Belle II computing

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on behalf of the Belle II computing group

KU KDM'15, Zakopane

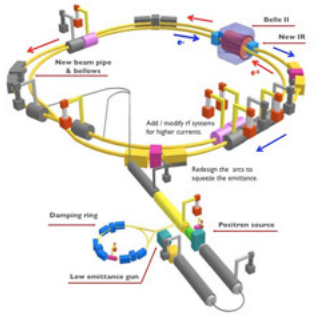
Outline

- ➔ Belle ⟶ Belle II
- ➔ Computing Requirements
- ➔ Computing Model
- ➔ Monte Carlo Campaigns
- ➔ PL sites

Belle → Belle II

- Experiment at the KEK B-factory with the main goal to study the **CP violation** in B meson decays;
- **Belle** experiment @ **KEKB e^+e^- collider**;
- **1 ab^{-1} data [772·10^6 B anti-B]**; (1999-2010)
- **L = 2.1·10^{34} $cm^{-2}s^{-1}$** (world record!)
- B-factories confirm **matter-antimatter asymmetry**; leads to **Nobel Prize** (2008)

- New Physics searches studying very rare processes in B and D mesons and τ-lepton decays at **SuperKEKB** collider;
- **Belle II** experiment @ **SuperKEKB**;
- **50 ab^{-1} data** (2017-2024: preliminary)

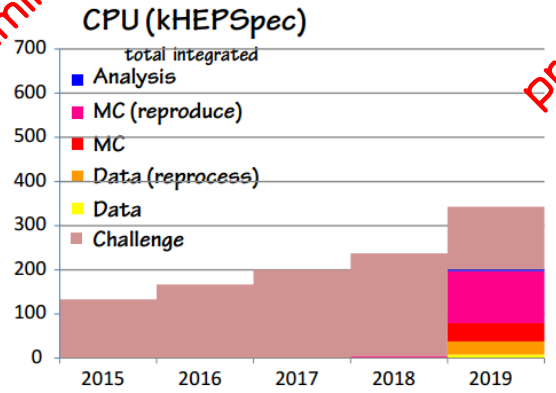


- 40x collision rate: **L = 8·10^{35} $cm^{-2}s^{-1}$**
- 50x data sample: **10ab^{-1}/year**

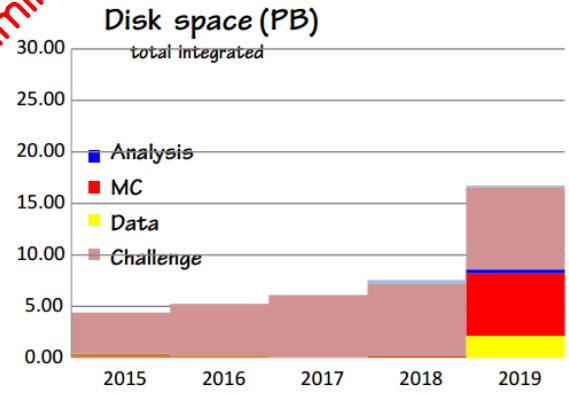
Belle II collaboration

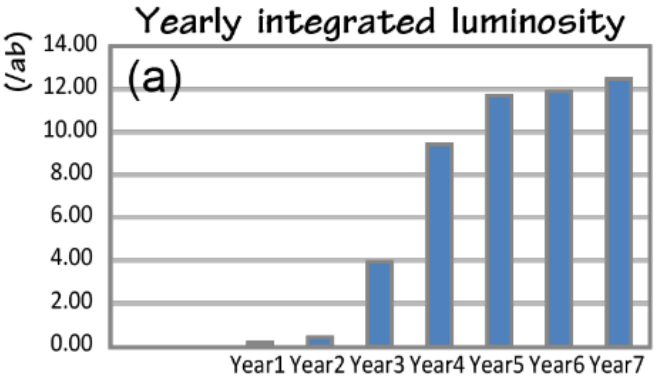
Requirements to Computing

preliminary



preliminary

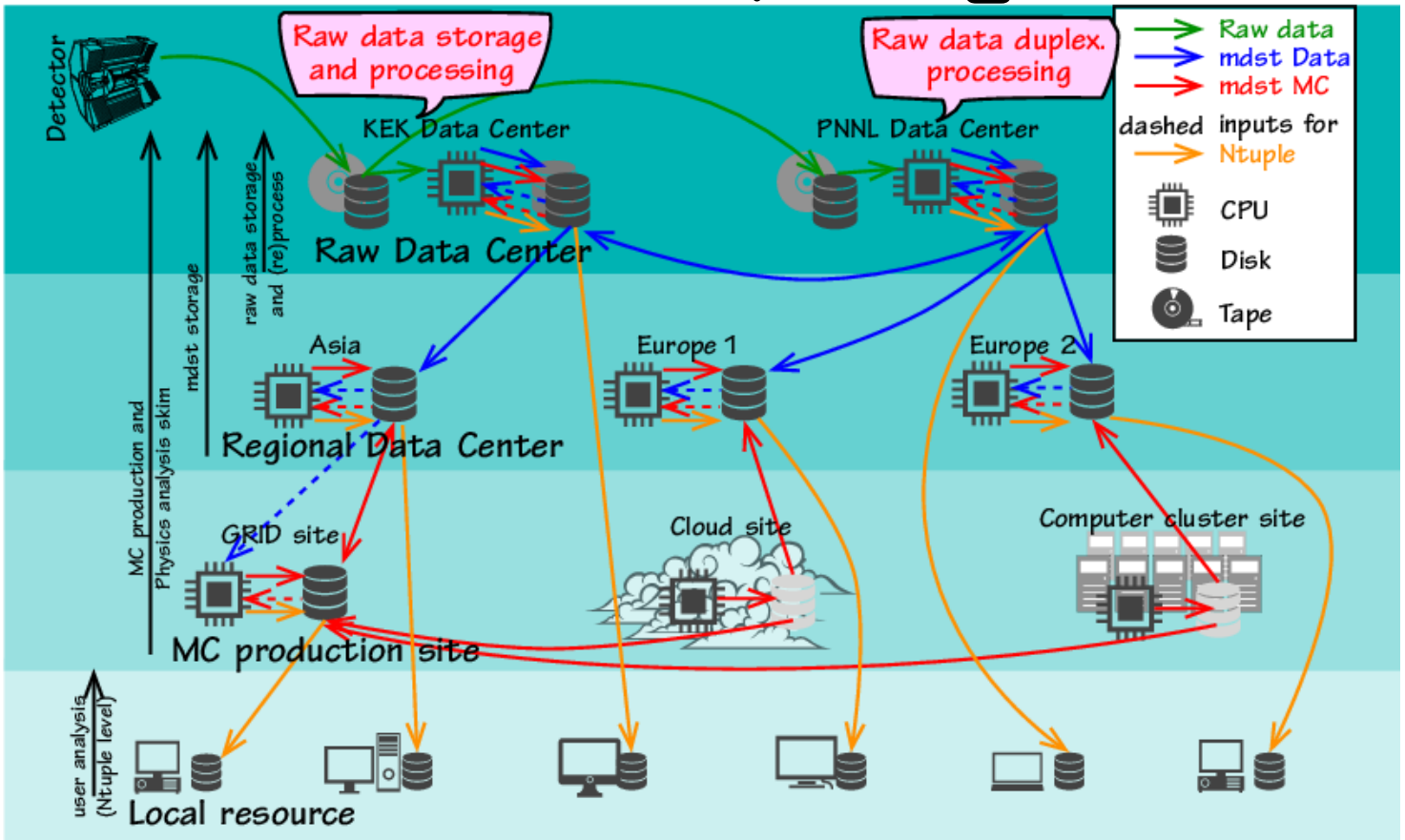




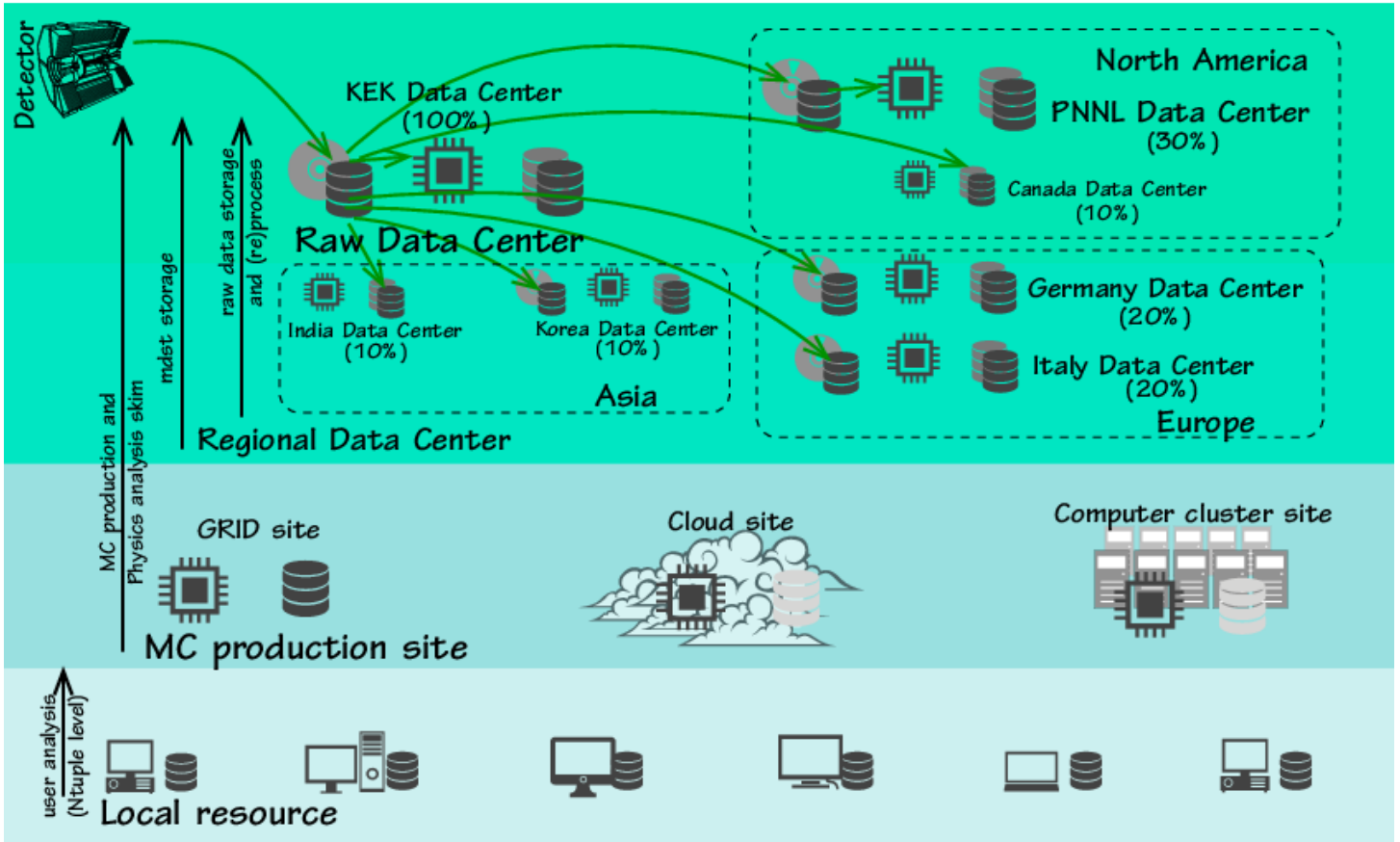
- ➔ short-term resource estimation
- ➔ physics run starts from **2017** (without VXD sub-detectors)
- ➔ physics run with full detector 2018

The Belle II computing model

for 3 years of operation



The Belle II computing model



Distributed Computing System

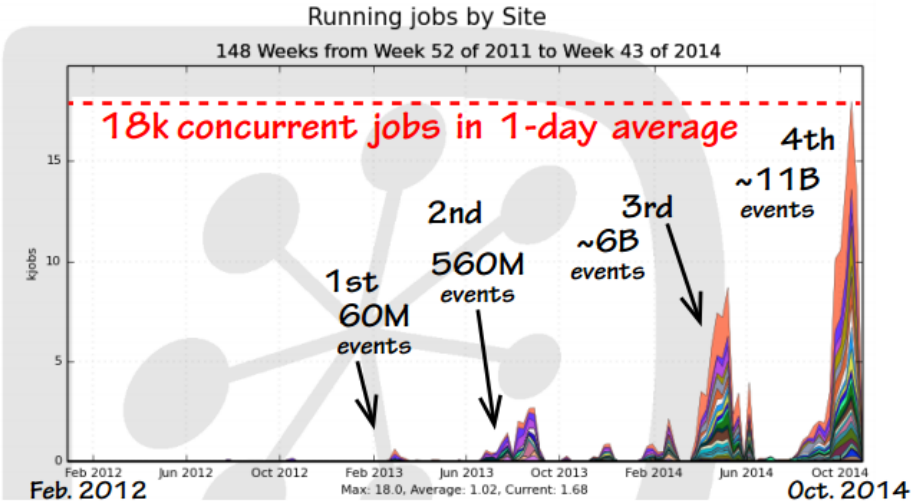
Based on existing, well-proven solutions plus extensions for Belle II:

- ➔ **basf2** (Belle Analysis Software Framework) for analysis, ...
- ➔ **gbasf2** for submitting grid-based basf2 jobs (based on DIRAC and AMGA API)
  - ◆ **DIRAC** (Distributed Infrastructure with Remote Agent Control developed by LHCb) for job management
  - ◆ **AMGA** (ARDA Metadata Grid Application) for metadata (e.g. LFN, run range, software version, ...)
- ➔ **CVMFS** for software distribution

Remarks:

- ➔ gbasf2/DIRAC development services by IFJ, KEK and PNNL teams

Challenges → MC production campaigns



15 countries/regions

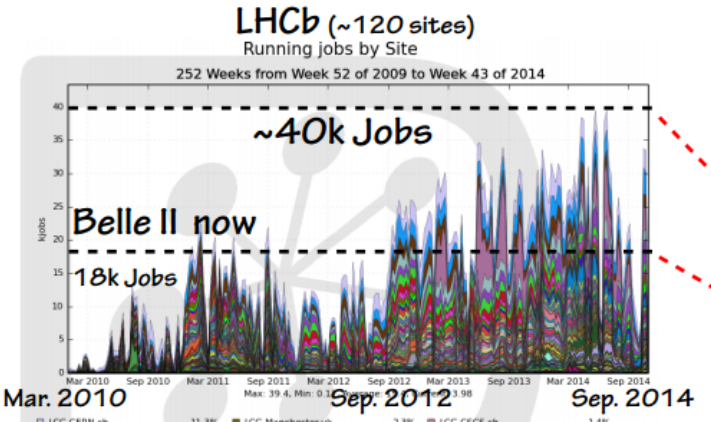
Australia, Austria, Canada, Czeck R., Germany, Italy, Japan, Korea, Poland, Russia, Slovenia, Taiwan, Turkey, Ukraine, USA

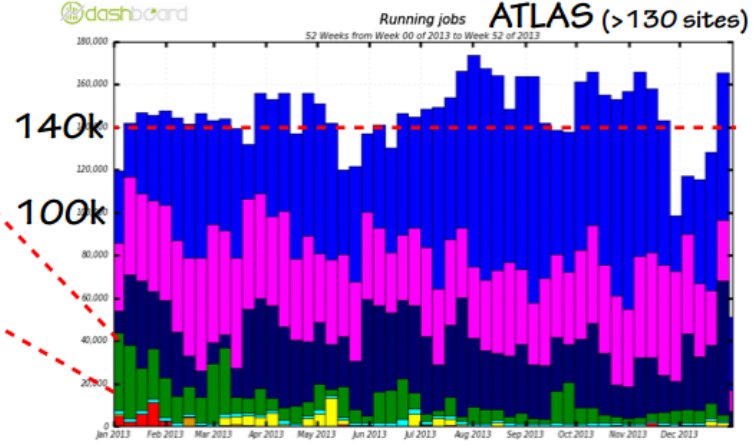
31 sites

GRID, Cloud, local cluster is available

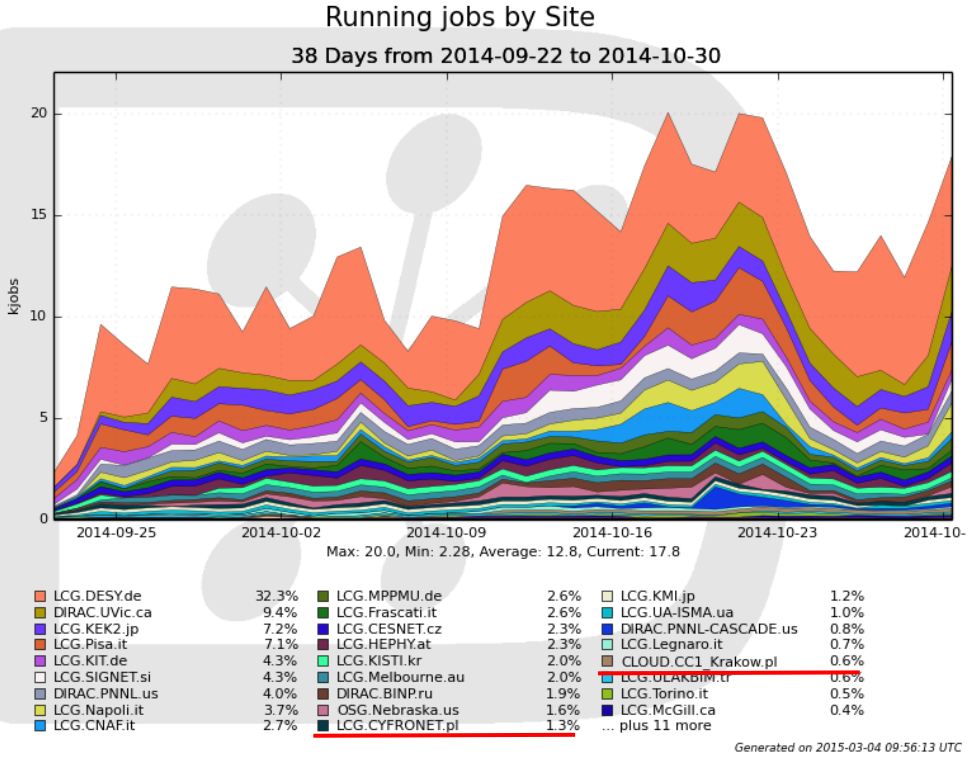
more than 3ab^{-1} in total

However, still a factor of x10 below requirements for full Belle II luminosity





4th MC production campaign



	2014CY : required CPU(kHS06)	2014(4thMC) real CPU(kHS06)
Japan(KEK+Nagoya)	34.12	14.15
US(15%)	19.99	4.88
Germany (12%)	15.99	33.08
Italy (10%)	13.32	15.01
Slovenia	2.87	3.35
Poland	2.87	2.10
Czech Rep.	1.08	2.39
Austria	2.51	2.77
Russia	11.49	2.29
Korea	7.54	1.72
India	4.67	0.00
China	2.87	0.00
Australia	2.51	1.82
Canada	4.31	9.46
Taiwan	5.03	0.19
Turkey	0.72	0.57
Mexico	1.08	0.00
Ukraine	1.44	1.72
Sum	134.42	95.60

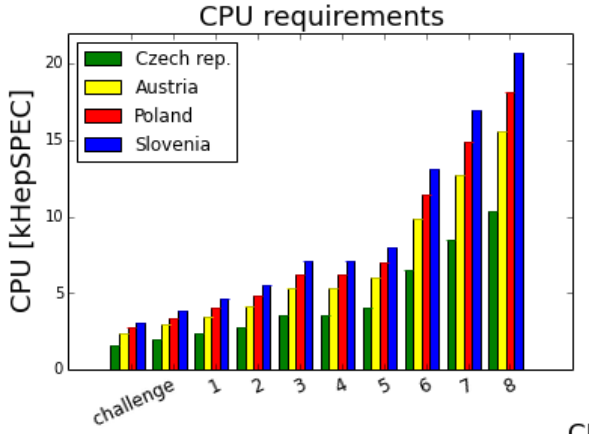
Preliminary

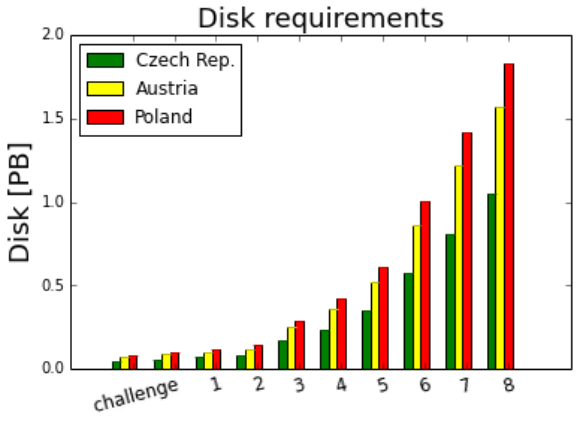
based on # of PhD researchers in 2013

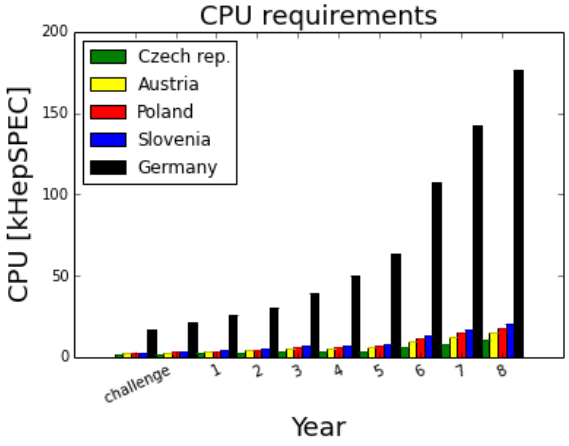
Remarks:

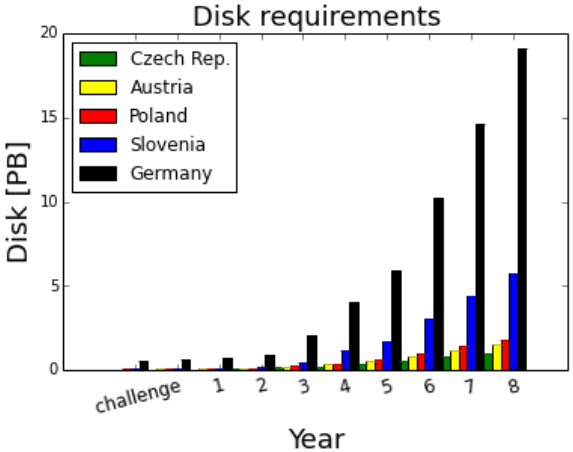
➔ next campaign in march 2015

PL sites vs. other MC production sites





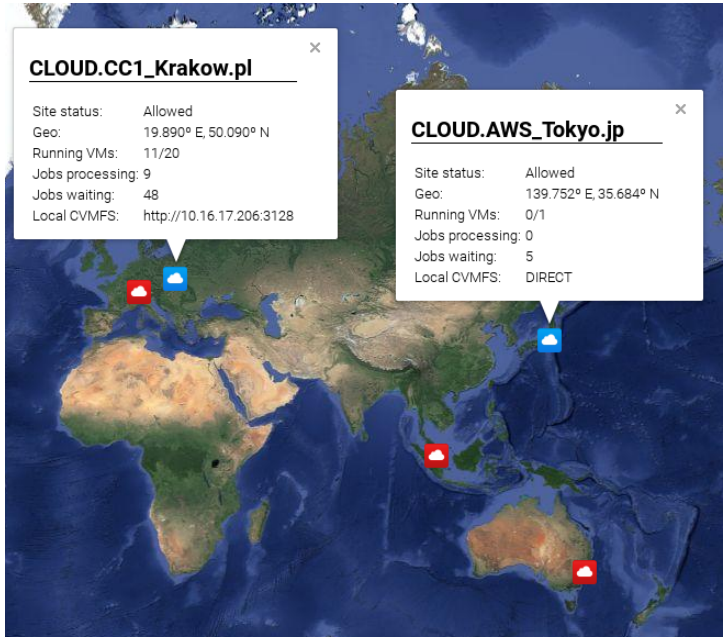




VMDIRAC is an extension to the DIRAC system which handle different cloud APIs like OCCI, EC2, Nova and helps to contextualise virtual machines through cloud-init script or ssh. Experiment software is provided by CVMFS (remote filesystem) with caching server in cloud location.

Works at IFJ PAN

- ➔ VMDIRAC EC2 driver development.
- ➔ Wallet monitoring (services cost).
- ➔ Spot Instance prices monitor in different regions.
- ➔ EC2 sites preparation/management for Belle II MonteCarlo data production.



Testbed sites:

- Institute in Krakow (CC1 EC2)
- University in Zurich (OpenStack EC2)
- Tokyo AWS region (Amazon EC2*)
- Singapore AWS region (Amazon EC2*)
- Sydney AWS region (Amazon EC2*)

*Educational grant from Amazon company for Belle II.

Summary

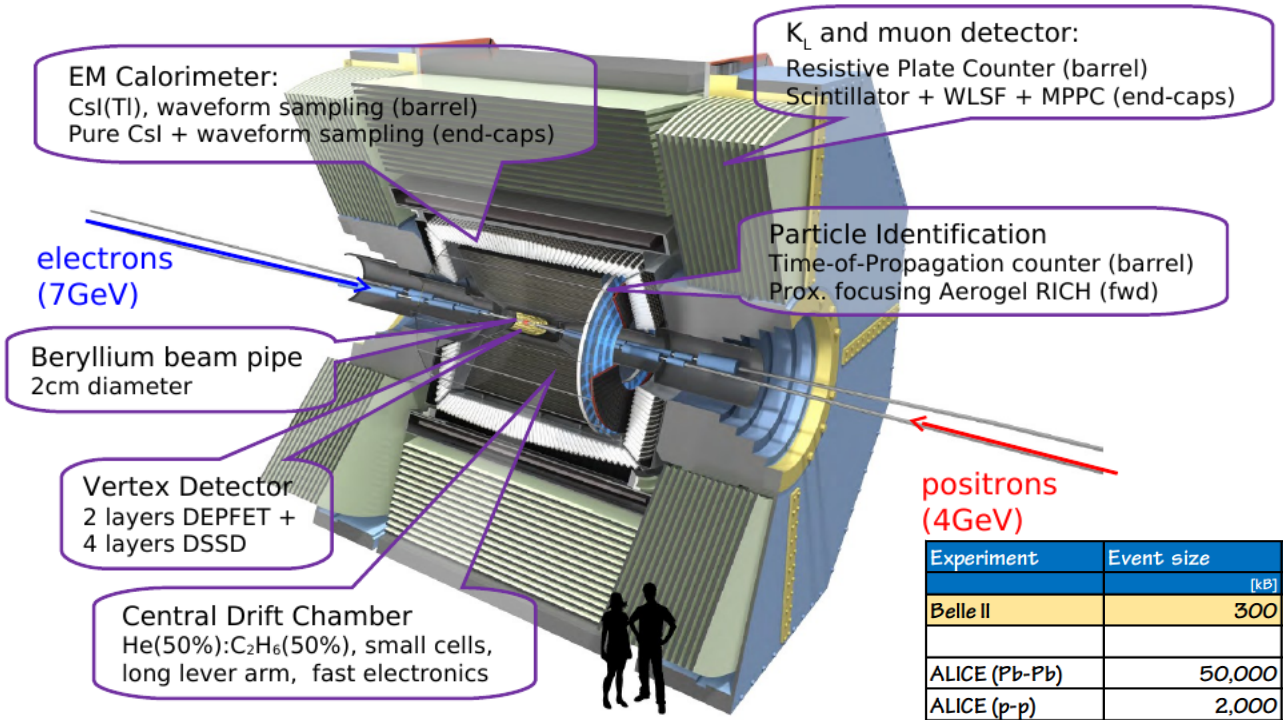
- ➔ indirect searches of New Physics via high precision flavor physics measurements; **identify the nature of NP**; complementarity to LHC;
- ➔ scale of the computing resources **~** resources of LHC experiments;
- ➔ computing system based on a **distributed computing technologies**;
- ➔ **computing model works fine;** contribution from PL sites is essential and started from the early stage of the Belle II computing activity;

References:

- ➔ T.Hara - B2GM & BPAC (02.2015)

BACKUP

The Belle II detector



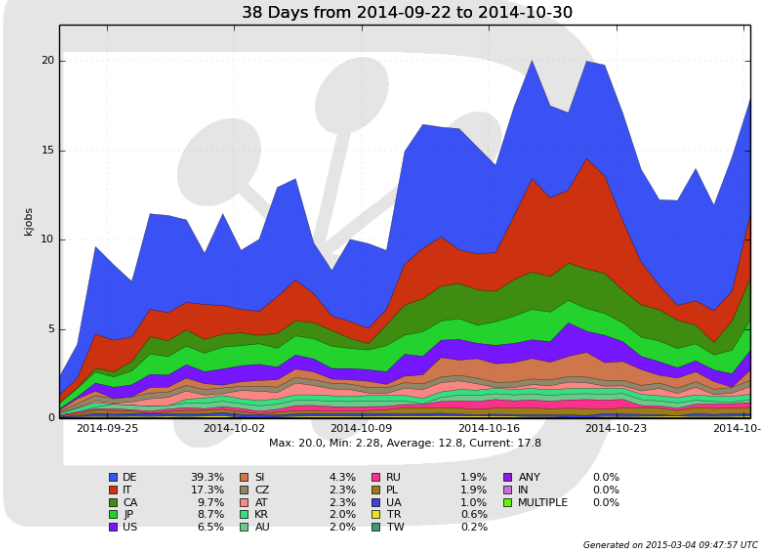
Event size:

- DST (300kB/event)
- mDST (40kB/event)

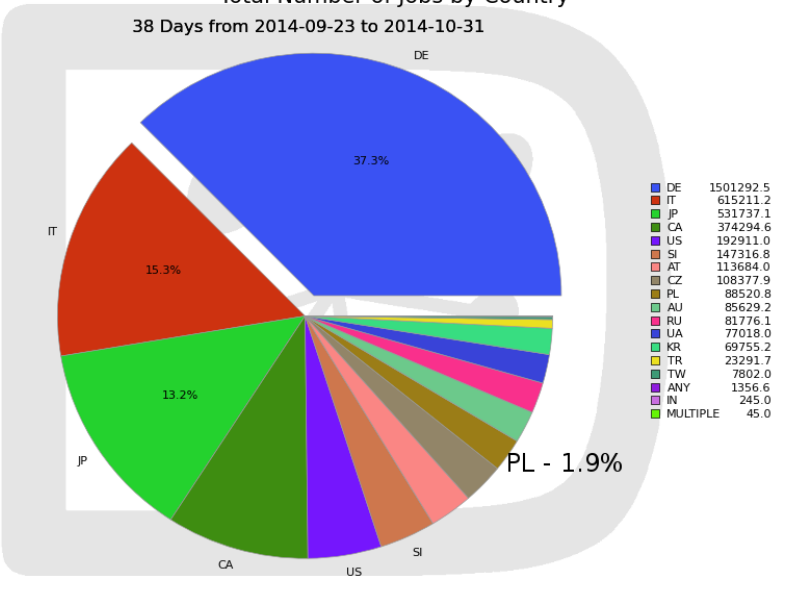
Experiment	Event size [kB]	Rate @ Storage [event/sec]	Rate @ Storage [MB/sec]	
Belle II	300	6,000	1,800	(@ max. luminosity)
ALICE (Pb-Pb)	50,000	100	4,000	
ALICE (p-p)	2,000	100	200	
ATLAS	1,500	600	700	
CMS	1,500	150	225 (<~1000)	
LHCb	55	4,500	250	

(LHC experiments: as seen in 2011/2012 runs)

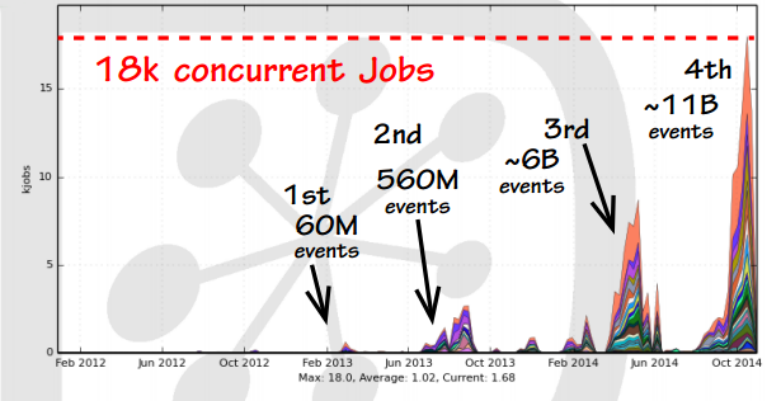
Running jobs by Country



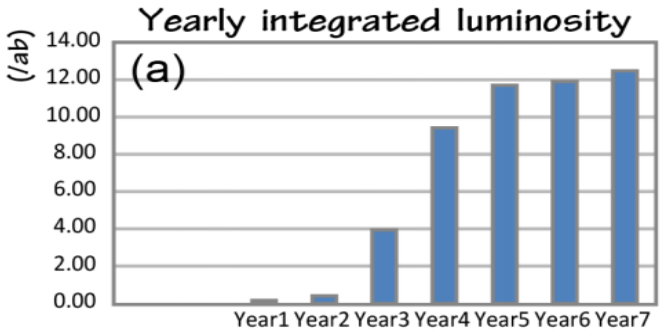
Total Number of Jobs by Country

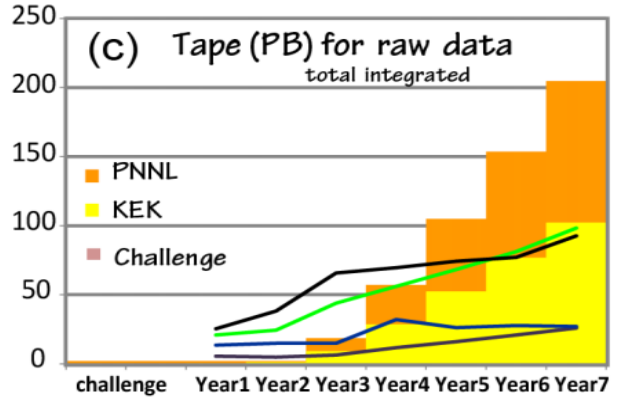


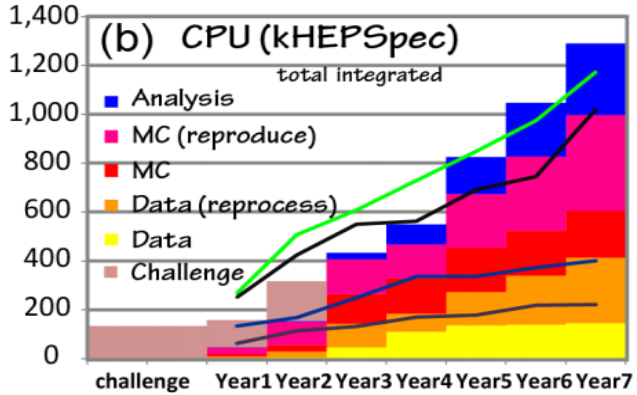
Running jobs by Site

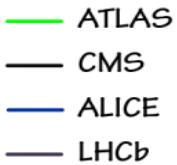


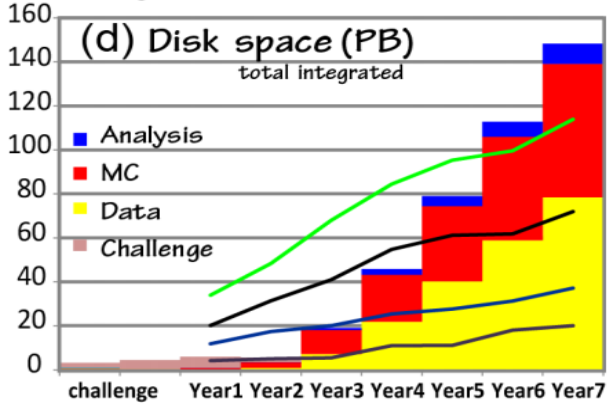
Requirements to Computing - 2014 version





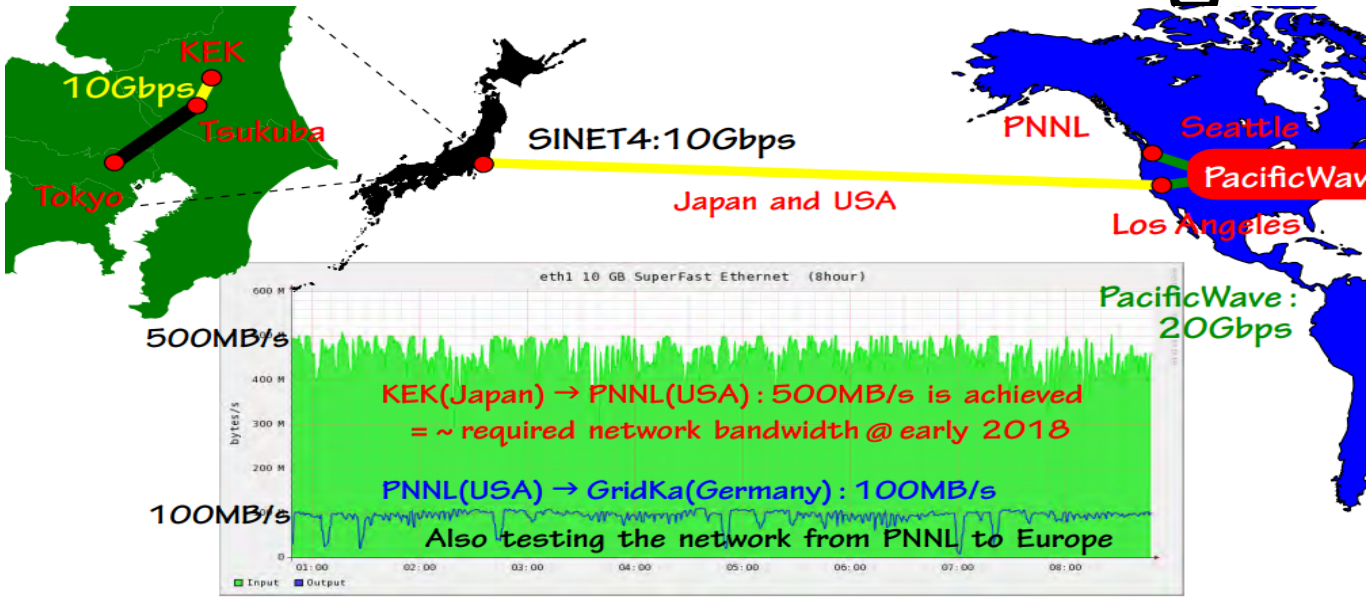






Pledge summary of LHC experiments : http://wlcg-rebus.cern.ch/apps/pledges/summary/

The data transfer challenges



But not enough for the network bandwidth @ middle of Year4 and later (~2GB/s)

We need a 40Gbps - 100Gbps network between Japan and USA

➔ Data transfer KEK to Europe via PNNL: KEK to PNNL and PNNL to Europe to cut the latency between KEK to Europe;

of Belle II colleagues (09.03.2015)

Country	#inst.	Colleagues	Institution Name	Colleagues
AUSTRIA	1	14	HEPHY, Austrian Academy of Sciences AUSTRIA	14
CZECH	1	8	Charles Univ. in Prague CZECH	8
GERMANY	11	89	Deutsches Elektronen-Synchrotron(DESY) GERMANY	15
			Johannes Gutenberg Univ. of Mainz GERMANY	2
			Karlsruhe Institute of Technology(KIT) GERMANY	14
			Ludwig Maximilians Univ. Muenchen(LMU) GERMANY	2
			Max Planck Institut fur Physik Muenchen GERMANY	16
			Semiconductor Laboratory of the Max Planck Society GERMANY	3
			Technical Univ. of Munich(Technische Universitaet Muenchen) GERMANY	6
			Univ. of Bonn GERMANY	14
			Univ. of Giessen GERMANY	8
			Univ. of Goettingen GERMANY	5
			Univ. of Heidelberg GERMANY	4
POLAND	1	11	Institute of Nuclear Physics PAN POLAND	11
SLOVENIA	2	17	Univ. of Ljubljana SLOVENIA	16
			Univ. of Nova Gorica SLOVENIA	1