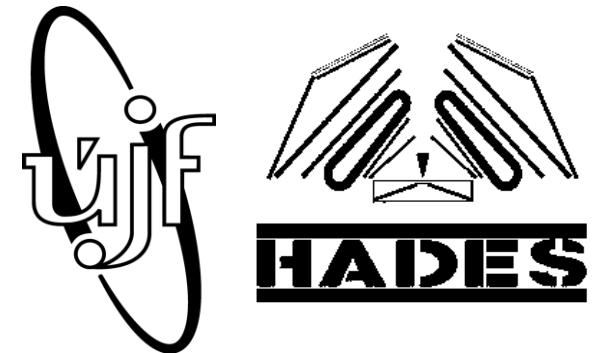


Pion induced reaction with carbon and polyethylene targets obtained by HADES in 2014

Pablo Rodríguez-Ramos

Workshop on two-pion and e^+e^- production in hadronic reactions, IPN-Orsay 2018



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Contents

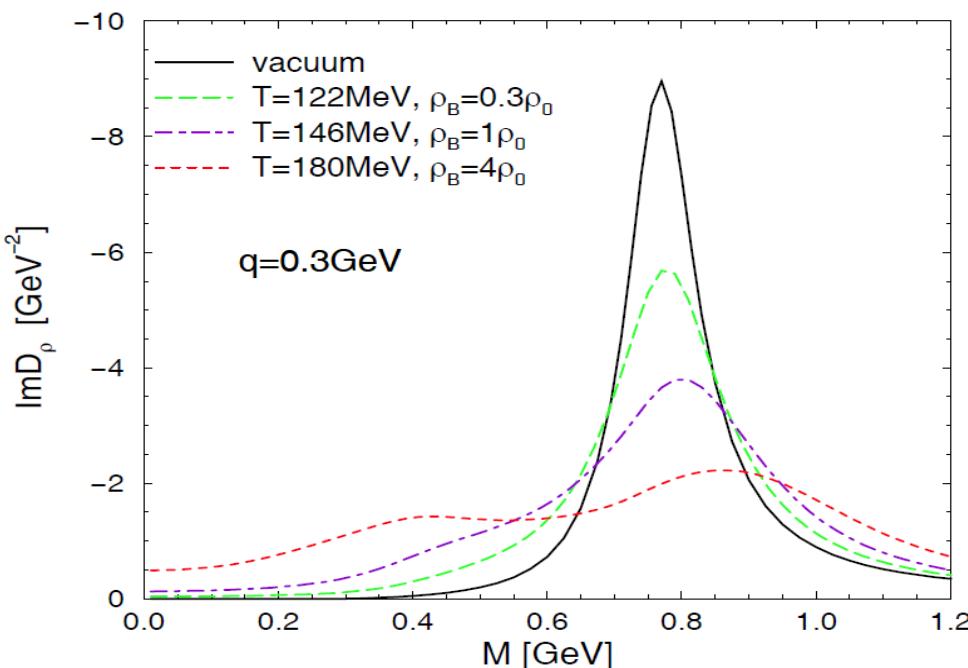
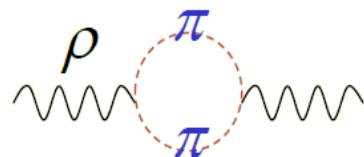
- Theory Introduction: ρ -in medium. Hadronic models.
- HADES physics for pion beam 2014.
- Selection of $\pi^- p$ elastic events.
- Selection of $e^+ e^-$ events.
- Cocktail source.
- Inclusive $e^+ e^-$ dilepton source.
- Exclusive $e^+ e^-$ dilepton source.
- 1D Efficiency corrections
- Summary

ρ in-medium: Hadronic Models

Vacuum

$$\Sigma_\rho(M) = -im_\rho \Gamma_{\pi\pi}(m)$$

$$M_\rho = 0.77 \text{ GeV}$$



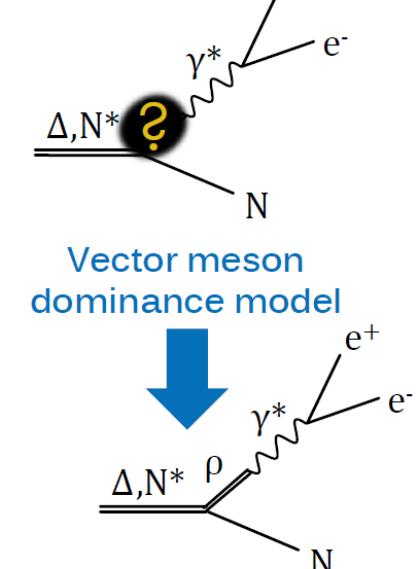
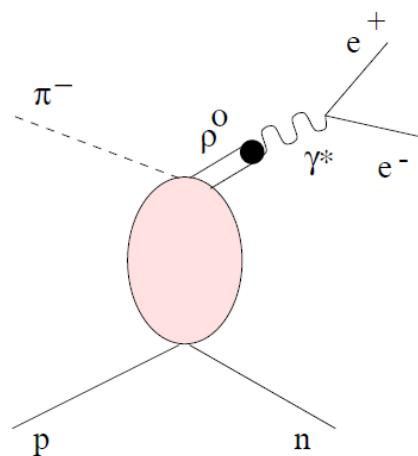
Modification of ρ spectral function in hot and dense matter, mainly due to the coupling of ρ to (anti)baryons

In-medium broadening

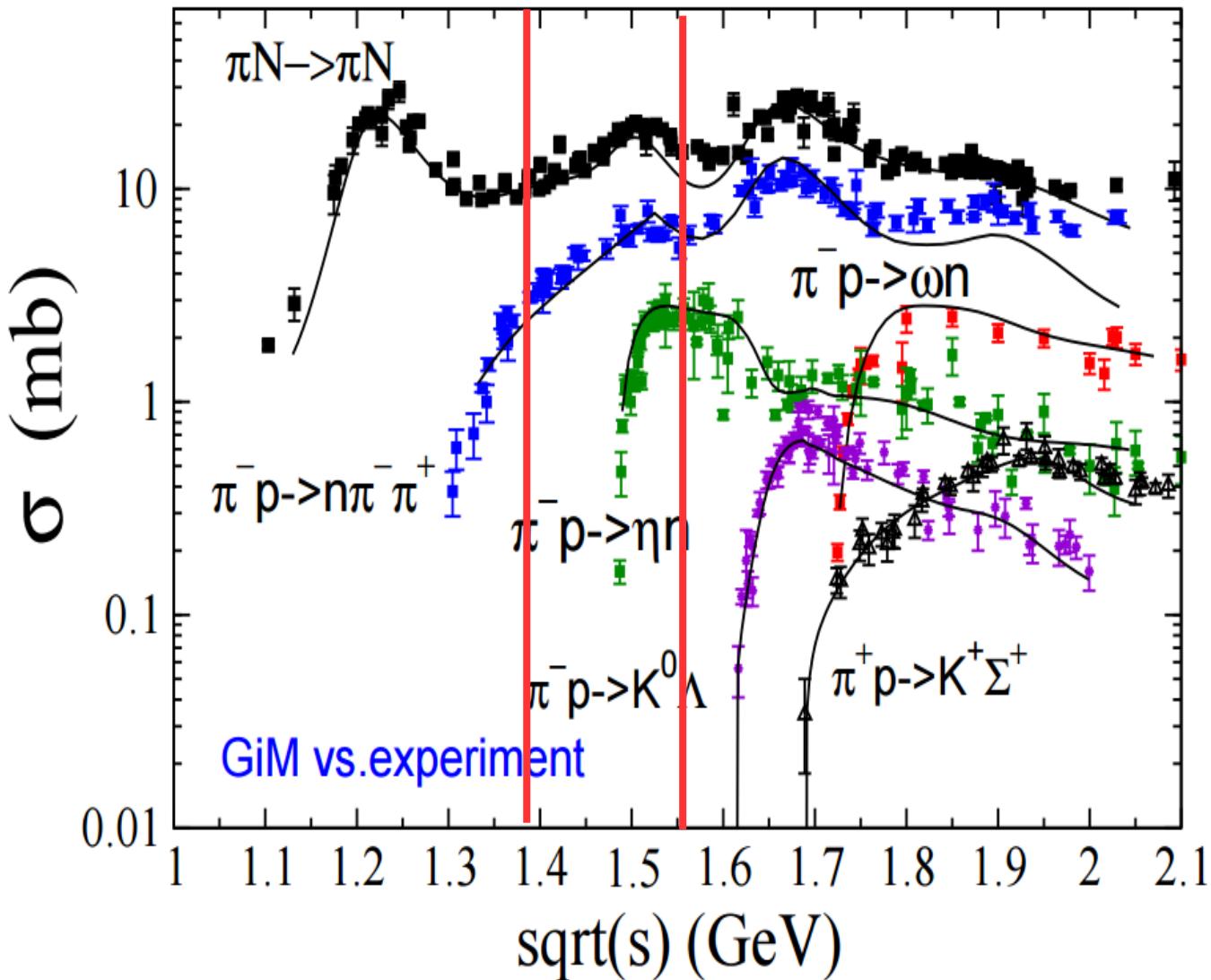
In-medium spectral function depends on ρNN^* coupling. Main players: $N(1520)$, $\Delta(1620)$, $N(1720)$,...

Coupling of ρ to baryonic resonances can be directly studied in NN and πN collisions

at 1-2 GeV via $N^*(\Delta) \rightarrow Ne^+e^-$ decays



Hades physics for pion beam (2014)



- Resonance excitation can be controlled by the variation of the projectile(pion) momentum
- HADES starts with $p=0.656/0.69/0.748/0.8$ GeV/c
- $\sqrt{s} = 1.46-1.55$ GeV: N(1520)

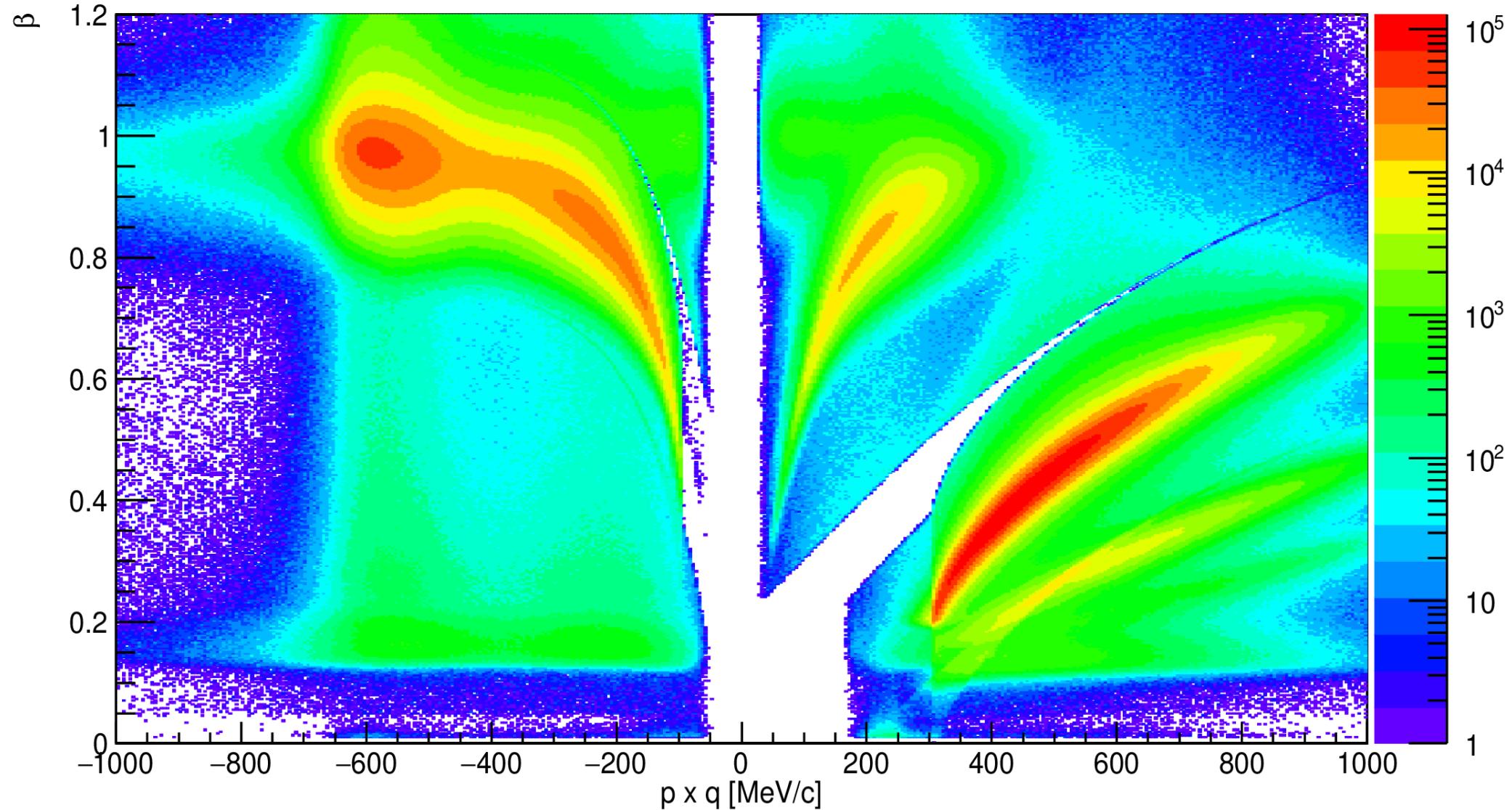
V. Shklyar *et al.* (GiBUU coupled-channel model)

arxiv: 1409.7920v1

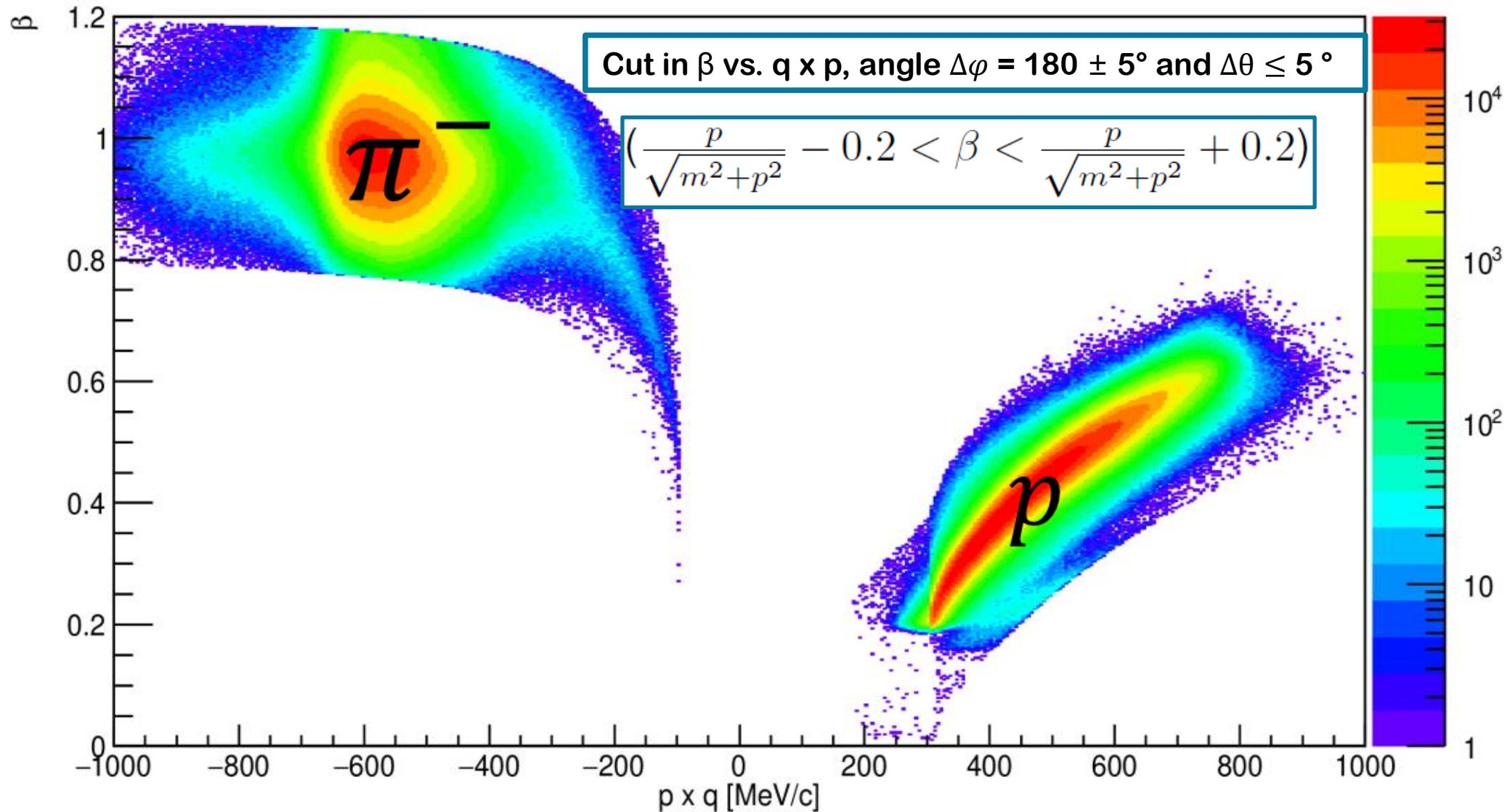
Selection of events – Elastic Scattering

- Selection of Elastic Scattering (ES) events
 - Identify $\pi^- + p \rightarrow \pi^- + p$ and with criteria:
 - $\Delta\varphi = |\varphi_\pi - \varphi_p| = 180^\circ$

Selection of events – Elastic Scattering



Selection of events – Elastic Scattering

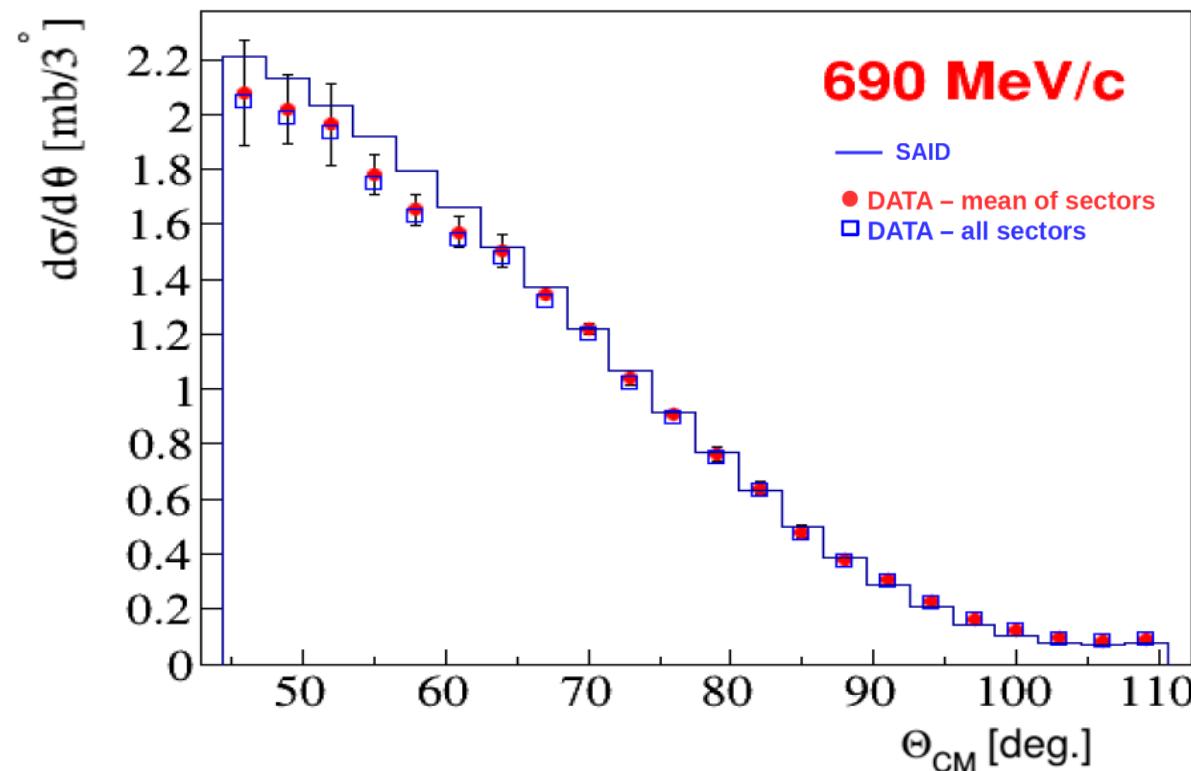


Determination σ_{acc}^{el} and normalization

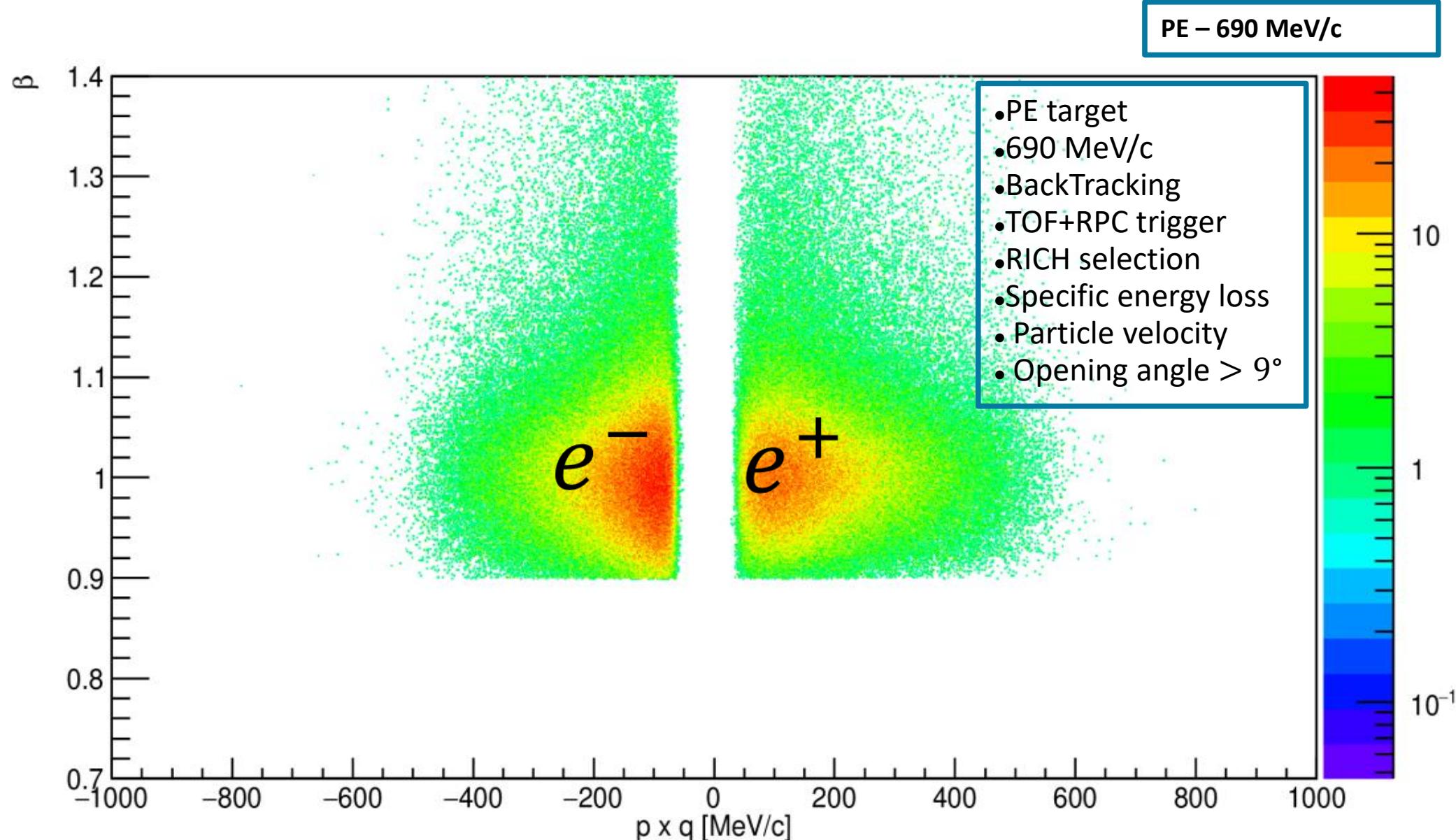
* events from July not included						
p [MeV/c]	N _{ev} (PE) x 10 ⁶	N _{beam} x 10 ⁹ corrected for dead time	N _{start} x 10 ⁹ (scalers)	N _{el} (60-110) ^{corr} x 10 ⁶	σ (60-110) [mb]	$\frac{\sigma}{N_{el}} \cdot 10^{-7}$ [mb]
690	776.82 *	36.59	47.11	34.68 36.93	3.077 3.10248	0.88 0.84

I.Ciepal

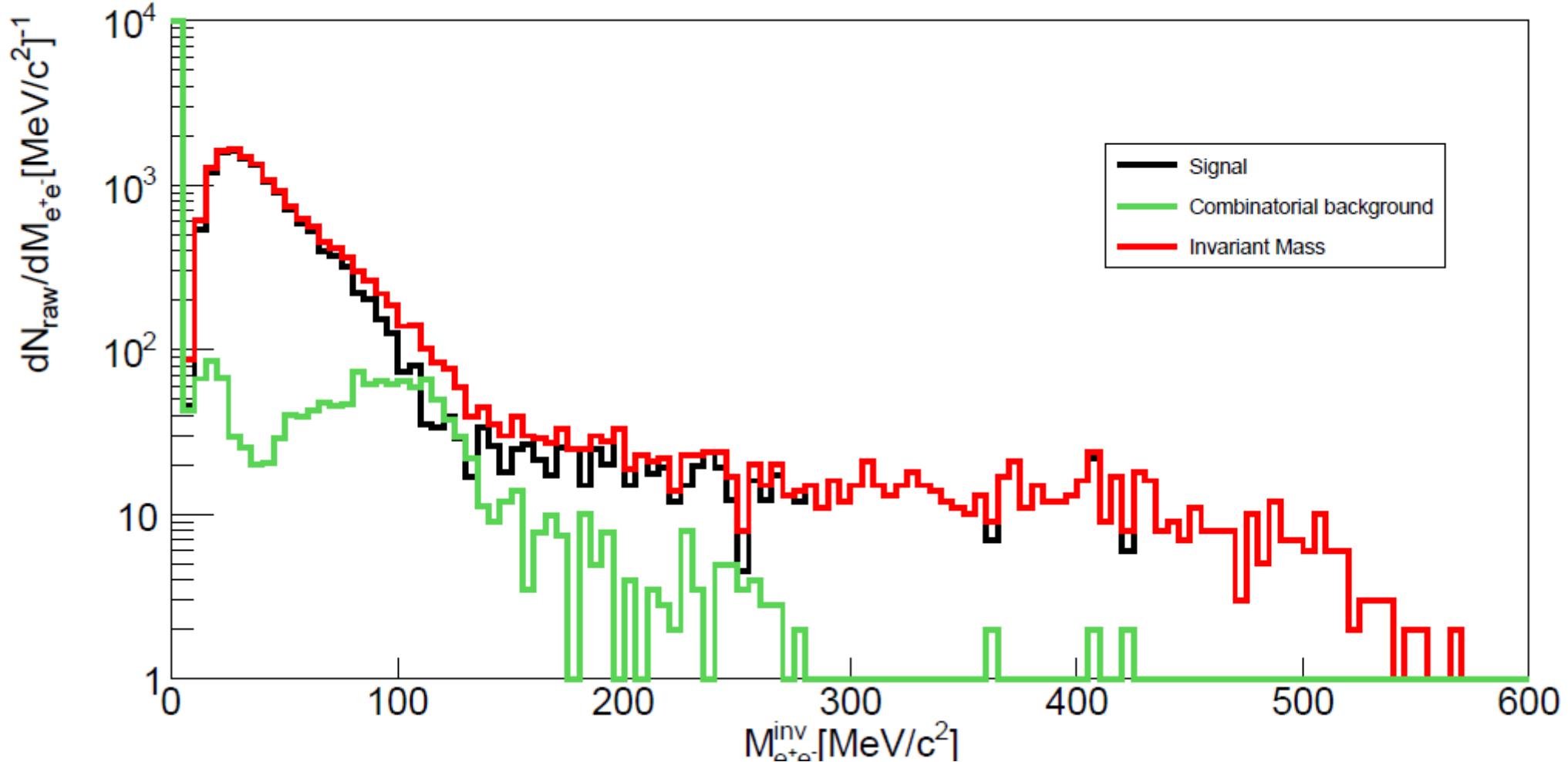
$$F = \sigma / N_{ev}$$



e^+/e^- Identification



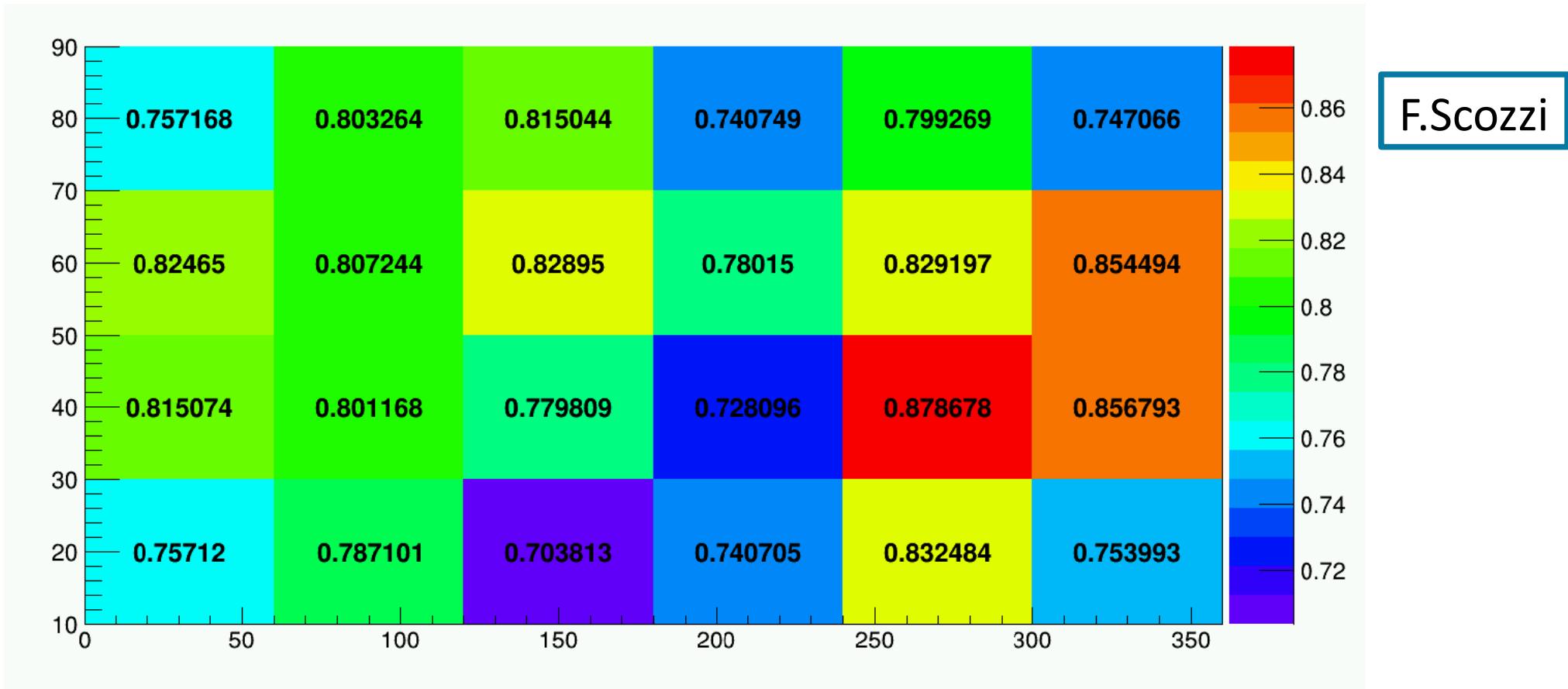
e^+e^- production PE target 690 MeV/c



Cocktail Source

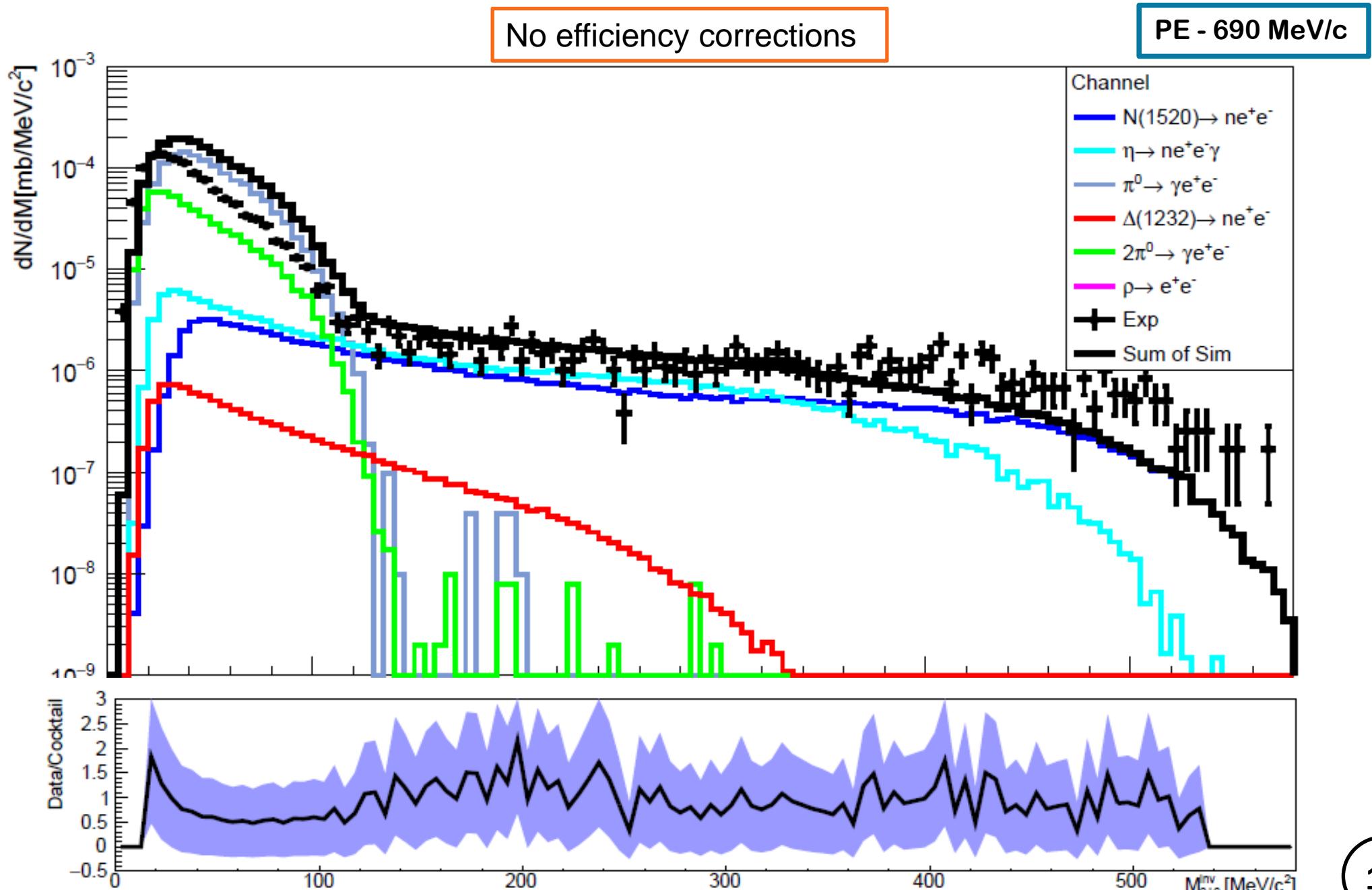
Channel	$\sigma[\text{mb}]$
$(\pi^0 \text{Dalitz}) \text{ from: } \pi^- p \rightarrow n\pi^0$	9,2
Single ($\pi^0 \text{Dalitz}$) from: $\pi^- p \rightarrow n\pi^0\pi^0$ $\pi^- p \rightarrow n\pi^-\pi^0(\pi^0\gamma e^+e^-)$	$2 \cdot 1,8 = 3,6$ $3,6 \cdot 2 = 7$ 10.6
$(\Delta \text{Dalitz}) \text{ from: } \pi^- p \rightarrow \pi\Delta(\Delta \rightarrow Ne^+e^-)$	8,37
$N(1520) \text{ Dalitz from: } \pi^- p \rightarrow N(1520)(N(1520) \rightarrow Ne^+e^-)$	40,8
$\eta \text{ Dalitz from: } \pi^- p \rightarrow n\eta(\eta \rightarrow \gamma e^+e^-)$	0,3(p) 0,7(C)
$\rho \text{ from: } \pi^- p \rightarrow n\rho(\rho \rightarrow e^+e^-)$	1,3

Efficiency Corrections BackTracking

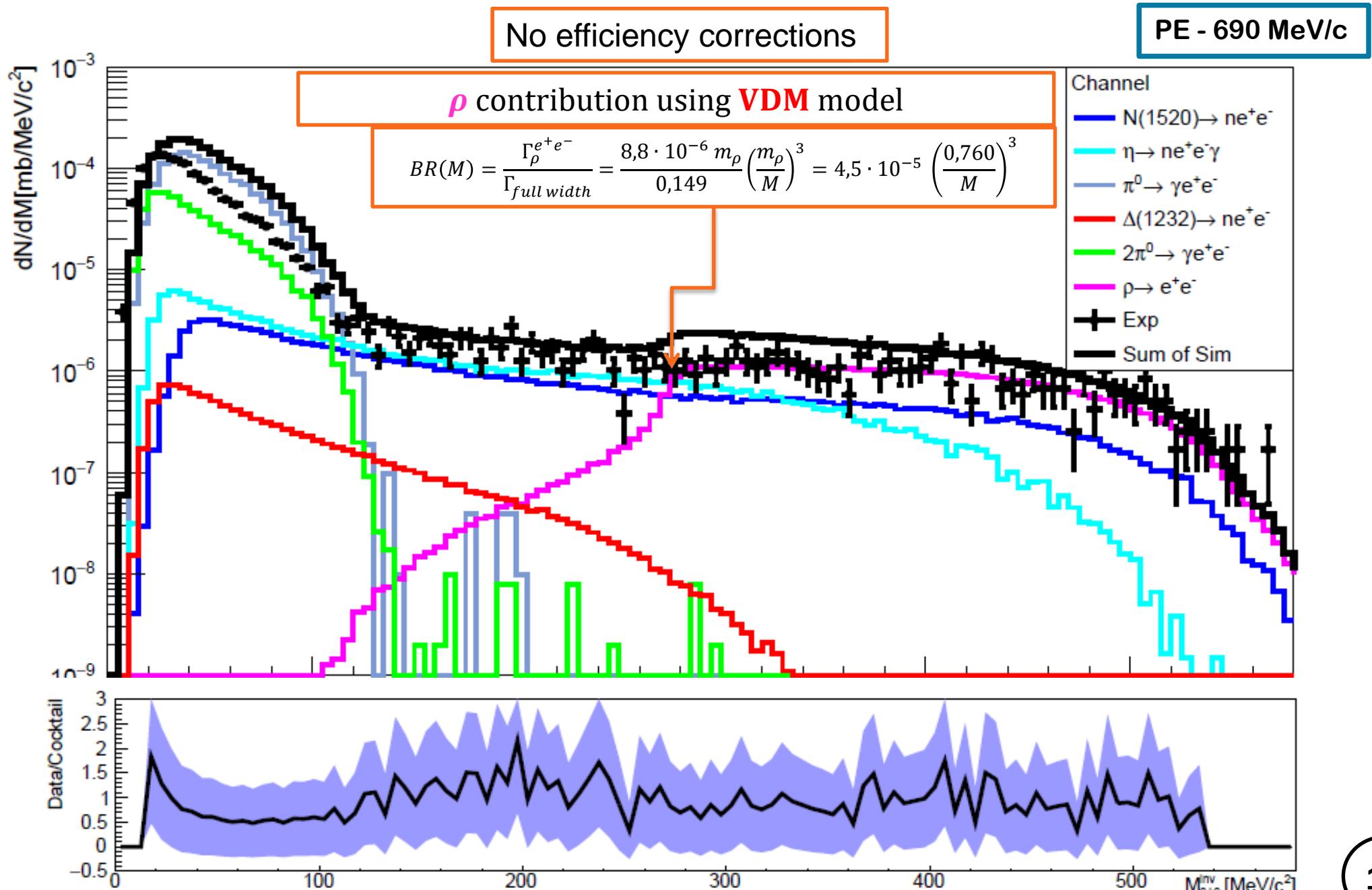


- All the data cocktail is corrected with a factor of 0,8 due to the efficiency corrections of the Backtracking

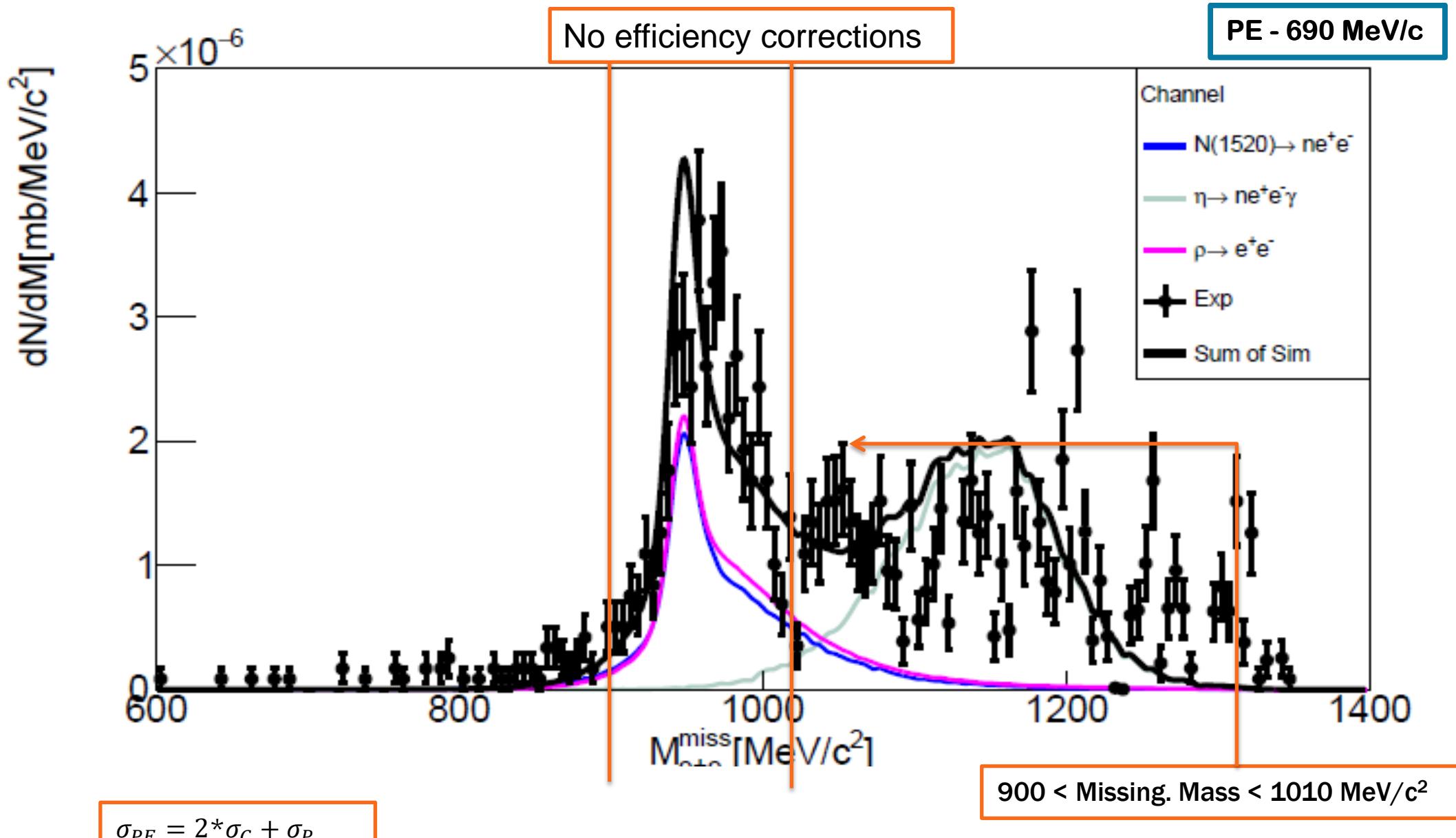
Inclusive e^+e^- cocktail – no ρ contribution



Inclusive e^+e^- cocktail – ρ contribution



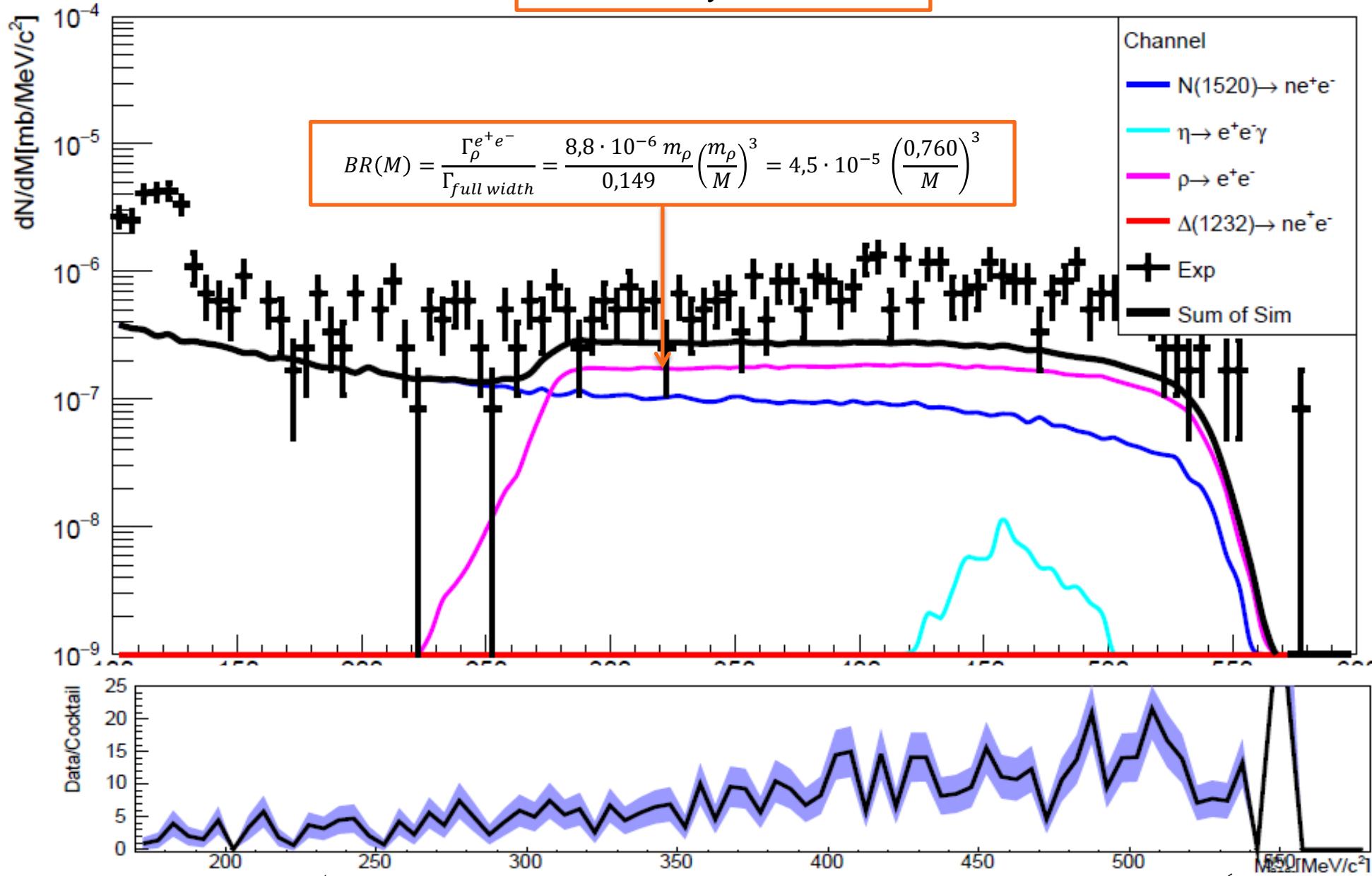
Exclusive Missing Mass e^+e^-



Exclusive Inv.Mass e^+e^- for

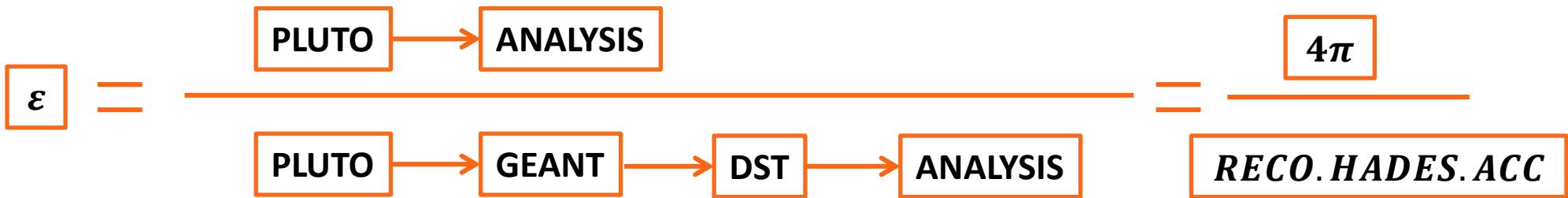
900 < Missing. Mass < 1010 MeV/c²

No efficiency corrections



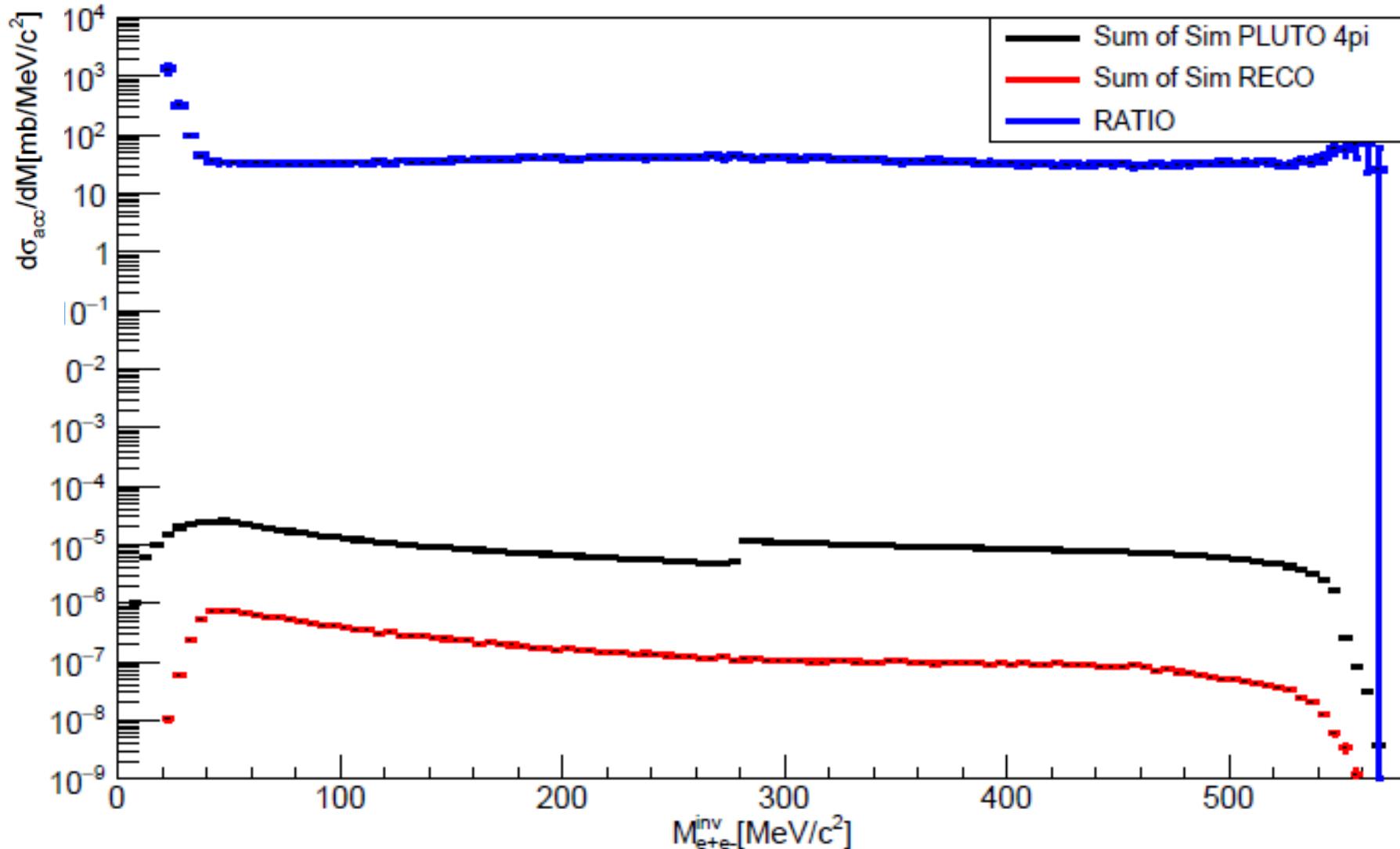
1D Efficiency Corrections

- 1D Efficiency corrections were done for inclusive invariant mass and exclusive invariant mass e^+e^- for a missing mass [900-1010 MeV/c²].



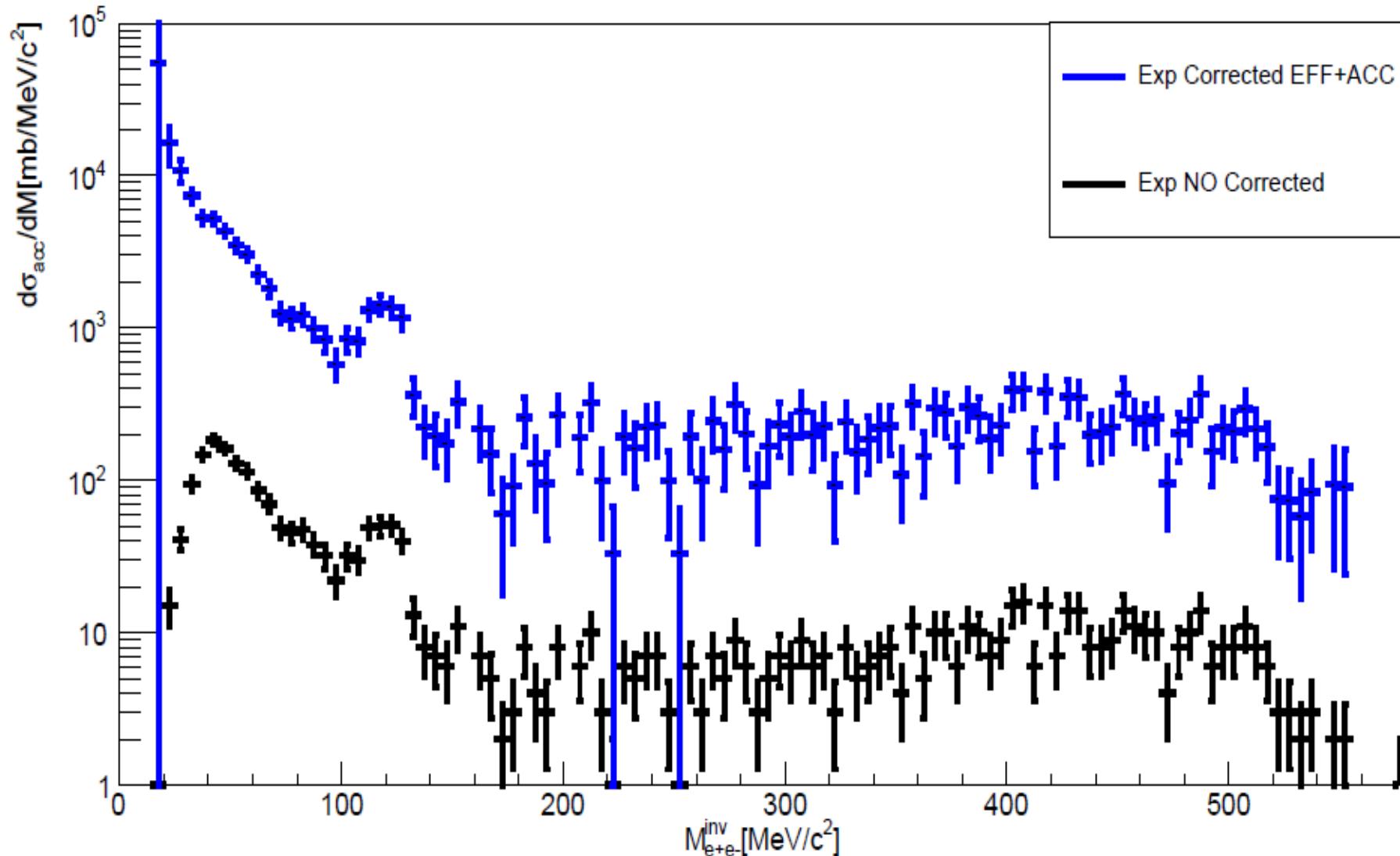
1D Efficiency Corrections

- Comparison of Exclusive Invariant Mass Distribution of **Sim.PLUTO4π** and **Sim.RECO**.
 $\text{RATIO} = 4\pi/\text{RECO}$



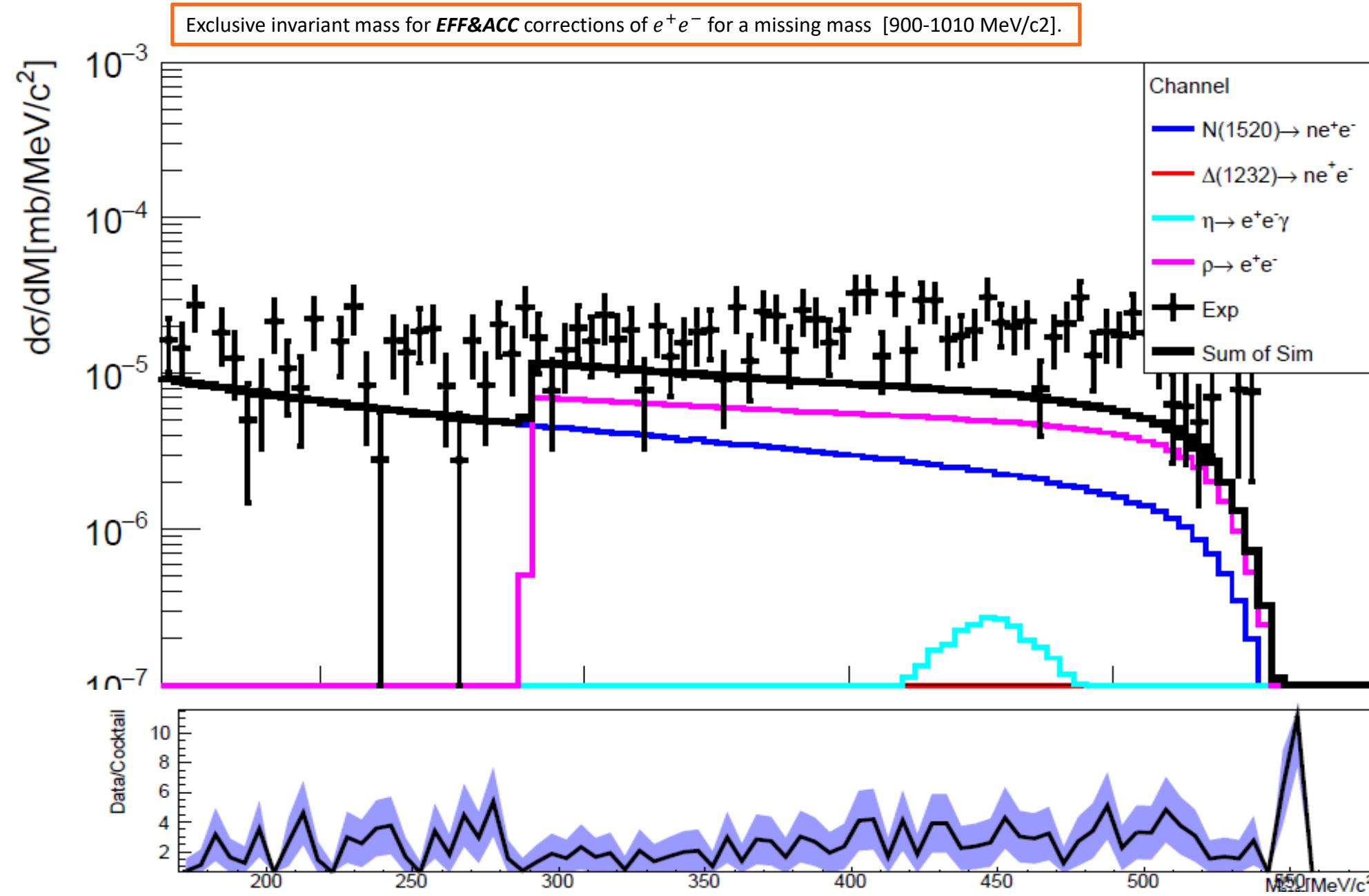
1D Efficiency Corrections

- Comparison of *Exclusive Invariant Mass Distribution* of Exp.Corrected EFF+ACC and Exp. No Corrected



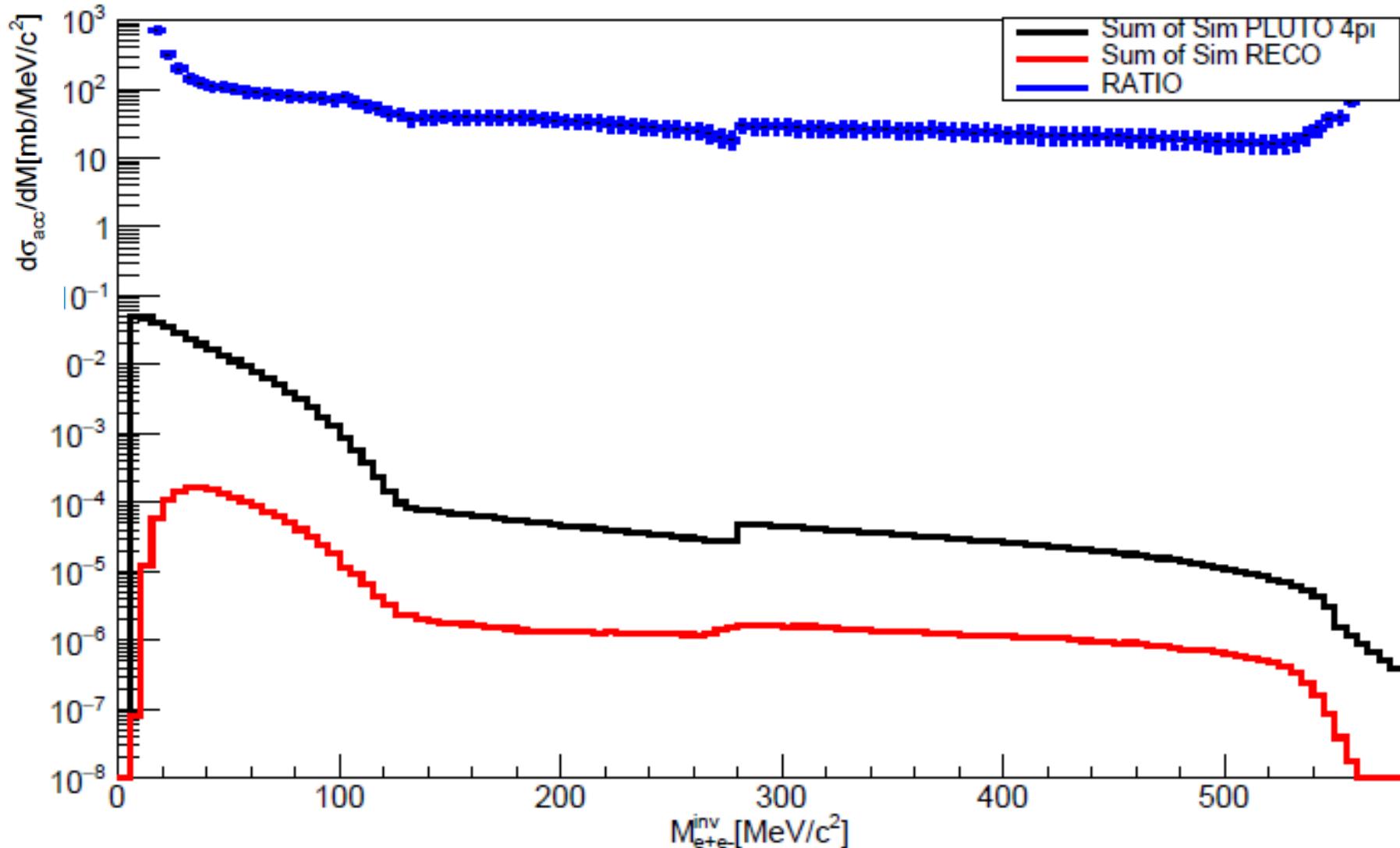
Exclusive Inv.Mass e^+e^- for

900 < Missing. Mass < 1010 MeV/c²



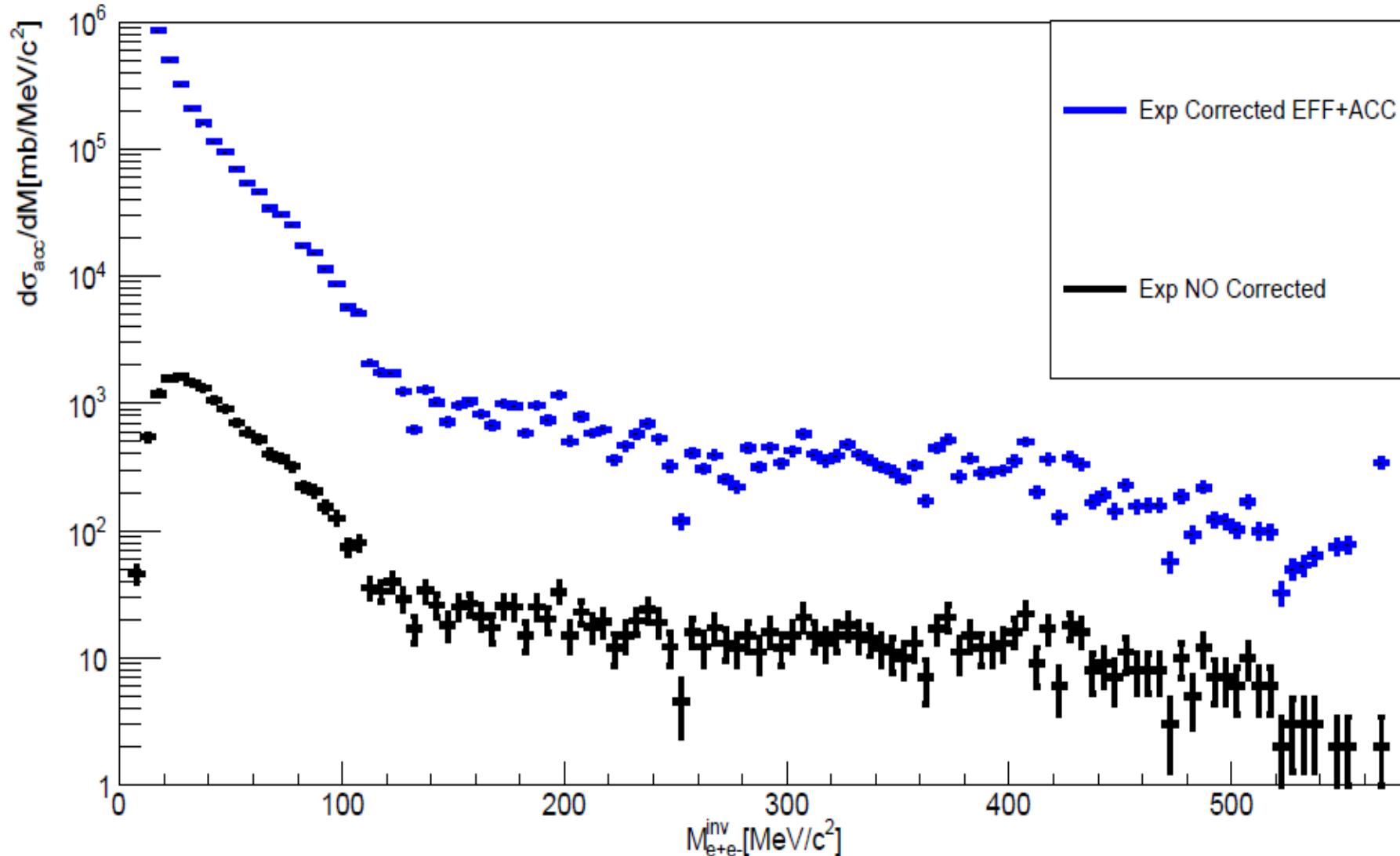
1D Efficiency Corrections

- Comparison of *Inclusive Invariant Mass Distribution PE* of Sim.PLUTO4 π and Sim.RECO.
 $\text{RATIO} = 4\pi/\text{RECO}$

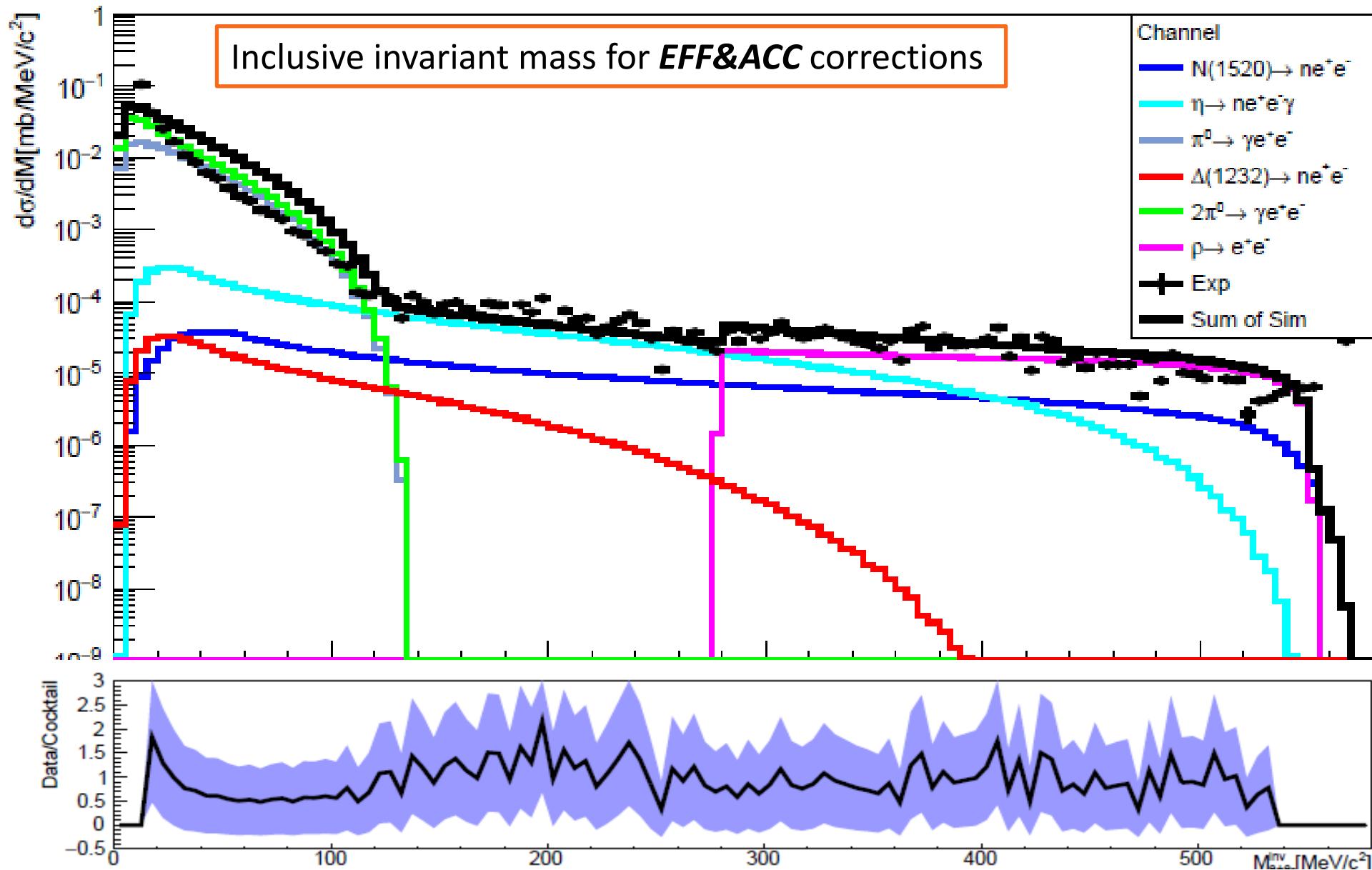


1D Efficiency Corrections

- Comparison of Inclusive Invariant Mass Distribution of **Exp.Corrected EFF+ACC** and **Exp. No Corrected**



Inclusive e^+e^- cocktail – ρ contribution



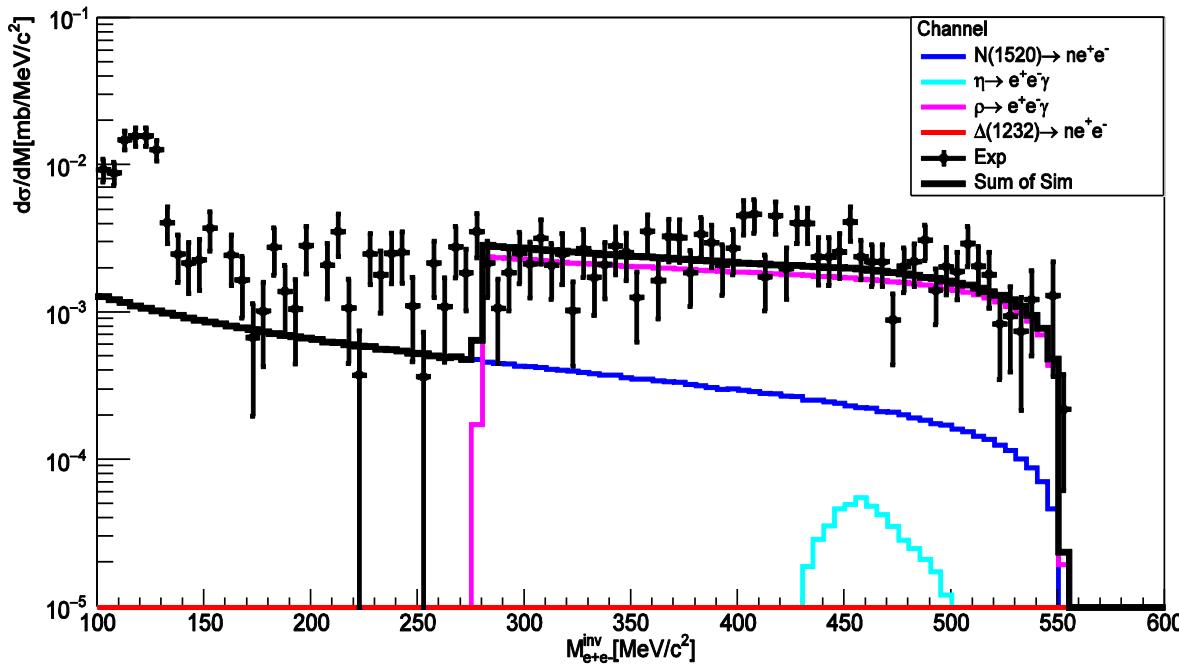
Summary

- Using missing mass cuts we identified the events from the reaction $\pi^- p \rightarrow n e^+ e^-$
- It is shown that $e^+ e^-$ yield of invariant mass above 250 MeV/c² region corresponding to the missing mass between [900-1010] MeV/c² is consisted with $N(1520) \rightarrow n\rho \rightarrow ne^+e^-$
- Models associate the excess of dilepton measured in HI reactions with the excitation and decay of baryonic resonances of dileptons via intermediate ρ meson.
- ρ contribution is obtained from PWA (partial wave analysis) of $\pi^+\pi^-$ HADES data measured in the same experiment and using the Strict Vector Dominance Model (VDM).
- The cut at 2 π mass threshold is due to our model converting measured $\pi^+\pi^-$ to e^+e^- yield, for the decay via intermediate ρ so such cut-off is expected
- 1D efficiency correction works well in the correction of EFF&ACC for exclusive/inclusive invariant mass.

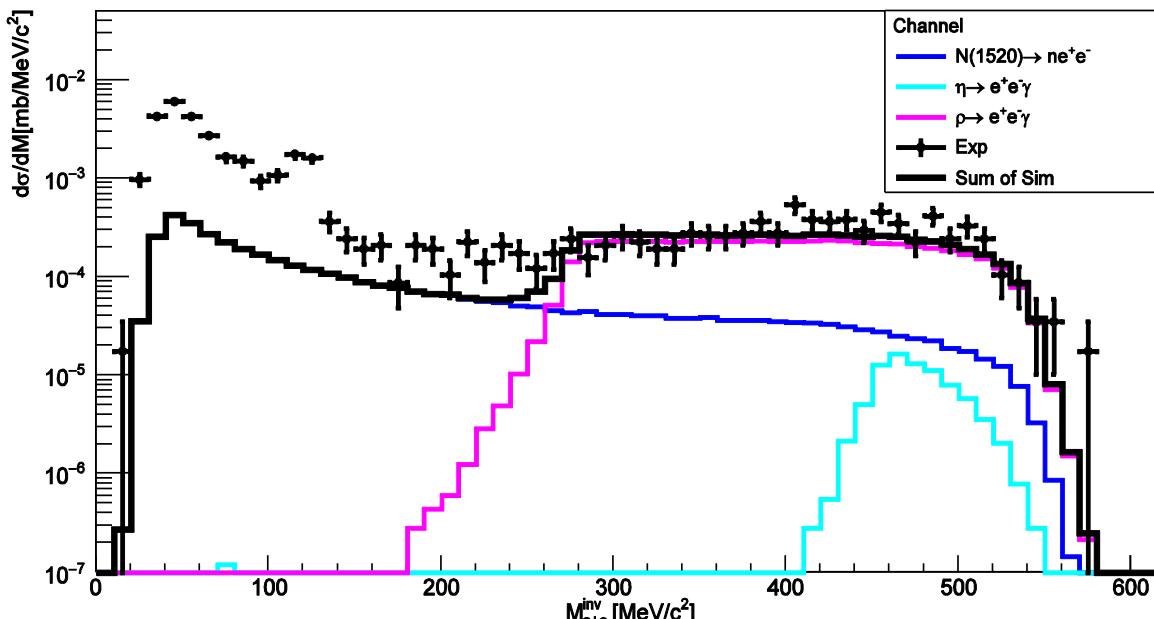
Thanks for your attention



Comparasion Exp.EFF&ACC vs. Exp.No.Corr

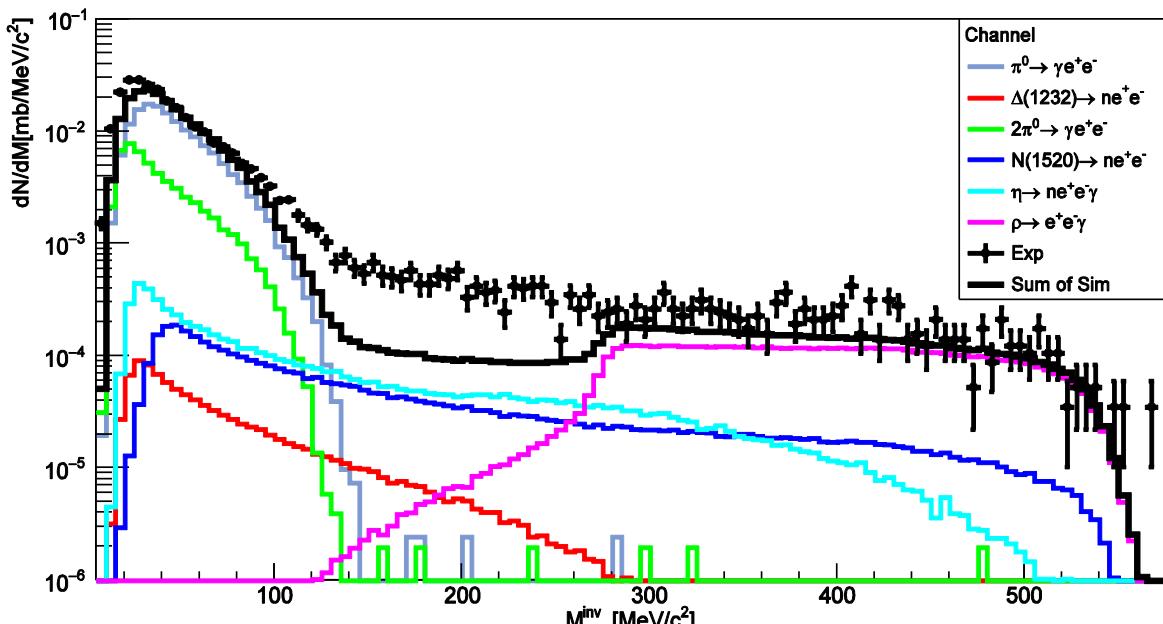
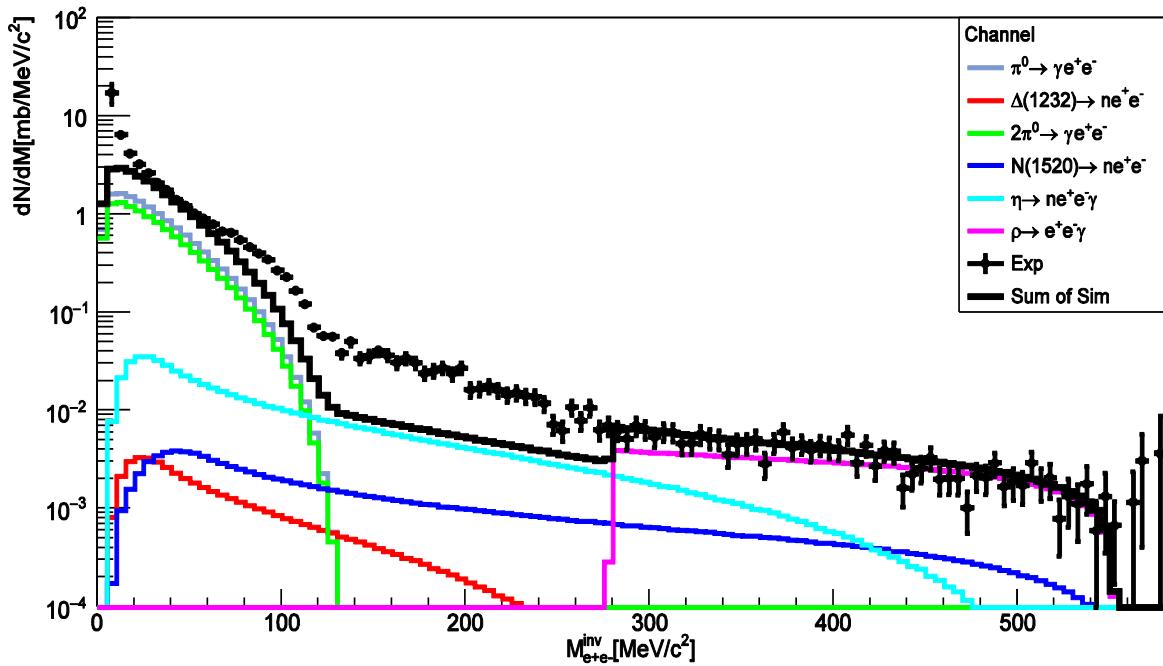


Corrected for
EFFICIENCY +
ACCEPTANCE

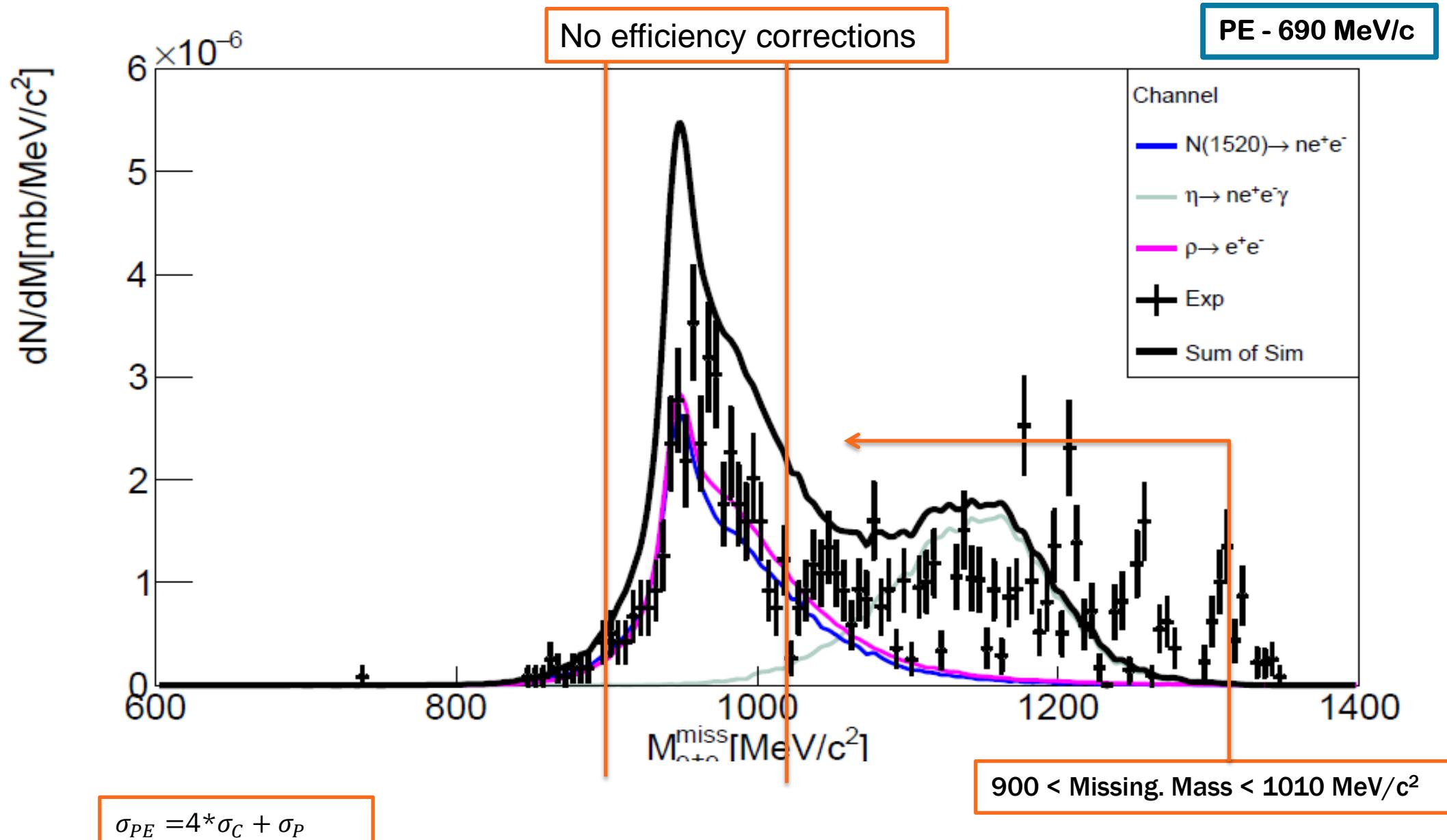


NO Correction

Comparasion Exp.EFF&ACC vs. Exp.No.Corr



Exclusive Missing Mass e^+e^-



Exclusive Missing Mass e^+e^-

