

DiRAC Resource Allocation Committee 14th Call Guidance notes for Applicants

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1. Introduction

- 1.1. The DiRAC (Distributed Research utilizing Advanced Computing) facility is the STFC national HPC resource for the UK astronomy, cosmology, particle physics and nuclear physics communities.

A table to show the availability of resources for RAC 14 is provided at [Annex 1](#).

A summary of the DiRAC-3 hardware is available at [Annex 2](#).

Information on the HPC services that DiRAC offers can be found on the [DiRAC website](#).

This document explains the process for the allocation of time on the DiRAC HPC facilities for the 14th Call.

2. DiRAC Resource Allocation Committee

- 2.1. The DiRAC Resource Allocation Committee (RAC) was established to oversee the time allocation for DiRAC project proposals. The membership of the RAC is available at <https://dirac.ac.uk/resource-allocation-committee/>. To maximise the quality of the scientific output of DiRAC, the allocation of time will be determined via robust, transparent peer review. The RAC has two sub-panels, one for Particle Physics & Nuclear Theory and one for Astronomy & Cosmology, which will consider the proposals within their respective remits. A meeting of the RAC attended by representatives from both Sub-Panels will determine the overall allocation of DiRAC time across the whole portfolio of proposals.

3. Call Closing Date

- 3.1. The RAC issues one call per year to apply for time on the DiRAC facility. The deadline for proposal submissions to the 14th Call is Tuesday 5th October 2021 at 16:00 UK time. The following documents should be sent direct to STFC (via email: DiRACRAC@stfc.ac.uk) by the deadline. STFC recommends that applicants send their documents via secure / encrypted email.

- **Full scientific proposal**
- **Technical Case**
- **Research Software Engineering (RSE) Support proposals**

- 3.2. Please note that all applicants must submit a Technical Case otherwise a full proposal submission will not be accepted. This year, the Technical Case does not need to be sent in advance and can be sent direct to STFC along with the full scientific proposal. Please submit the Technical Case as a Word document.
- 3.3. Successful awards will be scheduled to begin on 1st April 2022.
- 3.4. Please note that Discretionary and Seedcorn proposals can be submitted at any time and these allocations can start at any time.

4. Enquiries

- 4.1. All Call application forms and documentation can be found on the [DiRAC website](#). Enquiries should be directed as follows:
- RAC process and remit: STFC Swindon Office DirACRAC@stfc.ac.uk
 - Technical questions: dirac-support@epcc.ed.ac.uk
 - Direct allocations or discretionary requests: DiRAC Director, Prof Mark Wilkinson (miw6@leicester.ac.uk)

5. Equality, Diversity and Inclusion

- 5.1. In line with the UK Research and Innovation Diversity Principles, STFC expects that equality and diversity is embedded at all levels and in all aspects of research practice. We are committed to supporting the research community in the diverse ways a research career can be built with our investments. This includes career breaks, support for people with caring responsibilities, flexible working and alternative working patterns. With this in mind, we welcome applications from academics who job share, have a part-time contract, need flexible working arrangements or those currently committed to other longer, large existing grants. Please see our [Equality and Diversity webpages](#).

6. Impact of Covid-19 Pandemic

- 6.1. UKRI recognises that the COVID-19 pandemic has caused major interruptions and disruptions across our communities and are committed to ensuring that individual applicants and their wider team, including partners and networks, are not penalised for any disruption to their career(s) such as breaks and delays, disruptive working patterns and conditions, the loss of on-going work, and role changes that may have been caused by the pandemic.
- 6.2. Reviewers and Panel Members will be advised to consider the unequal impacts of the impact that COVID-19 related disruption might have had on the track record and career development of those individuals included in the proposal and will be asked to consider the capability of the applicant and their wider team to deliver the research they are proposing. Where disruptions have occurred applicants can highlight this within their application, if they wish, but there is no requirement to detail the specific circumstances that caused the disruption.
- 6.3. UKRI acknowledges that it is a challenge for applicants to determine the future impacts of COVID-19 while the pandemic continues to evolve. Applications should be based on the information available at the point of submission and, if applicable, the known application specific impacts of COVID-19 should be accounted for. Where known impacts have occurred, these should be highlighted in the application, including the assumptions/information at the point of submission. There is no need to include contingency plans for the potential impacts of COVID-19.
- 6.4. Reviewers will receive instructions to assume that changes that arise from the COVID-19 pandemic, post-submission, will be resolved and complications related to COVID-

19 should not affect their scores.

- 6.5. Where an application is successful, any changes in circumstances that affect the proposal will be managed as a post-award issue.

7. Eligibility

- 7.1. Each proposal must identify a Principal Investigator (PI) who has overall responsibility for the delivery of the proposed research and will act as the point of contact for all STFC, DiRAC and RAC communications.
- 7.2. In line with STFC's research grant conditions the PI must be either a) resident in the UK, or b) be employed by an overseas Research Organisation approved by STFC as eligible to apply for research grant funding. The STFC eligibility criteria can be found via this [link](#).
- 7.3. We welcome proposals that represent the UK's contribution to an International Research Programme. However, it is expected the proposed research programme will enhance the UK's research outputs. Applicants are invited to submit letters of verification if the work proposed is dependent on other scientific results or being part of a large collaboration. If any projects are heavily led by international collaborators full reasons for this must be provided in the case for support. If applicants are aware of any restrictions on their ability to acknowledge the use of DiRAC resources in their publications, for example because of rules within an international collaboration, they should indicate these in their proposal. (Note that this will not affect the assessment of the proposal but will ensure that appropriate reporting mechanisms can be agreed with the PI if the proposal is successful).
- 7.4. Please note that if applicants hold an existing STFC Consolidated Grant this does not automatically guarantee that they will be allocated computing time on DiRAC facilities.

8. Proposal Types

- 8.1. The categories of proposals considered by each RAC Call are:

- Short Projects
- Thematic Projects
- Research Software Engineer Support (for requests of 3 months or more)

Discretionary and Seedcorn proposals may be submitted at any time.

8.2. Short Projects

A Short Project is a self-contained research problem typically lasting 3-6 months, up to a maximum of 12 months. The category will include proposals intended to develop exploratory study by users new to HPC or to DiRAC.

8.3. Thematic Projects

A Thematic Project is a clearly defined research programme of outstanding scientific

merit which requires significant HPC resources over a period longer than 12 months and up to 36 months duration. The proposed research should be world-leading, with the expectation of making step changes in knowledge through the use of DiRAC resources. Applicants must demonstrate a track record of the productive use of HPC. Thematic projects must be centered on a singular scientific theme, but can contain a small number of sub-project activities, and can span multiple Research Organisations/Institutes. They can consist of a number of institutions or groups working on a large project /activity.

8.4. Thematic / large projects with significantly disparate scientific themes are advised to submit separate applications. Applicants should consider the range of material contained within submissions as very large proposals can have a detrimental effect on the peer review system due to lack of detail and insufficient justification of resources, and the need for reviewer diversity. No single application may request more than 80% of the RAC available time on any individual machine (please see [Annex 1](#)). Requests above this will not be considered by the RAC.

8.5. **Discretionary / Seedcorn proposals**

These are very small allocations of DiRAC resource (up to 100,000 x86 core hours or 1,000 GPU hours or 1,000 KNL node hours) for projects that fall into the following categories:

- Scientifically outstanding projects where DiRAC resources could enable a breakthrough to be made but where the impact of the research would be lost if the project were submitted according to the scheduled calls for proposals.
- Very small projects where the researcher is not already a member of an existing Short Project or Thematic Project.

Discretionary / Seedcorn applications cannot be used to uplift existing project activities. Proposals may be submitted at any time and should be sent directly to DiRAC: dirac-support@epcc.ed.ac.uk

Information on how to submit a Seedcorn proposal can be found on the [DiRAC website](#).

8.6. **Research Software Engineering (RSE) Support**

Applications can be made for support from the DiRAC Research Software Engineering (RSE) team to help improve and develop software for the DiRAC community.

Applicants must complete the RSE request form and should refer to the specific RSE guidance notes, available on the [DiRAC website](#). Applications for RSE support must be sent to STFC (DiRACRAC@stfc.ac.uk) by Tuesday 5th October 2021, 16:00 UK time. Your application will be forwarded to a member of the DiRAC RSE team for technical evaluation. This will then be forwarded to the RAC for their consideration and applicants will be notified of the outcome following the RAC Main Panel meeting.

A RAC award of RSE effort to a DiRAC project will enable the employment of a Research Software Engineer (RSE) to work specifically on the relevant software to enable new features or improve the performance of the code. Examples of this could be:

- Implementation of algorithmic improvements within an existing code in a portable

manner

- Improving the scalability of software on higher core counts in a portable manner
- Improving a code to enhance sustainability and maintainability
- Improvements to code that allow new science to be carried out on current and future DiRAC services
- The integration of new algorithms/functionality into a code;
- Porting and optimising a code to run efficiently on current and future DiRAC services
- Code development to take a code from a Tier-2 (Regional) or local university cluster to DiRAC level bringing new communities onto DiRAC

Applicants should note that RSE support is technical in nature and is not research support. In particular, RSE effort is not meant to be a replacement for PDRA/Post-grad student activity. The construction of a piece of scientifically valid code is the project's responsibility and is not the role of RSE support. If the initial review process identifies activities which are deemed to be out of scope, the PI will be contacted to discuss the appropriateness of DiRAC RSE effort for the required work prior to the proposal being considered by the RAC.

We expect applications to be for 3 to 12 months of effort in most cases. If you require shorter amounts of RSE time (e.g. to help profile or port an application), these are available to all funded DiRAC projects; please contact the DiRAC helpdesk: dirac-support@epcc.ed.ac.uk with your request. (Note that RSE time is finite and we cannot guarantee to support every such request).

9. How to submit a proposal

9.1. Applications for Short and Thematic Projects all require the submission of a Technical Case. Proposals will not be considered by the RAC unless the Technical Case has been completed and submitted. Applicants may discuss their request with the DiRAC RSE Team in advance of submitting a technical case by emailing DiRAC support (dirac-support@epcc.ed.ac.uk) and adding the heading "RAC 14 technical enquiry" into the subject of the email.

9.2. All proposals must submit the following documentation via email to STFC (DIRACRAC@stfc.ac.uk) by the closing date of Tuesday 5th October 2021, 16:00 UK time. STFC recommends that applicants send their documents via secure / encrypted email.

1. Scientific application form
2. Scientific case for support
3. Project Management case
4. Data Management Plan
5. Any letters of verification (non-mandatory, maximum of 3, if the work proposed is dependent on other scientific results or being part of a large collaboration)
6. Technical application form

9.3. Short Projects and Thematic Projects

For the 14th RAC Call, applicants should submit the documents listed above. Please note the following page limits for the Case for Support:

Short Projects: 9 pages

Thematic Projects: 13 pages

One of the following font types must be used:

- Standard Arial 11pt (please note that this is the preferred font for STFC)
- Helvetica Regular 11pt or
- an equivalent regular 11pt Sans Serif universal font e.g. FreeSans

The case for support must contain the following sections:

1. **Science justification and proposed research** (maximum 10 pages Thematic Projects, 7 pages Short Projects)

This should describe the proposed research programme and explain why the applicants wish to use DiRAC. It should address the following assessment criteria listed below. For Thematic proposals, points 1-7 should be no longer than 9 pages and point 8 must be no longer than 1 page. For Short proposals, points 1-7 should be no longer than 6 pages and point 8 must be no longer than 1 page.

1. Significance of the proposed research goals with reference to the STFC Roadmap
2. Appropriateness of the proposed methods/codes
3. Justification of the requested resources
4. Justification for any research software engineering support requested
5. Suitability of the investigator(s) for the proposed research
6. Justification of any periods of machine use in exclusive mode
7. A prioritised list of the projects within the proposal
8. Clarification of the absolute minimum time required for the proposed work, including full reasons for needing all of the time requested, why the time requested is essential for the successful completion of the project, and the scientific impact of any cuts. (Please note that the page limit has been extended to allow one page for this information).
9. The technical case and scientific case should both provide information explaining how intensively the proposed code will be used, and how much of the allocated time will be used by this code. This should be addressed and details provided for all of the major codes that are listed.

2. **Project and Data Management** (maximum 3 pages Thematic Projects, 2 pages Short Projects):

- The project management structure
- Availability of sufficient researcher effort to carry out the proposed research (For Thematic Projects a table should be included showing the estimated effort, as a percentage, that the PI and each Co-I expect to contribute to the project)
- A description of the internal allocation process for the allocation of time to sub-projects (if applicable)
- A work plan, with milestones against which the progress of the project will be measured
- Publication plans
- Project risk and mitigation analysis (include compute/storage usage, staff and technical risks)
- Data Management Plan – please note that completion of a short data management plan is mandatory and will be assessed by the RAC. Applicants are requested to address all points which are found in the [STFC Data Management Plan guidelines](#).

This includes: which communities may have potential interest in the data being produced by their DiRAC project; how and where the data from the project will be stored; how long the data will be stored and what metadata processes will be used. Applicants are encouraged to consult the DMPs of any collaboration they are a part of and to discuss this with their universities data management units.

3. **Relevant Publications** produced via DiRAC resources over the last 3 years (short annex)
4. **References** (short annex)

9.4. **General guidance and important points to note:**

9.4.1. No single application may request more than 80% of the available time on any individual machine (please see [Annex 1](#)).

9.4.2. Existing Thematic Projects wishing to apply for more computing time due to additional resources becoming available at DiRAC can submit using the following methods:

- Applications with scientific themes distinct from the existing award can be submitted as a separate proposal.
- Applications building on the same scientific theme as an existing award should apply as a new project, and this new award would then replace any existing compute award. **Pls requesting for a revised or updated thematic project must justify this request fully; the RAC will take into account all currently active projects which are based on a comparable science case.**

9.4.3. Proposals should be focused on scientifically coherent themes, but should contain sufficient technical and scientific detail. It should be noted that proposals with greater numbers of themes will generally result in poor coverage and potentially weaker reviews. In these cases it may be beneficial to submit multiple thematic requests.

9.4.4. Proposals should include adequate detail to justify the requested allocation and should be written in a way that is accessible to the RAC Panel, who may not be an expert in the given field (this especially applies to Thematic Projects proposals).

9.4.5. Please note that the resources requested in the scientific case should match those requested in the technical case. If the request is to change by more than 20% (increase or decrease), this must be justified in the scientific case for support and STFC must be contacted directly to discuss this.

9.4.6. DiRAC resources are divided into four allocation periods per year, starting 1st April, 1st July, 1st October and 1st January. Successful applicants will be advised of the total amount of resources they have been allocated and the periods within which the allocations must be used. Resources must be used in the allocation period to which they were assigned; they cannot be carried over to the next allocation period. For Thematic awards the first year allocation will be fixed and subsequent years are subject to change. The allocations for each period will be shown in the DiRAC SAFE system. For Thematic Projects a uniform resource usage profile will be assumed unless the application states otherwise. Significant deviations from uniform profiles may be requested in Thematic Project proposals with adequate justification, but it is

not guaranteed that they can be accommodated.

9.4.7. It is possible to request a delay to the start date of a project. This should be specified on the application form (start dates must be on the first day of a month).

10. Assessment Criteria

10.1. Proposals will be assessed according to the following criteria:

- a) **Scientific Excellence** (total weighting of 60%)
 - Significance of the proposed research goals with reference to the STFC Roadmap
 - Strategic value within the STFC programme
 - National and international competitiveness and leadership
 - Suitability and national/international standing of the investigator(s) for the proposed research
- b) **Project Management** (weighting 10%) **and Data Management** (weighting 10%)
 - Feasibility of project timeline considering the DiRAC resources requested and size of investigator team
 - Project risk and mitigation analysis (include compute/storage usage, staff and technical risks)
 - Publication plans
 - Availability of sufficient staff effort to carry out the proposed research and make full use of the allocation.
 - Direct response to the [STFC Data Management policy](#) guidelines
- c) **Technical Assessment by DiRAC RSE Team** (Total weighting 20%)
 - Appropriateness of the proposed architecture/machine selection
 - Justification for any Research Software Engineering Support requested
 - Efficiency of resource usage and how well code(s) vectorise
- d) **RAC Additional Scoring considerations:**
 - Alignment of the proposal with the call guidelines.
 - Full and effective usage of previous DiRAC allocations (not applicable to applicants who have not had a previous DiRAC allocation). Reasons for any under usage of previous DiRAC allocations will be taken into consideration.
 - Timely submission of interim and final reports of any previous DiRAC allocation (not applicable to applicants who have not had a previous DiRAC allocation).

Please note that applicants will not be penalised if they cannot meet the criteria in bullet points 2 and 3 due to technical problems, Covid-19 related reasons, or other personal circumstances such as caring responsibilities, illness, bereavement, or periods of special leave for example.

A score will be applied to the RAC additional scoring considerations which will then form a percentage decrease in the overall score gained from the main criteria with a maximum of 20% decrease in score.

11. Assessment Process

11.1. Discretionary / Seedcorn Proposals

Discretionary and Seedcorn proposals can be submitted direct to DiRAC dirac-support@epcc.ed.ac.uk at any time. They will be reviewed by the Chairs of the Sub-Panels and will not be sent out to external reviewers. Applicants will be notified of the outcome as soon as possible, usually within one week.

11.2. Short Projects and Thematic Projects

The relevant RAC Sub-Panel Chair will assign a RAC Sub-Panel member to act as the Introducer for each project proposal received. The Introducers will suggest names for external reviewers (referees). For Short Projects one usable expert review will be sought. For Thematic Projects six expert reviewers will be sought, at least one of which should be a non-UK based reviewer. For both Short and Thematic Projects a member of the DiRAC RSE Team will be asked to provide a technical assessment of the proposal (as detailed above) and provide a score on the technical case. Reviewers will only see the submitted documentation to the RAC (the scientific proposal form, case for support, data management plan, project management case, RSE request form, and letters of verification). These documents will be sent to reviewers via secure email and reviewers will be asked to return their comments to STFC via secure email. The technical assessment is solely completed by the DiRAC RSE Team and will not be sent to reviewers.

Applicants will be given an opportunity to respond in writing to reviewers' comments. It is strongly recommended that PIs make use of this opportunity. Please note that STFC will send the reviewers reports to applicants using secure encrypted email. If the Panel has any questions regarding the written proposal, these will also be sent to the applicants at the same time as the reviewer's comments so the applicants may respond.

Each proposal will be considered at a meeting of the relevant Sub-Panel. At the meeting, the Sub-Panel will provide an assessment of the proposal, taking into consideration the reviewers reports and the PI's response to the reviewers reports. At this meeting an overall ranked list of the proposals will be produced.

Following the Sub-Panel meetings, a further meeting of the RAC will be convened which will include selected members from each Sub-Panel. At this meeting the resources to be assigned to each proposal will be agreed. Applicants will be notified of the outcome for their proposal and provided with feedback as soon as possible after the RAC meeting.

12. Code Efficiency

12.1. The aim of the RAC process is to maximise the output of high quality research by the DiRAC facility. Scientific excellence will be the primary driver for allocation decisions and the RAC will balance 'time to science' against reasonable requirements on the operational efficiency of approved projects and simulation codes. It is recognised that the cutting-edge and novel nature of research across the DiRAC community means that many DiRAC codes are under active development and may not be as efficient or

scalable as more mature codes. Further, results obtained in a timely manner with a sub-optimal code will often have greater impact than results delayed by extended periods of code optimisation work. However, while it is recognised that new HPC users, or users of new codes, may not have sufficient resources or experience to provide full details of code efficiency, applicants will be required to demonstrate that their operational plan is as efficient as possible and that the architecture requested is the most appropriate for the work.

12.2. In cases of similarly ranked proposals, applicants who demonstrate more efficient use of DiRAC resources either in terms of actual code efficiency or more efficient operational strategies will be given preference.

12.3. The resources being offered in this call are based on new CPUs (AMD Rome, Intel Icelake) and GPUs (Nvidia A100) Intel Skylake. As the new resources will not be available for scaling or efficiency tests before the closing date of this call, scaling and efficiency information based on existing DiRAC services will be accepted. *If you are able to provide data from systems using the same (or similar) hardware as the new DiRAC services, please note that your request is based on these figures.*

13. Requesting exclusive use of a DiRAC system

13.1. Some projects may include (or may consist entirely of) sub-projects which require usage of an entire DiRAC machine, or significant fraction of a machine, for a period of longer than two days. This mode of use must be explicitly justified in the proposal, and a detailed timeline for the sub-project must be included. The technical assessment of such sub-projects will include an assessment of the efficiency of machine use.

13.2. If the request is approved, a fixed start date for the sub-project exclusive usage will be agreed to enable re-scheduling of other users to other machines during the period of unavailability. Time lost due to failure to meet the approved start deadline will not be compensated.

13.3. No more than two DiRAC machines will be operating in this mode at any one time. Where this mode of operation directly impacts on another project (e.g. due to technical requirements which mean it cannot be moved to another machine) it may be necessary to sub-divide periods of exclusive use or reserve a fraction of the cores for other projects. In cases where multiple Project proposals with overlapping scientific goals are received, if appropriate the RAC may invite the applicants to consider merging their proposals.

14. Project Reporting

14.1. All projects (Thematic, Short and Seedcorn) will be required to submit reports at the end of the project describing the use of the computing allocation, use of the storage allocation, progress against objectives, achievements and publications. In addition Thematic Projects will be required to complete annual progress reports. Report templates will be provided and you will be notified when the reports are due.

- 14.2. The annual progress report for Thematic Projects will be assessed by the appropriate RAC sub-panel against the original peer-reviewed milestones. Confirmation of resource allocations to a Thematic Project in subsequent allocation periods will be conditional on the approval of their progress report. The report should include explicit justification for any significant deviations from the science proposed in the original work plan, and any delays should be accounted for. Thematic Projects which are deemed not to be progressing satisfactorily may have their allocations in subsequent allocation periods reduced and/or may be required to submit interim reports at six month intervals. The RAC may solicit expert referees' reports in cases where scientifically significant changes to the original milestones for a Thematic Project are proposed in the annual report.
- 14.3. Failure to submit a satisfactory project annual report or project final report will result in subsequent proposals from the group being marked down (see paragraph 10.1, section d).

15. Storage Policy

- 15.1. Please note the following information regarding the DiRAC Storage Policy:

Quota - an amount of disk that you cannot exceed.

Allocation - an amount of disk that you are guaranteed to have access to.

/home - this will be small and have quotas applied of, say, 10GB. This is for storing code, key input files, etc. but is not a working space.

/scratch or /work - this is the main working area available to all compute nodes and is quota'd by having separate volumes/file systems, one per project. The amount of space allocated to scratch can be over-allocated, hence it is a quota rather than an allocation. It is left to the users to manage their data within the limits of the set quota. However, each DiRAC site reserves the right to sweep of files which have not been accessed for a given amount of time. This is at the discretion of each site.

/data (medium term) - this is for storing results awaiting final post processing or on which more work may be required prior to publication and transfer back to the user's own institution. These will be quota'd to reduce the risk of significant overutilisation. Sweeping will be used here as well, as it is not a permanent archive, but will be on a much longer access time, say 9 months.

Archive: This is tape storage. Applicants must specify what data products they wish to have backed up to tape. Note that DiRAC is not currently able to provide long-term data storage/curation.

Note that not all DiRAC sites have all categories of storage types described above available. DiRAC will endeavour to assign storage aligned to the categories requested but this may not be technically possible.

Annex 1: Availability of DiRAC systems for RAC 14

			Resources Available				
DiRAC Service	DiRAC system	CPU/GPU type	<u>Year 1</u> <u>(Q2 2022- Q1 2023)</u>	<u>Year 2</u> <u>(Q2 2023- Q1 2024)</u>	<u>Year 3</u> <u>(Q2 2024- Q1 2025)</u>	Total	UNITS
Data Intensive Service - Cambridge	CSD3_CPU	Intel skylake	2.01	0.00	0.00	2.01	Mcore-h
		Intel cascade lake	23.80	19.04	9.52	52.35	Mcore-h
		Intel icelake	178.29	100.89	142.63	421.81	Mcore-h
	CSD3_GPU	Nvidia A100	0.27	TBC	TBC	0.27	MGPU-h
Data Intensive Service - Leicester	DIaL	Intel skylake	51.09	29.29	100.92	181.29	Mcore-h
	DIaL-3	AMD Rome	224.26	179.40	179.40	583.07	Mcore-h
	SuperDome (6 TB RAM)	Intel skylake	1.26	1.01	1.01	3.28	Mcore-h
	3 Fat nodes (1.5TB RAM)	Intel skylake	0.95	0.76	0.76	2.46	Mcore-h
Extreme Scaling Service - Edinburgh	Tesseract	Intel skylake	307.13	0.00	0.00	307.13	Mcore-h
	Tesseract_GPU	Nvidia P100	0.28	0.22	0.22	0.73	MGPU-h
	Tursa_GPU	Nvidia A100	3.92	3.14	3.14	10.20	MGPU-h
	Tursa_CPU	AMD Rome	6.73	3.88	5.38	15.99	Mcore-h
Memory Intensive Service - Durham	Cosma7 (16 GB/core)	Intel skylake	74.32	55.44	75.39	205.15	Mcore-h
	Cosma8 (7.8 GB/core)	AMD Rome	208.50	139.88	274.49	622.87	Mcore-h
	2 Fat nodes (4 TB RAM)	AMD Rome	1.91	1.52	1.52	4.96	Mcore-h

Annex 2: Summary of DiRAC-3 hardware

Service	CPU nodes	GPU nodes	Fat nodes	Network	Storage
Data Intensive – Cambridge	268 nodes each with: <ul style="list-style-type: none"> ○ 2x 38-core Intel Icelake CPUs ○ 512 or 256 GB RAM Total: 20,368 cores	21 nodes each with: <ul style="list-style-type: none"> ○ 4x A100-80GB Nvidia GPUs ○ 1TB RAM ○ 2x 64-core AMD Milan CPUs Total: 84 GPUs	N/A	3:1-blocking, 200Gb/s	3.5 PB disk
Data Intensive – Leicester	200 nodes each with: <ul style="list-style-type: none"> ○ 2x 64-core AMD Rome CPUs ○ 512 TB RAM Total: 25,600 cores	N/A	N/A	3:1-blocking, 200Gb/s	4 PB disk
Extreme Scaling – Edinburgh	6 nodes, each with: <ul style="list-style-type: none"> ○ 2x AMD Rome CPUs ○ 256 GB RAM Total: 768 cores	112 nodes, each with: <ul style="list-style-type: none"> ○ 4x A100-40GB Nvidia GPUs ○ 2x AMD Rome CPUs ○ 1 TB RAM Total: 448 GPUs	N/A	Non-blocking, 200Gb/s	4 PB disk
Memory Intensive – Durham	360 nodes each with: <ul style="list-style-type: none"> ○ 2x 64-core AMD Rome CPUs ○ 1 TB RAM Total: 46,080 cores	N/A	2x 4TB with AMD CPUs	Non-blocking, 200Gb/s	5.3 PB disk; 20 PB tape; 1.1 PB SSD (checkpointing)