Overview of the Nuclear Physics Activities in Thailand

Somsak Dangtip
Thailand Institute of Nuclear Technology

Thailand Institute of Nuclear Technology

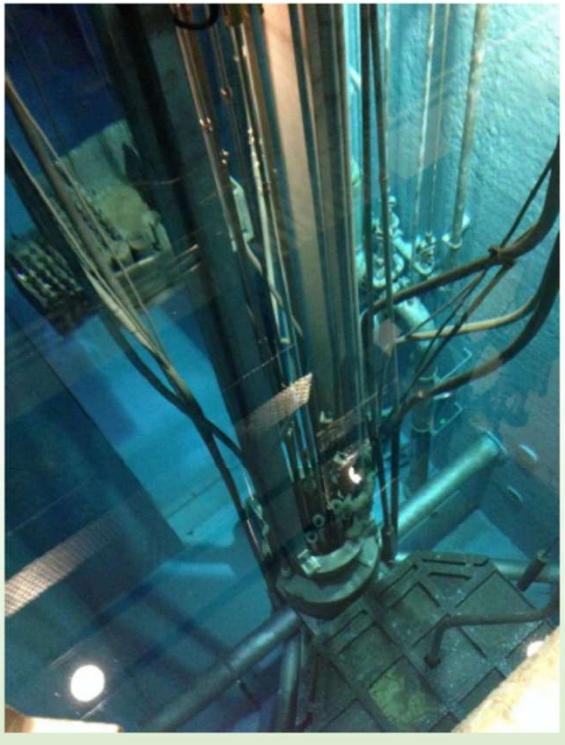
Thailand Institute of Nuclear Technology (Public Organization) : TINT

- Mission:
  - Carrying out research on nuclear science and technology and its applications
  - Providing nuclear technology-related services on producing radioisotopes and managing radioactive waste
  - Providing technical services to promote nuclear knowledge transfer and conducting trainings and human resource development on nuclear utilization
  - Conducting research on nuclear applications and other relevant areas including nuclear and radiation safety, measurements of environmental radioactivity, as well as radiation protection
  - Implementing nuclear safety, nuclear security, and nuclear safeguards

- Vision: To be a leading research and innovation institute and providing nuclear technology-based services for sustainability of the country and ASEAN

2. Nuclear Infrastructure : **Research Reactor Facility**

TRR-1/M1 Research Reactor, with a maximum steady state power of 1.3 MW, has been operated since 1977 for services and R&D purposes as follows.



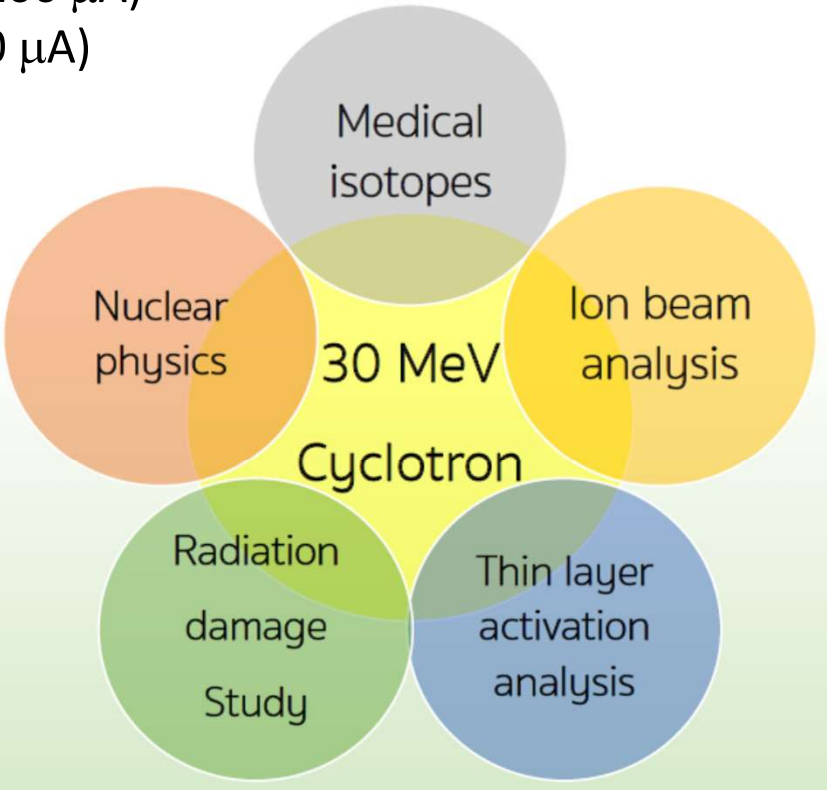
- **Neutron Activation Analysis (NAA)** is performed to analyze composition of samples.
- **Radioisotope production** such as I-131and Sm-153 which are employed in medical utilization for diagnosis and therapy, and P-32 for agricultural application
- **Gemstone coloration** is carried out to increase value of gemstone.
  For example, the color change of topaz or tourmaline could increase its value by 5-30 times.
- **Non-Destructive Techniques (NDT):** neutron experiments, nuclear physics, reactor engineering studies and neutron radiography
- **Reactor operator training** is carried out to enhance the competency of reactor operator.
- **Operation Hours:** Monday to Wednesday 26 hr/week and Thursday to Friday reserve for research and experiments, total 78 hr/month

2. Nuclear Infrastructure : Cyclotron Facility

Ions:

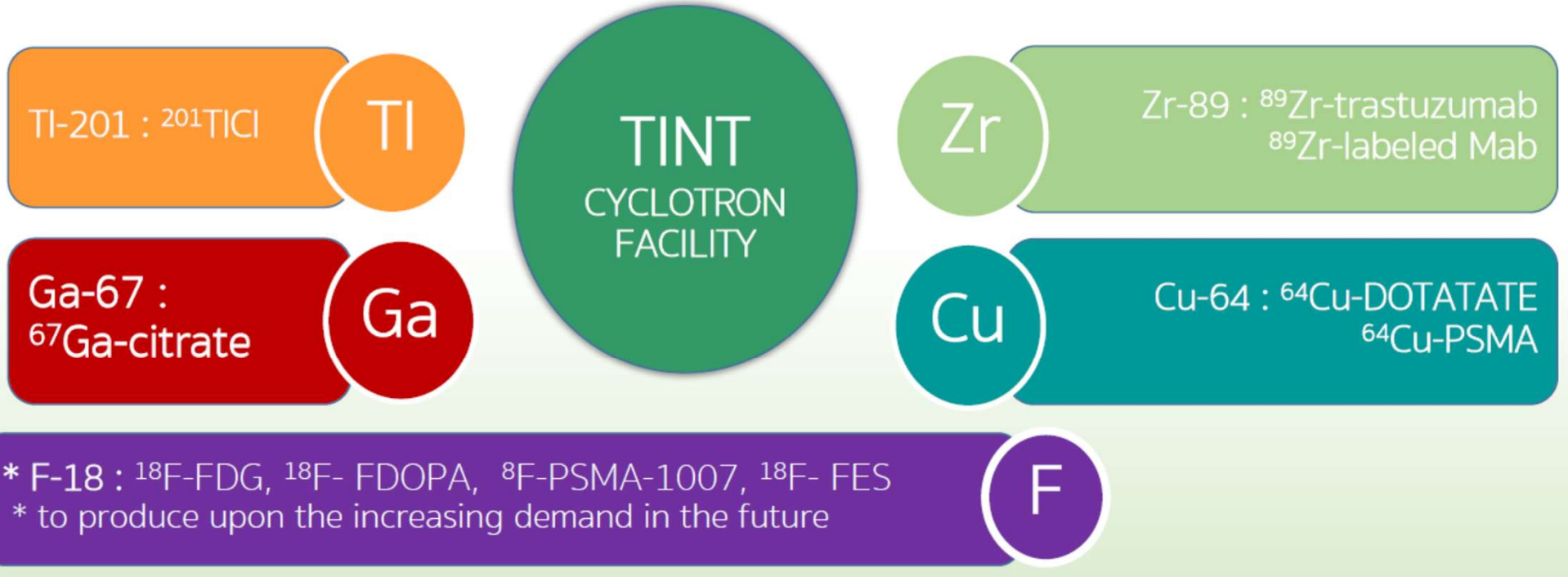
15 – 30 MeV H (up to 200 μA)
8 – 15 MeV D (up to 50 μA)

Purposes:
PET & SPECT isotopes
Ion beam research



2. Nuclear Infrastructure : Cyclotron Facility

List of radioisotopes and radiopharmaceuticals expected to be produced by TINT cyclotron



2. Nuclear Infrastructure : Tokamak Facility

TINT-EGAT-ASIPP of China have collaboration on the development of Tokamak device at China with a delivery and installment at TINT headquarter in Ongkharak which is a building complex to be exclusively the first Thailand Tokamak Facility.

Timeline

2020 – Start reconstruction
2023 - Formal inauguration of the Thailand Tokamak Facility
May 2023 - The machine was commissioned.
Jul 2023 – Opening ceremony

2. Nuclear Infrastructure : Tokamak Facility

TINT is a host center for CPaF, a large consortium comprises of 21 universities, 1 research institutes, and EGAT.

Center for Plasma and Nuclear Fusion (CPaF)

ASPNF-2023 by TINT & CPaF
May 29 – Jun 2, 2023 @ SWU, Ongkharak

6 IAC, EC, SC

FFPR, Applied FPR, AE

Fostering future generation

26 Affiliated Members

International Collaboration

CPaF

Center for Plasma and Nuclear Fusion Technology

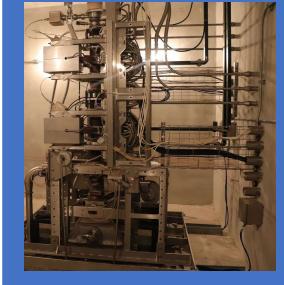
Thailand Institute of Nuclear Technology
(Public Organization)

2. Nuclear Infrastructure : Gamma Irradiation and E-Beam Accelerator Facility

Gamma Irradiation Facility offers services in many product categories of products and certified by European Commission for spice irradiation and by USDA for irradiation of **fresh mango, pineapple, mangosteen, lychee, longan, rambutan, dragon fruit and pomelo** to be exported to the U.S.

E-Beam Accelerator Facility offers services to a wide range of products including agricultural products such as spices, herbs, fruits, food, industrial materials, and medical devices.

Nuclear Infrastructure for sustainable development



2019

Electron Beam Accelerator Facility

2022

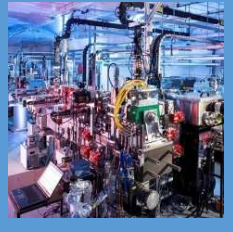
Cyclotron Facility,
Started construction

2023

Tokamak Facility

2027

Accelerator Mass Spectrometry Facility



2027

Self-Developed Electron Beam Accelerator Facility

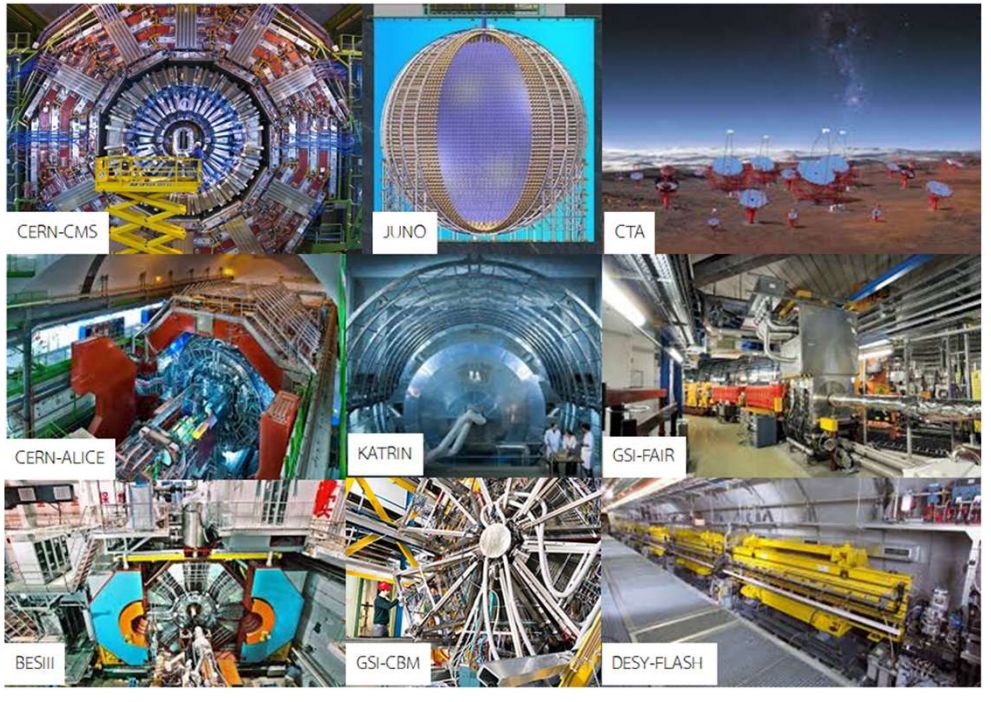
2037

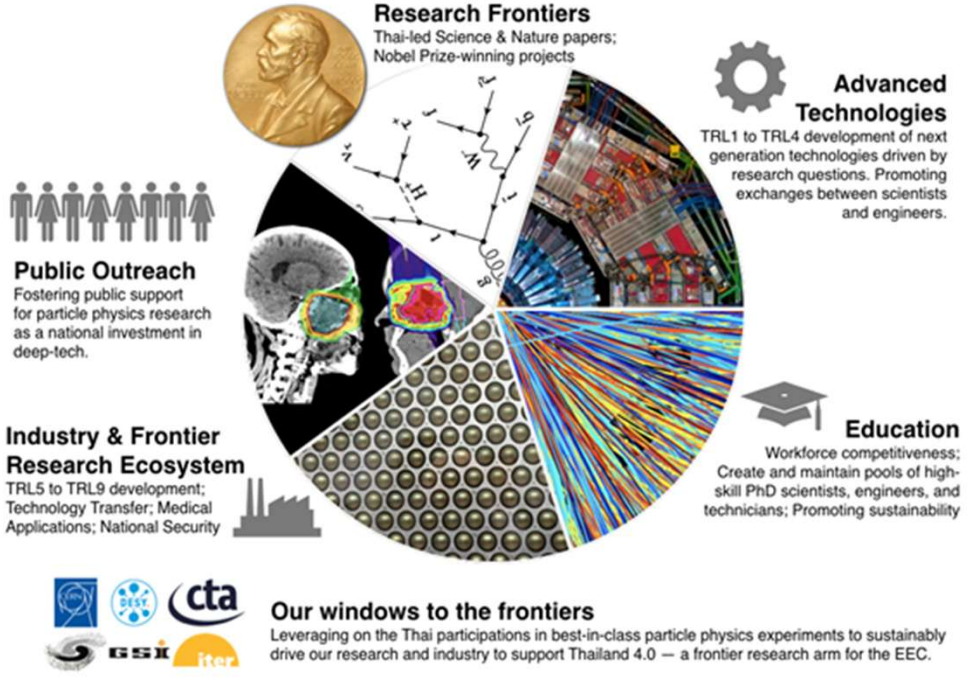
New Research Reactor

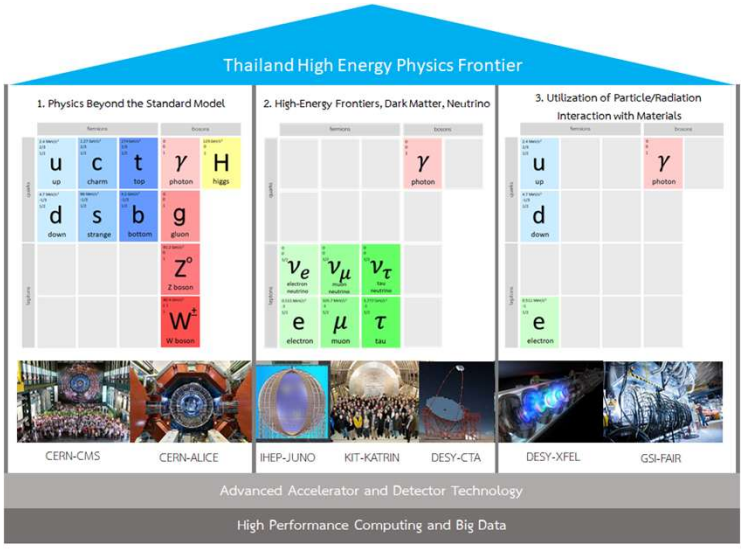
2037

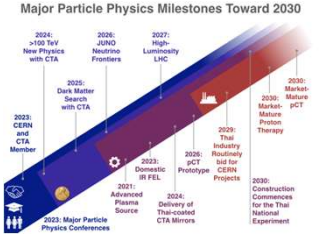
Nuclear Waste Facility

Courtesy of HRH Sirindhorn to HEP Laboratories
Contribution of Thai Researchers to HEP Activities





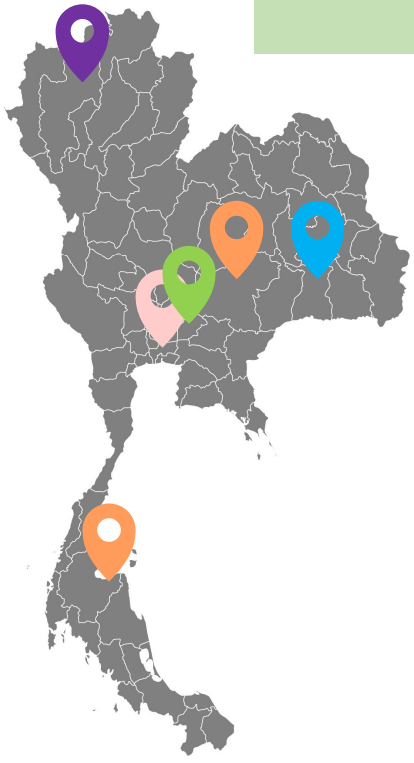




สถาบันเทคโนโลยีนิวเคลียร์แห่งชาติ

(องค์การมหาชน)

Review of Nuclear Physics, Education & Applications Activities in Thailand in 2024

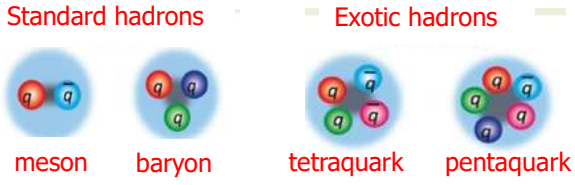


- Suranaree University of Technology (SUT) – IHEP Collaborations
- CU-CMS Collaborations
- Fast Ion Study in LHD using Neutron Diagnostics by MSU
- R& D on Proton Computed Tomography (pCT) with 250 MeV proton cyclotron at CU
- International School of Beam Dynamic and Accelerator at CMU
- Boron Neutron Capture Therapy (BNCT) at SUT

Suranaree University of Technology (SUT) – IHEP Collaborations

Infrastructure and Facility : BESIII (Beijing Spectrometer Experiment III Detector Gen 3 to study collisions between electron & positron in the energy range 2 – 4.9 GeV using Beijing Electron-Positron Collider (BEPC) @ Institute of High Energy Physics (IHEP), CAS Beijing) BESIII has > 82 institutional members from 16 countries in Asia Europe and the US

Objectives: to study exotic hadron with tetraquarks and pentaquarks




BESIII detector


BEPC


HRH visited BEPC, IHEP on April 6, 2011

Activities from the past year:

1 • SUT attended Seminar of experimental research on exotic hadrons at BESIII, 8 April 2024 @ Nankai U., China

2 • มทส. กระชับความร่วมมือ Research collaboration with Institute of High Energy Physics (IHEP), 10-11 April 2024 @ IHEP, Beijing, China

3 • SUT + NARIT + TPS hosted The 6th Sino-Thai Symposium on High Energy Physics, Astrophysics and Materials Science (STSP 2024), 19-23 August 2024 @ NARIT & Kantary Hills Hotel, Chiang Mai

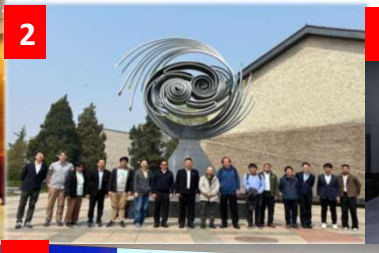
4 • SUT hosted the First Sino-Thai Workshop on Hadron Physics, 3-8 November 2024 @ Krabi, Thailand (participant from IHEP-BESIII>20)

5 • SUT and CU participated International Workshop on the High Energy Circular Electron Positron Collider (CEPC), 23-27 October 2024 @ Hangzhou, China, ซึ่งจัดโดย IHEP and Zhejiang U.

6 • Guest Researchers from Nankai U. (BESIII member) visited SUT for two months (July – August 2024)

7 • On Thai Ph.D. student joined Experiments at Nankai U.for three months (Mar – May 2024)


1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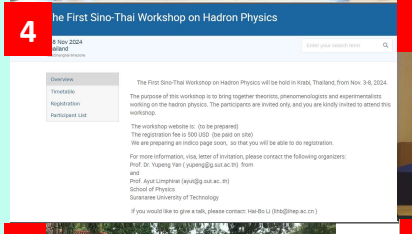
3



4

5

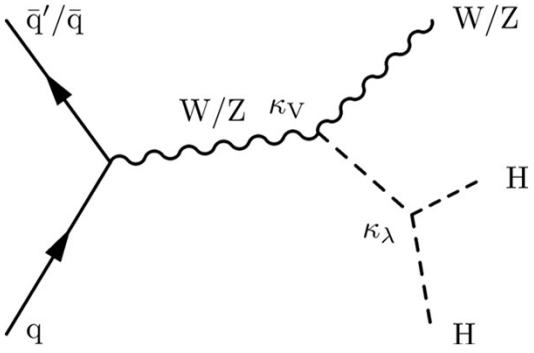

6


7

CU-CMS : Physics analysis

Higgs Physics

- Study signals of Higgs boson which decays to a pair of bottom quarks both in the Standard Model (SM) and beyond the Standard Model (BSM)



HHV signal; Look for bbbb with lepton events
(JHEP 10 (2024) 061)

Exotic particles

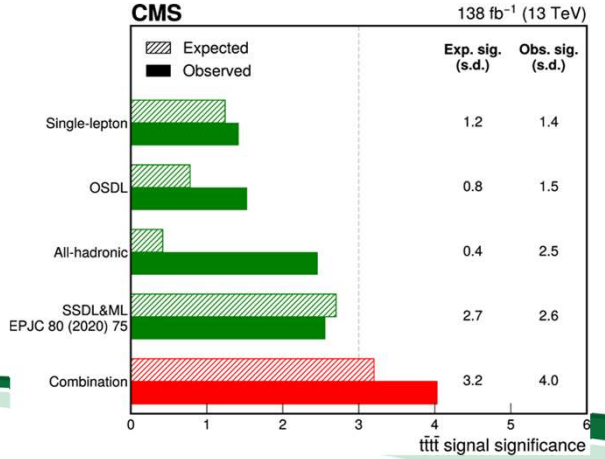
- Highly ionized particles (HIP)

Top physics

- Four-top analysis

tttt signal; Combine all studied channels at CMS

(Phys. Lett. B 844 (2023) 138076)



Offline Software and Computing

Full Simulation

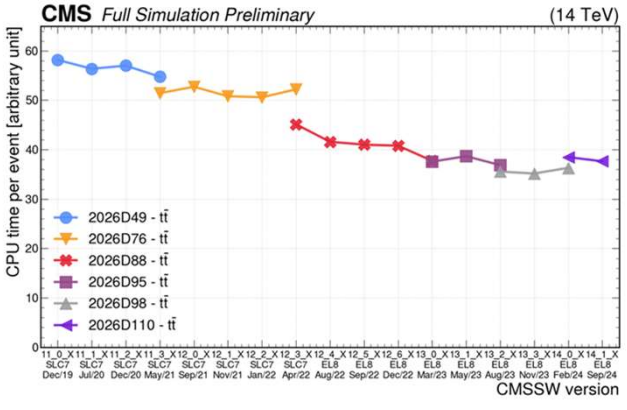
- Preparation for Phase 2 CMS Full Simulation (LHC Run 4, 2030)
- Improving performance of CMS Full Simulation (mainly on Geant4 and Fast simulation techniques)

Flash Simulation

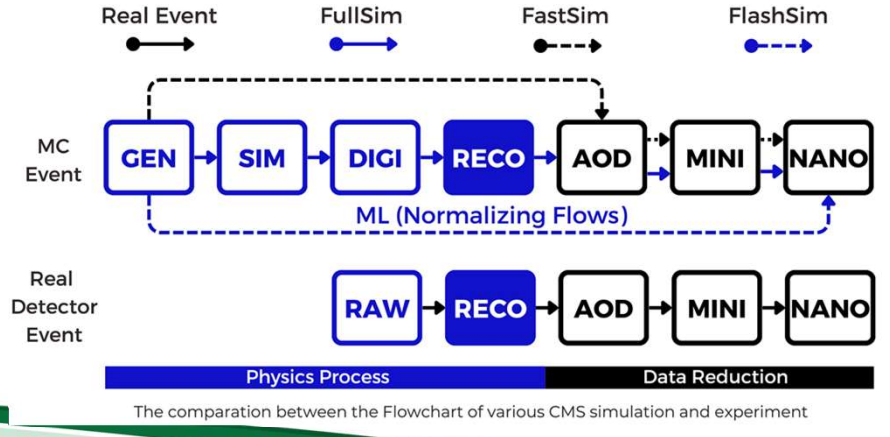
- End-to-End simulation without detector simulation, digitization, reconstruction
- Using Normalizing flow techniques, learning from Full Simulation NANOAODSIM (Smallest derived dataset used for physics analysis)
- Our group is responsible for Tau object

Computing Infrastructure

- Effort to try provide computing resources to CMS collaboration using HPC instead of dedicated WLCG site



Phase 2 CMS software performance



The comparation between the Flowchart of various CMS simulation and experiment

Flash simulation workflow.

Conference, School, and Outreaches

Recent school and conference

- Flavor Physics and CP Violation Conference (FPCP 2024) at Chulalongkorn University; 27 - 31 May 2024
- Asian-Europe-Pacific School of High-Energy Physics (AEPSHEP 2024); 12 - 25 June 2024

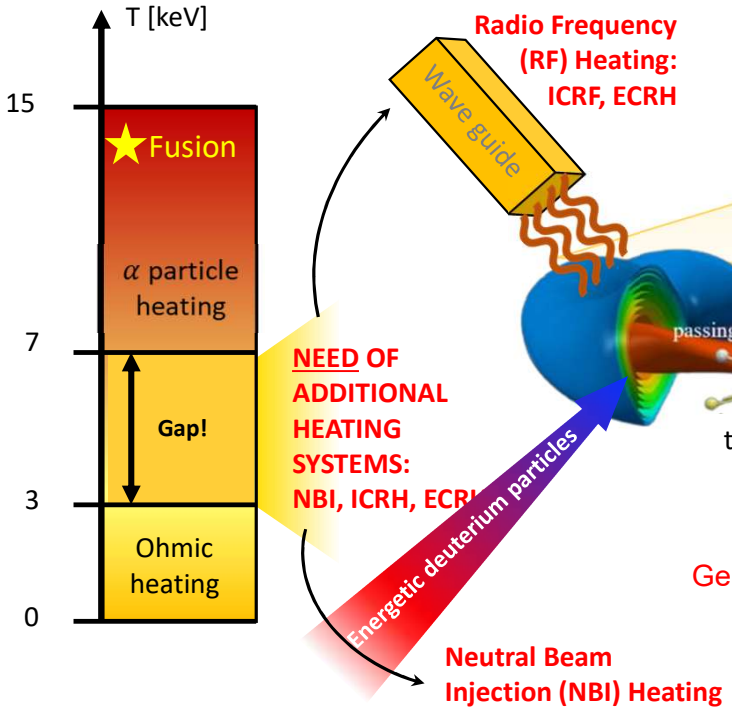
Future events

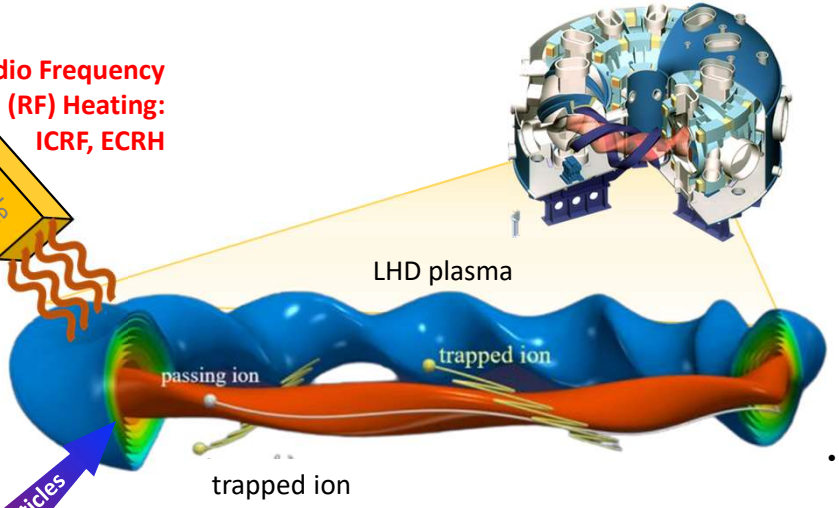
- Conference on Computing in High Energy and Nuclear Physics (CHEP 2026), Bangkok Thailand
- International Conference on High Energy Physics (ICHEP 2028)

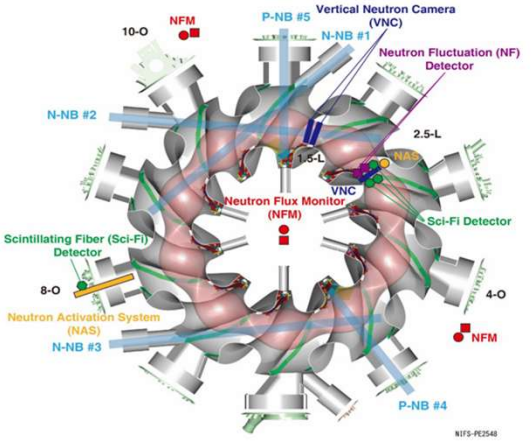
FPCP 2024

AEPSHEP 2024

Fast Ion Study in LHD using Neutron Diagnostics







- A comprehensive set of neutron diagnostics have been operated since 2017.
- **Only NES has been lacking in LHD.**

Generated by NBI/ICRF heating

Neutron to be measured by the compact neutron emission spectroscopy (CNES)

D + ***D*** [fast ion] → ^{3}He + **n [2.45 MeV]** + 3.27 MeV

D + ***D*** [fast ion] → ***T*** [1MeV] + ***p*** [3 MeV] + 4.03 MeV

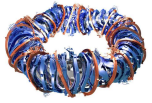
D + ***T*** [1MeV] → ***α*** [3.5 MeV] + **n [14.1 MeV]** + 17.6 MeV

NBI and ICRF heating excites fast ions and MHD instabilities ⇨ Induce further loss of particles ⇨ Reduce fusion burn & damage the first wall ⇨ **Degrade the performance of the reactor !**

International Collaboration Network

IPP-Germany

P. Koschinsky



Wentelstein 7-X

ITER, France

ASIPP, China

G.Q. Zhong

EAST

KFE, Korea

J. H. Kim

J. Jo

NIFS, Japan

SOKENDAI

M. Isobe
Co-PI

K. Ogawa
Co-PI

LHD Facility

Thailand

Exp./Stud.

S. Sangaroon
Principle Investigator

MSU

Exp./Sim./Stud.

A. Wisitsorasak
Co - PI

KMUTT

Sim./Stud.

B. Chatthong
Co - PI

PSU

Sim.

P. Klaywittaphat
Co - PI

TSU

T. Onjun
N. Poolyarat

TINT

Thailand Tokamak-1

E. Takada
NIT Toyama

S. Matsuyama
Tohoku University

I. Murata
Osaka University

S. Murakami
Kyoto University

R & D on pCT

Asst. Prof. Dr. Chinorat Kobdaj

Nuclear and particle physics group
School of Physics, Institute of Science
Suranaree University of Technology

Research Direction

Hardware

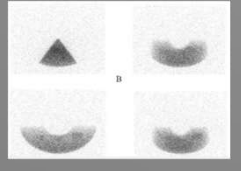
Study and design silicon sensor to be used for proton Computed Tomography (pCT) in diagnostic processes

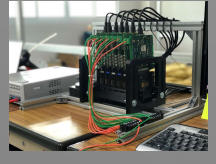
Software

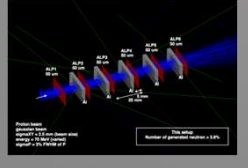
Develop software for image reconstruction from the pCT instrument and software for data acquisition

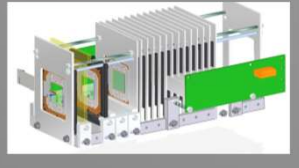
Biological sample

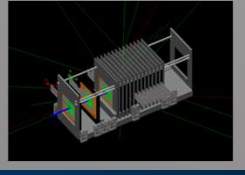
Culture normal and cancer cells to be used as the biological sample for survival distribution measurement











SYNCHROTRON
THAILAND
CENTRAL LAB

Table 2. Major parameters of the storage ring of SPS (in addition to those given in the text.

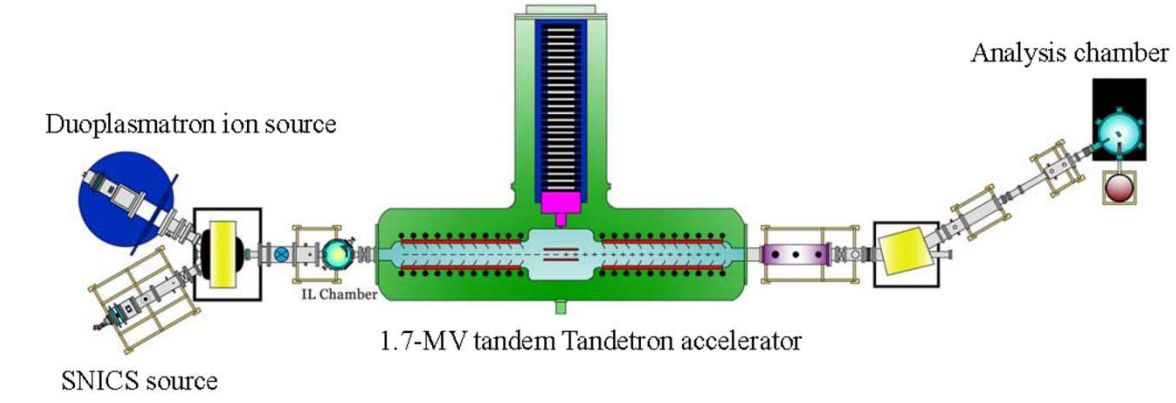
Electron beam energy [GeV]	1.2
Maximum beam current [mA]	120
Horizontal emittance [nm·rad]	41
Coupling [%]	0.8
Betatron tunes ν_x, ν_y	4.75, 2.82
Synchrotron tune ν_s	2.33×10^{-3}
Natural chromaticities ξx, ξy	-9.40, -6.61
Momentum compaction	0.0170
RF frequency [MHz]	118
Harmonic number	32
RF voltage [kV]	120
RF power [kW]	14
Number of RF cavity	1
Energy loss per turn [keV]	65.94

SPS-I

Plasma & Beam Physics Research Facility

Prof. Dheerawan Boonyawan

มหาวิทยาลัยเชียงใหม่
CHIANG MAI UNIVERSITY



. 1. Schematic diagram of the 1.7-MV tandem accelerator and ion beam line for ion beam analysis.

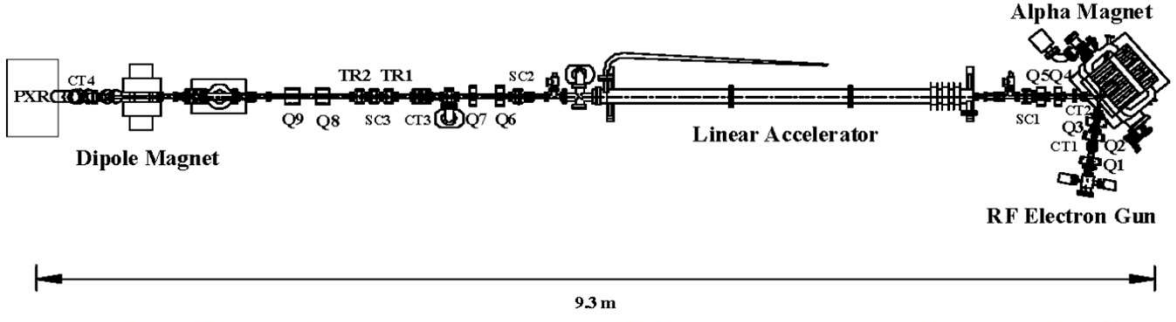


Fig. 5. Schematic layout of the accelerator system at Chiang Mai University for generation of short electron bunches. Q: quadrupole magnet, SC: screen, CT: current monitor, and TR and PXR: transition and parametric X- radiation experimental stations.

สถาบันเทคโนโลยีนิวเคลียร์แห่งชาติ
(องค์การมหาชน)

A/Prof. Sakhorn Rimjaem

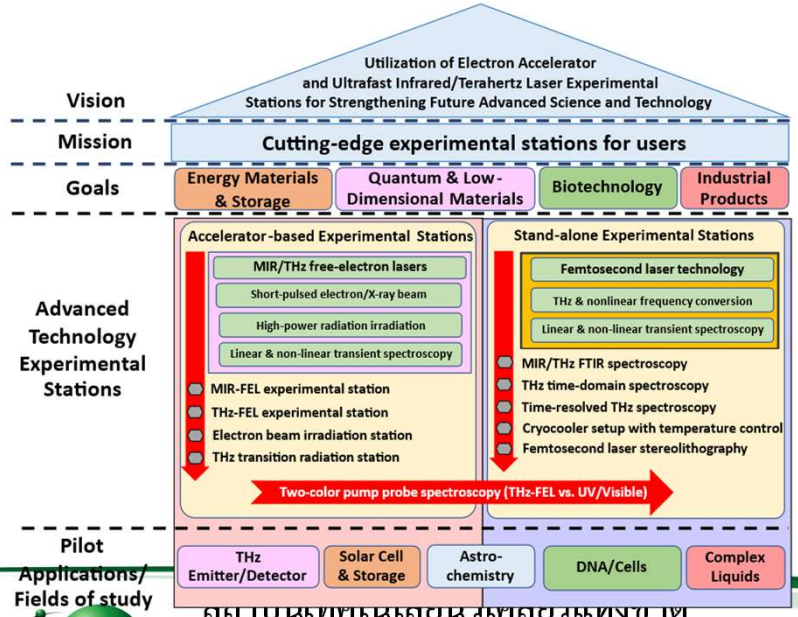
PBP-CMU Electron Linac Laboratory
ห้องปฏิบัติการวิจัยเครื่องเร่งอิเล็กตรอนเชิงเส้น

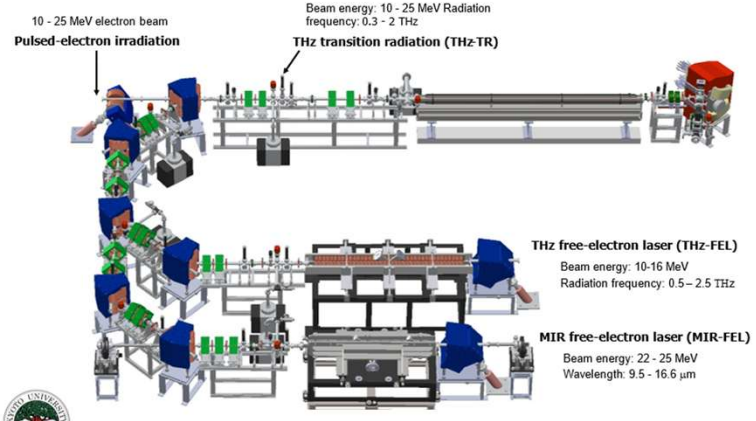
CMU
CHIANG MAI UNIVERSITY

สถาบันเทคโนโลยีนิวเคลียร์แห่งชาติ
(องค์การมหาชน)

Infrared Free-electron Laser Facility at Chiang Mai University

Ultimate Goal:
To establish a central laboratory that utilizes an electron linear accelerator, MIR-THz free-electron lasers, and short-pulse lasers for research and applications in materials science, biomolecular studies, agriculture, and industry.



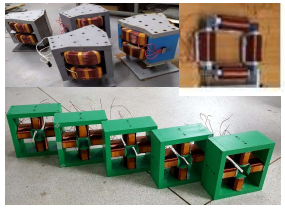


(องค์การมหาชน)

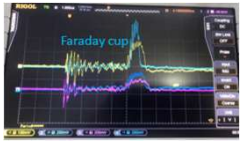
Timeline: Past, Present & Future

2022

- Developed accelerator components



- Generated 14- MeV electron beam



- Designed and constructed components in MIR FEL beamline

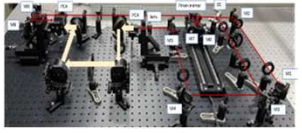
- Designed astrochemistry chamber

2023

- Design and constructed components in THz beamline

- Installation of MIR & THz FEL beamlines

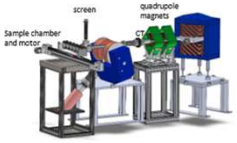
- Designed and construct THz time-domain spectroscopy; THz TDS)



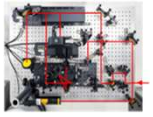
- Constructed astrochemistry chamber

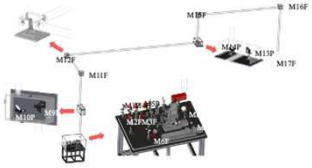
2024

- Design and construct electron beam irradiation station

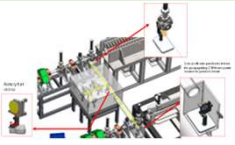


- Design and construct MIR FEL characterization and transportation system





- Design and construct electron bunch length measuring system

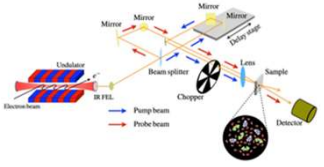


- User service for THz TDS

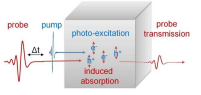
- Construct astrochemistry station

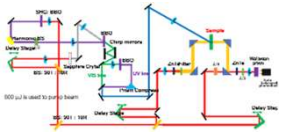
2025 - 2026

- Design and construct MIR-FEL irradiation station and pump-probe experiment



- Design and develop Time-resolved THz spectroscopy (TRTS)

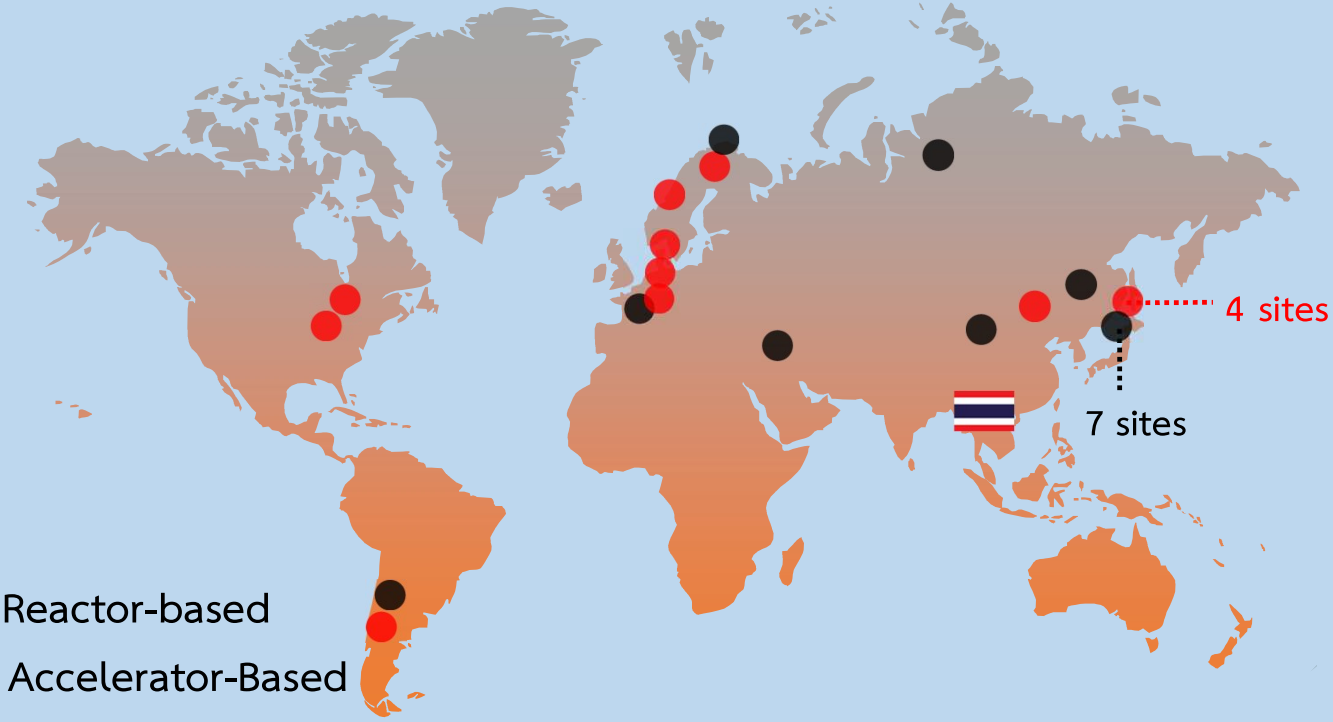


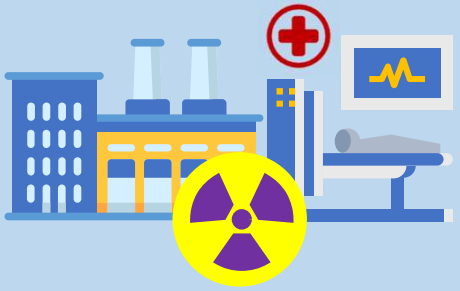


- Users service for MIR & THz FEL experimental stations

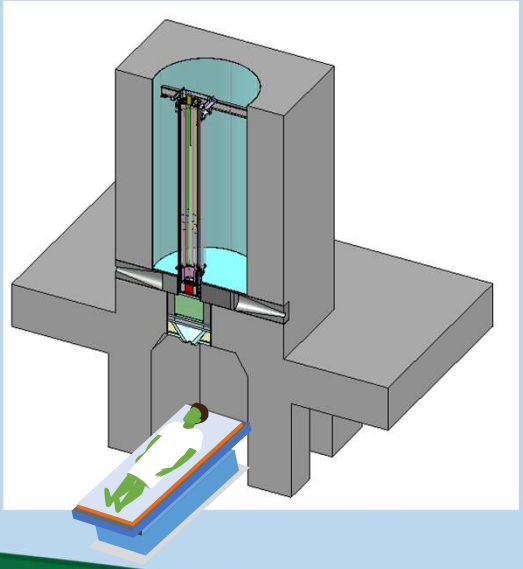
นโลยีนิวเคลียร์
(ยงค์การมหาชน)

BNCT worldwide





SUT-RR



สถาบันเทคโนโลยีนิวเคลียร์แห่งชาติ
(องค์การมหาชน)

THANK YOU

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