# $B^0 \to K^{0*}(K\pi)\mu\mu$ full angular analysis

## Systematics

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## Some thoughts on systematics

1. Limited amount of MC events for eff determination
2. kernel width for KDE
3. efficiency shape
4. Simulation mismodeling
5. wrong CP assignment
6. background determination
7. MC derived `pdf` component
8. angular resolution

# Limited amount of MC events for eff determination

## Split MC

- Split MC sample in N(=4) subsample;
- evaluate the efficiency via KDE for each sub sample $\epsilon_i$, $i = 1, \ldots, N$
- perform N fit on MC and/or control samples $J/\psi$ $\psi'(2s)$ and extract N set of angular parameters for each $q^2$ bin $X_i$;
- compute spread of parameter $X$ as $RMS(X)$
- systematics is $RMS(X)/\sqrt{N}$ (Is that correct, or it should be $/N$?)

# Limited amount of MC events for eff determination (II)

## Toy MC

- alternative method
- get `pdf` for N and D of efficiency $\epsilon = \frac{N}{D}$ with full MC statistics;
- generate toy MCs for N and D with as many events as in the original MC, following the `pdf`
- apply KDE on the toy MC samples, and get back $\epsilon$
- use these efficiencies to repeat the fit (as before) and take spread of output as systematics
- can be computational heavy

# Efficiency parametrization and shape

## Kernel width for KDE

- The KDE use a kernel with a given width
- we tried several, and choose one as an acceptable compromise;
- evaluate the systematics associated to this choice by varying the width up and down and compare the fit results;
- Alternative: we do have adaptive width for some of the bins, we can compare the adaptive with the fixed width and get the syst.

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## Efficiency shape

- From the control sample fit: compare fit results with $\mathrm{PDG}$ values (as in 2D analysis)

## Simulation mismodeling

- Compare fit result on $\mathrm{GEN}$ (w/o efficiency) and $\mathrm{RECO}$ (w/ efficiency) (as in 2D analysis)
- Q: how much of this already includes kernel width and eff shape syst?

# Other systematics

- As in 2D analysis
- wrong CP assignment
  - measure $B^0$ width with $K*(K\pi)J/\psi(\mu\mu)$ control sample
  - measure mistag ratio with $K*(K\pi)J/\psi(\mu\mu)$ control sample
  - fit N times data with mis-tag ratio randomly generated according to gaussian centered at nominal value and with $\sigma$ from the previous two methods.
- background determination
  - modify the parametrization of background ($+1$ degree of pol)
- MC derived `pdf` component
  - signal mass shape: use $J/\psi$ control sample, let mass shape free to float
- angular resolution
  - use generated angles in place of reconstructed ones, and compare.

# Summary

- First toughts on systematics, starting from those considered in 2D analysis;
- No major show stopper, we can redo most of the work already done for 2D analysis;
- we have a workplan for efficiency related systematics;
- In all cases, we need to perform the fit many many times, as expected
- cannot progress much w/o the fitting code...
- Adding all this to the AN