Computing Activities at the Spanish Tier-1 and Tier-2s for the ATLAS Experiment in the LHC Run3 period and towards High Luminosity (HL-LHC)

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Spanish ATLAS Tier-1 & Tier-2s

❖ Evolution of the Tiers Resources (Pledges CPU & Disk):

T1-ES	2022	2023	2024	2025	2026
CPU (kHS06)	52.0	57.2	60.0	81.1	103.6
Disk (PB)	4.6	5.4	6.5	8.4	10.2
Tape(PB)	10.9	14.1	17.9	25.6	32.4

T2-ES	2022	2023	2024	2025	2026
CPU (kHS06)	63.5	69.9	79.6	99.0	126.5
Disk (PB)	5.7	6.7	7.9	10.2	12.5

❖ Present resources provided by the ES ATLAS Tier-1 and Tier-2s:

SITE	CPU (kHEP-SPEC06)	DISK (PB)	TAPE (PB)
PIC	57.20	6.2	15.8
IFIC	58.60	3.41	-
IFAE	17.50	1.60	-
UAM	16.57	1.08	-

❖ Tier1:
- ➢ **PIC-Barcelona**

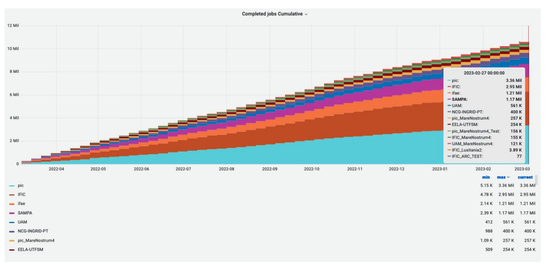
❖ A Federated Tier-2 (ATLAS):
- ➢ **60% IFIC-Valencia**
- ➢ **25% IFAE-Barcelona**
- ➢ **15% UAM-Madrid**

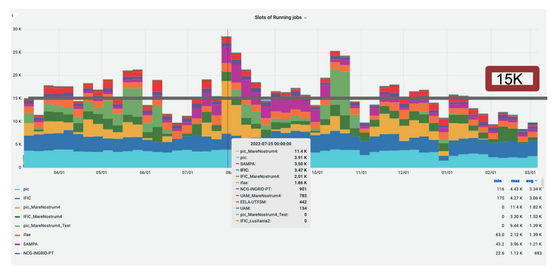
❖ Integrated in the WLCG project (World Wide LHC Computing GRID) and strictly following the experiment computing model.

❖ We represent the 3% for Tier-2 and 4% for Tier-1 of the total Tier-2s and Tier-1s resources respectively.

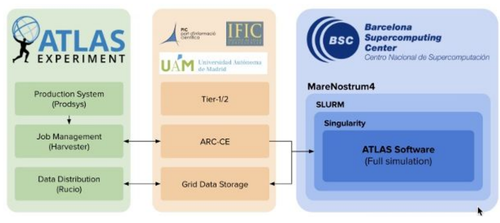
HPC and Grid ATLAS Tier-1 & Tier-2s jobs

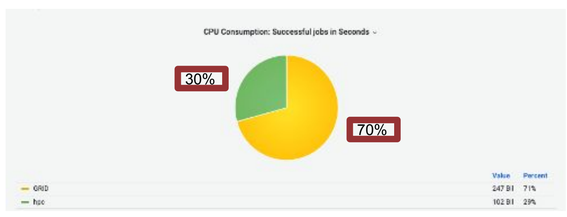
❖ Grid jobs running in the last year in the Spanish cloud:
- ➢ Availability and reliability of the Spanish sites for the Run-3, have been, on average above 95%.
- ➢ More than 10 million jobs (analysis + production) completed.
- ➢ More than 15k slots of running jobs on average in the last year.





❖ Use of the Mare Nostrum4 (HPC) by ATLAS Tier-1 and Tier-2s:
- ➢ Using ARC-CE at PIC, IFIC and UAM to interconnect Mare Nostrum and ATLAS production system.
- ➢ Only simulation workflow validated - singularity containers, pre-placed at MareNostrum's GPFS.
- ➢ Mare Nostrum accepts only SSH protocol for job submission and data transfer.



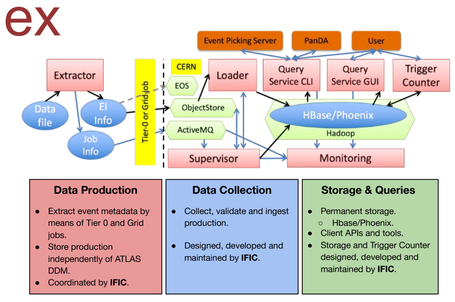


- ➢ Proportion of HS06 (s) provided by GRID resources (yellow) and the MareNostrum 4 HPC (green) in total contribution to the ATLAS computing by the Spanish cloud.
- ➢ 30 million hours approved at Mare Nostrum4 every year by ATLAS through Spanish gateways, which corresponds to 50% of the simulation jobs assigned to Spain.

ATLAS Event Index

❖ A system designed to be a complete catalogue of ATLAS events, real and simulated data.

❖ Partitioned architecture, following data flow:
- ➢ **Data Production:** extract event metadata from files produced at Tier-0 or on the Grid
- ➢ **Data Collection:** transfer EventIndex information from jobs to the central servers at CERN
- ➢ **Data Storage**: provide permanent storage for EventIndex data and fast access for the most common queries.

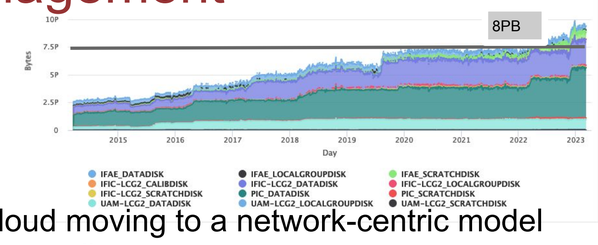


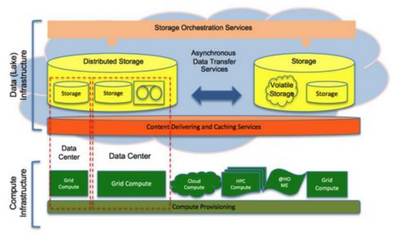
❖ Use Cases:
- ➢ Event Picking.
- ➢ Production consistency checks (Duplicate event and overlap detection).
- ➢ Trigger checks and event skimming

❖ The new system is in operation since last Spring 2022 and performing excellently.

Data Management

❖ Storage overview:
- ➢ More than 8 PB of ATLAS data stored in the Spanish Tier-1 and Tier-2 centers.





❖ Spanish cloud moving to a network-centric model (Datalake model):
- ➢ Fewer number of facilities operating storage services, less data replication.
- ➢ CPUs and storage not necessarily co-located: need to deliver the content over the WAN and/or cache it. A Datalake is feasible if the network speed is high (minimum 100 Gbps).

Analysis Facilities

❖ Guiding principle: Help physicist minimize time-to-insight, enabling iterative exploration of the data:;
- ➢ In the future, when processing 10x lumi/evts, avoid physicists 10x waiting time!!
- ➢ Boost productivity and competitiveness of our physics communities.

❖ Key features:
- ➢ Local acces to the reduced data samples (e.g. NanoAOD) with low latency from compute.
- ➢ Processing resources available with capacity and priority (CPUs, GPUs, Memory).
- ➢ Efficient and elastic infrastructure (e.g scheduling based on HTCondor) with dynamic expansion to HPC/Cloud to absorb peaks.
- ➢ Enhanced support to software tools (ROOT + Python ecosystem).
- ➢ Enable and encourage use of common repositories of code for analysis routines/workflows (e.g. analysis tree).
- ➢ Expert data/code manager: critical liaison role (not a final user, nor an infrastructure expert, however facilitating technology/access).

❖ Tipically consist of:
- ➢ Dedicated storage resources (of order of several 100s of TB).
- ➢ CPU resources used interactively and/or via a batch system (mostly HTCondor).
  - ■ Future User Interface (UI) to be designed in a flexible way, with user-friendly interfaces that do not discourage users.
  - ■ IFAE: Jupyter Notebook instances can be spawned via a dedicated portal.
- ➢ SW delivery mostly via CVMFS with increasing presence of containers.
- ➢ GPU resources available, but often not dedicated.
  - ■ IFIC: ARTEMISA infrastructure (http://artemisa.ific.uv.es).
- ➢ Network:
  - ■ LAN of multiple 10 Gbps to support the intense data throughput.
  - ■ WAN of 100 Gbps connectivity with the WLCG dedicated network for data lake access.

Conclusions and Perspectives

- The ATLAS Spanish Tier-1 and Tier-2s have more than 18 years of experience in the deployment of LHC Computing components and their successful operations.
- The sites are actively participating in the evolution of the Computing Models by the integration and update of ingredients/tools.
- The HL-LHC provides unprecedented opportunities for particle physics, yet its implementation poses technical and logistical challenges.
- An essential plan for upgrading computing infrastructure and optimizing data analysis methods is necessary to fully realize HL-LHC's potential and overcome its hurdles.

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