

# Search for $D_{(s)}^+ \rightarrow \pi^+ \mu^+ \mu^-$ and $D_{(s)}^+ \rightarrow \pi^- \mu^+ \mu^+$ decays

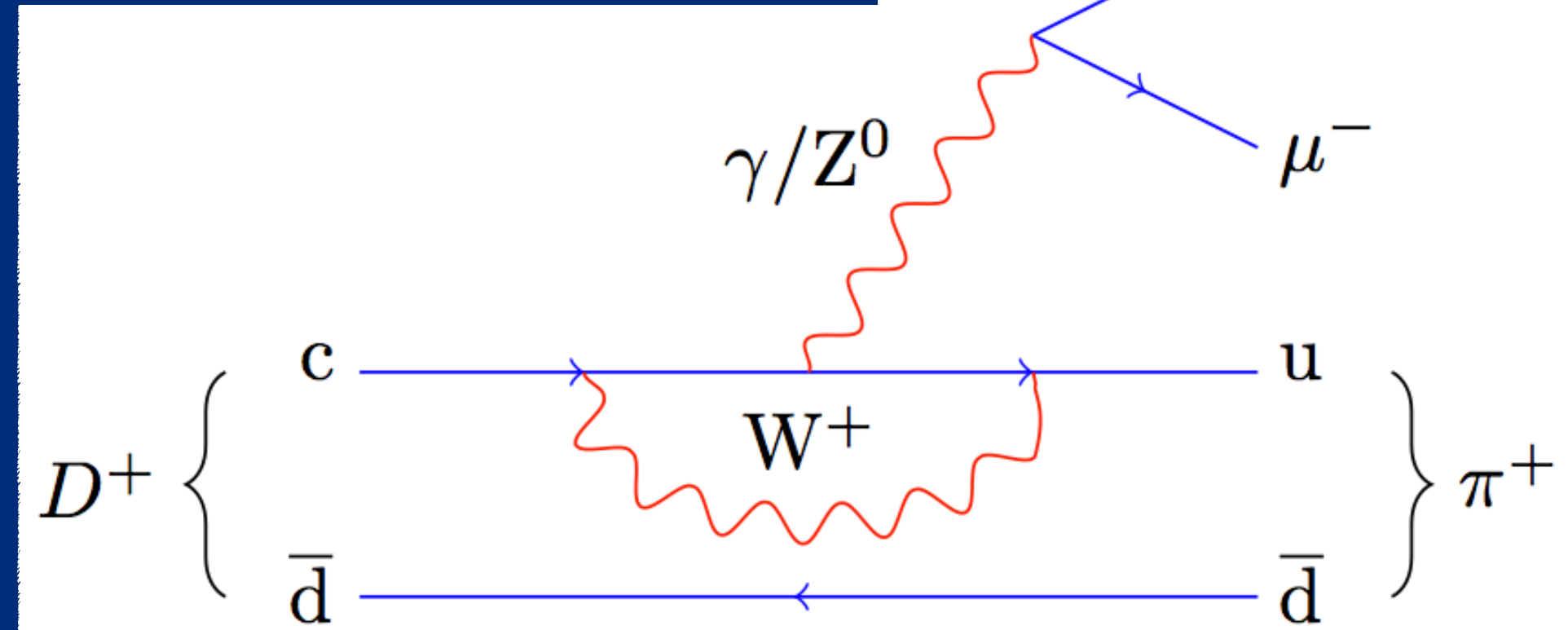


Ed Greening on behalf of the LHCb Collaboration  
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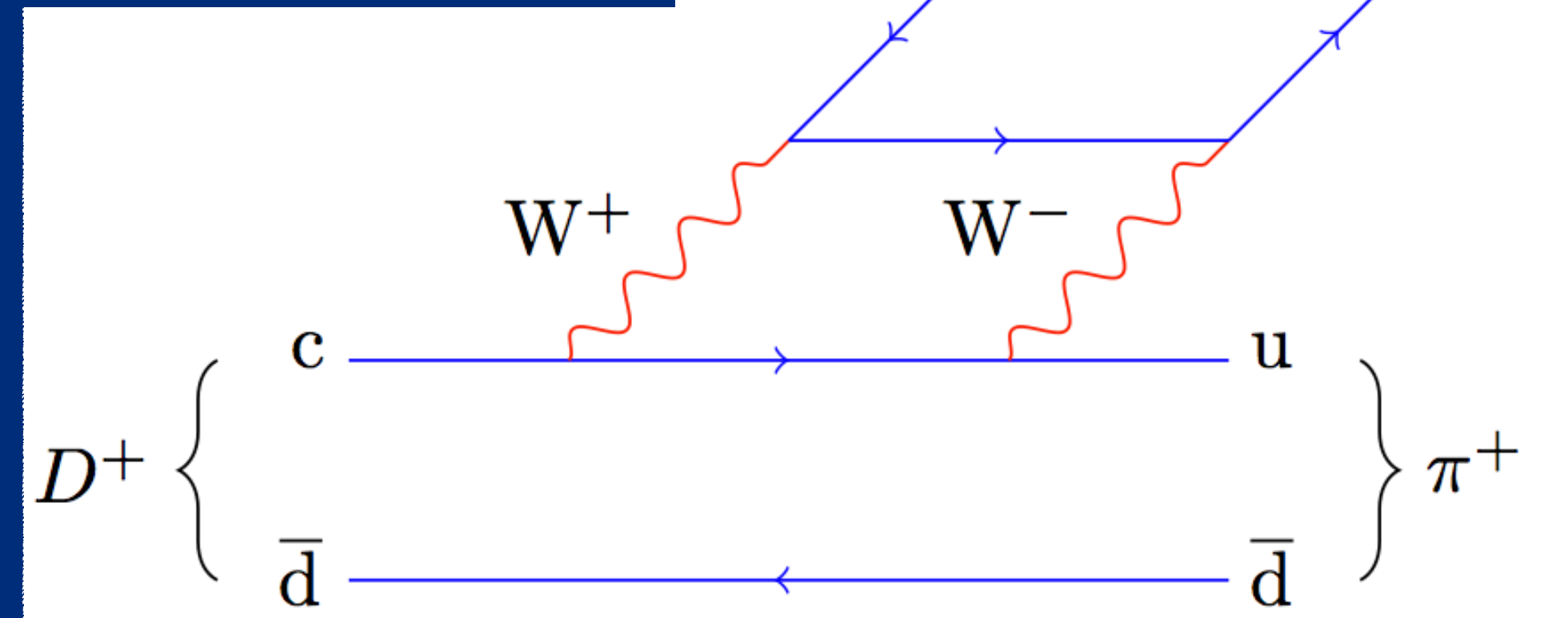
## $D_{(s)}^+ \rightarrow \pi^+ \mu^+ \mu^-$

- ★ **Flavour changing neutral current** processes contribute to  $D^+$  decays only
- ★  $\mathcal{B}_{\text{SM}}(c \rightarrow u \mu^+ \mu^-) \sim 10^{-9}$
- ★ Unobserved (unlike in equivalent B and K meson decays)
- ★ New physics may affect up and down-type quarks differently

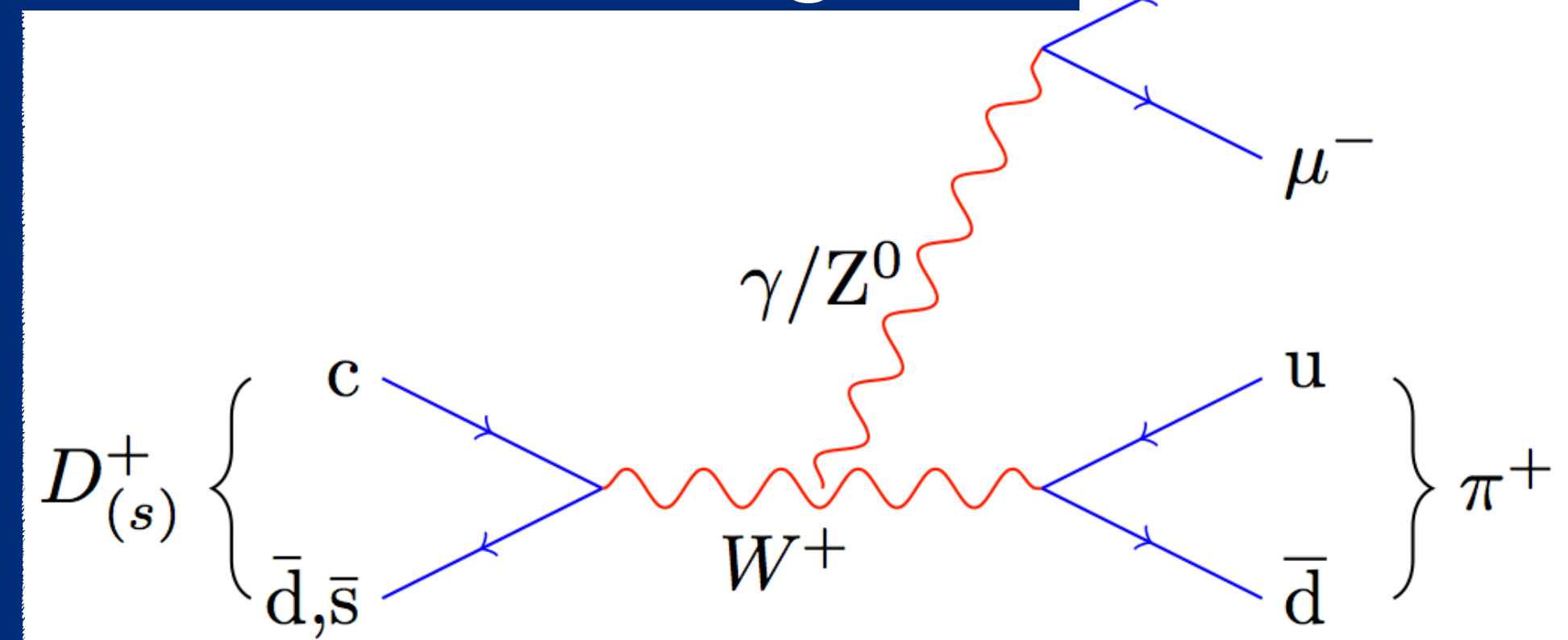
## Penguin diagram



## Box diagram

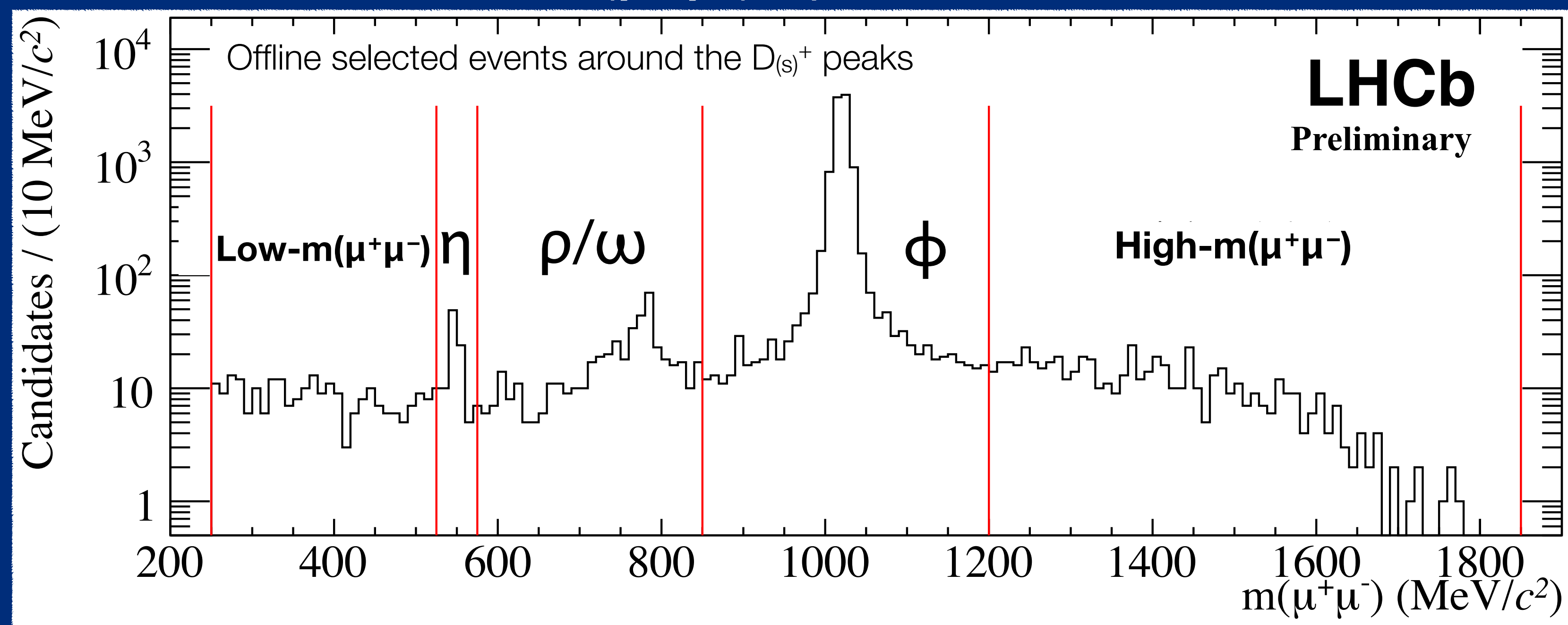


## Annihilation diagram



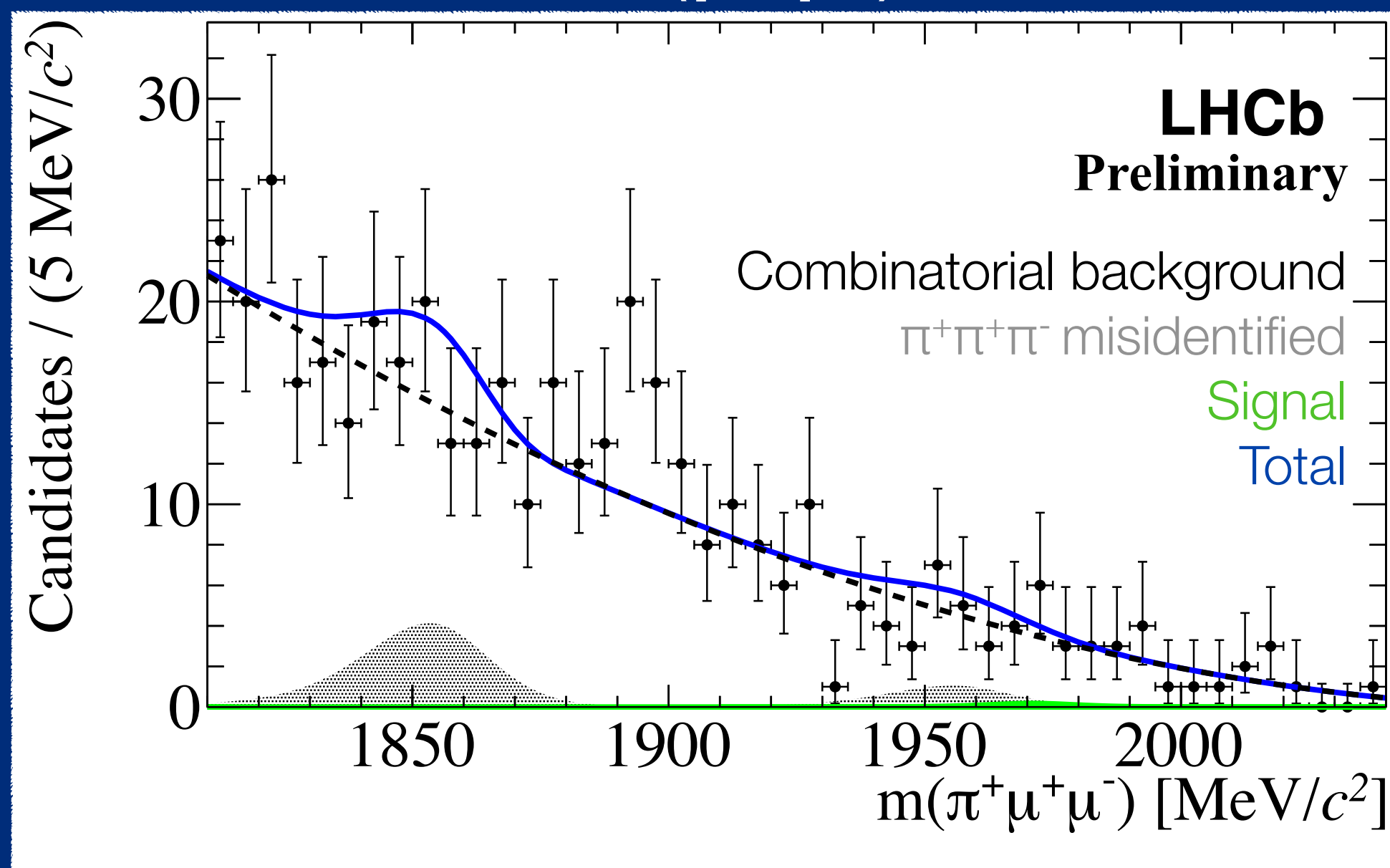
- ★ **Weak annihilation** processes contribute to  $D^+$  and  $D_s^+$  decays
- ★ Unobserved final state (in any system)

## $m(\mu^+ \mu^-)$ spectrum

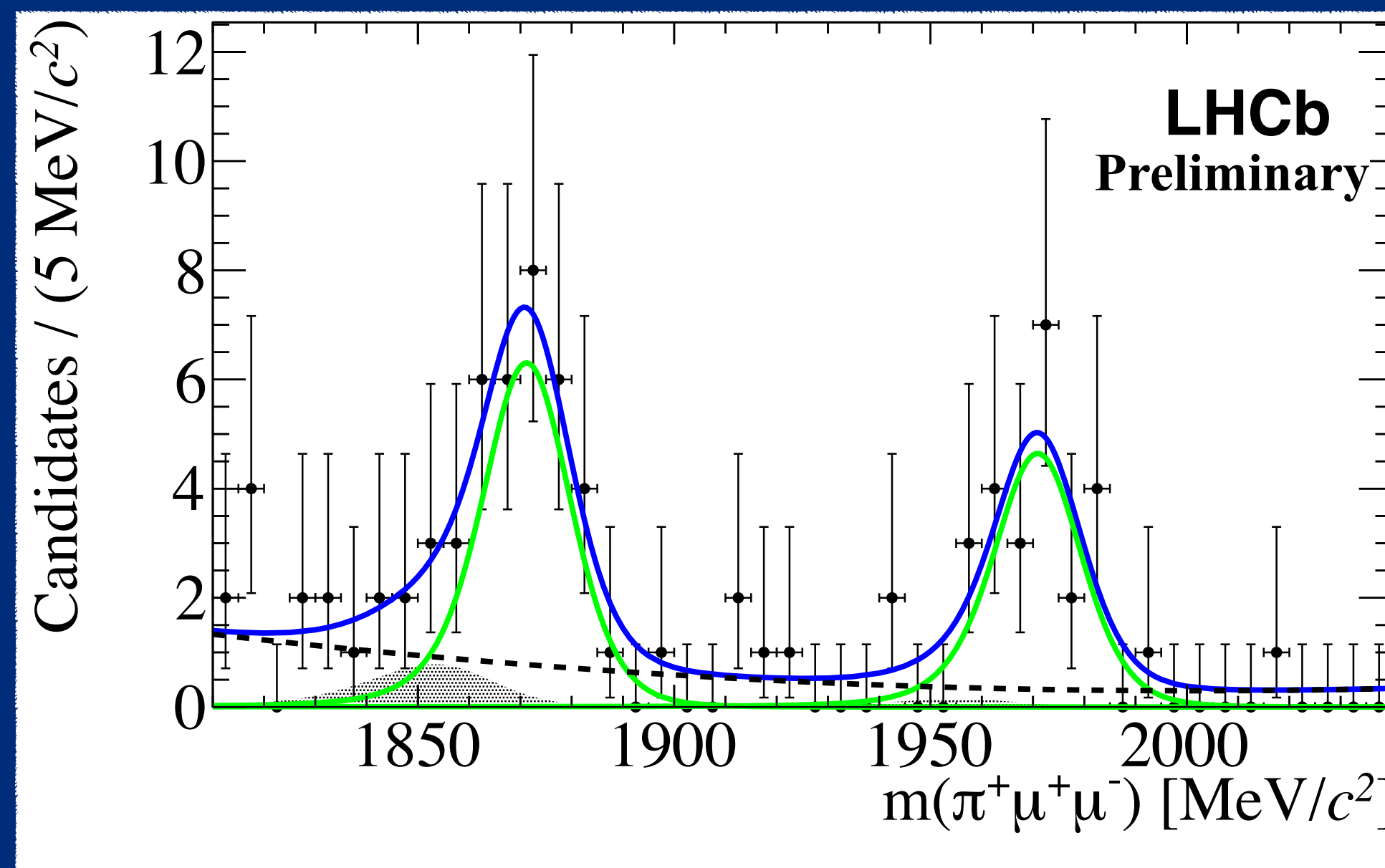


- ★ Analyse  $1.0 \text{ fb}^{-1}$  of 2011 data
- ★ Separate into five  $m(\mu^+ \mu^-)$  bins to isolate FCNC sensitive regions from resonances
- ★ Normalise using  $D_{(s)}^+ \rightarrow \pi^+(\phi \rightarrow \mu^+ \mu^-)$
- ★  $D_{(s)}^+ \rightarrow \pi^+ \pi^+ \pi^-$  peaking background shape and yield taken from data

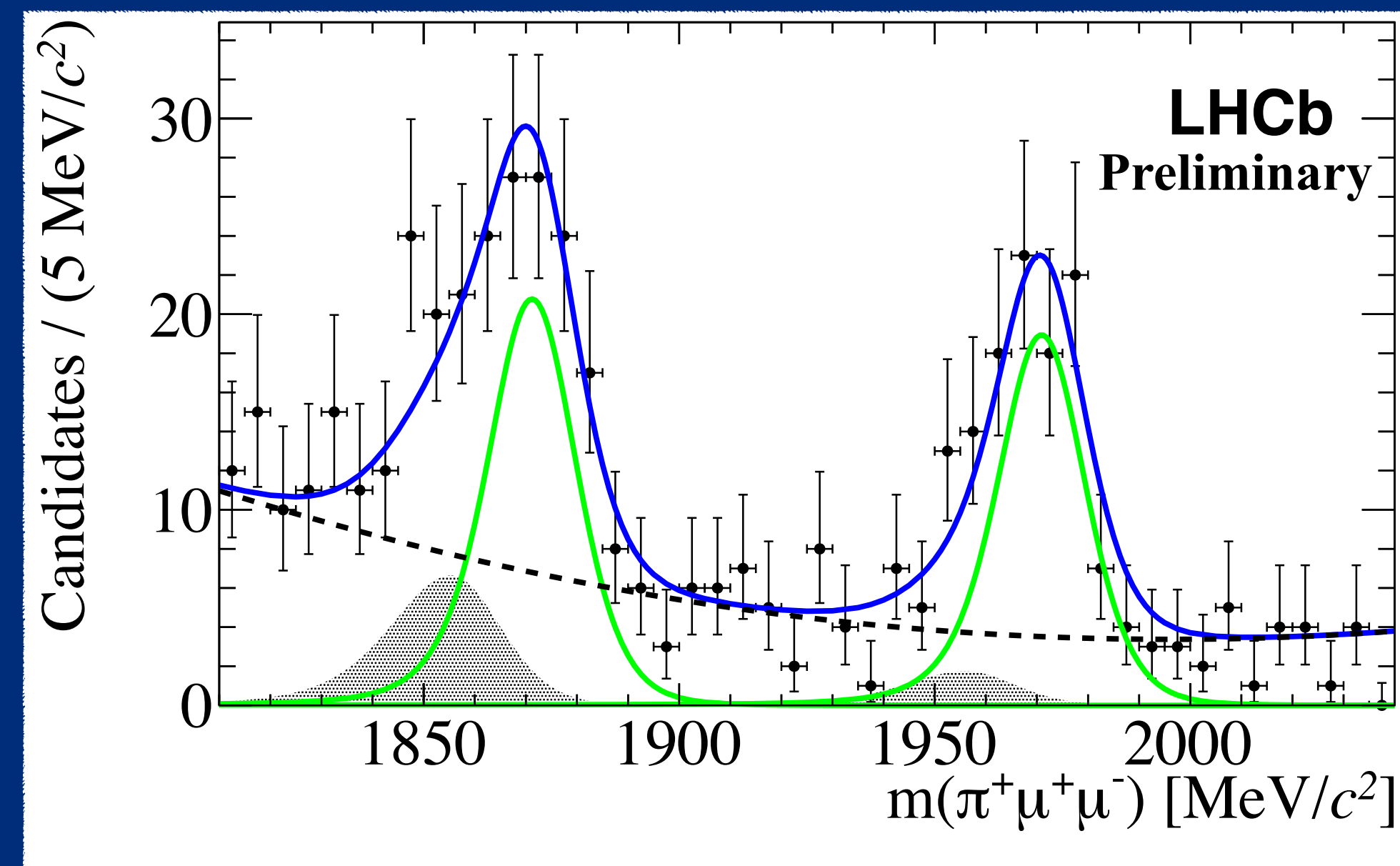
## Low- $m(\mu^+ \mu^-)$ bin



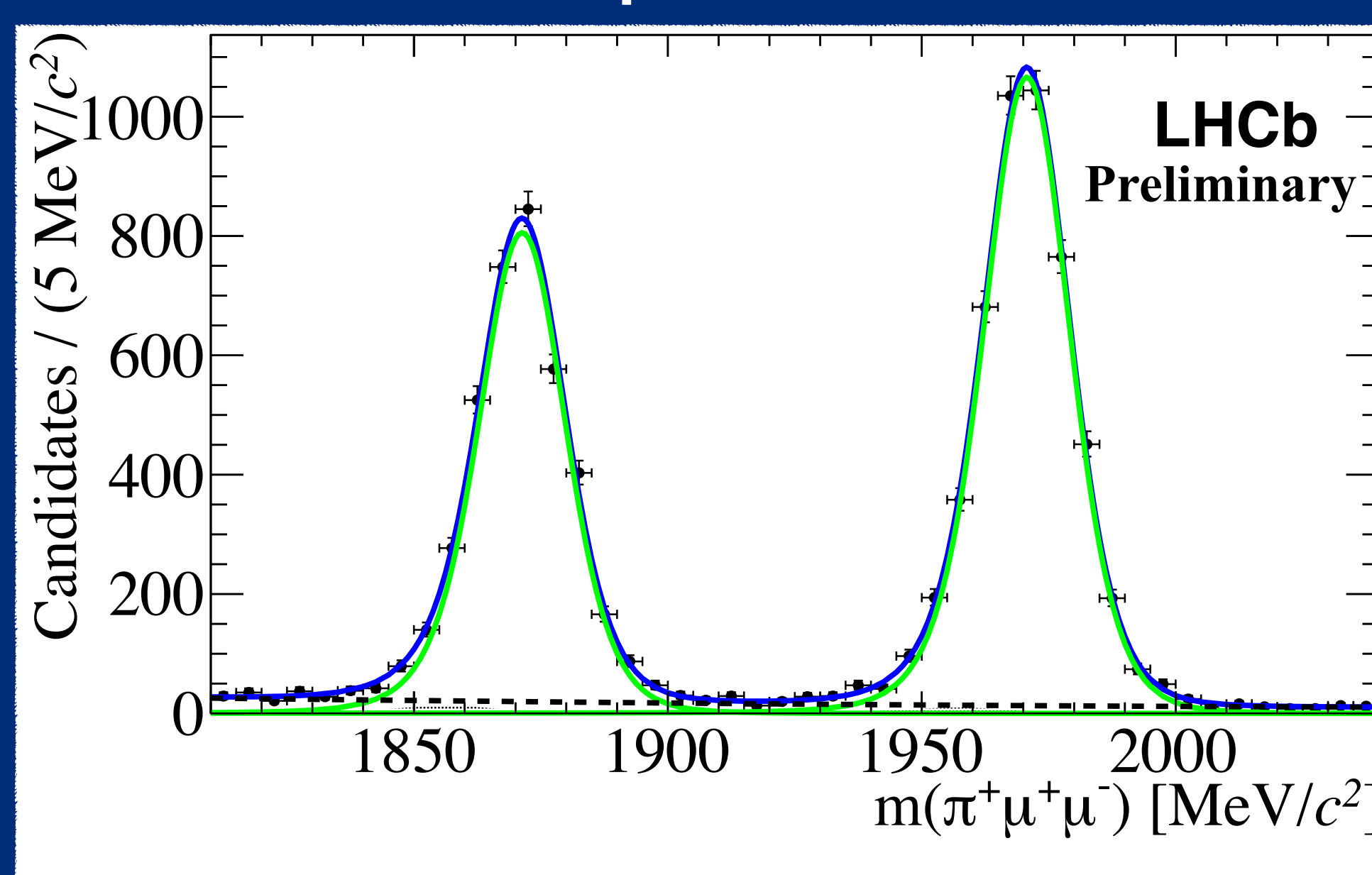
## $\eta$ bin



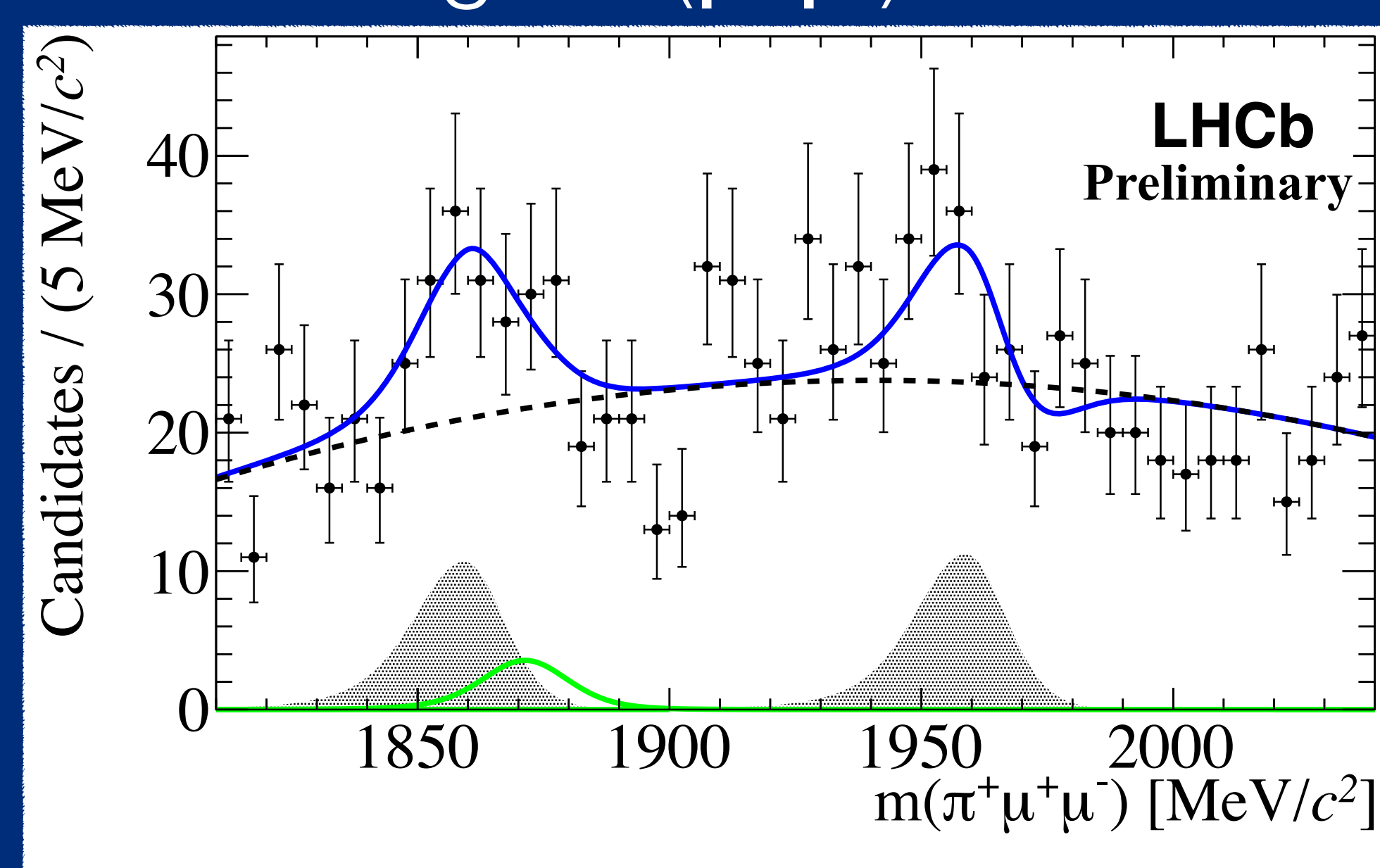
## $\rho/\omega$ bin



## $\phi$ bin



## High- $m(\mu^+ \mu^-)$ bin



First observation of the decay chains:

$$D_{(s)}^+ \rightarrow \pi^+(\eta \rightarrow \mu^+ \mu^-)$$

$$D_{(s)}^+ \rightarrow \pi^+(\rho/\omega \rightarrow \mu^+ \mu^-)$$

provide an important cross-check of the fit's ability to separate the signals from the peaking backgrounds

## The world's most stringent limits are set

an improvement of  $O(10^2)$  compared to prior measurement<sup>1,2</sup>

$$\mathcal{B}(D^+ \rightarrow \pi^+ \mu^+ \mu^-) < 8.3 \times 10^{-8} \text{ at 95\% C.L.}$$

$$\mathcal{B}(D_s^+ \rightarrow \pi^+ \mu^+ \mu^-) < 4.8 \times 10^{-7} \text{ at 95\% C.L.}$$

## Also: $D_{(s)}^+ \rightarrow \pi^- \mu^+ \mu^+$

- ★ Lepton number violating (LNV)
- ★ Can be mediated by a Majorana neutrino
- $\mathcal{B}(D^+ \rightarrow \pi^- \mu^+ \mu^+) < 2.5 \times 10^{-8}$  at 95% C.L.
- $\mathcal{B}(D_s^+ \rightarrow \pi^- \mu^+ \mu^+) < 1.4 \times 10^{-7}$  at 95% C.L.