



The Intermediate Silicon Tracker of sPHENIX

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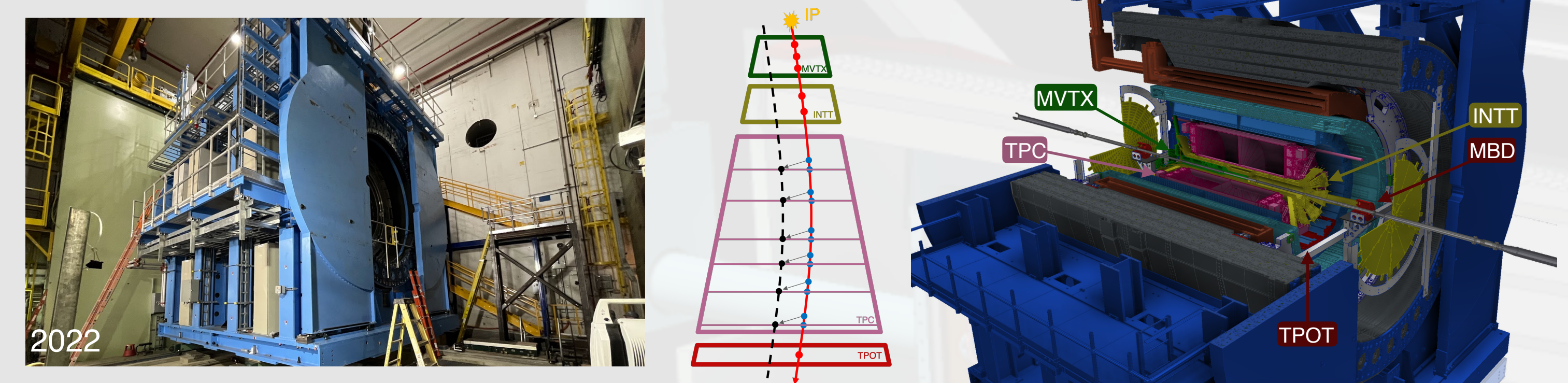
Abstract

The sPHENIX project is a new detector experiment at the Relativistic Heavy Ion Collider at BNL. Its aim is to study strongly interacting Quark-Gluon Plasma and cold-QCD by measuring photons, jets, jet correlations, and Upsilon family with high precision. To achieve these goals, a precise tracking system is necessary. The tracking system of the sPHENIX detector consists of the MVTX, TPC, TPOT, and the Intermediate Silicon Tracker (INTT). The INTT is a two-layer barrel silicon tracker that plays a unique role among the tracking detectors. It is capable of bridging the tracks of the MVTX and the TPC. In addition, its precise timing resolution enables the INTT to associate individual tracks and events to eliminate pile-up events. The INTT barrel installation and cabling were completed in March 2023. We have since commissioned and confirmed installation procedures and detector responses. The INTT status, performance evaluation by collision data, and calibration test results are presented in this poster.

sPHENIX : Full barrel calorimeters, 1.5 T solenoid and excellent tracking system

Tracking system :

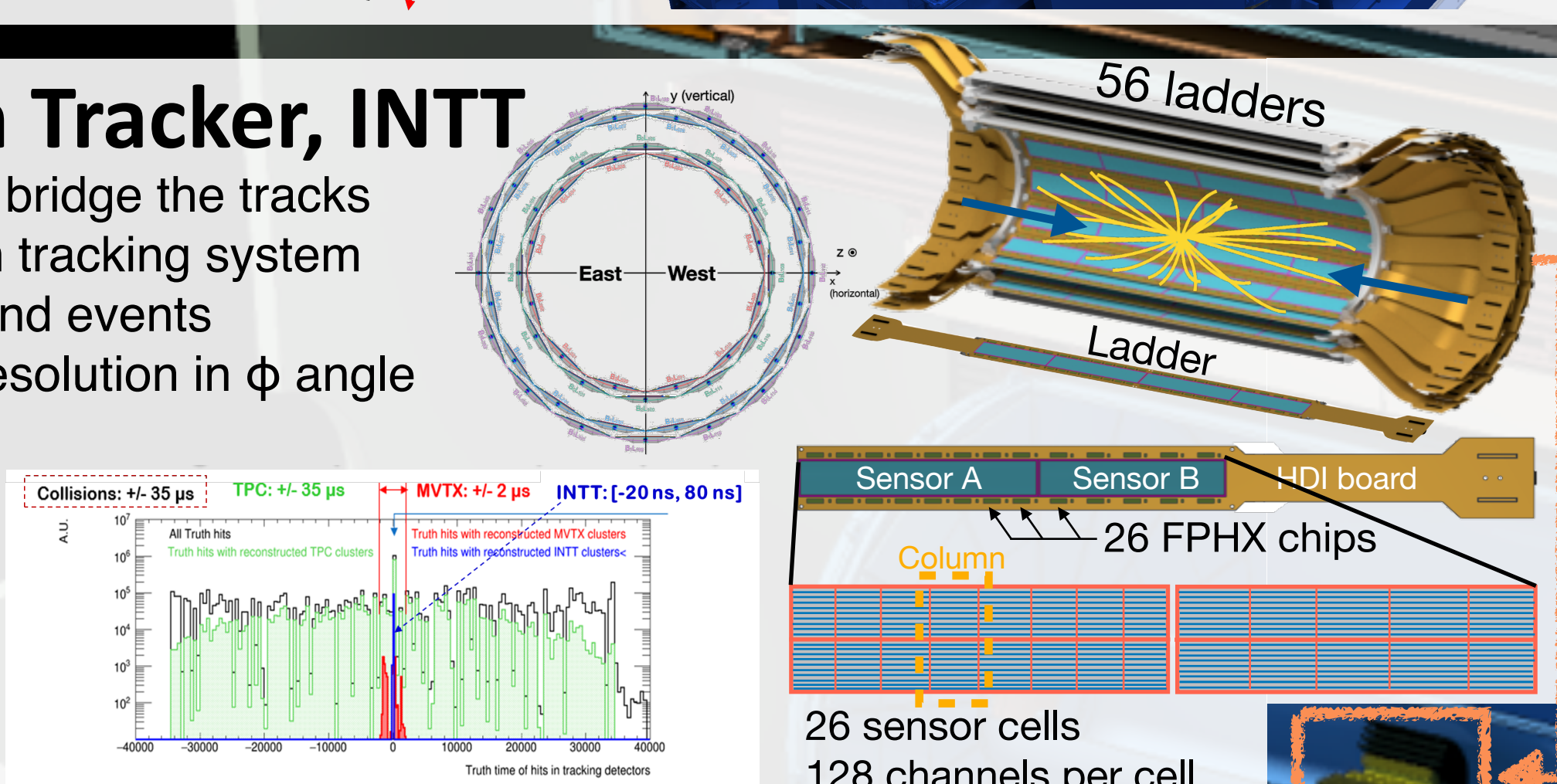
1. MAPS-based Vertex Detector, MVTX
 - Precise vertex measurement \rightarrow heavy flavor
2. Intermediate Silicon Tracker, INTT
 - Superb timing resolution \rightarrow Spin physics
3. Time Projection Chamber, TPC
 - Precise momentum measurement \rightarrow Upsilon ($3S$)
4. TPC Outer Tracker, TPOT
 - Additional space point outside TPC \rightarrow TPC distortion



Intermediate Silicon Tracker, INTT

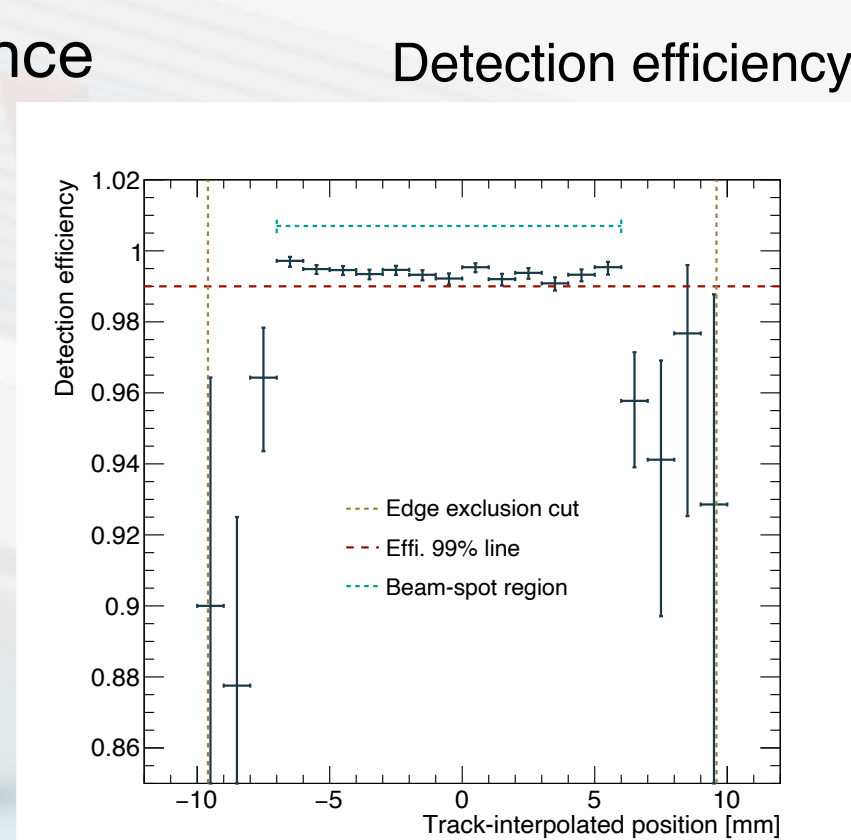
- Between the MVTX and TPC \rightarrow bridge the tracks
- Timing resolution 106 ns, best in tracking system \rightarrow Associate individual tracks and events
- Strip width 78 μ m \rightarrow excellent resolution in ϕ angle

Element	Value	Unit
Material budget	1.08%	X/X_0
Radius	7.5 & 10	mm
Strip length	20 or 16	mm
Total channels	$\sim 37k$	channels
Readout server	8	FELIX

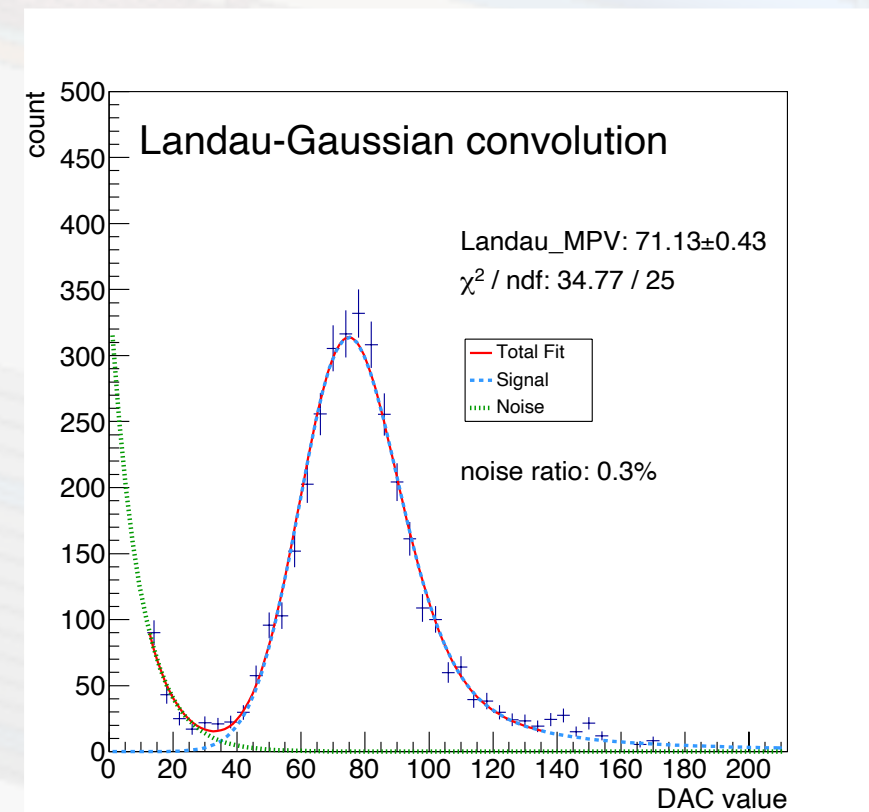


INTT ladder performance confirmation

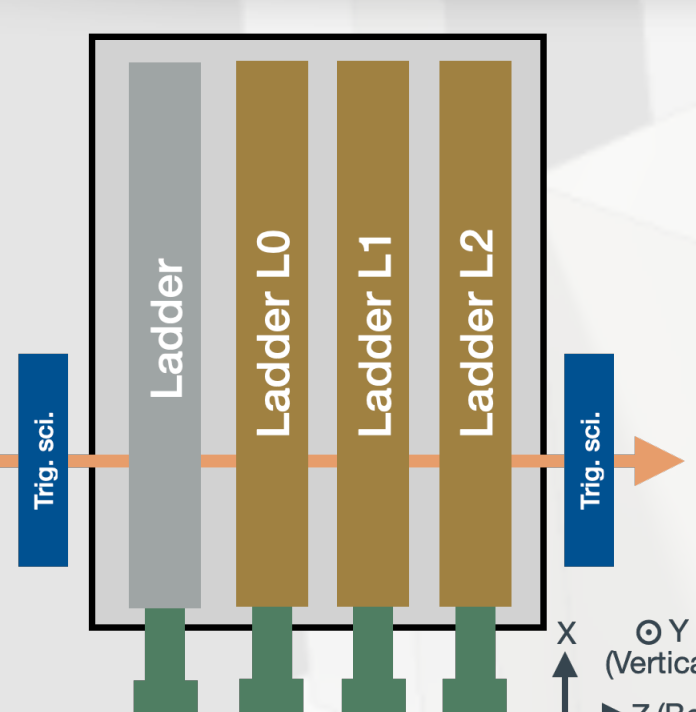
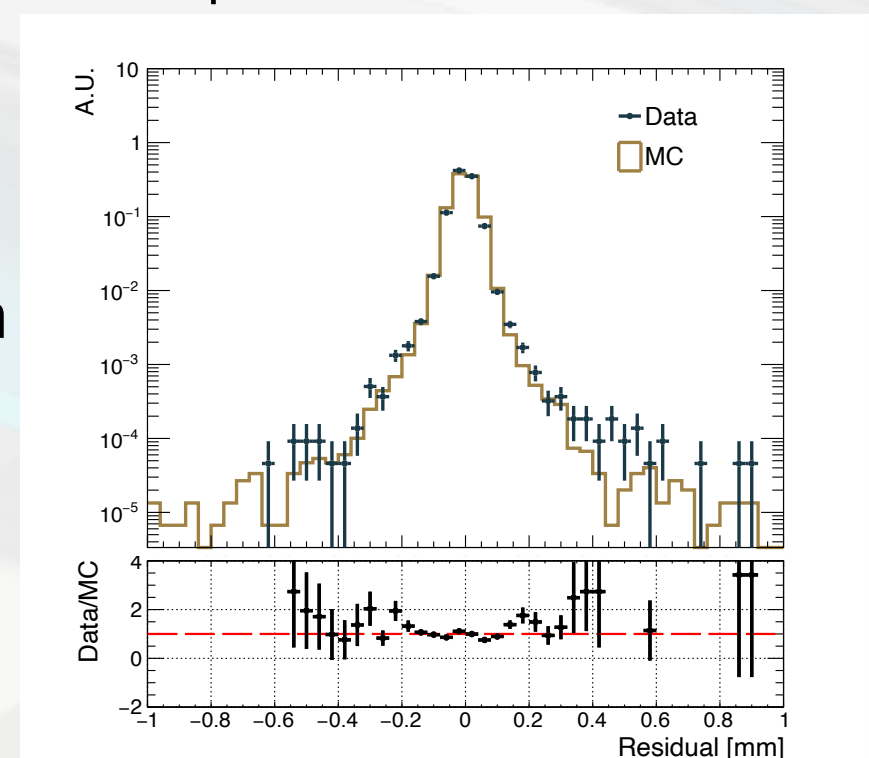
- Beam test experiment at ELPH, Japan, end of 2021
- Beam : e^+ with energy of 1 GeV/c
- External trigger : 2 scintillators coincidence
- 3 ladders were operated



Energy deposit distribution



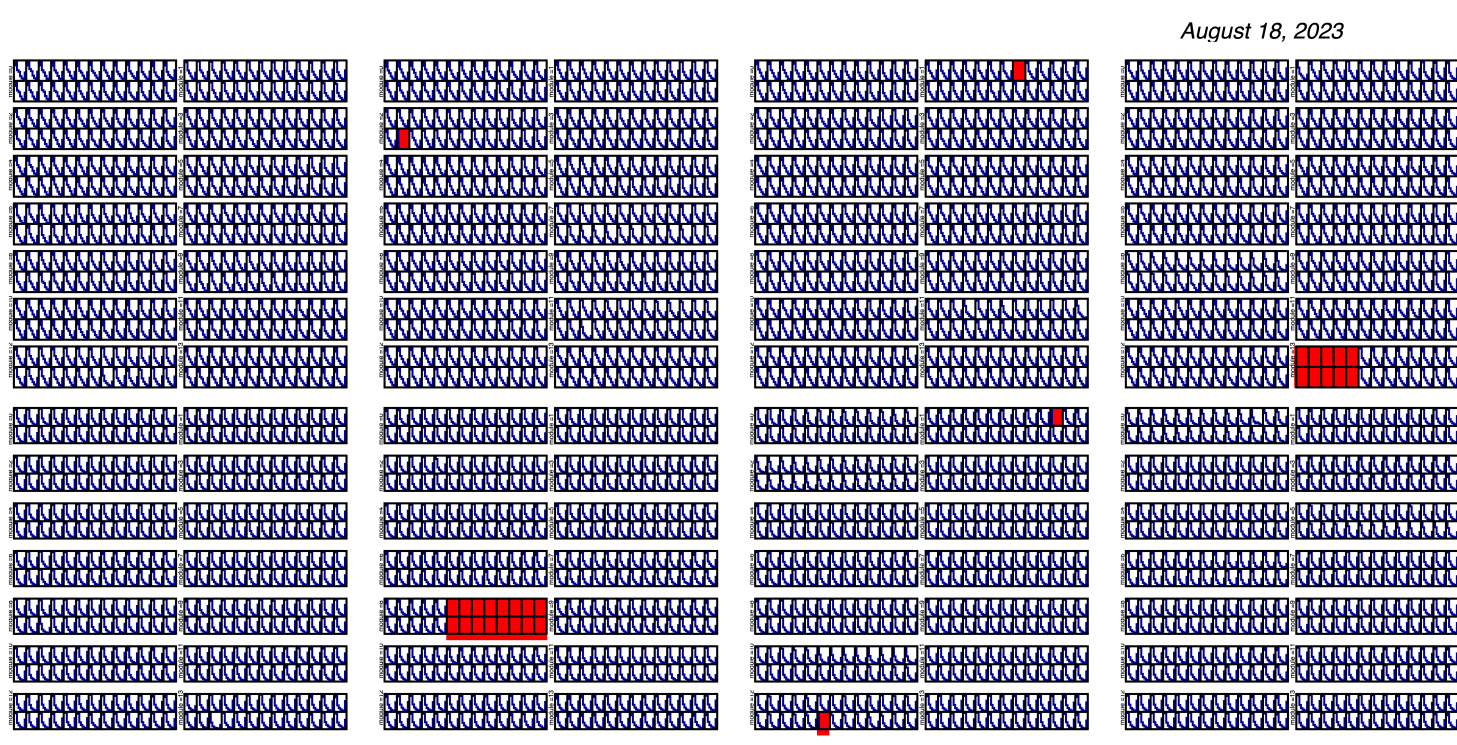
Spatial resolution distribution



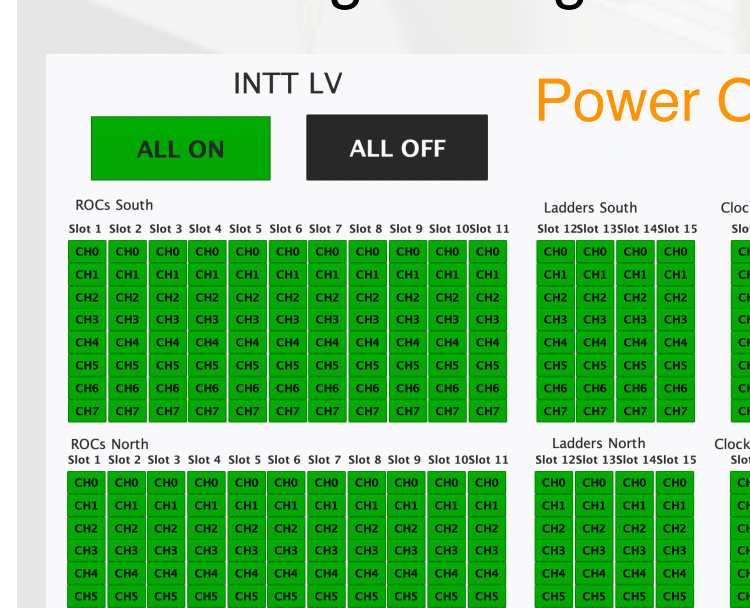
- Ladder energy deposit :
 - \rightarrow MPV : 71.13 ± 0.43 ADC (40 - 136)
 - \rightarrow 0.3% noise contamination in signal region
- Detection efficiency $\frac{N(L_0 \cap L_1 \cap L_2)}{N(L_0 \cap L_2)} \times 100\%$:
 - $\rightarrow 99.33 \pm 0.04(\text{stat}) \pm 0.06(\text{sys}) \%$
 - \rightarrow Uniformly excellent along sensor
- Spatial resolution :
 - \rightarrow Good agreement with Geant model

INTT Installation & system testing

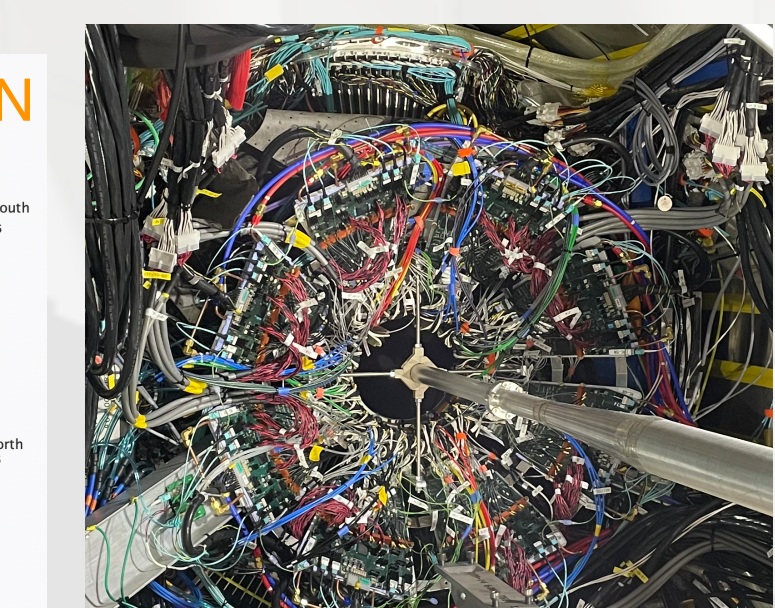
- INTT Insertion : Feb 28, 2023
- 222 out of 224 sensors fully bias voltage supplied
- 2908 out of 2912 chips functional
- Live channel efficiency : 99%
- System fully hands to shift crew



INTT High voltage GUI



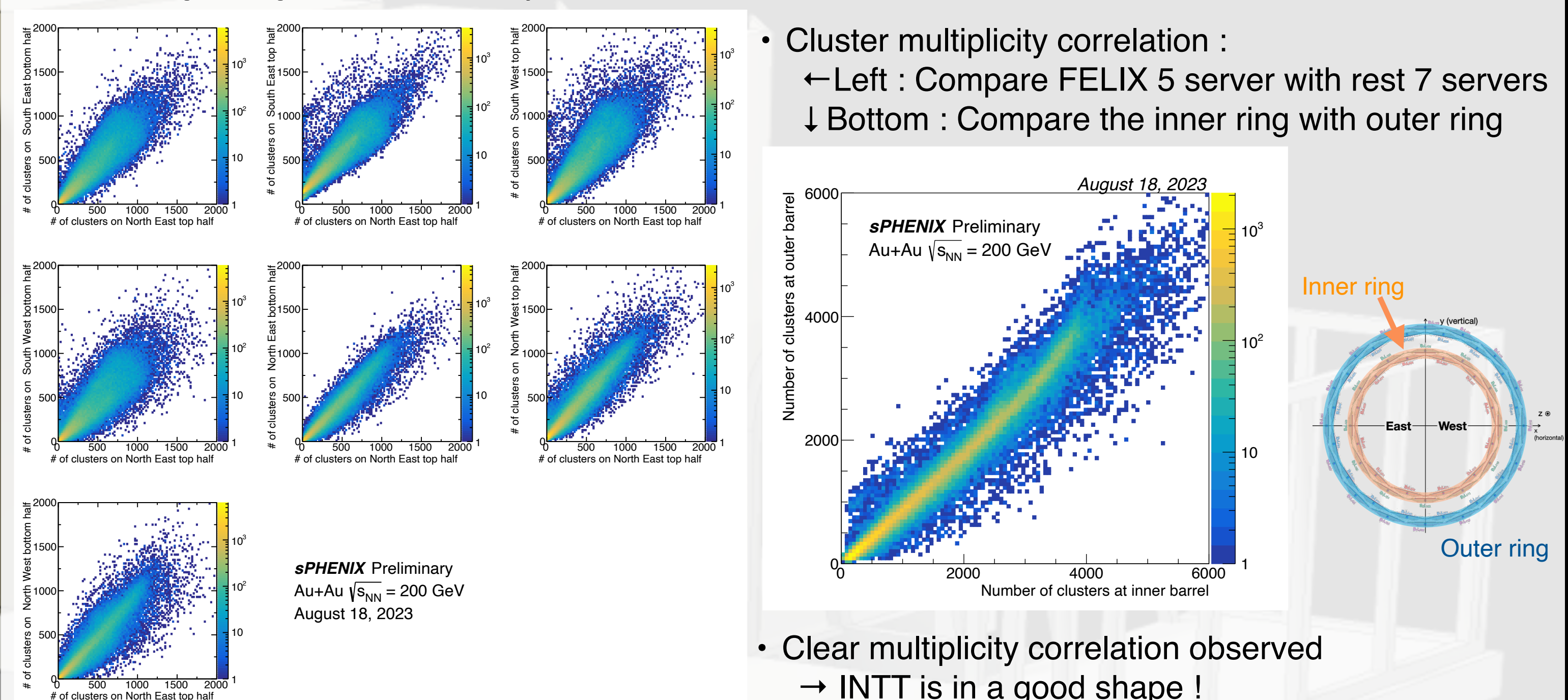
INTT insertion



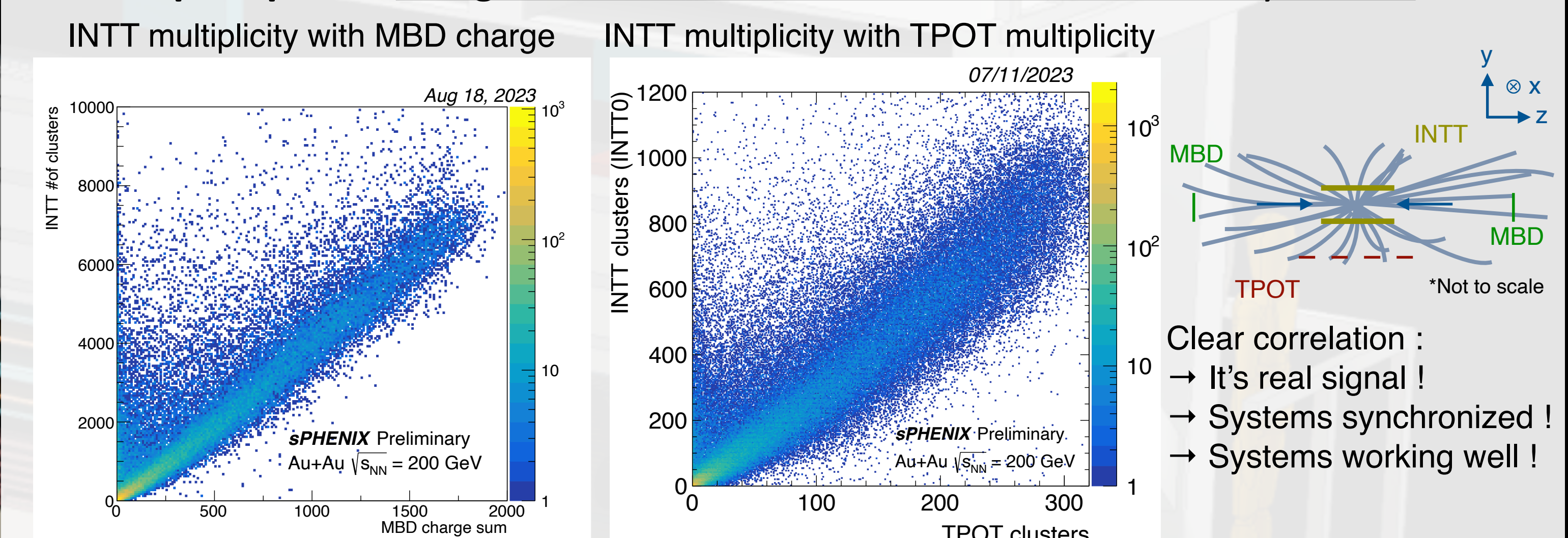
Tremendous work done by INTT group !

INTT commissioning with collision data (Au + Au)

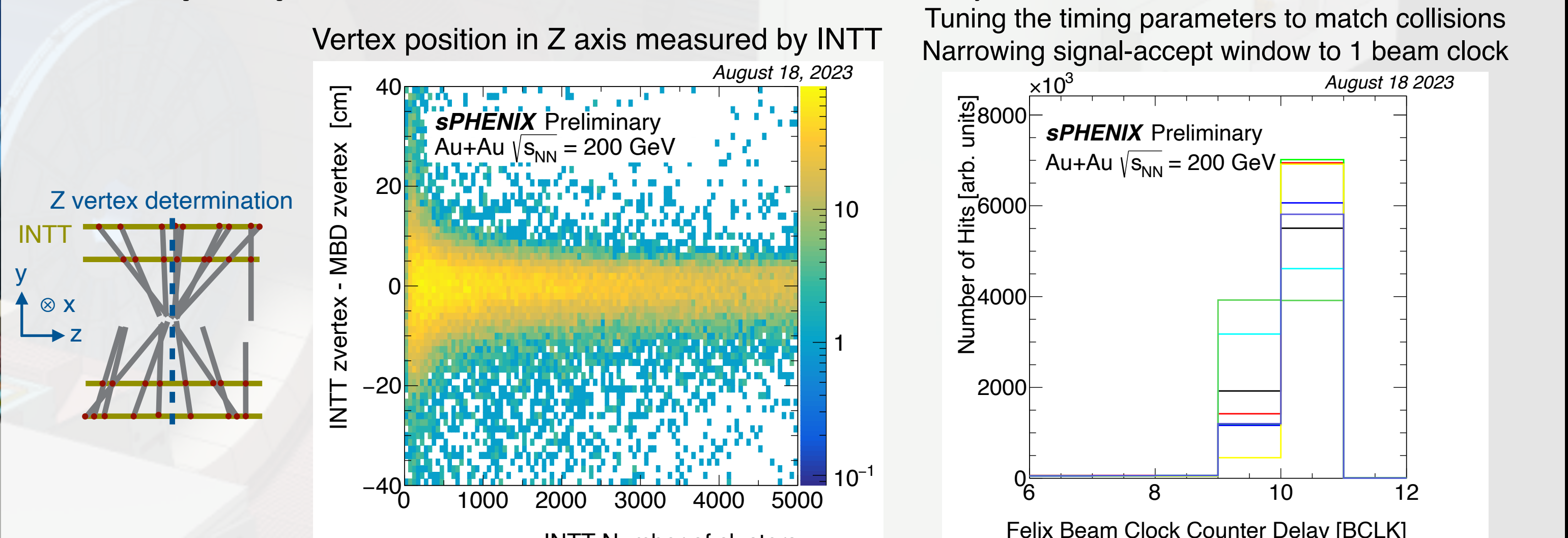
Roadmap stop 1st : Let's try to see the collision with INTT first !



Roadmap stop 2nd : Too good to be true ? Cross check with other systems !



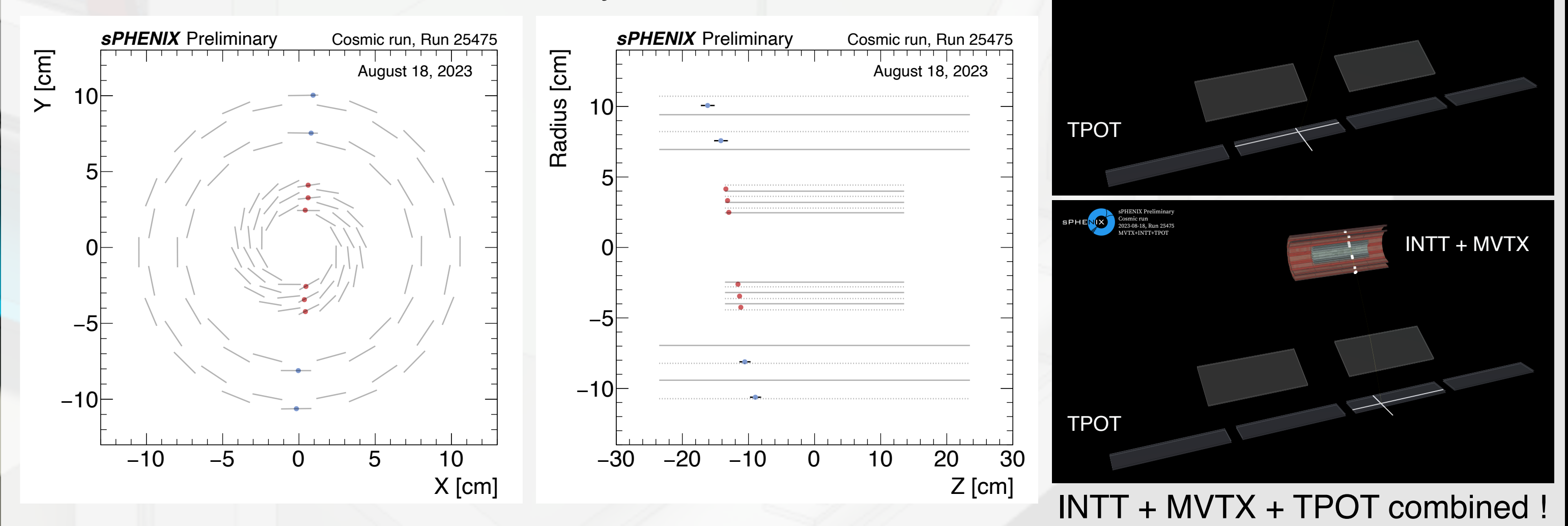
Roadmap stop 3rd : Move forward to detailed study !



Stay tuned ! More results from INTT are coming !

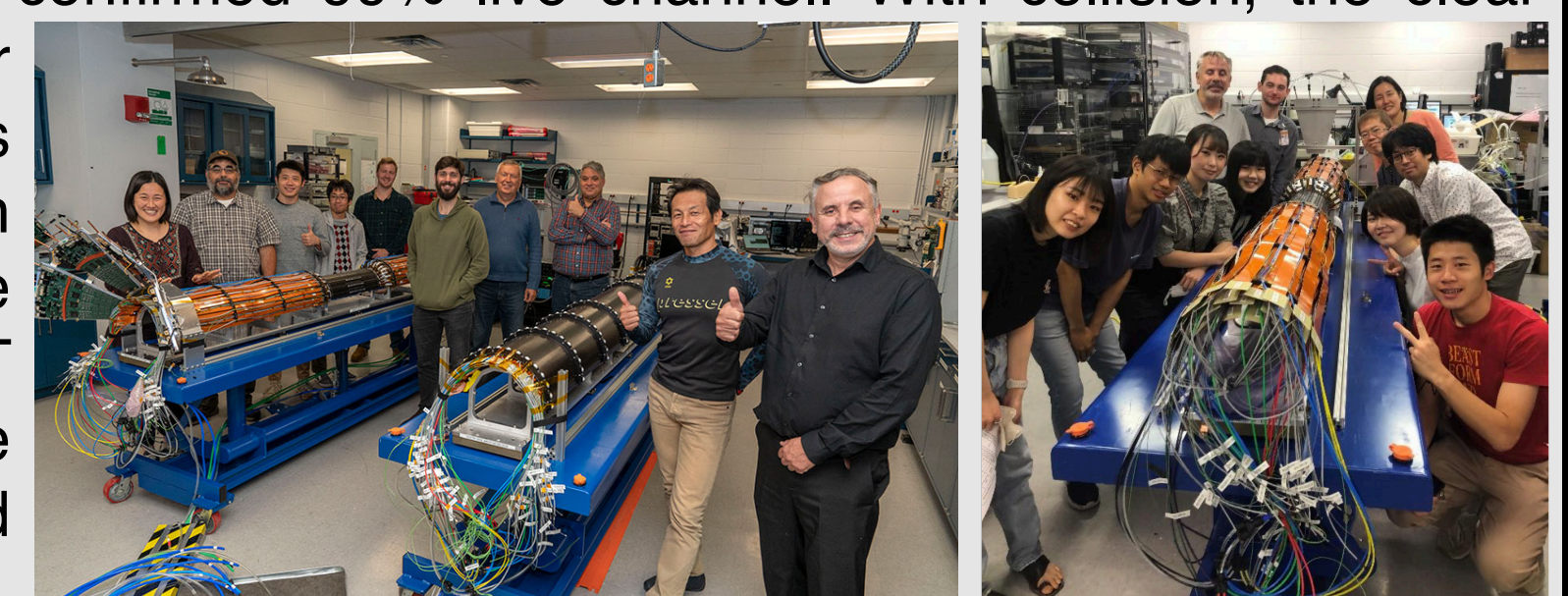
INTT commissioning with cosmic ray

Cosmic track candidates by INTT + MVTX



Conclusion

INTT, one of the sub-detectors of sPHENIX tracking system, plays a unique role. Its precise timing resolution is capable of associating individual tracks and events, which is essential to code-QCD physics. The ladder detection efficiency over 99% was measured in beam test experiment. After the INTT insertion, tremendous work carried out by the INTT group confirmed 99% live channel. With collision, the clear multiplicity correlation between each FELIX server was observed. The multiplicity distribution was able to correlate with MBD and TPOT as well. With cosmic ray, the cosmic track candidates were found by INTT + MVTX + TPOT combined. INTT was confirmed to be in a good shape. The commissioning and analyses are ongoing, and heading towards physics data taking.



* Not all members included