Status of dca study

Try to find a different variable for the charm beauty separation

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Status of dca study

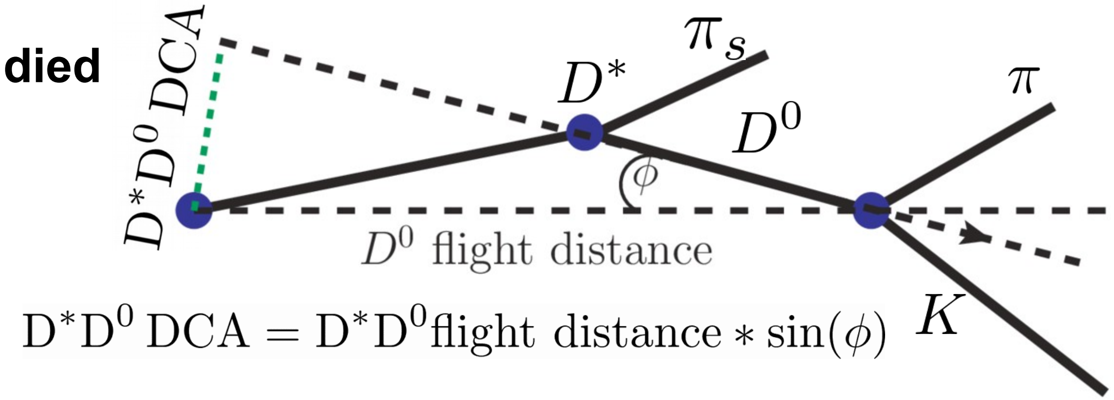
- We started to use, as HIN did it, dca (*distance of closest approach*) to distinguish between prompt (charm) and nonprompt (beauty) D* in D* final states (*charm beauty separation in D* final states*) more detailed BPH-talk
- BPH motivated us to study a similar variable like dca for this separation
- Next would be dca significance (for the moment not achievable with our reconstruction Ansatz)
- For this study we started with a MC closure test at 7TeV (D0Kpi sample with looser precuts on dEdx see preselection cuts for D* meson analyses, by Achim)
- **In the following we can see a set of different variables studied for the charm beauty separation**

  1.) dca (*product of the decay length and the angle*), 2.) cosphi

  3.) dlSig (*decay length significance*),

  4.) dca*dlSig (*product of the dca and the decay length significance*)

  5.) Idea for an approximation of dcaSig: moddca (*moddca = 20*DstarD0_dca/DstarD0_dlErr* + *DstarD0_dlSig*) unit-less



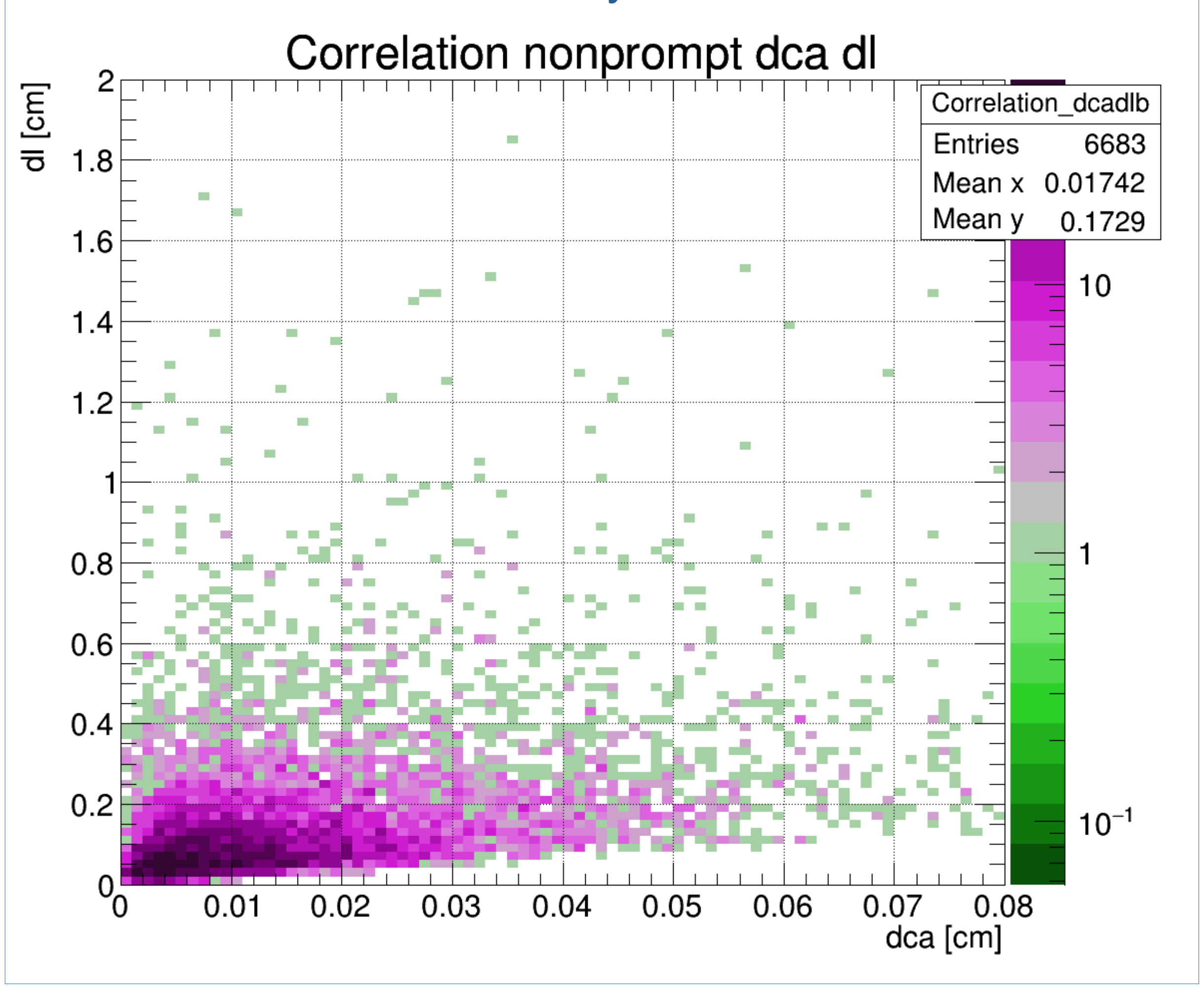
- We have correlation plots for beauty/charm in:

  1.) dca vs. dl 2.) dca vs. dlSig 3.) dca vs. cosphi 4.) dca*cosphi vs. dlSig 5.) cosphi vs. dlSig

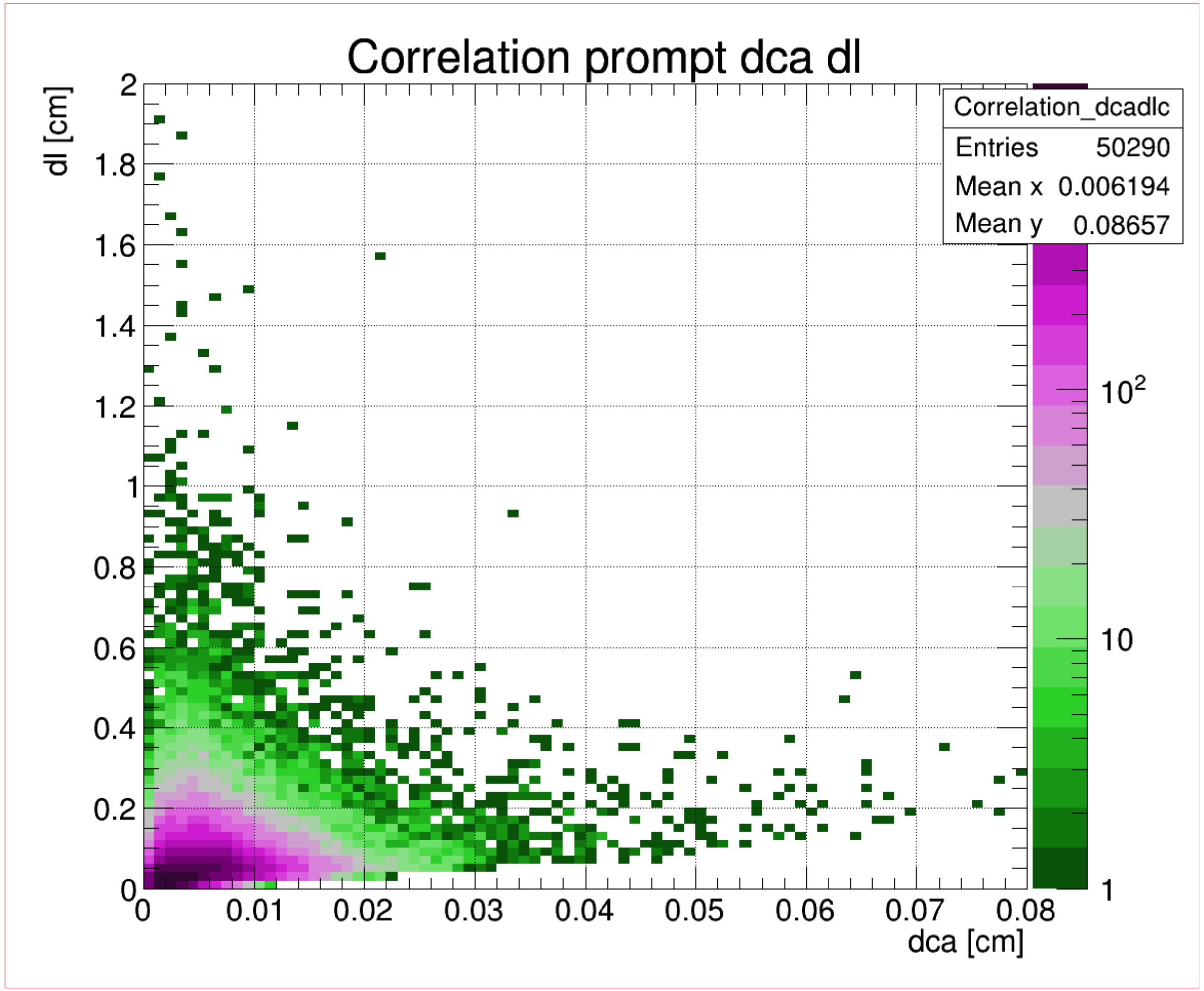
Correlation Plots

Correlation plots for dca vs. dl

beauty

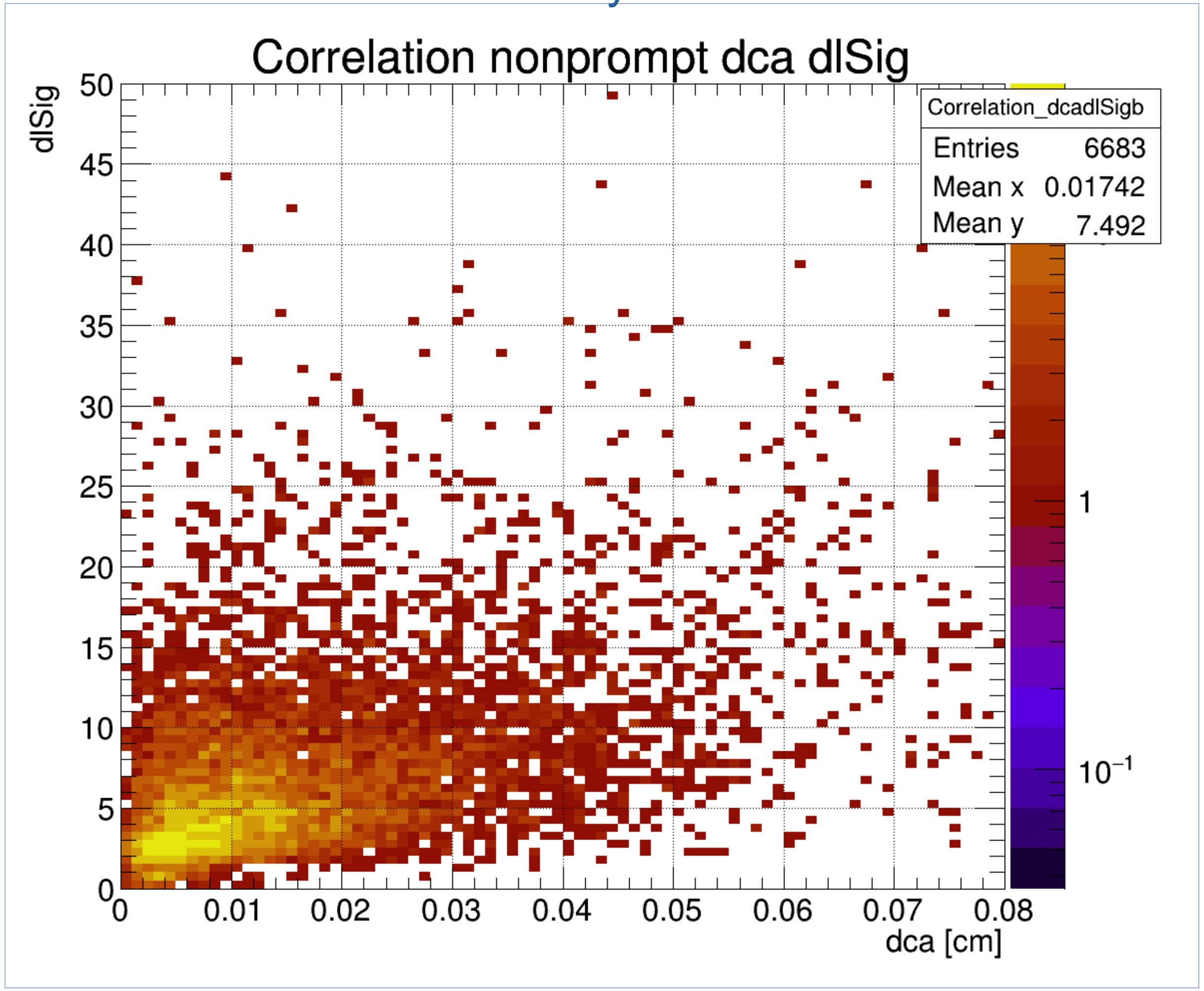


charm

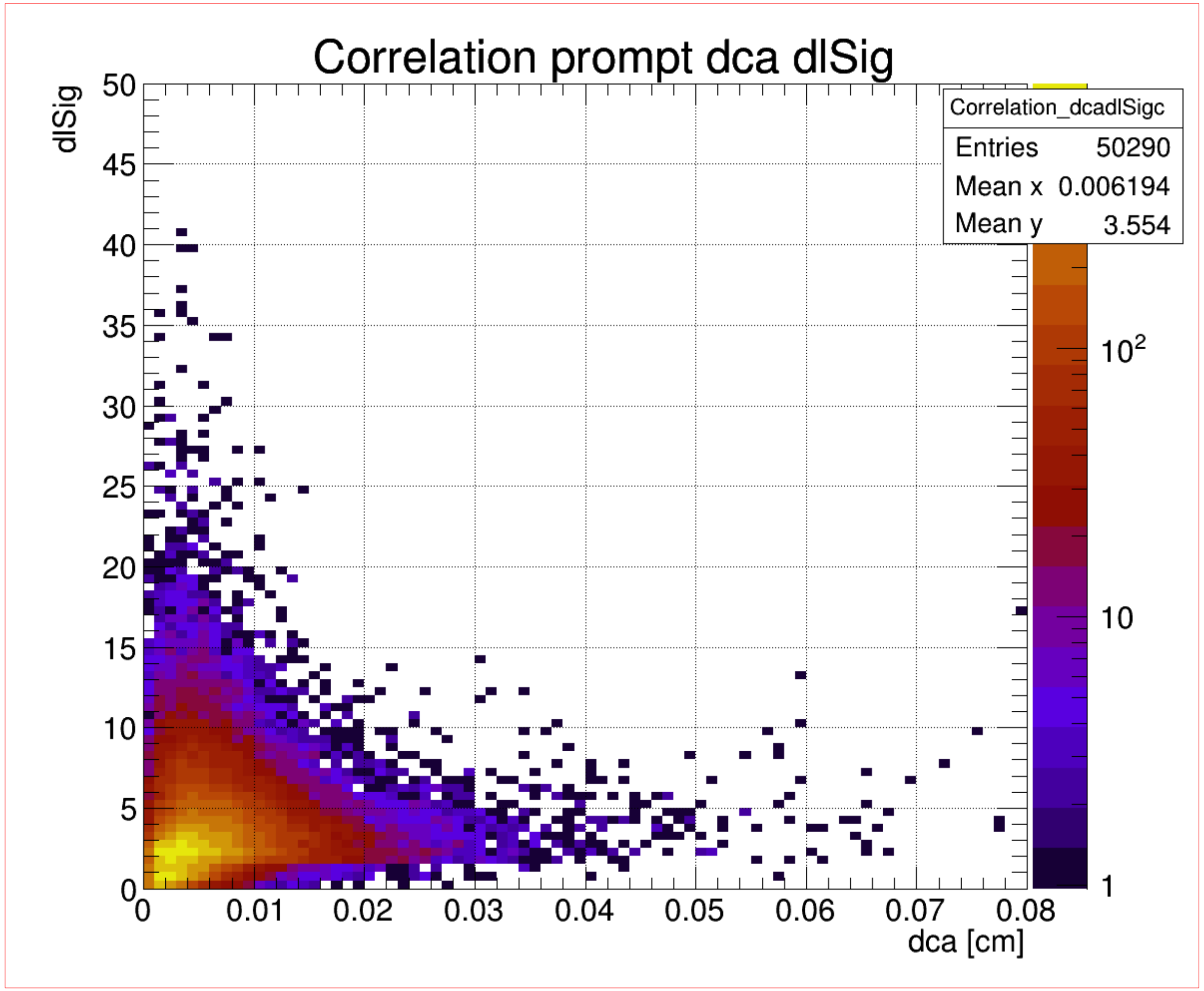


Correlation plots for dca vs. dlSig

beauty



charm



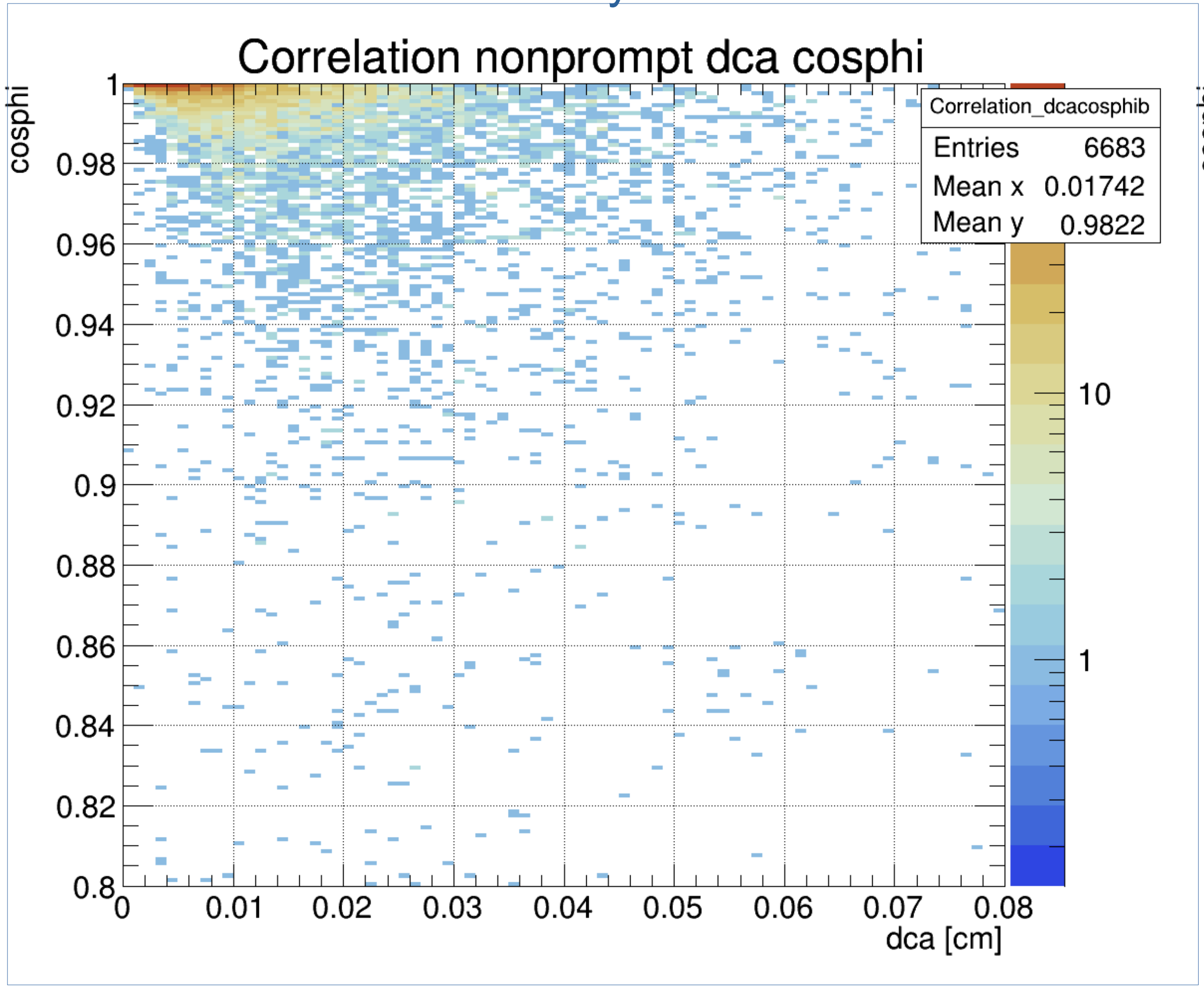
elliptical

motivation for dca*dlsig

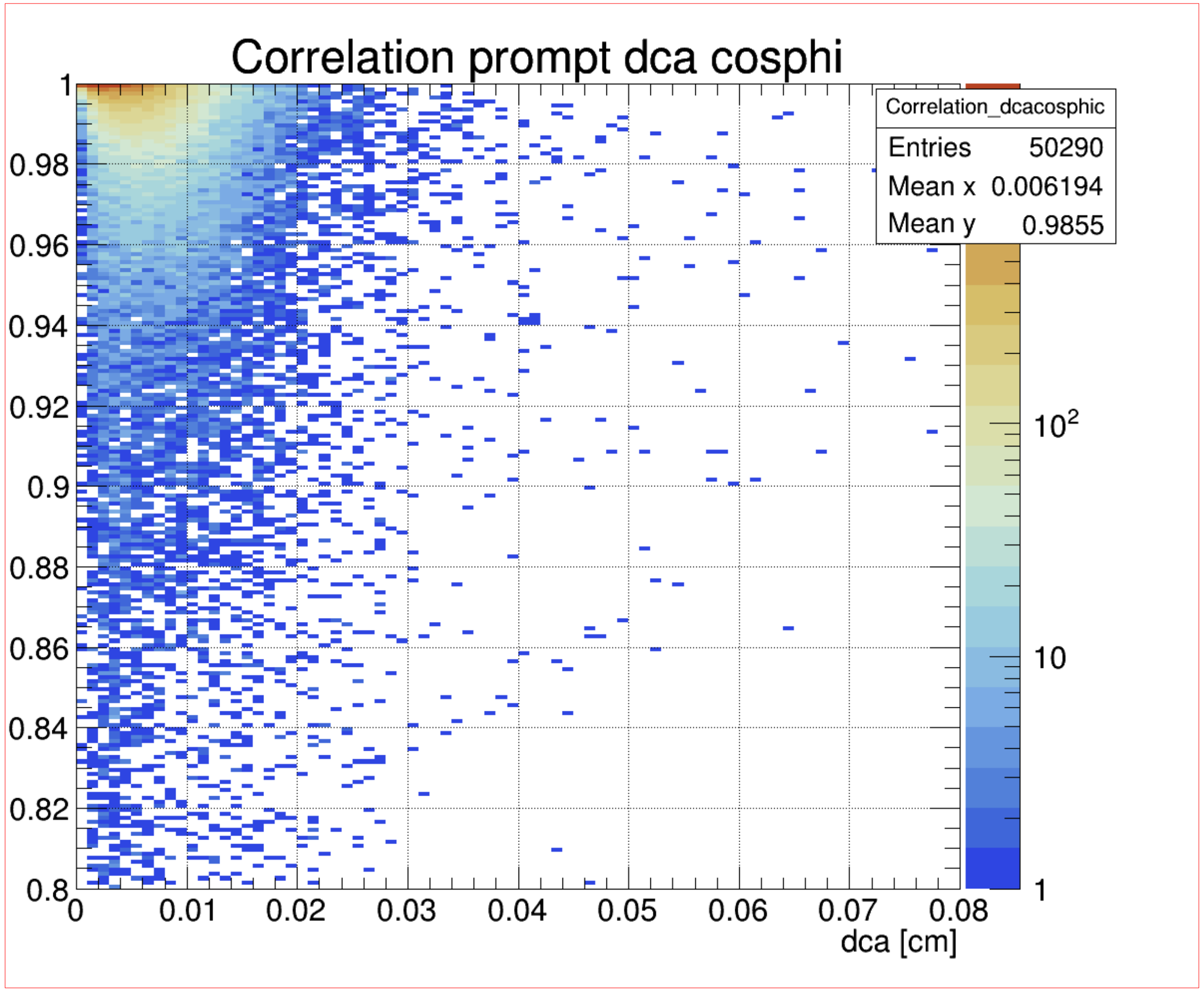
hyperbolic

Correlation plots for dca vs. cosphi

beauty

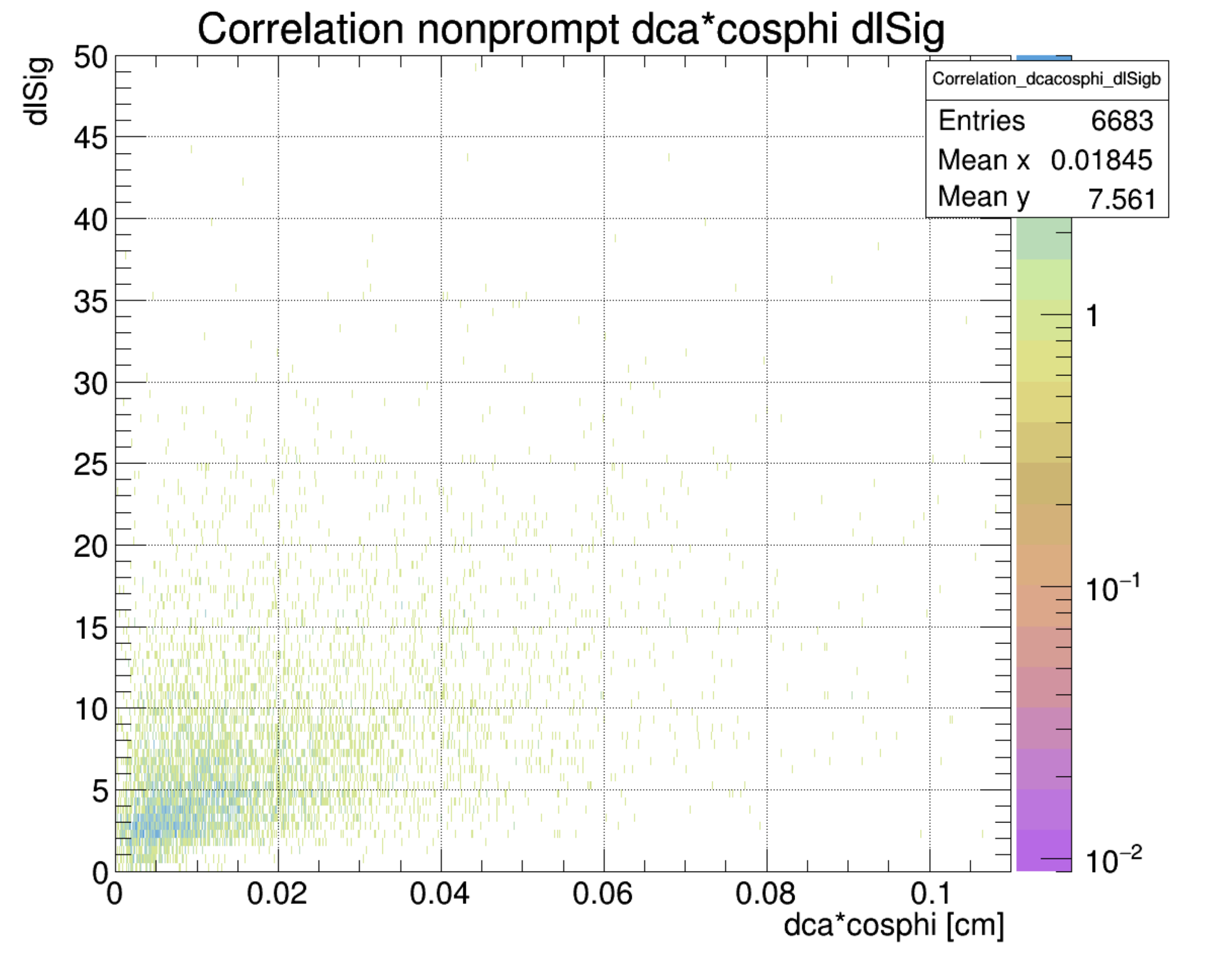


charm

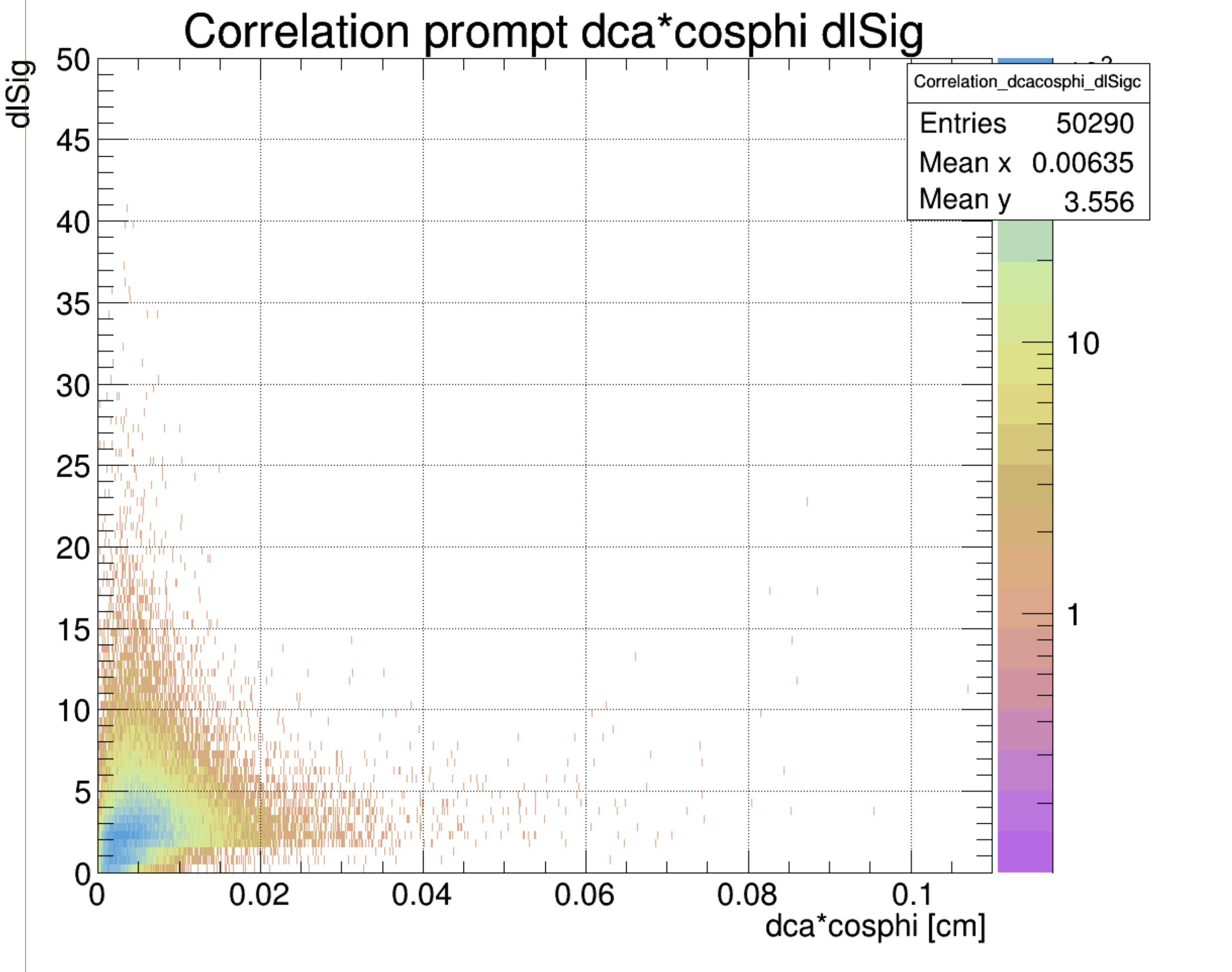


Correlation plots for dca*cosphi vs. dlSig

beauty

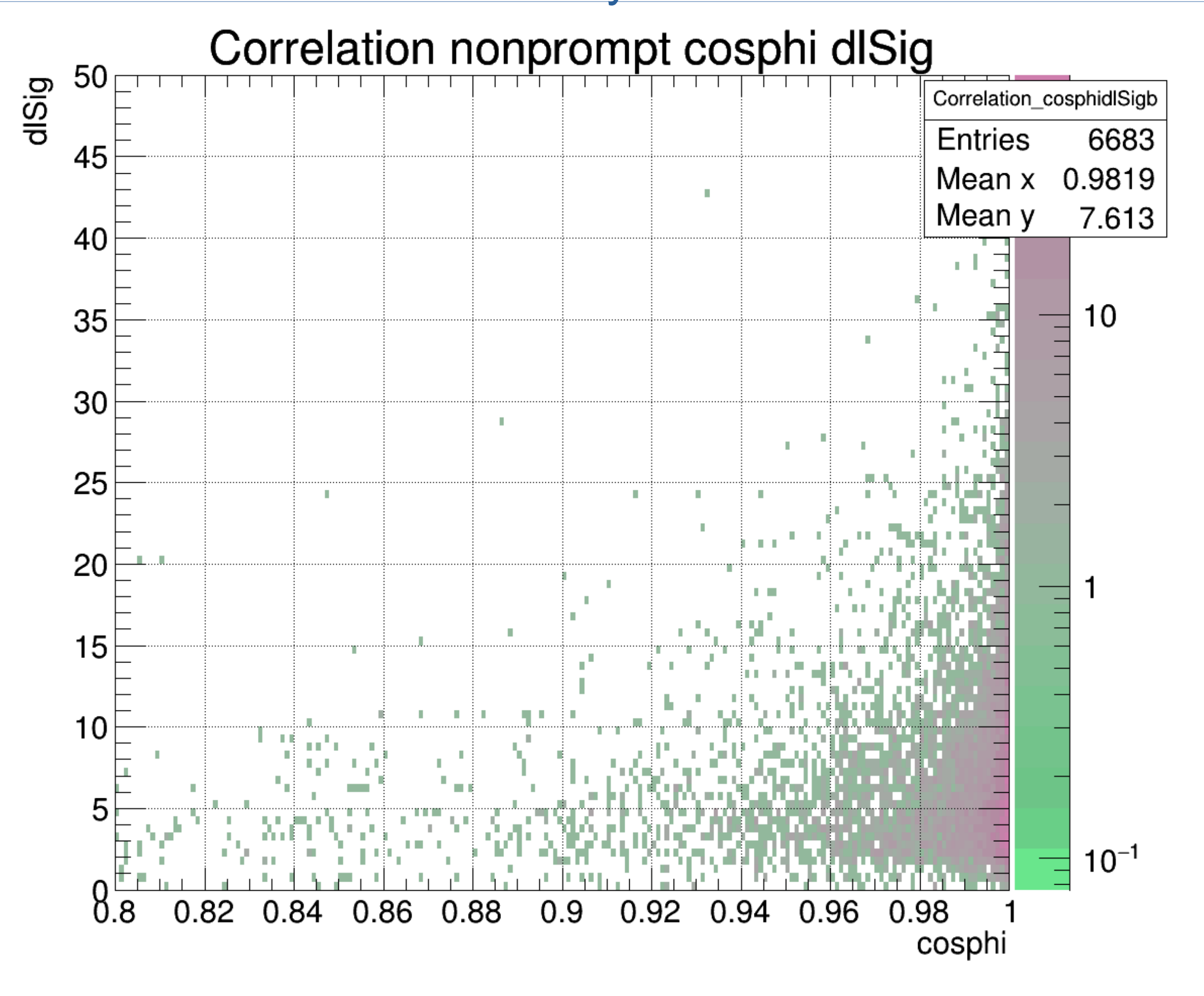


charm

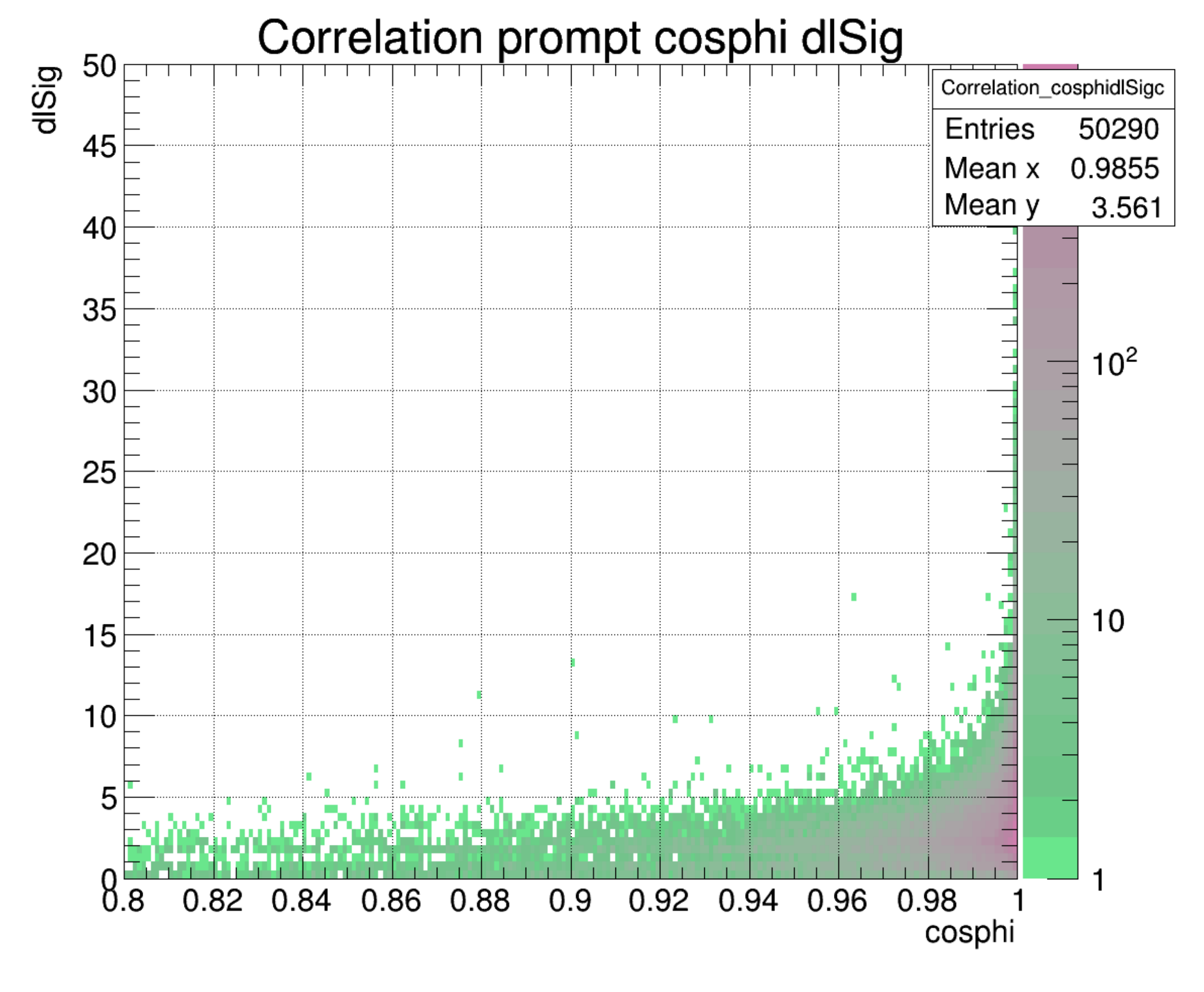


Correlation plots for cosphi vs. dlSig

beauty



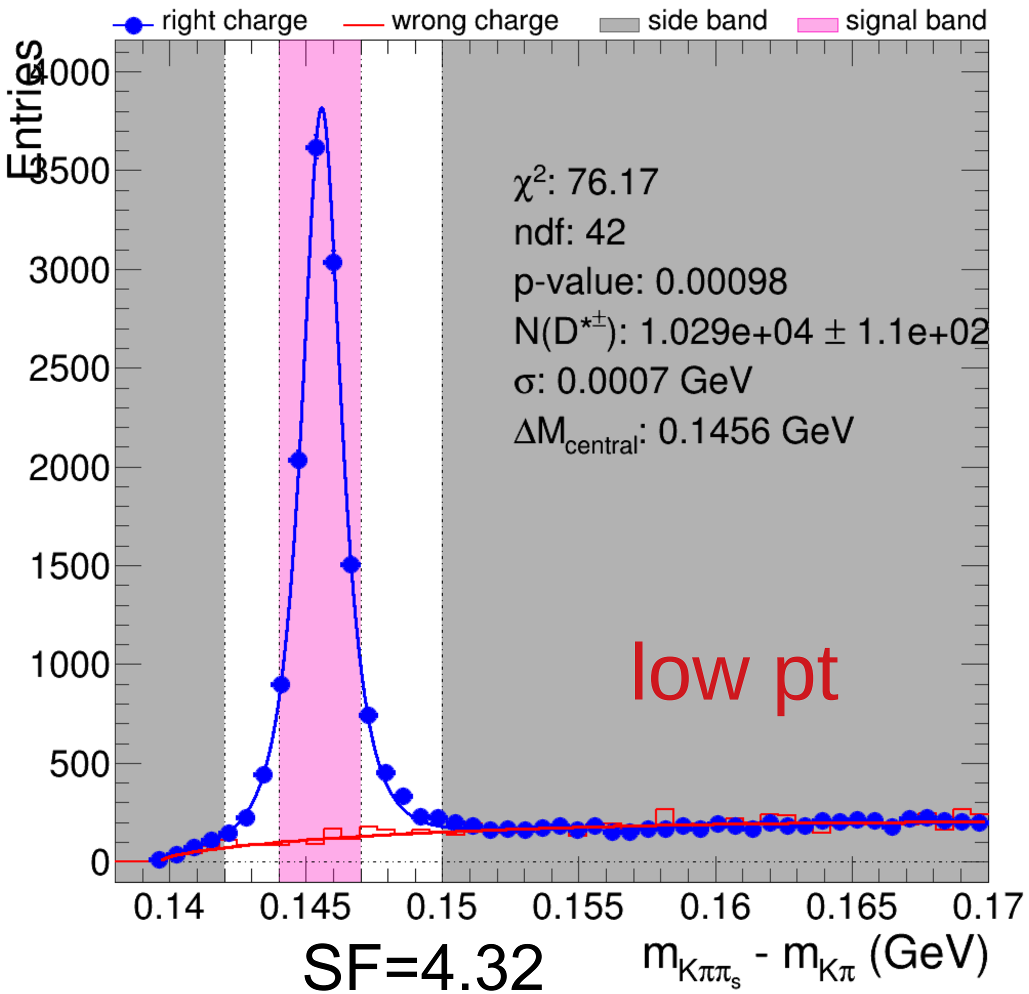
charm



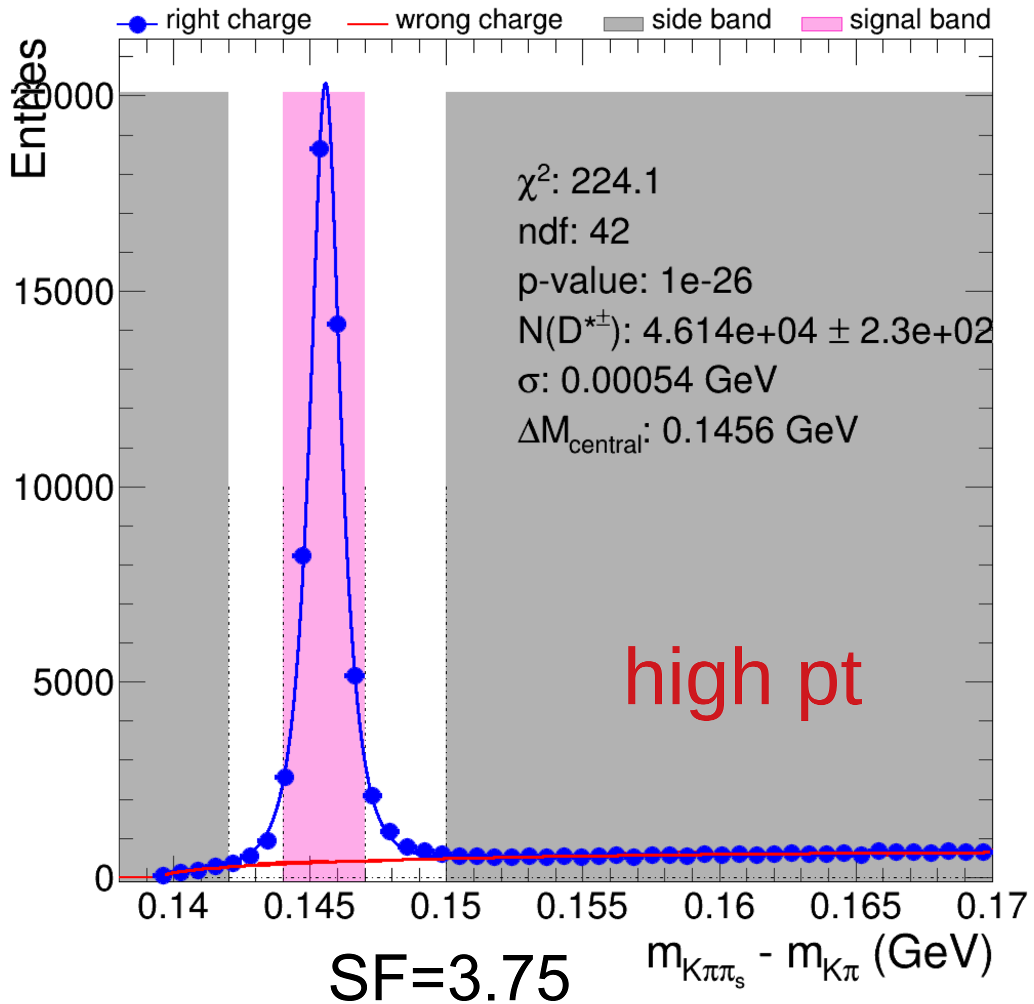
cb separation

Signal extraction

- The procedure for the signal extraction (shown in detail here) is the same for each of the used parameters:
- dca
- cosphi
- dlSig
- dcadlSig
- moddca

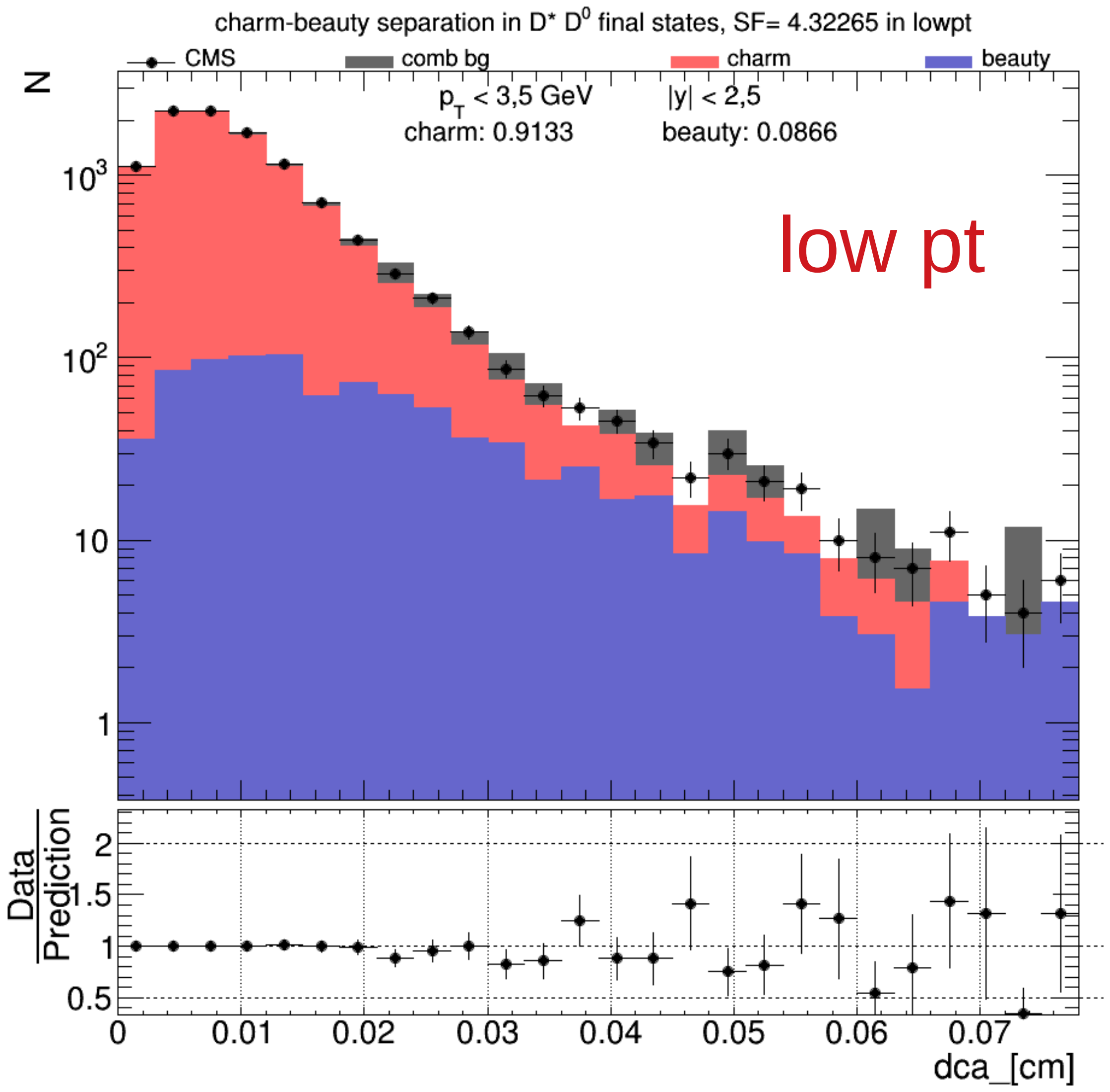


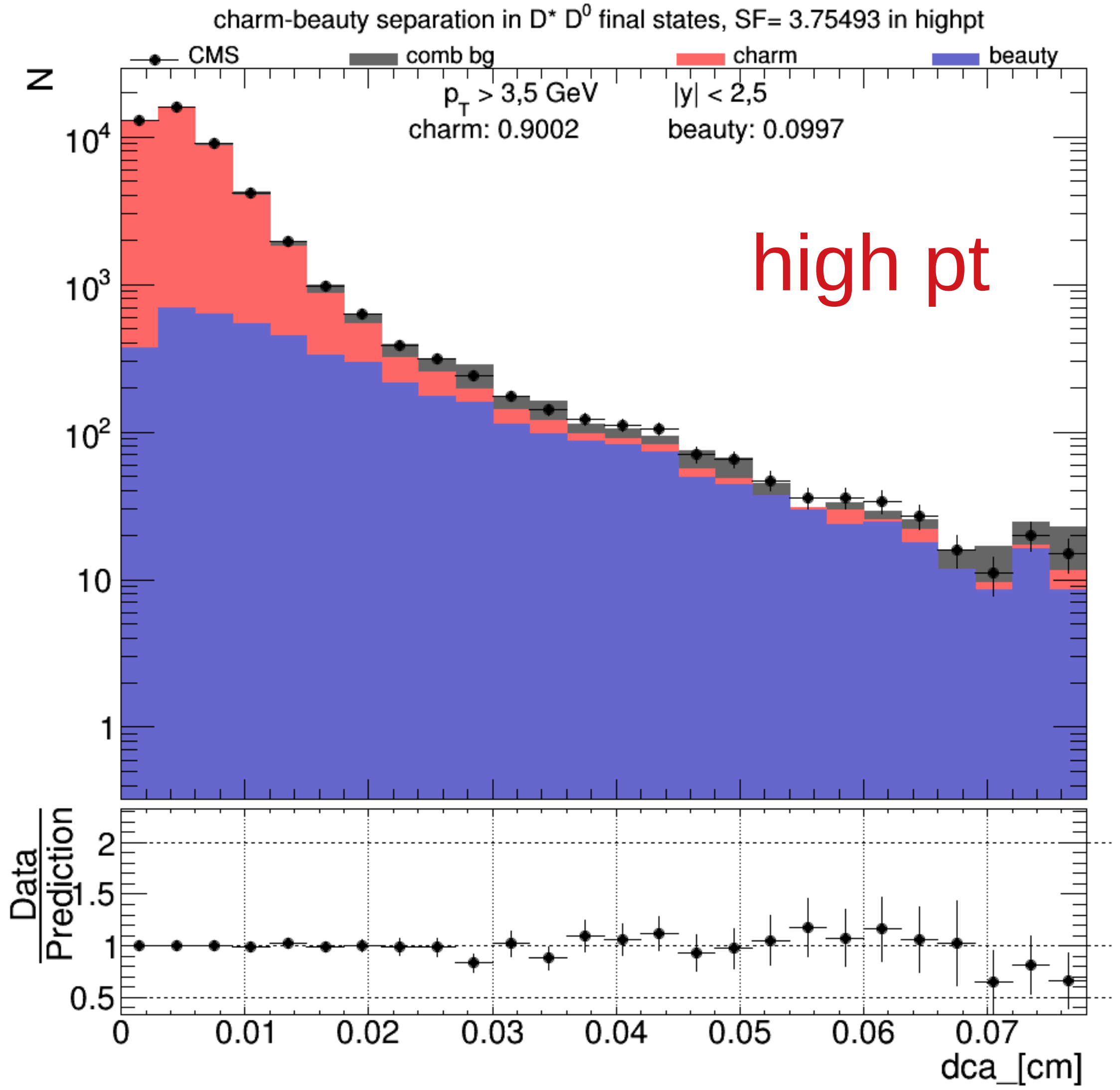
SF=4.32



SF=3.75

The charm beauty separation with dca





The charm beauty separation with dca

calculations with fit parameters c and b and fit errors δ_c and δ_b in bin **lowpt**

$$N_{c+b} = (c \pm \delta_c) \bullet N_c + (b \pm \delta_b) \bullet N_b = (1.027^{0.019}_{-0.019} \pm 0.019) \bullet 9153 + (0.759^{0.108}_{-0.103} \pm 0.1055) \bullet 1175$$

$$= (9400.13^{173.907}_{-173.907} \pm 173.907) + (891.825^{126.9}_{-121.025} \pm 123.962) = 10292 \pm 213.566$$

signal in data is: **10220.5** *with used SF=* **4.32265**

using the shortcuts: $\Delta_b = \delta_b \bullet N_b$ *and* $\Delta_{bc} = \sqrt{\Delta_b^2 + \Delta_c^2}$

$$\text{frac\_beauty} = \frac{b \bullet N_b}{b \bullet N_b + c \bullet N_c} = \frac{\Sigma^b}{\Sigma^b + \Sigma^c}$$

$$\text{fracErr\_beauty} = \sqrt{\left(\frac{\Delta_b}{\Sigma^b + \Sigma^c}\right)^2 + \left(\frac{\Delta_{bc} \bullet \Sigma^b}{(\Sigma^b + \Sigma^c)^2}\right)^2}$$

pythia prediction:

fraction from beauty: **0.0866526 ± 0.0121781** $f_b = \frac{N_b}{N_b + N_c} = 0.113768$

fraction from cahrm: **0.913347 ± 0.0253914** $f_c = \frac{N_c}{N_b + N_c} = 0.886232$

calculations with fit parameters c and b and fit errors δ_c and δ_b in bin **highpt**

$$N_{c+b} = (c \pm \delta_c) \bullet N_c + (b \pm \delta_b) \bullet N_b = (1.008^{0.008}_{-0.008} \pm 0.008) \bullet 41124 + (0.845^{0.039}_{-0.038} \pm 0.0385) \bullet 5435$$

$$= (41453^{328.992}_{-328.992} \pm 328.992) + (4592.58^{211.965}_{-206.53} \pm 209.247) = 46045.6 \pm 389.898$$

signal in data is: **45985.4** *with used SF=* **3.75493**

using the shortcuts: $\Delta_b = \delta_b \bullet N_b$ *and* $\Delta_{bc} = \sqrt{\Delta_b^2 + \Delta_c^2}$

$$\text{frac\_beauty} = \frac{b \bullet N_b}{b \bullet N_b + c \bullet N_c} = \frac{\Sigma^b}{\Sigma^b + \Sigma^c}$$

$$\text{fracErr\_beauty} = \sqrt{\left(\frac{\Delta_b}{\Sigma^b + \Sigma^c}\right)^2 + \left(\frac{\Delta_{bc} \bullet \Sigma^b}{(\Sigma^b + \Sigma^c)^2}\right)^2}$$

pythia prediction:

fraction from beauty: **0.0997398 ± 0.00462217** $f_b = \frac{N_b}{N_b + N_c} = 0.116734$

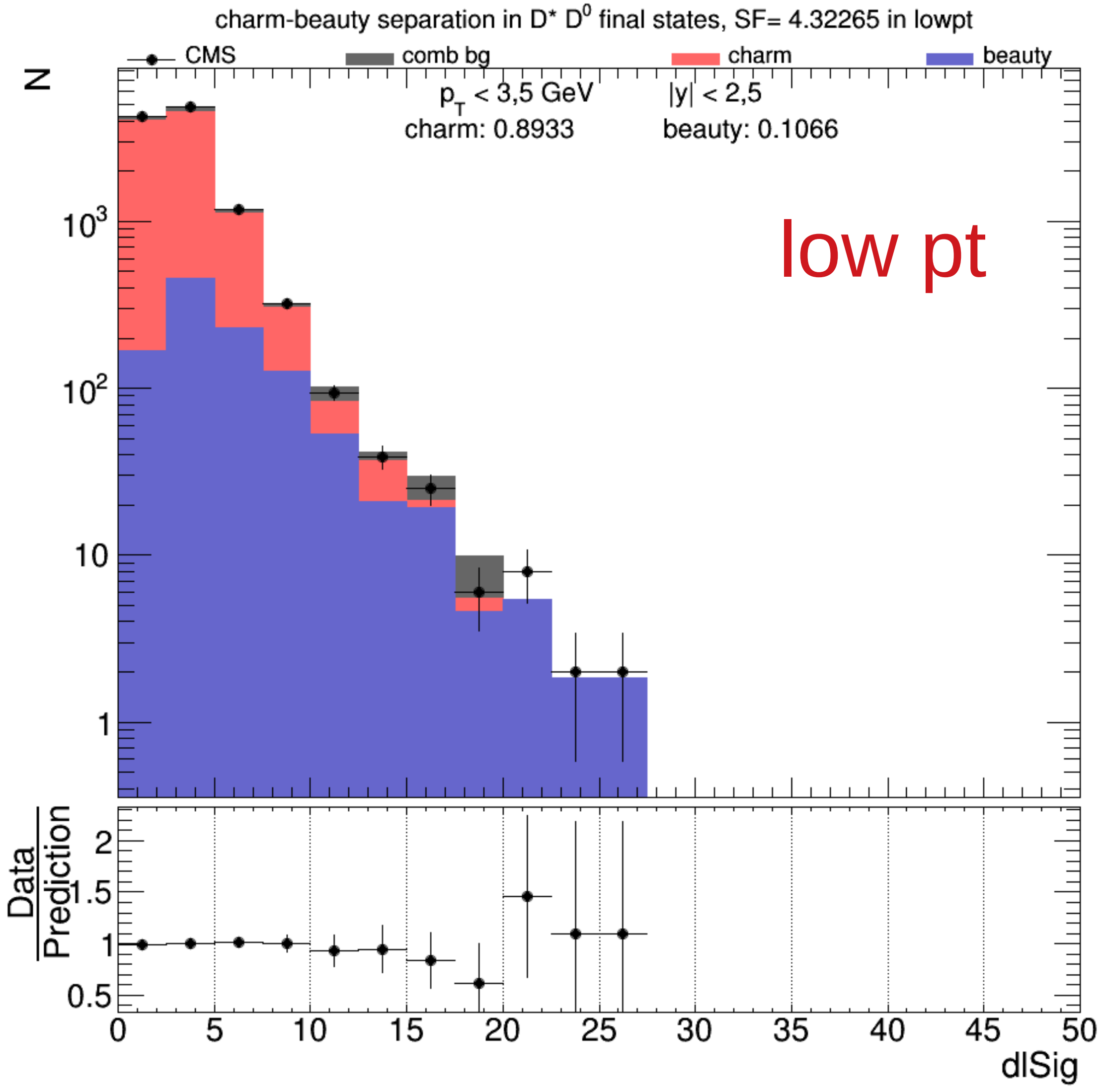
fraction from cahrm: **0.90026 ± 0.010448** $f_c = \frac{N_c}{N_b + N_c} = 0.883266$

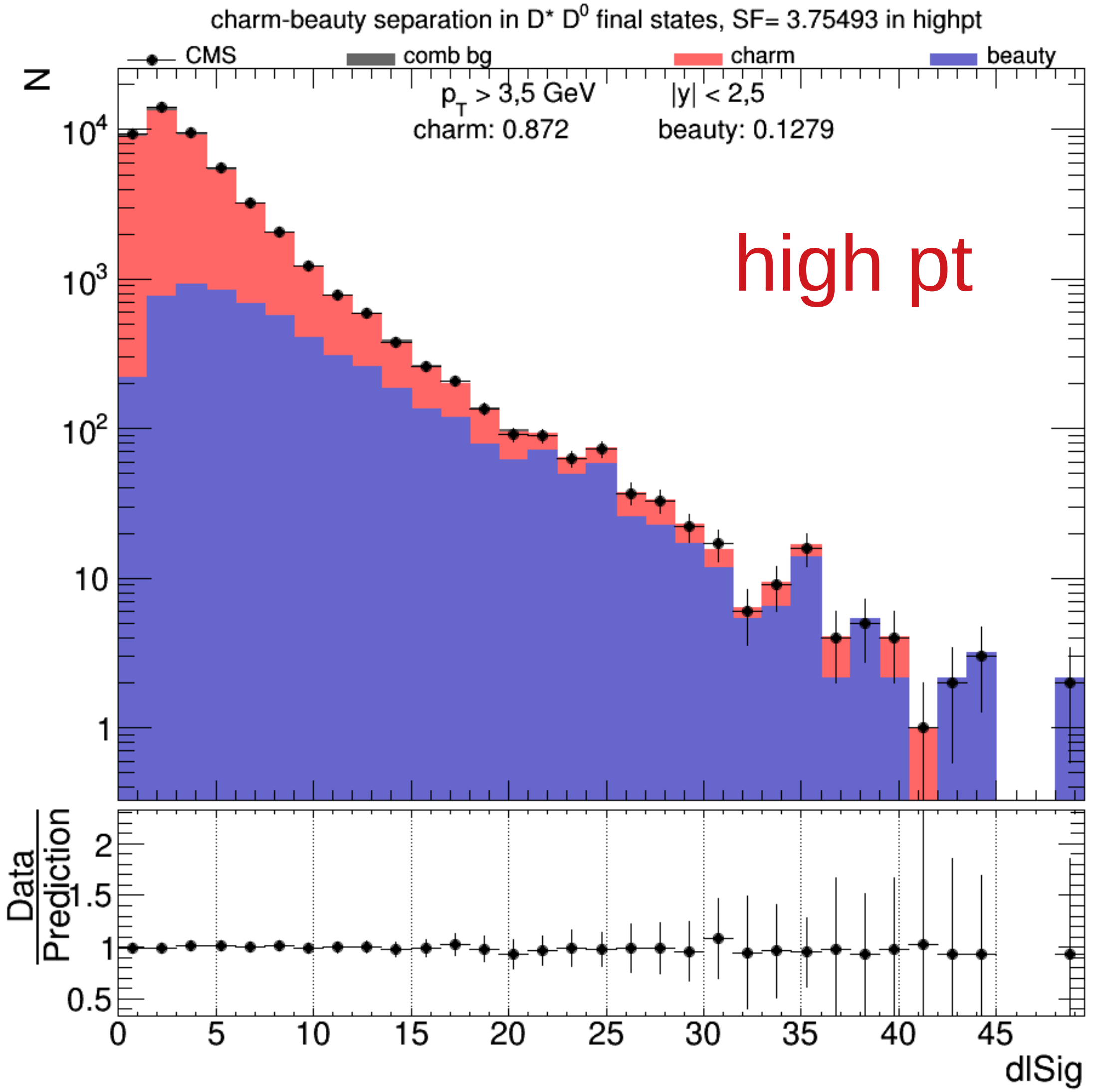
low pt

overrated

high pt

The charm beauty separation with dlSig





- dlSig not much better compared to dca

The charm beauty separation with dISig

calculations with fit parameters c and b and fit errors δ_c *and* δ_b *in bin* **lowpt**

$$N_{c+b} = (c \pm \delta_c) \bullet N_c + (b \pm \delta_b) \bullet N_b = (0.996^{0.021}_{-0.021} \pm 0.021) \bullet 9155 + (0.914^{0.127}_{-0.12} \pm 0.1235) \bullet 1191$$

$$= (9118.38^{192.255}_{-192.255} \pm 192.255) + (1088.57^{151.257}_{-142.92} \pm 147.089) = 10207 \pm 242.068$$

signal in data is: **10198** *with used SF=* **4.32265**

using the shortcuts: $\Delta_b = \delta_b \bullet N_b$ *and* $\Delta_{bc} = \sqrt{\Delta_b^2 + \Delta_c^2}$

$$\text{frac\_beauty} = \frac{b \bullet N_b}{b \bullet N_b + c \bullet N_c} = \frac{\Sigma^b}{\Sigma^b + \Sigma^c}$$

$$\text{fracErr\_beauty} = \sqrt{\left(\frac{\Delta_b}{\Sigma^b + \Sigma^c}\right)^2 + \left(\frac{\Delta_{bc} \bullet \Sigma^b}{(\Sigma^b + \Sigma^c)^2}\right)^2}$$

pythia prediction:

fraction from beauty: **0.10665 ± 0.0146309** $f_b = \frac{N_b}{N_b + N_c} = 0.115117$

fraction from cahrm: **0.89335 ± 0.0283489** $f_c = \frac{N_c}{N_b + N_c} = 0.884883$

low pt

calculations with fit parameters c and b and fit errors δ_c *and* δ_b *in bin* **highpt**

$$N_{c+b} = (c \pm \delta_c) \bullet N_c + (b \pm \delta_b) \bullet N_b = (0.976^{0.01}_{-0.01} \pm 0.01) \bullet 41135 + (1.073^{0.051}_{-0.049} \pm 0.05) \bullet 5490$$

$$= (40147.8^{411.35}_{-411.35} \pm 411.35) + (5890.77^{279.99}_{-269.01} \pm 274.5) = 46038.5 \pm 494.529$$

signal in data is: **46036.7** *with used SF=* **3.75493**

using the shortcuts: $\Delta_b = \delta_b \bullet N_b$ *and* $\Delta_{bc} = \sqrt{\Delta_b^2 + \Delta_c^2}$

$$\text{frac\_beauty} = \frac{b \bullet N_b}{b \bullet N_b + c \bullet N_c} = \frac{\Sigma^b}{\Sigma^b + \Sigma^c}$$

$$\text{fracErr\_beauty} = \sqrt{\left(\frac{\Delta_b}{\Sigma^b + \Sigma^c}\right)^2 + \left(\frac{\Delta_{bc} \bullet \Sigma^b}{(\Sigma^b + \Sigma^c)^2}\right)^2}$$

pythia prediction:

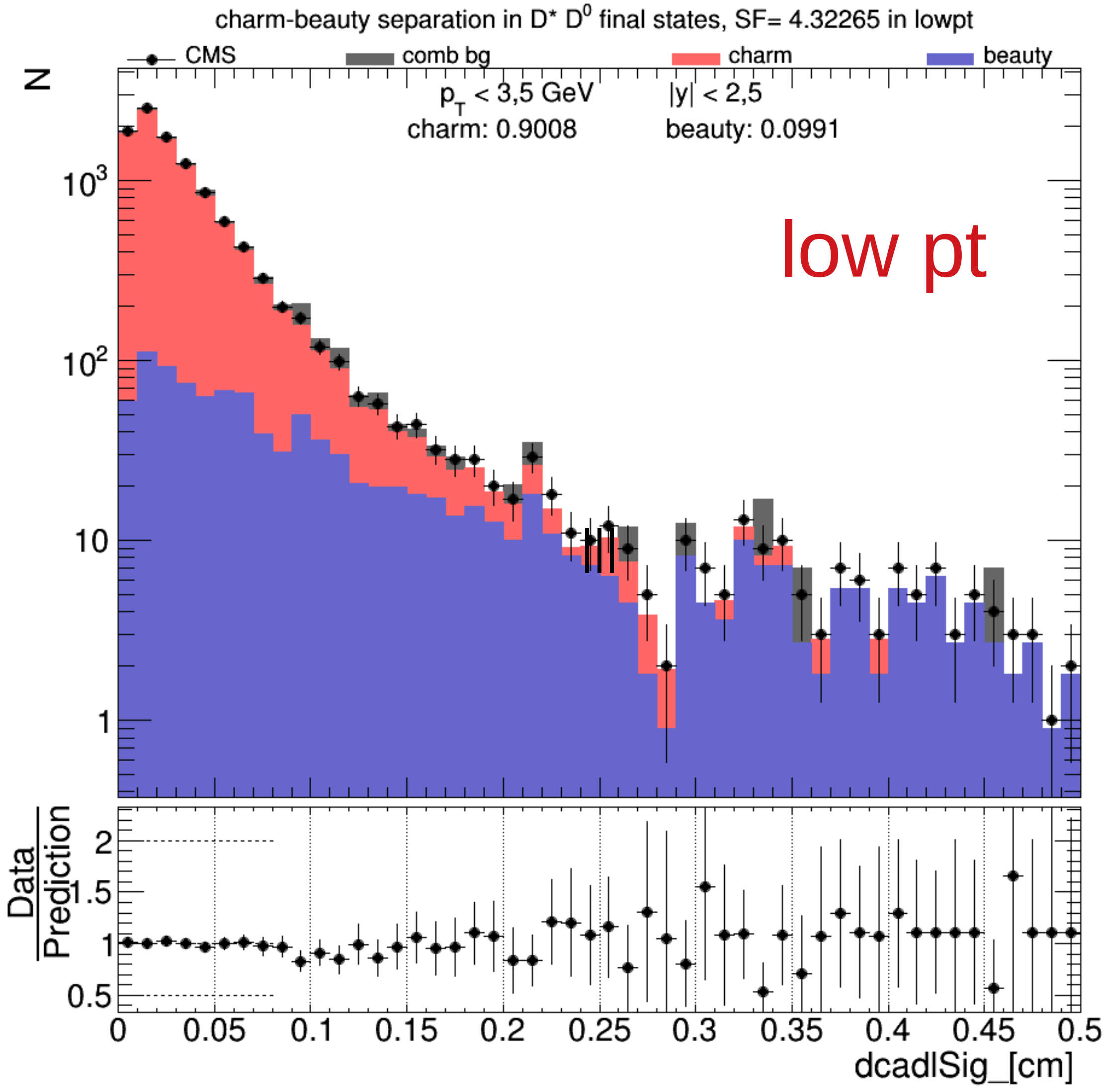
fraction from beauty: **0.127953 ± 0.00611876** $f_b = \frac{N_b}{N_b + N_c} = 0.117748$

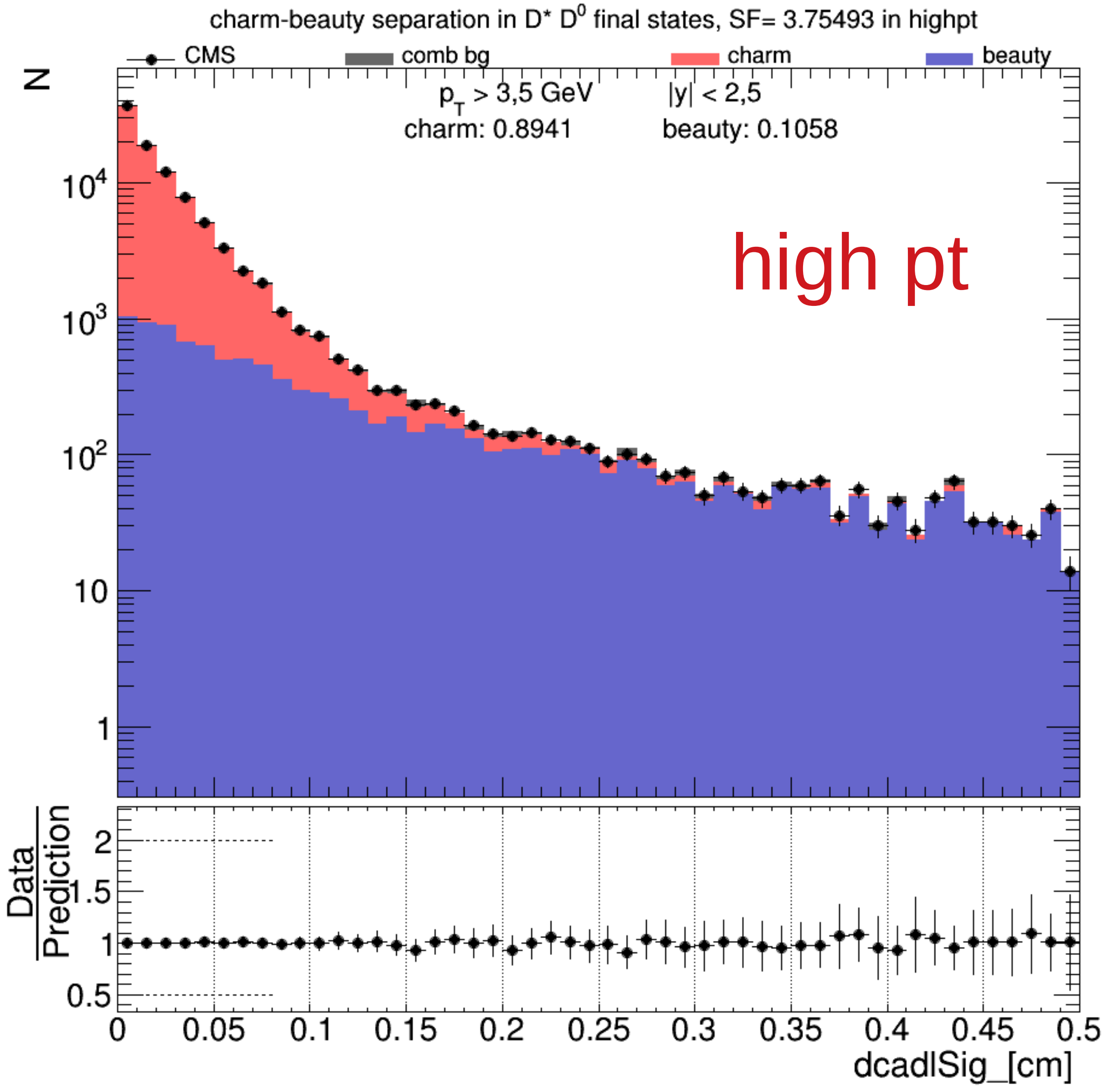
fraction from cahrm: **0.872047 ± 0.0129452** $f_c = \frac{N_c}{N_b + N_c} = 0.882252$

high pt

- dISig not much better compared to dca

The charm beauty separation with dca*dlSig





- dca*dlSig is working relatively good :-)

The charm beauty separation with dca*dlSig

calculations with fit parameters c and b and fit errors δ_c and δ_b in bin **lowpt**

$$N_{c+b} = (c \pm \delta_c) \bullet N_c + (b \pm \delta_b) \bullet N_b = (1.007^{0.018}_{-0.018} \pm 0.018) \bullet 9153 + (0.902^{0.09}_{-0.084} \pm 0.087) \bullet 1125$$

$$= (9217.07^{164.754}_{-164.754} \pm 164.754) + (1014.75^{101.25}_{-94.5} \pm 97.875) = 10231.8 \pm 191.633$$

signal in data is: **10174.8** *with used SF=* **4.32265**

using the shortcuts: $\Delta_b = \delta_b \bullet N_b$ *and* $\Delta_{bc} = \sqrt{\Delta_b^2 + \Delta_c^2}$

$$\text{frac\_beauty} = \frac{b \bullet N_b}{b \bullet N_b + c \bullet N_c} = \frac{\Sigma^b}{\Sigma^b + \Sigma^c}$$

$$\text{fracErr\_beauty} = \sqrt{\left(\frac{\Delta_b}{\Sigma^b + \Sigma^c}\right)^2 + \left(\frac{\Delta_{bc} \bullet \Sigma^b}{(\Sigma^b + \Sigma^c)^2}\right)^2}$$

pythia prediction:

fraction from beauty: **0.0991759 ± 0.00974442** $f_b = \frac{N_b}{N_b + N_c} = 0.109457$

fraction from cahrm: **0.900824 ± 0.0233224** $f_c = \frac{N_c}{N_b + N_c} = 0.890543$

low pt

calculations with fit parameters c and b and fit errors δ_c and δ_b in bin **highpt**

$$N_{c+b} = (c \pm \delta_c) \bullet N_c + (b \pm \delta_b) \bullet N_b = (2.017^{0.014}_{-0.014} \pm 0.014) \bullet 41122 + (1.982^{0.066}_{-0.064} \pm 0.065) \bullet 4953$$

$$= (82943.1^{575.708}_{-575.708} \pm 575.708) + (9816.85^{326.898}_{-316.992} \pm 321.945) = 92759.9 \pm 659.612$$

signal in data is: **92729.2** *with used SF=* **3.75493**

using the shortcuts: $\Delta_b = \delta_b \bullet N_b$ *and* $\Delta_{bc} = \sqrt{\Delta_b^2 + \Delta_c^2}$

$$\text{frac\_beauty} = \frac{b \bullet N_b}{b \bullet N_b + c \bullet N_c} = \frac{\Sigma^b}{\Sigma^b + \Sigma^c}$$

$$\text{fracErr\_beauty} = \sqrt{\left(\frac{\Delta_b}{\Sigma^b + \Sigma^c}\right)^2 + \left(\frac{\Delta_{bc} \bullet \Sigma^b}{(\Sigma^b + \Sigma^c)^2}\right)^2}$$

pythia prediction:

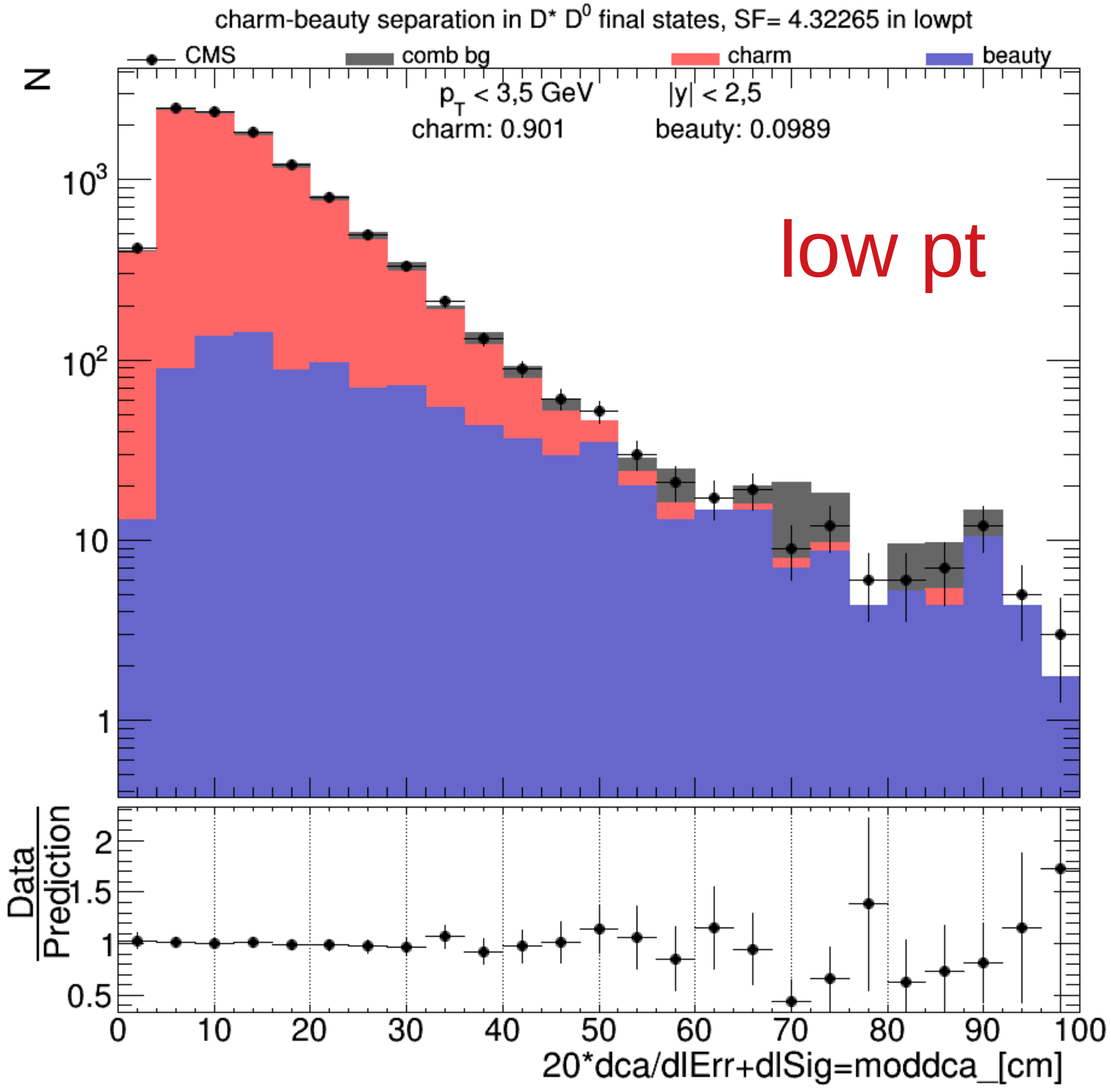
fraction from beauty: **0.105831 ± 0.00355139** $f_b = \frac{N_b}{N_b + N_c} = 0.107499$

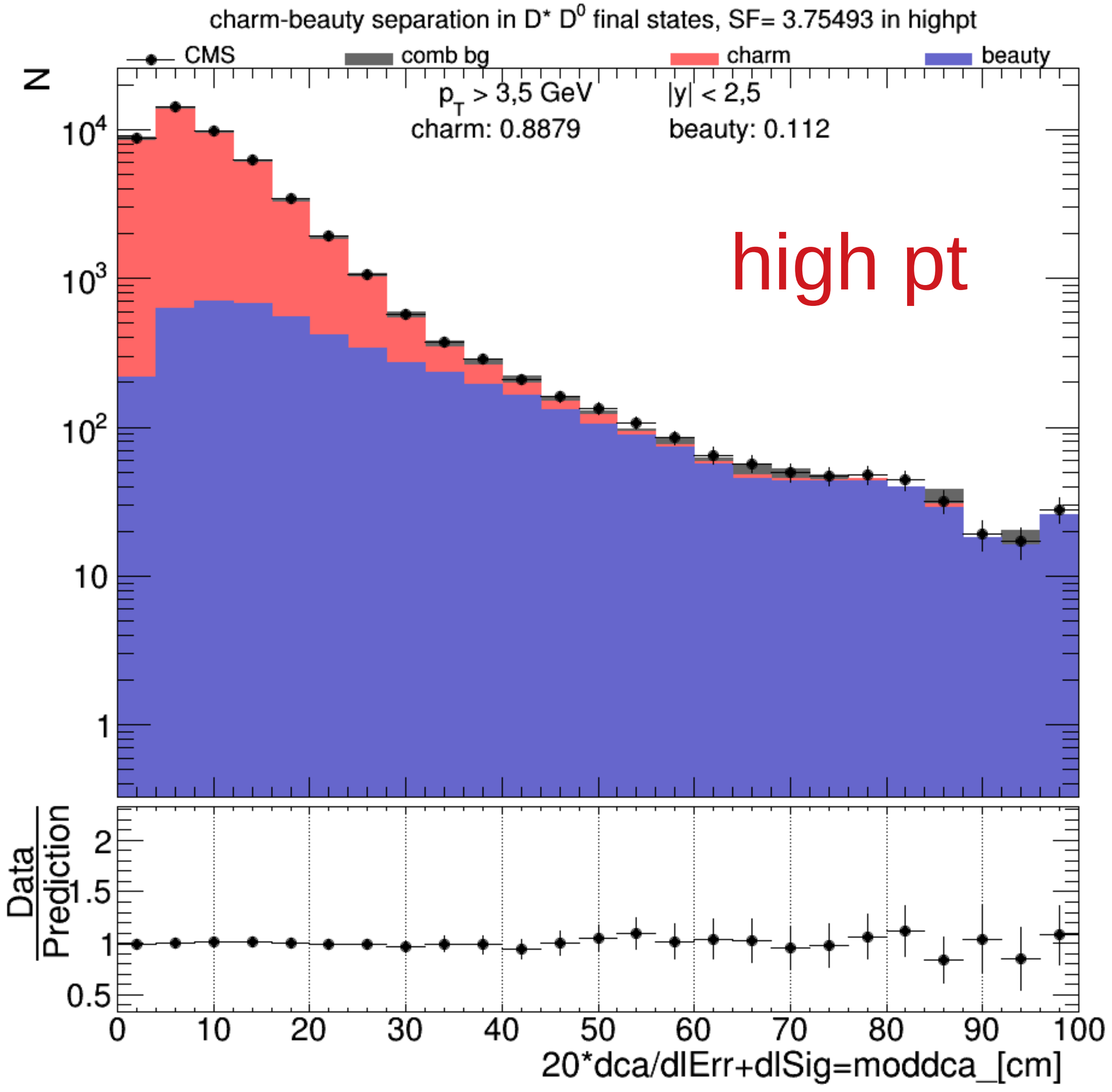
fraction from cahrm: **0.894169 ± 0.00888533** $f_c = \frac{N_c}{N_b + N_c} = 0.892501$

high pt

- dca*dlSig is working relatively good :-)

The charm beauty separation with moddca





- moddca is working but not really better than dca

The charm beauty separation with moddca

calculations with fit parameters c and b and fit errors δ_c and δ_b in bin **lowpt**

$$N_{c+b} = (c \pm \delta_c) \bullet N_c + (b \pm \delta_b) \bullet N_b = (1.005^{0.019}_{-0.019} \pm 0.019) \bullet 9155 + (0.868^{0.101}_{-0.095} \pm 0.098) \bullet 1164$$

$$= (9200.78^{173.945}_{-173.945} \pm 173.945) + (1010.35^{117.564}_{-110.58} \pm 114.072) = 10211.1 \pm 208.013$$

signal in data is: **10178.6** *with used SF=* **4.32265**

using the shortcuts: $\Delta_b = \delta_b \bullet N_b$ *and* $\Delta_{bc} = \sqrt{\Delta_b^2 + \Delta_c^2}$

$$\text{frac\_beauty} = \frac{b \bullet N_b}{b \bullet N_b + c \bullet N_c} = \frac{\Sigma^b}{\Sigma^b + \Sigma^c}$$

$$\text{fracErr\_beauty} = \sqrt{\left(\frac{\Delta_b}{\Sigma^b + \Sigma^c}\right)^2 + \left(\frac{\Delta_{bc} \bullet \Sigma^b}{(\Sigma^b + \Sigma^c)^2}\right)^2}$$

pythia prediction:

fraction from beauty: **0.0989462 ± 0.0113517** $f_b = \frac{N_b}{N_b + N_c} = 0.112802$

fraction from cahrm: **0.901054 ± 0.0250422** $f_c = \frac{N_c}{N_b + N_c} = 0.887198$

low pt

calculations with fit parameters c and b and fit errors δ_c and δ_b in bin **highpt**

$$N_{c+b} = (c \pm \delta_c) \bullet N_c + (b \pm \delta_b) \bullet N_b = (0.992^{0.008}_{-0.008} \pm 0.008) \bullet 41132 + (0.961^{0.039}_{-0.038} \pm 0.0385) \bullet 5358$$

$$= (40802.9^{329.056}_{-329.056} \pm 329.056) + (5149.04^{208.962}_{-203.604} \pm 206.283) = 45952 \pm 388.369$$

signal in data is: **45913.7** *with used SF=* **3.75493**

using the shortcuts: $\Delta_b = \delta_b \bullet N_b$ *and* $\Delta_{bc} = \sqrt{\Delta_b^2 + \Delta_c^2}$

$$\text{frac\_beauty} = \frac{b \bullet N_b}{b \bullet N_b + c \bullet N_c} = \frac{\Sigma^b}{\Sigma^b + \Sigma^c}$$

$$\text{fracErr\_beauty} = \sqrt{\left(\frac{\Delta_b}{\Sigma^b + \Sigma^c}\right)^2 + \left(\frac{\Delta_{bc} \bullet \Sigma^b}{(\Sigma^b + \Sigma^c)^2}\right)^2}$$

pythia prediction:

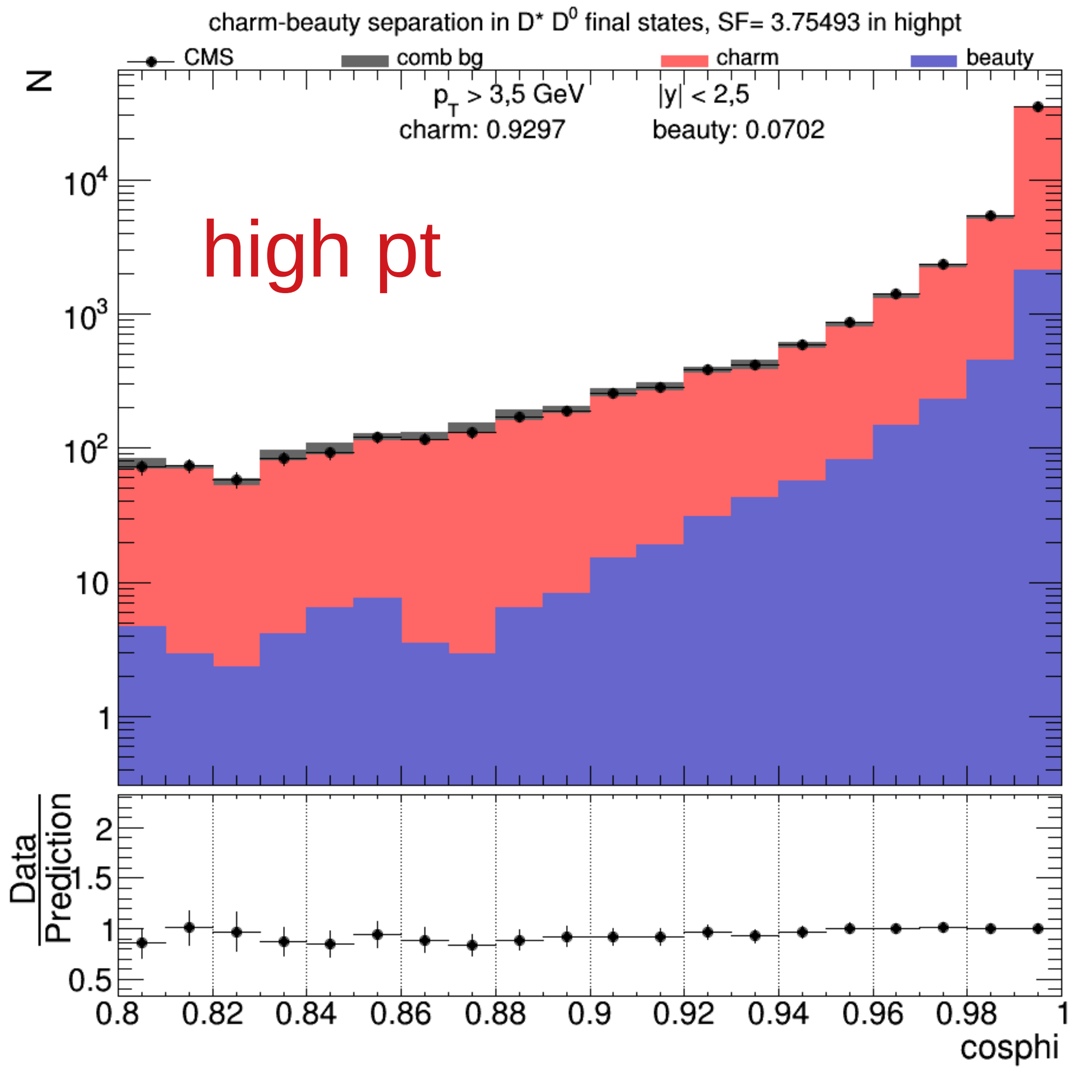
fraction from beauty: **0.112053 ± 0.00458791** $f_b = \frac{N_b}{N_b + N_c} = 0.115251$

fraction from cahrm: **0.887947 ± 0.0103729** $f_c = \frac{N_c}{N_b + N_c} = 0.884749$

high pt

- moddca is working but not really better than dca

The charm beauty separation with cosphi



calculations with fit parameters c and b and fit errors δ_c and δ_b in bin **highpt**

$$N_{c+b} = (c \pm \delta_c) \bullet N_c + (b \pm \delta_b) \bullet N_b = (1.042^{0.033}_{-0.033} \pm 0.033) \bullet 41134 + (0.59^{0.247}_{-0.246} \pm 0.2465) \bullet 5492$$

$$= (42861.6^{1357.42}_{-1357.42} \pm 1357.42) + (3240.28^{1356.52}_{-1351.03} \pm 1353.78) = 46101.9 \pm 1917.11$$

signal in data is: **46036.7** *with used SF=* **3.75493**

using the shortcuts: $\Delta_b = \delta_b \bullet N_b$ *and* $\Delta_{bc} = \sqrt{\Delta_b^2 + \Delta_c^2}$

$$\text{frac\_beauty} = \frac{b \bullet N_b}{b \bullet N_b + c \bullet N_c} = \frac{\Sigma^b}{\Sigma^b + \Sigma^c}$$

$$\text{fracErr\_beauty} = \sqrt{\left(\frac{\Delta_b}{\Sigma^b + \Sigma^c}\right)^2 + \left(\frac{\Delta_{bc} \bullet \Sigma^b}{(\Sigma^b + \Sigma^c)^2}\right)^2}$$

pythia prediction:

fraction from beauty: **0.0702851 ± 0.02951** $f_b = \frac{N_b}{N_b + N_c} = 0.117788$

fraction from cahrm: **0.929715 ± 0.0485968** $f_c = \frac{N_c}{N_b + N_c} = 0.882212$

- cosphi is not suitable for the charm beauty separation

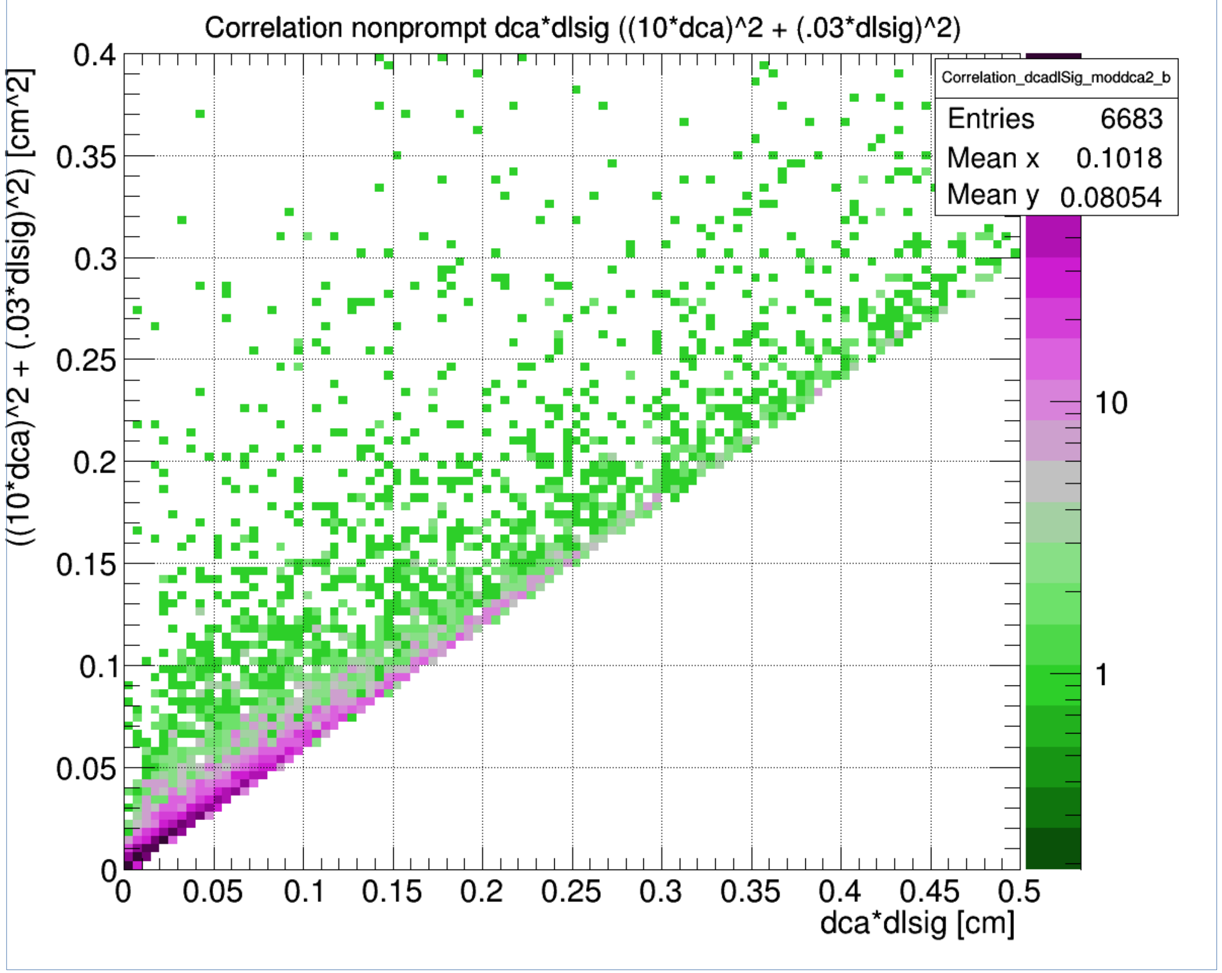
Summary and outlook

- dlSig not much better compared to dca
- dcadl*Sig is working relatively good :-)
- moddca is working but not really better than dca
- cosphi is not suitable for the charm beauty separation
- Next steps:
  - MC closure test on bin by bin separation with dca*dlSig
  - Use more statistic (2015 5TeV)

Backup

Correlation plots for dca*dlsig vs. ((10*dca)^2 + (.03*dlsig)^2)

beauty



charm