Search for invisible decays of ω and ϕ with J/ψ data at BESIII

invisible signal reconstruction

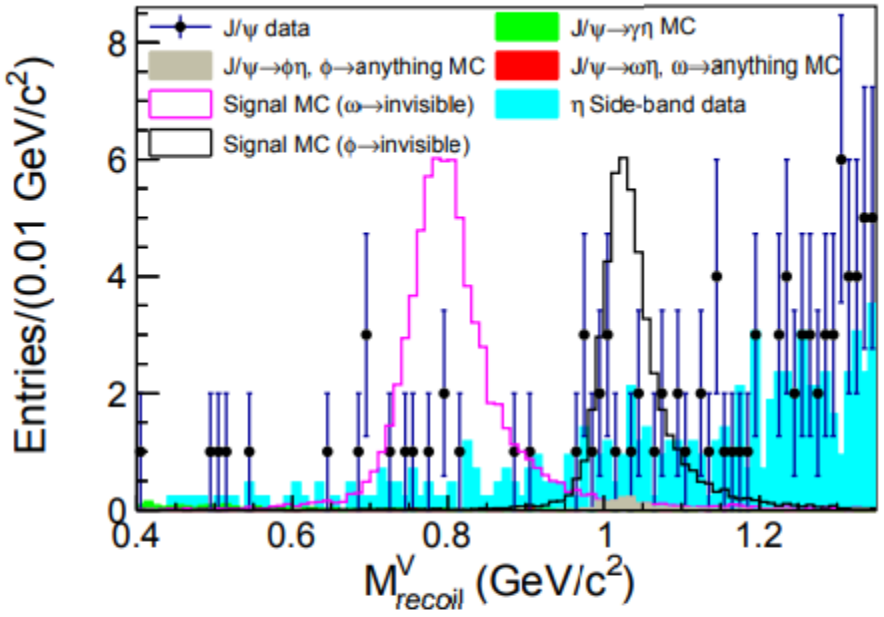

FIG. 1. (Color online) Invariant mass recoiling against the selected η candidate ($M^V_{\rm recoil}$) for data (black dot points with error bars), signal MC samples (pink and black histograms for ω and ϕ, respectively) and various expected backgrounds shown as different colored histograms.

The signals of the invisible decays of ω and ϕ mesons are inferred from the invariant mass of the system recoiling against the selected η candidate, defined as $M^V_{\rm recoil} \equiv \sqrt{(E_{cm} - E_{\pi^+\pi^-\pi^0})^2 - P^2_{\pi^+\pi^-\pi^0}}$, where E_{cm} is the CM energy, and $E_{\pi^+\pi^-\pi^0}$ and $P_{\pi^+\pi^-\pi^0}$ are the energy and momentum of the $\pi^+\pi^-\pi^0$ system in the CM frame, re-

reference channel reconstruction

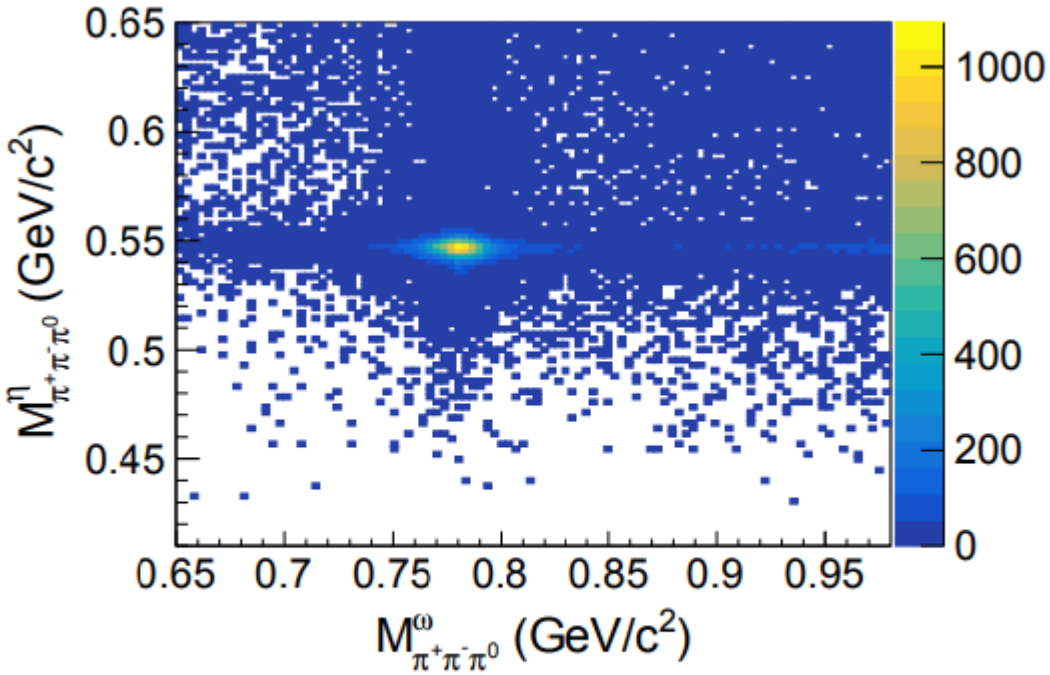

FIG. 3. (Color online) Distribution of $M^{\omega}_{\pi^+\pi^-\pi^0}$ versus $M^{\eta}_{\pi^+\pi^-\pi^0}$ for data.

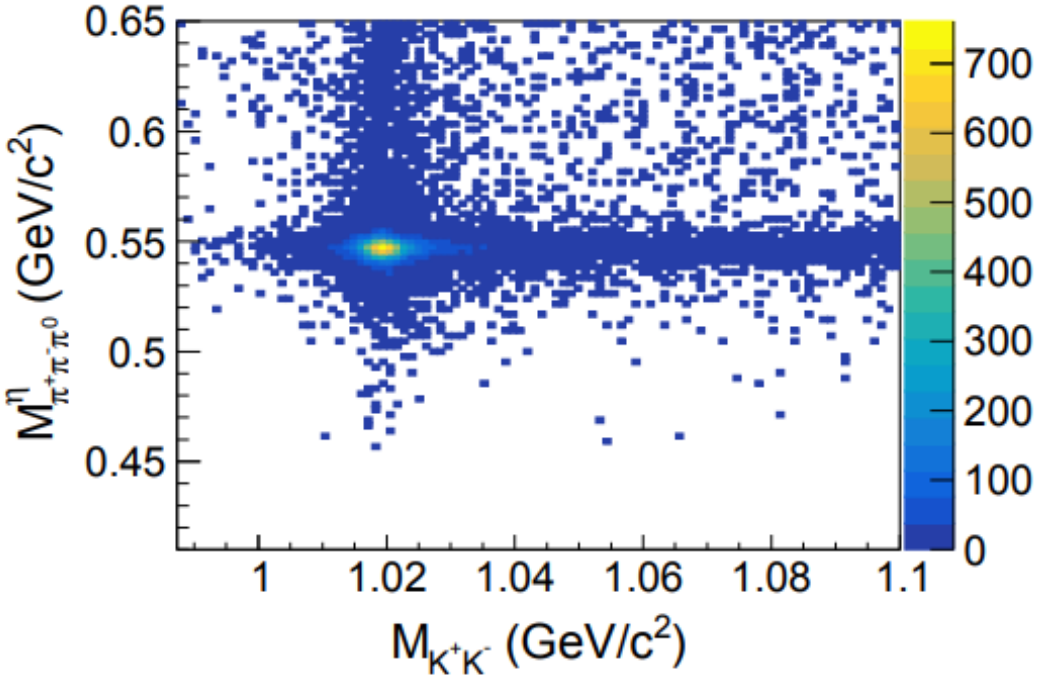

FIG. 5. (Color online) Distribution of $M^{\phi}_{K^+K^-}$ versus $M^{\eta}_{\pi^+\pi^-\pi^0}$ for data.

result and theoritical prediction

$\mathcal{B}(\omega \to \text{invisible}) < 7.3 \times 10^{-5}$ and $\mathcal{B}(\phi \to \text{invisible}) < 1.7 \times 10^{-4}$

mode	s-wave	p-wave
$\mathrm{BR}(\Upsilon(1S) \to \chi\chi)$	4.2×10^{-4}	1.8×10^{-3}
$\mathrm{BR}(\Upsilon(1S) \to \nu\bar{\nu})$	9.9×10^{-6}	
$\mathrm{BR}(J/\Psi \to \chi\chi)$	2.5×10^{-5}	1.0×10^{-4}
$\mathrm{BR}(J/\Psi \to \nu\bar{\nu})$	2.7×10^{-8}	
$\mathrm{BR}(\eta \to \chi\chi)$	3.4×10^{-5}	1.4×10^{-4}
$\mathrm{BR}(\eta' \to \chi\chi)$	3.7×10^{-7}	1.5×10^{-6}
$\mathrm{BR}(\eta_c \to \chi\chi)$	1.3×10^{-7}	5.3×10^{-7}
$\mathrm{BR}(\chi_{c0}(1P) \to \chi\chi)$	2.7×10^{-8}	1.2×10^{-7}
$\mathrm{BR}(\phi \to \chi\chi)$	1.9×10^{-8}	7.8×10^{-8}
$\mathrm{BR}(\omega \to \chi\chi)$	7.2×10^{-8}	3.0×10^{-8}

Table I Estimated branching ratios for the narrowest mesons. The two columns correspond to the assumption that the Dark Matter annihilation in the early universe occurs in either the s-wave or p-wave. Neutrino branching ratios are from Ref.[17]. All mesons have a branching ratio (even if tiny) to neutrinos.