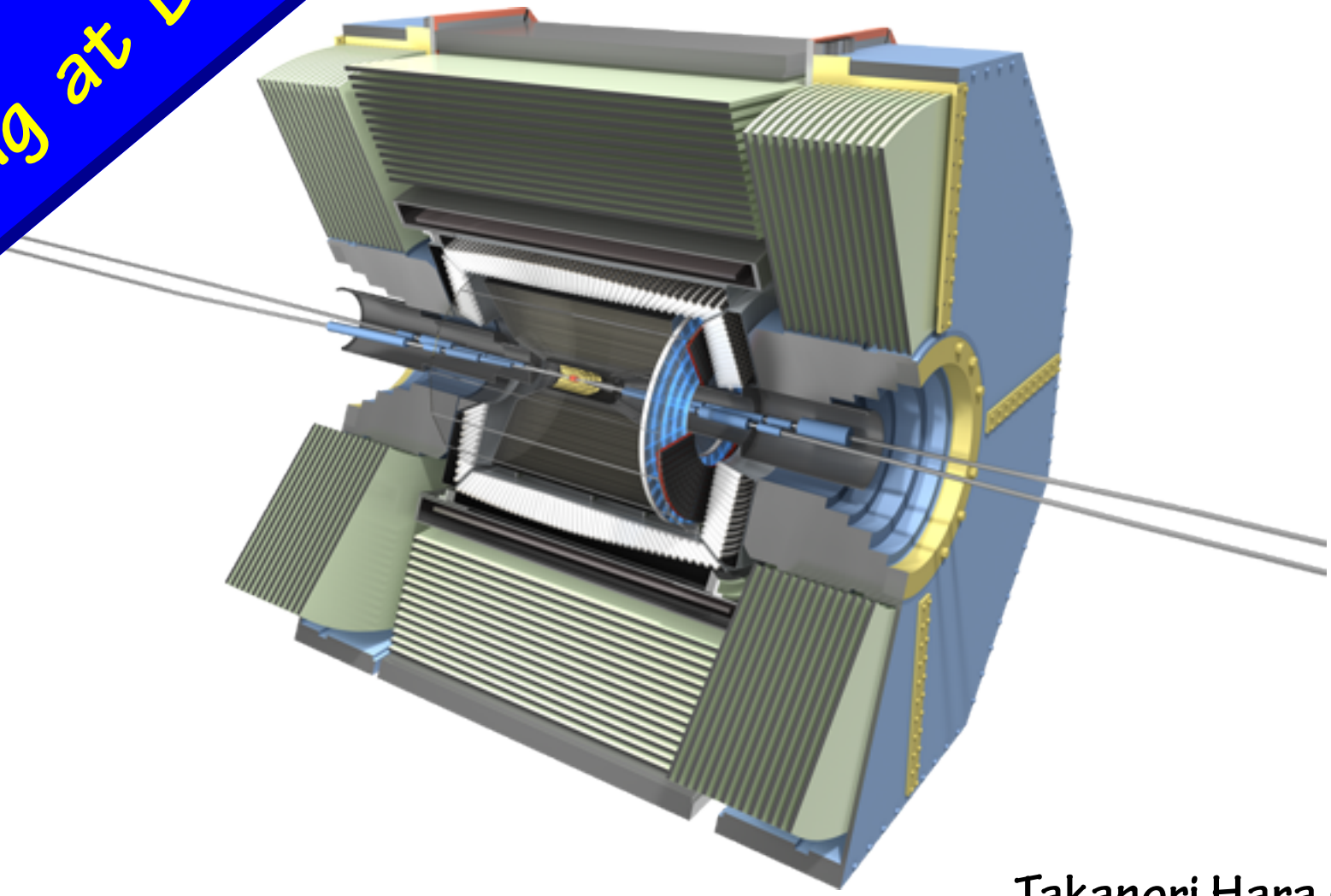
Computing at Belle II

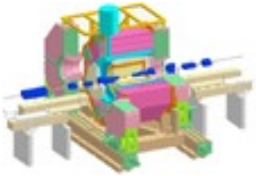


Takanori Hara (KEK)

Mar. 14, 2012

FJPPL workshop

Belle Collaboration



Belle is an experiment at the KEK B-factory. Its goal is to study the origin of CP violation.

[一般向 (日本語)| Introduction (English)]

Belle members only

KEK [English]

KEKB

Belle II

Belle Calendar 2011

On Earthquake

As is now well known, Japan suffered a terrible earthquake and tsunami on March 11, which has caused tremendous damage, especially in the Tohoku area. Fortunately, all KEK personnel and users are safe and accounted for. The injection linac did suffer significant but manageable damage, and repairs are underway. The damage to the KEKB main rings appears to be less serious, though non-negligible. No serious damage has been reported so far at Belle. Further investigation is necessary. We would like to convey our deep appreciation to everyone for your generous expressions of concern and encouragement.

Recent Physics Results

Conference Papers 2010

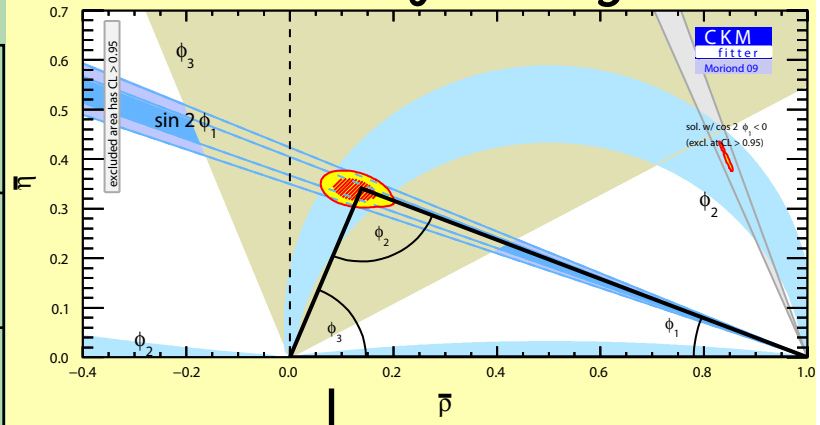
We got a kind offer from IN2P3 (actually, inside/outside of the Belle community), e.g. temporary storage space, CPU powers. We cordially appreciate that.

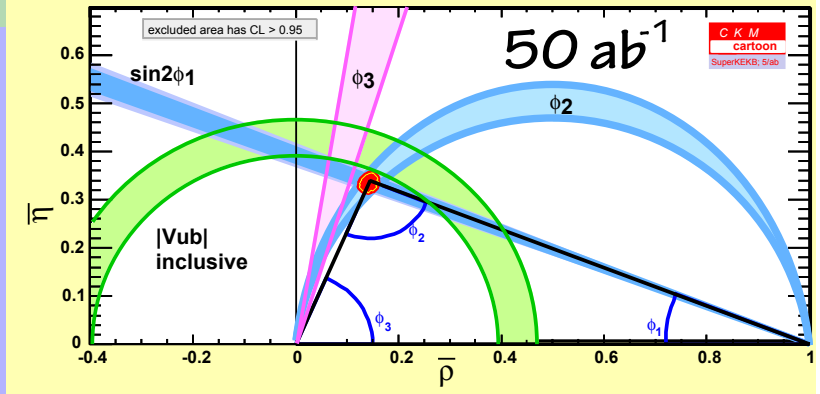
Search for New Physics !

observables for tanβ-M_H

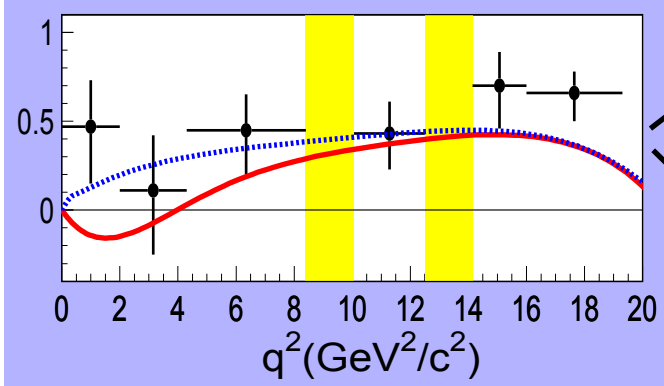
observables	$\mathcal{B}(b\to s\gamma)$	$\mathcal{B}(B\to\tau\nu)$	R(D) in $B\to D\tau\nu$
Current 0.6 ab^{-1} (=657 M BB)	12.6 %	25 %	25 %
5 ab^{-1}	7.7 %	10 %	8 %
50 ab^{-1}	6.8 %	3 %	2.5 %

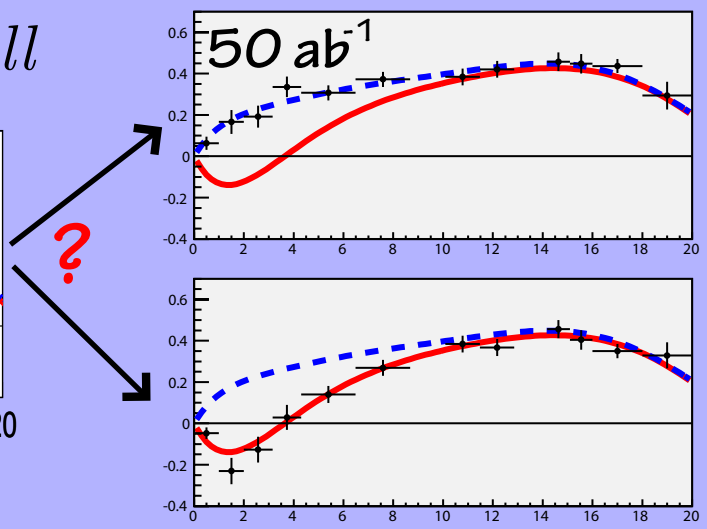
Unitariry triangle





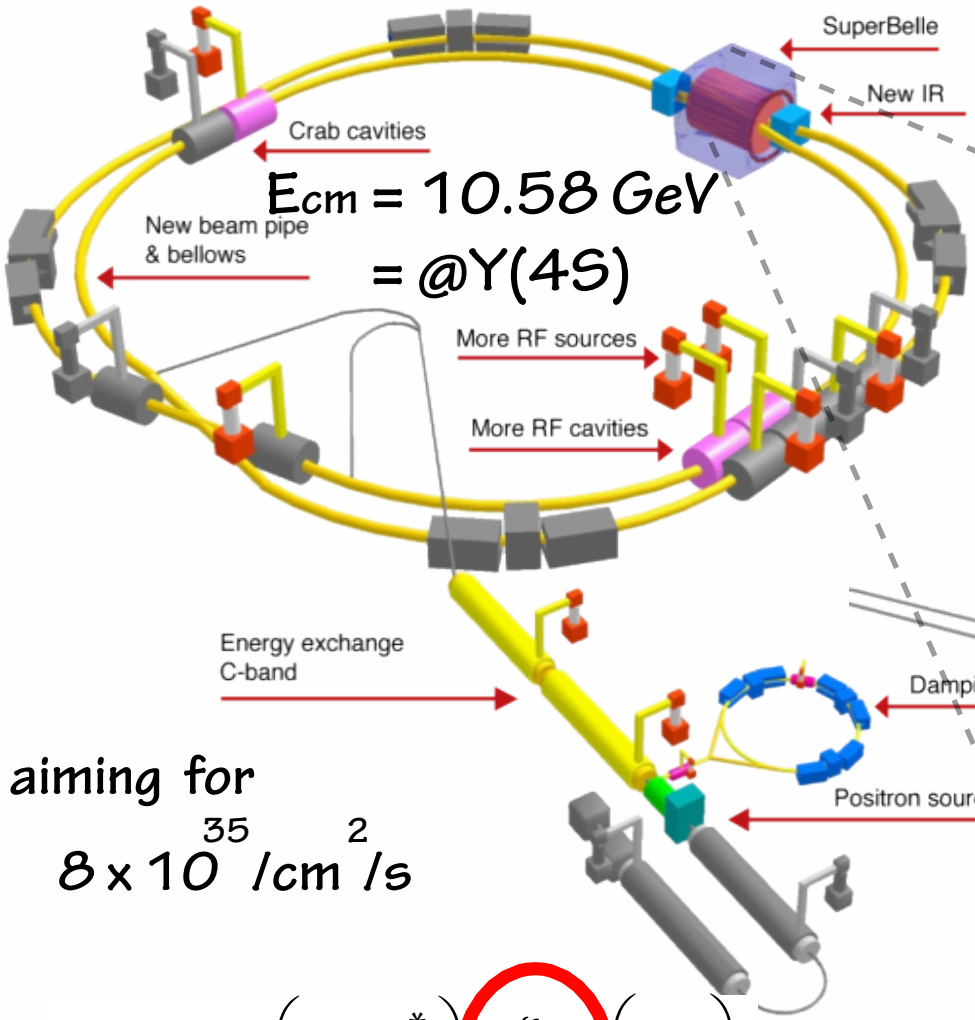
FB Asym. in $B\to K^*ll$





able to search for NP beyond the SM

SuperKEKB / Belle II



E_{cm} = 10.58 GeV
= @Y(4S)

aiming for
8×10^{35} /cm^2/s

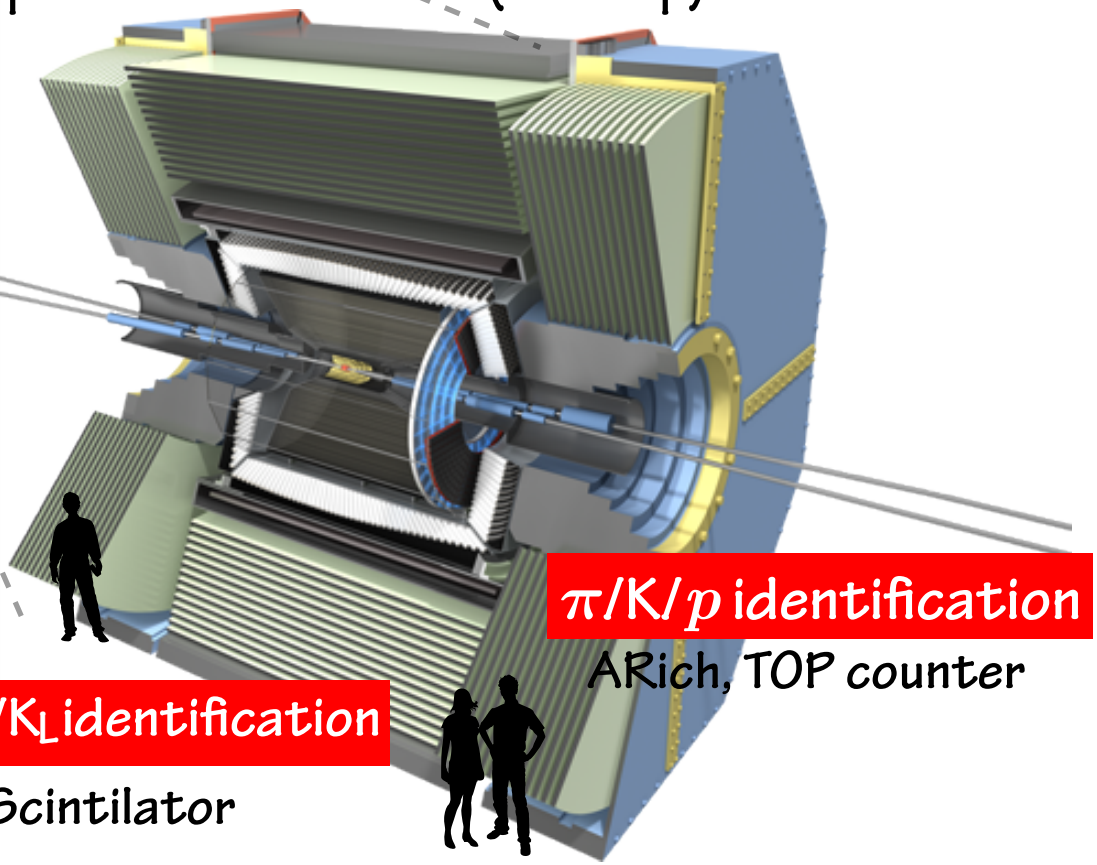
$$L = \frac{\gamma_\pm}{2er_e}\left(1+\frac{\sigma_y^*}{\sigma_x^*}\right)\frac{I_\pm \xi_{\pm y}}{\beta_y^*}\left(\frac{R_L}{R_y}\right)$$

tracking/vertexing

small-cell Drift Chamber
Silicon Strip det.
longer lever arm
Pixel detector

e/γ detection

pure-CsI calorimeter (end-cap)



π/K/p identification

ARich, TOP counter

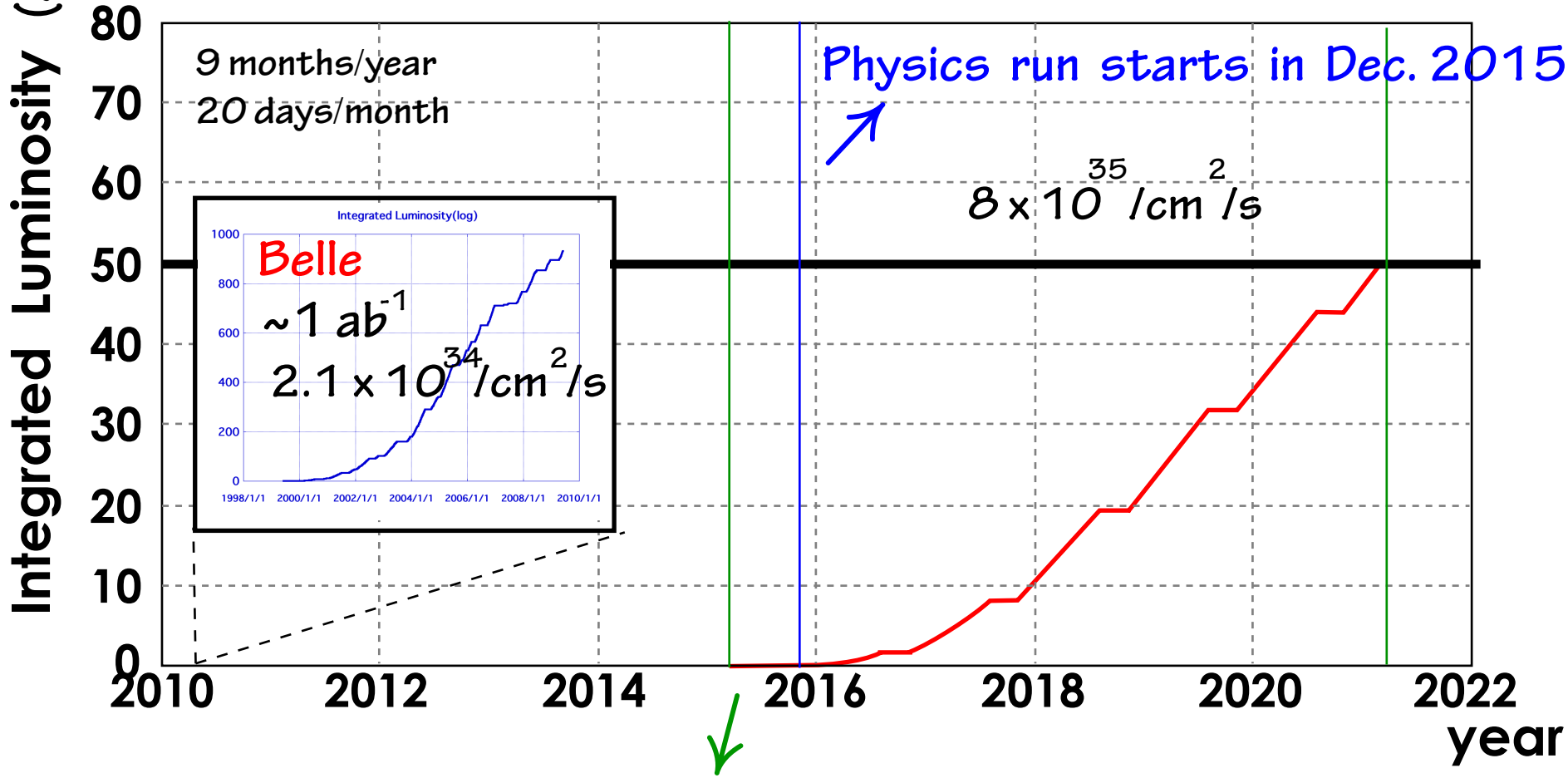
μ/K$_L$ identification

Scintilator

Belle II Luminosity Prospect

50 ab^{-1} by the end of 2020JFY = × 50 present

→ We will reach 50 ab^{-1} in 2021

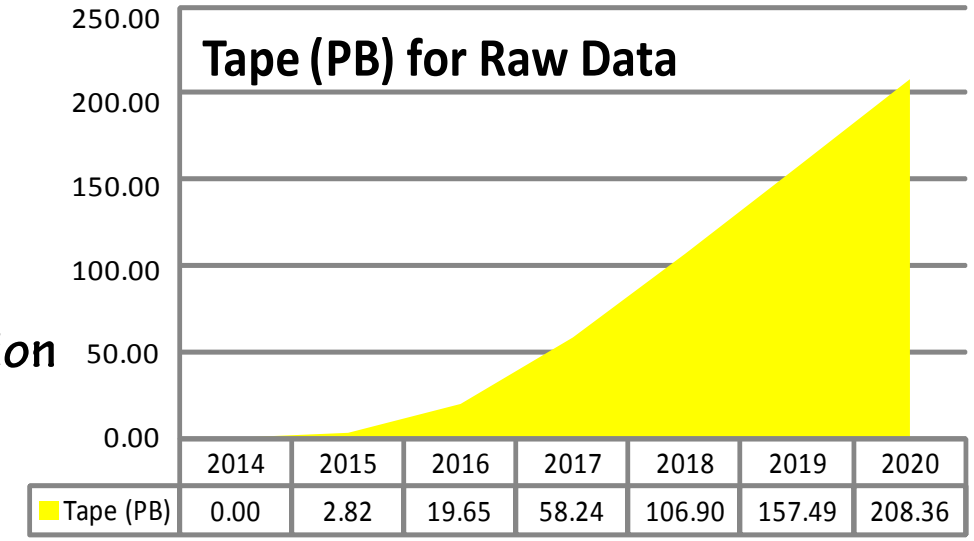


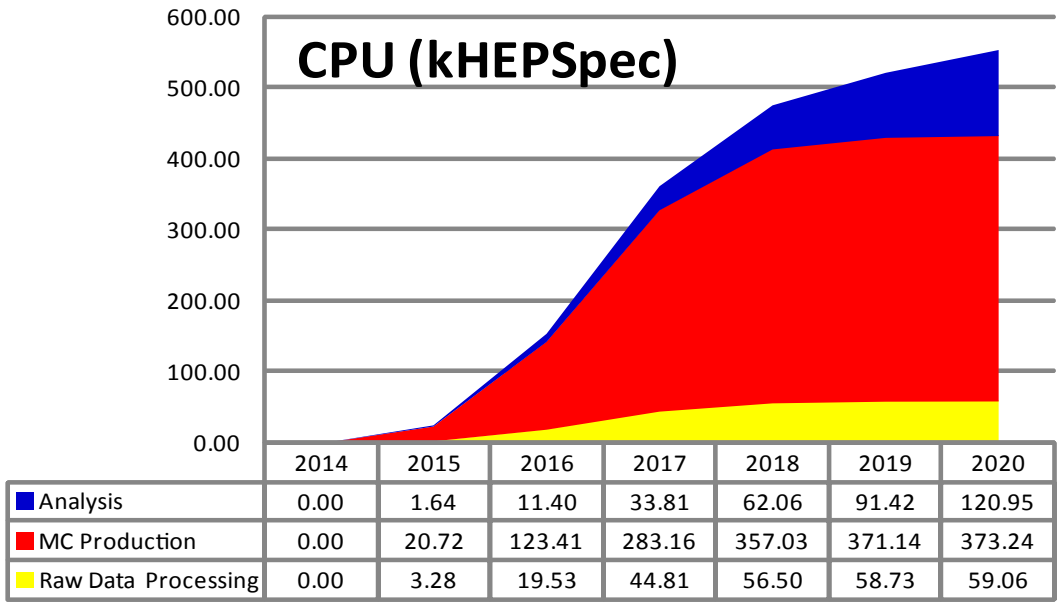
Commissioning starts in early 2015

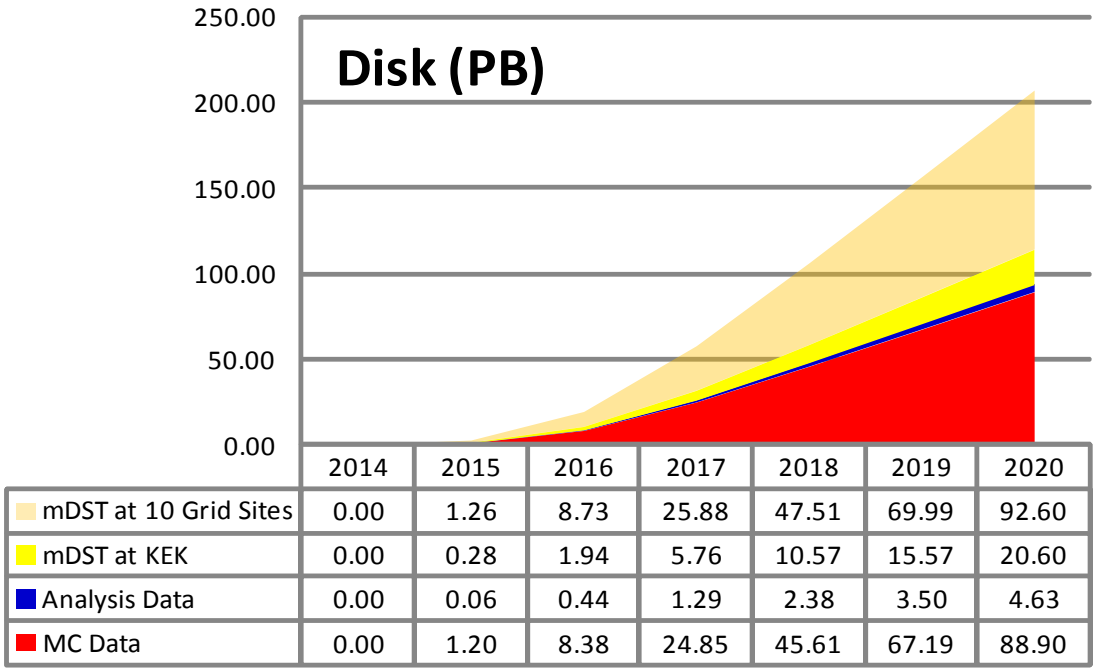
Hardware Resources

Preliminary estimates depend on many unknown parameters

- accelerator performance
- data reduction
- performance of simulation/reconstruction
- analysis requirements, ...







Required resources for KEK

For rawdata process, MC (25%), analysis

safety factor (x 2) applied

Fiscal year	2015	2016	2017	2018	2019	2020
Tape [PB]	3	20	58	107	157	208
Disk [PB]	0.7	4.6	14	26	38	50
CPU [kHepSPEC]	7	42	100	132	145	155
WAN [Gbit/s]	0.6	3.8	8.8	11	11	12

5 months for DST

another 5 months for MC prod.

Belle

~1.5PB disk
~3.5PB tape
~45 kHEPSpec (3/5 used)
(=~4,000 cores (3GHz))

Resources (Germany)

For MC (~14%) + analysis.
and 1 copy of mDST datasets

Fiscal year	2015	2016	2017	2018	2019	2020
Disk [PB]	0.31	2.1	6.3	12	17	23
CPU [kHepSPEC]	3.2	19	45	60	66	71
WAN [Gbit/s]	0.084	0.48	1.1	1.4	1.5	1.5

Comparison

Experiment	Event Size [kB]	Rate [Hz]	Rate [MB/s]
High rate scenario for Belle II DAQ:			
Belle II	300	6,000	1,800
LCG TDR (2005):			
ALICE (HI)	12,500	100	1,250
ALICE (pp)	1,000	100	100
ATLAS	1,600	200	320
CMS	1,500	150	225
LHCb	25	2,000	50

Belle II Collaboration

17 countries/regions
62 institutes
392 colleagues

Japan	: 129
Germany	: 53
Russia	: 33
Korea	: 32
USA	: 37

Belle II GRID sites

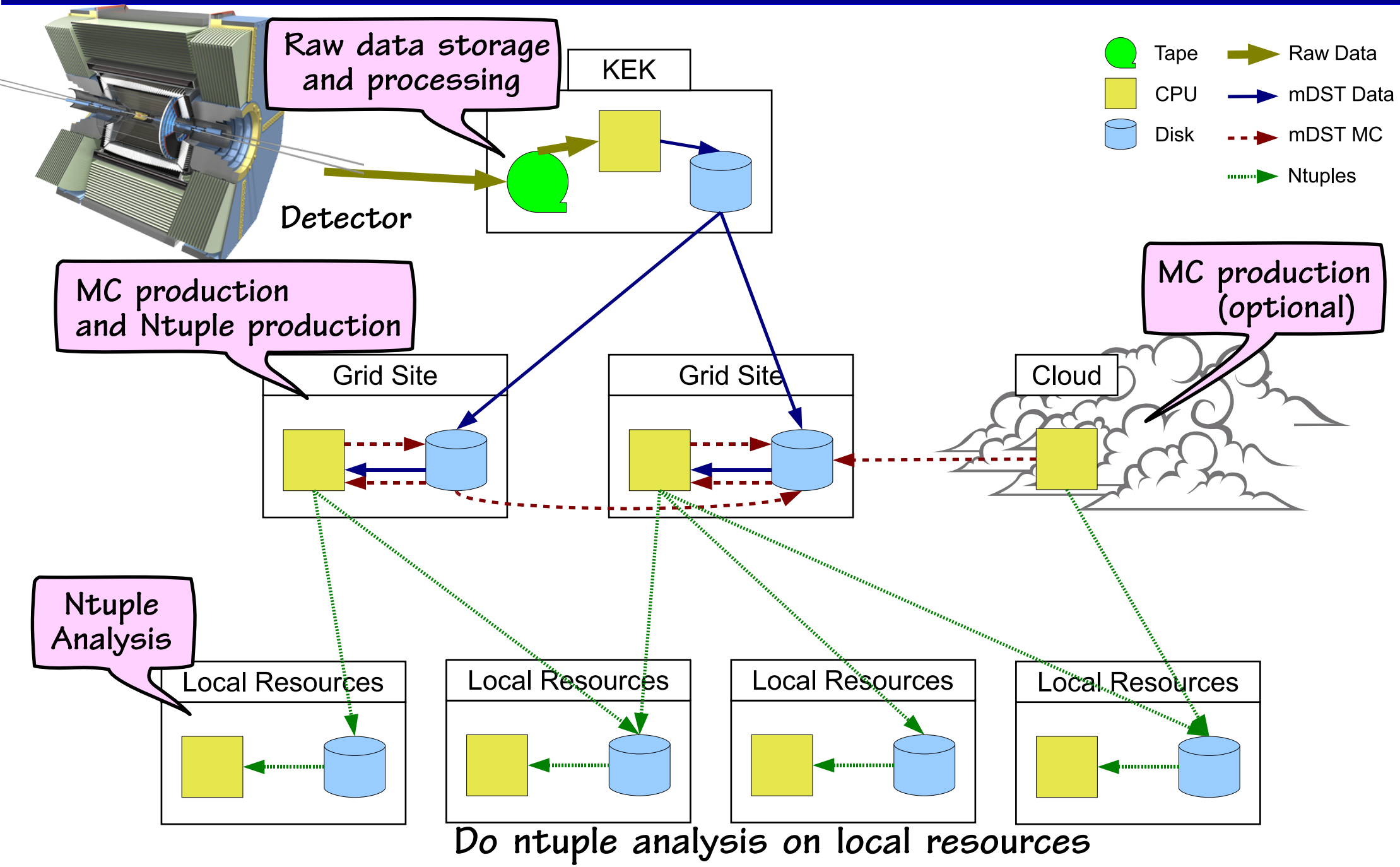
GRID middleware

gLite

OSG

- Australia : LHC Tier2/3, Belle VO, Cloud system
- Austria : LHC Tier2
- China (IHEP) : LHC Tier2, DIRAC server
- Czech Republic : LHC Tier2, Belle VO
- Germany : LHC Tier1/2, Belle VO
- India : LHC Tier2, Belle II data center planned
- Japan (KEK) : Belle VO
- Korea (KISTI) : LHC Tier2, Belle VO
- Poland : LHC Tier2/3, Belle VO, Cloud system
- Russia : LHC Tier2
- Slovenia : LHC Tier2, Belle VO
- Taiwan : LHC Tier1/2
- USA : OSG @ PNNL planned, Belle VO @ OSG exists

Belle II Computing Model

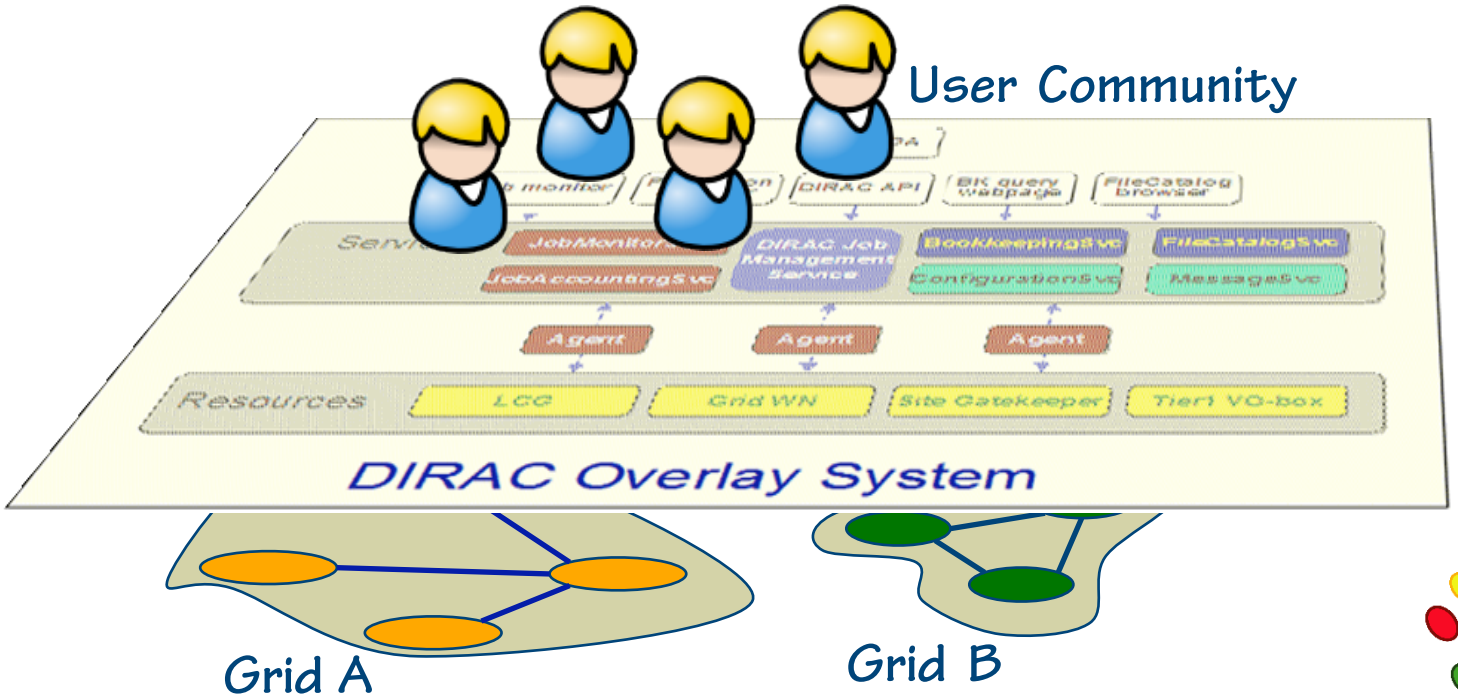


Distributed Computing System

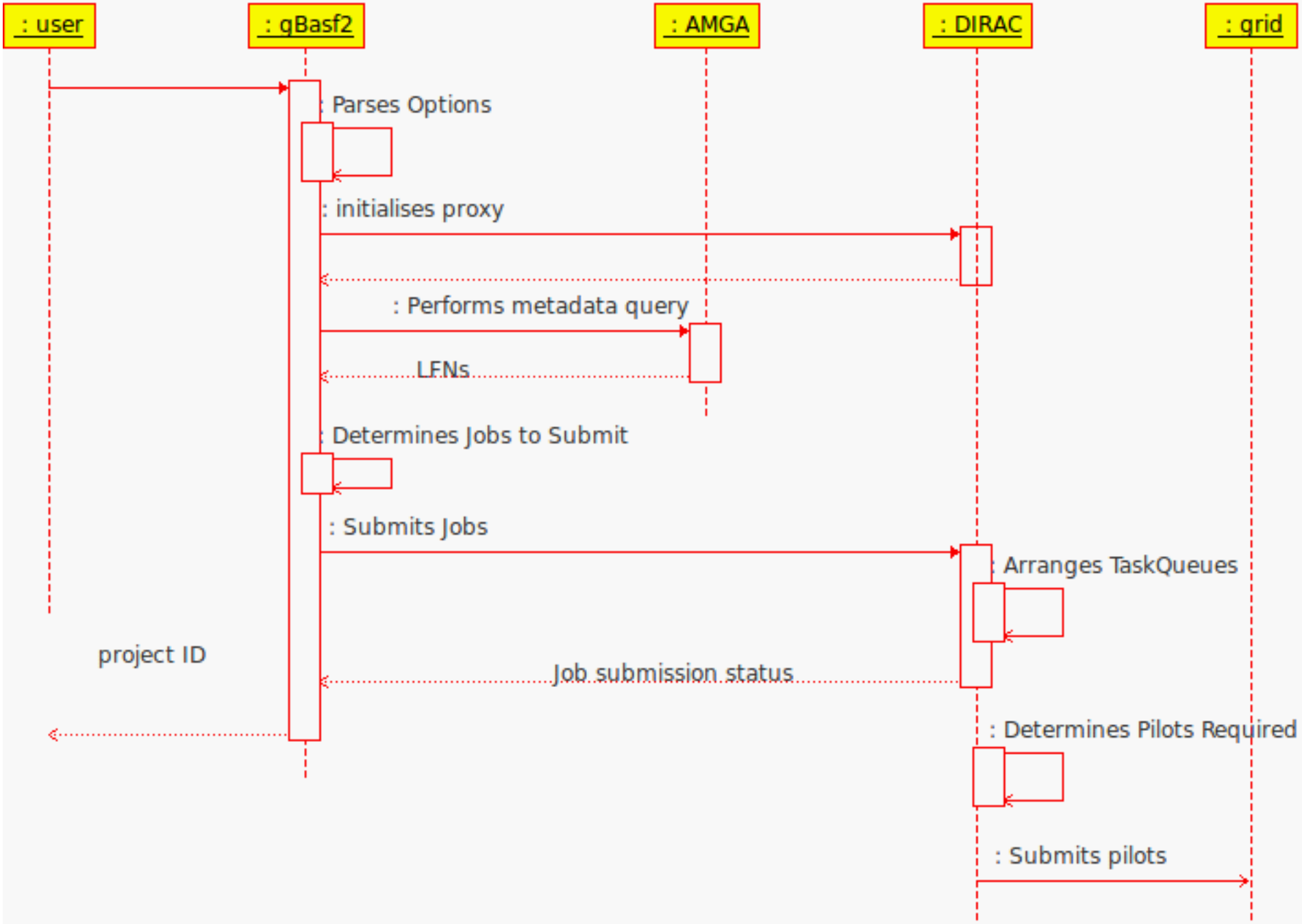
- DIRAC (developed by LHCb)

  Distributed Infrastructure with Remote Agent Control

  → Pilot jobs
  → Modular structure that enabled it possible to submit to different backends.
  → It provides many features that we would have to develop



Belle MC Production w/ DIRAC



User Interface : gbasf2

python steering file, same as for ofline basf2 jobs,
but with additional parameters for the grid job

Basf2 Steering File options

The default configuration option for gBasf2 is to set a number of variables in your normal basf2 steering file:

```
############################
# gBasf2 configuration     #
############################
#Name for project
project='e055-test'
# (optional) Job priority [0-10]
priority='1'
#Experiments (comma separated list)
experiments='13,57'
#Metadata query
query='id > 10 and id < 15'
#Type of Data ('data' or 'MC')
type='data'
#estimated Average Events per Minute (eg Mcprod = 40)
evtpermin='45'
# (optional) Files to be sent with the job
inputsandboxfiles = 'file1.txt,file2.txt'
# (optional) max events - the maximum number of events to use
maxevents ='100000'
```

You can then invoke gBasf2 using the steering file and it will do the rest:

```
./gbasf2.py -s steering_file.py
```

basf2 : Belle II Analysis Software Framework

User Interface : gbasf2

Project Overview as dirac_admin@Dirac-Test - Mozilla Firefox

File Edit View History Bookmarks Tools Help

https://kek2-uidev.cc.kek.jp:15043/DIRAC/Dirac-Test/dirac_admin/systems/projects/overview

Most Visited ▾ EPP Nagios PWLCG Tier2 ▾ Tools ▾ Investigate ▾ Belle ▾ Dev ▾ iCMS DIRAC@JP ROC DIRAC

Project Overview as dirac_admi...

Systems ▾ Jobs ▾ Virtual machines ▾ Projects ▾ Datasets ▾ Help

Select all Select none Reschedule Project Terminate Project

Project	Progress	Status	LastUpdate	Submission Time	Owner
test3	100%	Done - with failures	one week ago	2010-12-28 17:17:5	tkuhr
test1	100%	Done - with failures	one week ago	2010-12-28 14:21:5	tkuhr
loadstorm-kek2	60%	Run	s ago	2010-12-22 06:38:4	dirac
loadstorm-all	100%	Don	s ago	2010-12-22 05:35:5	dirac
installation	100%	Done - with failures	ten minutes ago	2011-01-05 02:11:0	dirac
e055-test	100%	Done - with failures	20 hours ago	2011-01-04 06:47:4	dirac
NoGroup	100%	Done	two weeks ago	2010-12-22 05:50:3	dirac

Show Jobs
Show Failures

Page 1 of 1 Items per page: 50

Projects > Projects

dirac@ dirac_admin ▾ (/C=AU/O=APACGrid/OU=The University

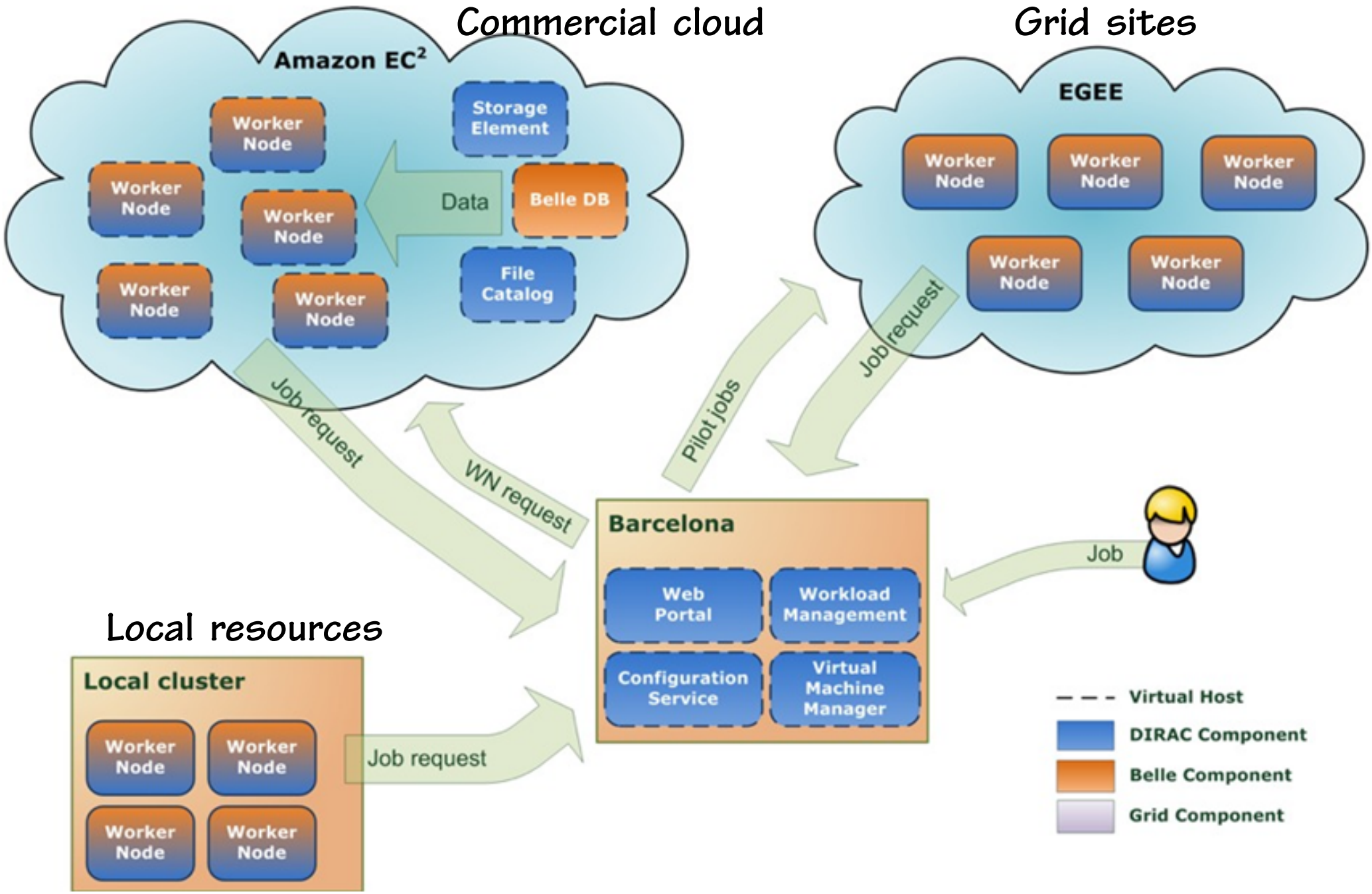
DIRAC server @ IHEP China

Analysis projects provide high level user interface

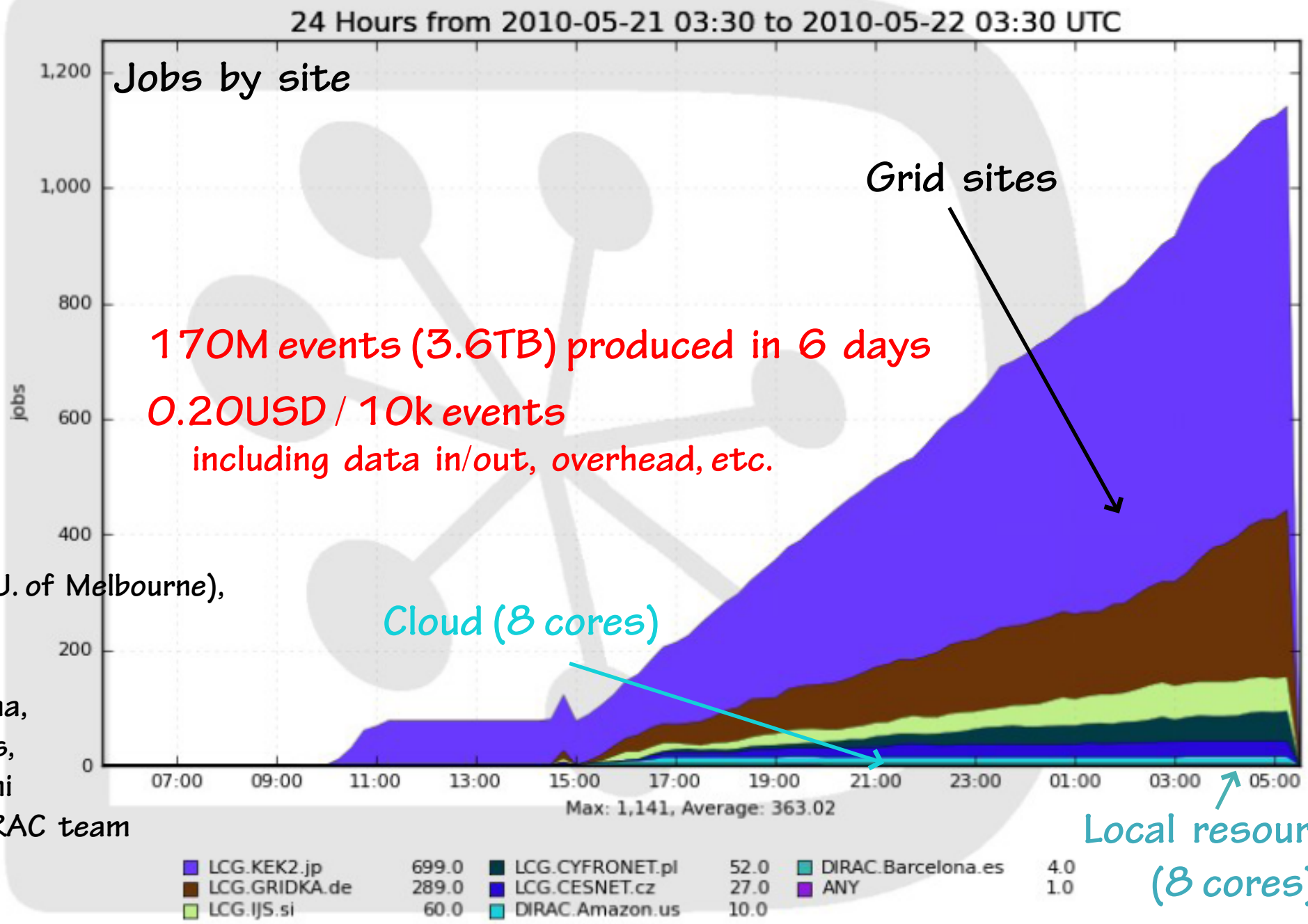
Jobs submitted, scheduled, run, output collected, progress displayed

→ bookkeeping of jobs

Belle MC Production w/ DIRAC

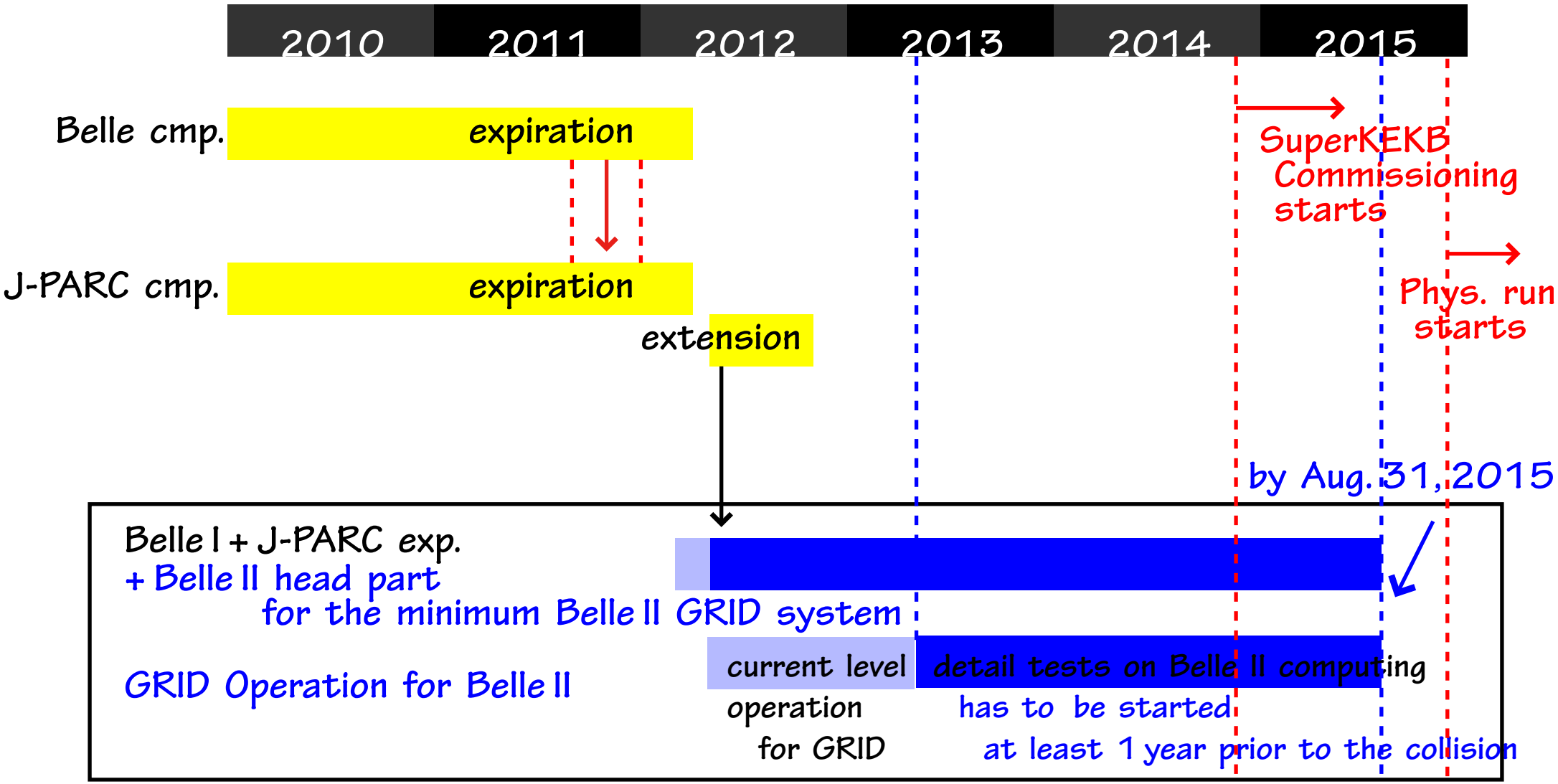


DIRAC test : grid + cloud+ local



T.Fifield (U. of Melbourne),
and
M.Sevior
A.Carmona,
A.Casajus,
R.Graciani
& The DIRAC team

Schedule


2010
2011
2012
2013
2014
2015
Belle cmp.
expiration
J-PARC cmp.
expiration
extension
SuperKEKB Commissioning starts
Phys. run starts
by Aug. 31, 2015
Belle I + J-PARC exp.
+ Belle II head part
for the minimum Belle II GRID system
GRID Operation for Belle II
current level operation for GRID
detail tests on Belle II computing
has to be started
at least 1 year prior to the collision

Specification

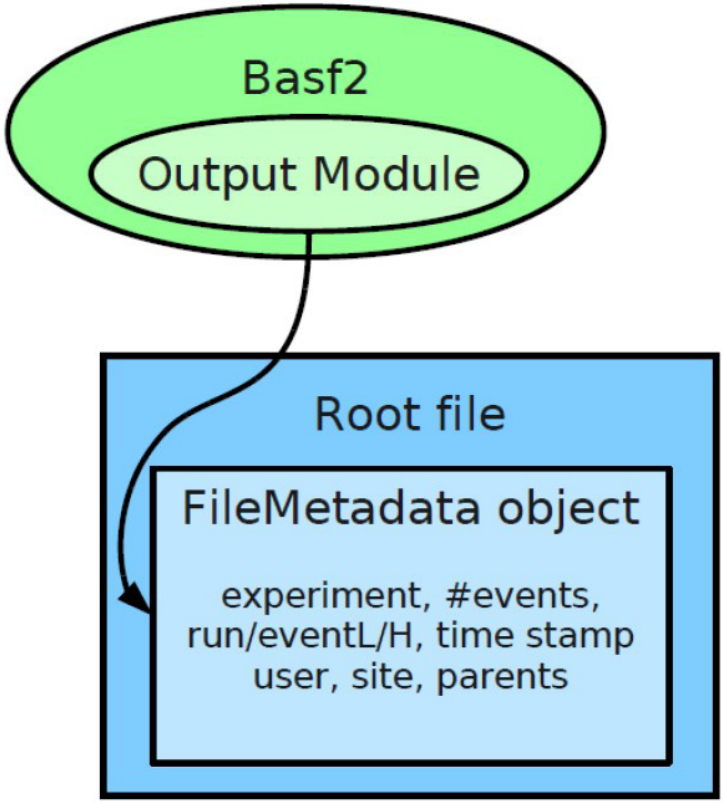
		Belle current system	Final specification
Storage	Disk/Tape	1.5PB/3PB	6.9PB/16PB DDN SFA 10000, IBM TS3500)
	# of tape drivers	~10	60
	HSM cache	0.4PB	3PB (included in 6.9PB)
CPU	# of Cores	~4000	4080 Xeon5670(2.03GHz) IBM System x iDataPlex
	and memories	80 workgroup servers 3840 (computing servers) (4GB) 3/5 used for Belle	300 (4GB)+240(8GB) 3540 (computing servers) 3084 (4GB) 456 (8GB)
	internal Disk drive		1TB
	OS	SL5	RedHat EL5 or SL5
Band Width	transfer rate (single connection)		200MB/s disk : par 1 process par 1 thread staging disk (HSM) : par 1 process par 1 thread tape (HSM) : par 1 process par 1 thread : 150MB/s
	total throughput		50GB/s disk storage ctrl - CN staging disk ctrl (HSM) - CN

Data Registration Tool

Metadata has to be extracted from the output files

Tool for Belle 1 data implemented

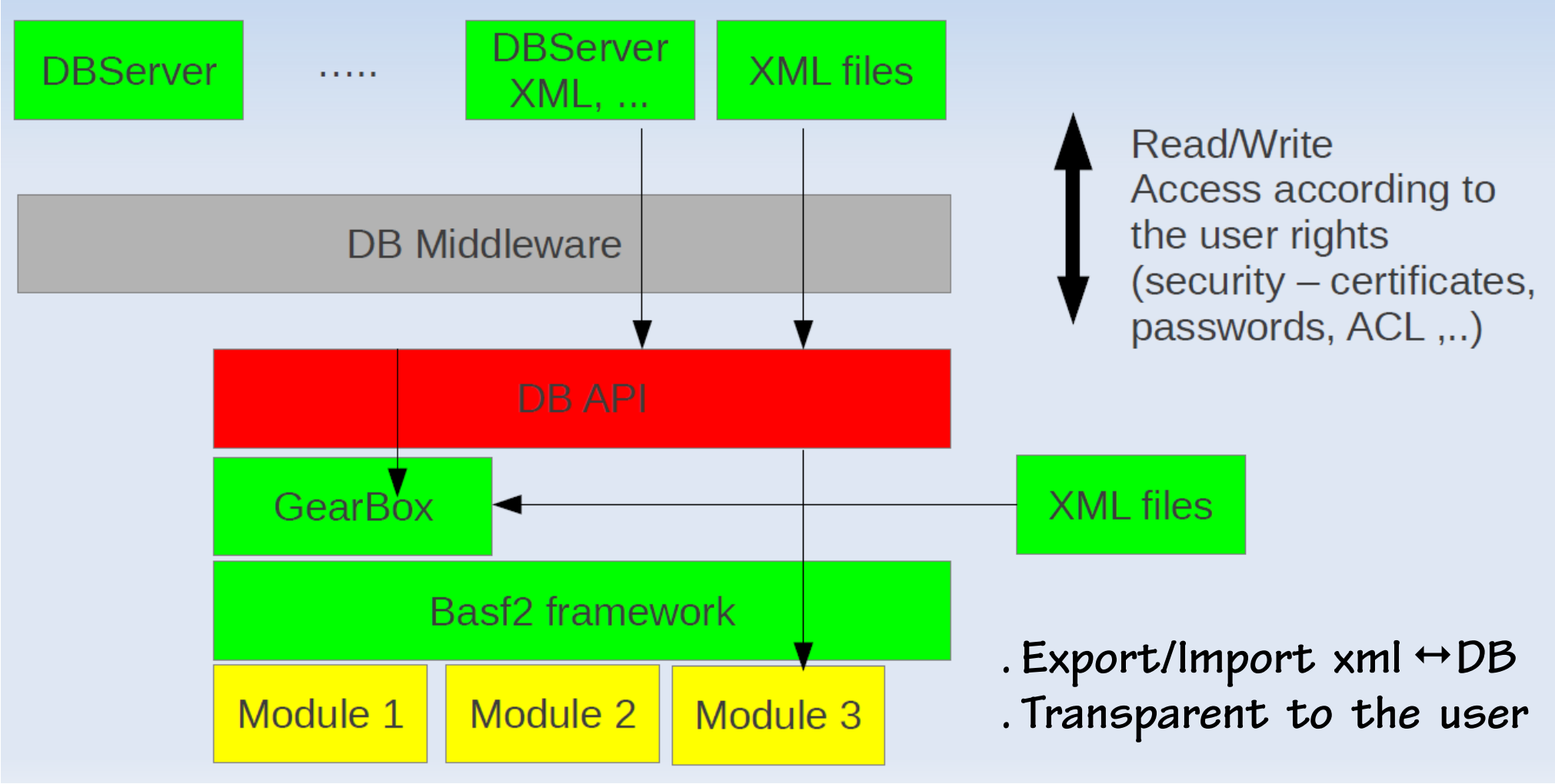
```
hep2.kisti.re.kr - PuTTY
LFN : //f3/belle/bdata/exp13.charm-00/evtgen-charm-00-all-e000013r001627-b200308
07_1600.mdst
Starting : 1316418750
data Type[real(1)/MC(2): 2
MC type : 1003
stream  : 0
Exp No: 13
Run No: 1627
File No : f1627
ID No : 1627
EXP date : 1050501
EXP time : 162516
parentID :
Belle Library version : b20030807_1600
Belle Detector version : 1
End :1316418754
Run status : good
hostname : hep2.kisti.re.kr
Create Date : Mon Sep 19 16:52:34 KST 2011
Min evt : 1
Max evt : 8294
~
~
~
~
```



Metadata automatically stored in Belle II files

Database

DB type : Logger DB for online environment monitoring
Configuration DB for data needed to start a run
Condition DB for all data needed offline
e.g. geometry, calibration, alignment



Software Installation

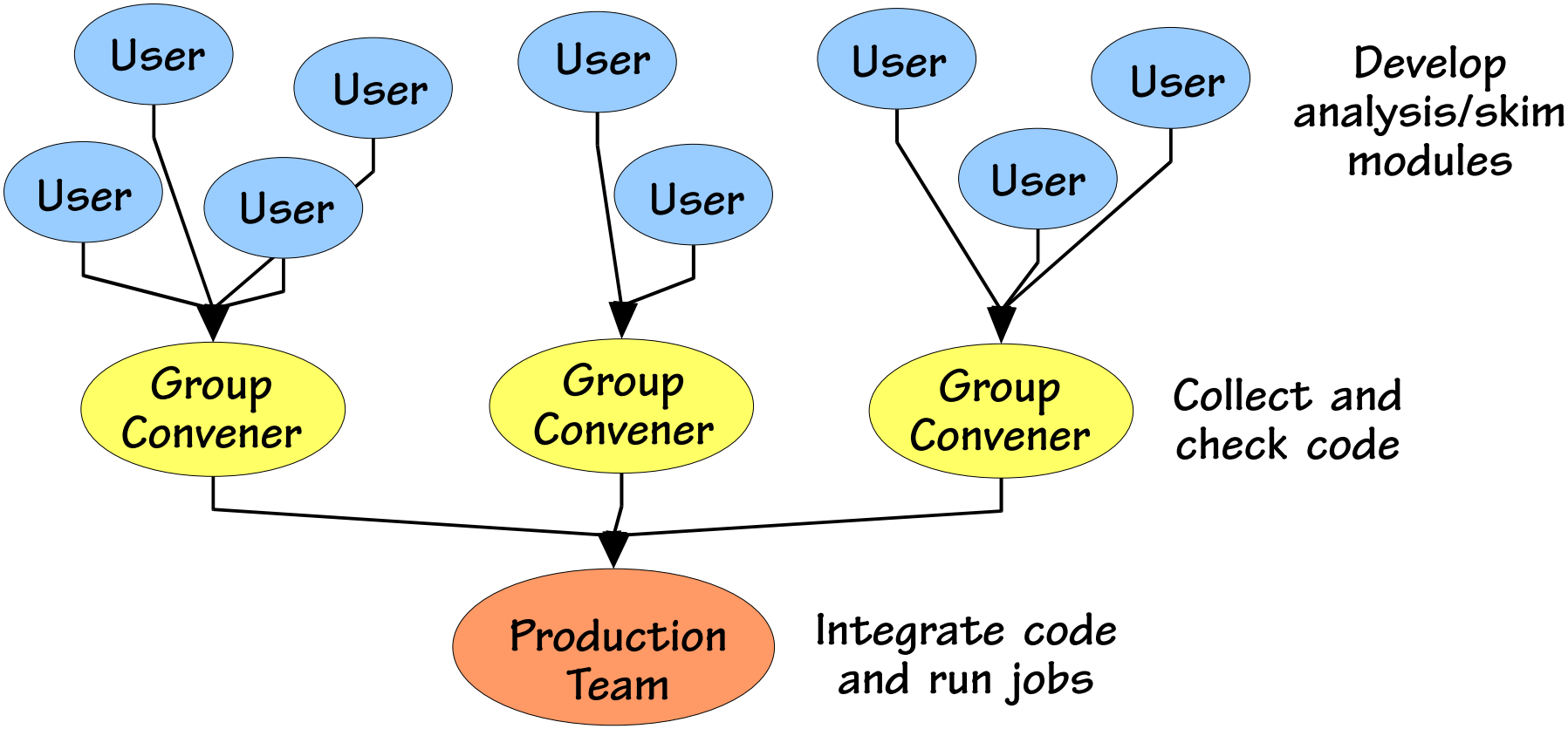
Offline software (basf2) installation is needed
to run Belle II jobs on grid sites

Current solution:	Installation jobs, validation jobs
Next step:	Investigate solutions provided by DIRAC
Mid term:	Use Cern VM-FS

Needs support of sites,
already installed in Ljubljana and Melbourne

Server at CERN?

Organized Analysis



Problem: inefficient resource usage by many users
complexity of grid environment for many users

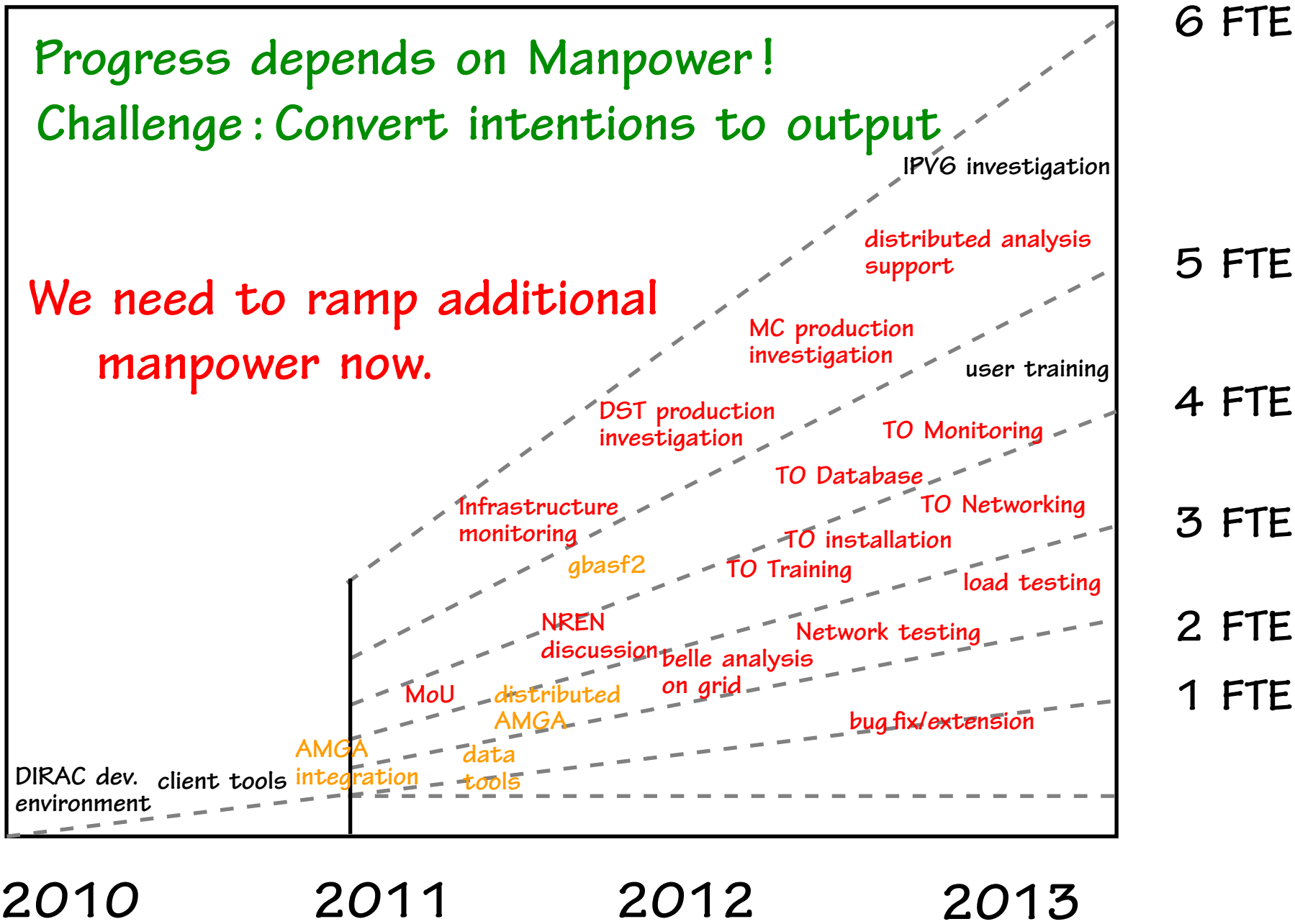
same as for official generic MC and signal MC

Manpower on Computing

Progress depends on Manpower!

Challenge: Convert intentions to output

We need to ramp additional manpower now.



Belle II GRID sites

GRID middleware

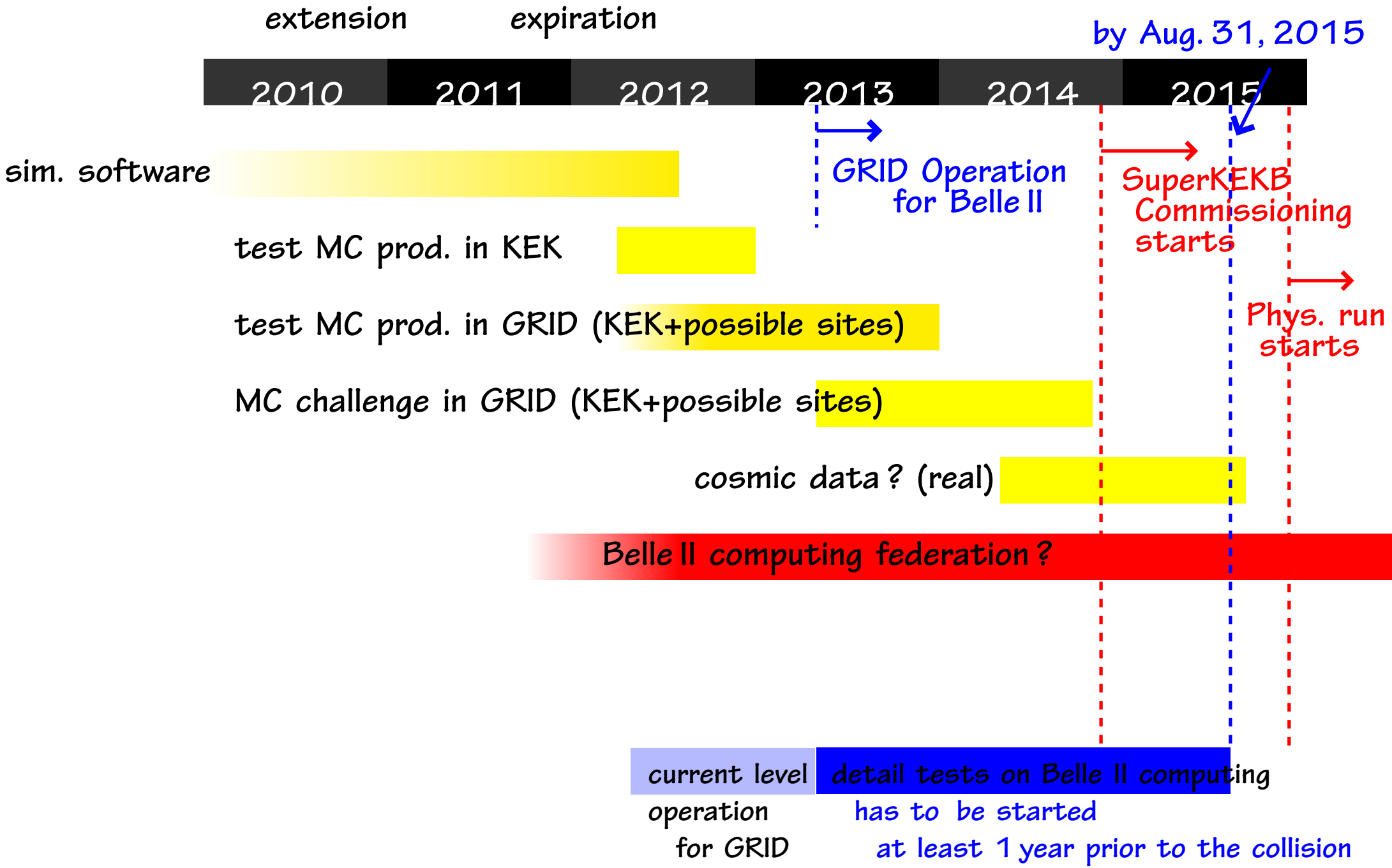
gLite

OSG

- Australia : LHC Tier2/3, Belle VO, Cloud system
- Austria : LHC Tier2
- China (IHEP) : LHC Tier2, DIRAC server
- Czech Republic : LHC Tier2, Belle VO
- Germany : LHC Tier1/2, Belle VO
- India : LHC Tier2, Belle II data center planned
- Japan (KEK) : Belle VO
- Korea (KISTI) : LHC Tier2, Belle VO
- Poland : LHC Tier2/3, Belle VO, Cloud system
- Russia : LHC Tier2
- Slovenia : LHC Tier2, Belle VO
- Taiwan : LHC Tier1/2
- USA : OSG @ PNNL planned, Belle VO @ OSG exists

2012, Jan. : KEK-PNNL meeting @ Richland
2012, Feb. : KEK-India institutes meeting @ Kolkata
2012, Mar. : Belle GRID site meeting @ Munich

Plan


extension
expiration
by Aug. 31, 2015
2010
2011
2012
2013
2014
2015
sim. software
GRID Operation for Belle II
SuperKEKB Commissioning starts
test MC prod. in KEK
test MC prod. in GRID (KEK+possible sites)
Phys. run starts
MC challenge in GRID (KEK+possible sites)
cosmic data ? (real)
Belle II computing federation ?
current level
detail tests on Belle II computing
operation for GRID
has to be started
at least 1 year prior to the collision

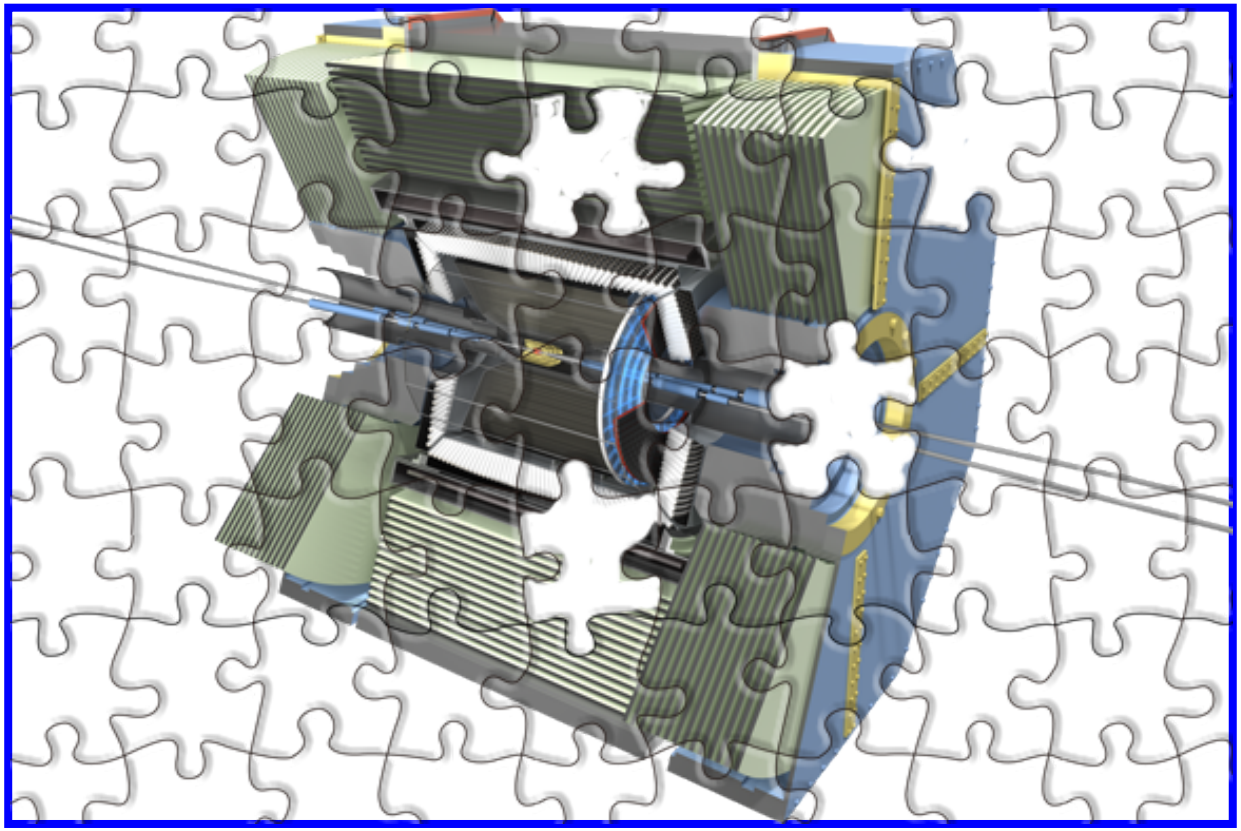
Summary

Deployment of Belle II grid site collaboration started

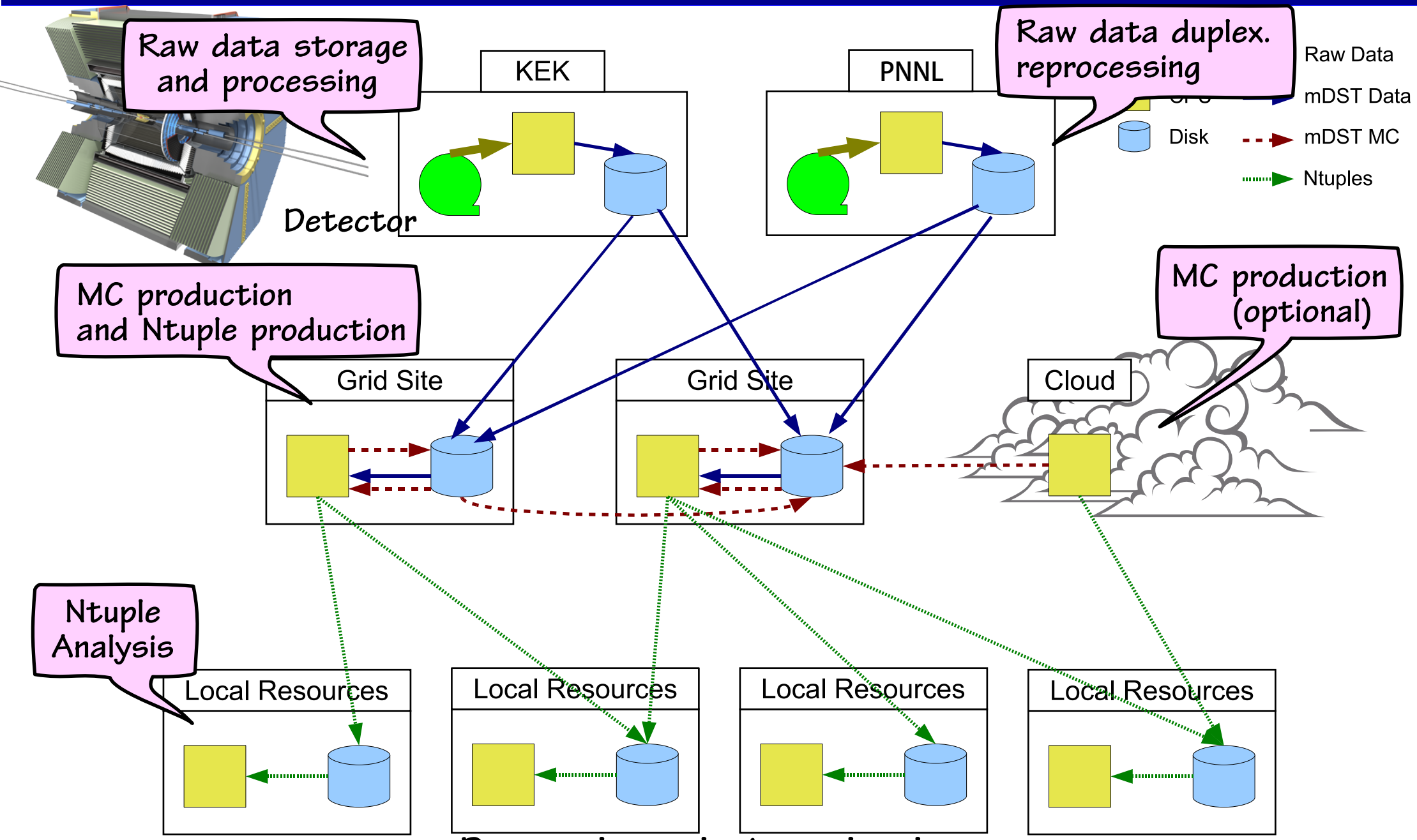
Many pieces of puzzle are getting ready

user interface, analysis projects, dataset tools, metadata catalog, data registration tool, software installation, database, New computer …

but still many missing pieces



Belle II Computing Model



Do ntuple analysis on local resources