Update of Ω_c^0 lifetime measurement

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Ω_c^0 lifetime measurement meeting

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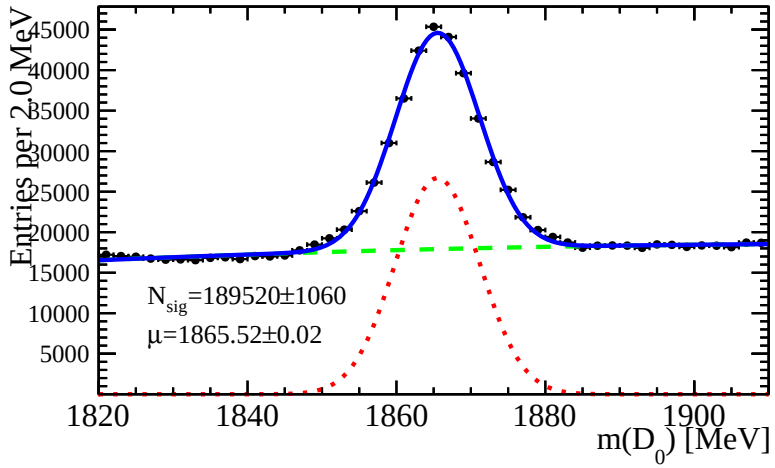
Mass fit

- Define diffrent mass regions in the mass spectrum
  - Sideband: $[1820, 1830] \cup [1910, 1920]$
  - SignalWindow: $[1865 - 2.5 \times \sigma, 1865 + 2.5 \times \sigma]$
- Fit to the D0_M of data sample that passed all selctions
- For background: SignalWindow/Sideband $= 1.439$
- For signal: SignalWindow/TotalRegion $= 0.987$



$\log \chi^2_{IP}$ modelling

- Bukin function, a modified Novosibirsk function with extended tail parameters

$$\mathcal{P}(x;\mu,\sigma,\xi,\rho_1,\rho_2) = \begin{cases} \exp\left\{ \dfrac{(x-x_1)\xi\sqrt{\xi^2+1}\sqrt{2\ln 2}}{\sigma\left(\sqrt{\xi^2+1}-\xi\right)^2 \ln\left(\sqrt{\xi^2+1}+\xi\right)} + \rho_1\left(\dfrac{x-x_1}{\mu-x_1}\right)^2 - \ln 2 \right\} & x \le x_1, \\ \exp\left\{ -\left[\dfrac{\ln\left(1+2\xi\sqrt{\xi^2+1}\dfrac{x-\mu}{\sigma\sqrt{2\ln 2}}\right)}{\ln\left(1+2\xi^2-2\xi\sqrt{\xi^2+1}\right)}\right]^2 \times \ln 2 \right\} & x_1 < x < x_2, \\ \exp\left\{ \dfrac{(x-x_2)\xi\sqrt{\xi^2+1}\sqrt{2\ln 2}}{\sigma\left(\sqrt{\xi^2+1}-\xi\right)^2 \ln\left(\sqrt{\xi^2+1}+\xi\right)} + \rho_2\left(\dfrac{x-x_2}{\mu-x_2}\right)^2 - \ln 2 \right\} & x \ge x_2. \end{cases}$$

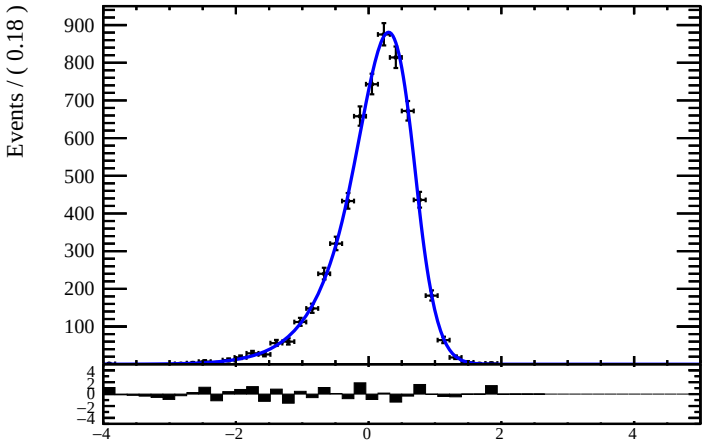
where

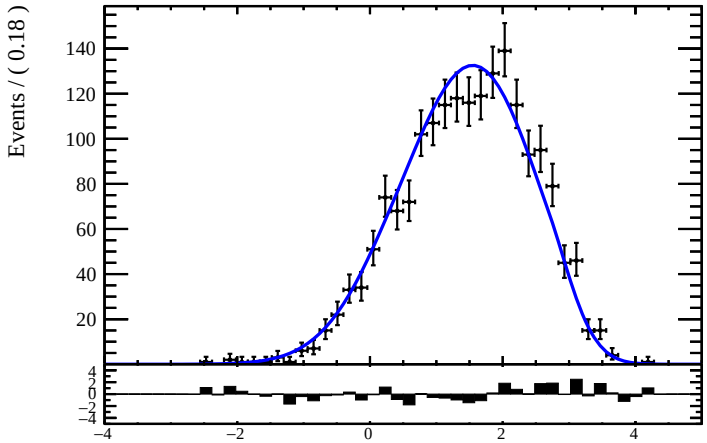
$$x_1 = \mu + \sigma\sqrt{2\ln 2}\left(\frac{\xi}{\sqrt{\xi^2+1}} - 1\right)$$

$$x_2 = \mu + \sigma\sqrt{2\ln 2}\left(\frac{\xi}{\sqrt{\xi^2+1}} + 1\right)$$

Fit to IPCHI2 of MC sample

- Fit with all parameters free
- Prompt component (left) and secondary component (right)



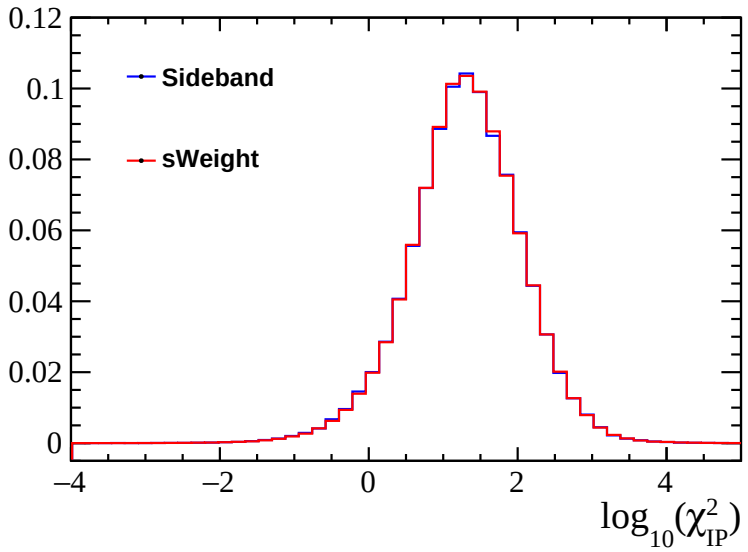


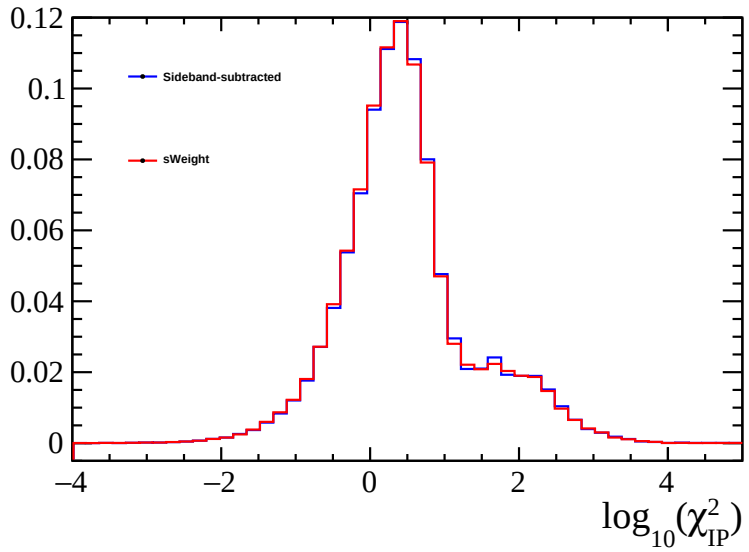
Fit to IPCHI2 of data sample

- Approach 1: Fit to data in the SignalWindow
  - Fixed parameters: prompt shape parameters
  - Fix background contribution with shape of sideband data and number of backgrounds normalized to SignalWindow
- Approach 2: Fit to sWeighted data
  - Fixed parameters: prompt shape parameters

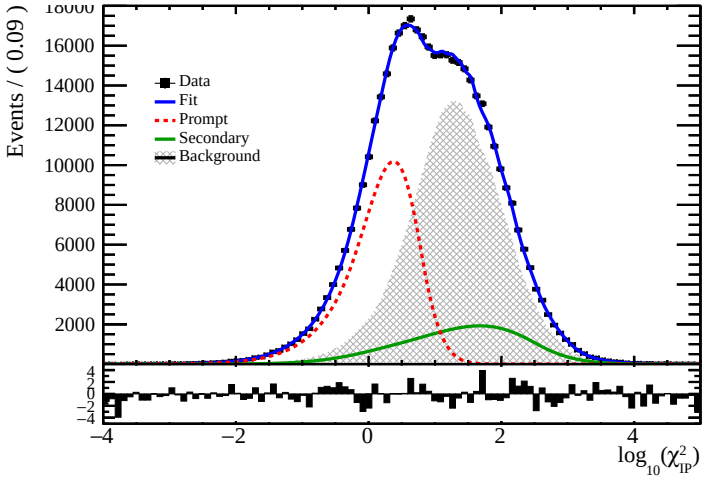
Comparison of distributions

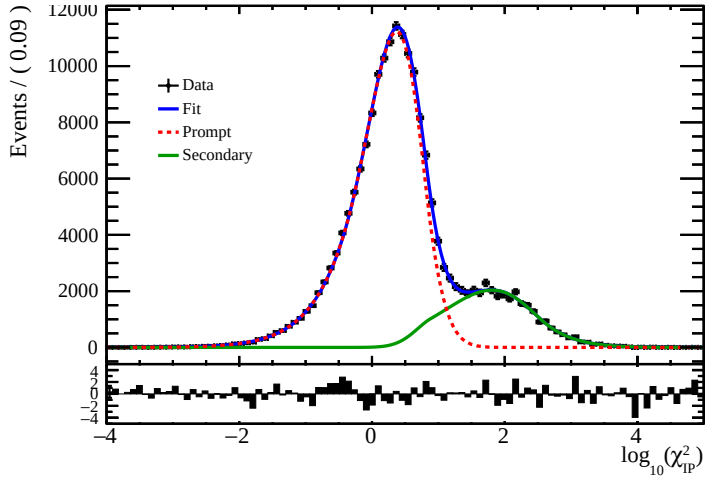
- Distributions of two approaches agree well
  - IPCHI2 of sideband background sample and total sample with background sWeight (left)
  - IPCHI2 of SignalWindow sample with sideband-background subtraction and total sample with signal sWeight (right)





Fit results

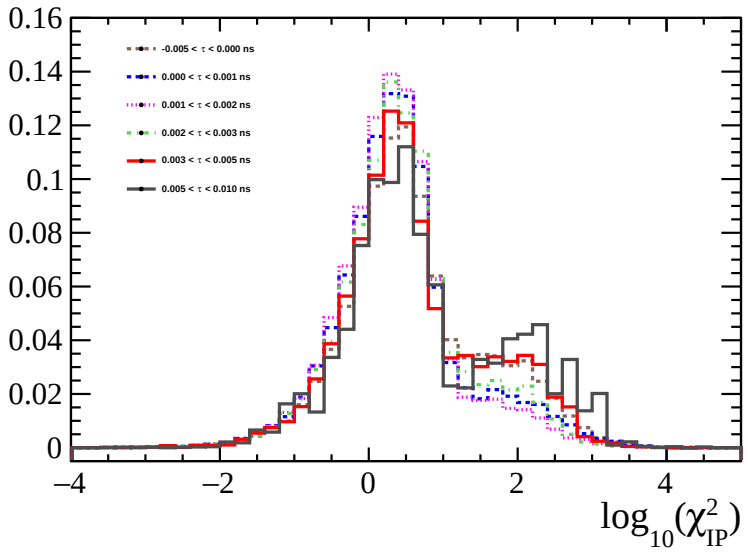


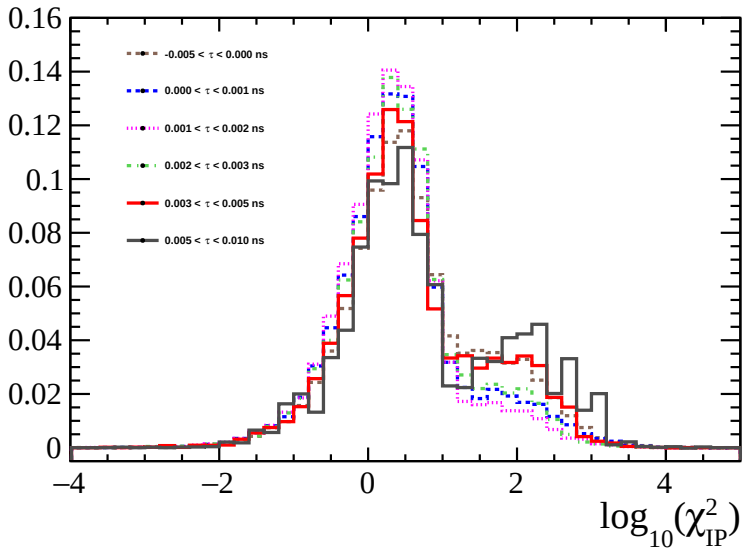


Sample	MC	MC	KeysPdf	KeysPdf	sWeight	sWeight
Component	prompt	secondary	prompt	secondary	prompt	secondary
μ	0.30 ± 0.02	1.55 ± 0.09	0.38 ± 0.00	1.68 ± 0.04	0.37 ± 2.72	1.81 ± 7.55
σ	0.45 ± 0.01	1.04 ± 0.03	0.45	0.93 ± 0.06	0.45	0.70 ± 66.88
ξ	-0.17 ± 0.02	-0.05 ± 0.07	-0.17	-0.19 ± 0.04	-0.17	-0.12 ± 13.23
ρ_1	-0.05 ± 0.02	-0.83 ± 0.31	-0.05	-0.86 ± 0.39	-0.05	-3.93 ± 226.48
$\rho 2$	-0.62 ± 0.17	-2.62 ± 0.95	-0.62	-0.67 ± 0.15	-0.62	-0.24 ± 29.02
N_{prompt}	5938 ± 77	-	137359 ± 1978	-	151298 ± 785915	-
$N_{secondary}$	-	1597 ± 40	-	49450 ± 2022	-	38202 ± 802666

IPCHI2 in different decay time bins

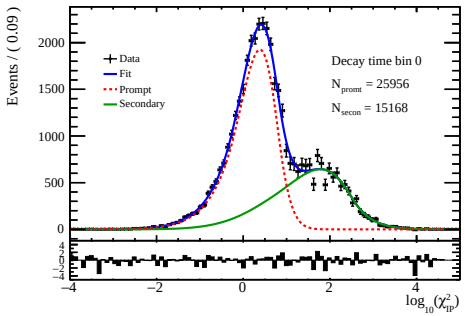
- Binning: [-0.005, 0., 0.001, 0.002, 0.003, 0.005, 0.01] ns
- sWeight from total mass fit (left) and mass fits in each decay time bin (right)

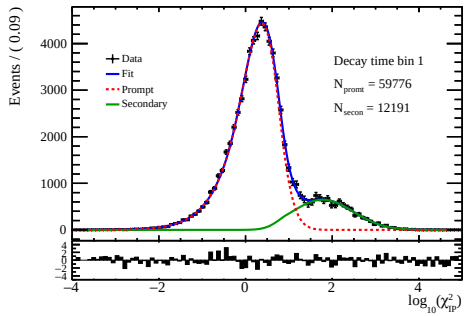


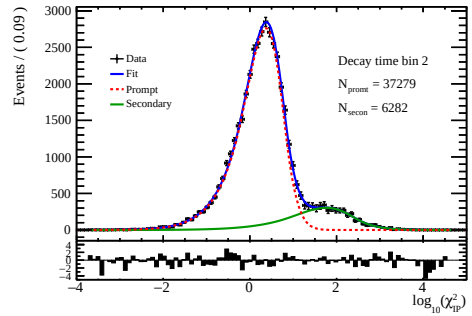


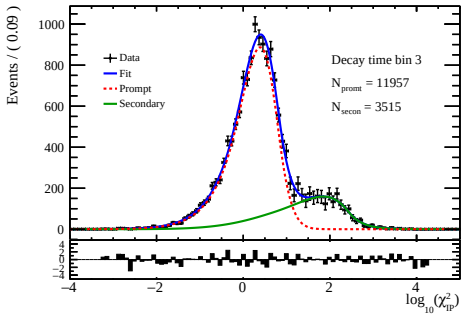
Fit to IPCHI2 in different decay time bins

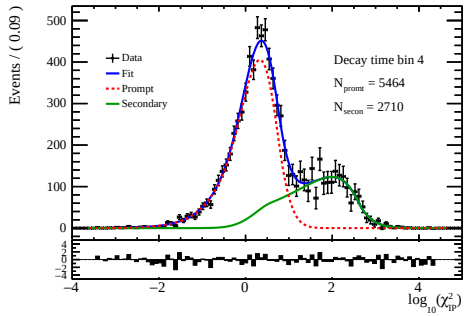
- Fix to the same prompt parameters
- The 3rd and 4th bin `STATUS=NOT POSDEF`

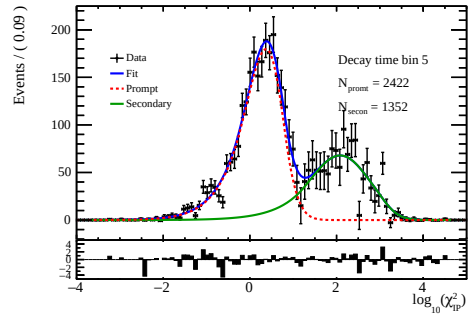












MC request

- Re-decay fast simulation sample (Progress: 50%)
  - `evt+std://MC/2016/26104081/Beam6500GeV-2016-MagDown-Nu1.6-25ns-Pythia8/Sim09d-ReDecay01/Trig0x6138160F/Reco16/Turbo03/Stripping28r1NoPrescalingFlagged/ALLSTREAMS.DST`
  - `evt+std://MC/2016/26104081/Beam6500GeV-2016-MagUp-Nu1.6-25ns-Pythia8/Sim09d-ReDecay01/Trig0x6138160F/Reco16/Turbo03/Stripping28r1NoPrescalingFlagged/ALLSTREAMS.DST`
- Additional option to improve the statistics (ongoing)
  - Generator-level PT and P cuts of PT$>400\,\mathrm{MeV}$ and P$>800\,\mathrm{MeV}$ are safe

Backup slides

Samples of $D^{*+} \to D^0(\to K^-K^+\pi^-\pi^+)\pi^+$ mode

- Data sample
  - 2016 Collision data collected by `Hlt2CharmHadDstp2D0Pip_D02KmKpPimPipTurbo`
- 2016 MC sample
  - EventType: 27165003
  - Identify prompt contribution with D^{*+} MOTHER ID

Turbo selection

DaughtersCuts	TRCHI2DOF < 3.0 PT > 250.0 P > 1000.0 MIPCHI2DV(PRIMARY) > 3.0
K	PIDK > 5
π	PIDK < 5
CombinationCuts	(APT1+APT2+APT3+APT4) > 1800.0 AP > 25000.0 ADOCA(i,4) < 100.0, i=1,2,3 ACHI2DOCA(i,4) < 10.0, i=1,2,3
MotherCuts	CHI2VXNDOF < 12.0 PT > 2000.0 P > 30000.0 BPVDIRA > cos(0.02) BPVLTIME() > 0.0001 BPVVDCHI2 > 25

Pre-selections

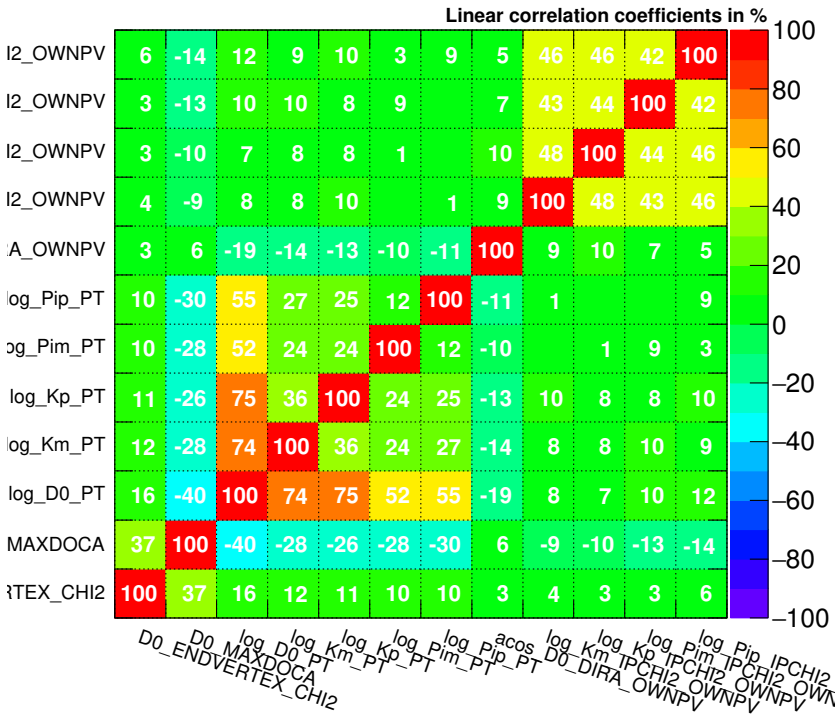
- Additional PT cuts due to generator-level cuts in MC sample
- Further PID cuts to be consistent to signal channel

Variable	Cuts
D0_PT	> 2900 MeV
Daughters' PT	> 300 MeV
Daughters' P	2900 MeV
K PIDK	> 10
π PIDK	< 0

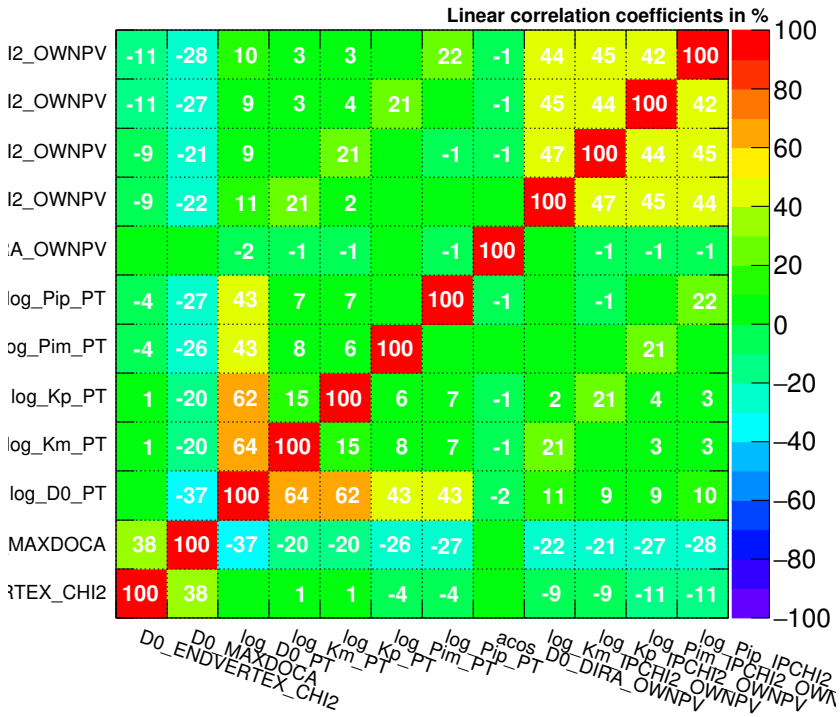
BDT with MC sample as signal

- Try to train with MC sample as signal and sideband data sample as background
- Similar training variables as signal mode: Vertex quality, PT, IPCHI2 (not include PID variables)
- Correlation matrices below

Correlation Matrix (signal)

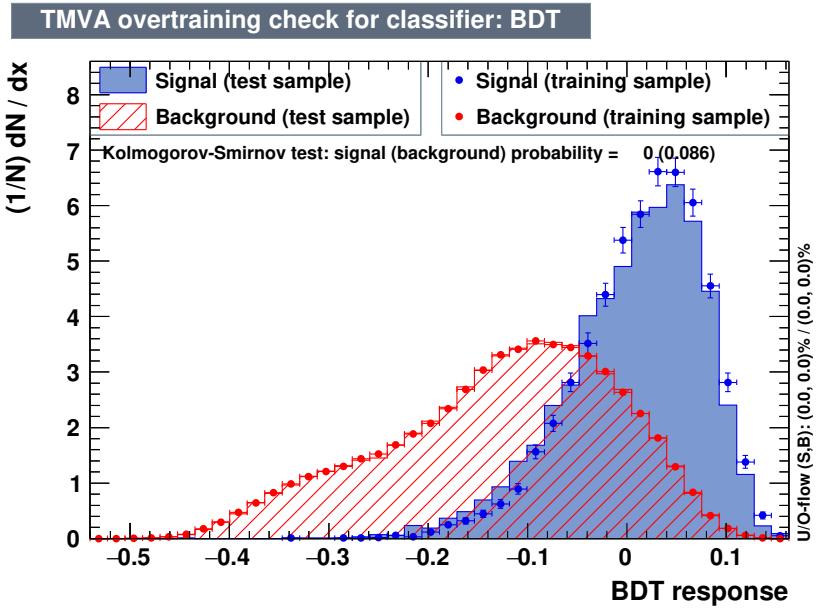


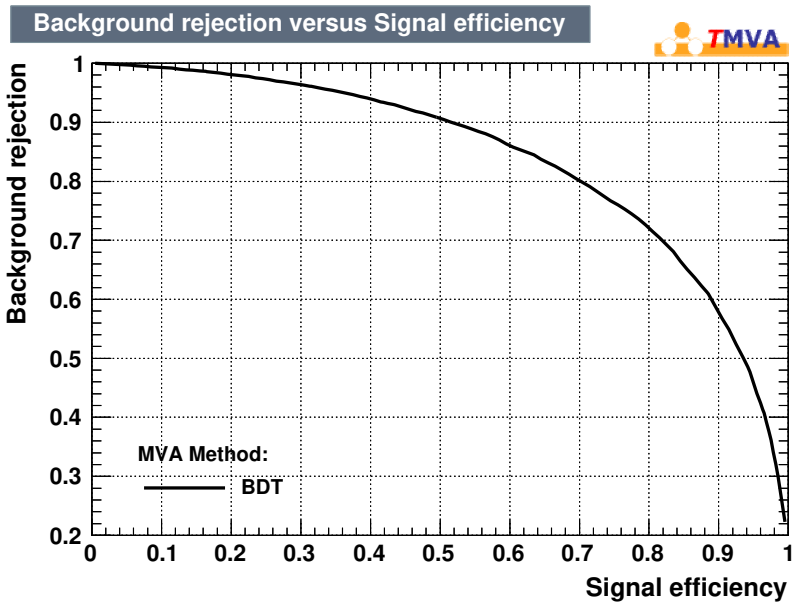
Correlation Matrix (background)



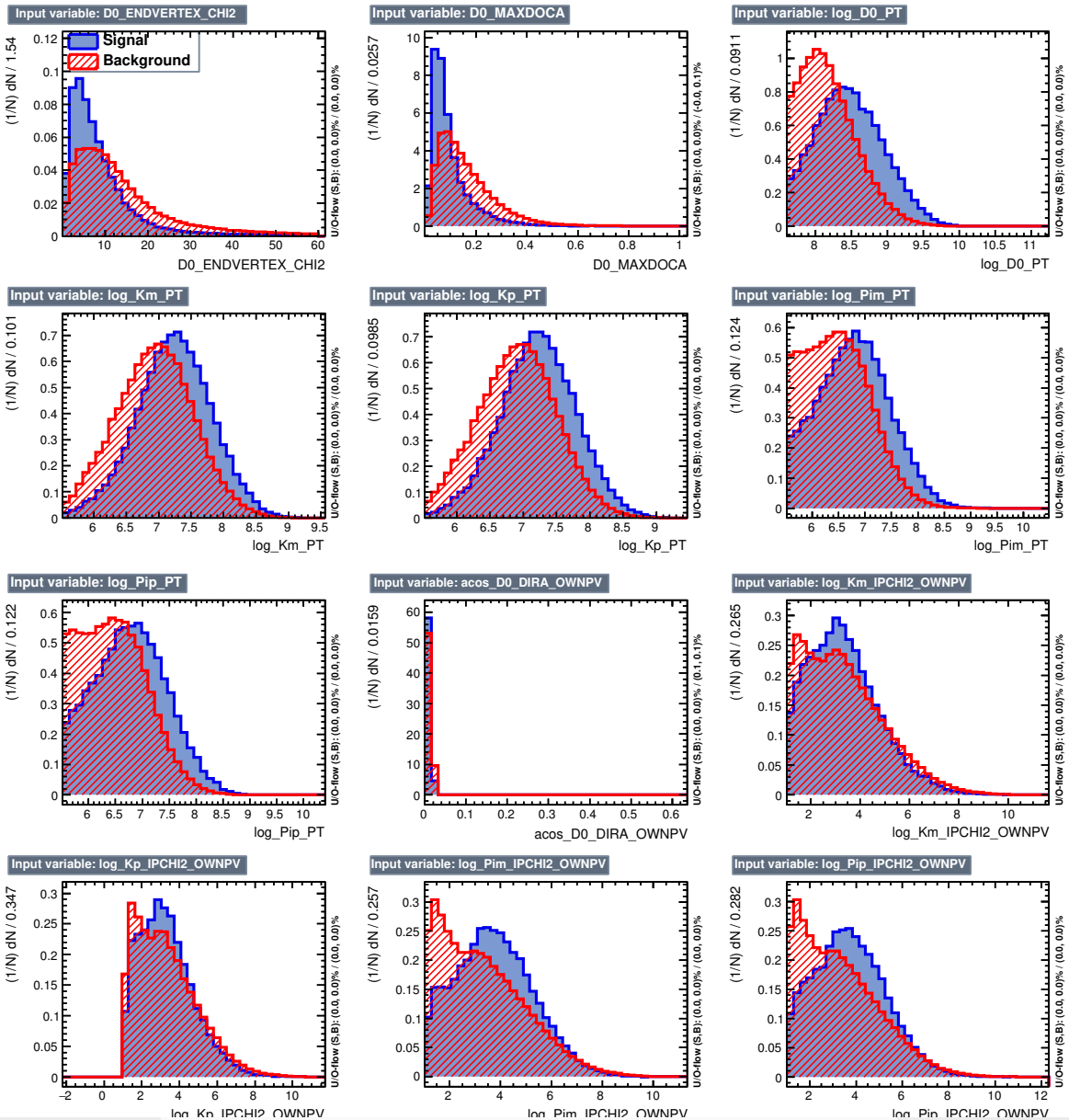
BDT performance

- BDT response (left) and ROC curve (right)
- Choose BDT> -0.1 to get high signal efficiency and improved signal/background ratio

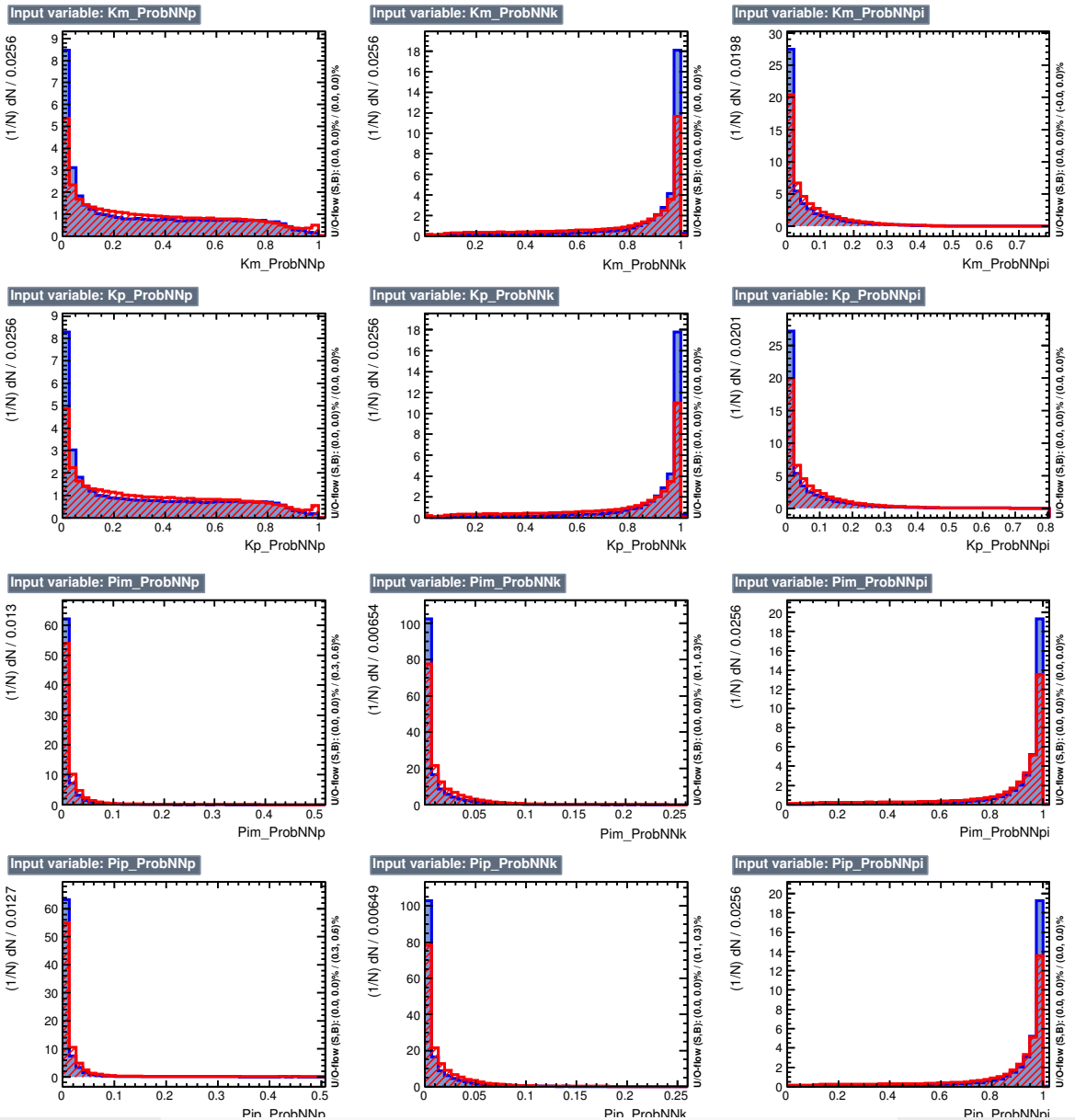




Training variables with sWeighted sample as signal



Training variables with sWeighted sample as signal



Turbo selections of $\Omega_c^0 \to pK^-K^-\pi^+$

Items	Cuts
Daughter K	(TRCHI2DOF<3) (PT>500.) (P>1000.) (PIDK>10.) (MIPCHI2DV(PRIMARY) > 4.0)
Daughter π	(TRCHI2DOF<3) (PT>500.) (P>1000.) (PIDK<0.) (MIPCHI2DV(PRIMARY) > 4.0)
Daughter p	(TRCHI2DOF<3) (PT>500.) (P > 10000.) (PIDp > 10.0) & ((PIDp-PIDK) > 5.0) (MIPCHI2DV(PRIMARY) > 4.0)
CombinationCut	(in_range(2386.0, AM, 2780.0)) ((APT1+APT2+APT3+APT4) > 3000.0) (AHASCHILD(PT > 1000.0)) (ANUM(PT > 500.0) >= 2) (AHASCHILD((MIPCHI2DV(PRIMARY)) > 8.0)) (ANUM(MIPCHI2DV(PRIMARY) > 6.0) >= 2)
MotherCut	(VFASPF(VCHI2PDOF) < 10.0) (BPVDIRA > cos(0.01)) (BPVLTIME() > 0.0001) (BPVVDCHI2 > 10.0)