Current Status of $S\pi$RIT-TPC

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for the $S\pi$RIT-TPC collaborators
The purpose of this project is to constrain the symmetry-energy term in the nuclear Equation of State (EoS).

- Measurements of the density dependence of the nuclear symmetry energy at supra-saturation densities on $\rho \sim 2\rho_0$.
- The momentum distributions of pions and light particles with $Z \leq 3$ emitted in central collisions of neutron rich nuclei.
- Systematic study by changing combination of beams and target

<table>
<thead>
<tr>
<th>Prim. Beam</th>
<th>2nd Beam + Target</th>
<th>Energy [MeV/A]</th>
<th>Isospin asymmetry</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{123}_{\text{Xe}}$</td>
<td>$^{108}<em>{\text{Sn}} + ^{112}</em>{\text{Sn}}$</td>
<td>300</td>
<td>0.09</td>
</tr>
<tr>
<td>$^{123}_{\text{Xe}}$</td>
<td>$^{112}<em>{\text{Sn}} + ^{124}</em>{\text{Sn}}$</td>
<td>300</td>
<td>0.15</td>
</tr>
<tr>
<td>$^{238}_{\text{U}}$</td>
<td>$^{132}<em>{\text{Sn}} + ^{124}</em>{\text{Sn}}$</td>
<td>300</td>
<td>0.22</td>
</tr>
<tr>
<td>$^{238}_{\text{U}}$</td>
<td>$^{124}<em>{\text{Sn}} + ^{112}</em>{\text{Sn}}$</td>
<td>300</td>
<td>0.15</td>
</tr>
</tbody>
</table>
Experimental View in 2015
SπRIT-TPC structure

2.06m long x 1.50m wide x 0.74m

<table>
<thead>
<tr>
<th>Pad Plane Area</th>
<th>1.3 m x 0.9 m</th>
<th>Gas Gain</th>
<th>2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Pads</td>
<td>12096 (112x108)</td>
<td>E-field</td>
<td>135 V/cm</td>
</tr>
<tr>
<td>Pad size</td>
<td>12 mm x 8 mm</td>
<td>Drift velocity</td>
<td>5.5 cm/μs</td>
</tr>
<tr>
<td>Drift Distance</td>
<td>50 cm</td>
<td>dE/dx range</td>
<td>Z=1-8, π, p, d, t, He, Li-O</td>
</tr>
<tr>
<td>Pressure</td>
<td>1 atmosphere</td>
<td>Two-track res.</td>
<td>2.5 cm</td>
</tr>
<tr>
<td>Gas composition</td>
<td>90% Ar + 10% CH₄</td>
<td>Multiplicity limit</td>
<td>200</td>
</tr>
</tbody>
</table>
Contents

- Biggest concern:
  - Installation test
  - Read out electronics (Presented by Dr. Isobe)
    - Cosmic ray data
  - Space charge effect (Gating Grid Driver by Mr. Suwat)

- Trigger Arrays
  - Active collimator: (Tsinghua Univ., China)
  - Krakow veto and Trigger wall: (IFJ-PAN, Poland)
  - Multiplicity trigger array: (Kyoto Univ., Japan)

- Accessories
  - Laser Calibration system: (RIKEN)
  - Cooling system: (RIKEN)
Installation Test done last Summer

Trusty crane operator

Push with jacks

Checking clearance outside
Success!
Cosmic Ray

24 AsAds was mounted on TPC.
No missing pads was found on 6046 pads.

A half of helical track was observed in 0.5 Tesla.

Cosmic ray was detected.
Space Charge Effect

Gating Grid Driver is discussed by Mr. Suwat later.

Intensity dependence was measured in HIMAC on Nov. 2014. G.G.D. prevent gain dropping due to space charge.
How to Trigger

Simulated tracks of central collision for $^{132}\text{Sn} + ^{124}\text{Sn}$ with 300MeV/u, generated by UrQMD and traced with GEANT4
Active Collimator

- Detection efficiency of 100% is achieved.
- Position dependence of light output is small.
- It should be ready by middle of June.

Four Plastic scintillators read by MPPC(3x3mm)
Krakow Veto Array and Trigger wall

**MPPC:** HAMAMATSU, $1 \times 1$ mm$^2$, 10000 pixels

**WLS:** BCF92

**PA:** current preamplifier, $\tau < 2$ ns (P. Lasko)
Prototype discriminator

1 mm thick BC404 wrapped with ESR foil

10 channel fast discriminator with FPGA
Beam Test in HIMAC, Nov. 2014

Constructing mounting frame
It should be ready by 15 June 2015
Multiplicity Trigger Array

Extruded scintillator

Wave length shifter is inserted along hole and light output is read by MPPC

Active Collimator & target

Field Cage

Krakow Veto and trigger wall

Multiplicity Trigger Array

450mm

MPPC
1.3x1.3m
Beam Test in HIMAC

- Efficiency of 98% was achieved in HIMAC.
- More than 50 photo-electrons were detected for whole position.
- Reduction of light correction from the far side is 16%.

- Designing mount structure
- It should be ready by middle of June.
Readout by EASIROC
(Extended Analogue Silicon-pm Integrated Read Out Chip)

Originally, it was developed by Omega group LAL, France.
VME module is developed at Tohoku Univ.

Logic out signal is delayed 52 ns.

The trigger logic combining trigger arrays will be tested soon.
Calibration System with $\text{N}_2$ Laser

Wave length: 337nm
Power: 180 uJ/pulse

Anode wire signal was observed
The power density at the focusing point was \(~135 \mu J/mm^2\).
Laser Light deliver

Keeping the power density, laser light have to be divided into a several lines.
Two possibilities; using fiber bundle or optics
Air Cooling System

• Air flow around the surface of AsAd
Summary

- It is confirmed $S\pi$RIT-TPC is working properly.
  - Waiting for all AsAds mounted.
  - Gating Grid Driver is necessary.

- Trigger Arrays gave promising results.
  - Trigger logic out can be provided in 100 ns.
  - They will be ready on June.
  - Logic diagram is needed to be tested.

- Laser calibration system and cooling system are under developing.

- We are preparing to be ready by this September.