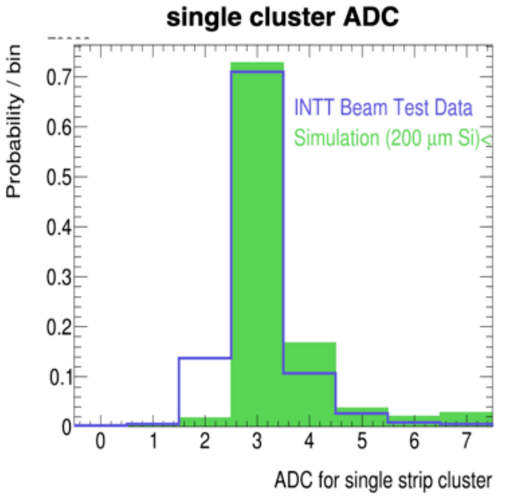
Call for the paper preparation for the 3rd test beam experiment

Genki Nukazuka (RIKEN)

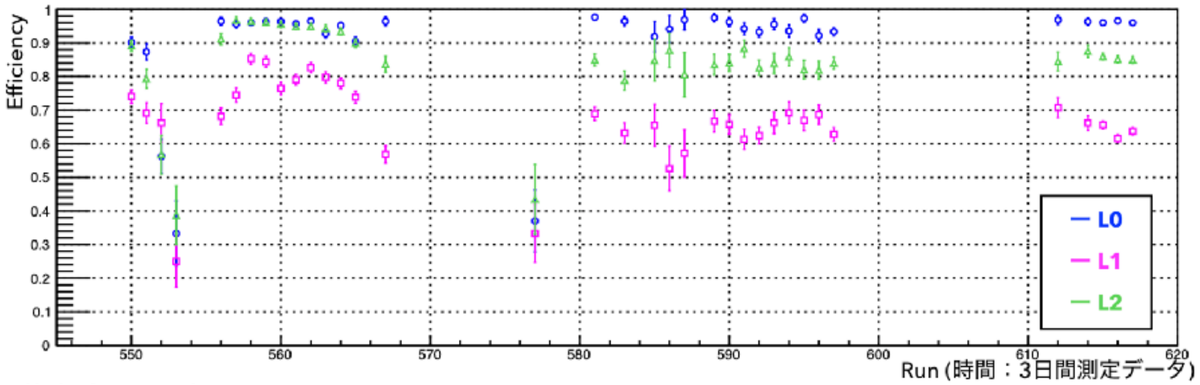
Test beam experiment?



ADC distributions from 1st test beam experiment and simulation.

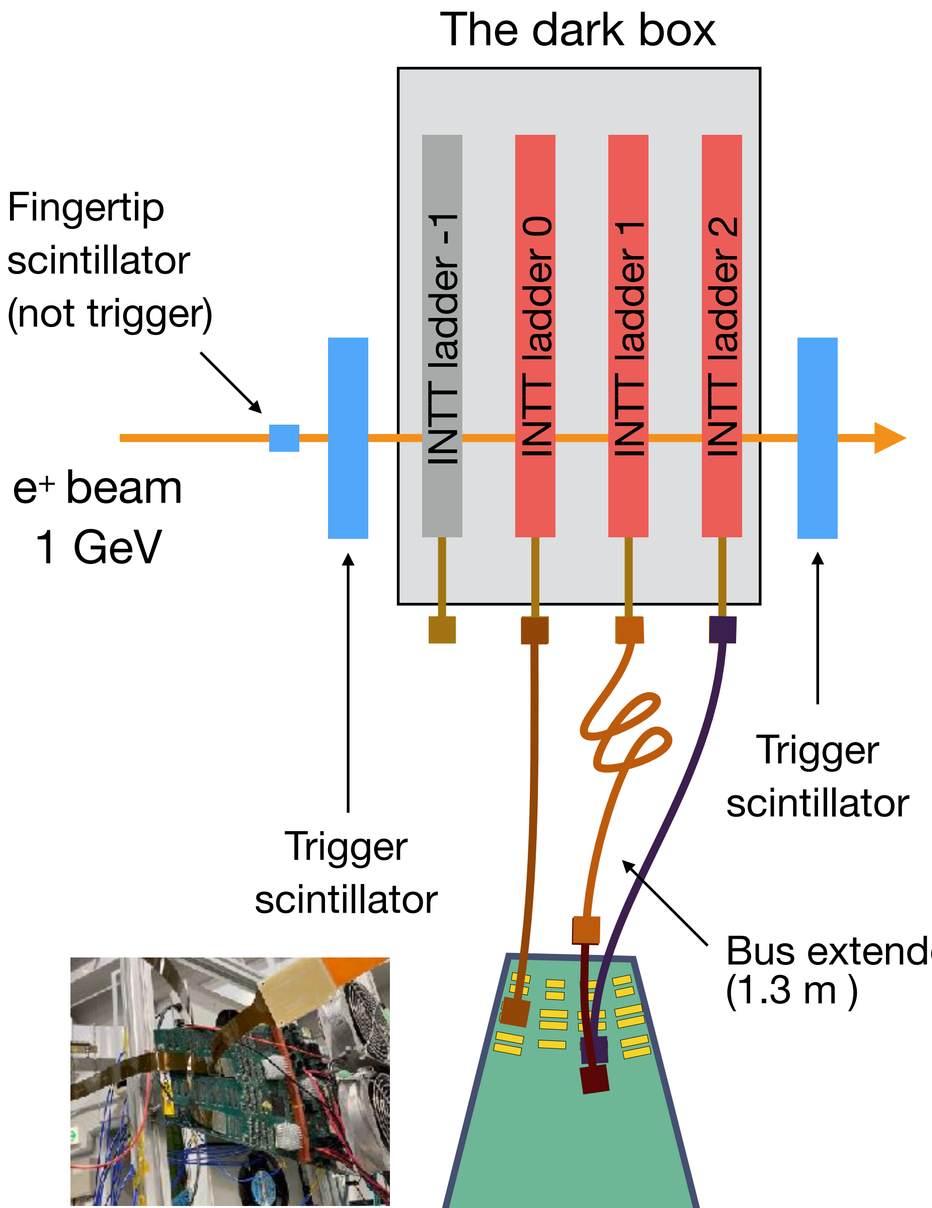
3 test beam experiments were conducted for evaluation of INTT ladder:

- 1st: 2018 at Fermi lab, USA
  - ADC distribution was different from one from Geant4 simulation.
  - Hit position analysis
- 2nd: 2019 at Fermi lab, USA
  - ? prototype ladders were used.
  - DAC scan was successful.
  - Detection efficiency was up to 96.0%± 0.5%.

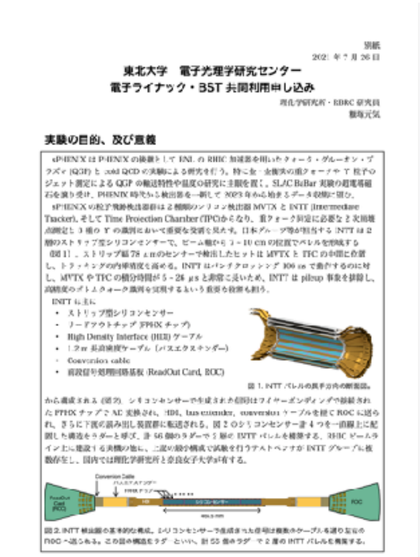


- 3rd: 2021 at ELPH, Japan
  - 4 mass production ladders were used. One came from Taiwan but didn't work.
  - DAC was successful.
  - Detection efficiency was around 99.0%.
  - Additional setup1: the ladders were tilted with respect to the beam to have different ADC distributions.
  - Additional setup2: A lead plate was put in front of the set up to get events with multiple tracks.

3rd test beam experiment



The detection efficiency obtained in the 2nd test beam experiment was up to 96.0% ± 0.5%. It was much lower than the expectation. After lots of tests at test bench in NWU, we had confident with ourselves to go to the next step, so I proposed another test beam experiment at ELPH in Tohoku Univ., Japan. The proposal was approved thanks to the successful interview. Beam time for us was assigned from Dec/7/2021 to Dec/10/2021.


東北大学　電子光理学研究センター
電子ライナック・3.5T 共同利用申し込み
実験の目的、及び意義

Proposal


sPHENIX INTT 検出器の実機を用いた性能評価
研究代表　疇原元気（理研 BNL 研究センター）

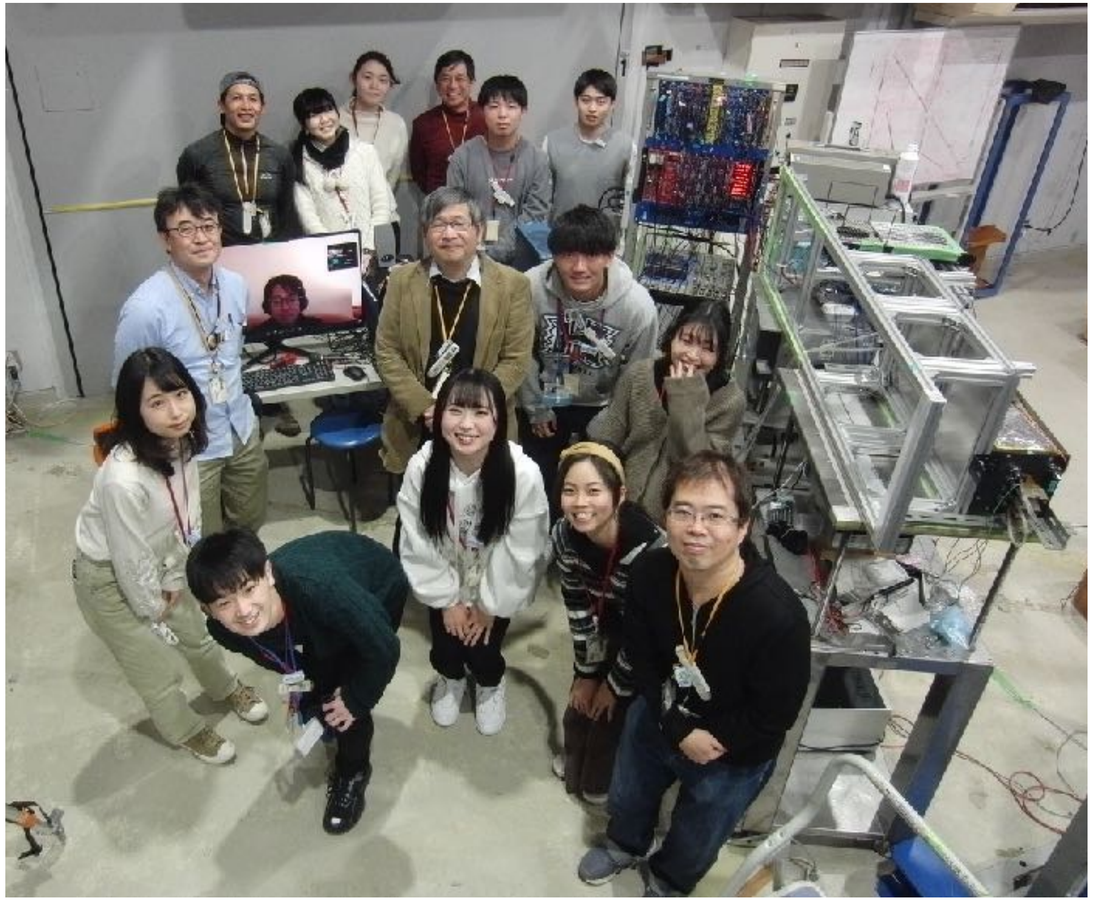

要求ビームタイムの見積もり

Inteview slides

3rd test beam experiment: who?

RIKEN:
Genki, Itaru, Yasuyuki, Hideto
NWU:
Takashi, Maya, Miu, Mika, Yumika, Runa, Misaki, Mai W
Rikkyo:
Hikaru, Yusuke, Genta
JAEA:
Shoichi
NCU:
Cheng-Wei
BNL:
Rachid

and lots of help from ELPH.



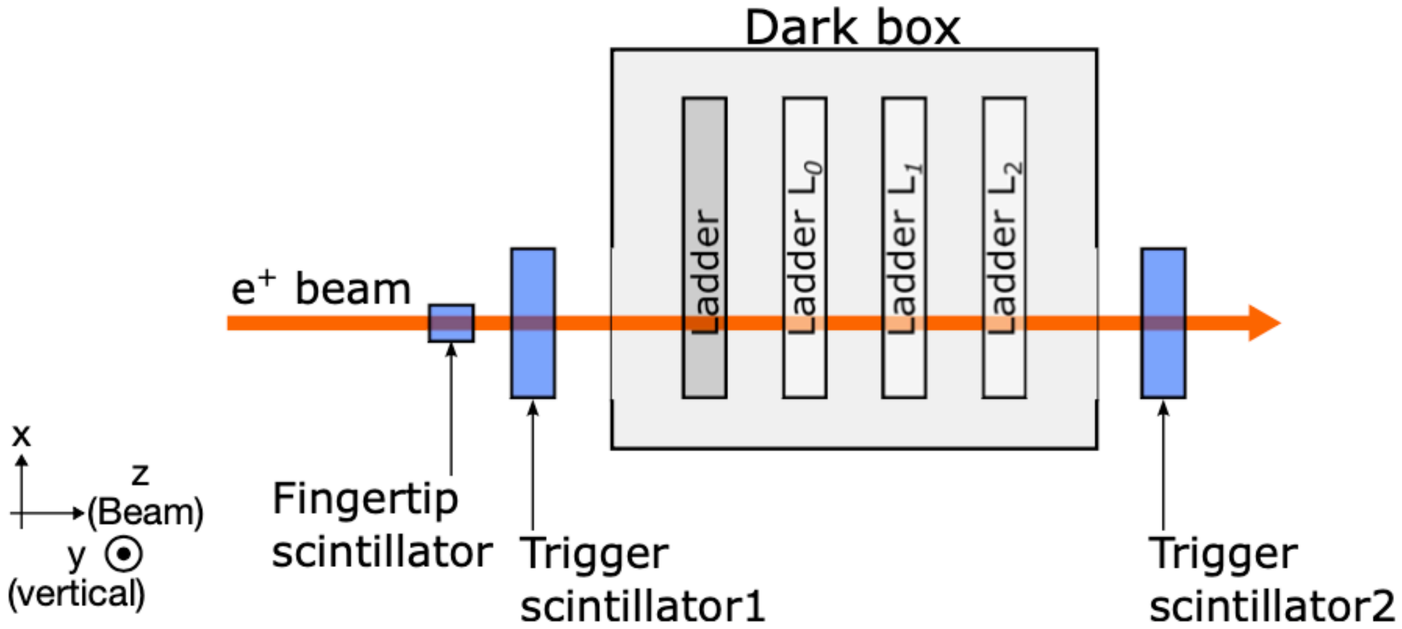
Plan of publications from INTT

Topics	Target Journal	Leading Author	Timeline	Remaining Issues
Bus Extender ✓ (Electrical)	The Japan Institute of Electronics Packaging	Takashi Kondo (TIRI)	2022/May → published Aug. 2022	To be announced from Takashi later
2021 Beam Test✓	ELPH Ann. Rprt.	Genki/Cheng-Wei	2022/Winter	ADC distribution, Resolution, Efficiency, cluster size
2021 Beam Test	NIM		2025/Summer	
Bus Extender (Mechanical)	NIM	Takashi	2025?	Final evaluation of the yield rate
INTT Ladder	**NIM**	**Itaru**	**2025/Winter**	**Ladder, BEX, CC, ROC**
INTT Barrel	NIM	Itaru/Rachid	2025/Summer	Felix, mechanical structure, cooling/power system, stream readout, etc.

https://indico.bnl.gov/event/26549/contributions/102601/attachments/59779/102747/250207_PublicationPlan.pdf

ELPH annual report

- We submitted an ELPH annual report in March 2022. It was recently released: ELPH Annual report, 29, 2022.
- Yuka was in charge of DAC scan analysis
- Cheng-Wei was in charge of detection efficiency analysis
- Genki did anything else (coordination, introduction, setup, figures, communication with ELPH, etc.)



(ELPH Experiment : #2984)

Performance evaluation of the Intermediate Tracker for sPHENIX

G. Nukazuka[1], C.W. Shih[2], Y. Sugiyama[3], Y. Akiba[1], H. En'yo[1,4], T. Hachiya[3], S. Hasegawa[5], M. Hata[3], H. Imai[4,6], M. Morita[3], I. Nakagawa[1,4], Y. Nakamura[6], G. Nakano[6], Y. Namimoto[3], R. Nouicer[7], M. Shibata[3], M. Shimomura[3], R. Takahama[3], K. Toho[8], M. Tsuruta[8], and M. Watanabe[3]

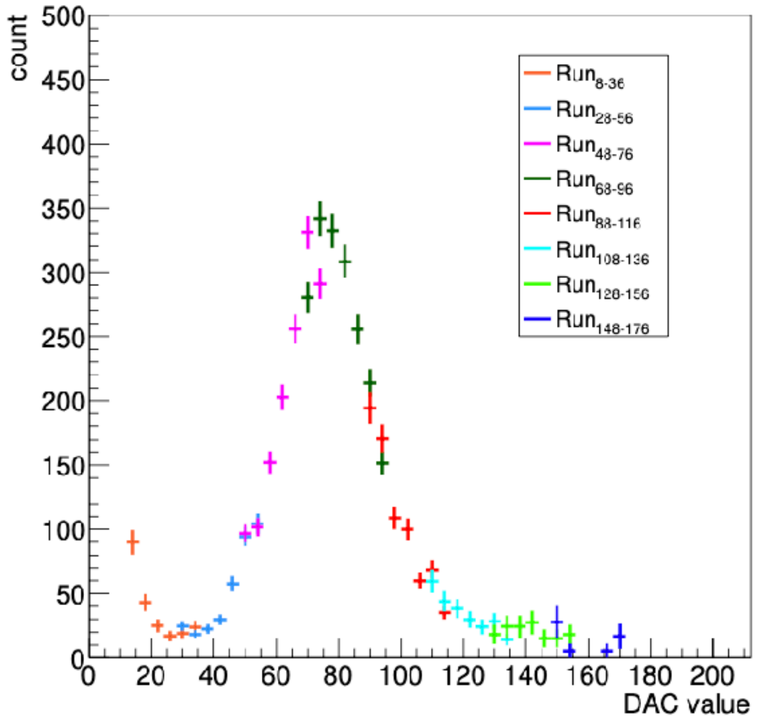
[1]*RIKEN BNL Research Center, Brookhaven National Laboratory, Upton, New York 11973-5000, USA*
[2]*Department of Physics, and Center of High-energy and High-field Physics, National Central University, Chungli, Taiwan*
[3]*Nara Women's University, Kita-uoya Nishi-machi Nara 630-8506, Japan*
[4]*RIKEN Nishina Center for Accelerator-Based Science, Wako, Saitama 351-0198, Japan*
[5]*Advanced Science Research Center, Japan Atomic Energy Agency, 2-4 Shirakata Shirane, Tokai-mura, Naka-gun, Ibaraki-ken 319-1195, Japan*
[6]*Physics Department, Rikkyo University, 3-34-1 Nishi-Ikebukuro, Toshima, Tokyo 171-8501, Japan*
[7]*Brookhaven National Laboratory, Upton, New York 11973*
[8]*Research Center for Electron Photon Science, Tohoku University, Sendai, 982-0826*

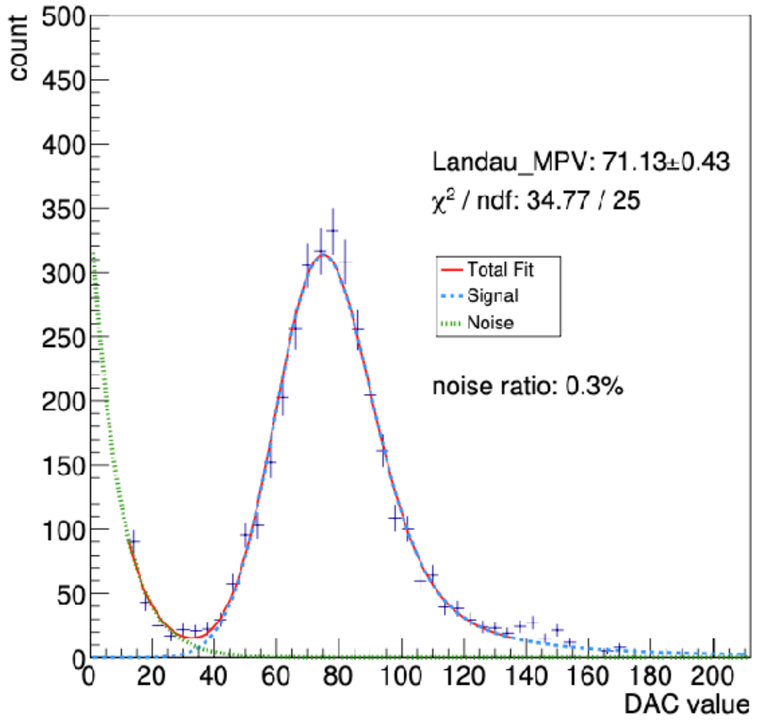
The silicon strip barrel detector, namely the intermediate tracker (INTT), is one of the tracking detectors in the sPHENIX detector complex at the Relativistic Heavy Ion Collider in Brookhaven National Laboratory. Using the positron beam with a momentum of 1 GeV at the ELPH gamma-ray irradiation room, we evaluated the performance of the mass production INTT ladders. The energy deposit curve showed that noise contamination to the minimum ionization particle's peak is about 0.3 %. This feature enables us to operate the detector with a low threshold, leading to high detection efficiency. The detection efficiency of one of the ladders was found to be $99.33 \pm 0.04(\mathrm{stat}) \pm 0.06(\mathrm{sys})$ %, and it was uniform over the silicon cells.

§1. Introduction

sPHENIX collaboration will be launched in 2023 at the Relativistic Heavy Ion Collider in Brookhaven National Laboratory for the investigation of Quark-Gluon Plasma and cold-QCD. The sPHENIX detector consists of the micro-vertex detector (MVTX), the intermediate tracker (INTT), the time projection chamber (TPC), the electromagnetic calorimeter, the superconducting magnet, and the hadron calorimeter.

ELPH annual report

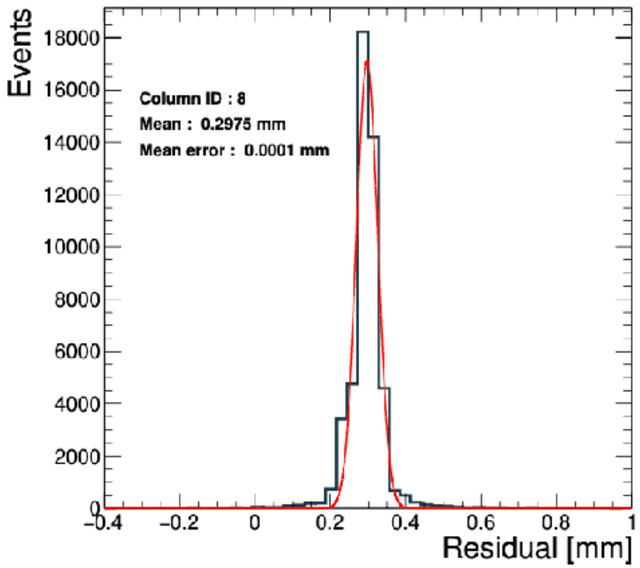


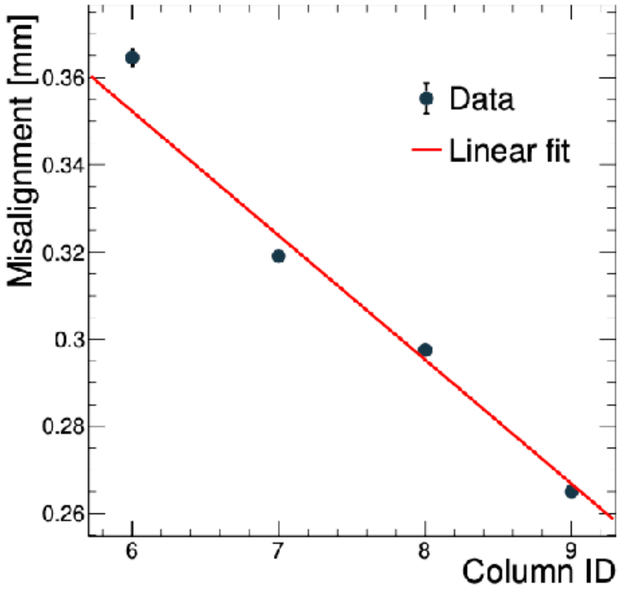


- MIP peak was successfully reconstructed with single-hit clusters.
- The convolution function of landau and gauss was fitted to the MIP peak well.
- Noise contamination to the MIP peak estimated by exponential function was about 0.3%.

- The results look fine. What needs to be done additionally?

ELPH annual report

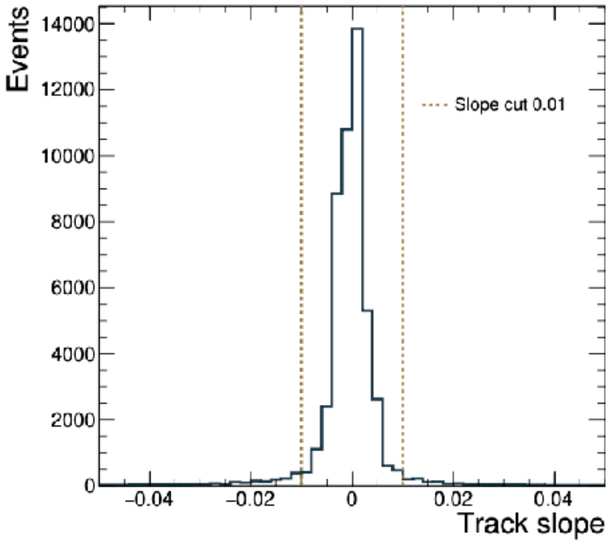


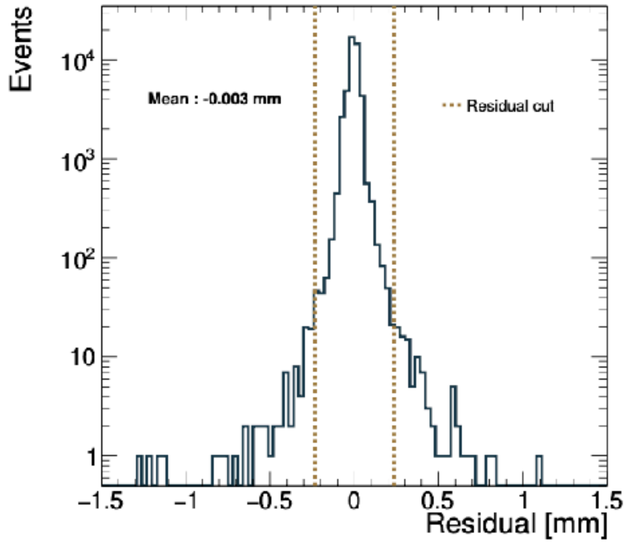


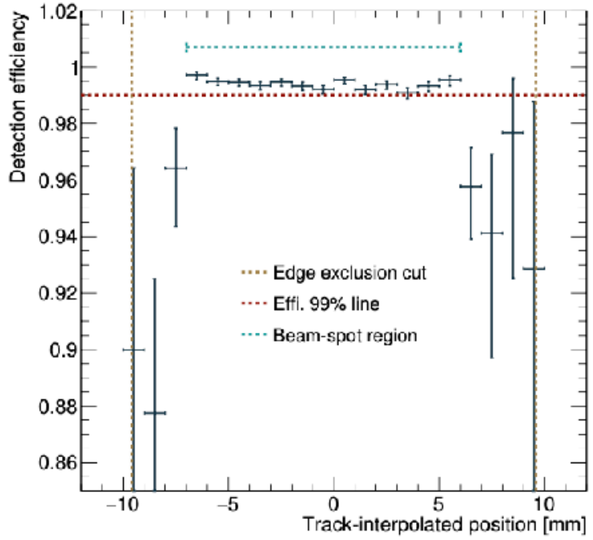
- Tracking using all 3 ladders was done nicely.
- Misalignment of a ladder was performed using other 2 ladders for each chip column.

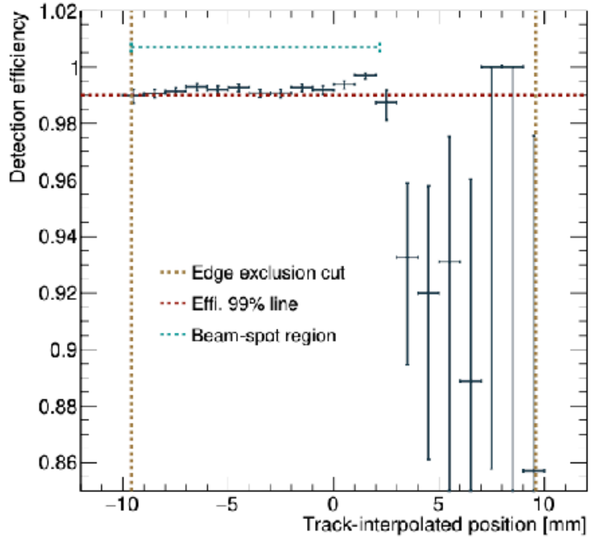
- Are we satisfied with the results?

ELPH annual report









Analsis	Run	ε (%) Ladder 0	ε (%) Ladder 1	ε (%) Ladder 2
Cheng-Wei	89	$99.3^{+0.2}_{-0.2}$	$99.5^{+0.1}_{-0.2}$	$97.1^{+0.3}_{-0.4}$
Miu	87 88 89	99.53 ±0.02	99.39 ±0.03	99.56 ±0.02
FNAL in 2019	96.0±0.5			
Cosmic ray by Genki	$98.2^{+1.2}_{-2.4}$			

- The detection efficiency measurements were performed with 2-point tracking. Very high efficiency was confirmed by multiple analyzers.
- What is missed?

Plan of publications from INTT

Month	Week	Topic
5	1	-
	2	-
	3	AuAu commissioning
	4	AuAu commissioning
6	1	AuAu commissioning
	2	AuAu commissioning
	3	AuAu commissioning
	4	AuAu commissioning
7	1	Analysis
	2	Analysis
	3	Analysis
	4	Analysis
8	1	Analysis/Paper writing
	2	Analysis/Paper writing
	3	Analysis/Paper writing
	4	Analysis/Paper writing
9	1	Review in the INTT group
	2	Review in the INTT group
	3	Review in the INTT group
	4	Submit

- The first priority of INTT group is commissioning, which is about to start. We cannot take so much effort on test beam analysis.
- On the other hand, Cheng-Wei has lots of updates to be shown. It's OK to take time to review hits results.
- There is no deadline of submission. Going in a too rush isn't good idea. The realistic schedule should consider time of analysis, discussion, paper writing, review of draft, correcting draft, re-review of updated draft. Probably, submission at the end of September can be made. Earlier submission than this is totally fine if all procedures are done properly.
- Anybody can join the paper preparation. Currently in my mind,
  - Genki: coordination, anything else
  - Cheng-Wei: analysis
  - Itaru/Takashi/Rachid: adviser