

# GiBUU at FPF

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- **GiBUU : Quantum-Kinetic Theory and Event Generator**  
based on a BM solution of Kadanoff-Baym equations, allows for off-shell propagation
- GiBUU propagates phase-space distributions, not particles
- Physics content and details of implementation in:  
**Buss et al, Phys. Rept. 512 (2012) 1- 124**
- Code from [gibuu.hepforge.org](http://gibuu.hepforge.org), new version **GiBUU 2021**  
add. details in Gallmeister et al, Phys.Rev. C94 (2016) no.3, 035502

# GiBUU Ingredients

## ■ Initial State Interactions

- Treats all ISI processes: QE, RES, 2p2h, DIS (switch to DIS = PYTHIA at  $W \sim 3$  GeV)
- Contains large number of  $N^*$  resonances and mesons, up to charm
- Contains modelling of color transparency ( $Q^2 > 14$  GeV<sup>2</sup> for N-N collisions)

## ■ Final State Interactions

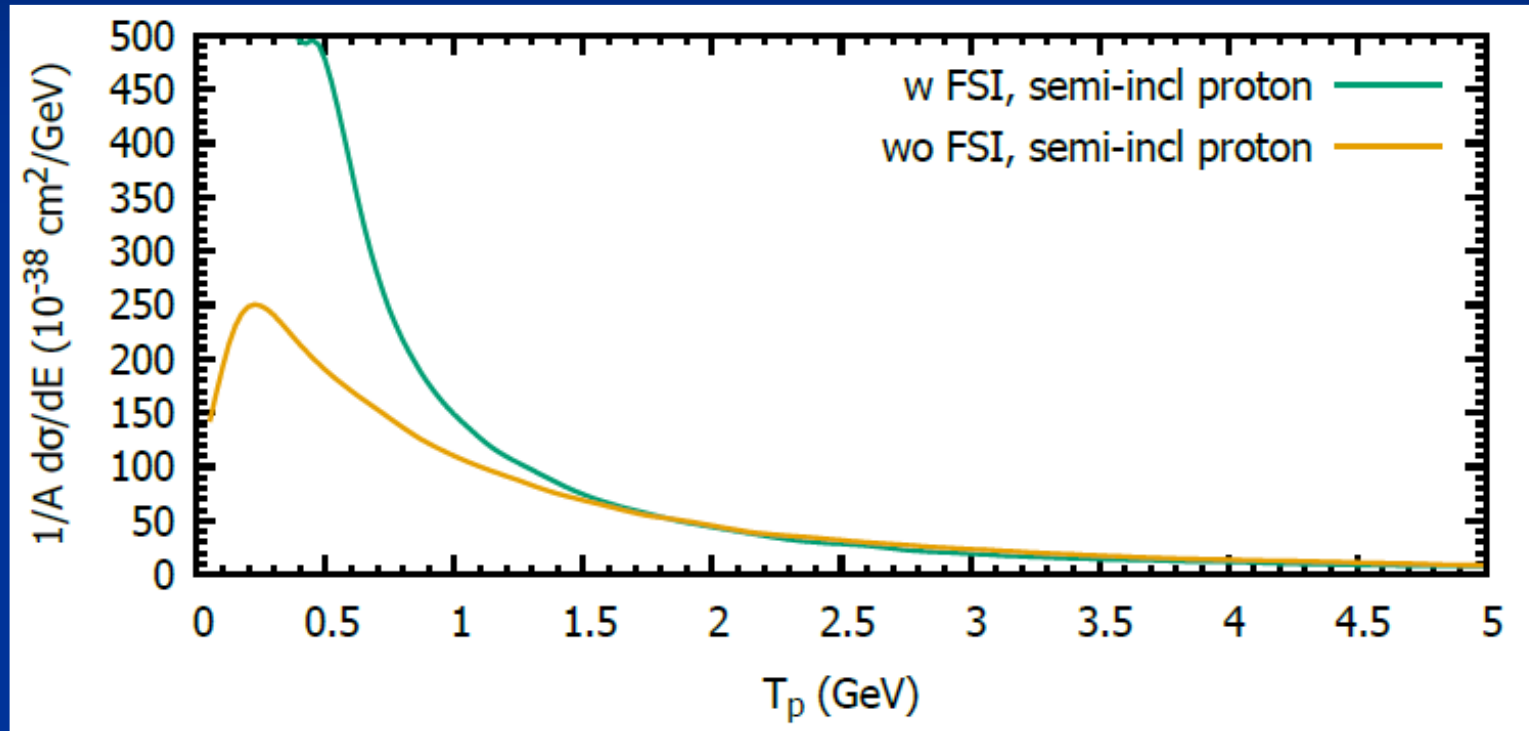
- Fully relativistic, relativistically correct collision criteria for FSI

## ■ Widely tested on

- heavy-ion reactions ( $< 20$  AGeV),  $p + A$ ,  $\pi + A$
- $(e, A)$  reactions (JLAB:  $E < 6$  GeV, HERMES: 28 GeV, EMC: 230 GeV)
- $(\nu, A)$  reactions (MiniBooNE, T2K, MINERvA)



# FSI effects in energy spectra

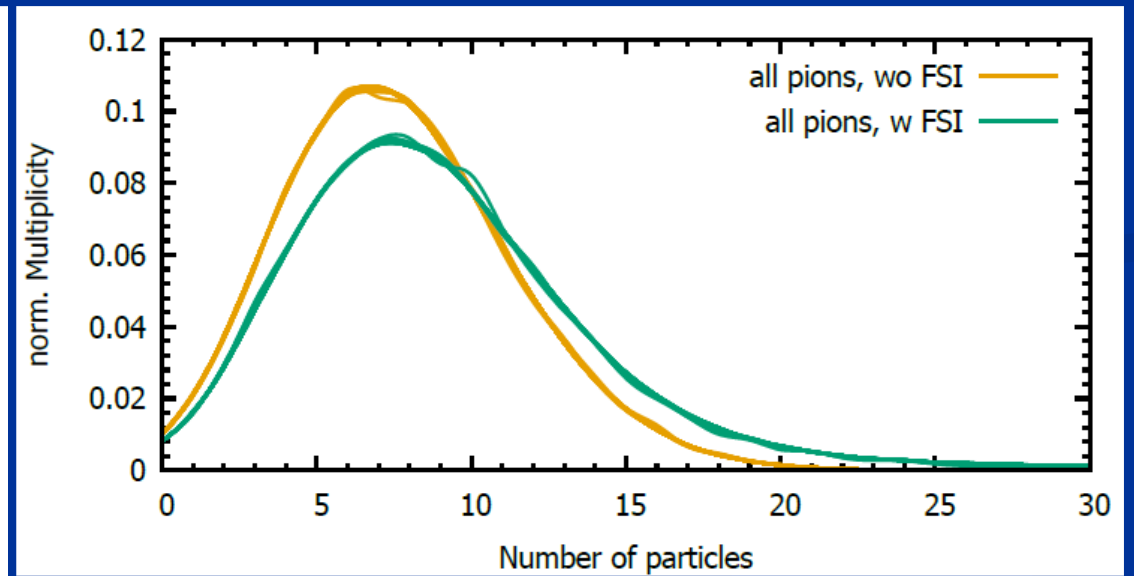
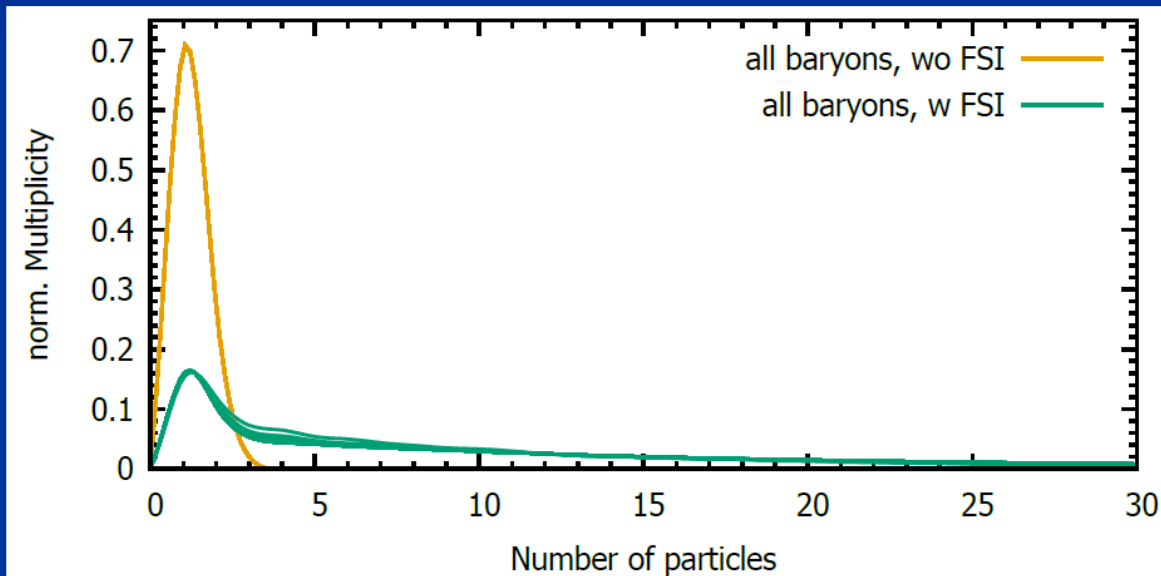


Target: W, 1 TeV

- FSI sets in below  $\sim 1.5$  GeV kinetic energy

# FSI effects on multiplicities

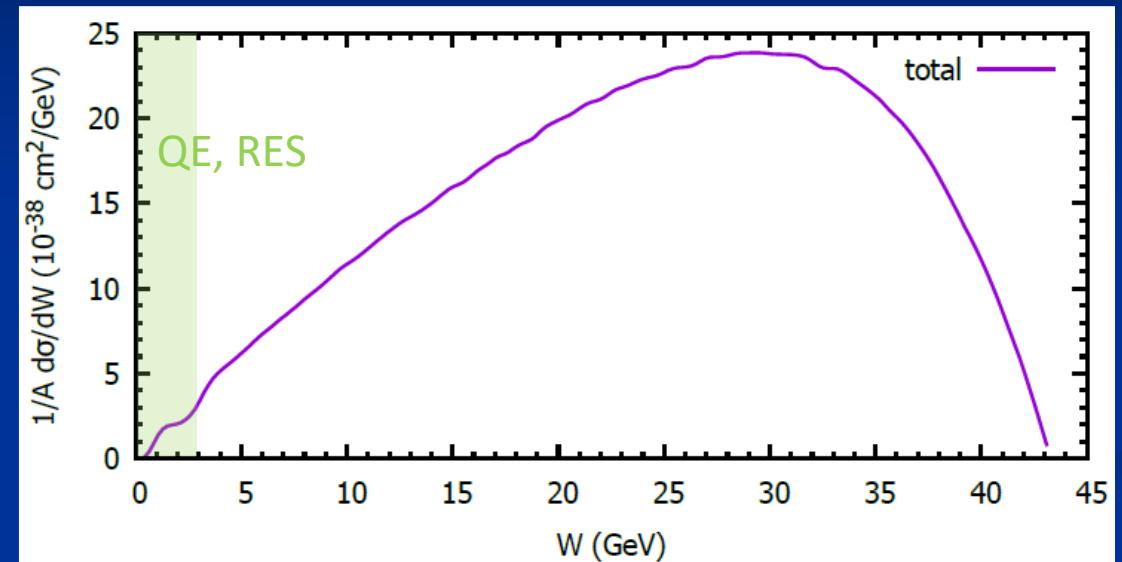
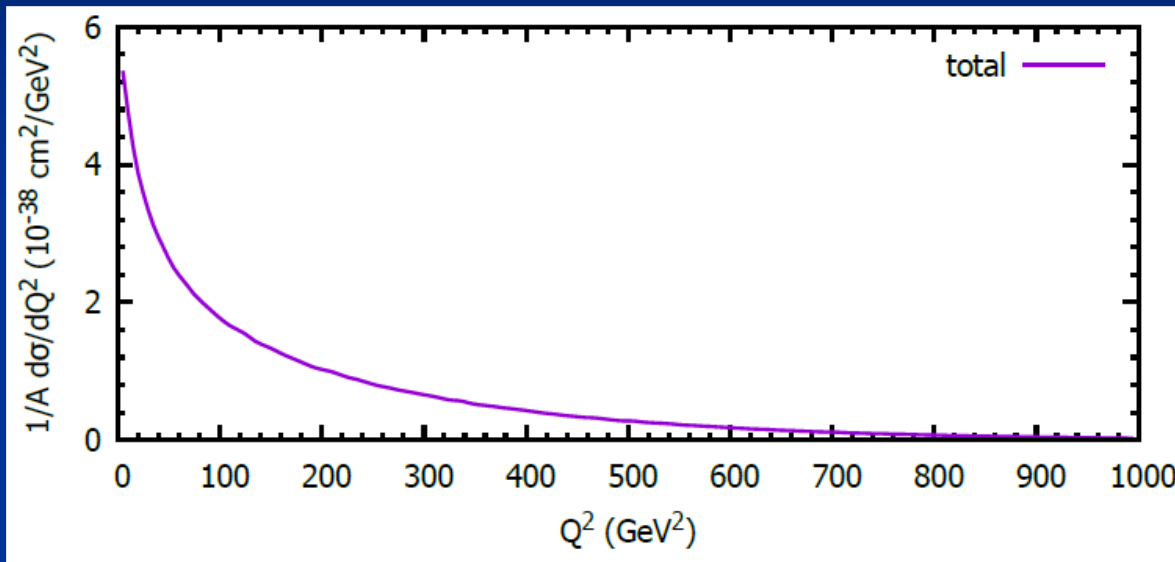
Dramatic ,avalanche effect' on baryon multiplicity



Target: W, 1 TeV



# FPF, 1 TeV, incl. distributions



Dominated by DIS, have to worry about Color Transparency in FSI:

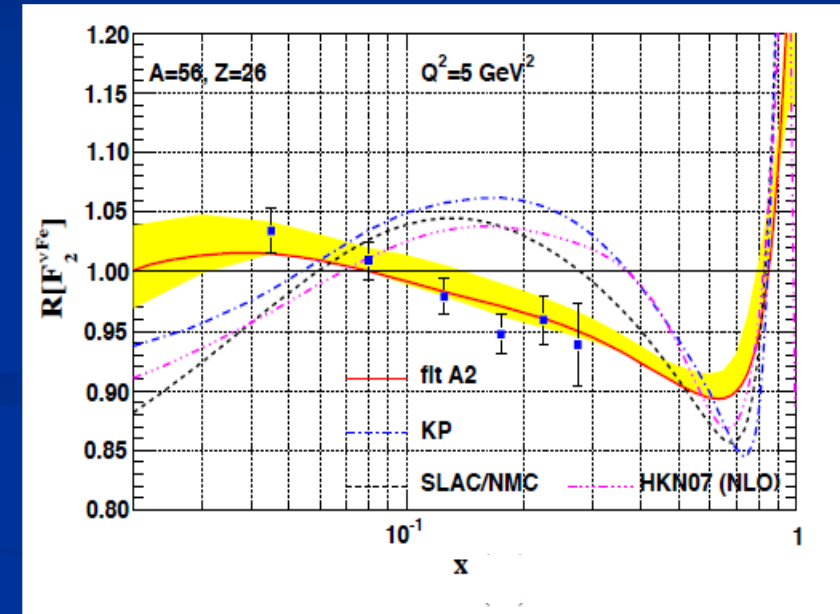
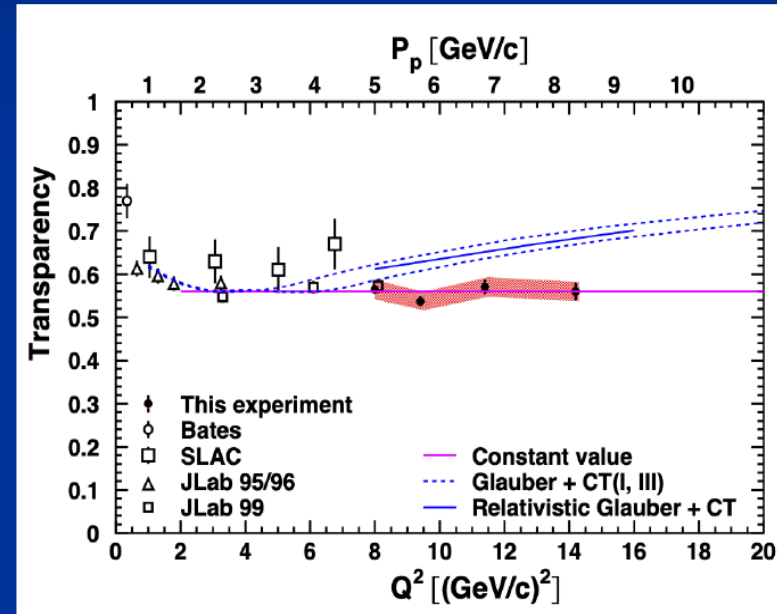
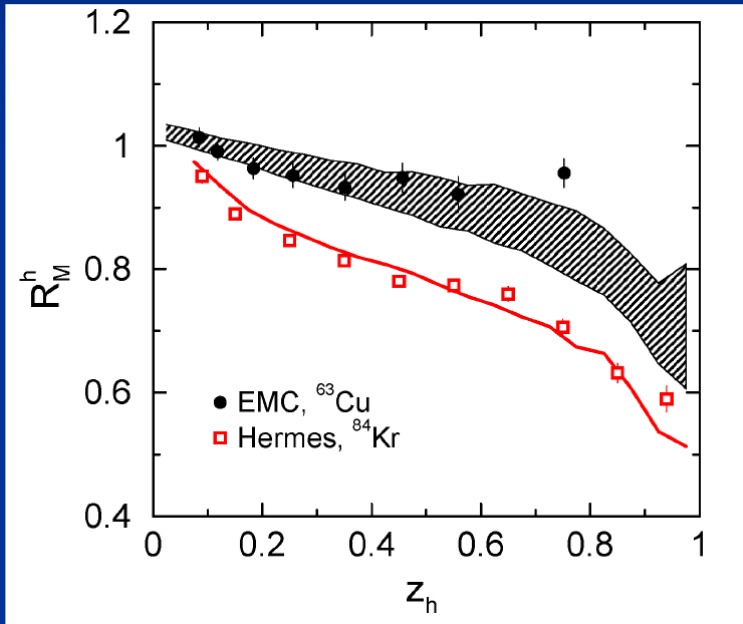
$$\frac{\sigma^*(t)}{\sigma} = X_0 + (1 - X_0) \cdot \left( \frac{t - t_P}{t_F - t_P} \right), \quad X_0 = r_{\text{lead}} \frac{\text{const}}{Q^2},$$

Farrar, Strikman et al

describes JLAB and HERMES hadronization data, also EMC

# $\nu A$ Problems for FPF

JLAB 2021



Where is Color Transparency ???

EMC effect for neutrinos,  
tension with electrons

K. Gallmeister, U.M., Nucl. Phys. A 801 (2008) 68

[Time Dependent Hadronization via HERMES and EMC Data Consistency](#)

