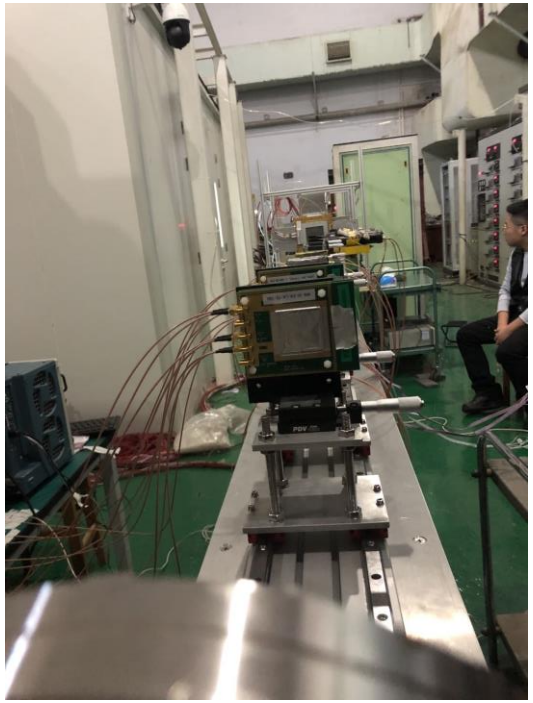
Study of Sc-ECAL at the BEPC testbeam facility

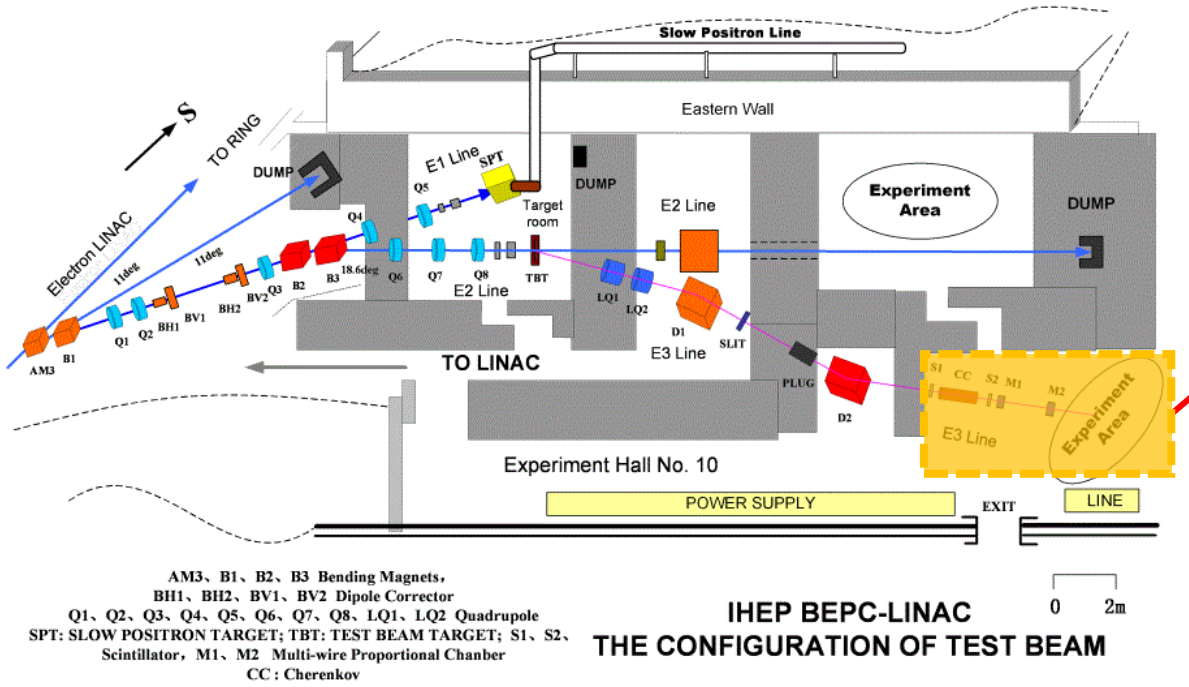


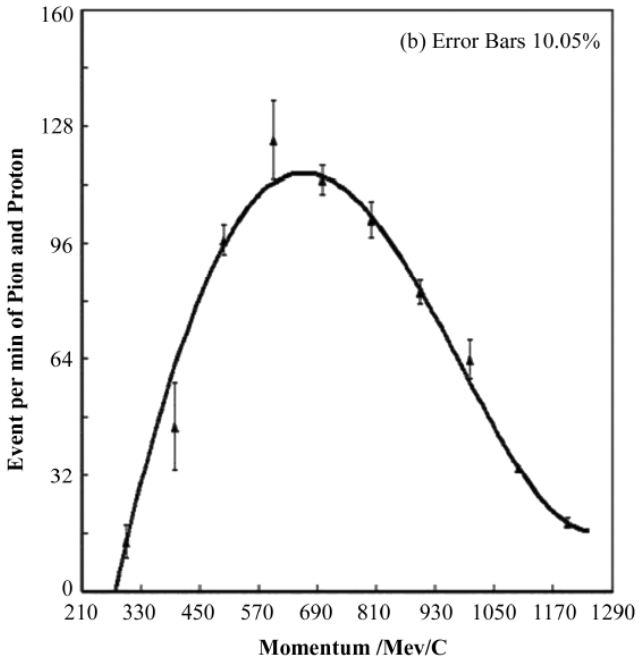
Yazhou Niu

On behalf of the CEPC Calorimeter working group

CEPC DAY
November 25, 2020

IHEP beam line facility

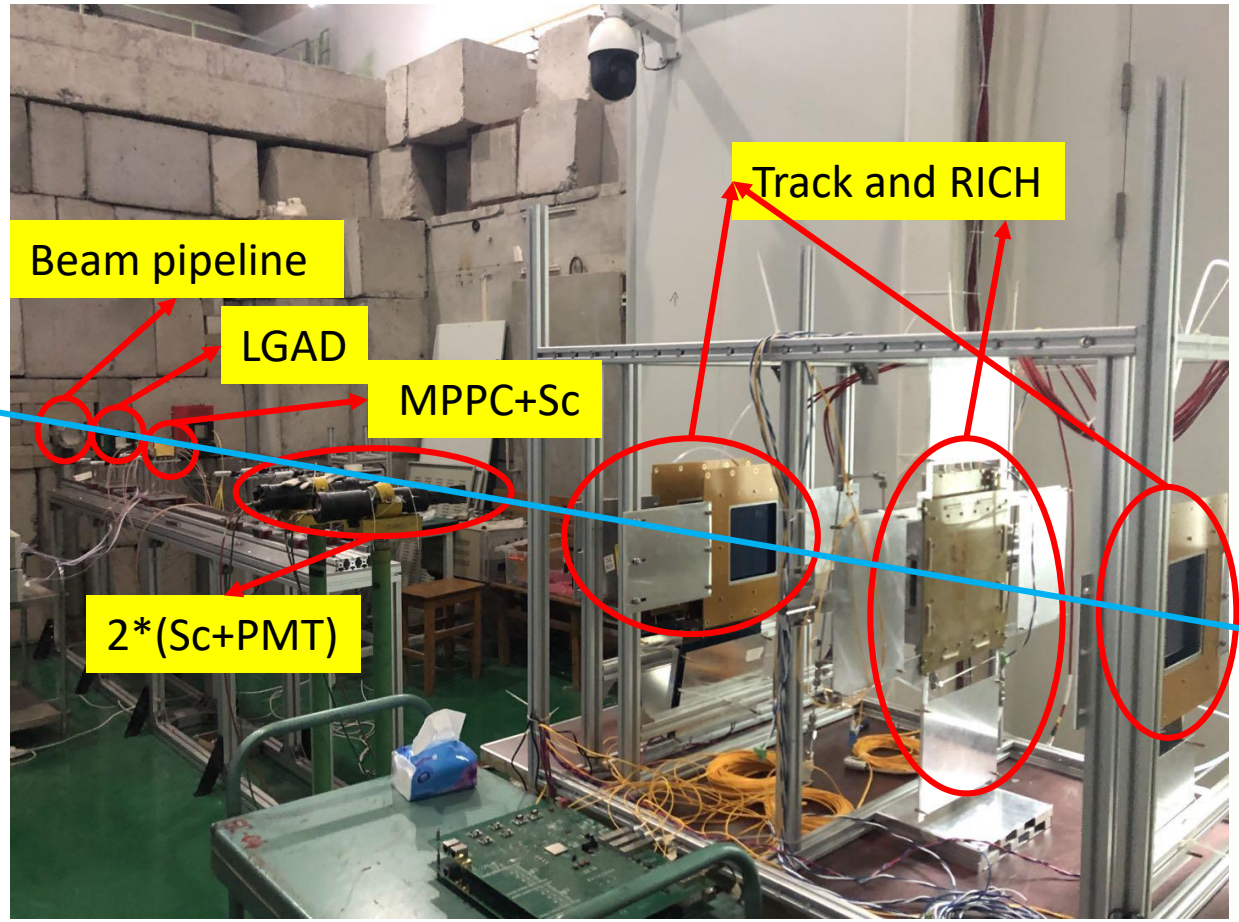




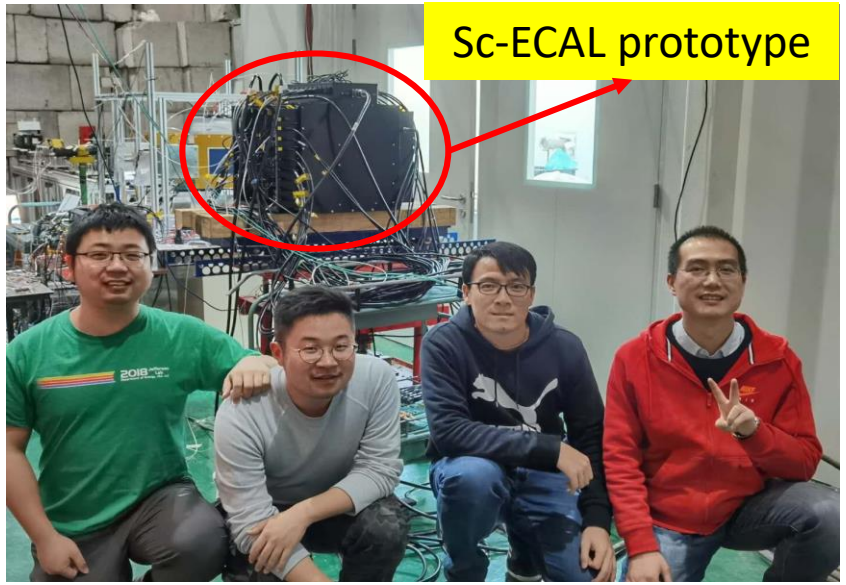
Nuclear Techniques, Vol.34, No.4 (2011)

- E3 beam line: secondary particle beam
  - Mixed with proton/pion: proton dominate
  - Momentum : 300MeV-1.2GeV
  - Event rate: less than 100 per minute

Under detectors

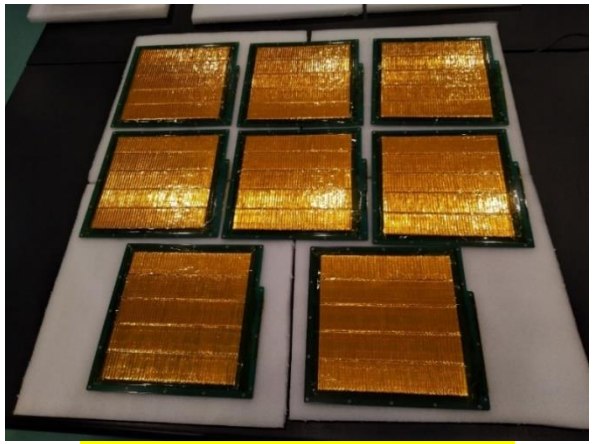


- Participants of Sc-ECAL BT
  - USTC: Yunlong Zhang, Zhongtao Shen, Yazhou Niu, Anshun Zhou, Yukun Shi
  - IHEP: Zhigang Wang, Mingyi Dong, Jiechen Jiang
  - SJTU: Yanyun Duan, Danning Liu

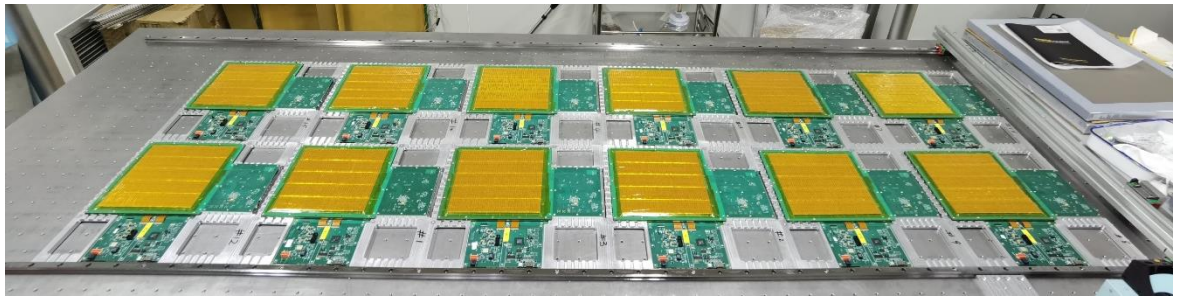


CEPC Sc-ECAL prototype

scintillator strips

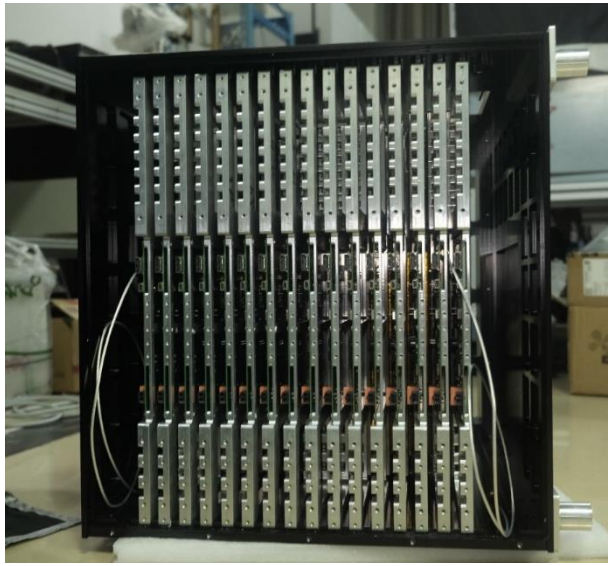


Ecal Basic Unit (EBU)



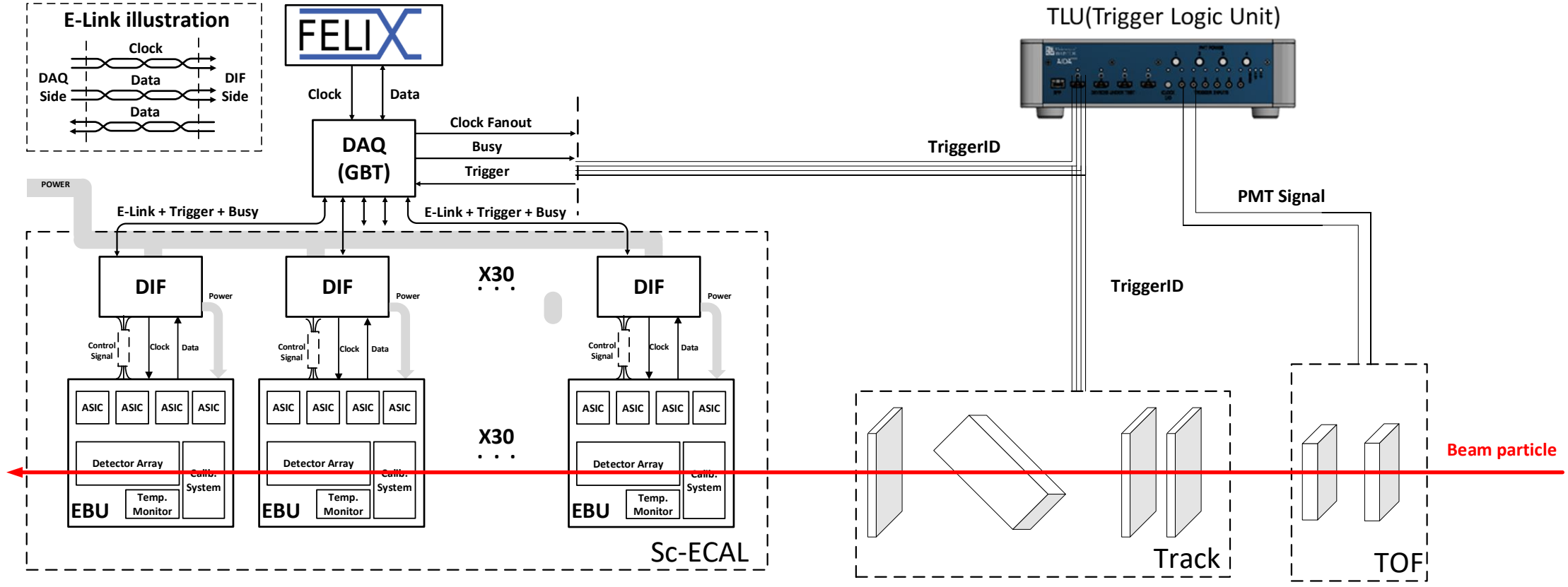
Super-layer

- 210 strips coupling with SiPM channels in one EBU
- 32 EBU layers and 32 DIF layers produced
- 16 super-layers in total, one is DR by Wataru's group
- Sc-ECAL prototype fabricated, fans cooling and light shield also integrated

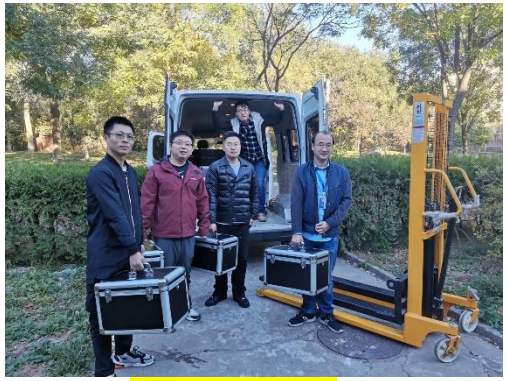


Sc-ECAL prototype

Trigger logic for test beam



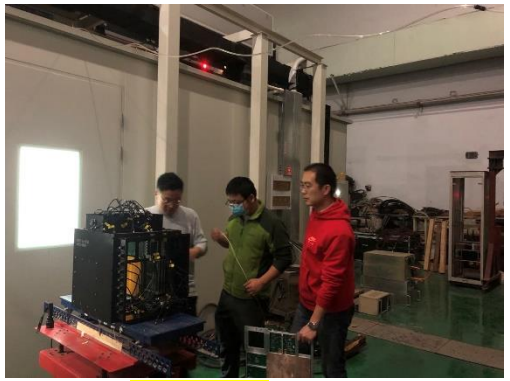
Timeline



transport

10.23

10.25



setup

10.27

10.28

beam optimization

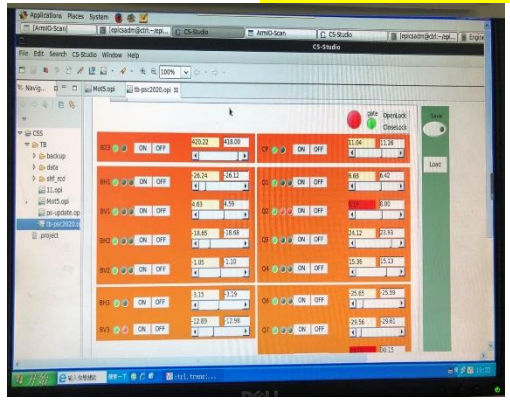
10.30

11.3

commissioning

beam supply

data collection finished

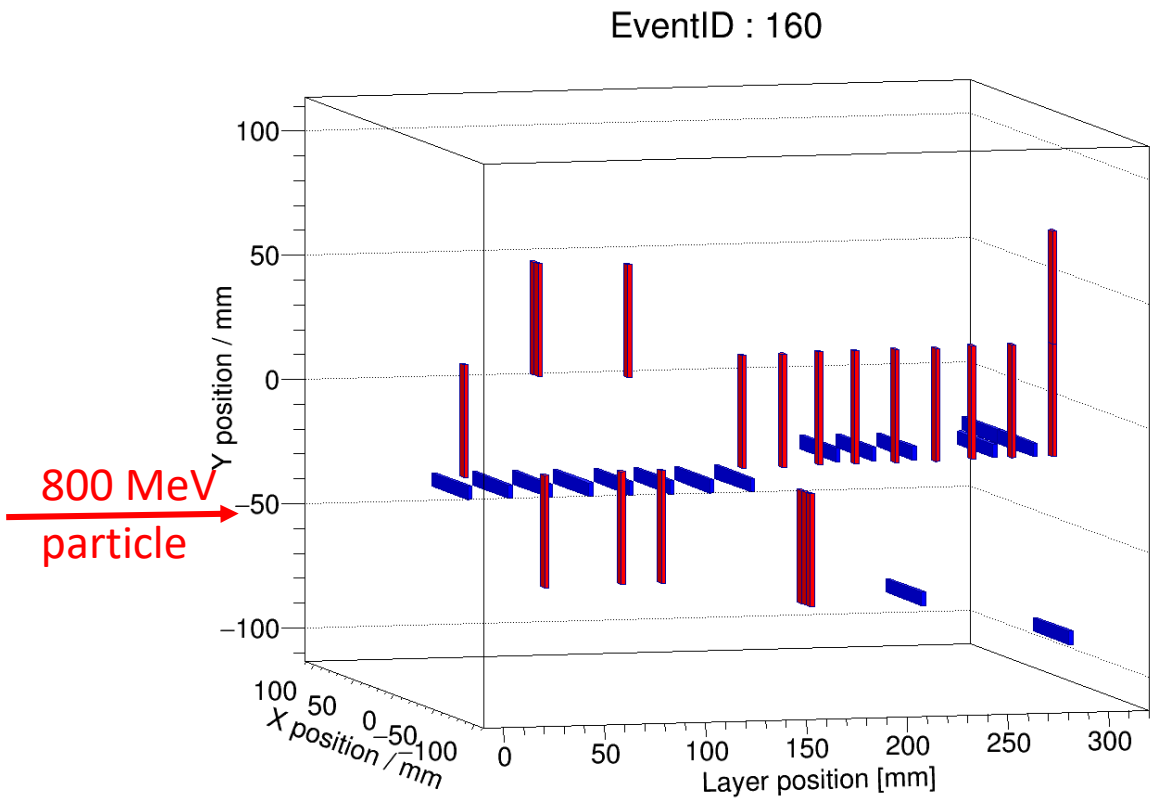


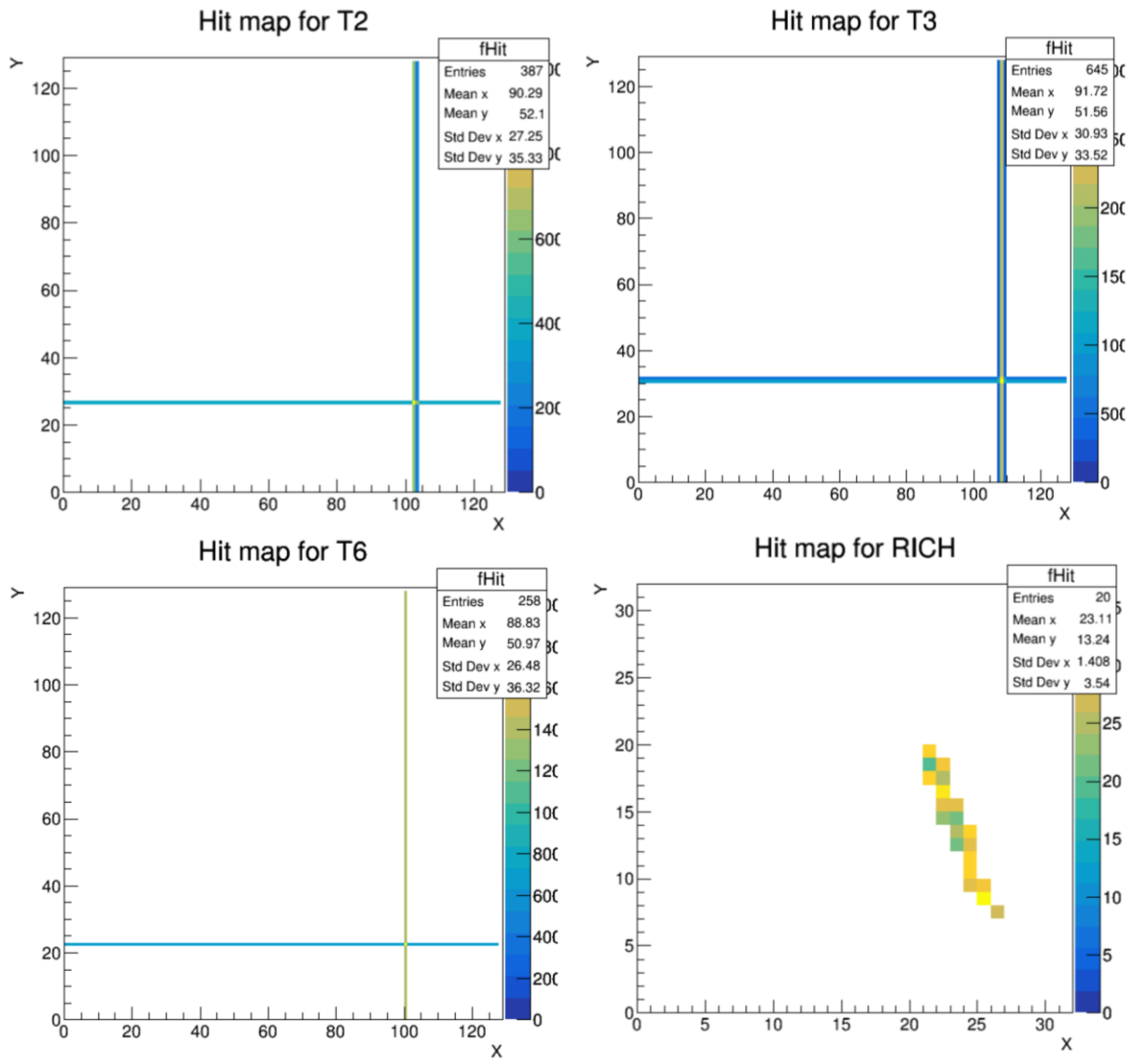
Beam Test Data Collection

Date	Beam Momentum	Trigger	Events
20201028	800 MeV	ECAL L1&L2	90789
20201029	800 MeV	ECAL L1&L2	20117 + 17866 + 57655
20201030	500 MeV	TOF	874
20201031	500 MeV	TOF	296 + 1243 + 173 + 2564 + 1445
20201101	800 MeV	TOF	626 + 1729 + 1544
20201101	1 GeV	TOF	1566
20201102	500 MeV (Cu Target)	TOF	71 + 28 + 178
20201102	1 GeV	TOF	728

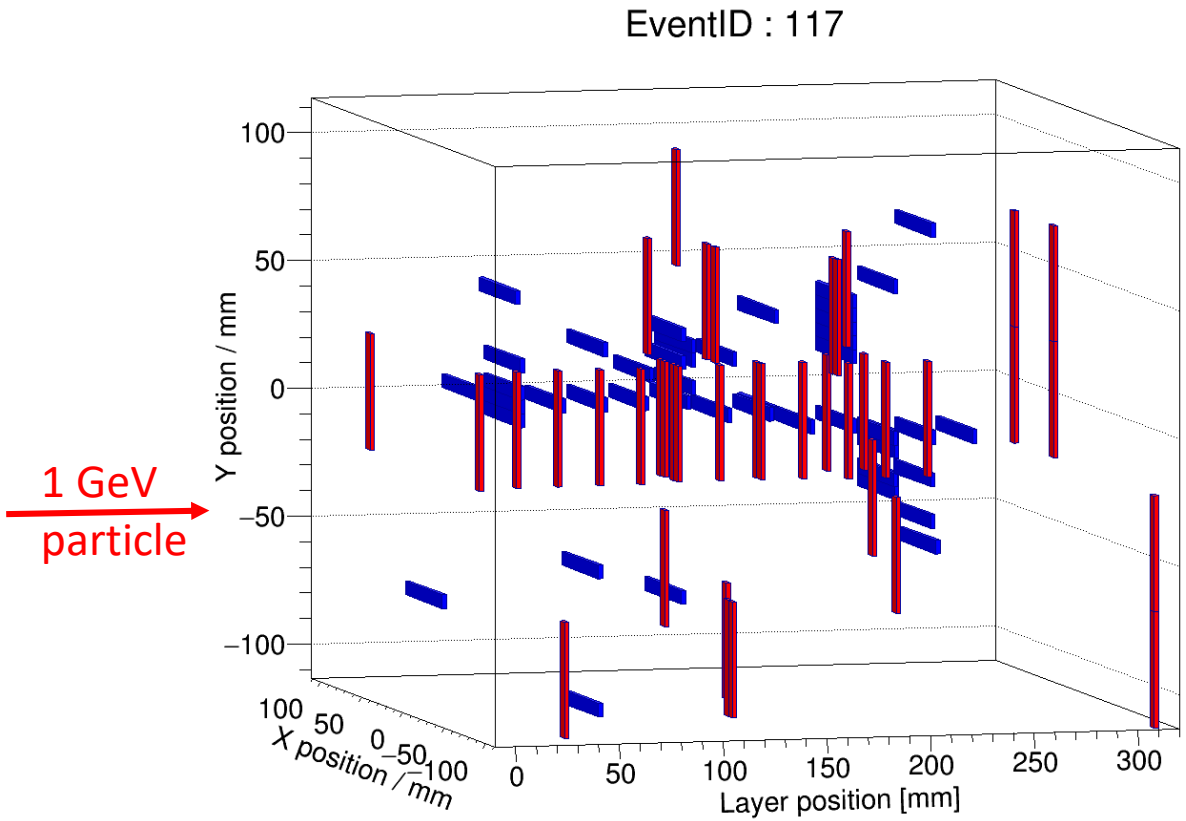
- Three momentum, namely 500 MeV, 800 MeV, 1 GeV
- Total 12 thousands events have been collected

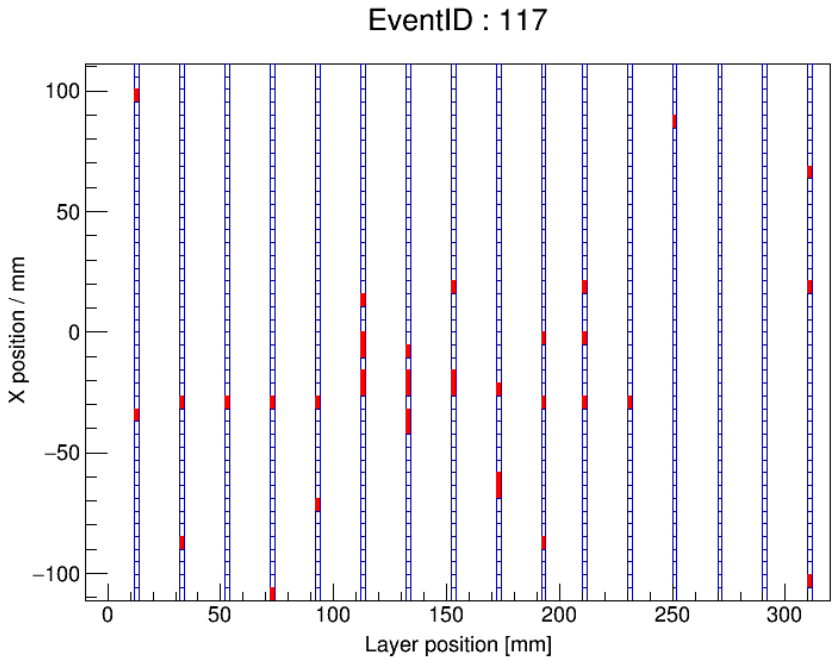
Event build with track

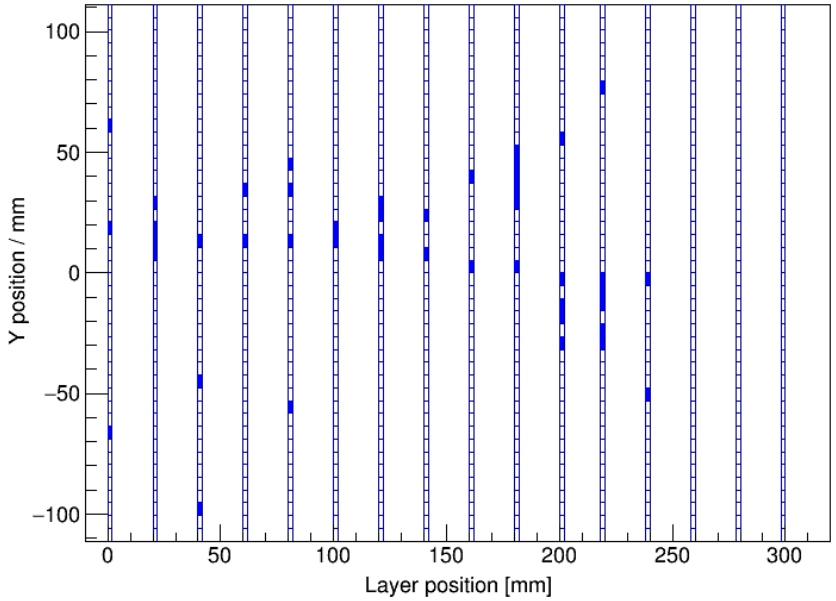




Proton candidate event

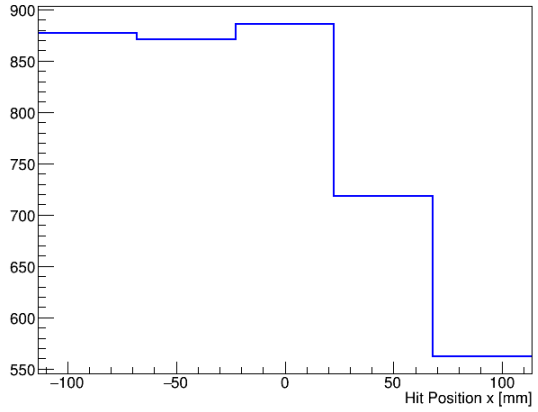


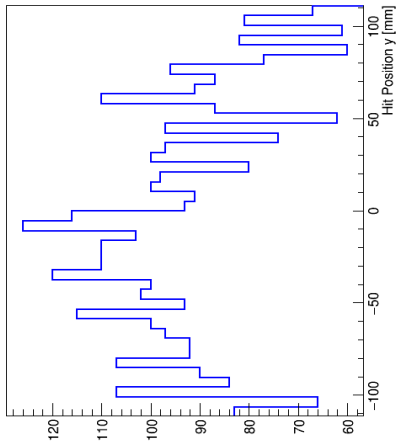


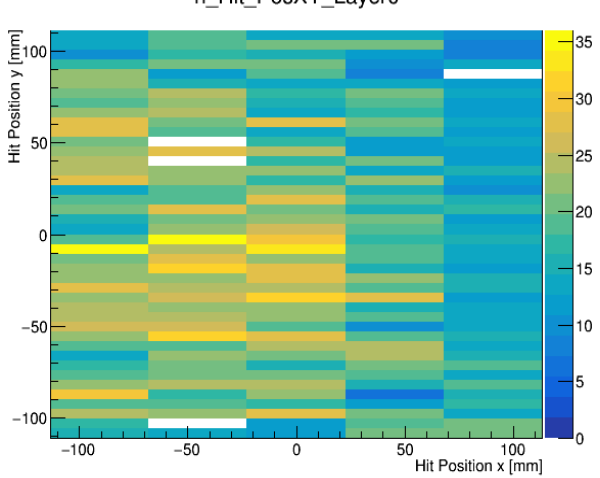


Beam test results I

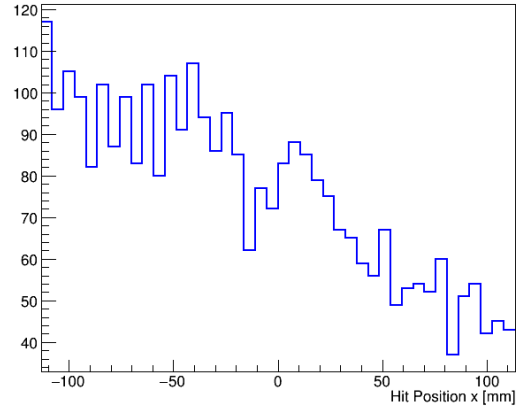
Layer0

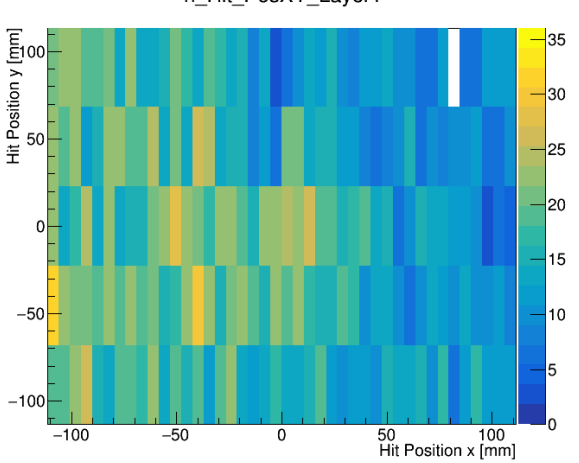


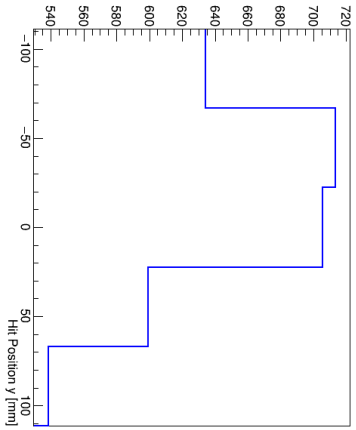




Layer1

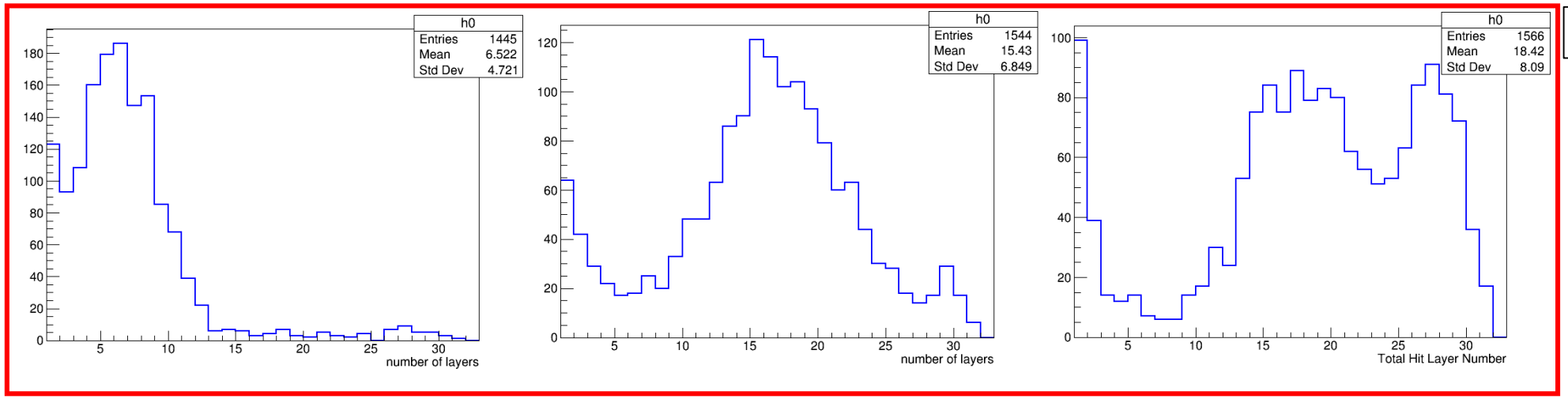




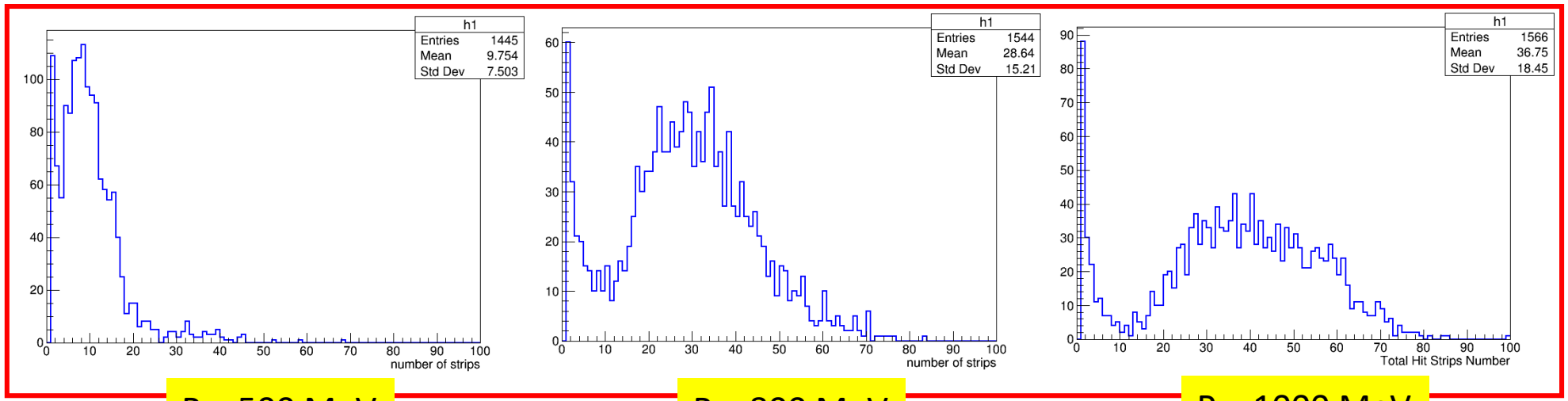


- Beam not well-collimated and collide with material (pipeline)

Beam test results II



Total hit Layer number



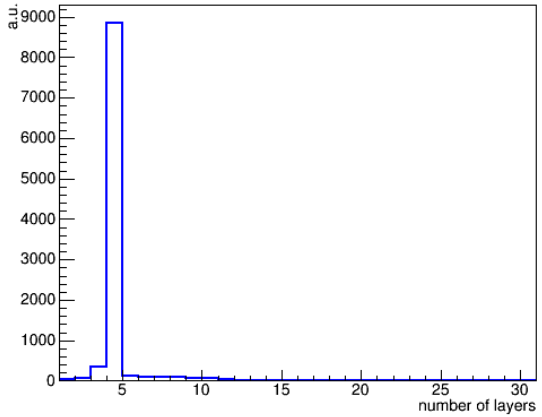
Total hit Strip number

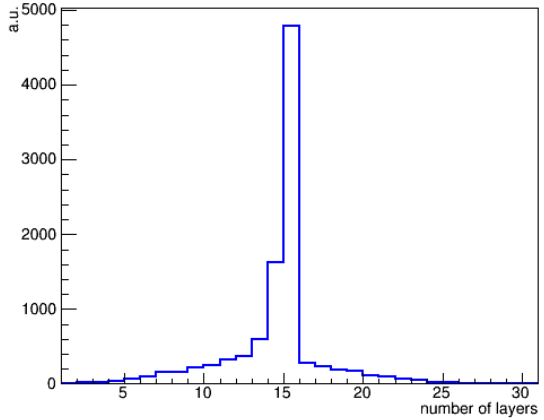
P = 500 MeV

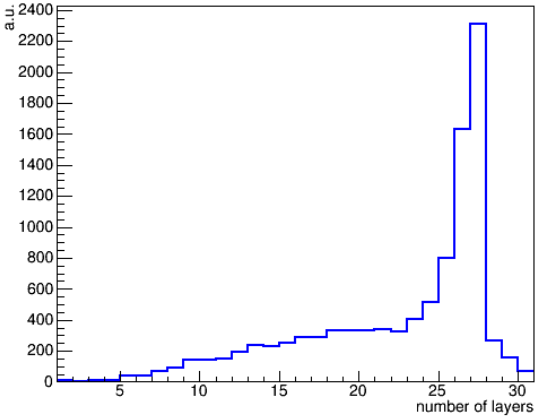
P = 800 MeV

P = 1000 MeV

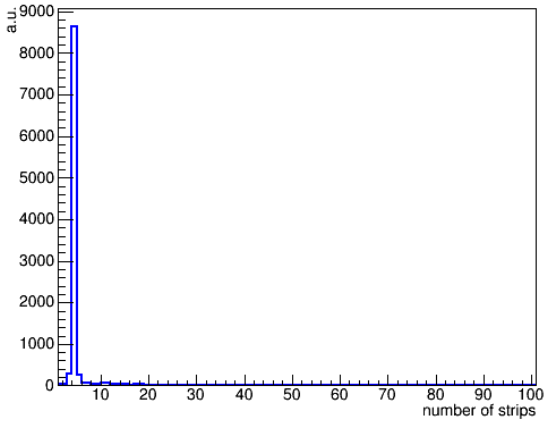
Sc-ECAL MC results - proton

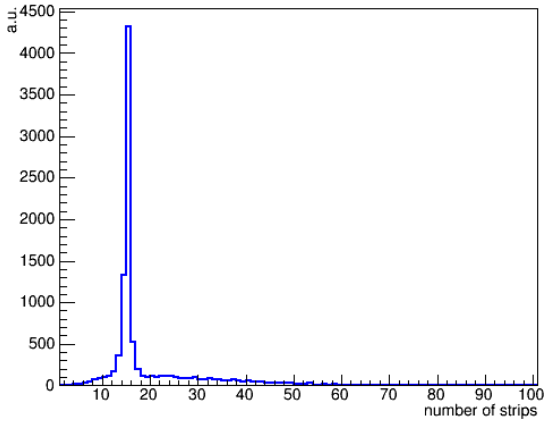


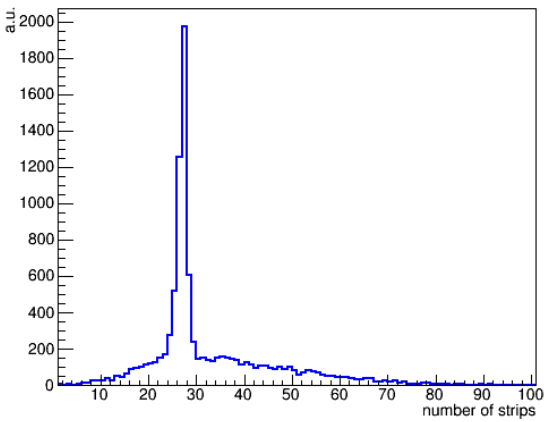




Total hit Layer number







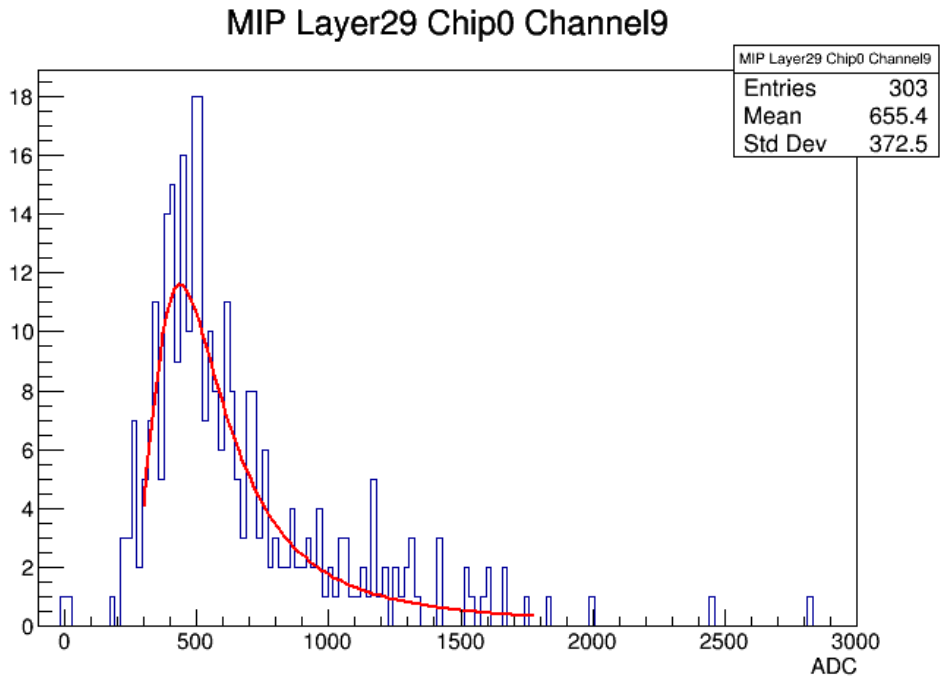
Total hit Strip number

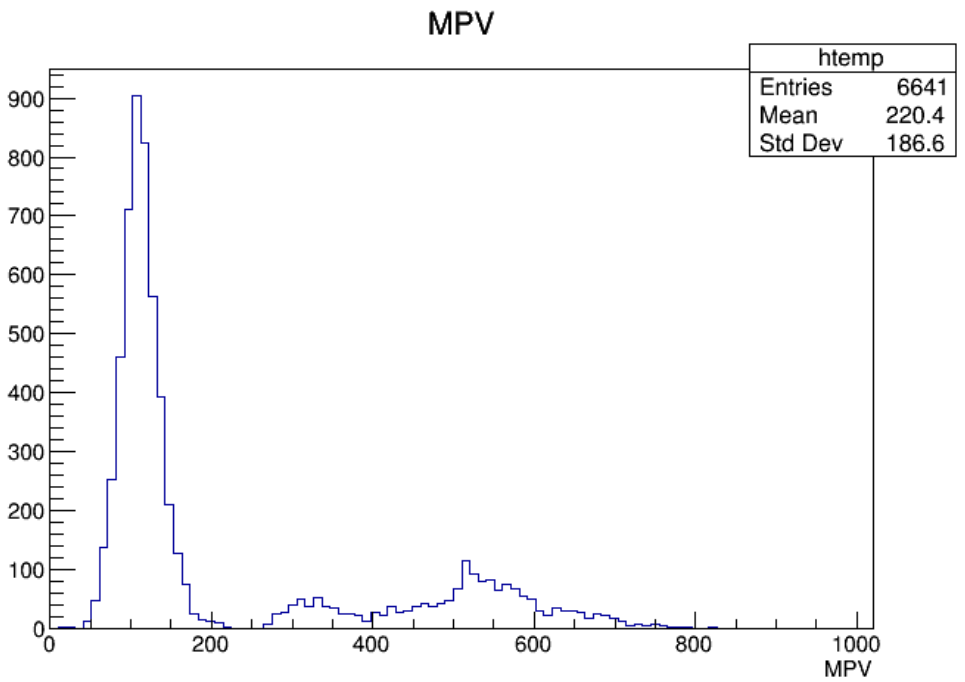
P = 500 MeV

P = 800 MeV

P = 1000 MeV

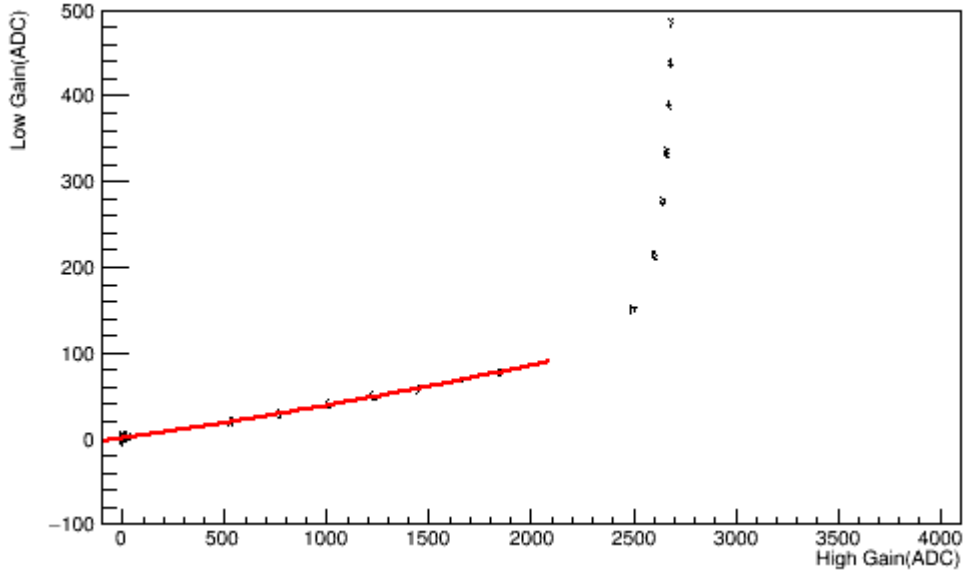
MIP Calibration – cosmic ray data

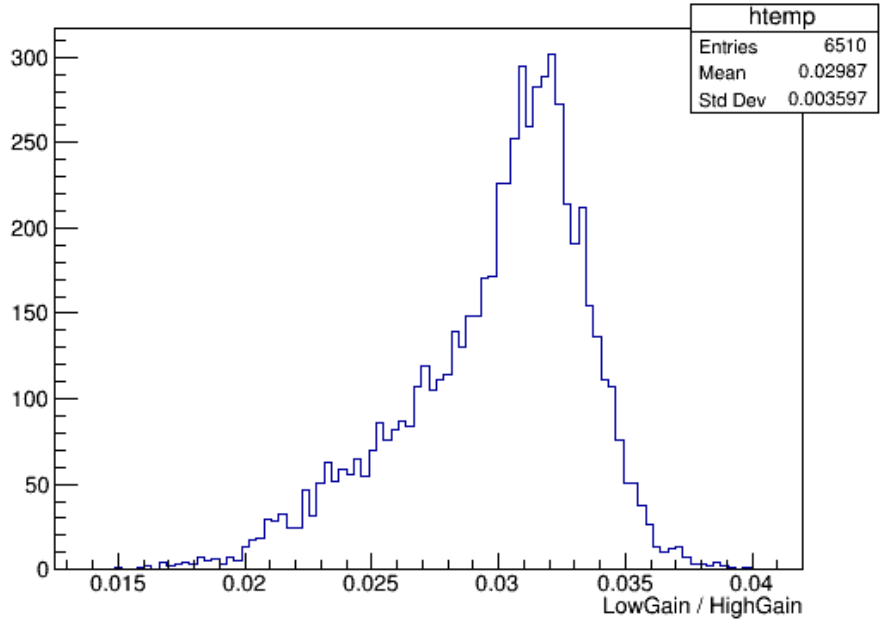




- Channel by channel calibration by cosmic ray test
- Statistic is not enough, more data would be collected

Inter-calibration – DAC test





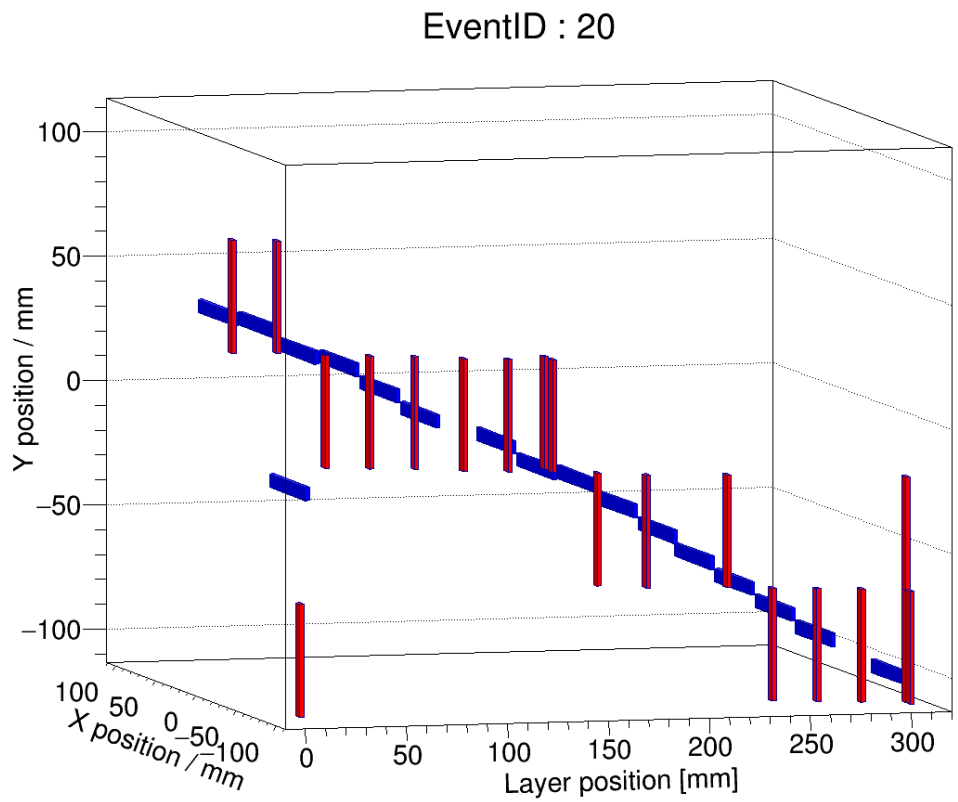
- The ratio between high gain and low gain calibration
- Channel by channel calibration by injection charge

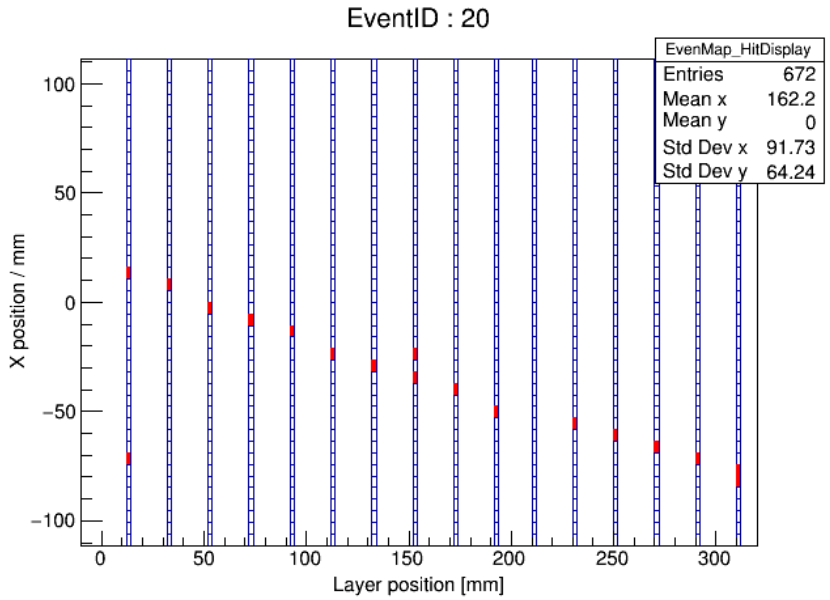
Summary

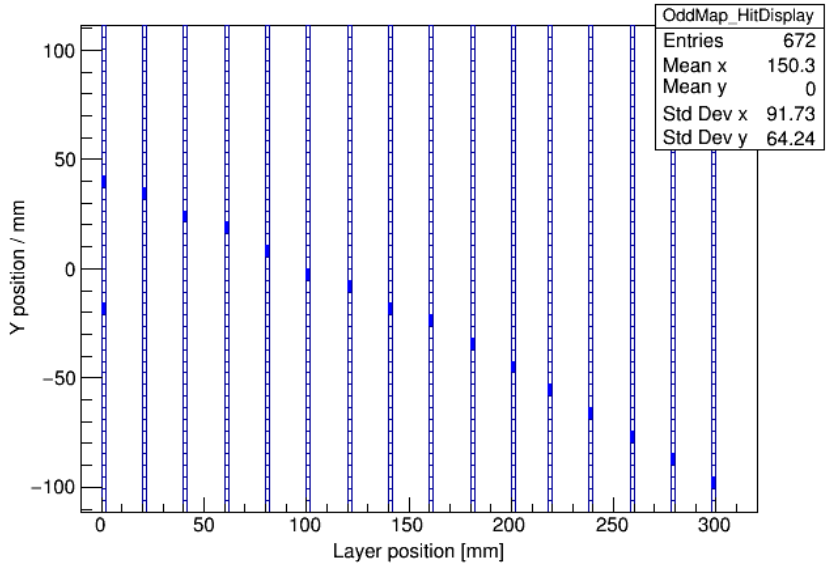
- Benefit a lot from the beam test, though the beam is not ideal
- Transport and setup of the Sc-ECAL prototype smoothly
- Event build with track detectors successfully by TLU triggerID
- Total 12 thousands events of 500 MeV, 800 MeV and 1 GeV momentum mixed positive particles have been collected
- Calibration and data analysis are ongoing
- Continue to cosmic ray testing and analysis
- Prepare BT at DESY on 1-14 March, 2021

Cosmic ray event

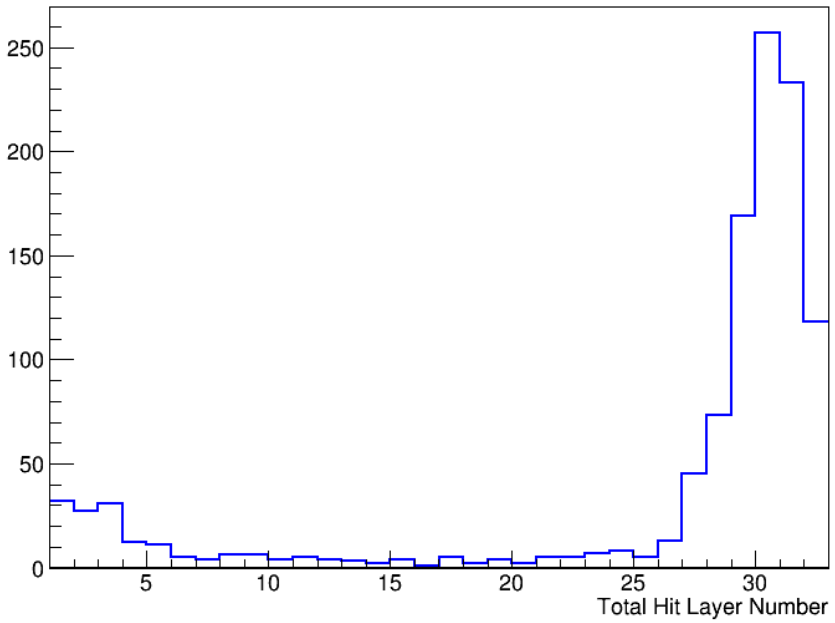
Cosmic ray

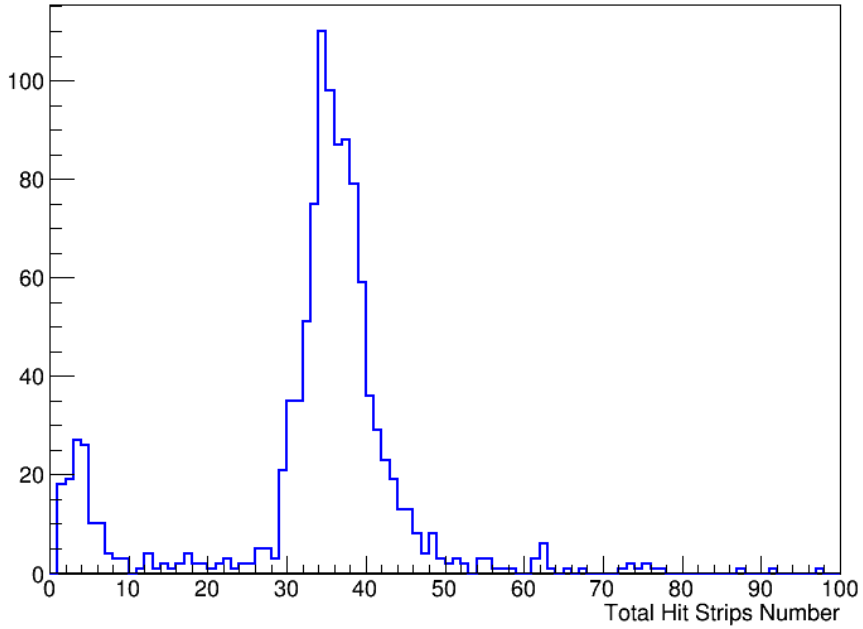




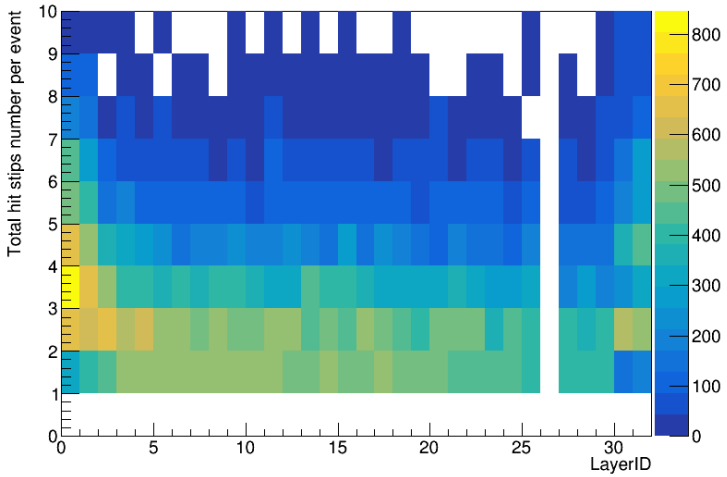


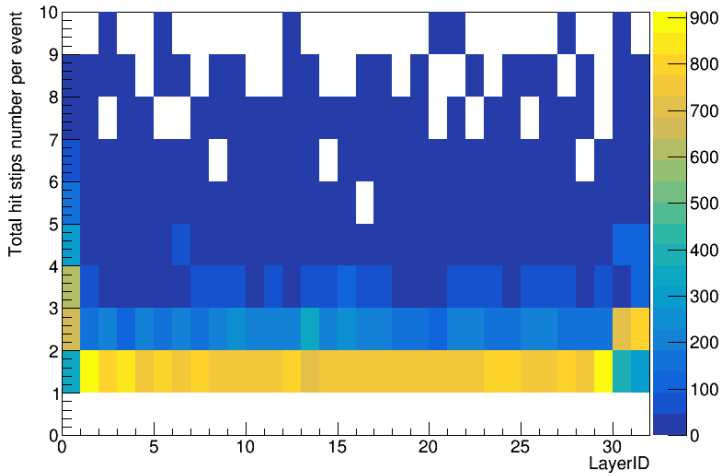
Cosmic ray event

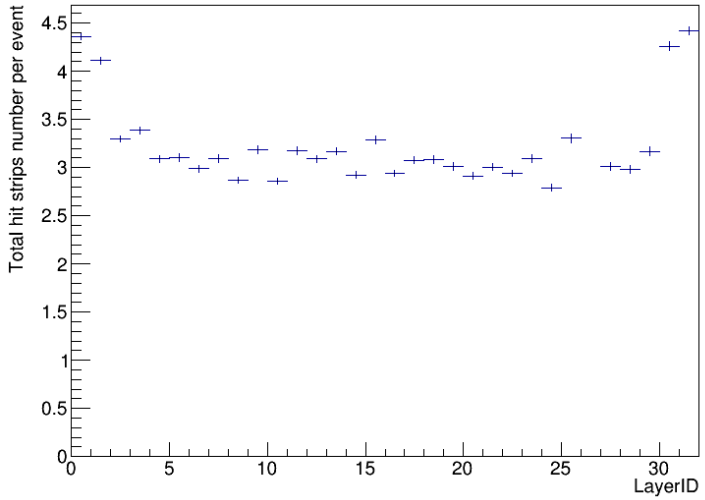


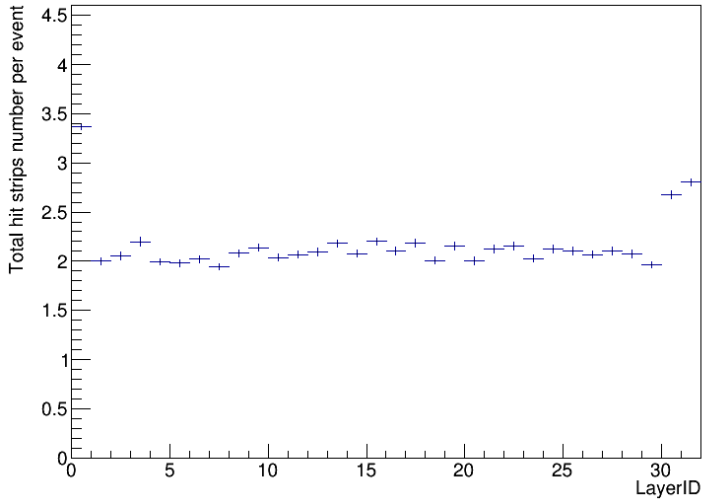


Beam test results vs. Cosmic ray test









IHEP E3 line beam PID

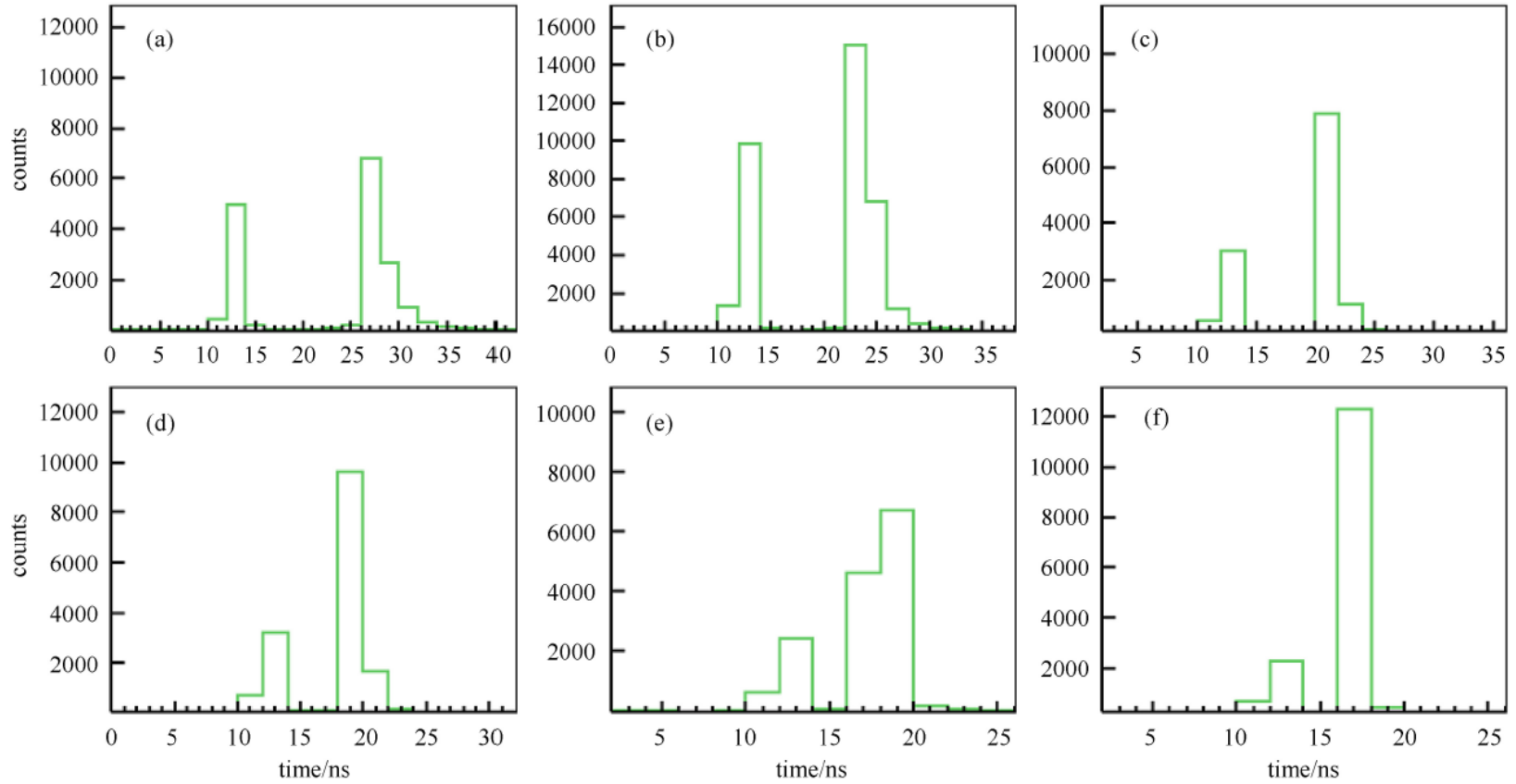


Fig. 7. (color online) Flight times of p/π^+ at different momenta: the flight time of p is much more than that of π^+. (a) 500 MeV/c; (b) 600 MeV/c; (c) 700 MeV/c; (d) 800 MeV/c; (e) 900 MeV/c; and, (f) 1000 MeV/c.