

# Background characterization for $B \rightarrow \tau \nu_\tau$ Decay

A. Rakitin

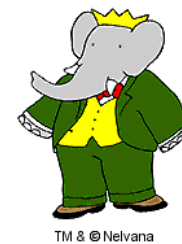
Caltech

June, 2010

Post-Elba Meeting



# Background characterization

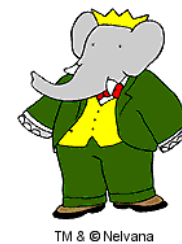


- To determine it I used Alejandro/Elisa's code (many thanks!)
- I only had to plug-in my signal  $B \rightarrow \tau \nu$  selection (for 5 decay modes:  
 $\tau \rightarrow e, \mu, \pi, \rho, a_1$ ) – see next page

The full lists of the decay modes together with corresponding branching fractions are given at:

[http://www.slac.stanford.edu/~arakitin/SuperB/B+B-\\_generic.log](http://www.slac.stanford.edu/~arakitin/SuperB/B+B-_generic.log)

[http://www.slac.stanford.edu/~arakitin/SuperB/B0B0bar\\_generic.log](http://www.slac.stanford.edu/~arakitin/SuperB/B0B0bar_generic.log)

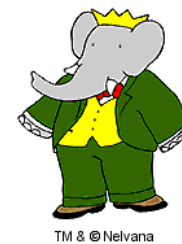


# Signal $B$ Selection (for reference purposes)

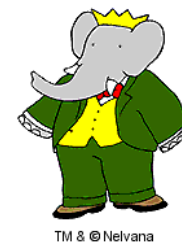
- For each pair “tag  $B$  - signal  $B$ ”:
  - ➡ make sure the signal  $B$  doesn't overlap with tag  $B$  (explicit check for common tracks and photons)
  - ➡ require all tracks to be used:  $N_{trk}(\text{tag } B) + N_{trk}(\text{sig } B) = \text{total } N_{trk}$
  - ➡ if we have (several) 3-pion-track candidates ( $a_1 \rightarrow \rho^0 \pi, \rho^0 \rightarrow \pi^+ \pi^-$ ) – select one with  $\rho^0$  mass closest to PDG value
  - ➡ if we have one leptonic or pionic track (plus, may be, a few photons):
    - if the track is muon or electron candidate – choose it
    - if pion + (several) 2-photons candidates ( $\rho \rightarrow \pi \pi^0$ ) select one with  $\pi^0$  mass closest to PDG value
    - if no suitable  $\rho$  candidates found – choose  $\pi$
  - ➡ in all other cases (present  $K, p$ , non-decaying  $\pi^0$  and  $K_S$ ) – skip this sig  $B$
- **Notice that I require signal  $B$  to be selected together with tag  $B$**



# Decay modes classification



- Leptonic decays:
  - Including charm ( $D$  or  $D^*$ )
  - Charmless
- Hadronic decays:
  - According to the number of daughters: 1 through 12
  - Question: Do we know what is 1-daughter decay mode? But it is small anyhow...



# $B^+B^-$ Generic Sample

Total number of events in the sample	3080512
# of events after tag $B$ + sig $B$ selection	140218 (4.55%)
Out of them:	
– Self-Cross-Feed	39997 (28.52%)
– Non-Self-Cross-Feed	100221 (71.48%)
Only these 100K Non-SCF events are analyzed	

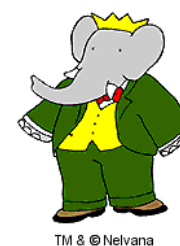
Tag  $B^\dagger$ :

	$e$	$\mu$	$\tau$	Total
lepton + $D^{(*)}$ decays	2626 (2.62%)	5514 (5.50%)	611 (0.61%)	8751 (8.73%)
lepton with no $D$ decays	36 (0.04%)	37 (0.04%)	1 (0.00%)	74 (0.07%)
hadronic decays				91396 (91.19%)

Signal  $B^\dagger$ :

	$e$	$\mu$	$\tau$	Total
lepton + $D^{(*)}$ decays	12244 (12.22%)	12228 (12.20%)	5476 (5.46%)	29948 (29.88%)
lepton with no $D$ decays	272 (0.27%)	251 (0.25%)	92 (0.92%)	615 (0.61%)
hadronic decays				69658 (69.50%)

$^\dagger$  All percents are taken with respect to the total number of analyzed non-SCF events

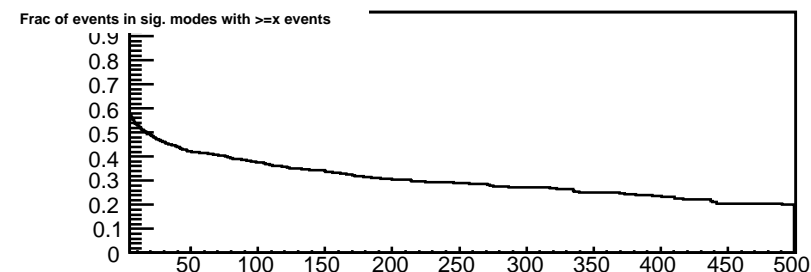
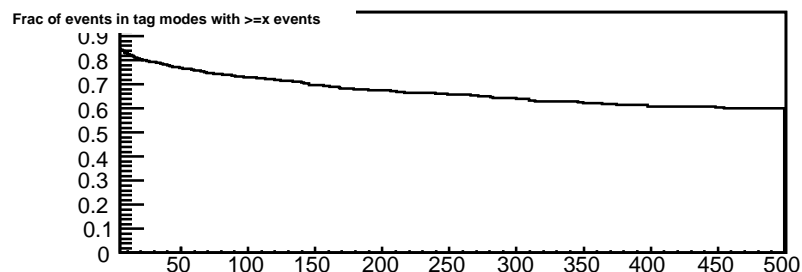
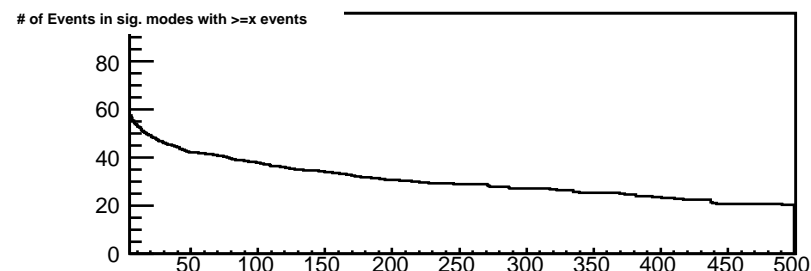
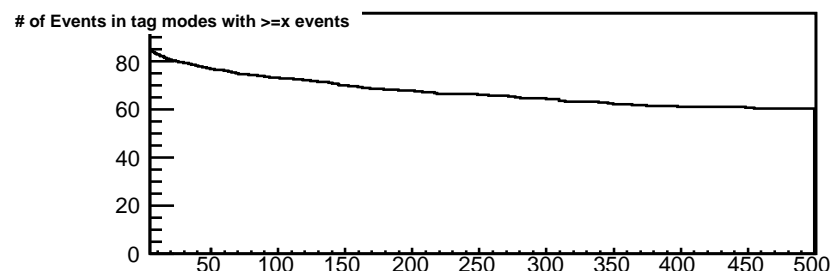
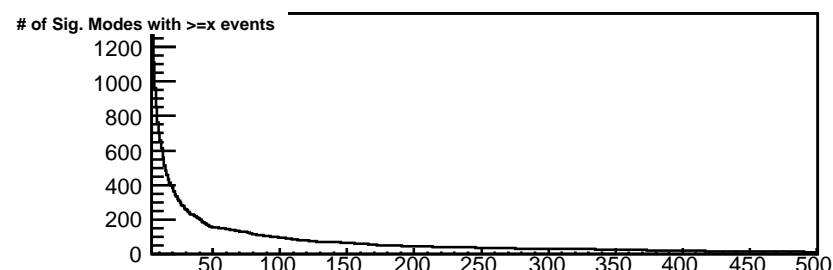
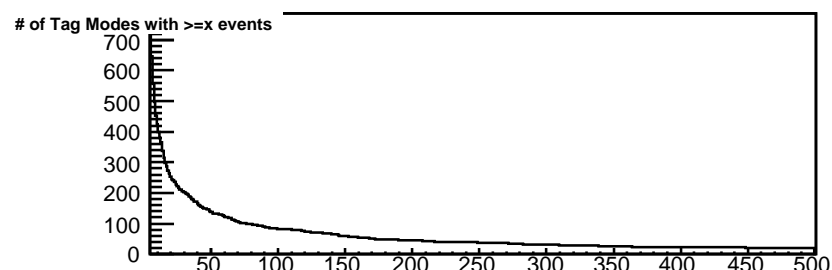


# #'s of had. modes & events vs. cut on # of events per mode

hadronic decays with  $> 1$  daughter

Tag side

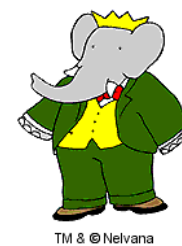
Sig side



- Top row: Number of modes vs cut on the number of events per mode
- Middle row: Number of events in populated modes (modes with  $N_{ev} \geq \text{cut}$ )
- Bottom row: Fraction of events in populated modes (middle row divided by # of non-SCF events)

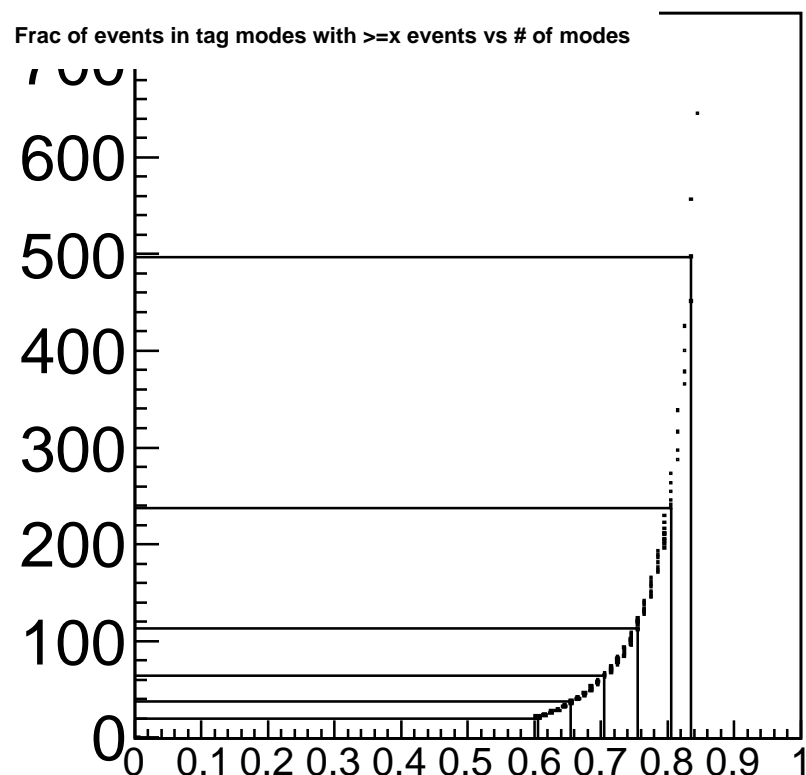


# # of had. modes vs frac of events

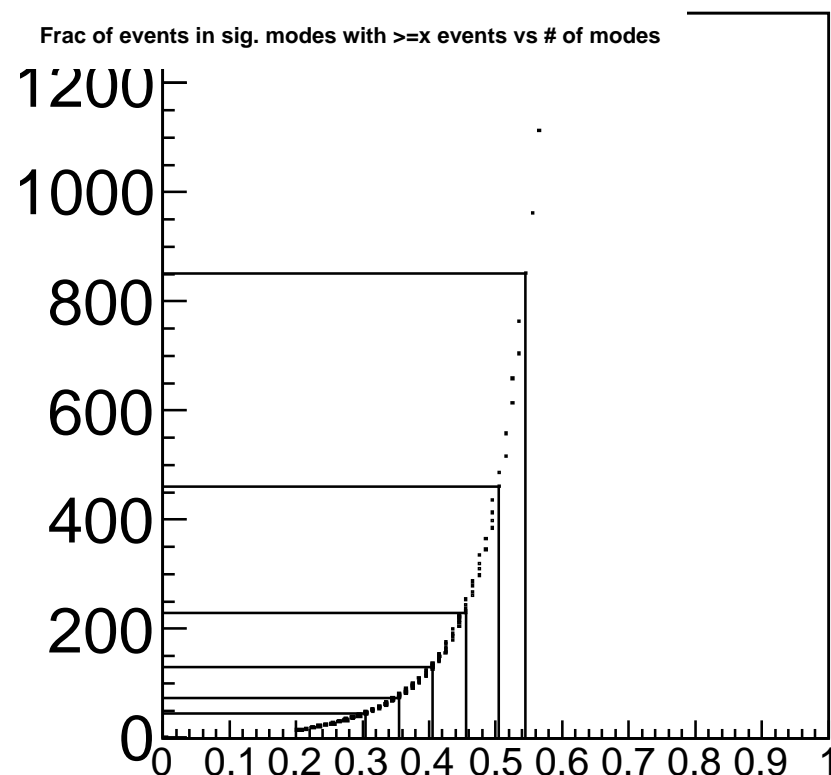


TM & © Nelvana

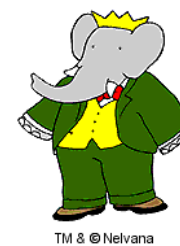
Tag side



Sig side



	Tag $B$						Sig $B$					
Fraction	0.83	0.80	0.75	0.70	0.65	0.60	0.54	0.50	0.45	0.40	0.35	0.30
# of modes	497	237	113	64	37	20	851	460	229	130	73	44

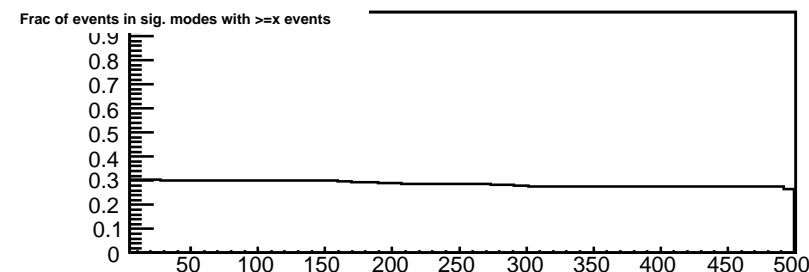
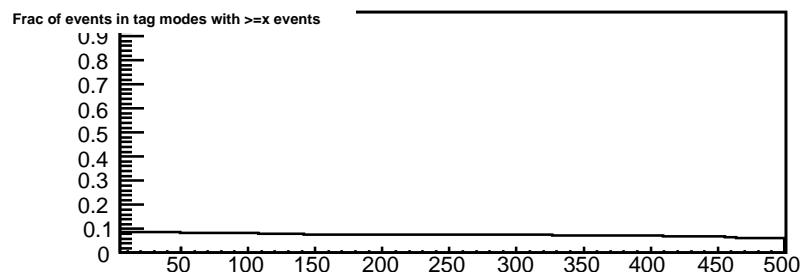
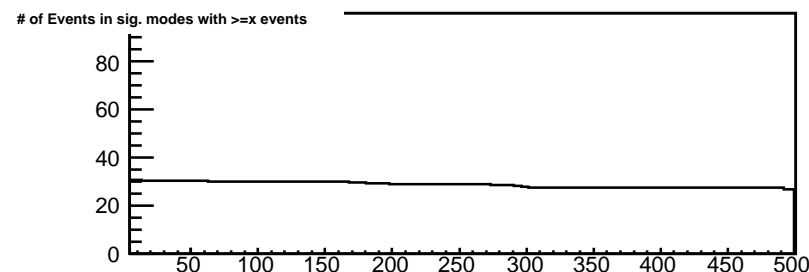
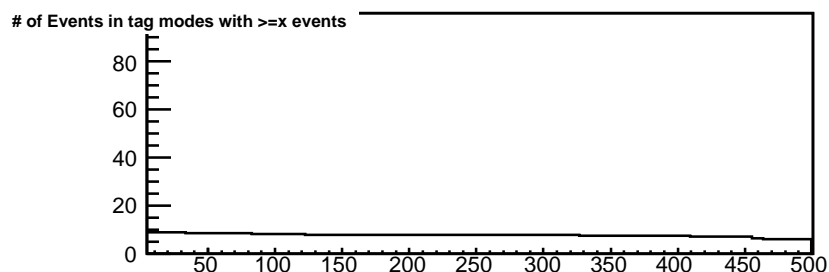
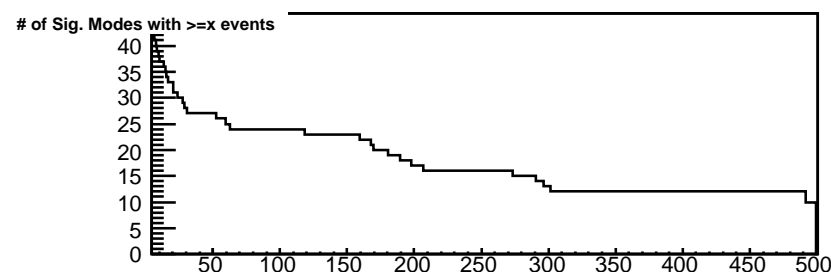
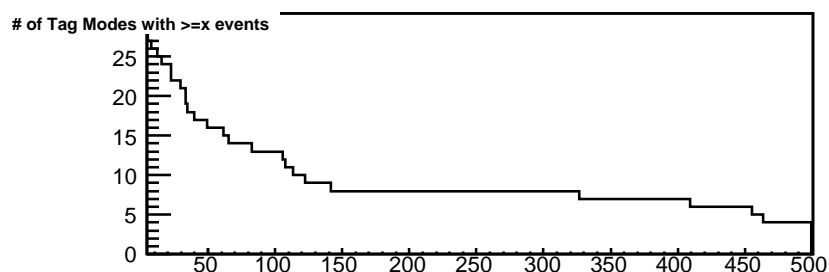


# #'s of lep. modes & events vs. cut on # of events per mode

leptonic decays (with & without charm)

Tag side

Sig side

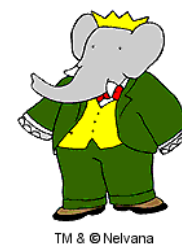


- Top row: Number of modes vs cut on the number of events per mode
- Middle row: Number of events in populated modes (modes with  $N_{ev} \geq \text{cut}$ )
- Bottom row: Fraction of events in populated modes (middle row divided by # of non-SCF events)



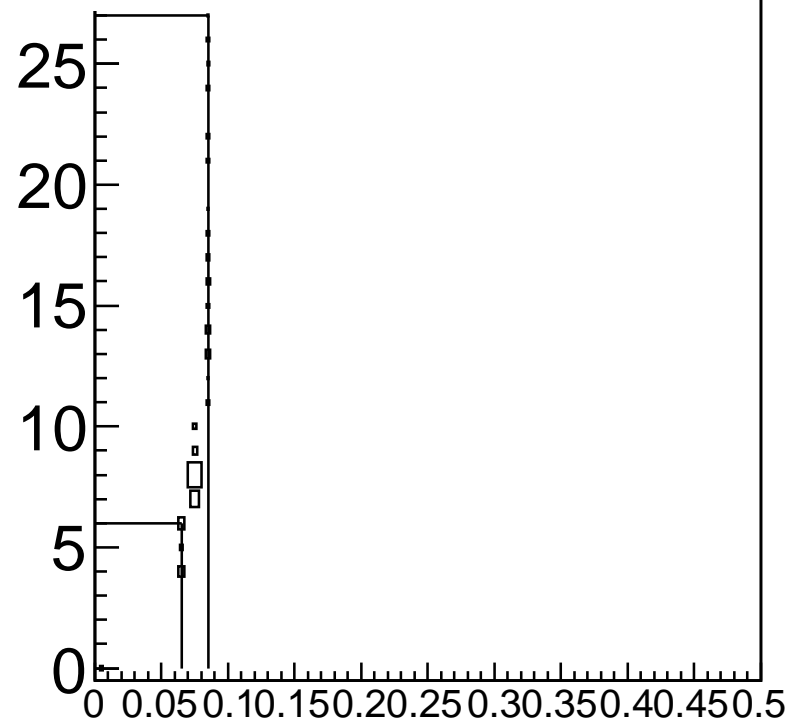


# # of lep modes vs frac of events



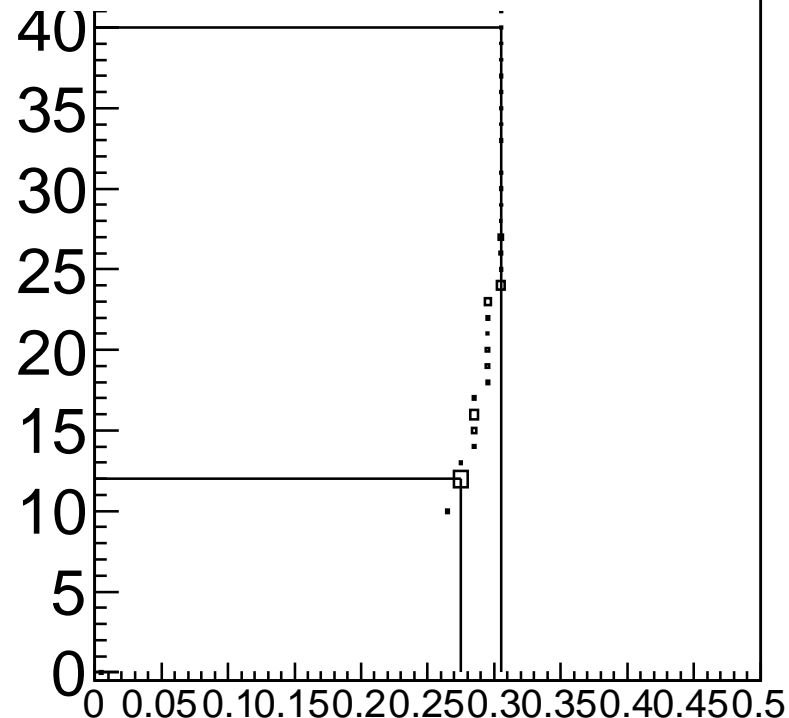
Tag side

Frac of events in tag modes with  $\geq x$  events vs # of modes



Sig side

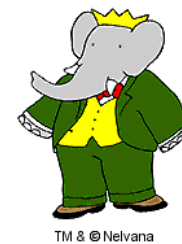
Frac of events in sig. modes with  $\geq x$  events vs # of modes



	Tag $B$		Sig $B$	
Fraction	0.09	0.07	0.30	0.27
# of modes	27	6	40	12



# $B^0\overline{B}^0$ Generic Sample



Total number of events in the sample	3292626
# of events after tag $B$ + sig $B$ selection	115574 (3.51%)
Out of them:	
– Self-Cross-Feed	46159 (39.94%)
– Non-Self-Cross-Feed	69415 (60.06%)
Only these 70K Non-SCF events are analyzed	

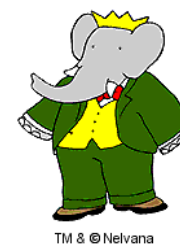
Tag  $B^\dagger$ :

	$e$	$\mu$	$\tau$	Total
lepton + $D^{(*)}$ decays	1815 (2.61%)	4958 (7.14%)	663 (0.96%)	7436 (10.71%)
lepton with no $D$ decays	20 (0.03%)	21 (0.03%)	0 (0.00%)	41 (0.06%)
hadronic decays				61938 (89.23%)

Signal  $B^\dagger$ :

	$e$	$\mu$	$\tau$	Total
lepton + $D^{(*)}$ decays	6636 (9.56%)	6926 (9.98%)	3452 (4.97%)	17014 (24.51%)
lepton with no $D$ decays	150 (0.21%)	137 (0.20%)	28 (0.04%)	315 (0.45%)
hadronic decays				52086 (75.04%)

$^\dagger$  All percents are taken with respect to the total number of analyzed non-SCF events

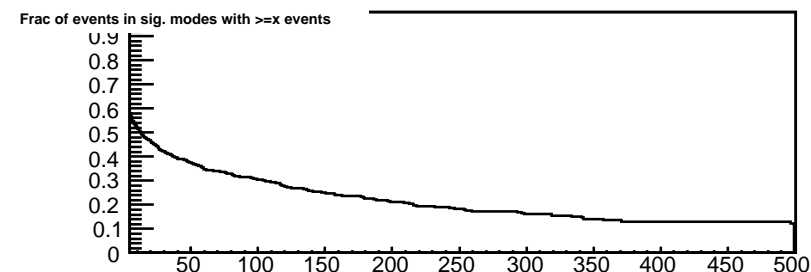
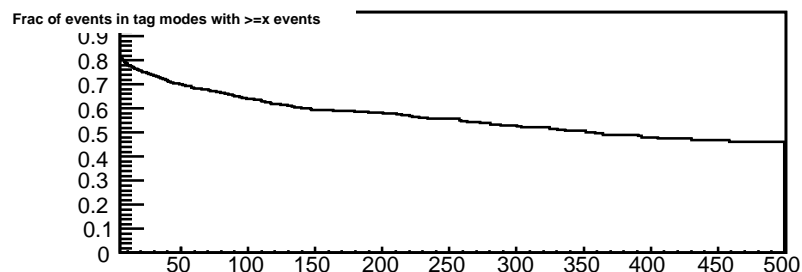
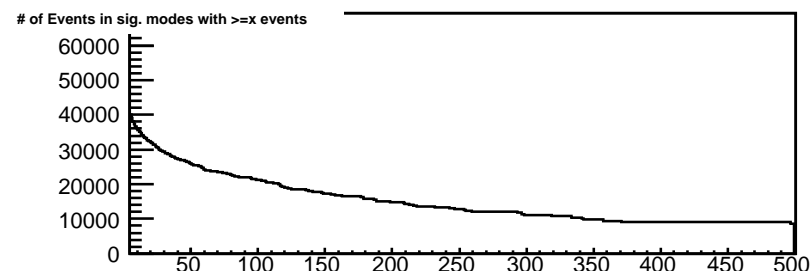
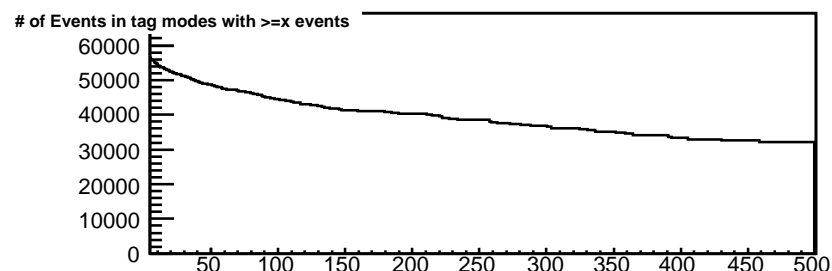
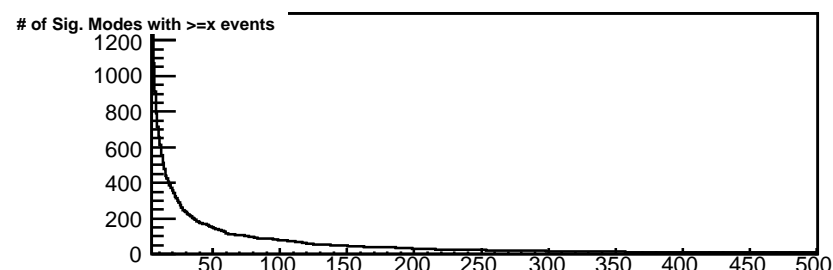
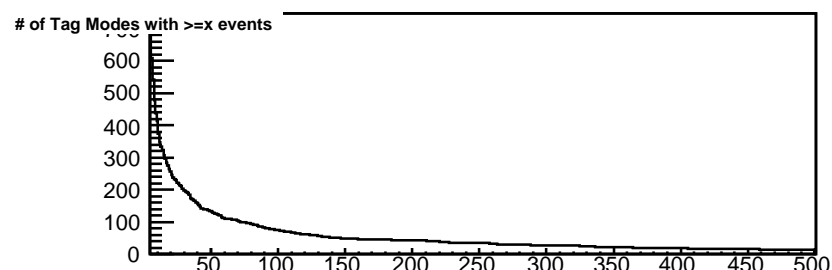


# #'s of had. modes and events vs. cut on # of events per mode

hadronic decays with  $> 1$  daughter

Tag side

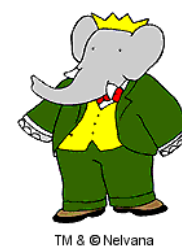
Sig side



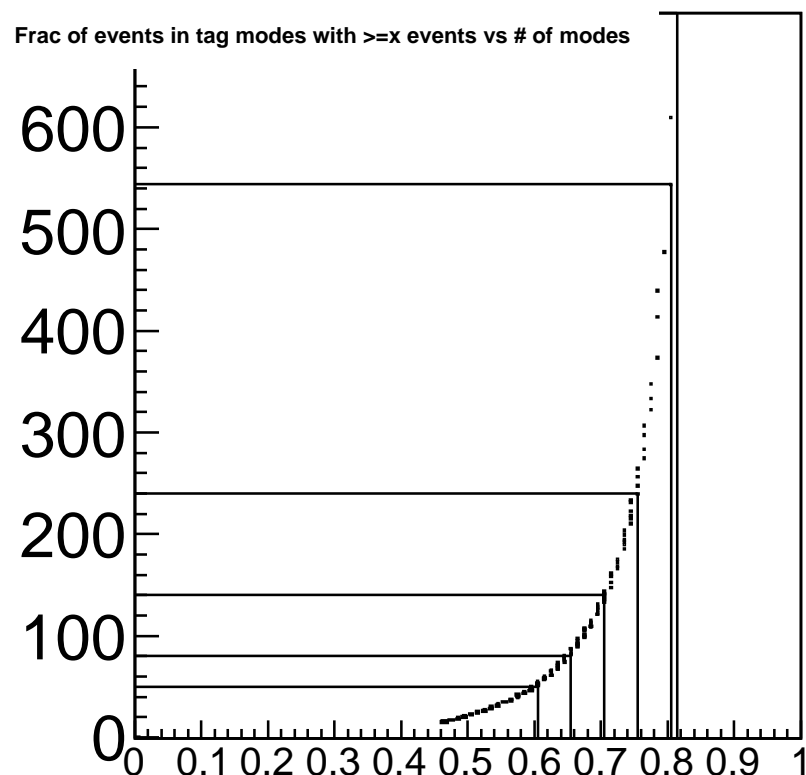
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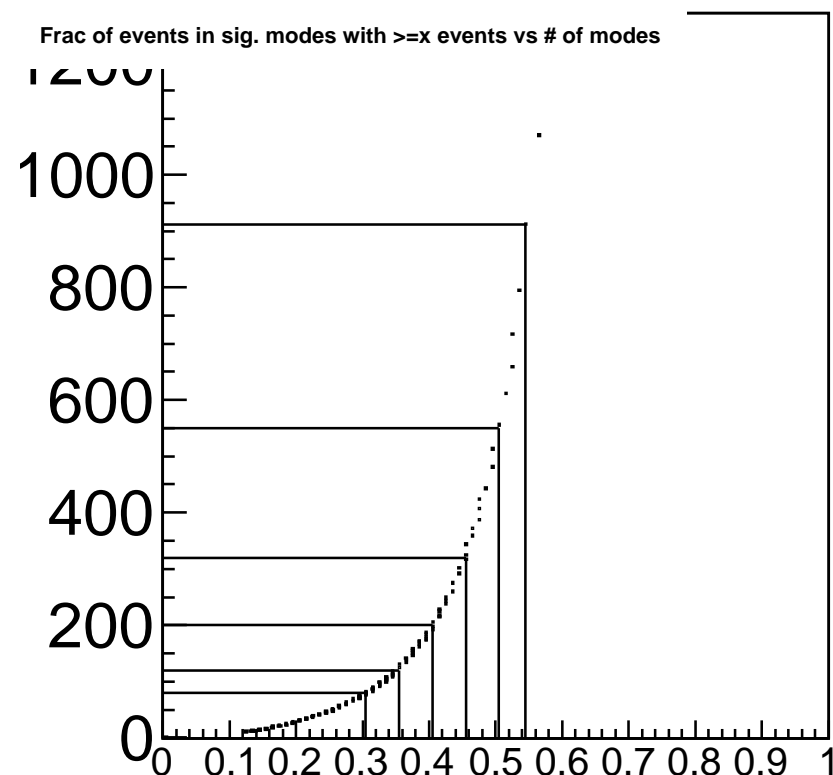
# # of had. modes vs frac of events



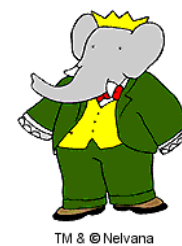
Tag side



Sig side



	Tag $B$						Sig $B$					
Fraction	0.81	0.80	0.75	0.70	0.65	0.60	0.54	0.50	0.45	0.40	0.35	0.30
# of modes	712	544	240	140	80	50	911	550	320	200	120	80

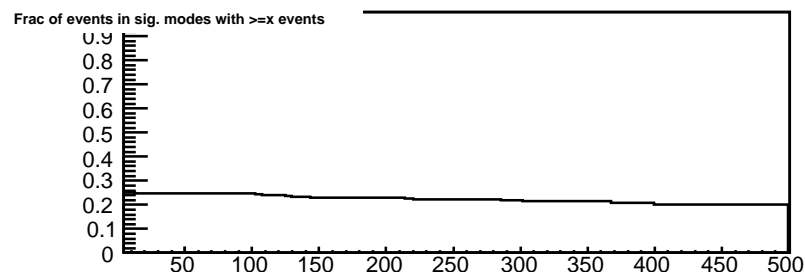
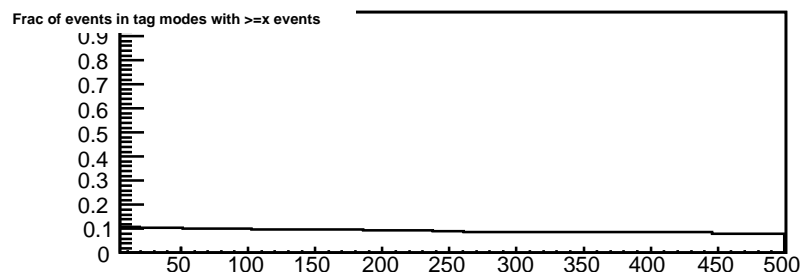
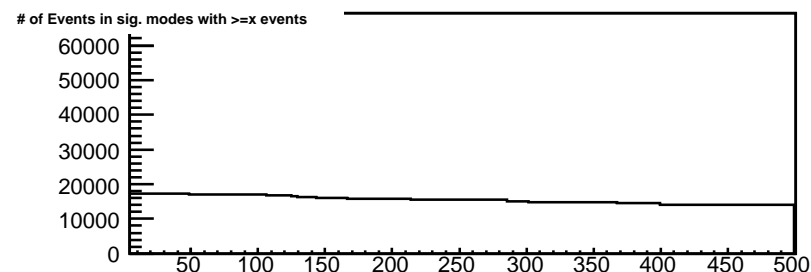
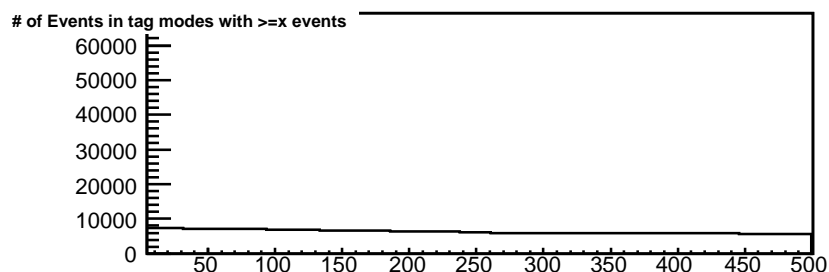
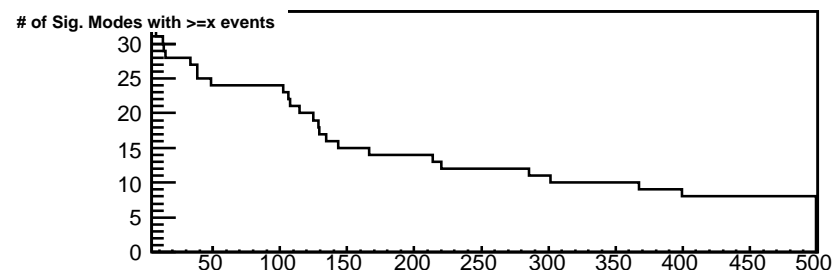
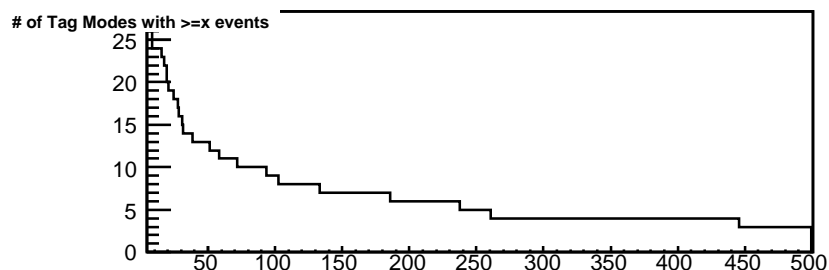


# #'s of lep. modes and events vs. cut on # of events per mode

leptonic decays (with & without charm)

Tag side

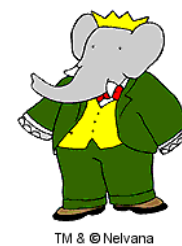
Sig side



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- Middle row: Number of events in populated modes (modes with  $N_{ev} \geq \text{cut}$ )
- Bottom row: Fraction of events in populated modes (middle row divided by # of non-SCF events)



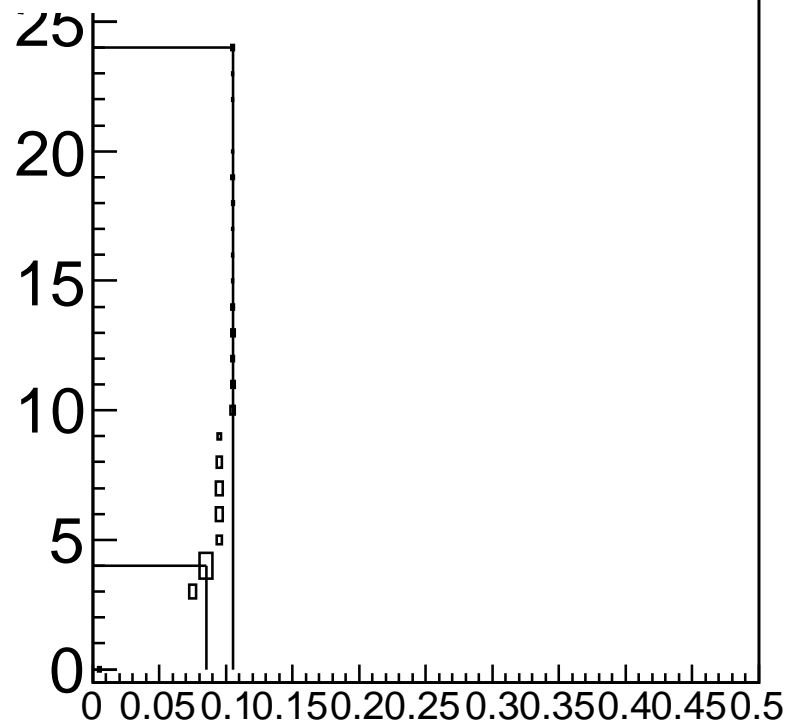
# # of lep. modes vs frac of events



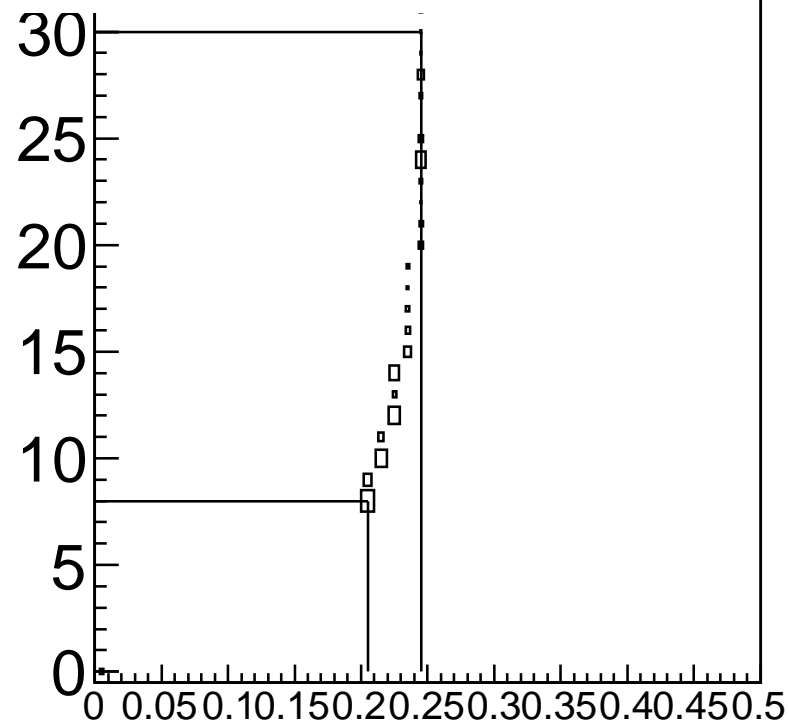
Tag side

Sig side

Frac of events in tag modes with  $\geq x$  events vs # of modes



Frac of events in sig. modes with  $\geq x$  events vs # of modes



	Tag $B$		Sig $B$	
Fraction	0.11	0.08	0.25	0.20
# of modes	24	4	30	8



# All tables



			Tag $B$						Sig $B$					
had.	$B^+ B^-$	Fraction	0.83	0.80	0.75	0.70	0.65	0.60	0.54	0.50	0.45	0.40	0.35	0.30
		# of modes	497	237	113	64	37	20	851	460	229	130	73	44
	$B^0 \overline{B}^0$	Fraction	0.81	0.80	0.75	0.70	0.65	0.60	0.54	0.50	0.45	0.40	0.35	0.30
		# of modes	712	544	240	140	80	50	911	550	320	200	120	80

			Tag $B$		Sig $B$	
lep.	$B^+ B^-$	Fraction	0.09	0.07	0.30	0.27
		# of modes	27	6	40	12
	$B^0 \overline{B}^0$	Fraction	0.11	0.08	0.25	0.20
		# of modes	24	4	30	8

I think that we should generate only selected hadronic modes (hadronic cocktail), but keep ALL leptonic modes because, despite low branchings, some of them may have very high reconstruction efficiencies (such as  $B \rightarrow \pi^0 \ell \nu$ )