QUPosium2023

Addressing five mysteries of the Universe with new eyes

Mon. Dec. 11 - Wed. Dec. 13

Epochal Tsukuba International Congress Center

Tsukuba, Japan

Opening Remarks

- **Scope of QUPosium2023**
- **Introduction to Tsukuba, KEK, and QUP**

Masashi Hazumi (QUP, KEK)

Scope of QUPosium2023

To discuss most exciting developments and exchange ideas towards addressing 5 major mysteries of the Universe:

1. What drives inflation and causes accelerated expansion of early Universe?
2. Why is there more matter than antimatter in the Universe?
3. What are the fundamental properties of neutrinos?
4. What is the nature of dark matter?
5. What is dark energy that causes accelerated expansion in late Universe?

Scope of QUPosium2023 (cont.)

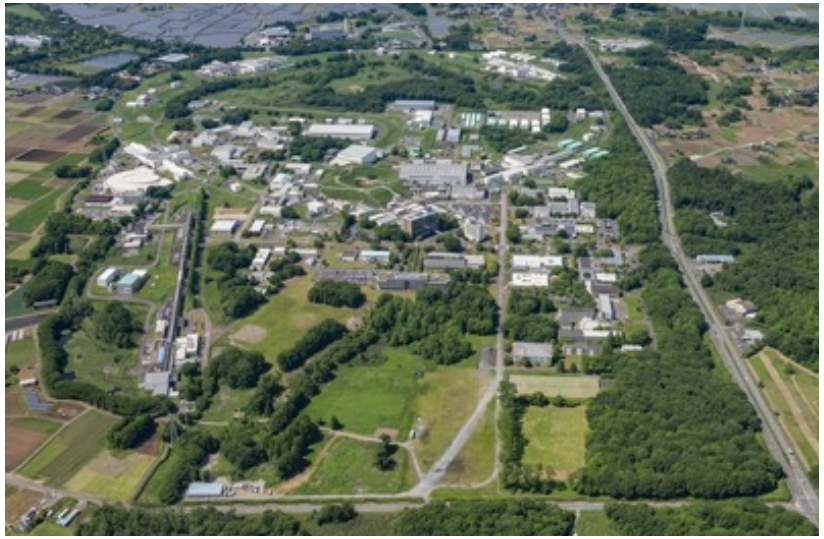
- The symposium will provide a venue to discover overlaps in methodologies, and discuss how we can integrate the efforts to produce new academic and social values.
- Keynote and invited plenary speakers will introduce big questions and methods to address them in their research areas, as well as cutting-edge research results and new directions.
- Symposium participants, especially early career researchers, will have opportunity to present posters of their research. Posters will be displayed around the conference venue throughout the conference and will be accessible from the timetable web page.

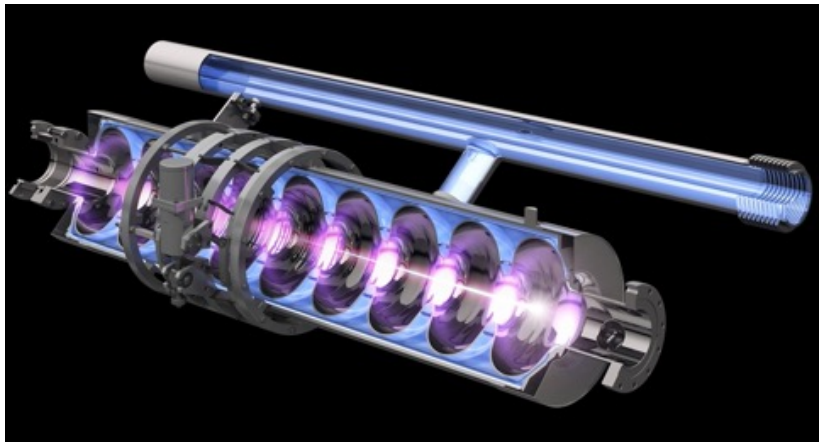
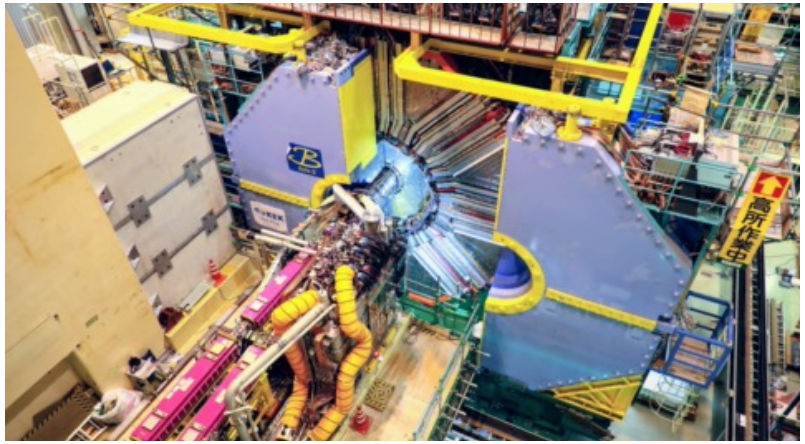
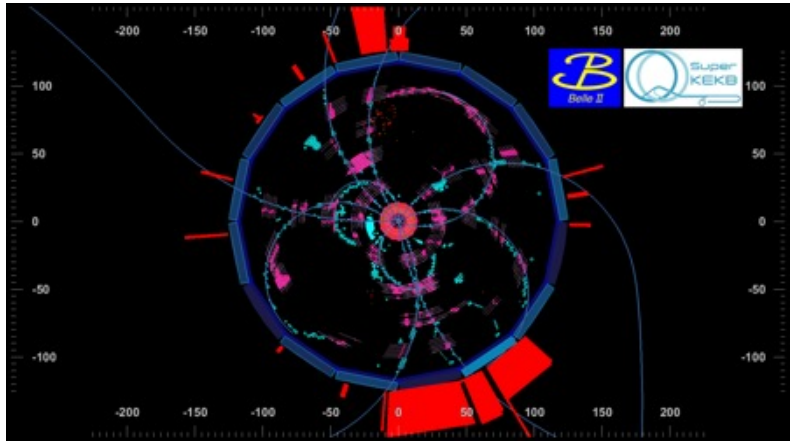
Welcome to Tsukuba

known as the **Tsukuba Science City,**
a planned science park developed in the 1960s.

KEK

KEK, the High Energy Accelerator Research Organization, is one of the world's leading accelerator science research laboratories, using high-energy particle beams and synchrotron light sources to probe the fundamental properties of matter. With state-of-the-art infrastructure, KEK is advancing our understanding of the universe that surrounds us, its mechanisms and their control.



WPI Program

By MEXT and JSPS

(World Premier International Research Center Initiative)

Shaping the future science in Japan
beyond borders and barriers

17 centers since 2007

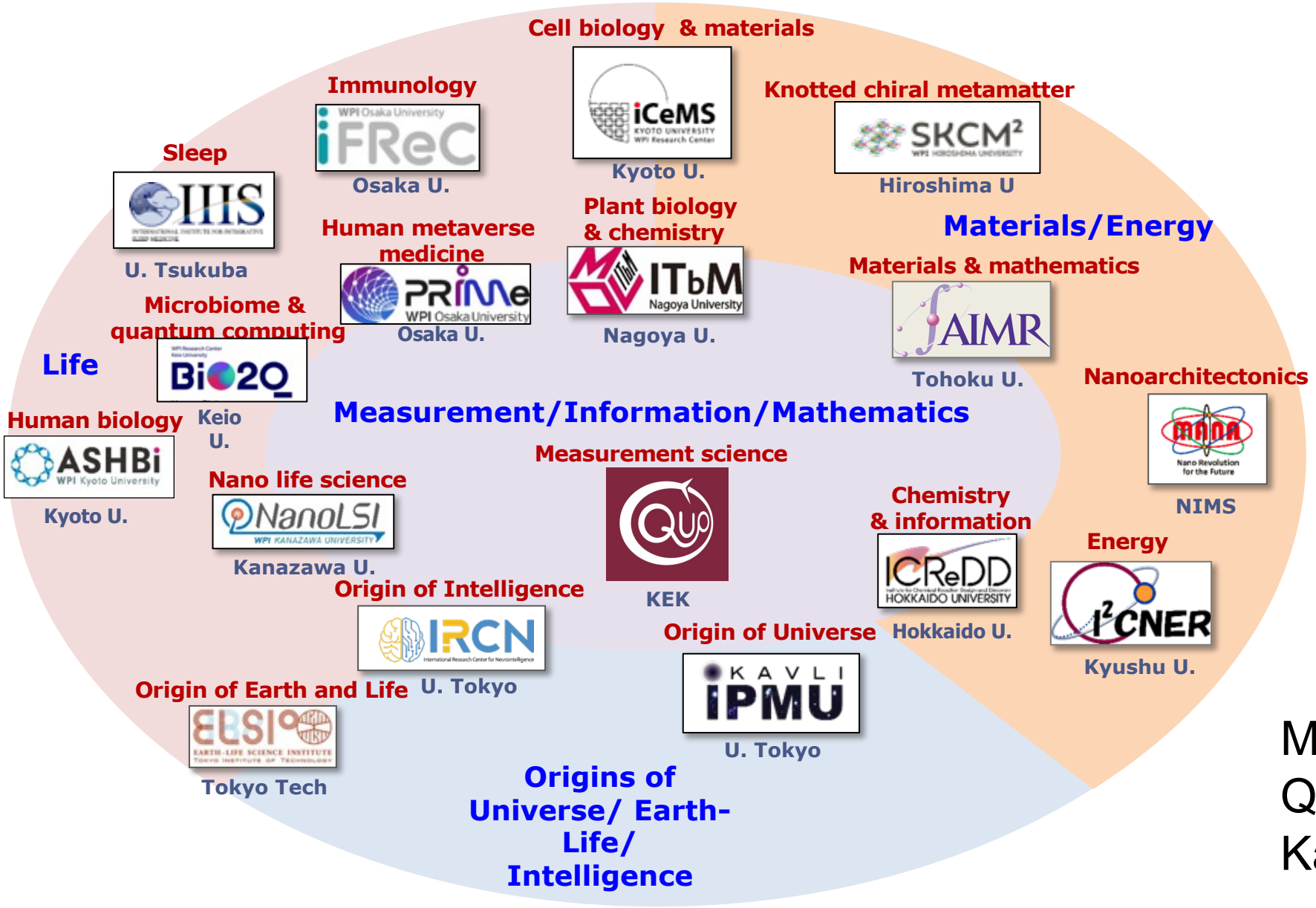
Four basic features:

1. Critical mass of outstanding PIs
2. International environment
3. Long term financial support
4. Robust follow up

Missions:

- World-Leading Scientific Excellence and Recognition
- Global Research Environment and System Reform
- Values for the Future

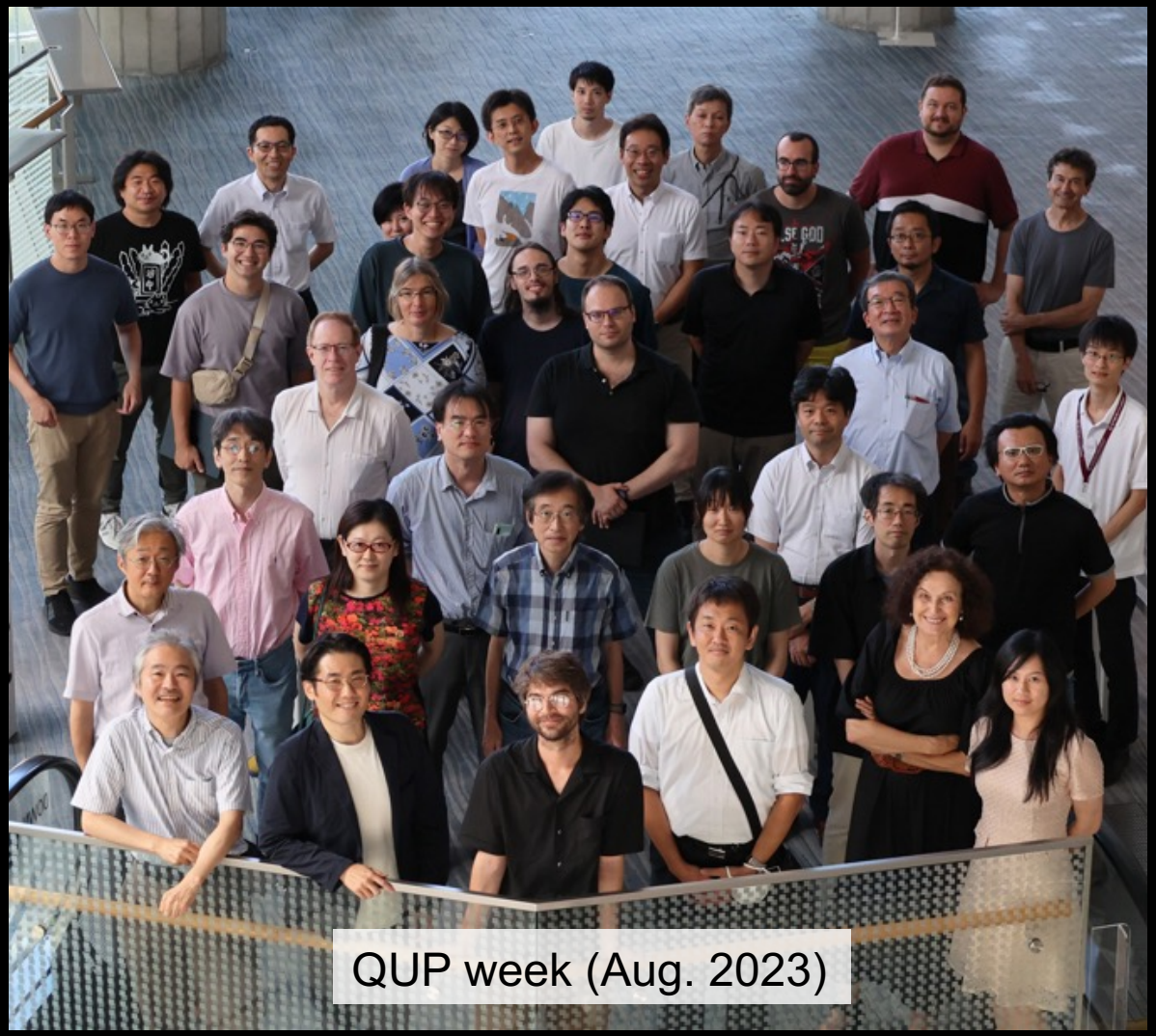
WPI Science Map



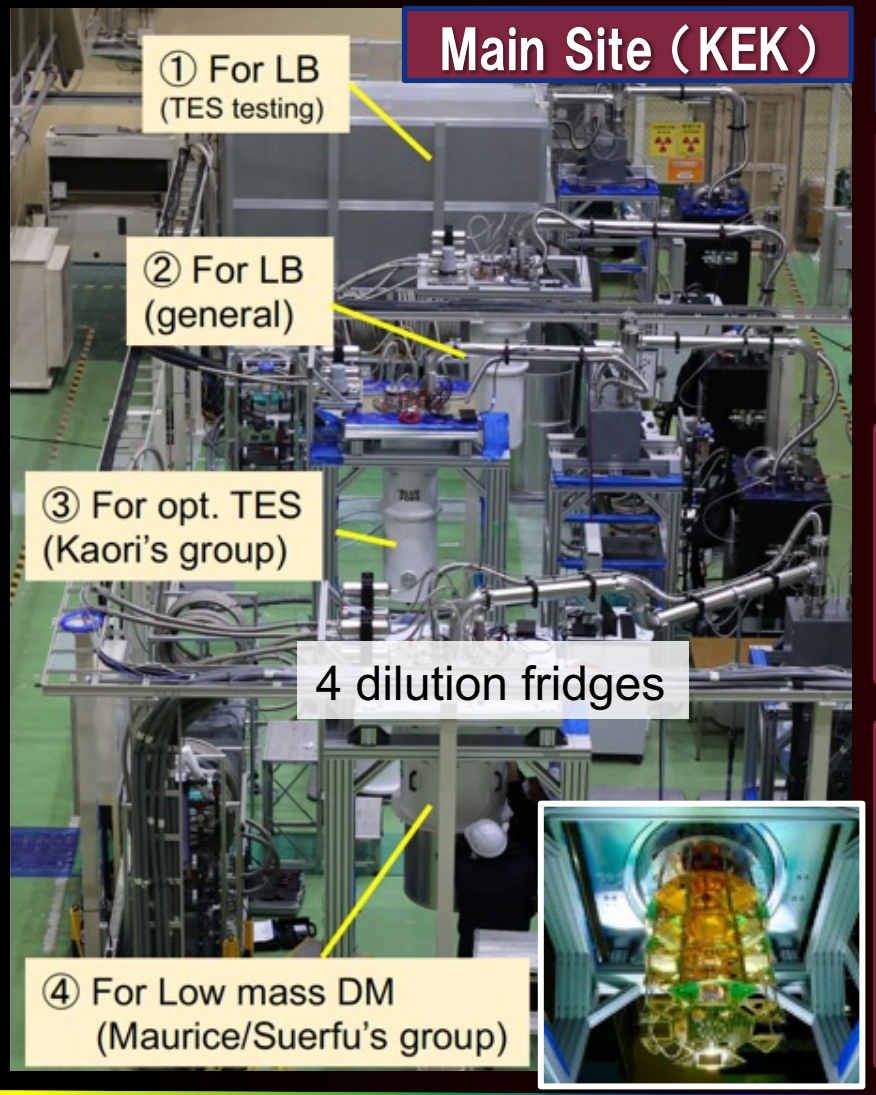
MoU between QUP and Kavli IPMU

International Center for
Quantum-field Measurement Systems for
Studies of the Universe and Particles
WPI research center at KEK

- Established on December 16, 2021.
- QUP's tagline: **Bring New Eyes to Humanity.**
  - Developing measurement systems for studies of the Universe and Particles


QUP week (Aug. 2023)

Main Site (KEK)



Three Satellites

Toyota Central R&D Labs.

ISAS, JAXA

UC Berkeley

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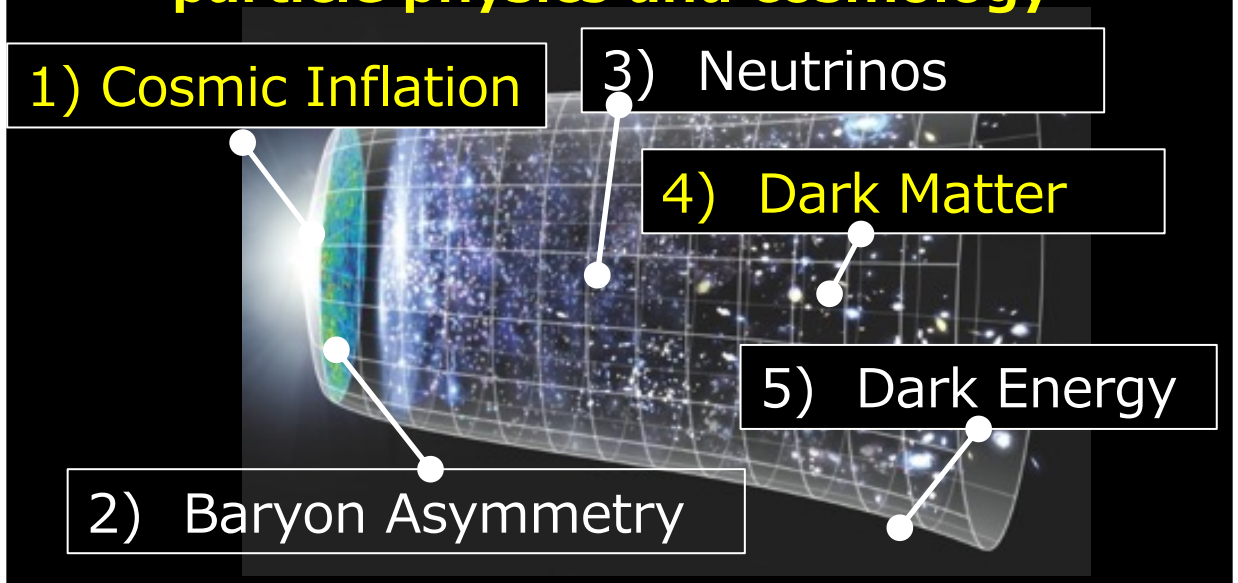
QUP's "P & U"

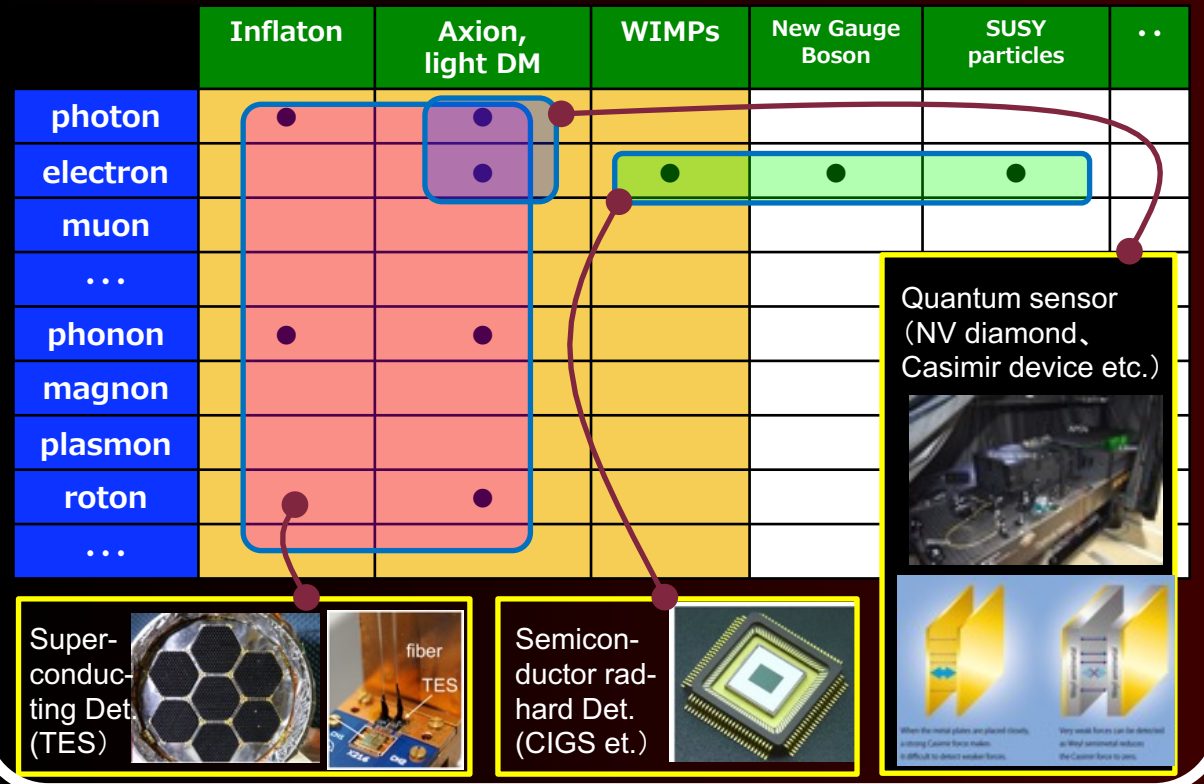
Five Mysteries: tensions between particle physics and cosmology



A resolution of any of the five mysteries will revolutionize our picture of the Universe! In many cases, resolutions require new quantum fields.
New eyes for new quantum fields are needed to make an observational breakthrough.

QUP's "Q"

QUP invents new quantum-field measurement systems more sensitive than ever at intersections of new and existing quantum fields.



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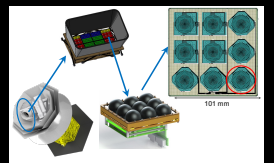
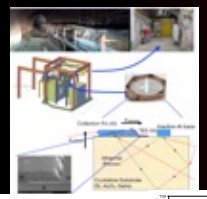
On-going Activities

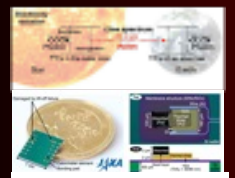
Low Temperature Detectors

w/ Superconducting TES



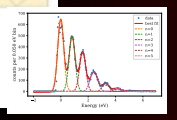
SpaceTES for LiteBIRD





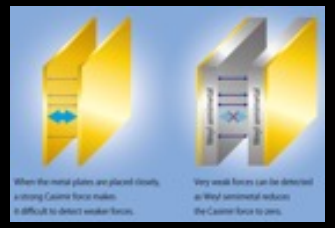
Solar Axion Search

QUP-Kamioka-DM project



Quantum Sensors

(new ways to use quantum effects)



Casimir device

NV Diamond

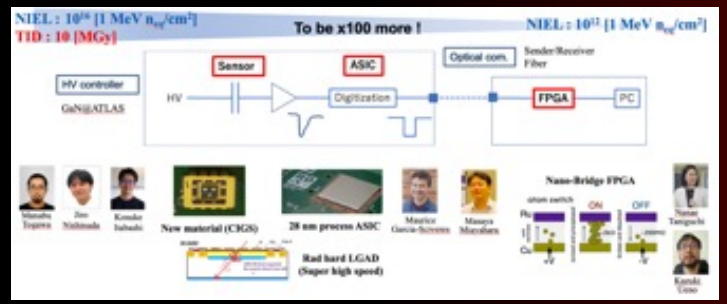
Theory

Producing new ideas for measurements with experimentalists



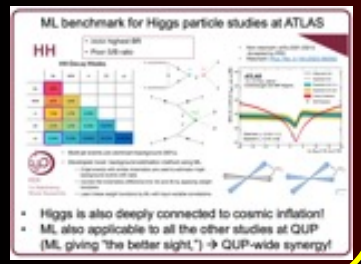

+ affiliate members

Semiconductor Rad-hard Devices



Readout electronics, DAQ, and data analysis (including machine learning)

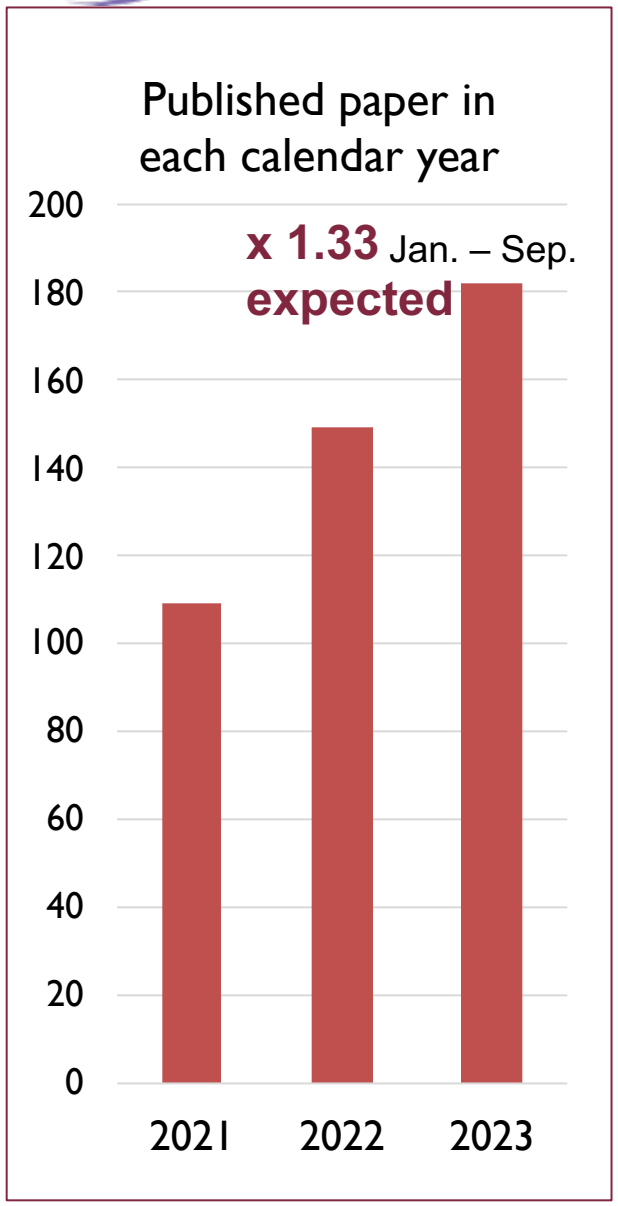
Machine learning workshop

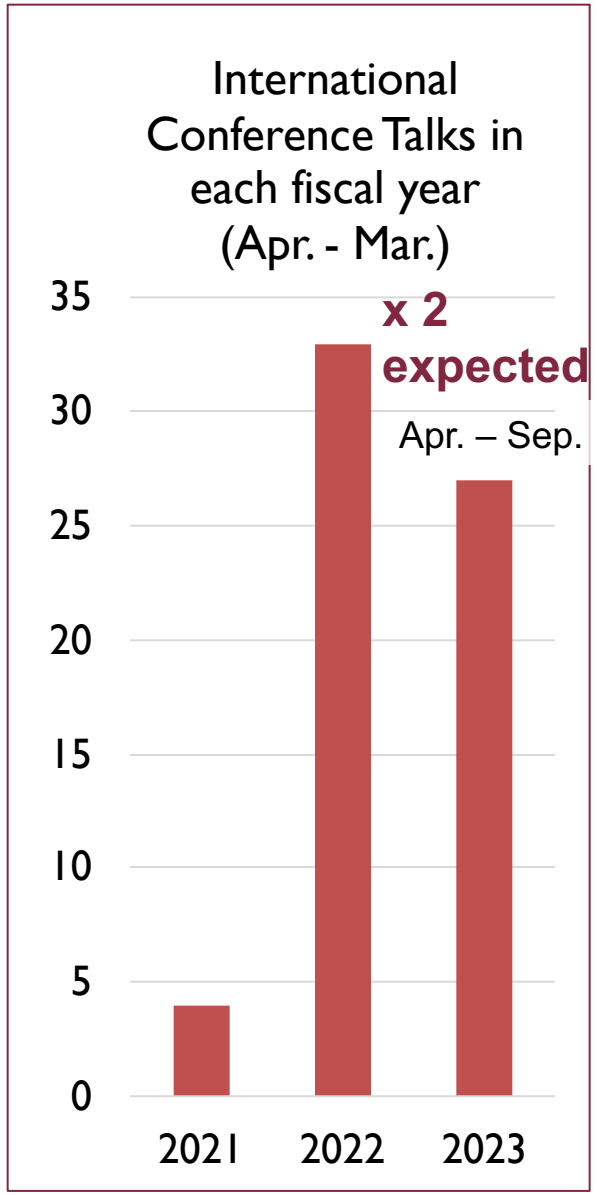


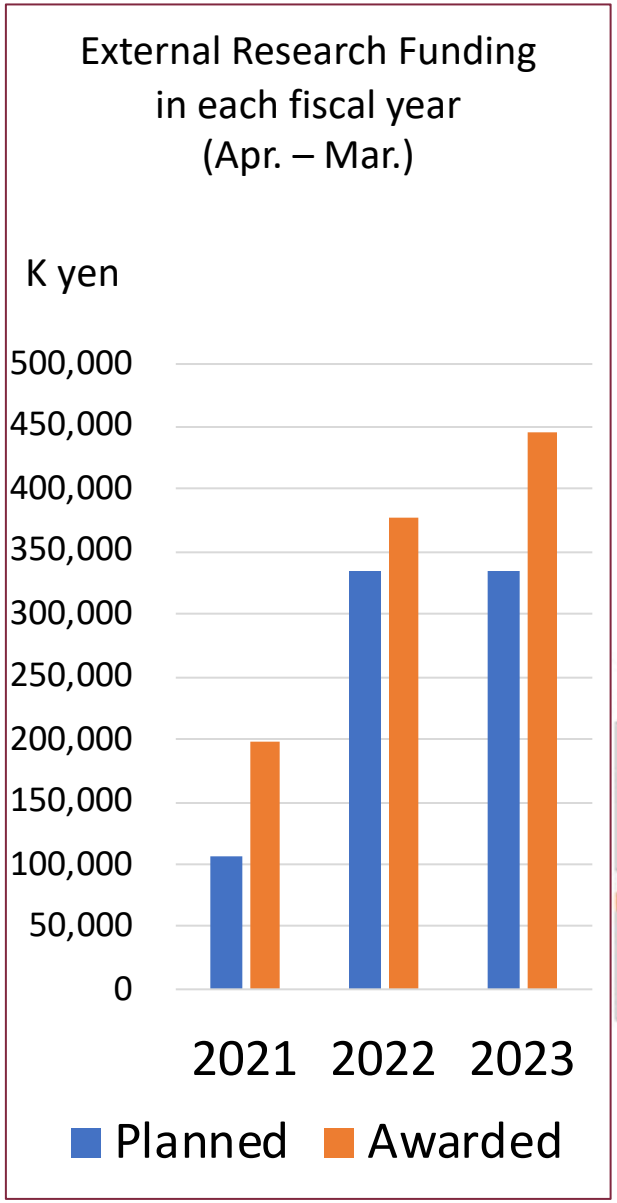
Advanced Systems Engineering (Systemology)

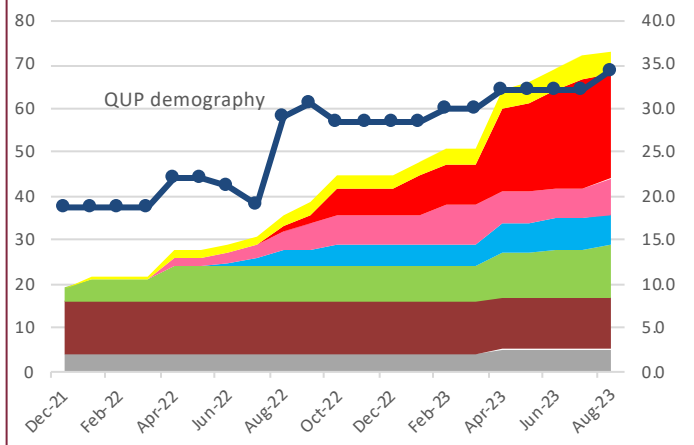
Systemology Support Section

Statistics - Papers, Presentations, Fundings, Personnel



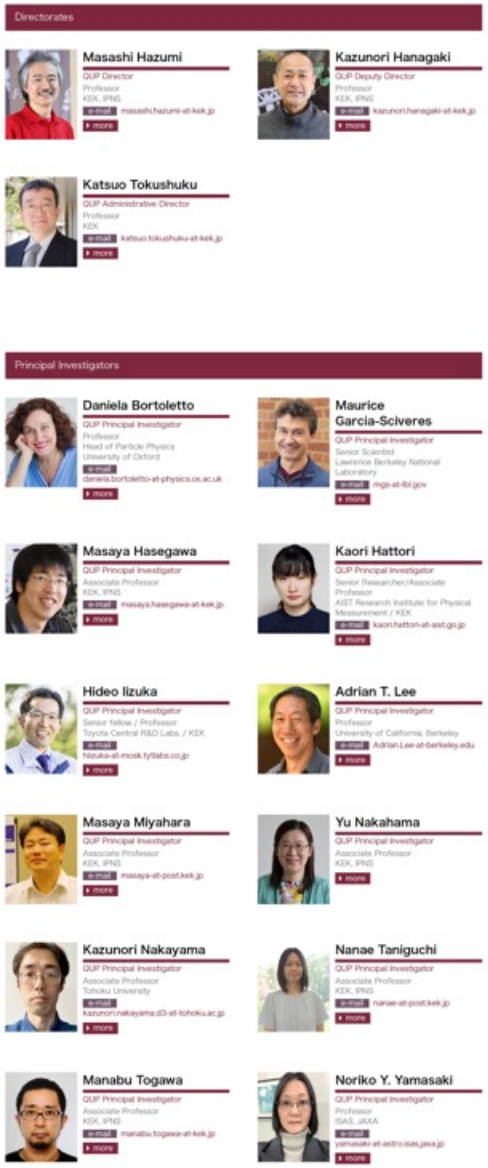


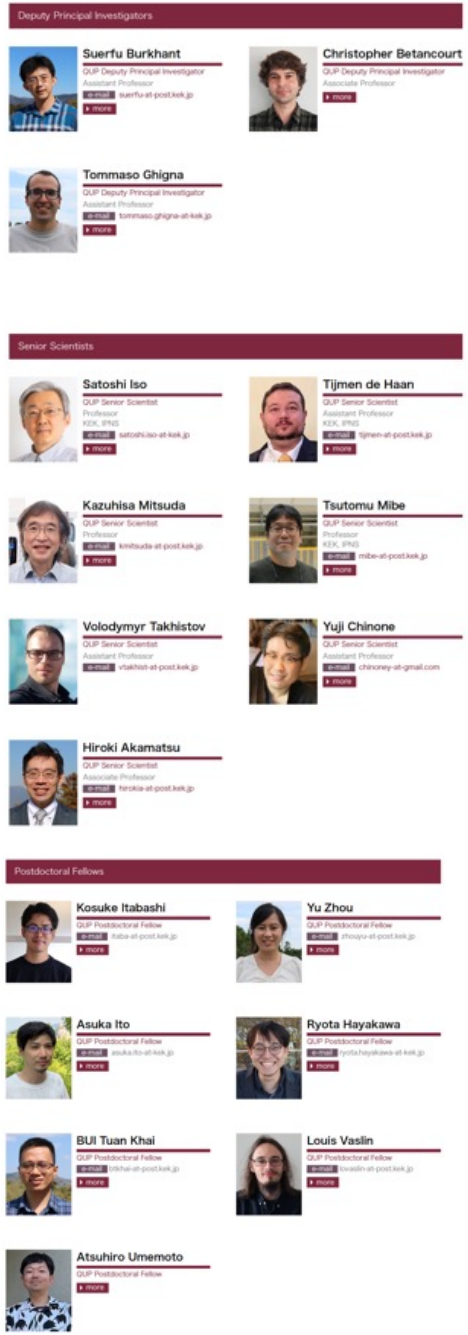


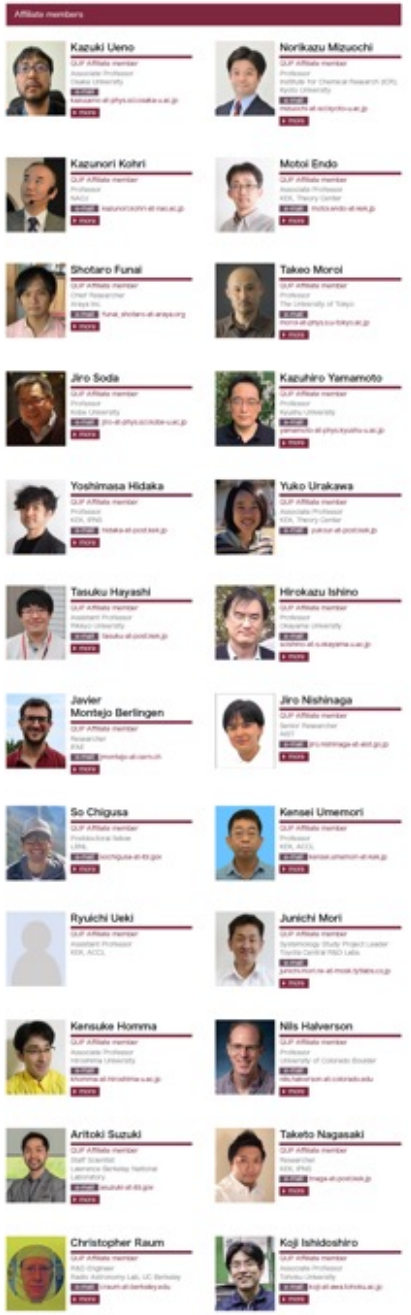


New:
Deputy Pis &
Flagship PM

Members







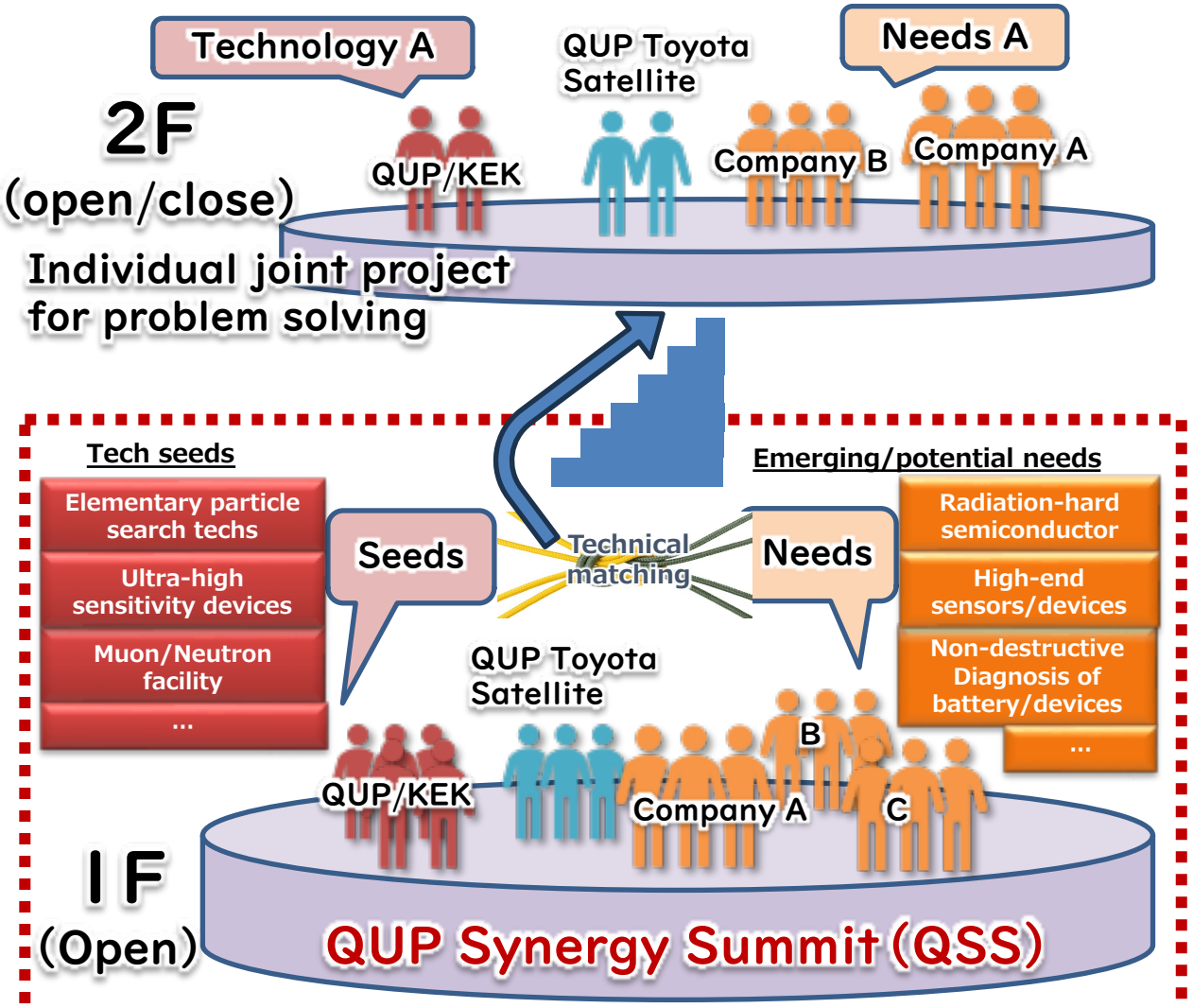
https://www2.kek.jp/qup/en/member/

We are growing like a start-up company.

~50 researchers and ~100 total members in one year.

A new framework for synergy between industry and fundamental science at KEK

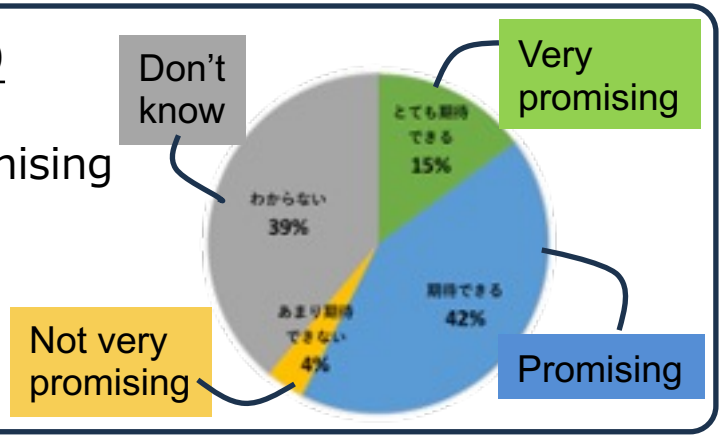
QUP Synergy Summit (QSS)



Survey at an EXPO

Question:
Does QSS seem promising to your company?

More than half were positive!



Kick off meeting on July 18, 2023

- @ Toyota Central R&D Labs., with 33 participants from QUP, KEK, Toyota Motor Corp., DENSO, MIRISE Techs., Nagoya U.
- Identified soft errors due to cosmic rays (μ & n) as the 1st candidate

2nd synergy summit held on Oct. 26, 2023

Accelerating QUP's Research with Systems Engineering

- QUP's new eyes are often used in large systems (accelerator science, satellites, etc...). There, the question is always how to create complex systems quickly and accurately, and how to proceed with complex projects.
- QUP introduces advanced systems engineering methodologies with a focus on model-based systems engineering. A special section (Systemology Support Section) has been set up for this purpose.

Completed major reqruitment in the Systemology Support Section

Organization of Systemology Support Section

Section leader
Mitsuda

Systems Engineering unit leader
Mitsuda

Multi-discipline Engineering unit leader
Narasaki

System Engineer
Kaneko

System Engineer
Shiomi

3D CAD designer
Hirasawa

Mechanical/thermal Engineer
Part-time assignment from KEK

Principal Engineer
Kagawa

S&MA
from HIREC company

Electronics engineer
Part-time assignment from KEK

System Engineer
Mori (from Toyota)

Concurrently assigned as the lead system engineer and the S&MA engineer of SpaceTES (LiteBIRD QUP) project, respectively.

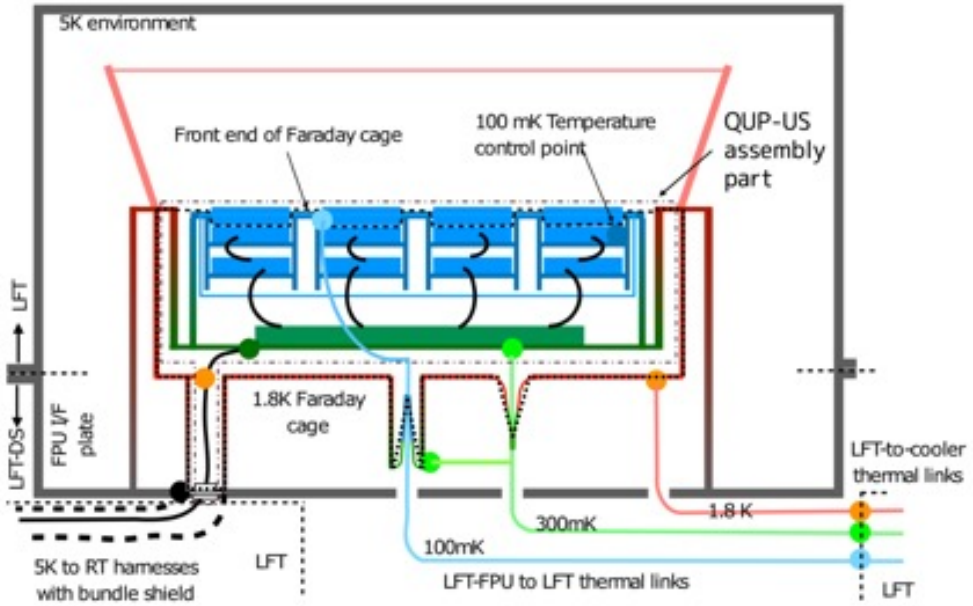
Concurrently assigned as the project leader of the systemology study project

S&MA = System safety & Mission Assurance

(C) Senior members who are responsible to foster young system architects.

A mechanical engineer from Europe will stay for 3+ months using QUP Internship Program (QUPIP).

Initial achievements: The interface of the LiteBIRD focal plane detector system was studied using a systems engineering approach, and several essential design changes were accomplished.



QUP Internship Program (QUPIP)

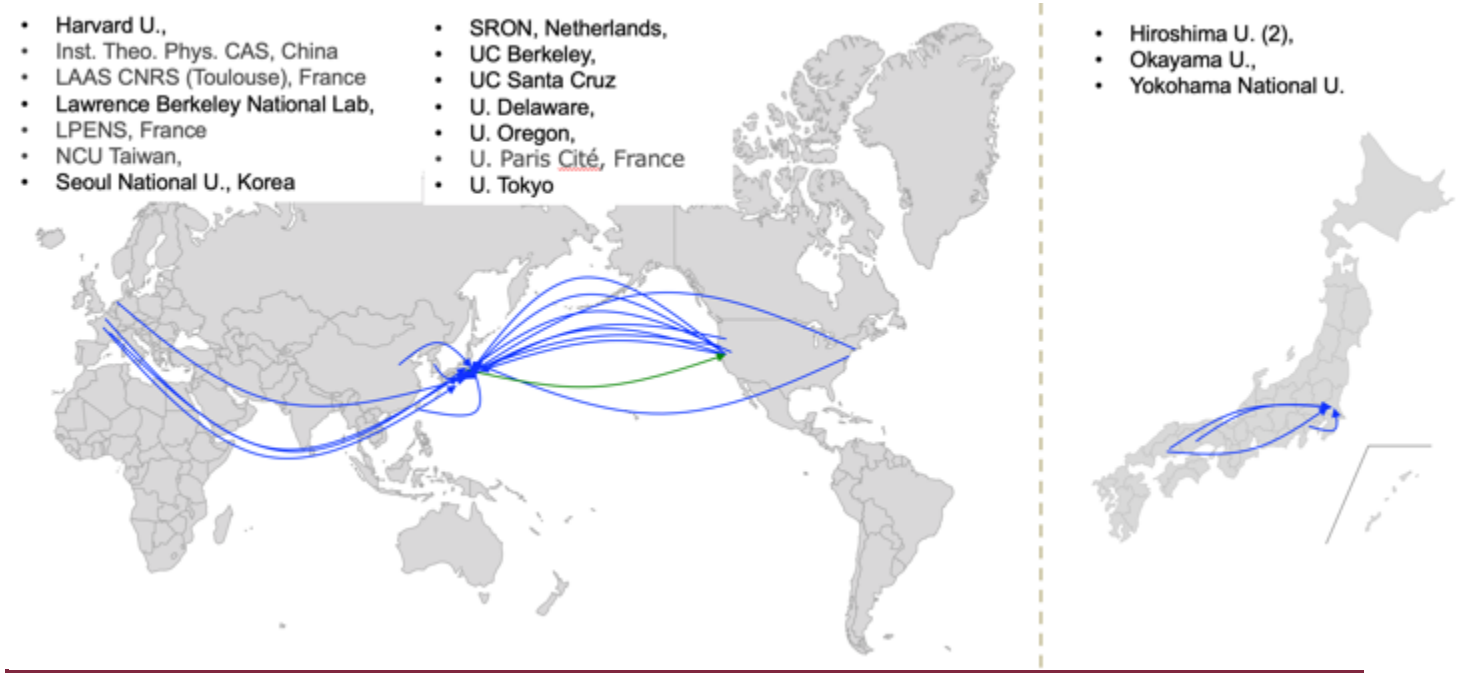
QUP's new human resource building program, which also helps PIs' research and future collaboration.

Advertisement posted on April 6, 2023 https://www2.kek.jp/qup/en/news/detail20230406.html

- Invite applications for young researchers (post-doctoral fellows and graduate students) to stay and work with QUP researchers at the KEK Tsukuba campus, a QUP satellite institution (UC Berkeley), or QUP PI's home institutions (Oxford University, LBNL) for 1 to 3 months.

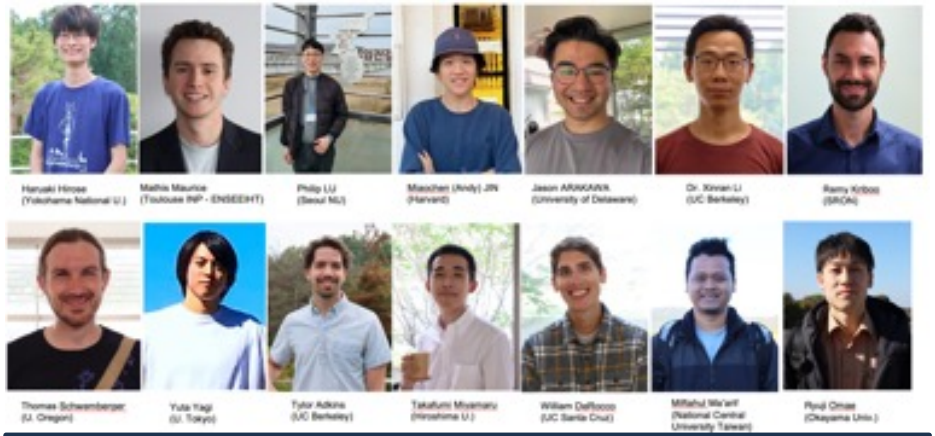
We already accepted 19 applications.

- Harvard U.,
- Inst. Theo. Phys. CAS, China
- LAAS CNRS (Toulouse), France
- Lawrence Berkeley National Lab,
- LPENS, France
- NCU Taiwan,
- Seoul National U., Korea
- SRON, Netherlands,
- UC Berkeley,
- UC Santa Cruz
- U. Delaware,
- U. Oregon,
- U. Paris Cité, France
- U. Tokyo
- Hiroshima U. (2),
- Okayama U.,
- Yokohama National U.



Two first papers from QUPIP! – arXiv:2309.05703, arXiv:2309.12258

14 interns already visited us.



QUP also contributes to international exchange program **"RISE-CMB-INFLATE program"**

Two researchers stated at QUP

Serena Giardiello (Cardiff U.)

Silvia Micheli (Sapienza University in Rome)

Scope of QUPosium2023

To discuss most exciting developments and exchange ideas towards addressing 5 major mysteries of the Universe:

1. What drives inflation and causes accelerated expansion of early Universe?
2. Why is there more matter than antimatter in the Universe?
3. What are the fundamental properties of neutrinos?
4. What is the nature of dark matter?
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Please enjoy great scientific presentations and discussions!