September 28 2026

QUP: the hub of KEK's quantum strategy

Introduction of QUP

International Center for Quantum-field Measurement Systems for Studies of the Universe and Particles

Toshiyuki Azuma

Director of QUP, KEK

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

Chief Scientist, AMO Physics Laboratory

Deputy Director of Pioneering Research Institute

Just 40 years before …

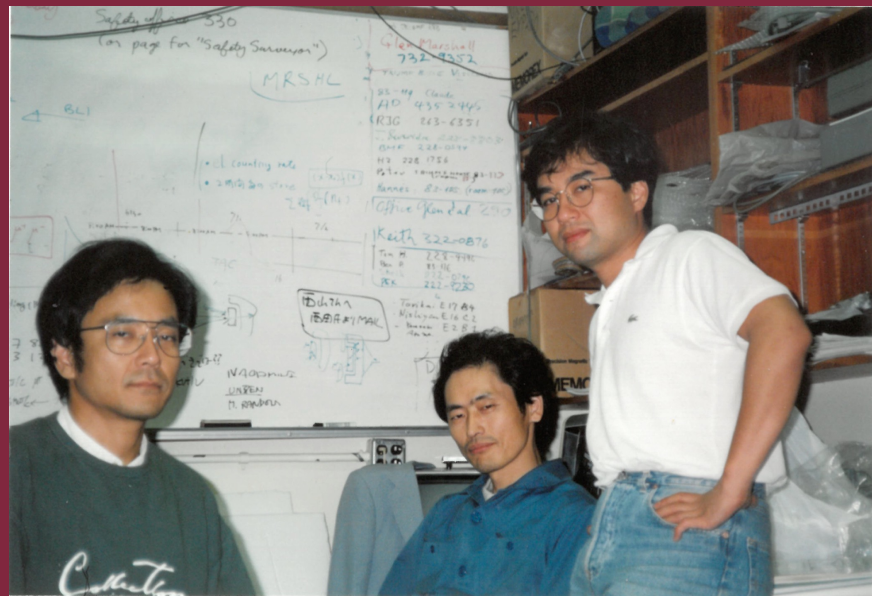
POSITIVE/NEGATIVE MUON

Muon spin resonance
in my graduate school days
@KEK_Japan

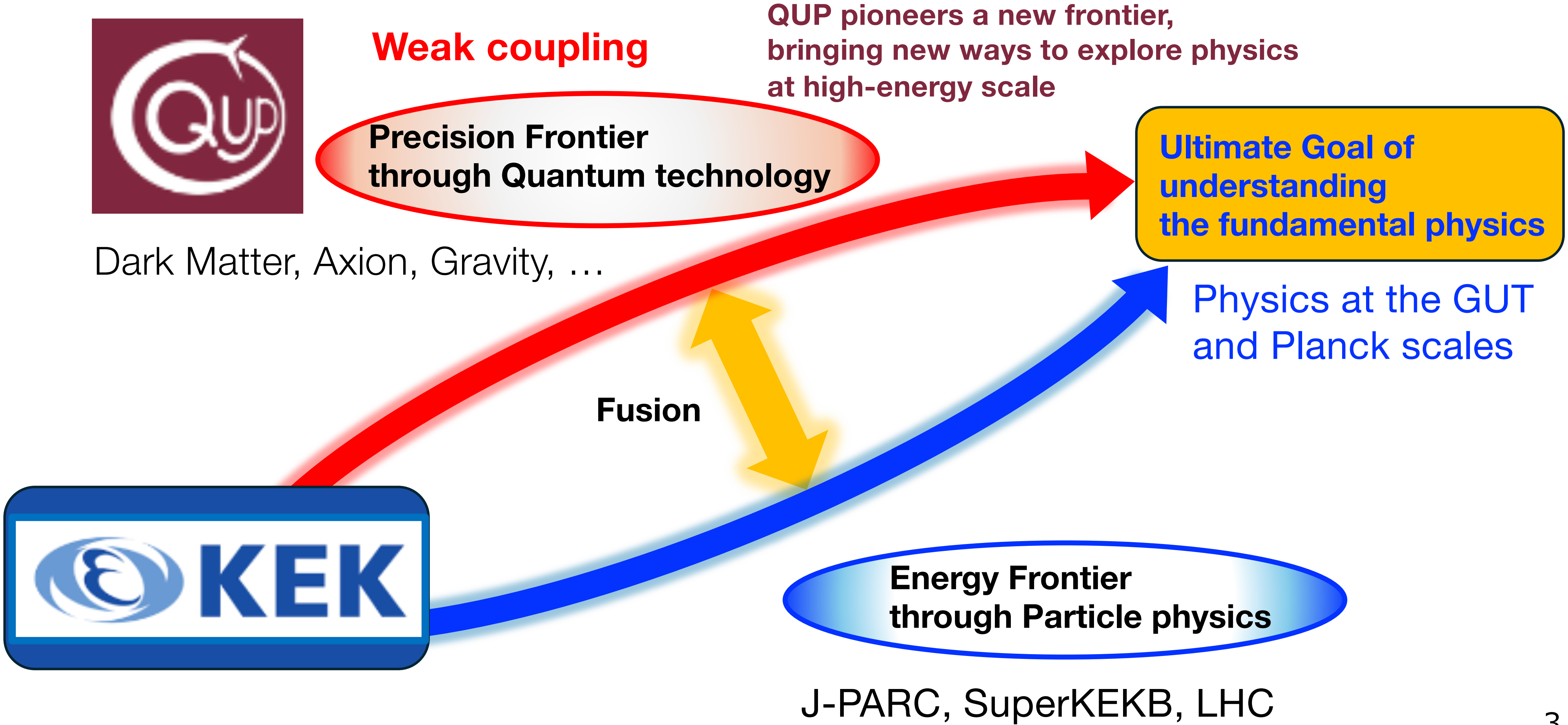
Muon avoided level crossing
in my Post-Doc. days
@PSI_Switzerland

Barkas Effect
The difference between positive and negative muons in energy loss in the low-energy region

as Research Associate at Univ. Tokyo
@TRIUMF_Canada



My Science Vision Fusion: Precision Frontier with Quantum Technology + Energy Frontier with Large Colliders

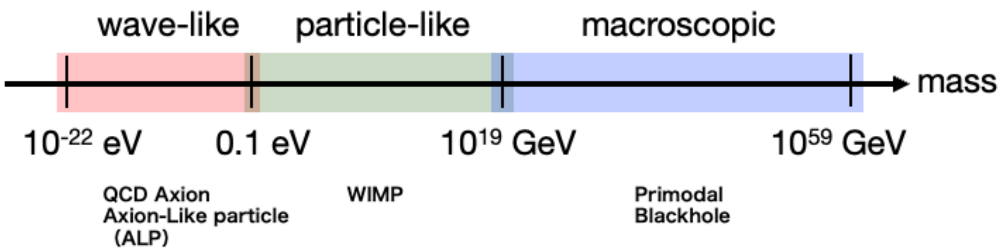


Ultimate goal of the research

reveal the invisible Universe with quantum eyes

■ Dark Matter (DM)

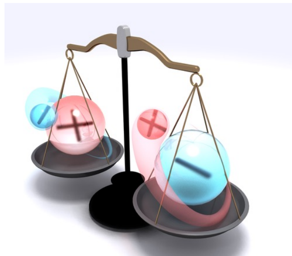
- ~85% of matter in the Universe is dark and remains unknown
- Compelling **Ultra-Light DM** candidates (≪1 eV), such as axions and dark photons, remain experimentally elusive



the projects outside QUP

■ Gravity

- Weakest fundamental force with several insufficiently tested regimes
- Probing gravity at sub-micron scales and with antimatter
- LIGO/VIRGO/KAGRA established sub-kHz gravitational wave detection, higher frequencies remain uncharted territory



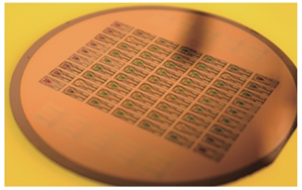
ALPHA experiment

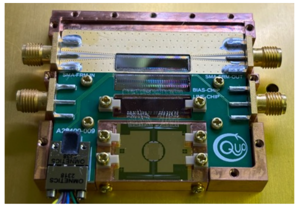
LIGO experiment

■ New Regimes of Other Fundamental Forces, Symmetries

Opening new research frontiers to drive discovery at the intersection of particle physics, astrophysics and quantum science

New framework





Pillar 1
Fundamental Forces & Hidden Sectors

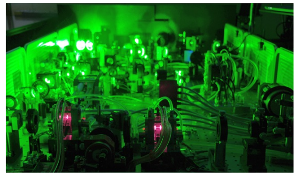
- TES for QED Test with Muonic Atoms

Pillar 2
Light Dark Matter

- Superconducting Qubits
- Kamioka TES
- NV Center Diamond

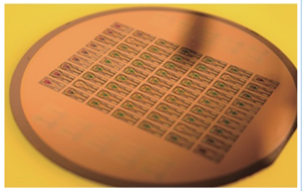
Pillar 3
Gravity

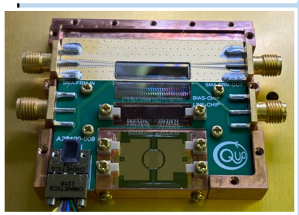
- Superconducting RF Cavities for GW
- Atomic Fountain for Antimatter Gravity



New framework

Theory Group   PIs: Nakayama, Takhistov





Pillar 1
Fundamental Forces & Hidden Sectors

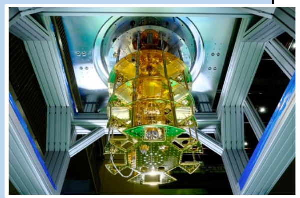
PI:
Azuma

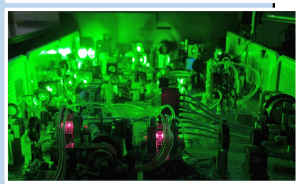
Pillar 2
Light Dark Matter

PI:
Nitta, Garcia-Sciveres
Hasegawa, Herbschleb

Pillar 3
Gravity

PI:
Nitta, Fujiwara





Technology Advancement

Superconducting Detectors
PIs:
Yamasaki, Lee

Semiconductor Detectors
PIs:
Bortoletto, Takahashi, Togawa,
Miyahara, Nakahama

Cryogenic Engineering
PI: Okamura

Engineering support section   led by Haba

QUP as a Core of KEK Quantum Research

KEK

TOYOTA CENTRAL R&D LABS

TOYOTA

Joint research with companies and national laboratories

AIST
NATIONAL INSTITUTE OF ADVANCED INDUSTRIAL SCIENCE AND TECHNOLOGY (AIST)

NIMS

and more

Various quantum beams allow to study spin/state of atom, electron, and nucleus

Alliance promotion department

Toward International Excellence in the Quantum Frontier

- Sensor for basic science
- Gravity
- Quantum connection
- Dark Matter detection

QUP

Material science

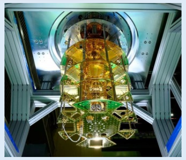
IMSS

Quantum material using multi-beam

Particle physics

IPNS

Cryo-CMOS Theory



Accelerator and Applied Research Laboratories

Cryo technology
SC cavity Q>10^{11}

World-wide research collaboration using KEK's network

CERN

Fermilab

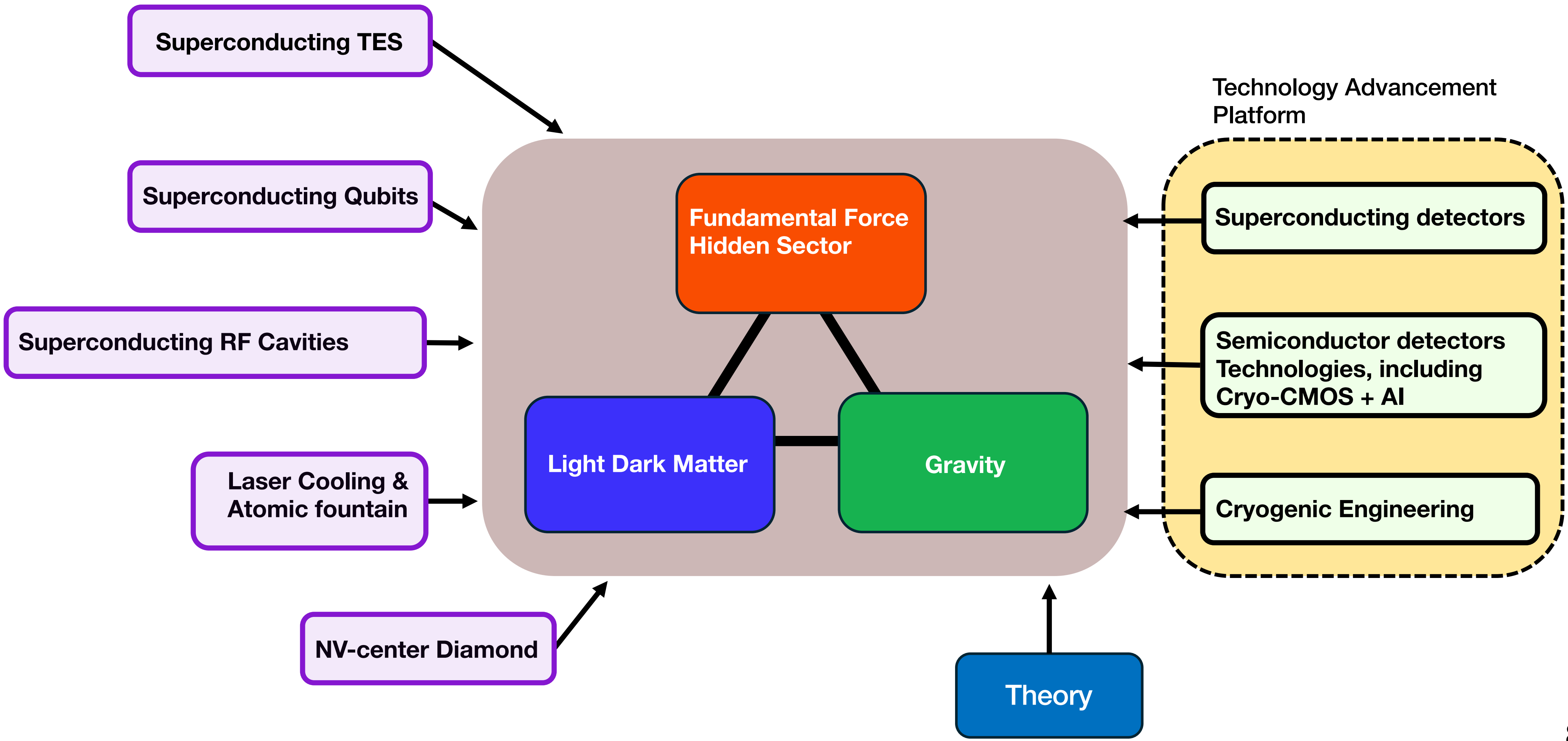
Berkeley
UNIVERSITY OF CALIFORNIA

UNIVERSITY OF OXFORD

UTokyo

and more

New framework



New PI and Leading Council member

◉ New Director Toshiyuki Azuma

◉ New Leadership Council

Deputy Director: Tsutomu Mibe

Executive Assistant to Director: Tadayuki Takahashi

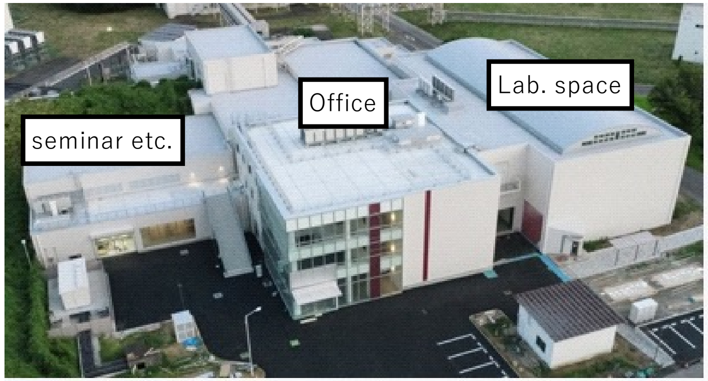
◉ New PIs

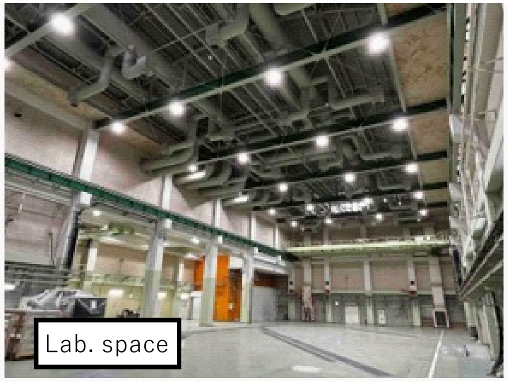
- Tatsumi Nitta
- Makoto Fujiwara
- David Herbschleb
- Takahiro Okamura
- Toshiyuki Azuma
- Tadayuki Takahashi

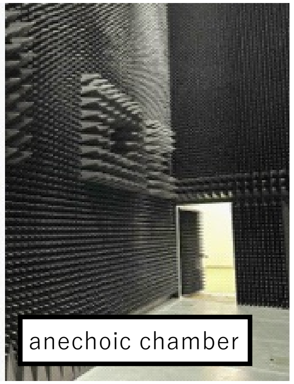



New Building for under one roof: QUP Office + Facility

moved to the new QUP building in FY2025.





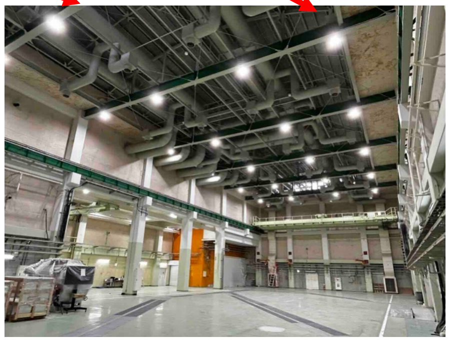


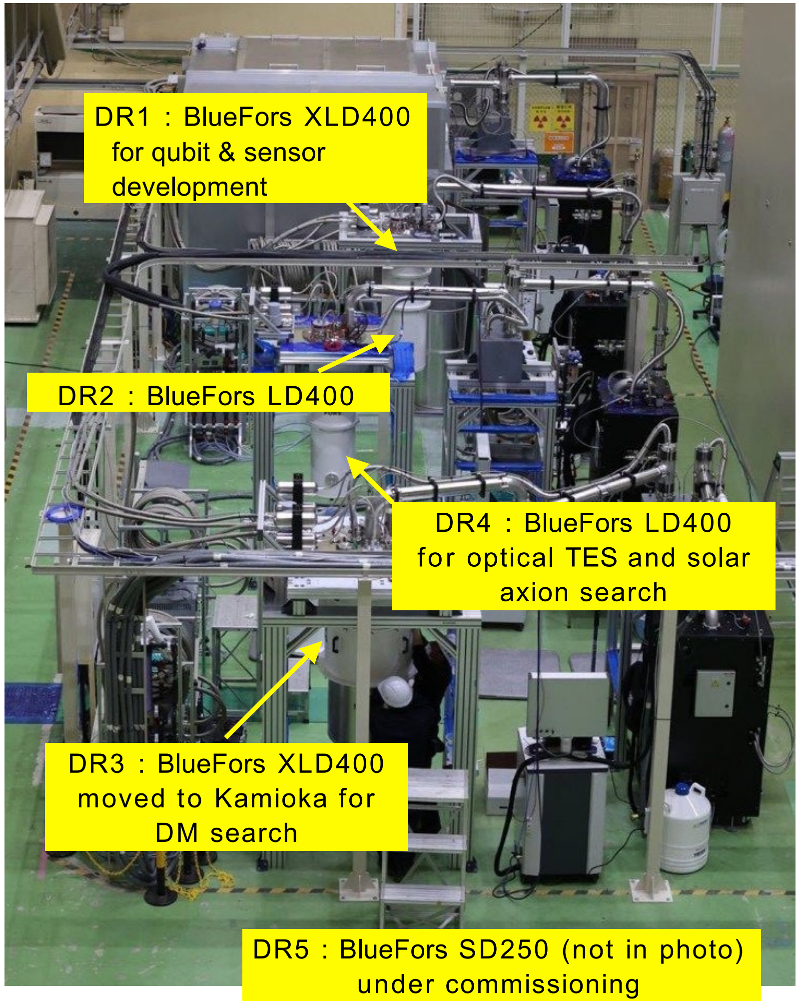
The opening of the new complex was celebrated at an inauguration ceremony held in March 2026.

Many leading researchers from collaborating and closely related institutes and universities came together.

Five Cryogenics (Dilution Refrigerators)

DR1	DM search by qubit & sensor development
DR2	commissioning→DM/axion search by qubit
DR3	Kamioka DM search
DR4	Optical TES & Solar axion search
DR5	commissioning→wide applications





New QUP: output and perspective

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Fundamental Forces & Hidden Sectors
- TES for QED Test with Muonic Atoms

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- Superconducting Qubits
- Kamioka TES
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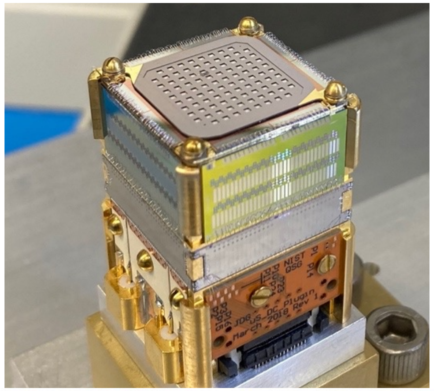
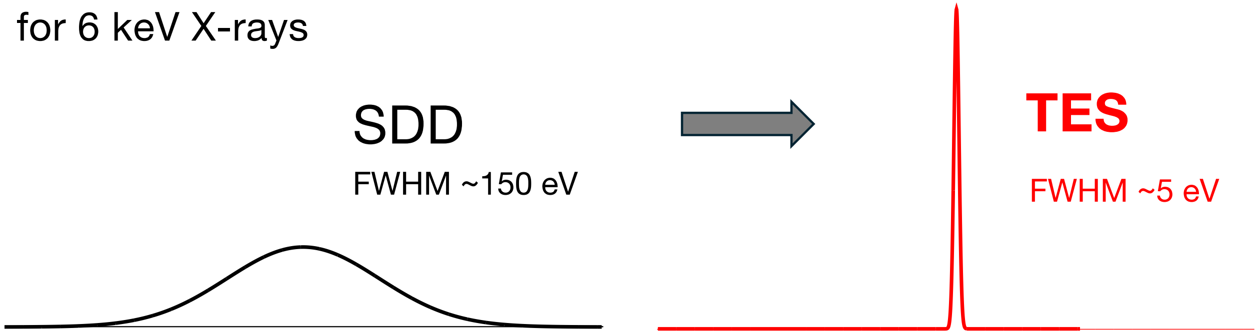
Science Target I: Fundamental Forces, Hidden Sectors
QED Test with Muonic Atoms

led by T. Azuma

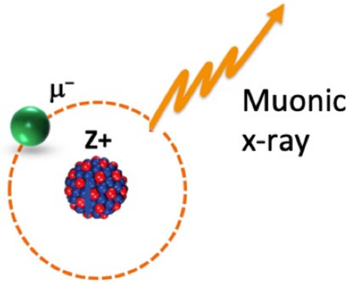
Superconducting TES (Transition Edge-type Sensor)
for x-ray detection covering the energy region from 1 keV to 150 keV

Drastic improvement in the resolution (more than 50 times) compared with the traditional semiconductor device (ex. Silicon Drift Detector)



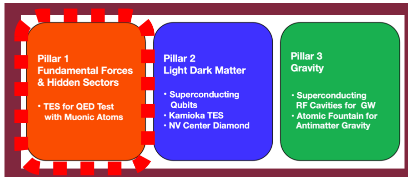


The world's highest-intensity slow NEGATIVE MUON beam supplied from J-PARC/KEK
enables the preparation of **muonic atoms** isolated in a vacuum



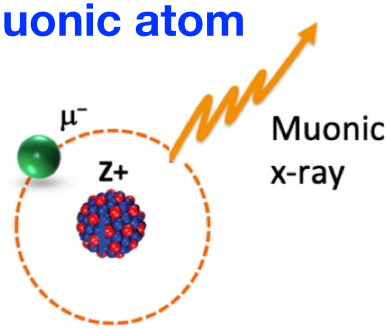
already excellent results based on our original idea:

[1] BSQED test: ***PRL***126,173001(2021) + ***PRL***130,173001(2023)
[2] Exotic highly-charged ions: ***PRL***134,193001(2025) + ***PRL***134,243001(2025) *Editors' Suggestion*
[3] fs dynamics of muon and electrons: ***PRL***127, 053001(2021) *Editors' Suggestion*



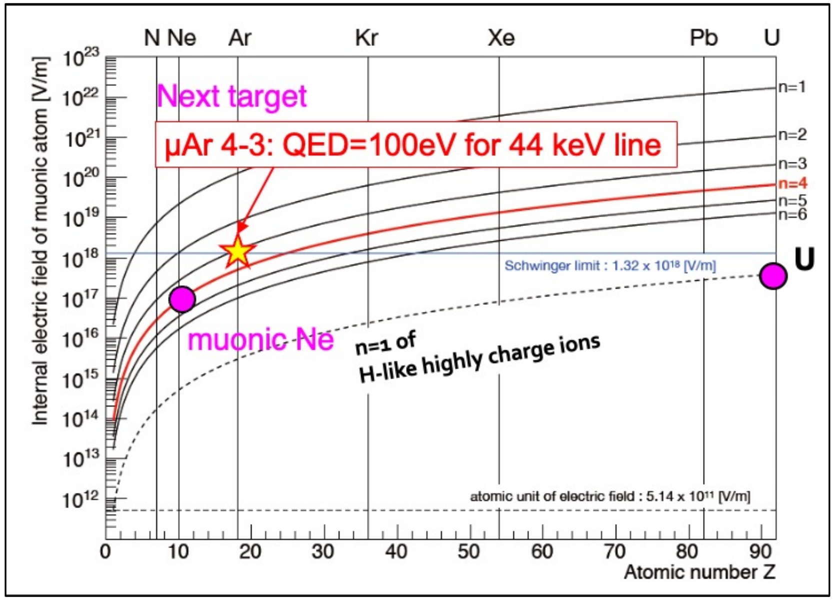
Science Target I: Fundamental Forces, Hidden Sectors
QED Test with Muonic Atoms

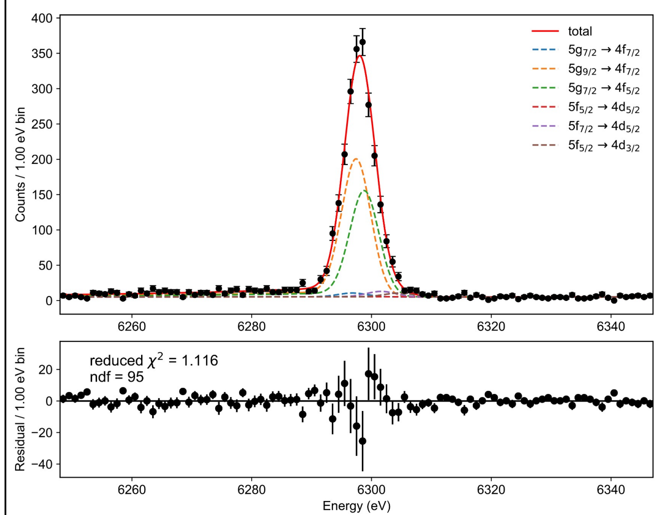
muonic atom



The orbit of a negative muon is located very close to, or even inside, the nucleus of a muonic atom.

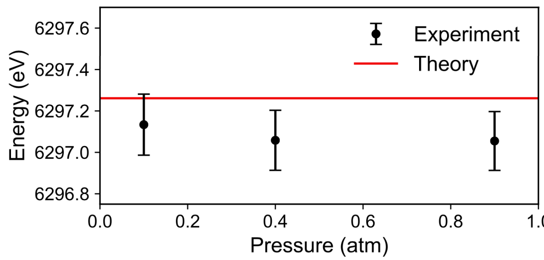
Ideal probe to explore QED (Quantum ElectroDynamics) test under the strongest fields





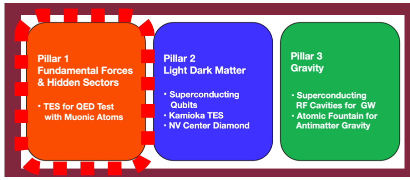
μNe → μAr

accuracy of **5.8% → < 1%**



the $5g_{9/2}$- $4f_{7/2}$ transition energy of μNe :
our experiment:
6297.08 ± 0.04 (stat.) ± 0.13 (syst.) eV
most advanced theory:
6297.26 eV.

Phys. Rev. Lett. 126,173001(2021) + ***Phys. Rev. Lett.*** 130,173001(2023)



QED Test with Muonic Argon

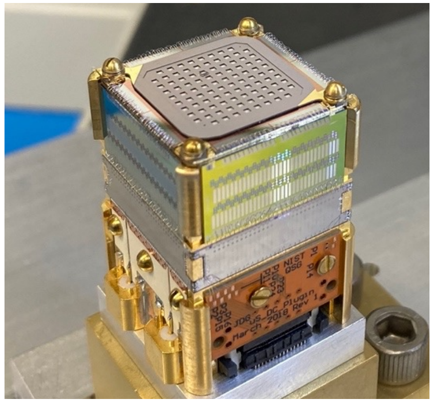
X-ray region: 44 keV

Muonic Ar 4f-3d transition

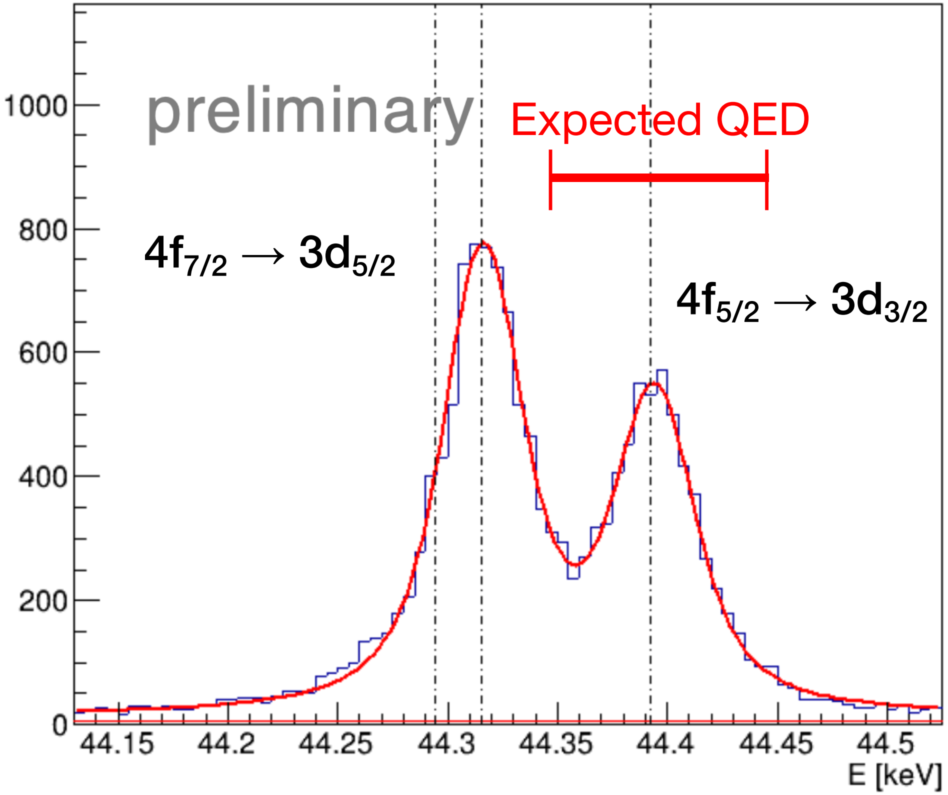
- **Ar gas** target 0.9 atm, 17 hours
- Fit with double Voigt + constant
- Estimated statistical error
  ~ 0.4 eV against **100 eV QED**

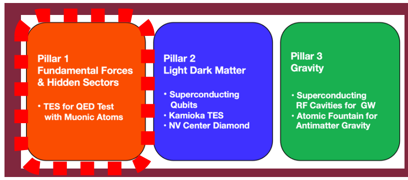
Unger,
QUP Postdoc

	50 keV TES
Saturation energy	70 keV
Readout system	microwave
Absorber thickness (material)	1.85 μm (Au) & 20 μm (Bi)
Absorber area	0.73 x 0.73 mm²
Absorber collimated area	0.67 x 0.67 mm²
Number of pixel	96
Total collection area	43.1 mm²
ΔE (FWHM)	20 eV @ 40 keV (8 eV @ 17 keV)



under analysis





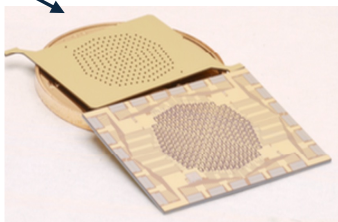
Muonic molecules

X-ray energy: 2 keV

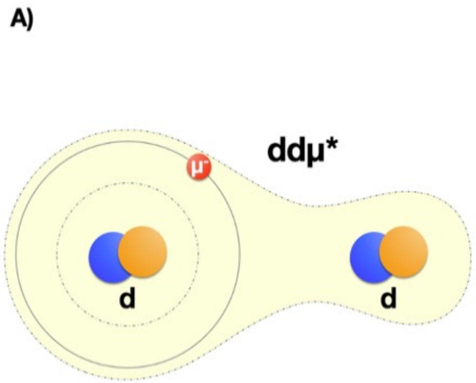
Science Advances 12 (2026) eaed3321

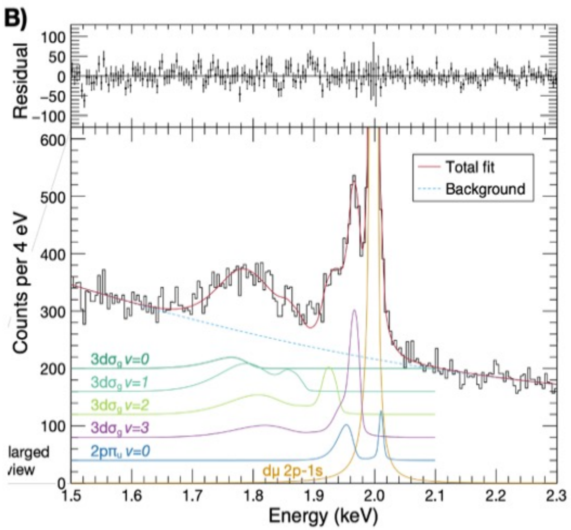
We are also pioneering precision studies of **muonic molecules** —an extension of muonic atom research—where the vibrational structure can only be described through rigorous few-body calculations. This represents the first high-precision experimental exploration of such systems.

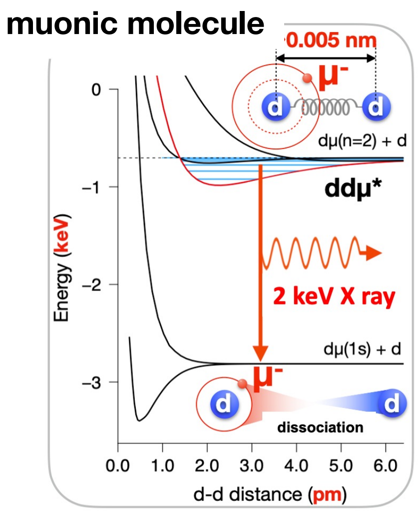
ddμ / dtμ : key for muon catalyzed fusion



Rev. Sci. Instrum. 90, 123107 (2019)





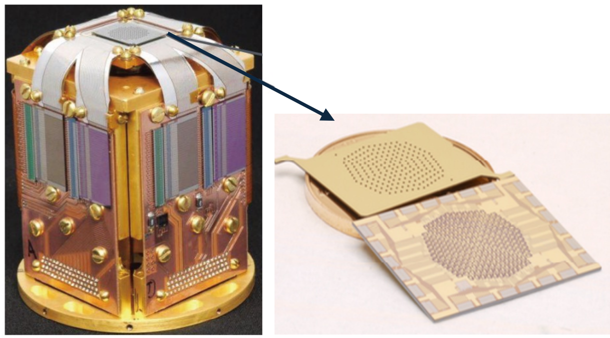


X-ray spectrum associated with the dissociation of resonance states in the muonic deuterium molecule. A) Schematic diagram of ddμ. B) Observed X-ray energy spectrum and the theoretical calculation.*

Muonic molecules

X-ray energy: 2 keV

We are also pioneering precision studies of **muonic molecules**



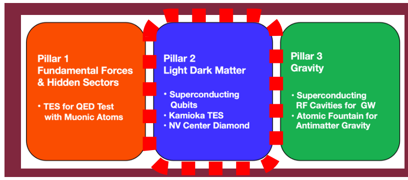
Rev. Sci. Instrum. 90, 123107 (2019)

Present Drawback:

The major source of uncertainty is unwanted particles (e.g., electrons) accompanying the pulsed muon beam, which cause heating of the TES detector.

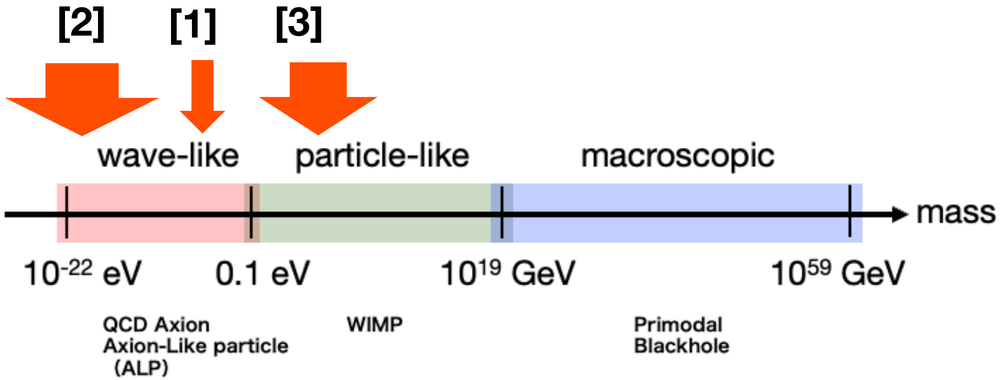
Next Step:

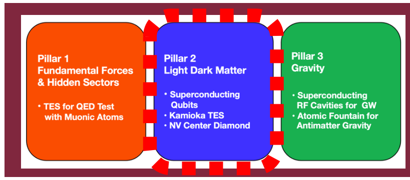
Pulsed muon beam @J-PARC → DC muon beam @TRIUMF ??



Overview: A Coherent Strategy for the Low-Mass Frontier

	Approach	DM-type	Mass range (eV)	Interaction
[1]	**Superconducting Qubit**	**wave-like**	$10^{-5} – 10^{-2}$	**photon coupling**
[2]	**NV-diamond**	**wave-like**	$10^{-22} – 10^{-8}$	**fermion spin coupling**
[3]	**TES @ Kamioka**	**particle-like**	$10^{0} – 10^{9}$	**scattering**



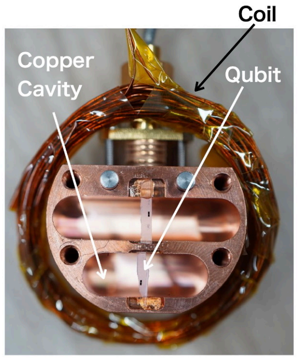


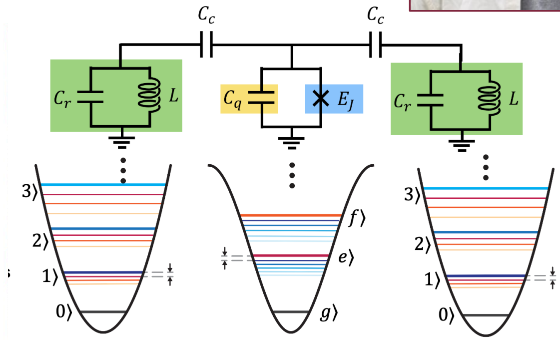
Science Target II: Dark photon/Axion Search with a Qubit System in Superconducting Circuits

led by T. Nitta

old exp. using a huge magnet at CERN (**~ 10 m** size)

state-of-the-art quantum technologies: quantum qubit **(~ cm** size)





Bosonic Qubit Ancilla qubit readout resonator

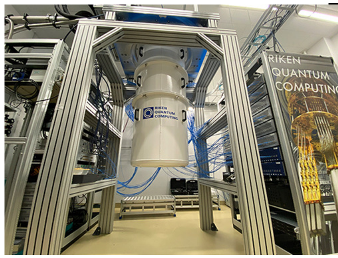
fabricated by our team

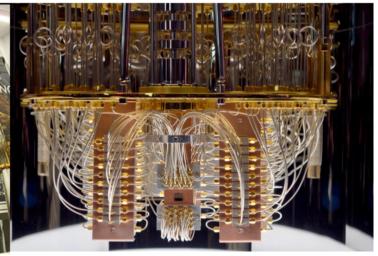
Why superconducting qubits?

Alternative Applications of Superconducting Quantum Computer Technology

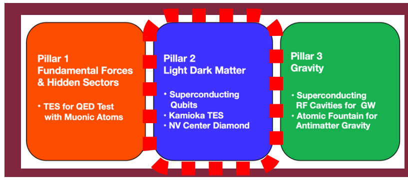
- **Working at GHz**
  perfectly match the promising dark matter signal frequency range
- **Very sensitive**
- **Designable circuit**

Our original proposal: ***PRL*** 131,211001 (2023) + ***PRL*** 133,021801 (2024)

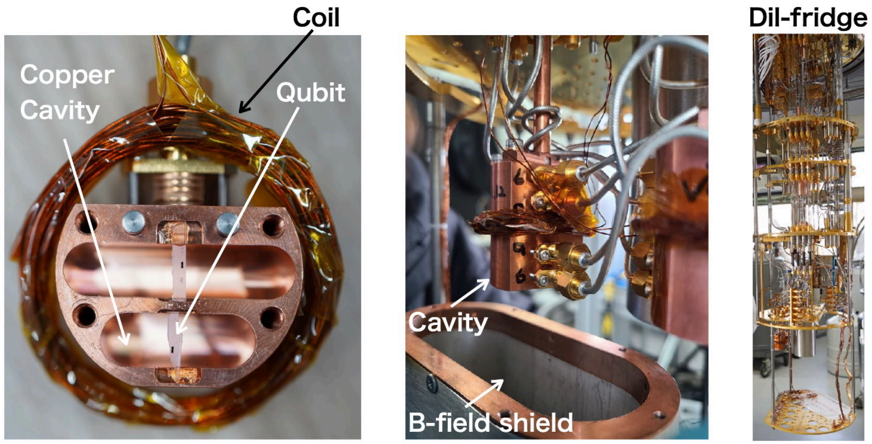




RIKEN U-Tokyo & IBM



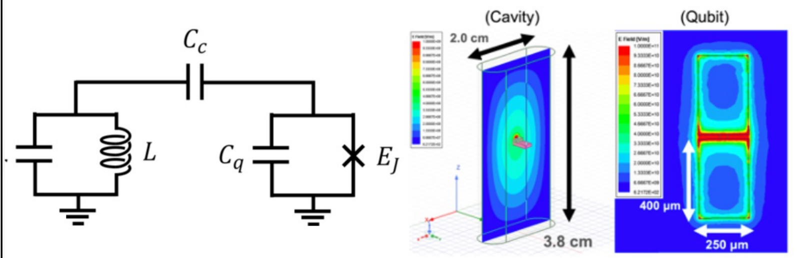
Qubit System in Superconducting Circuits



Developed cavity for qubit control under cryogenic environments

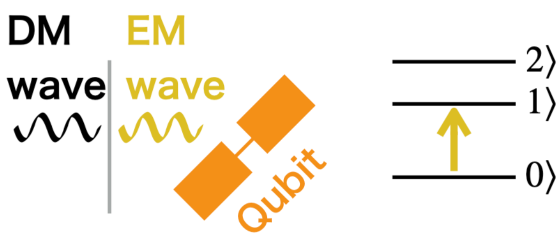
DarQ-Lamb

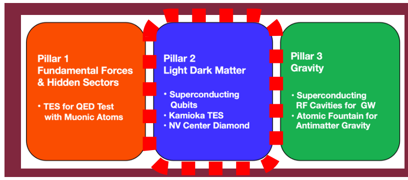
Cavity Tuning with qubits



DarQ-Direct

Quantum computer is DM sensor



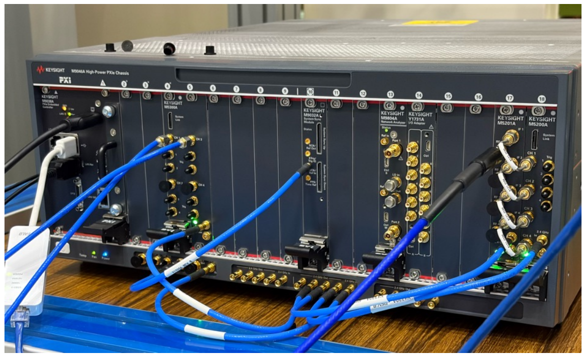


Qubit System in Superconducting Circuits

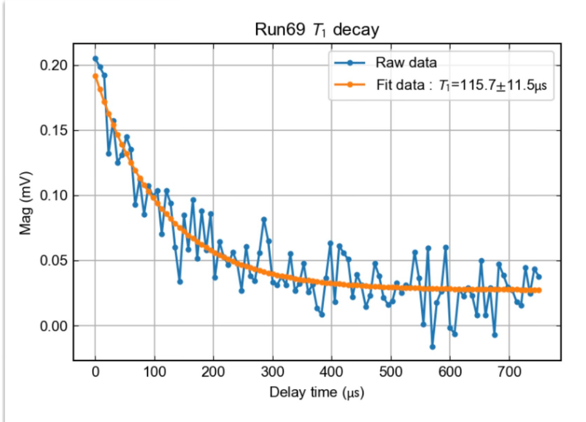
In-group fabricated qubits

- 2 of 5 QUP dilution refrigerators equip qubit RF lines
- Recently qubit control system was installed

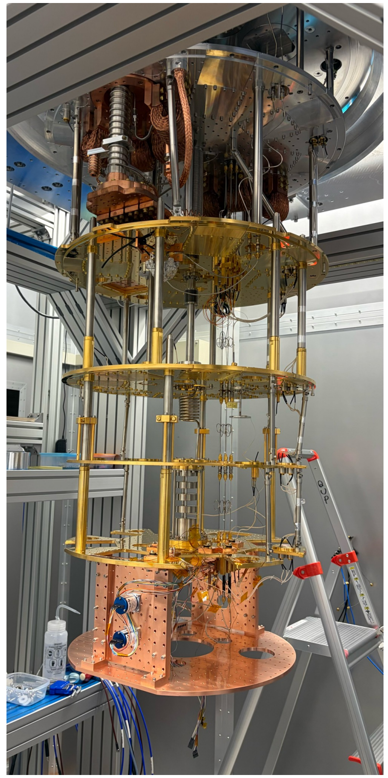
→ **Established qubit readout system**



Qubit control system



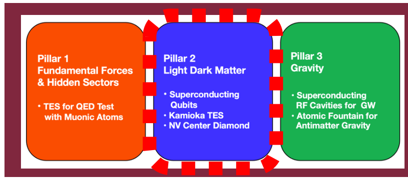
In-group fabricated qubits have decent performance (**T1 and T2 > 100μs**)



QUP dilution refrigerator

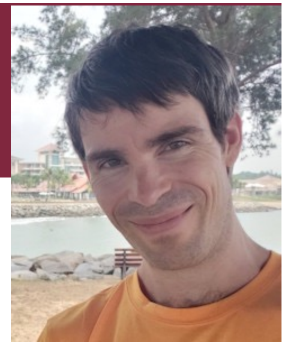
Technology Advancement

Superconducting Detectors	Semiconductor Detectors	Cryogenic Engineering
PIs: Yamasaki, Lee	PIs: Bortoletto, Takahashi, Togawa, Miyahara, Nakahama	PI: Okamura



Science Target III: Light Dark Matter Search Using NV center in diamond

led by D. Herbschleb

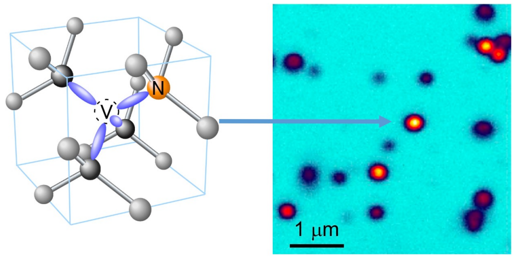


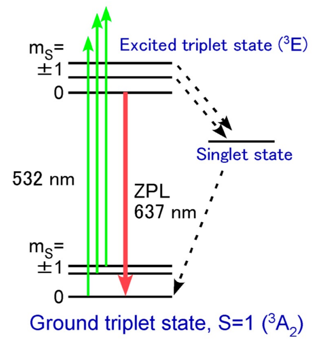
New ideas beyond qubits for DM search, including **qutrits**, are emerging from QUP theory (QUP, **Kyoto-U**, **Tohoku-U**)

Goal:

- Ensemble NV measurements under cryogenic (4K) conditions
- Searching for axion-like particles and dark-photon–type dark matter using a magnetic sensor based on NV-center **electron and nuclear spins**.
- Setting constraints on their couplings to electrons at least at one mass point in the range **$M=10^{-22} \sim 10^{-8}$ eV**

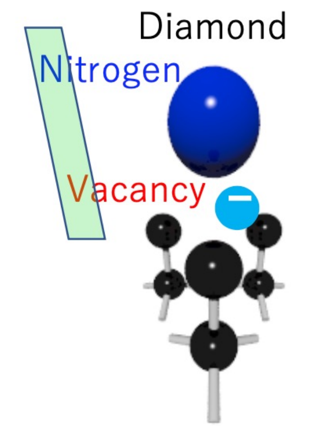
Confocal image at RT

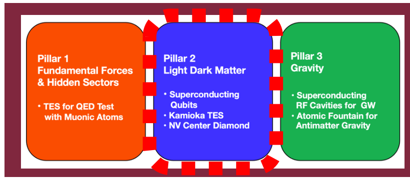




Approach:

- High-purity diamond synthesis by Mizuochi-Lab. for longer coherence time
- Lensing system and broader laser irradiation
- Antenna development for a cryogenic environment in collaboration with **TOYOTA Satellites**
- **Parallel setup at QUP and Kyoto** for simultaneous measurements





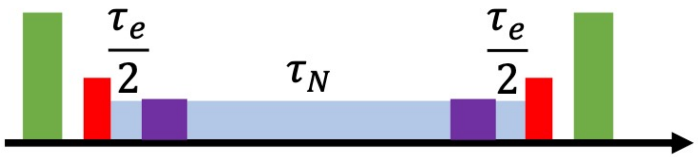
Science Target III: Light Dark Matter Search
Using NV center in diamond

New ideas: Original and Unconventional NV sensing for DM detection

one-to-one electron-nuclear spin

Hybrid-spin decoupling for noise-resilient DC quantum sensing

Sensor: nuclear spin
Method: novel

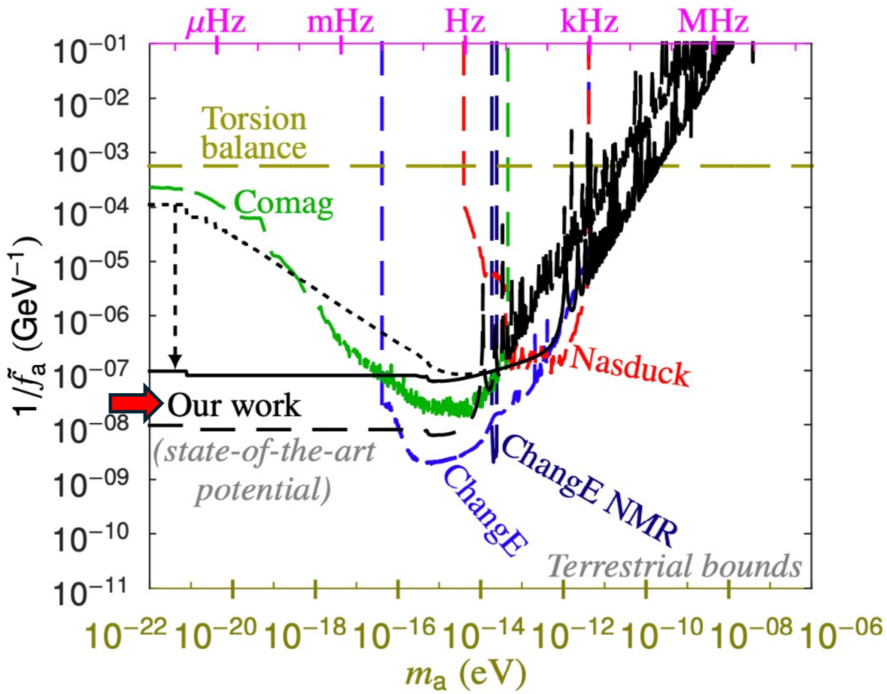


Magnetic field sensitivity: none
Frequency range: broad

Pseudo magnetic field

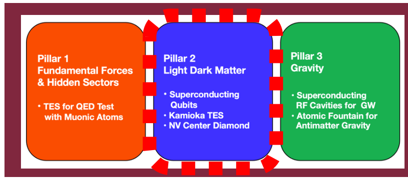
$$B_{ps} \approx 4 \times 10^4 \ \mathrm{aT} \times \left(\frac{g_{aNN}}{10^{-10}}\right)$$

Axion sensitivity: excellent



S. Chigusa, M. Hazumi, E. D. Herbschleb, Y. Matsuzaki, N. Mizuochi, K. Nakayama, arXiv:2511.16732 (**2025**).

extended coherence time at low-temperature

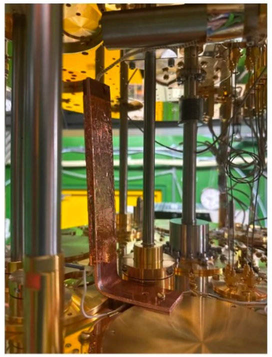


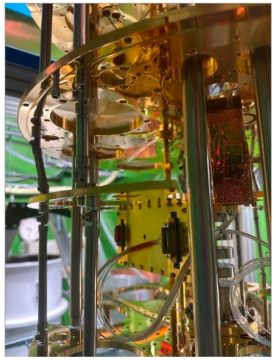
Science Target IV : Light Dark Matter Search at the underground of Kamioka Using Superconducting TES

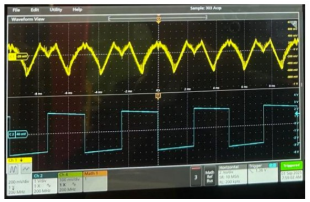
led by Garcia-Sciveres

Cryogenic platform in a low-background underground environment
(collaboration of QUP, LBNL, Tohoku-U.)

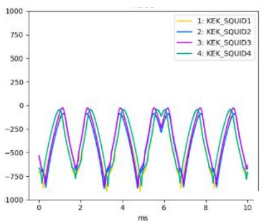
- Dilution Refrigerator successfully commissioned, and SQUID is ready
- The movable table for Lead Shielding was already installed in April, and full construction is scheduled to finish in September 2026.



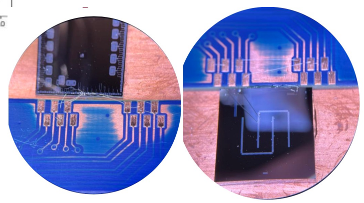




Voltage-flux from SQUID in Kamioka *(measured in Sep)*



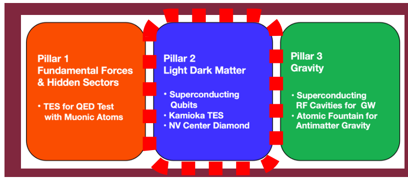
Same SQUID measured in LBL



TES detector

Cryostat

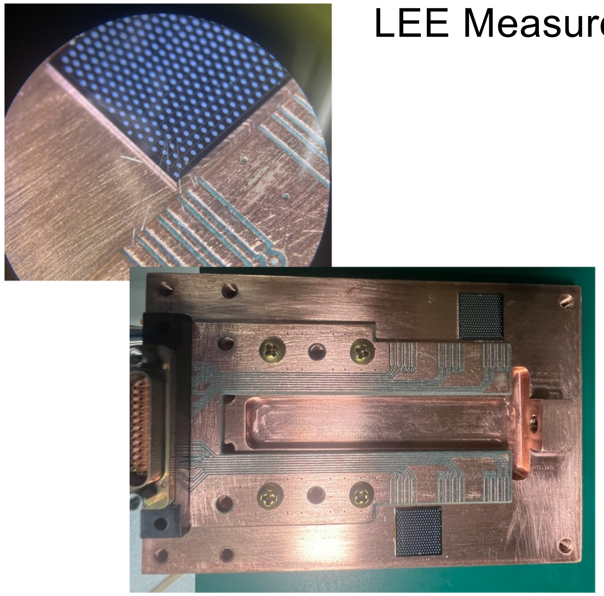
Rails for lead shield

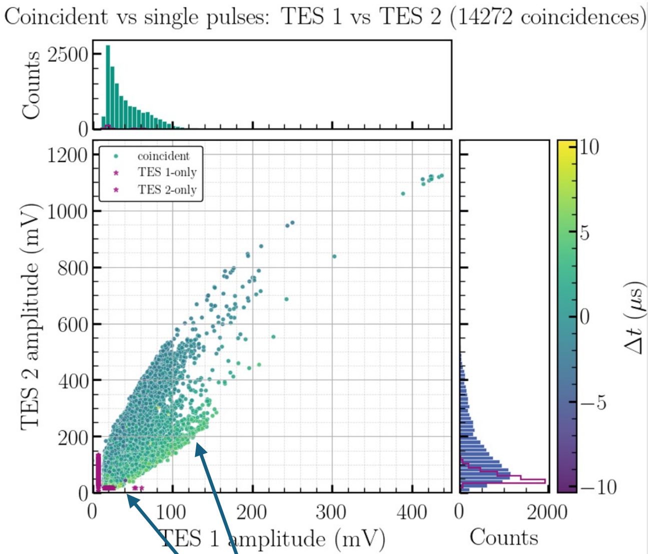


Detector operation results from Kamioka

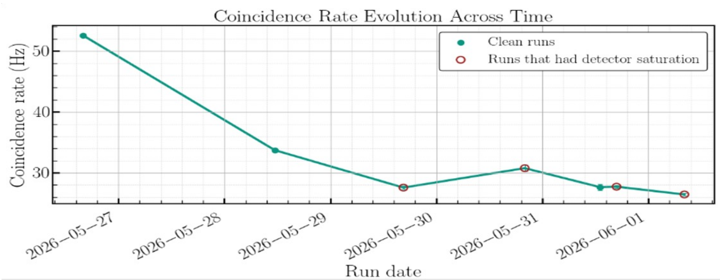
Low-Energy Excess (origin of major background)

LEE Measurement on Silicon QET chips





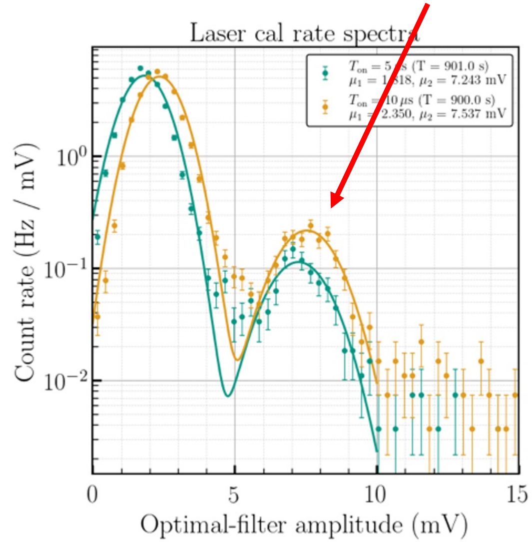
bulk LEE
metal film LEE



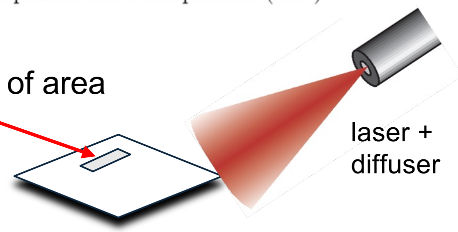
LEE decreases as time advances

Laser calibration on single TES (on Si)

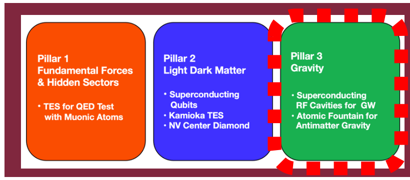
single photon signal



TES <1% of area



laser + diffuser



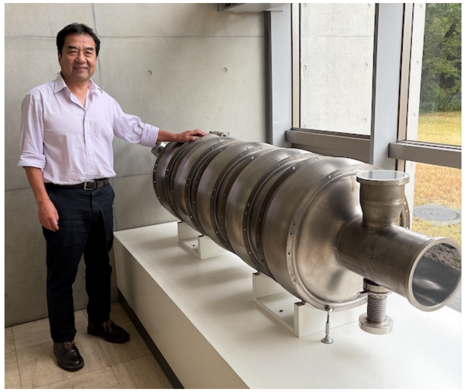
Science Target VI : Gravitational Wave Detection Using Superconducting RF (SRF) Cavities

led by T. Nitta with T. Kubo (KEK)

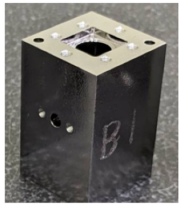
Superconducting RF Cavities

Q-value: 10^{11}
minimal energy loss

KEK's SRF technology (**~ m** size)



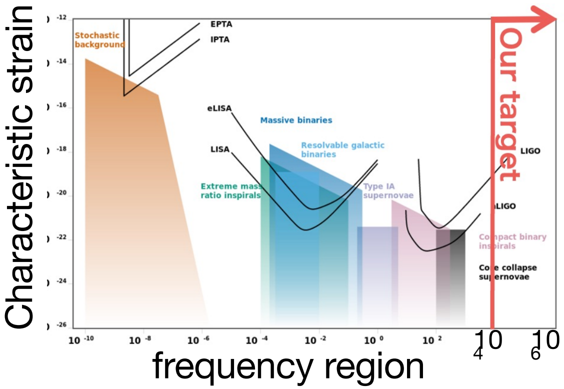
state-of-the-art quantum technologies: (**~ cm** size)



fabricated by our team

gravitational wave interferometers (**~ km** size)

Joint Research and Cross-disciplinary Collaboration with KEK



Gravitation wave detection in the unexplored high-frequency region:

→ kHz - MHz GW can be detectable

Pillar 1
Fundamental Forces & Hidden Sectors
• TES for QED Test with Muonic Atoms

Pillar 2
Light Dark Matter
• Superconducting Qubits
• Kamioka TES
• NV Center Diamond

Pillar 3
Gravity
• Superconducting RF Cavities for GW
• Atomic Fountain for Antimatter Gravity

Superconducting RF (SRF) Cavities

Phys. Rev. Applied 25, 034076 (2026)

Editors' suggestion

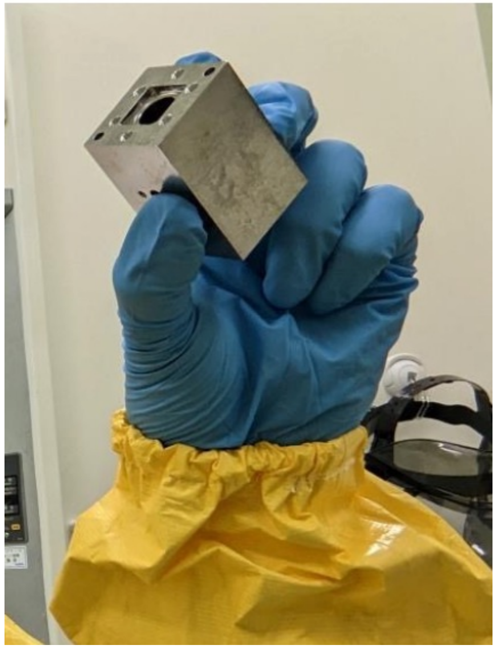
Achievement 2025

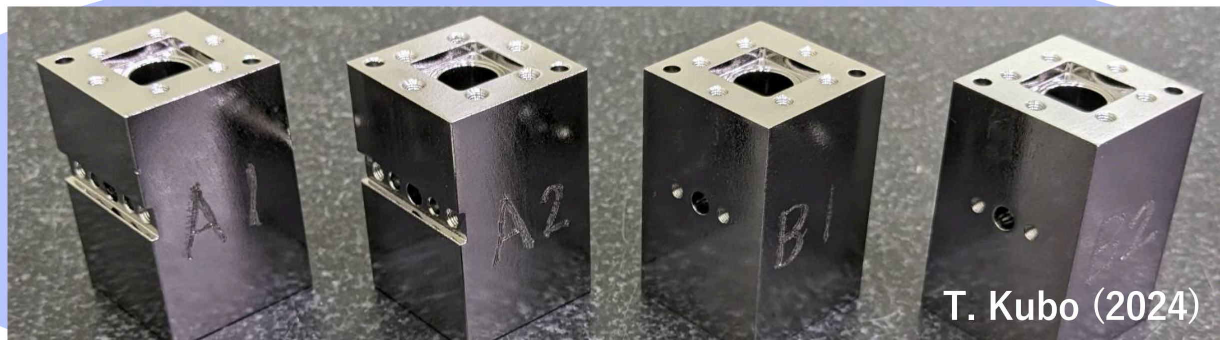
Three-dimensional niobium coaxial cavity

Q-value: 3×10^9 = T_1 ~0.1 sec
World record in coaxial cavities

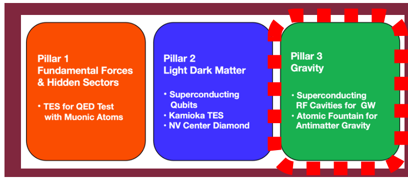
Stable upon exposure to air

collaboration with NTT





Insight through Accelerators.
KEK



Superconducting RF (SRF) Cavities

Outlook

Gravitational Wave

A. **Cavity Q-factor at single photon regime**
Conservative: $4\text{x}10^9$ with Nb coax cavity (almost achieved)

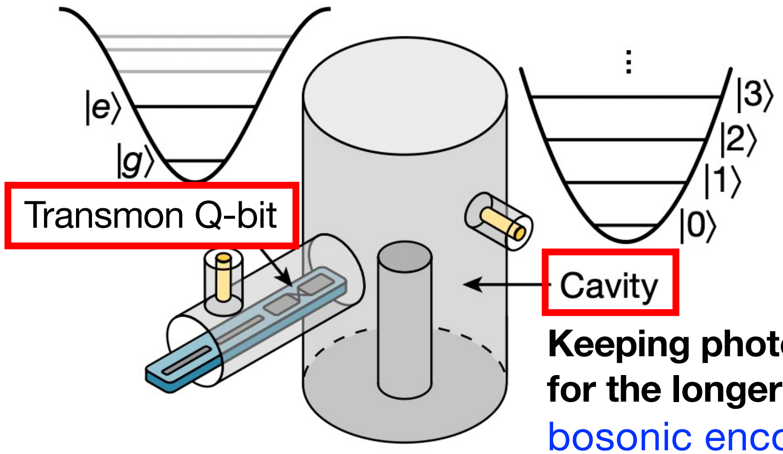
B. **Magnetic field introduced in the superconducting cavity**
(Nobody realized yet)
Conservative: 100 Gauss Nb cavity for cavity tuning with lower Q

Collaboration with **Akito KUSAKA** (Uni.of Tokyo)

C03 超伝導・量子技術によるマイクロ波
重力波探索で挑む宇宙創生

Grant-in-Aid for Transformative Research Areas (A)

Quantum Memories → **Hybrid with Transmon Q-bit + Cavity**

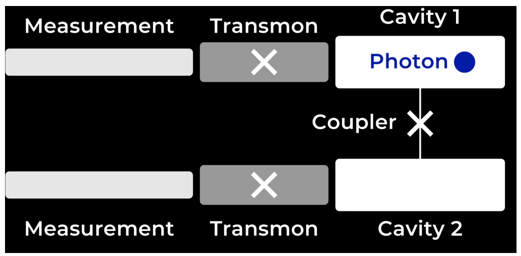


Keeping photons for the longer time
bosonic encoding

Yale group: Brock et al., Nature 2025

a different approach from integrated quantum bits on a chip

D-Wave + qci Quantum Circuits, Inc.



Company: Quantum Circuit

PI
Makoto Fujiwara (TRIUMF)
joined QUP
from April 2026
(as cross appointment)

Momose (UBC)
joined QUP
from August 2026
(as cross appointment)

Collaboration between KEK and TRIUMF

Antimatter Gravity Using Atomic Fountain

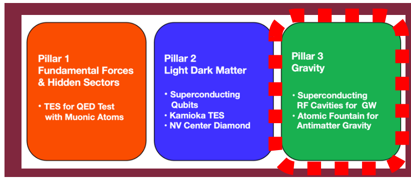
already started from April 2026

Today

Letter of Intent for Collaboration between KEK-QUP and TRIUMF

Pursuant to the Memorandum of Understanding between **the High Energy Accelerator Research Organization ("KEK")** and **TRIUMF INC. ("TRIUMF")**, effective **January 30th, 2025**, KEK's International Center for Quantum-field Measurement Systems for Studies of the Universe and Particles (QUP) and TRIUMF wish to further express their mutual interest in developing a collaborative research program on atomic hydrogen fountains and interferometry for antimatter gravity studies. The collaboration will bring together expertise in atomic and laser physics, quantum control, and precision measurement, with the aim of developing techniques that may ultimately be applied to gravitational studies of antihydrogen.

Through this Letter of Intent, KEK-QUP and TRIUMF affirm their intention to further develop this collaboration and to work toward a formal Project Agreement, as provided in the MOU, which will define its scope and other terms and conditions. This Letter of Intent reflects the parties' present intentions and does not create legally binding commitments.



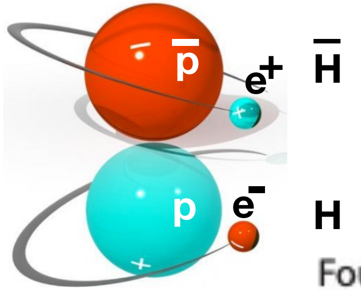
Science Target V : Antimatter Gravity Using Atomic Fountain

led by M. Fujiwara

Fujiwara(TRIUMF):PI
(Apr 26 -)

Test of **CPT** & **Weak Equivalence Principle**

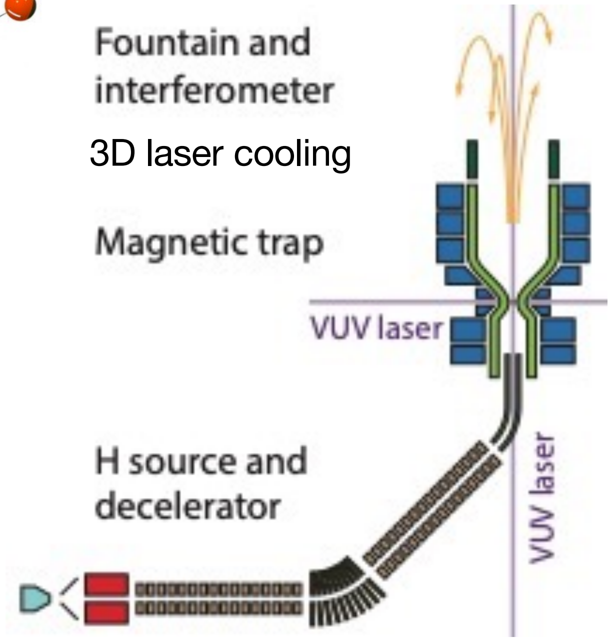
Precision Antimatter Gravity Measurement with Quantum Techniques
– (Anti)Atomic Fountains, (Anti)Atom Interferometer



Key technologies: high-intensity, short-wavelength lasers

originally cultivated in
low-energy muon beam applications
@**J-PARC, KEK** plays a central role.

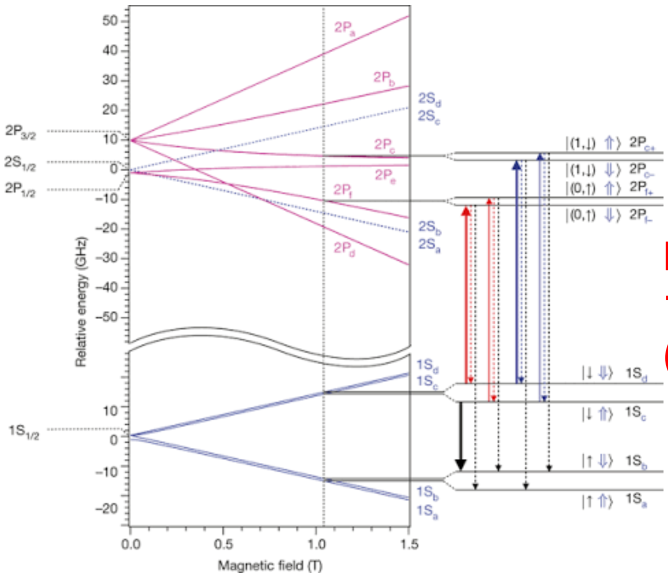
Joint Research and
Cross-disciplinary Collaboration with KEK



starting with hydrogen
@ TRIUMF, Canada

Why is quantum manipulation of (anti)H so hard?

Antihydrogen / Hydrogen



Fundamental Transitions
121 nm
(10.2 eV)

Vacuum-ultra violet light:

- **Does not transmit in air**
- **No solid-state laser medium**
- **Optics; e.g. windows only 50% efficiency**

QUP

Goal

10 μJ/pulse
100 MHz width
5 ns pulse length

World's Highest Power Narrow Line Pulse Laser at 121 nm

New VUV technologies (phase & time shape control of ns pulses)

Insight through Accelerators. KEK

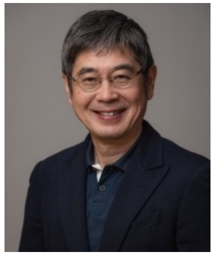
Pillar 1
Fundamental Forces & Hidden Sectors
- TES for QED Test with Muonic Atoms

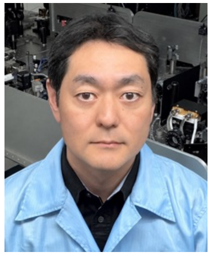
Pillar 2
Light Dark Matter
- Superconducting Qubits
- Kamioka TES
- NV Center Diamond

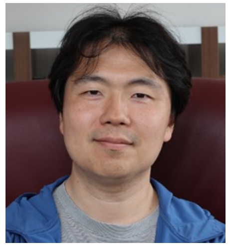
Pillar 3
Gravity
- Superconducting RF Cavities for GW
- Atomic Fountain for Antimatter Gravity

Progress from the startup

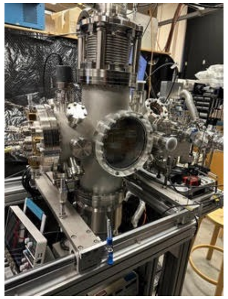
1. Laser development
- 2nd J-PARC Lyman-α laser achieved 5 μJ pulse energy
- Diode laser transferred from Canada, being commissioned at J-PARC


Momose (UBC), QUP Researcher (Aug 26-)


Oishi, QUP Researcher (June 26-)

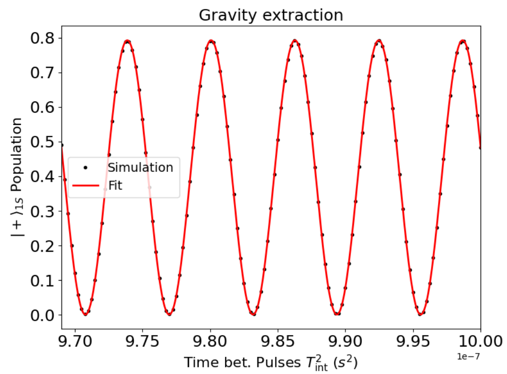

Imai, QUP Postdoc (Jul 26 -)

2. Atomic Hydrogen Source Development
- Required for demonstrating a 100 MHz linewidth
- Design completed
- Source chamber being fabricated


Hydrogen source at UBC (Momose)

3. Theory & Simulations
- New postdoc, **Amer,** driving the quantum calculations
- In collaboration with world experts incl. Müller (Berkeley)


Amer, QUP Postdoc (Aug -)



1S-2P (anti)H Interferometer simulations (Amer)

4. Funding applications
- Major efforts in Japan (MEXT) and Canada (CFI, NSERC)

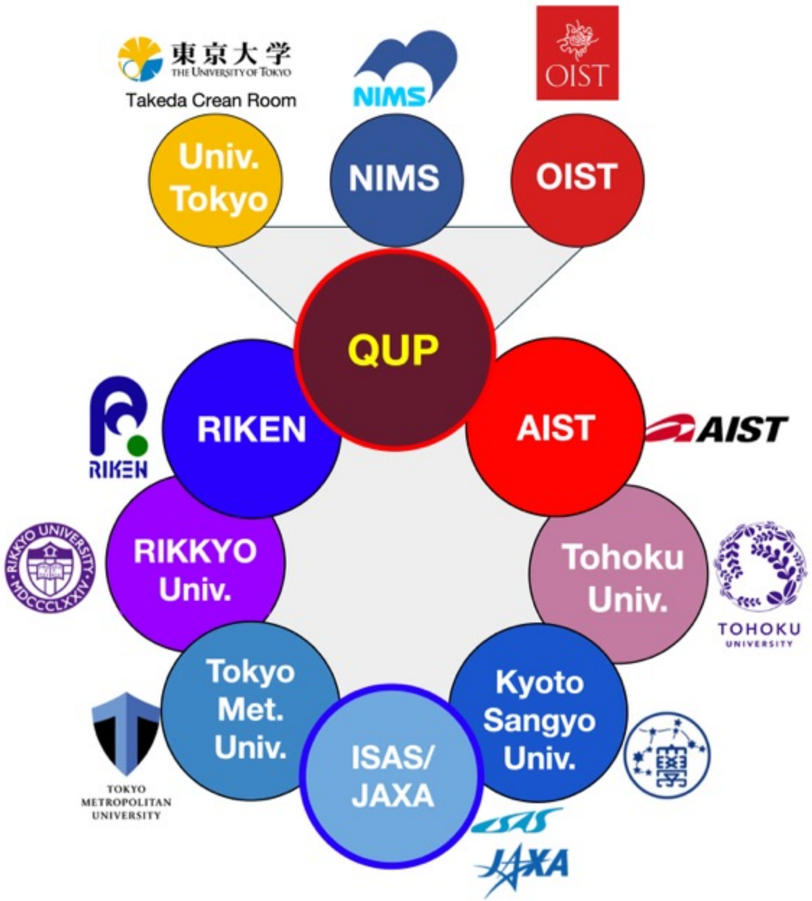
Technology Advancement Platform

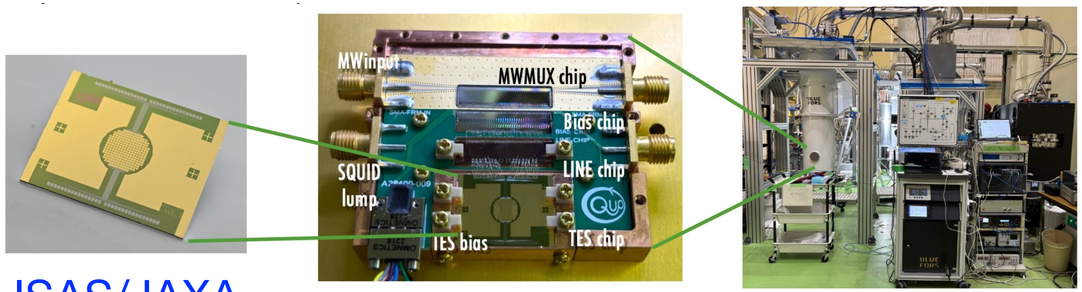
Technology Advancement

Superconducting Detectors	Semiconductor Detectors	Cryogenic Engineering
PIs: Yamasaki, Lee	PIs: Bortoletto, Takahashi, Togawa, Miyahara, Nakahama	PI: Okamura

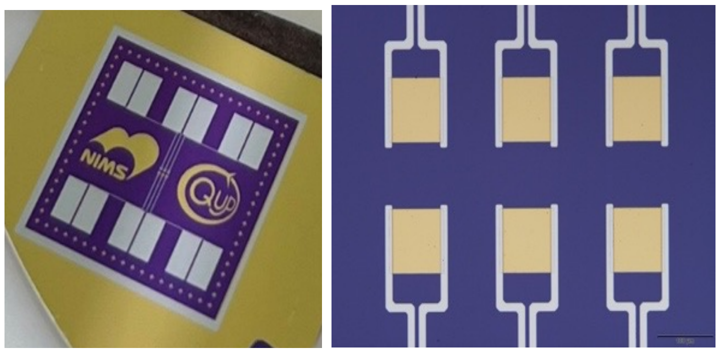
Superconducting Detector Platform closely connected with the JAXA satellite

led by N. Yamasaki

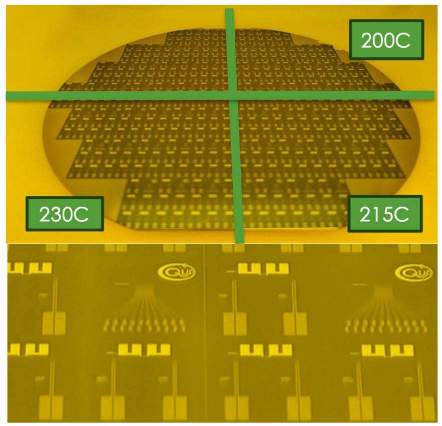




ISAS/JAXA AIST QUP



NIMS/QUP

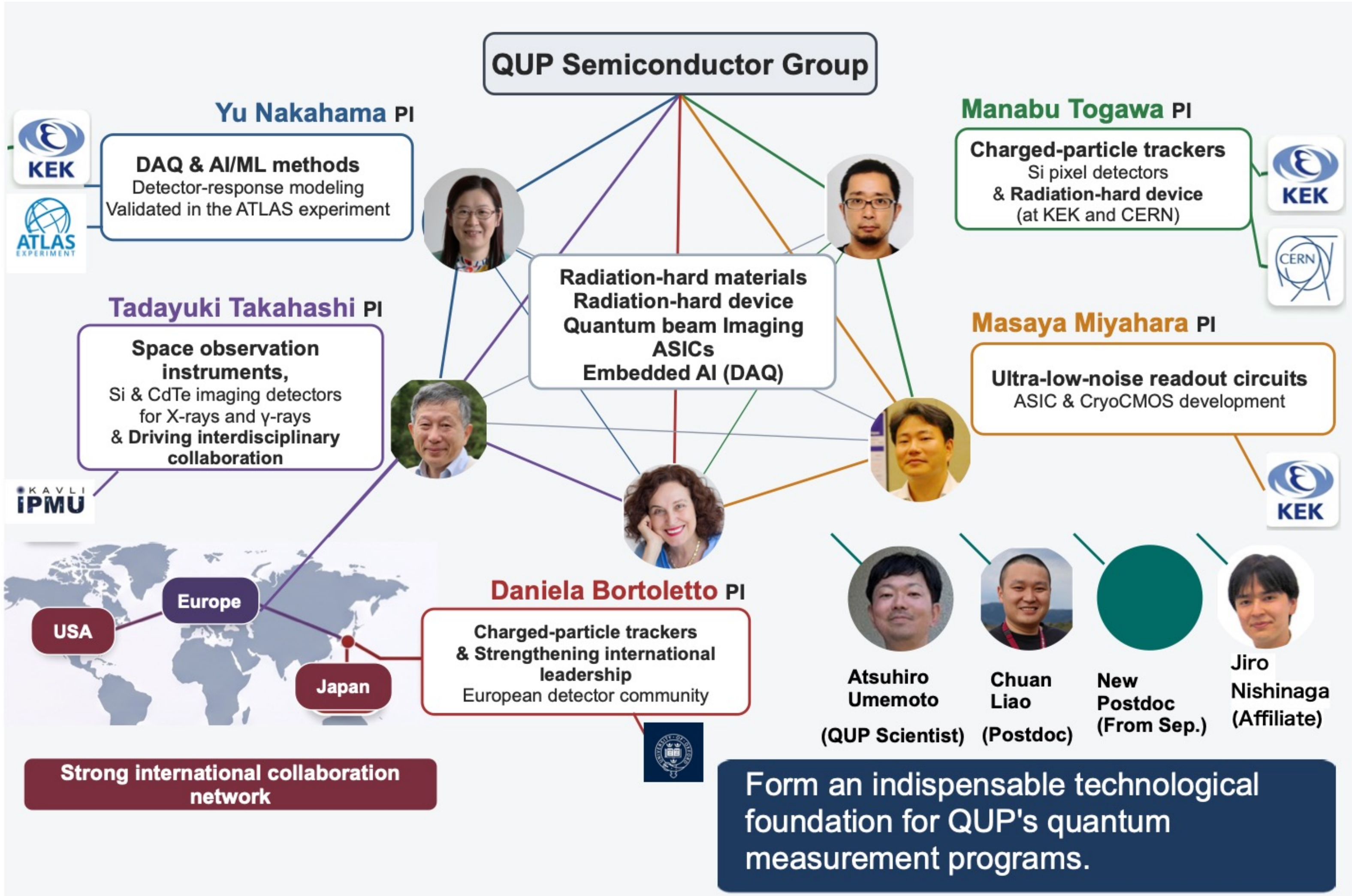


Berkeley/QUP

Technology Advancement

Superconducting Detectors PIs: Yamasaki, Lee	Semiconductor Detectors PIs: Bortoletto, Takahashi, Togawa, Miyahara, Nakahama	Cryogenic Engineering PI: Okamura

Semiconductor platform



Technology Advancement

Superconducting Detectors PIs: Yamasaki, Lee	Semiconductor Detectors PIs: Bortoletto, Takahashi, Togawa, Miyahara, Nakahama	Cryogenic Engineering PI: Okamura

CryoCMOS development:
Cryo-CMOS ADC Verified at 4.2 K

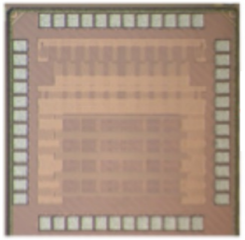
led by M. Miyahara

Cryo-CMOS ASIC for Quantum Qubit control / Quantum Computing

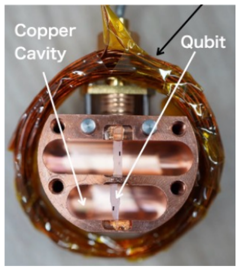
ここから、新・未来へ
MOONSHOT
RESEARCH & DEVELOPMENT PROGRAM

Essential technologies for high-density quantum computers

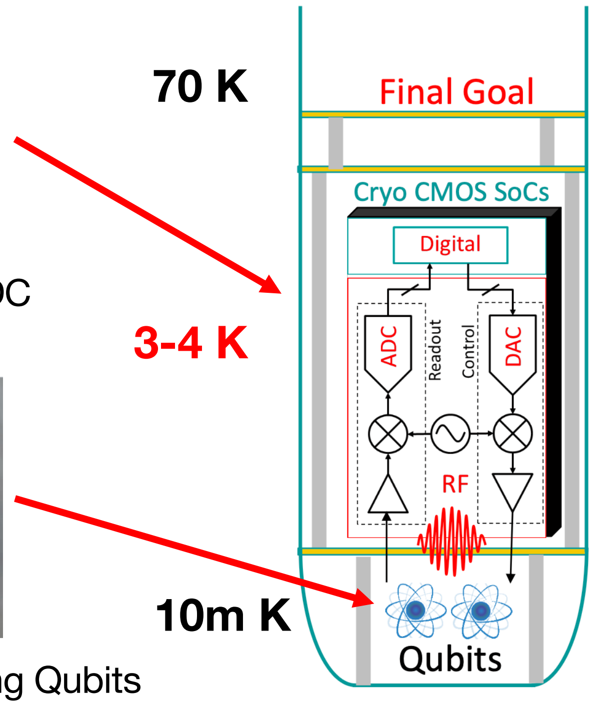
This technology is a key to QUP Superconducting Qubits (led by Nitta)

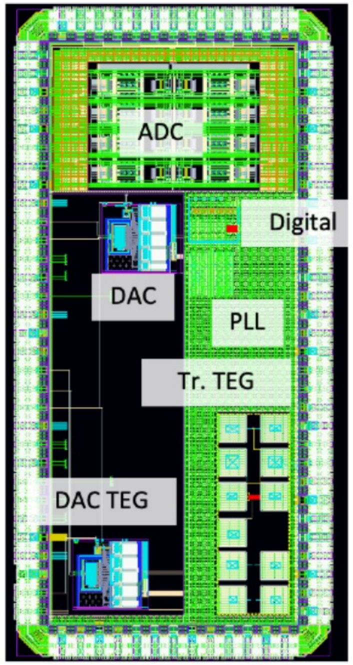


Cryo-CMOS ADC

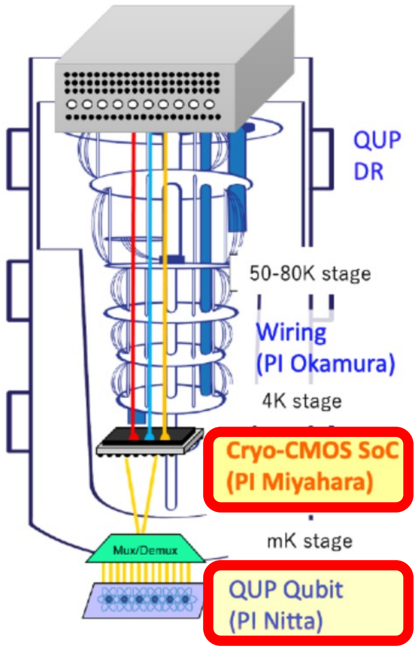


Supoerconducting Qubits





Cryo-CMOS SoC



SoC-based qubit control @KEK

Technology Advancement

Superconducting Detectors PIs: Yamasaki, Lee	Semiconductor Detectors PIs: Bortoletto, Takahashi, Togawa, Miyahara, Nakahama	Cryogenic Engineering PI: Okamura

Cryogenic Engineering platform

led by T. Okamura

Newly established platform due to its strategic importance to QUP

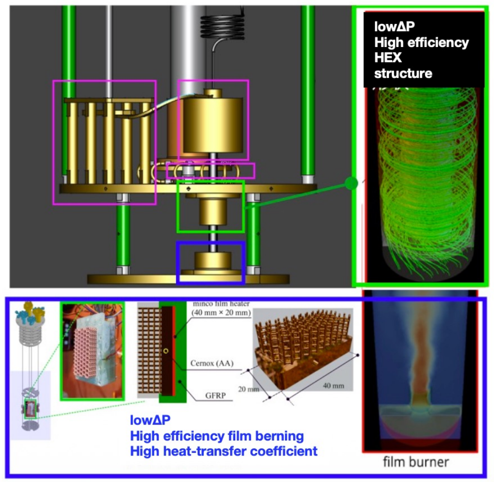
Research Field of PI Okamura (from **KEK**)

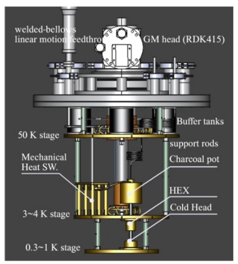
In collaboration with
Toyota Central R&D Labs

– Cryogenic system development for Cryo-CMOS

– Sub-Kelvin Cryogenic system development for Quantum Technologies.

Reduced He consumption and increased cooling capacity through optimized Kapitza thermal resistance, fluid control, and Adsorption.

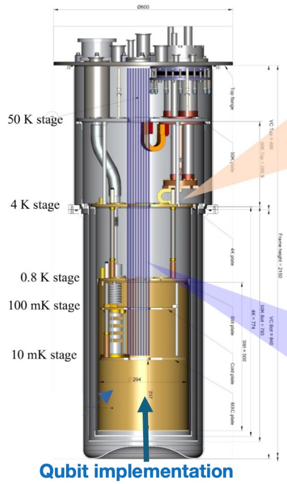


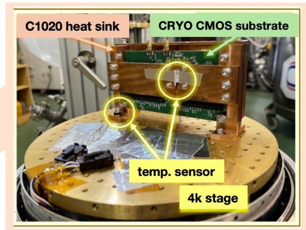


Reduced He consumption & enhanced colling power

Kapitza reduction + Efficient utilization of He heat-transfer

4He sorption
0.8K >1.5mW
3He sorption
0.3K > 100 uW



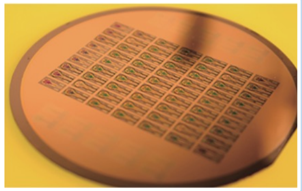


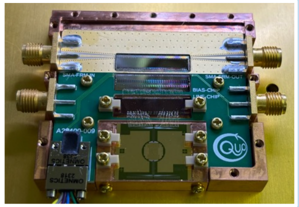
QUP member: Dr. **H. Fukuyama**
(Former Director of Cryogenic Research Center, The University of Tokyo)

Specialist in mK cryogenic system

New framework

Theory Group PIs: Nakayama, Takhistov





Pillar 1
Fundamental Forces
& Hidden Sectors

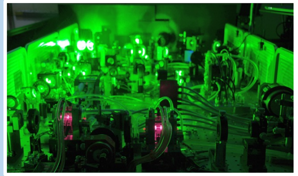
PI:
Azuma

Pillar 2
Light Dark Matter

PI:
Nitta, Garcia-Sciveres
Hasegawa, Herbschleb

Pillar 3
Gravity

PI:
Nitta, Fujiwara



Technology Advancement

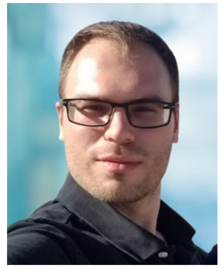
Superconducting Detectors	Semiconductor Detectors	Cryogenic Engineering
PIs: Yamasaki, Lee	PIs: Bortoletto, Takahashi, Togawa, Miyahara, Nakahama	PI: Okamura

Engineering support section led by Haba

Theory Group

led by K. Nakayama, V. Takhistov

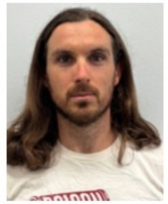
Foundational role in QUP's scientific program :
defining observables, developing search concepts, guiding sensitivity studies, and connecting QUP programs to fundamental physics discovery

- 22 small-team papers submitted or published since July 2025

- 9 WPI posters, multiple visiting international student/postdoc projects near publication





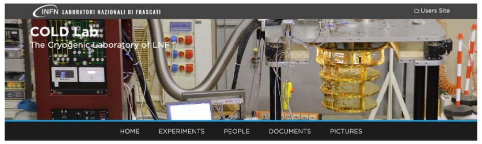
QUPIPs (internship students) were actively involved in research resulting in scientific publications" (ex: Arakawa, Takhistov, et al, JCAP 02 (2026) 026; de Giorgi, Takhistov, et al, JHEP accepted)

Growing Global Momentum
- Worldwide expansion of quantum-enabled searches for fundamental physics
- Similar initiatives emerging at major laboratories and universities

Strong communications with leading international partners: CERN, CEA, Fermilab, DESY, INFN

DESY — DESY QUANTUM Center for Quantum Technology and Applications

INFN

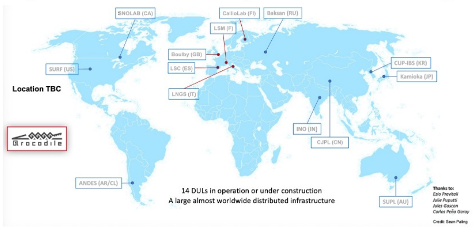


FNL — Fermilab — Quantum research
Quantum sensing

CERN — QTI CC2, DRD5

CEA — cea irfu, cea iramis

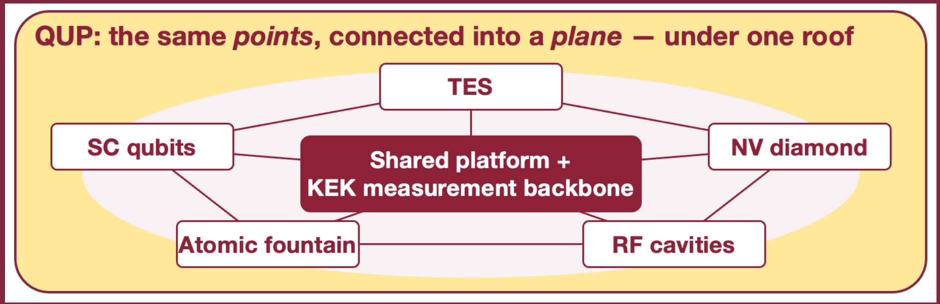
Cryogenic Detectors for LDM
Figure from the talk by Belina von Krosigk



A Global Network to search for High Frequency Gravitational Waves — GravNet

Conclusion Quantum Sensing for New Physics

Not one detector. Not one experiment.
One international center exploring nature through many quantum technologies.



We recently launched a collaboration between QUP-KEK and QTI-CERN.
Why not build an even broader and stronger collaboration with TRIUMF?

Thank you