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Computing Resources Scrutiny Group

Autumn 2025 Report

R Aaij (The Netherlands), J Amundson (US), L Del Debbio (UK), K Dziedziniewicz-Wojcik (CERN, acting Scientific Secretary), D Elia (Italy), E Fede (France), D Gingrich (Canada), J M Hernández (Spain, Chair), J Kleist (Nordic countries), T Mkrtchyan (Germany), M Schulz (CERN)

1 Introduction

The Computing Resources Scrutiny Group (C-RSG) is responsible for reviewing the computing resource requests of the four Large Hadron Collider (LHC) Collaborations – ALICE, ATLAS, CMS, and LHCb – for resources provided through the Worldwide LHC Computing Grid (WLCG). Based on these reviews, the C-RSG makes recommendations to the WLCG Computing Resource Review Board (C-RRB) on the allocation of resources, in line with the approved physics programs of the experiments.

This report presents the outcome of the C-RSG autumn 2025 review, covering pledged resources for 2026 and preliminary estimates for the 2027 WLCG year. Unless otherwise stated, each reporting period begins on 1 April.

The C-RSG's findings and recommendations are based on the information provided by the Collaborations, including current computing resource usage, plans for 2026, early projections for 2027, written responses to follow-up questions from the C-RSG, and discussions held via Zoom for clarification. As in recent years, the autumn review was conducted through virtual meetings. The reports submitted by the Collaborations also addressed the recommendations issued following the most recent review in spring 2025 [1].

In addition, the C-RSG held an informal meeting with the LHCC WLCG referees on 29 April 2025. This discussion provided an opportunity to exchange views on areas of shared interest regarding computing resources and usage. While the mandates of the two groups differ, their overlapping roles in evaluating and overseeing resource utilisation made for a valuable and productive exchange.

Some key performance parameters, such as trigger rates, event processing times and sizes, play a central role in driving the resource requests of the LHC experiments. It is essential to monitor the evolution of these parameters in a consistent manner across all four experiments. To avoid duplication of effort and ensure that no critical aspects are overlooked, coordination between the LHCC and the C-RSG is crucial. It was agreed that the C-RSG will focus on monitoring parameters related to CPU and storage usage, while the LHCC will oversee parameters tied to physics and data policy, such as trigger rates, the ratio of simulated to recorded data events, the adoption of various analysis data formats, and the scientific relevance of both data and simulation samples.

The C-RSG's recommendations for WLCG resource provisioning in 2027 are detailed in this report.

2 C-RSG Membership

The German representative, Tigran Mkrtchyan, will step down at the end of December 2025. Following consultations with the Chair of the WLCG RRB and the German funding agencies, Thomas Hartmann (DESY) has been proposed as his successor. In preparation for his anticipated appointment, he participated as an observer in the Autumn 2025 scrutiny.

Just before this scrutiny round, the UK Science & Technology Facilities Council (STFC) nominated Luigi Del Debbio (University of Edinburgh) as the successor to Chris Alton (Swansea University) as the UK-proposed member of the C-RSG.

We would like to express our gratitude to the German and UK funding agencies for the nominations, to T. Hartmann and L. Del Debbio for agreeing to serve, and to T. Mkrtchyan and C. Alton for their many years of dedicated and highly valued contributions to the C-RSG. We now invite the RRB to formally confirm these nominations.

The C-RSG thanks Andrea Valassi for his dedicated service as the group's Scientific Secretary from 2022 to 2025. His support was instrumental in ensuring the smooth and effective operation of the C-RSG's activities. We warmly welcome Katarzyna Dziedziniewicz-Wójcik as his successor. She has already provided valuable support to the group during this review.

The Chair thanks the C-RSG members for their dedication and expert advice. The group also expresses its gratitude to CERN management for its continued support of the C-RSG's work. Sincere thanks are extended to the Collaboration representatives for their active engagement in the scrutiny process and for their efforts in addressing previous recommendations.

3 Interactions with the Experiment Collaborations

All Collaborations submitted their reports by 26 August 2025. The C-RSG thanks the Collaborations for the timely delivery of their detailed documents [2–5], which also included responses to the findings and recommendations from the spring 2025 scrutiny round [1].

The group is grateful to the computing representatives of the Collaborations for their availability, their constructive responses to the questions raised by the C-RSG, and their follow-up contributions in response to additional requests for information. The dedicated meetings with experiment representatives were particularly valuable and are warmly acknowledged by the C-RSG.

Dedicated teams of C-RSG referees were assigned to review the ALICE and LHCb requests. As in previous years, and in agreement with the ATLAS and CMS managements, a single team of referees evaluated the ATLAS and CMS reports and requests to ensure a consistent assessment. The referees then presented their findings to the full C-RSG, which collectively developed the observations and recommendations outlined in this report.

In preparation for the Spring 2026 scrutiny, the C-RSG requests that the experiments submit their documents by Tuesday, 10 February 2026. The reports should include the utilization of computing resources during the 2025 calendar year, the final resource requests for the 2027 WLCG year, and responses to both the general recommendations and those specific to each Collaboration.

4 Background for Preliminary 2027 Requests

Funding agencies were requested to submit their pledged resource contributions for 2026 by the deadline of 15 September 2025. Table 1 presents the balance (in percentage) between the CPU, disk, and tape resources approved by the RRB and those pledged by the various funding agencies for each

experiment, broken down by tier level. With the exception of Tier0, where pledges match the approved resource levels, significant shortfalls appear at both Tier1 and Tier2. While it is possible that some funding agencies did not enter their pledges in time, the situation remains a cause for concern.

Balance [%] 2026 Computing resources: (Pledged - RRB_Aproved) / RRB_Approved

		ATLAS	CMS	ALICE	LHCb	Total
Tier0	CPU	0	0	0	0	0
	Disk	0	0	0	0	0
	Tape	0	0	0	0	0
Tier1	CPU	1	6	-13	-14	-3
	Disk	0	-6	-14	-2	-4
	Tape	0	-7	1	-8	-3
Tier2	CPU	8	-3	1	-16	1
	Disk	-1	-11	6	-33	-5

Table 1 Balance (in percent) between pledged and RRB-approved computing resources for 2026, as of 10 October 2025. Numbers in red highlight a shortfall in pledged resources, while numbers in green indicate a surplus.

The year 2027 will mark the beginning of the LHC Long Shutdown 3, which will extend until the end of 2029 (see Fig. 1). Since no new experimental data will be collected in 2027, computing resource requirements are expected to remain flat or grow only modestly. The HLT farms and Tier0 computing resources will be available for offline use during this period, so CPU demands on WLCG sites are not expected to increase. Storage requirements are foreseen to grow slowly, driven primarily by data reprocessing campaigns and new MC simulations.

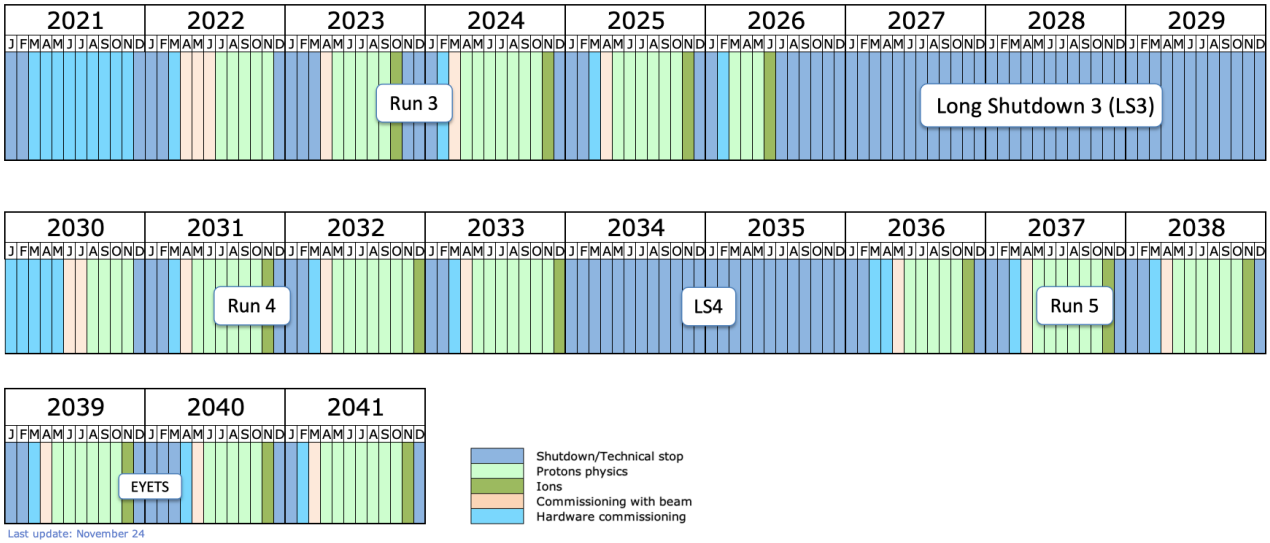

Figure 1 Long-term LHC schedule as revised in September 2024

WLCG has revised downwards its estimates of purchasing power, assuming a constant annual budget and taking into account historical hardware purchasing trends. Based on this analysis, annual increases of approximately 10% in CPU and tape capacity, and 5% in disk capacity, are projected to be achievable within the same budget envelope. Disk storage is the most expensive infrastructure at WLCG sites. As emphasized in our previous report, optimizing disk usage remains essential. This includes monitoring for cold data and enforcing eviction policies.

The C-RSG provides below an overview of the current computing plans of the LHC Collaborations, preliminary 2027 resource estimates, and corresponding findings and recommendations.

5 Resource Requests: ALICE

The C-RSG report is based on the usage and resource requests provided by the ALICE experiment, a written set of responses to C-RSG scrutiny questions [2], additional material provided as part of the answers to the scrutiny questions, and a remote meeting with the ALICE computing coordinators. The C-RSG thanks the ALICE team members for providing compact responses to the C-RSG recommendations from the Spring 2025 scrutiny report, their timely responses to questions from the C-RSG in this scrutiny, and their answers and explanations during the remote meeting. Especially the detailed answers to these questions and the provided additional material allowed a deeper insight into the resource-critical activities of the collaboration.

In 2027, ALICE plans to carry out extensive processing campaigns of Run 3 data. This will include reprocessing the entire 2023 Pb–Pb dataset and 50% of the 2024 Pb–Pb data, as well as performing a second pass over the entire 2026 Pb–Pb dataset. The O2 disk buffer will be cleared as required to recall Pb–Pb data from tape for reprocessing. In addition, large MC productions corresponding to both p–p and Pb–Pb data will be carried out.

For resource calculations, ALICE assumes that Pb-Pb running will occur in 2026, but the potential effects of p–Pb running instead of Pb–Pb are also taken into account. The C-RSG acknowledges that the remaining uncertainties in the details of the 2026 heavy ion program have the potential to impact, to a limited degree, the resources required in 2027.

Table 2 shows the ALICE preliminary resource requests for 2027. The CPU request for 2027 is 3% higher than in 2026, with the largest increase at the Tier2 level. A 10% increase in disk storage compared to 2026 has been requested. The increase in the request of tape resources is at the 6% level. These requests are modest. Nevertheless, the C-RSG did not expect an increase in CPU, given the end of data taking in mid-2026 and the expected availability of the online EPN farm for offline processing from then on.

ALICE		2025		2026			2027	
		RRB approved	Pledged	Request	2026 req. / 2025 RRB	RRB approved	Prelim Request	2027 req. / 2026 RRB
CPU	Tier0	680	680	710	104%	710	720	101%
	Tier1	690	596	720	104%	720	730	101%
	Tier2	730	750	810	111%	810	850	105%
	Total	**2100**	**2026**	**2240**	**107%**	**2240**	**2300**	**103%**
	HLT							
	Others							
Disk	Tier0	78.0	78.0	90.0	115%	90.0	96.0	107%
	Tier1	79.0	69.1	90.0	114%	90.0	100.0	111%
	Tier2	77.0	82.5	89.0	116%	89.0	101.0	113%
	Total	**234.0**	**229.6**	**269.0**	**115%**	**269.0**	**297.0**	**110%**
Tape	Tier0	220.0	220.0	292.0	133%	292.0	306.5	105%
	Tier1	123.0	117.4	155.0	126%	155.0	169.5	109%
	Total	**343.0**	**337.4**	**447.0**	**130%**	**447.0**	**476.0**	**106%**

Table 2 The ALICE Collaboration's resource requests and C-RSG recommendations for 2025 and 2026, and preliminary resource requests for 2027.

Conclusions and Recommendations

The C-RSG finds that the computing resource estimates provided by the ALICE Collaboration are consistent with the presented schedule of their physics program.

ALICE-1 The C-RSG recommends to include into future reports more detailed background information, so that the reasoning behind decisions and requests can be realized. The answers provided to the additional questions and in the face-to-face meeting have been at the right level. The description of the process to manage non-accessed data allowed us to appreciate the systematic effort dedicated to this activity.

ALICE-2 The C-RSG recommends that, in addition to the reported resources needed to produce one MC event, the corresponding information on the resources required for the other processing steps also be provided, to ensure a complete understanding of the total resource requests.

ALICE-3 The C-RSG recommends that future reports include a more detailed description of activities targeted at reducing resource requirements, such as the ongoing work to move from strategy A to strategy B for data compression.

ALICE-4 The C-RSG recommends to share a more detailed insight into the use of the different opportunistic resources, including an assessment of the potential impact on the physics program if these resources were no longer available.

ALICE-5 The C-RSG recommends that the experiment reassess whether the requested CPU increases, albeit moderate, are fully justified, taking into account the availability of the online EPN farm in 2027 for offline processing.

6 Resource Requests: ATLAS

ATLAS computing resource requests for 2027 are based on the documentation provided by the experiment [3] and the virtual meeting held between ATLAS computing coordinators and C-RSG. Both the material submitted and the exchanges during the meeting were very useful, providing detailed information on the data management and data access.

Concerning the activities planned in 2027, they are mostly devoted to MC productions for Run 3 analyses. Although major reconstruction campaigns of the Run 3 data are no longer foreseen, a fast reprocessing of the 2026 data with finalized conditions and possible software improvements is likely to be completed in the first months of 2027.

The requests cover the year 2027, which will be the first year of the LHC Long Shutdown 3. This explains the relatively modest amount of additional resources requested.

No CPU increase is requested for Tier1 and Tier2, while only a 1.6% increase is requested for Tier0. Concerning the storage capacities across all Tiers, less than 8% growth is requested for disk and less than 7% for tape.

Opportunistic tape resources provided by two sites (DESY-Hamburg Tier-2 in Germany and North-East Tier-2 in the USA) are currently being used for additional replicas of MC datasets: if proven to be operationally successful, such kind of resources will be considered by ATLAS to hold extra (unique) copies of EVNT, HITS, and AOD in the near future.

Table 3 shows the ATLAS preliminary resource request for 2027.

ATLAS		2025		2026			2027	
		RRB approved	Pledged	Request	2026 req. / 2025 RRB	RRB approved	Prelim Request	2027 req. / 2026 RRB
CPU	Tier0	1100	1100	1265	115%	1265	1285	102%
	Tier1	1635	1639	1802	110%	1802	1802	100%
	Tier2	1998	2297	2202	110%	2202	2202	100%
	Total	**4733**	**5036**	**5269**	**111%**	**5269**	**5289**	**100%**
	HLT			438			1000	
	Others						800	
Disk	Tier0	56.0	56.0	65.0	116%	65.0	68.0	105%
	Tier1	186.0	186.7	199.0	107%	199.0	214.0	108%
	Tier2	227.0	218.9	243.0	107%	243.0	262.0	108%
	Total	**469.0**	**461.6**	**507.0**	**108%**	**507.0**	**544.0**	**107%**
Tape	Tier0	258.0	258.0	302.0	117%	302.0	312.0	103%
	Tier1	561.0	567.6	692.0	123%	692.0	741.0	107%
	Total	**819.0**	**825.6**	**994.0**	**121%**	**994.0**	**1053.0**	**106%**

Table 3 ATLAS Collaboration's resource requests and C-RSG recommendations for 2025 and 2026, along with preliminary resource requests for 2027.

Conclusions and Recommendations

The C-RSG congratulates ATLAS for the great and successful effort done in efficiently using the resources, as witnessed by the small amount of cold data reported, the dynamic replication of popular datasets, and the efficient data clean-up procedures. Additionally, the inclusion of some opportunistic resources in the planning, beyond the HLT farm, has been much appreciated.

ATLAS-1 The C-RSG recommends that ATLAS examine the factors preventing a more rapid transition to fast simulation. Extensive use of fast simulation remains essential to reduce the CPU requirements for simulation.

ATLAS-2 Considering the availability of the HLT farm and Tier-0 in 2027, which may be repurposed for offline data processing and simulation, the C-RSG recommends that the experiment carefully reassess whether the requested CPU and disk increases at the Tier-0 level, albeit moderate, are genuinely necessary.

7 Resource Requests: CMS

The CMS resource requests for 2027 are based on documentation provided by the experiment team [4], as well as discussions held during a virtual meeting between the CMS computing coordinators and the C-RSG. Both the documentation shared with the C-RSG and the exchanges during the meeting proved highly valuable, offering comprehensive insights into data management and data access requirements.

These requests pertain to the year 2027, which marks the beginning of the Long Shutdown 3 of the LHC. This context explains that no increase in compute resources is expected for 2027. The increase in requested disk and tape storage is mainly driven by legacy processing of Run 3 data and the corresponding MC simulation. In addition, Run 2 NanoAOD(SIM) will be redone from the existing MiniAOD(SIM) to ensure compatibility with Run 3.

CMS has made commendable efforts to keep increases in resource requests modest, though there are areas, as highlighted in the recommendations, where the C-RSG believes that further efficiency gains remain achievable. CMS has modified its disk data placement and replication strategy, leading to a reduction in storage requests. Measures include reducing the initial number of replicas for certain data formats, limiting the use of particularly large data formats, and promptly replacing older data types when new versions become available.

As part of saving space, CMS also plans to delete a significant amount of data from tape. It is worth noting that, while large-scale deletion campaigns on tape free up space, tape repacking is required to make the space available and should be coordinated with the affected sites.

Table 4 shows the preliminary CMS resource request for 2027.

CMS		2025		2026			2027	
		RRB approved	Pledged	Request	2026 req. / 2025 RRB	RRB approved	Prelim Request	2027 req. / 2026 RRB
CPU	Tier0	1180	1180	1350	114%	1350	1350	100%
	Tier1	1100	1166	1200	109%	1200	1200	100%
	Tier2	1900	1830	2000	105%	2000	2000	100%
	Total	**4180**	**4176**	**4550**	**109%**	**4550**	**4550**	**100%**
	HLT			350			860	
	Others							
Disk	Tier0	70.0	70.0	81.0	116%	81.0	81.0	100%
	Tier1	142.0	133.8	164.0	115%	164.0	180.0	110%
	Tier2	175.0	159.6	198.0	113%	198.0	217.0	110%
	Total	**387.0**	**363.4**	**443.0**	**114%**	**443.0**	**478.0**	**108%**
Tape	Tier0	442.0	442.0	515.0	117%	515.0	530.0	103%
	Tier1	445.0	411.5	540.0	121%	540.0	610.0	113%
	Total	**887.0**	**853.5**	**1055.0**	**119%**	**1055.0**	**1140.0**	**108%**

Table 4 CMS Collaboration's Collaboration's resource requests and C-RSG recommendations for 2025 and 2026, and preliminary resource requests for 2027.

Conclusions and Recommendations

CMS-1 The C-RSG recommends that CMS strengthen its data access monitoring capabilities to enable more precise identification of cold data on disk for removal. In particular, CMS is encouraged to collaborate with the XrootD development team to improve the monitoring of remote data access.

CMS-2 The C-RSG further recommends that CMS assess the effort required to enhance different aspects of data management, in order to prioritize activities that will deliver the greatest impact. In particular, the committee highlights the importance of adopting practices already in use by other LHC experiments, such as dynamic dataset replication based on access popularity and maintaining minimal disk placement of infrequently accessed data.

CMS-3 The C-RSG commends the recent changes in data disk placement policies, specifically the reduction from two to one initial copy of miniAOD datasets and the production of AOD data format for MC only on demand, which have resulted in a substantial reduction in storage

needs. The C-RSG requests that the experiment evaluate the resulting gains with respect to the requested disk and tape resources for 2025 and 2026, and that it subsequently reassess its storage requirements for 2027 in light of these policies.

8 Resource Requests: LHCb

The assessment of the preliminary LHCb computing resource requests for 2027 is based on the documentation provided by the experiment [5] and discussions between the C-RSG and LHCb computing management during the virtual face-to-face meeting.

The year 2027 is expected to be the first full Long Shutdown year. Therefore, the resource request is dominated by CPU needs, while additional disk and tape requirements remain relatively moderate. MC production will follow the LHCb production model, and a full *resprucing* of the entire Run 3 dataset will be carried out. In this process, the FULL and TURCAL streams are skimmed using defined sets of selection criteria, and the event content is reduced to a size comparable to that of an event in the TURBO stream.

Table 5 shows the LHCb preliminary resource request for 2027.

LHCb		2025		2026			2027	
		RRB approved	Pledged	Request	2026 req. / 2025 RRB	RRB approved	Prelim Request	2027 req. / 2026 RRB
CPU	Tier0	283	283	344	122%	344	408	119%
	Tier1	928	849	1127	121%	1127	1337	119%
	Tier2	518	535	629	121%	629	747	119%
	Total	**1729**	**1667**	**2100**	121%	**2100**	**2492**	**119%**
	HLT			600			2700	
	Others			100			100	
Disk	Tier0	54.9	54.9	70.9	129%	70.9	73.3	103%
	Tier1	89.9	89.3	107.1	119%	107.1	108.0	101%
	Tier2	17.4	15.2	20.7	119%	20.7	20.9	101%
	Total	**162.2**	**159.4**	**198.7**	123%	**198.7**	**202.2**	**102%**
Tape	Tier0	170.4	170.4	202.2	119%	202.2	211.9	105%
	Tier1	194.8	181.2	233.7	120%	233.7	249.0	107%
	Total	**365.2**	**351.6**	**435.9**	119%	**435.9**	**460.9**	**106%**

Table 5 The LHCb Collaboration's resource requests and C-RSG recommendations for 2025 and 2026, and preliminary resource requests for 2027.

For 2027, LHCb requests a 19% increase in CPU resources, a 2% increase in disk, and 6% in tape storage compared to 2026. An additional 2700 kHS23 years of CPU work is expected to be provided by the HLT farm, available for offline processing during the shutdown. Additionally, a CPU work of 100 kHS23 years is expected to be supplied by opportunistic resources.

In previous reports, CPU resource requests for LHCb were derived from the design assumptions regarding the processing time of full simulation events. In accordance with earlier recommendations from the C-RSG, LHCb has re-evaluated the estimates taking into account real Run 3 simulation data, which have recently become available. The factor-of-two divergence between the initial design-based projections and the actual CPU capacity required for full simulation explains the sudden increase in

the requested CPU resources. The impact of the doubled CPU requirements for full simulation on the requests to WLCG sites is mitigated by the availability of the HLT resources during the LHC Long Shutdown 3.

Conclusions and Recommendations

The following recommendations are made:

LHCb-1 The CPU work required to simulate a single event in the full simulation has doubled compared to the number used in previous years to estimate the simulation CPU needs. The C-RSG requests that LHCb quantify the impact of this increase on the CPU resources already approved for 2025 and 2026, and clarify whether the allocated resources remain sufficient to meet the experiment's simulation goals.

LHCb-2 The C-RSG asks LHCb to discuss software optimization plans to reduce the CPU needed to fully simulate an event.

LHCb-3 The C-RSG asks LHCb to detail the actions being taken to mitigate the CPU increase in the full simulation without relying on additional pledged or opportunistic resources, such as the adoption of alternative simulation approaches, or adjustments in the event production strategy.

LHCb-4 The C-RSG asks LHCb to provide monitoring data on the ratio of full- to fast-simulated events used by end-user analysis jobs in future usage reports.

LHCb-5 The C-RSG encourages LHCb to include in future reports activities aimed at optimizing the use of pledged resources. Areas of focus may include more efficient CPU utilization, reduction of generated event sizes, enhancement of memory-efficient multi-threading support, and exploration of emerging architectures, such as ARM CPUs and GPUs.

9 Comments and Overall Recommendations

In 2027, the LHC experiments plan to carry out extensive data reprocessing campaigns of Run 3 data and to produce large MC samples corresponding to Run 3 conditions with final calibrations. The continued availability of the online farms throughout 2027 will provide a significant contribution of CPU resources for offline processing. This should allow the CPU requests to the WLCG sites to remain at the levels requested for 2026.

The notable exception is LHCb, which foresees a substantial increase in CPU needs due to a reassessment of the requirements for full-event simulation. The C-RSG has issued a specific recommendation to LHCb to prioritize efforts to accelerate the simulation during the next 18 months, ahead of the start of the 2027 WLCG year.

For storage resources, the experiments request only modest increases, consistent with what can be achieved under the revised flat funding scenarios. Nevertheless, the C-RSG encourages further optimization of storage usage, including improved management of data on disk and the deletion of obsolete data currently retained on tape.

In the Spring 2025 report, the C-RSG noted that experiments had made extensive use of CPU capacity beyond their pledges at WLCG sites, as well as significant opportunistic resources, primarily from HPC centres. Leveraging these resources has greatly expanded MC production, resulting in additional simulations that could substantially impact storage requirements.

Based on the responses to our recommendation to quantify the data volume generated by these additional MC samples, we have observed that the data volume is significant and generally not included in the storage resource plans. The experiments have been implementing storage optimizations within the available resources to accommodate the output of these extended productions.

Beyond the offline use of the HLT farms, ATLAS and LHCb account for a fraction of the expected CPU from opportunistic sources in their resource models (row *Others* in the resource tables 2, 3, 4, and 5). This estimate is subtracted from the CPU requested from the WLCG sites, and the corresponding storage needs are then included in their resource requests. The fraction included is not large, given the uncertainties, but significant. The C-RSG encourages CMS and ALICE to adopt a similar approach. In particular, the C-RSG considers that storage requirements arising from activities not covered in CPU resource planning should not be included in the requested storage resources.

An important observation from this review is that ATLAS and CMS allocate a substantial share of their computing resources to processing and storing the so-called parking or delayed data streams. These trigger lines complement the main physics streams but are reconstructed with lower priority. In practice, however, the abundance of beyond-pledge and opportunistic CPU resources available to both experiments allows the parking/delayed data to be reconstructed promptly.

For CMS, approximately 60% of the CPU and disk resources are used for processing and storing parking data, while around 45% are allocated to tape archival. The latter fraction is lower because only a single replica of the raw parking data is stored on tape at CERN. Notably, CMS devotes a larger share of its computing resources to parking data than to its main physics stream.

In contrast, for ATLAS, the delayed data constitute a significantly smaller fraction of the total raw data, around 20%.

The committee notes that the large-scale data reconstruction campaigns planned by the experiments for 2027 will require sustained high read rates from tape. At present, tape throughput is not formally included among the computing requirements. The C-RSG suggests that this issue be discussed between the WLCG and the experiments, in order to assess whether experiments should explicitly communicate their I/O rate requirements as part of future planning.

The C-RSG notes that during the forthcoming Long Shutdown 3, from mid-2026 to the end of 2029, computing requirements are not expected to increase significantly. In contrast, the start of Run 4 is expected to entail a sharp rise in resource needs for ATLAS and CMS. For effective coordination with funding agencies, long-term projections of computing requirements will be essential. Depending on the funding model, both a gradual increase in resources and a large step around 2030 may be considered as plausible scenarios. CMS and ATLAS are expected to provide updated projections of their computing needs in the form of Computing CDR/TDR reports during 2026.

The committee observes that several tasks with a direct impact on resource requirements are currently limited by a shortage of available effort. For ATLAS, this concerns the derivation and subsequent approval of recommendations for analyses (adjustments, tunings and calibrations) needed to enable the use of fast simulation. For CMS, insufficient effort is devoted to the monitoring and purging of cold data on disk. For ALICE, additional effort is needed to resolve the calibration issues of the TPC that currently hinder the transition to a more compressed raw data format, while for LHCb, further work is required to accelerate the full simulation. The C-RSG notes that strengthening support for these activities would help optimize resource usage and reduce future computing demands.

The C-RSG makes the following recommendations for all experiments:

ALL-1 To better assess resource requirements and harmonize resource request information across experiments, the C-RSG requests that all future resource request reports include summary tables showing the percentage of requested resources along two dimensions:

- First dimension: data-taking era (Run 1 + Run 2, Run 3, and Run 4).
- Second dimension:
  - For CPU: processing activity (MC generation, MC fast and full simulation, MC reconstruction, detector data processing, production of reduced data formats, and user analysis).
  - For disk and tape: data format type (detector raw data, detector reconstructed data, MC generation+simulation+reconstruction data, and reduced analysis formats for data and MC). Where applicable, disk usage should also include contributions from operations and user data.

The C-RSG further requests that equivalent tables be provided in the resource utilization reports, reflecting usage at the end of the reported period.

ALL-2 Following feedback from the experiments, the agreed data popularity metric for assessing the volume of cold data on disk is defined as the total volume of disk-resident data that has not been accessed within 12 months of its placement on disk. The C-RSG requests that this metric be included in all future resource request reports.

ALL-3 In preparation for the final computing resource requests in the next scrutiny round, the C-RSG recommends evaluating potential optimizations in storage usage to help limit projected increases. These include more proactive deletion of cold data from disk, systematic replacement of analysis datasets with newly produced versions, and removal of obsolete data from tape.

ALL-4 In view of the forthcoming long shutdown 3, where computing requirements are not expected to increase significantly, and the start of the Run 4 that will presumably require a sharp increase in resources, the C-RSG recommends that the experiments include in their next report long-term projections of computing resource needs. Such projections will assist the funding agencies in defining the most effective investment strategy.

References

[1] Computing Resources Scrutiny Group. C-RSG Spring 2025 report. *CERN-RRB-2025-009*, 1 April 2025.

[2] ALICE Collaboration. ALICE Summary Status of Run 3 Data Processing and Computing Resources Estimates for 2027. 1 August 2025.

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