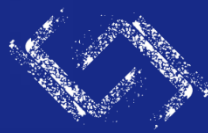




国家高能物理科学数据中心

National HEP Science Data Center



高能所计算中心

IHEP Computing Center

IHEP Projects and Plans

Xiaowei Jiang, Tao Cui, Fazhi Qi

IHEP Computing Center

2024-10-09



1 About IHEP and Projects

2 About IHEP-CC

3 WLCG in China

IHEP Overview



History

1950

1953

1958

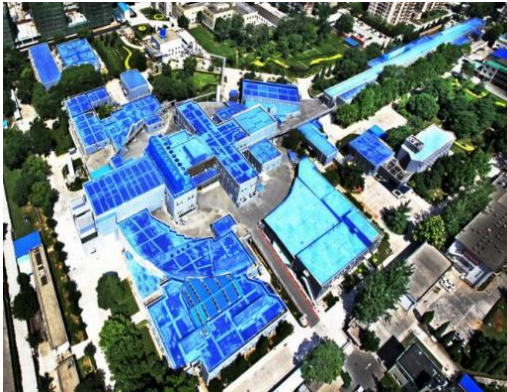
1973

Institute of High Energy Physics



IHEP' real start is from the construction of Beijing Electron Positron Collider (BEPC) in 80's, and now is a large and comprehensive center for HEP and multidisciplinary research.

~1,500 employees, ~1,000 graduate students and an annual budget of ~ 500M\$
4 campuses



Shijingshan, Beijing

Beijing Electron Positron Collider



Dongguan, Guangdong

China Spallation Neutron Source



Huairou, Beijing

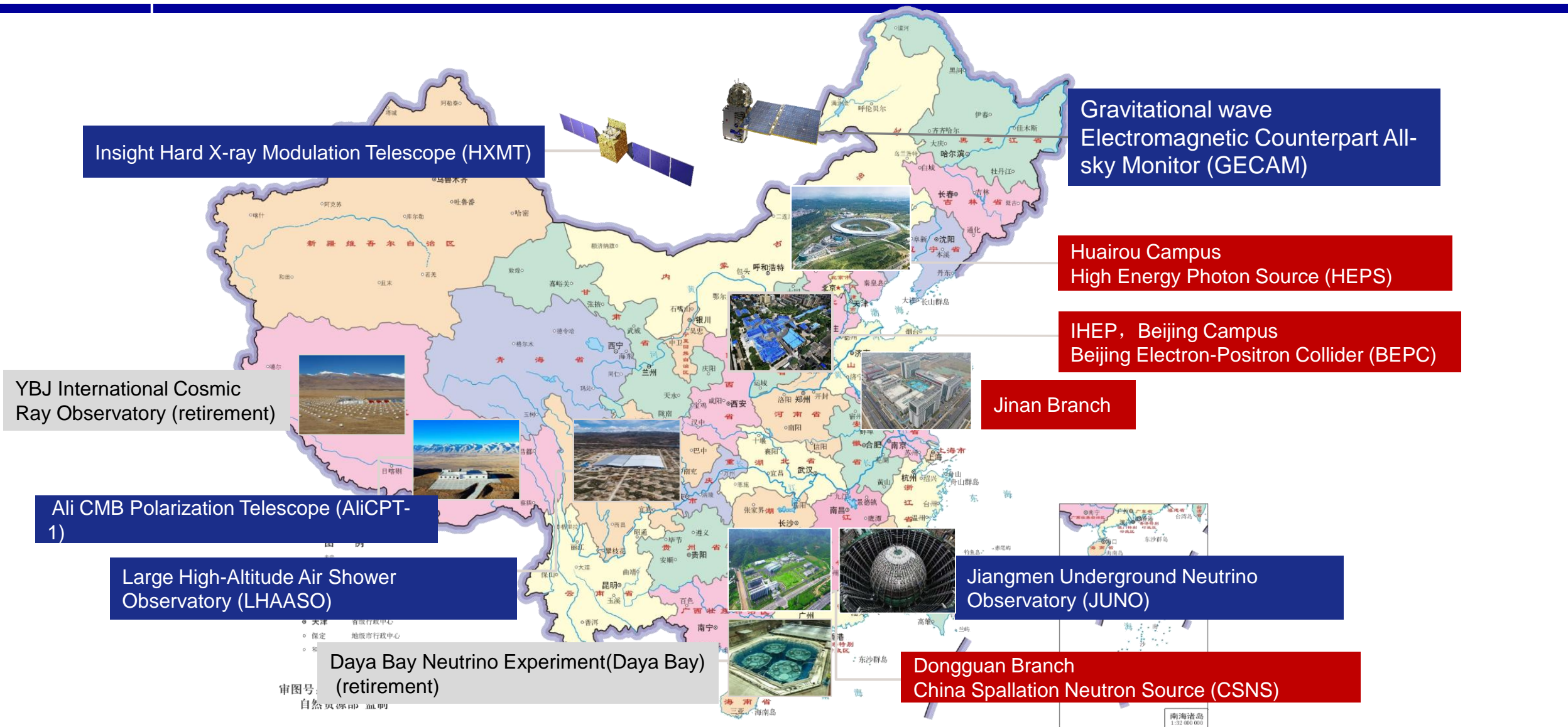
High Energy Photon Source



Jinan, Shandong

Technology Transfer

Large Science Facilities

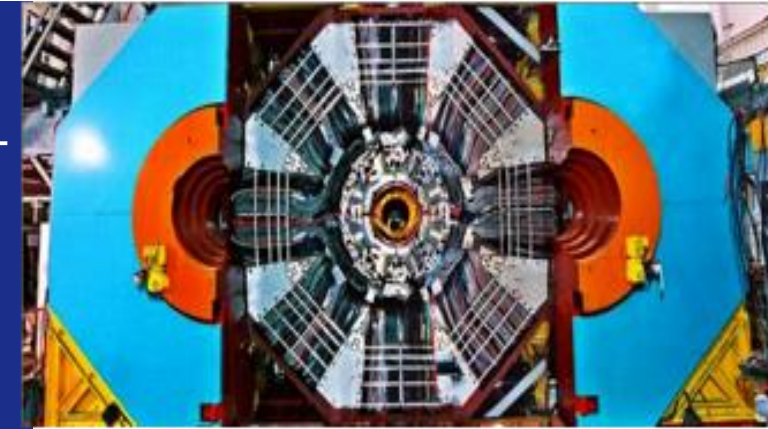


Beijing Electron-Positron Collider II Beijing Spectrometer (BESIII) Experiment



- For hadron physics and τ -charm physics with the highest accuracy
- The peak luminosity of the double-ring e^+e^- collider (BEPCII) is $10^{33}\text{cm}^{-2}\text{s}^{-1}$ at center-of-mass energy 3.78 GeV
- BESIII International Collaboration

Country/region: 16; University/Institutions: 85; Collaborators: ~600

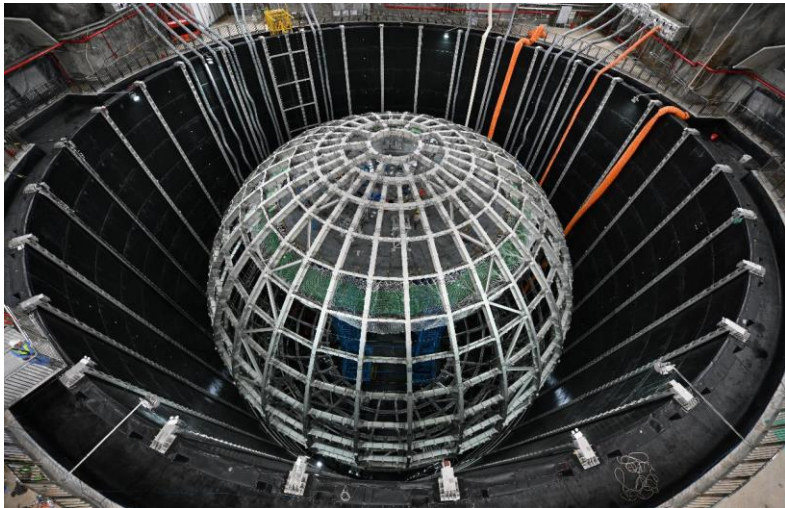


Jiangmen Underground Neutrino Observatory (JUNO)



- A 20 kt liquid scintillator detector with unprecedented 3% energy resolution (at 1 MeV) under the 700-meter overburden
- **Science:** To determine neutrino mass hierarchy and precisely measure oscillation parameters, observe supernova neutrinos, solar neutrinos, geoneutrinos, ...
- Construction will be completed in 2024
- JUNO International Collaboration

Country/region: 17; University/Institutions: 74; Collaborators: 754

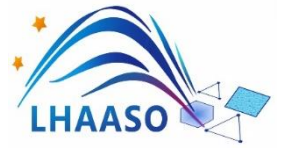


JUNO Experiment

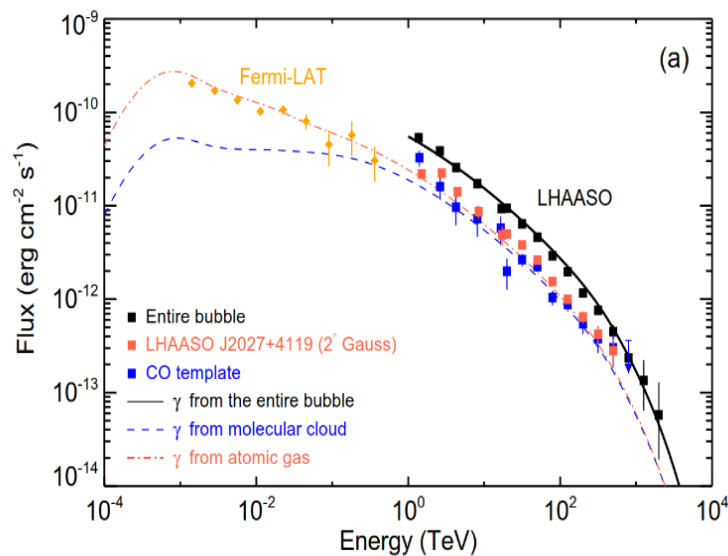


23rd JUNO Intl Collaboration meeting held from Feb. 22- 26, 2024

Large High Altitude Air Shower Observatory (LHAASO)



- World largest air shower array (with e, m, water Č detectors and Č telescope) for the high energy γ -astronomy and cosmic-ray physics
- Construction completed in 2023 and interesting results came out:
 - Highest γ -rays from the Milky Way: 2.5 PeV
 - 43 identified γ -rays sources up to ~ 1 PeV \rightarrow PeVatrons in the Milky Way
 - Energy spectrum of high energy γ -rays from the Crab Nebula as the standard candle
- International Collaboration : Countries/regions:5, members:~300
 - French colleagues actively involved: University Paris City



High Energy Photon Source (HEPS)



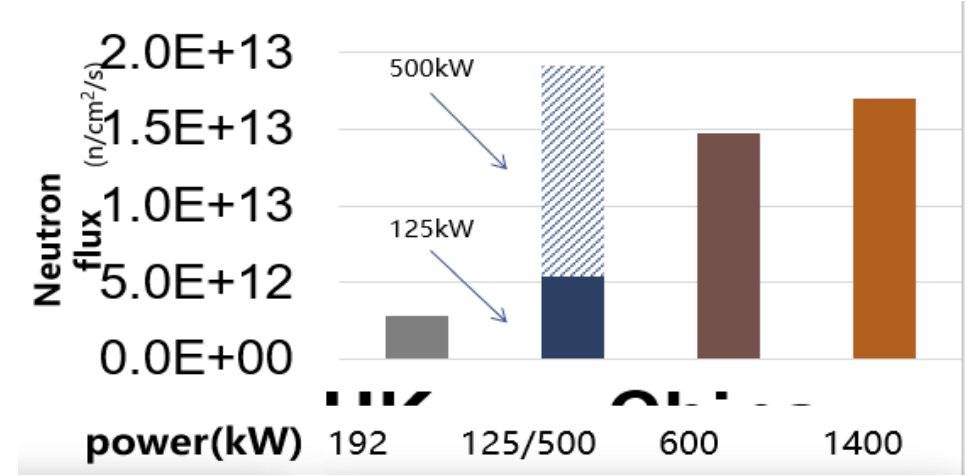
- The first 4th generation synchrotron in Asia
- Civil construction completed in 2022,
- Project scheduled for completion in 2025
- Source Optimisée de Lumière à Energie Intermédiaire du LURE(SOLEIL): the national synchrotron in France
- Two sides mainly work on position and acquisition control in light sources



China Spallation Neutron Source (CSNS)



- Located in Dongguan, south of China
- Smooth operation since 2019 with an efficiency > 90%
- Power reached 120 kW, 20% higher than design
- 8 beamlines, 2 to be completed

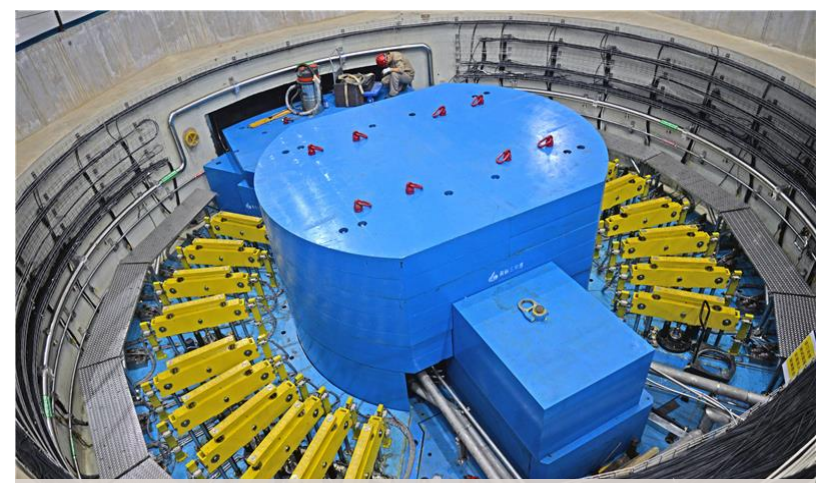


CSNS → CSNSII

- Beam power: 100 kW → 500 kW
- Add 10 more beamlines
- Team beam facility + muon beams
- Construction started 2024



Bird's View



Target Station

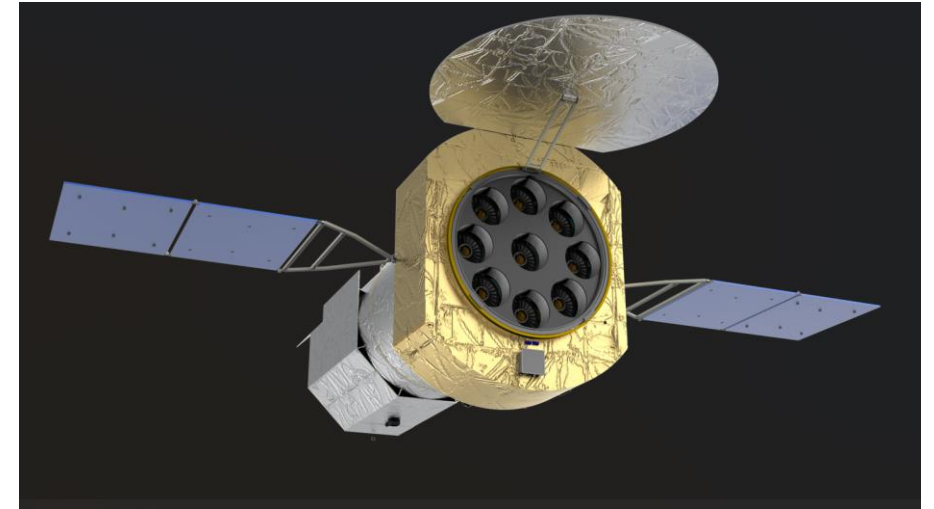
Space Programs

China Space Station: High Energy cosmic-Radiation Detector (HERD)



- 3D crystal calorimeter for dark matter searches and cosmic-rays
- Acceptance & energy range $\times 10$
- Selected for the Chinese Space Station, to be launched in ~ 2027
- In collaboration with Italy, Sweden, Switzerland, ...

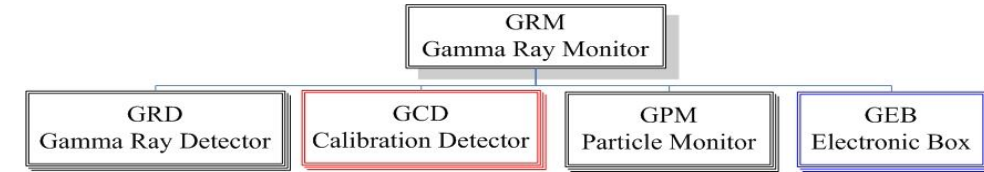
enhanced X-ray Timing and Polarimetry (eXTP) Observatory



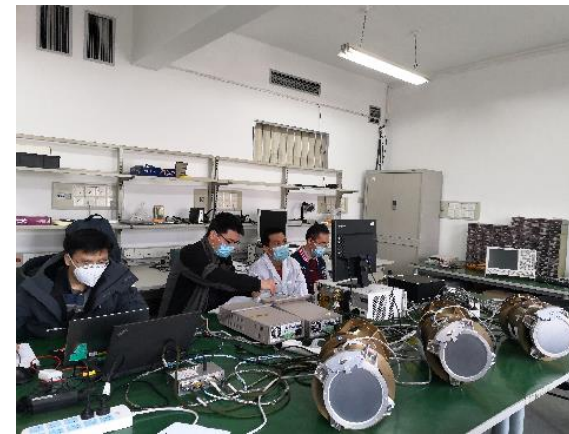
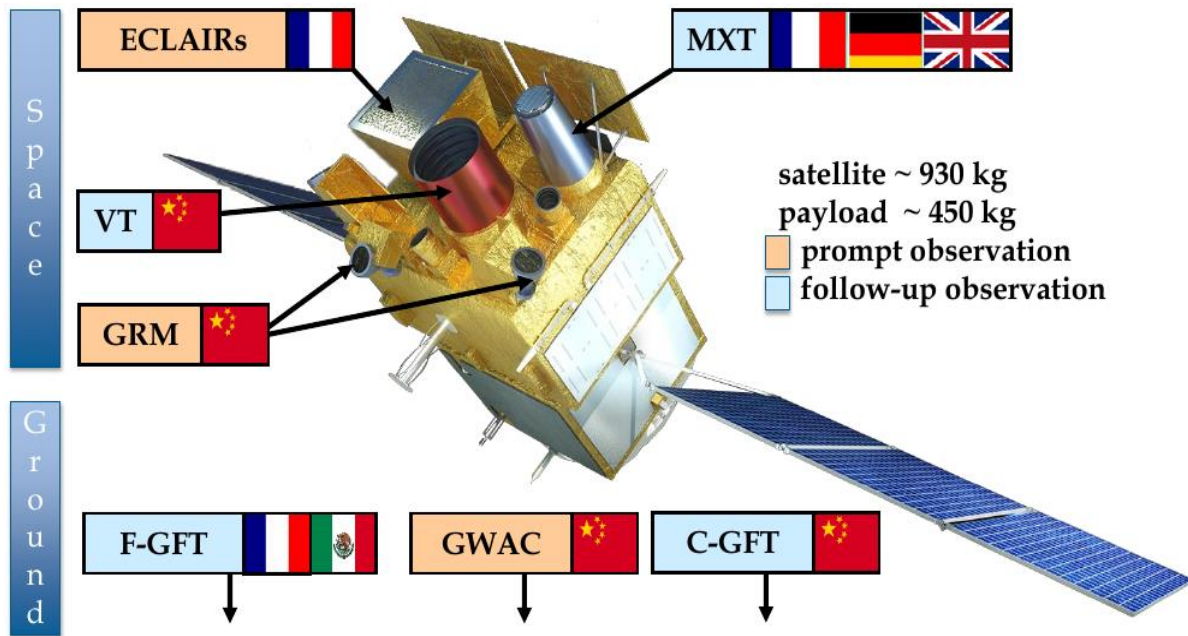
- the next generation telescope for “**Enhanced X-ray Timing and Polarization Mission**”
- A leading flagship observatory for black holes, neutron stars and extreme physics, to be launched in ~ 2027
- A large international collaboration with major German participation

Collaboration on Space Program: SVOM/GRM (Gamma-Ray Monitor)

- Launched in June 2024, with lifetime of 3+2 years
- GRM: gamma-ray monitor with wide field of view developed by IHEP
 - Location, Spectrum, Temporal characteristics of bursts



Nal(Tl): X-ray detector (15~5000 keV)
3 GRDs with different orientations

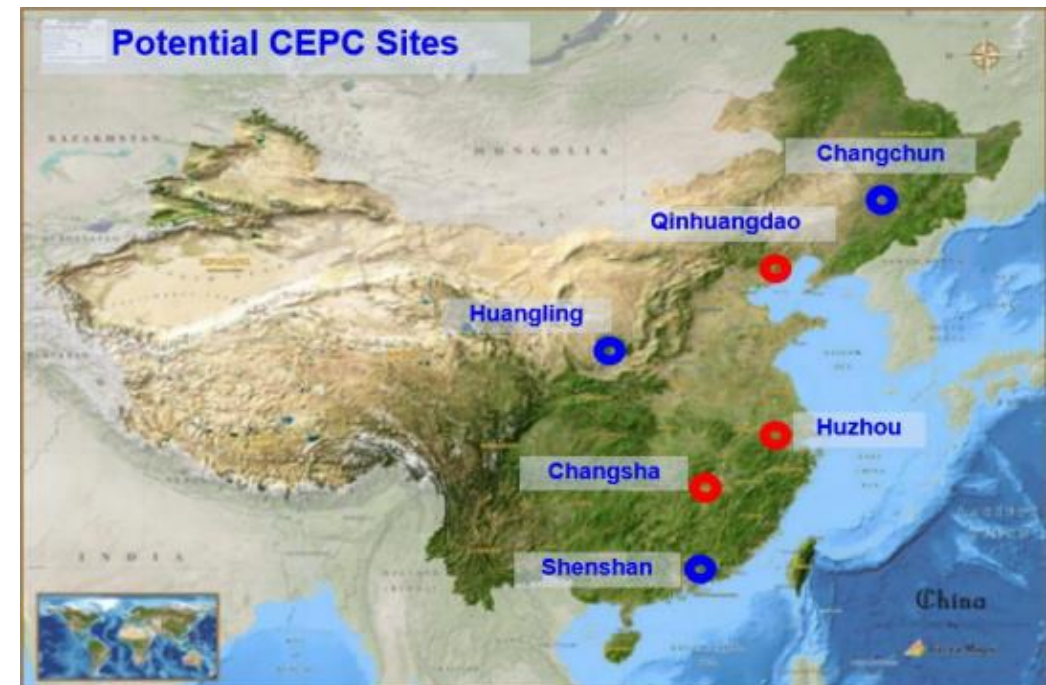
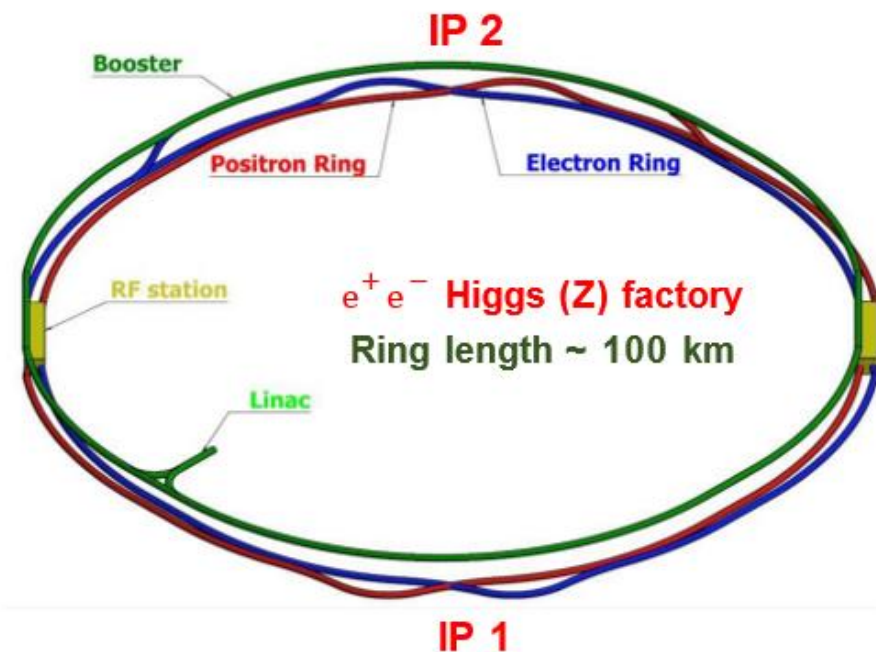


Acoustic and vibration tests on SVOM carried out in August of 2023 in Shanghai

Circular Electron Positron Collider (CEPC)



- CEPC is an e^+e^- Higgs factory producing Higgs / W / Z bosons and top quarks, aims at discovering new physics beyond the Standard Model
- Proposed in September 2012 right after the Higgs discovery
- Upgrade: Super pp Collider (SppC) of $\sqrt{s} \sim 100$ TeV in the future.



<http://cepc.ihep.ac.cn>

International Cooperation

- Play an active role in many international cooperative projects:
ATLAS, CMS, LHCb, AMS, Belle-II, PANDA, EXO, ILC, etc.
- Develop a long-term cooperative relationship with the US, European and Asian countries
- Host international large science projects and welcome participation around the globe:
BESIII, JUNO, LHAASO, CEPC, HERD, eXTP, etc.





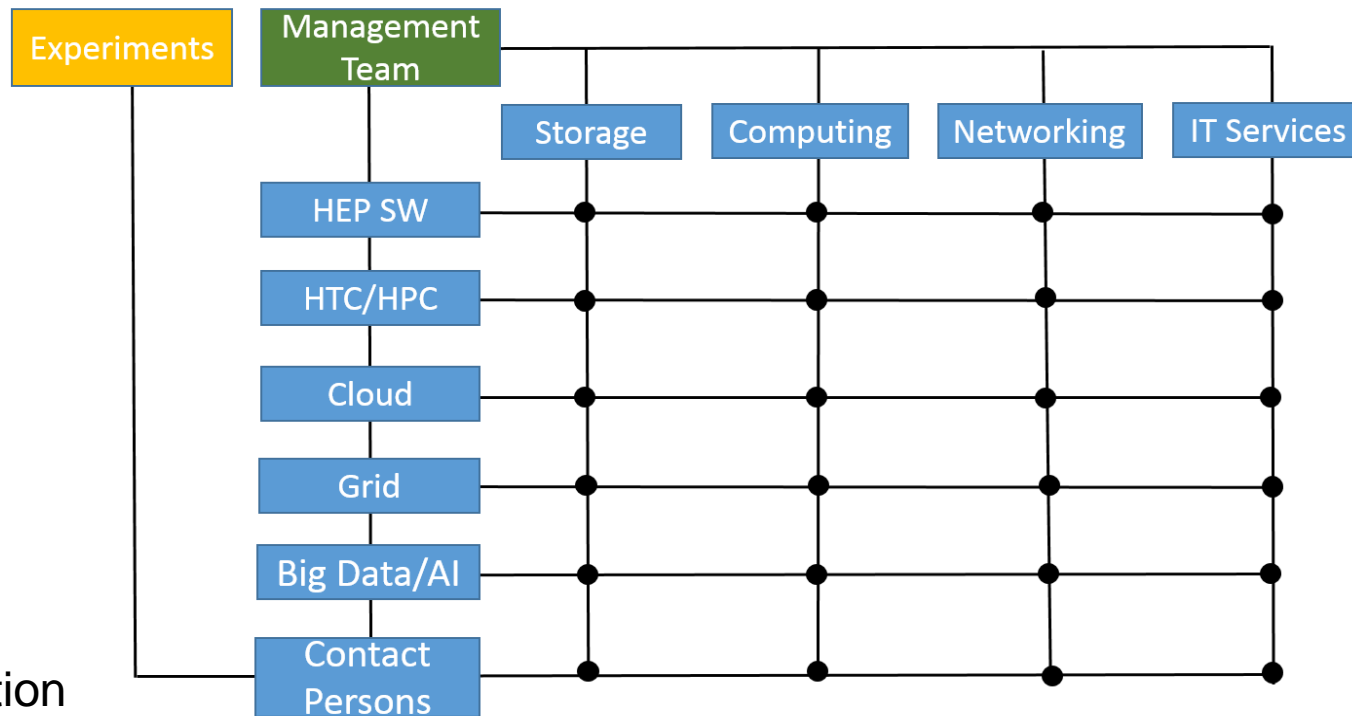
❖ Mission

1. Provides high performance computing environments for HEP experiments

- Facilities
- Computing
- Storage
- Network
- Software

2. Research & Development on IT

- to promote scientific research and discovery
 - Network , Storage, Computing, Software
- to facilitate management and improve operation efficiencies of the institute
 - Information services development and deployment





- Human resources of IHEP-CC (~100 member)
 - Currently ~60 staffs, 6 post doctors, 15 visiting members, 28 master and Ph.D. students
- Research fields

Computing and Storage

- High Performance Computing
- High Throughput Computing
- Grid/Cloud computing
- Distributed storage

Network and Cyber security

- Datacenter and campus network
- Dedicated link for remote experiments
- International network collaboration

IT Services

- Database technology and application
- Conferencing Technology
- Institutional management tool

Scientific Software

- Open data and open science
- Scientific data management
- Scientific software framework

Innovation

- Big data
- AI for science
- Quantum computing

Data & Computing Requirements



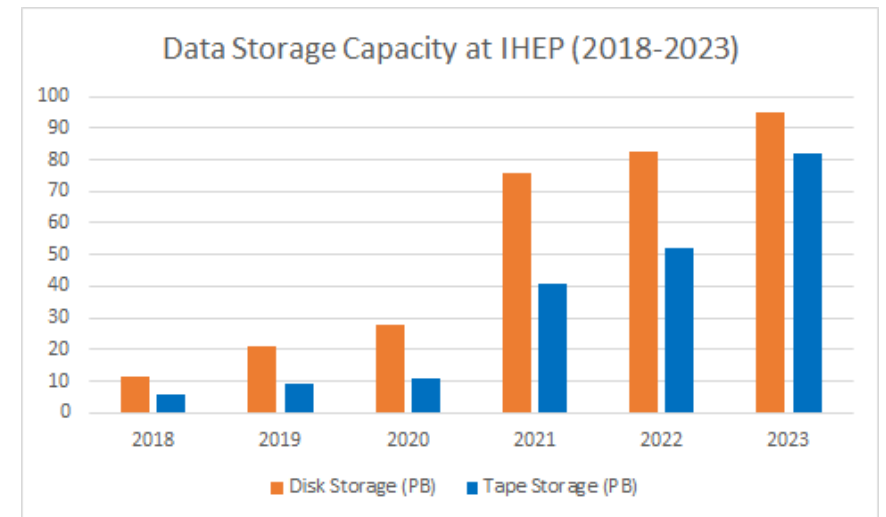
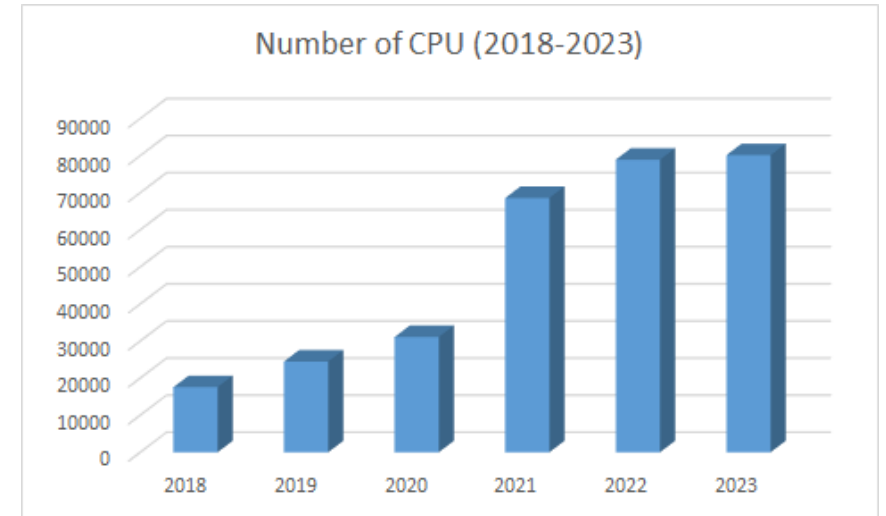
Research Areas	Experiment	Demand Characteristics	Storage (per year)	Computing	Exp. Location	Status
Particle Physics	BESIII	HTC	2 PB	20,000 CPU Cores	Beijing	Running
	DYB		500 TB	3,000 CPU Cores	Guangzhou, Guangzhou	Running
	JUNO		3 PB	5,000 CPU Cores 5,000 CPU Cores	Jiangmen, Guangdong	Data-taking Stopped
	CEPC		>500PB	2,500 CPU Cores >1,000,000 CPU Cores	TBD	Pre-research
	LHC		10 PB	6,000 CPU Cores	WLCG T1/T2 Sites	Running
Particle Astrophysics	LHAASO		10 PB	23,000 CPU Cores	Daocheng, Sichuan	Running
	HXMT/GECAM/AlIcPT		500 TB	5,500 CPU Cores	Beijing	Running
	HERD		3 PB	7,000 CPU Cores 4,000 CPU Cores	Beijing	Pre-research
	eXTP		400 TB	2,000 CPU Cores	Dongguan, Guangdong	Pre-research
Multidiscipline	CSNS SPS		HTC+HPC	1 PB >300 PB	15,000 CPU Cores >10,000 CPU Cores	Huairou, Beijing
	HEPS	>300 PB		2000 CPU Cores >10,000 CPU Cores	Huairou, Beijing	Under Construction
Theoretical Physics	Lattice QCD	HPC	1 PB	>1P Flops (double)	Beijing	Running
Accelerator/Dector /Beamline Design			1 PB	>1P Flops (double)	Beijing	Running

Computing - "One Platform, Multi Center"

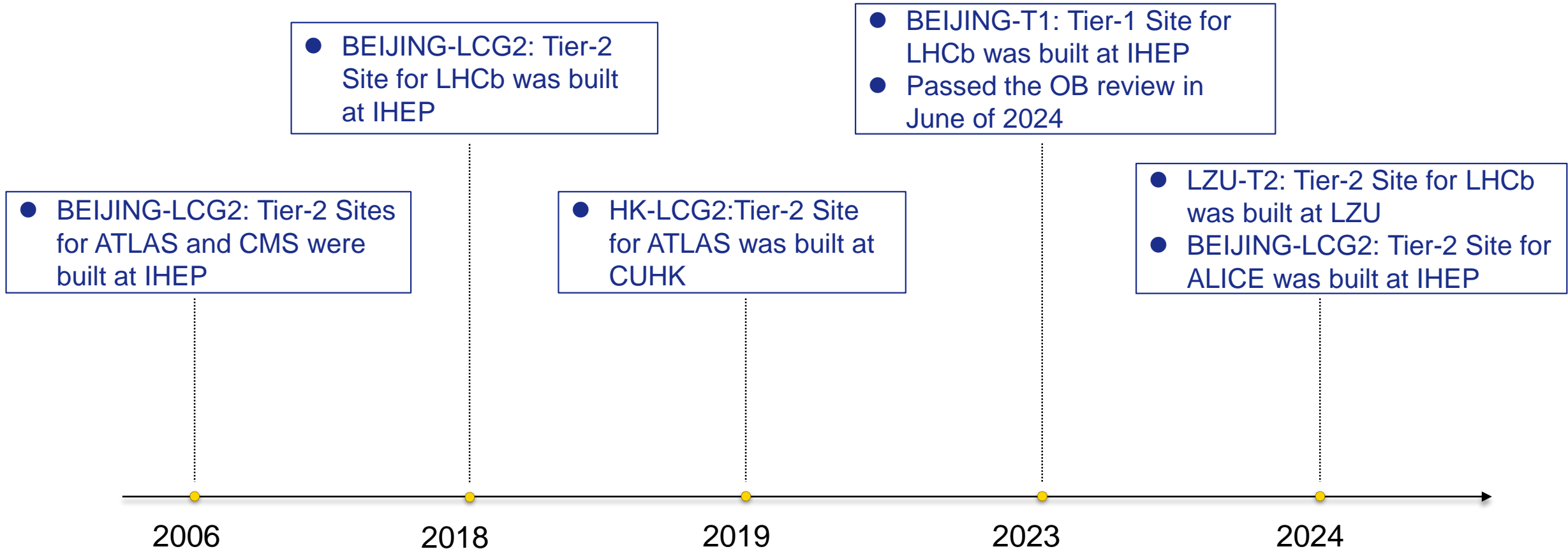




- Distributed centers
 - Beijing, Huairou, Dongguan,
 - Daocheng, Jiangmen, ...
- HTC and HPC for 28 experiments/projects
- Data archive and sharing for HEP projects of China
- Quantity of resources grew exponentially
 - >100K CPU cores
 - >110 PB Disk Storage
 - >130 PB Tape Storage



WLCG History in China



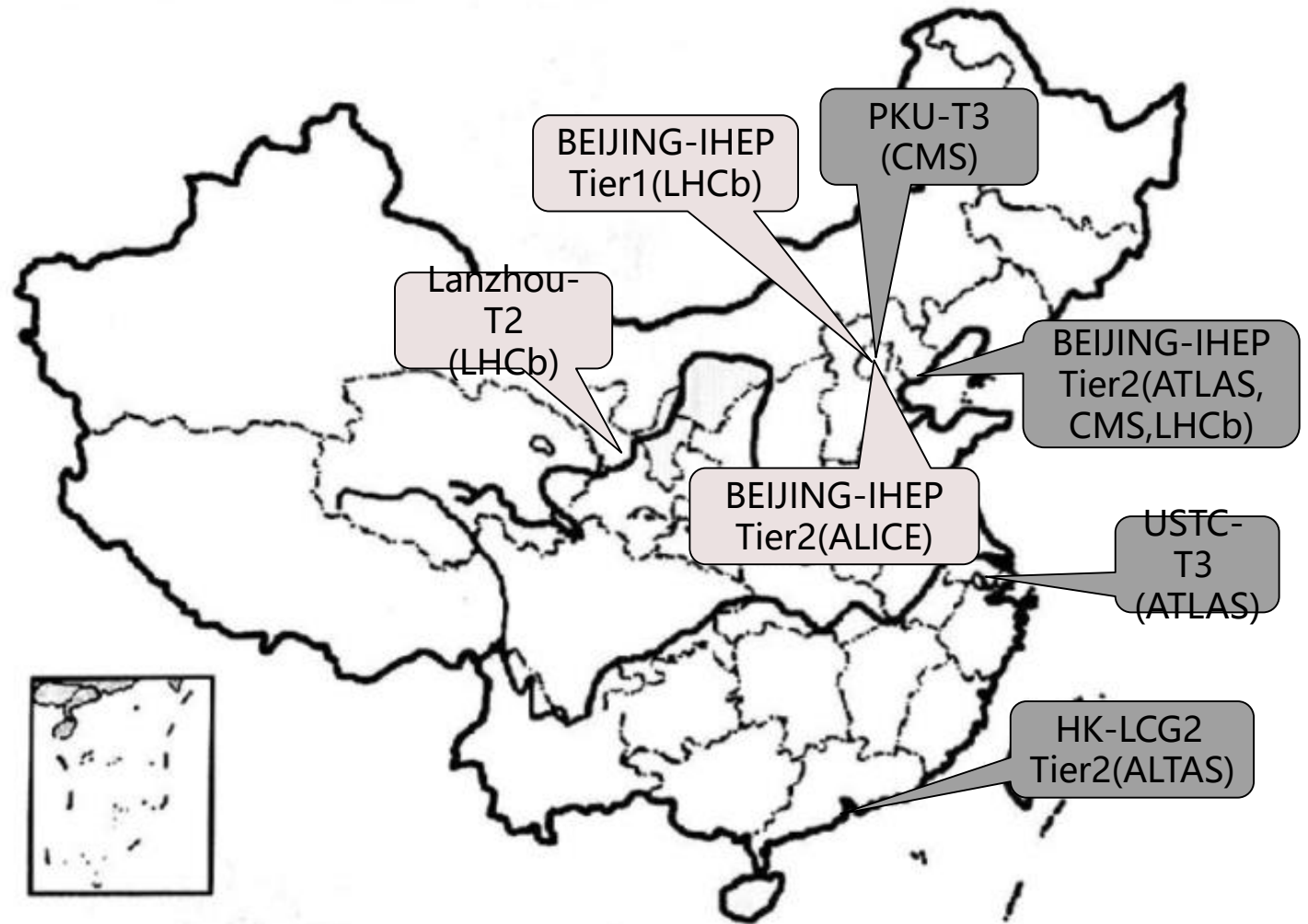


- Tier-2 sites

- BEIJING-IHEP (ATLAS, CMS, LHCb)
- HK-CUHK(ATLAS)

- New Sites

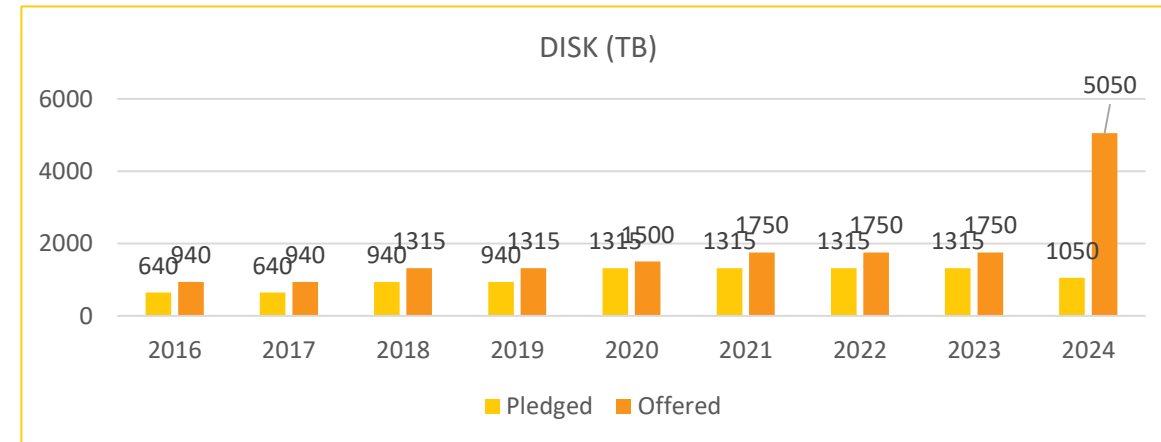
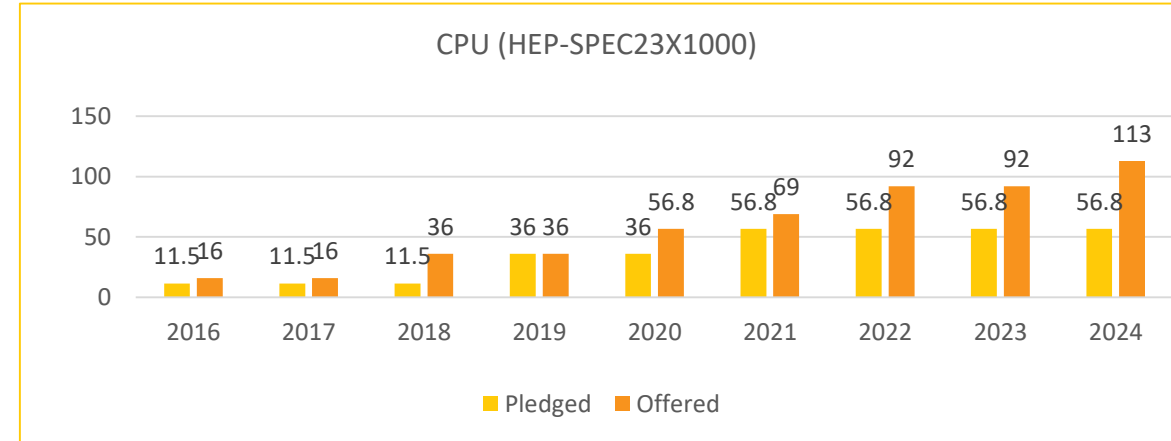
- Tier-1: BEIJING-IHEP (LHCb)
- Tier-2: LZU-T2 (LHCb)
- Tier-2: BEIJING-IHEP (ALICE)



The Status of WLCG Sites at IHEP



- CPU: 5256 cores with ~113k HS23
 - LHCb T1: 3216 Cores (~6000 CPU cores in 2025)
 - ALICE T2: 1152 Cores
 - ATLAS T2: 444 Cores (update to 1536 in 2024)
 - CMS T2: 444 Cores (update to 1536 in 2024)
- Disk Storage: 5.1 PB
 - LHCb T1: 3.2 PB (>10PB in 2025)
 - ALICE T2: 0.84 PB
 - ATLAS T2: 0.4 PB (update to 1.1PB in 2024)
 - CMS T2: 0.65 PB (update to 1.4PB in 2024)
- Tape Storage: 3PB
 - LHCb T1: 3PB (10PB in 2024 and 20PB in 2025)

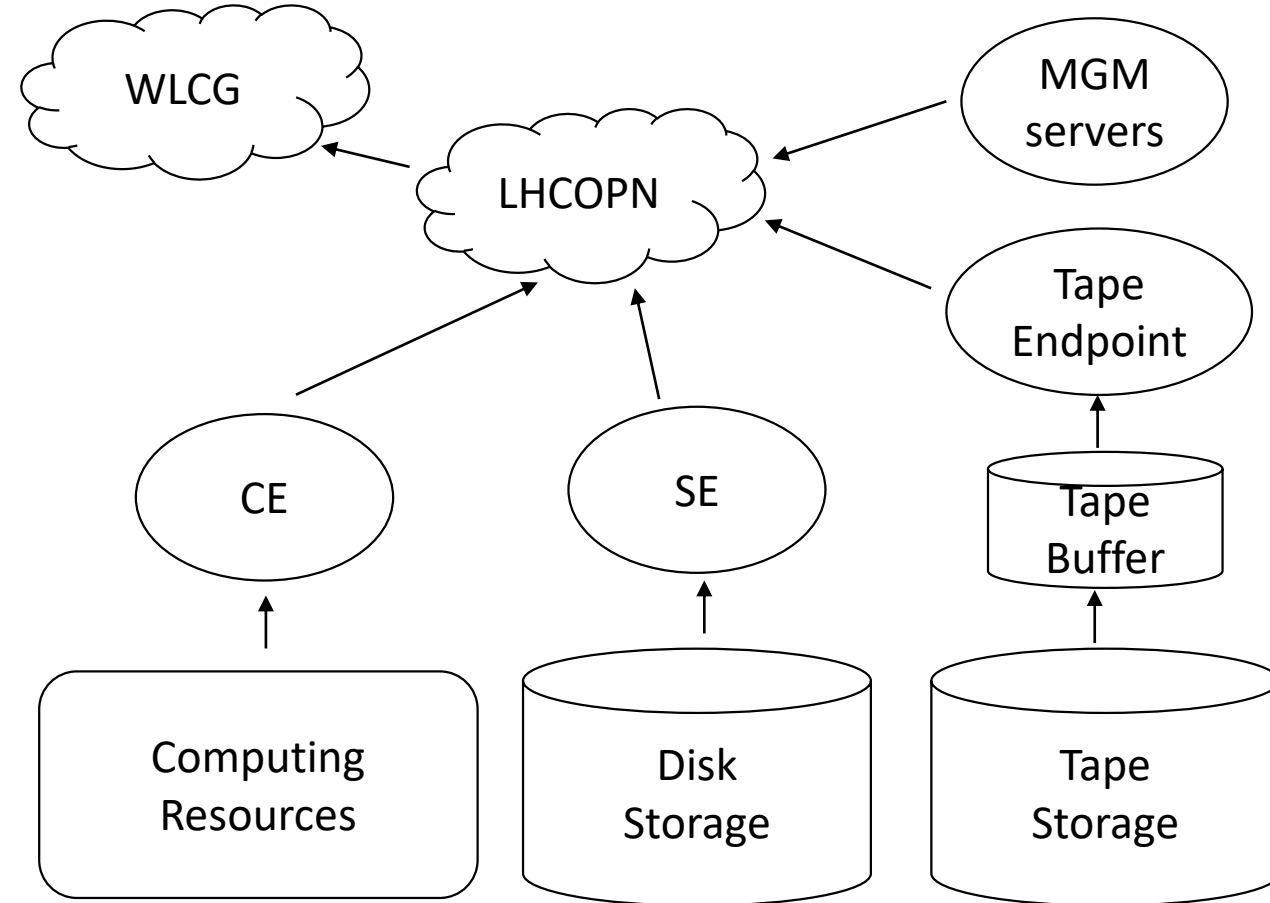


Computing and Storage Resources of IHEP sites

The First WLCG Tier1 Site



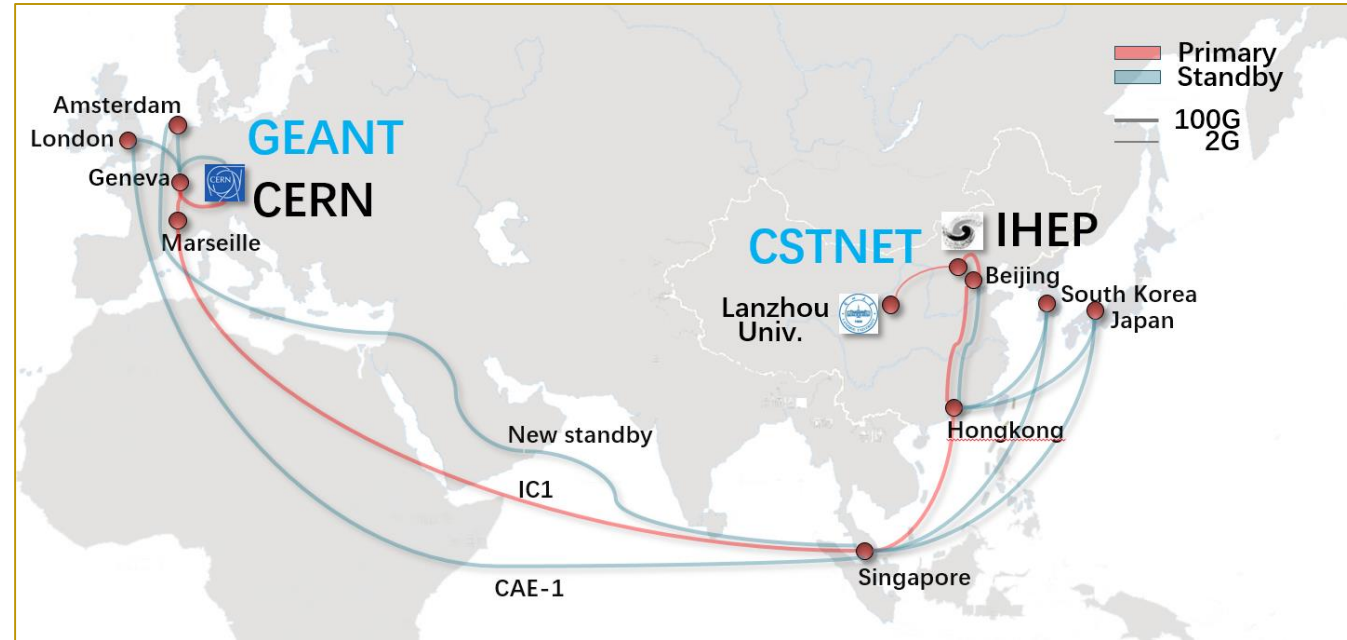
- Building LHCb Tier1 site starts since October 2022
 - Cooperated with Chinese LHCb Collaboration
- First Step
 - Computing: 3216 CPU cores (67 kHS23), 40 worker nodes (Intel & AMD)
 - Disk storage: 3.2 PB, 4 storage arrays
 - Tape storage: 3PB, 4 drivers (IBM) and 170 tapes, LTO-9
- Near Plan
 - Disk storage: 10 PB will be added in early of 2025
 - Tape storage: 10PB in 2024 and 20PB in 2025 and 2~4 drives should be added to match the requirements



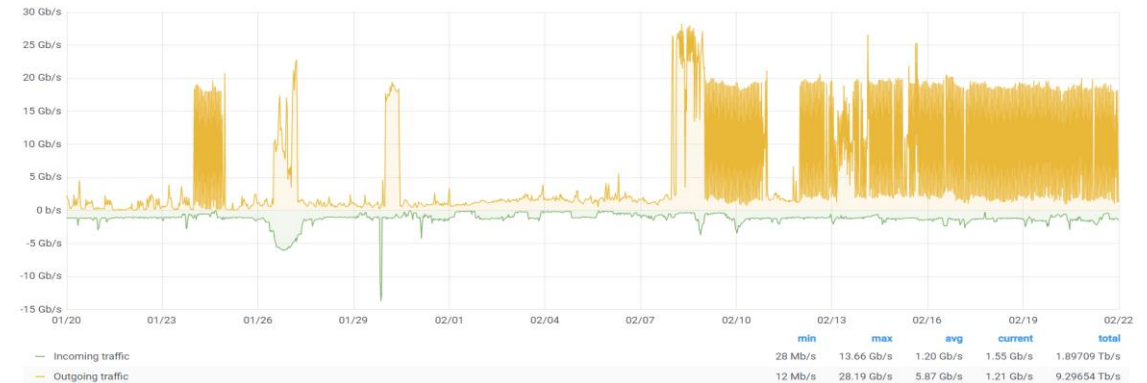
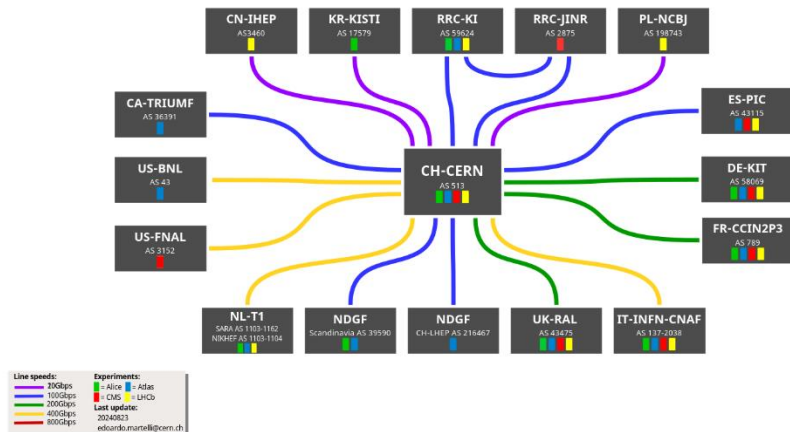
Network for Tier-1



- LHCOPN@IHEP
 - 20Gbps bandwidth ensured
 - 3 links redundancy
- LHCONE@IHEP
 - 100Gbps bandwidth Shared
 - WLCG is the largest user of the links



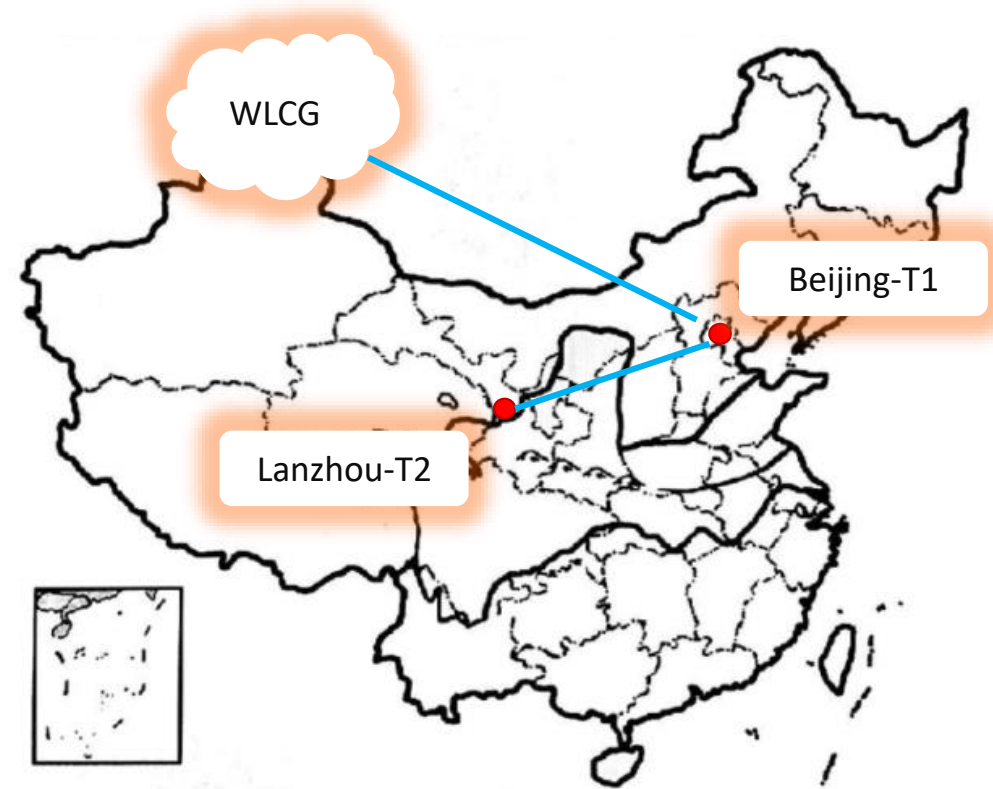
LHCOPN



New LHCb Tier-2 Site at LZU



- A new LHCb Tier-2 site is reaching to be ready at Lanzhou University (LZU)
 - 3520 CPU cores, ~77,000 HS23
 - 3.4PB Disk Storage
 - Dedicated 2Gbps link between IHEP and LZU
- Started to run LHCb jobs and waiting for data test
- Jointly maintained by CC-IHEP and LZU
 - Hardware maintenance: Lanzhou University
 - Software deployment and maintenance: CC-IHEP



New ALICE Tier-2 Site at IHEP



- A new ALICE Tier-2 is reaching to be ready at IHEP
 - Cooperated with Chinese ALICE group, lead by FDU
 - All servers are deployed at the new machine room of Huairou Campus
- Construction started since Dec. 2023
 - 1152 CPU cores, 30,600 HS23
 - 840TB disk storage (Phase 1)
- Going into production

the report of ALICE in WLCG Operation Meeting

- ALICE
 - **Thanks very much to IHEP Beijing** as T2 also for ALICE now!
 - Good job success rates since Aug 20
 - SE fully functional since last week
 - **Maarten:** Worth to mention this is the first time ALICE has significant resources allocated in China

Grid Sites for Other VOs

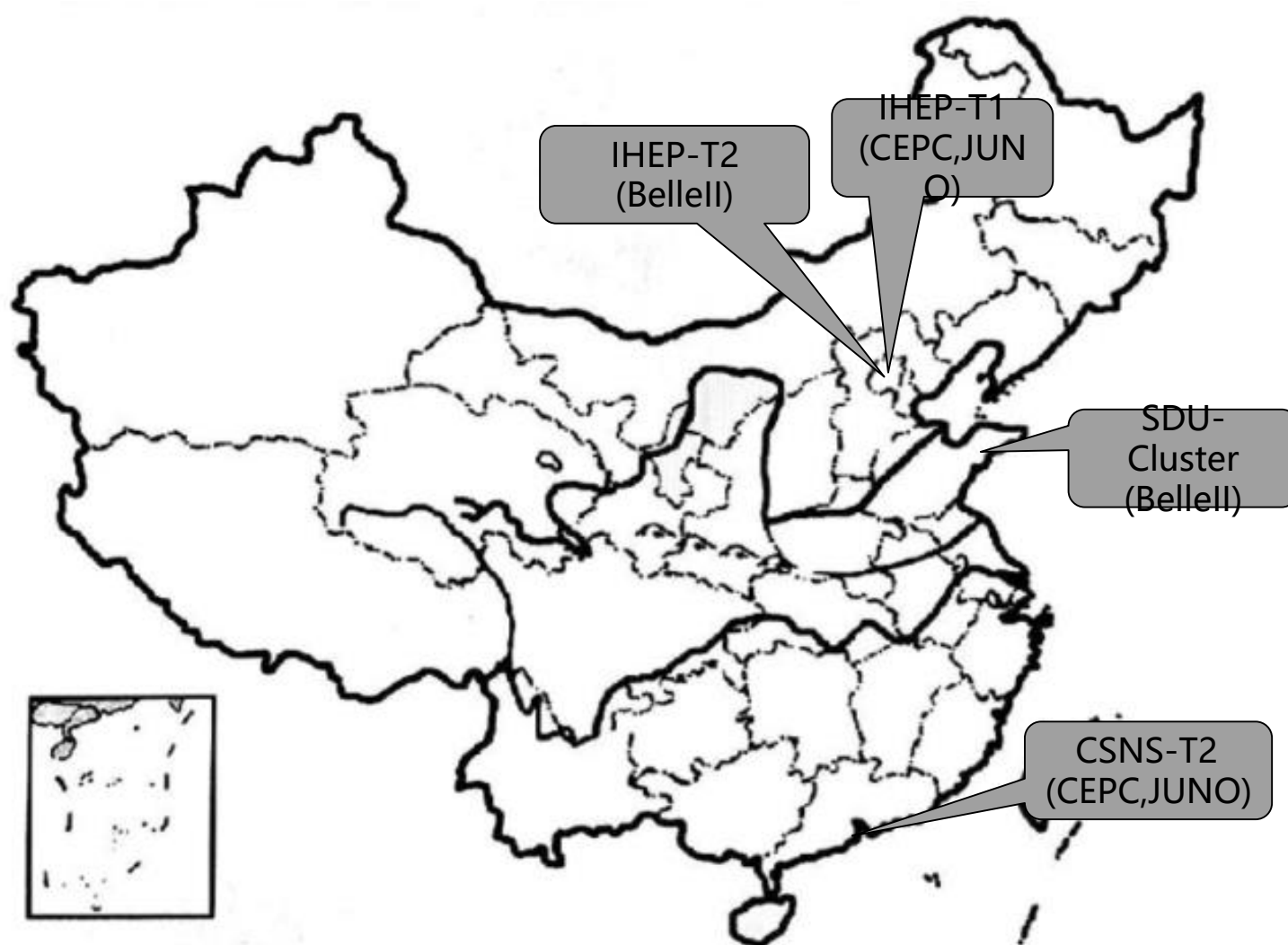


- CEPC & JUNO

- T0&T1 is located at IHEP
- CSNS Tier2 site in Dongguan

- BELLEII

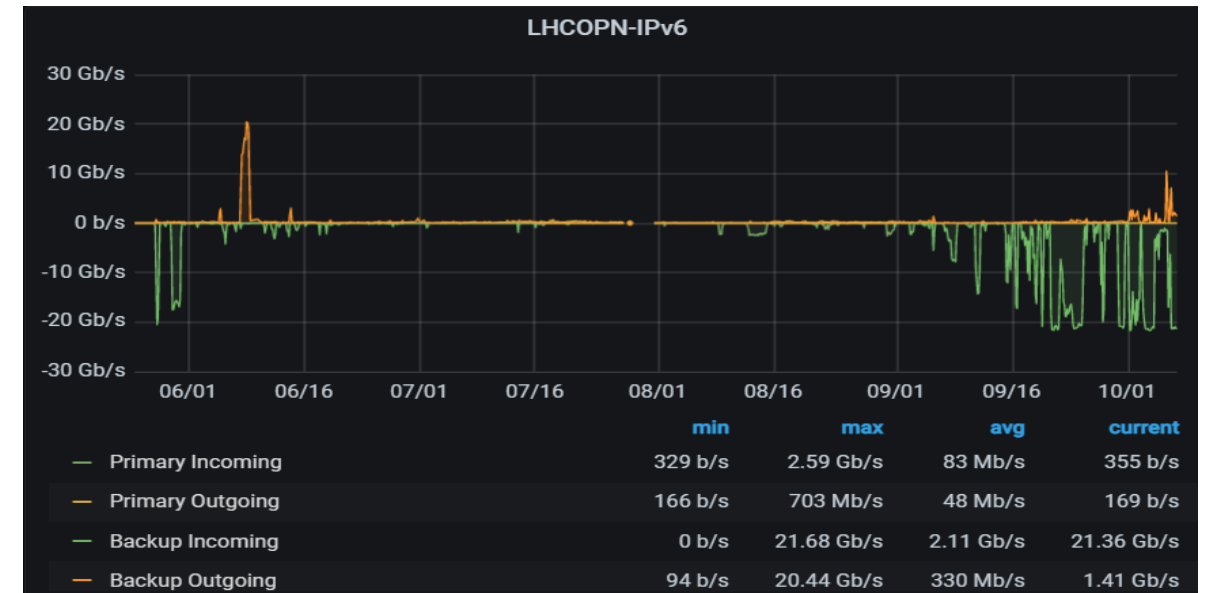
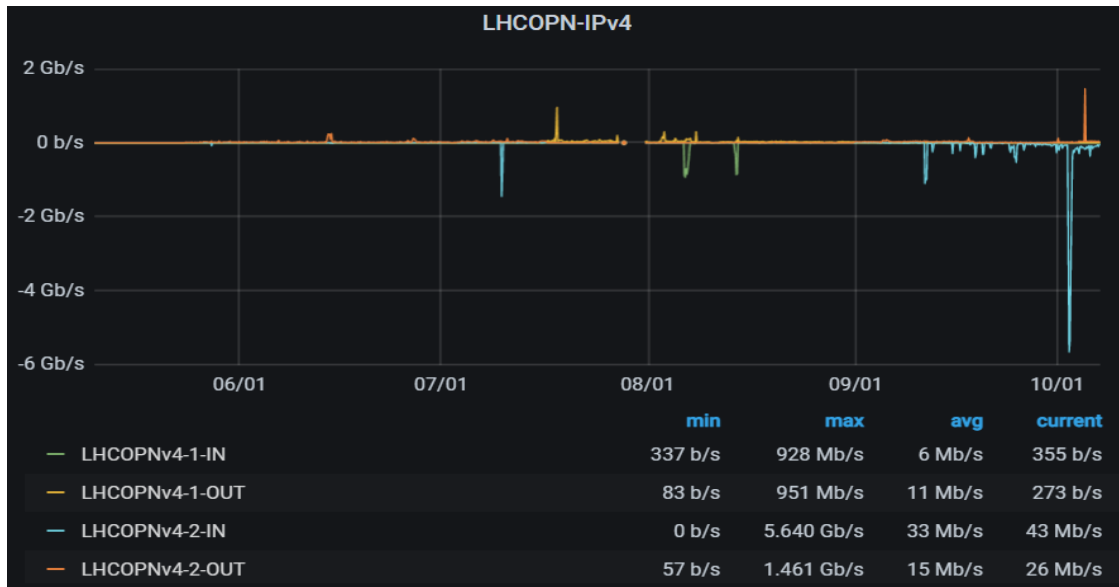
- Tier-2: BEIJING-IHEP
- Cluster: SDU



The Network Status of LHCb T1 @IHEP



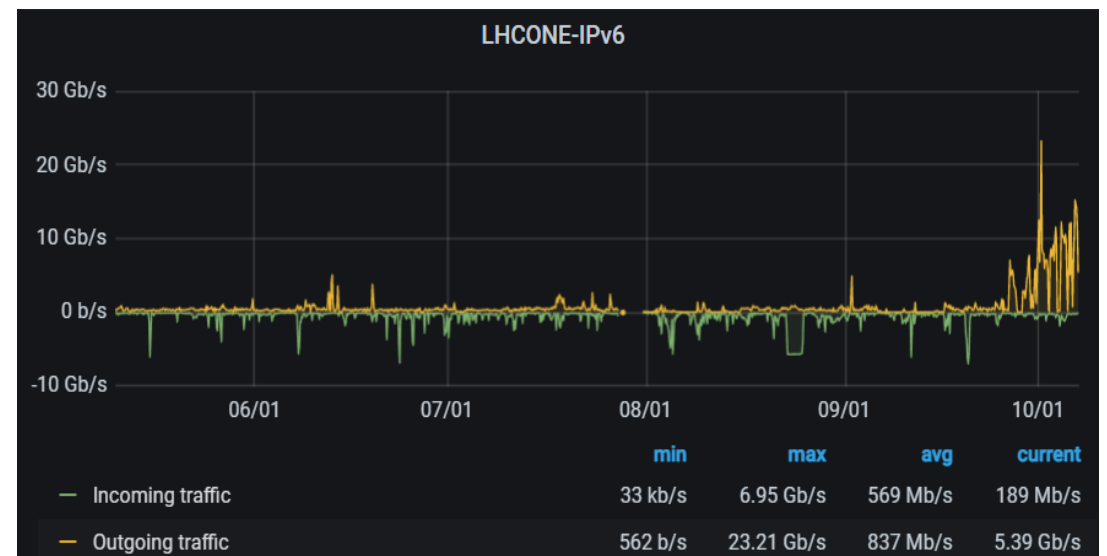
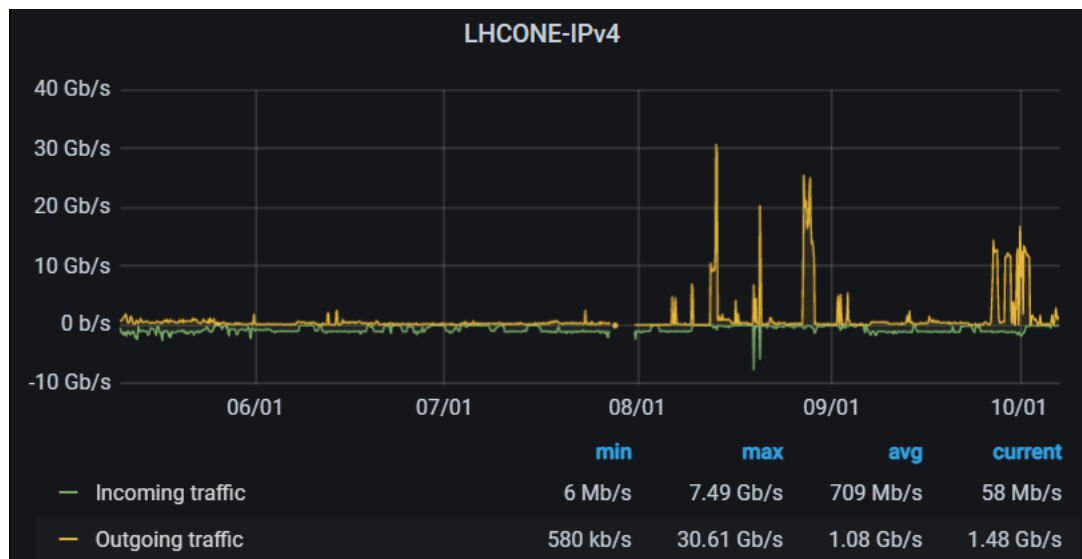
- LHCOPN@IHEP traffic is growing
- Max bandwidth is 22.4Gbps



The Network Status of LHCONE@IHEP



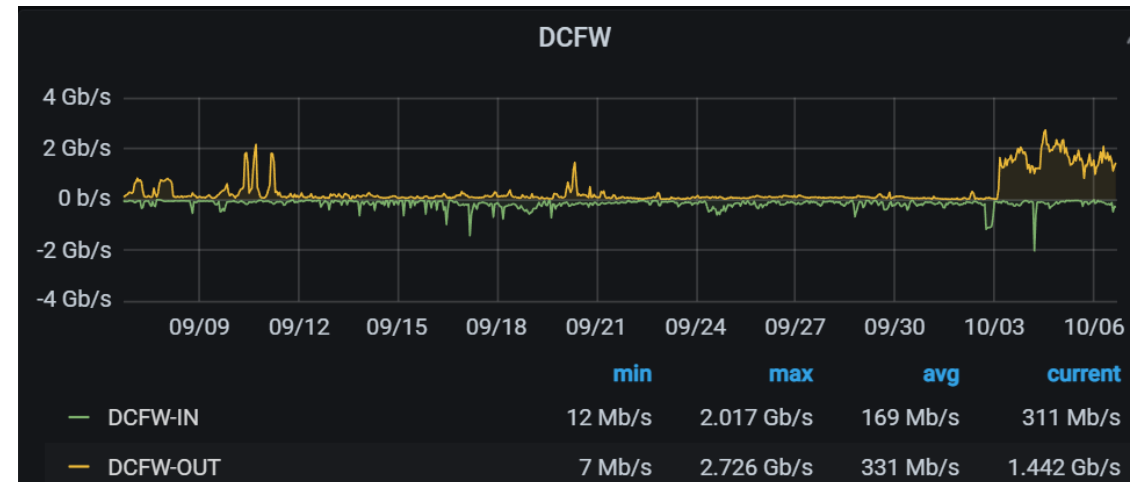
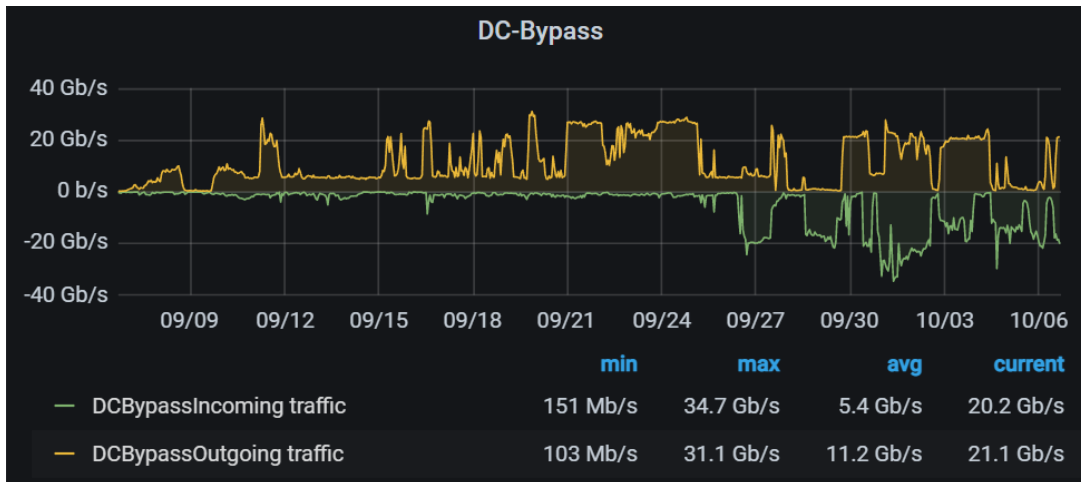
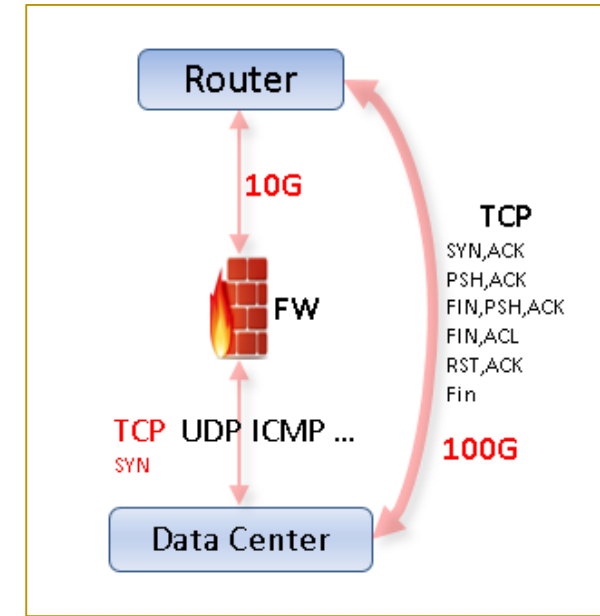
- The 100G link works well and traffic is growing
- The limitation to USA direction because of 10G bandwidth



Scientific Data Traffic Bypass Policy



- Bypass policy
 - Bypass TCP communication except TCP SYN, Support Public-IPv4 and IPv6
 - The FW assumes normal security protection for all hosts
 - The FW traffic includes TCP-SYN, UDP, IPv4-NAT and so on
- Current Status
 - The MAX bandwidth > 35Gbps and FW bandwidth <3Gbps
 - Running well





- IHEP and other Chinese universities/institutes are benefitting a lot from LHCOPN & LHCONE
- Thanks for the help from LHCOPN&LHCONE
- Thanks for the help from WLCG and the partner sites