Breit-Wigner Distribution for Rho0 methods

Weekly SRC/CT Meeting

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Definition of BW Distribution

Definition B

Definition A

3. Contributions from ρ^0, $f_0(980)$, and $f_2(1270)$

Contributions from ρ^0, $f_0(980)$, and $f_2(1270)$ mesons are described analytically. The shapes of these resonances are described with a relativistic Breit-Wigner function (rBW) [64,65]:

$$\mathrm{rBW}(M_{\pi\pi}) = \frac{A M_{\pi\pi} M_0 \Gamma(M_{\pi\pi})}{\left(M_0^2 - M_{\pi\pi}^2\right)^2 + M_0^2 \Gamma^2(M_{\pi\pi})}, \qquad (1)$$

where M_0 is the mass of the resonance under study and A is a normalization constant. For wide resonances one should account for the dependence of the resonance width on mass:

$$\Gamma(M_{\pi\pi}) = \left(\frac{M_{\pi\pi}^2 - 4m_\pi^2}{M_0^2 - 4m_\pi^2}\right)^{(2J+1)/2} \times \Gamma_0 \times M_0/M_{\pi\pi}, \qquad (2)$$

S. Acharya et al., Phys. Rev.C 91,064901 (2019)

The **relativistic Breit-Wigner distribution** (after the 1936 nuclear resonance formula[1] of Gregory Breit and Eugene Wigner) is a continuous probability distribution with the following probability density function,[2]

$$f(E) = \frac{k}{\left(E^2 - M^2\right)^2 + M^2\Gamma^2},$$

where k is a constant of proportionality, equal to

$$k = \frac{2\sqrt{2}M\Gamma\gamma}{\pi\sqrt{M^2+\gamma}} \quad \text{with} \quad \gamma = \sqrt{M^2\left(M^2+\Gamma^2\right)}.$$

(This equation is written using natural units, $\hbar = c = 1$.)

It is most often used to model resonances (unstable particles) in high-energy physics. In this case, E is the center-of-mass energy that produces the resonance, M is the mass of the resonance, and Γ is the resonance width (or *decay width*), related to its mean lifetime according to $\tau = 1/\Gamma$. (With units included, the formula is $\tau = \hbar/\Gamma$.)

Outline

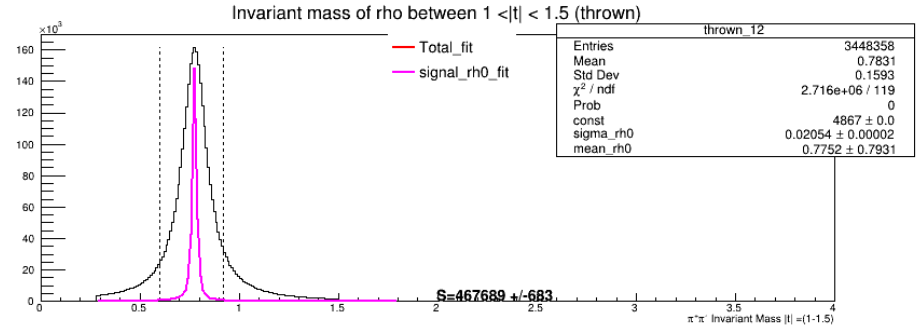
Formula Breit-Wigner Distribution

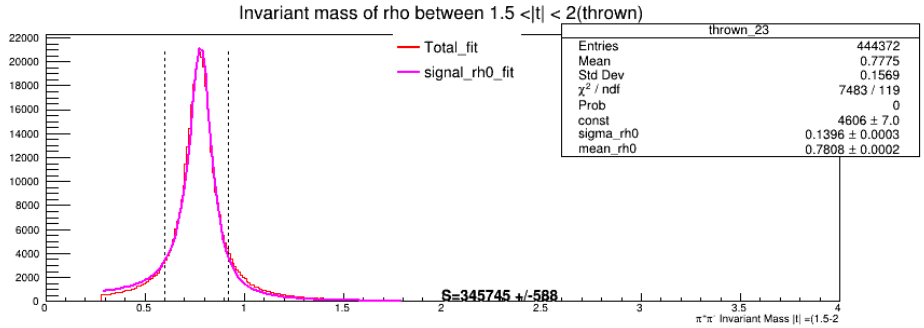
Thrown: Definition A
Thrown: Definition B (uncorrected)
Thrown: Definition B(corrected)

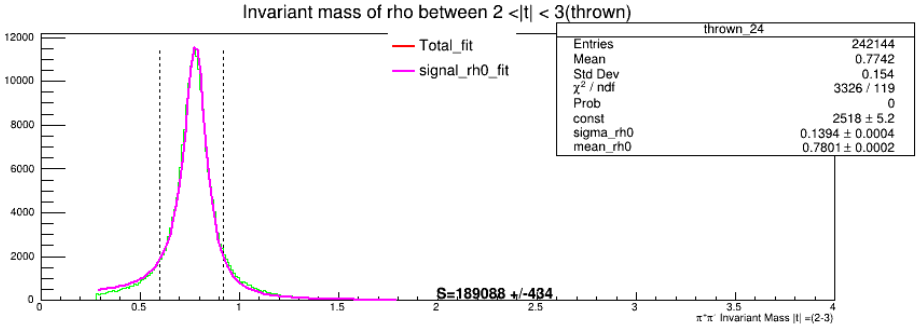
Reconstruct Simulation: Definition A
Reconstruct Simulation: Definition B (uncorrected)
Reconstruct Simulation: Definition B(corrected)

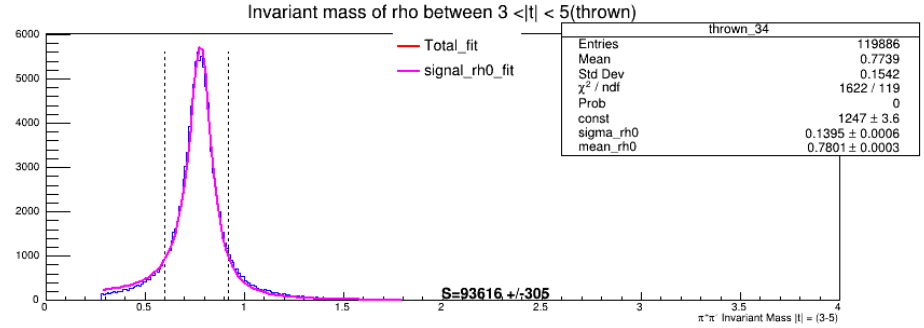
Data: Definition A
Data: Definition B (uncorrected)
Data: Definition B(corrected)

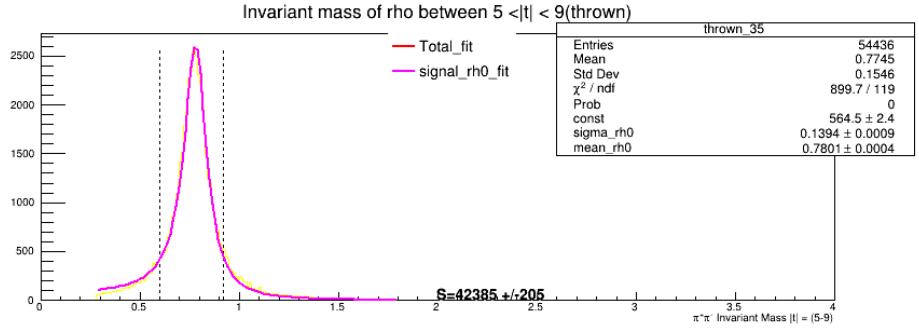
Thrown: Definition A





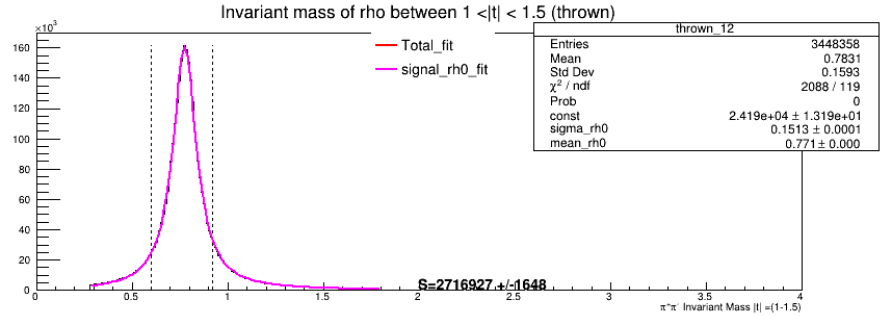


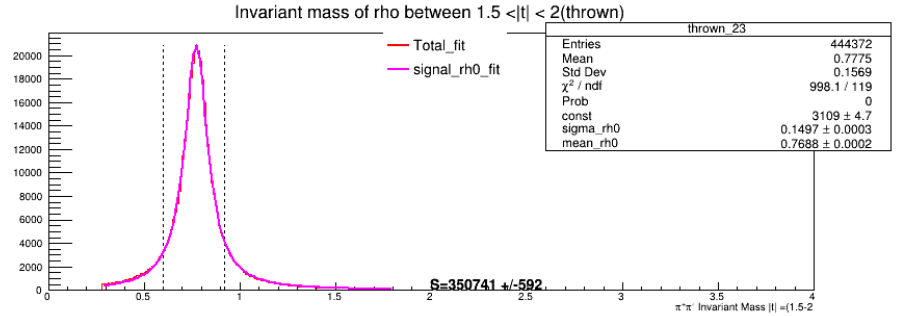


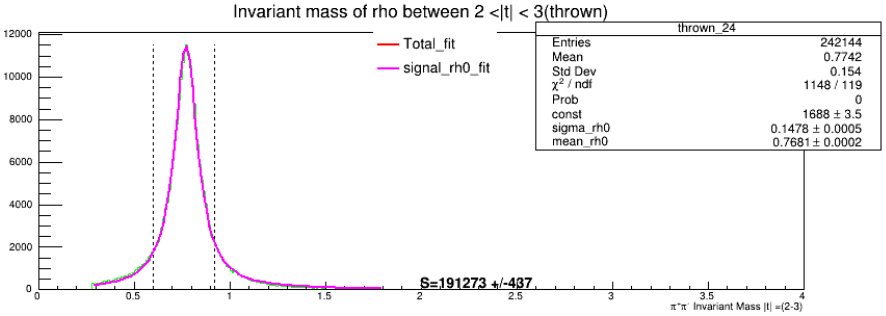


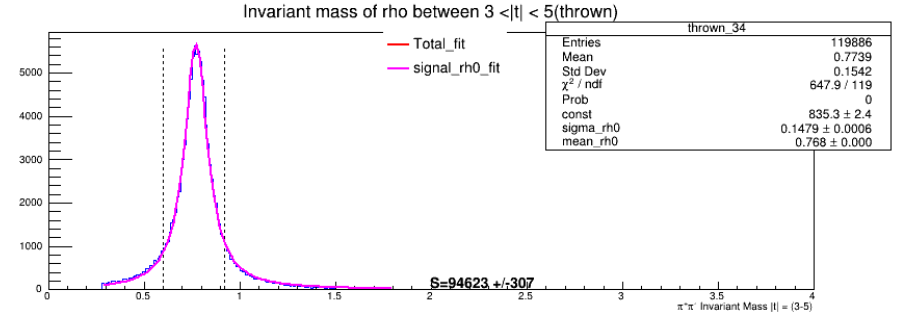
Relativistic BW function is used to fit the thrown (:Definition A)

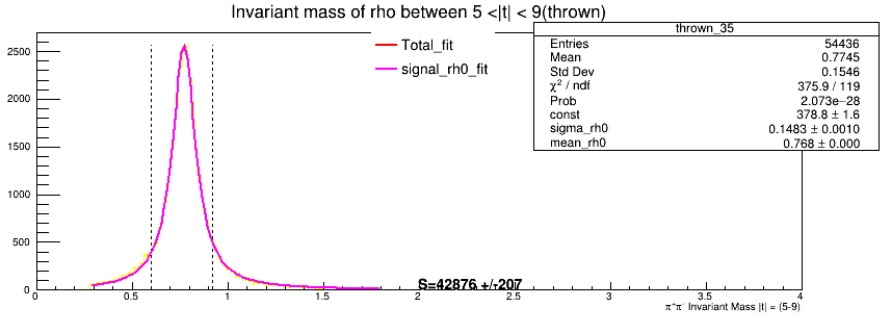
Thrown:Definition B [Phase Space not corrected]





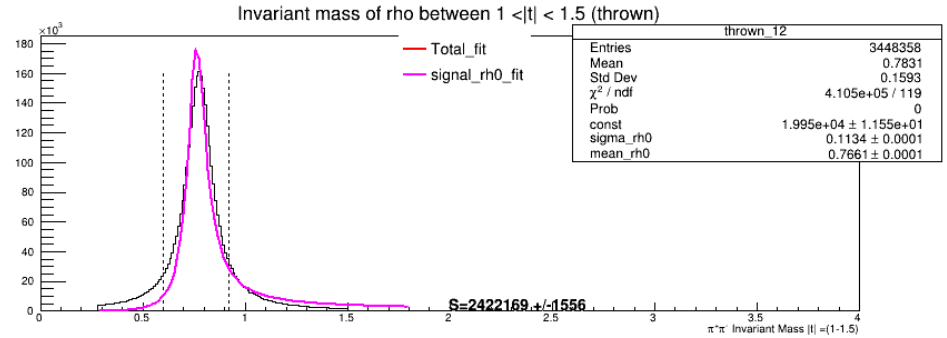


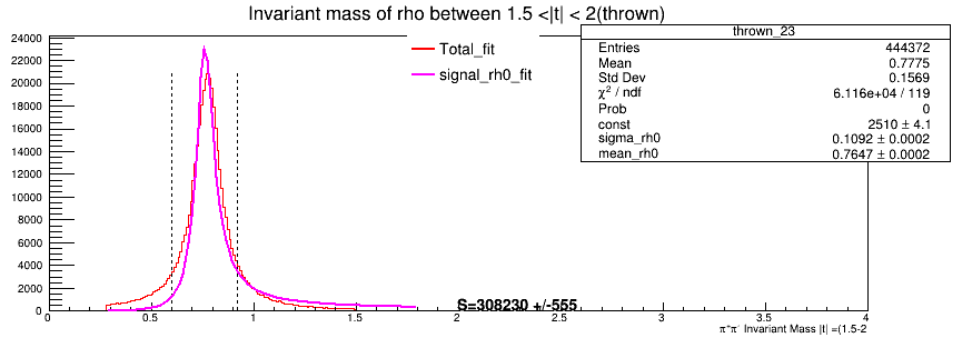


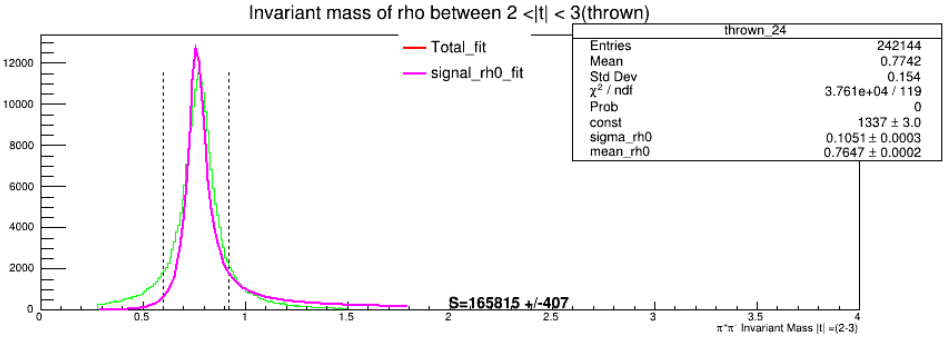


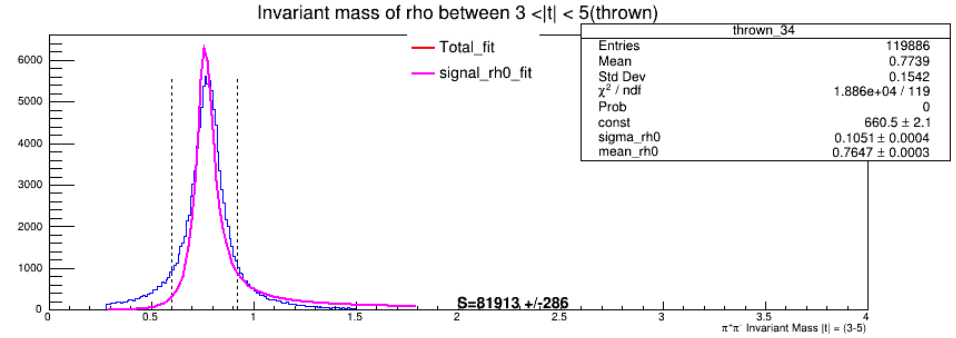
Relativistic BW function is used to fit the thrown (Definition B)
Phase Space correction not applied

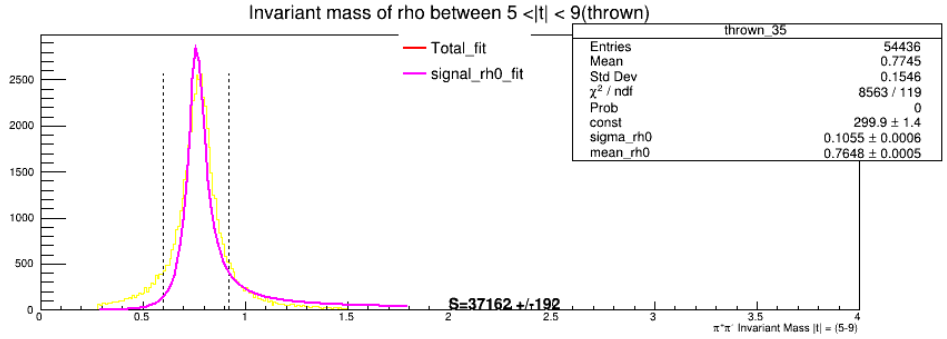
Thrown: Definition B (Phase space corrected)





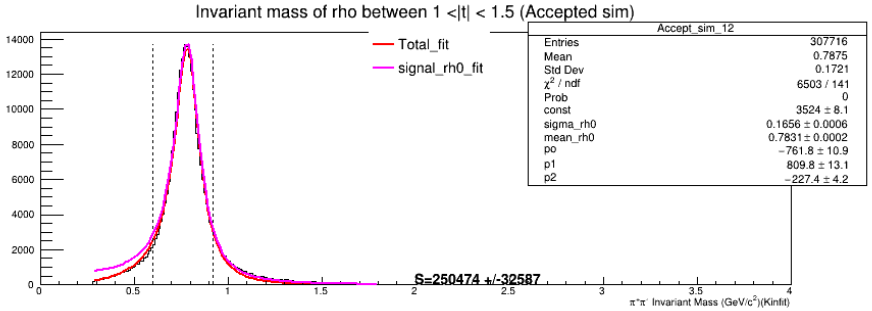


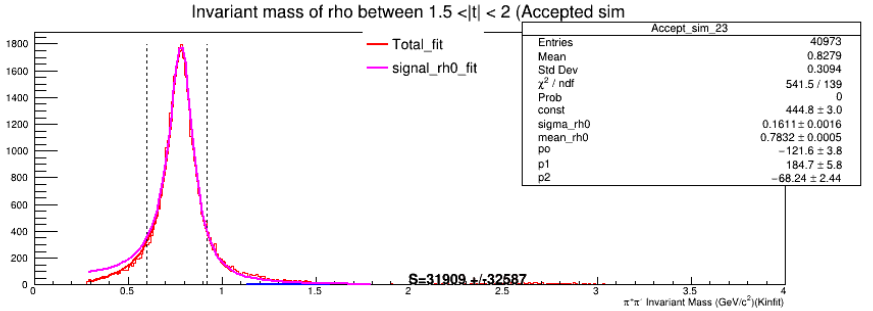


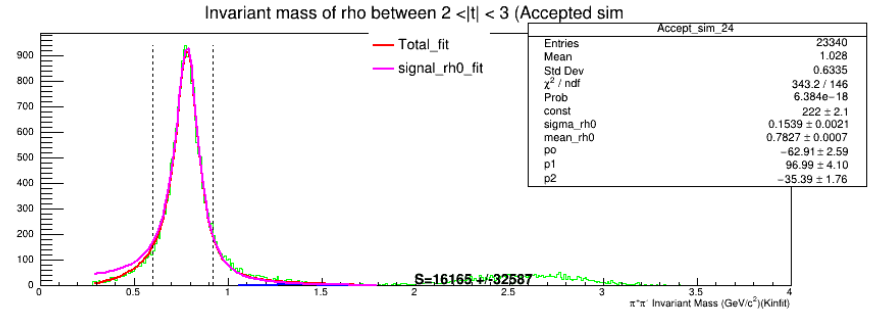


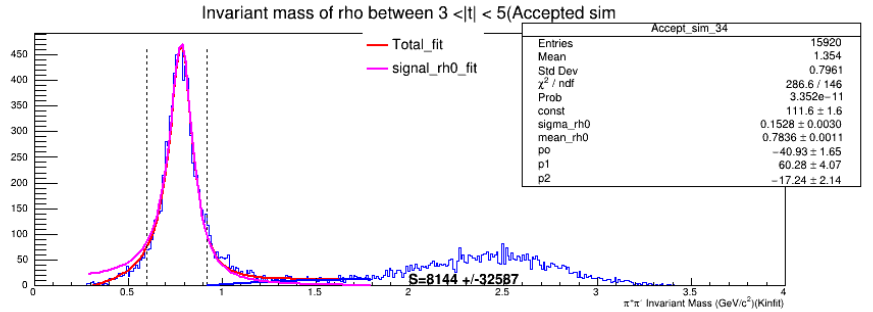
Relativistic BW function is used to fit the thrown (:Definition B)
Phase Space correction implemented

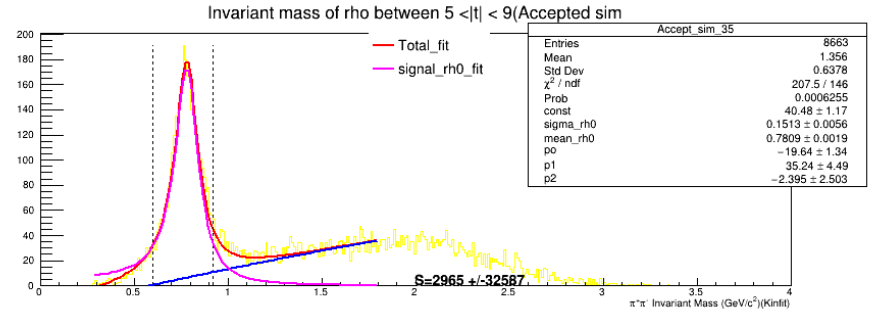
Reconstructed Simulation:Definition A





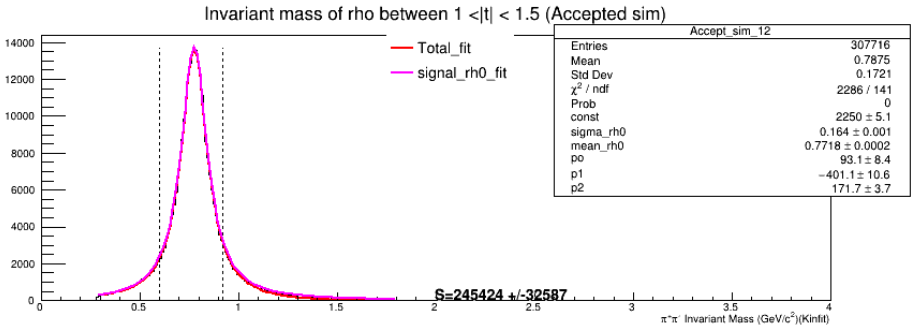


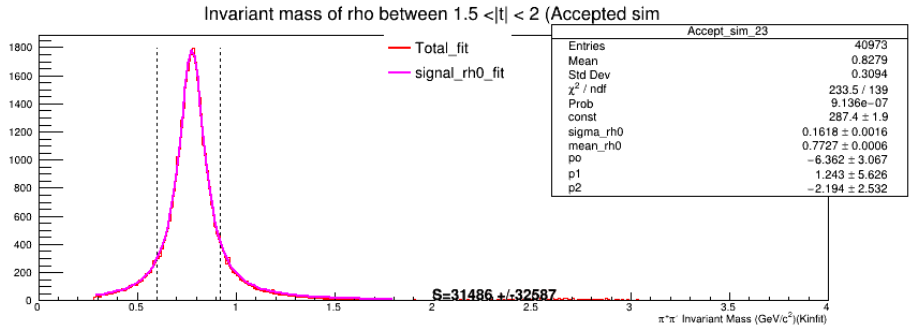


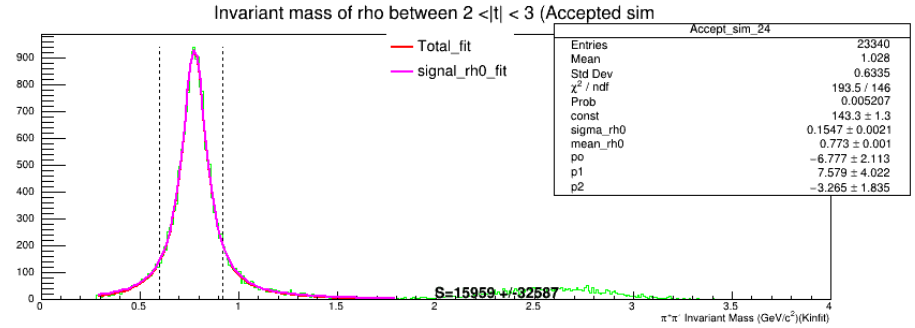


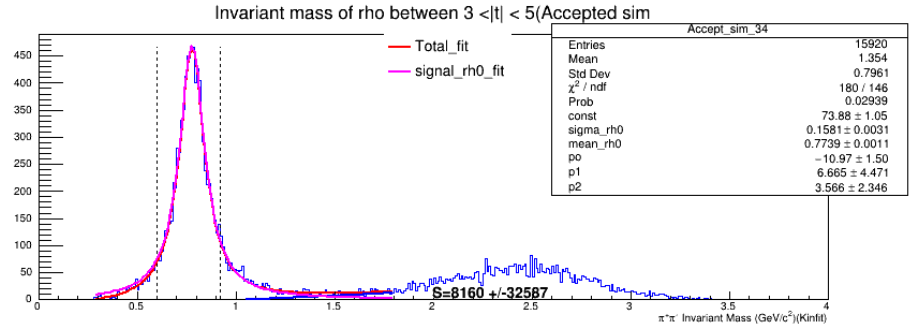
Relativistic BW function + 2nd order polynomial is used to fit the simulation (:Definition A)

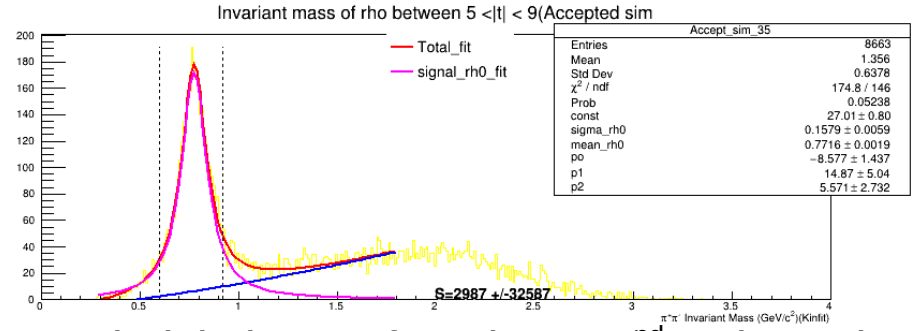
Reconstructed Simulation:Definition B(Phase Space not corrected)





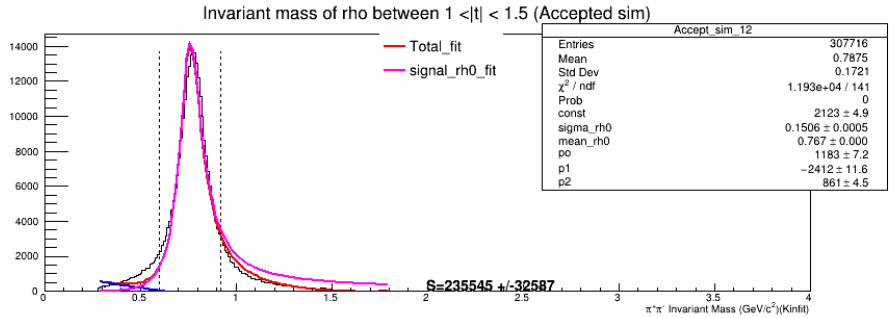


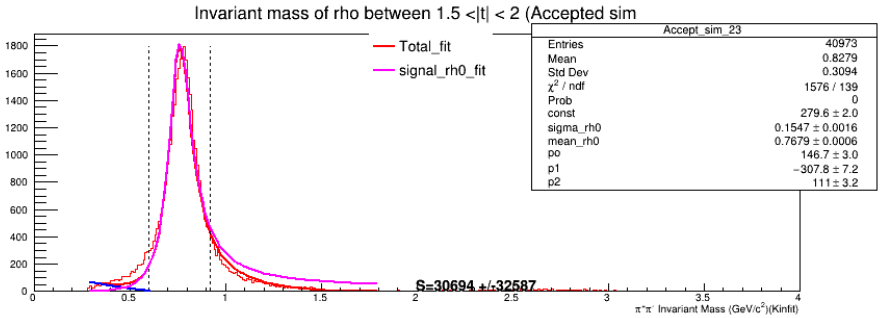


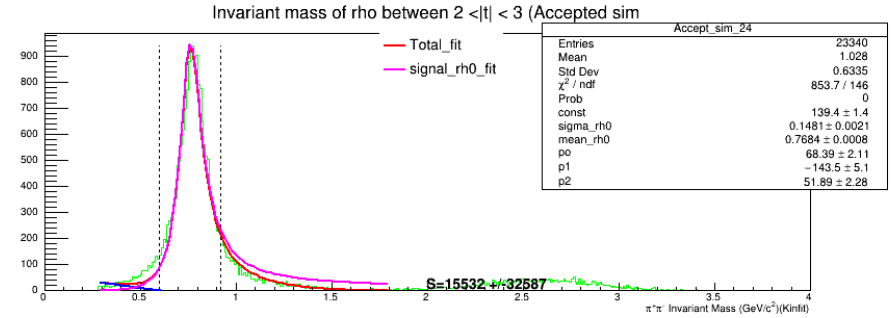


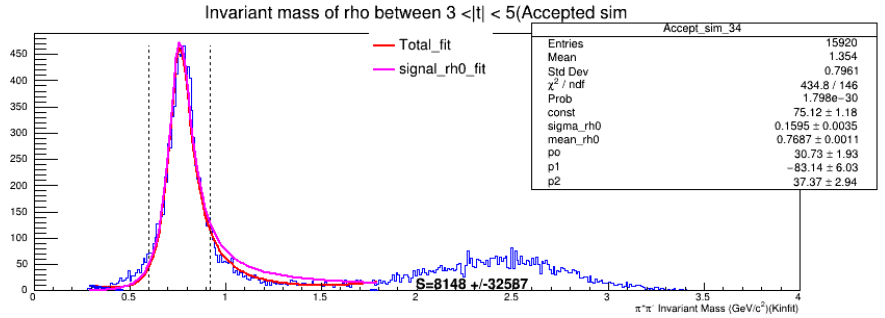
Relativistic BW function + 2nd order polynomial is used to fit the simulation (:Definition B). Phase Space correction not Applied

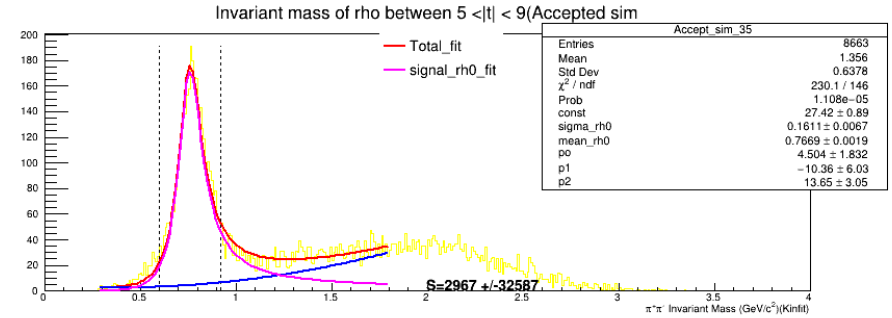
Reconstructed Simulation:Definition B(Phase Space corrected)





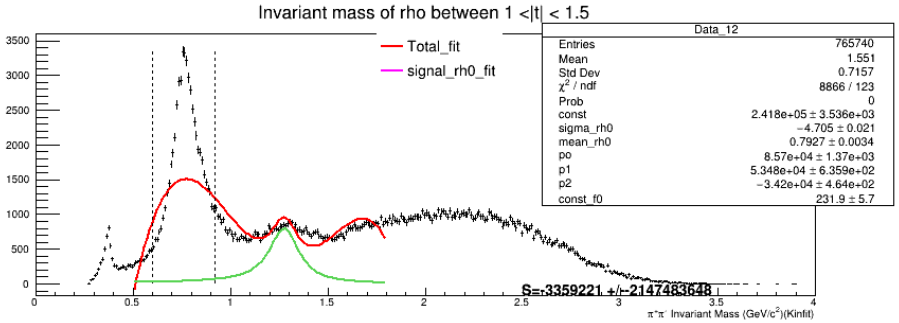


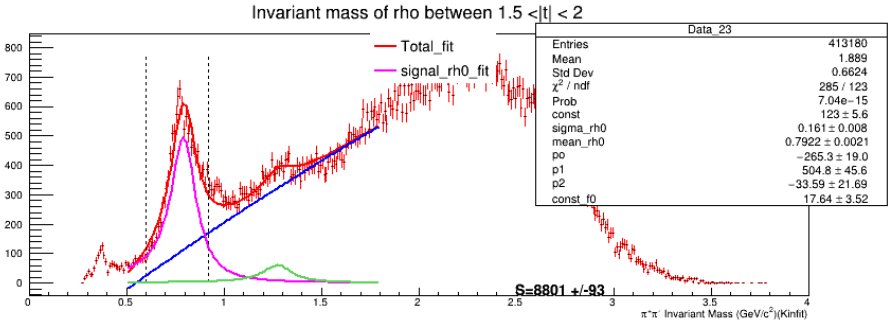


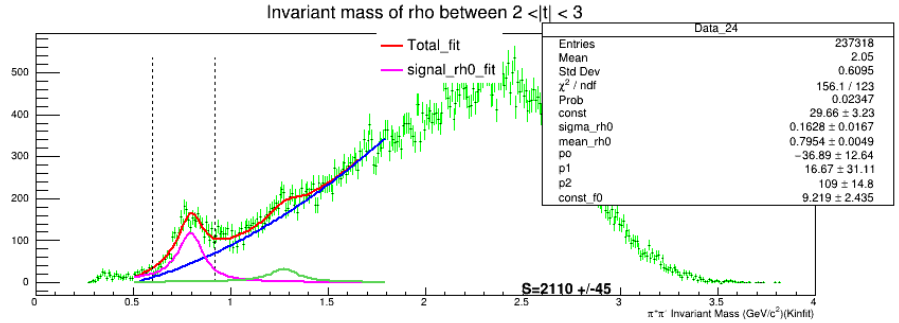


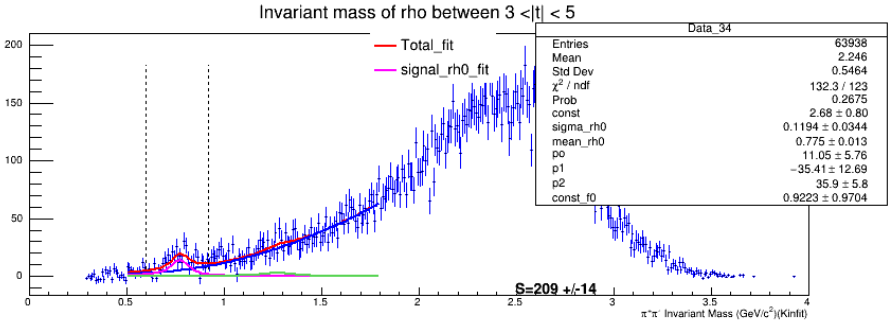
Relativistic BW function + 2nd order polynomial is used to fit the simulation (:Definition B). Phase Space correction Applied

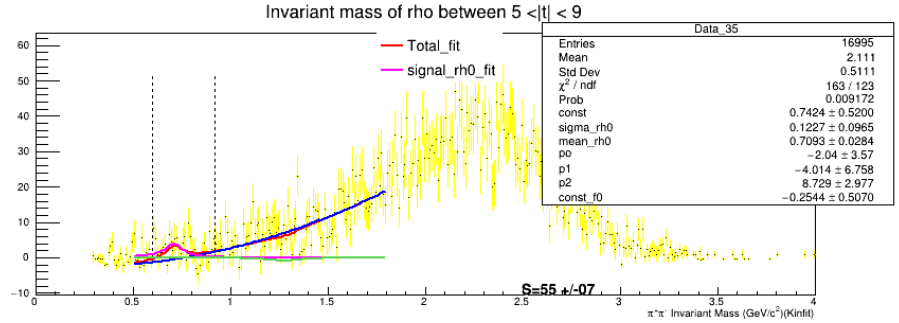
Data :Definition A





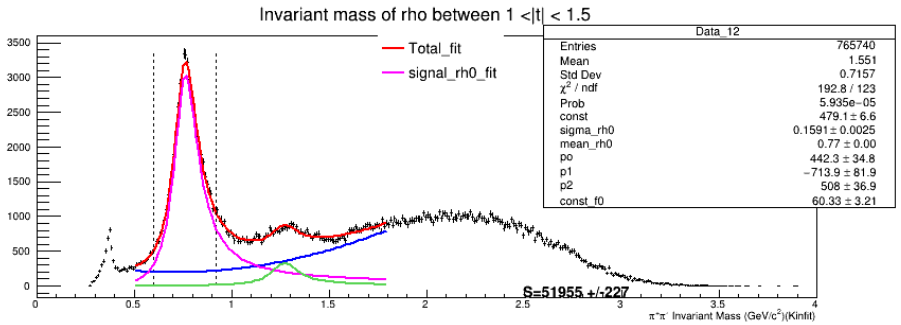


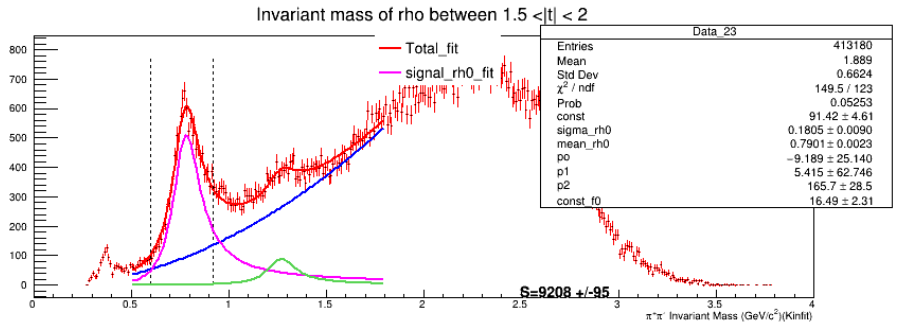


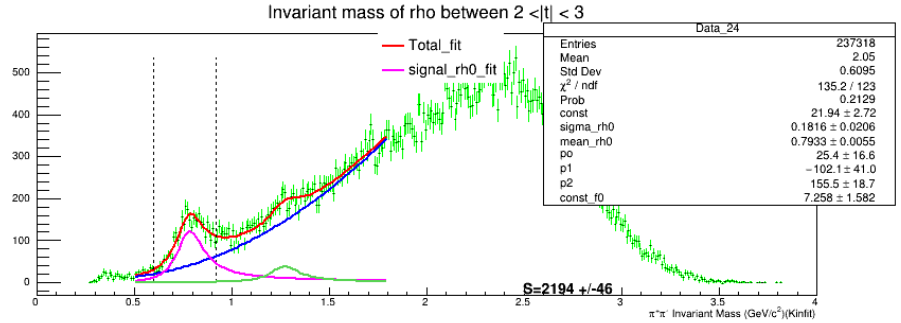


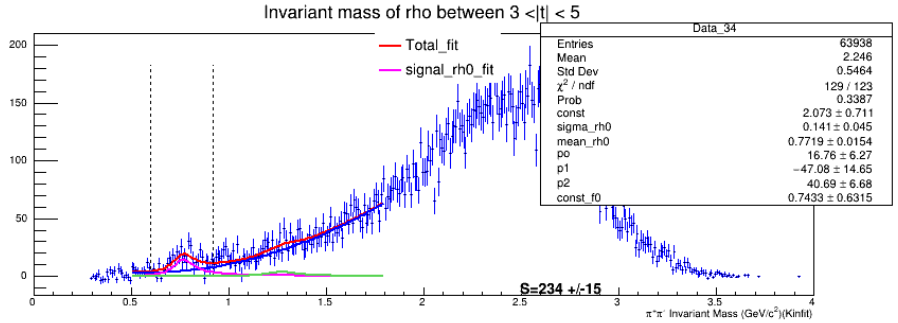
Relativistic BW function + 2nd order polynomial +BW(f0 meson) is used to fit the simulation (Definition A).

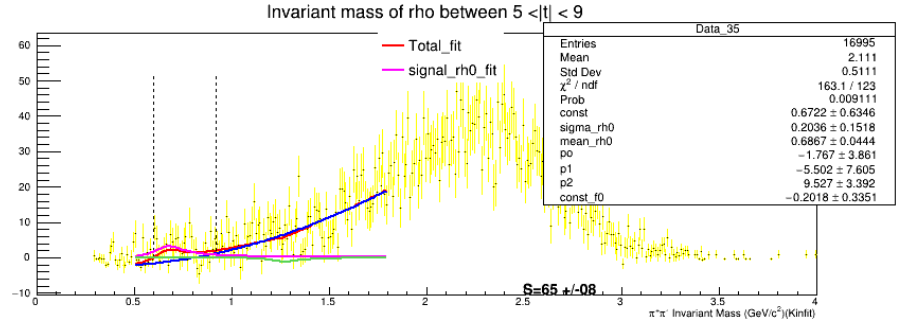
Data :Definition B(phase space corrected)





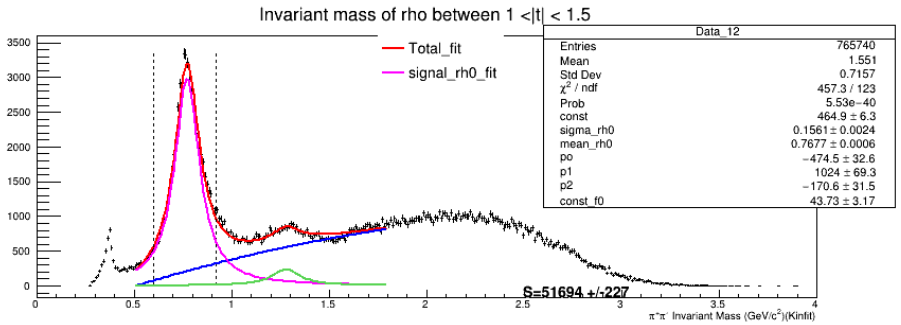


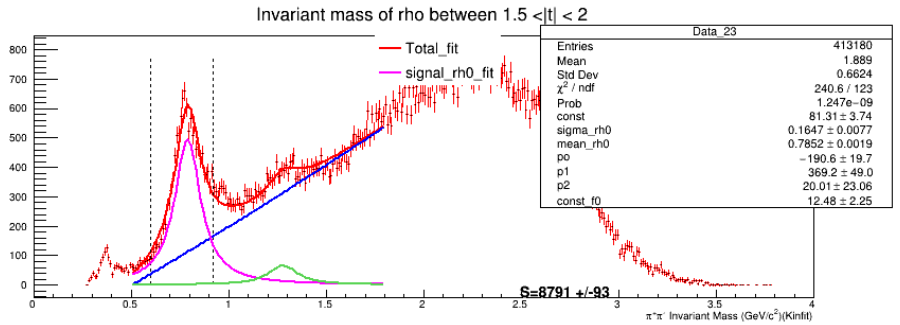


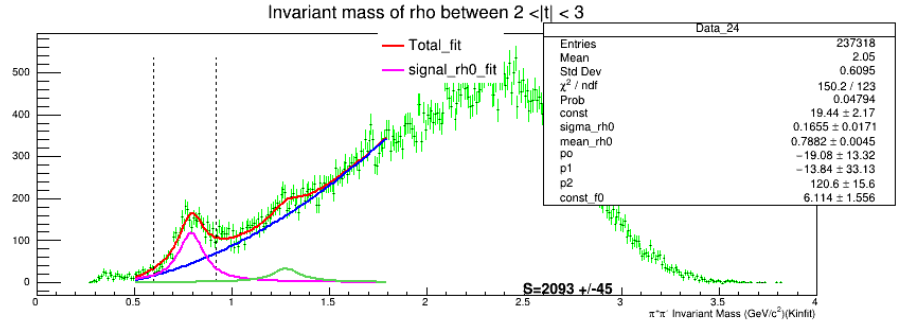


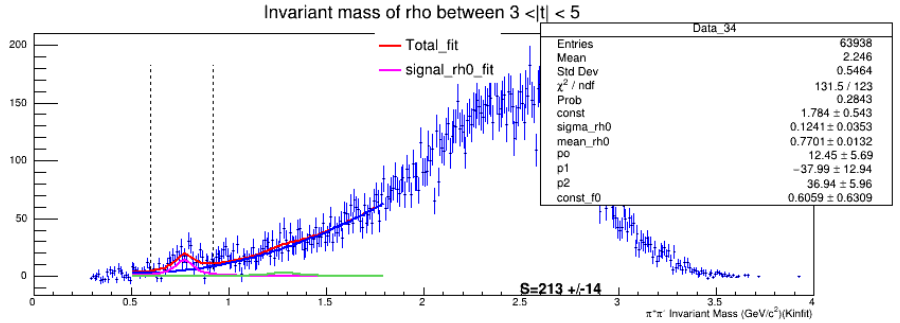
Relativistic BW function + 2nd order polynomial +BW(f0 meson) is used to fit the simulation (:Definition B). Phase Space correction Applied

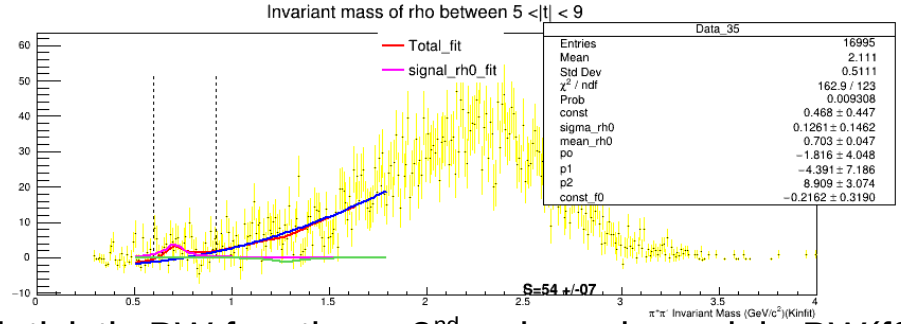
Data :Definition B(Phase space not corrected)











Relativistic BW function + 2nd order polynomial +BW(f0 meson) is used to fit the simulation (:Definition B). Phase Space correction not Applied