Successful Asian Collaboration in sPHENIX Experiment at RHIC

RIKEN/RBRC
Itaru Nakagawa

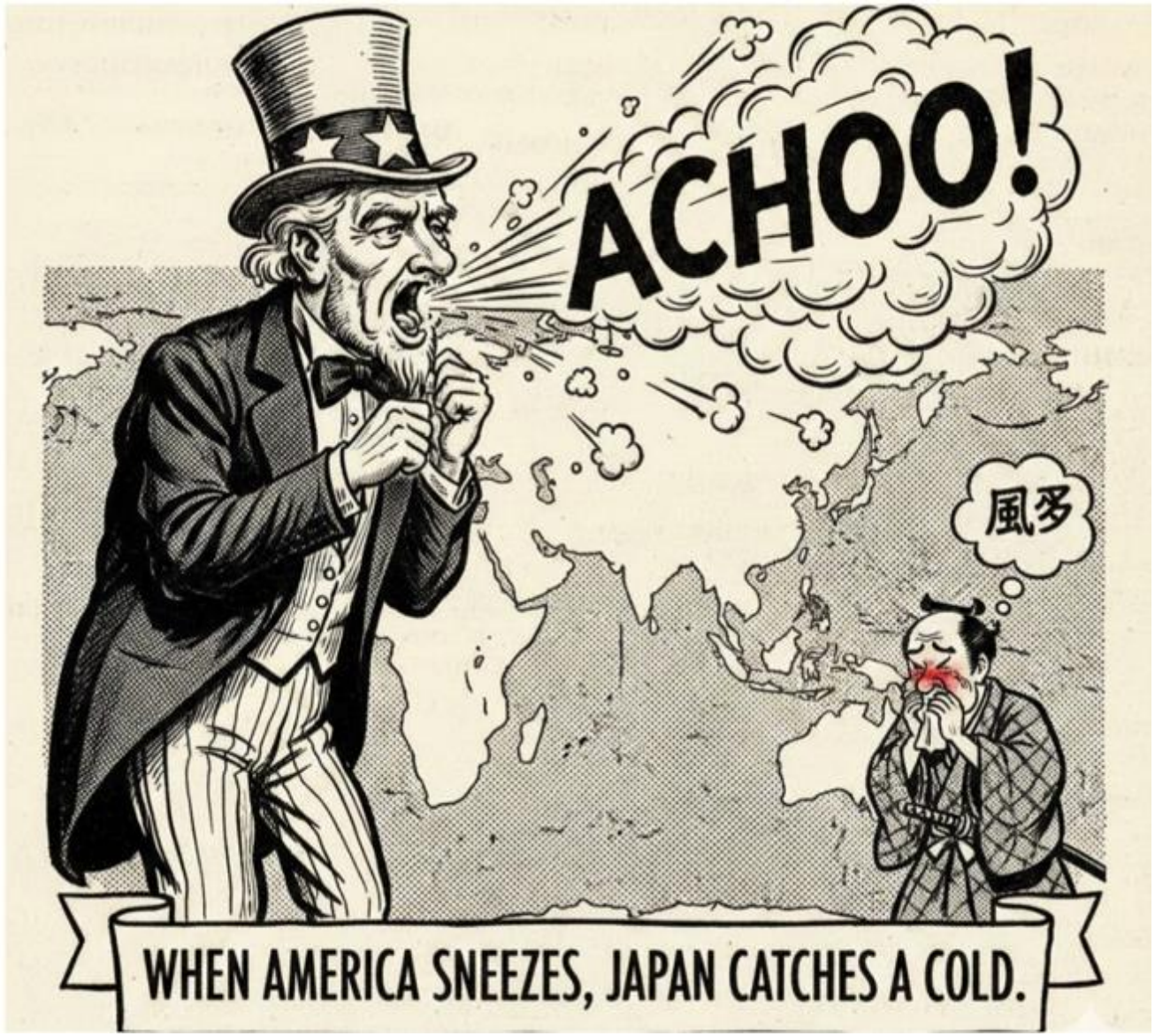
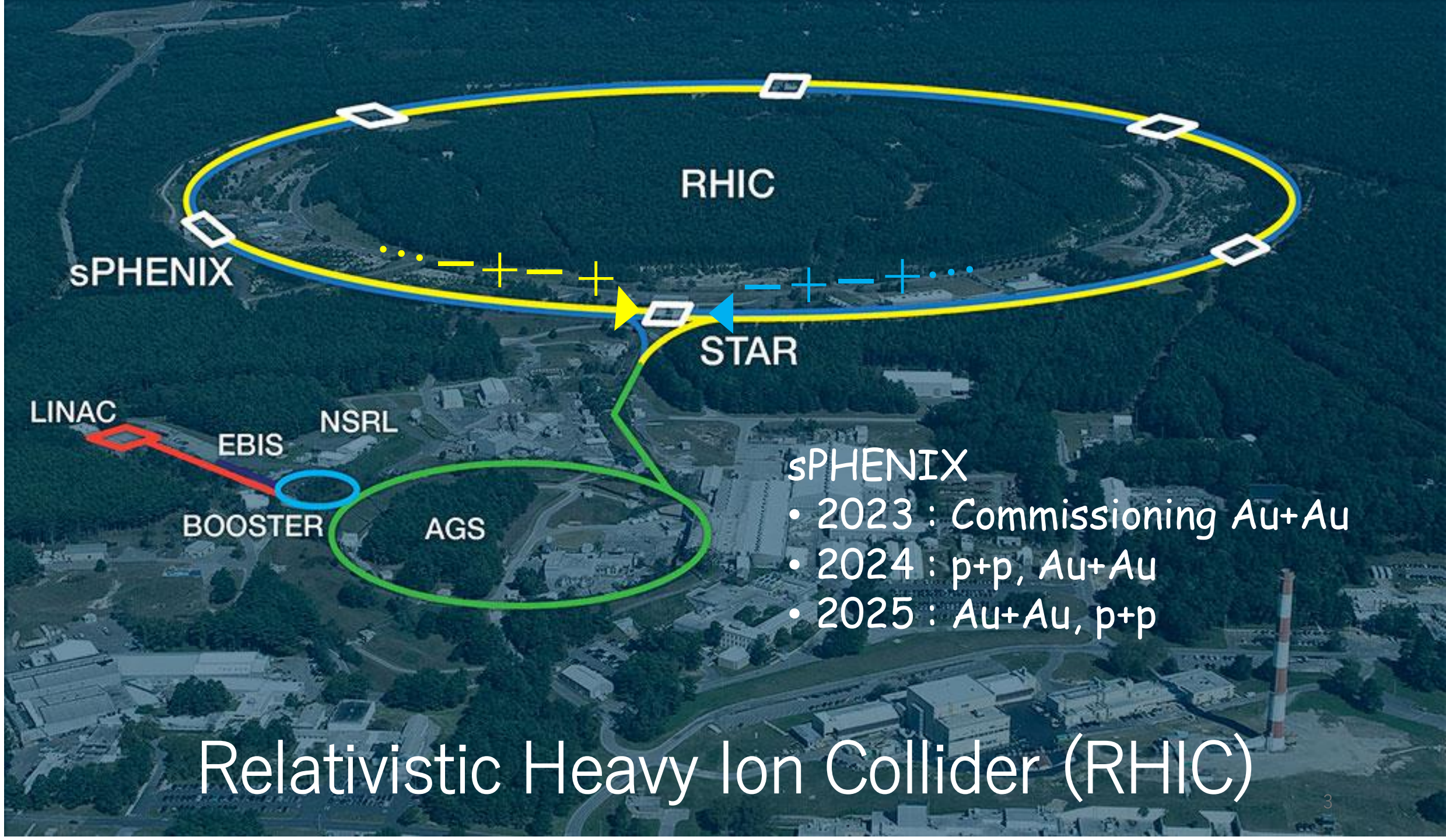
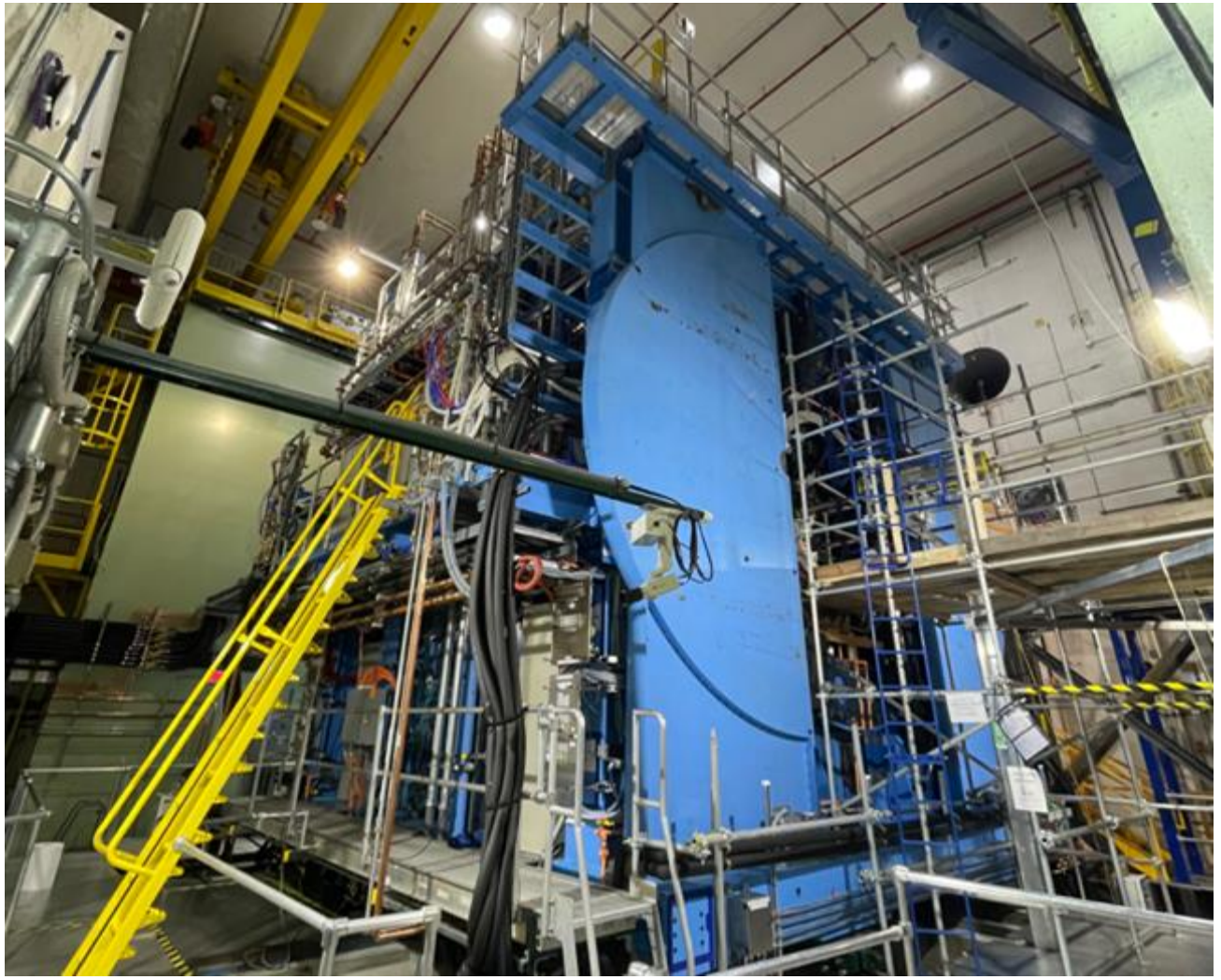


Image created by Gemini

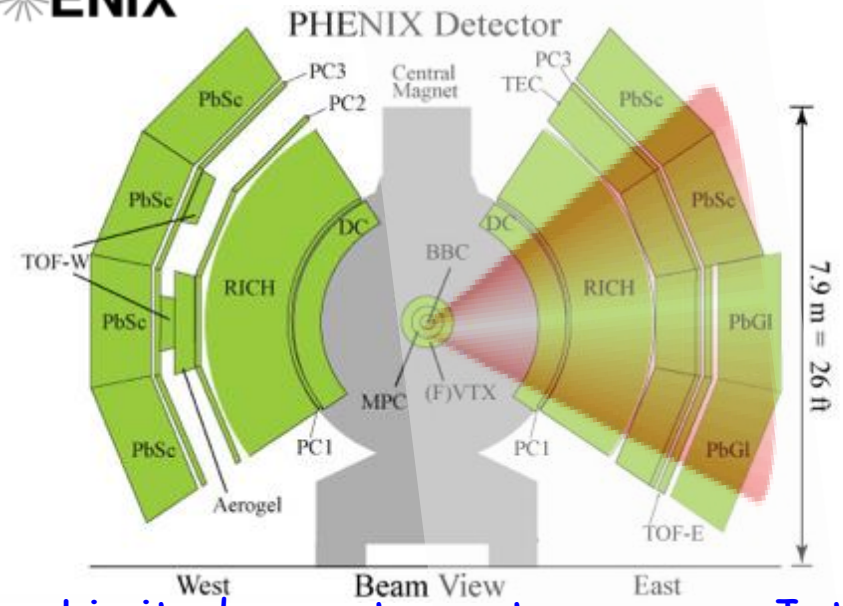


Relativistic Heavy Ion Collider (RHIC)

sPHENIX Experiment
~New Generation Jet Detector~

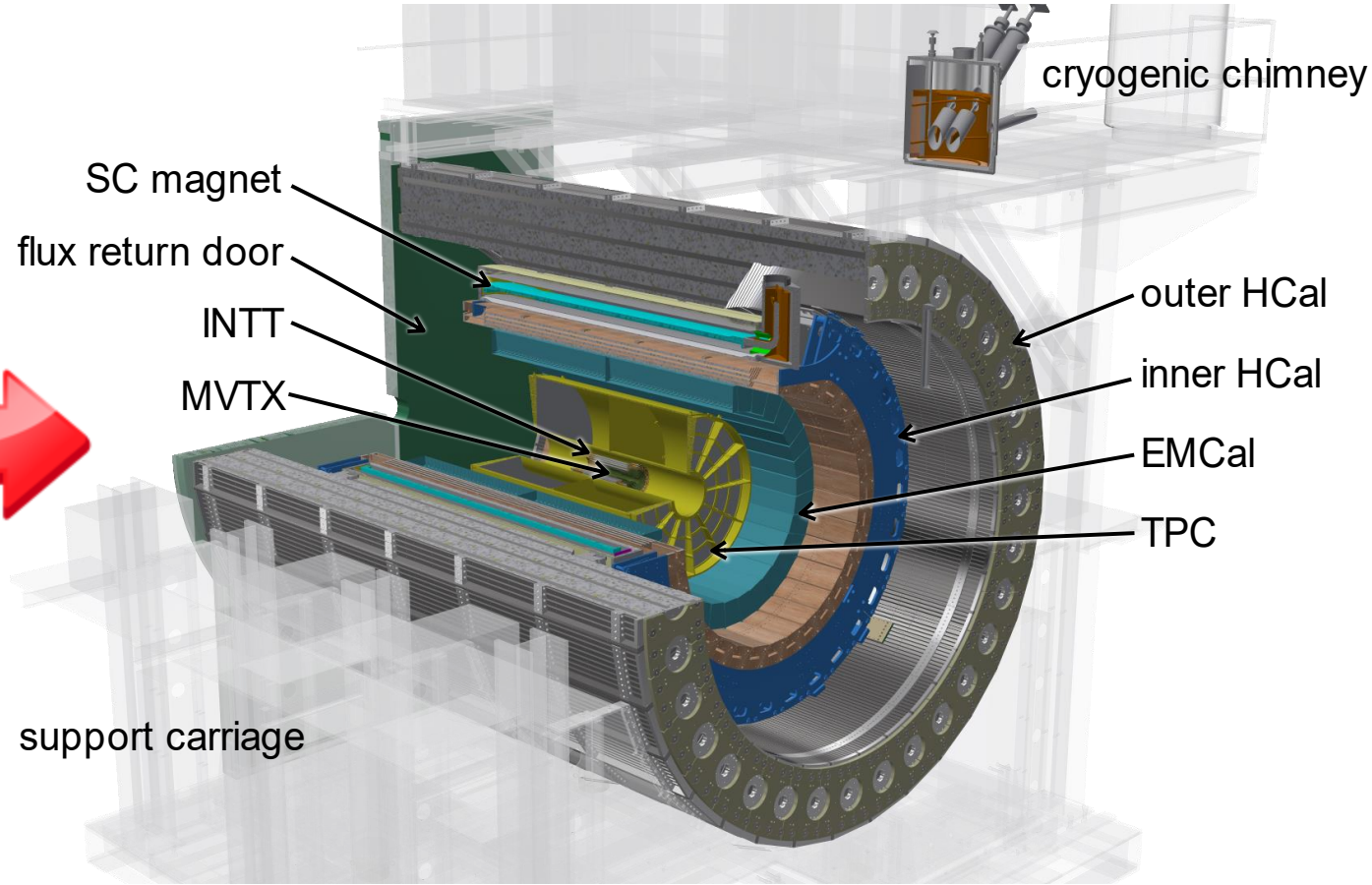


What's new about sPHENIX



Limited acceptance to measure Jet.

4π, but incomplete for jet without HCAL

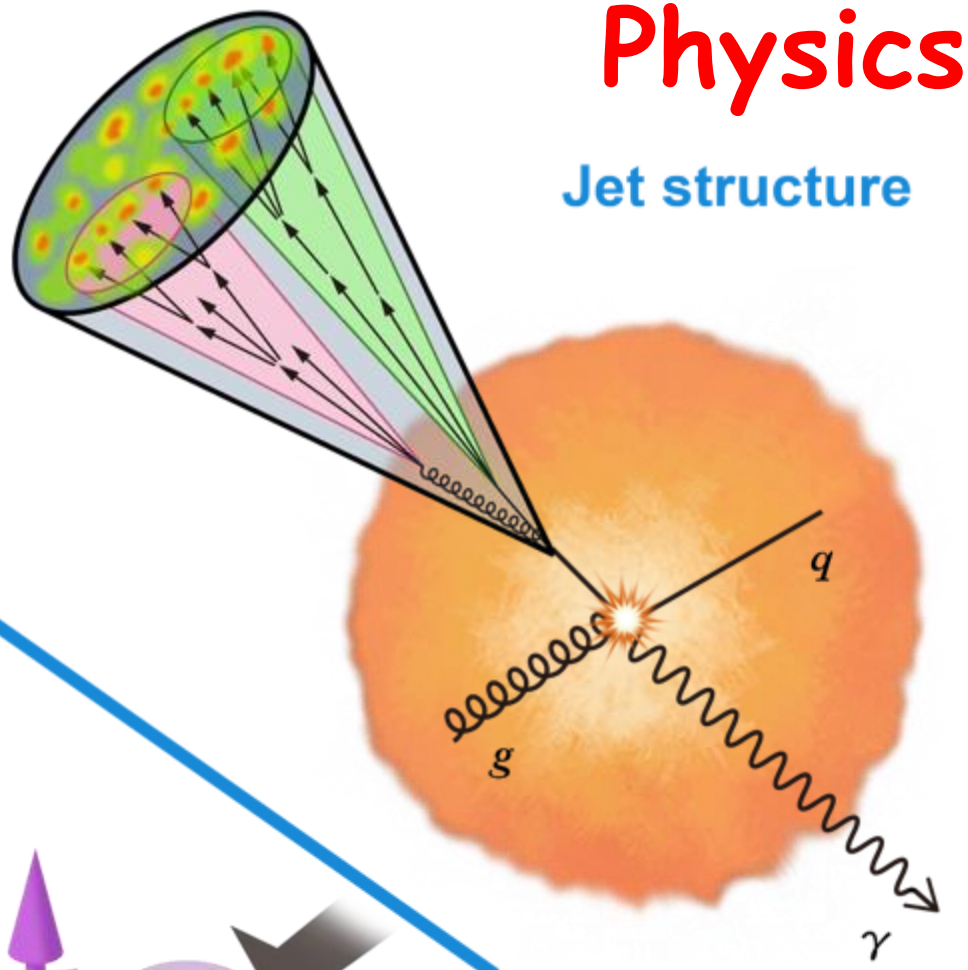


4π & -1<η<1 with HCAL
Designed to be ideal detector for Jet

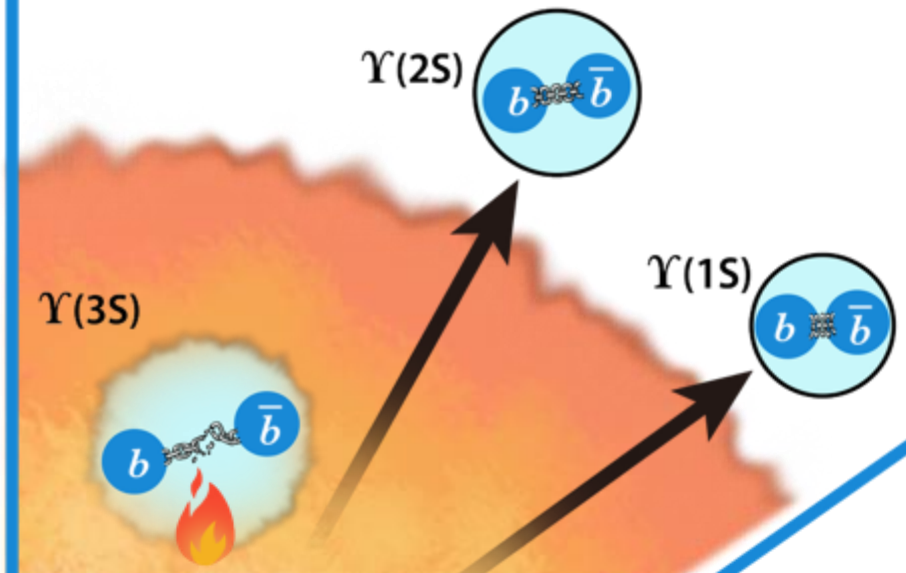
Illustrated by Misaki Ouchida (Hokkaido University)

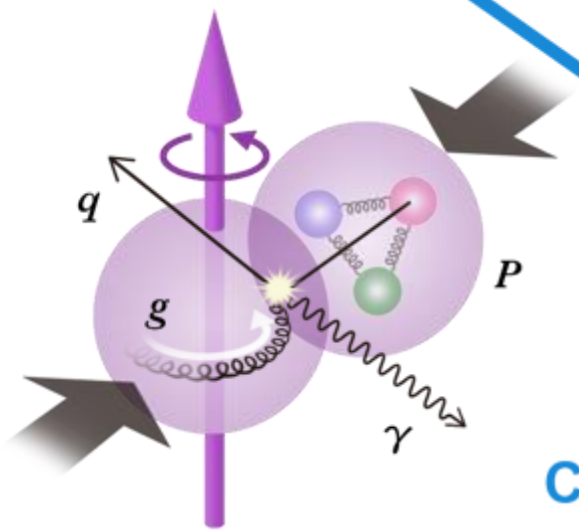
Physics Goals

Jet structure



Quarkonium spectroscopy



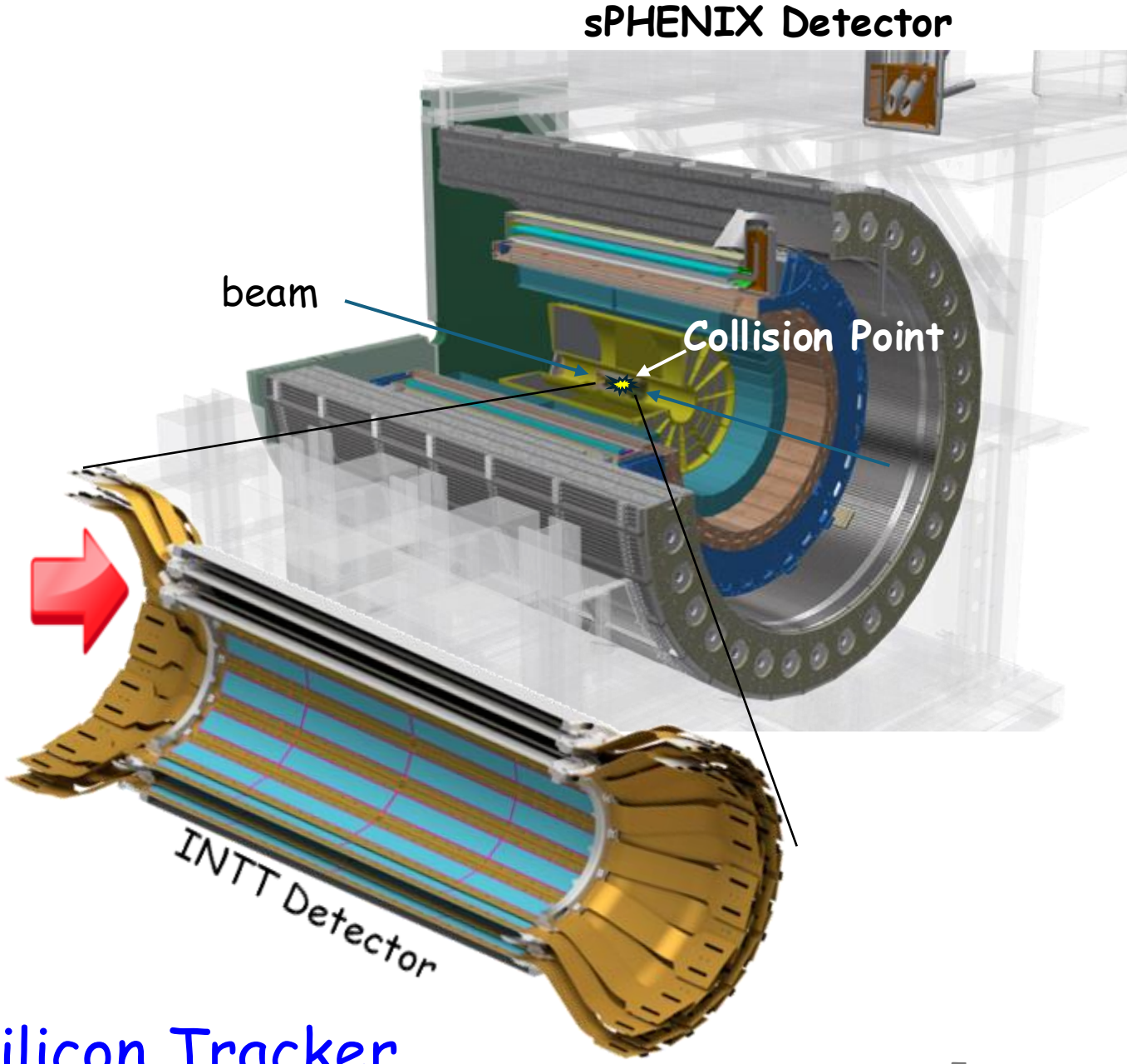


Cold QCD

sPHENIX

Parton energy loss

INTT-sPHENIX



INTermediate Silicon Tracker

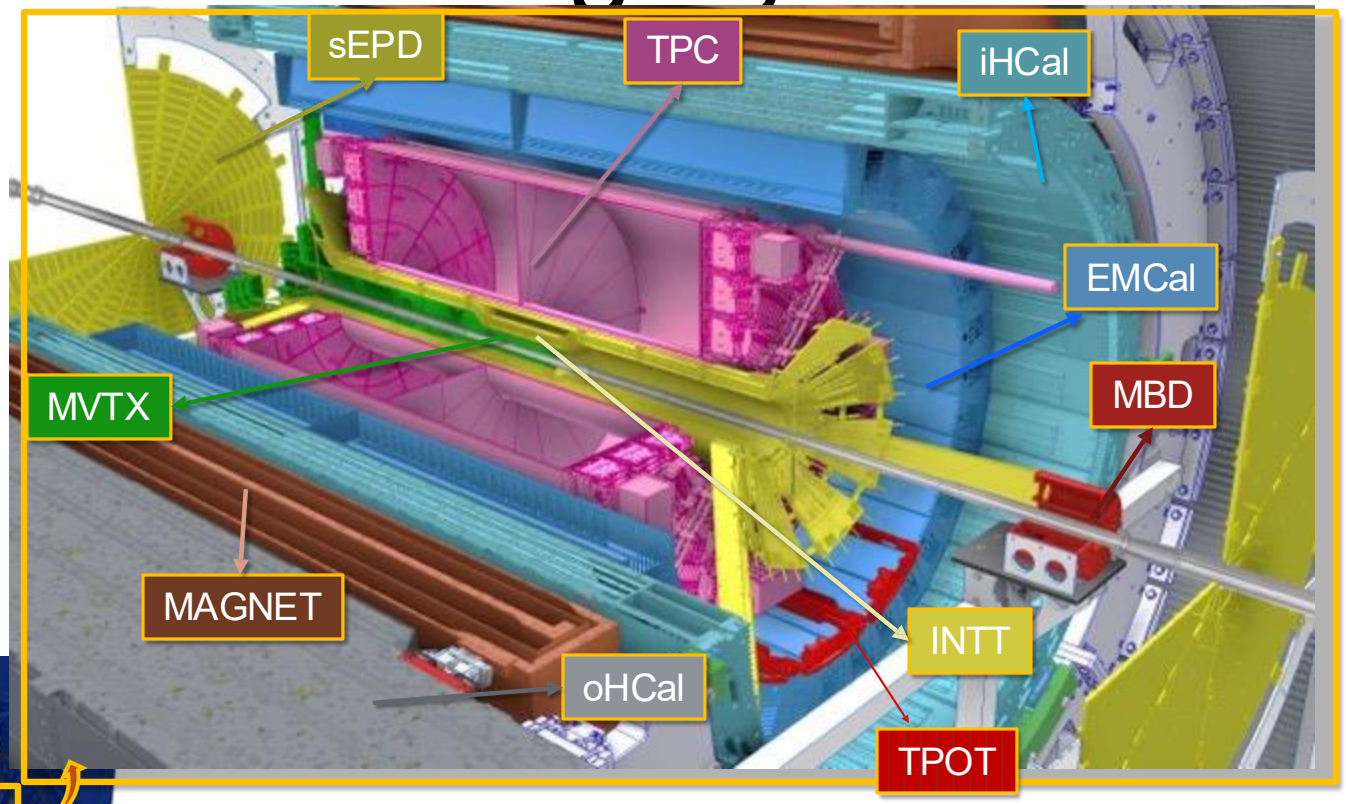
sPHENIX Tracking System

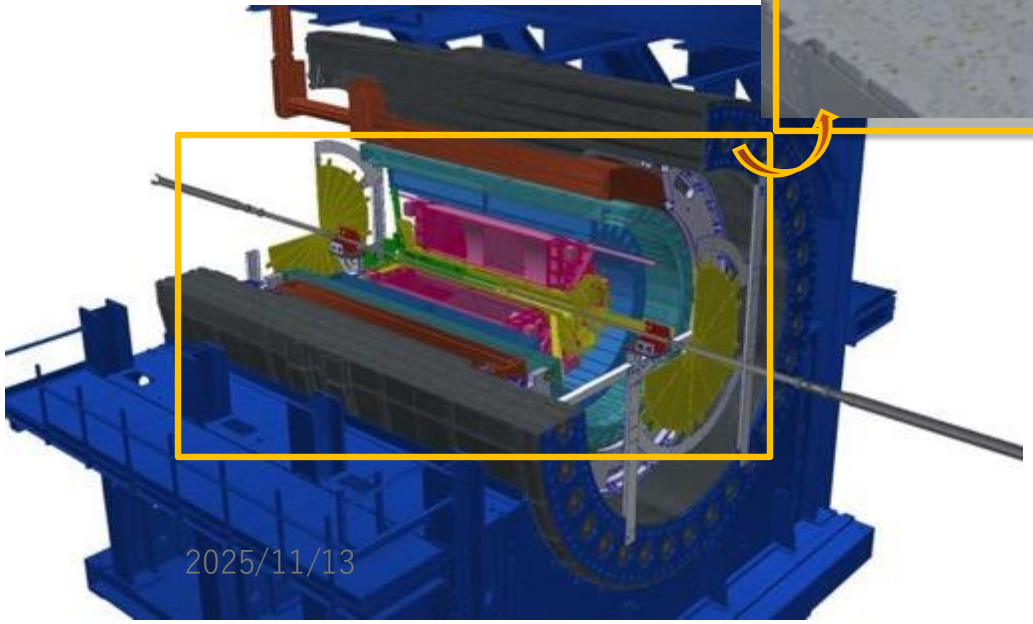
Silicon pixel detector (MVTX)
- 29 um x 27 um, pixels
- 2.5 cm < R < 4.5cm
- 20 BLCK integration time

Silicon strip detector (INTT)
- 78um, strip sensors
- 7cm < R < 11cm
- 1 BCLK timing resolution

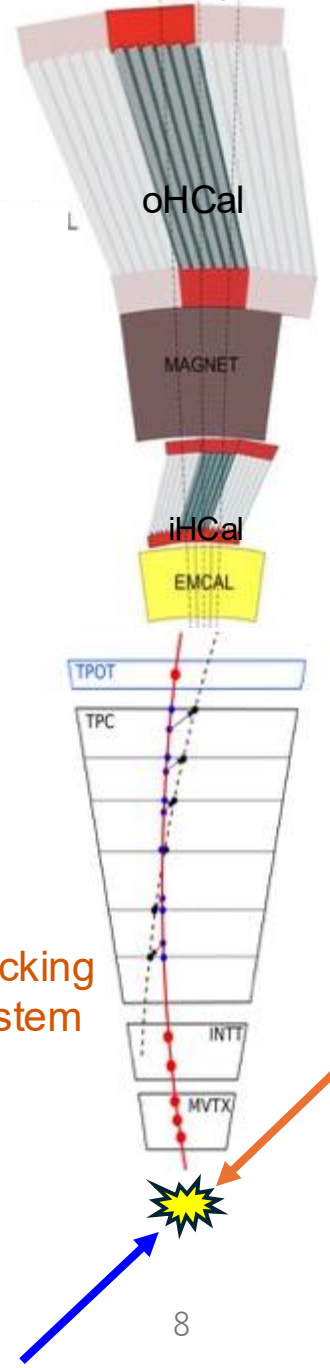
Time projection Chamber (TPC)
- 20cm < R < 78cm
- Spatial resolution, ~100um
- Long drift time, ~13us

TPC Outer Tracker (TPOT)
- Calibrate TPC





Calorimeter system

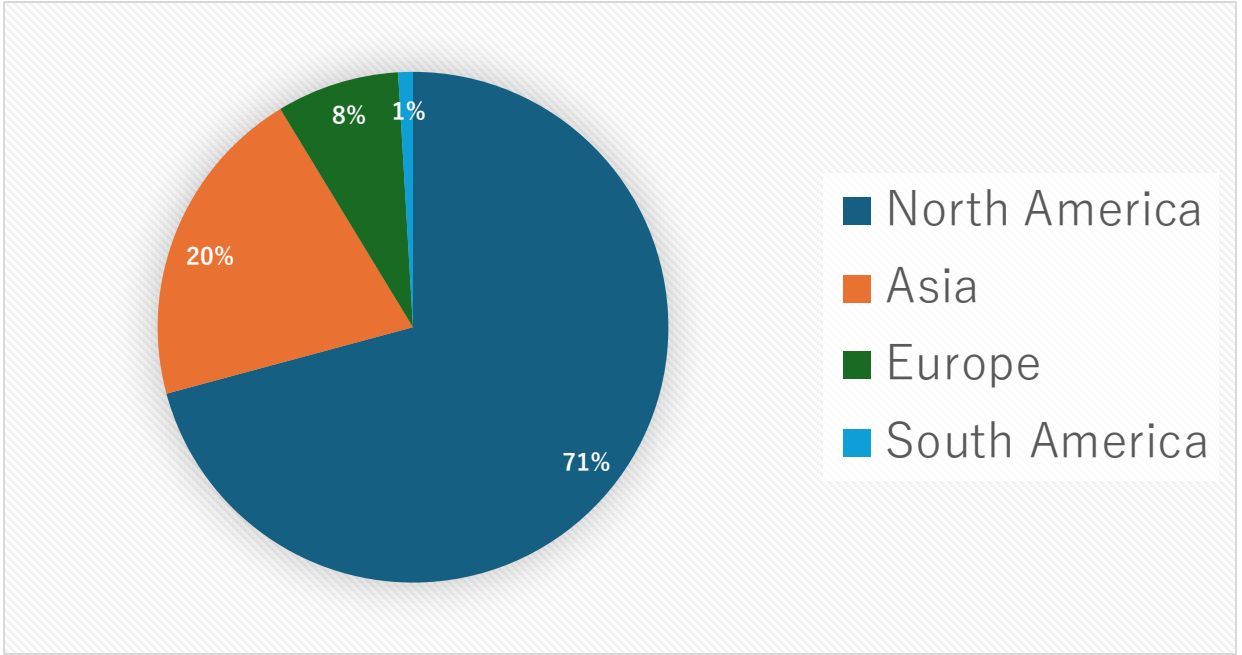


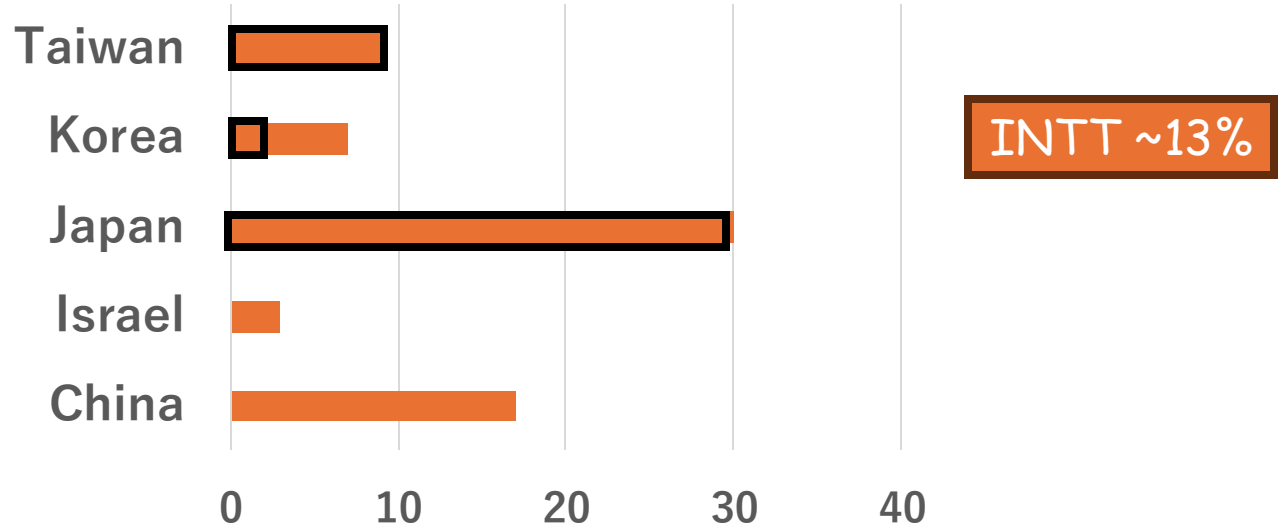
Tracking system

sPHENIX Collaboration

The sPHENIX collaboration

M.I. Abdulhamid[13], U. Acharya[13], E.R. Adams[7], G. Adawi[13], C.A. Aidala[26], Y. Akiba[39], M. Alfred[14], S. Ali[13], A. Alsayegh[10], S. Altaf[15], H. Amedi[13], D.M. Anderson[17], V.V. Andrieux[15], A. Angerami[21], N. Applegate[17], H. Aso[41], S. Aune[6], B. Azmoun[3], V.R. Bailey[13], D. Baranyai[9], S. Bathe[2], A. Bazilevsky[3], S. Bela[22], R. Belmont[33], J. Bennett[15], J.C. Bernauer[43], J. Bertaux[37], R. Bi[7], A. Bonenfant[6], S. Boose[3], C. Borchers[13], H. Bossi[25], R. Botsford[22], R. Boucher[11], A. Brahma[13], J.W. Bryan[35], D. Cacace[3], I. Cali[26], M. Chamizo-Llatas[3], S.B. Chauhan[35], A. Chen[22], D. Chen[43], J. Chen[12], K. Chen[5], K.Y. Chen[30], K.Y. Cheng[30], C.-Y. Chi[8], M. Chiu[3], J. Clement[7], E.W. Cline[43], M. Connors[13], E. Cook[15], R. Corliss[43], Y. Corrales Morales[25], E. Croft[22], N. d'Hose[6], A. Dabas[13], D. Dacosta[13], M. Daradkeh[13], S.J. Das[7], A.P. Dash[4], G. David[9,43], C.T. Dean[25], K. Dehmelt[43], X. Dong[20], A. Drees[43], J.M. Durham[23], A. Enokizono[30], H. Enyo[39], J. Escobar Cepero[13], R. Esha[43], B. Fadem[28], R. Feder[3], K. Finnelli[43], D. Firak[43], A. Francisco[6], J. Frantz[35], A. Frawley[11], K. Fujiki[41], M. Fujiwara[29], B. Garcia[7], P. Garg[43], G. Garmire[15], E. Gentry[7], Y. Go[3], C. Goblin[6], W. Goodman[22], Y. Goto[39], A. Grabas[6], O. Grachov[48], J. Granato[22], N. Grau[1], S.V. Greene[47], S.K. Grossberndt[2], R. Guidolini-Cecato[3], T. Hachiya[29], J.S. Haggerty[3], R. Hamilton[7], J. Hammond[3], D.A. Hangal[21], S. Hasegawa[18], M. Hata[29], W. He[12], X. He[13], T. Hemmick[43], A. Hodges[15], M.E. Hoffmann[22], A. Holt[14], B. Hong[19], M. Housenga[15], S. Howell[43], Y. Hu[20], H.Z. Huang[4], J. Huang[3], T.C. Huang[32], D.A. Huffman[22], C. Hughes[17,22], J. Hwang[19], T. Ichino[41], M. Ikemoto[29], D. Imagawa[41], H. Imai[41], D. Jah[7], J. James[47], H.-R. Jheng[25], Y. Ji[20], Z. Ji[4], H. Jiang[8], M. Kano[29], L. Kasper[47], T. Kato[41], Y. Kawashima[41], M.S. Khan[13], T. Kikuchi[41], J. Kim[50], B. Kimelman[47], H.T. Klest[43], A.G. Knospe[22], M.B. Knuesel[7], H.S. Ko[20], J. Kuczewski[3], N. Kumar[2], R. Kunnawalkam Elayavalli[47], C.M. Kuo[30], J. Kvapil[23], Y. Kwon[50], J. Lajoie[34], J.D. Lang[7], A. Lebedev[17], S. Lee[45], L. Legnosky[43], S. Li[8], X. Li[23], T. Lian[22], S. Liechty[7], S. Lim[38], D. Lis[7], M.X. Liu[23], W.J. Llope[48], D.A. Loomis[26], R.-S. Lu[32], L. Ma[12], W. Ma[12], V. Mahaut[6], T. Majoros[9], I. Mandjavidze[6], E. Mannel[3], C. Markert[46], T.R. Marshall[4], C. Martin[45], H. Masuda[41], G. Mattson[15], M. Mazeikis[15], C. McGinn[25], E. McLaughlin[8], J. Mead[3], Y. Mei[20], T. Mengel[7,45], M. Meskowitz[22], J. Mills[3], A. Milov[49], C. Mironov[25], G. Mitsuka[40], N. Morimoto[29], D. Morrison[3], L.W. Mwibanda[10], C.-J. Naïm[43], J.L. Nagle[7], I. Nakagawa[39], Y. Nakamura[41], G. Nakano[41], A. Narde[15], C.E. Nattrass[45], D. Neff[6], S. Nelson[27], D. Nemoto[41], P.A. Nieto-Marín[17], R. Nouicer[3], G. Nukazuka[39], E. O'Brien[3], G. Odyniec[20], S. Oh[20], V.A. Okorokov[31], A.C. Oliveira da Silva[17], J.D. Osborn[3], G.J. Ottino[20], Y.C. Ou[32], J. Ouellette[7], D. Padrazo Jr.[3], T. Pani[42], J. Park[7], A. Patton[25], H. Pereira Da Costa[23], D.V. Perepelitsa[7], M. Peters[25], S. Ping[12], C. Pinkenburg[3], R. Pisani[3], C. Platte[47], C. Pontieri[3], T. Protzman[22], M.L. Purschke[3], J. Putschke[48], R.J. Reed[22], L. Reeves[15], S. Regmi[35], E. Renner[23], D. Richford[2,51], C. Riedl[15], T. Rinn[23], C. Roland[25], G. Roland[25], A. Romero Hernandez[15], M. Rosati[17], D. Roy[42], A. Saed[22], T. Sakaguchi[3], H. Sako[18], S. Salur[42], J. Sandhu[22], M. Sarsour[13], S. Sato[18], B. Sayki[23], B. Schaefer[22], J. Schambach[34], R. Seidl[39], B.D. Seidlitz[8], Y. Sekiguchi[39], M. Shahid[13], D.M. Shangase[26], Z. Shi[23], C.W. Shih[30], K. Shiina[41], M. Shimomura[29], R. Shishikura[41], E. Shulga[43], A. Sickles[15], D. Silvermyr[24], R.A. Soltz[21], W. Sondheim[23], I. Sourikova[3], P. Steinberg[3], D. Stewart[48], S. Stoll[3], Y. Sugiyama[29], O. Suranyi[2], W.-C. Tang[30], S. Tarafdar[47], E. Thorsland[15], T. Todoroki[40],

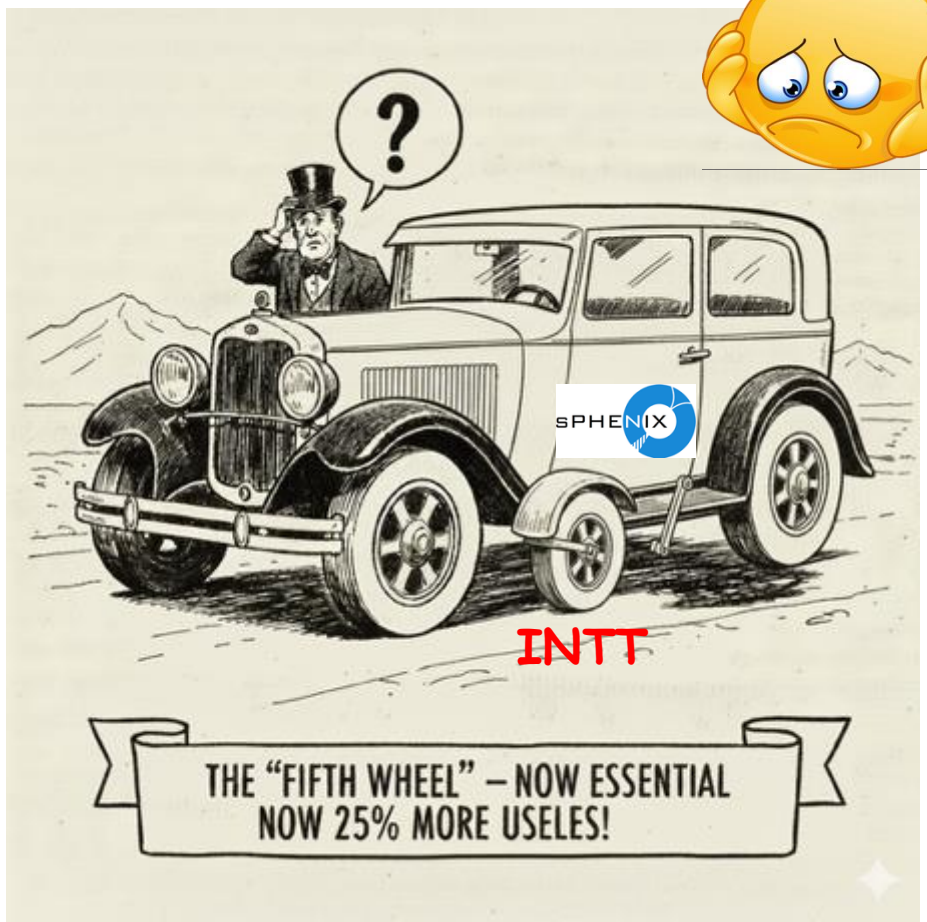




INTT ~13%

Total 330 Collaborators from 54 institutions

Strategy to maximize the presence



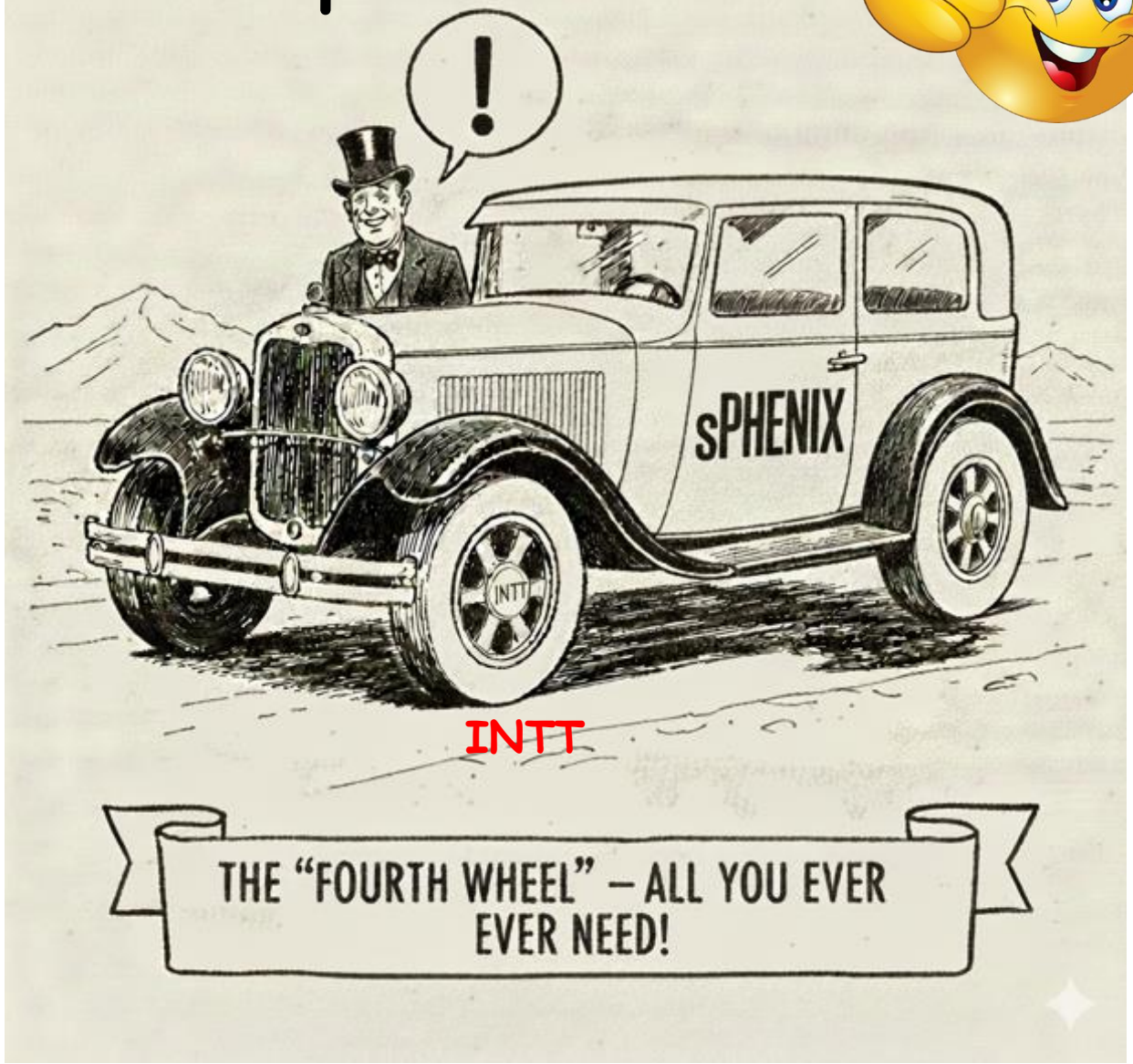


Image created by Gemini

INTT Collaboration


Donald Pinelli


Rachid Nouicer


Yasuyuki Akiba


Itaru Nakagawa


Takashi Hachiya


Maya Shimomura


Genki Nukazuka


Kazuma Fujiki


Mai Watanabe Misaki Hata


Dan Cacace


Wei Xie


Akitomo Enokizono


Takahiro Kikuchi


Tomoya Kato


Ryota Shishikura


Robert Pisani


Antonio Vederosa


Steven Andrade

BNL
Steven Andrade, Stephen Boose, Daniel Cacace, Raul Cecato, Donald Pinelli, Rachid Nouicer, Robert Pisani,Nick Seberg, Antonio Vederosa

Rikkyo Univ.
Kazuma Fujiki
Tomoya Kato,
Takahiro Kikuchi,
Ryota Shishikura

Purdue Univ.
Joseph Bertaux,
Milan Stojanovic,
Wei Xie,
Han-Sheng Li
(former member)

Korea Univ.
Byungsik Hong,
Jaein Hwang

National Taiwan Univ.
Rong-Shyang Lu, Jenny Huang,
Lian-Sheng Tsai, Ou-Wei Cheng

National Central Univ.
Chia-Ming Kuo, Kai-Yu Cheng,
Cheng-Wei Shih, Wei-Che Tang

TIRI
Takashi Kondo

JAEA
Shoichi Hasegawa

RIKEN, RBRC
Yasuyuki Akiba, Akitomo Enokizono,
Itaru Nakagawa, Genki Nukazuka

Nara Women's Univ.
Manami Fujiwara, Takashi Hachiya,
Misaki Hata, Mahiro Ikemoto, Rin Kan,
Mai Kano, Nao Morimoto,
Maya Shimomura,
Yuka Sugiyama, Yuri Terasaka,
Hinako Tsujibata, Mai Watanabe


Yuka Sugiyama


Shoichi Hasegawa


Takashi Kondo


Nick Seberg


Stephen Boose


Milan Stojanovic


Byungsik Hong


Jaein Hwang


Lian-Sheng Tsai


Jenny Huang


Mai Kano


Manami Fujiwara


Raul Cecato


Joseph Bertaux


Chia-Ming Kuo


Rong-Shyang Lu


Kai-Yu Cheng


Wei-Che Tang


Ou-Wei Cheng


Cheng-Wei Shih


Hinako Tsujibata


Yuri Terasaka

Kan Rin

Mahiro Ikemoto

Nao Morimoto

INTT Collaboration


Donald Pinelli


Rachid Nouicer


Yasuyuki Akiba


Itaru Nakagawa


Takashi Hachiya


Maya Shimomura


Genki Nukazuka


Kazuma Fujiki


Mai Watanabe Misaki Hata


Dan Cacace


Wei Xie


Akitomo Enokizono


Takahiro Kikuchi


Tomoya Kato


Ryota Shishikura


Robert Pisani


Antonio Vederosa


Steven Andrade

Rikkyo Univ.
Kazuma Fujiki
Tomoya Kato,
Takahiro Kikuchi,
Ryota Shishikura

BNL
Steven Andrade, Stephen Boose,
Daniel Cacace, Raul Cecato,
Donald Pinelli, Rachid Nouicer,
Robert Pisani,Nick Seberg,
Antonio Vederosa

Purdue Univ.
Joseph Bertaux,
Milan Stojanovic,
Wei Xie,
Han-Sheng Li
(former member)

Korea Univ.
Byungsik Hong,
Jaein Hwang

National Taiwan Univ.
Rong-Shyang Lu, Jenny Huang,
Lian-Sheng Tsai, Ou-Wei Cheng

National Central Univ.
Chia-Ming Kuo, Kai-Yu Cheng,
Cheng-Wei Shih, Wei-Che Tang

TIRI
Takashi Kondo

JAEA
Shoichi Hasegawa

RIKEN, RBRC
Yasuyuki Akiba, Akitomo Enokizono,
Itaru Nakagawa, Genki Nukazuka

Nara Women's Univ.
Manami Fujiwara, Takashi Hachiya,
Misaki Hata, Mahiro Ikemoto, Rin Kan,
Mai Kano, Nao Morimoto,
Maya Shimomura,
Yuka Sugiyama, Yuri Terasaka,
Hinako Tsujibata, Mai Watanabe


Yuka Sugiyama


Shoichi Hasegawa


Takashi Kondo


Nick Seberg


Stephen Boose


Milan Stojanovic


Byungsik Hong


Jaein Hwang


Lian-Sheng Tsai


Jenny Huang


Mai Kano


Manami Fujiwara


Raul Cecato


Joseph Bertaux


Chia-Ming Kuo


Rong-Shyang Lu


Kai-Yu Cheng


Wei-Che Tang


Ou-Wei Cheng


Cheng-Wei Shih


Hinako Tsujibata


Yuri Terasaka

Kan Rin

Mahiro Ikemoto

Nao Morimoto

INTT Collaboration


Donald Pinelli


Rachid Nouicer


Dan Cacace


Wei Xie


Robert Pisani


Antonio Vederosa


Steven Andrade


Yasuyuki Akiba


Itaru Nakagawa


Takashi Hachiya


Maya Shimomura


Genki Nukazuka


Kazuma Fujiki


Mai Watanabe Misaki Hata


Akitomo Enokizono


Takahiro Kikuchi


Tomoya Kato


Ryota Shishikura


Yuka Sugiyama


Shoichi Hasegawa


Takashi Kondo


Nick Seberg


Stephen Boose


Milan Stojanovic


Byungsik Hong


Jaein Hwang


Lian-Sheng Tsai


Jenny Huang


Mai Kano


Manami Fujiwara


Raul Cecato


Joseph Bertaux


Chia-Ming Kuo


Rong-Shyang Lu


Kai-Yu Cheng


Wei-Che Tang


Ou-Wei Cheng


Cheng-Wei Shih


Hinako Tsujibata


Yuri Terasaka

Kan Rin

Mahiro Ikemoto

Nao Morimoto

Purdue Univ.
Joseph Bertaux,
Milan Stojanovic,
Wei Xie,
Han-Sheng Li
(former member)

Korea Univ.
Byungsik Hong,
Jaein Hwang

National Taiwan Univ.
Rong-Shyang Lu, Jenny Huang,
Lian-Sheng Tsai, Ou-Wei Cheng

National Central Univ.
Chia-Ming Kuo, Kai-Yu Cheng,
Cheng-Wei Shih, Wei-Che Tang

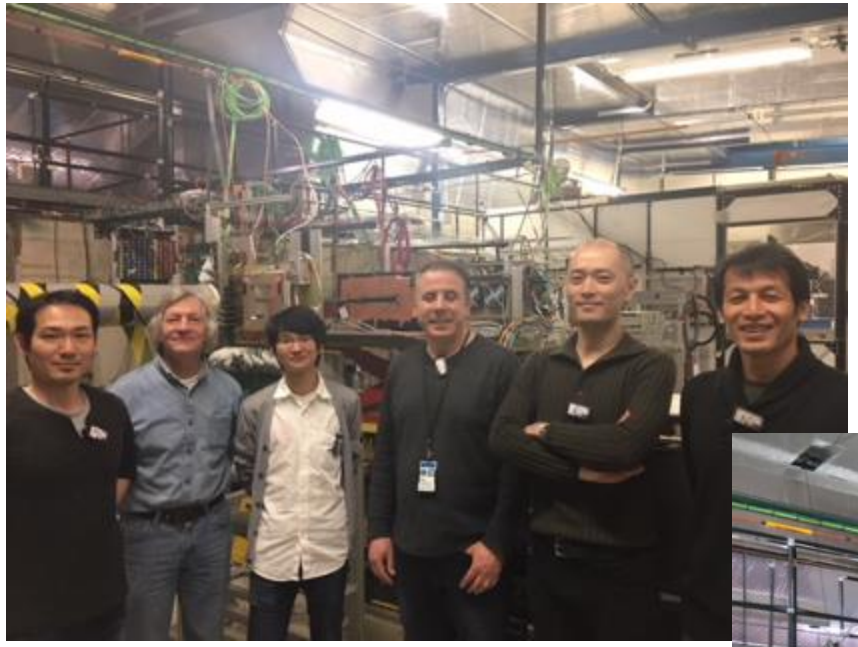
TIRI
Takashi Kondo

JAEA
Shoichi Hasegawa

RIKEN, RBRC
Yasuyuki Akiba, Akitomo Enokizono,
Itaru Nakagawa, Genki Nukazuka

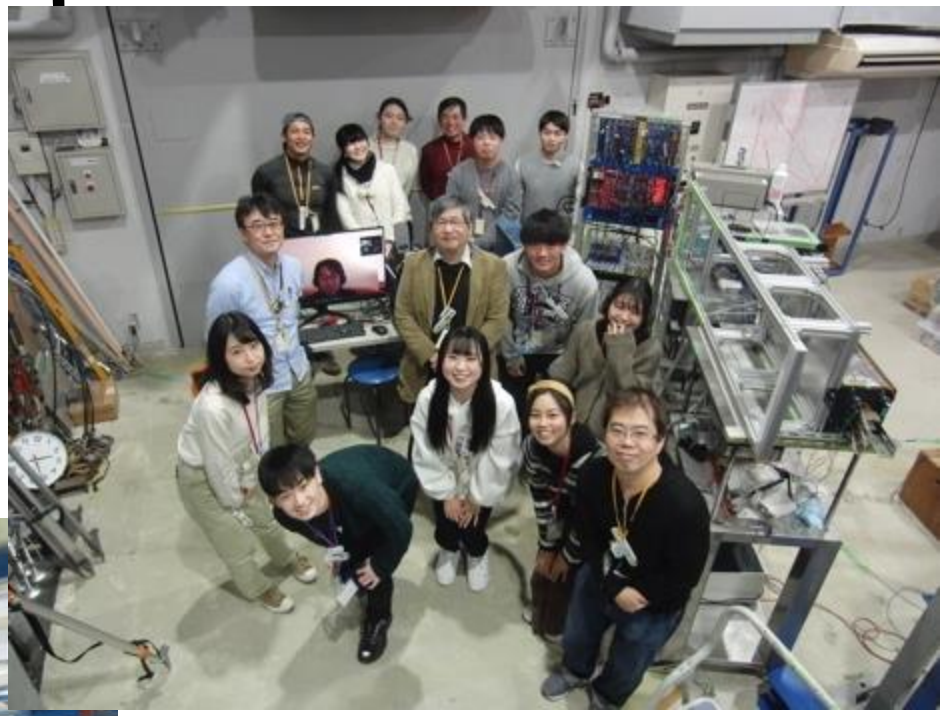
Nara Women's Univ.
Manami Fujiwara, Takashi Hachiya,
Misaki Hata, Mahiro Ikemoto, Rin Kan,
Mai Kano, Nao Morimoto,
Maya Shimomura,
Yuka Sugiyama, Yuri Terasaka,
Hinako Tsujibata, Mai Watanabe

Three Beam Tests of INTT



2018@FNAL

2019@FNAL



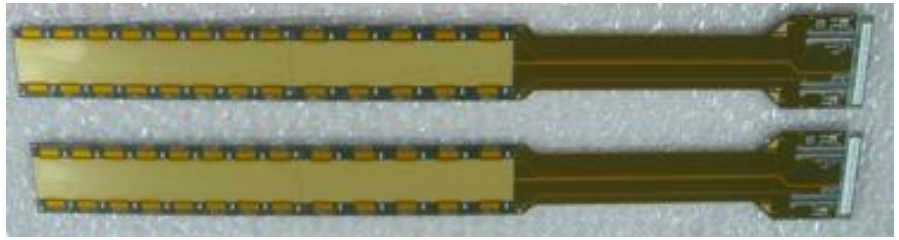
2021@ELPH in Japan

have confirmed that the INTT ladder is performing as designed.!

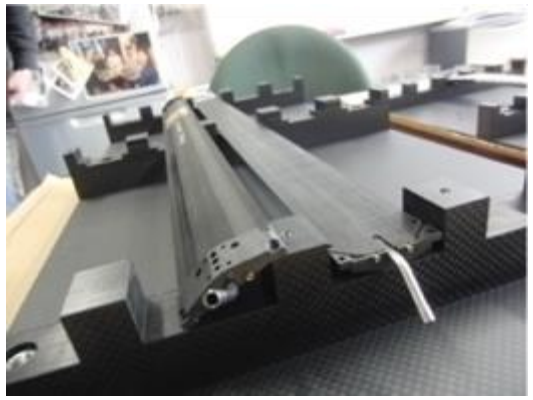
INTT Silicon Ladder

Bus Extender

HDI



Stave



PDK
プリント電子研究所

山下マテリアル株式会社
YAMASHITA MATERIALS

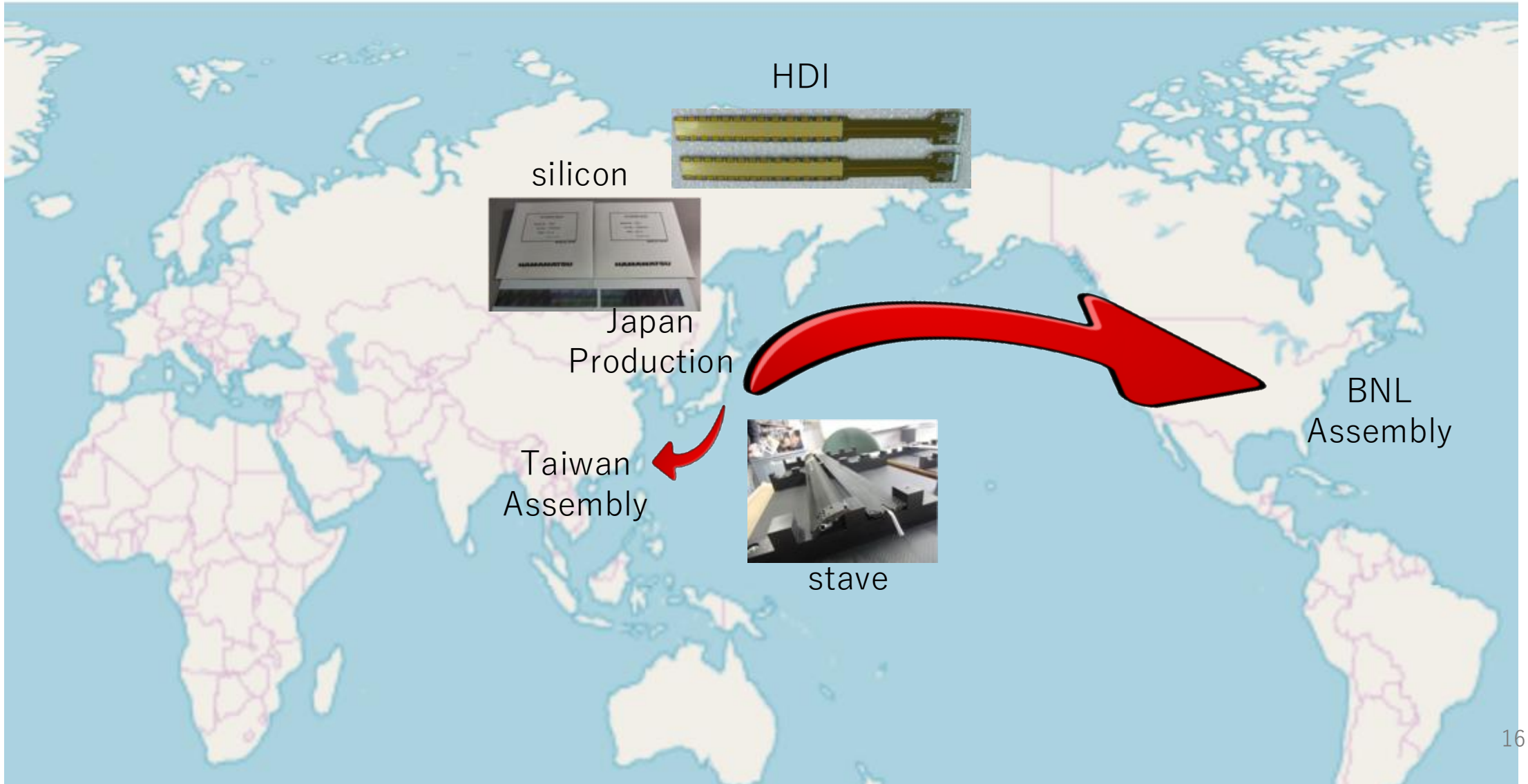
HAMAMATSU
PHOTON IS OUR BUSINESS

ASUKA Co., Ltd.

Silicon

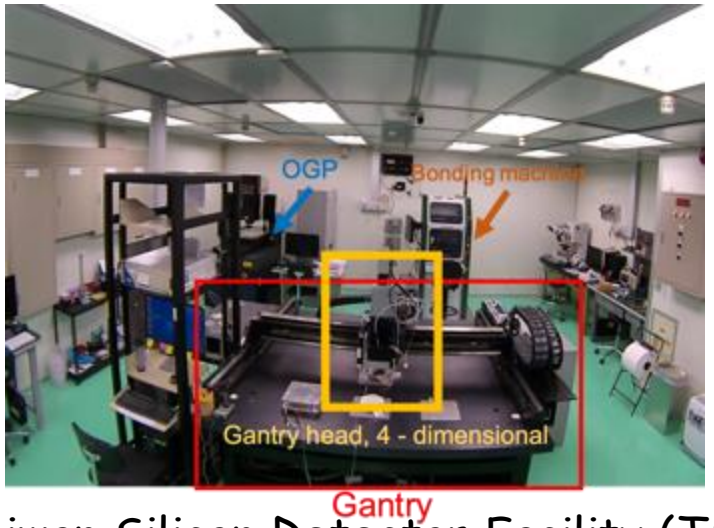
Ladder Elements Production in Japan

Ladder Assembly System



INTT assembly in Taiwan

1/3 of Ladder Assembled



Taiwan Silicon Detector Facility (TSiDF)

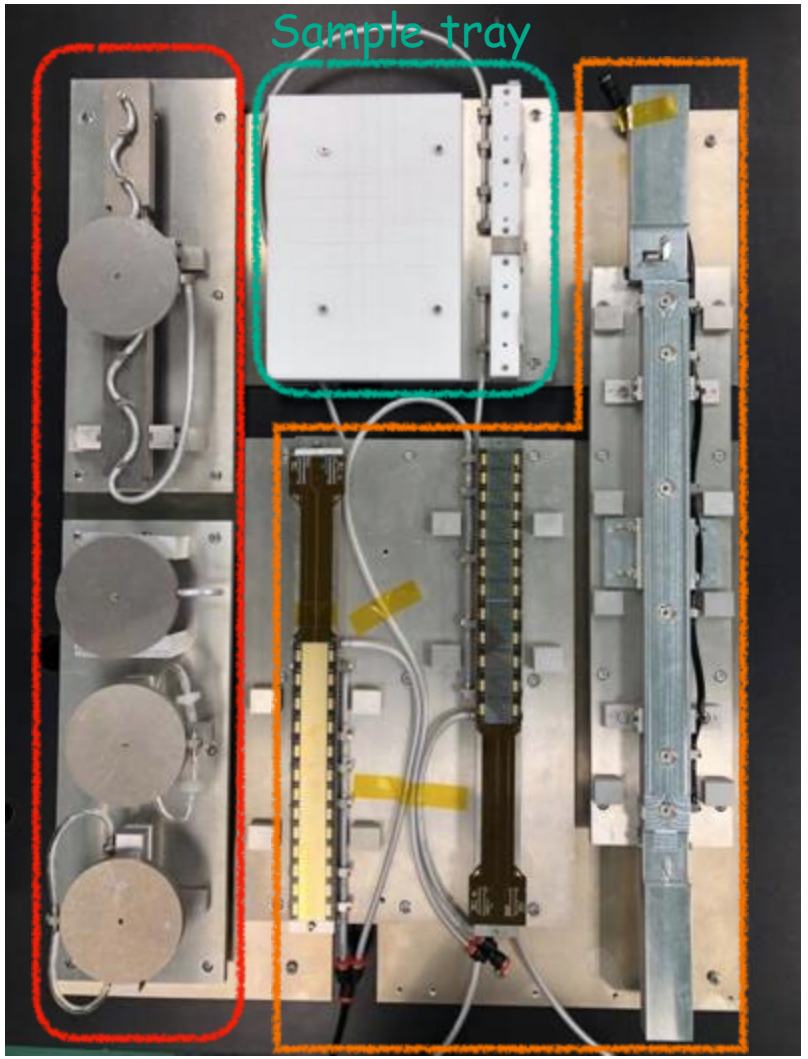
Assembly Unit : Half-ladder

Assembly procedures :

1. Chips glued on HDI then wire-bonded
2. Sensors glued on HDI then wire-bonded
3. Encapsulate all wire-bonds
4. Thermal cycles modules

Ladder assembly procedures :

- 2 half-ladder glued on stave




Rong-Shyang Lu


Lian-Sheng Tsai


Wei-Che Tang

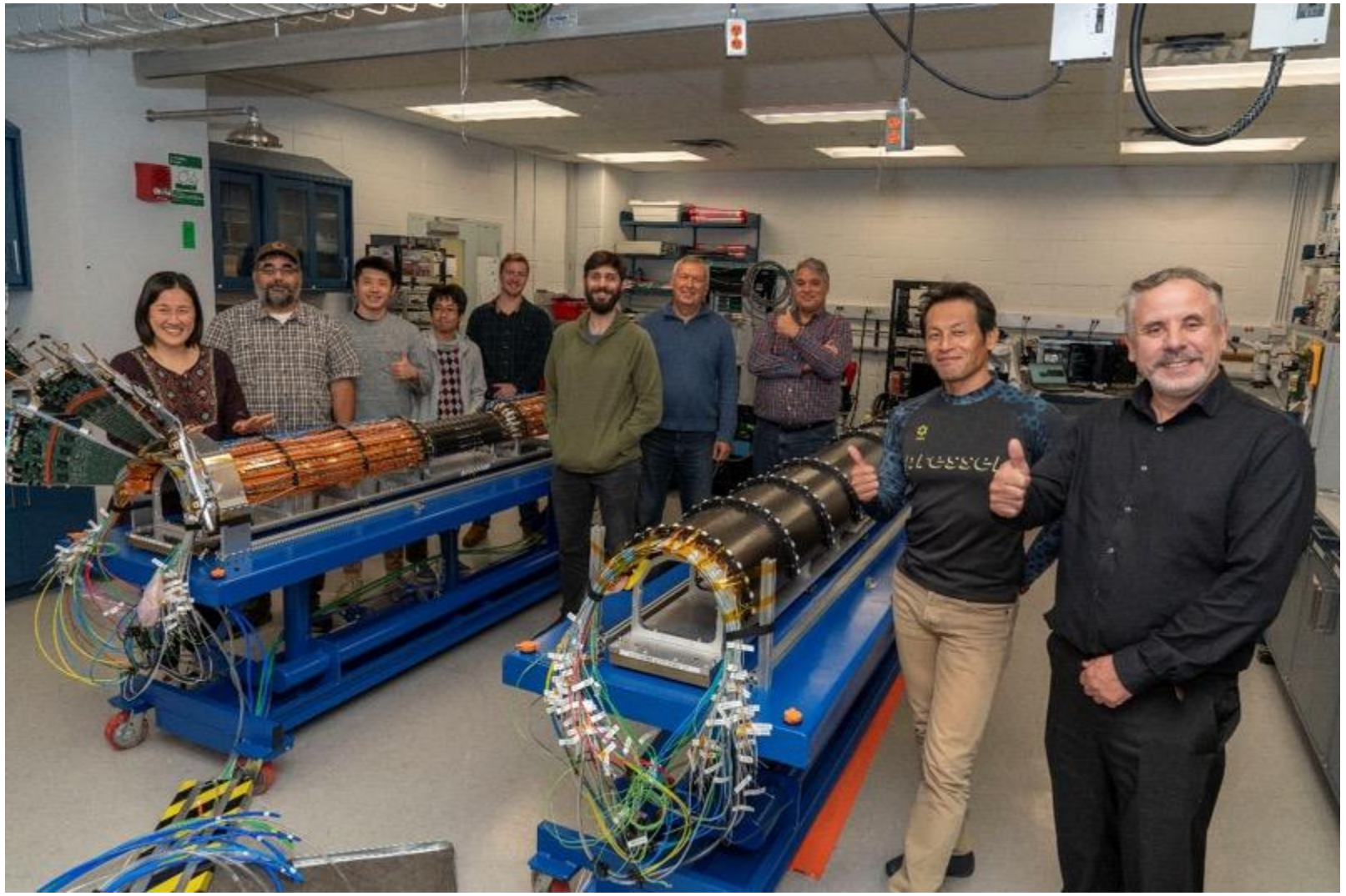

Jenny Huang

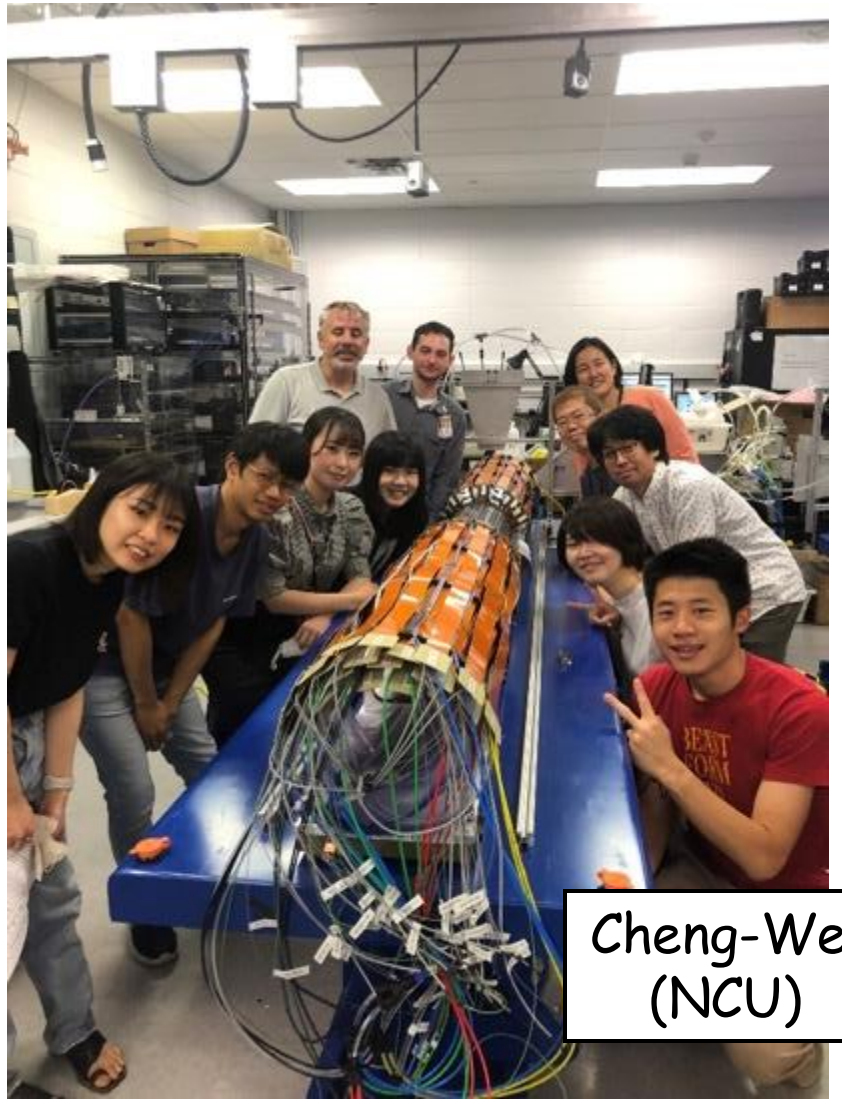

Kai-Yu Cheng


Cheng-Wei Shih


Ou-Wei Cheng

INTT-Silicon Strip Detector





Cheng-Wei (NCU)

Japan-Taiwan-Korea-USA international Collaboration

Mid. May, 2023

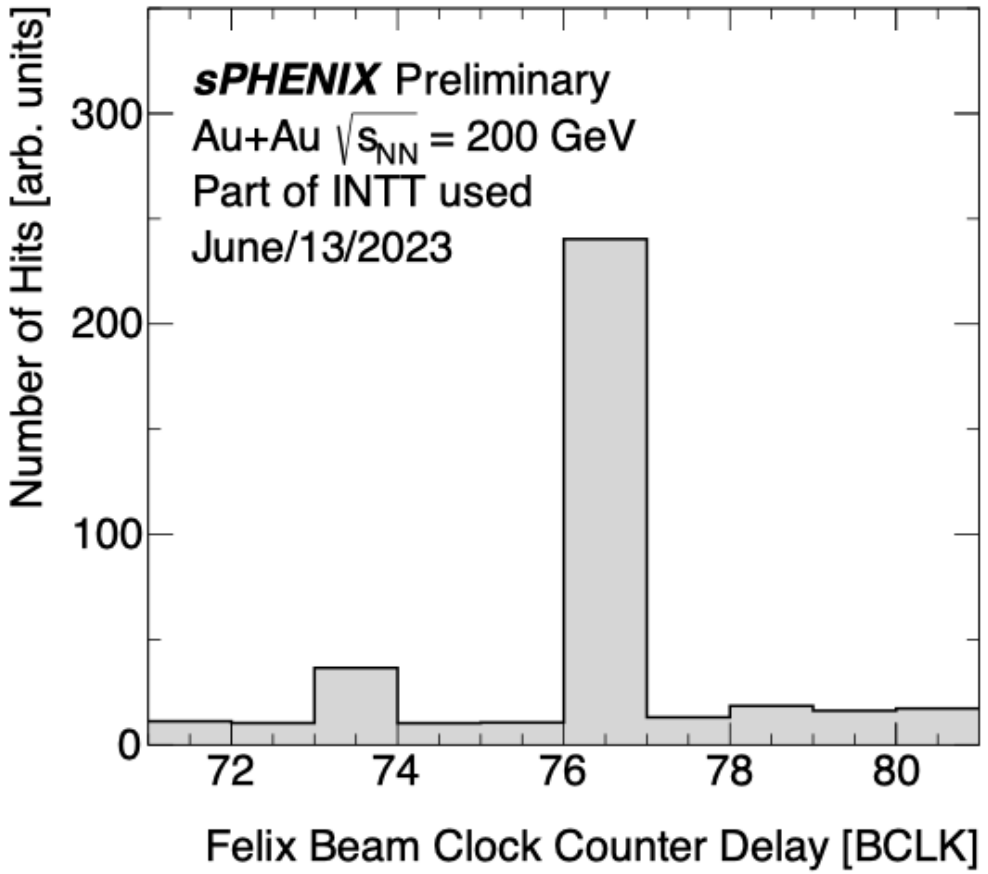
sPHENIX Commissioning

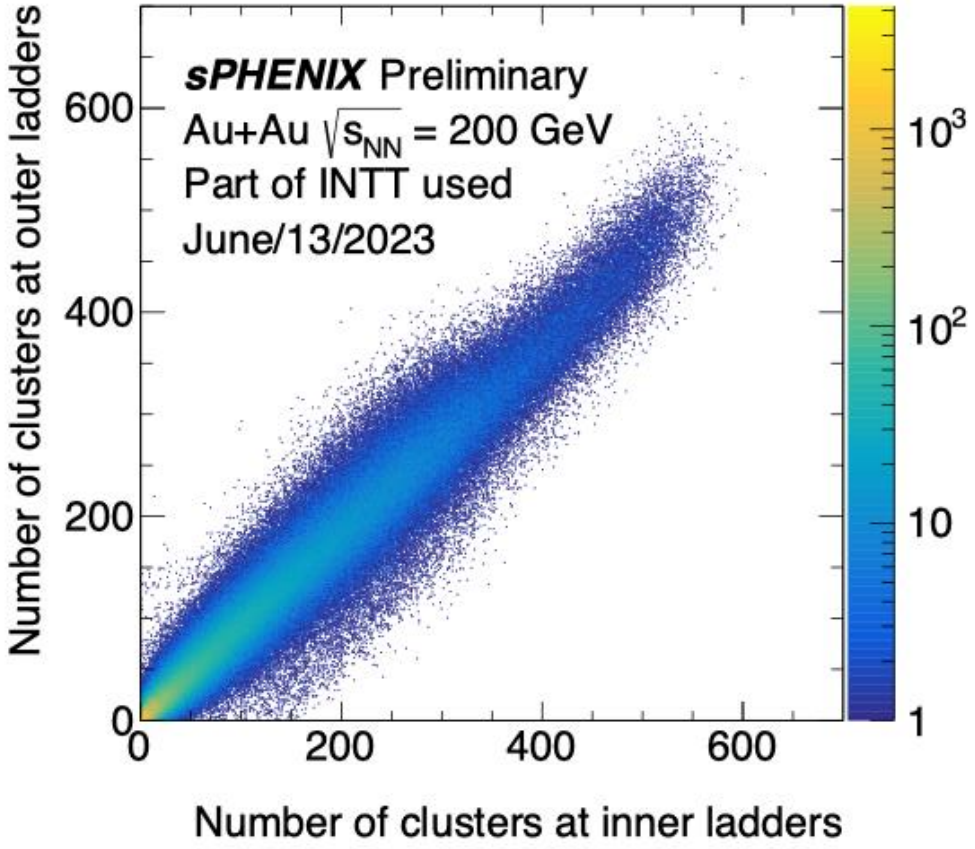
Are we looking at true signal?

New detector, new electronics, new beam environment, new data acquisition, new decorder, new analysis software…

INTT Commissioning

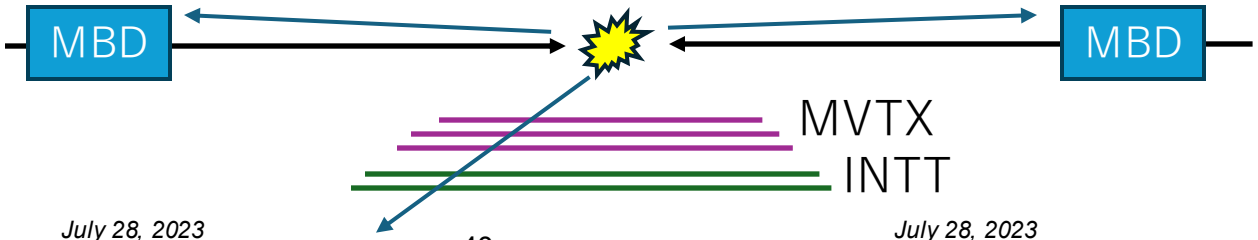
New detector, new electronics, new beam environment, new data acquisition, new decorder, new analysis software…

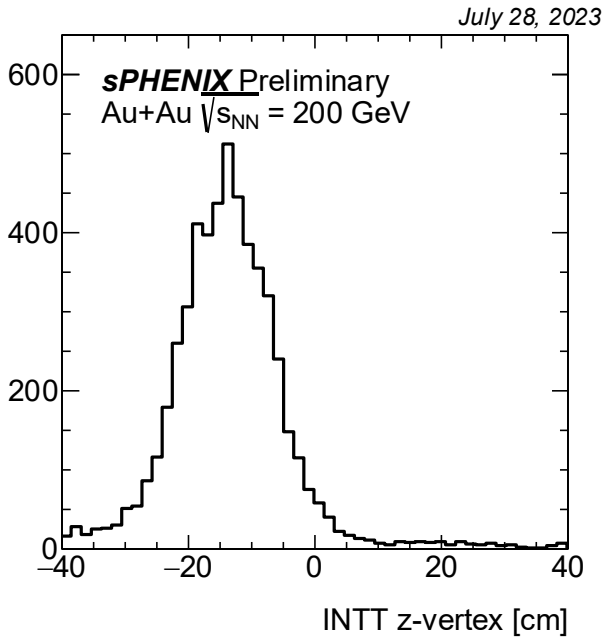




Preliminary Plots approved within 3 weeks started commissioning

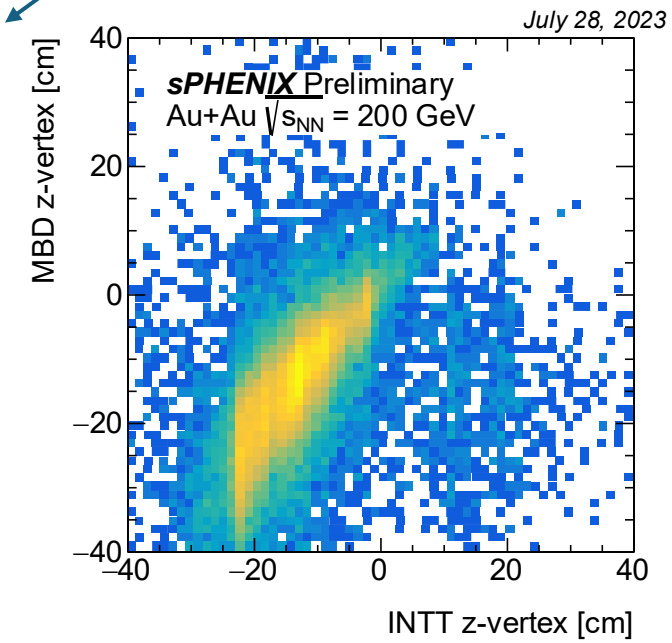
Providing Reliable Reference to MBD





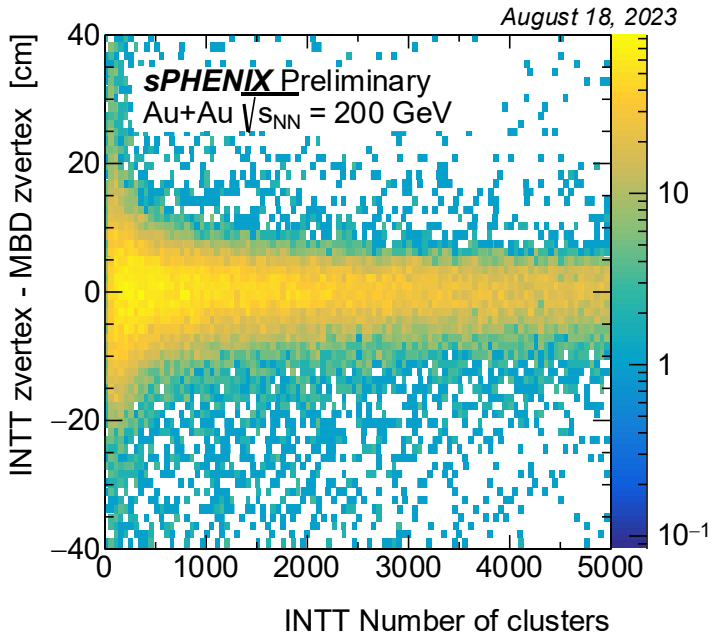
z_{vtx} distribution reconstructed by INTT.

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.

INTT also provided reliable references for MVTX and TPC as well

INTT 2Weeks Analysis Workfest

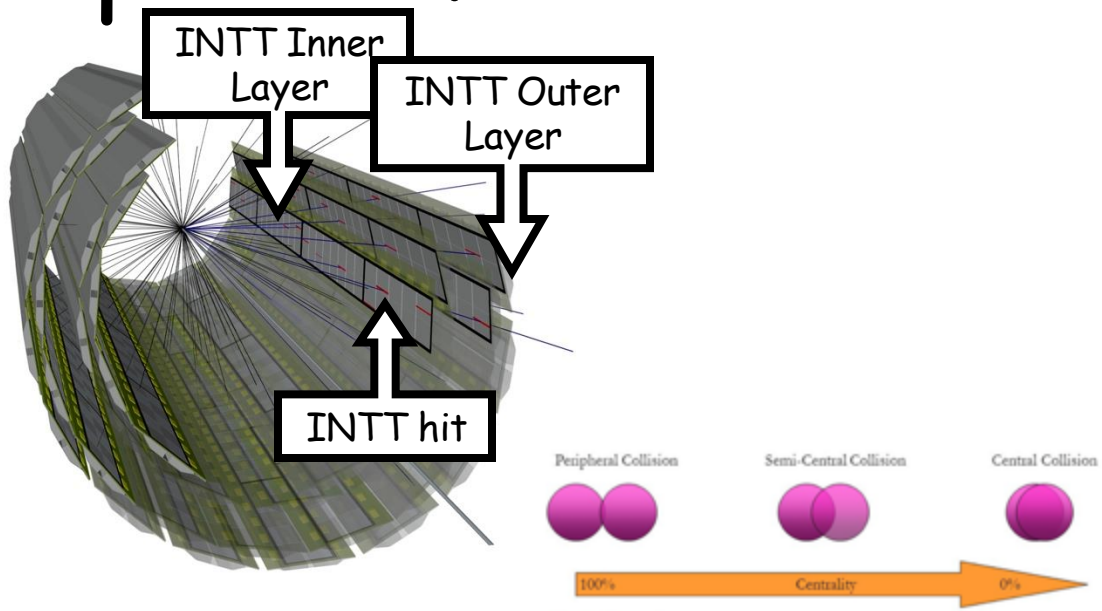
- Boost up analysis of new data
- Training of junior students
- Stoic lifestyle of Taiwanese/Korean senior students made good influences to younger students

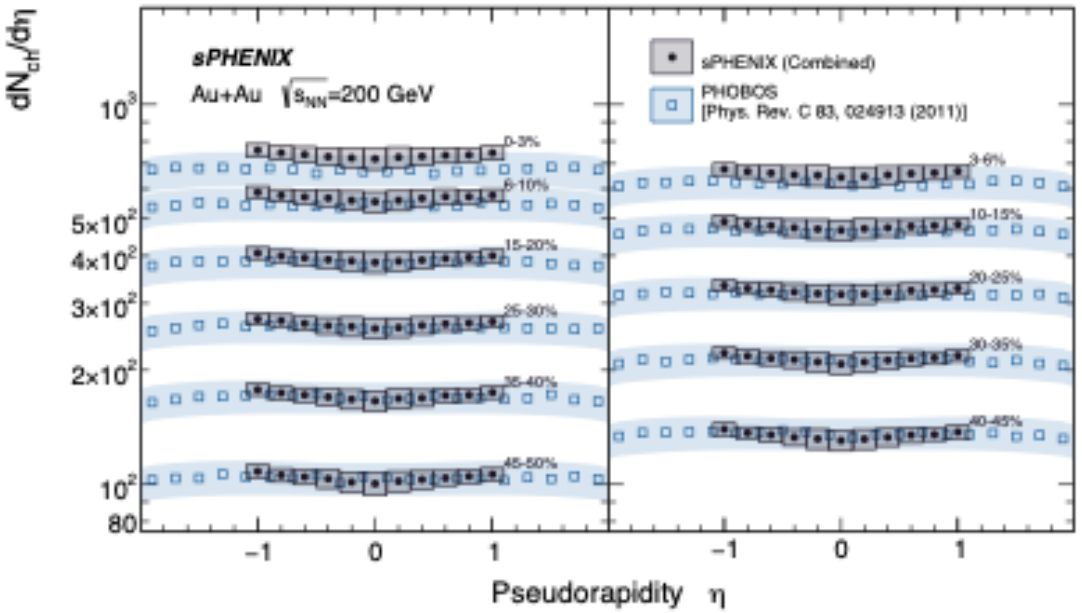
November, 2023 in Taiwan

November, 2024 in Korea

One of 2 First Physics Papers of sPHENIX

https://link.springer.com/article/10.1007/JHEP08(2025)075

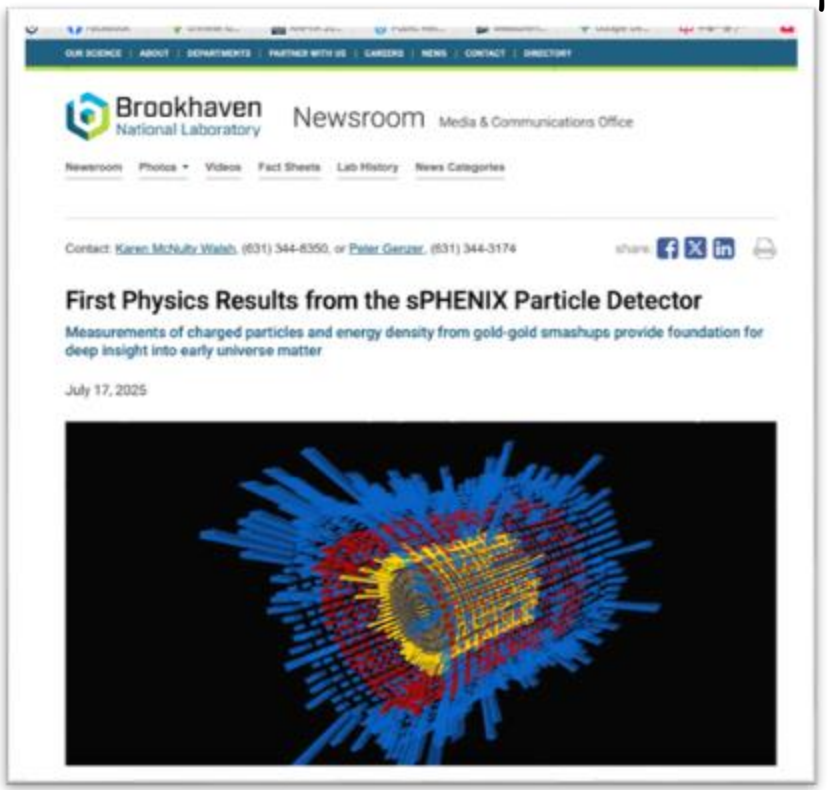




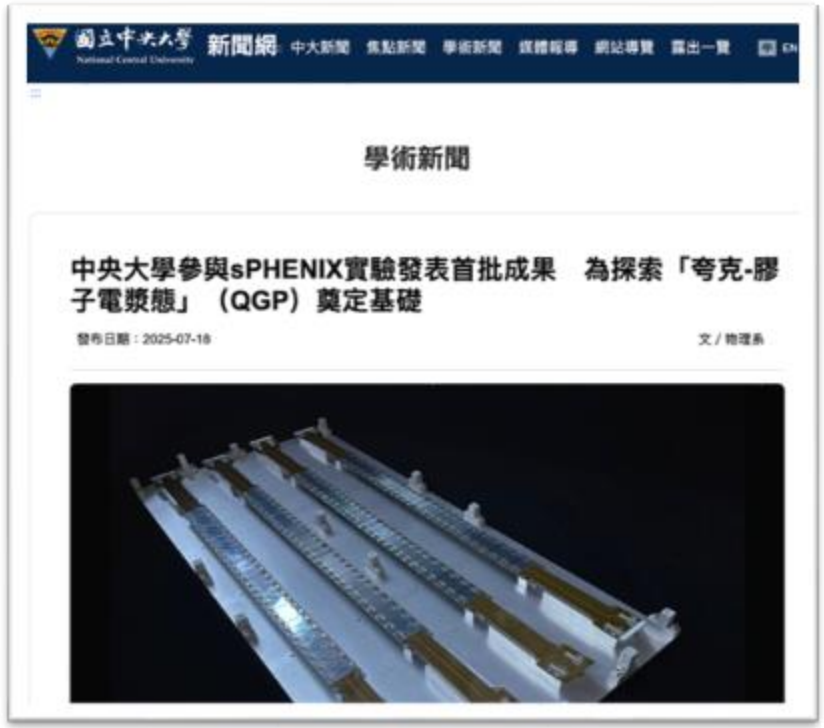
- Measured charge multiplicity in Au+Au using INTT
- In good agreement with existing RHIC data!
- 2025/8/12 Published from Journal of High Energy Physics.
- Cheng-Wei Shih (NCU) gave a plenary Talk at Initial Stage 2025 in NTU

Press Release

National Central University (Taiwan)



Brookhaven (USA)



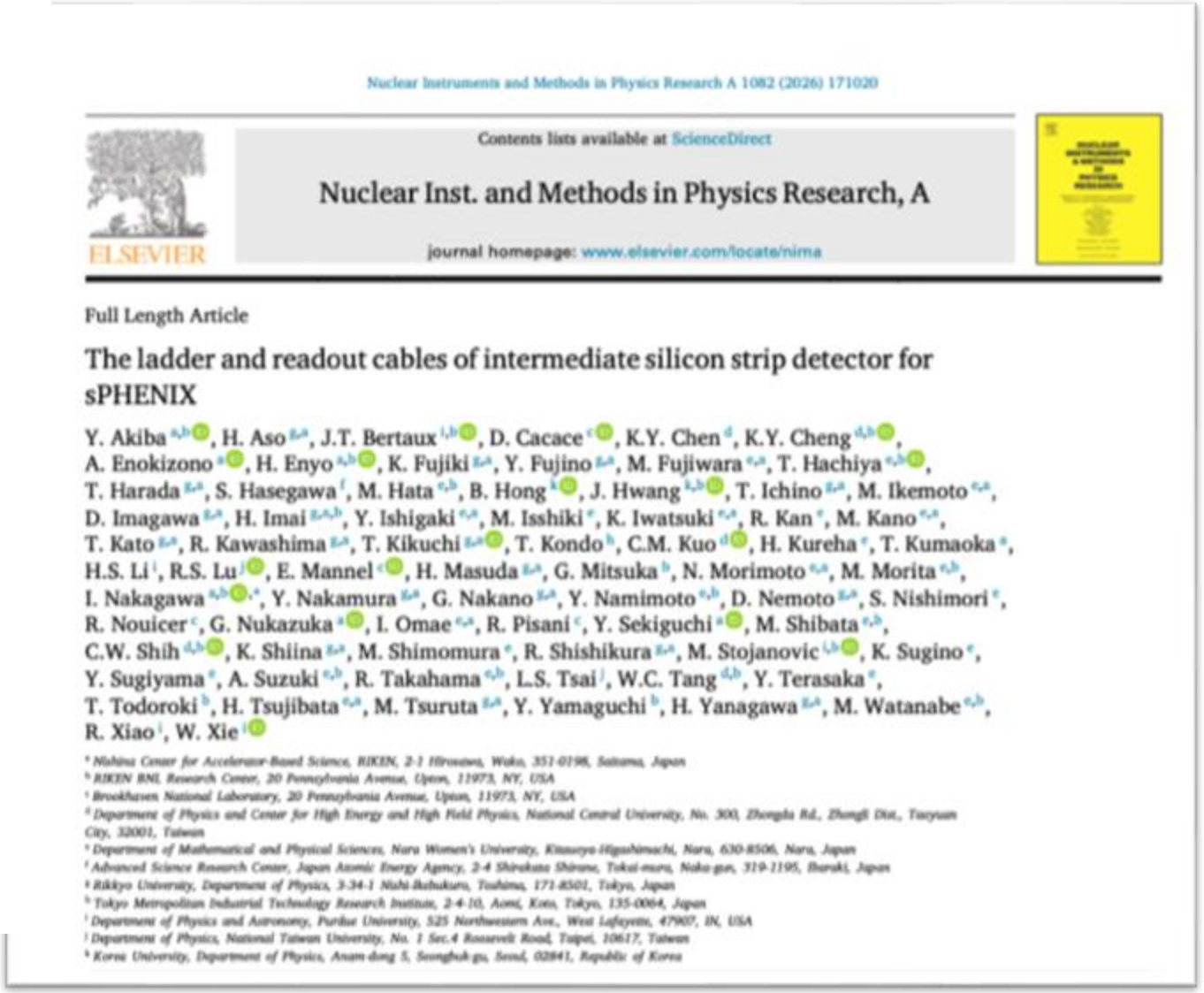
RIKEN & Nara Women's Univ. (Japan)

First NIM Paper of sPHENIX Main Detector

Technical publications

Name	Journal	arXiv	Date
INTT test beam	Sub. NIM-A	physics.ins-det/2509.00908	September 2025
INTT ladder + readout	NIM-A 1082 (2026) 171020	physics.ins-det/2503.09105	March 2025
TPOT performance	NIM-A 1066 (2024) 169615	physics.ins-det/2403.13789	March 2024
ACTS track reconstruction	Computing and Software for Big Science 5 (2023) 23	physics.ins-det/2103.06703	March 2021
Test Beam 2D Projective EMCal	IEEE Trans. Nucl. Sci. 68 (2021) 173	physics.ins-det/2003.13685	March 2020
Test Beam EMCal+HCal	IEEE Trans. Nucl. Sci. 65 (2018) 2901	physics.ins-det/1704.01461	April 2017

https://www.sphenix.bnl.gov/PublicResults#final



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

Contents lists available at ScienceDirect

Nuclear Inst. and Methods in Physics Research, A

journal homepage: www.elsevier.com/locate/nima

Full Length Article

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

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

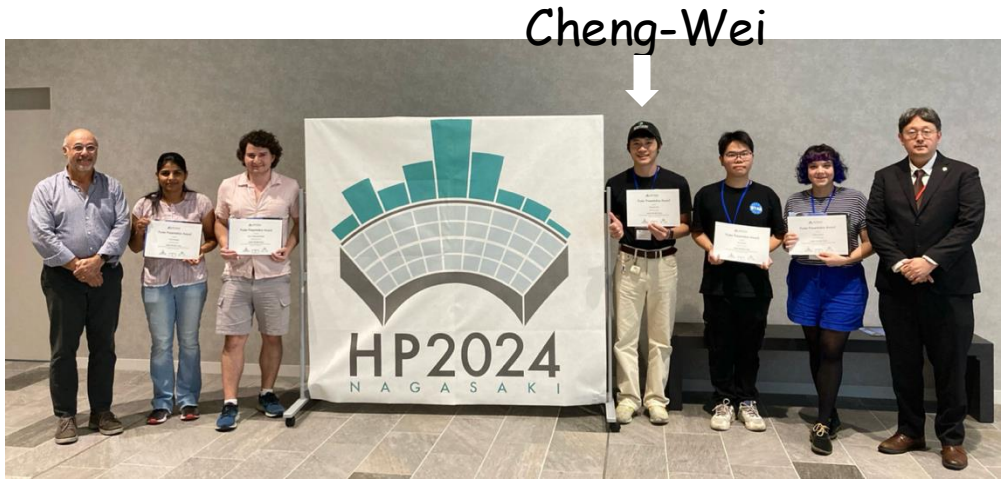
Nishina Center for Accelerator-Based Science, RIKEN, 2-1 Hirosawa, Wako, 351-0198, Saitama, Japan
RIKEN BNL Research Center, 20 Pennsylvania Avenue, Upton, 11973, NY, USA
Brookhaven National Laboratory, 20 Pennsylvania Avenue, Upton, 11973, NY, USA
Department of Physics and Center for High Energy and High Field Physics, National Central University, No. 300, Zhongda Rd., Zhongli Dist., Taoyuan City, 32001, Taiwan
Department of Mathematical and Physical Sciences, Nara Women's University, Kitauoya-Higashimachi, Nara, 630-8506, Nara, Japan
Advanced Science Research Center, Japan Atomic Energy Agency, 2-4 Shirakata Shirane, Tokai-mura, Naka-gun, 319-1195, Ibaraki, Japan
Rikkyo University, Department of Physics, 3-34-1 Nishi-Ikebukuro, Toshima, 171-8501, Tokyo, Japan
Tokyo Metropolitan Industrial Technology Research Institute, 2-4-10, Aomi, Koto, Tokyo, 135-0064, Japan
Department of Physics and Astronomy, Purdue University, 525 Northwestern Ave., West Lafayette, 47907, IN, USA
Department of Physics, National Taiwan University, No. 1 Sec.4 Roosevelt Road, Taipei, 10617, Taiwan
Korea University, Department of Physics, Anam-dong 5, Seongbuk-gu, Seoul, 02841, Republic of Korea

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/Winter**	**In preparation**
Bus Extender (Mechanical)	NIM	Takashi	2026?	Final evaluation of the yield rate

sPHENIX Poster/Presentation Awards

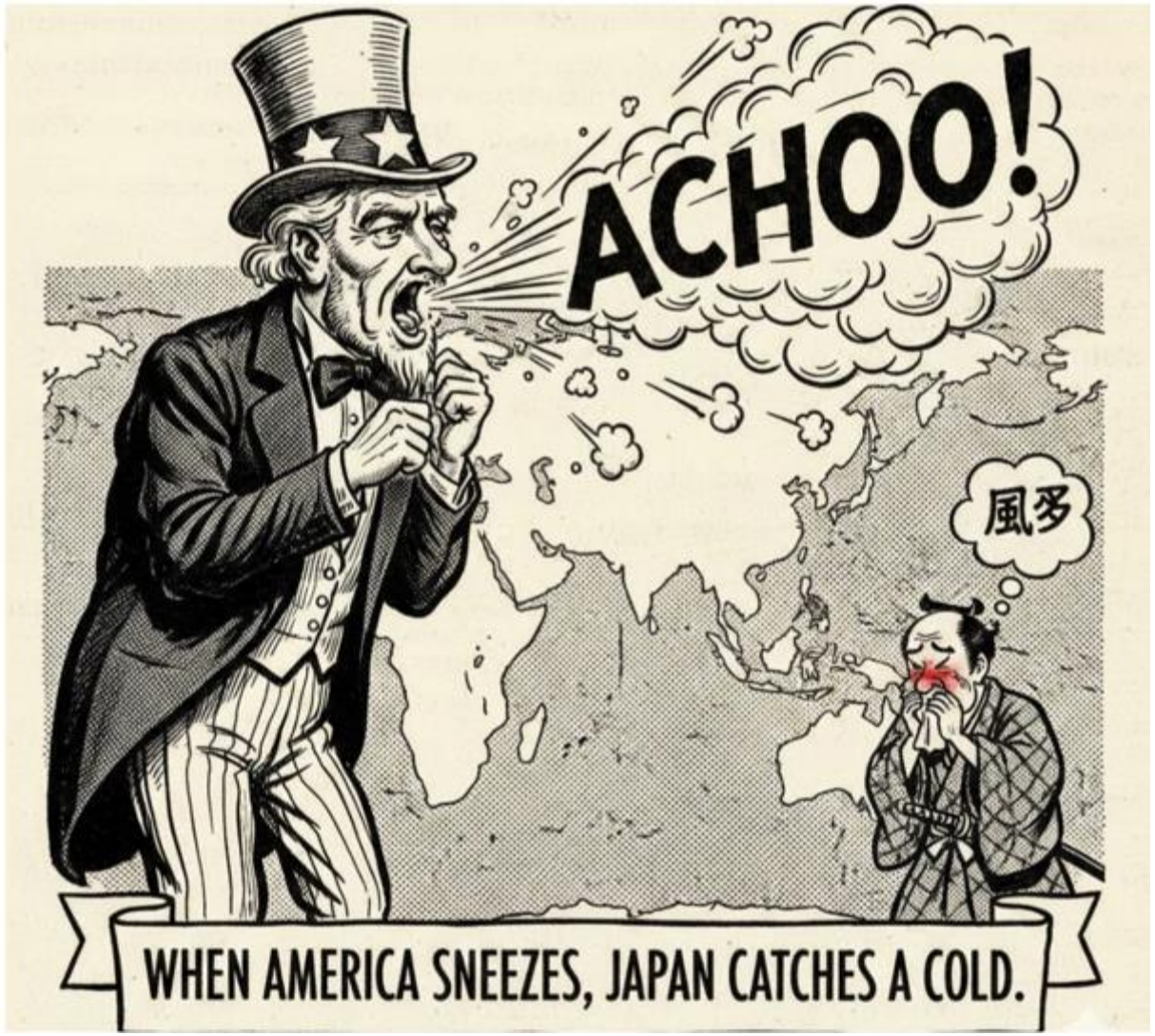
Major Conference	sPHENIX Winner	Subsystem
Initial Stages 2025	Emma McLaughlin (Columbia U.)	Calorimeter
QM2025	Jaein Hwang (Korea Univ.)	INTT
Hard Probe 2024	Cheng-Wei (NCU)	INTT
QM2023	Cheng-Wei (NCU)	INTT



- 2024 Student Presentation Award of the Physical Society of Japan (Cheng-Wei, NCU)
- 2nd Year Doctoral Course Research Fellowships, Japan Society for the Promotion of Science (Ryotaro Koike, Kyoto Univ.)

INTT team contributes to sPHENIX gaining worldwide recognition.

Take initiative of sPHENIX!



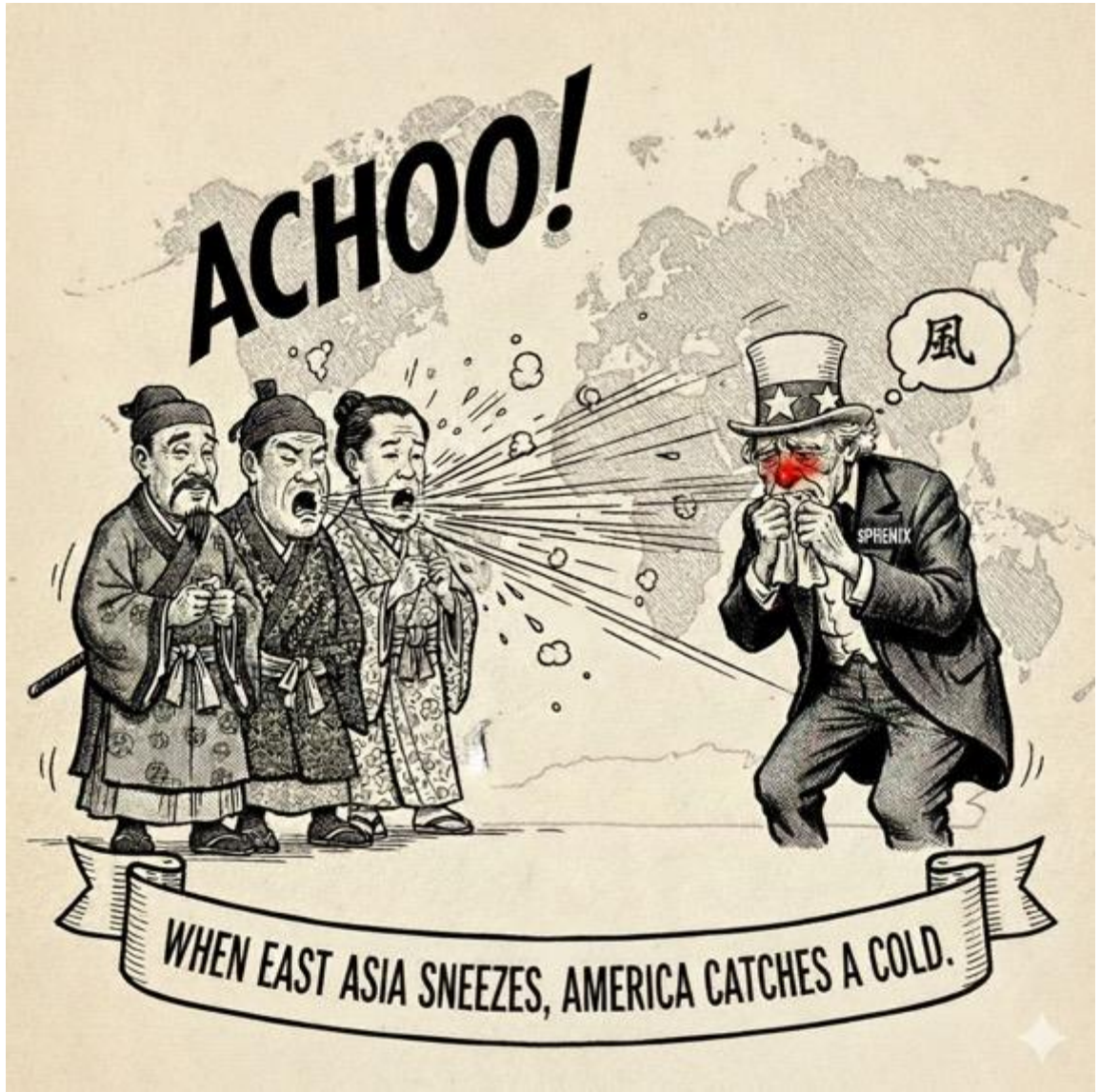


Image created by Gemini

Summary

- sPHENIX is a new experiment at RHIC.
- Operation 2023 – 2025.
- Japan-Taiwan-Korea-USA are collaborating to build INTT silicon detector.
- Taking advantage of geographical advantage of eastern Asia, we formed very strong team.
- The INTT team has been successful in taking the initiative of sPHENIX experiment!