B_s signal selection

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for
B_s Mixing group

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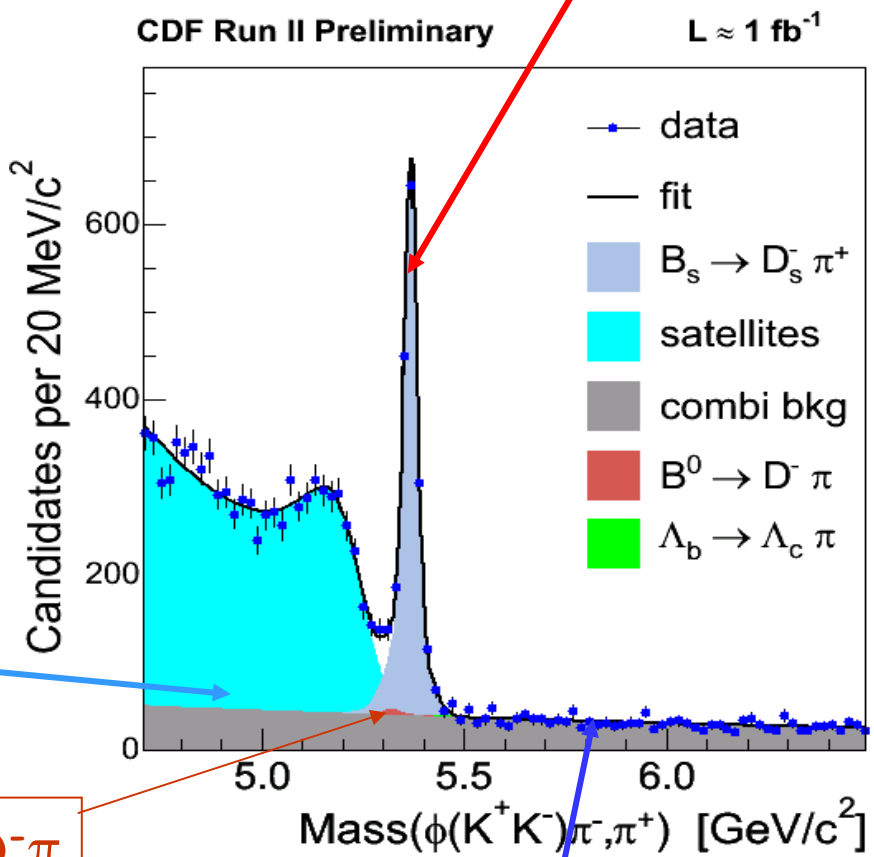
The Blessed Selections: hadronic decays

$B_s \to D_s \pi$
- $D_s \to \phi\pi$ $\phi \to KK$
- $D_s \to K^{*0}K$ $K^{*0} \to K\pi$
- $D_s \to 3\pi$

$B_s \to D_s 3\pi$
- $D_s \to \phi\pi$
- $D_s \to K^{*0}K$

Signal $B_s \to D_s\pi$ $D_s \to \phi\pi$



Partially reconstructed B mesons

$B^0 \to D^-\pi$

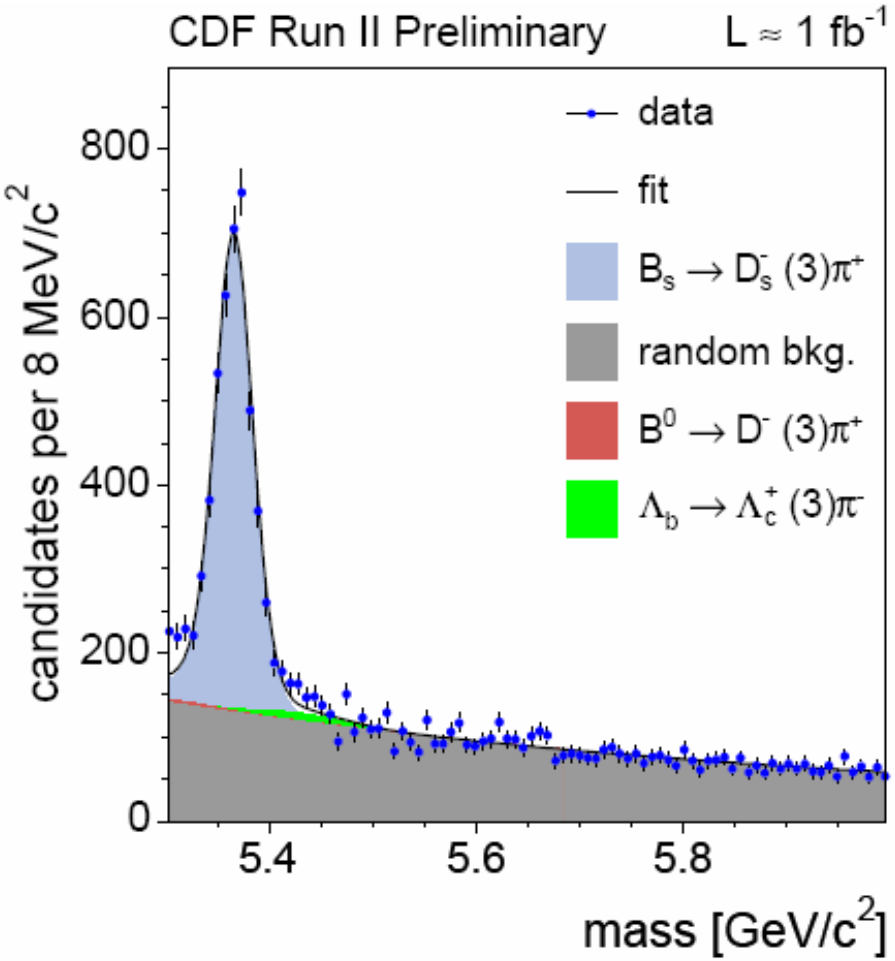
Combinatorial background

Hadronic B_s decays summary

$B^+ \rightarrow D^0\pi$ ~ 26,000

$B^0 \rightarrow D^-\pi$ ~ 22,000

Decay channel	Yield
$B_s \rightarrow D_s\pi$ $D_s \rightarrow \phi\pi$	1587
$B_s \rightarrow D_s\pi$ $D_s \rightarrow K^{*0}K$	762
$B_s \rightarrow D_s\pi$ $D_s \rightarrow 3\pi$	627
$B_s \rightarrow D_s3\pi$ $D_s \rightarrow \phi\pi$	428
$B_s \rightarrow D_s3\pi$ $D_s \rightarrow K^{*0}K$	200
Total	3604



Blessed selection B_s semileptonic Decays

$B_s \rightarrow D_s l X$

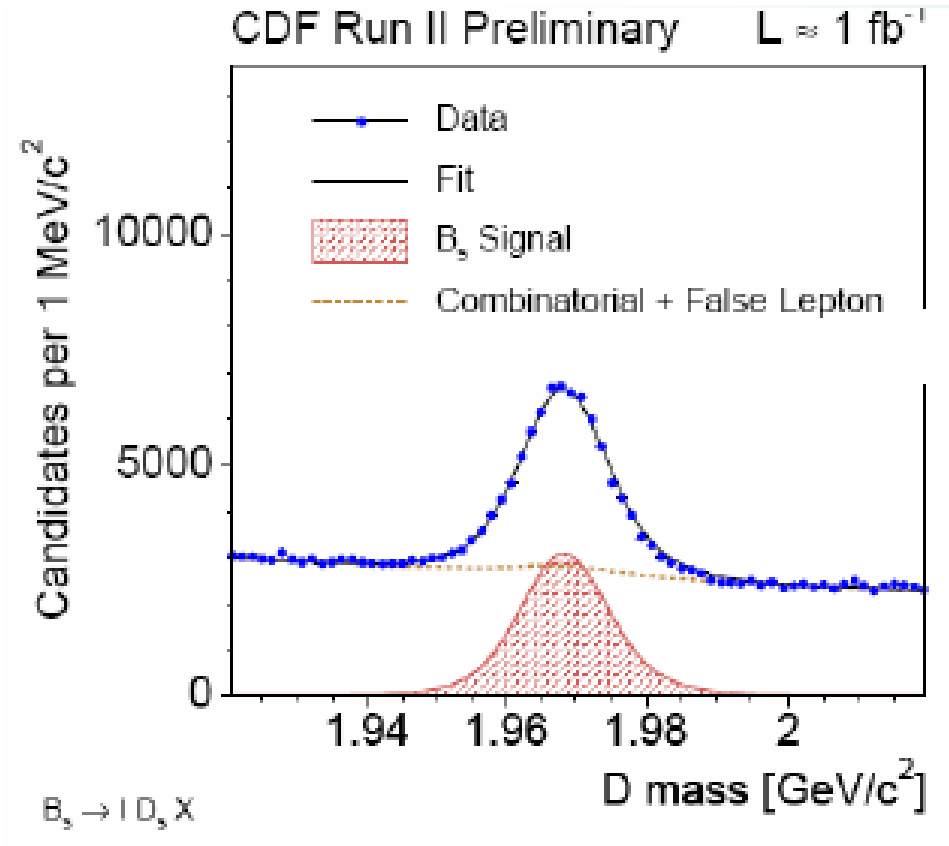
$D_s \rightarrow \phi\pi$ $\phi \rightarrow KK$

$D_s \rightarrow K^{*0}K$ $K^{*0} \rightarrow K\pi$

$D_s \rightarrow 3\pi$

Total yield:

$D_s l$ ~37,000 events

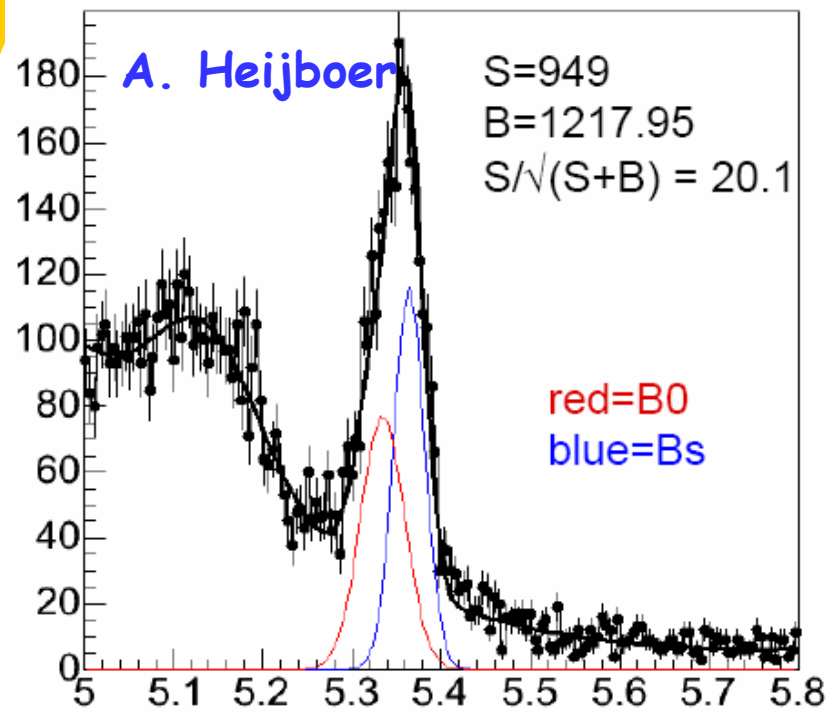


What can we do to improve it?

- Include PID in the selection
- Use NN to discriminate signal from background
- Add new decay modes

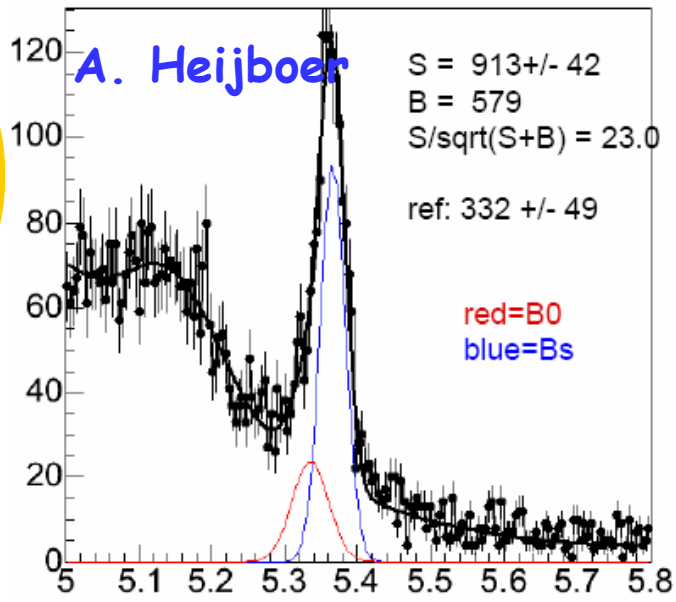
Including PID in the selections

$B_s \to D_s \pi$ $D_s \to K^{*0} K$ $K^{*0} \to K\pi$ has reflection from
$B^0 \to D\pi$ $D \to K\pi\pi$ when you give K mass to π



Standard analysis use
D^+ veto:
$|M_{K\pi\pi} - M_{D^+}| > 24$ MeV

Including PID in the selections



Aart proposal:

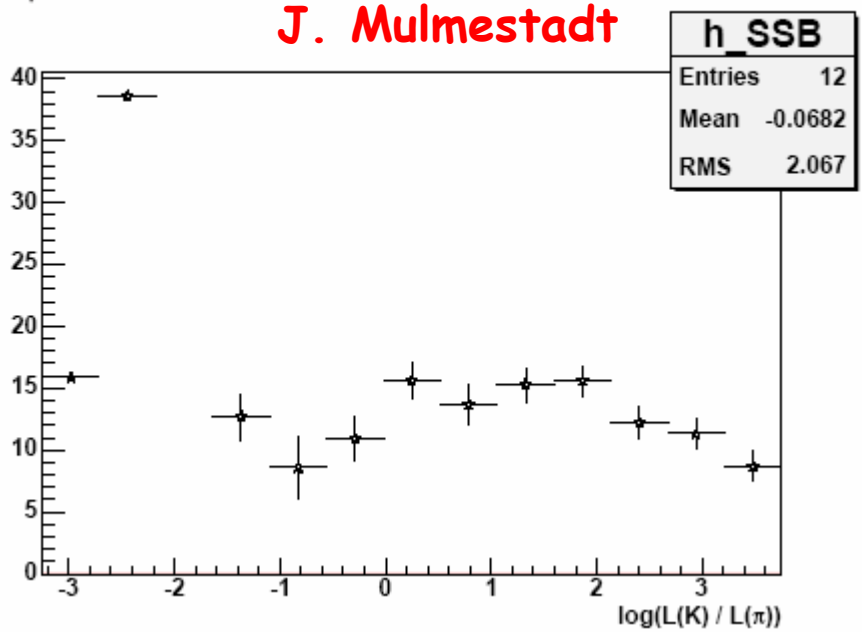
$|M_{K\pi\pi} - M_{D^+}| > 18$ MeV OR CCL$\geq$0

$S/\sqrt{S+B}$ 19.2$\rightarrow$23.0

Give this to NN

$S/\sqrt{S+B}$

J. Mulmestadt



Johannes idea:

LR cut event by event increases D_s $S/\sqrt{S+B}$ 16$\rightarrow$40

In progress the B_s significance evaluation

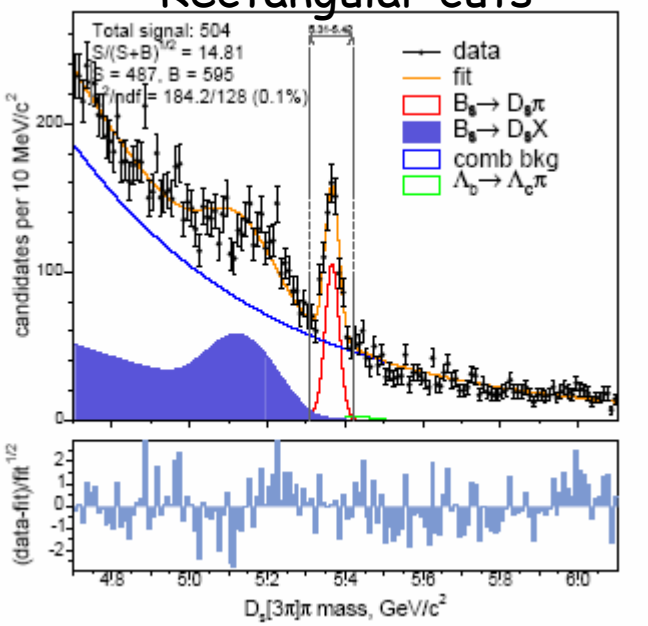
Neural Network selections

B. Casal, K. Anikeev

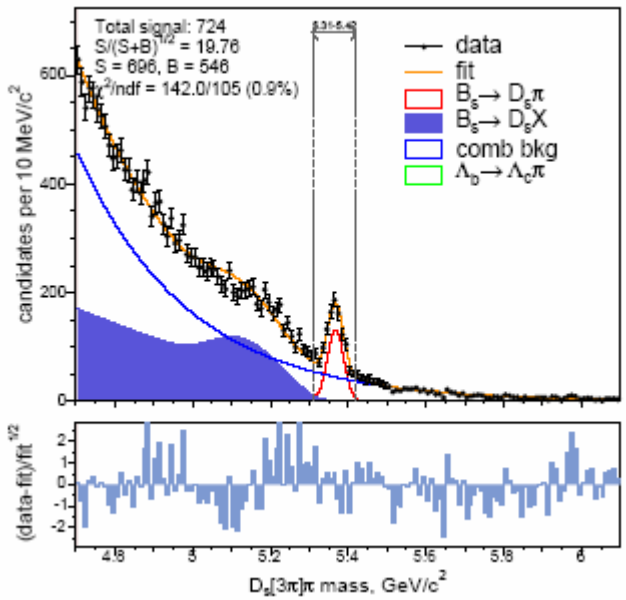
Use ROOTSNNS v3.0

- Train NN to separate signal from bckg (side bands)
- Optimize to maximize $S/\sqrt{S+B}$
- Fit mass distribution using the actual mixing fitter

Rectangular cuts



NN cuts



$S/\sqrt{S+B}$ Increase 33% like adding 78% of more data

Neural Network selections summary

B. Casal, K. Anikeev

Table of S and B ($S/\sqrt{S+B}|_{total} = \Sigma S_i/\sqrt{\Sigma S_i + \Sigma B_i}$)

Mode	RECT cuts S	RECT cuts B	NN selection S	NN selection B
$B_s \to D_s^- \pi^+$, $D_s \to \phi\pi$	1430	317	1704	239
$B_s \to D_s^- \pi^+$, $D_s \to K^{*0}K$	649	328	828	293
$B_s \to D_s^- \pi^+$, $D_s \to 3\pi$	487	595	696	546
$B_s \to D_s^-(3\pi)^+$, $D_s \to \phi\pi$	421	620	649	185
$B_s \to D_s^-(3\pi)^+$, $D_s \to K^{*0}K$	185	334	425	192
$B_s \to D_s^-(3\pi)^+$, $D_s \to 3\pi$	–	–	225	162
Total $S/\sqrt{S+B}$, 5.31 – 5.42 GeV/c^2	43.30		57.78	

57.78/43.30=1.3 improvement σ_A

Use wrong charge events as background in the future?

Partially Reconstructed B

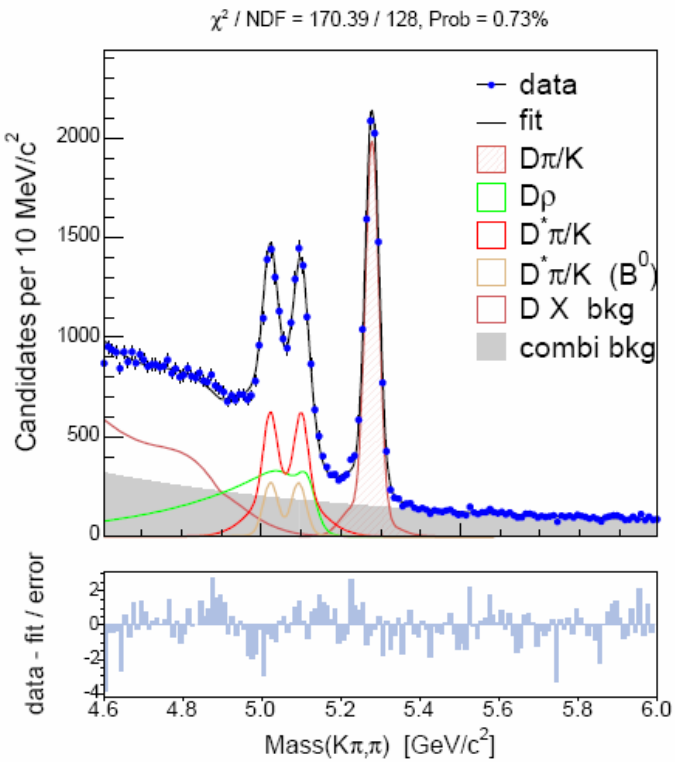
Jeff Miles

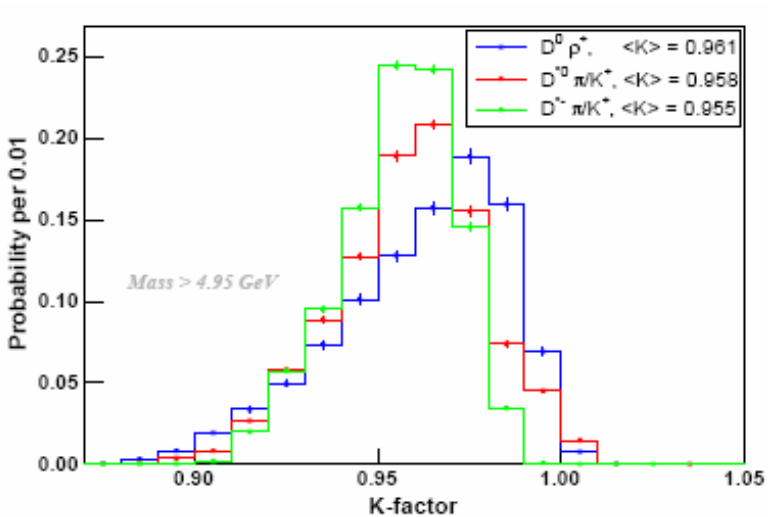
$B \to D\rho$, $D^*\pi$ $\rho^+ \to \pi^+\pi^0$, $D^* \to D\gamma/\pi^0$ treated as hadronic?

- Large yields (same order of fully reconstructed)
- High k-factor, lose soft γ/π^0
- Lower S/B

$$ct = \frac{L_{xy} \cdot M_{PDG}}{p_T^{reco}} \cdot K$$

Depend on mass





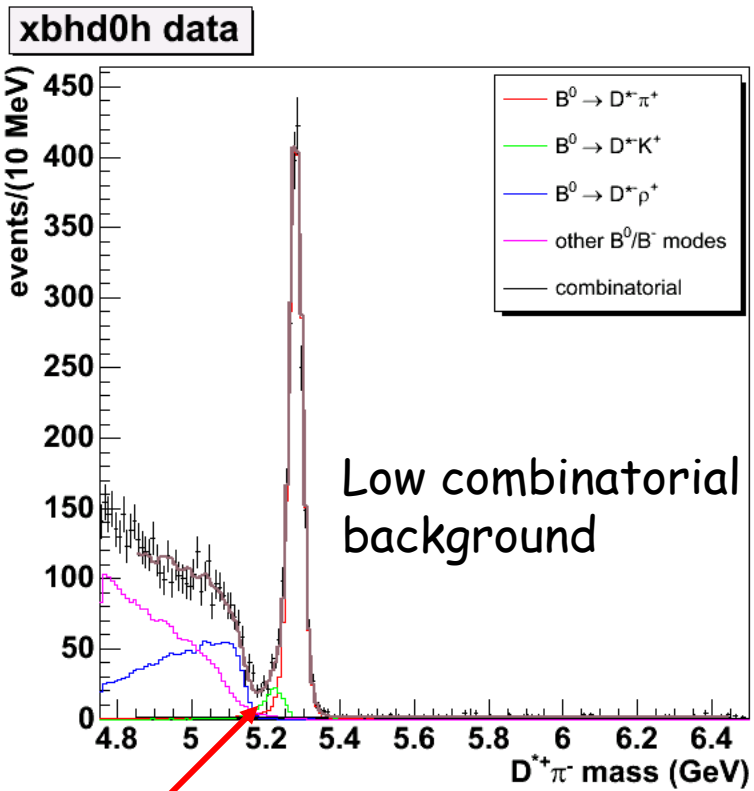
Different K def. investigated finally use the standard one

Partially Reconstructed B

Amanda Deisher

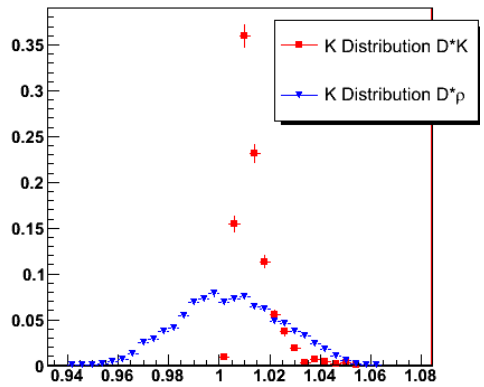
$B^0 \rightarrow D^{*-}[D^0\pi^-]\pi^+$

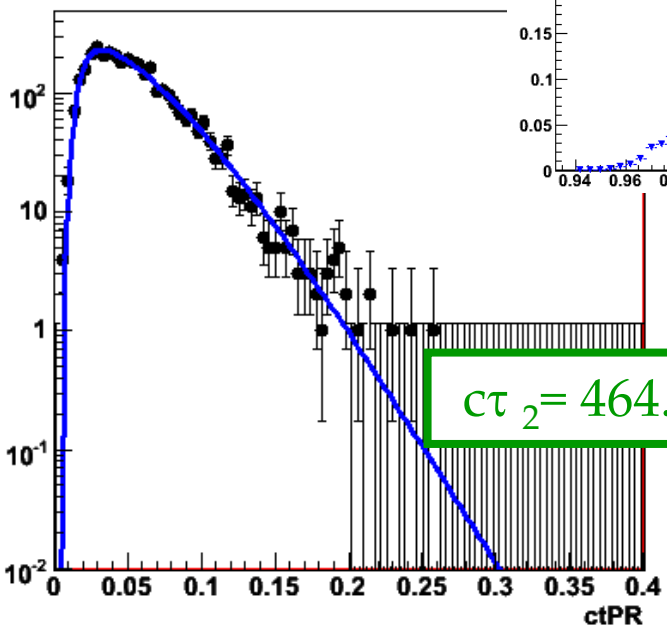
$$ct^* = \frac{L_{xy}^* \cdot m_B^*}{p_T^*} \cdot K \qquad K = \frac{p_T^*}{p_T} \cdot \frac{m_B}{m_B^*} \cdot \frac{L_{xy}}{L_{xy}^*}$$



Above 5.17 GeV
$D^*\pi$ and D^*K

5.00 <mass< 5.35 GeV/c^2





$c\tau_2 = 464.6\ ^{+14.2}_{-13.5}\ \mu m$

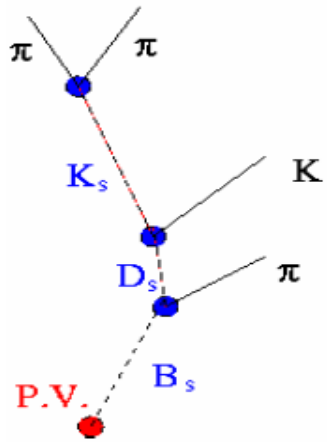
New Decay Modes

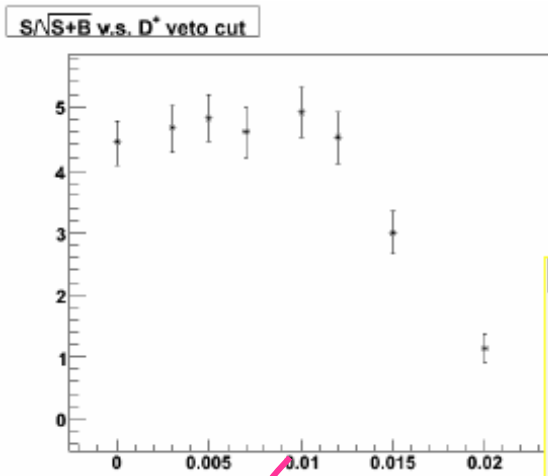
Simone Pagan Griso

$B_s \to D_s \pi$ $D_s \to K_s K$ $K_s \to \pi\pi$ has reflection from
$B^0 \to D\pi$ $D \to 3\pi$ as for $D_s \to K^{*0} K$ $K^{*0} \to K\pi$

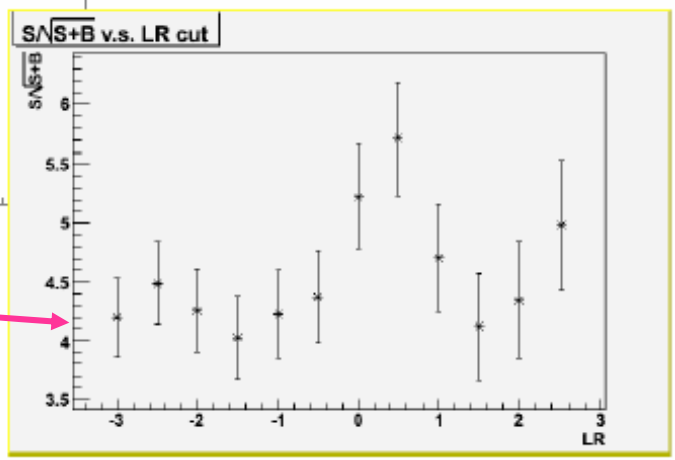
Different topology easy to separate

~270 events 1fb^{-1}





Using PID



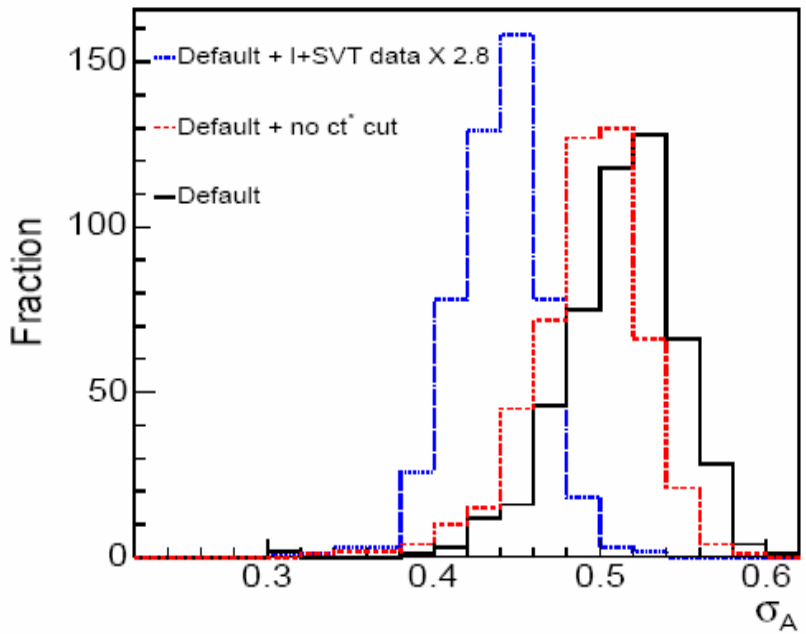
16% increase $S/\sqrt{S+B}$

Semileptonic decay modes

V. Tiwari, G. Gomez-Ceballos

- Improve event selection including PID $B_s \rightarrow D_s l x$:
  - $D_s \rightarrow \phi\pi$ combinatorial bck reduce by factor 2
  - $D_s \rightarrow K^*K$ yield increased by factor ~2.5 and combinatorial bck reduced by factor 2
- Include l+SVT dataset
- Remove the ct* cut

Noticeable gain



Summary

The number of events can be increased by including new decay modes, partially reconstructed events and by optimizing cuts.

Plan for the summer:

Include partially reconstructed modes and optimize cuts.

The actual gain on Δm_s significance will be the combination of all the effect.

Expected improvements on σ_A:

- 1.3 for the hadronic decay modes cuts optimization
- "Something" for semileptonic decays
- Under evaluation for adding partially reconstructed hadronic decay