Innovating to Expand the Utilization of Space Frontiers

Leadership Development Program for Space Exploration and Research

Program for Leading Graduate Schools, Nagoya University

Greetings from the Program Director

Program director
Hideyo Kunieda
Vice-president, Nagoya University
Professor, Graduate School of Science
Division of Particle and Astrophysical Science

The people on the surface of the earth are protected from particles, ultraviolet radiation, and X-rays from the space by a thin layer of atmosphere just 100km thick. Humanity acquired the tools to escape this atmosphere and enter space only 50 years ago. Ever since then, humanity has been surprised by the view of space only visible from outside the atmosphere. Earth observation, communications, and weightless experiments which can only be performed in space have become realities. Humanity's other dream, to expand beyond the Earth, has taken people not only to the space station, several hundred km above the ground, but to the moon and Mars as well. Humanity has been captivated by the reality of space, scarcely imaginable from the Earth's surface. You, the reader, doubtlessly feel the same way.

However, we face steep hurdles, such as how to escape the clutches of the Earth gravity, and how to withstand the harsh environment of space. What we are attempting to achieve is to impart to graduate students like yourself the difficulty of the challenges presented by space, and the joy that taking them on brings. The ChubuSat Instrument Development Project, a core course work of our program, begins with considering our mission in space. The experiments and observations which can only be performed in space produce new creative potential that cannot be achieved through ground-based experiments alone. The next step is creating a mission design which satisfies the requirements of the observation and experiments, while withstanding the tremendous vibration, shock, and sound pressure produced by launch. In this project, you will also create detailed designs and prototypes of instrument with an eye to the vacuum, zero gravity, and temperature variation in space orbit, and then perform environmental testing which simulates severe vibration and shock. We would then like to launch the instrument which survives in such harsh tests.

This program aims to provide students with a broad fundamental knowledge about space development, reinforce this knowledge through experimentation, and produce future personnel who can be active in space related industries and research organizations. The most important aspect of space development is achieving high levels of reliability, even in extreme environments, and this program will cultivate this spirit not only through classroom instruction but hands-on work as well. I have been involved in many onboard instruments myself, and hope to share that excitement with you.

and the Program Coordinator

Program coordinator

Hiroyasu Tajima

Professor, Solar-Terrestrial Environment Laboratory
Project Manager, ChubuSat Project

Space is considered to be the final frontier for humankind, however, it is already a part of the foundation of our modern society, with broadcasting, communications and GPS satellites. Already heavily dependent on space infrastructure, we are now indeed moving into an age in which the use of space will only increase further. It is therefore vital for us to advance our understanding of space including the solar-terrestrial environment surrounding our planet, on which both space infrastructure and the daily life of humankind are dependent. We also need to develop and make the best use of technologies designed to protect our social infrastructure and keep us safe and secure.

Despite this clear demand, the space related budgets of many developed countries, including Japan, are leveling off, while China, South Korea, and India, are beginning to catch up with countries with established space programs. Faced with this reality, space industries in many Western nations are expanding mostly in the private sector by employing large numbers of PhD graduates. This global competition has affected Japan, too. While Japan is leading in space science, the development of space technology and the development of advanced materials, at the same time the country lacks sufficient numbers of internationally outstanding leaders capable of devising and implementing projects. As a result, Japan is not always making effective use of the cutting-edge expertise and technology at its disposal.

Taking advantage of proximity to the centre of the Japanese aerospace industry, the Leadership Development Program for Space Exploration and Research at Nagoya University aims to develop world-class leaders who can integrate advanced technologies and knowledge with broad visions and utilize them in industries. Creation of a network of such leaders in next-generation industries will advance and expand the utilization of space technologies and infrastructures that improve people's daily lives.

This program values self-development of students through their own experiences. A flagship of this program is the ChubuSat Instrument Development Project where students engage in space development and utilization through the ChubuSat satellite, Nagoya University's industry-academia cooperative satellite project. In this activity, students do not merely follow predefined procedures, but work in student-led teams of 5 to 8 people in varying fields, competing among themselves and learning from their own failures as they plan and carry out projects. This promotes greater exchange between students in differing fields, and cultivates project planning and management skills, and problem-solving skills that are required of leaders in not only space-related industries but also a wide range of industries.

Additionally, students' global communication skills can be trained in global academic environments through the 3-6 months internship experiences at research institutions in foreign countries. Internship experiences in practical environments at companies will help students broadening their perspectives, acquiring execution skills, and finding their career paths.

We look forward to participation of enthusiastic students who want to develop their leadership skills and to take a lead of the world in space utilization.

About the Program

Goals

The Leadership Development Program for Space Exploration and Research aims to produce individuals who combine the broad knowledge and vision to be able to comprehensively survey a given field of research on the basis of deep specialty knowledge, experience and advanced technology. These individuals will have the ability to lead internationally competitive projects in the space industry and the advanced industries that support it, as well as a wide range of next-generation industries that use space. Activities through their network will lead to expanded use of space that contributes to improving people's lives.

The Leaders We Want to Develop in the Program

The program strives to develop international leaders who can spur innovations that will expand the use of the space frontier. These leaders will combine broad perspectives and solid expertise, project planning, management and execution, problem-solving, and global communication skills. Industry values leaders with rich experience.

Program Features

Development of International Leaders Who Will Expand the Use of Space

This program is the only Program for Leading Graduate Schools in the field of space. It aims to expand the use of space, humankind's largest remaining frontier, while confronting the harsh space environment and fostering international leaders for the next generation who will stimulate developments and innovations in various advanced industries.

Comprehensive Evaluation of Student Achievement

Faculty members constantly monitor their students' activities and evaluate students' leadership abilities (execution, problem-solving ability, motivation, planning ability, etc.) and their contributions in each activity, assessing their level of achievement in a way that cannot be measured by their performance in coursework only.

Developing Leaders While Emphasizing Students' Independence and Execution

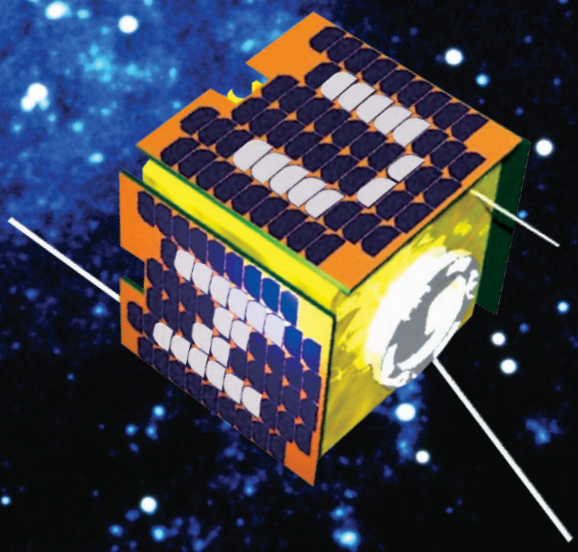
The program helps students to acquire their own images of leadership and real-world knowledge by providing a series of seminars in which leaders in various fields relate their own experiences and global leadership training course in which students gain the knowledge needed to become international leaders through interactive courses. Students are also provided opportunities to think deeply about and practice leadership; students themselves plan seminar topics and materials and plan and organize various activities, such as sessions to discuss and exchange opinions on various issues with faculty members.

Satellite Instrument Development Project

The ChubuSat Instrument Development Project uses ChubuSat, a 50-kg class microsatellite developed mainly by Nagoya University. The project is carried out in conjunction with the Advanced Technology Office and Industry, Academia and Government Cooperation Office. Students carry out independent projects to foster their problem-solving and project management skills. Students cooperate with others from different academic fields in working toward a common goal of proposing a satellite mission, resolving problems themselves when they are encountered with. This stimulates multidisciplinary interactions with different ways of thinking.
See page 7 for details.

Internships to Gain Broad Experiences Beyond the University Environment

Students' global communication skills are fostered through experiences in international research environments in research institutions in various countries. Their outlook is also broadened through experience of practical environments in companies, helping them to acquire practical abilities and gaining support for a career path.



Program Curriculum

Curriculum to Gain Solid Expertise, and Broad Perspectives

Basics for Space Science and Engineering

Students reinforce the fundamentals of space science and engineering through online lectures on mechanics, electromagnetism, statistical thermodynamics, mathematical physics, and programming

Video Lectures on Space Science and Engineering

Video lectures on space fundamentals (particle physics, astrophysics, solar-terrestrial physics, space engineering), space applications (astronomical, space plasma and earth observations; space communications), space development (space transportation, satellites, space environment and weather, space exploration), and advanced technologies (materials, instrumentation and measurements, numerical simulations).

Overview of Space Research and Development

Students acquire basic knowledge covering the areas of science and engineering necessary for space research and development, including space engineering, space science, manufacturing and numerical simulations, organizational management, and scientific literacy.

Classroom Scene in "Overview of Space Research and Development" Session

Lecture Courses on Space Science and Engineering

This group includes a lecture course on a satellite system (introduction of satellite, subsystem details, parts and materials control, assembly and tests, launches, ground stations, and operations). There is also a lecture course on *monozukuri* (manufacturing and engineering) and an advanced general engineering laboratory course (Graduate School of Engineering).

Short Courses on Space Science and Engineering

This group includes short courses on application and development of satellites; thermal design, analysis, and practical training; structural design, analysis, and practical training; and short courses on *monozukuri* (manufacturing and engineering).

Curriculum to Foster International Communication and Practical Leadership Skills

English Training

English classes are mandatory for program students who have not achieved the required level of English proficiency by English assessment test as IELTS and others.

Internships

These internships allow students to experience global research environments at research institutions in foreign countries or real-world working environments at companies.

Leadership Development Seminars

Full-time faculty members organize seminars and discussions in each of the following categories, conducted mainly in English. Students need to participate at least a specified number of seminars (5 times or more) in each category during their program course.

1. Seminars and discussions featuring leaders in various fields
2. Seminars on the human science and social matters (government, business, finance and other topics)
3. Seminars on space applications (observation, exploration, manned space missions)
4. Seminars on *monozukuri* (manufacturing and engineering) and factory tours at companies
5. Seminars for self-training including student-organized events

Global Leadership Training

Interactive lectures and exercises for students to acquire international knowledge and perspectives (international relations, business, international law, space law, international joint projects, international competition), global communications training (cross-cultural exchange, negotiation and presentation skills), case studies of projects, and management training.

Curriculum to Cultivate Problem-Solving, Organizational Management, and Execution

ChubuSat Instrument Development Project Mission Proposal Phase
(Up to eight hours per week for six months)

Teams of five to eight students from differing academic fields prepare mission proposals that utilize ChubuSat microsatellites. These projects are organized and carried out by students to develop their problem-solving, organizational management, and execution. Proposals judged to be the most meaningful and viable may be supported until launch in ChubuSat Instrument Development Project Flight-Model Fabrication Phase.

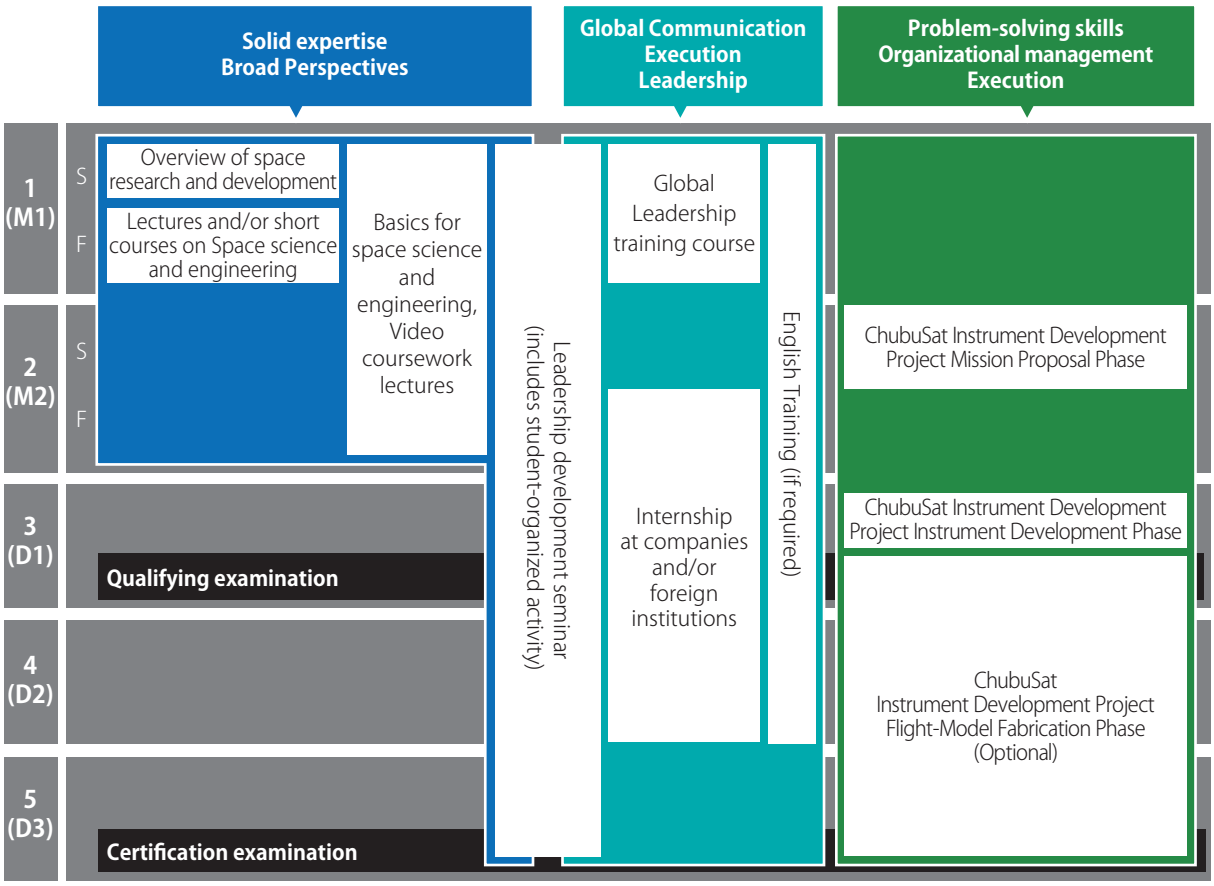
ChubuSat Instrument Development Project Instrument Development Phase
(Up to 16 hours per week for three months)

Students choose from the following projects related to ChubuSat instrument development and operation.

- Continuing work on fabricating and testing a prototype instruments proposed in ChubuSat Instrument Development Project Mission Proposal Phase
- Development related to actual ChubuSat satellites (GPS position measurement, solar panel deployment mechanism, on-board computers utilizing commercial FPGA, etc.)
- ChubuSat operation-related (attitude control adjustment, etc.)

ChubuSat Instrument Development Project Flight-Model Fabrication Phase

Students may participate in the development of highly-feasible satellite instruments selected from ChubuSat Instrument Development Project Mission Proposal Phase. Students participate on the team of their choice to continue development with the support of a faculty advisor. The goal is to install instruments on a ChubuSat for launch. Students are not limited working of the instrument proposed by their own team.



Curriculum overview

ChubuSat Instrument Development Project

Overcoming Failures in Carrying a Project to Completion

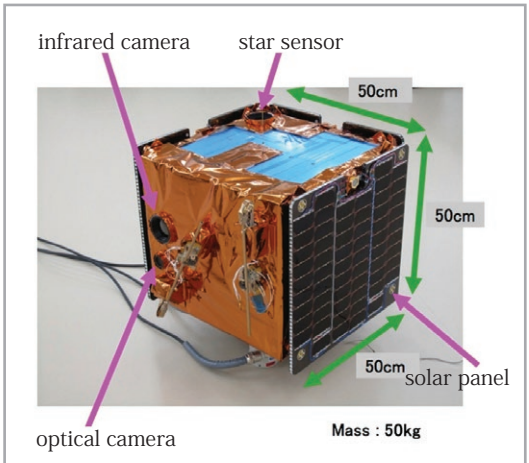
Practical experience in space development and utilization is gained through the use of ChubuSat, a joint industry-academia artificial satellite project led by Nagoya University. Students propose onboard instruments and carry out simulations • design, fabrication, environmental tests, preparations for installation on satellite, and operation and data analysis. Through these activities they experience the development of satellite instruments under the guidance of faculty members. Projects are not carried out according to pre-determined procedures; rather, teams of five to eight students from different areas plan and carry out projects while encouraging and competing with each other and overcoming difficulties and failures. This stimulates interactions among students from different academic fields and helps them to cultivate the skills and abilities needed to serve as leaders in advancing a wide range of industries, not limited to those related to space. This includes planning ability, organizational management ability, and problem-solving ability. The ChubuSat Instrument Development Project consists of three phases, and in Flight-Model Fabrication Phase students are actually given the opportunity to develop instruments that will be onboard ChubuSat.

Students presenting interim reports in English

Students working on the ChubuSat Instrument Development Project

ChubuSat

ChubuSat is a microsatellite of about 50 kg, jointly developed by Nagoya University, Daido University, and the *Monozukuri* Aerospace Support Technology Team (MASTT), a consortium of 24 small and medium-sized aerospace enterprises in the Chubu Region. It was developed with the aims of decreasing satellite costs and lowering the barrier to participate in space development. These efforts are intended to stimulate participation in space development by private enterprise, and expand space utilization by expanding private-sector demand—goals which align with those of our program. The first satellite, ChubuSat-1 (Kinshachi-1) was launched from Yasny, Russia on November, 2014 using a Dnepr rocket. One of the projects proposed by our students is expected to be launched as ChubuSat-2 in FY2015.



ChubuSat-1 (Kinshachi-1)

Student Support

Financial Aid

- As a rule, all students of the program will receive 85,000 yen per month as a basic scholarship to allow them to dedicate themselves to the course curriculum (excluding students receiving Society for the Promotion of Science Research Fellowship and other scholarships). A full scholarship of 150,000 yen per month will be provided to high-achieving doctoral course students to encourage them to complete a higher volume of coursework than that required to complete the program, obtain greater levels of achievement, participate in various internships, and contribute as leaders in student activities. Screening for this scholarship is conducted every 6 months for doctoral course students. To qualify, a student must fulfill the requirements for the full scholarship at the time of the screening.
- Students wishing to receive other financial assistance and those who have been accepted for a Society for the Promotion of Science Research Fellowship are asked to inquire at the Admissions Office for details, since the level of financial aid will differ.

Special Category for International Students (See also page 9)

- In most cases international students accepted in this category will receive a scholarship of 200,000 yen per month from M1.
- In the special category for international students, restrictions exist in cases when other forms of financial assistance are also being received. Please inquire at the Admissions Office for details.

Course and Research Support

Program students receive the following support to encourage and support their coursework and independent studies.

- Students receive travel and living costs to support international and corporate internships.
- Students may receive up to 300,000 yen for expenses involved in attending international schools or participating in international conferences to present research results. This support is competitive, with multiple opportunities provided to submit applications. About 20 applications will be accepted each year.
- Students may receive up to 1,000,000 or 1,500,000 yen depending on research categories for expenses to encourage original and independent studies. Applications can be submitted a couple of times each year, with about 20 applications accepted annually through a competitive selection process.
- Support of up to 50,000 yen per person is given for travel within Japan so that students can participate in domestic meetings and conferences.

Advisor System

Every year, two faculty members are assigned as the faculty advisers to students of each grade. These academic-year advisors monitor students' overall progress during the year as well as their level of achievement in each course, holding interviews with students about every six months to provide suitable advice to each individual. They are also available to respond to students' questions about coursework or other issues. Academic-year advisors report the progress of students under their supervision at regular education committee meetings held every week. Problems are discussed by the entire faculty if any.

Career Path Support

Career path support for LGS program students is provided primarily by faculty members in charge of industry-academia-government collaboration, and includes support for corporate internships. The faculty members monitor students' career paths and provide guidance and support. They also work in collaboration with the Nagoya University Human Resources Development Division and Business Capacity Development Center to support the development of a variety of career paths.

Candidates and Selection Process

Eligible candidates

- As a rule, M1 graduate students of Nagoya University who have decided to continue on to a doctoral program
- Students who can commit to this program until obtaining a degree or the program concludes
  For example, even if a student in the program is accepted for a Society for the Promotion of Science Research Fellowship DC1 or DC2, he or she will not be able to leave this program.

Guidance for new M1 spring applicants
(held at the beginning of April)

Number of Students to be Admitted

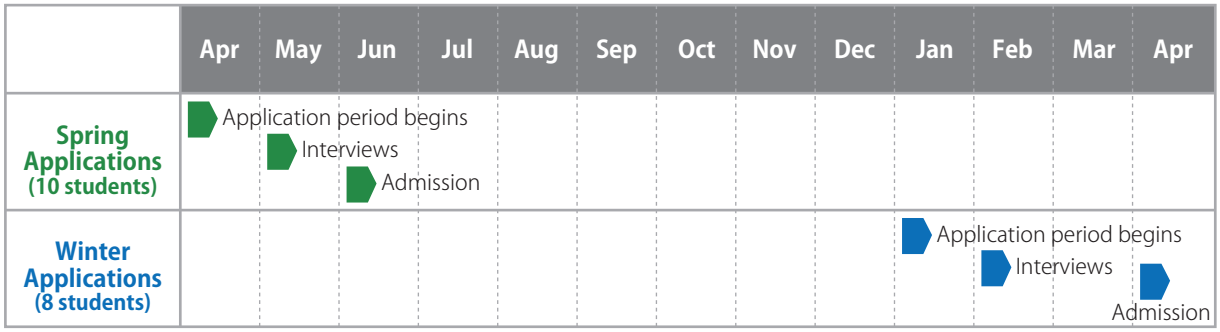
- Twenty students, including two within the D1 admission category and five within the international student pre-admission category.
- The following number of students is reserved for each postgraduate course to ensure the diversity of students.
  — Science + Mathematics: 5 students, Engineering: 5 students, Environmental Studies: 1 student —
  If this number is not filled during winter admissions, students will be selected from other postgraduate courses.

International Student Pre-admission Guidelines

- In order to acquire excellent students currently residing in other countries, only international students who have graduated, or will graduate, from a university outside Japan are accepted in this category. As a rule, these applicants will take the LGS screening prior to the entrance examination. The reserved number of students for the postgraduate course does not apply to applicants in this category.
- Up to top three students accepted within the pre-admission category will receive generous financial aid within the "special international student category."
- Students not admitted under the special international student category may still apply to receive the same financial aid as regular students.

Application Period

New students are admitted twice a year, in the spring and winter.



Note: D1 transfer students are admitted in fall and spring, while international pre-admission students are accepted at any time. Please inquire at the Admissions Office for details.

Selection Process

Applicants will be selected on the basis of their aspirations as described in their application form, the opinions of faculty members, and the results of their interview. A range of perspectives will be considered in the selection of applicants, including the applicant's desire to participate in the program, his or her prospects of displaying international leadership in the space related industry in the broad sense, after acquiring a PhD, and his or her vision of leadership, basic academic skills, ability to form logical, simple, and persuasive explanations, communication skills, and English proficiency.

Organization and Faculty

There are 68 program members, including 55 from Nagoya University, 1 from foreign university, 4 from research institutions in Japan, 3 from industry, 1 from government committee.
In addition, there are 16 specially appointed staff and 14 administrative staff.
(As of January 1, 2015)

Affiliated Institutions

Participating Schools and Departments at Nagoya University
Division of Particle and Astrophysical Science, Graduate School of Science
Department of Aerospace Engineering, Graduate School of Engineering

Eight Universities in Other Countries
Michigan State University
Ohio State University
Seoul National University
University of California, Berkeley
University of Colorado
University of Leicester
University of Michigan
University of Oxford

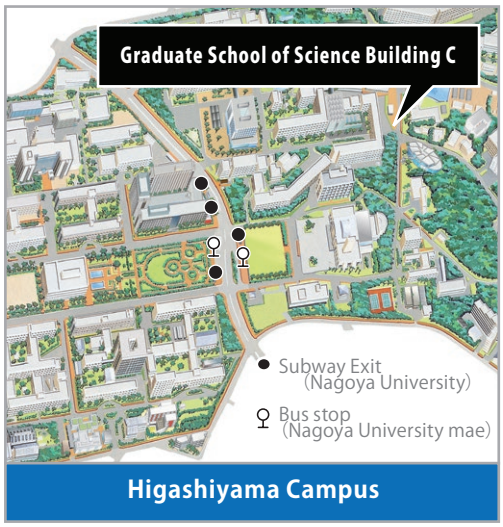
Universities and Institutions in Japan
Aichi Medical University
High Energy Accelerator Research Organization
Japan Aerospace Exploration Agency
Keio University
Osaka University

Companies
Boeing Company
Hamamatsu Photonics
Mitsubishi Electric Advanced Technology R&D Center
Mitsubishi Heavy Industries, Ltd., Aerospace Division
NEC Space Systems, Ltd.
Toyota Motor Corporation

Supporting Companies
APC Aerospecialty Inc.
Hikari Manufacture Co., Ltd.
Kosaka Iron Works Co., Ltd.
Matsuda Kako Co., Ltd.
Meioh Electronics, Ltd.
Tamagawa Industries, Ltd.
Toyo Koku Denshi Co., Ltd.

(in alphabetical order)

Contact



C315, Graduate School of Science Building C
Graduate School of Science, Nagoya University

Furo-cho, Chikusa-ku, Nagoya
464-8602, Japan
Tel:+81-52-789-2930 Fax: +81-52-789-2931

E-mail : office@frontier.phys.nagoya-u.ac.jp
URL : http://www.frontier.phys.nagoya-u.ac.jp