

Studies of ROE event shape variables with BReco

<http://www.slac.stanford.edu/~ocariz/2body/simu0704.pdf>

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BABAR Montecarlo Simulation Workshop

Overview

- Motivation, method
 - Examples, relevant features
 - Conclusions
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Thanks to Aaron Roodman for providing us with the datasets used here...

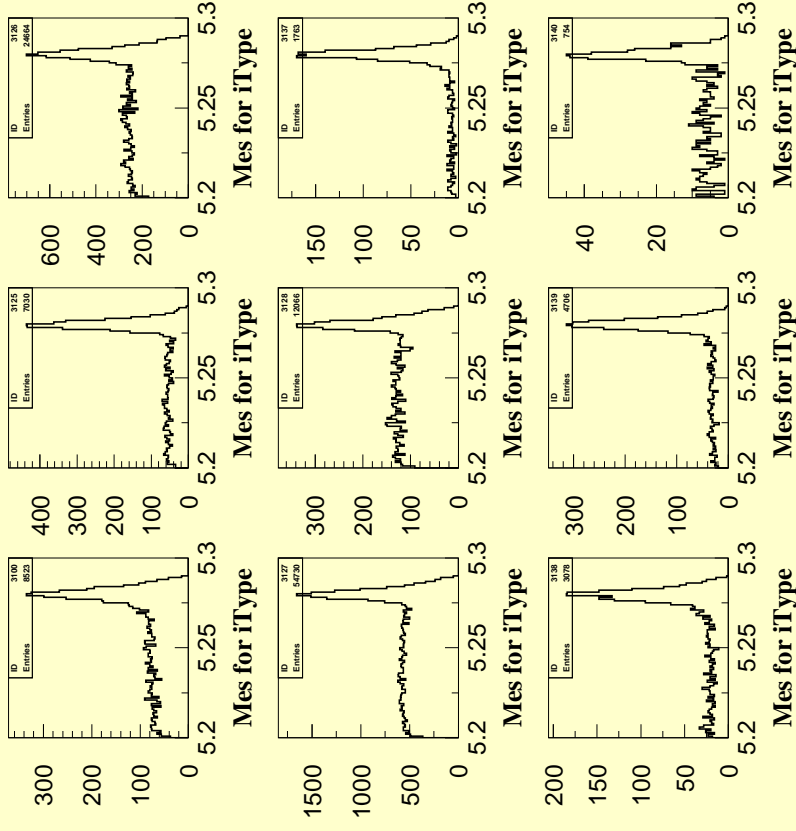
The idea ...

- Arised from need to evaluate some systematics in a 2-body ($B^+ \rightarrow h^+ \pi^0$) and a 3-body (Dalitz $B^0 \rightarrow K^+ \pi^- \pi^0$) analysis
- Event shape variables appear at several locations in these analyses
 - preselection: R_2 , sphericity (not big issue)
 - tighter selection: cut on $|\cos(\theta_S)|$ (2b) and NN (3b). In the past, a systematic was assigned as arising from the $|\cos(\theta_S)|$ "slope" in MC (assuming no slope should be there)
 - fit: \mathcal{F} . Systematics evaluated by changing parametrisation, and with reweighting from Data/MC comparison.

A short look at SP5 Breco

➤ I have had a look at Aaron Roodman's Breco roottuples

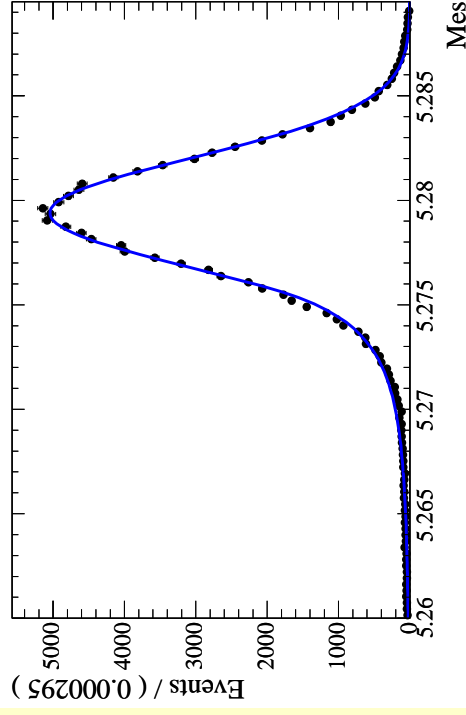
→ Selecting a $B^+ \rightarrow \pi^0 X$ Breco sample



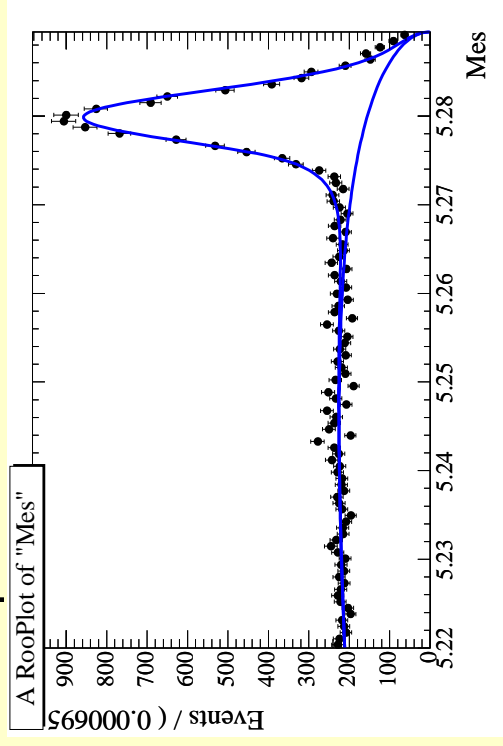
- Several decay channels
- Different S/B ratios
- Good statistics
- Can choose just the "cleaner" ones

The global sample

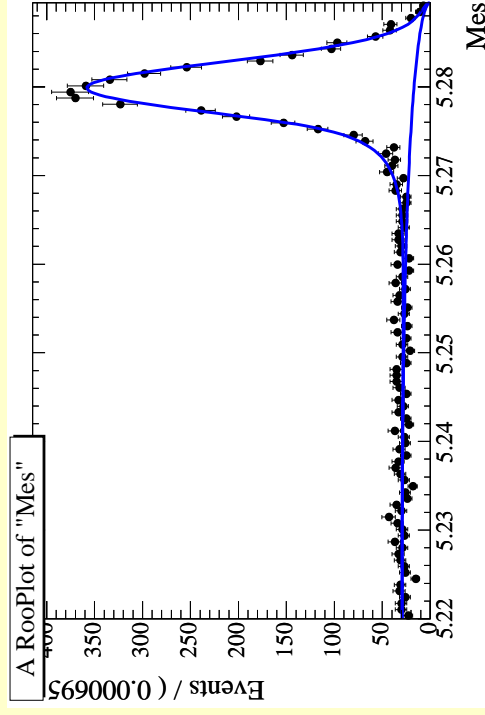
- Obtain m_{ES} PDF from SP5 MC
- CBshape parametrisation looks suitable
- Fit Signal and Background (argus) components in data (allow m_{ES} mean and sigma to float in fit)
- Subtract background (with sPlots)
- Compare Data and MC



m_{ES} on SP5 MC

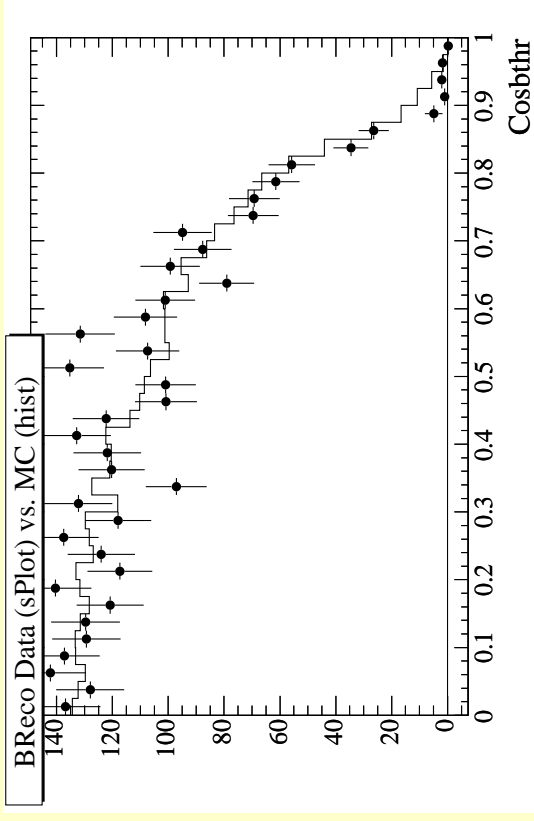
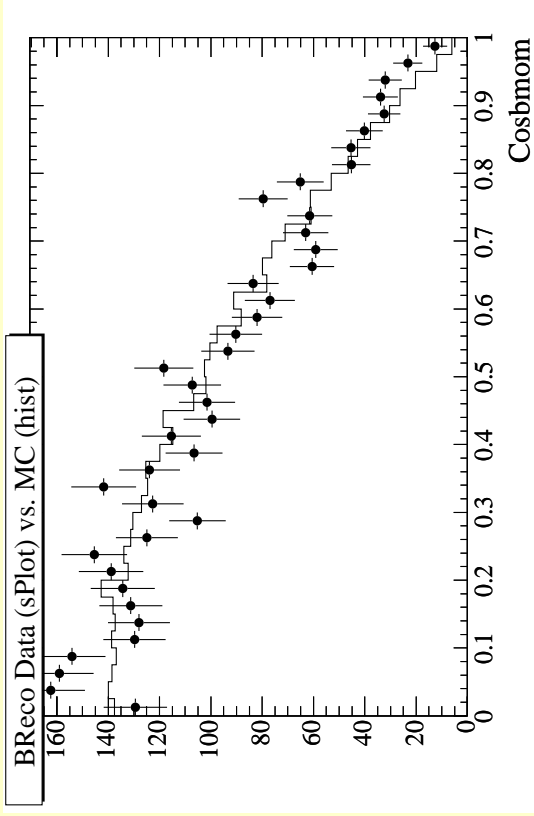


Fit to the full data sample



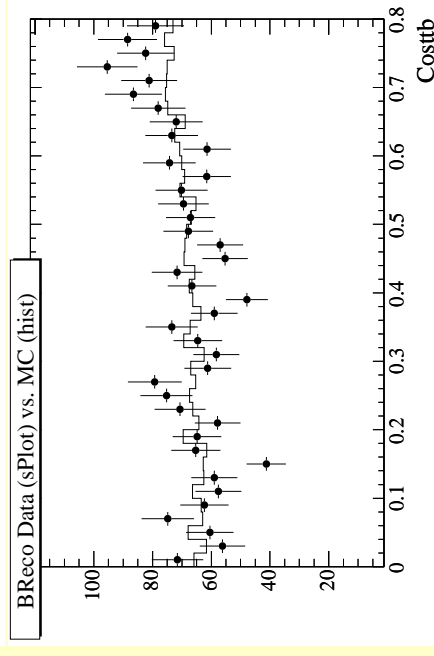
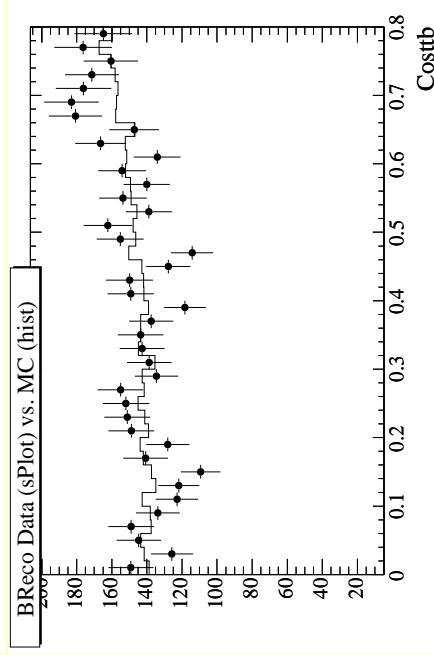
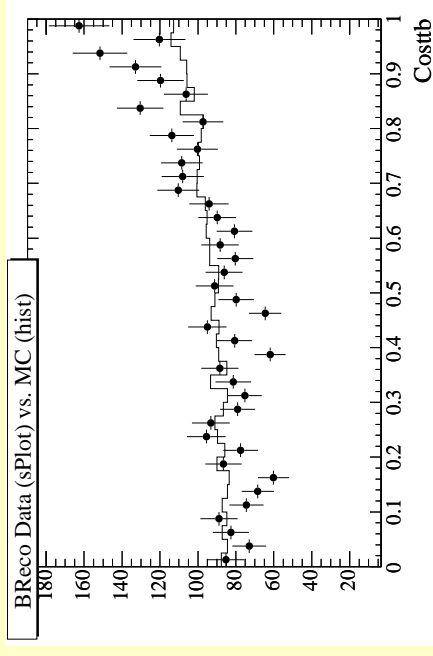
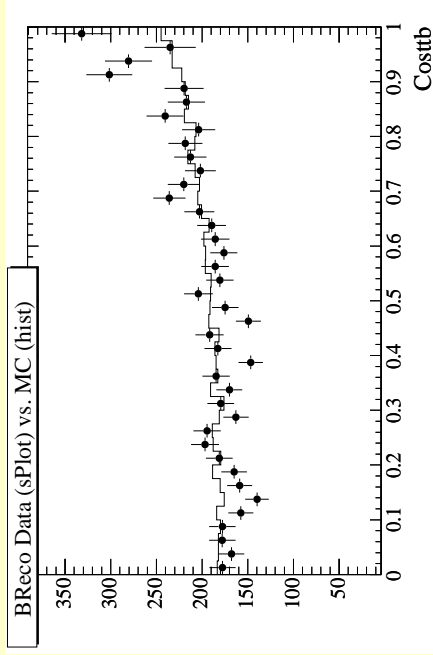
fit to the "clean" data subset

Compare event shape variables ... (I)



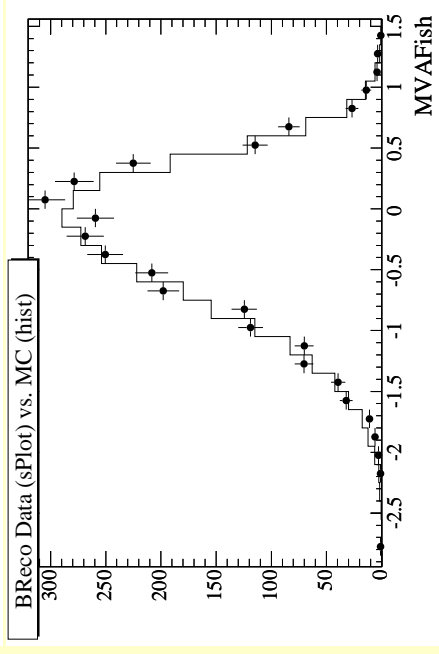
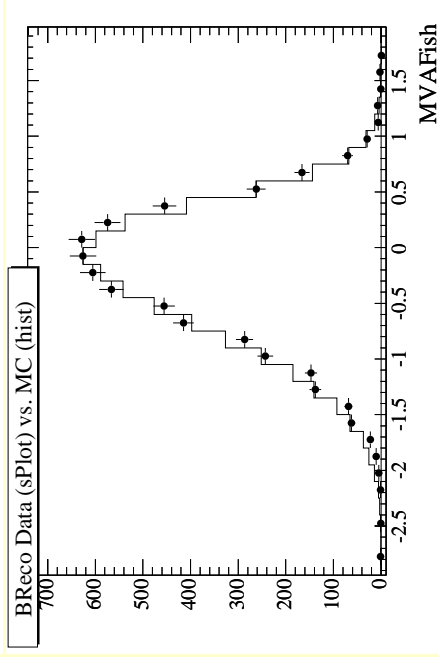
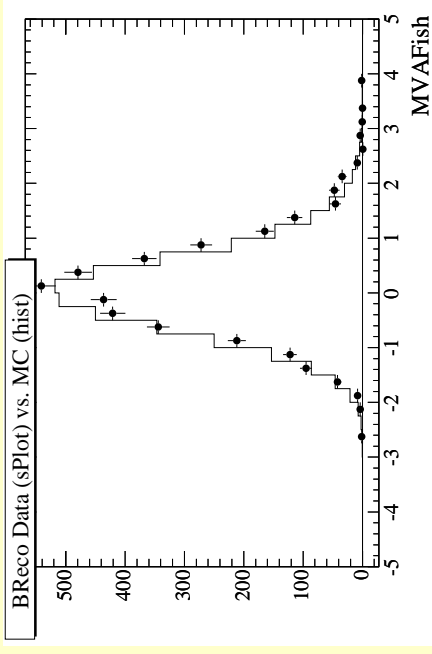
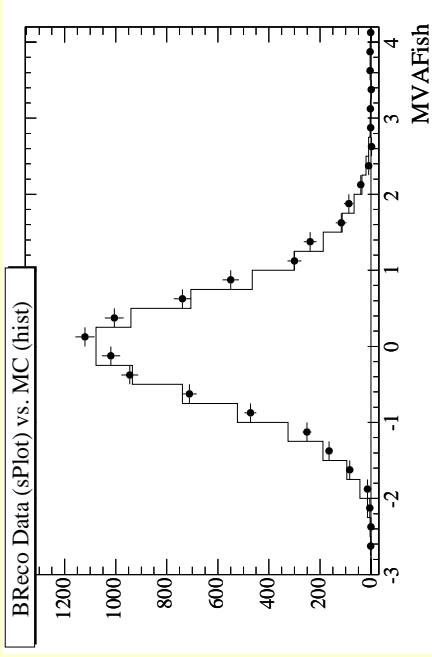
- Start with the nice ones...
- $\cos\theta_{B,z}$ and $\cos\theta_{T_{B,z}}$ look reasonably well simulated (except maybe at high values...)
- These variables are mostly kinematic- and acceptance- sensitive
- We know they do not need to look similar in our charmless signal modes
- A more clean analysis should reweight BRco to have them match the charmless acceptance... TBD

Compare event shape variables ... (II)



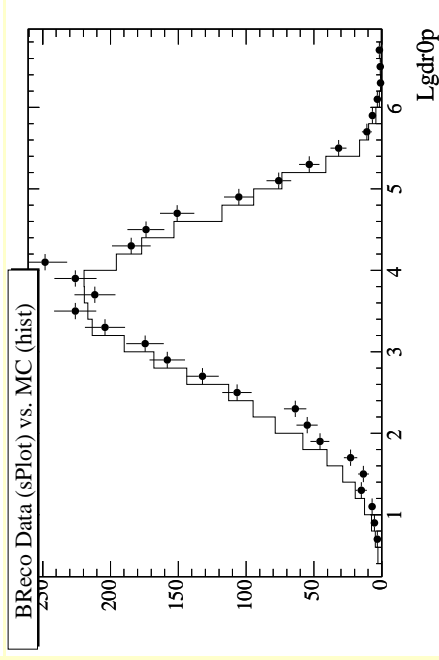
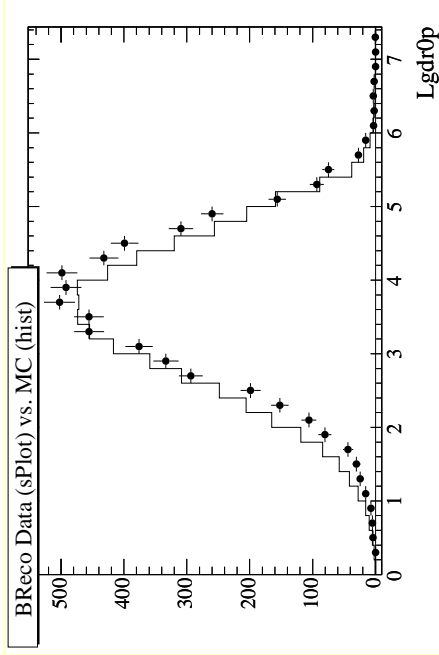
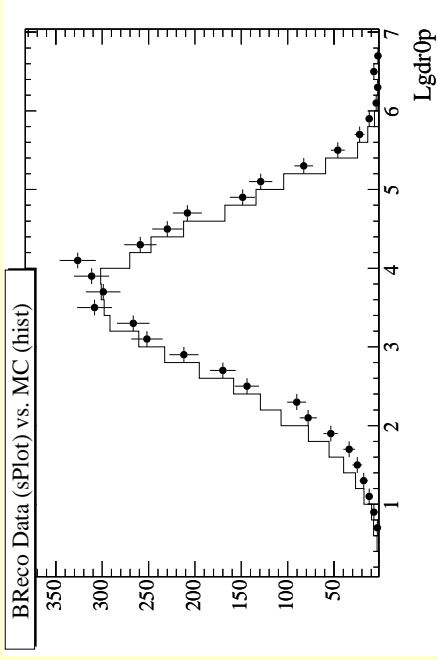
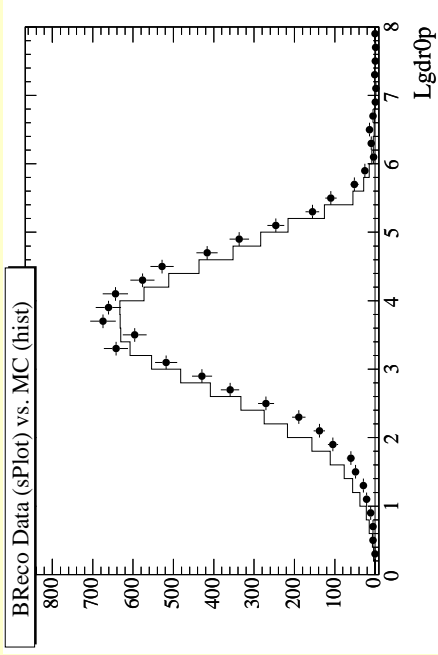
- Look now at the ROE event shape variables (“clean” at the right)
- $|\cos(\theta_S)|$ slope is different (in fact, disagreement clusters at
- $|\cos(\theta_S)| > 0.8$, right there where we cut...
- Cross-check with \mathcal{F} ($\sim 85\%$ correlated) ...

Compare event shape variables ... (III)



- Look now at \mathcal{F} (before and after $|\cos(\theta_S)|$ cut, “clean” at the right)
- Mismatch: overall shift...
- Remember \mathcal{F} is a linear combination $\mathcal{F} = 0.5 - 0.6 \times L_0 + 1.3 \times L_2$

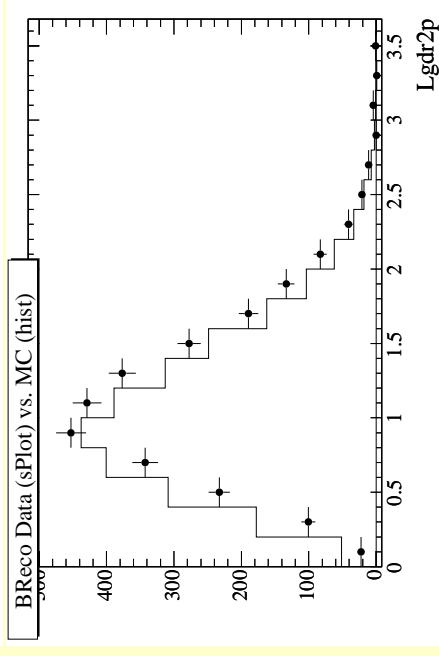
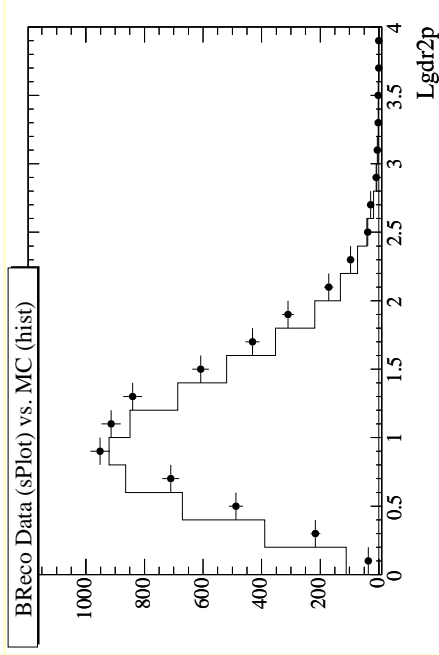
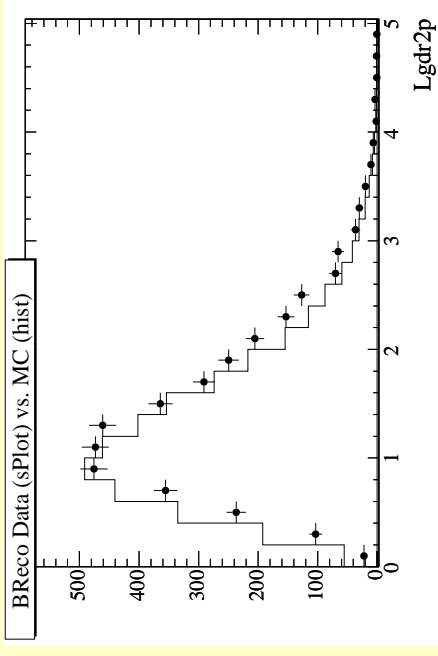
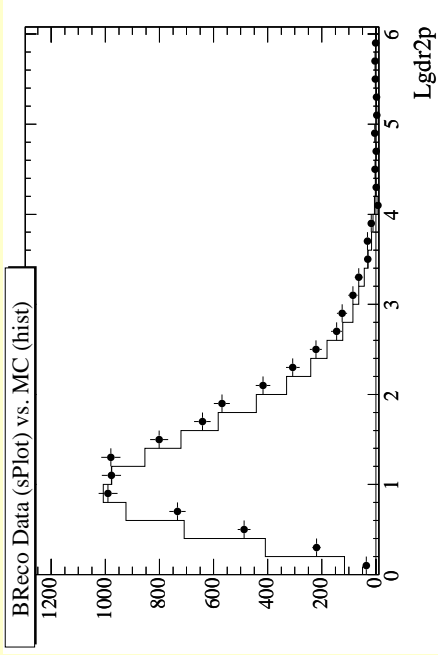
Compare event shape variables ... (IV)



$$L_0 = \sum_{i, \text{ROE}} |\vec{p}_i|$$

... mismatch relatively insensitive to $|\cos(\theta_S)| \dots$

Compare event shape variables ... (V)



$$L_2 = \sum_{i, \text{ROE}} |\vec{p}_i| \times \cos^2(\theta_i)$$

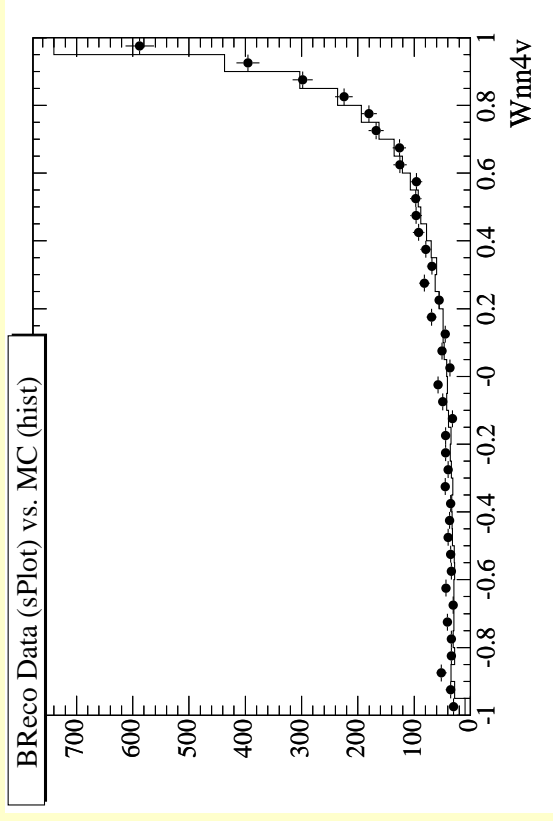
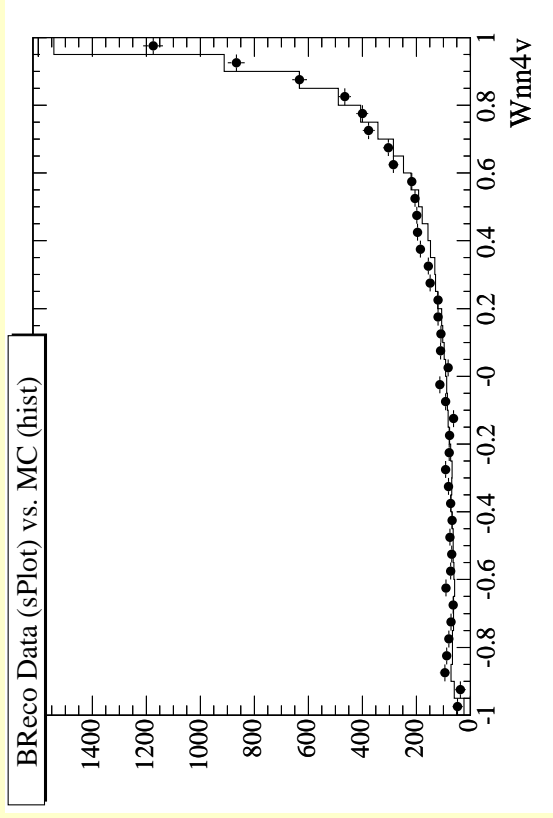
$|\cos(\theta_S)|$ cuts away the “jetty” components of the ROE...

Compare event shape variables ... (last)

- Track back what \mathcal{F} is built of: L_0 and L_2 ...
 - Both variables are clearly shifted
 - Both are estimators of the total ROE energy detected
 - To some extent, $a_1 \times L_0 - a_2 L_2$ (or L_0/L_2 , as $K_S^0 \pi^0$ uses) cancels out that global mismatch!
-
- List of TBD things:
 - Split L_i into their charged/neutral components
 - Look for correlations with multiplicities, spectra ...
 - How different are things for B^0/B^+ ?
 - We know L_i mismatch is also on B^0 BReco ...
 - ... but $|\cos(\theta_S)|$ seems in better agreement... (c.f. A. Roodman)

Another issue: 3body NNs

- Many Q2B, 3B and 4B analyses use NNs
- Typical inputs are $\cos\theta_{T_{B,z}}$, $\cos\theta_{B,z}$, L_0 and L_2
- NN might look for non-linear $L_0 - L_2$ combinations !
- potentially dangerous....



- Example from the Dalitz $B^0 \rightarrow K^+ \pi^- \pi^0$ analysis...
- A cut on $NN > 0.76$ brings a $\sim 6\%$ disagreement on efficiency...
- analysis more interested in Acp's and partial fractions than BR's
- NN is *not* used in the fit (also for other reasons...)

(... not really a ...) conclusion

- After BABAR 346, I had the hope of not looking at MVA's again...
- ... but this is becoming a non-negligible source of systematics
- some of our channels (i.e. $K^+\pi^-$) have small expected statistical errors ($\sim 2\%$)...
- ... already challenged by systematics on selection criteria !
- (not all) analyses with low S/B and/or yields can live without MVA discrimination!
- ... we may need to spend time/effort/neurons addressing the issue of "total detected energy"
- ... the TBD list may well increase