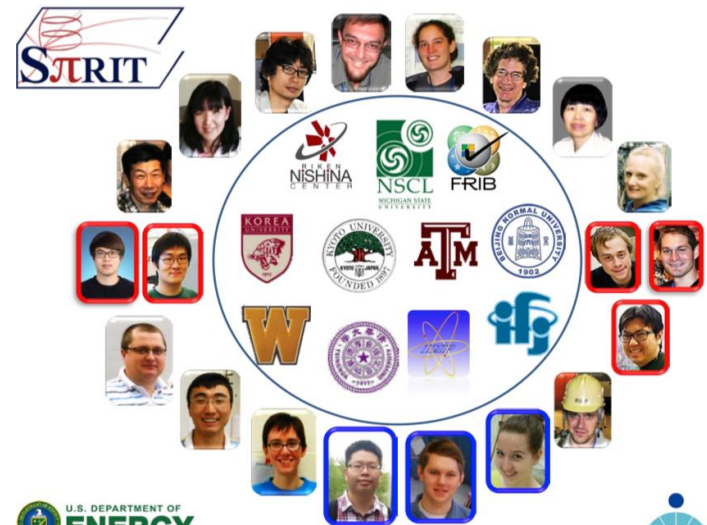


Current Status of $S\pi$ RIT-TPC

Mizuki Kurata-Nishimura, RIKEN

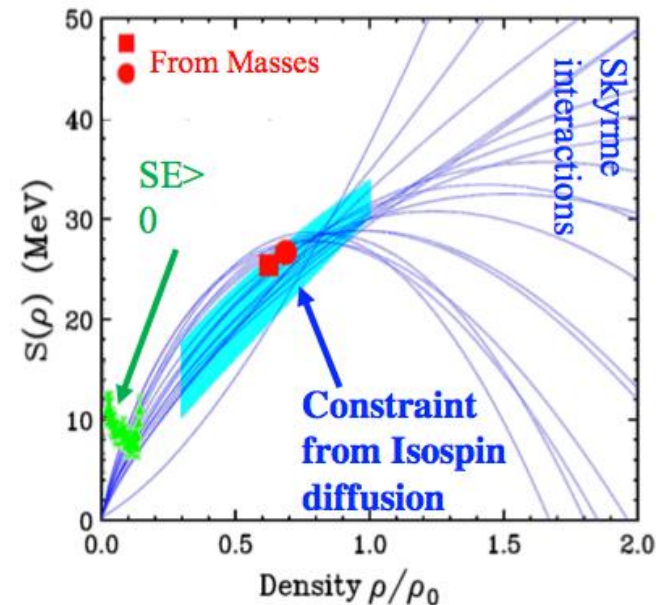
for the $S\pi$ RIT-TPC collaborators



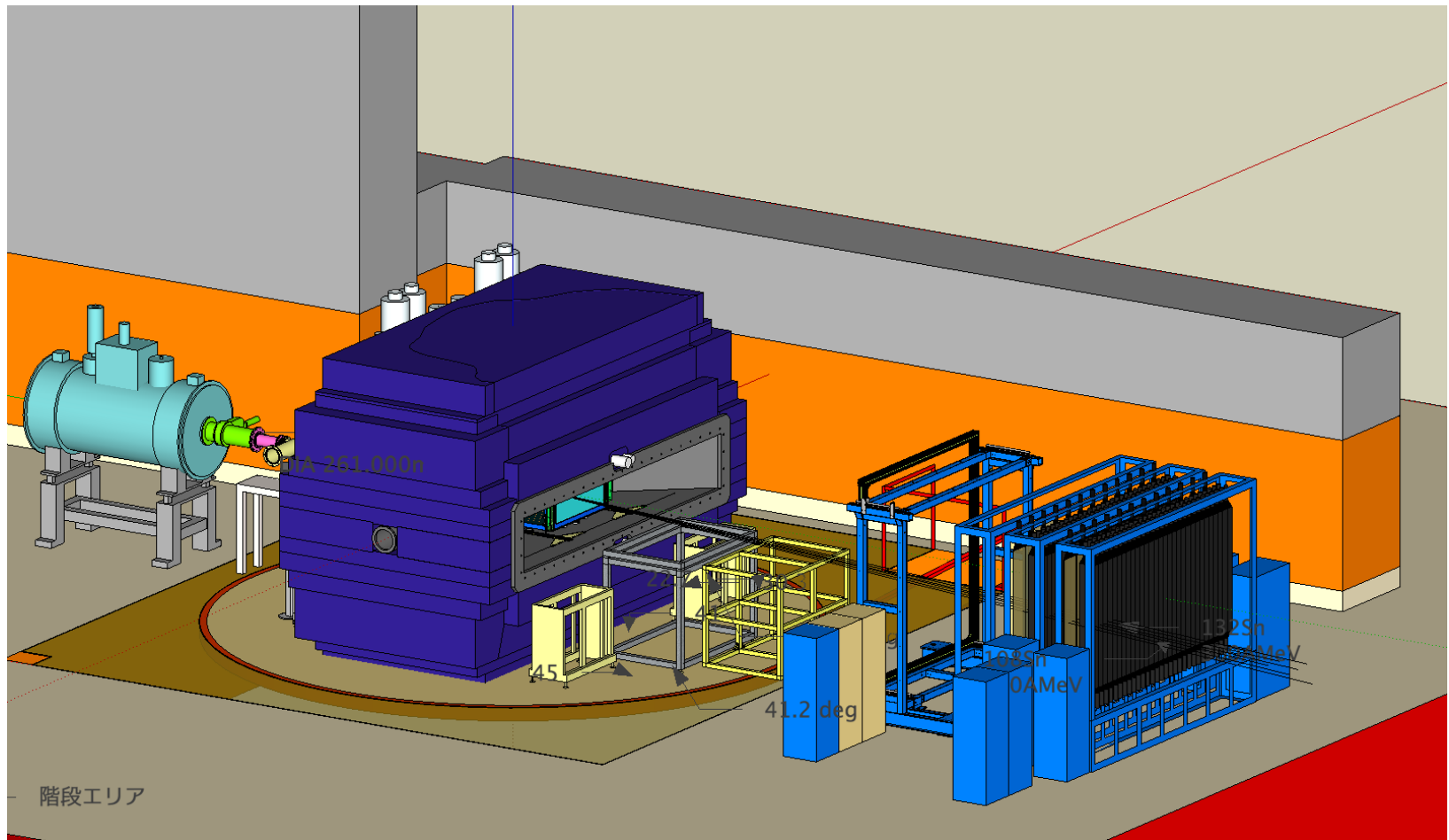
Nuclear symmetry energy

- 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

Prim. Beam	2 nd Beam + Target	Energy [MeV/A]	Isospin asymmetry
^{123}Xe	$^{108}\text{Sn} + ^{112}\text{Sn}$	300	0.09
^{123}Xe	$^{112}\text{Sn} + ^{124}\text{Sn}$	300	0.15
^{238}U	$^{132}\text{Sn} + ^{124}\text{Sn}$	300	0.22
^{238}U	$^{124}\text{Sn} + ^{112}\text{Sn}$	300	0.15

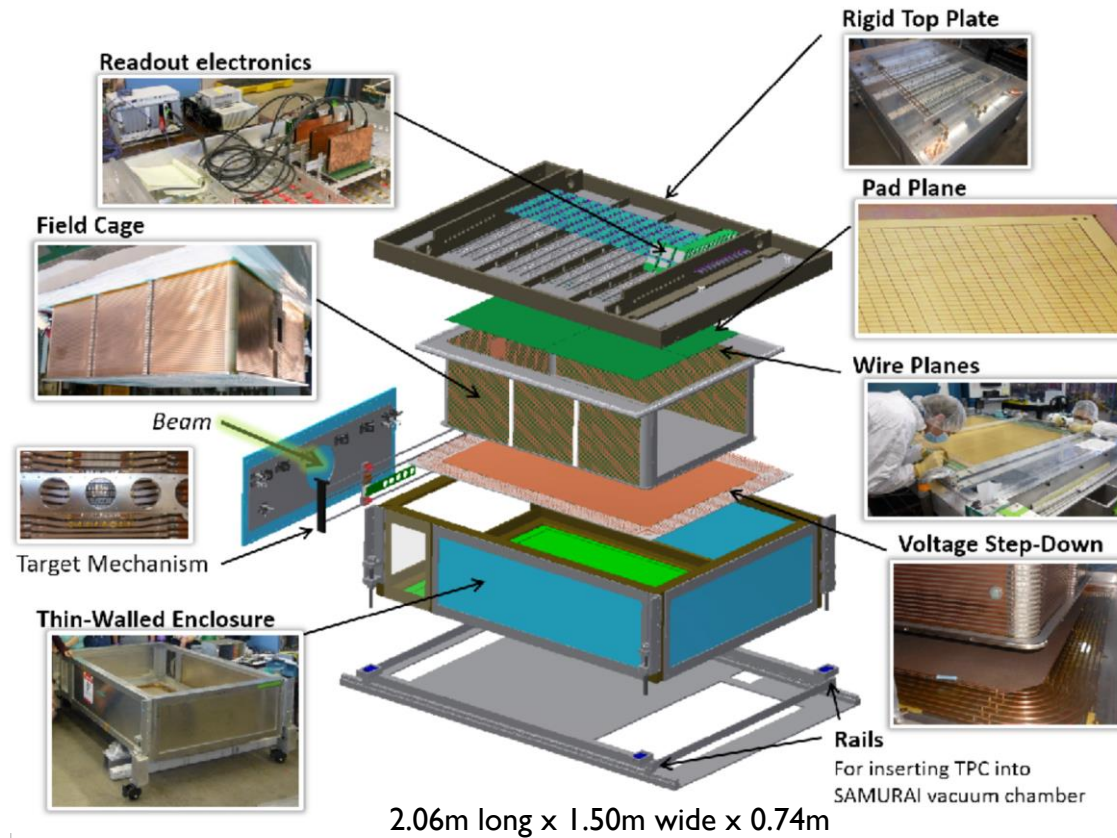


Experimental View in 2015



S π RIT-TPC structure

NIM A 784 (2015) 513–517.



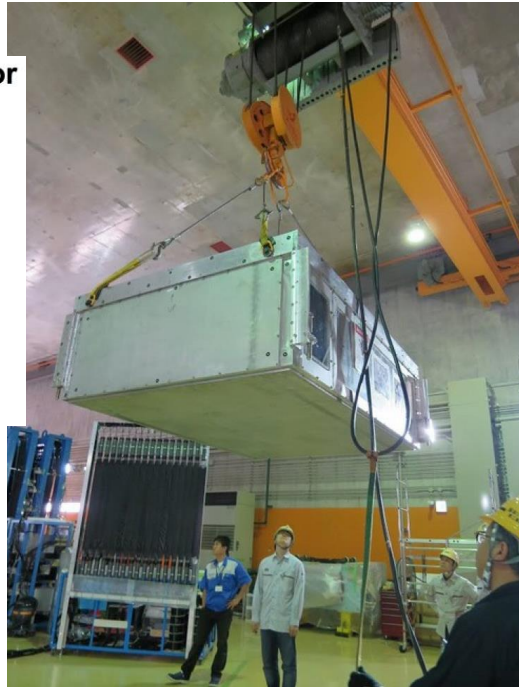
Pad Plane Area	1.3 m x 0.9 m	Gas Gain	2000
Number of Pads	12096 (112x108)	E-field	135 V/cm
Pad size	12 mm x 8 mm	Drift velocity	5.5 cm/ μ s
Drift Distance	50 cm	dE/dx range	Z=1-8, π , p, d, t, He, Li-O
Pressure	1 atmosphere	Two-track res.	2.5 cm
Gas composition	90% Ar + 10% CH ₄	Multiplicity limit	200

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)

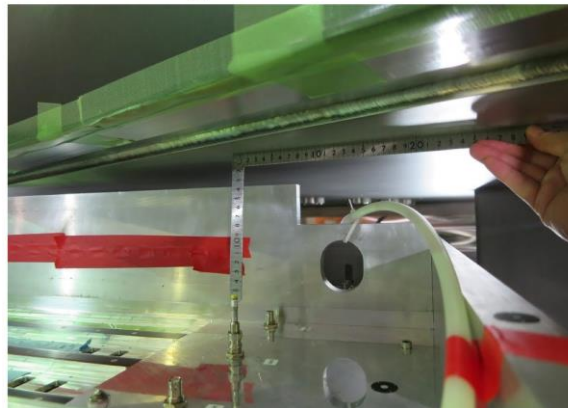
Installation Test done last Summer

Trusty crane operator



Push with jacks

Checking clearance outside

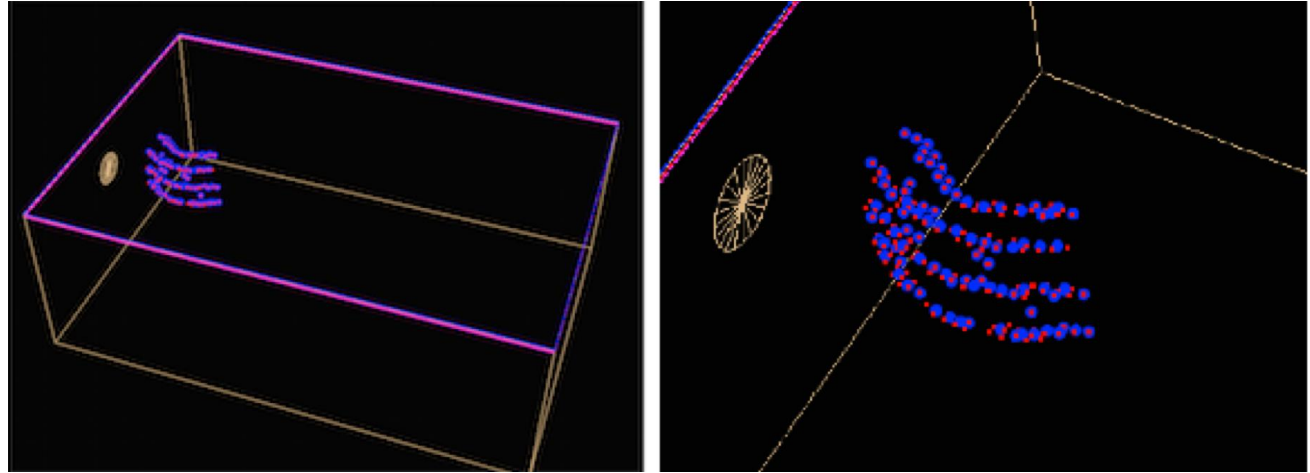


Success!



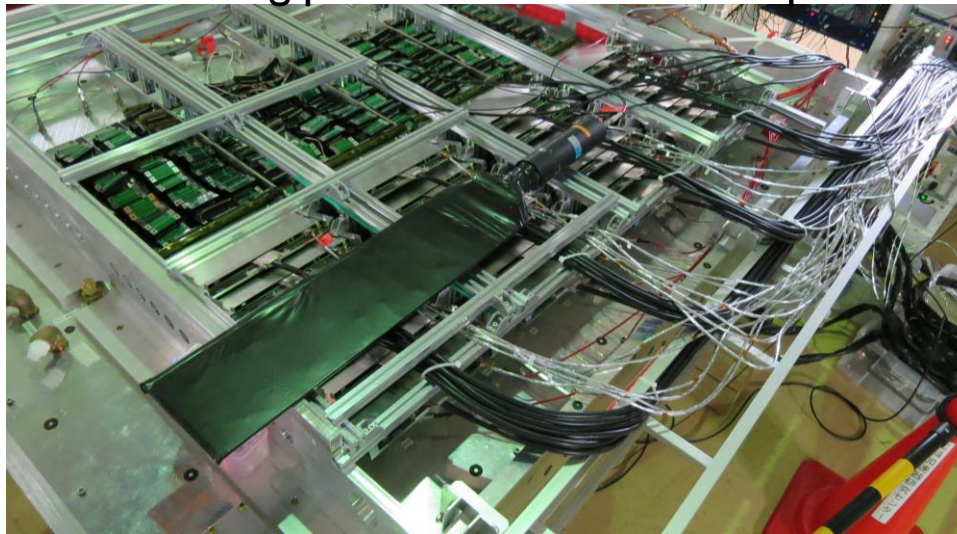
Cosmic Ray

A half of helical track was observed in 0.5 Tesla.

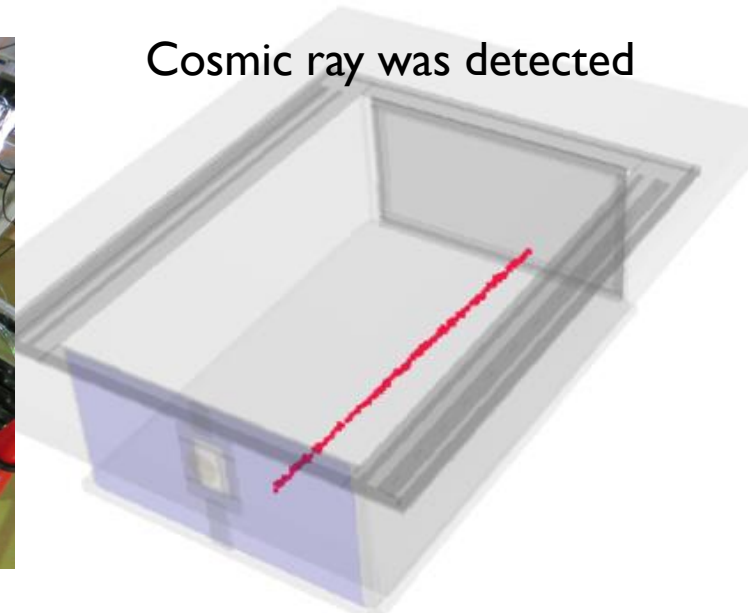


24 AsAds was mounted on TPC.

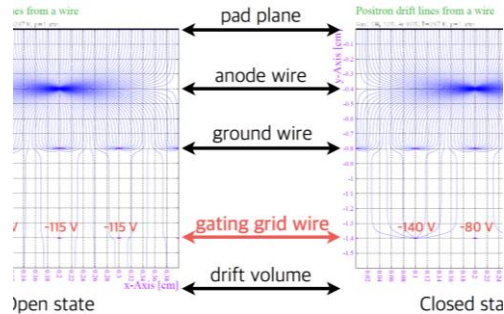
No missing pads was found on 6046 pads



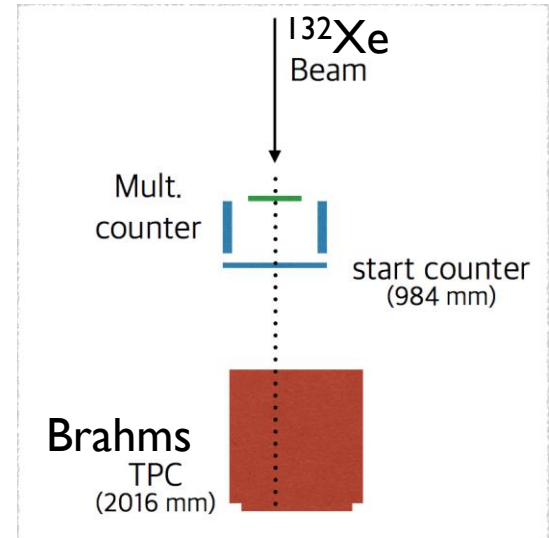
Cosmic ray was detected



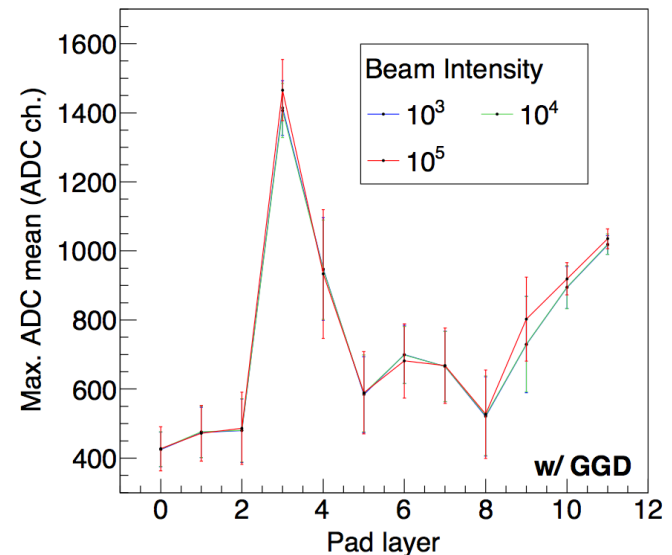
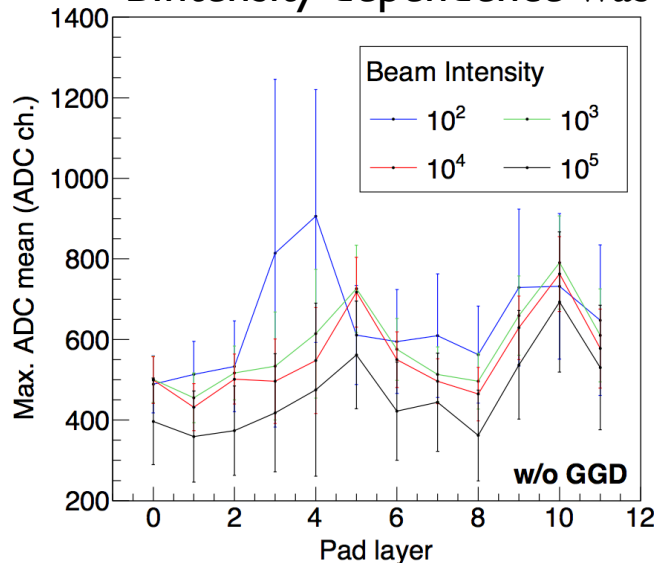
Space Charge Effect



Gating Grid Driver is discussed by Mr. Suwat later



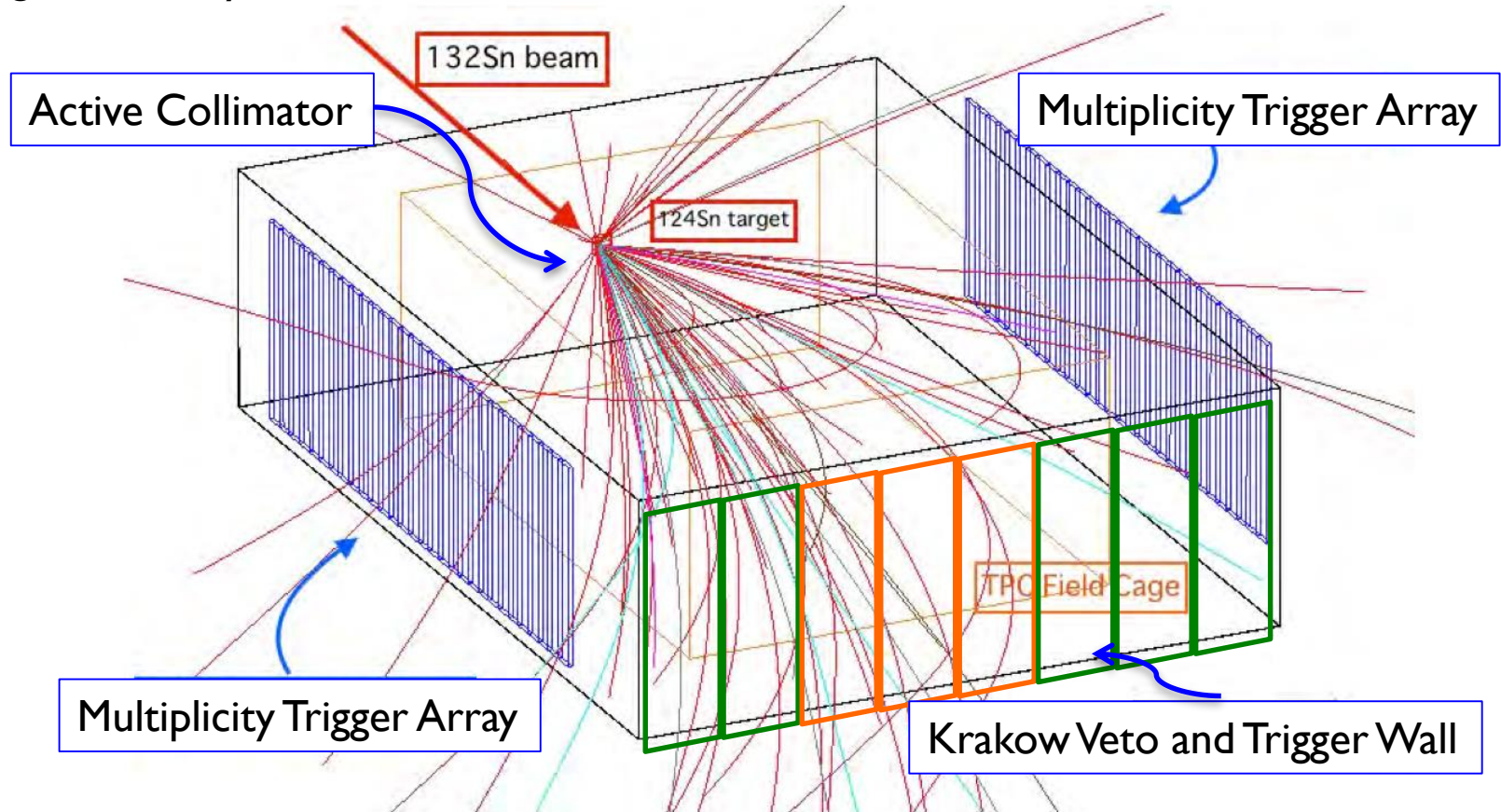
Beam intensity dependence was measured in HIMAC on Nov. 2014



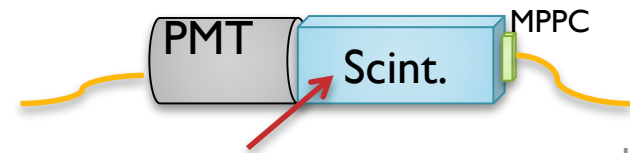
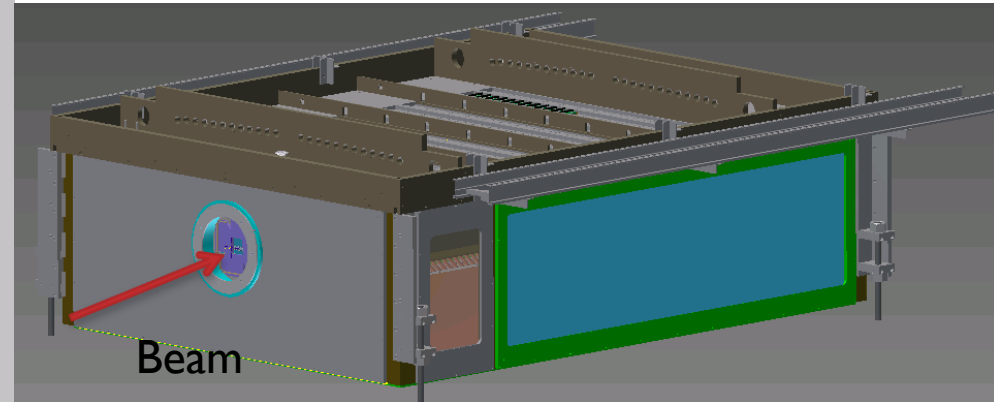
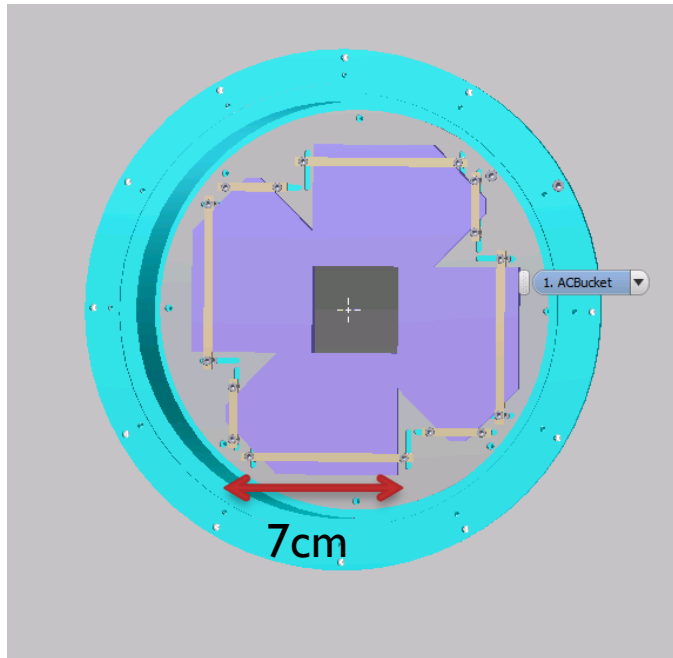
G.G.D. prevent gain dropping due to space charge.

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

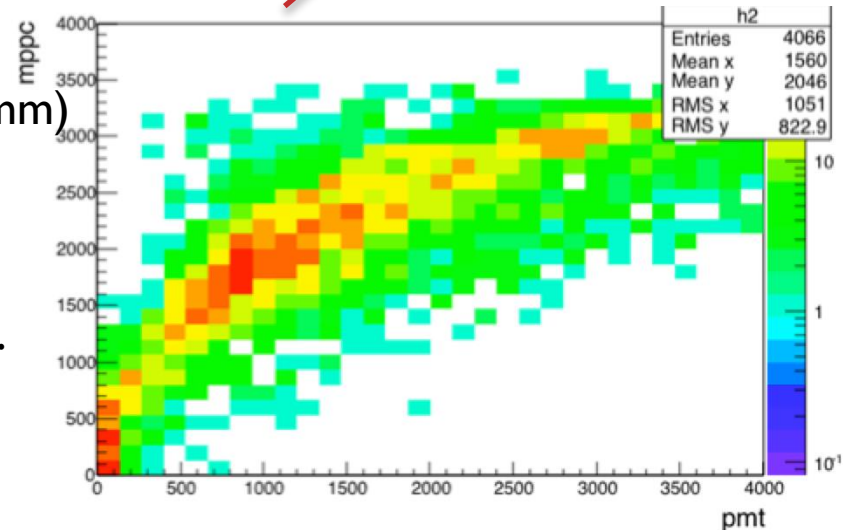


Active Collimator



Four Plastic scintillators read by MPPC(3x3mm)

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

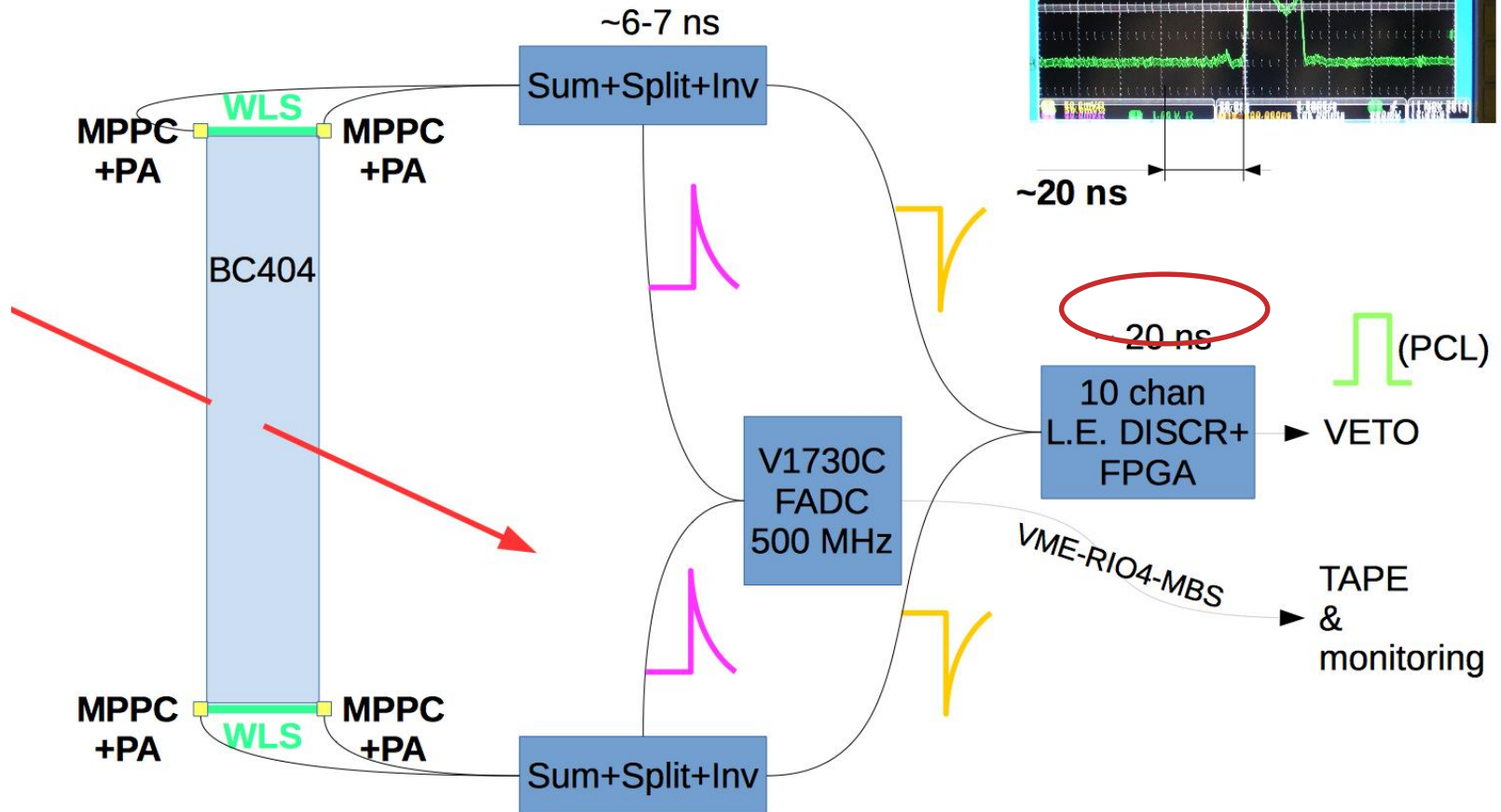
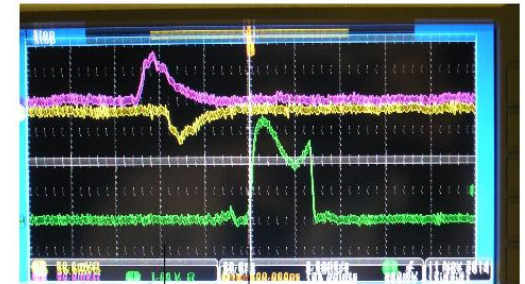
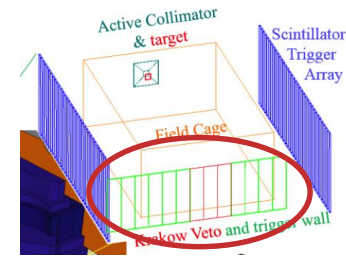


Krakow Veto Array and Trigger wall

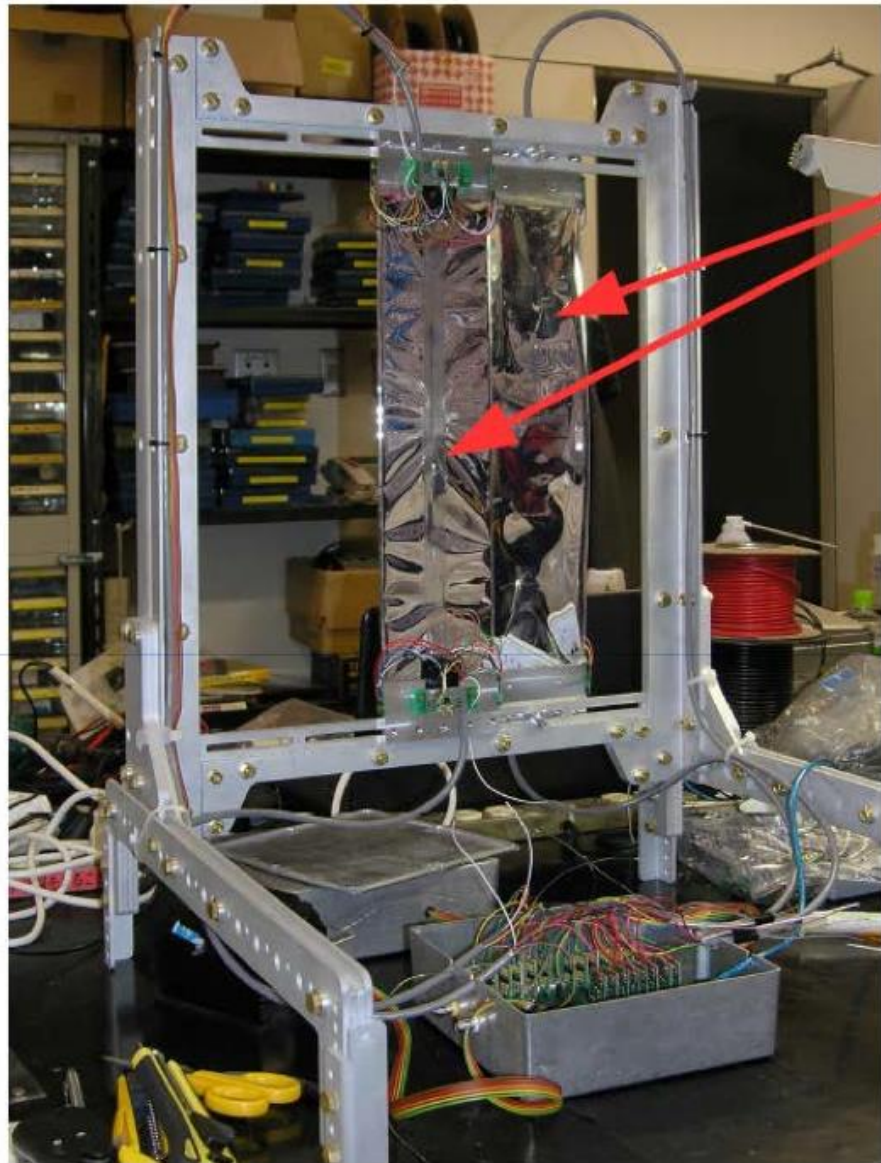
MPPC: HAMAMATSU, $1 \times 1 \text{ mm}^2$, 10000 pixels

WLS: BCF92

PA: current preamplifier, $\tau < 2 \text{ ns}$ (P. Lasko)

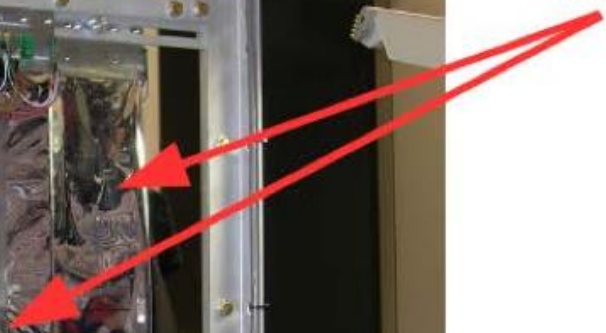


prototype

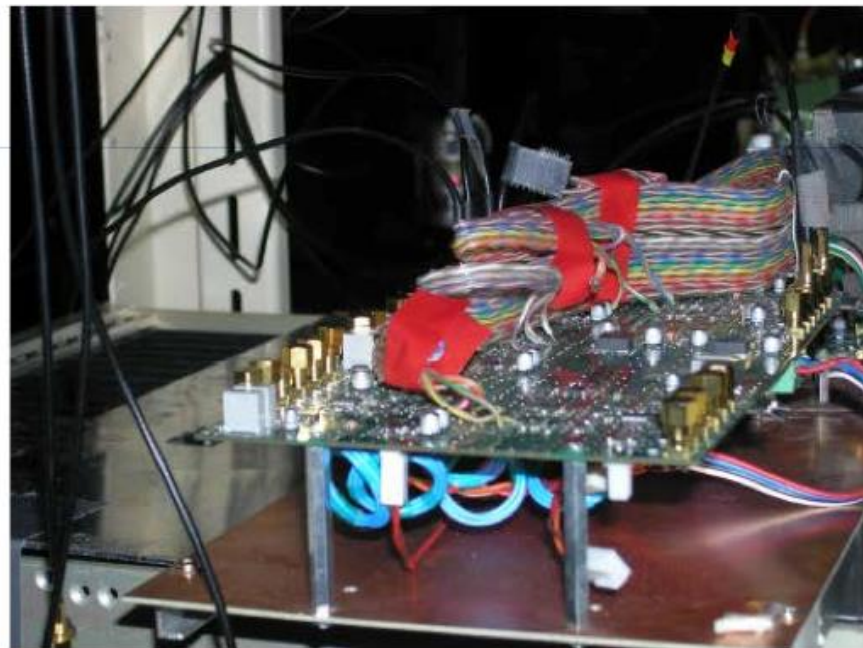


discriminator

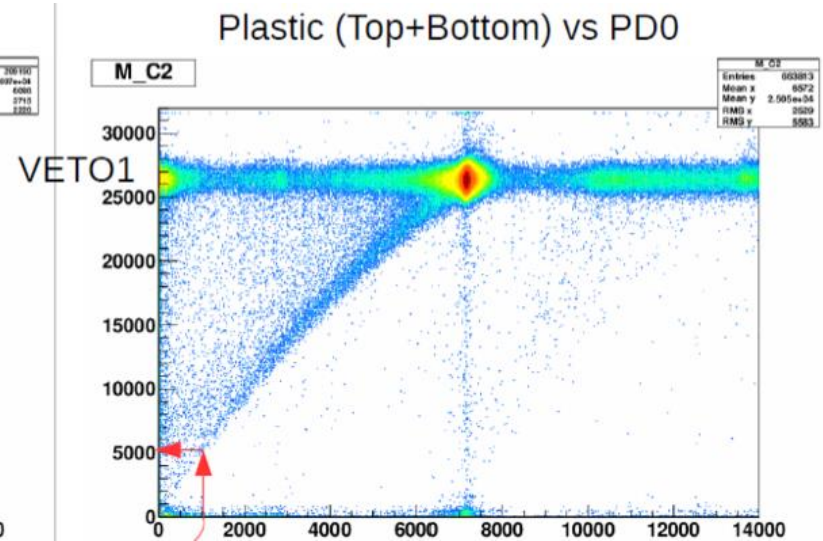
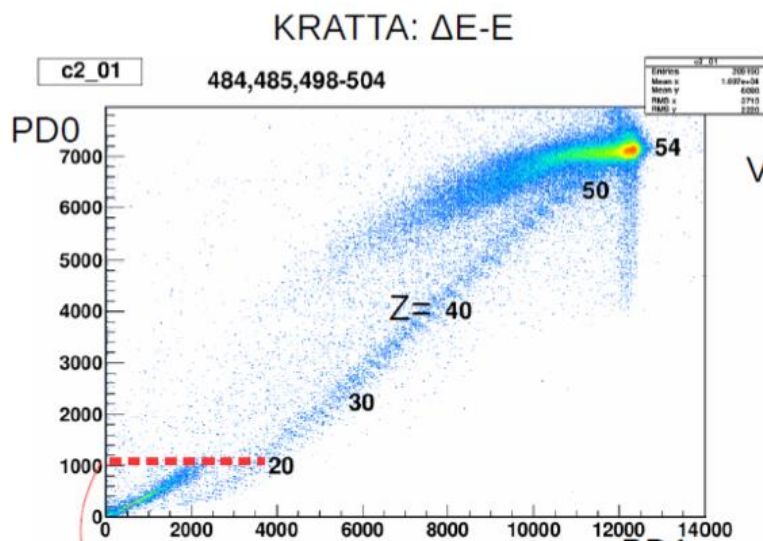
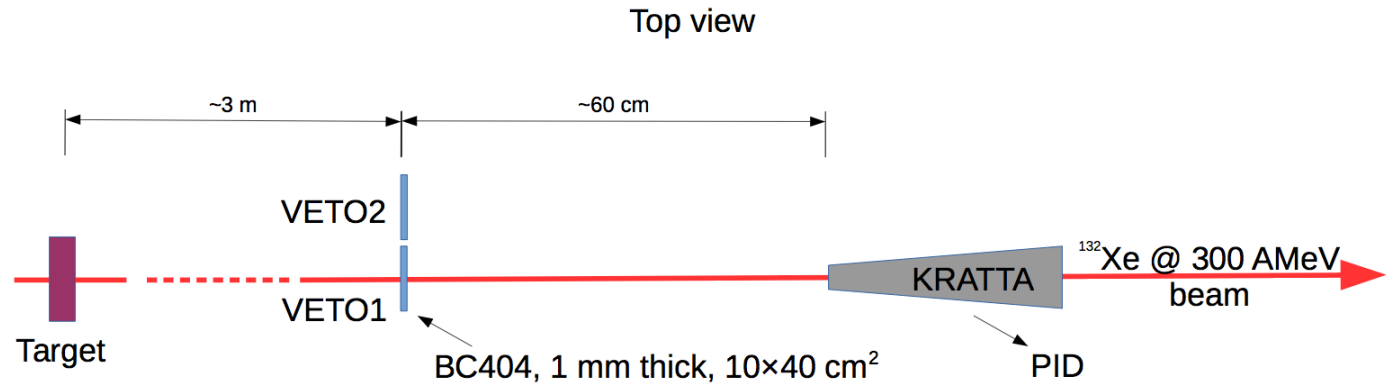
1 mm thick BC404 wrapped with ESR foil



10 channel fast discriminator
with FPGA

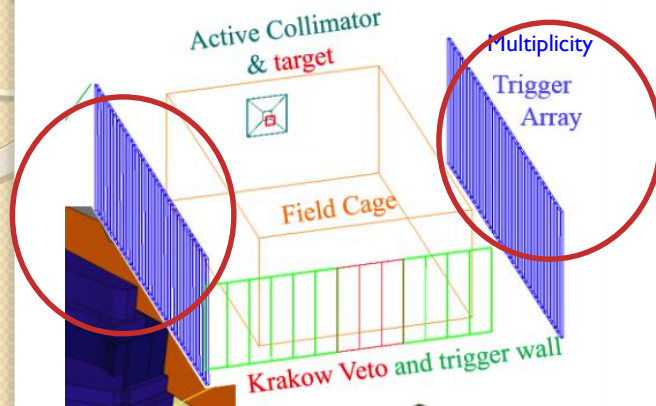


Beam Test in HIMAC, Nov. 2014

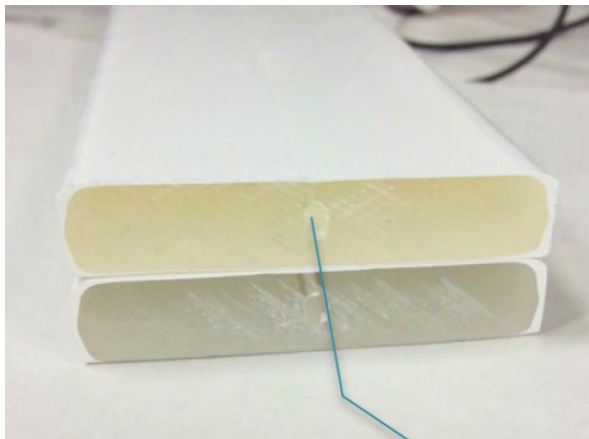


Constructing mounting frame
It should be ready by 15 June 2015

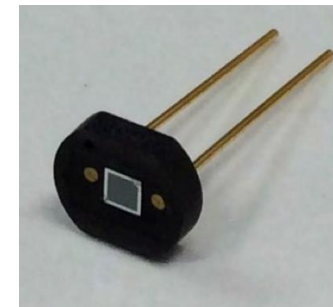
Multiplicity Trigger Array



Extruded scintillator

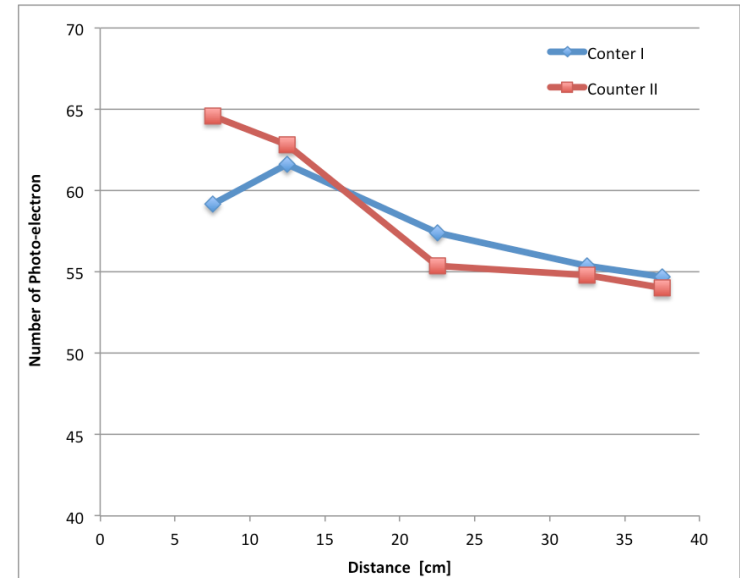
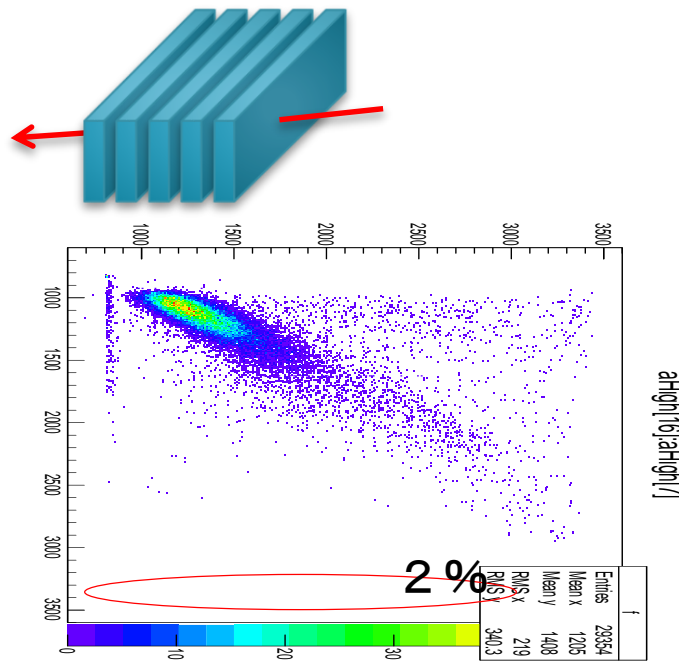


Wave length shifter is inserted along hole and light output is read by MPPC



MPPC
1.3x1.3m
m

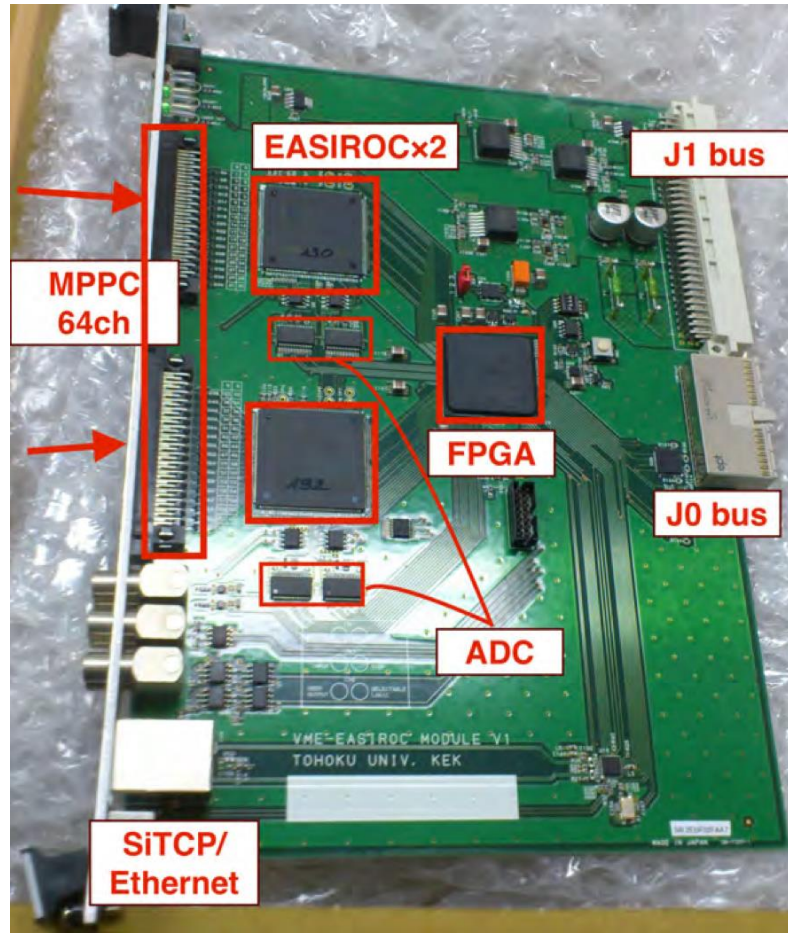
Beam Test in HIMAC



- 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.

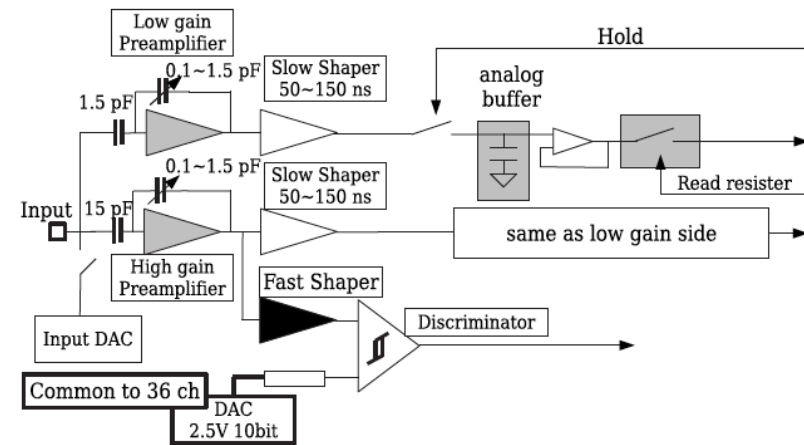
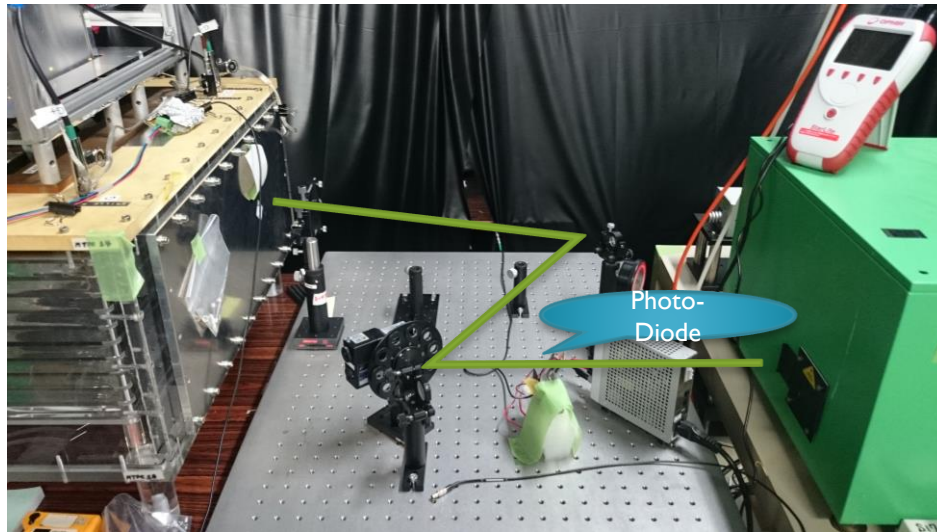


図 2.1: EASIROC 内部回路

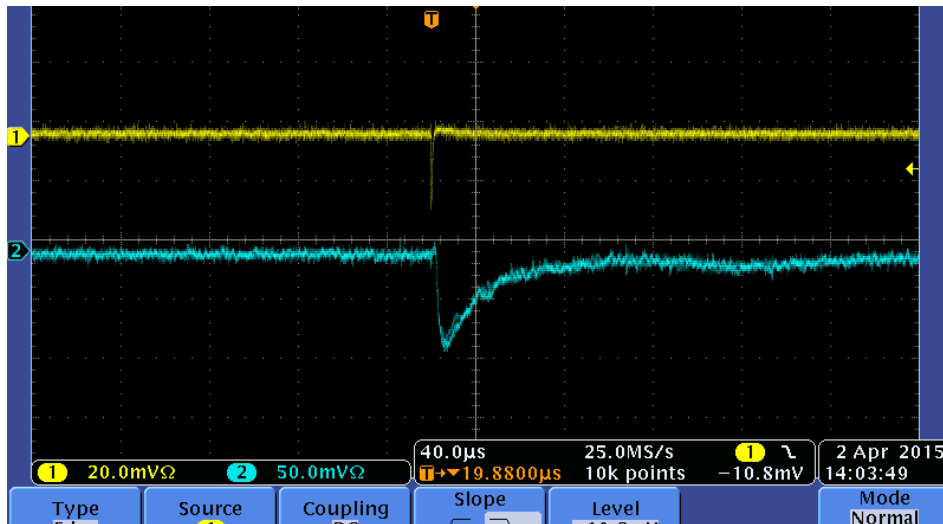
Logic out signal is delayed 52 ns.

The trigger logic combining trigger arrays will be tested soon.

Calibration System with N₂ Laser

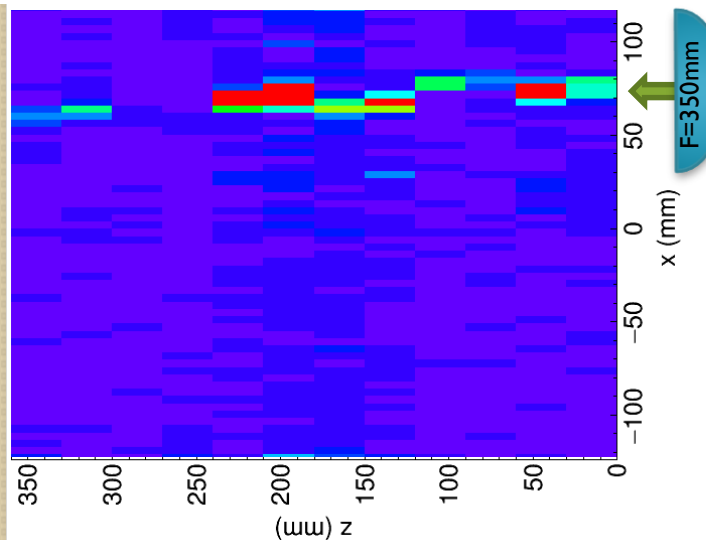
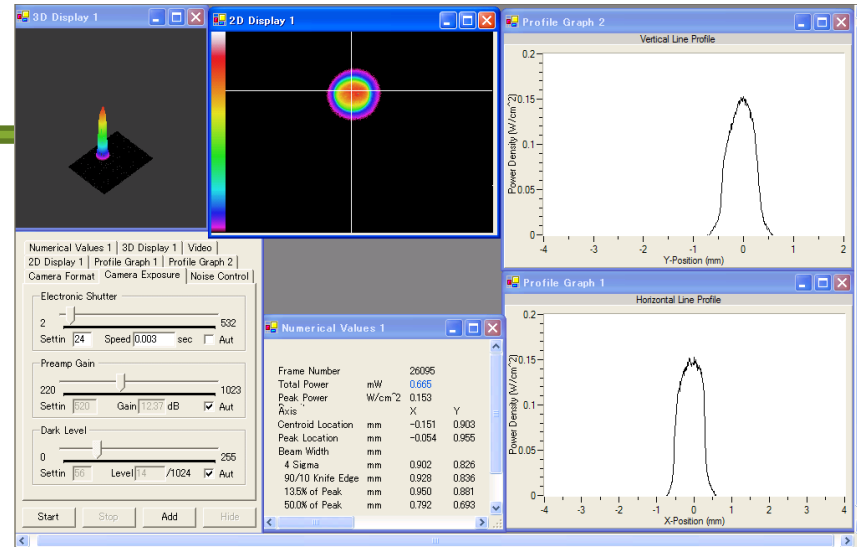
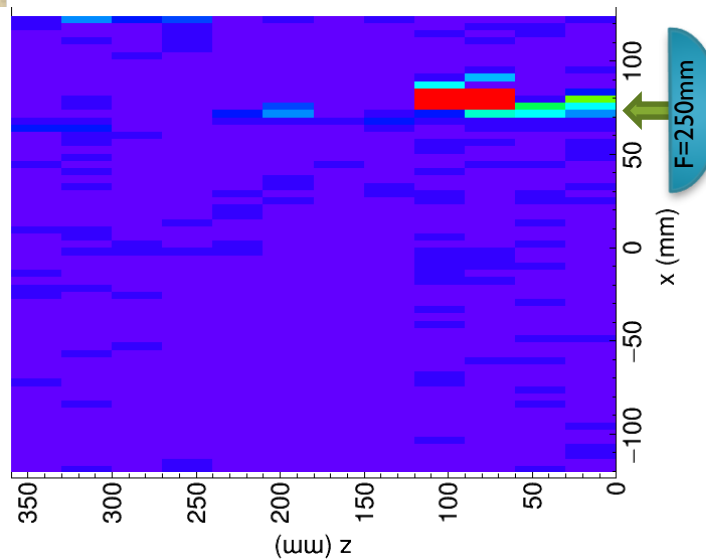


Wave length: 337nm
Power: 180 uJ/pulse



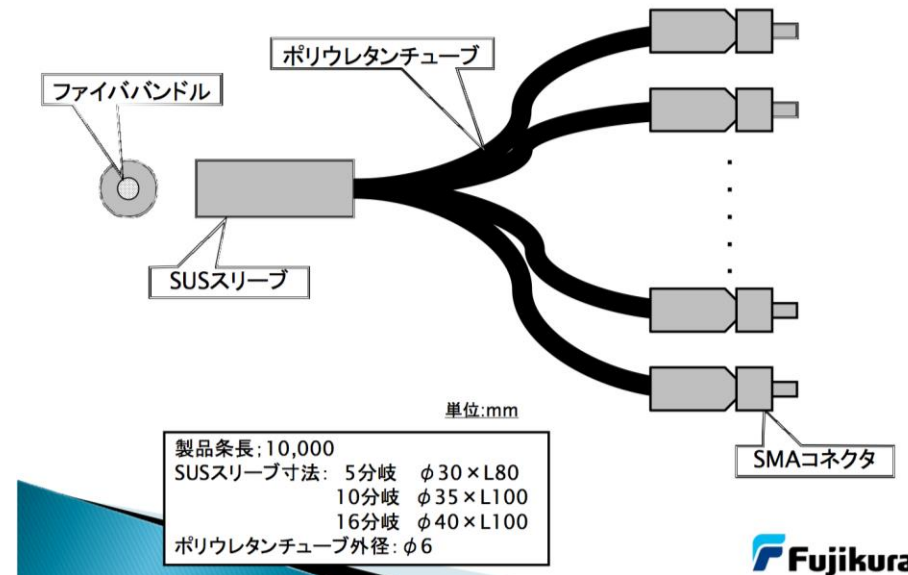
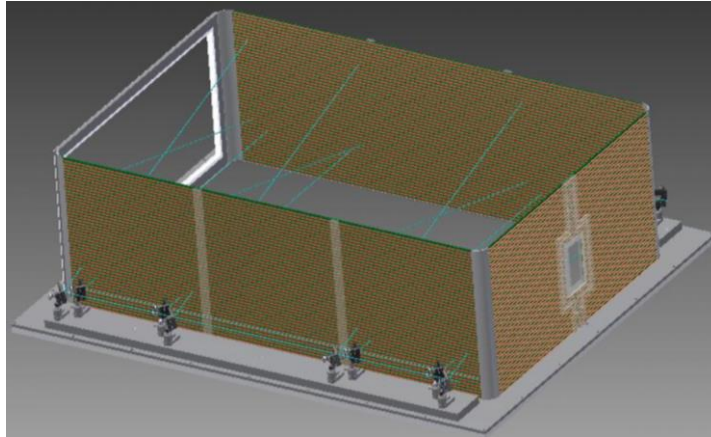
Anode wire signal was observed

Laser track



The power density at the focusing point was $\sim 135\mu\text{J}/\text{mm}^2$.

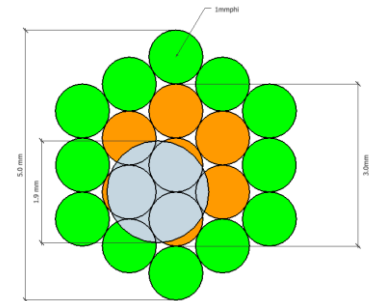
Laser Light deliver



Fujikura

Keeping the power density, laser light have to be divided into a several lines.

Two possibilities; using fiber bundle or optics

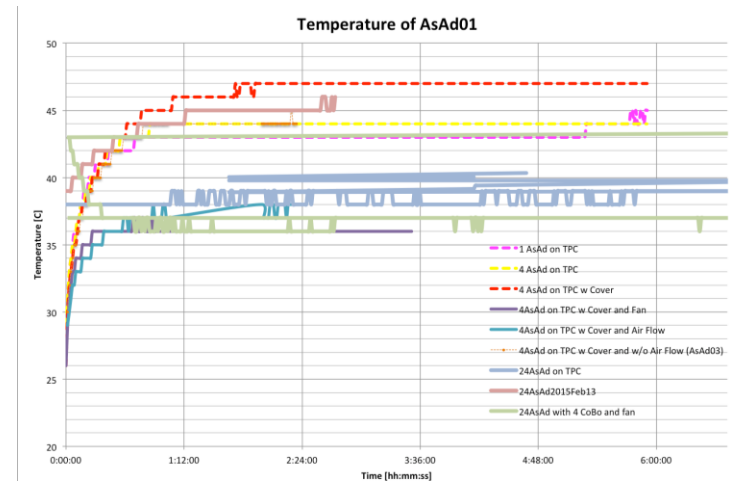
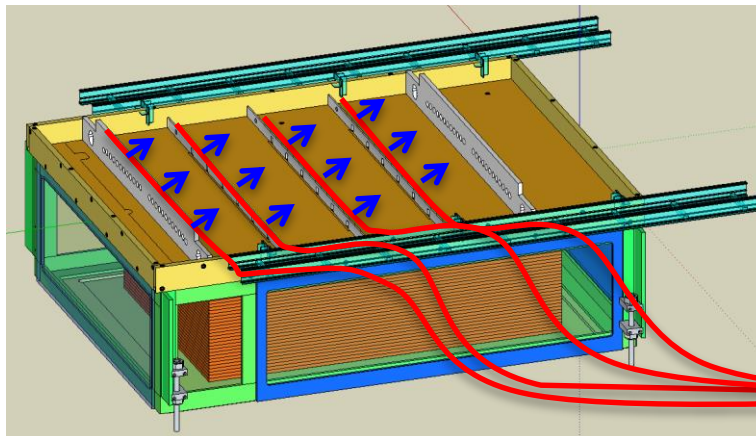
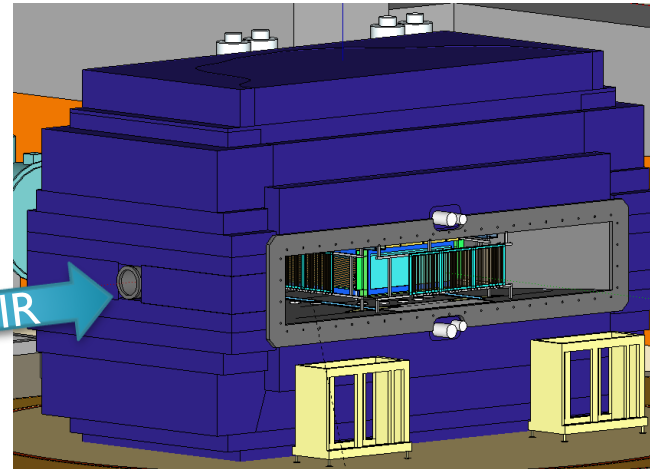


Air Cooling System

- Air flow around the surface of AsAd



AIR



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.