Study of multiplicity-dependent ρ⁰(770) production in pp collisions with ALICE

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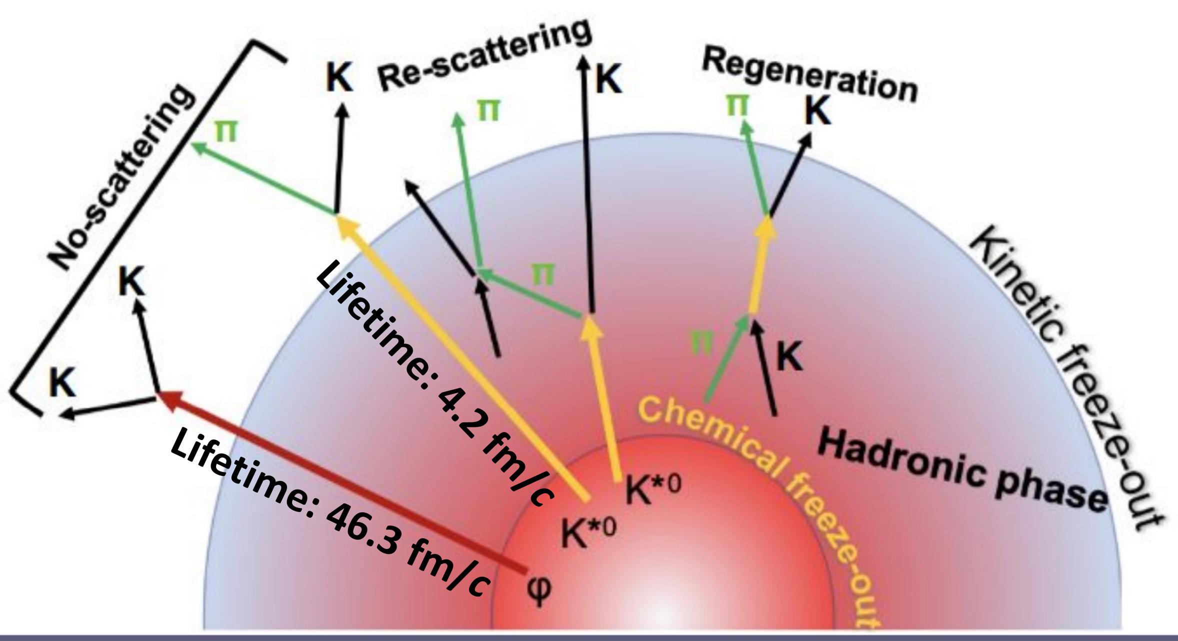
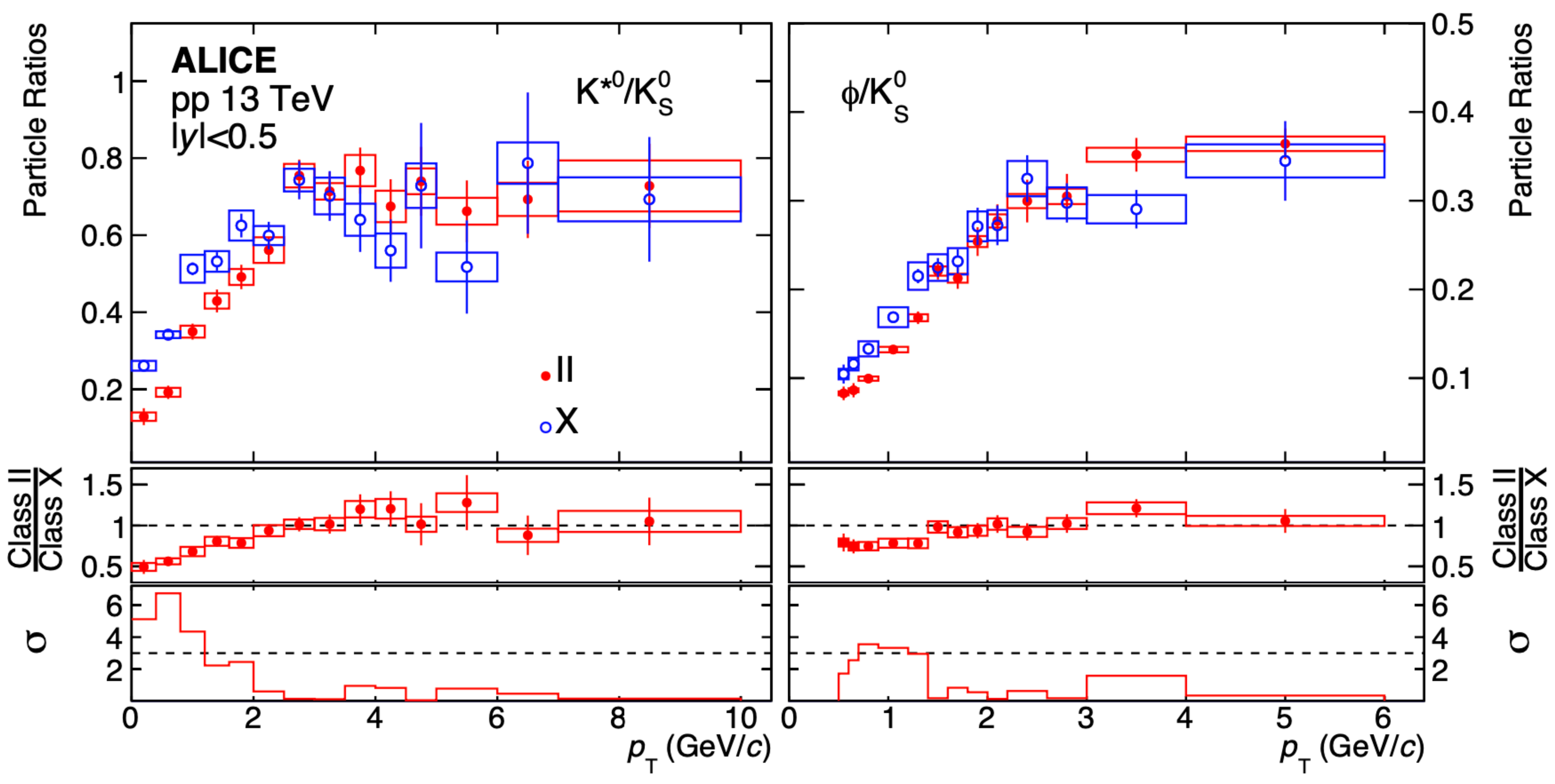
1. MOTIVATION

Probing the properties of hadronic phase:

Short-lived resonances are ideal probes to study the properties of the hadronic phase. Since the resonance lifetime is comparable to that of the hadronic phase, their yields can be affected by the rescattering and regeneration effects.

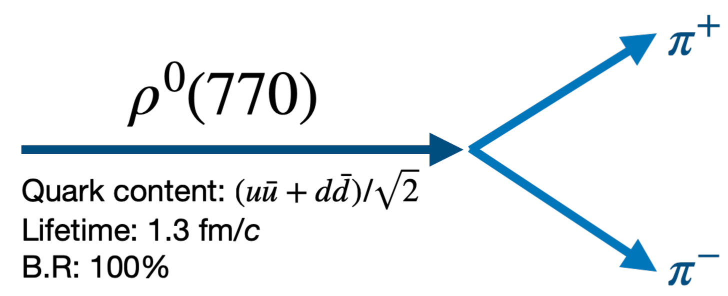


Rescattering in small collision systems: [1]



The K^{*0}/K^0_S ratio decreases from low to high multiplicity, especially in the low p_T region, while the ϕ/K^0_S ratio does not change significantly.

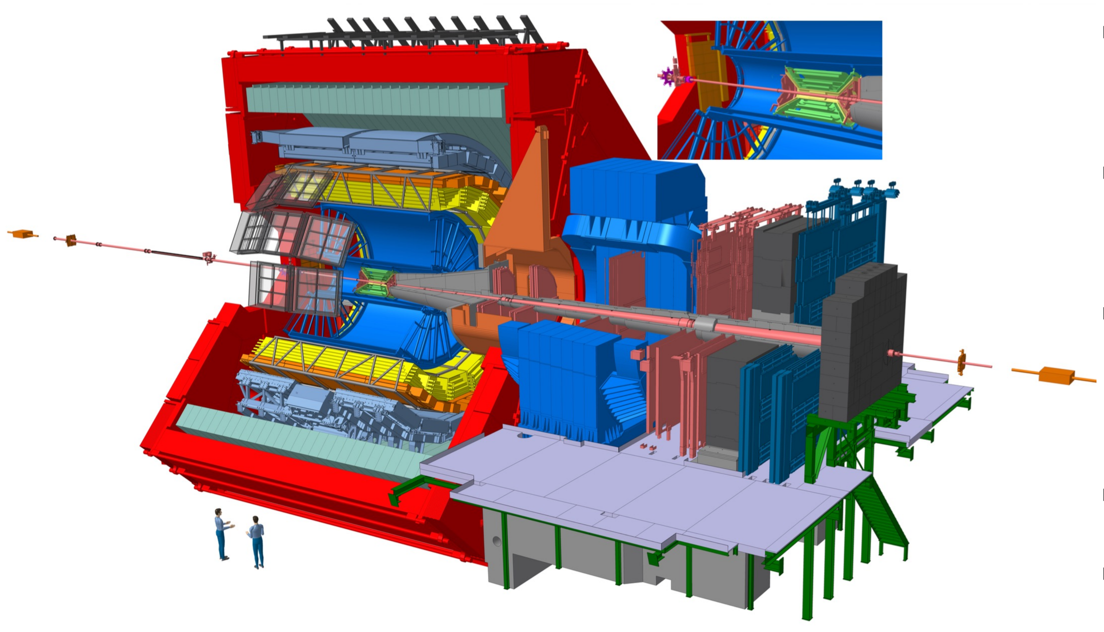
These results, measured in pp collisions, give us information about a possible short-lived hadron gas phase.



In this context, the $\rho^0(770)$ is particularly interesting due to its very short lifetime, so it is suitable to study the hadronic phase in small collision systems.

2. ALICE DETECTOR

ALICE subsystems relevant to this analysis:



- TPC (Time Projection Chamber): particle identification, tracking
- TOF (Time of Flight): particle identification
- ITS (Inner Tracking System): tracking and vertexing
- V0: multiplicity (Run 2)
- FT0: multiplicity (Run 3)

3. ANALYSIS METHOD

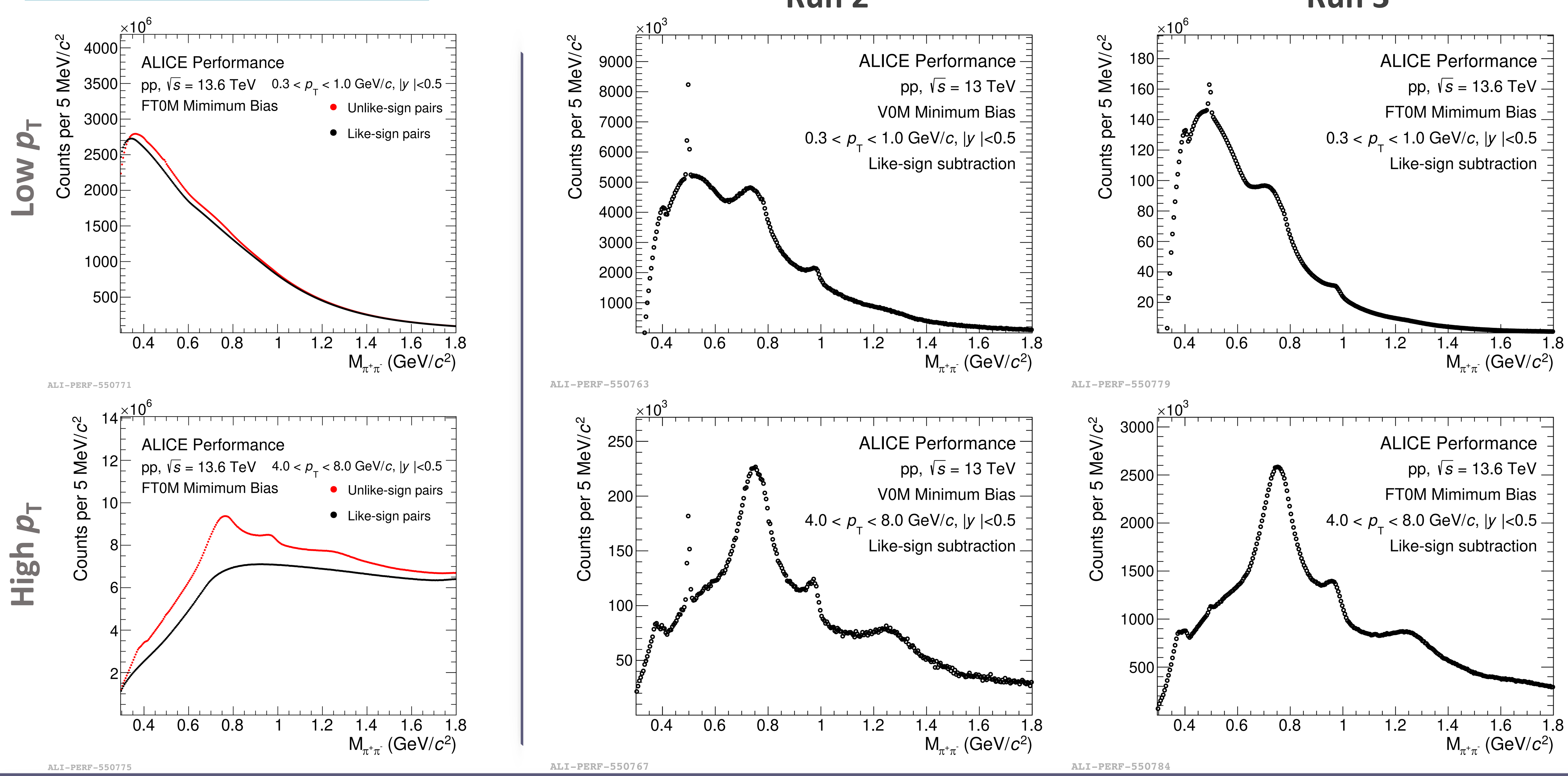
Analysis target and process:

Event & Track Selection → Invariant Mass Distribution → Signal Extraction (current status) → Correction → Physics Observables

- **Target:** Multiplicity-dependent $\rho^0(770)$ production
- **Collision system & Data:** pp at $\sqrt{s}$ = 13 TeV from Run 2 & $\sqrt{s}$ = 13.6 TeV from Run 3
- **Event selection & Multiplicity:** V0M(Run 2) & FT0M(Run 3) minimum bias events
- **Track selection:** $\pi^{\pm}$ candidate with $p_T > 0.15$ GeV/c, $|\eta| < 0.8$
- **Background estimation:** Like-sign pair

4. STATUS

Invariant mass distribution:



- In invariant mass distributions with like-sign subtraction, peaks from various hadronic decays are recognized
- Similar performance between Run 2 and Run 3
- Currently, about x10 more statistics of data from Run 3 are available

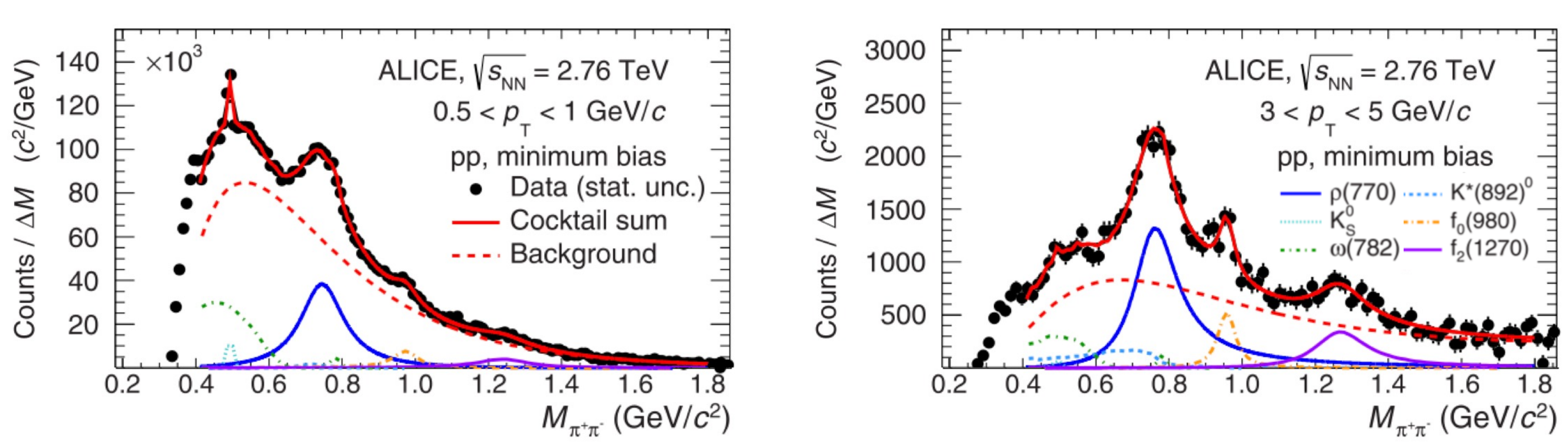
→ Run 3 will allow us to study multiplicity-dependent ρ^0 production

▾

Fitting procedure to signal extraction

5. PLAN

Contribution: [2]



$\rho^0(770) \to \pi^+\pi^-$
$K^0_S \to \pi^+\pi^-$
$\omega(782) \to \pi^0\pi^+\pi^-$, $\omega(782) \to \pi^+\pi^-$

$K^*(892)^0 \to K^{\pm}\pi^{\mp}$ ($K^{\pm}$ is reconstructed as a $\pi^{\pm}$)
$f_0(980) \to \pi^+\pi^-$
$f_2(1270) \to \pi^+\pi^-$

Fitting method:

- Peak model based on relativistic Breit-Wigner function: ρ^0, f_0, f_2

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

- Get templates from MC, normalized to known yield: K^{*0}, K^0_s, ω
- Background shape function:

$$F_{BG}(m) = (m - 2\cdot m_\pi)^{par0} \cdot \exp(par1 + par2\cdot m + par3\cdot m^2)$$

REFERENCES : [1] ALICE Collaboration. Physics Letters B Volume **807**, 135501 (2020)
[2] ALICE Collaboration. PHYSICAL REVIEW C **99**, 064901 (2019)