

From Vertex To Detector: Fine-tuning NuWro

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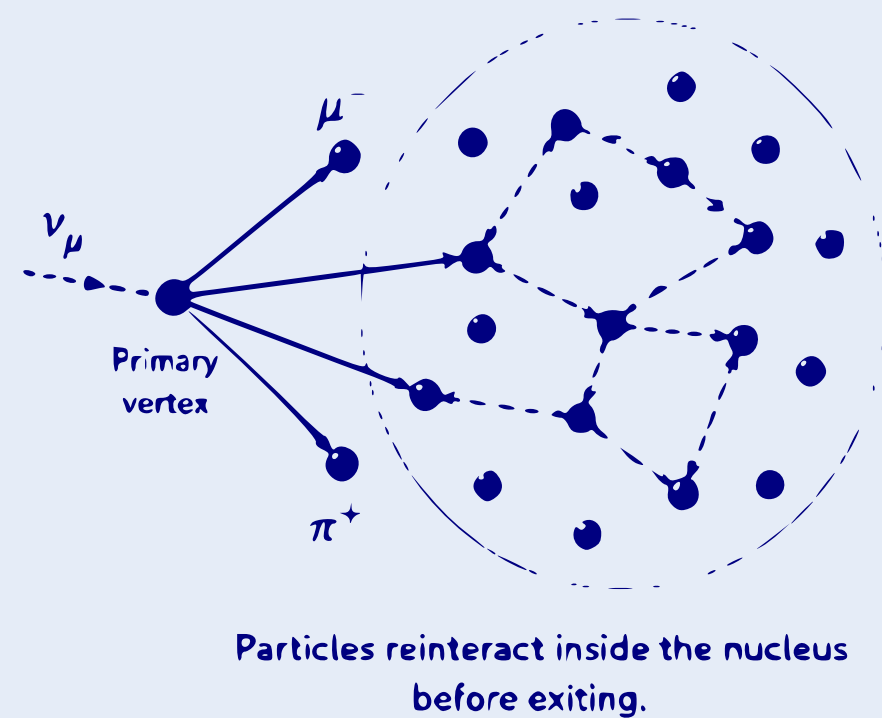
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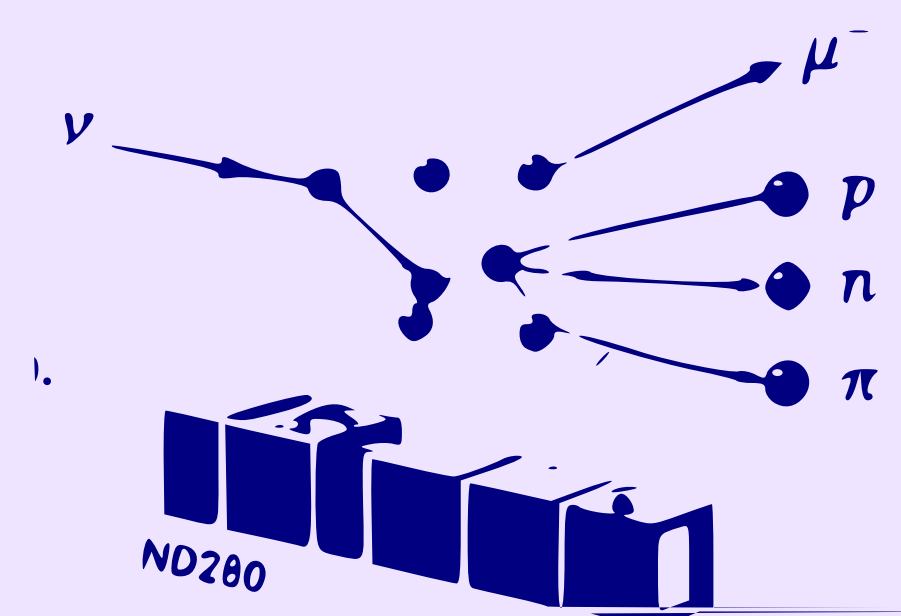
WHAT IS FSI

Final-state interactions are interactions between particles produced at the primary vertex as they pass through the nucleus.



WHY FSI MATTERS?

- FSI can alter interaction topology.
- FSI can affect reconstructed nucleon kinetic energy.
- Oscillation parameters are sensitive to reconstructed neutrino energy.
- Quality of reconstruction depends on control over FSI

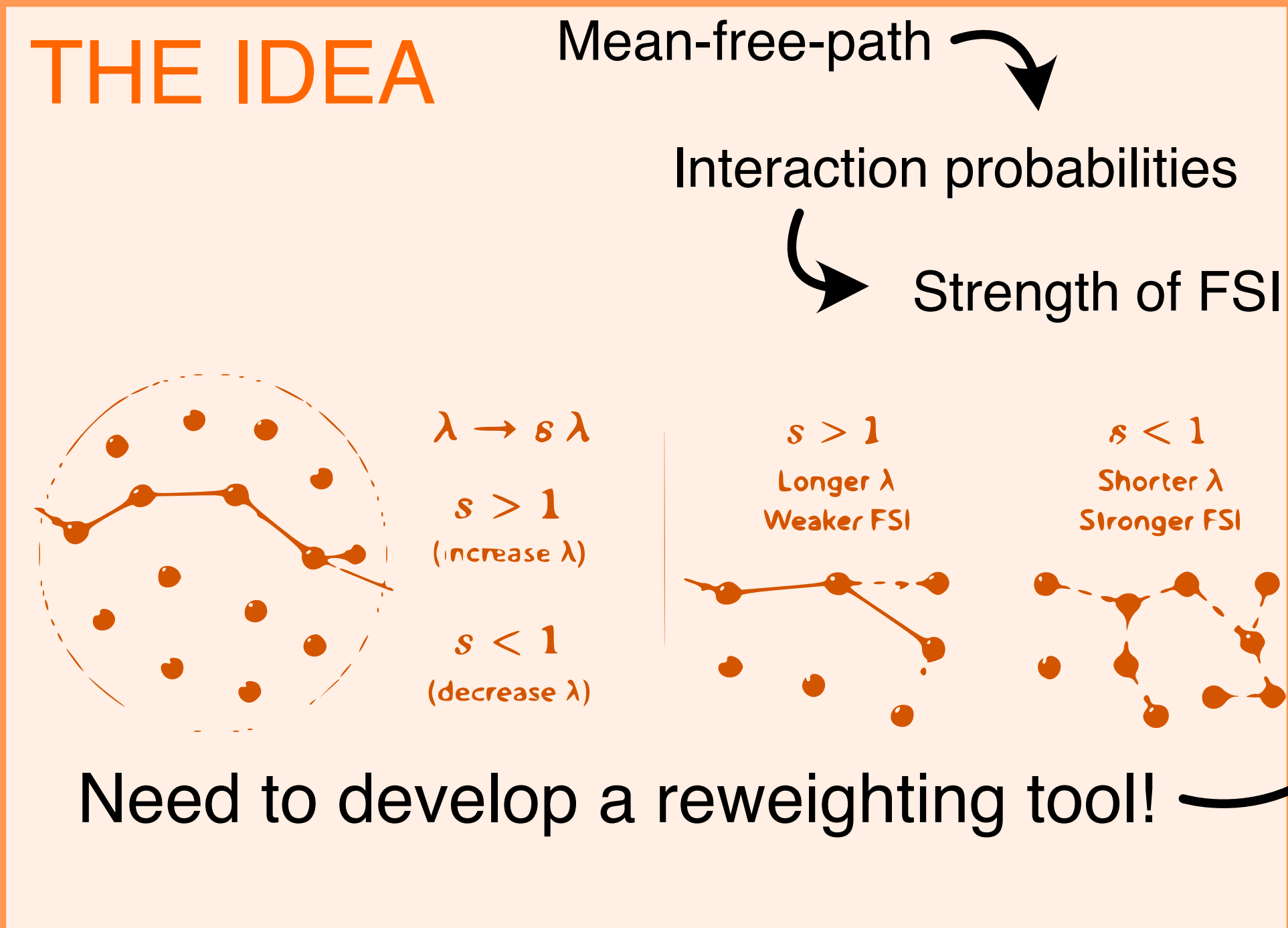
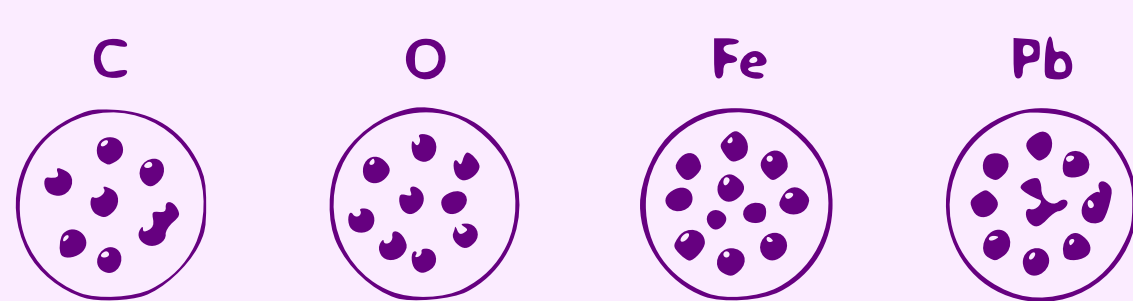


GOAL

To quantify uncertainty in nucleon-FSI modelling!

WHAT WE COMPARE

Instead of using nucleon-nucleon scattering data, we tune directly to neutrino data from experiments performed simultaneously on different nuclear targets.

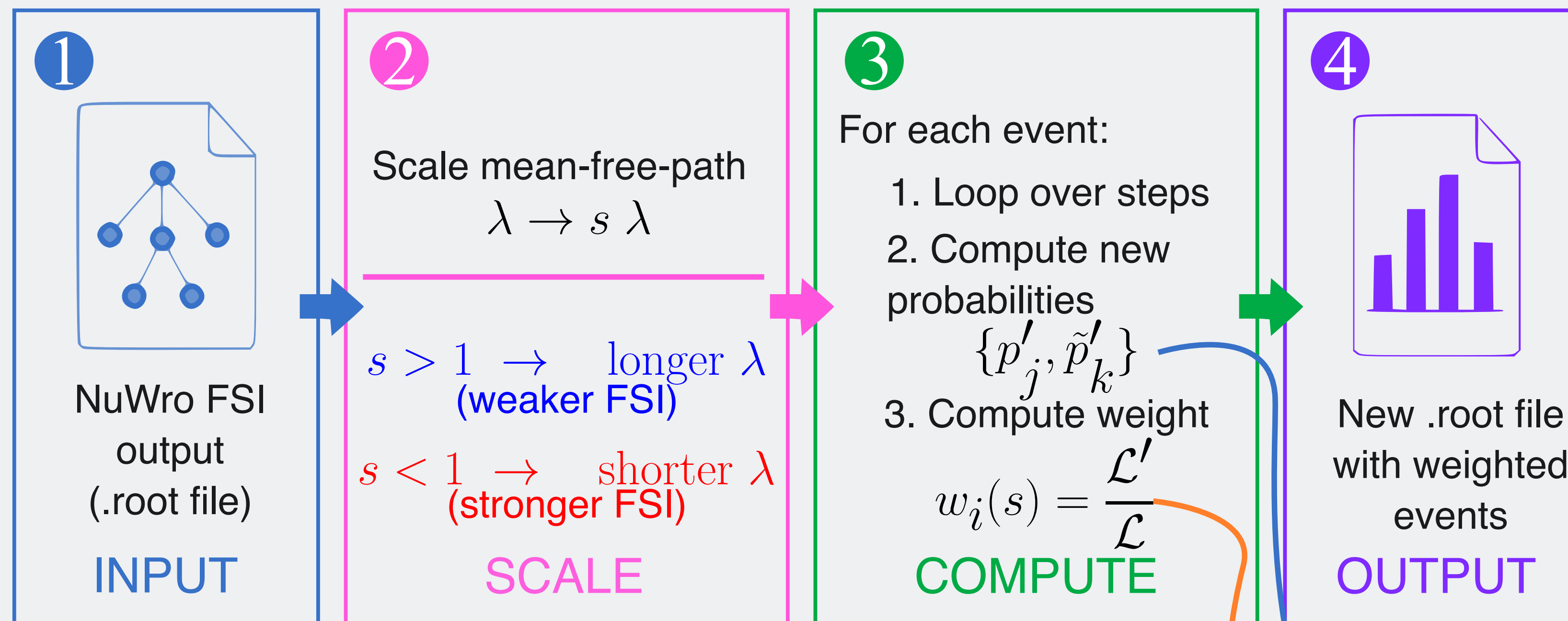


WHAT IMPROVES

Better predictions on all exclusive observables!

WHAT IS THE MESSAGE

A method to quantify uncertainties from FSI modelling
 New uncertainties are smaller than previous proton transparency studies
 NuWro 25.11 includes a fine-tuned nucleon-FSI model

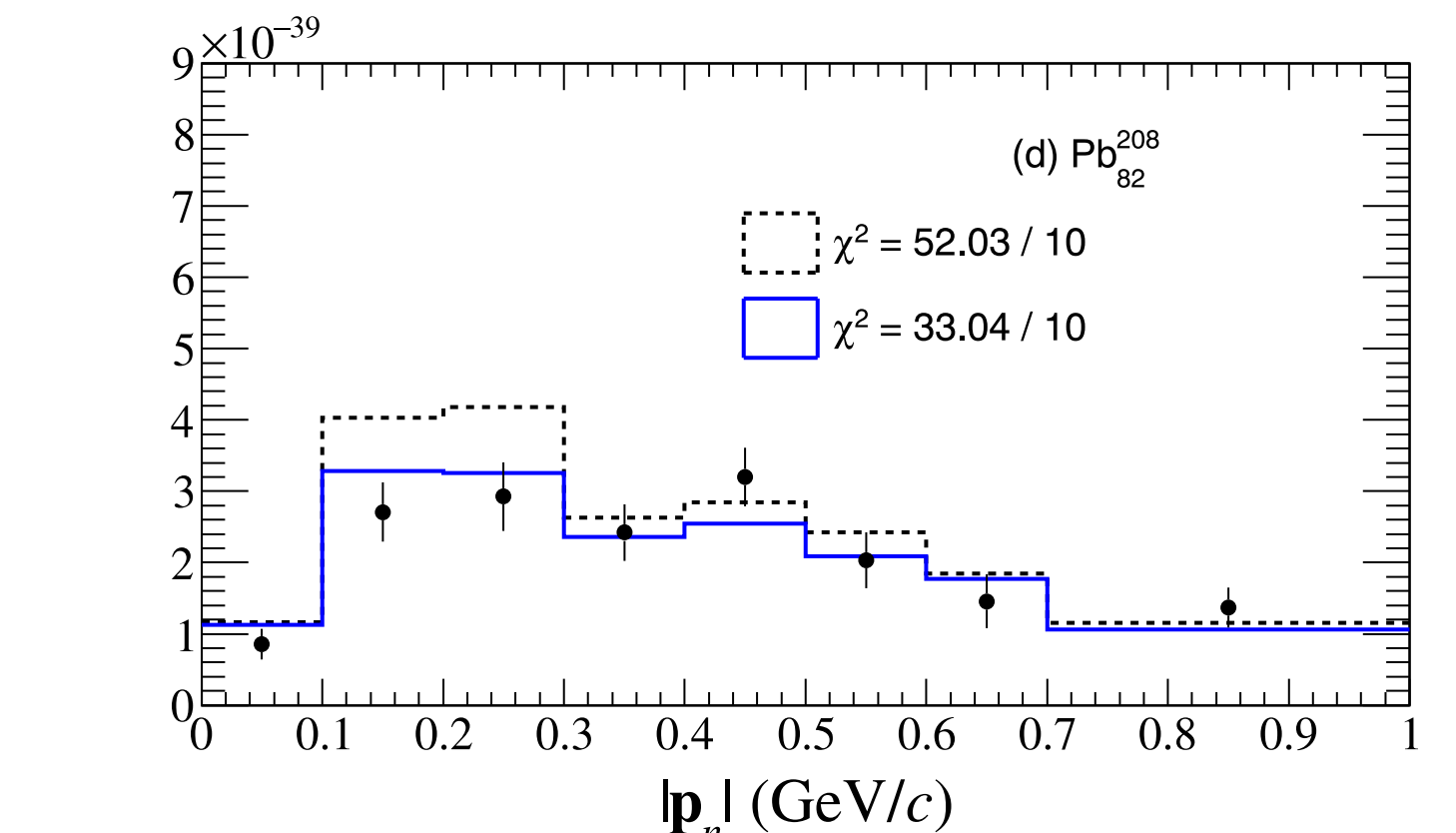
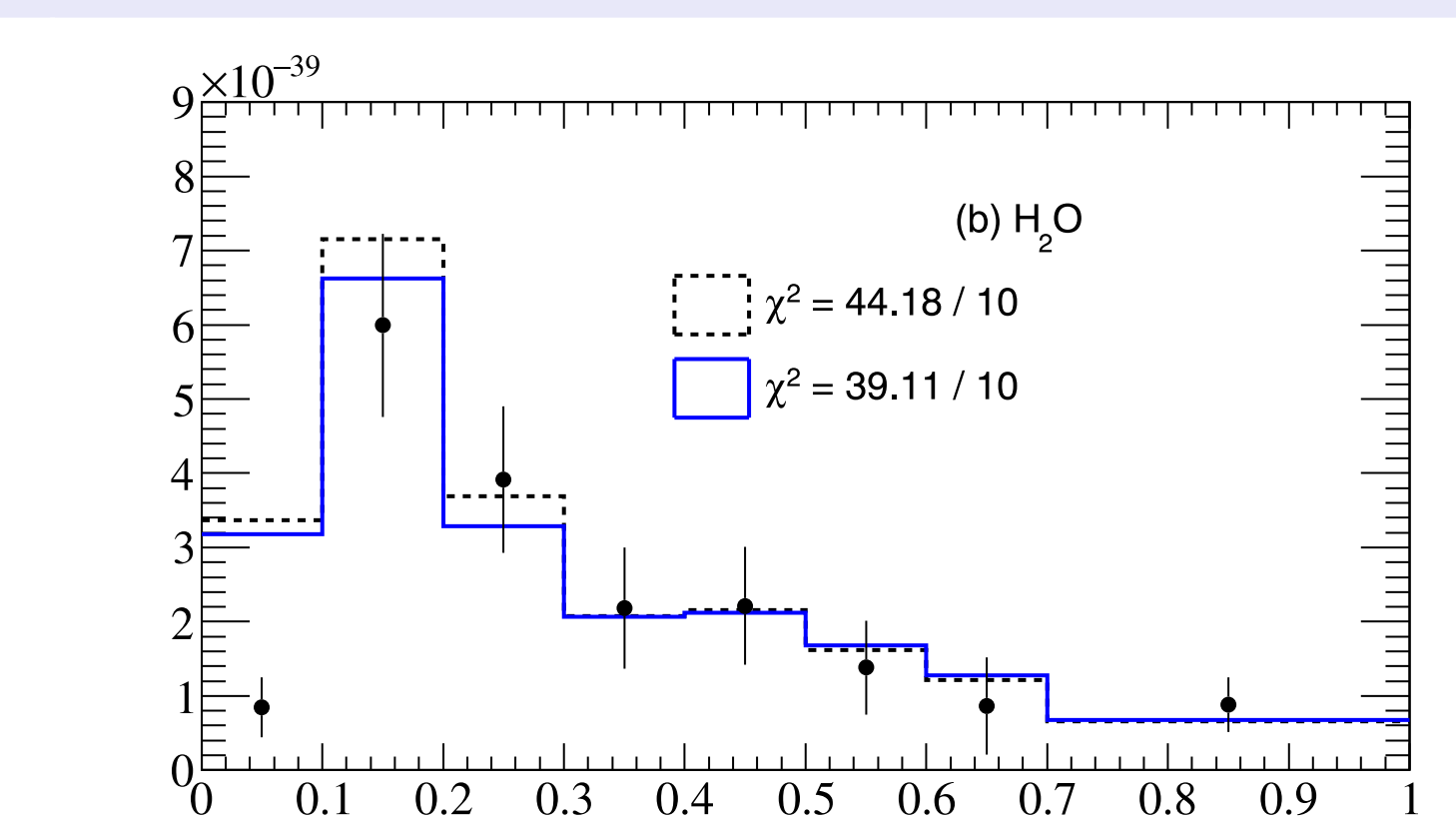
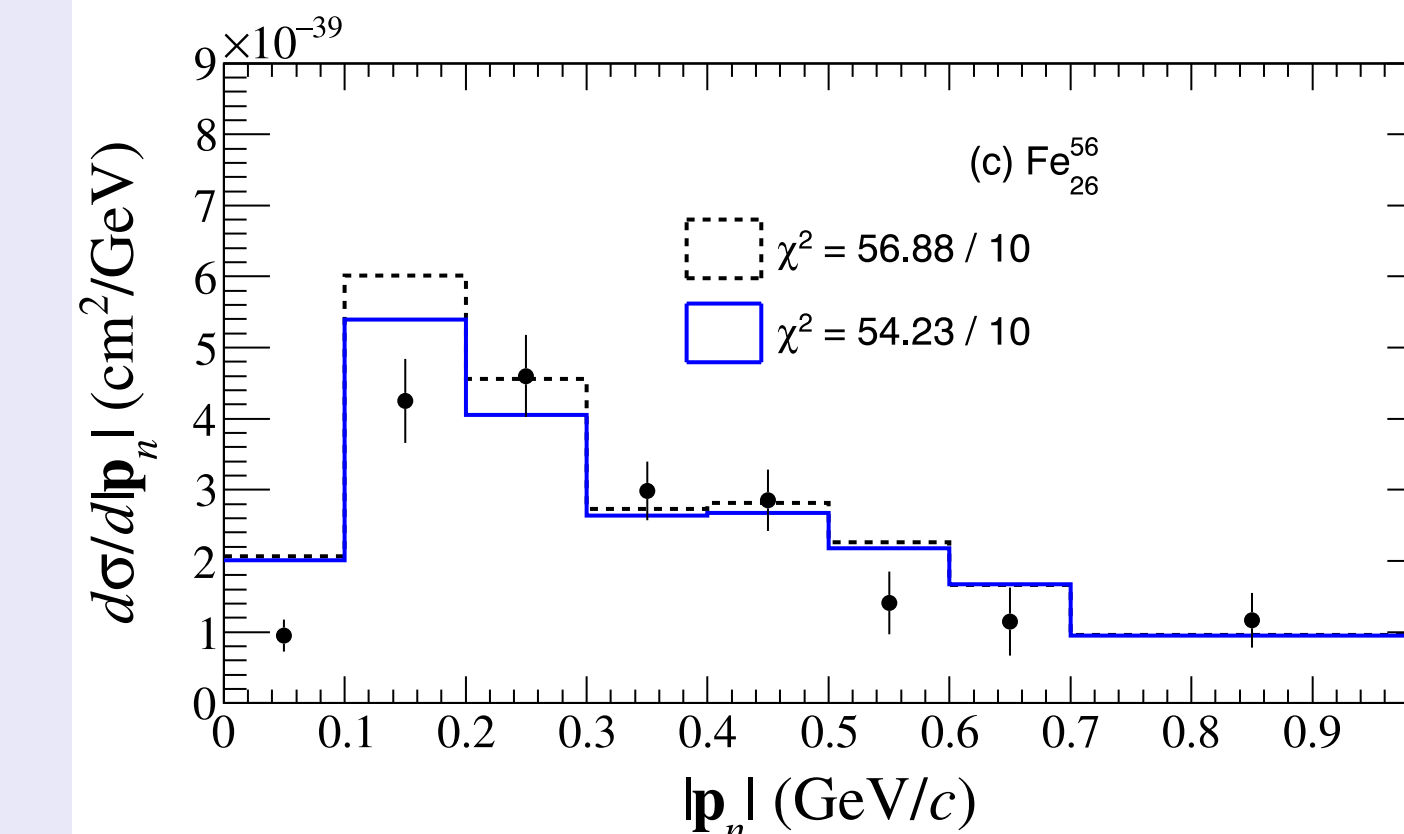
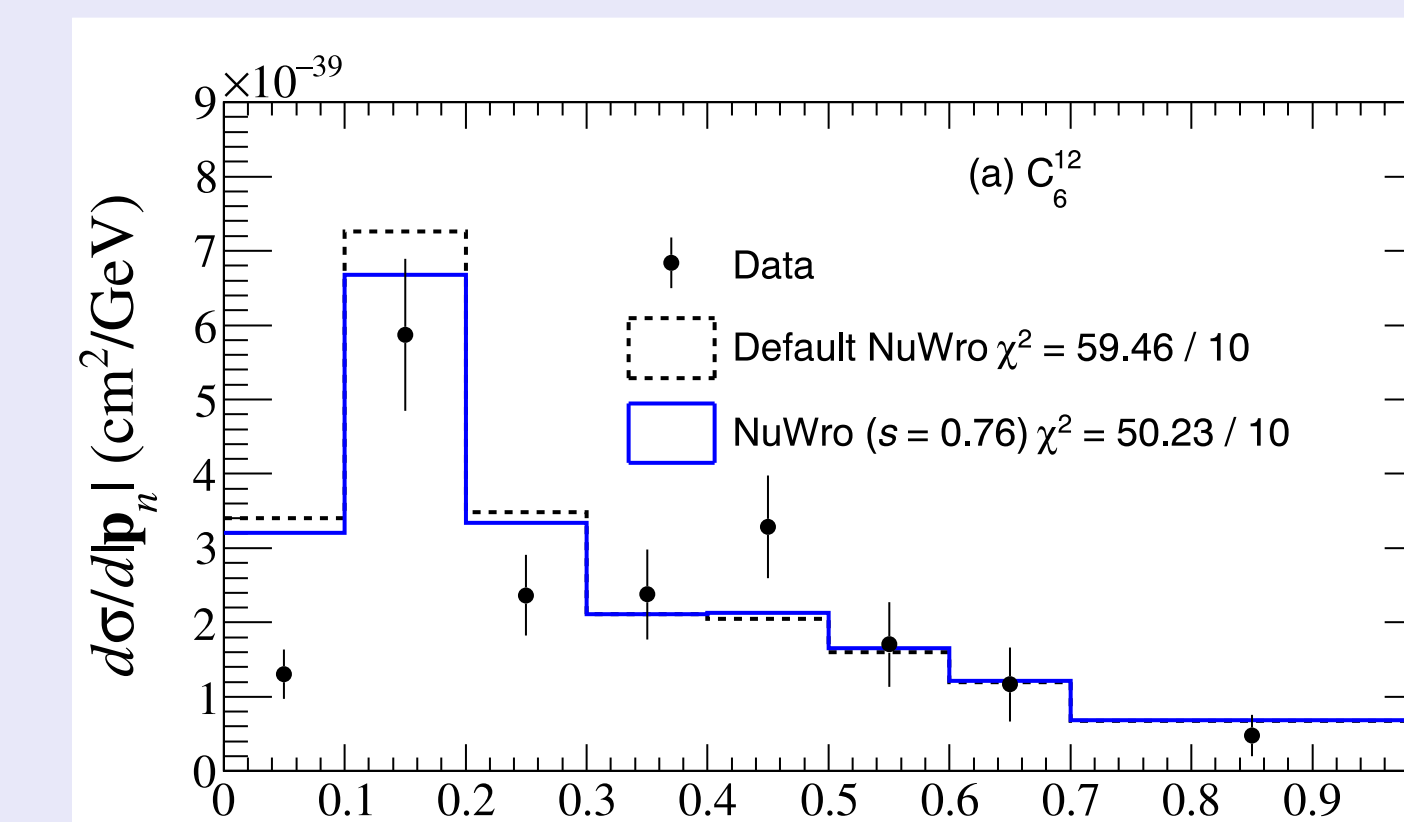
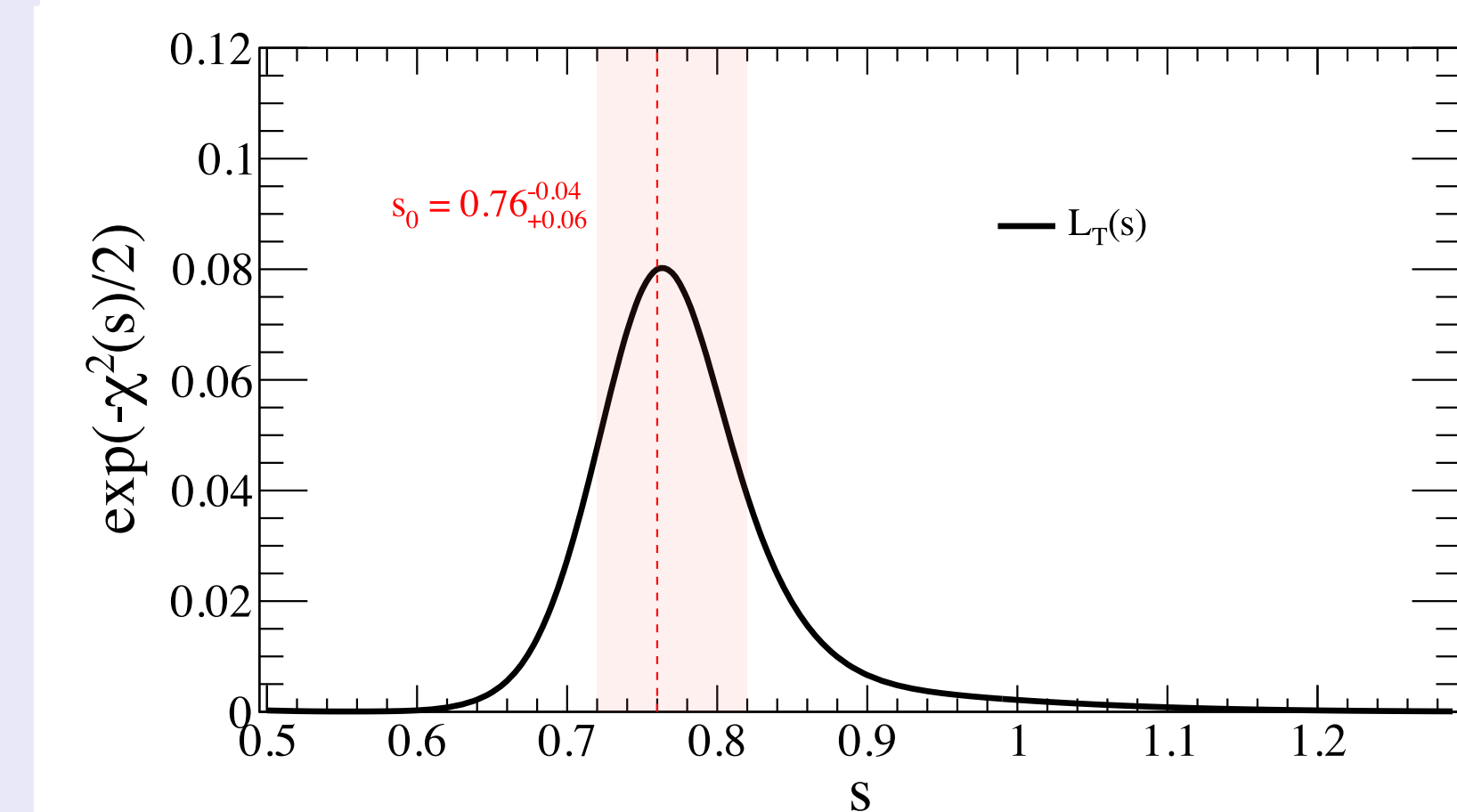
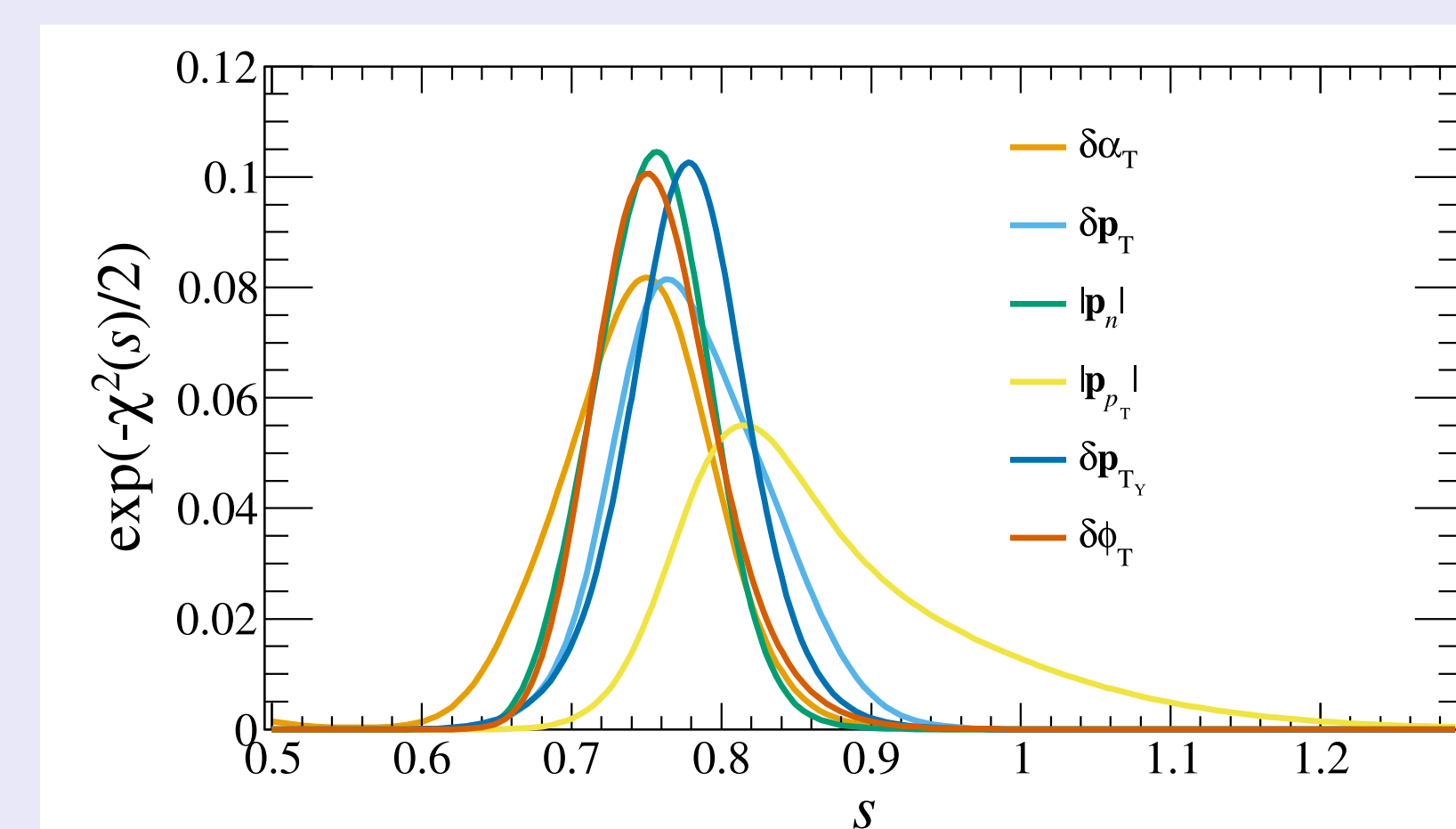


Original Likelihood $\mathcal{L} = \left(\prod_{j=1}^{N_s} p_j \right) \left(\prod_{k=1}^{N_f} \tilde{p}_k \right)$ | LIKELIHOOD OF AN EVENT | New likelihood $\mathcal{L}' = \left(\prod_{j=1}^{N_s} p'_j \right) \left(\prod_{k=1}^{N_f} \tilde{p}'_k \right)$

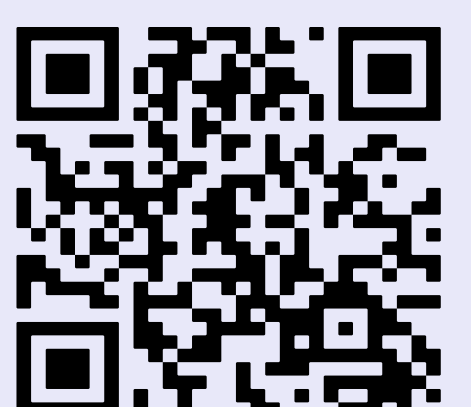
HOW PROBABILITIES CHANGE WITH SCALING (s)

Non-interaction step (survival probability) $\tilde{p} \rightarrow \tilde{p}' = \tilde{p}^{1/s}$ | Interaction (Pauli-blocked) step $p \rightarrow p' = 1 - (1 - p)^{1/s}$

RESULTS



More results in Prasad H., Sobczyk J. T., Phys. Rev. D 113 (2026) 096023 (Scan the code)



A list of references



NuWro Github

ACKNOWLEDGEMENT

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