Charm background to strange quark production in e^+e^- collisions

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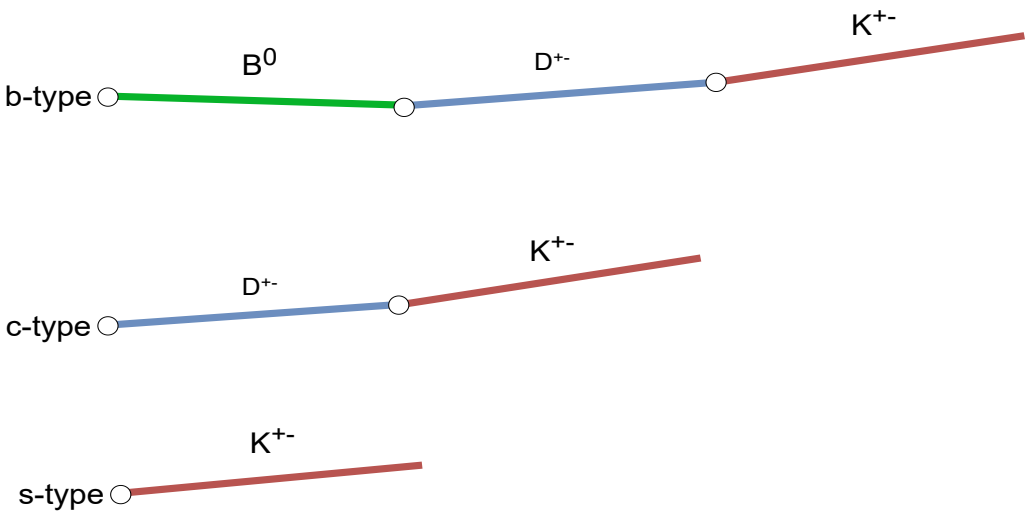
Introduction



Why $c\bar{c}$ is the background of $s\bar{s}$:

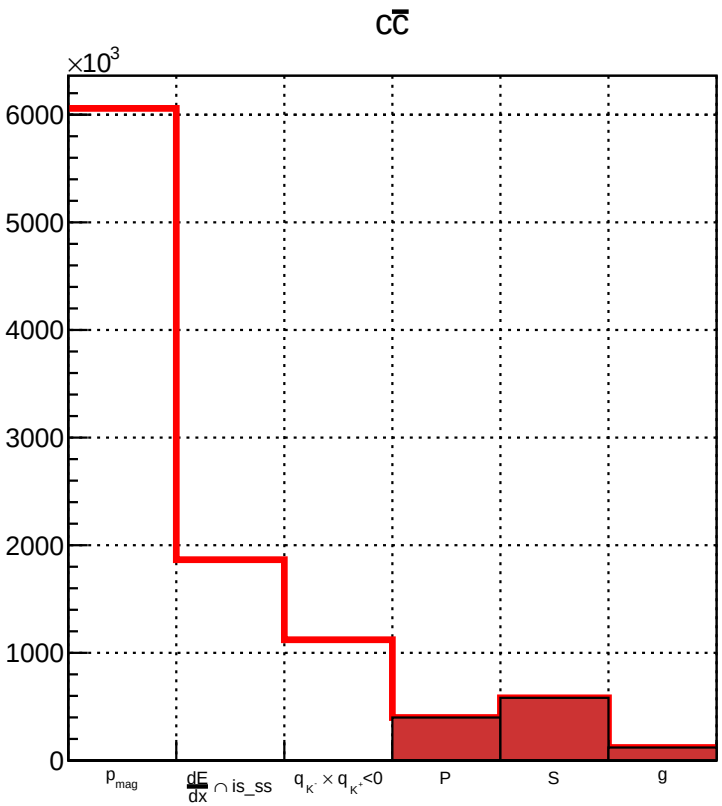
- Both have same final state
- They have similar cross section

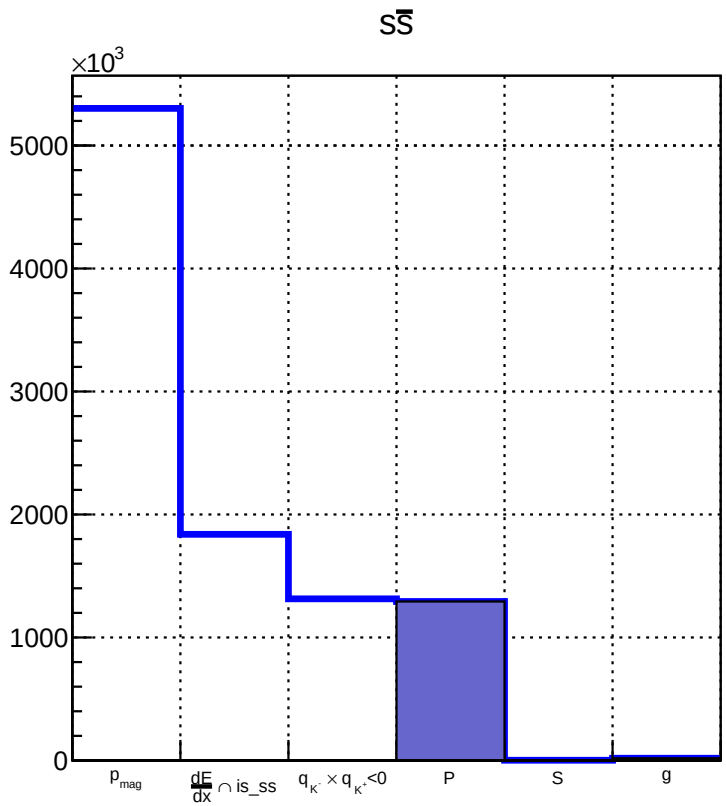
Initial analysis

Initial kaons should go through several cut stages:

- Left handed samples
- $p_{mag} > 15\ GeV$
- $\frac{dE}{dx}$ for reconstructed K closed to corresponding value from Bethe–Bloch formula
- Leading kaons are chosen(K^- and K^+ with the highest momentum)
- The magnitude of the leading K momentum bigger than for leading π(i.e. this event is not associated to $u\bar{u}$ or $d\bar{d}$)
- reconstructed K^+ and corresponding K^- have opposite charge signs

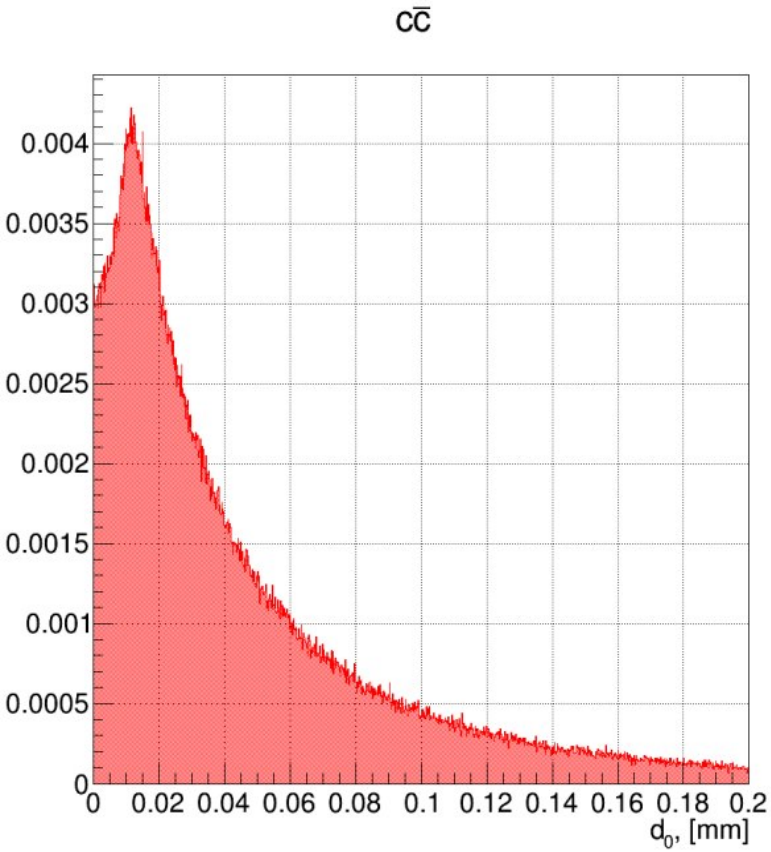
Cut stages

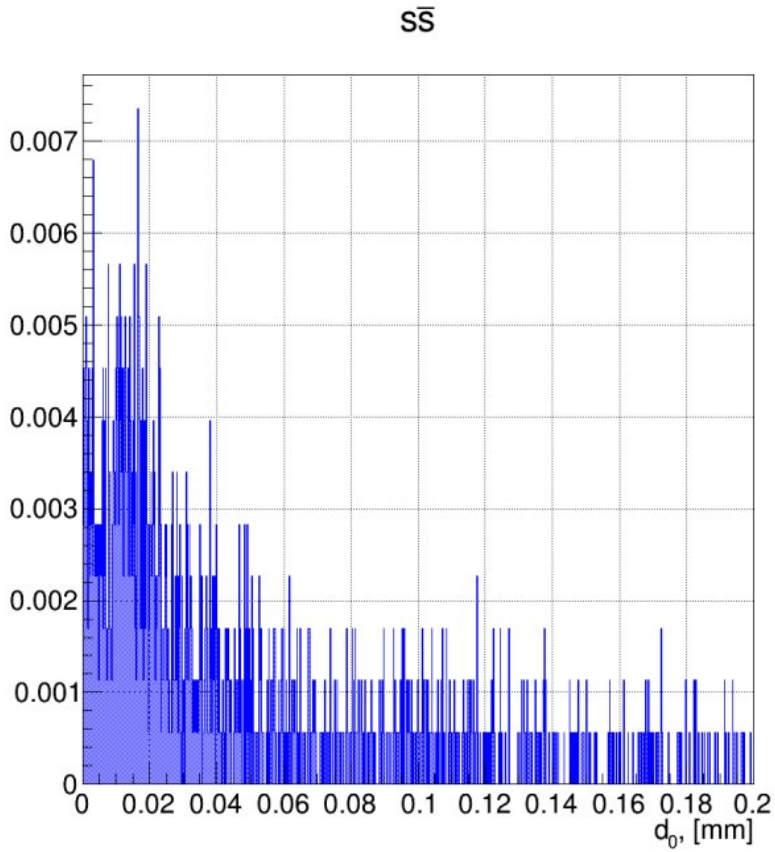




	p_{mag}	$\frac{dE}{dx} \cap is\_ss$	$q_{K-} \times q_{K+} < 0$	Only primary	Secondary	Garbage
$c\bar{c}$	6058908	1865436	1121648	399009	581843	120333
$s\bar{s}$	5302002	1838752	1314164	1292601	1768	18107

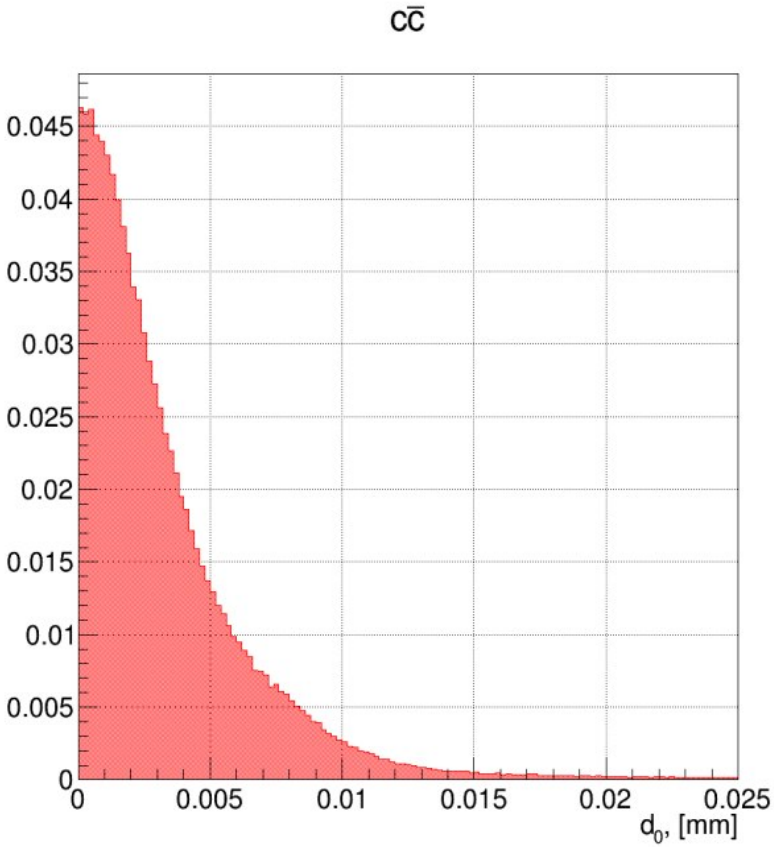
Events with secondary vertices

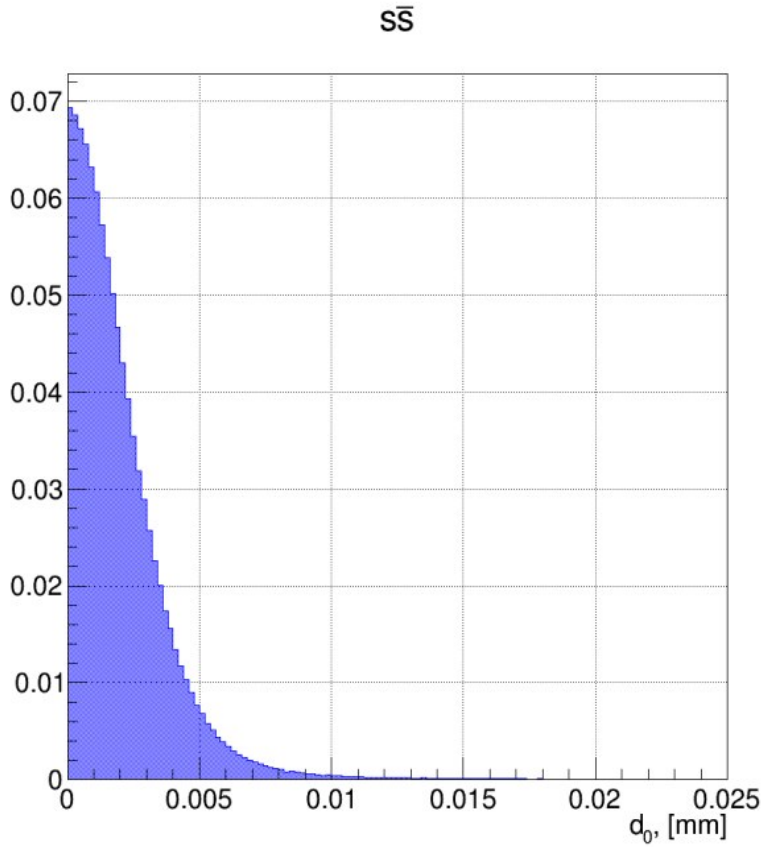




	$c\bar{c}$	$s\bar{s}$
Events	581843	1768
Percentage	99.7%	0.3%

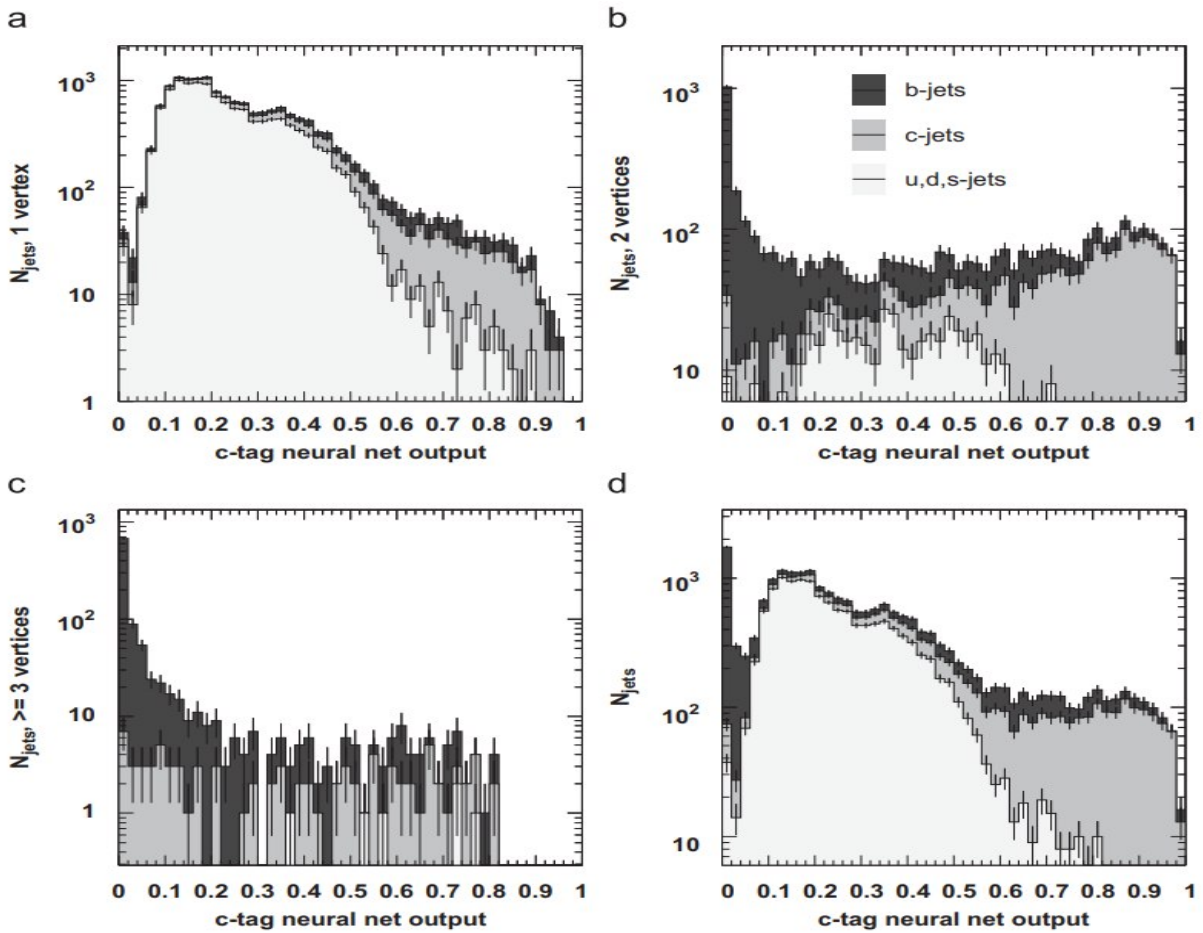
Events without secondary vertices





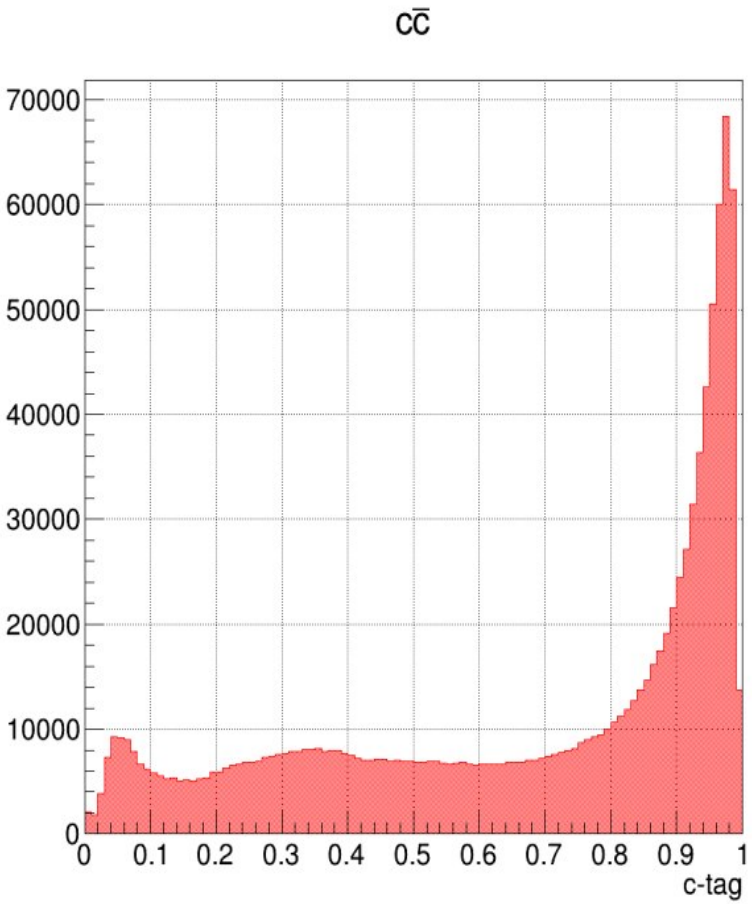
	$c\bar{c}$	$s\bar{s}$
Events	399009	1292601
Percentage	23.6%	76.4%

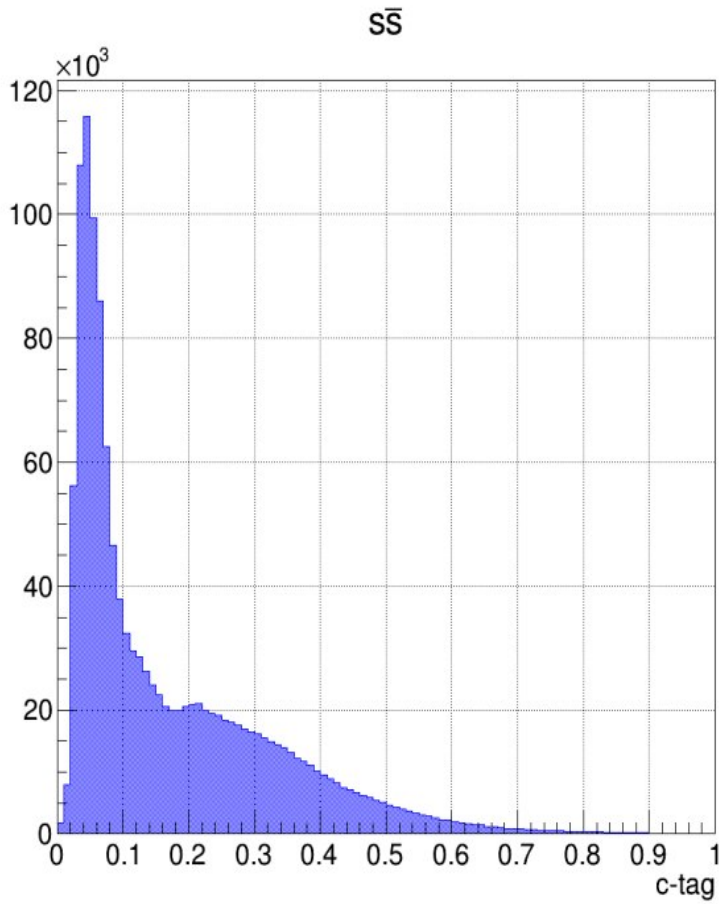
c-tag analysis



- The LCFIVertex package - https://doi.org/10.1016/j.nima.2009.08.059

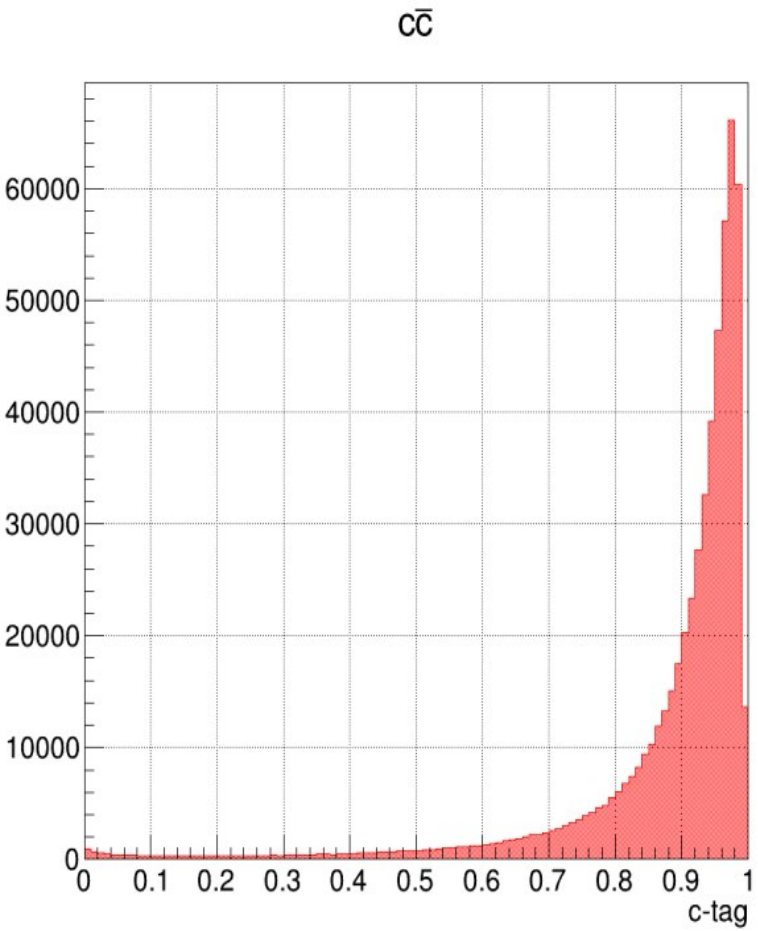
c-tag analysis

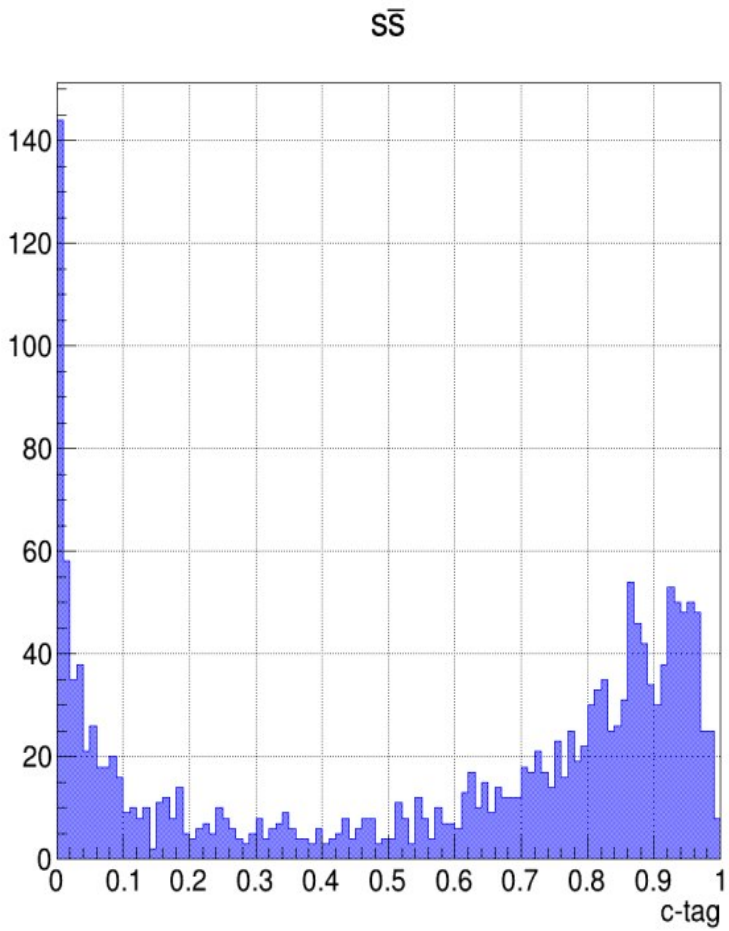




Total c-tag distribution(Different scale!)

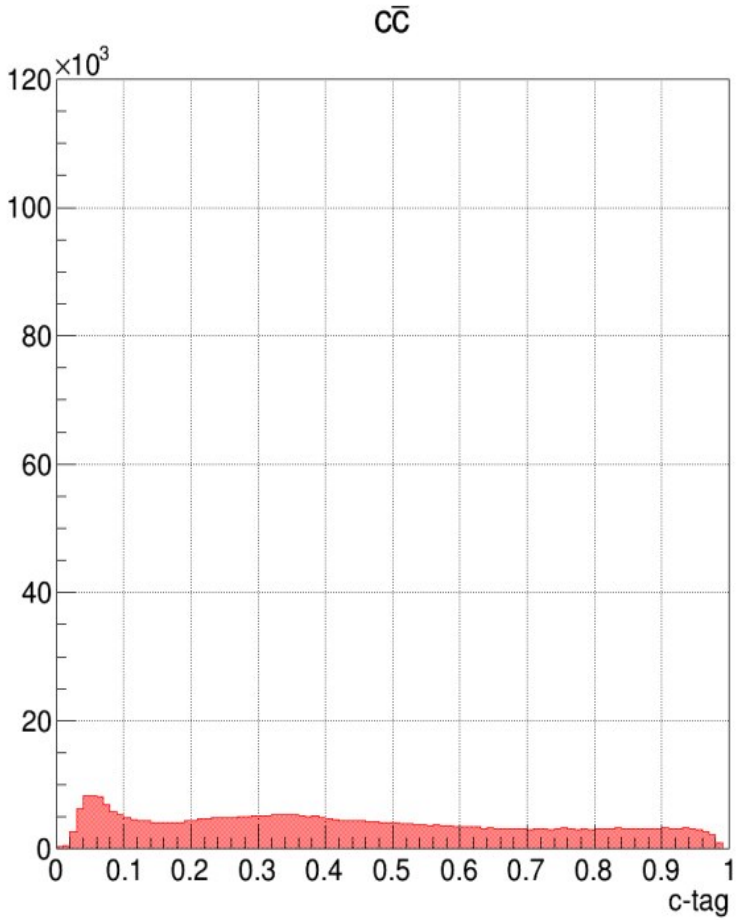
c-tag analysis

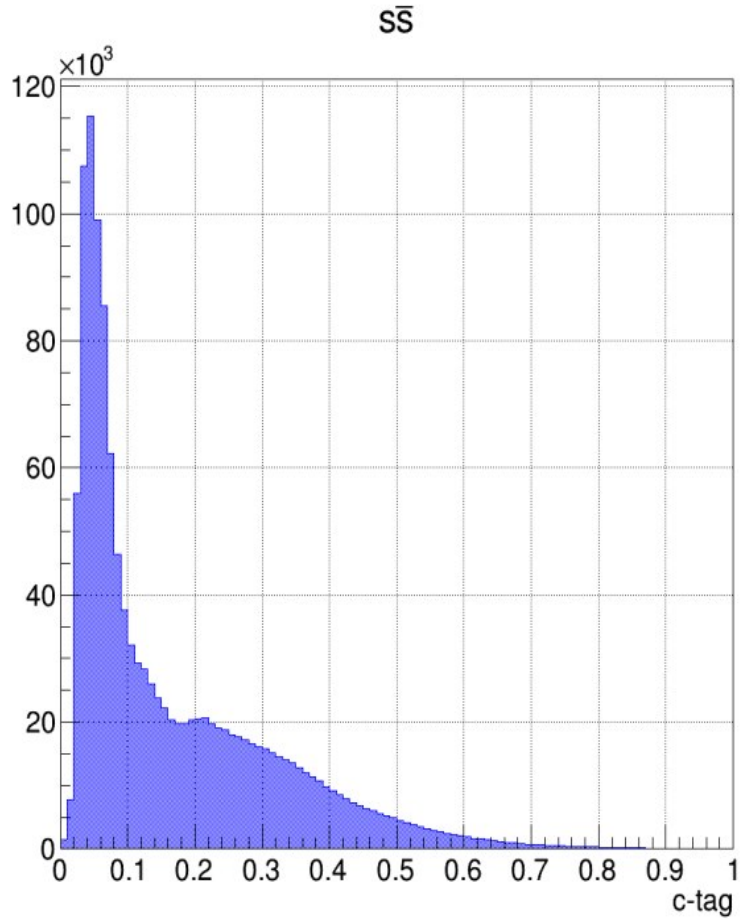




c-tag distribution for events with secondary vertices(Different scale!)

c-tag analysis





Total c-tag for events without secondary vertices

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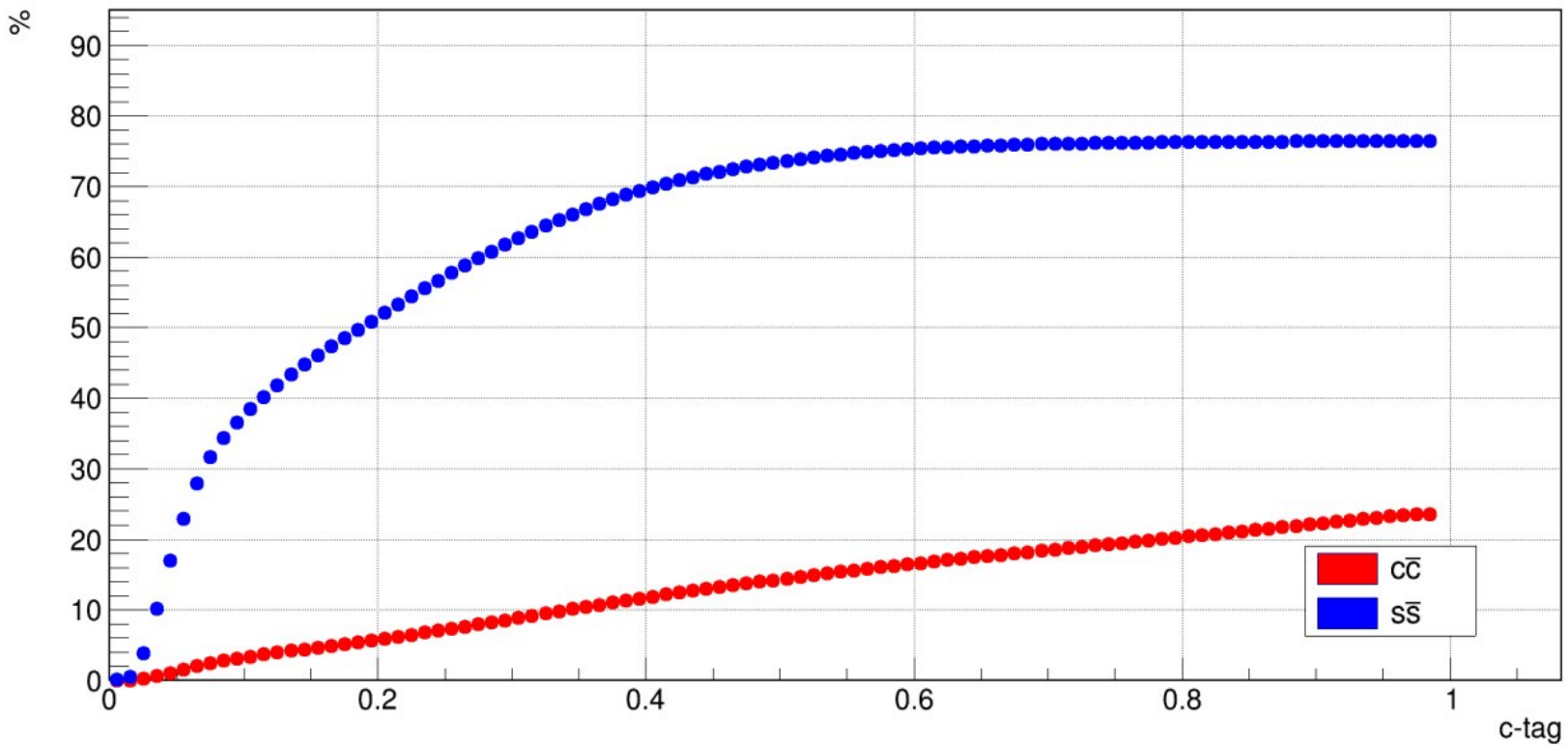
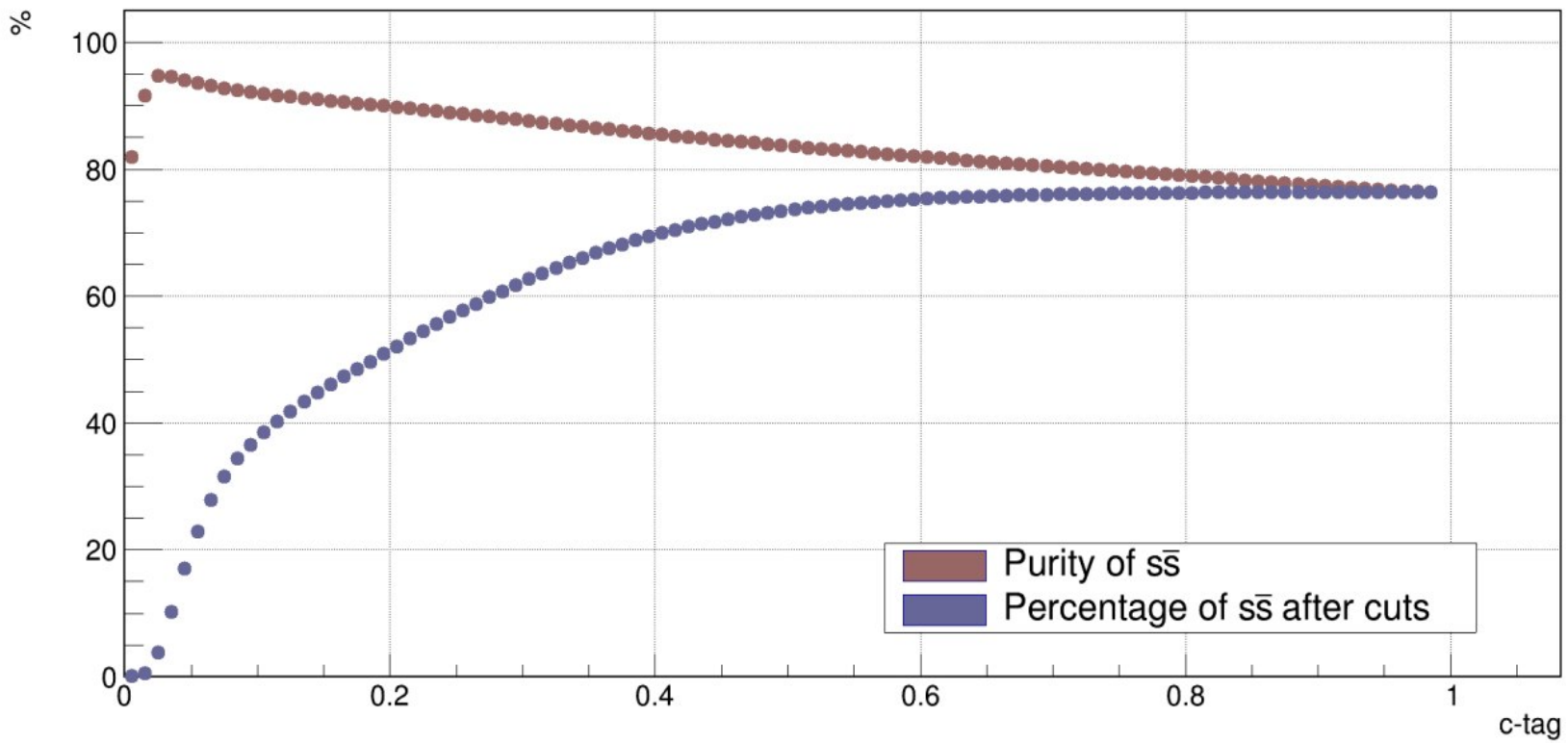


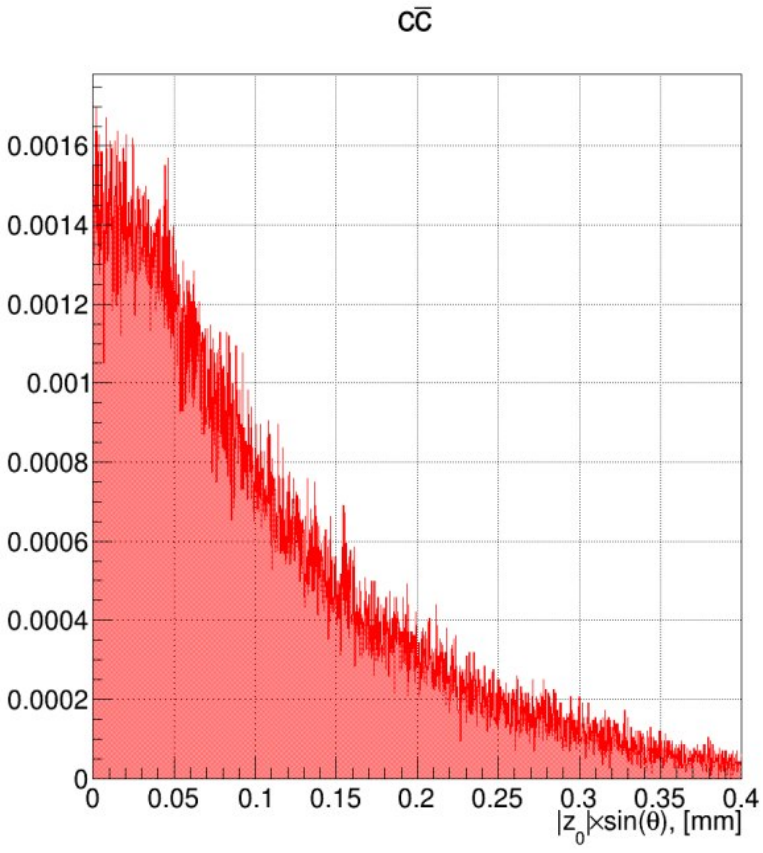
c-tag<0.6 does not have impact on the $s\bar{s}$ statistics, but it significantly decreases background statistics

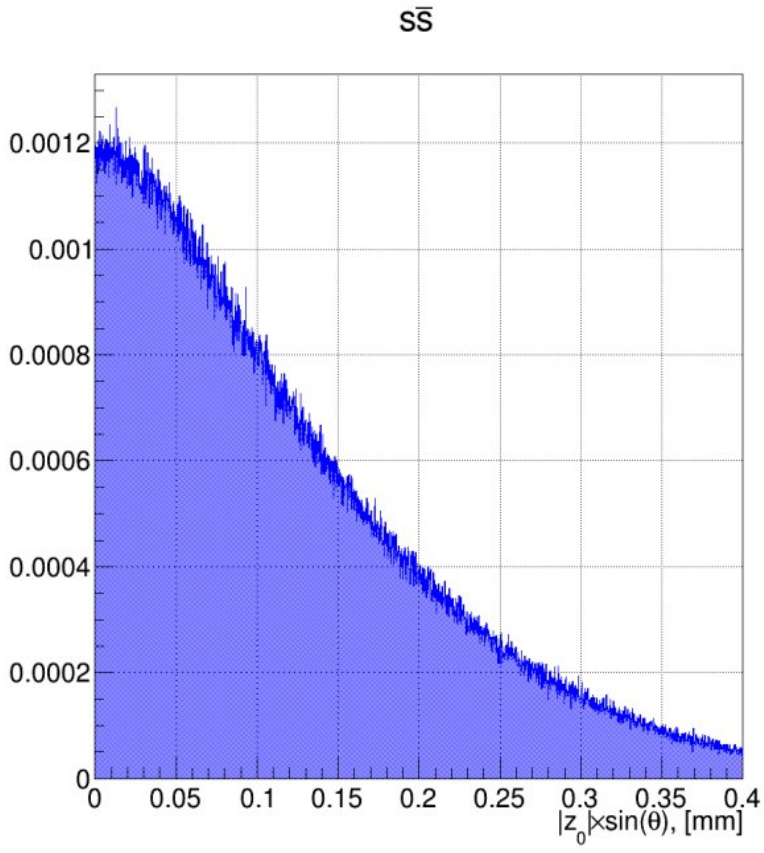
Optimal c-tag cut



When c-tag value decreases purity grows, but in the same time statistics for $s\bar{s}$ is lost, which is an intuitively expected result.

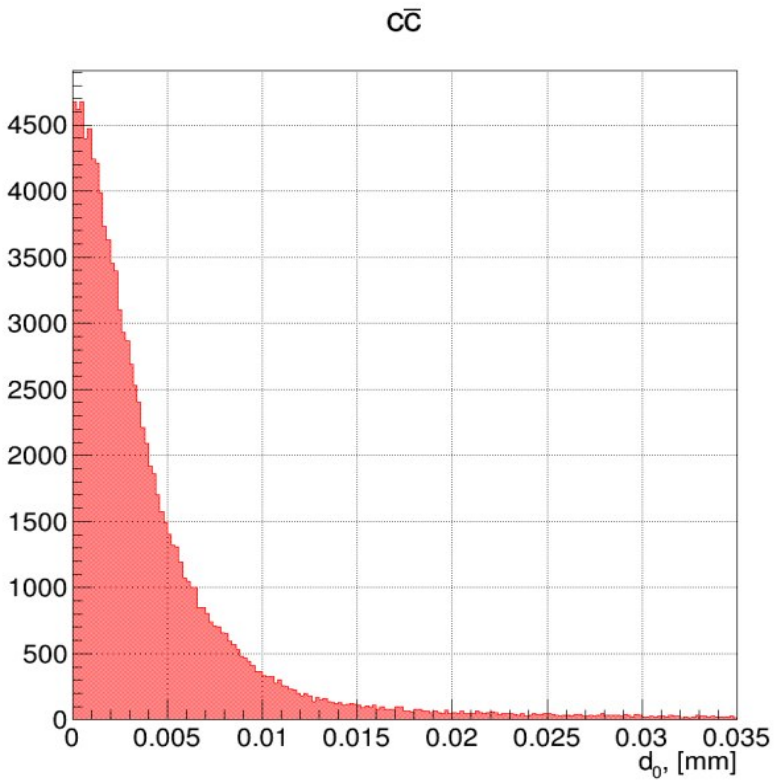
$|z_0| \times sin(\theta)$

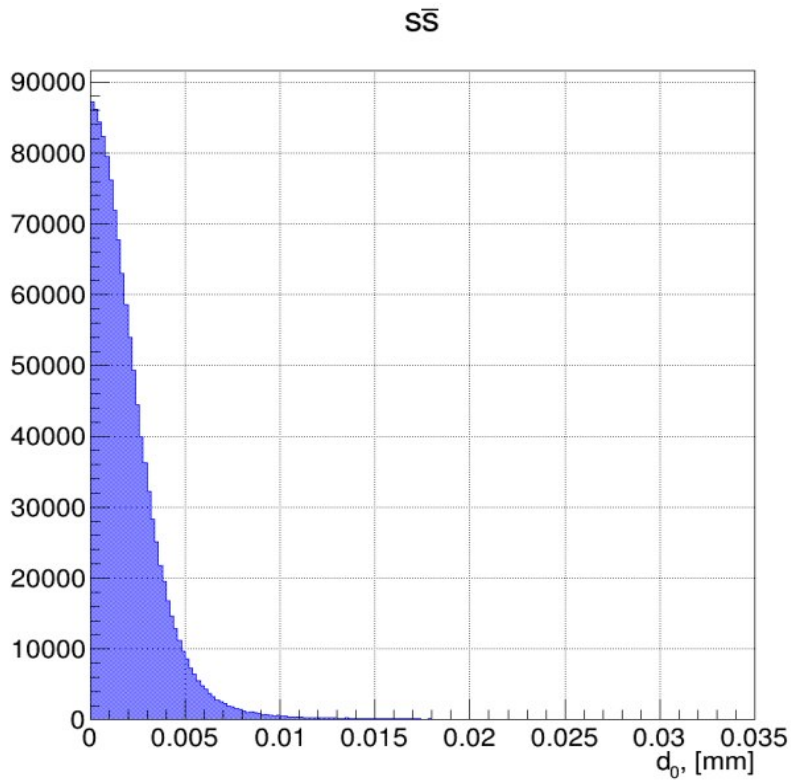




There is no significant difference between $c\bar{c}$ and $s\bar{s}$

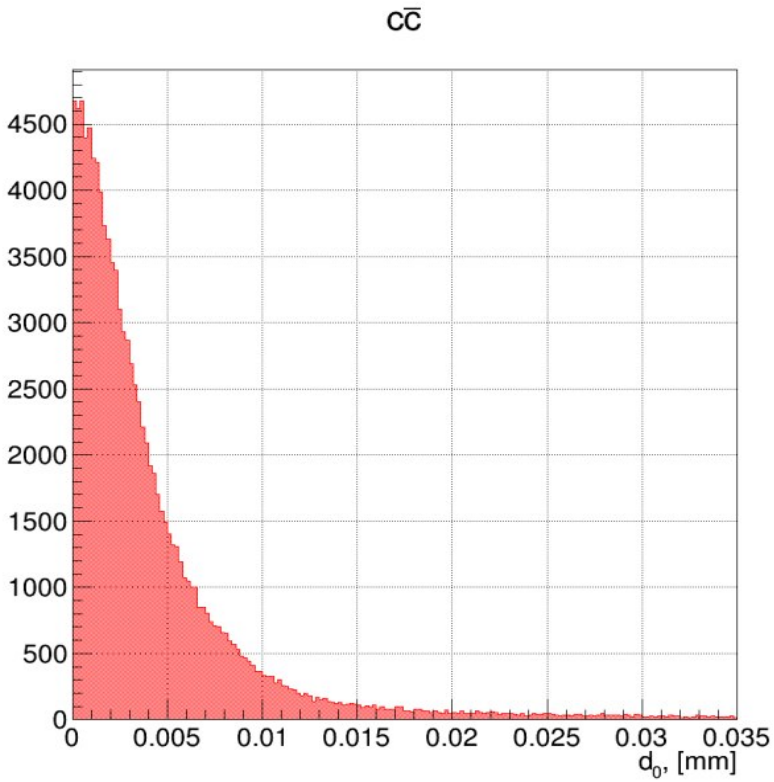
c-tag and d_0 cuts

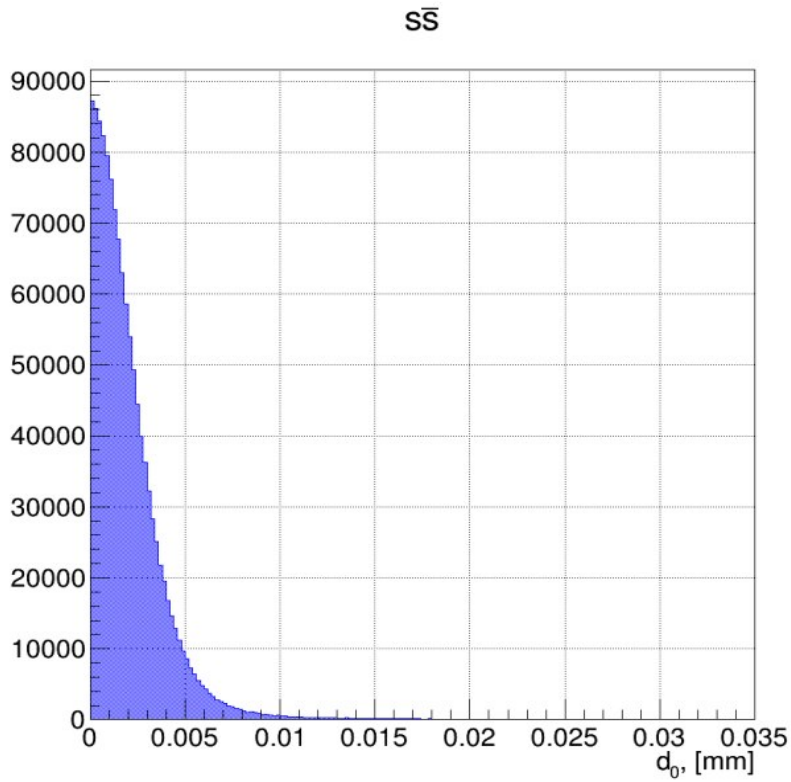




Approximately all $s\bar{s}$ events has $d_0 < 10\mu m$ unlike of $c\bar{c}$

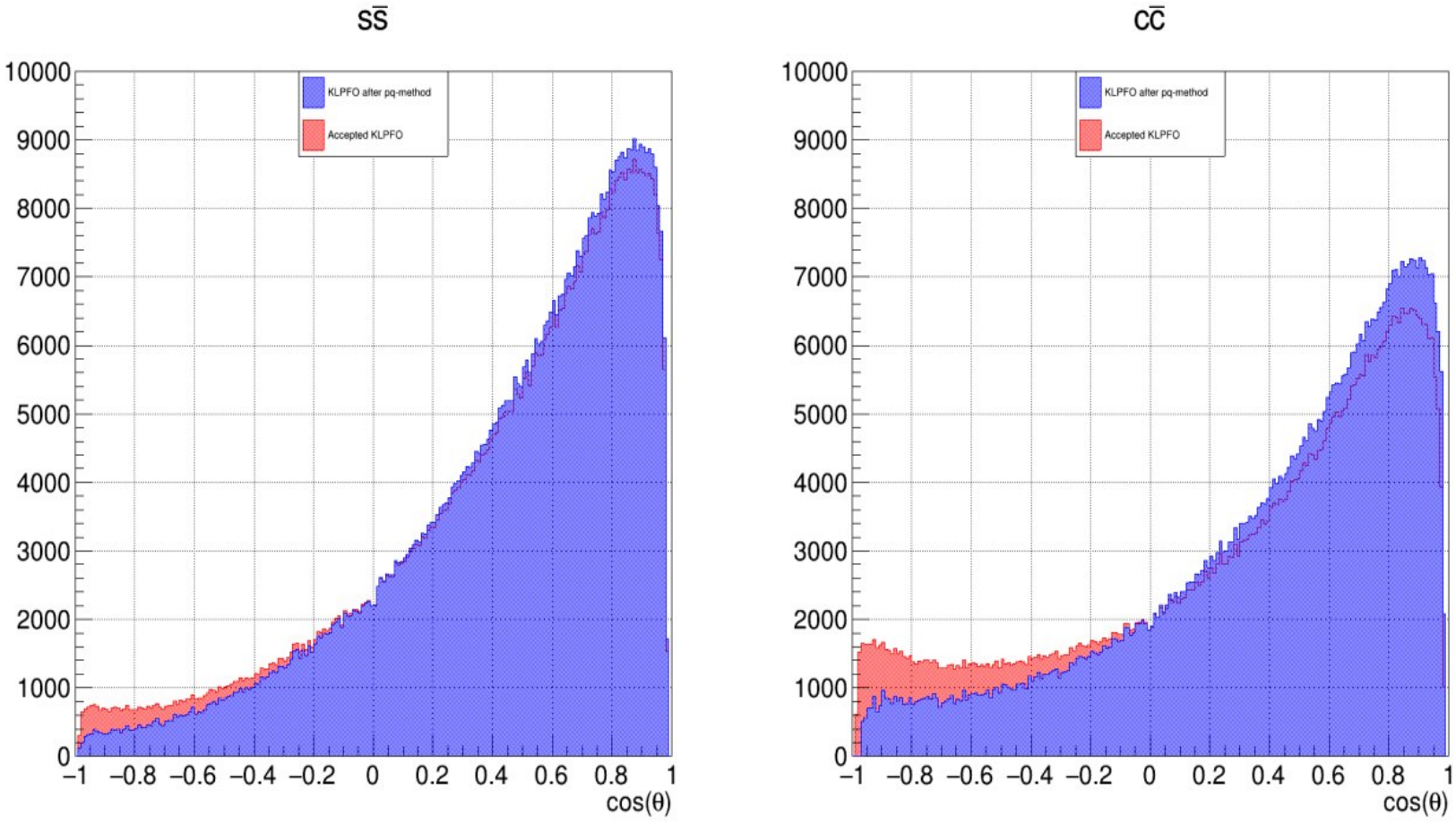
c-tag and d_0 cuts





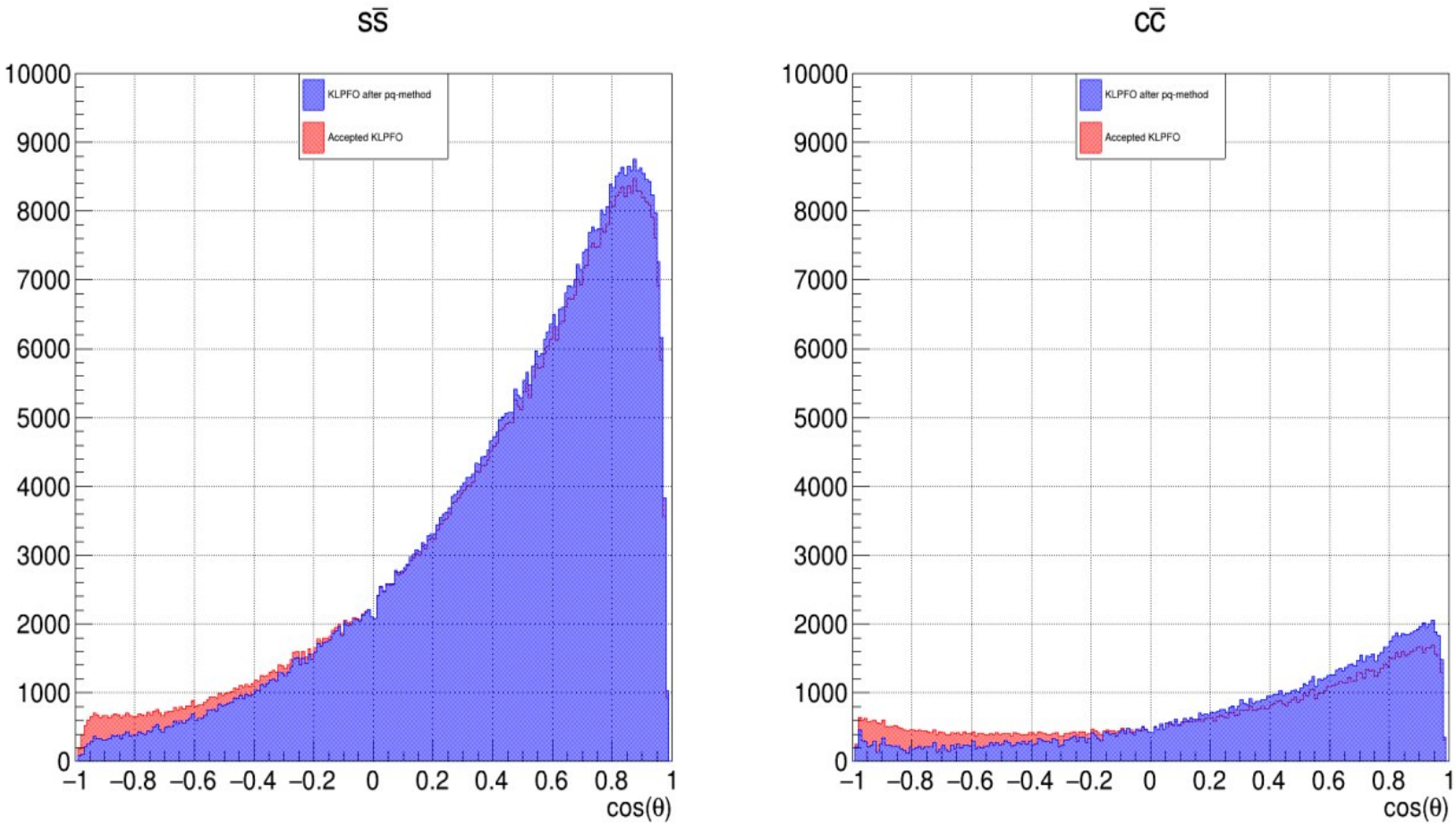
	Events c-tag<0.6	Percentage c-tag<0.6	Events c-tag$<0.6 \cap d_0 < 10\mu m$	Percentage c-tag$<0.6 \cap d_0 < 10\mu m$
$c\bar{c}$	110331	8.1%	98399	7.4%
$s\bar{s}$	1255305	91.9%	1240213	92.6%

Cross-section plot



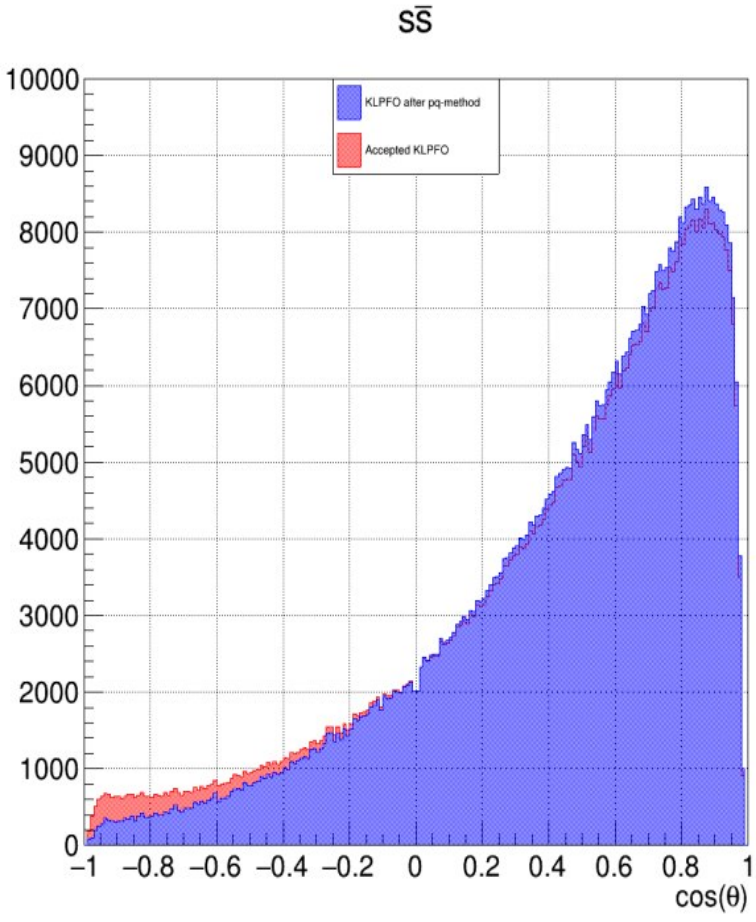
Initial cross section

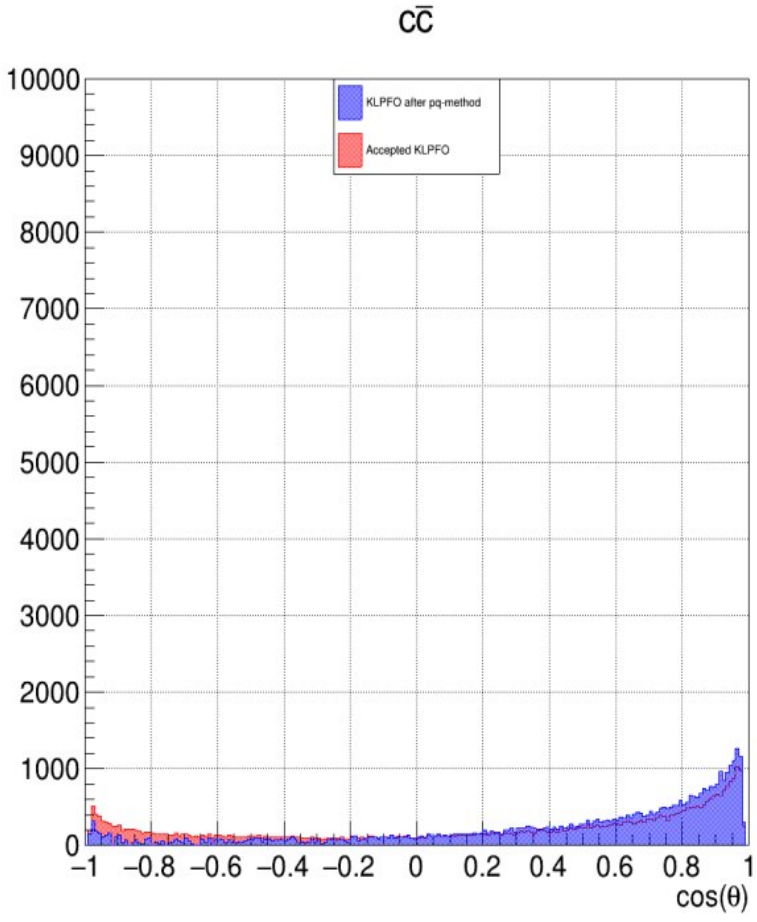
Cross-section plot



Cross section after vertex separation

Cross-section plot





Cross section after vertex separation and c-tag<0.6 with $d_0 < 10\mu m$ cuts

Conclusions

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- $|z_0| \times sin(\theta)$ is not useful for this background analysis

Conclusions

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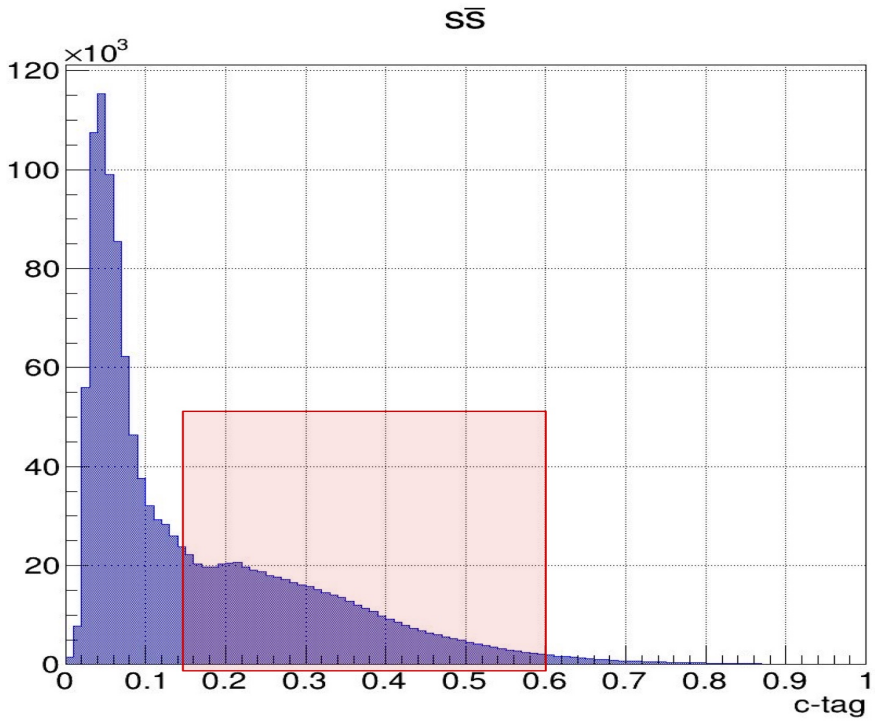
- Quantities such as d_0, z_0 itself are not useful for this background analysis
- c-tag<0.6 is the optimal value which does not have an impact on $s\bar{s}$ statistics, but can significantly improve the purity
- $|z_0| \times sin(\theta)$ is not useful for this background analysis
- d_0 can be used for background reduction in combination with c-tag cut, the optimal value of it is $d_0 < 10\mu m$

Backup slides

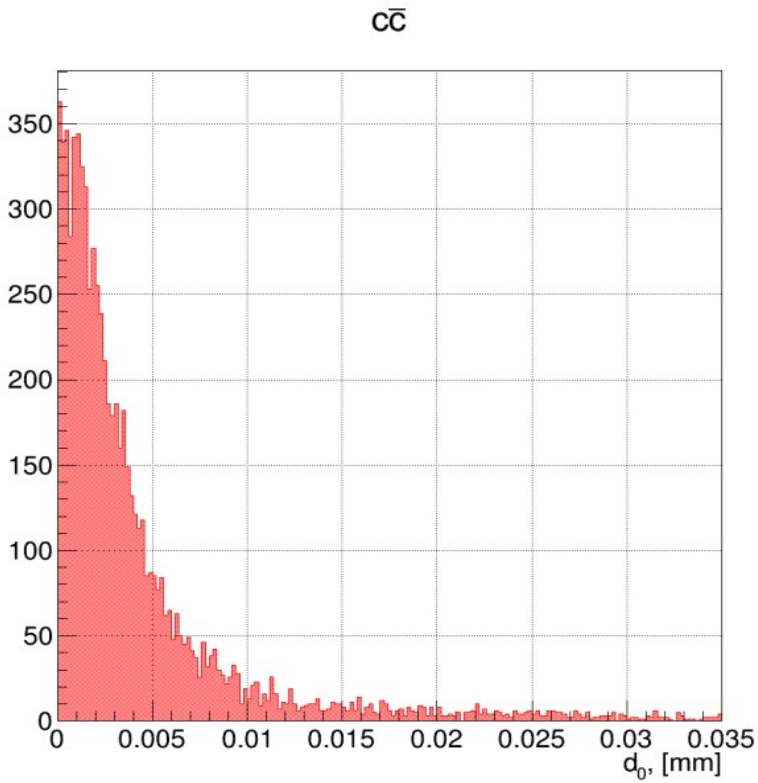
New c-tag cut searching

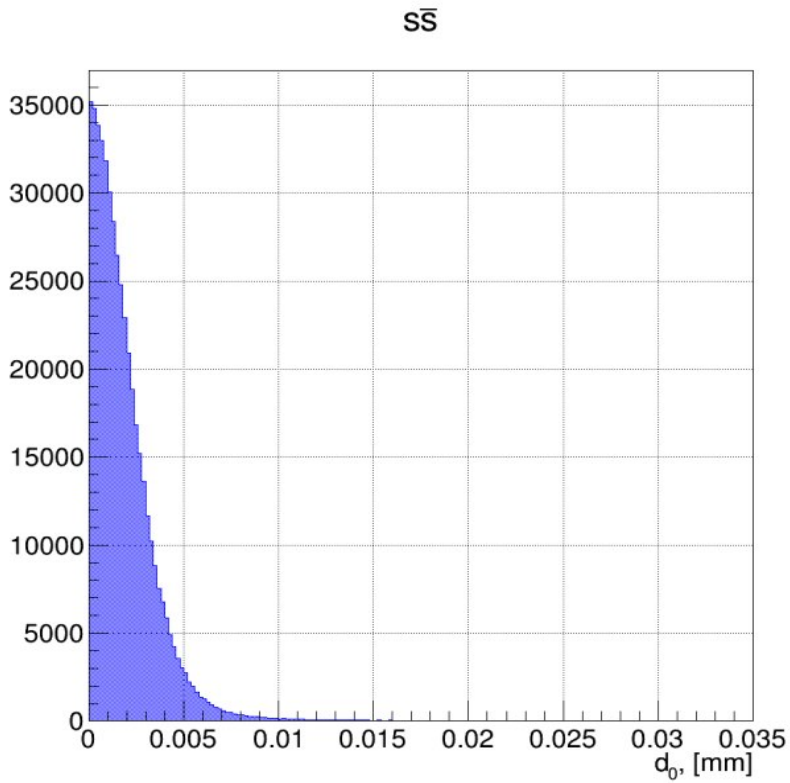


Monte-Carlo truth(▸ LCIO software - https://github.com/iLCSoft/LCIO) tells us:

Majority of the kaons from the region 0.15 <c-tag< 0.6 are inherited from ϕ, $K_1(1270)^0$, $K^*(892)^0$, $K^*(892)^+$ and ρ

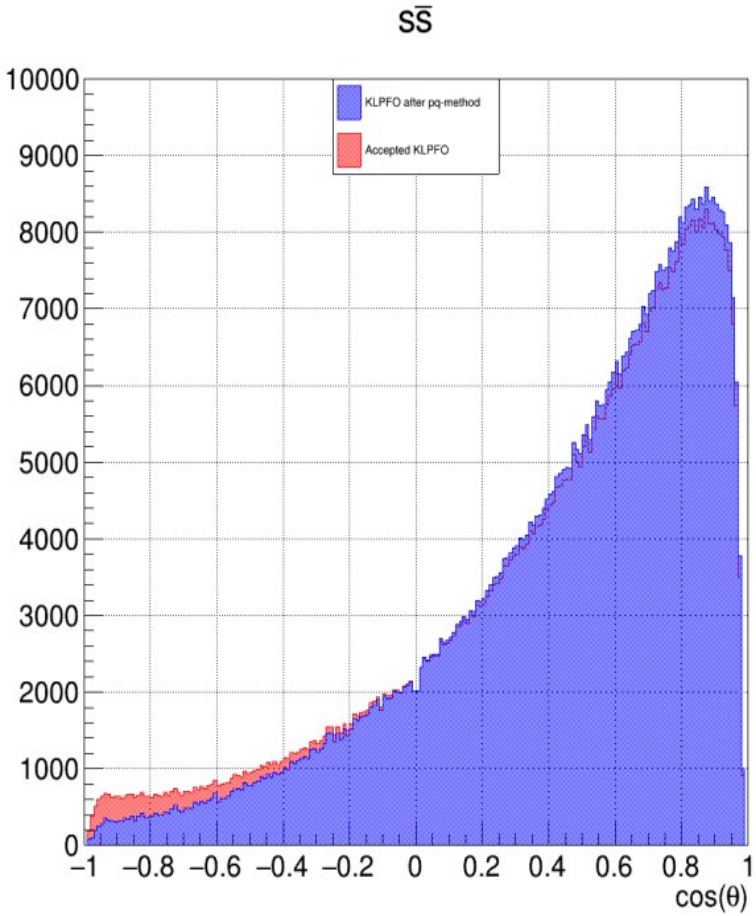
New c-tag and d_0 cuts

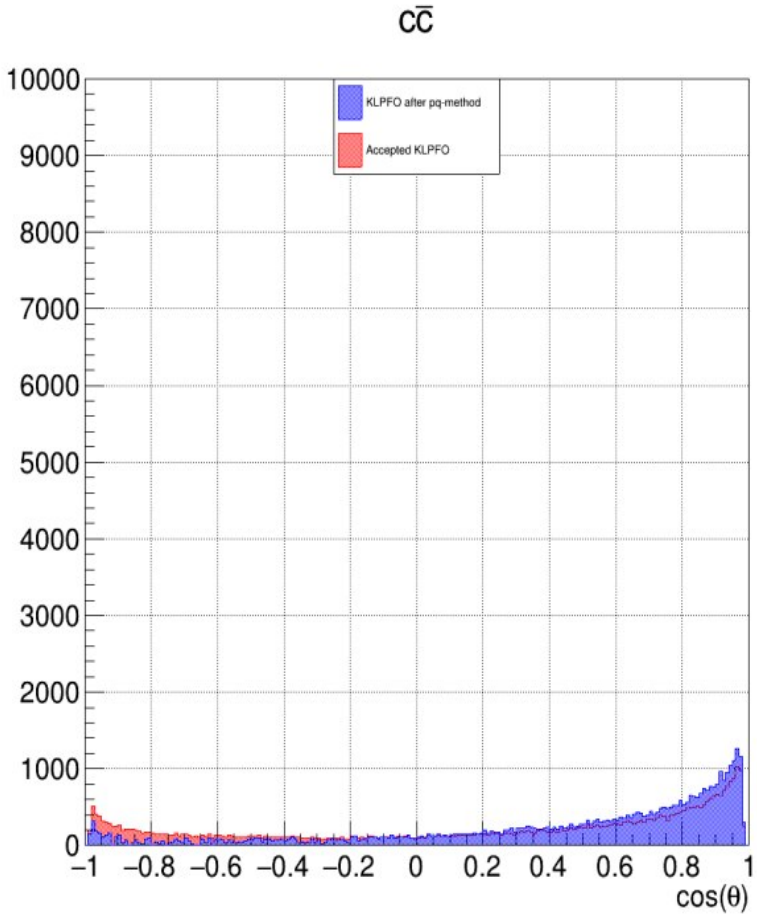




	Events c-tag<0.15	Percentage c-tag<0.15	Events c-tag$<0.15 \cap d_0 < 10\mu m$	Percentage c-tag$<0.15 \cap d_0 < 10\mu m$
$c\bar{c}$	6674	1.6%	7635	1.4%
$s\bar{s}$	476777	98.4%	476771	98.6%

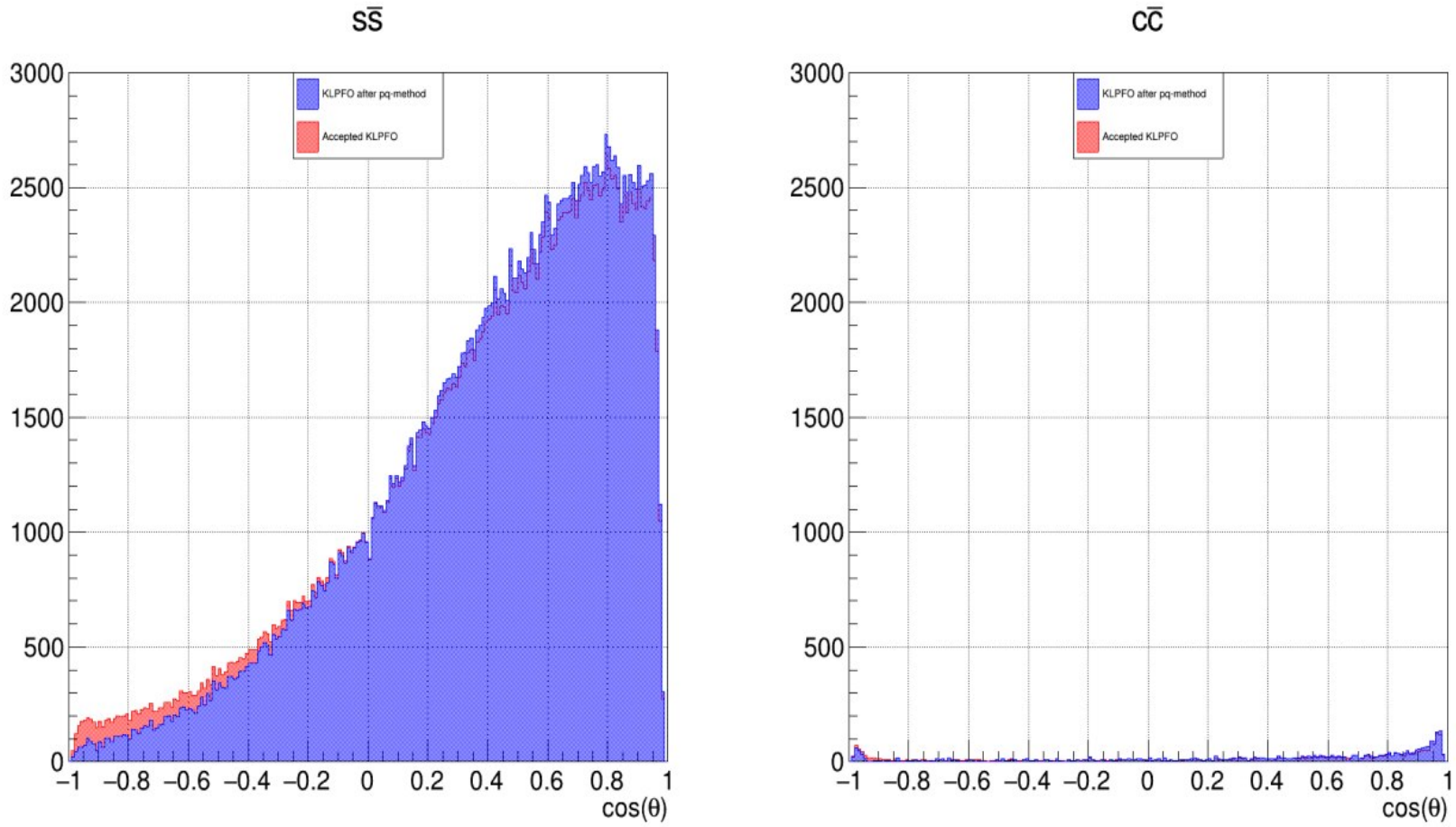
Cross section comparison





Cross section after vertex separation and c-tag<0.6 with $d_0 < 10\mu m$ cuts

Cross section comparison



Cross section after vertex separation and c-tag<0.15 with $d_0 < 10\mu m$ cuts