



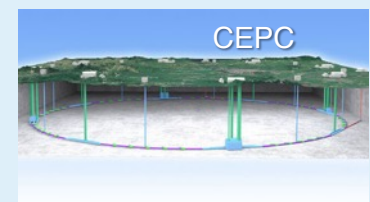
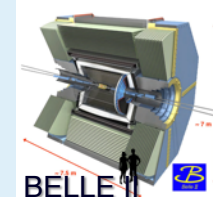
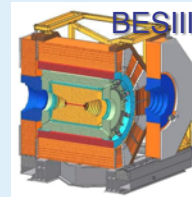
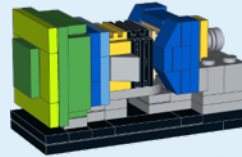
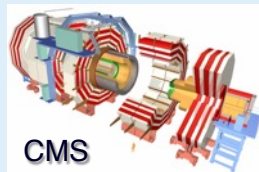
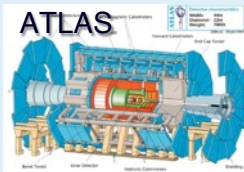
e-Science Activities in China

Gang Chen
Institute of High Energy Physics, CAS

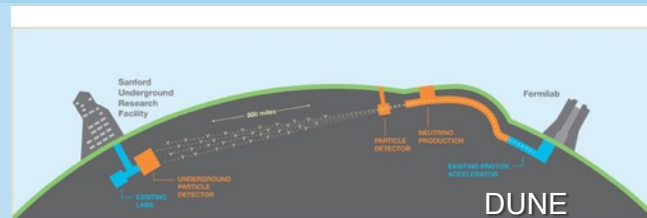
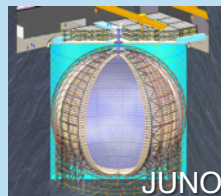
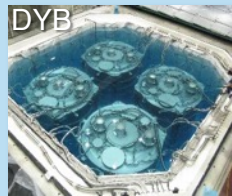
ISGC2021
March 23, 2021



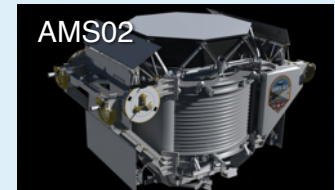
HEP Related Projects



Accelerator based particle physics



Neutrino experiments and CMB telescope



Cosmic ray and astrophysics experiments



Neutron Source and Synchrotron Radiation Facilities



Science Facilities & Sites of IHEP



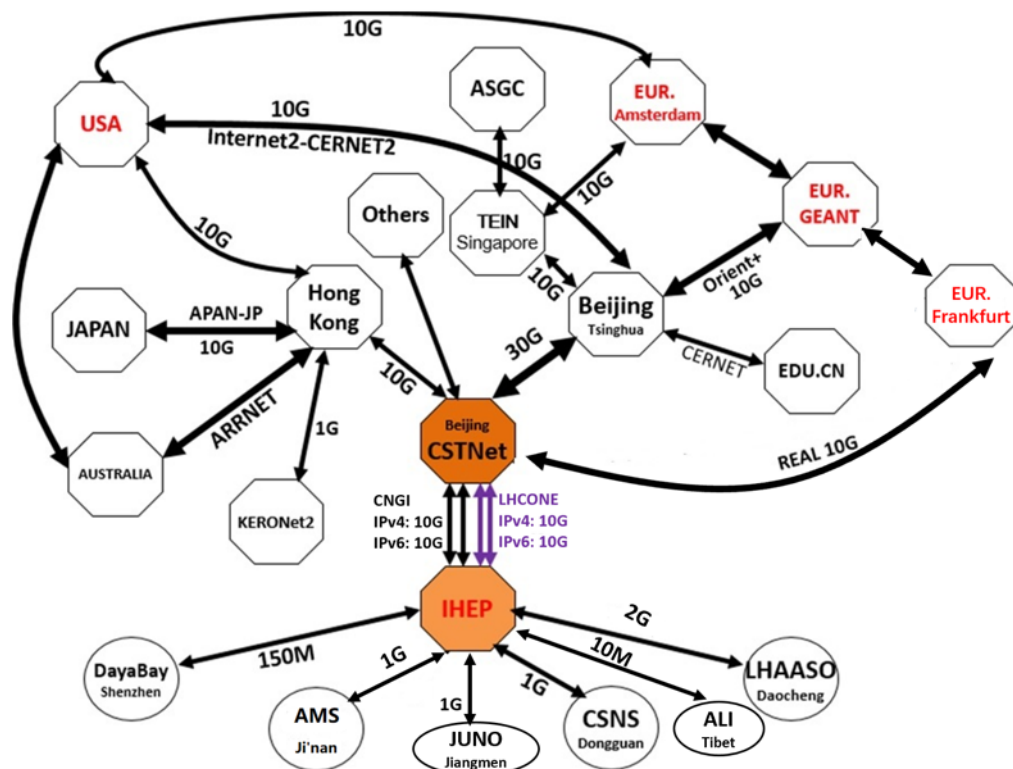
Data Challenges @IHEP

- BECP II/BES III: Running, up to 2030
 - ~1PB raw data/year, >10PB totally now
- DYB: data taking stopped at the end of 2020
 - >2PB raw data totally, data analysis is ongoing
- LHAASO: Running
 - >6PB raw data/year, will run for 20 years
- CSNS: Running
 - 300TB raw data /year for Phase I (3 beamlines, now)
 - > 2PB raw data/year for Phase II (+7 beamlines, 2023)
 - > 5PB raw data/year for Phase III (+7 beamlines, 2030)
- JUNO: data taking from 2022
 - >2PB raw data/year, will run for 10 years
- HEPS: data taking from 2024
 - >200PB raw data/year for Phase I (14 beamlines)
- ATLAS, CMS, LHCb, Belle II, ...



Domestic and International Links

- Dedicated links for remote sites
 - 10Mbps to 2Gbps
 - Some will be upgraded to 5Gbps and 100Gbps soon
- International networks
 - IHEP-Europe: 10 Gbps + 10 Gbps
 - IHEP-USA: 10 Gbps + 10 Gbps
 - ~17 PB data exchange in 2020
- LHCONE
 - Peering to ESNat, Internet2, GEANT were established
 - All the LHCONE peers are finished



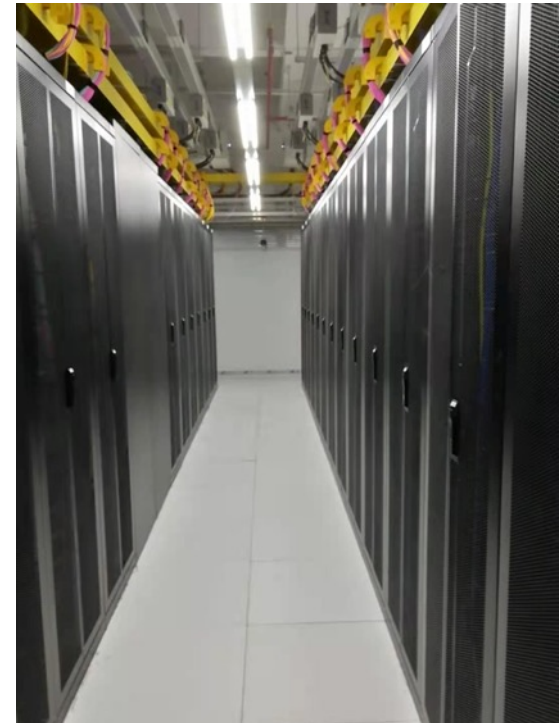
Computing Resources in Beijing

- 33K CPU cores, 190 GPU cards
 - HTCondor cluster runs for HTC jobs - 26K CPU cores
 - Slurm cluster runs for HPC jobs - 4K CPU Cores + 190 GPU cards
 - WLCG tier2 sites & DIRAC sites - 3K CPU cores
- About 42PB disk storage, 21PB tape storage
 - Luster (23PB) and EOS (17.4PB) as two main file systems
 - Castor for tape storage , EOS CTA coming soon
 - 1.6PB DPM



Computing Center at CSNS

- Mainly for neutron source facility
- Current resources:
 - ~6500 CPU cores
 - 8 Tesla P100 GPU cards
 - 600TB disks space and 700TB tapes
- New resources to be commissioned in couple of weeks:
 - 22K X86 CPU cores for HTC and HPC
 - 9600 ARM-based (Huawei) Kunpeng-920 CPU cores for HPC. HEP software deployed and evaluated.
 - 80 Tesla V100 GPU cards
 - 6PB (Huawei) disks



Computing Center in Ji'nan

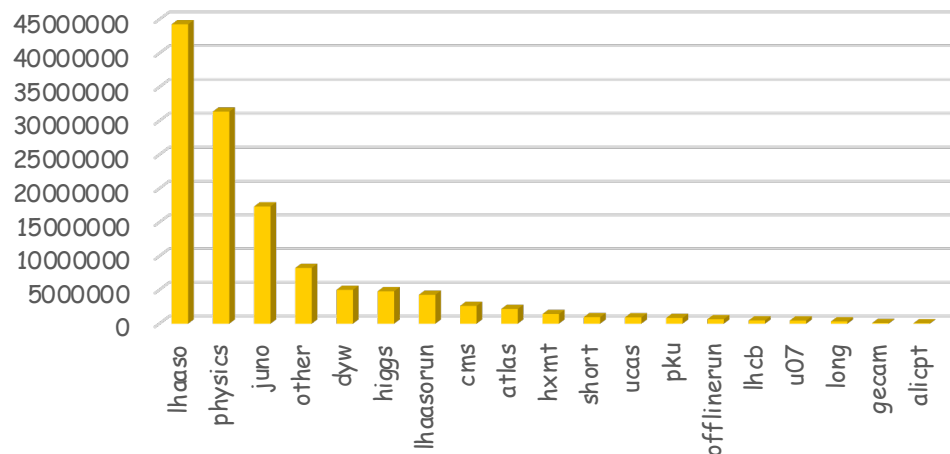
- Dedicated to AMS02, operated by IHEP
- 30K CPU cores, HPE ProLiant DL325 Gen10 Plus, with MD 7742 CPU
- 2.55 PB of disk space
- 1Gbps dedicated link to IHEP



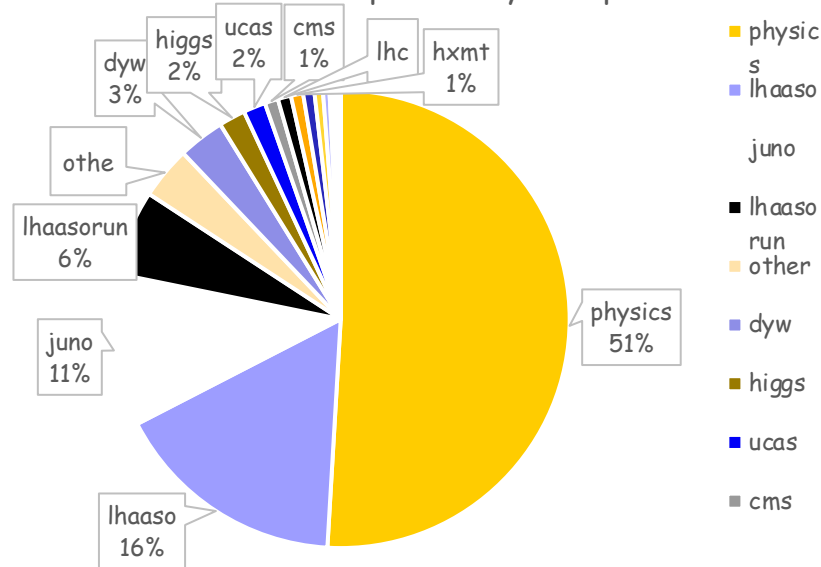
HTCondor Cluster Status

- Upgraded to 8.8.9
- Statistics (last one year)
 - Total job number: **165.8 millions**
 - Total Walltime in hours: **126.6 millions**

Job Count By Group in 2020



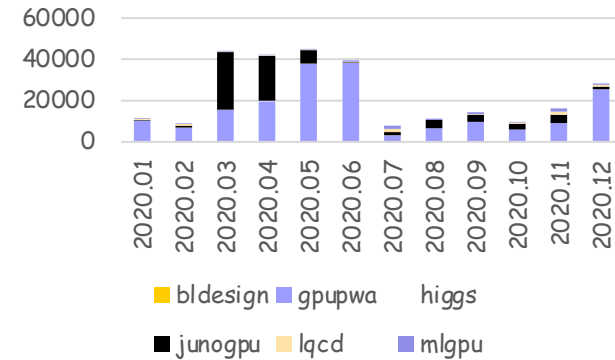
WallTime Proportion By Group in 2020



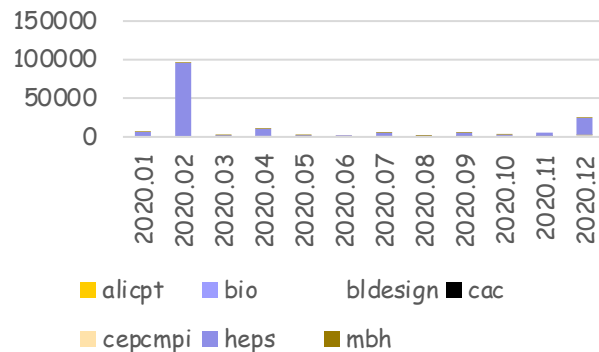
Slurm Cluster Status

- Upgraded to 19.05.6
- Jobs (2020.1.1 - 2020.12.31)
 - 7 CPU apps: 159K jobs, 14M CPU hours
 - 6 GPU apps: 203K jobs, 762K GPU hours

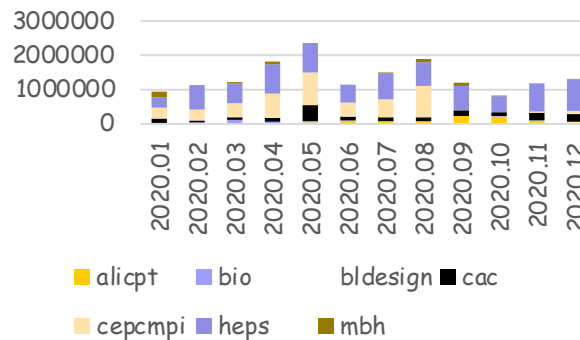
Num. of GPU Jobs



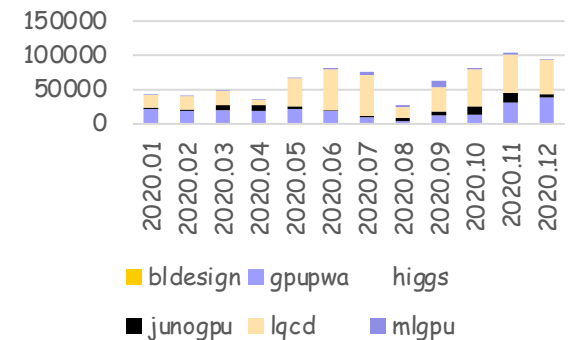
Num. of CPU Jobs



Consumed CPU Hours

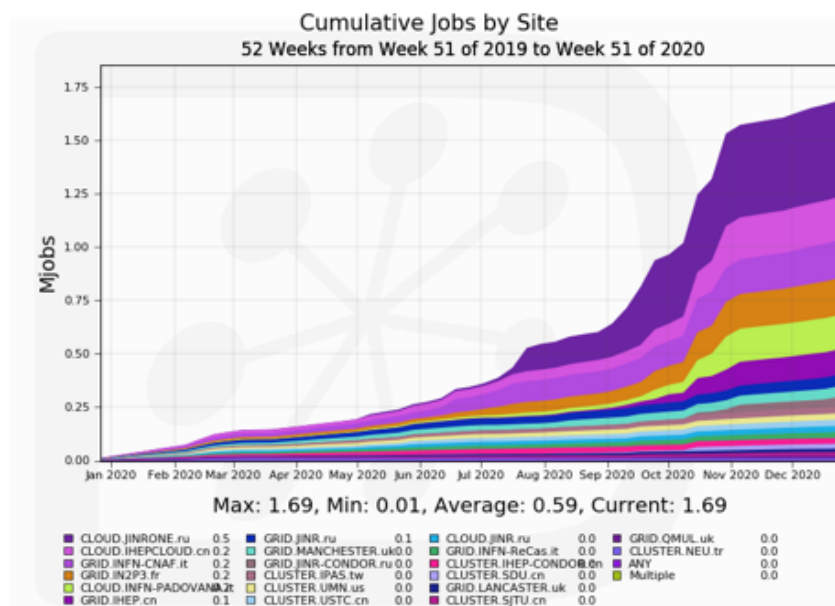
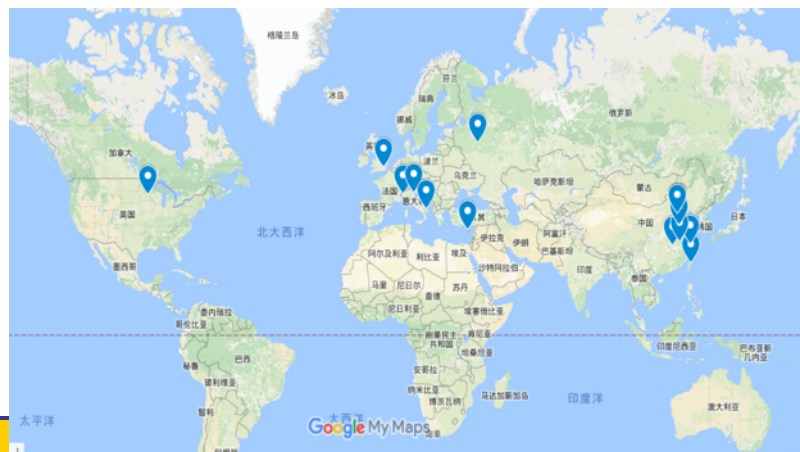


Consumed GPU Hours



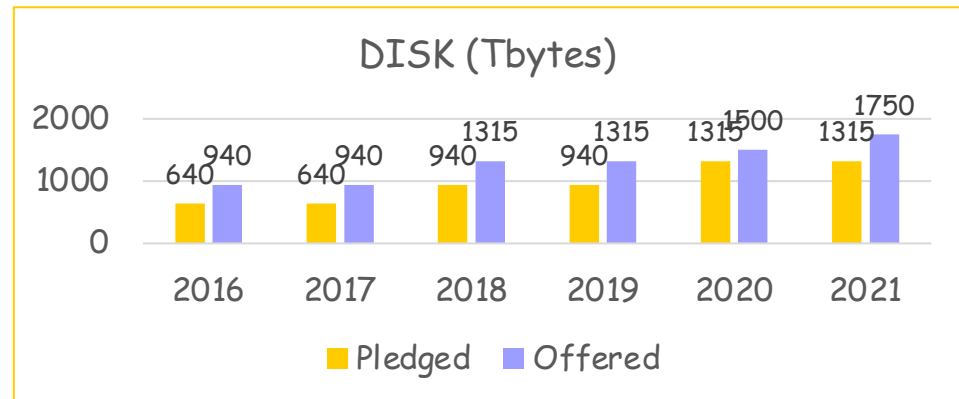
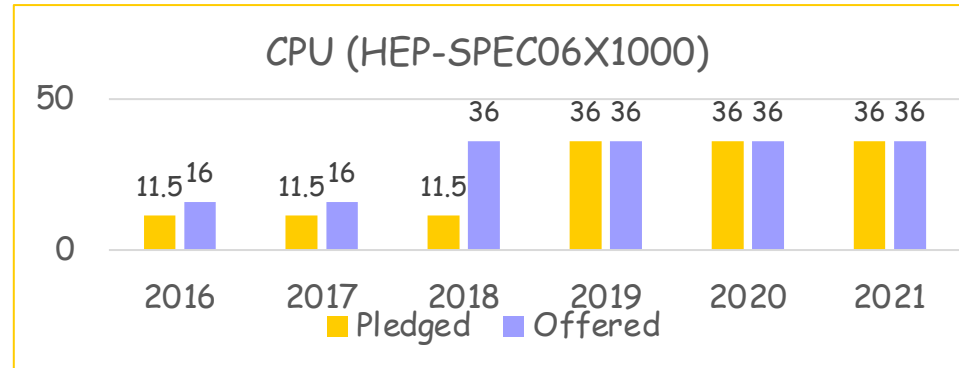
DIRAC Distributed Computing

- Distributed computing based on DIRAC is to integrate and share resources globally
 - Sites: 17 from USA, UK, France, Italy, Russia, Turkey, Taiwan, China
 - Data centers
 - Resource type includes cloud, cluster and grid
- Network: 10Gb/s to USA and Europe, 10 Gb/s to Taipei
- Resource: ~5200 CPU cores, ~3PB storage
- About 1.69M jobs running in 2020
- Multiple experiments supported
 - BESIII, CEPC, JUNO



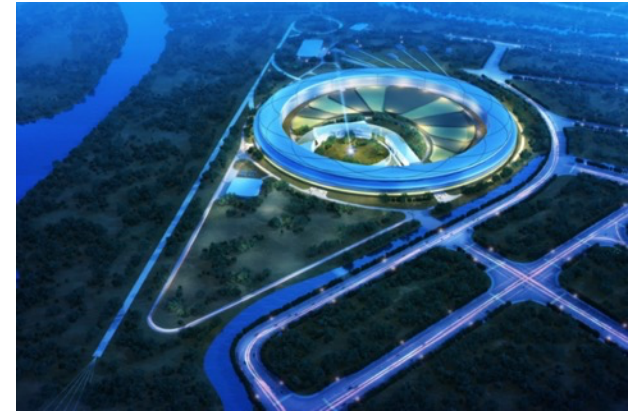
BEIJING-LCG2 Tier2 Resources

- CPU: 3048 cores
 - Intel Golden 6140 2160 Cores
 - Intel E5-2680V3: 696 Cores
 - Intel X5650 192 Cores
- Batch: HT-condor
- DPM: 1750TB
 - 4TB * 24slots with Raid 6, 5 Array boxes
 - DELL MD3860 8TB*60 slots
 - DELL ME4084 10TB*42 slots
 - DELL ME4084 12TB*84 slots
- VO: ATLAS, CMS, LHCb, BelleII, CEPC



Data Management System for HEPS

- Data structure and data flow may depend on beamlines
- Users may not be familiar with data tools
- A user friendly data service needed to be defined and developed:
 - Data policy
 - Guidelines for the design and implementation of DMS
 - Metadata catalogue
 - Catalogue framework
 - Metadata database
 - Metadata ingestor
 - Acquire metadata from DAQ/control system
 - Data transfer system
 - Beamline storage → Central storage → Tape
 - APIs for interacting with other systems
 - DAQ system, storage system, data analysis system, user service system, proposal system
 - Data service
 - Data access, data search, data download

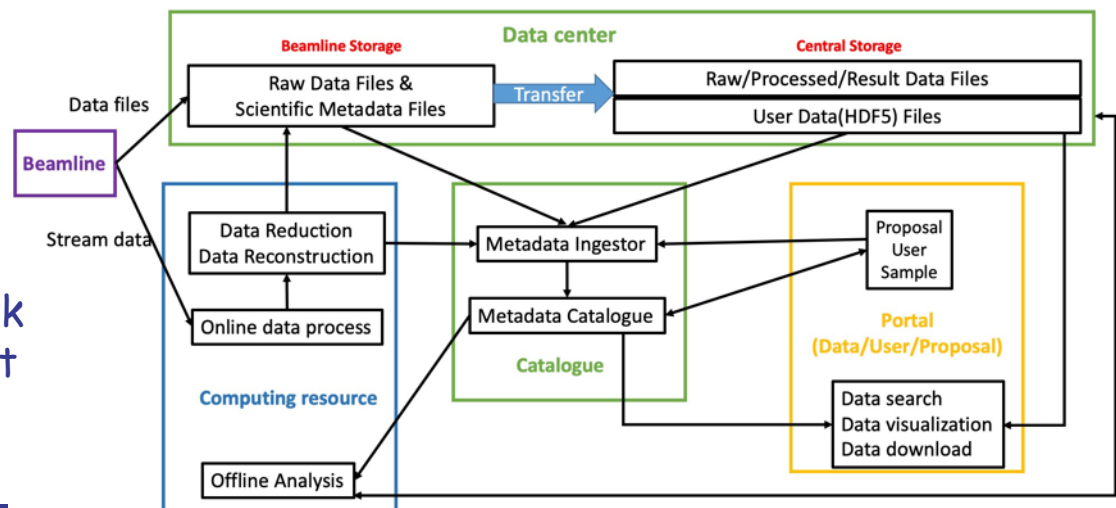


- High Energy Photon Source
- 14 beamlines initially and 70 beamlines in total to be deployed

Main parameters	Unit	Value
Beam energy	GeV	6
Circumference	m	1360.4
Emittance	<u>pm·rad</u>	< 60
Brightness	<u>phs/s/mm²/mrad²/0.1%BW</u>	>10 ²²
Beam current	mA	200
Injection		Top-up

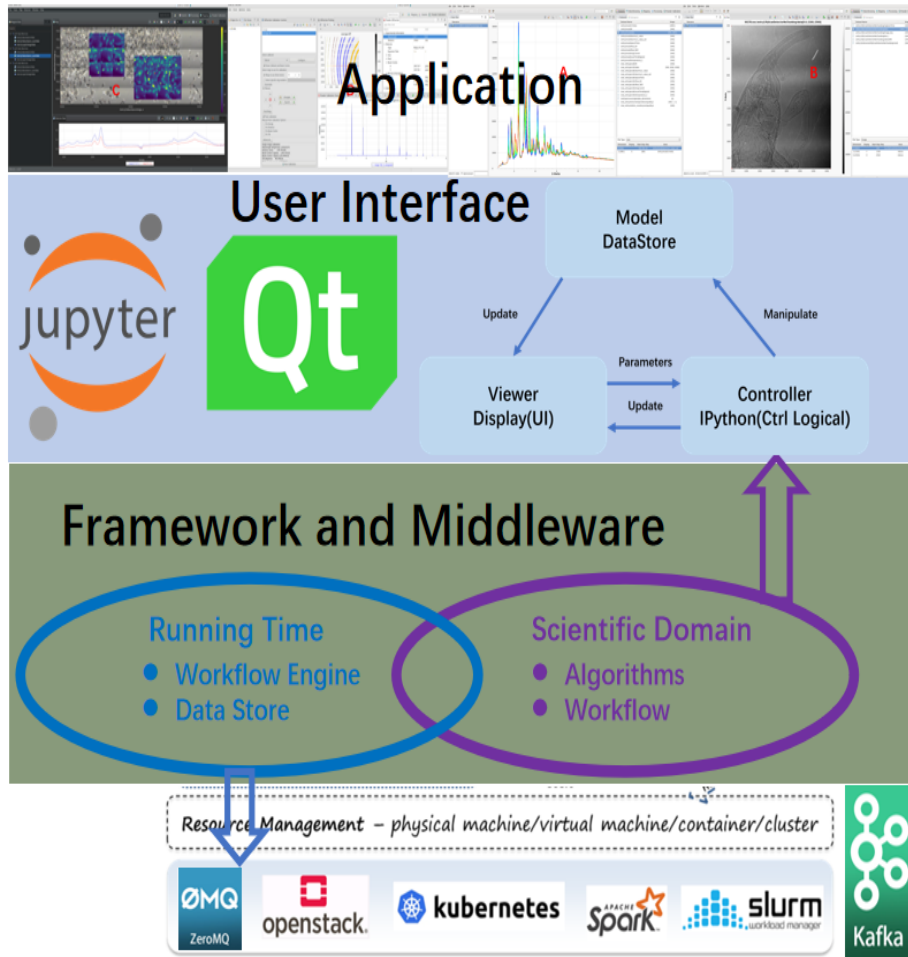
Data Management System for HEPs

- The Data Management System has passed FDR
- Fundamental functions are implemented on the testbed
- HDF5 data format schema Specified (cooperate with beamline scientists)
- Data analysis framework and computing system integrated
- Performance of the IT infrastructure was verified

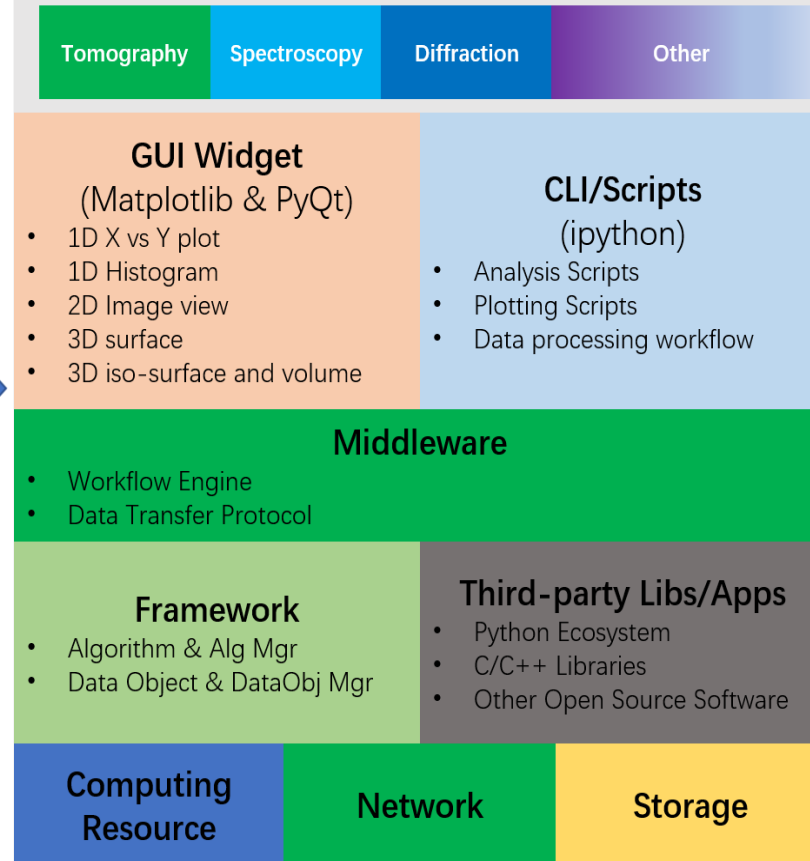


Please refer to Ms. Hao Hu's talk in tomorrow's "Data Management & Big Data" session.

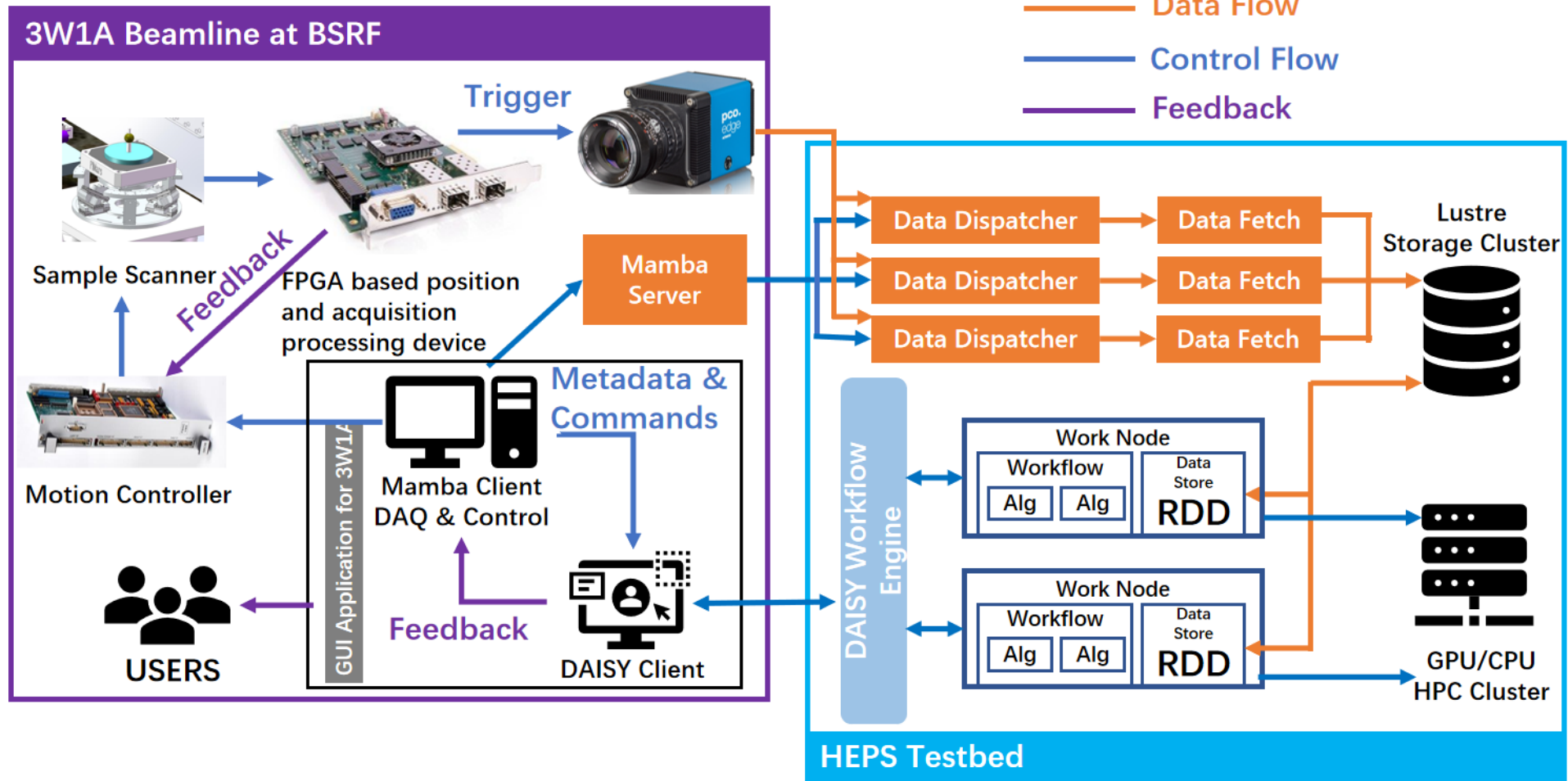
Software Framework Overview



Scientific Analysis Application



1800



Production system will be ready in 2024.



Conclusions

- e-Science system has been expanded in the last two years to accommodate more applications of particle physics, photon source and neutron source.
- New computing centers set up and integrated to establish a distributed platform
- ARM-based CPU system has been set up and software has been migrating to the new system
- More work should be carried out to meet the increasing requirements.



Thank you

