$\Lambda_b \to p\mu\nu$ Update

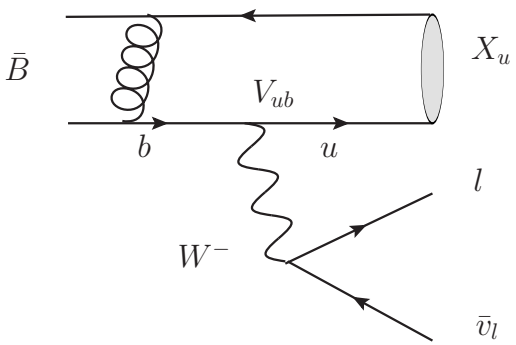
William Sutcliffe

March 19, 2013

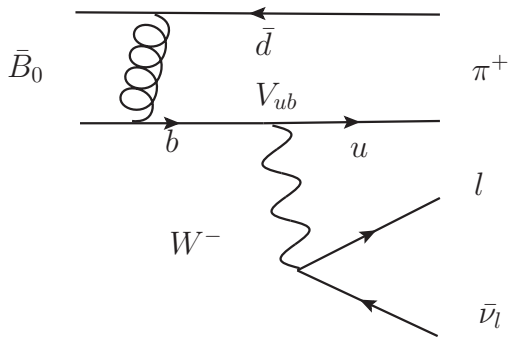
Current Status of $|V_{ub}|$

- Semi-Leptonic B Decays:

Inclusive ($\bar{B} \to X_u l \bar{\nu}_l$)

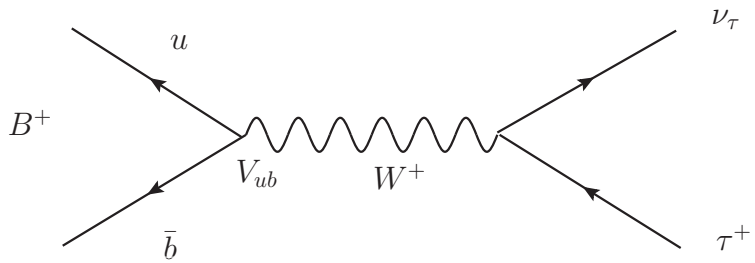


Exclusive ($\bar{B}_0 \to \pi^+ l \bar{\nu}_l$)



$$|V_{ub}| = (4.41 \pm 0.15^{+0.15}_{-0.17}) \times 10^{-3} \qquad |V_{ub}| = (3.23 \pm 0.31) \times 10^{-3}$$

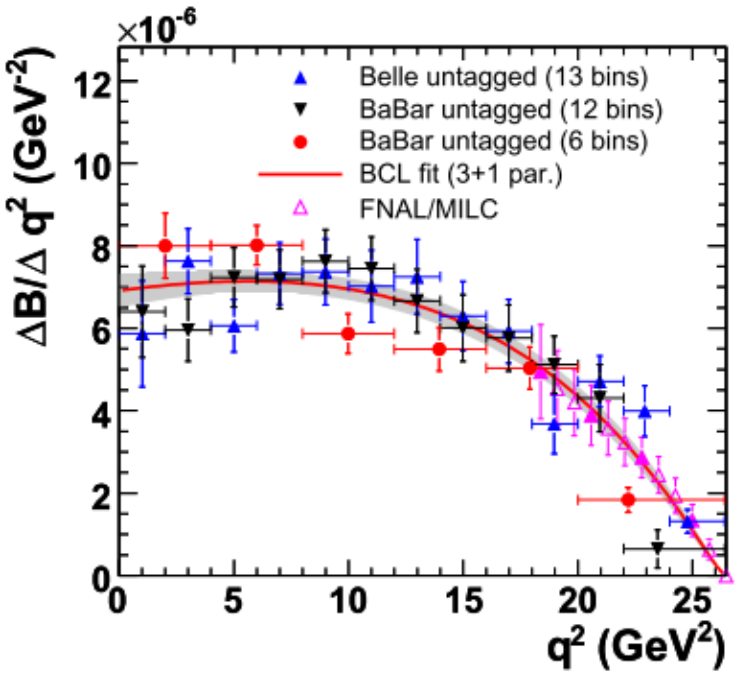
- Leptonic B decays ($B^+ \to \tau^+ \nu_\tau$):



Exclusive Measurements of $|V_{ub}|$

- BaBar, Belle and CLEO: $|V_{ub}| = (3.23 \pm 0.31) \times 10^{-3}$
- Exclusive Approach:
  - Exclusive final state $(\bar{B}_0 \to \pi^+ l^- \bar{\nu}_l)$
  - $\frac{d\Gamma}{dq^2} = \frac{G_F^2 |V_{ub}|^2}{24\pi^3} |p_\pi|^3 |f_+(q^2)|^2$
  - $|f_+(q^2)|^2$ predicted by lattice QCD
  - Uncertainty dominated by $|f_+(q^2)|^2$.

Measured partial branching fraction $\Delta B(\bar{B}_0 \to \pi^+ l^- \bar{\nu}_l)$ [2]:



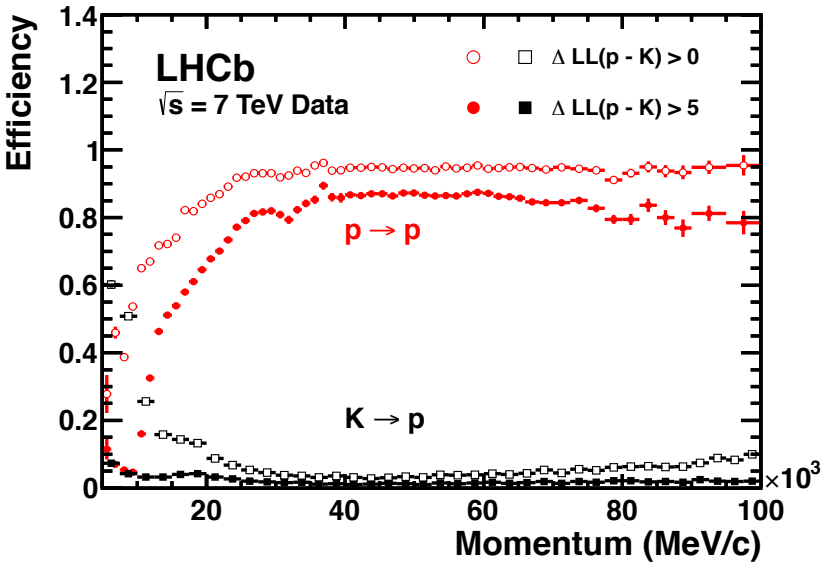
[2] J. Beringer et al., Determination of V_{ub} and V_{cb} (Particle Data Group). *Phys. Rev.* D**86**, 010001 (2012).

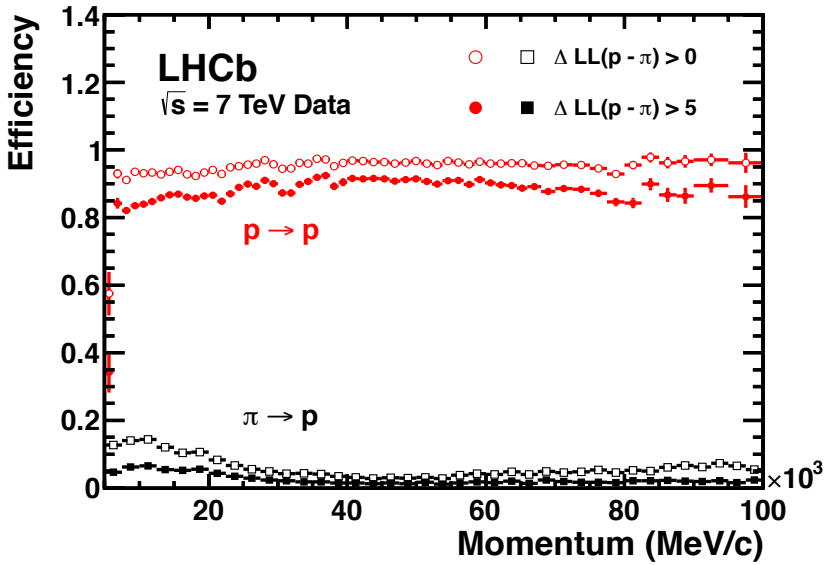
Current $B_s \to K\mu\nu$ Stripping Selection

Kaon cuts	Muon cuts	Mother cuts
$P > 3000$ MeV/c	$P > 3000$ MeV/c	$cos\theta_{B_s Y} > 0.99$
$p_T > 800 MeV/c$	$p_T > 800 MeV/c$	$E_\nu < 2000$ MeV
Track $\chi^2 < 6.0$	Track $\chi^2 < 4.0$	Vertex $\chi^2 < 2.0$
Min IP $\chi^2 > 16.0$	Min IP $\chi^2 > 12.0$	χ^2 sep. from PV > 100.0
$\Delta LL(K - p) > 0$	$\Delta LL(\mu - p) > 0$	
$\Delta LL(K - \pi) > 5$	$\Delta LL(\mu - \pi) > 3$	
$\Delta LL(K - \mu) > 0$	$\Delta LL(\mu - K) > 0$	

- StdLooseMuons and StdLooseKaons selections also used.
- Track Ghost probability < 0.5
- Combination cut: $1500 MeV/c^2 \leq M_{K\mu} \leq 5500 MeV/c^2$.

RICH PID performance





- High K-p misidentification rate / low p-p identification efficiency below 15 GeV/c.

Stripping Efficiency for Signal

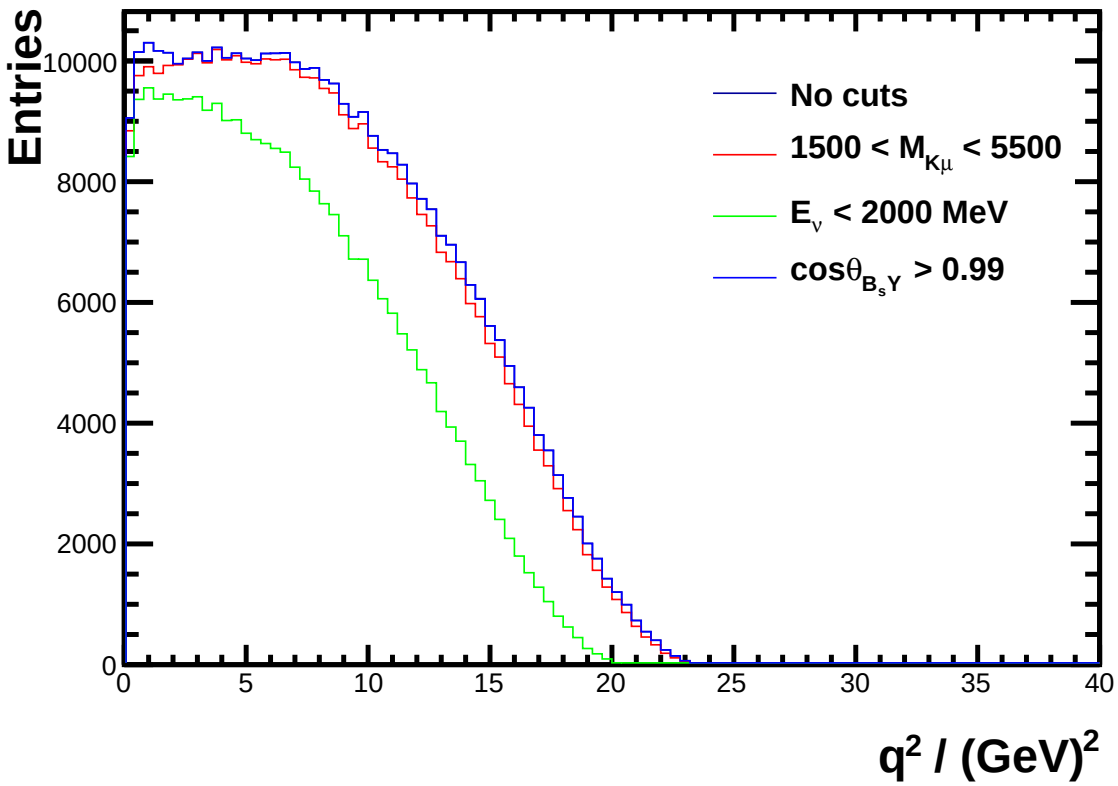
- No available $\Lambda_b \to p\mu\nu$ MC sample yet.
- Strip $B_s \to K\mu\nu$ 2011 MC sample using existing line + $P_K > 10$ GeV/c.
- Signal Efficiency for stripping: $7.2 \pm 0.1\%$.
- Acceptance, $A \approx 1.4\%$.
- In 1 fb^{-1} expect:
  $N_{Events} = 2 \times \sigma(b\bar{b}) \times f_{\Lambda_b} \times \mathcal{L} \times B(\Lambda_b \to p\mu^-\bar{\nu}) \times A$

  Taking $f_{\Lambda_b} \sim 0.25$, $B(\Lambda_b \to p\mu^-\bar{\nu}) \sim 10^{-4}$, $\sigma(b\bar{b}) \sim 280\mu$b

  $N_{Events} \approx 2 \times 10^5$

$B_s \to K\mu\nu$ MC q^2 distribution

- Remove certain cuts to investigate their impact.
- E_ν cut kills the endpoint of the q^2 distribution.



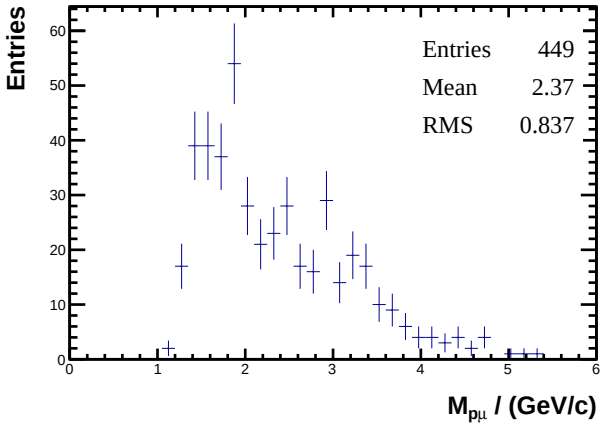
$\Lambda_b \to p\mu\nu$ Line

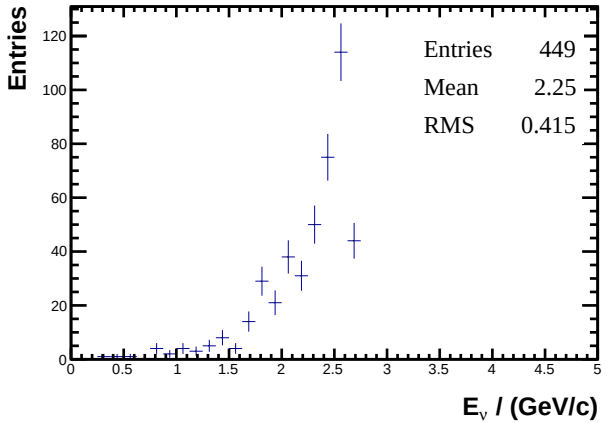
- $\Lambda_b \to p\mu\nu$ stripping line based on the current $B_s \to K\mu\nu$ line.
- Remove E_ν cut. Demand $P_{proton} > 15$ GeV/c and 1000 MeV/c^2 $\leq M_{p\mu} \leq$ 5600 MeV/c^2.
- Test using TestMyStrippingLineOn2012Data_Reco14.py script (100,000 events):

$L_b \to p\mu\nu$ line	Retention (%)	Accepted	ms/evt
Above cuts	0.449	449	0.474
2000 MeV/c^2 $\leq M_{p\mu}$	0.246	246	0.386

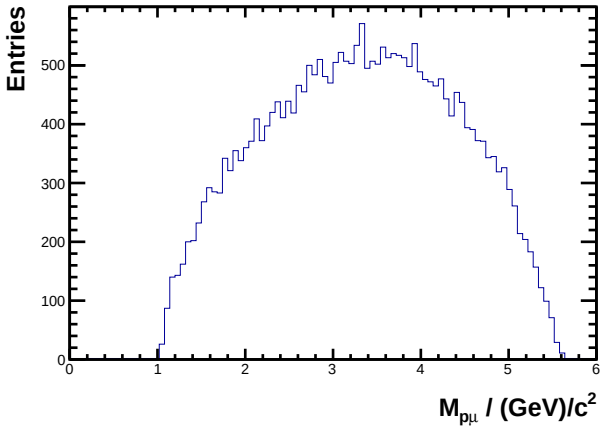
- Require retention $< 0.05\%$ and timing < 0.5 ms/evt.

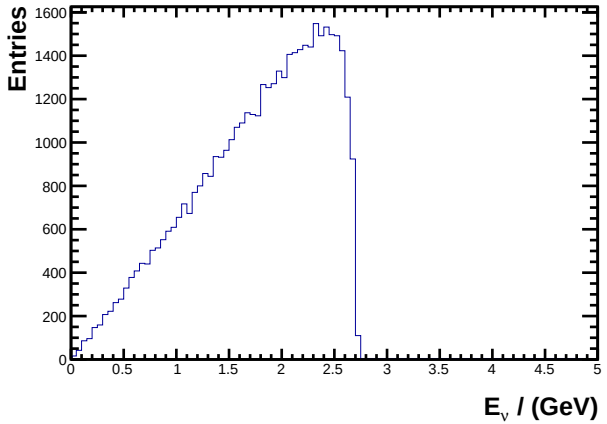
$M_{p\mu}$ and E_ν Distributions using 2012 test data



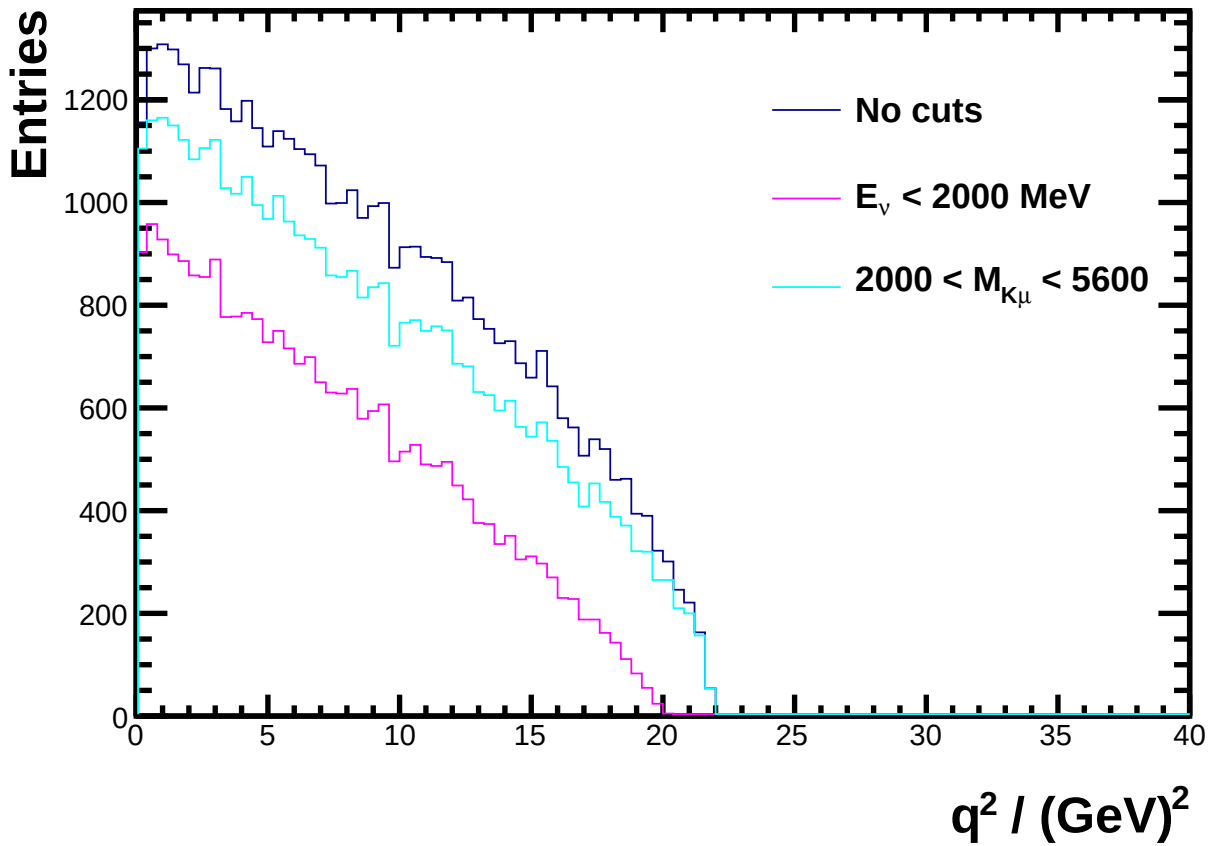


$M_{p\mu}$ and E_ν Distributions for generator level $\Lambda_b \to p\mu\nu$





$\Lambda_b \to p\mu\nu$ generator level q^2 distribution



Conclusion

- E_ν cut kills the q^2 endpoint.
- Additional cuts required to reduce retention to $< 0.05\%$.
- $\Lambda_b \to p\mu\nu$ MC approved (1 million events).
- Presenting to the Semi-leptonic working group tomorrow.