Report of MHEP-EXP Group

2025 IOP Retreat

December 19th, 2025

https://indico.phys.sinica.edu.tw/event/364/

MHEP-EXP (7+2)

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王子敬

Suen Hou
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Wen-Chen Chang
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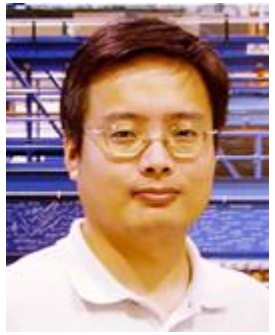

Song-Ming Wang
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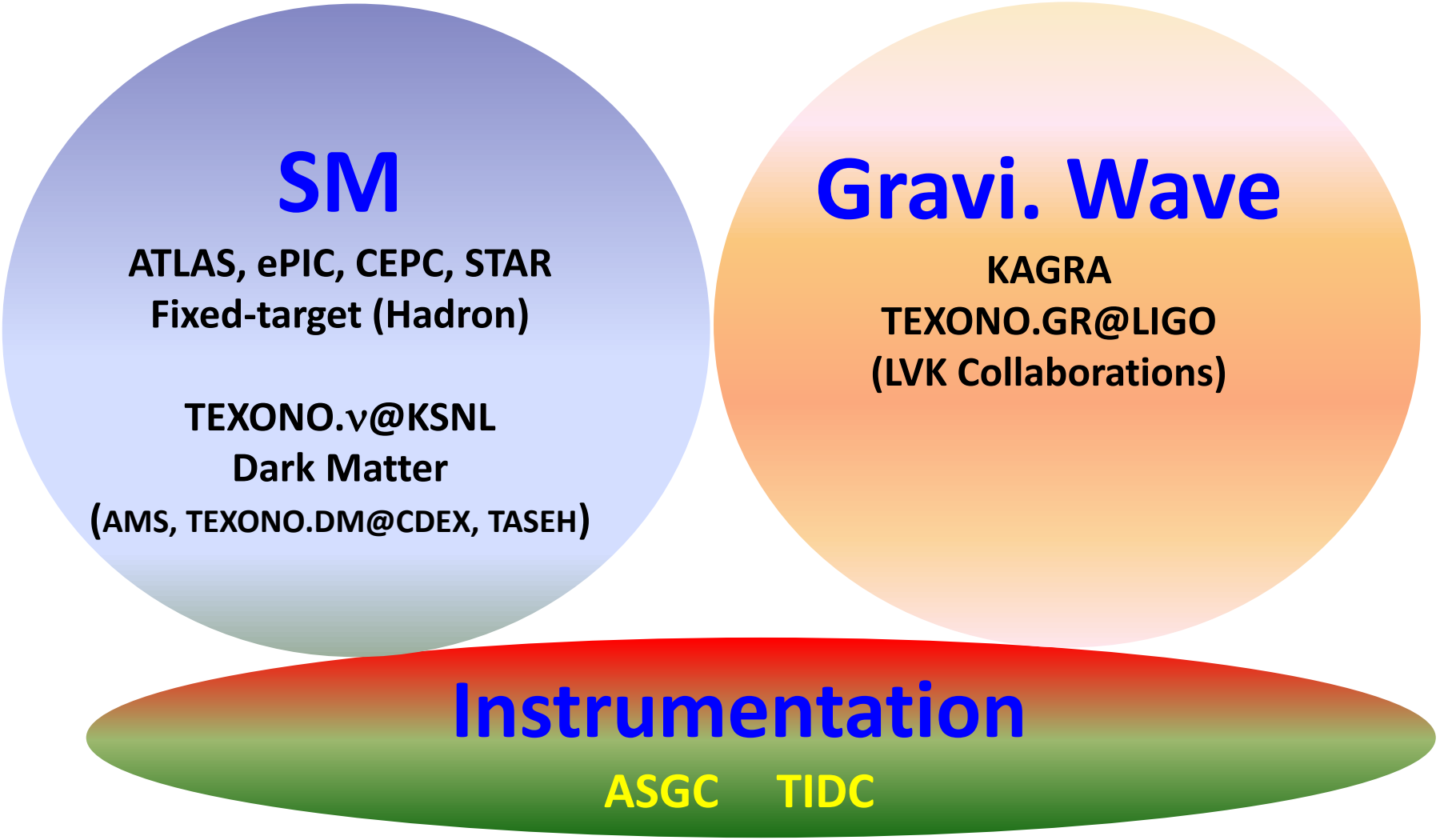
MHEP-EXP


SM
ATLAS, ePIC, CEPC, STAR
Fixed-target (Hadron)
TEXONO.ν@KSNL
Dark Matter
(AMS, TEXONO.DM@CDEX, TASEH)
Gravi. Wave
KAGRA
TEXONO.GR@LIGO
(LVK Collaborations)
Instrumentation
ASGC TIDC

Institute of Physics, Academia Sinica
MHEP-EXP

Collider Physics
Search for new particles and new physics

ATLAS
1999 ~
S.M. Wang/ S. Hou /Y. Yang

CEPC – Higgs factory
S. Hou

Hadron Physics
probing nucleons by GeV photons and hadrons

LEPS, SeaQuest, COMPASS, J-PARC
1999 ~
W.C. Chang

STAR 2024 ~
Y. Yang
ePIC 2022~
Y. Yang / W.C. Chang

Astroparticle Physics
Study cosmic-rays, search for anti-matter, dark matter

AMS
1995 ~
S. Haino/ Y.H. Chang /Y. Yang

Neutrino & Dark Matter
With low energy detectors

TEXONO
1996 ~
H.T. Wong

Gravitational Wave
New tool to study the universe

World wide GW detector network (LVK)
KAGRA **2016 ~** *S. Haino*
LIGO **2021 ~** *H.T. Wong*

Axion & Dark Matter
DM searches with micro-wave cavity

TASEH
2020 ~
Y.H. Chang + QMP

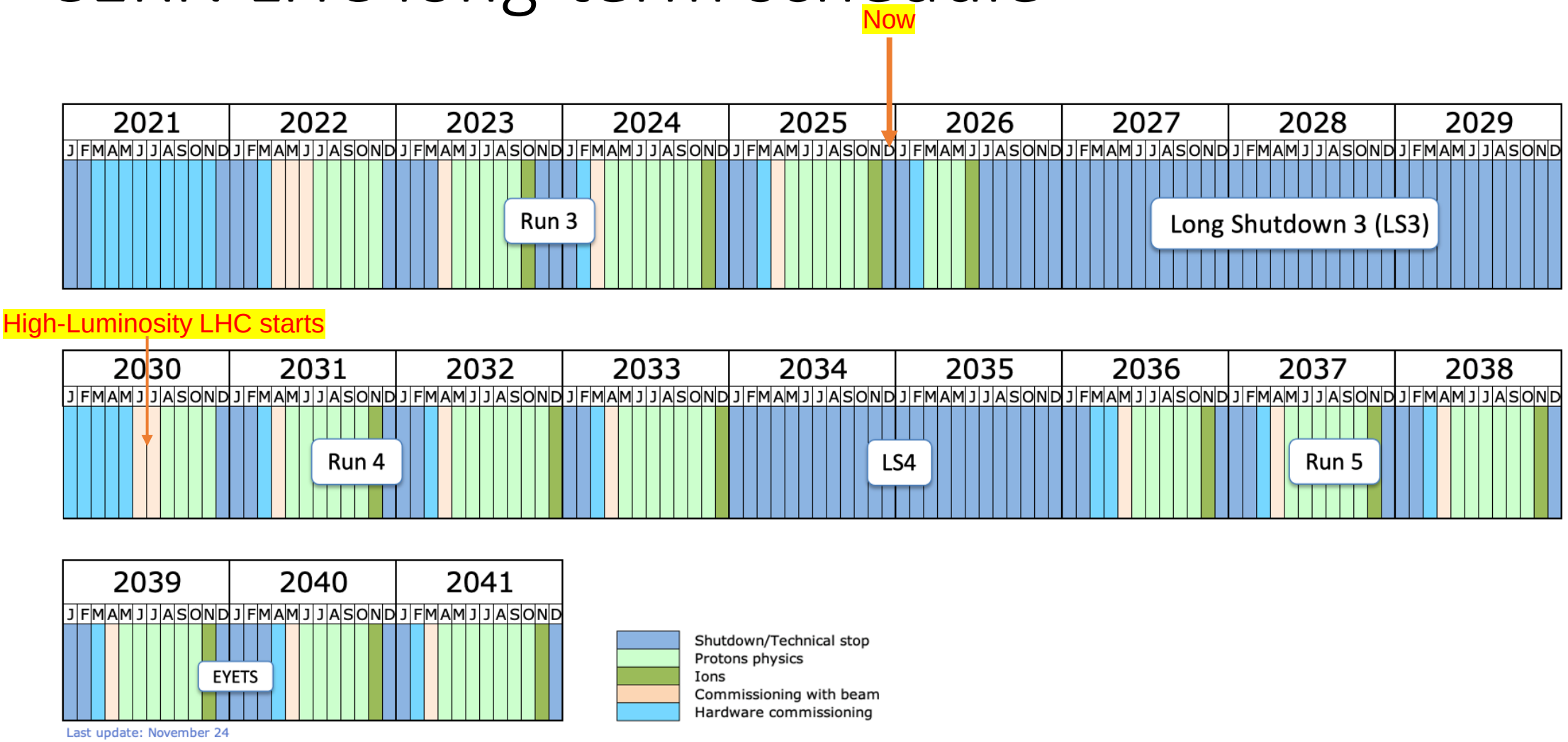
Experimental support
Detectors Construction & Applications

Instrumentation
TIDC
C.H. Lin/ Y.H. Chang

ASGC (Academia Sinica Grid Computing Center)
From HEP to e-Science

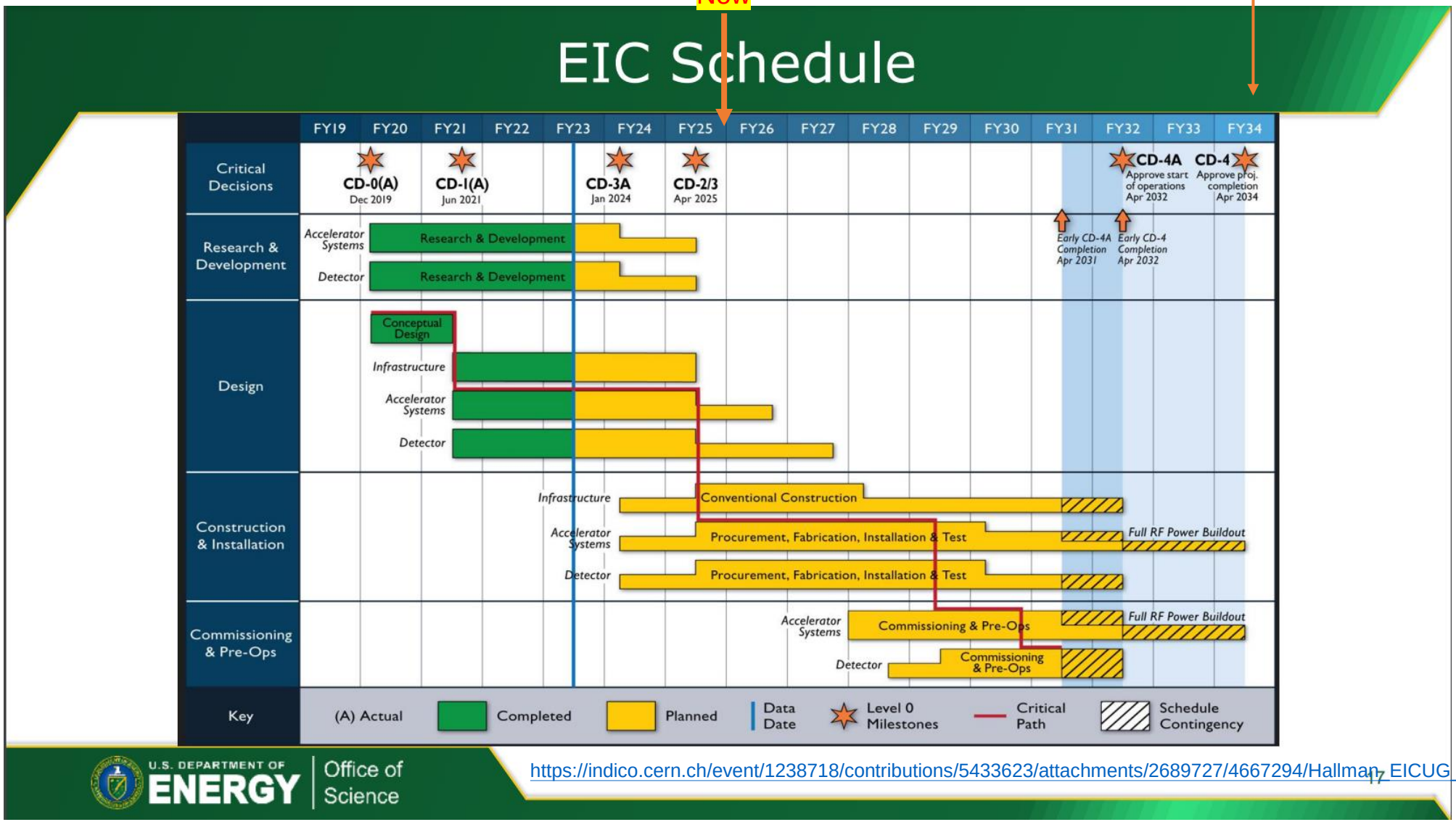
Computing
S.M. Wang/ E. Yen /Y.H. Chang

CERN LHC long-term schedule



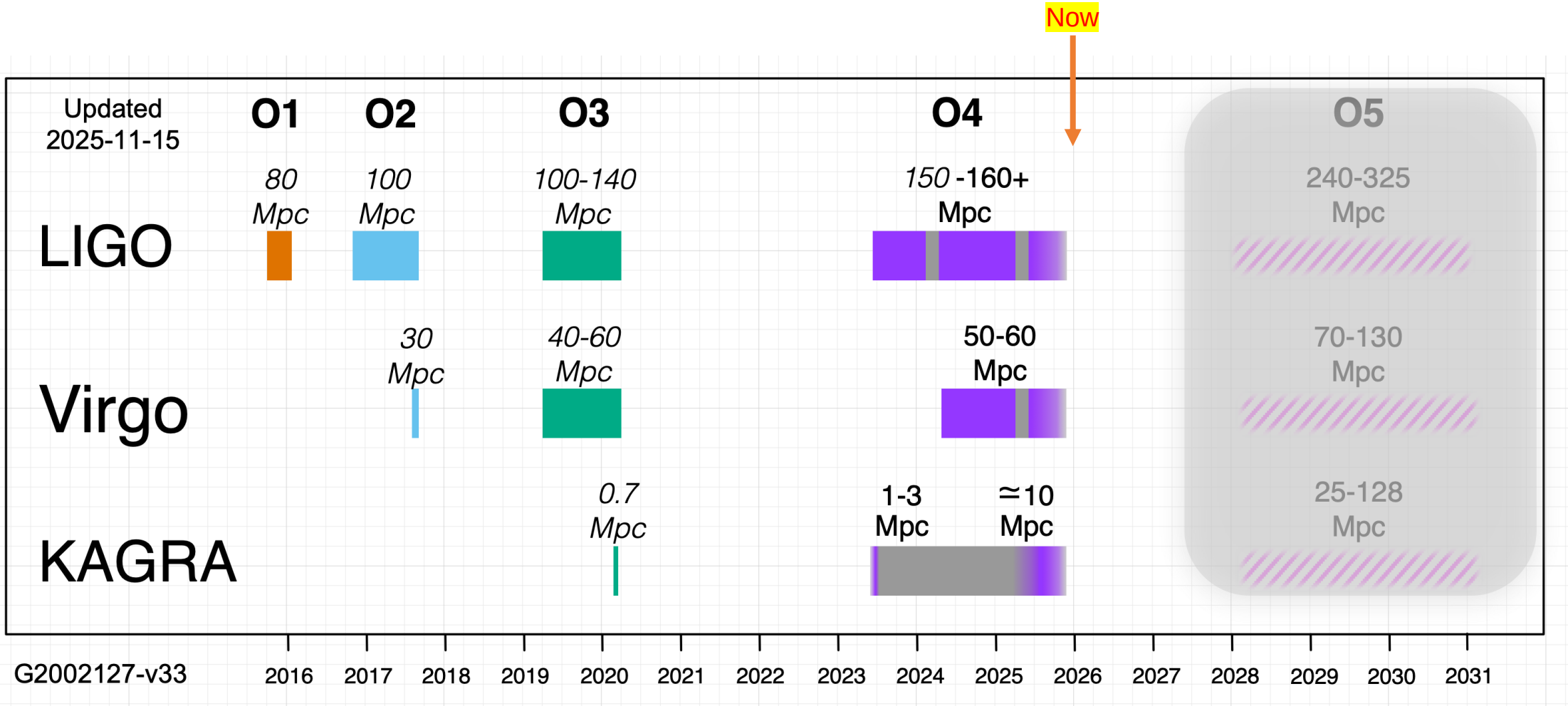
https://lhc-commissioning.web.cern.ch/schedule/LHC-long-term.htm

U.S. EIC Construction Schedule



https://indico.cern.ch/event/1238718/contributions/5433623/attachments/2689727/4667294/Hallman_EICUG_Talk_07242023.pdf

LIGO, VIRGO AND KAGRA OBSERVING RUN PLANS



https://observing.docs.ligo.org/plan/

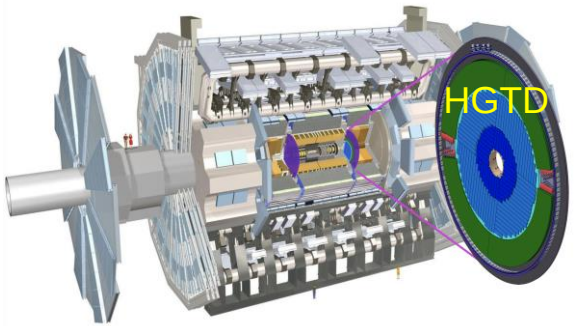
2025 AAC Report

These are mostly very positive developments. On the other hand, Ming-Lee Chu, who is an expert in electronics and has played major roles in the design and implementation of many electronic devices for the MHEP-EXP group, will retire soon. Moreover, as self-reflected by the MHEP-EXP members, the sub-critical manpower participating in large-scale international collaborations is undercutting the significance of their contributions. To make the matter worse, some PIs are spreading themselves too thin in too many experiments. Without significant increase in funding and brighter prospects for recruiting more faculty members, postdoctoral fellows and graduate students in sight, MHEP-EXP should critically assess their research portfolio, phase out the ones they deem non-essential and prioritize the remaining projects. Retirement is indeed a risk in sustaining a productive program; yet, it is also a great opportunity to re-vitalize and strengthen MHEP-EXP.

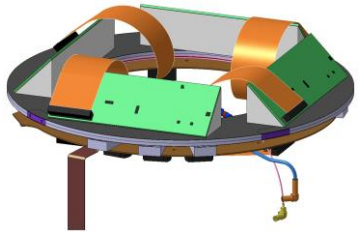
- Our international projects are long-term ones. It will take time to phase out any of them.
- We will make the discussions formal and review them on an annual basis.

ATLAS Status and Plans

- Run3 ends on June 29th 2026, undergo 3.5 years shutdown for Phase-2 upgrade
- Run4 (HL-LHC) : starts in 2030



HGTD



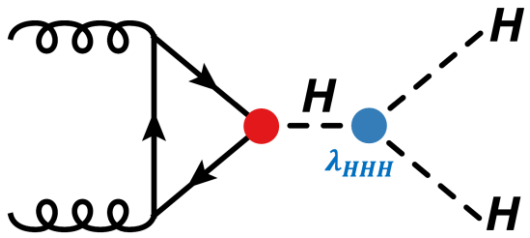
BCM’

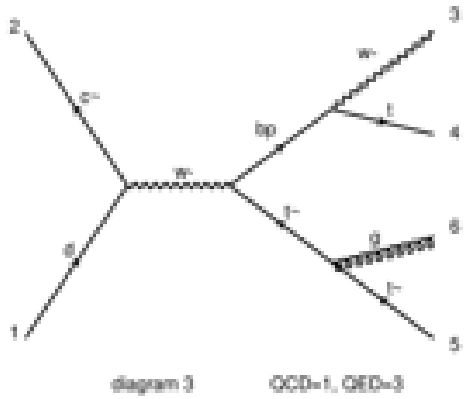
- **Phase-2 Upgrade**
  - Taiwan’s contributions
    - Muon readout electronics (hardware)
    - HGTD (High Granularity Timing Detector)
      - Optical fibers + HV cables (hardware), Production Database (software)
    - BCM’ (Beam Condition Monitor’) (hardware)
  - Part-1:
    - Taiwan has fullfilled hardware obligation, production database to be ready in 2026
  - Part-2:
    - Upgrade detector installation to start late 2026
      - Require postdocs and students base at CERN to take part in installation, testing and commissioing

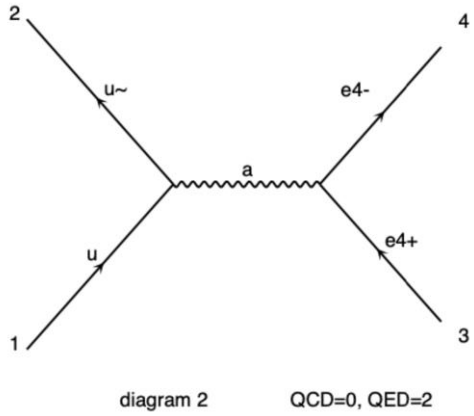
ATLAS Status and Plans

AS+NTHU: Applying joint proposal (Vanguard Research Program) to fund research activities over the next 4 years

- **Data analyses**
  - Collaborate on Di-Higgs searches (pp->HH), one of HL-LHC key analyses
    - HH->bbtautau (joined since 2018)
    - HH->bbVV (V=W,Z) (new)
    - HH->multileptons (new)
  - Search for the 4th generation fermions (inspired by Prof. Hsiang-nan Li's recent papers)
    - Study sensitivity using Run2+Run3 (~400 fb-1) and HL-LHC (~3000 fb-1) data samples
  - Heavy Ion measurements
    - Gain experience for EIC
- **Recruit students from NTHU**
- **Support Part-2 of Phase-2 upgrade and the ATLAS experiment Maintenance and Operation fee**







2025 AAC Report: TASEH

TASEH - We applaud the success of the TASEH experiment in obtaining its first result within 2 years of the inception of the experiment, and we look forward to new results based on a different design of the cavity and the addition of the Josephson Parametric Amplifier. We encourage the PI to investigate the opportunities to mount other `Tabletop' experiments addressing fundamental physics in the future.

The ideas suggested by AAC report is certainly interesting, but we don't have the capacity to implement yet, as we have not yet operated our current hardware stably. These items will be in our mind but probably be implemented in a longer time frame.

2025 AAC Report: EIC

EIC - A new initiative for the MHEP-EXP is to participate in the EIC (Electron-Ion Collider) to be constructed at the Brookhaven National Laboratory in the US. The EIC, expected to be completed around 2035, will be a major collider facility for nuclear and particle physics dedicated to the study of quark and gluon structures inside the proton and nuclei. The primary physics goals of the EIC have significant overlap with the research expertise and interest of the MHEP-EXP group members. Given the fact that the physics analysis of the SeaQuest and COMPASS experiments will wrap up in a year or two, it is timely for the MHEP-EXP to actively embark on the EIC project. Other institutes, including National Central University and National Taiwan University, have also joined the EPIC Collaboration for the EIC project. The MHEP-EXP group is in an excellent position to take a leadership role for the EIC-Taiwan team. The MHEP-EXP group led by the PIs, Wen-Chen Chang and Yi Yang, has already contributed to the zero-degree calorimeter (ZDC) for accessing the "forward physics", requiring the tagging of particles emitted at very small angles. Several beam tests using a prototype array of LYSO crystals have already been performed.

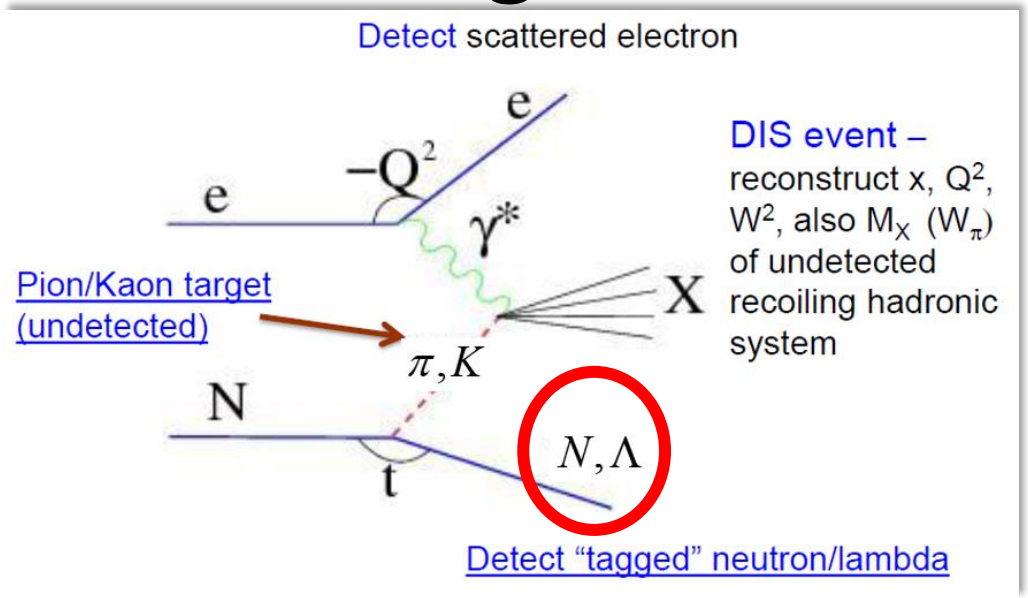
2025 AAC Report: EIC

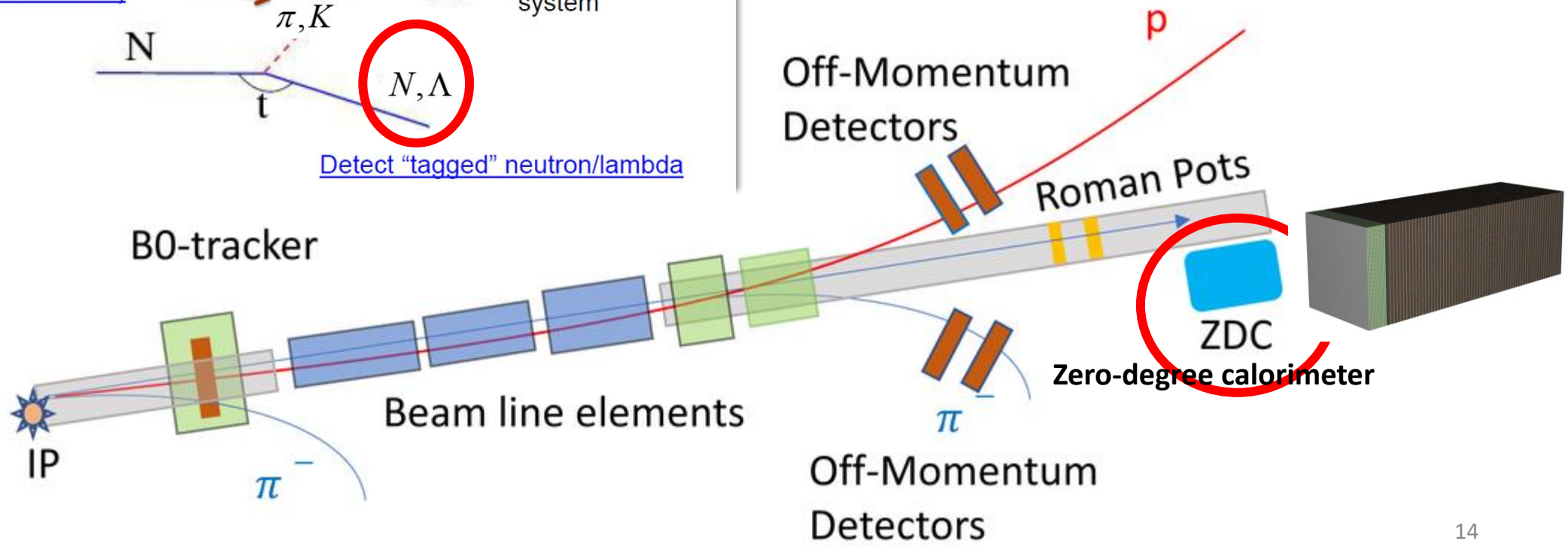
In addition to the detector R&D project for EIC, it is essential for the MHEP-EXP to develop a compelling physics case enabled with the ZDC detector. Based on their extensive expertise in the quark and gluon structures of the nucleons and mesons gained from the SeaQuest and COMPASS experiments, the MHEP-EXP group is strongly encouraged to take a leadership role in articulating the physics case for their proposed hardware project. Active interactions between the MHEP-EXP group and the MHEP theory group would be most helpful.

As the EIC project will only be available for experiments after 2035, it is important to participate in research activities related to the EIC physics prior to 2035. In addition to the exclusive-reaction program pursued by Wen-Chen Chang at J-PARC, other possible activities include the analysis of the large amount of the polarized p-p data collected at the STAR experiment at RHIC, of which Yi Yang is a member. Analyzing the ATLAS p-p and p-A data which are related to the EIC forward physics would be another attractive opportunity. We expect the MHEP-EXP members will carefully contemplate the most promising plan.

From this July, Wen-Chen started to organize biweekly phone meetings on EIC physics discussion, joined by EIC members of AS, NTU, NCU and NTHU. We will do our best to carry out the EIC-related physics study within the on-going projects and prepare ourselves ready for some early physics when EIC starts.

Sullivan Process for Meson (pion/kaon) PDFs & EIC Zero-degree calorimeter (ZDC)





Long-term R&D Projects of pion/kaon PDFs

- Physics analysis:
  - Perform a new global analysis of pion/kaon PDFs including data of charmonium production and Sullivan processes, other than the Drell-Yan.
  - Improve the understanding of Sullivan process in collaboration with theorists.
- EIC ZDC:
  - Optimize the design of EIC ZDC for tagging the Sullivan events.
  - Develop good machine-learning (ML) models for fast simulation, energy reconstruction, and particle identification.
  - Implement ML models of good capability of particle identification for the online trigger (FPGA+GPU) .

2025 AAC Report: TEXONO

TEXONO - The latest result from TEXONO on the upper limit of coherent neutrino nucleus elastic cross section with reactor neutrinos is very interesting. As the Kuo-Sheng power plant was already decommissioned, and the data-taking just started at the Sanmen Reactor Neutrino Laboratory (SMNL), it might be possible to pursue a more sensitive measurement at SMNL. A positive detection of coherent neutrino nucleus scattering with reactor neutrinos could have significant implications on studying neutrino oscillation with neutral-current interaction with reactor antineutrinos.

2025 AAC Report: Gravitational Wave

Gravitational Wave - We are glad to learn that the team has access to the TSRI facility and is making good progress in setting up the B1-ASGRAF. However, we concur with Henry Wong that there is an urgent need of expertise in photonics for advancing the R&D effort in improving the mirrors for the future upgrade of the gravitational-wave observatories. Seeking collaboration with the local photonics industry or experts in academia might be a solution. In response to the concern raised by the ACC two years ago, Sadakazu Haino is planning to relocate back to the IoP. This move would facilitate the coordination of activities in gravitational waves under the new international Collaboration. However, depending on the instrumentational interests of the individual investigator, it is not obvious that there is no drawback if the two senior IoP researchers continue to work separately on KAGRA and LIGO.

Reply to AAC-2023 Comments

H.T. Wong, S. Haino (2023/12/22)

"…. Some concern that by splitting the effort among two collaborations (KAGRA and LIGO), neither will be as effective as possible …."

We note that:

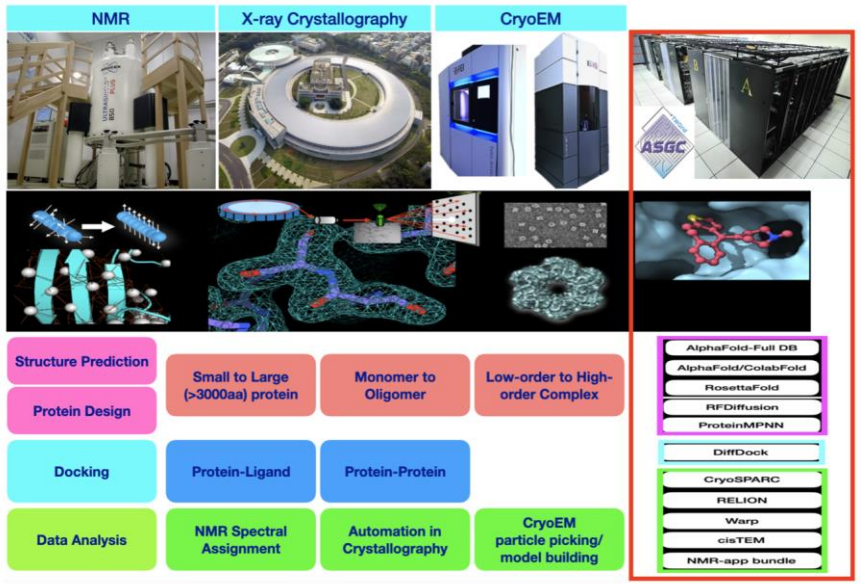
- **The ecosystem of international GW is different** (e.g. from HEP): data taking, analysis and publications of key results are shared by all three programs as "LVK Collaboration". Different teams work on different projects under one big world-wide corporation. Taiwan needs to learn where and how to find its place in this thriving subject.
- **There are complementing merits** to be associated with LIGO and KAGRA:
  - **KAGRA**, being a smaller, less resourced, "catching-up" experiment, allows Taiwan:
    - To hold visible positions and contribute to key important projects within limited resources,
    - To be part of the GW science results and spot-lights and to have flexibility to achieve optimal operation to access LIGO's data directly,
    - To enable Taiwan as a new comer in GW science to be the largest international partner in KAGRA.
  - **LIGO,** being a much matured, sophisticated, and professionally managed experiment with future secured, allows us:
    - To work and get connected with the leading groups/experts with several decades of credits in frontier-defining GW R&D projects, and to acquire the tools directly from the original producers,
    - To actually operate the most advanced hardware in situ and to quality-check the discovery data real time.
    - To connect TW community to LIGO's substantial information and resource pool – archive, hardware, software, operational protocols etc., in addition to data access.
- **There are No Drawbacks or Overhead** to be connected to both experiments. In particular, there is no "annual membership fee" involved in GW programs. (In LIGO, membership is reviewed every year based on delivery of quality work agreed upon the previous year.)

2025 AAC Report: ASGC

ASGC Center - We congratulate the team on the success of winning funding support from the National Science and Technology Council (NSTC) for establishing the NSTCCore center for the domestic scientific community. At this moment, the Center has attracted 127 research groups with 466 users, clearly going beyond the boundary of IoP. Their operational model with relatively low service charge is sound. Their goal of reaching out to more users should be encouraged. We would recommend the PIs to consider a long-range sustainable model while enjoying the current success.

ASGC Core Facility is an integral part of the research infrastructure

- ASGC has been the Core facility for scientific computing and big data analysis, funded by AS and NSTC from 2023
- Vision: accelerating scientific discovery with growing computing capacity
  - User-oriented, service-based approach
    - Flexible collaboration models and customized services are strategic focus
  - Integrated platform of data, algorithm and computing
  - Besides hardware, service and HR are of the equal importance
- Supporting particle physics communities together with TIDC, serving as the computing arms
- Physics is the primary user community of ASGC
  - MHEP keeps driving the advancement of scientific computing system and technology
  - ASGC is extending services beyond the domain boundaries, based on the collaborations with Physicists
  - 645 Users in 203 PI Groups, from 30 Institutes



Addressing Challenges for sustainability

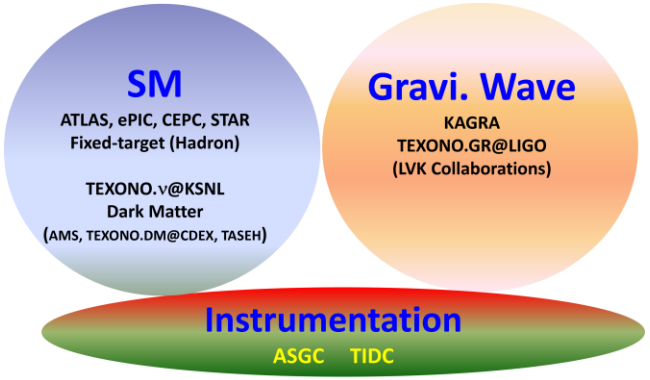
- Target: growing Users x Service x Resource, with reliability and efficiency
- Maximize the effectiveness of budget from AS and NSTC
- Short of advanced GPU resource: budget, scientific computing support are key issues
- Data Center reliability: 20 years old
  - Power system upgrade
  - Energy efficiency
  - Upgrade for higher power consumption & liquid-cooling computing hardware in the near future
  - Deployment & R/D on Intelligent monitoring & control
- High-price electricity cost
- Improving system efficiency
  - Improving users' experience, utilization, and reducing the waiting time
- HR & Capacity building: enhancing professional skills according to user needs and ICT progress
  - Have to catch up/support evolving needs of scientific computing and AI applications
  - Hard to have backup HR for key technologies
  - User support needs more investment
  - Uncompetitive ecosystem
- Pricing strategy
  - Baseline: covering power consumption (including data center operation)
  - Will rely mainly on data services and advanced services

2025 AAC Report: TIDC

TIDC - The outstanding issue is the imminent retirement of Ming-Lee Chu who is the integral element of TIDC. We fully understand the desire of recruiting a replacement promptly. However, it is more important to assess the long-range needs in instrumentation of the future research directions and priorities of MHEP-EXP in order to identify the candidates with the appropriate qualifications.

We recognize the concern regarding the imminent retirement of Dr. Ming-Lee Chu. However, recruiting a research engineer with expertise comparable to Dr. Chu is inherently challenging and cannot be achieved immediately.
Moreover, new MHEP-EXP experiments require expertise across multiple technical domains, including electronics, mechanics, cooling, software, and system testing, **making a team-based approach essential** rather than reliance on a single individual.
To ensure continuity, we are actively training several postdoctoral researchers and students with other high energy physics groups at Academia Sinica, NCU, and NTU, who are already engaged in instrumentation and experimental operations. In parallel, we collaborate with experts from local companies, allowing us to provide immediate technical support for ongoing and new experiments.

Strategic Plan for 2025-2035



- We pursue key discoveries of fundamental MHEP physics with **ATLAS, STAR, J-PARC, ePIC, DM search, and GW**.
- **Continual recruitment of new faculty members** working on accelerator-based MHEP, DM search, and GW.
- **The relocation of two PIs** will expand the local manpower of teamwork in ATLAS and GW, which will also improve the leadership and visibility of IoP in the local community.
- **Recruitment of Ph.D. students** from the National Cheng Kung University and the National Central University, where some of the group members have joint appointments.
- Through **Taiwan Instrumentation and Detector Consortium (TIDC)**, we continue strong and coherent collaboration with the other Taiwan teams on the accelerator-based MHEP projects.

International Schools/Conferences in 2025

- **February 5-15**, CHiP International Gravitational Wave Winter School 2025, https://indico.phys.sinica.edu.tw/event/125/
- **March 17-21**, International Symposium on Grids & Clouds (ISGC) 2025, https://indico4.twgrid.org/event/51/
- **June16-18**, Workshop on parton distribution functions in the EIC era, https://indico.phys.sinica.edu.tw/event/283/
- **August 19-30**, CHiP International Gravitational Wave Summer School 2025, https://indico.phys.sinica.edu.tw/event/302/
- **November 16-21**, The 14th international "Hiroshima" Symposium on the Development and Application of Semiconductor Tracking Detectors (HSTD 14), https://indico.phys.sinica.edu.tw/event/174/
- **November 27-29**, ANPhA 2025 - The 2025 Asian Nuclear Physics Association (ANPhA) board meeting & the ANPhA symposium on nuclear physics facilities in Asia, https://indico.phys.sinica.edu.tw/event/228/

We greatly appreciate the strong support of IoP and the significant efforts of administrative staff!