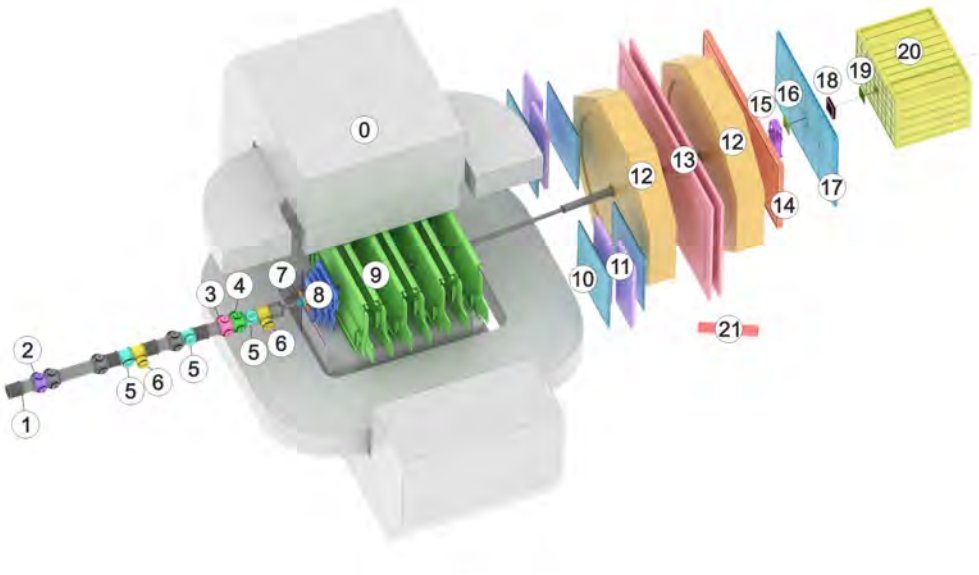
BM@N Run 8 raw data production on distributed infrastructure with DIRAC



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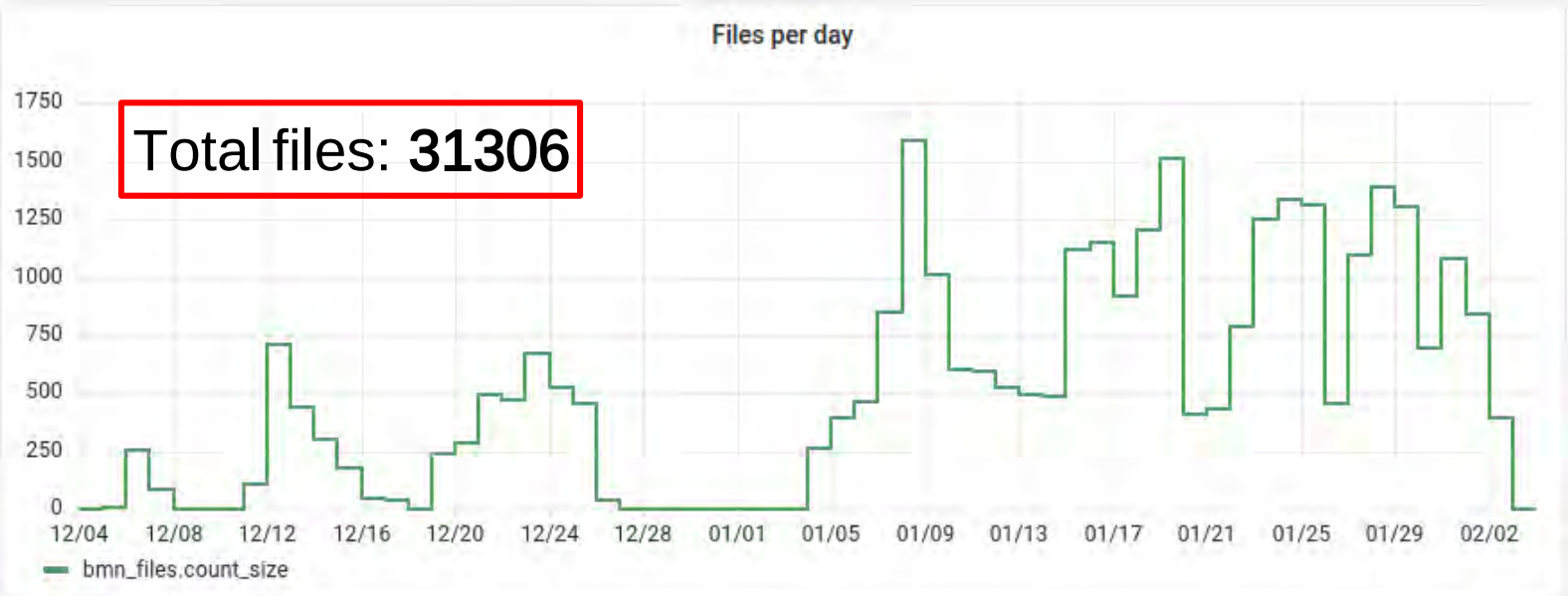
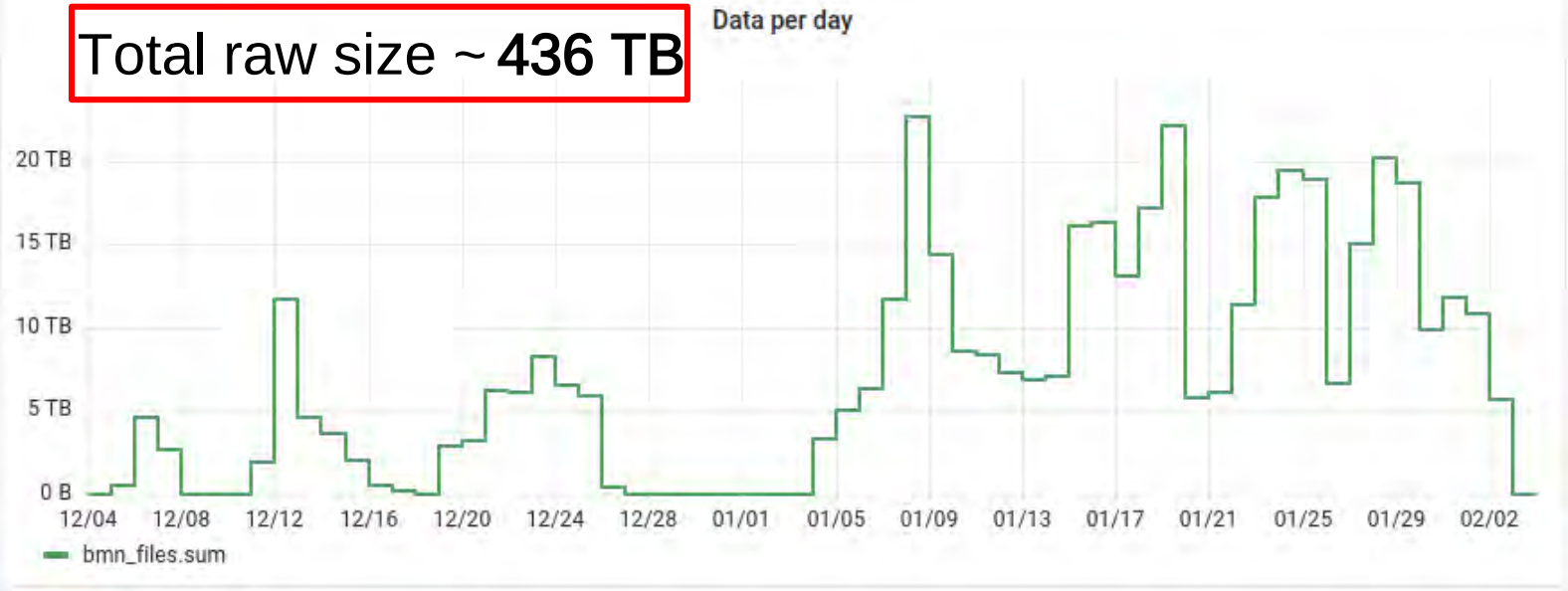
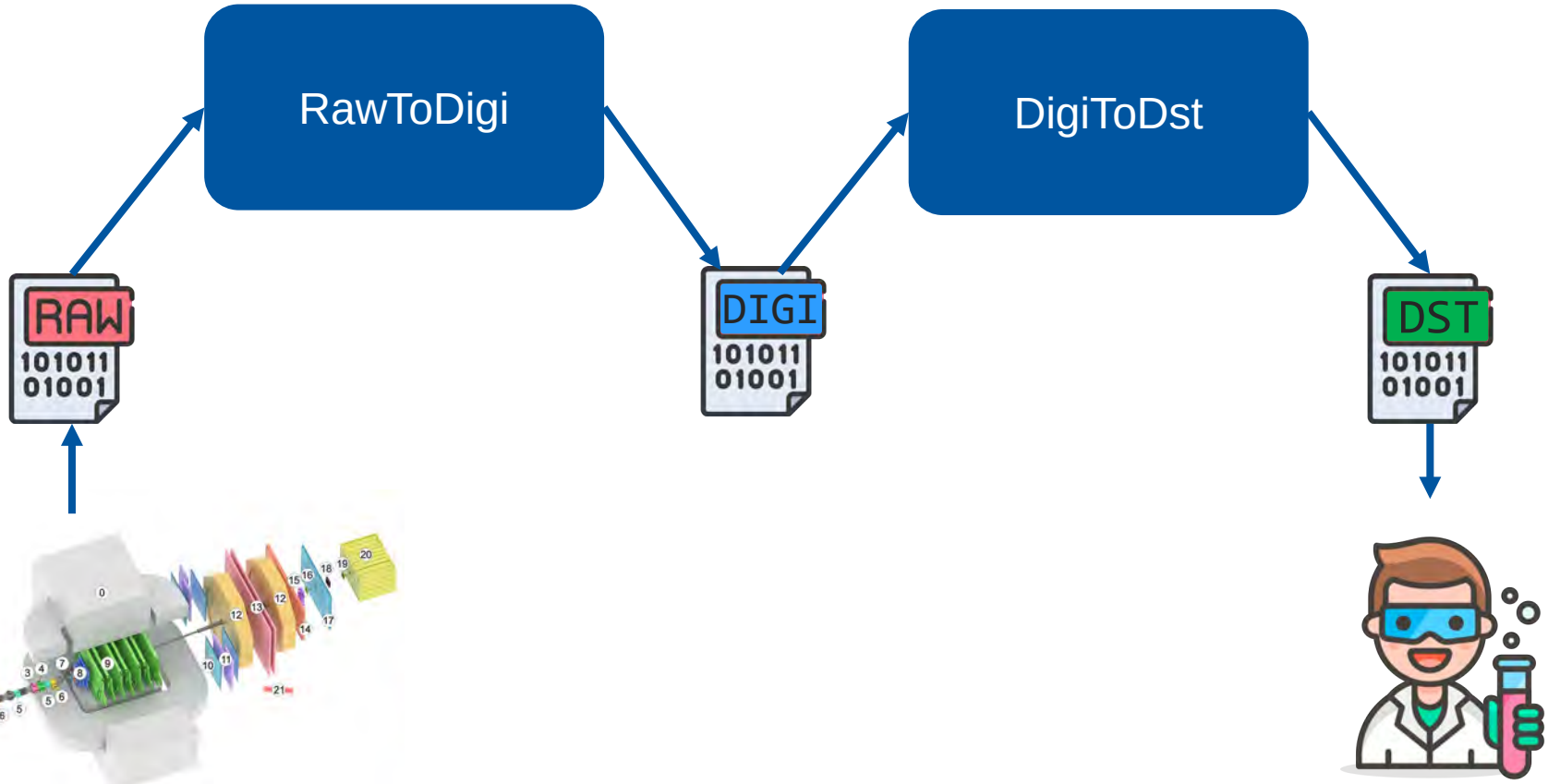
AYSS Conference 2023, 30 October - 03 November 2023

Run8 Data collection





Workflow of production



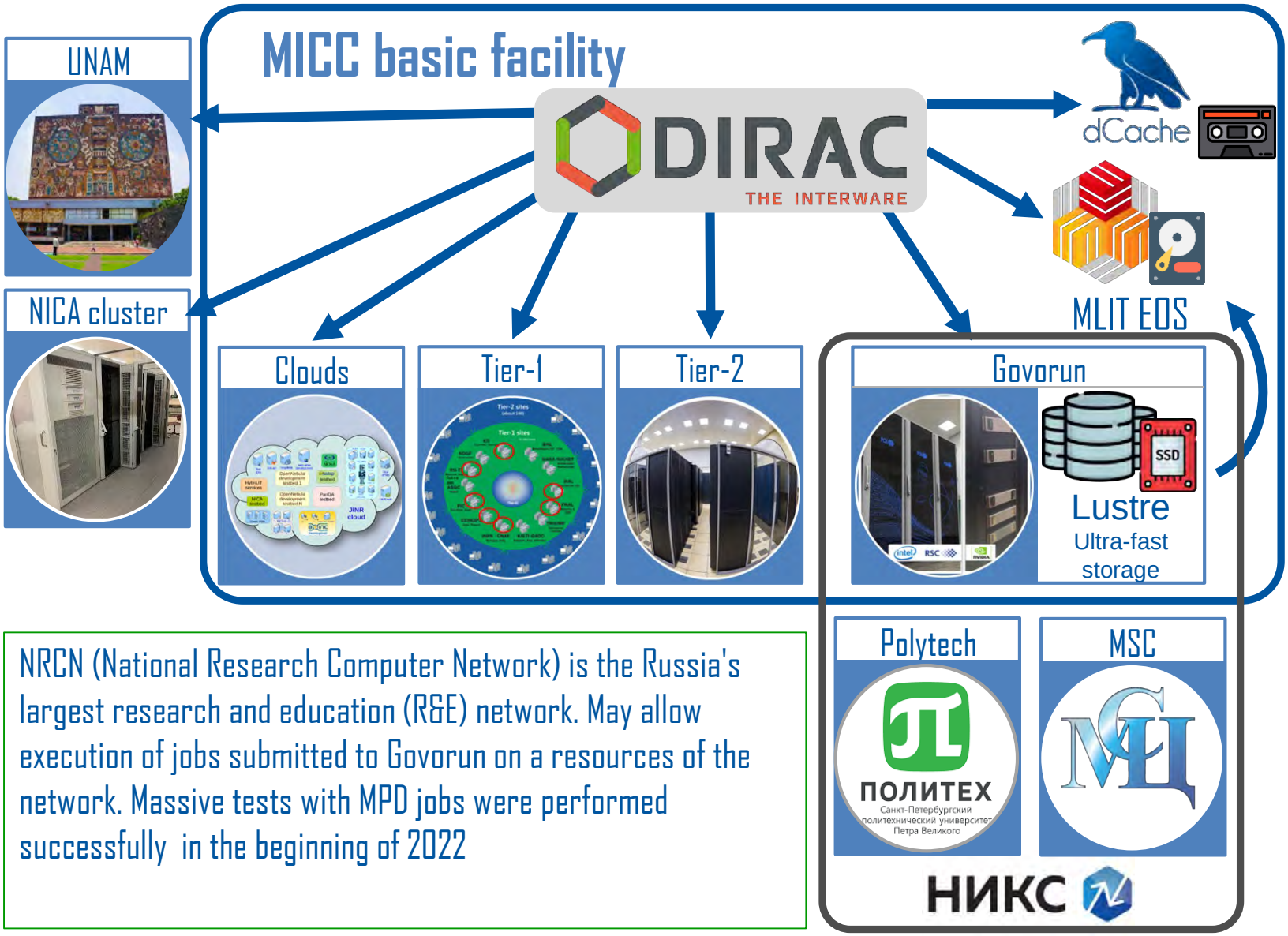
The main task:

Develop fast and repeatable way to consistently perform BM@N productions for all data in general,
and for BM@N Run8 in particular

Side task:

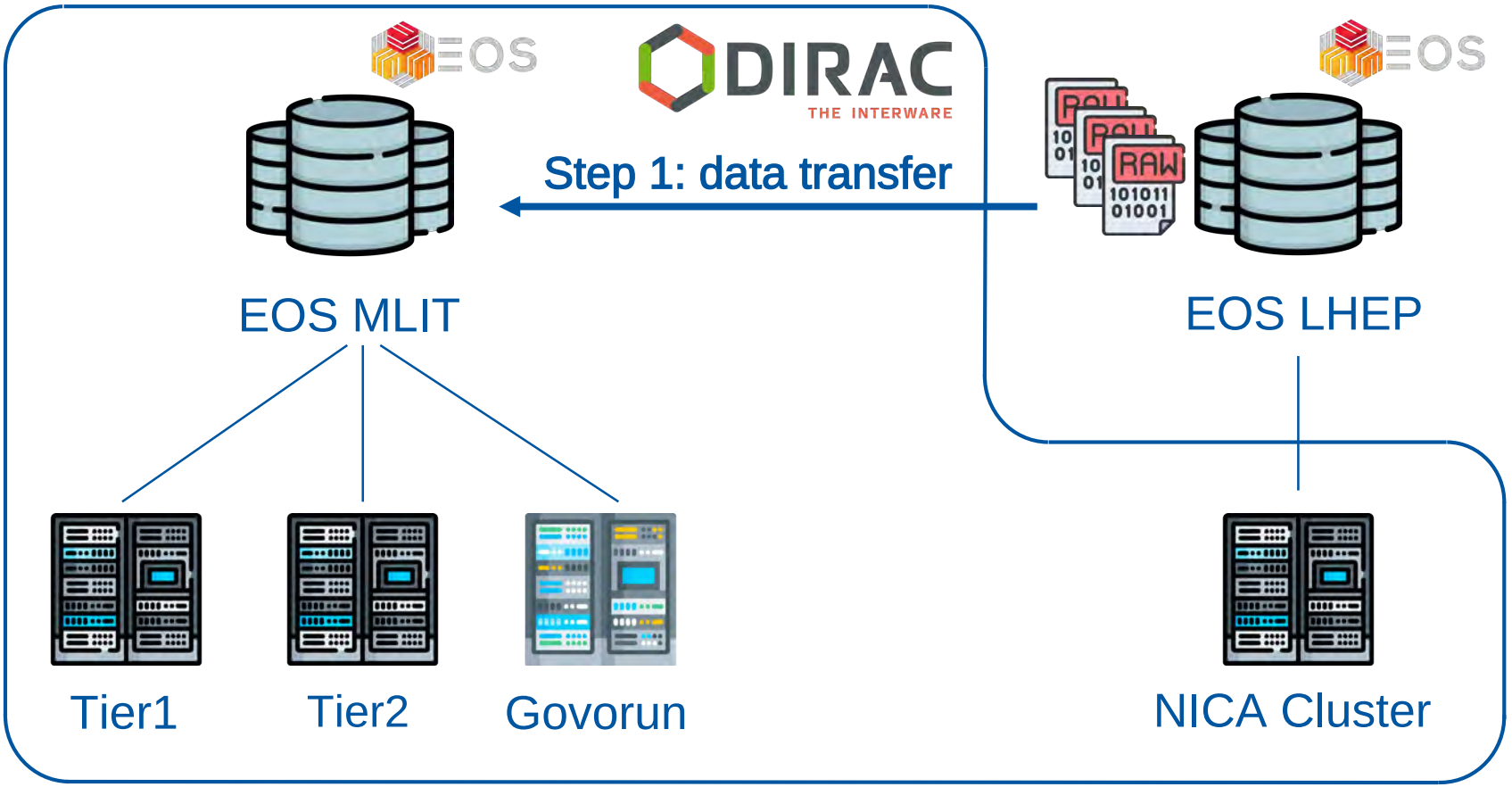
Develop methods to record and use information about current productions
for estimation of future productions

DIRAC in JINR

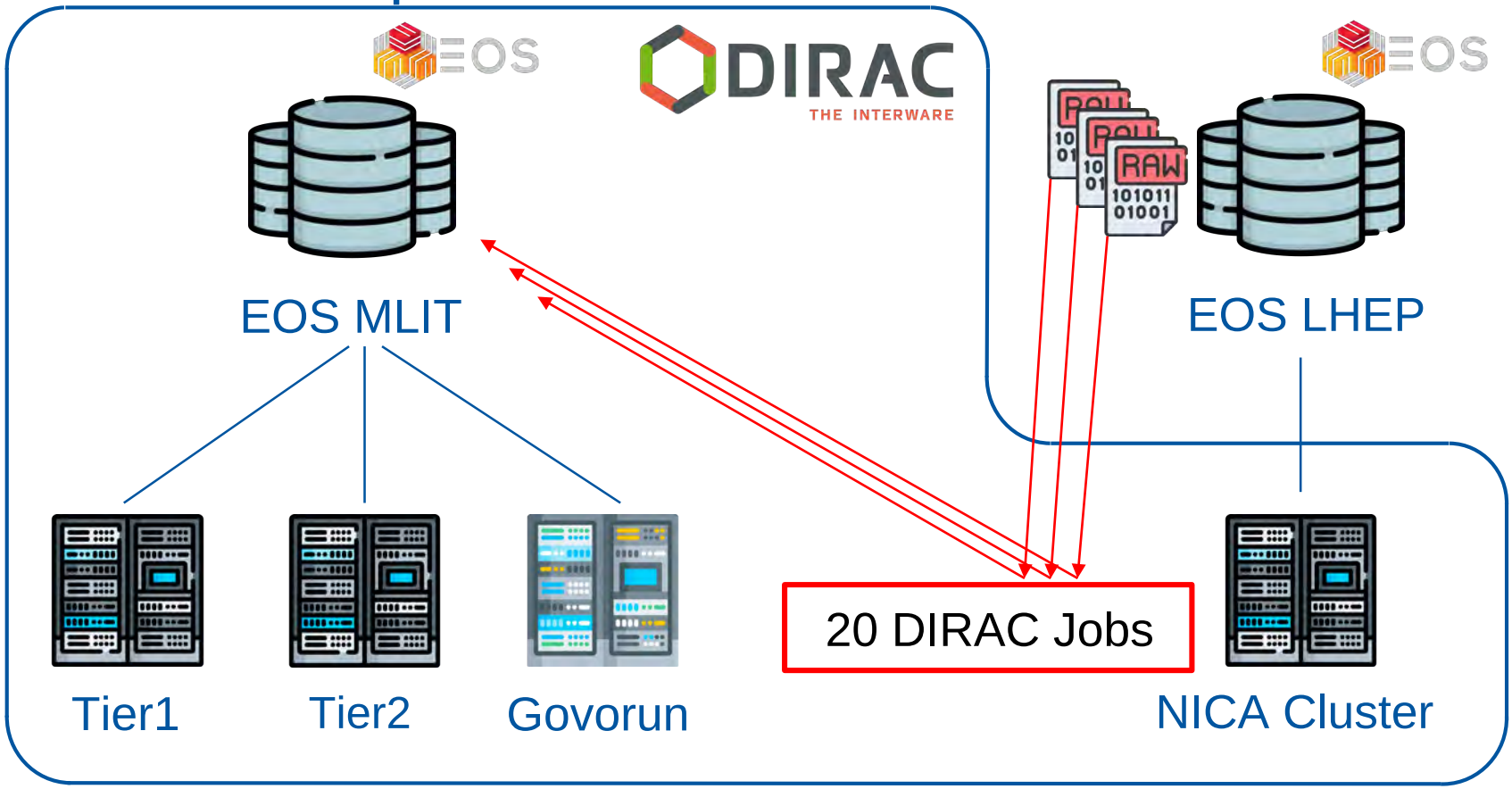


NRCN (National Research Computer Network) is the Russia's largest research and education (R&E) network. May allow execution of jobs submitted to Govorun on a resources of the network. Massive tests with MPD jobs were performed successfully in the beginning of 2022

General scheme of resources



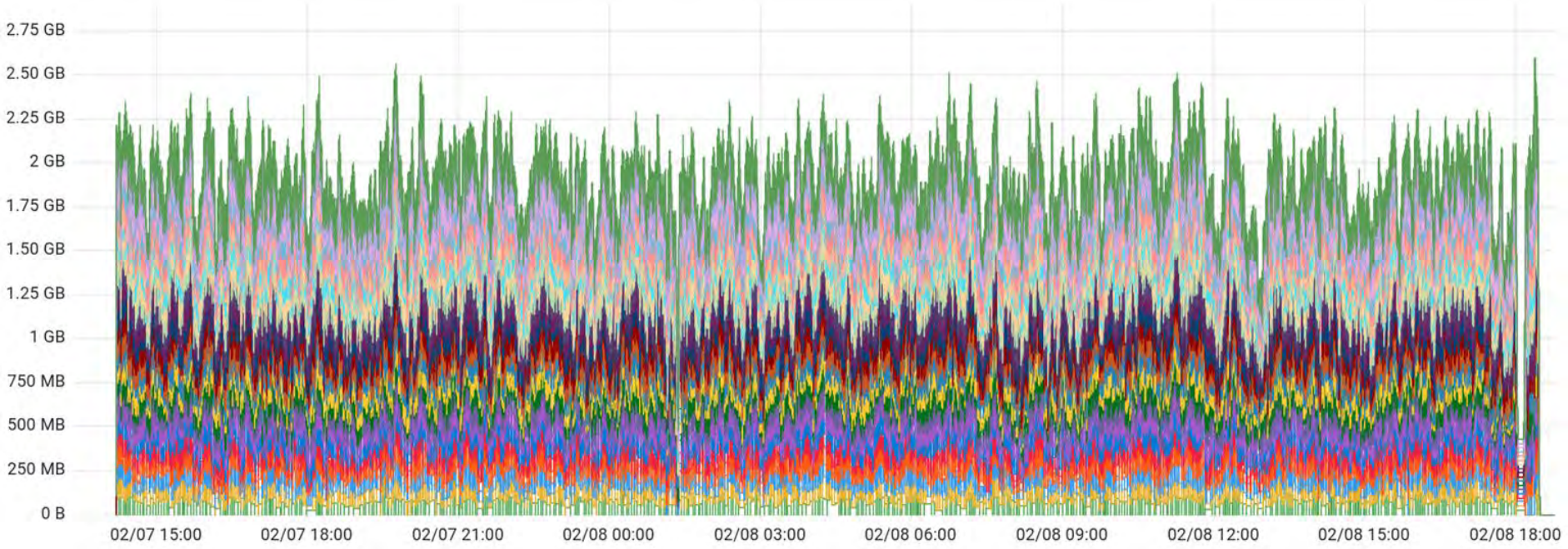
Step 1: Data transfer

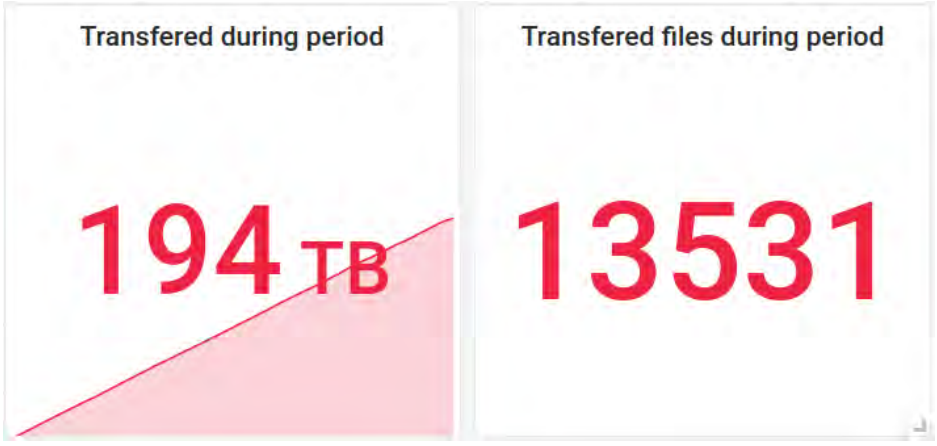


- Single stream of xrootd transfer can not exceed 100MB/s. **Transfer would take ~ 50 days.**
- NCX interface node can sustain not more than 10 streams(1GB/s total). And that would overload its network.

So, 20 independent DIRAC jobs were sent to NICA cluster to perform transfers with one stream each.

Step 1: Data transfer





Average transfer speed on 20 streams
1.92 GB/s

Total transfer duration:
2d 15h

Step 2: Estimate the load

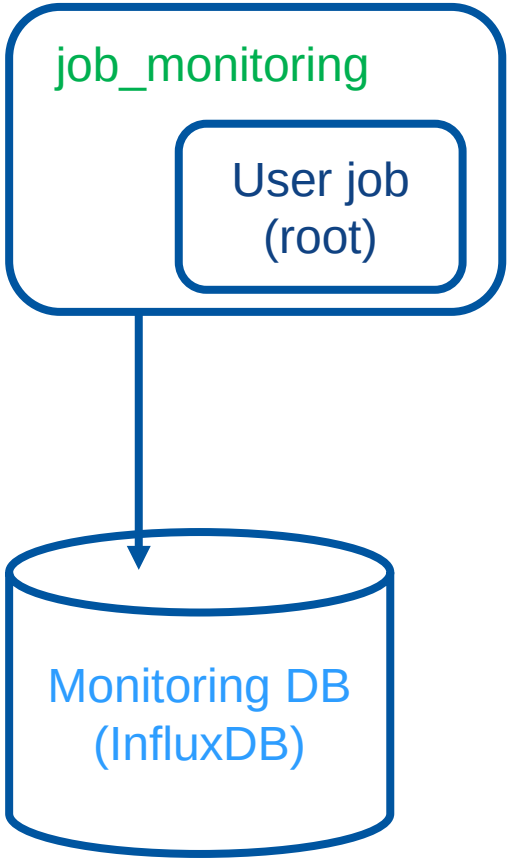
Size of files created during Run 8

Step 2: Raw2Digi job profiling

```
$ root macro.C(input)
```

Here is a standard process run

```
$ job_monitoring root macro.C(input)
```

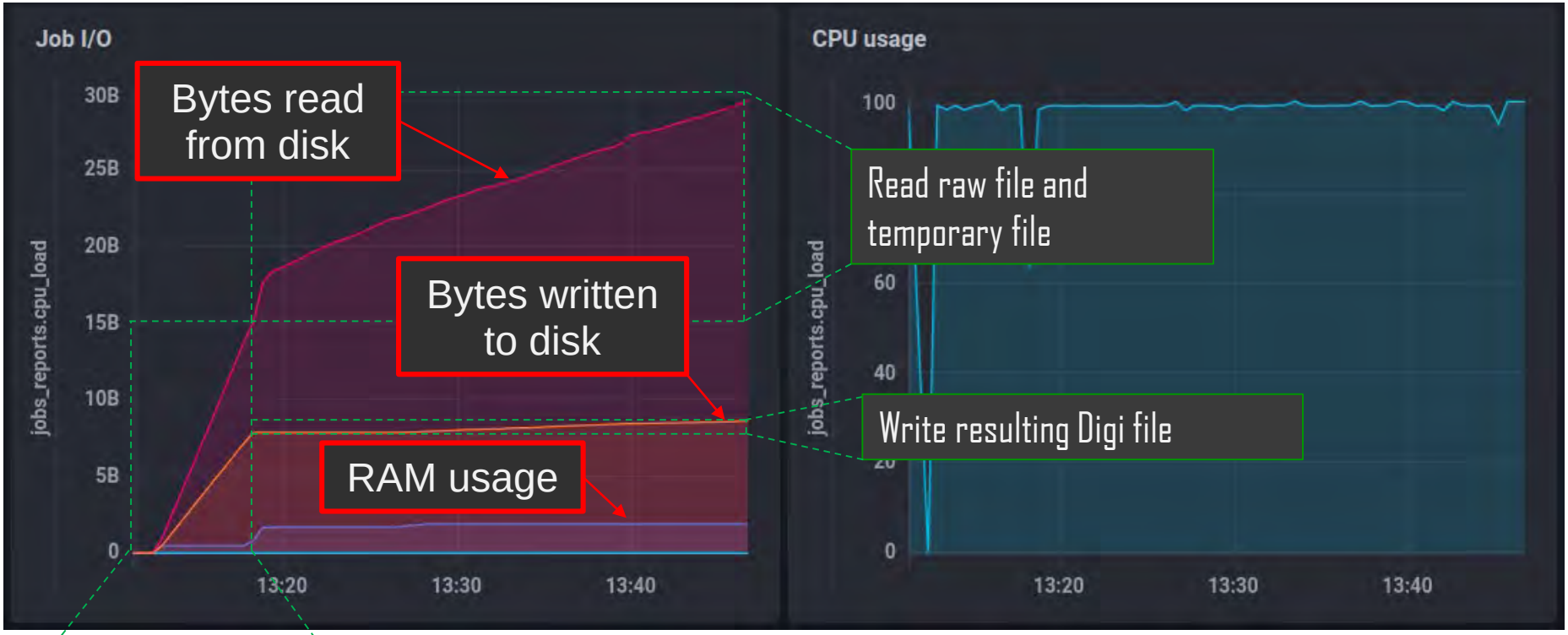


With the help of developed script we may record information about:

1. CPU used
2. RAM used
3. DISK read/write

Main issue was to record not only parameters of initial root process, but also its child processes.

Step 2: Raw2Digi job profiling



Initial read of 15GB raw file and creation of temporary 8 GB file

Disk usage

Temporary file: **+8 GB**

Result file: **800MB**

Total disk usage per 15 GB job: **25 GB**

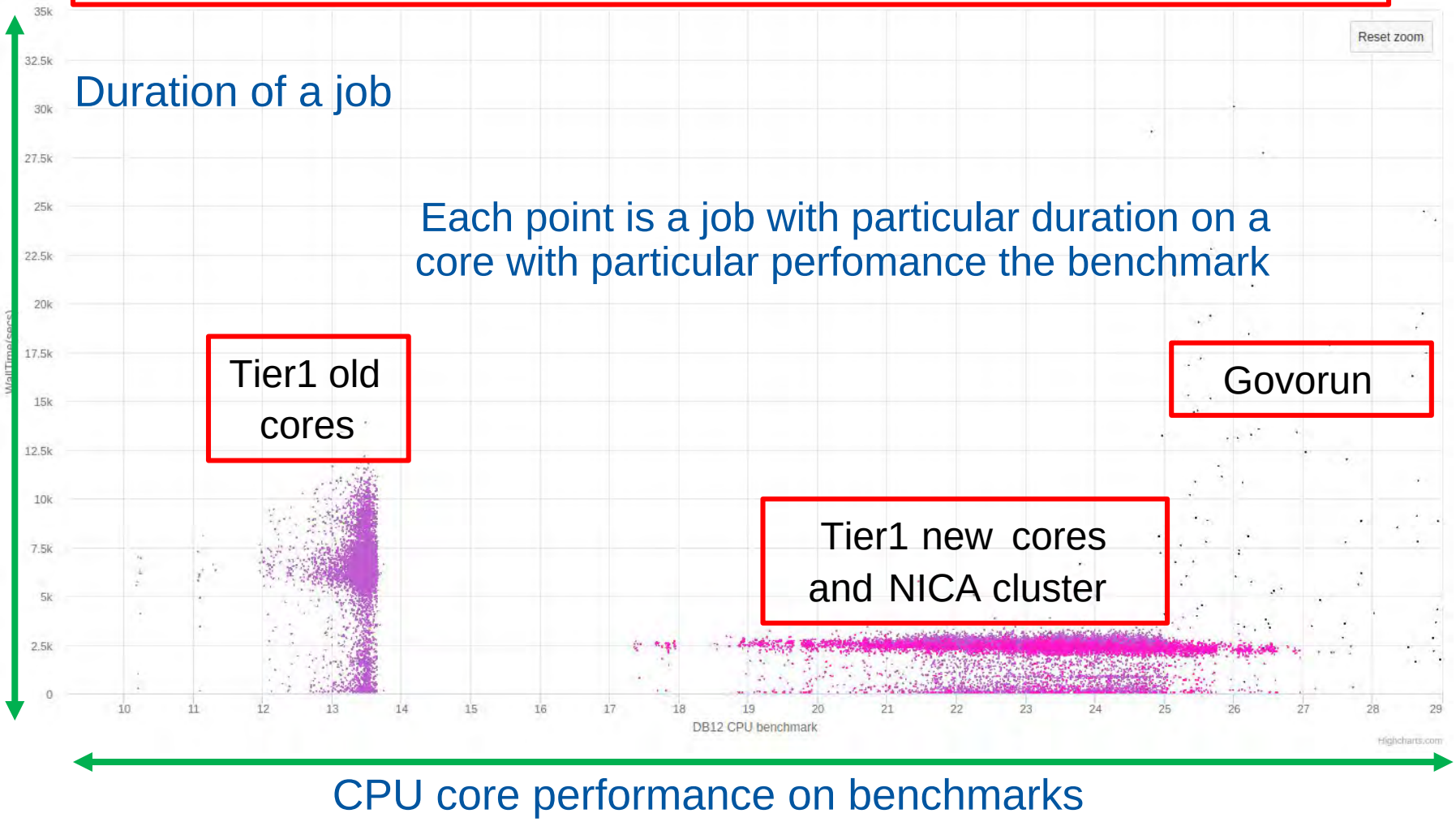
RAM usage : **~2GB**

Step 2: Raw2Digi job profiling

Once Raw2Digi had strange 5m idle period.
Reason is a request to a database which failed by timeout.

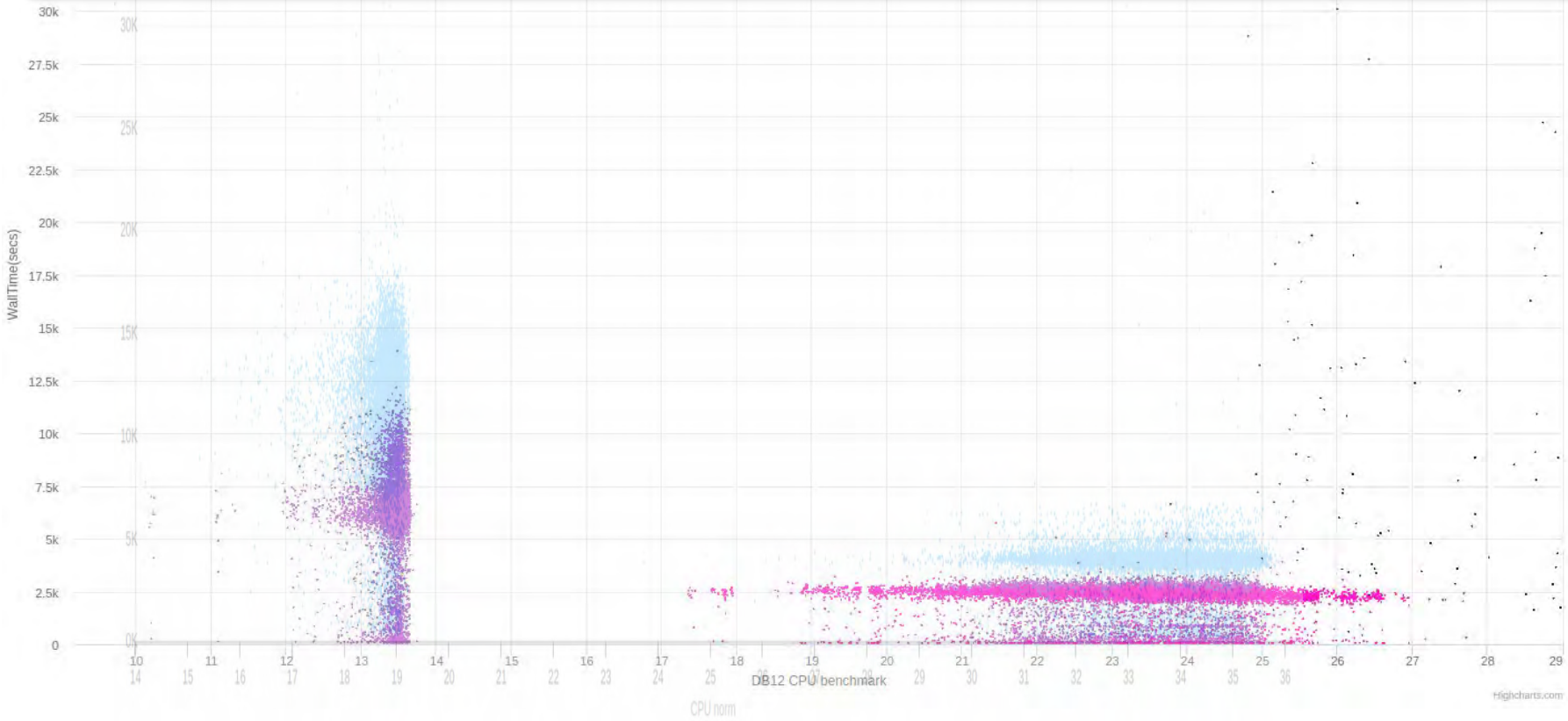
Step 3: Massive production Raw2Digi

Total duration of Raw2Digi campaign – 35 hours

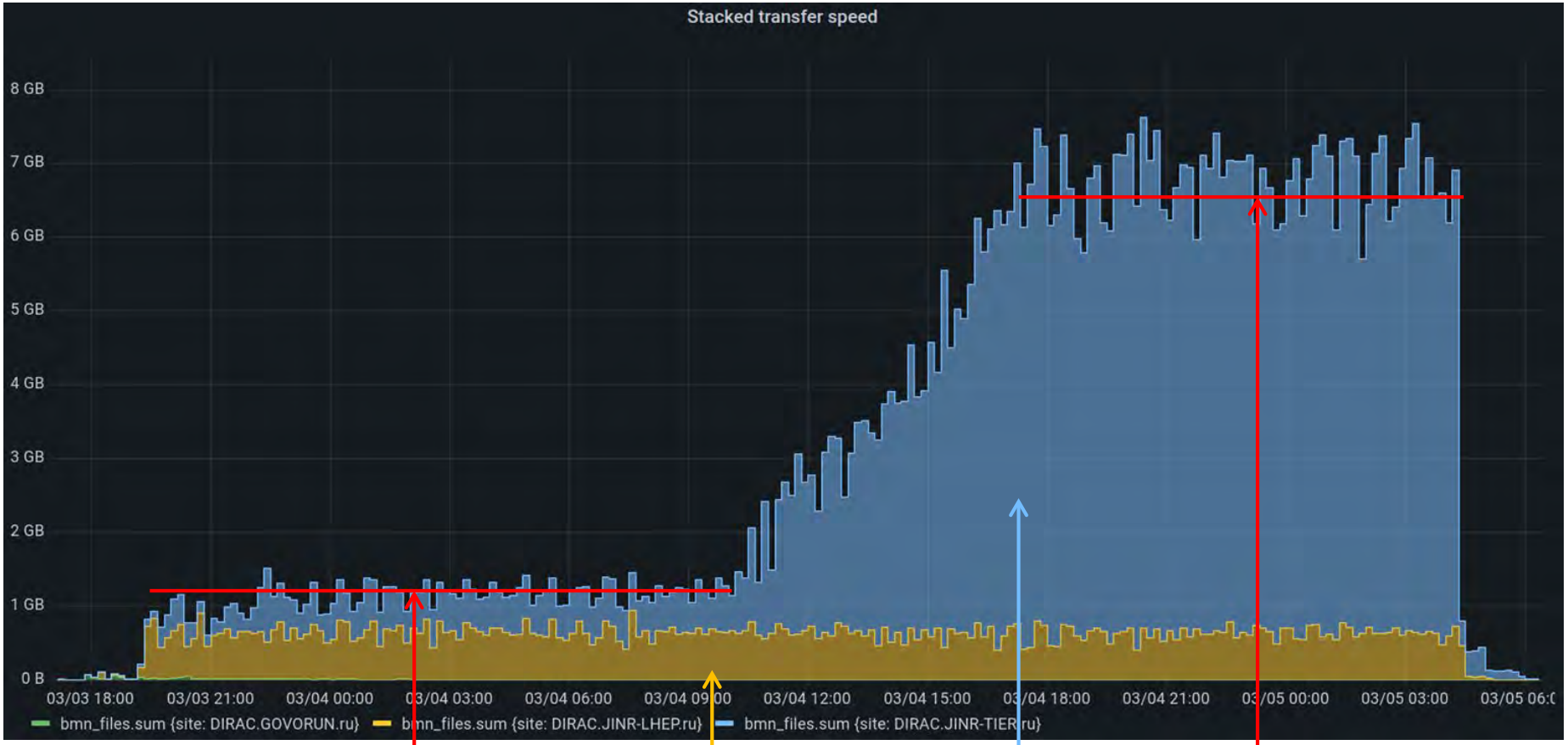


Step 3: Massive production Raw2Digi

Average Raw2Digi calculation time increased by 60%
(from 35 hours to 56 hours)



Step 3: Network usage



300 jobs running
4 MB/s per job

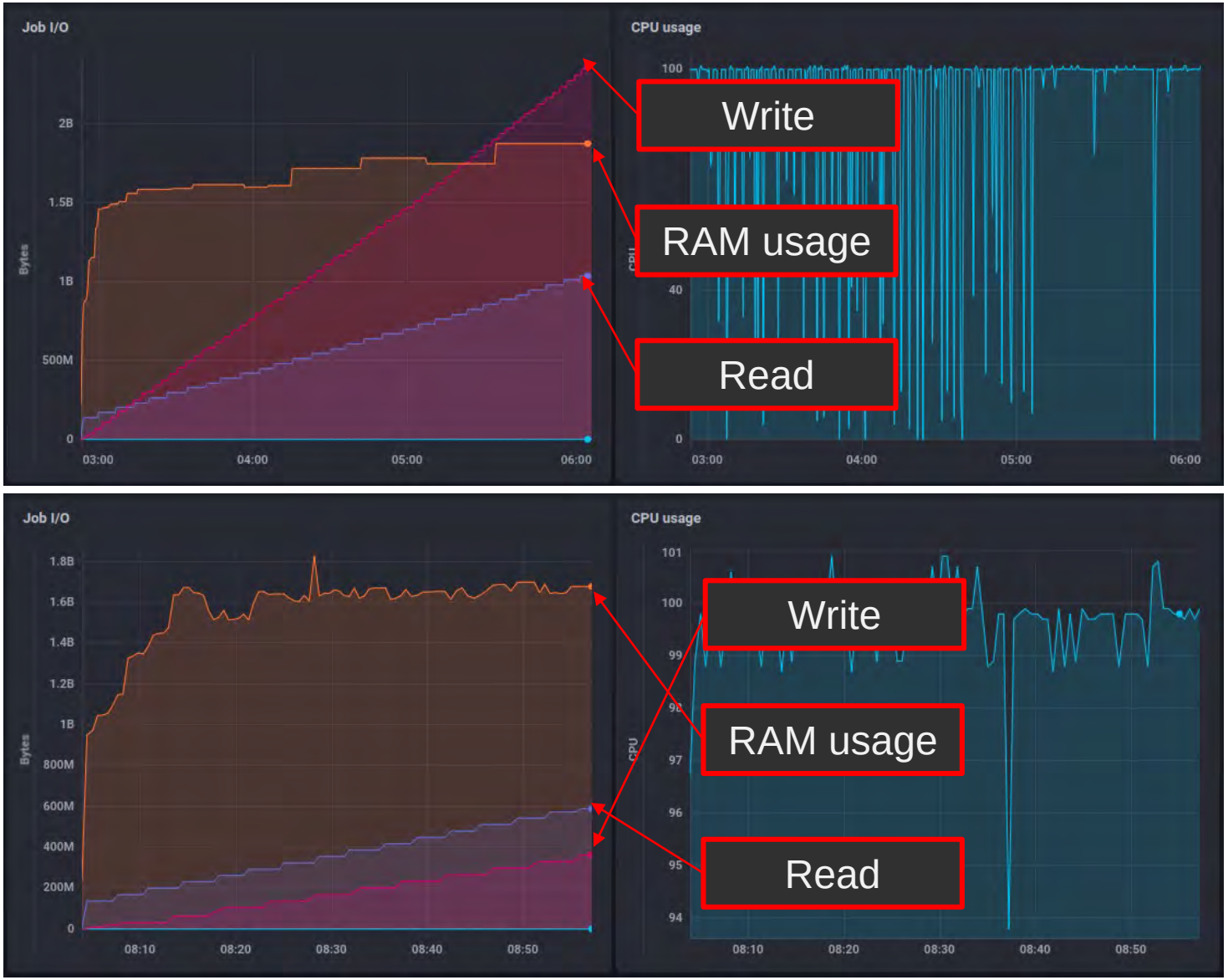
NICA Cluster

Tier1

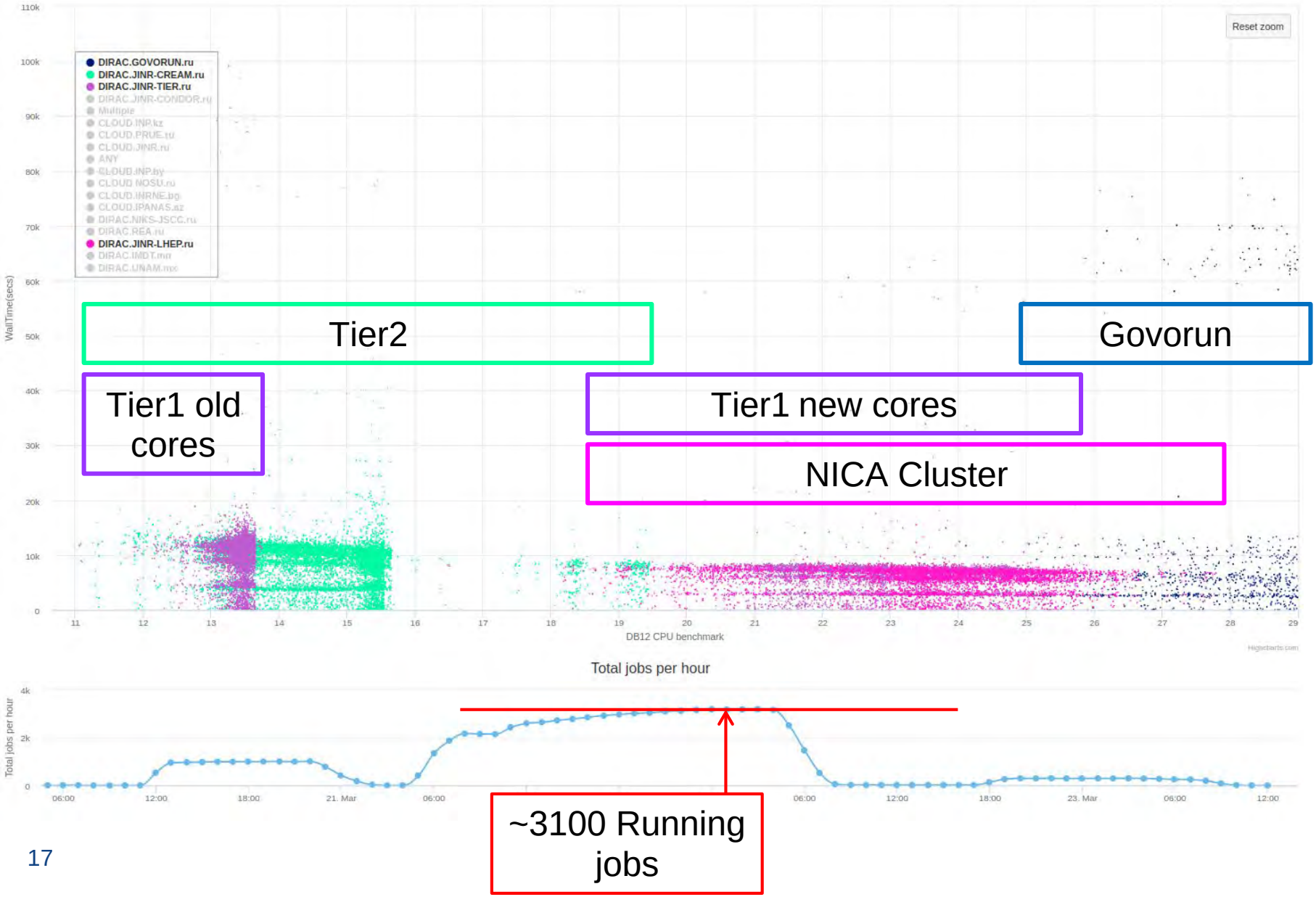
1580 jobs running
4.1 MB/s per job

Maximal transfer speed (Read+Write) with EOS in MLIT – 7.5 GB/s

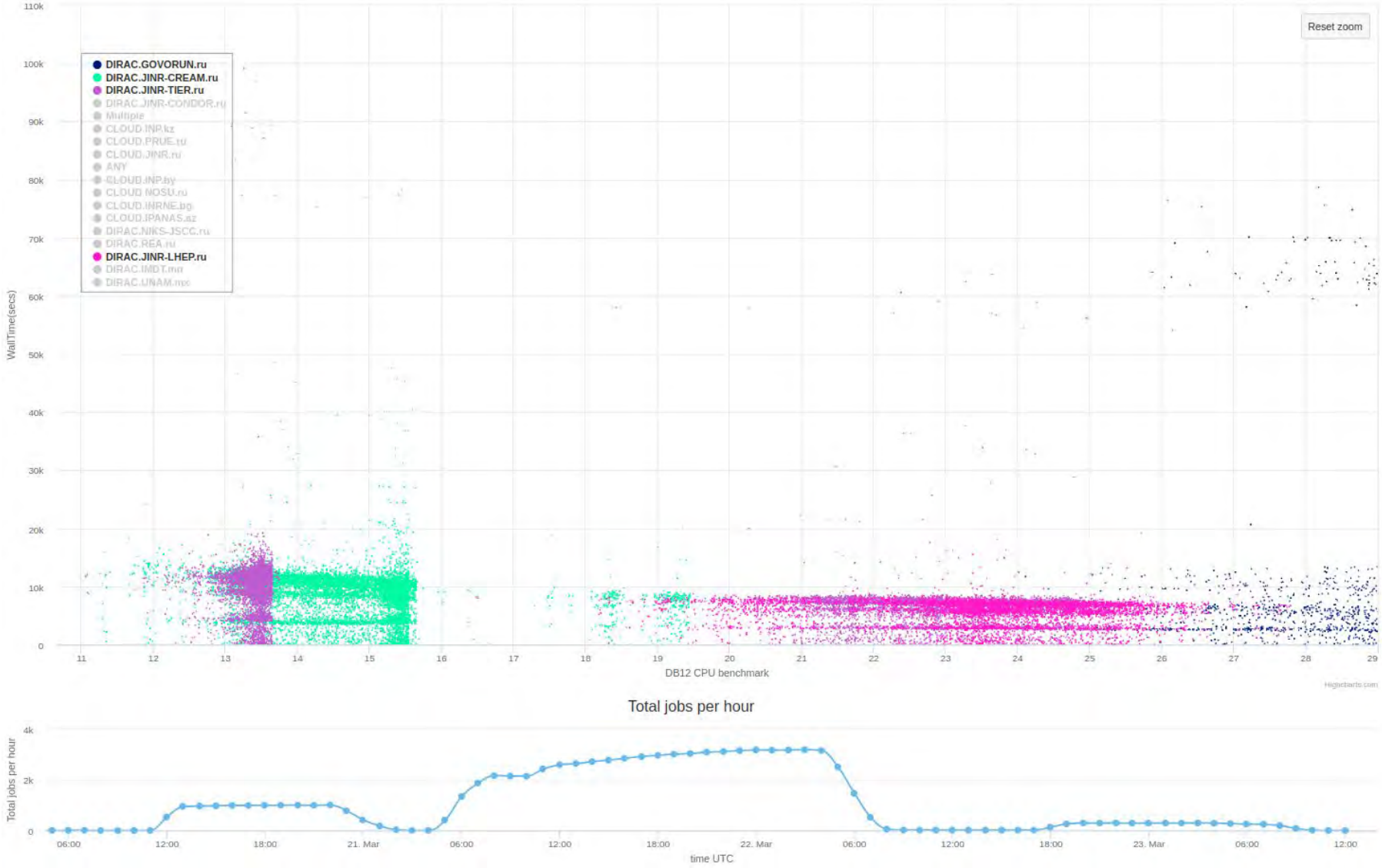
Step 4: Digi2Dst profiling



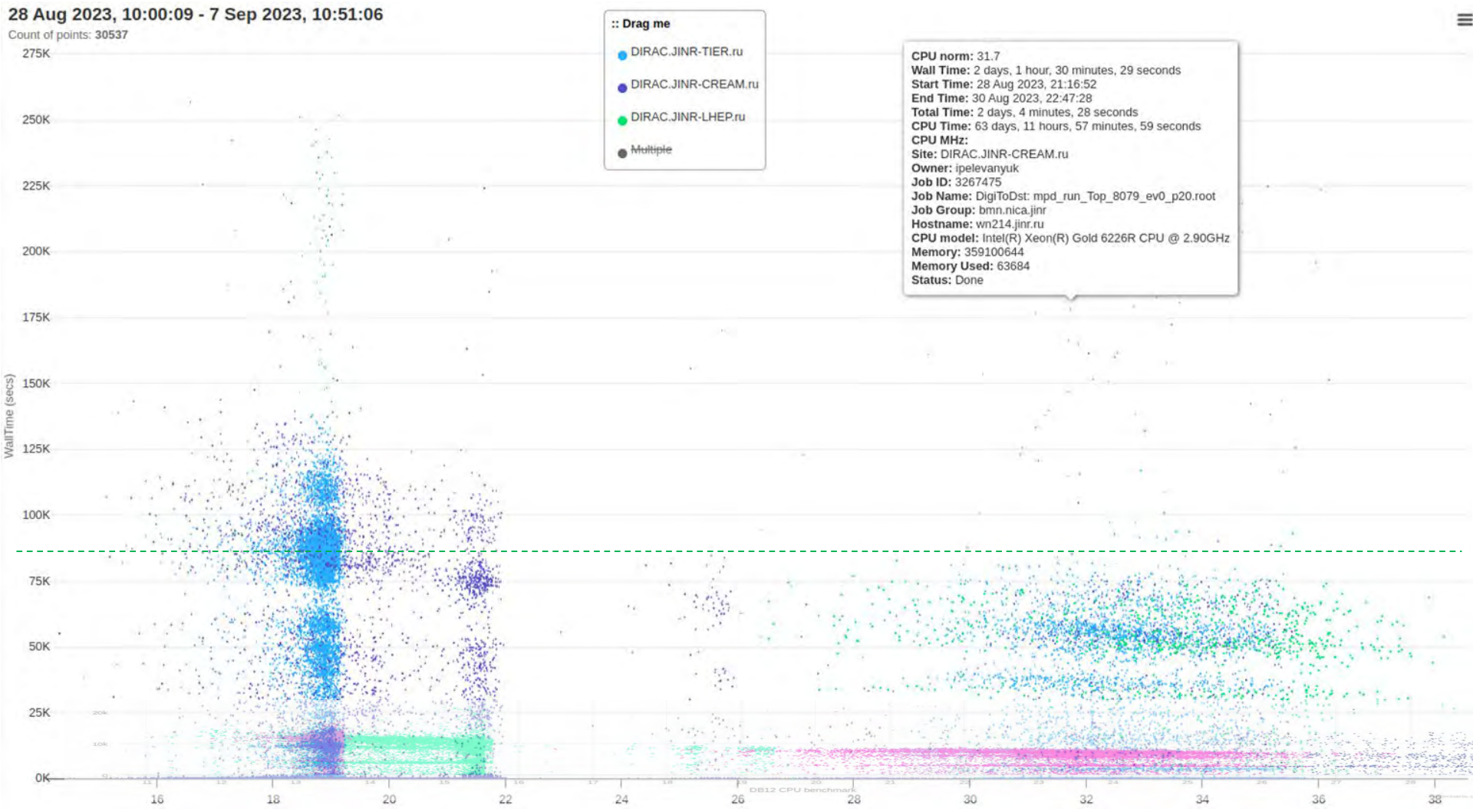
Step 5: Initial production Digi2Dst



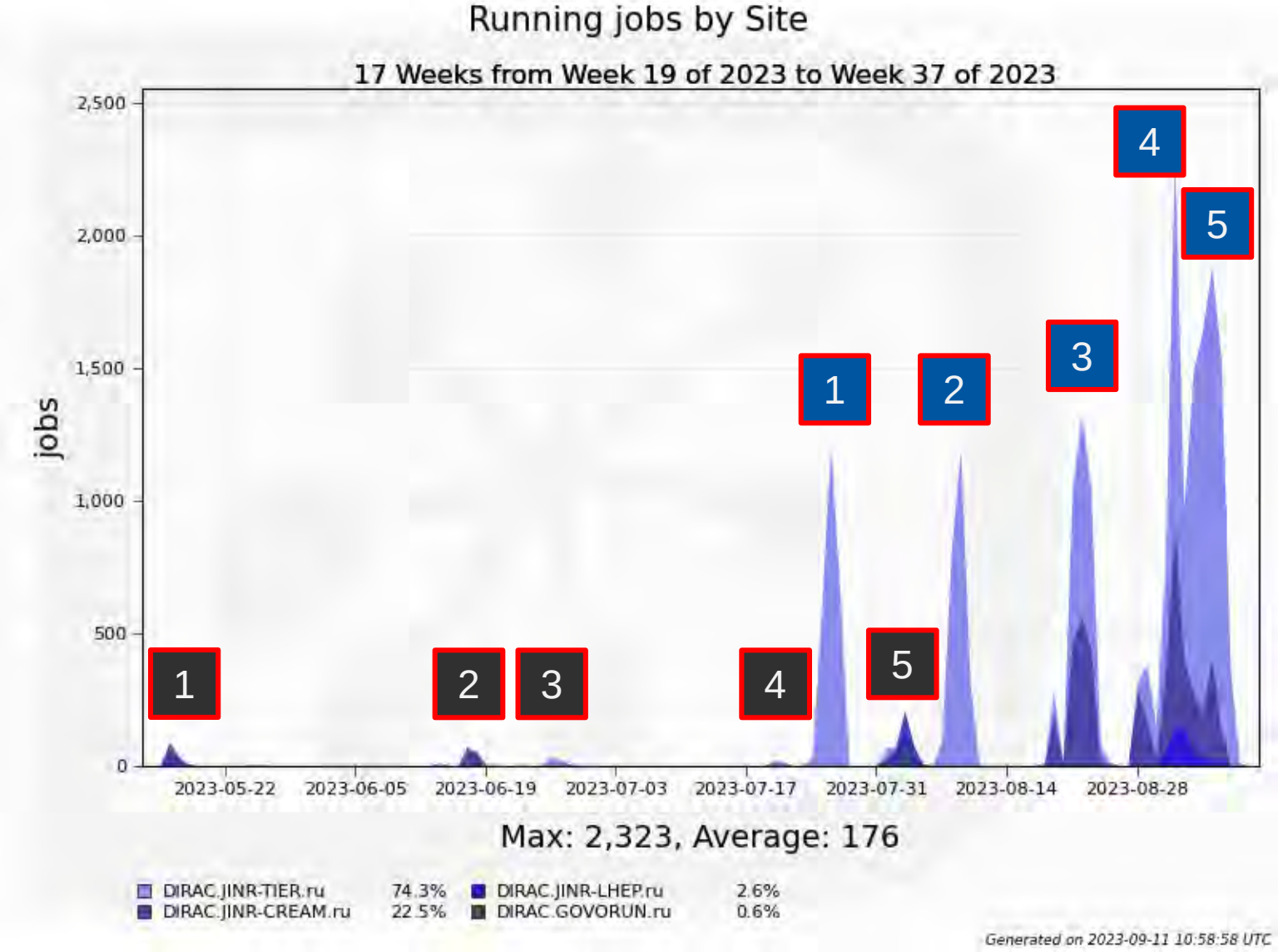
Step 5: Initial production Digi2Dst



Step 5: New VF Digi2Dst

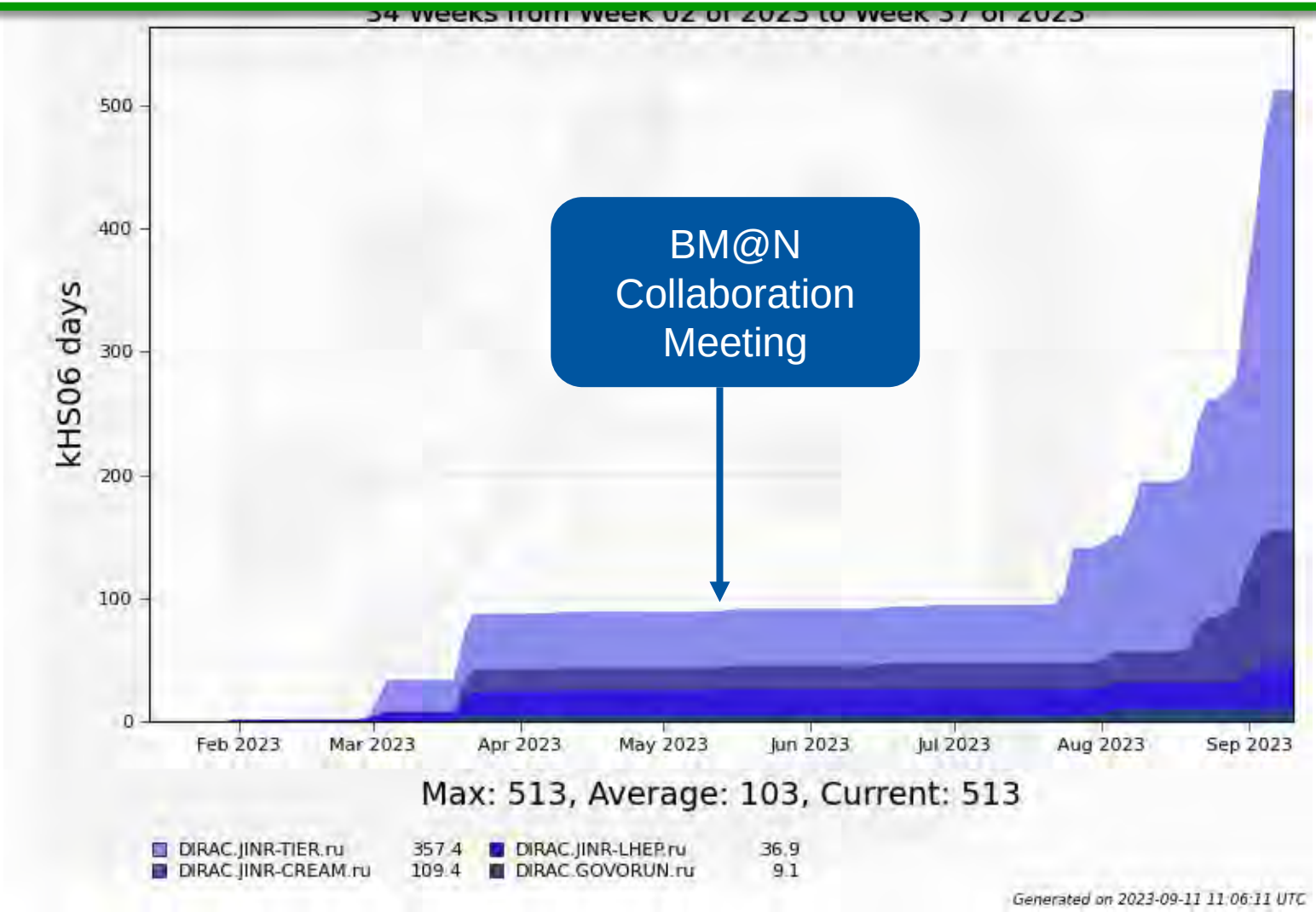


How we have got there



Consumed resources

We consumed roughly 70 CPU core years



Acknowledgments

The whole **BM@N** collaboration

Responsible for resources:
Tier-1,Tier-2, EOS: Valery Mitsyn
Govorun: Dmitry Podgainy, Dmitry Belyakov, Aleksandr Kokorev
NICA cluster: Ivan Slepov
Network: Andrey Dolbilov

Results

- For the first time JINR computing infrastructure united by DIRAC was used for raw data reconstruction not in test mode but in production.
- Full BM@N run8 production took considerable amount of resources. Up to now ~70 CPU core years has been consumed.

Fast and repeatable way to consistently perform B@MN productions for all data was proposed!
It was successfully applied several times for BM@N Run8 during 2023.

A set of methods was developed and applied to record the information about running productions.
It proved to be useful not only for estimation of future productions, but also for evaluation of current workloads and their comparison with previous.


JINR
MLiT

Individual CPU core performance study

- Centralized job management gives possibility for centralized and unified performance study of different computing resources.
- Before running user jobs DIRAC Pilots execute benchmark for CPU core they are running on.
- Benchmark is DiracBenchmark2012 or DB12. It evaluate just CPU core performance. Disk I/O, RAM speed, Network, CPU caches and other highly important aspects of performance are **neglected by DB12.**

DB12 benchmark study

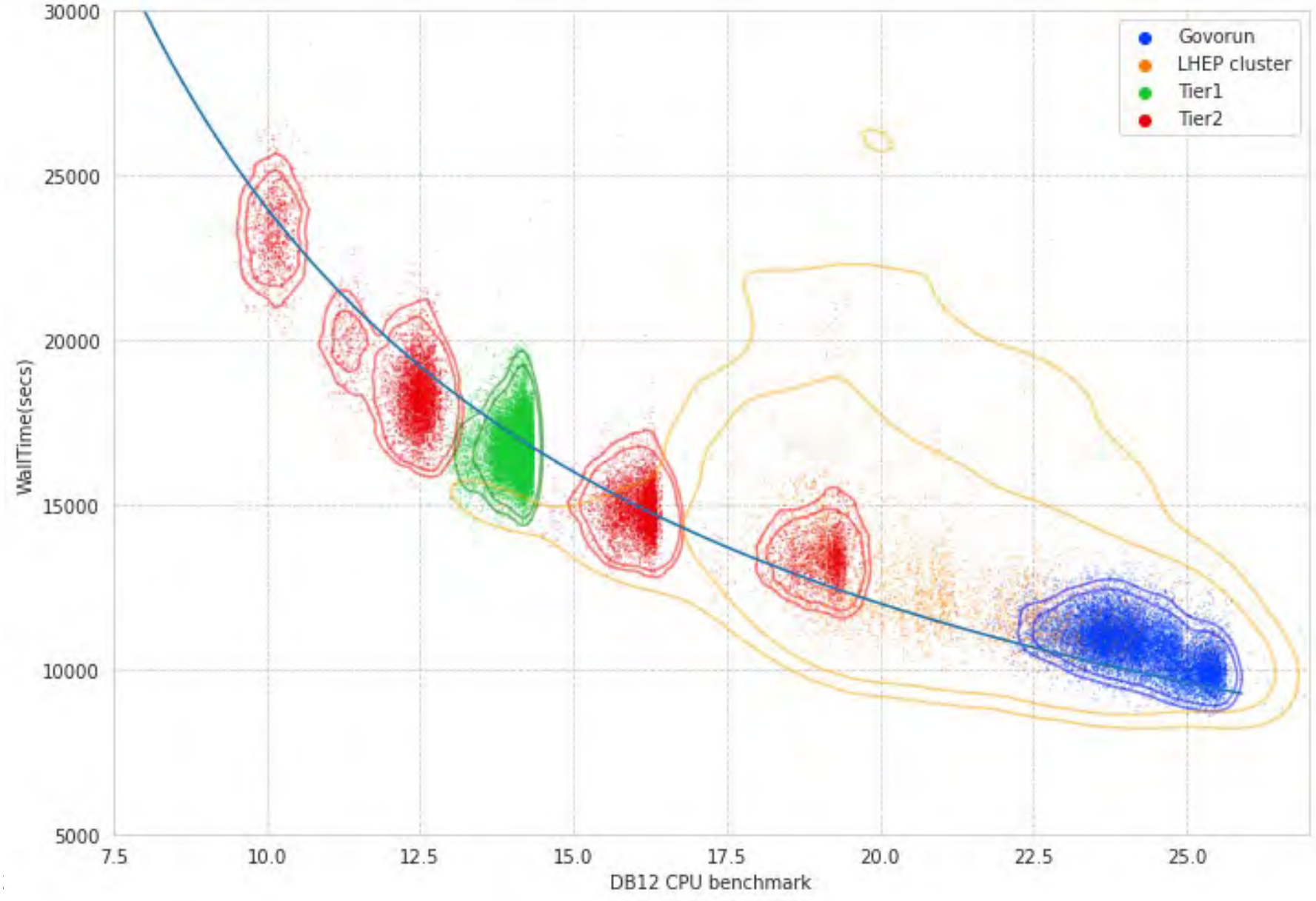
Piece of road from point A to B	←	A Monte-Carlo task
Speed of the car	←	Performance of the computer
Time to complete	←	Time to complete

$$Time = \frac{Amount\ of\ work}{Speed\ of\ computer}$$

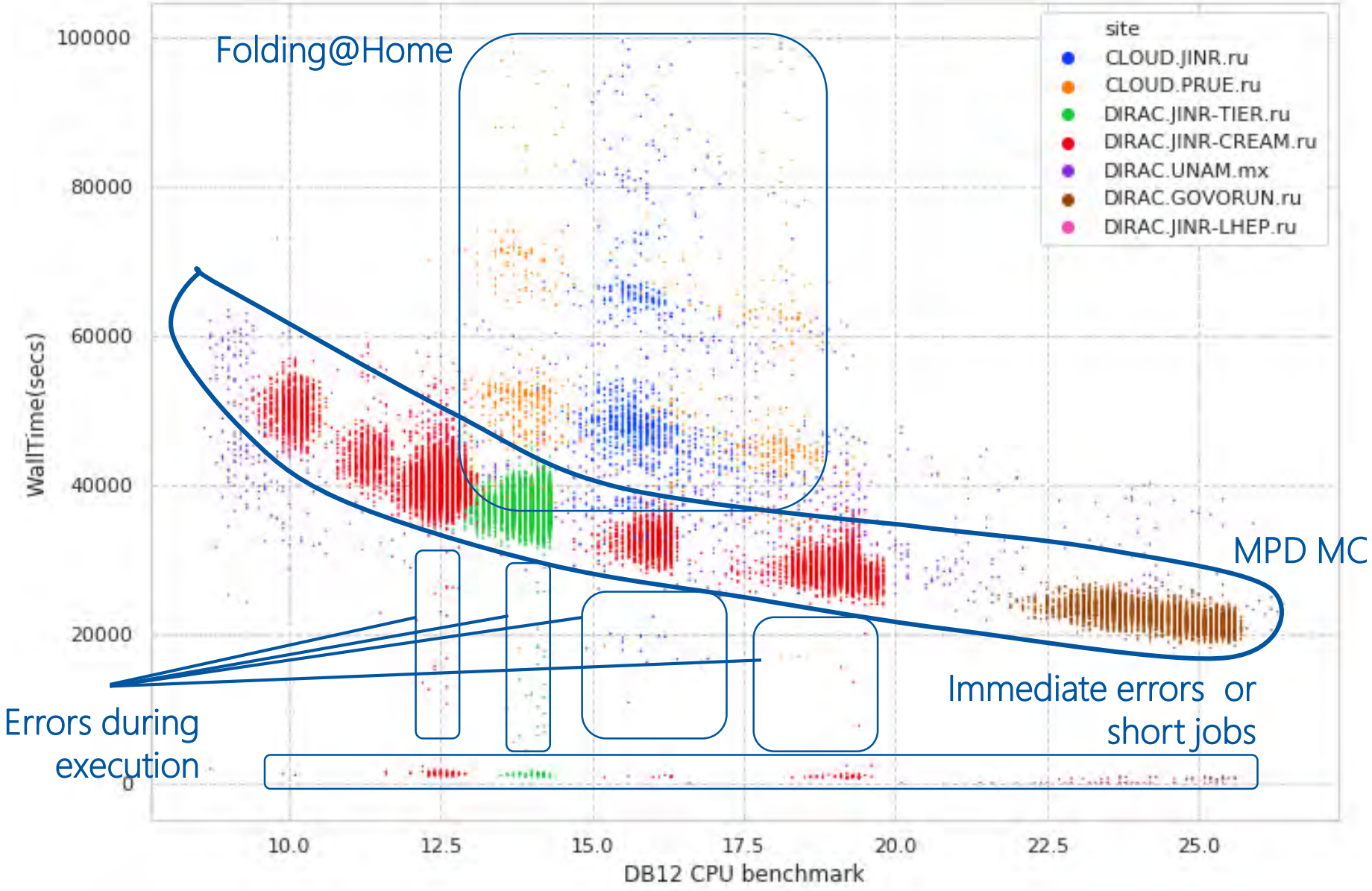
DB12 gives results like: 10(old slow core), 17 (standard server core), 27 (high performance core)

What if we build a plot, where X is DB12 result, Y is time in seconds. Then, every point on the plot represent one job.
It would be mostly useless if all jobs were unique and different.
But, in the real life there are usually many similar jobs.

Performance analysis



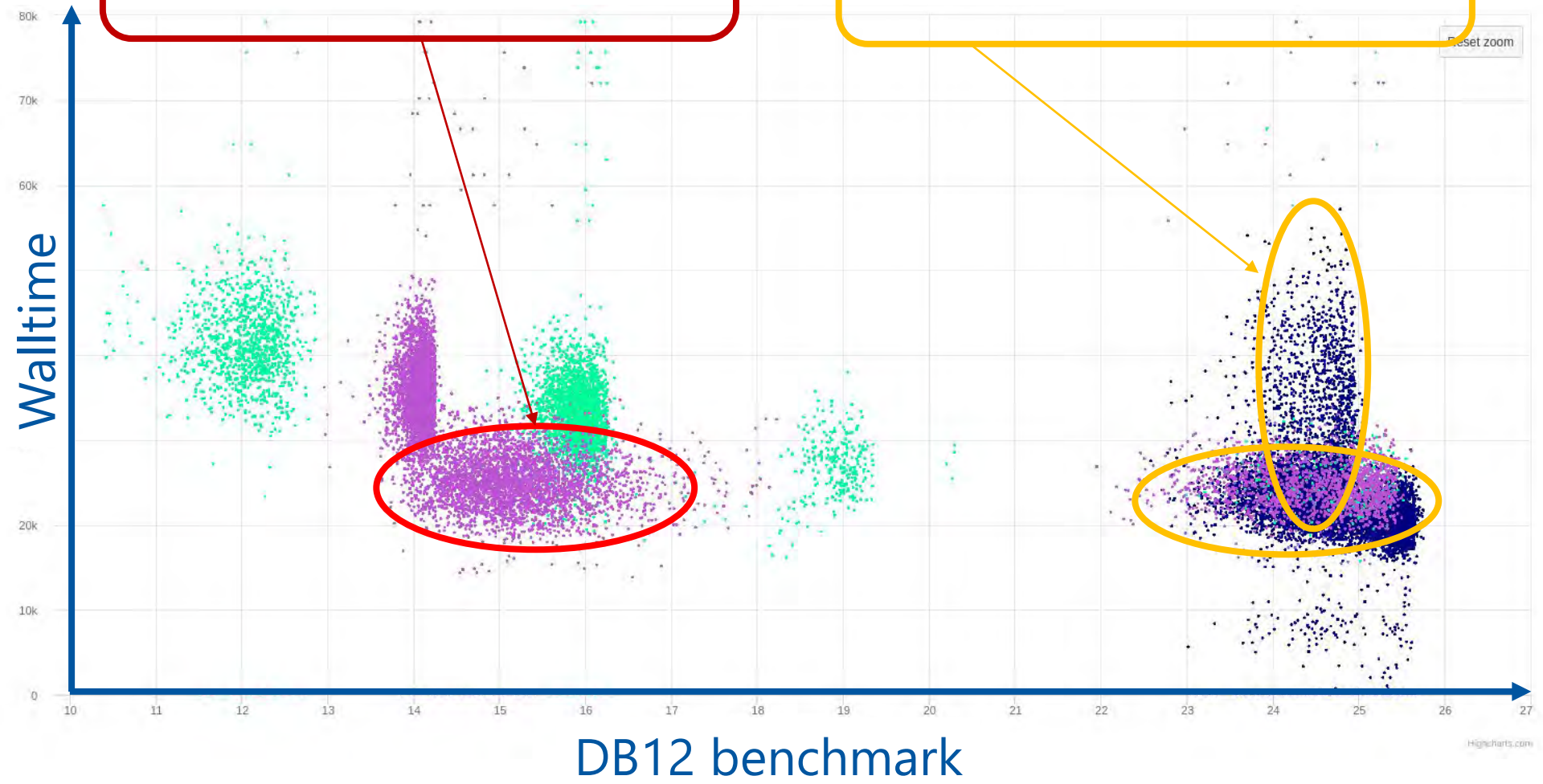
Performance analysis



Discoveries

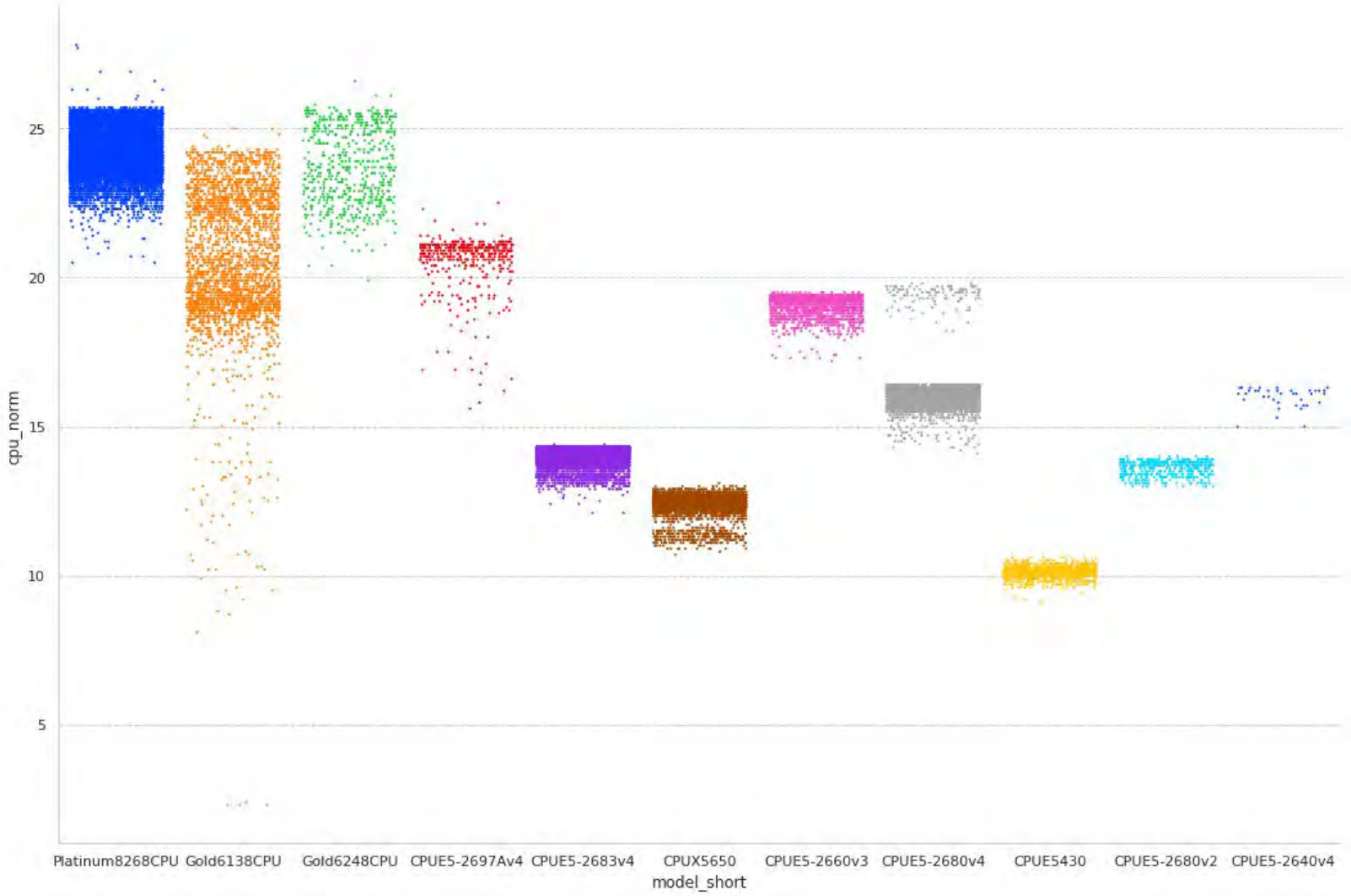
Wrong AMD processors estimation

Occasional speed loss on high ram Govorun nodes



DB12 benchmark

CPU core performance

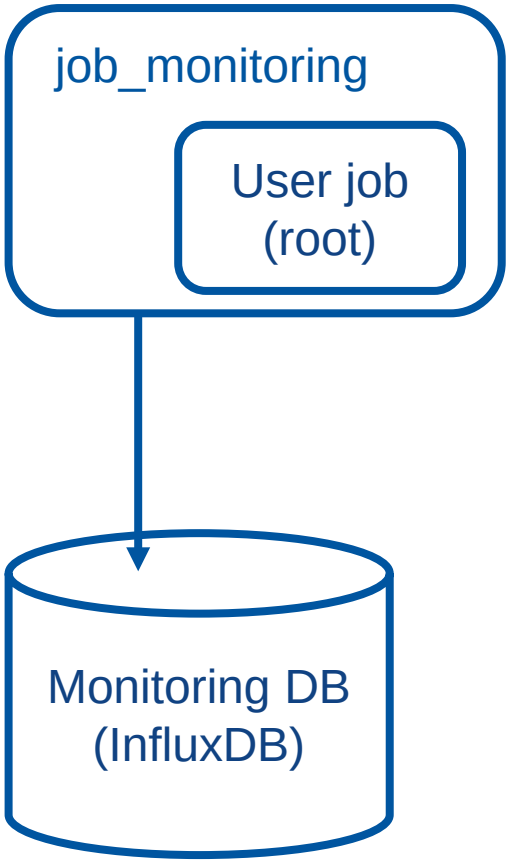


Total CPU performance

User job monitoring

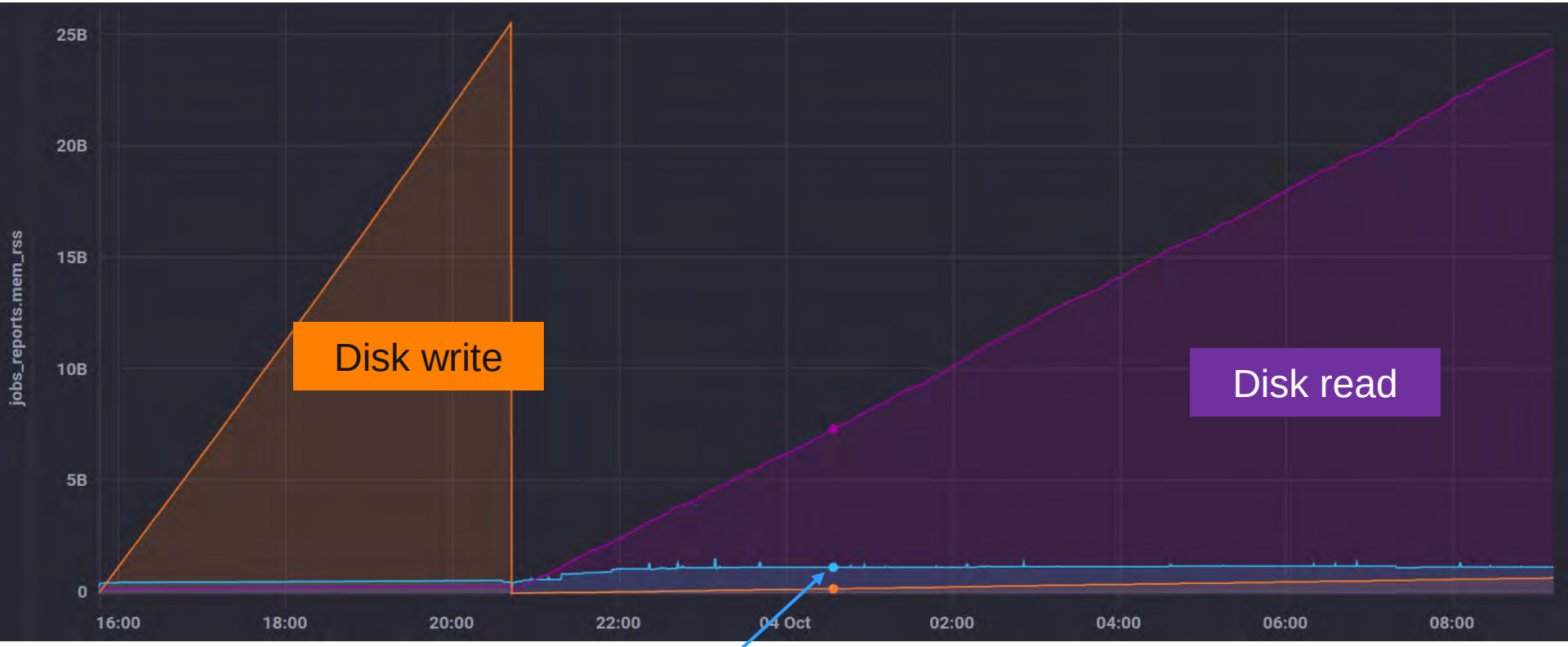
```
$ root macro.c(input)
```


```
$ job_monitoring root macro.c(input)
```



User job monitoring

GenToDst job on Govorun



Detailed articles

1. Gergel, V., V. Korenkov, I. Pelevanyuk, M. Sapunov, A. Tsaregorodtsev, and P. Zrelov. 2017. **Hybrid Distributed Computing Service Based on the DIRAC Interware**.
2. Korenkov, V., Pelevanyuk, I. & Tsaregorodtsev, A. 2019, "**Dirac system as a mediator between hybrid resources and data intensive domains**", CEUR Workshop Proceedings, pp. 73.
3. Balashov, N.A., Kuchumov, R.I., Kutovskiy, N.A., Pelevanyuk, I.S., Petrunin, V.N. & Tsaregorodtsev, A.Y. 2019, "**Cloud integration within the DIRAC Interware**", CEUR Workshop Proceedings, pp. 256.
4. Korenkov, V., Pelevanyuk, I. & Tsaregorodtsev, A. 2020, **Integration of the JINR hybrid computing resources with the DIRAC interware for data intensive applications**.
5. Kutovskiy, N., Mitsyn, V., Moshkin, A., Pelevanyuk, I., Podgayny, D., Rogachevsky, O., Shchinov, B., Trofimov, V. & Tsaregorodtsev, A. 2021, "**Integration of Distributed Heterogeneous Computing Resources for the MPD Experiment with DIRAC Interware**", Physics of Particles and Nuclei, vol. 52, no. 4, pp. 835-841.
6. Pelevanyuk, I., "**Performance evaluation of computing resources with DIRAC interware**", AIP Conference Proceedings 2377, 040006 (2021)