Analysis of $D^0 \rightarrow K_S^0 \pi^+ \pi^- \pi^0$

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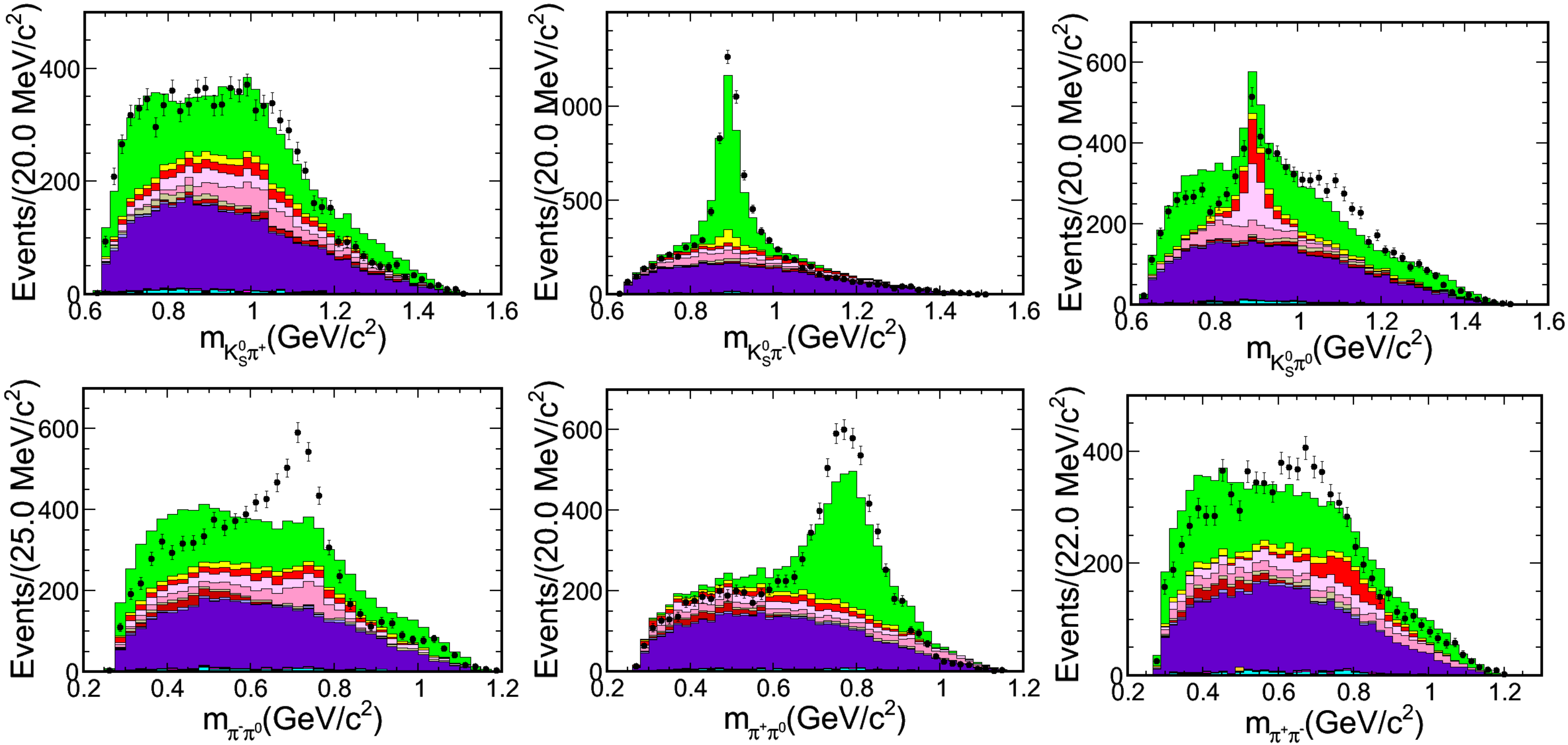
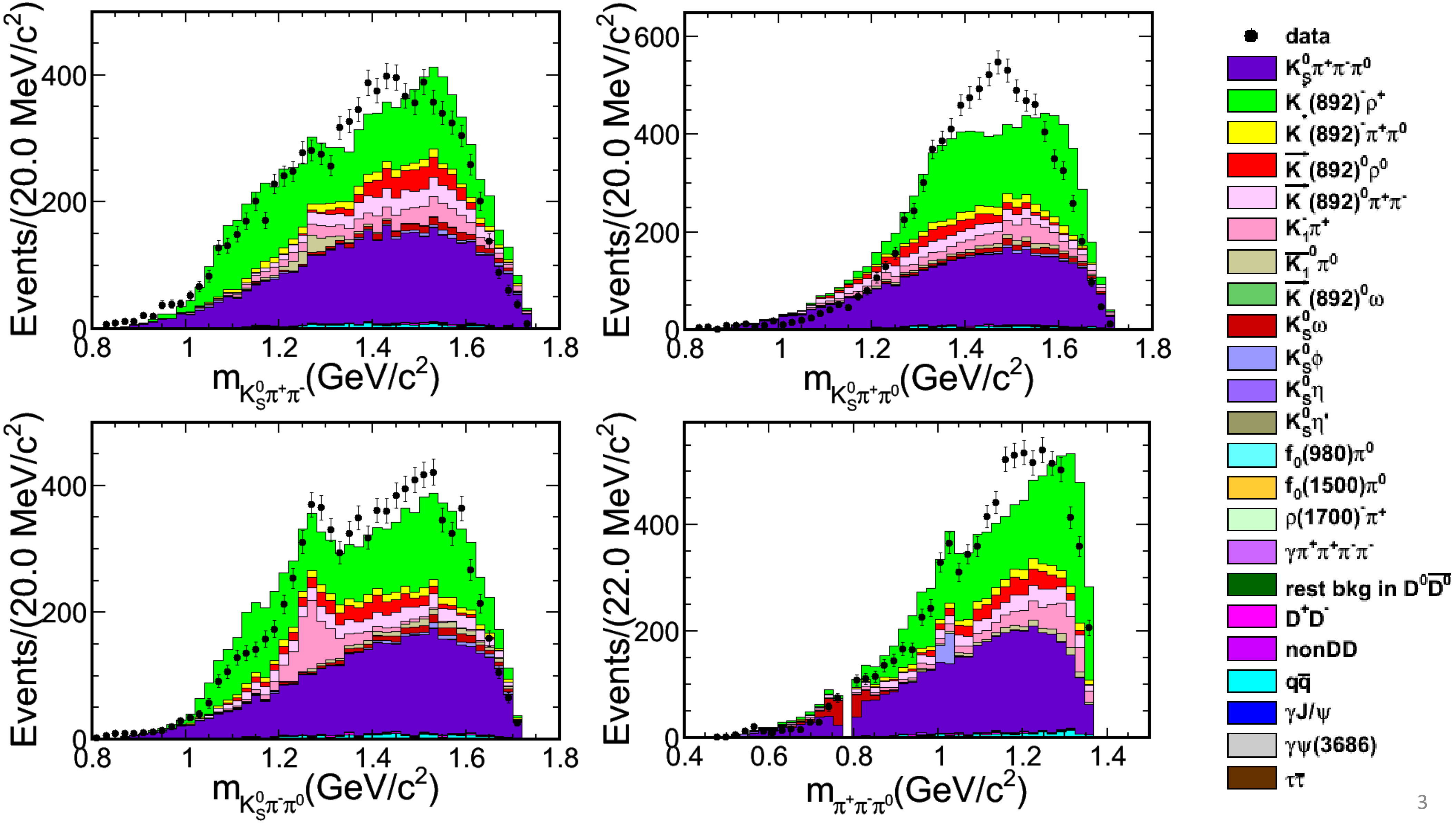
$D^0 \to K_S^0\ \pi^+\ \pi^-\ \pi^0$



$D^0 \to K_S^0 \pi^+ \pi^- \pi^0$



Amplitude Analysis

➢ Likelihood Construction

It is a fit method;
MINUIT is used to determined the fit parameters;
Background is subtracted with negative weight method.

$$\ln L = \sum_{i}^{N_{data}} w_i^{data} \ln S(a_i, p_j) - \sum_{i}^{N_{bkg}} w_i^{bkg} \ln S(a_i, p_j)$$

PDF is calculated by

$$S(a_i, p_j) = \frac{\epsilon(p_j)|A(a_i, p_j)|^2 R_4(p_j)}{\int \epsilon(p_j)|A(a_i, p_j)|^2 R_4(p_j) dp_j}$$

4-momentum dependent

MC integration $\frac{1}{N_{mc}} \sum_{j}^{N_{mc}} |A(a_i, p_j)|^2$

$\epsilon(p_j)$: efficiency; $R_4(p_j)$: four-body phase space;
$A(a_i,p_j)$: total amplitudes.

Amplitude Analysis

➢ Amplitude Construction

Total amplitudes is modeled as the sum over all the partial wave amplitudes;

$$A(a_i, p_j) = \sum_i a_i A_i(p_j)$$

$a_i = \rho_i e^{i\phi_i}$: the complex coefficient;

$A_i(p_j)$: the ith partial wave amplitude.

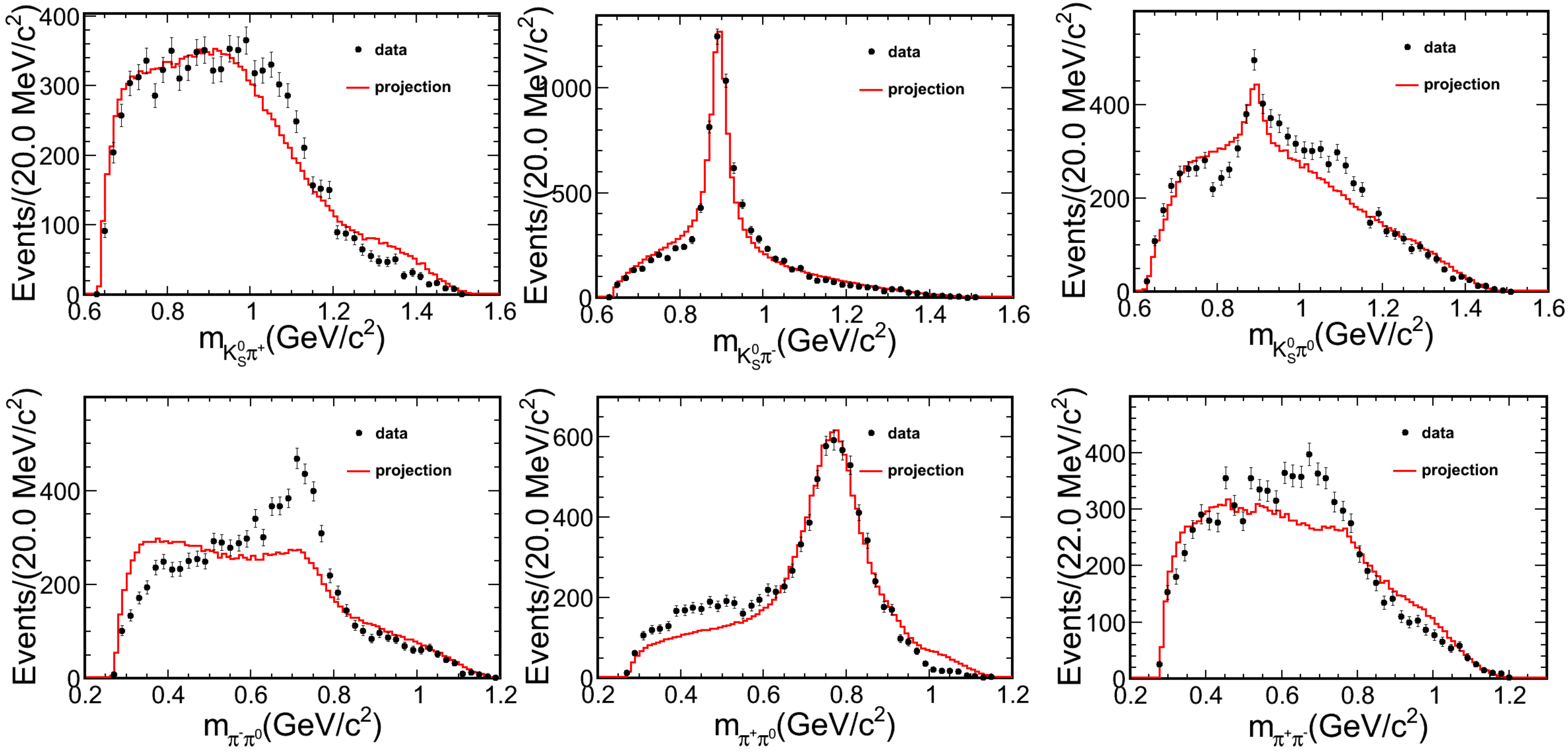
$$A_i(p_j) = P_i^1(p_j) P_i^2(p_j) S_i(p_j) F_i^1(p_j) F_i^2(p_j) F_i^D(p_j)$$

- $P_i^1(p_j)$ and $P_i^2(p_j)$ are the propagators of intermediate resonances 1 and 2;
- $F_i^1(p_j)$, $F_i^2(p_j)$ and $F_i^D(p_j)$ are the Blatte-Weisskopf barriers (PRD 86, 010001 (2012));
- $S_i(p_j)$ is the spin factor and constructed with the covariant tensors.
  (Eur. Phys. J. A16, 537 (1992))

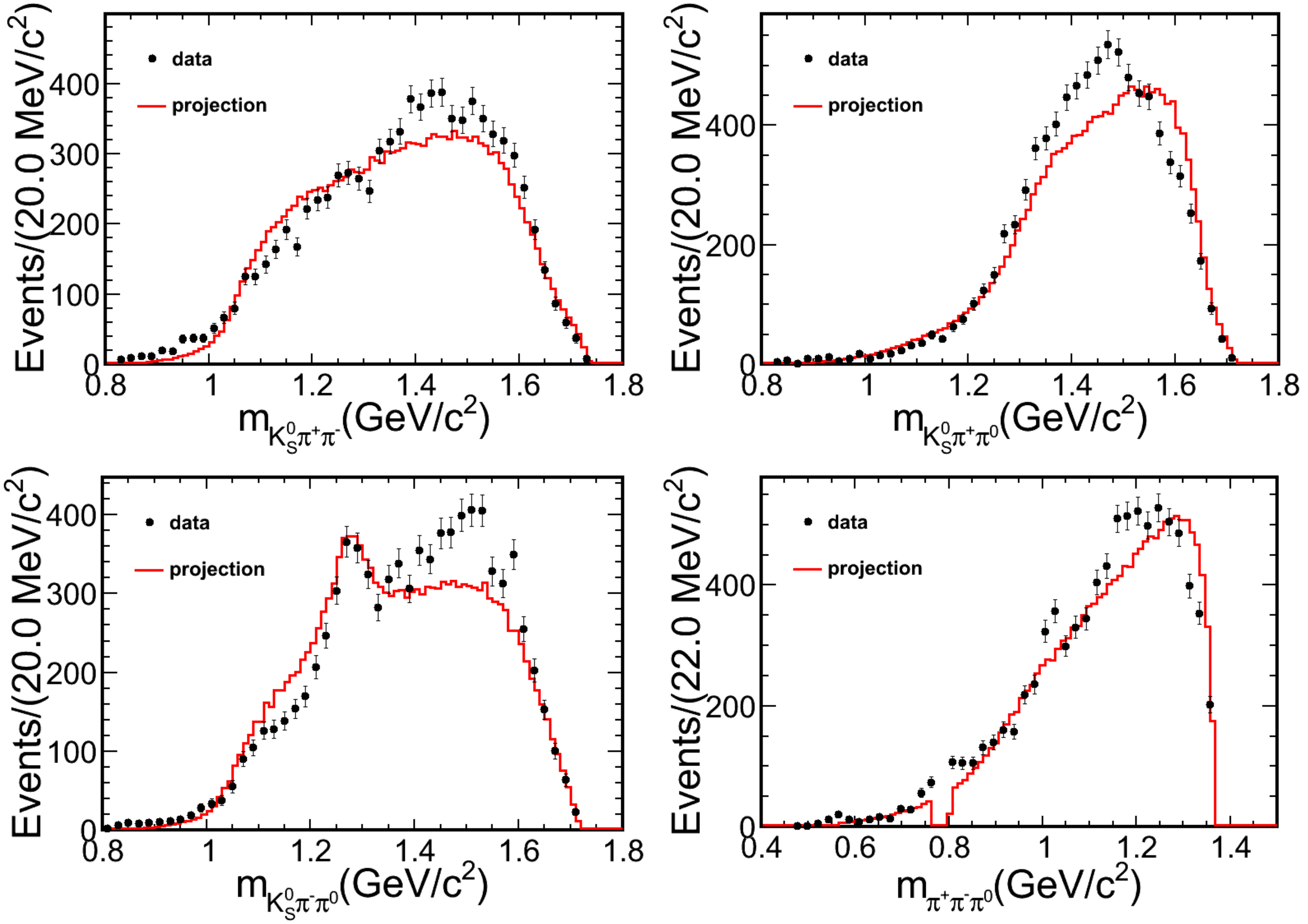
Amplitude Analysis

Component	Amplitude
$D^0 \to K^{*-}\rho^+$	$D^0[S] \to K^{*-}\rho^+$
	$D^0[P] \to K^{*-}\rho^+$
	$D^0[D] \to K^{*-}\rho^+$
$D^0 \to \bar{K}^{*0}\rho^0$	$D^0[S] \to \bar{K}^{*0}\rho^0$
	$D^0[P] \to \bar{K}^{*0}\rho^0$
	$D^0[D] \to \bar{K}^{*0}\rho^0$
$D^0 \to K_1^-(1270)\pi^+$	$D^0 \to K_1^-(1270)\pi^+,\ K_1^-(1270)[S] \to K^{*-}\pi^0$
	$D^0 \to K_1^-(1270)\pi^+,\ K_1^-(1270)[D] \to K^{*-}\pi^0$
	$D^0 \to K_1^-(1270)\pi^+,\ K_1^-(1270)[S] \to \bar{K}^{*0}\pi^-$
	$D^0 \to K_1^-(1270)\pi^+,\ K_1^-(1270)[D] \to \bar{K}^{*0}\pi^-$
	$D^0 \to K_1^-(1270)\pi^+,\ K_1^-(1270)[S] \to \bar{K}^0\rho^-$
	$D^0 \to K_1^-(1270)\pi^+,\ K_1^-(1270)[D] \to \bar{K}^0\rho^-$

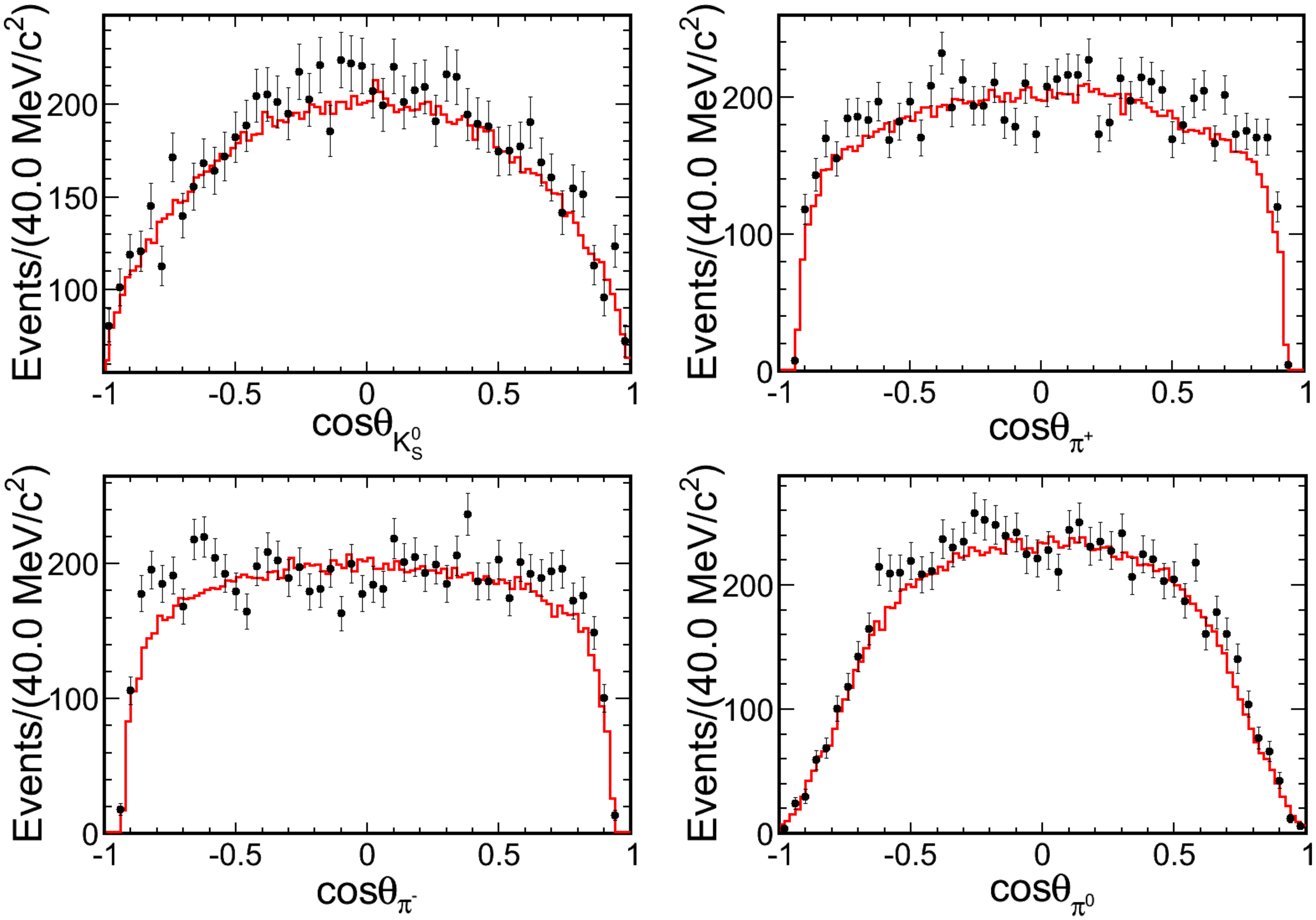
Projection


data
projection
Events/(20.0 MeV/c²)
Events/(22.0 MeV/c²)
m_{K_S^0 π^+}(GeV/c²)
m_{K_S^0 π^-}(GeV/c²)
m_{K_S^0 π^0}(GeV/c²)
m_{π^- π^0}(GeV/c²)
m_{π^+ π^0}(GeV/c²)
m_{π^+ π^-}(GeV/c²)

Projection


data
projection
Events/(20.0 MeV/c²)
$m_{K_S^0\pi^+\pi^-}$(GeV/c²)
$m_{K_S^0\pi^+\pi^0}$(GeV/c²)
$m_{K_S^0\pi^-\pi^0}$(GeV/c²)
Events/(22.0 MeV/c²)
$m_{\pi^+\pi^-\pi^0}$(GeV/c²)

Projection



Events/(40.0 MeV/c^2)
$\cos\theta_{K_S^0}$
$\cos\theta_{\pi^+}$
$\cos\theta_{\pi^-}$
$\cos\theta_{\pi^0}$

Projection