

# 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**

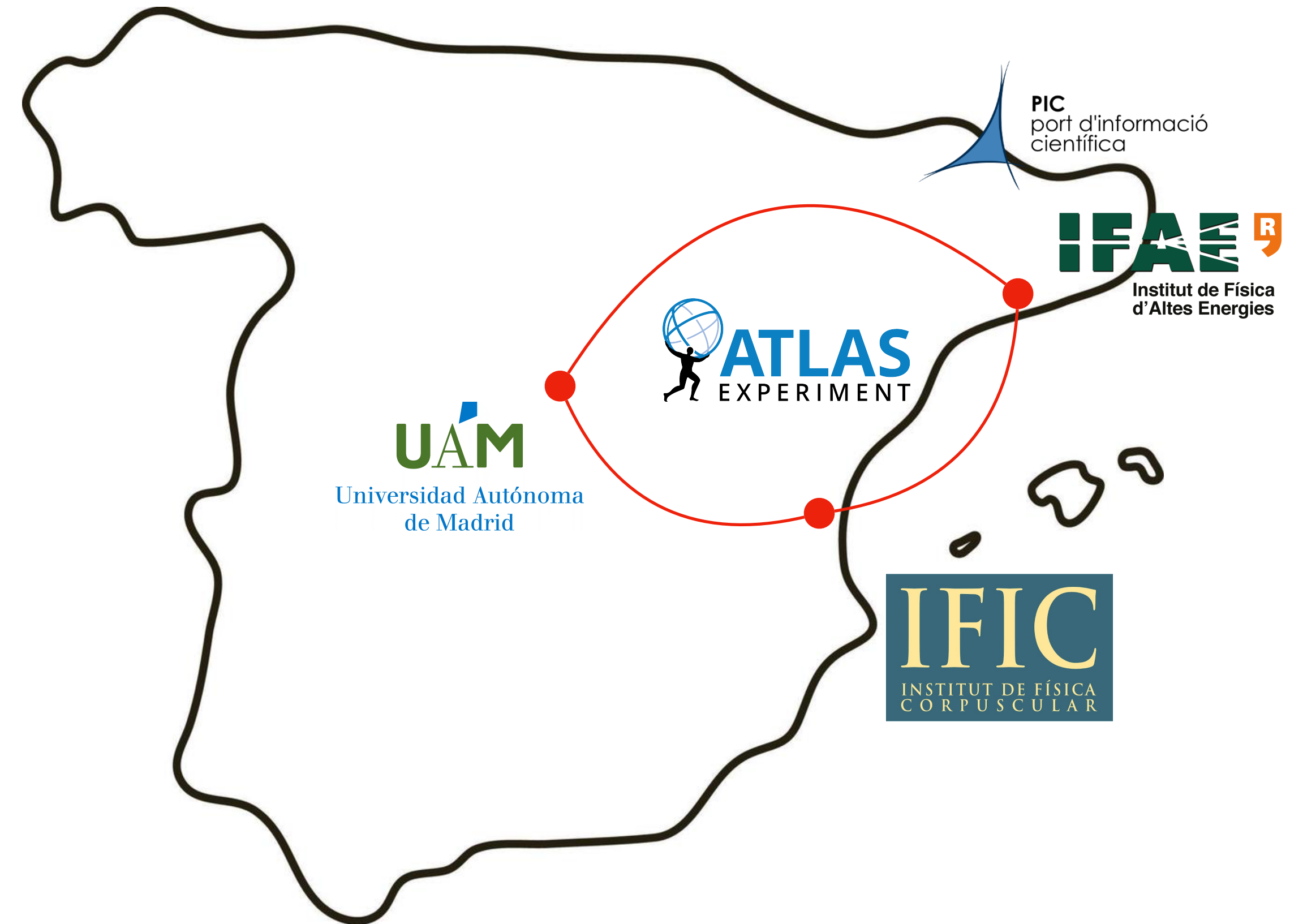


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# The Spanish TIER-1 and TIER-2s for ATLAS

- 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**.



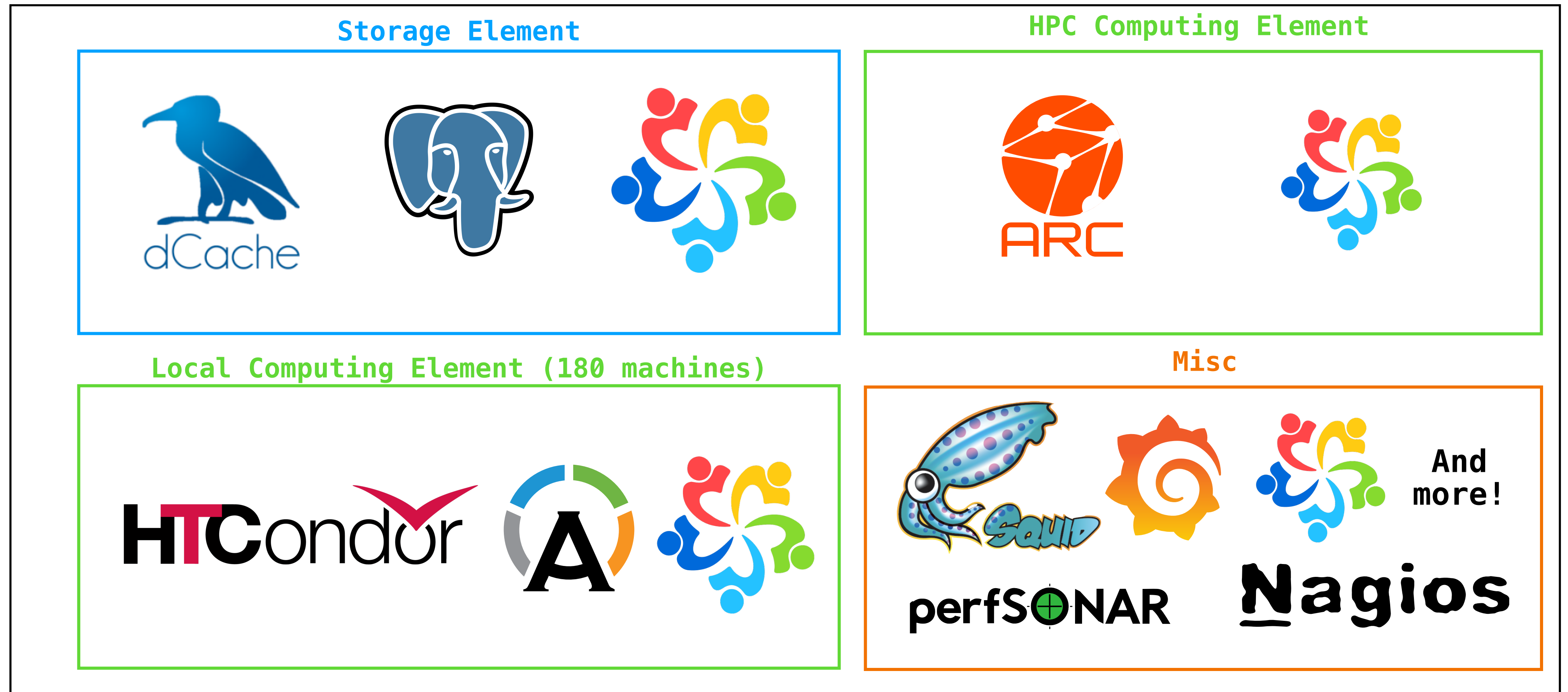
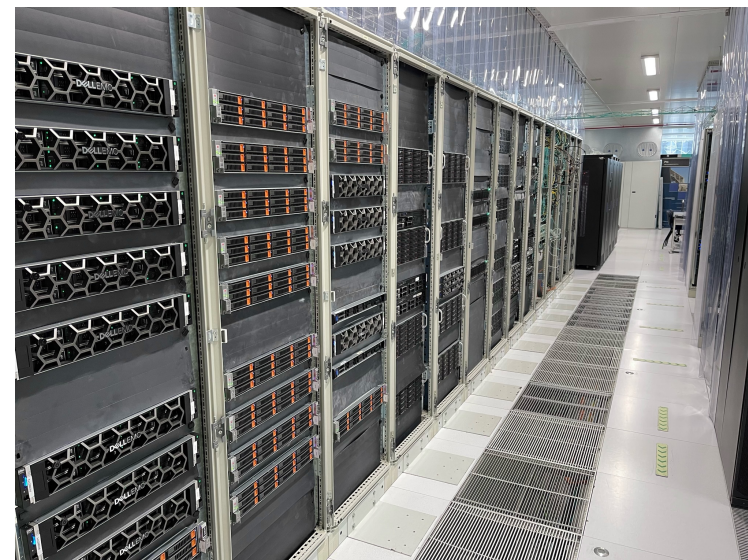
Site	% of TIER-2	Location
IFIC	60	Valencia
IFAE	25	Barcelona
UAM	15	Madrid

# 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)



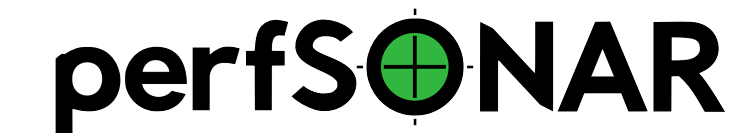
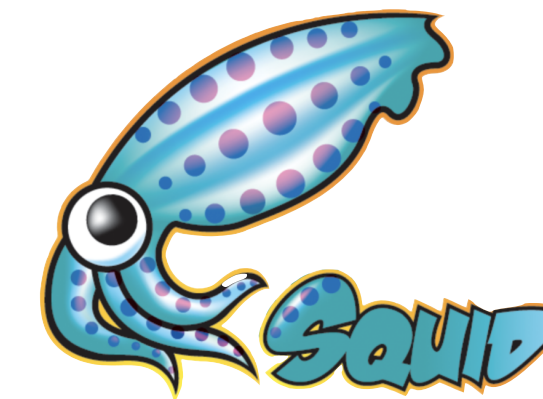
## HPC Computing Element (1 machine)



## Local Computing Element (64 machines)



## Misc (15 machines)

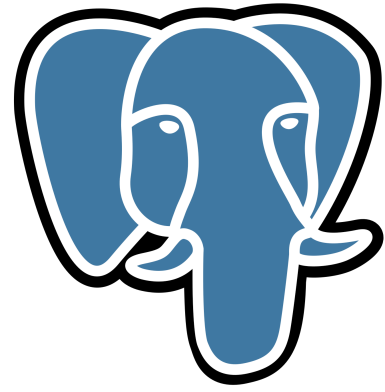


And more!

# UAM TIER-2 Overview



## Storage Element (50 machines)



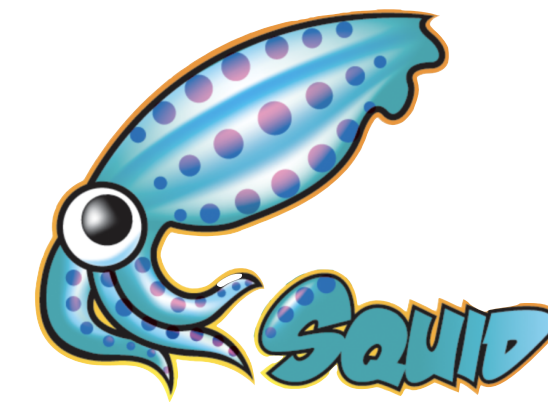
## HPC Computing Element (1 machine)



## Local Computing Element (25 machines)



## Misc (10 machines)



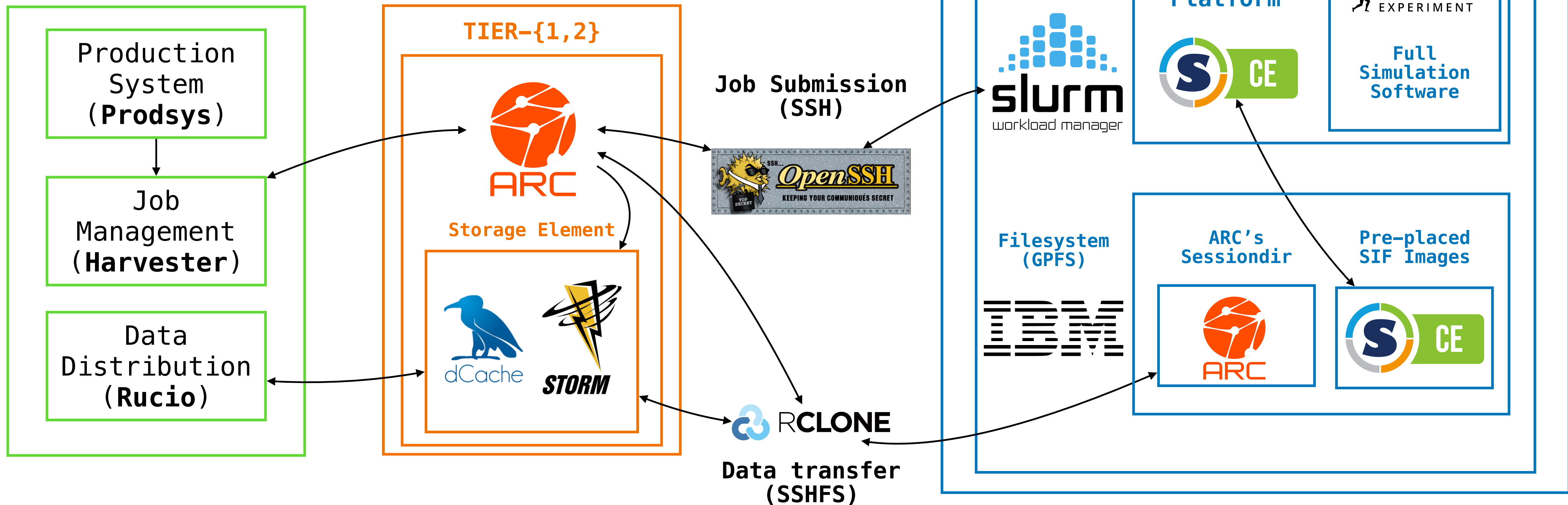
perfSONAR



And more!



# Leveraging HPCs

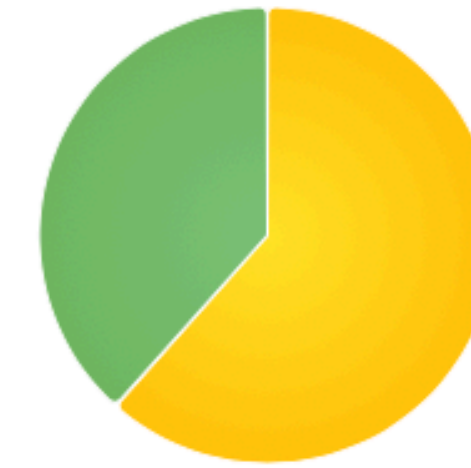


**Note:** MN5 disallows outbound and inbound **Internet** access...

# HPCs in numbers

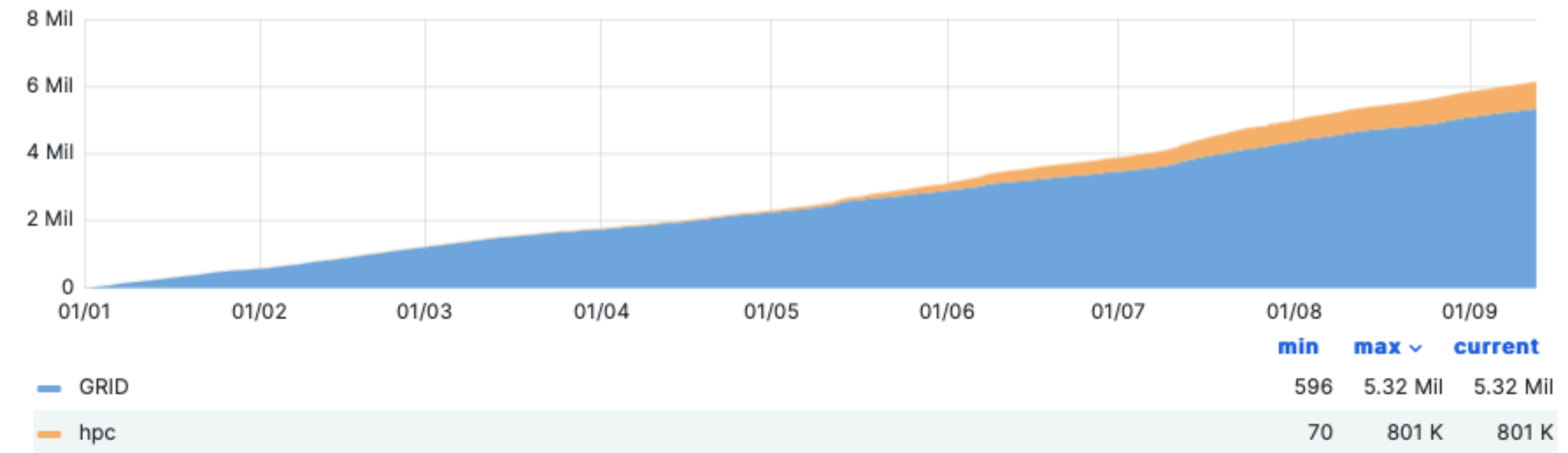
- On **April 2024** the BSC migrated from MN4 to **MN5**.
- Only the **simulation workflow** has been validated.
- **30 million hours** are approved at MN5 every year for ATLAS:
  - Through **Spanish R&D gateways**.
  - This corresponds to **50%** of **simulation** jobs assigned to Spain.
- HS23 / core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

CPU Consumption: Successful jobs in Seconds

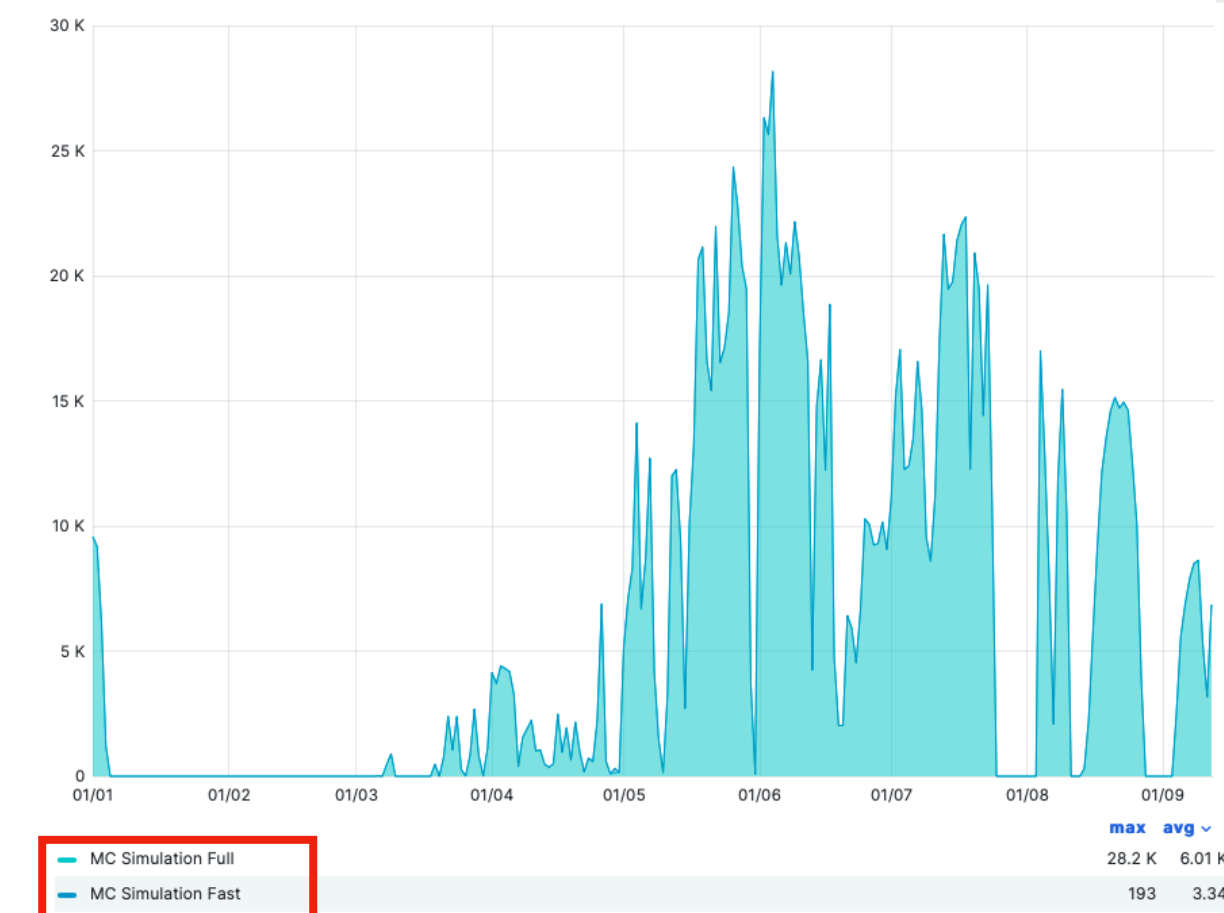


	Value	Percent
GRID	141 Bil	62%
hpc	88.2 Bil	38%

Completed jobs Cumulative

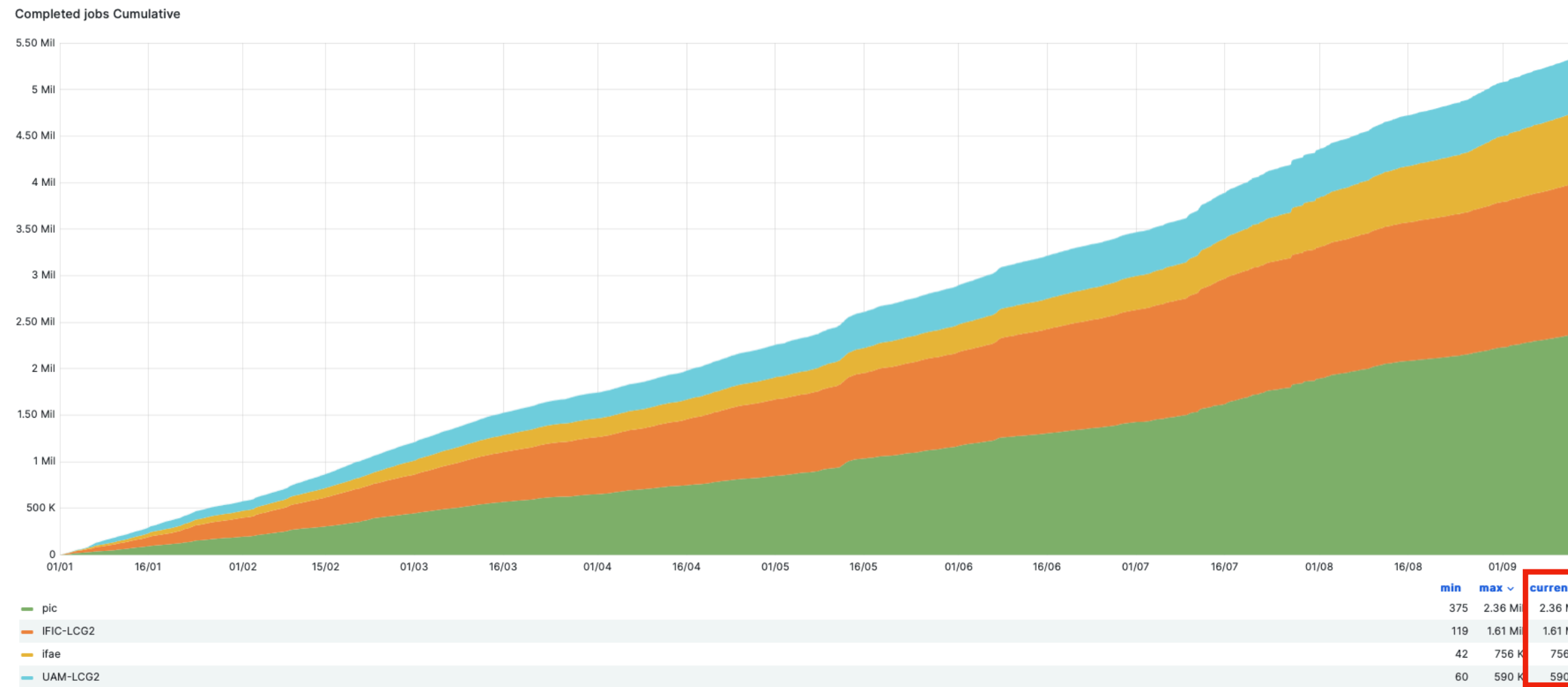


Slots of Running jobs by ADC activity

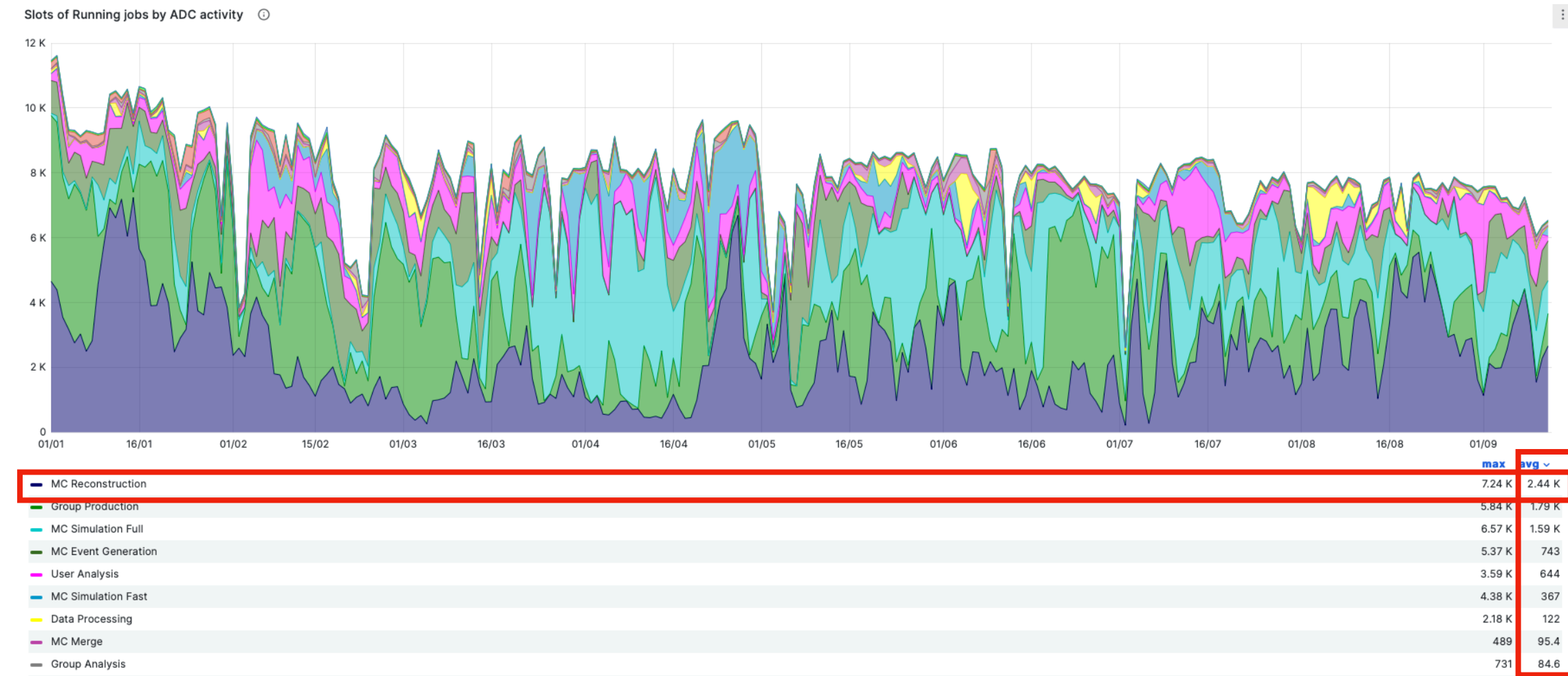




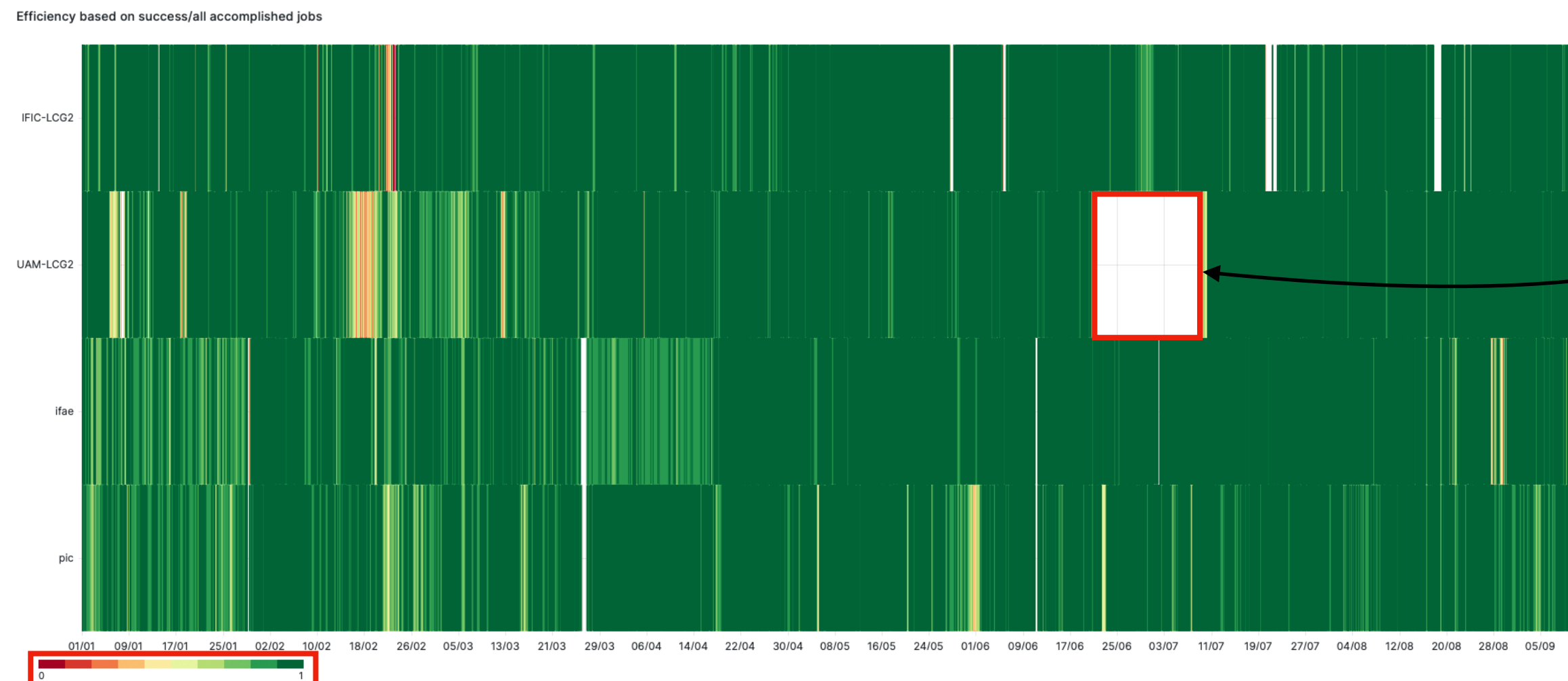
# Jobs, slots and job efficiency



~ 5.4 million jobs completed



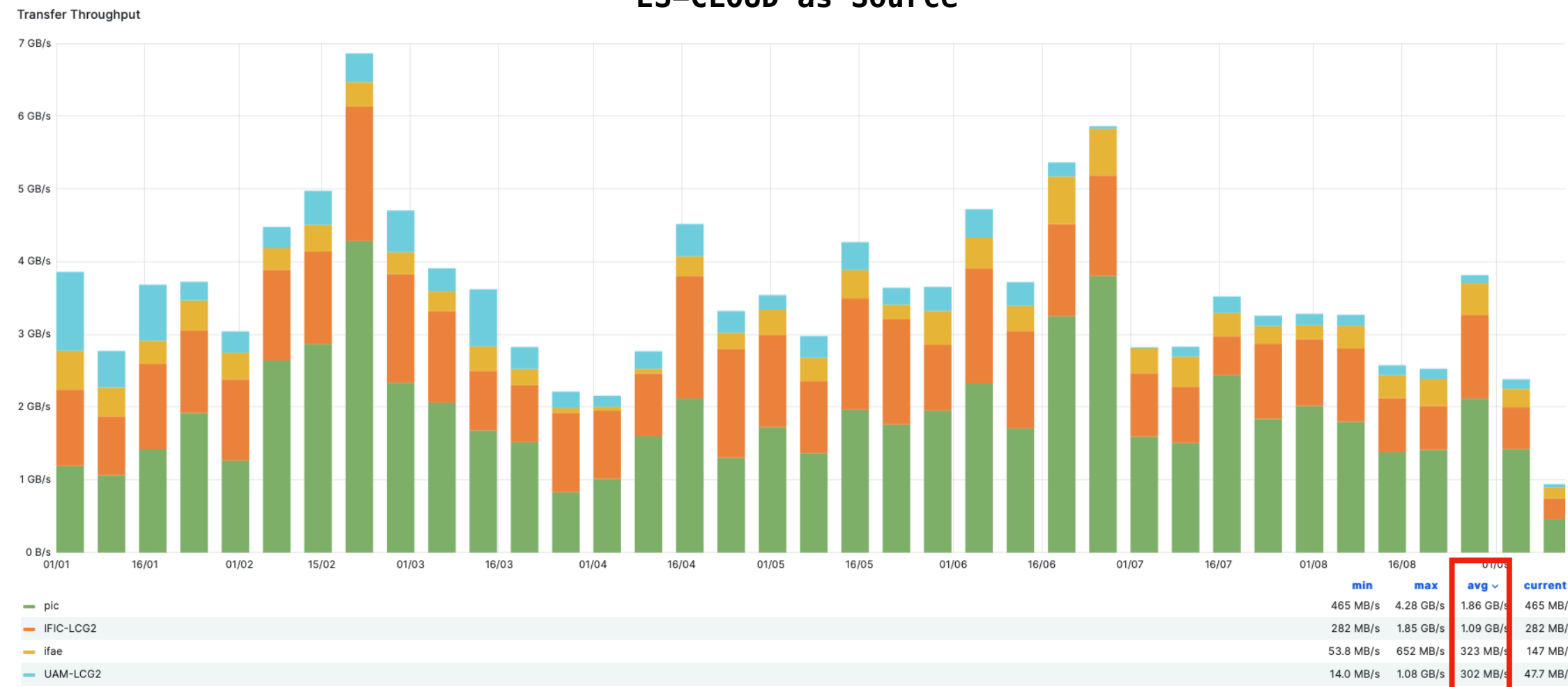
~ 10k slots of running jobs on average



Site downtime and recommissioning

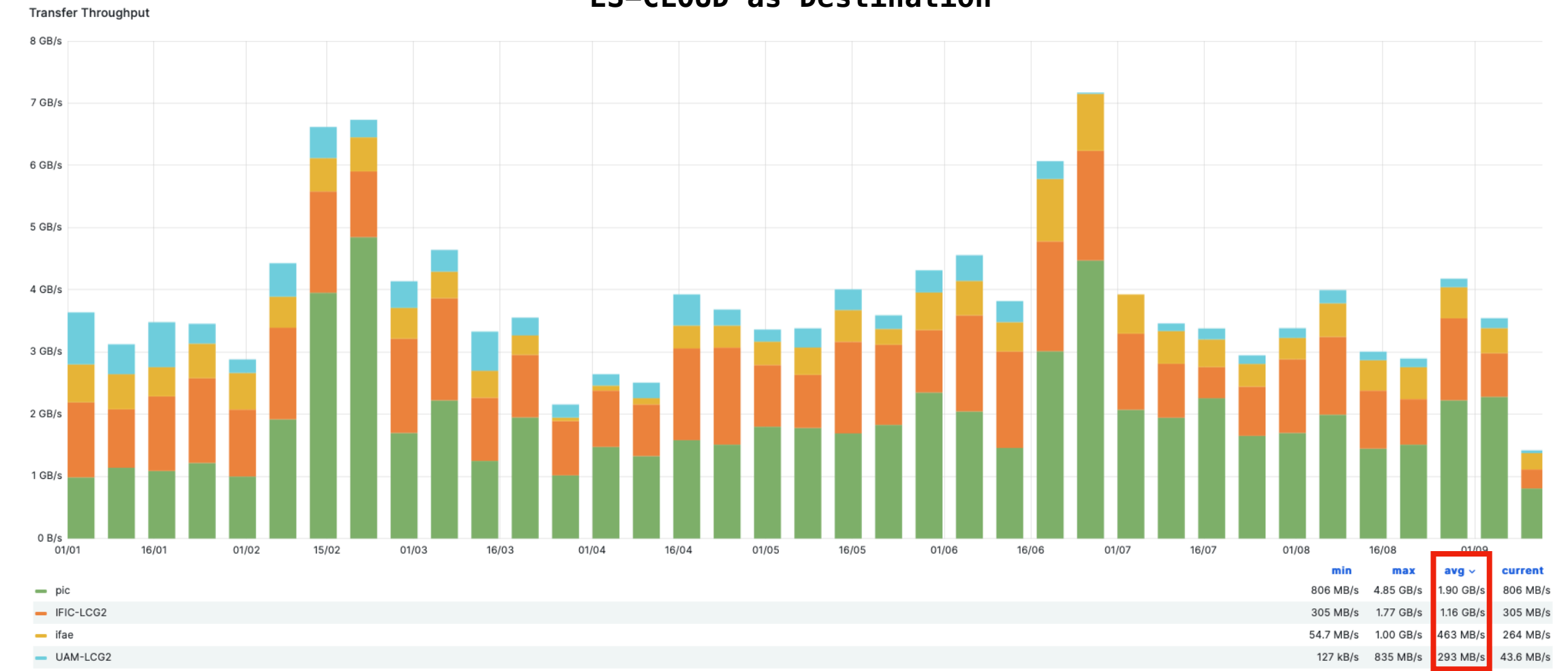
# Transfer throughputs and data volume

ES-CLOUD as Source



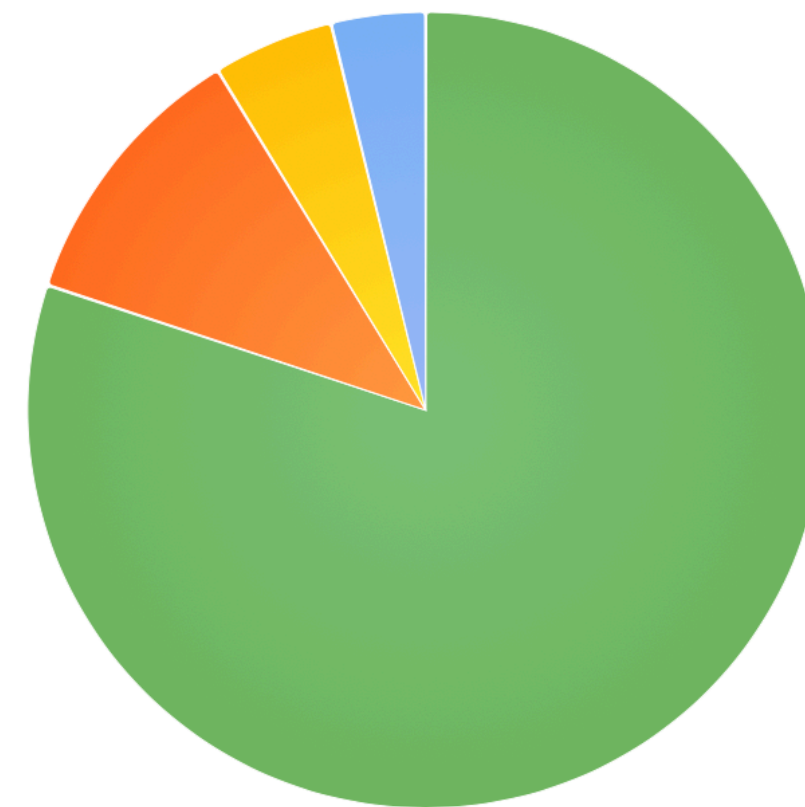
~ 9.27 PB/month

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

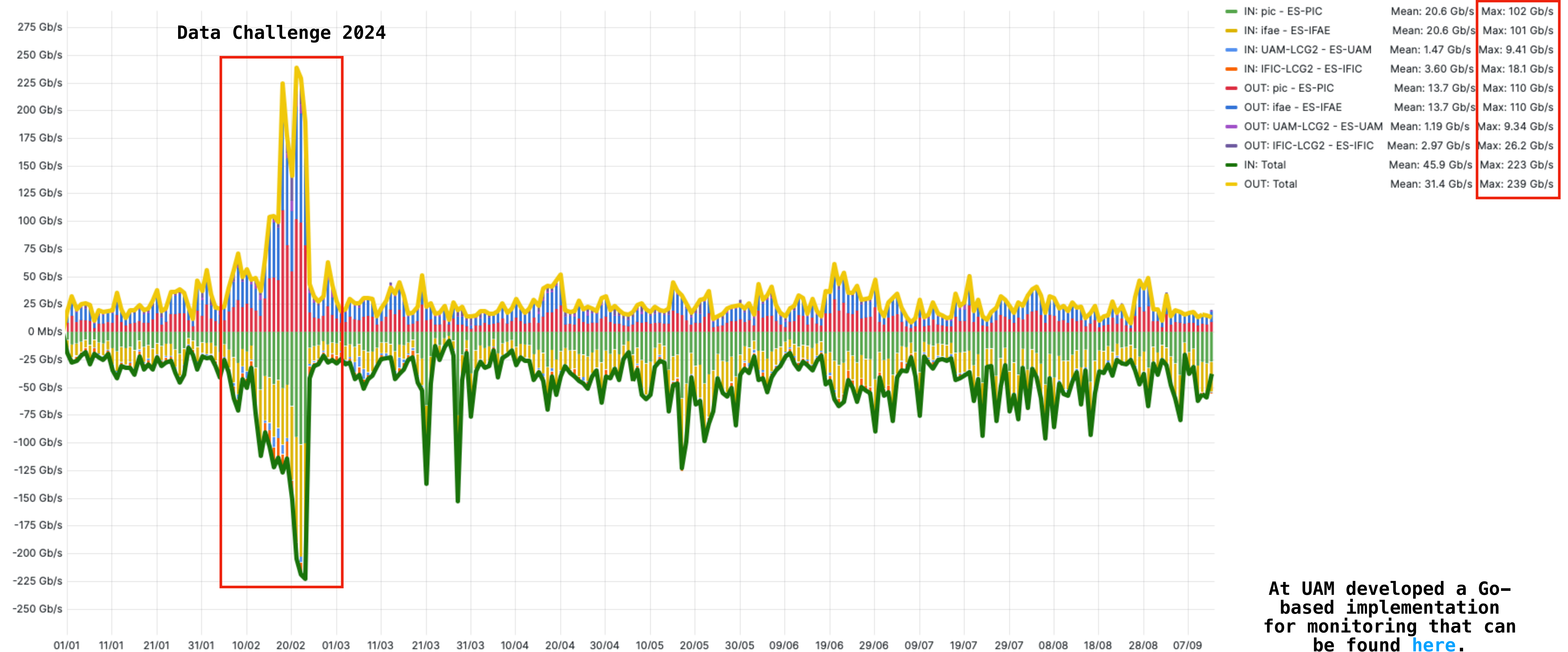
Value	Percent
24.0 PB	80%
3.33 PB	11%
1.45 PB	5%
1.13 PB	4%





# 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		

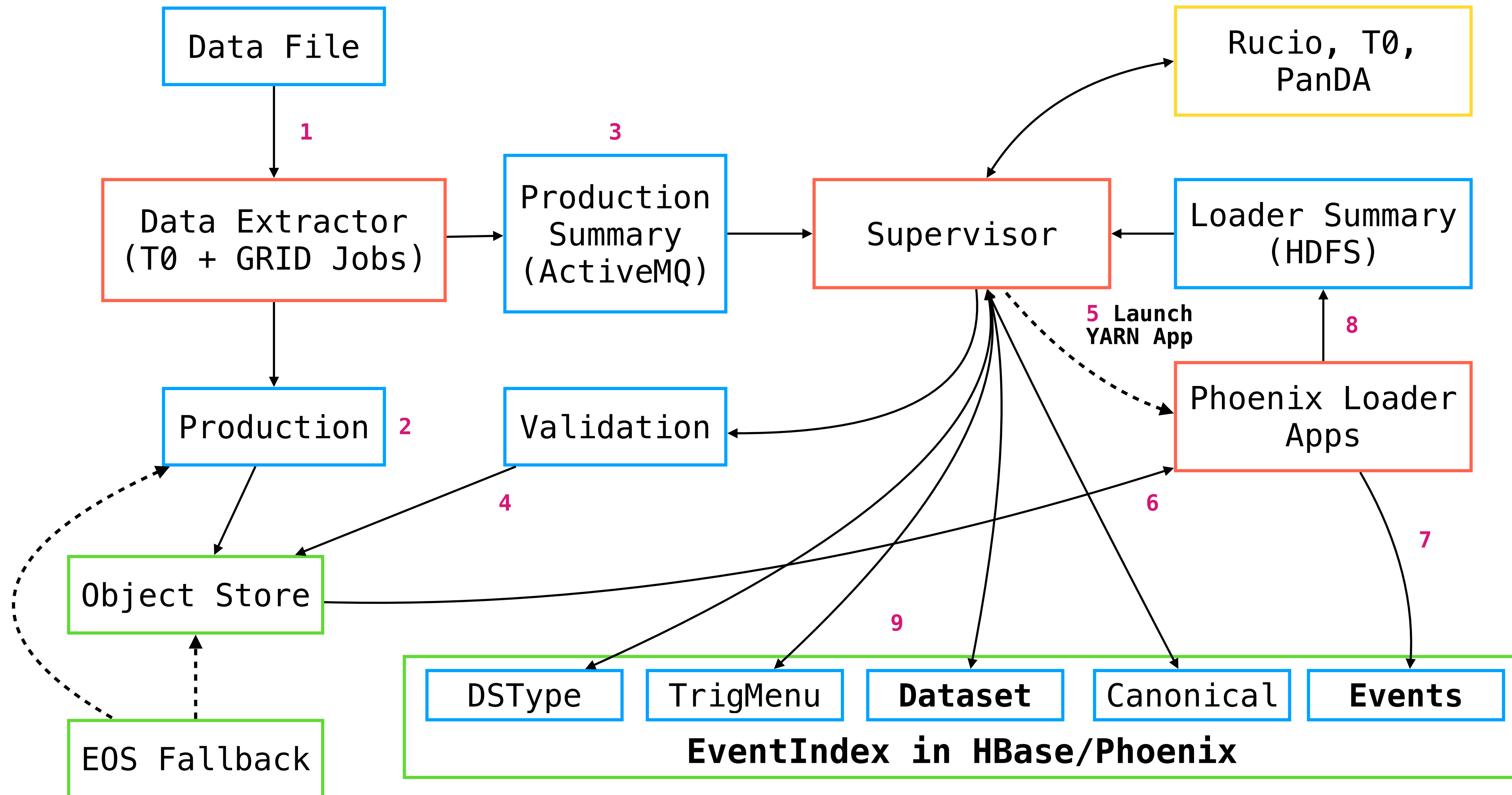
# R&D at IFIC: The ATLAS Event Index

- **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

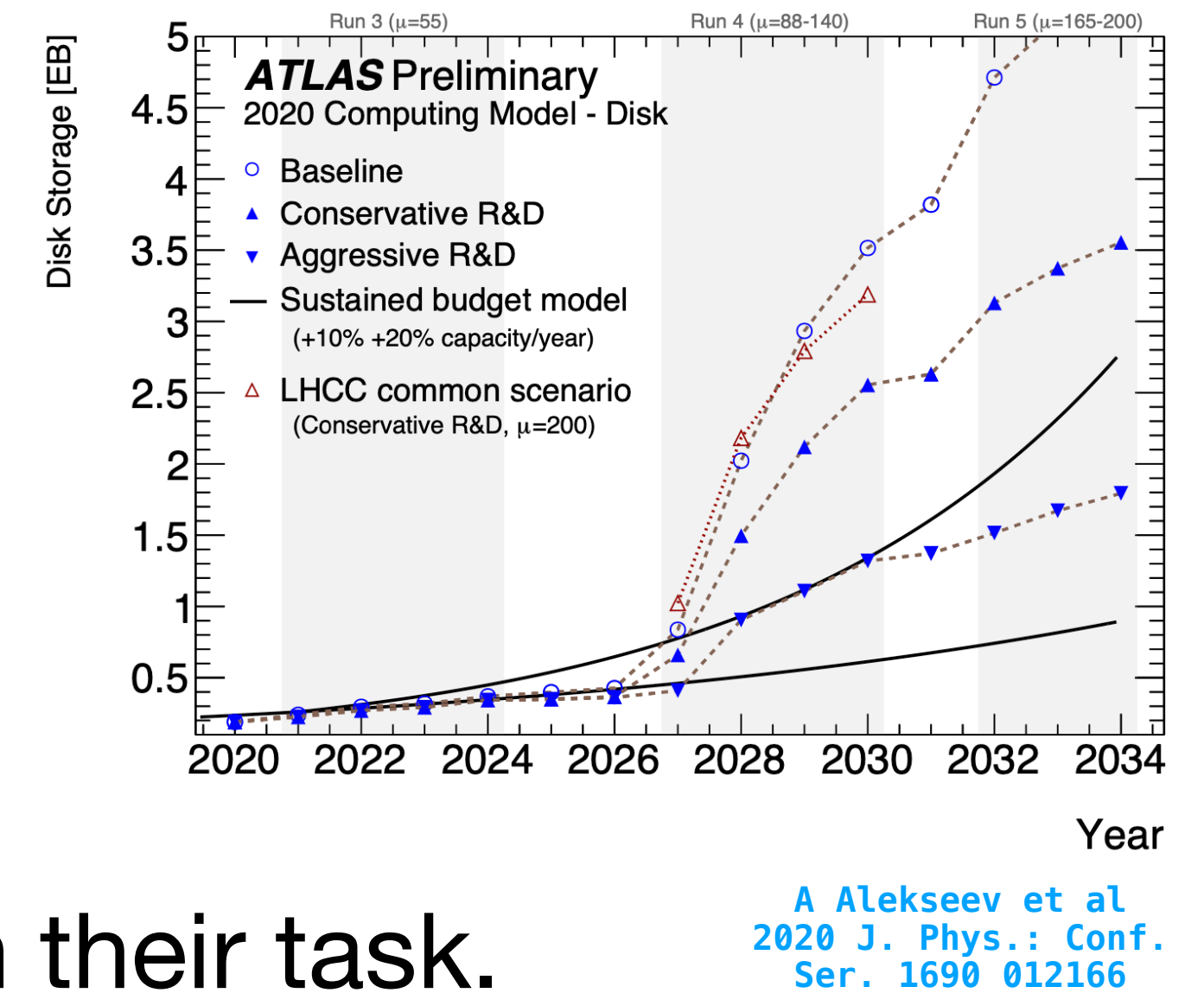


- At UAM we developed a **Telegraf** input **plugin** for **SLURM**:
  - Added on **Telegraf 1.32** through [PR #15700](#).
- UAM hosts an **AlmaLinux mirror** at <https://mirrors.ft.uam.es/almalinux>.
- Deployment of **analysis facilities** at various TIER-2s.
- **Participation** in the **operation**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