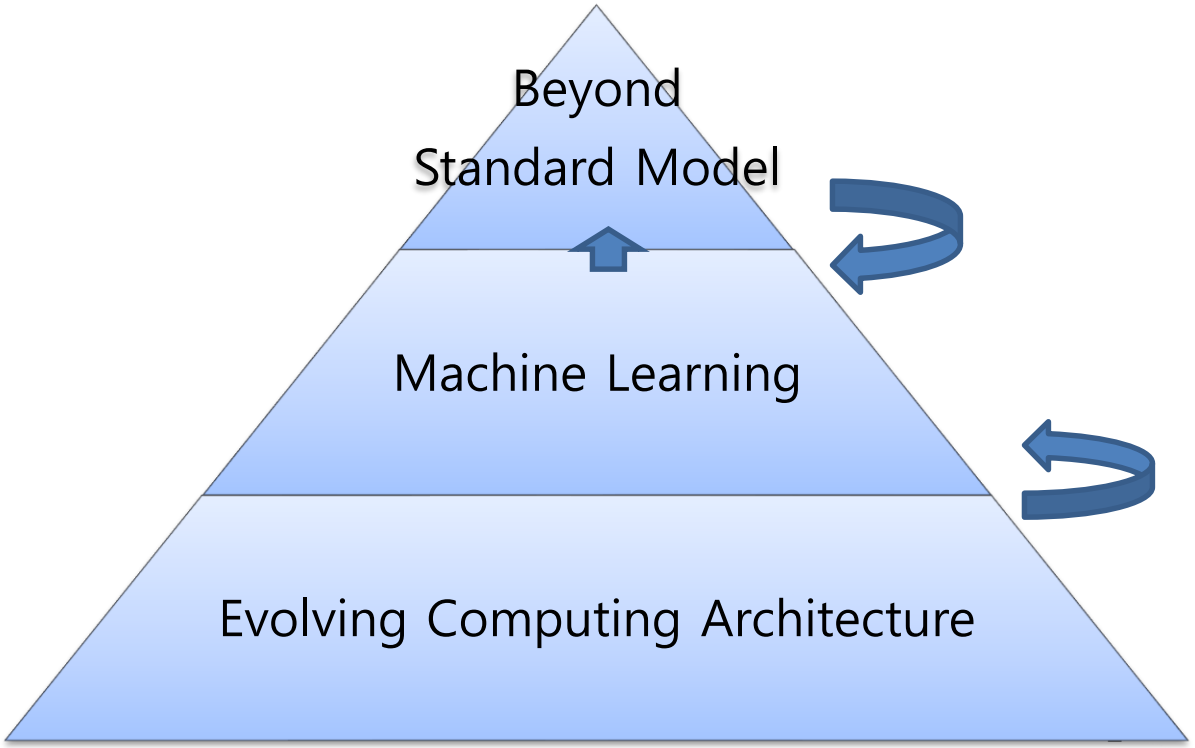
HEP Computing in Korea

2023. 4. 12

Kihyeon Cho (KISTI)

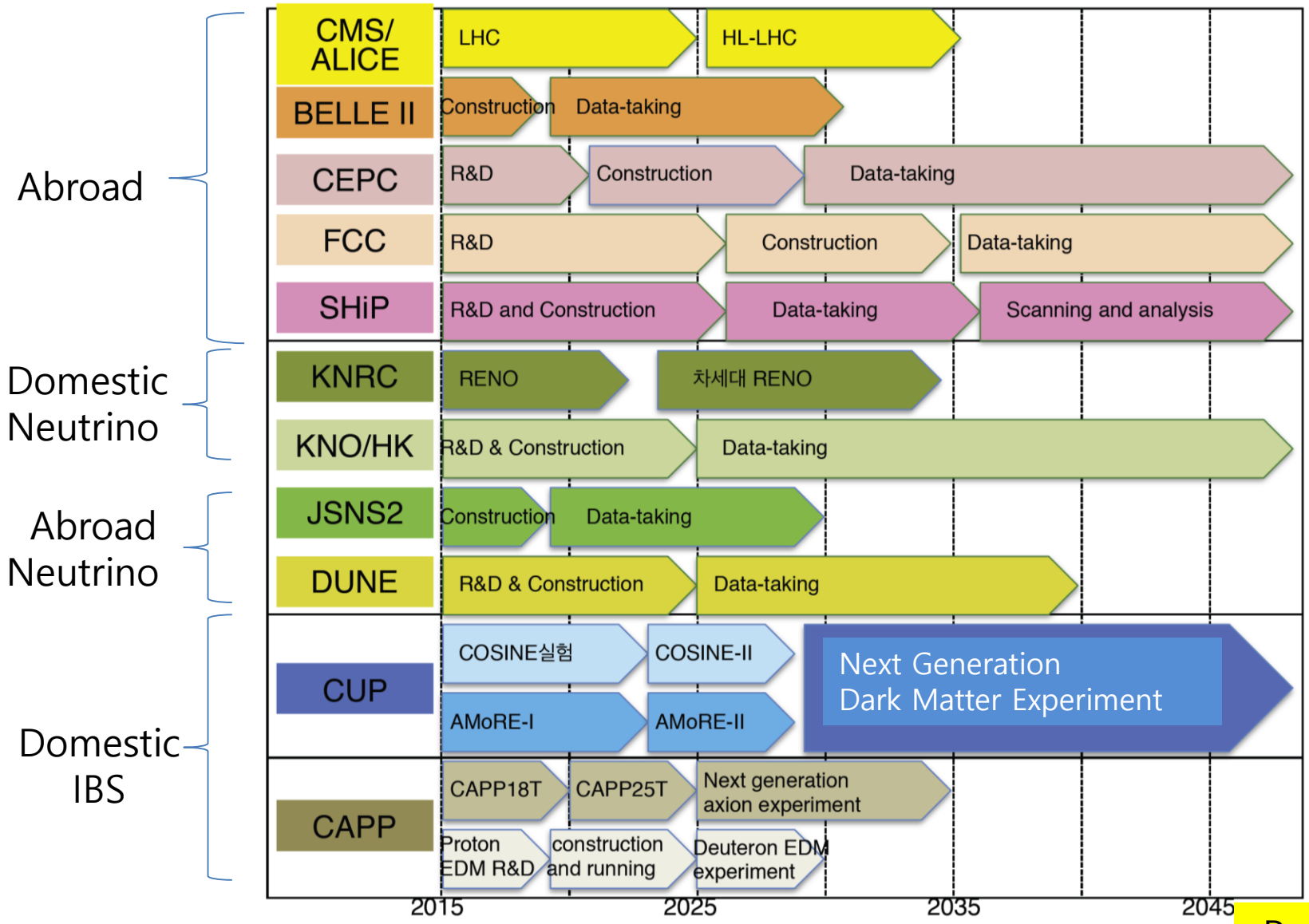
Contents

1. HEP in Korea
2. e-Science revision
3. Evolving Computing Architecture
4. Summary



1. HEP in Korea

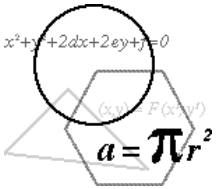
HEP Experiments in Korea



Prof. Y. Kwon

2. e-Science Revision

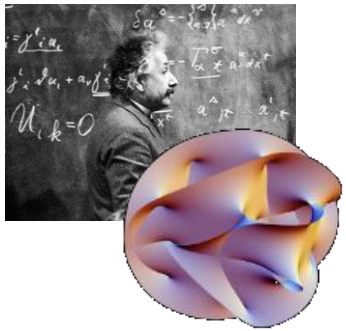
The changing nature of scientific research

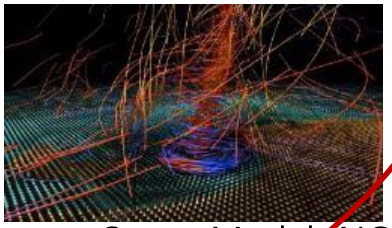


$$H(t)|\psi(t)\rangle = i\hbar\frac{\partial}{\partial t}|\psi(t)\rangle$$

Experimental Theoretical Computational Simulation

Large Hadron Collider





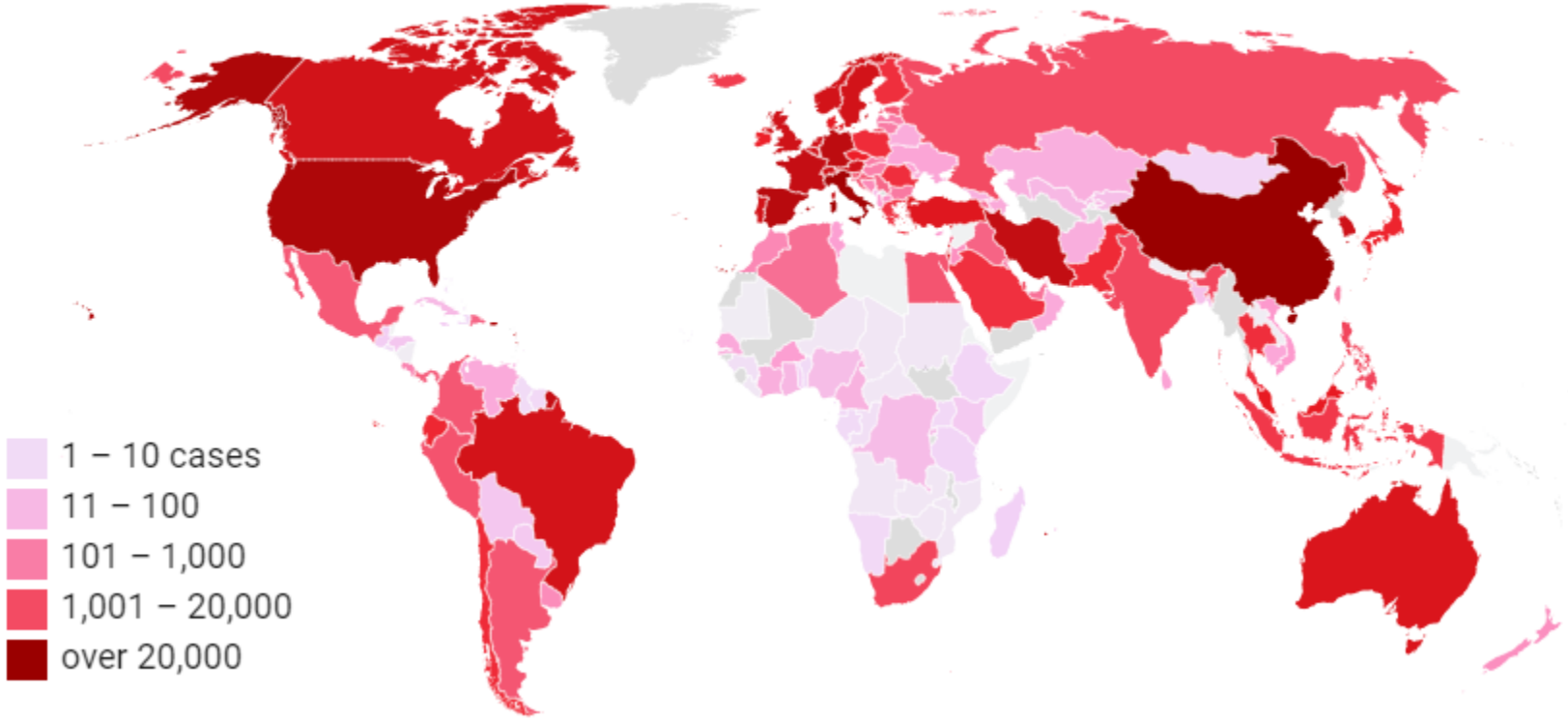
Severe Storm Model (NCSA)

e-Science

Prof. D. Reed

COVID 19

Total cases: **417,966** | Total deaths: **18,615** | As of: March 24, 8 PM eastern time
Hover over the map to see the number of cases and deaths per country



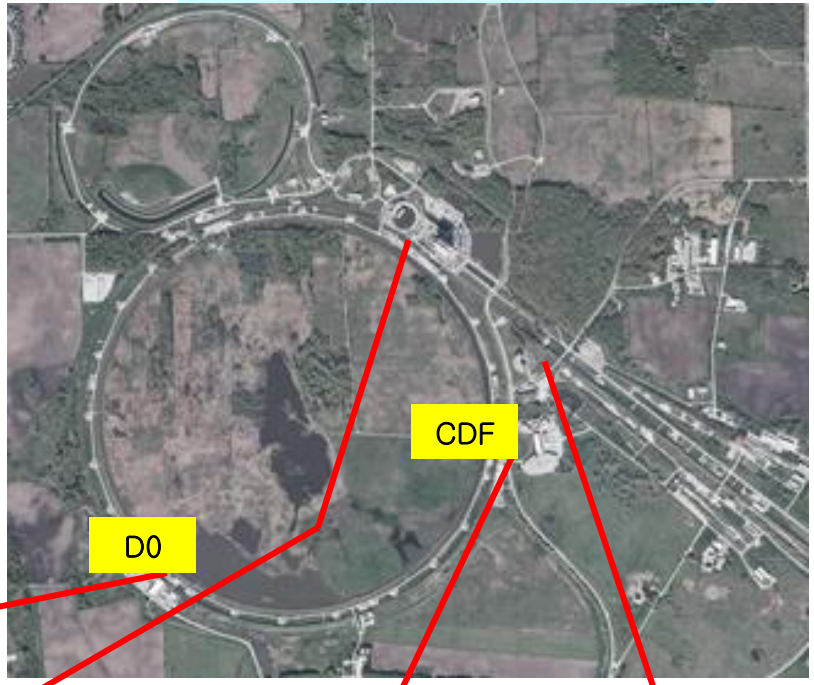
Due to COVID-19 pandemic ⇒ e-Science is coming back in the spotlight.

K. Cho, JKPS, 53, 1187 (2008)

e-Science back

- The goal of e-Science
  - ✓ to study High Energy Physics anytime, anywhere even if we are not on-site laboratories
- Due to COVID-19, we cannot be on-site.
- Therefore, we need e-Science.

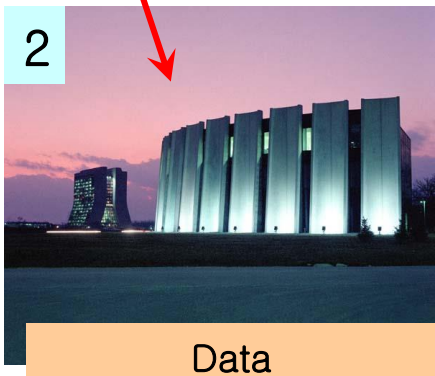
Fermilab, USA



Datra Production (On-line)

Data Analysis

Data Production (On-line)

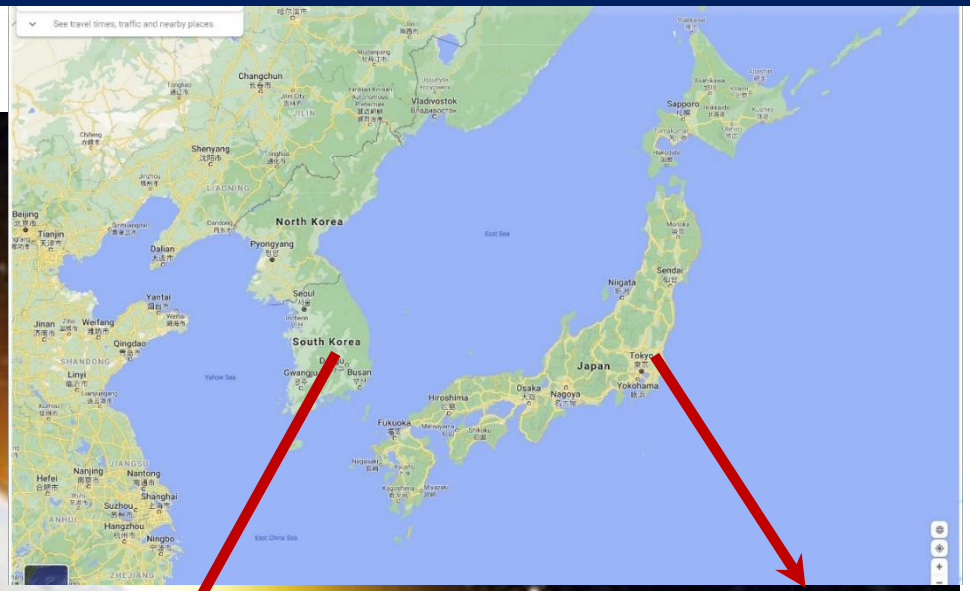


Data Processing(Off-line)

ONLINE OFFLINE

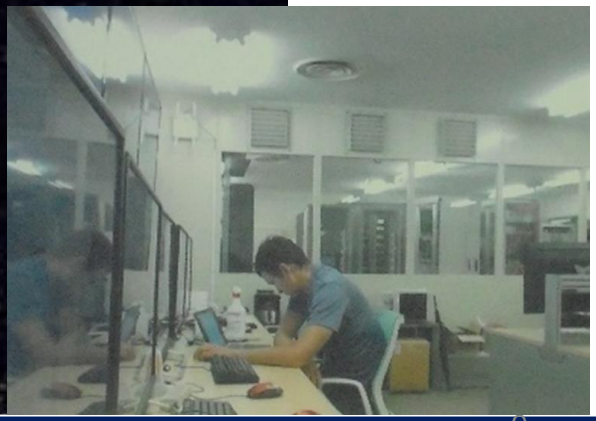
Belle II

Belle II Remote Control Room



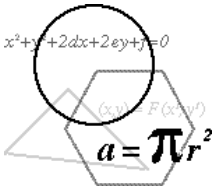
KISTI Remote Control Room

KEK Belle II Control Room



We take shifts at KISTI even if we are not at KEK.

The changing nature of scientific research



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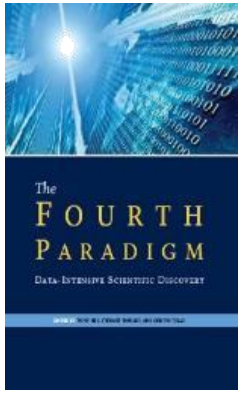
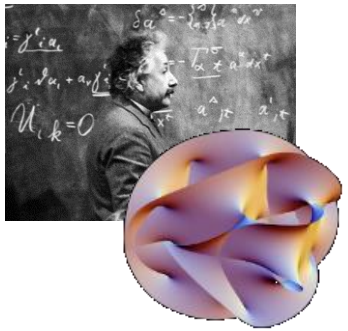
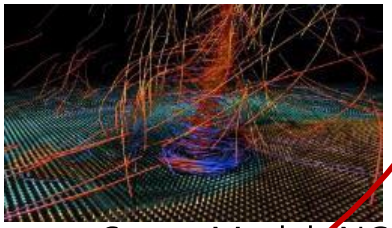


Experimental → Theoretical → Computational Simulation → Data and Machine Learning

Large Hadron Collider





Severe Storm Model (NCSA)

ARRAY OF THINGS

e-Science

Exp.

Obs.

Big Data Production

● Fermi telescope

● CERN(CMS, ALICE, SHiP)

KiSTi www.kisti.re.kr

● KEK(Belle II)

NET-WORK

● Fermilab(DUNE)

● LSST

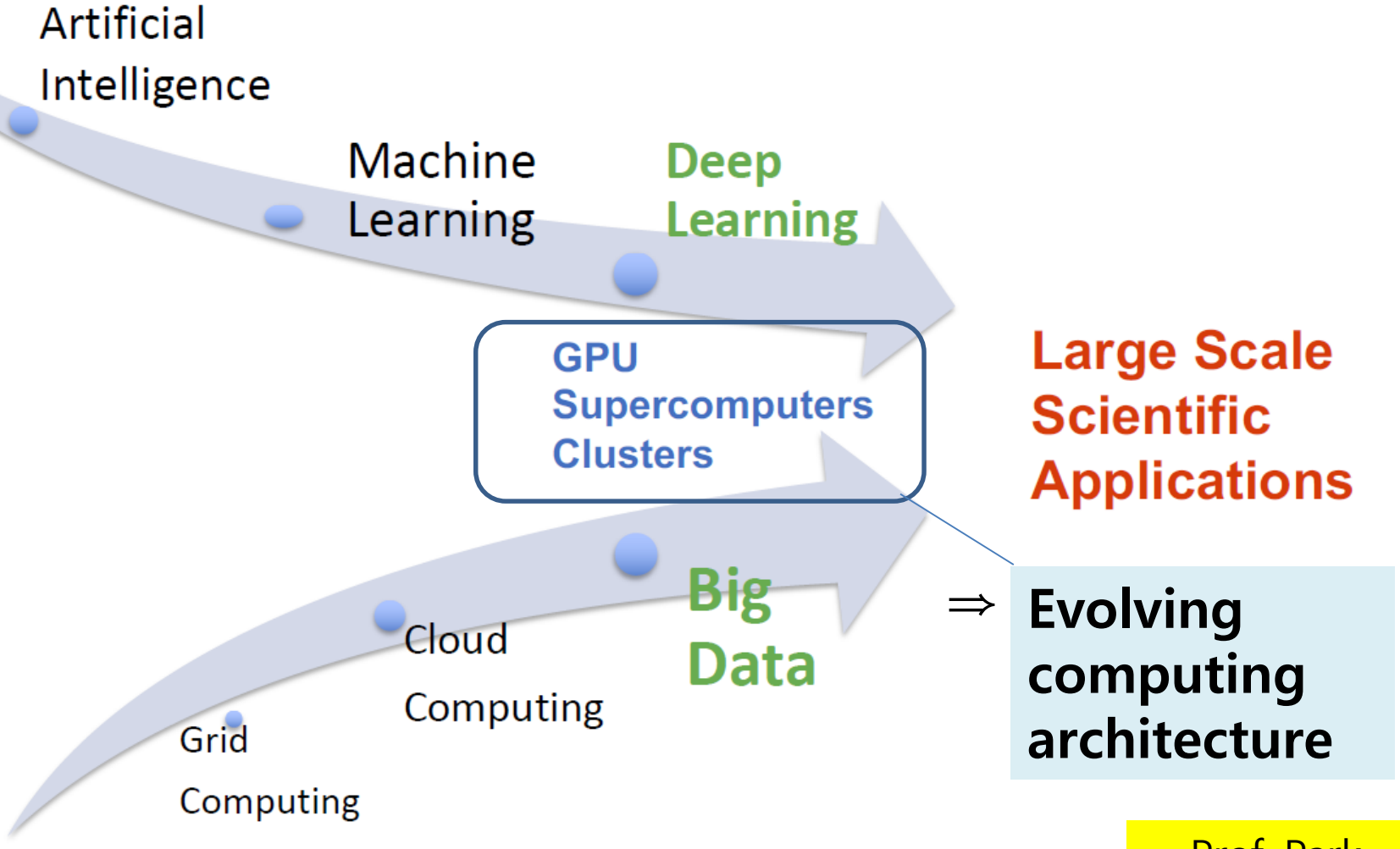
● ICECube

● Experimental data

● Observation data

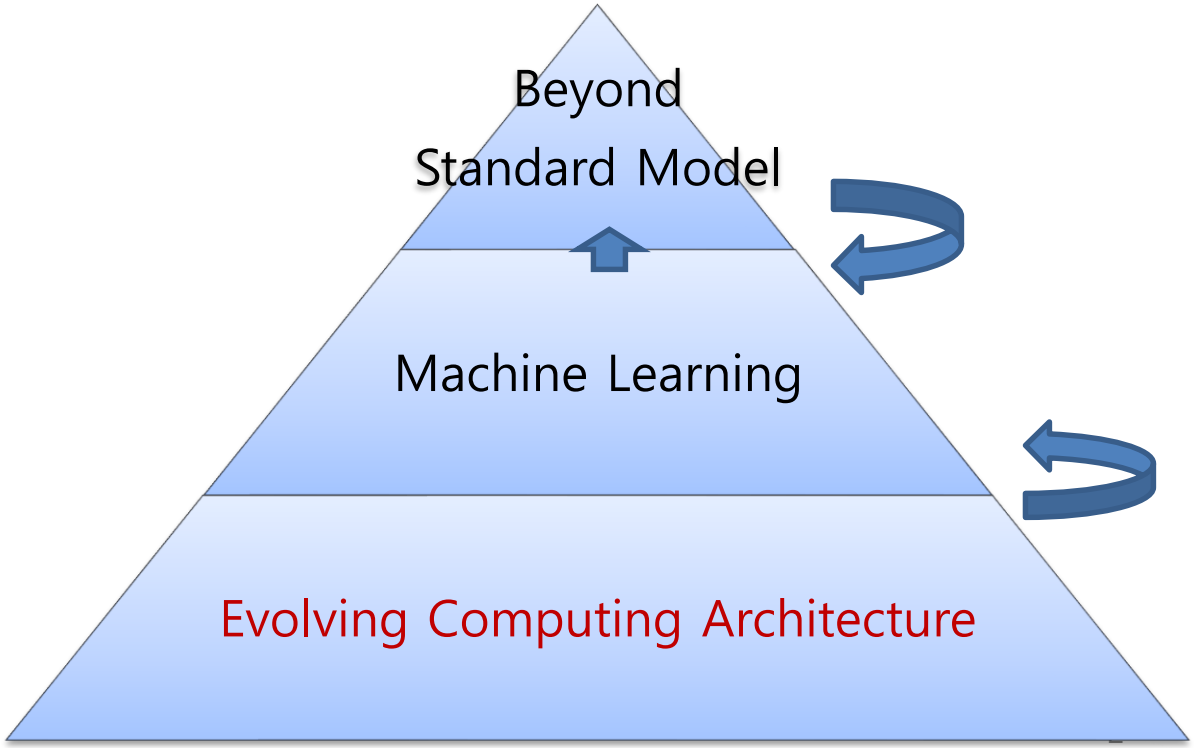
Year	Experiment	Data size
1999~2010	Belle	~1 PB
2008~current	LHC(CMS)	10~20 PB/year
2019~2026	Belle II	100 PB
2026~	HL-LHC(CMS) DUNE	100PB/year (5~10 times of current)

Big data & Deep Learning for Large Scale Scientific Applications

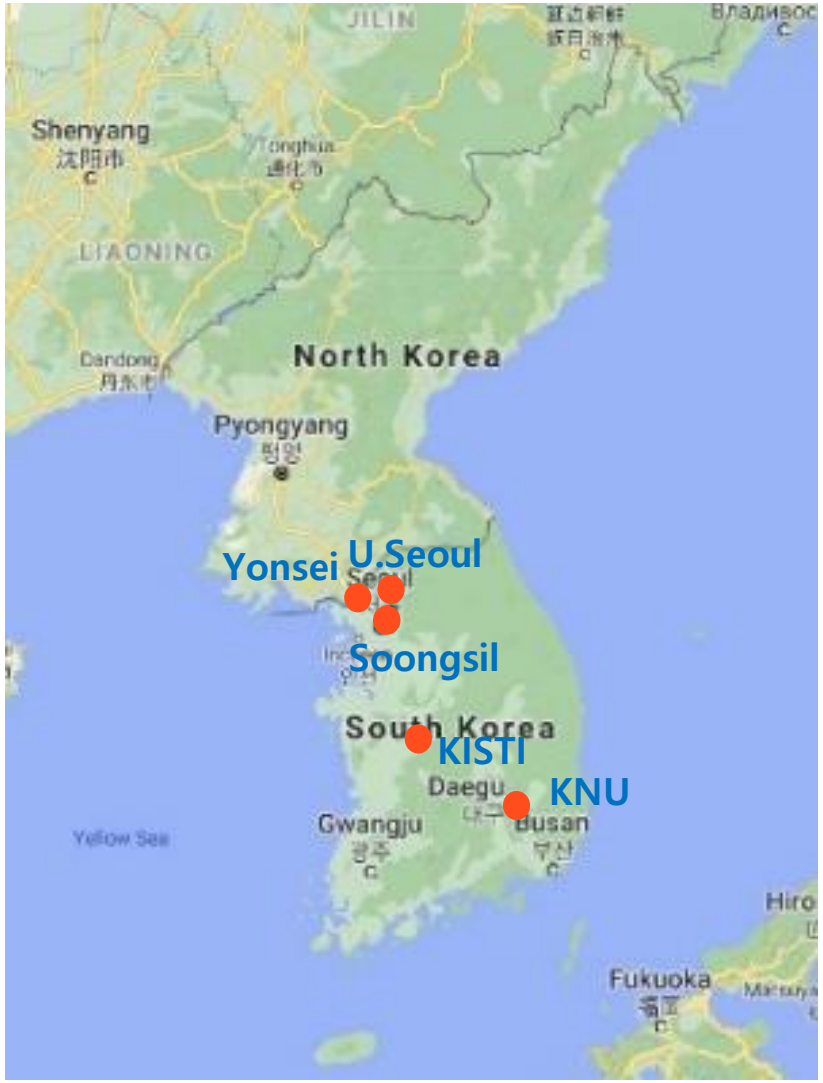


Prof. Park

3. Evolving Computing Architecture



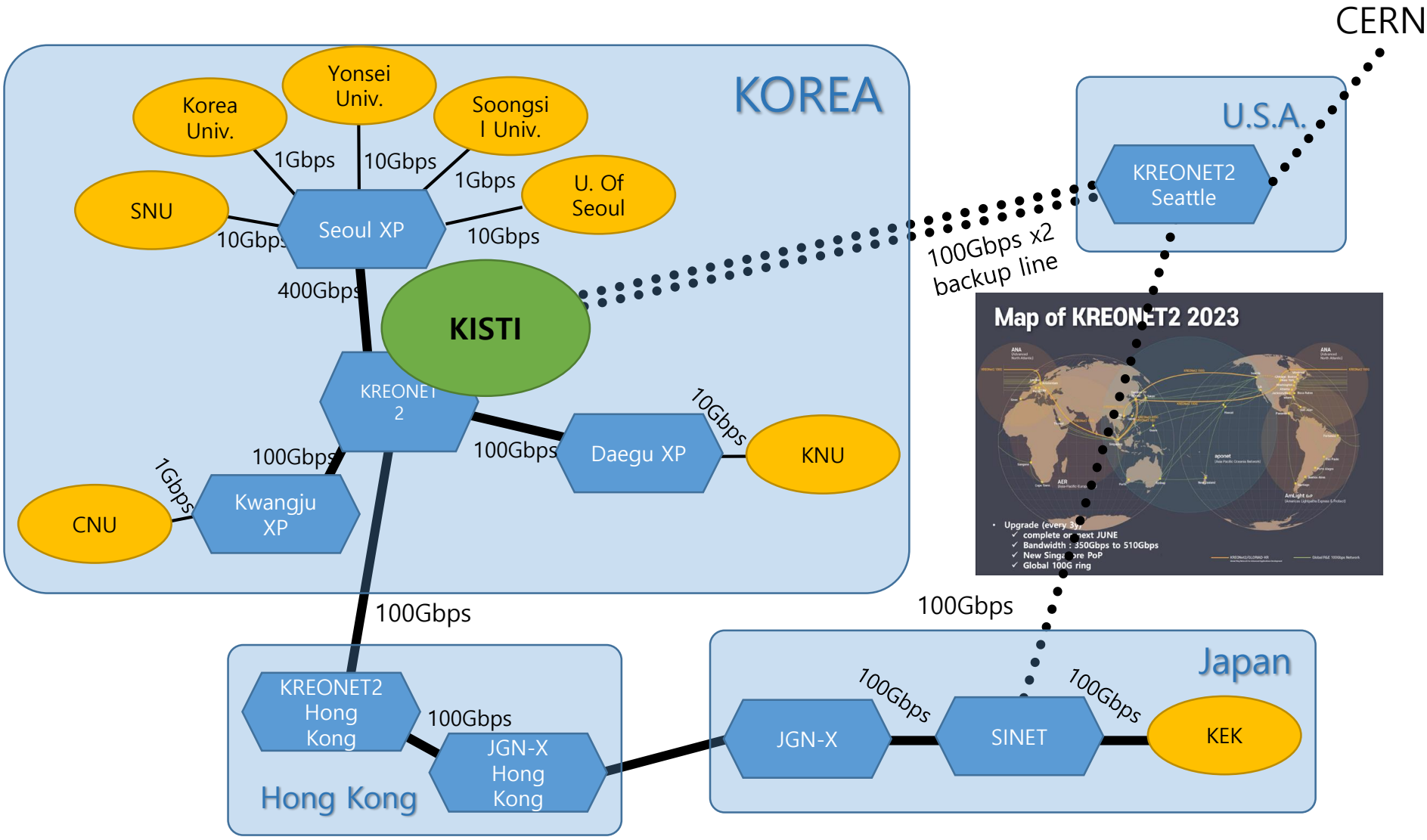
HEP Computing in Korea



1. Grid Farm
   - Soongsil U. & Yonsei U.
     - Belle II Farm
   - KNU & U. of Seoul
     - CMS Tier-3
   - KISTI-GSDC
     - ALICE Tier-1, CMS Tier-2,3
     - Belle II Farm, LIGO, RENO

2. Evolving computing architecture
   - KISTI-5 supercomputer
   - KISTI-6 supercomputer

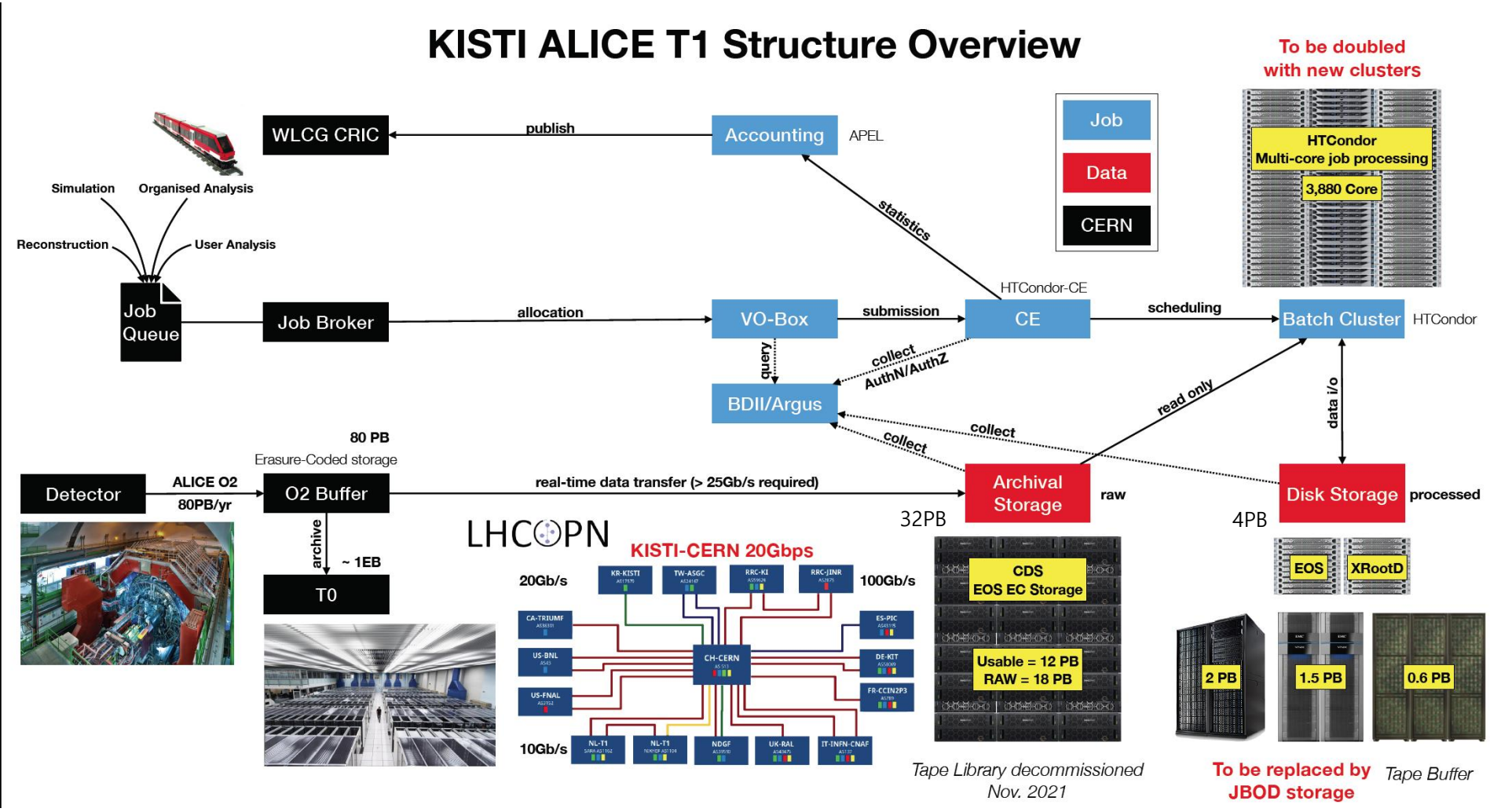
Connected via KRONET2



- HEP computing is connected with KISTI at 1~10 Gbps of KROENET2.
- KISTI is also connected to CERN with LHCOPN and LHCONE.

1. Grid Computing: KISTI-GSDC

KISTI ALICE Tier-1



Dr. S. Ahn

KISTI Belle II Farm

- New system has been in operation since July 2022.

	HOST NAME	H/W	MIDDLEWARE	OS
CE	belle-ce2.sdfarm.kr	Dell R640	HTCondor-ce	CentOS 7.9
WN	belle-wn[2201~2206].sdfarm.kr		HTCondor	

- Specification of WN
  - # of WN : 6 nodes
  - # of cpu/node : 2
  - # of core/cpu : 18
  - HyperThread ON
  - # of Logical core/node : 72
  - Total job slots : 432
  - Memory size per node : 384GB
  - Memory size per job slot ≈ 5.3GB
  - Disk space per job slot : 10GB

- HEP-SPEC06
  - CPU : Intel Xeon Gold 6245 @3.10GHZ
  - HS06/node : 942.76
  - TOTAL : 5.7K HEP-SPEC06

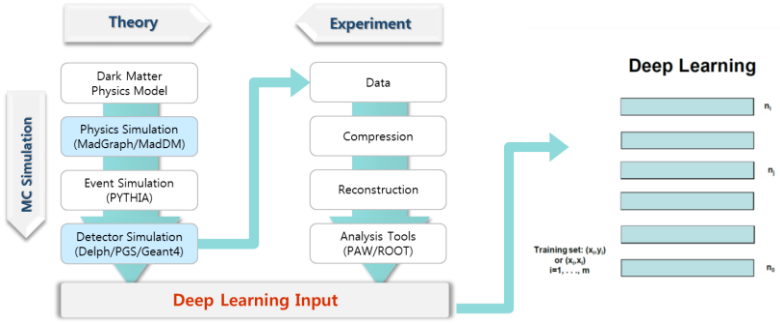
- Storage Element (New system will be introduced by May): 100TB NAS storage

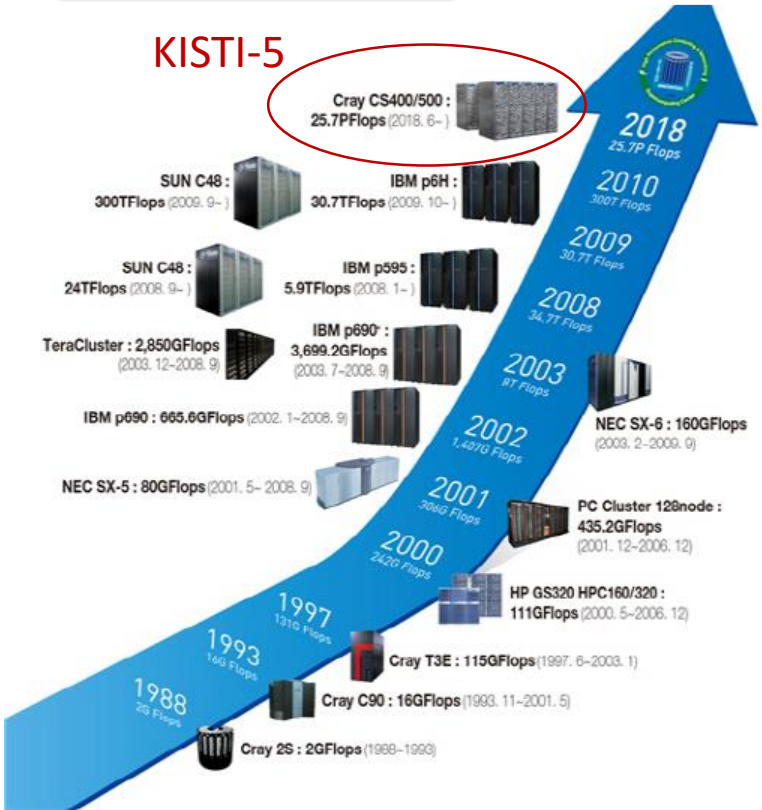
	HOST NAME	H/W	MIDDLEWARE	OS
Head Node	belle-se2-head.sdfarm.kr	Dell R640	dCache	CentOS 7.9
Disk Node	belle-se2-disk01.sdfarm.kr			
	belle-se2-disk02.sdfarm.kr			

I. Yeo

2. Evolving Computing Architecture

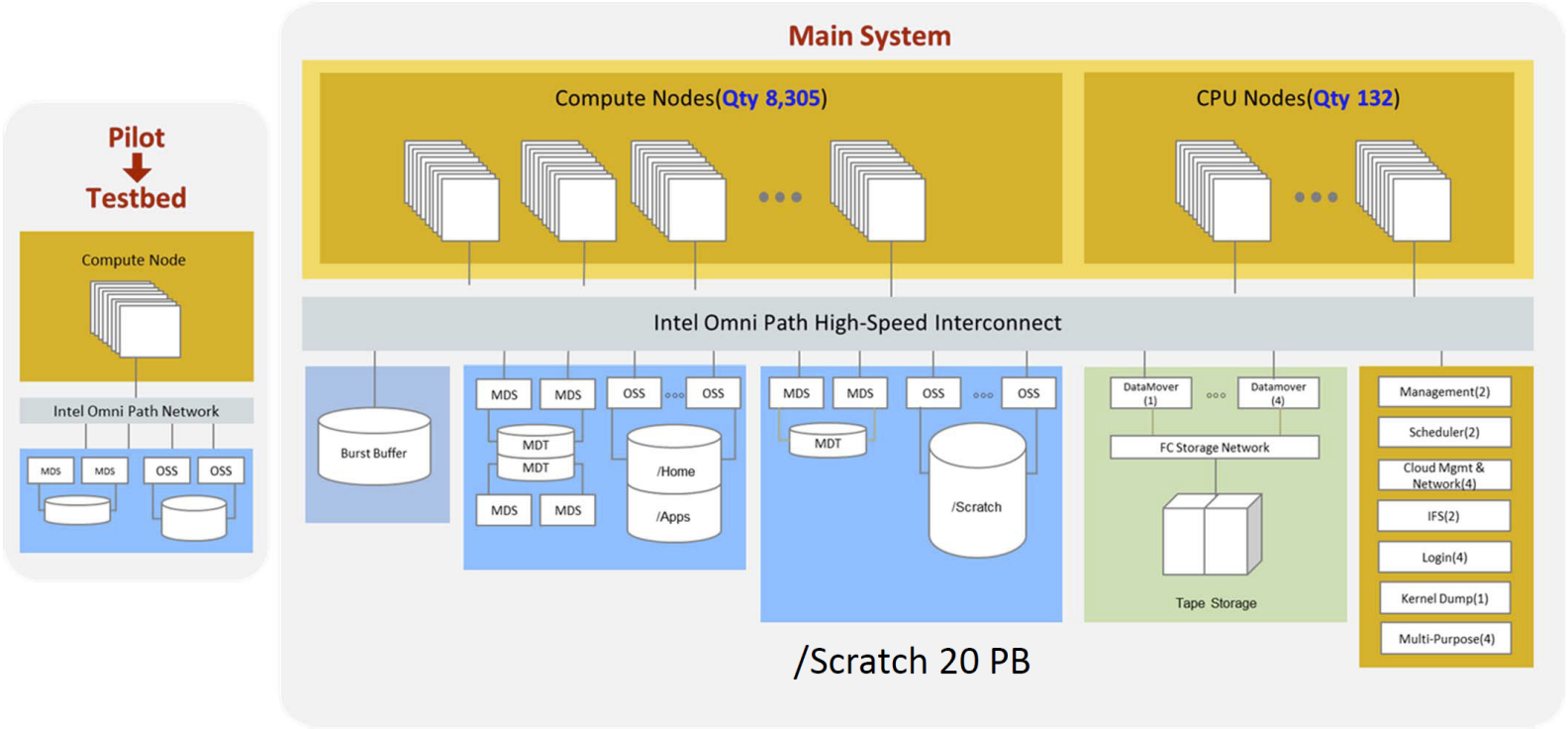
KISTI-5 supercomputer





- CPU 25.7PF
  - ✓ Heterogeneous: 25.3PF CS400 w/KNL
    - Manycore system
  - ✓ CPU-only: 0.4PF CS500 w/Skylake
- Storage
  - 21PB SPS
  - 10PB Archive
- Launched in November 2018
  - ✓ Ranked 11th of Top 500

Architecture of KISTI-5 supercomputer



/Home 0.5 PB /Apps 0.5 PB

Burst Buffer 0.8 PB (SSD)

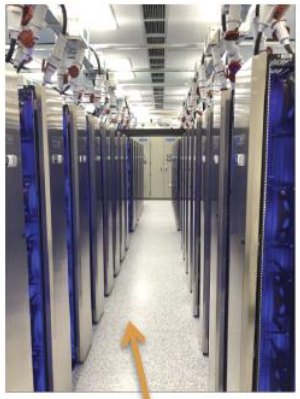
Tape Storage 10 PB

1 account=100 SRU = 6400 node*hour (KNL)

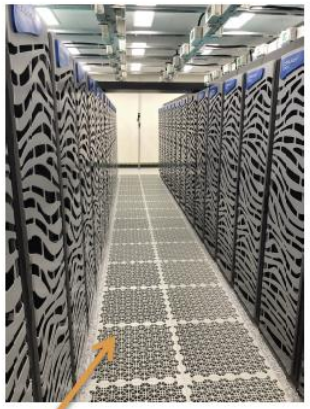
M.S. Joh

Rack Front Door

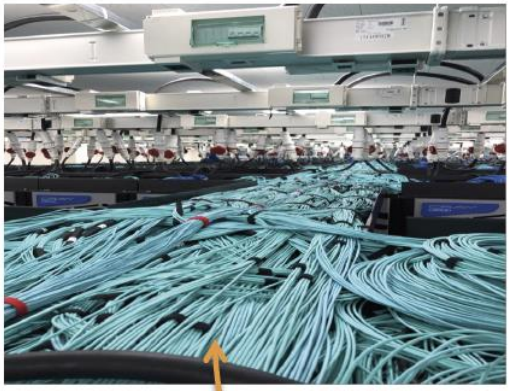
Rack Rear Door



Hot Aisle

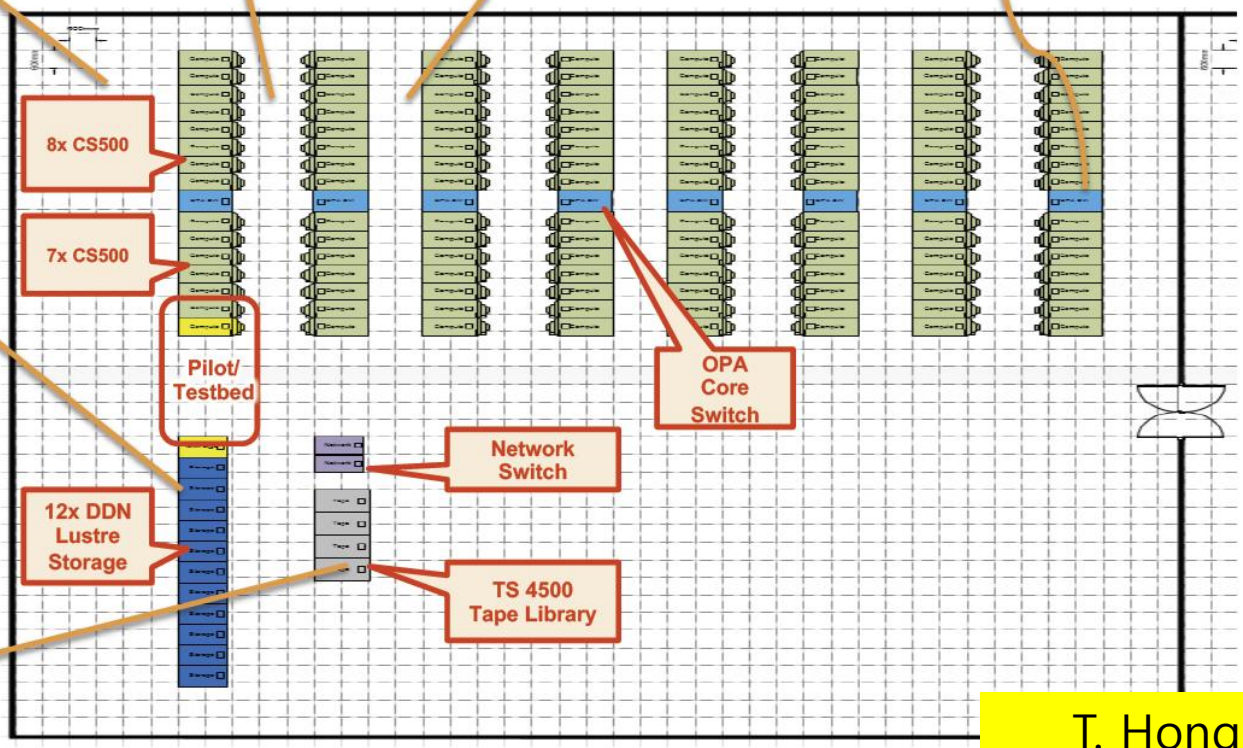


OPA Optic Cables



Disk Storage (21PB)

Tape Storage (10PB)



T. Hong

KISTI-6 supercomputer

- Will come to KISTI in Q2, 2024
- Cost: $225M
- Computational resources
  - 600 PF, Storage 200PB
  - CPU-only Partition (1.5K node)
  - CPU+GPU Partition (3K nodes)
  - Storage (Flash 20PB, HDD 180 PB)
  - Interconnect Network (400 GBPS)
- Infrastructure
  - Electricity: 18MW
  - Cooling Capacity: 4000 RT
  - Space: less than 300m^2
  - Direct Liquid Cooling

- Hetero computing environment with CPU and GPU at the same time
- Storage resources for large scale computations, AI requirements and I/O bandwidth
- Balanced performance of computing and storage networks

  ⇒ the latest interconnect technology load map

4. Summary

- Due to COVID-19 pandemic, e-Science is coming back such as Belle II remote control room.
- New physics beyond Standard Model needs machine learning and evolving computing architecture.
- HEP computing merges from Grid farm to evolving computing architecture.

⇒ Therefore, KISTI-6 supercomputer will play an important role to study HEP in Korea besides Grid farms.

Thank you.
(cho@kisti.re.kr)

One page summary plot

HEP Computing in Korea

1. Due to COVID-19 pandemic,
   e-Science is coming back
   (eg. KISTI's Belle II remote control room).

2. New physics beyond Standard Model
   needs machine learning and
   evolving computing architecture.

3. HEP computing merges
   from Grid farm (eg. KISTI-GSDC)
   to evolving computing architecture
   (eg. KISTI-5,6 supercomputer)

⇒ Therefore, KISTI-6 supercomputer
  will play an important role to study
  HEP in Korea besides Grid farms.