

Selection Process for QUP Project Q

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1. International Center for Quantum-field Measurement Systems for Studies of the Universe and Particles (QUP)

The International Center for Quantum-field Measurement Systems for Studies of the Universe and Particles, QUP, was established at KEK on December 16, 2021. It was selected as the 14th International Research Center under the World Premier International Research Center Initiative (WPI) by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) of Japan. WPI aims to build "globally visible research centers" with an excellent research environment and high research standards that will attract many leading researchers worldwide by supporting voluntary efforts such as introducing system reforms. The financial support from the MEXT will be provided for ten years, from JFY2021 to JFY2030, after which the MEXT requires the host institution (KEK for QUP) to make the center financially self-sustaining.

QUP is the only WPI center that specializes in measurement systems. With its basic concept of **"bringing new eyes to humanity to see this beautiful world (the true nature of space-time and matter),"** QUP is launching new research projects. At the same time, QUP also engages in research to apply the invented and developed new eyes to a wide range of academic fields and their implementation in society.

The projects promoted by QUP can be divided into two main categories: the development of new measurement methods and devices through four research clusters (Low-Temperature Detector Cluster, Quantum Detector Cluster, Rad-Hard Devices Cluster, and Data Acquisition and Analysis Cluster) and projects that use technologies developed at QUP to see the true nature of space-time and matter. The former is the backbone of QUP and is called the Foundation Layer, while the latter is called the Application Layer because of its application nature of using the outcomes of the Foundation Layer. Both are essential to QUP's mission. There are projects called "QUP Flagship Projects" in the Application Layer, which we give special treatment because they need a lot of resources or for other substantial reasons. QUP prioritizes the allocation of human resources to flagship projects. As of November 2022, there is one flagship project, the development of the superconducting detector array, which serves as the "eye" of the JAXA-led LiteBIRD satellite. LiteBIRD is an ambitious project to find faint

imprints of the primordial gravitational waves predicted by cosmic inflation through precise observations of the cosmic microwave background. Several QUP PIs are involved in the project. From a technical standpoint, it will be the world's first superconducting millimeter-wave detector array to operate in deep space. The type of superconducting detector to be developed by QUP is a superconducting transition edge sensor (TES). We, therefore, call the project "SpaceTES for LiteBIRD" hereafter.

2. Project Q

QUP is about to launch its second flagship project, following SpaceTES for LiteBIRD. We have named the framework for this project Project Q. **The goal of Project Q is to explore new quantum fields and obtain world-class results with a new quantum field measurement system.**

QUP's projects share the common motivation of searching for new physics principles (Beyond the Standard Model). In particular, we aim to develop new eyes to solve mysteries derived from cosmological observations (inflation, dark energy, dark matter, etc.,) implement them and carry out observations. The solution to these mysteries may require introducing new quantum fields such as inflatons, axions, supersymmetric particles, etc., and various theoretical proposals have been made to this end. QUP considers their verifications as an essential task. The highest-level goal in the search for new principles in physics is the unification of quantum theory and gravity theory; QUP also has a great interest in this ambitious goal.

Project Q attempts to launch a project from scratch by carefully selecting themes based on the above recognition of the current academic status quo.

3. Requirements for Project Q Proposal

3.1 Principal Investigator (PI)

The proposal must have one PI; if selected for Project Q, the PI will simultaneously obtain QUP affiliation and become a PI of the QUP organization, with the requirement that sufficient FTEs be used to promote Project Q. This can be a cross-appointment. As a guideline, a PI's FTE is expected to be at least 40%.

3.2 Proposal Contents

The proposal must outline a path to explore new quantum fields and obtain world-class results with the new quantum field measurement system. The schedule and required resources must also be described for the current plan.

4. Selection Procedure

4.1 Project Q Selection Committee

The Project Q Selection Committee consists of the following members.

- Masashi Hazumi (QUP Director), Chair
- Kazunori Hanagaki (QUP Deputy Director, IPNS Deputy Director)
- Katsuo Tokushuku (QUP Administrative Director)
- Naohito Saito (QUP Advisor, IPNS Director)
- Satoshi Iso (QUP Senior Researcher, IPNS Professor)
- Tsutomu Mibe (QUP Senior Researcher, IPNS Professor)
- Kazuhisa Mitsuda (QUP Senior Researcher, NAOJ Professor)

The role of the Selection Committee is to select Project Q by evaluating the proposed methods to search for "new quantum fields" from the following points of view:

Evaluation Points

- Significance in physics
- Novelty of the search method (novelty as a quantum field measurement system)
- Feasibility of the plan
- Timing to obtain the search results (the earlier the better)
- Whether there are worthwhile intermediate achievements along the way to the final results
- Consistency with QUP's missions
- Consistency with QUP's milestones (in particular, targets to be achieved by summer 2025 for QUP's interim review and by the end of FY2030 for QUP's final review)
- PI's commitment (high FTE, external funding status, funding acquisition plans, etc.)

4.2 Proposal Submission

As an initial step, you should submit a cover page, a two-page Expression of Interest, a one-pager summary slide, and a list of references. A template is attached at the end of the text. Please follow the instructions in the template to complete the form.

4.3 Down Selection and Initial Investigation

Down-selection will be done for proposals. At this stage, interviews will be conducted if necessary. The number of proposals will be narrowed down to a maximum of two. The QUP Systemology Support Section will provide systems engineering support for the selected

proposals to refine the plan further. Proposals that pass the down-selection process will be considered QUP projects, regardless of the outcome of the final selection process. Proposals that do not pass the down-selection may also become QUP's projects; this will be decided by the QUP director, with inputs from the review committee.

4.4 Final Selection and Start-up

The final selection will not necessarily wait for the end of the systems engineering support. The committee will select either of a maximum of two for Project Q. QUP will immediately begin soliciting personnel for about three researchers (and a PI if needed), to have the PI and researchers take up their positions at the earliest possible time. Depending on the proposed scale, we expect to eventually form a group of up to about ten researchers in the QUP. For the proposal not selected, we aim to determine the commitment level of QUP.

One possible scenario in a final selection is the following: The project selected as Project Q will produce world-class results within the period MEXT financially supports QUP. In contrast, the other project not selected has scientific significance but takes longer to obtain results. We do not necessarily require that final results be available by FY2030 for projects with a particular significance in physics. For such time-consuming projects, however, having reasonable intermediate goals is essential.

5. Selection Schedule

Proposals will be accepted between January 15 and February 15, 2023. The selection committee will begin evaluation as soon as a proposal is posted. The down-selection is aimed to be made by March 1, 2023. The final selection is planned to be made by March 31, 2023.

6. Remarks

We intend to promote Project Q as QUP's project, so the PI of Project Q should be affiliated with QUP (not necessarily with 100% FTE, but cross-appointment is possible.) Since QUP is not a funding agency, the selection process for Project Q shall not be regarded as an open call for external funding.

QUP is one of the WPI research centers, and its grants should be used primarily to hire people. Therefore, while QUP can support personnel and facility-related expenses for Project Q, other funding must be planned separately to carry out the project, with the PI taking the lead and QUP providing support.

Project Q Concept Proposal

Instructions are in blue.

Examples are in red. Please remove them when you use this template.

0. Cover page (*1 page*)

Proposal Title: **Search for Inflatons with Noble Quantum Sensors**

PI: **Marie Skłodowska-Curie (QUP, Univ. Paris)**

Co-Is : **Luis Walter Alvarez (UC Berkeley), Masatoshi Koshiha (U Tokyo)**

Members: **Sir John Douglas Cockcroft, Felix Bloch, Maria Goeppert-Mayer**

Proposal Date: **2023, January 15**

1. Expression of Interest (*2 pages*)

Please give concise summaries of the following items.

- 1) Science goals: describe in one sentence what scientific mysteries the proposed experiment is targeting.*
- 2) Scientific objectives: describe top-level quantitative requirements of the proposed experiment so that comparisons with other proposals or projects on-going or in preparation are possible.*
- 3) Scientific investigations: describe the investigations (methods, instruments, observations, analyses, etc.) to be conducted by the proposed experiment, clearly relating them to the scientific objectives of the mission. Also describe the novelty of the search method (novelty as a quantum-field measurement system)*
- 4) Schedule, milestones and budget: describe the schedule of the proposed experiment, clarifying what will be achieved by summer 2025 and the end of the fiscal year 2030. Show the budget profile to meet the schedule. Please also state whether there are worthwhile intermediate goals as milestones leading to the final results.*
- 5) The commitment level of the PI: describe the FTE of the PI, the status of external funding, plans to obtain it, etc.*

2. Supplemental "One-Pager" (*1 page*)

Please attach one-page summary slide that graphically describes your proposal.

3. References (*no page limitation*)

If you have references, please list here.