



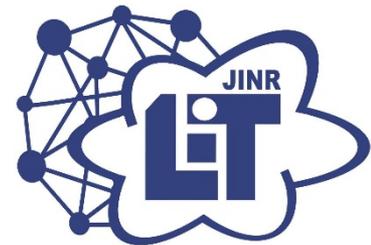
First results of applying a probabilistic approach to simulation of BM@N data centers

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Introduction

The important task

Predictive modeling of data storage and processing centers, both as from the BM@N detector, as for simulated particle collision events for comparison with the expected results and optimization of the facility detectors geometry.

Probabilistic approach to simulate

- Representation of information processes as byte streams
- Using of probability distributions of significant data acquisition processes – the probabilities of loss of incoming information should be determined for different configurations of the data centers equipment

Simulation goal

Determine the hardware configuration that will ensure the operability of the data storage and processing system



The simulation software complex

- equipment parameters
- list of tasks for processing

Database

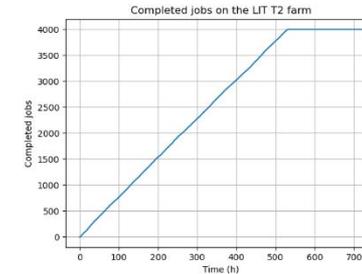
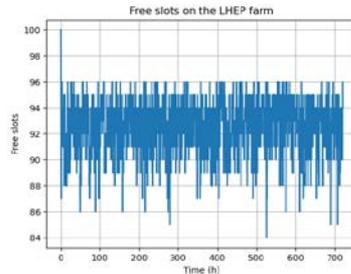
- simulation results

Module for setting of equipment configurations

The software complex modules

Transfer and processing data simulation module

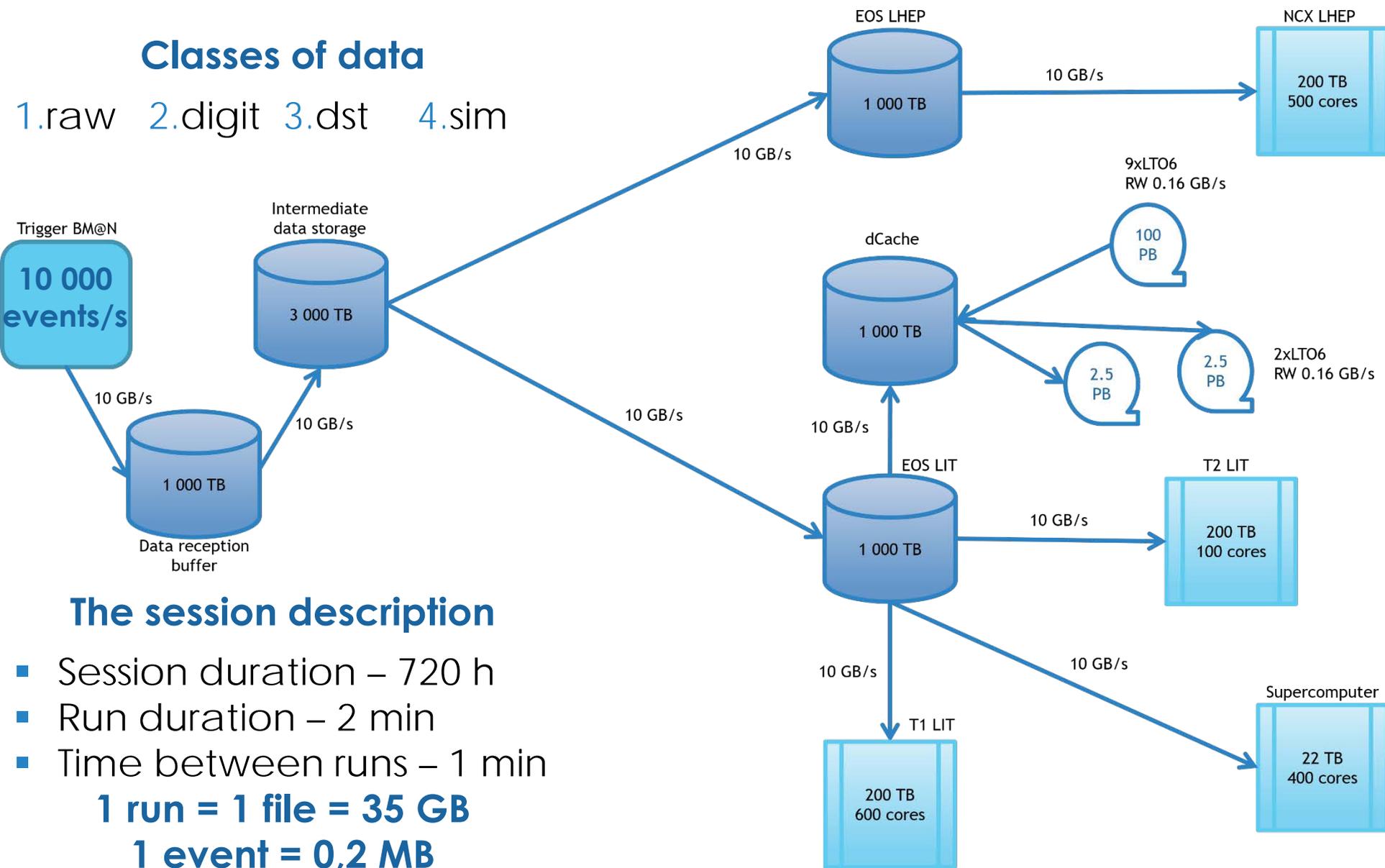
Module for presenting results



The simulated structure

Classes of data

1.raw 2.digit 3.dst 4.sim



The session description

- Session duration – 720 h
- Run duration – 2 min
- Time between runs – 1 min

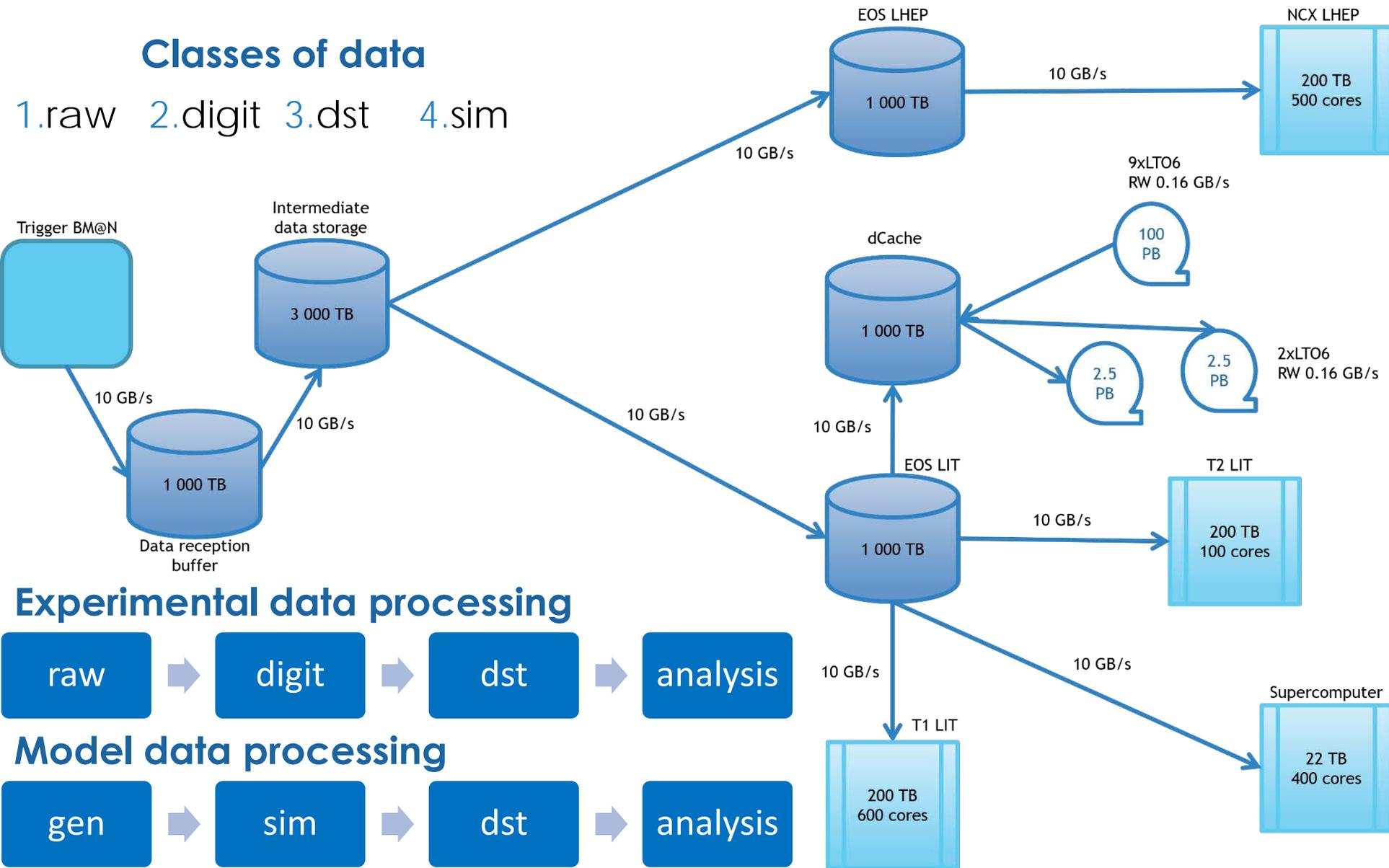
1 run = 1 file = 35 GB

1 event = 0,2 MB

The simulated structure

Classes of data

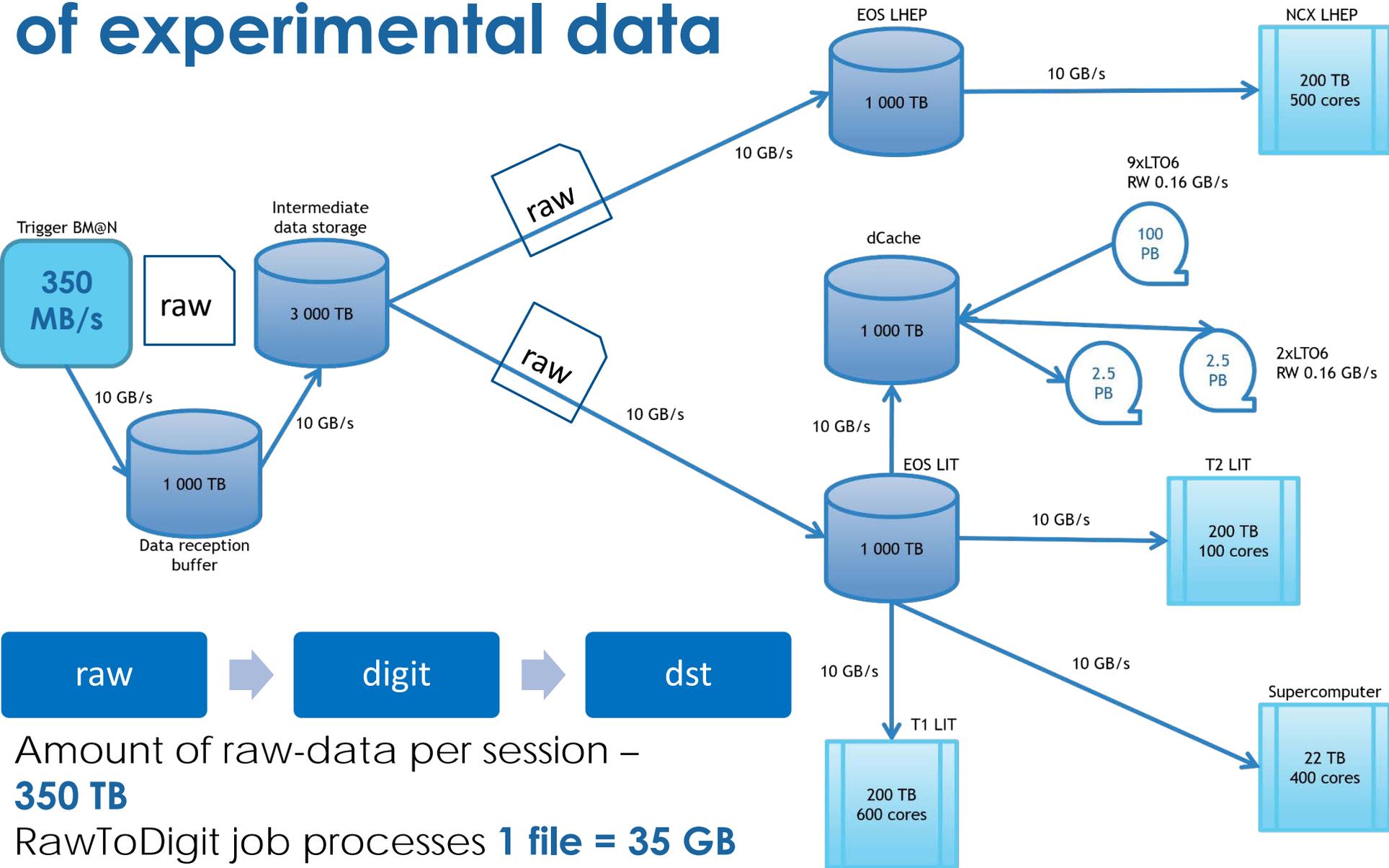
1.raw 2.digit 3.dst 4.sim



Classes of jobs

No	Class	Event processing time on one processor (ms)	The average amount of input (GB)	Number of events in the file (1 file = 1 job)	Job execution time (s)	The average amount of output (GB)	Number of jobs
1	RawToDigit	150	35	175 000	26 250	1	10 000
2	DigitToDst	30	1	175 000	5 250	0,6	10 000
3	GenToSim	60	2	175 000	10 500	8	300
4	SimToDst	30	8	175 000	5 250	1	300
5	DstToAna	10	1	175 000	1 750	0,1	1 000

Acquisition and processing of experimental data



Amount of raw-data per session –
350 TB

RawToDigit job processes **1 file = 35 GB**

Scenarios for executing jobs

№	Class	Location of the executing jobs / % of jobs	
		Scenario 1	Scenario 2
1	RawToDigit	NCX LHEP / 40% T2 LIT / 45% Supercomputer / 15%	NCX LHEP / 50% T2 LIT / 15% Supercomputer / 35%
2	DigitToDst	NCX LHEP / 40% T2 LIT / 45% Supercomputer / 15%	NCX LHEP / 50% T2 LIT / 15% Supercomputer / 35%

Results of Scenario 1 (1)

Total number

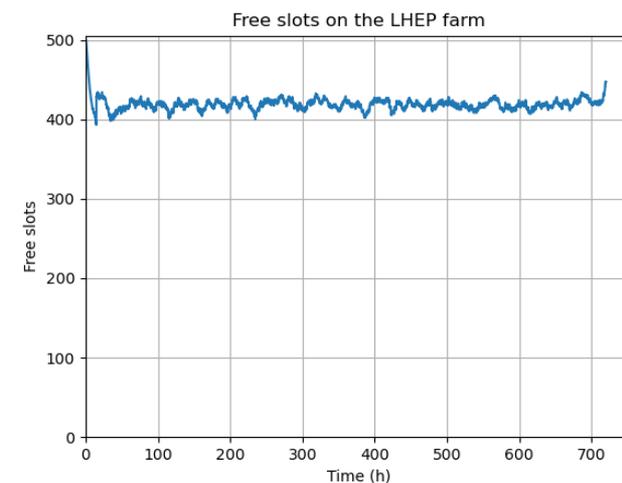
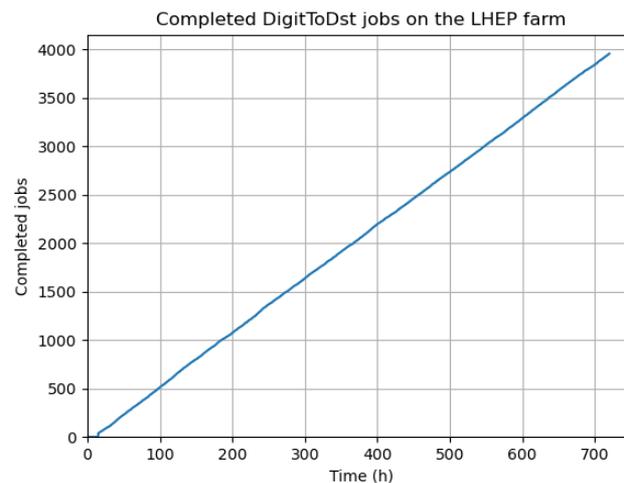
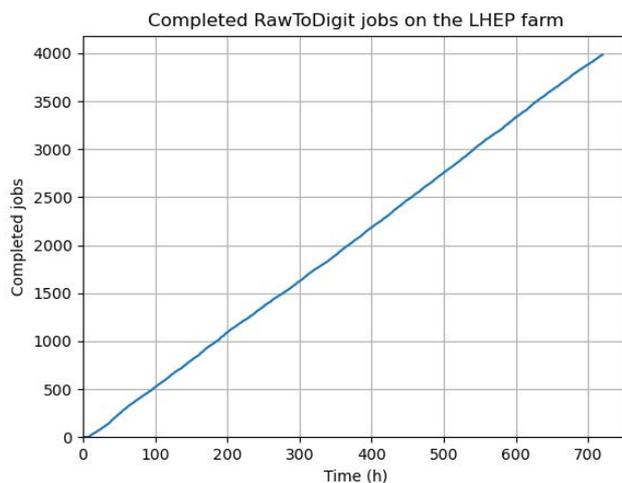
RawToDigit jobs – **10 000**

DigitToDst jobs – **10 000**

LHEP farm: 500 slots

RawToDigit jobs – **4 000 (40%)**

DigitToDst jobs – **4 000 (40%)**



- 400 slots are free
- There are not jobs queues
- The farm is not fully loaded

We can process more tasks on the farm

Results of Scenario 1 (2)

Total number

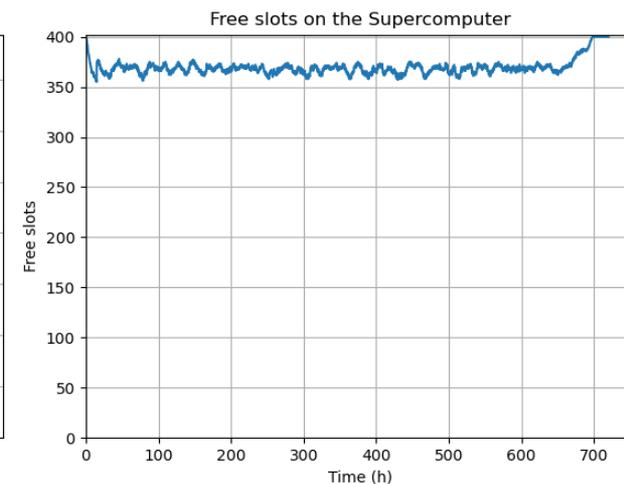
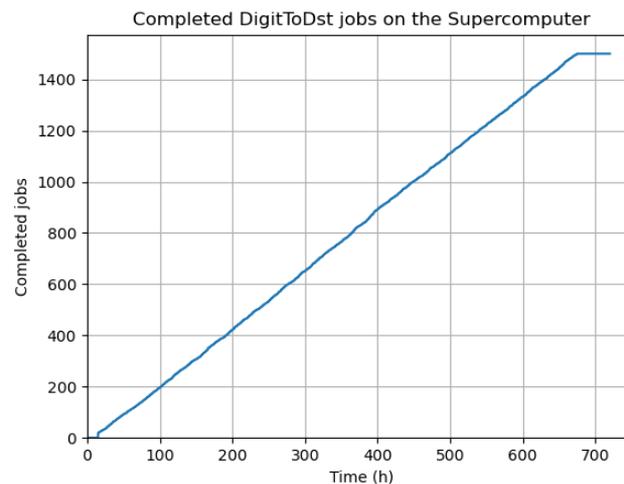
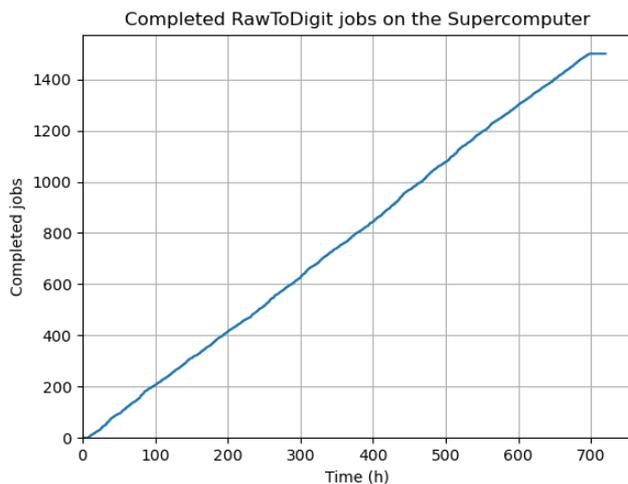
RawToDigit jobs – **10 000**

DigitToDst jobs – **10 000**

Supercomputer: 400 slots

RawToDigit jobs – **1 500 (15%)**

DigitToDst jobs – **1 500 (15%)**



- 350 slots are free
- There are not jobs queues
- The Supercomputer is not fully loaded

We can process more tasks on the Supercomputer

Results of Scenario 1 (3)

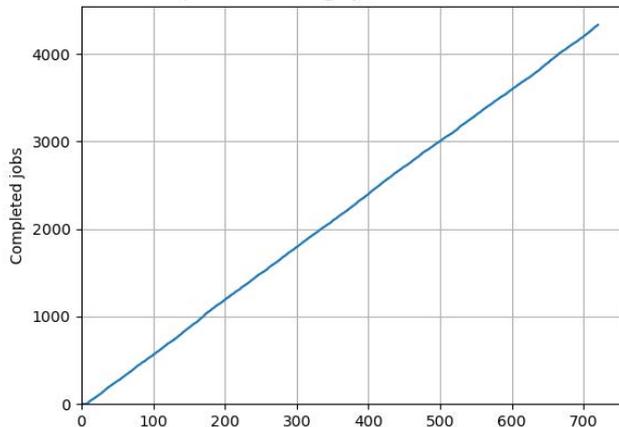
Total number
RawToDigit jobs – 10 000
DigitToDst jobs – 10 000

T2 LIT farm: 100 slots

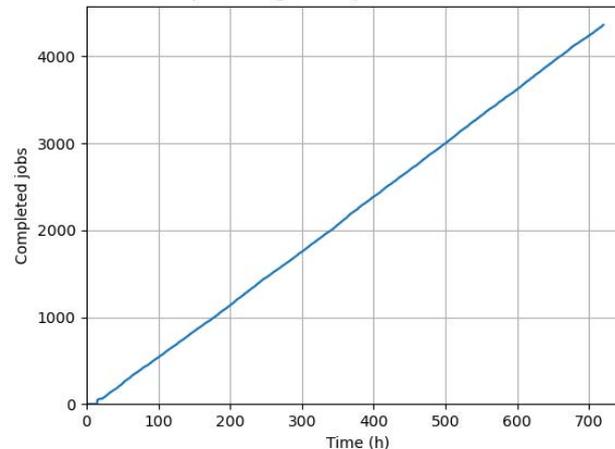
RawToDigit jobs – 4 500 (45%)

DigitToDst jobs – 4 500 (45%)

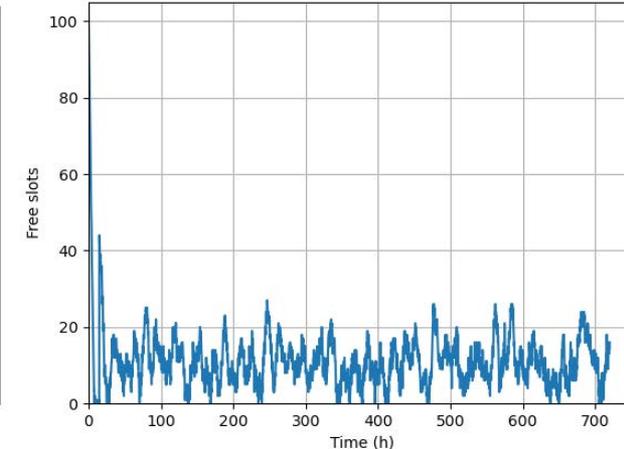
Completed RawToDigit jobs on the T2 LIT farm



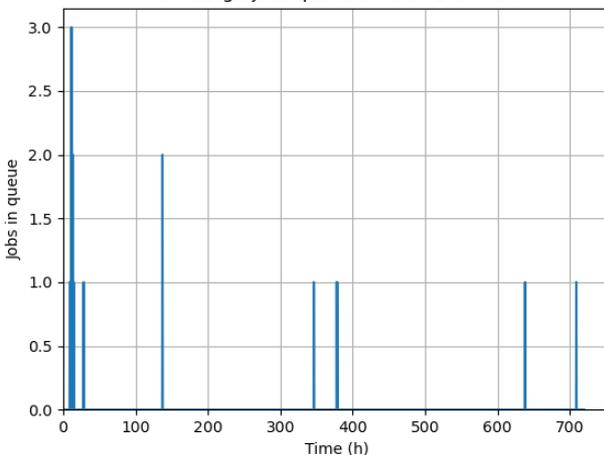
Completed DigitToDst jobs on the T2 LIT farm



Free slots on the LIT T2 farm



RawToDigit jobs queue on the T2 LIT farm



- The T2 LIT farm is fully loaded
- There are jobs queues

Solution: to redistribute the number of jobs across compute nodes of data center

Results of Scenario 2 (1)

Total number

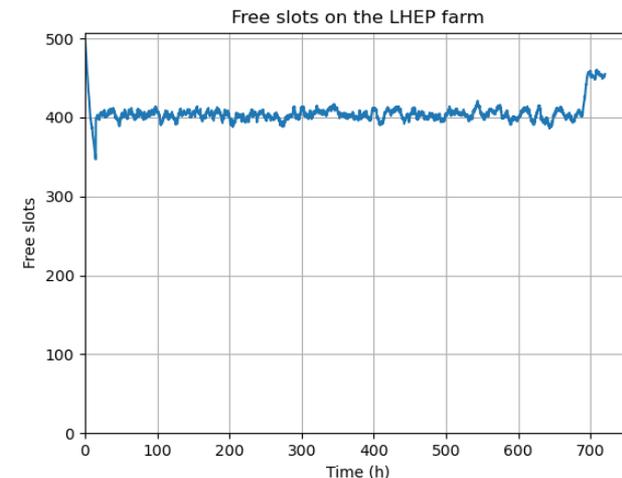
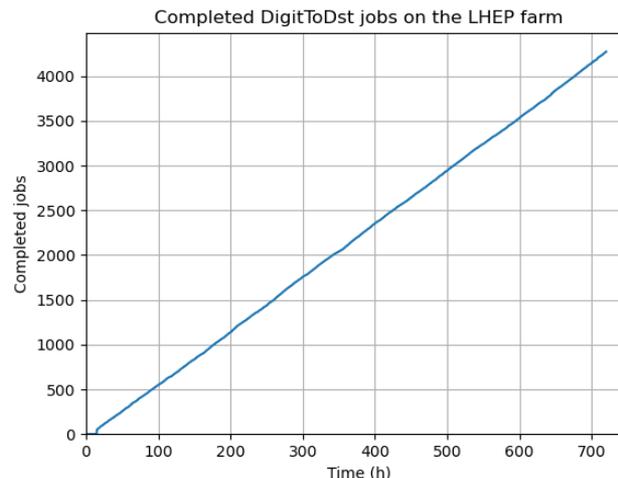
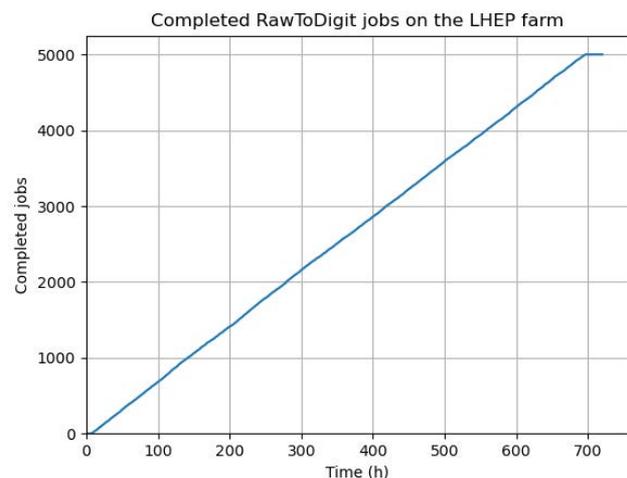
RawToDigit jobs – **10 000**

DigitToDst jobs – **10 000**

LHEP farm: 500 slots

RawToDigit jobs – **5 000 (50%)**

DigitToDst jobs – **5 000 (50%)**



- 350 slots are free
- There are not jobs queues
- The farm is not fully loaded

We can process more tasks on the farm

Results of Scenario 2 (2)

Total number

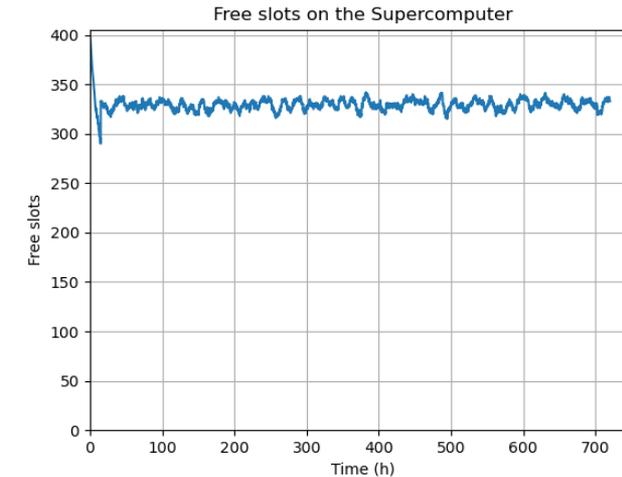
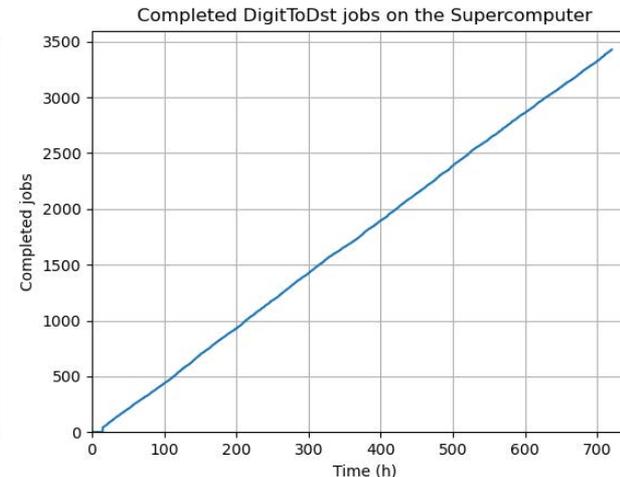
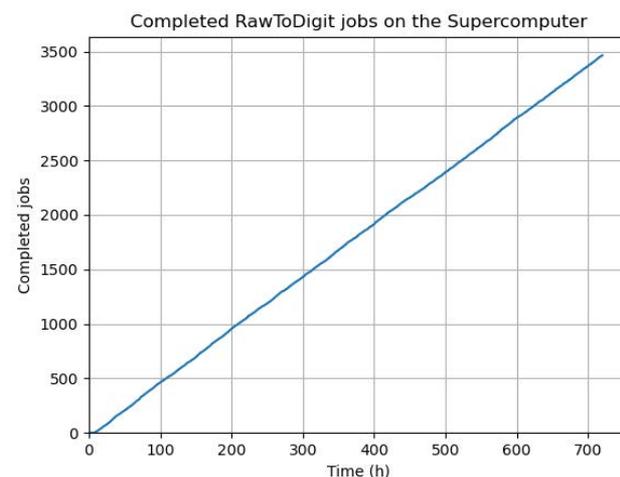
RawToDigit jobs – **10 000**

DigitToDst jobs – **10 000**

Supercomputer: 400 slots

RawToDigit jobs – **3 500 (35%)**

DigitToDst jobs – **3 500 (35%)**



- 250 slots are free
- There are not jobs queues
- The Supercomputer is not fully loaded

We can process more tasks on the Supercomputer

Results of Scenario 2 (3)

Total number

RawToDigit jobs – **10 000**

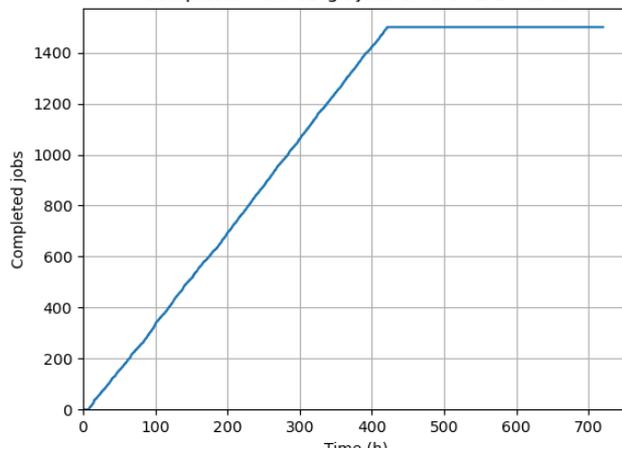
DigitToDst jobs – **10 000**

T2 LIT farm: 100 slots

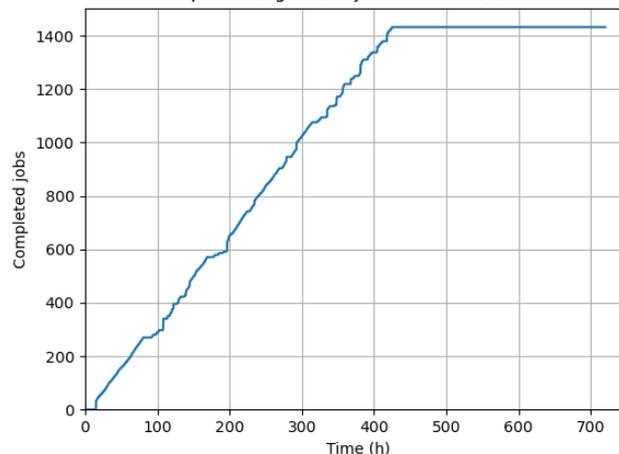
RawToDigit jobs – **1 500 (15%)**

DigitToDst jobs – **1 500 (15%)**

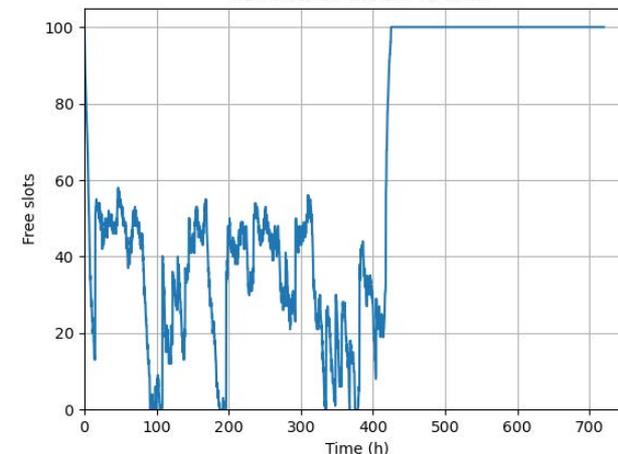
Completed RawToDigit jobs on the T2 LIT farm



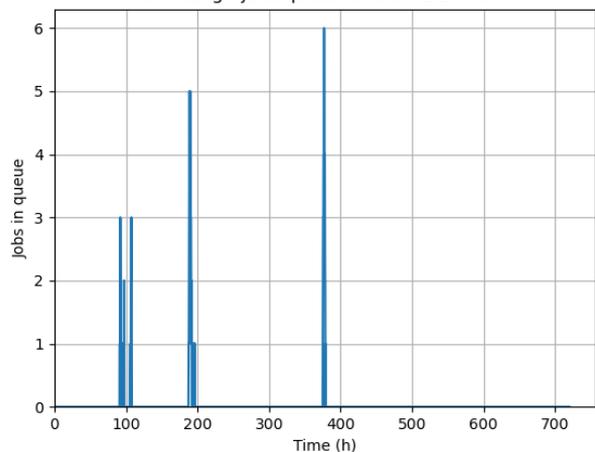
Completed DigitToDst jobs on the T2 LIT farm



Free slots on the LIT T2 farm



RawToDigit jobs queue on the T2 LIT farm



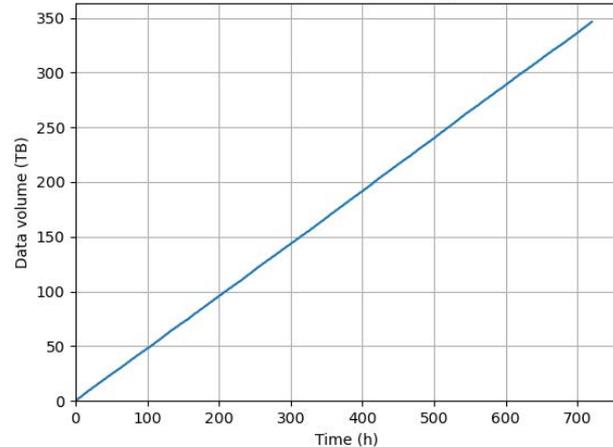
- All jobs were processed in 400 hours
- There are jobs queues

The results require additional research



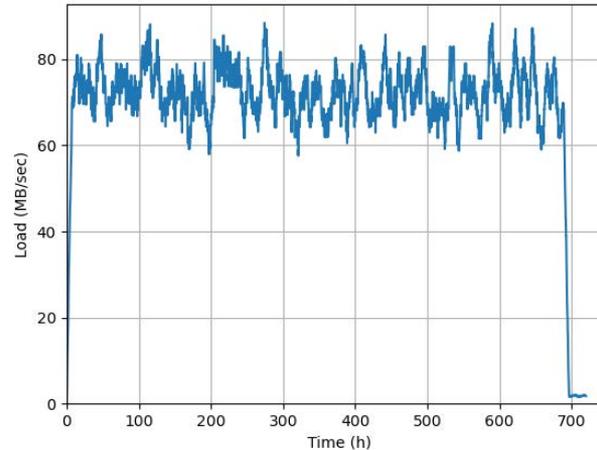
Total results

Data volume on the Intermediate data storage / EOS LHEP / EOS LIT



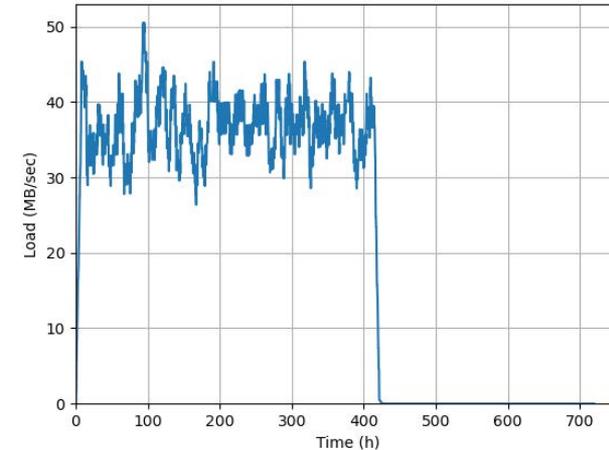
- Amount of raw-data per session – 350 TB

Load of link to the LHEP farm



- Maximum load of link to the LHEP farm – 90 MB / sec

Load of link to the LIT T2 farm



- Maximum load of link to the LIT farm – 50 MB / sec



Conclusions and Outlook

- Developed a tool for modeling the process of data acquisition and processing.
- Based on the simulation results, we can predict the load of farms, data pools and communication links.
- Modeling of 2 primary processing scenarios (executing [RawToDigit](#) and [DigitToDst](#) jobs).
- **Next steps:**
 - including other types of jobs (GenToSim, SimToDst, DstToAna) in the described scenarios,
 - modeling other possible scenarios for executing jobs.



5th Collaboration Meeting of the BM@N Experiment at the NICA Facility

Thank you for the attention!

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