The 7th Asian Triangle Heavy-Ion Conference (ATHIC 2021)
November 5-9, 2021, Inha Univ. Incheon, Korea.

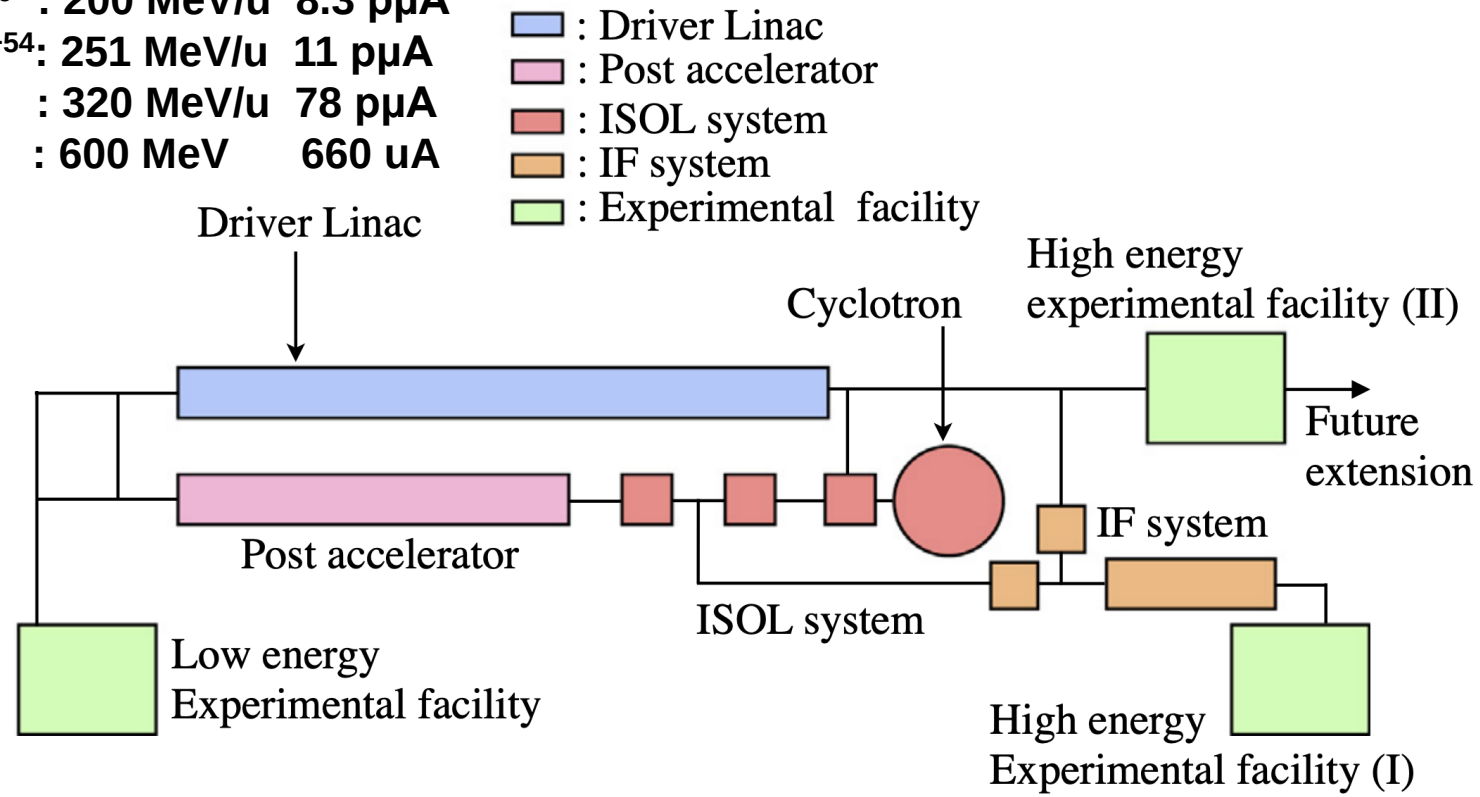
LAMPS experiment -Status & Plan -

Lee Jong-won for LAMPS collaboration

RAON

- First Heavy-ion accelerator for basic science in KOREA
- Operation start from end of 2021 / 2022

U^{+79} : 200 MeV/u 8.3 pμA
Xe^{+54}: 251 MeV/u 11 pμA
O^{+8} : 320 MeV/u 78 pμA
p : 600 MeV 660 uA



LAMPS – Physics

-Nuclear symmetry energy at high density

Using rare isotope beam

Various beam energy

Various collision system

-Ratio of mirror nuclei & π^-/π^+

-Isospin diffusion parameter

-Collective flow

-Dipole emission

-Energy range

18.5 MeV/u < E_{beam} < 250 MeV/u

-Example of reactions

50,54Ca + 40Ca, 68,70,72Ni + 58Ni, 106,112,124,130,132Sn + 112,118,124Sn …

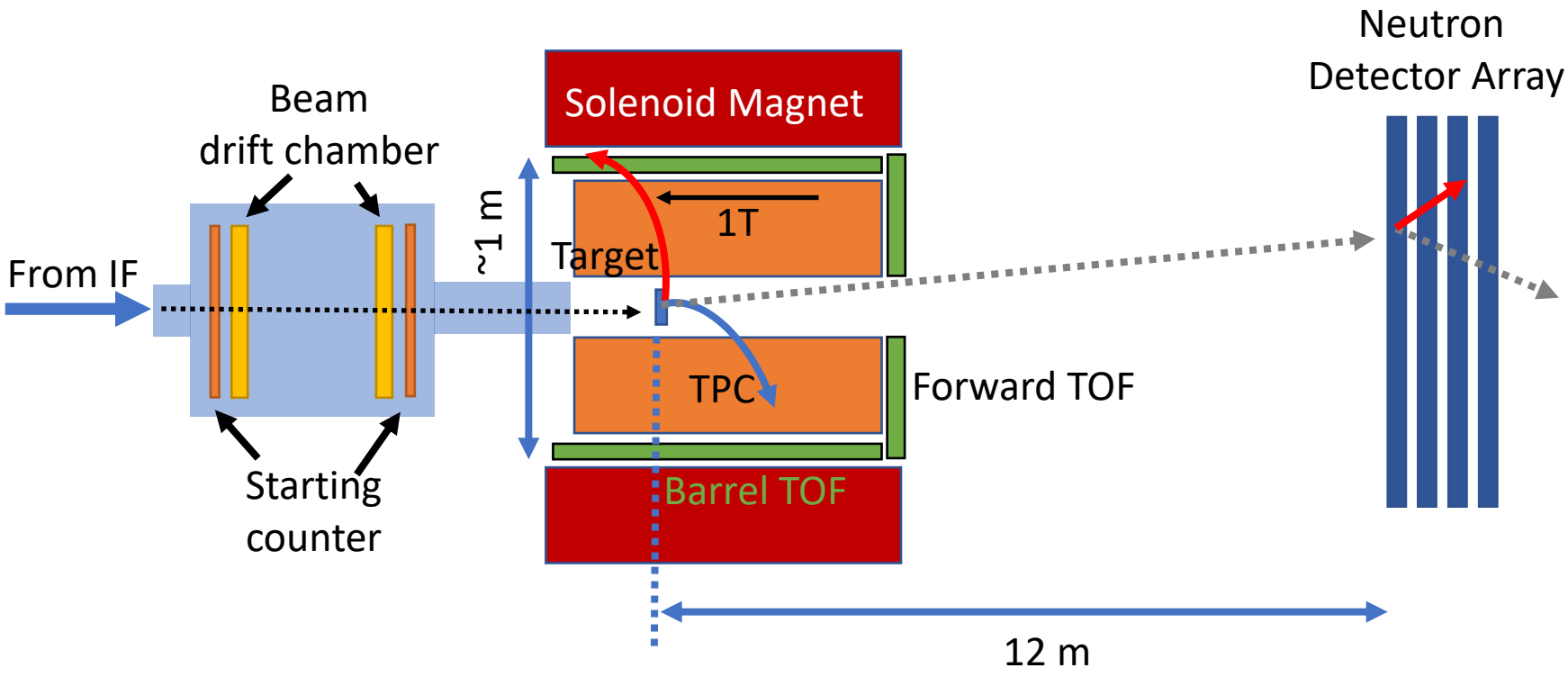
RAON is best facility for LAMPS

"LAMPS" is
Large Acceptance **Multi-Purpose** Spectrometer

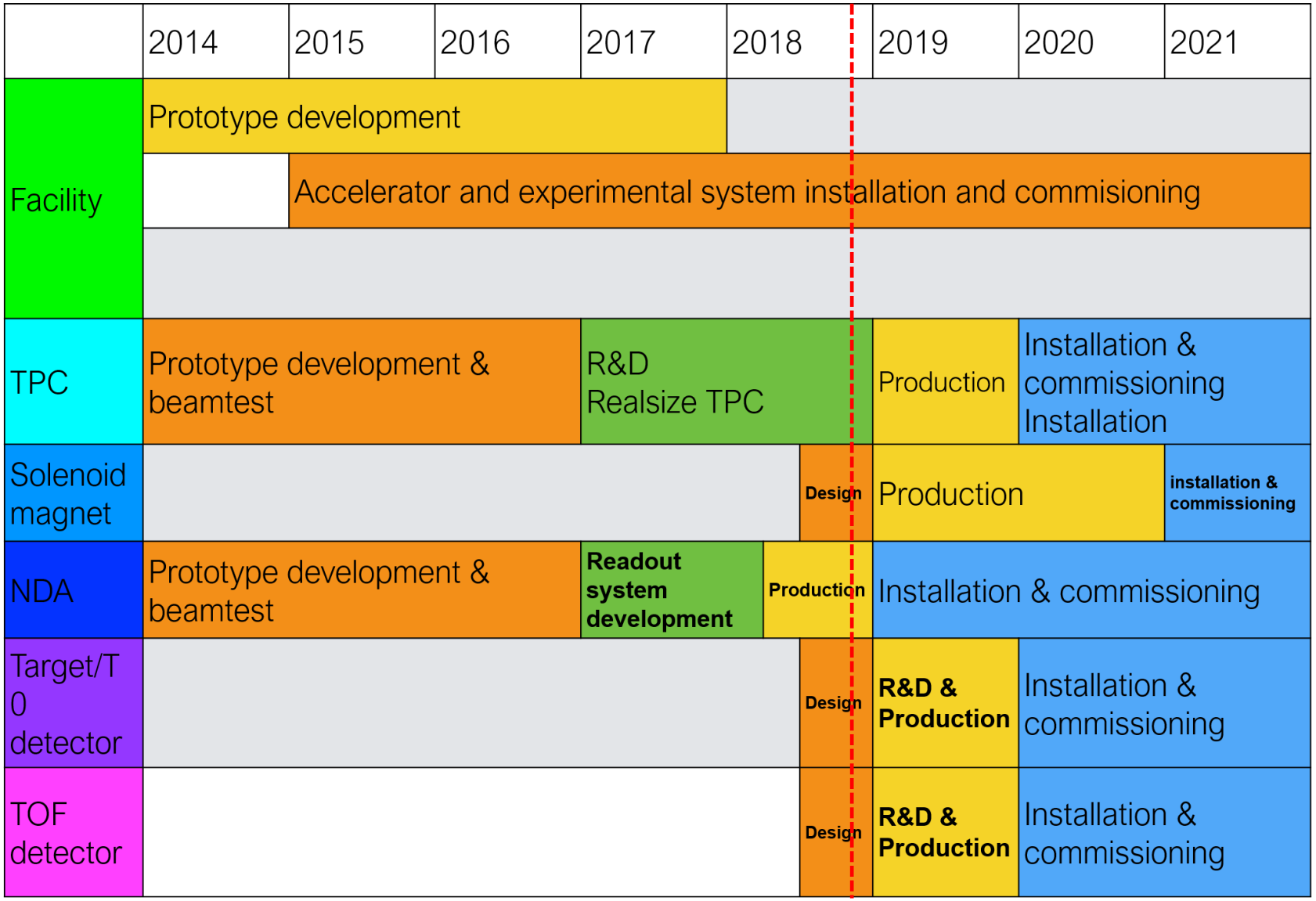
Measureable parameters

- Particle ratios: n/p, 3H/3He, etc.
- Pion ratio (π^-/π^+)
- Collective flow
- Electric dipole emission

LAMPS detector system



Status & Plan @ ATHIC 2018



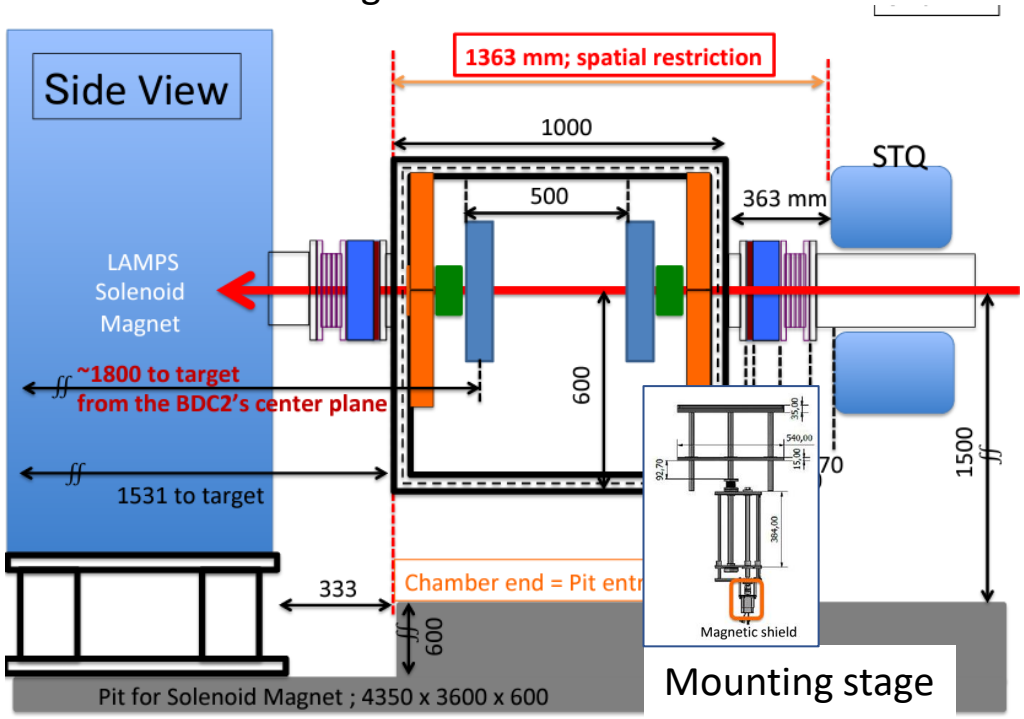
No detector was built in Nov. 2018

Upstream detectors

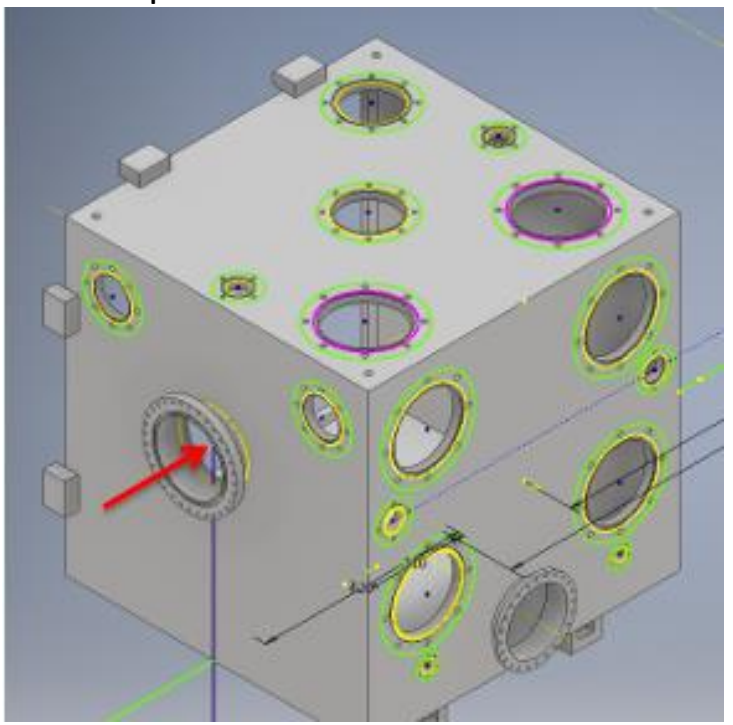
Upstream vacuum chamber
Starting counter
BDC

Upstream vacuum chamber

Arrangements in LAMPS hall



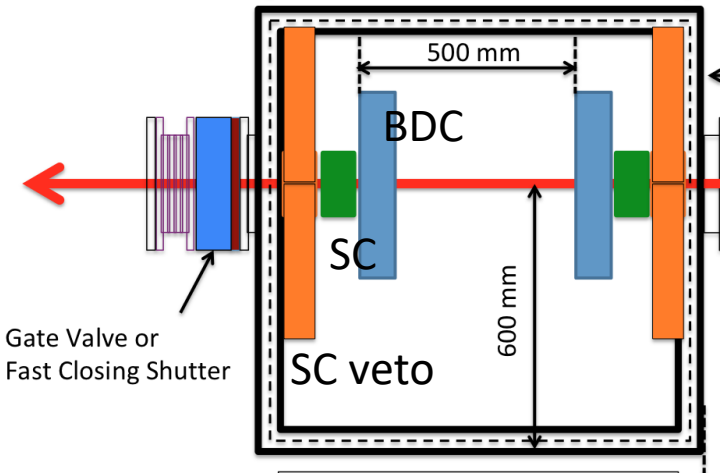
Upstream vacuum chamber



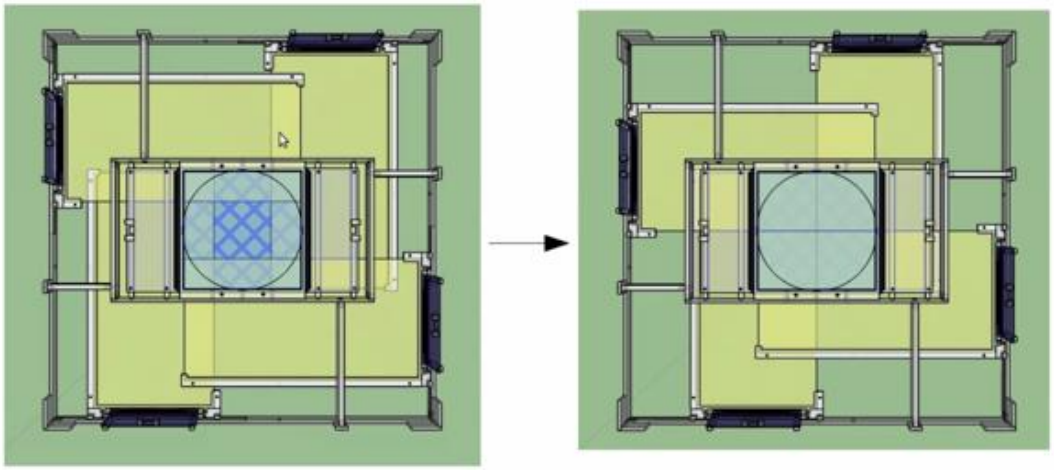
- Two detectors, Starting counter and Beam drift chamber, will be placed in vacuum chamber
- Positions of SC and BDC can be adjusted using servo powered mounting stage
- Almost ended production, will be installed in LAMPS beam line in 2021

Starting counter (SC)

Upstream vacuum chamber



SC active area adjustment



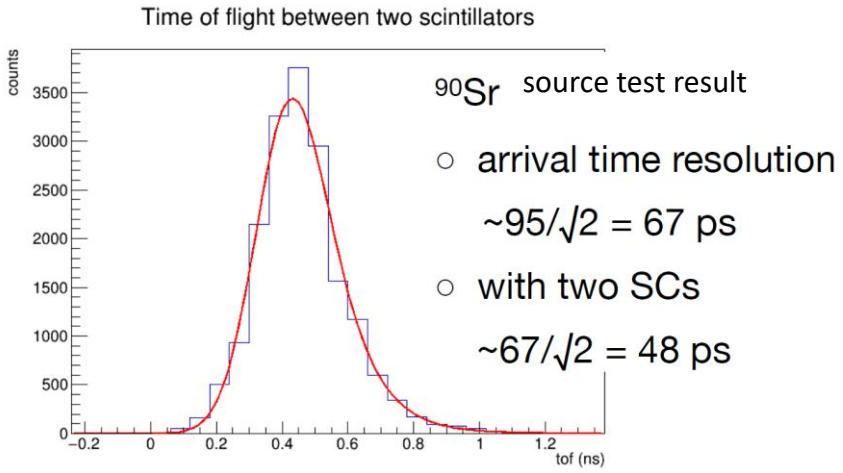
Features

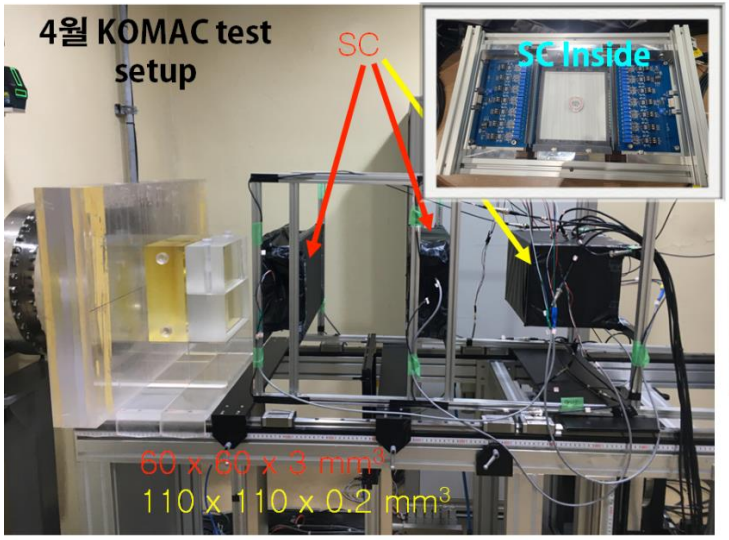
- Scintillator + MPPC (SiPM) + 4 movable veto scintillators
- Thin scintillator(0.2mm) : High rate heavy ion beam, suppress energy loss.
- MPPC(SiPM) array : Near solenoid magnet, increase light yield. Working in vacuum (cooling)
- Movable veto system : Select beam size.
- Two layer : Measure energy/timing of beam particle
- VME multi hit ADC / TDC readout electronics

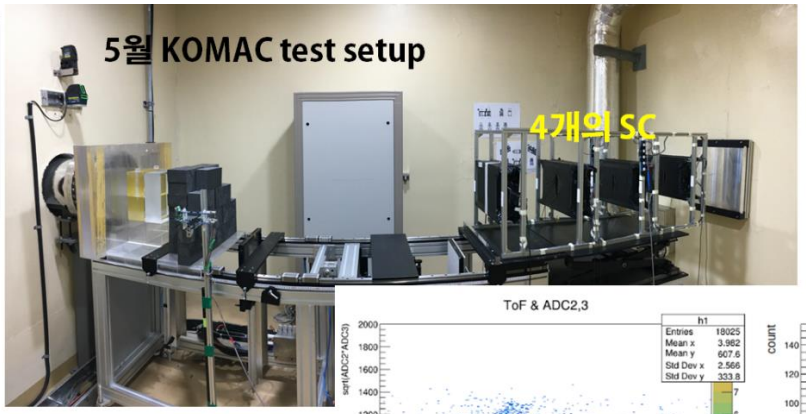
SC mppc array readout board

SC performance

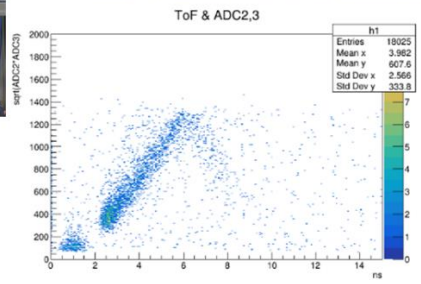
1. All detector component designs were done. <u>Detector construction will be end in 2021.</u>
2. Performance test was done with RI sources (α, β) and two times of 100 MeV proton beam test
3. Estimated two SC integrated timing resolution was ~70 ps.

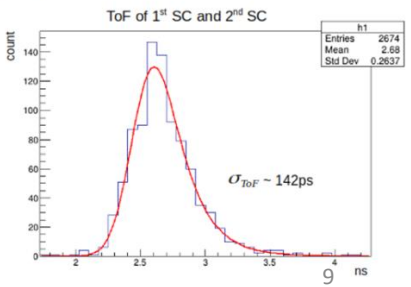




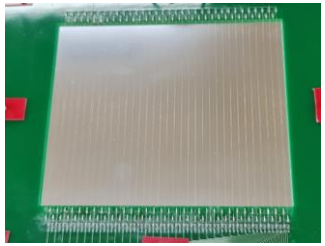


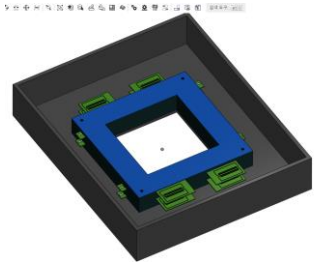
○ **arrival time resolution**
~142/√2 ~ 100 ps
○ **with two SCs**
~100/√2 ~ 70 ps



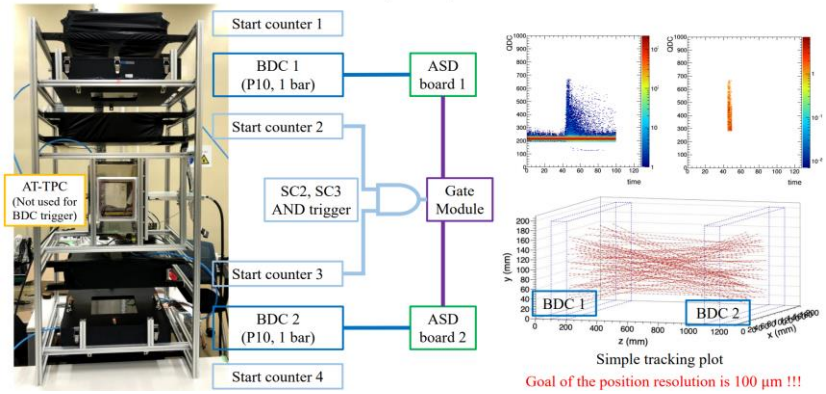


Beam drift chamber





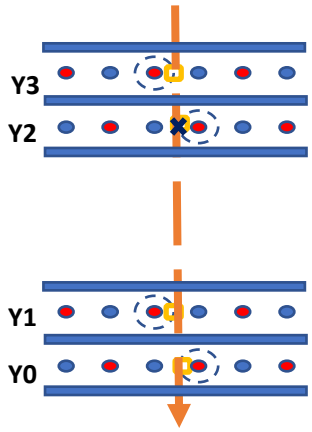
Beam Drift Chamber (BDC): Cosmic Muon Data



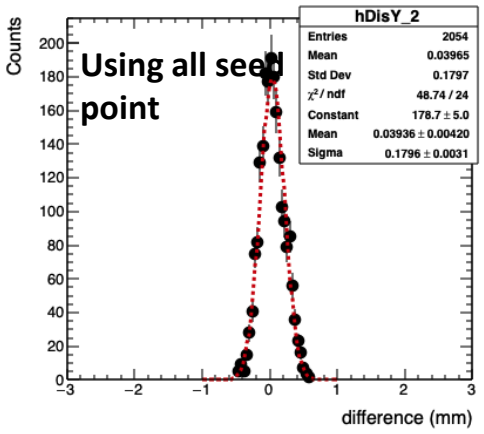
Goal of the position resolution is 100 μm !!!

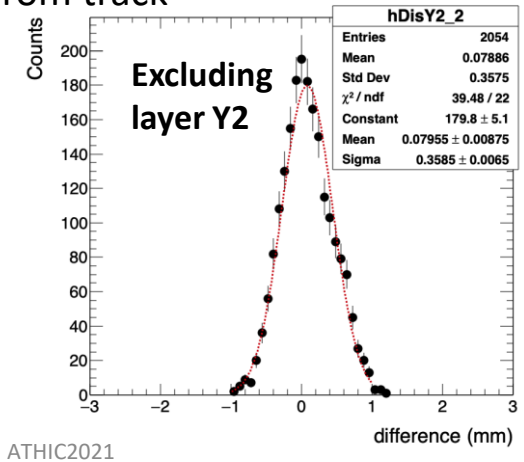
Features

- XX'YY'/ Module, 2 modules for beam particle tracking
- Position resolution 253 μm (Proto type)->goal 100 μm
- 2.5 mm wire-wire interval
- ASD board + VME TDC readout
- Proto type was built & tested.
- Will operate in vacuum chamber -> Under design

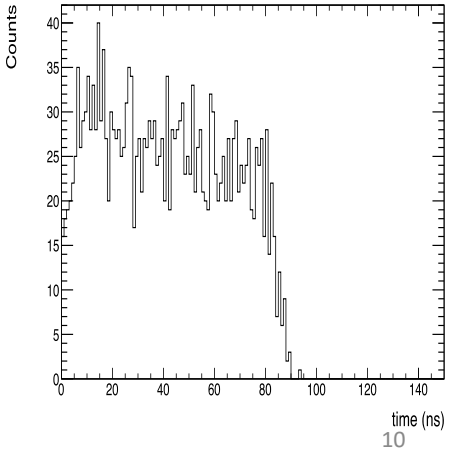


Residuals from track



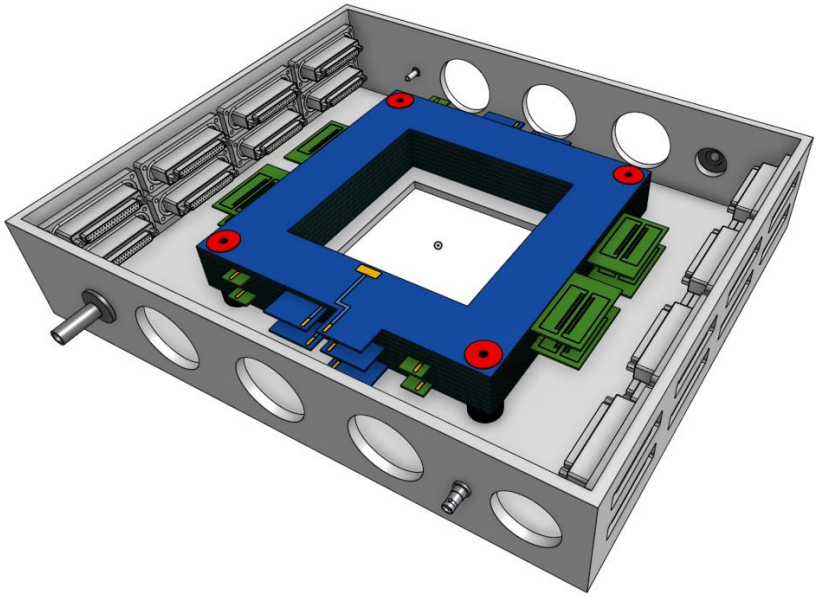


Drift time dist.

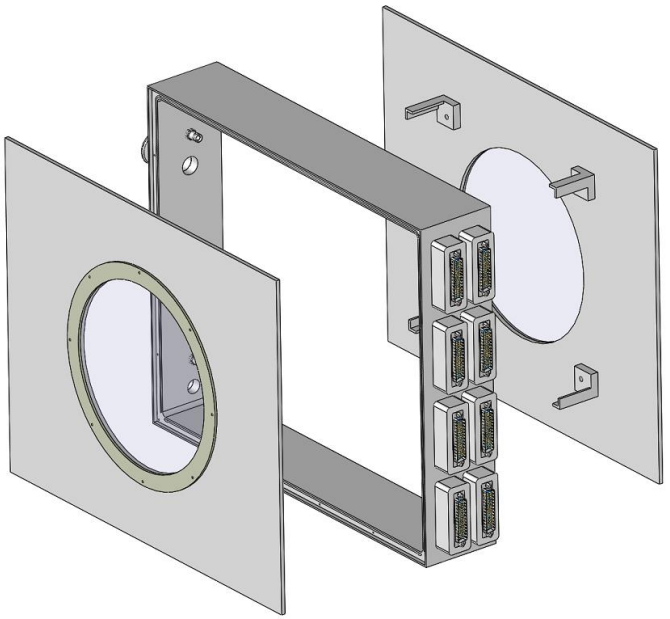


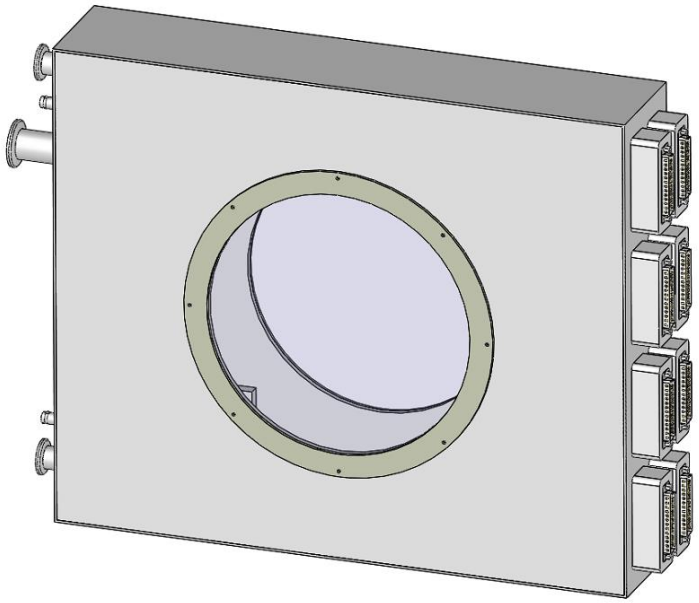
BDC Plan

Prototype v2 BDC



BDC for LAMPS



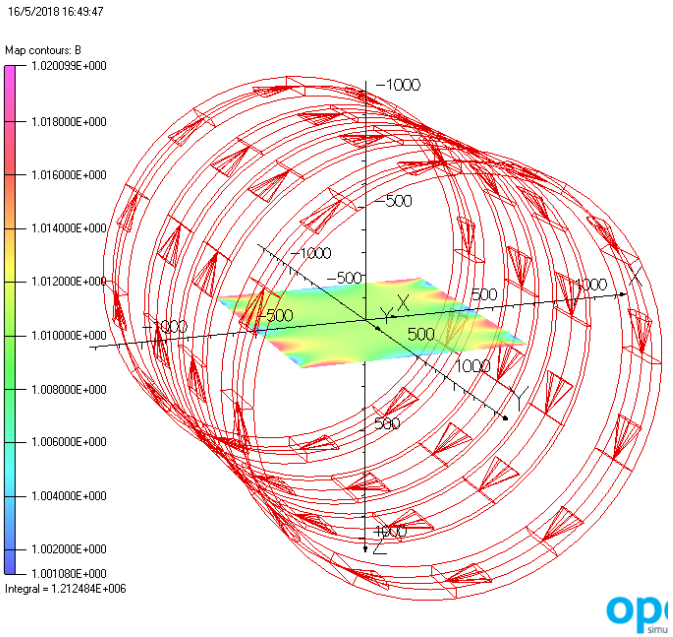


We plan to make another prototype BDC for several test till early 2022. <u>BDCs for LAMPS experiment will be produced in the first half of 2022.</u>

Spectrometer

Solenoid magnet
TPC
Barrel/Forward TOF

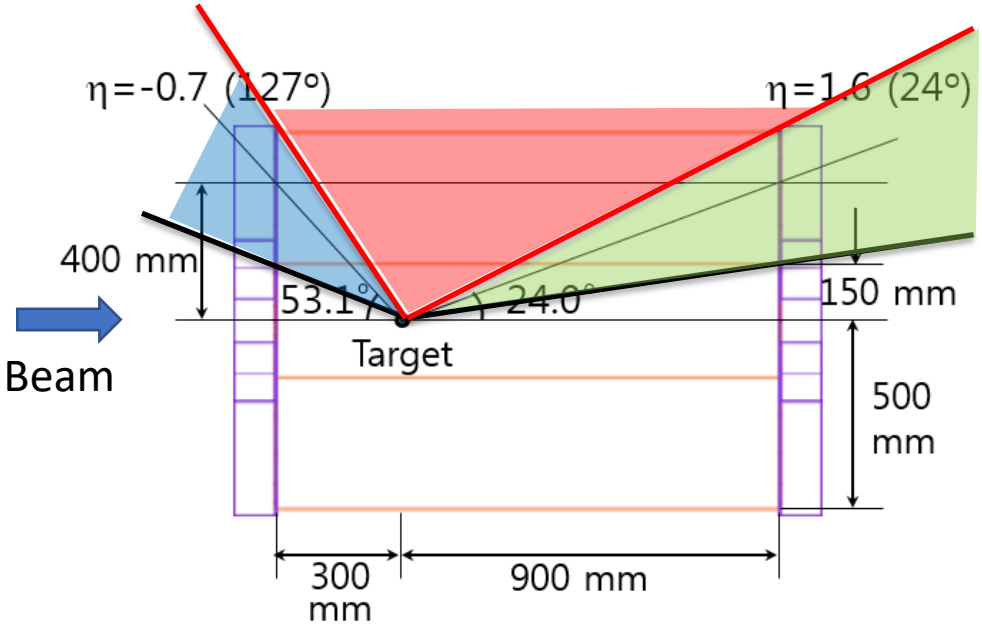
Solenoid magnet

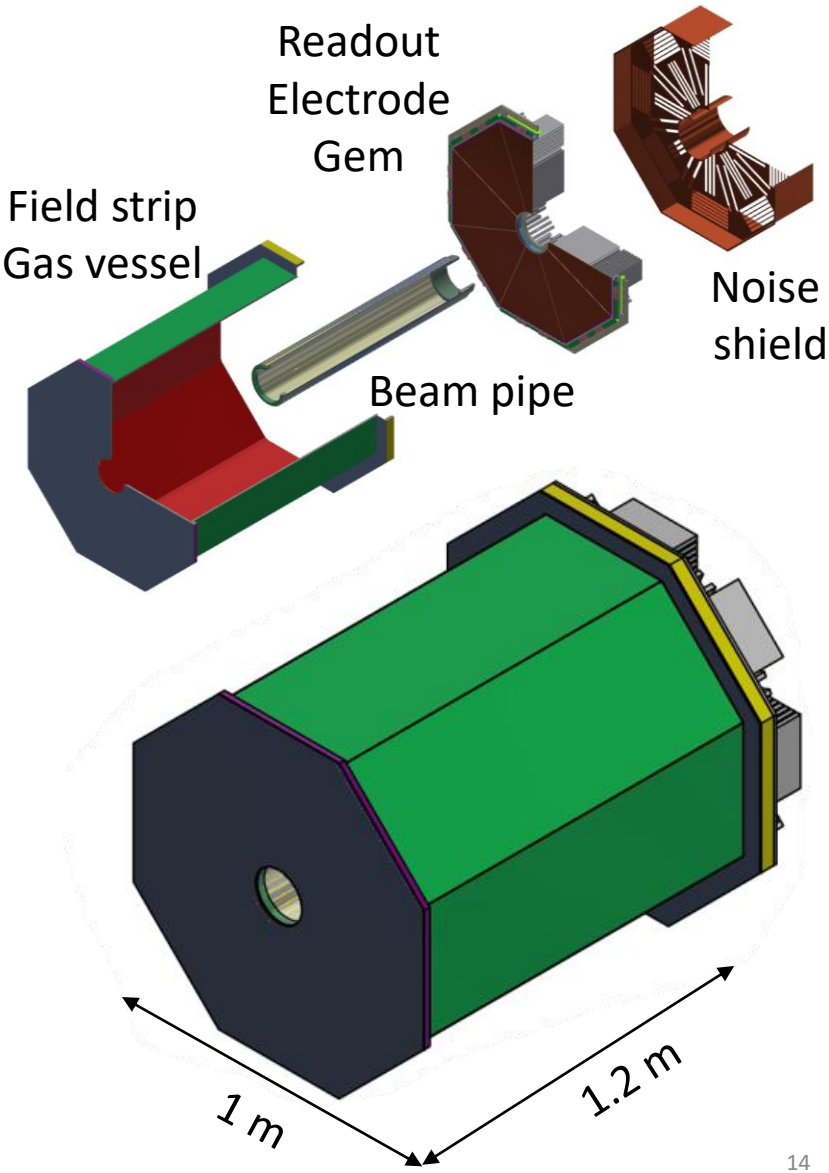


Features

- Field Intensity : upto 1T
- Field uniformity ΔB/B : 1.8 % (MC), Measurement undergoing
- Inner radious : 1.6 m
- Placed in LAMPS experiment hall for commissioning & field map measurement

Time projection chamber (TPC)





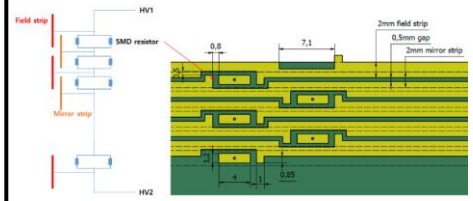
Features

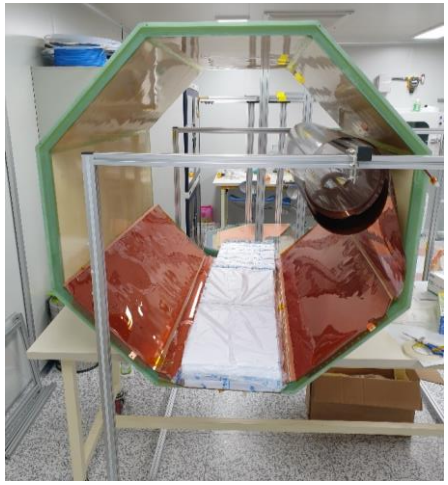
- Large acceptance TPC detector η : -0.7~1.6
- Gas volume : 1.2 m x 1 m octagonal prism shaped
- Drift length : 1.2 m - Drift velocity > 6cm/ms
- Quadruple GEM system - gain ~ 10^4 @ P-20 gas
- Gas vessel : rohacell + G10 sheet- t/X_0 ~ 1.45%
- Readout channel : 21,512ch
- DAQ : GET system (88AsAd – 22CoBo – 3mTCA)

TPC production

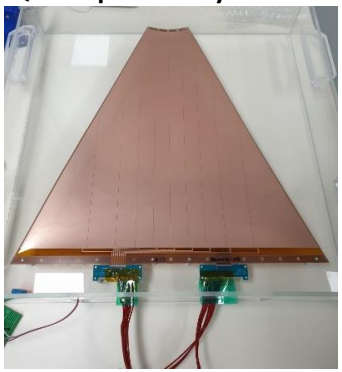
2019 - 2021

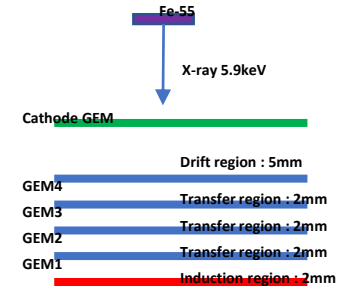
Field Strip

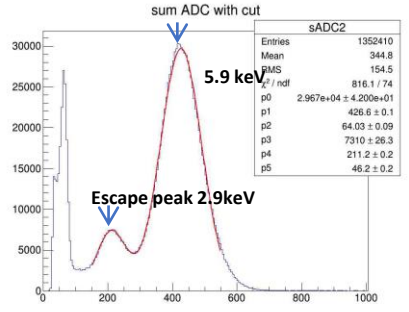


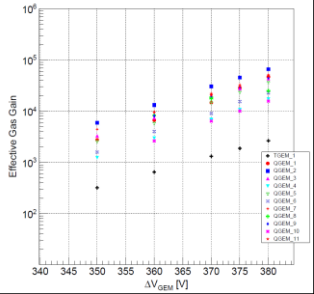


Quadruple GEM system

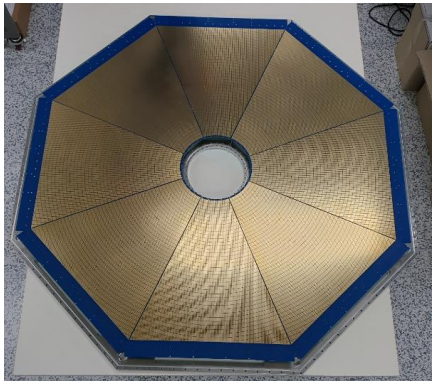


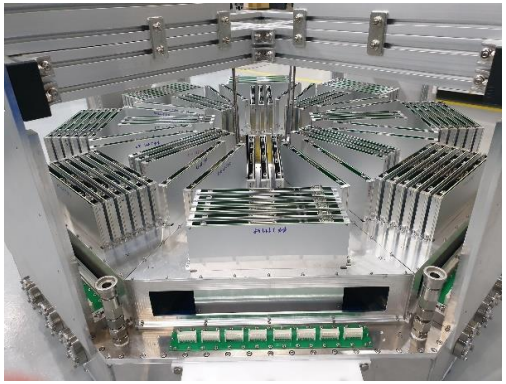




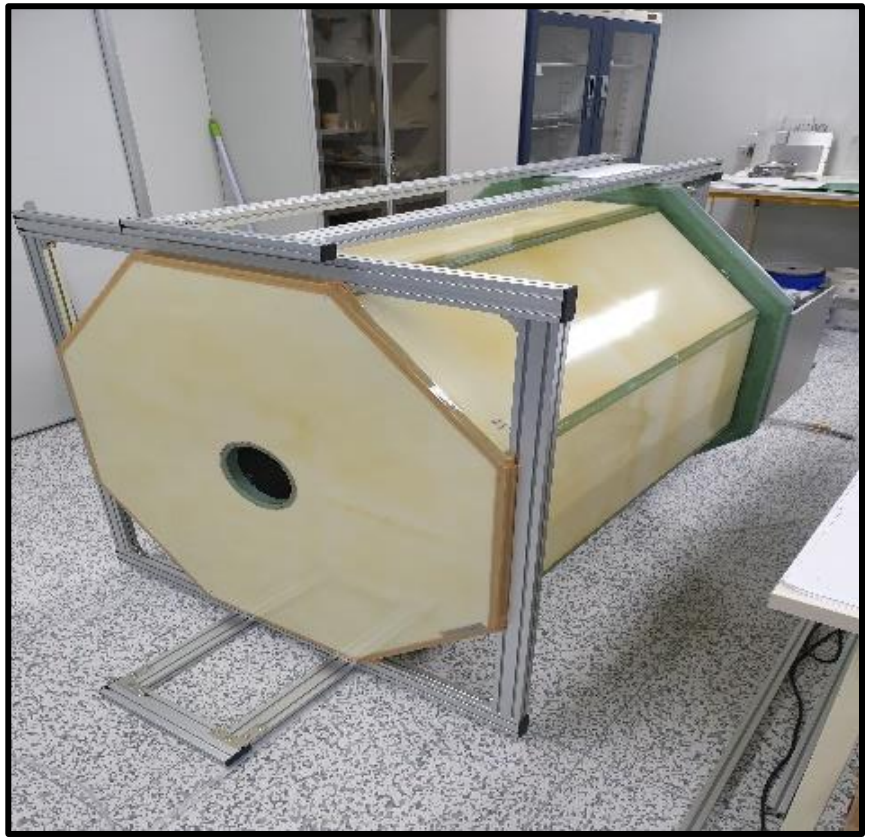


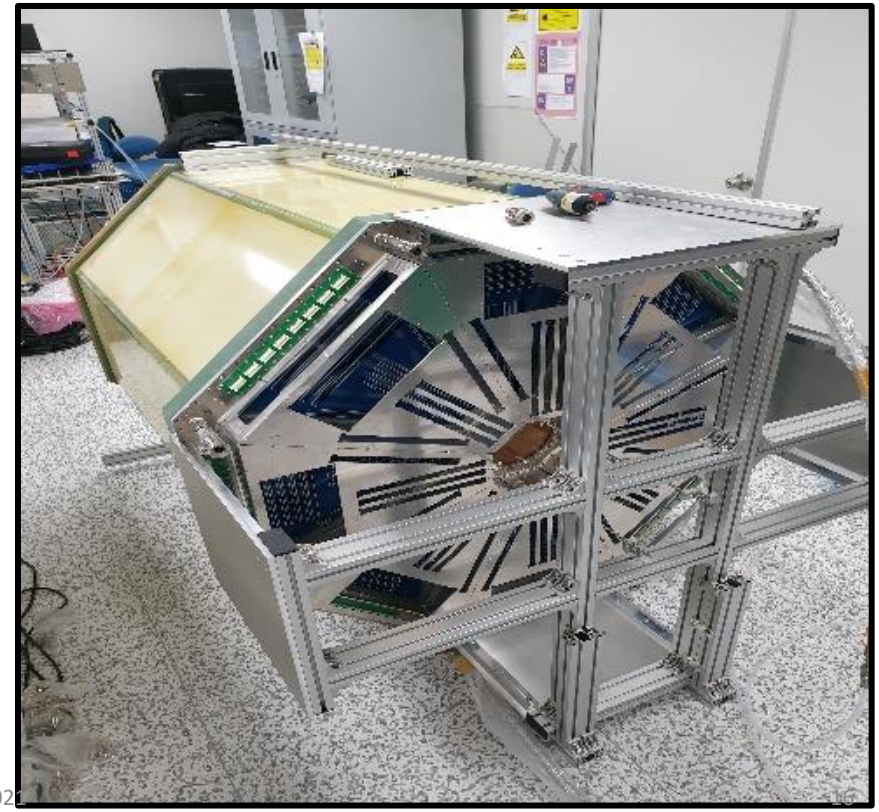
Readout system



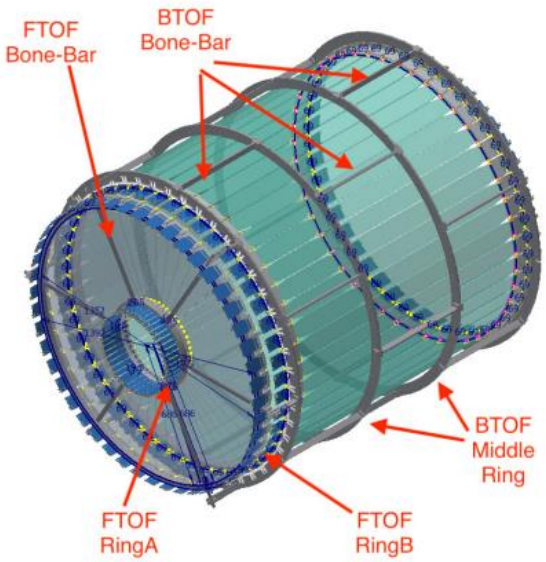


Integration



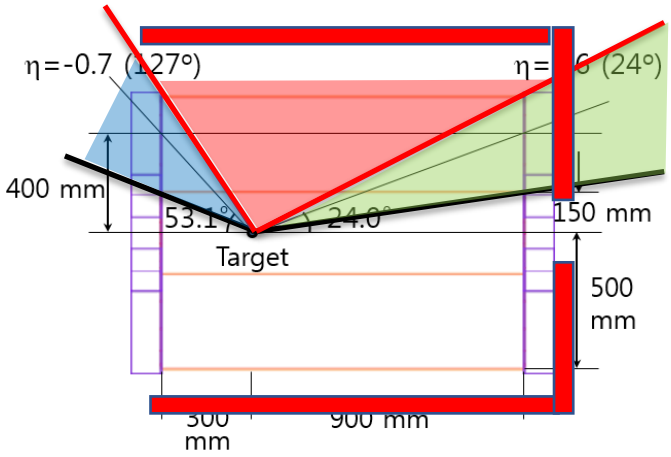


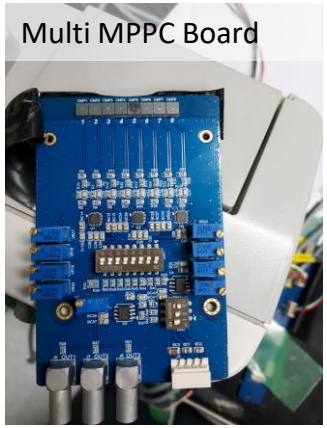
Barrel/Forward TOF



Features

- BTOF
  - 48 segmented scintillator bar
  - 5 MPPC array for both side : Light yield, Magnet
  - Timing resolution < 150 ps
  - Position resolution ~3 cm
  - Measure charged particle tof of η -0.7 ~ 1.6 (Barrel side)
- FTOF
  - 48 segmented trapezoid shaped scintillator
  - 8 and 3 MPPC array for both side : Light yield, Magnet
  - Timing resolution : ~142 ps
  - Position resolution ~ 3 cm
  - Measure charged particle tof of η > 1.6 (forward)

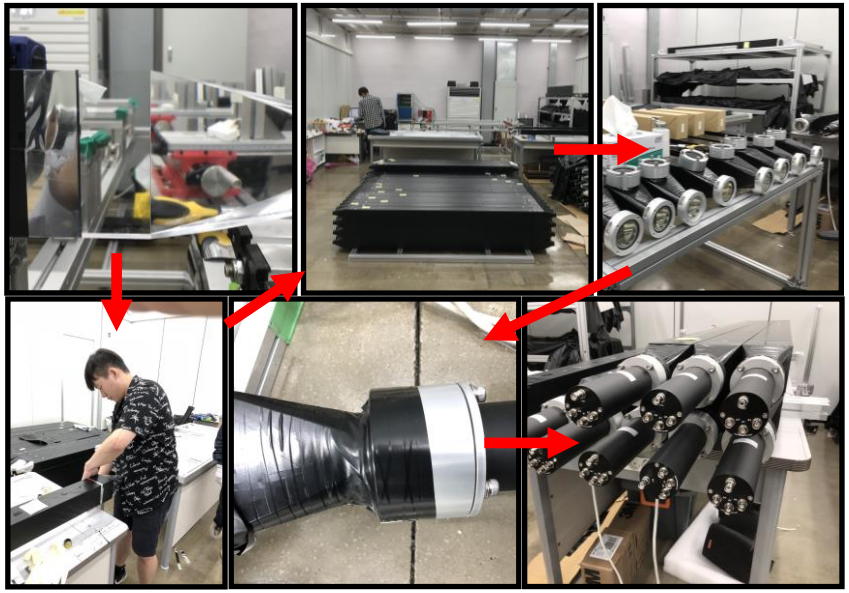




Detector construction will be ended in 2021

Neutron detector array

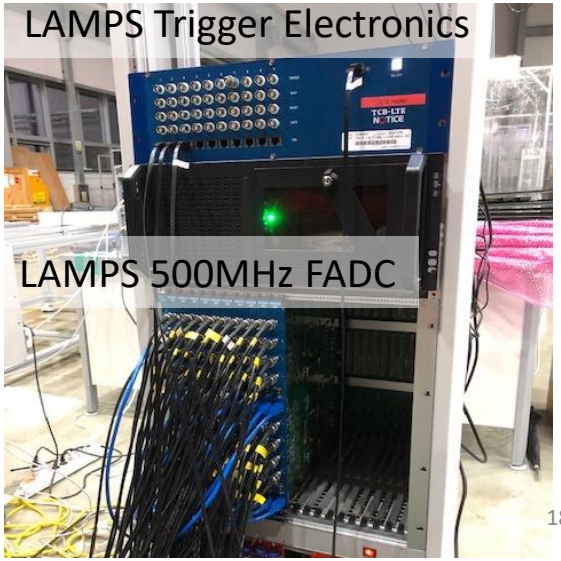
2018 ATHIC



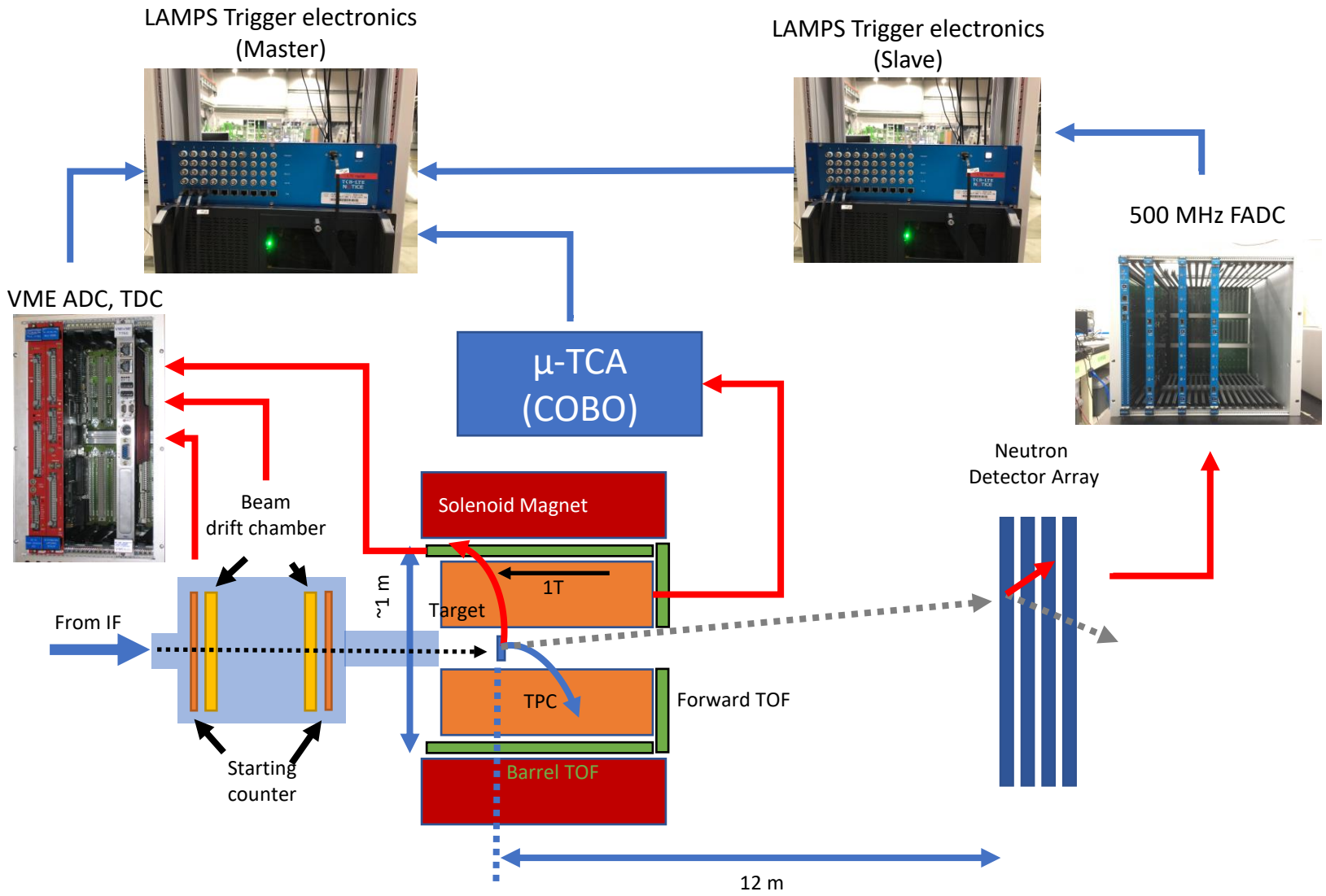
2019-2021

Features

- 160 x {Thick (10 cm x 10 cm x 2m) scintillators + 2 PMTs} for 4 layers
- 80 x {Thin (1 cm x 10 cm x 2 m) scintillators + 2 PMTs} for VETO
- 2x2 m^2 detection area, 80 cm thickness
- Neutron detection efficiency/layer: ~17% (65 MeV), 12% (392 MeV)
- Timing resolution 301 ps (FWHM)
- Position resolution 4.6 cm (FWHM)
- VETO plane for all 4 layers : Flexible setup for increase acceptance. Reduce recoil proton contamination.
- 500 MHz FADC readout for multi-hit suppression

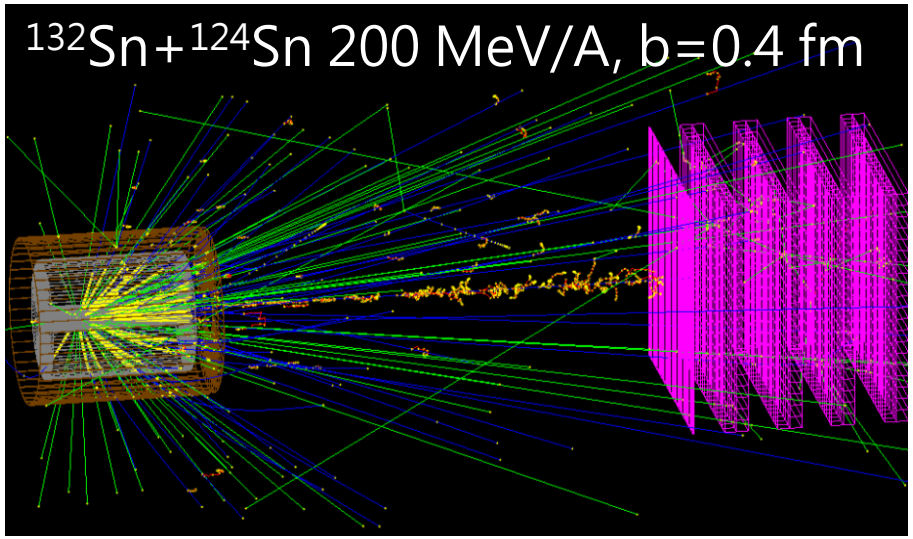


Data readout electronics



All trigger information are sent to LTE, LTE decides to issue trigger based on trigger map.
All data readout computers are connected to 10G networks, send data without bottle neck.

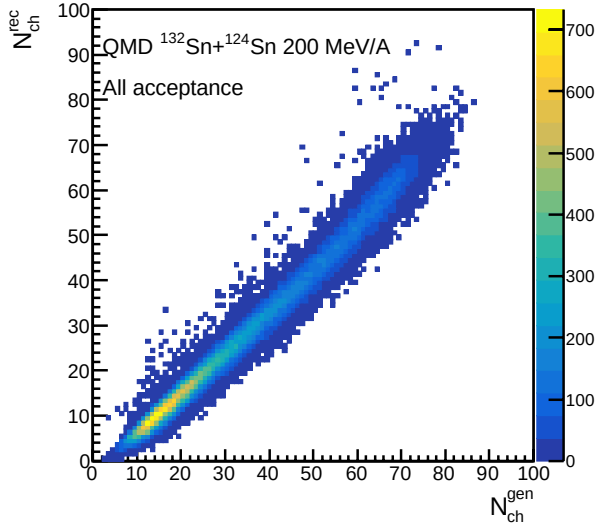
MC



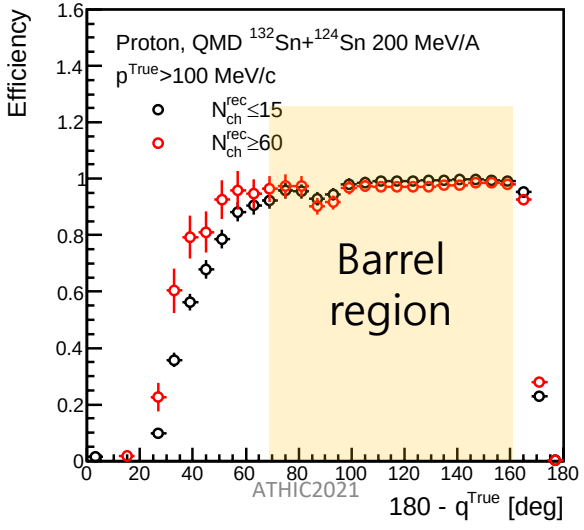
Generalized analysis framework (KEBI) is under development.

- Geant4 based
- Track and vertex reconstruction with Genfit2 and RAVE
- > 95% track reconstruction efficiency
- ~3% momentum resolution for proton

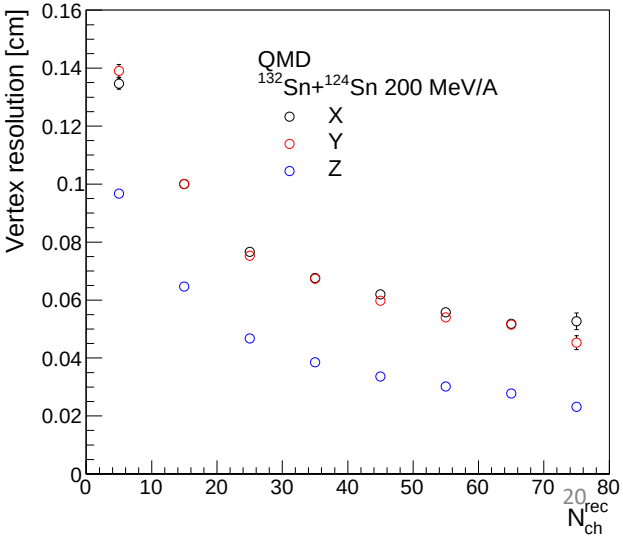
Correlation between # of gen. and rec. tracks



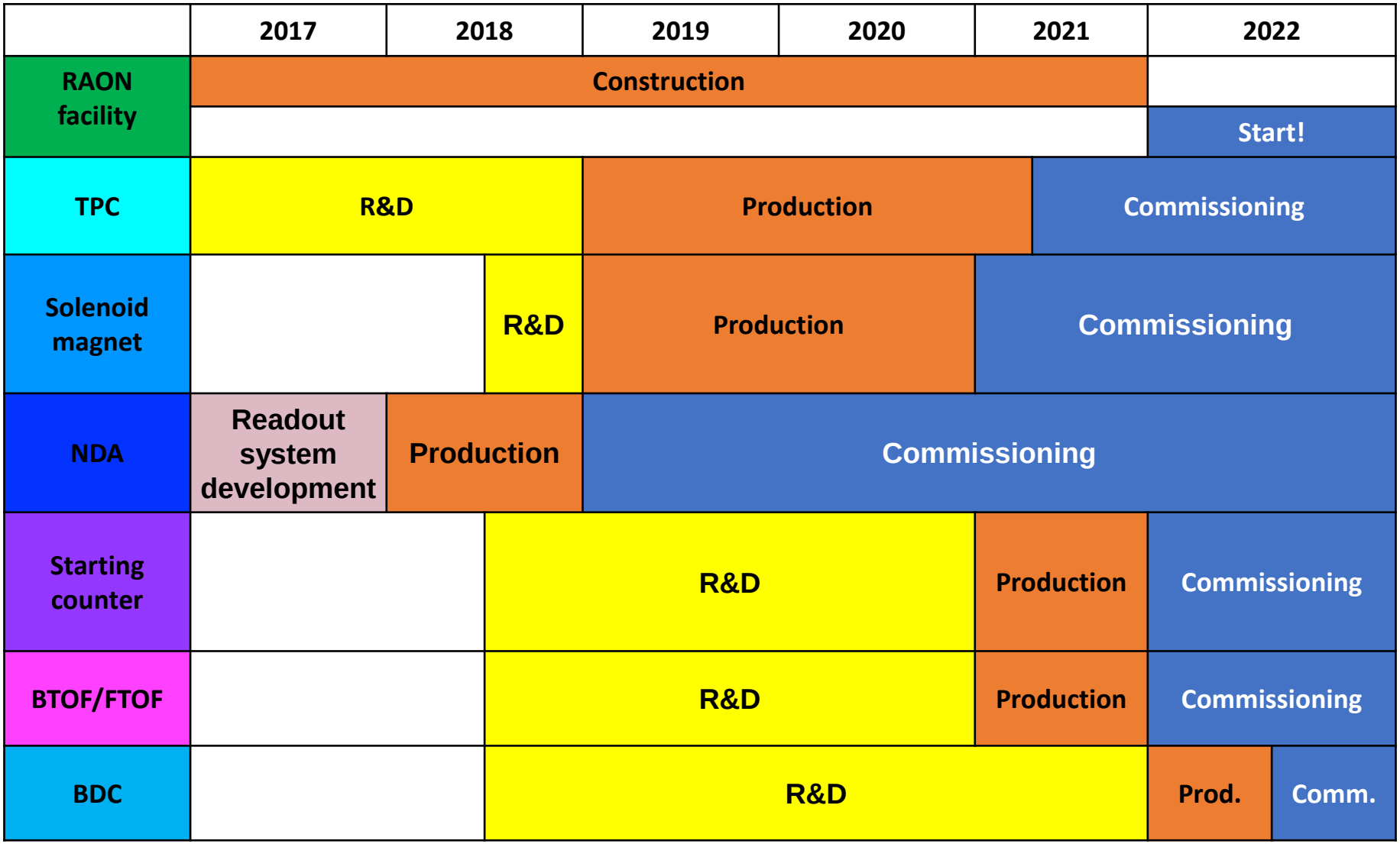
Efficiency vs theta



Vertex resolution



Summary



All detector will be prepared in mid 2022

Detector system

Detector	Type	Role	Performance	Purpose
Starting counter	Plastic scintillator	Time origin, Beam rate, Energy	High rate tolerance (10^6 pps) Timing resolution 100 ps	Beam diagnostic, T_0
Beam drift chamber	Gas Drift chamber	Beam shape, Interaction point on target	High rate tolerance (10^6 pps) Position resolution 300 um	
TPC	Gas Time projection chamber	Momentum of Charged particle	Momentum resolution	Charged particle energy/momentum
Barrel/Front TOF	Plastic scintillator	Energy, Momentum (TOF, charged particle)	Timing resolution 150 ps Position resolution :	
Neutron detector array	Plastic scintillator	Energy, Momentum (TOF, charged particle)	Timing resolution 300 ps	Neutron energy / momentum

Additional detectors for forward charged particle is under studying .