Eta' and TDCPV report

Padova Belle II meeting
10/04/2020
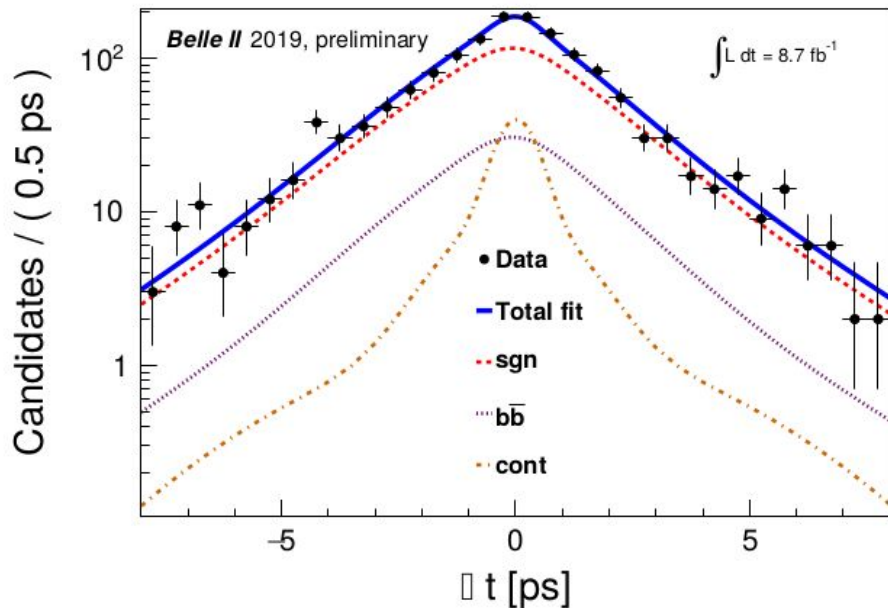
Stefano Lacaprara, Valeria Fioroni

INFN Padova, Unipd

Measurement of the B^0 lifetime using fully reconstructed hadronic decays in the 2019 Belle II dataset
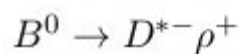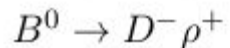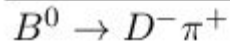
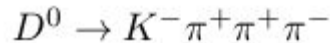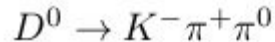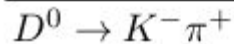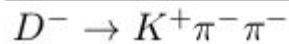BELLE2-CONF-DRAFT-2020-011

Strasbourg group

$$\tau_{B^0} = 1.48 \pm 0.28 \pm 0.06 \text{ ps}$$

PDG

$$1.519 \pm 0.004 \text{ ps}$$

Decay
$B^0 \to D^- \pi^+$
$B^0 \to D^- \rho^+$
$B^0 \to D^{*-} \pi^+$
$B^0 \to D^{*-} \rho^+$
$D^{*+} \to D^0 \pi^-$
$D^- \to K^+ \pi^- \pi^-$
$D^0 \to K^- \pi^+$
$D^0 \to K^- \pi^+ \pi^0$
$D^0 \to K^- \pi^+ \pi^+ \pi^-$
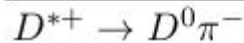
CWR ended, waiting for final green light

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Reconstruction of $B^0 \rightarrow J/\psi K_S^0$ and $B^+ \rightarrow J/\psi K^+$

Yusa-san, Niigata
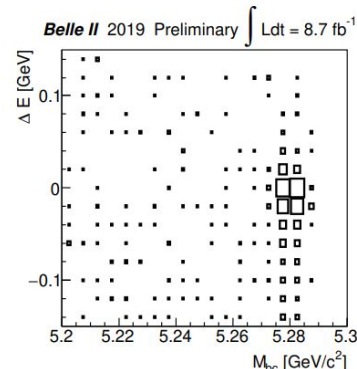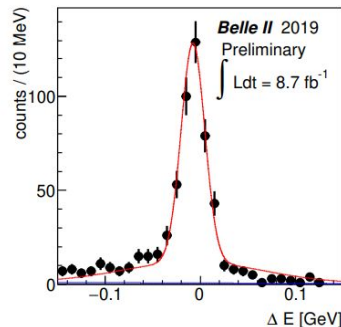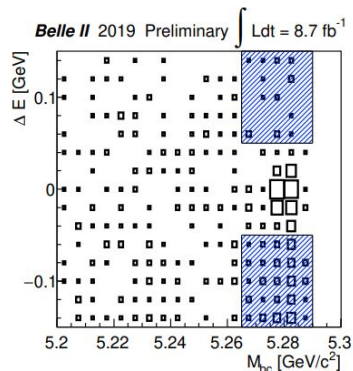
$$B^0 \rightarrow J/\psi K_S^0$$

$$B^+ \rightarrow J/\psi K^+$$

Some discussion on K+ contamination in Ks
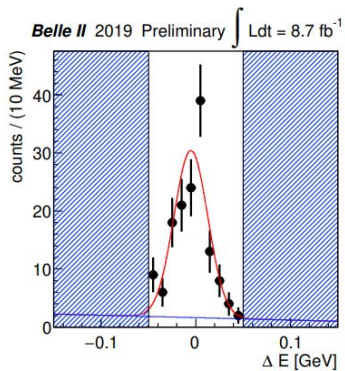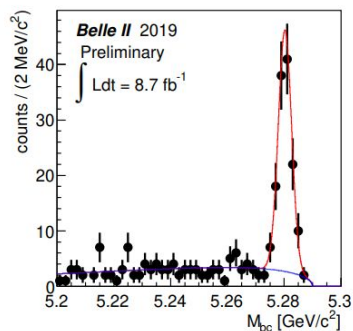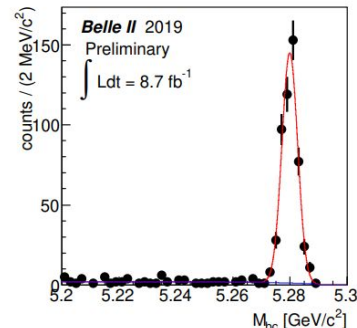
BELLE2-NOTE-PH-2019-042

Mode	Signal	Background	Expected signal
$B^0 \rightarrow J/\psi K_S^0$, $J/\psi \rightarrow e^+ e^-$	48.8 ± 7.7	11.9 ± 1.2	44.4 ± 3.3
$B^0 \rightarrow J/\psi K_S^0$, $J/\psi \rightarrow \mu^+ \mu^-$	80.3 ± 9.3	13.0 ± 1.4	75.6 ± 4.7
$B^0 \rightarrow J/\psi K_S^0$, $J/\psi \rightarrow \ell^+ \ell^-$	128.0 ± 11.9	25.0 ± 1.8	120.0 ± 5.7

Mode	Signal	Background	Expected signal
$B^+ \rightarrow J/\psi K^+$, $J/\psi \rightarrow e^+ e^-$	175.7 ± 13.2	7.2 ± 0.9	190.0 ± 10.0
$B^+ \rightarrow J/\psi K^+$, $J/\psi \rightarrow \mu^+ \mu^-$	322.0 ± 17.4	4.2 ± 0.6	290.3 ± 18.1
$B^+ \rightarrow J/\psi K^+$, $J/\psi \rightarrow \ell^+ \ell^-$	495.5 ± 21.6	11.3 ± 1.0	480.3 ± 20.7

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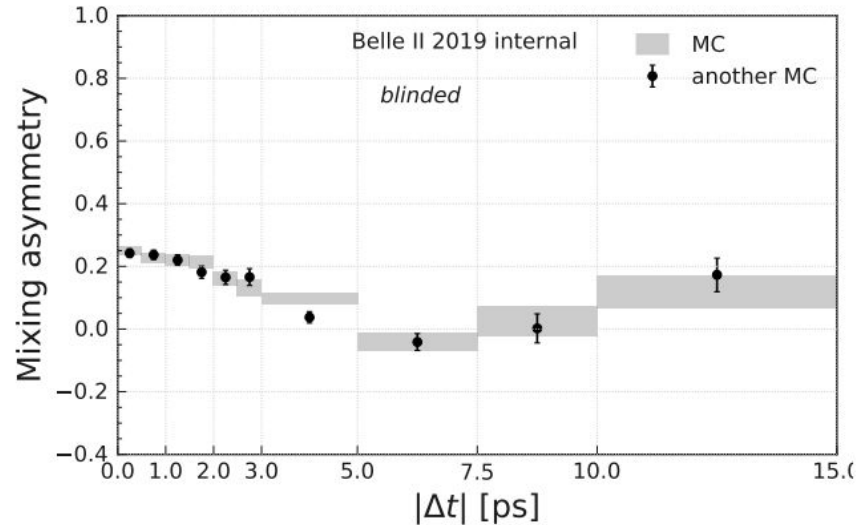# B^0-$\bar{B}^0$ mixing rediscovery in fully-hadronic decays with the early Phase III data at Belle II

(Ale did the same with semileptonic channel last summer)

$$A_{mix}(\Delta t) = \frac{N_{unmixed}(\Delta t) - N_{mixed}(\Delta t)}{N_{unmixed}(\Delta t) + N_{mixed}(\Delta t)},$$

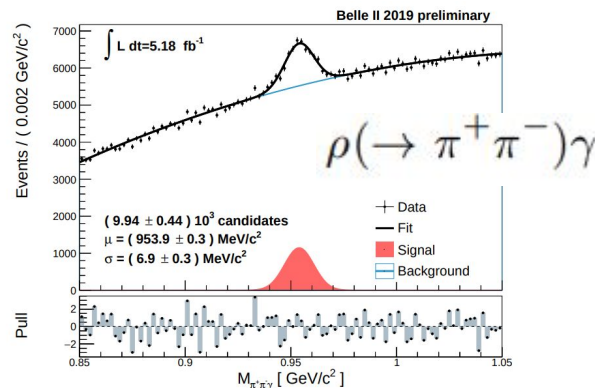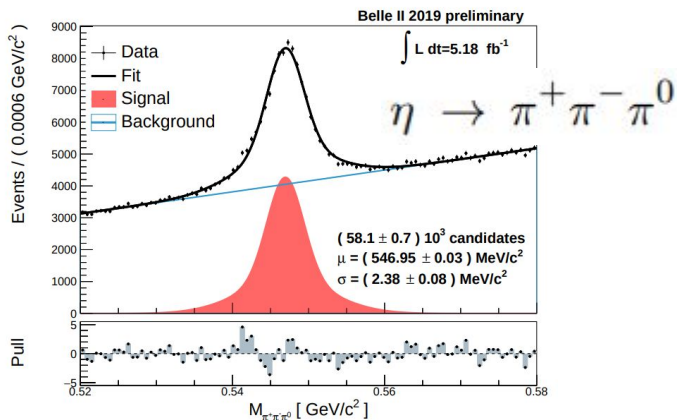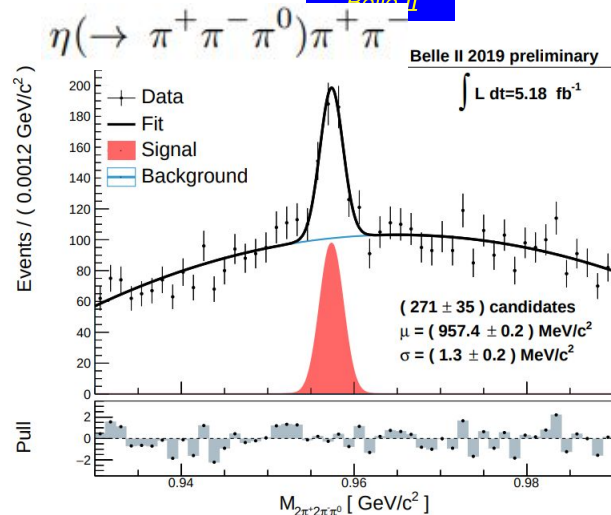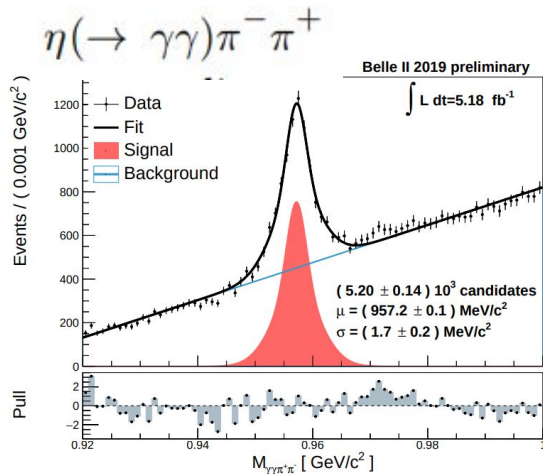$$A_{mix} = 1 - 2\chi_d, \qquad A_{mix}^{measured} = A_{mix}^{PDG}(1 - 2\omega),$$

$$B^0 \rightarrow D^{(*)\pm} \text{ hadron}^{\mp}$$
$$\pi^{\mp}, \rho^{\mp} \text{ or } a_1^{\mp}$$
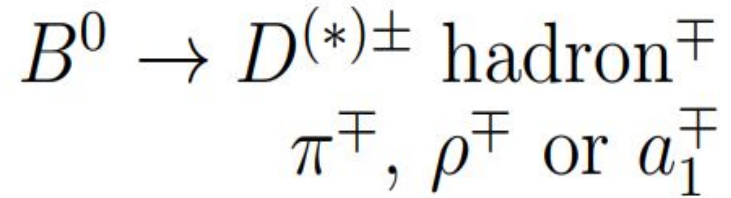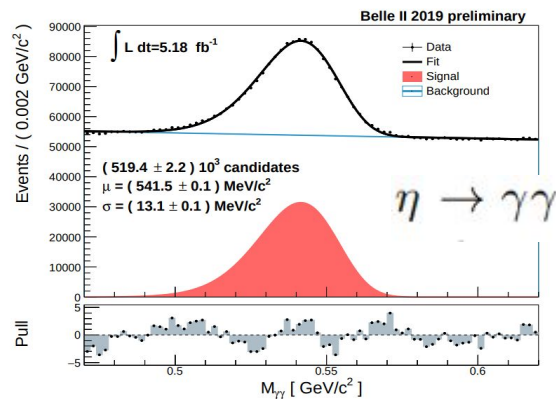
- Goal: data-MC comparison of A(Dt)
- Possible masure of Dm (and tau) requires more work
  - Still RC
- Postponed until a time integrated measurement of w and deltaw is available (Fernando - TS)

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Rediscovery of η and η' mesons in early phase 3 Belle II data

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B->eta' K

- Using only **ch1: η'->η (ɣɣ) π⁺π⁻**
  - and **ch3: η'->ρ (π⁺π⁻) ɣ**
- Expected signal 8.8 /fb (Run2019): **Efficiency=1**

	η'->η (ɣɣ) π⁺π⁻	η'->ρ (π⁺π⁻) ɣ	**Total**
B^0->η' K_s	36.4	61.4	100
B^+->η' K^+	113	190	300

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Efficiency

- **Reconstruction-only efficiency for $B^+ \to \eta' K^+$, $\eta' \to \eta$ ($\gamma\gamma$) $\pi^+\pi^-$**
  - About 40%
  - +7% SxF
- No further selection to reduce background!
- Average cand/ev ~2
- First cand (best χ^2_{vtx}) is the correct one

Only first candidate

Sorted by χ^2_{vtx}

$< N_{cands/ev} > = 2.18$
$RMS_{cands/ev} = 1.86$
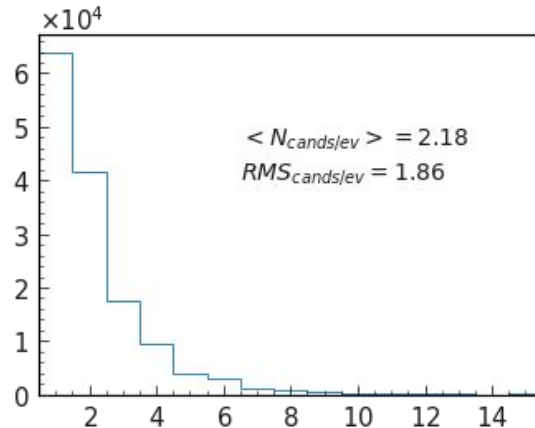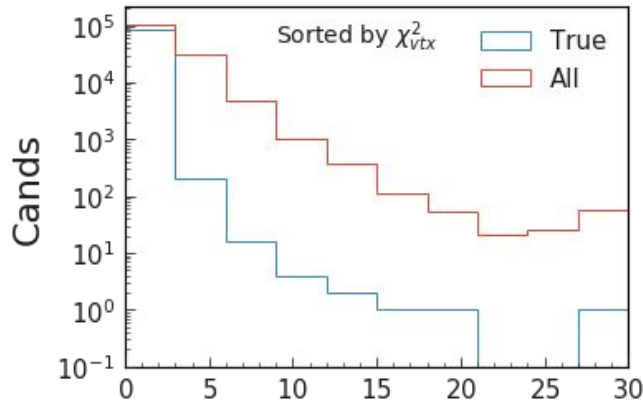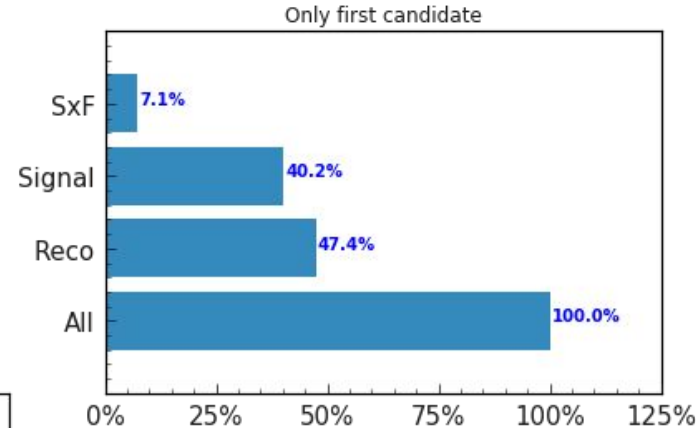
$B^0 \epsilon$ ~39.7% SxF 9.6% ncad/ev~3

$\eta' \to \rho$ ($\pi^+\pi^-$) γ

$B^+ \epsilon$ ~13.4% SxF 8.2%
$B^0 \epsilon$ ~12.9% SxF 8.1%
To be understood.

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Expected events (including eff) 8.8 /fb

- Signal (SxF)

	η'->η (ɣɣ) π⁺π⁻	η'->ρ (π⁺π⁻) ɣ	**Total**
B^0->η' K_s	14 (3)	8 (5)	22 (8)
B^+->η' K^+	45 (10)	25 (15)	70 (25)

- Fully accessible for charged mode,
  - hard but maybe possible to neutral one with 2019 statistics
- Need to optimize cut for S/B+SxF rejection
  - Start with rectangular cuts
  - try MVA later.

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Studio note Belle

Valeria

- Ci sono un po' di note Belle (I) sulle early searches per questo canale
  - Adeguate per il livello di comprensione del ns rivelatore e MC oggi
- Studio e controllo di avere le variabili nella ns ntupla.
  - Poi confronto S, B, e SxF: e' una buona variabile su cui tagliare
  - Confronto dati - MC: il MC modella bene i dati quindi la possiamo usare.

- HadronB skim (similar to hadron)
- Good quality Tracks and Gamma
- pt>100 (200) MeV
  - per η'->η (ɣɣ) π⁺π⁻ (η'->ρ (π⁺π⁻) ɣ
- K/pi PID (different for soft and hard pion)
  - Which is which?
- E_gamma>50(100) MeV
- cosTBTO<0.9 (no cut on R2?)
- Ks selection (goodKs)
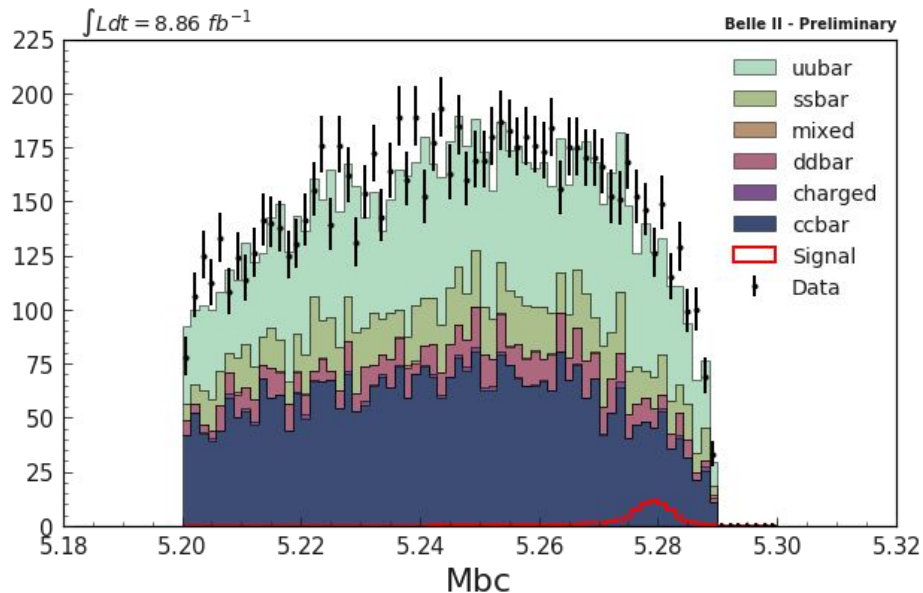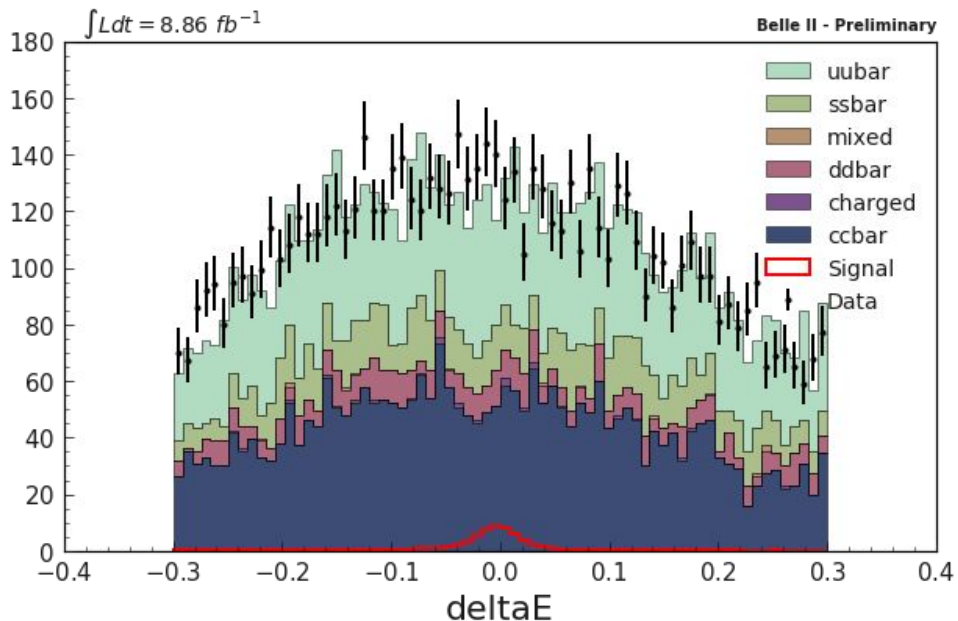- Eta helicity angle (to be added)
- Lilkelihood Ratio cut for CS

Belle Note 402
Apr. 29, 2001
v2

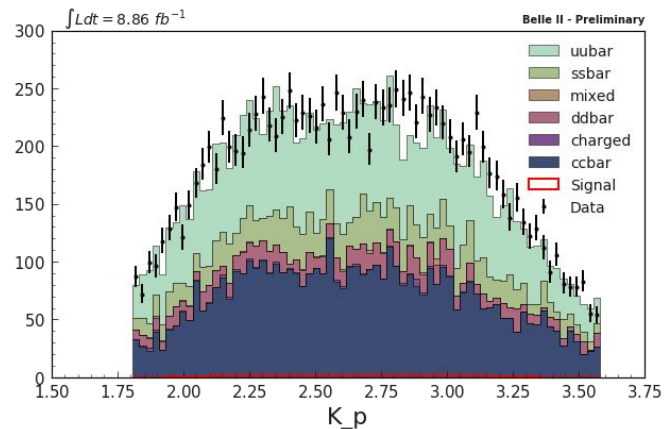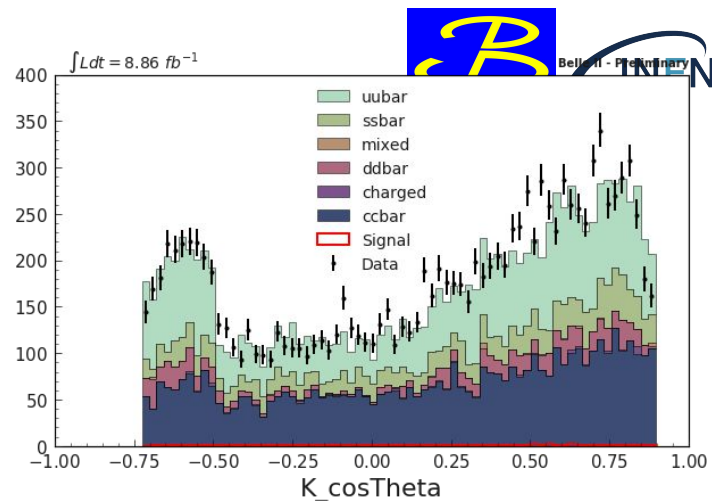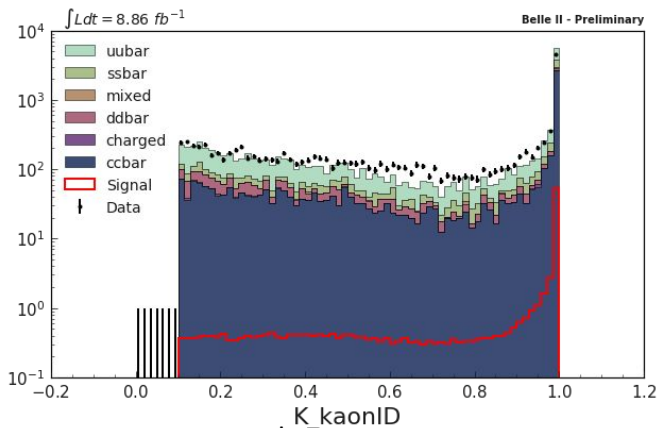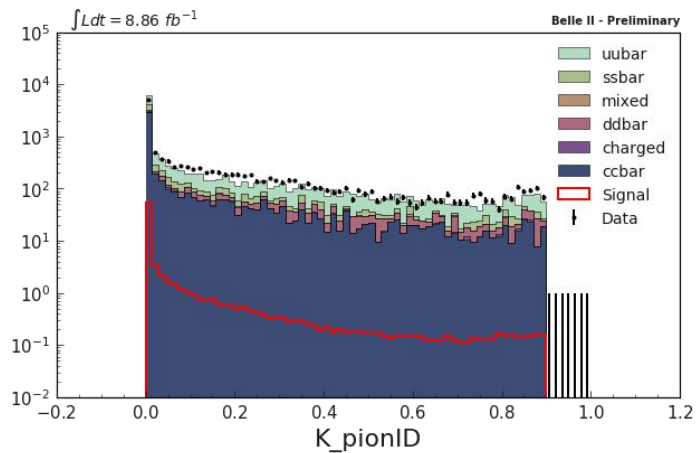**Update on the Study of $B \to \eta' h^+, \eta'(K_S^0)$ at Belle**

S.C. Hsu[1*], P.T. Chang[1], H.C. Huang[1], Y.S. Lin[1], C.H. Wang[2†]
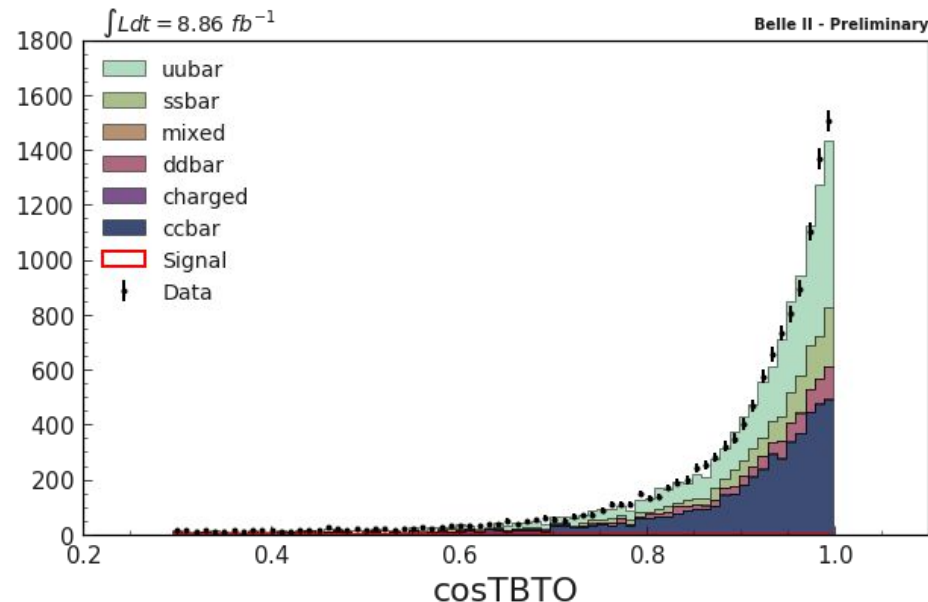
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B⁺->η' K⁺, η'->η (ɣɣ) π⁺π⁻ Data vs MC

- Started comparison of Data (proc10 + prompt) and MC13b (run dependent) for a set of variables

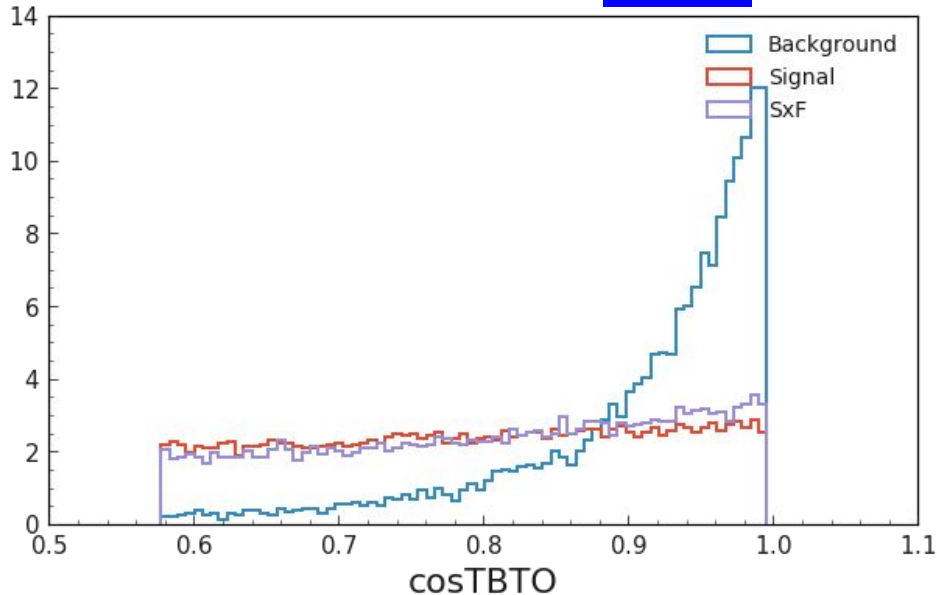Stefano Lacaprara, INFN Padova

PID variables for K

11

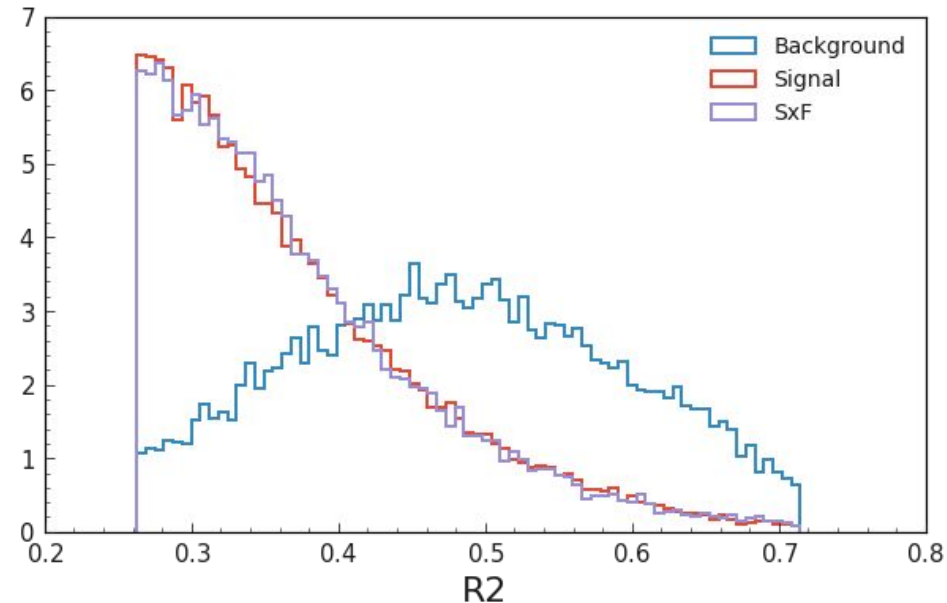# Cont Suppression variables
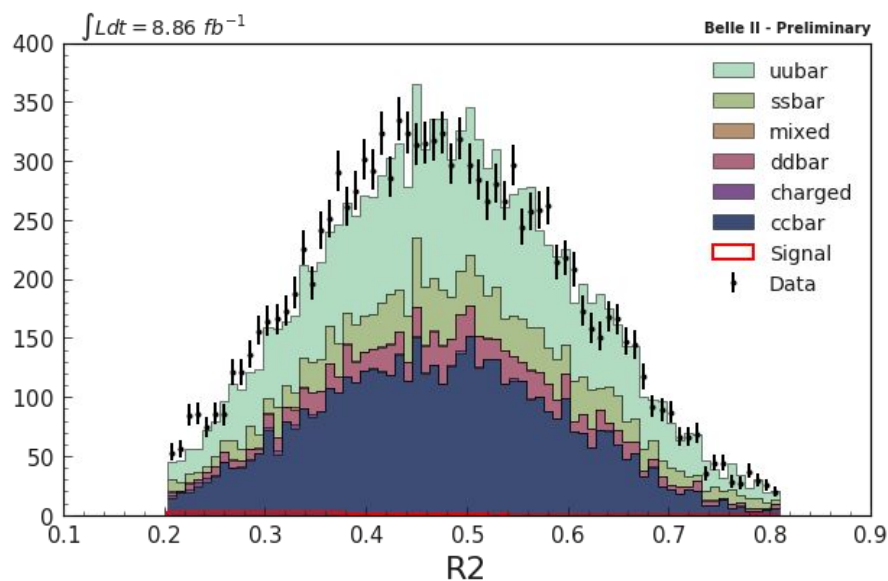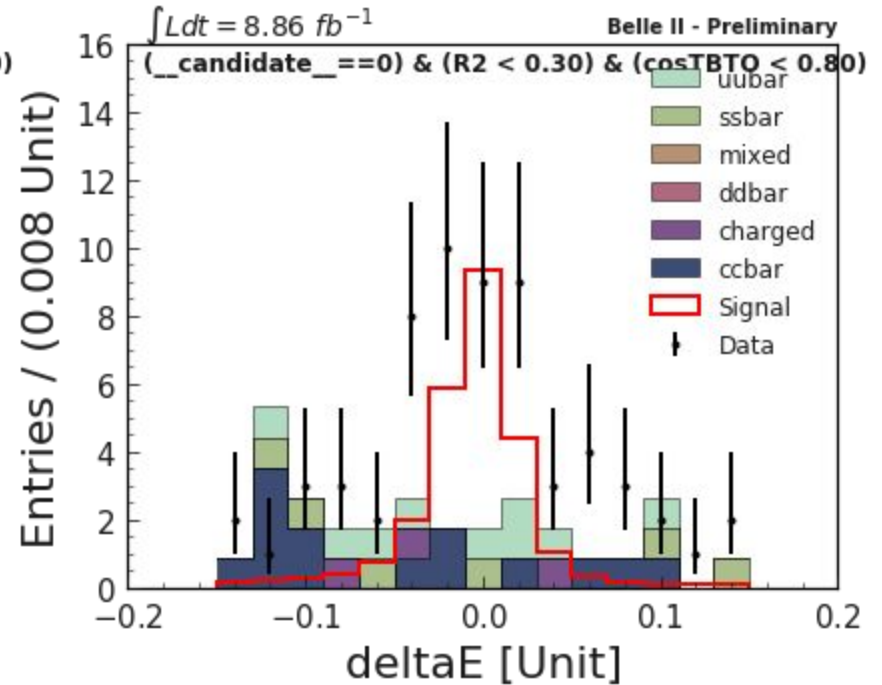

Nice agreement MC - Data, can be used for Continuum Suppression

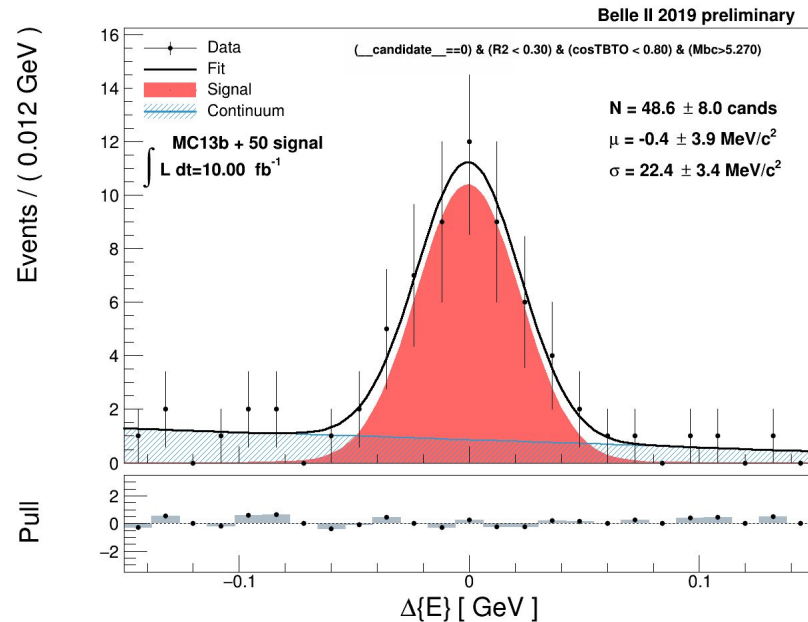Stefano Lacaprara, INFN Padova
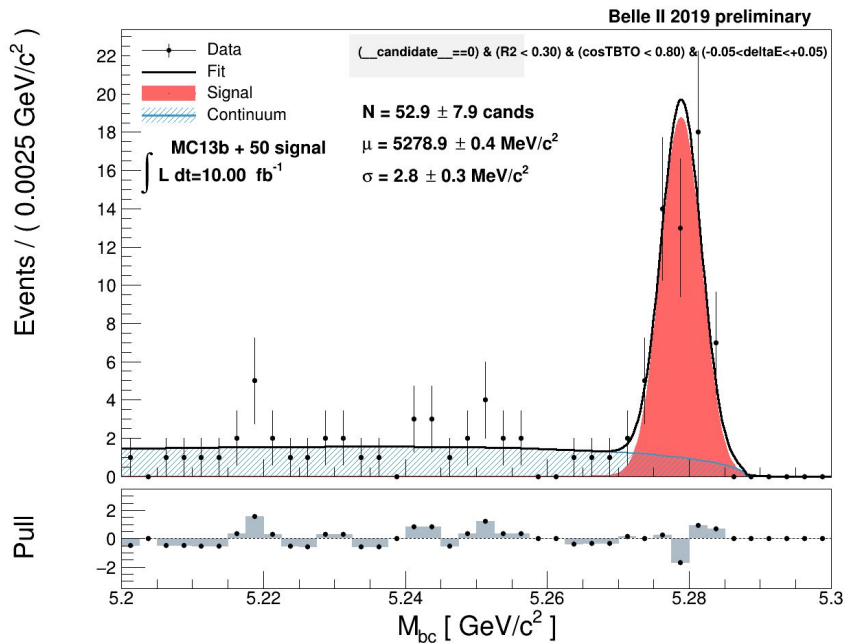
Event shape (BB vs qq)

- Do not use (yet) MVA continuum suppression
- Use just these two variables
  - Simple CS cut
  - Signal region: **R2<0.3 and cosTBTO<08**

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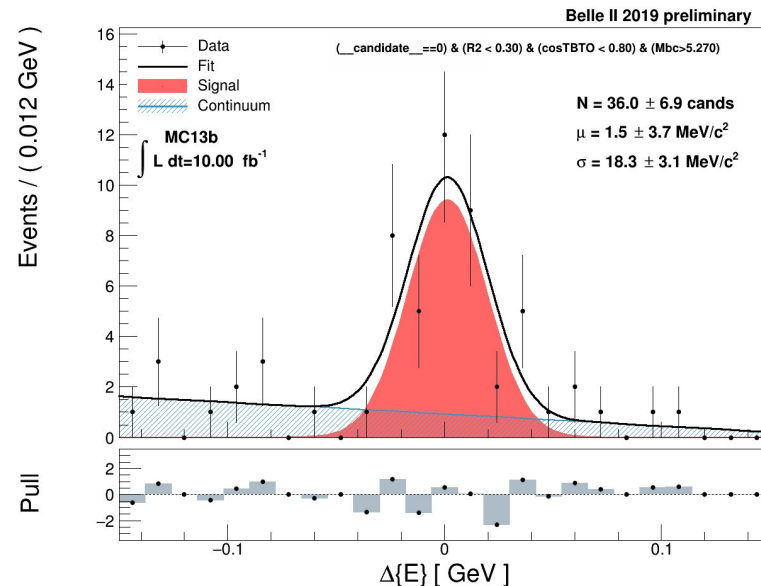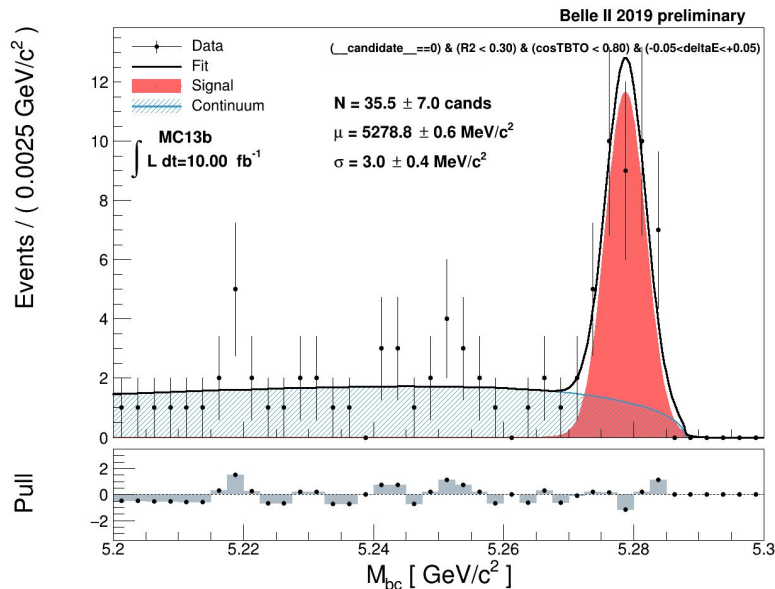
Data - MC in signal region

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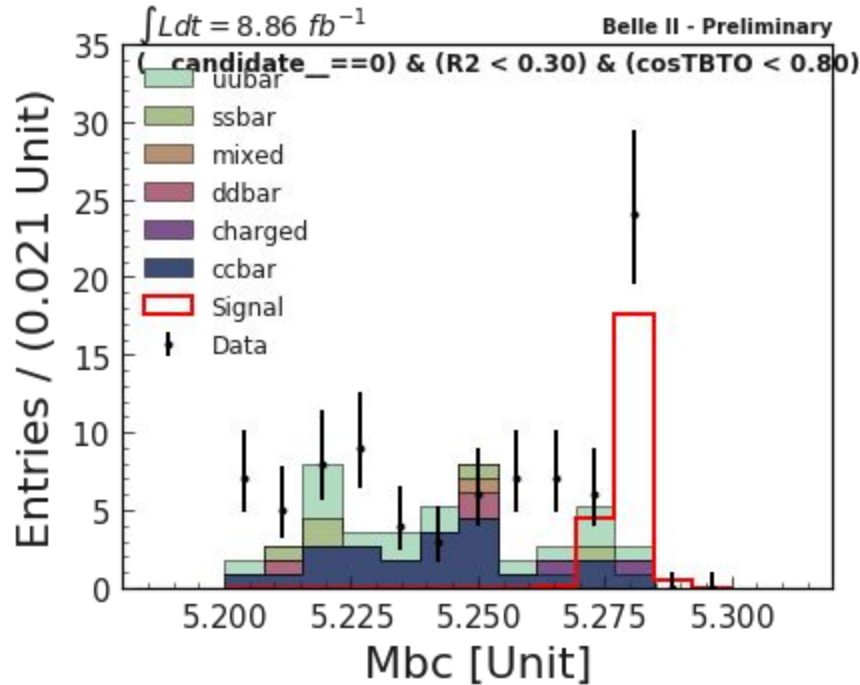
Try to fit signal: only MC + signal injection

- Cut Mbc>5.27 GeV and |De|<0.05 in the other plot.
- No 2D fit (yet) working on it
- Injected 50 events, seen 53+/-8 (Mbc) and 47+/-8 (De)

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Try to fit signal: only MC (with its bb signal)

- Previously removed signal from generic BB
  - Now use MC as data: do not remove signal
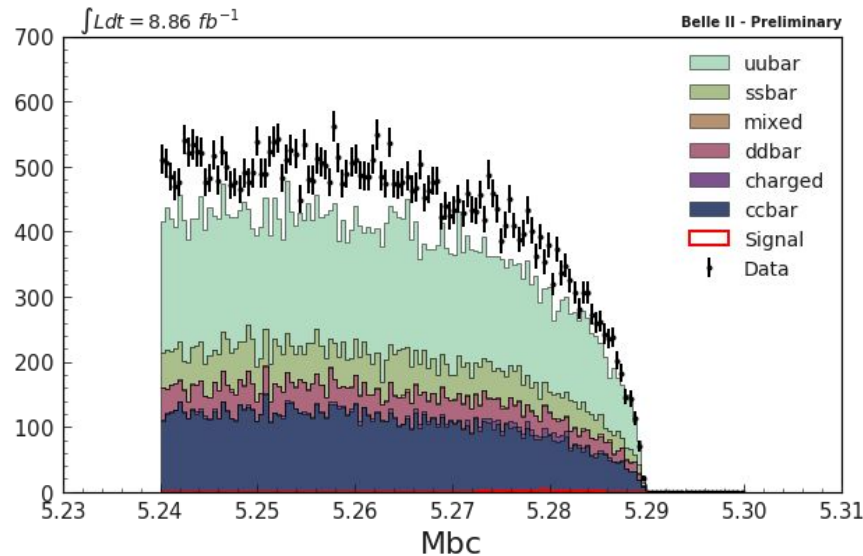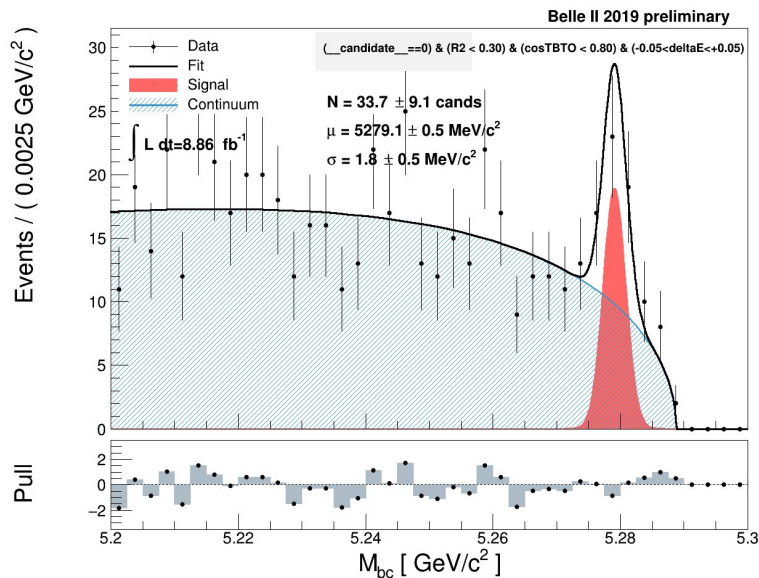- There are 35 candidates in 10/fb
- Seen 35+/-7 (Mbc) and 36+/-7 (De)

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Try to fit signal: Data
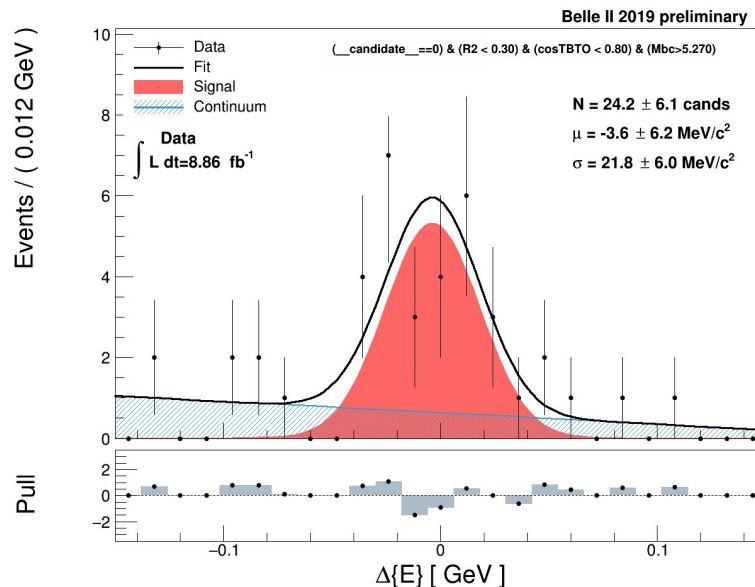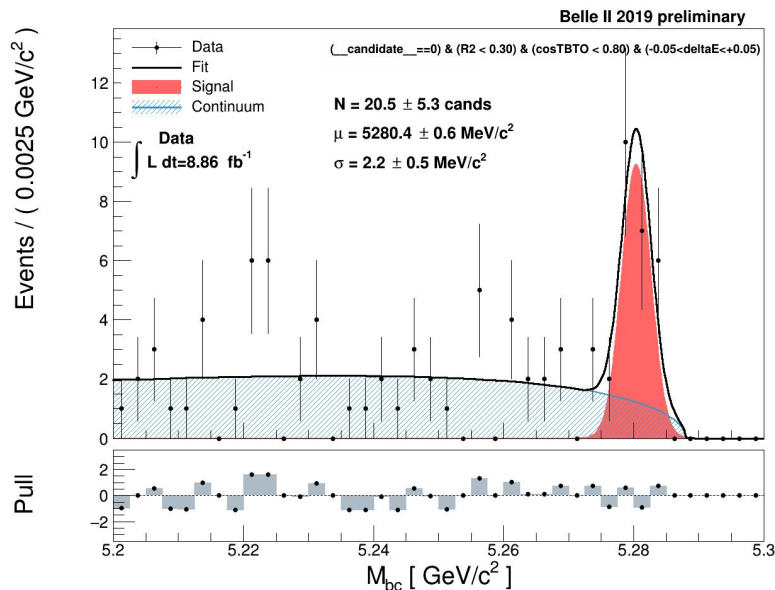
- **Clear signal visible!**
- **seen 20.5+/-5 (Mbc) and 24+/-6 (De)**
  - Expected: 35 * 0.886= 31

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B⁺ -> η' (->ρ (π⁺π⁻) ɣ) K⁺

- Similar work started
- Some normalization issue with MC
- Signal seen

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B⁰ -> η' Kₛ

B⁺->η' K⁺, η'->η (γγ) π⁺π⁻

B⁰ -> η' (->ρ (π⁺π⁻) γ) Kₛ

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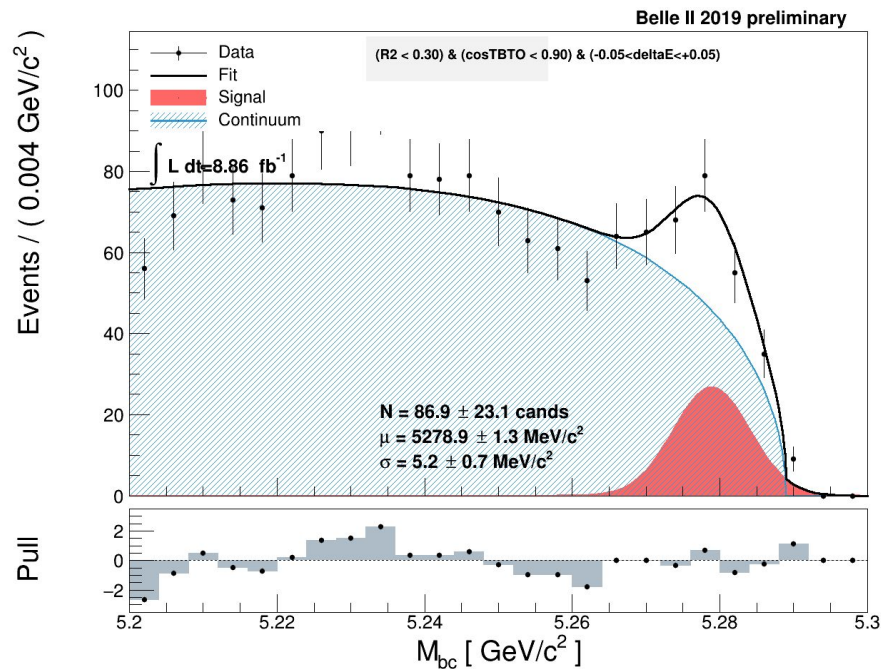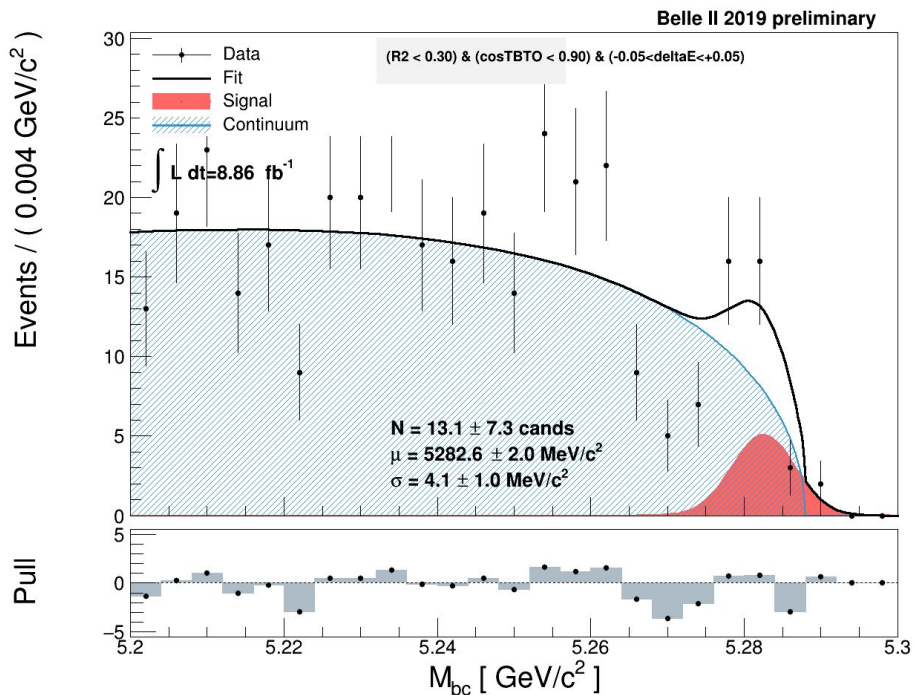
Outlook

- Finally eta' plot have been approved
- And we can move to more interesting stuff
  - Charmless B^+ and B^0 signal seen on data
  - Work ahead is planned
- Will present these results at next TDCPV meeting (tuesday)
  - Valeria started to work, slowed down due to connection problem, hopefully now solved.

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