



# IBiSCo usage for the Belle II experiment

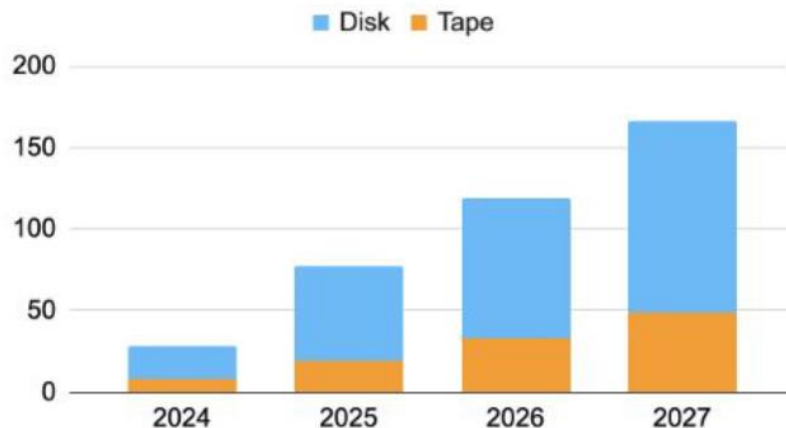
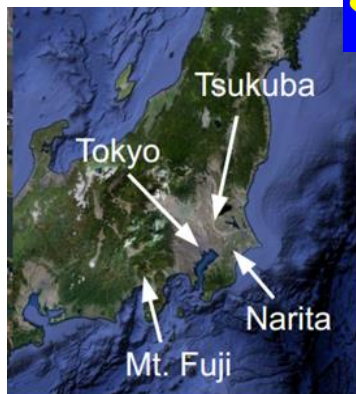
Dr. Silvio Pardi for the Belle II Napoli group

# Belle II Experiment

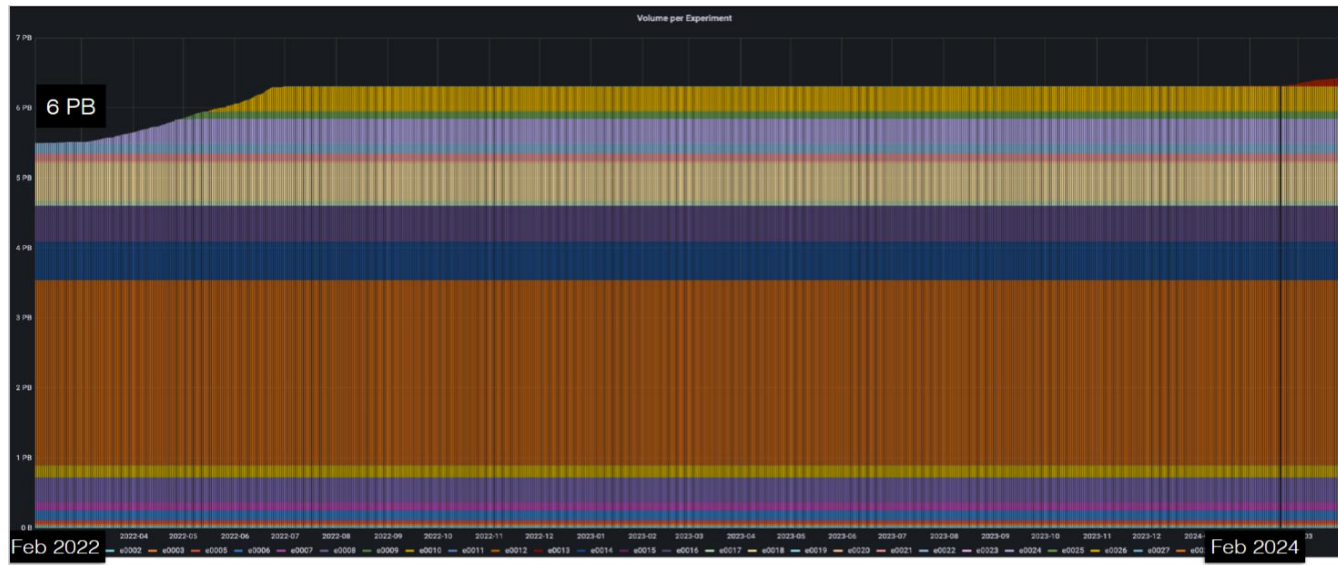


Asymmetric lepton collider.

- Upgrade from previous Belle experiment.
- 50 ab<sup>-1</sup> at the end of the experiment (x50 than the previous B factories)
- Estimated size of the dataset collected by the experiment is O(10) PB/year.



- Data taking started in 2019.
- In July 2022 we started the Long Shutdown 1
- Data taking restarted early 2024, first collision 20 February 2024



# Belle II Computing Model

Similar to WLCG, but without using the term "Tier-N"

## KEK = Host laboratory (cf. T0)

- To register detector data onto Grid
- Permanent store of 100% raw data
- Prompt processing
- incl. the activities below

## Raw Data Centers (cf. T1)

- Permanent store of replica raw data distributed over 6 sites
- Prompt processing and Reprocessing
- incl. the activities below

## Regional Data Centers (cf. T1+T2)

- To host data for analysis
- incl. the activities below

## MC Production Centers (cf. T1+T2+T3)

- To run MC production jobs and analysis jobs



## DIRAC

- The main system with configuration, workload management + data I/O by jobs
  - We used to have a DIRAC extension for "dataset" distribution and deletion => switched to Rucio
- Hosted at KEK, BNL, and a few other sites

## Rucio

- The distributed data management system
- File catalog + Metadata catalog
  - We used to use LFC, migrated to Rucio in 2021
  - We have been using AMGA, supported by KISTI, but now moving to Rucio
- Hosted at BNL

## FTS

- To transfer files (protocol = mostly davs, in some cases srm+https, or root)
- Hosted at KEK and BNL

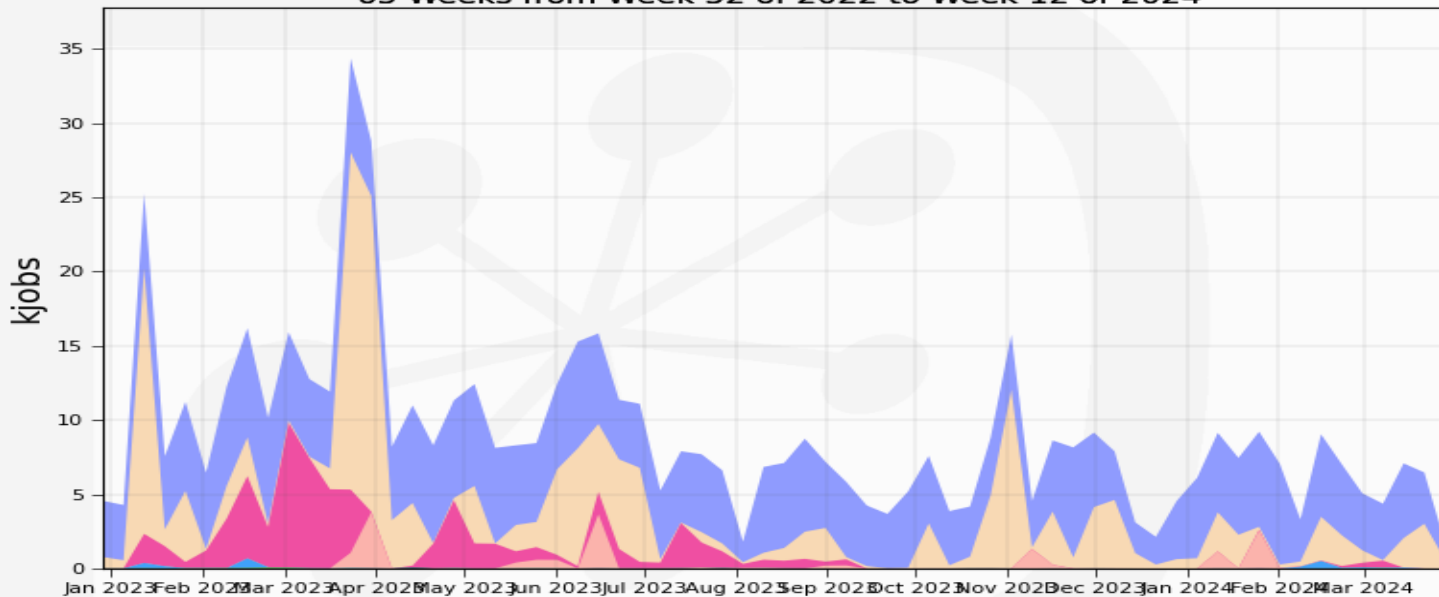
## VOMS, IAM

- Hosted at KEK (VOMS replica at DESY for redundancy)
- Test IAM at CNAF, for early phase testing (very helpful)

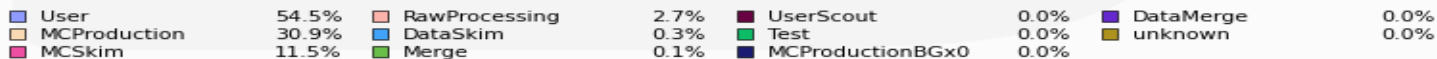
2024.Feb.06 - BPAC annual review - Computing - Ueda I.

## Running jobs by JobType

65 Weeks from Week 52 of 2022 to Week 12 of 2024



Max: 34.3, Min: 1.71, Average: 8.99, Current: 1.71



Generated on 2024-04-17 15:45:12 UTC

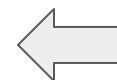
- 55 sites providing pledged and opportunistic resources
- 29 Storages
- 5 Tape systems

TYPE	Resource provided
CPU Pledge	451.6 kHS06/kHS23
CPU Oport.	408.9 kHS06/kHS23
DISK	16.8 PB
TAPE	11.9 PB

For Production: 31 kjobslots pledged and 33 kJobslot opportunistic

\*Additional storage under implementation in some of the sites

TYPE	Resource provided
CPU	36,7 kHS06/HS23
DISK	550 TB



Resource for calibration

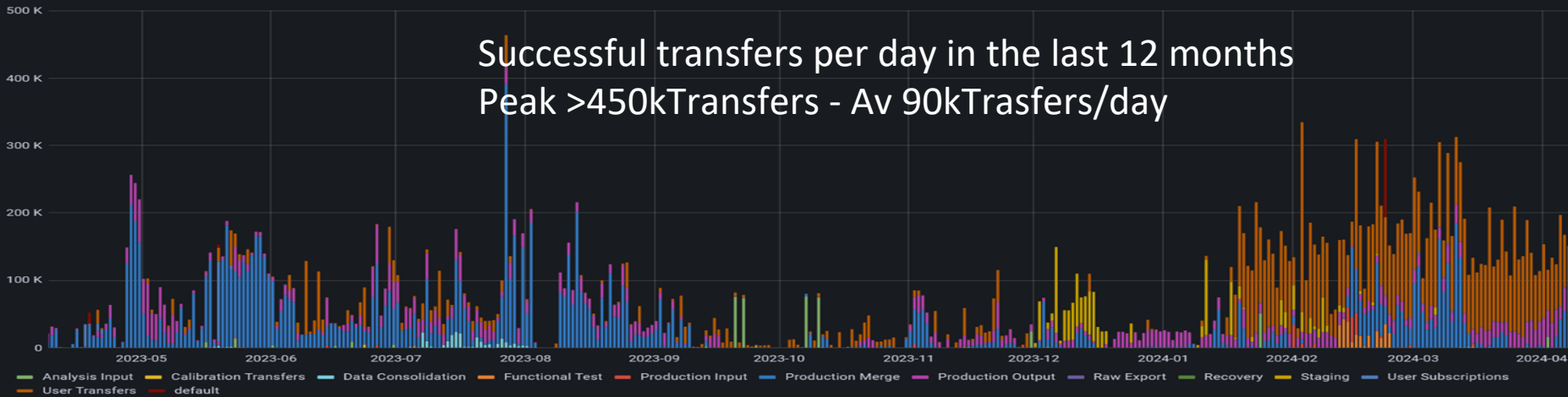
## NEW CHALLENGES FOR SITES

- Token Based Authentication
- End-of-life of storage technologies (DPM, gsiftp, srm)
- Update the Operative system (RHEL9/Almalinux9)
- Network Operation (Link update, Jumbo Frame)

# Belle II Computing Model

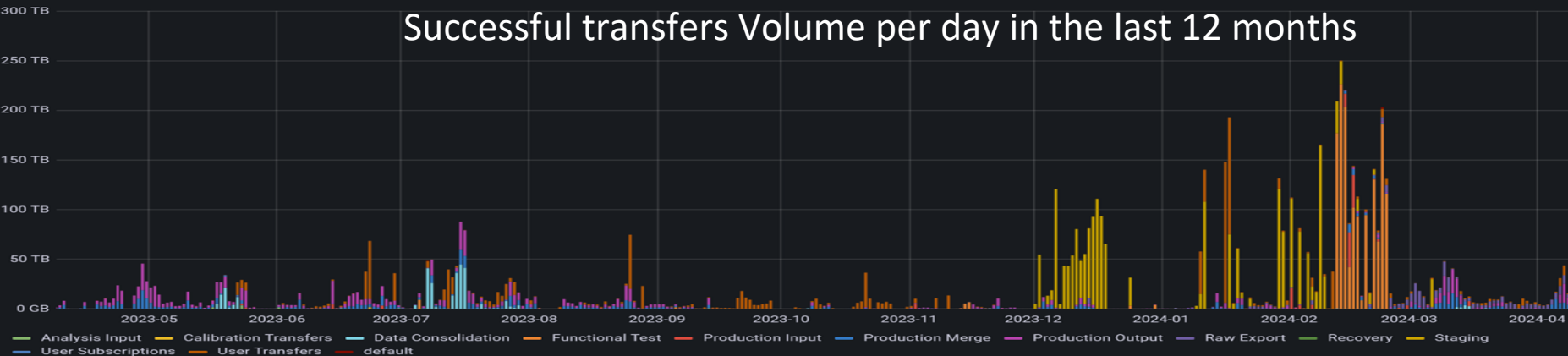
Successful transfers (activity)

Successful transfers per day in the last 12 months  
Peak >450k Transfers - Av 90k Trasfers/day



Successful transfers volume (activity)

Successful transfers Volume per day in the last 12 months





2PB of Storage Reserved for Belle II, the disk space is released for the collaboration according with the pledged program.

32 Nodes dedicate for Belle II each one with 48 core and 96 threads for a total of 3.072 thread.

Each node provides 1.1 kHS06 for a total of more than 35 kHS06 available for the experiment

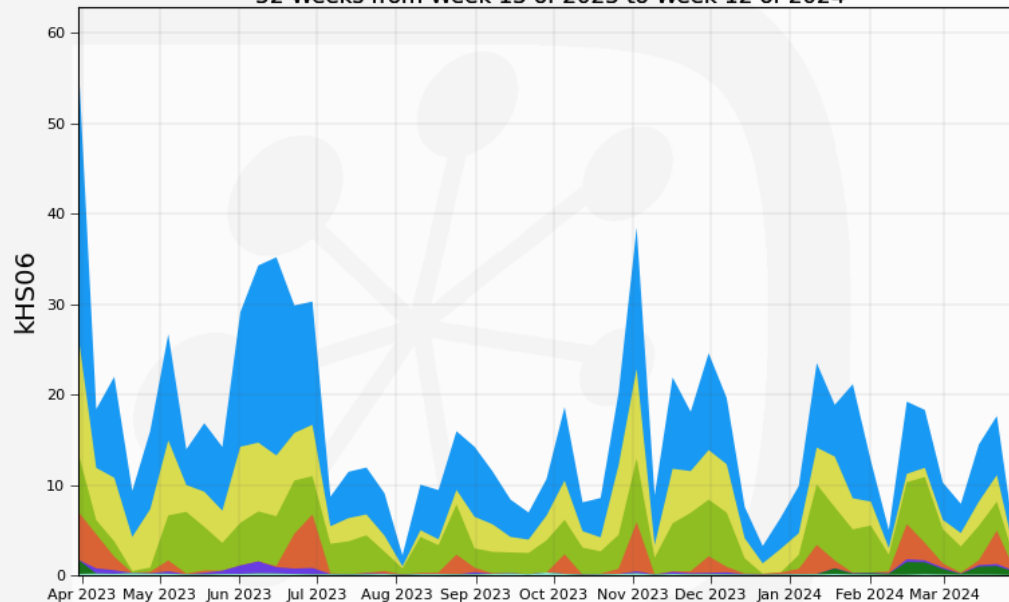
The available resources are enough to cover the pledged request for the next years



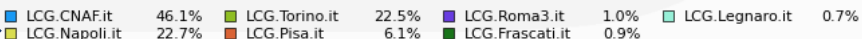
# Belle II Italian Sites

## Normalized CPU usage by Site

52 Weeks from Week 13 of 2023 to Week 12 of 2024



Max: 57.2, Min: 2.20, Average: 16.4, Current: 3.80



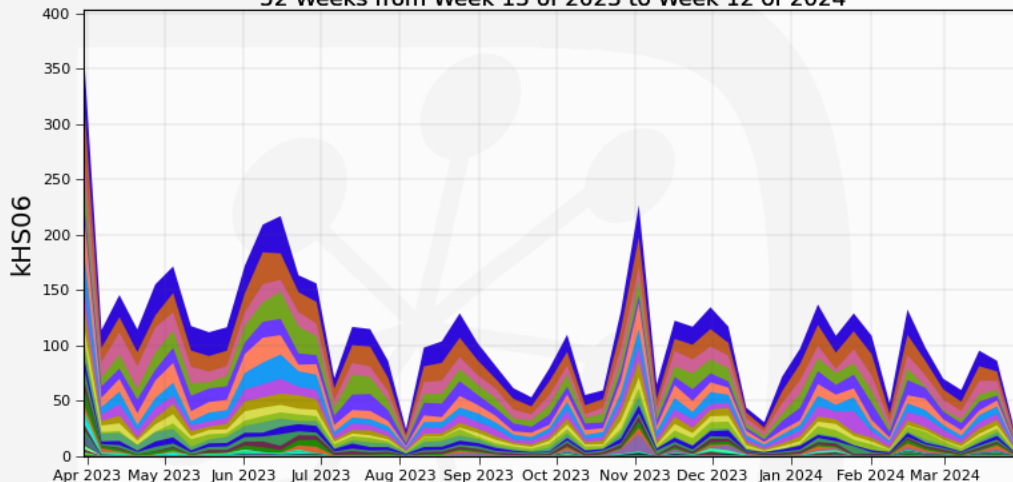
Generated on 2024-04-17 08:44:42 UTC

SITE	kHS06 Pledged	kHS06 Opportunistic
CNAF	27	
Napoli+Cosenza	14	10
Pisa	8	10
Torino	6	24
Frascati		0,5
Roma3		1
Legnaro		2
<b>TOTAL</b>	<b>55 kH06</b>	<b>47,5 kHS06</b>

# Usage of Computing resources in Belle II

## Normalized CPU usage by Site

52 Weeks from Week 13 of 2023 to Week 12 of 2024



Max: 367, Min: 22.3, Average: 112, Current: 22.3

OSG.BNL.us	14.5%	LCG.Napoli.it	3.3%	LCG.KISTI.kr	0.3%	LCG.Legnaro.it	0.1%
LCG.KEK.jp	12.4%	LCG.Torino.it	3.3%	LCG.TAU.il	0.3%	DIRAC.Shandong.cn	0.1%
ARC.SIGNET.si	9.5%	CLOUD.Australia.au	2.8%	EuroHPC.Vega.si	0.3%	OSG.UMiss.us	0.1%
DIRAC.UVic-local.ca	9.0%	LCG.CESNET.cz	2.7%	LCG.IHEP.cn	0.3%	DIRAC.BIN.ru	0.1%
LCG.KEK2.jp	8.1%	LCG.IN2P3CC.fr	2.1%	LCG.CYFRONET.pl	0.2%	LCG.ULAKBIM.tr	0.1%
LCG.DESY.de	7.6%	LCG.HEPHY.at	1.8%	DIRAC.INDU.jp	0.2%	DIRAC.TMU.jp	0.1%
LCG.CNAF.it	6.8%	LCG.KIT-TARDIS.de	1.6%	LCG.Roma3.it	0.2%	LCG.KMI.jp	0.0%
LCG.KIT.de	5.9%	LCG.Pisa.it	0.9%	LCG.LAL.fr	0.1%	DIRAC.Niigata2.jp	0.0%
DIRAC.UVic.ca	4.4%	ARC.MPPMU.de	0.8%	LCG.Frascati.it	0.1%	... plus 15 more	

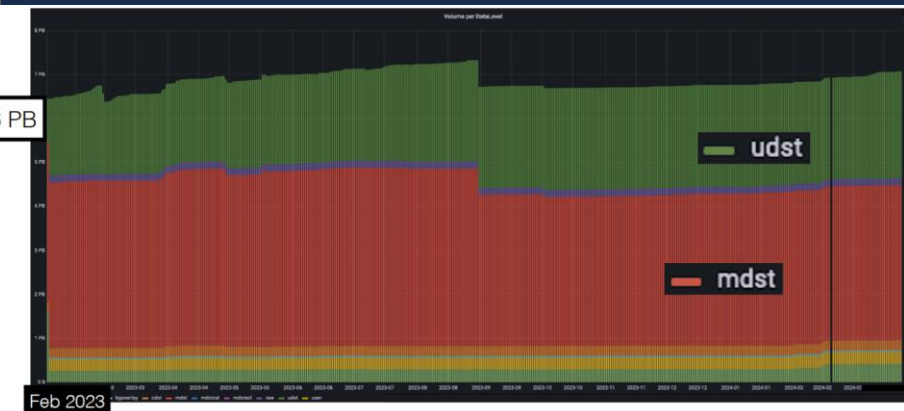
Generated on 2024-04-16 15:19:47 UTC

**Milestone for Italy 2023/24- 12%  
Italian Share in the last 12 months  
13.1%**

- Peak > than 40k jobs running.
- 32k Job Slots Pledged and a similar amount of Opportunistic resources
- User Jobs 51.2%

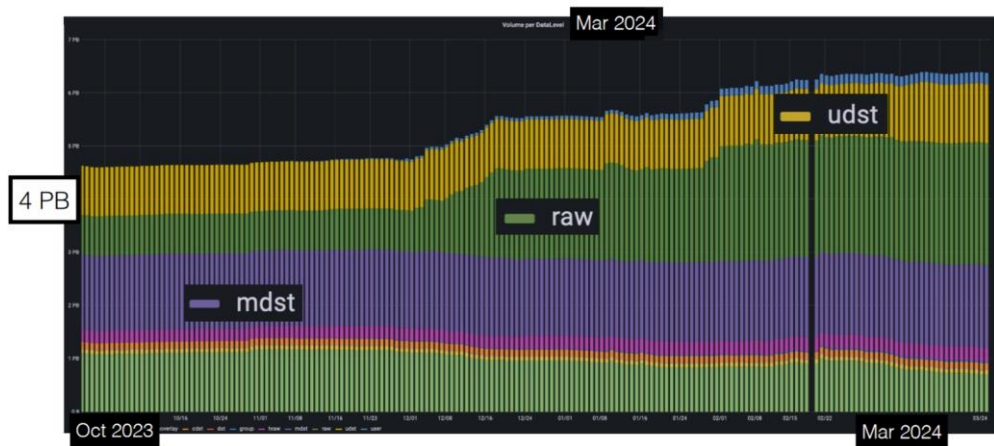
**IBiSCo Napoli on the TOP 10**

# Storage Resources in Belle II



Temporary data/replicas on DISK  
intermediate output, raw data  
staged for reprocessing, analysis  
output, calibration data, ...

Persistent data on DISK with life cycles based on  
data production/processing campaigns  
mdst: reconstructed data (both real data and MC)  
udst: skimmed data produced from mdst, with  
additional parameters for analysis

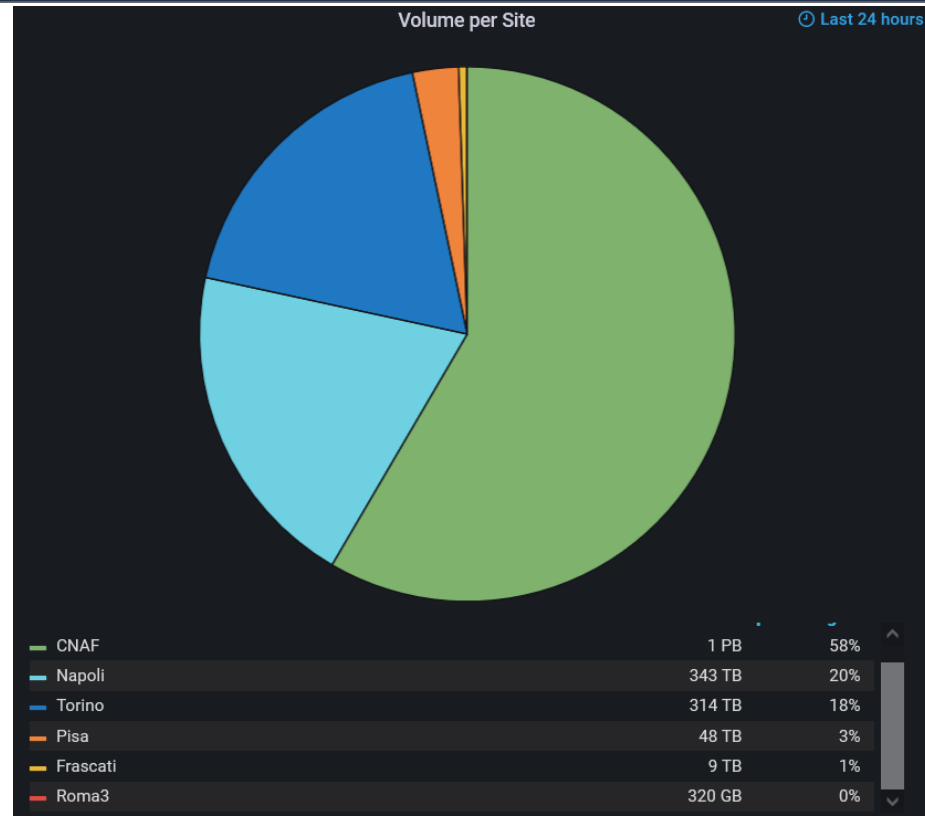


# Storage Resources

IBiSCo Napoli Storage in the set of PRIMARY Storage of Belle II experiment which include the more stable and performant facilities of the collaboration.

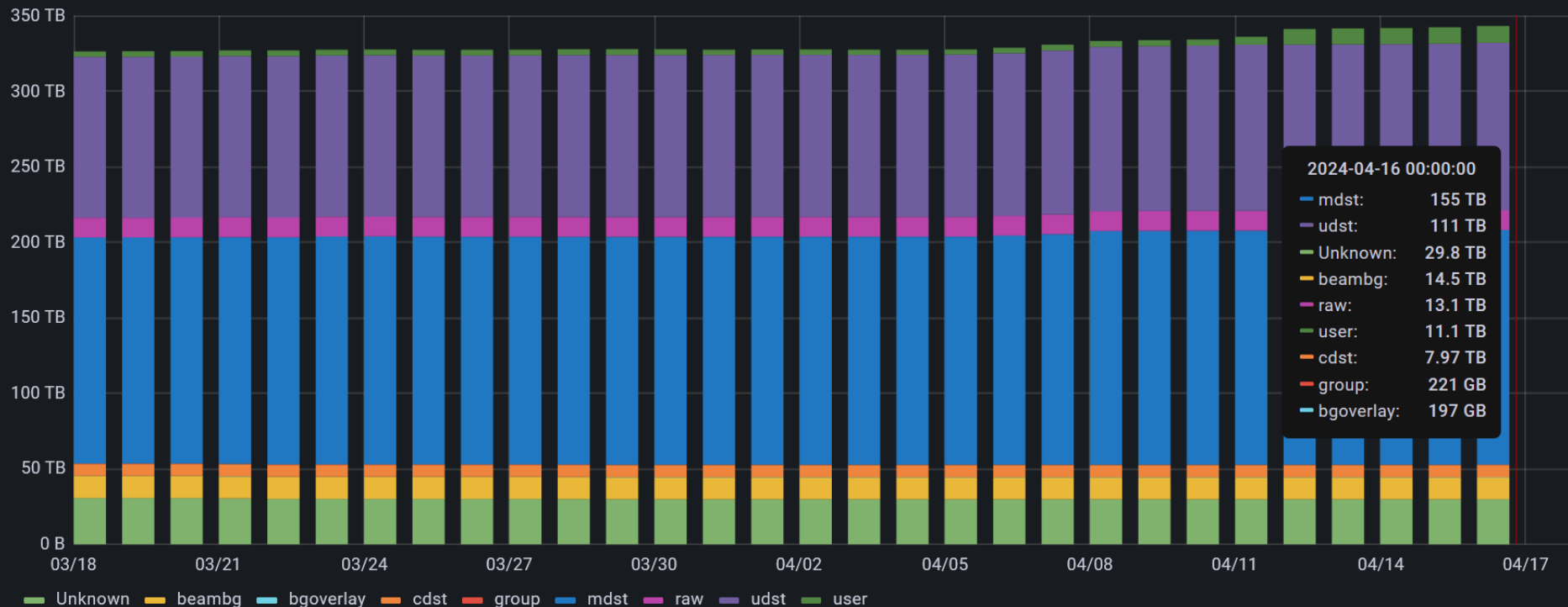
The disk area is dynamically managed by the Data Management System.

Currently there are 343TB occupied



# Usage of IBiSCo Napoli Storage in Belle II

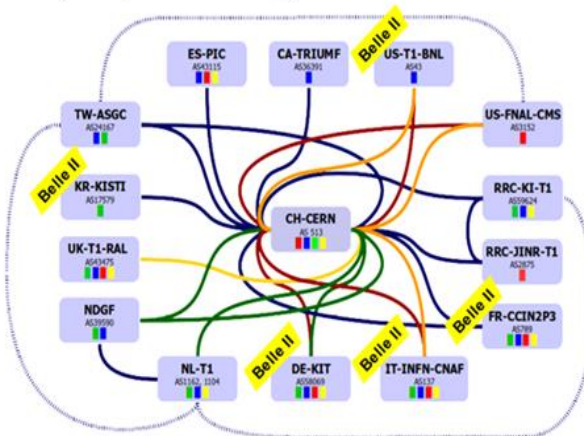
Volume per DataLevel ▾



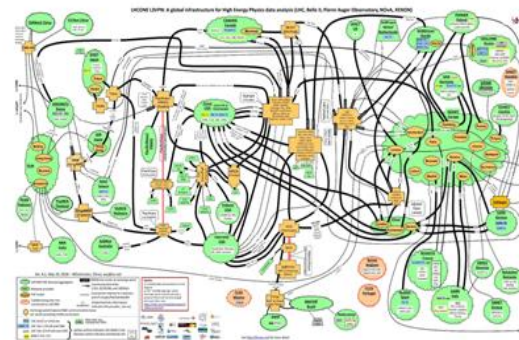
## 100G Global Ring runned by SINET



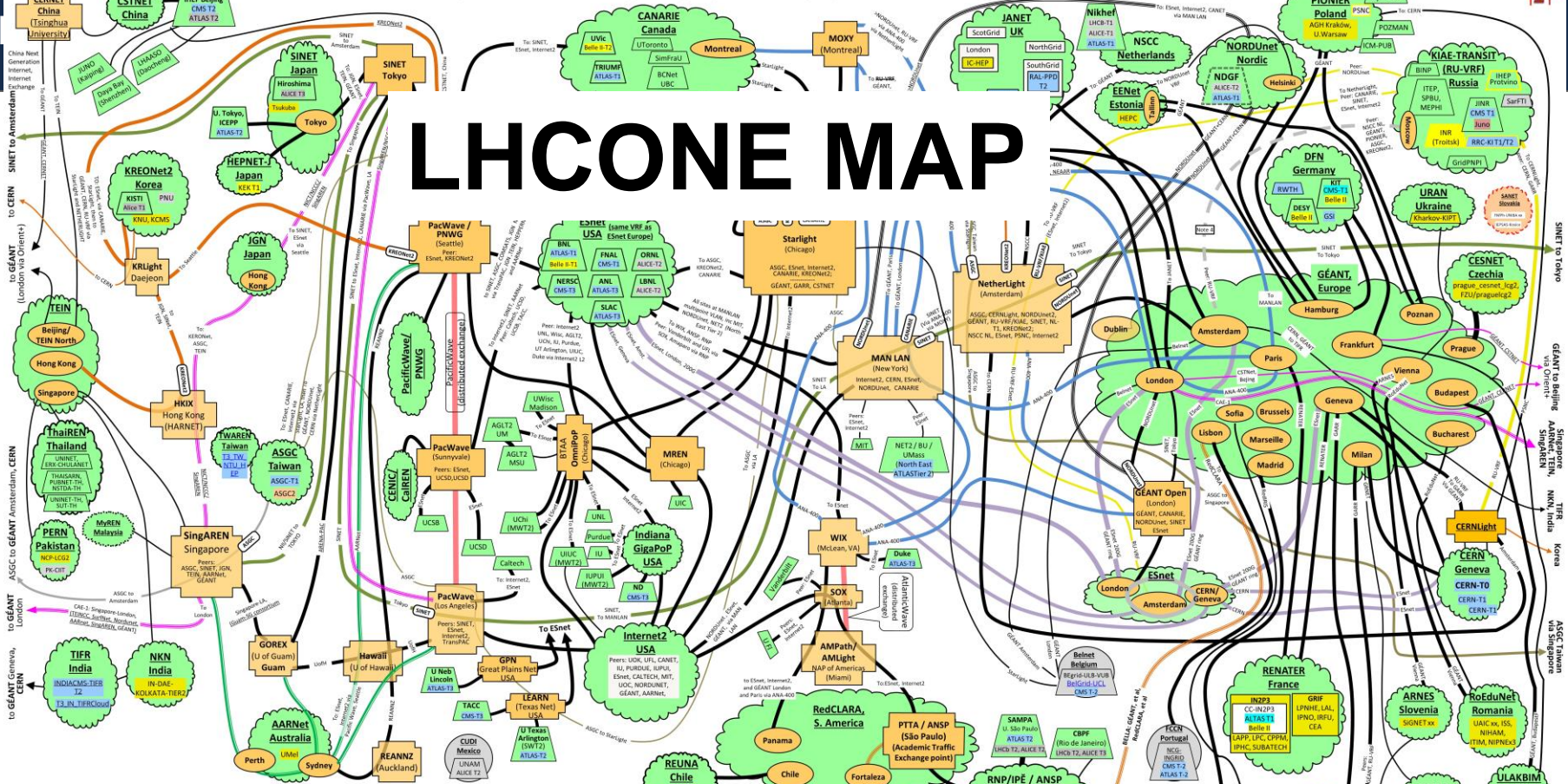
## LHCOPN Optical infrastructure that can be used without jeopardizing resources



## LHCONE L3 VPN Connecting all the major Data Centres



# LHCONE MAP



**LHCONE Map Ver. 6.0, 2022-11-15 – WEJohnston, Esnet, wej@es.net**

**Legend:**

- Green cloud:** LHCONE VRF domain/aggregator - A provider network.
- Orange box:** Connector network – provides, e.g., an IP path between VRFs.
- Blue circle:** Provider network PoP router.
- Blue square:** WLCG sites that are NOT connected to LHCONE.
- Blue triangle:** Exchange point.
- Black line:** NREN/site router at exchange point.
- Black line with dots:** Communication links: 1/10, 20/30/40, and 100Gb/s or N x 100G.
- Thin black line:** Underlined link information.
- Thin black line with dots:** Indicates link provider; not use.
- Double dash outline:** Indicates distributed site.
- Light blue outline:** Future site.

**International infrastructure by provider/collaboration**

- Black line:** Various
- Green line:** ARIANet
- Orange line:** GEANT
- Blue line:** SINET, Japan, global ring
- Light blue line:** ASGC, Taiwan
- Dark blue line:** Esnet transcantastic, USA
- Light green line:** NICT/NCC/C/Singaren
- Light purple line:** ANA-300/400 - Various links provided by CANARIE, Esnet, GEANT, Internet2, NORDUnet, SURFnet, SINET, IU/NSF
- Light blue line:** SINET
- Light green line:** NORDUnet
- Light orange line:** KIAE, Russia
- Light purple line:** KREONet2, Korea
- Light blue line:** BELLA: GEANT, et al
- Light green line:** RedCLARA, et al

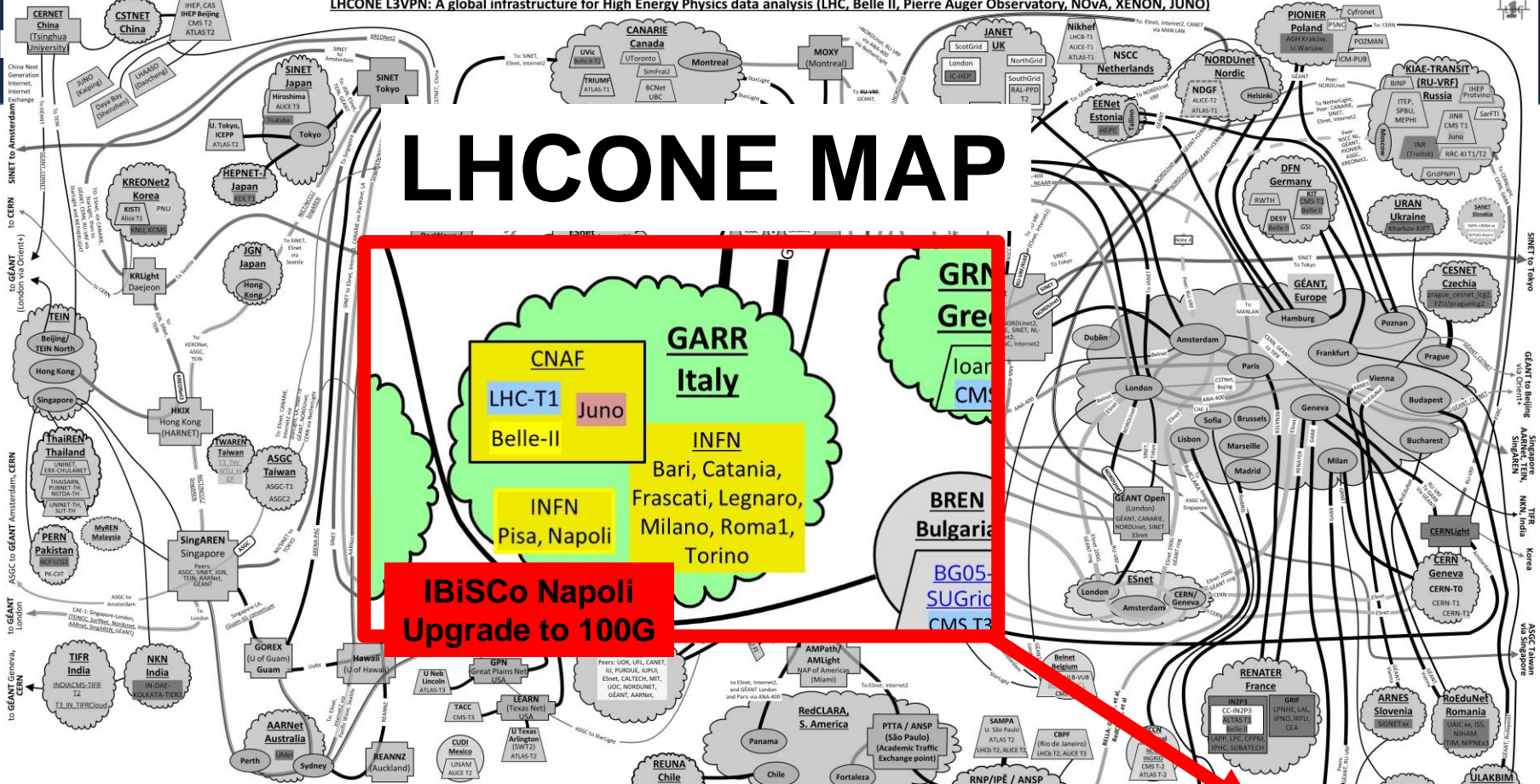
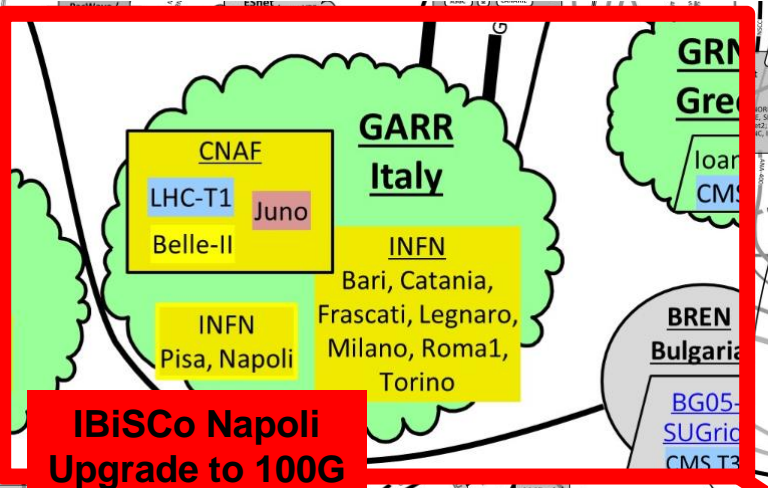
**Legend for sites:**

- SHKRT:** LHC ALICE or LHCb site
- CNAF-T1:** LHC Tier 1 ATLAS and CMS
- UChi:** LHC Tier 2/3 ATLAS and CMS
- KEK:** Belle II Tier 1/2
- JUNO:** JUNO
- Light blue box:** Sites that are standalone VRFs

**NOTES**

- 1) ONLY links involved in LHCONE are shown
- 2) LHCOPN links are not shown on this diagram
- 3) For map explanation see: "Interpreting the LHCONE Map" at <https://www.dropbox.com/s/1w6o5t8901tra/AD08B58708F8FC1A4cCrea?dl=0>
- 4) GEANT and CANARIE have shutdown the peering between their VRF and KIAE, as a result of the Ukraine war.

# LHCONE MAP



LHCONE Map Ver. 6.0, 2022-11-15 – WEJohnson, Etnet, wej@es.net

- LHCONE VRF domain/aggregator - A provider network.
- Connector network – provides, e.g., an IP path between VRFs.
- Provider network PoP router.
- WLCG sites that are not connected to LHCONE.
- Exchange point.

International infrastructure by provider/collaboration

- Various
- AARNet
- GÉANT
- SINET, Japan, global ring
- ASGC, Taiwan
- Etnet transatlantic, USA
- NIC/T/NCC/Singapore
- ANA-300/400 – Various links provided by CANARIE, Etnet, GÉANT, Internet2, NORDUnet, SURFnet, SINET, IU/NSF
- SINET
- NORDUnet
- KIAE, Russia
- KREONet2, Korea
- BELLA: GÉANT, et al
- RedCLARA, et al

SHK/T/E: LHC ALICE or LHCb site  
 CNAF-T1: LHC Tier 1 ATLAS and CMS  
 UCH: LHC Tier 2/3 ATLAS and CMS  
 KER: Belle II Tier 1/2  
 JUNO: JUNO

Sites that are standalone VRFs

NOTES

- ONLY links involved in LHCONE are shown
- LHCOPN links are not shown on this diagram
- For map explanation see "Interpreting the LHCONE Map" at <https://www.dropbox.com/ln/1/0/20/30/40?dl=1&AD=8559878F8FC1A4eCea3e0f14>
- GÉANT and CANARIE have shutdown the peering between their VRF and KIAE, as a result of the Ukraine war.



- Authentication with token for computing and storages resources
- Currently running DIRAC v7r3, Migration to DIRAC 8.0
- Migration from AMGA Metadata Catalog to RUCIO
- Transition from SRM/Gsiftp to DAVS/Https protocols for storage access
- Cloud resources: Exploit new technologies for use Cloud resources

IBiSCo Napoli is a testbed site for new technologies.

# Conclusions

Belle II resumed data taking in early 2024, and activities are now ongoing to collect new data and continue the intense scientific program.

The IBiSCo Napoli site is actively contributing to distributed computing activities by providing stable, up-to-date, and well-ranked computational and storage resources.

Thanks to its extensive experience in running data centers, the Napoli site is also coordinating infrastructure and network activities for the entire experiment. The IBiSCo site serves as a reference center for testing new technologies.