

$\gamma\gamma \rightarrow \phi J/\psi$ in Belle and Belle II

Discussion

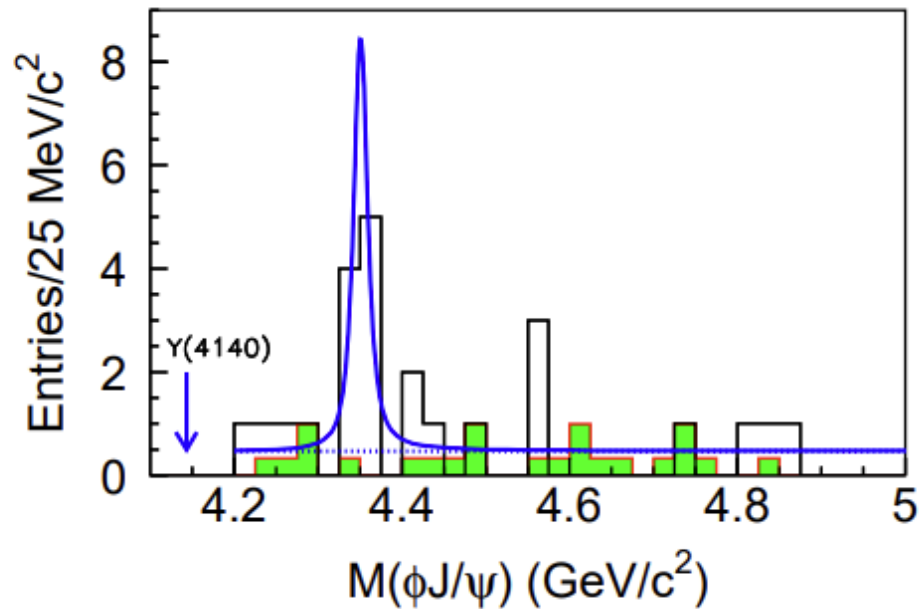
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Motivation

Belle observed $X(4350)$ in $\gamma\gamma \rightarrow \phi J/\psi$ more than 3.2σ in 2010
(only 8.8 events in $825 fb^{-1}$ from fitting)

Can be improved and further checked with higher statistic
(B1 + B2 = $\sim (1.49 - 1.83 fb^{-1})$)
Still finding other motivation

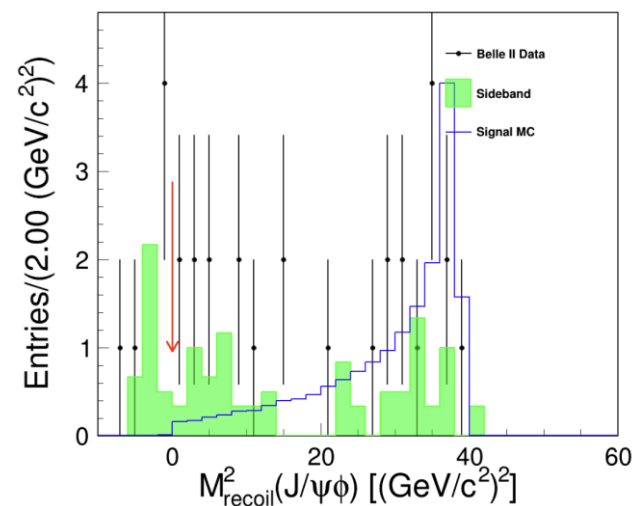
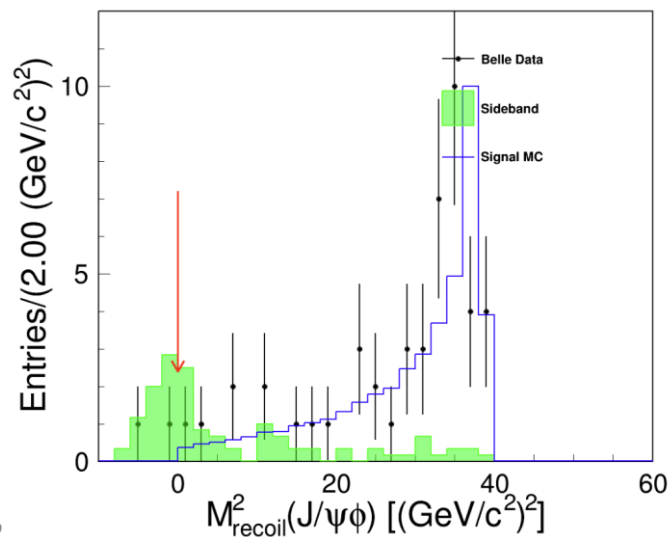
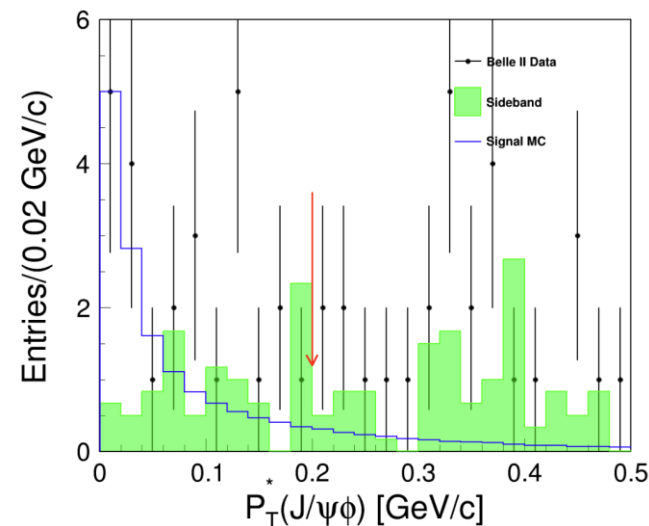
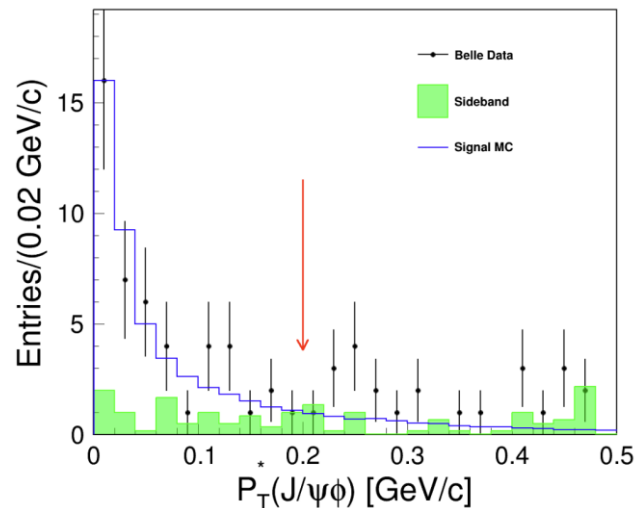


Event selection

- Good charged tracks
 - $|dr| < 0.5 \text{ cm}, |dz| < 5 \text{ cm}$
 - $N_{goodtrack} = 4$
- Particle Identification
 - $muID > 0.1$ for all
 - $eID > 0.1$ for all e
 - $atcPIDBelle(2,3) < 0.4$ for all K
 - $eID < 0.75$ for all K to suppress contributions from gamma-conversion
- Bremsstrahlung photons
 - within 0.05 radians of the original electrons
 - $E_\gamma > 20 \text{ MeV}$
- $J/\psi, \phi$ reconstruction
 - $3.07 \text{ GeV}/c^2 < M_{\ell^+\ell^-} < 3.136 \text{ GeV}/c^2$
 - $2.934 \text{ GeV}/c^2 < M_{\ell^+\ell^-} < 3.00 \text{ GeV}/c^2$ and $3.17 \text{ GeV}/c^2 < M_{\ell^+\ell^-} < 3.236 \text{ GeV}/c^2$ for sideband
 - $1.0088 \text{ GeV}/c^2 < M_{K^+K^-} < 1.0312 \text{ GeV}/c^2$
 - $1.005 \text{ GeV}/c^2 < M_{K^+K^-} < 0.9938 \text{ GeV}/c^2$ and $1.0355 \text{ GeV}/c^2 < M_{K^+K^-} < 1.0686 \text{ GeV}/c^2$ for sideband

Event selection

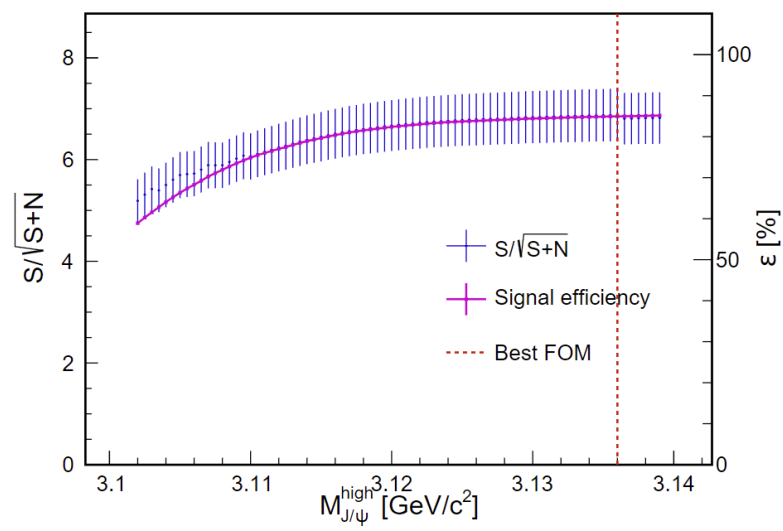
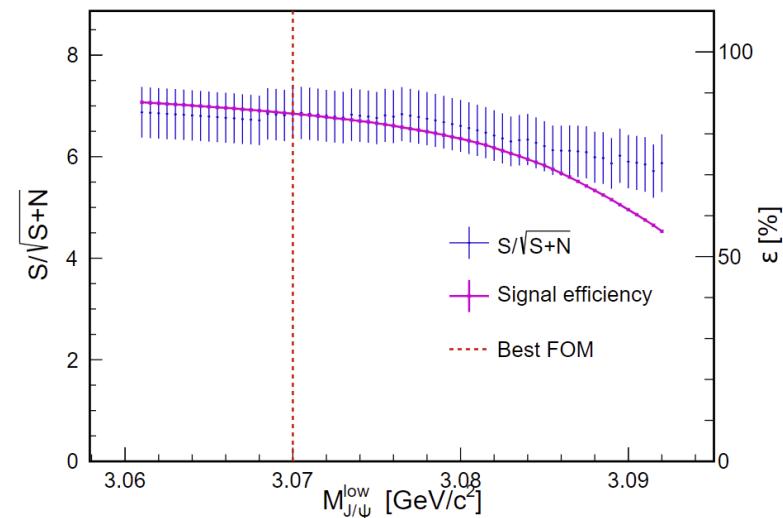
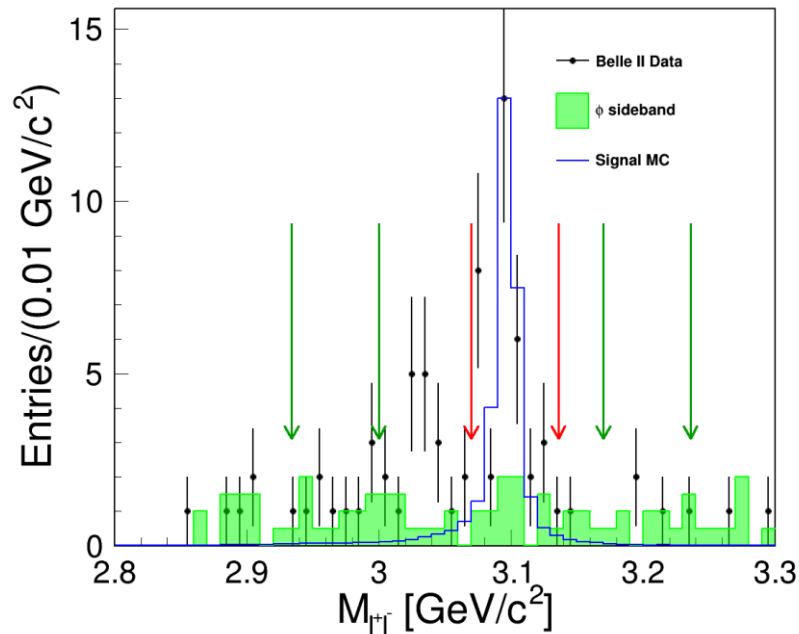
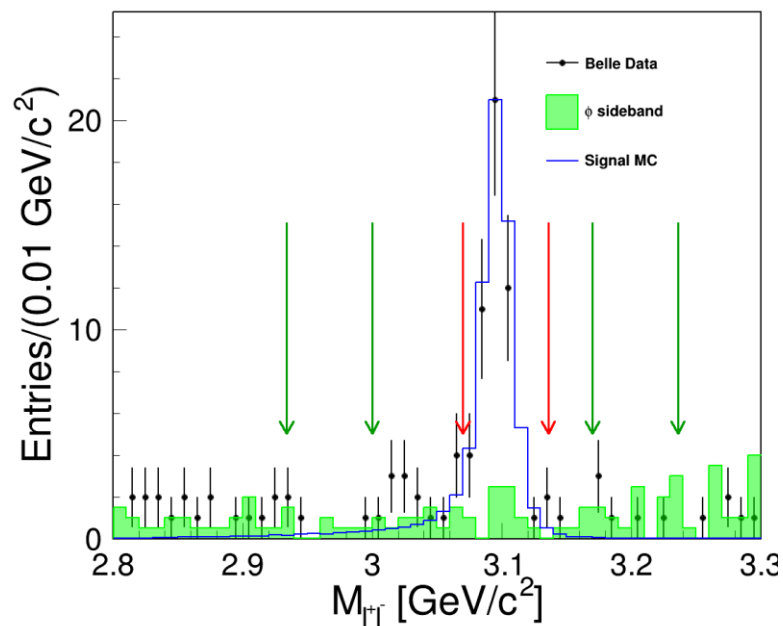
- $M_{Rec}^2 > 3.5 \text{ (GeV/c}^2\text{)}^2$ for $K^+K^-\ell^+\ell^-$ to suppress ISR backgrounds. (optimized using the F.O.M)
- $P_t^* < 0.2 \text{ GeV/c}$ for $\phi J/\psi$ system to identify $\gamma\gamma \rightarrow \phi J/\psi$ events.



J/ψ reconstruction

$3.077 \text{ GeV}/c^2 < M_{\ell^+\ell^-} < 3.117 \text{ GeV}/c^2$ for J/ψ signal

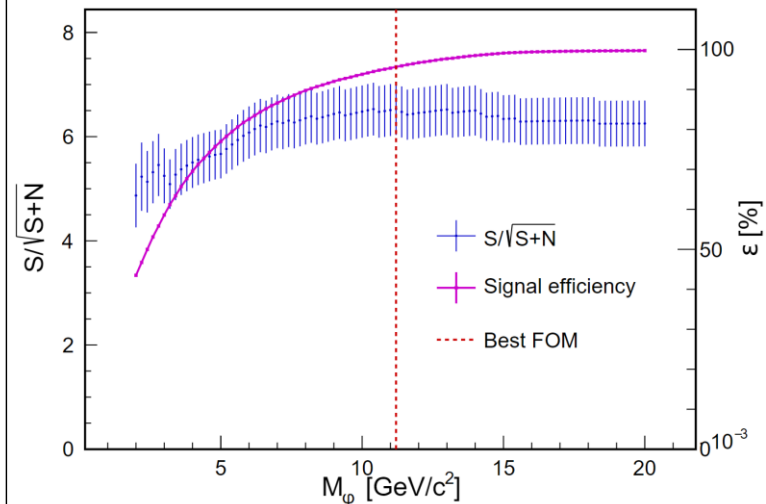
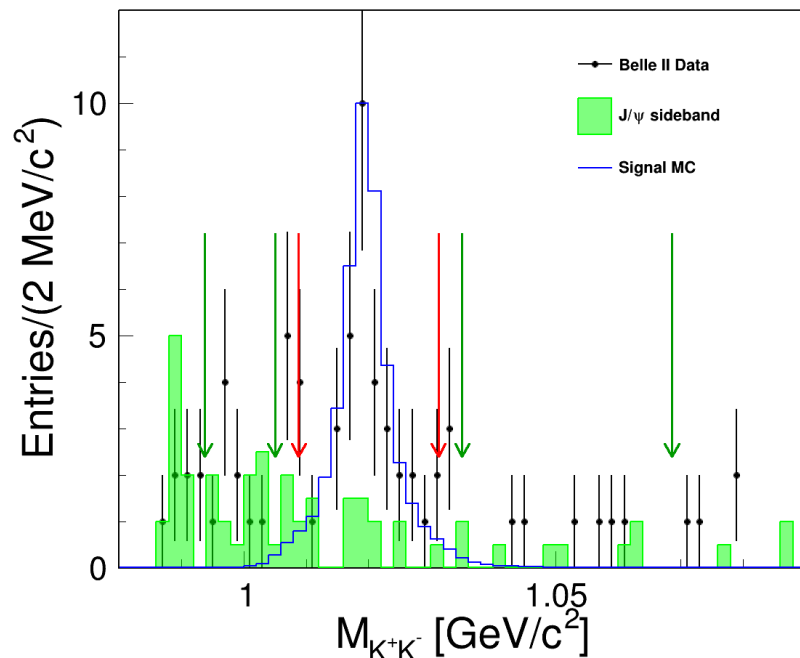
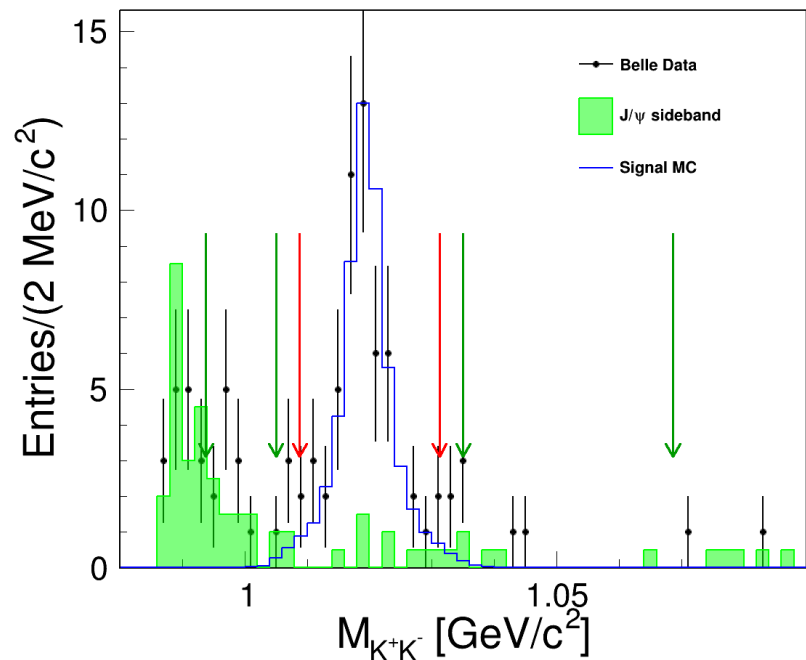
$3.0 \text{ GeV}/c^2 < M_{\ell^+\ell^-} < 3.06 \text{ GeV}/c^2$ and $3.14 \text{ GeV}/c^2 < M_{\ell^+\ell^-} < 3.20 \text{ GeV}/c^2$ for J/ψ sideband



ϕ reconstruction

$1.0088 \text{ GeV}/c^2 < M_{K^+K^-} < 1.0312 \text{ GeV}/c^2$ for ϕ signal

$1.005 \text{ GeV}/c^2 < M_{K^+K^-} < 0.9938 \text{ GeV}/c^2$ and $1.0355 \text{ GeV}/c^2 < M_{K^+K^-} < 1.0686 \text{ GeV}/c^2$ for ϕ sideband



Some events from gamma-conversion can be found in the regions $<0.995 \text{ GeV}/c^2$, not sure how to deal with.

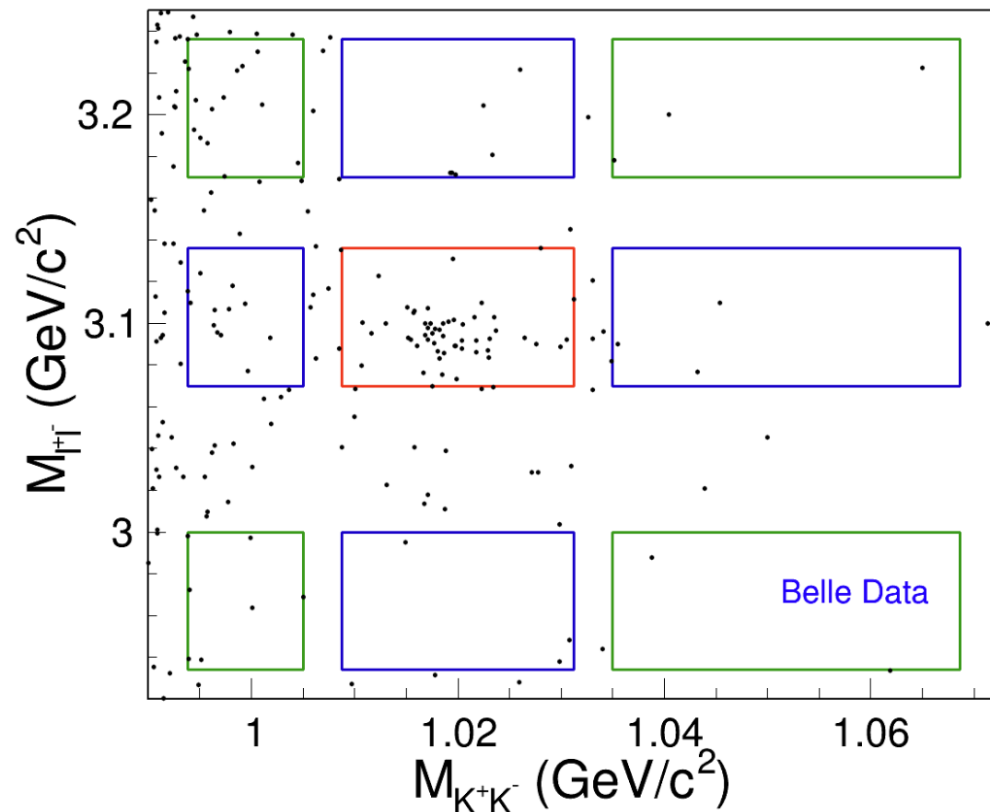
$\phi J/\psi$ reconstruction

$3.077 \text{ GeV}/c^2 < M_{\ell^+\ell^-} < 3.117 \text{ GeV}/c^2$ for J/ψ signal

$3.0 \text{ GeV}/c^2 < M_{\ell^+\ell^-} < 3.06 \text{ GeV}/c^2$ and $3.14 \text{ GeV}/c^2 < M_{\ell^+\ell^-} < 3.20 \text{ GeV}/c^2$ for J/ψ sideband

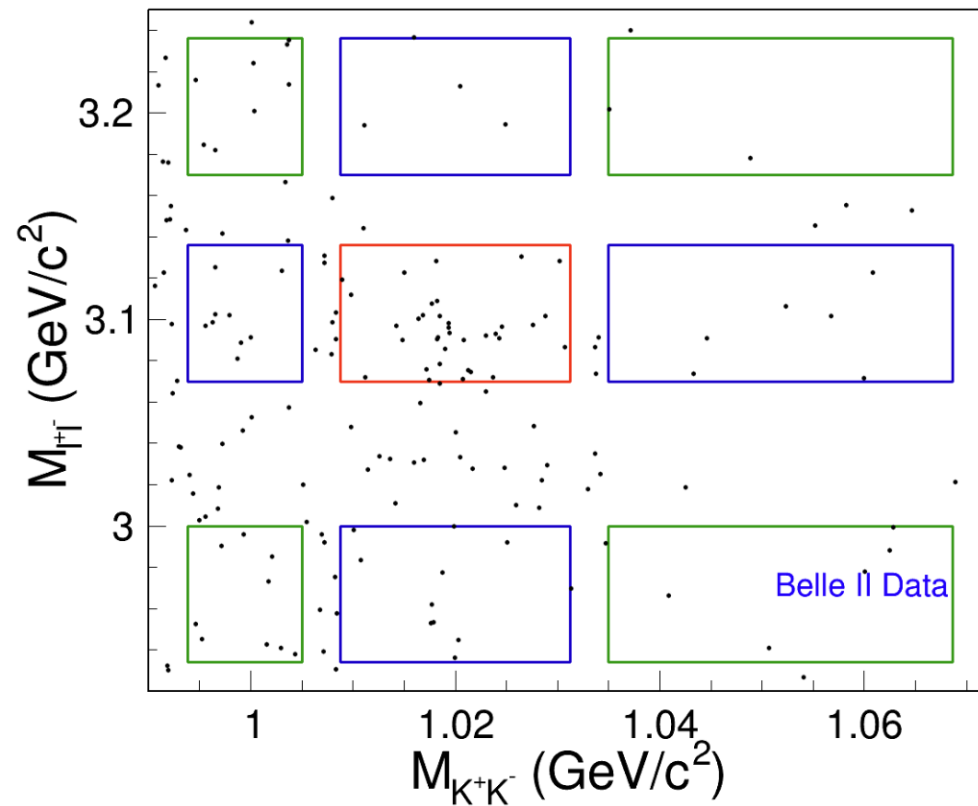
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B1 : 980fb 50 events with 5.75 sideband, $\varepsilon = 16.3\%$.

B1 previous: 815fb 24 events with 7.6 sideband, $\varepsilon \approx 9.9\%$.



B2 : 365fb 35 events with 8.25 sideband, $\varepsilon = 28.9\%$.

Main efficiency improve source for belle

Belle previous work use lowmult skim, with skim efficiency for about 75% .

Optimized J/ψ mass region improve efficiency for 15%

