Analysis status of Kyoto multiplicity array for the SπRIT experiment

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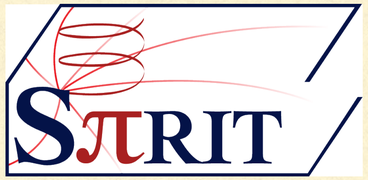


Outline of my talk

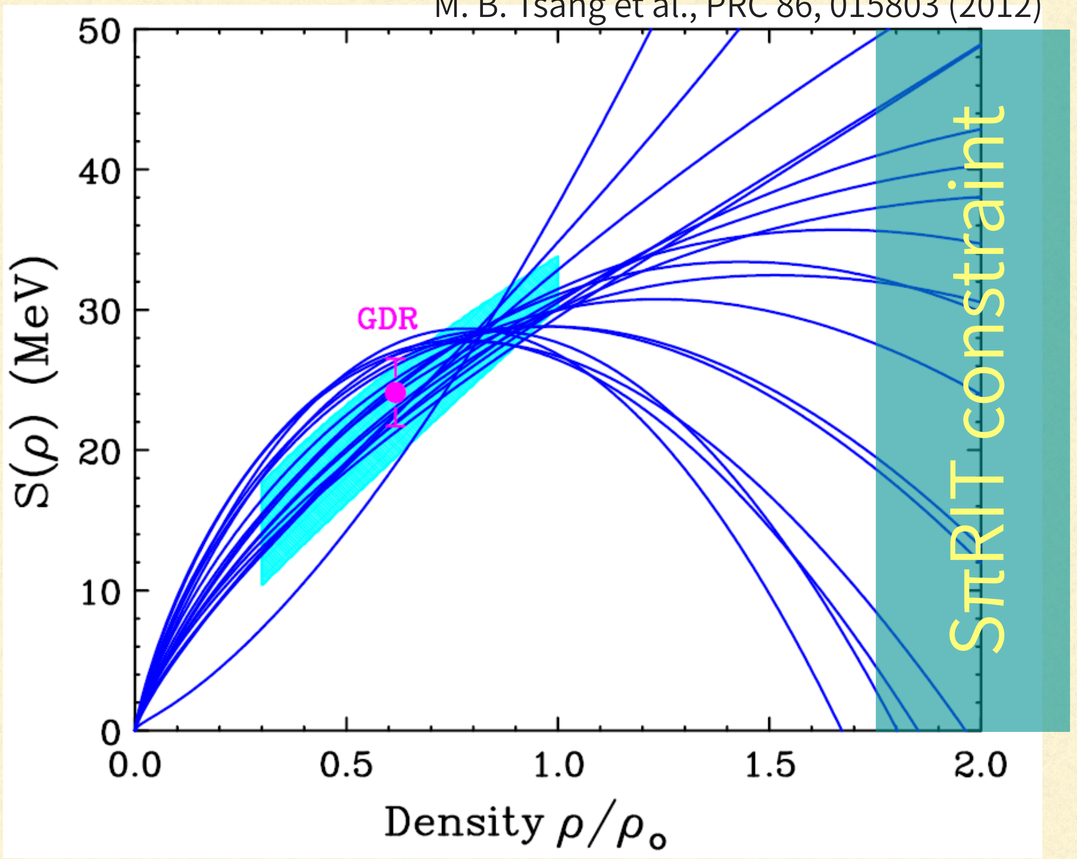
- Physics motivation and detector of the SpiRIT project
  - Nuclear symmetry energy from HIC.
  - Trigger system
- Comparison among several transport models, and experimental data
  - UrQMD, JQMD, AMD w/w.o cluster correlation are compared.
  - Models vs. data: multiplicity on the Kyoto-array
- Summary

Physics motivation

- Constrain the density dependence of the nuclear symmetry energy
  - An important factor to build the nuclear EOS.
  - In particular, high density region should be investigated.
  - Charged π meson from HIC is predicted as a good probe.
  - π^-/π^+: yield ratio or spectrum ratio.

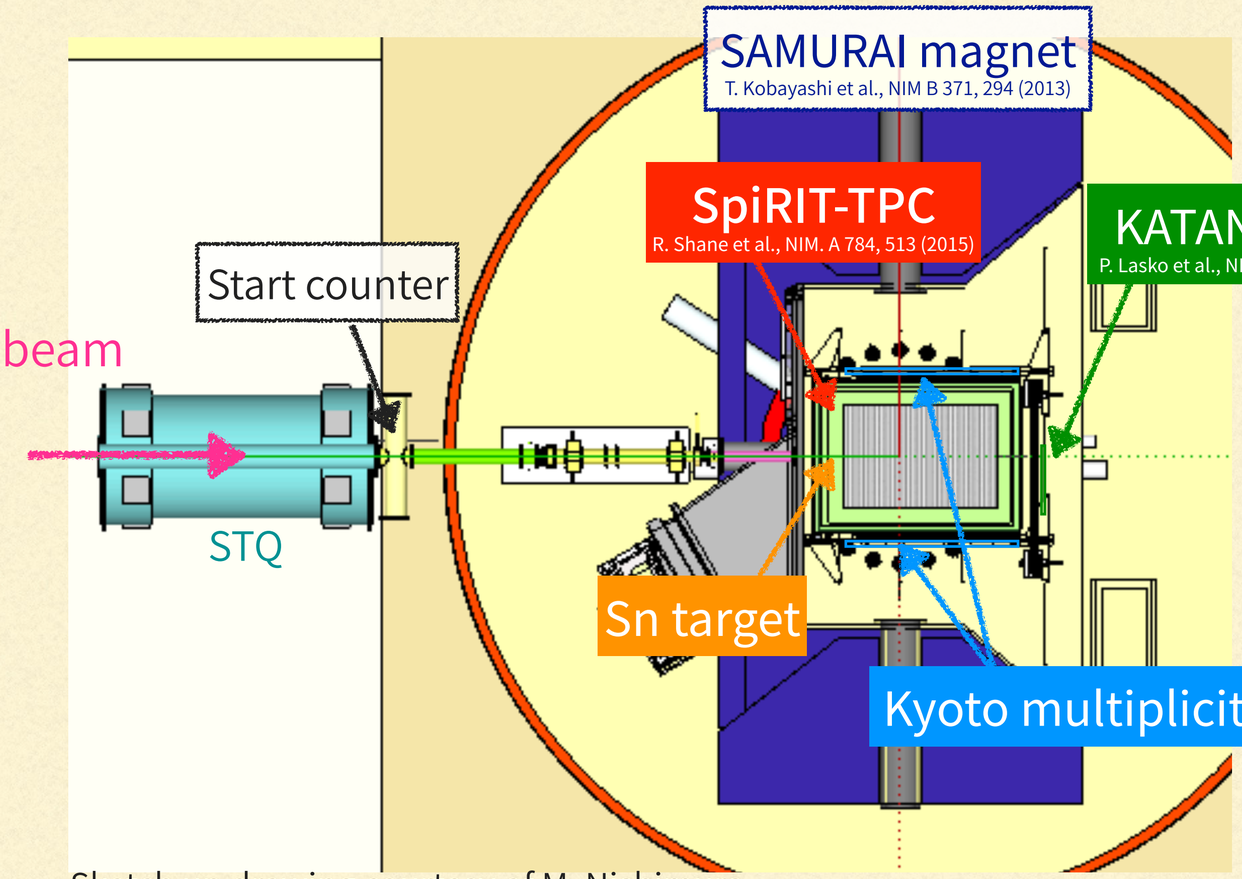
- Experiment @ RIKEN-RIBF
  - HIC in RIBF energy region realizes ~$2\rho_0$ of density.
  - $^{132}Sn^{124}Sn$, $^{108}Sn^{112}Sn$,
  - → systematic study, cancel the coulomb effect.
  - TPC & SAMURAI dipole 0.5 T, and NeuLAND
  - π^-/π^+, n/p, t/^{3}He, flow, … etc

M. B. Tsang et al., PRC 86, 015803 (2012)



Trigger system of SpiRIT-TPC

- π production cross-section is dependent on the centrality / impact parameter.
  - Central collision is good to produce pion, and also to extract the information of dense matter.
  - In basically, impact parameter correlates with the spectator Z or A, and anti-correlates with the multiplicity.

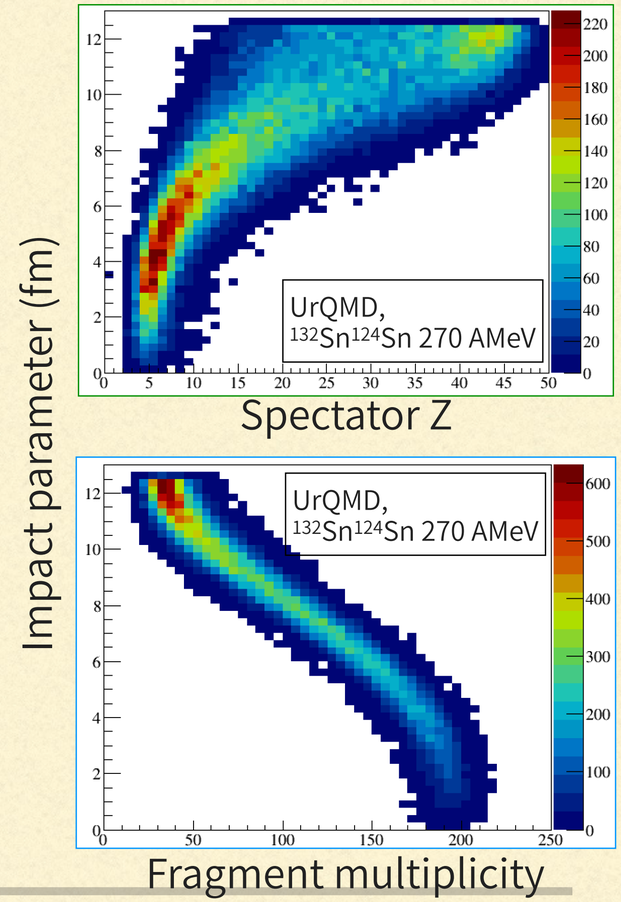


Sketch up drawing courtesy of M. Nishimura

detects spectator particle,
and vetoes high Z events.

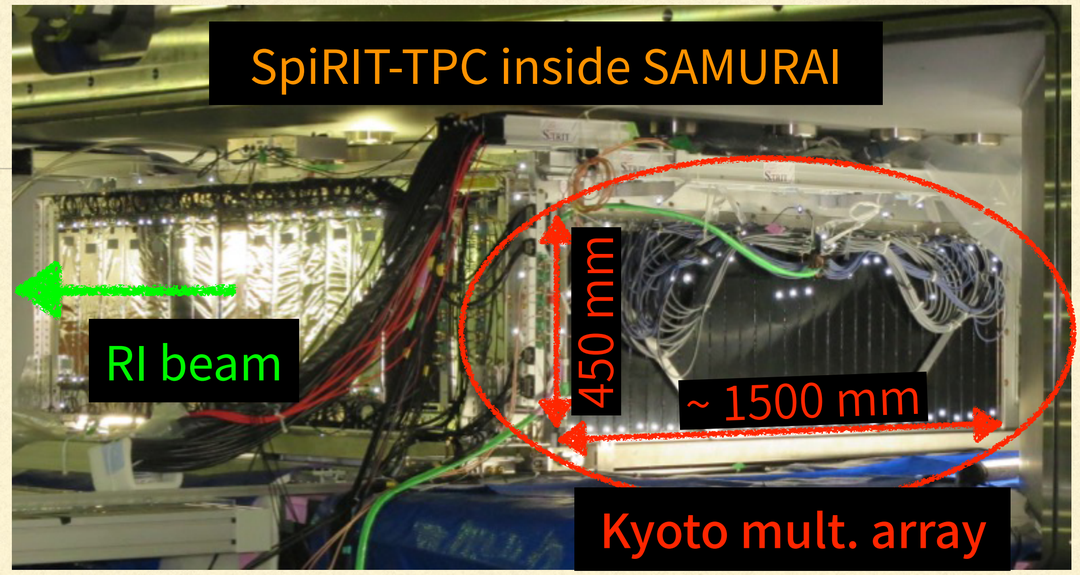
Contributed Krakow's group,
In details or analyses → Jerzy's talk.

detects multiplicity,
selects high mult. event.

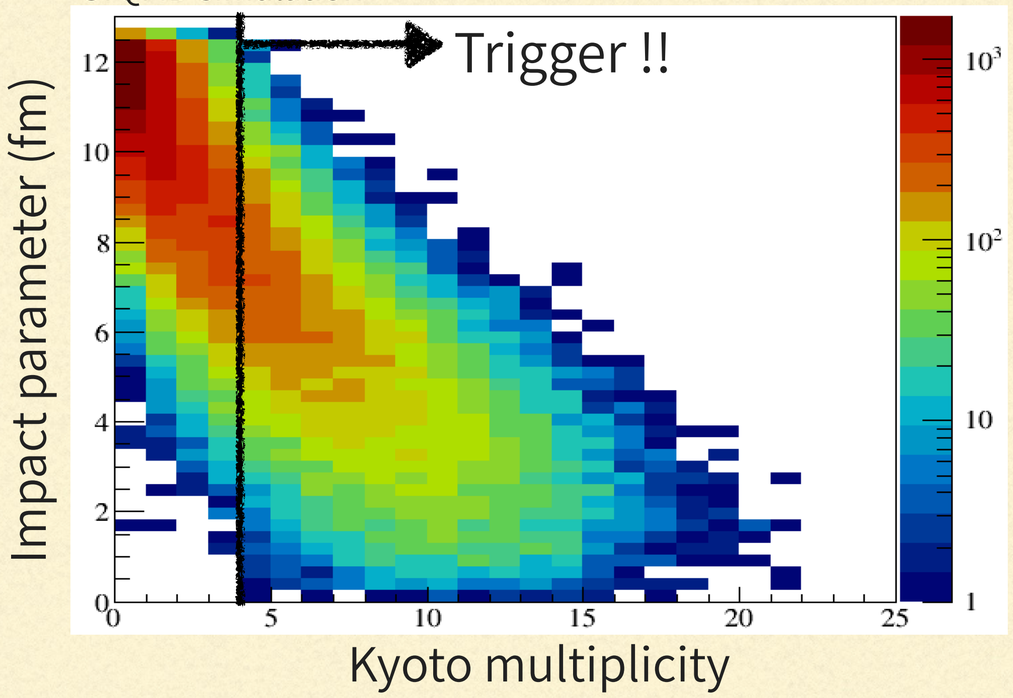


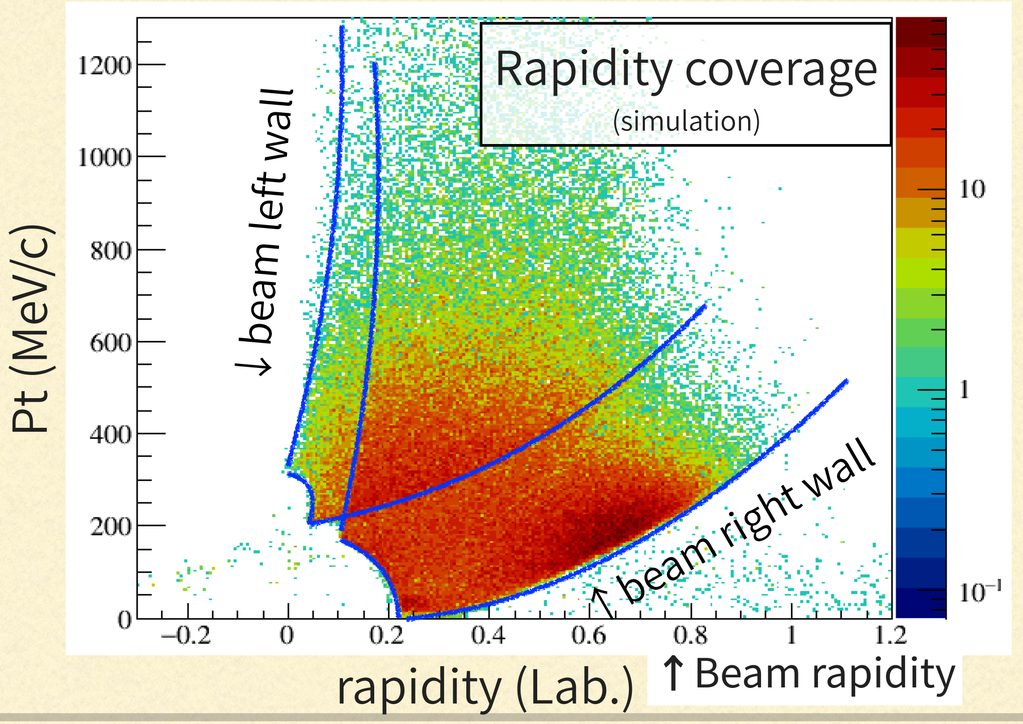
Kyoto multiplicity array

- That is sensitive to sideward multiplicity
  - 2 walls, left & right of the TPC, covers mid-rapidity region.
  - 30 pairs of plastic(450*50*10 mm^3) + WLS fiber + MPPC / wall.
  - ~ 96 % of detection eff. for light charged particles.
  - Generate the online-level trigger with Mult. ≧ 4.



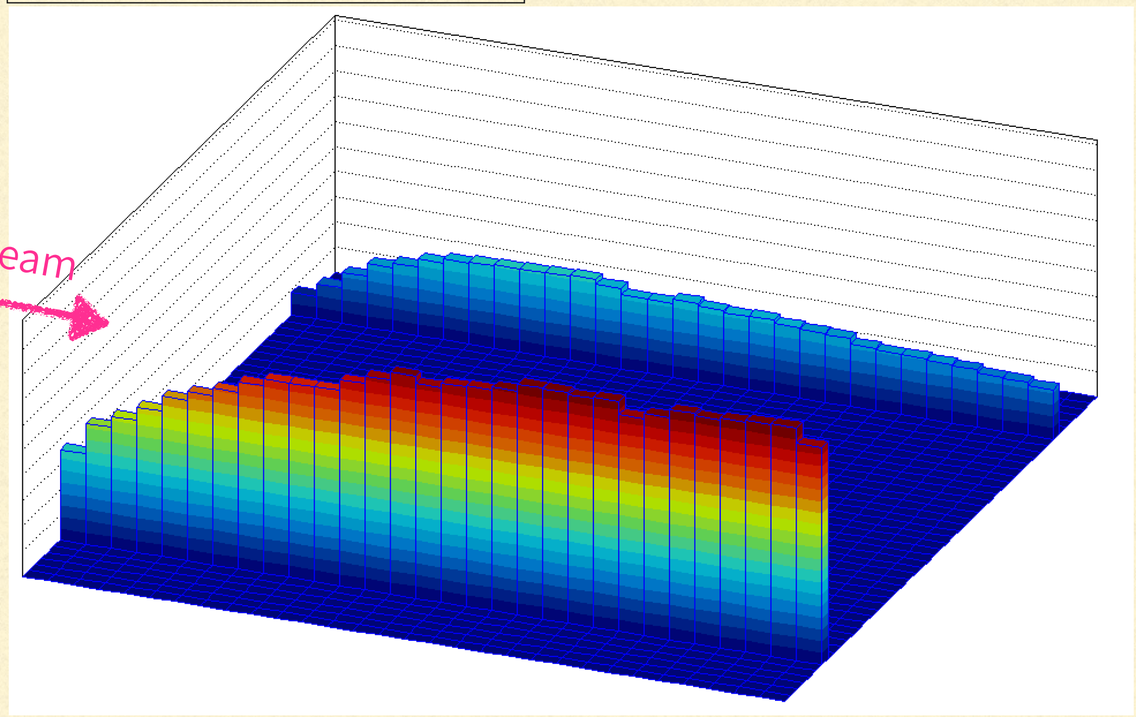
UrQMD simulation





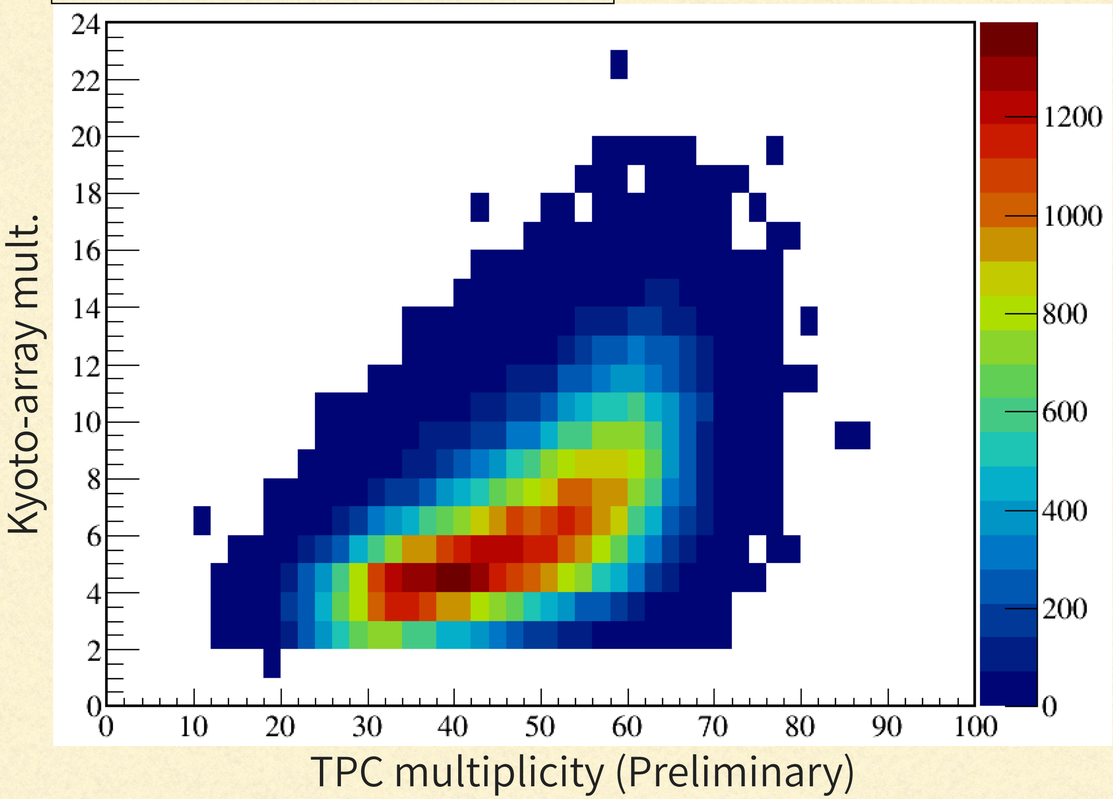
Preliminary analysis, simple correlations

Hit pattern distribution



- Charged particle curves due to the magnetic field.

TPC mult. vs. Kyoto mult.



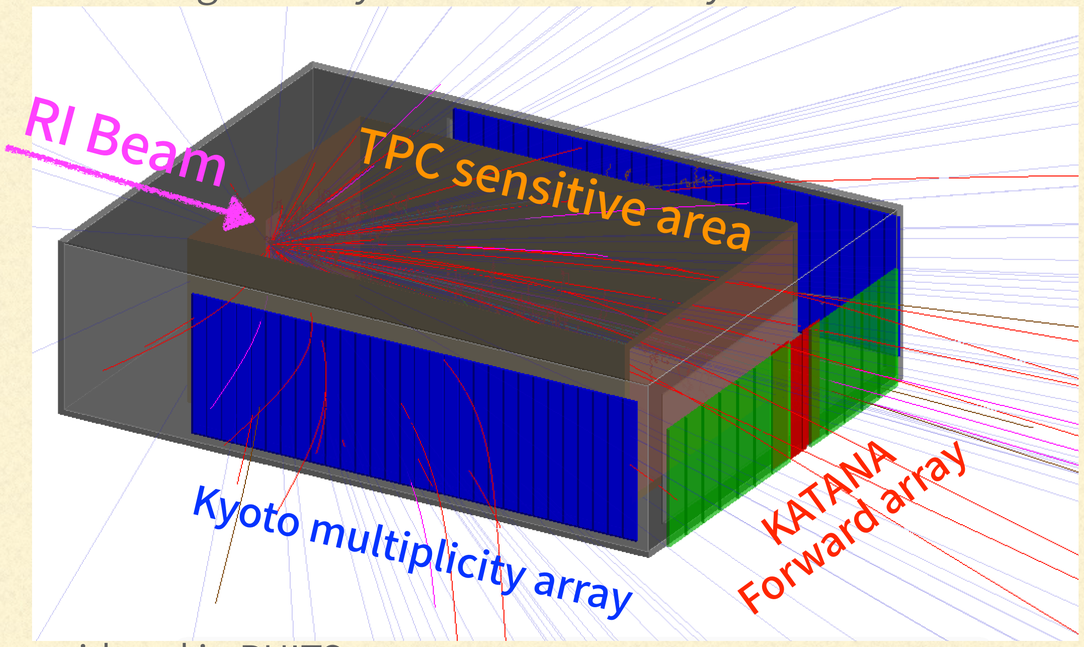
- TPC tracking efficiency is not yet well investigated. But well correlation can be seen.

Simulation ~comparison among models~

- Impact parameter was biased by the trigger.
  - Information on the experimental trigger bias is important to apply models toward the physics analysis.
  - Studied basic features of several transport calculations with GEANT4.

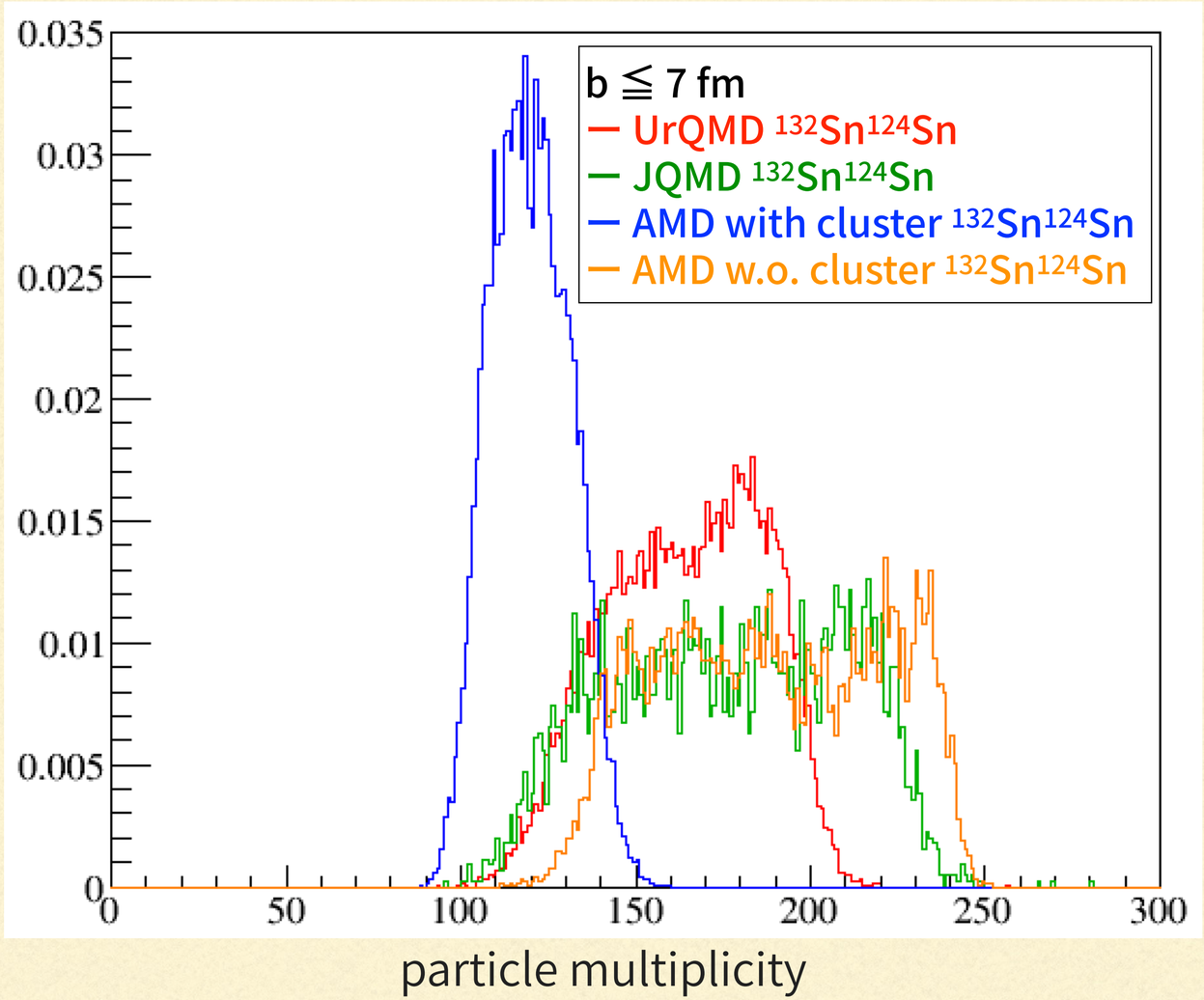
- UrQMD + clustering
  - 132Sn+124Sn, 270 AMeV, b=0-12.5 fm
  - Geometrical clustering by J. Lukasik.
- AMD with/w.o. cluster correlation
  - 132Sn+124Sn, 270 AMeV, b=0-7 fm
  - Developed by A. Ono, N. Ikeno.
- JQMD (PHITS)
  - 132Sn+124Sn, 281 AMeV, b=0-13 fm

geometry and tracks built by GEANT4



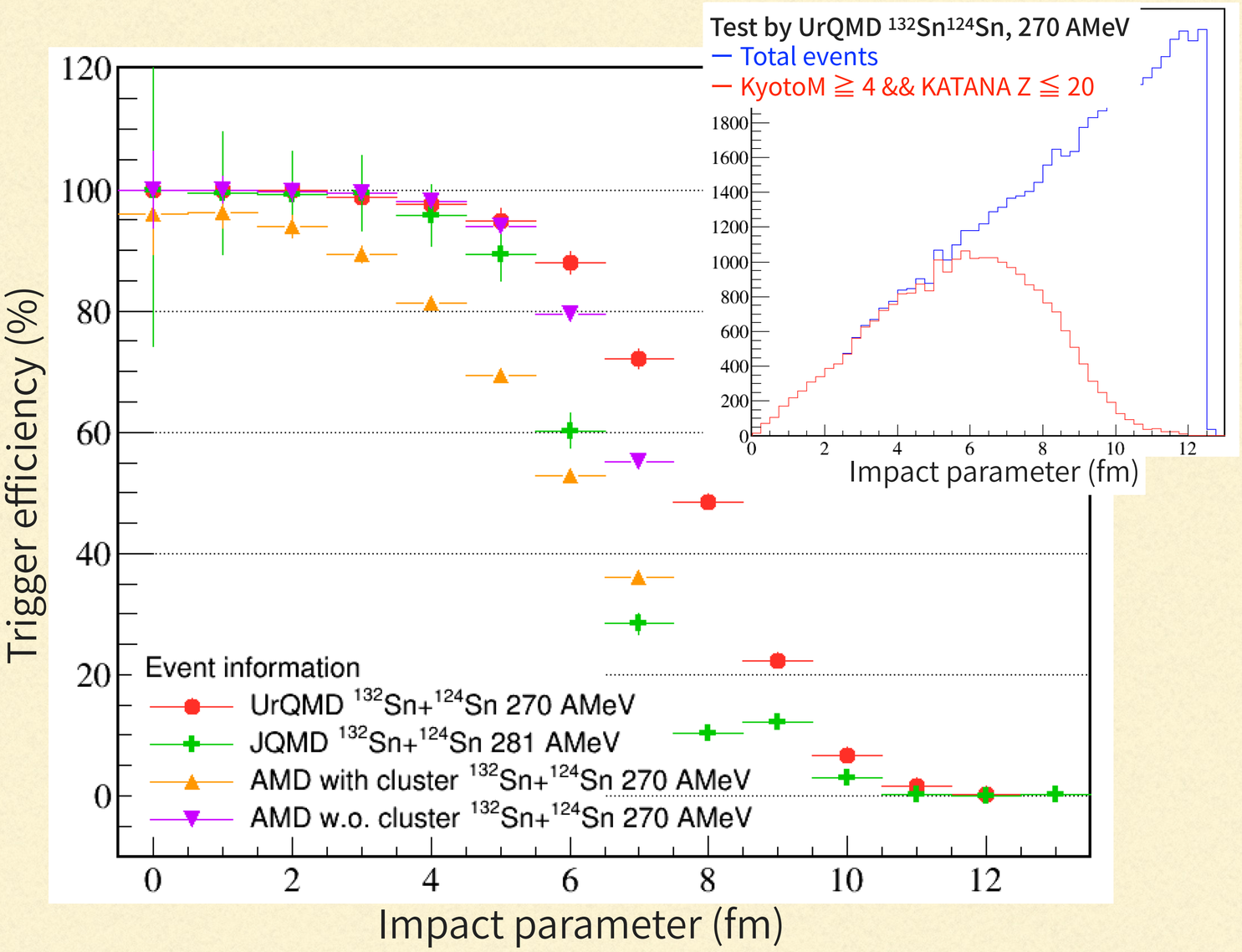
↑ Energy deposit of incident beam can be considered in PHITS.
This corresponds to 270 AMeV at center of the Sn target we used.

Fragment multiplicity distribution



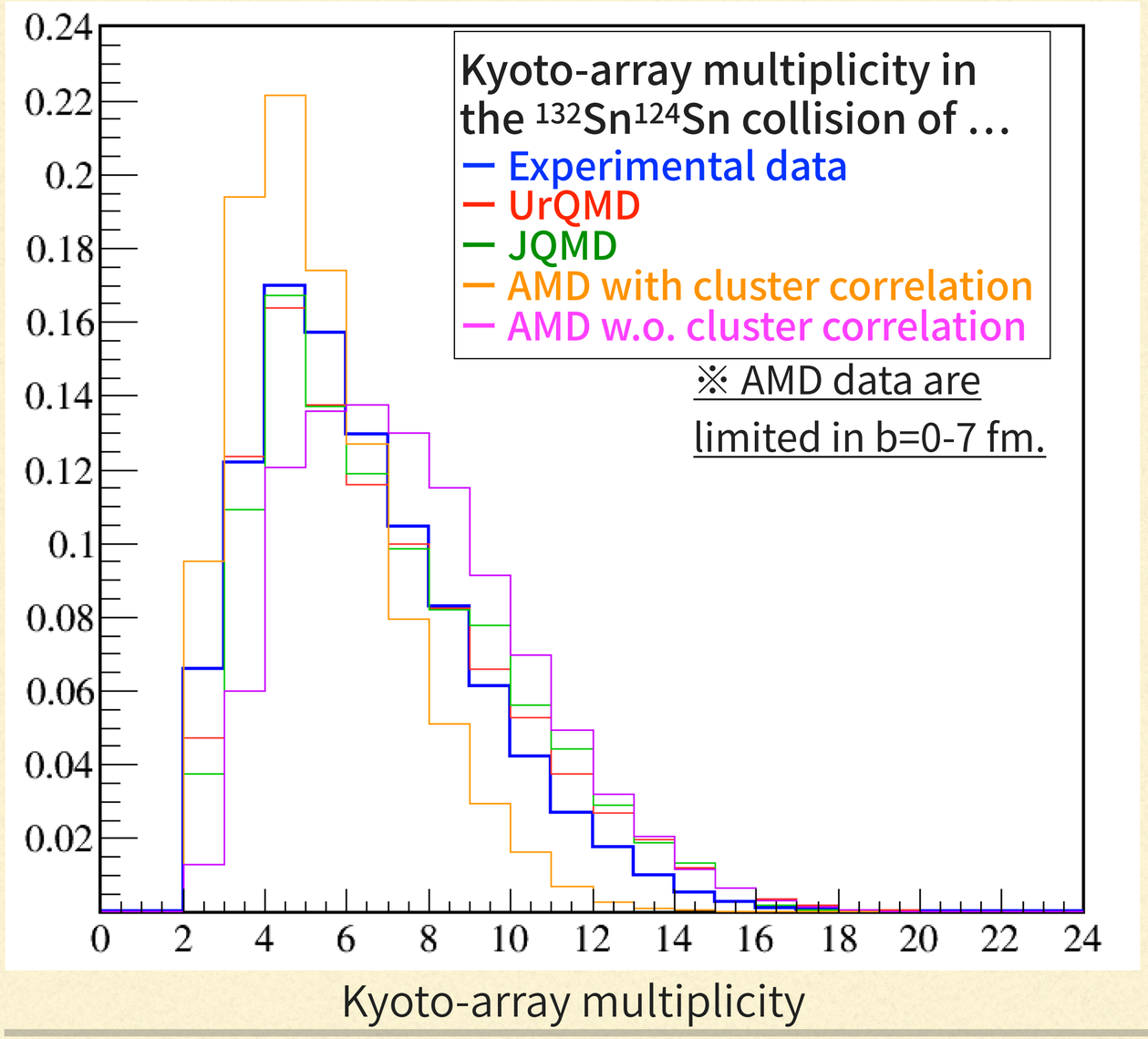
- All four models are normalized in impact parameter and the number of events.
  - This includes all of fragments emitted from a collision.
  - AMD with cluster correlation model has less multiplicity, and sharp distribution.
  - JQMD and AMD without cluster correlation have similar distribution form.
  - How much these differences affect ?

Trigger efficiency vs. impact parameter



- Trigger efficiency: how much events will be triggered by the SpiRIT trigger system?
  - ex) UrQMD case
  - Mean of b ~ 6 fm, width ~ 4 fm.
  - ~ 40 % of events will be triggered in total.
  - On mid-peripheral region, models look to have a discrepancy.
  - On the central collision, almost all of events can be triggered. On the other hand, there seems to be a model dependency how much peripheral events are included in our data.

Kyoto multiplicity: experiment vs. simulation



- Those models can reproduce experimental data well ?
  - Kyoto-array multiplicity is one of the simple reference to check the validity of models.
  - AMD with cluster correlation model has less multiplicity on Kyoto-array.
  - The other three models have similar trend, or are a little bit shifted to higher multiplicity than experimental data.
  - On UrQMD and JQMD, there are no large differences in Kyoto-array multiplicity as much as that seen in the trigger efficiency.→ another aspect will be needed.

Summary & future prospect

- We have performed 1st experiment at RIKEN-RIBF.
  - TPC and ancillary detectors worked without large problems.
  - Analysis is ongoing !
- Comparison with simulation using Kyoto multiplicity array
  - To understand experimental trigger bias, four kind of models, that are UrQMD, JQMD, AMD w/w.o. cluster correlation, were compared.
  - On the mid-peripheral region, models have a discrepancy on the trigger efficiency.
  - Sideward charged particle multiplicity looks not bad agreement to the experimental data.
  - Parameter tunings for cluster correlation in AMD seems to be necessary in terms of a multiplicity.
- In future,
  - Try to see integrated trigger efficiency from experiment. Background study is necessary.
  - Good knowledge to understand the cross-section and the impact parameter distribution of our experiment.
  - Also, different aspects are necessary to evaluate each models from the experimental data.

SπRIT collaboration

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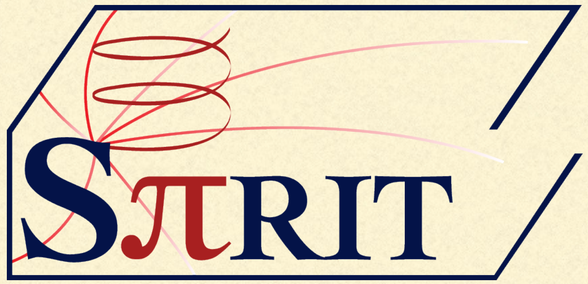

Thank you for your attention !!