$B^+ \rightarrow J/\psi\ (\mu\mu)\ K^+$ measurment
Prospect with first ATLAS data

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

- With first Atlas Data the we will measure the B^+
  - Mass
  - Differential and Total cross section
  - Lifetime

Analysis Procedure

Signal+Background study is performed using 145500 bb->J/Ψ X events corresponding to a luminosity of 13.2 pb^{-1}. The procedure followed for selecting the $B \rightarrow J/\psi K^+$ events comprises :

- the identification of the J/ψ decaying to two muons
- the finding of the primary and secondary vertex of the interaction
- and the combination of a positive charged track (K+ candidate) to form the B+ candidate event.

J/ψ selection

- All the possible muon pairs with one muon having $p_t \geq 3.0$ GeV and the other $p_t \geq 6.0$ GeV
- The muon pairs are fitted to a common vertex using CDF fitter.
- A chi2/NDF <10 and a Lxy>0.1 mm cut is applied to the fitted vertices.
- From the vertices surviving the previous cuts we keep only these that have an invariant mass inside a 120 GeV window around $m_{J/\psi}$.

B^+ Selection

- Retain remaining tracks with $p_t \geq 1.5$ GeV $\eta<2.7$, select the positively charged not coming from the primary vertex $|d0|/\sigma d0 > 1$, these are K+.

- The J/ψ muons and the K+ are fitted in a common vertex .
- A chi2/NDF <10 , $p_t \geq 6$ GeV and a Lxy>0.1 mm cut is applied to the fitted vertices.
- From the vertices surviving the previous cuts we keep only these that have an invariant mass inside a window around m_{B+}.
- In case that more that two B^+ candidates are found in the same event the one with the smallest chi2/NDF is accepted.

B+ Mass

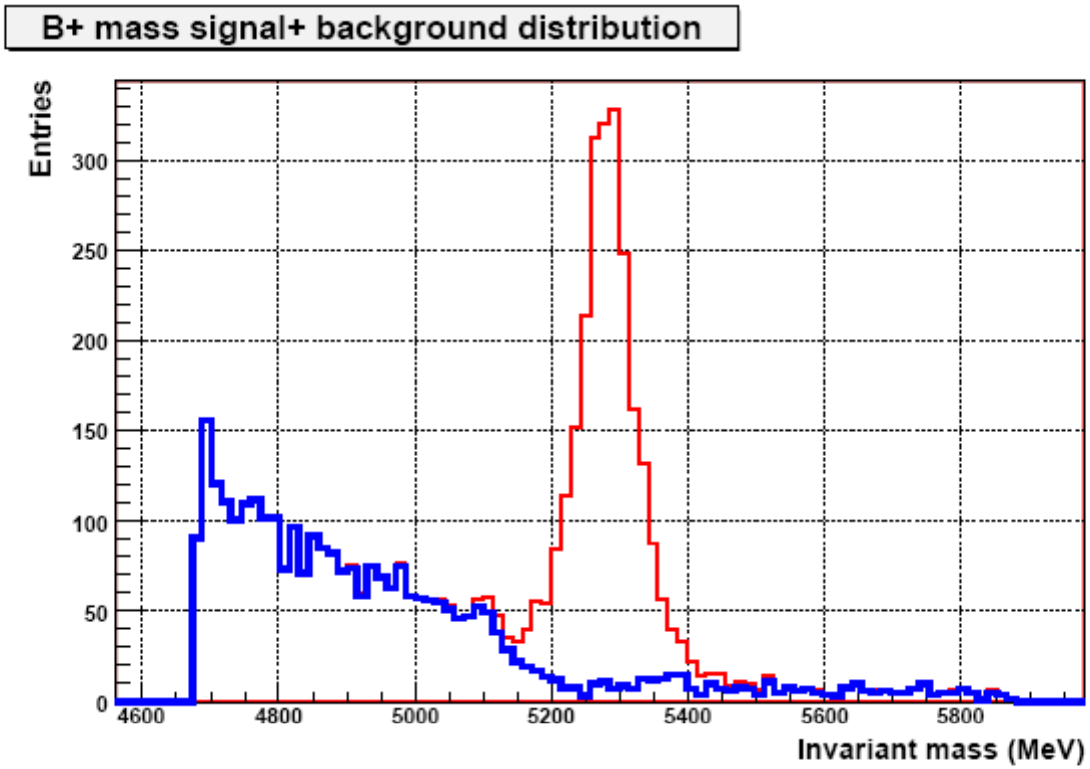
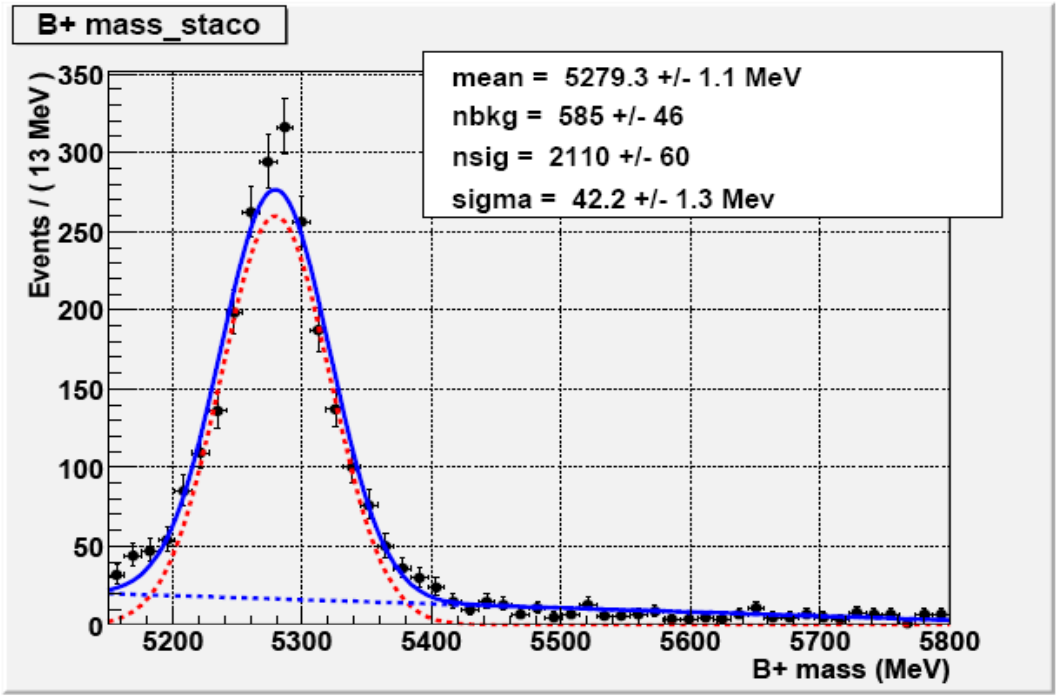


Figure 2: B^+ and background reconstructed mass distributions based on the MC Truth information. (Red for Signal and Blue for Background)

Mass Fit Results

	STACO	MuiD	No muon ID
B^+mass mean MeV	5279.3±1.1	5279.2±1.1	5279.3± 1.1
B^+ mass σ MeV	42.2 ±1.3	41.8 ±1.3	40.1 ±1.3

Table 6: B^+ Mass Fit Results



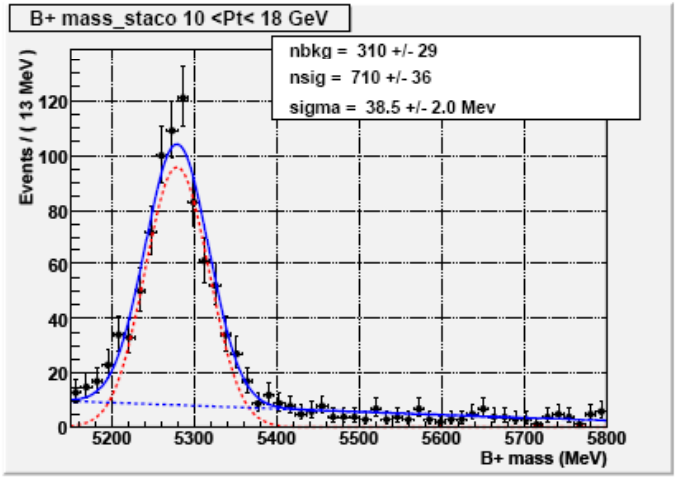
Cross Section

- Cross section formula

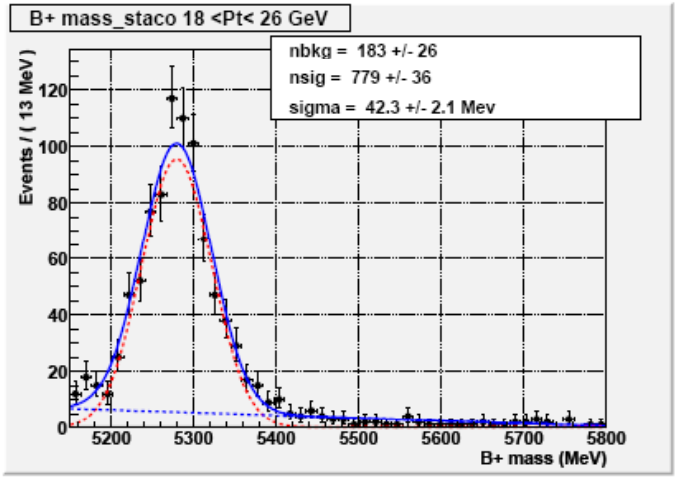
$$\frac{d\sigma(B^+)}{dp_T} = \frac{N_{sig}}{\Delta p_T \cdot \mathcal{L} \cdot \mathcal{A} \cdot BR}$$

- We calculate the overall acceptance-efficiency A which is calculated for each in p_t bin.
- We fit the B+ in p_t bins using the same function as before but performing a maximum likelihood fit.
- The B+ mass M is kept fixed using the results from the previous section.

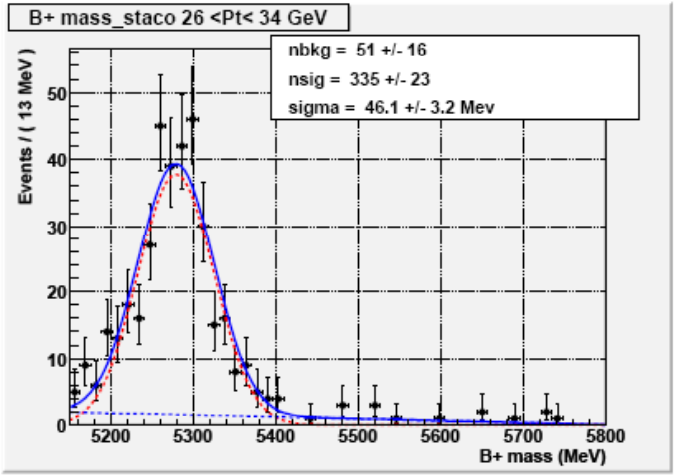
Differential Cross Section



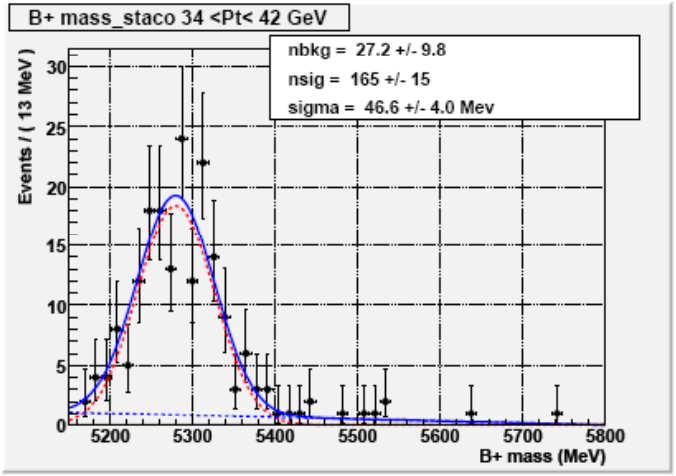
(a) $10 \leq p_T < 18$ GeV



(b) $18 \leq p_T < 26$ GeV



(c) $26 \leq p_T < 34$ GeV



(d) $34 \leq p_T < 42$ GeV

B^+ lifetime measurement

Importand quantities

- Transverse decay length and its sign definition Lxy:

$$L_{xy} = \frac{\vec{X} \cdot \vec{p}_T}{|p_T|^2}$$

- Proper decay length

$$\lambda = L_{xy} \cdot \frac{m}{p_T^B}$$

- The proper decay time is defined as :

$$\tau = \lambda / c$$

B^+ lifetime measurement

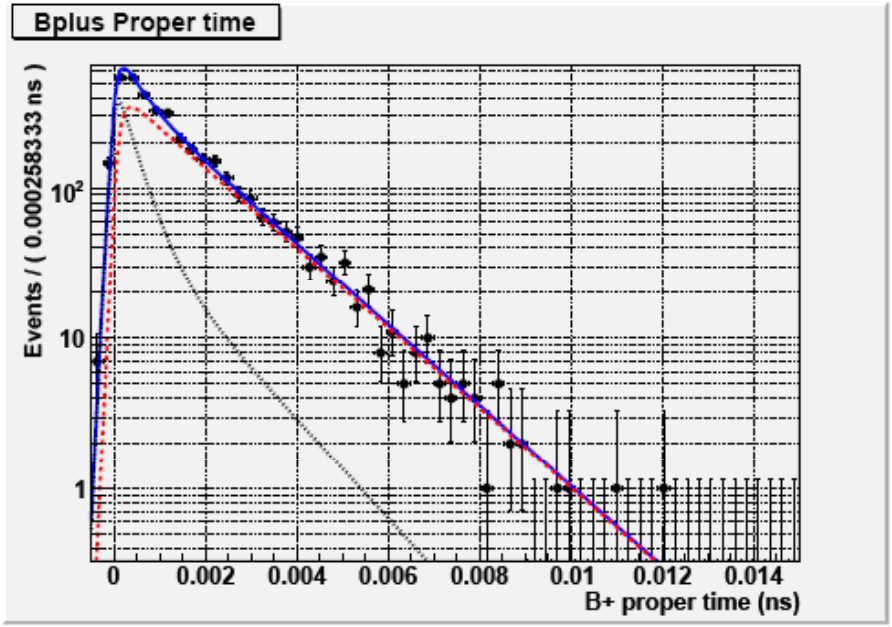


Figure 6: B^+ lifetime fit (STACO).Signal (dashed red), background (dashed black), overall (blue)

Lifetime Fit Results	
Signal lifetime τ ps	1.637±0.036
Bkg1 lifetime τ_1 ps	1.320±0.24
Bkg2 lifetime τ_2 ps	0.370±0.067

Table 11: Lifetime fit results based on a luminosity of $13.2 pb^{-1}$

BACKUP
SLIDES

Mass Fit

- The likelihood function in the signal region is :

$$L = \alpha f_{sig} + (1-\alpha) f_{bkg}$$

- where a is the fraction of signal events in the fitted region and :

$$f_{sig} = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{1}{2}(\frac{M_i - M}{\sigma})^2}$$

$$f_{bkg} = b(M_i - \tfrac{w}{2}) + \tfrac{1}{w}$$

- where M is the mean of the B+ mass , b is the slope of the background and w the range of the unbinned fit.

Efficiencies

	Identification Method		
J/ψ number	STACO	MUID	No Muon ID
1	105187	104694	117537
2	317	1011	9302
>2	2	13	1178
# of events	145500	145500	145500
1 J/ψ %	72.29	71.95	80.78
2 J/ψ %	0.22	0.69	6.39
>2 J/ψ %	0.0014	0.0089	0.8096
Total	72.51	72.64	87.98

Table 3: J/ψ efficiencies for the three identification methods. without a cut in the proper length

Cross Section Result

	STACO $\mathscr{A}$ %	MuiD $\mathscr{A}$ %	No ID $\mathscr{A}$ %
$10 \leq p_T < 18$ GeV	20.12±1.02	20.49±1.02	22.36±1.08
$18 \leq p_T < 26$ GeV	37.31±1.72	35.87±1.63	34.34±1.58
$26 \leq p_T < 34$ GeV	44.97±3.09	42.55±3.09	43.36±3.22
$34 \leq p_T < 42$ GeV	51.56±4.68	48.43±4.68	45.00±3.48

Table 7: Efficiency $\mathscr{A}$ for the various p_T bins

	Signal	Background	S/B ratio
$10 \leq p_T < 18$ GeV	538±33	151±33	3.56±0.1
$18 \leq p_T < 26$ GeV	590±35	106±25	5.56±0.1
$26 \leq p_T < 34$ GeV	253±20	30±15	8.4±0.5
$34 \leq p_T < 42$ GeV	125±12	15±8	8.3±0.8

Table 8: Expected signal and background events in the four p_T bins for $10pb^{-1}$

B^+ lifetime measurement

- The function use is of the form

$$F_c(t) = exp(-t/\tau) \otimes G(t, \mu, s \cdot \sigma_i)$$

- In order to seperate between the signal and the background area the proper decay time pdf was multiplied with the B^+ Mass PDF. Then a simultaneous fit both in B^+ proper time and Mass is performed.

B^+ lifetime measurement

- The proper decay time distribution, for the signal region was parametrized as the convolution of exponential function with a Gaussian resolution function
- The background decay time distribution was parametrized as two different exponential functions each convoluted with a Gaussian resolution function
- In the model used, the per event error on the reconstructed decay length is taken in account

B^+ lifetime measurement

- The uncertainty of the transverse decay length (only the contributions arising from the uncertainties on the primary and secondary vertex coordinates considered) The experimental uncertainty in *Lxy* is:

$$\sigma^2_{L_{xy}} = \frac{1}{(p^B_T)^2} \cdot [\sigma^2_x (p^B_x)^2 + 2\sigma^2_{xy} p^B_x p^B_y + \sigma^2_y (p^B_y)^2 + \sigma^2_{x1} (p^B_x)^2 + \sigma^2_{y1} (p^B_y)^2]$$