LHC Machine & Detectors status (short summary and highlights)

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"First results from the LHC and their physical interpretation"
Protvino, 19-21 October 2010

The talk layout

- LHC machine
- CMS, ATLAS, LHCb

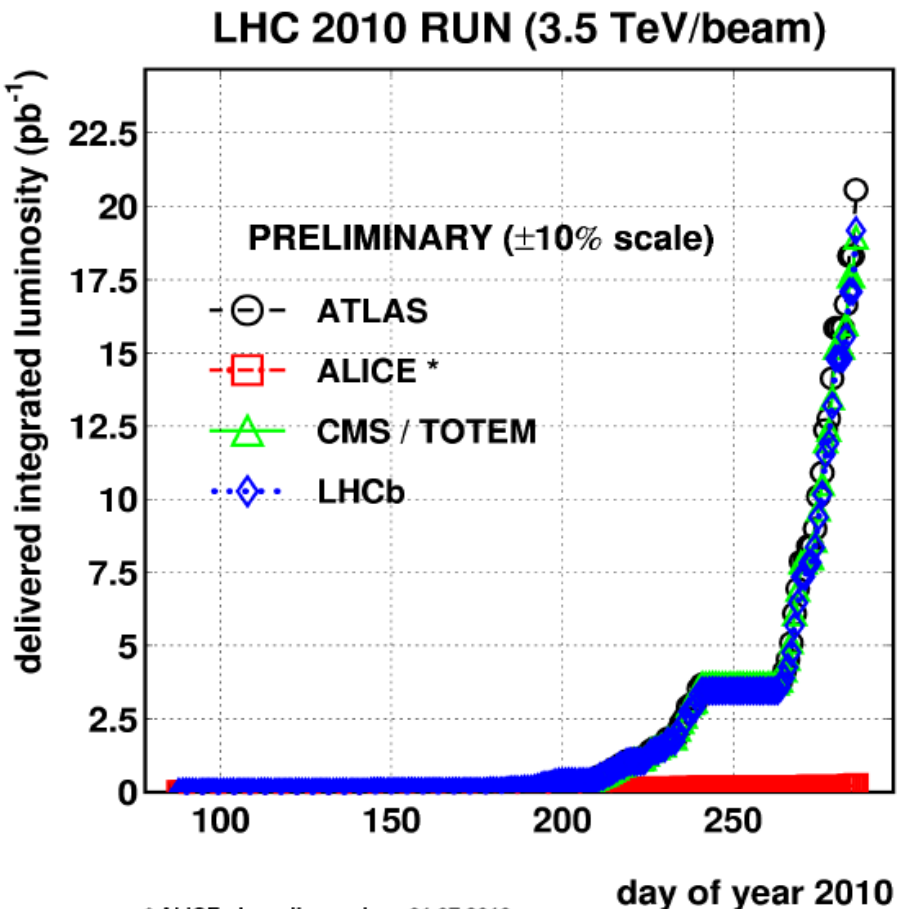
LHC machine status
(following talk of W.Venturini)

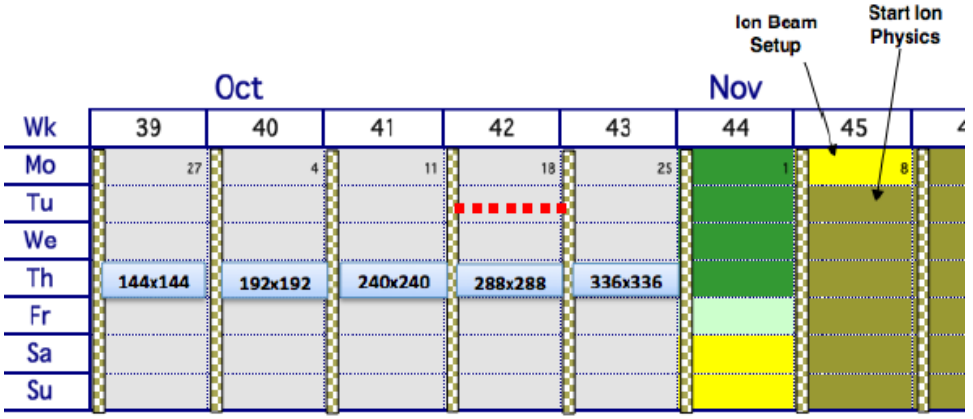
Date	Achieved	
Feb 28	Restart with beam.	
Mar 12	Ramp to 1.18 TeV.	
Mar 19	Ramp to 3.5 TeV.	
Mar 30	First collisions at 7 TeV centre of mass.	Luminosity ~ $2\,10^{27}$ cm^{-2} s^{-1}
Apr 01	Start squeeze commissioning.	Regular physics runs 2 on 2 bunches of 10^{10} Un-squeezed 1 colliding pairs per experiment Rates around 100Hz
Apr 07	Squeeze to 2 m in points 1 and 5.	
Apr 09	Single nominal bunch of 1.1 1011 stable at 450GeV.	
Apr 16	Squeeze to 2m in all points	
April 24	First stable beams at 7 TeV, 3 on 3, squeeze to 2m.	Luminosity ~ $2\,10^{28}$cm^{-2} s^{-1}
May	Increase bunch intensity to $2\,10^{10}$. Increase k_b.	Regular physics runs
May 24	13 on 13, 8 colliding pairs per experiment.	Luminosity ~ $3\,10^{29}$cm^{-2} s^{-1}
June	Increase bunch intensity to nominal, squeeze to 3.5m.	No physics !
June 25	First stable beams at 7 TeV, 3 on 3 nominal bunch.	Luminosity ~ $5\,10^{29}$cm^{-2} s^{-1}
July 15	13 on 13, 8 colliding pairs per experiment, $9\,10^{10}$/ bunch	Luminosity ~ $1.5\,10^{30}$cm^{-2} s^{-1}
July 30	25 on 25, 16 colliding pairs per experiment, $9\,10^{10}$/ bunch	Luminosity ~ $3\,10^{30}$cm^{-2} s^{-1}
Aug 19	48 on 48, 36 colliding pairs 1 5 and 8 (< in 2), $9\,10^{10}$/ bunch	Luminosity ~ $6\,10^{30}$cm^{-2} s^{-1}
Aug	Stable running period to consolidate operation and MP	~2 MJ per beam
4-10 Sept	Commissioning of 10A/s ramp, transverse FB, Xing angle studies	No physics !
10-22 Sept	Commissioning of bunch trains, setting up of protection devices	No physics !
23Sept-14 Oct	Stable beams with increasing k_b (56→104→152→200→248→....)	~15 MJ per beam, L ~ 10^{32} cm^{-2} s^{-1}

Impressive and successful commission strategy !

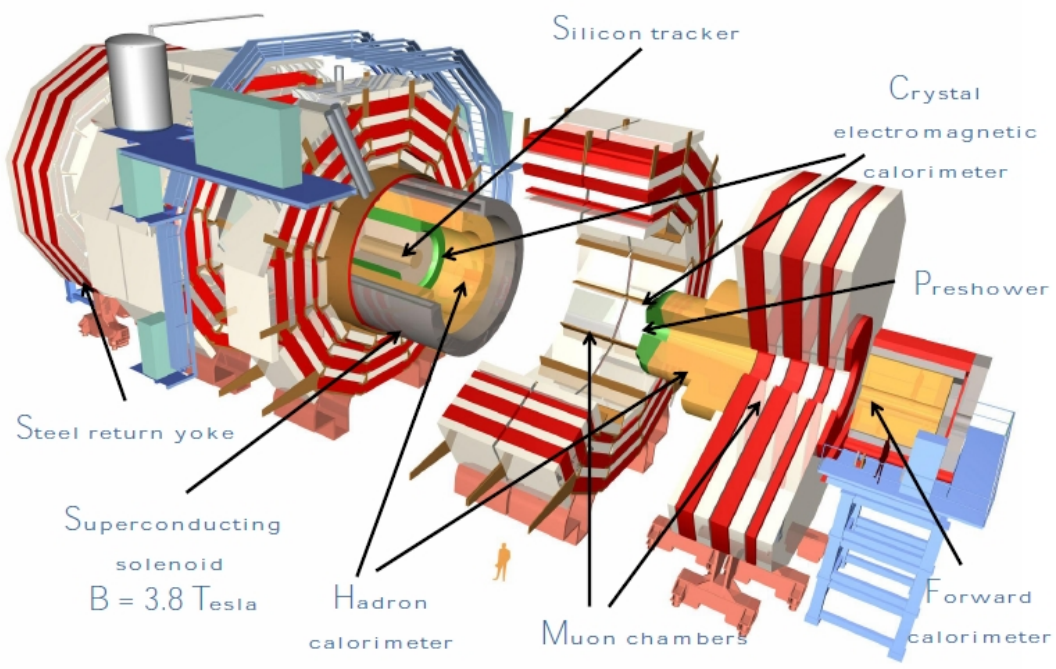
LHC machine status
(following talk of W.Venturini)

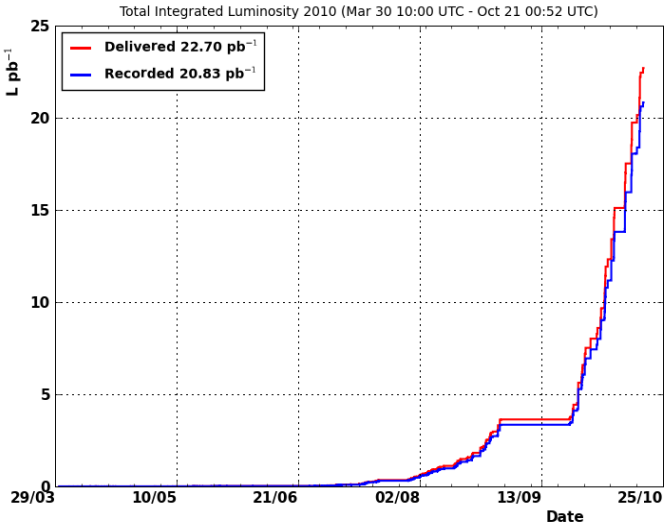
Bunch intensity – nominal(10^{11}), number of bunches increasing
Normalized emittance < nominal !
Peak luminosity L~1.4×10^{32} cm^{-2} sec^{-1} has been achieved
Expected integrated luminosity & end of 2010 run ~40-50 pb^{-1}
Prospects for 2011: L~2×10^{32} cm^{-2} sec^{-1} $\int Ldt \sim 1$ fb^{-1}
Important opened question – beam energy : 3.5 TeV, 4 TeV, 4.5 TeV ?

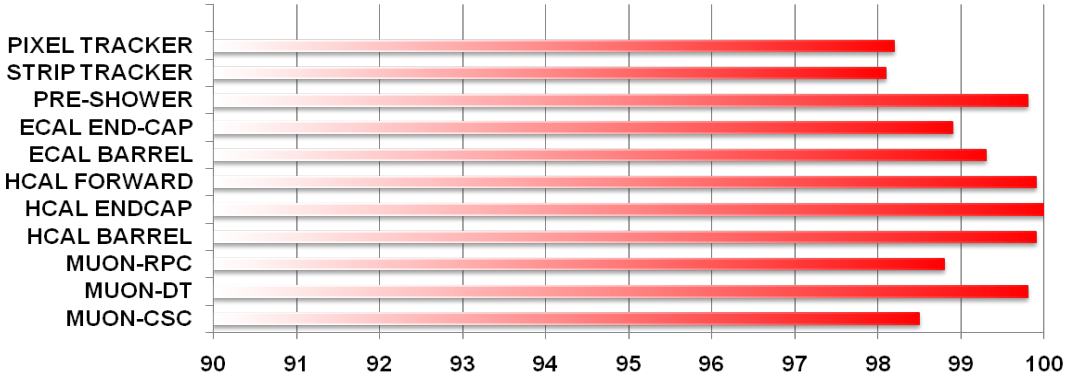




CMS experiment
(following talks of M.Jeitler, G.Boudoul, R.Castello)



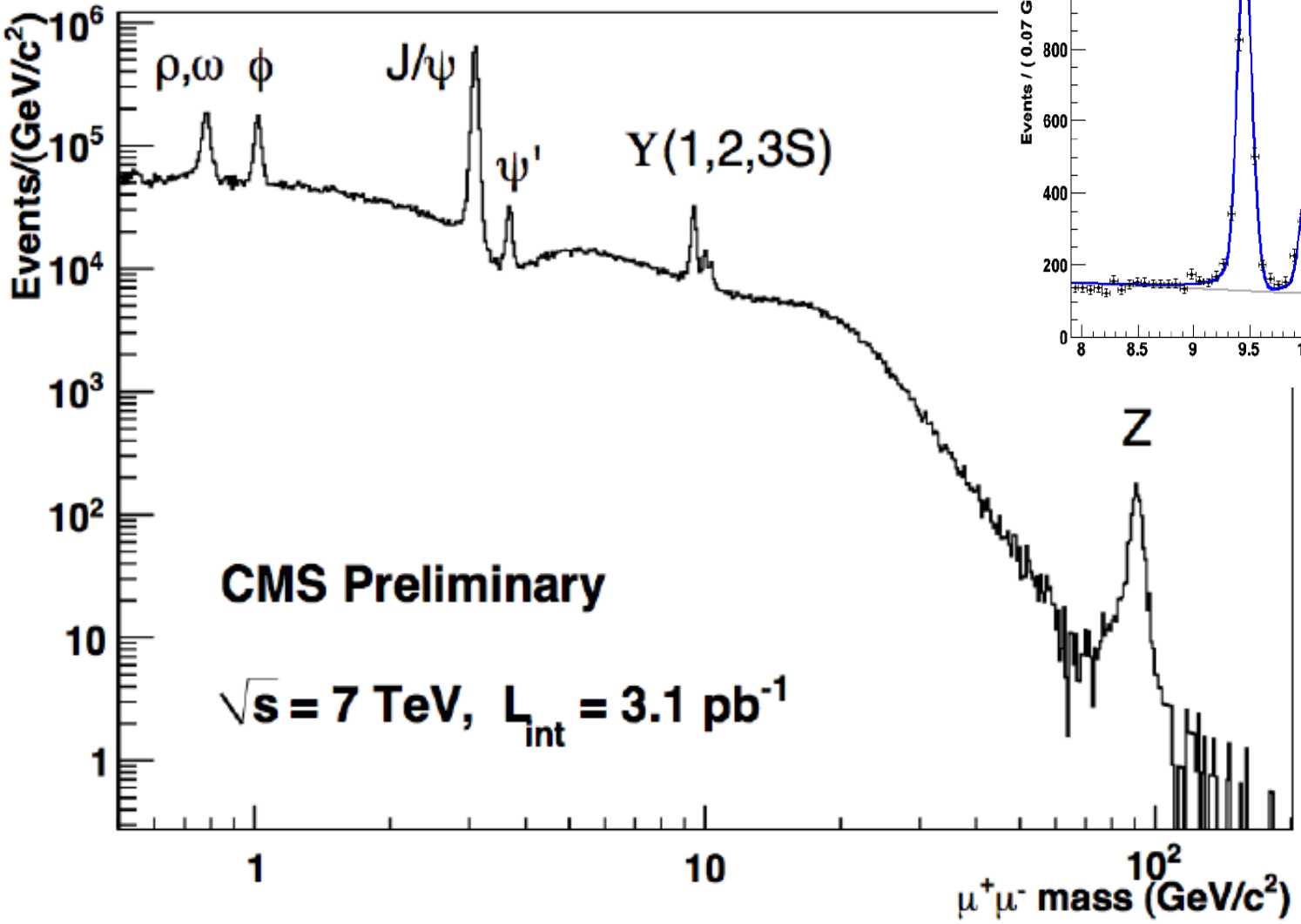


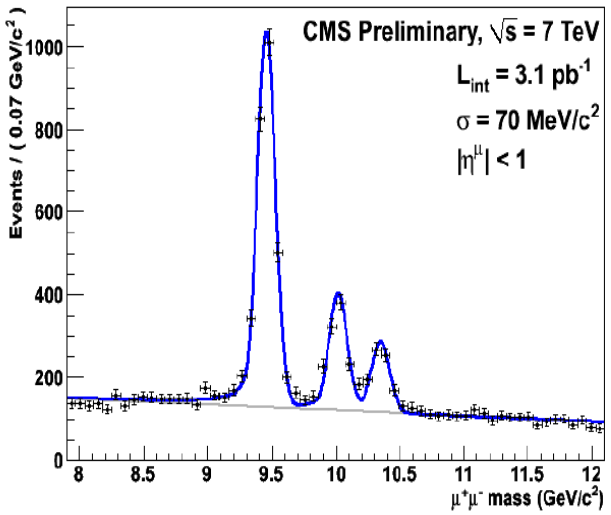


	MUON-CSC	MUON-DT	MUON-RPC	HCAL BARREL	HCAL ENDCAP	HCAL FORWARD	ECAL BARREL	ECAL END-CAP	PRE-SHOWER	STRIP TRACKER	PIXEL TRACKER	
Ряд1	98,5	99,8	98,8	99,9	100	99,9	99,3	98,9	99,8	98,1	98,2	

CMS experiment
(following talks of M.Jeitler, G.Boudoul, R.Castello)

Detector is in excellent state, dimuon spectrum is very impressive !

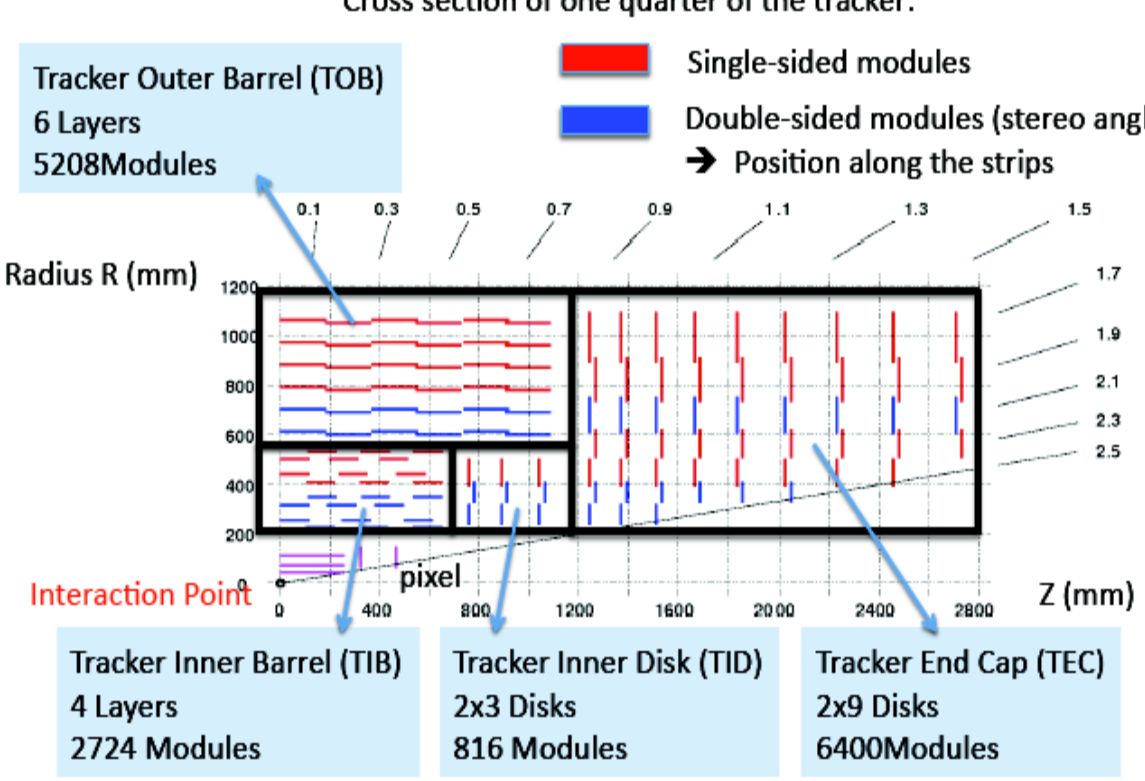


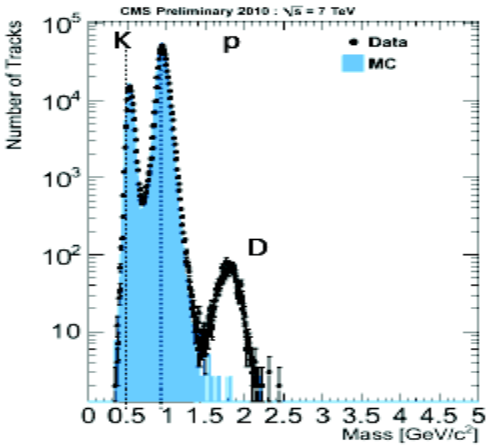


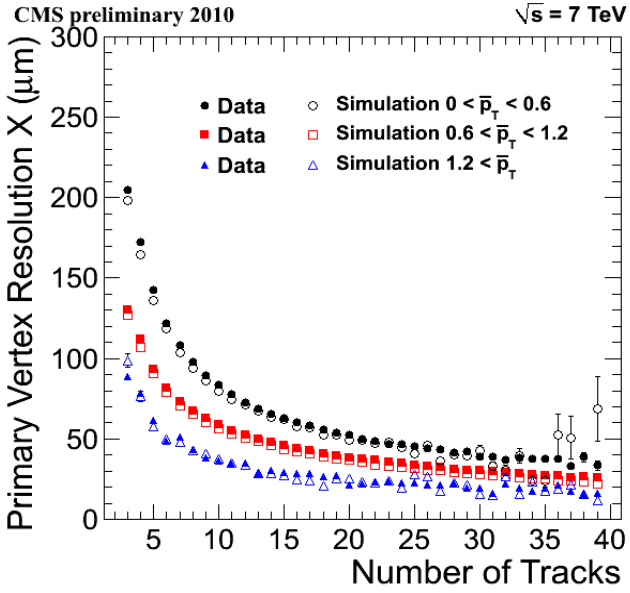
CMS experiment
(following talks of M.Jeitler, G.Boudoul, R.Castello)

Unique Si tracker, the largest ever built: 10M channels, ~200 m^2

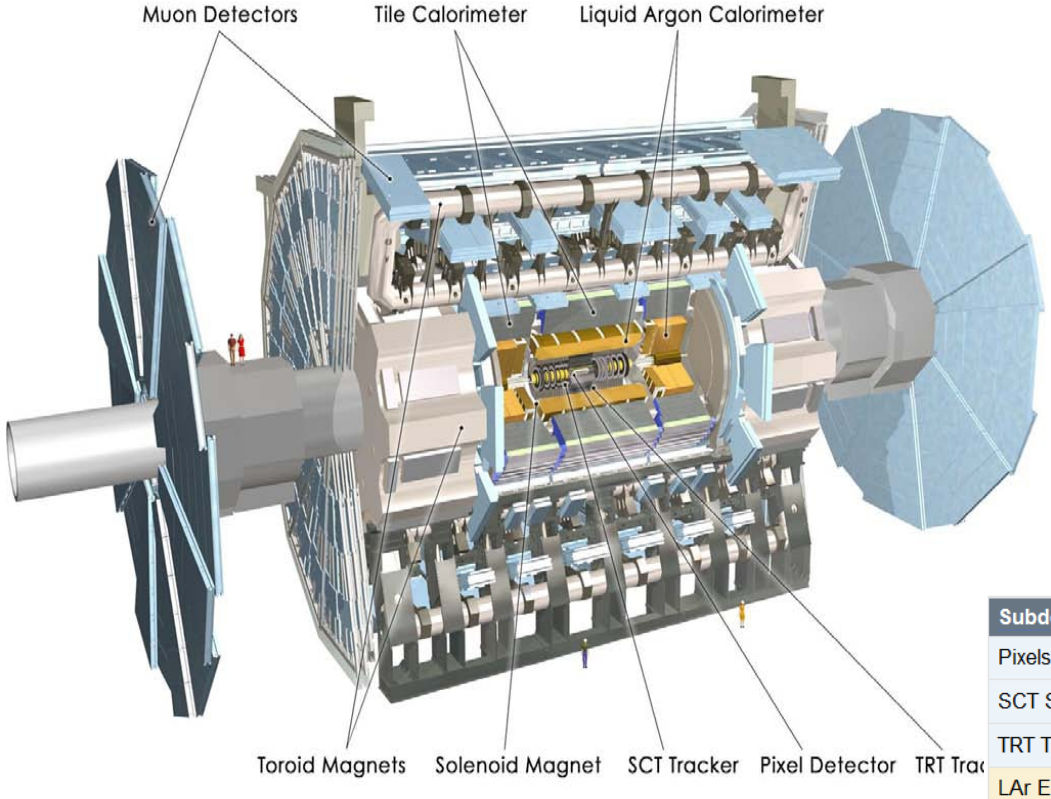
Cross section of one quarter of the tracker:

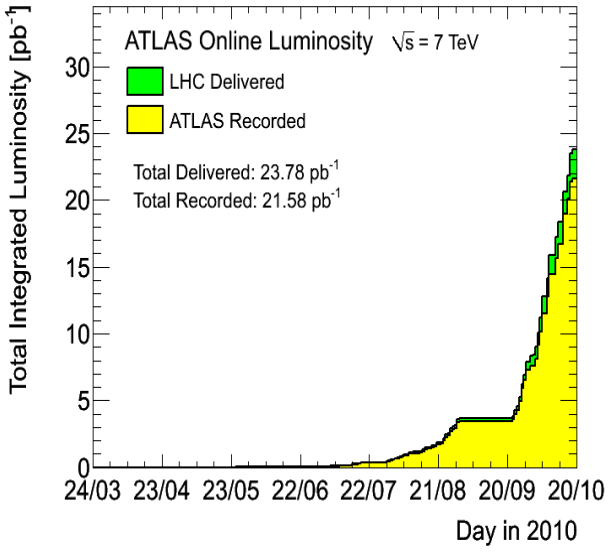






Atlas experiment
(following talks of A.Solodkov, R.Mashinistov,

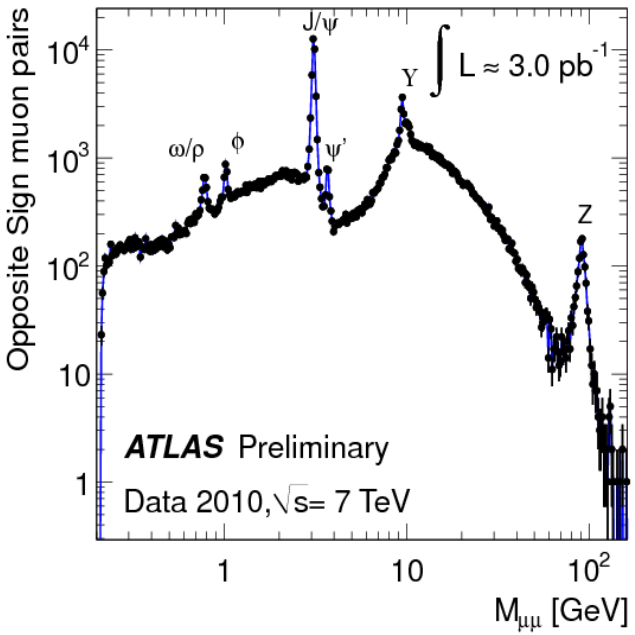


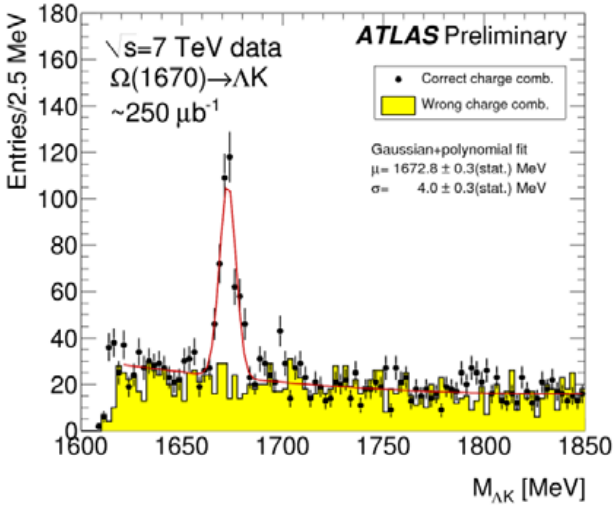


Length : ~ 46 m
Radius : ~ 12 m
Weight : ~ 7000 tons
~100M channels
3000 km of cables

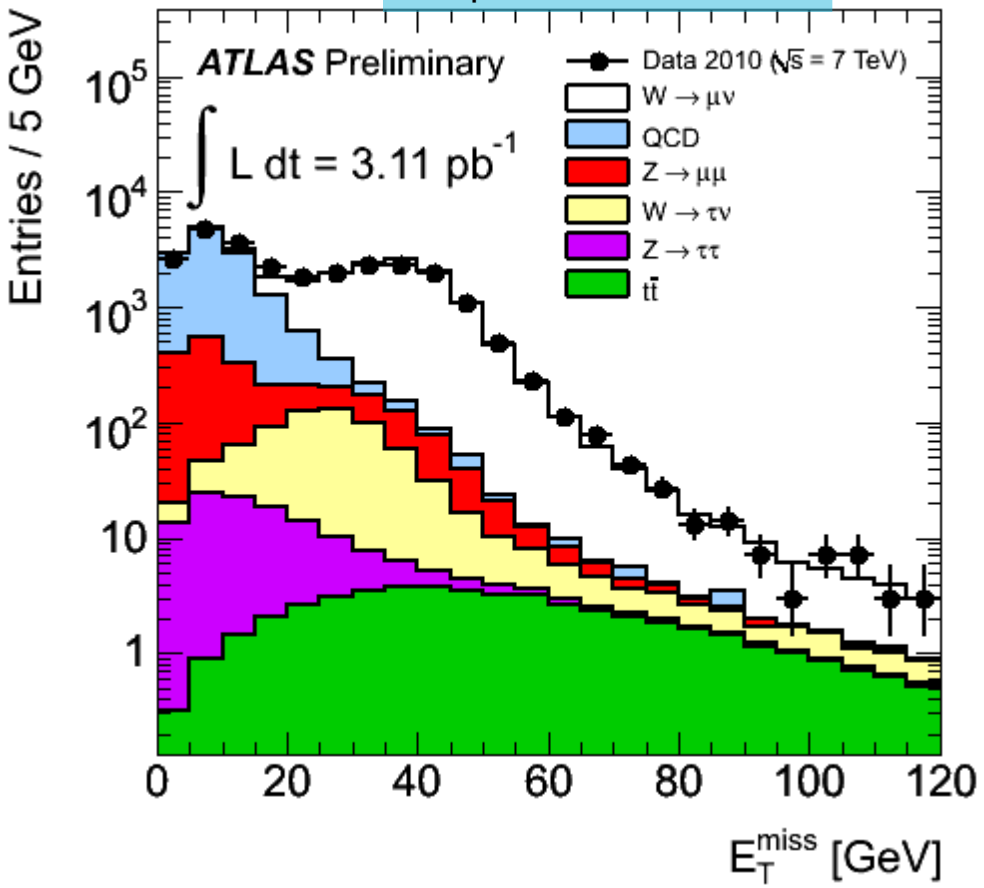
Subdetector	Number of Channels	Approximate Operational Fraction
Pixels	80 M	97.3%
SCT Silicon Strips	6.3 M	99.2%
TRT Transition Radiation Tracker	350 k	97.1%
LAr EM Calorimeter	170 k	98.1%
Tile calorimeter	9800	96.9%
Hadronic endcap LAr calorimeter	5600	99.9%
Forward LAr calorimeter	3500	100%
LVL1 Calo trigger	7160	99.9%
LVL1 Muon RPC trigger	370 k	99.5%
LVL1 Muon TGC trigger	320 k	100%
MDT Muon Drift Tubes	350 k	99.7%
CSC Cathode Strip Chambers	31 k	98.5%
RPC Barrel Muon Chambers	370 k	97.0%
TGC Endcap Muon Chambers	320 k	98.6%

Atlas experiment
(following talk of A.Solodkov)

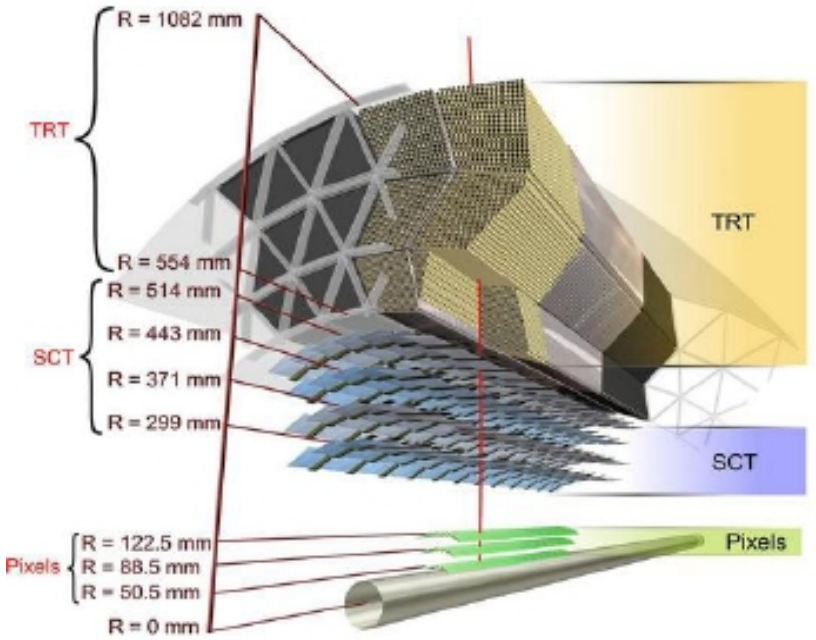




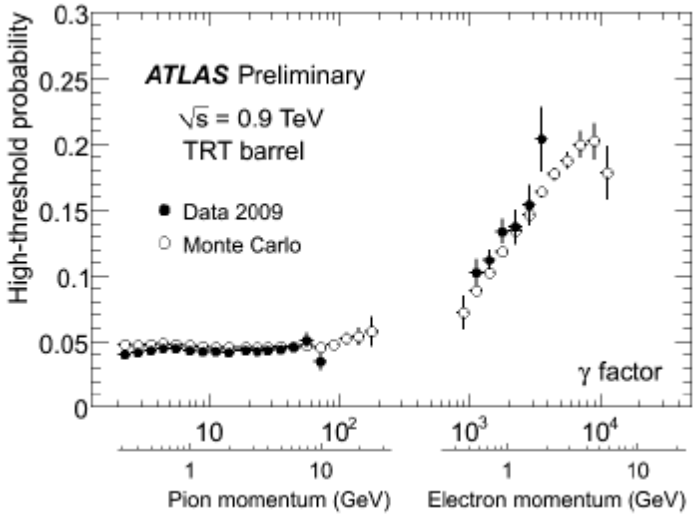
W→μν: 10397 events

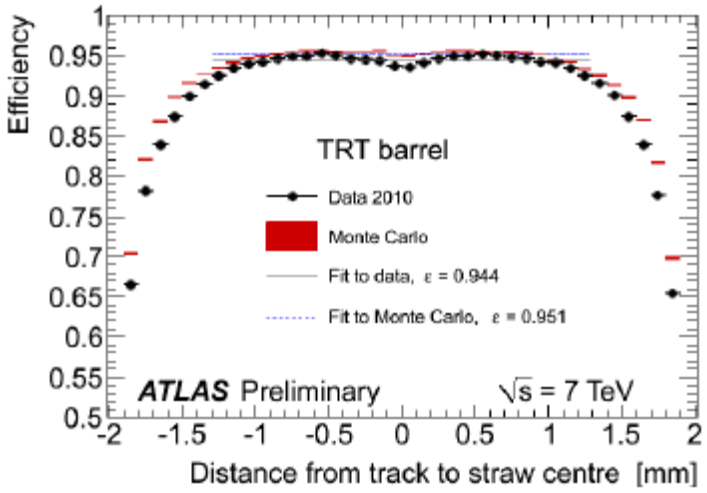


Atlas TRT
(following talk of R.Mashinistov)



Barrel 52544 straws, 1.44m
Each end-cap 122880 straws





Peculiarities of the LHCb experiment
(talk of I.Belyaev+ myself)

The concept of the experiment is to look for NP in rare processes with heavy b(c)-quarks: rare decays, flavour oscillations, CPV etc. Prooved to be effective:

$K_L \to \mu\mu \to m_c$ (Vainshtein,Khriplovich 1974) ;

$B^0 - \bar{B}^0 \to m_t > 100$GeV (Argus) ;

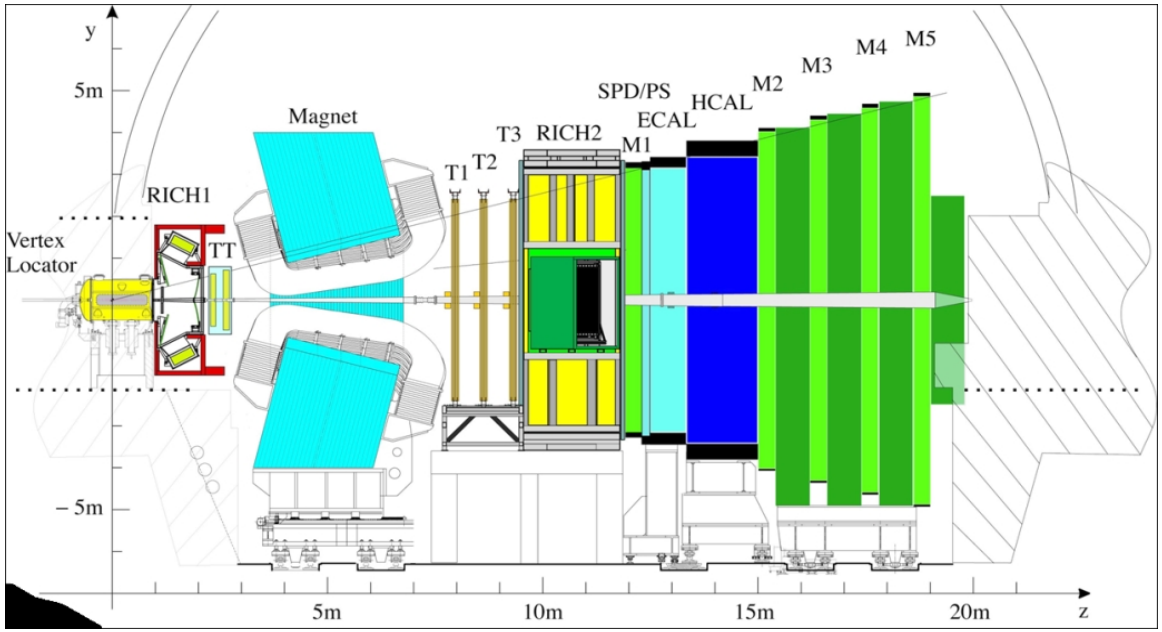
EW in Z decays $\to m_t = 175 \pm 12$ GeV; $m_H < 195$ GeV

LHC is good for b-physics: the $b\bar{b}$ xsection is large: $\sqrt{s}$=7-14 TeV $\sigma(b\bar{b}) \sim$300-500 μb; B_s, B_c, Λ_b available

forward spectrometer $2<\eta<5$; $0.9^o<\theta<16^o$ (4% of 4π) ~1/3 $\sigma(b\bar{b})$

Designed to work @ $L=2 \times 10^{32}$ $\to$ 2 fb^{-1} /year (10^7 sec); 0.4 int/pp

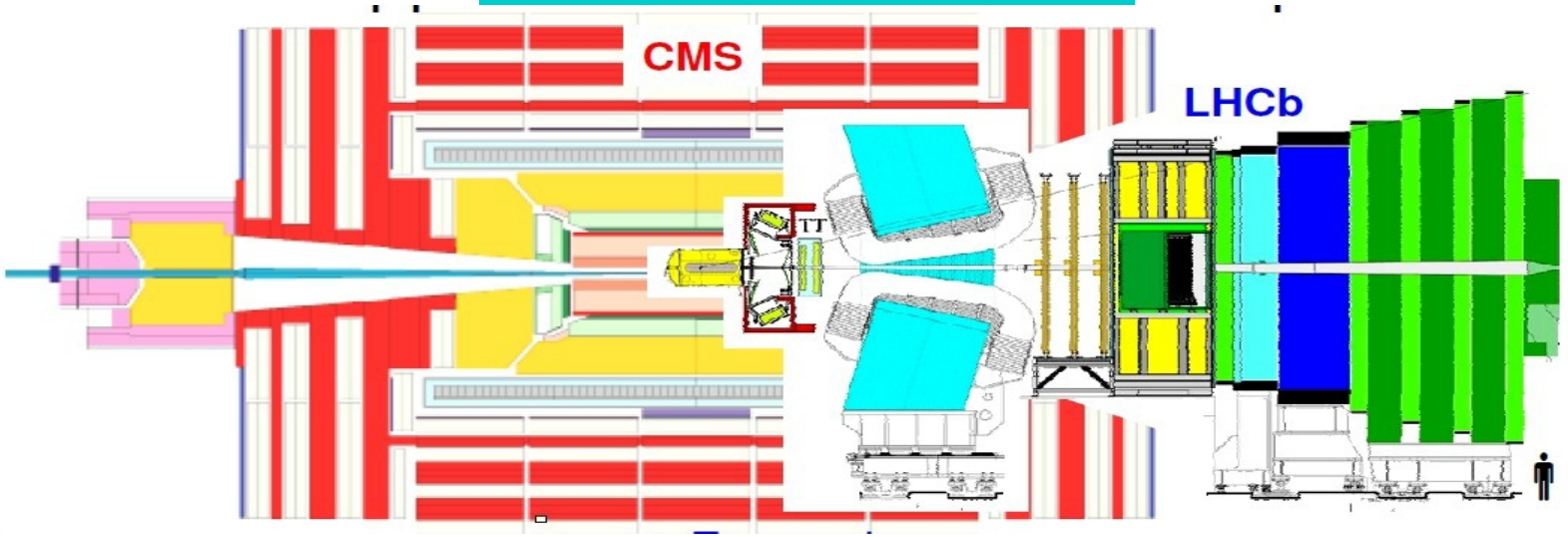
Features: PV @ IP resolution; particle ID: p, K, π, γ, μ, e

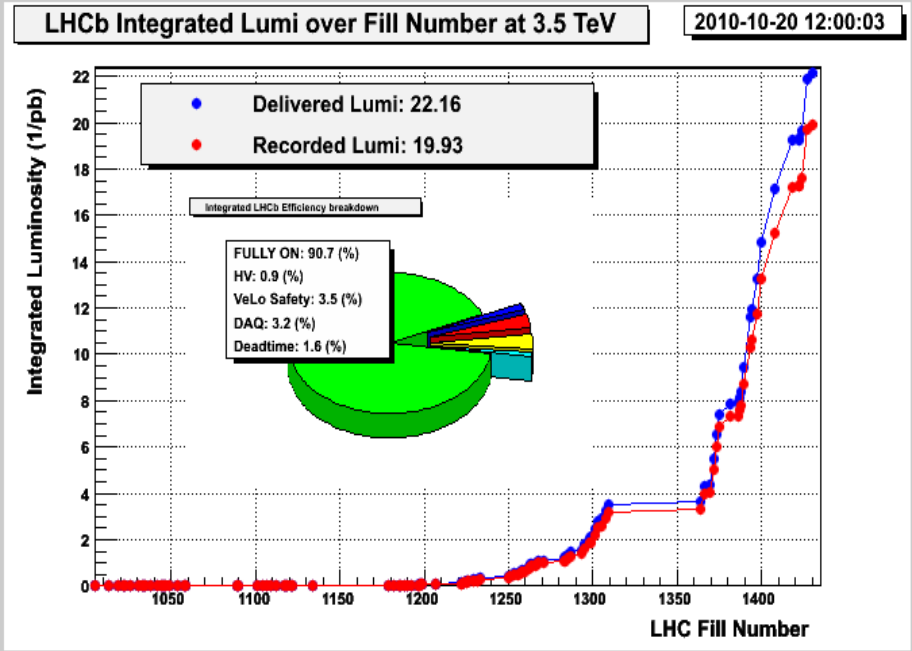


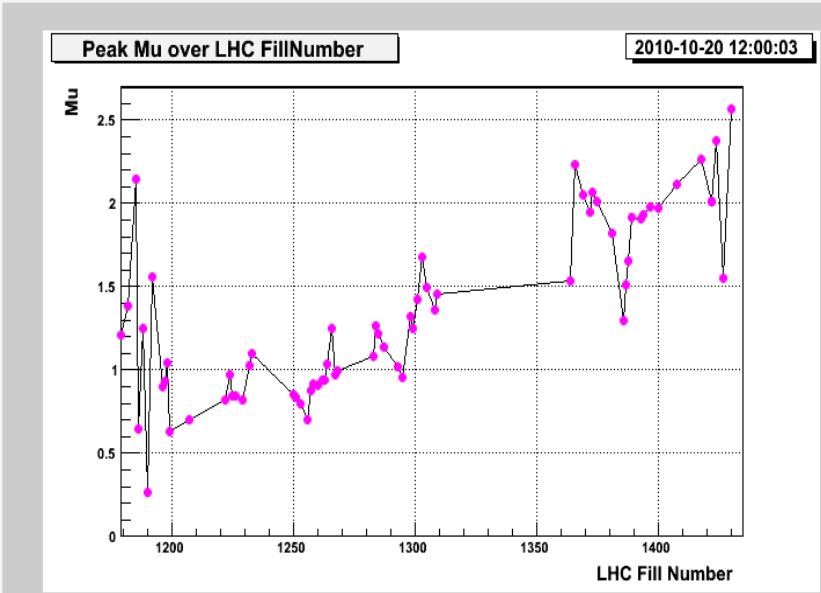
Main parts of LHCb

- vertex detector
- Tracking system (+magnet)
- RICH 1,2
- Calorimeters
- Muon system
- Trigger&DAQ

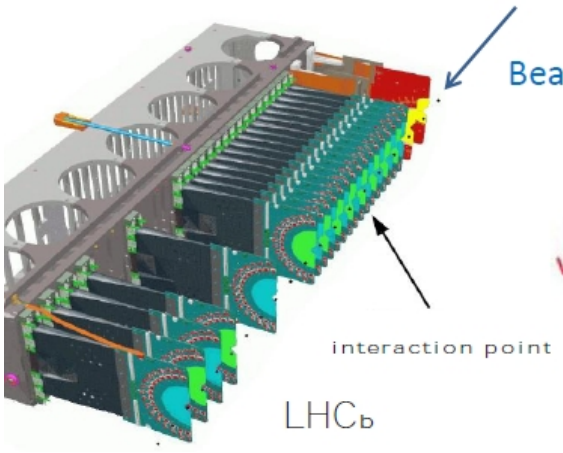
LHCb data taking

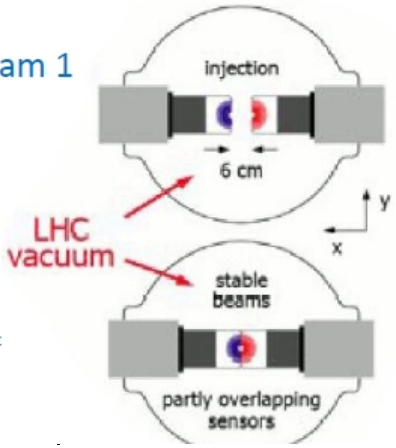






LHCb Vertex Locator (VELO)

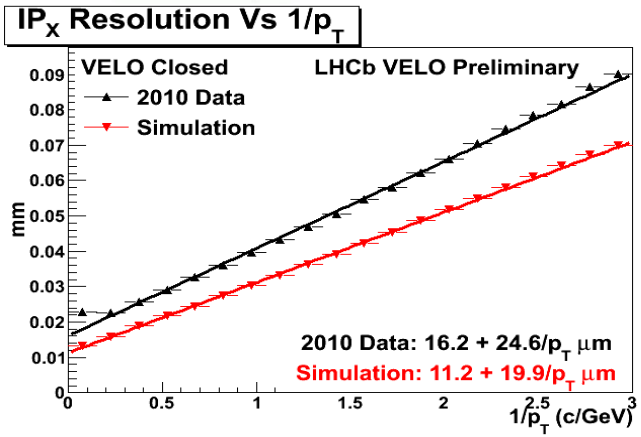


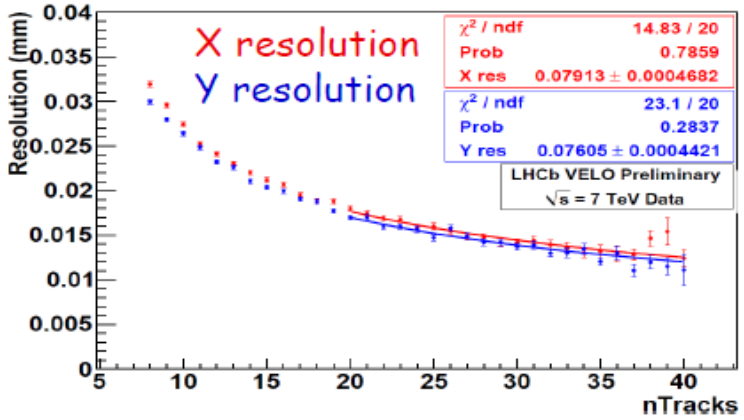


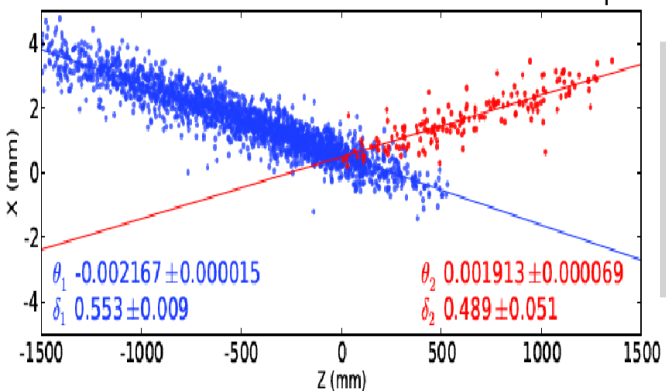
2 retractable halfs; 21 stations/half R/φ-strips; pitch 40-100μm; 8 mm from beam (physics); 172K channels

PV : $\sigma_{x,y}$ ~15 μm ; σ_z ~90 μm (>20 trk)

IP : $\sigma_{x,y}$ ~16 μm MC : $\sigma_{x,y}$ ~11 μm ; σ_z ~60 μm

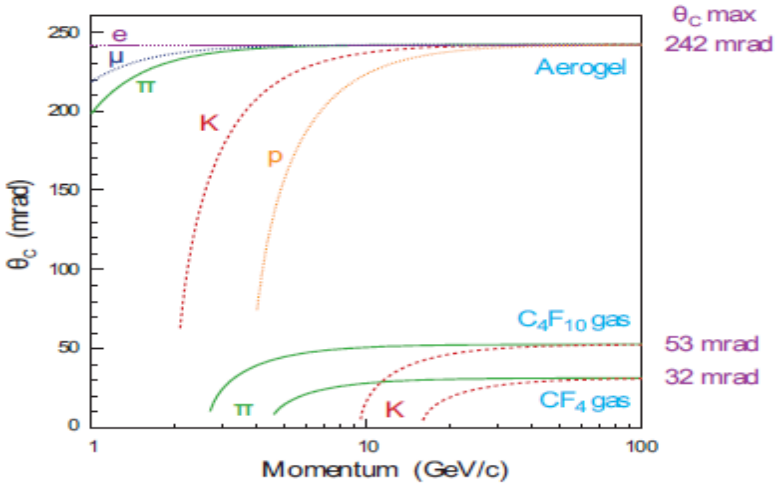


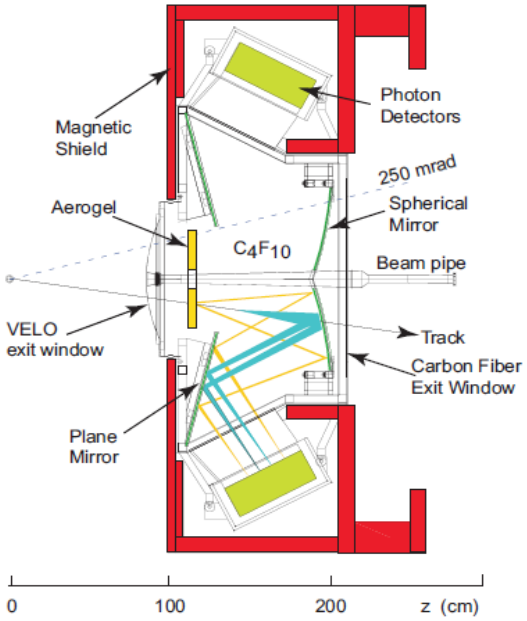




VELO provides new method of L measurement «beam-profile» reconstructing vertexes of beam-gas interactions

RICH detectors

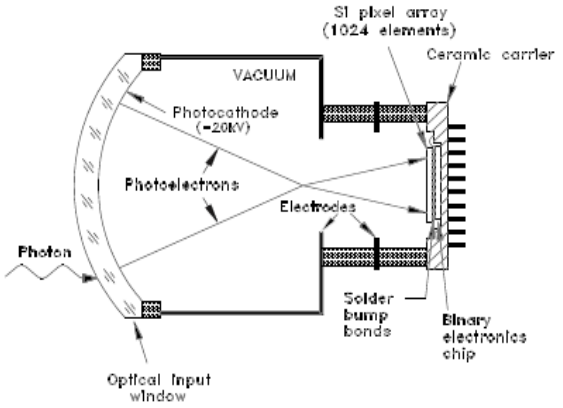




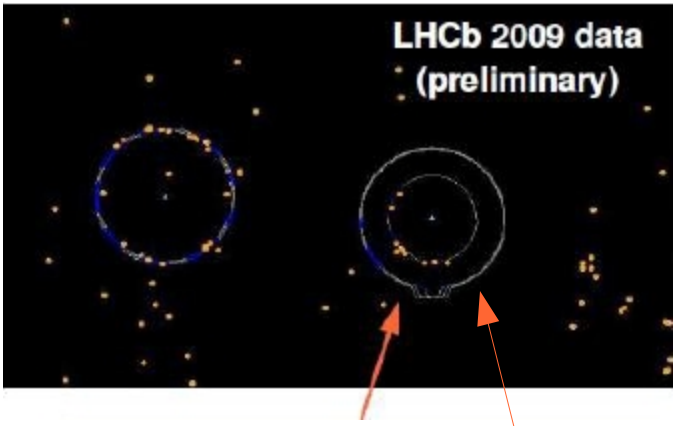
RICH1: Aerogel n=1.03, p=2-10 GeV ; C_4F_{10} n=1.0014, p=10-60 GeV
Carbon fibre spherical mirrors 2% X_0

RICH2: CF_4 n=1.0005 p=15-100 GeV

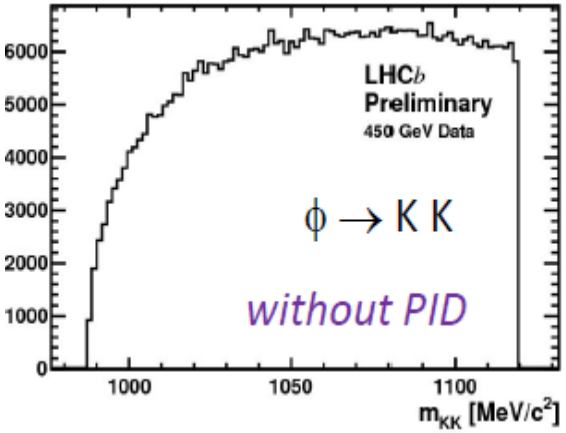
Hybrid Photon Detector (position sensitive)
HV -20 kV; 1024 Si pixels 0.5×0.5 mm^2 → 2.5×2.5 mm^2 granularity
196+288 tubes

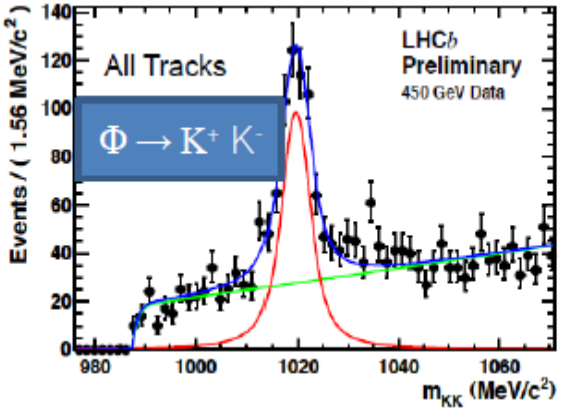


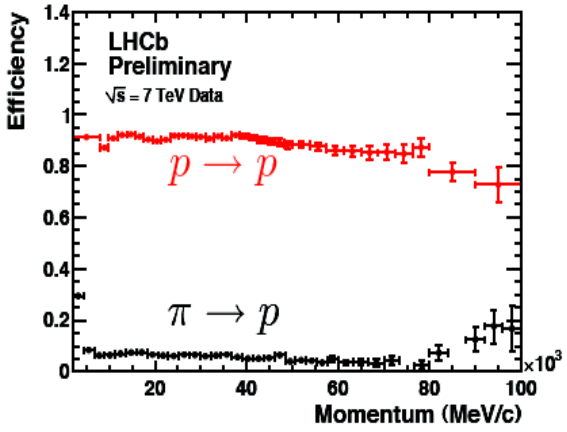
RICH performance

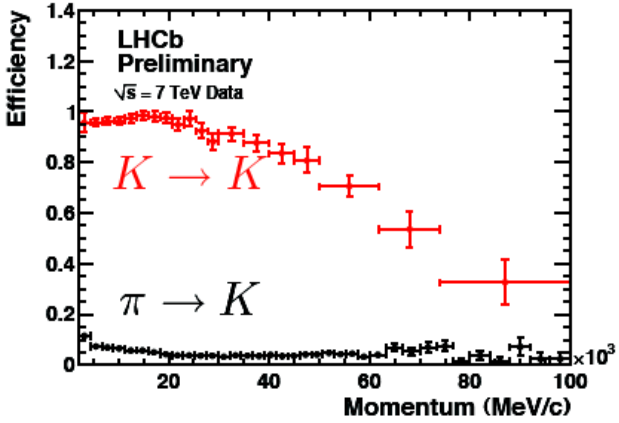


π – hypothesis K



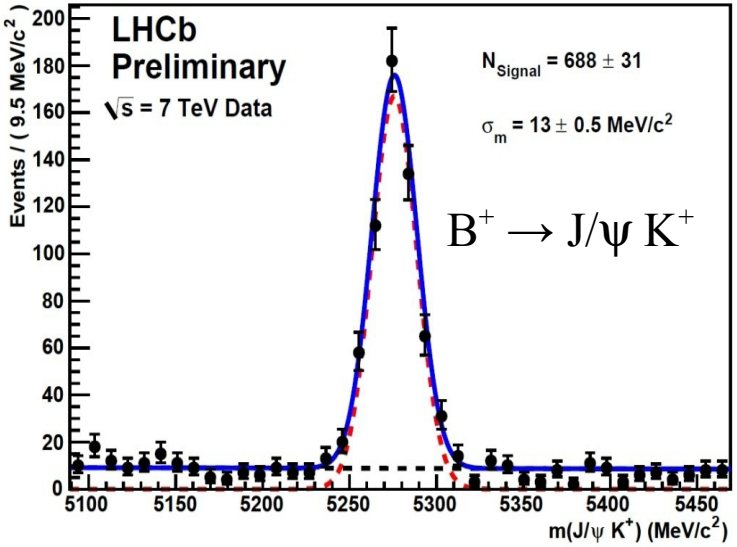


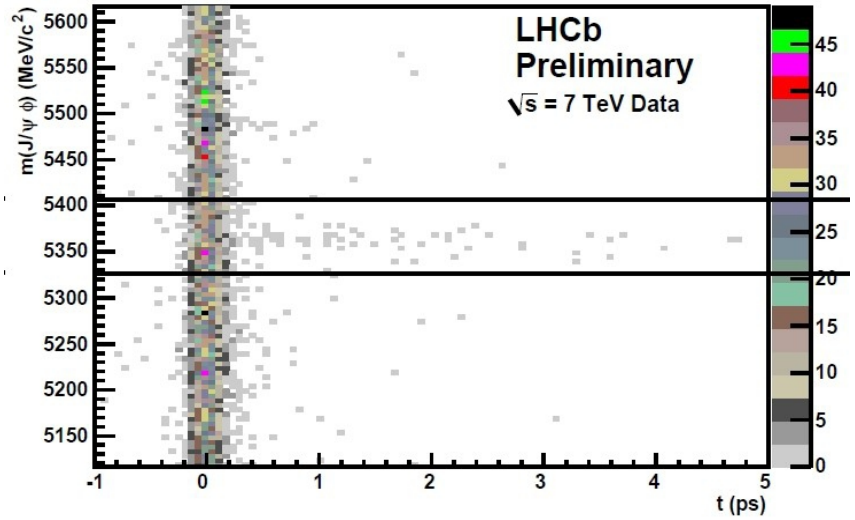




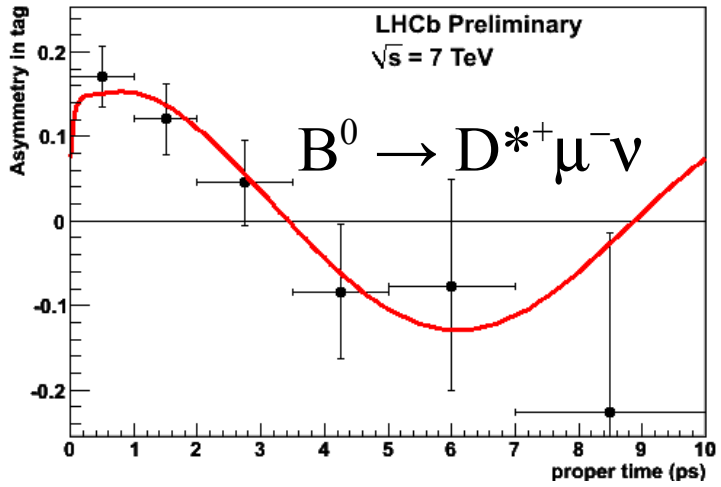
Standard «candles» $K_s \to \pi^+\pi^-$ $\Lambda \to p\,\pi^-$ $\varphi \to K^+ K^-$
used to estimate the performance

Fully reconstructed B-decays ~3 pb^{-1}
B-oscillations

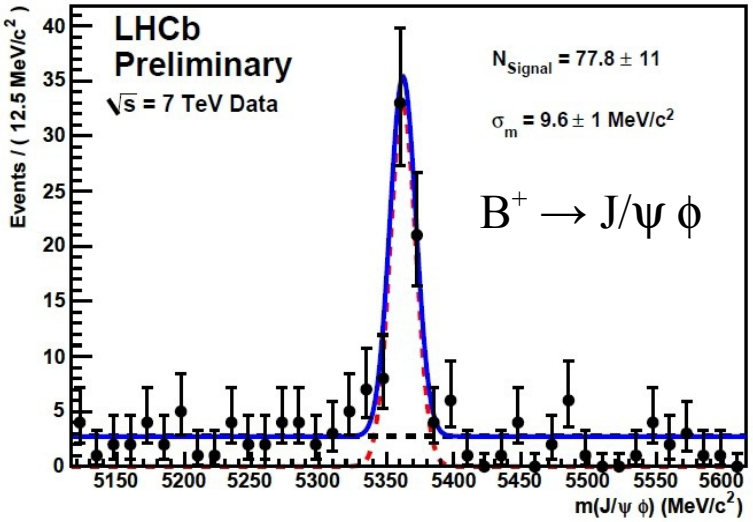




Flavour Oscillation signal region



t > 0.30 ps



Conclusions

- LHC machine is in a very good state , progress in 2010 is impressive
- LHC detectors are in an excellent state , the concept of the detectors proven with data
- First physics results are published
- In the year 2011 LHC detectors will reach the frontiers of knowledge in HEP
- I Wish NP discoveries for everybody