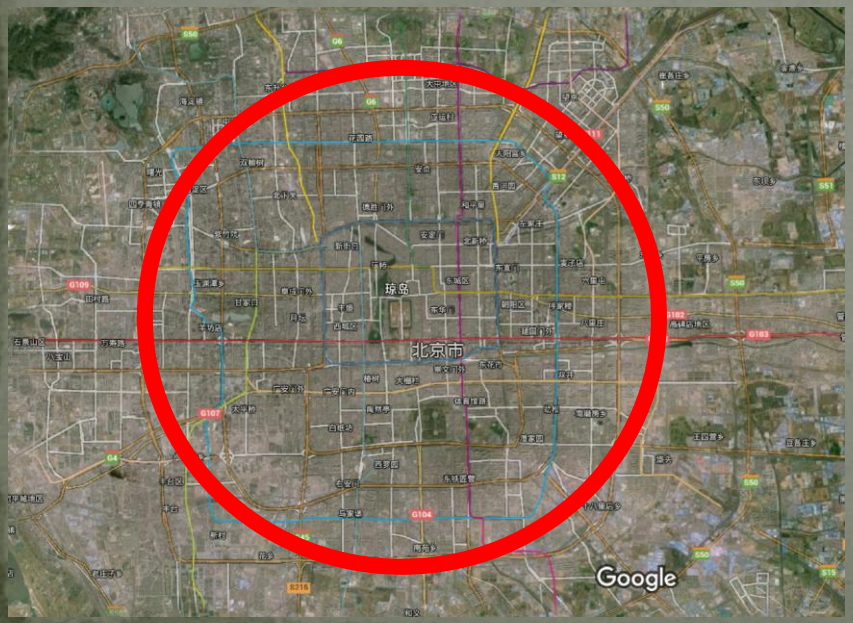
The Status of the RIKEN SπRIT experiment



Tetsuya MURAKAMI
Department of Physics
Kyoto University

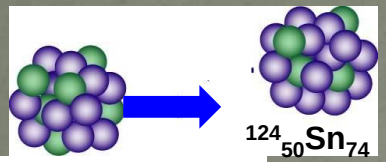
For the SπRIT Collaboration

SπRIT Collaboration

SAMURAI Pion Reconstruction and Ion-Tracker

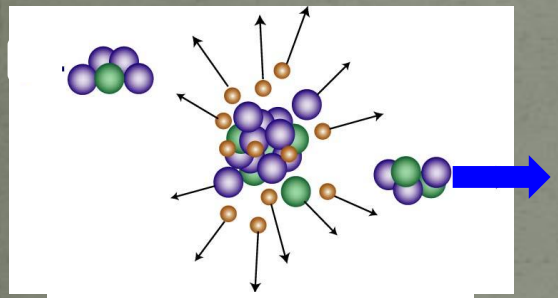
U.S. DEPARTMENT OF ENERGY
Office of Science

Heavy ion collisions



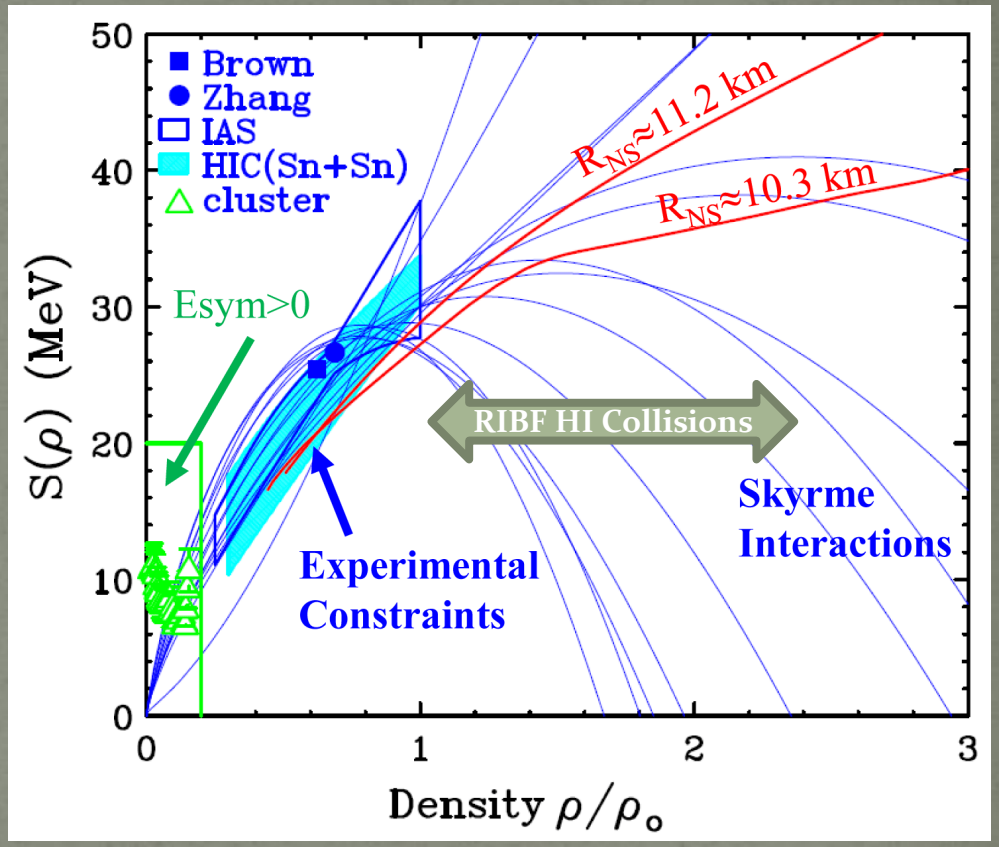
$^{132}_{50}Sn_{82}$ (n-rich)
@200~300 MeV

$\rho/\rho_0 \sim (\gamma+1)$ 2.3 @ 300 MeV/nucleon



High-density
(participant region)

Light particle production



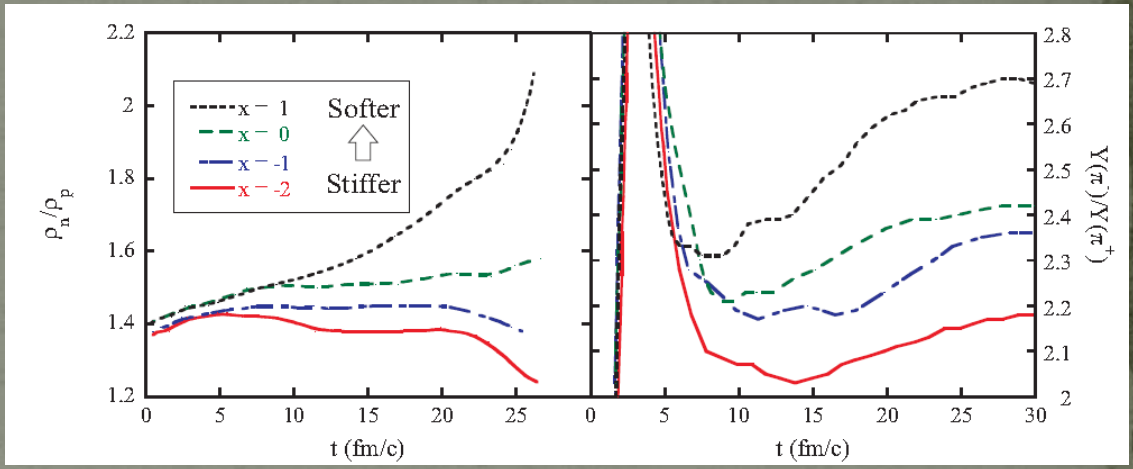
Tsang et al. Phys. Rev. C 86, 015803 (2012)

Naïve Approach

The symmetry pressure expels neutrons from and attracts protons to high density region of neutron-rich system.

Prediction of transport theory

Suppress Y(n)/Y(p), $Y(\pi^-)/Y(\pi^+)$, etc.



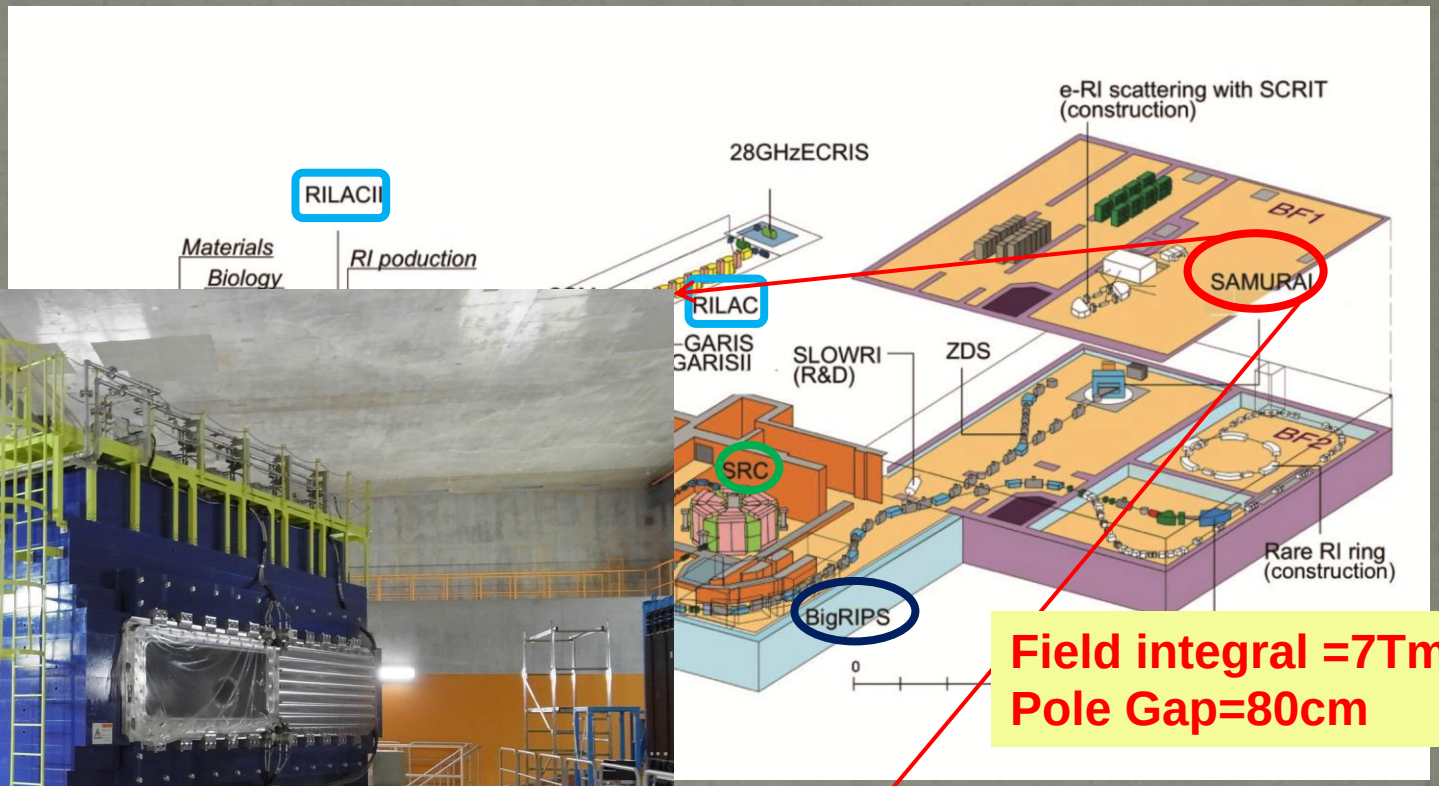
Bao-An Li et al., Phys. Rev. C 71, 014608 (2005)

One of good probes

π^-–π^+ production ratio from HI collisions in wide range of δ

RIBF: Radio-Isotope Beam Factory

Accelerator complex of two linacs and five cyclotrons



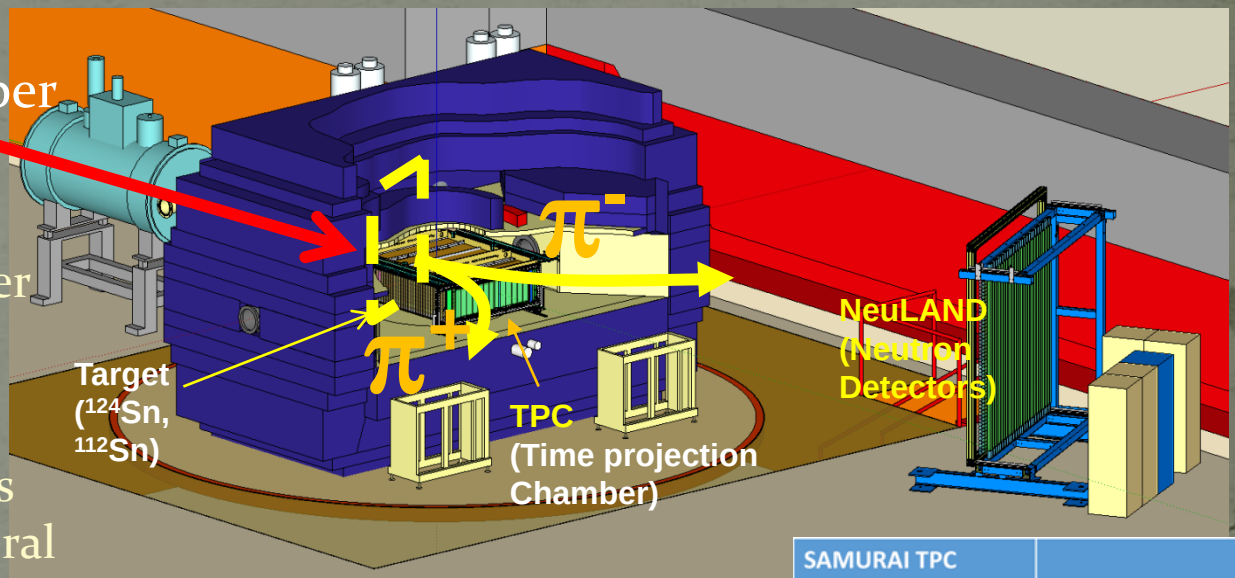
Field integral =7Tm
Pole Gap=80cm

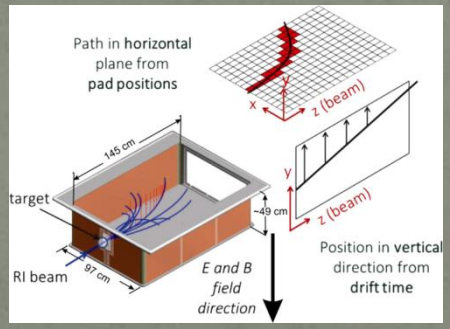
eV/u (Light Ions up to 440MeV/u)
Separator (80mradx100mrad,

Our choice of experimental setup

Equipment

- TPC
  - –Time Projection Chamber
    - π^+ , π^- , p, d, t, ^{3}He, ^{4}He, IMF's
    - The SAMURAI chamber is at air
- Trigger scint. array:
  - selects central collisions and suppresses peripheral collisions.
- NeuLAND:
  - provides neutron information





R. Shane et al.
Nucl. Instr. Meth. A 784 (2015) 513-517

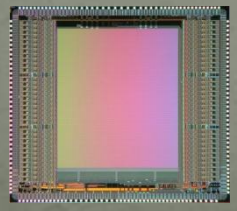
SAMURAI TPC Parameters	Values
Pad plane area	1.34m x 086 m
Number of pads	12096 (108 x 112)
Pad size	12 mm x 8 mm
Drift distance	53 cm
Pressure	1 atmosphere
dE/dx range	Z=1-3 (STAR EI.), 1-8 (GET EI.)
Two track resolution	2.5 cm
Multiplicity limit	200 (may impact absolute pion eff. in large systems)

Readout system of SPiRIT-TPC

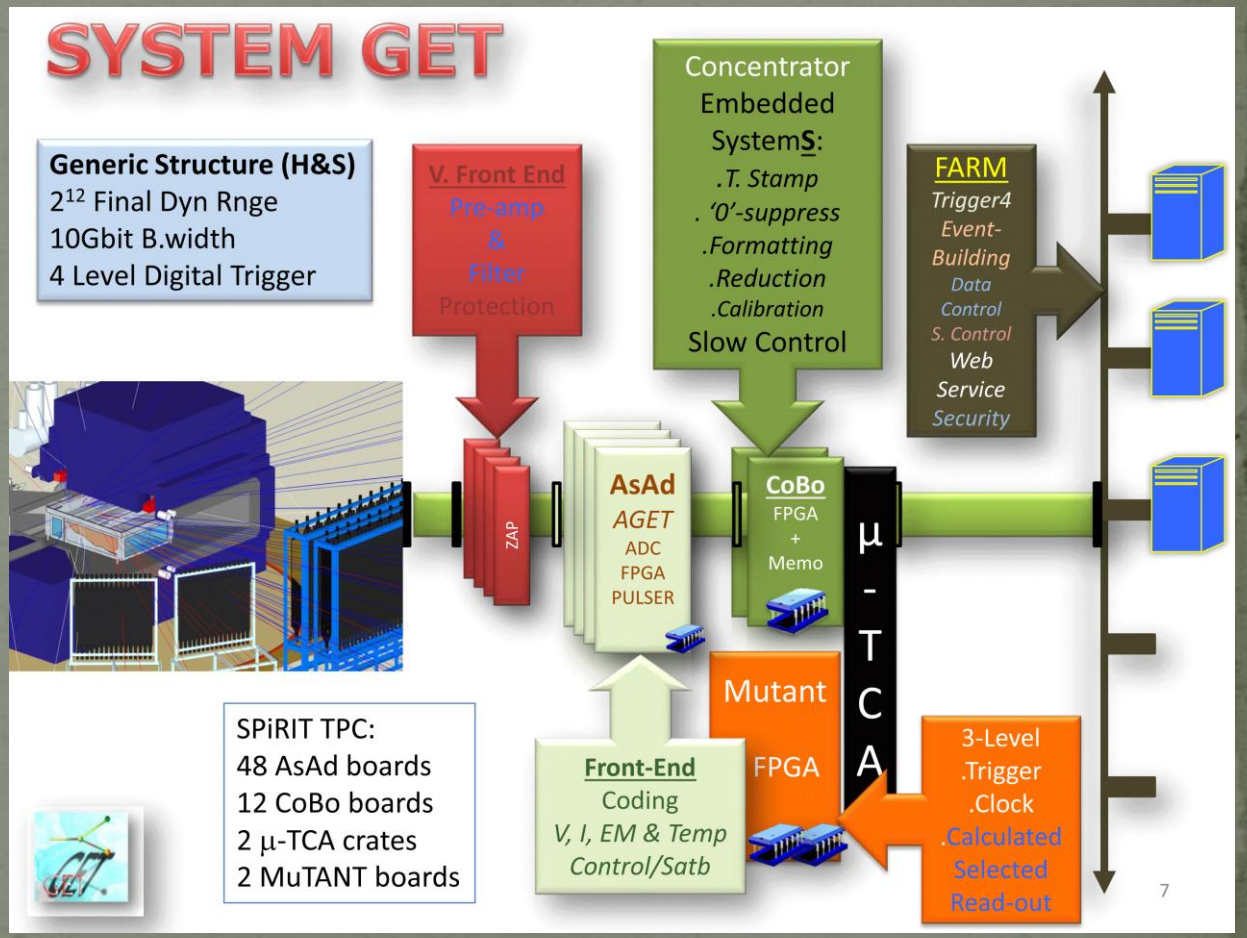
E. Pollacco, et al., Procedia 37 (2012) 1799-1804

Requirements:
high DAQ rate (~1kHz)
Good ADC resolution (>10bit).
Z=1 particle measurement in the chamber where Z>50 beam passing through.

Apply newly developed GET system:
General Electronics for TPC



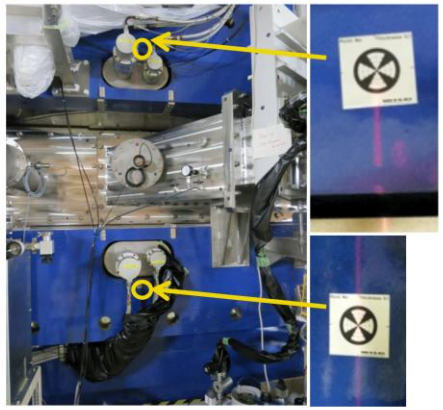
AMS CMOS 0,35 µm



SAMURAI Magnet Rotation on 0 deg

Done on 9 July 2015

M. Nishimura, T. Isobe, J. Estee, and T. Murakami
for SAMURAI Collaboration



Passage to the Experiment

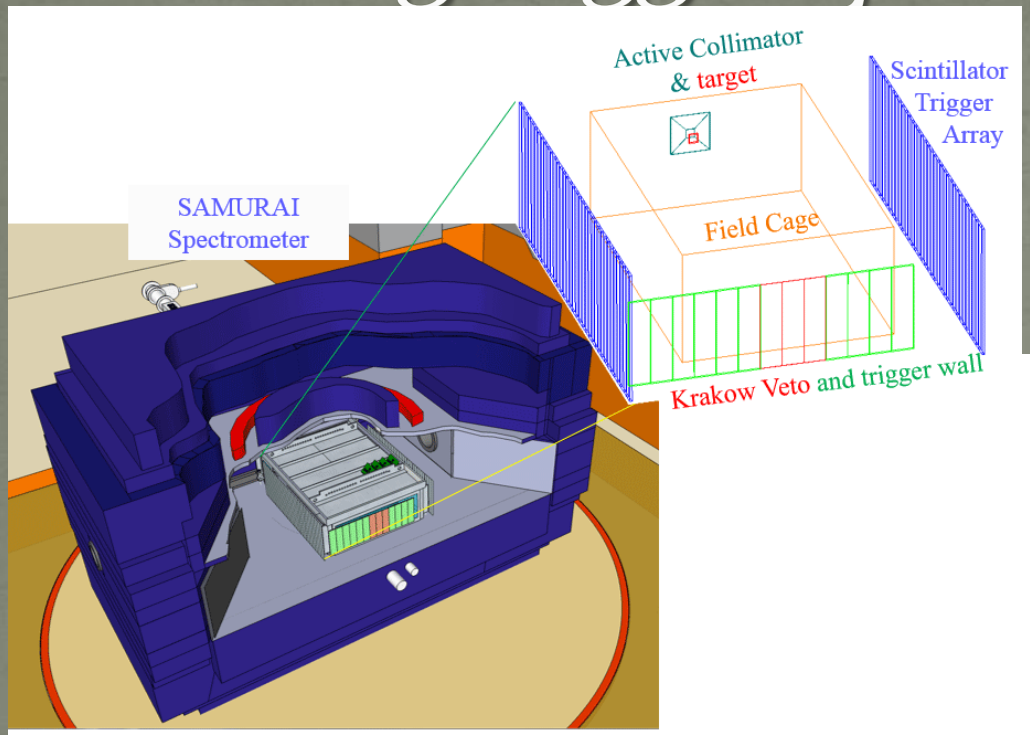
Roadmap of TPC after NuSYM15

- July 2015: Rotate SAMURAI magnet first time.
- Re-install all AsAd boards after repairing the gain problem.
- Oct. 2015: Commission of TPC outside SAMURAI magnet.
- Nov. 2015 – Mar, 2016: Data analysis, calibration and improvement and development of online/offline software.
- Jan – Mar, 2016: Insert and test TPC as well as all auxiliary detectors inside SAMURAI magnet. Move NeuLAND to 30 deg. Set up experiment SAMURAI22 and 15.
- Apr., 2016: Commission of TPC inside SAMURAI magnet

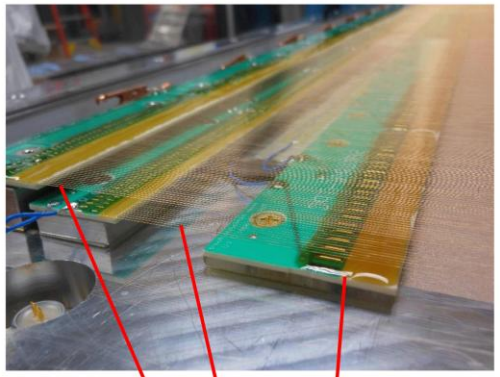
Primary	Beam	Target	E_{beam}/A	δ_{sys}	Goal	Date
^{124}Xe	^{108}Sn	^{112}Sn	300	0.09	Probe minimum δ	4/30-5/4
	^{112}Sn	^{124}Sn	300	0.15	Probe intermed. δ	5/4-5/6
^{238}U	^{132}Sn	^{124}Sn	300	0.22	Probe maximum δ	5/25-5/29
	^{124}Sn	^{112}Sn	300	0.15	Probe intermed. δ	5/30-6/1

Summer 2015 re-installing AsAd boards

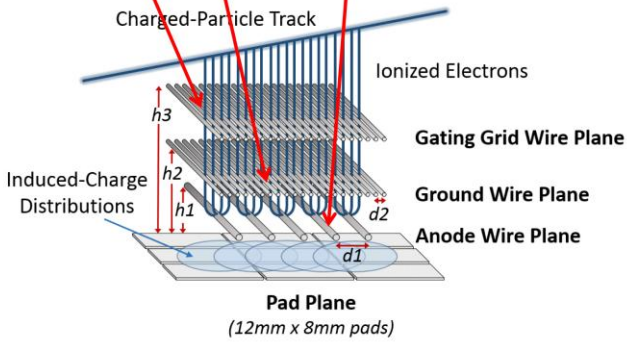
Finalizing trigger system



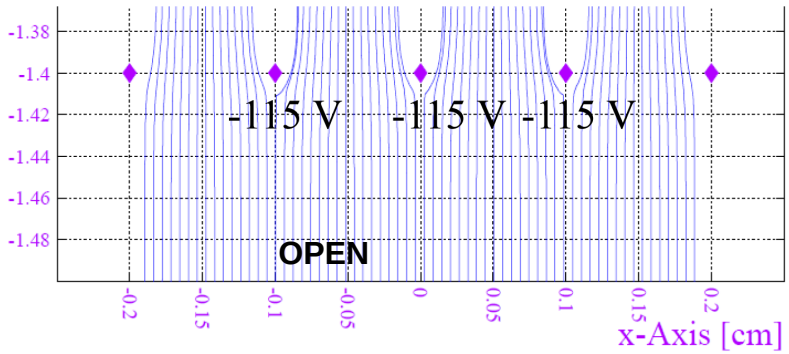
Wire planes



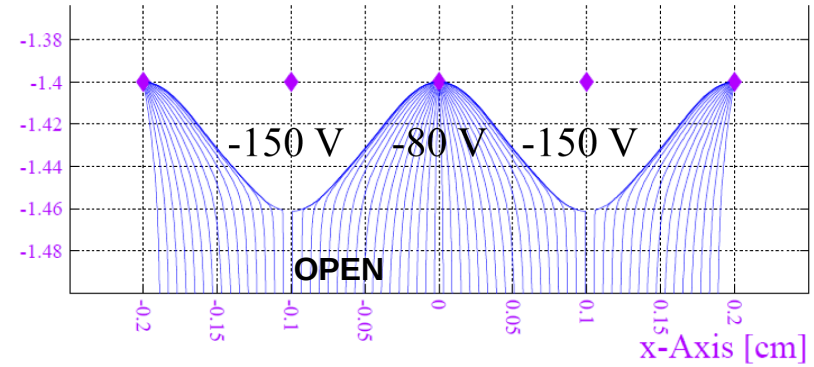
Plane	height (mm)	pitch (mm)	diameter(μm)
Anode	4.05	4	20
Ground	8.1	1	75
Gating grid	14	1	75



Gating grid and its driver

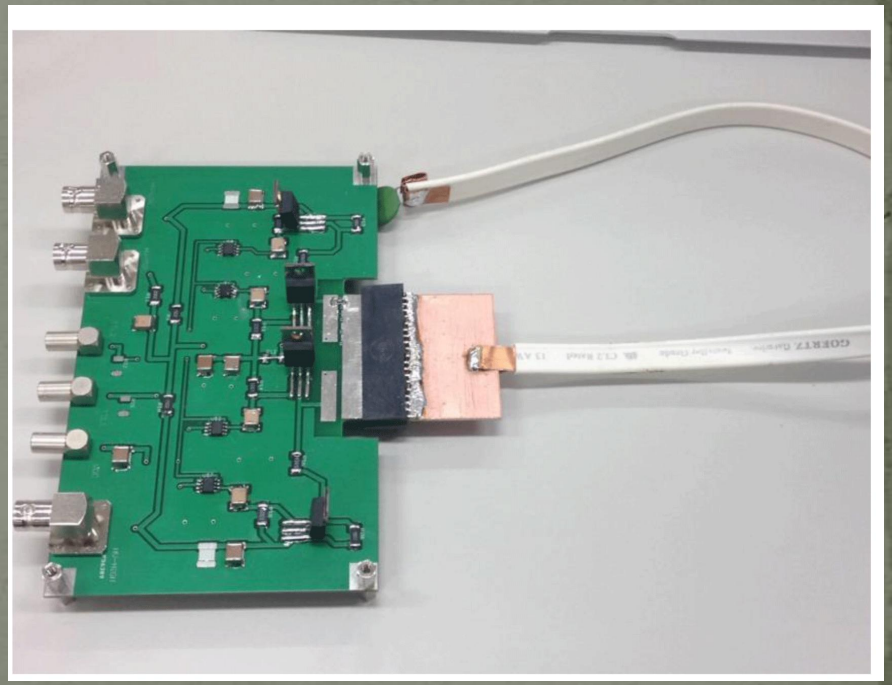


Garfield simulation of open gating grid - electrons pass through freely

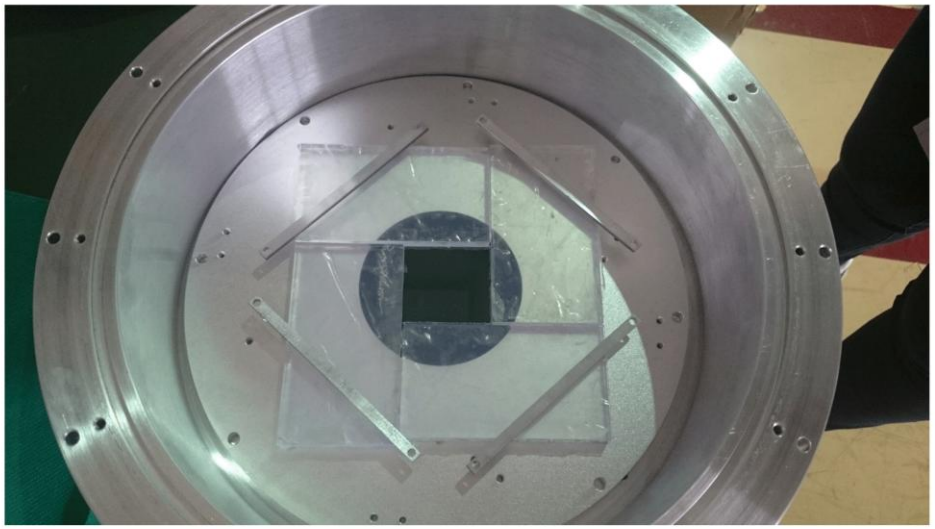


Garfield simulation of closed gating grid – electrons trapped by the wires

Conceptual drawing (voltages are not final values)

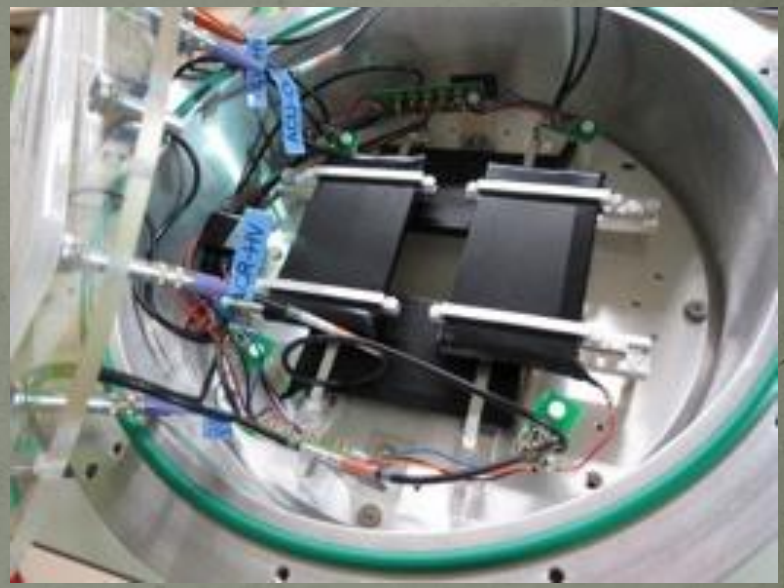


Active Collimator(Tsinghua Univ.)

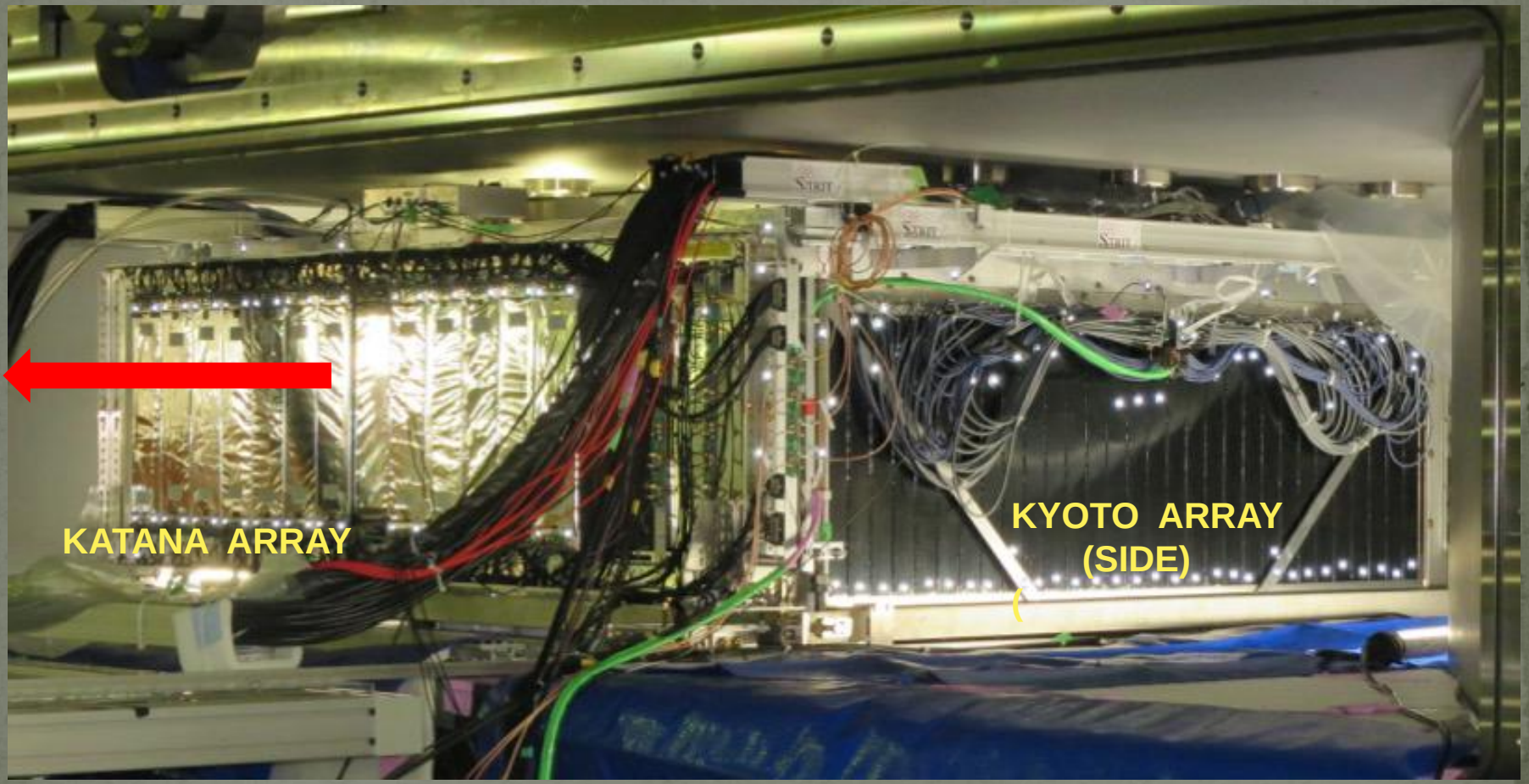


Plastic:BC-408	Size	Wavelength of Max. Emission
	90mm*50mm*6mm	425nm

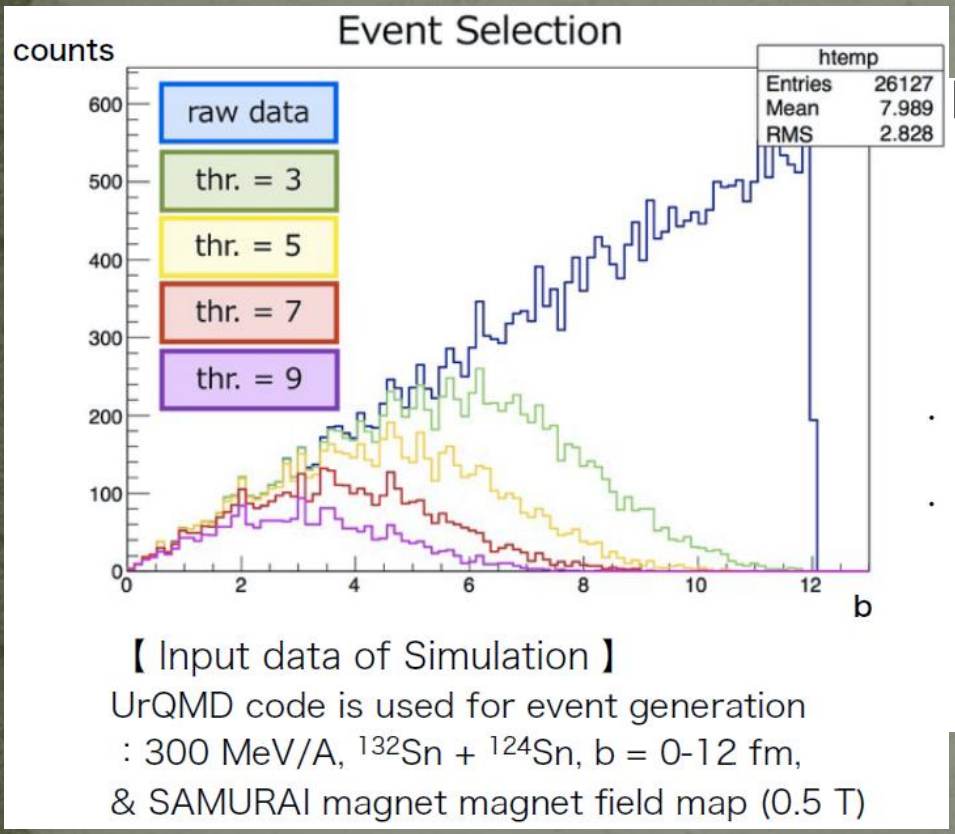
MPPC:S10931-100P	Size	Peak sensitive wavelength
	3mm*3mm	440nm



Side array & Front array



Centrality selection

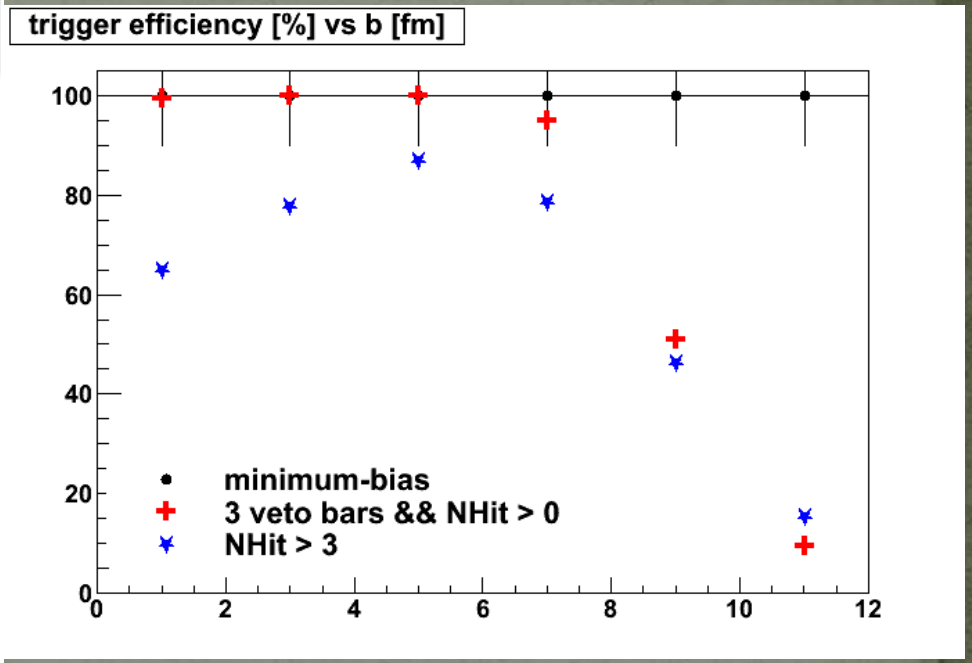


【 Input data of Simulation 】

UrQMD code is used for event generation

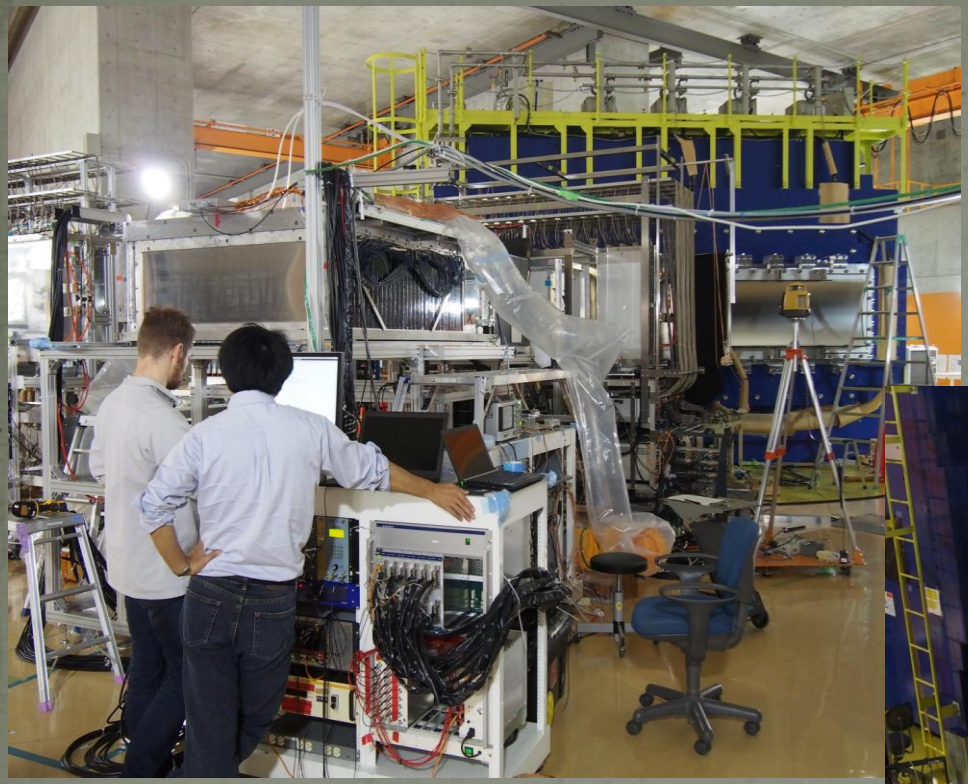
: 300 MeV/A, ^{132}Sn + ^{124}Sn, b = 0-12 fm,

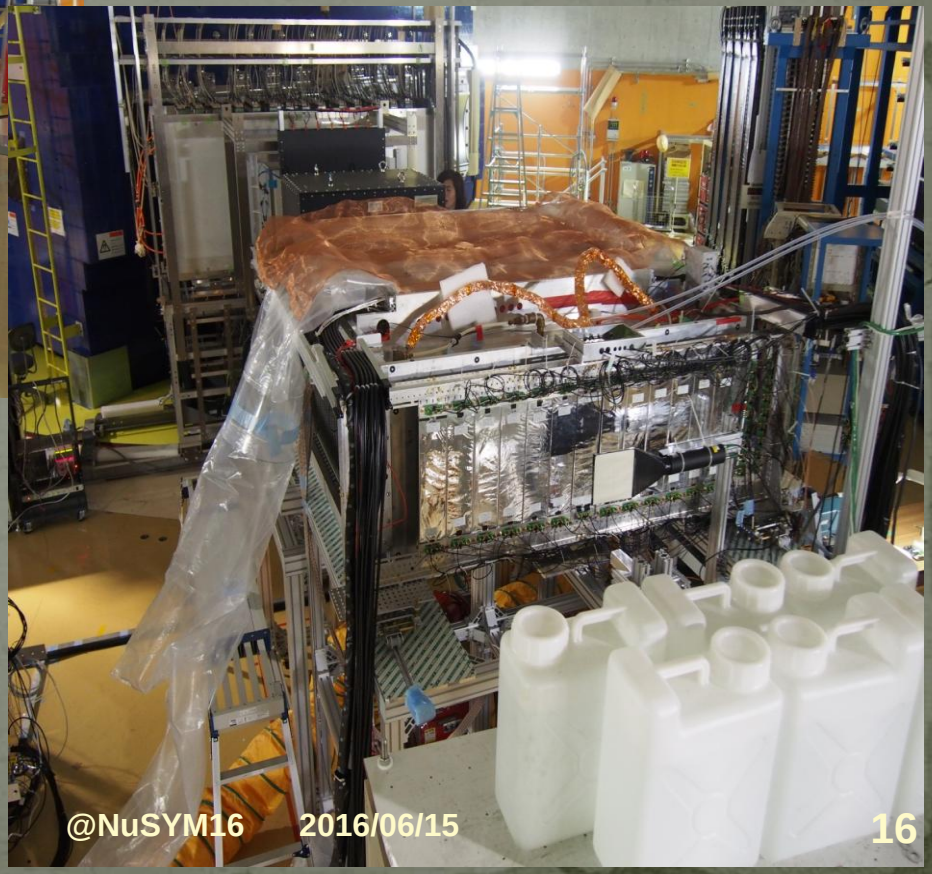
& SAMURAI magnet magnet field map (0.5 T)



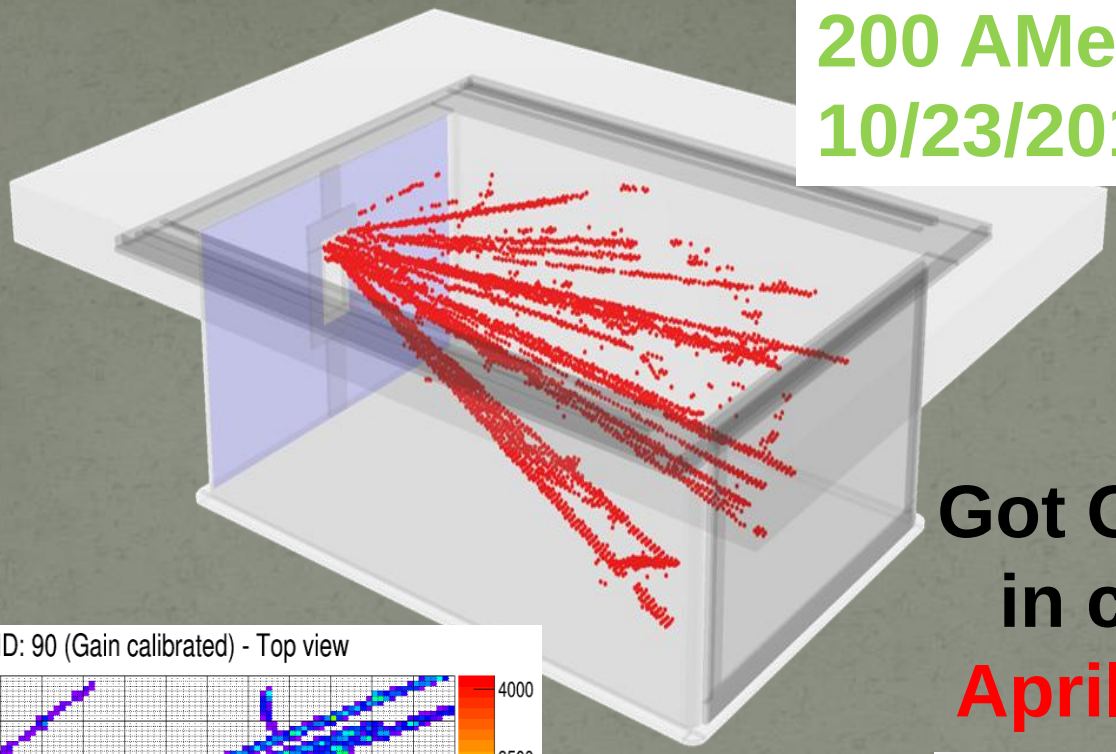
Impact parameter

Commission Run in October 2015



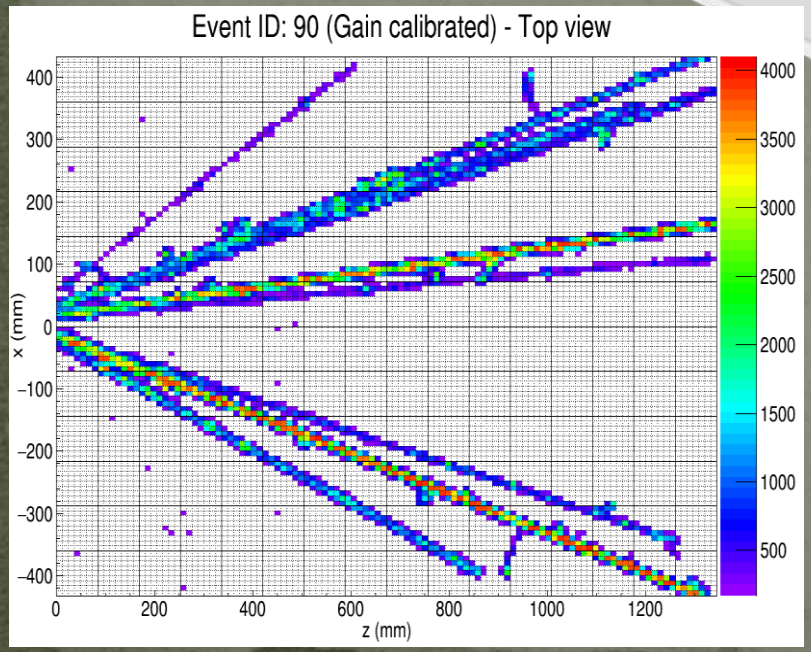


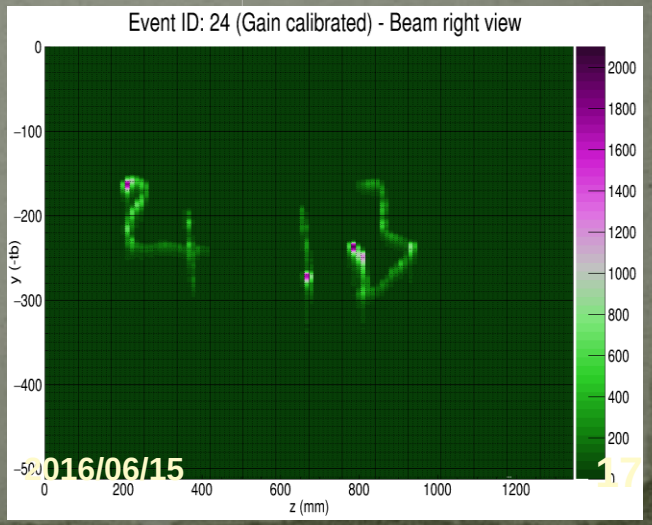
Reactions from 200 AMeV ^{79}Se+Al 10/23/2015, RIKEN

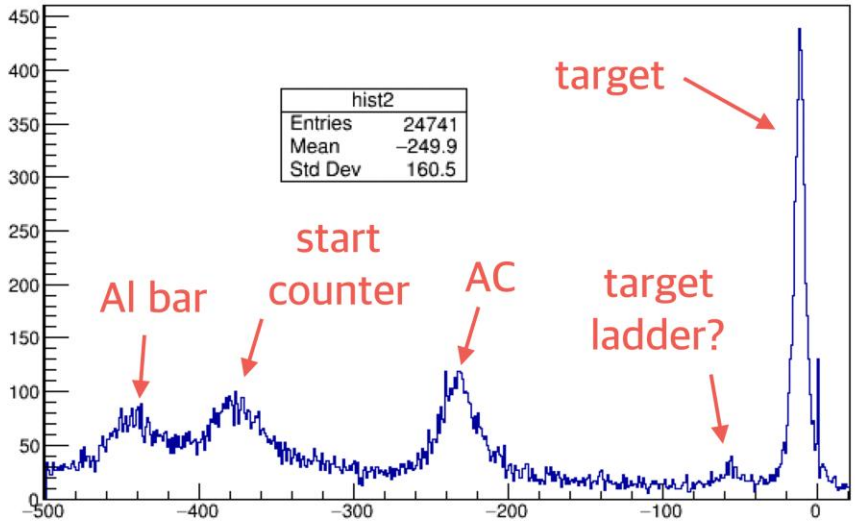


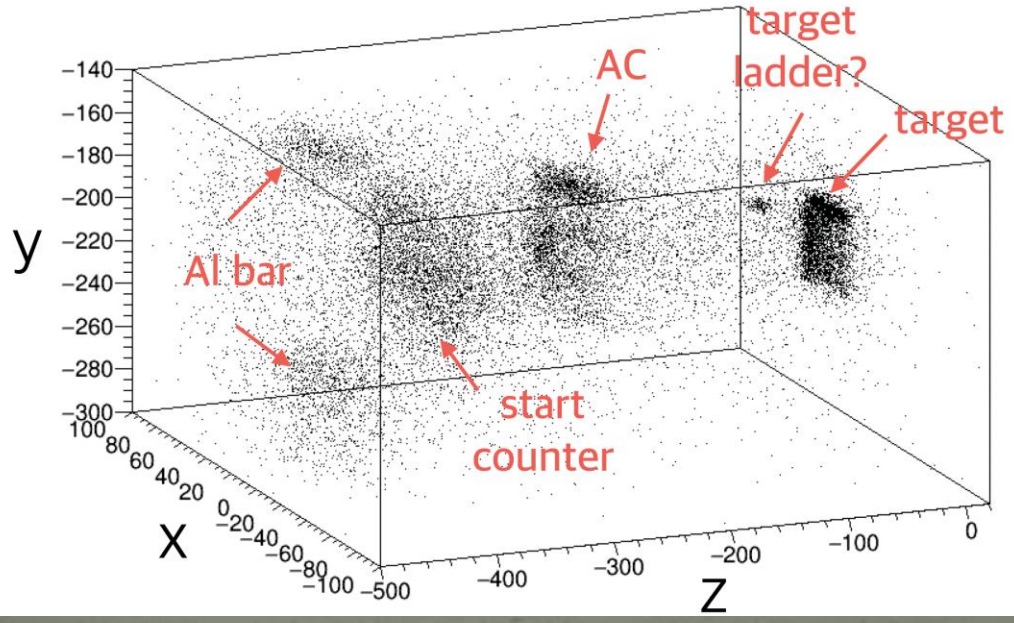
Got OMEN in cosmic event

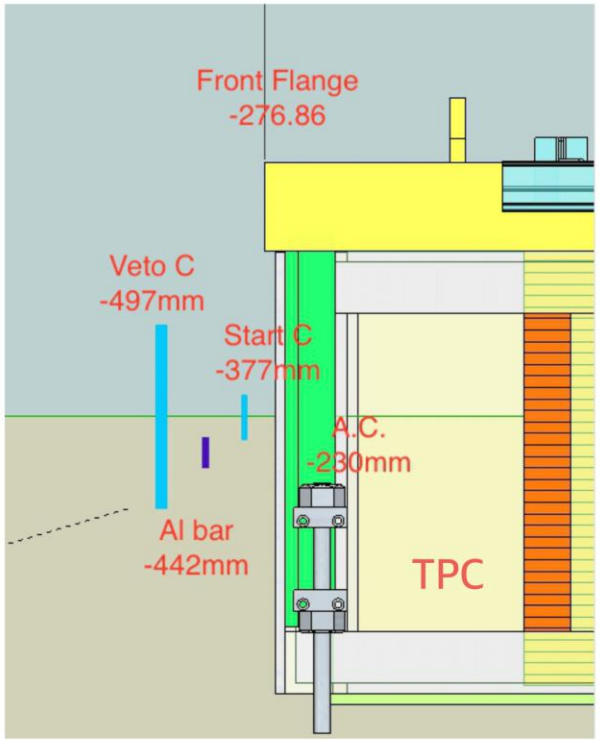
April 13, 2016

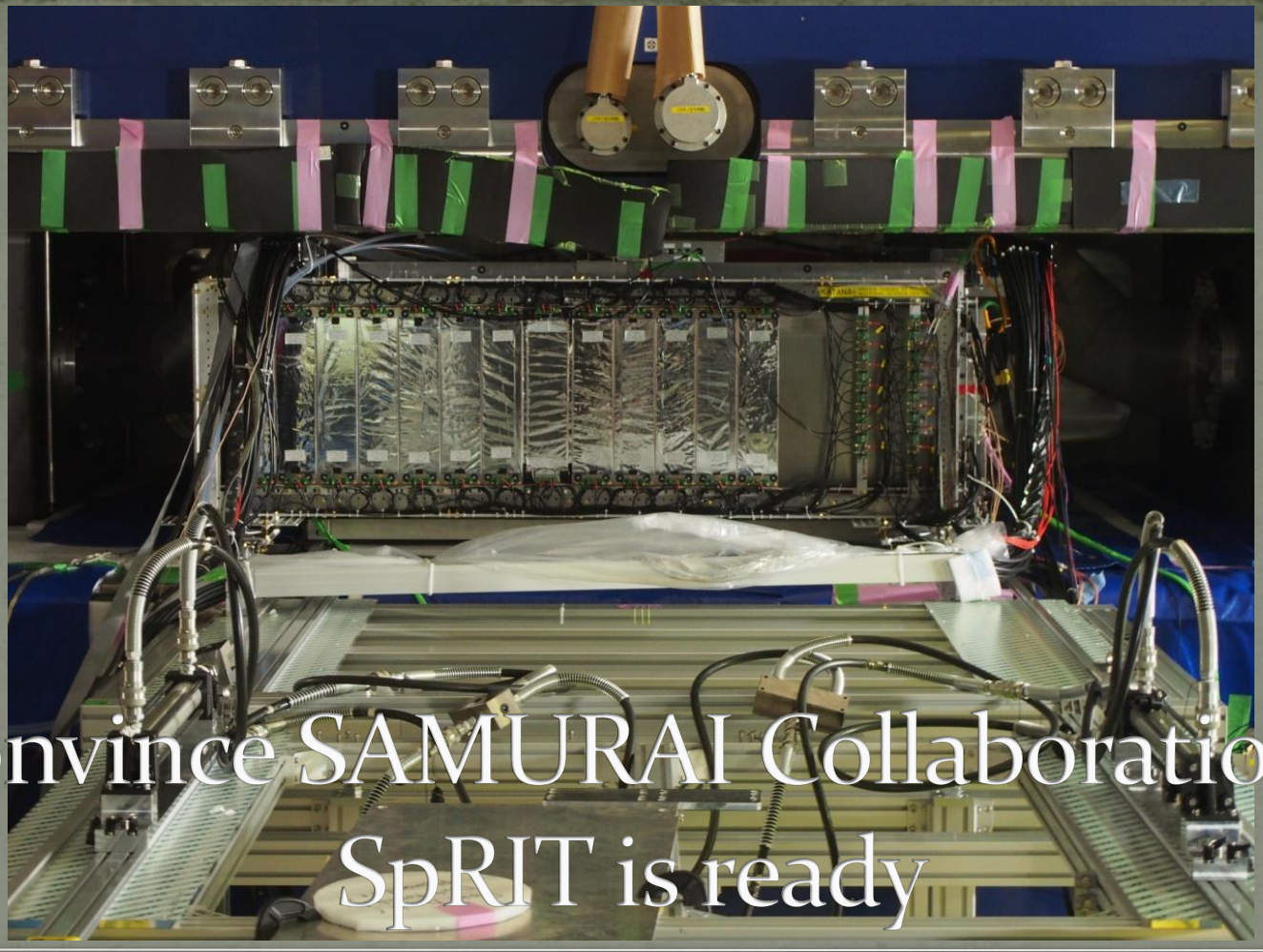





hist2
Entries 24741
Mean −249.9
Std Dev 160.5
target
start counter
Al bar
AC
target ladder?

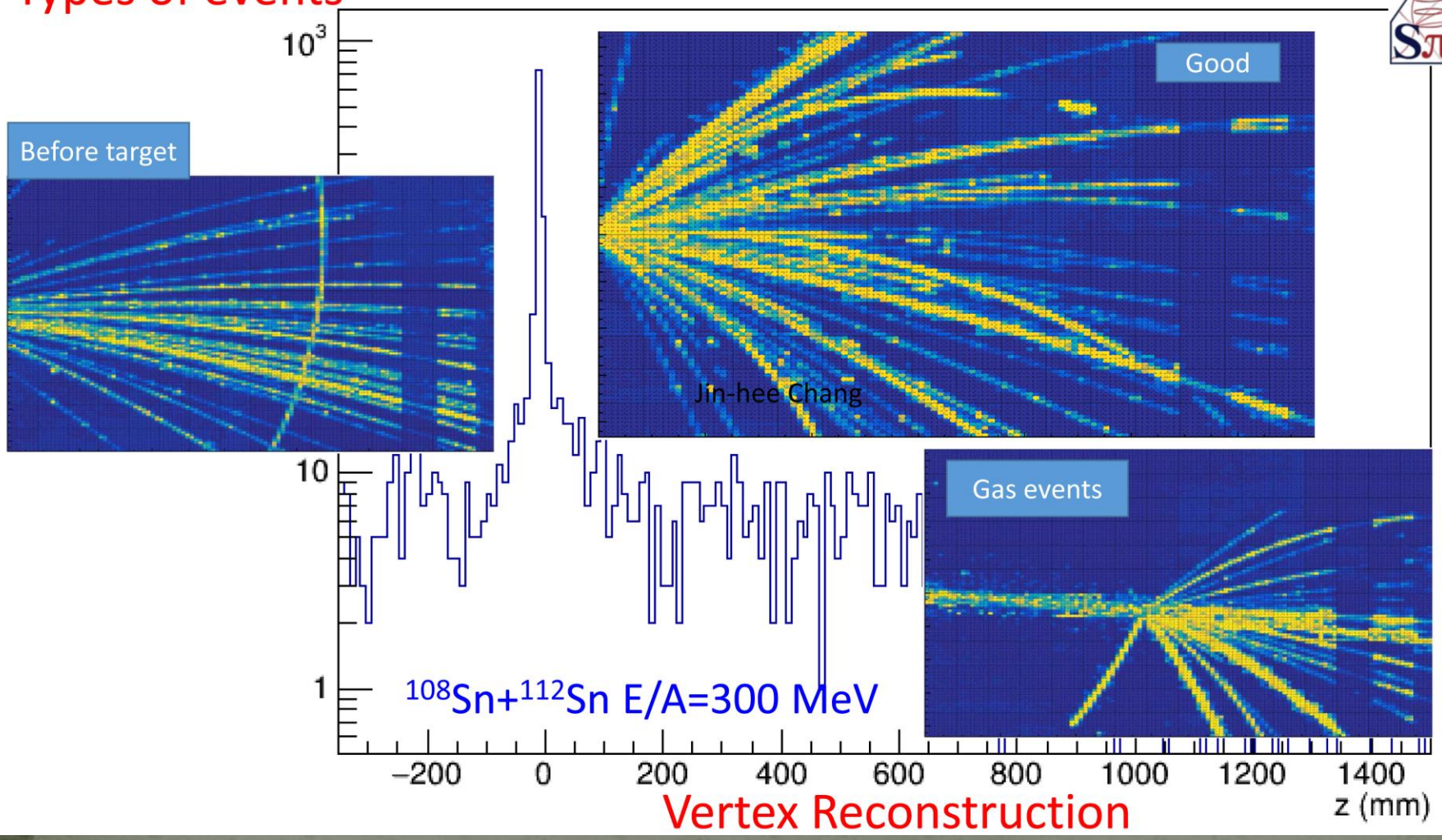

target ladder?
AC
target
Al bar
start counter
y
x
z


Front Flange
-276.86
Veto C
-497mm
Start C
-377mm
A.C.
-230mm
Al bar
-442mm
TPC



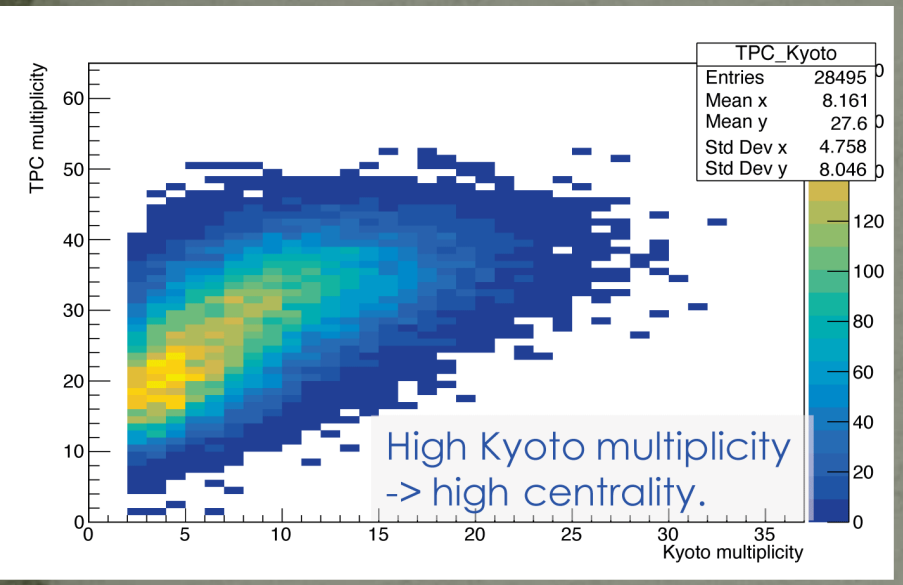
Convince SAMURAI Collaboration : SpRIT is ready

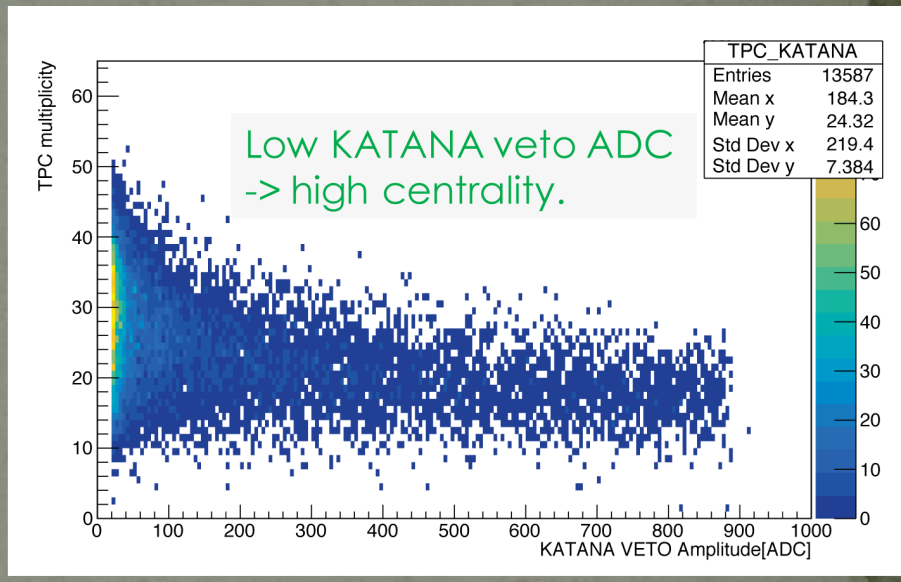
Types of events



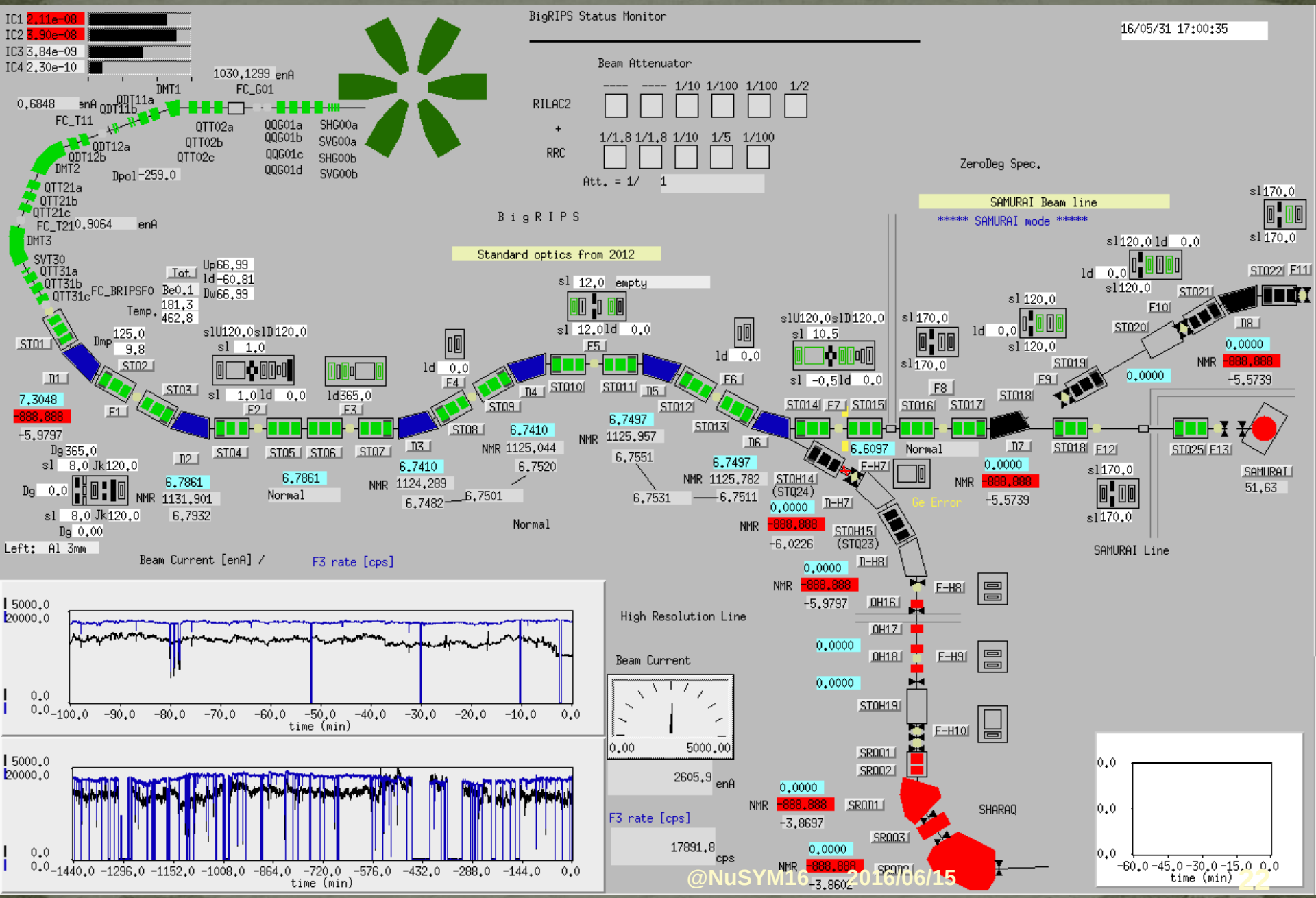
Vertex Reconstruction

Verify performance of trigger detectors





Select Kyoto Multiplicity ≥ 4
KATANA veto cuts peripheral events


BigRIPS Status Monitor
16/05/31 17:00:35
Beam Attenuator
RILAC2
RRC
Att. = 1/ 1
ZeroDeg Spec.
SAMURAI Beam line
***** SAMURAI mode *****
B i g R I P S
Standard optics from 2012
SAMURAI Line
High Resolution Line
Beam Current
F3 rate [cps]
Beam Current [enA] /
time (min)
@NuSYM16 2016/06/15
22

Obtain right beam energies

Adjusting thicknesses of production target and degraders

$^{108}Sn+^{112}Sn$:

@F7: 298.52 AMeV

@ Tgt center: 268.92 AMeV

$^{112}Sn+^{124}Sn$:

@F7: 298.42 AMeV

@ Tgt center: 270.22 AMeV

$^{132}Sn+^{124}Sn$:

@F7: 293 AMeV (still approximate number)

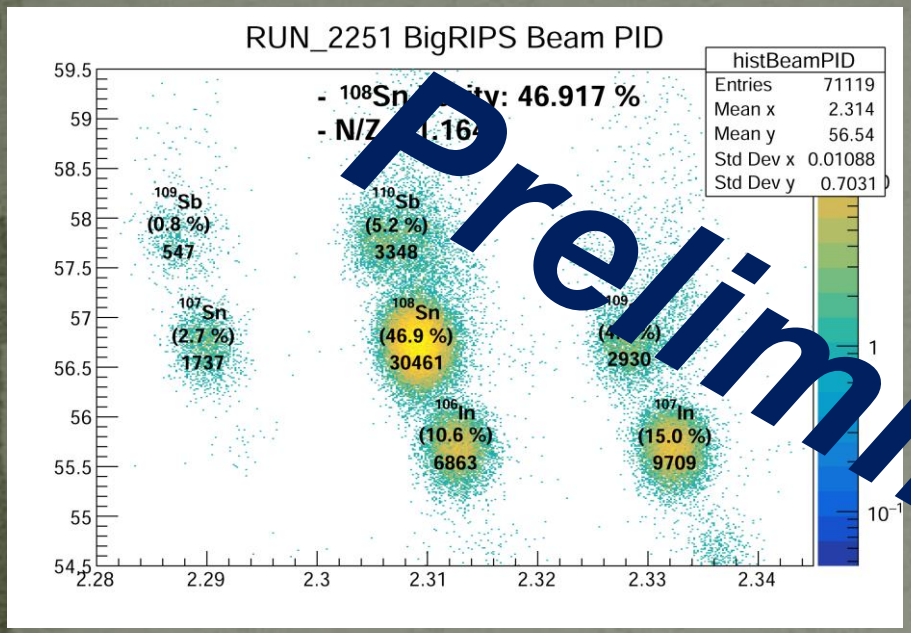
@ Tgt center: 268.93 AMeV

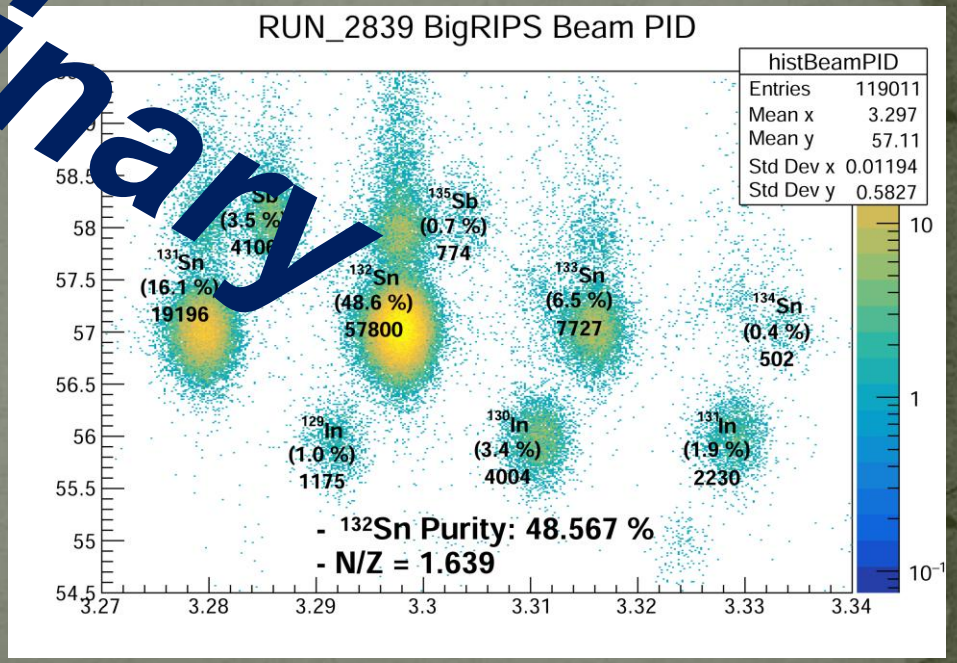
$^{124}Sn+^{112}Sn$:

@F7: 296 AMeV (still approximate number)

@ Tgt center: 270.19 AMeV

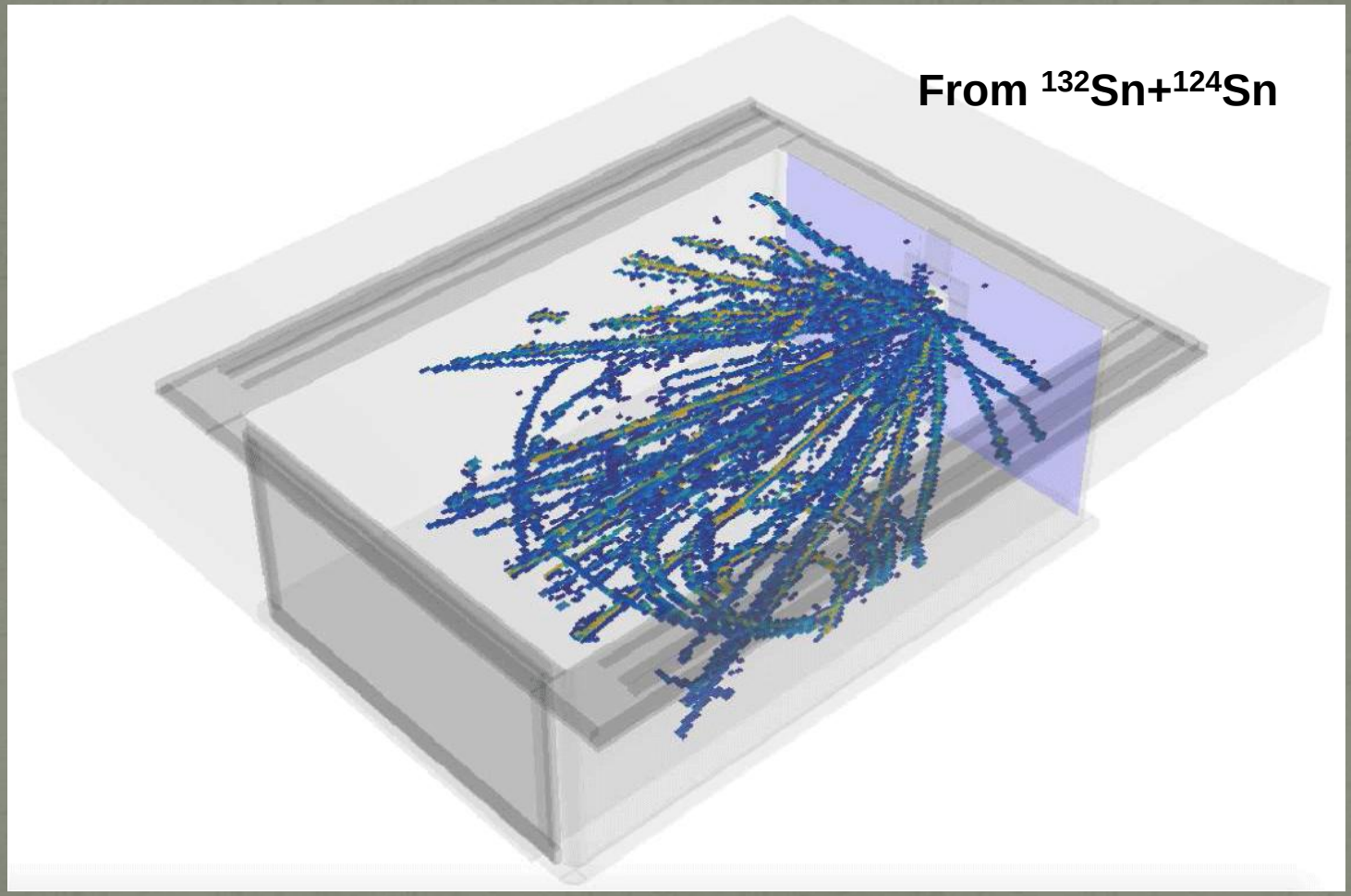
Managed to get about 50% purity for most of beams (except for ^{124}Sn)





Scales are not yet correct.

Impressive Example of events



Summary

- We have just finished the first series of SπRIT experiments two weeks ago.
- First sight of semi-online data seem very promising.
- We hope to release the first results in a year.