

Cluster Counting performances and physics studies

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IV SuperB Collaboration Meeting – Isola
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DCH Session, June 2nd 2012



Outline

- Aim of the study, configurations and samples
- **HAD Breco side**
 - B_{reco} selection efficiencies
 - m_{ES} distributions
- **$B^+ \rightarrow K^+ \nu \nu$ signal MC studies**
 - selection efficiency
 - m_{ES} , K spectrum, E_{extra} distributions
- Conclusions

Aim of the study

- Test impact on physics of kaon PID selectors incorporating Cluster Counting
- Configurations for CC performances

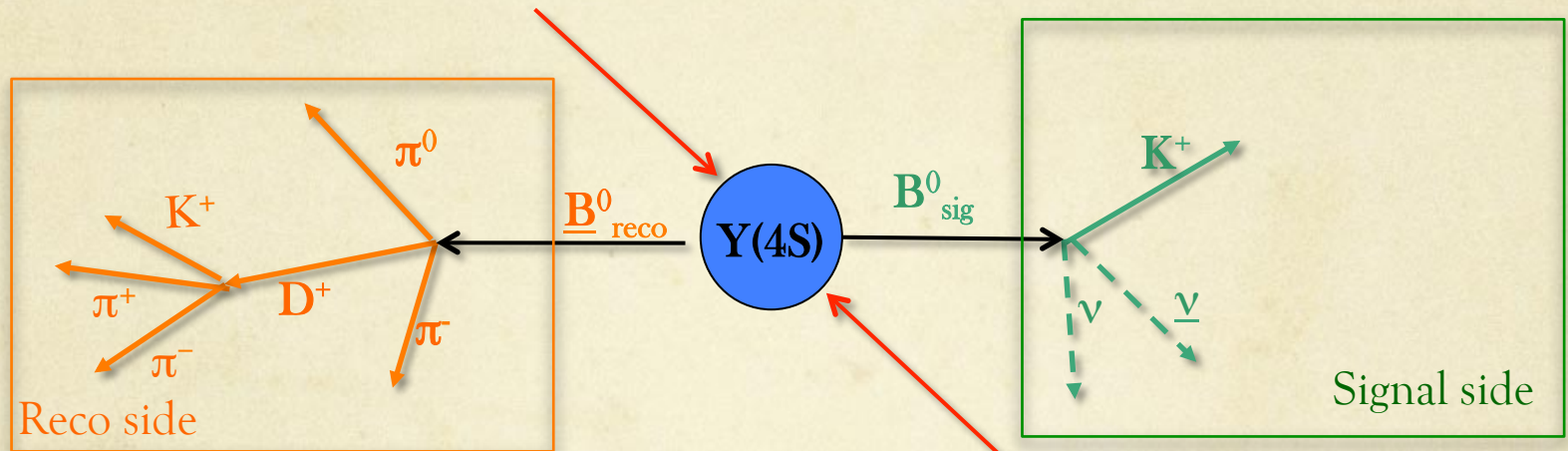
- **DCH bbr**: selectors a-la-BaBar (no CC)
- **DCH A**: 100% improvement in performances wrt BaBar
- **DCH A + TOF** : 100% improvement in performances wrt BaBar + FWD TOF
- **DCH B**: 70% improvement in performances wrt BaBar
- **DCH C**: 50% improvement in performances wrt BaBar
- **DCH D**: 30% improvement in performances wrt BaBar

Tools and Samples

- Use FastSim V0.3.1, with DCH detector config from Jean-François
- Produce signal and HAD cocktail sample, reconstructed through PacHadRecoilUser (FastSim package for Hadronic Recoil Analysis)
- Samples: for each DCH configuration
 - 10^6 $B^+ \rightarrow K^{*+} \nu \bar{\nu}$ signal events
 - 10^6 $B^+ B^-$ hadronic cocktail events

(no machine background mixing)

$B^+ \rightarrow K^+ \nu \nu$ in the HAD recoil



○ B_{reco} side: full reconstruction of hadronic B final states

○ B_{sig} side: use tracks and neutrals not involved in the reco side reconstruction and look for a $K^{(*)}$ /lepton not accompanied by additional (charged or neutral) particles + missing energy

B^+B^- cocktail MC
($B \rightarrow HAD$ cocktail vs $B \rightarrow$ generic):
 B_{reco} side studies

Selection

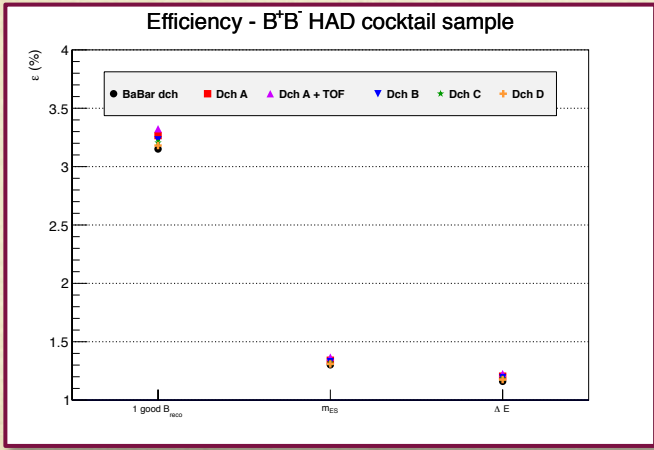
- at least 1 reconstructed HAD B_{reco}
- K passing **TightLHKaonSelection**
- Best B_{reco} chosen according to smallest ΔE
- Reco side selection
 - $5.270 < m_{\text{ES}} < 5.288 \text{ GeV}/c^2$
 - $-0.09 < \Delta E < 0.05 \text{ GeV}$

Efficiencies (I)

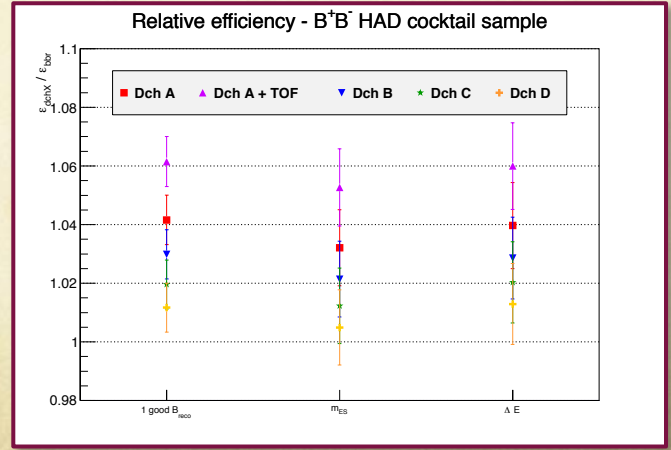
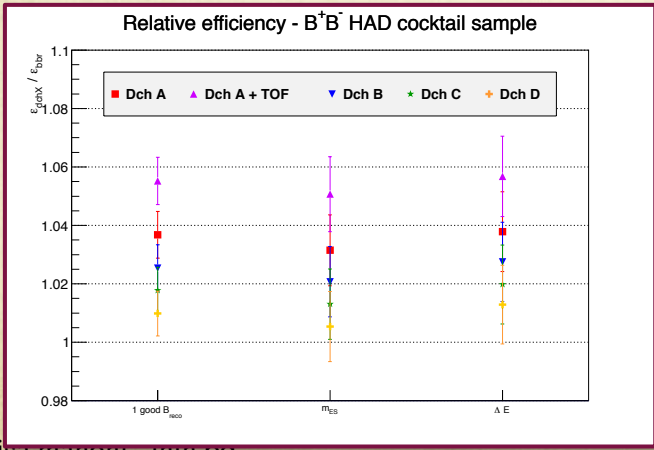
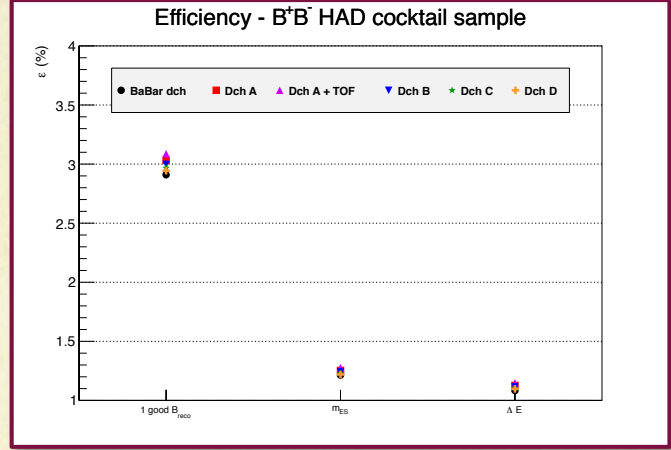
	BaBar	DCH_A	DCH_A + TOF	DCH_B	DCH_C	DCH_D
All B_{reco} modes (%)						
B_{reco}	3.150 ± 0.017	3.266 ± 0.018	3.324 ± 0.018	3.233 ± 0.018	3.206 ± 0.018	3.181 ± 0.017
m_{ES}	1.302 ± 0.011	1.343 ± 0.011	1.368 ± 0.012	1.329 ± 0.011	1.319 ± 0.011	1.309 ± 0.011
ΔE	1.162 ± 0.011	1.206 ± 0.011	1.228 ± 0.011	1.194 ± 0.011	1.185 ± 0.011	1.177 ± 0.011
Breco modes with at least 1 K (%)						
B_{reco}	2.910 ± 0.017	3.031 ± 0.017	3.089 ± 0.017	2.997 ± 0.017	2.967 ± 0.017	2.944 ± 0.017
m_{ES}	1.215 ± 0.011	1.254 ± 0.011	1.279 ± 0.011	1.241 ± 0.011	1.230 ± 0.011	1.221 ± 0.011
ΔE	1.084 ± 0.010	1.127 ± 0.011	1.149 ± 0.011	1.115 ± 0.010	1.106 ± 0.010	1.098 ± 0.010

Efficiencies (II)

All B_{reco} modes



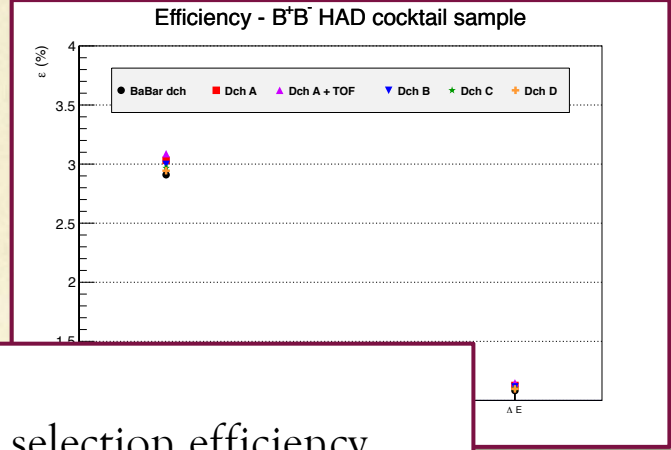
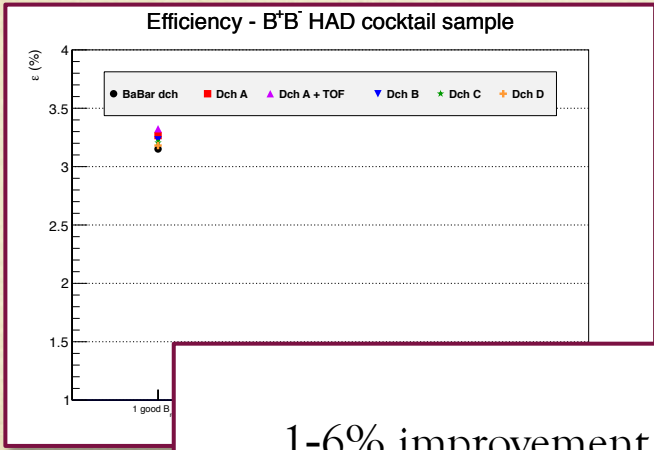
B_{reco} modes with at least 1 K



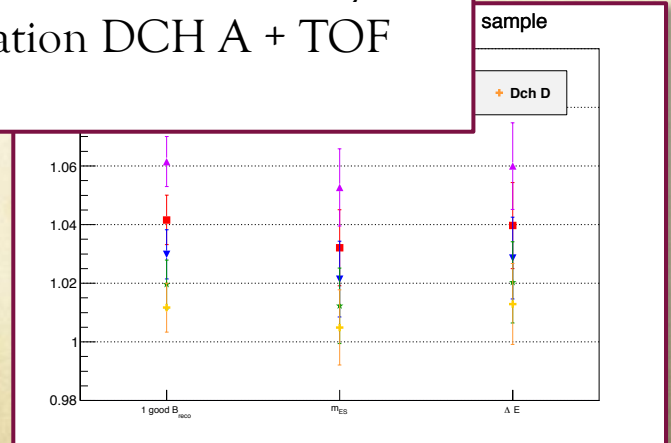
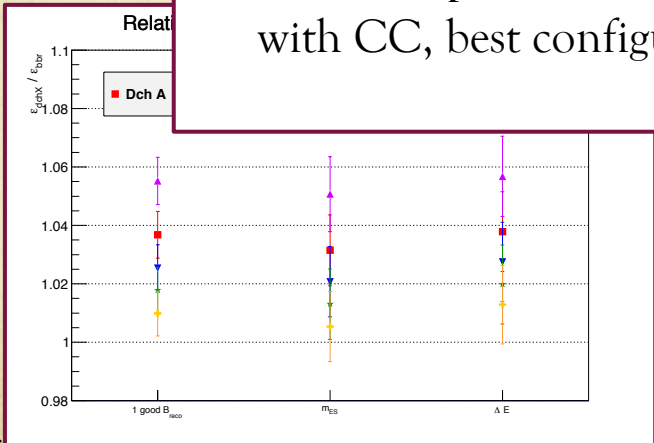
Efficiencies (II)

All B_{reco} modes

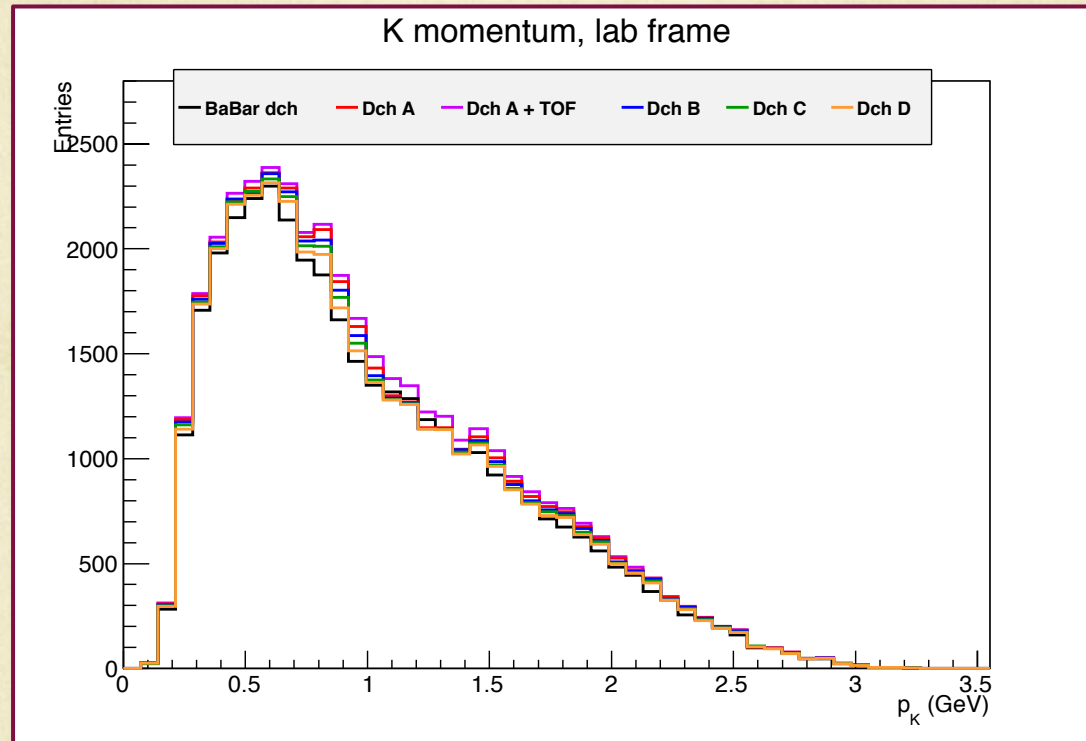
B_{reco} modes with at least 1 K



1-6% improvement in selection efficiency with CC, best configuration DCH A + TOF

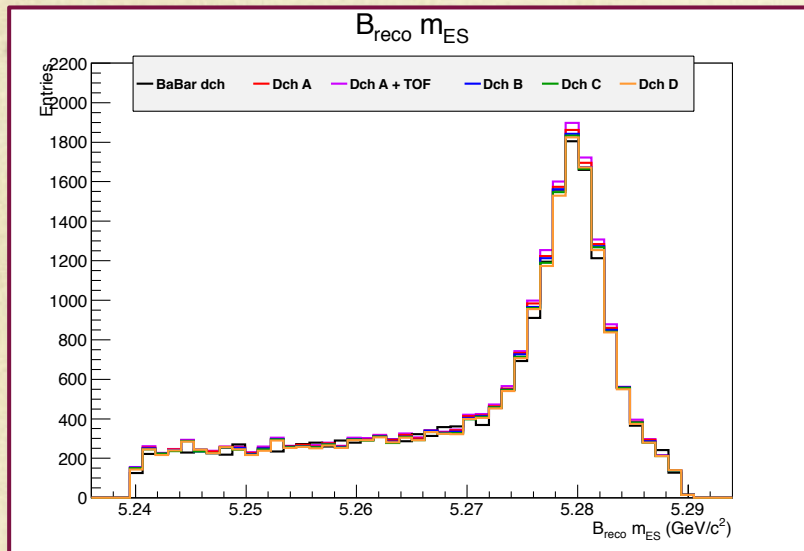


B_{reco} Side K momentum

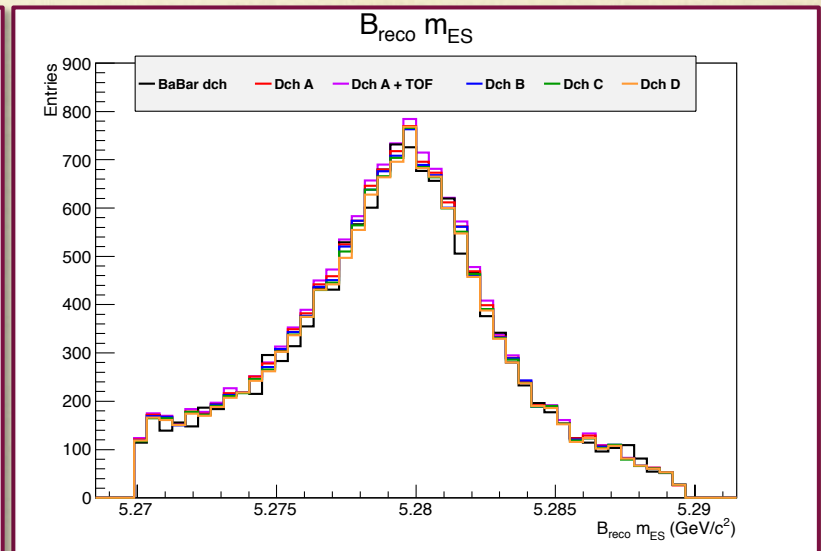


m_{ES} distributions (I)

before $m_{ES}-\Delta E$ selection



after $m_{ES}-\Delta E$ selection

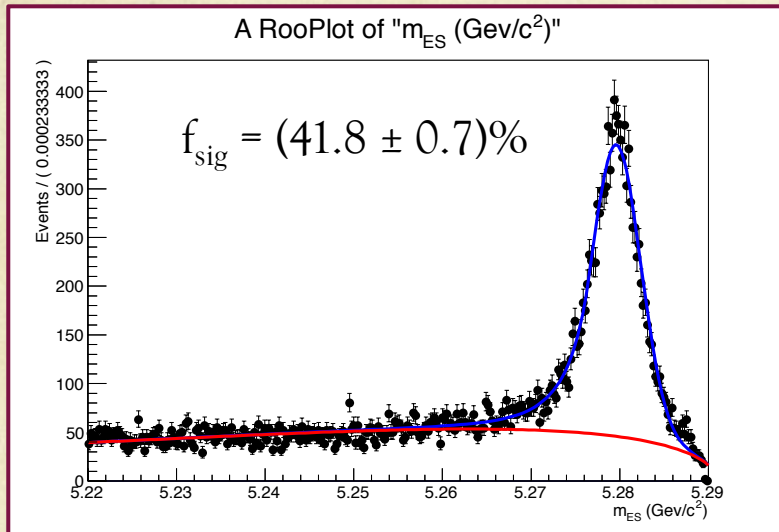


- extra-events, selected with CC, are mostly in the m_{ES} peak region

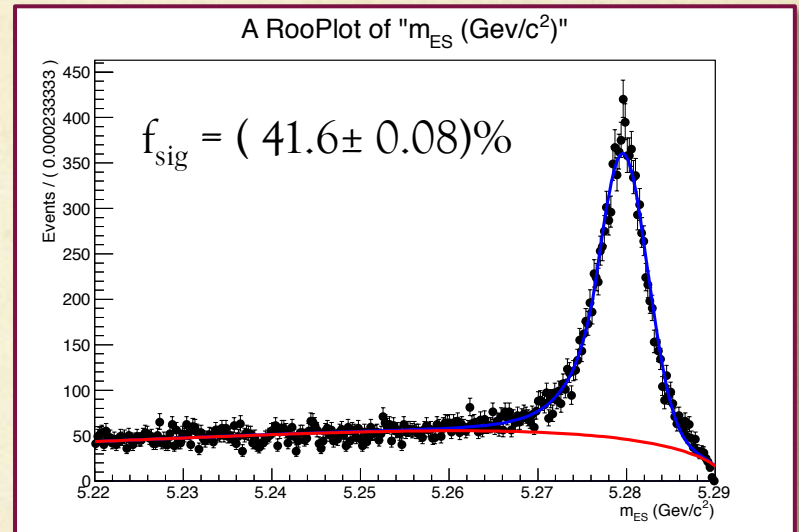
m_{ES} distributions (II)

- Try to estimate purity with CB+Argus fit

DCH A + TOF



DCH BBR



- small extra-statistics and not precise description of the peak region don't allow to appreciate a significant difference in purity (if any)

$B^+ \rightarrow K^+ \nu \nu : B_{\text{sig}}$ side studies

Selection

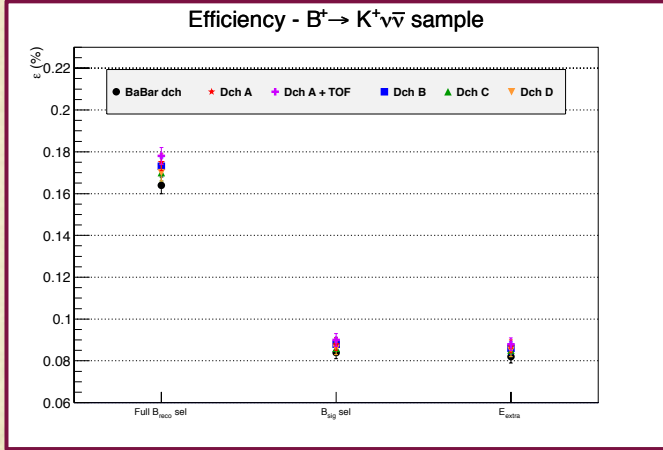
- Same as B^+B^- generic for Breco side Purity estimation (“Full B_{reco} sel”)
 - Signal side
 - 1 K passing TightLHKAonSelection
 - no extra tracks
 - $p_K^* > 1.5 \text{ GeV}$
 - $|\cos\theta_{\text{miss}}| < 0.9$
 - $E_{\text{extra}} < 300 \text{ MeV}$ (“ E_{extra} sel”)
-)} (“Bsig sel”)

Efficiencies (I)

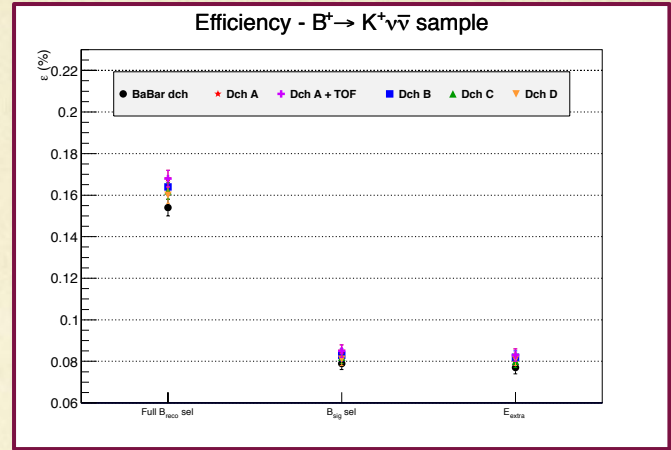
	BaBar	DCH_A	DCH_A + TOF	DCH_B	DCH_C	DCH_D
All B_{reco} modes (%)						
Full B_{reco} sel	0.164 ± 0.004	0.175 ± 0.004	0.178 ± 0.004	0.173 ± 0.004	0.172 ± 0.004	0.170 ± 0.004
B_{sig} sel	0.084 ± 0.003	0.088 ± 0.003	0.090 ± 0.003	0.088 ± 0.003	0.087 ± 0.003	0.086 ± 0.003
E_{extra}	0.082 ± 0.003	0.087 ± 0.003	0.088 ± 0.003	0.086 ± 0.003	0.085 ± 0.003	0.085 ± 0.003
Breco modes with at least 1 K (%)						
Full B_{reco} sel	0.154 ± 0.004	0.164 ± 0.004	0.168 ± 0.004	0.163 ± 0.004	0.162 ± 0.004	0.160 ± 0.004
B_{sig} sel	0.079 ± 0.003	0.083 ± 0.003	0.085 ± 0.003	0.083 ± 0.003	0.082 ± 0.003	0.081 ± 0.003
E_{extra}	0.077 ± 0.003	0.082 ± 0.003	0.083 ± 0.003	0.081 ± 0.003	0.080 ± 0.003	0.080 ± 0.003

Efficiencies (II)

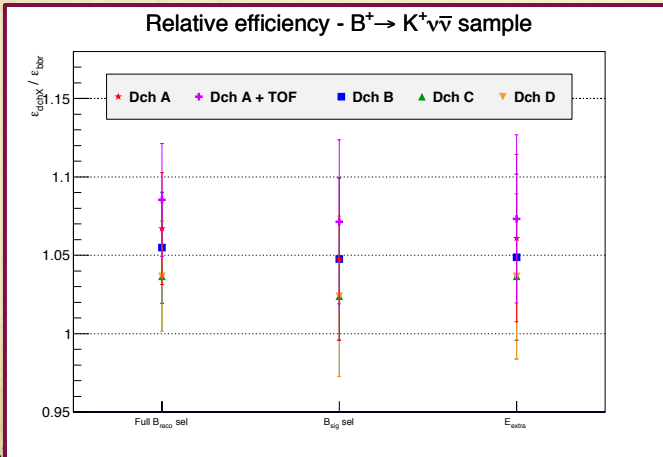
All B_{reco} modes



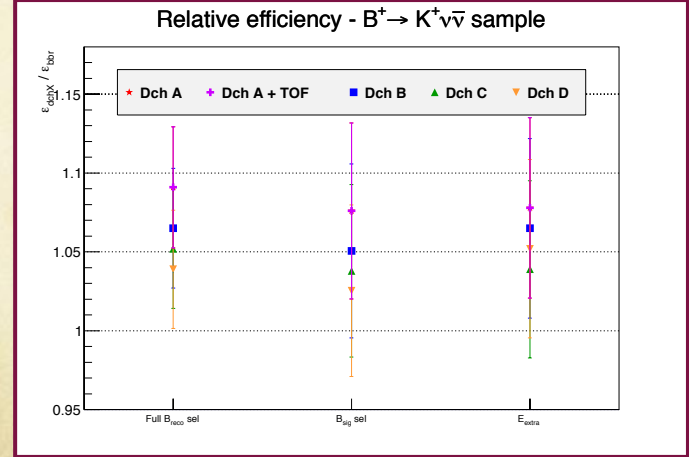
B_{reco} modes with at least 1 K



Relative efficiency - $B^+ \rightarrow K^+ \nu \bar{\nu}$ sample



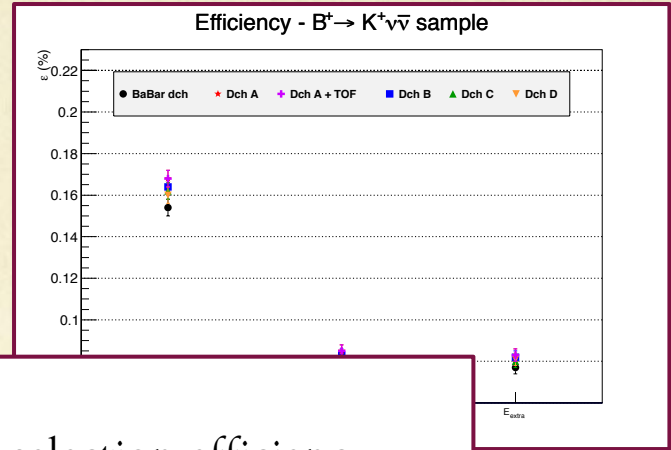
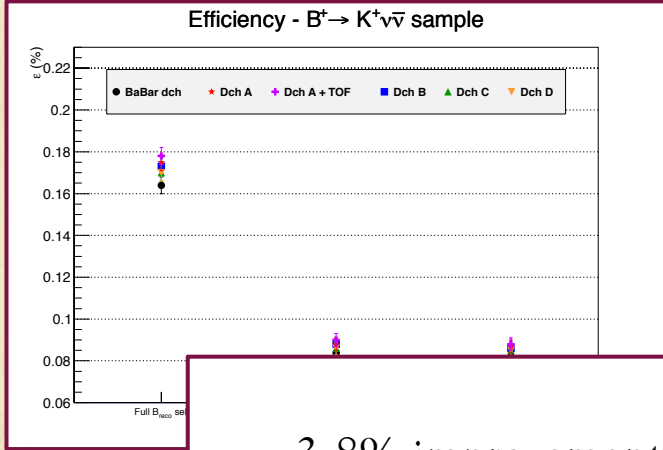
Relative efficiency - $B^+ \rightarrow K^+ \nu \bar{\nu}$ sample



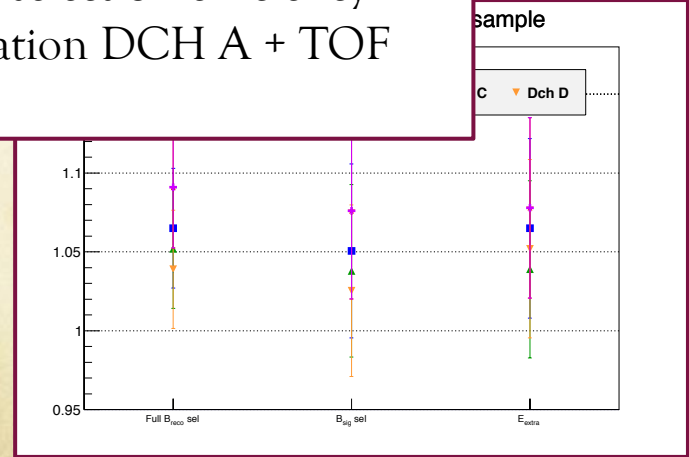
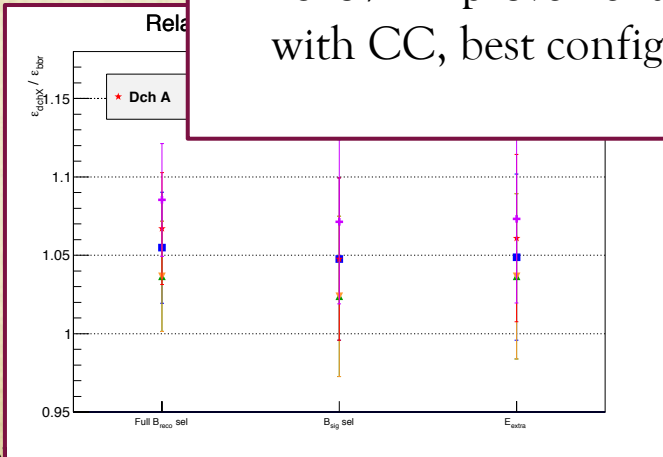
Efficiencies (II)

All B_{reco} modes

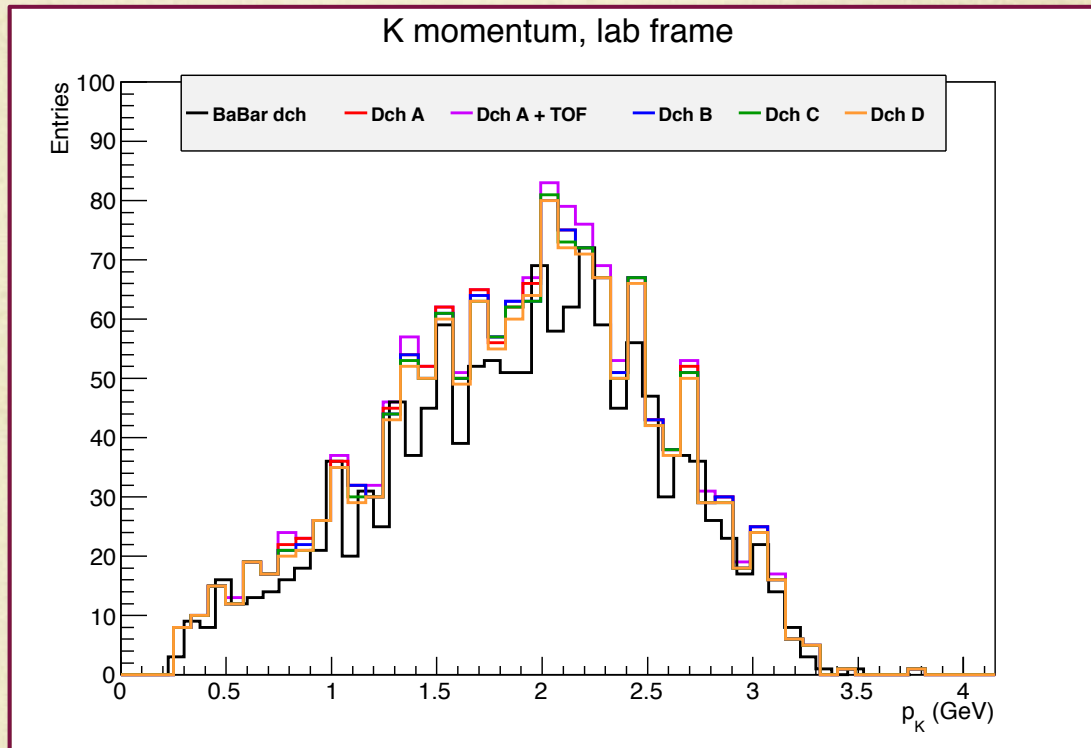
B_{reco} modes with at least 1 K



3-8% improvement in selection efficiency with CC, best configuration DCH A + TOF



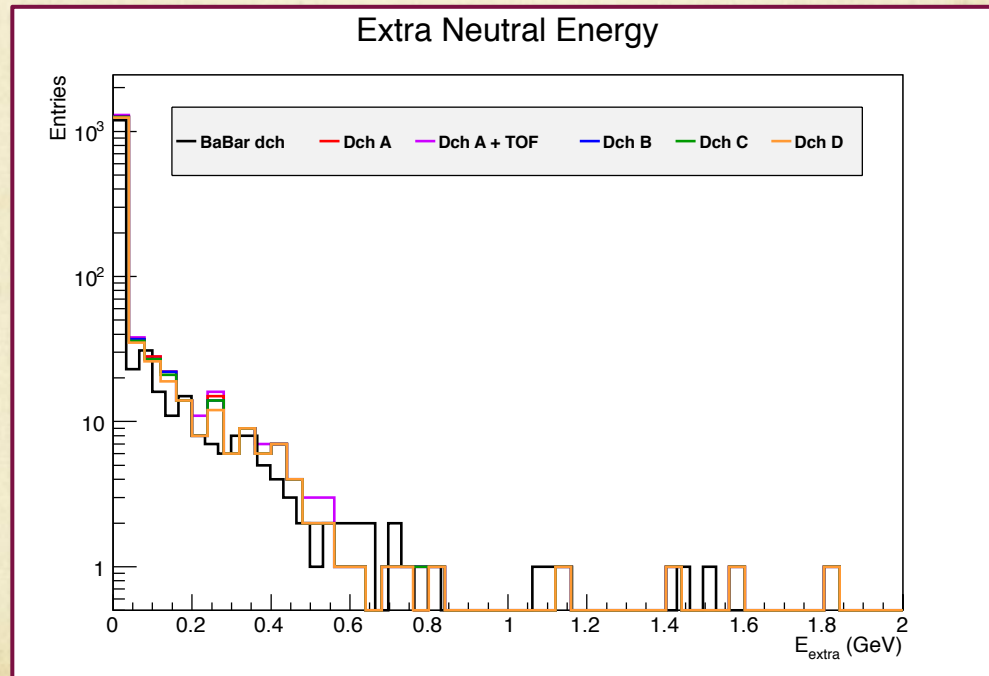
Signal Side K momentum



- with CC, recover events with signal side K mainly in the low p_K region

E_{extra} distributions

- E_{extra} = neutral energy not associated to B_{reco} nor to B_{sig}
- Not a big difference in E_{extra} shape when adding CC



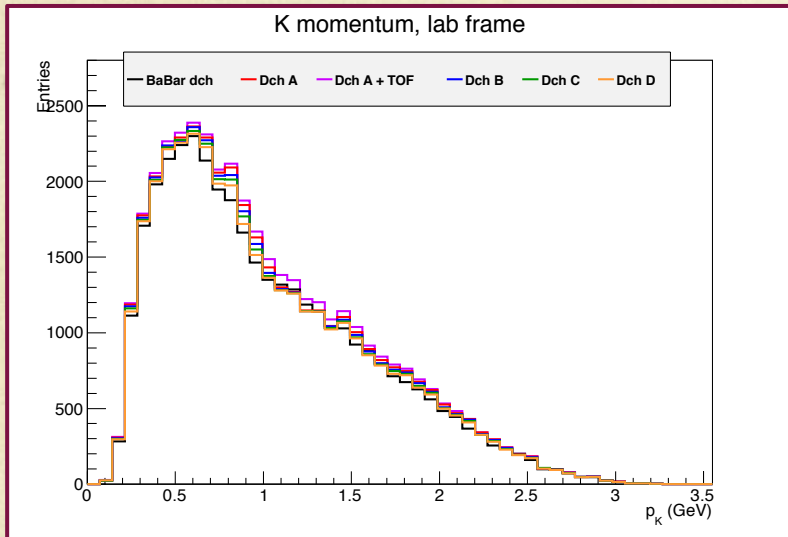
Conclusions

- Cluster Counting performances impact on physics investigated
 - $B^+ \rightarrow K^+ \nu \nu$ against HAD Breco
- Signal MC and HAD Breco cocktail, in different DCH scenarios, studied
- Breco (Bsig) sample: 1-6% (3-8%) improvement in selection efficiency with CC, best configuration DCH A + TOF as expected

Extra Slides

B_{reco} side K momentum

HAD cocktail



signal MC

