

# Belle II Computing

several  
slides  
from  
T. Hara



Bundesministerium  
für Bildung  
und Forschung

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LMU

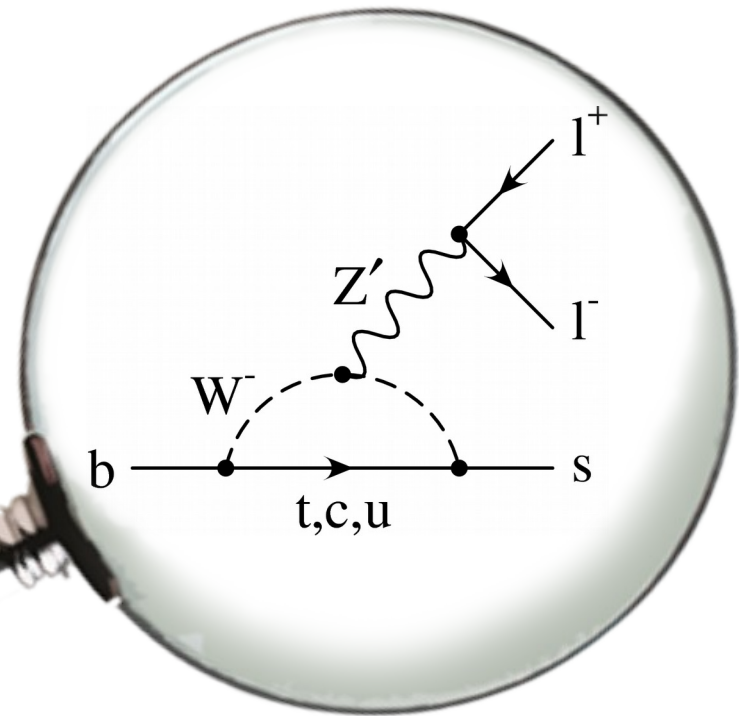
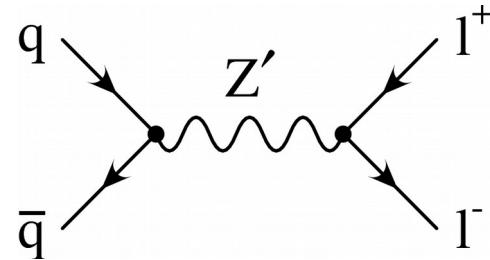
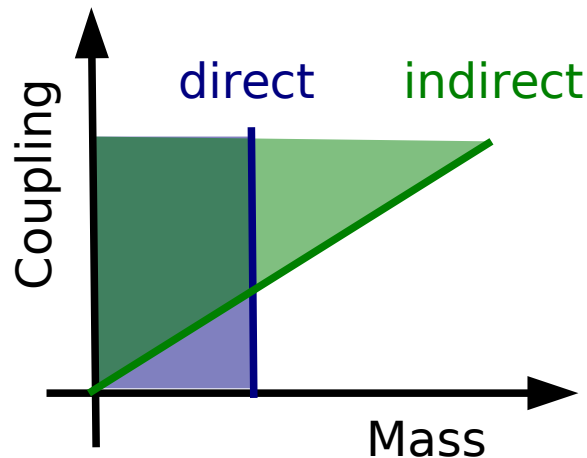


# Search for New Physics

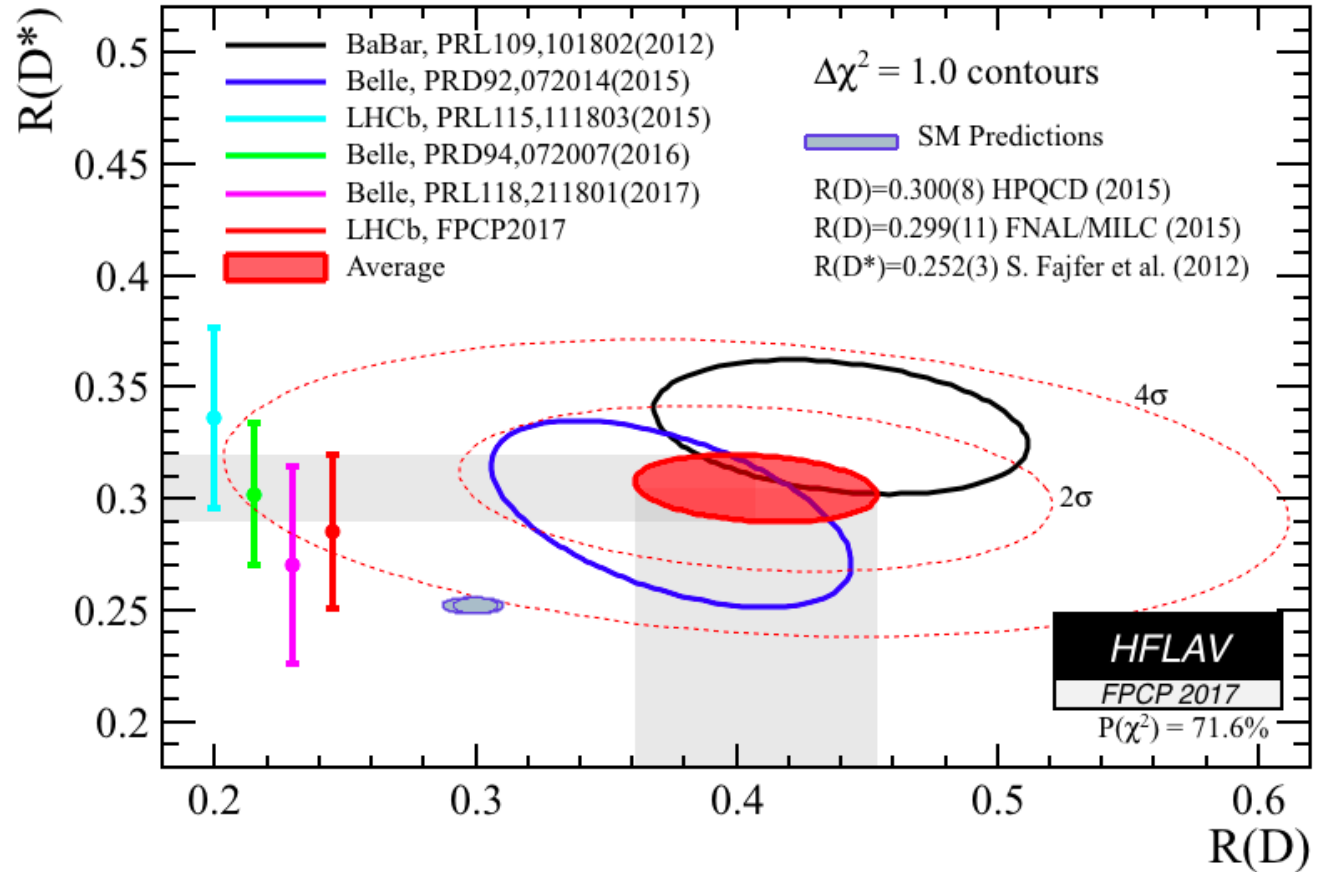
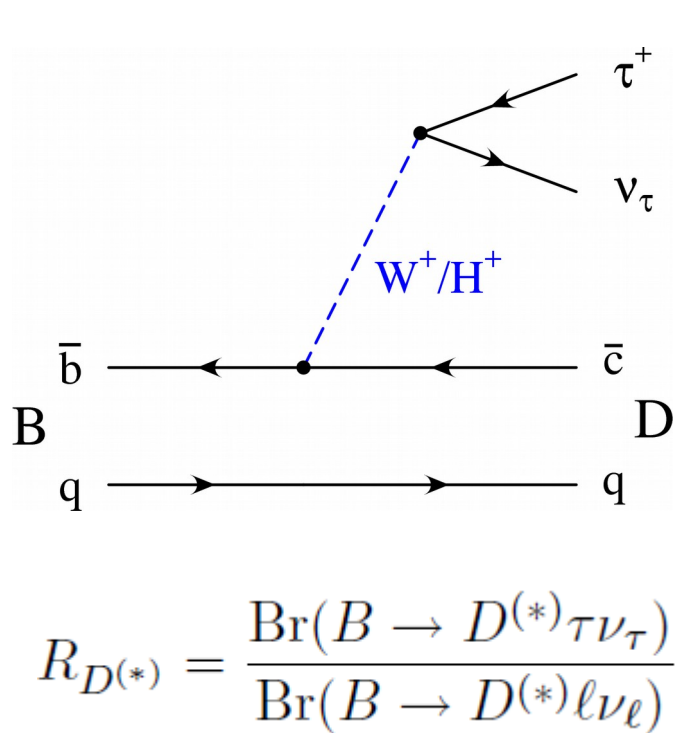
→ There must be so far unobserved particles or forces

▪ **Direct search:** Production of new particles → ATLAS, CMS @ LHC

▪ **Indirect search:**  
Contribution of virtual new particles to observed processes  
→ Flavor physics



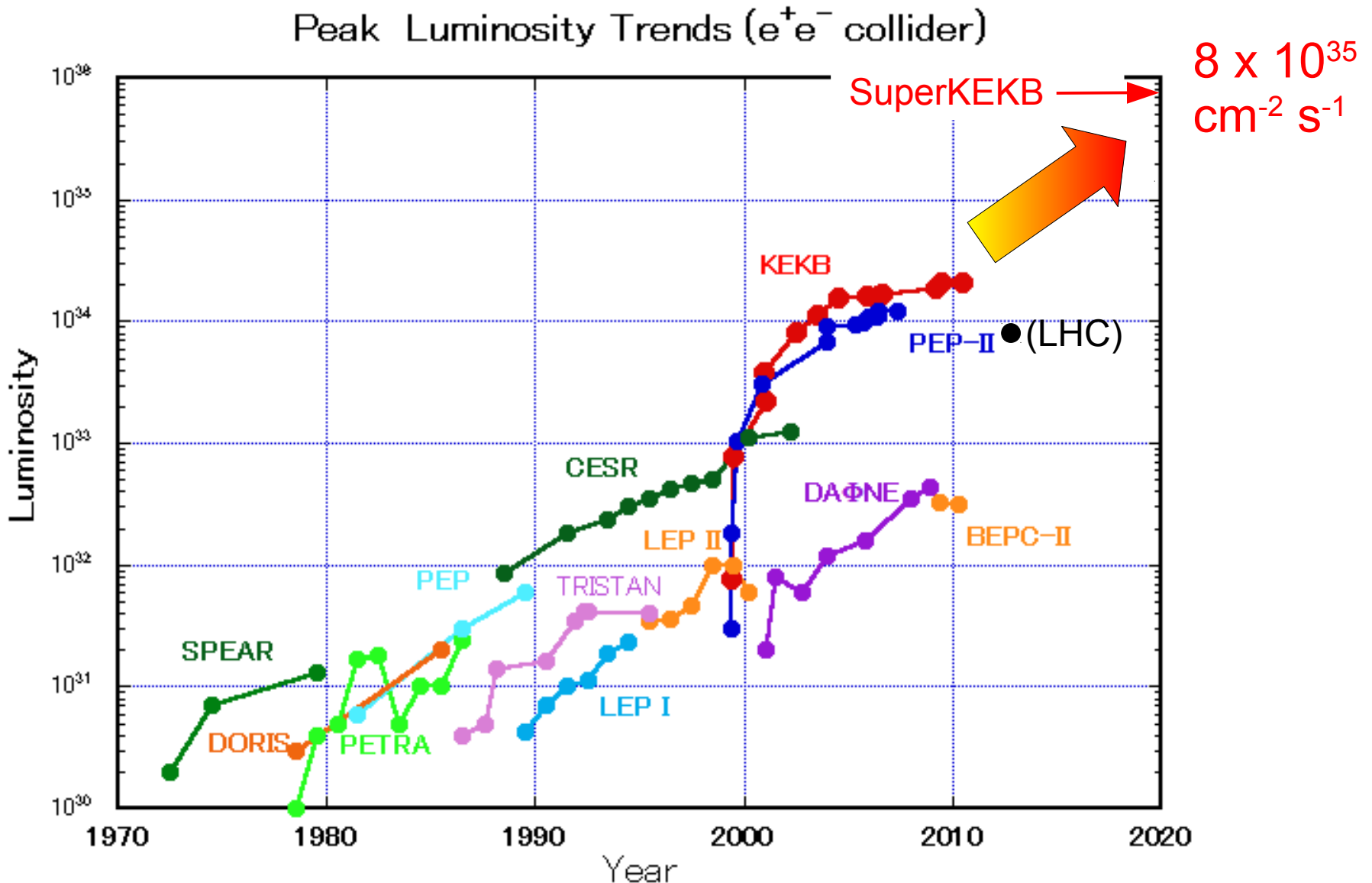
# $B \rightarrow D^{(*)} \tau \nu$



World average of  $R(D)$ ,  $R(D^*)$   $4.1\sigma$  away from SM prediction

# Belle II @ SuperKEKB: $50 \text{ ab}^{-1}$

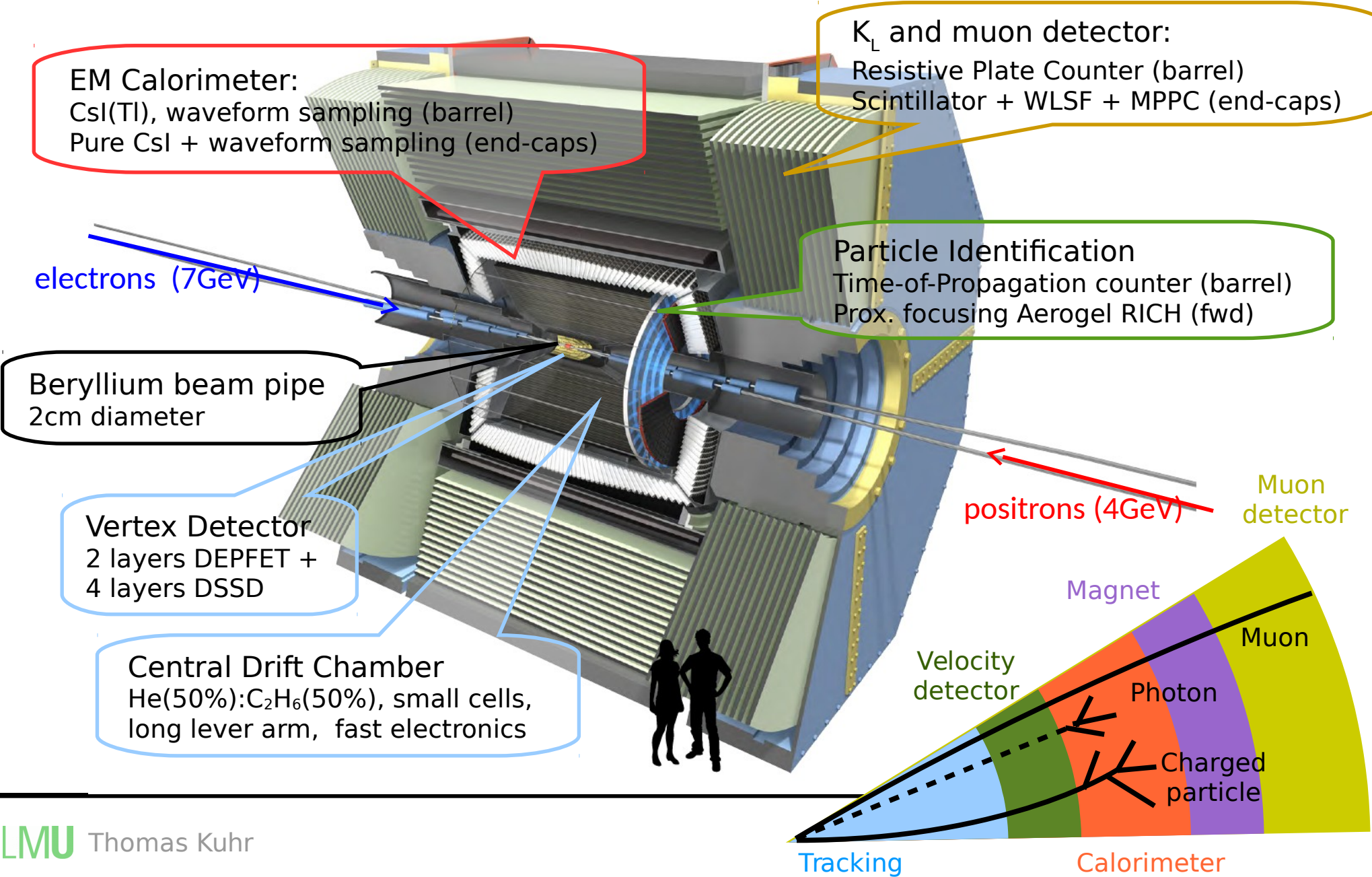
Belle:  $1 \text{ ab}^{-1}$   
LHC Run 3:  $0,3 \text{ ab}^{-1}$



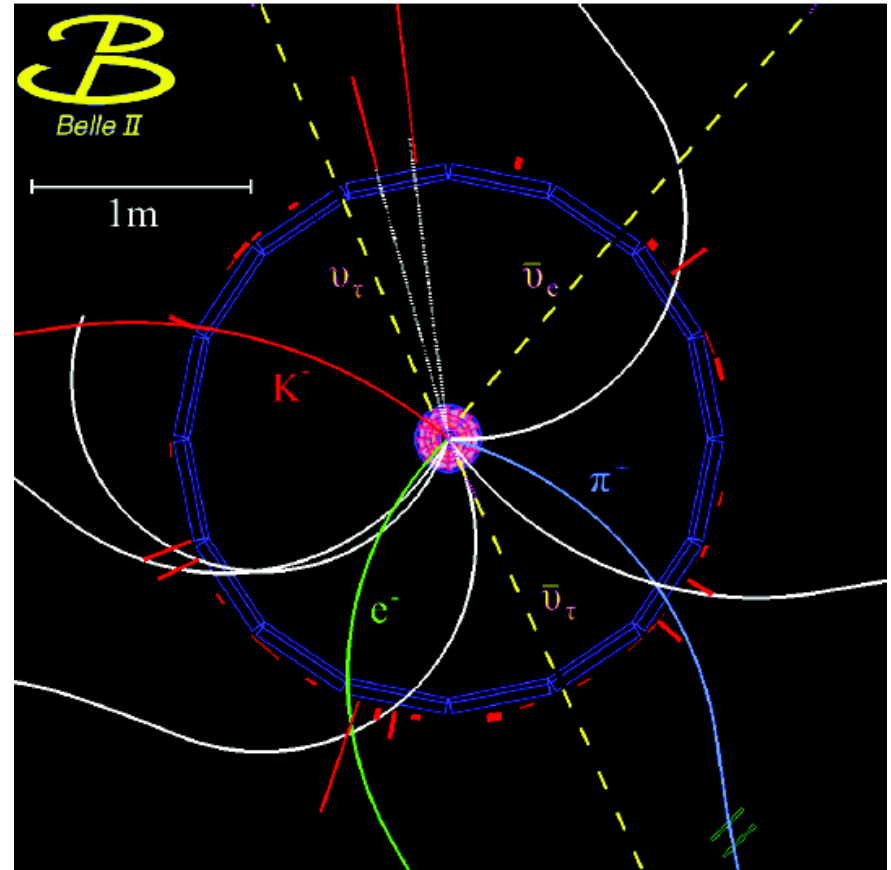
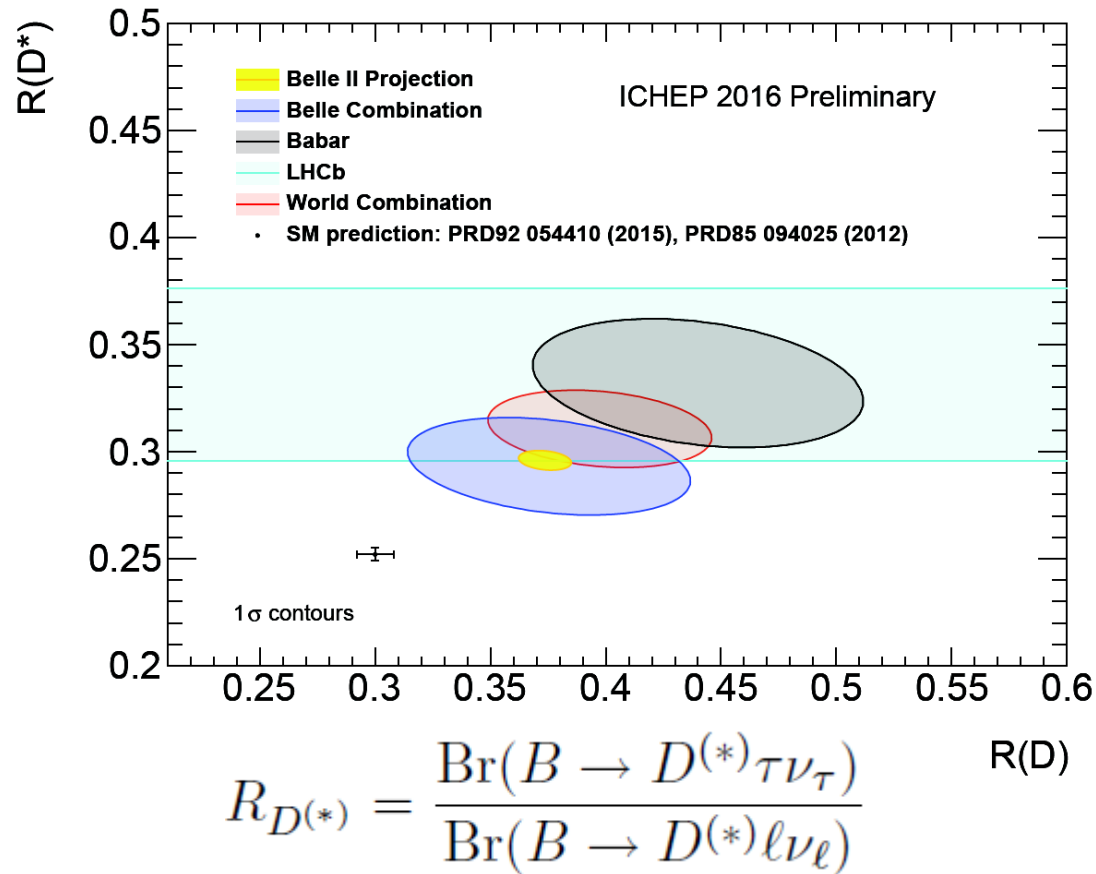


# Belle II Detector

TDR: arXiv:1011.0352

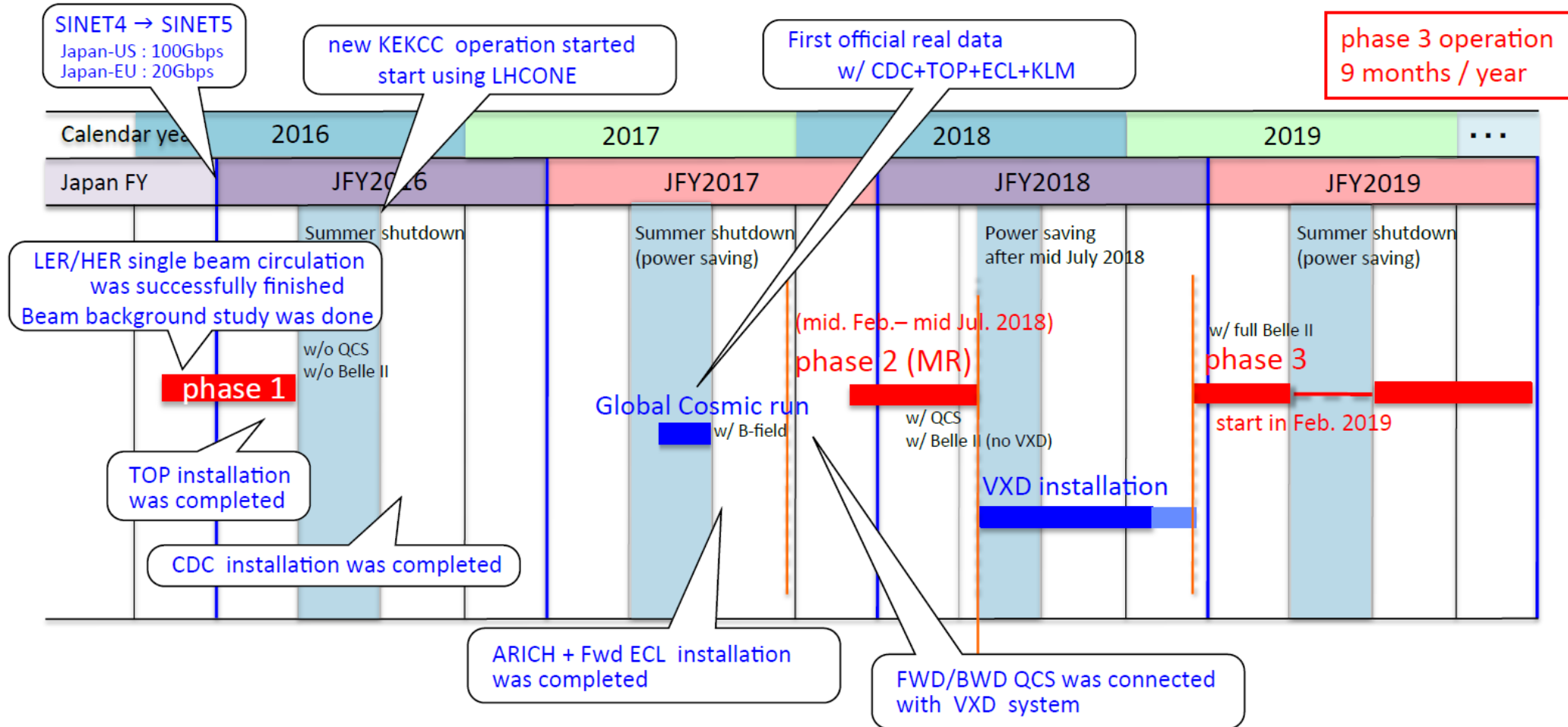


# B → D<sup>(\*)</sup>τν @ Belle II

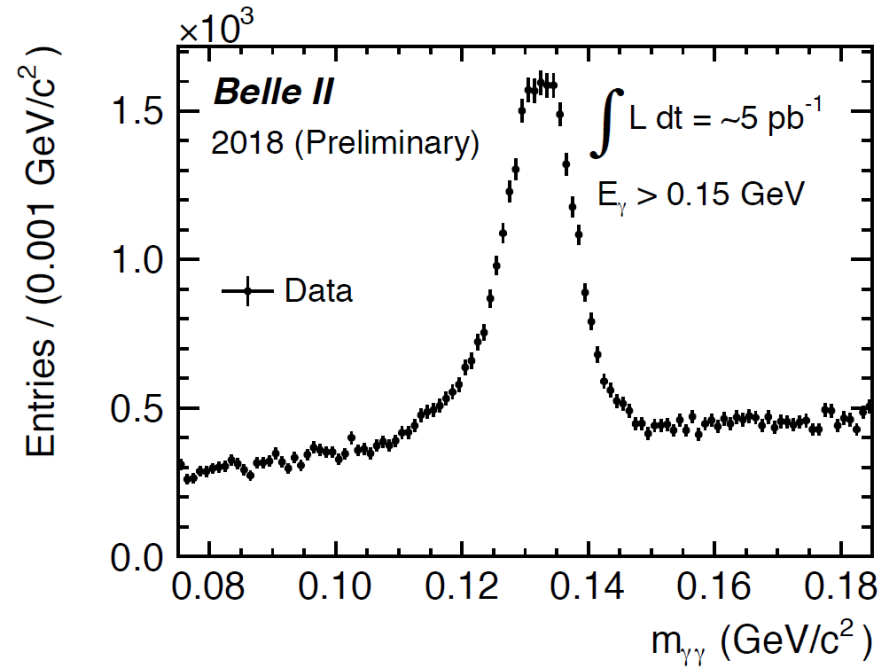
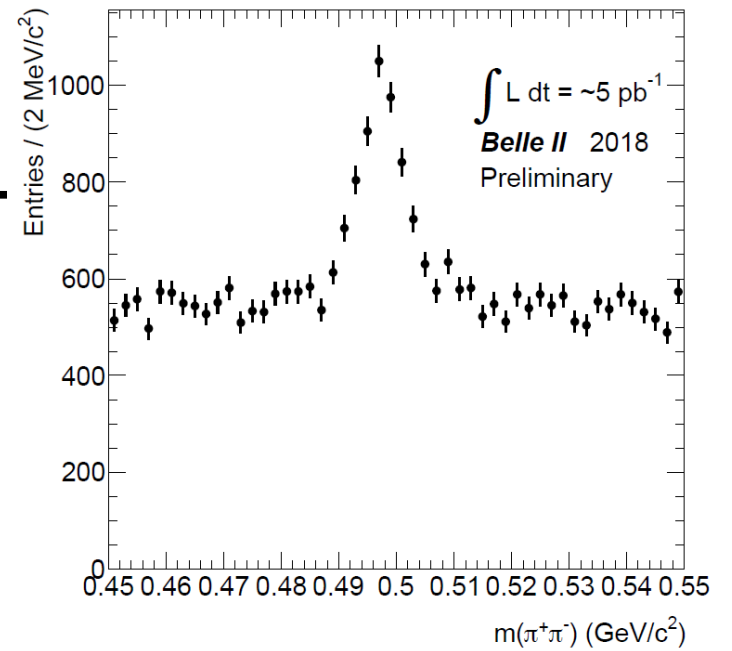
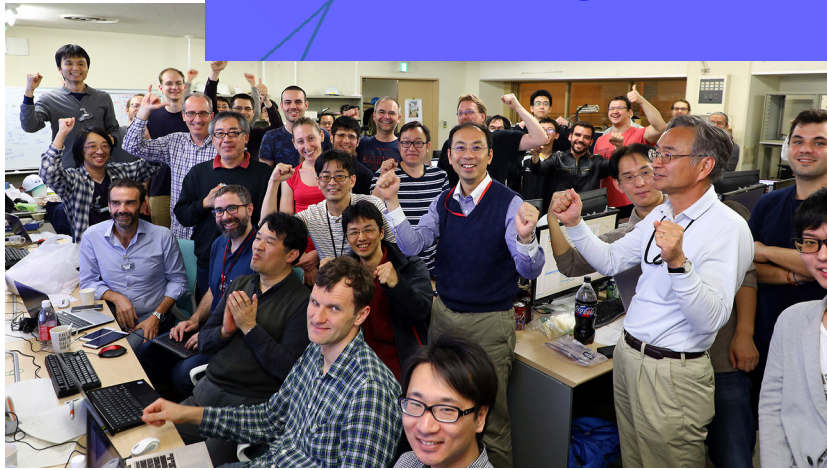
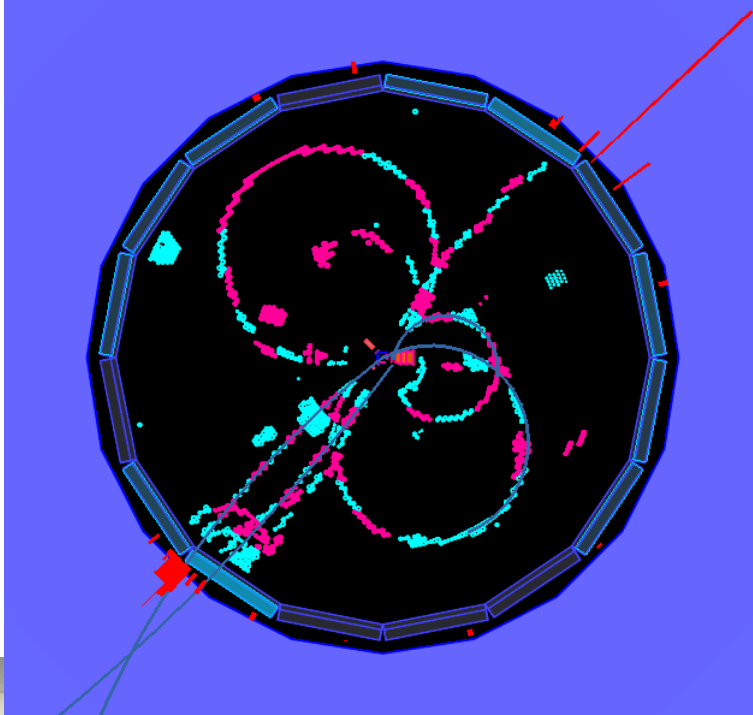


➤ Challenge: Reconstruction of decays with neutrinos

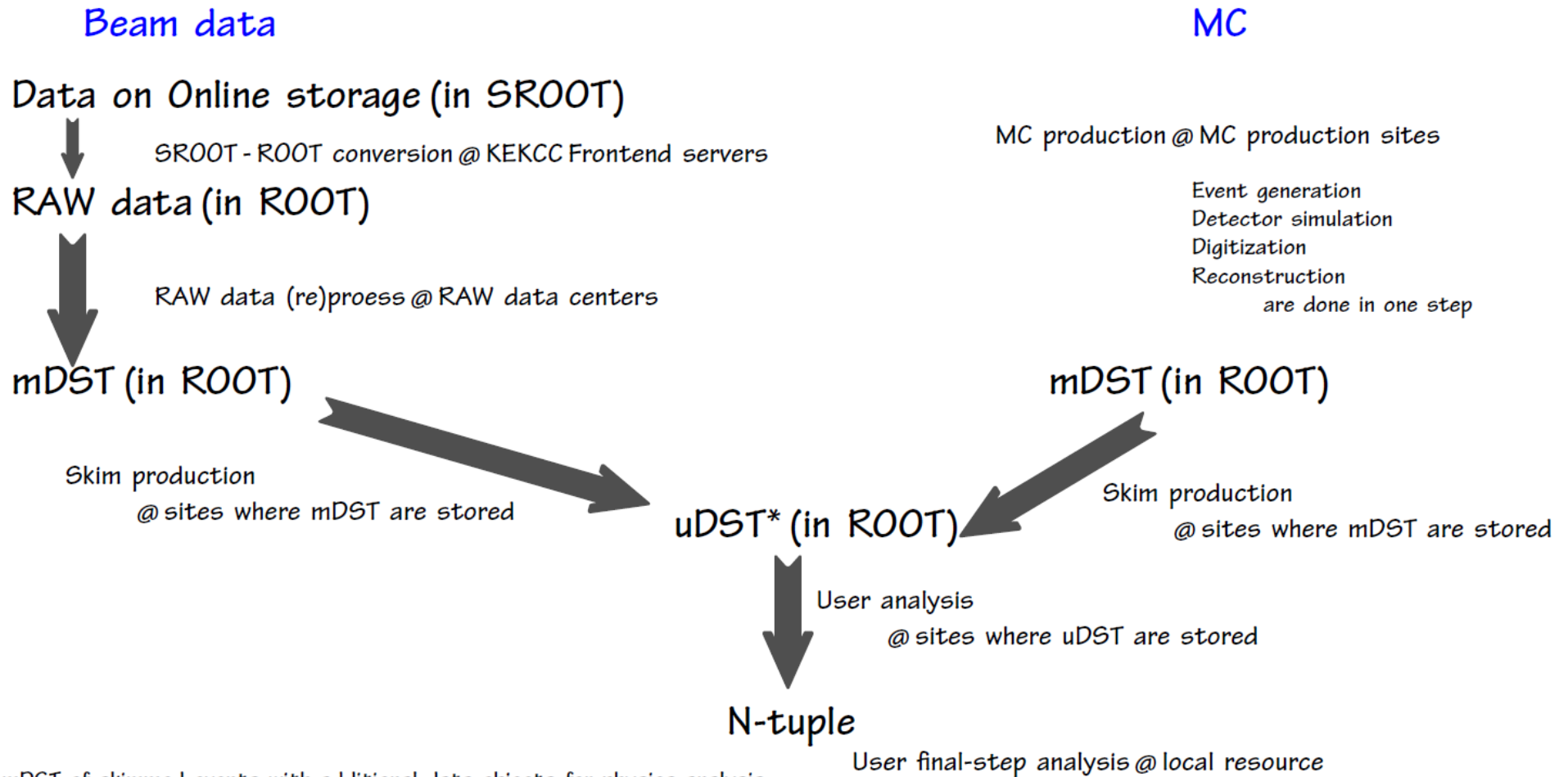
# Time Line



# First Collisions on April 26



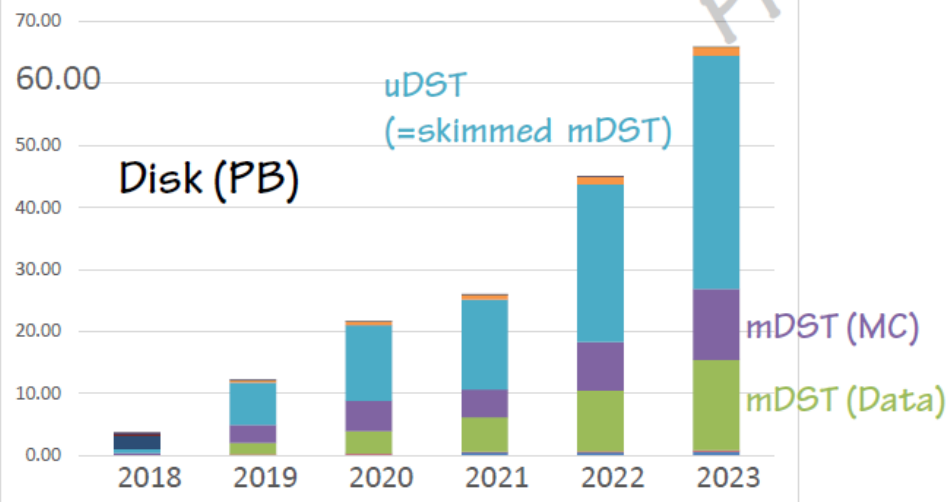
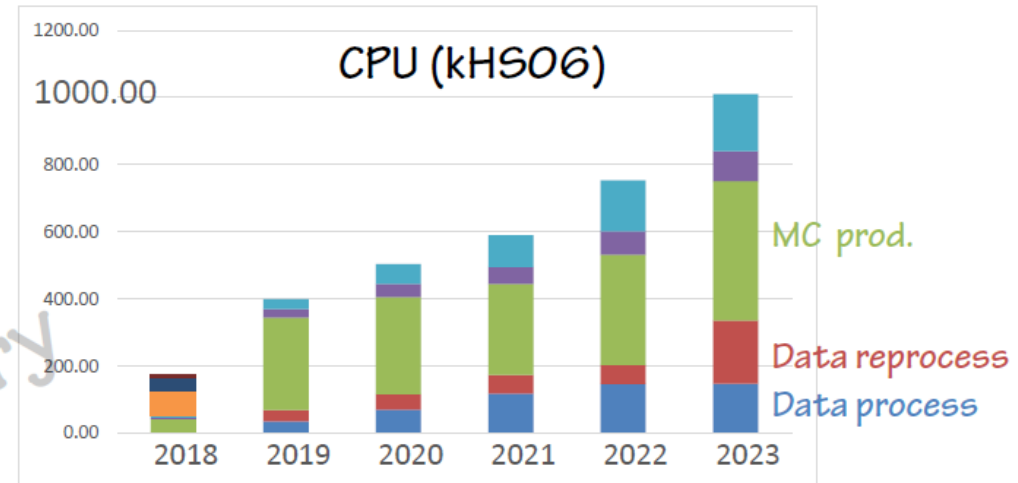
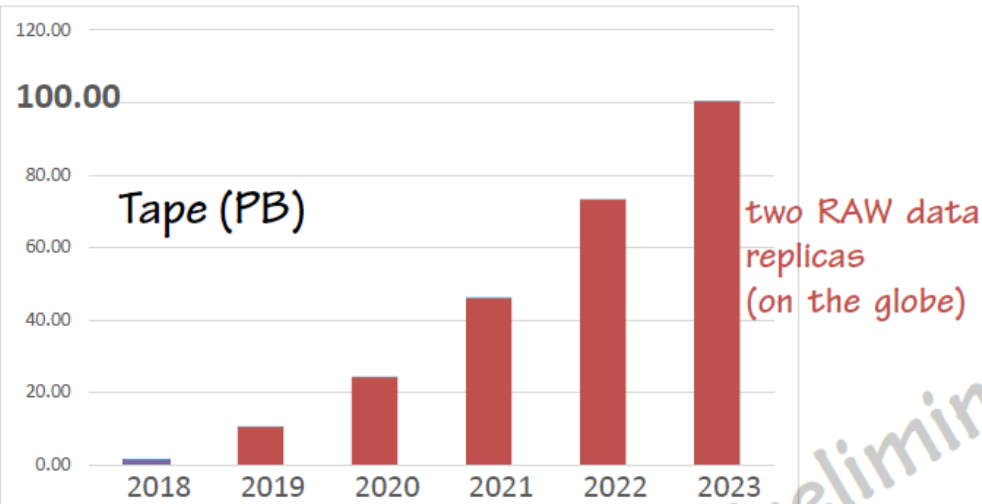
# Data Flow



\*: uDST = mDST of skimmed events with additional data objects for physics analysis



# Resource Estimates



Updates

Realistic software

Detailed requests from physics

Concrete analysis framework

Updated data distribution strategy

Uncertainties

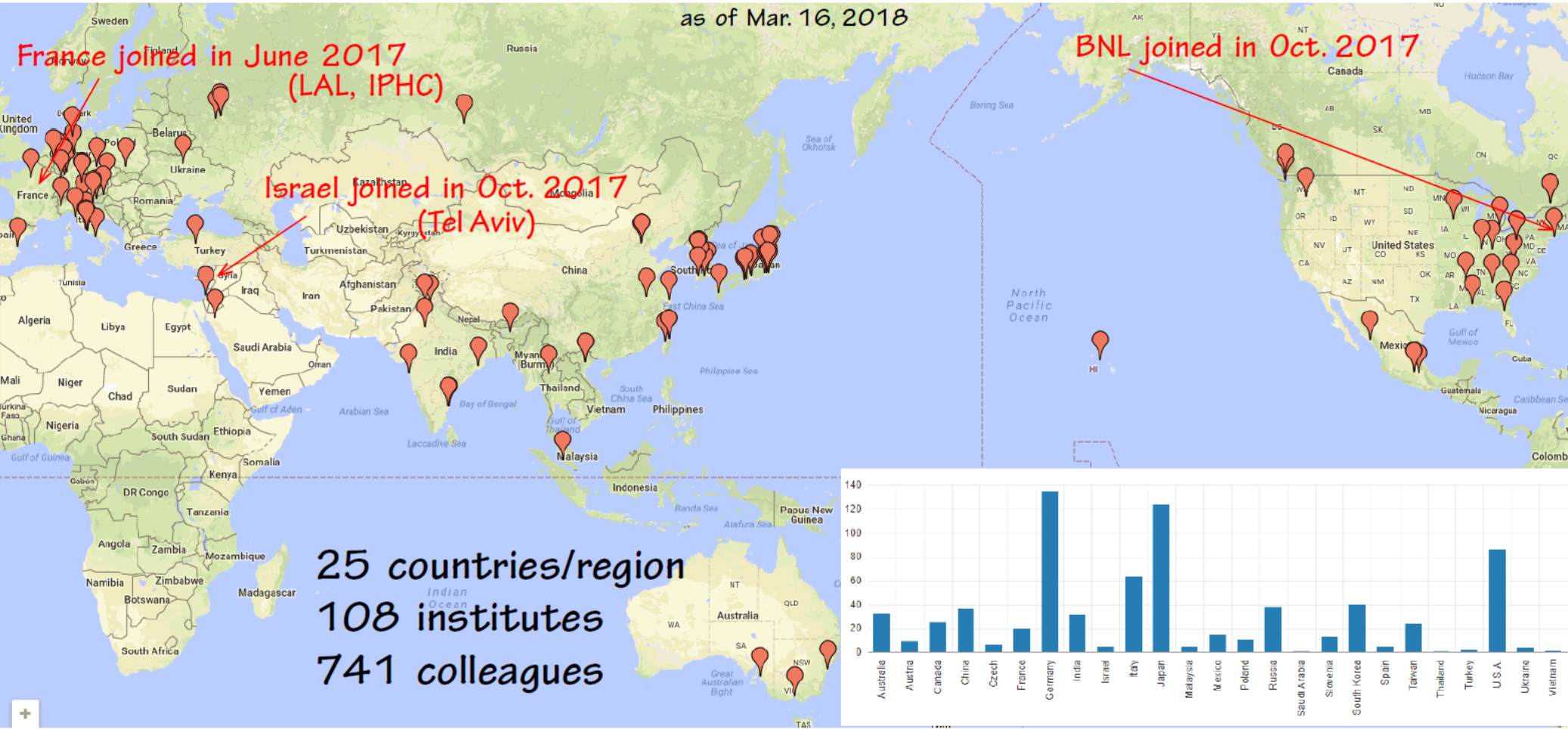
Luminosity profile

Background level

etc...

Looks similar to LHC experiments in Run1

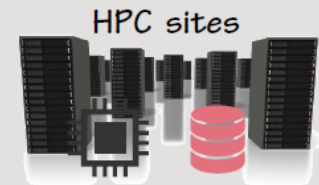
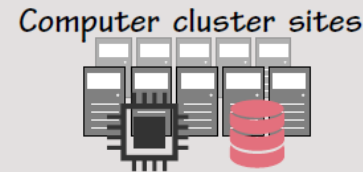
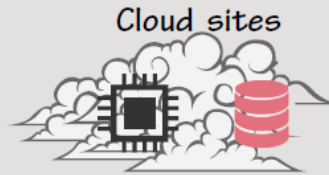
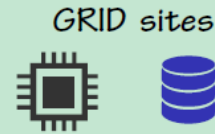
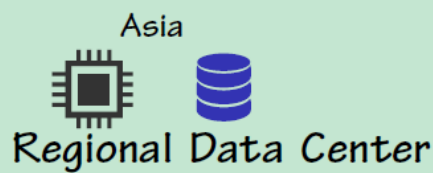
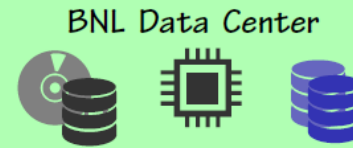
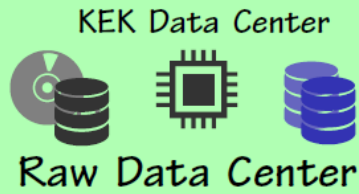
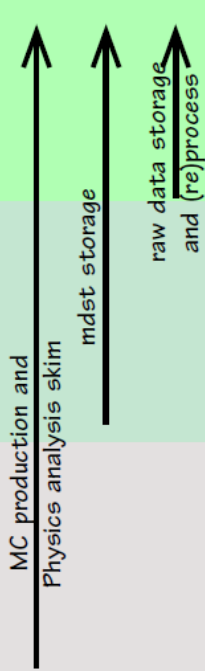
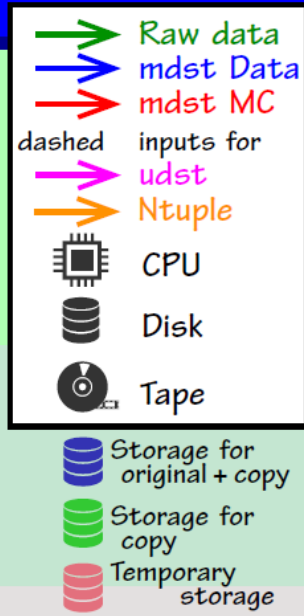
# Belle II Collaboration



# Computing Model



## Belle II Computing Model



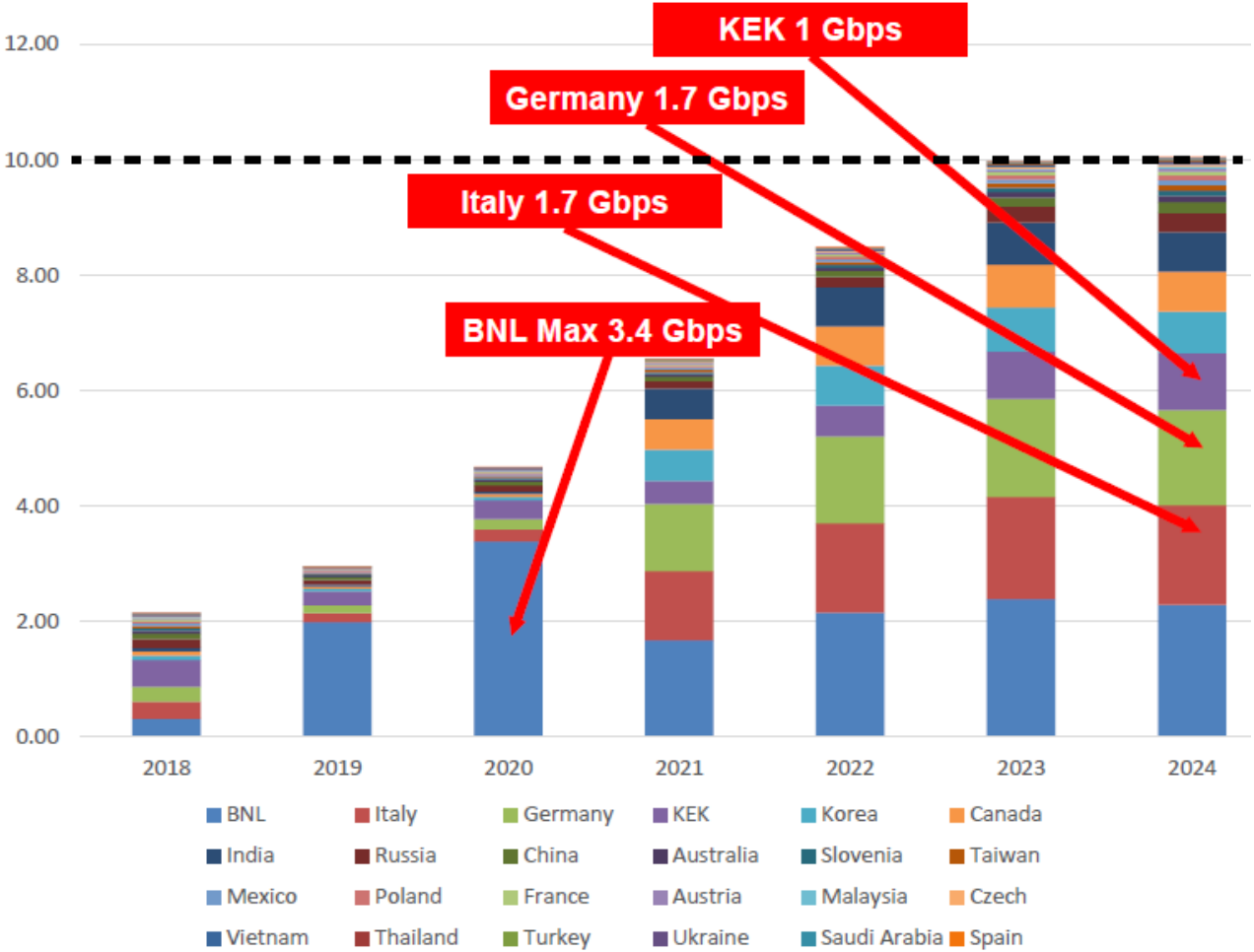
user analysis (Ntuple level)



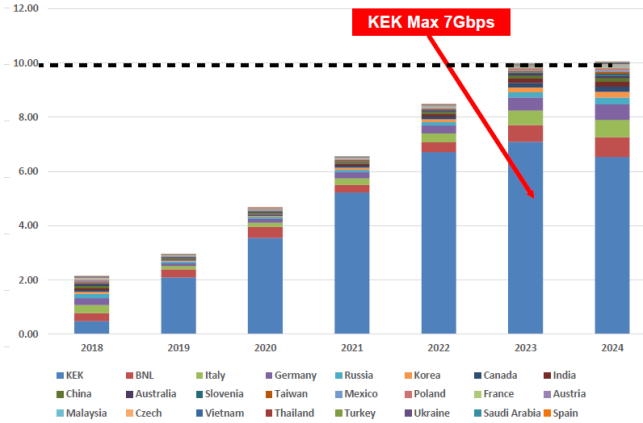


# Expected Network Traffic

Data Replication - Total Inbound Traffic per Site per Year

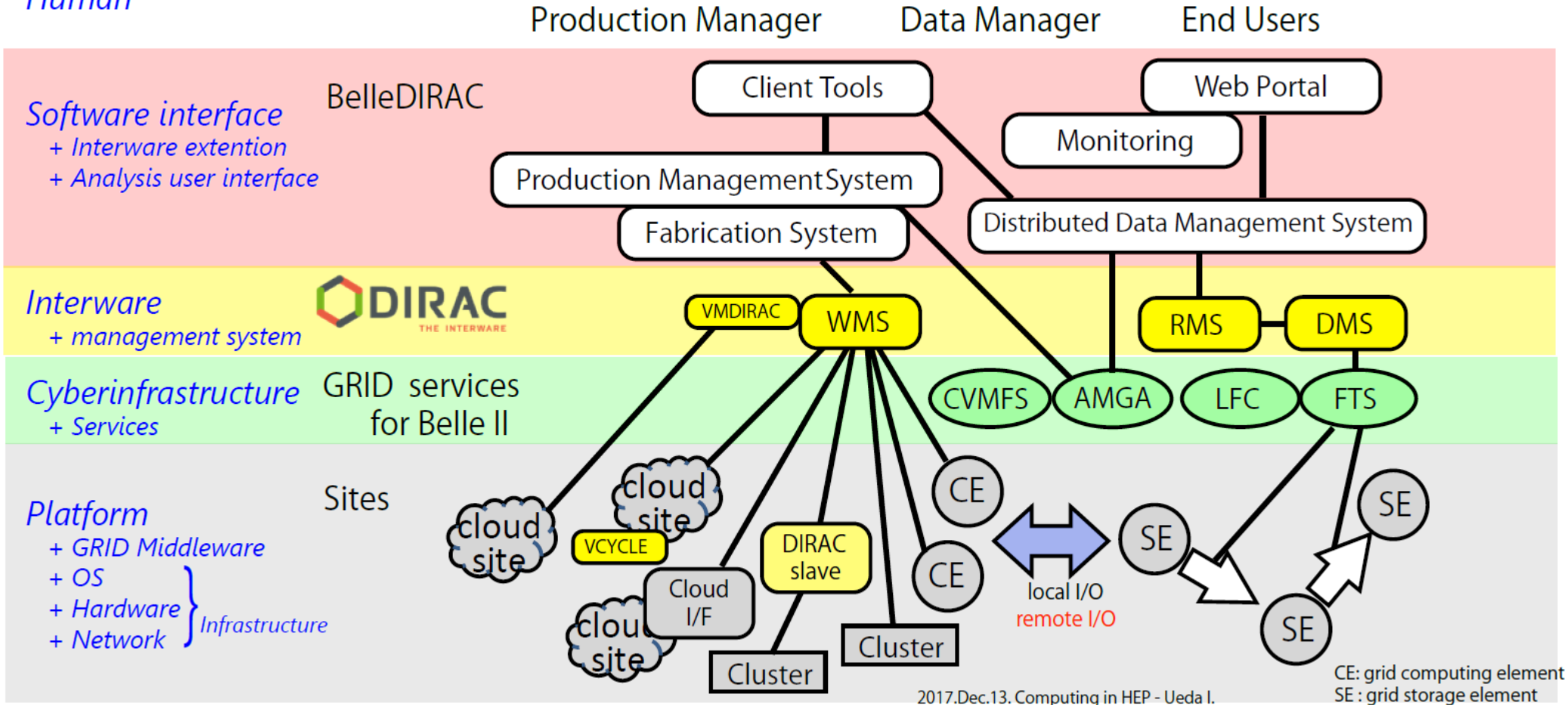


Data Replication - Total Outbound Traffic per Site per Year

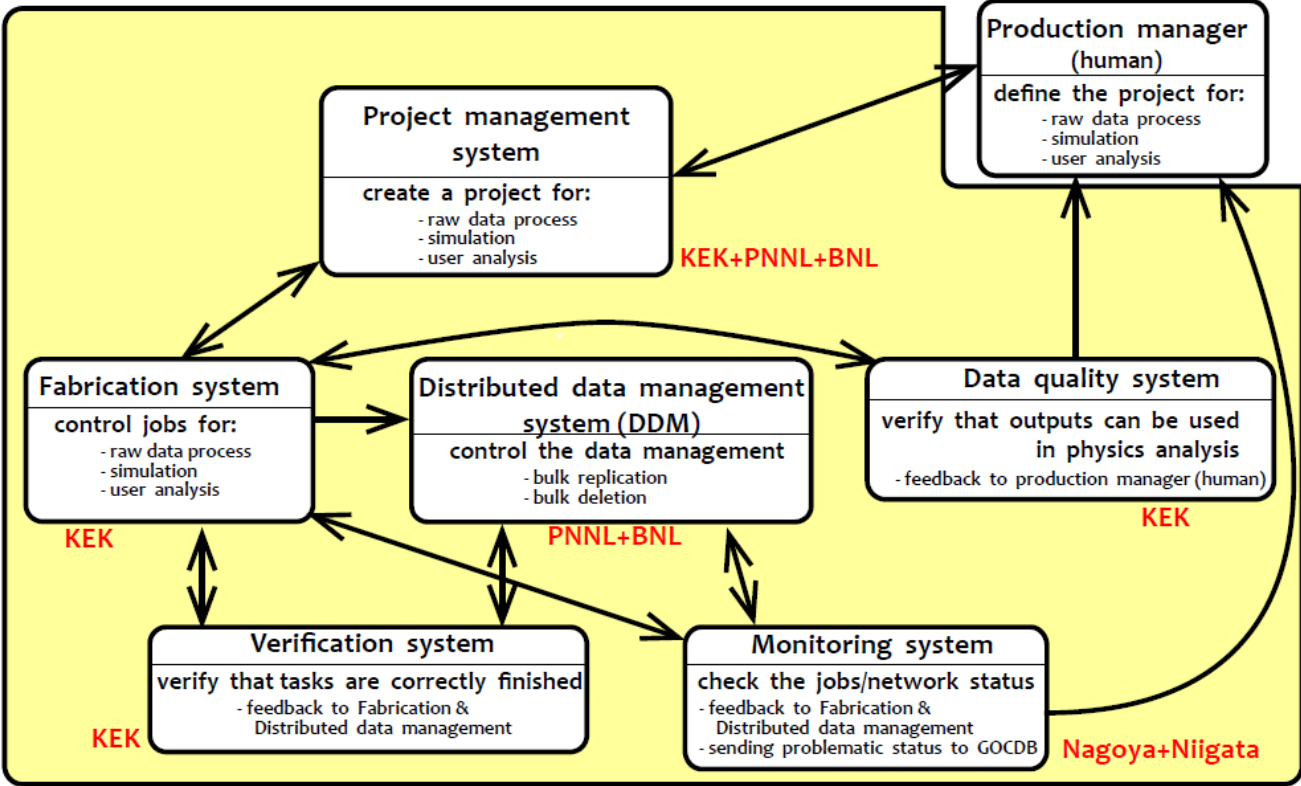
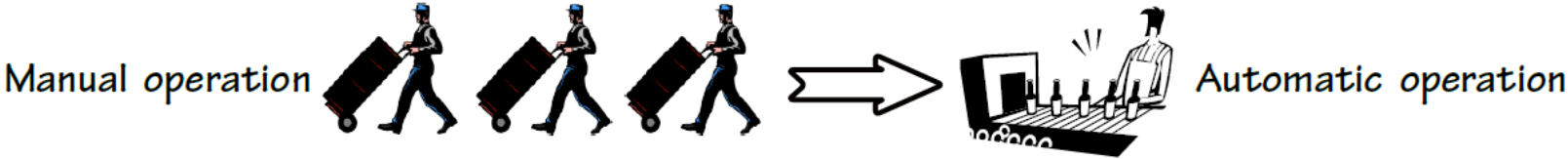


# Computing System

Human



# Production System

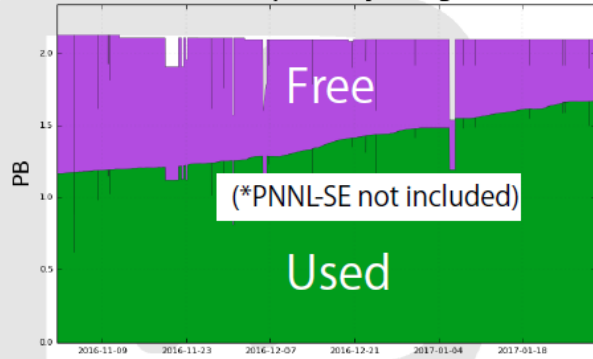


- Different types of production
  - MC production (w/ or w/o BG)
  - Skim production
  - RAW data process
- Huge variety of modes
  - BB, udsc, signal, background
  - many physics skims
- Complicated data management over world-distributed sites
- Reduce human error and perform effective operation

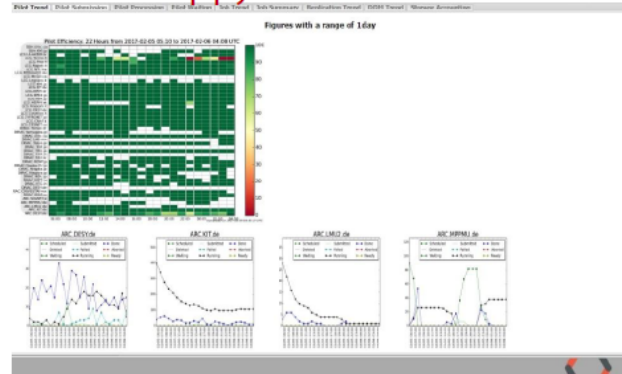
# Monitoring

## Used/Free disk space for destination storages

Total Space by usage



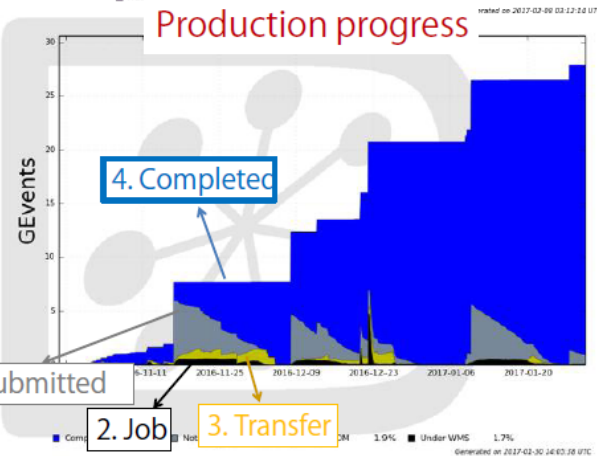
## HappyFace → DIRAC



## Data Transfer Map



## Production progress



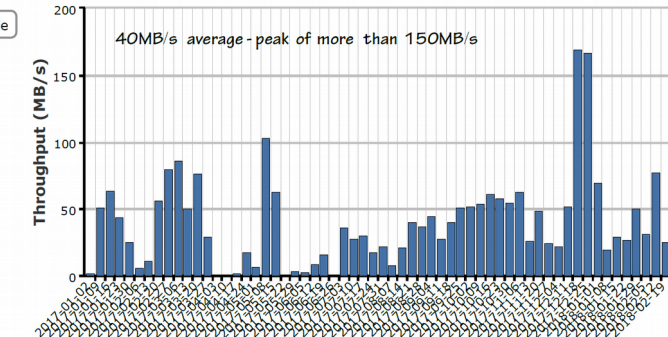
## Storage access check from computing node

Site	SE	Port Check	List (ls)	Pressure File	Upload	CHSM (LUL)	Download	CHSM (DL)	RM (File)
DIRAC.KIT.jp	KIT THP-SE	OK	OK	OK	OK	OK	OK	OK	OK
DIRAC.Yamagata.jp	KIT THP-SE	OK	OK	OK	OK	OK	OK	OK	OK
DIRAC.Yamagata.jp	KIT THP-SE	OK	OK	OK	OK	OK	OK	OK	OK
LOG.LUXEMBURG.fr	LUXEMBURG THP-SE	OK	OK	OK	OK	OK	OK	OK	OK
DIRAC.Tokyo.jp	KIT THP-SE	OK	OK	OK	OK	OK	OK	OK	OK
DIRAC.TMI.jp	KIT THP-SE	OK	OK	OK	OK	OK	OK	OK	OK
DIRAC.TMI.jp	KIT THP-SE	OK	OK	OK	OK	OK	OK	OK	OK
DIRAC.TMI.jp	KIT THP-SE	OK	OK	OK	OK	OK	OK	OK	OK
DIRAC.CINVESTAV.mx	PNNL THP-SE	OK	OK	OK	OK	OK	OK	OK	OK
DIRAC.Niiga.jp	KIT THP-SE	OK	OK	OK	OK	OK	OK	OK	OK
ARC.LMU.de	DESY THP-SE	OK	OK	OK	OK	OK	OK	OK	OK
DIRAC.Niiga.jp	KIT THP-SE	OK	OK	OK	OK	OK	OK	OK	OK
DIRAC.ITG.it	PNNL THP-SE	OK	OK	OK	OK	OK	OK	OK	Failed
LOG.Roma.it	CNAF THP-SE	OK	Failed	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.
ARC.DESY.de	DESY THP-SE	OK	OK	OK	OK	OK	OK	OK	OK

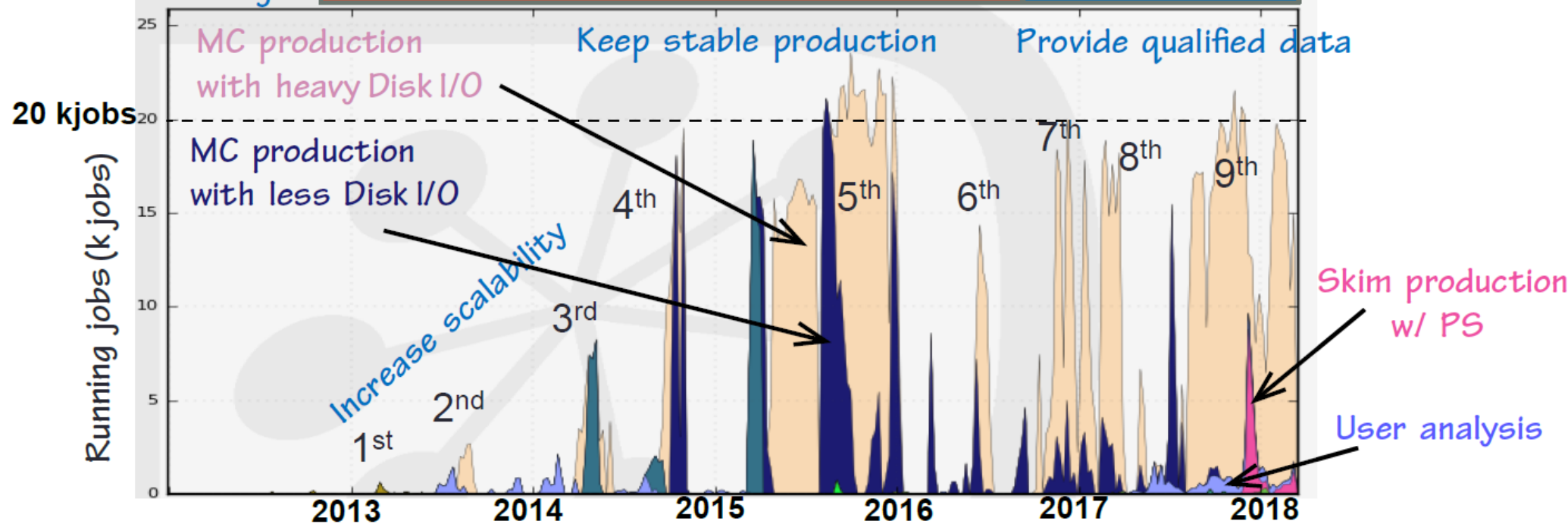
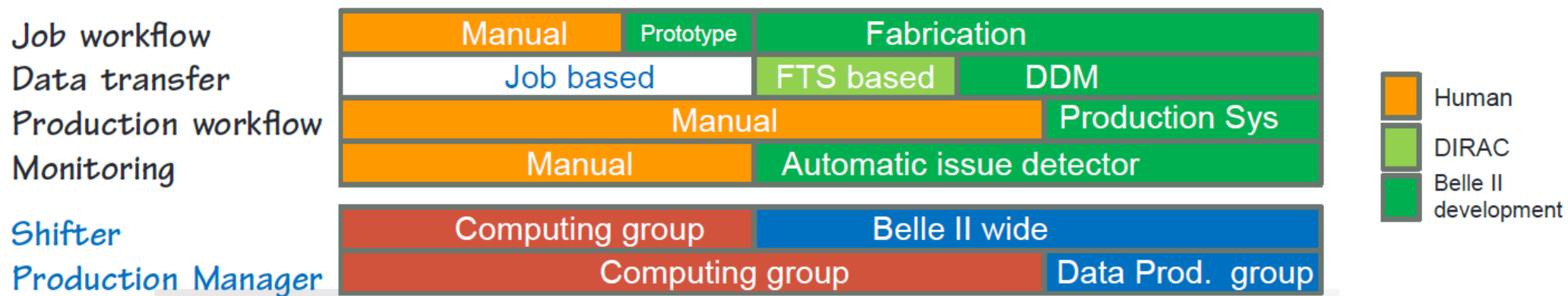


VOS  
belle

## Throughput

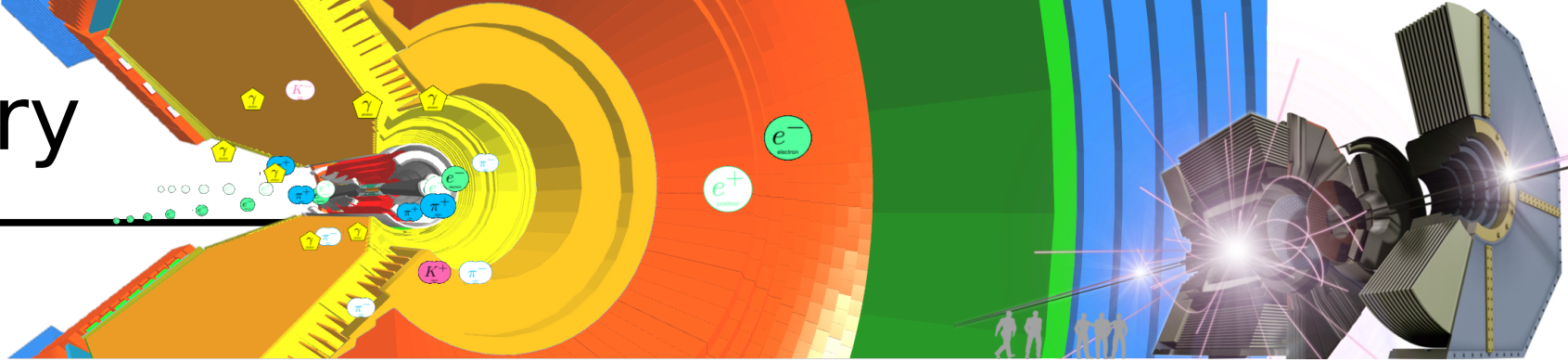


# MC Production Campaigns

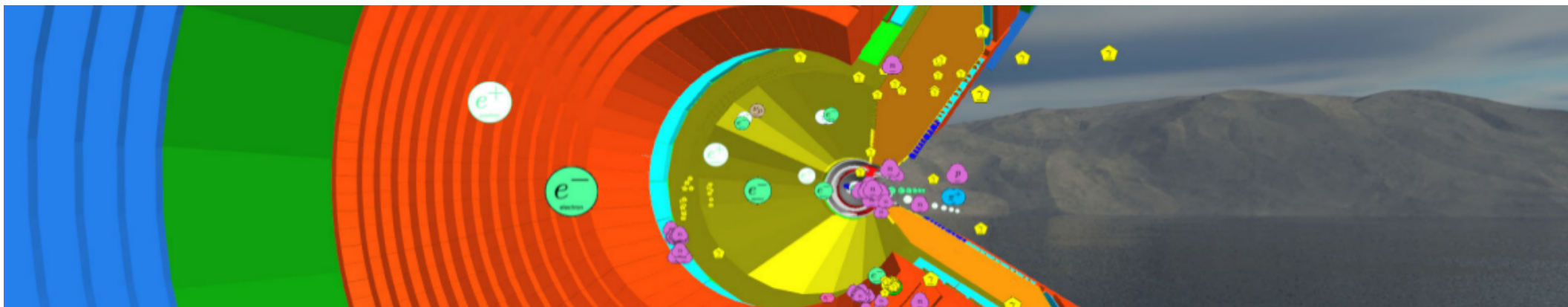




# Summary



- Exciting physics potential with  $50 \text{ ab}^{-1}$  at Belle II
- Two orders of magnitude higher data volume than at Belle
- Distributed computing system based on
  - ➔ Existing technologies: DIRAC, LFC, CVMFS, ...
  - ➔ Own development: DIRAC extensions, gbasf2 client, ...
- DIRAC provides interface to ARC-CEs



# Belle II Virtual Reality

