

22nd International Conference on Computing in High Energy and Nuclear Physics, Hosted by SLAC and LBNL, Fall 2016

## Highlights of the Belle II Computing

Takanori Hara (KEK), Hideki Miyake (KEK), Ikuo Ueda (KEK IPNS), Kiyoshi Hayasaka (Nigata Univ.), Yuji Kato (Nagoya Univ.), Silvio Pardi (INFN, Napoli)  
Martin Sevier (University of Melbourne), Fabrizio Bianchi (Universita degli Studi di Torino), Vikas Bansal (PNNL), Malachi Schram (PNNL)

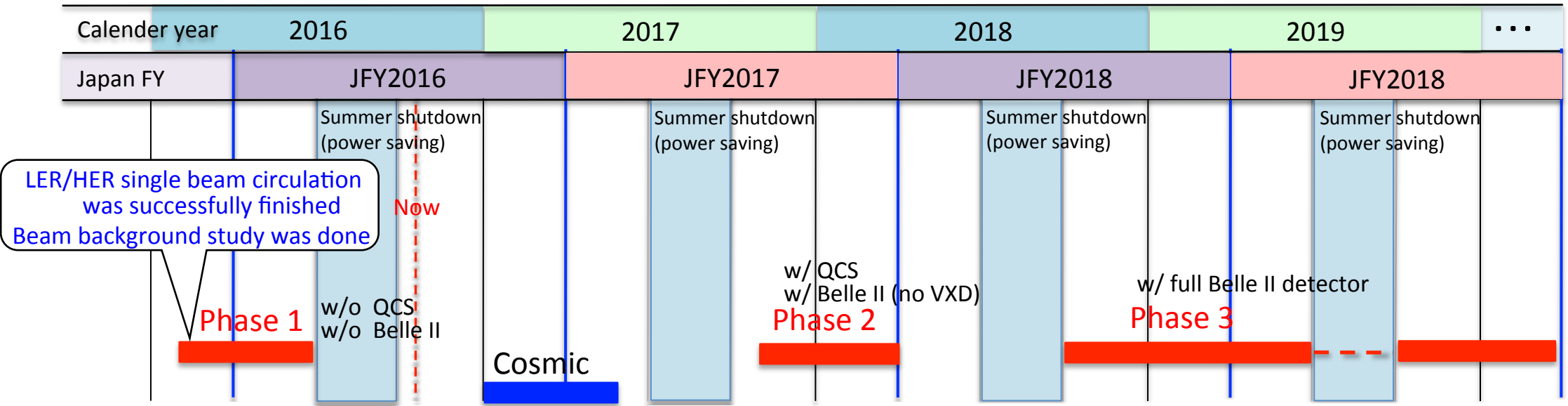
### and for the Belle II Computing Group



Trak 9  
Oct 11, 2016 @ San Francisco

takanori.hara@kek.jp

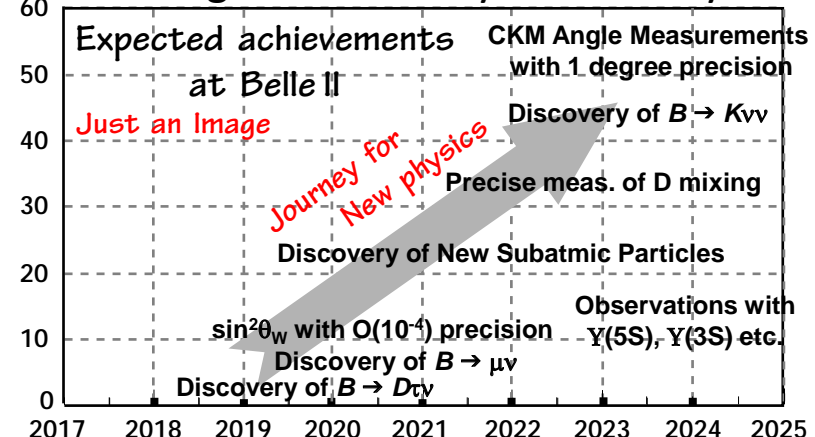
# Belle II Experiment : Time line



SINET4 → SINET5  
 KEKCC replacement

In 2017  
 Dress rehearsal is planned (concurrent running of different type process)  
 → Raw data processing  
 → MC production  
 → User analysis  
<https://indico.cern.ch/event/505613/contributions/2227937/>  
 Fast Calibration is necessary  
<https://indico.cern.ch/event/505613/contributions/2227271/>

( $ab^{-1}$ ) Aiming for Discovery of new Physics





# Interoperability with DIRAC

KIT, CNAF, CESNET, HEPHY, KISTI, Nagoya, ULAKBIM, CYFRONET, .....



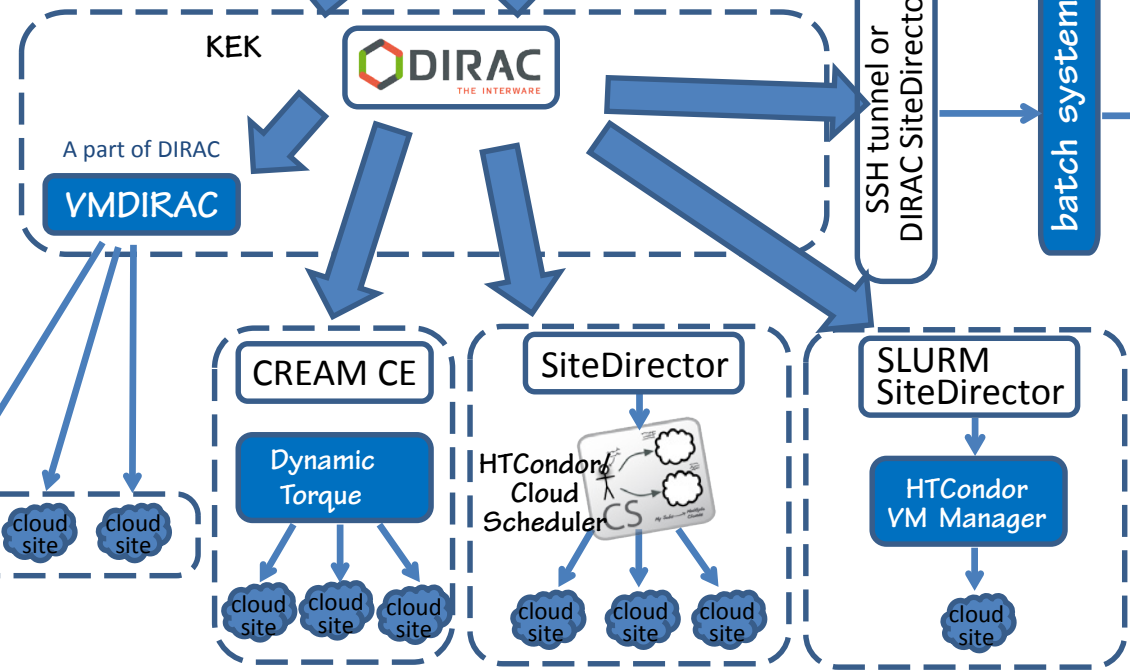
GRID Middlewares



SIGNET, DESY

Distributed Infrastructure with Remote Agent Control (originally developed for LHCb)

- Provided as a DIRAC plugin
- Need additional installation
- Multiple cloud sites allowed
- Handle each cloud as a site
- No modification in cloud site



Melbourne

- Seen as a traditional CREAM CE site
- Installed in each cloud site

UVic

PNNL HPC

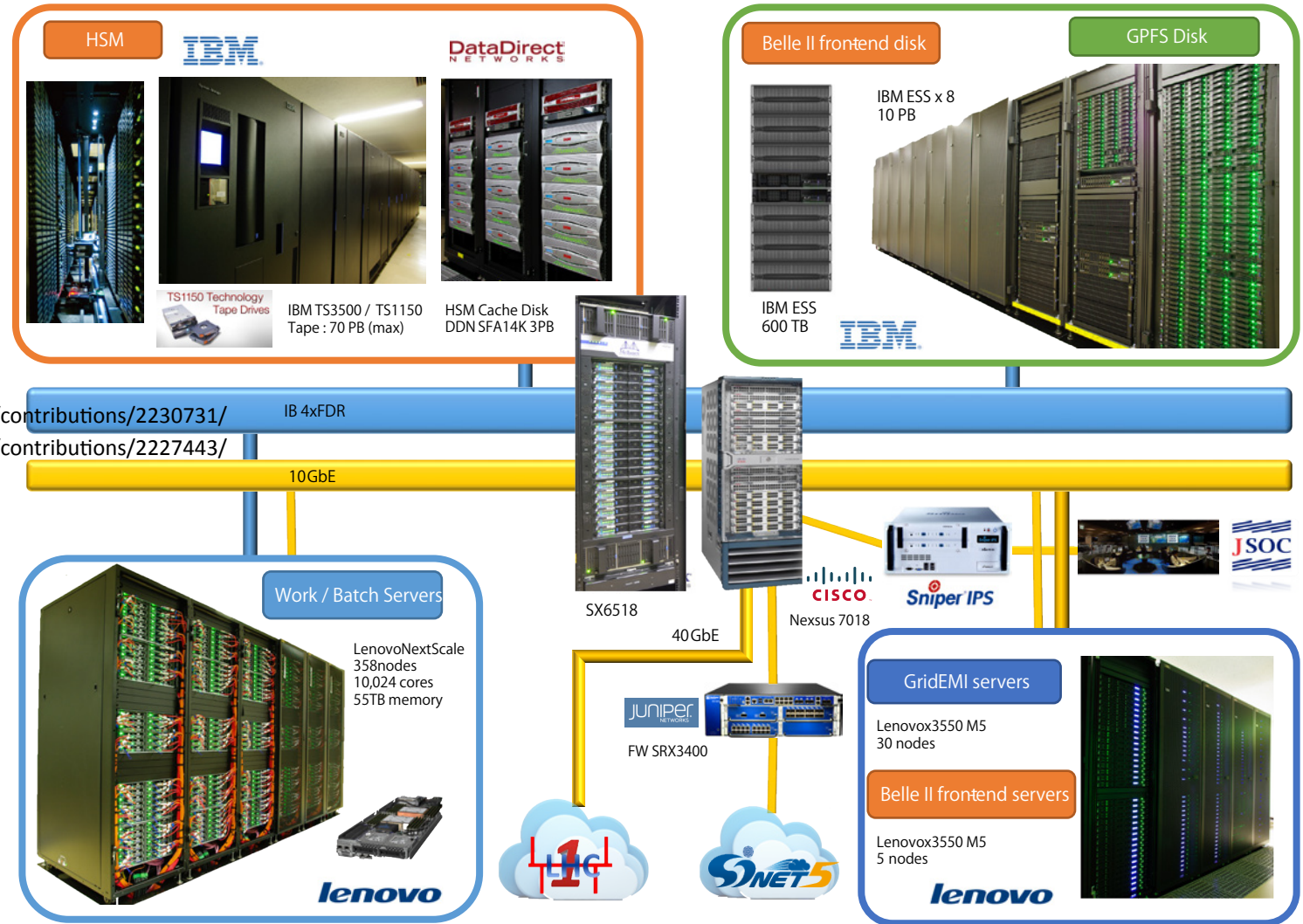
Academic clouds Commercial clouds, Amazon EC2, etc



BINP, CINVESTAV, UAS universities in Japan, Korea, India

# KEKCC : main computing system

Duration  
Sep 2016 - Aug 2020



Shared with  
Belle,  
Belle II,  
ILC,  
J-PARC,  
KAGRA,  
Theory groups

<https://indico.cern.ch/event/505613/contributions/2230731/>  
<https://indico.cern.ch/event/505613/contributions/2227443/>

~10,000 cores  
≈230 kHS06

# Belle II Distributed Computing system and services in use



DIRAC main servers @ KEK

hardware maintained by KEK CRC  
services maintained by Belle II

DIRAC servers for test/development purpose  
at PNNL (USA)



AMGA @ KEK (Metadata) +

hardware maintained by KEK CRC  
services maintained by Belle II



LFC@KEK (Replica)

hardware / services maintained by KEK CRC



DB @ KEK

hardware maintained by KEK CRC  
services maintained by Belle II

Currently, DB servers at PNNL (USA)



VOMS @ KEK (+ @PNNL, @DESY)

hardware / services maintained by KEK CRC



FTS3@KEK (+ @PNNL)

hardware / services maintained by KEK CRC

Belle II Distributed Computing Core Services  
are being reconfigured (almost done)



cvmfs /cvmfs/belle.cern.ch/{releases, externals} is used for software distribution  
stratum0 @ KEK (soon)      stratum1 @ PNNL, DESY(?)

DIRAC client installation via cvmfs

Access GOCDB

to get downtime information

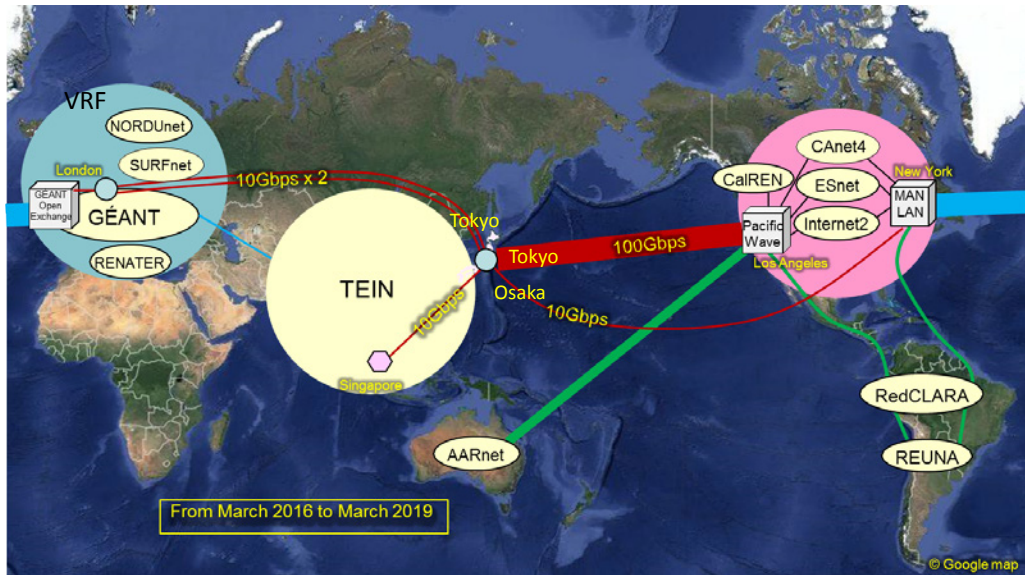



ticketing system  
non-LCG site: JIRA @ DESY



HappyFace is utilized, too  
PerfSONAR mesh is also used

# Network transition





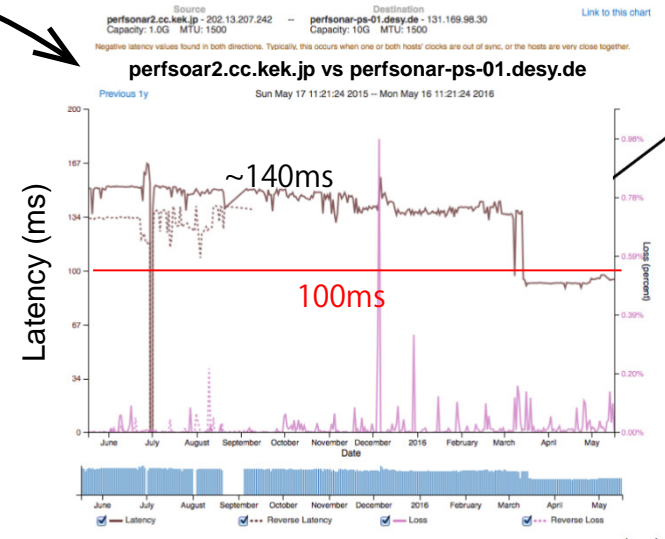
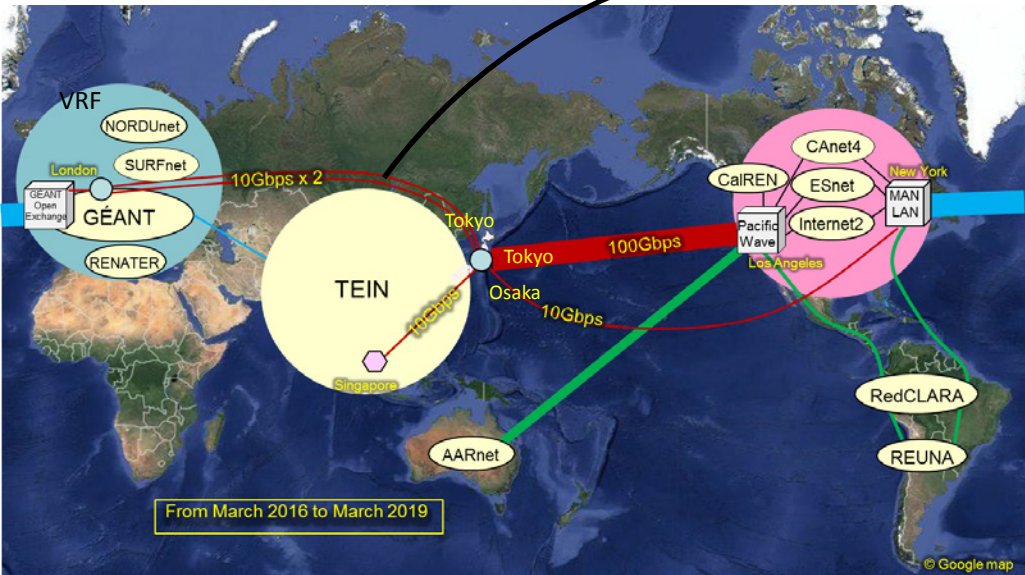
**Work / Batch Servers**

Lenovo NextScale  
358nodes  
10,024 cores  
55TB memory

# Network transition

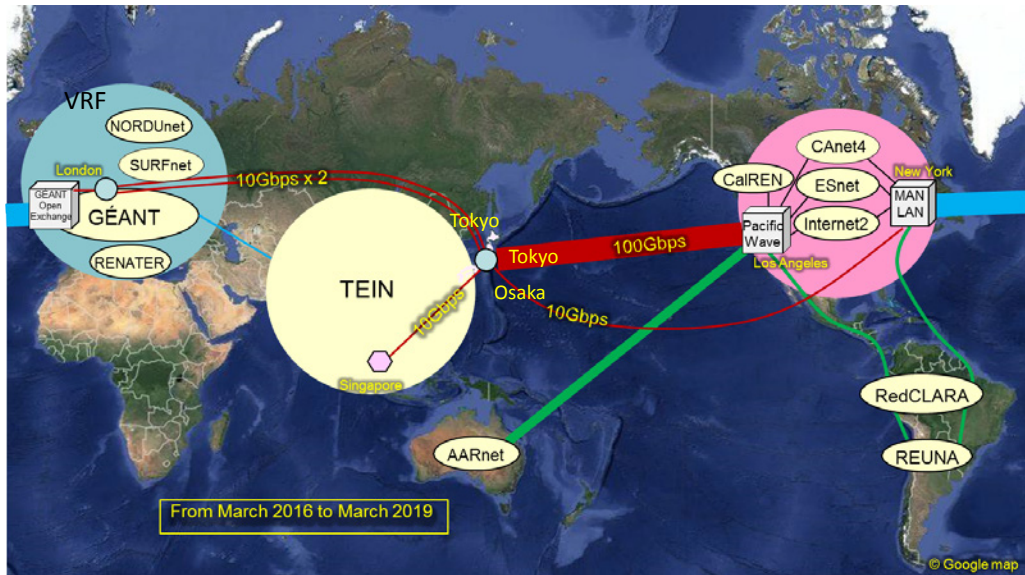



- SINET4 + present KEKCC
  - NYC link by SINET4 (upto 10G)
  - non LHCONE
- SINET5 + present KEKCC
  - London link by SINET5 (upto 20G)
  - non LHCONE
- SINET5 + new KEKCC
  - London link by SINET5 (upto 20G)
  - with LHCONE



Upgrade to SINET5 happened  
Latency drops

# Network transition

**Work / Batch Servers**

Lenovo NextScale  
358nodes  
10,024 cores  
55TB memory





INFN-Napoli (Italy)  
 PNNL (USA)  
 updated the network  
 in September  
 ↓  
 Further data transfer  
 test will be done

**KEK Outgoing**

- SINET4 + present KEKCC
  - NYC link by SINET4 (upto 10G)


**KEK Incoming**

- SINET5 + present KEKCC
  - London link by SINET5 (upto 20G)

- SINET5 + new KEKCC
  - London link by SINET5 (upto 20G)
  - with LHCONE

Destination	SINET4 [Gbps]	SINET5 old KEKCC [Gbps]	SINET5 new KEKCC LHCONE [Gbps]	Increase over old KEKCC & LHCONE
PNNL	3.6	3.9	8.4	115%
DESY	3	3	-	-
KIT	3.5	3.2	-	-
CNAF	-	3.8	9.0	136%
NAPOLI	3	3	8.8	190%

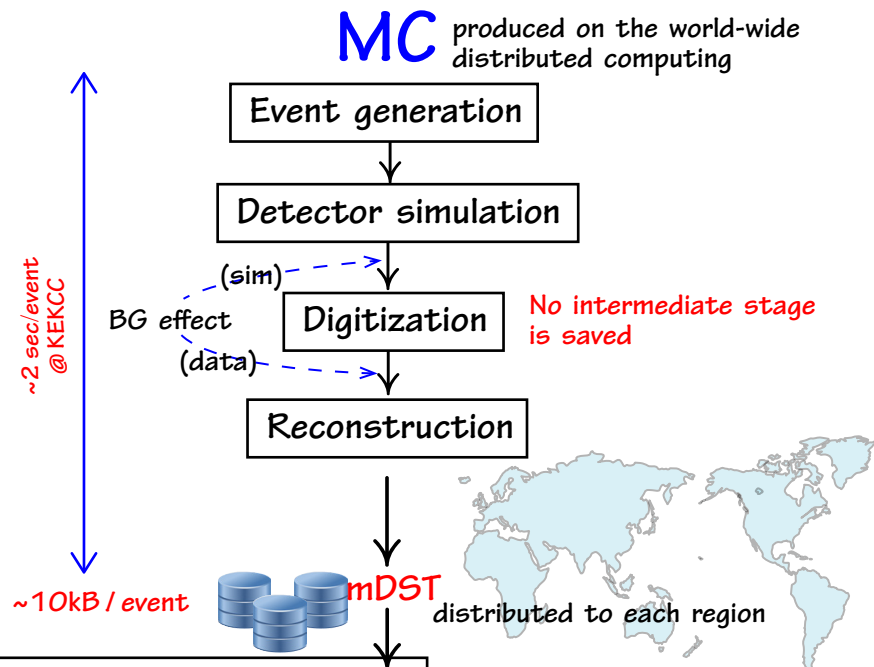
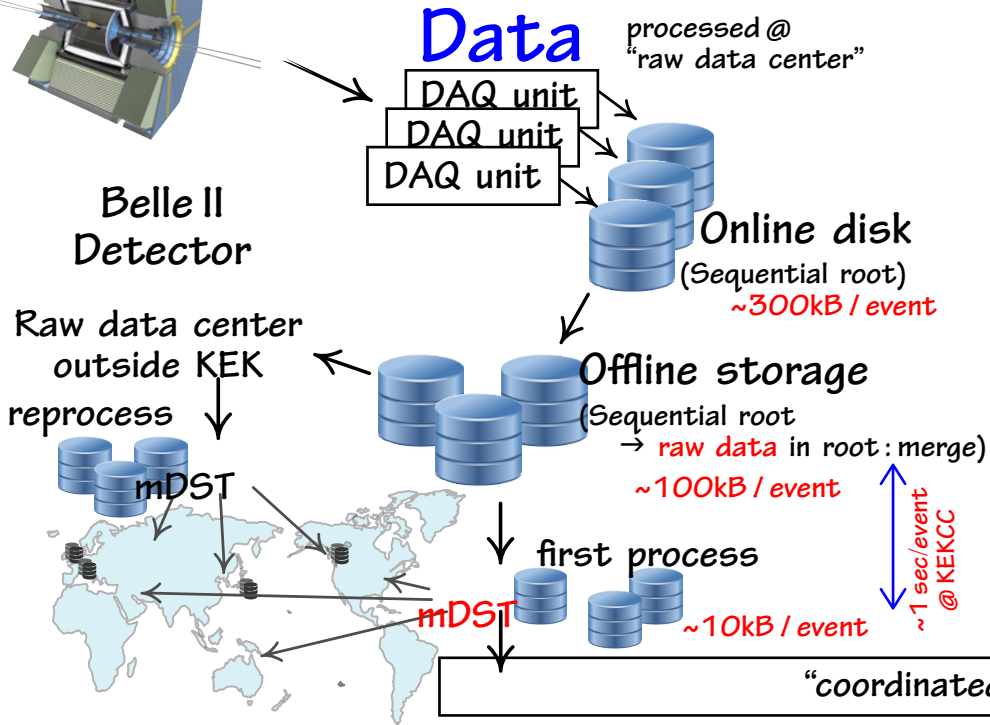
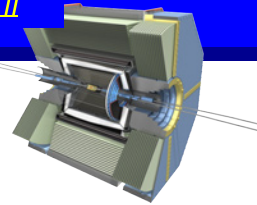
Source	SINET4 [Gbps]	SINET5 old KEKCC [Gbps]	SINET5 new KEKCC LHCONE [Gbps]	Increase over old KEKCC & LHCONE
PNNL	4.6	6.3	-	-
DESY	4	8	-	-
KIT	5	7	-	-
CNAF	7	7	13.5	93%
NAPOLI	5.5	6.6	13	97%



**Work / Batch Servers**

Lenovo NextScale  
 358nodes  
 10,024 cores  
 55TB memory

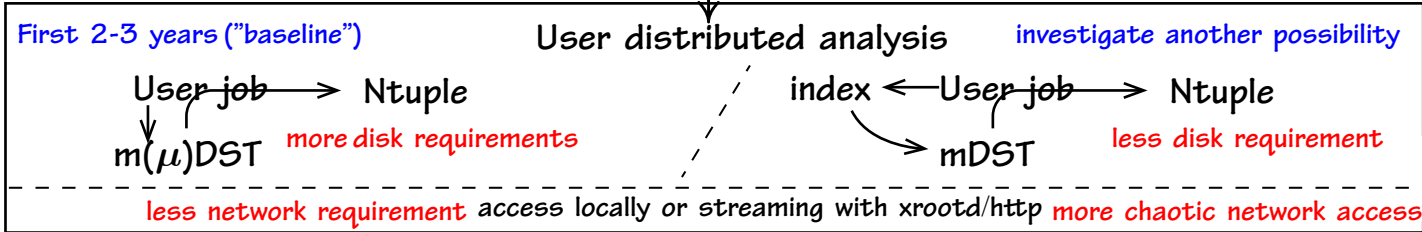
# Data flow diagram



"coordinated" group skimming

group official skim: mDST,  $\mu$ DST, index

mDST: reconstruction level info.,  
 $\mu$ DST: mDST + particle level info.,  
index: collection of pointers to events



Performance and reliability of WebDav protocol is being evaluated

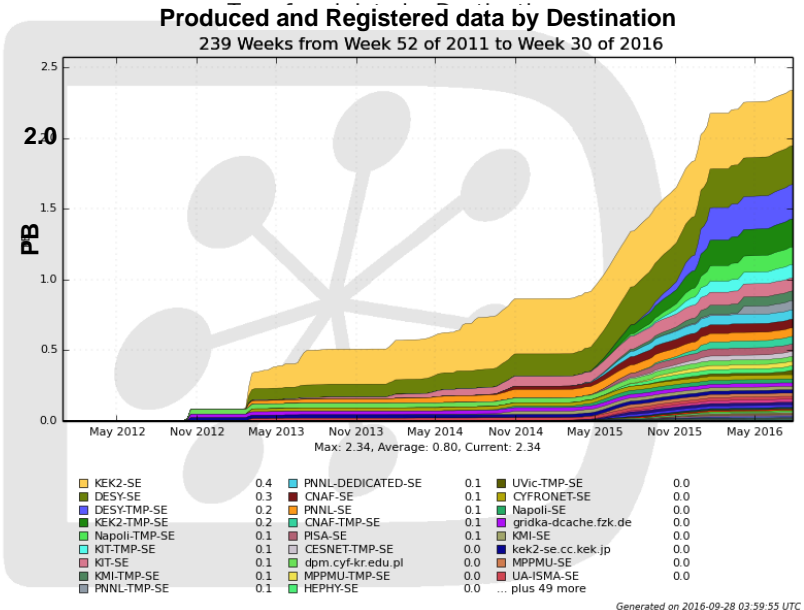
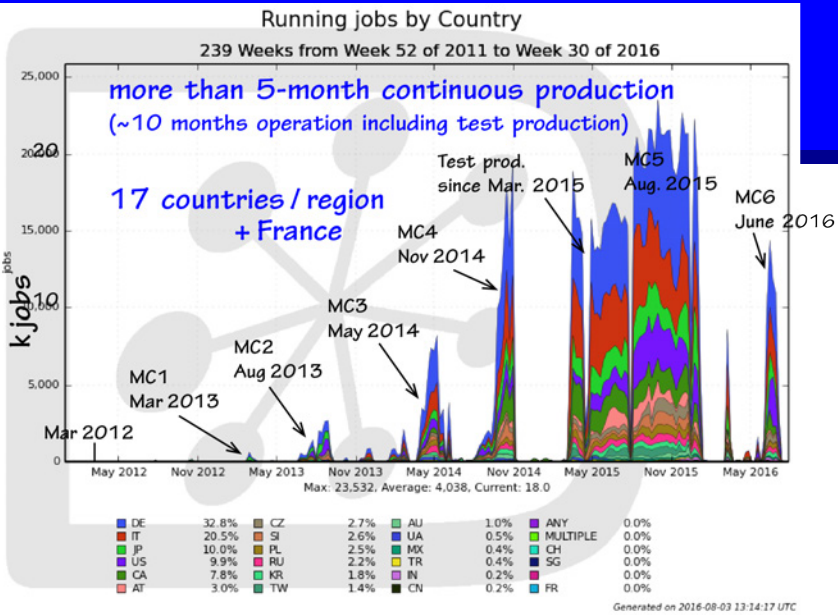
<https://indico.cern.ch/event/505613/contributions/2230950/>

Data Federation is being tested, too

<https://indico.cern.ch/event/505613/contributions/2230951/>



# Belle II distributed computing



## Aiming for the discovery of new physics

- ~6kHz @ online storage
- ~100kB / event for raw data @ offline storage, ~10kB / mDST
- Raw data : more than 10PB/year @ full luminosity

## Computing resources

- Grid : CREAM-CE, ARC-CE, HTCondor-CE
- Clusters w/o middleware : ssh or DIRAC SiteDirector
- Cloud : VMDIRAC, CloudSchedule, Dynamic Torque
- Others : Spontaneous pilot instantiation, VOINC

## Storage elements

- STORM, DPM, Bestman2, dCache, DIP, XRootD  
(38%), (29%), (19%), (14%) : 2.1PB (as of 2016 Feb)

## Catalogue

- AMGA (Metadata) + LFC (Replica)
- DFC (for development instance)

## Extended

- Automated "Production system"  
based on Transformation system

Plan to start the next large-scale MC production from November.

# Summary

⇒ SuperKEKB accelerator :

LER/HER beam circulation was successfully done as scheduled

Belle II detector :

Right now, CDC(Central Drift Chamber) is being installed

⇒ Main Computer @ KEK was entirely replaced in August 2016

→ Belle II distributed computing core services are being reconfigured (almost done)

→ the next large-scale MC production is scheduled from this November

⇒ SINET5 improved the connection of Japan-USA, Japan-Europe

⇒ KEK LHCONE connection is now fully configured

Network @ other sites will contribute to the performance improvement  
(INFN-Napoli, PNNL, etc.)

→ next data transfer challenge is scheduled to complete the performance test