# Science Cloud in Taiwan

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Taiwan**

**ISGC 2025
18 March 2025**

ASGC - Core Facility for Scientific Computing

- **WLCG Tier Centre - building capacity by participating the development & deployment of the world largest and advanced distributed cloud research infrastructure**
  - **WLCG is moving towards O(1000)PB scale in RUN4**
- **Core Facility - computing arms of HEP experiment, research facility and research communities, based on WLCG core technologies**
  - **Also part of the research infrastructure**

TAIWAN INSTRUMENTATION AND DETECTOR CONSORTIUM (TIDC)
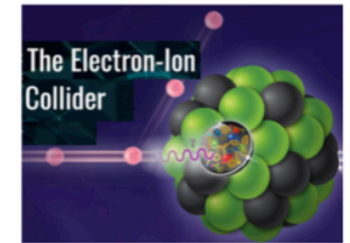
Neutrino/MHEP

CryoEM

Quantum Materials Physics

Bioimaging

Physics of Active & Living Matter

Drug Discovery

Astrophysics

Computational Chemistry
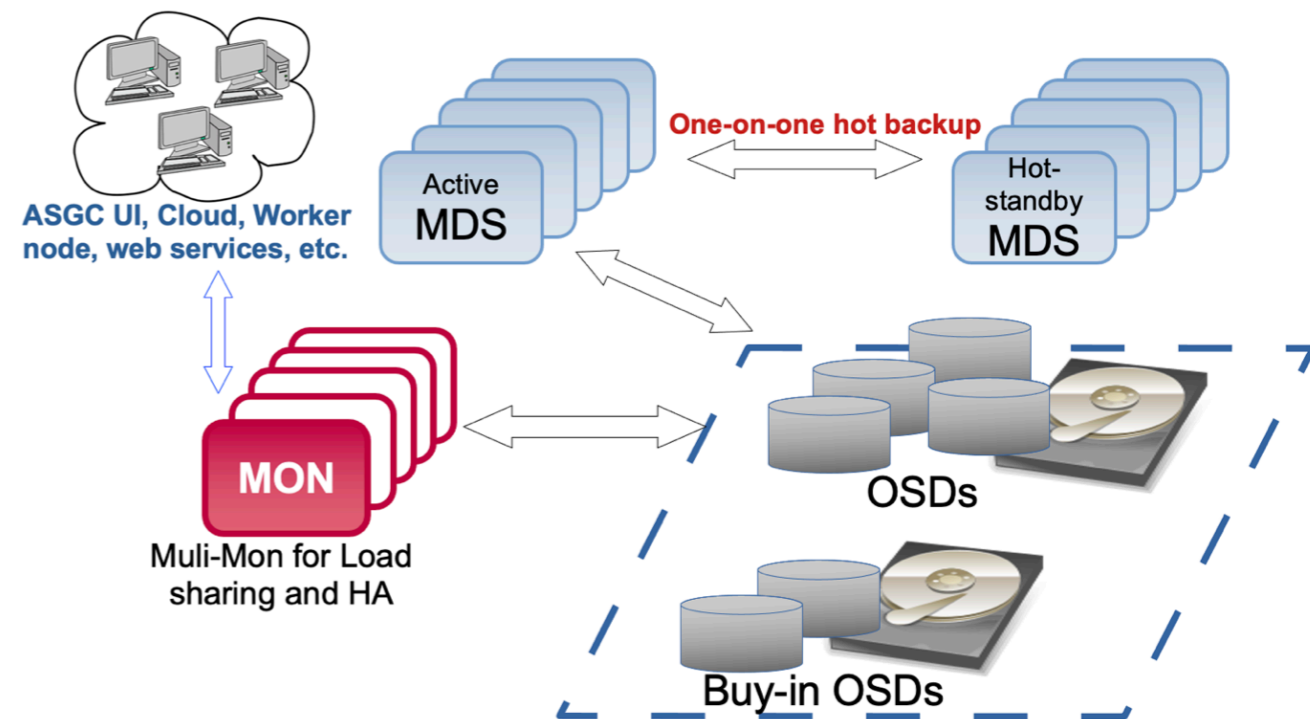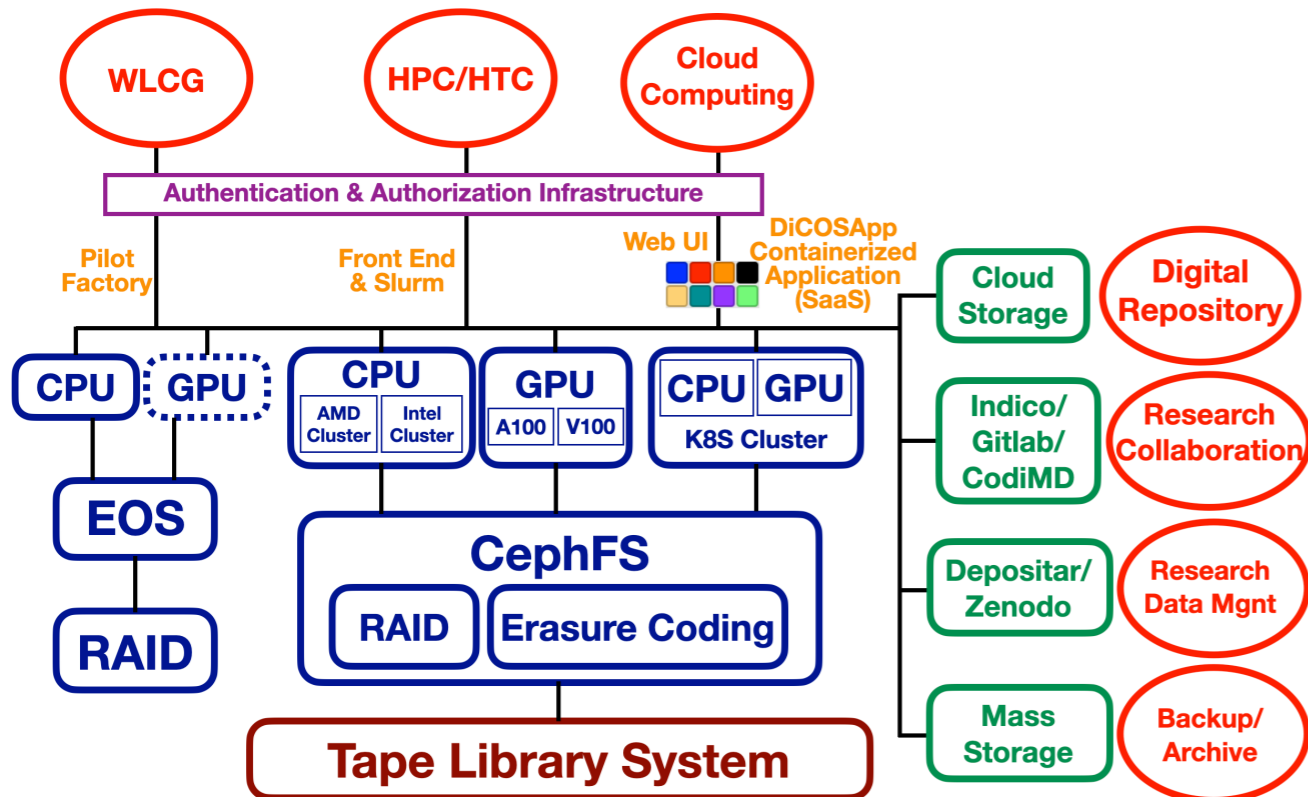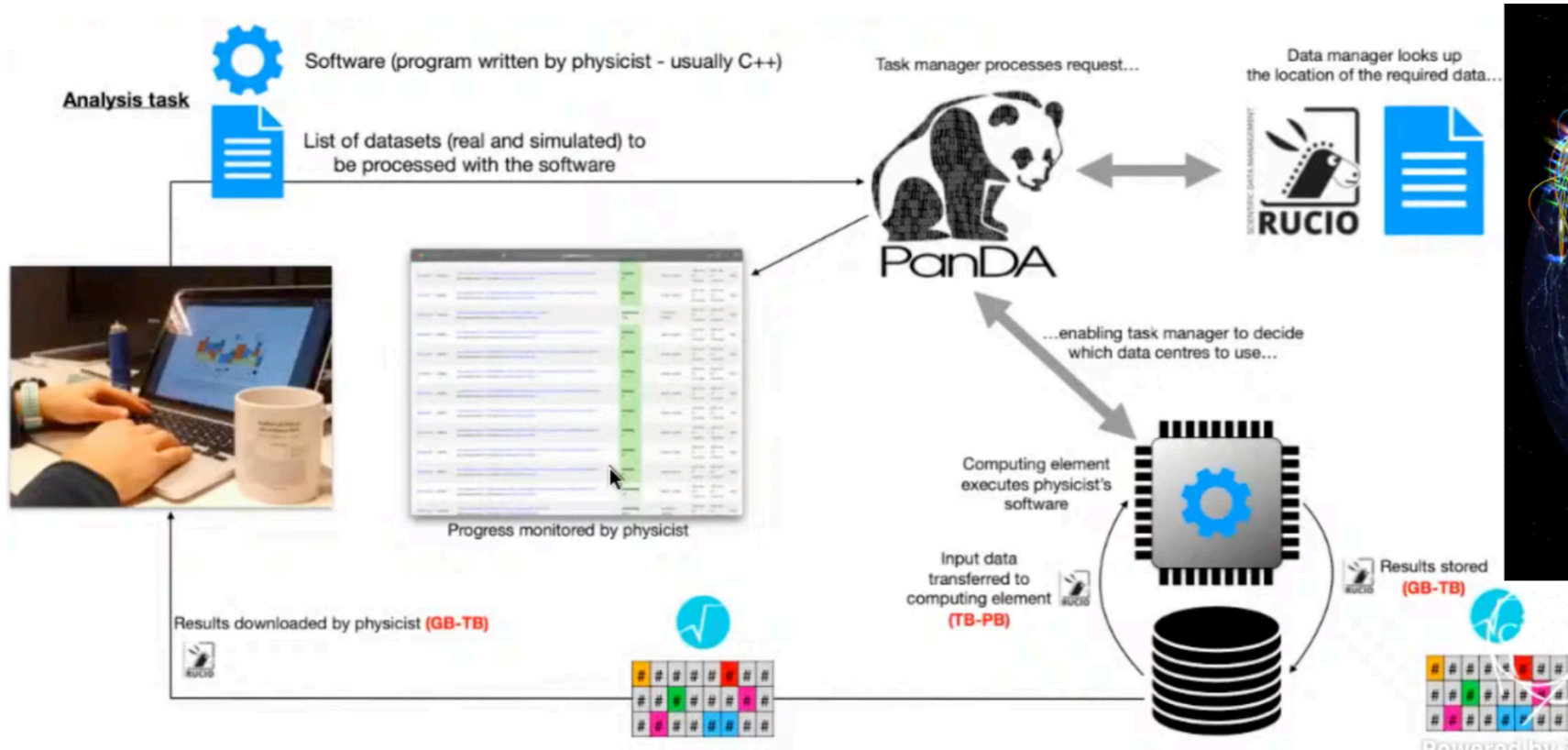
Earth Science

Biodiversity & Ecology

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WLCG-based
# Distributed Cloud infrastructure for Scientific computing

- **PanDA + RUCIO serves as the core of the common distributed infrastructure**
  - **Federation of distributed institute resources**
  - **Federation of core facilities (including CryoEM, NSRRC, NMR, computing centre, etc.)**
- **Web-based Cloud services & Slurm clusters are provided**
  - **VM for core services and on-demand worker nodes managed by OpenStack**
  - **Containerized resources managed by Kubernetes framework - for software on-demand services and part of core services**
    - **Batch and interactive GUI jobs: Jupyterlab, virtual desktop**
    - **GPU Cloud**
    - **SaaS: web-based application environment with microservices**
- **Resource status: 4.4M CPU jobs, and 50K GPU Jobs in 2024 (Jan. 2025) *****
  - **5,152 CPUCores + 2,176 CPUCores (by end 2024)**
  - **24x A100 GPUBoards, 16x4090, 48xV100, 56x3090 (+ 16x L40S soon): high demanding**
  - **Ceph is the common scalable storage pools: > 10PB is online (+2.5PB by end 2024)**
    - **6 MDS + 6 hot-standby (one-on-one backup); 7 MONs**
    - **462 OSDs, 51 hosts.**
  - **1x full rack 10PB LTO9 tape storage will be available in Q4 2024 - backup**
- **Both core technology and application platform are evolving with user experiences**
  - **170 PI Groups, 565 users from 64 Institutes in Taiwan**
- **OSG software stack has been deployed for IGWN and will be part of the infrastructure**

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ASGC Science Cloud Architecture

73+ Web Applications Provided (Software-as-a-Service)

CryoSPARC 32 P100 — Version: 3.2, Resources: 83% — Launch
CryoSPARC 1080ti — Version: 3.3.2, Resources: 29% — Launch
CryoSPARC RTX3090 — Version: 3.3.2, Resources: 26% — Launch
spyder cpu/eman2 — Version:, Resources: 17% — Launch
Octave — Version: V5.2, Resources: 29% — Launch
Transfer Data — Version:, Resources: 86% — Launch

CryoSPARC RTX3090 — Version: 4.0.2, Resources: 26% — Launch
CryoSPARC RTX3090 — Version: 4.1.1, Resources: 26% — Launch
CryoSPARC RTX3090 — Version: 4.4.1, Resources: 26% — Launch
cisTEM — Version:, Resources: 86% — Launch
Ovito — Version:, Resources: 86% — Launch
OpenACC — Version: GPU P100, Resources: 83% — Launch

AlphaFold — Version: GPU with A100, Resources: 75% — Launch
AlphaFold (Full DB) — Version: GPU with A100, Resources: 75% — Launch
IMOD — Version: GPU with 1080ti, Resources: 29% — Launch
Triton — Version: 22.01-py3 (GPU P100), Resources: 83% — Launch
AlphaFold — Version: GPU with RTX3090, Resources: 26% — Launch
AlphaFold — Version: GPU with V100, Resources: 17% — Launch

RoseTTAFold — Version: GPU with rtx3090, Resources: 26% — Launch
Dynamo — Version: GPU with 1080ti, Resources: 29% — Launch
MATLAB — Version:R2018b on GPU V00, Resources: 17% — Launch
Jupyter Lab — Version: CPU with Tensorflow v1, Resources: 86% — Launch
Jupyter Lab gpu 3090 — Version: GPU with Tensorflow 3090, Resources: 26% — Launch
Jupyter Lab GPU 1080ti — Version: GPU with Tensorflow v2, Resources: 29% — Launch

RFDIFFUSION — Version: 2023 on GPU V00, Resources: 17% — Launch
diffdock — Version: 2023 on GPU V00, Resources: 17% — Launch
EvoDiff — Version: V100, Resources: 17% — Launch
Jupyter Lab GPU V100 — Version: GPU with Tensorflow V100, Resources: 17% — Launch
Jupyter Lab GPU A100 — Version: GPU with Tensorflow A100, Resources: 75% — Launch
Jupyter Lab Cryocare GPU — Version: GPU with 1080ti, Resources: 29% — Launch

QIIME2 — Version: Genome, Resources: % — Launch
Scipion3 — Version: P100, Resources: 83% — Launch
Phenix — Version:, Resources: 86% — Launch
Jupyter Lab GPU A100 — Version: GPU with Tensorflow v2.6, Resources: 75% — Launch

- **Web Portal**
- **Application over Cloud**
- **Jupyterlab**
- **Web Terminal**

LabVIEW Run-Time Engine — Version: 2019 — Launch

MorphoGraphX — Version: GPU with P100, Resources: 83% — Launch
Deepmd-kit — Version: GPU with A100, Resources: 75% — Launch
Deepmd-kit — Version: GPU with V100, Resources: 17% — Launch
MAML — Version: GPU with A100, Resources: 75% — Launch

DiCOS-BioSAXS Platform

Warp — Version: rtx4090, Resources: 700% — Launch
MAML — Version: GPU with V100, Resources: 17% — Launch
PVserver — Version: 5.8.0 (GPU 1080TI), Resources: 29% — Launch
Paraview Client — Version: 5.8.0, Resources: 86% — Launch

About | Job Submission | Job Monitoring | Data Management
ATSAS ▸ DAMMIN
AMBER — DAMMIF
Rosetta — GASBOR

R studio — Version: 10 CPU Cores, Resources: 54% — Launch
PyRoot — Version: GPU with 1080ti, Resources: 29% — Launch
qiskit — Version:, Resources: 86% — Launch
NVIDIA CUDA-Quantum A100 — Version:, Resources: 100% — Launch
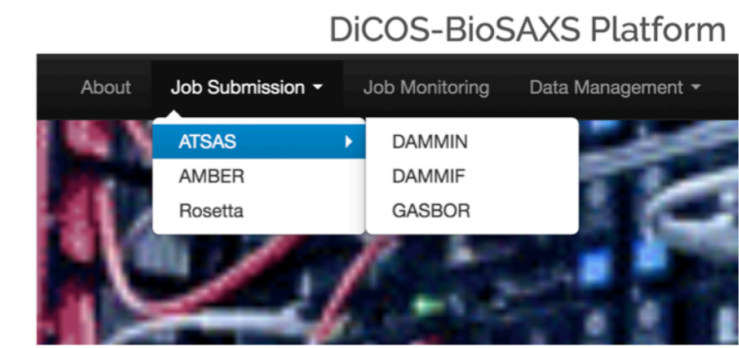
Customized Cloud Services for Proteomics/Life Science Communities


Source: Prof. Kuen-Phon Wu, IBC AS
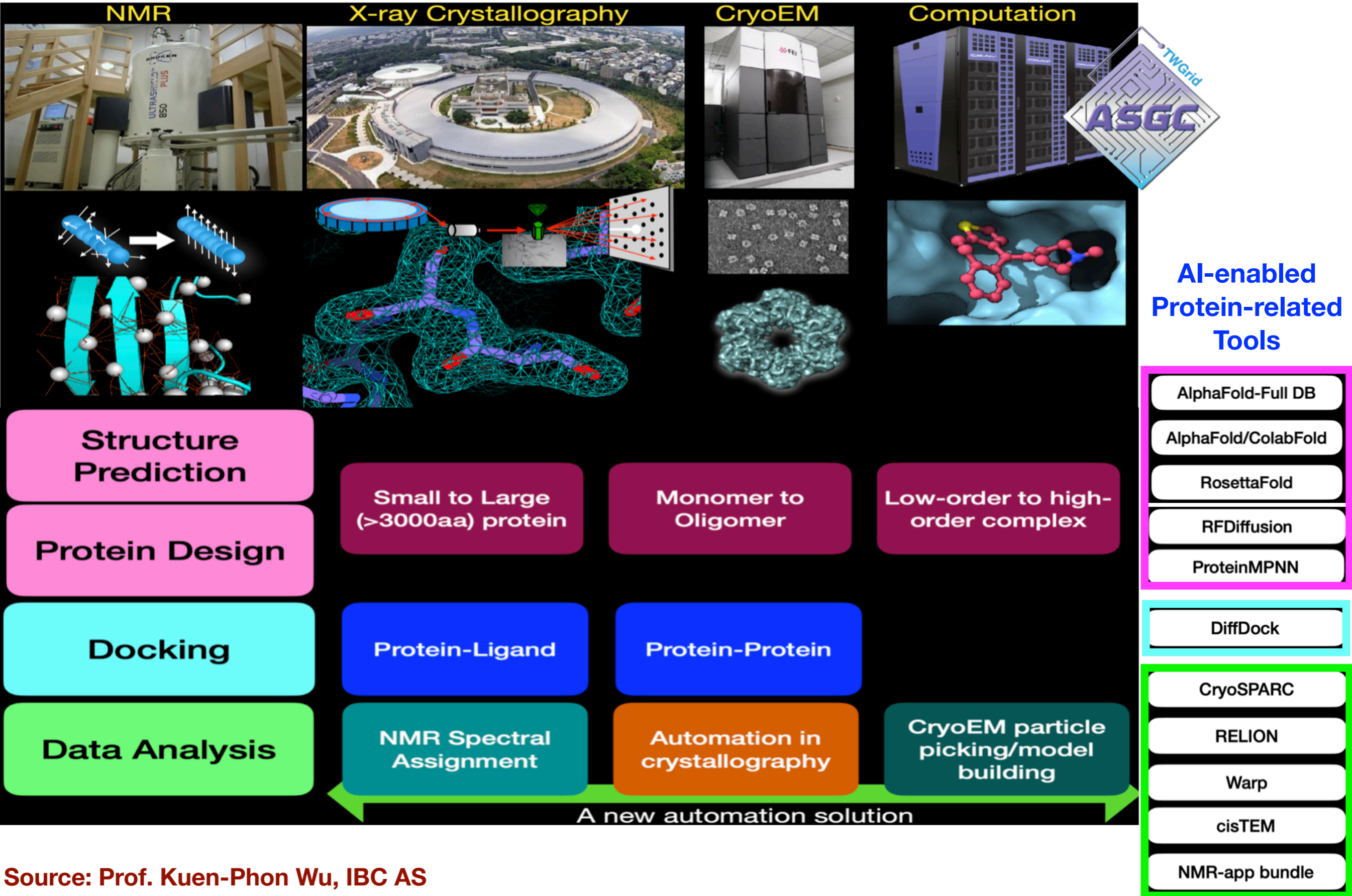
ASGC Science Cloud Resource Usage

- **Sustained growth of users, utilization, reliability and satisfaction in 2024**
  - **174 PI Groups, 595 users from 25 Institutes in Taiwan**
  - **Finished 4.94M CPU jobs, and 52.8K GPU Jobs, with 99%+ reliability**
  - **26+ supported research publications**
  - **Demands of advanced GPU keeps growing in 2024 - 20% utilization growth in high usage situation**
  - **CPU usage has increase of 333% in 2024**
- **Gaining trust of users/ building collaboration with user communities**
  - **Customized services: just like tailored-made services in the cloud/ serving as the computing arm**
- **Onboarding new hardware and retiring legacy ones for power saving and performance improvements: 5,760 CPUCores, 210 GPUBoards, 12PB Disk, 410PB Tape**
 - **New procured HW (1,920 + 256 CPUCores, 2.5PB Disk Storage) had been available on 20 Dec 2024**
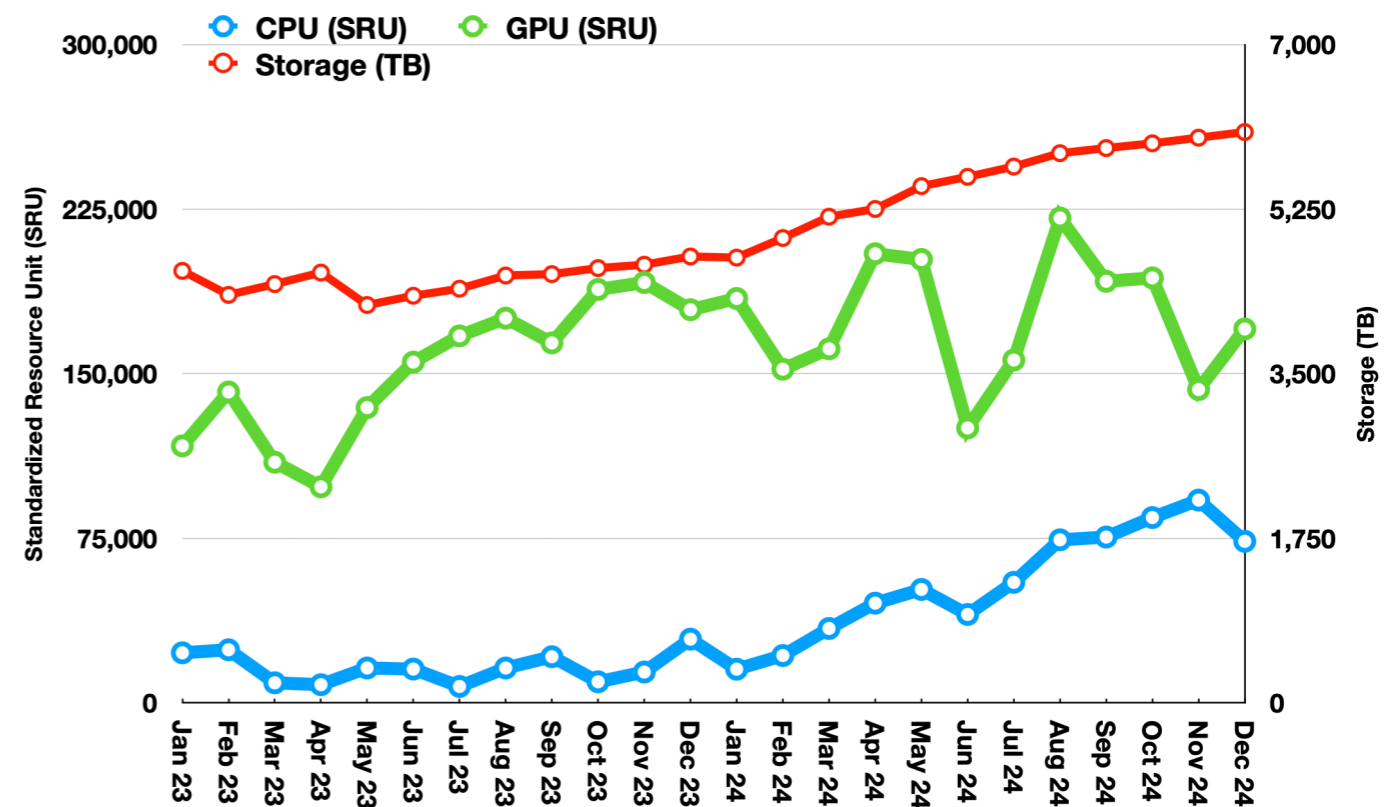
GPU Resource Usage in 2024

- **GPU demand keeps growing in 2024: <u>20%</u> utilization growth comparing to 2023 under high usage situations**
  - **Diversified user communities**
  - **Not just AI model training and development, scientific computing also requires large amount of high-end GPU resource**
- **Users can hardly access to the most advanced GPU like H100 - Urgent action is needed before being GPU disadvantaged**
  - **Unaffordable usage cost, not mentioning the acquisition of powerful enough high-end GPUs**
  - **Long waiting queue for competing the rare resources for the academic**
- **A100 servers @ASGC with large embedded GPU memory (80GB) and interconnection bandwidth (NVLink) becomes the alternative**
  - **Congested jobs/requests for limited A100 servers (24 boards in 3 servers) has been since 2023**
    - **A100, 3090 are almost saturated - average utilization in 2023&2024 are around 60%. Users were forced to choose less advanced V100. Usage of V100 in 2024 has grown by 1.4 times (average utilization is about 45%). Even the primitive GPUs (P100 & 1080ti) are also highly utilized.**
    - **Although newly procured 4090 (8 boards only) served as the substitute in time**
- **More investment in advanced GPU is needed, for both AI development as well as scientific computing**
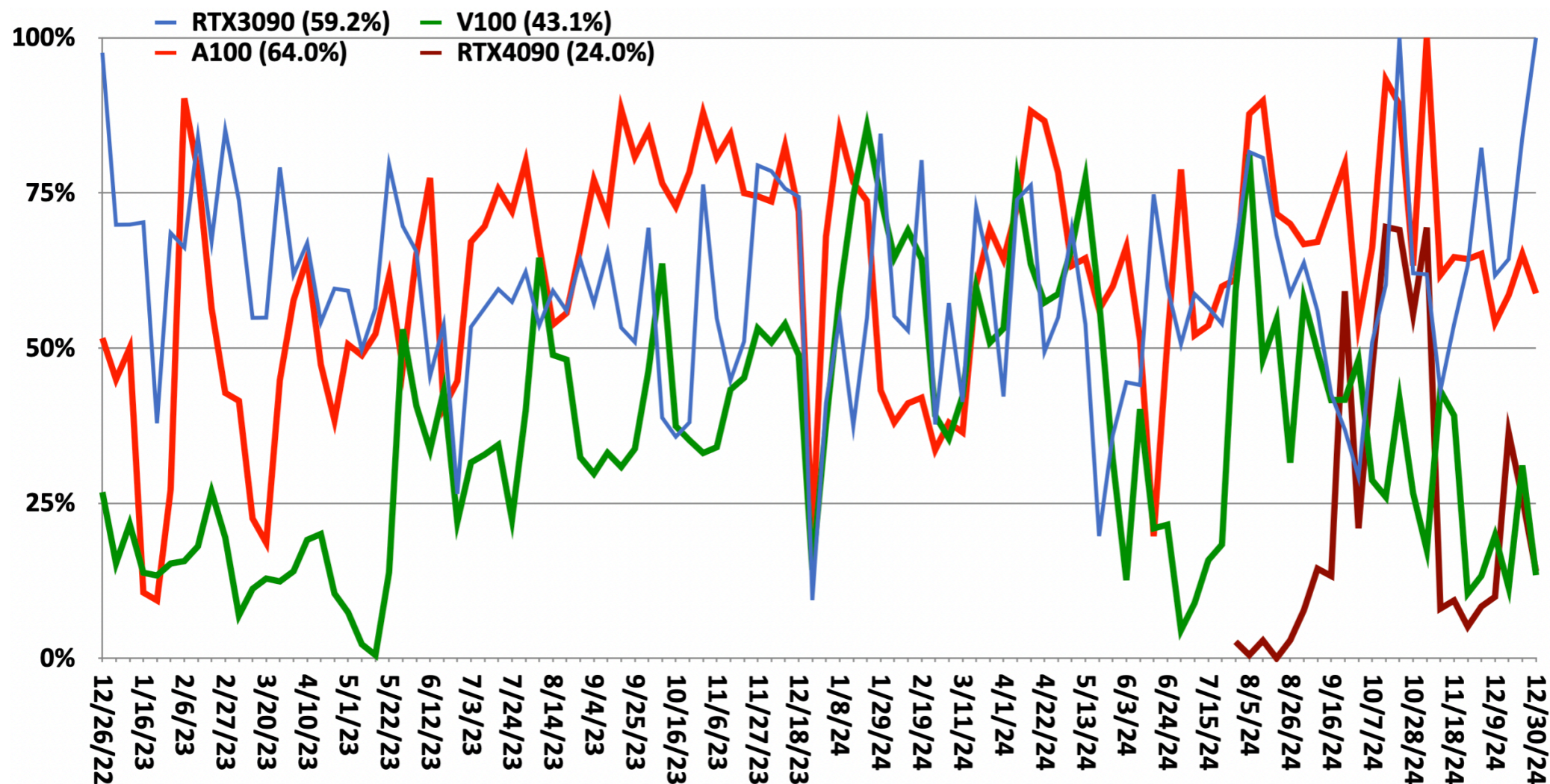
Energy Efficiency Improvement

- **Reliability enhanced by intelligent monitoring and control is the key approach**
- **Retirement of legacy hardware**
- **Improvement of AHU efficiency, including the replacement by top-flow cold air**
  - **Anomaly detection**
  - **Well-prepared backup plan**
- **Energy-sensitive operation:**
  - **Plan for power efficient hardware: e.g., non-X86 CPUs**
  - **Power saving - shutdown idle WNs when the waiting queue is quite short**
    - **20% power usage reduction in 2023 - Effective on 3 CPU clusters (> 3,000 CPUCores) from May 2023**
- **Overall, DC Power consumption reduced 20% for two straight years from 2023**
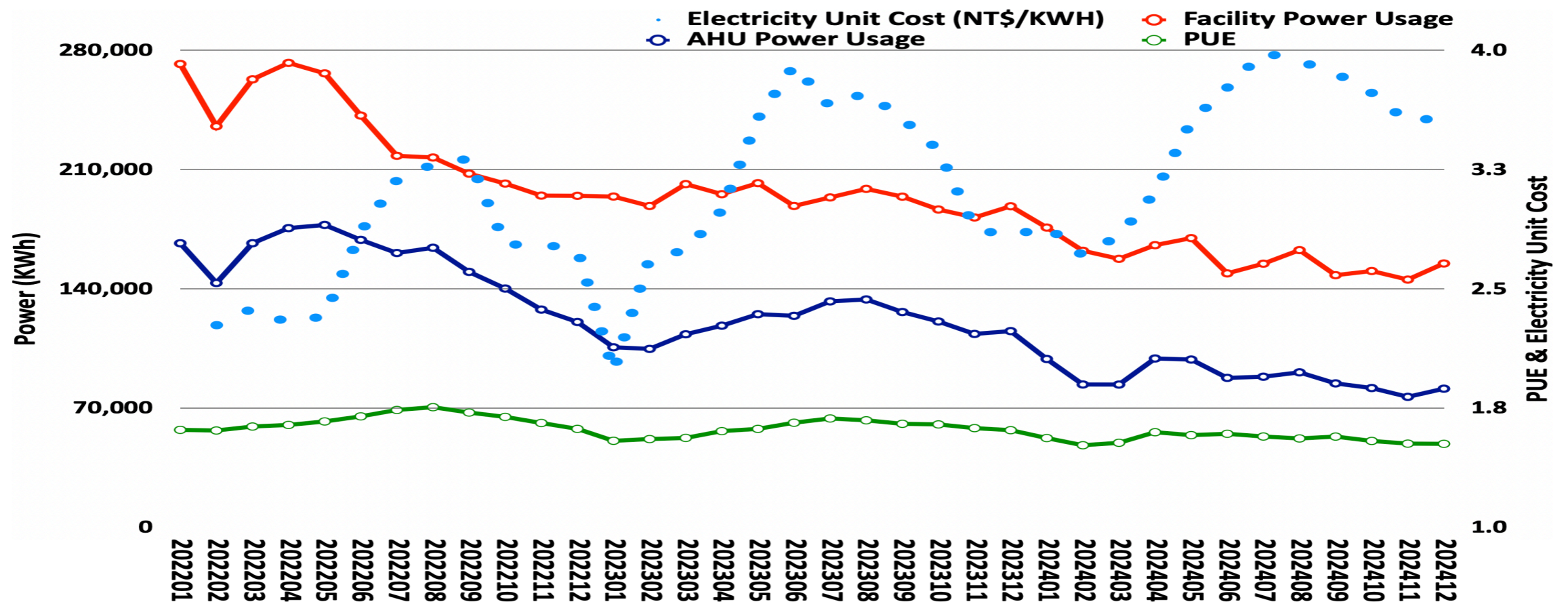
Capacity Building

- **User community engagement with flexible collaboration model**
  - QCD, DFT, First Principle, Astronomy/Astrophysics, Neutrino, GW, HEP, Proteomics, Computational Chemistry, Drug discovery, NGS, Earth Science, Social Science, etc.
  - Engagement with other core facilities: ASCEM, NMR, NSRRC
  - Understanding user requirements and supporting workflow integration
  - Collaboration model: pay-as-you-go, buy-in, facility/service collocation, reservation
- **Supporting user access to ASGC services easier and enhance application efficiency**
- **Training and workshop/conference: 250+ participants in 2024**
  - 4x training a year on ASGC services with hands-on
  - Thematic computing/application training together with user communities: 3x events in 2024
  - Also covers AI applications, HEP data analysis and more activities.
- **Core technology and international collaboration: ISGC (annual event since 2002)**

Action Plans in 2025

- **Broader user community engagement**
  - **Condense Matter, Earth science, life science, engineering, AI & AI-enabled researches, research data management etc.**
- **Enhanced resilience & efficiency of storage system**
  - **Moving cold data to Tape: KAGRA, Soundscape, Earthquake, Satellite images, etc.**
  - **Kick off tape backup services**
- **AI-enabled big data analytics: extending from development platform and software/program integration**
- **Gaining certification of ISO27001 + ISO27017 (for Cloud Service)**
- **HW procurement and retirement plan**
  - **Another 2,176+ CPUCores (higher than AMD Genoa) and GPUs (L40S or higher-end) online**
  - **3PB+ disk and 4PB+ tape on board**
  - **1080ti retirement**
- **Capacity Building: another 4x training events, ISGC2025**
  - **GPU Computing, AI application, ASGC Core Technology (distributed Cloud, BDA, AAI, data repository), etc.**
- **Effective communication**
  - **Contact point**
  - **Responsive**
  - **Information service**
  - **Weekly user meeting**
- **Call for collaboration - flexibility and R&D oriented**
  - **AI-enabled BDA for research applications and new services**
  - **Efficiency**
  - **Security - intelligent monitoring and responses**

Summary and Future Works (Update Needed)

- **Supporting high-performance data analysis needs of multiple-disciplinary applications by making better use of ASGC resources, with reliability and efficiency**
- **Based on WLCG core technology, a scalable, consistent progress distributed computing system and services are available for TIDC**
  - **PanDA+RUCIO, AAI, CVMFS, monitoring & control, system efficiency and security**
  - **Supporting both batch (HTC/HPC) and cloud services (SaaS) at the same time**
- **Both the capacity of users and ASGC are growing according to collaborations and ICT evolution**
  - **Extended from local ATLAS/CMS groups, to broader scientific communities**
  - **Providing ASGC service training and thematic training/workshop**
  - **Collaboration platform: ISGC annual event since 2002**
- **Upcoming Services**
  - **Data efficiency and reliability: enrich backup and archive services by integration of disk & tape storages**
    - **Migration to CTA will be kicked off in 2025**
  - **Two Factor Authentication service has been effective since Jan 2025**
- **Prototyping Hybrid quantum cloud service in the near future**

# Thank you

Backup Slides

WLCG Tier2 for ATLAS is running smoothly

- **Site has been in production since July 2024 with helpful and careful investigation of USATLAS**
  - Connection with LHCONE was reestablished, efficiency was also affirmed
- **Supporting MC Simulation jobs and analysis jobs mainly afterwards**
- **Current Status: > 111K CPUCore-Days (2024.8 - 2025.2.26)**
  - Transfer efficiency: > 92%
  - CPU Efficiency: > 89%
  - Storage used: > 1.2PB
  - Data Transmission: > 2PB (in+out)
  - Issue: limited network bandwidth (3Gbps) connecting to LHCONE

- **Pledge in 2025**
  - CPU: 30K HEPscore23
  - Disk: 5 PB, managed by EOS
- **Job slots - 2,208**
  - ~ 839 job slots are available now because of OS migration
- **Next Step:**
  - Making better use of ASGC resource, e.g, pre-stage for analysis jobs
  - Will take USATLAS operation shift in Asia time zone in 2025
- **Migration to AlmaLinux 9 - will be accomplished before Q1 of 2025**
 - 2-stage: ~ 1,370 job slots in AlmaLinux will be online in Sep.


Transfer Efficiency


Slots of Running jobs
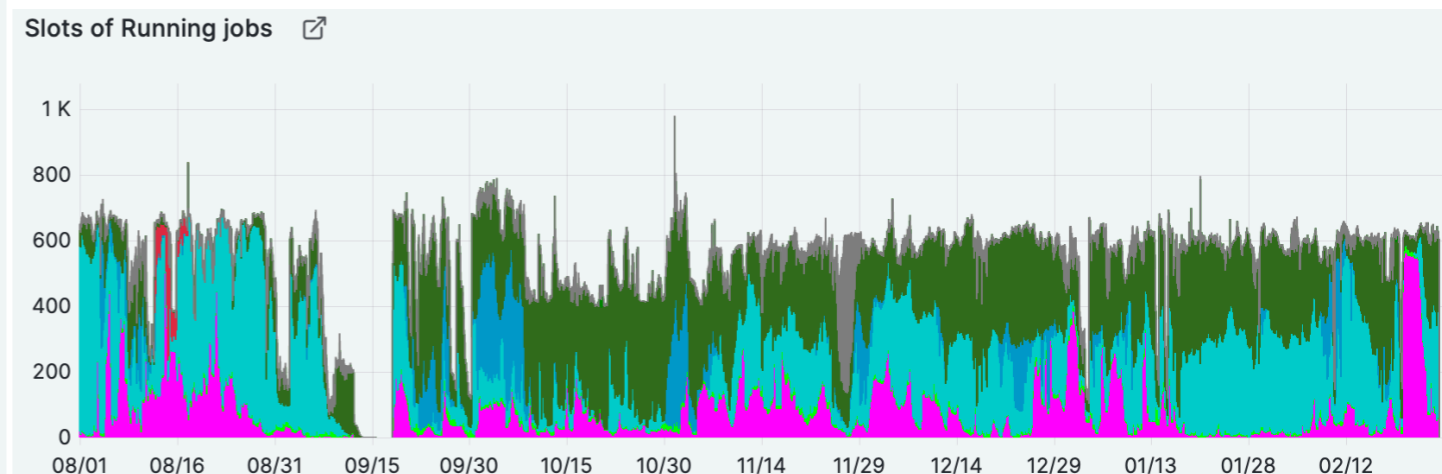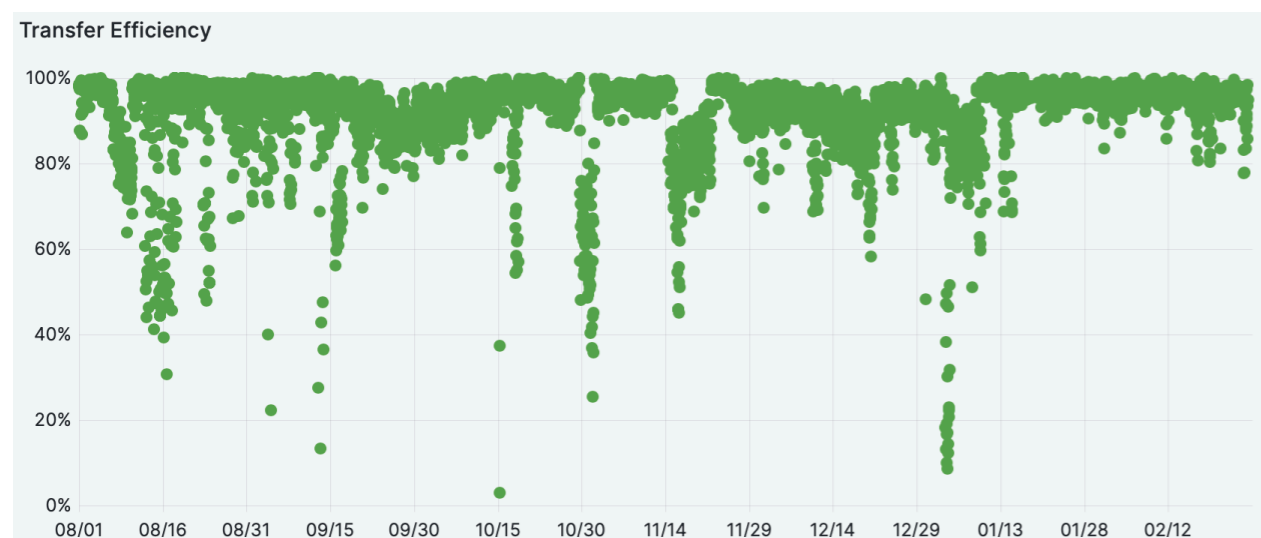
CMS Tier3

- **CMS T3 is managed by ASGC from 2022, in collaboration with TIDC and local CMS groups (NTU and NCU)**
- **Analysis facility: 6,496 CPUCore-Days, 1,727 GPUBoard-Day, 463,422 events processed in 2024**
  - **Both Condor/UI and CRAB/ARC-CE are available**
    - **CephFS shared filesystem: 3TB/group by default**
    - **EOS by xrootd and fuse: 1PB**
  - **Condor cluster**
    - **768 cores(AMD EPYC 7713) + 768 cores (Intel CPU E5- 2650 v4)**
  - **Supporting user's access to CMS data or CRAB jobs submission**
  - **JupyterLab is also available for local user analysis**
- **User training and support are also provisioned**
  - **e.g., using Coffea with template for columnar analysis @ASGC**

tidc-ui01.grid.sinica.edu.tw

TIDC cpu pool

slurm-ui.twgrid.org

NSTC cpu pool
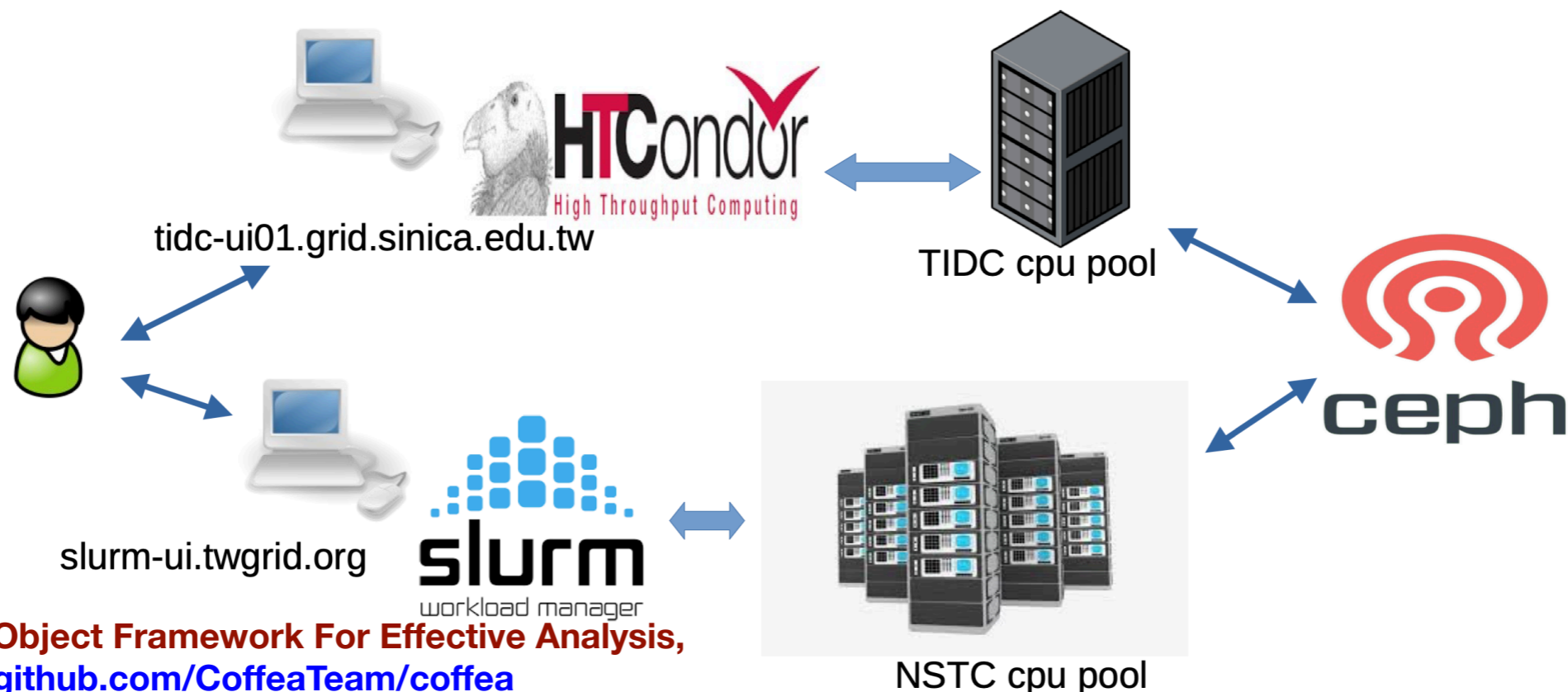
Coffee = Column Object Framework For Effective Analysis,
https://github.com/CoffeaTeam/coffea

Taiwan Contributions in ATLAS

- **AS served as Online Data Quality coordinator for 7 yrs (2017, 2018, 2023, 2025)**
- **Higgs measurements in H->WW decay (NTHU + AS)**
  - **Differential kinematic measurement in HH->WW*->lvlv**
    - **An overall 20% improvements across different kinematic regions**
  - **Quantum entanglement**
- **Search for double Higgs boson in HH —> bb$\tau\tau$ decay**
  - **World best expected sensitivity for single channel**
- **Search CP-odd Higgs boson in A —> ZH —> llbb**
- **High Granularity Timing Detector (HGTD) for ATLAS in HL-LHC**
  - **Taiwan-ATLAS responsible for producing electrical and optical fiber cables, and implementing a production database**
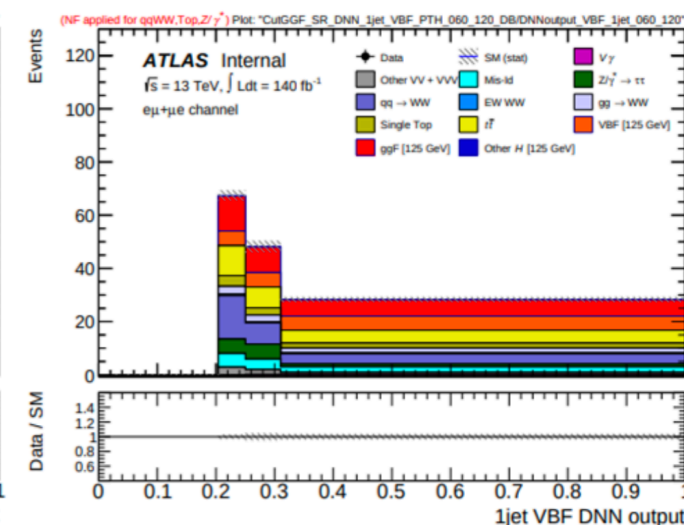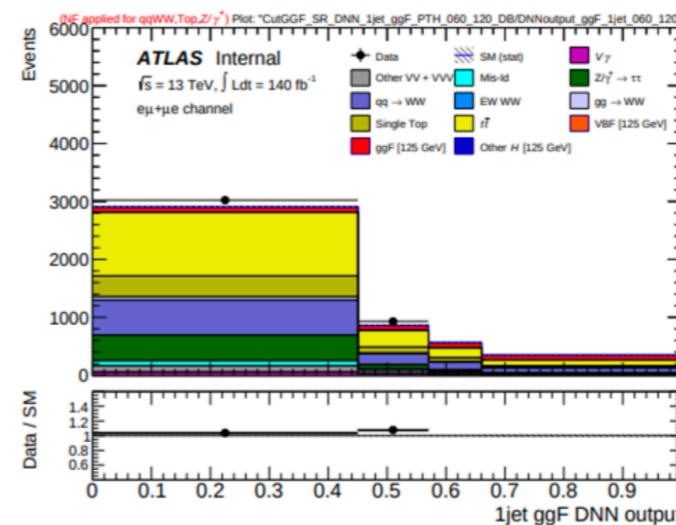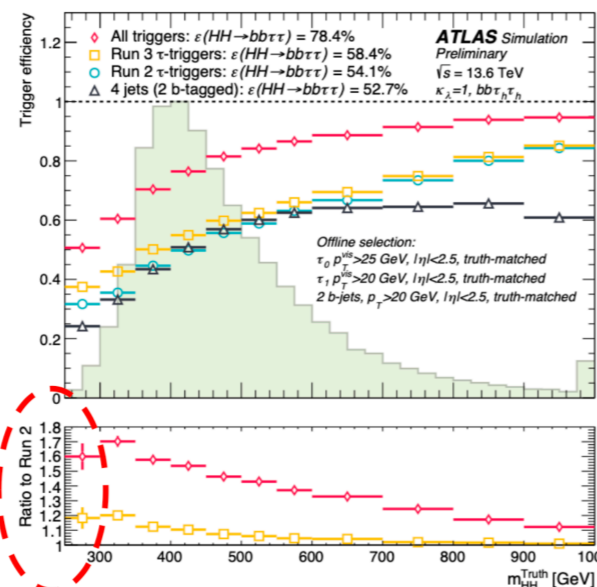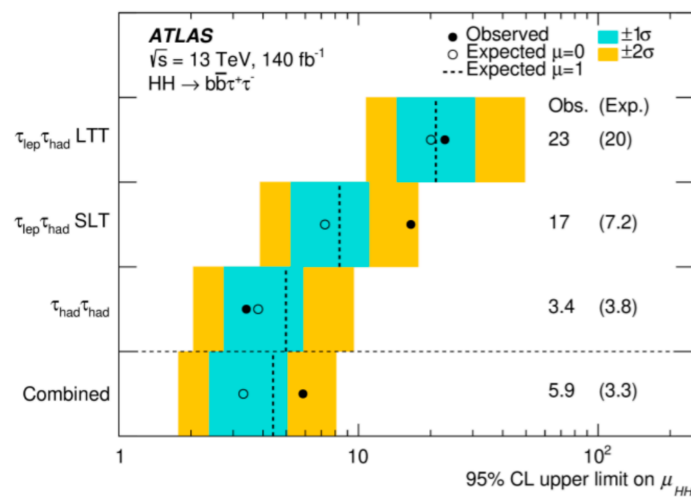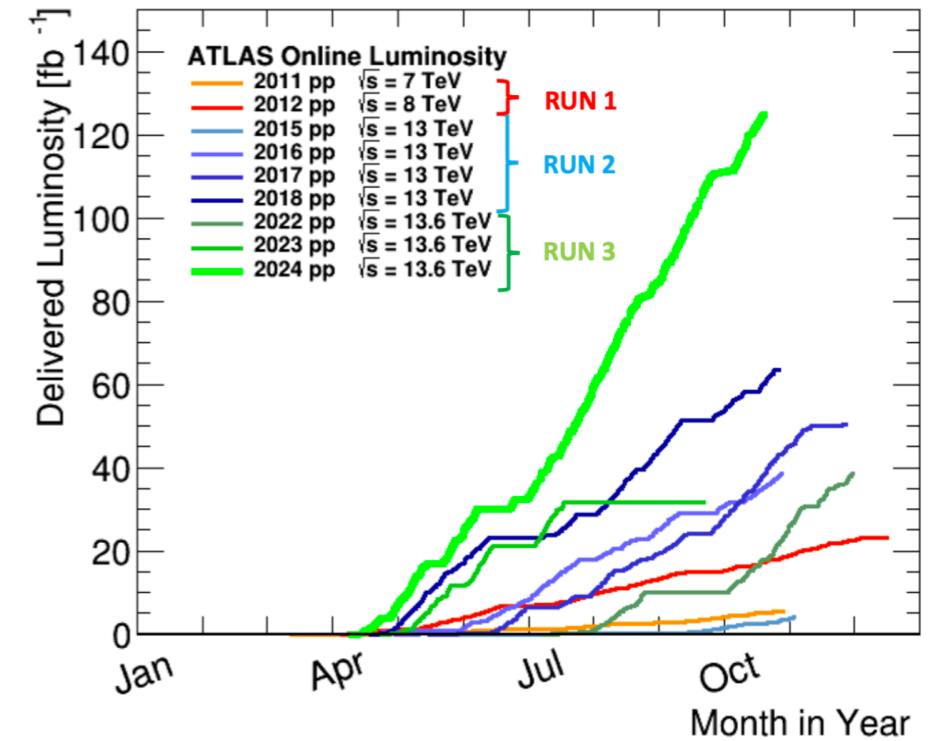
HH trigger acceptance improvement

GGF and VBF DNN in the 1 jet category