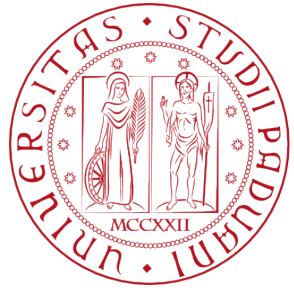
Search for charmless B decay in Belle II experiment

Student: Daniele Dal Santo

Dipartimento di Fisica e Astronomia "Galileo Galilei"
Corso di Laurea in Physics
10th September 2020



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The skimming

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What we expect is that the efficiency of the skimming defined as

$$\frac{\#\ \textit{signal events passing the skimming}}{\#\ \textit{signal events}} \approx 100\%, \qquad (1)$$

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The efficiency for the channel $B_0 \to \phi(KK)K_S$ has been recently checked and is $\approx 50\%$.

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- $0.92 < M_{\eta'} < 1\,GeV/c^2$
- $0.5 < M_\eta < 0.57\,GeV/c^2$
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If so, then the skimming procedure works well since it has a mild effect on the signal, while still reducing the background.

KS test

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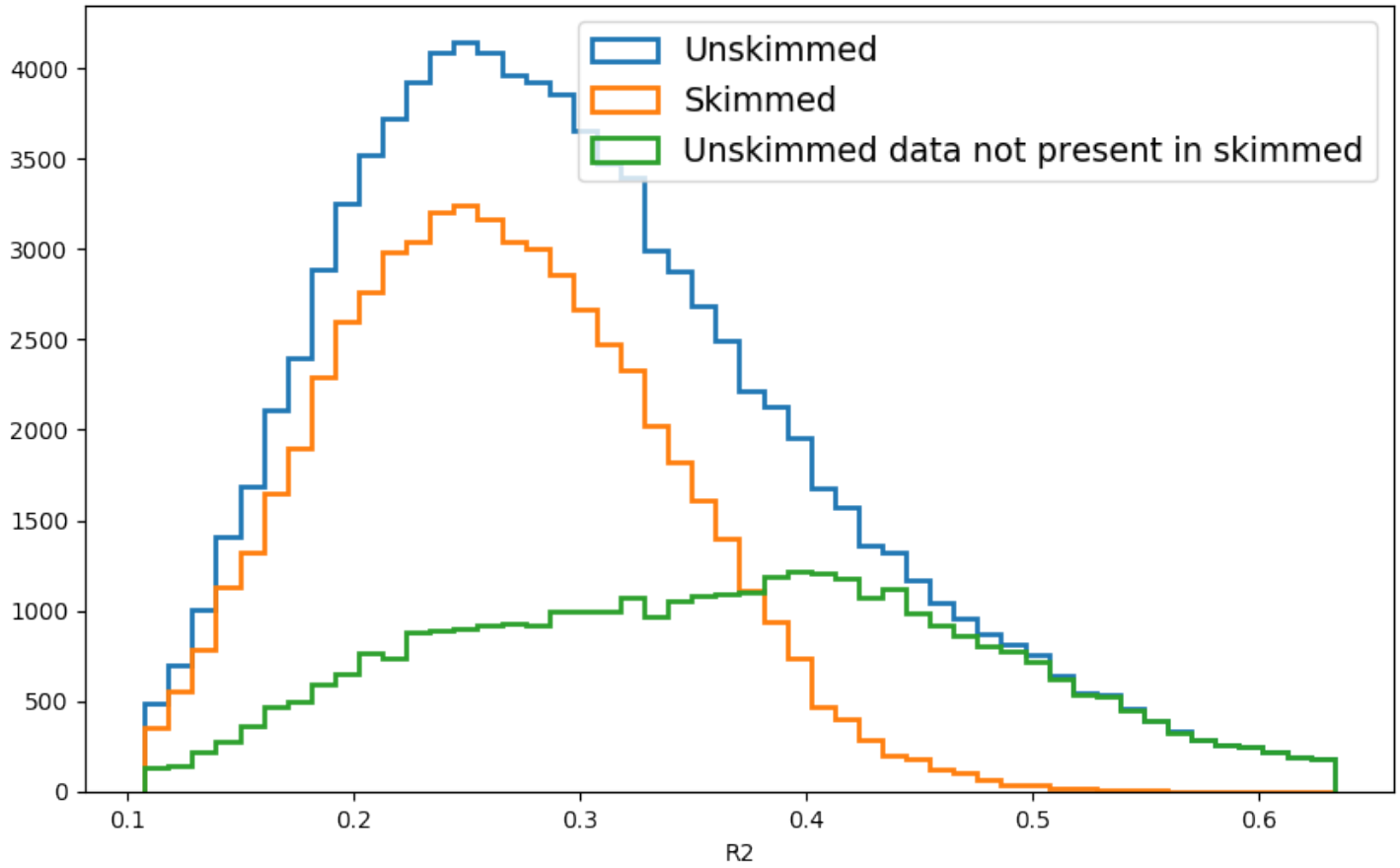
The variables at disposal are $\gtrsim 300$ so a KS test was employed to select variables for which the shape of the distribution changed due to skimming.

Background related variables

Between the variables highlighted by the KS statistics, many are correlated ones used to distinguish signal and background.



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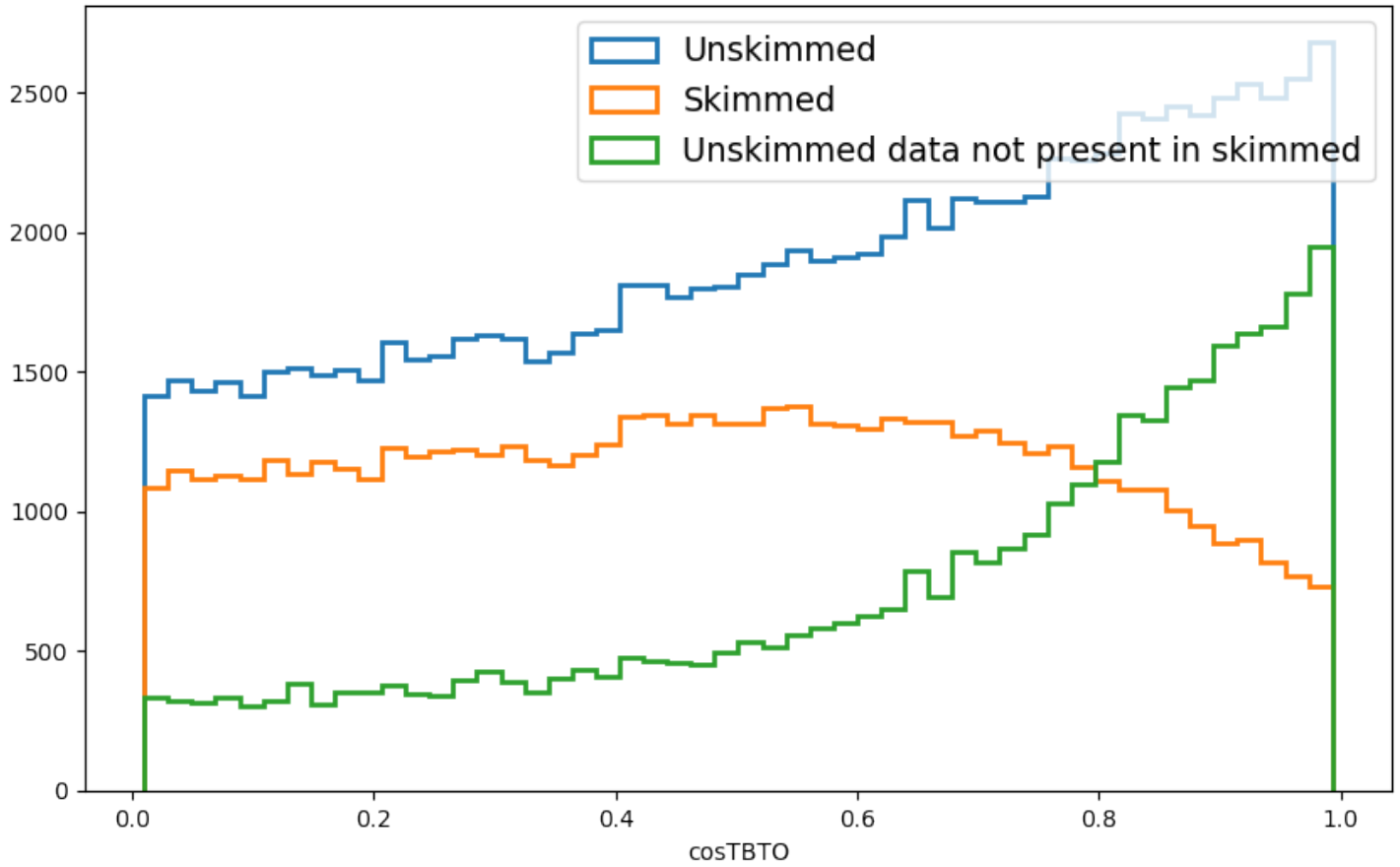
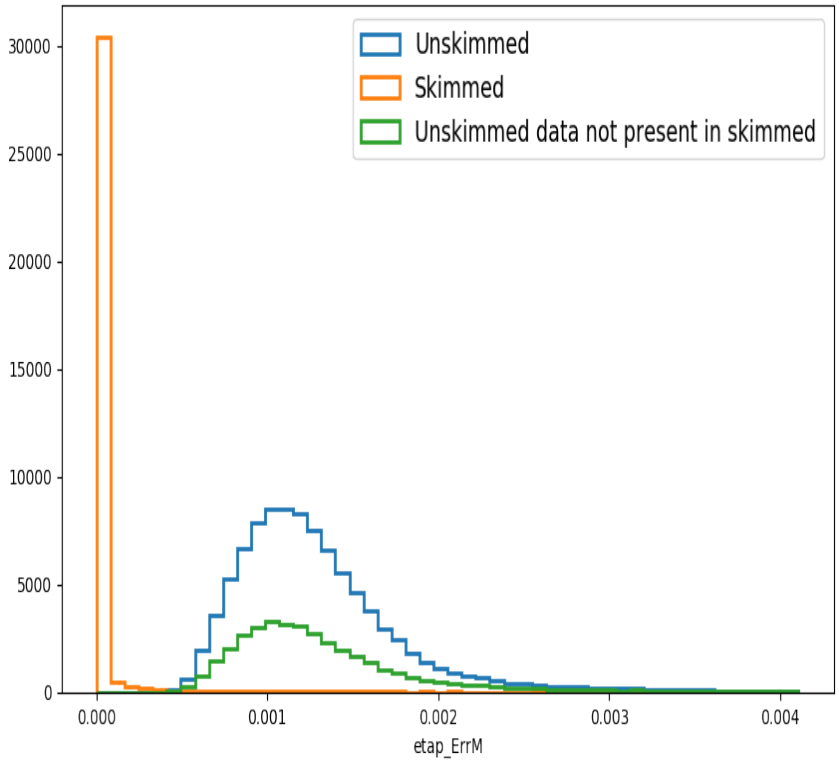
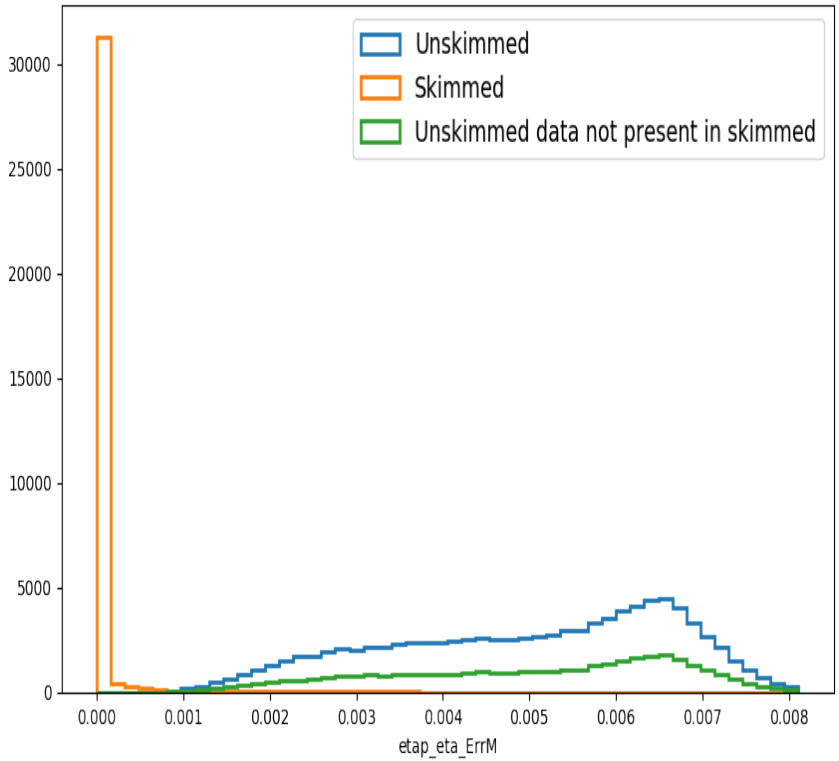


Mass errors

A first relevant observation coming from this qualitative comparison is the fact that errors on masses are suppressed after skimming.





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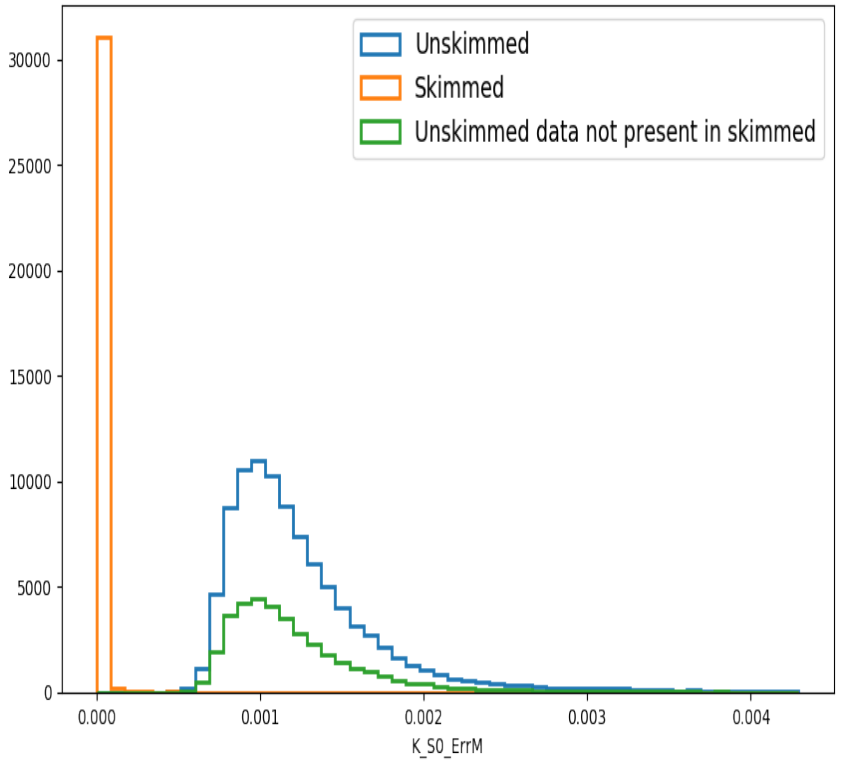

Global efficiency

As a first estimate of the selection efficiency defined in Eq.1, one can compute the ratio between the number of events in the data frame before and after the skim, which gives:

$$\epsilon_1 = \frac{49402}{79267} = 62.3^{+0.3}_{-0.4}\ \%. \tag{2}$$

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$\rightarrow$ Eq.3 reveals that the selection contained in the skimming affects the data frame in a stronger way than expected.

Background reduction

These same ratios were computed using 2 files (one skimmed, one not) containing $c\bar{c}$ background events. The results are:

$$\epsilon_1^{bkg} = \frac{9705}{74645} \sim 12\%, \tag{4}$$

$$\epsilon_2^{bkg} = \frac{438}{2588} \sim 17\%. \tag{5}$$

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$\rightarrow$ The skimming procedure is indeed able to cut a significant amount of background events.

Efficiency histogram

Then, I considered the variables E_γ, $M_{\eta'}$, M_η, M_{K_S} and $cos\theta_{p,\nu}$ of the skimmed and unskimmed data frames, after having applied the selections defined in the 2^{nd} slide.

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The regions between the quantile 0.05 and 0.95 of the unskimmed distributions were divided in 45 bins and the ratio

$$r_i = \frac{\#\ events\ in\ the\ i^{th}\ bin\ in\ the\ skimmed\ distribution}{\#\ events\ in\ the\ i^{th}\ bin\ in\ the\ unskimmed\ distribution} \quad (6)$$

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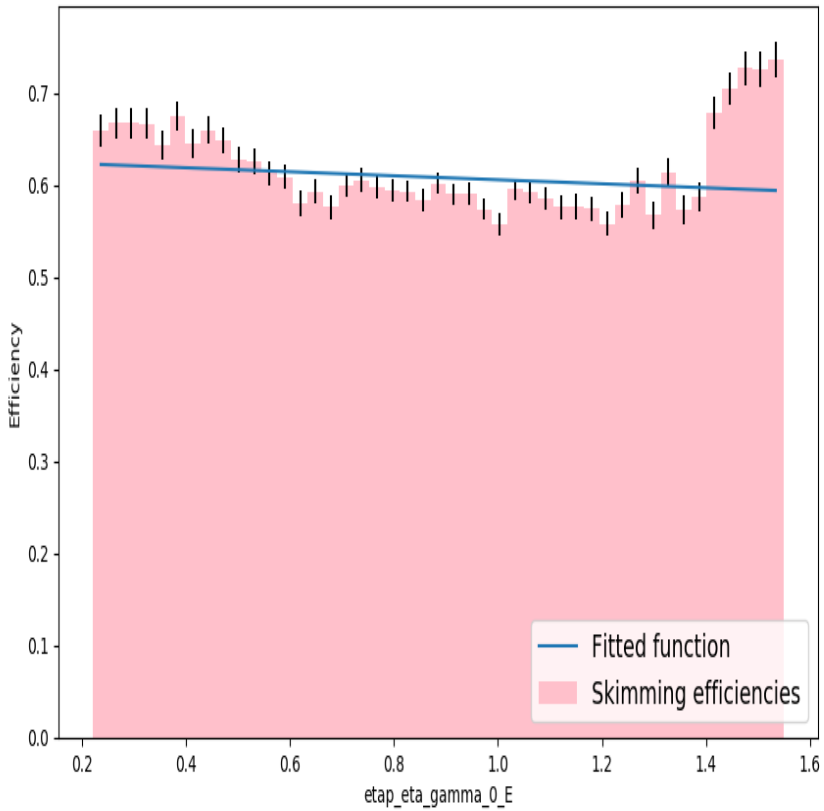
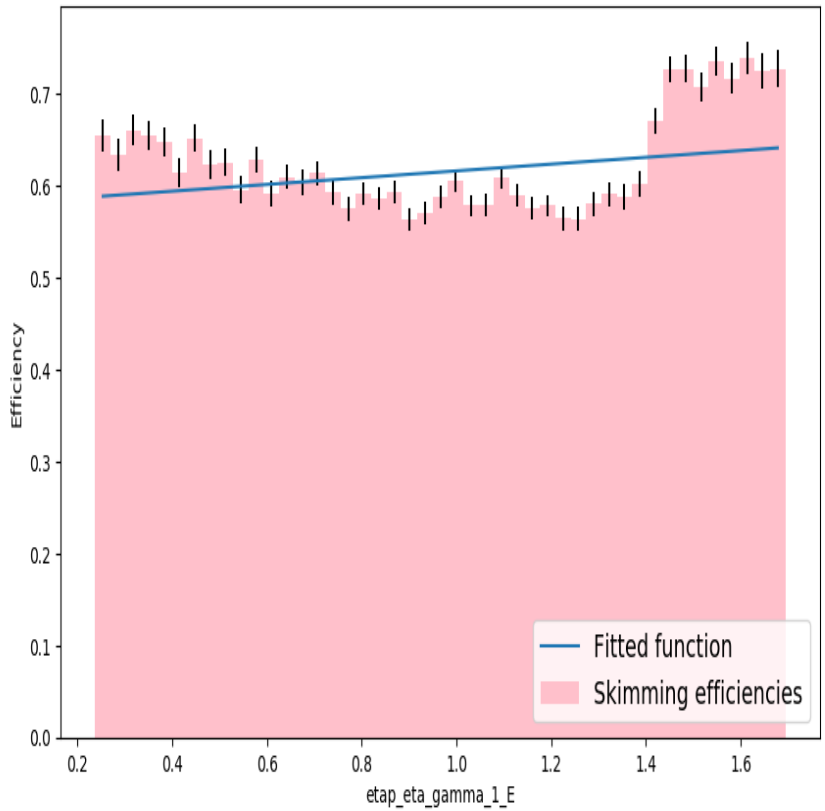
We expected $r_i \approx constant \approx 1$.

Efficiency histogram





Variable	Intercept	Slope
etap_eta_gamma_0_E	0.609 ± 0.006	-0.02 ± 0.02 GeV^{-1}
etap_eta_gamma_1_E	0.615 ± 0.007	0.04 ± 0.02 GeV^{-1}

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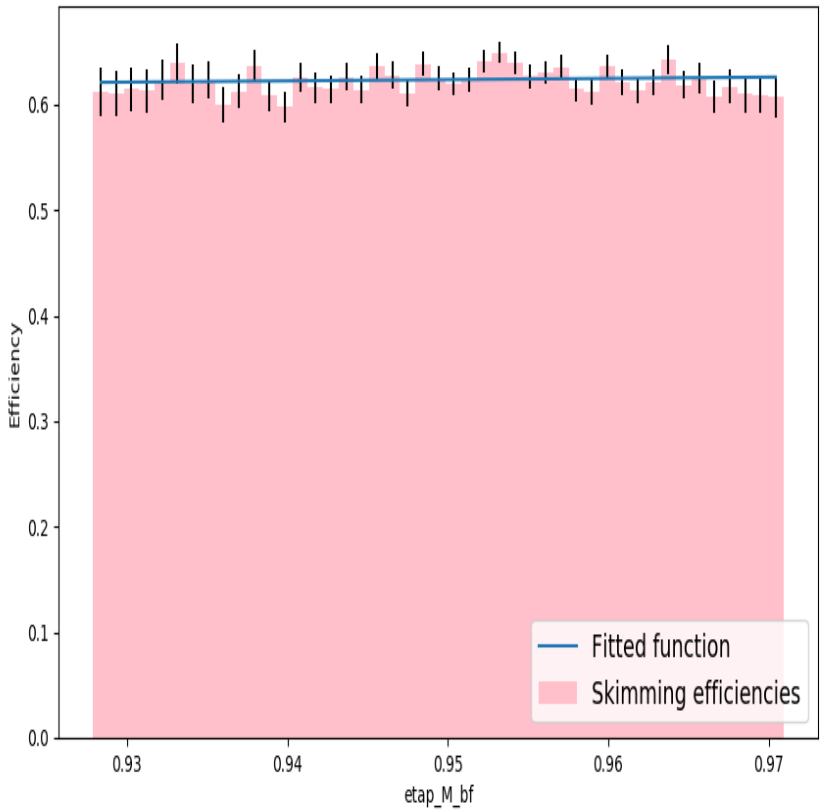

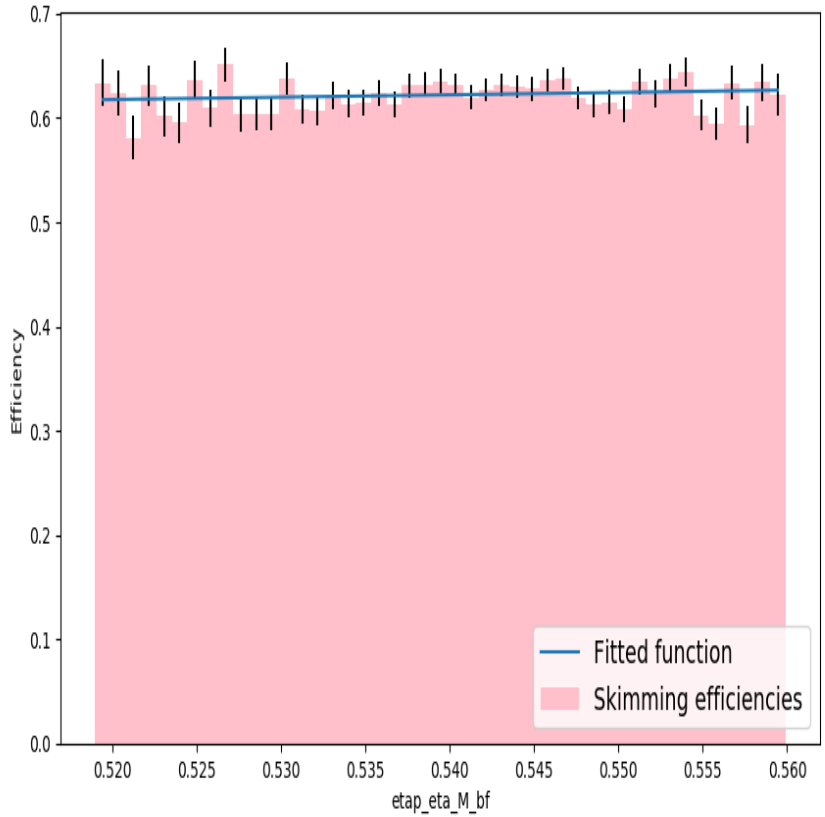

Variable	Intercept	Slope
etap_M_bf	0.624 ± 0.002	0.1 ± 0.2 GeV^{-1}
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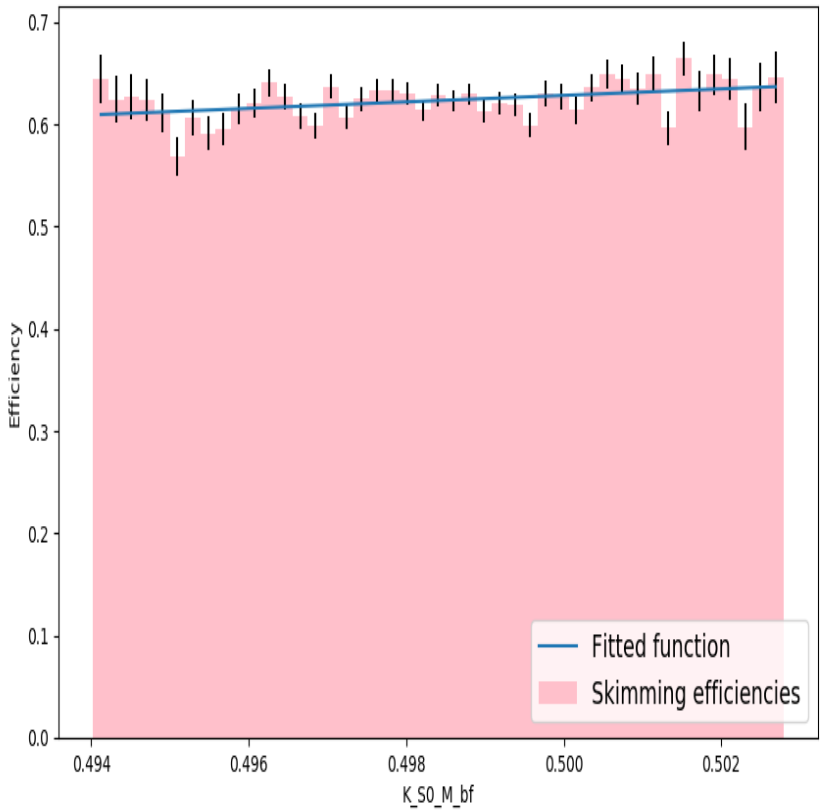
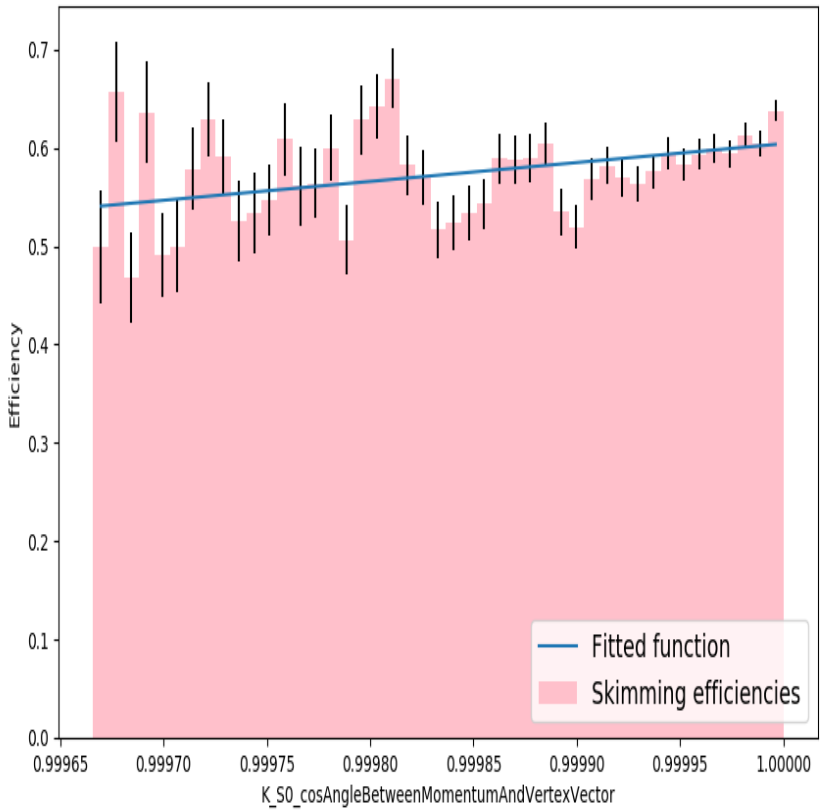
Efficiency histogram





Variable	Intercept	Slope
K_S0_M_bf	0.623 ± 0.002	3 ± 1 GeV^{-1}
$\cos\theta_{p,v}$	0.572 ± 0.007	190 ± 60

Next step

As it is evident the current skimming procedure determines a (too) strong rejection of signal events with respect to the current analysis procedures.

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$\rightarrow$ The next step of my work (already started) will be to deeply understand how the skimming procedure works and analyse which is the condition that determines the loss of nearly 40% of the signal.

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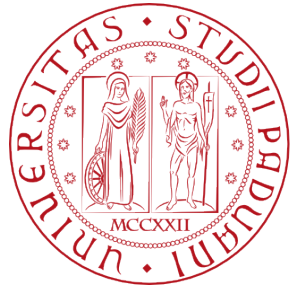

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