

Study of decay $B^0 \rightarrow K^+ K^- \pi^0$ at Belle II
Group meeting

Quan Wen, Kairui Huang

Samples at Belle II

□ Data samples(will be used)

- Run1: 365.29 fb^{-1} data samples collected at $\Upsilon(4S)$ peak $\sqrt{s} = 10.58 \text{ GeV}$
- Run2: 133.12 fb^{-1} data samples collected at $\Upsilon(4S)$ peak $\sqrt{s} = 10.58 \text{ GeV}$

□ MC16rd simulation sample

- Generic MC samples at 4S for Run1: 1429.226 fb^{-1} Run2: 517.112 fb^{-1}
- Signal MCrd: 2×10^6 events

□ Skim

- HLT hardon skim(f_bhadronic_p2)

Preliminary Selection

□ Charged track candidate:

- ✓ $dr < 0.5$ cm, $|dz| < 2.0$ cm and θ in CDC Acceptance
- ✓ $nTracks \geq 2$
- ✓ **Kaon PID: $KaonIDNN > 0.6$**

□ γ candidate:

- ✓ $0.2976 < \theta < 2.6180$ rad
- ✓ $clusterNHits > 1.5$
- ✓ $|clusterTiming| < 200$ ns
- ✓ $E_{\gamma}^{fEndcap} > 80$ MeV, $E_{\gamma}^{Barrel} > 30$ MeV, $E_{\gamma}^{bEndcap} > 60$ MeV

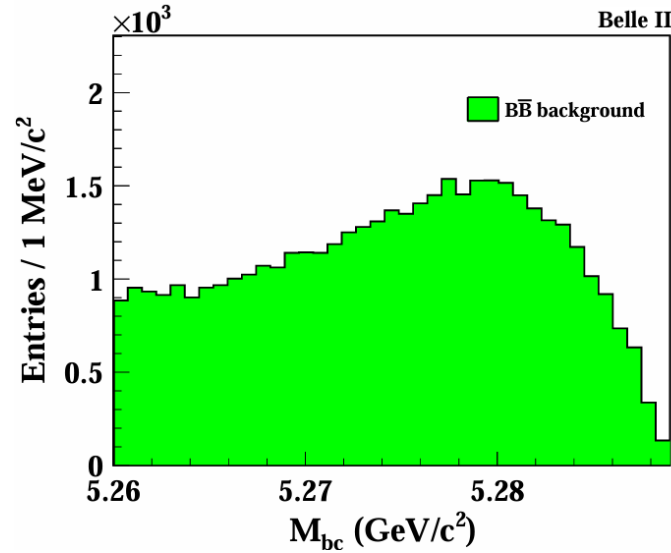
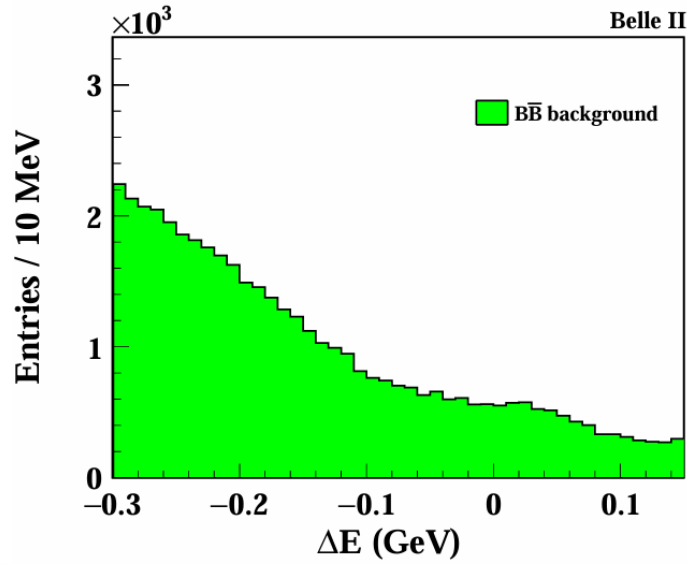
□ π^0 candidate:

- ✓ 105 MeV $< M_{\gamma\gamma} < 150$ MeV

□ B^0 candidate:

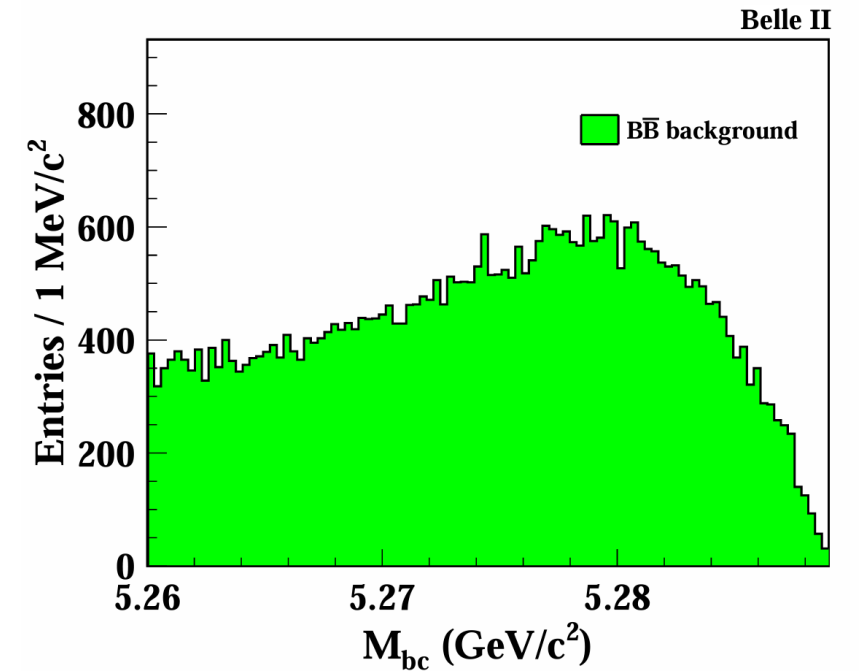
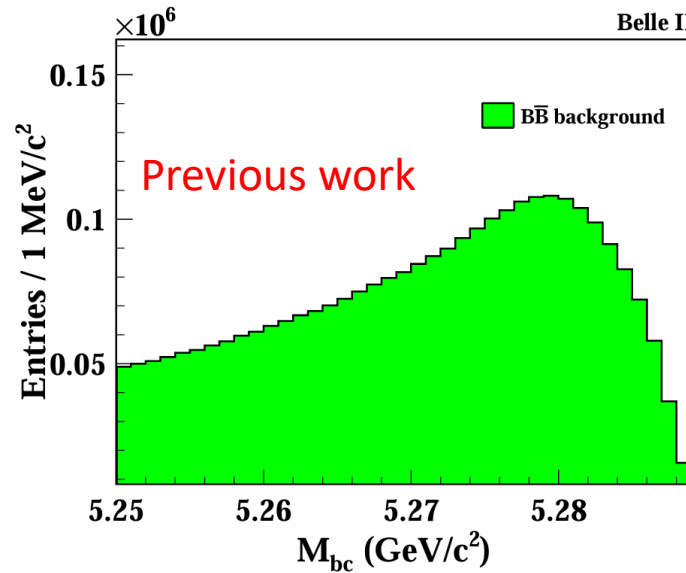
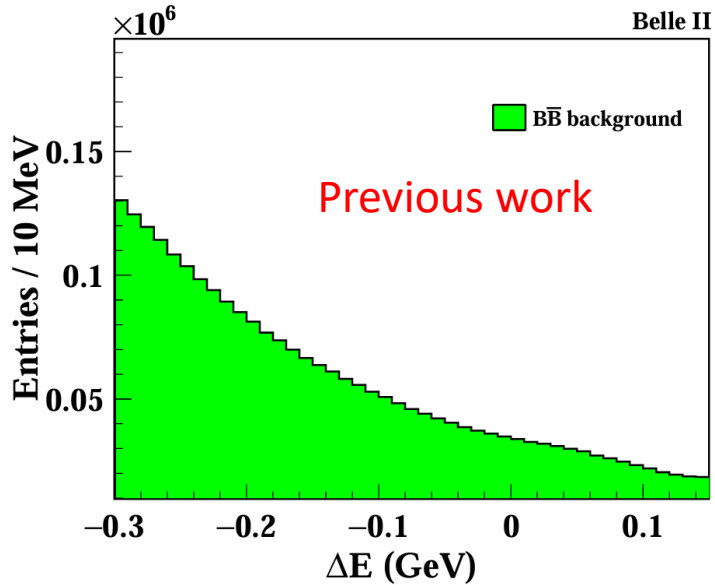
- ✓ **5.26 GeV $< M_{bc} < 5.289$ GeV** && -0.3 GeV $< \Delta E < 0.15$ GeV

Preliminary Selection

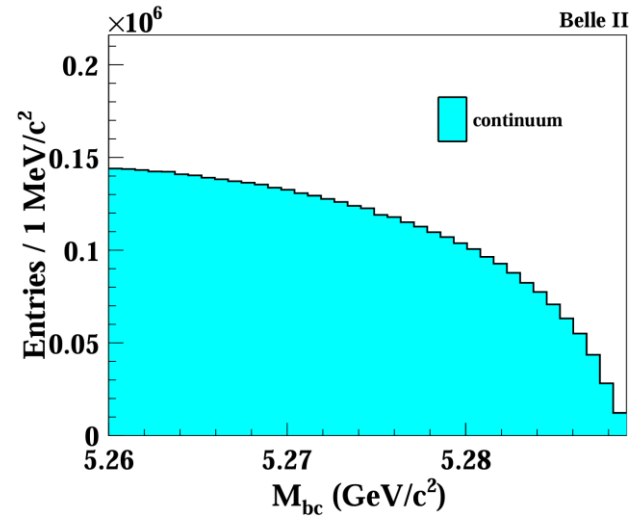
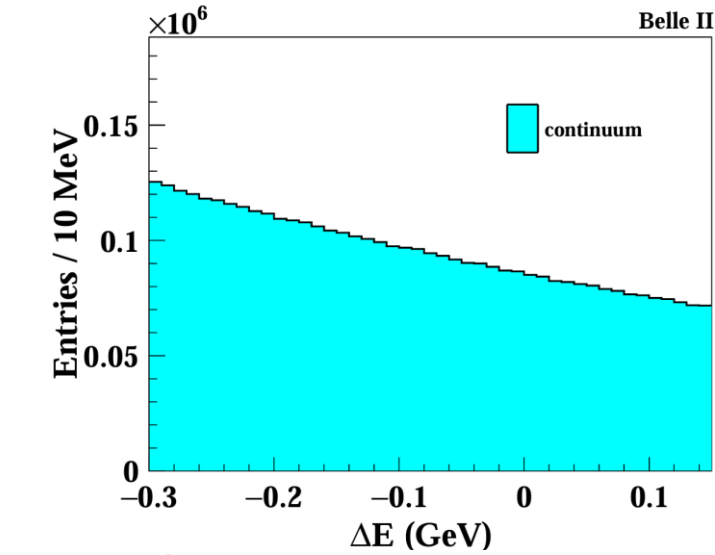


43599 events for BB bkg

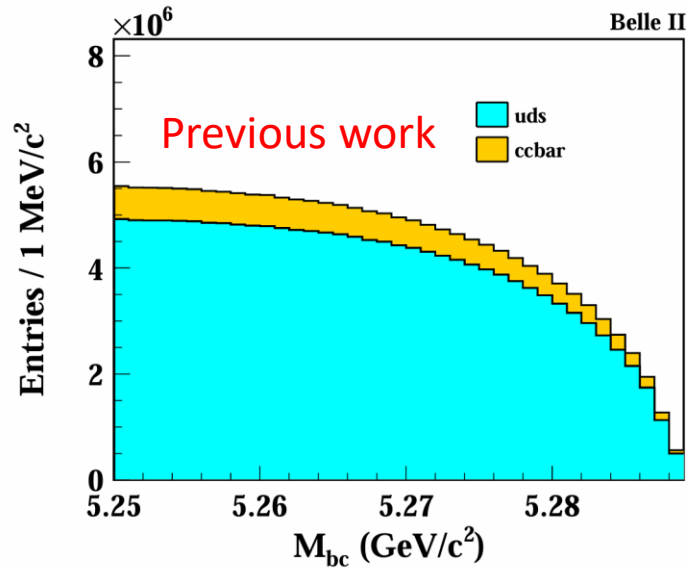
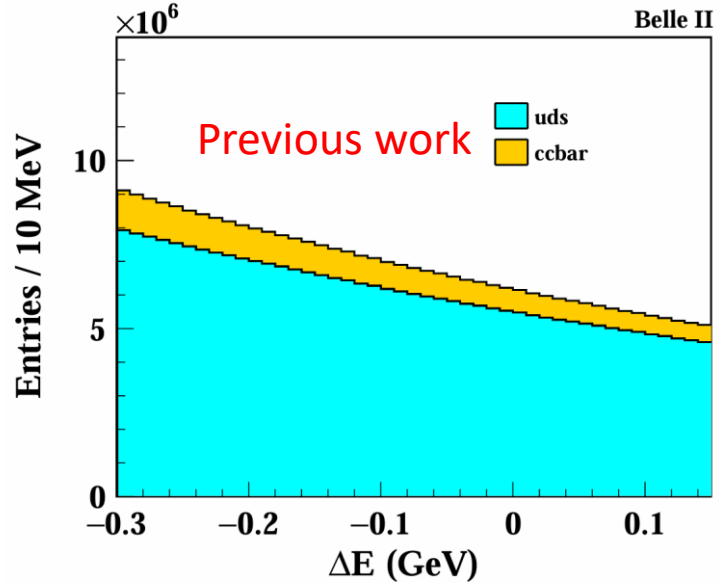
□ ΔE and M_{bc} distribution from BB bkg



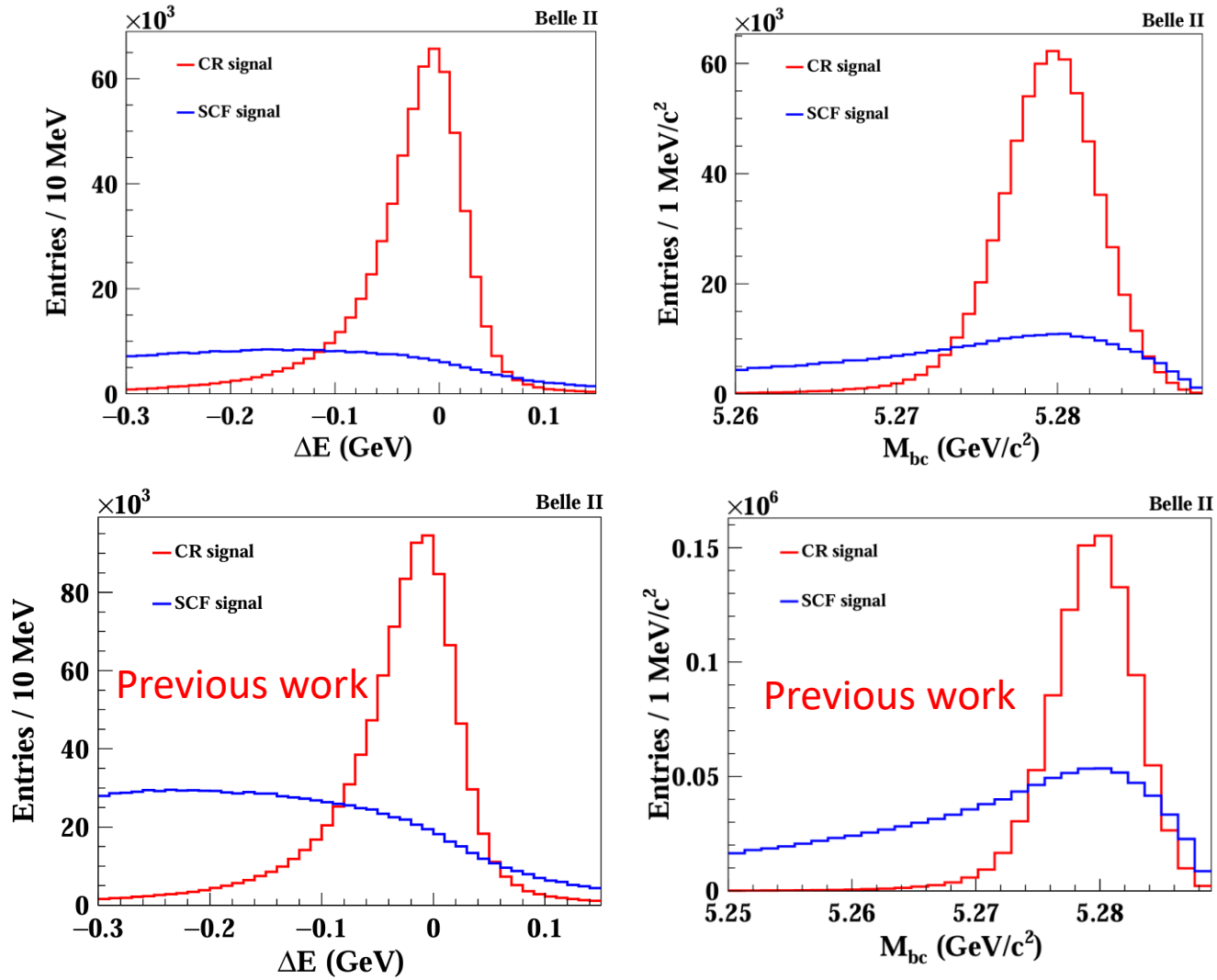
Preliminary Selection



□ ΔE and M_{bc} distribution from continuum bkg



Preliminary Selection



□ ΔE and M_{bc} distribution of sig

FBDT Training (MC-based)

□ Train and Test sample

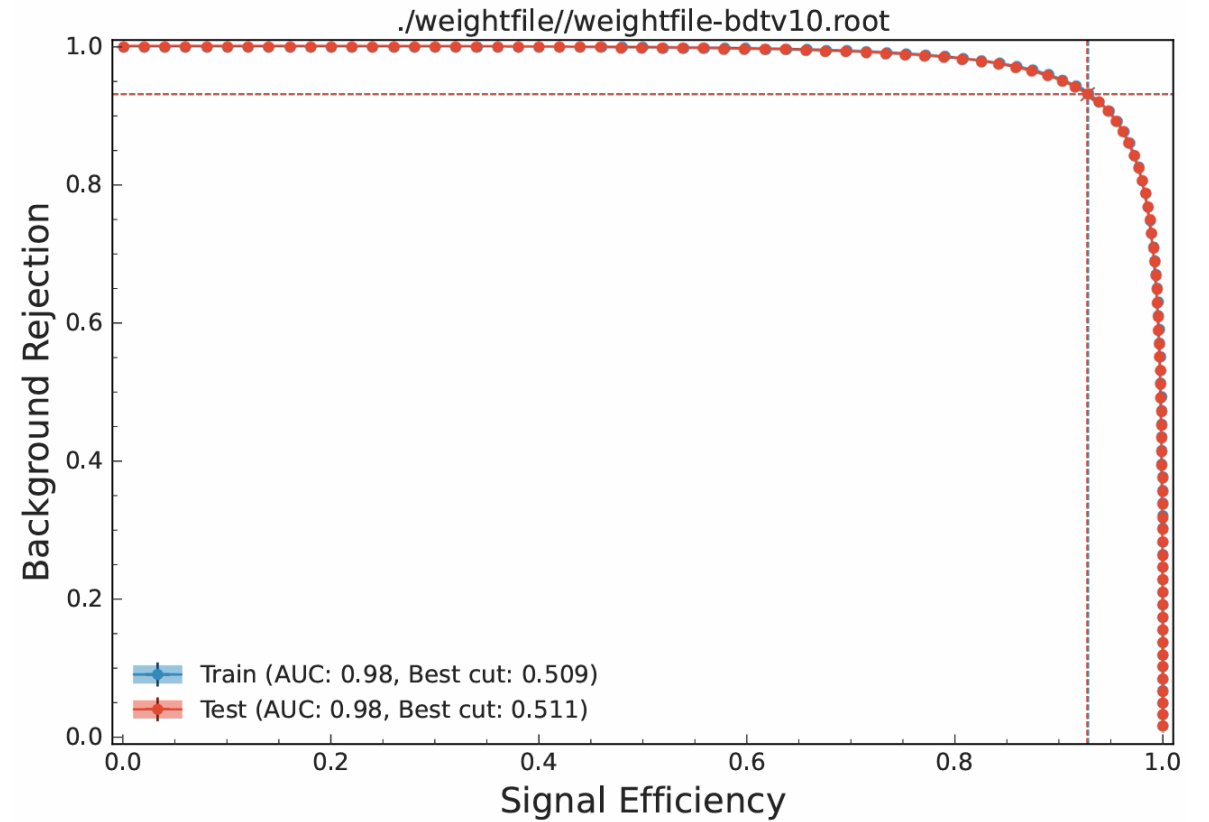
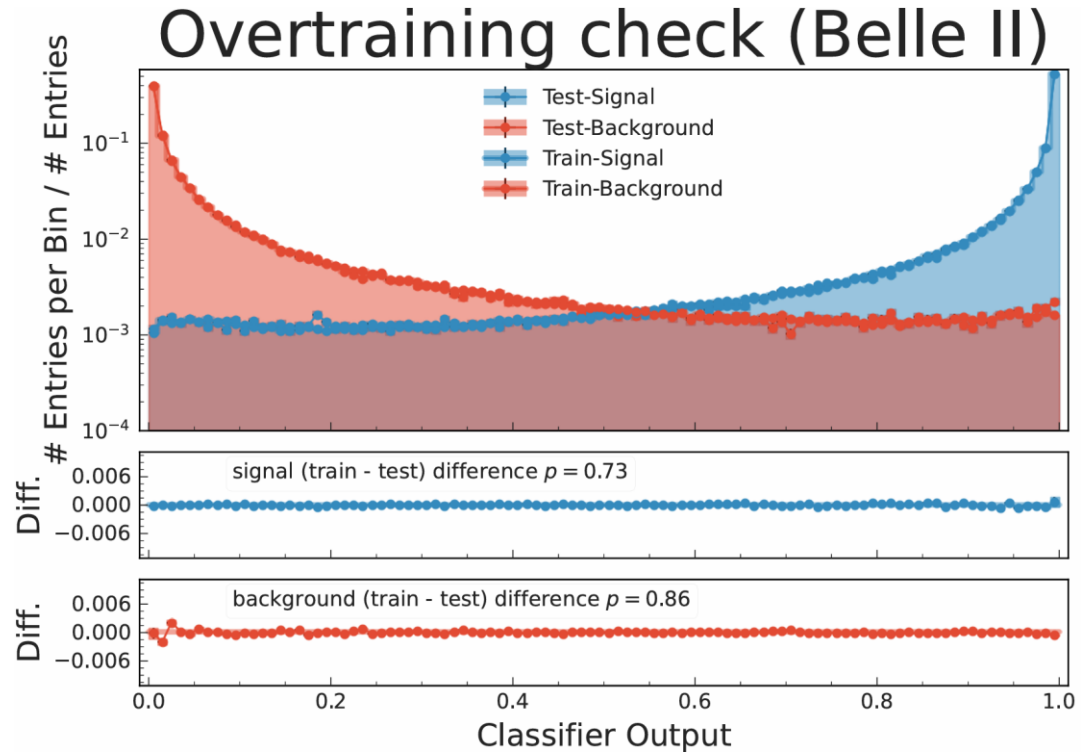
Train sample: 4×10^5 CR signal events and continuum background events

Test sample: 1×10^5 CR signal events and continuum background events

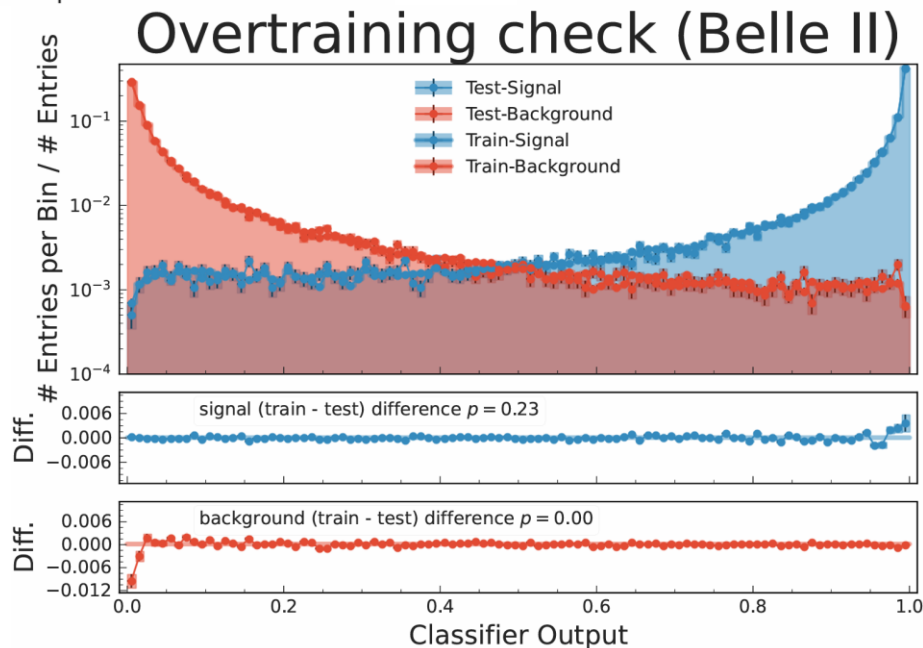
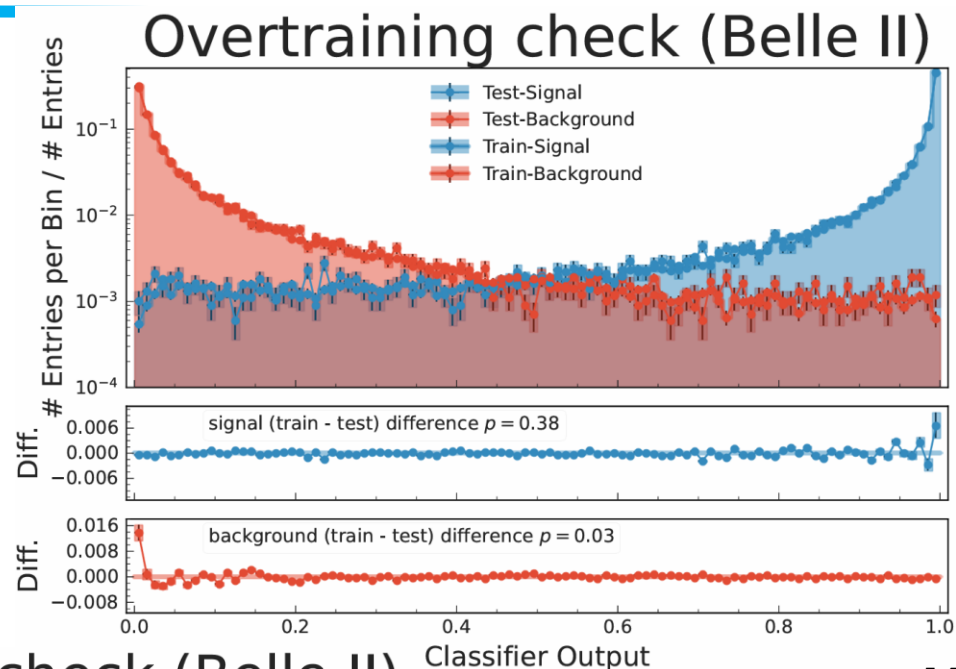
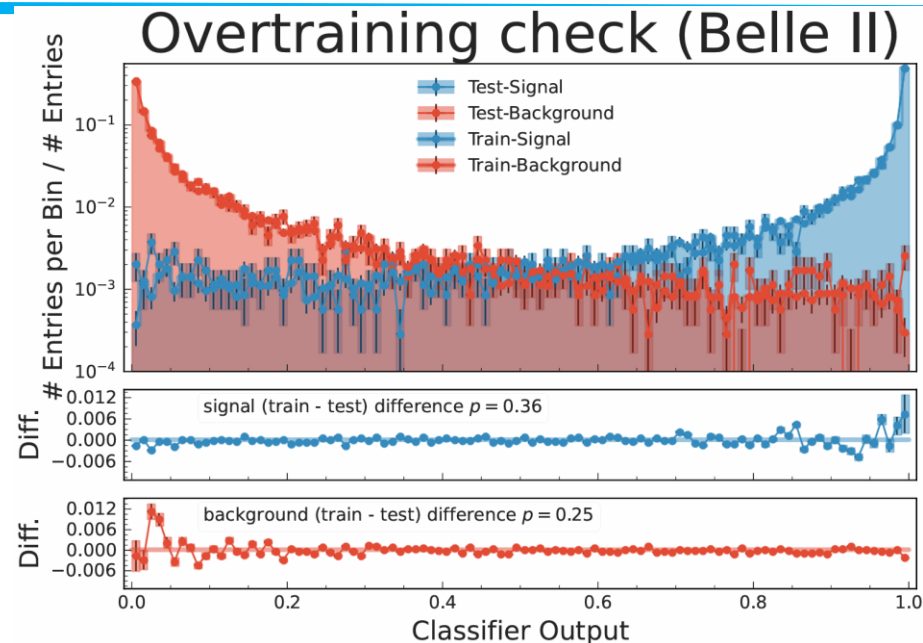
24 Variables used in FBDT training comes from previous work

Variable	Abbreviation	Variable	Abbreviation
foxWolframR2	foxWo4	DeltaZ	Delta
cosTBTO	cosTB	abs_qrGNN	abs_q
CleoConeCS2	CleoC4	qpKinLepton	qpKin
KSFVVariablesHso12	KSFV7	foxWolframR3	foxWo3
KSFVVariablesHso02	KSFV6	qpSlowPion	qpSlo
foxWolframR4	foxWo2	KSFVVariablesHso0	KSFV5
CleoConeCS3	CleoC3	foxWolframR1	foxWo1
CleoConeCS2ROE	CleoC2	KSFVVariablesHso2	KSFV4
thrustOm	thrus2	qpMaximumPstar	qpMax
chiProb	chiPr	KSFVVariablesHso22FS1	KSFV3
thrust	thrus1	KSFVVariablesHso20FS1	KSFV2
KSFVVariablesHso10FS1	KSFV1	CleoConeCS3ROE	CleoC1

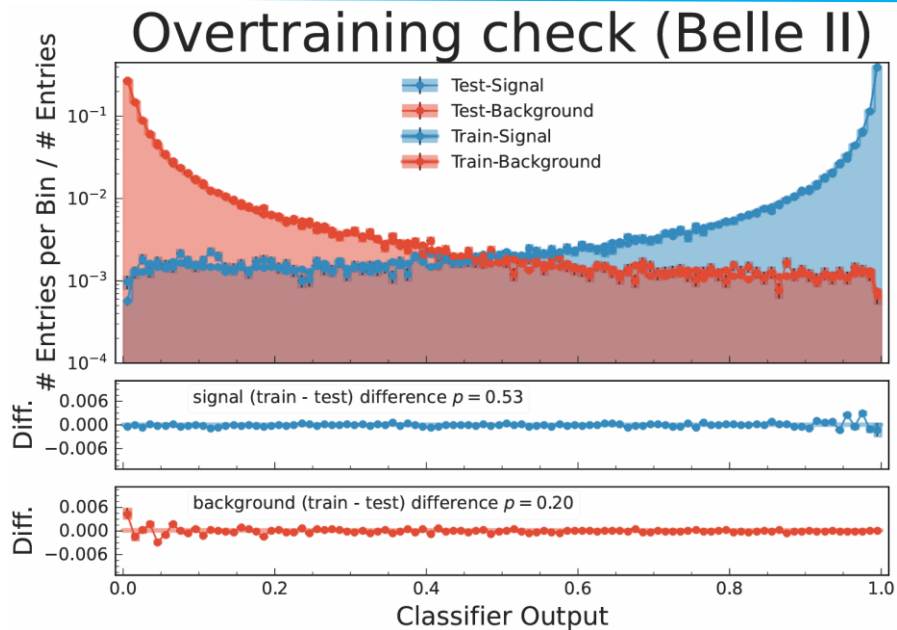
FBDT Training (MC-based)



FBDT Training (offres-data-based)

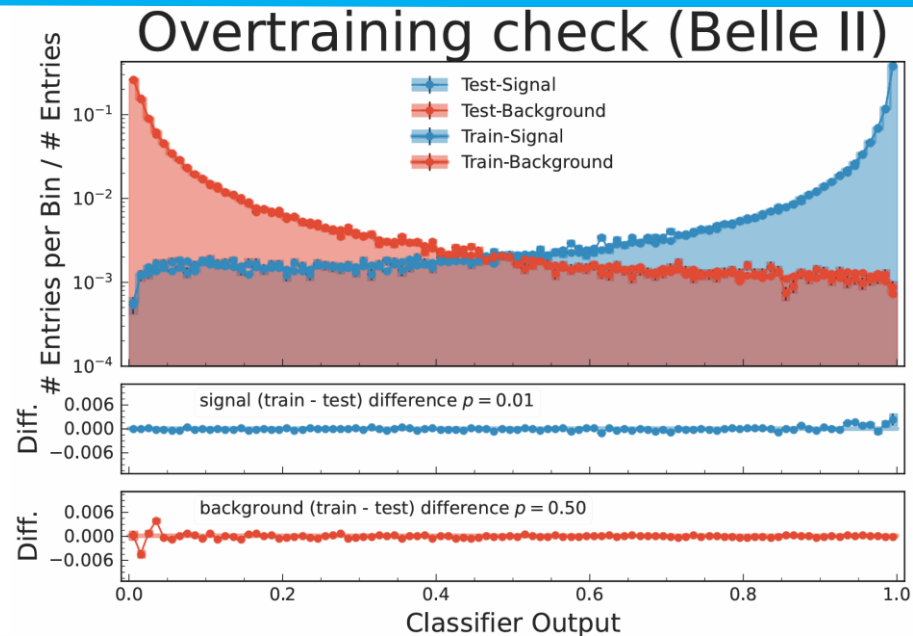


FBDT Training (offres-data-based)

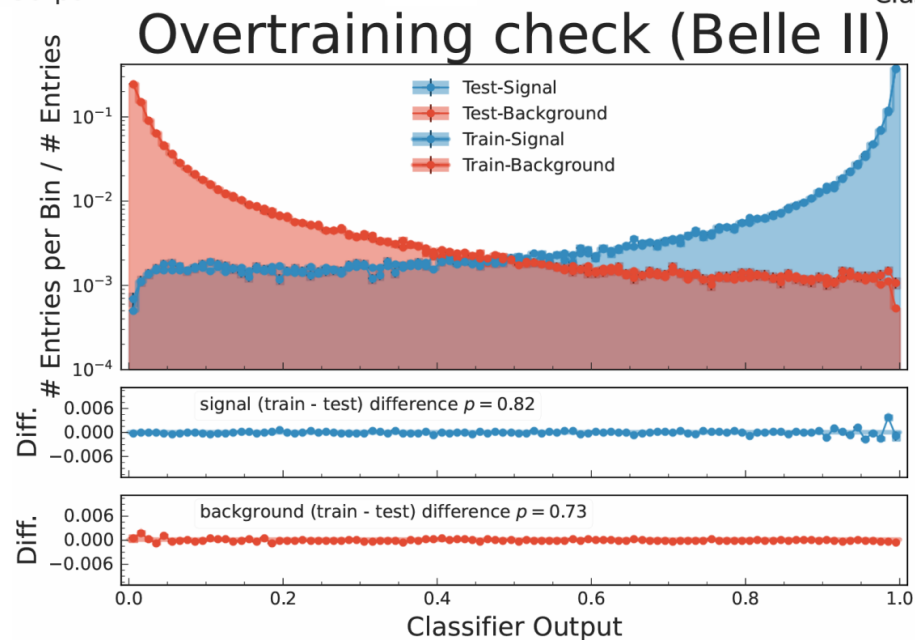


$M_{bc} > 5.22 \text{ GeV}$
Total events: 14×10^4

$M_{bc} > 5.20 \text{ GeV}$
Total events: 24×10^4



$M_{bc} > 5.21 \text{ GeV}$
Total events: 19×10^4



FBDT Training (offres-data-based)

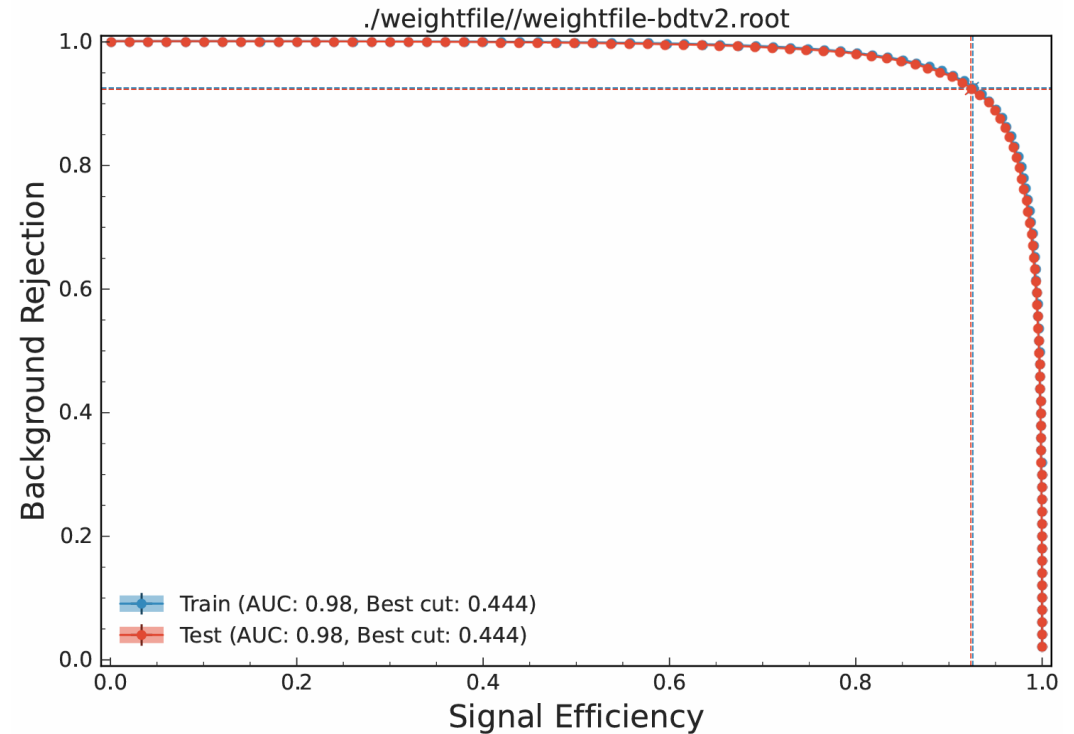
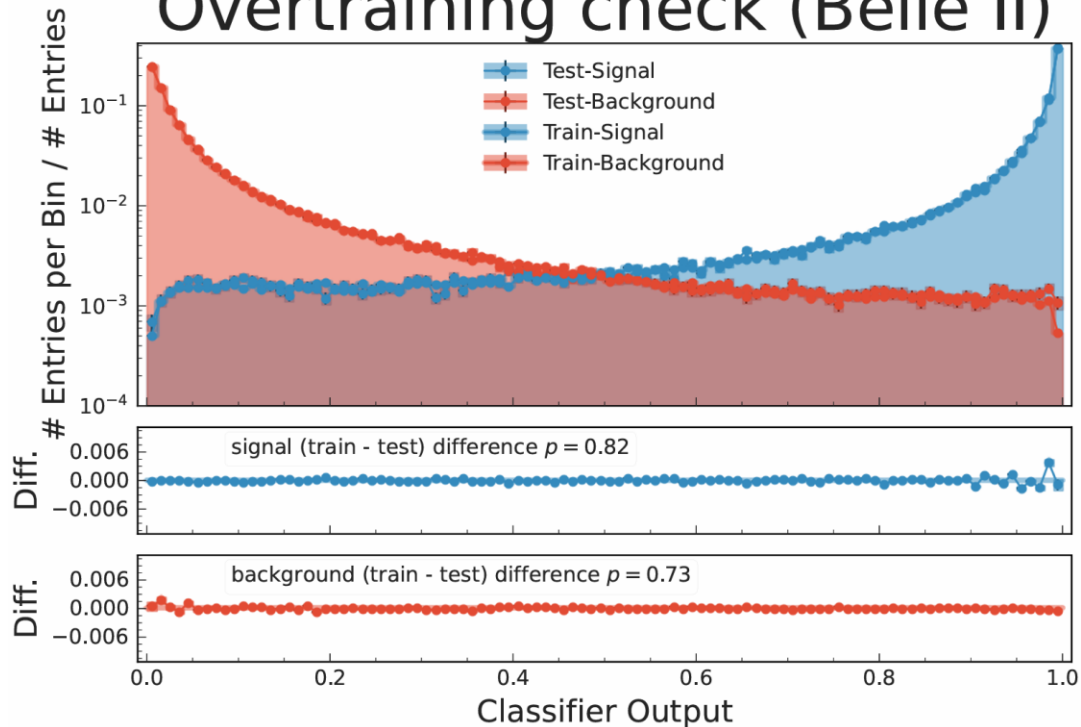
□ Train and Test sample

Train sample: 1.9×10^5 CR signal events and 4S-offres data events (run1+run2)

Test sample: 0.45×10^5 CR signal events and 4S-offres data events

Loose M_{bc} requirement for 4S-offres data $M_{bc} > 5.2$ GeV

Overtraining check (Belle II)



Control samples $B^+ \rightarrow \bar{D}^0 (\rightarrow K^+ \pi^- \pi^0) \pi^+$

□ Charged track candidate:

- ✓ $dr < 0.5$ cm, $|dz| < 2.0$ cm and θ in CDC Acceptance
- ✓ Kaon PID: KaonID > 0.1 , KaonIDNN > 0.6
- ✓ Pion PID: PionID > 0.1 , **PionIDNN > 0.6**

□ γ candidate:

- ✓ $0.2976 < \theta < 2.6180$ rad
- ✓ clusterNHits > 1.5
- ✓ $|\text{clusterTiming}| < 200$ ns
- ✓ $E_\gamma^{fEndcap} > 80$ MeV, $E_\gamma^{Barrel} > 30$ MeV, $E_\gamma^{bEndcap} > 60$ MeV

□ B^+ candidate:

- ✓ 5.26 GeV $< M_{bc} < 5.29$ GeV && -0.3 GeV $< \Delta E < 0.15$ GeV

□ π^0 candidate:

- ✓ 105 MeV $< M_{\gamma\gamma} < 150$ MeV

□ D^0 candidate:

- ✓ 1.826 GeV $< M_{k\pi\pi} < 1.893$ GeV

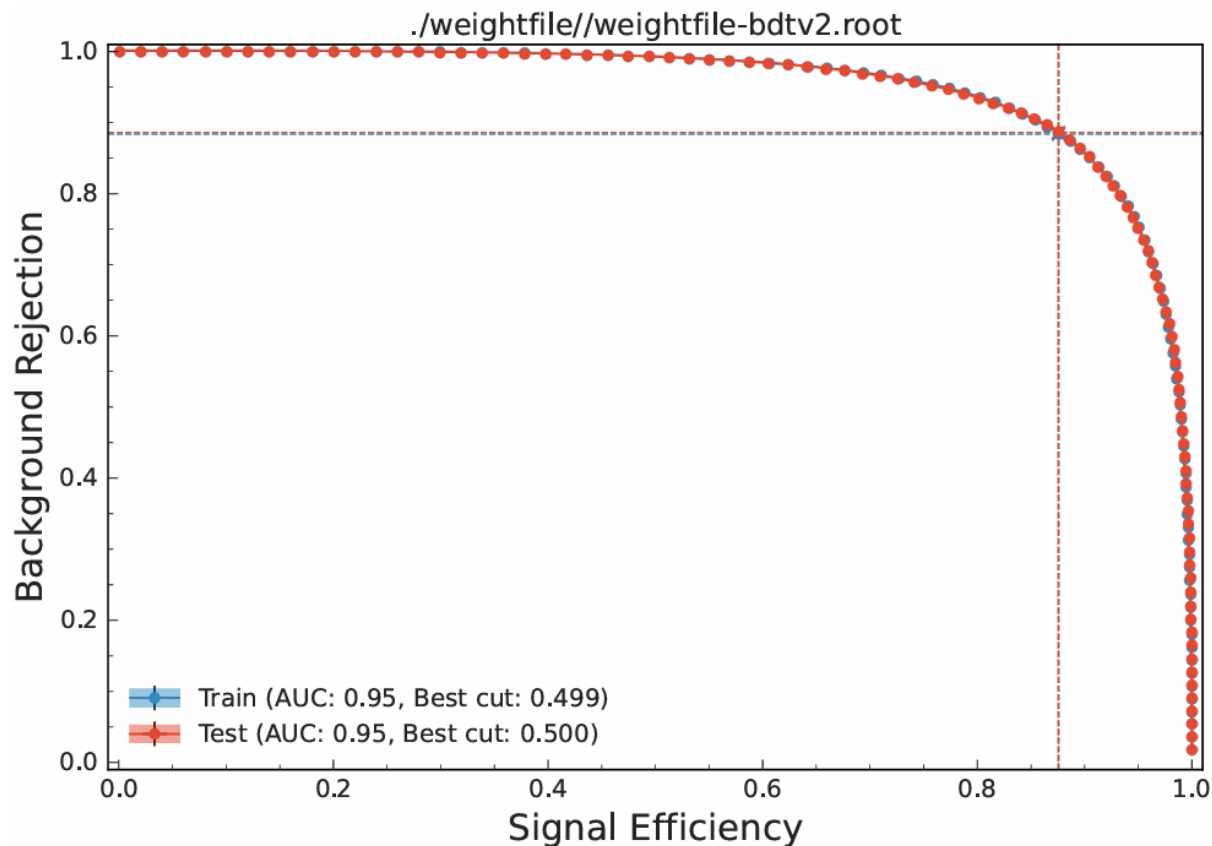
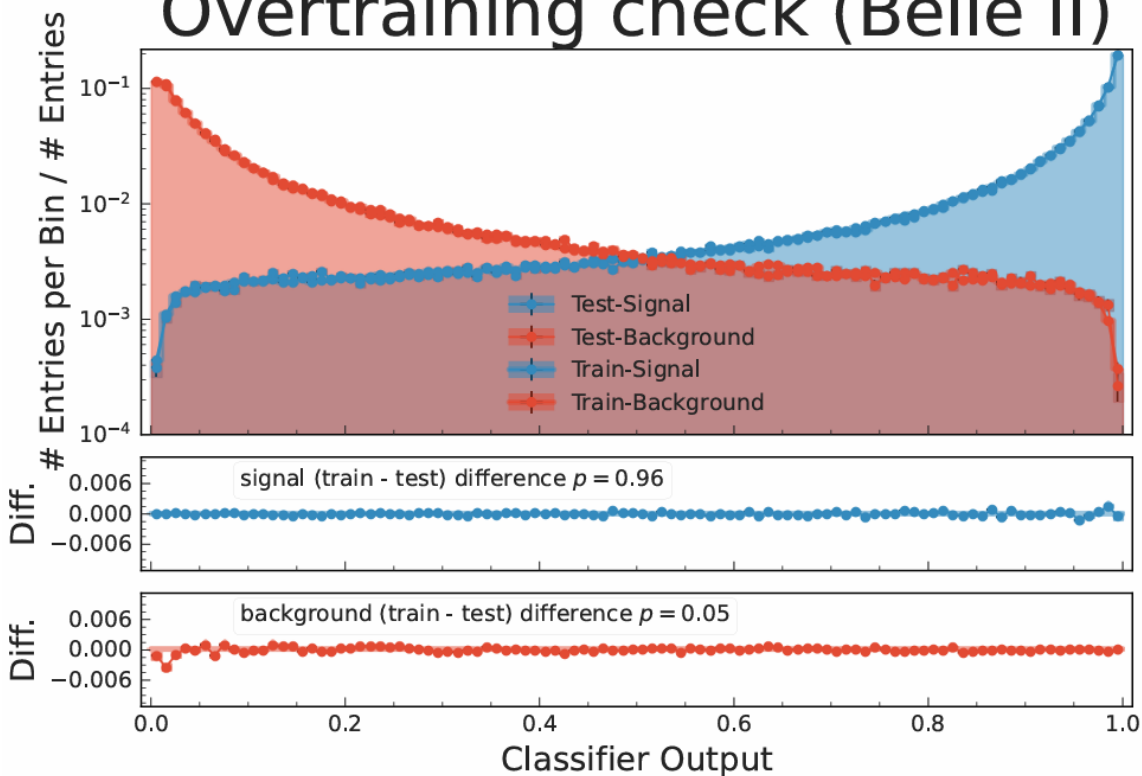
FBDT Training (MC-based)

□ Train and Test sample

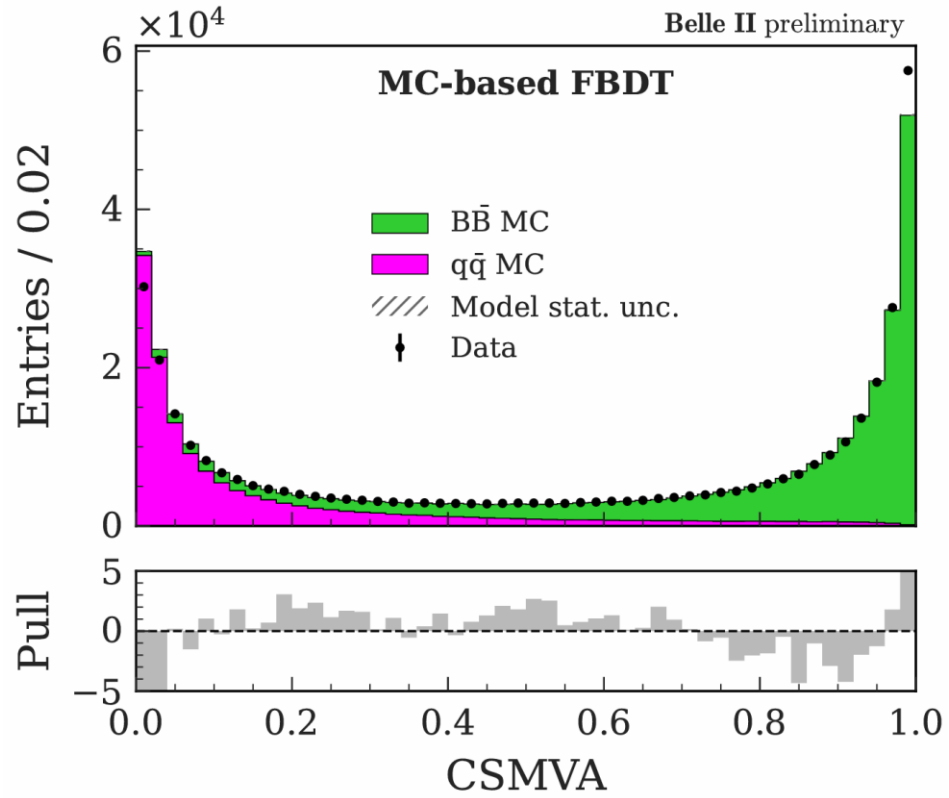
Train sample: 3×10^5 CR signal events and continuum background events (run1)

Test sample: 0.9×10^5 CR signal events and continuum background events

Overtraining check (Belle II)

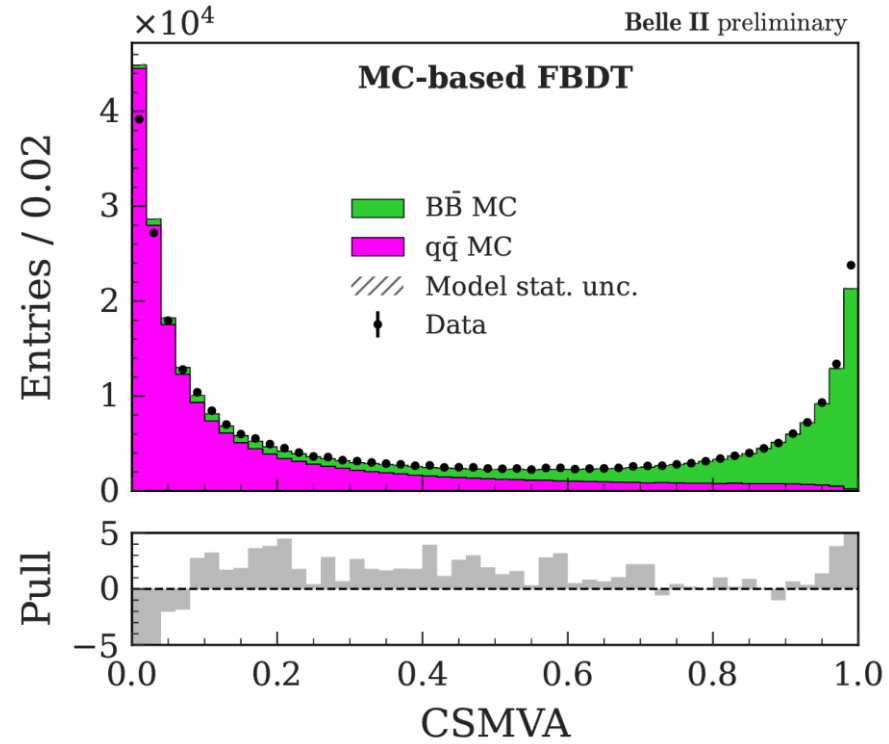


Data-simulation comparison (MC-based)



Signal enhanced:

$$5.272 \text{ GeV} < M_{bc} < 5.285 \text{ GeV} \quad |\Delta E| < 0.05 \text{ GeV}$$



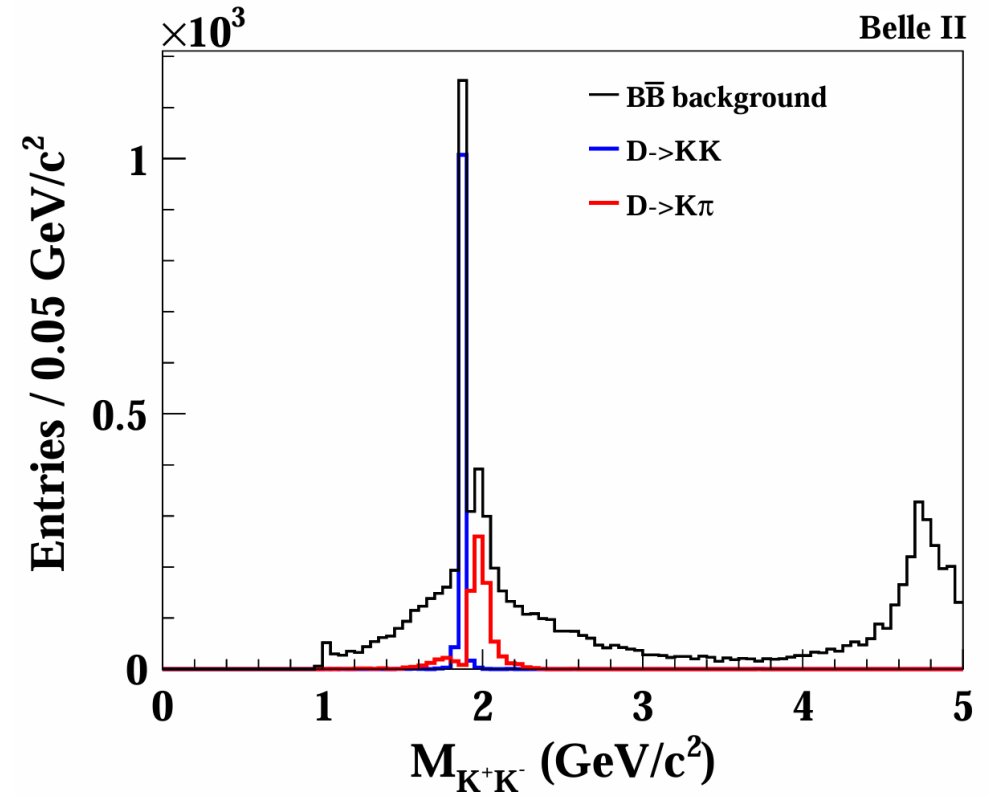
bkg enhanced

$$\vec{p}_{\pi^0}^{*'} = \sqrt{(E_{beam} - E_{K^+}^* - E_{\pi^+}^* - E_{\pi^-}^*)^2 - m_{\pi^0}^2} \times \frac{\vec{p}_{\pi^0}^*}{|\vec{p}_{\pi^0}^*|}$$

Summary

Next:

- Veto M_{KK} , $M_{K\pi}$
- Optimize selection criteria



Thanks for listening!