

# Computing activities at the Spanish TIER-1 & TIER-2s for the ATLAS Experiment in the LHC Run-3 period and towards High Luminosity

**CHEP24 - International Computing in High Energy & Nuclear Physics  
Conference, 21-25 October 2024, Kraków, Poland**

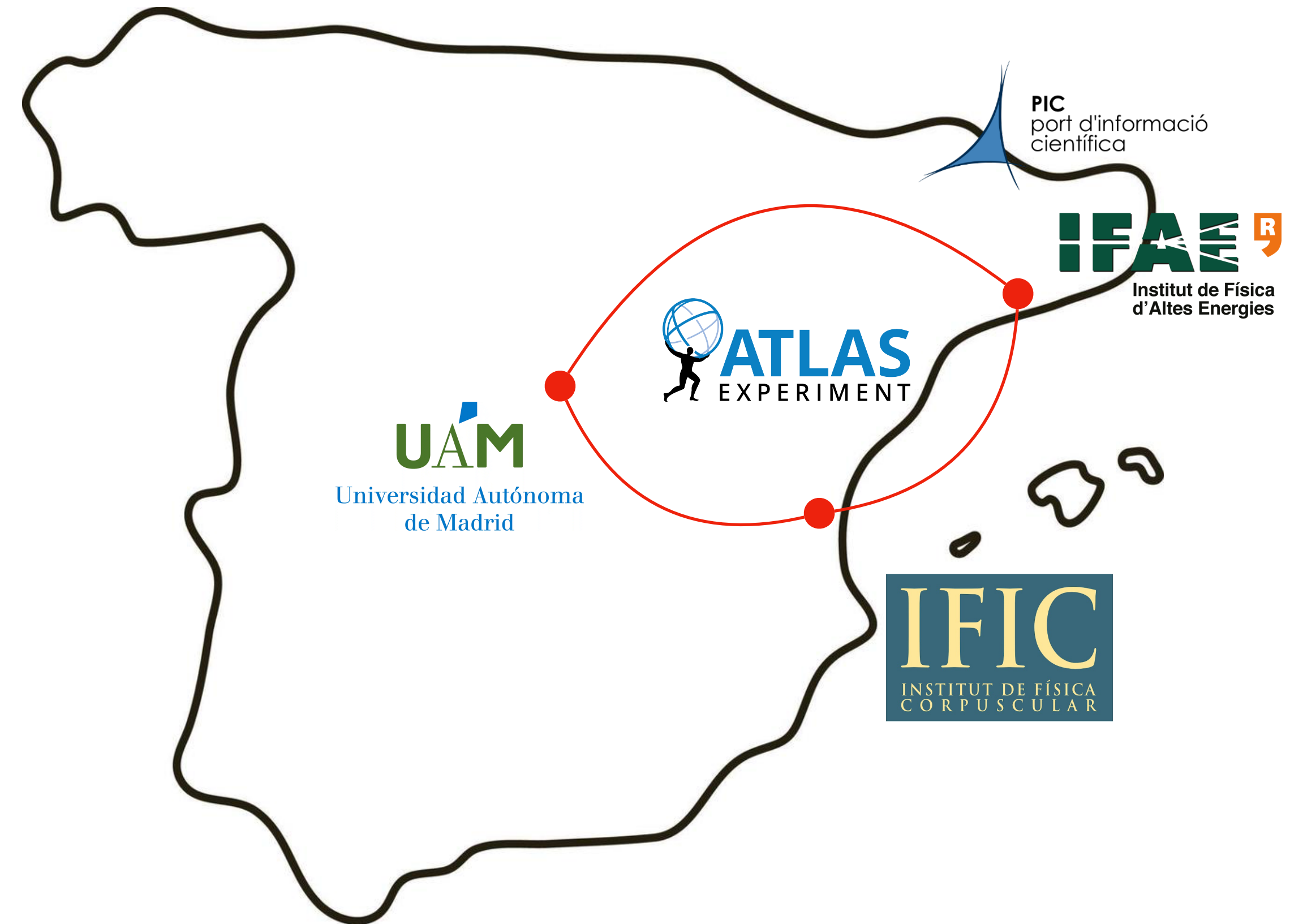


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# The Spanish TIER-1 and TIER-2s for ATLAS

- From ATLAS' point of view, Spain contributes with a **TIER-1** and a **TIER-2** site:
  - The **TIER-1** site is located at **PIC** in **Barcelona** and is **co-located** with **IFAE**. PIC also takes part in CMS and LHCb. PIC is a **collaboration** between **CIEMAT** and **IFAE**.
  - The **TIER-2** is actually federated across **3 locations**.
- All sites are **integrated** in the **WLCG project** and adhere to its **computing model**.



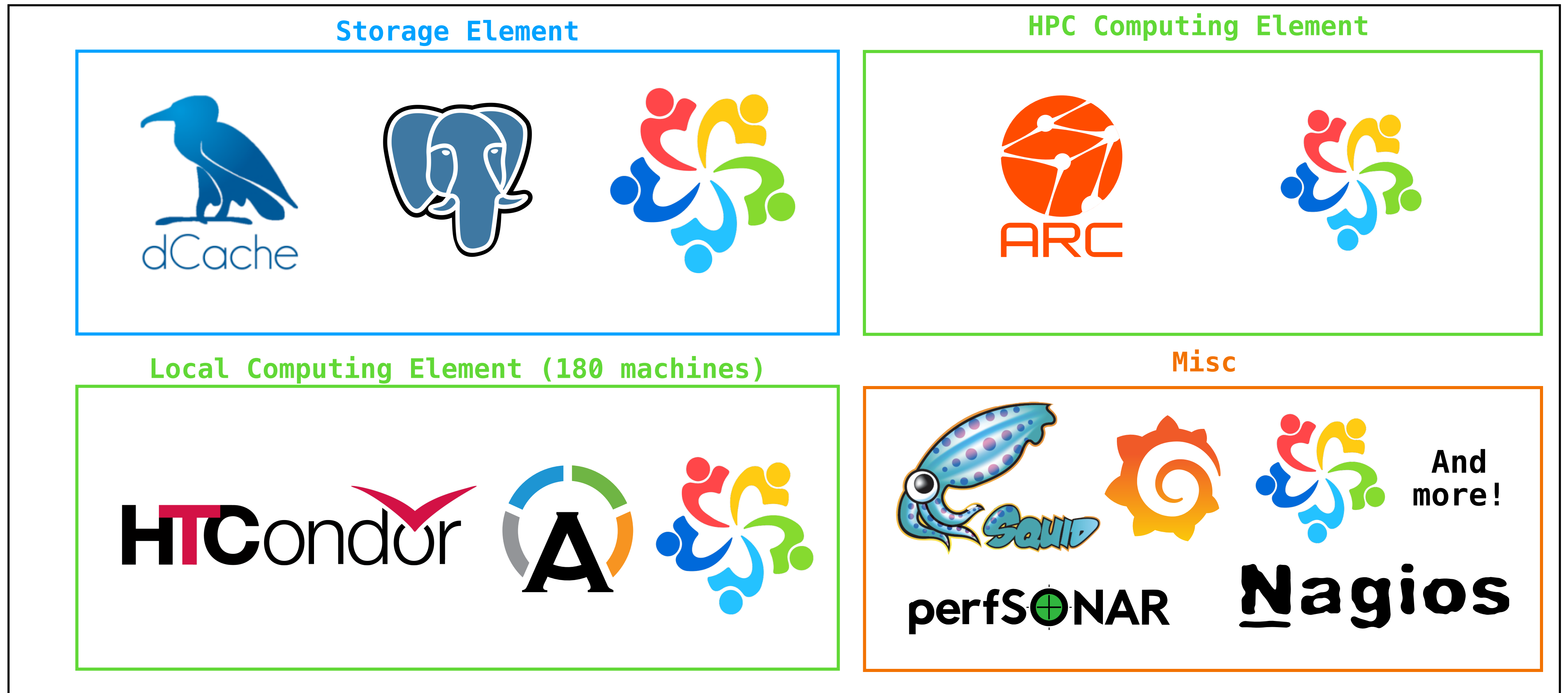
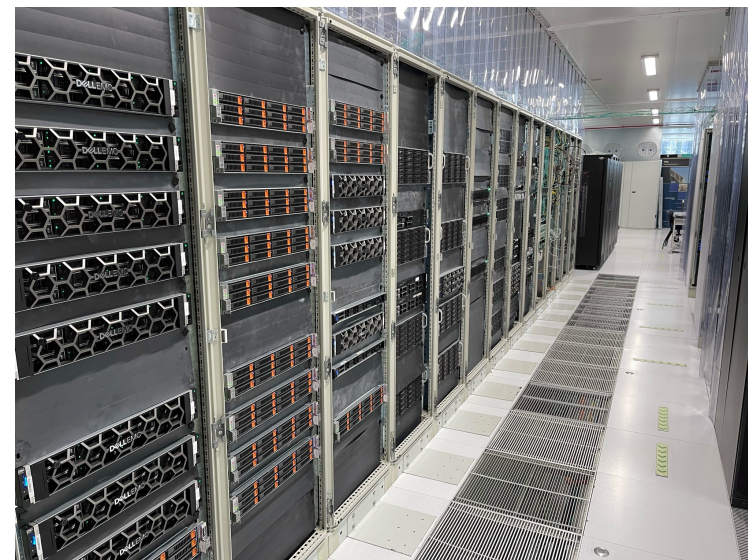
Site	% of TIER-2	Location
IFIC	60	Valencia
IFAE	25	Barcelona
UAM	15	Madrid

# Pledges and resources

<b>T1-ES</b>	<b>2023</b>	<b>2024</b>	<b>2025</b>	<b>2026</b>
<b>CPU [kHS23]</b>	57.2	60.64	73.575	94.013
<b>Disk [PB]</b>	5.44	6.520	8.369	10.229
<b>Tape [PB]</b>	14.120	18.08	25.245	32.258
<b>% of ATLAS</b>	3	4	4.5	5

<b>T2-ES</b>	<b>2023</b>	<b>2024</b>	<b>2025</b>	<b>2026</b>
<b>CPU [kHS23]</b>	69.9	73.4	99.0	126.5
<b>Disk [PB]</b>	6.7	7.9	10.2	12.5
<b>% of ATLAS</b>	3	4	4.5	5

# PIC/IFAE Overview



**Note:** The logos link to their respective websites!

# IFIC TIER-2 Overview



## Storage Element (22 machines)



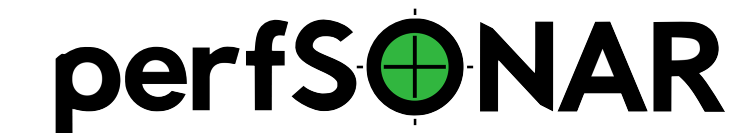
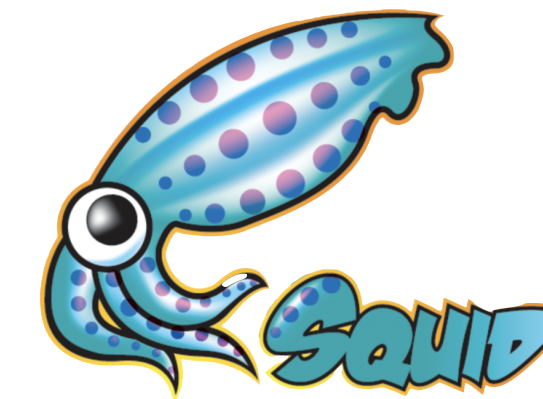
## HPC Computing Element (1 machine)



## Local Computing Element (64 machines)



## Misc (15 machines)

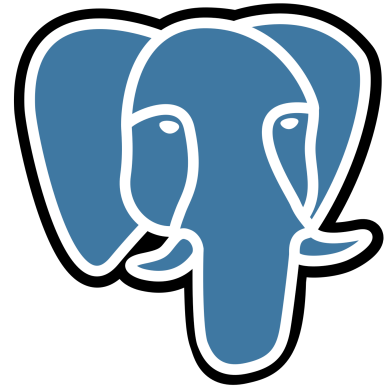


And more!

# UAM TIER-2 Overview



## Storage Element (50 machines)



## HPC Computing Element (1 machine)



## Local Computing Element (25 machines)

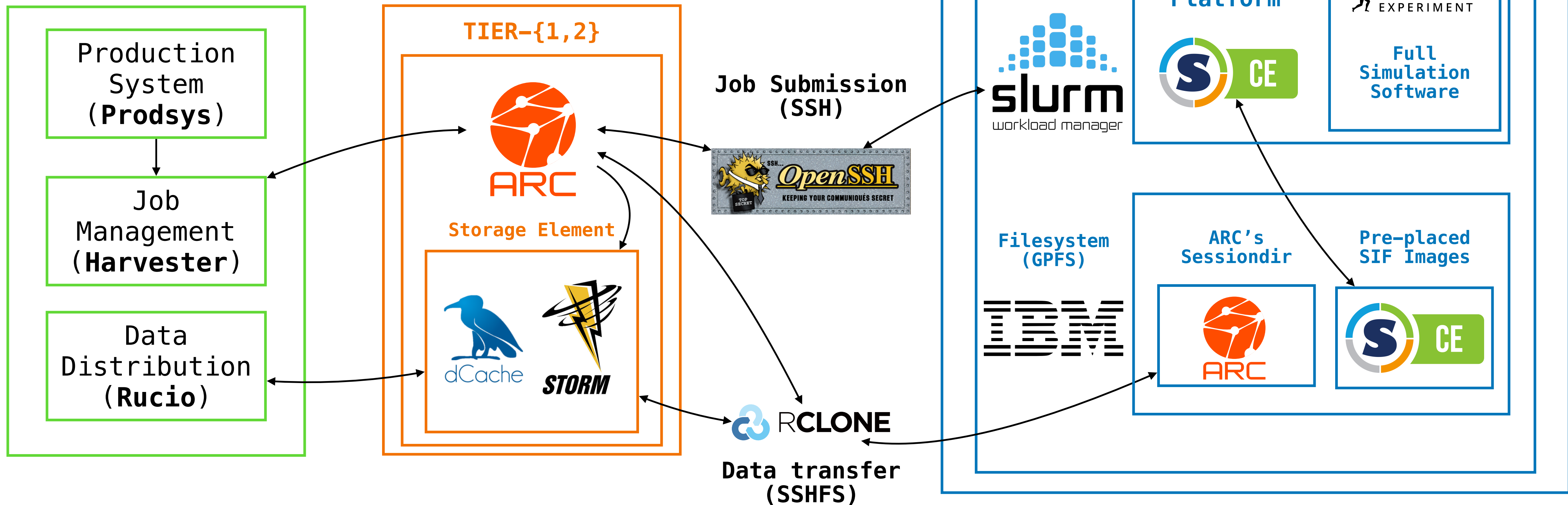


## Misc (10 machines)



And more!

# Leveraging HPCs

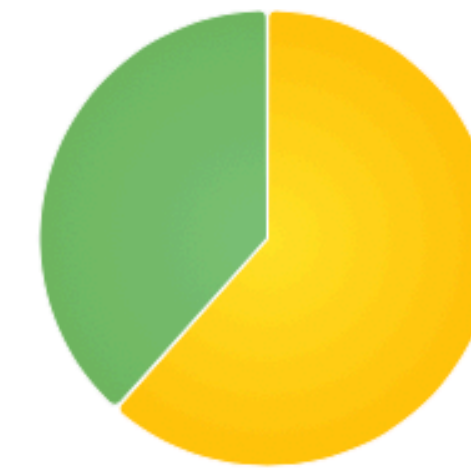


**Note:** MN5 disallows outbound and inbound **Internet** access...

# HPCs in numbers

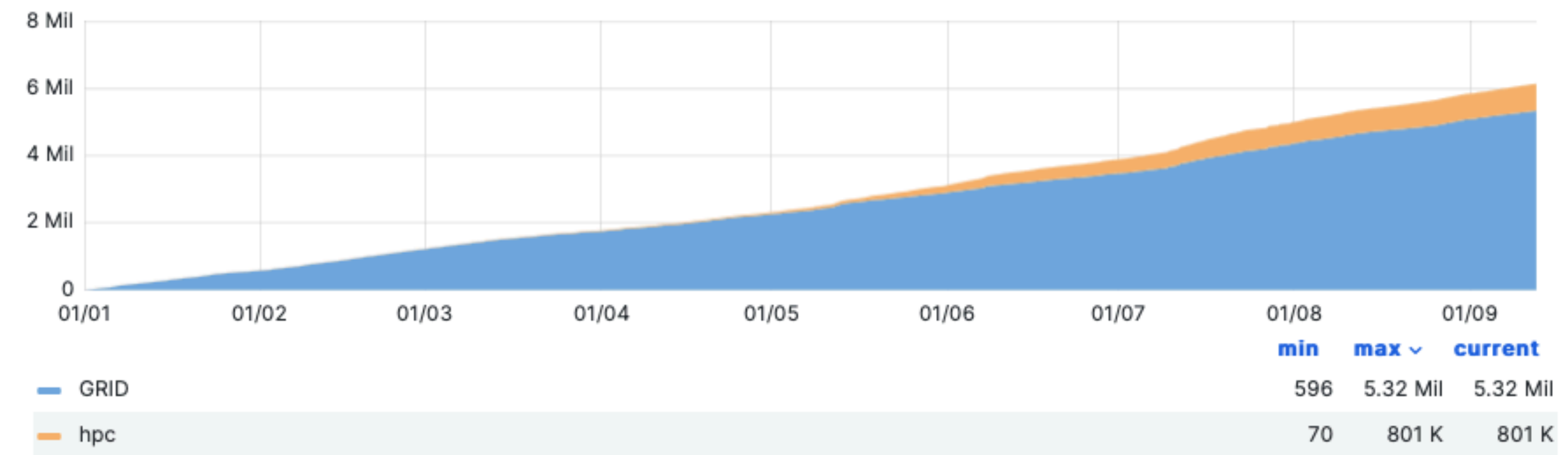
- On **April 2024** the BSC migrated from MN4 to **MN5**.
- Only the **simulation workflow** has been validated.
- **30 million hours** are approved at MN5 every year for ATLAS:
  - Through **Spanish R&D gateways**.
  - This corresponds to **50%** of **simulation** jobs assigned to Spain.
- **HS23 / core = 27,1155**

CPU Consumption: Successful jobs in Seconds

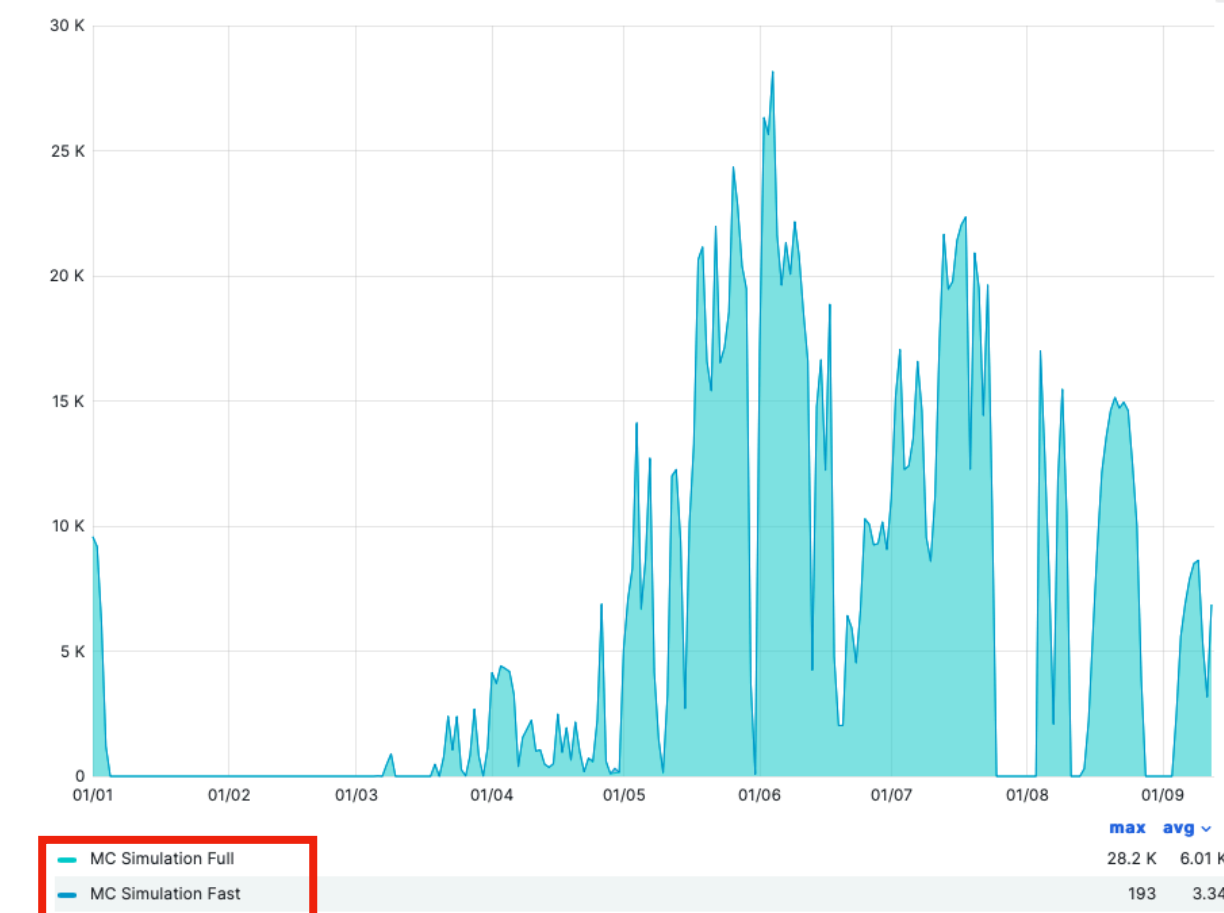


	Value	Percent
GRID	141 Bil	62%
hpc	88.2 Bil	38%

Completed jobs Cumulative

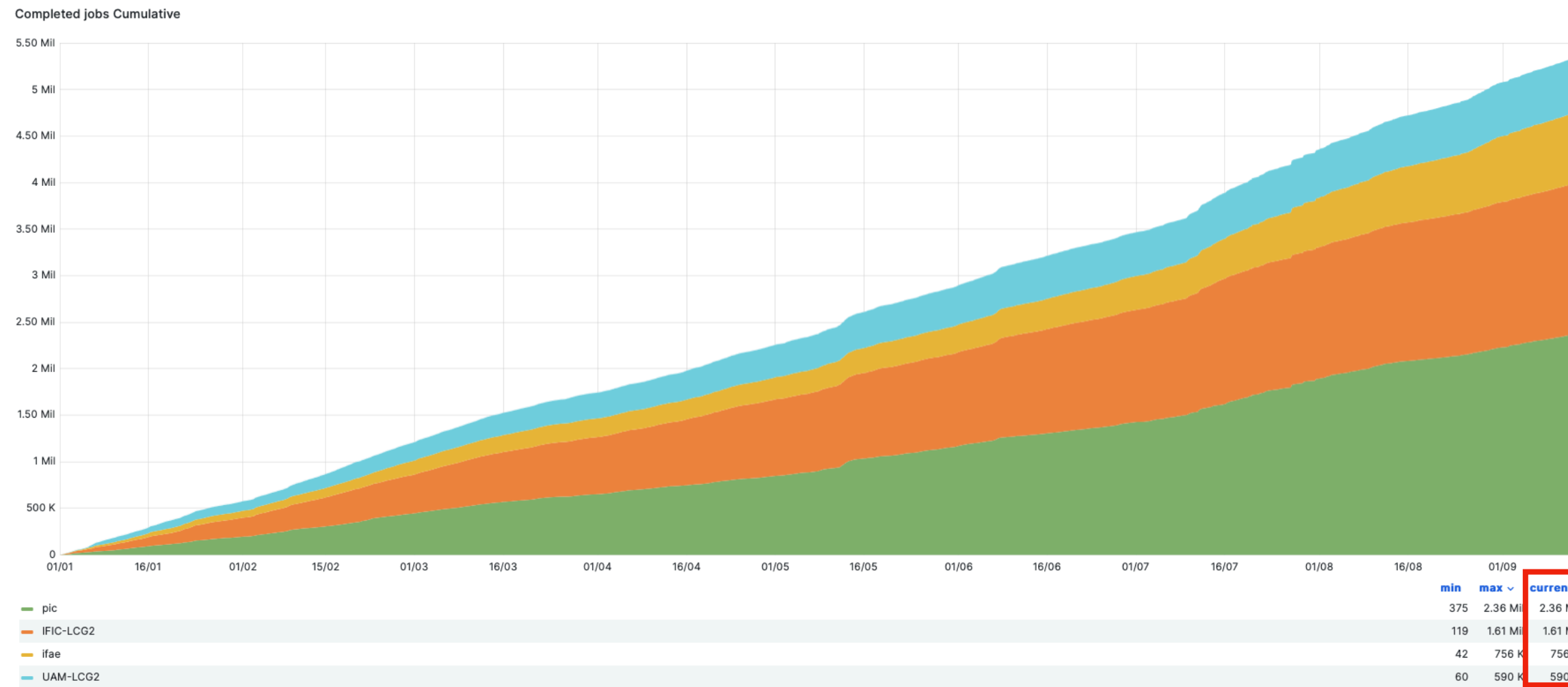


Slots of Running jobs by ADC activity

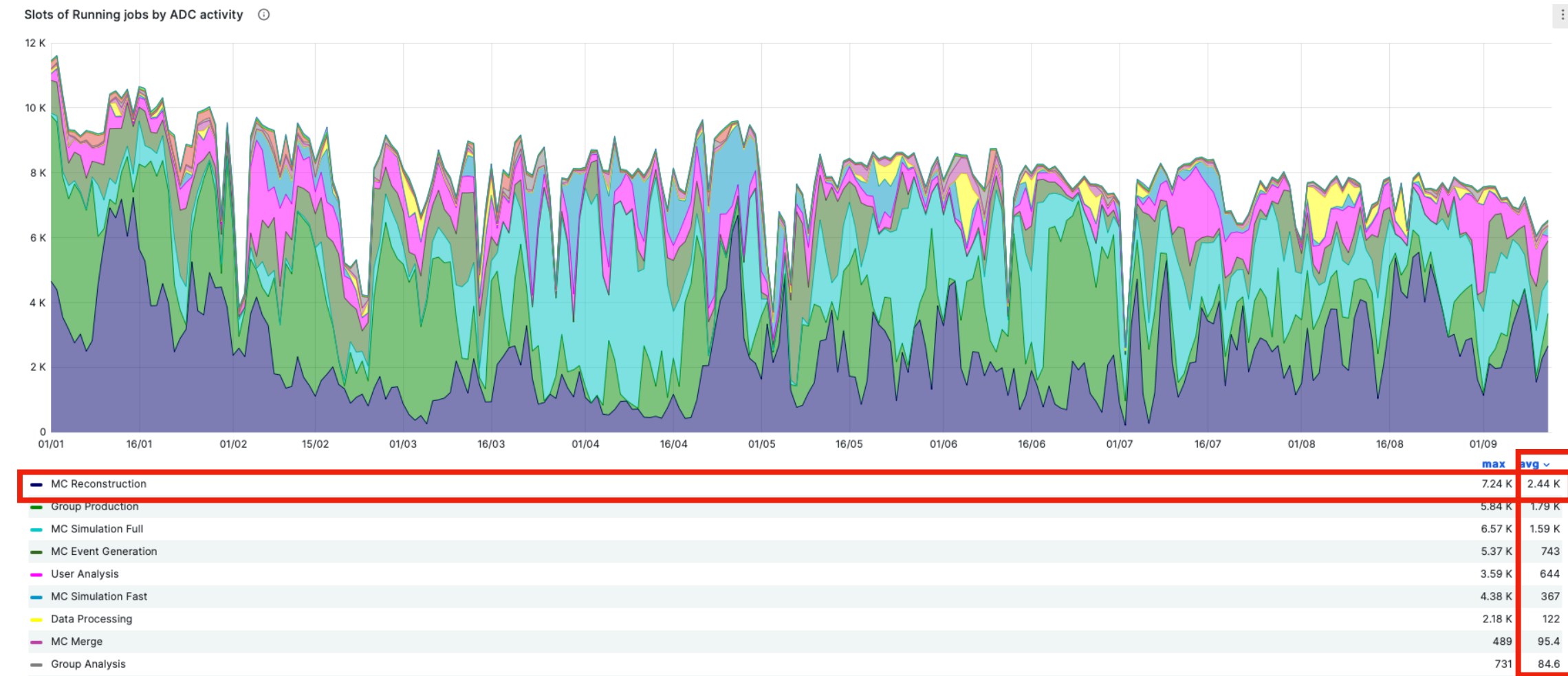




# Jobs, slots and job efficiency



~ 5.4 million jobs completed



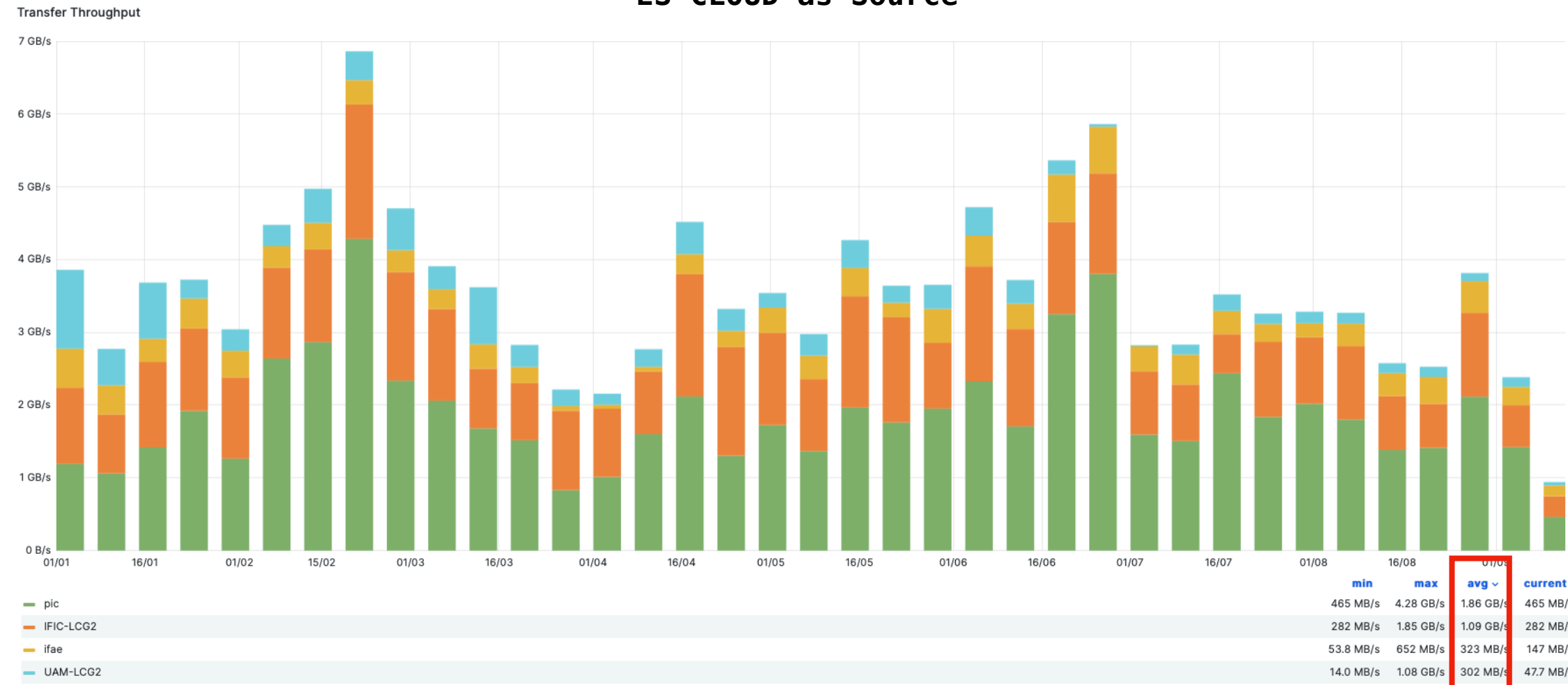
~ 10k slots of running jobs on average



Site downtime and recommissioning

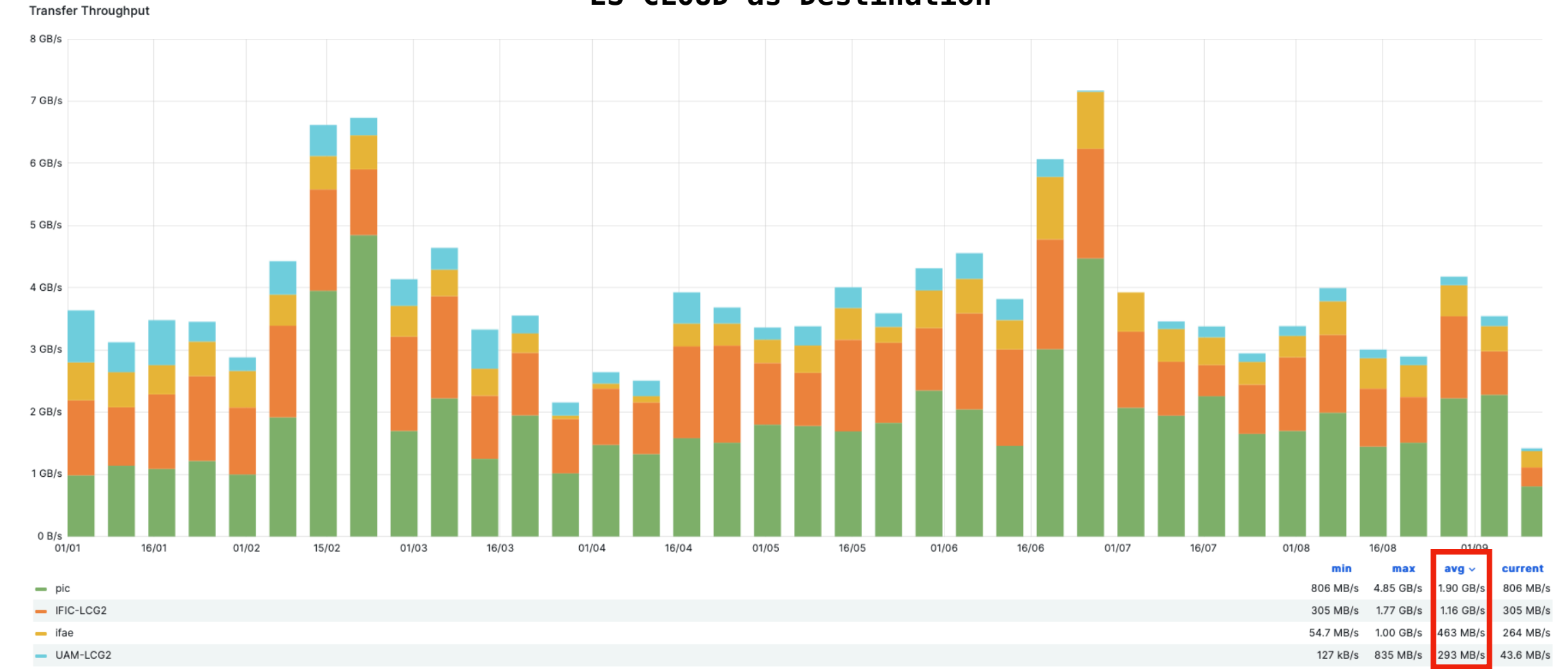
# Transfer throughputs and data volume

ES-CLOUD as Source



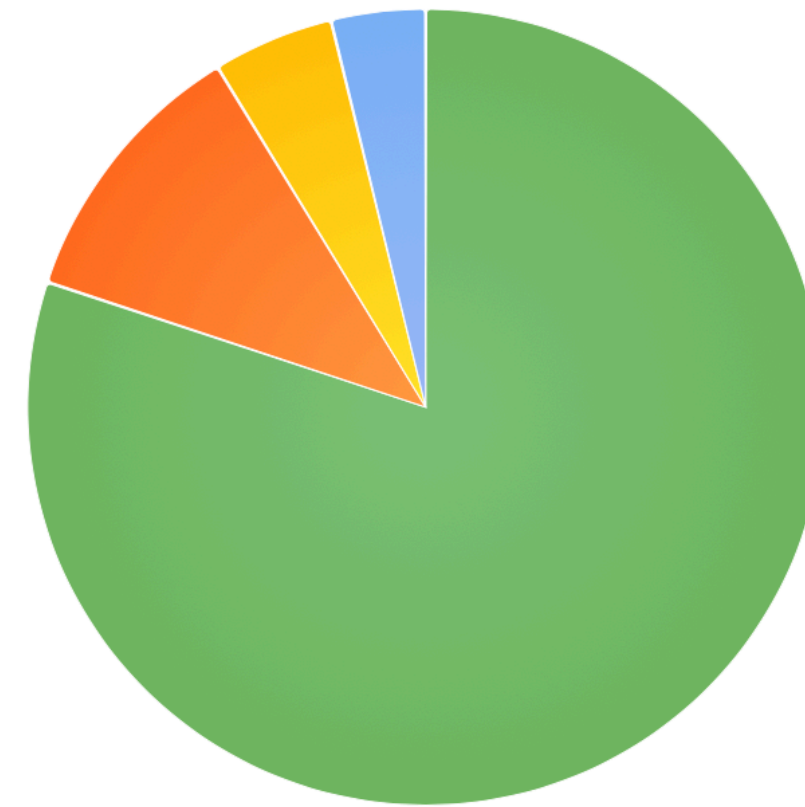
~ 9.27 PB/month

ES-CLOUD as Destination



~ 9.89 PB/month

Volume by experiment\_site Last 24 hours



pic  
IFIC-LCG2  
ifae  
UAM-LCG2

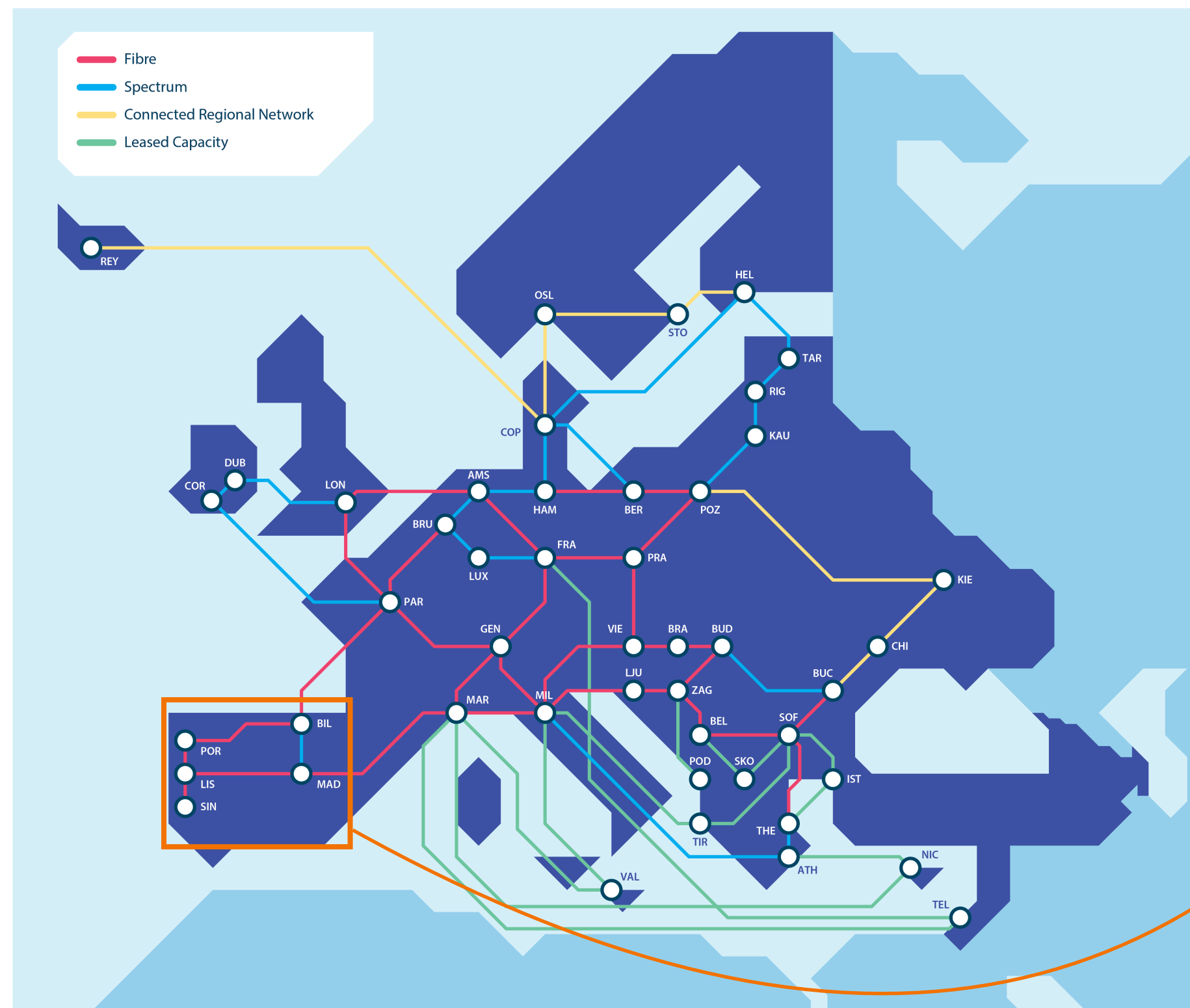
4.8 Disk +  
19.2 Tape

Value	Percent
24.0 PB	80%
3.33 PB	11%
1.45 PB	5%
1.13 PB	4%

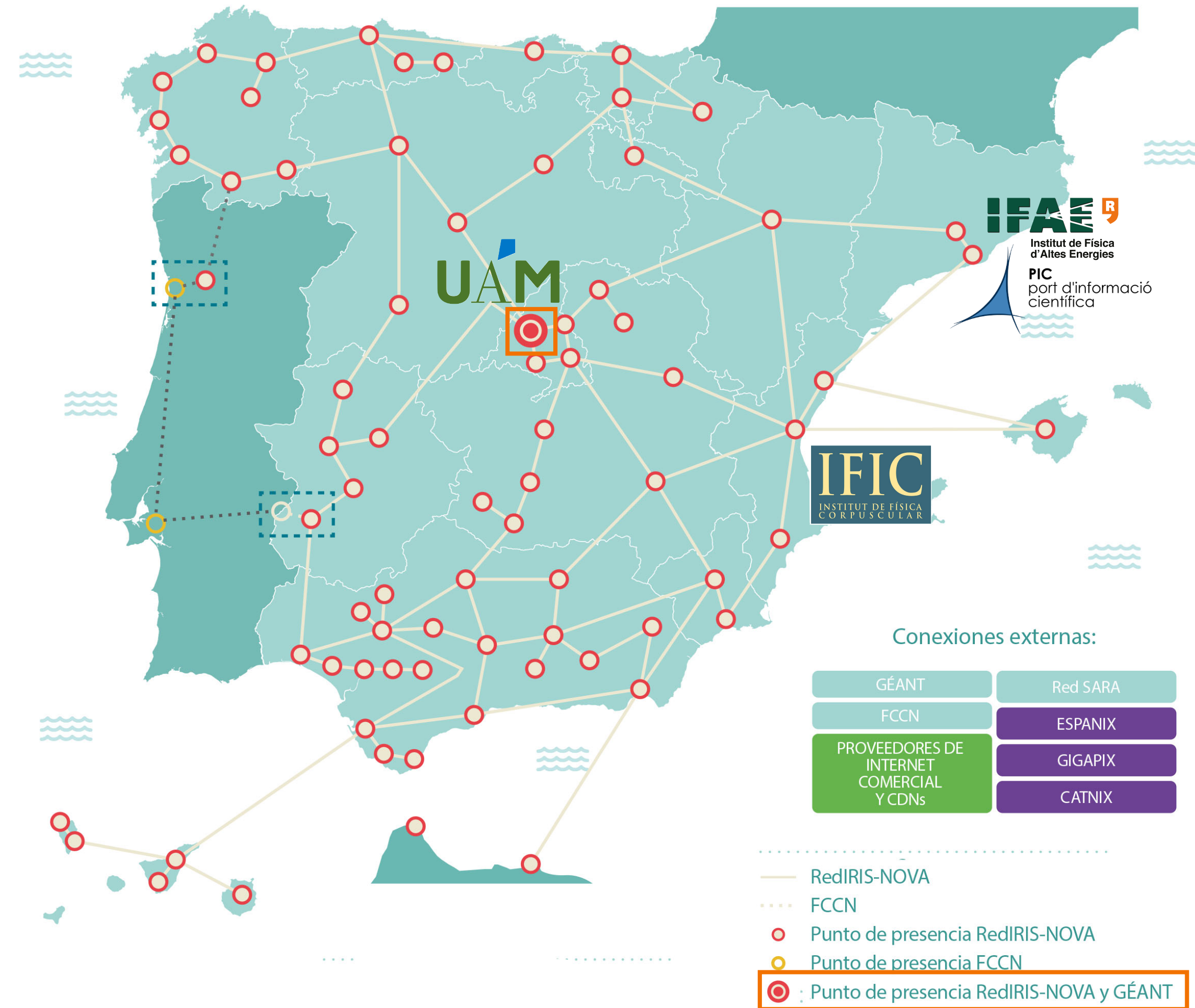
# Network infrastructure



The GÉANT network interconnects Europe's NRENs and provides onward connectivity to regional networks worldwide. Enabling the most important scientific discoveries, it is essential to Europe's research and education communities.

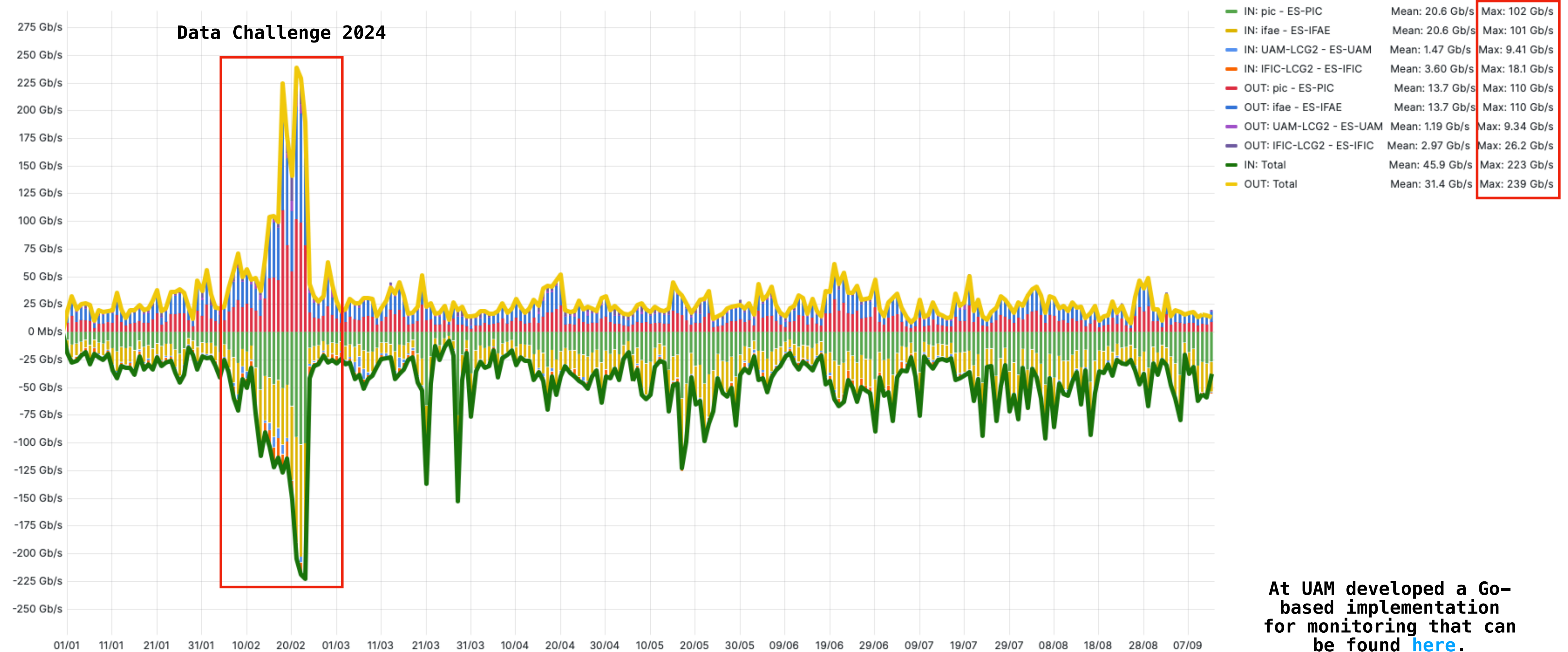


January 2024



# A traffic snapshot

WLCG Site Network Input/Output



At UAM developed a Go-based implementation for monitoring that can be found [here](#).

# Current data rates and outlook

	<b>PIC/IFAE</b>	<b>IFIC</b>	<b>UAM</b>
<b>Current Data Rate</b>	<b>2 x 100 Gbps</b>	<b>2 x 100 Gbps</b>	<b>10 Gbps</b>
<b>Infrastructure</b>	2 x Redundant 100 Gbps files	2 x Redundant 100 Gbps fibers	1 x LHCONE fiber
<b>Outlook</b>	Update to <b>500 Gbps</b> by 2026	Nothing foreseen	Upgrade to <b>50 Gbps</b> imminent
<b>HL-LHC</b>	<b>REDIRIS</b> is rolling out <b>400 Gbps</b> technology beginning in 2024		

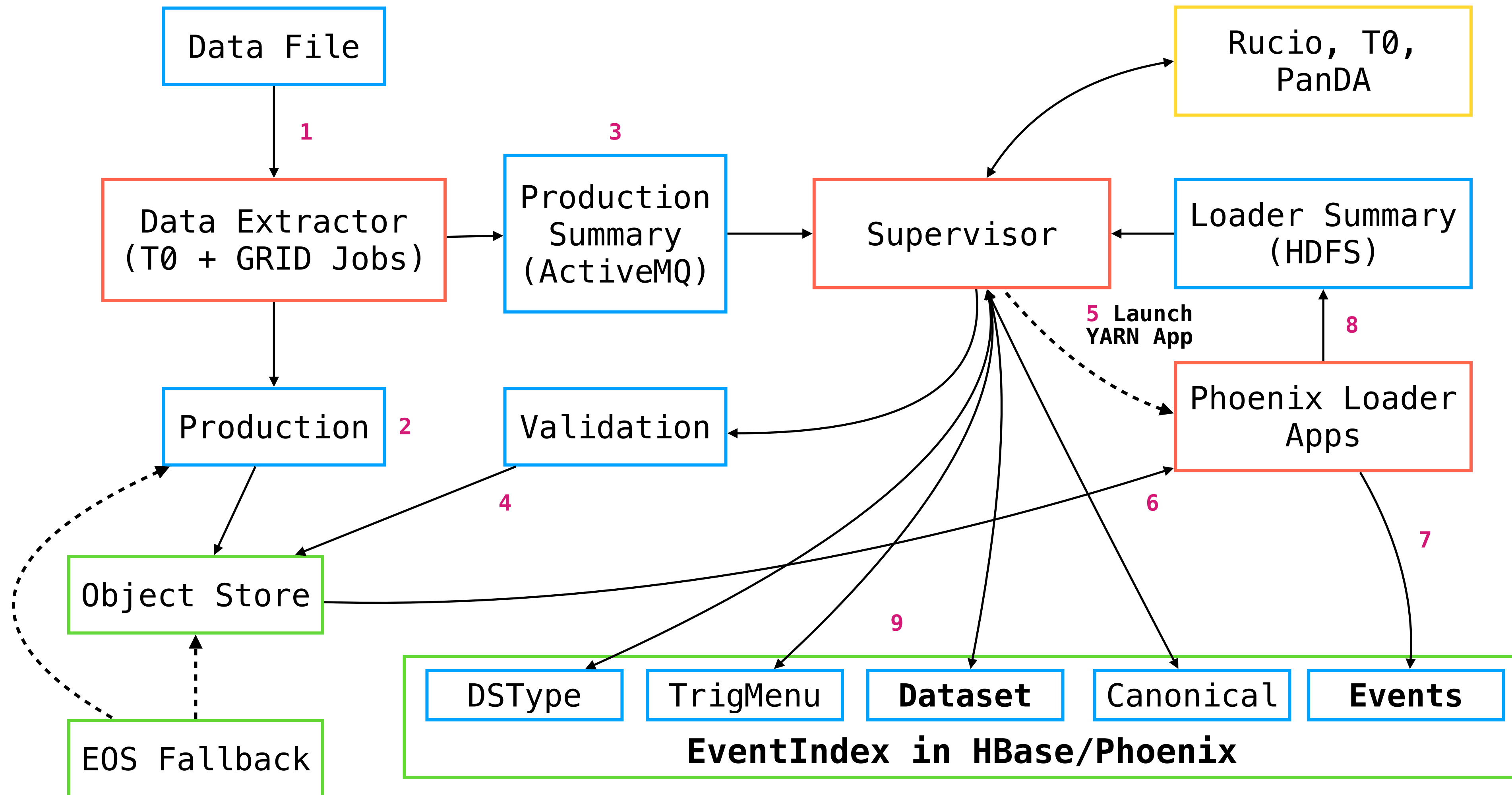
# R&D at IFIC: The ATLAS Event Index

- **IFIC** is responsible for the **Data Extractor**, **Supervisor** and the **Phoenix Loader Apps**.

- In numbers...

- **+1306 billion events** processed.
- **+614K datasets**
- **+48 million files**

In a single HBase Table!



# R&D at IFIC: The ATLAS Event Index

- **EventIndex**: Catalogue of real and simulated events.
- Use cases:
  - Event **picking**
  - **Counts** or **selections**
  - **Overlaps...**
    - Of **triggers** in a dataset
    - Of **events** in derivations
  - Production **checks**
- Data **production, collection, final backend** and **applications**.
- Data **collection**:
  1. **Extract** metadata from events.
  2. **Validate** the metadata.
  3. **Load** metadata into EventIndex.
- Tech **stack**:
  - **HBase + Phoenix**
  - **Scala, Spark** and **RDD API**.



# R&D, OSS and operation

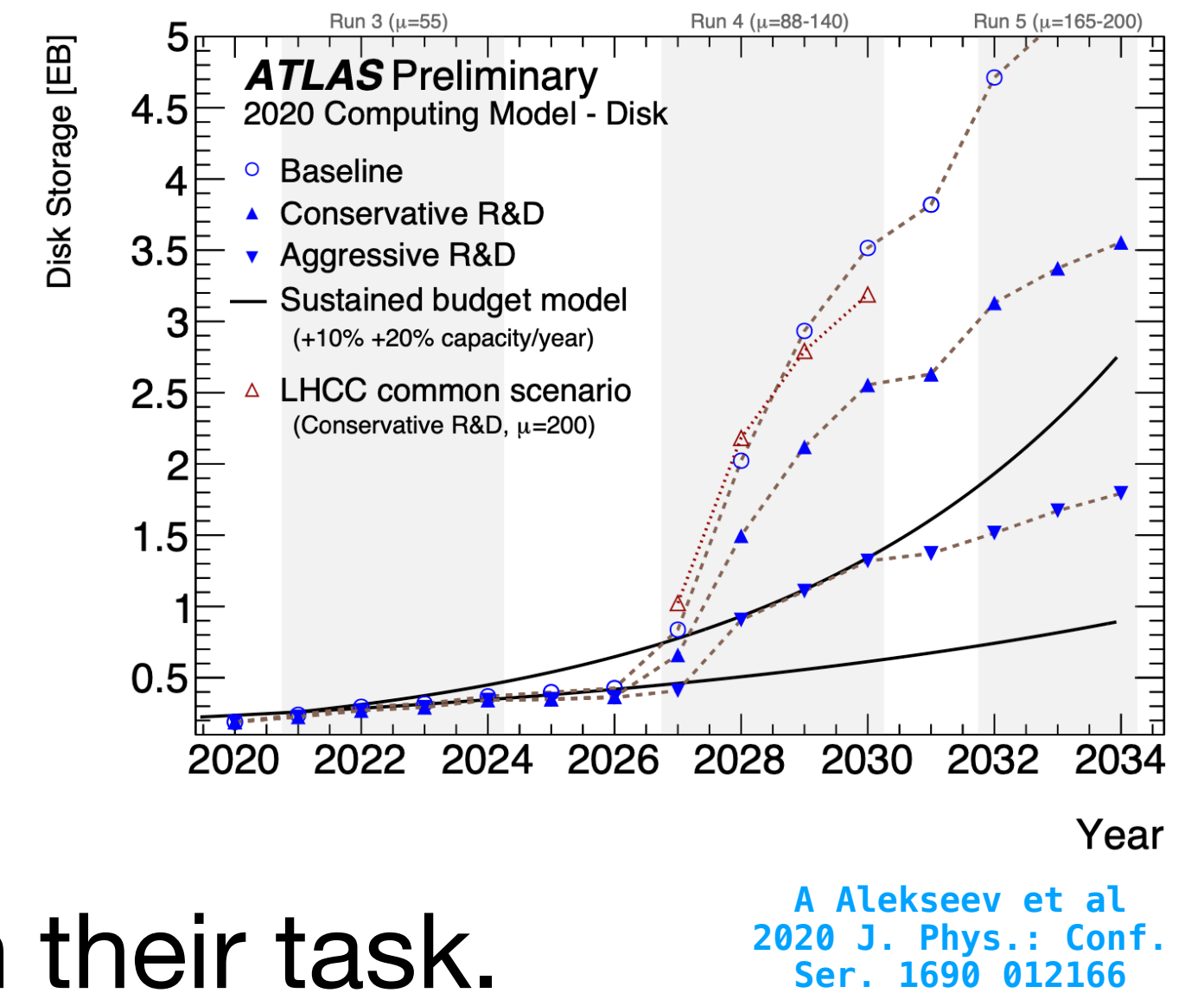


- At UAM we developed a **Telegraf** input **plugin** for **SLURM**:
  - Added on **Telegraf 1.32** through [PR #15700](#).
- UAM hosts an **AlmaLinux mirror** at <https://mirrors.ft.uam.es/almalinux>.
- Deployment of **analysis facilities** at various TIER-2s.
- **Participation** in the **operation** and **coordination** of distributed **computing**.



# Analysis Facilities

- **Key idea: minimise the time-to-insight:**
  - With **10x data** we **don't** want to **wait 10x** more too!
  - **Well designed analysis facilities (AFs) aid physicists'** in their task.
- **Key features:**
  1. **Local access to data: DAOD\_PHYSLITE** stored **on-site** for iterations.
  2. **Wealth (and quality) of resources:** CPUs, GPUs, RAM, SSDs...
  3. **Efficient and elastic** infrastructure: LRMSs, peak absorption on HPC/Cloud.
  4. **Modernisation: SW ecosystems, Uls, expert on-call, analysis logic reuse...**



# Working on the AFs



- The previous features **translate** into:

1. **Dedicated** (i.e. 100s of TBs) **local storage** for the AF.
2. **CPU** resources **'pooled'** on priority-configured **LRMSs** (i.e. **HTCondor**).

3. Gradual **transition** from **CVMFS** to **containers**: already done on **HPC!**

4. **Fast network backbone** for **LAN** and **WAN (DataLake)** data access.

PIC's already working on the EULake Prototype

5. **Modernised UIs: Jupyter** Notebooks and the new **Jupyter Lab**:

- We can use **Dask**, **HTCondor**, **RDataFrames**, **coffea...** even **Spark!**
- We can **homogenise resources** behind a **friendly interface**: IFIC's [Artemisa](#).
- We **follow** in the footsteps of CERN's **SWAN**, already **deployed** at **IFAE & IFIC**.

KORE

# Closing thoughts

- ATLAS' Spanish **TIER-1** and **TIER-2s** offer **4%** of all resources and strive to reach **5%**.
- The **efficiency** for all sites is **above 90%**; the federated TIER-2 is a **Nucleus-T2**.
- **PIC**, **IFIC** and **UAM** are leveraging **HPC** resources for simulation jobs.
- **IFAE** is **co-located** with **PIC**: **optimised** and dynamic **resource** sharing.
- UAM is **operating** the site whilst making **contributions** to **WLCG** and **OSS** SW.
- **IFIC** **designs**, **develops** and **maintains** key parts of ATLAS' **EventIndex**.
- The **national network** operator is working on **enhancing** the network **backbone**.
- **Work** ongoing to **deploy** and operate **Analysis Facilities** in preparation for the **HL-LHC**.

# Thanks to our national research projects

**PIC's TIER-1 project PID2022-142604OB-C21/C22 of the MICINN**

**IFIC's TIER-2 project PID2022-136323OB-C21 of the MICINN**

**IFAE's TIER-2 project PID2022-142604OB-C22 of the MICINN**

**UAM's TIER-2 project PID2022-136323OB-C22 of the MICINN**



**Any questions?**