Situation of pion physics

theorists

experimentalists

π-/π+ ratio is a good probe of Esym!

Great! I'm going to measure it.

Apply money, build facilities, …

Wait, there is missing physics or other effect.

OK, what is it?

Threshold effect.

OK.

s-wave and p-wave pion potential.

…

clustering effect, Pauli Blocking effect.

…

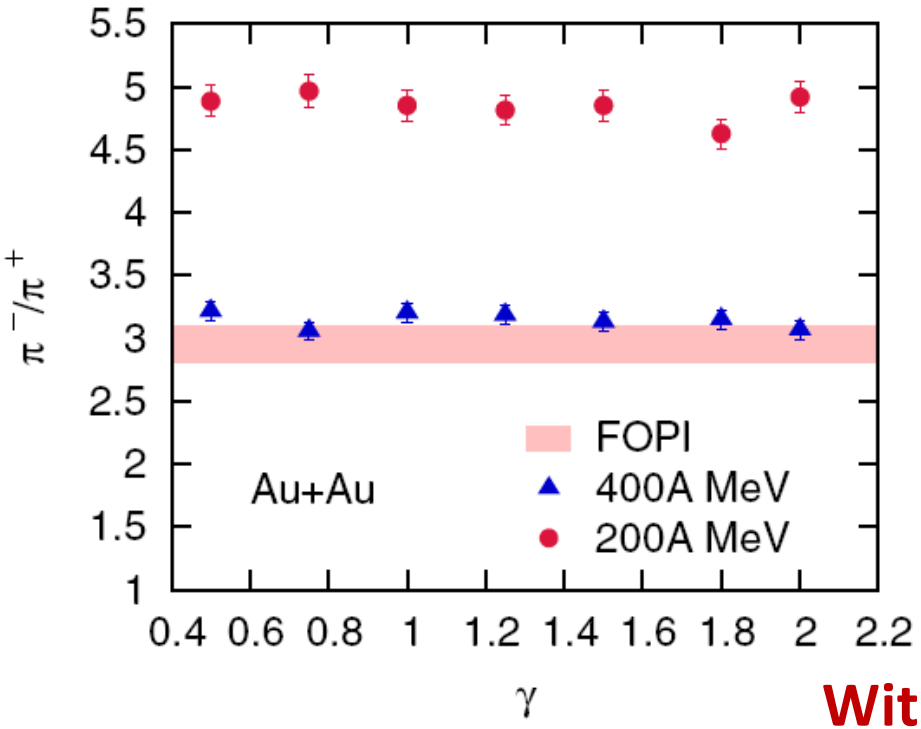
Model dependence.

…Is π-/π+ ratio a good probe of Esym?

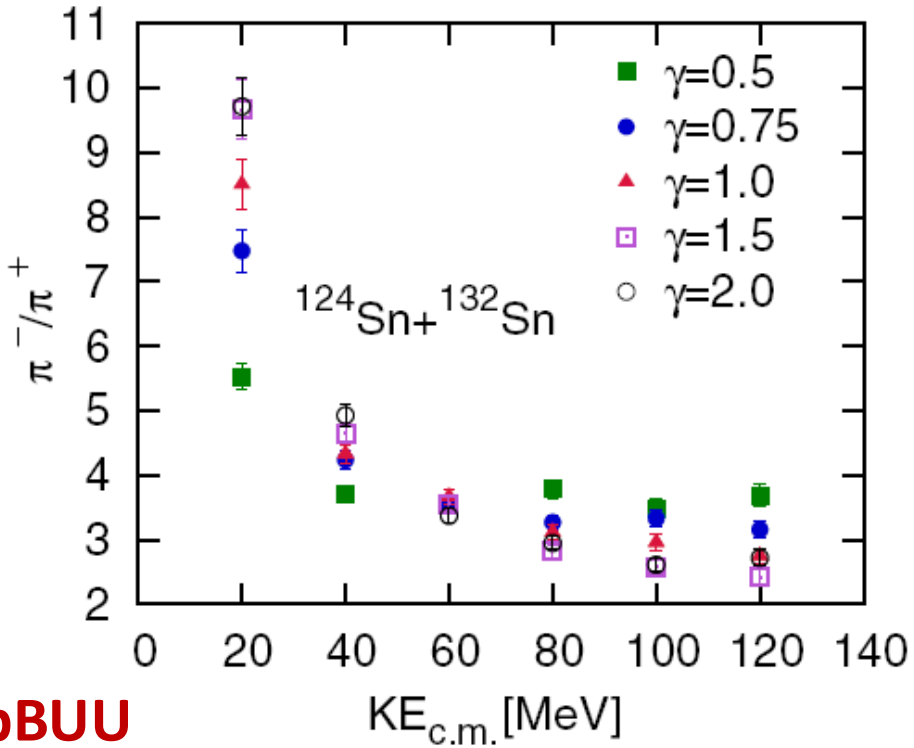
Talk by Pawel Danielewicz

Pion optical potential $U_{\pi^\pm} = \mp 8\, S_{\rm into}\, \rho_T\, \dfrac{\rho^{\gamma-1}}{\rho_0^{\gamma}}$ **related to Esym**

$$S_{\rm int}(\rho) = S_0\,(\rho/\rho_0)^{\gamma}$$



With pBUU

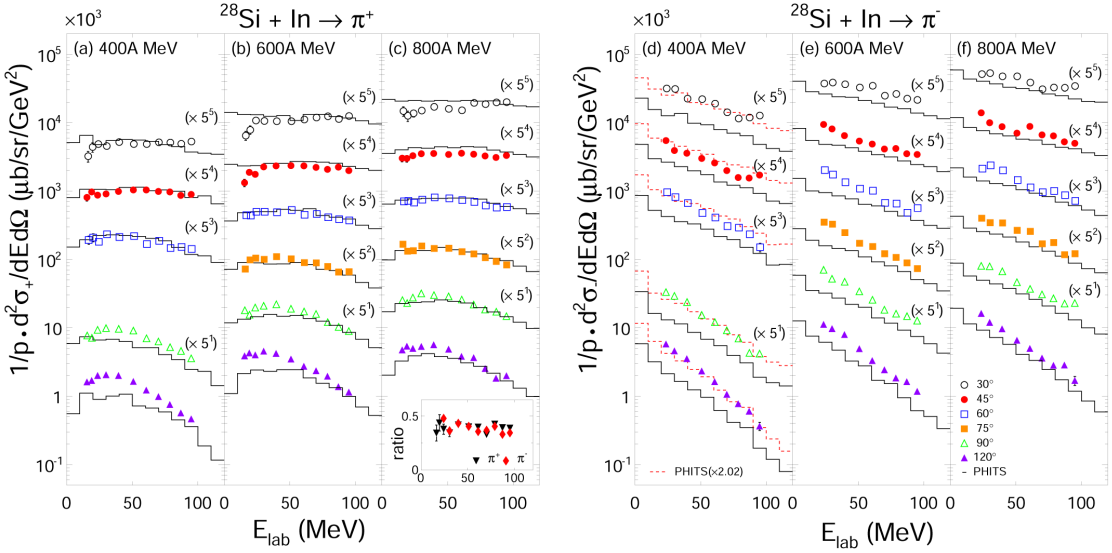


Integrated ratio insensitive to Esym

Energy spectra sensitive to Esym

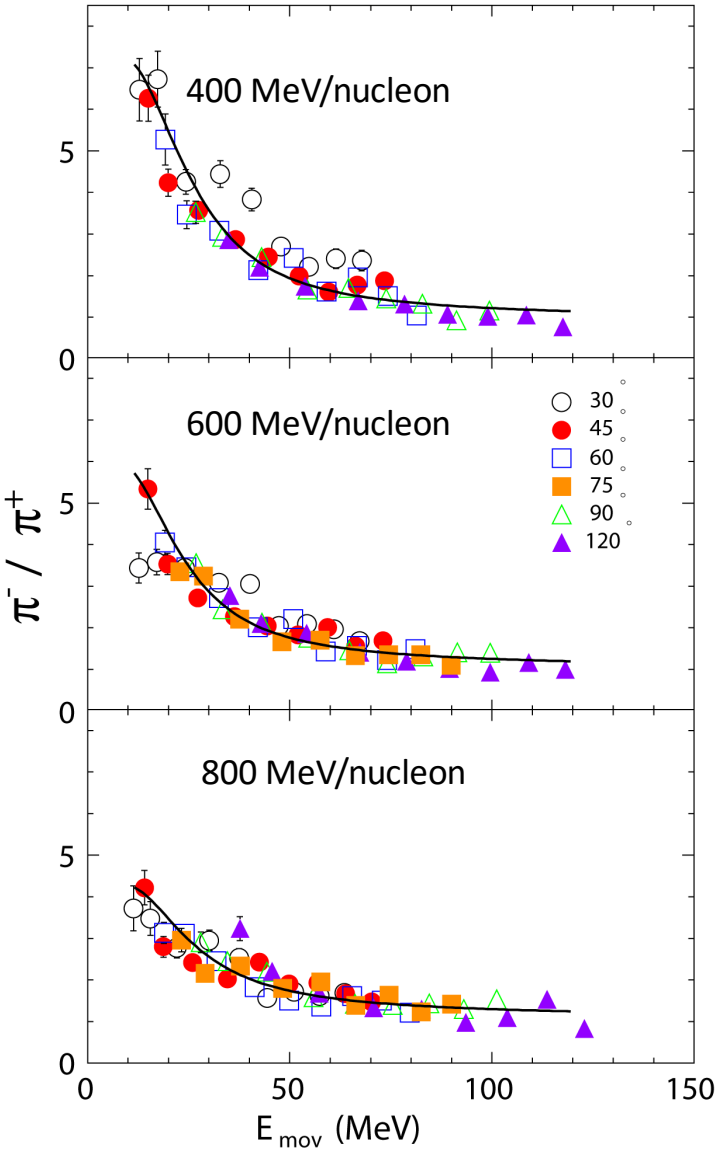
Talk by Tetsuya Marukami

Considerable experimental efforts for pion measurement



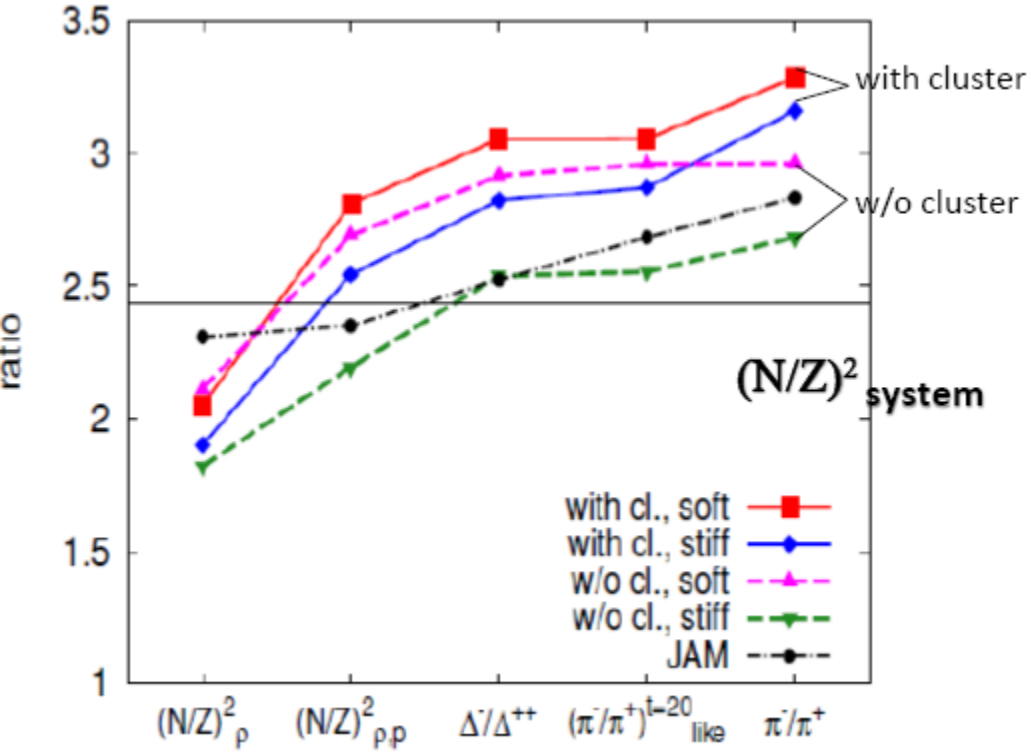
Compared with JQMD

Call for transport efforts to explain the experimental data

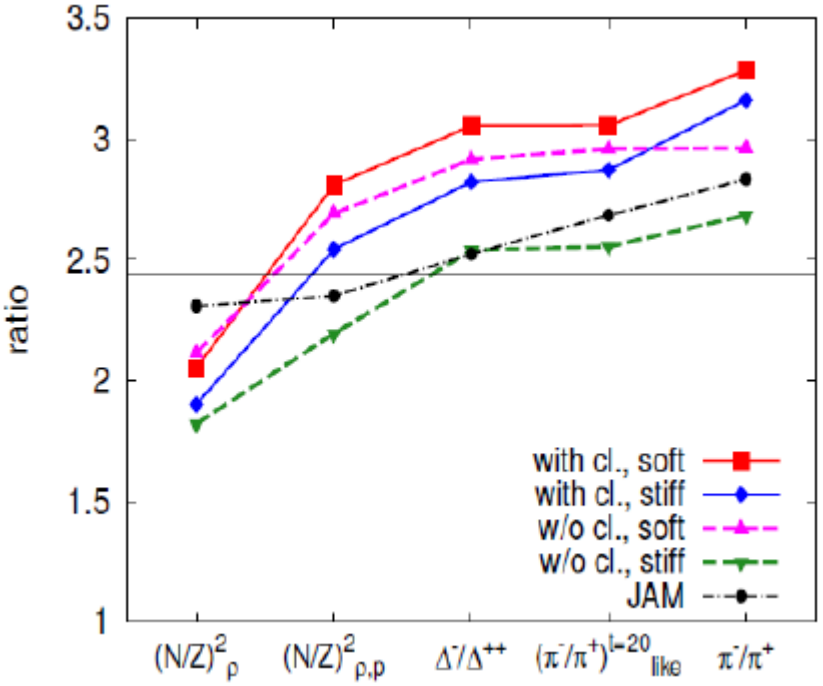


Talk by Natsumi Ikeno

Clustering effect on π-/π+ ratio



Pauli Blocking effect on π-/π+ ratio

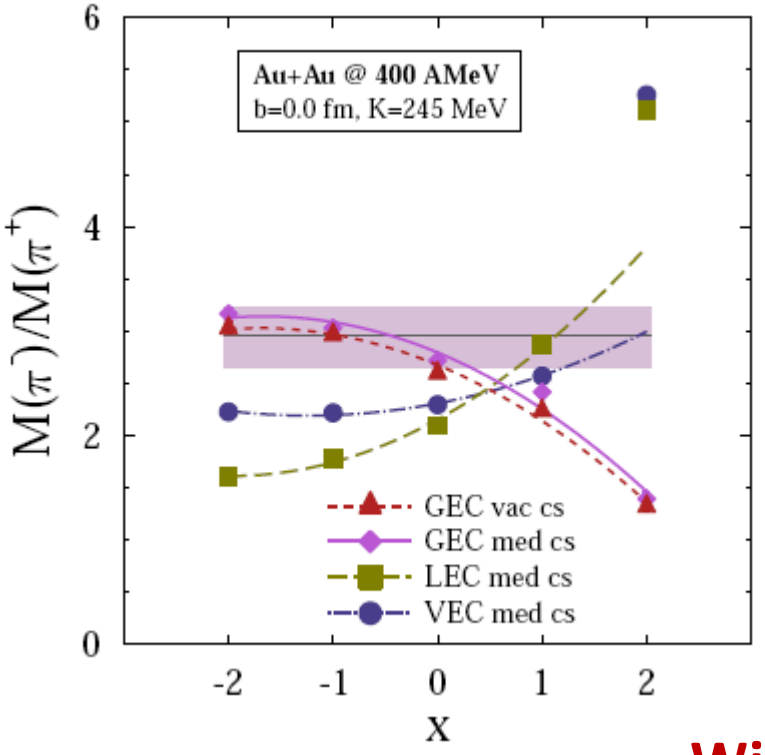


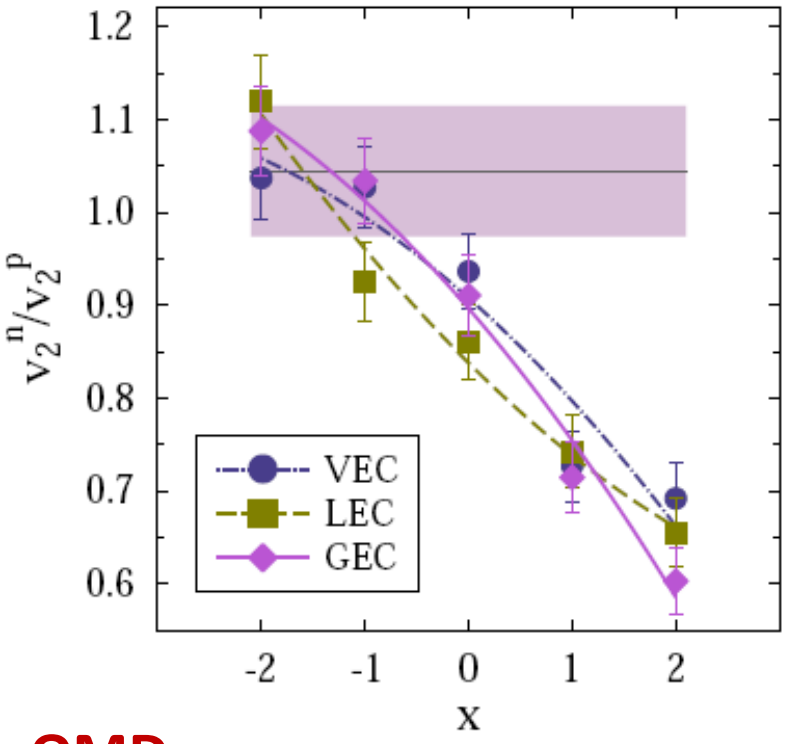
With JAM

Talk by Mircea Dan Cozma

LEC: local energy conservation
GEC: global energy conservation
VEC: in-vacuum energy conservation

Consistent Esym
with π-/π+ and v2n/v2p

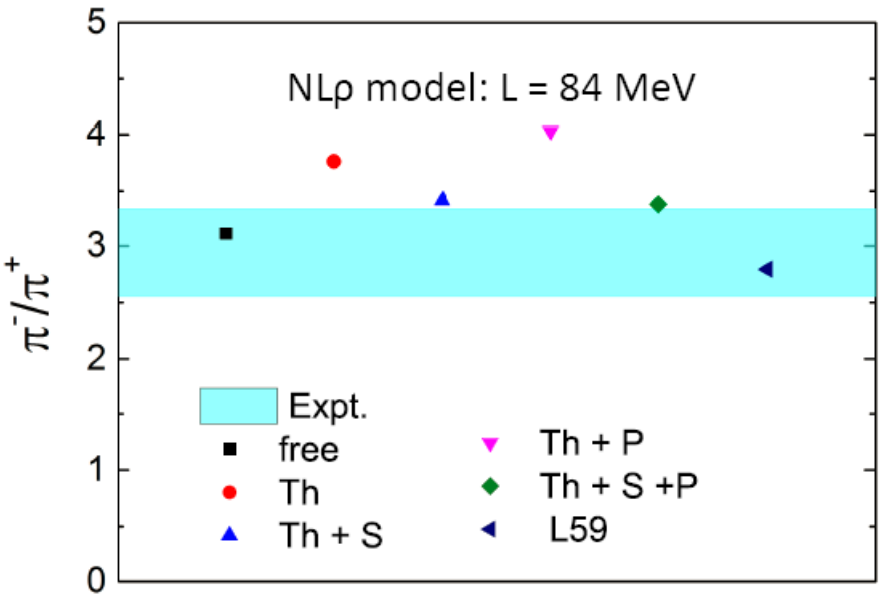


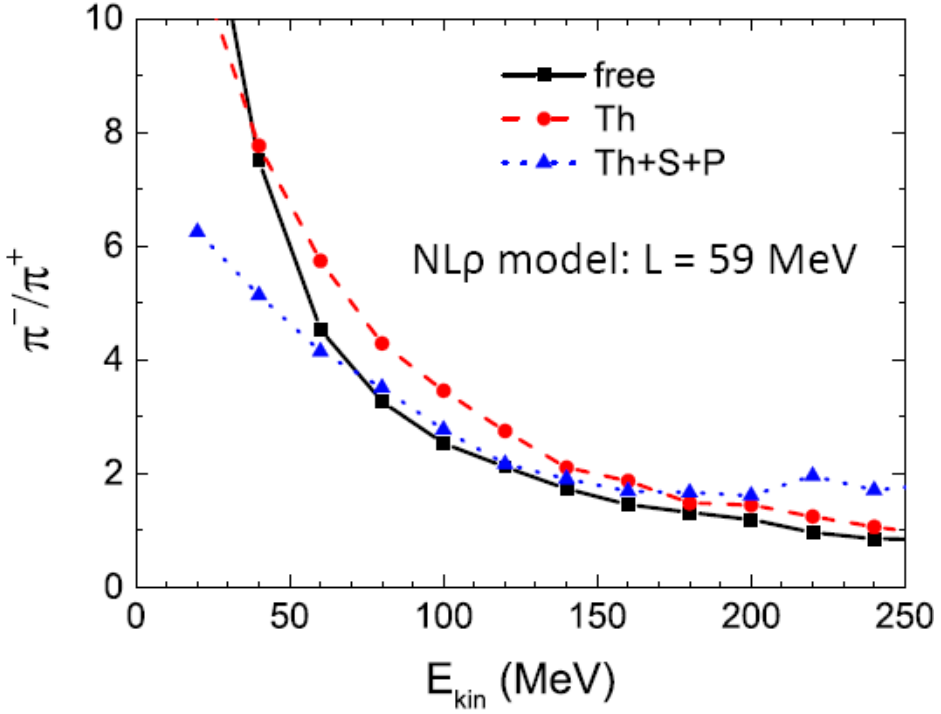


With TuQMD

Talk by Che Ming Ko

Combined effects from threshold, s-wave, p-wave





With RVUU

What we have achieved in the transport comparison project-Benchmark

- HIC: theoretical error bar for transport flow- 30% at 100 AMeV and 13% at 400 AMeV; Uncertainties from initialization and Pauli Blocking.
- Box-Cascade (tentative): reproduce <σv> within 5% by modified Bertsch's approach by turning off the spurious scattering; Pauli Blocking underestimated by 10-20% depending on BUU or QMD at extremely low T.

What we have achieved in the transport comparison project-Benchmark

- Box-Vlasov (tentative): Different damping from BUU and QMD; Reproduce oscillation frequency from linear response theory within ?%.
- Box-Pion (tentative): theoretic error for π-/π+ ratio; Reproduce results from kinetic equation within ?%.

Some considerations on organizing code authors

- Code authors are volunteer to help.
- Their efforts we can ask for are finite.
- They could be more active in the beginning but less active later on.
- They want to see progresses/benchmarks as published in the paper.
- They want to make their code known and improve their code rather than ruin their code.
- Number of participant codes decreases with increasing efforts
  - HIC: 9 BUU and 9 QMD
  - Box-Cascade: 7 BUU and 8 QMD
  - Box-Vlasov: 7 BUU and 5 QMD
  - Box-Pion: 3(?) BUU and 5 QMD

If you understand all these …

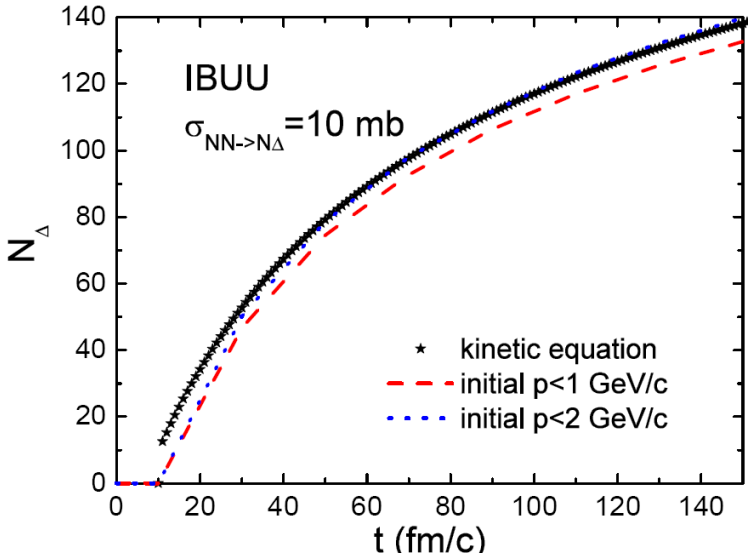
Questions for discussions – transport comparison project

- Next comparison
  - Compare momentum-dependent mean-field potential (for the nucleon effective mass measurement)?
  - Clustering effect in transport model?
- Standard subroutine for experimentalists, with well tested components in transport models (initialization, NN scattering, Pauli Blocking, MF, Δ and π production)?
- Requirement for the useful conclusion from transport comparison (theoretical uncertainty, reproduce theoretical limit with ?%, …)?
- Suggestions for organizing code authors for homework calculation (divergence due to different code treatments or carelessness)?

Some considerations on Box-Pion

- Already great efforts:
  - Phase I (Dc1P0, Dc2P0)
  - Phase II and new Phase II (Db1P0, Db2P0, Db2Pb)
  - Phase III (Da2Pa)

  It turns out the convergence is not very good.
- Four components:
  - N+N->N+Δ (√)
  - N+Δ->N+N (?)
  - Δ ->N+π (?)
  - N+π -> Δ (?)



If you want to be thorough, …

Proposal to fix the other three components -begin with a box with half N and half Δ

- Compare N+Δ->N+N with results from kinetic equation.
- Combine N+N->N+Δ and N+Δ->N+N

  => N+N<->N+Δ, compare with results from kinetic equation.

  Phase I fixed!
- Compare Δ ->N+π with results from kinetic equation.
- Compare N+π -> Δ with results from kinetic equation.
- Combine Δ ->N+π and N+π -> Δ

=> Δ <->N+π , compare with results from kinetic equation.

- Combine N+N<->N+Δ and Δ <->N+π, compare with results from kinetic equation.

  A big task!

  Phase II fixed!