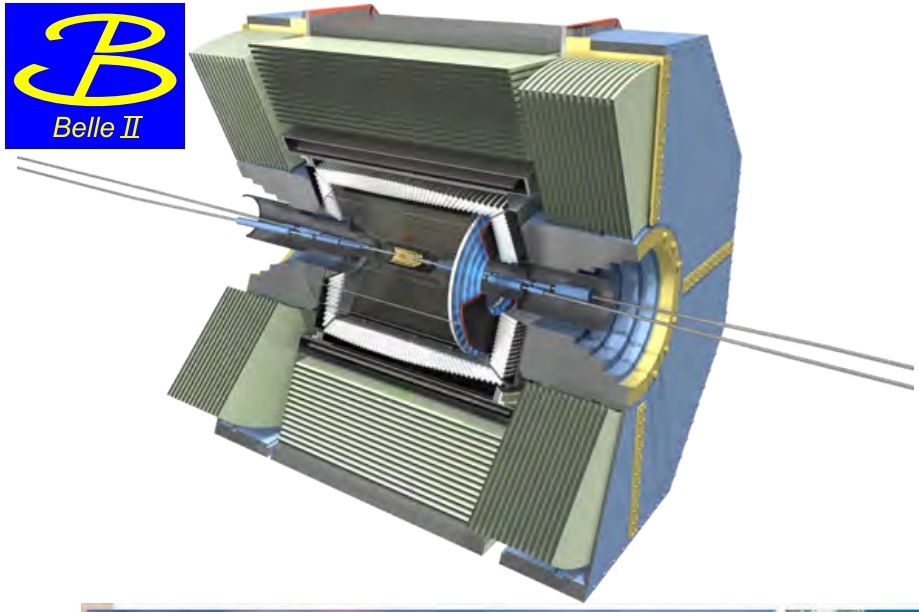


Belle II

ATCF6 in Thailand

21 Nov. 2022

Takanori HARA (KEK IPNS / SOKENDAI)

Slides are collected and based on recent presentations done by
Peter Križan (Instituta Jožef Stefan) , Michel Hernandez Villanueva (DESY),
Hiroaki Ono (the Nippon Dental University), Silvio Pardi (INFN / Napoli)

Belle II quick recap

Belle II today

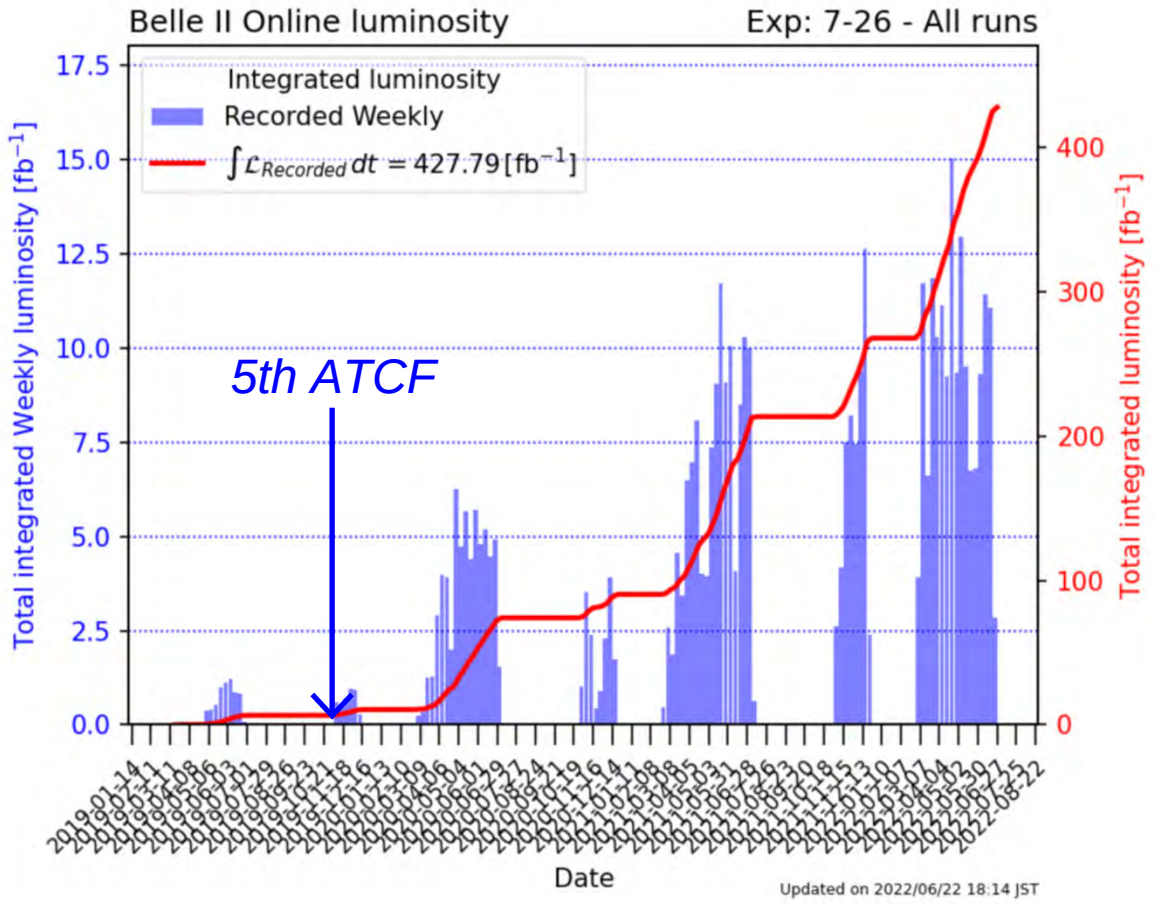
Very successful data taking
throughout the pandemic

-overall data taking efficiency of 89.5%

-reached world record instantaneous luminosity:
$4.7 \times 10^{34}\ cm^{-2}\ s^{-1}$,
collected up to $15\ fb^{-1}$ per *week*

-recorded luminosity at Belle II: $428\ fb^{-1}$
(Belle 988 fb^{-1}, BaBar 513 fb^{-1})

Ultimate goal: reach 50 ab^{-1} by operating
at the instantaneous luminosity of 6 x 10 $^{35}\ cm^{-2}\ s^{-1}$



Belle II has started publishing new physics results

Still, an e^+e^- machine running at (or near) Y(4S) is complementary to LHCb in several aspects

Unique capabilities of a B factory:

- → *Exactly two B mesons produced*
- → *High flavour tagging efficiency*
- → *Detection of neutral particles (e.g. γ, Ks, KL)*
- → *Very clean detector environment*

- *Lifetimes of charmed hadrons*
- *Measurements to help understand the long standing tension between inclusive and exclusive V_{xb} determinations.*
- *Test of Lepton Flavour Universality: $B^0 \to X e^- \nu_e$ vs $B^0 \to X \mu^- \nu_\mu$*
- *Searches for new physics in rare decays of the type b → s: $B \to X_s \ell\ell$, $B^\pm \to K^\pm \nu\nu$, $b \to s\gamma$ transitions, $K\pi$ puzzle*

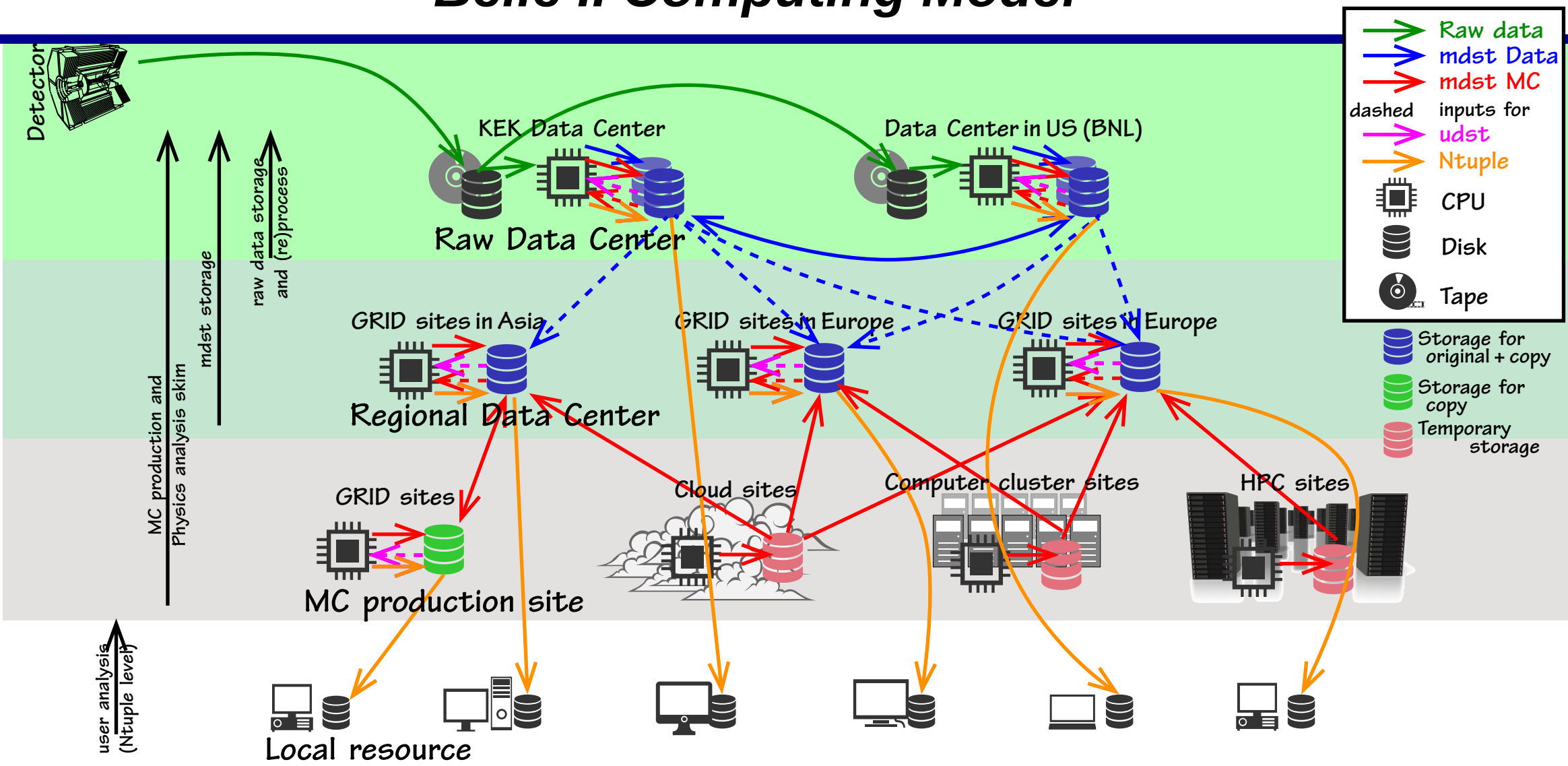
these results based on an integrated luminosity of up to ~190 fb^{-1}

More results with recorded luminosity (428 fb^{-1}) will come

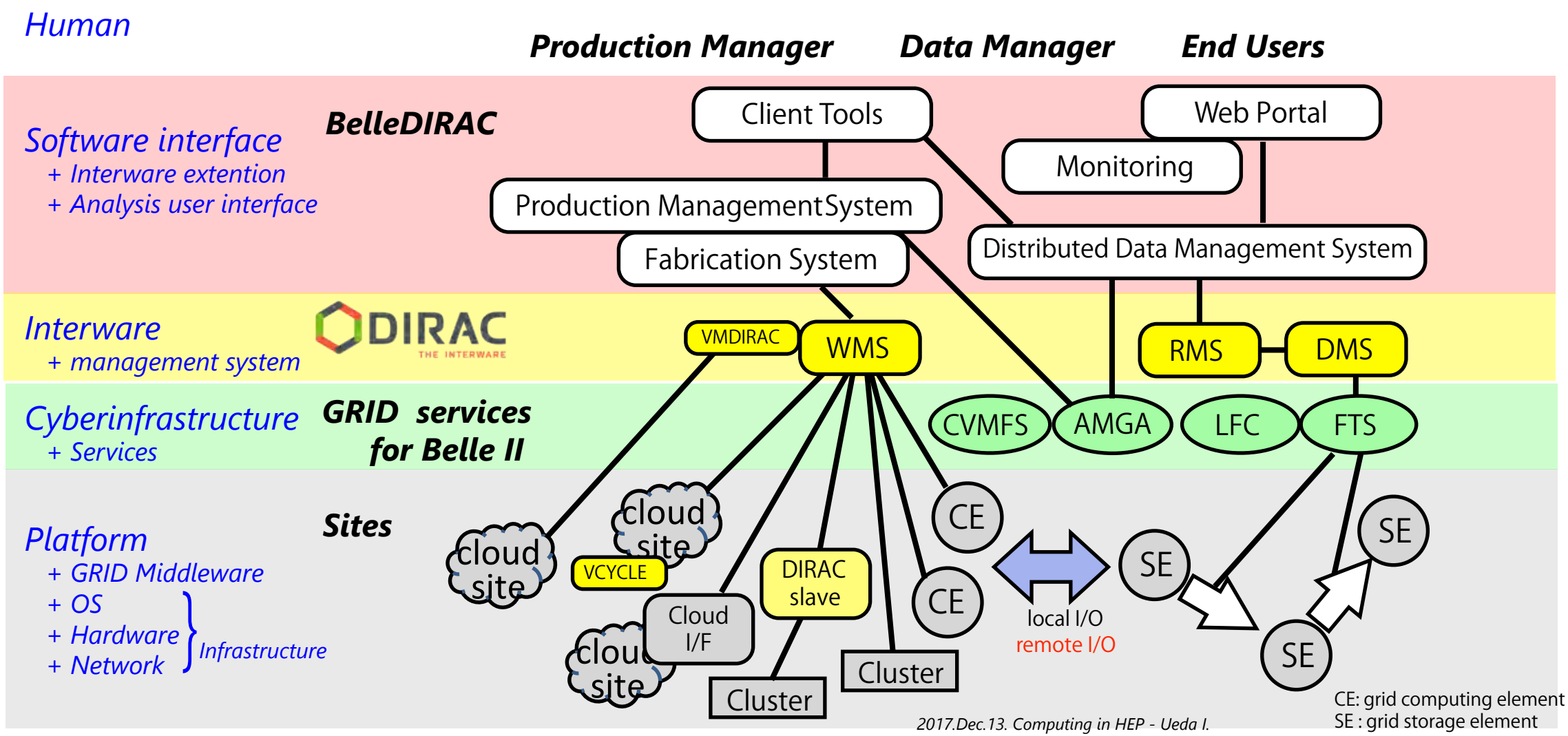
Belle II Collaboration

Belle II Computing Model

until the end of March 2021



Belle II Distributed Computing Structure



Distributed computing infrastructure at Belle II

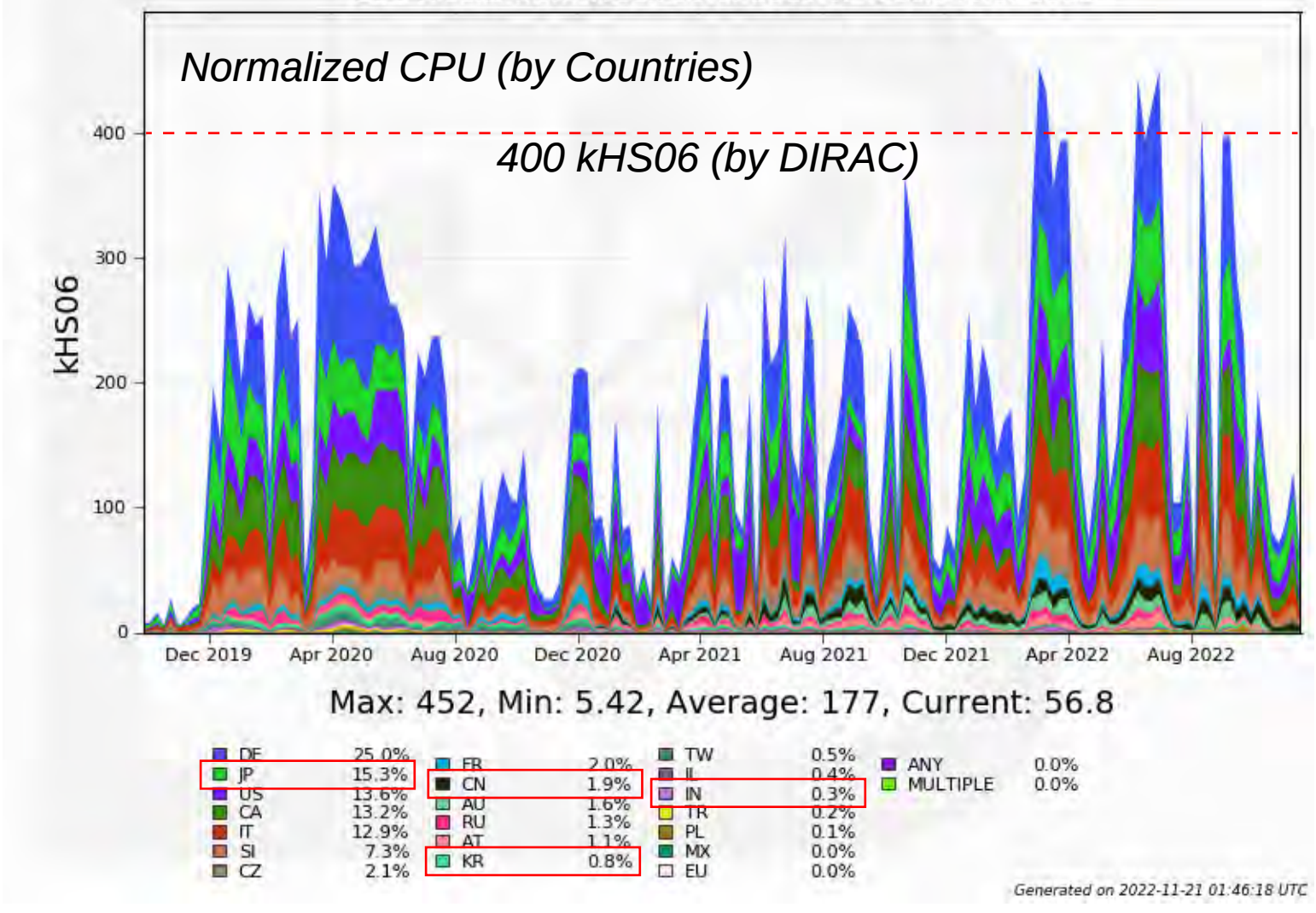
- *Storage Elements (SEs)*
  - *29 storage sites. 5 Tape systems.*
    - *92% of Storage on LHCONE.*
    - *8.2 PB reachable via IPv6 over of 13.8 PB.*
    - *All sites except 3 nominally support HTTP/WebDAV.*

Storage	*Space (PB)*
Disk	*13.6*
Tape	*10.1*

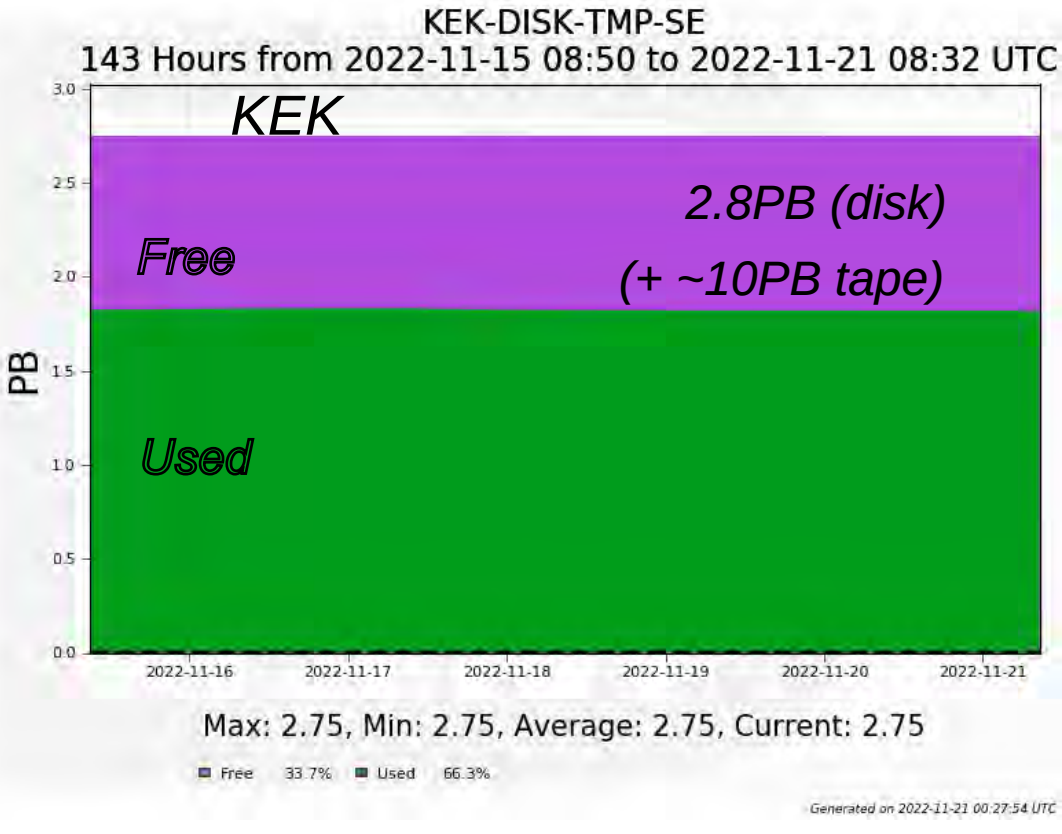
- *Sites (CEs)*
  - *55 sites registered in DIRAC.*
    Some sites with multiple CEs.
    - *24 Sites Providing Pledged CPUs.*
    - *12 Sites Pledged + Opportunistic.*
    - *18 Sites Opportunistic Only.*
  - *Most part of the sites (49) are EL7 based.*

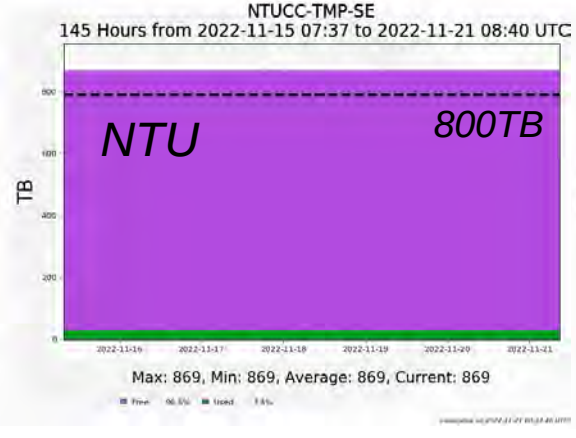
CPU	*kHS06*	*Job slots*
Pledged CPU	*452*	*31,484*
Opportunistic CPU	*310*	*25,377*
TOTAL	*762*	*56,861*

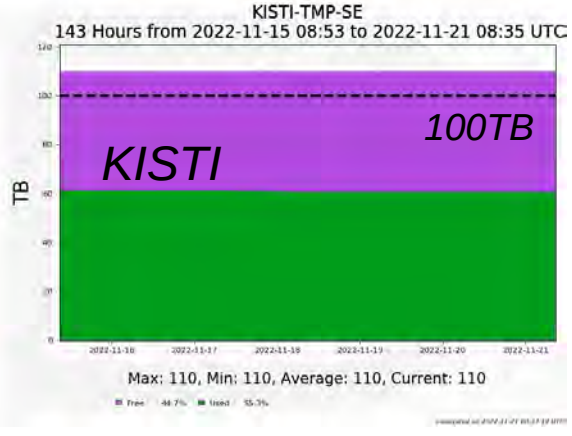
Compute Element

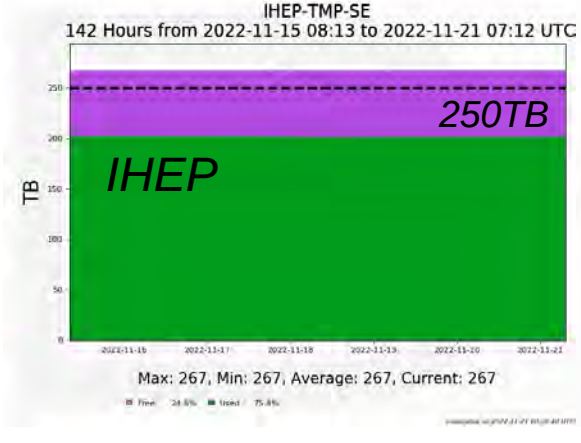


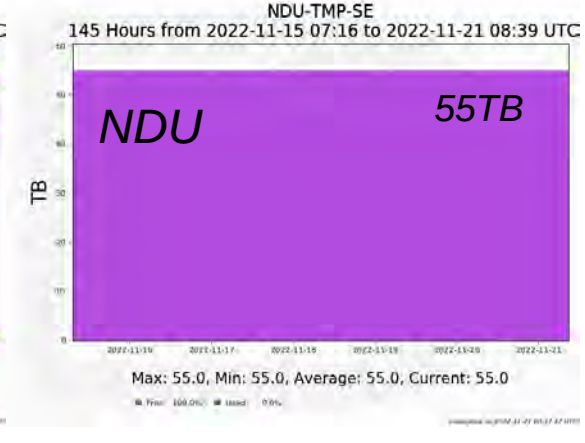
Storage Element











Network environment for Belle II

30% of sites on LHCONE covering more that 80% of Computing and Storage Resources

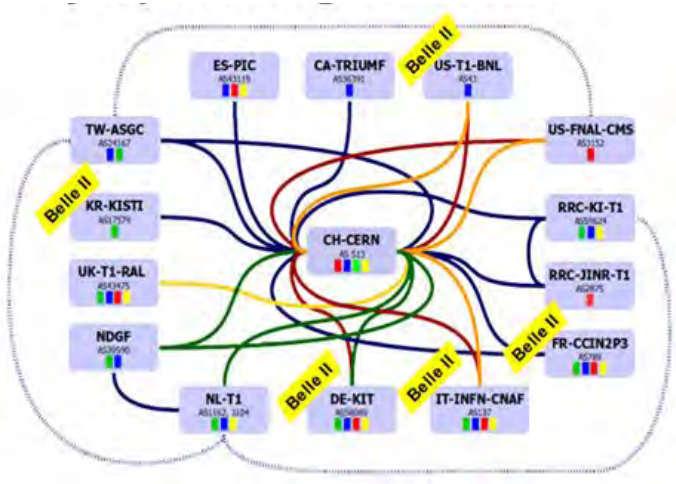
70% of sites General IP

5 Sites on LHCOPN

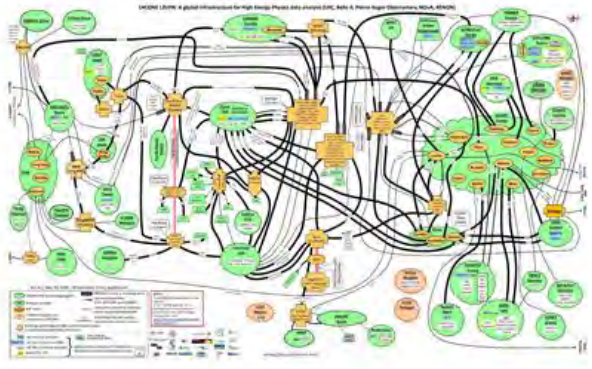
100G Global Ring runned by SINET

Thanks to SINET6

LHCOPN optical infrastructure that can be used without jeopardizing resources



LHCONE L3 VPN Connecting all the major Data Centers



Changes and Improvements since 5th ATCF

Operations under Pandemic

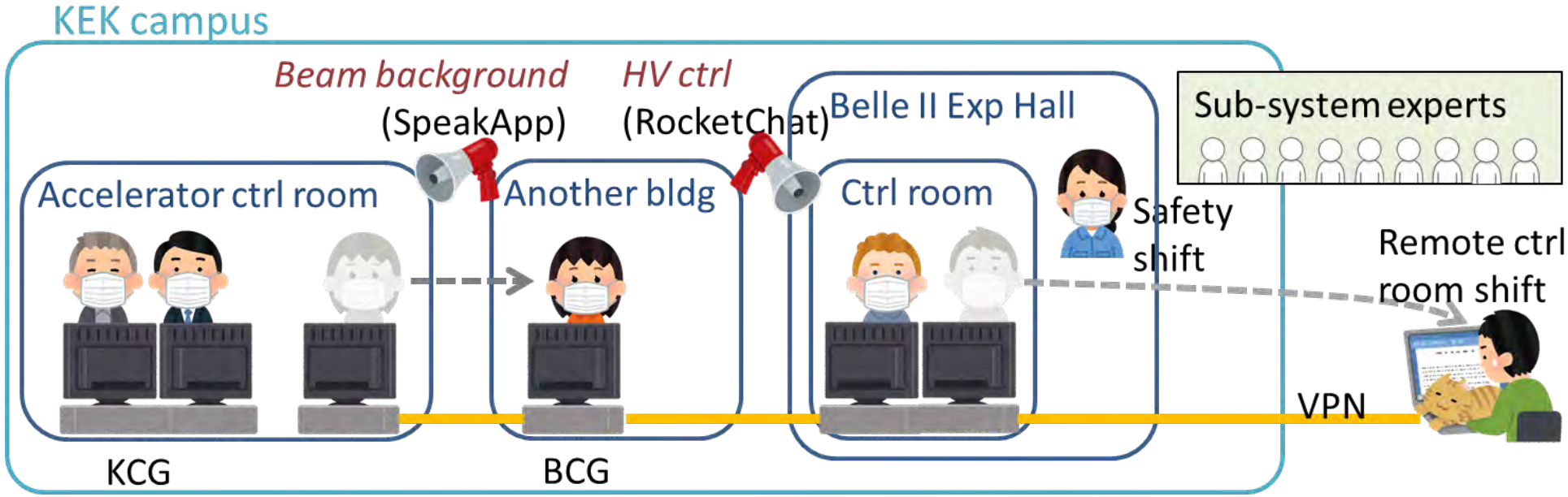
Keep minimizing person-to-person contact, avoiding 3Cs, and taking hygiene

3Cs : closed spaces, crowded places, and close-contact settings

1 BCG shifter @ Acc ctrl room → 1 BCG shifter @ Other bldg

2 CR local shifters → New scheme of 2 remote + 1 local CR shifters

Data production shifts / Software quality check shifts are done by remotely



Successful Rucio integration in Belle II comp.

a big step forward in preparing for the future needs of Belle II distributed computing

Rucio *can tolerate the coming increase in data volumes that we expect with higher luminosity brings us highly anticipated new features, e.g. automatic file deletion*

Transition schedule

by Jan. 14	*Preparation*
on Jan. 14	*Job draining*
on Jan. 15	*LFC → RFC* *cDDM → RDDM* *BelleDIRAC update*
on Jan. 18	*Configuration* *user tools* *BelleRawDIRAC*
on Jan. 19	*Post transition*

in 2021

Rucio operation has started !!

Thanks to the hard work from

Ikuo Ueda (KEK), Yuji Kato (Nagoya / KMI), Cedric Serfon (BNL),
John De Stefano, Hironori Ito, Paul Laycock, Ruslan Mashinistov (BNL),
Hideki Miyake (KEK), Michel Hernandez Villanueva (U. of Mississippi)

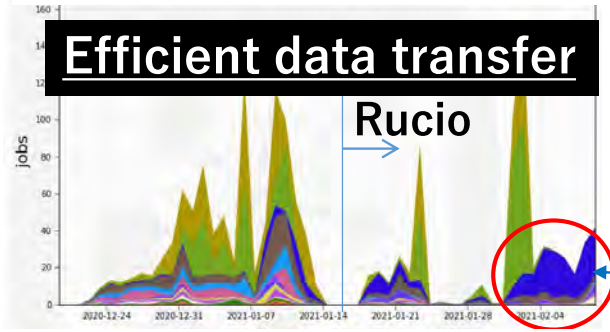
Data Transfer Performance

Using Rucio Subscriptions Data movement between SEs is managed by **Rucio rules** :

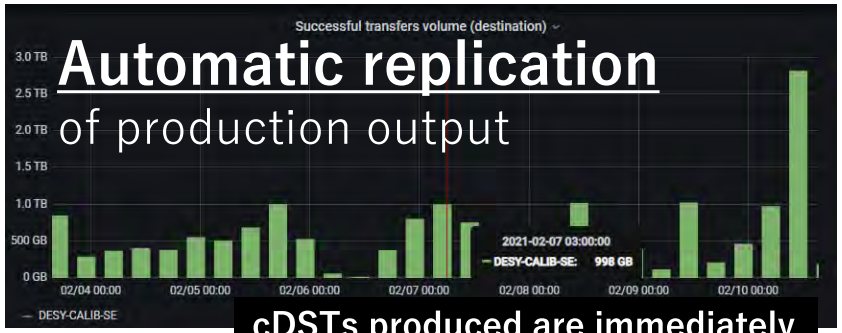
Rucio brought many advantages

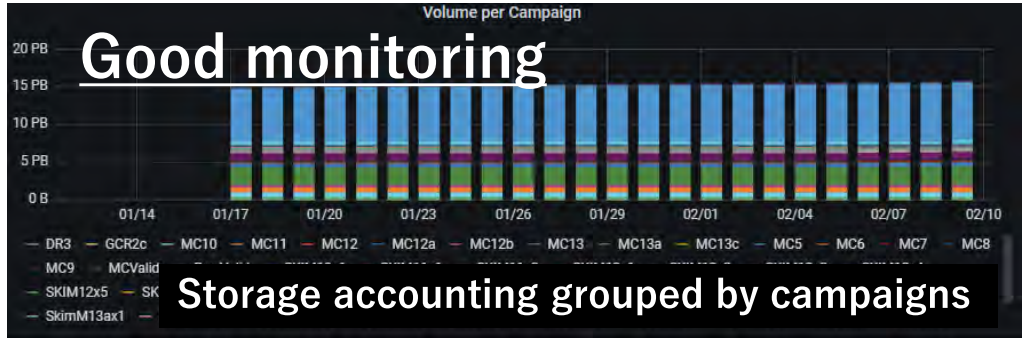
- **Already many benefits**

Merge jobs for data mdst/cdst



Merge jobs are performed at site where file is produced. Avoid unnecessary transfer.

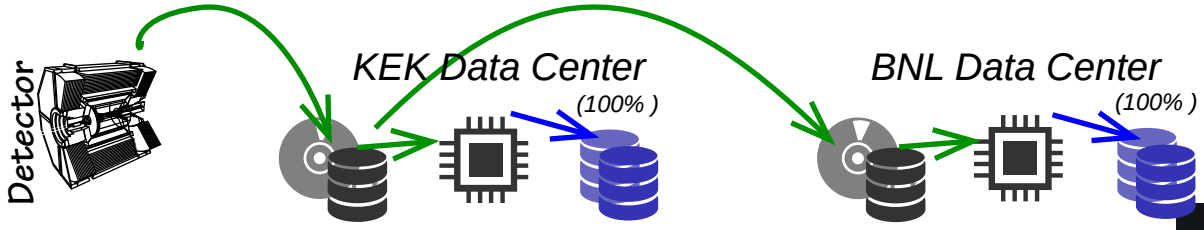




- **More benefits expected**
  - Automatic deletion of old files. Gradually starting “manual” deletion
  - Popularity (how many times specific file is accessed)
  - Quota per user

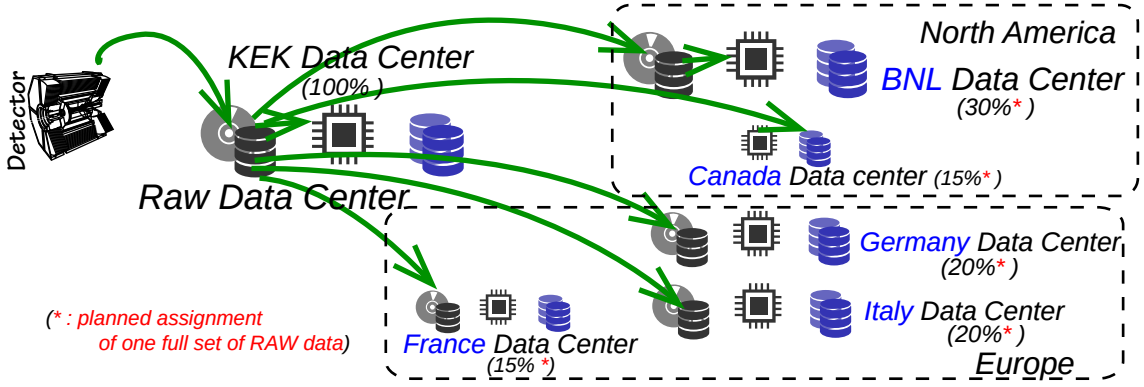
RAW data distribution to multiple RAW data centers

Raw Data Centers

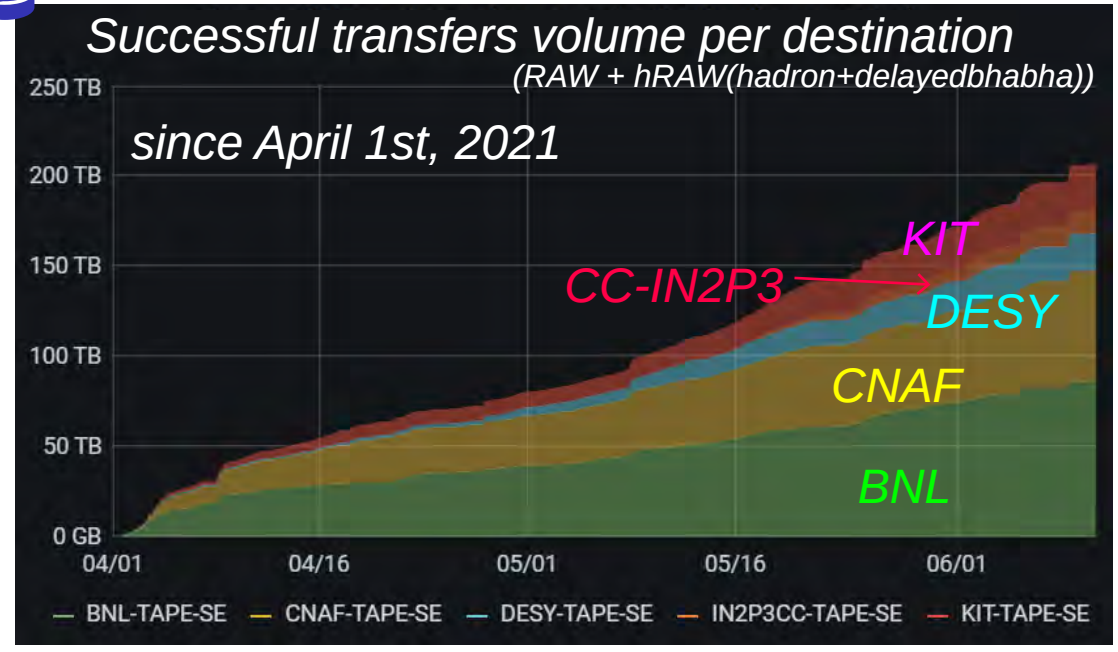


For first three years after Belle II data taking started,
BNL was the only Raw data center outside KEK

Since 2021 April, we have started distributing RAW data
to other RAW data centers as planned



in addition to BNL,
KIT, CNAF : joined from April 1st, 2021
DESY : from April 20th, 2021
CC-IN2P3 : from May 19th, 2021
UVic : from April 2022



Thanks to efforts of Distributed computing and Core computing members, site members on each RAW data center, network providers

Data access and transfer with WebDAV

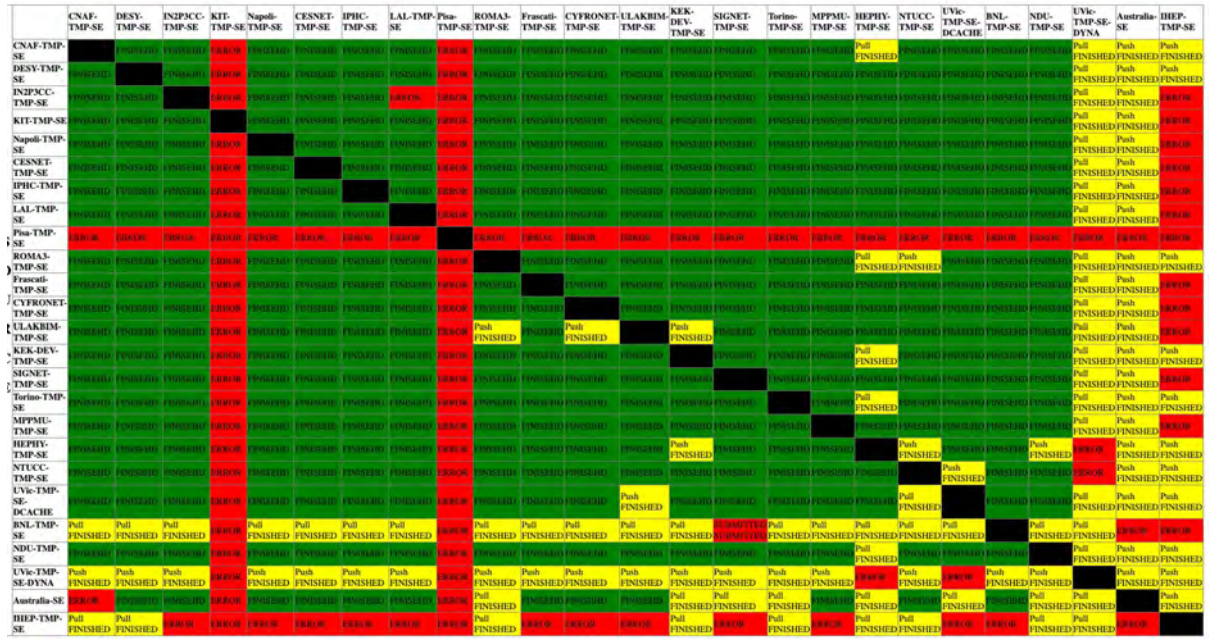
- *Steps for enabling HTTPS/WebDAV in our operations:*
  - *Implementing Storage Resource Report via JSON file (replacement of of SRM accounting).*
  - *Enable WebDAV/https on all storage*
  - *Make WebDAV Third-party-copy working*

- *Current status:*
  - *Increasing DAVS traffic during 2022*
  - *From 37% (first quarter)*
    to 72% (third quarter)
- *Tests with third-party-copy in progress:*

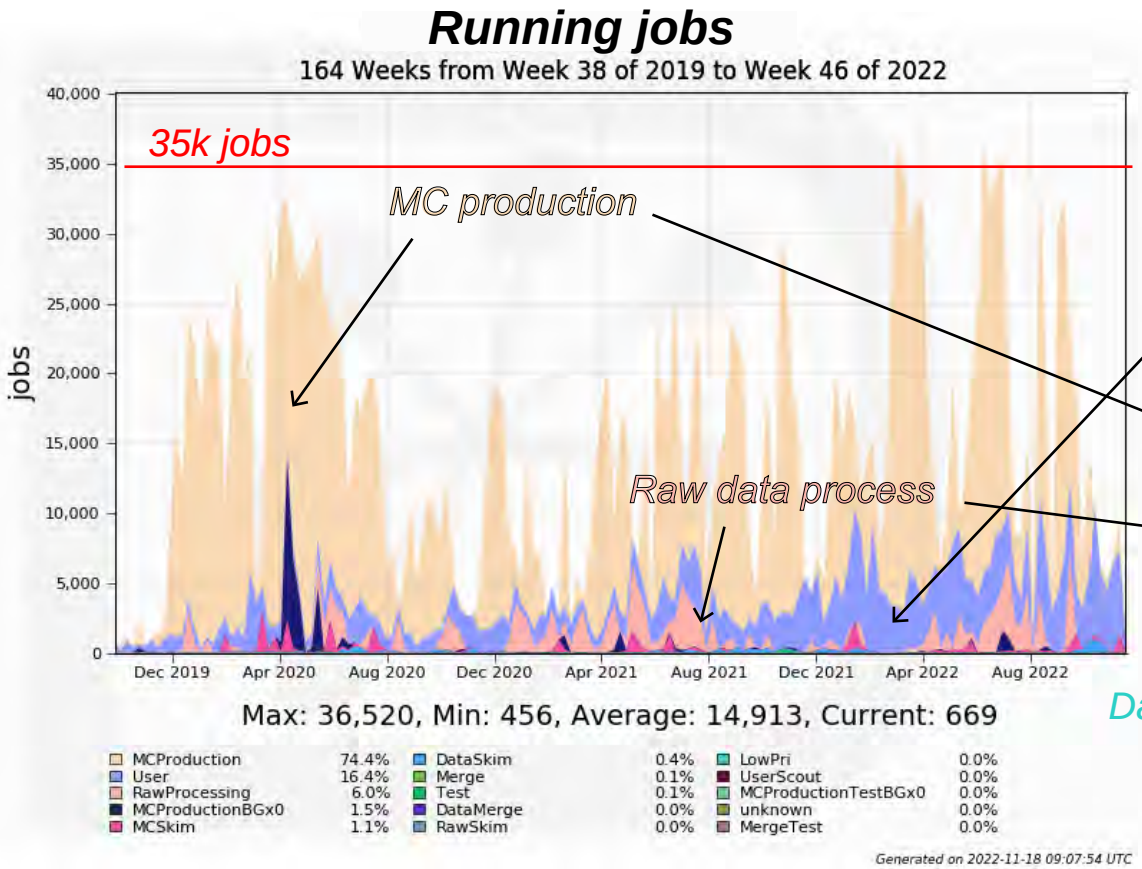
Green: transfers successful.

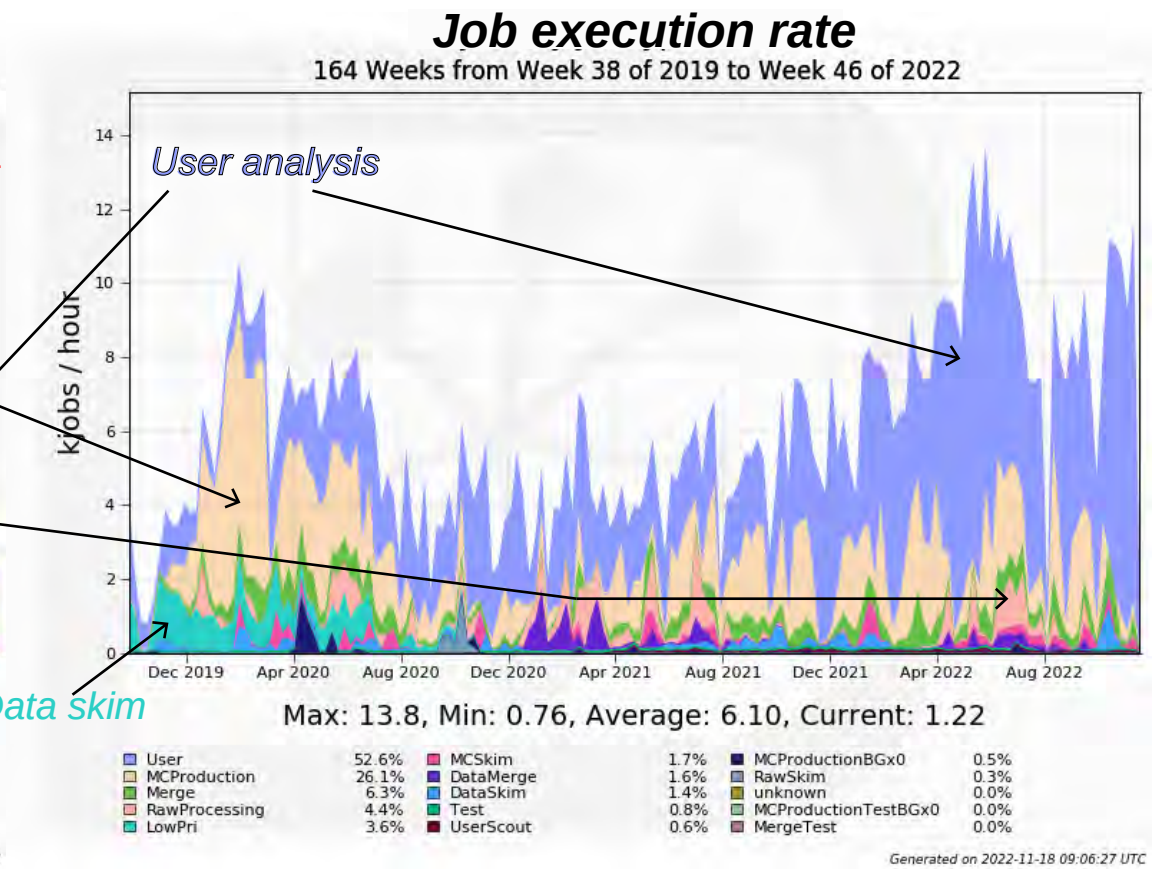
Yellow: at least a pull or push completed.

Red: all transfers failed.



Running jobs trend



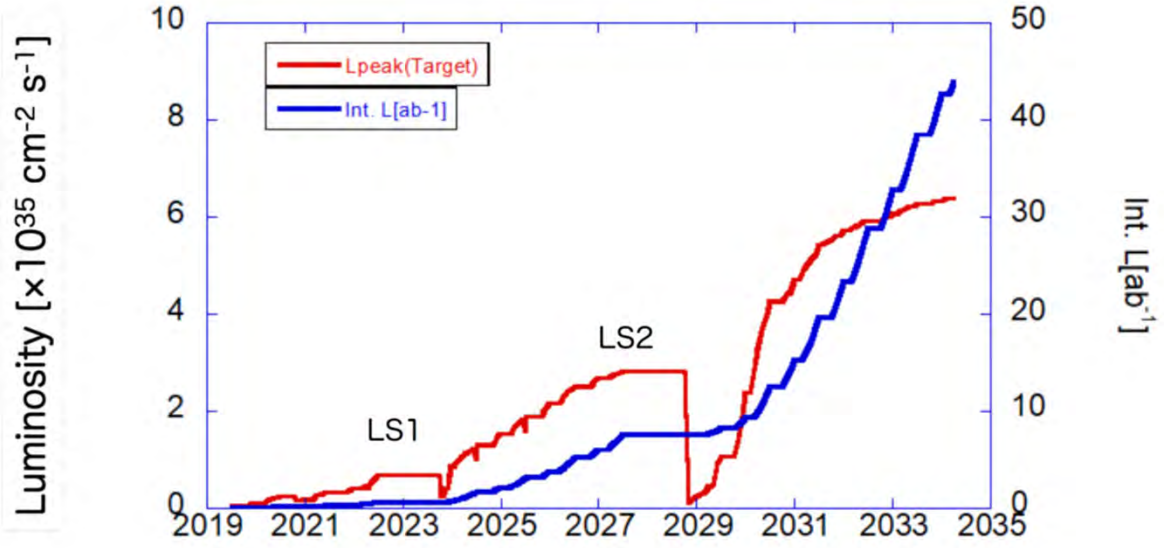


MC production job : long and stable
User analysis job : short and numerous

Very early stage of experiment : MC production + Physics skim
Early stage of experiment : Data process + MC production + Physics skim
These days : User analysis

Experiment plan

Experiment plan



Ultimate goal: reach 50/ab by operating at the design luminosity of 6 x 10^{35} cm^{-2} s^{-1}

Current working plan follows the KEK Roadmap2020

-LS1 in 2022-23 for the full pixel vertex detector (PXD) installation & partial replacement of MCP-PMTs in TOP

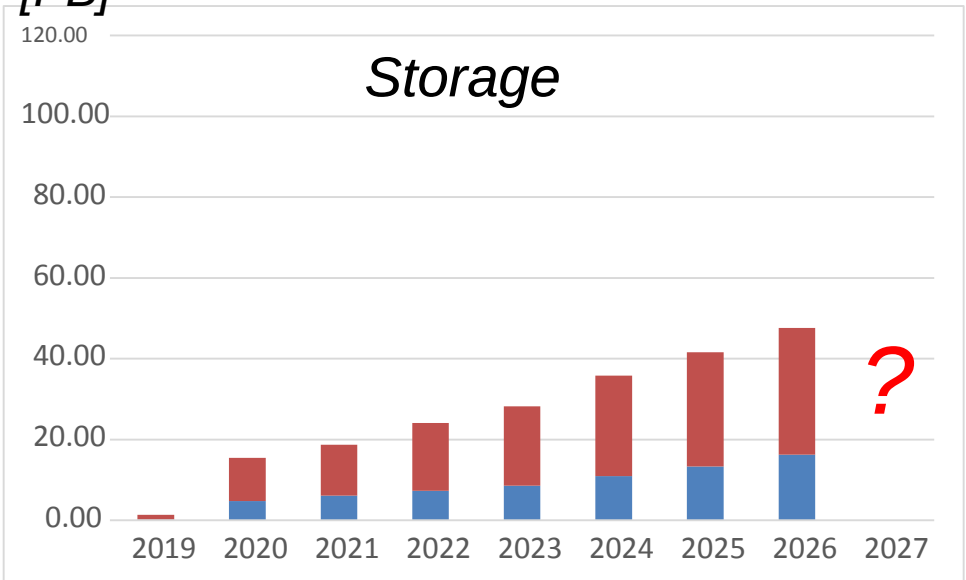
-options for an interaction region upgrade (LS2) ≳ 2026 under study → https://arxiv.org/abs/2203.11349

Beyond: discussions of physics and detector options with an upgraded accelerator to reach an even larger data sample of ~250/ab

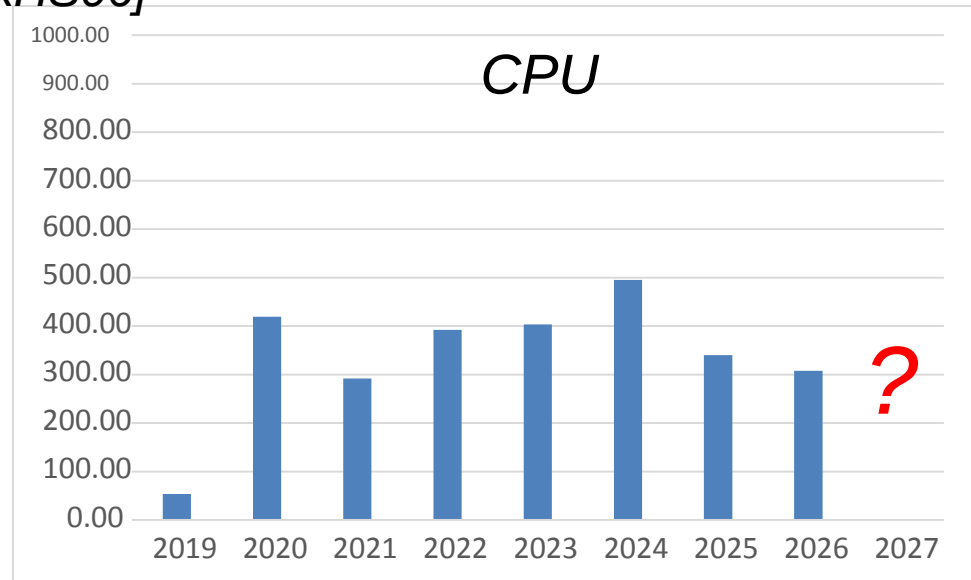
Computing Resource Estimation

Belle II Computing Steering Group *esitmates the resource requirement for the next and succeeding three years*

[PB]



[kHS06]



Resource estimation heavily relies on LS2 schedule...

2 → 1 *1 → 0.5 (once in two years)*

Number of MC production canpaign with newer software will be reduced

+ software will be more stable
+ data will be too much to simulate in short period

but we may not be able to keep using the same MC samples for more than two years....

Expected RAW data transfer per year *(w/ full luminosity)*

Summary

- *Belle II experiment*
  - *even under COVID pandemic, operation was done smoothly*
  - *Now under LS1 (long shutdown 1) to replace PXD/TOP.* *(will be resumed from Oct 2023)*
- *Distributed computing*
  - *Many things are changed and improved*
    - *+ Rucio integration was done successfully*
    - *+ RAW data is being distributed to RAW Data Centers in the world*
    - *+ User analysis jobs are getting increased*
- *Experiment plan*
  - *LS2 is under study and "the beyond" is under discussion*
    - *→ depending on these, compute/storage estimation will be changed ...*

35% of the Belle II colleagues are belonging to institutes in Asia

Hardware/Human resources + good network connection are the key

Many thanks to ATCF organizers

Suranaree University of Technology(SUT)
and Global Science experimental Data hub Center (GSDC),
Korea Institute of Science and Technology Information (KISTI)

and sorry I couldn't attend the meeting in person.