

Annex 1

to the Call for Expression of Interest for the hosting and operation of European quantum computers integrated in HPC supercomputers

**APPLICATION FORM**

**Call REF: EUROHPC-2022-CEI-QC-01**

Application Ref: [***ACRONYM***]

***IMPORTANT NOTICE***

*Applicants must use this template for their applications (designed to highlight important aspects and facilitate the assessment against the evaluation criteria).*

***Character*** *and* ***page limits****:*

* *page limit: 90 pages*
* *minimum font size — Arial 8 points*
* *page size: A4*
* *margins (top, bottom, left and right): at least 15 mm (not including headers & footers).*
* *pagination instructions: each document from the application must be individually numbered in the bottom right corner.*

*Please abide by the formatting rules. They are not a target! Keep your text as concise as possible. Do not use hyperlinks to show information that is an essential part of your project.*

*Please include in the header (top left) of each page the Acronym of the Application.*

*Before filling in this form, please read carefully the relevant call for Expression of Interest, and any other reference documents related to this call available on our site https://eurohpc-ju.europa.eu/current-calls*

*Please make sure that your application:*

* *is submitted on the correct form, completed in full and dated;*
* *is signed by the person authorised to enter into legally binding commitments on behalf of the applicant;*
* *meets the submission arrangements set out in the call;*
* *is submitted by the deadline.*

*Applicants may be requested to provide additional information or to clarify the supporting documents submitted in connection with the application, provided that such information or clarification does not substantially change the proposal.*

* Paragraphs in italics or boxes with paragraphs in italics are intended as an explanatory guidance for the applicant and shall be deleted before bidding.*

* Don’t forget to delete this page and explanatory text in italics.*

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| **PROGRAMME CONCERNED** |
| **European quantum computers**  |
| **REFERENCE NUMBER OF THE CALL**  |
| EUROHPC-2022-CEI-QC-01 |
| **SUMMARY OF THE APPLICATION** |
| Concerned Supercomputer Name: |
| Identity of the Coordinator/Applicant: |
| Consortium: *YES/NO*  |
| Coordinator: *Partner1*:  | Contribution Coordinator: XXX *Euro*Contribution *partner1*: XXX *Euro* |
| Summary of the Application:(*in EN, max 1000 words)*  |
| Would the hosting consortium be ready to include additional Participating States if selected? *YES/NO*If YES, please include the indicative amounts of the contribution of the additional Participating States:  |

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# I. INFORMATION ON THE APPLICANTS

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| **1 REFERENCES OF THE APPLICANTS**  |

1.1 (*Option 1: Applicant No1 — or Option 2: Coordinator;* *please indicate what is applicable*):

|  |
| --- |
| **1.1.1 IDENTITY OF THE APPLICANT** |
| Official name in full: |
| Acronym: (if applicable)  |
| Official legal form:  |
| Legal personality[[1]](#footnote-2): |
| Place of establishment or registration:(Address and country)  |
| Entity registration number: (Not applicable if the applicant is a public-sector body.)  |
| VAT number (if applicable): |

The legal details are attached in the Legal Entity Form[[2]](#footnote-3) to be provided as annex. Any changes in the legal entity form must be notified in writing to the Executive Director.

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| --- |
| **1.1.2 CONTACT DETAILS** |
| Street address: |
| Postcode: |
| City: |
| Region (if applicable): |
| Country: |
| Telephone: Mobile:  |
| Fax: |
| E-mail address: |
| Website:  |

Any change in the addresses, phone numbers, fax numbers or e-mail, must be notified in writing to the Executive Director. The Executive Director will not be held responsible in the event that it cannot contact an applicant**.**

|  |
| --- |
| **1.1.3 CONTACT PERSON RESPONSIBLE FOR THE Expression of Interest**  |
| Family name: First Name: |
| Position/Function: |
| Telephone: Mobile: |
| Fax: |
| E-mail address: |
| **1.1.4 LEGAL REPRESENTATIVE (PERSON AUTHORISED TO SIGN THE HOSTING AGREEMENT)** |
| Family name: First Name: |
| Position/Function/Mandate: |
| Telephone: Mobile: |
| Fax:  |
| E-mail address: |

l'Arc de Triomphe

1.2 Applicant No 2 (If applicable, repeat this part as often as is required to include all applicants)*.*

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| **1.2.1 IDENTITY OF THE APPLICANT** |
| Official name in full: |
| Acronym: (if applicable)  |
| Official legal form:  |
| Legal personality[[3]](#footnote-4): |
| Place of establishment or registration:(Address and country)  |
| Entity registration number: (Not applicable if the applicant is a public-sector body.)  |
| VAT number (if applicable): |

The legal details are attached in the Legal Entity Form[[4]](#footnote-5) to be provided as annex. Any changes in the legal entity form must be notified in writing to the Executive Director.

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| --- |
| **1.2.2 CONTACT DETAILS** |
| Street address: |
| Postcode: |
| City: |
| Region (if applicable): |
| Country: |
| Telephone: Mobile:  |
| Fax: |
| E-mail address: |
| Website:  |

Any change in the addresses, phone numbers, fax numbers or e-mail, must be notified in writing to the Executive Director. The Executive Director will not be held responsible in the event that it cannot contact an applicant**.**

|  |
| --- |
| **1.2.3 CONTACT PERSON RESPONSIBLE FOR THE APPLICATION**  |
| Family name: First Name: |
| Position/Function: |
| Telephone: Mobile: |
| Fax: |
| E-mail address: |

# III. INFORMATION ON THE EXPRESSION OF INTEREST

## III.1 General System specifications

*Applicants should describe how the following general system specifications will be met, for the quantum computer, the supercomputer of the hosting entity and the hosting site (the data centre).*

*The application should enable the development of real use cases supporting the adoption of applications with scientific, industrial and societal relevance for Europe. Although identified applications do not need to provide a definite quantum advantage, they should allow the development of libraries for quantum computers/simulators in a HPC environment.*

*Furthermore, the applications should support the implementation and testing of quantum software stacks, libraries etc., which facilitate the link from a high-level description of algorithms to a low-level implementation on the hardware, for solving concrete problems and applications expected to demonstrate quantum advantage. The Quantum/HPC integration should follow a co-design approach together with the development of applications that will run on the quantum computers, thus contributing to the advance of new quantum software and applications. The applications, software and the high-level implementation should, to the extent possible, be independent of the underlying qubit platforms and they should be run/tested on as many integrated quantum computing platforms as possible within the EuroHPC infrastructure.*

*The quantum computers can range from pilots and experimental systems to prototypes and operational systems. The quantum computers should have at least 10 qubits, with a 2-qubit gate error rate of less than 1%, or equivalently with a 2-qubit gate fidelity at least above 99%, and allow for a maximum circuit depth and number of entangled qubits by the installation date. The quantum computer should integrate EU technologies and uptake research outputs emanating from Quantum Flagship/Eu-funded projects or from national research programmes of the EuroHPC Participating States. Applications to the Call for Expression of Interest should clearly identify the technical features of the targeted quantum computer, including the quantum processing unit (qubits, entanglement capability, control etc.) and the integration (type interface, interconnection, software stack, etc.) between the quantum computer and the rest of the EuroHPC infrastructure.*

*The application should also explain how access to the quantum computer integrated in the HPC system of the hosting entity will be implemented in agreement with the EuroHPC JU Access Policy. This is of particular importance for applications from entities where the ownership of the HPC system and the quantum computer will be different and the EuroHPC JU does not own HPC resources.*

*The selected hosting entities should ensure to the extent possible cooperation with complementary projects launched, notably in the area of the EuroHPC-2020-01-b: “Pilot on quantum simulator”. Successful applicants, should establish from the beginning of this cooperation appropriate IP exploitation agreements. They should also contribute to spreading excellence across Europe, notably through the involvement of participants from EuroHPC Participating States currently developing their HPC/quantum infrastructure, and incorporating results emanating from the Quantum Flagship/Eu funded projects or national research programmes of the EuroHPC Participating States.*

*The hosting entity will host at the time of delivery of the quantum computer a supercomputer with the following requirements:*

* *A capability computing system with an aggregated performance level capable of executing at least 4 Petaflop (sustained performance measured using linpack benchmark)*
* *Covering the needs of a wide range of applications, and in particular of key/grand challenge applications that demonstrably require the capability usage of the quantum computer, also in combination with the supercomputer at the hosting entity, i.e. using simultaneously the quantum computer and significant resources of the existing HPC system.*

*The hosting site of the quantum computer and interconnected supercomputer should comply with the following requirements:*

* *UPS power available to cover the critical systems including control electronics equipment of the quantum computing system.*
* *Adequate capacity for hosting the proposed quantum computing JU system*
* *Sufficient contiguous floor space available for hosting the proposed quantum computer which will be integrated with the existing supercomputer and auxiliary systems*
* *At least 100 Gbit/s connectivity towards the rest of the GEANT Network (link capacity).*
* *Hosting physical security*
* *Hosting fire mitigation equipment/procedures*
* *Hosting IT access security*
* *On call service support teams for IT issues*
* *Dedicated on-call service team for facilities issues*
* *Regularly measure the satisfaction of the users with the service via a user survey*

*Applications should include a description of the proposed quantum computer and hosting site, including features such as:*

* *Detailed description of the site hosting the system including information about physical constraints relevant for the quantum computer (room temperature, hygrometry, etc)*
* *Outline description of the hosting entity’s HPC supercomputer where the quantum computer will be integrated including*
	+ *System architecture*
	+ *Type of nodes and their configuration (e.g. accelerated, CPU, High memory, etc.)*
	+ *Memory and storage capacities and architecture*
	+ *Ratio of different node types within the system (accelerator/CPU, memory size,...)*
* *Description of the main features of the targeted quantum computer system including e.g:*
	+ *Technical features of the targeted quantum computer, including the quantum processing unit (qubits / individual quantum units, entanglement capability, control, error rate, gate fidelity etc.)*
	+ *Physical requirements (room temperature, hygrometry, expected dimension etc.)*
	+ *Information on expected maturity of the technology at the time of delivery*
	+ *Information on the expected availability of the components, manufacturing timeline and time to delivery after signature of the contract with the vendor of the quantum computer.*
* *Description of the integration between the quantum computer, the existing supercomputer and the rest of the EuroHPC infrastructure (technical, legal and policy aspects)*
	+ *Planned physical arrangement of the quantum computer and supercomputer in the data centre*
	+ *Type of interface, interconnection, software stack etc.*
	+ *Required hardware and software for the integration with the supercomputer and foreseen developments*
	+ *User access and resource allocation including access models for hybrid quantum-classical algorithms and applications*
	+ *Legal arrangements for the installation and operation of the quantum computer integrated in the supercomputer of the hosting entity*
* *Collaboration and cooperation with other initiatives such as the call EuroHPC-2020-01-b: “Pilot on quantum simulator” or national programmes*
* *What type of application domains (e.g. computational, HPDA, AI …) and specific applications (e.g. new materials, drugs design, astrophysics…) will the system be optimised for? What are the expected performance increases for the targeted applications?*
* *Acceptance tests and benchmarks to be used for the acceptance of the quantum computer*
* *Other related software/services ( support of workflows, workflow management, user interface, quantum software stack, quantum computing libraries, supported programming languages …)*

## III.2 Total Cost of Ownership (TCO)

*The applicant should include an estimation of the cost of the quantum computer that the applicant has in mind to host and that has been described in the previous section “general system specifications”.*

*The estimation of the TCO will be based on an estimation of the acquisition costs of a potential system that complies with the general system specifications and on an estimation of its operating costs. The costs related to the construction of the hosting site per se (i.e., the costs related to the building infrastructure that will host the quantum computer, etc.) shall not be covered by the EuroHPC JU. The costs of the preparation and adaptation of the hosting site incurred by the hosting entity that can be directly accounted to the quantum computer may be considered as part of the TCO.*

*Applicants should provide their intention with regards to the duration of the operations of the quantum computer in the hosting entity. This should include not only their proposal for the duration of the operations, but their preference with the ownership of the quantum computer once the operations are finished (e.g. buy it, decommissioning it …).*

### III.2.1 Site Preparation

*The hosting entity should be able to meet the baseline requirements set out herein in time for the anticipated timeline for the delivery of the quantum computer. The applicant should provide a plan of how and in what timeline the preparation of the hosting site for the quantum computer will be realised, including costs of each action (indicating the ones that will be considered as in-kind contribution) and the definitive date at which the site will be ready for the installation of the EuroHPC quantum computer.*

### III.2.2 Acquisition Costs

*Applicants should detail the estimation for the cost of the acquisition of the quantum computer. Applicants should indicate clearly what costs will be included in this category, how they will calculate them and who will pay for those.*

### III.2.3 Operating Costs

*Applicants should provide an auditable methodology to calculate and to verify the operating costs of the quantum computer for the duration of the action. Applicants should describe the model that will be used for calculating the costs of the Operational expenditures (OPEX), detailing the cost elements included in the model and providing estimates for each cost.*

*The hosting entity should be in position to provide an accurate estimate and to verify the operating costs of the quantum computer, by ensuring, for example, the functional separation, and to the extent possible, the physical separation of the quantum computers and any national or regional computing systems it operates with the exception of the supercomputer where the quantum computer will be integrated.. The applicants should explain how the quantum computer shares its IT environment, storage, support services and other infrastructure in the data centre and how operating costs will be shared between the supercomputer of the hosting entity and the integrated EuroHPC quantum computer.*

*The method should be used to calculate the operating costs and the amount that will be covered by Union's contribution. Applicants can use the indicative list of cost elements provided in Appendix 2 to consider in the calculation of the operating costs.*

*Applications should include at least the following information and/ or estimations:*

1. *Average power usage effectiveness (PUE) for the current data centre over the last 12 months.[[5]](#footnote-6) And, in the case that the applicant would be upgrading the site to host the quantum computer, what is the planned (design specification) PUE for your upgraded data centre[[6]](#footnote-7)*
2. *Depreciation time for the building, technical building infrastructure and IT investments and method used for the depreciation of the assets (e.g. linear) associated with the quantum computer.*
3. *Average cost of IT on-call service (24/7) (internal or outsourced) over the last 12 months. If the existing IT service will not cover the quantum computer a description and cost model should be provided for the planned services.*
4. *. Current electricity price in EUR/kWh (all taxes included) and if available, electricity price in EUR/kWh (all taxes included) at the expected installation time of the quantum computer.*
5. *Number of system administrators (FTE) expected to be dedicated to the operation of the quantum computing service (including critical auxiliary services such as storage, scheduling system, connection to the supercomputer etc.), including average Person Month cost.*
6. *Number of user support staff (FTE) expected to be dedicated to the support of the users of the quantum computing service and application support including average Person Month cost.*
7. *Number of technical support staff (FTE) expected to be dedicated for an Application Support Team including average Person Month cost.*
8. *IT environment including storage (disks, tapes ...) architecture, capacities and their ability to be extended to serve the user communities of the quantum computing service.*
9. *Other relevant costs e. g. for the cooling medium*

### III.2.4 Integration Costs

### *Applicants should detail the estimation for the cost of the integration of the quantum computer with the HPC supercomputer. Applicants should indicate clearly what type costs will be included in this category and how they are calculated.*

*The application to the call for expression of interest should include the request for a grant to cover the integration of the quantum computer with the existing supercomputer of the hosting entity, including the necessary developments of the quantum hardware and the software stack. Applications should provide sufficient details to understand and evaluate the concept, the feasibility within the proposed timeline (technology, partners etc) and to justify the indicative costs. The description should further explain how co-design will be used to support the development of applications, software and the high-level implementation. Applications and the application programming interface should, to the extent possible, be independent of the underlying qubit platform and they should be run/tested on as many quantum computing platforms as possible within the EuroHPC infrastructure*

### III.3 Experience of the hosting entity in installing and operating similar systems

*Applicants should provide information on their expertise, experience and capabilities in working with quantum technologies as well as installing and operating quantum computers and supercomputers:*

* *Previous experience with installing and operating quantum and supercomputers. Provide information in case the applicant’s site has experience in hosting very early releases of new systems. If relevant, applicants must provide documentation of their experience in having installed systems in the last 5 years (especially systems using quantum computing technologies and supercomputers that ranked in the Top500 at the time of their first listing).*
* *In the case of installing and operating a supercomputer for a 3rd party (supercomputer is legal title of 3rd party and operated for them at agreed SLA) or operating a supercomputing service or equivalent major infrastructure for a 3rd party (3rd party pays for a service with agreed SLA, supercomputer is the legal title of the hosting site); applicants must provide a description of the service provided as well as at least one contact person from the 3rd party from whom the JU may request a reference for this service.*
* *Description of the current organizational structure and the teams of people responsible for the supercomputer operation and management (including user support and specialist support of the HPC systems). If available, include current procedures and tools for system management, help desk project management, configuration management, training and education put in place.*
* *Description of the current procedures adopted by the supercomputing operation and management team to monitor HPC systems. Please indicate which of these are these are in-house and which are 3rd party solutions; how they have been integrated and customized. List any current Quality Control certifications your organization has obtained for system management, help desk project management, configuration management, training and education.*
* *Description of the current procedures adopted by the supercomputing operation and management team to trace and resolve issues and communicate them to users and other stakeholders. Include description of current procedures adopted by the supercomputing operation and management team to ensure that service level agreements are met.*
* *Description of any current continuity procedures the operations team or the Network Operations Center (NOC) has in place and description of current workload management software and methodology (bonus/malus; backfill; etc.) in place.*
* *Description of previous experience in providing quantum computer and supercomputer access and other related services to users from other member states or pan European environments (e.g. PRACE)*
* *Information on other relevant experience in quantum computing such as collaborations with research institutions, universities, industry or the delivery of courses to user communities.*

### [III.4 Quality of the hosting facility's physical and IT infrastructure, its security and its connectivity with the rest of the Union](#_Toc535579471)

*Applicants should provide information of the hosting physical and IT infrastructure, including security and connectivity that the site can provide for both the supercomputer and the integrated quantum computer.*

*For the site preparation, the hosting entity should be able to meet the baseline requirements set out herein in time for the anticipated timeline for the delivery of the quantum. The applicants should provide a plan of how and in what timeline they intend to realise the preparation of the site, including the definitive date at which the site will be ready for the installation and integration of the quantum computer. This may include, but is not limited to Gantt charts, contractual timelines, construction permits and work contracts status.*

*Applicants should include (at least) the following information related to the current and proposed capacities of the hosting facility of the supercomputer and integrated quantum computer and how to achieve them:*

1. *Description of the intended hosting entity site and facility, including integration and interconnection with different platforms, cooling methods and experience on cooling systems, power measurement facilities, accessibility, possibility to accommodate visitors, courses, possible extendibility of the site (m² and KW) and description of physical security concept, including access control, CCTV, etc.*
2. *Power measurement facilities in place at infrastructure level (device type, location of measurement at rack, pdu, centre) and maximum levels of energy measurement according to the EE HPC Power Measurement Methodology. If available, reference to any memberships of energy efficiency interest groups or codes of conduct (e.g. EE HPC WG , EU Code of Conduct, EMAS, or other); certifications for energy efficiency and sustainability (e.g. ISO / IEC 13273).*
3. *Information about the connection to the power grid, including maximum capacity of connection to the power grid and other characteristics such as redundant connection to the power grid. Information about power grid quality (number of outages from supplier in last 48 months, starting January 1st 2018) and energy procurement method (e.g., long-term contracts, annual market based purchases, other).*
4. *Information about availability of the data centre: expressed as a minimum percentage of uptime or in maximum number of hour’s downtime that the hosting entity deem are acceptable per year. Average availability of data centre infrastructure (cooling, power, etc.) (over the last 24 months for current)*[[7]](#footnote-8)*.*
5. *Information about connectivity towards the rest of the GEANT Network (link capacity) and the Network Operating Centre (NOC) and its reachability (e.g. 24/7).*
6. *Facility managers (in-house or outsourced) involved in ensuring the operation of the data centre, and their specialization.*
7. *Total memory and storage capacities of the centre, defining what part would be dedicated to the quantum computing service.*

### [III.5 Quality of service to the users, namely capability to comply with the service level agreement](#_Toc535579472)

*The applicant should specify the benchmarks or deliverables which the applicant intends to employ to achieve the expected results and targets and how they will be used. These should include at least the SLAs in the Hosting Agreement and information related to:*

1. *Access time accounting model that will be used to control the allocation time of the quantum computer integrated with the hosting entity’s supercomputer. Description of access time policy proposed and how the total number of jobs in waiting queue ready to run will be measured. Provide historic system uptake and usage for the existing supercomputers or recent HPC systems of the hosting entity.*
2. *Availability of help-desk; number of active projects currently supported. Description of services provided by user support (e.g. 1st level, 2nd level, application support) and of policy regarding response times for level 1, 2 and 3 tickets*[[8]](#footnote-9)*.*
3. *Overview of training course curriculum related to HPC including quantum computing and links towards user documentation pages, user tutorials and webinars*[[9]](#footnote-10)*.*
4. *Description of how the on-call service (24/7) for the supercomputing service and infrastructure facilities are set up and work. Include, if available, results from the user satisfaction surveys for your site for the last 5 years.*
5. *Fraction of time for which the current supercomputing service (supercomputer + all necessary auxiliary services like storage, network, login nodes, etc. + main software services like scheduler, access to file systems, etc.) has been available over the last 12 months[[10]](#footnote-11)*
6. *Results of regular regression tests to assess the stability of performance of your current supercomputer service. If applicable, please provide a description of the regression test used and the frequency at which it is run.*
7. *Description of any additional services that may not be critical to running the computing service but may provide an additional benefit to the end user. If applicable, please provide a description of these services.*

*Applicants should provide details on how they propose to achieve these tasks for the hosting of the quantum computer integrated with the supercomputer. Applicants should indicate subcontracted action tasks (if any) and explain the reasons why (as opposed to direct implementation).*

By submitting an application the applicant accepts that in case of award certain data like the name, locality and amount (amongst others) will be published.

By submitting an application, the applicant and participants of the hosting consortium accept the terms and conditions set out in the call for expression of interest and the model hosting agreement to be found in Annex 2 of the call for expression of interest.

|  |
| --- |
| I declare that all information provided in this application form and its annexes is correct.Date: Signature of the legal representative of the coordinator organisation |

# CHECKLIST FOR APPLICANTS

*Please use this checklist to ensure that you attach all of the necessary documents*

|  |  |  |
| --- | --- | --- |
| **Document and content** | **Coordinator** | **Partner** |
| All sections of the application form have been filled in, where appropriate, in accordance with the Call for Expression of Interest or any other document provided as guidance related to the programme concerned.  | **[ ]**  | N/A |
| Provision of an appropriate supporting document proving the commitment of the Member State where the hosting entity is established or of the competent authorities of the Participating States of the hosting consortium to cover the share of the total cost of ownership of the quantum computer that is not covered by the Union contribution. | **[ ]**  | **[ ]**  |
| The declaration(s) on honour has (have) been signed and attached in original (see template in Annex a) | **[ ]**  | **[ ]**  |
| Legal details have been included in the Legal Entity Form annexed.<http://ec.europa.eu/budget/contracts_grants/info_contracts/legal_entities/legal-entities_en.cfm> | **[ ]**  | N/A |
| Mandate letters have been signed and attached in original (if applicable; see template in Annex b) | N/A | **[ ]**  |

1. Legal personality is understood as applicant’s capacity to sign contracts and constitute a party in court proceedings under the applicable national legislation. [↑](#footnote-ref-2)
2. <http://ec.europa.eu/budget/contracts_grants/info_contracts/legal_entities/legal-entities_en.cfm> [↑](#footnote-ref-3)
3. Legal personality is understood as applicant’s capacity to sign contracts and constitute a party in court proceedings under the applicable national legislation. [↑](#footnote-ref-4)
4. <http://ec.europa.eu/budget/contracts_grants/info_contracts/legal_entities/legal-entities_en.cfm> [↑](#footnote-ref-5)
5. [↑](#footnote-ref-6)
6. [↑](#footnote-ref-7)
7. Facility is deemed available when no facility issues are affecting the running of the supercomputing service. Availability = total hours – (scheduled + unscheduled downtime) [↑](#footnote-ref-8)
8. Level 1 => simple request, can be solved in 1 day; Level 2 => more complex request, requires some research, can take up to 5 working days to resolve, Level 3 => request that requires vendor response to resolve, may take longer than 5 working days [↑](#footnote-ref-9)
9. or provide electronic copies if these are not reachable online or without a user account [↑](#footnote-ref-10)
10. Available = fully up and running and reachable by the users and at least 98% of compute nodes available [↑](#footnote-ref-11)