γ analysis update in $B^{\pm} \to (K^+K^-\pi^+\pi^-)_D K^{\pm}$ decays

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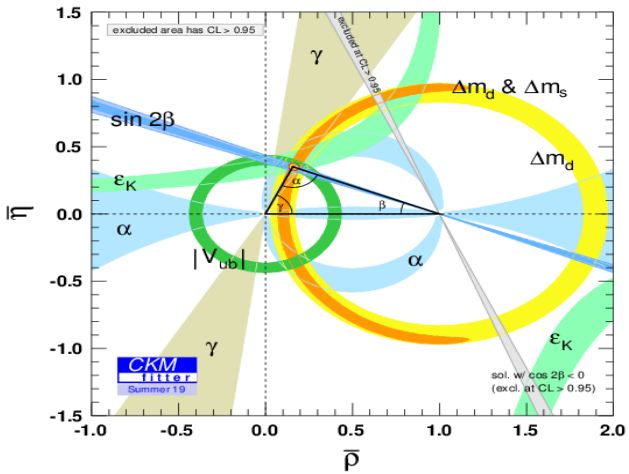


Summary of last time

- γ from $B^{\pm} \to DK^{\pm}$, $D \to K^+K^-\pi^+\pi^-$, arXiv:hep-ph/0611272
- Model independent measurement with BESIII strong phase input
- Expected precision from signal-only study: $\Delta\gamma = 12^{\circ}$
- B candidate selection with BDT
- Inital mass fits

Summary of analysis procedure

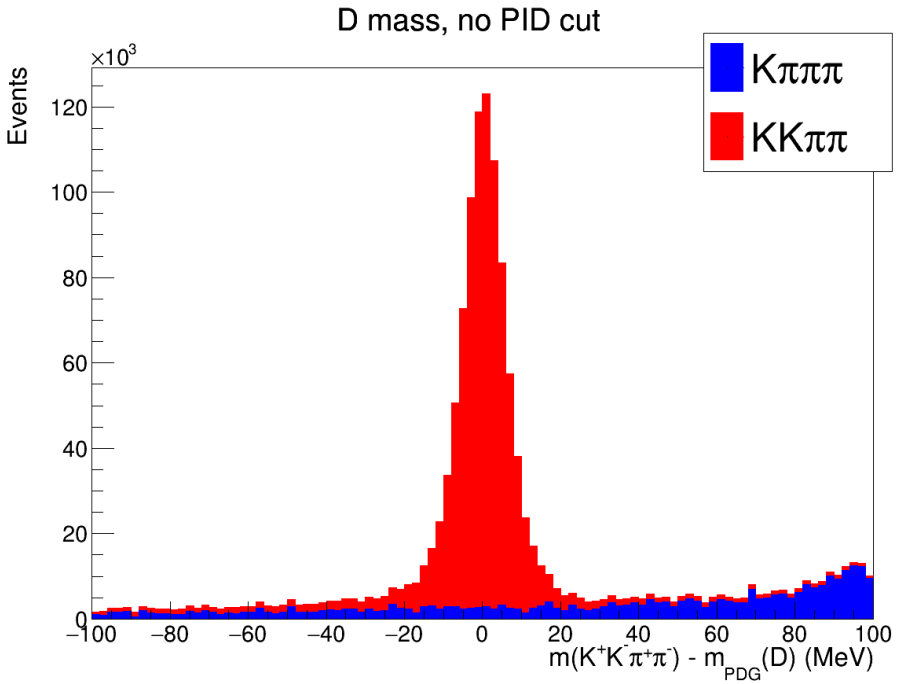
1. Perform global fit to fix yields and shapes
2. Separate $B^{\pm}$ candidates by charge and into bins
3. Extract $x_{\pm}$ and $y_{\pm}$ with a simultaneous fit
4. Interpret $x_{\pm}$ and $y_{\pm}$ in terms of γ

Outline

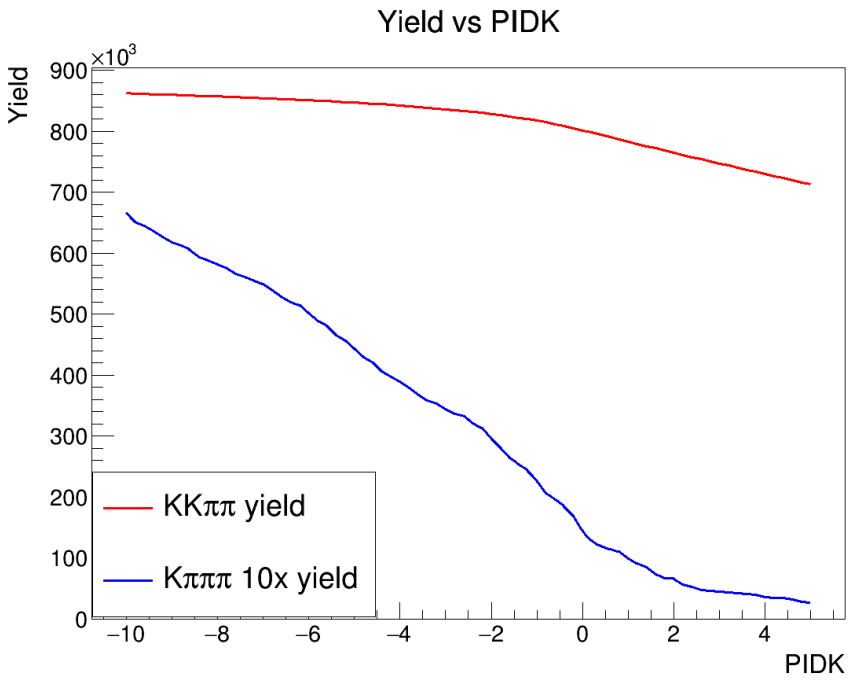
1. Backgrounds
   - Mis-ID from $D \to K\pi\pi\pi$
   - Charmless backgrounds
2. Global mass fit
3. Toy studies
   - Standard fits with 4 and 8 bins
   - Biases in CP observables
   - Systematics from c_i, s_i
4. Summary and future work

Mis-ID from $D \to K\pi\pi\pi$

- Mis-ID of D daughter $\pi \to K$
- Peaks a much higher D mass
- Much higher branching ratio
- Similar background from $D \to \pi\pi\pi\pi$ is negligible



(a) D invariant mass for $KK\pi\pi$ and $K\pi\pi\pi$

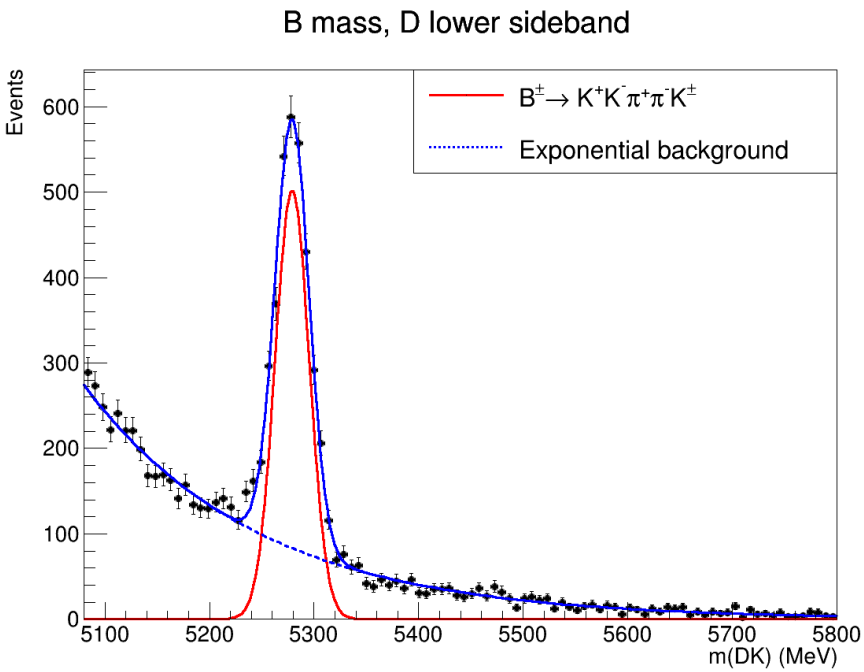


(b) Yield of $KK\pi\pi$ and $K\pi\pi\pi$ vs PIDK

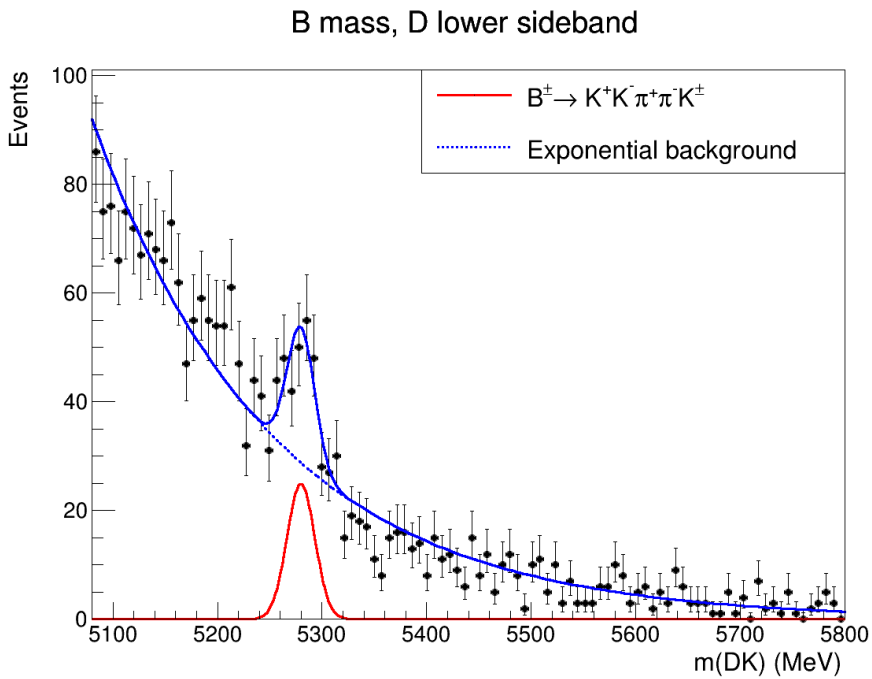
Charmless backgrounds

- Background from $B^{\pm} \to KK\pi\pi h^{\pm}$
- Flight significance (FS) cut at 2
- Look in the lower D mass sideband $m(D) = [1770\,\text{MeV}, 1820\,\text{MeV}]$
- Upper sideband contaminated with $K\pi\pi\pi$
- Train a separate BDT without χ^2_{DTF} to preserve D sidebands
- Overlap between samples without FS cut: 0.0%
- Overlap between samples with FS cut: 0.0%

Total charmless background yield



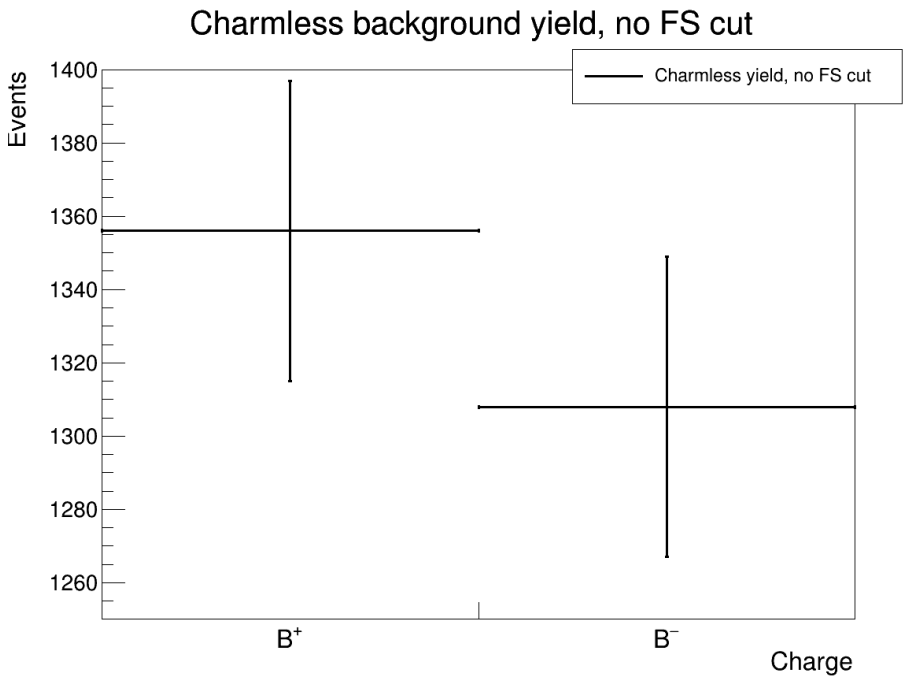
(a) Without flight significance cut



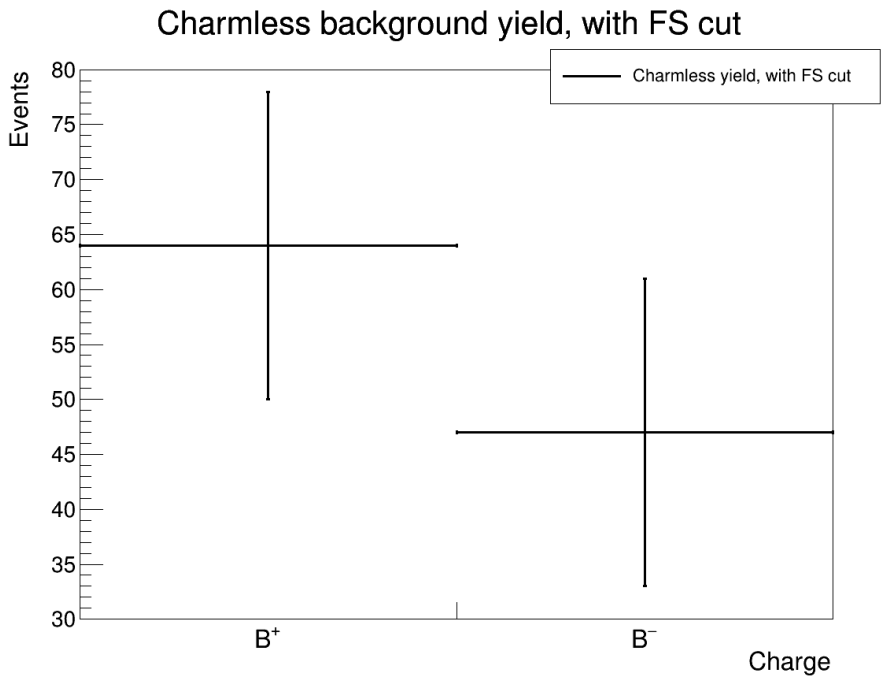
(b) With flight significance cut

Figure 2: Charmless background in the D sideband

Charmless backgrounds by charge



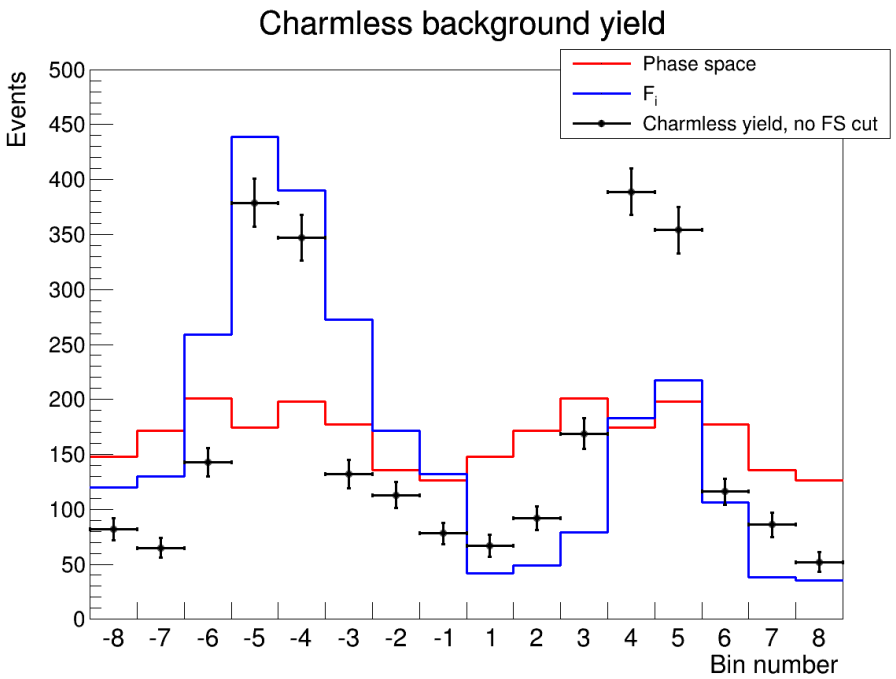
(a) Without flight significance cut



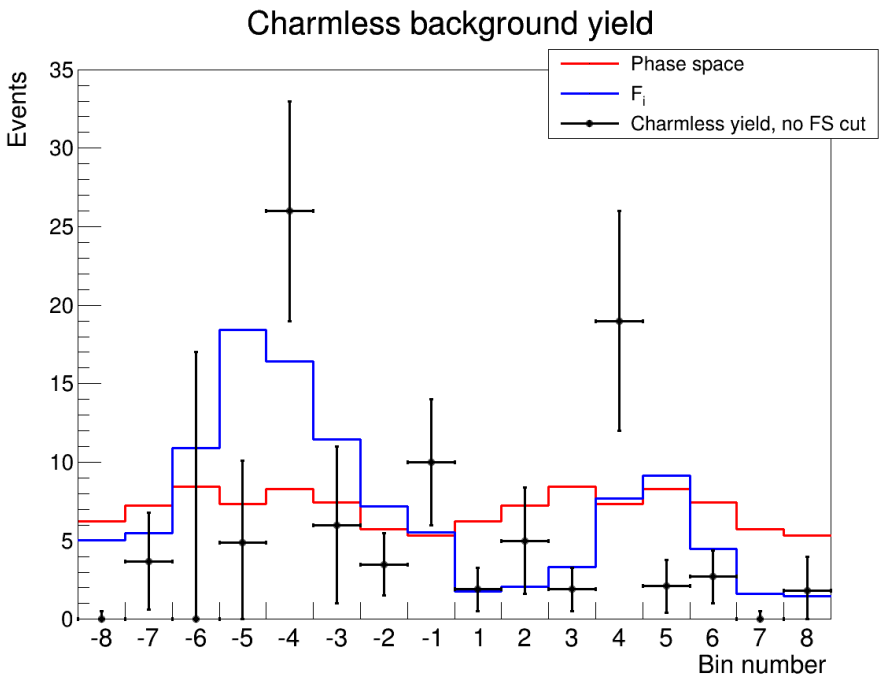
(b) With flight significance cut

Figure 3: Charmless background split by charge

Charmless backgrounds by bins



(a) Without flight significance cut



(b) With flight significance cut

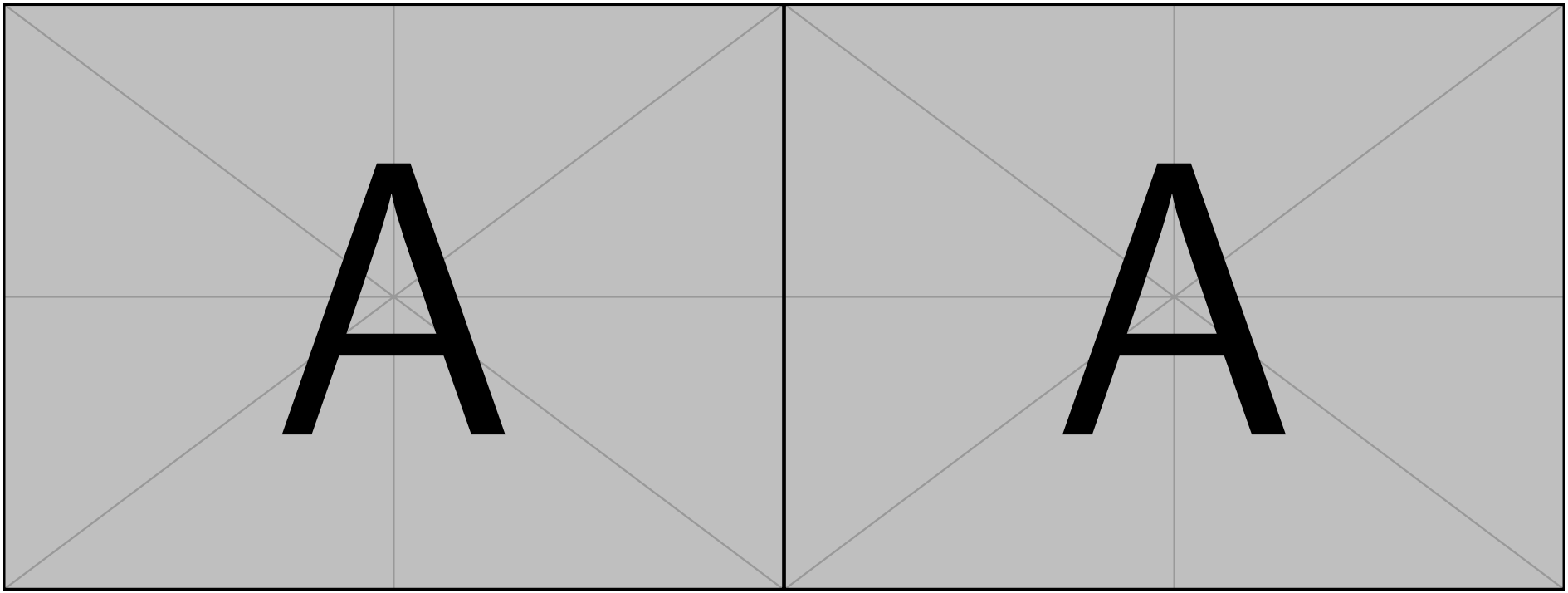
Figure 4: Charmless background split by bins

BDT cut optimization

- Minimize statistical γ error

- Procedure:
  1. Perform global fit to fix signal and background yields and PDF shapes
  2. Generate 1000 toy datasets using the global fit parameters
  3. Fit for γ
  4. Extract expected γ precision from γ distribution of toy datasets

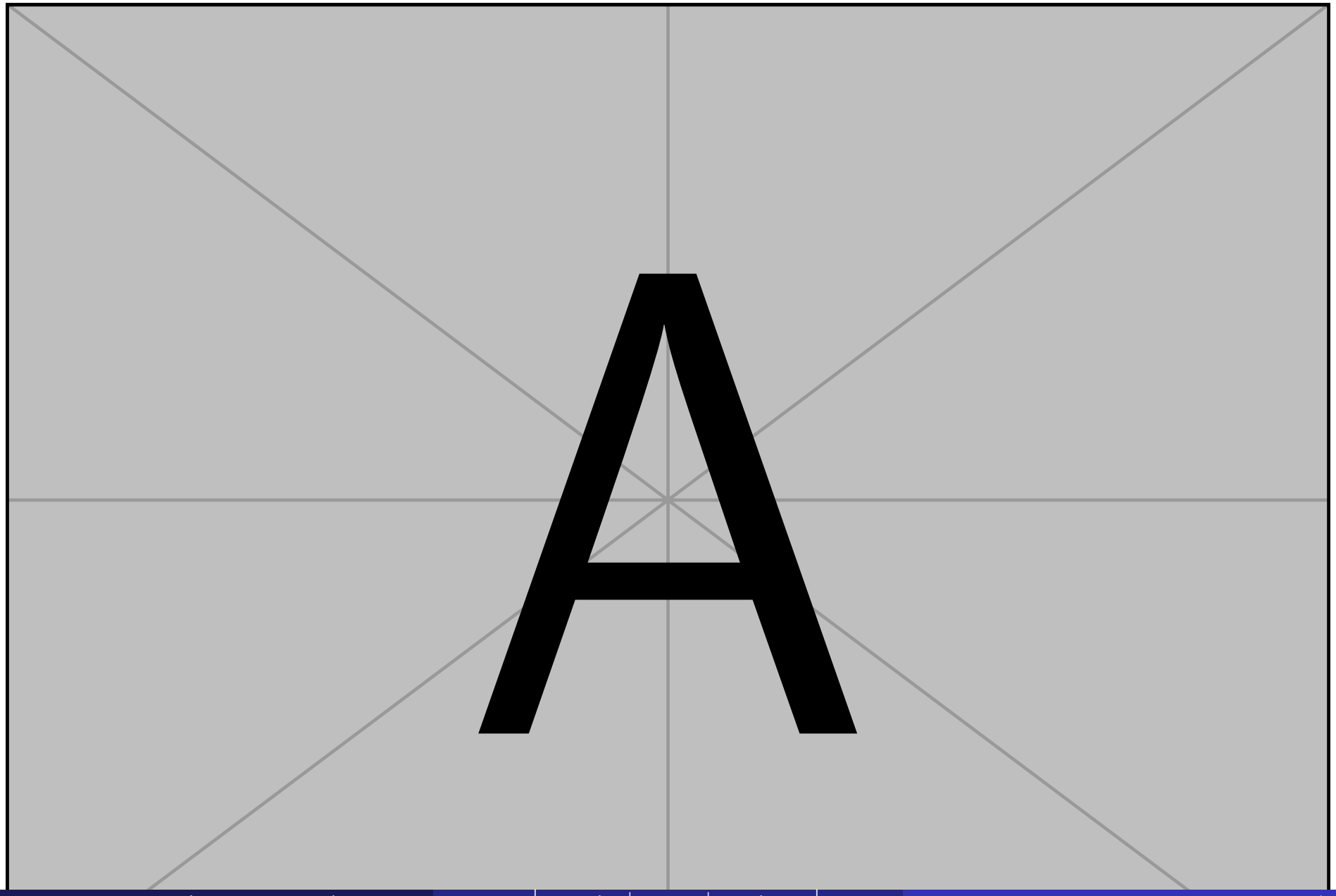
BDT cut optimization



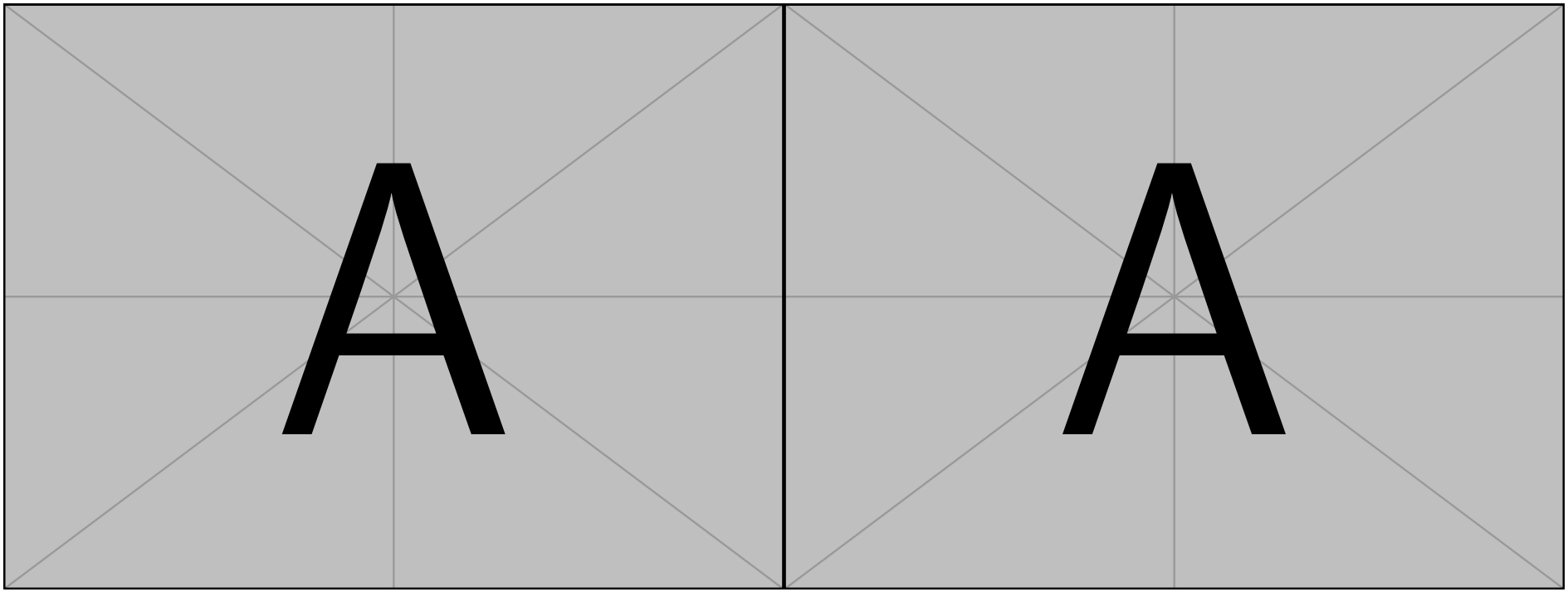
(a) γ precision vs BDT cut for 4 bins

(b) γ precision vs BDT cut for 8 bins

Global mass fit



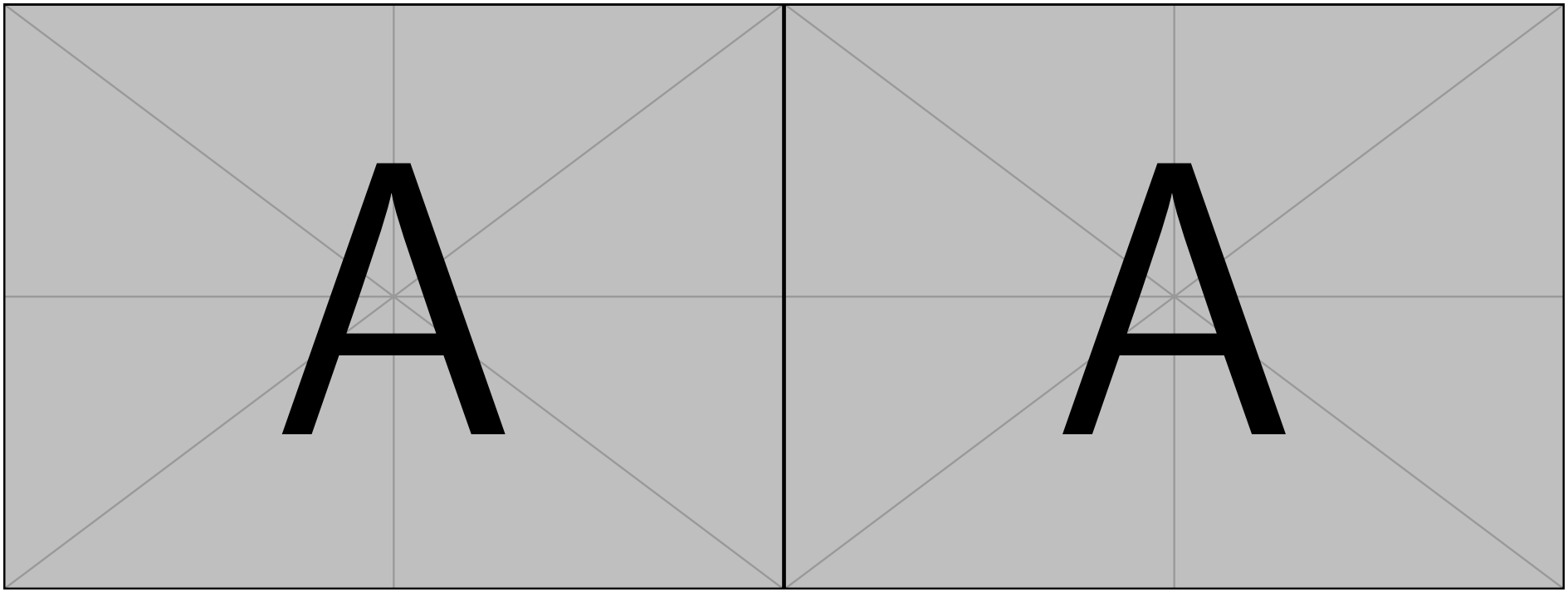
Standard toy studies with 4 and 8 bins



(a) 4 bins **(b)** 8 bins

Figure 7: γ precision in toy studies

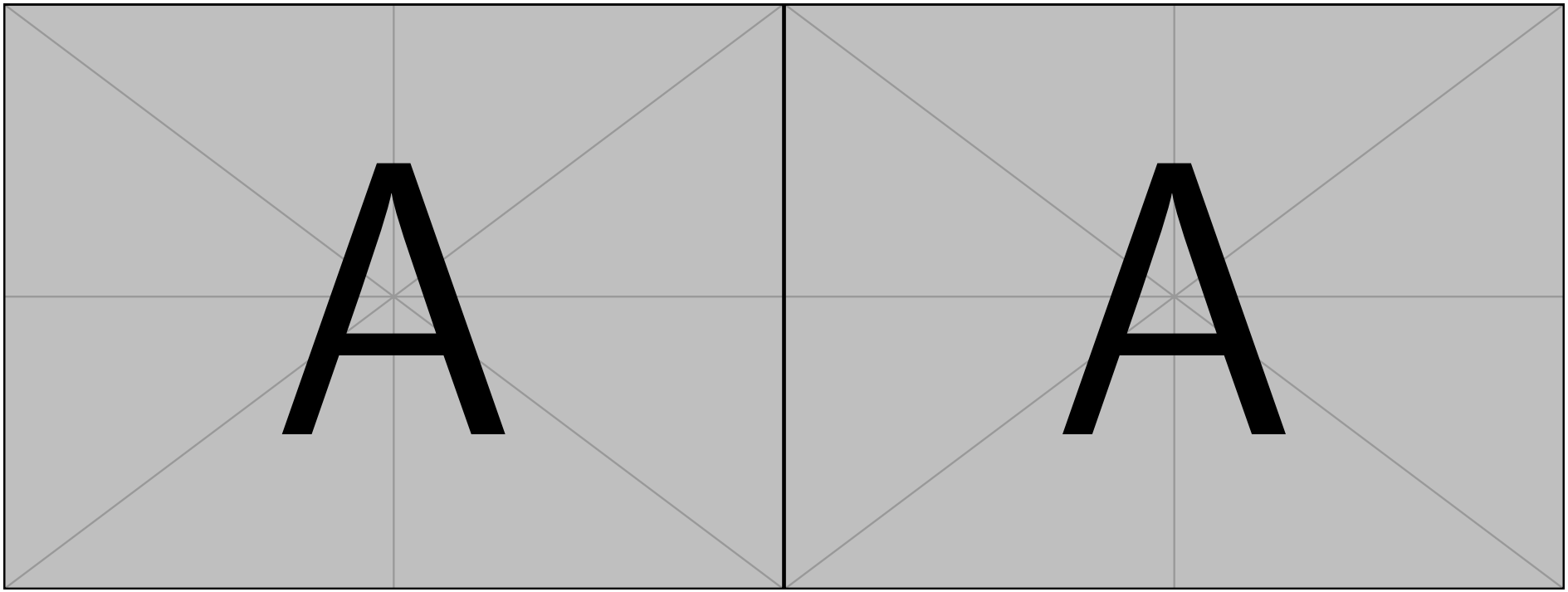
Biases in CP observables



(a) 4 bins **(b)** 8 bins

Figure 8: CP observable that has bias

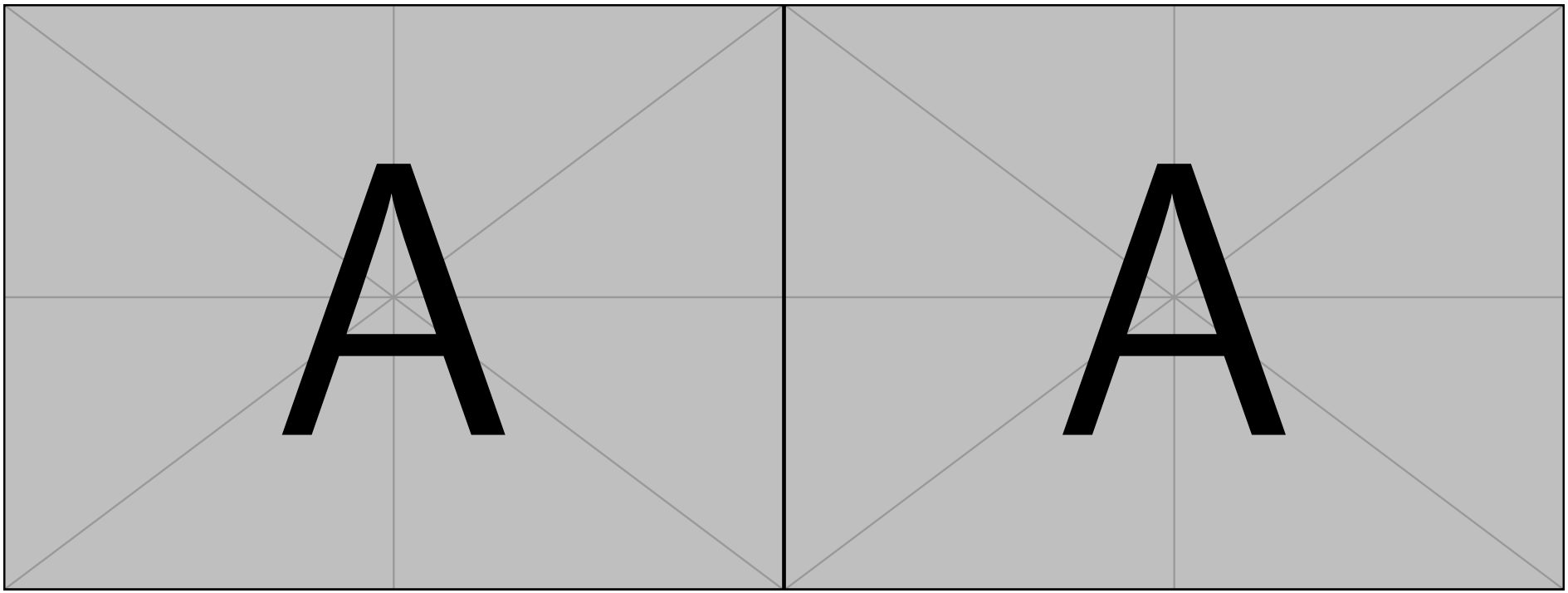
Biases in CP observables



(a) 4 bins **(b)** 8 bins

Figure 9: CP observable bias with increased statistics

Systematics from c_i, s_i



(a) 4 bins **(b)** 8 bins

Figure 10: Systematic uncertainty from c_i and s_i with extrapolated BESIII statistics

Summary and future work

- Summary:
  1. Global mass fit looks promising
  2. $D \to K\pi\pi\pi$ and charmless backgrounds under control
  3. Toy studies show no suspicious behaviour
  4. Expected c_i and s_i systematics are not too large
- Next steps:
  1. Study semileptonic backgrounds in RapidSim
  2. Recalculate PID efficiencies with PIDCalib
  3. Refit MC signal shapes
  4. Rerun everything with Run 1 (finally!)