

Taiwanese Perspective

Chia-Ming Kuo (NCU, Taiwan)
on behalf of the EIC-Taiwan team

Current/Past Experimental Particle Physics Programs (1/2)

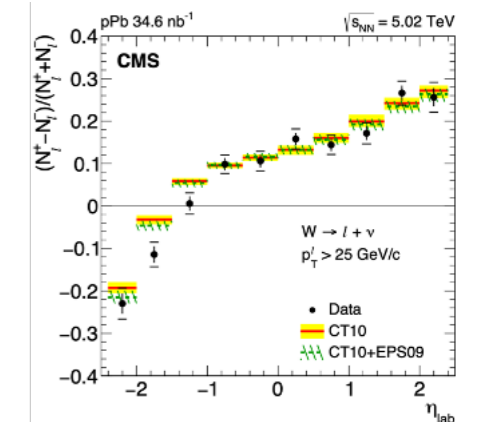
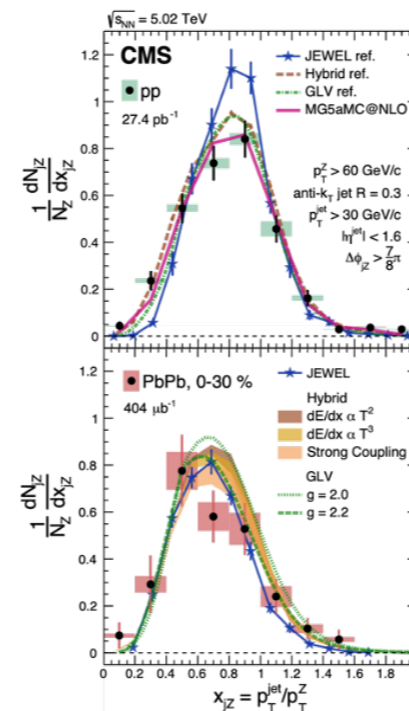
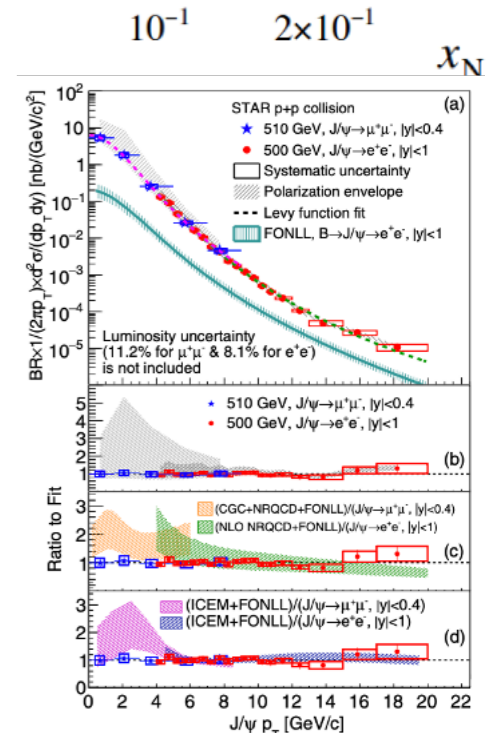
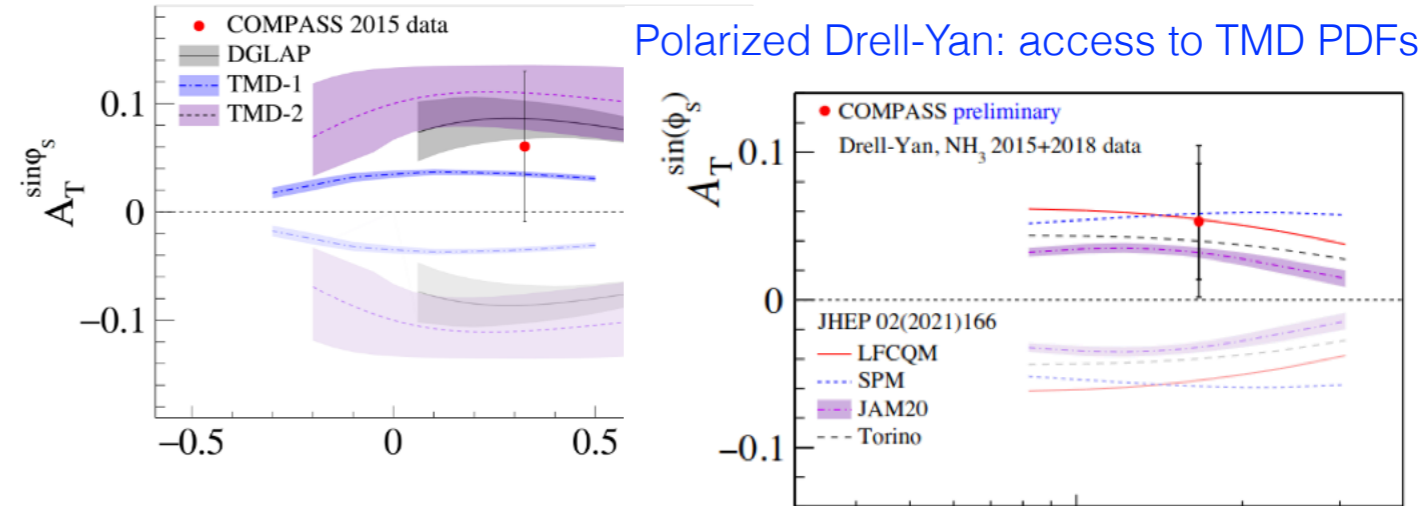
• Hadron Physics:

- LEPS, LEPS2 @ Spring8 (2000 -)
- E906/SeaQuest @ FNAL (2009 - 2017)
- COMPASS @ CERN (2012 - 2022)
- E16, E50 @ J-PARC (2017 -)

• Heavy Ion Physics:

- PHOBOS @ BNL (1994 - 2004)
- PHENIX @ BNL (1997 - 2015)
- STAR @ BNL (2015 -)
- sPHENIX @ BNL (2018 -)
- CMS @ CERN (1999 -)

TMD Sivers Asymmetry in Drell-Yan



Current/Past Experimental Particle Physics Programs (2/2)

- **High Energy Physics:**

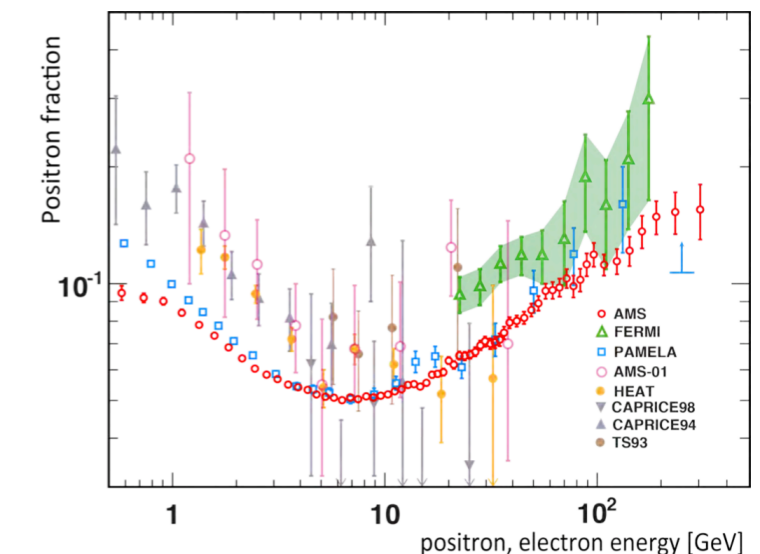
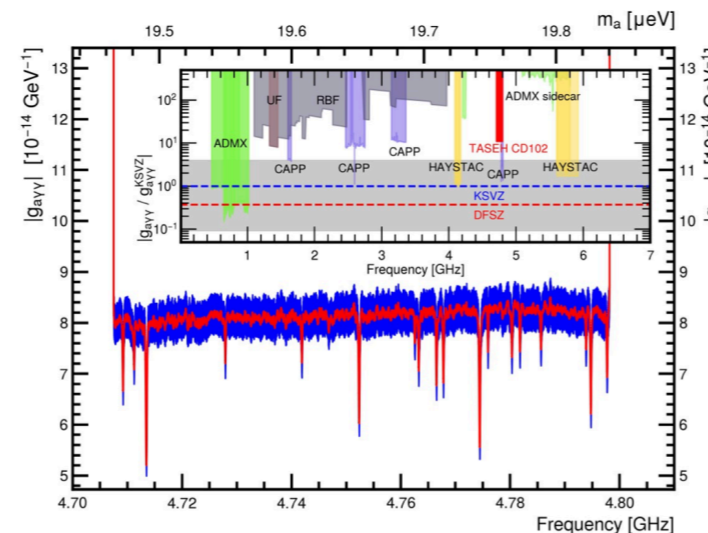
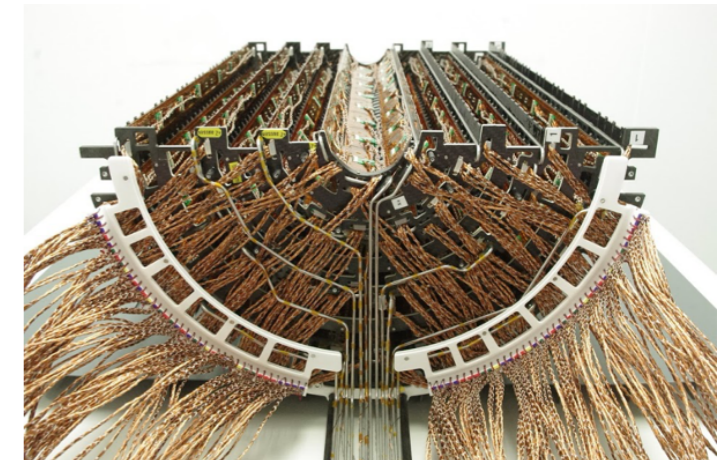
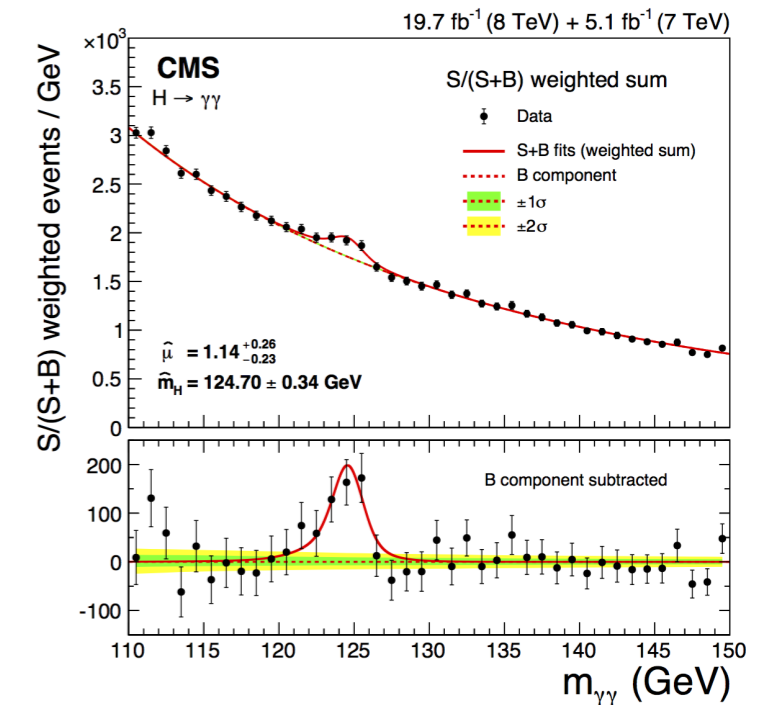
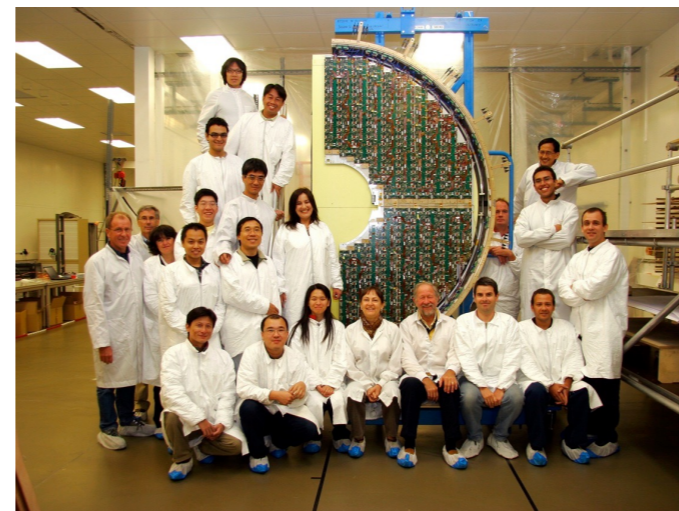
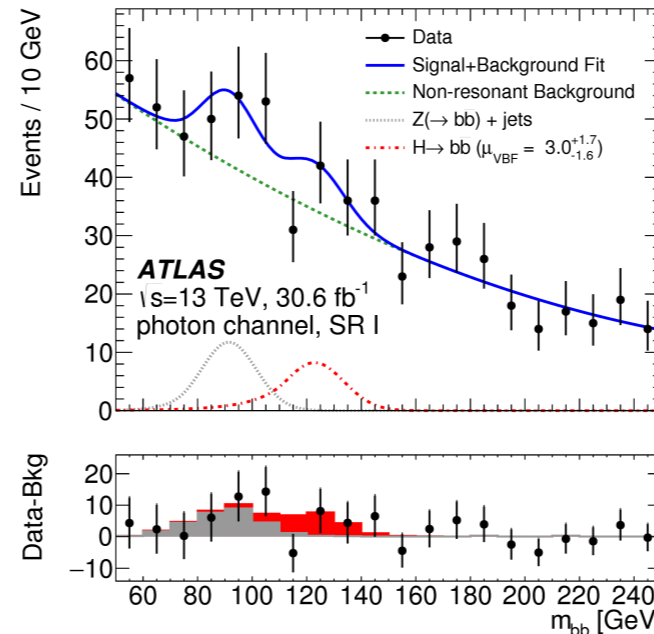
- Belle, Belle II @ KEK
- CDF @ FNAL
- ATLAS, CMS @CERN

- **Astroparticle physics:**

- AMS @ ISS/CERN

- **Neutrino/Dark Matter Physics:**

- TEXONO @ KSNL, Taiwan
- CDEX @ CJPL
- Daya Bay, JUNO @ Hong-Kong
- TASEH @ Taiwan



Towards a common project for all Taiwanese groups

- At the end of 2017, all young PIs signed a letter of intent to reach a consensus on future selection
- In spring 2020, a white paper was submitted to National Science and Technology Council (NSTC)
 - main objective: plan for common detector facilities, i.e. Taiwan Instrumentation and Detector Consortium (TIDC)
- In October 2020, the five major experimental particle physics groups in Taiwan signed the EIC EOI

ePIC will be the first experimental project in which major Taiwanese groups collaborate

Workshops and school

TIDC EIC Workshop

August 18–19, 2022
Department of Physics, NCKU, Tainan, Taiwan

Agenda: <https://indico.phys.sinica.edu.tw/event/52/>

Invited Speakers:
Chung-Wen Kao (CYCU)
Hsiang-nan Li (AS)
Po-Ju Lin (AS)
Jen-Chieh Peng (UIUC)
Zhenyu Ye (UIC)
Rong-Hwei Yeh (Asia Univ.)

Organizers:
Wen-Chen Chang (AS)
Chia Ming Kuo (NCU)
Rong-Shyang Lu (NTU)
Yi Yang (NCKU)

Sponsors
Ministry of Science and Technology (MOST)
Taiwan Instrumentation Detector Consortium (TIDC)
National Cheng Kung University (NCKU)
Department of Physics, NCKU



2022/8 @ NCKU

THE 2ND TIDC EIC WORKSHOP

January 3, 2023
Institute of Physics, Academia Sinica

Registration Deadline **December 15, 2022**

INVITED SPEAKERS
✓ Jiunn-Wei Chen (NTU)
✓ Chia-Yu Hsieh (AS)
✓ David Lin (NYCU)
✓ Po-Ju Lin (AS)
✓ Cheng-Wei Shih (NCU)
✓ Rong-Hwei Yeh (Asia Univ.)

ORGANIZERS
Wen-Chen Chang (AS)
Chia Ming Kuo (NCU)
Rong-Shyang Lu (NTU)
Yi Yang (NCKU)

SPONSORS
Taiwan Instrumentation and Detector Consortium
Institute of Physics, Academia Sinica
Division of Particles and Fields, The Physical Society of Taiwan

Info & Registration
<https://indico.phys.ntu.edu.tw/Workshops/activities/2023-eic-workshop/>

Contact Us
02-33668648
chhuang@phys.ntu.edu.tw

January 3, 9 AM to 6 PM
Conference Room 1, 5F, Institute of Physics, Academia Sinica



2023/1 @ IPAS

NCU workshop on EIC physics and detectors

12/9 2022
Fri.

National Central University

Organization Committee:

Jen-Chieh Peng (UIUC/NCU),
Wen-Chen Chang (AS),
Chia-Ming Kuo (NCU)



- We will host an EIC summer school from August 28th to 30th 2023 at NTU
- international participation is very welcome
- We would like to host the East-Asia EIC meeting in November 2023

EIC Taiwan team



- **Academia Sinica**

- Wen-Chen Chang, Hsiang-Nan Li, Di-Lun Yang, Suen Hou, Chih-Hsun Lin

- **National Taiwan University**

- Rong-Shyang Lu, Kai-Feng Jack Chen, Stathes Paganis, Juinn-Wei Chen

- **National Central University**

- Jen-Chieh Peng (UIUC/NCU), Chia-Ming Kuo

- **Chung Yuan Christian University**

- Chung-Wen Kao

- **National Tsing Hua University**

- Pai-Hsien Jennifer Hsu

- **National Yang-Ming Chiao-Tung University**

- C.-J. David Lin, Anthony Francis

- **National Cheng Kung University**

- Yi Yang

10 experimental PIs/6 theoretical PIs

Physics interests

- Preliminary ideas**

- Pion and Kaon PDFs** (tagged-DIS; sec. 7.1.3 of YR)

- W.C. Chang, J.W.Chen, C.W. Kao, D. Lin

- GPDs** (DVCS, TCS, DVMP; sec. 7.2.2 of YR)

- P.J. Lin, J.W. Chen, C.W. Kao

- CGC** (di-jet, di-hardon DIS, $e+A \rightarrow e'+A'+J/\psi, \phi, \rho, \dots$; sec. 7.3.1 and 7.3.9 of YR)

- C.M. Kuo, H.N. Li

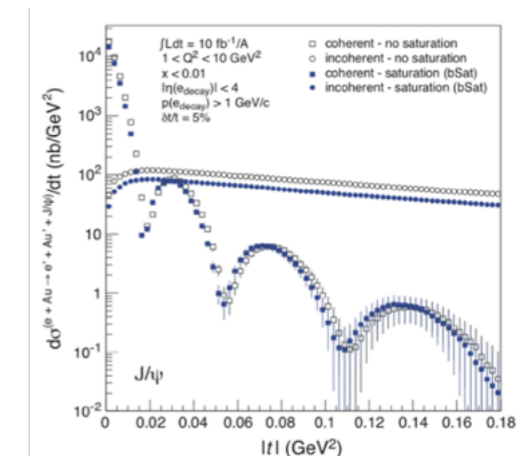
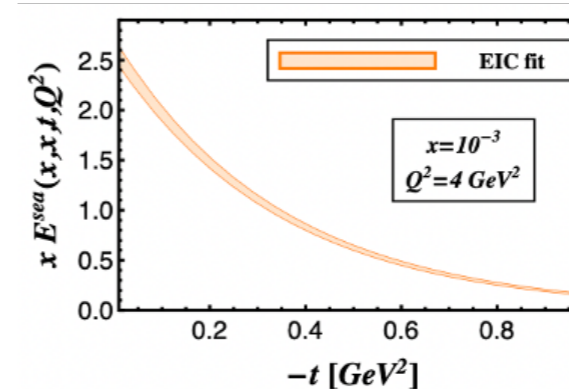
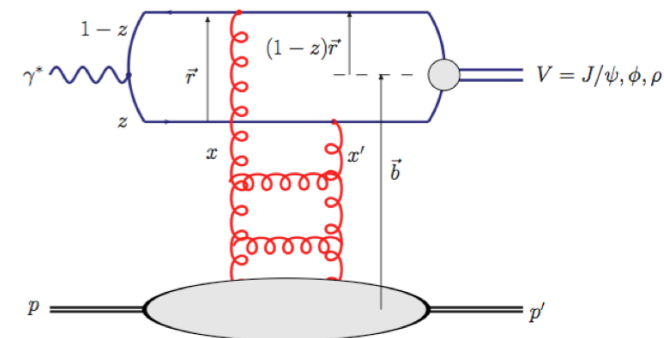
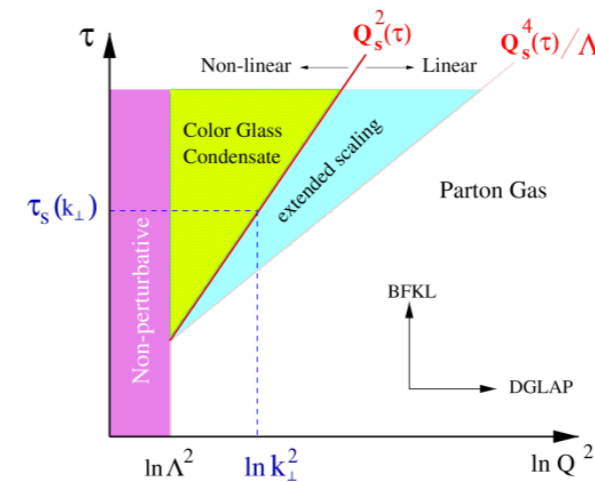
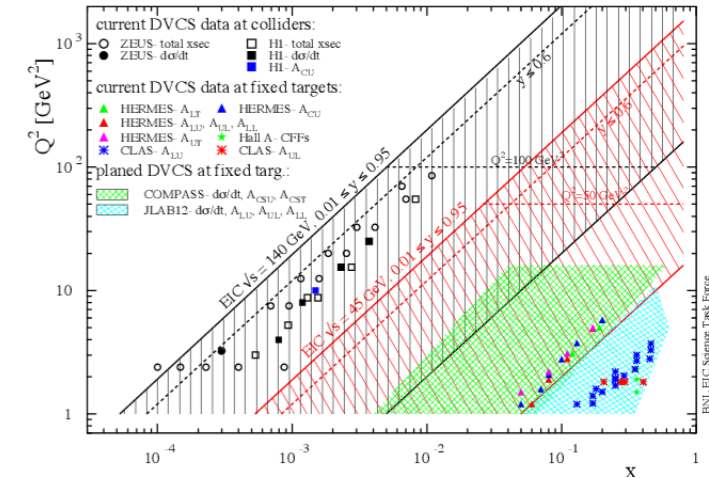
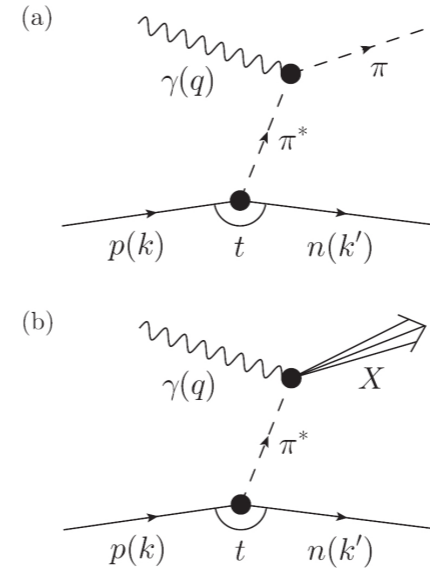
- hard probes** (jet, heavy quarks; sec. 7.3.6 of YR)

- Y. Yang

- Initial simulation studies associated with target jet structure under ep and/or EIC environment** (sec. 7.1.6 of YR)

- K. F. Chen, Y. T. Chien

- DIS2023 talk:
<https://indico.cern.ch/event/1199314/contributions/5188249/>



Theoretical programs

- QCD effective theories and lattice QCD
- Parton distributions functions
- Aspects of atomic and nuclear physics in particle-matter interactions

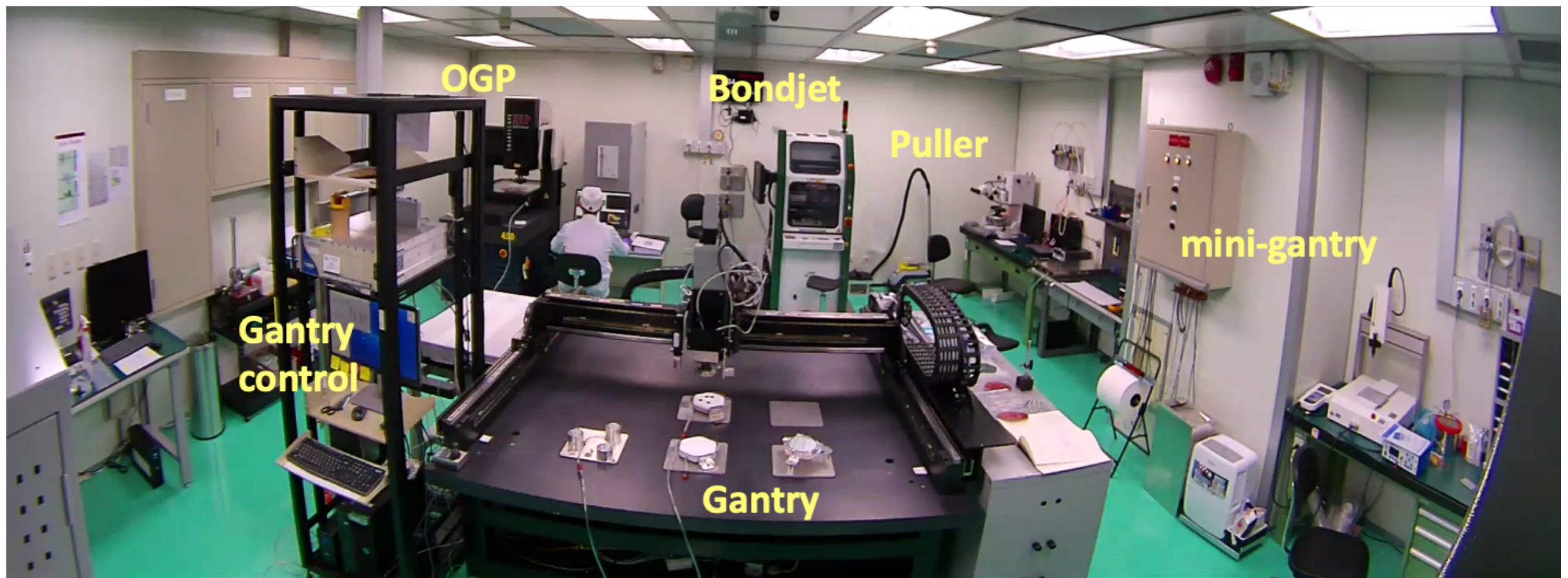


Taiwan Instrumentation and Detector Consortium (TIDC)

- TIDC was established in 2019 and became an official core facility of NSTC in 2022
- website: <https://tidc.phys.ntu.edu.tw/WordPress/>
- facilities are distributed among four institutes (**NTU**, AS, NCU, NCKU)
- Projects:
 - **CMS HGCal**
 - **one of six module assembly centers (5000 modules)**, silicon QC, production of HD/LD hexabaroads and DC-DC converters
 - **sPHENIX INTT**
 - assembled 1/3 (40) of silicon ladders
 - **STAR forward silicon tracker**
 - assembled the mechanical structure and bond hybrid PCBs
 - **AMS silicon strip tracker**
 - bond hybrid PCBs



Taiwan Silicon Detector Facility (TSiDF) @ NTU

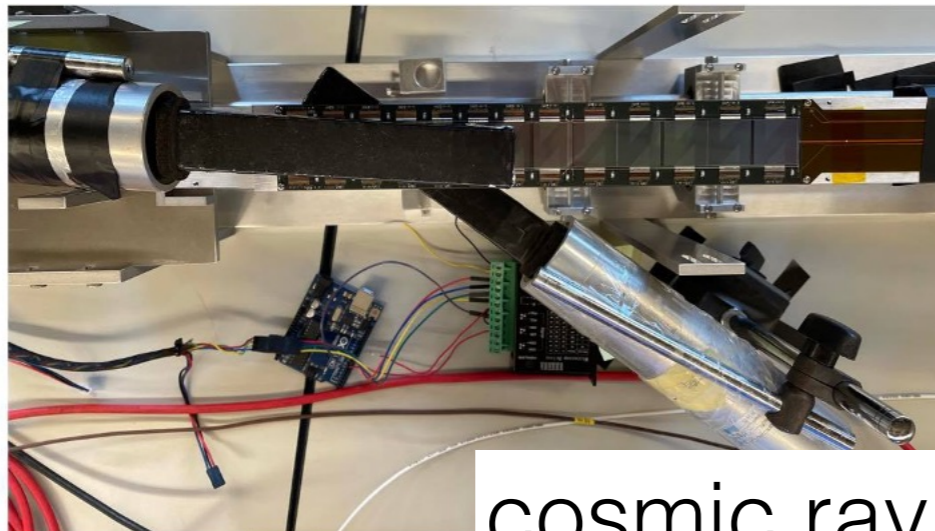
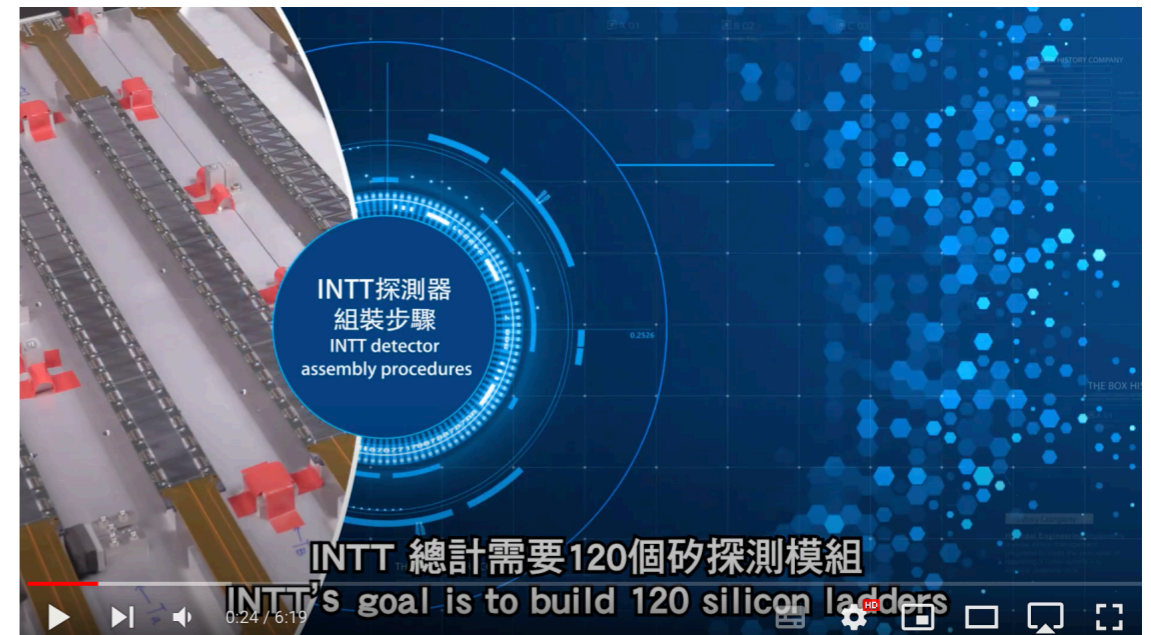
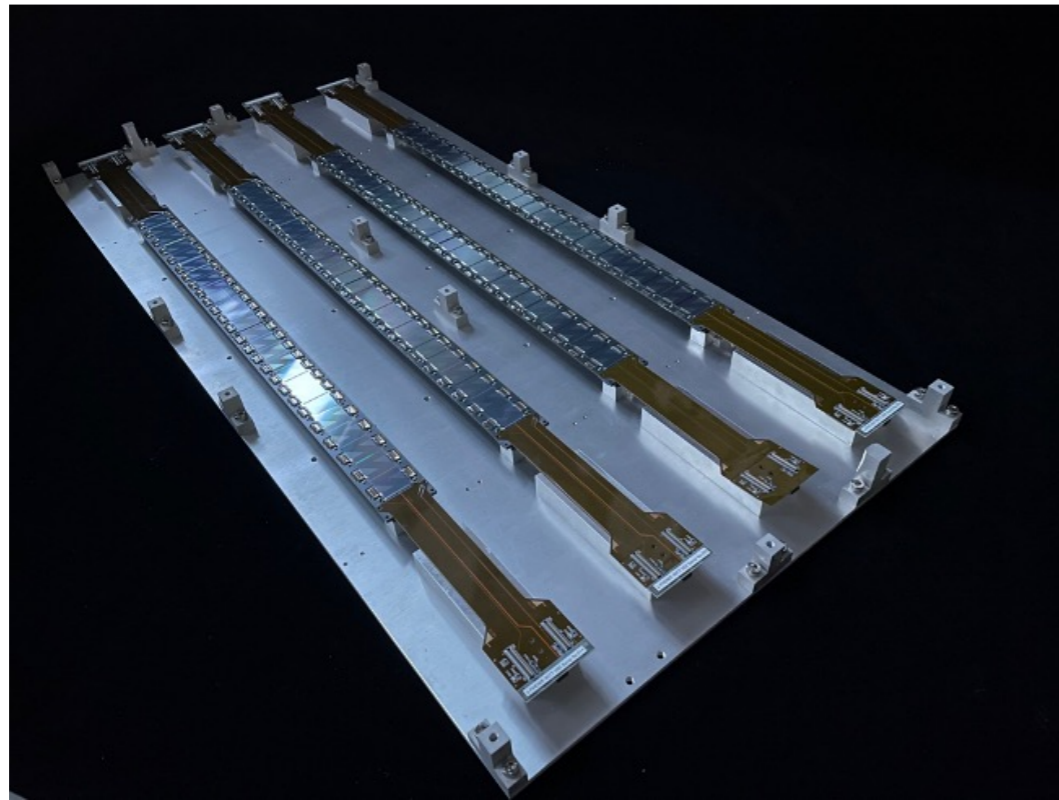


- TIDC's main facility; final detector assembly is performed here

Busy time at TSiDF

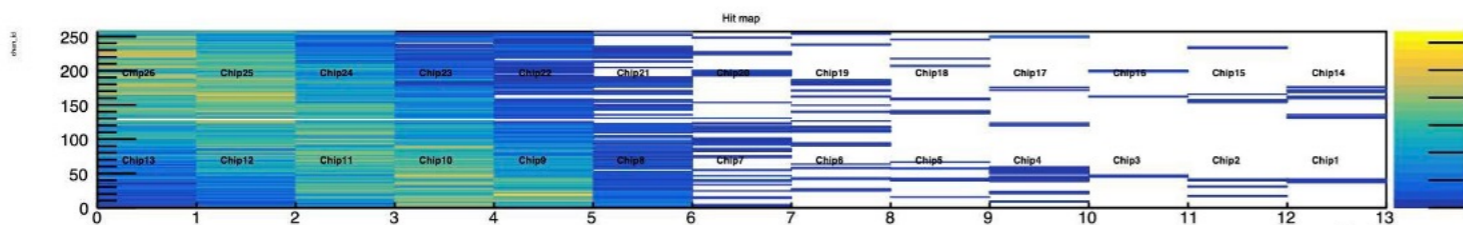


sPHENIX silicon ladder assembly @ TSiDF



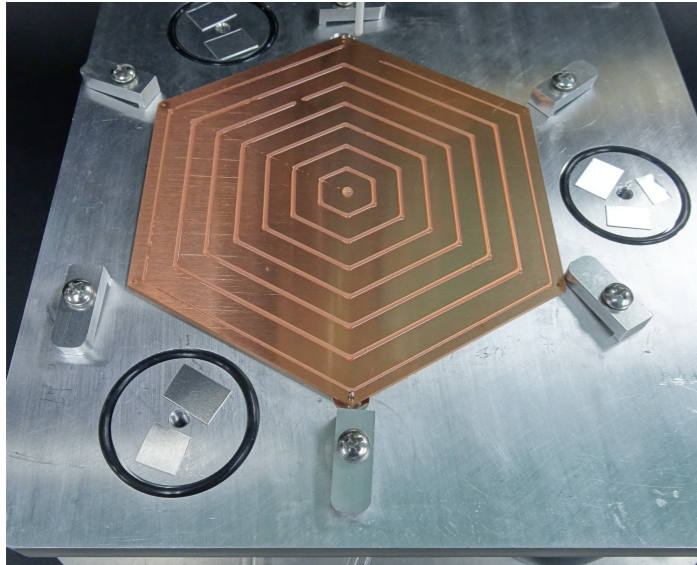
cosmic ray test

Assembly video: [link](#)

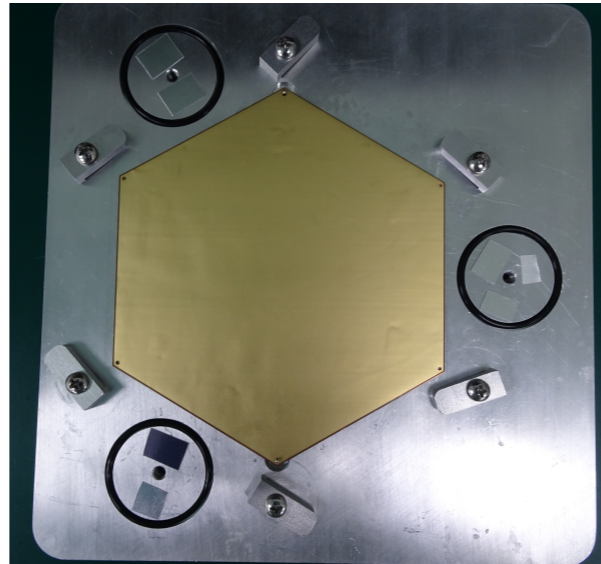


CMS HGCal module assembly @ TSiDF

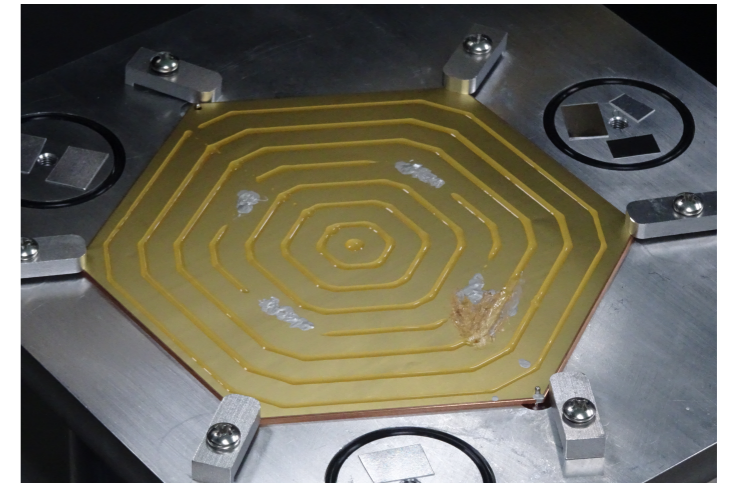
1. Deposit expose on Cu baseplate



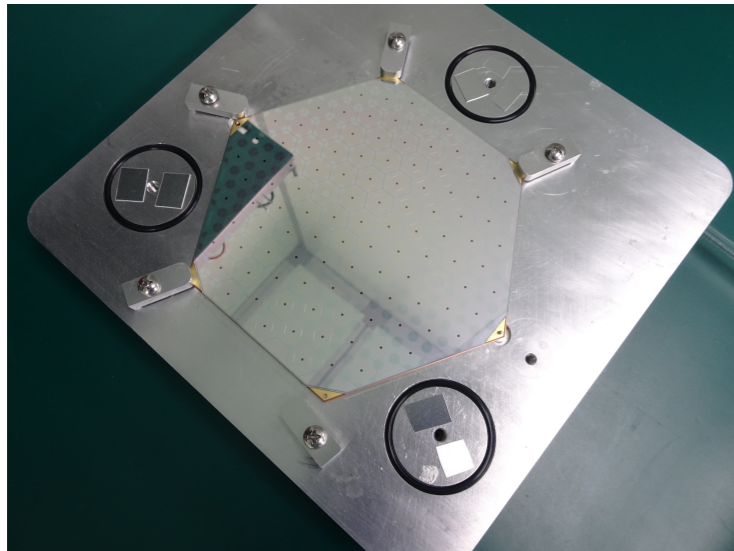
2. Place gold-plated Kapton film



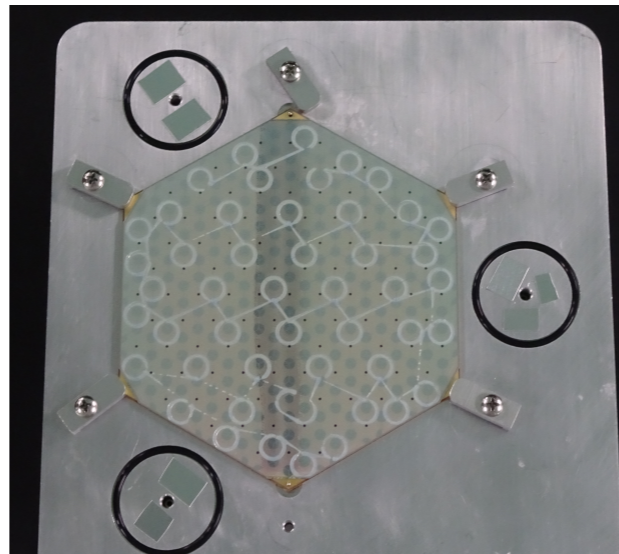
3. Deposit epoxy and silver epoxy on Kapton



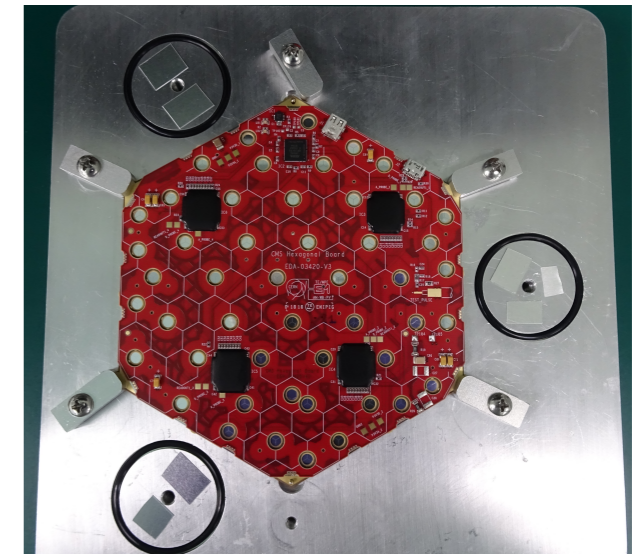
4. Place sensor on top of Kapton



5. Deposit epoxy on sensor, avoiding opening bond pads

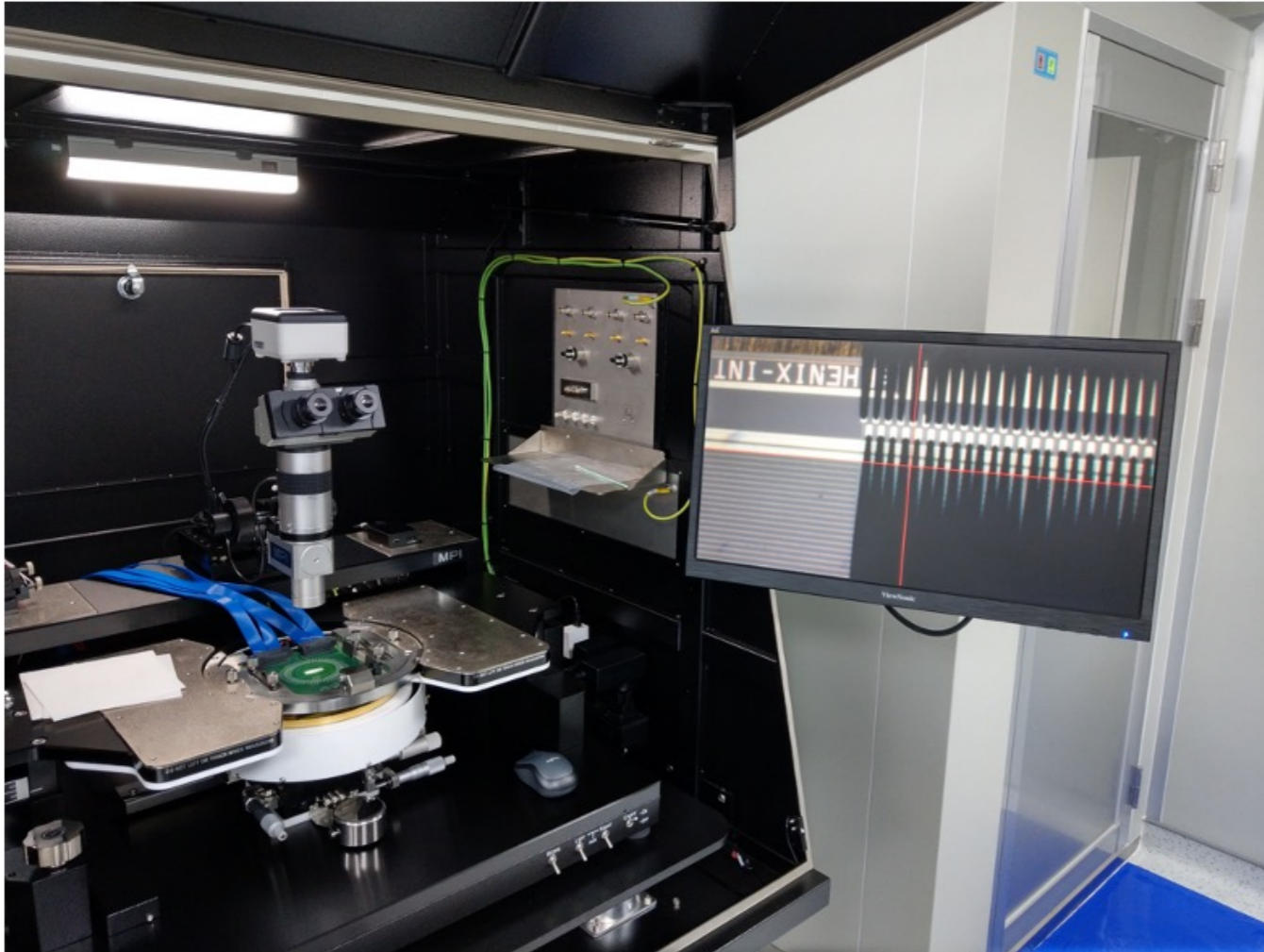


6. Place PCB on top of sensor

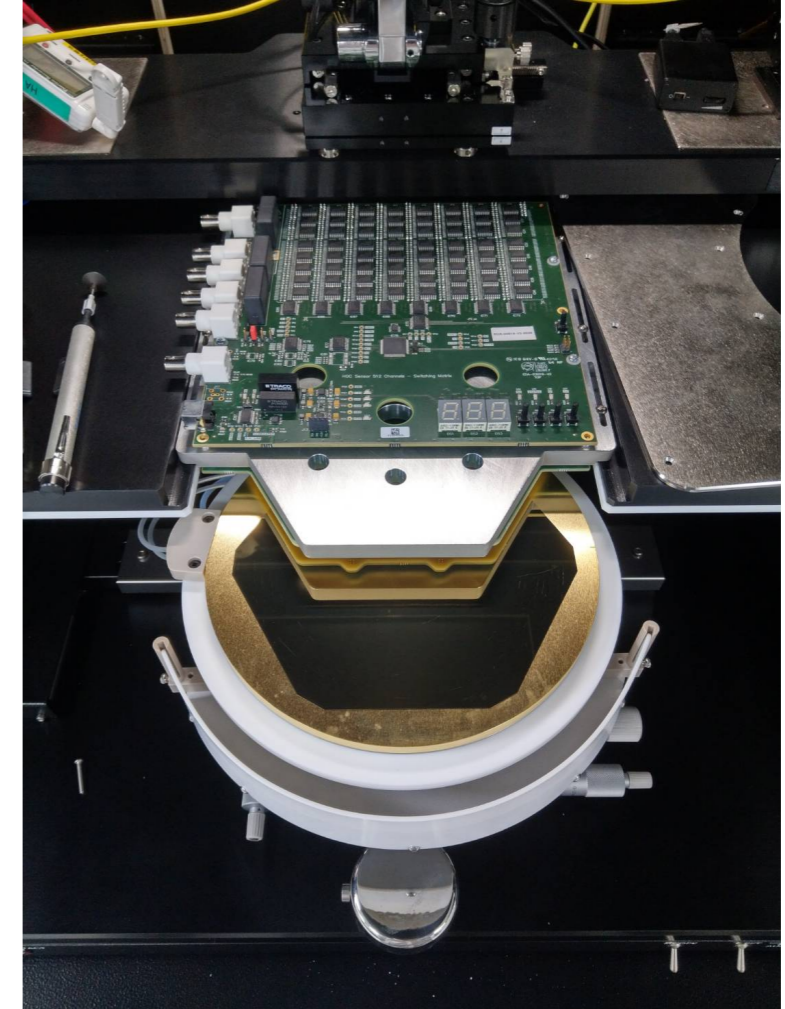


Assembly video: [link](#)

Silicon Sensor QC @ NCU



All sPHENIX silicon sensors
were measured here



CMS HGCal SQC

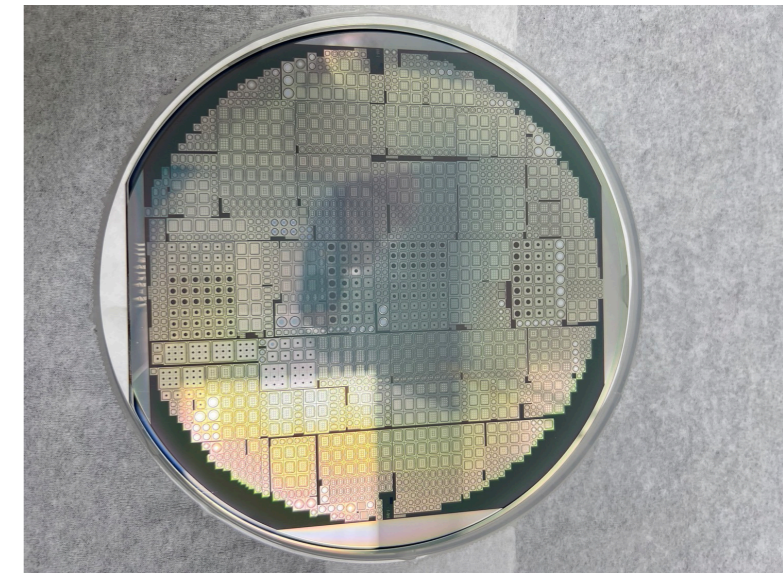
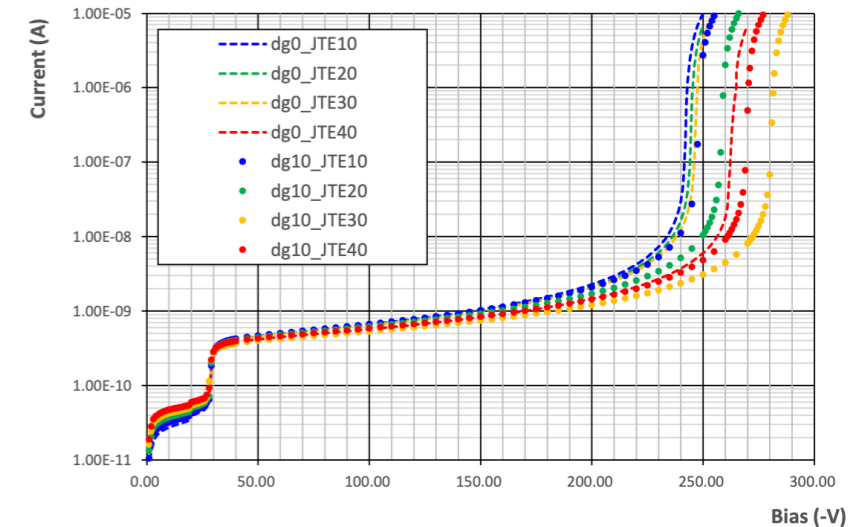
High precision machine shop @ AS



- All assembly tools are produced here

EIC-Taiwan detector activity 1: LGAD sensor R&D

- started with DC-LGAD
- TCAD simulation used to decide the LGAD sensor process parameters
- first goal: verify sensor process flow and TCAD simulation
- first batch of production with TSRI finished at the end of 2022
- the electrical performance of sensors is being carried out

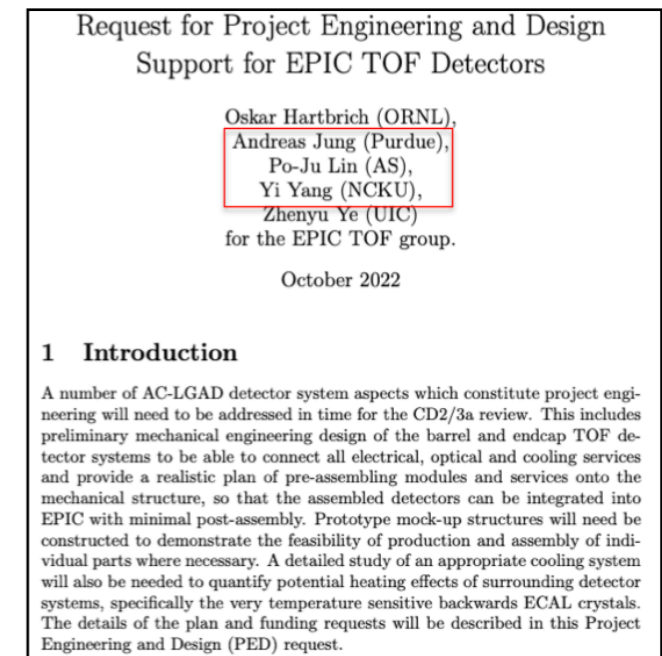
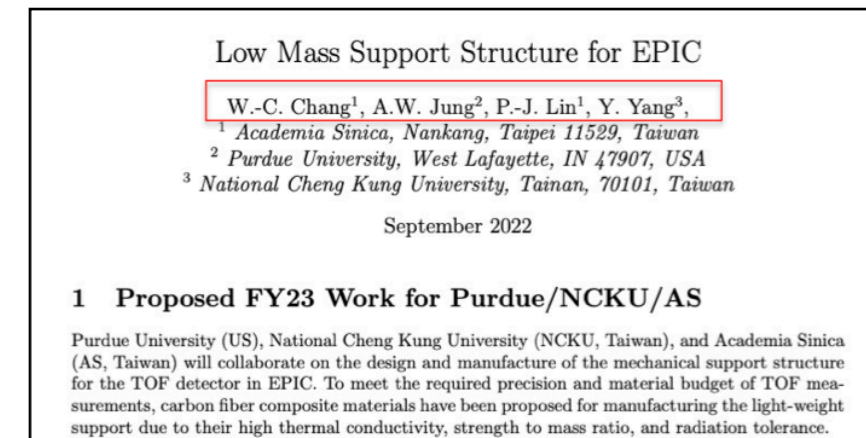


more details in Rong-Shyang Lu's talk

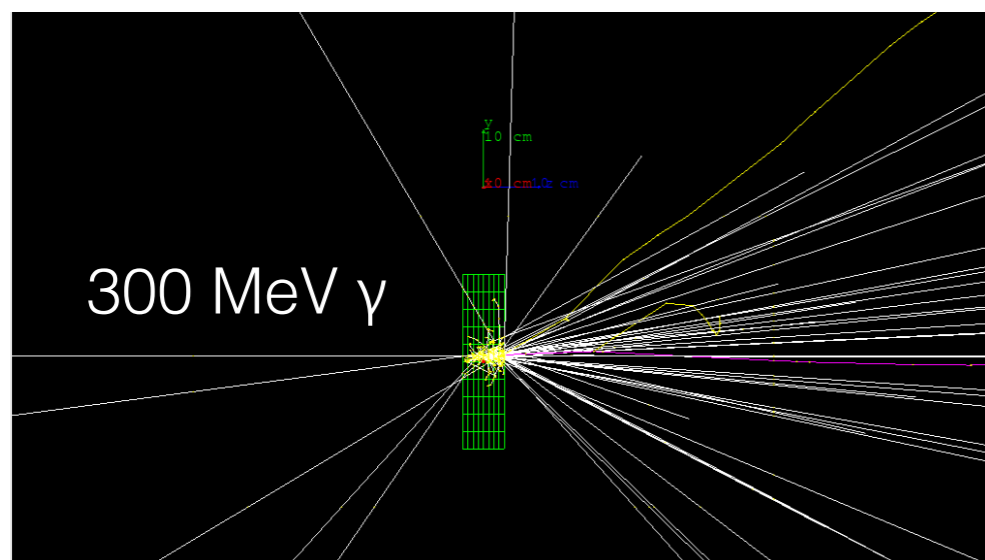
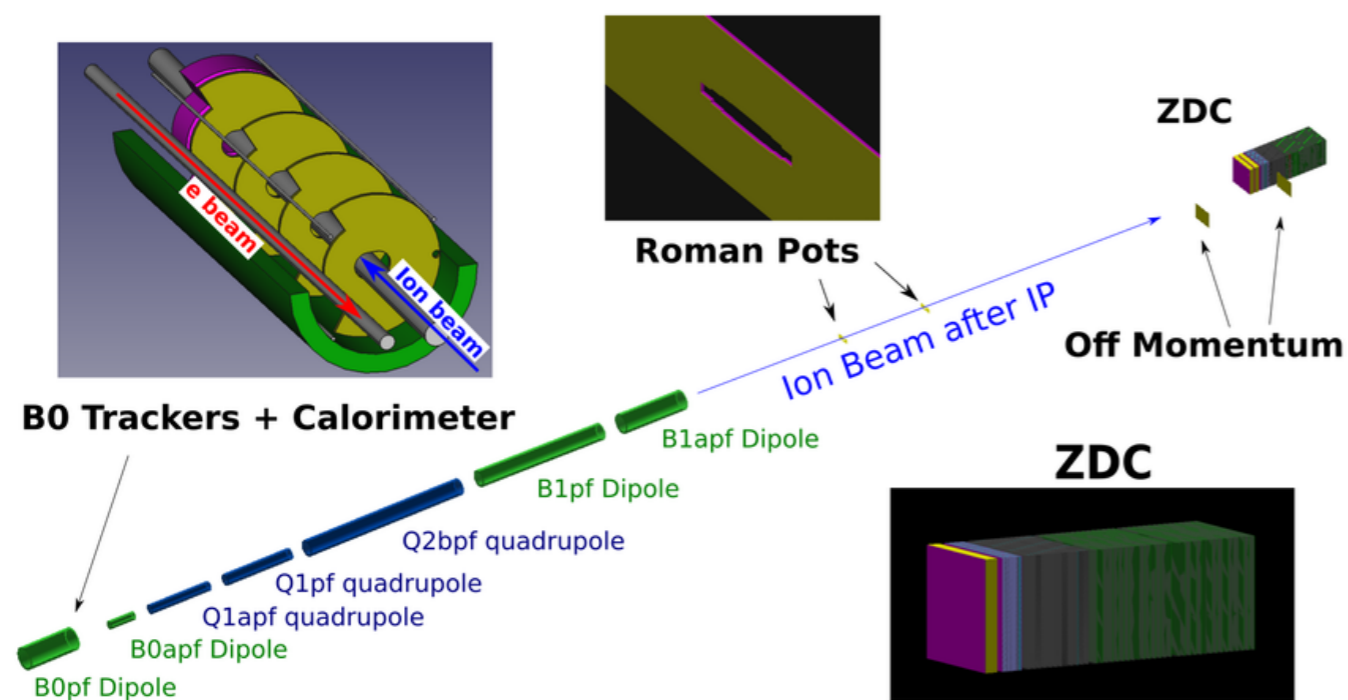
EIC-Taiwan detector activity 2: Mechanical structure for Barrel TOF

- similar concept of STAR IST
- rather long support (1.35m) with minimal deflection
 - R&D with carbon fiber composite materials
- NCKU/AS and Purdue University will collaborate
- project engineering and design (PED) will be carried out

more details in Yi Yang's talk



EIC-Taiwan detector activity 3: ZDC

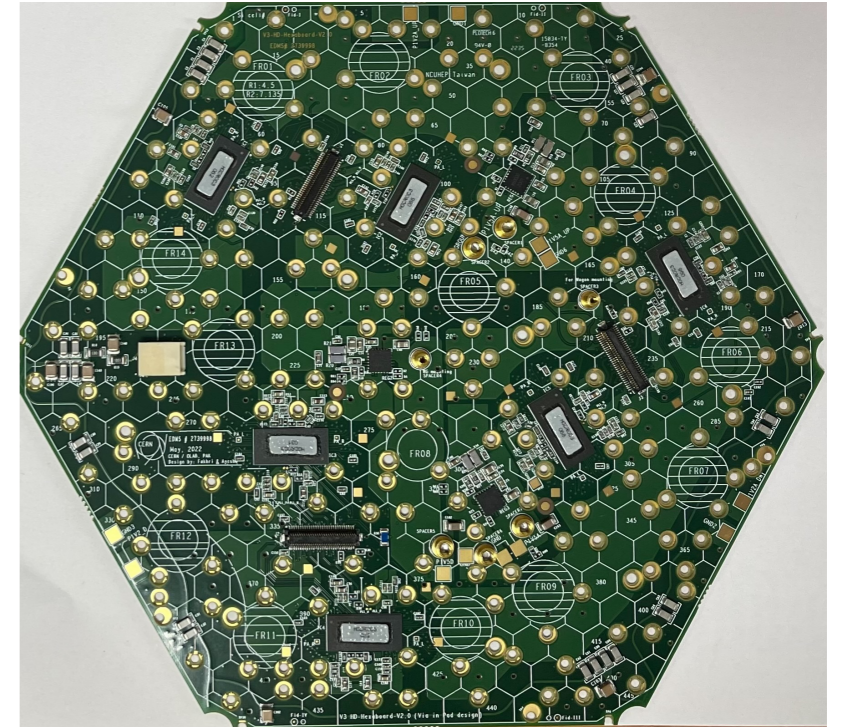


- interested in contributing to ZDC with building an EMCal prototype with LYSO
- physics motivations: meson structure/CGC/...
- LYSO producer: Taiwan Applied Crystal
- NTU has been working on studies with LYSO LY and timing with SiPM
- in contact with CMS experts to understand the use of SiPM up to 2×10^{14} n/cm²
- funding situation will be clear in April
- Po-Ju Lin is picking up simulation work from Shimizu-san
- started working on standard alone G4 simulation
- experience with PbWO₄ calibration at CMS ECAL

more details tomorrow

Other possibilities

- **Optical readout (fiber-optics)**
 - Taiwan opto-electronics companies contribute to ATLAS upgrades
- **PCB production and assembly**
 - CMS HGCal HD hexaboards
 - DC-DC converters
- **Computing (ASGC)**
 - Academia Sinica Grid Computing Center
 - **ATLAS T1/T2/T3, CMS T1/T2/T3**
 - ~30K CPU cores/ 128 GPU boards/ >9 PB storage



Funding situation

- **EIC has not yet formally funded in Taiwan**

- current activities are mainly funded by personal research grants (non-EIC projects)
- The funding cases are usually bottom-up in Taiwan
 - NSTC is aware that the EIC will be a common project among experimental particle physicists in Taiwan

- **Towards funding EIC-Taiwan**

- physics motivation and detector projects
 - depending on the level of funding we need and the importance of the project
 - sign special MOU so that dedicated grants (such as Taiwan's contributions to the LHC phase-2 upgrade – CMS HGCal/ATLAS HGTD)
 - apply to special grants (3-5 years)
 - rely on personal EIC grant (but it's difficult to make significant contributions to detector projects)
 - additional support from other funding source such as higher education sprout project funded by Ministry of Education

Summary

- We started to form the EIC Taiwan group, including experimentalists and theorists
- On-going detector R&D projects for EIC
 - LGAD sensor R&D, mechanical support for barrel TOD, ZDC
- Other possibilities: detector assembly with TIDC, computing, and so on
- Over the next few years, we will try to identify projects and prepare funding applications