Status of Computing

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Introduction

- The Belle II computing model
- Accounting: CPU and storage used in 2015 and 2016
- Resource estimate for the years 2018 to 2021.

Belle II Computing Model

Belle II Computing Model (1)

- Raw data coming out of the DAQ system, are permanently stored (two replica), calibrated and processed.
  - A second copy of raw data will be permanently stored for safety
- Fully reconstructed events are stored in the miniDST format.
- Monte Carlo events are simulated and reconstructed using the same software used to process detector events and then also stored in miniDST format.
  - The MC/data luminosity ratio will be 4 in 2018, 3 in 2019, 2 in 2020 and 1 afterwards.
- Two replica of data and MC mDST will be stored for safety and to avoid processing bottleneck

Belle II Computing Model (2)

- Detector and Monte Carlo events miniDST are then "skimmed" to create set of selected events that suit a specific group of physics analysis.
  - During the skimming step, additional information are computed and added to the events.
  - The output of the skimming step will consist of either index files that contain "pointers" to events in miniDST format or deep copies of events in microDST format.
  - The feasibility of using the index file technology is currently under investigation and we plan to use deep copy skims in microDST format at least for the first few years of data taking.

- Two copies of microDST will be stored for safety and to avoid bottleneck in data access.

Belle II Computing Model (3)

- The understanding of the detector and the quality of the software will increase over time, resulting in new releases of the software that will require reprocessing of the data to exploit the improvements.
  - Reprocessing of detector data is expected to trigger the re-creation of the corresponding Monte Carlo data samples and the skimming of these new data samples.
  - We plan to have two reprocessing per year in 2018 and 2019, one reprocessing in 2020 and a reprocessing every two years afterwards.
- The user analysis will run on skimmed events, unless a suitable skim is unavailable.
  - User analysis job will produce n-tuples that will be transferred over the network to local farms for further analysis
- Detector data processing, simulation and skimming will be centrally managed, while physics analysis will be users responsibility.

Belle II Computing Model (4)

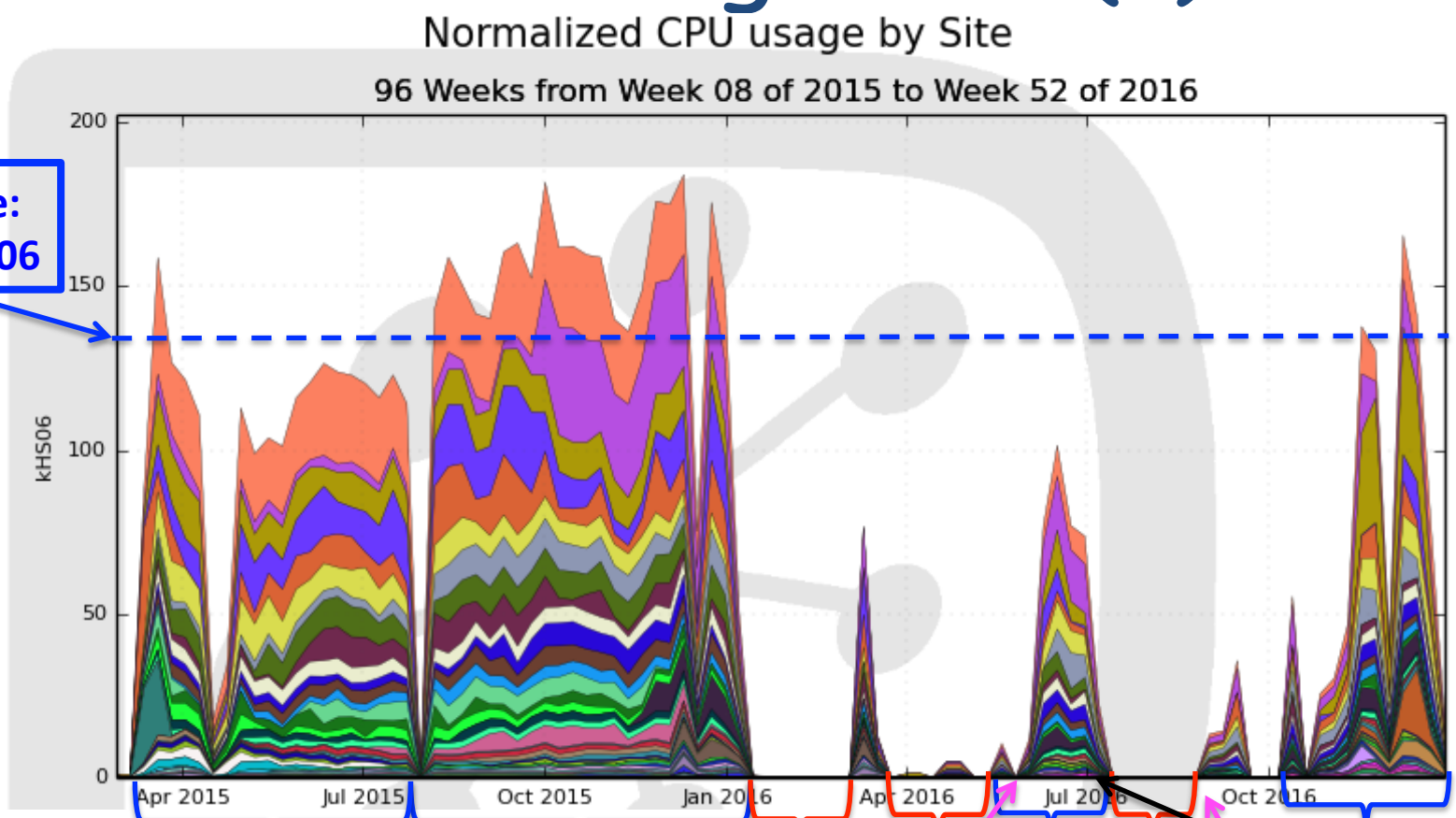
- Status (computing part, not algorithm implementation):
  - MC production: ok
  - Reconstruction: ok
  - Calibration: starting development
  - Skimming: starting development
  - Analysis on the grid: starting
- This year we'll have dress rehearsal of the whole production system with MC
- Field test with cosmic run

Classification of Belle II Computing Centers

- KEK is the host laboratory of the Collaboration. It receives raw data from the Belle II's online computing farm and records them on permanent mass storage. It also performs reconstruction of the data, Monte Carlo production and provides resources for end-user analysis.
- Raw Data Centers receive the raw and reconstructed data, providing a distributed permanent backup of the raw data, permanent storage and management of data needed during the analysis process, and offer a Grid-enabled data service. They also perform re-processing of raw data, Monte Carlo production and provide resources for end-user analysis.
- Regional Data Centers provide Grid-enabled disk storage to host a partial copy of the reconstructed data and concentrate on tasks such as simulation, end-user analysis.
- Monte Carlo Production Centers provide resources for Monte Carlo production and optionally end-user analysis.
- Local farms provide resources for n-tuple level analysis

Accounting

Accounting: CPU (1)



Estimate: 138 kHS06

PRE-MC5

MC5 10 ab^{-1}

MC5 Data Validation

Grid Servers Upgrade

MC6 1 ab^{-1}

Coll. Tools @DESY

MC7 2 ab^{-1}

Now Almost Automated

Will Be Semi-automated

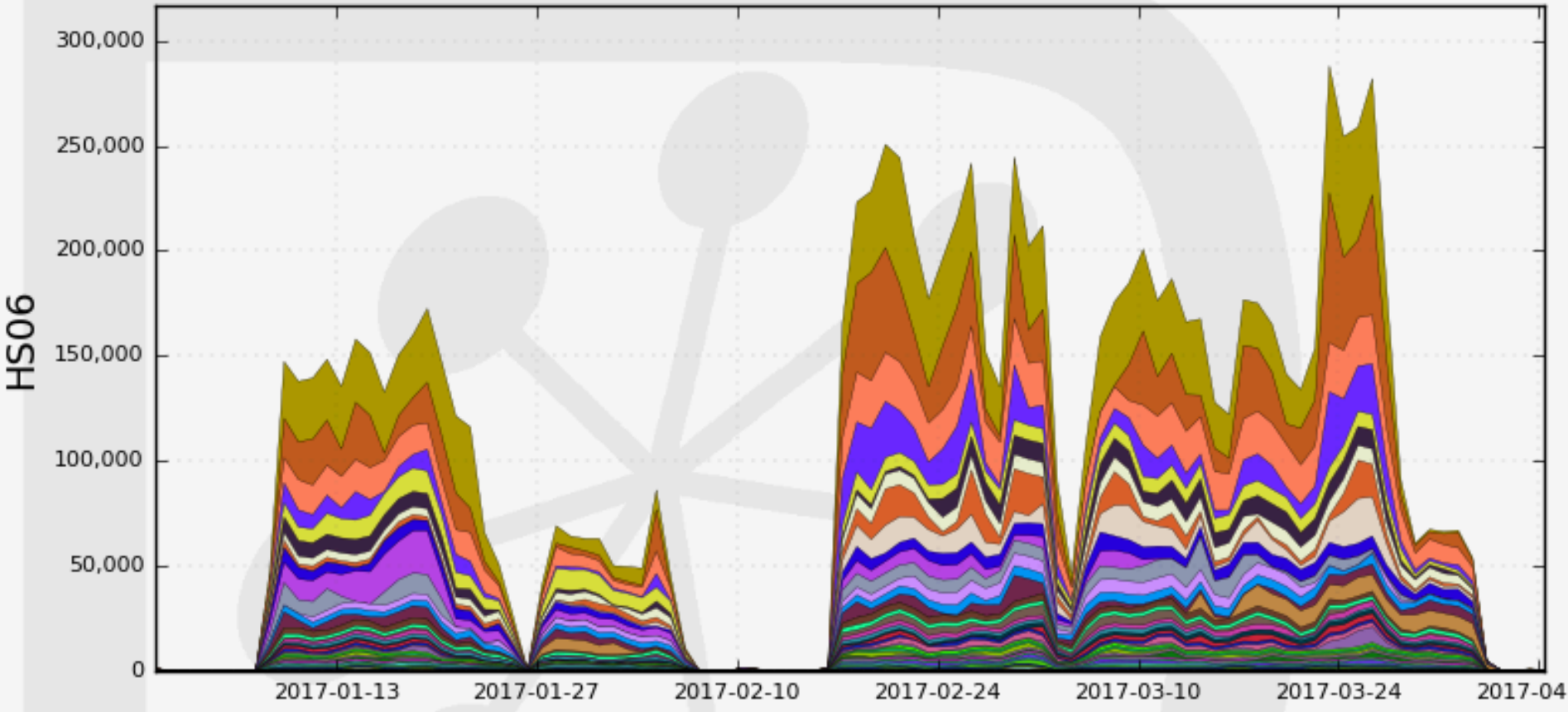
BPAC Review

KEKCC Replacement

Data Production Group

Normalized CPU usage by Site

13 Weeks from Week 52 of 2016 to Week 14 of 2017



Max: 287,970, Average: 106,505, Current: 377

DIRAC.UVic.ca	18.3%	LCG.CESNET.cz	3.3%	ARC.DESY.de	1.1%
LCG.KEK.jp	12.4%	LCG.KIT.de	3.3%	DIRAC.MIPT.ru	1.0%
LCG.DESY.de	10.2%	DIRAC.PNNL.us	3.0%	LCG.Melbourne.au	1.0%
LCG.KEK2.jp	6.3%	LCG.NTU.tw	2.4%	LCG.CYFRONET.pl	0.8%
LCG.Napoli.it	4.8%	LCG.CNAF.it	2.3%	DIRAC.CINVESTAV.mx	0.8%
DIRAC.RCNP.jp	3.7%	LCG.HEPHY.at	2.3%	DIRAC.IITG.in	0.8%
LCG.KMI.jp	3.6%	DIRAC.PNNL2.us	1.7%	ARC.SIGNET.si	0.7%
LCG.Pisa.it	3.5%	DIRAC.BINP.ru	1.5%	ARC.MPPMU.de	0.6%
ARC.KIT.de	3.4%	LCG.KISTI.kr	1.2%	... plus 25 more	

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Resource Estimate

Change in Luminosity Profile

June 2016

Year	2017	2018	2019	2020	2021
Luminosity (ab^{-1}/year)	0.23	0.31	2.82	6.31	10.26
Integrated Luminosity (ab^{-1})	0.23	0.54	3.36	9.67	19.93

December 2016

Year	2017	2018	2019	2020	2021
Luminosity (ab^{-1}/year)	0.00	0.54	2.82	6.31	10.26
Integrated Luminosity (ab^{-1})	0.00	0.54	3.36	9.67	19.93

February 2017

Year	2017	2018	2019	2020	2021
Luminosity (ab^{-1}/year)	0.00	0.21	2.82	6.31	10.26
Integrated Luminosity (ab^{-1})	0.00	0.21	3.03	9.34	19.60

Assuming 9 months running per year and nominal luminosity profile

Phase 2: 0.04 ab^{-1}
Phase 3: 0.17 ab^{-1} assuming Phase 3 start in Nov 2018

History of Changes on Input Parameters

Raw Data Compression
HLT data reduction

	Jun 2016	Dec 2016	Feb 2017
Raw Data Size (kB/ev)	300	100 ± 25	100 ± 25
CPU for Reconstruction (HEPSpec *s /ev)	45	22.0 ± 4.9	21.5 ± 4.4
CPU for MC (HEPSpec *s /ev)	100	63.2 ± 13.3	60.0 ± 12.7
Detector mDST (kB/ev)	20	5.0 ± 1.8	6.8 ± 3.2
MC mDST (kB/ev)	25	7.0 ± 2.6	9.0 ± 4.2

Software measurements on rel 00-07-01

Software measurements in rel 00-08-00
Increase in mDST size comes from a new much improved clustering algorithm in ECL

Resource Estimate Evolution

(errors from uncertainties on impact of software developments)

June 2016

	2018	2019	2020	2021
Tape	4.2	13.8	39.6	81.6
Disk	5.4	8.2	20.4	33.9
CPU	474	609	708	881

LHCb (2017)

Tape (PB)	60
Disk (PB)	28
CPU (kHS06)	375

	2018	2019	2020	2021
Tape	2.2±0.3	6.4±1.6	18.2±4.5	36.5±9.3
Disk	5.5±1.3	11.9±2.9	20.3±4.8	20.4±4.7
CPU	387±41	478±75	541±79	643±91

Dec 2016
Raw data compression
Soft Meas on rel 00-07-01
Skim + Analysis Model

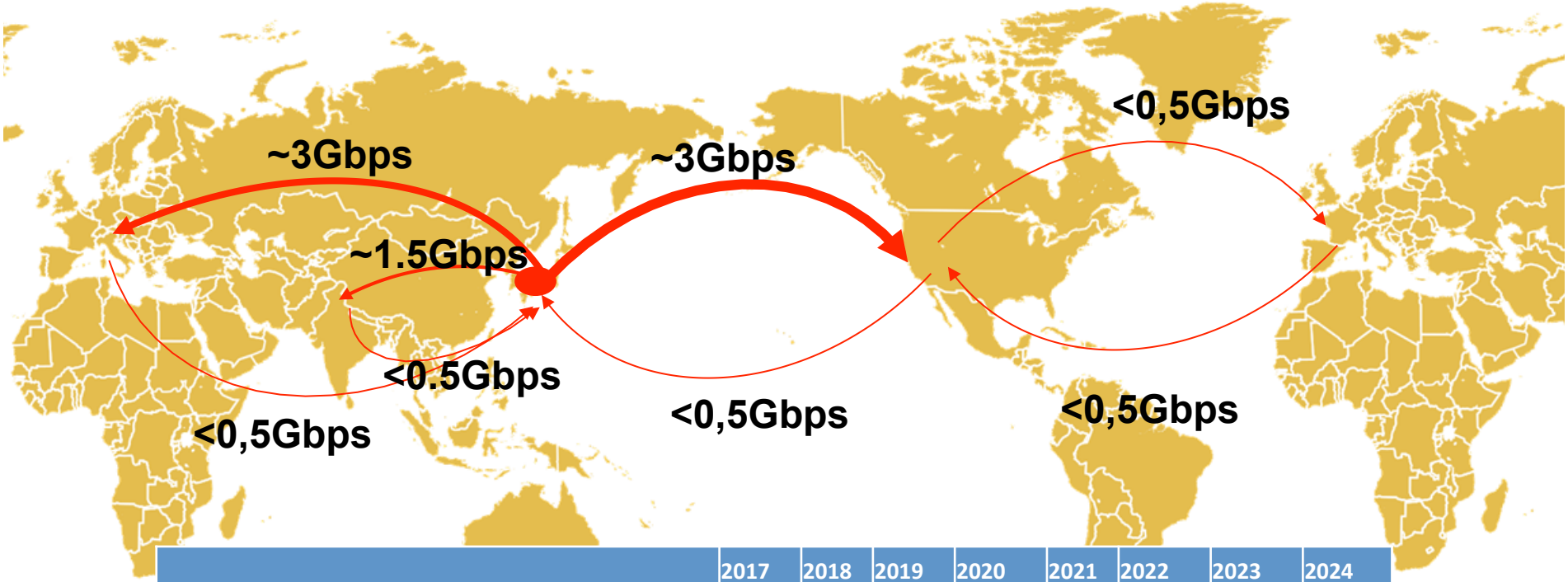
	2018	2019	2020	2021
Tape	1.6±0.1	5.8±1.4	17.6±4.3	35.9±9.1
Disk	3.5±1.3	14.1±3.1	25.9±5.5	26.3±5.6
CPU	187±27	400±67	473±75	563±86

Feb 2017
Luminosity Update
Soft Meas on rel 00-08-00

Approved by BPAC

Total traffic per regions

N.B. USER ANALYSIS TRAFFIC NOT INCLUDED



	2017	2018	2019	2020	2021	2022	2023	2024
KEK to ASIA	0,08	0,08	0,06	0,06	1,13	1,37	1,39	1,42
KEK to EU	0,19	0,18	0,12	1,82	2,27	2,74	2,81	2,87
KEK to USA+MEX+CANADA	0,08	0,24	1,56	1,75	2,18	2,64	2,67	2,70
EU to KEK	0,19	0,18	0,10	0,11	0,12	0,15	0,24	0,30
USA+MEX+CANADA to KEK	0,08	0,09	0,07	0,06	0,07	0,09	0,14	0,17
ASIA to KEK	0,08	0,08	0,05	0,05	0,06	0,07	0,11	0,14
USA+MEX+CANADA to EU	0,16	0,17	0,13	0,12	0,13	0,16	0,26	0,32
EU to USA+MEX+CANADA	0,16	0,17	0,09	0,10	0,12	0,14	0,22	0,28

Procurements in 2018

- Year X procurements should cover Belle II needs until when the Year X+1 procurements come online
  - The exact date can be different for different countries
- Assuming that new procurement are online on April 1st, then Year X procurement should cover needs until April 1st of year X+1

	2018	25 % of 2019 increment	Total
Tape (PB)	1.6	1.0	2.6
Disk (PB)	3.5	2.7	6.2
CPU (kHEPSpec06)	187	53	240

- Desired procurement for 2018 in Italy:
  - 300 TB (55 kEuro)
  - 5 kHEPSpec06 (40 kEuro)

Analysis Farm(s) for n-tuple analysis

- Different options:
  - Use DESY farm ?
  - One farm in Italy ?
  - Many farms in different (all ?) sites in Italy ?
- Pisa has offered to host the Belle II italian analysis farm
  - Taking advantage of the already existing interactive analysis farm (CMS+ others)
  - Technical advantage: the CPU see directly the SE
    - Your analysis jobs can be configured to send your n-tuples to Pisa, no need to manually transfer them.
  - Test are possible now (using INFN AAI credentials)
- At the PI meeting it was decided to explore this possibility
  - Testing (instructions are posted in the agenda)
  - Discussing with computing referees

Backup