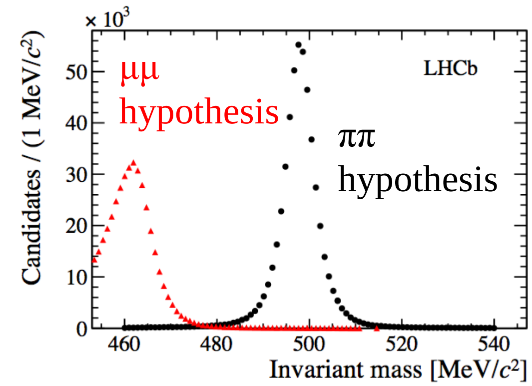
Search for the rare decay $K_S^0 \to \mu^+\mu^-$

FCNC family :

SM prediction $B(K_S^0 \to \mu^+\mu^-) = (5.0 \pm 1.5) \times 10^{-12}$

Normalisation:

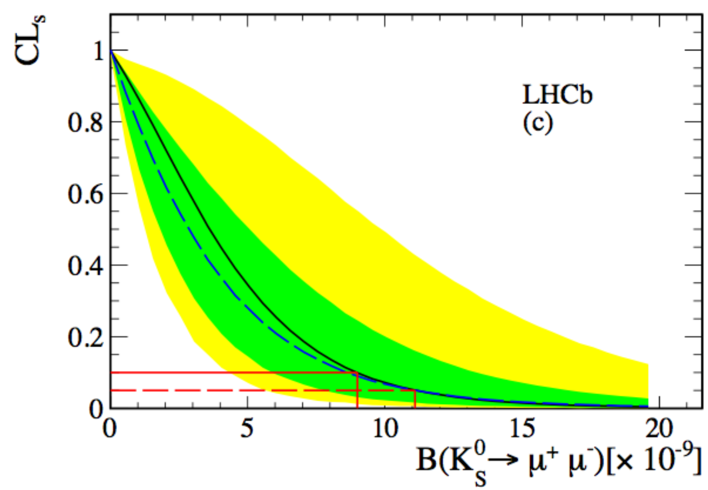
$$\frac{\mathcal{B}(K^0_S \to \mu^+\mu^-)}{\mathcal{B}(K^0_S \to \pi^+\pi^-)} = \frac{\epsilon_{\pi\pi}}{\epsilon_{\mu\mu}} \frac{N_{K^0_S \to \mu^+\mu^-}}{N_{K^0_S \to \pi^+\pi^-}}$$



We measure with 1.0 fb $^{-1}$:

$$B(K_S^0 \to \mu^+\mu^-) < 11(9) \times 10^{-9}$$

This limit is a factor 30 below the previous measurement !



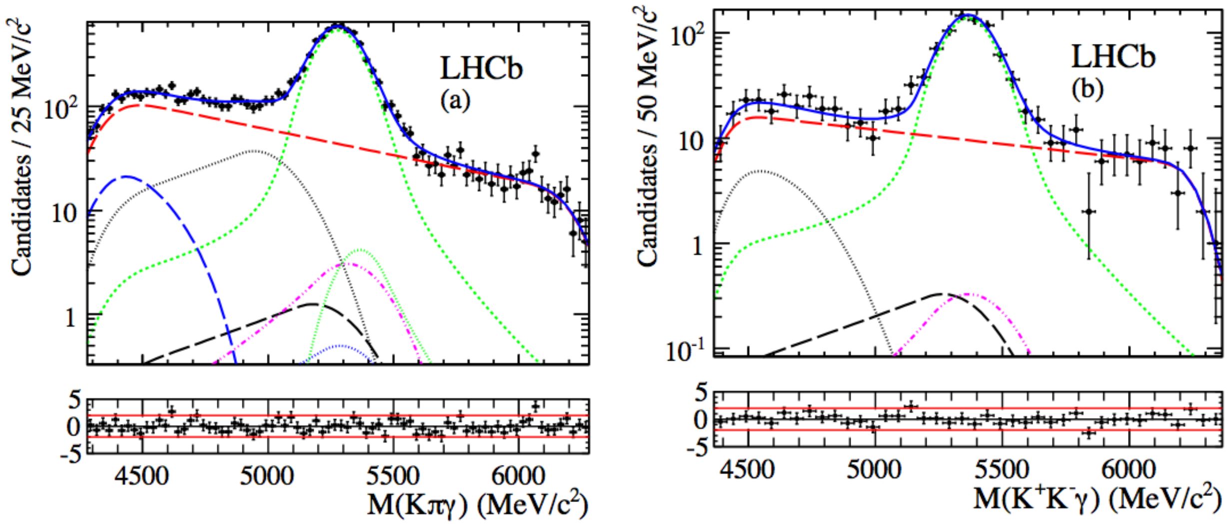
K^0_S	K^0_L	D^0	B^0	B^0_s
< 9 x 10^{-9} (90% CL)	(6.84 ± 0.11) × 10^{-9}	< 1.1 x 10^{-8} (90% CL)	< 0.8 x 10^{-9} (90% CL)	< 3.8 x 10^{-9} (90% CL)
LHCb	BNL E871	LHCb	LHCb	LHCb

Dimuon decays of neutral flavoured mesons

arXiv:1209.4029v2

Radiative decays

- Family of FCNC.
- NP can affect observables such as CP asymmetry…
- Mass resolution of ~ 90 MeV dominated by ECAL.



We measure with 1.0 fb^{-1}

$$\frac{\mathcal{B}(B^0 \to K^{*0}\gamma)}{\mathcal{B}(B^0_s \to \phi\gamma)} = 1.23 \pm 0.06\,(\text{stat.}) \pm 0.04\,(\text{syst.}) \pm 0.10\,(f_s/f_d)$$

World's best measurements ! $\mathcal{B}(B^0_s \to \phi\gamma) = (3.5 \pm 0.4) \times 10^{-5}$

$$\mathcal{A}_{CP}(B^0 \to K^{*0}\gamma) = (0.8 \pm 1.7\,(\text{stat.}) \pm 0.9\,(\text{syst.}))\%$$

arXiv:1209.0313

B_s *Mixing and CP Violation*

Semileptonic asymmetries

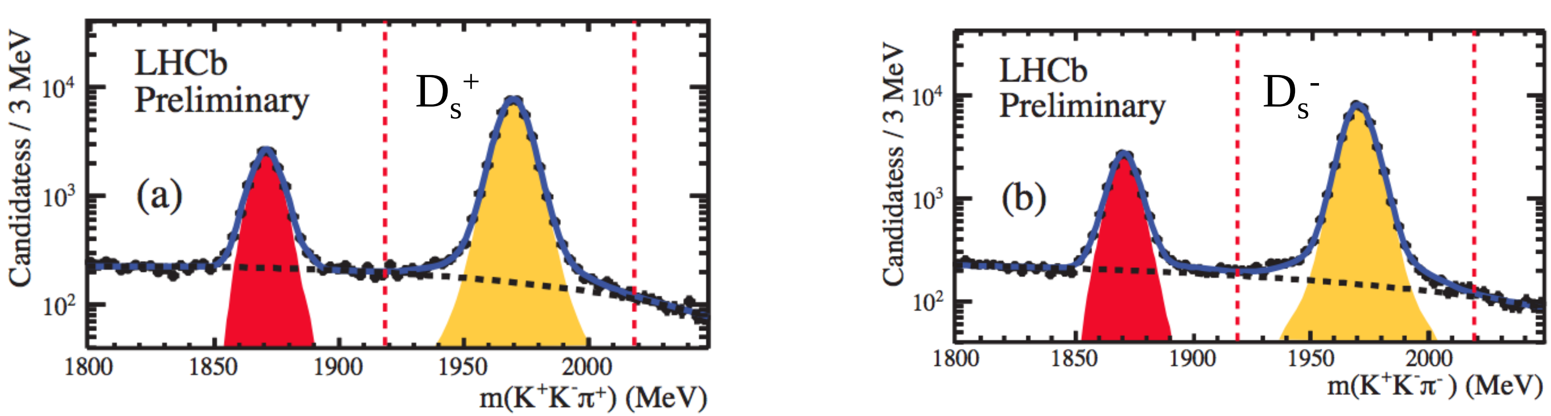
The observales :

$$a_s = 1 - \left|\frac{q}{p}\right|^2 = \mathrm{Im}\left(\frac{\Gamma_{12}^s}{M_{12}^s}\right) + O\left(\left(\mathrm{Im}\frac{\Gamma_{12}^s}{M_{12}^s}\right)^2\right) = \left|\frac{\Gamma_{12}^s}{M_{12}^s}\right| \sin\phi_{12}^s$$

How we measure it :

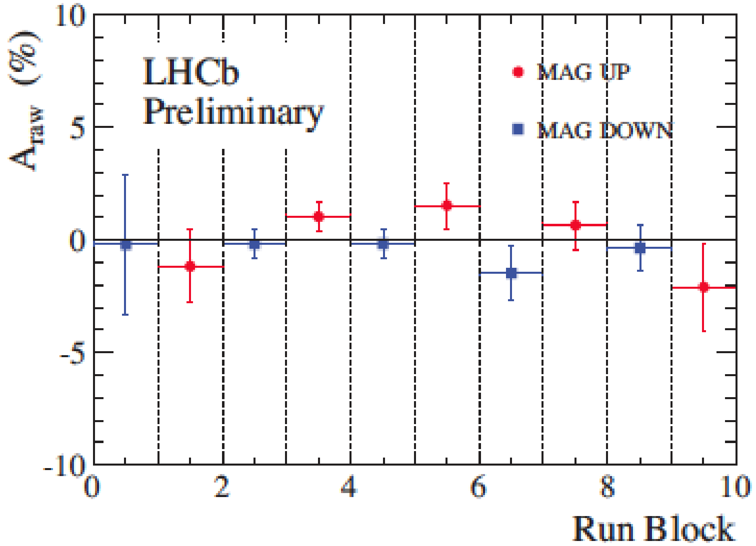
$$A^s_{\mathrm{measured}} = \frac{\Gamma[D_s^-\mu^+] - \Gamma[D_s^+\mu^-]}{\Gamma[D_s^-\mu^+] + \Gamma[D_s^+\mu^-]} = \frac{a_{sl}^s}{2} + \left[a_p - \frac{a_{sl}^s}{2}\right]\kappa_S$$

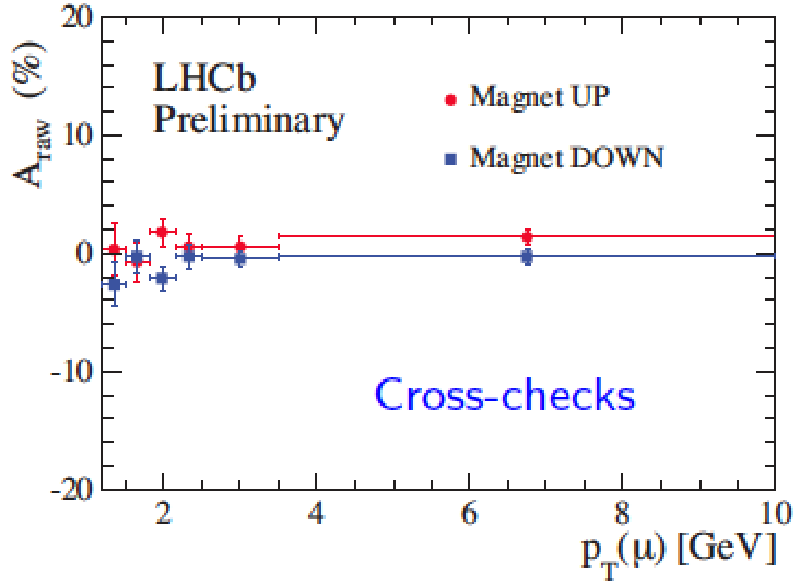
Yields 190 k B_s^0 candidates in 1.0 fb^{-1}:



LHCb-CONF-2012-022

Semileptonic asymmetries





Delicate systematic treatement is needed :

- Obtain any corrections from data/control samples.
- Pay attention to the π and μ detection asymmetries.
- Swap magnetic field to help cancel effects.

LHCb-CONF-2012-022

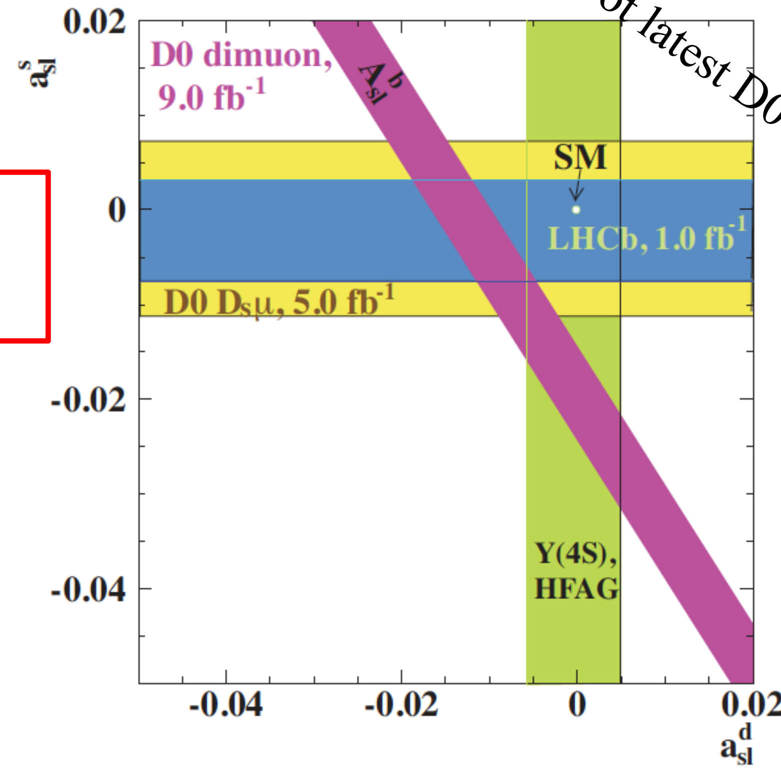
Semileptonic asymmetries

We measure :

$a_{sl}^{\,s} = (-0.24 \pm 0.54 \pm 0.33)$ %

Most precise measurement !

And also in agreement with SM
as quoted in arXiv:1205.1444
$a_{sl}^{\,s} = (0.0019 \pm 0.0003)$ % and
$a_{sl}^{\,d} = (-0.0041 \pm 0.0006)$ %

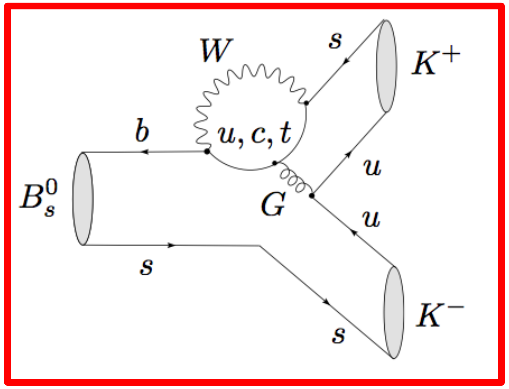


Not latest D0 result

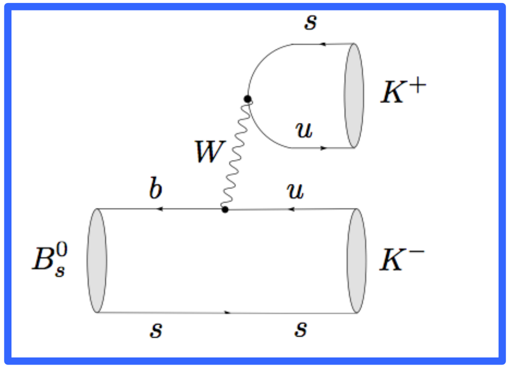
LHCb-CONF-2012-022

- Dominant systematic is from limited statistics in control sample.
- **3 tension with SM in the D0 result, not confirmed or excluded by LHCb.**
- More decay modes, data are needed. But also the B^0 mode!

$B_s \to KK$ *effective lifetime*



- $B_s \to K^+K^-$ is a *CP* even eigenstate :
    - Dominantly a penguin decay.
    - Doubly Cabibbo suppressed tree decay.

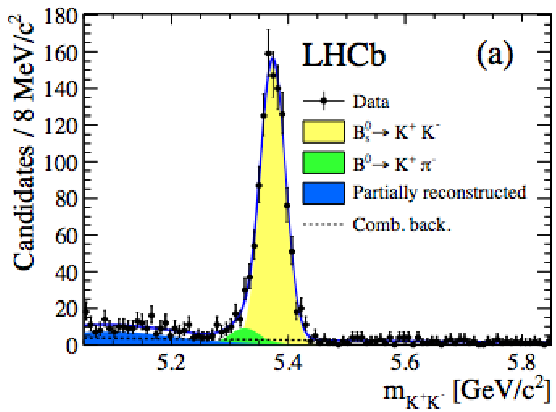


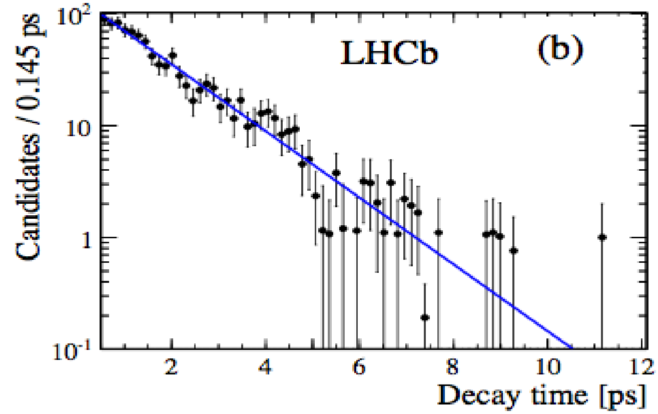
- Analysis uses minimal lifetime biasing selection :
    - No selection on variables biasing the lifetime.
    - Trigger and event selection based on NN using
    - Primiarly particle identification.

✓ Independent of previous measurement using 40 pb^{-1} of data using a complementary technique in Phys.Lett. B 707 (2012) 349

This independent analysis is currently being updated with 1.0 fb^{-1}

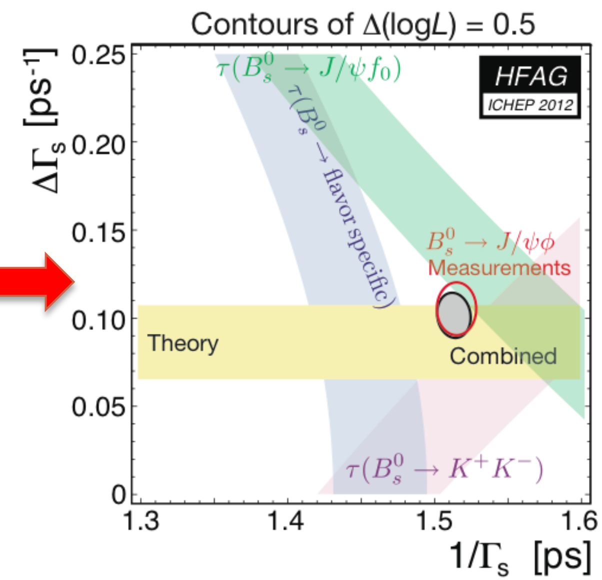
$B_s \to KK$ effective lifetime





$$\tau_{KK} = 1.455 \pm 0.046\ (\text{stat}) \pm 0.006\ (\text{syst})\ \text{ps}$$

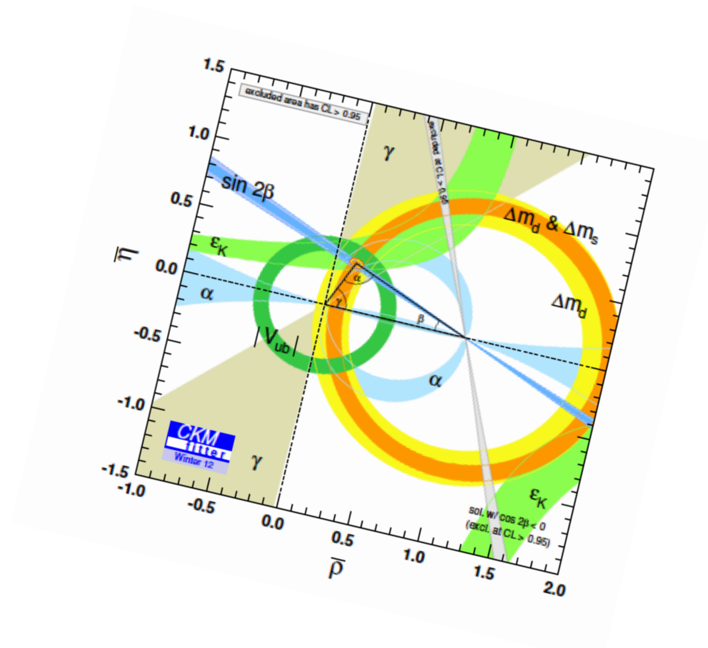
HFAG Combinations
(ICHEP 2012*)



(*) This plot will be updated for CKM 2012

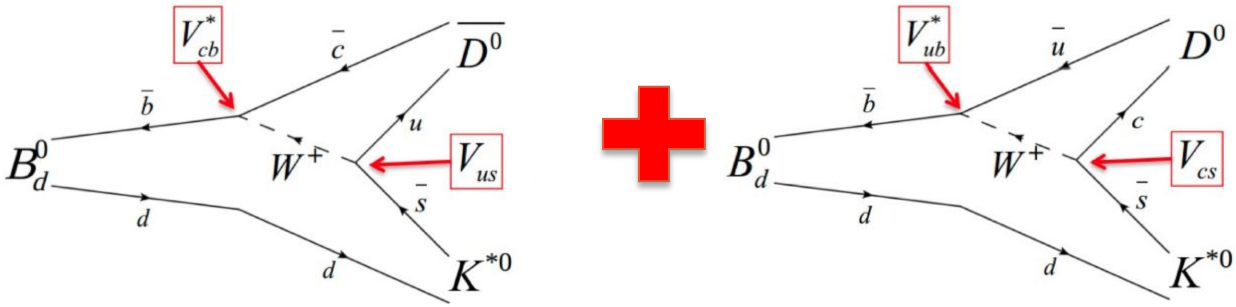
arXiv:1207.5993

Towards the measurement of the angle γ

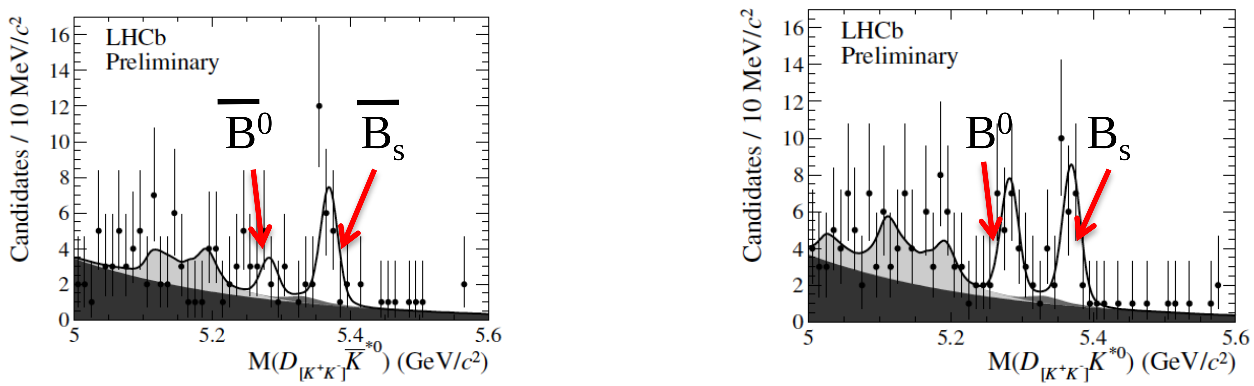


Patience patience lots more to come next week !

Measurement of *CP* observables in $B^0 \to DK^{*0}$ with $D \to K^+K^-$



Two color suppressed decay modes → Interference → Sensitivity to γ



LHCb-CONF-2012-024

$$\mathcal{A}_{\rm d}^{\rm KK} = -0.47^{+0.24}_{-0.25}(stat) \pm 0.02(syst)$$
$$\mathcal{A}_{\rm s}^{\rm KK} = 0.04 \pm 0.17(stat) \pm 0.01(syst)$$

More documentation

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH (CERN)

LHCb-PUB-2012-006
August 8, 2012

arXiv:1208.3355v1 [hep-ex] 16 Aug 2012

Implications of LHCb measurements and future prospects

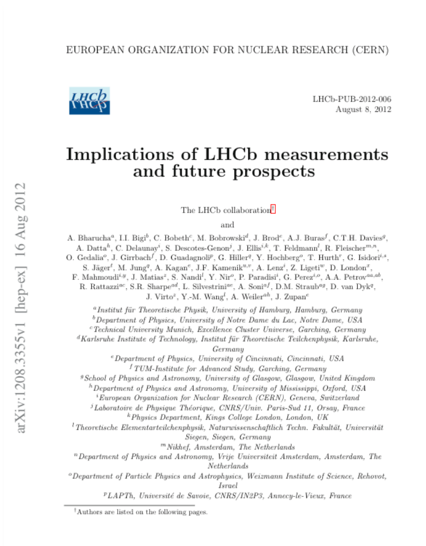
The LHCb collaboration[†]

and

A. Bharucha[a], I.I. Bigi[b], C. Bobeth[c], M. Bobrowski[d], J. Brod[e], A.J. Buras[f], C.T.H. Davies[g], A. Datta[h], C. Delaunay[i], S. Descotes-Genon[j], J. Ellis[i,k], T. Feldmann[l], R. Fleischer[m,n], O. Gedalia[o], J. Girrbach[f], D. Guadagnoli[p], G. Hiller[q], Y. Hochberg[o], T. Hurth[r], G. Isidori[i,s], S. Jäger[t], M. Jung[q], A. Kagan[e], J.F. Kamenik[u,v], A. Lenz[i], Z. Ligeti[w], D. London[x], F. Mahmoudi[i,y], J. Matias[z], S. Nandi[l], Y. Nir[o], P. Paradisi[i], G. Perez[i,o], A.A. Petrov[aa,ab], R. Rattazzi[ac], S.R. Sharpe[ad], L. Silvestrini[ae], A. Soni[af], D.M. Straub[ag], D. van Dyk[q], J. Virto[z], Y.-M. Wang[l], A. Weiler[ah], J. Zupan[e]

[a] Institut für Theoretische Physik, University of Hamburg, Hamburg, Germany
[b] Department of Physics, University of Notre Dame du Lac, Notre Dame, USA
[c] Technical University Munich, Excellence Cluster Universe, Garching, Germany
[d] Karlsruhe Institute of Technology, Institut für Theoretische Teilchenphysik, Karlsruhe, Germany
[e] Department of Physics, University of Cincinnati, Cincinnati, USA
[f] TUM-Institute for Advanced Study, Garching, Germany
[g] School of Physics and Astronomy, University of Glasgow, Glasgow, United Kingdom
[h] Department of Physics and Astronomy, University of Mississippi, Oxford, USA
[i] European Organization for Nuclear Research (CERN), Geneva, Switzerland
[j] Laboratoire de Physique Théorique, CNRS/Univ. Paris-Sud 11, Orsay, France
[k] Physics Department, Kings College London, London, UK
[l] Theoretische Elementarteilchenphysik, Naturwissenschaftlich Techn. Fakultät, Universität Siegen, Siegen, Germany
[m] Nikhef, Amsterdam, The Netherlands
[n] Department of Physics and Astronomy, Vrije Universiteit Amsterdam, Amsterdam, The Netherlands
[o] Department of Particle Physics and Astrophysics, Weizmann Institute of Science, Rehovot, Israel
[p] LAPTh, Université de Savoie, CNRS/IN2P3, Annecy-le-Vieux, France

[†] Authors are listed on the following pages.


EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH (CERN)

LHCb-PUB-2012-006
August 8, 2012

Implications of LHCb measurements and future prospects

The LHCb collaboration

and

arXiv:1208.3355v1 [hep-ex] 16 Aug 2012

Two workshops LHCb Collaboration + Theorists:
30 November 2011 and 16 April 2012 @ CERN

Summary of the document LHCb-PUB-2012-009 submitted to the European Strategy Preparatory Group

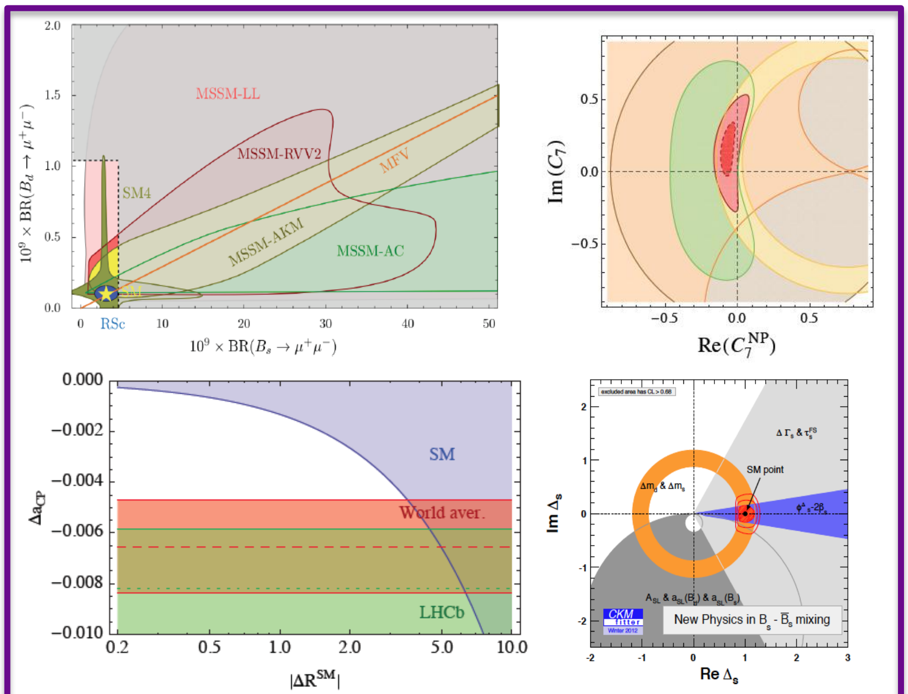
A Few Highlights

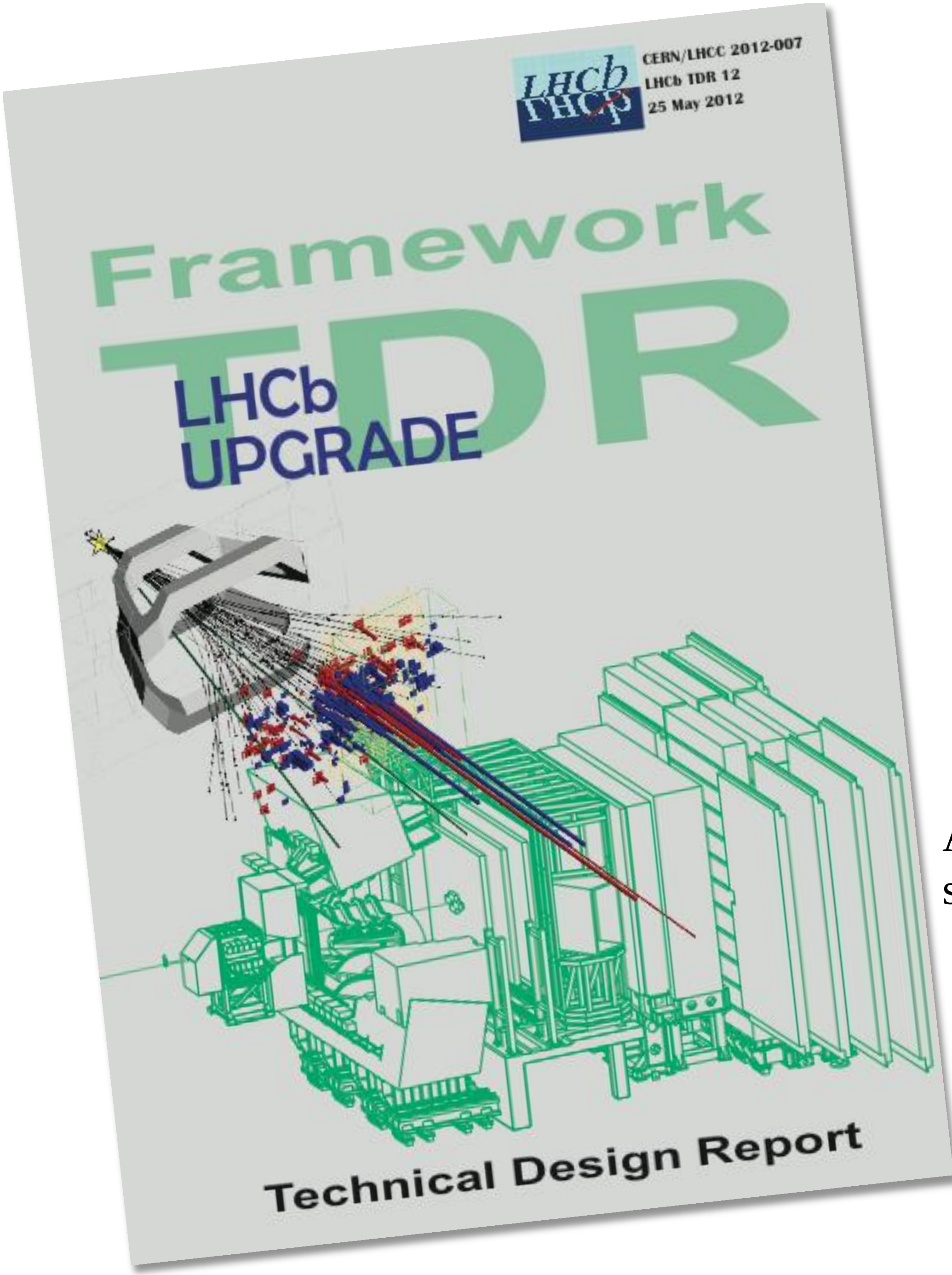
Bs→ μμ

*B→ K*ll*

Charm CPV

Bs mixing





What about the future?

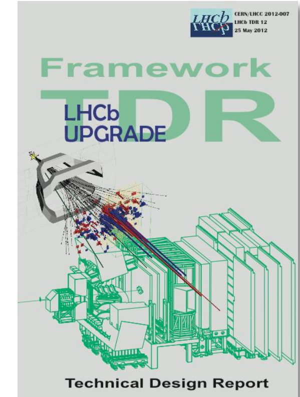
A Framework TDR for the LHCb upgrade submitted in June to LHCC for approval

Highlights from the Upgrade physics

Type	Observable	Current precision	LHCb 2018	Upgrade ($50\,\mathrm{fb}^{-1}$)	Theory uncertainty
B_s^0 mixing	$2\beta_s\ (B_s^0 \to J/\psi\ \phi)$	0.10 [9]	0.025	0.008	~ 0.003
	$2\beta_s\ (B_s^0 \to J/\psi\ f_0(980))$	0.17 [10]	0.045	0.014	~ 0.01
	$A_{\rm fs}(B_s^0)$	6.4×10^{-3} [18]	0.6×10^{-3}	0.2×10^{-3}	0.03×10^{-3}
Gluonic penguin	$2\beta_s^{\rm eff}(B_s^0 \to \phi\phi)$	–	0.17	0.03	0.02
	$2\beta_s^{\rm eff}(B_s^0 \to K^{*0}\bar{K}^{*0})$	–	0.13	0.02	< 0.02
	$2\beta^{\rm eff}(B^0 \to \phi K_S^0)$	0.17 [18]	0.30	0.05	0.02
Right-handed currents	$2\beta_s^{\rm eff}(B_s^0 \to \phi\gamma)$	–	0.09	0.02	< 0.01
	$\tau^{\rm eff}(B_s^0 \to \phi\gamma)/\tau_{B_s^0}$	–	5 %	1 %	0.2 %
Electroweak penguin	$S_3(B^0 \to K^{*0}\mu^+\mu^-; 1 < q^2 < 6\,\mathrm{GeV}^2/c^4)$	0.08 [14]	0.025	0.008	0.02
	$s_0\, A_{\rm FB}(B^0 \to K^{*0}\mu^+\mu^-)$	25 % [14]	6 %	2 %	7 %
	$A_{\rm I}(K\mu^+\mu^-; 1 < q^2 < 6\,\mathrm{GeV}^2/c^4)$	0.25 [15]	0.08	0.025	~ 0.02
	$\mathcal{B}(B^+ \to \pi^+\mu^+\mu^-)/\mathcal{B}(B^+ \to K^+\mu^+\mu^-)$	25 % [16]	8 %	2.5 %	~ 10 %
Higgs penguin	$\mathcal{B}(B_s^0 \to \mu^+\mu^-)$	1.5×10^{-9} [2]	0.5×10^{-9}	0.15×10^{-9}	0.3×10^{-9}
	$\mathcal{B}(B^0 \to \mu^+\mu^-)/\mathcal{B}(B_s^0 \to \mu^+\mu^-)$	–	~ 100 %	~ 35 %	~ 5 %
Unitarity triangle angles	$\gamma\ (B \to D^{(*)}K^{(*)})$	~ 10–12° [19, 20]	4°	0.9°	negligible
	$\gamma\ (B_s^0 \to D_s K)$	–	11°	2.0°	negligible
	$\beta\ (B^0 \to J/\psi\ K_S^0)$	0.8° [18]	0.6°	0.2°	negligible
Charm CP violation	A_Γ	2.3×10^{-3} [18]	0.40×10^{-3}	0.07×10^{-3}	–
	ΔA_{CP}	2.1×10^{-3} [5]	0.65×10^{-3}	0.12×10^{-3}	–

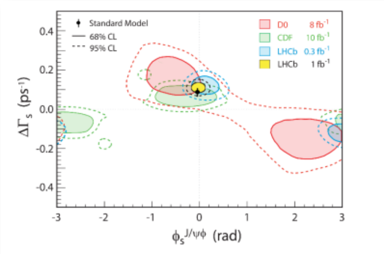
Goal of LHCb upgrade: collect 50 fb^{-1} to reach the theoretical error on several flavor physics variables

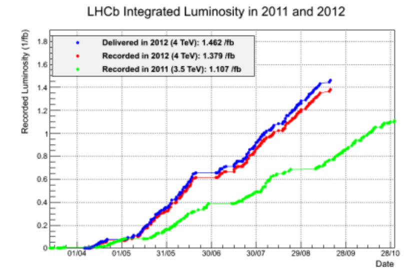
Upgrade planning



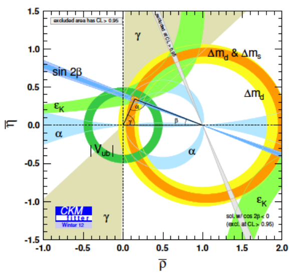
- June 2011 : LoI fully endorsed
- June 2012 : Framework TDR submitted, waiting for feed back.
- 2012 : Continue R&D towards technical choices
- 2013 : Technical review & choice of technology. TDRs & prototype validation.
- 2014-16 : Tendering & serial production.
- 2016-17 : Quality control & acceptance tests.
- 2018/19 : Installation (18 months according to planning!)

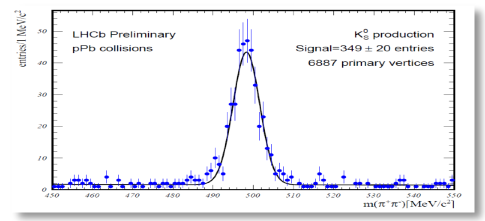
Conclusion

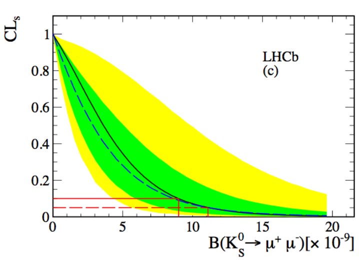


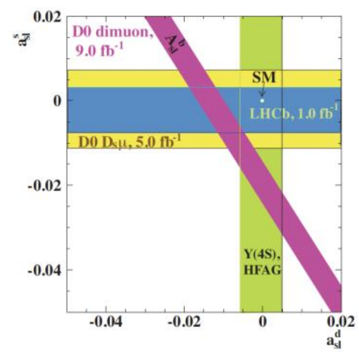


- So far collected 1.4 fb^{-1} in 2012.
- All disks for the deferred HLT are deployed.
- The ion-proton pilot went smoothly.
- Lots of new results and we expect an other bunch next week.
- Greedy for precision and surprises.
- Upgrade program advancing.
- We would like to thanks the LHC !

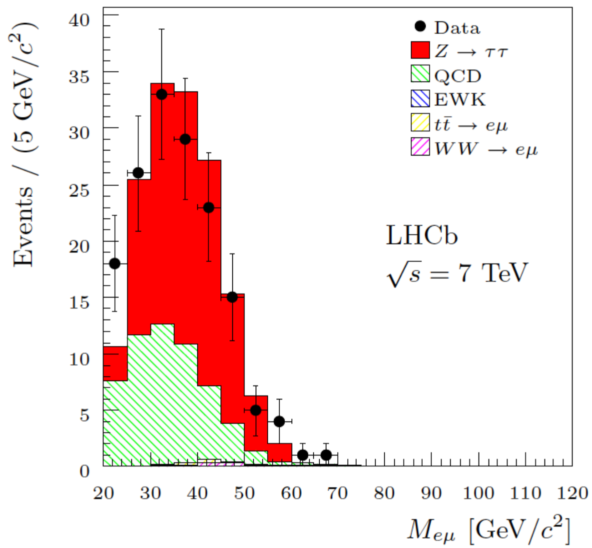


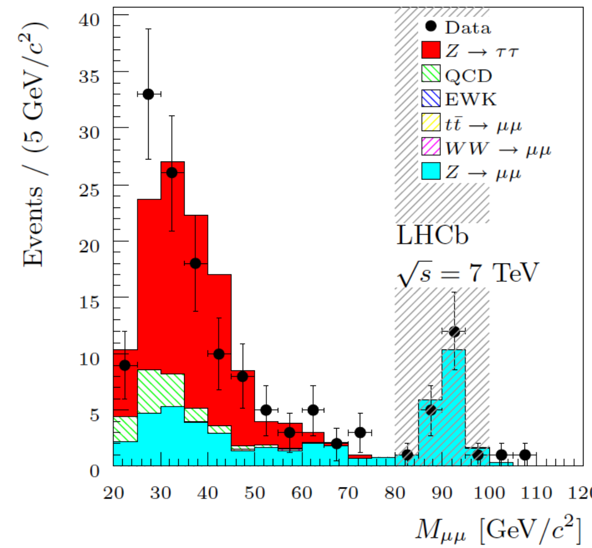


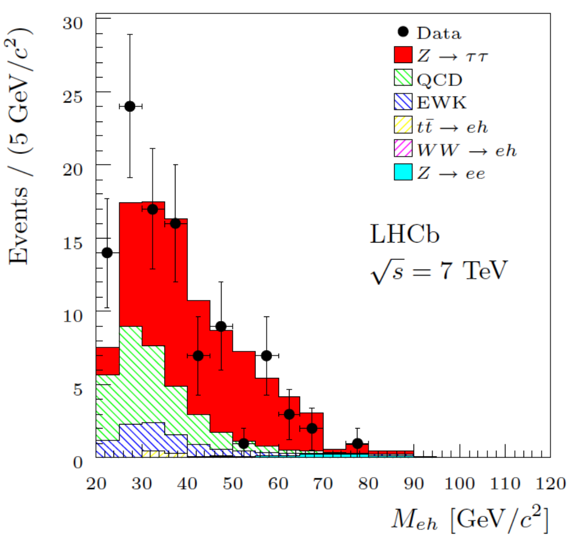


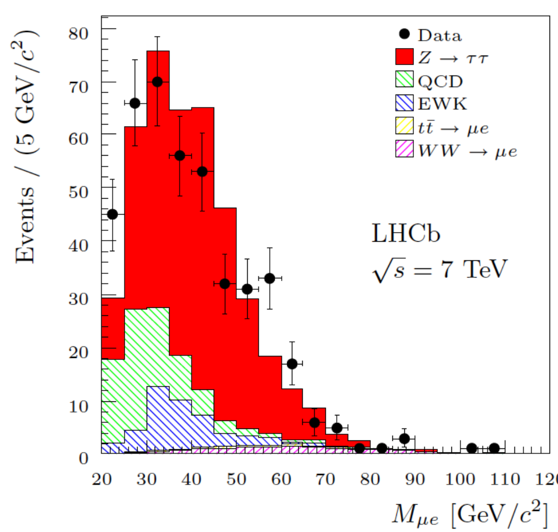


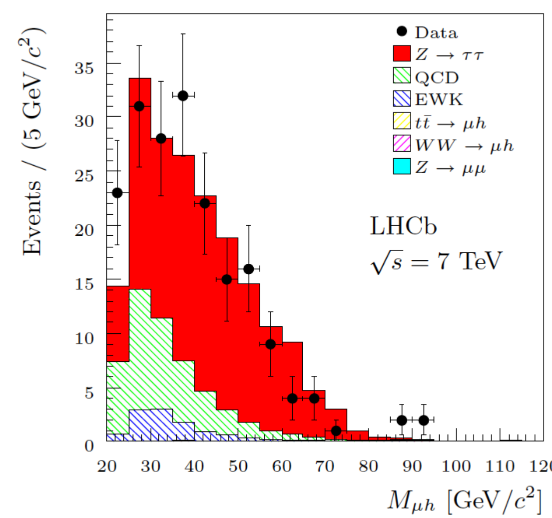
Backup slides


Data
$Z \to \tau\tau$
QCD
EWK
$t\bar{t} \to e\mu$
$WW \to e\mu$
LHCb
$\sqrt{s} = 7$ TeV
Events / (5 GeV/c^2)
$M_{e\mu}$ [GeV/c^2]

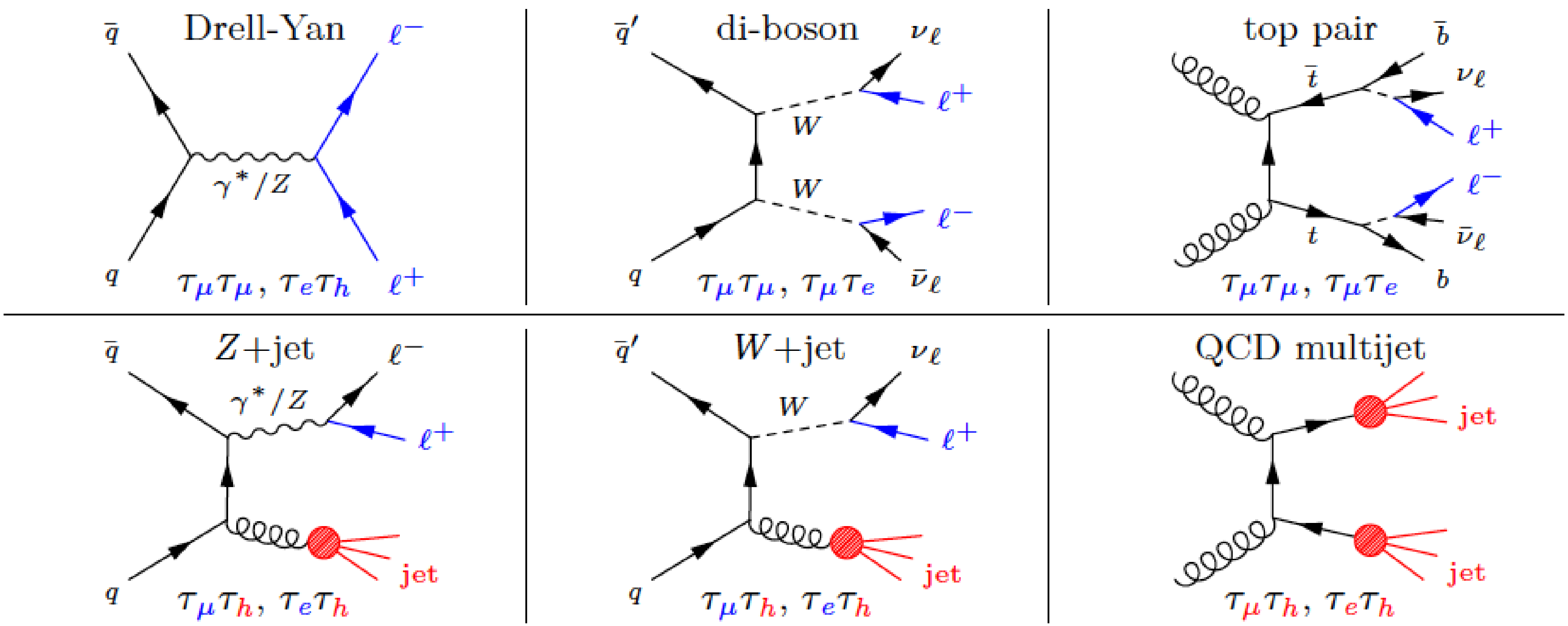

Data
$Z \to \tau\tau$
QCD
EWK
$t\bar{t} \to \mu\mu$
$WW \to \mu\mu$
$Z \to \mu\mu$
LHCb
$\sqrt{s} = 7$ TeV
Events / (5 GeV/c^2)
$M_{\mu\mu}$ [GeV/c^2]


Data
$Z \to \tau\tau$
QCD
EWK
$t\bar{t} \to eh$
$WW \to eh$
$Z \to ee$
LHCb
$\sqrt{s} = 7$ TeV
Events / (5 GeV/c^2)
M_{eh} [GeV/c^2]


Data
$Z \to \tau\tau$
QCD
EWK
$t\bar{t} \to \mu e$
$WW \to \mu e$
LHCb
$\sqrt{s} = 7$ TeV
Events / (5 GeV/c^2)
$M_{\mu e}$ [GeV/c^2]


Data
$Z \to \tau\tau$
QCD
EWK
$t\bar{t} \to \mu h$
$WW \to \mu h$
$Z \to \mu\mu$
LHCb
$\sqrt{s} = 7$ TeV
Events / (5 GeV/c^2)
$M_{\mu h}$ [GeV/c^2]

Z→ ττ backgrounds

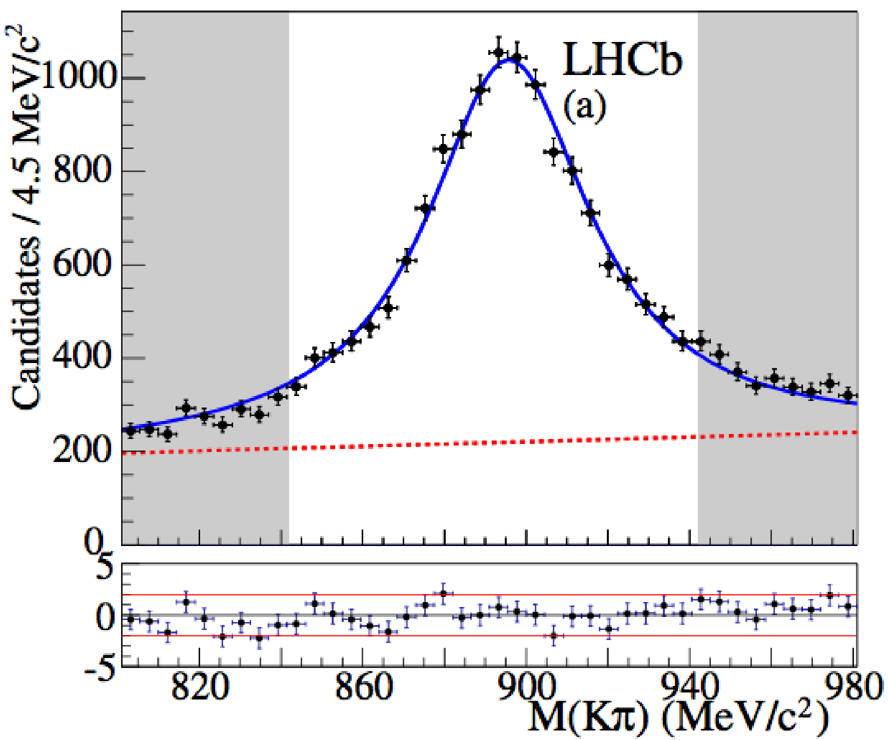


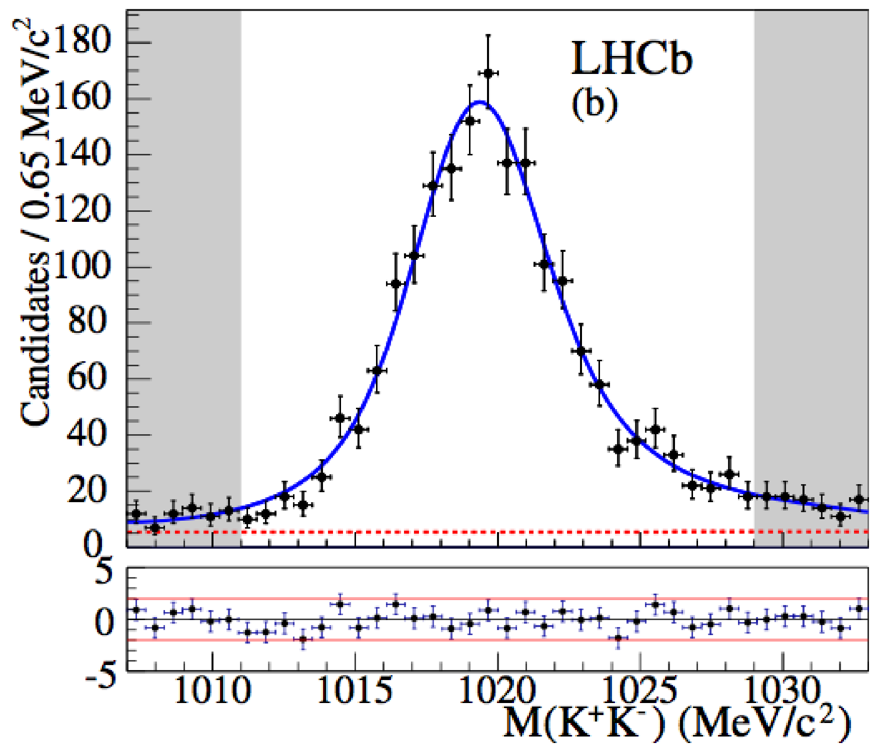
$Z \rightarrow \tau\tau$ selections

	ATLAS	CMS	LHCb
triggers	muon $p_T > 10 - 15$ $\tau_\mu\tau_\mu$, $\tau_\mu\tau_e$, $\tau_\mu\tau_h$ electron/hadrons $E_T > 15/16$ $\tau_e\tau_h$	muon $p_T > 9 - 15$ $\tau_\mu\tau_\mu$, $\tau_\mu\tau_e$, $\tau_\mu\tau_h$ electron $E_T > 12$ $\tau_e\tau_h$	muon $p_T > 15$ $\tau_\mu\tau_\mu$, $\tau_\mu\tau_e$, $\tau_\mu\tau_h$ electron $p_T > 10$ $\tau_\mu\tau_e$, $\tau_e\tau_h$
muon	track + muon system isolated $p_T > 17$ (15/10) $\lvert\eta\rvert < 2.4$	track + muon system isolated $p_T > 15$ (19/10) $\lvert\eta\rvert < 2.1$	track + muon system isolated $p_T > 20$ (20/5) $2.0 < \eta < 4.5$
electron	track + ECAL isolated $E_T > 17$ $\lvert\eta\rvert < 2.47$	track + ECAL isolated $E_T > 15$ $\lvert\eta\rvert < 2.4/2.1$	track + ECAL isolated $p_T > 20$ (20/5) $2.0 < \eta < 4.5$
hadrons‡	one or three-pronged anti-k_T $p_T > 20/25$ $\lvert\eta\rvert < 2.47$	one or three-pronged anti-k_T $p_T > 20$ $\lvert\eta\rvert < 2.3$	one-pronged isolated $p_T > 5$ $2.25 < \eta < 3.75$

‡ see *Trg, ID and tau-reco in ATLAS* (Tan 09 : 00) and *Trg, ID and tau-reco in CMS* (Calabria 09 : 20)

Intermediate states for radiative decays





Semileptonic asymetries systematics

Table 3: Absolute systematic uncertainties in A_{meas}.

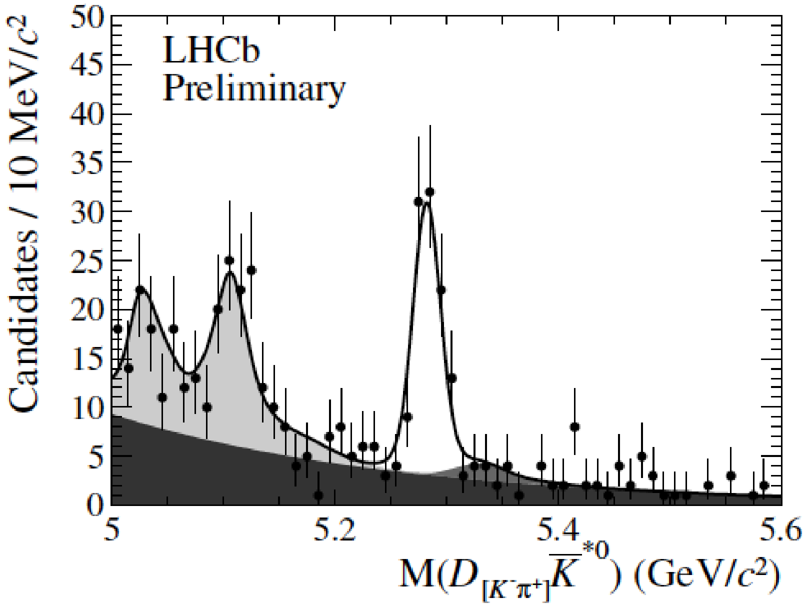
Sources	$\sigma(A_{\text{meas}})$ (%)
Signal modelling in D_s^+ mass fit	0.06
Background from other b hadrons	0.05
Momentum difference between π and μ	0.06
Momentum difference between the same sign and opposite sign kaons	0.02
Muon corrections	0.05
Varying run conditions between field-up and field-down	0.01
Muon mis-identification	0.01
HLT2 bias in μ-topological trigger	0.05
Statistical uncertainty on the efficiency ratios	0.10
Total	0.16

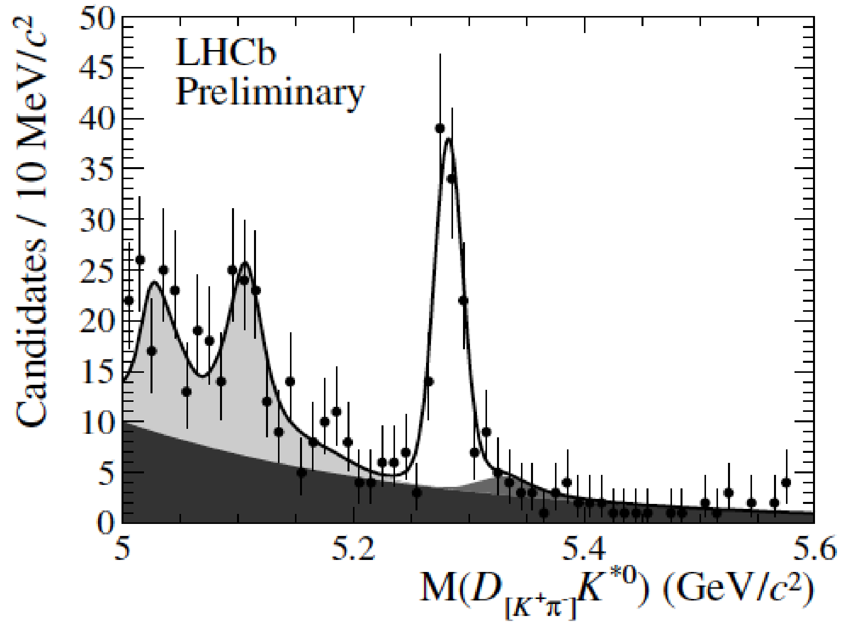
$K\mu\mu$ systematics

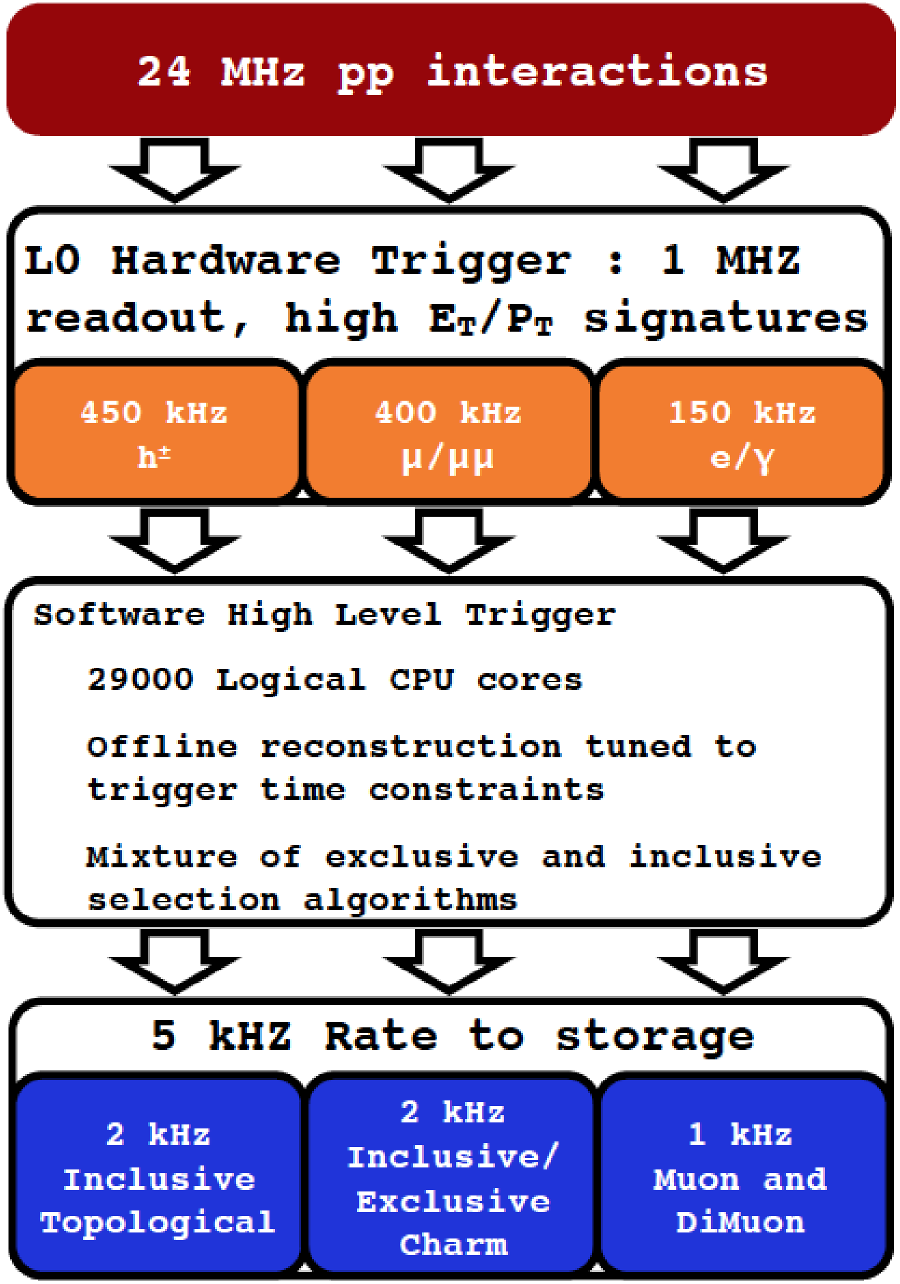
Table 1: Signal yield (N_{sig}), differential branching fraction ($\mathrm{d}\mathcal{B}/\mathrm{d}q^2$), the parameter F_{H} and dimuon forward-backward asymmetry (A_{FB}) for the $B^+ \to K^+\mu^+\mu^-$ decay in the q^2 bins used in the analysis. Results are also given in the $1 < q^2 < 6\,\text{GeV}^2/c^4$ range where theoretical uncertainties are best under control.

q^2 (GeV^2/c^4)	N_{sig}	$\mathrm{d}\mathcal{B}/\mathrm{d}q^2$ ($10^{-8}\,\text{GeV}^{-2}c^4$)	F_{H}	A_{FB}
$0.05 - 2.00$	159 ± 14	$2.85 \pm 0.27 \pm 0.14$	$0.00\,^{+0.12}_{-0.00}\,^{+0.06}_{-0.00}$	$0.00\,^{+0.06}_{-0.05}\,^{+0.03}_{-0.01}$
$2.00 - 4.30$	164 ± 14	$2.49 \pm 0.23 \pm 0.10$	$0.14\,^{+0.16}_{-0.10}\,^{+0.04}_{-0.02}$	$0.07\,^{+0.08}_{-0.05}\,^{+0.02}_{-0.01}$
$4.30 - 8.68$	327 ± 20	$2.29 \pm 0.16 \pm 0.09$	$0.04\,^{+0.10}_{-0.04}\,^{+0.06}_{-0.04}$	$-0.02\,^{+0.03}_{-0.05}\,^{+0.03}_{-0.03}$
$10.09 - 12.86$	211 ± 17	$2.04 \pm 0.18 \pm 0.08$	$0.11\,^{+0.20}_{-0.08}\,^{+0.02}_{-0.01}$	$-0.03\,^{+0.07}_{-0.07}\,^{+0.01}_{-0.01}$
$14.18 - 16.00$	148 ± 13	$2.07 \pm 0.20 \pm 0.08$	$0.08\,^{+0.28}_{-0.08}\,^{+0.02}_{-0.01}$	$-0.01\,^{+0.12}_{-0.06}\,^{+0.01}_{-0.01}$
$16.00 - 18.00$	141 ± 13	$1.77 \pm 0.18 \pm 0.09$	$0.18\,^{+0.22}_{-0.14}\,^{+0.01}_{-0.04}$	$-0.09\,^{+0.07}_{-0.09}\,^{+0.02}_{-0.01}$
$18.00 - 22.00$	114 ± 13	$0.78 \pm 0.10 \pm 0.04$	$0.14\,^{+0.31}_{-0.14}\,^{+0.01}_{-0.02}$	$0.02\,^{+0.11}_{-0.11}\,^{+0.01}_{-0.01}$
$1.00 - 6.00$	357 ± 21	$2.41 \pm 0.17 \pm 0.14$	$0.05\,^{+0.08}_{-0.05}\,^{+0.04}_{-0.02}$	$0.02\,^{+0.05}_{-0.03}\,^{+0.02}_{-0.01}$

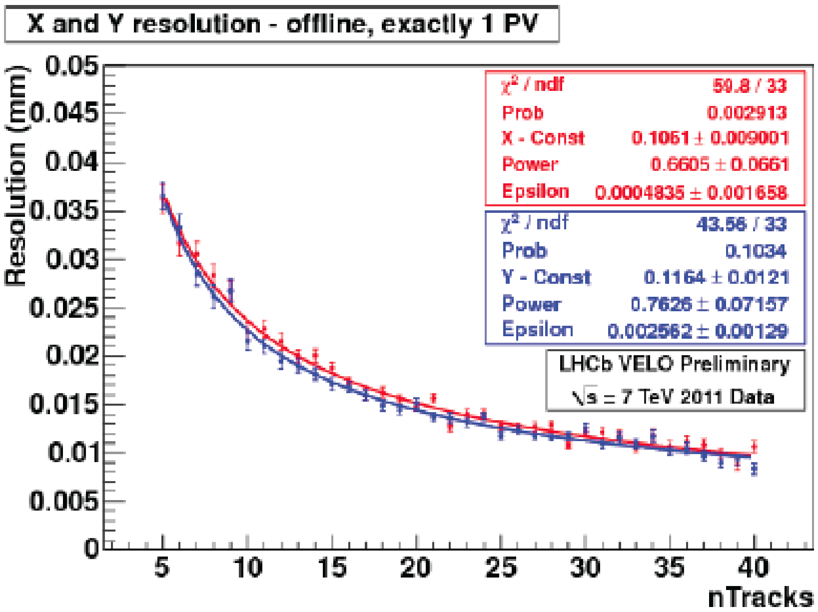
DK* favored modes

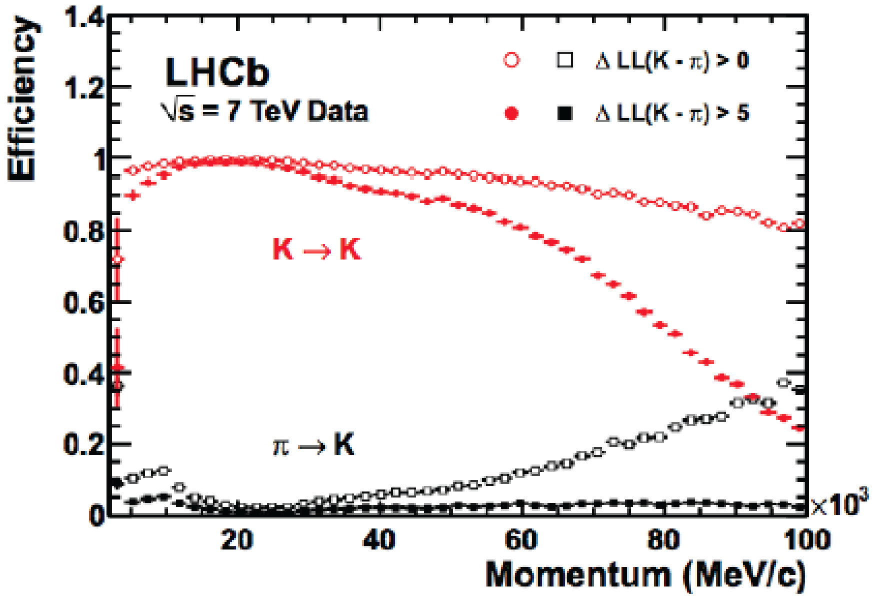


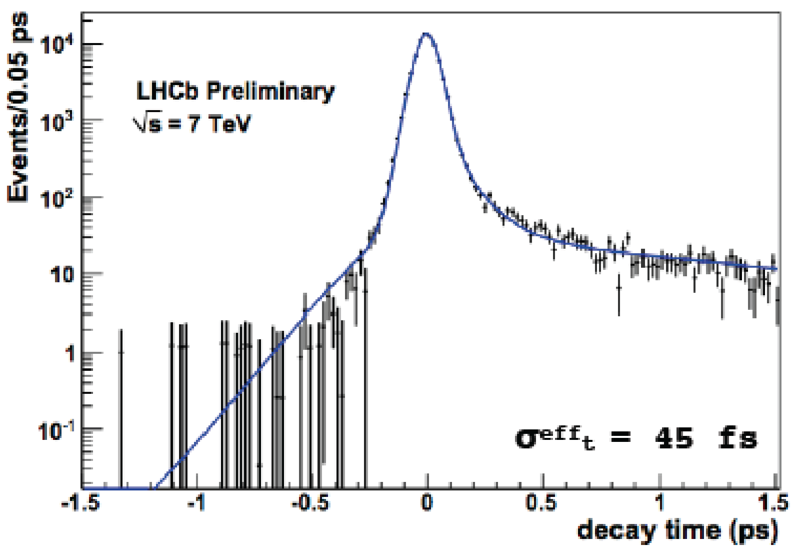


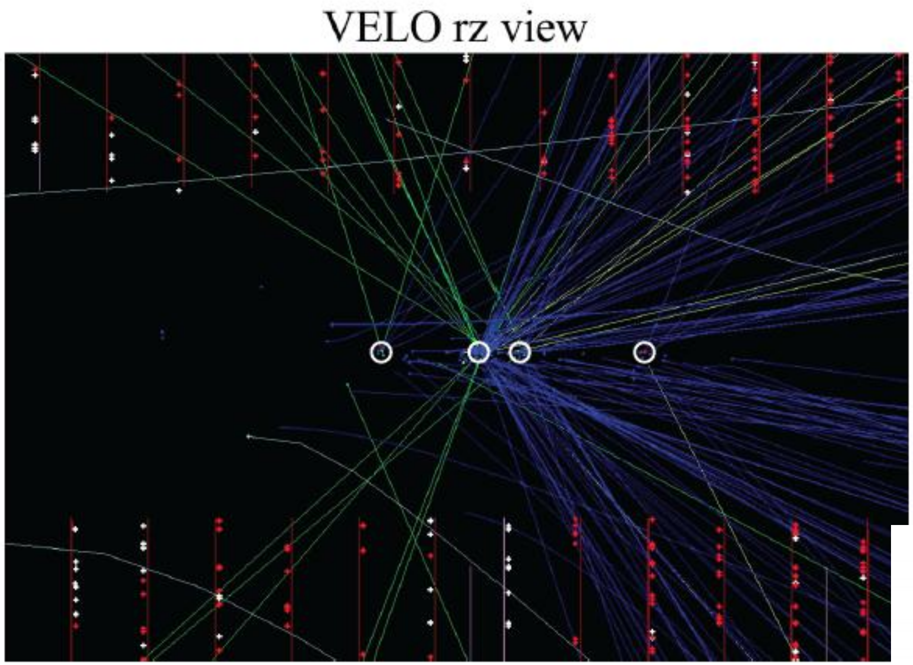

24 MHz pp interactions
L0 Hardware Trigger : 1 MHZ readout, high E_T/P_T signatures
450 kHz
$h^{\pm}$
400 kHz
$\mu/\mu\mu$
150 kHz
e/γ
Software High Level Trigger
29000 Logical CPU cores
Offline reconstruction tuned to trigger time constraints
Mixture of exclusive and inclusive selection algorithms
5 kHZ Rate to storage
2 kHz
Inclusive
Topological
2 kHz
Inclusive/
Exclusive
Charm
1 kHz
Muon and
DiMuon

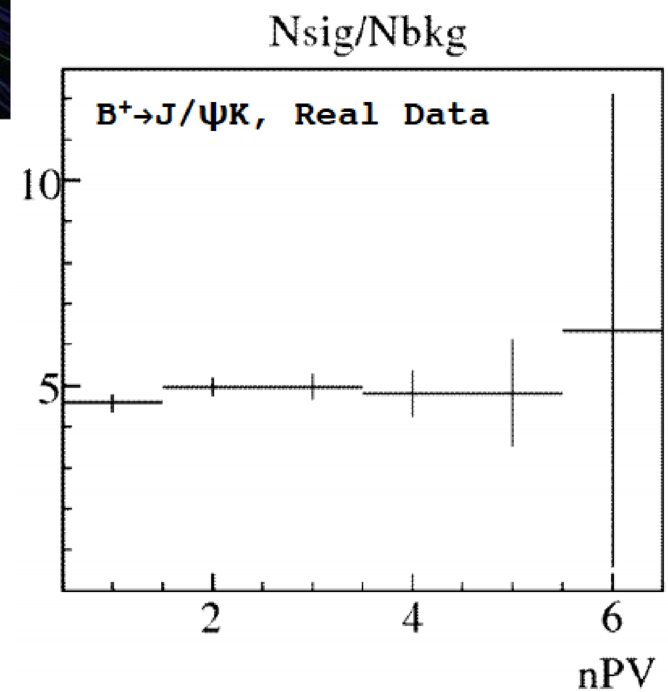
Performances



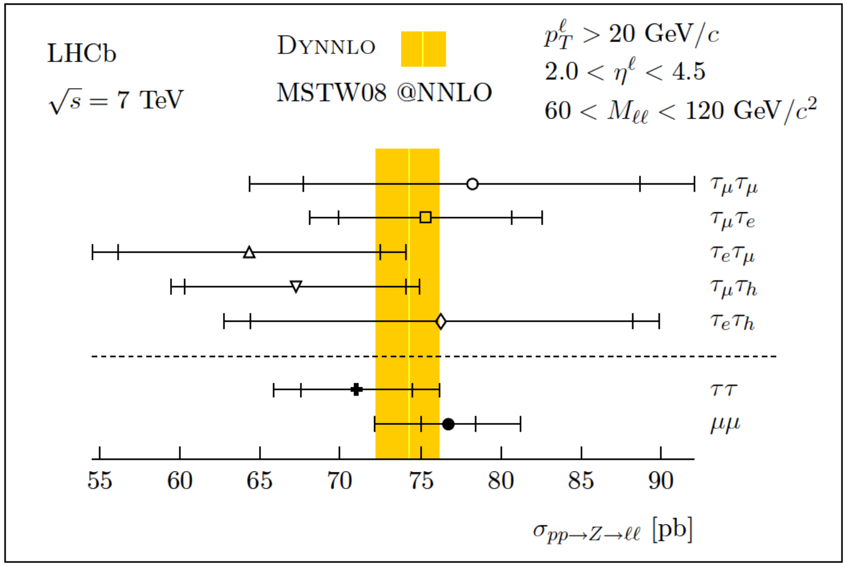





VELO rz view


Nsig/Nbkg
B⁺→J/ψK, Real Data
10
5
2
4
6
nPV

$$\sigma_{pp\to Z\to\tau\tau}\left(\sqrt{s}=7\ \text{TeV}, 60 < M_{\tau\tau} < 120\ \text{GeV}, 2.0 < \eta^{\tau} < 4.5, p_T^{\tau} > 20\ \text{GeV}\right)$$



Reprocessing2012													
Tue Sep 25 06:45:24 2012													
Beam4000GeV-VeloClosed-MagDown	**DQ Bad**			**DQ OK**			**All not Bad**						
	Files	**Runs**	**Lumi (pb-1)**	**Files**	**Runs**	**Lumi (pb-1)**	**Events**	**Files**	**Runs**	**Lumi (pb-1)**	**% of total**	**% of OK**	**% of RAW**
Real Data	1632	100	1.478	90744	524	282.918	4779383943	104113	624	325.639	-	-	-
Reco14	-	-	-	46817	429	141.312	2341056116	46817	429	141.312	43.3	49.9	43.3
Stripping20	-	-	-	-	-	-	25470315	16444	355	93.965	66.4	66.4	28.8
Merging (DIMUON)	-	-	-	944	107	22.194	6215025	944	107	22.194	23.6	-	6.8
Beam4000GeV-VeloClosed-MagUp	**DQ Bad**			**DQ OK**			**All not Bad**						
	Files	**Runs**	**Lumi (pb-1)**	**Files**	**Runs**	**Lumi (pb-1)**	**Events**	**Files**	**Runs**	**Lumi (pb-1)**	**% of total**	**% of OK**	**% of RAW**
Real Data	12	2	0.002	300	12	0.910	46922883	988	22	3.321	-	-	-
Reco14	-	-	-	285	15	0.852	13507337	285	15	0.852	25.6	93.6	25.6
Stripping20	-	-	-	-	-	-	-	-	-	-	-	-	-
Merging (DIMUON)	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	**DQ Bad**			**DQ OK**			**All not Bad**						
	Files	**Runs**	**Lumi (pb-1)**	**Files**	**Runs**	**Lumi (pb-1)**	**Events**	**Files**	**Runs**	**Lumi (pb-1)**	**% of total**	**% of OK**	**% of RAW**
Real Data	1644	102	1.479	91044	536	283.828	4826306826	105101	646	328.959	-	-	-
Reco14	-	-	-	47102	444	142.164	2354563453	47102	444	142.164	43.2	50.0	43.2
Stripping20	-	-	-	-	-	-	25470315	16444	355	93.965	66.0	66.0	28.5
Merging (DIMUON)	-	-	-	944	107	22.194	6215025	944	107	22.194	23.6	-	6.7
Progress since Tue Sep 25 01:06:53 2012													
Progress	**DQ Bad**			**DQ OK**			**All not Bad**						
	Files	**Runs**	**Lumi (pb-1)**	**Files**	**Runs**	**Lumi (pb-1)**	**Events**	**Files**	**Runs**	**Lumi (pb-1)**	**% of total**	**% of OK**	**% of RAW**
Real Data	-	-	-	-	-	-	-	-	-	-	-	-	-
Reco14	-	-	-	1227	3	4.630	58688421	1227	3	4.630	1.4	1.6	1.4
Stripping20	-	-	-	-	-	-	1542697	800	10	5.828	2.0	2.0	1.8
Merging (DIMUON)	-	-	-	5	3	0.464	122276	5	3	0.464	-1.0	-	0.1

SEARCH FOR THE DECAY $K_S \to 2\mu$

S. GJESDAL, G. PRESSER, P. STEFFEN, J. STEINBERGER
F. VANNUCCI * and H. WAHL
CERN, Geneva, Switzerland

H. FILTHUTH, K. KLEINKNECHT **, V. LÜTH and G. ZECH
Institut für Hochenergiephysik, Heidelberg, Germany

Received 1 March 1973

A search for the decay $K_S \to 2\mu$ has given negative results. The 90% confidence upper limit for the branching ratio of 3.1×10^{-7} excludes the models of Christ and Lee, and of Dass and Wolfenstein, designed to explain the $K_L \to 2\mu$ problem.

In this letter, we present the result of a search for the decay $K_S \to 2\mu$. The experiment was motivated by the suggestion of Christ and Lee [1] that an unexpectly large, *CP*-violating decay $K_S \to 2\mu$ could overcome the difficulties encountered in the explanation of the results of Clark et al. [2] in the decay $K_L \to 2\mu$. In the search for this decay, the authors obtain an upper limit of 1.8×10^{-9} for the branching ratio, whereas this decay can proceed via the intermediary of two gamma-rays, and a *minimum* branching ratio 6×10^{-9} can be predicted on the basis of the known 2γ decay rate and unitarity [3]. The suggestion of Christ and Lee was generalized somewhat by M.K. Gaillard [4], and incorporated in a definite model by Dass and Wolfenstein [5]. The Wolfenstein model is very simple and is the following. Let K_1 and K_2 be the *TCP* positive and *TCP* negative K^0 amplitudes, respectively. Then a (*CP*-violating) $K_1 \to 2\mu$ amplitude is proposed which adequately cancels the "unitarity amplitude" $K_L \to 2\gamma \to 2\mu$. This imposes the boundaries $12.5 \times 10^{-6} \geqslant \Gamma(K_S \to \mu\mu)/\Gamma_S \geqslant$ $\geqslant 1.1 \times 10^{-6}$ on the branching ratio for the $K_S \to 2\mu$ decay. This probably is the only sensible way in which the abstract suggestion of Christ and Lee can be realized. The less specific arguments of Christ and Lee, and Gaillard, give the less restrictive lower limits $\Gamma(K_S \to \mu\mu)/\Gamma_S \geqslant 5 \times 10^{-7}$ and 2.8×10^{-7}, respectively, for the branching ratio.

* On leave from IPN, Orsay, France
** Now at Universität Dortmund, Germany.

The experiment was done in a short neutral beam at the external proton beam of the CERN PS. Protons of 24 GeV/*c* were hitting a platinum target. Neutral particles produced under 75 ± 12 mrad were accepted by a 2 m long tapered uranium collimator, embedded in a 20 kG magnetic field.

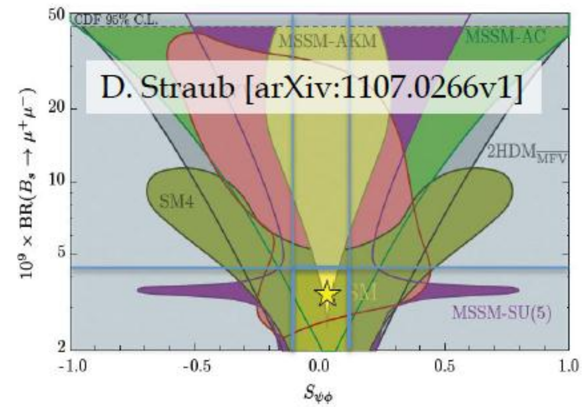
Neutral two-body decays were recorded in a magnetic spectrometer [6] using four pairs of planes of multiwire proportional chambers [7], at 4.65 m (A), 11.60 m (B), 16.35 m (C), and 22.57 m (D) from the production target, as shown in fig. 1. Downstream of the last proportional chamber, a plane of 12 scintillation counters, each $1.6 \times 425 \times 450\ \mathrm{mm}^3$, arranged 6 above and 6 below the symmetry plane, was used for triggering on charged particle pairs. This plane is followed by an absorber made of light concrete ($A = 19, Z = 11$), 280 cm long, a vertical hodoscope of scintillation counters ($6 \times 1200 \times 375\ \mathrm{mm}^3$), 40 cm light concrete and a horizontal hodoscope of eight counters ($6 \times 1500 \times 300\ \mathrm{mm}^3$). The surface covered by the two hodoscopes ("μ counters") is $300 \times 120\ \mathrm{cm}^2$. Details of the apparatus are described elsewhere [6].

Events were recorded on magnetic tape whenever there were two or more hits in the trigger counter plane, two hits in the two vertical wire planes of chambers B and C, one or two hits in the two horizontal wire planes of these chambers, and two hits in the horizontal and vertical wire planes of chamber D. For a spill-out time of 350 msec, there were about 800 events recorded per PS burst. The total sample contains 10^9 events; for a quarter of it (sample I) the first chamber (A) is missing.

Motivations for the physics upgrade

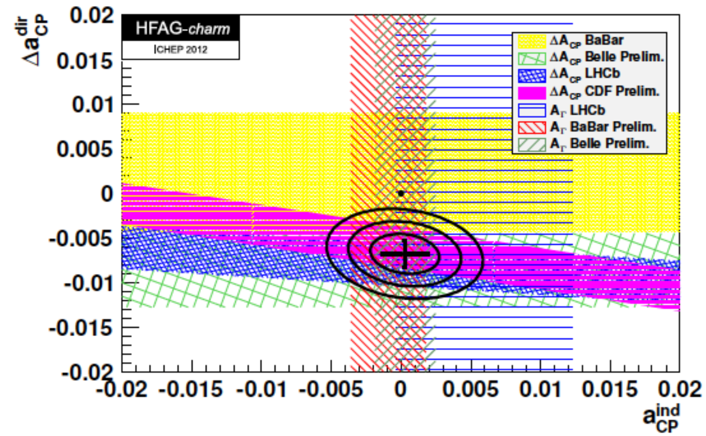
1.0 fb-1, Phys. Rev. Lett. 108 (2012) 231801 + LHCb-CONF-2012-002

Current limit getting close to SM:
$BR(B_s \rightarrow \mu^+\mu^-) = (3.2 \pm 0.2) \times 10^{-9}$
Rule out SUSY @ large tan β.
$\phi_s = 0.001 \pm 0.101 \pm 0.027$ deg.



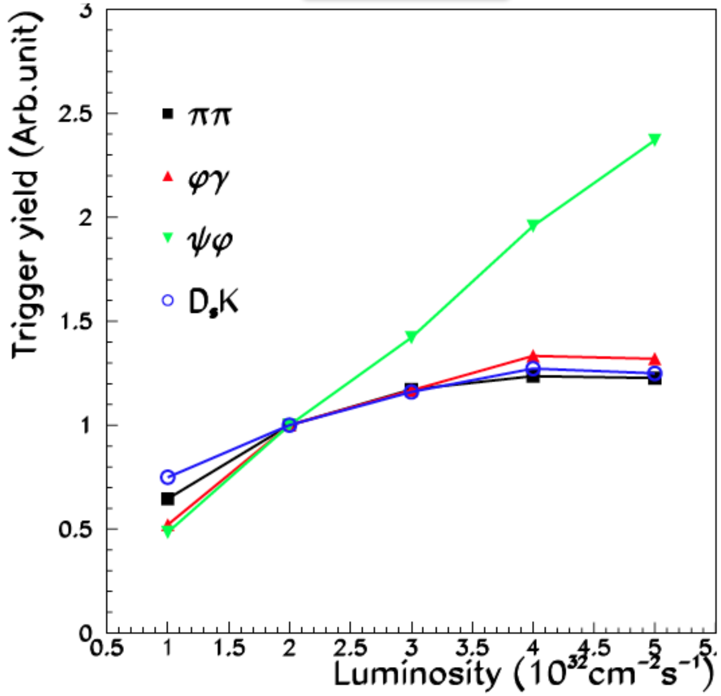
0.6 fb-1, PRL 108, 111602 (2012)

CP Violation in Charm:
$\Delta A_{CP} = (-0.82 \pm 0.21 \pm 0.11)\%$
Theory community is debating
Expected statistical sensitivity
$\sigma(\Delta A_{CP}) \sim 0.12 \times 10^{-3}$

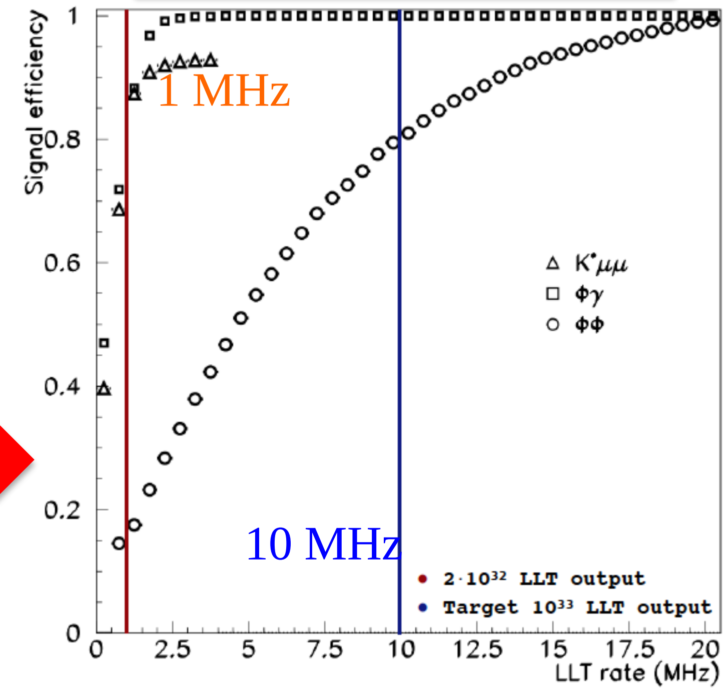


Trigger Upgrade

Today



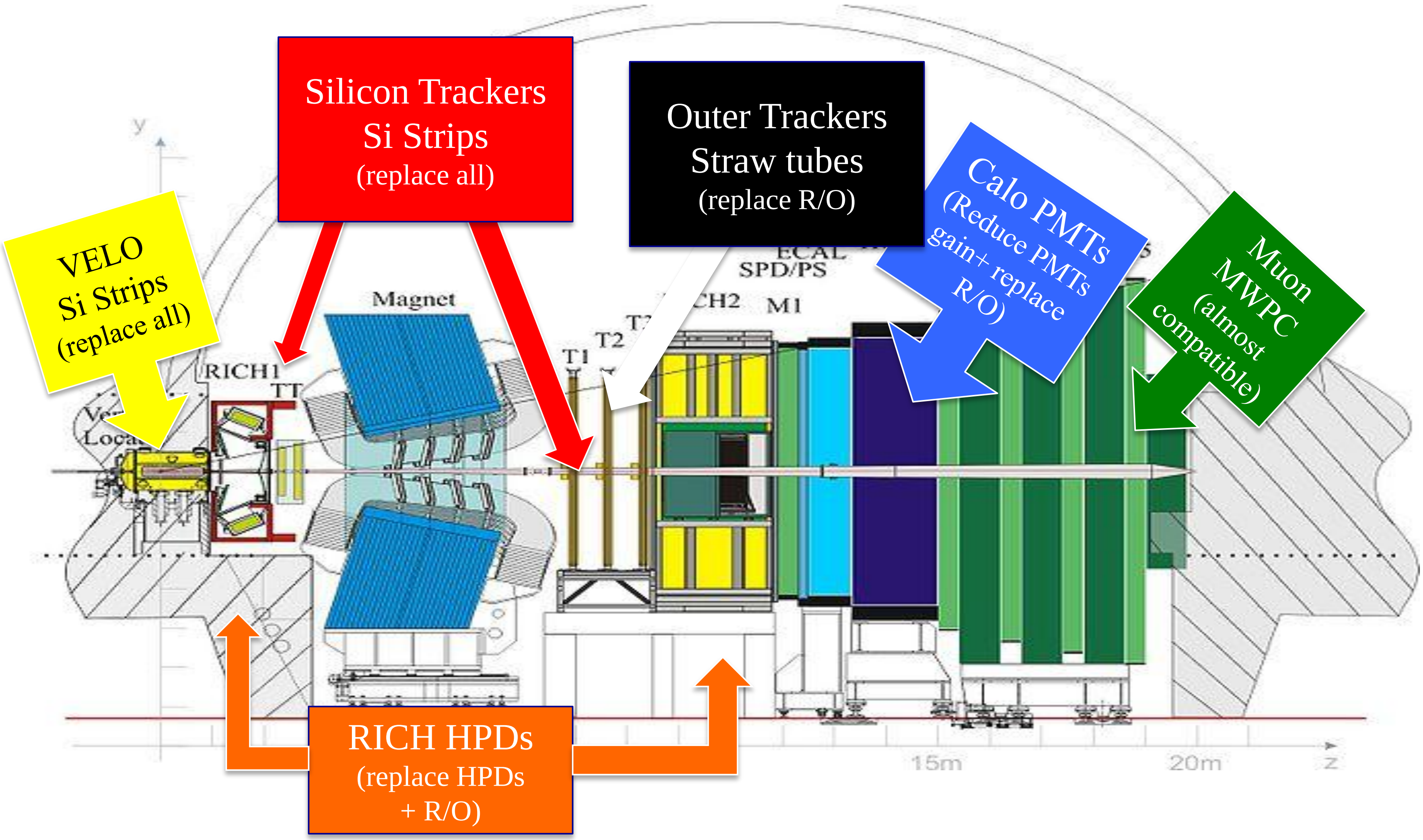
Soon @10^{33} cm^{-2}s^{-1}



- Current detector limited to 1 MHz trigger Level-0 trigger.
- Particularly limiting for hadronic decay modes, and would become more limiting as the luminosity rises due to pileup

- Upgrade detectors to 40 MHz readout
- Implement first level software trigger for all detectors

Detector Upgrade



Design a common Read Out Board : Tell 40.