

中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences



高能所計算中心
IHEP Computing Center

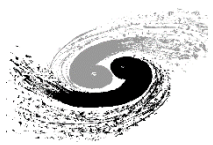
The Networking and Computing Status at IHEP

Qi Fazhi

CC, IHEP, CAS

2023-04-13





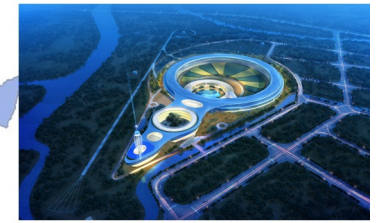
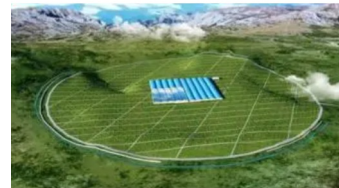
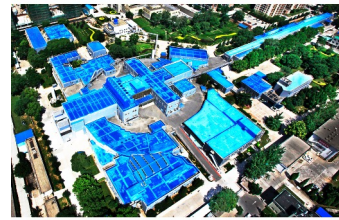
IHEP Overview



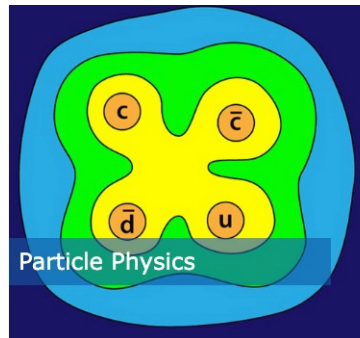
• Institute of High Energy Physics, Chinese Academy of Sciences

• Focus on fundamental researches in

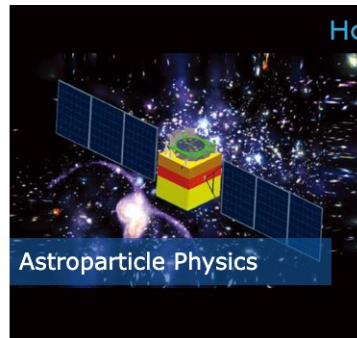
- particle physics
- particle astrophysics and cosmology
- accelerator physics and technology
- detection technology and electronics
- radiation applications
- Computing technologies and applications



Accelerator Technology and Science



Particle Physics



Astroparticle Physics



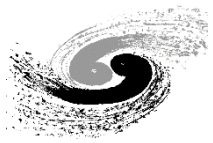
Multi-Disciplinary Research



Computing



Technology Transfer



About IHEP CC



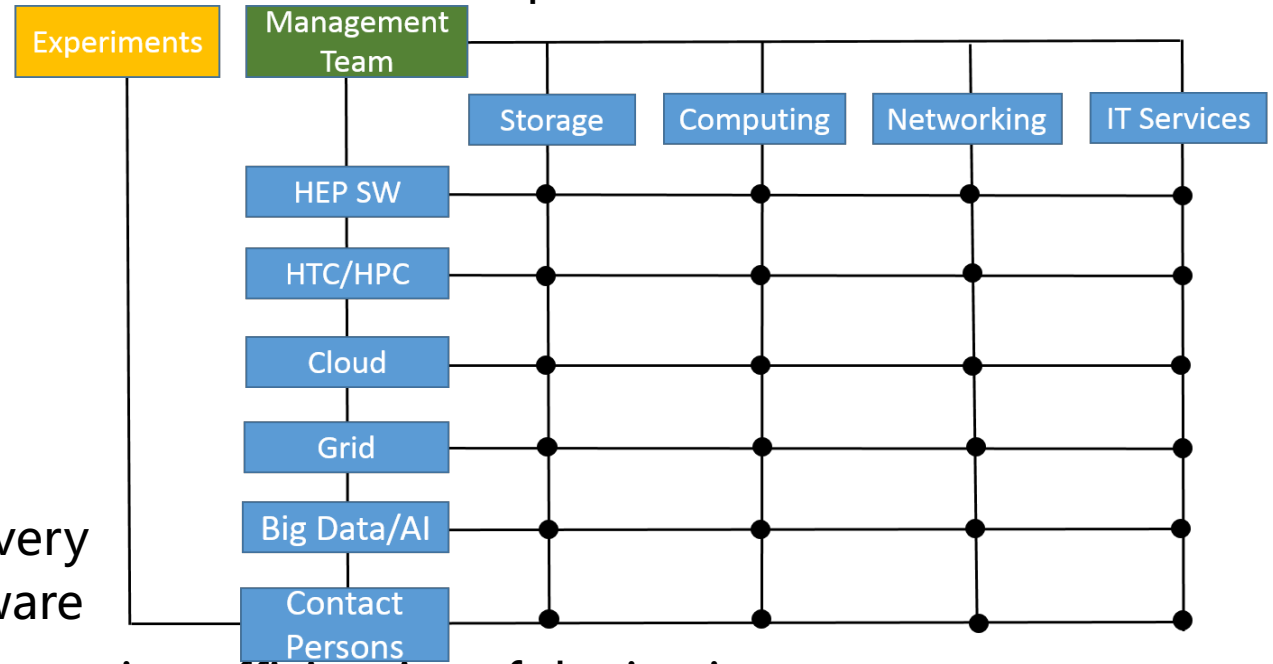
- ❖ 55 staffs(Beijing & Dongguan) + 50 Post Dr. & students
- ❖ Mission

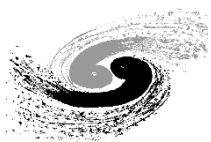
1. Provides high performance computing environments for HEP experiments

- Facilities
- Computing
- Storage
- Network
- Software

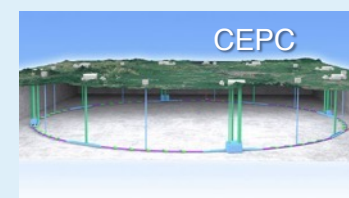
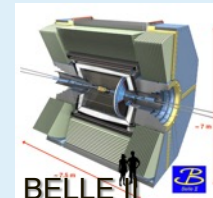
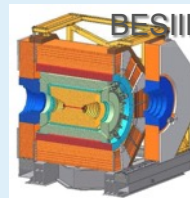
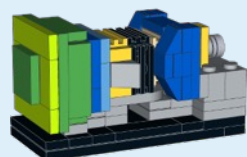
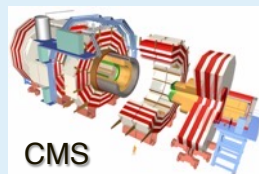
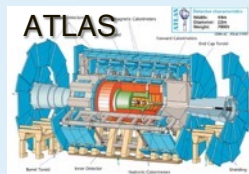
2. Research & Development on IT

- 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

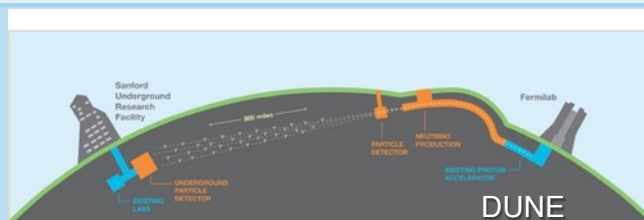
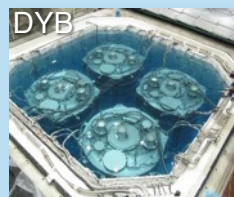




IHEP Related Projects



LHCb
Accelerator based particle physics



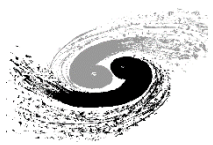
JUNO
Neutrino experiments and CMB telescope



LHAASO
Cosmic ray and astrophysics experiments

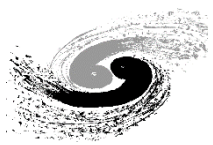


CSNS
Neutron Source and Synchrotron Radiation Facilities



Science Facilities & Sites of IHEP

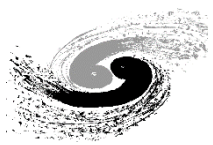




Data and Computing Challenges @IHEP



Type	Experiment Name	Features	Data volume	Computing resource	Location	Status
Practical Physics	BESIII	HTC (CPU)	2PB/year	10,000 CPU Cores	Beijing	Running
	DYB		500TB/year	3,000 CPU Cores	Shenzhen	Closed
	JUNO		3PB/year	10,000 CPU Cores	Jiangmen	In construction
	CEPC		10PB/year	100,000 CPU Cores	TBD	TBD
	LHC		1PB/year	2000 CPU Cores	WLCG	Running
Cosmic ray & astrophysics	LHAASO		6PB/year	10,000 CPU Cores	Daocheng	Running
	HXMT/GECAM/AliCPT		500TB/year	5,000 CPU Cores	Beijing	Running
	HERD eXTP		3PB/year 400TB/year	2,000 CPU Cores 2,000 CPU Cores	Beijing	In 3 Years In 3 Years
Neutron and Synchrotron Radiation	CSNS SPS		1PB/年 >300PB/year	2,000 CPU Cores >10,000 CPU Cores	Dongguan Dongguan	Running TBD
	HEPS		>300PB/year	>10,000 CPU Cores	Huairou, Beijing	In 3 Years
Theory Physics	LQCD	HPC(CPU+GPU)	1PB	>1P Flops (double)	Beijing	Running
Accelerator Design	Accelerator Simulation		1PB	>1P Flops (double)	Beijing	Running



Domestic and International Connections



- Dedicated links for remote sites

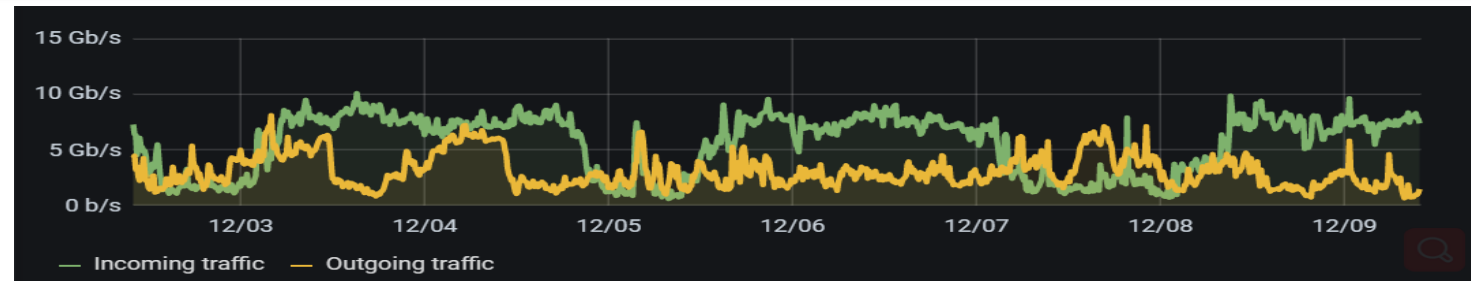
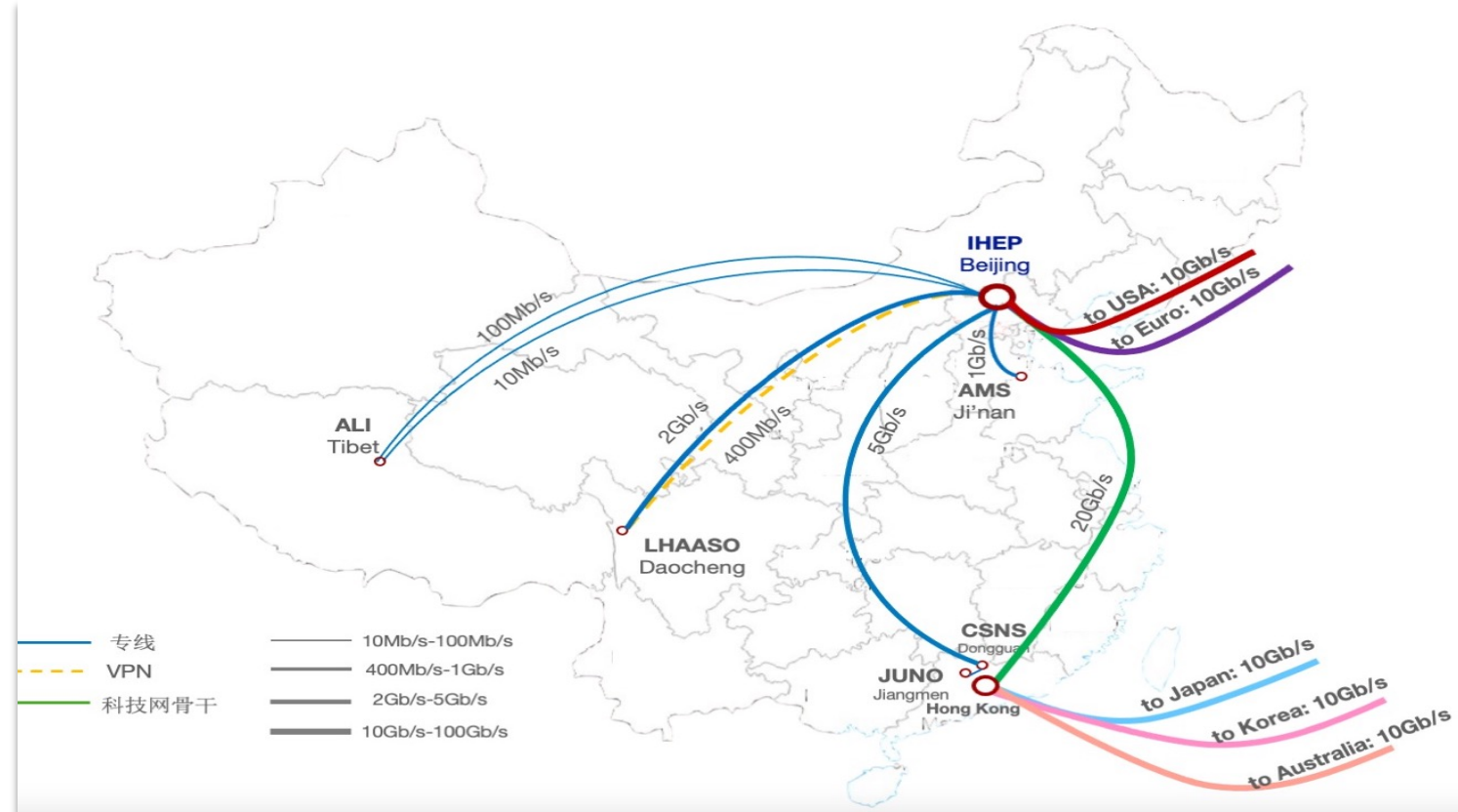
- 10Mbps to 20Gbps
- Some will be upgraded to 100Gbps soon

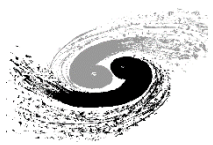
- International networks

- IHEP-Europe: 10 Gbps + 10 Gbps
- IHEP-USA: 10 Gbps + 10 Gbps
- ~50 PB data exchange in 2022

- LHCONE

- Peering to ESNet, Internet2, GEANT were established
- All the LHCONE peers are finished





Computing Model: One Platform, Multi Centers (1/2)



• The main strategy of IHEP-CC

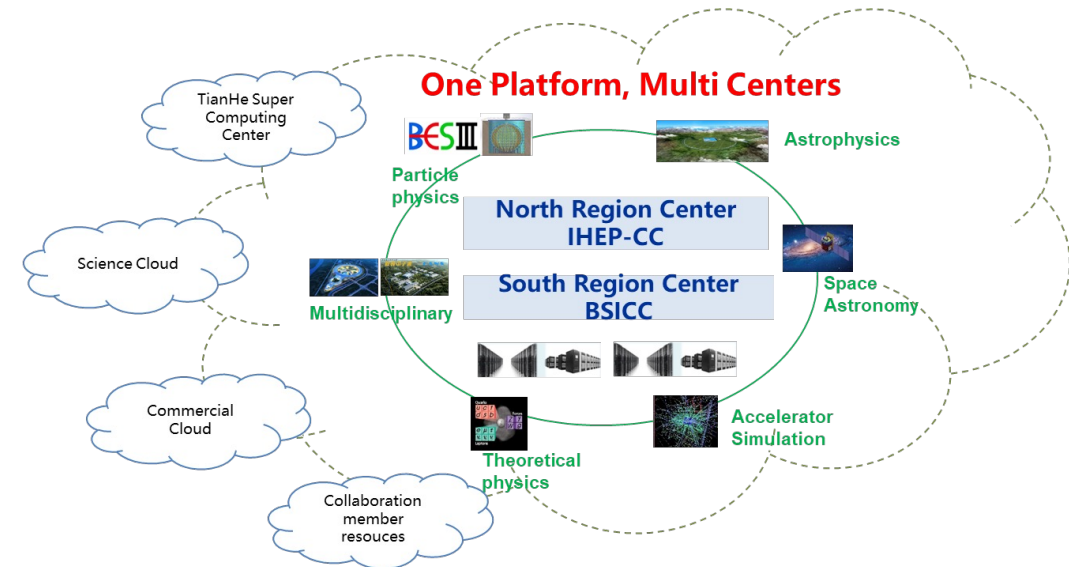
- A platform serves the data processing demands of HEP scientific research fields.
 - ◆ particle physics, theoretical physics, space astronomy, ray science, and accelerator design
- Appropriately use opportunistic resources with as little change of user habit as possible.

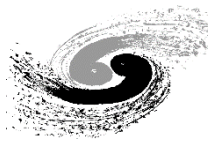
• Two main region centers

- Two main region centers IHEP Computing Center (Beijing) & Big Scientific and Intelligent Computing Center (Dongguan).

• Several edge sites in China

- Experiments onsite resources.
 - ◆ For fast data processing.
- CC from Collaboration members.
 - ◆ Shandong Univ., Univ. of Science and Technology of China, Lanzhou Univ. etc.).
- On-demand resources.
 - ◆ commercial clouds and super computing centers.





Computing Model: One Platform, Multi Centers (2/2)



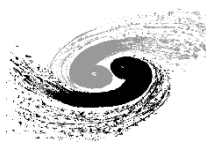
Current Status

Resource of two region centers

	CPU	GPU card	Disk	Tape	Network
IHEP-CC (Beijing)	43,000 intel-x86	250 Nvidia V100	80 PB	80 PB	40Gpbs internet connection 400Gpbs internal connection
Big Scientific and Intelligent Computing Center (Dongguan)	~20,000 intel-x86; ~10,000 arm	~100 Nvidia v100	6PB	---	20Gpbs internet connection 400Gpbs internal connection

- OMAT, a Monitor tool, is developed and deployed to collect sites running status.
- The solutions for computing and storage integration is undergoing
 - LHAASO simulation jobs from IHEP-CC (Beijing) HTC Cluster have been dispatched to BSICC (Dongguan) HPC cluster.
 - In hand roll way.
 - Data result is transferred back by HTCondor.
 - Users among sites are mapped directly.
 - Xcache & EOS remote replica are being studied.
 - Token-based authentication and authorization are being studied.

Site	Resource Utilization unit: %	Total Time Provided by The Site unit: CPU Hours	Site Resource unit: CPU Cores	HTC Job Number unit: Jobs	HTC Job Time unit: CPU Hours	HPC Job Number unit: Jobs	HPC Job Time unit: CPU Hours
DaoCheng	21.65%	675,891	3,672	2,707	146,478	-	-
BSICC	58.85%	5,278,911	34,480	17,222	5,839	373	3,091,471
CSNS	37.35%	735,569	5,900	-	-	835	327,205
SDU	41.93%	152,312	1,028	8,097	63,930	-	-
USTC	37.30%	512,593	3,458	9,394	191,426	-	-
LZU	30.73%	119,323	707	658	36,609	-	-



Current Status of "One Platform, Multi Center"



高能物理计算中心
HEPC Computing Center

高能物理计算平台站点概况

资源总览



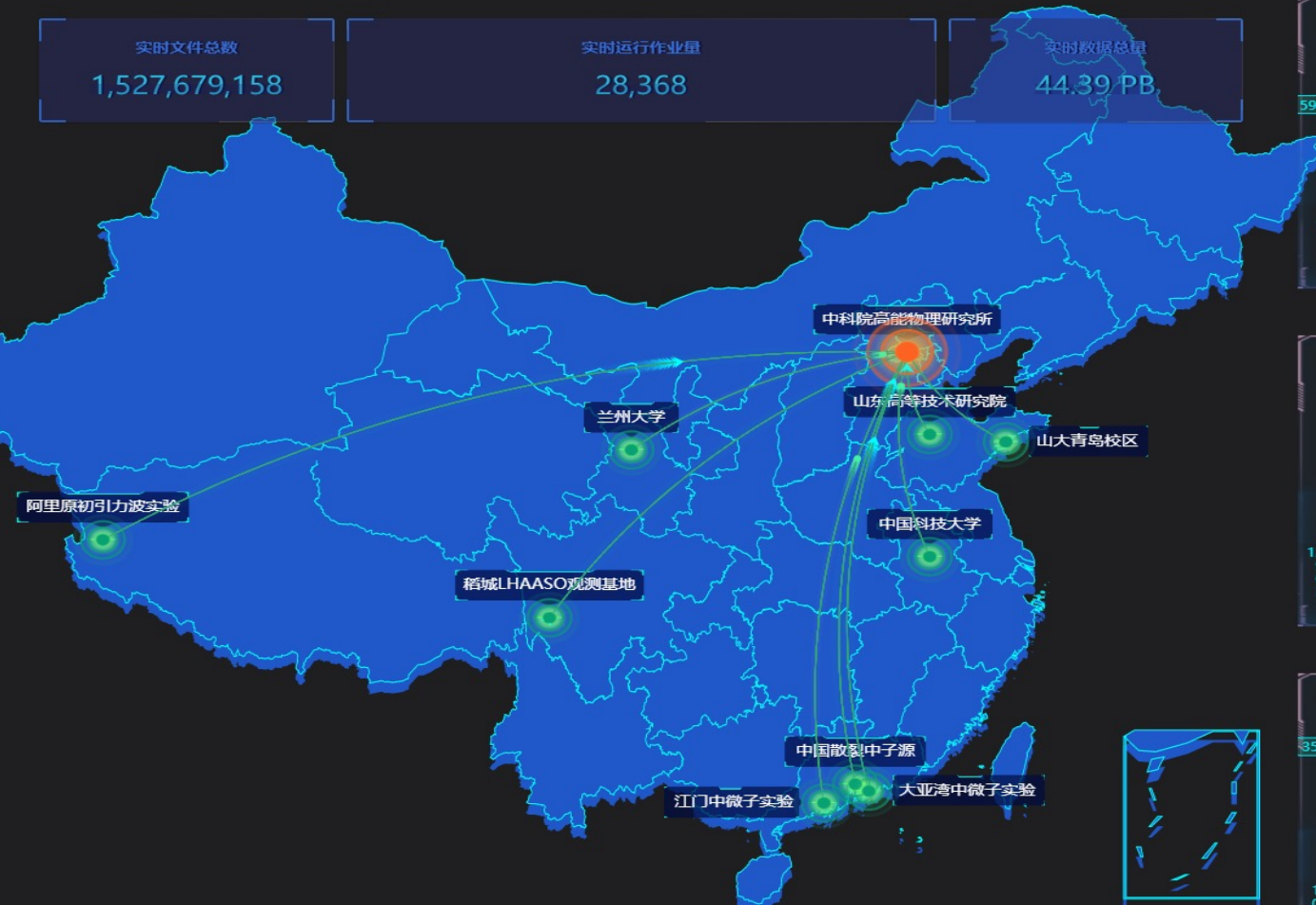
中国散裂中子源

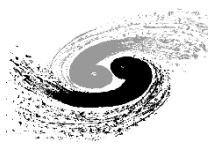


山东高等技术研究院



其他站点





R&D: Computing for HEPS



• High Energy Photon Source (HEPS), will be in production in 2025;

• Computing & Communication system (HEPSCC)

- Network, Computing, Storage, Data analysis framework, Data management, Database & Public Service, Monitoring, Security.

• Progress of R&D for HEPSCC system

■ Computing

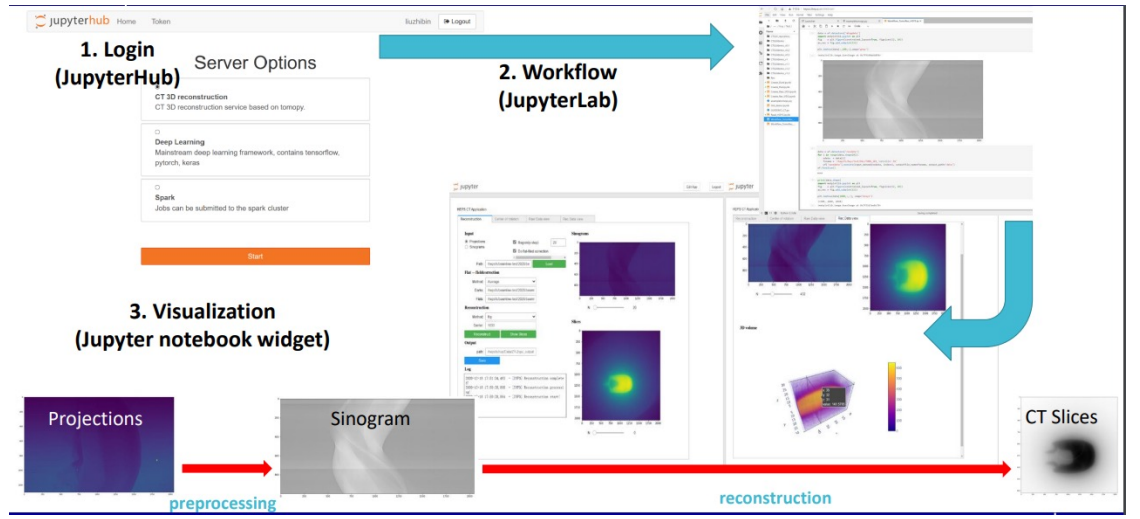
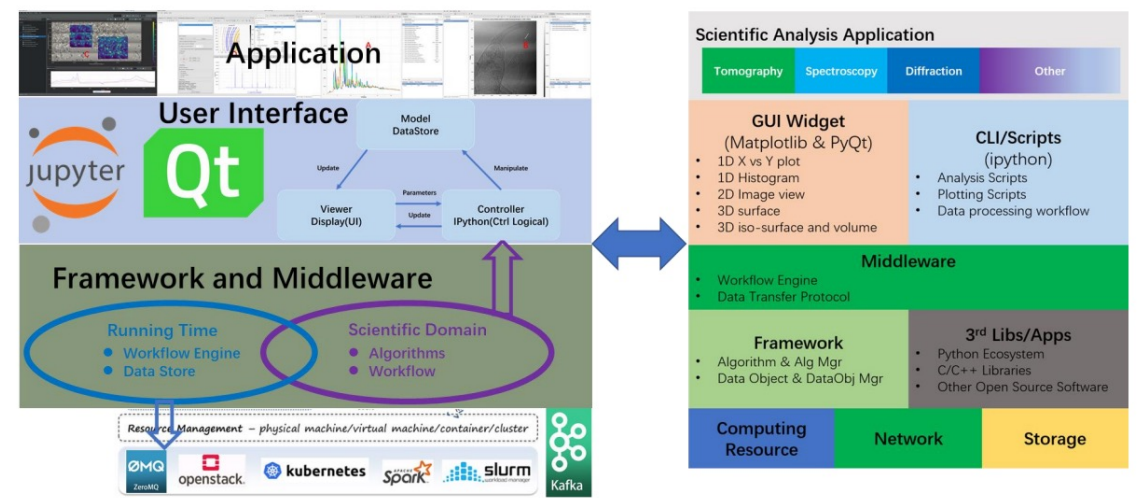
- ✓ Docker+K8S+JupyterHub, supporting multi-core CPU and GPU.
- ✓ Integrate with data analysis framework, deploy docker image.

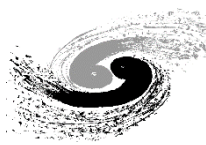
■ Data analysis framework

- ✓ Develop IDE and user GUI base on PyQt.
- ✓ Integrate methods and algorithms: Tomopy, UFO, pyFAI.
- ✓ Provide data visualization and analysis based on Jupyter notebook Widget.

■ Data management system

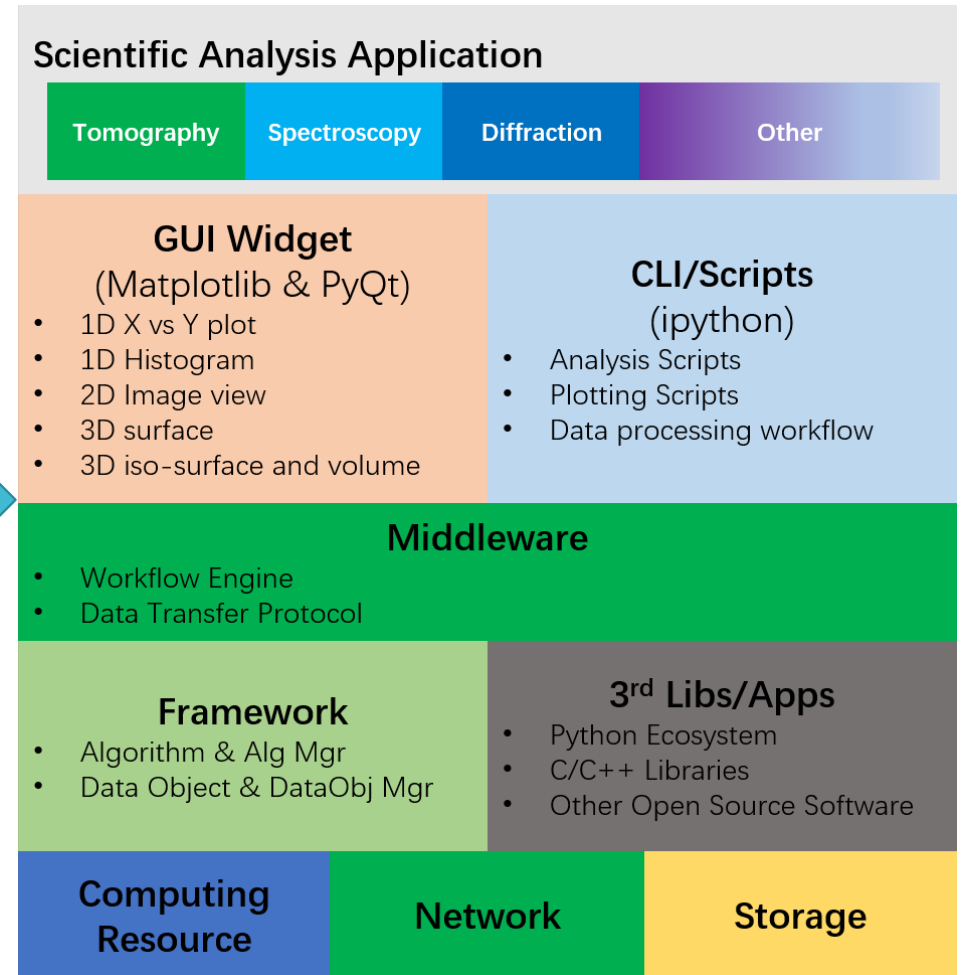
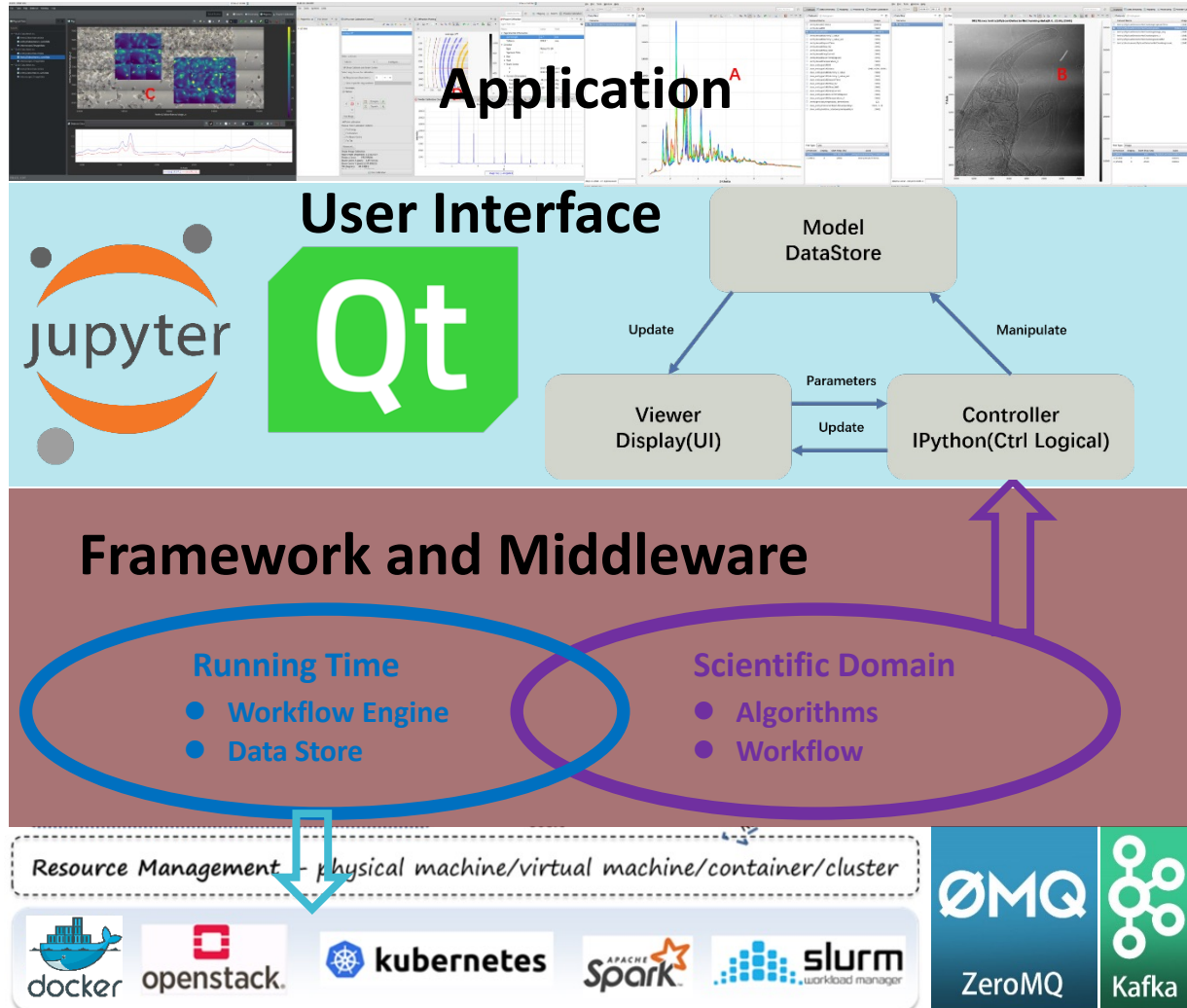
- ✓ Metadata catalogue: API server + MongoDB.
- ✓ Data transfer: full path data transfer with ACLs of files and folders.



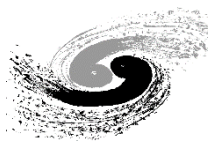


Data Analysis Integration Software Framework for Xray Experiments (DAISY)

Data Organization Management and Access Software (DOMAS)



Yu Hu, Hao Hu, The Design and Development of the scientific data and software for High Energy Photon Source in China



Current Status of WLCG in China-Mainland



- Tier-2 sites

- BEIJING-IHEP (ATLAS, CMS, LHCb)

- Tier-3 sites

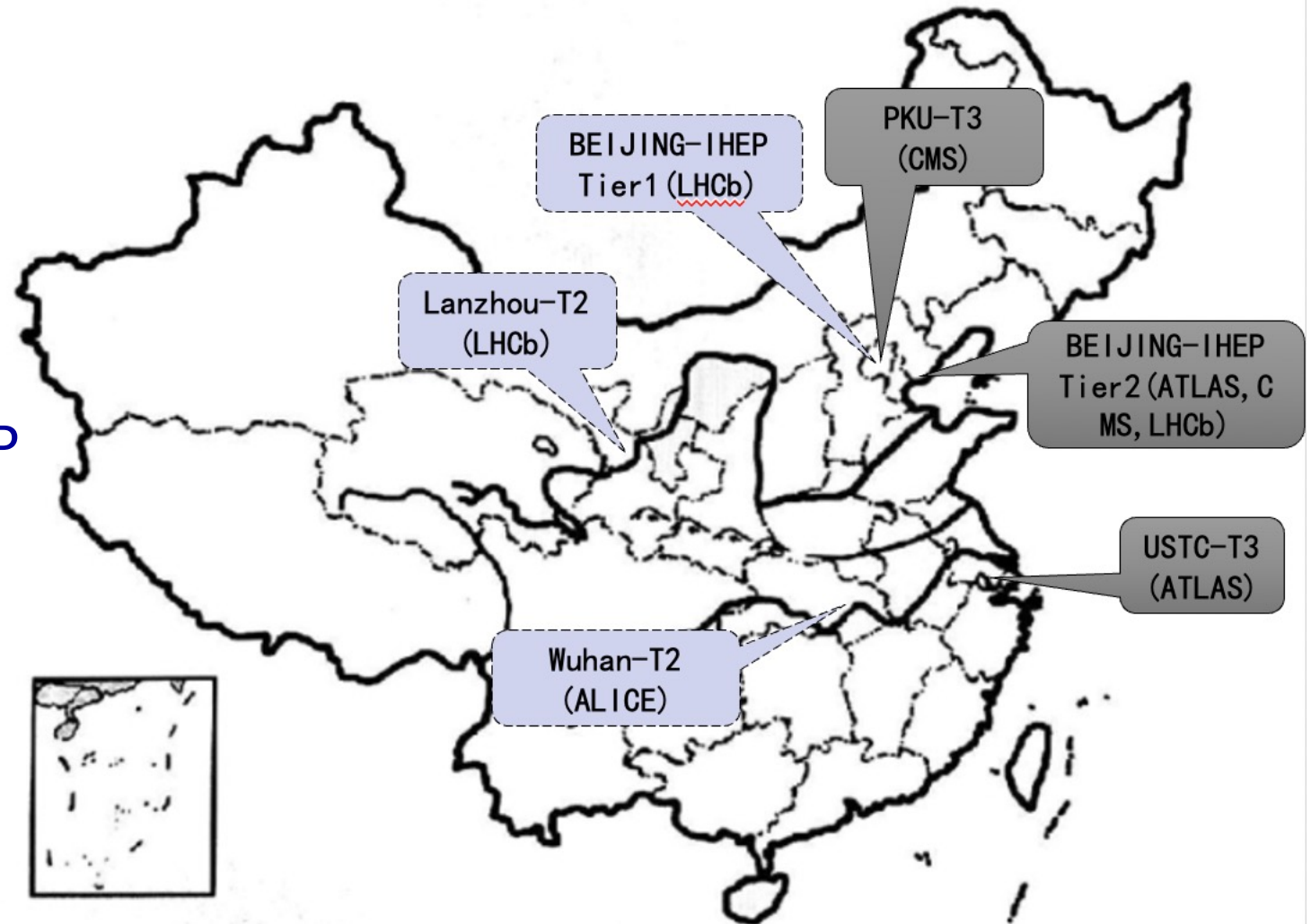
- PKU-T3 (CMS)
- USTC-T3 (ATLAS)

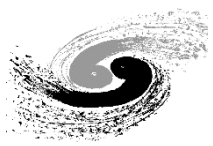
- Certification Authority at IHEP

- cagrid.ihep.ac.cn

- Sites under development

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





WLCG sites at IHEP



• WLCG Tier2 Sites

- ATLAS, CMS, from 2006
- LHCb, from 2018

• Computing Resources

- ~4.2K CPU cores

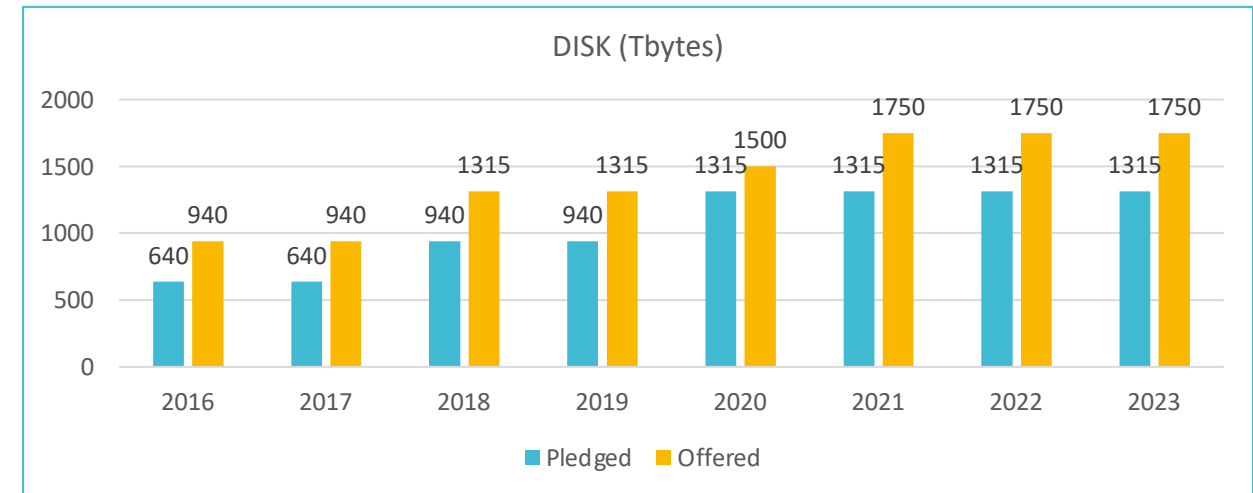
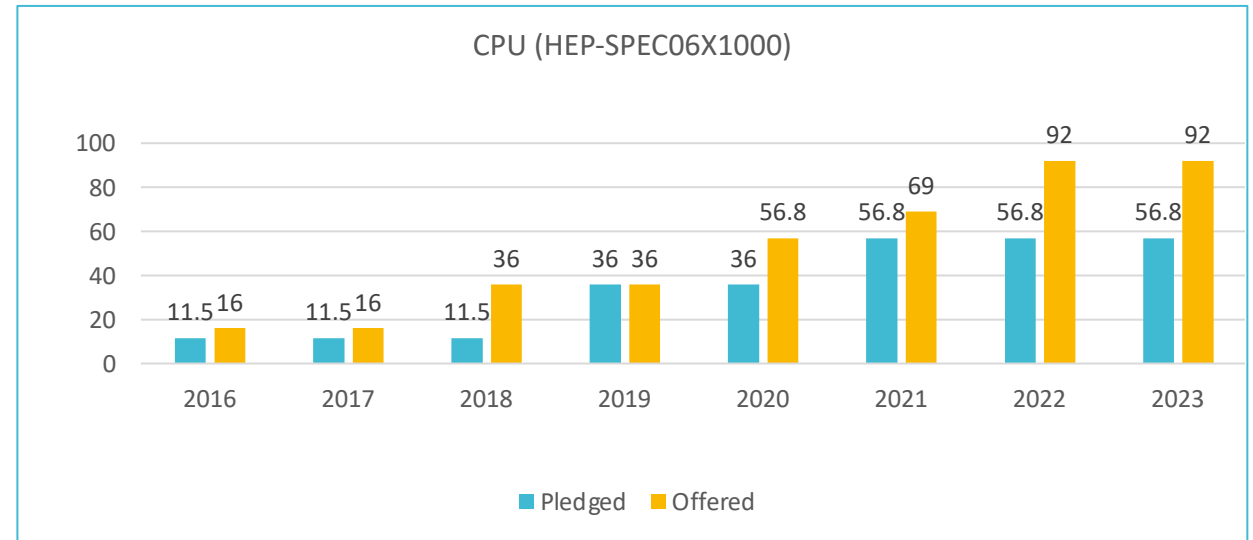
• Disk Storage

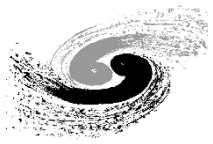
- ~ 1.7 PB

• Network

- 10Gbps network link to Europe
- IPv4/IPv6

Proposal of LHCb Tier-1 at IHEP was approved by WLCG Overview Board in Dec. 2022(proto-WLCG T1 Center for LHCb)
It should be ready before Jul. 2023





LHCb Tier-1 @IHEP



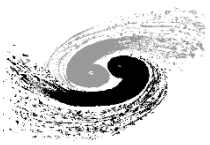
● IHEP LHCb Tier 1 site is under construction

■ Storage and computing resources are completed procurement and gradually arrived

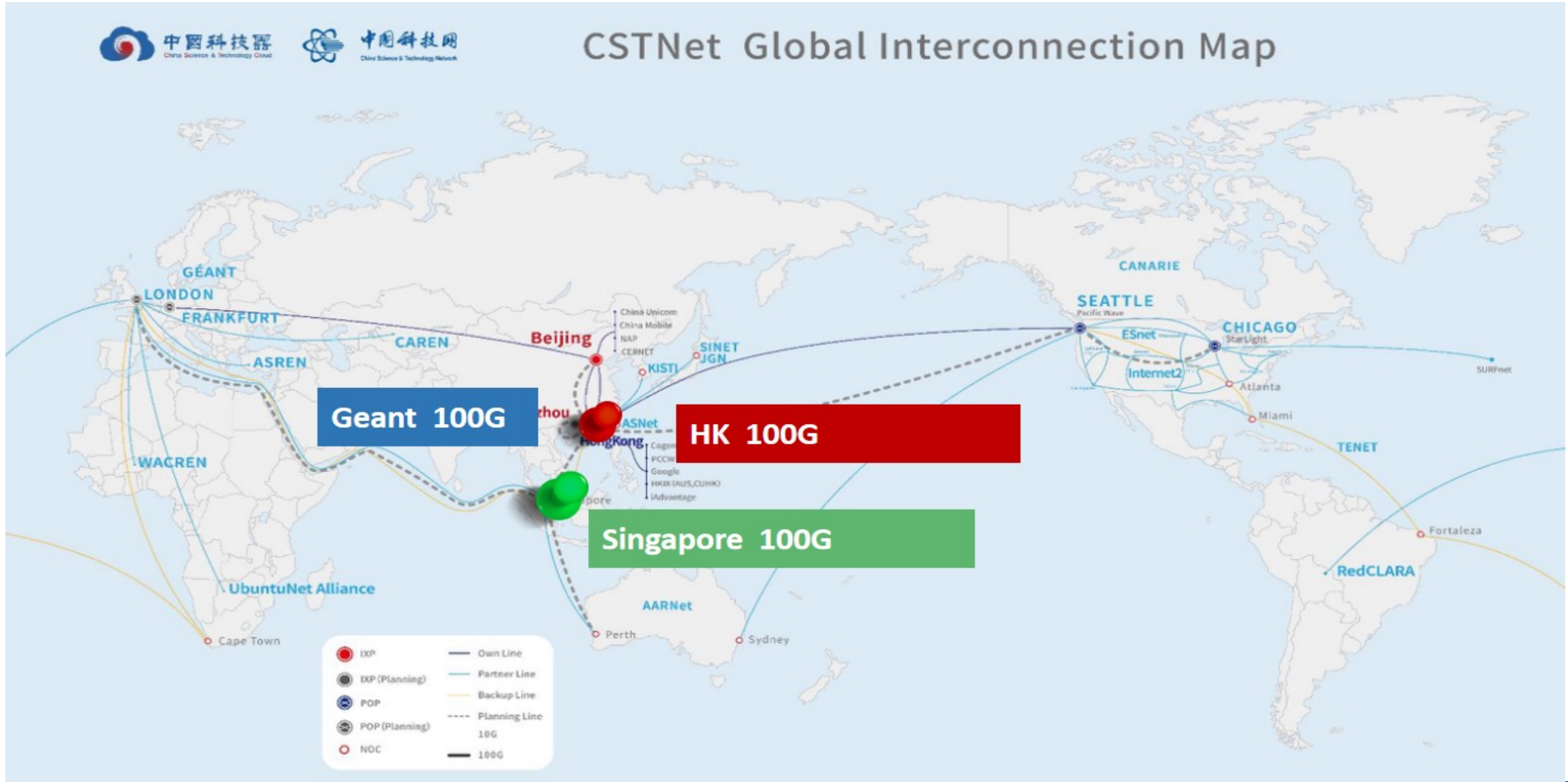
- ◆ 3000 CPU cores, Intel Xeon Platinum 8352Y,
- ◆ ~3.2PB disk storage, DELL PowerVault ME484,
- ◆ Lenovo TS4500 Tape Library, LTO9 Drives and Tapes.

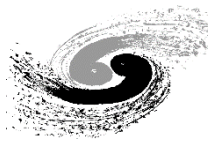
■ Network devices and connections will be ready soon

- ◆ Devices: 100G Router linecards and Optical modules are arrived
- ◆ CSTNET to GEANT 10G -> 100G
- ◆ IHEP to CSTNET 20G -> 100G



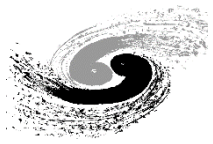
Plan:100G global interconnection is coming (CSTNet)





Summary

- The computing and networking capability, and “One platform, multi centers” strategy has been expanded in the last two years to accommodate more applications of particle physics, photon source and neutron source.
- The LHCb Tier-1 center @IHEP will be ready before Jul.
- More work (especially software R&D) should be carried out to meet the increasing requirements.



Thanks