MHEP-exp Group Report for the 2025 AAC Meeting

- Research summary/highlights (2020-2025)
  - J.D. Brandenburg et al., “The STAR Forward Silicon Tracker”, Nucl. Instrum. Methods A 1072, 170202 (2025).
    Yi Yang is the deputy project manager for the STAR Forward Silicon Tracker (FST) project and the principal investigator for mechanical structure for STAR FST R&D and production, and one of the main authors of the paper.
  - ATLAS Collaboration, “Combination of Searches for Higgs Boson Pair Production in pp Collisions at sqrt(s)=13 TeV with the ATLAS Detector”, Phys. Rev. Lett. 133, 101801 (2024).
    The bb⏐⏐ results which were published in Phys. Rev. D 110 (2024) 032012 and contributed greatly by the AS group, is included in this combination. The bb⏐⏐ results have the best single channel expected limit on the Higgs boson pair production cross section in the ATLAS experiment.
  - M.G. Alexeev et al. (COMPASS Collaboration), “Final COMPASS Results on the Transverse-Spin-Dependent Azimuthal Asymmetries in the Pion-Induced Drell-Yan Process“, Phys. Rev. Lett. 133, 071902 (2024).
    The combined results of the 2015 and 2018 Drell-Yan runs support the QCD-predicted sign change for the Sivers functions. The AS group has been involved and contributed significantly to the success of this measurement in terms of instrumentation, data taking, and data analysis.
  - S. Karmakar et al. (TEXONO Collaboration), “New Limits on Coherent Neutrino Nucleus Elastic Scattering Cross Section at the Kuo-Sheng Reactor Neutrino Laboratory”, Phys. Rev. Lett. 134, 121802 (2025).
    This work reported the most sensitive results at the time of publication on the pursuit of neutrino coherent scattering with the nucleus with reactor neutrinos.
  - M. Aguilar et al. (AMS Collaboration), “Antiprotons and Elementary Particles over a Solar Cycle: Results from the Alpha Magnetic Spectrometer”, Phys. Rev. Lett. 134, 051002 (2025). (Editor’s suggestion, Featured in Physics, Physics viewpoint)
    The AS group is one of the two parallel groups working on antiproton, and it took us ~4 years to complete the work.
  - A. G. Abac et al. (LVK Collaborations), “Ultralight vector dark matter search using data from the KAGRA O3GK run”, Phys. Rev. D 110, 042001 (2024).
    We searched for ultralight vector dark matter by laser interferometric gravitational wave detectors through the measurement of oscillating length changes in the arm cavities. KAGRA has a unique feature due to the differing compositions of its mirrors, enhancing the signal in the length change.

- Reply to 2023 AAC report:
  - Points raised by AAC:
    - "*However, there is some concern that by splitting the effort among two collaborations (KAGRA and LIGO), neither will be as effective as possible.*"
    - "*We also encourage PIs to be based primarily at the Academia Sinica.*"
    - "*It is imperative to recruit new Pis in the coming years.*"
    - "*It is essential for the MHEP group to lay out a viable long-range plan which builds on the MHEP's expertise acquired through past and ongoing projects while exploring promising new research directions. We recommend that the group maintain a strong component of participation in ATLAS at the LHC. Without real expansion in the number of Pis, we recommend that the group remain focused on a limited number of collaborations.*"

      This concern is consistent with the point mentioned in the part of Faculty hires of Comments and Recommendations for IOP: "*Faculty hires: Each case must be evaluated carefully based on the long-range plans and in consideration of synergy and total impact. Of special concern to the AAC (and the AS central admin as expressed in a separate communication to the AAC) is that the recent hires in the MHEP group do not seem to follow a coherent strategy. New, disconnected projects are being added, which run the risk of being subcritical in each area and loss of competitiveness.*"

  - ❖Our reply:
    - ❖ Our group agrees on a long-range plan of accelerator-based HEP (ATLAS, J-PARC, and U.S. EIC), Dark Matter (DM) search, and GW (LIGO, Virgo, and KAGRA, (LVK)).
    - ❖ The key discoveries are shared by LVK with complementary merits and more coordination, which in the coming years will be reorganized as the International Gravitational Wave Network (IGWN) with Drs. Wong and Haino and Kuan (new faculty expected to recruit in 2027).
    - ❖ The recruitment of Yi Yang, who works on the STAR, ATLAS, AMS, and ePIC experiments, was done in 2024. It is consistent with our long-term planning of collider physics. He and his group are based at AS.
    - ❖ Song-Ming Wang has been taking the leadership of ASGC since September 2024. He will gradually spend more time at AS in the future.
    - ❖ Sadakazu Haino is now preparing to leave CERN to gradually spend more time at AS in the future.

- SWOT Analysis
  - **Strength:**
    - Strong participation in many renowned international projects, complemented by a recognized domestically-based program.
    - Independent and well-established faculty members.
    - Strong technical and facility support from the IoP research scientists and the ASGC facility.
    - Well-established HEP models are being applied to the new project LIGO-Virgo-KAGRA international GW network, where collaborators are not experienced in big projects.
  - **Weaknesses:**
    - Difficulty in recruiting faculty, postdocs, and Ph.D. students. Lack of the critical mass of manpower in large-sized international projects like ATLAS and EIC.
    - Lacking good evidence of new physics beyond the standard model. The conventional HEP field is less attractive to the young generation.
    - The techniques and community of GW are less familiar to our background.
  - **Opportunities:**
    - Strong and coherent collaboration with other Taiwan teams on EIC, KAGRA, and LIGO.
    - Established connections and working relationships with teams in China, India, and Turkey in the TEXONO program.
    - The loose collaboration of LVK on GW will evolve into the new IGWN framework in which the IOP-GW activities – both experiment and theory – will operate as one group.
  - **Threats:**
    - The scale of physics to pursue is getting wider and it will take a longer time to get discoveries.
    - Retain a good leadership of experimental HEP research in Taiwan.
    - Deteriorating development of international relationships may impede certain plans of the TEXONO-CDEX program.

- Strategic Plan for 2025-2035
  - We pursue key discoveries of fundamental MHEP physics with ATLAS, J-PARC, U.S. EIC, DM search, and GW.
  - Recruitment of new faculty members working on accelerator-based MHEP, DM search, and GW, as well as research scientists after the retirement of senior ones.
  - The relocation of 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 (NCKU) and the National Central University, where some of the group members have joint appointments.
  - Through the Taiwan Instrumentation and Detector Consortium (TIDC), we continue strong and coherent collaboration with the other Taiwan teams on the accelerator-based MHEP projects.