Figure 1: Crystal hadron intensity vs crystal total energy for CsI(Tl) crystals in calorimeter clusters produced by photons in Phase 2 Data in the momentum range 0.5-1 GeV/c. Photons are selected from $e^+e^- \rightarrow \mu^+\mu^- (\gamma)$ control sample. For further discussion on the result see Section 4 in reference [1]. For selection details see Appendix D in reference [2].

Figure citations:


Figure 2: Histogram of the crystal hadron intensity for CsI(Tl) crystals with energy above 0.25 GeV in calorimeter clusters produced by photons selected from $e^+e^- \rightarrow \mu^+\mu^-(\gamma)$ control sample in Phase 2 Data and MC. Errors are statistical only. For further discussion on the result see Section 4 of reference [1]. For selection details see Appendix D in reference [2].

Figure citations:


Figure 3: Cluster energy distribution of $\pi^-$ with $p_{\text{lab}} = 1 - 3$ GeV/c, selected from $K_S^0 \rightarrow \pi^+\pi^-$ control sample from Phase 2 Data and Monte Carlo (MC). MC labelled “No Birks and PS” does not include simulations of CsI(Tl) scintillation response to highly ionizing particles. MC labelled “w Birks and PS” includes simulations of the Birks scintillation efficiency and simulations of the ionization dE/dx dependent CsI(Tl) scintillation pulse shapes. Errors are statistical only. For further discussion on the result see Section 7 of reference below. For selection details see Appendix E in reference below.

Figure citation:

Figure 4: Crystal hadron intensity vs crystal total energy for CsI(Tl) crystals in calorimeter clusters produced by $\pi^-$ in Phase 2 Data with $p_{\text{lab}} = 1-3$ GeV/c and cluster energy outside the range 0.15 – 0.25 GeV (ionization cluster veto to select hadronic showers). $\pi^-$ are selected from $K_S^0 \rightarrow \pi^+\pi^-$ control sample. For further discussion on the result see Section 7 of reference below. For selection details see Appendix E in reference below.

Figure citation:

Figure 5: Crystal hadron intensity vs crystal total energy for CsI(Tl) crystals in calorimeter clusters produced by $\pi^-$ in Phase 2 simulation with $p_{\text{lab}} = 1 - 3$ GeV/c and cluster energy outside the range 0.15 - 0.25 GeV (ionization cluster veto to select hadronic showers). $\pi^-$ are selected from $K_S^0 \rightarrow \pi^+\pi^-$ control sample. For further discussion on the result see Section 7 of reference below. For selection details see Appendix E in reference below.

Figure citation:

Figure 6: Histogram of the crystal hadron intensity for CsI(Tl) crystals with energy above 0.25 GeV, in calorimeter clusters produced by $\pi^-$ with $p_{\text{lab}} = 1-3$ GeV/c and cluster energy outside the range $0.15 - 0.25$ GeV (ionization cluster veto to select hadronic showers). $\pi^+$ are selected from $K^0_S \rightarrow \pi^+\pi^-$ control sample. Errors are statistical only. For further discussion on the result see Section 7 of reference below. For selection details see Appendix E in reference below.

Figure citation:

Figure 7: Distribution of “Number of Hadron Crystals” defined as the sum of the cluster association weights of crystals in a calorimeter cluster that have a significant amount of hadron scintillation component emission. π⁺ are selected from $K^0_S \rightarrow \pi^+\pi^-$ control sample and μ⁻ are selected from $e^+e^- \rightarrow \mu^+\mu^-(\gamma)$ control sample from Phase 2 Data and MC. Errors are statistical only. For further discussion on the result see Section 10 of reference below.

Figure citation:

Figure 8: Distribution of the invariant mass computed using the $K_S^0$ and $K_L^0$ candidates selected from $e^+e^- \rightarrow \phi \gamma \rightarrow K_S^0 K_L^0 \gamma$ control sample from Phase 2 Data and MC. The $K_L^0$ momentum magnitude is computed from $\gamma$ and $K_S^0$ candidates by applying total energy conservation. The $K_L^0$ momentum direction is given by the location of the candidate calorimeter cluster. $K_L^0$ candidates in the region $m_{\phi}^{\text{Calc}} < 1.12$ GeV/c$^2$ are selected. Errors are statistical only. For further discussion on the result and selection details see appendix of reference below.

Figure citation:

Figure 9: Distribution of calculated momentum magnitude for $K^0_L$ candidates from $e^+e^- \rightarrow \phi \gamma \rightarrow K^0_SK^0_L\gamma$ control sample selected from Phase 2 Data and MC. Errors are statistical only. For further discussion on the result and selection details see appendix of reference below.

Figure citation:

Figure 10: Distribution of measured cluster energy for $K^0_L$ candidates from $e^+e^- \rightarrow \phi \gamma \rightarrow K^0_S K^0_L \gamma$ control sample selected from Phase 2 Data and MC. Errors are statistical only. For further discussion on the result and selection details see appendix of reference below.

Figure citation:

Figure 11: Crystal hadron intensity vs crystal total energy for CsI(Tl) crystals in calorimeter clusters produced by $K^0_L$ selected from $e^+e^- \rightarrow \phi \gamma \rightarrow K^0_S K^0_L \gamma$ control sample in Phase 2 Data. For further discussion on the result see Section 4 in reference below. For selection details see appendix in reference below.

Figure citation:

Figure 12: Distribution of pulse shape discrimination based multivariate classifier output for calorimeter clusters produced by $K_L^0$ candidates selected from $e^+e^-\rightarrow \phi(\gamma)\rightarrow K_S^0K_L^0(\gamma)$ control sample in Phase 2 Data and MC. Errors are statistical only. For further discussion on the result see Section 4 in reference below. For selection details see appendix in reference below.

Figure citation:

Figure 13: Distribution of pulse shape discrimination based multivariate classifier output for calorimeter clusters produced by photons candidates selected from $e^+e^- \rightarrow \mu^+\mu^- (\gamma)$ control sample in Phase 2 Data and MC. Errors are statistical only. For further discussion on the result see Section 4 in reference [1]. For selection details see Appendix D in reference [2].

Figure citations:


Figure 14: $K^0_L$ identification efficiency and photon fake-rate (photon-as-hadron) as a function of momentum for pulse shape discrimination based multivariate classifier for tight cut of $\Theta_{\text{PSD}} < 0.02$, where $\Theta_{\text{PSD}}$ is the output of the classifier. Errors are statistical only. For further discussion on the result see Section 4 in reference below.

Figure citation:

Figure 15: $K_L^0$ identification efficiency and photon fake-rate ($\text{photon-as-hadron}$) as a function of cluster energy for pulse shape discrimination based multivariate classifier for tight cut of $\Theta_{PSD} < 0.02$, where $\Theta_{PSD}$ is the output of the classifier. Errors are statistical only. For further discussion on the result see Section 4 in reference below.

Figure citation:

Figure 16: $K^0_L$ identification efficiency and photon fake-rate (photon-as-hadron) as a function of momentum for pulse shape discrimination based multivariate classifier for loose cut to achieve 95% efficiency for $K^0_L$ identification. Errors are statistical only. For further discussion on the result see Section 4 in reference below.

Figure citation:

Figure 17: $K^0_L$ identification efficiency and photon fake-rate (photon-as-hadron) as a function of momentum for shower shape based multivariate classifier for loose cut to achieve 95% efficiency for $K^0_L$ identification. Errors are statistical only. For further discussion on the result see Section 4 in reference below.

Figure citation: