

Japan and Europe Network for Neutrino and Intensity Frontier Experimental Research, H2020 Jennifer2 Computing WorkShop - Task 5.1 CERN, 12. December 2019



# **Belle II Computing Model - Tools**

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## The Belle II Experiment: Physics motivation

- B-Factories legacy, complementarity to the LHCb
  - $\rightarrow$  The stage for the physics of Belle II:
  - Stress-testing the SM and sensitively probing new physics via, e.g.,
    - Precision CKM measurements: CP violation, meson mixing, decay rates;
    - Rare processes, e.g., flavour-changing neutral currents;
    - SM-forbidden processes, e.g., lepton-flavour non-universality, Lepton number/flavour violation;
    - Direct searches for light new states; Dark sector.

Better precision requires a lot of data (of good quality)!

### Precision of CKM unitarity triangle:





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M. Bračko, Jennifer2 CompWS, CERN, 2019/12/12



### The SuperKEKB Collider





### **Belle II Collaboration**





### **Belle II Detector**

EM Calorimeter: CsI(TI), waveform sampling (barrel+ endcap)

Beryllium beam pipe: 2cm diameter

electrons (7 GeV)

Vertex Detector: PXD: 2 layers DEPFET SVD: 4 layers DSSD

#### Central Drift Chamber:

He(50%):C₂H₅(50%), smaller cell size, longer lever arm, fast electronics K<sub>L</sub> and µ Detector:

Resistive Plate Chambers (barrel outer layers) Scintillator + WLSF + SiPM's (end-caps , inner 2 barrel layers)

**Particle Identification:** 

Time-of-Propagation Counter (TOP) (barrel) Proximity focusing Aerogel RICH (ARICH) (fwd) dE/dx in CDC (centre)

positrons (4 GeV)



### Data processing; data model

- A huge amount of data has to be managed, and made available to the scientific community spread worldwide.
- Large computing power is needed to reconstruct physics events in large detectors, with millions of readout channels.





### Belle II data model – in more detail





### **RAW data processing/reprocessing**





#### We artificially throttled RAW data (re)process jobs at KEK to confirm if RAW data reprocess jobs can run at BNL



### **Distributed Components**





### Main Distributed Components

## BelleRawDIRAC

- DIRAC extension
- Performs first upload to grid storage and metadata setting

## • BelleDIRAC

- DIRAC extension
- Production System, DDM, client tools

## • gbasf2

- Command line tool to easily submit basf2 steering files to the grid
- Part of BelleDIRAC repository

## Catalogues

- LFC (files)
- AMGA (metadata about datasets+files)



### Belle II Distributed Computing System and services in use





### **Distributed Computing usage/performance**

MC / Skim productions, RAW data process and User analyses are running on Distributed Computing Computing sites in the world provide CPU and Storage for Belle II



In 2019 only ~25% CPU usage of 2018, and also not used continuously (Luminosity lower than expectations; SW improvements/new features take time)



We expect much better CPU usage next year.



### Summary/Conclusions

- Data taking with the full Belle II detector started successfully
- Computing is utilized to make this process efficient improvements/automation will free some human resources...
- Tools and gathered experiences are important and can be shared within this project to achieve some synergy