



HIGH ENERGY ACCELERATOR RESEARCH ORGANIZATION

# **MECHANICAL ENGINEERING CENTER**

# MEC

# MECHANICAL ENGINEERING CENTER

The Mechanical Engineering Center is one of the divisions of Applied Research Laboratory in High Energy Accelerator Research Organization (KEK). It is a research support center, which consists of researchers and engineers who specialize in mechanical engineering.

As a part of Applied Research Laboratory, we design and build machines and instruments used by KEK employees, researchers and students for experiments. We have a wide range of activities from providing materials, supporting design/machining, and participating in various research projects. The support for private companies, which mass-produce machines is also part of the scope. The Mechanical Engineering Center takes a pivotal role in the research activities for mechanical engineering related technology necessary to engage in the future supportive tasks.

The main facilities include Machine Shops No.1 and No.2 with about 100 units of machine tools, and Machine Shop No.3 with measuring equipment. In addition to these facilities, Tsukuba campus provides facilities for ultra precision machining and ultra precision measurement. These facilities provide a constant temperature room whose temperature is maintained at about  $\pm 0.5^{\circ}\text{C}$  and a Class 1000 cleanroom.

## CONTRIBUTION TO SOCIETY

Mechanical Engineering Center holds "Mechanical engineering workshop" and "Drawing workshop" for KEK employees/researchers and students to promote the diffusion of knowledge among them, and provides the researchers with materials, parts, and tools. We supports researchers directly or indirectly to make experiments successful. We also play proactive role in technology transfer as well as technical assistance for the people from Japanese/overseas universities, research institutions, and the private sector.

Furthermore, Mechanical Engineering Center organizes "Mechanical workshop" to promote networking for people from various fields and contributes to exchange of information and facilitation of the research activities.

In the KEK open house, we make efforts to provide to the general public the opportunity to experience the enjoyment from and the essence of mechanical work through experiencing actual material, demonstration of machine tools, research and development report, and the displayed actual machines.



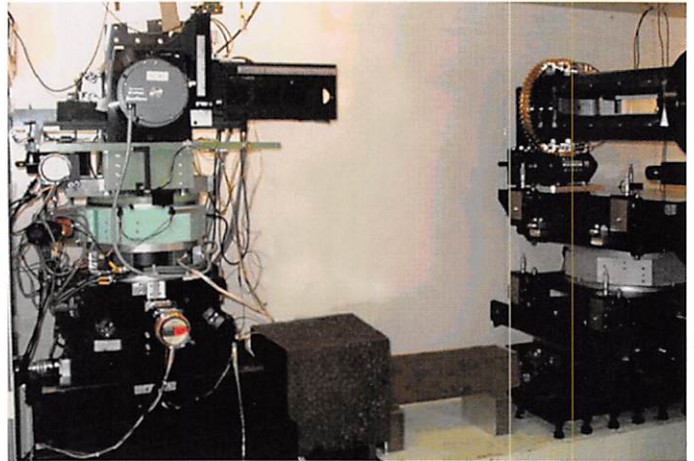
Mechanical workshop



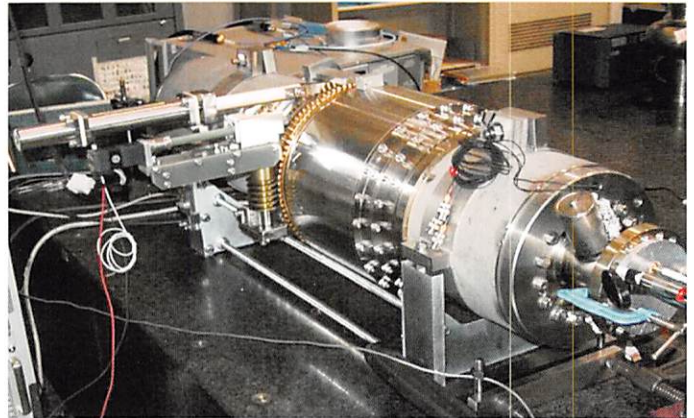
# RESEARCH AND DEVELOPMENT

In order to facilitate the research plan in KEK, we need to deal with issues, which cannot be solved only by the existing technologies. The Mechanical Engineering Center is engaged in research and development of specialized mechanical engineering.

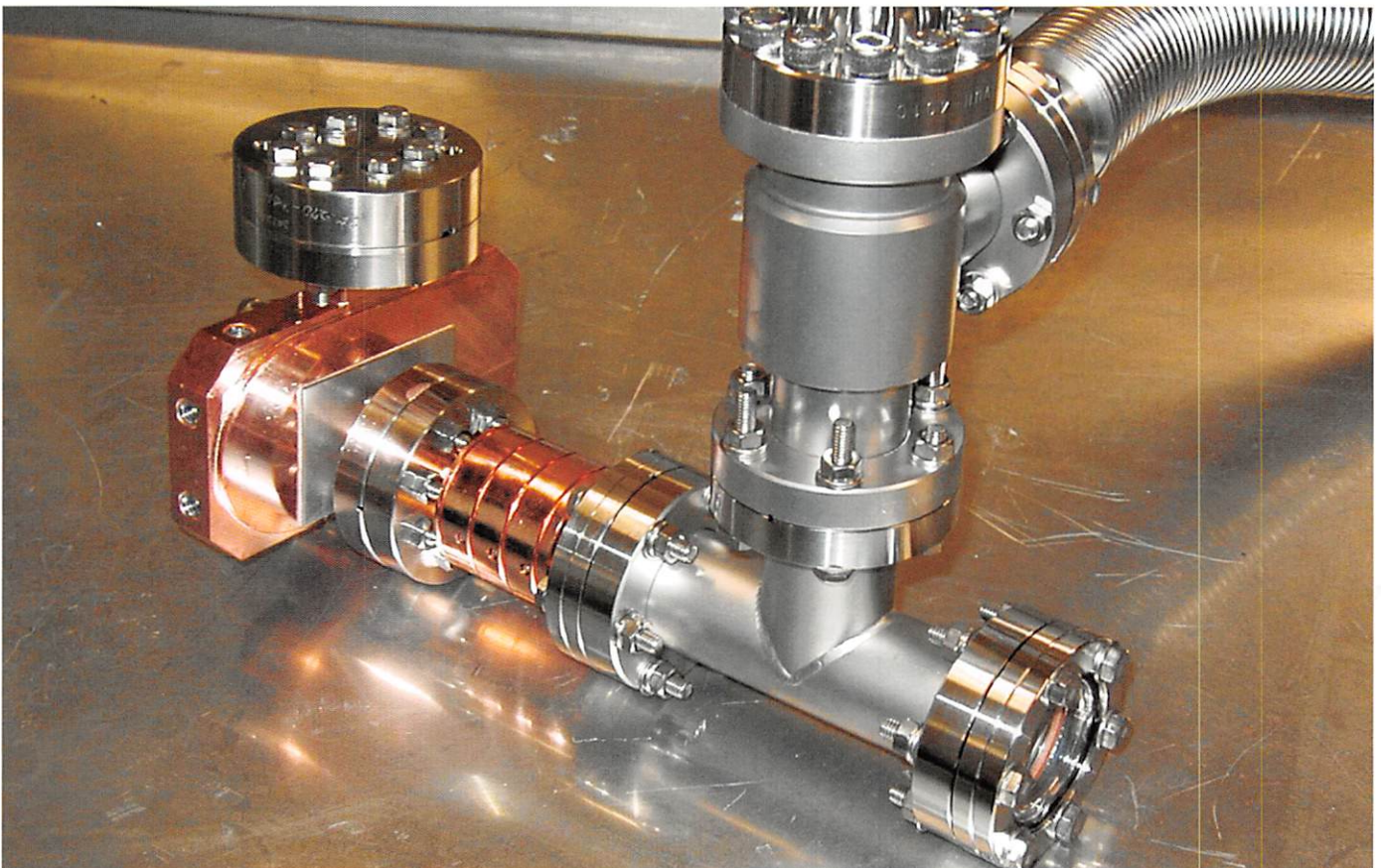
We actively work on technology transfer and technical assistance for various fields and industry. Therefore, research results are used not only for KEK research plans but also for other sectors. We are also actively involved in academic meetings/activities and education at undergraduate and graduate level for the purpose of returning to the society of our academic benefits obtained from research and development.



Ultraprecision large free-form equipment without datum surface. It is achieved by straight line stability of the laser and high precision angle measuring technique of  $10^{-7}$  rad.



Development of the tuner using superconducting cavity ball screw operating in the temperature of  $-271^{\circ}\text{C}$ -liquid helium and piezo actuator.



Development of high electrical field normal conducting cavity by using superprecision machining technique for copper.



# MACHINING TECHNIQUE

The Mechanical Engineering Center uses various machining techniques and tools to make necessary equipments and their component parts used in KEK.

## Mechanical working

We provide NC wire-cut electron discharge machining, waterjet machining, and diamond saw machining in addition to cutting/grinding by common processing machinery.

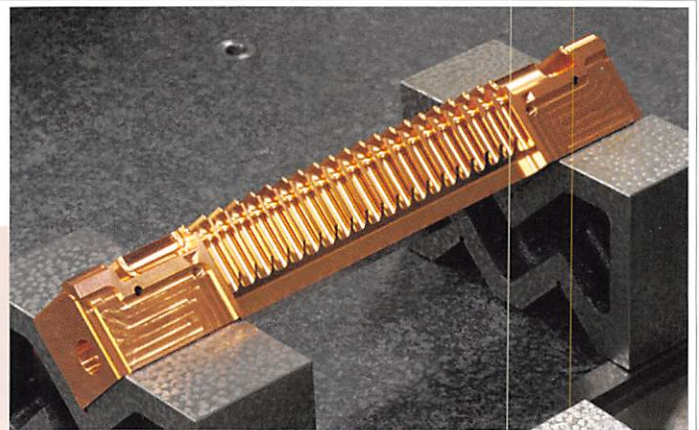
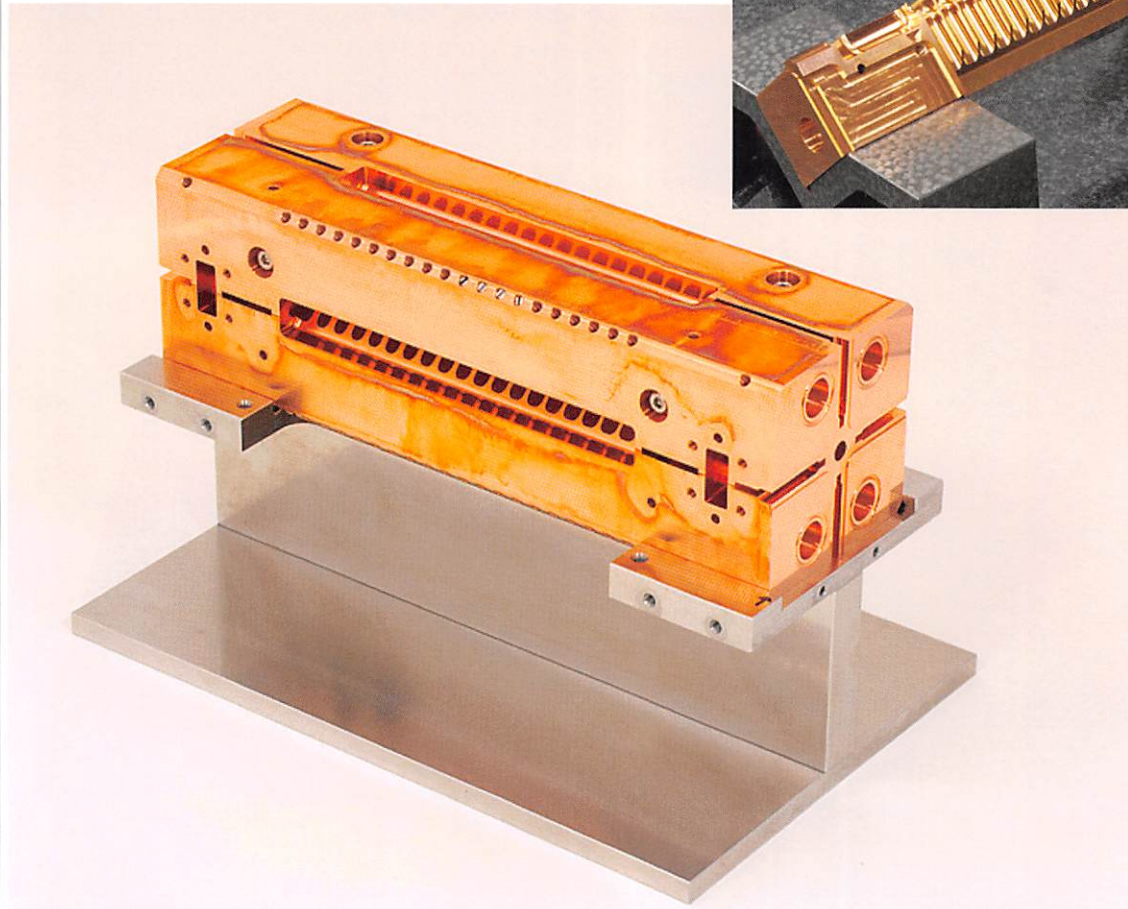
For machining, the Mechanical Engineering Center is capable of handling lathe machining up to outer diameter of 1200 mm, and milling up to 1200mm × 800mm × 500mm. Ultra-high Precision Lathe with static pressure air-bearing system also achieves the accuracy of  $\pm 1\mu\text{m}$  and surface roughness (Ra) of  $0.03(\mu\text{m})$ .



Cut wire with a wire-electrical discharge machine



Absorber after cutting



The quadrant-type structure of X-band accelerator



## Welding

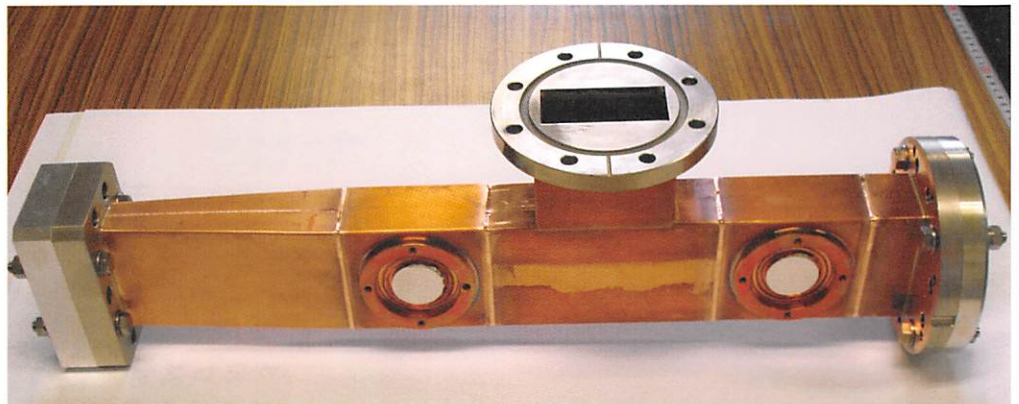
We apply TIG welding to make vacuum vessels, which are made of aluminum alloy and stainless steel. These are high vacuum vessels, which satisfy the specification  $10^{-8}$ Pa. In order to accommodate precision welding which will not allow dissimilar metal and oxidization, electron beam welding is installed.

In addition, we use various welding techniques such as ark welding and spot welding according to the materials and applications.

Furthermore, we work on a new welding method, which will be necessary in the future.



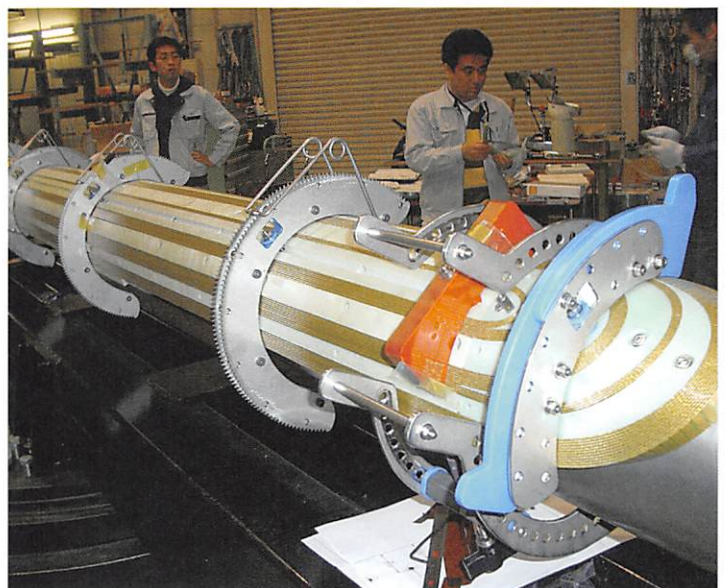
Waveguide with reflector (design/fabrication)



Waveguide connected by electron beam welding

## Assembly

For making instruments at Mechanical Engineering Center, we process parts according to the user's requirements and specifications, and also assemble and adjust the instruments. We also develop fixture for complicated products and high precision machines. Mechanical evaluation tests for accuracy and machine performance test are conducted if necessary.



Applying the 2-cavity/4-cavity multiple magnetic field superconducting magnet for J-PARC



# DESIGN

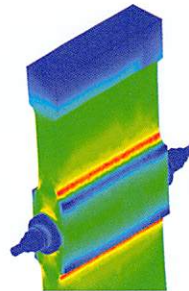
Based on user's concept, first we bring mechanical specification into shape. After that, we start the mechanical design to achieve required function while considering preparation period and the costs.

Machines and equipment used in KEK require a certain degree of performance, which will meet the most advanced research capabilities. There are many issues that should be solved at the design and assembly stages due to the unique application and harsh environment in which the machines are used. It is very often that we have difficulty finding reference and information. The budget and time constraint of experiment limit our development and verification process. It is also difficult to perform repair and modification work if the machines are used in a high radiation environment.

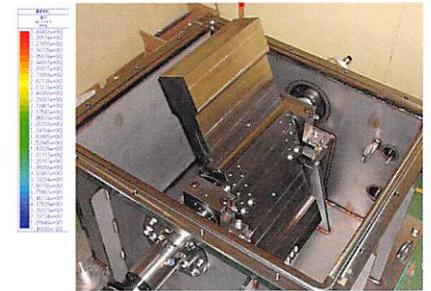
In order to respond to the situation mentioned above, the Mechanical Engineering Center needs to provide required machines within the limited period and costs, and we are capable of offering the required

consultation and engineering.

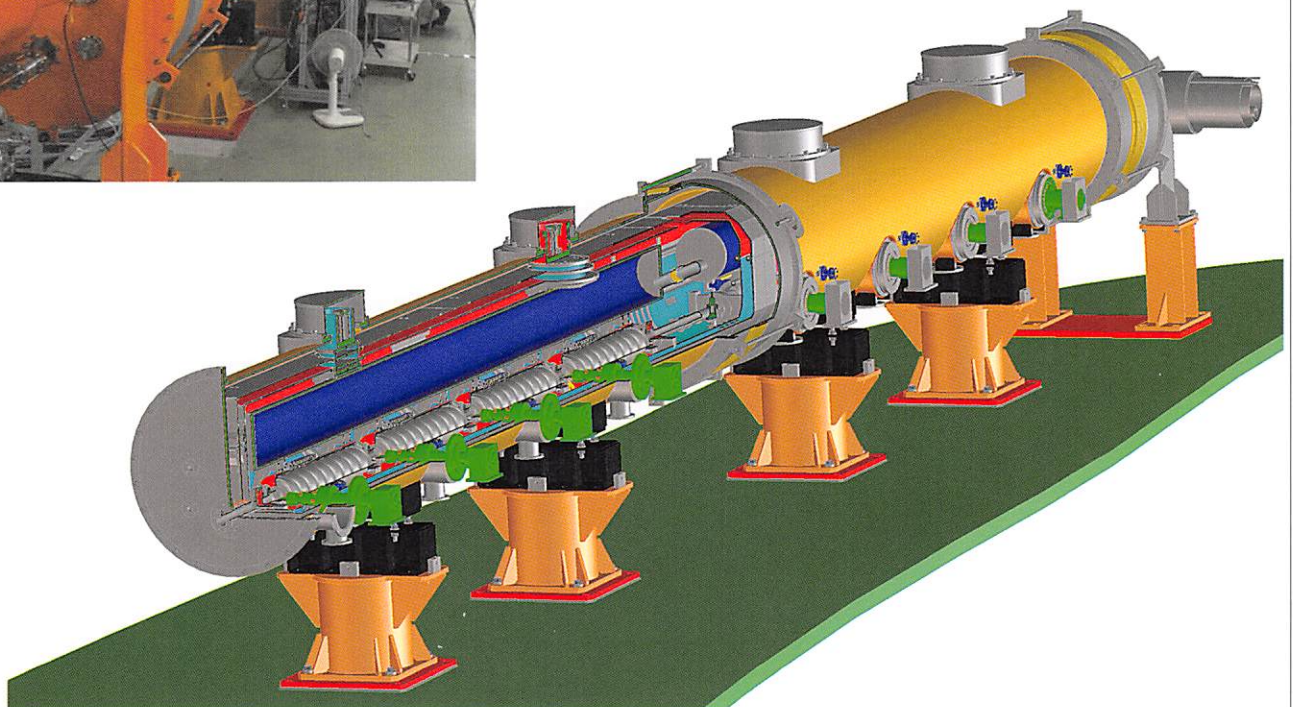
The quality and accuracy of specification and design can improve by using various analysis software and CAD simulation. In addition, if necessary, we conduct strength/durability tests for materials and parts to obtain information.



Analysis of rotor strength



Neutron beam line 100Hz T0 chopper at J-PARC





# MEASUREMENT / EVALUATION

Various tests and evaluations are conducted to ensure the quality control of the parts and machines we make. We also accept the inspection and evaluations necessary to promote a research plan in KEK.

In the Mechanical Engineering Center, the following measuring instruments are equipped in order to inspect and evaluate in-house parts and equipments as well as inspection/evaluation requested by others.

Measuring instruments to measure shape and dimensions such as:  
coordinate measuring machine (CMM), shape measuring instrument, roundness measuring instrument.

Measuring instruments (microscopes) to evaluate surface properties such as:  
an interferometer, a roughness gauge, an ultralow threshold gauge, a laser microscope, an ultradeep-shape-measuring microscope.

Measuring instruments to measure material strength such as:  
hardness gauge, material strength tester, universal measuring instruments (tensile/compression).

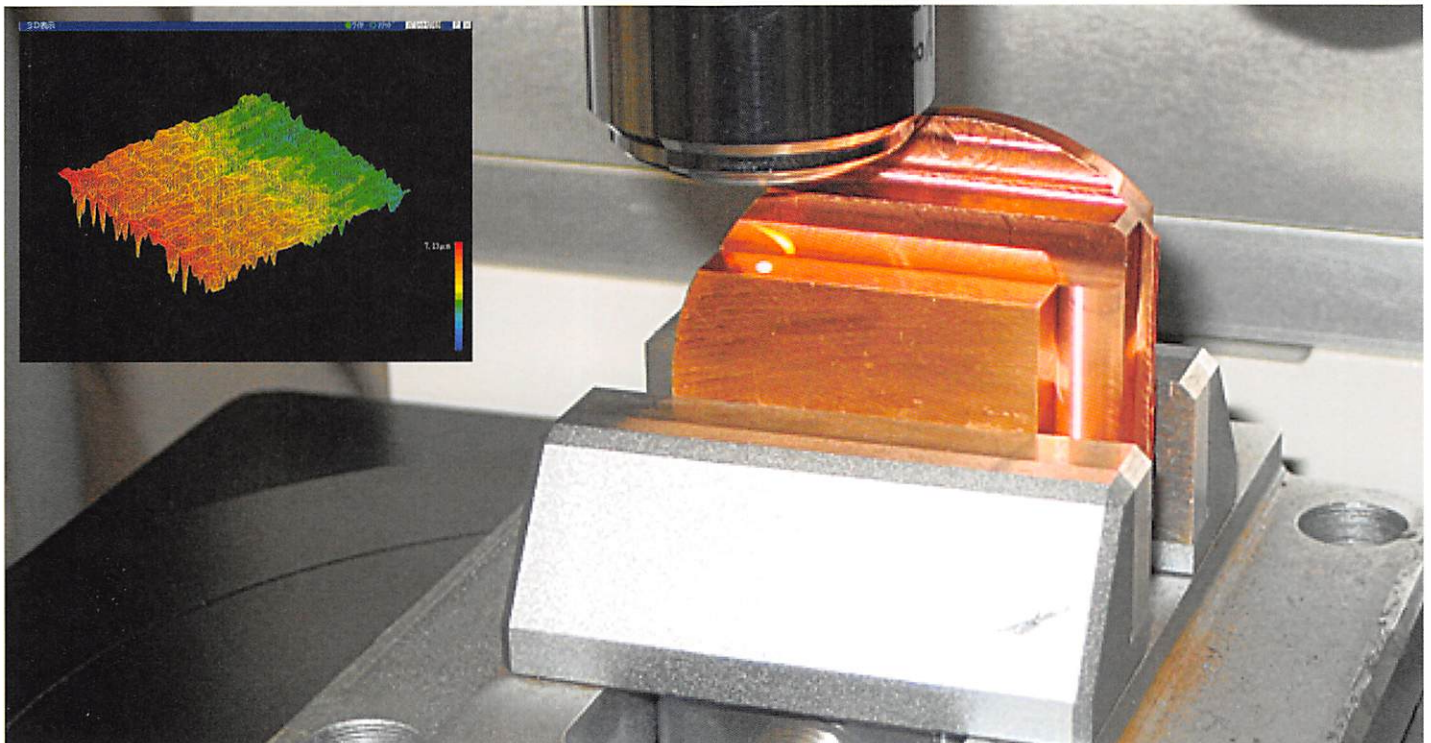
We maintain and manage these instruments for use and at the same time, we make effort to improve our technical skill and knowledge of

machine operations and data analysis. Our unique ideas can be applied to the measuring methods and data analysis. Therefore, we have the ability to meet requirements that exceed the capacity of the existing machine and instruments.

On the other hand, we develop our own measuring instruments for specific functions as well as machines with the capability of ultrahigh-precision measuring, which a general-purpose machine cannot achieve. With these machines and instruments we conduct new measurement /evaluation of research.

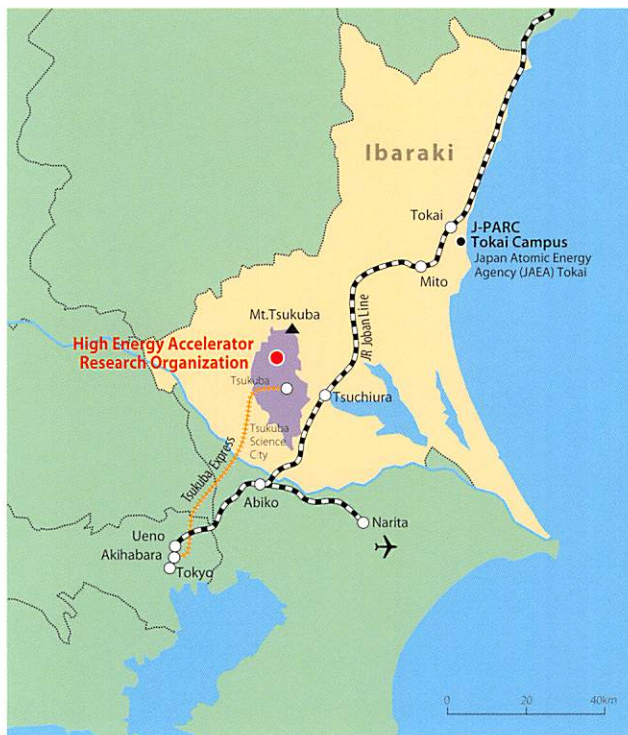


Precise dimension measurement by  $\mu\text{m}$  order using 3D coordinate measuring equipment



Observation of slice machining surface with microscope for ultradeep measuring, and an example of machining surface observed by resolution of sub-micron order.

# ACCESS



- Tsukuba Express  
From Tsukuba Station, take a bus.
- JR Joban line  
Take a bus from Tsuchiura, Arakawaoki, or Hitachinouchiku,  
(45 minutes from each station)  
Joban Expressway Bus "Tsukuba"  
(leaves Tokyo Station by Yaesu south exit)  
Get off at Tsukuba Center and take a bus  
(approximately 80 minutes from Tokyo Station)
- Joban Expressway  
Get off at Sakura-Tsuchiura I.C.  
(approximately 30 minutes from the I.C.)

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