# Run23 INTT and sPHENIX Commissioning status and results

Genki Nukazuka (RIKEN/RBRC)

April. 4th 2023
Young@sPHENIX

# Run23, Timeline

- April :
  - All detectors had been installed except sEPD.
- May/1? :
  - Commissioning with beam started.
- Aug/01:
  - The trouble with the RHIC valve box happened.
- Aug/03:
  - HCAL cosmic trigger implemented. Commissioning with cosmic rays started.
- Aug/04:
  - ALD decision to end the run
- Aug/05:
  - Switch to two-person shifts
- Sep/13:
  - INTT was turned off in preparation for TPC repair. End of cosmics data taking for all tracking detectors.
- Sep/29:
  - End of shift operation at 24:00.
- Oct/02:
  - End of Run party

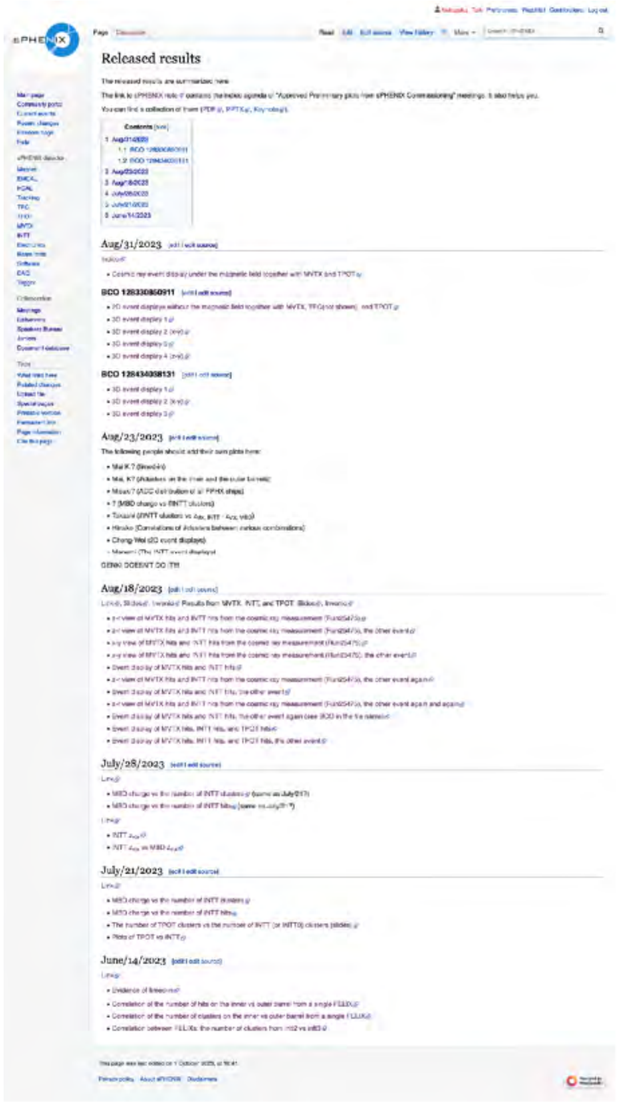

# Run23, Commissioning, INTT

The status of most of the commissioning topics was presented at the recent workshop at RIKEN.

| Timing | Title | Speaker |
|---|---|---|
| 28/09/2023 10:55 | sPHENIX status | Genki Nukazuka (RIKEN) |
| 28/09/2023 11:15 | sPHENIX実験-中間飛跡検出器INTTを用いたトラッキングアルゴリズム開発について | Hinako Tsujibata (NWU) |
| 28/09/2023 13:00 | sPHENIX実験における中間飛跡検出器 INTT 用シリコンセンサーでのエネルギー損失測定の評価 | Yuka Sugiyama (NWU) |
| 28/09/2023 13:15 | topical: jets and heavy-flavors | Takashi Hachiya (NWU) |
| 28/09/2023 13:50 | 中間飛跡検出器INTTのノイズ解析 | Ryota Shishikura (Rikkyo) |
| 28/09/2023 14:05 | sPHENIX-INTTシリコン検出器が示す200GeV金原子核衝突におけるヒットクラスター数の検証 | Tomoya Kato (Rikkyo) |
| 28/09/2023 14:50 | sPHENIX-INTT検出器でのmultiplicity測定 | Misaki Hata (NWU) |
| 28/09/2023 15:20 | 高エネルギー重イオン衝突実験sPHENIXにおけるジェット再構成の研究 | Mai Watanabe (NWU) |
| 28/09/2023 17:15 | sPHENIX-INTTシリコン検出器の信号振幅バイアス電圧依存性の研究 | Takahiro Kikuchi (Rikkyo) |
| 29/09/2023 15:00 | sPHENIX実験INTT検出器のデータ収集タイミングの調整とパイルアップについて | Mai Kano (NWU) |
| 29/09/2023 15:15 | Development of an Event Display for INTT Detector at sPHENIX | Manami Fujiwara (NWU) |

# Run23, Commissioning, INTT

The released plots were summarized in [the sPHENIX wiki](#).



Released results

Aug/31/2023

BCO 12833080911

BCO 12834038131

Aug/23/2023

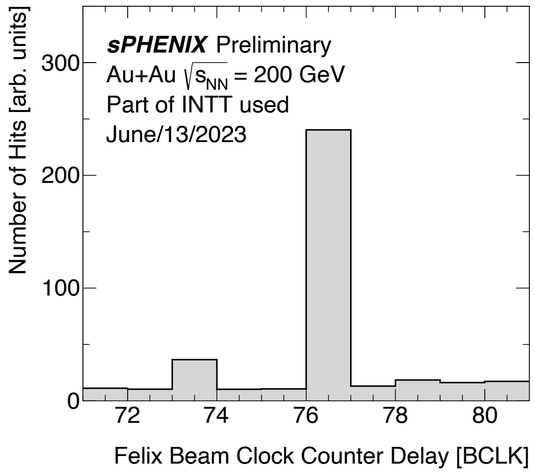
Aug/18/2023

July/28/2023

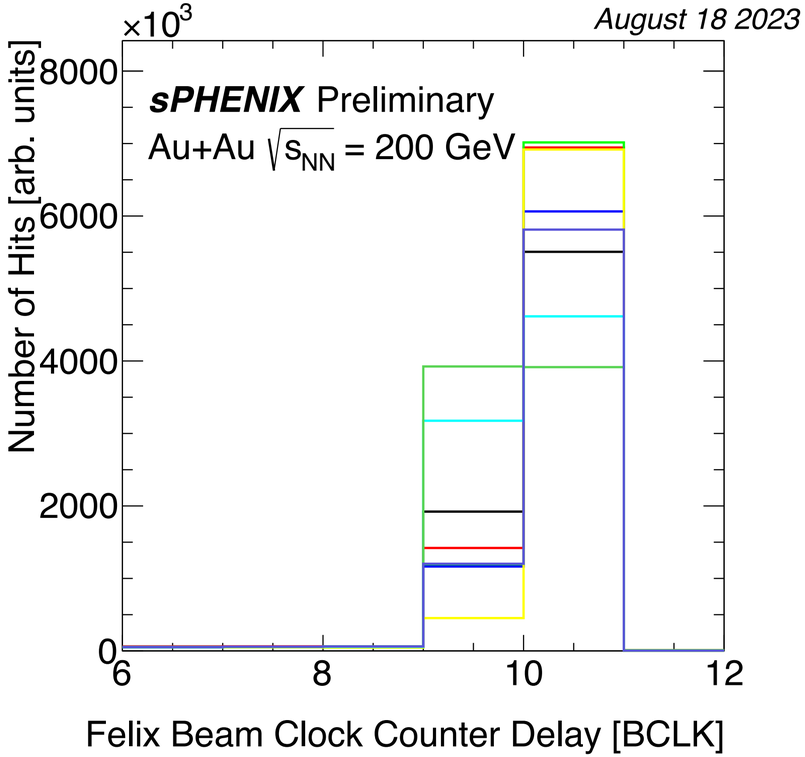
July/21/2023

June/14/2023

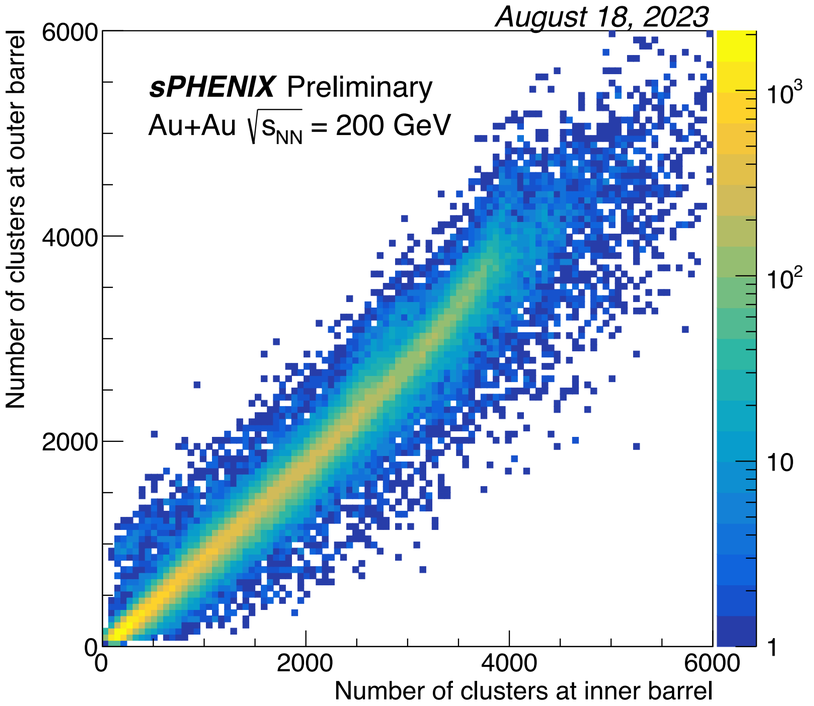
# Run23, Commissioning, INTT




**The first evidence of timed-in.**
**Only 1/8 part of INTT.**
**Released on June/13/2023.**

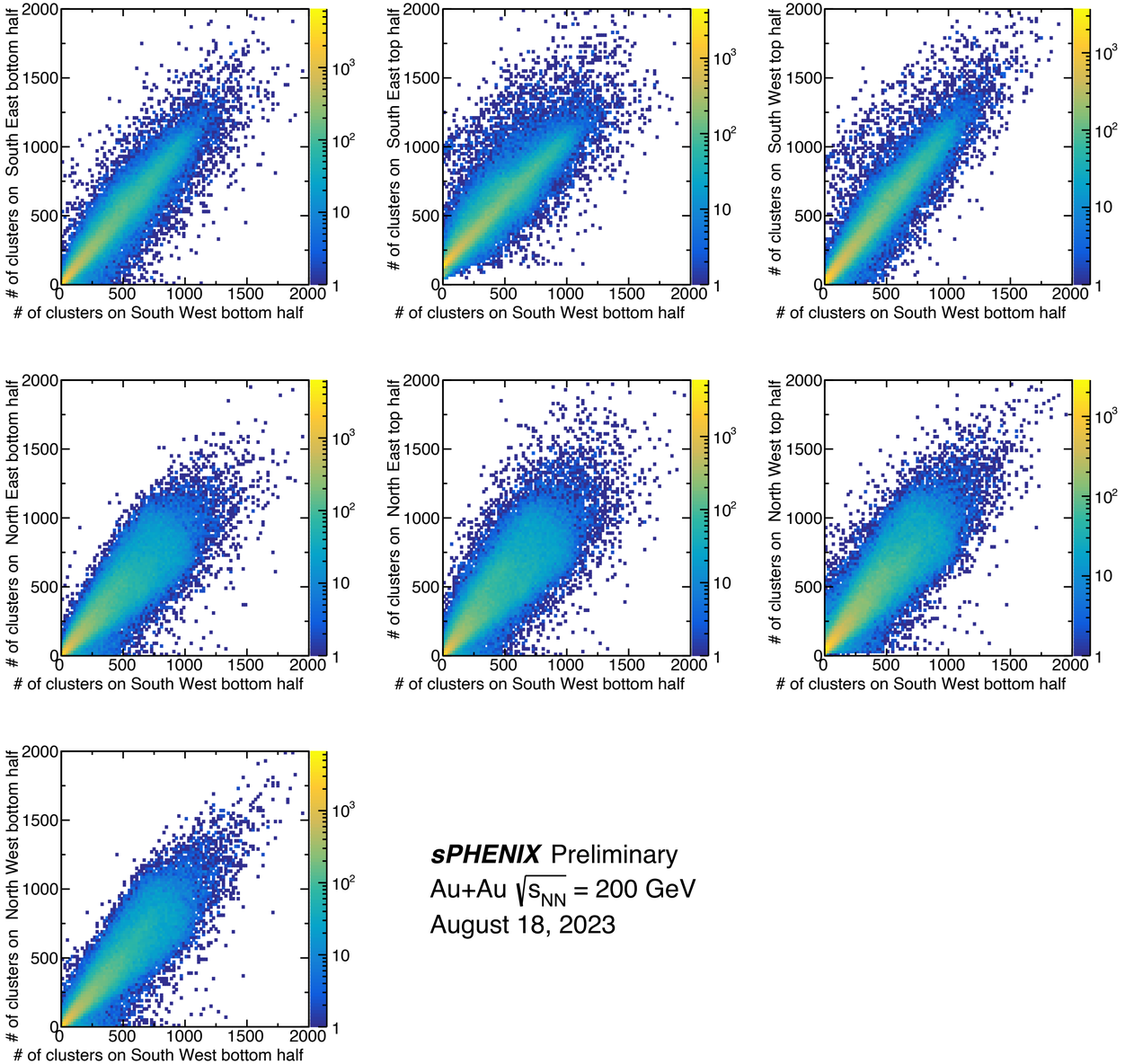



**Evidence of the timing resolution within 2 BCO.**
**Released on Aug/18/2023.**




**Evidence of healthy operation of INTT.**
**#clusters on the inner barrel and the outer barrel.**
**Released on Aug/18/2023.**

# Run23, Commissioning, INTT

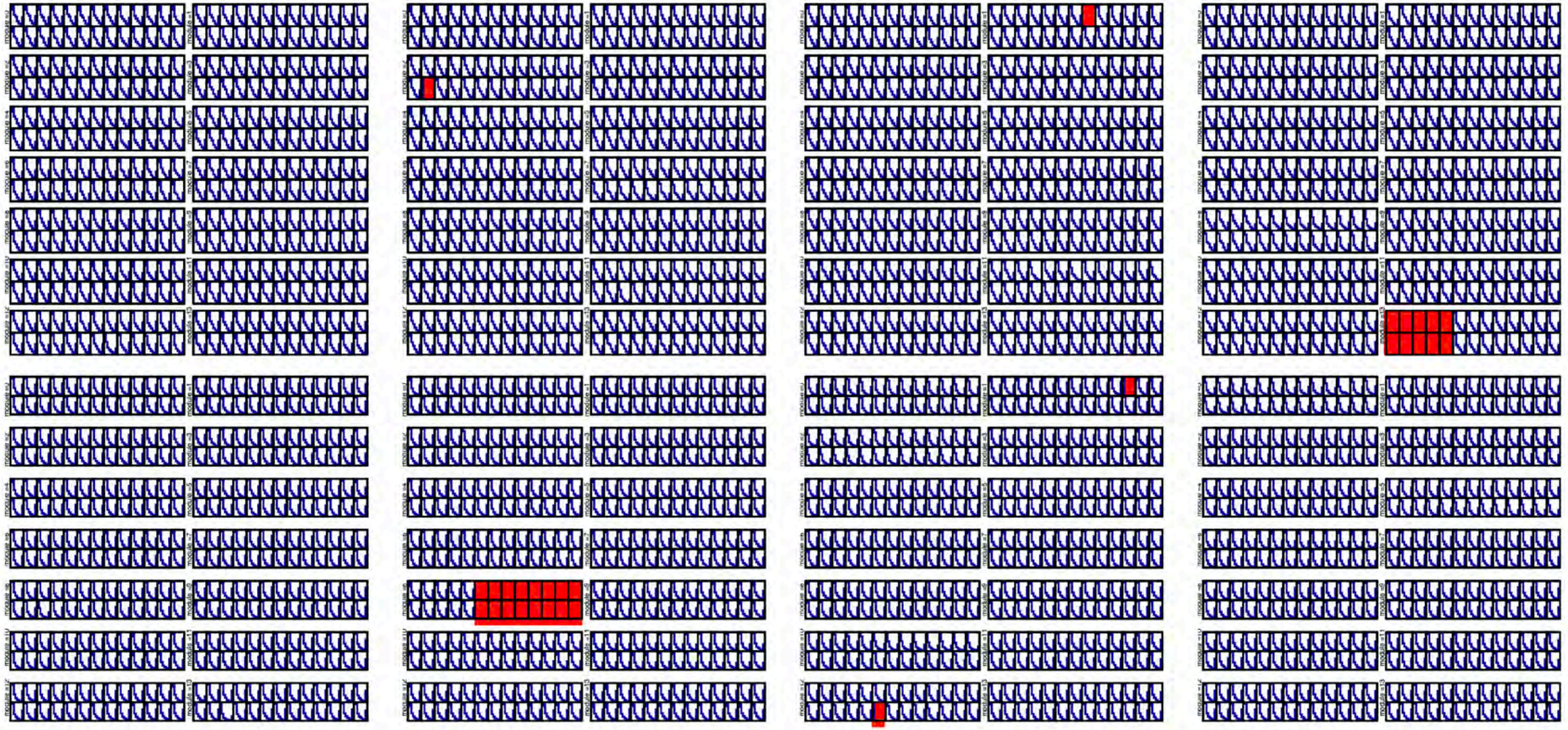



***sPHENIX*** Preliminary
Au+Au $\sqrt{s_{NN}}$ = 200 GeV
August 18, 2023

**Correlations of #clusters**
**between the south west bottom half of INTT**
**and the other parts.**
**Released on Aug/18/2023.**

# Run23, Commissioning, INTT

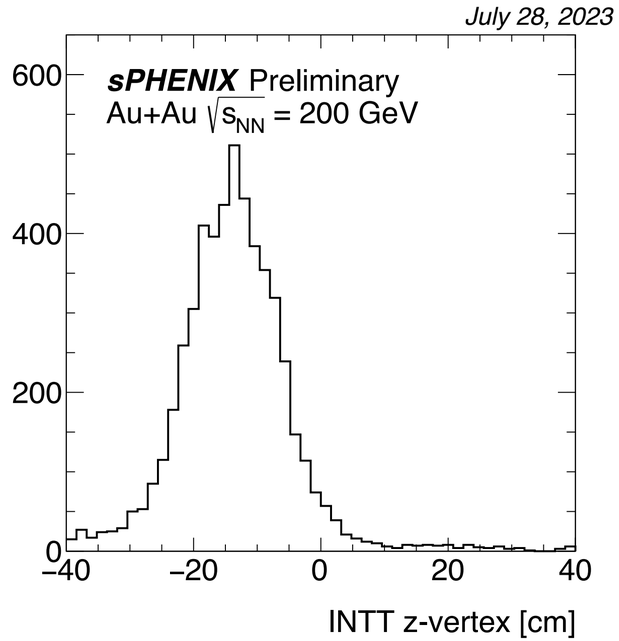
August 18, 2023



ADC distribution of all FPHX chips.
It means most of the chips (2882 / 2912 ~ 0.990) are in good condition.
Released on Aug/18/2023.

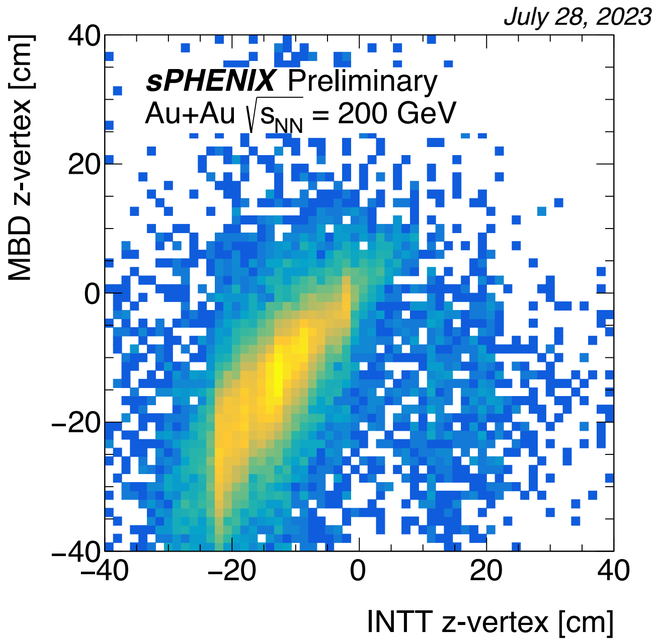
***sPHENIX*** Preliminary
Au+Au $\sqrt{s_{NN}}$ = 200 GeV

# Run23, Commissioning, INTT



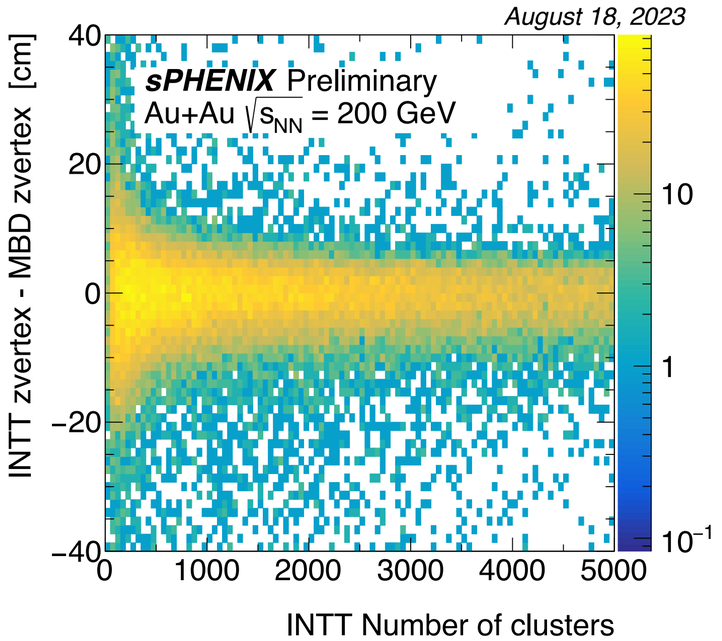

**$z_{vtx}$ distribution reconstructed by INTT.**

**Released on Aug/18/2023.**




**A correlation of $z_{vtx}$ reconstructed by INTT and MBD.**

**Released on Aug/18/2023.**

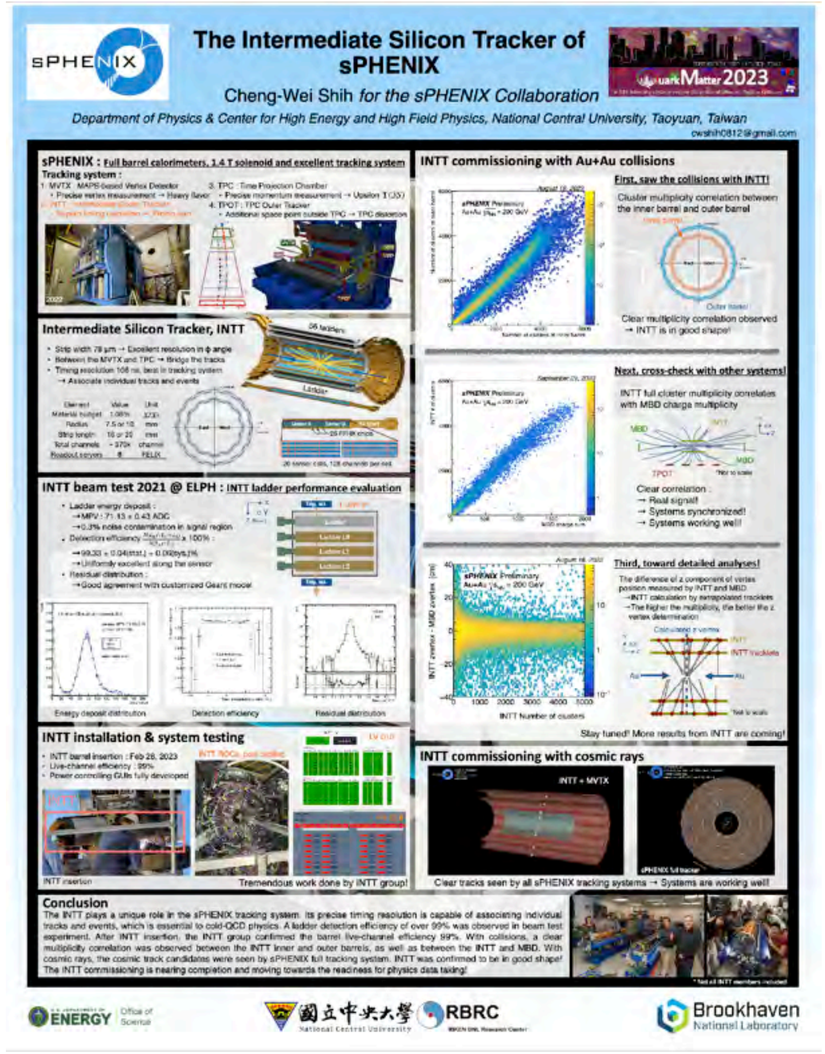


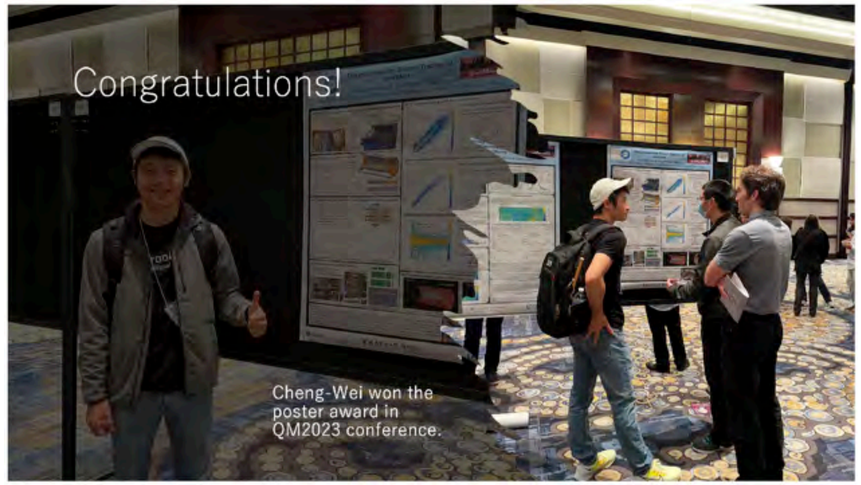

**A correlation between #INTT clusters and the difference of $z_{vtx}$ reconstructed by MBD and INTT.**

**Released on Aug/18/2023.**

# Run23, Commissioning, INTT

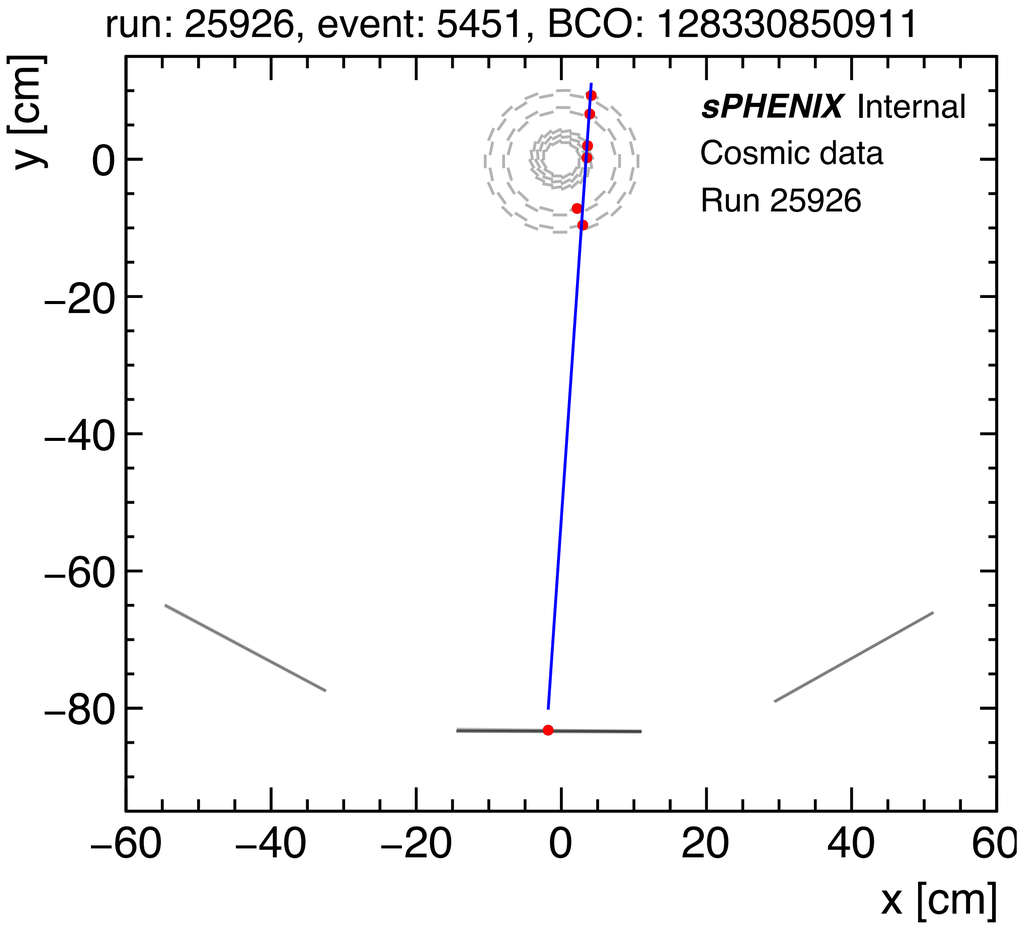
**Our colleague, Cheng-Wei Shih, from National Central University, Taiwan, won the poster award in QuarkMatter2023 for “The Intermediate Silicon Tracker of sPHENIX”.**



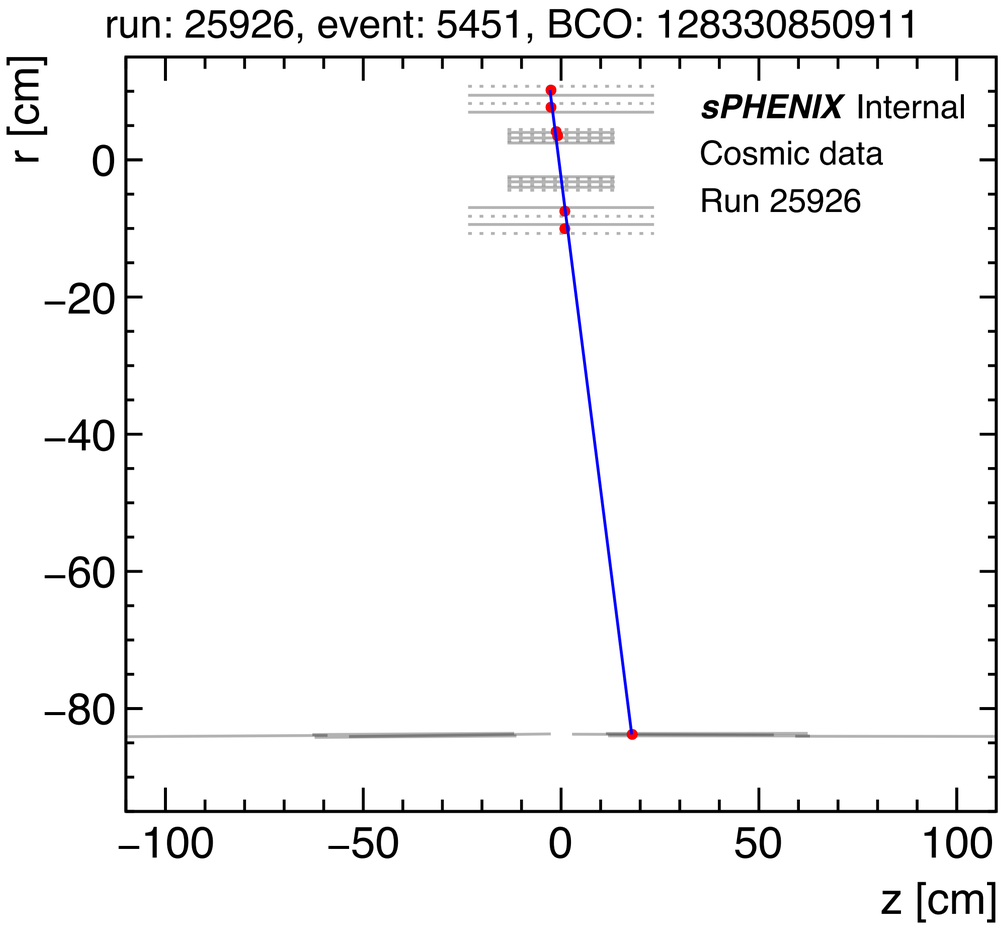


# Run23, Commissioning, INTT

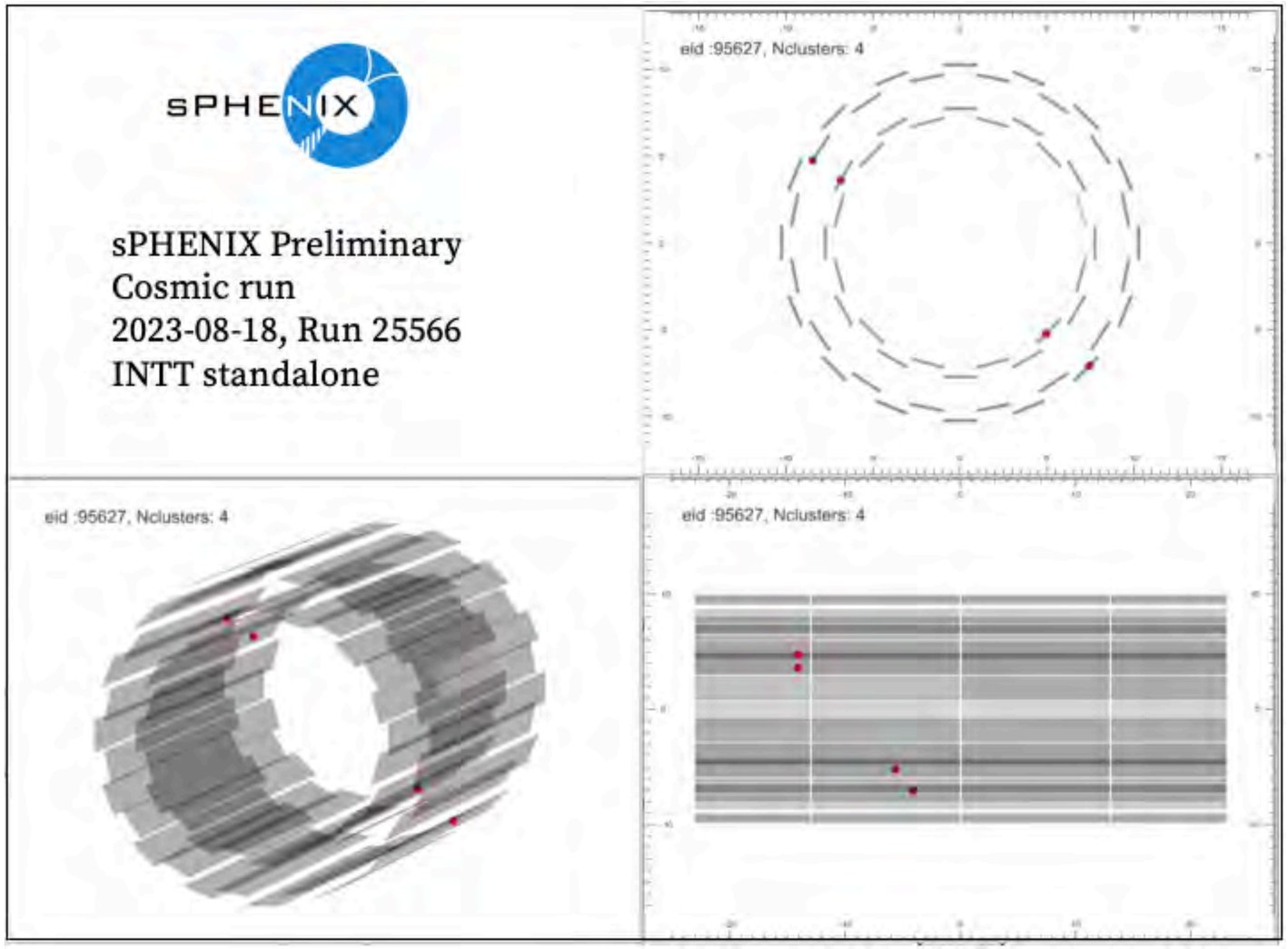

**Cosmic ray measurements together with MVTX, TPC, and TPOT.**

# Run23, Commissioning, INTT

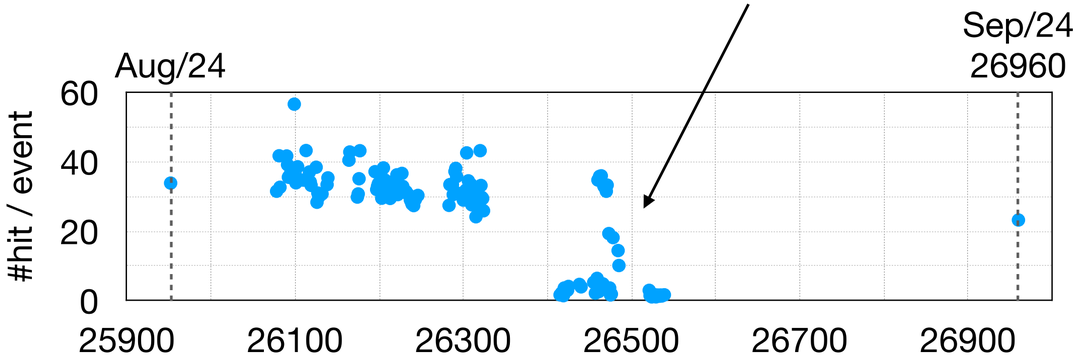

**Cosmic ray measurements together with MVTX, TPC, and TPOT.**

# Run23, Commissioning, INTT



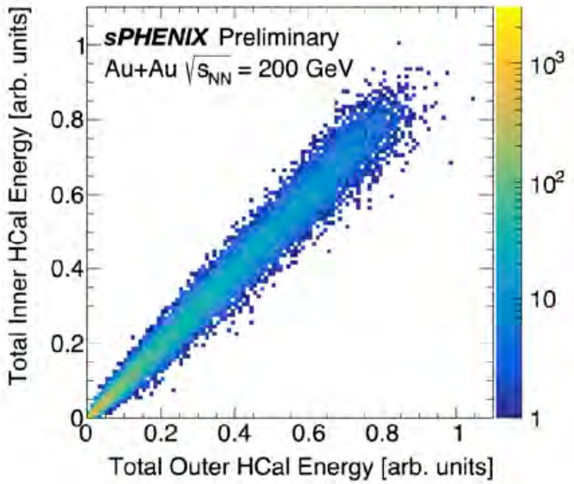

Standalone Cosmic ray measurements.

Failure on LV for ROCs on the south side.
We should have found it earlier…

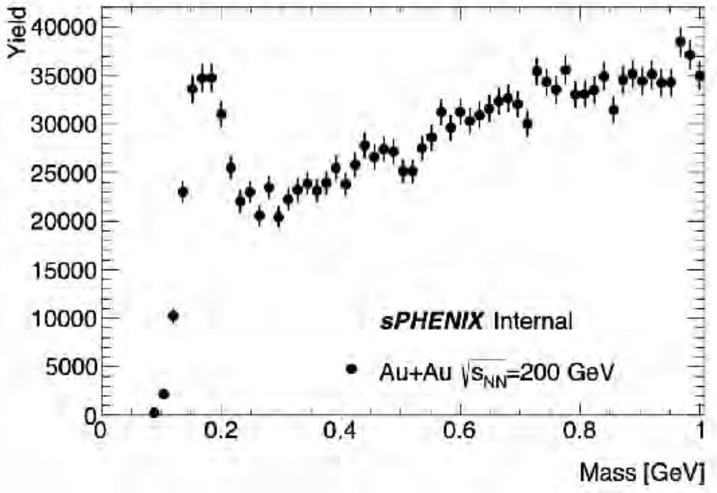



**#hit/event as a function of runs.**
**Hot channels were not excluded in this analysis.**
**INTT was operated on for 1 month in stable condition.**
**#hit/event depends on the trigger condition.**

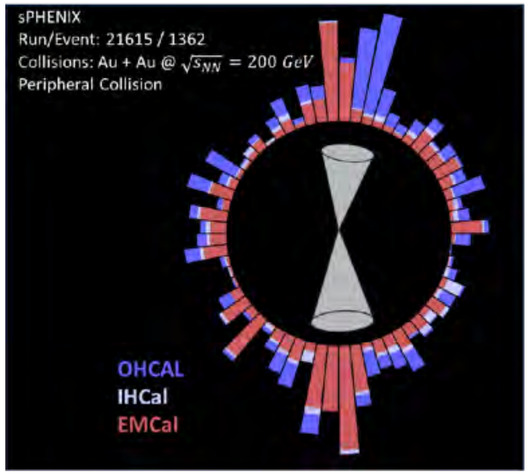
# Run23, Commissioning, Calorimeters



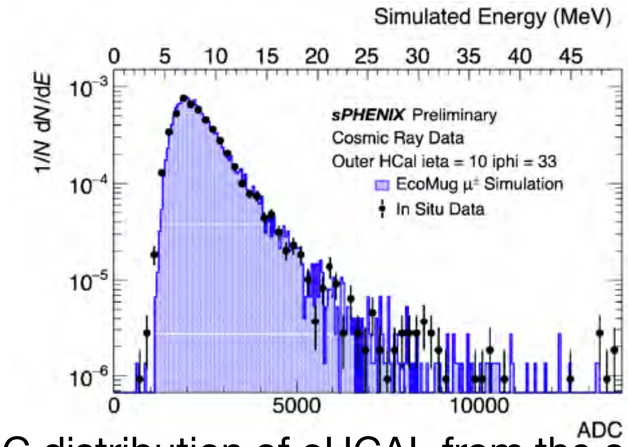

Correlation of measured energy by oHCAL and iHCAL.



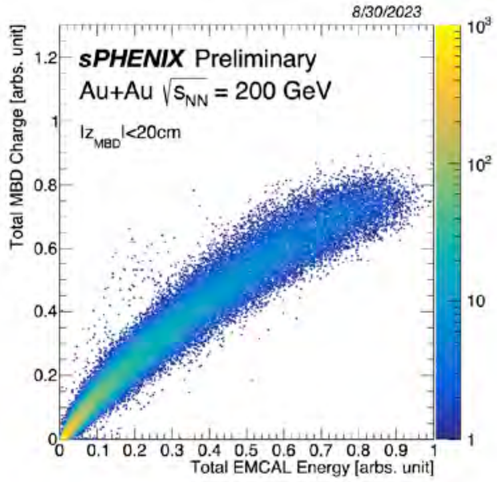

EMCAL measured $\pi^0$ signal from γ + γ.




A di-jet (like?) event obtained in 2023.



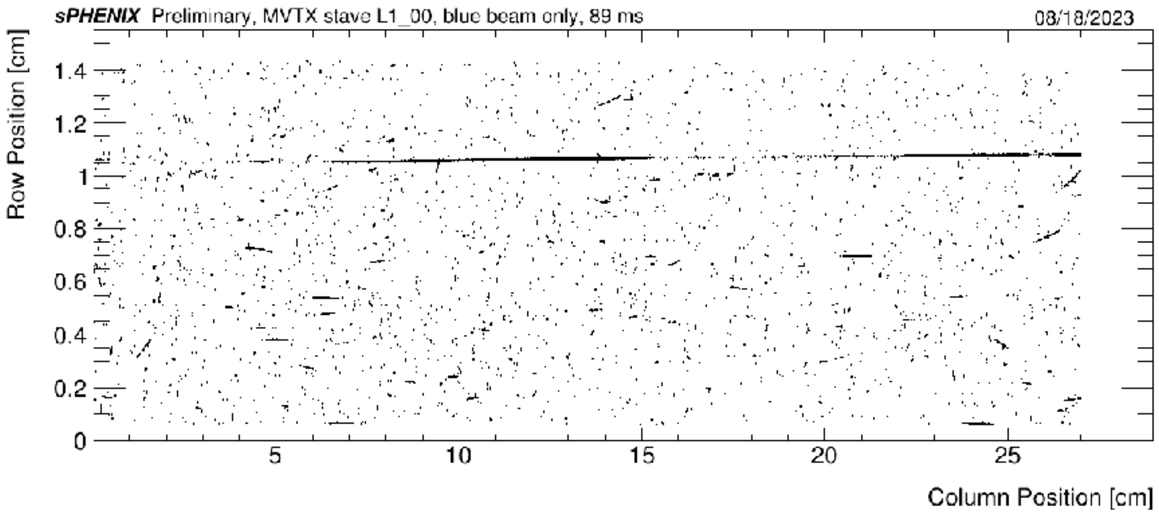

ADC distribution of oHCAL from the cosmic runs and comparison to the simulation.

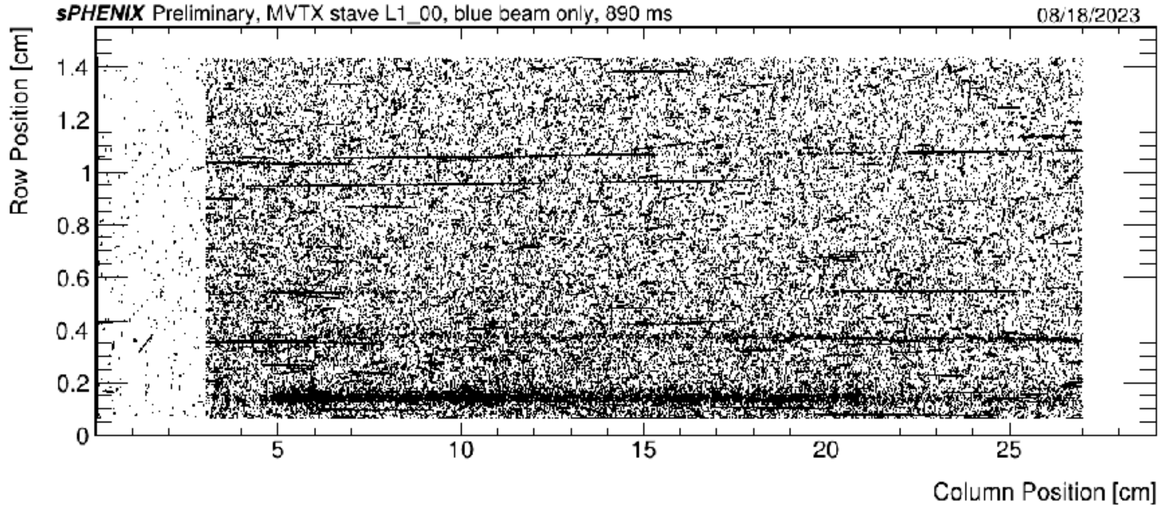



Correlation b/w EMCAL energy and MBD charge.

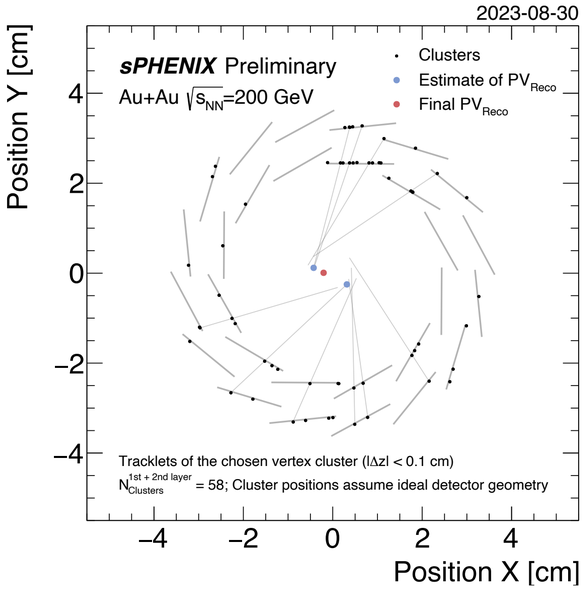
# Run23, Commissioning, MVTX

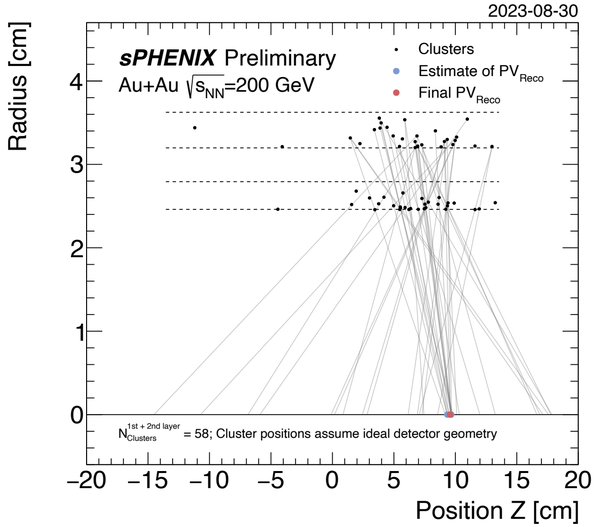
The background measurements with only a blue beam.



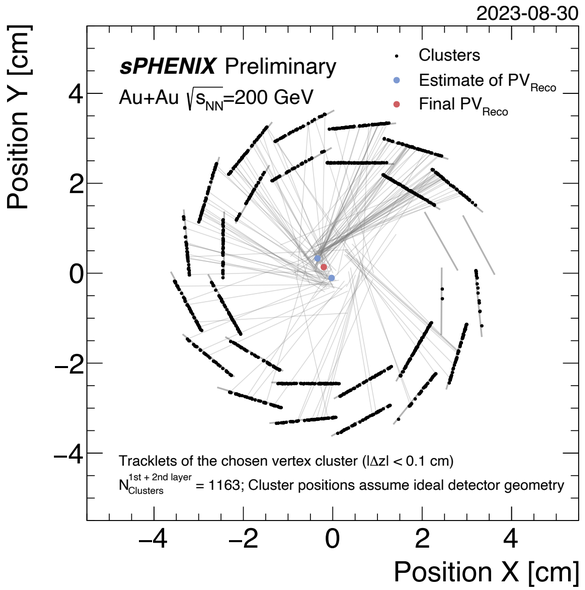



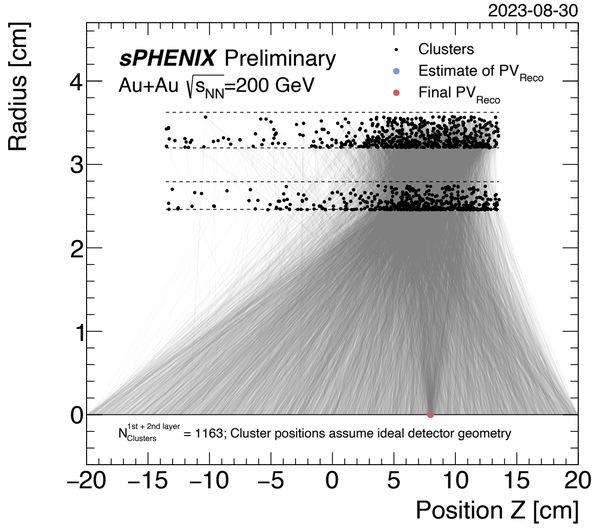
# Run23, Commissioning, MVTX

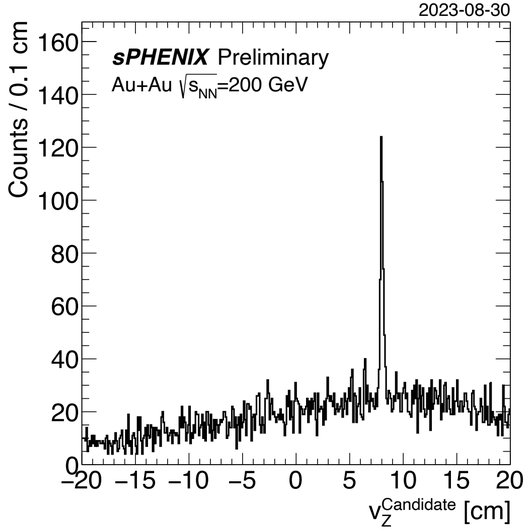


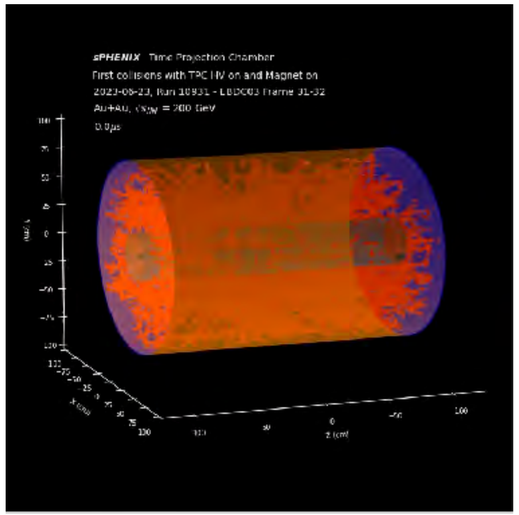

Event displays shown in QM2023.

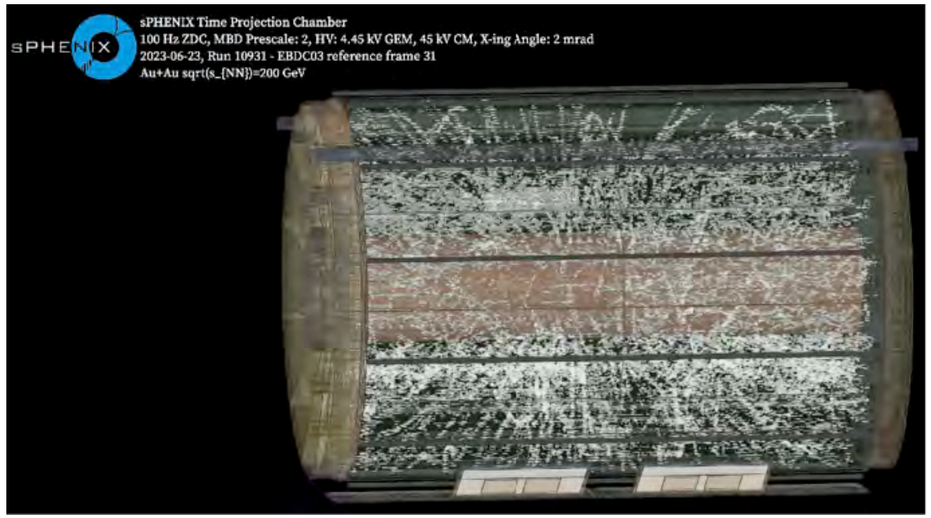


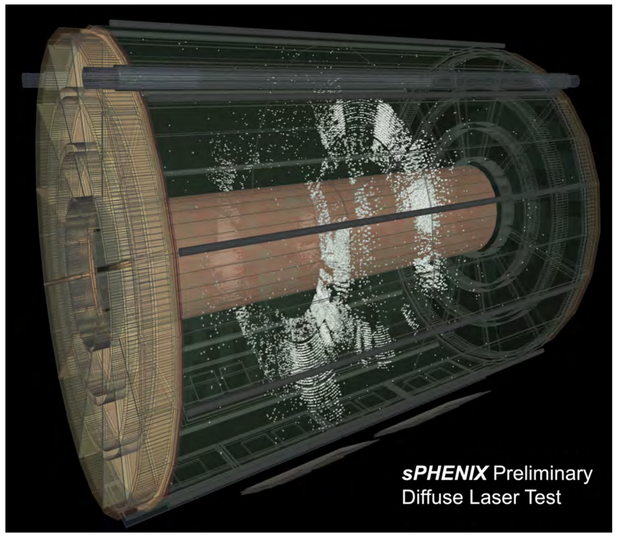



# Run23, Commissioning, TPC

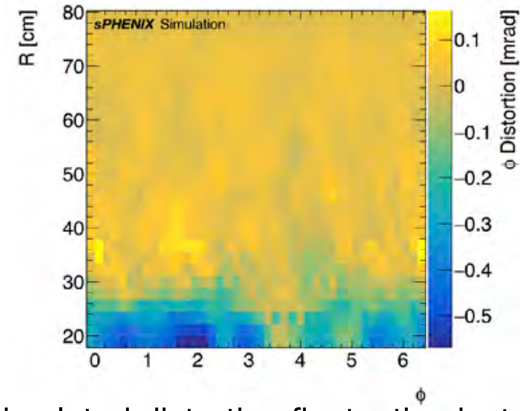



Event display of frame 31, run 10931 (June/23/2023)




Event display of the diffuse laser test.
It demonstrates how the electrons from the diffuse laser flash travel as a sheet through the TPC.

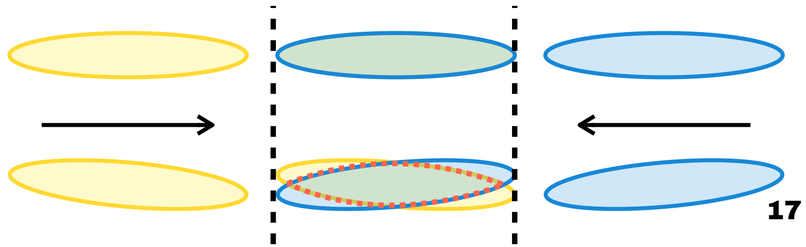



Simulated distortion fluctuation in ϕ.

# sPHENIX Status
## New Input From Run 2023

| Year | Beam | $\sqrt{s_{NN}}$ (GeV) | Data Taking (Weeks) | Luminosity, (\|z\| < 10 cm) | |
|---|---|---|---|---|---|
| | | | | Recorded | Sampled |
| 2023 | Au + Au | 200 | 9 | 3.7 $nb^{-1}$ | 4.5 $nb^{-1}$ |

- The unexpected end of the run.
  - We proposed carrying 6 weeks of Au+Au measurements over 2024.
  - How we proceed ( Au+Au, then $p^{\uparrow}+p^{\uparrow}$ or vice versa) is not determined yet.
- New luminosity estimation by RHIC.
  - RHIC made a new luminosity estimation based on the results in 2023.
  - The luminosity of Au+Au is not affected a lot, though $p^{\uparrow}+p^{\uparrow}$ is decreased by 1/5.
- Luminosity estimation with a beam crossing angle.
  - A non-zero beam crossing angle is needed to limit the distribution of the collision points in z-direction.
  - According to our measurement in 2023, it affects luminosity.



# Proposed Plan

| Year | Beam | $\sqrt{s_{NN}}$ (GeV) | Data Taking (Weeks) | Luminosity, (\|z\| < 10 cm) Min. Bias | Calo. |
|---|---|---|---|---|---|
| 2024 | $p^{\uparrow}+p^{\uparrow}$ | 200 | 12 | 0.3 $pb^{-1}$ (5 kHz) | 45 $pb^{-1}$ |
| 2024 | $p^{\uparrow}+Au$ | 200 | 5 | 0.003 $pb^{-1}$ | 11 $pb^{-1}$ |
| 2025 | Au + Au | 200 | 20.5 | 13 $nb^{-1}$ | 21 $nb^{-1}$ |

Beam Use Proposal 2022

Beam Use Proposal 2023

| Year | Beam | Data Taking (Weeks) | Luminosity, (\|z\| < 10 cm) Min. Bias |
|---|---|---|---|
| 2025 | Au + Au | 20.5 /24.5 | 5.2 /6.3 $nb^{-1}$ |

**Scenario-A**
First Au+Au for commissioning, then $p^{\uparrow} + p^{\uparrow}$.

**Scenario-B**
First $p^{\uparrow} + p^{\uparrow}$ for both commissioning and physics, then Au+Au for physics.

| Year | Scenario | Beam | Data Taking (Weeks) | Luminosity, (\|z\| < 10 cm) Min. Bias | Calo. |
|---|---|---|---|---|---|
| 2024 | A | Au + Au | | Only Commissioing | |
| 2024 | A | $p^{\uparrow}+p^{\uparrow}$ | 13/17/21 | 0.34/0.44/0.54 $pb^{-1}$ | 23/31/39 $pb^{-1}$ |
| 2024 | B | $p^{\uparrow}+p^{\uparrow}$ | 9/13/17 | 0.23/0.34/0.44 $pb^{-1}$ | 15/23/31 $pb^{-1}$ |
| 2024 | B | Au + Au | 3 | 0.4 $nb^{-1}$ | |

# BACKUP SLIDES

# sPHENIX Runs: Effect by the Beam Crossing Angle to Luminosity

| Crossing angle $\theta$ | $L(\theta,\ \text{all}\ z)/L(\theta=0,\ \text{all}\ z)$ | $L(\theta, \lvert z\rvert < 10\ \text{cm})/L(\theta,\ \text{all}\ z)$ | $\sigma_z$ in sPHENIX [cm] | Lumi/Week all $z$ [$\mu\text{b}^{-1}$] | Lumi/Week ($\lvert z\rvert < 10$ cm) [$\mu\text{b}^{-1}$] |
|---|---|---|---|---|---|
| 0 mrad | 1.0 | 0.30 | 26 | 2210 | 660 |
| 1 mrad | 0.30 | 0.52 | 14 | 660 | 340 |
| 2 mrad | 0.15 | 0.79 | 8 | 330 | 260 |

**Table 2.1:** Summary of projected 2025 Au+Au luminosity production under different crossing angle scenarios. The luminosity/week is based on the average of the minimum and maximum projection. The vertex width $\sigma_z$, and thus the vertex factor $L(\theta, |z| < 10\ \text{cm})/L(\theta,\ \text{all}\ z)$, is taken from direct measurements in sPHENIX in 2023 Au+Au running, as suggested by C-AD. All other values are taken directly from C-AD guidance. The right column, which is the luminosity per week within the narrow vertex, is the relevant quantity for sPHENIX physics.