

INTT Publications and Plan

RIKEN/RBRC

Itaru Nakagawa

on behalf of INTT team

Ladder NIM (Published) ✓

Nuclear Instruments and Methods in Physics Research A 1082 (2026) 171020



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Published 2025/9/20

Full Length Article

The ladder and readout cables of intermediate silicon strip detector for sPHENIX

Y. Akiba^{a,b}, H. Aso^{g,a}, J.T. Bertaux^{i,b}, D. Cacace^c, K.Y. Chen^d, K.Y. Cheng^{d,b},
A. Enokizono^a, H. Enyo^{a,b}, K. Fujiki^{g,a}, Y. Fujino^{g,a}, M. Fujiwara^{e,a}, T. Hachiya^{e,b},
T. Harada^{g,a}, S. Hasegawa^f, M. Hata^{e,b}, B. Hong^k, J. Hwang^{k,b}, T. Ichino^{g,a}, M. Ikemoto^{e,a},
D. Imagawa^{g,a}, H. Imai^{g,a,b}, Y. Ishigaki^{e,a}, M. Isshiki^e, K. Iwatsuki^{e,a}, R. Kan^e, M. Kano^{e,a},
T. Kato^{g,a}, R. Kawashima^{g,a}, T. Kikuchi^{g,a}, T. Kondo^h, C.M. Kuo^d, H. Kureha^e, T. Kumaoka^a,
H.S. Liⁱ, R.S. Lu^j, E. Mannel^c, H. Masuda^{g,a}, G. Mitsuka^b, N. Morimoto^{e,a}, M. Morita^{e,b},
I. Nakagawa^{a,b},*, Y. Nakamura^{g,a}, G. Nakano^{g,a}, Y. Namimoto^{e,b}, D. Nemoto^{g,a}, S. Nishimori^e,
R. Nouicer^c, G. Nukazuka^a, I. Omae^{e,a}, R. Pisani^c, Y. Sekiguchi^a, M. Shibata^{e,b},
C.W. Shih^{d,b}, K. Shiina^{g,a}, M. Shimomura^e, R. Shishikura^{g,a}, M. Stojanovic^{i,b}, K. Sugino^e,
Y. Sugiyama^e, A. Suzuki^{e,b}, R. Takahama^{e,b}, L.S. Tsai^j, W.C. Tang^{d,b}, Y. Terasaka^e,
T. Todoroki^b, H. Tsujibata^{e,a}, M. Tsuruta^{g,a}, Y. Yamaguchi^b, H. Yanagawa^{g,a}, M. Watanabe^{e,b},
R. Xiaoⁱ, W. Xieⁱ

Publications [\[edit | edit source\]](#)

INTT Barrel Performance [\[edit | edit source\]](#)

• in preparation [\(overleaf\)](#)

INTT Tohoku Beam Test [\[edit | edit source\]](#)

• 2025/8/31 preprint [arXiv:2509.00908](https://arxiv.org/abs/2509.00908)

INTT Ladder and Readout Cables [\[edit | edit source\]](#)

• 2025/10/1 published NIMA1082(2026)171020

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  SerialNo={11},
  author={Akiba, Y. and others},
  title={The ladder and readout cables of intermediate silicon strip detector for sPHENIX},
  year={2026},
  journal={Nuclear Instruments and Methods in Physics Research A},
  volume={1082},
  pages={171020},
  post={myhost(http://arxiv.org/abs/2503.09105)},
  primaryClass={physics.ins-det},
  doi={10.1016/j.nima.2025.171020},
}
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• 2025/3/12 preprint [arXiv:2503.09105](https://arxiv.org/abs/2503.09105)

Bus Extender (Electrical Characteristics) [\[edit | edit source\]](#)

• Development of Long and High-Density Flexible Printed Circuits (Trans. Jpn. Inst. Electron. Packag.)

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@article{Takahashi Kondo2022,
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  author={Takahashi Kondo and Kohei Fujiwara and Takashi Hachiya and Hikaru Imai and Miu Morita and Itaru Nakagawa and Naoyuki Sato and Masato Tsuruta and Daisuke Yanagawa},
  journal={Transactions of The Japan Institute of Electronics Packaging},
  volume={15},
  number={ },
  pages={E21-007-1-E21-007-10},
  year={2022},
  doi={10.5104/jiepeng.15.E21-007-1}
}
```

sPHENIX/INTT wiki

Thanks to team members in R&D/Construction phase of INTT

Proposed plan for INTT Publications

Topics	Target Journal	Leading Author	Timeline	Status
Bus Extender ✓ (Electrical)	The Japan Institute of Electronics Packaging	Takashi Kondo (TIRI)	2022/Aug	Published
2021 Beam Test ✓	ELPH Ann. Rprt.	Genki/Cheng-Wei/Yuka	2022/Winter	Published
INTT Ladder ✓	NIM	Itaru	2025/Sept.	published
2021 Beam Test	NIM	Genki/Cheng-Wei	2025/Summer	Submitted
INTT Barrel	NIM	Itaru/Rachid	2025/Fall	In preparation
Bus Extender (Mechanical)	NIM	Takashi	2025?	Final evaluation of the yield rate

Author List

- Either INTT team authors or sPHENIX Collaboration
- This is the 1st Detector paper using collision data, so INTT team author list is allowed.
- Many INTT team authors who contributed to the barrel construction phase will be dropped from the sPHENIX collaboration author list.
- I personally prefer INTT team authors to credit their contributions and acknowledge to BNL/sPHENIX crews.



Full Length Article

The ladder and readout cables of intermediate silicon strip detector for sPHENIX

Y. Akiba ^{a,b}, H. Aso ^{g,a}, J.T. Bertaux ^{i,b}, D. Cacace ^c, K.Y. Chen ^d, K.Y. Cheng ^{d,b}, A. Enokizono ^a, H. Enyo ^{a,b}, K. Fujiki ^{g,a}, Y. Fujino ^{g,a}, M. Fujiwara ^{e,a}, T. Hachiya ^{e,b}, T. Harada ^{g,a}, S. Hasegawa ^f, M. Hata ^{e,b}, B. Hong ^k, J. Hwang ^{k,b}, T. Ichino ^{g,a}, M. Ikemoto ^{e,a}, D. Imagawa ^{g,a}, H. Imai ^{g,a,b}, Y. Ishigaki ^{e,a}, M. Isshiki ^e, K. Iwatsuki ^{e,a}, R. Kan ^e, M. Kano ^{e,a}, T. Kato ^{g,a}, R. Kawashima ^{g,a}, T. Kikuchi ^{g,a}, T. Kondo ^h, C.M. Kuo ^d, H. Kureha ^e, T. Kumaoka ^a, H.S. Li ⁱ, R.S. Lu ^j, E. Mannel ^c, H. Masuda ^{g,a}, G. Mitsuka ^b, N. Morimoto ^{e,a}, M. Morita ^{e,b}, I. Nakagawa ^{a,b}, Y. Nakamura ^{g,a}, G. Nakano ^{g,a}, Y. Namimoto ^{e,b}, D. Nemoto ^{g,a}, S. Nishimori ^e, R. Nouicer ^c, G. Nukazuka ^a, I. Omae ^{e,a}, R. Pisani ^c, Y. Sekiguchi ^a, M. Shibata ^{e,b}, C.W. Shih ^{d,b}, K. Shiina ^{g,a}, M. Shimomura ^e, R. Shishikura ^{g,a}, M. Stojanovic ^{i,b}, K. Sugino ^e, Y. Sugiyama ^e, A. Suzuki ^{e,b}, R. Takahama ^{e,b}, L.S. Tsai ^j, W.C. Tang ^{d,b}, Y. Terasaka ^e, T. Todoroki ^b, H. Tsujibata ^{e,a}, M. Tsuruta ^{g,a}, Y. Yamaguchi ^b, H. Yanagawa ^{g,a}, M. Watanabe ^{e,b}, R. Xiao ⁱ, W. Xie ⁱ

Scope for the Barrel NIM

Hardware Configuration

- Introduction (Itaru, Rachid)
- Barrel Structure (Rachid, Dan)
- Beam Clock Distribution (Itaru)
- LV/Bias power system (Itaru, Ivan)
- Cooling System and heat removing performance (Rachid, Rob)
- ~~ROC~~
- Felix (Itaru, Raul)
- ~~RC-DAQ~~

Beam Commissioning

- # of live/good channels (Jaein)
- Trigger/Extended Trigger/Stream readout modes, Timing resolution (Ryotaro, Genki?)
- ~~DAC Scan (+)~~
- ~~Half entry (Tomoki)~~
- ~~FPIX Chip saturation (Shang-Yu)~~
- Signal to noise ratio (Cheng-Wei)
 - Noise hit rate from the abort gap.
- ~~Cluster size (+)~~
- Hit multiplicity correlation inner outer and/or w/ MBD/MVTX? (Genki?/Cheng-Wei)
- Tracklet(Genki?) ADC, etc...
- Z-vertex reconstruction performance (Mahiro?)
- XY-Vertex reconstruction (Cheng-Wei)
- Efficiency? (Takahiro/?)
- Cosmic ray event display (Cheng-Wei)

Dead and Hot Channel Maps

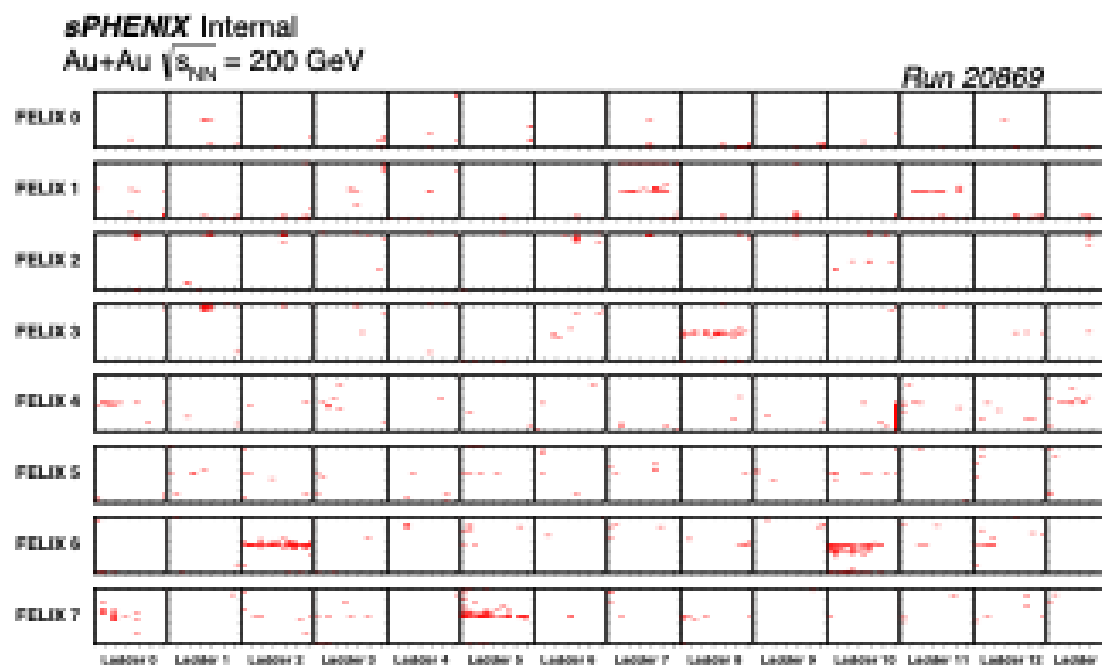


Figure 6: The map of hot channels of run 20869.

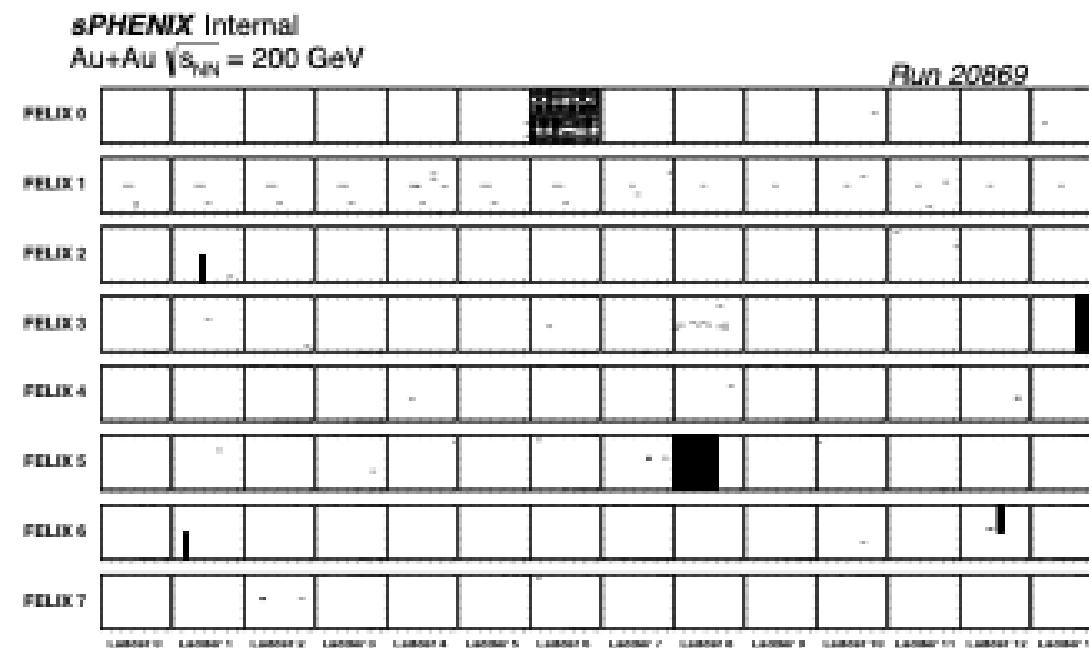
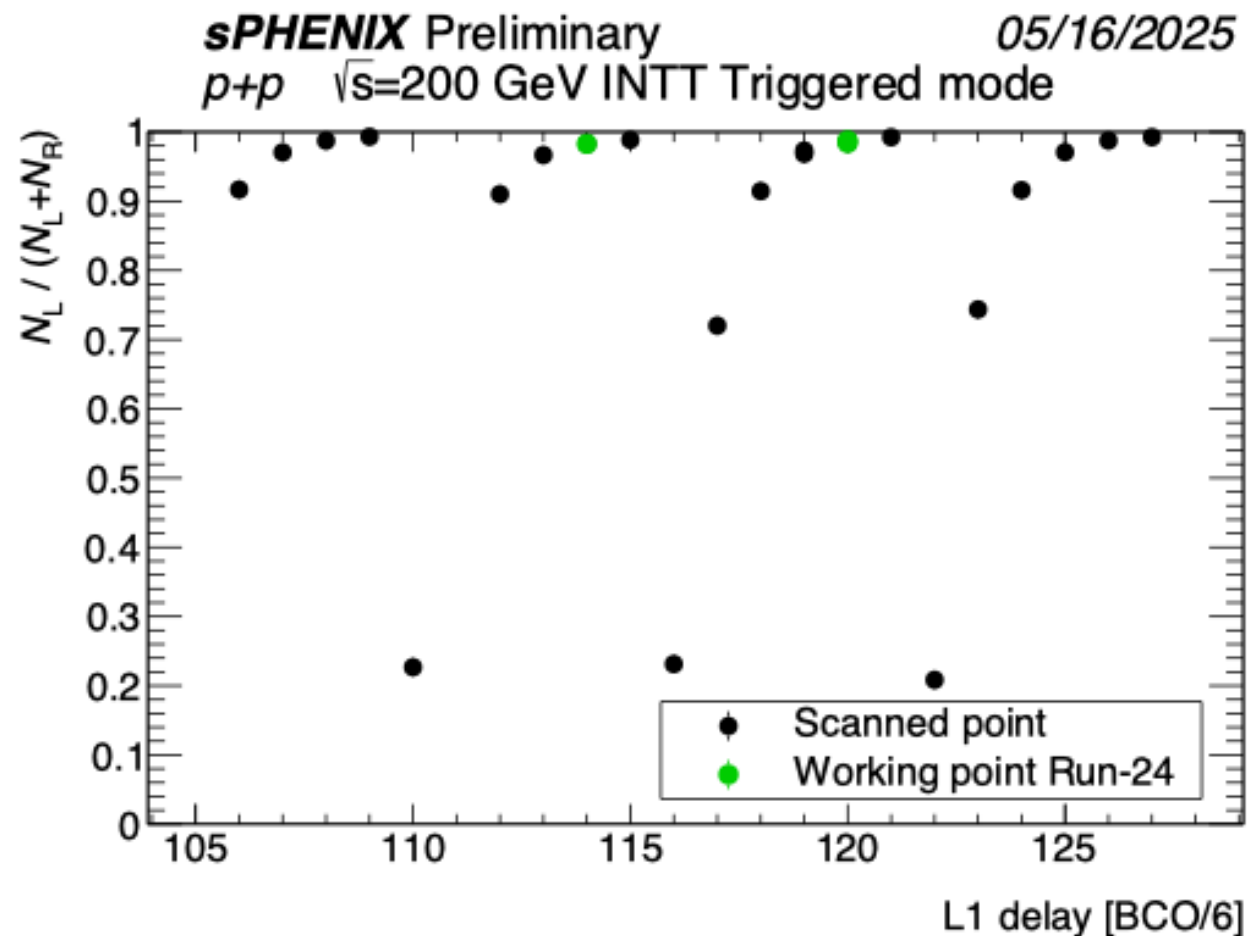
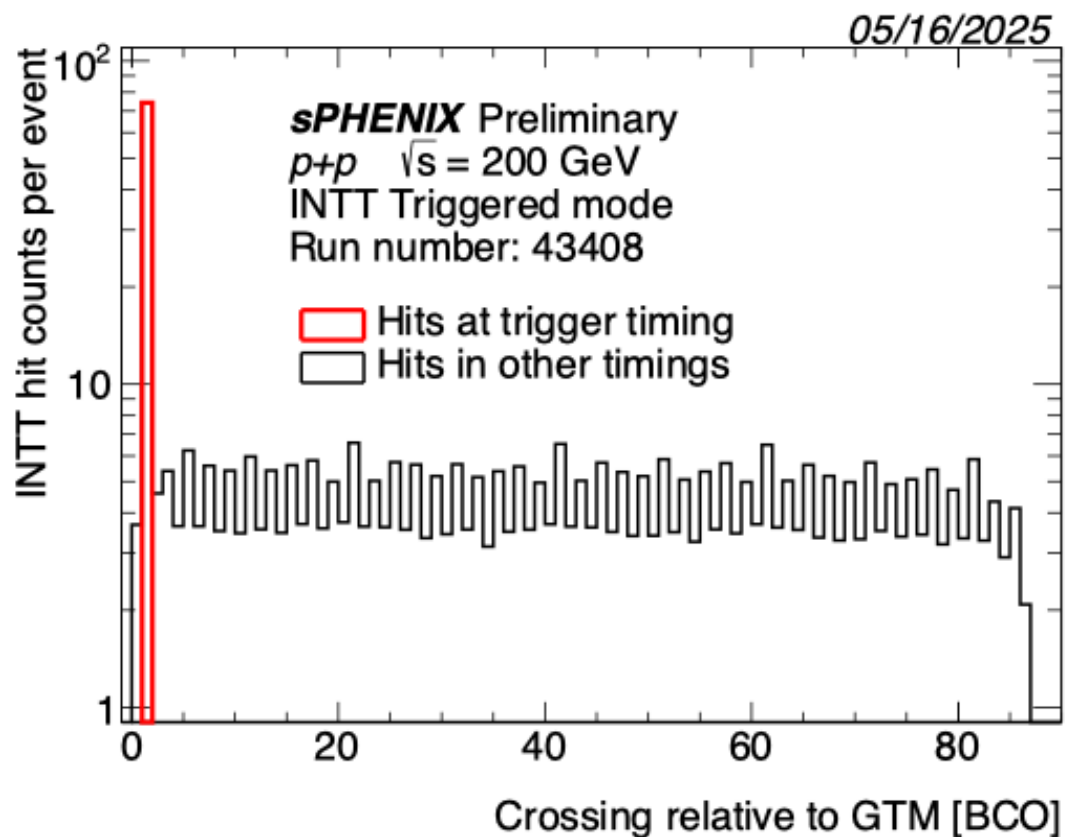


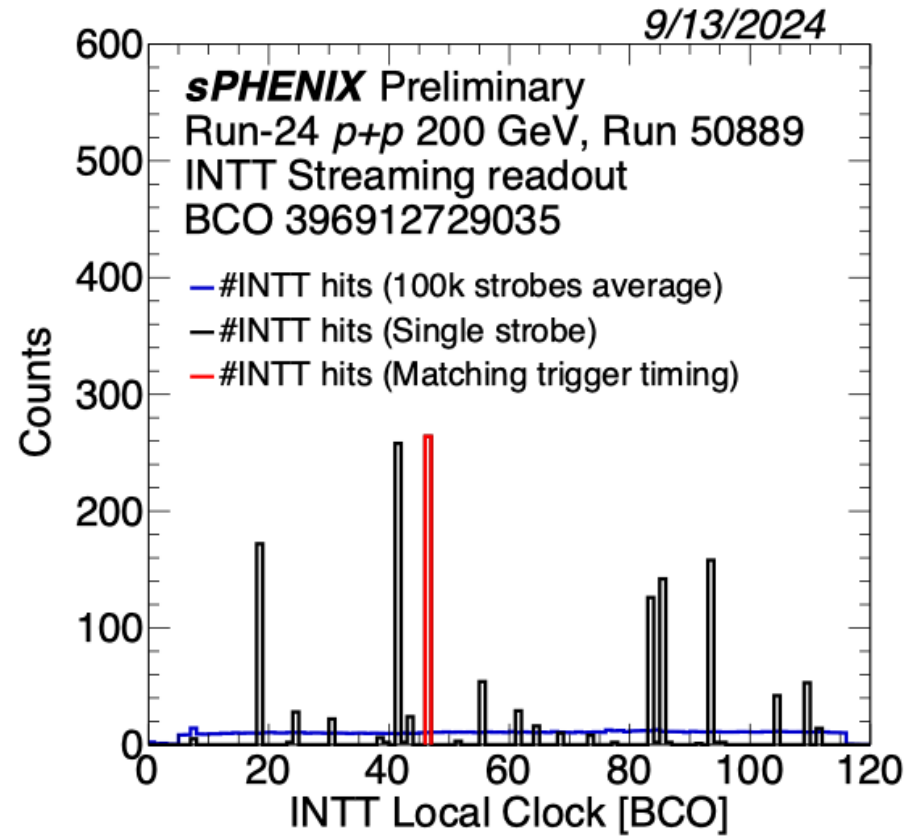
Figure 7: The map of dead channels of run 20869.

Phi distributions

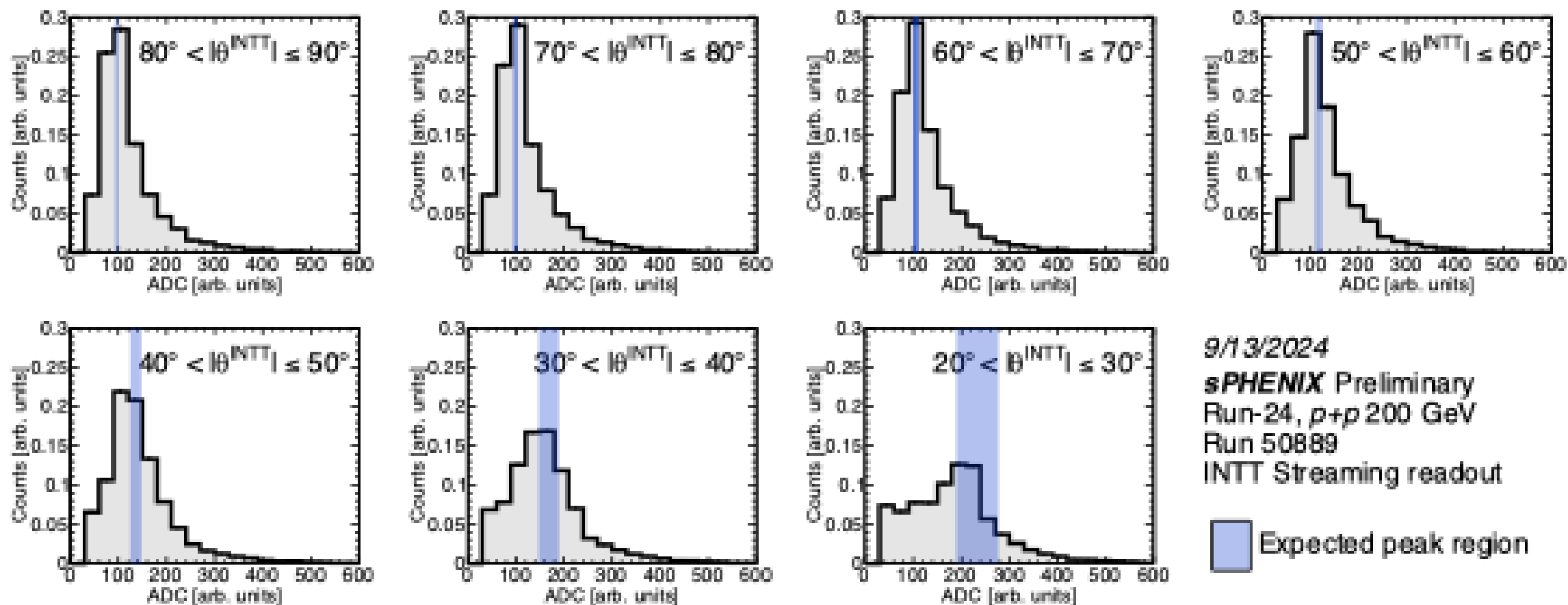
Timing Plot



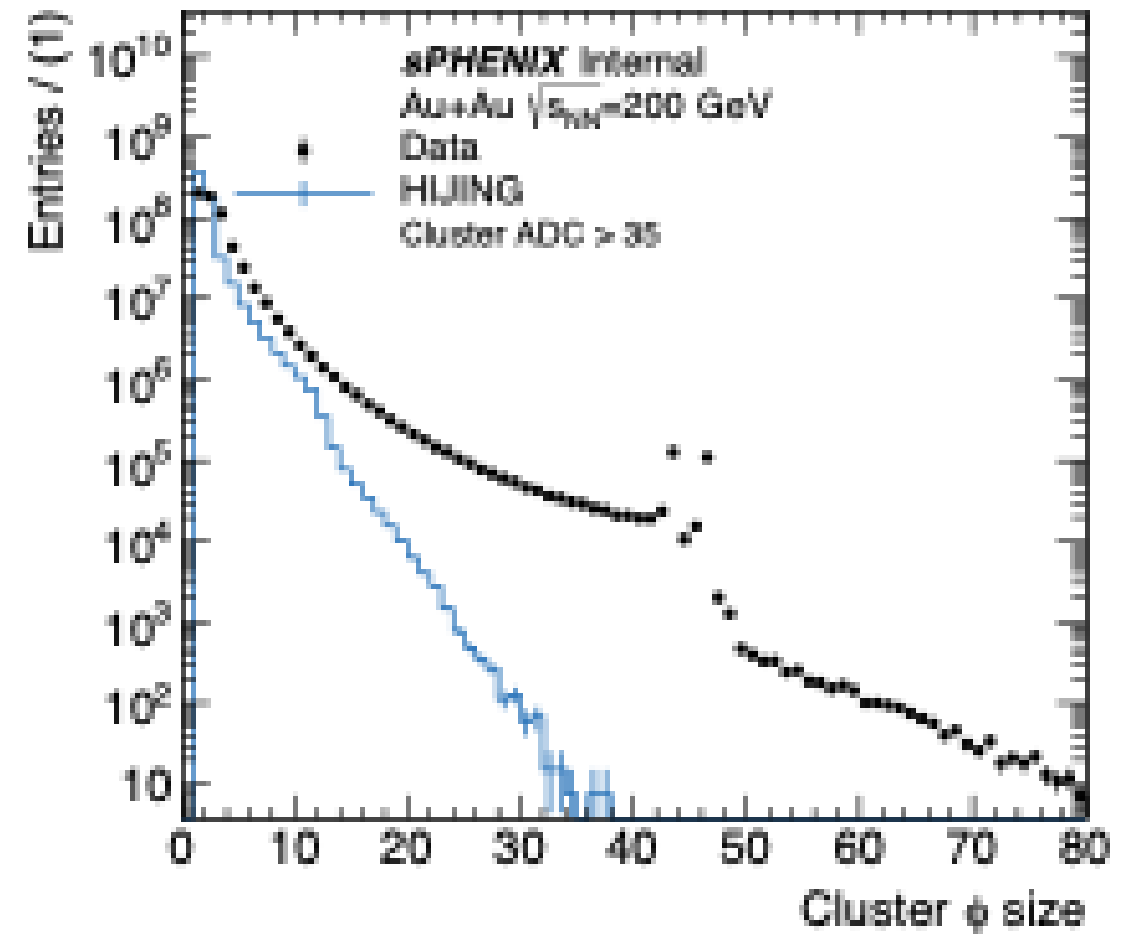
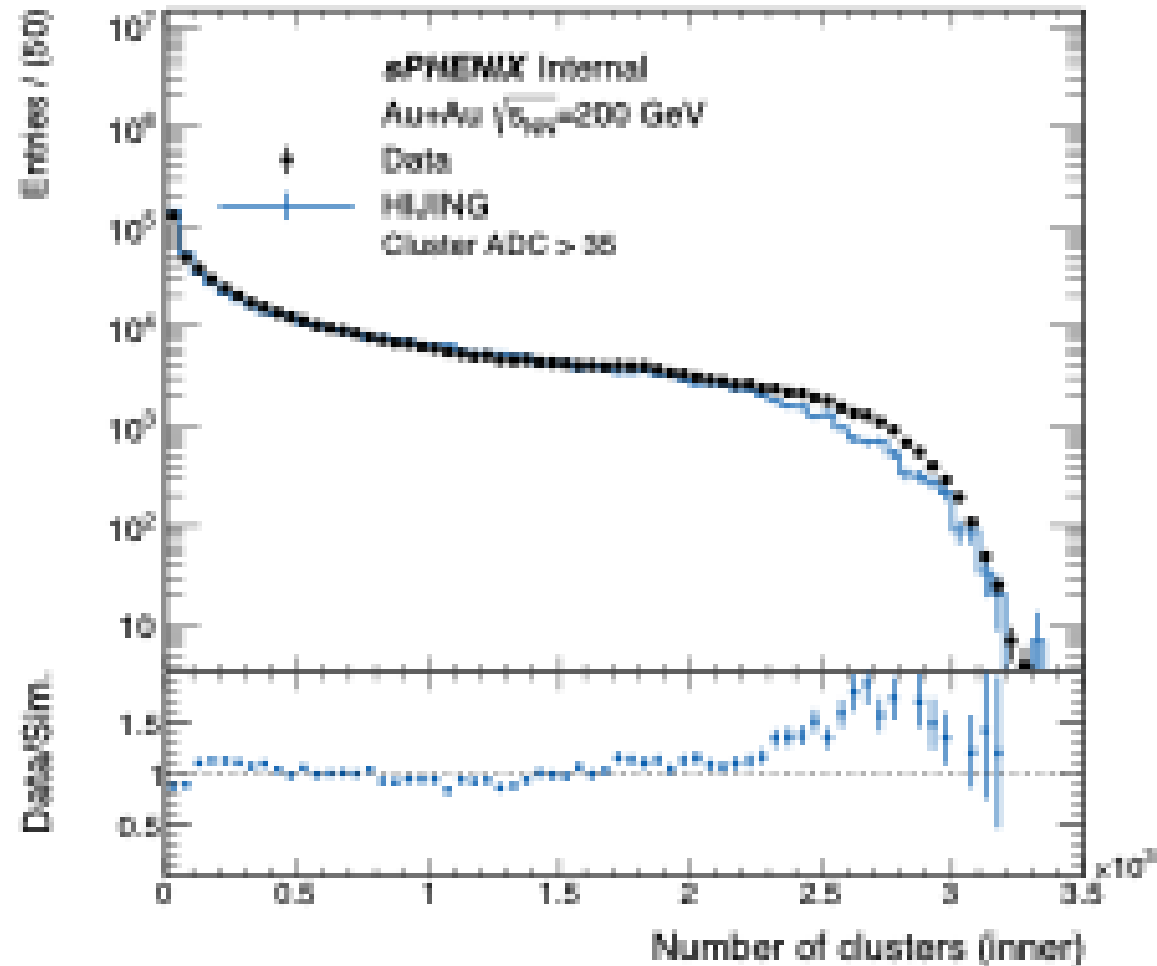
Stream Readout



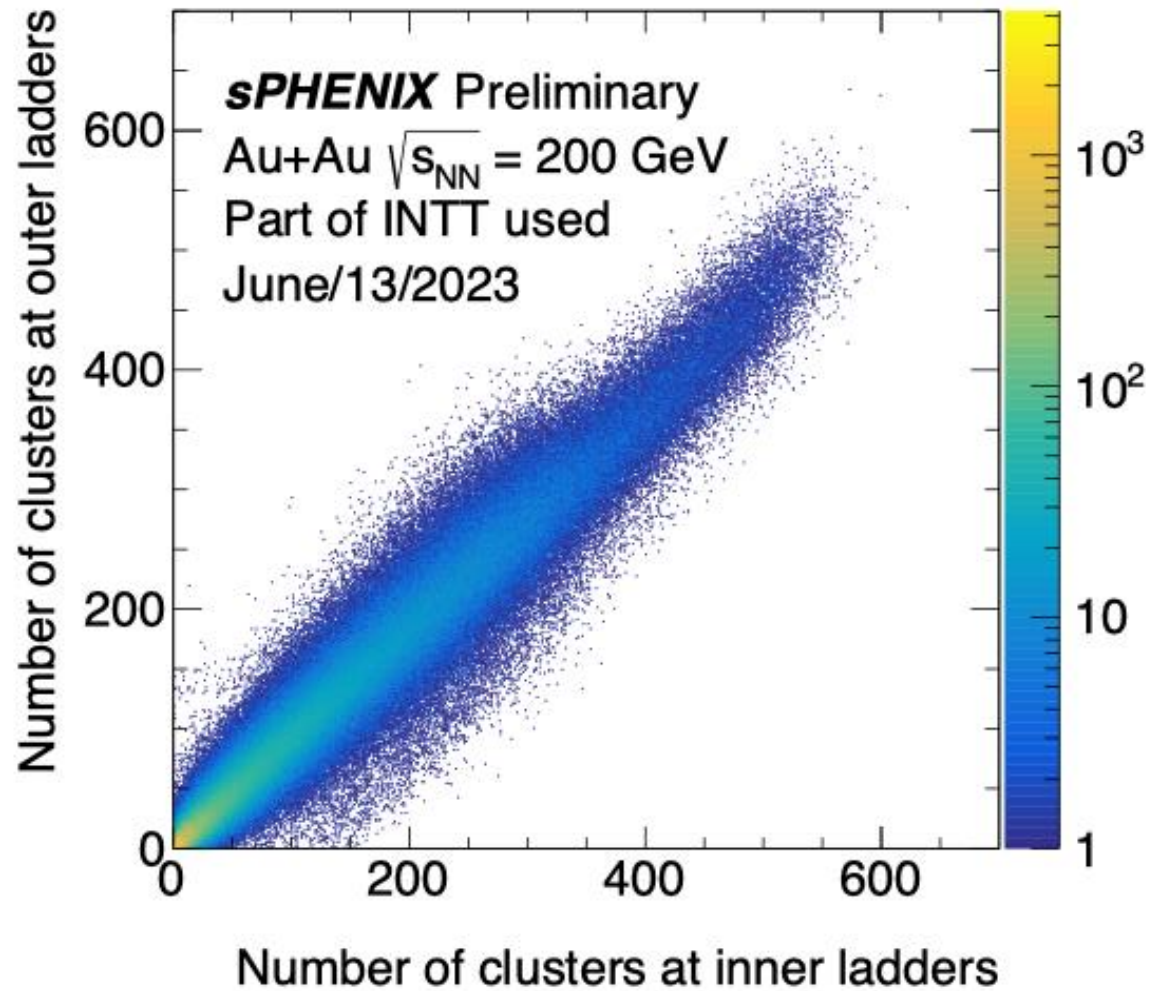
ADC Distribution



Cluster Distributions



INTT hits Inner vs Outer



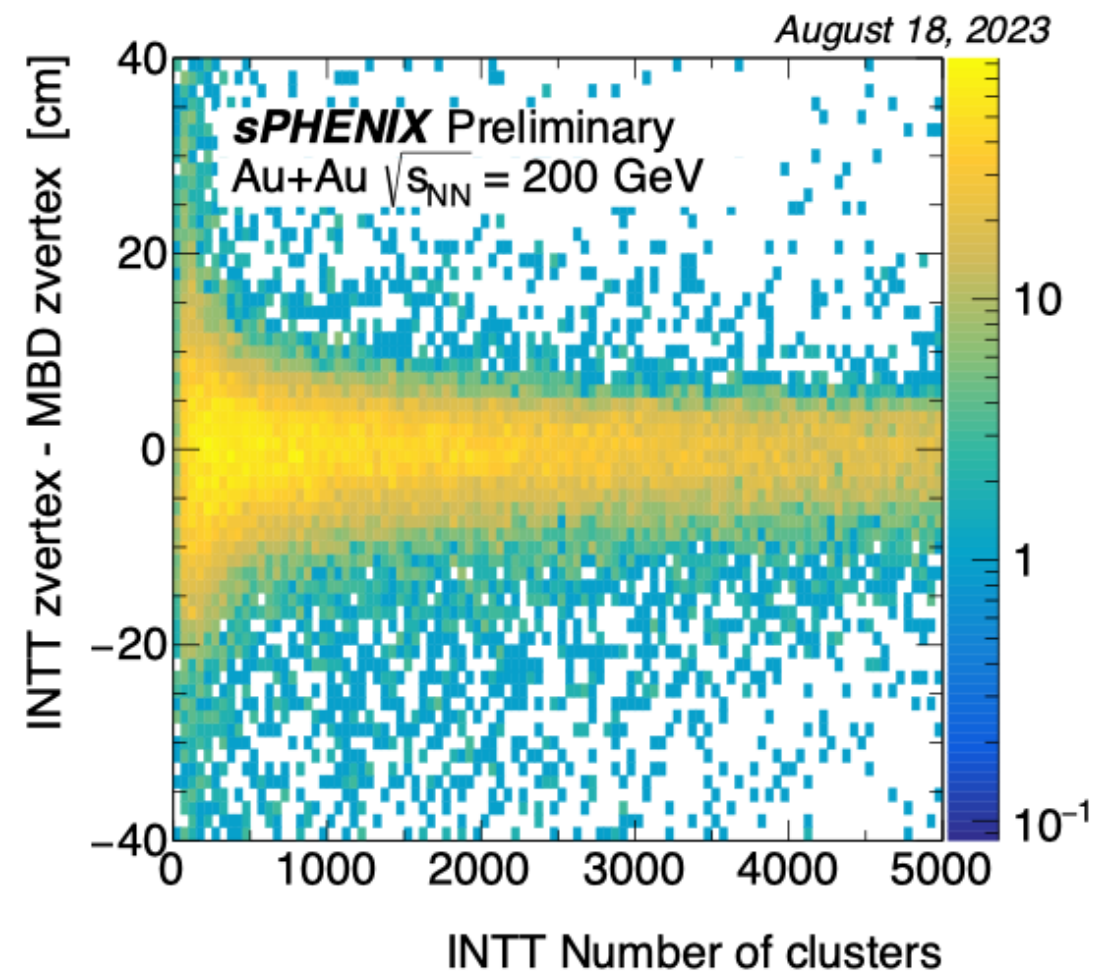
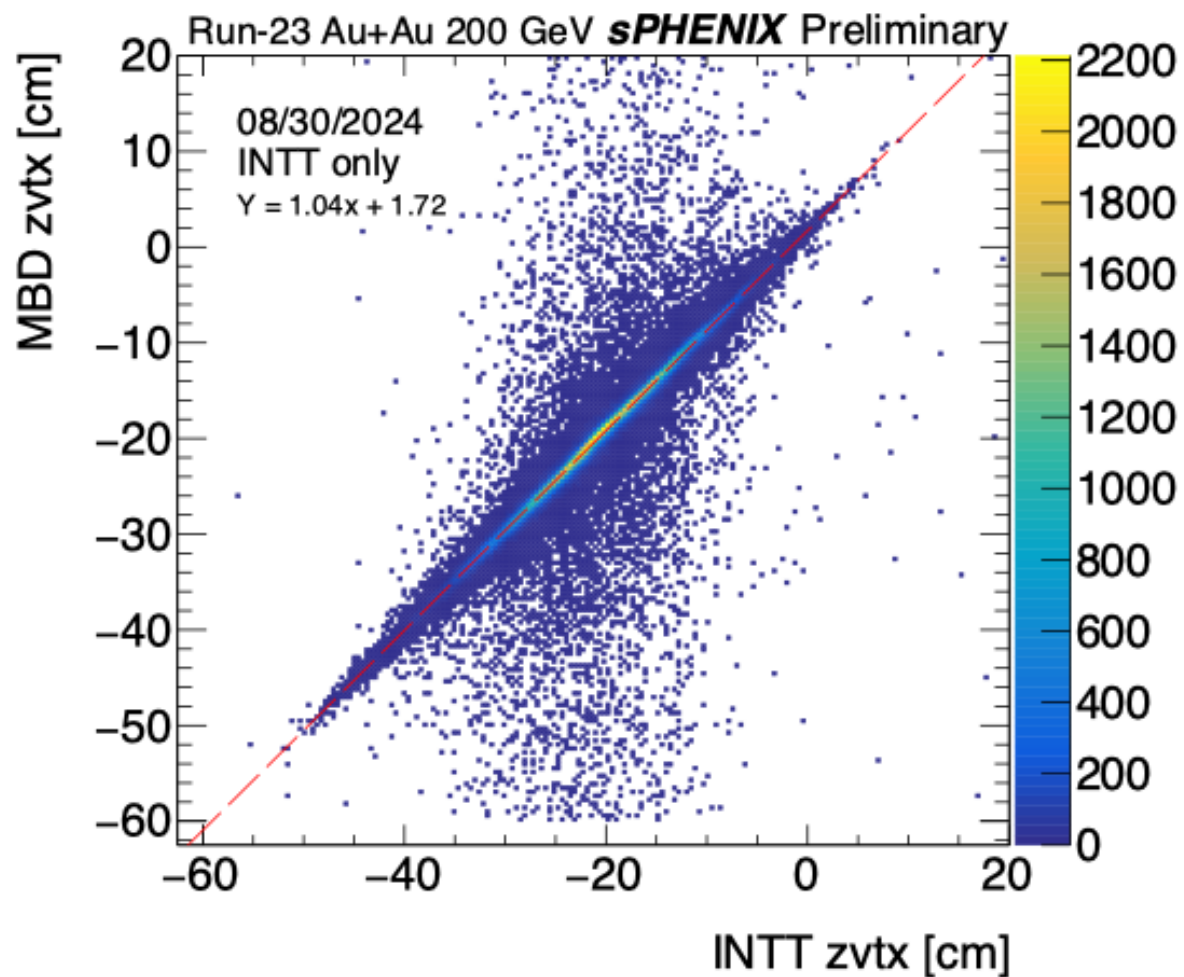
Should update with full INTT

INTT vertex Reconstruction

- Z-vertex reconstruction resolution with INTT half detector method (Mahiro)

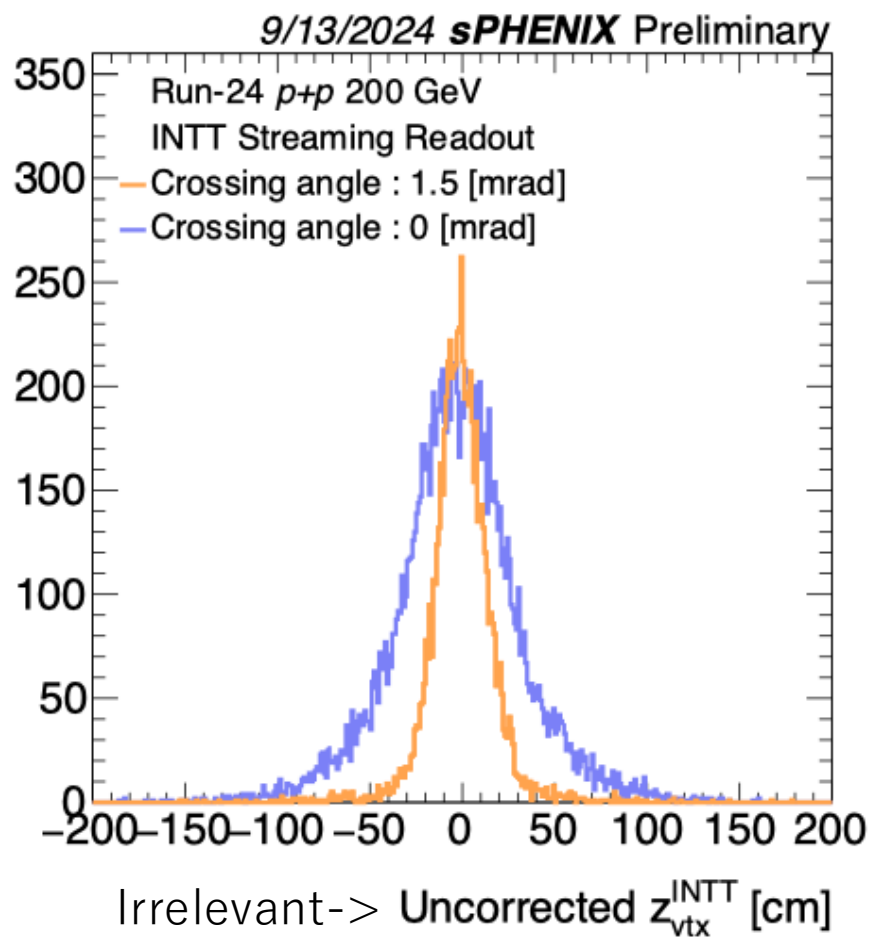
INTT vs MBD Vertex

Committee's decision
Include available plots as much as possible.

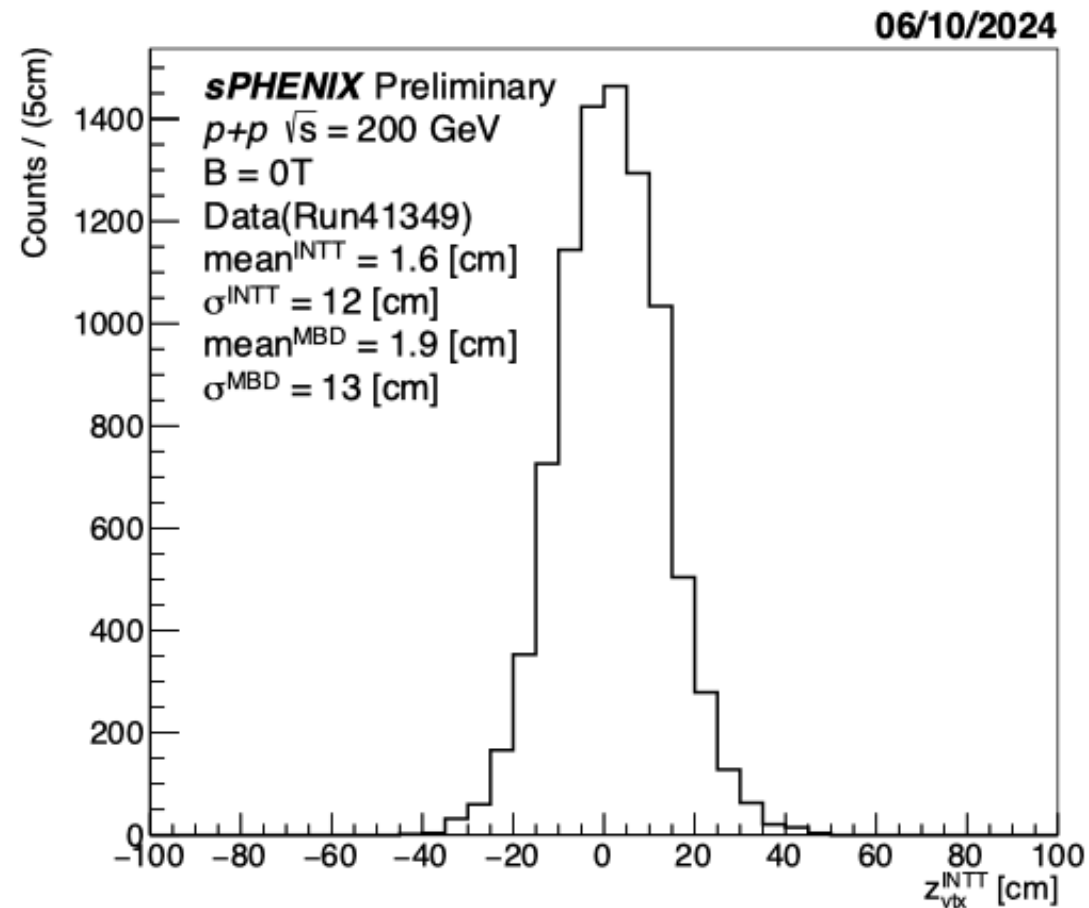


Vertex Reconstruction

Mahiro is in charge
Field off.



INTT-determined [vertex](#) (streaming, field on)



NTT-determined [vertex](#) (triggered, field off)

The screenshot displays the Overleaf web editor interface. The top navigation bar includes options like Menu, Home, and various editing tools. The left sidebar shows a file explorer with files like BarrelPerformance.tex, cas-common.sty, and INTTBarrel_NIM.tex. The main editor area is split into two panes. The left pane shows the LaTeX source code for INTTBarrel_NIM.tex, which includes a preamble with document class, package loading, and author macros. The right pane shows the rendered PDF output, featuring a title page for 'The Intermediate Silicon Strip Detector for sPHENIX*' with a list of authors and affiliations, followed by an abstract and the beginning of the introduction section.

INTTBarrel_NIM.tex Source Code (Left Pane):

```

1 %
2 % Copyright 2019-2021 Elsevier Ltd
3 %
4 % This file is part of the 'CAS Bundle'.
5 % -----
6 %
7 % It may be distributed under the conditions of the LaTeX Project Public
8 % License, either version 1.2 or later is part of all distributions of LaTeX
9 % later version. The latest version of this license is in
10 % http://www.latex-project.org/lppl.txt
11 % and version 1.2 or later is part of all distributions of LaTeX
12 % version 1999/12/01 or later.
13 %
14 % The list of all files belonging to the 'CAS Bundle' is
15 % given in the file 'manifest.txt'.
16 %
17 %
18 % Template article for cas-dc documentclass for
19 % double column output.
20
21 \documentclass[a4paper,fleqn]{cas-dc}
22
23 % If the frontmatter runs over more than one page
24 % use the longmktitle option.
25
26 \documentclass[a4paper,fleqn,longmktitle]{cas-dc}
27
28 % 2024/3/2 \usepackage[authoryear,longnamesfirst]{natbib} causes error in TexShop
29 \usepackage[numbers]{natbib}
30 \usepackage[authoryear]{natbib}
31 \usepackage[authoryear,longnamesfirst]{natbib}
32 \usepackage{lineno}
33 \linenumbers
34
35 %%%Author macros
36 \def\tsc#1{\csdef{#1}{\textsc{\lowercase{#1}}\xspace}}
37 \tsc{WGM}
38 \tsc{QE}
39
40 %%%
41
42 % Uncomment and use as if needed
43 %\newtheorem{theorem}{Theorem}
44 %\newtheorem{lemma}{Lemma}
45 %\newdefinition{rmk}{Remark}
46 %\newproof{pf}{Proof}
47 %\newproof{pot}{Proof of Theorem \ref{thm}}
48
49 \begin{document}

```

Rendered PDF Output (Right Pane):

The Intermediate Silicon Strip Detector for sPHENIX*

Y. Akiba^{a,b}, H. Aso^{a,c}, J. T. Bertaux^{i,b}, D. Cacace^c, K. Y. Chen^d, K. Y. Cheng^{d,b}, A. Enokizono^a, H. Enyo^{a,b}, K. Fujiki^{a,c}, Y. Fujino^{a,c}, M. Fujiiwara^{a,c}, T. Hachiya^{a,c}, T. Harada^{a,c}, S. Hasegawa^a, M. Hata^{a,b}, B. Hong^c, J. Hwang^{k,b}, T. Ichino^{a,c}, M. Ikemoto^{a,c}, H. Imagawa^{a,c}, H. Imai^{a,c}, Y. Ishigaki^{a,c}, M. Isshiki^c, K. Iwatsuki^{a,c}, R. Kan^c, M. Kano^{a,c}, T. Kato^{a,c}, Y. Kawashima^{a,c}, T. Kikuchi^{a,c}, T. Kondo^b, C. M. Kuo^c, C. Kureha^a, T. Kumaoka^a, H. S. Liⁱ, R. S. Luⁱ, E. Mannel^c, H. Masuda^{a,c}, G. Mitsuka^b, N. Morimoto^{a,c}, M. Morita^{a,b}, I. Nakagawa^{a,b,c}, Y. Nakamura^{a,c}, G. Nakano^{a,c}, Y. Namimoto^{a,c}, D. Nemoto^{a,c}, S. Nishimori^c, R. Nouicer^c, G. Nukazuka^a, I. Omae^{a,c}, R. Pisani^c, Y. Sekiguchi^a, M. Shibata^{a,b}, C. W. Shih^{i,b}, K. Shiina^{a,c}, M. Shimomura^a, R. Shishikura^{a,c}, M. Stojanovic^{i,b}, K. Sugino^c, Y. Sugiyama^a, A. Suzuki^{i,b}, R. Takahama^{a,b}, W. C. Tang^{d,b}, Y. Terasaka^a, T. Todoroki^c, H. Tsubibata^{a,c}, T. Tsuruta^{a,c}, Y. Yamaguchi^b, H. Yanagawa^{a,c}, M. Watanabe^{a,c}, R. Xiaoⁱ and W. Xieⁱ

ARTICLE INFO

ABSTRACT

A new barrel type silicon detector was constructed in the central rapidity region of sPHENIX detector complex as a part of its tracking system. The sPHENIX is the novel detector launched in 2023 and has been commissioned using proton-proton and Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV at the Relativistic Heavy Ion Collider (RHIC) in Brookhaven National Laboratory. The new silicon detector is called intermediate tracker (INTT) provides a single event timing resolution and establishes advanced tracking together with a CMOS monolithic-active-pixel-sensor (MAPS) based silicon-pixel vertex detector (MVTX), a time-projection chamber (TPC), and a microgaseous-based detector. The INTT detector is two layer structure of full azimuth coverage and its inner and outer barrels comprise of 24 and 32 silicon ladders, respectively. Each silicon ladder consisted of four silicon strip sensors to cover the rapidity range of $-1.1 < \eta < 1.1$ at the radial distance of 7 to 10.3 cm from a beam axis. The silicon sensor is 78 μ m pitch, 320 μ m thick, and its length is either 16 or 20 mm. The INTT detector was fully integrated into thedaq system of the sPHENIX and its signals were processed by eight Felix servers as a part of the data acquisition.

1. Introduction

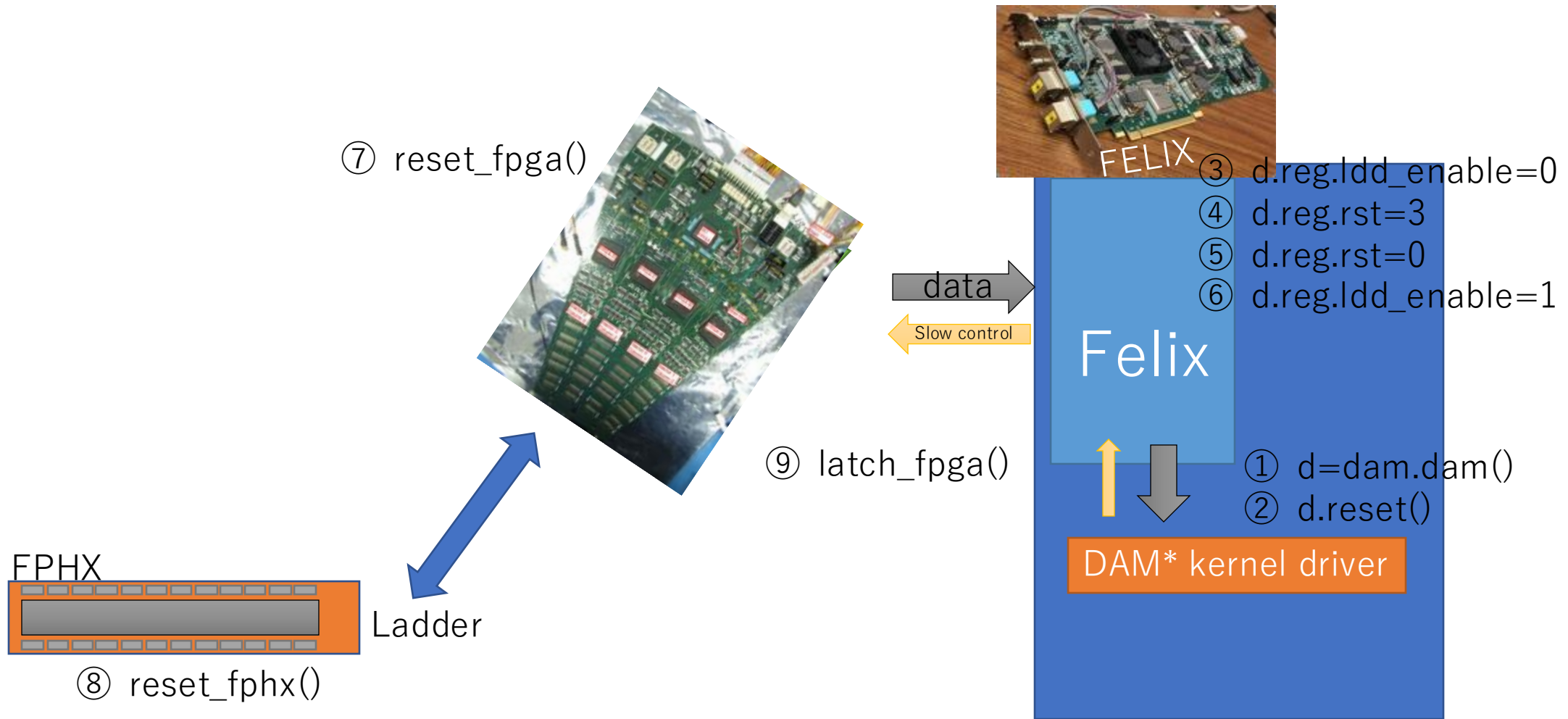
The sPHENIX detector [1, 2] at the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory, USA is a major upgrade of the PHENIX detector [3], which was decommissioned in 2017. The sPHENIX experiment collects high statistics proton-proton, proton-nucleus, and nucleus-nucleus data, enabling state-of-the-art studies of jet modification, pion suppression, and open heavy-flavor production to probe the microscopic nature of the strongly-coupled quark-gluon plasma. Such measurements are complementary to those of experiments at the Large Hadron Collider (LHC) at CERN, and will allow a broad range of cold quantum-chromodynamic studies [4].

The sPHENIX detector provides precision vertexing, tracking, and electromagnetic and hadronic calorimetry in the central pseudorapidity region $|\eta| < 1.1$ with full azimuthal coverage at the full RHIC collision rate. A comprehensive assessment of these requirements led to the development of the reference design shown in Fig. 1. In its overall layout, sPHENIX follows the typical geometry of modern collider detectors. The tracking system comprises a CMOS monolithic-active-pixel-sensor (MAPS) microvertex detector (MVTX), a silicon-strip intermediate tracker

Schedule

- Material Preparation : October ~ December
- Editing : ~ End of Feb 2026
- 1st Release to INTT group review : beginning of March 2026
- 1st Release to sPHENIX collaboration review : End of April 2026
- Submission to NIM : May 2026

Felix Readout System Initialization Routine (I)



We would like to have any response flag from each initialization steps as much as possible so that we will know which process failed in the initialization sequence.

Lognote P110

