B-Physics Status and Prospects with the ATLAS Experiment

22nd Rencontres de Blois

On Behalf of the ATLAS Collaboration
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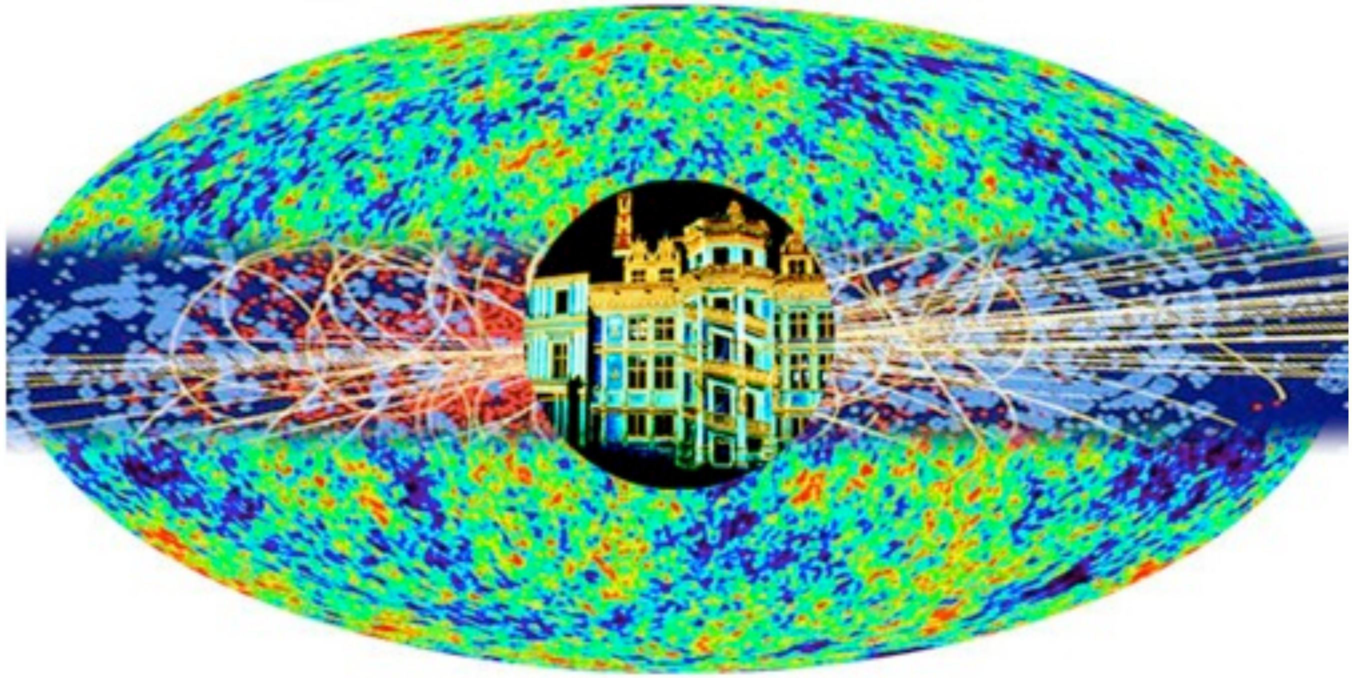
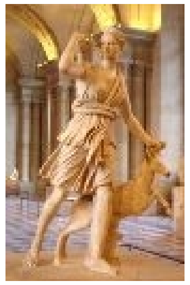
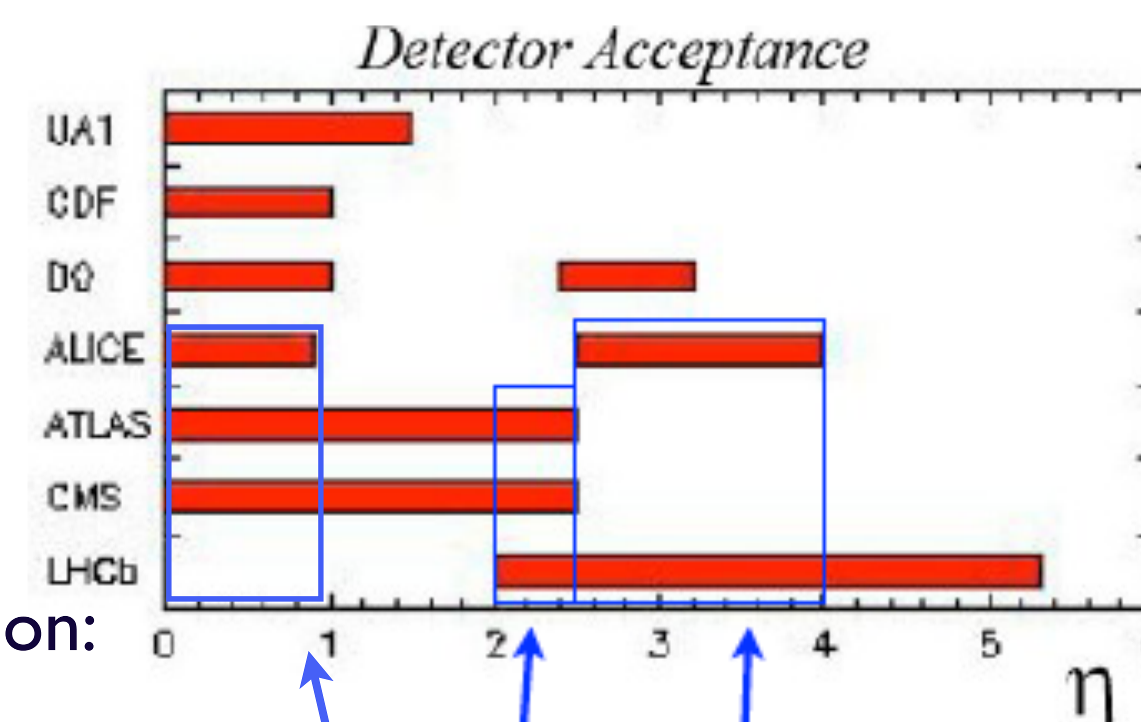




The importance of the B-physics program for the general purpose experiments ATLAS and CMS

- Complement the B-physics program of the dedicated LHCb experiment. (Some limited studies on B-decays will be performed by ALICE)
  - Access different rapidity regions
  - Fully profit from trigger capabilities at high luminosity
- Provide excellent means for detector performance studies at start-up
  - Mass position and resolution down to low mass regions (Inner Detector (ID) and Muon Spectrometer (MS))
  - Muon momentum scale calibration and muon efficiency for low pT muons (Tag and Probe method using J/ψ and ϒ)
  - Secondary vertex reconstruction and ID/MS relative alignment
  - Validate b-tagging algorithms
- Provide measurement of bb(bar)cross section: Important for several high pT channels
  - Higgs searches
  - New Physics



ATLAS and CMS Overlap regions with ALICE and LHCb

B-physics timeline-program for ATLAS and CMS

Start-up — **End 2010** — **End 2011**

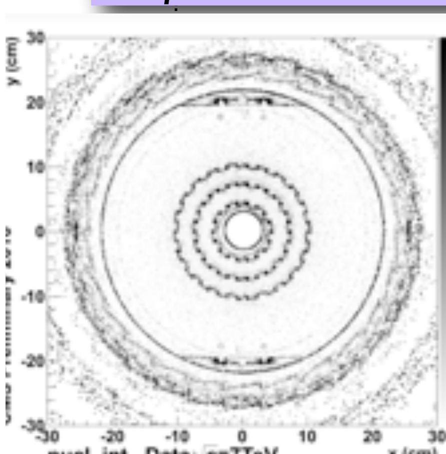
$\int \mathscr{L}$: 10 pb^{-1} → 100 pb^{-1} → 1fb^{-1} → 10fb^{-1} → 100fb^{-1}

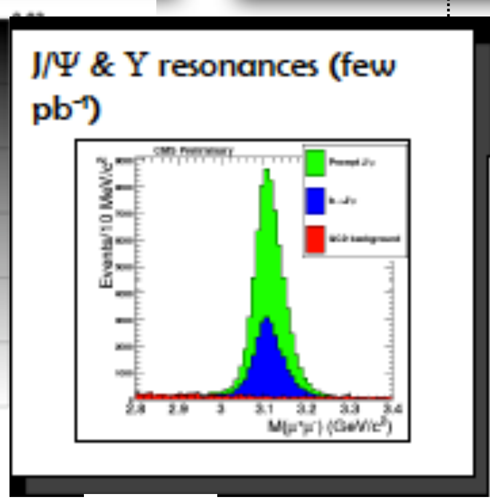
- *Detector and trigger understanding and calibration*
- *J/ψ, ϒ and exclusive B-channels measurement (testers)*
- *Early measurements of b-production and decays*

- *B-hadron properties: polarization ...*
- *New decay limits*
- *Study background for rare decays*

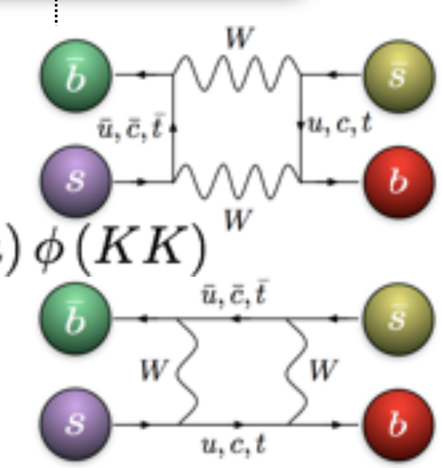
- *Searches for CP-violation in weak decays of B-mesons*
- *Rare decay searches*
- *Λb polarization*

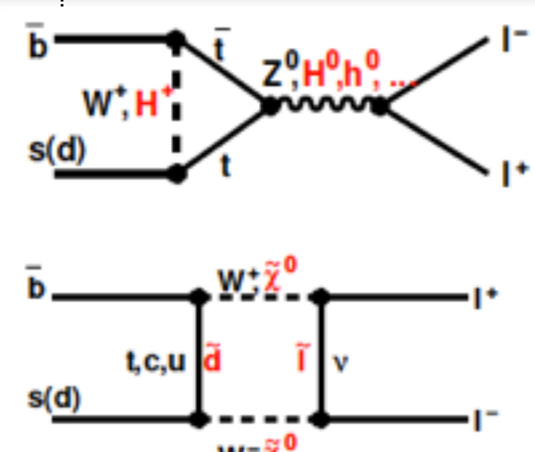
- *CP- violation*
- *Rare decays*





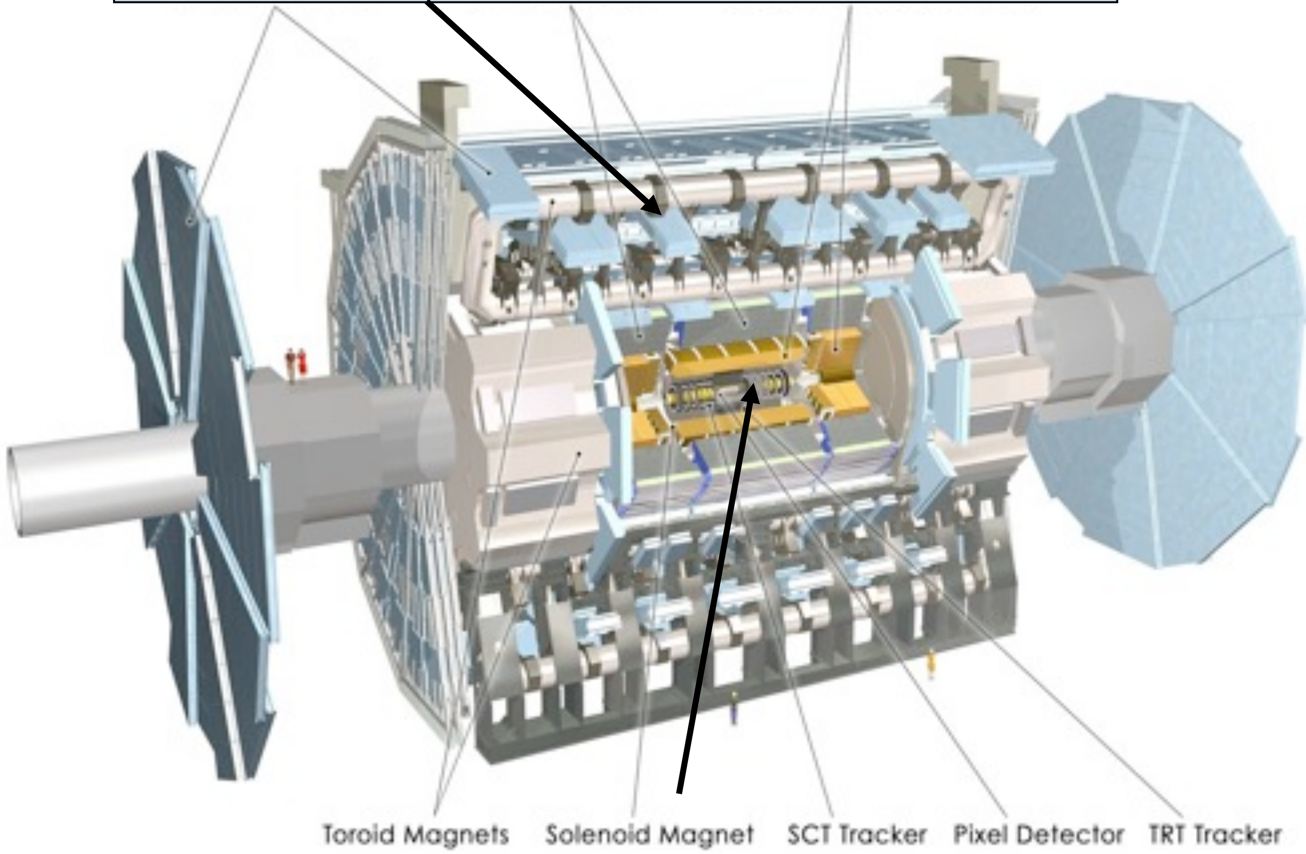
$$\left\{ \begin{array}{l} B_s^0 \\ \bar{B}_s^0 \end{array} \right\} \rightarrow J/\psi\,(\mu\mu)\,\phi\,(KK)$$





The ATLAS and CMS Detectors

Muon Spectrometer (|η|<2.7) : air-core toroids with gas-based muon chambers.
Muon trigger and measurement with **momentum resolution < 10% up to Em ~ 1 TeV**

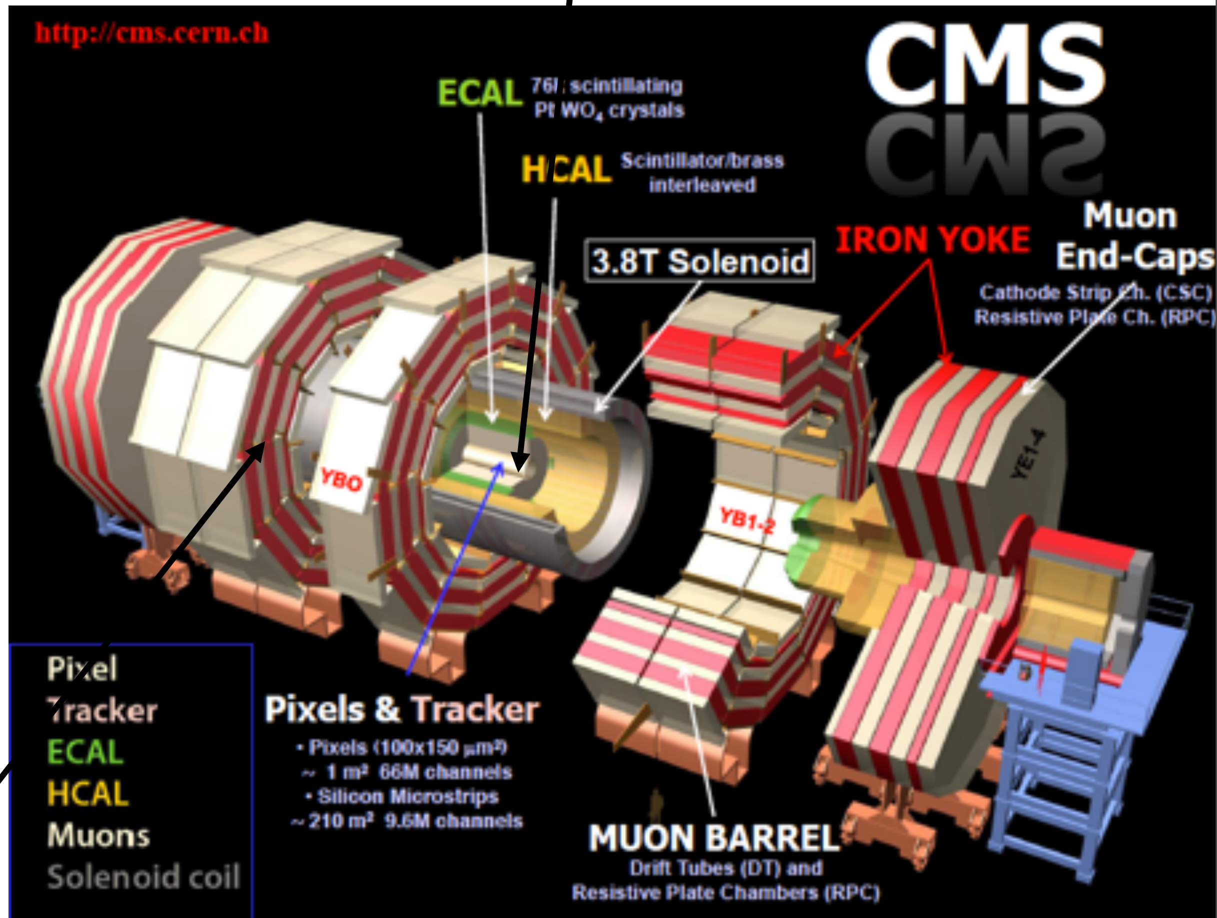


Inner Detector (|η|<2.5, B=2T):
Si Pixels, Si strips,
Transition Radiation detector (straws)
Precise tracking and vertexing,
e/π separation
Momentum resolution:
$\sigma/pT \sim 3.4\times10^{-4}$ pT (GeV)+0.015

Inner Detector (|η|<2.5, B=3.8T):
Si Pixels and Microstrip detector,

Precise tracking and vertexing,

Momentum resolution:
$\sigma/pT \sim 1.5\times10^{-4}$ pT (GeV)+0.005

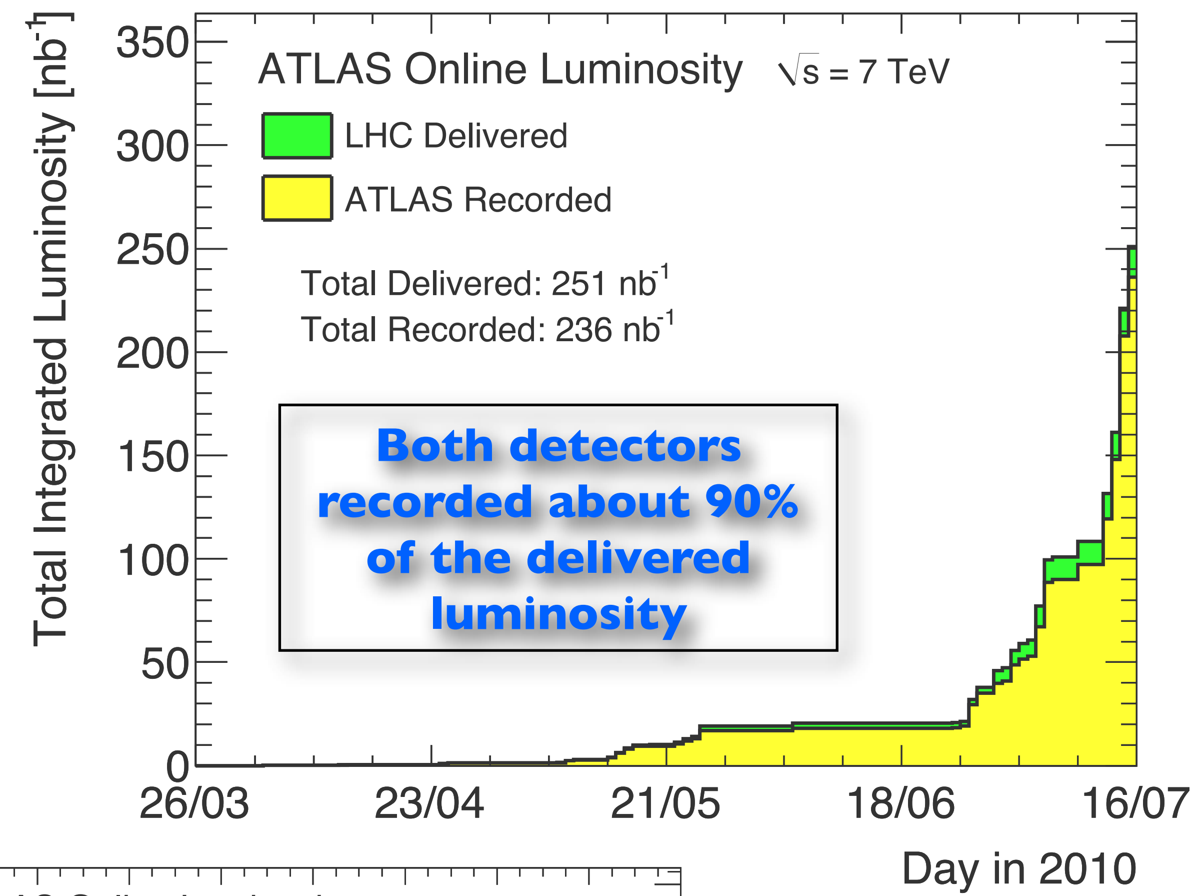


Muon Spectrometer (|η|<2.4) in iron return yoke with gas-based muon chambers.
Muon trigger and measurement with **momentum resolution ~5% for~ 1 TeV** with inner tracker

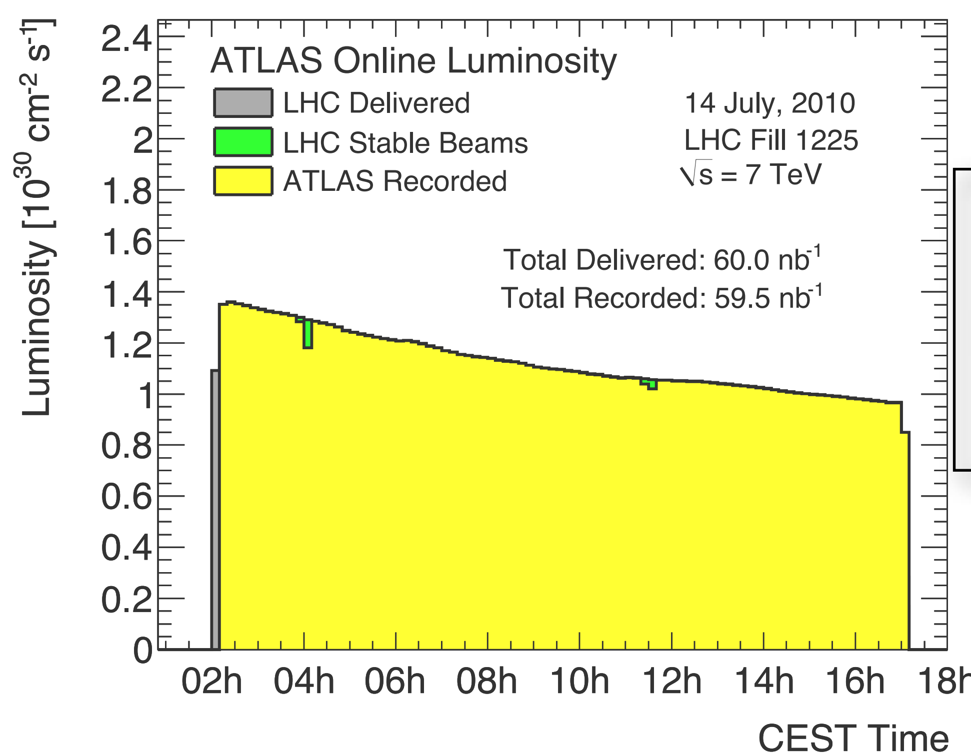
Overall Statistics for 7 TeV Collisions

Key elements for B-physics searches at LHC

- Dedicated efficient trigger based on low pT muons
- Muon coverage: |η|<2.7 (ATLAS), |η|<2.4 (CMS)
- Track resolution for momentum and mass measurements
- Secondary vertex resolution



Both detectors performed remarkably well already at the start-up of LHC



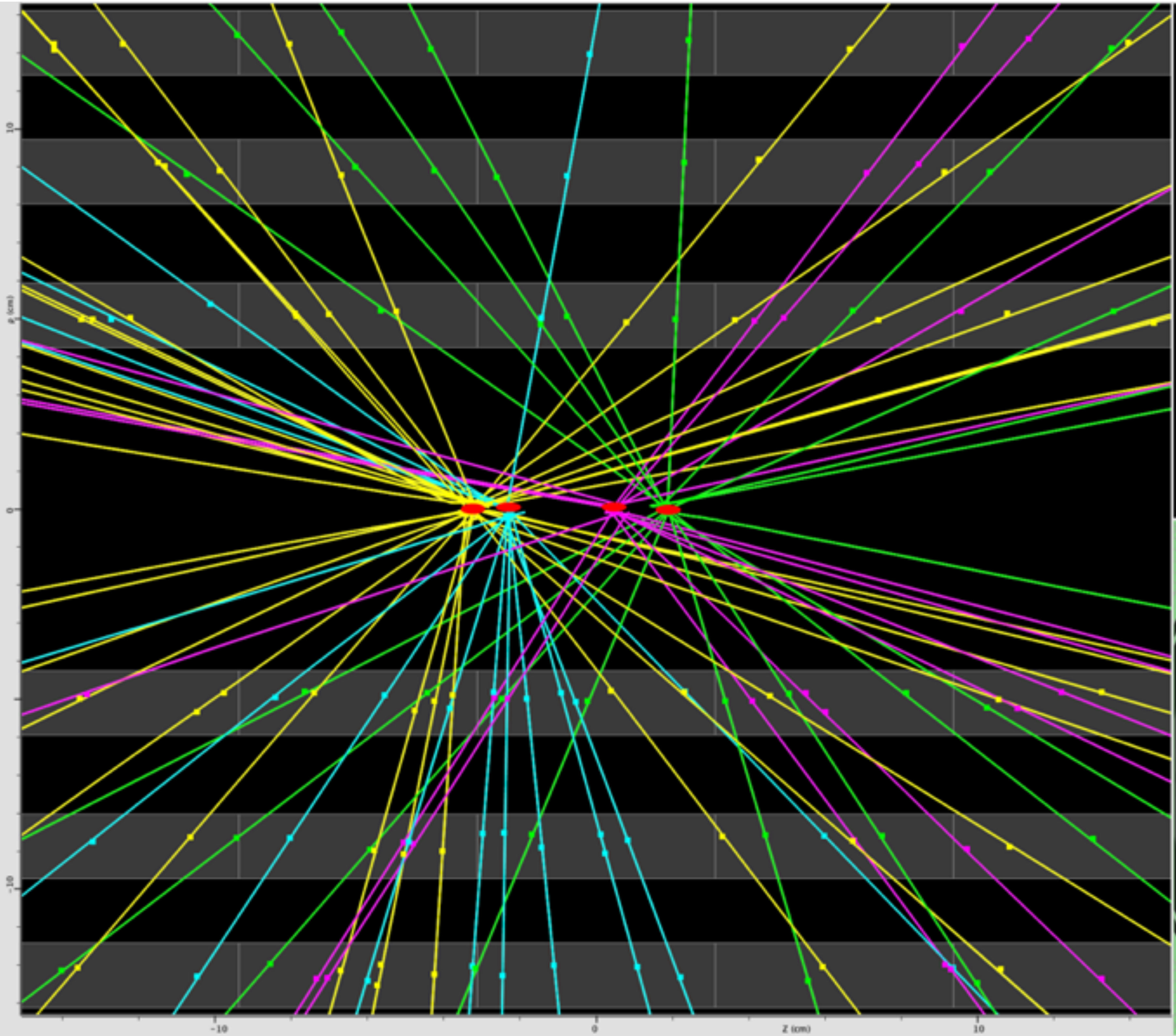
60 nb^{-1} in one fill on July 14th
59.5 nb^{-1} recorded
Peak luminosity 1.4×10^{30}

Trigger strategy for B-physics at the current low luminosity period, in ATLAS

- Profit from the low luminosity to understand Level 1 (L1) and High Level Trigger (HLT) performance for B-physics
  - During the start-up period: $L < 10^{28}$ Use minimum bias trigger (MBTS)
    - based on trigger scintillators at z: ± 3.5m from Interaction Point (IP) cover: $2.09<|\eta|<2.82$, $2.82<|\eta|3.84$ (two rings)
    - >99.5% efficient (any track multiplicity)
    - Not prescaled
  - For $L\sim10^{28}$, MBTS based High Level muon trigger→study L1 muon efficiency (look for muon reconstructed at the Muon Spectrometer)
  - For $L\sim10^{29}$, L1 Muon trigger→study dedicated B-triggers' efficiency (no requirement on muon pT)

As we have entered the $L>10^{30}$ era dedicated non-prescaled B-triggers are now in effect

A 7 TeV collision event with four pile-up vertices reconstructed

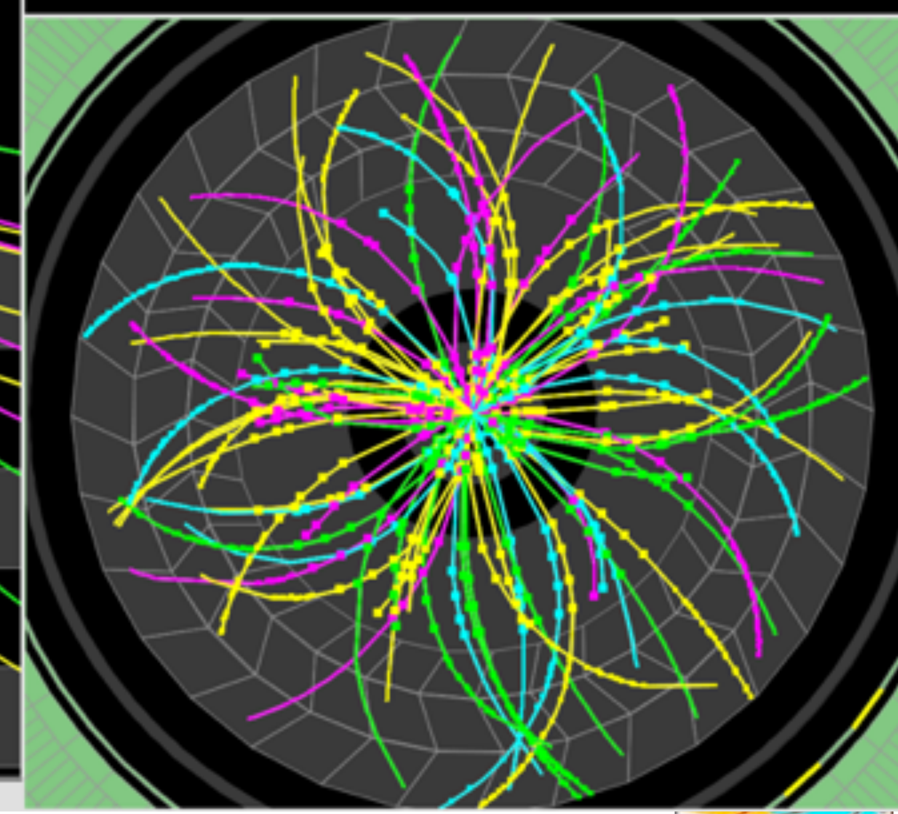


ATLAS EXPERIMENT

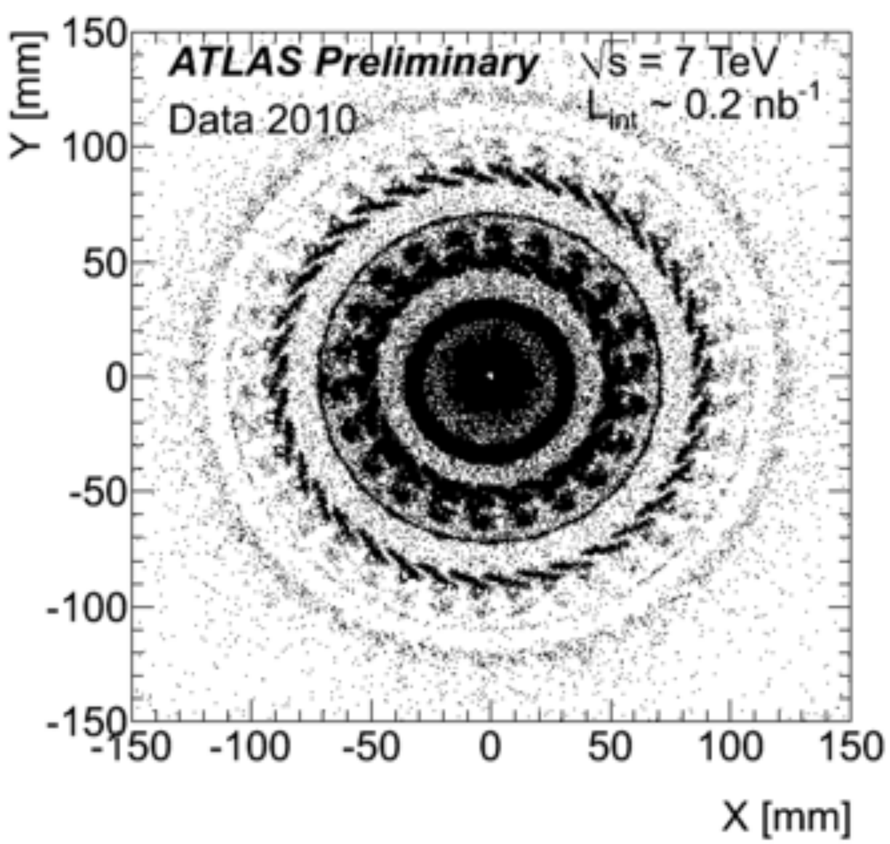
Run Number: 153565, Event Number: 4487360

Date: 2010-04-24 04:18:53 CEST

Event with 4 Pileup Vertices in 7 TeV Collisions

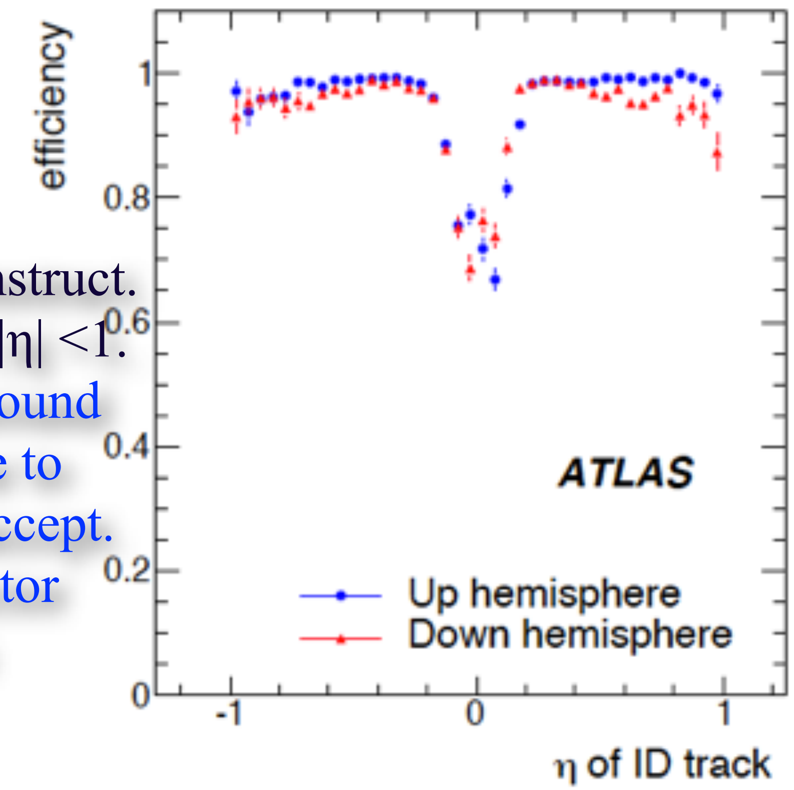


Inner Detector (7TeV data) and Muon Spectrometer performance (Cosmics)

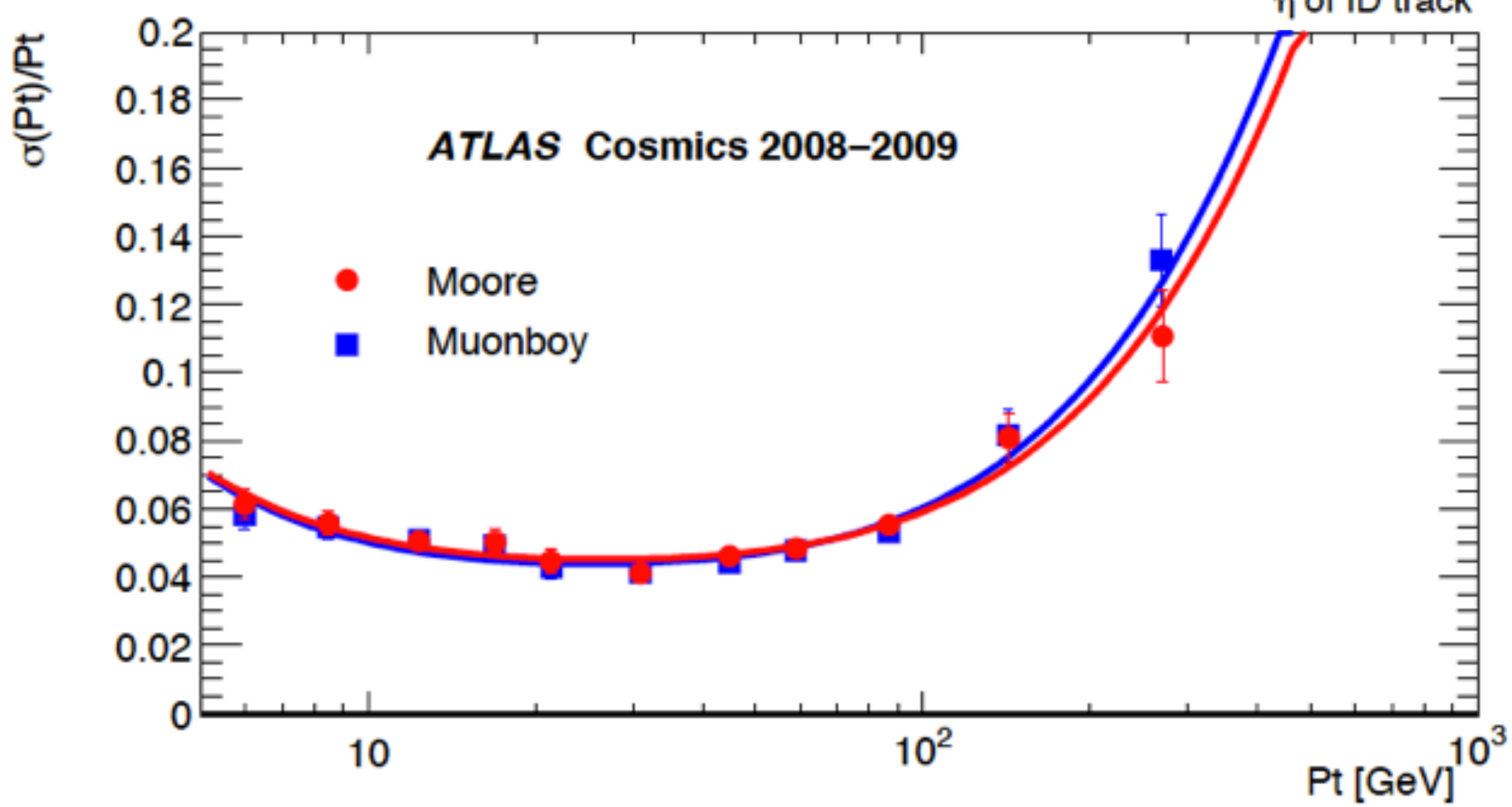


"Tomography" of the Inner Detector from the precise reconstruction of the secondary vertices from nuclear interactions. Precise determination of the material "budget" is possible

- Muon reconstruct. efficiency in |η| <1.
  - loss around |η|=0 due to loss of accept. for detector services

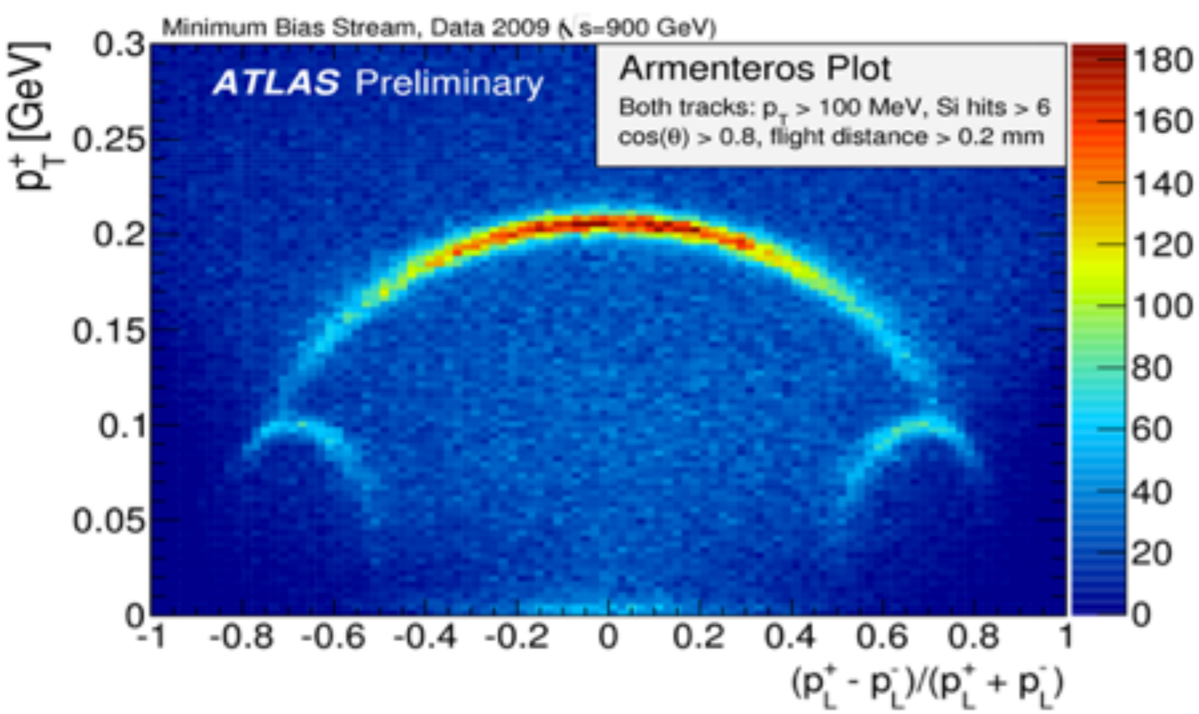


- Muon resolution in pT from cosr
(Top-Bottom method)
- The fitted function contains:
  - energy loss uncertainties
  - multiple scattering
  - intrinsic resolution



Chara

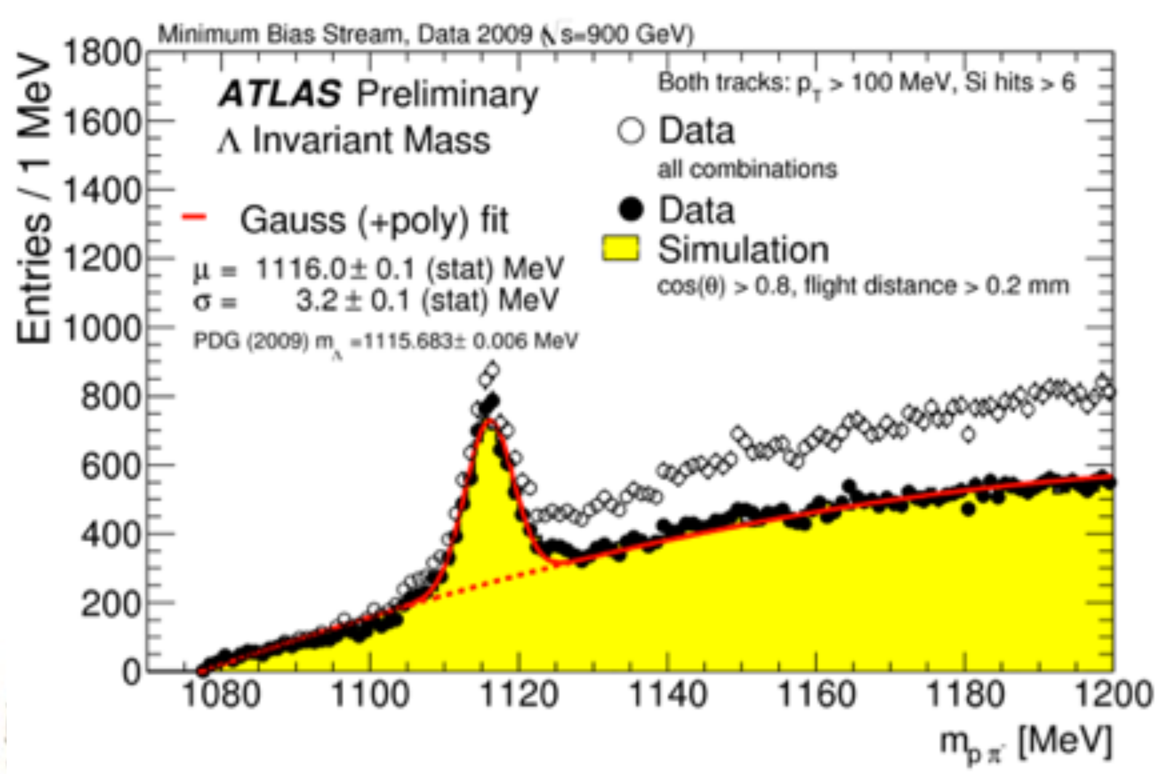
First resonances observed with minimum bias trigger

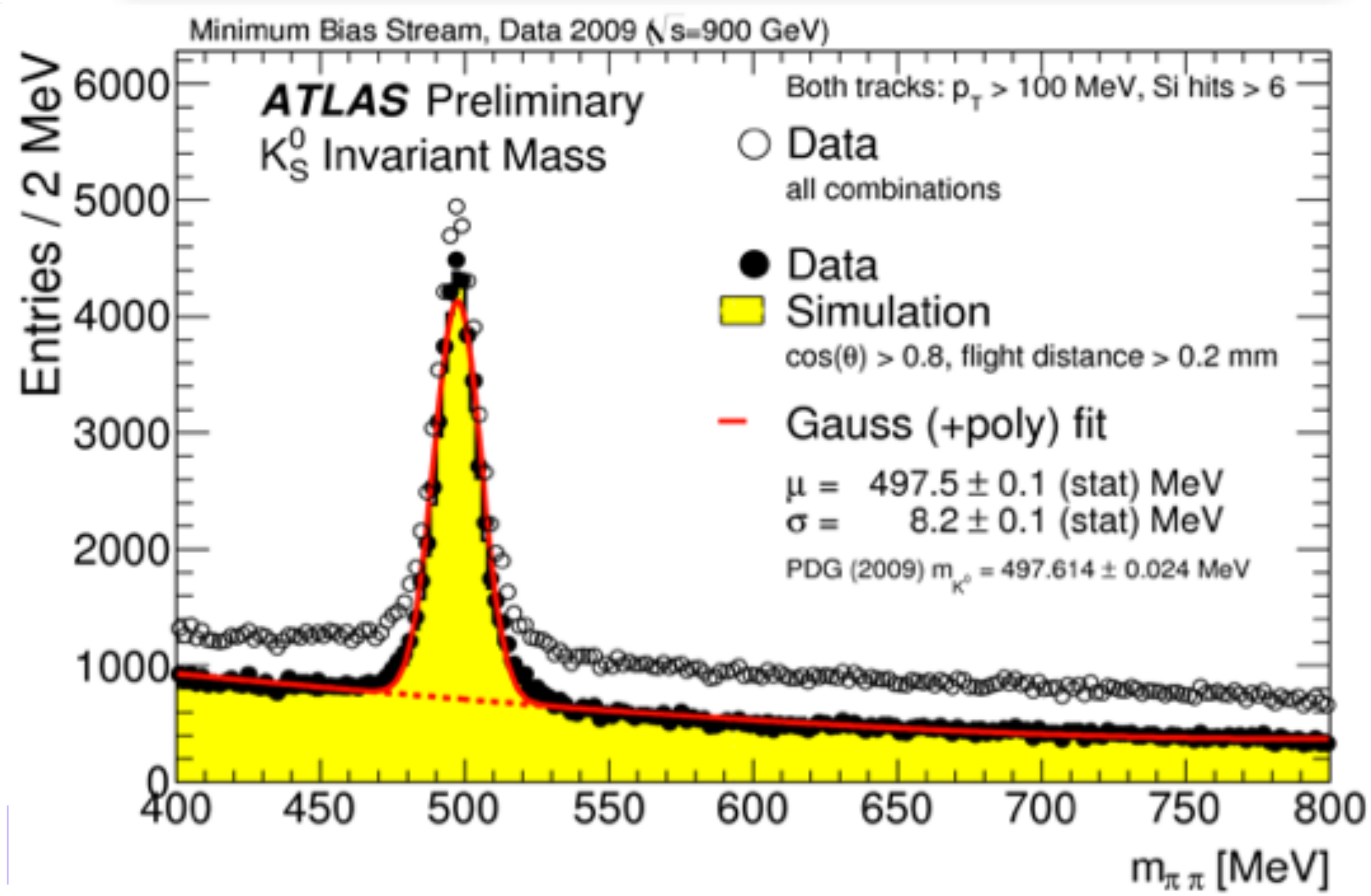


Reconstructed masses of various weak decay resonances provide a stringent test of tracking performance

➡ mass positions and widths agree well with PDG values and expected detector resolution from MC

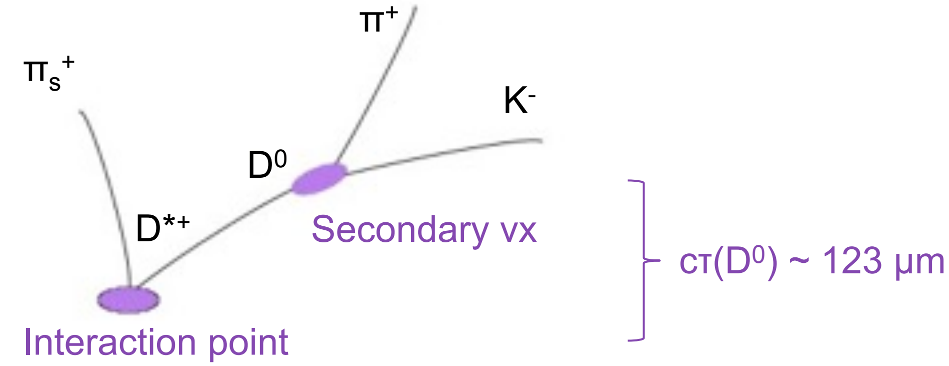
➡ Secondary vertex reconstruction and constraint on flight distance reduce combinatorial background



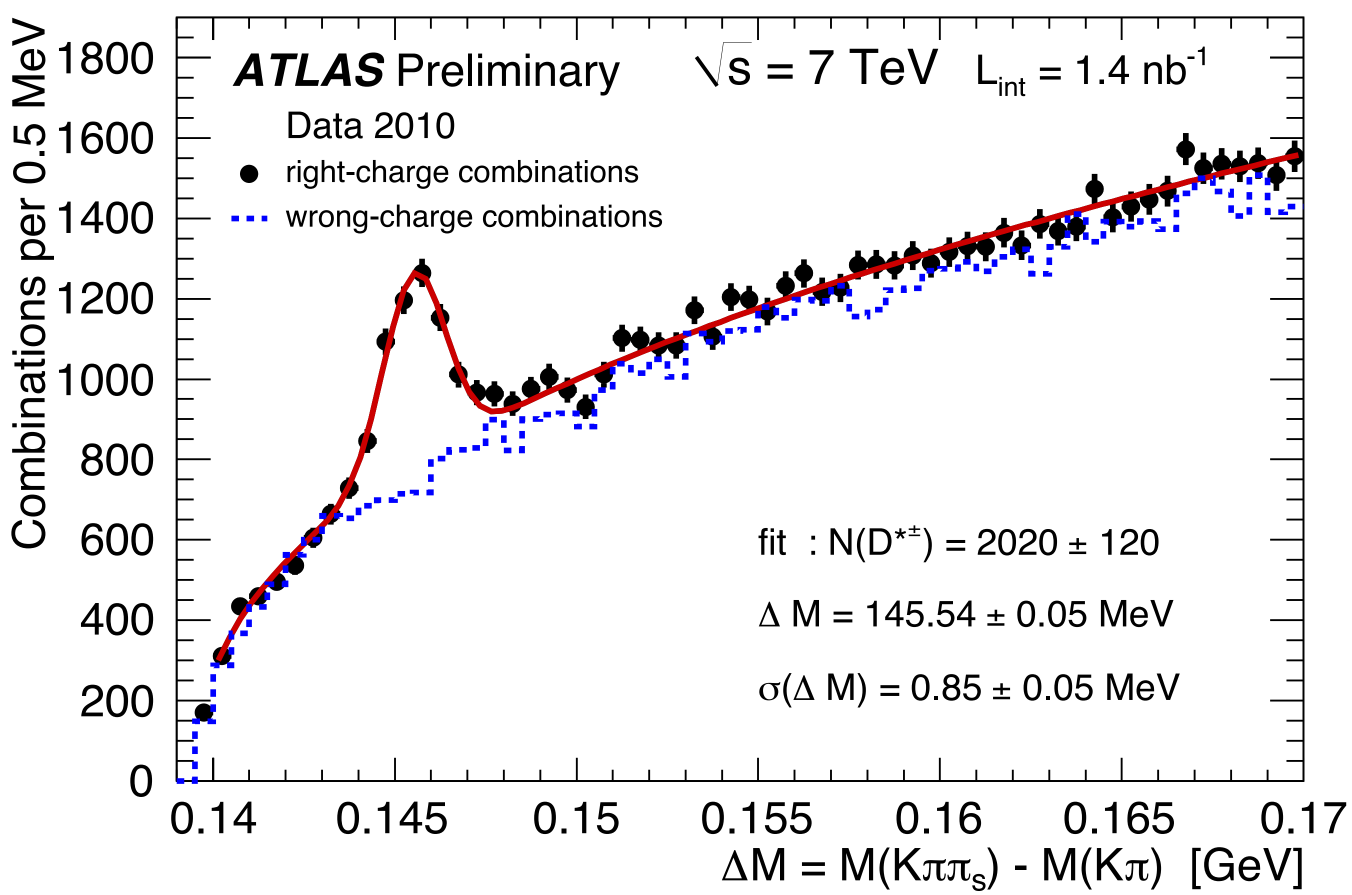


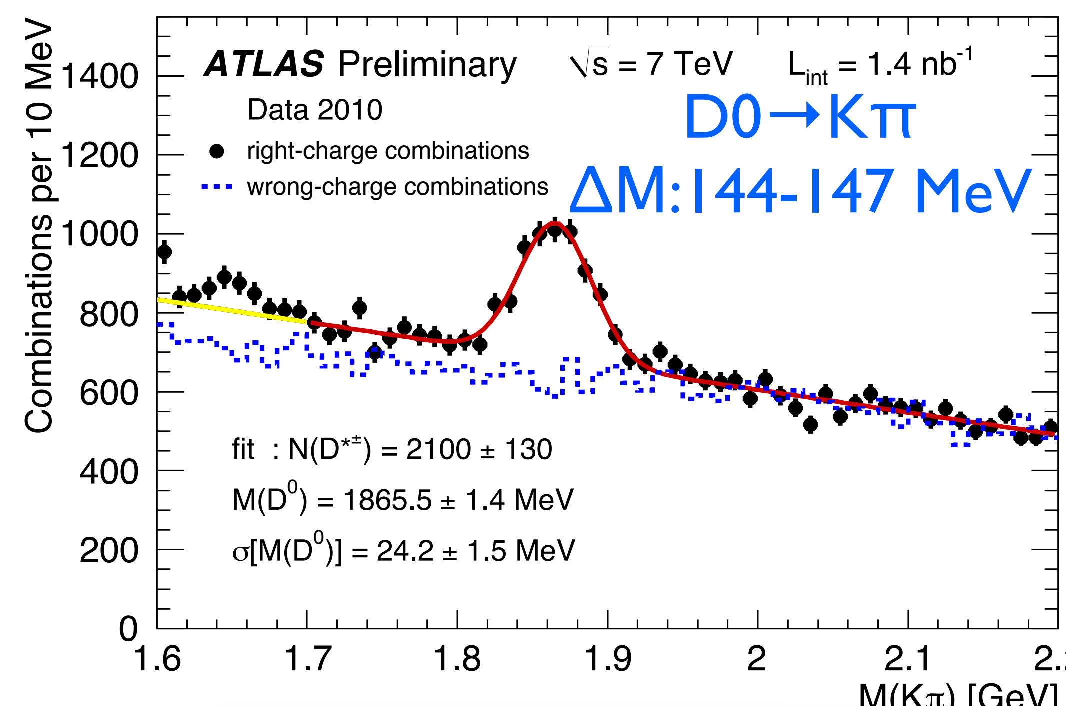
Observation of open charm in minimum bias events : $D^{*(\pm)} \rightarrow (K^-\pi^+)\pi_s^{(\pm)}$, $D^+ \rightarrow K^-\pi^+\pi^+$, $D_s^{(\pm)} \rightarrow \varphi\pi^+$

- Abundant cc(bar) and bb(bar) production at LHC
  - Inclusive measurements for open charm production is feasible with the first data using D*
  - Events with D* accompanied by a muon can provide a measurement of the bb/cc fraction: D*μ from b and c decays (++/--)/(+-)



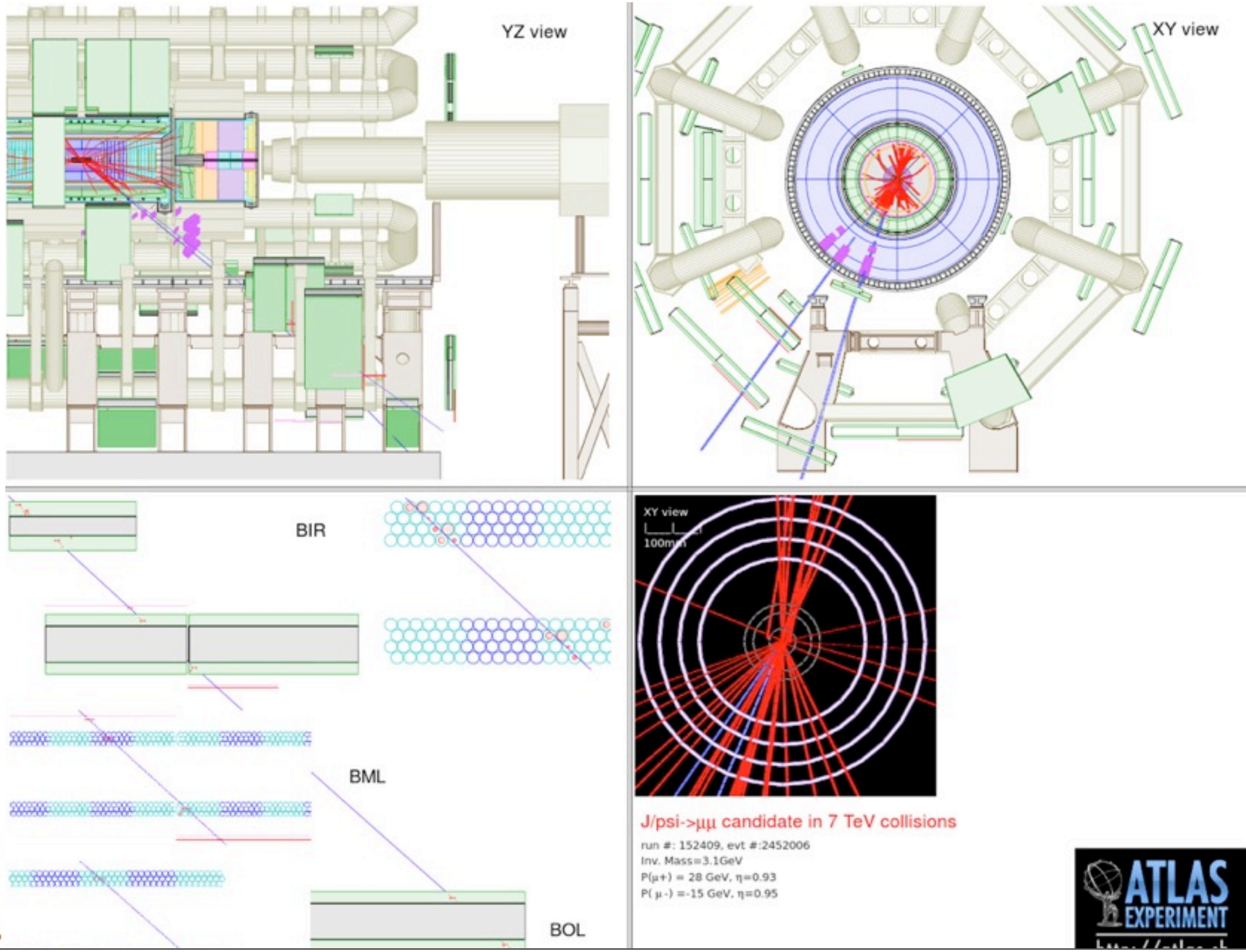
Reconstruct D* from D0π decays
pT (K, π) > 1 GeV
pT of soft pions > 0.25GeV
Positive decay length
ΔM (Kππ)-(Kπ) >140MeV



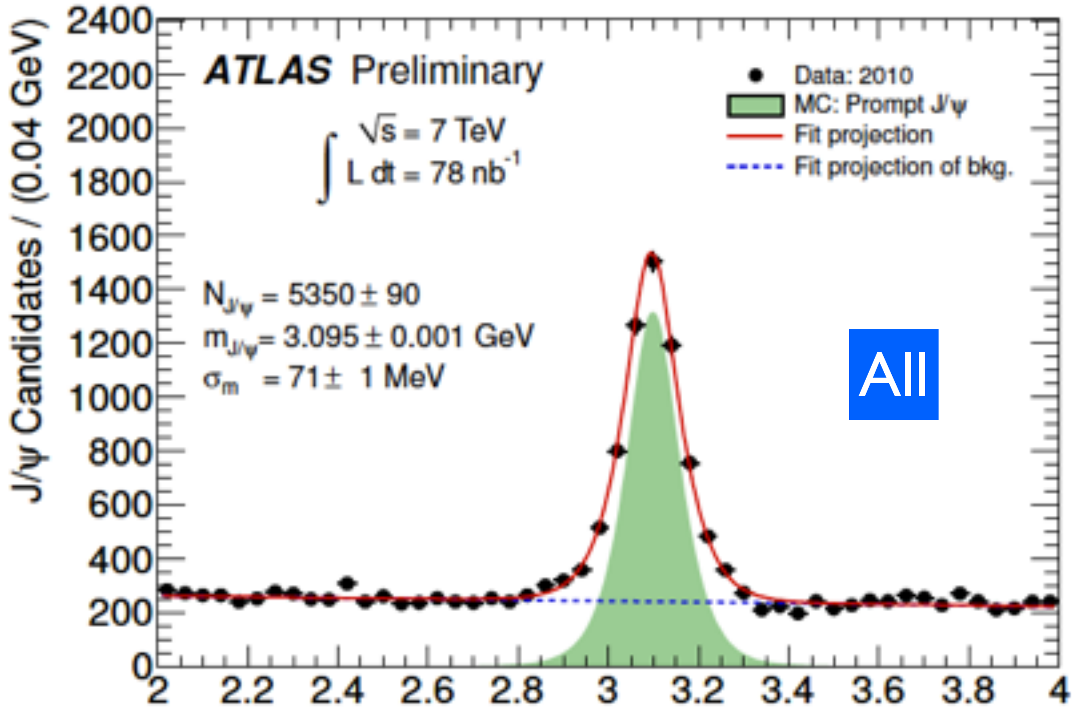


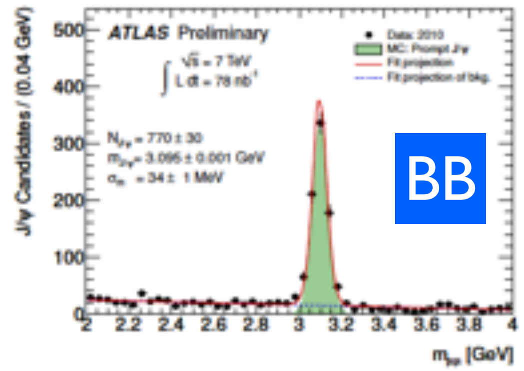
More in the talk by Darren Price

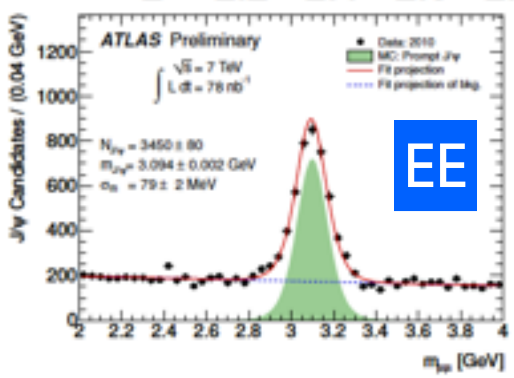
J/ψ candidate event decaying in two muons in the forward region of the detector

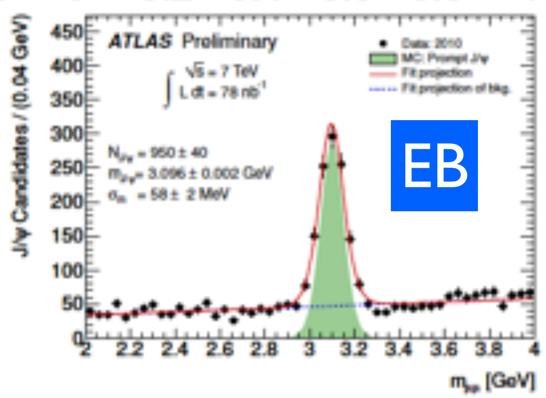


First observations of "Onia": Properties of J/ψ candidates





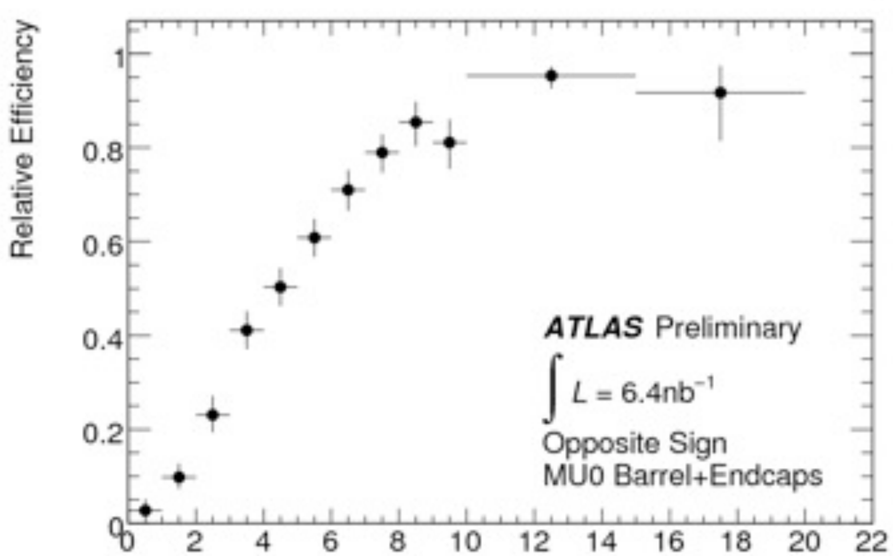




Mass and width in Good agreement with MC in different eta regions

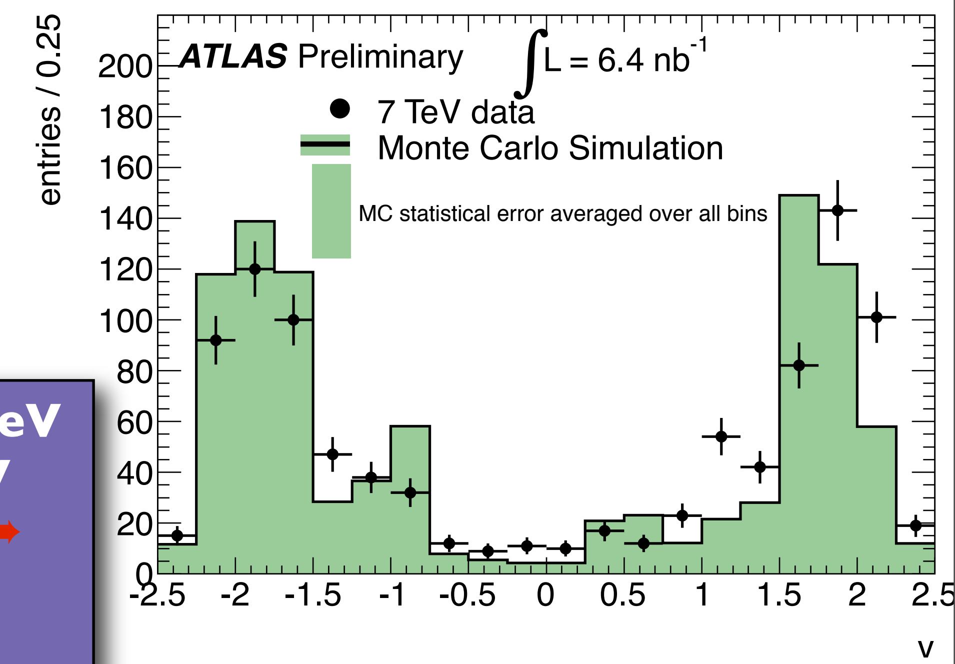
Mass position: 3095±1MeV
Mass width: 71±1MeV
In central region (BB)➠
Mass: 3095±1MeV
Width: 34±1MeV

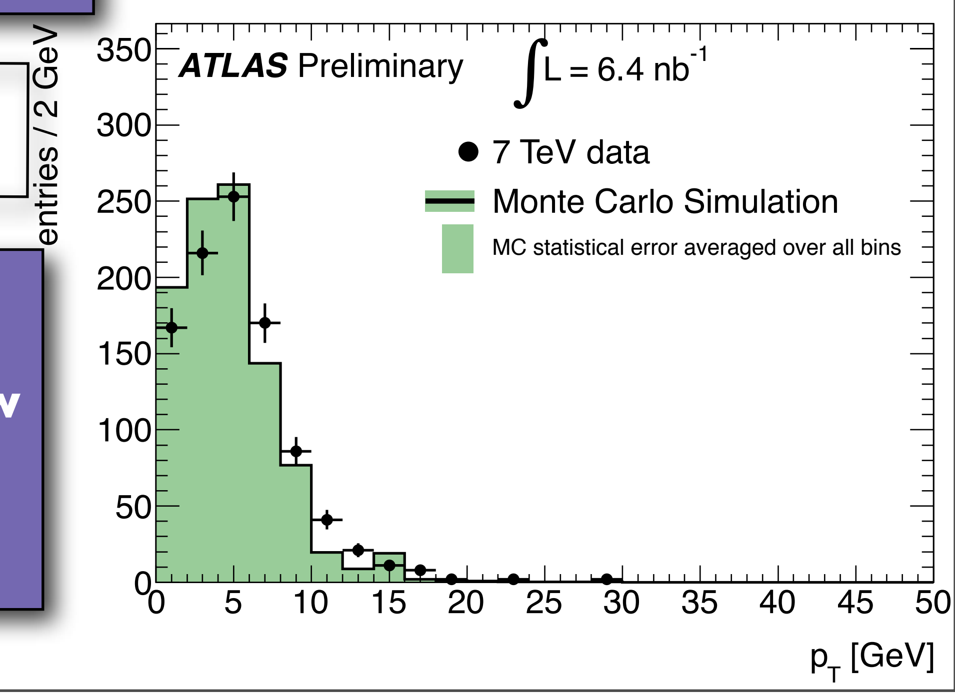
More in the talk by Darren Price



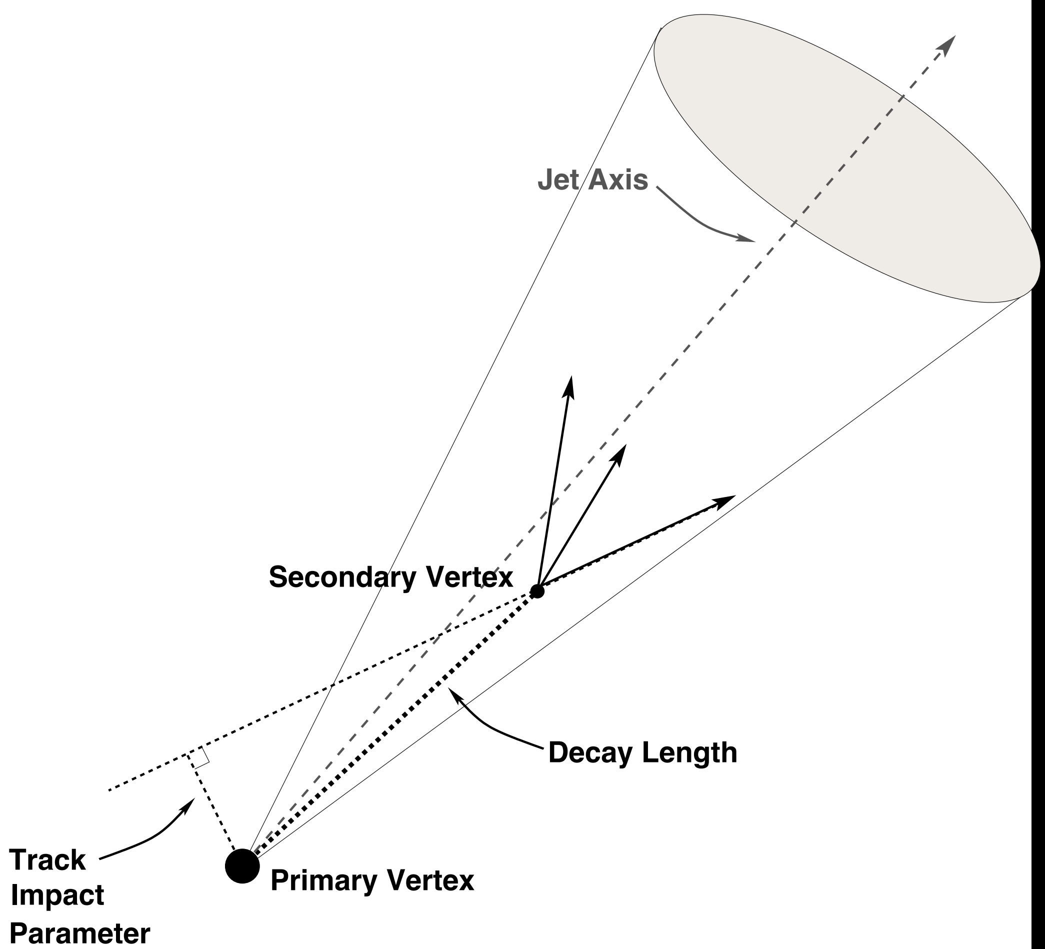
Data obtained with minimum bias trigger: Allowed Access to very low pT J/ψ
➠Study L1 Muon trigger efficiency

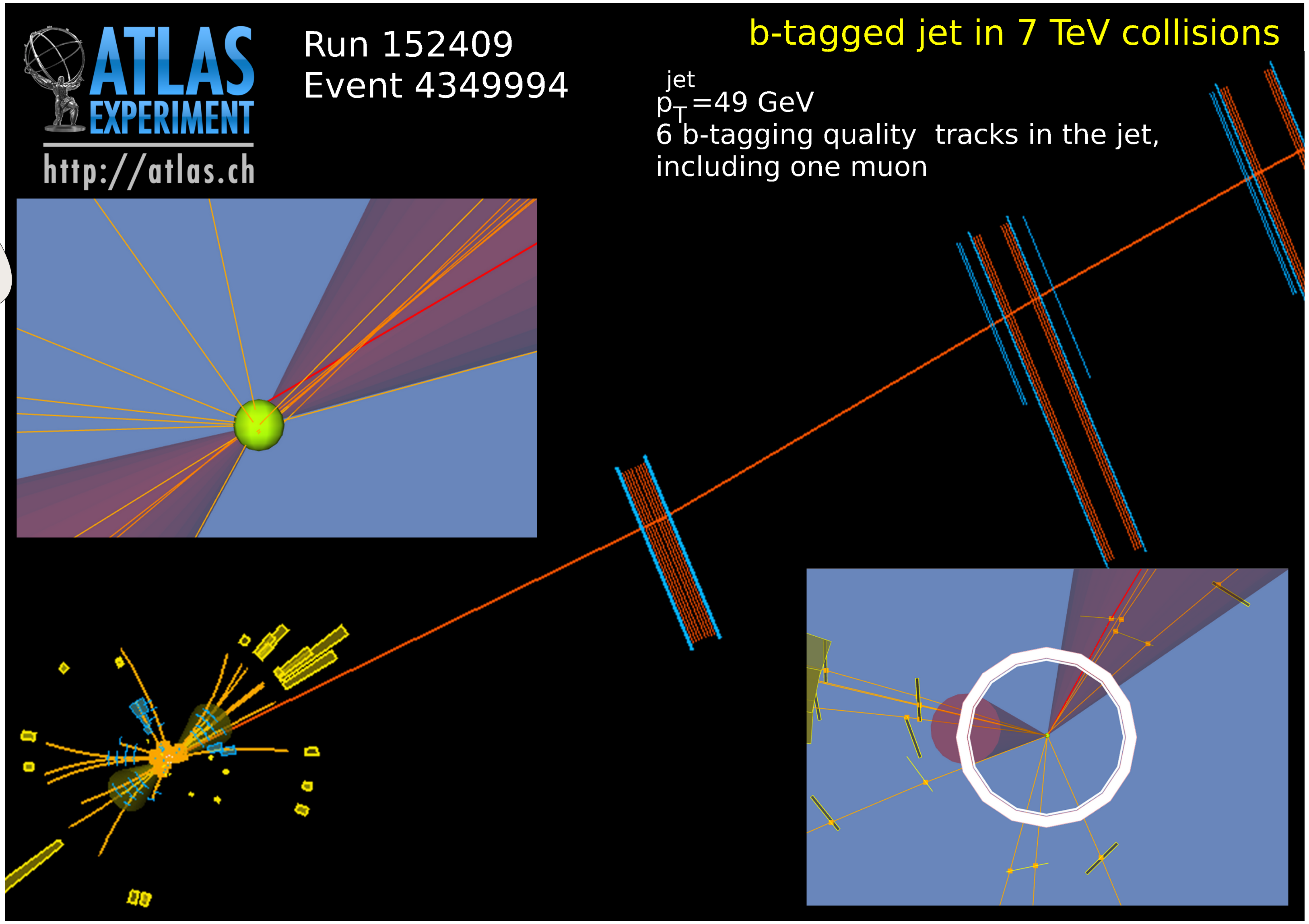
- Most of J/ψ's populate the forward region and have very low pT
- Reasonably good agreement with detector description in the MC





Observation of b-jets, b-tagging variables: First steps before $b\bar{b}$ cross-section measurement



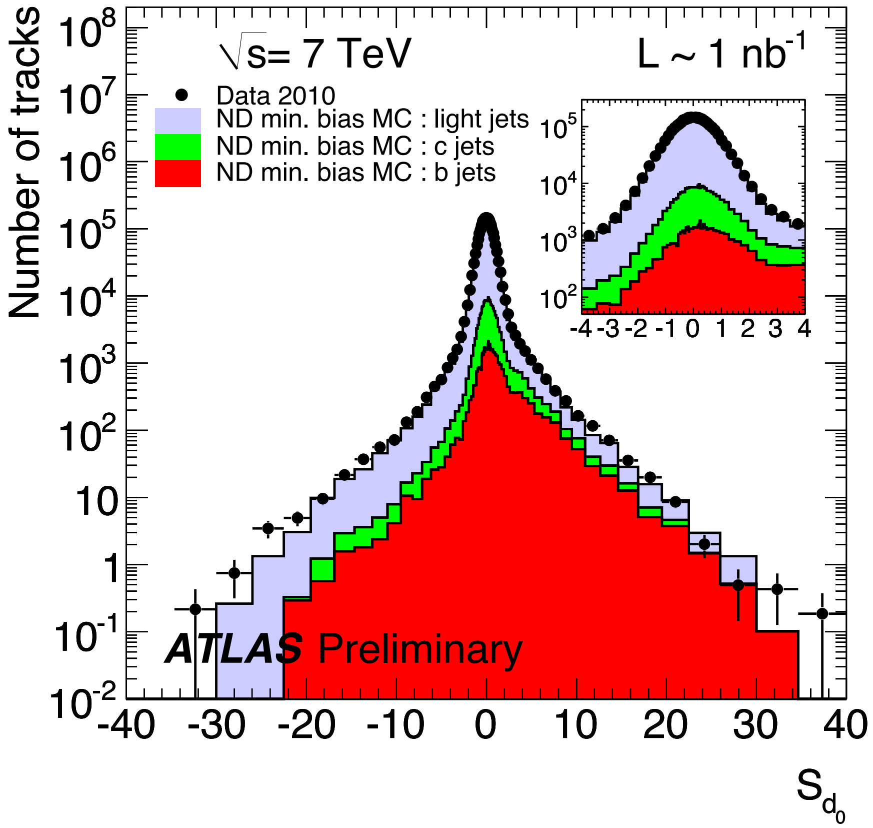


Identify jets from b-quarks:

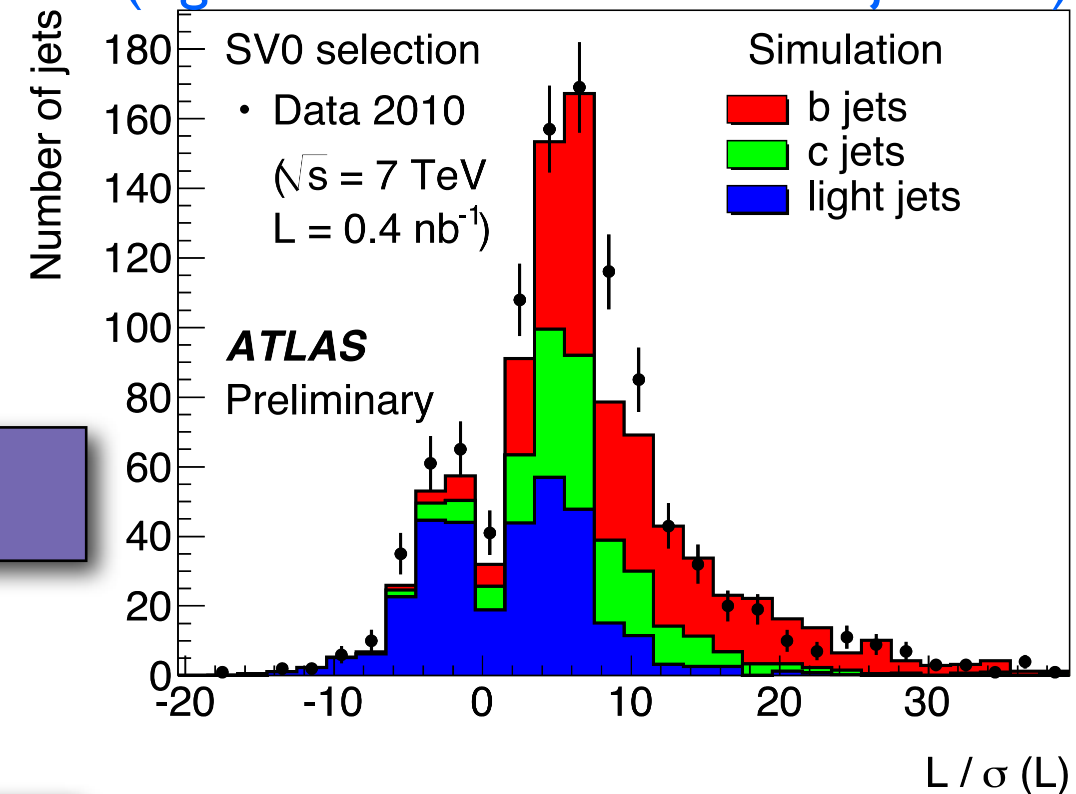
- **From the displaced vertex of the b-jet (secondary vertex-impact parameter)**
- **From the properties of the muon inside a b-jet (pT relative to jet axis)**

Observation of b-jets, b-tagging variables: First steps before $b\bar{b}$ cross-section measurement

Impact Parameter significance

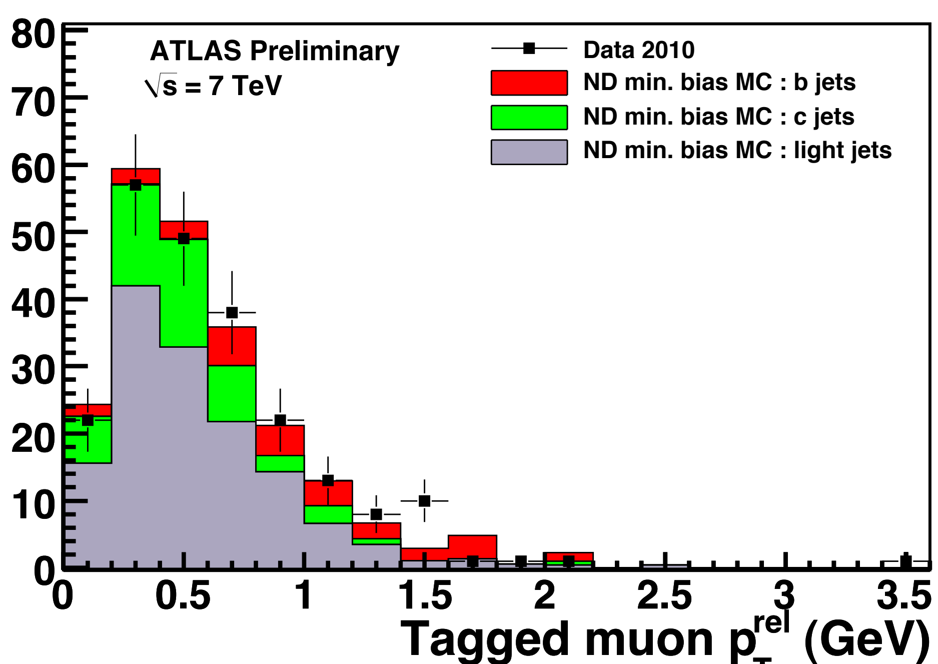


3D decay length significance (signed w.r.t the calorimeter jet axis)

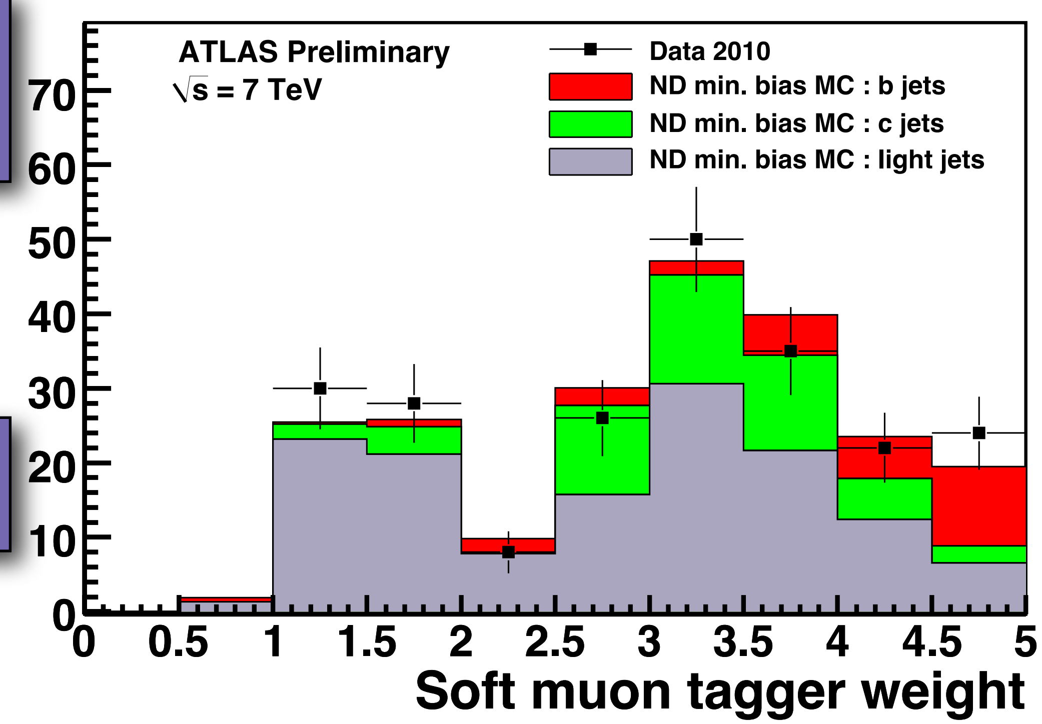


Comparison with MC

Muon pT Relative to the jet axis (pT rel)



Comparison with MC



Perspectives:
Selected B-physics topics for the immediate & further future

- B- Trigger Strategy
- "Onia" Production and Spin-alignment measurements
- $B^+ \rightarrow J/\psi\ K^+$ (reference channel)
- $Bd \rightarrow J/\psi\ K^*$ (reference channel) and $Bs \rightarrow J/\psi\ \varphi$
- $Bs \rightarrow \mu\mu$

Results based on simulations at 14 TeV

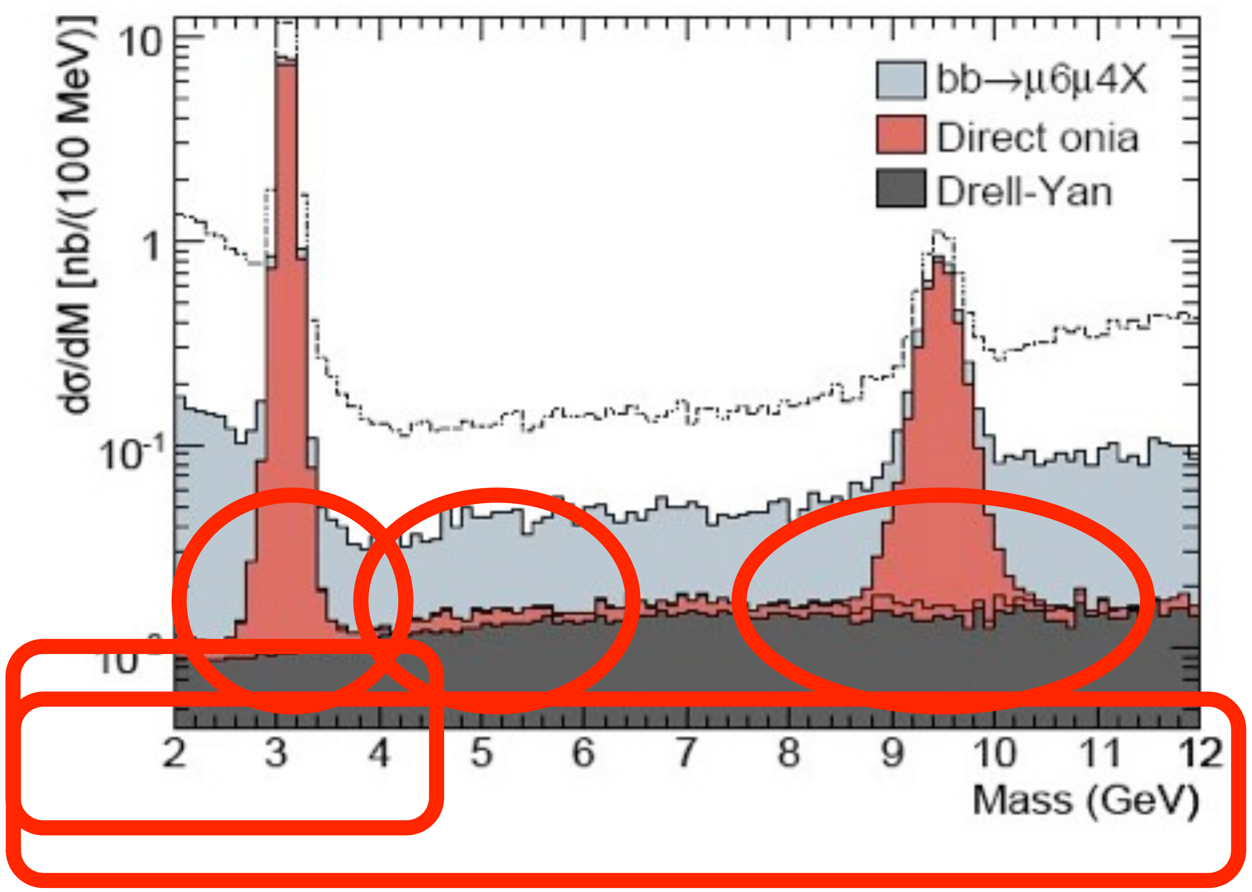
B-Trigger Strategy

- ➔ Low p_T single / two muons
  - Control samples, only at very low luminosity
- ➔ Di-muon (common vertex) & invariant mass ranges:
  - J/ψ and other heavy quarkonia decaying to μμ
  - Very rare B→μμ
  - Semileptonic rare decays B→Xs μμ

➠ Need to cover side-bands around the signal region

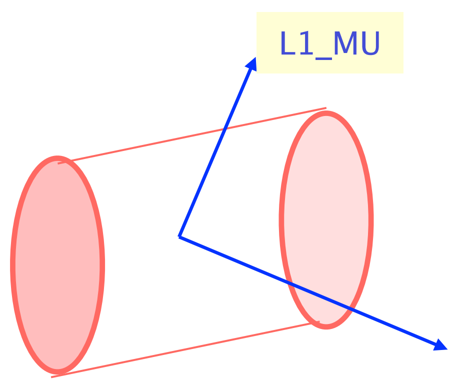
➠ Control measurements in di-muon low mass (bb, cc contributions)

➠ while Trigger for a mass range



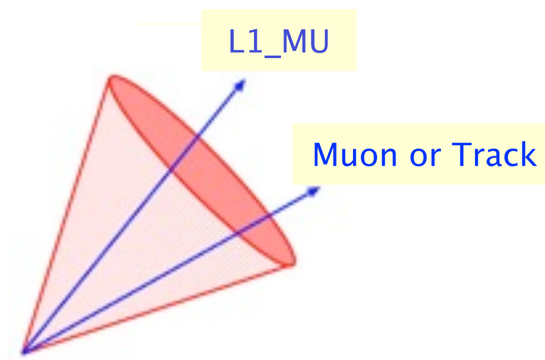
B-Trigger Strategy

FullScan Trigger



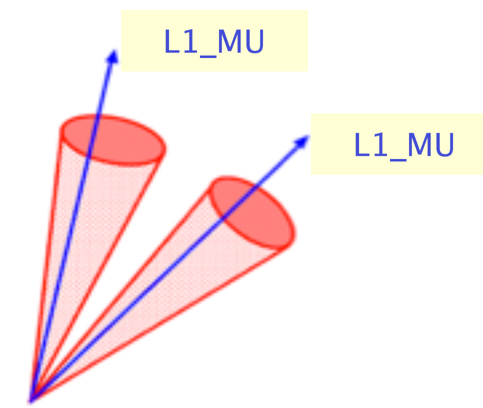
<u>One L1 muon</u>
confirm muon at L2
Tracking in entire detector, search for the 2nd muon
Mass & vertex cuts

Single muon Trigger



<u>One L1 muon</u>
confirm muon at L2
Tracking in one large RoI,search for the 2nd muon
Mass & vertex cuts

Di-muon Trigger



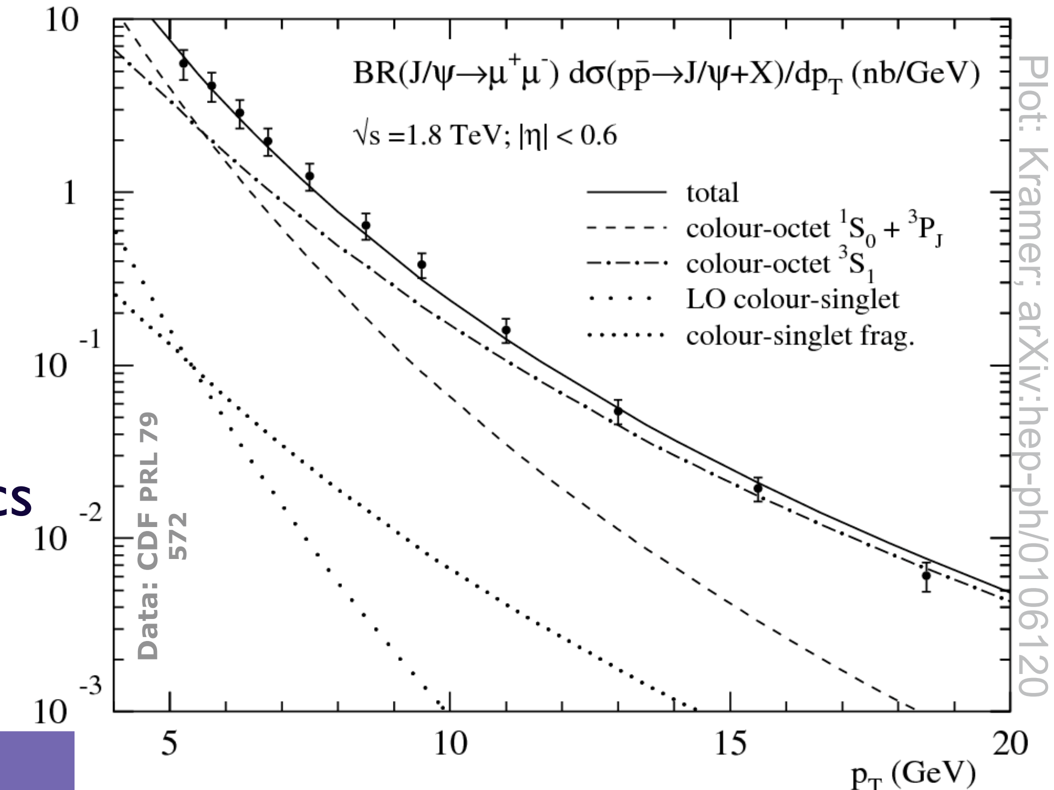
<u>Two L1 muons</u>
confirm muon at L2
Tracking in small RoI
Mass & vertex cuts

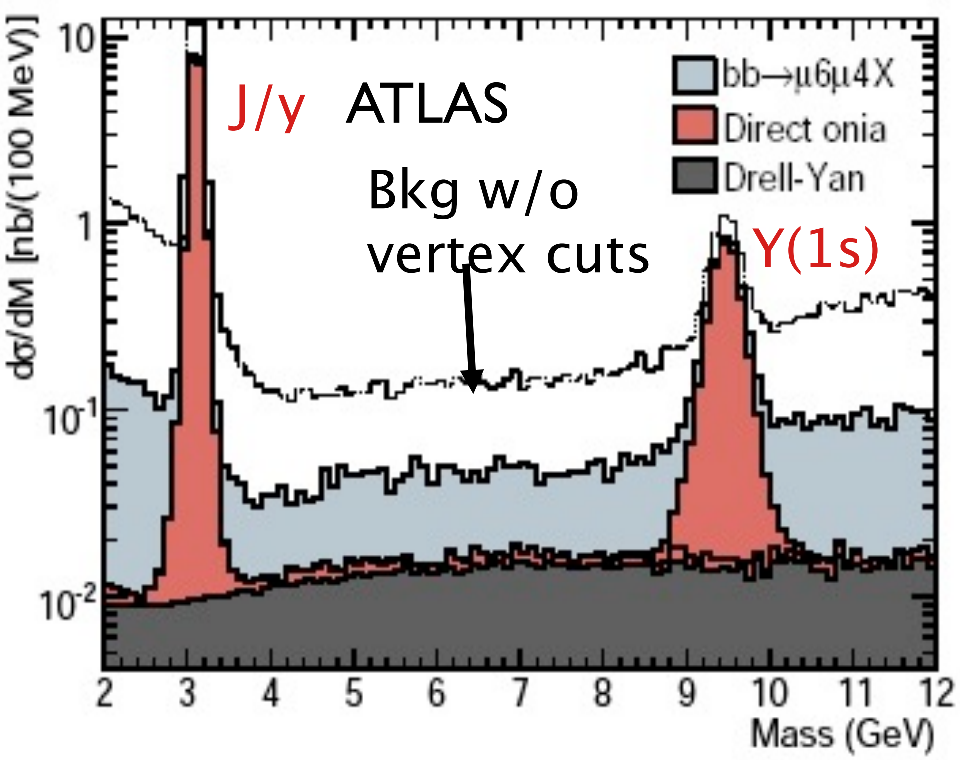
The lowest level 1 muon trigger thresholds are 4 GeV, 6 GeV

- Single L1 muon triggers:
  - Use lowest muon pT threshold and FullScan(time consuming) for highest efficiency at startup
- L1 di-muon triggers:
  - Use lowest muon pT threshold (MU4)
  - Provides reduced background and is operational at higher luminosity.

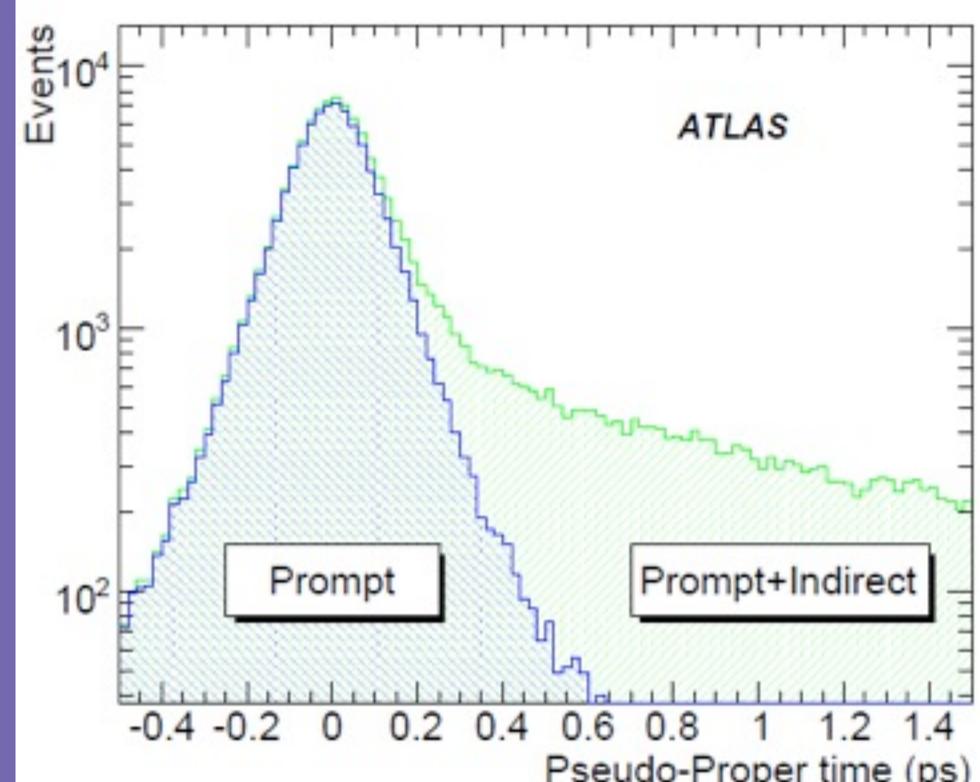
J/ψ and ϒ production cross section measurements

- Motivation: Understand quarkonium production mechanism
  - Testbed for perturbative and non-perturbative QCD
  - Use quarkonium to determine low-x gluon PDF's
- Quarkonia are important background for several B-physics processes at LHC ➠measure inclusive cross-section
- Spin alignment of quarkonia states not yet understood



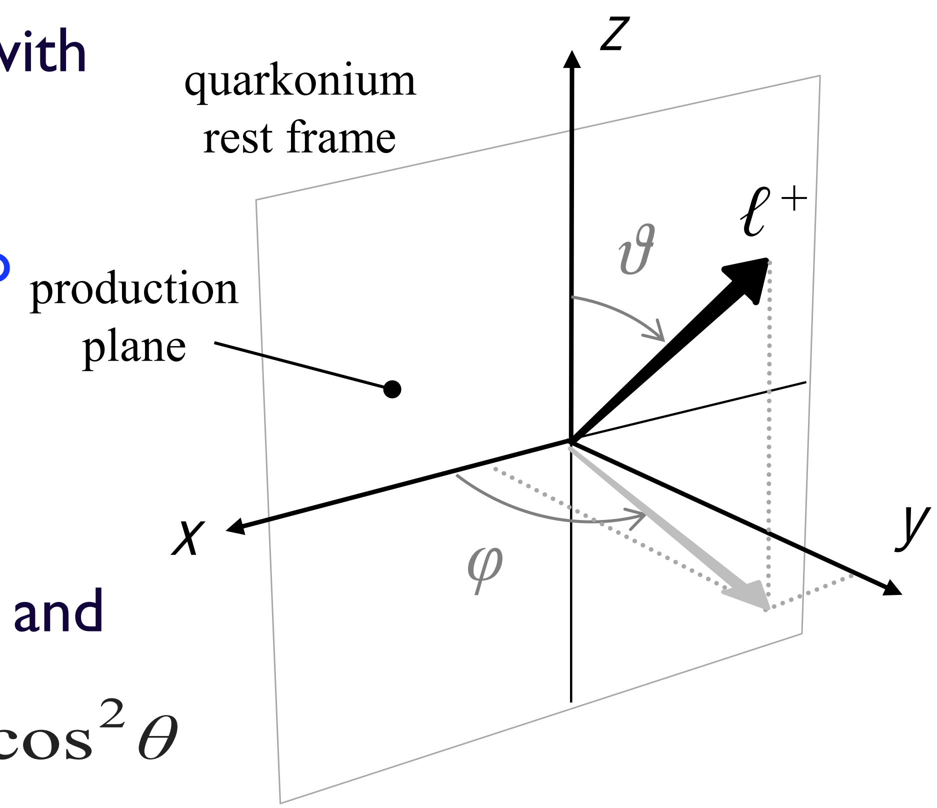


- Separate J/ψ s produced from QCD (prompt) and b-hadron decays (indirect)
- Measure the ratio $R= \sigma(bb \rightarrow J/\psi)/\sigma(pp \rightarrow J/\psi)$ of the cross-sections of the two processes (systematics mostly cancel)
- With $1pb^{-1}$, the ratio in pT, η can be measured with a statistical precision of ~10%.

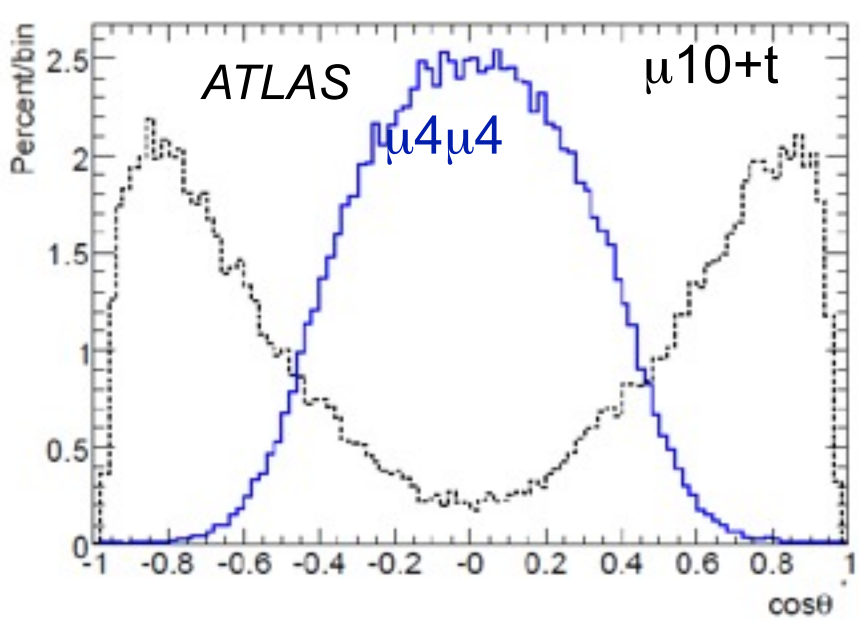


J/ψ and ϒ spin-alignment measurements

- CDF and D0 results are in conflict both with each other and with various theoretical models
  - In ATLAS, measurement of high pT polarization will allow to distinguish between different production models
- Detector and trigger acceptance need to be well understood
- In order to have full cosθ*coverage need to combine di-muon and single muon trigger measurements



$$\frac{dN}{d\cos\theta} \propto 1 + \alpha\cos^2\theta$$



Sample	p_T, GeV	$9-12$	$12-13$	$13-15$	$15-17$	$17-21$	>21
J/ψ, $\alpha_{gen}=0$	α	0.156 ±0.166	−0.006 ±0.032	0.004 ±0.029	−0.003 ±0.037	−0.039 ±0.038	0.019 ±0.057
	σ, nb	87.45 ±4.35	9.85 ±0.09	11.02 ±0.09	5.29 ±0.05	4.15 ±0.04	2.52 ±0.04
J/ψ, $\alpha_{gen}=+1$	α	1.268 ±0.290	0.998 ±0.049	1.008 ±0.044	0.9964 ±0.054	0.9320 ±0.056	1.0217 ±0.088
	σ, nb	117.96 ±6.51	13.14 ±0.12	14.71 ±0.12	7.06 ±0.07	5.52 ±0.05	3.36 ±0.05
J/ψ, $\alpha_{gen}=-1$	α	−0.978 ±0.027	−1.003 ±0.010	−1.000 ±0.010	−1.001 ±0.013	−1.007 ±0.014	−0.996 ±0.018
	σ, nb	56.74 ±2.58	6.58 ±0.06	7.34 ±0.06	3.53 ±0.04	2.78 ±0.03	1.68 ±0.02
Υ, $\alpha_{gen}=0$	α	−0.42 ±0.17	−0.38 ±0.22	−0.20 ±0.20	0.08 ±0.22	−0.15 ±0.18	0.47 ±0.22
	σ, nb	2.523 ±0.127	0.444 ±0.027	0.584 ±0.029	0.330 ±0.016	0.329 ±0.015	0.284 ±0.012

J/ψ polarisation

J/ψ cross-section

Results at extrema of polarisation states

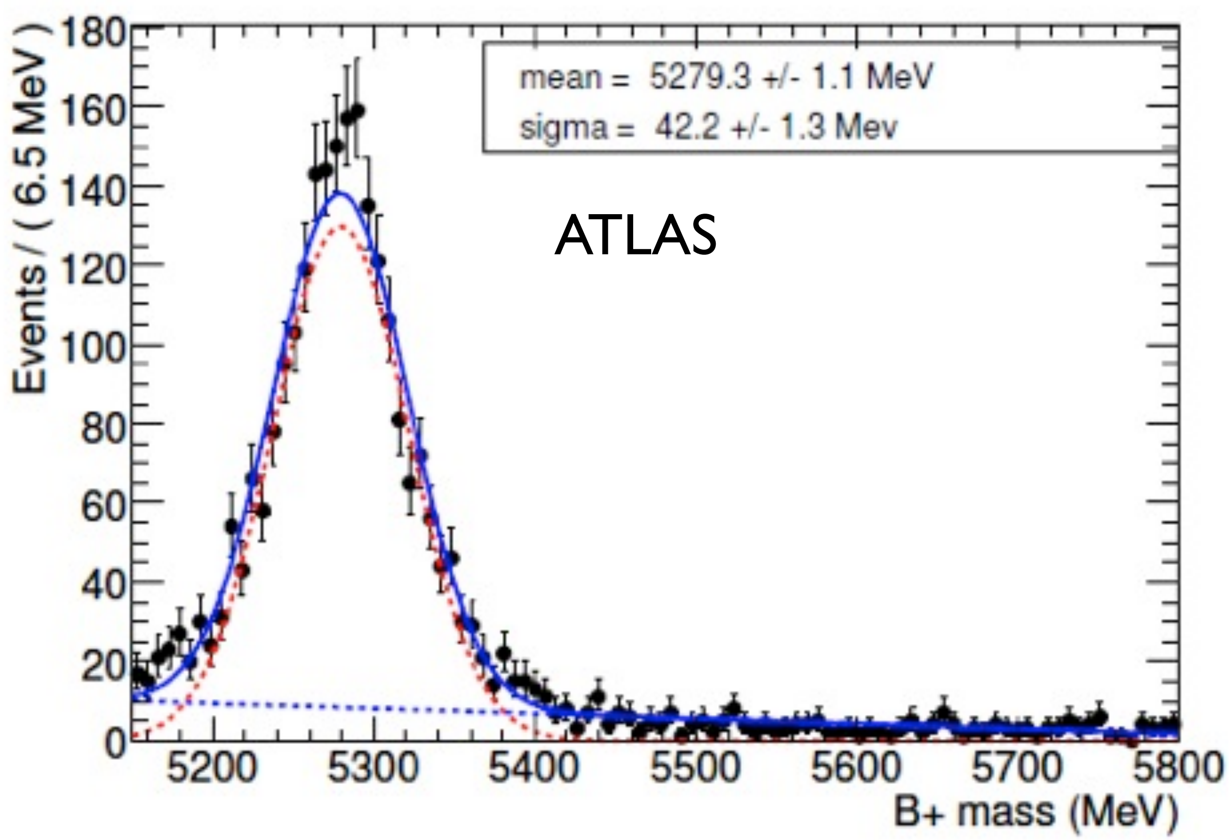
ϒ polarisation

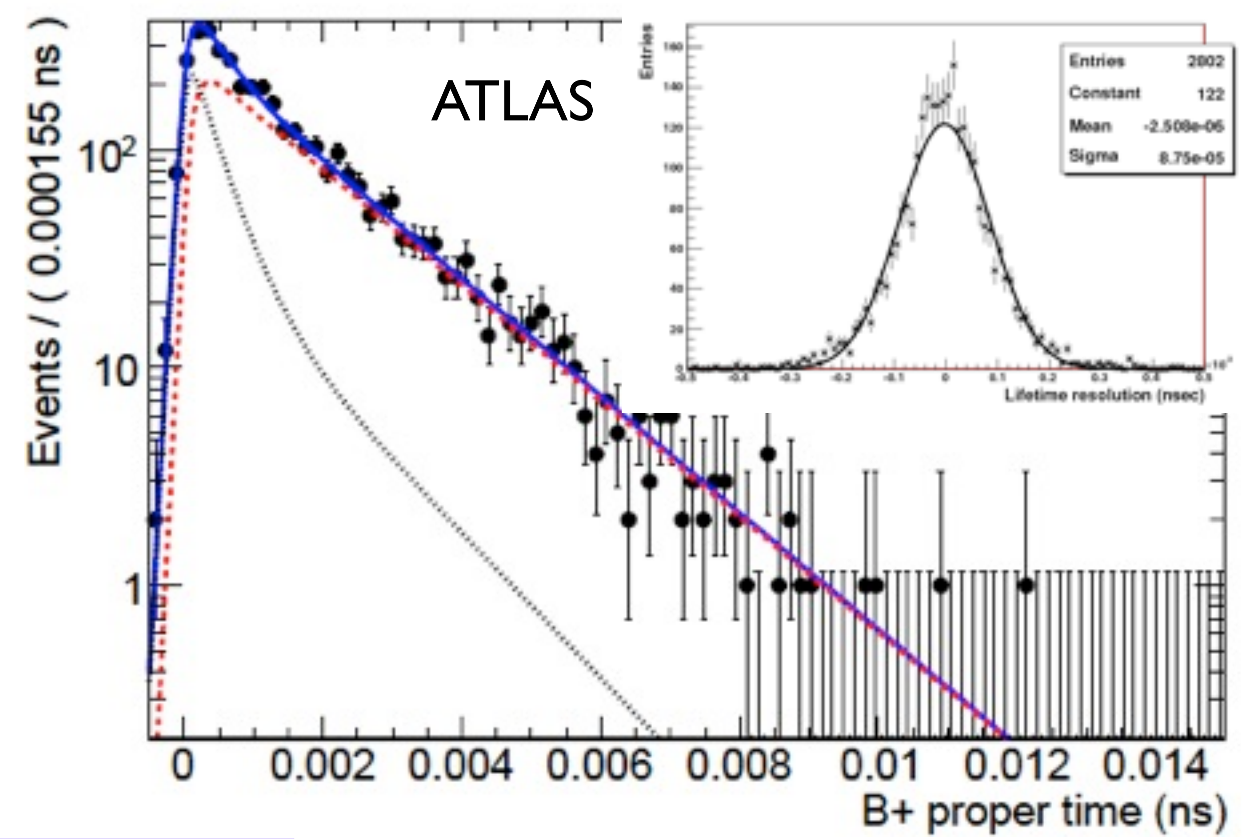
ϒ cross-section

$B^+ \rightarrow J/\psi(\mu\mu)\, K^+$

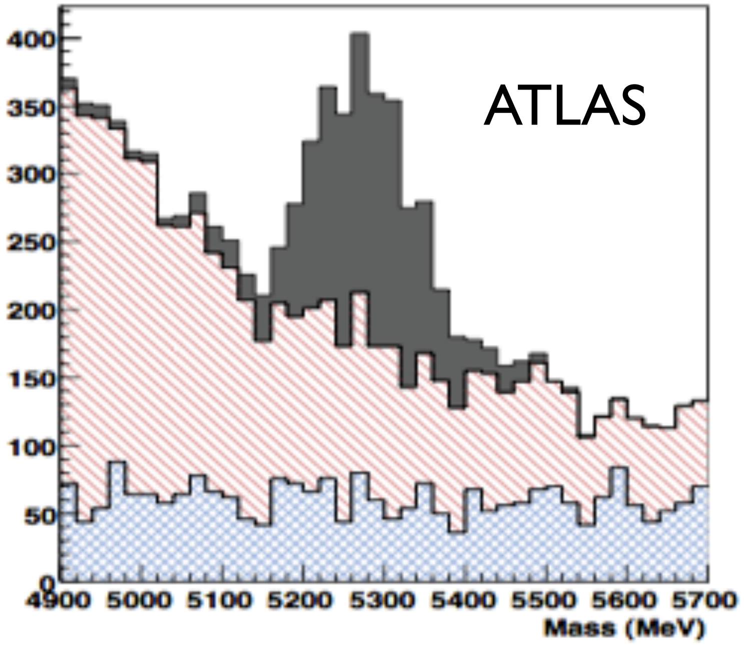
- Reference channel for the search for rare decays
  - Measure total and differential cross-section ($\sim$10pb^{-1} needed)
- Expected resolution in lifetime measurement ~90 fsec

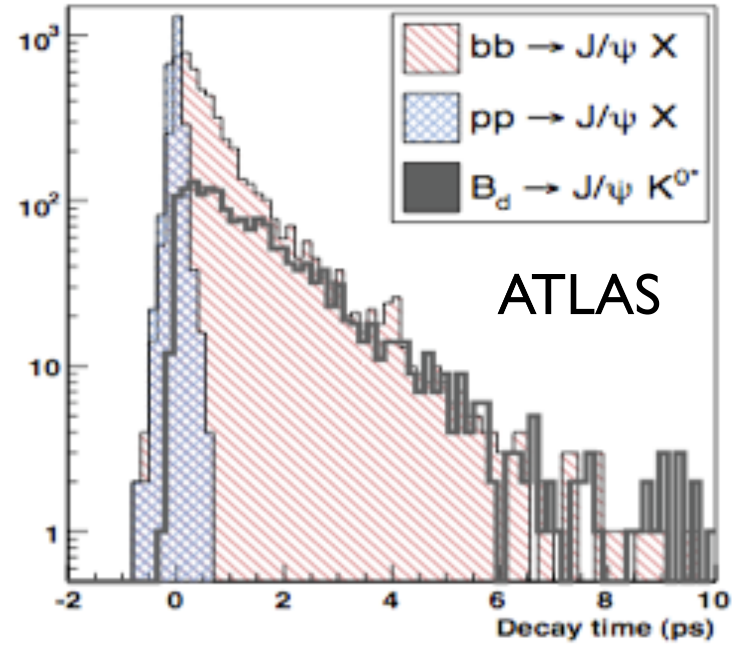
Cross section	(stat)	(total)
Total	~3 %	~15 %
dσ/dpT	~10 %	~16-20 %
Signal lifetime to ~ 2.5 % (stat only)		





- The channel $B_s \to J/\psi\phi$ is a promising indirect route to New Physics
  - "Weak mixing phase" ϕ_s has been calculated in the SM and is very small (-0.0368±0.0018) but may be enhanced by BSM processes
- The topologically identical $B_d \to J/\psi K0^*$ (15x greater statistics) is the primary background and is also essential as a control channel (test of lifetime measurement and tagging calibration)





In early data, loose cuts will be used (No vertex displacement cut)

After ~10 pb^{-1} the precision on the B_d lifetime will be 10% and similar precision for the B_s mean lifetime will be available after 150 pb^{-1}

Parameter	$B_d \to J/\psi K^{0*}$ after 10 pb^{-1}		$B_s \to J/\psi\phi$ after 150 pb^{-1}	
	Simulated value	Fit result + st error	Simulated value	Fit result + st error
Mean lifetime ,ps^{-1}	0.651	0.73 ± 0.07	0.683	0.743 ± 0.051
Mean mass m, GeV	5.279	5.284 ± 0.006	5.343	5.359 ± 0.006
Lifetime resolution σ, ps		0.132 ± 0.004		0.152 ± 0.001
Mass resolution σ_B, GeV		0.054 ± 0.006		0.061 ± 0.006
n_{sig}/N	0.16	0.155 ± 0.006	0.018	0.031 ± 0.005
n_{bck1}/N	0.062	0.595 ± 0.017	0.397	0.379 ± 0.006

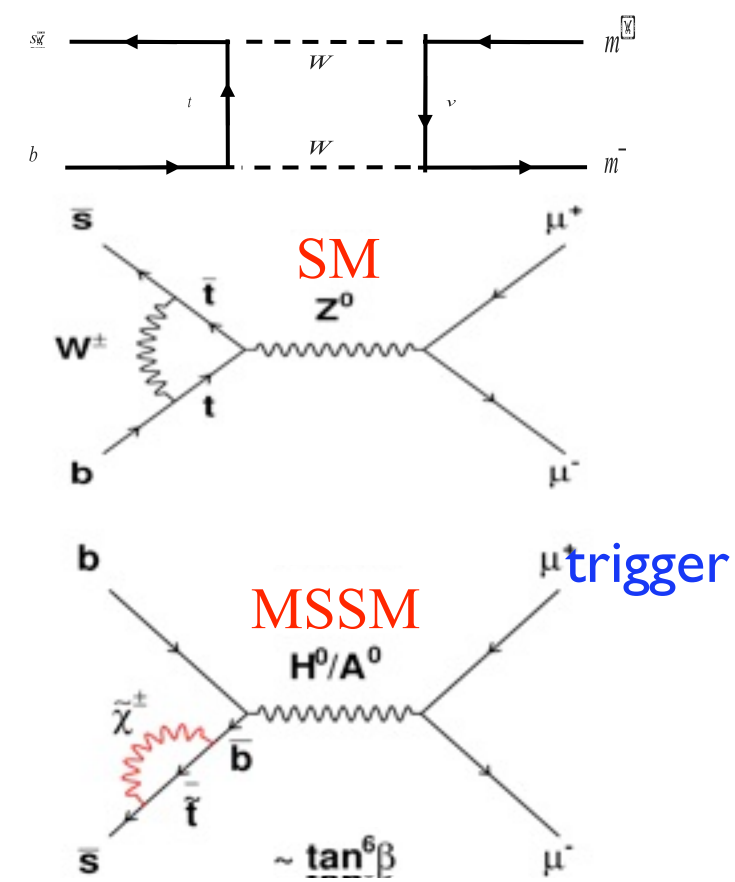
ATLAS b-flavour tagging performance

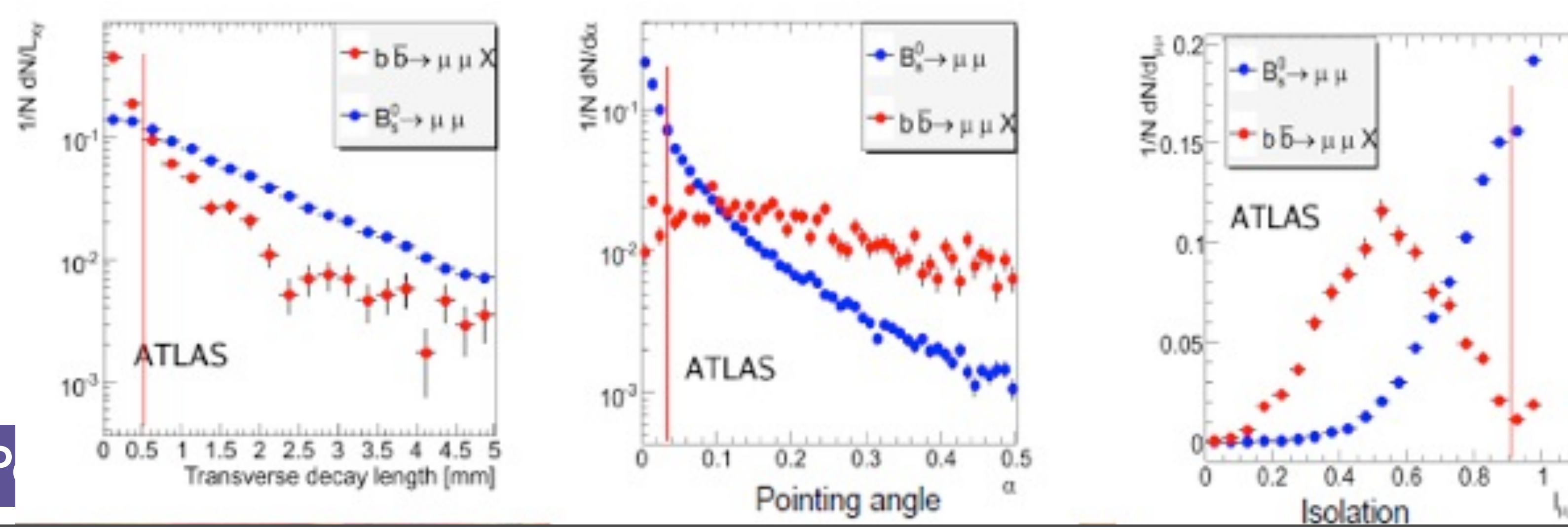
- After about 1 fb^{-1}, it will be possible to extract interesting parameters from the $B_s \rightarrow J/\psi\phi$ decays
  - FLAVOUR TAGGING (determine whether the decay is from a B_s or an anti-B_s) is an essential part of this decay. $B_s \rightarrow J/\psi\phi$ is not self-tagging
    - In ATLAS, the best flavour tagging performance for $B_s \rightarrow J/\psi\phi$ is obtained using the jet charge tagging algorithm, which is a "same side" tag
      - Utilize correlations between the original quark flavour and momenta, and the charge and momenta of the fragmentation products (jet charge tagging)
- Calibration of the jet-charge tag will be done with the self-tagging reference channel $B_d \rightarrow J/\psi K^{0*}$, and will validate Monte Carlo models for fragmentation
  - Validated Monte Carlo will be used to determine the tagger quality for $B_s \rightarrow J/\psi\phi$

Tuned jet charge tagger performance		
Parameter	**$B_d \rightarrow J/\psi K^{0*}$**	**$B_s \rightarrow J/\psi\phi$**
Luminosity	150 pb^{-1}	1.5 fb^{-1}
Tag Efficiency	0.870 ± 0.003	0.625 ± 0.005
Wrong tag fraction	0.380 ± 0.004	0.374 ± 0.005
Dilution	0.240 ± 0.009	0.251 ± 0.010
Quality	0.050 ± 0.004	0.039 ± 0.003

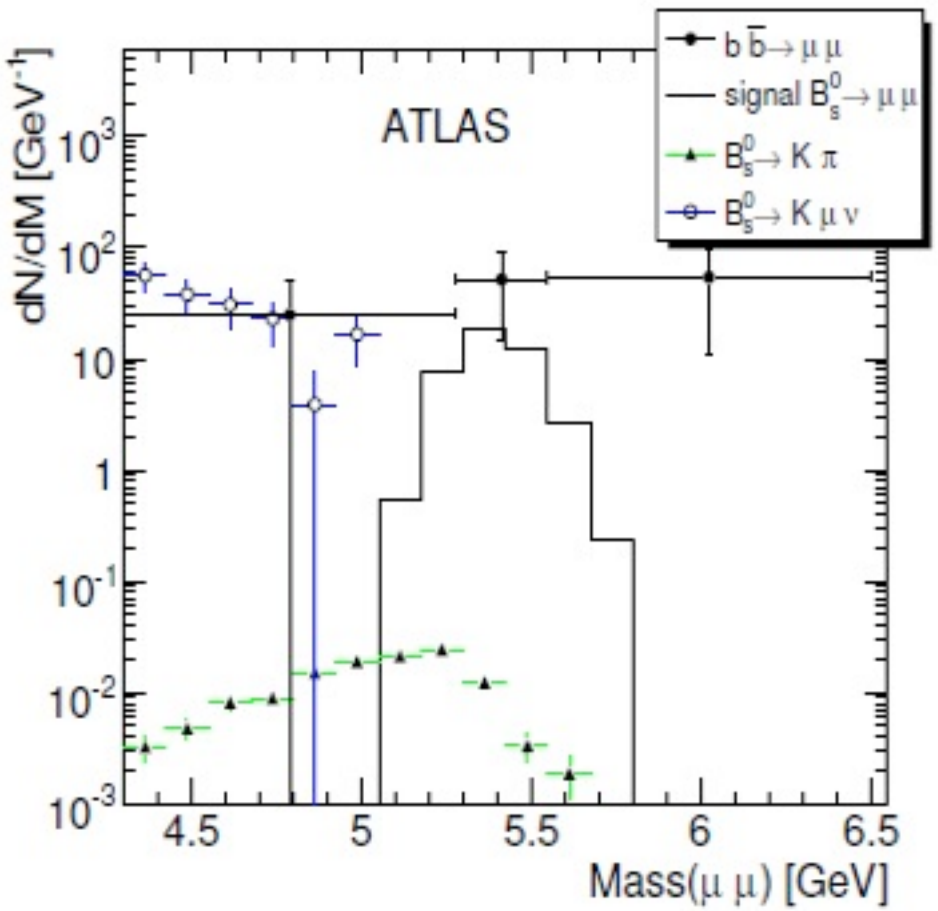
ATLAS performance for $B_s \to \mu\mu$

- $B_s \to \mu\mu$ highly suppressed in Standard Model:
  - Best exp. limit BR CDF($B_s \to \mu\mu$)< $4.x10^{-8}$ (95%CL)
  - $BR_{SM} = (3.42 \pm 0.52) \times 10^{-9}$
- Sensitive to New Physics (new particles in the loop)
- Main challenge to control the background; the strategy of ATLAS is:
  - Trigger on events with $B_s \to \mu\mu$ candidates using dedicated algorithms
  - Discriminating variables:
    - decay length significance
    - pointing angle between di-muon momentum and direction of flight (direction defined by the primary and secondary vertices)
    - muon isolation (no hadronic activity around Bs flight direction)
    - mass window around M(Bs)





ATLAS performance for $B_s \to \mu\mu$



- After 1 fb^{-1} ATLAS will have collected $O(10^6)$ dimuons in the invariant mass range 4-7 GeV
  - This will allow tuning of cuts and potentially training of multivariate procedures
- Use $B+ \to J/\psi(\mu\mu)K+$ as a reference channel (similar to CDF & D0)
- Branching Ratio will be estimated by normalization to the $B^+ \to J/\psi(\mu\mu)K^+$ events

The ATLAS $B_s \to \mu\mu$ programme will continue throughout the lifetime of the detector

After 10 fb^{-1} (1 year @ 10^{33}) we expect (SM):

Expected #ev after kinemat. preselec.	150	7000000
	$B_s \to \mu\mu$ efficiency	$bb \to \mu\mu X$ efficiency
Isolation>0.9	0.24	$(2.6 \pm 0.3) \times 10^{-2}$
L_{xy} > 0.5 mm	0.26	$(1 \pm 0.3) \times 10^{-3}$ *)
α < 0.017 rad	0.23	
$M = M_{Bs}{}^{+140}_{-70MeV}$	0.76	0.079
Events/10fb^{-1}	5,7	14^{+13}_{-10}

Summary

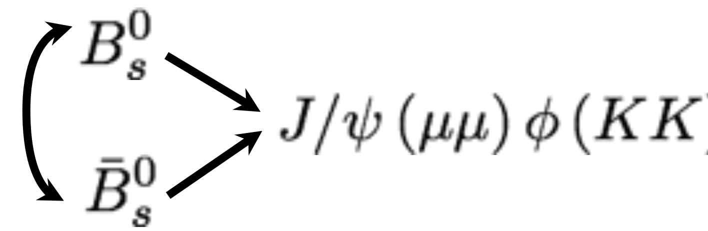
- ATLAS detector is performing remarkably well in the fourth month since the first 7TeV collisions.
  - The performance studies of the Tracking system -one of the main components in the B-physics program- are very advanced and include detailed understanding of the material, the momentum resolution and the vertexing, as well as the first physics-performance results.
    - The first signals of meson and baryon resonances have been reconstructed and the agreement of their precise comparison to MC expectations is impressive.
  - The other main component for the B-physics program -the Muon Spectrometer- has reconstructed large number of muons down to the lowest possible pT, allowing for the observation of $J/\psi \to \mu\mu$ with the lowest possible pT and providing thus the ideal "tool" to study the muon reconstruction efficiency.
    - Several thousands of J/ψ 's $\to \mu\mu$ have been observed and the first physics results are about to appear.
- For the short and long term B-physics program of ATLAS an efficient, fast and adaptable to high luminosity di-muon trigger scheme, will allow to collect large numbers of B-hadron decays involving $\mu\mu$ in the final state, throughout the life time of the experiment.

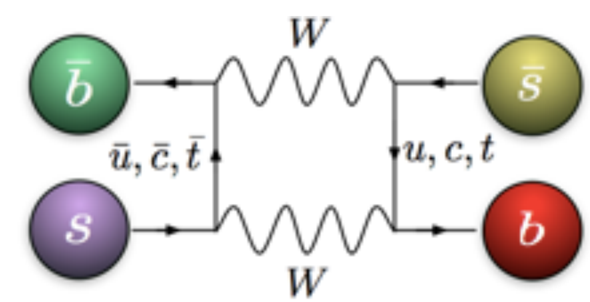
Early B-Physics data will provide information on quarkonia production mechanisms and spin alignment and will also allow calibration studies in support of New Physics searches

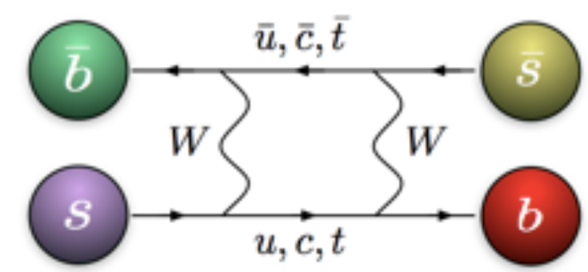
Reserve slides

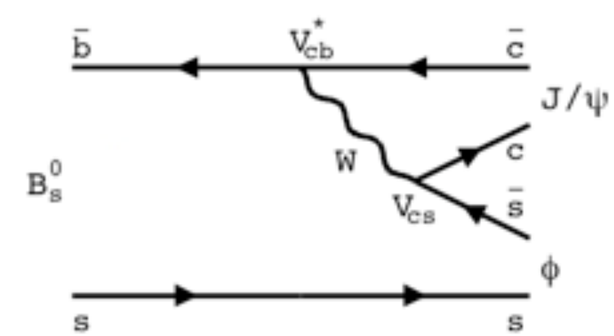
Introduction to $B_s \to J/\psi\phi$ and $B_d \to J/\psi K^{0*}$

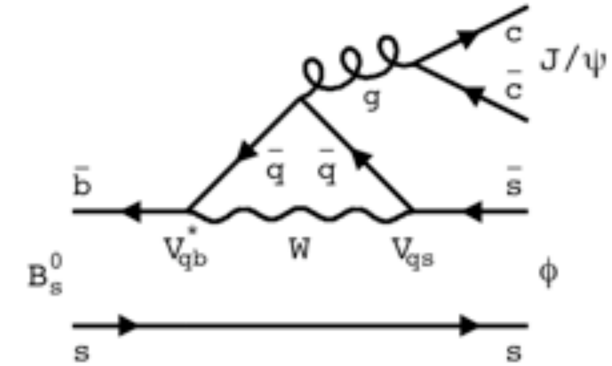
- The channel $B_s \to J/\psi\phi$ is a promising indirect route to New Physics
  - "Weak mixing phase" ϕ_s has been calculated in the SM and is very small (-0.0368±0.0018) but may be enhanced by BSM processes
- The time-dependent angular distribution of this decay depends on 7 physics parameters: 2 independent complex transversity amplitudes, mean lifetime and mass eigenstate width difference ($\Delta\Gamma$), weak mixing phase
- The analysis ultimately will involve a fit to these parameters, and is sensitive to
  - statistics, experimental resolutions of lifetime, mass and decay angles
  - flavour tagging performance, background rejection
- Early statistics do not permit the full fit - e.g. in D0/CDF a few thousand signal events allowed a 2-dimensional profile likelihood fit in the ϕ_s-$\Delta\Gamma$ plane. At the full LHC potential the simultaneous determination of all 7 parameters will be possible
- With small integrated luminosities, the ATLAS programme will begin with calibration measurements supporting this analysis
- The topologically identical $B_d \to J/\psi K^{0*}$ (15x greater statistics) is the primary background and is also essential as a control channel
  - High precision tests of lifetime measurement systematics
  - Flavour tagging calibration



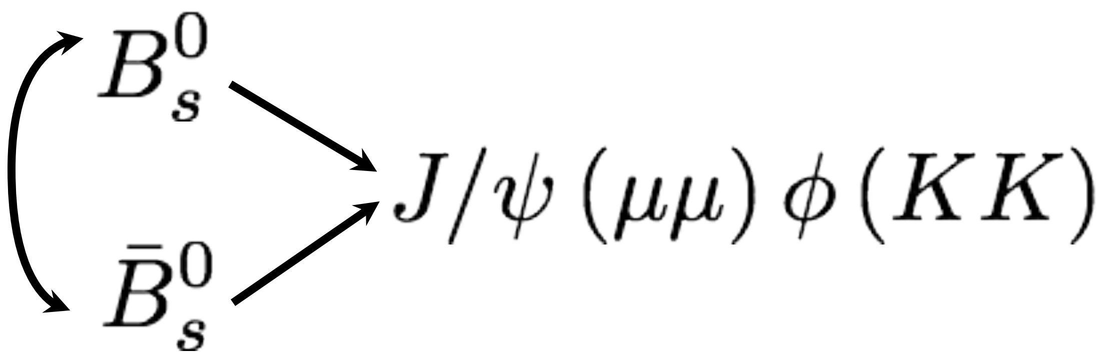






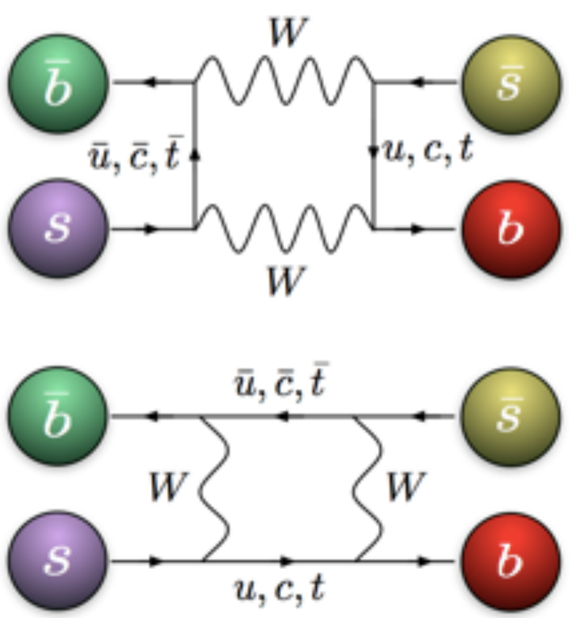


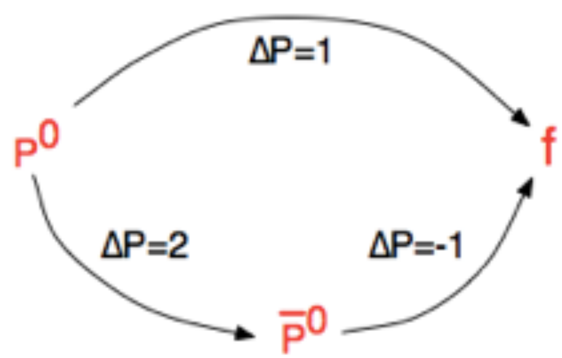
BSM physics from $B_s \to J/\psi\phi$

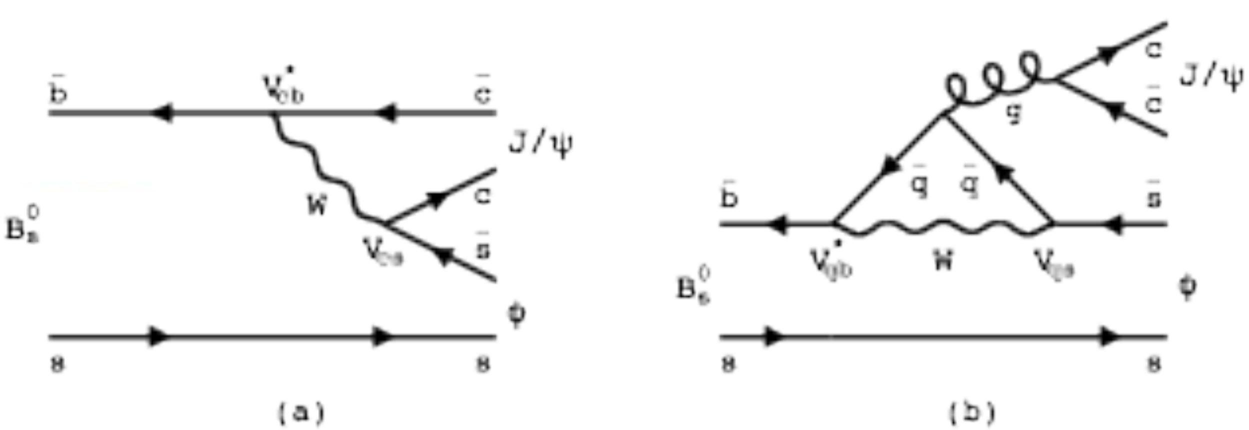


The state and anti-state can decay to the same final state, and can also undergo mixing

Mixing, decay and interference processes







New source of CP-violation may appear in the mixing, directly in the decay amplitudes, or in interference between the two processes

The main parameter of interest is the *weak mixing phase* ϕ_s

$$\phi_s \equiv 2\arg\left[V_{ts}^* V_{tb}\right] + \phi_{BSM}$$

Summary of performance for $B_s \rightarrow J/\psi\phi$ with $30fb^{-1}$

$B_s \rightarrow J/\psi\phi$			
Luminosity	30 fb-1 (≈3 years)	Signal proper time resolution	**83 fs**
Statistics	**~240 000**	J/ψ trigger efficiency wrt Monte Carlo	**72%**
Offline $J/\psi \rightarrow \mu\mu$ candidate cuts	2 oppositely charged inner detector tracks matched with muons, pt> {6,4} GeV fitting to common vertex $\chi^2<6$; $M_{\mu\mu} \in \pm 3\sigma$, σ=58 MeV	Offline $\phi \rightarrow KK$ candidate cuts	2 oppositely charged inner detector tracks not matched with muons, pt> 0.5 GeV fitting to common vertex $\chi^2<6$; $1009.2<M_{TT}<1029.6$ MeV
Offline $Bs \rightarrow J/\psi(\mu\mu)\ \varphi(KK)$ candidate cuts	4 tracks from J/ψ,φ candidates fitting to common vertex $\chi^2<10$; resultant pt of refitted tracks > 10 GeV	Signal event selection efficiency wrt Monte Carlo	**41%** before secondary vertex cuts; **30%** after
		Background	**~30%** after secondary vertex cuts, dominated by $B_d \rightarrow J/\psi K^{0*}$ and $bb \rightarrow J/\psi X$

Flavour tagging definitions

Efficiency

$$\varepsilon_{tag} = \frac{N_r + N_w}{N_t}$$

Dilution

$$D_{tag} = \frac{N_r - N_w}{N_r + N_w} = 1 - 2w_{tag}$$

Wrong-tag fraction

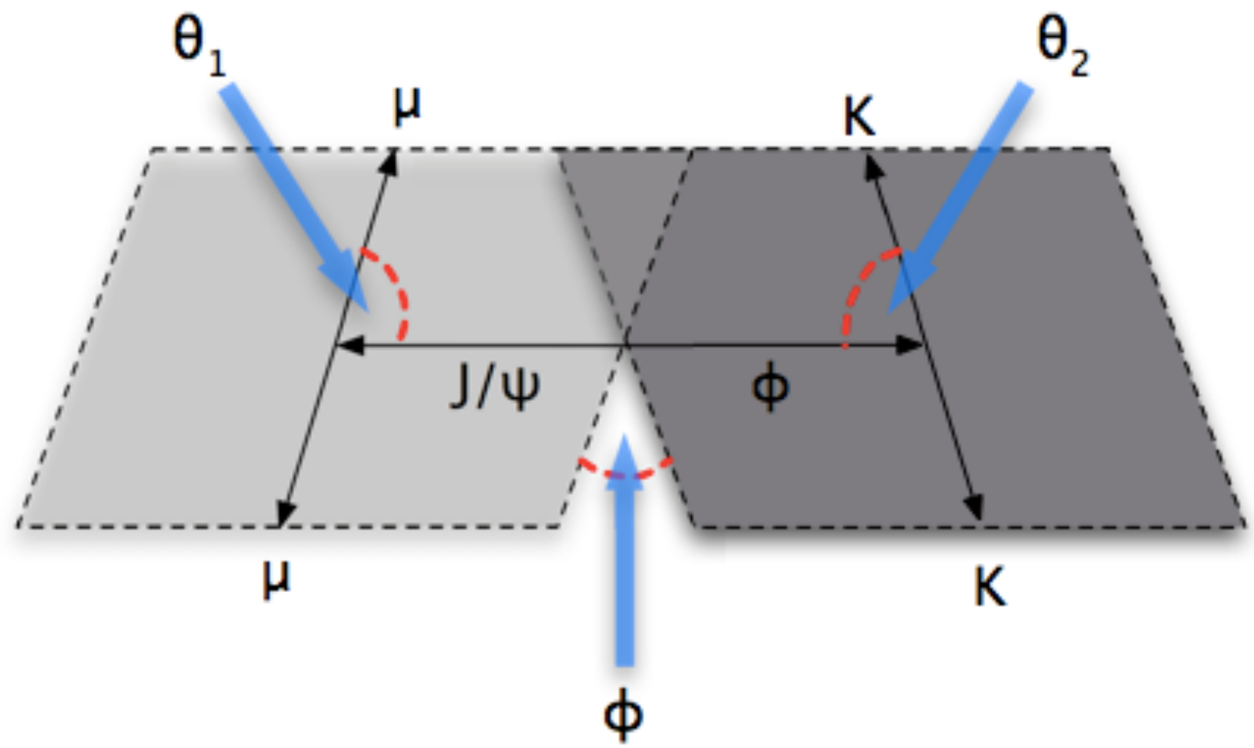
$$w_{tag} = \frac{N_w}{N_r + N_w}$$

Quality

$$Q_{tag} = \varepsilon D_{tag}^2$$

Extracting new physics from $B_s \to J/\psi\phi$

- The state and anti-state decay to the same final-state so it is necessary to separate out the CP-odd and CP-even states in order to be able to measure CP-violation
- This is done via a *transversity decomposition* where the decay amplitude is broken down into three component *transversity amplitudes* which each have a definite CP-eigenstate
- The amplitudes can only be accessed from the angles of the final decay products and the decay time of the B-meson. The angular distribution is non-trivial even in the absence of CP-violation effects since the decay is S→VV
- The analysis involves identifying the decays, measuring the decay angles and decay time, and performing a maximum likelihood fit to the function which expresses the angular distribution in terms of the transversity amplitudes. The expression is model-independent.
- The weak phase can be obtained from this fit



$B(t=0) = B_s^0$

Transversity amplitudes

$$W^+(\theta_1,\theta_2,\phi,t) = \frac{d\sigma}{d\theta_1 d\theta_2 d\phi dt} = \sum_k \Omega^{(k)}(t)\, g^{(k)}(\theta_1,\theta_2,\phi)$$

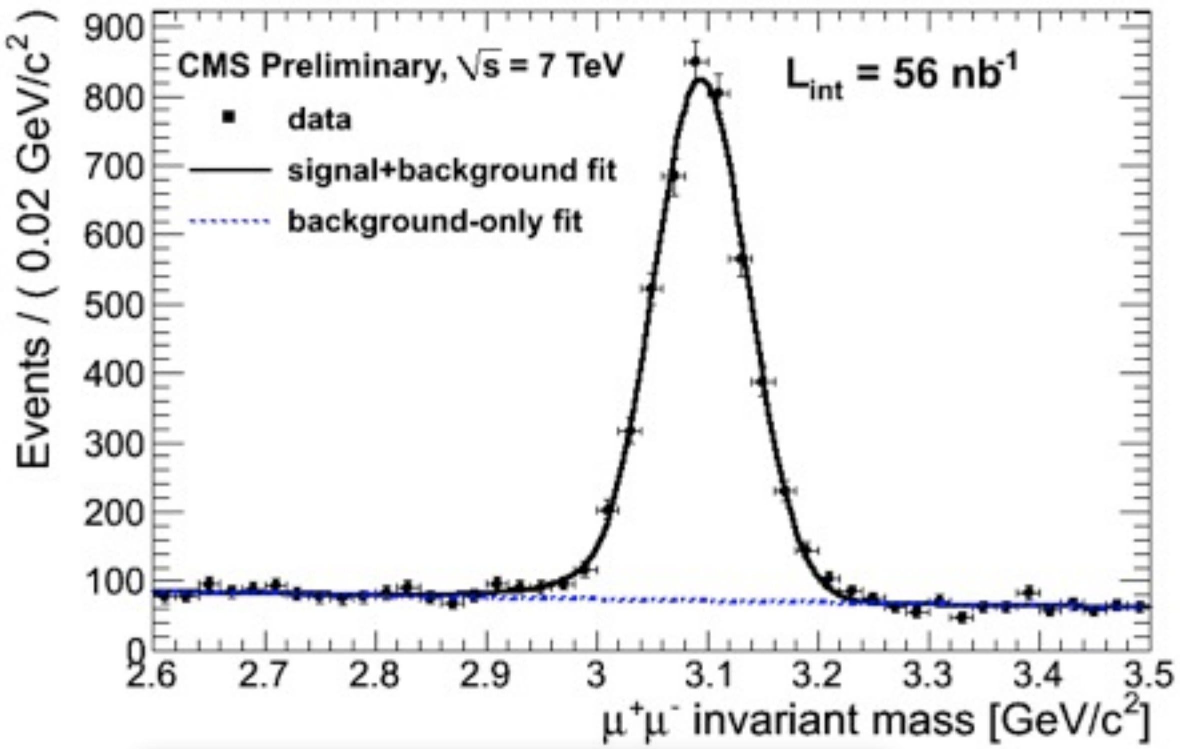
$$W^-(\theta_1,\theta_2,\phi,t) = \frac{d\sigma}{d\theta_1 d\theta_2 d\phi dt} = \sum_k \bar{\Omega}^{(k)}(t)\, g^{(k)}(\theta_1,\theta_2,\phi)$$

$B(t=0) = \bar{B}_s^0$

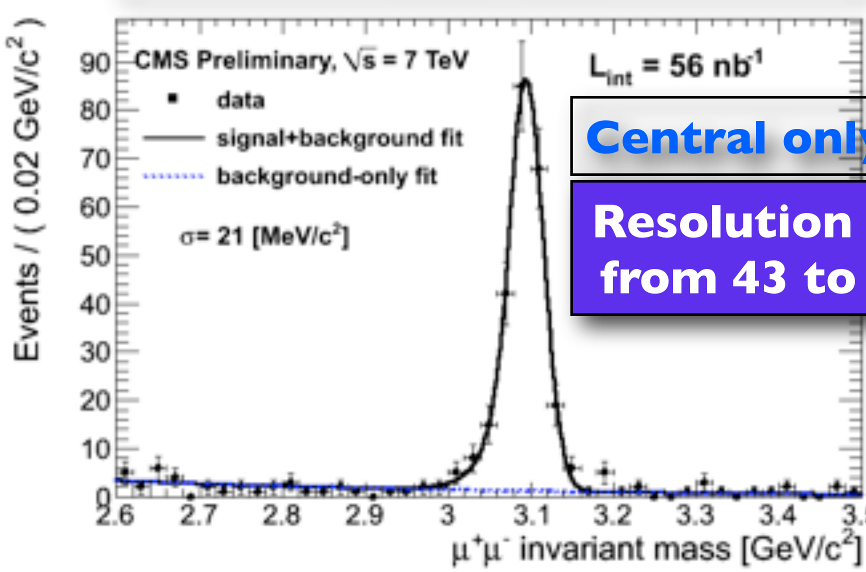
Spin dynamics

First observations of "Onia" candidates

More in the talk by Valery Zukhov



Signal events: 4150 222
Mass: 3.094 0.001 (stat) MeV
σ: 43.1 1.9 (stat) MeV
S/B= 5.2

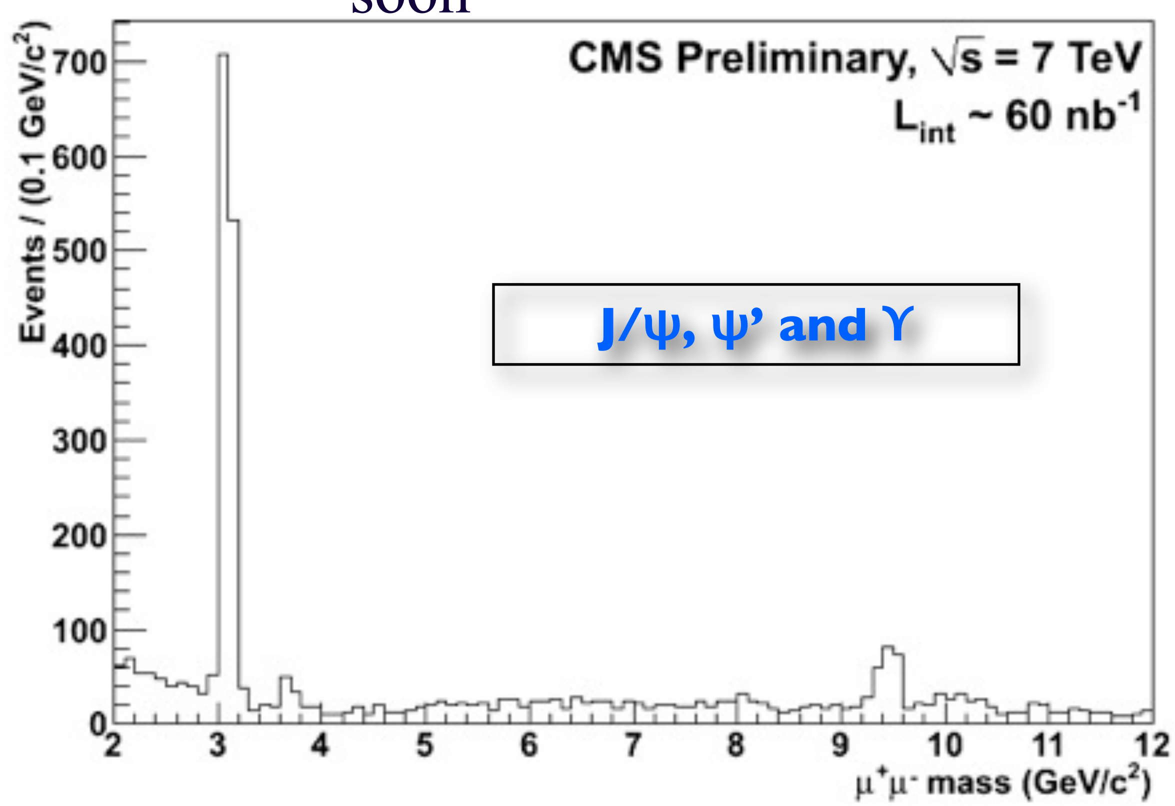


Central only

Resolution improves from 43 to 21 MeV !

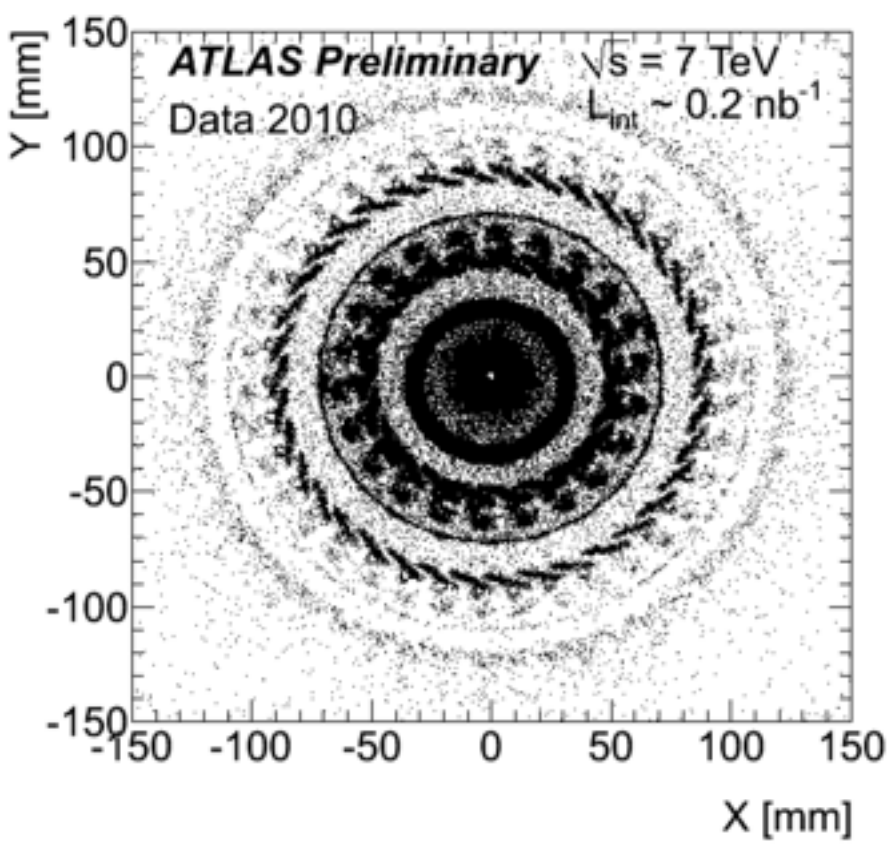
Ongoing studies:

- Mass position studied as a function of pT and η (material effects)
- Efficiencies from Tag and Probe method are well advanced
- More on flight distance and *b→J/ψ + X to prompt ratio* soon



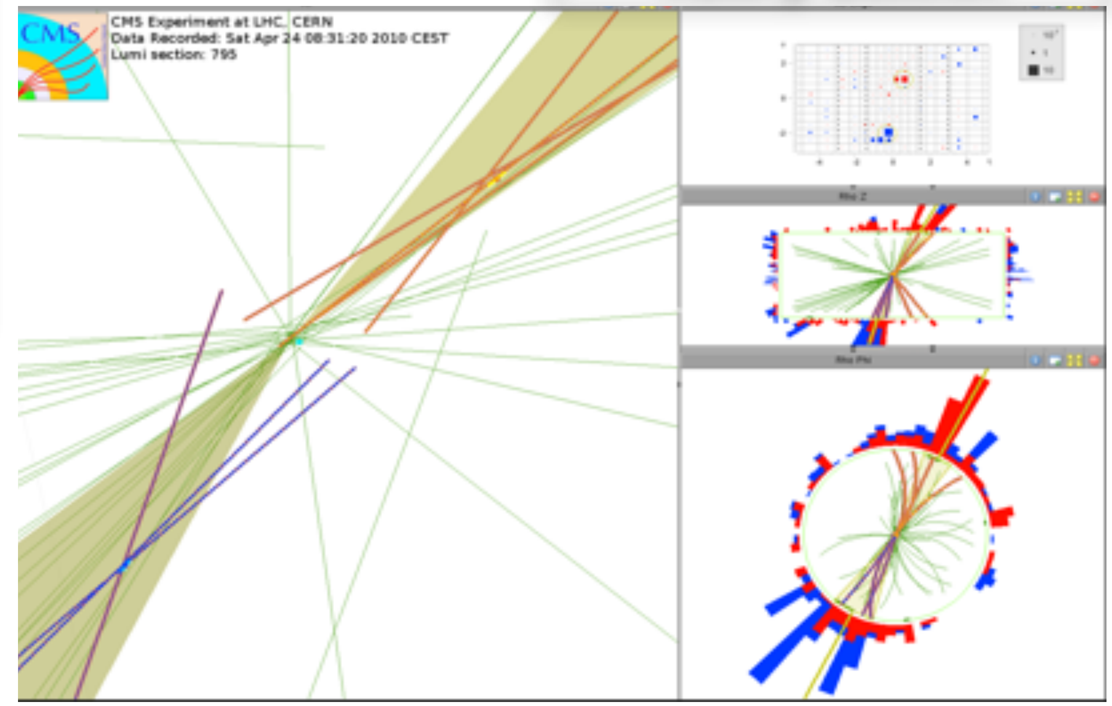
J/ψ, ψ' and Υ

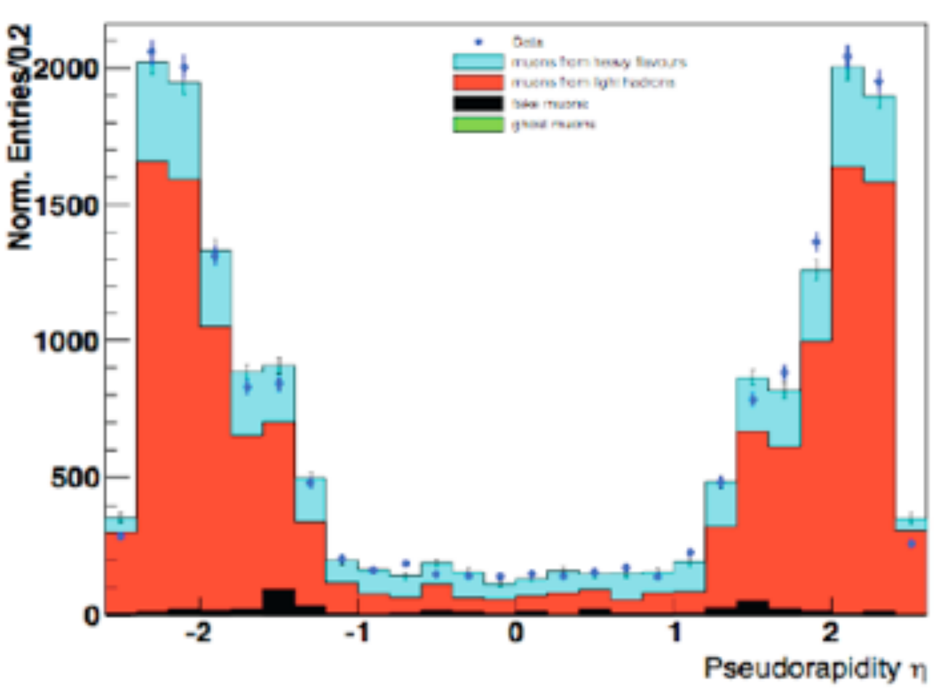
Inner Detector and Muon Spectrometer performance with 7TeV data

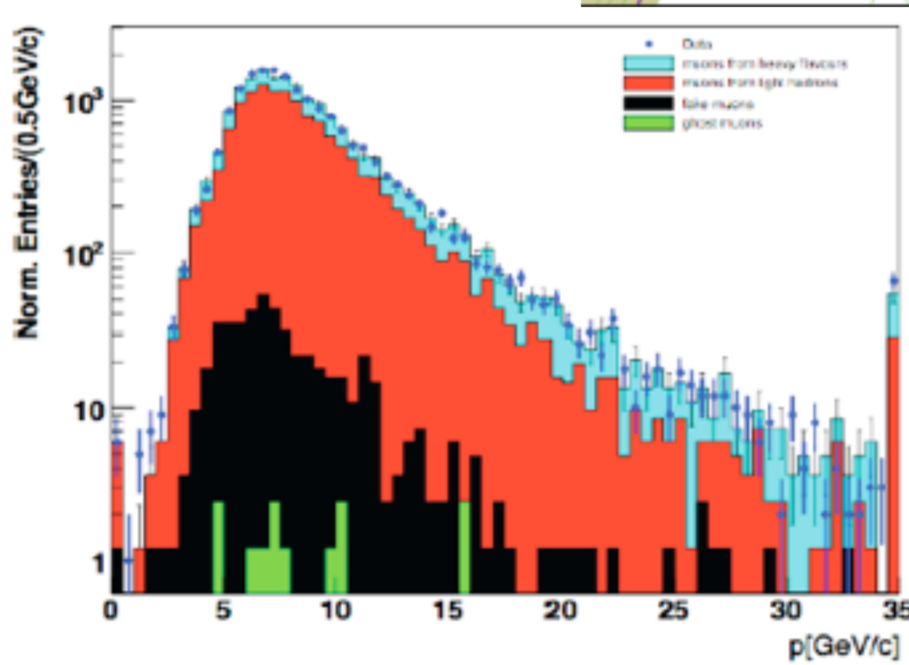


"Tomography" of the Inner Detector from the precise reconstruction of the secondary vertices from nuclear interactions. Precise determination of the material "budget" is possible

b-jet example
More in the talk by Valery Zukhov







- η and p_T distributions dominated by light hadron decay muons (red)
- good agreement with MC prediction, including
  - heavy flavor decays (blue)
  - punch-through (black)
  - fakes (green)