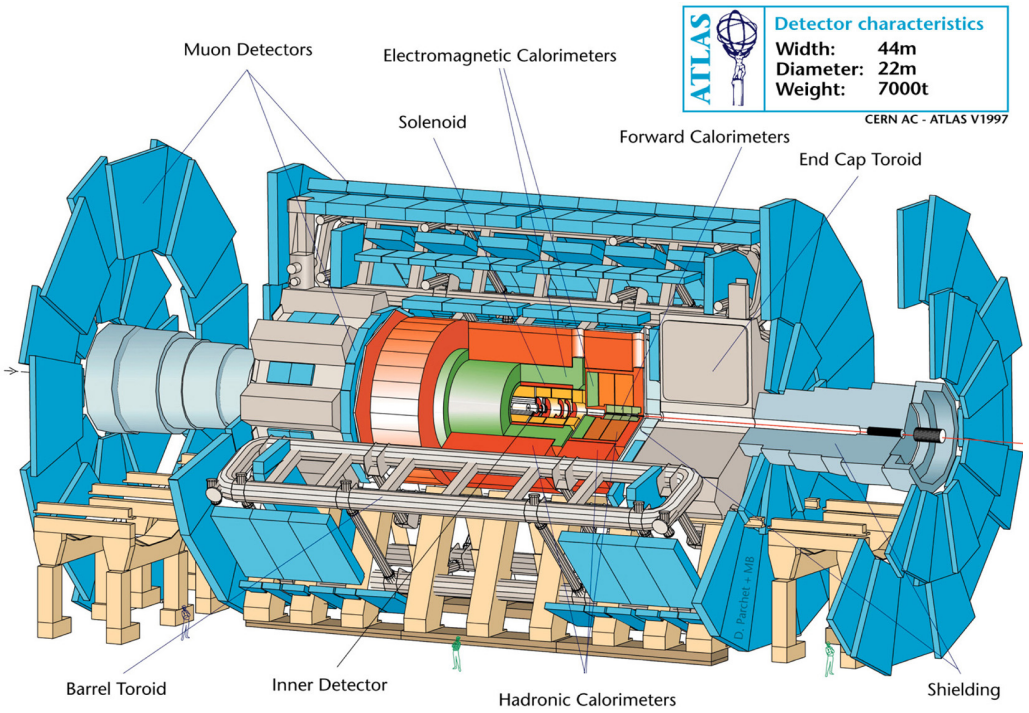
Exclusive B-Decays in ATLAS

Alessandro Cerri for the ATLAS collaboration

ATLAS

- General purpose pp detector
- Few peculiarities:
  - Huge massive detector!
  - Solenoidal field tracker complemented by separate muon spectrometer
- Will not go into details, feel free to ask questions



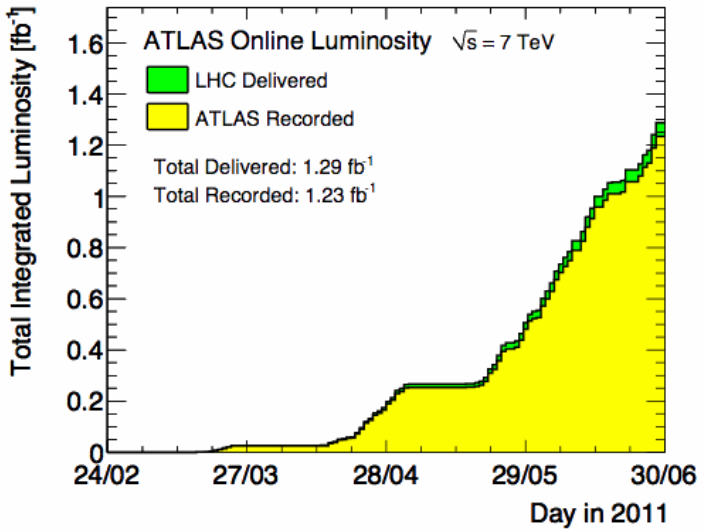
B physics with ATLAS

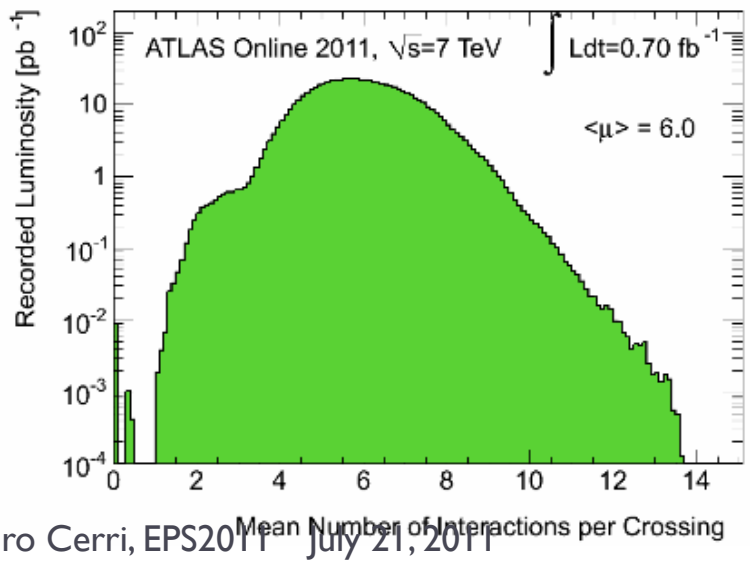
- Large b production cross-section [few 100 μ b]
- Excellent muon detection and tracking performance
  - B physics in ATLAS is mostly driven by muon-based triggers!

ATLAS data taking

- 1.23 fb^{-1} integrated in 2011
- 1.26E33 cm^{-2} s^{-1} peak luminosity
- Overall data taking efficiency >95%
  - All subsystems >90%
- Expect >10 fb^{-1} by the end of 2012
- <# interactions/crossing>: 6
- Results discussed based on
  - 2010 (~40 pb^{-1})
  - 2011 (~1.2 fb^{-1} so far)

data, depending on specific result discussed

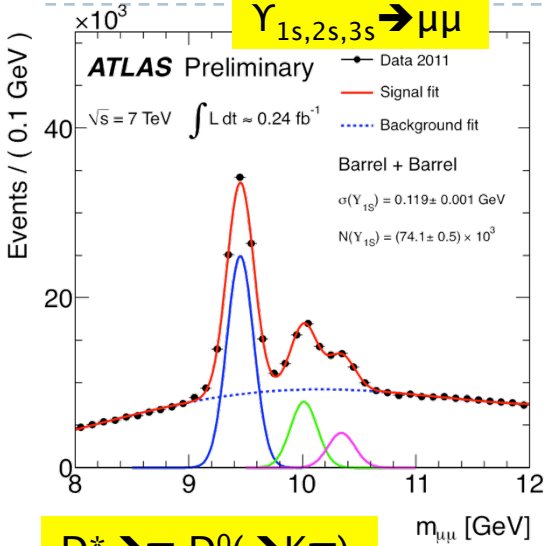




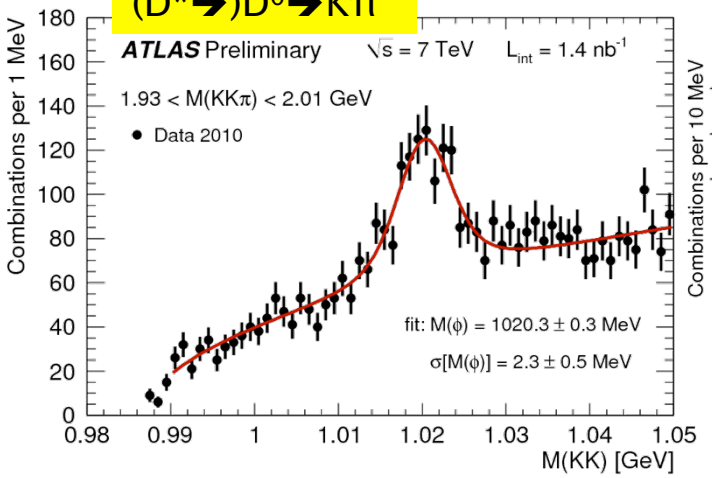
ATLAS-CONF-2010-034, ATLAS-CONF-2010-045, ATLAS-CONF-2010-062, ATLAS-CONF-2011-017, arxiv/1106.5325v1, Nucl. Phys. B 850-3

Reconstruction of particles in ATLAS

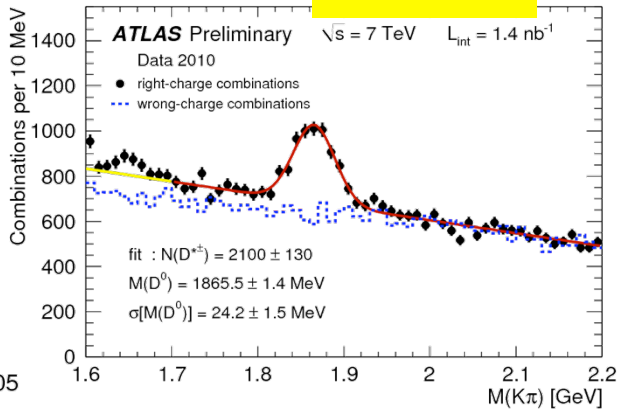
$\Upsilon_{1s,2s,3s} \rightarrow \mu\mu$



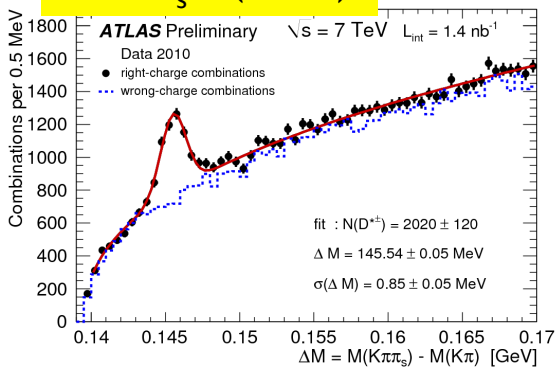
$(D^* \rightarrow) D^0 \rightarrow K\pi$



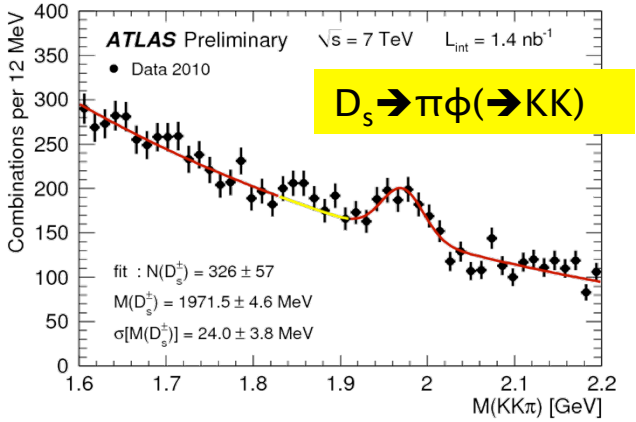
$D^+ \rightarrow K\pi\pi$



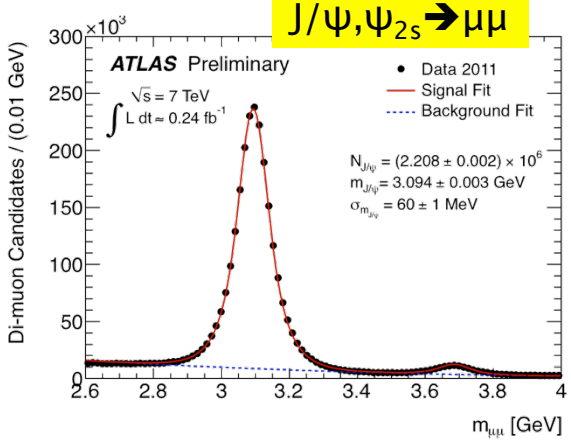
$D^* \rightarrow \pi_s D^0 (\rightarrow K\pi)$



$D_s \rightarrow \pi\phi (\rightarrow KK)$

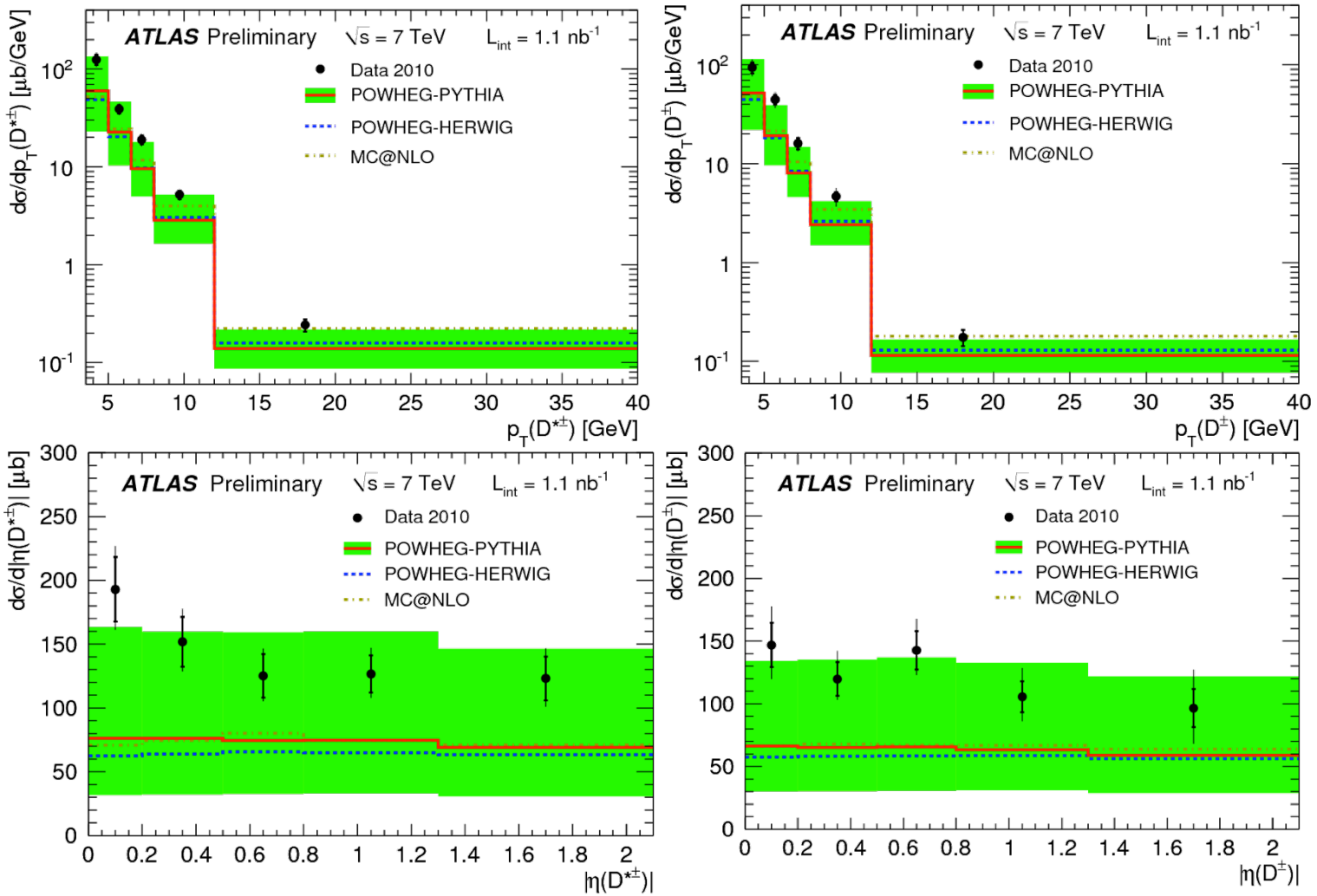


$J/\psi, \psi_{2s} \rightarrow \mu\mu$



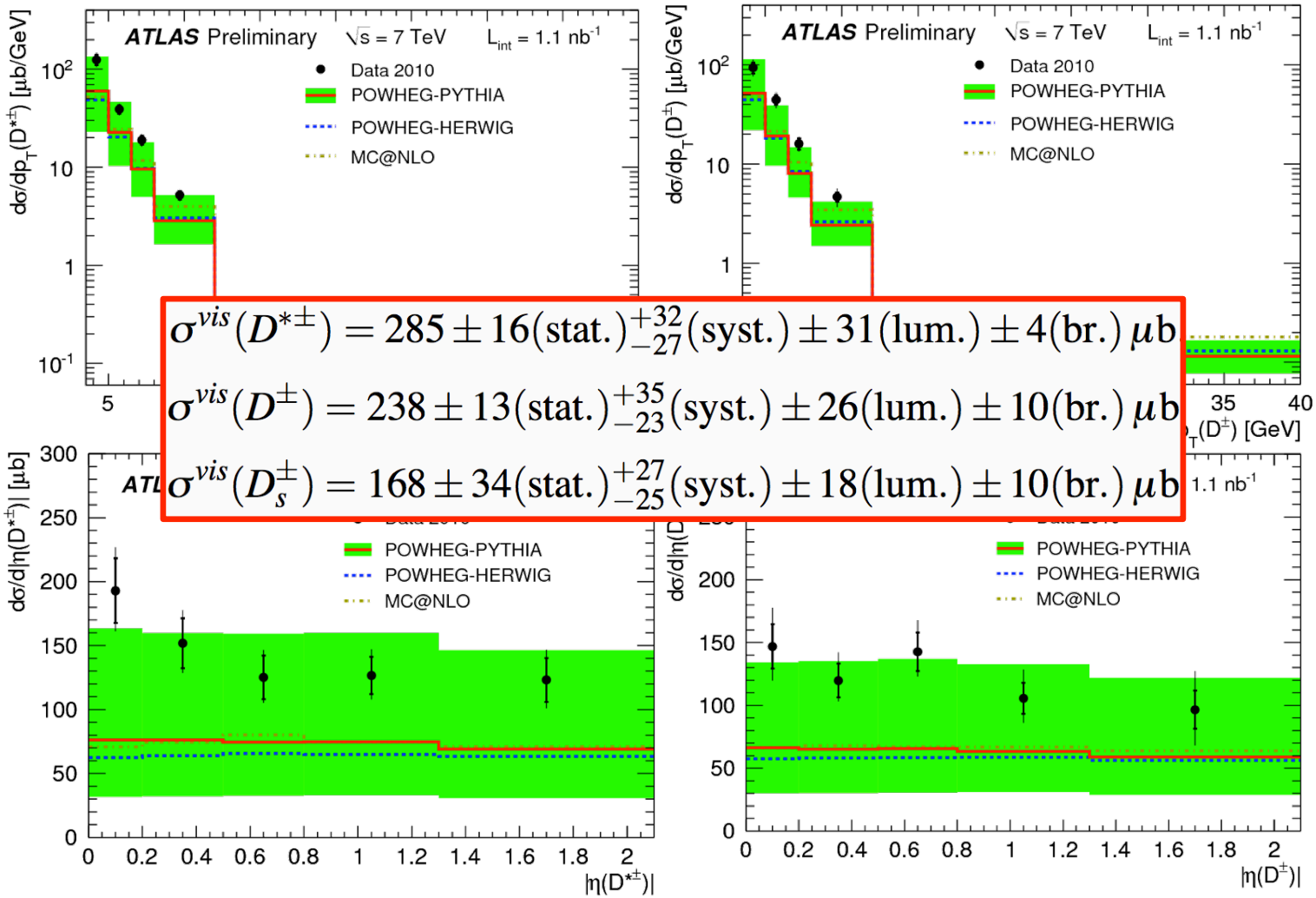
We also reconstruct Λ, Σ, Ω, Λ_b, etc.

Open charm cross section



Good agreement with MC predictions for differential and integrated cross-sections

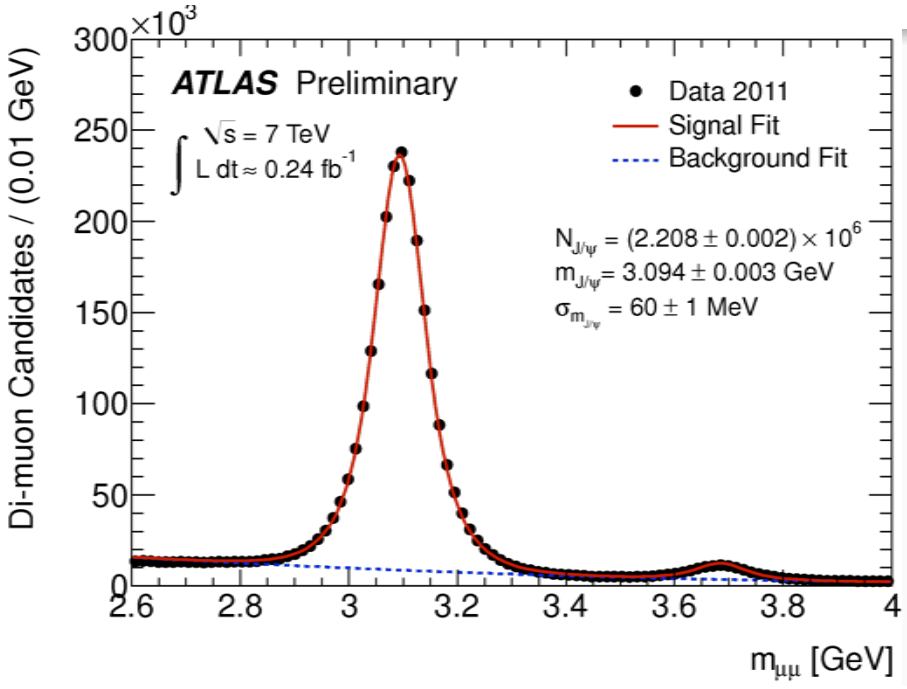
Open charm cross section

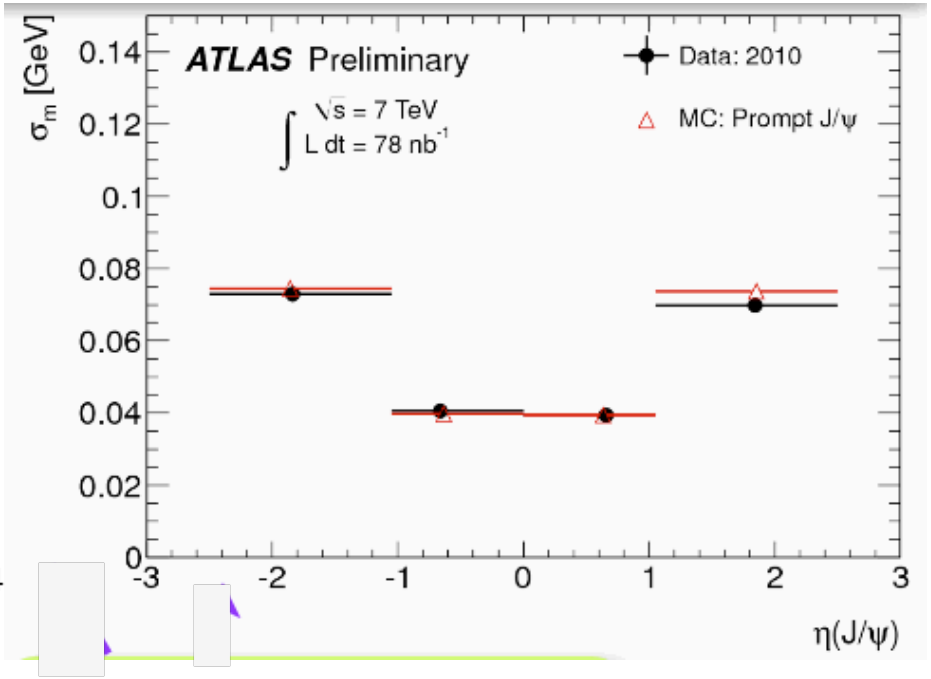


Good agreement with MC predictions for differential and integrated cross-sections

Mass resolution: J/ψ studies

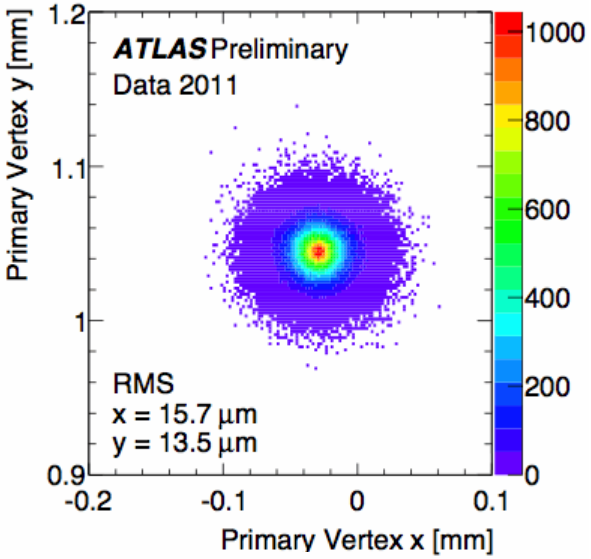
- J/ψ ➔ μμ, fit 2-track vertex
- Mass value and dependency on η (J/ψ) consistent with PDG/MC:

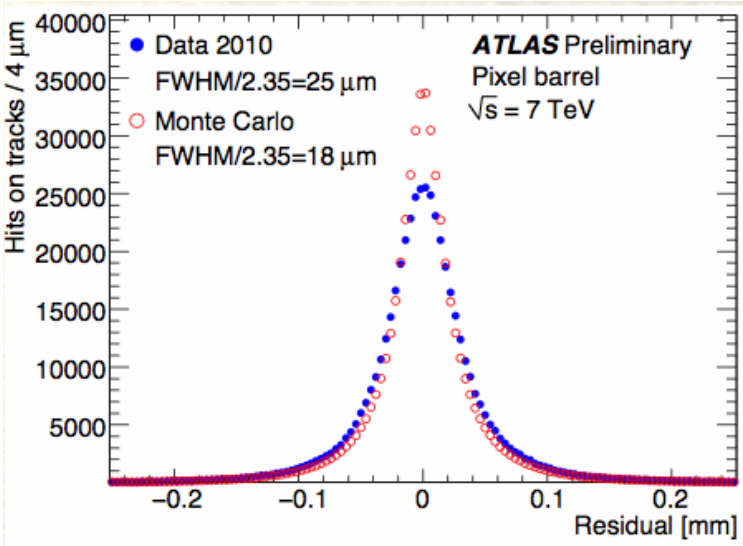


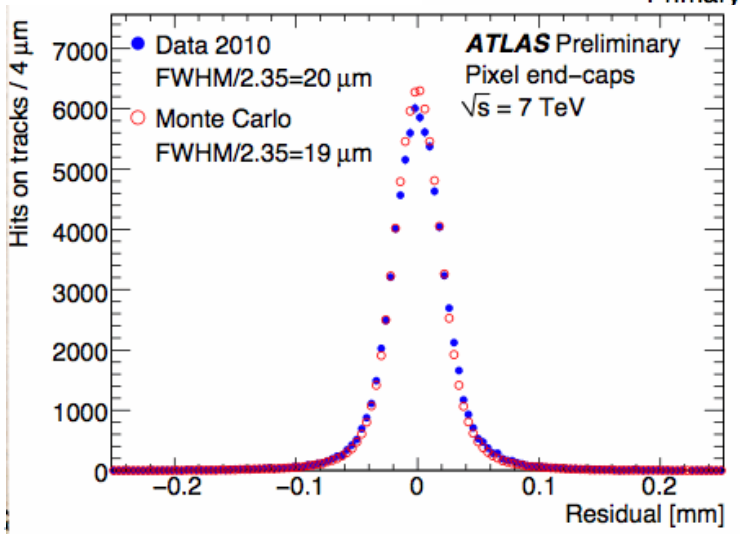


Proper time: tracking & PV determination

- PV determined with 13-16 μm precision
- Tracker residuals within expected performance, not fully consistent with simulation

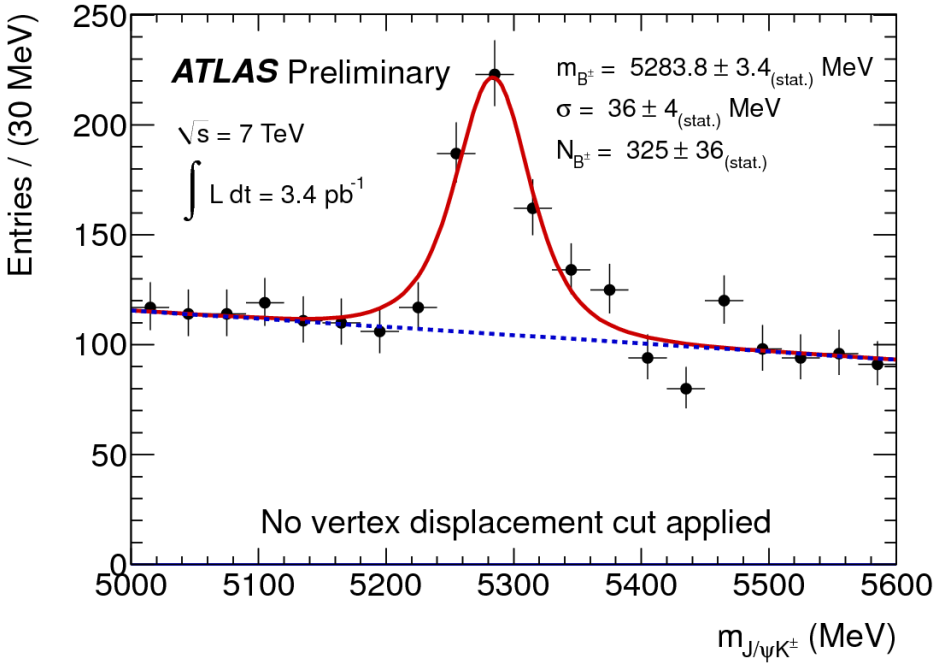


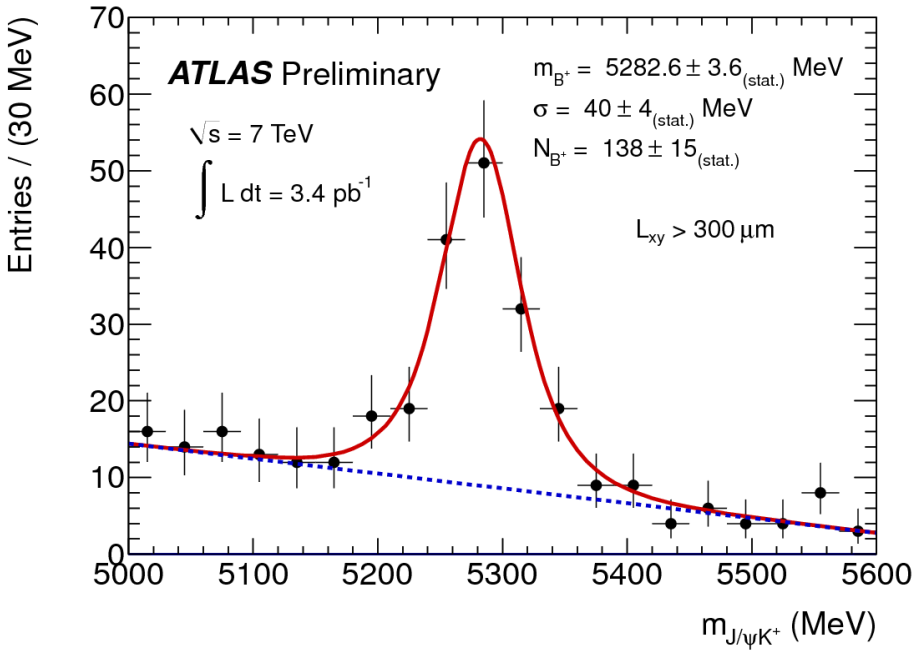




One additional track: $J/\psi K^+$

- Select additional track with K mass hypothesis
- Fit 3-track vertex, with mass-constraint on J/ψ
- Unbinned maximum-L fit with Gaussian+linear background

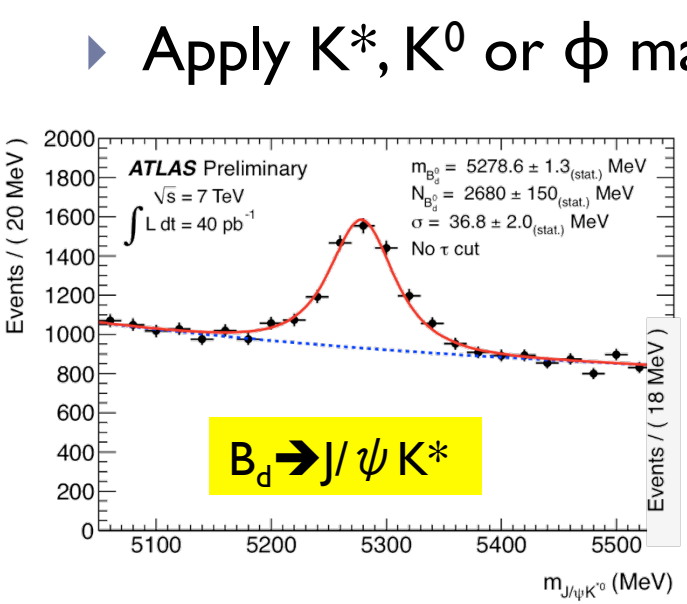


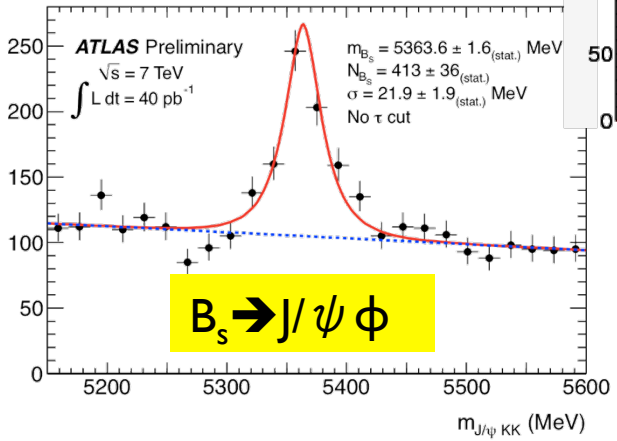


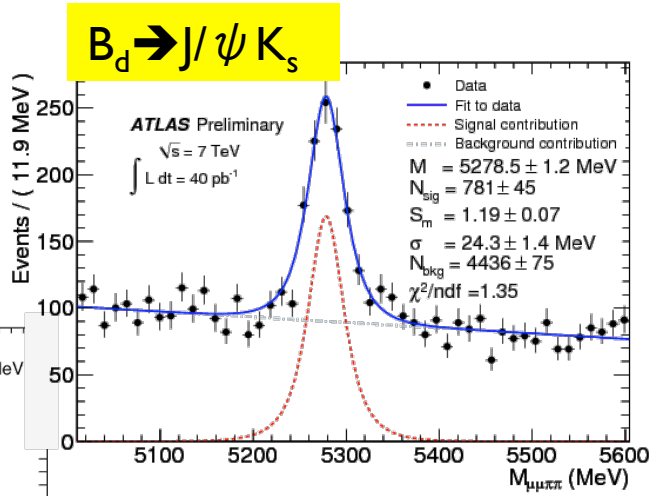
- Measured mass consistent with PDG within statistical uncertainty

Two additional tracks…

- Add two tracks, assume $K^* \rightarrow K\pi$, $K^0 \rightarrow \pi\pi$, or $\phi \rightarrow KK$ and $J/\psi \rightarrow \mu\mu$
- Fit 4-track vertex or two 2-track vertices
- Apply K^*, K^0 or ϕ mass cut





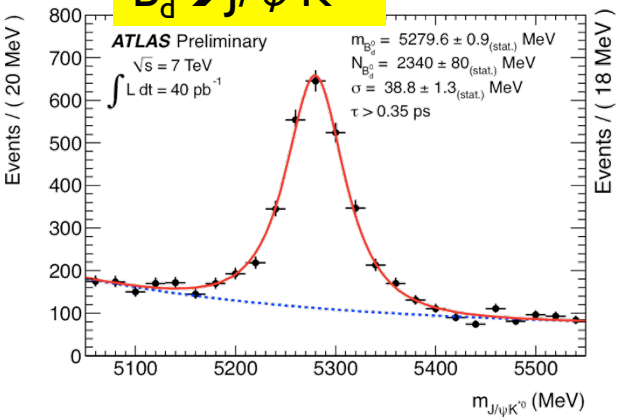


- Mass values compatible with PDG within stat. uncert.

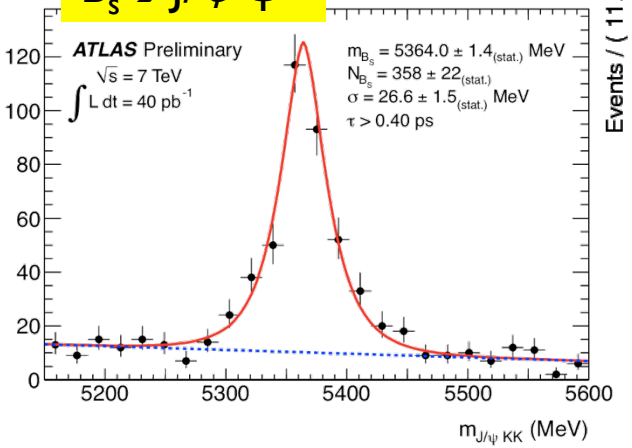
ATLAS-CONF-2011-050, ATLAS-CONF-2011-115

Adding a lifetime cut…

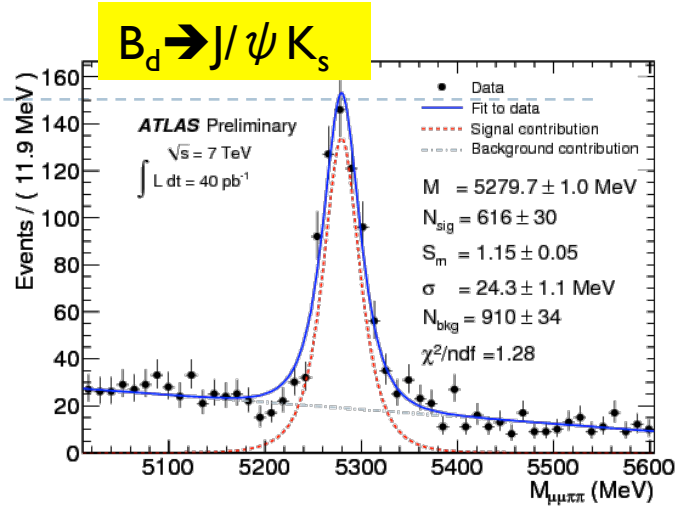
$B_d \rightarrow J/\psi K^*$



$B_s \rightarrow J/\psi \phi$



$B_d \rightarrow J/\psi K_s$



Mode	τ cut	M_B[MeV]	σ_M [MeV]	N_{signal}	$N_{background}$
Bd (K^*)	No	5278.6±1.3	36.8±2.0	2680±150	10280±110
	Yes	5279.6±0.9	38.8±1.2	2340±80	1330±60
Bd (K_s)	No	5278.5±1.2	24.3±1.4	781±45	4436±75
	Yes	5279.7±1.0	24.3±1.1	616±30	910±34
Bs	No	5363.6±1.6	21.9±1.9	413±36	764±17
	Yes	5364.0±1.4	26.6±1.6	358±22	90±7

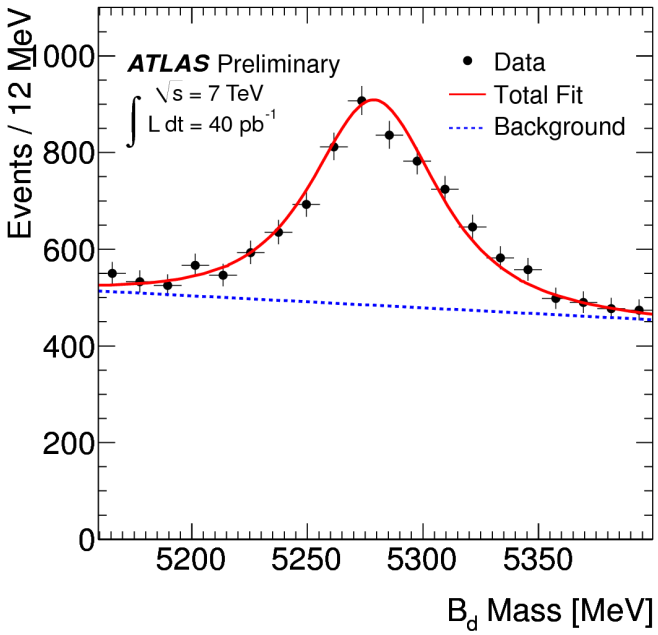
Consistent masses with PDG, good mass resolution

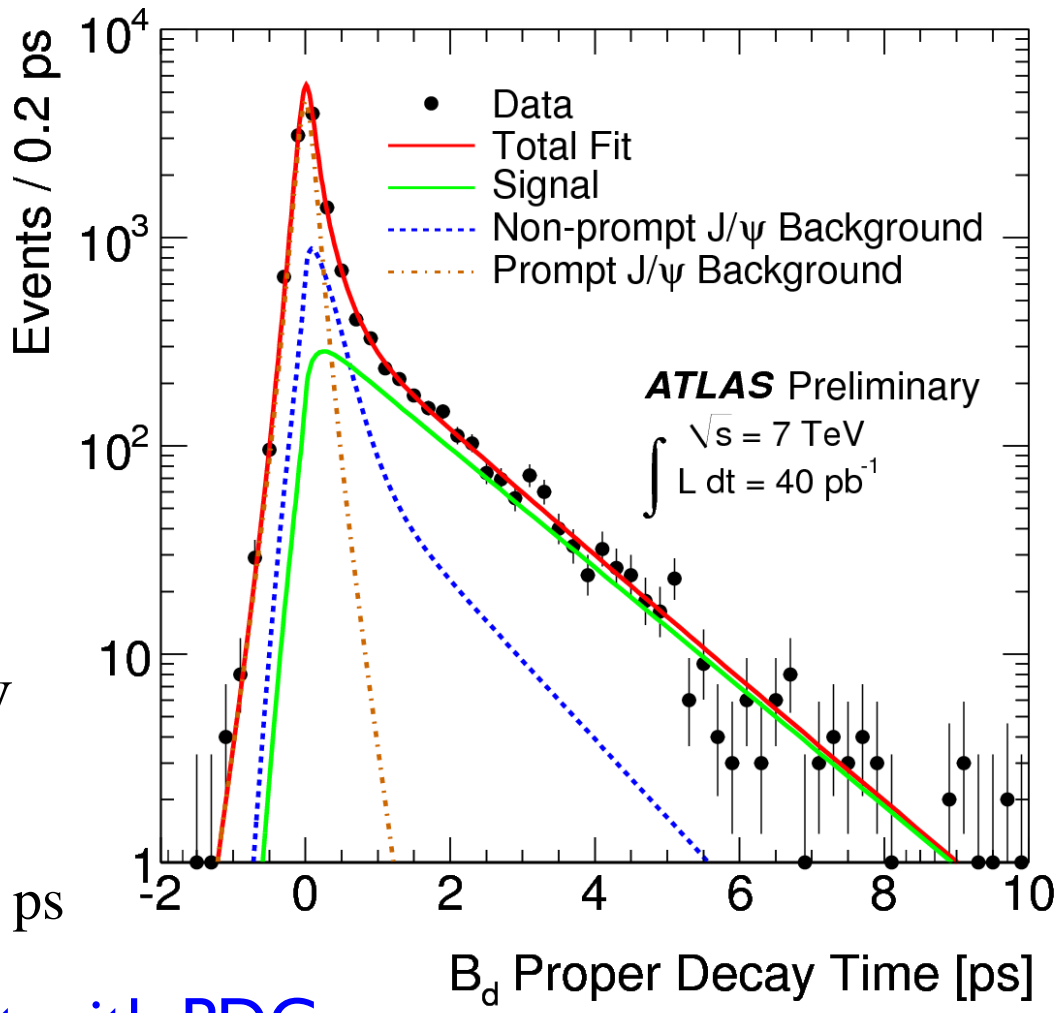
Measuring lifetimes

- Perform simultaneous unbinned max-L fit to mass and decay time distributions
  - Signal:
    - M: Gaussian with predicted per-candidate mass resolution plus corrective scale-factor
    - τ : Gaussian-smeared truncated exponential
  - Background:
    - M: Linear function
    - τ :
      1. One Gaussian
      2. Two Gaussian-smeared truncated exponentials
      3. One Gaussian-smeared symmetric exponential [exp(-| τ_{Bck3}|)]
- 12 free parameters!

  f_{sig}, m_B, S_m, S_τ , τ_B, b, τ_{Bck2a}, τ_{Bck2b}, τ_{Bck3}, f_{Bck1},f_{Bck2},f_{Bck3}

Lifetime fit results: B^0





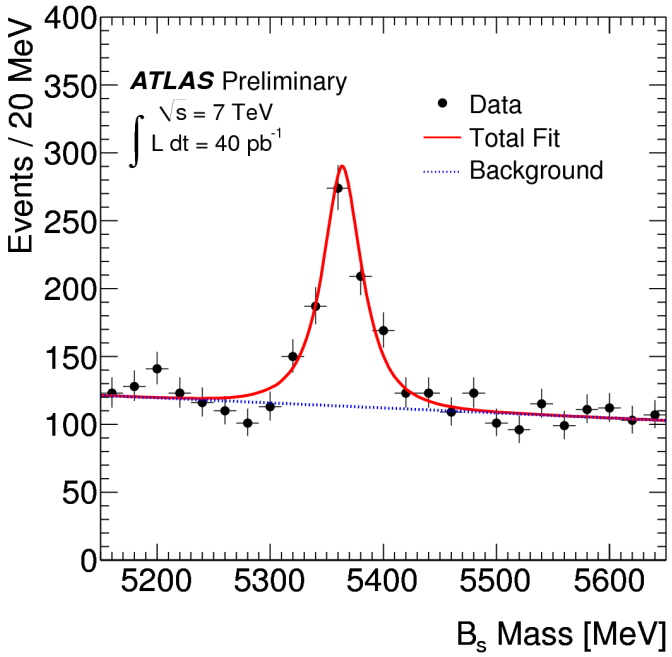
$$m_{B_d} = (5279.0 \pm 0.8)\text{MeV}$$

$$\sigma_m = (34.3 \pm 0.9)\ \text{MeV}$$

$$\tau_{B_d} = (1.51 \pm 0.04 \pm 0.04)\ \text{ps}$$

Good agreement with PDG

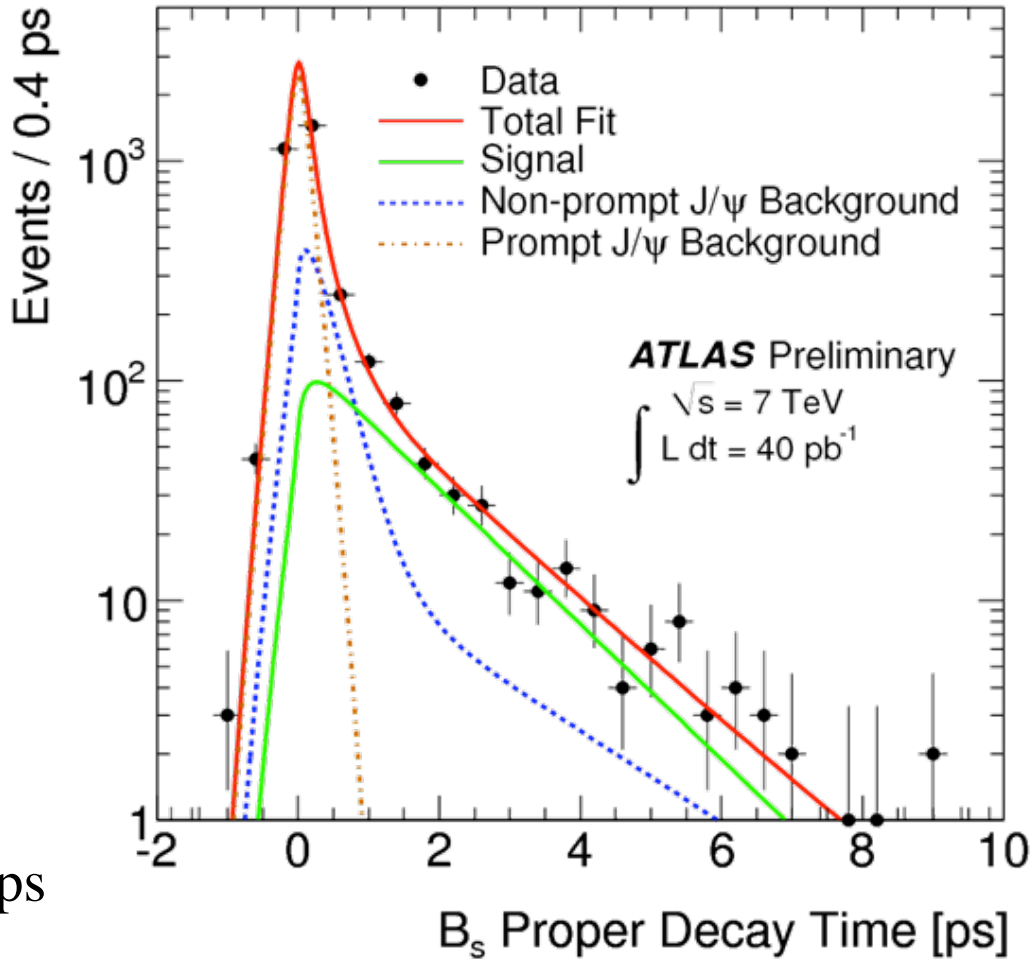
Lifetime fit results: B_s



$$m_{B_s} = (5363.7 \pm 1.2)\text{MeV}$$

$$\sigma_m = (24.8 \pm 1.2)\ \text{MeV}$$

$$\tau_{B_s} = (1.41 \pm 0.08 \pm 0.05)\ \text{ps}$$



Good agreement with PDG

Summary and Outlook

- B physics in ATLAS is mostly based on muon triggers
- Heavy-flavor signals (D, D*, Ds etc.) encouraging
- We will be competitive in the long run:
  - 2 fb^{-1} from LHCb will be integrated when ATLAS will have collected 10 fb^{-1}
  - ATLAS will make a valuable contribution to β_s
- On-track for CPV measurements, we have successfully assessed our performance in terms of mass and proper-time reconstruction
- Looking forward to many more fb^{-1} of integrated luminosity!