ATCF6 in Thailand 21 Nov. 2022 Takanori HARA (KEK IPNS / SOKENDAI)

Belle II

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)



Centara Ao Nang Beach Resort & Spa Krabi

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 x 10³⁴ cm² 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:

- \rightarrow Exactly two B mesons produced
 - → High flavour tagging efficiency
 - \rightarrow 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: $B^0 \rightarrow Xe^-v_e vs B^0 \rightarrow X\mu^-v_u$

•Searches for new physics in rare decays of the type $b \rightarrow s: B \rightarrow X_{S}\ell\ell$, $B^{\pm} \rightarrow K^{\pm}_{VV}$, $b \rightarrow s\gamma$ transitions, $K\pi$ puzzle

More results with recorded luminosity (428 fb⁻¹) will come

these results based on an integrated luminosity of up to ~190 fb⁻¹

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.
- 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.

Storage	Space (PB)
Disk	13.6
Таре	10.1

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

Compute Element



Storage Element



I Fine 24.5% . Used 75.8%

more a state of the state

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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

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1 BCG shifter @ Acc ctrl room \rightarrow 1 BCG shifter @ Other bldg
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3Cs : closed spaces, crowded places, and close-contact settings

2 CR local shifters \rightarrow 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 comp¹⁴

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



Rucio operation has started !!



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



Rucio brought many advantages



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)
 - Ouota per user

RAW data distribution to multiple RAW data centers



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.

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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 10³⁵ 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) \gtrsim 2026 under study \rightarrow 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



Resource estimation heavily relies on LS2 schedule...



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

D 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.