RIBF ULIC Symposium/mini-WS Report

*** English only**

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Name of Applicant	Akira Ono		
Affiliation	Tohoku University	e-mail	ono@nucl.phys.tohoku.ac.jp
Tel	022-795-6458	Fax	

Title	[RIBF-ULIC- :] Experimental study of equation of state of asymmetric nuclear matter though heavy RI collisions at RIBF
Date	July 27th, 2018
Place	RIKEN Wako Campus, RIBF building, small conference room
Language	[ ] English [o] Japanese
HP address	https://indico2.riken.jp/event/2821/
Contact Person(s) (Name, Affiliation)	Tadaaki Isobe (RNC)

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Summary of discussions and its (expected) results:

Heavy ion collision (HIC) is a kind of unique way to study the density-dependent nuclear equation of state (EoS) in the laboratory. This workshop aims to make a constraint on the nuclear symmetry energy term of EoS. The HIC experiment by using Sn isotopes were carried out at RIBF in 2016 spring. As the charged pion ratio is suggested to be a main observable for studying the symmetry energy, it was figured out that we need to understand the collision dynamics in order to discuss the symmetry energy based on the pion result.

Followings are what we discussed in the workshop:

- Theoretical effort to make the constraint on nuclear symmetry energy through the gravitational wave measurement from neutron star merger is also made after GW170817 discovery. Heavy ion collision is another way to make the constant. Though study with heavy ion collision is expected to make stronger constraint currently, large number of GW events would make stronger constraint eventually.
- Ikeno et al. pointed out that pion result depends on the clustering effect of heavy ion collision dynamics. We need to be able to reproduce the clustering effect in transport code for making the constraint on symmetry energy based in pion result. Proton, deuteron and triton rapidity distribution is expected to be measured and shown by SPiRIT experiment in the near future.
- Measurement of directed and elliptic flow is another way to discuss the nuclear EoS. Recently Cozma et al. published the paper discussing how much symmetry energy is sensitive to flow observables. According to Cozma et al., elliptic flow is sensitive to Ksym for the beam energy of around E/A=270MeV, which corresponds to RIBF energy.
- The current status of the transport code comparison for pion production was reported and discussed. The box simulations reveal some uncertainties in the transport code results due to

the different treatments of processes to produce Delta and pions, while much larger uncertainties in pion production seems to originate from the dynamics of nucleons in heavy-ion collisions. It is therefore important to study simultaneously pion observables and other collective observables such as stopping and flow.

- As the clustering effect of nucleons and the measurement of directed/elliptic flow are expected to be useful to validate transport codes in describing collision dynamics. We concluded it is better to polish up current transport code based on those observables. In particular, we discussed the comparison with the AMD simulation on the elliptic flow. It may be important to study the dependence of the elliptic flow on the transverse momentum, for which we decided to continue the AMD calculation to increase the statistics.
- We made the homework of: 1. Obtain the Z=1 particle spectra experimentally for benchmarking the clustering effect in transport code. 2. Check if it is feasible to extract the information of symmetry energy through the measurement of directed/elliptic flow by using AMD model calculation.

Participants list(Name, Affiliation):

- Natsumi Ikeno (Tottori University)
- Mizuki Nishimura (RIKEN)
- Masanori Kaneko (Kyoto University)
- Tetsuya Murakami (Kyoto University)
- Tadaaki Isobe (RIKEN)
- Akira Ono (Tohoku University)

Please attach other documents as needed.