EU grant n.822070

Belle II

Dr. Silvio Pardi

LHCOPN/LHCONE workshop - CERN Geneva, CH

13-14 Jan 2020

Outline

Belle II Status and Plans

Belle II Network

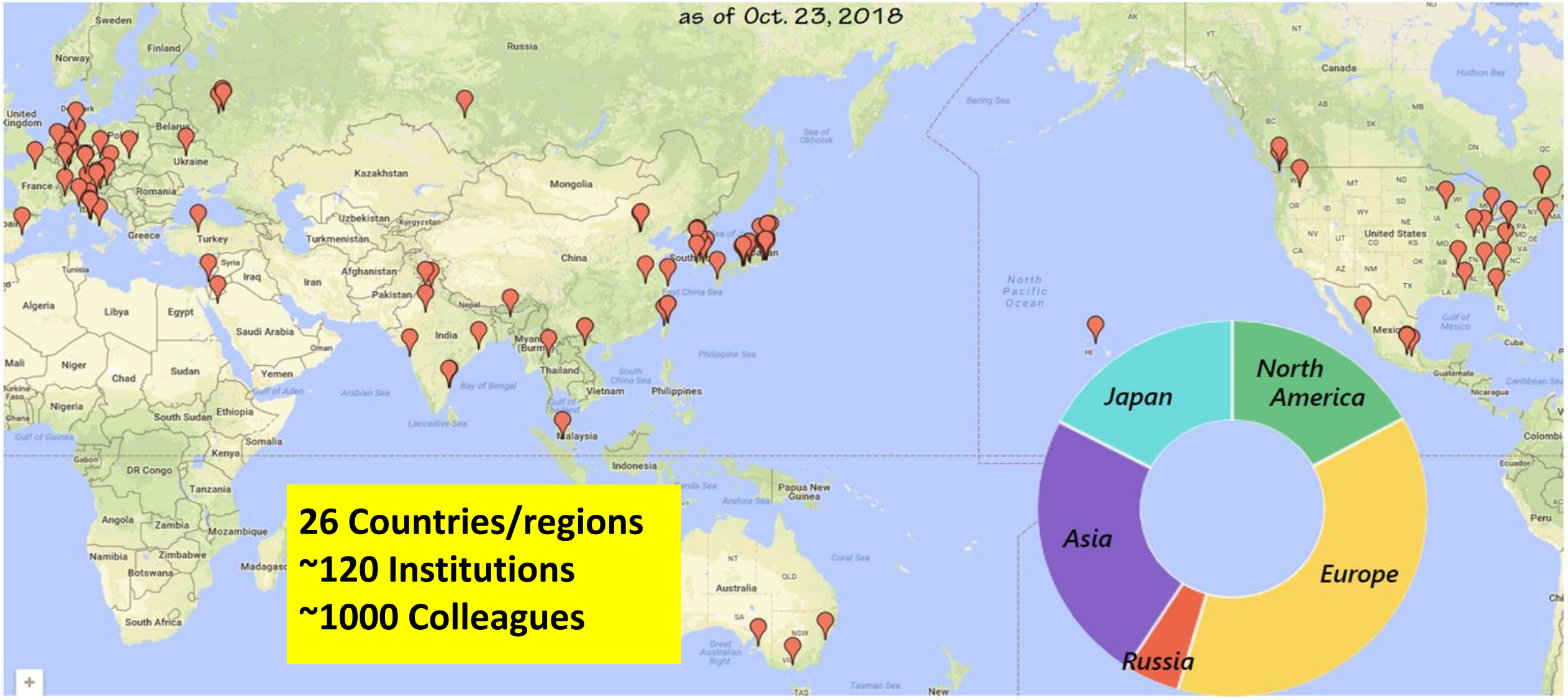
Network Data Challenge

Network Monitoring

Questions for Experiments

Conclusions

Belle II Collaboration



Phase3 beam run has started on 3/11 !

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PARTICLE PHYSICS NEWS AND RESOURCES

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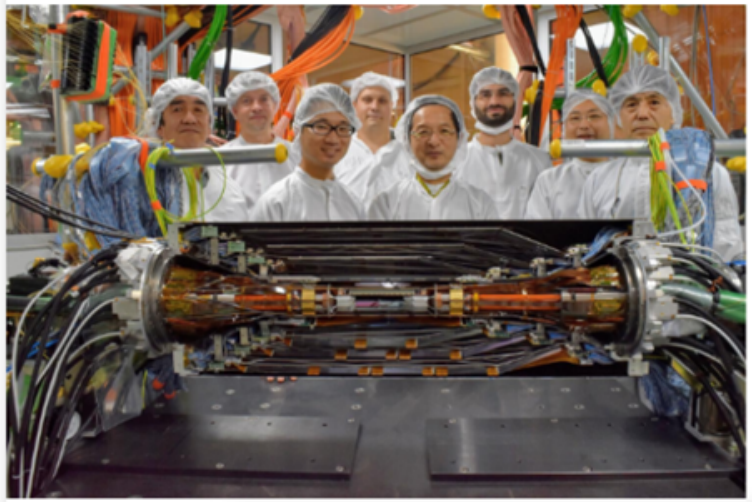
A communication resource from the **world's particle physics laboratories.**



SuperKEKB Phase 3 (Belle II Physics Run) Starts

Belle II and SuperKEKB are poised to become the world's first Super B factory facility. Belle II aims to accumulate 50 times more data than its predecessor, Belle, and to seek out new physics hidden in subatomic particles that could shed light on mysteries of the early universe.

Read the Release

https://www.kek.jp/en/newsroom/2019/03/11/1600/#!

KEK 大学共同利用機関法人 高エネルギー加速器研究機構

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KEK > News > SuperKEKB Phase 3 (Belle II Physics Run

SuperKEKB Phase 3 (Belle II Physics Run) Start

2019/03/11 Pressrelease ACC IPNS

On March 11th, 2019, Phase 3 operation of the SuperKEKB project began marking a major milestone in the development of Japan's leading particl phase will be the physics run of the project, in which the Belle II experime taking data with a fully instrumented detector.

The KEKB accelerator, operated from 1999 to 2010, currently holds the w

physicsworld

Magazine | Latest | People | Impact

https://physicsworld.com/a/major-revamp-complete-at-superkekb-particle-physics-facility/

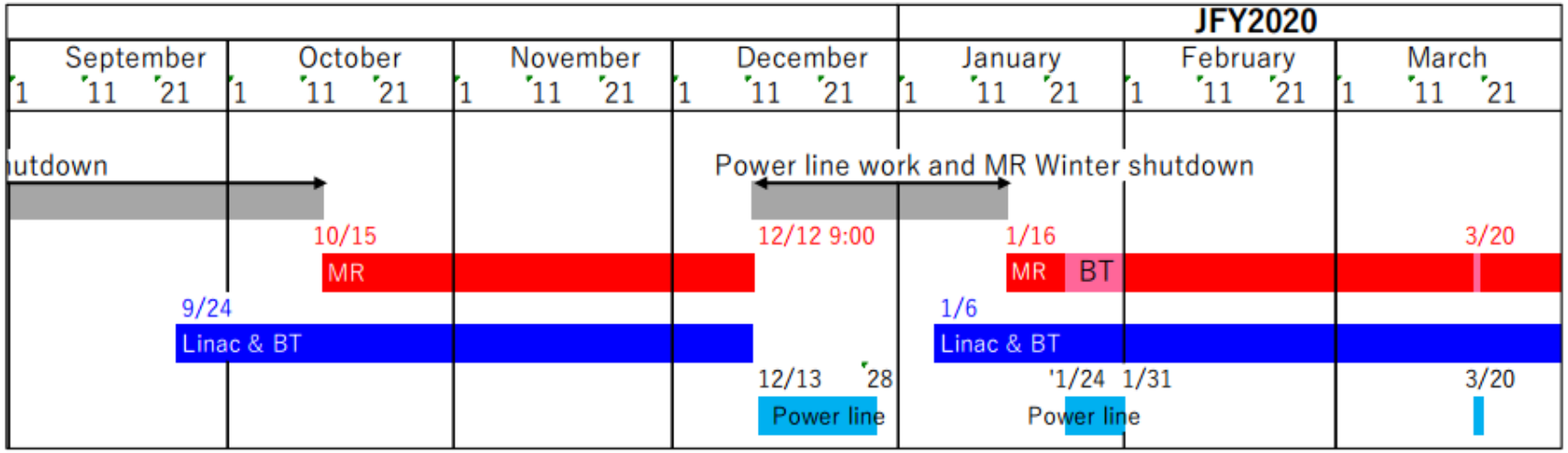
projects and facilities

PROJECTS AND FACILITIES | NEWS

Major revamp complete at SuperKEKB particle-physics facility

Belle II Experiment : run plan (until 2020 Summer)

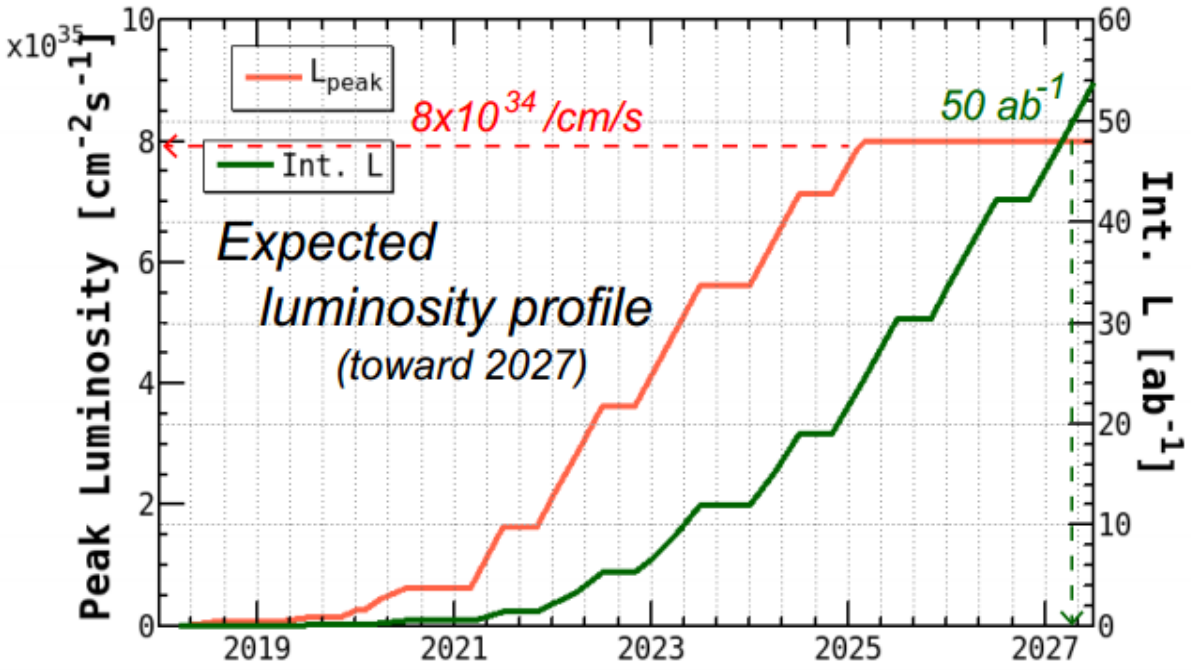
(and toward 2027)

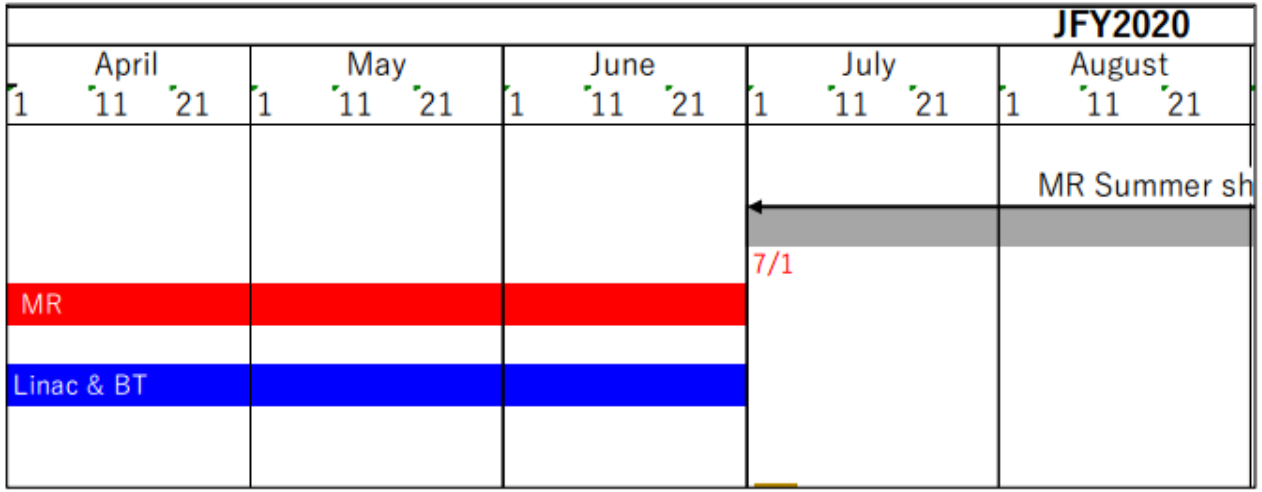


Luminosity goal

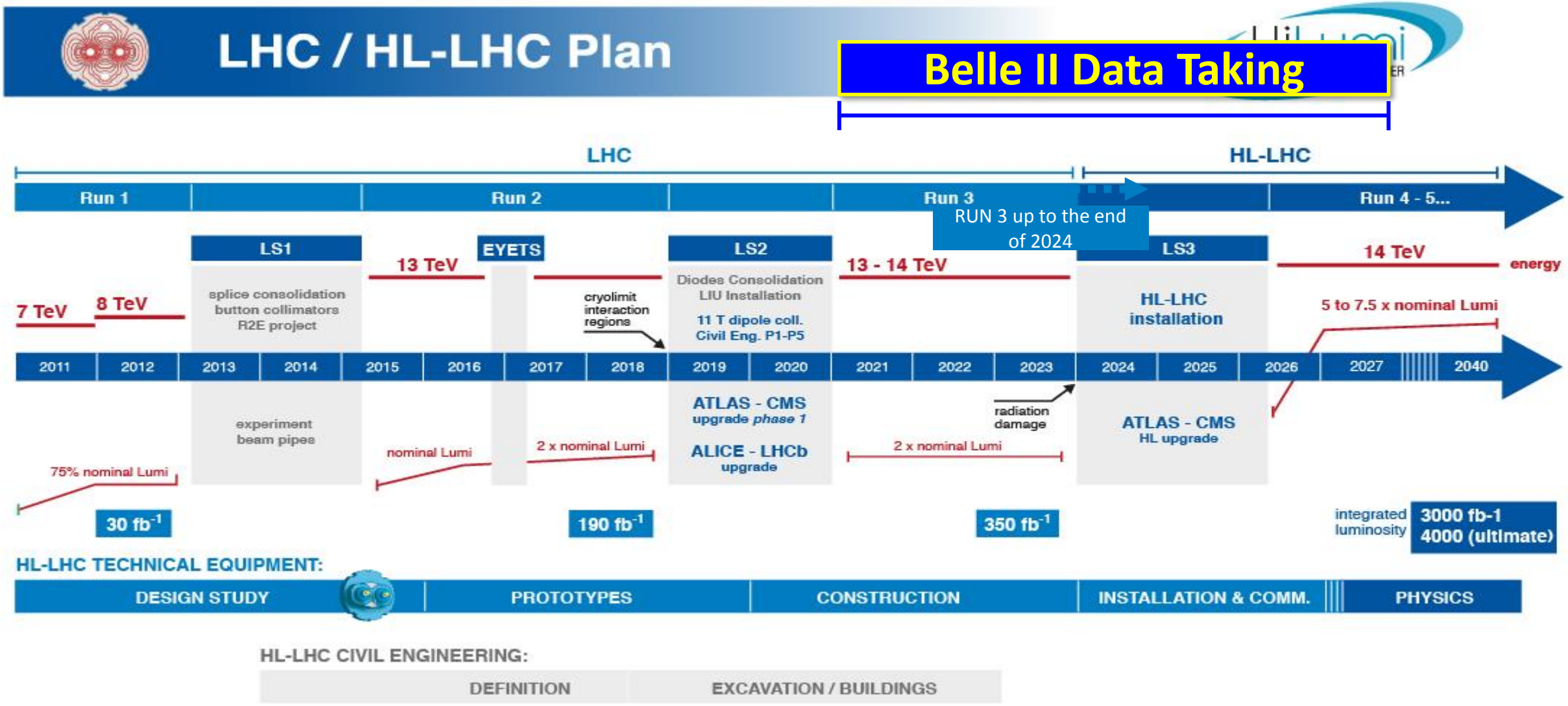
Integrated : 200 fb^{-1}

peak : 2~3x10^{34} $cm^{-2}s^{-1}$

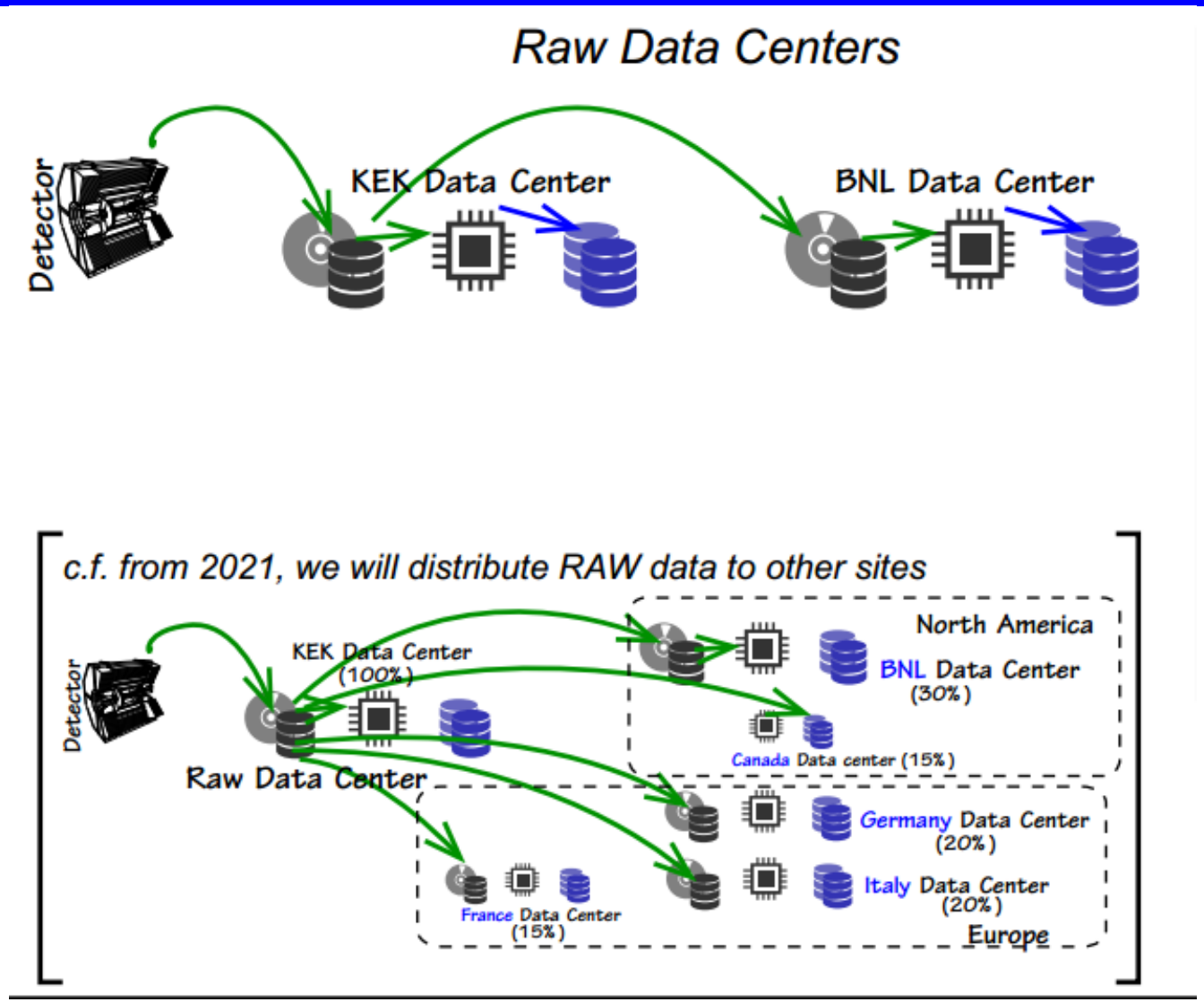




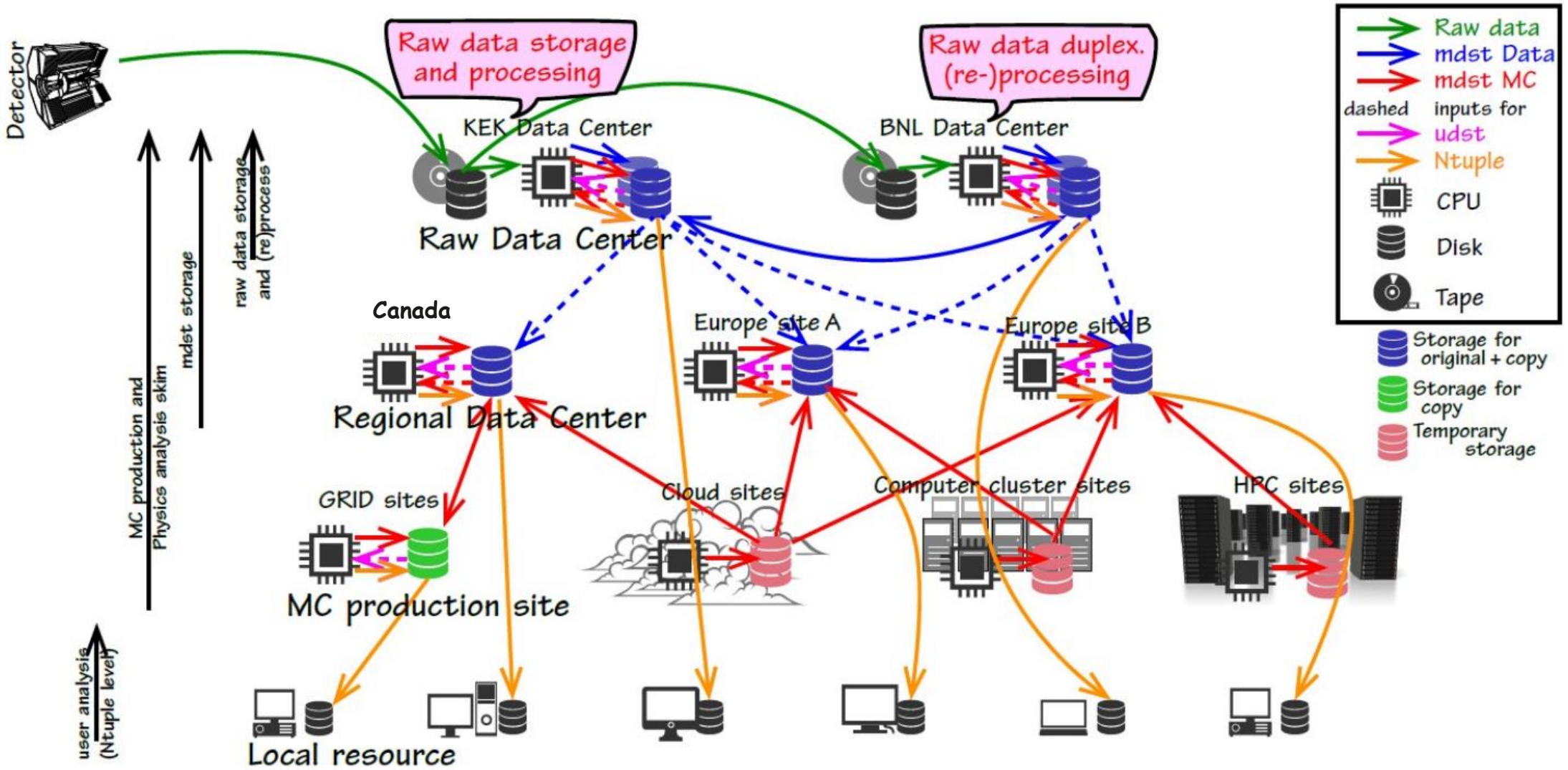
Belle II in the HL-LHC



Belle II Computing Model



Belle II Computing Model



SINET 100Gbit/s RING

- **JP-EU link upgrade from 2x10G to 1x100G -Feb. 2019 (Tokyo to Amsterdam on NetherLight + L3 Peering GEANT-SINET)**
- **JP-NY link replaced by LA-NY 100G link . March 2019**
- **New Trans-Atlantic NY-EU 100G March 2019**
- https://www.nii.ac.jp/news/release/2019/0301.html
- meetings.internet2.edu/media/medialibrary/2019/03/07/20190307-nakamura-SINET.pdf
- https://www.geant.org/News_and_Events/Pages/100Gbps-ring-connection-around-the-globe-supercharges.aspx

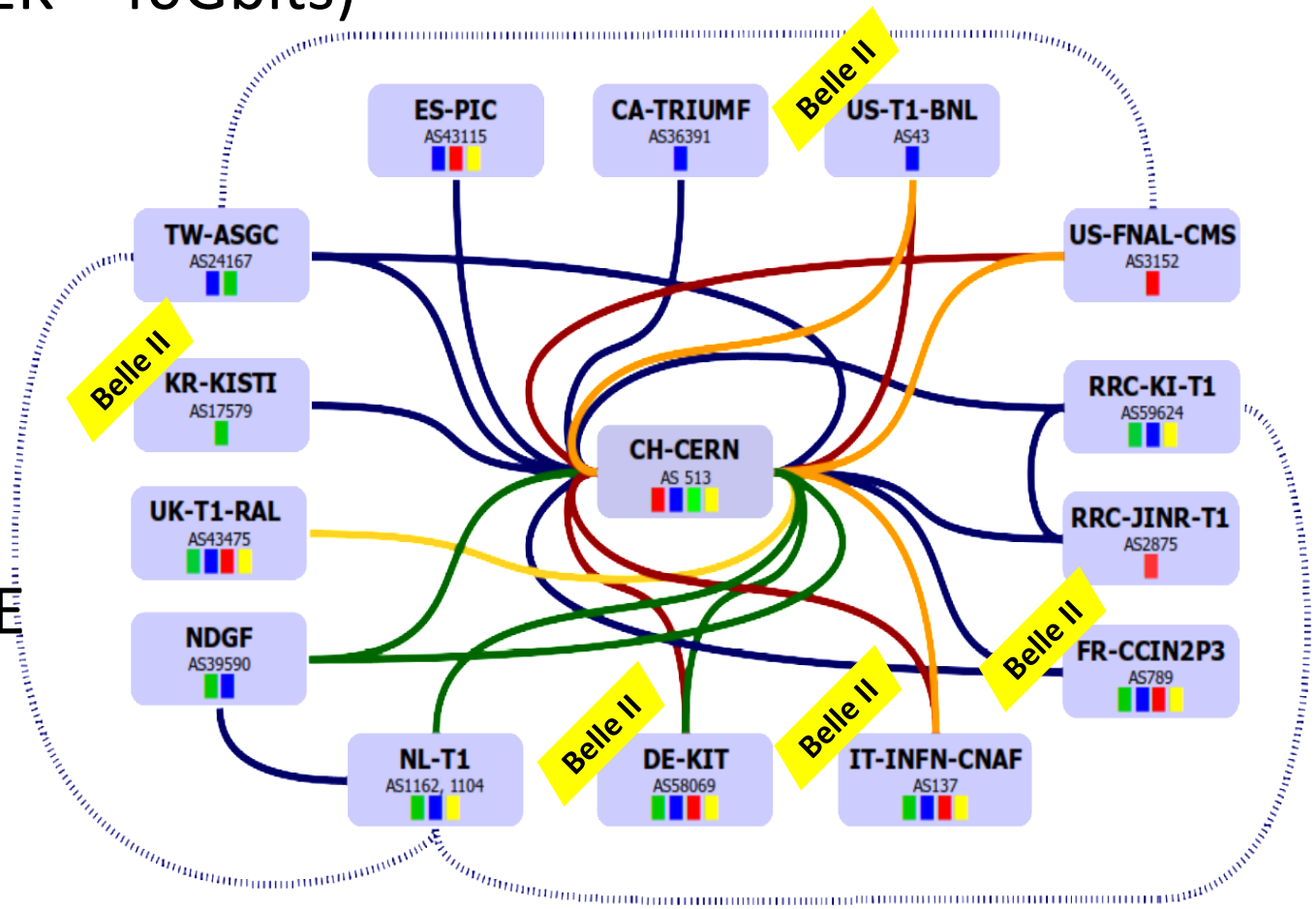
Belle II Network

- 30% Sites on LHCONE (including KEK - 40Gbits)
- 70% Sites General IP
- 5 Sites on LHCOPN

All RAW Data Centers are on LHCONE

More than 80% of Storage on LHCONE

More than 80% of Computing Power on LHCONE



Data Challenge 2015-2016 : Summary

Pacific Northwest NATIONAL LABORATORY
Proudly Operated by Battelle Since 1965

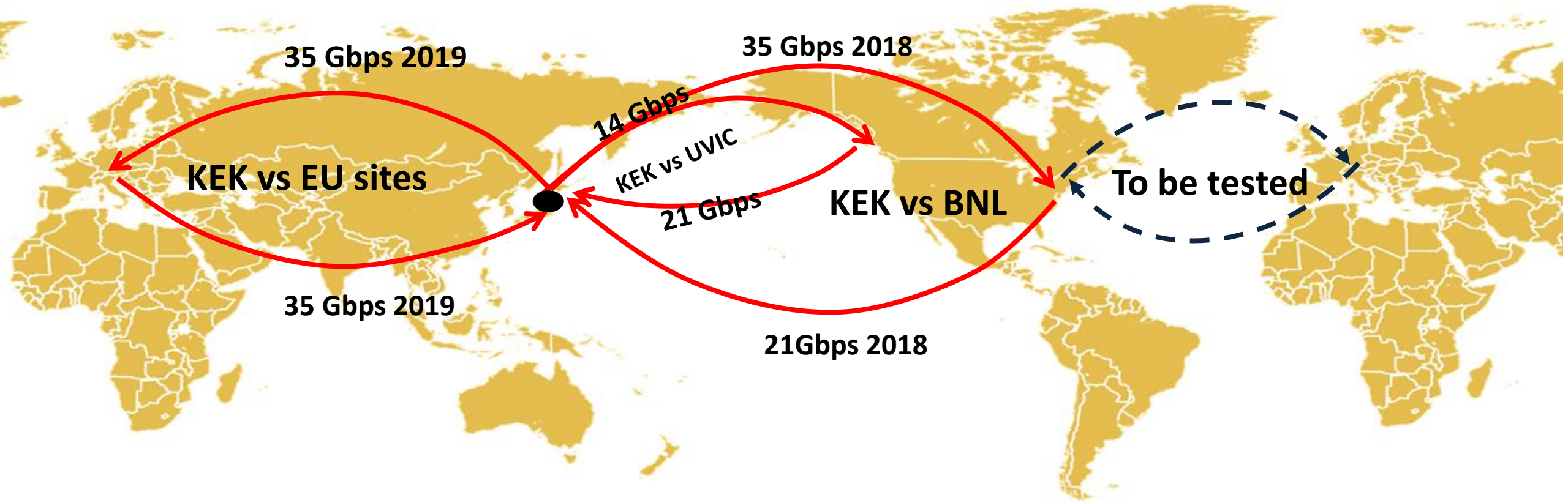
Overall Summary

Source →	KEK	PNNL	DESY	KIT	CNAF	NAPOLI	SIGNET
KEK		4.6 Gbps	4 Gbps	5 Gbps	7 Gbps	5.5 Gbps	2.5 Gbps
PNNL	4 Gbps		6.6 Gbps	6 Gbps	9 Gbps	8 Gbps	-
DESY	3 Gbps	6.6 Gbps		8 Gbps	8 Gbps	8* Gbps	3 Gbps
KIT	3.5 Gbps	> 4* Gbps	6-8 Gbps		6-8 Gbps	6 Gbps	3 Gbps
CNAF	-	8 Gbps	10 Gbps	6 Gbps		8* Gbps	3 Gbps
NAPOLI	3* Gbps	3* Gbps	3* Gbps	3 Gbps	3* Gbps		3* Gbps
SIGNET	0.8 Gbps	0.6* Gbps	5 Gbps	2-5 Gbps	5 Gbps	2* Gbps	

Network Data Challenge activity started in 2015.

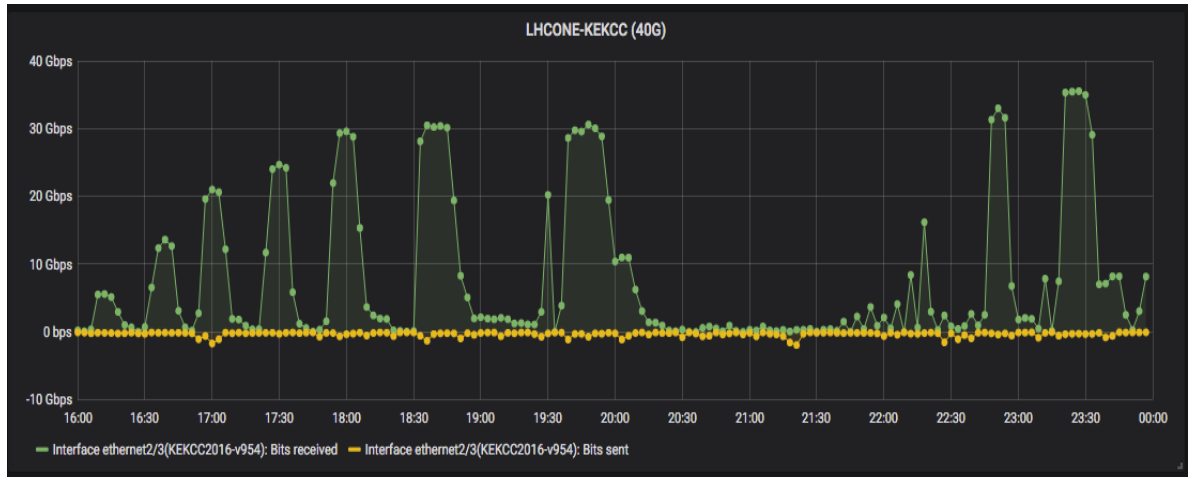
FTS Jobs From KEK to the candidate RAW Data Center.

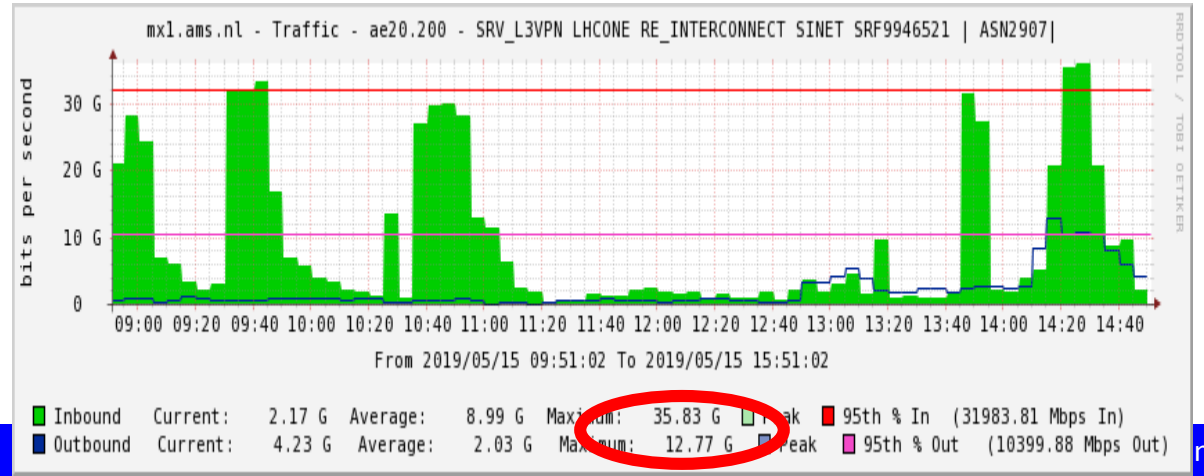
Data Challenge 2018/2019 via FTS Jobs



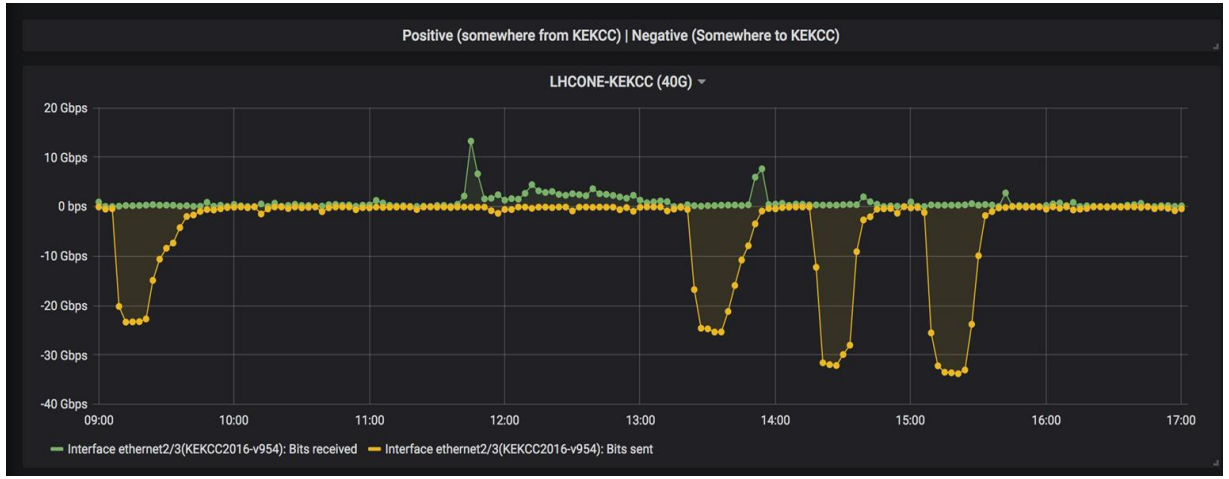
Network Data Challenge KEK vs EU (May 2019)

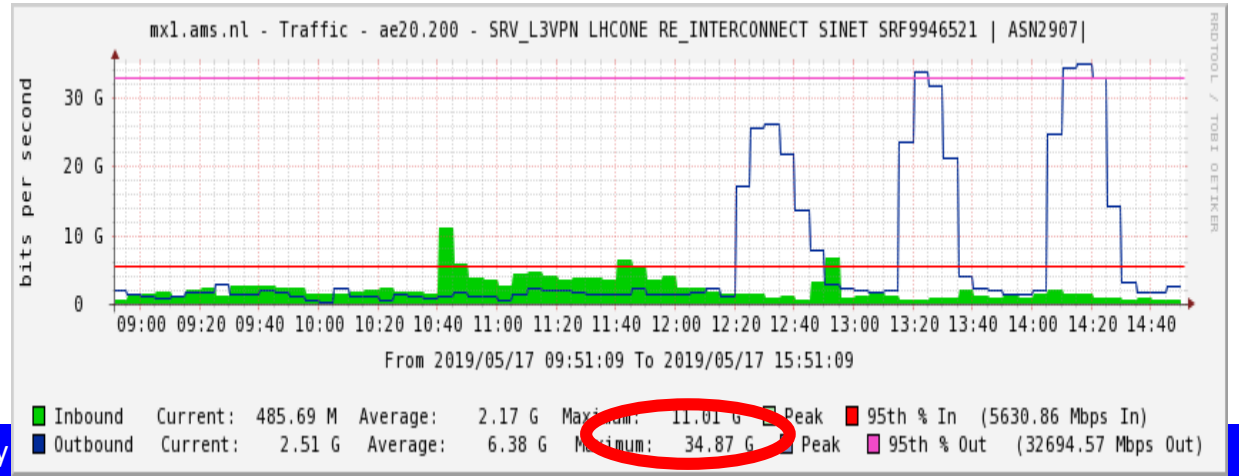
KEK-> EU (FTS job with multiple destinations CNAF,DESY, KIT, IN2P3, Napoli and SIGNET)
Max 35.83 Gbps with 16 streams



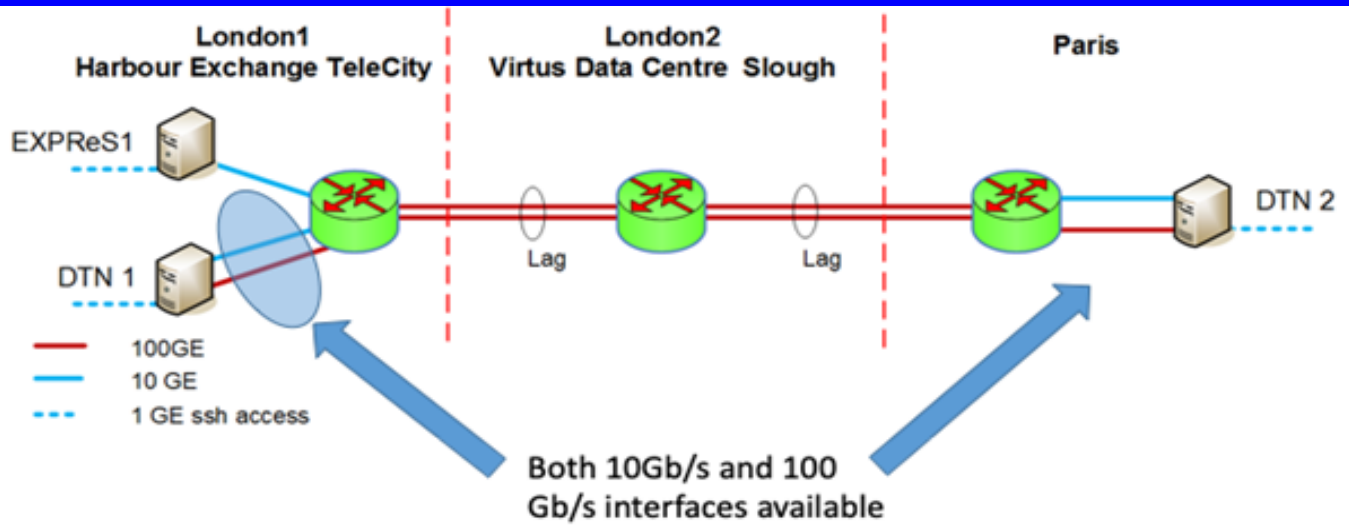


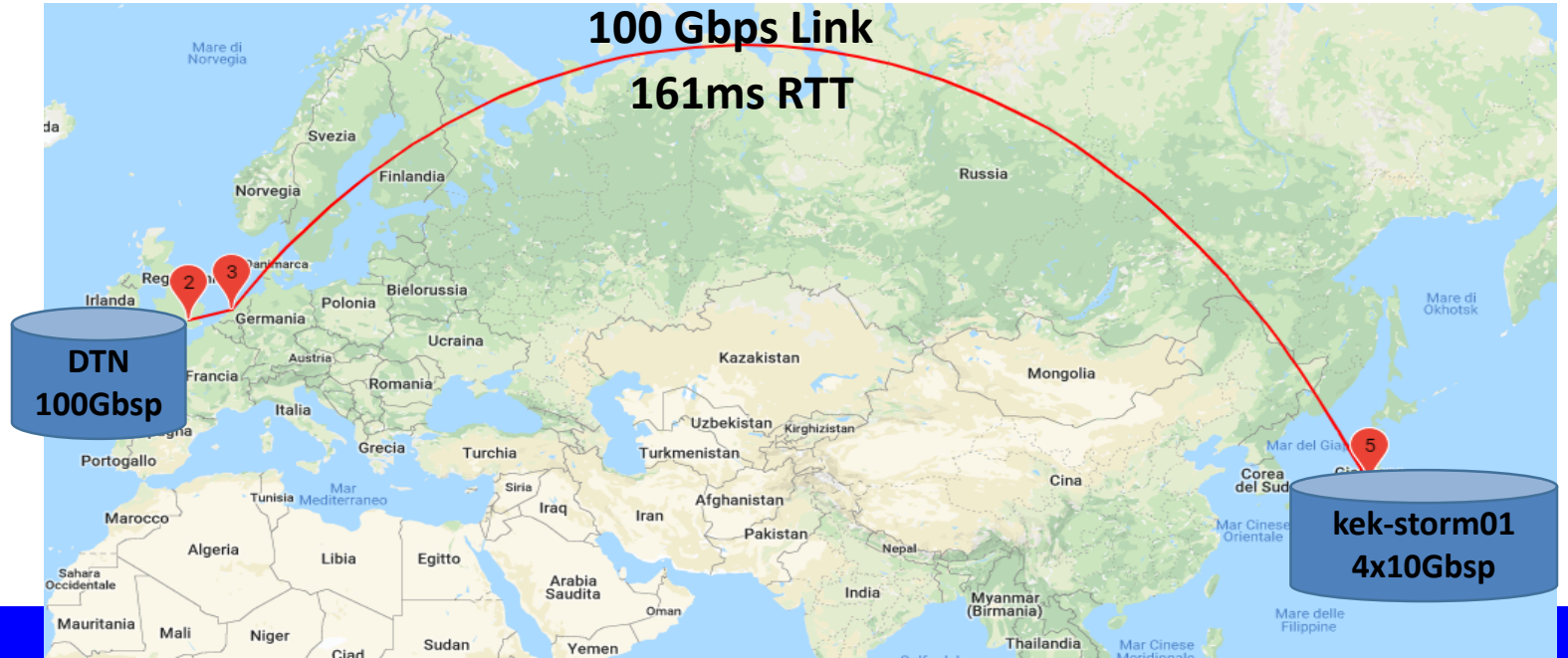
EU->KEK (FTS job with multiple source CNAF,DESY, KIT, IN2P3, Napoli and SIGNET)
Max 34.87 Gbps with 16 streams





Network Data Challenge KEK vs EU via DTN by GEANT





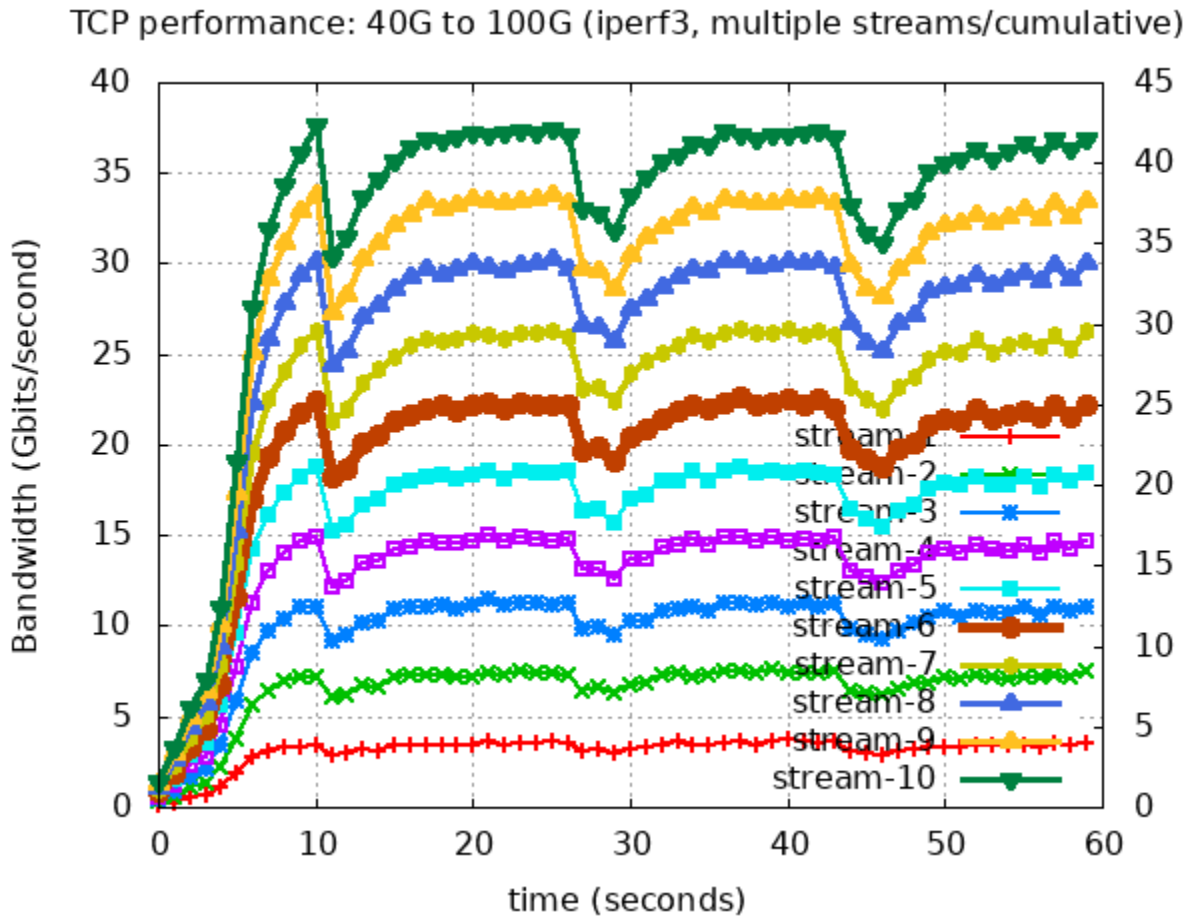
DTN service run on a server optimized to send and receive data at 100Gbps without system bootleneck.
It's equipped with an array NVME SSD 8 lane PCI-e 3.0
And multiple 100G NIC.
It's connected directly on the network without firewall.

Tools installed

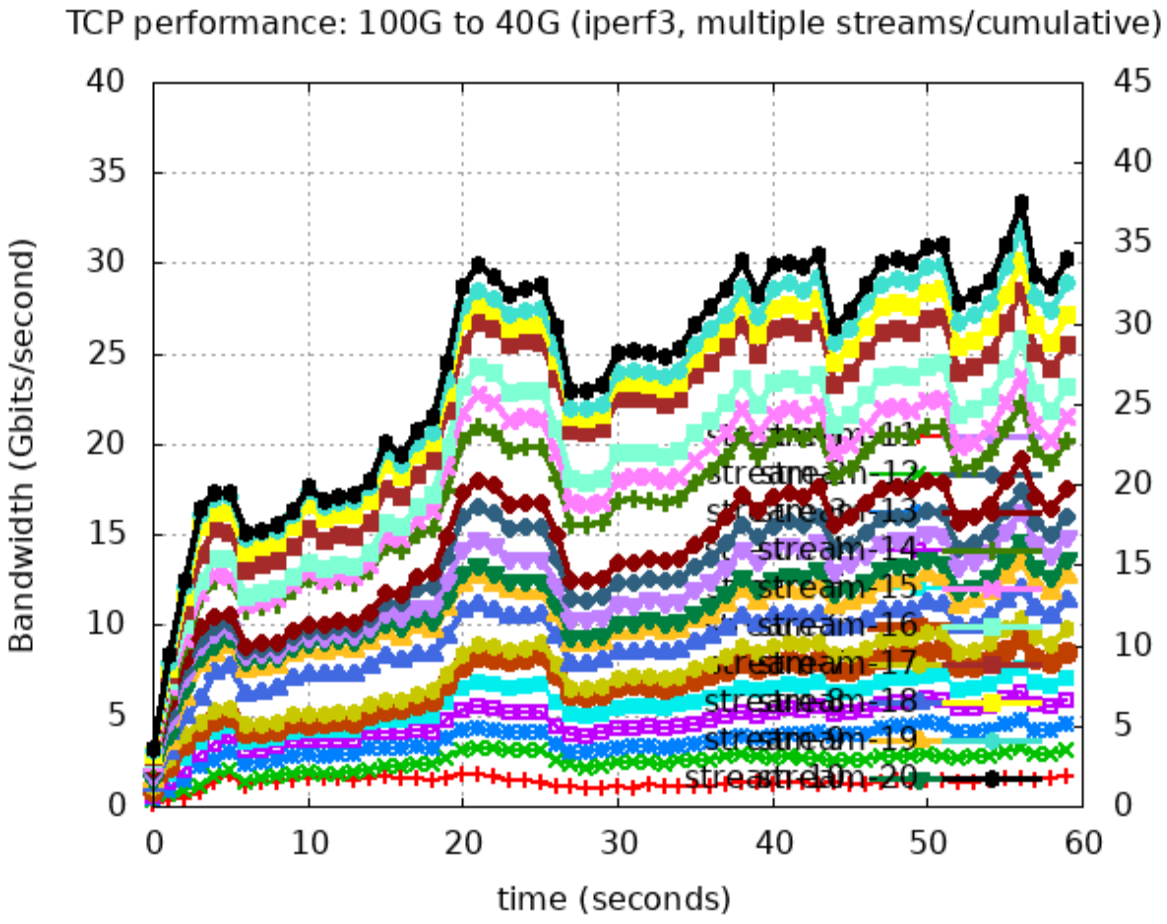
- Fast Data Transfer Service (FDT)
- GridFTP
- Udpmon
- Iperf (v2.0.8)
- Iperf3 (v3.1.2)

KEK<->DTN in London

KEK to DTN Max 37Gbps with 10 processes



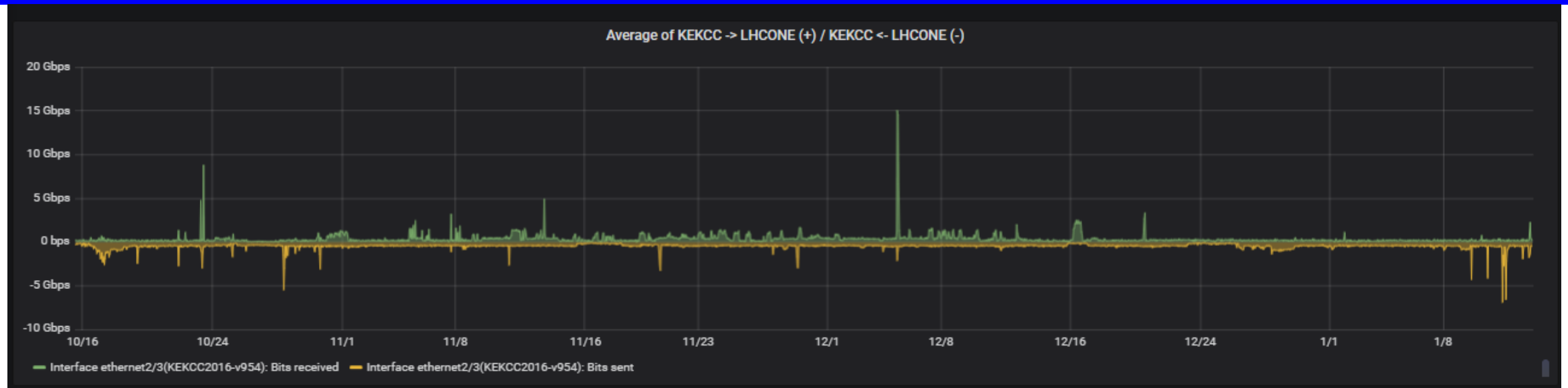
DTN to KEK 33Gbps with 20 processes

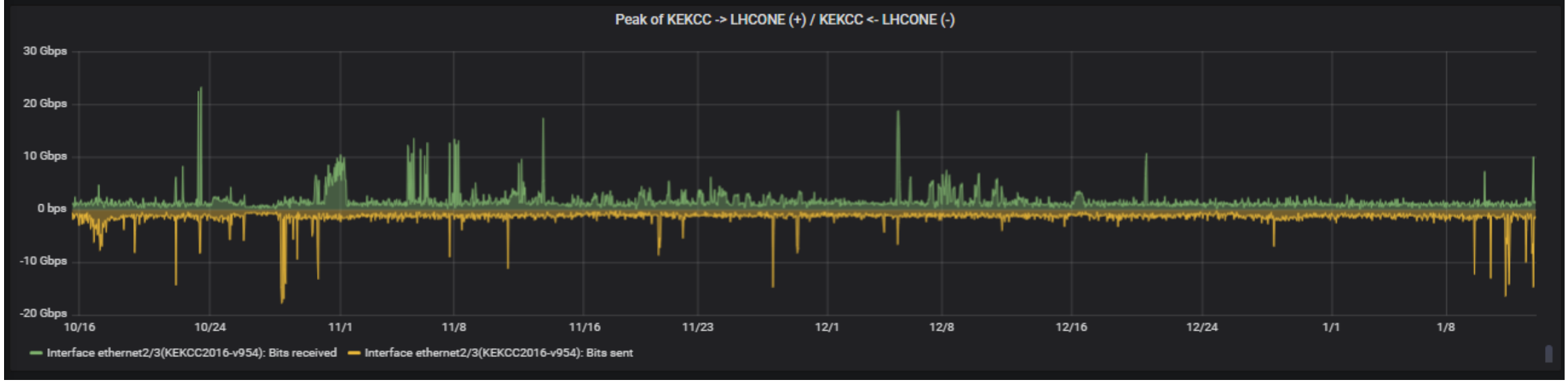


Network Monitoring

- Tools provided by Data Centers
- Graphs provided by Network Operators
- Perfsonar Mesh
- FTS Monitoring
- Internal Tools integrated in DIRAC

Network Monitoring KEK LHCONE





BNL vs SINET – Last 2 months

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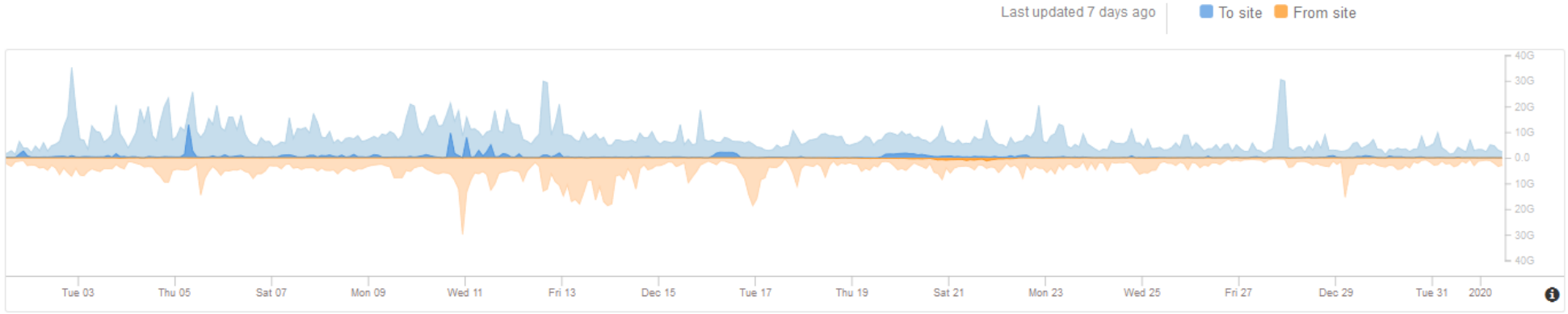
Brookhaven National Laboratory

Summary Interfac



Options

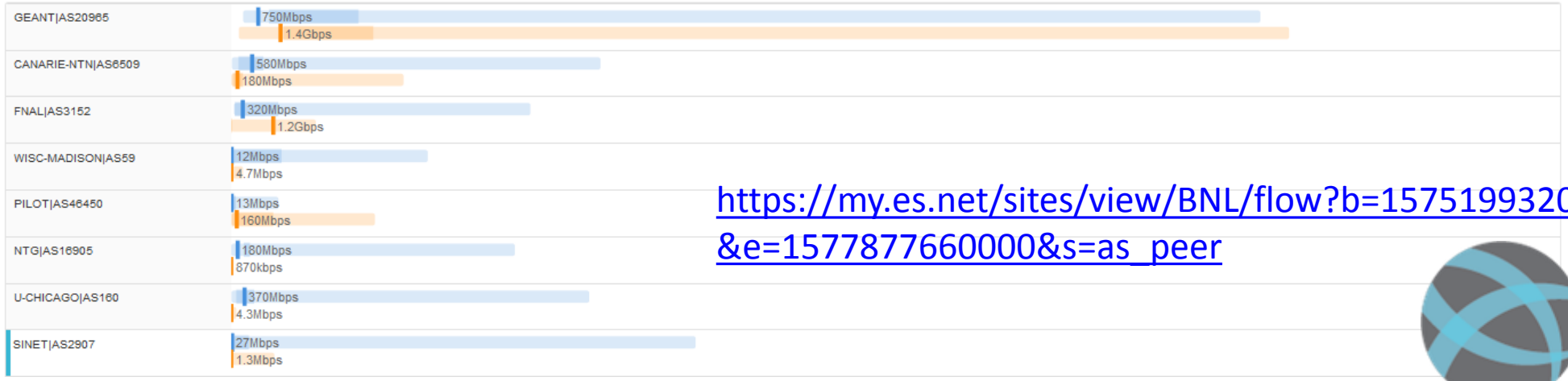
TIME RANGE

2019-12-01 - 2020-01-01

BREAKDOWN

- Protocol
- Applications
- Autonomous Systems (origin)
- Autonomous Systems (peer)
- Country
- Sites
- Facilities

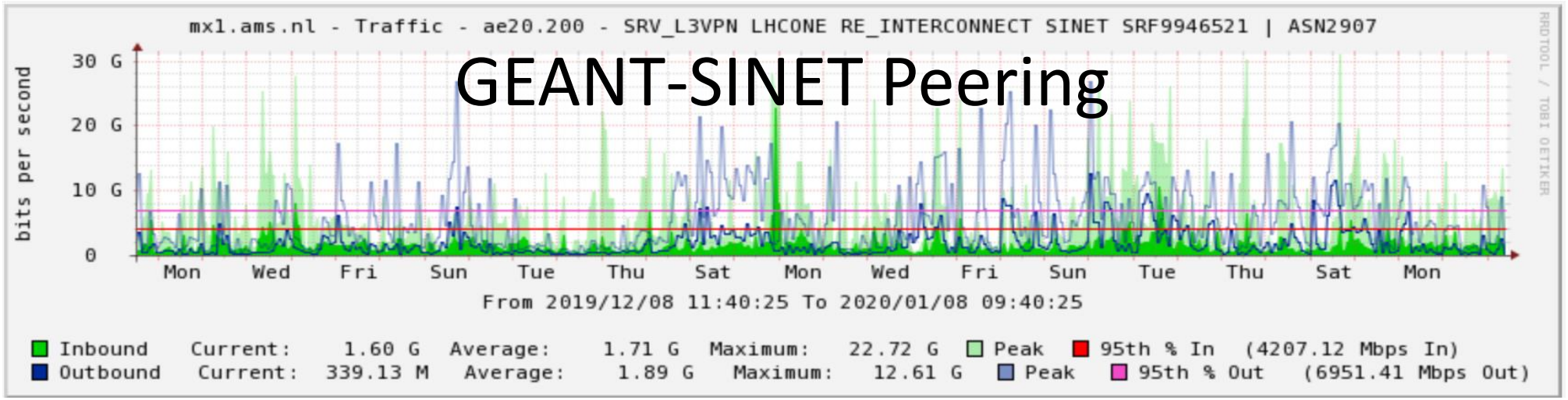
Top flows (as_peer)



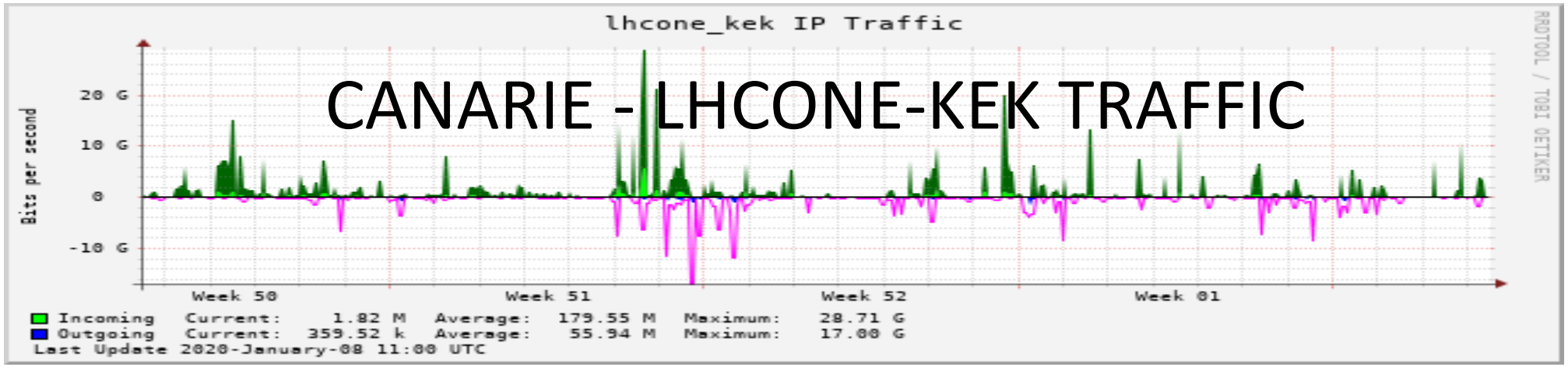
https://my.es.net/sites/view/BNL/flow?b=1575199320000&e=1577877660000&s=as_peer

ESnet
ENERGY SCIENCES NETWORK

GEANT and CANARIE Peering



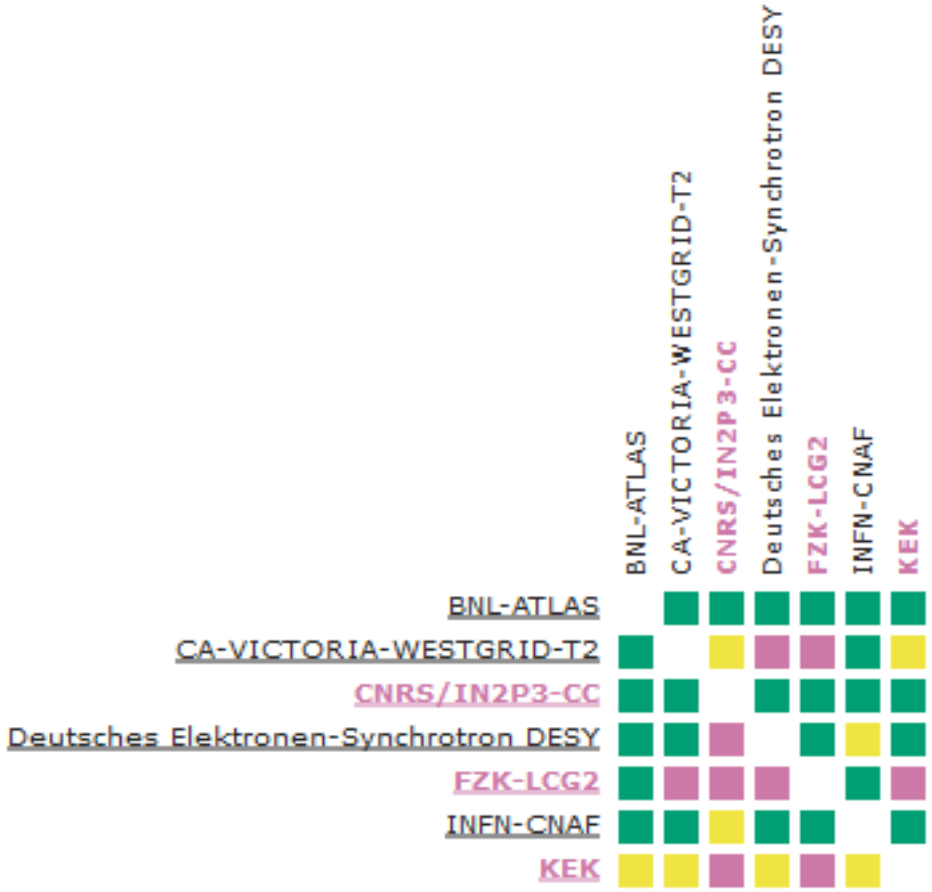
https://tools.geant.org/portal/links/p-cacti/graph_view.php?action=tree&tree_id=30&leaf_id=9090



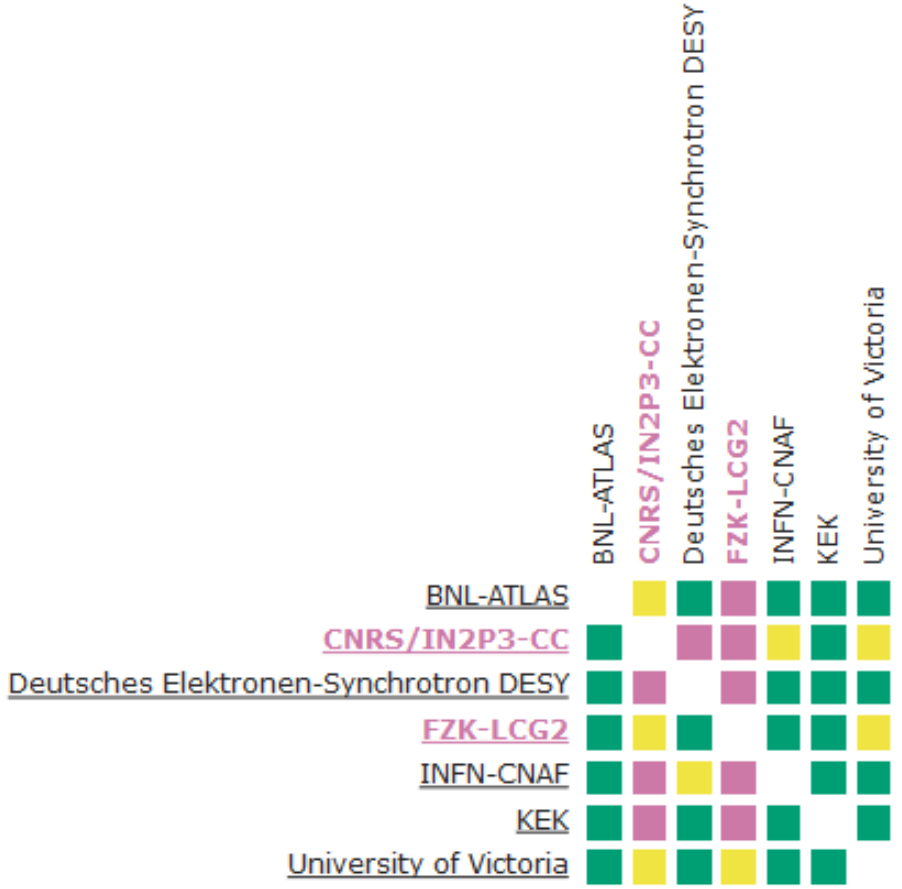
https://weathermap.canarie.ca/ntn/lhcone_kek-month.png

Perfsonar MADDASH (RAW Data Centers)

Belle II RAW Data Centers IPv4 Throughput

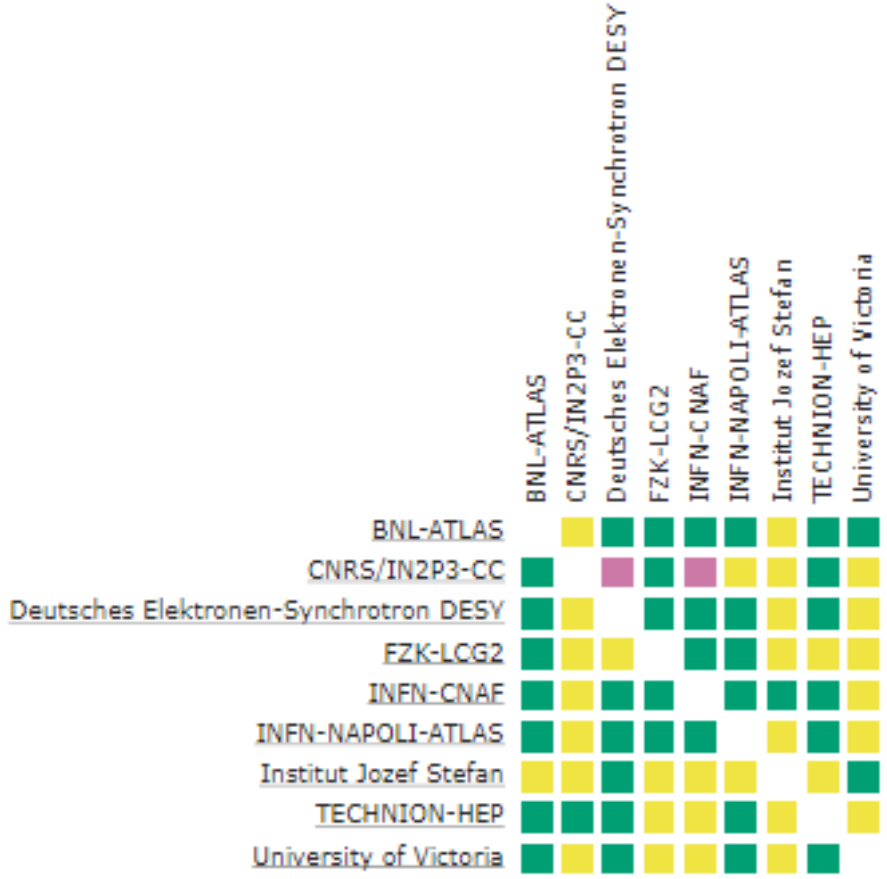


Belle II RAW Data Centers IPv4 Latency



Perfsonar MADDASH IPv6 Mesh

Belle II Mesh Config - Belle II IPv6 Latency - Loss



Belle II Mesh Config - Belle II IPv6 Bandwidth - Throughput

Questions for experiments

- Where do you foresee more network bandwidth will be required? How much? Why? When?
- What network services or features would you have wished in Run2, but they were not available?
- What network services or features will/would you need in the next runs?
- What are your main concerns about the network? Reachability? Bandwidth? Security? Reliability? Availability? Operations? Monitoring? Performance? Cost? Others?
- Do you have any suggestion to address these concerns?

- Where do you foresee more network bandwidth will be required? How much? Why? When?

Estimation of peaks for MC, Data Reprocessing, Skimming and Analysis

Traffic IN 2020-2027 (Gbps)

	20	21	22	23	24	25	26	27
Armenia	0,0	0,1	0,1	0,2	0,2	0,3	0,4	0,5
Australia	0,1	0,3	0,6	0,8	1,1	1,5	1,9	2,5
Austria	0,0	0,1	0,3	0,4	0,5	0,7	0,8	1,1
Canada	0,1	0,2	0,4	0,3	0,5	0,6	1,0	1,0
China	0,3	0,8	1,7	2,3	3,2	4,5	5,4	7,1
Czech	0,0	0,1	0,2	0,3	0,4	0,5	0,6	0,8
France	0,1	0,2	0,4	0,3	0,5	0,6	1,0	1,0
Germany	0,6	1,7	3,6	4,6	6,5	8,8	11,1	13,4
India	0,1	0,3	0,7	1,0	1,4	1,9	2,3	3,0
Israel	0,0	0,1	0,2	0,3	0,4	0,5	0,6	0,8
Italy	0,4	1,2	2,4	2,9	4,2	5,8	7,4	8,5
KEK	0,7	1,6	3,2	4,6	5,3	8,6	11,5	16,9
Korea	0,2	0,5	1,0	1,4	2,0	2,7	3,3	4,4
Malaysia	0,0	0,0	0,1	0,1	0,1	0,2	0,2	0,3
Mexico	0,1	0,2	0,4	0,5	0,7	1,0	1,2	1,6
Poland	0,1	0,2	0,5	0,6	0,9	1,2	1,5	1,9
Russia	0,3	0,8	1,8	2,5	3,5	4,8	5,8	7,7
Saudi Arabia	0,0	0,1	0,2	0,3	0,4	0,5	0,6	0,8
Slovenia	0,1	0,3	0,7	0,9	1,2	1,7	2,1	2,7
Spain	0,0	0,0	0,1	0,1	0,1	0,2	0,2	0,3
Taiwan	0,1	0,2	0,5	0,6	0,9	1,2	1,5	1,9
Thailand	0,0	0,1	0,1	0,2	0,2	0,3	0,4	0,5
Turkey	0,0	0,1	0,1	0,2	0,2	0,3	0,4	0,5
Urkaine	0,0	0,1	0,3	0,4	0,5	0,7	0,8	1,1
USA	0,2	1,2	2,5	2,8	4,1	5,6	7,4	7,9
VietNam	0,0	0,0	0,1	0,1	0,1	0,2	0,2	0,3

Aggregated peak ~90Gbps at the max luminosity

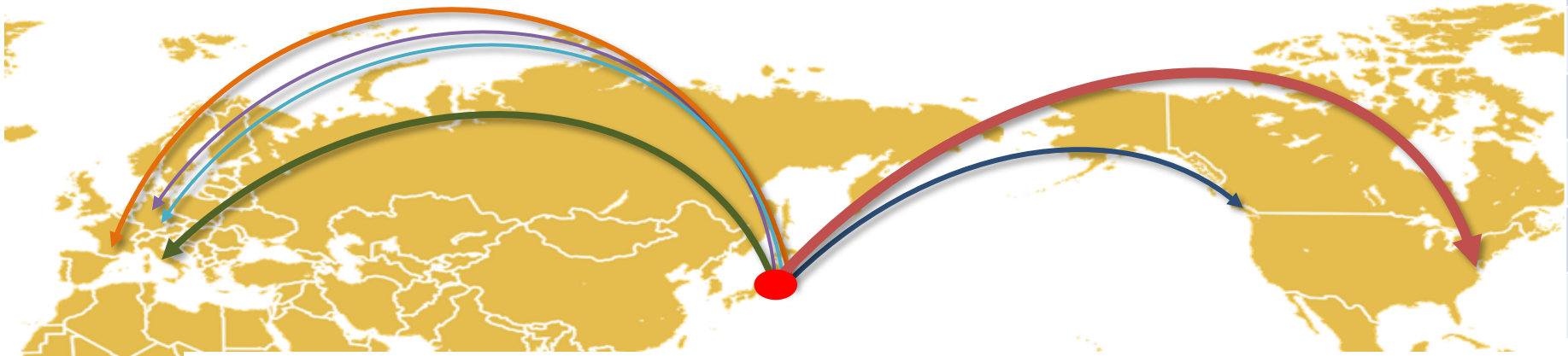
“it is difficult to predict, especially the future”. Neils Bohr

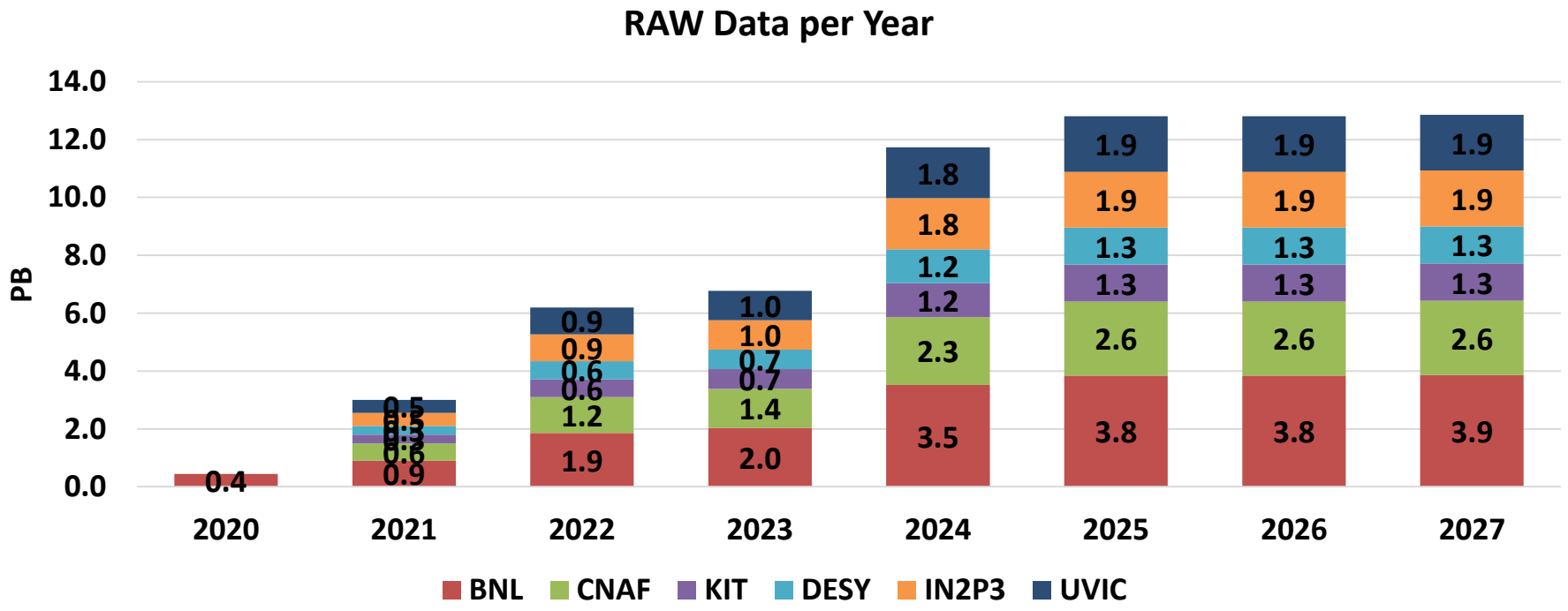
Traffic OUT 2020-2027 (Gbps)

	20	21	22	23	24	25	26	27
Armenia	0,1	0,1	0,2	0,3	0,3	0,1	0,1	0,1
Australia	0,1	0,2	0,4	0,6	0,8	1,1	1,4	1,7
Austria	0,0	0,1	0,2	0,2	0,3	0,5	0,6	0,8
Canada	0,1	0,3	0,7	1,0	1,4	2,0	2,4	3,3
China	0,2	0,6	1,2	1,6	2,2	3,1	4,0	5,0
Czech	0,0	0,1	0,1	0,2	0,3	0,4	0,5	0,6
France	0,1	0,3	0,7	1,0	1,4	2,0	2,4	3,3
Germany	0,5	1,5	3,2	4,3	5,8	8,3	10,5	13,5
India	0,1	0,3	0,5	0,7	0,9	1,3	1,7	2,1
Israel	0,0	0,1	0,1	0,2	0,3	0,4	0,5	0,6
Italy	0,4	1,1	2,4	3,2	4,3	6,1	7,7	10,0
KEK	0,7	2,4	5,0	6,2	8,8	12,0	14,9	18,1
Korea	0,1	0,4	0,8	1,0	1,4	1,9	2,5	3,1
Malaysia	0,0	0,0	0,0	0,1	0,1	0,1	0,2	0,2
Mexico	0,0	0,1	0,3	0,4	0,5	0,7	0,9	1,2
Poland	0,1	0,2	0,3	0,4	0,6	0,8	1,1	1,4
Russia	0,2	0,6	1,3	1,7	2,4	3,4	4,3	5,4
Saudi Arabia	0,0	0,1	0,1	0,2	0,3	0,4	0,5	0,6
Slovenia	0,1	0,2	0,5	0,6	0,8	1,2	1,6	1,9
Spain	0,0	0,0	0,0	0,1	0,1	0,1	0,2	0,2
Taiwan	0,1	0,2	0,3	0,4	0,6	0,8	1,1	1,4
Thailand	0,0	0,0	0,1	0,1	0,2	0,2	0,3	0,4
Turkey	0,0	0,0	0,1	0,1	0,2	0,2	0,3	0,4
Urkaine	0,0	0,1	0,2	0,2	0,3	0,5	0,6	0,8
USA	0,6	1,3	2,7	3,7	5,0	7,1	8,8	11,7
VietNam	0,0	0,0	0,0	0,1	0,1	0,1	0,2	0,2

2° RAW Data Copy Replication Strategy

RAW Data Center	Share after 2021
BNL	30%
CNAF	20%
UVIC	15%
IN2P3	15%
KIT	10%
DESY	10%





Raw Data Strategy

About 300 days of Data Acquisition per year

Goal and constraints:

- Finalize the second copy of the collected RAW Data within 24h
- All files of a RUN must be replicated on the same site
- Do the copy asynchronously in burst.

	2020	2021	2022	2023	2024	2025	2026	2027
TB per DAY	1.5	9.9	20.5	22.3	38.6	42.1	42.1	42.3
Max TB per RUN	0.5	3.3	6.8	7.4	12.9	14.0	14.0	14.1

Network Data Challenge 2018-2019

MAXIMUM Performance reached during Network Data Challenge KEKCC->RAW-DCs (with 16 streams per file in FTS Jobs). To be confirmed/improve during the test vs TAPE systems

LINK	Peak (Gbps)	Average (Gbps)	Data per Day (TB)	Site Connection	Peak/Site Connect.	Average/Site Connect.	Security Factor TBperDay /42TB
KEK-BNL	35.0	15.5	167	200	18%	8%	x 4
KEK-CNAF	20.0	15.0	162	200	10%	8%	x 4
KEK-DESY	16.0	10.0	108	100	16%	10%	x 2.5
KEK-IN2P3	12.4	4.1	44	40	31%	10%	x 1
KEK-KIT	20.0	13.0	140	100	20%	13%	x 3.3
KEK-UVIC	14.0	10.0	108	100	14%	10%	x 2.5

RAW Data Center Testing

CNAF, DESY, GridKa, IN2P3, UVic should come online as RAW data centers in 2021.

We started the activity to assess the readiness to host and manage the RAW data

- Data transfer from tape to tape between KEK and RDC
- Run reconstruction on data stored in a RDC

- The activity will involve the Network Monitoring

- Test will be done using: 2GB,5GB and 10GB Files (5GB current target size for RAW data)

- What network services or features will/would you need in the next runs?

Improve the monitoring of Belle II traffic on international links

- Current status:
  - CANARIE provides a view vs KEK
  - ESNET provides a view of the traffic between BNL vs SINET
  - GEANT provides the peering between SINET and GEANT

Bandwidth for RAW Data Copy:

Belle II does not have a private network like LHCOPN to move RAW Data.

All data are moved via LHCONE with no reservation.

RAW Data Centres should assure a bandwidth share while dimensioning their WAN Connection and Storage LAN.

Bandwidth vs Asian and Russian sites :

Moving or streaming data from sites with large storage vs smaller sites with just CPU, could be an useful paradigm to optimize resource utilization.

However many sites, specially from the region of Asia and Russia does not show enough performance in term of bandwidth to widely adopt this strategies.

The cause can be a combination of issue at LAN and WAN level.

Operation and Performance:

- Data Rate Optimization Site-to-Site
- Proper Site Configuration (i.e. Bonding Configuration of Storage, MTU etc)
- IPv6-only resources available in some site in coming years?

- Do you have any suggestion to address these concerns?

Bandwidth for RAW DC:

Multi-ONE, Marking Traffic?

May FTS play a role to guaranteed the needed Bandwidth share? HEP Community have multiple FTS servers may be possible/useful an inter FTS communication?

Bandwidth of Sites:

As Belle II community we can make more effort in extend the Perfsonar dashboard where possible, make Data Challenge and report progresses. Worker Node connection should be tested as well.

Conclusions

- Belle II has started data taking and is working hard to reach the maximum luminosity with a roadmap up to 2027.
- Max usage of the Network is expected since 2024
- Large improvement in the global Network Connectivity in 2019.
- RAW Data Center testing Started
- Improve the flow monitoring would be beneficial
- Main concerns:
  - Reservation of the bandwidth for the second copy of raw data
  - Connectivity of small sites of different regions.
  - Sites Configuration, IPv6

Belle II

Backup

ACTIVE SITES

SITE	
AUSTRIA	1
AUSTRALIA	1
CANADA	2
CINA	1
CHECZ	1
GERMANY	5
FRANCE	2
ISRAEL	1
INDIA	3
ITALY	12
JAPAN	15
KOREA	3
MEXICO	2
POLAND	3
SLOVENIA	1
TURCHIA	2
TAIWAN	1
USA	3
RUSSIA	3

Some endpoint represent multiple sites

Goal for RAW Data Center

Example of Amount of Data that we can transfer in 1 day with different Traffic patterns over a virtual channel with max peak of 10Gbit/s

Traffic Pattern	95th (Gbps)	Peak (Gbps)	95th % of Peak	Mean data Rate (Gbps)	Mean % of 95th	(TB) per Day	(PB) per Month	Site-40G Peak/40	Site-40G Aver./40	Site 100G Peak/100	Site 100G Aver./100
Normal	4.5	10	45%	1.6	35%	17.0	0.5	25%	4%	10%	2%
Busty	1	10	10%	0.3	30%	3.2	0.1	25%	1%	10%	0%
Sustained Busty	9	10	90%	2.7	30%	29.2	0.9	25%	7%	10%	3%
MAX	9.8	10	98%	7.8	80%	84.7	2.5	25%	20%	10%	8%

Example of Amount of Data that we can transfer in 1 day with different Traffic patterns over a virtual channel with max peak of 15Gbit/s

Traffic Pattern	95th (Gbps)	Peak (Gbps)	95th % of Peak	Mean data Rate (Gbps)	Mean % of 95th	(TB) per Day	(PB) per Month	Site-40G Peak/40	Site-40G Aver./40	Site 100G Peak/100	Site 100G Aver./100
Normal	6.8	15	45%	2.4	35%	25.5	0.8	38%	6%	15%	2%
Busty	1.5	15	10%	0.5	30%	4.9	0.1	38%	1%	15%	0%
Sustained Busty	13.5	15	90%	4.1	30%	43.7	1.3	38%	10%	15%	4%
MAX	14.7	15	98%	11.8	80%	127.0	3.8	38%	29%	15%	12%

Example of Amount of Data that we can transfer in 1 day with different Traffic patterns over a virtual channel with max peak of 20Gbit/s

Traffic Pattern	95th (Gbps)	Peak (Gbps)	95th % of Peak	Mean data Rate (Gbps)	Mean % of 95th	(TB) per Day	(PB) per Month	Site-40G Peak/40	Site-40G Aver./40	Site 100G Peak/100	Site 100G Aver./100
Normal	9.0	20	45%	3.2	35%	34.0	1.0	50%	8%	20%	3%
Busty	2	20	10%	0.6	30%	6.5	0.2	50%	2%	20%	1%
Sustained Busty	18	20	90%	5.4	30%	58.3	1.7	50%	14%	20%	5%
MAX	19.6	20	98%	15.7	80%	169.3	5.1	50%	39%	20%	16%

PhD Fraction 2020

PhD fraction	
Australia	2,35
Austria	1,04
Canada	3,13
China	4,18
Czech Rep.	0,78
France	1,57
Germany	12,01
India	2,87
Israel	0,52
Italy	13,84
Japan	21,67
Korea	3,66
Malaysia	0,52
Mexico	1,83
Poland	1,83
Russia	7,31
Saudi Arabia	0,26
Slovenia	2,09
Spain	0,26
Taiwan	2,09
Thailand	0,52
Turkey	0,52
Ukraine	0,52
USA	13,84
VietNam	0,78

previous KEKCC replacement schedule (2016 !!)

2016

	CPU (cores)	Disk (PB)	Tape (PB)
Current KEKCC	4,000 ~45kHS06	6	18
New KEKCC	10,000 ~200kHS06	13	70 maximum capacity

OS : SL6.7

2020 CPU : 15,000 cores
Disk : 17PB
Tape : 100PB (max capacity)
Expectation

ICHEP2020 : July 30 - August 5

	Month	2016 June				2016 July					2016 August					2016 September			
	Week	1w	2w	3w	4w	1w	2w	3w	4w	5w	1w	2w	3w	4w	5w	1w	2w	3w	4w
KEKCC	Data migration						Data migration (Disk) w/ rsync								8/29 Disk freaze				
	HSM downtime												Tape (8/15-8/17)						
	(Tape access)												data on tape cannot be accessed						
	Complete system downtime										8/5-8/8 (power outage)								
	GRID services												SE on HSM						
New KEKCC	System test																		
	Operation																		

Previous replacement schedule in 2016

Reconfigure the distribured computing core services from the scratch

BelleDIRAC downtime

GRID services maintained by CRC : it takes less than one day to switch VOMS running on the current KEKCC to the new system. This will happen someday in August. (LFC also)

Belle II operating GRID services : depends on our decision

Two months overlap period (July+August) of operation of the current and new KEKCCs.

Belle II Computing Centers

In Belle II we do not use the term "tier" in general (except in the Service Level MoU)

KEK - the host laboratory

- raw data and other forms of data on permanent mass storage
- for reconstruction (processing of raw data)
- also for Monte Carlo production and end-user analysis

Raw Data Centers

- raw and reconstructed data permanent storage
- for data-intensive analysis, re-processing of raw data
- also for Monte Carlo production and end-user analysis

Regional Data Centers

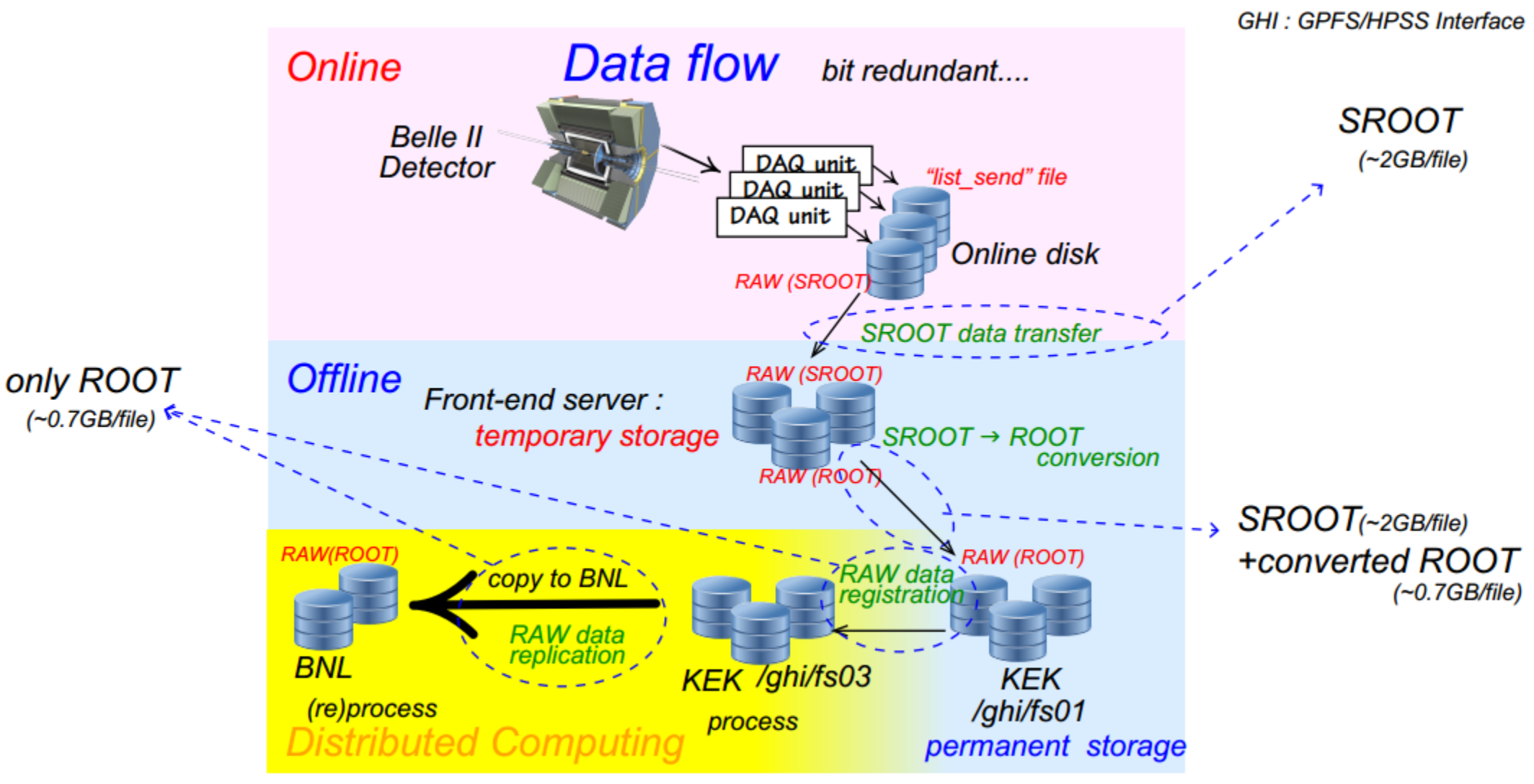
- partial copy of the processed data
- end-user analysis
- also for Monte Carlo production

Monte Carlo Production Centers

- Monte Carlo production and optionally end-user analysis

A single site may play multiple roles, depending on its size and resources availability

DATA FLOW


GHI : GPFS/HPSS Interface
Online
Data flow
bit redundant....
Belle II Detector
DAQ unit
DAQ unit
DAQ unit
"list_send" file
Online disk
RAW (SROOT)
SROOT
(~2GB/file)
SROOT data transfer
Offline
Front-end server :
temporary storage
RAW (SROOT)
SROOT → ROOT
conversion
RAW (ROOT)
only ROOT
(~0.7GB/file)
SROOT(~2GB/file)
+converted ROOT
(~0.7GB/file)
RAW(ROOT)
copy to BNL
RAW data
replication
RAW data
registration
RAW (ROOT)
BNL
(re)process
KEK /ghi/fs03
process
KEK
/ghi/fs01
permanent storage
Distributed Computing

Raw Data Flow in bunches

Online-offline copies/conversion in bunches

- All the files of a run come only after the end of the run
- Many files to be put into FTS in a short time

Raw data files are grouped in "data blocks"

- Each data block replicated to a Raw Data Center
- A single Raw Data Center receives all the files in a time window
  - others will be waiting for next data blocks to come in the next time windows

that means

Transfers of raw data files in bunches

- Data flow with peaks and intervals, rather than a constant flow
  - With the full luminosity, the export from KEK may be a constant flow,
  - and multiple Raw Data Centers may receive raw data (of different data blocks) at the same time, but we should not have all the links constantly busy all the time

Belle II Usage of Grid Storage Elements

"Local SEs"

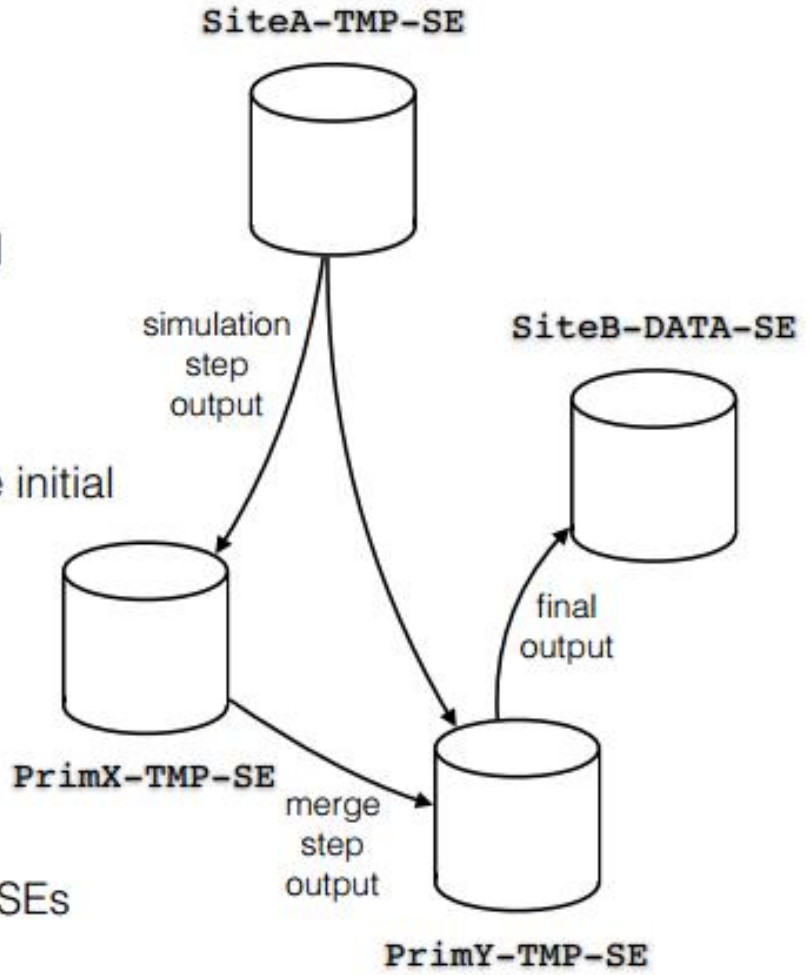
- Each site has an associated SE
  - Output data are uploaded to its TMP-SE
  - Input data are taken from its DATA-SE
- A non-grid site would use a near-by (and rather large) SE

"Primary SEs"

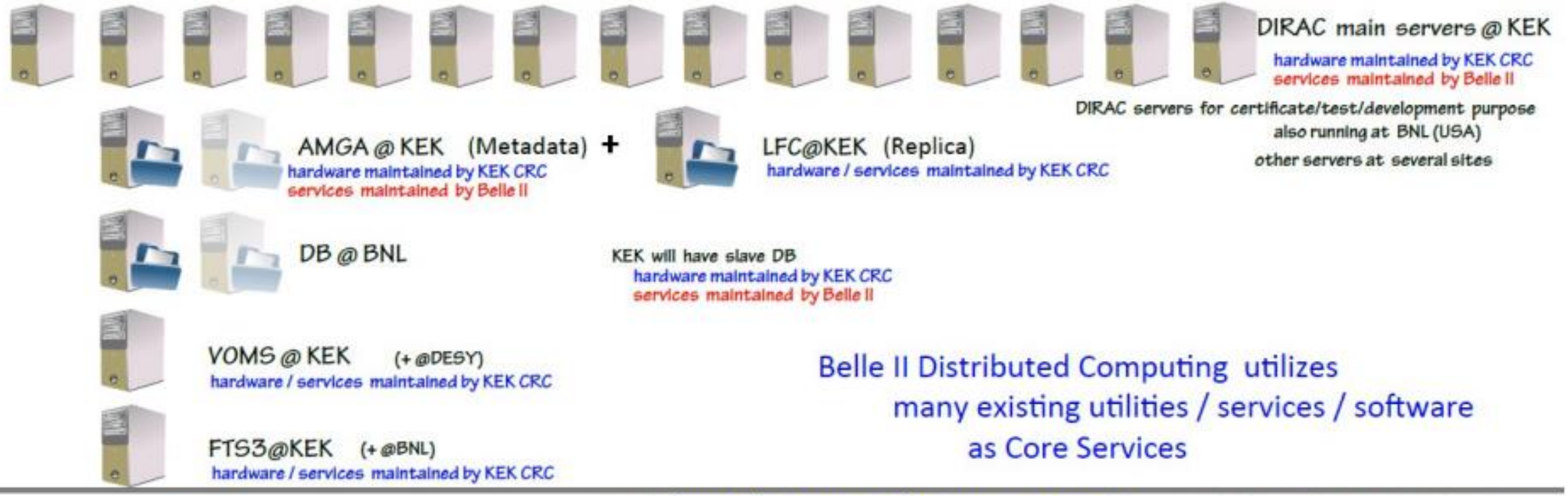
- A set of "large" and "stable" sites host the initial replicas (cf. Regional Data Centers)
  - on its TMP-SE
- "Merge" jobs to run at those large sites

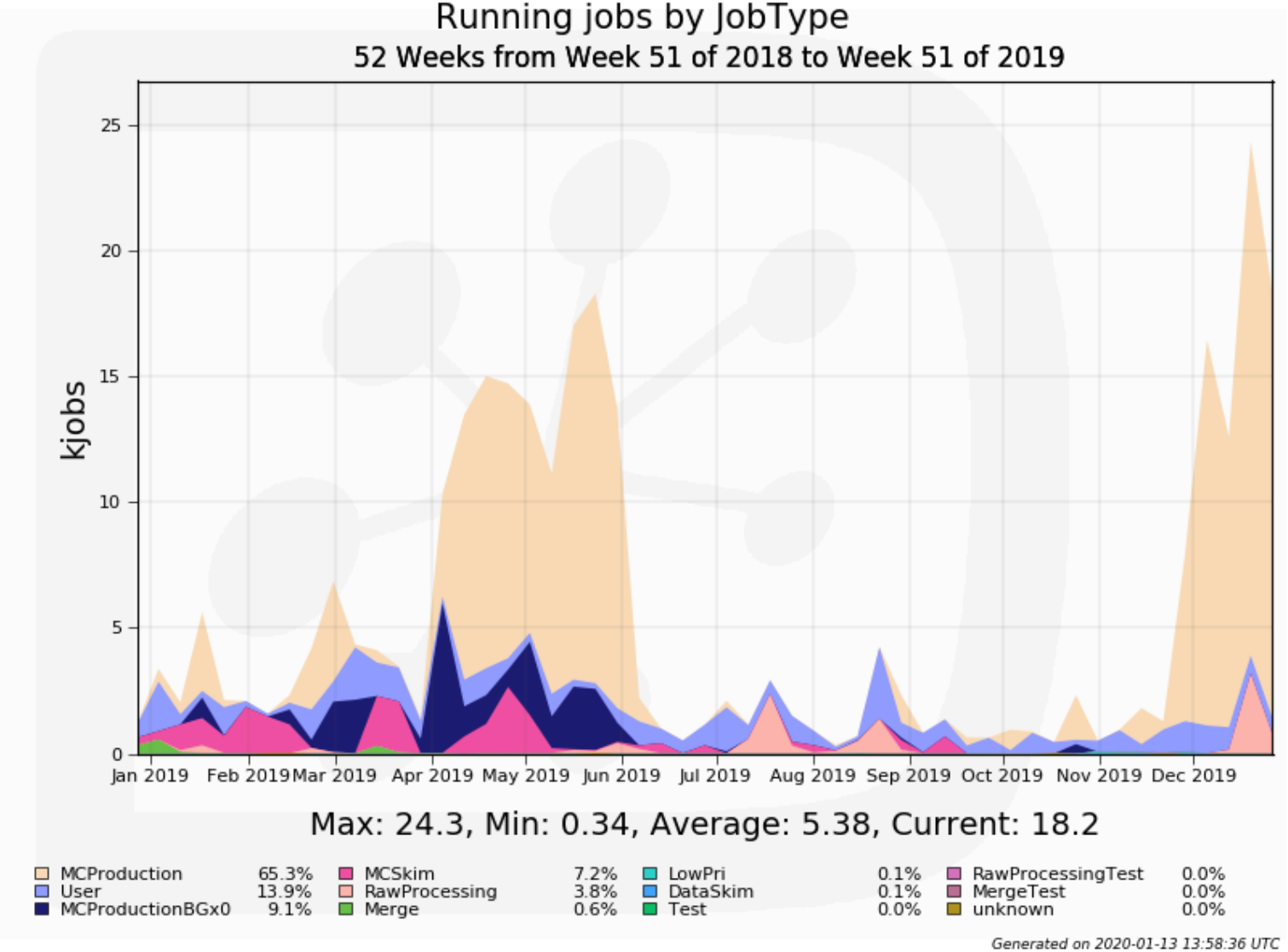
Data distribution

- The "final" output (after merge steps) are replicated from the primary SEs to other SEs



Computing Infastructure




Running jobs by JobType
52 Weeks from Week 51 of 2018 to Week 51 of 2019
kjobs
25
20
15
10
5
0
Jan 2019
Feb 2019
Mar 2019
Apr 2019
May 2019
Jun 2019
Jul 2019
Aug 2019
Sep 2019
Oct 2019
Nov 2019
Dec 2019
Max: 24.3, Min: 0.34, Average: 5.38, Current: 18.2
MCProduction 65.3%
User 13.9%
MCProductionBGx0 9.1%
MCSkim 7.2%
RawProcessing 3.8%
Merge 0.6%
LowPri 0.1%
DataSkim 0.1%
Test 0.0%
RawProcessingTest 0.0%
MergeTest 0.0%
unknown 0.0%
Generated on 2020-01-13 13:58:36 UTC

DATA FLOWS LIST : 2 full copy for each data type

TYPE OF DATA	2018-2020	2021-2024
RAW Data Replication	100% BNL up to 2020.	BNL (30%) and other sites Italy, Germany, Canada, France.
MDST (Data Processing)	Produced at KEK and BNL and sent to all sites	Produced at KEK, BNL and in all RAW data centers and then sent to all sites.
Data Reprocessing	Produced at BNL and sent to all sites up to 2020.	BNL and in all RAW data center and sent to all sites.
Skimming	Produced by all sites and sent to all sites. The amount of data stored in each site depend from the number of phd	
MC Reprocessing		
MC pre-Data Taking		
MC Data		
Analysis	Chaotic	