

# High Energy Physics in the Quantum Era

Co-hosted by **KEK theory center** and **RIKEN iTHEMS**

There are **3 key words** in this workshop.  
I will speak on behalf of these 3 key words.

Satoshi Iso (KEK / RIKEN)  
in the quantum era

Institute for  
High Energy Accelerators

KEK



Particle Physics is an **extremely advanced framework of quantum physics**

But now sometimes, KEK is called institute for old-quantum physics, compared to recent developments of quantum-information/computer.

Is particle physics really an old-quantum physics?

Of course, NO !!

That is why all of you are here at KEK to attend the workshop.

## Satoshi Iso in **the quantum era**

I first encountered the concept of quantum information in 90's.

One of my papers in early 90's is about

open quantum system w/decoherence

and I was a little bit familiar with such concept.

When I read the paper by Shor, I was fascinated

but also thought that it is

*mathematically nontrivial, but NOT physically.*

*no more than quantum mechanics.*

**It was indeed wrong.**

Then some of my students at KEK (SOKENDAI) persuaded me to work on quantum non-equilibrium physics / quantum information, and I finally realized that

**“Quantum” is nontrivial and more than interesting.**

# What aspect of “quantum” is important in particle physics?

## Experiments:

Quantum **sensors** for new experiments/observation

Quantum computer for **big data** analysis

Quantum **measurements**

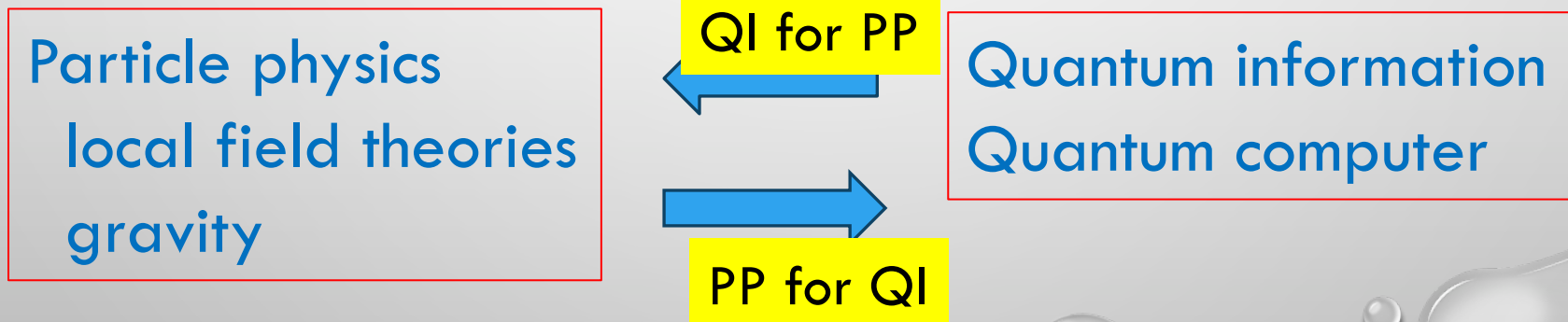
And more

## Theory:

Quantum **computation** of field dynamics

Conceptual understanding of quantum **field theories** / quantum **gravity**

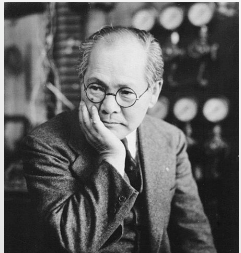
Open quantum physics in **non-equilibrium**



# The third key word: RIKEN iTHEMS

## RIKEN @ Wako, Saitama

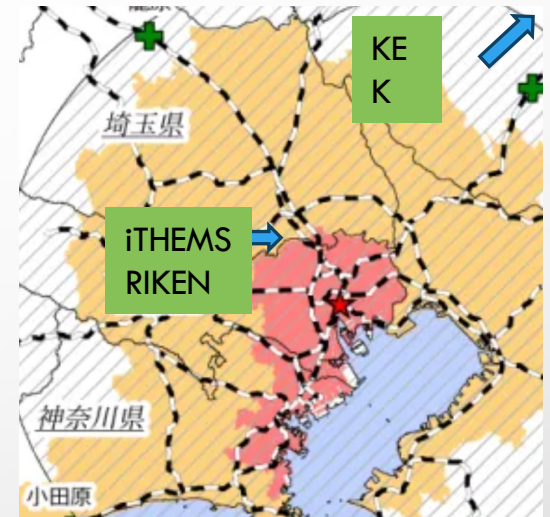
RIKEN was founded in 1917, and has grown rapidly in size and scope, today encompassing a network of world-class research institutes across Japan.



Yoshio Nishina  
PI/President  
1931-51



Shinichiro Tomonaga  
1931 -37 QED



Director



T. Hatsuda  
(phys.)

Deputy Directors



T. Tsuboi  
(Math.)



S. Nagataki  
(Astro.)



C. Beauchemin  
(Biology)



T. Miyoshi  
(Comp.)



T. Tada  
(Phys.)



T. Nagai

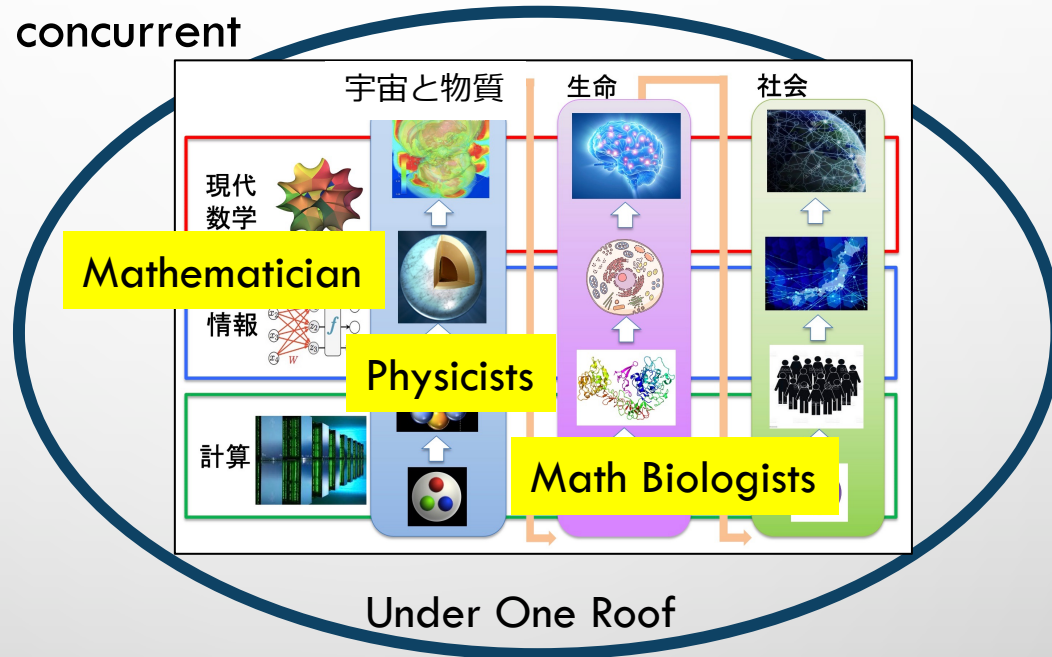
# iTHEMS

Interdisciplinary Theoretical and  
Mathematical Sciences Program

~ 50 members + many concurrent

Founded in 2016 by Tetsuo Hatsuda  
(2013-2016 iTHES)

*iTHEMS spirit*  
No boundaries  
in Sciences





2025/4



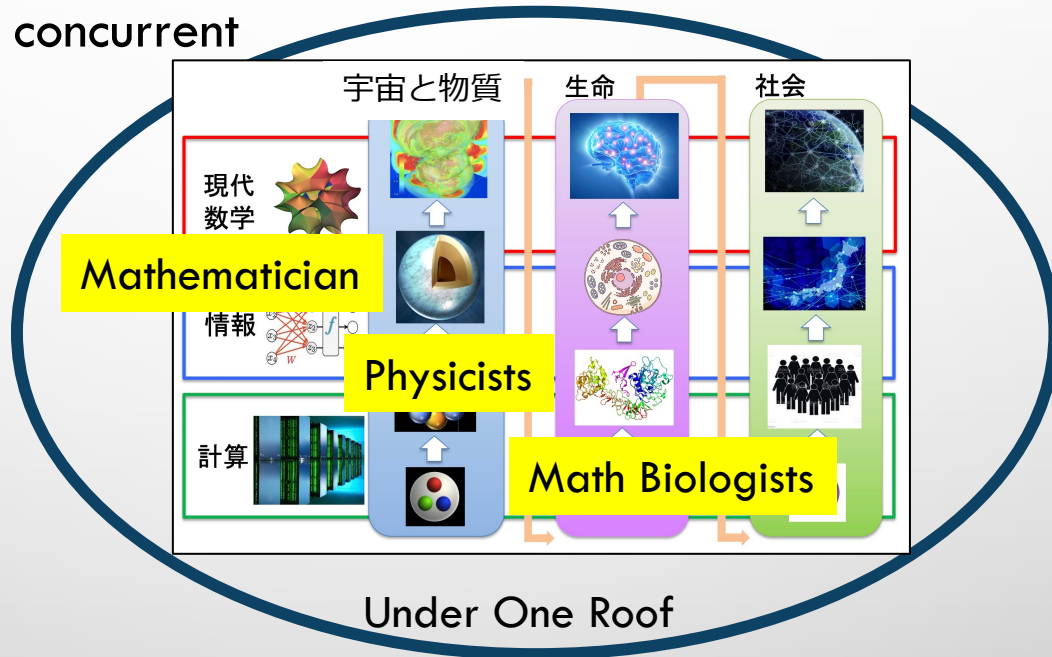
Center for Interdisciplinary  
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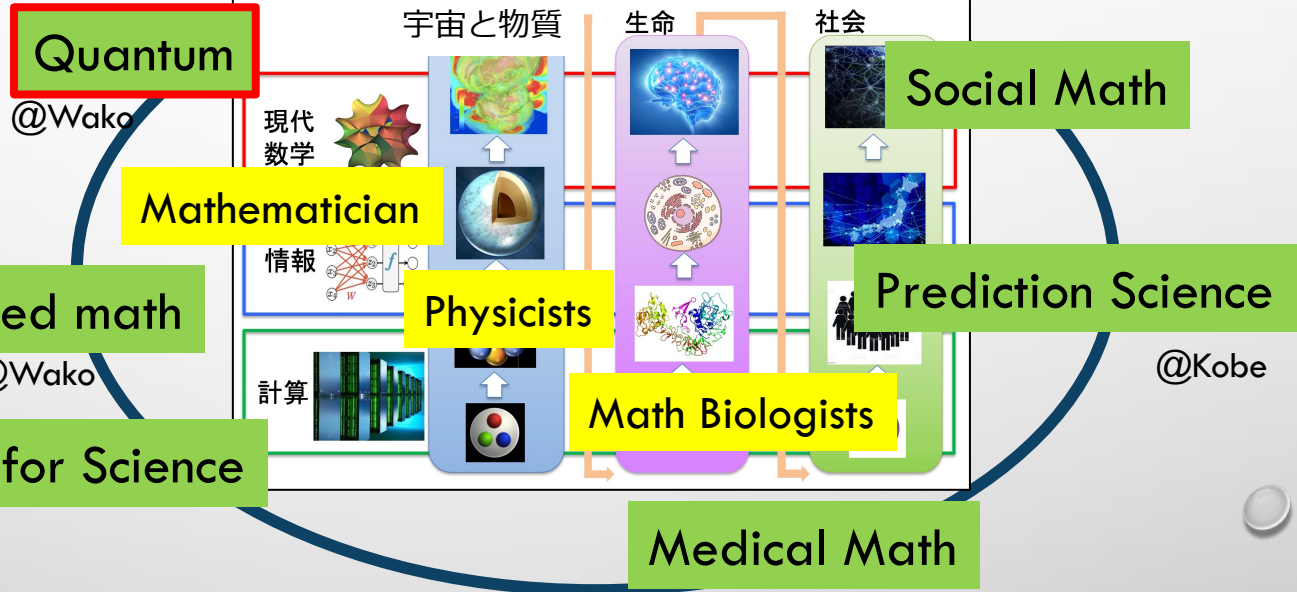
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@Wako

@Wako

@Kobe

@Kobe, Yokohama, Nihonbashi



## Transdisciplinary organization across RIKEN

RIKEN Quantum: quantum computational science for basic research

### ① 物理学



初田  
(iTHEMS)



木村  
(RNC)



有田  
(CEMS)



濱崎  
(CPR)



柚木  
(CPR/R-CCS)

### ② 化学



中嶋  
(R-CCS)



杉田  
(CPR)

### ③ 生命科学



磯村  
(CBS)



豊泉  
(CBS)



清田  
(R-IH)

### ④ 人文 社会科学



入来(本部  
未来戦略室)

### ⑥ 情報科学



Zhao  
(AIP)



Quang  
(AIP)

### ⑤ 計算科学



青木  
(R-CCS)



肥山  
(RNC)



伊藤  
(R-CCS)

### iTHEMS



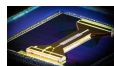
### AIP



### R-CCS



### IBM-Q Quantinuum



### CPR



### RNC



### CEMS



### CBS



### R-IH

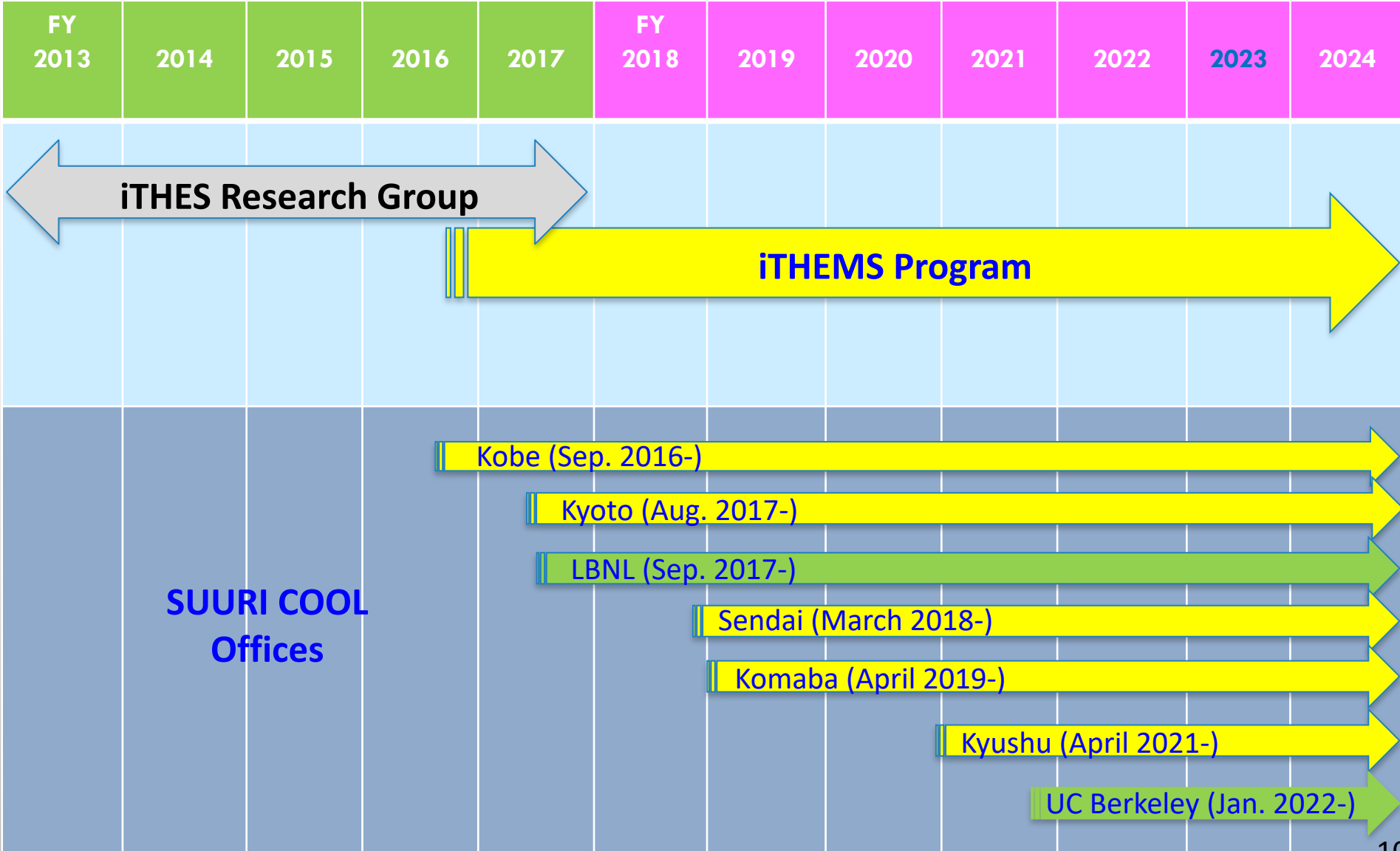


### RQC



## RIKEN 3<sup>rd</sup> Midterm

## RIKEN 4<sup>th</sup> Midterm



## SUURI-COOL Domestic Satellite Offices



**SUURI-COOL Kobe**  
(RIKEN Kobe IIB bldg. 7F)



FY2016-

**SUURI-COOL Kyushu**  
(Ito, West no.1 bldg., 7F)



W1-A-717  
SUURI-COOL(Kyushu)

FY2021-

**SUURI-COOL Sendai**  
(Tohoku U. AIMR, 3F)



FY2018-



**iTHEMS  
Headquarters**  
(Wako, 2F - 4F)



FY2019-

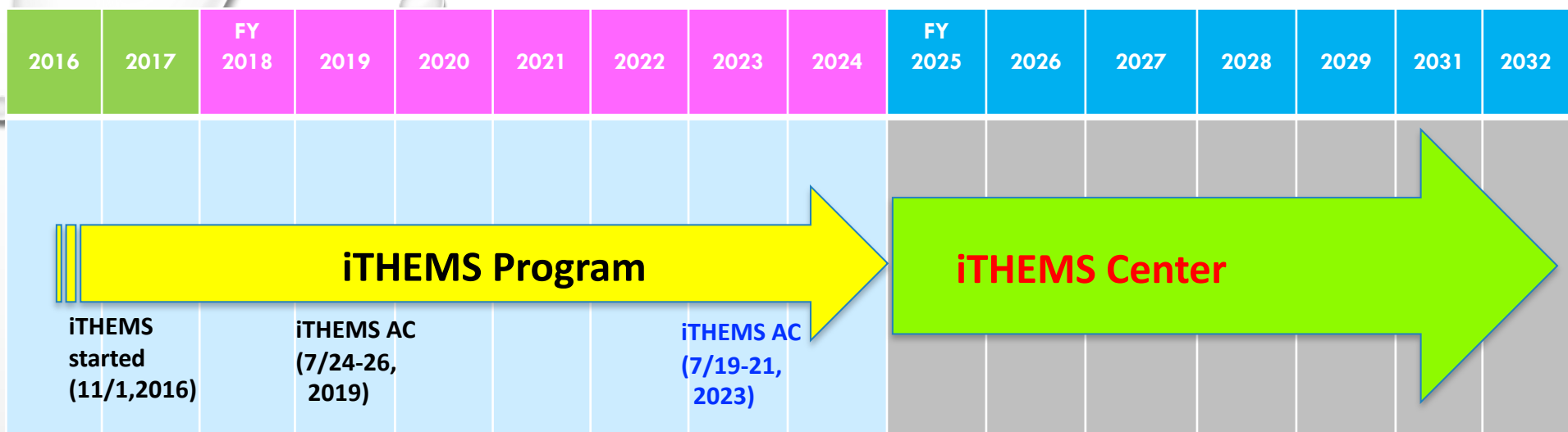
**SUURI-COOL Komaba**  
(U. Tokyo, K4 bldg., 2F)



FY2017-



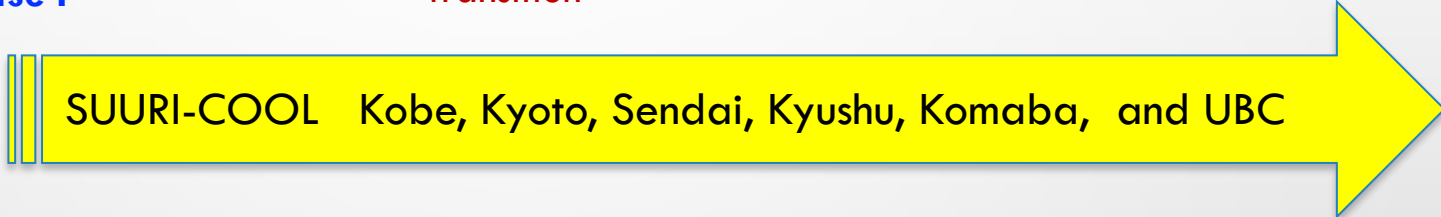
**SUURI-COOL Kyoto**  
(Kyoto U., Maskawa bldg. 2F)



Phase I

Transition

Phase II



We launched



Focussed on particle physics in quantum era

A joint position for an assistant prof in quantum physics is now open.



Thank you for your attention.

I hope you enjoy the workshop,  
and  
please also visit **RIKEN iTHEMS !!**

