Advanced Technology Center
A Partner of Innovate Astronomy

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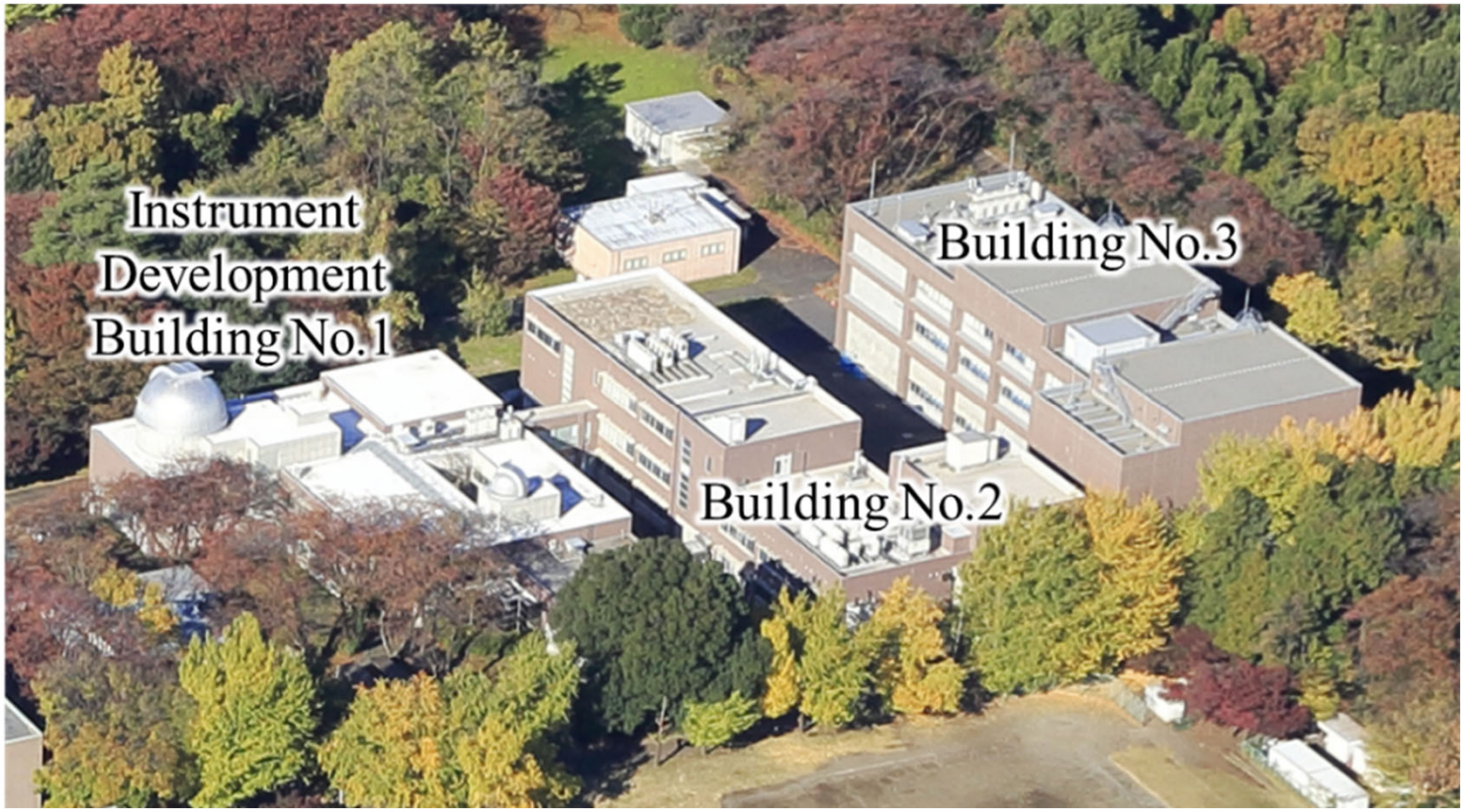
A brief overview of ATC

ATC is the center of instrument development for ground base and space telescopes at NAOJ. It covers Optical/IR and radio astronomy, as well as gravitational wave detection system.
Established in 1993 at NAOJ Mitaka campus initially for Subaru Telescope, ATC now covers ALMA, KAGRA, TMT, SOLAR-C, JASMINE, etc., and has now ~60 employees (research, engineering, and support staff).

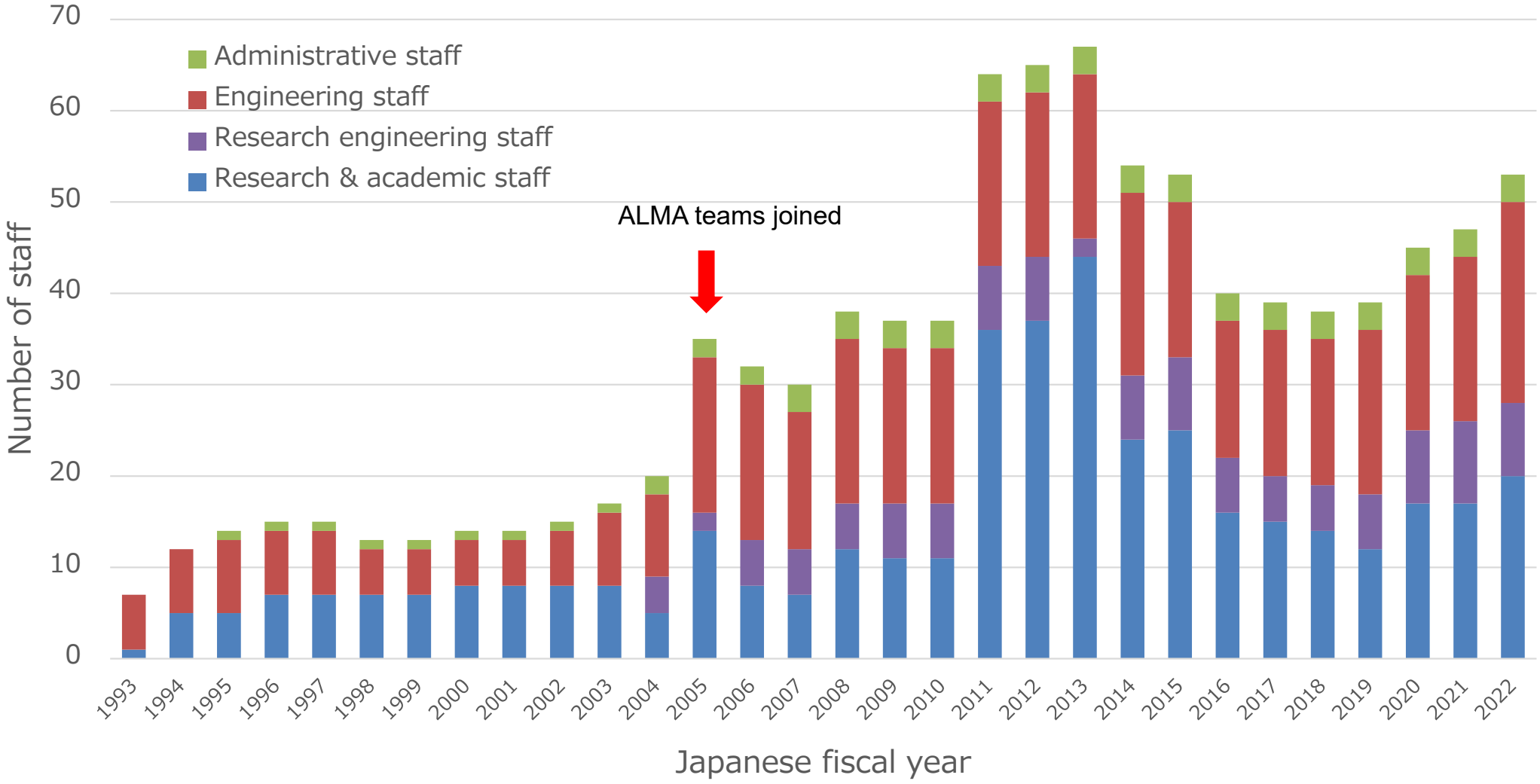


Missions

1. to support astronomical projects (ground and space) as a research and development center for advanced technologies (astronomical project support),
2. to pioneer internationally competitive technologies related to astronomy (development of new technologies), and
3. utilizing the above opportunities, to provide scientific activities and educational programs for undergraduate and graduate students, and young researchers and engineers (young scientist training).

from ATC-TD-001

Number of Staff

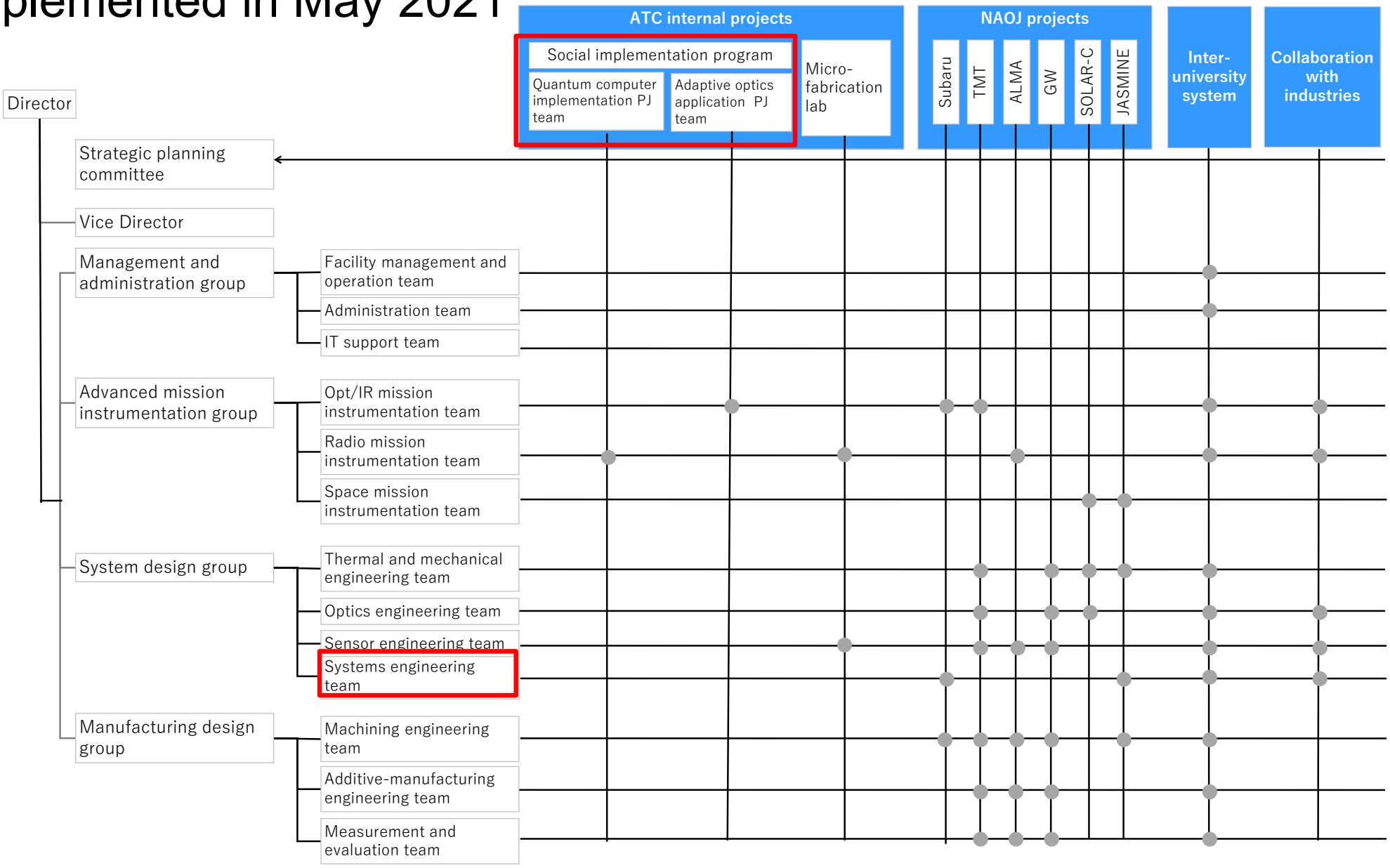


ATC has been requesting NAOJ top management to hire necessary staff, resulted in increasing the number.

New Organization Structure

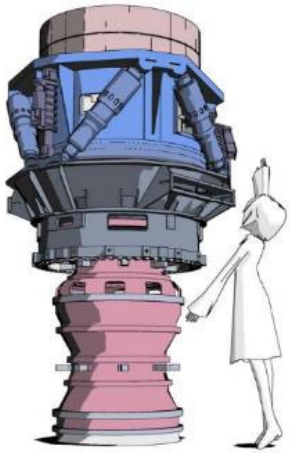
Implemented in May 2021

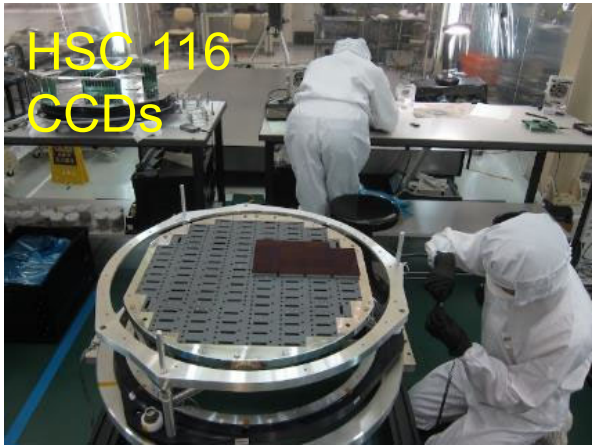
As of November 2023



Achievement

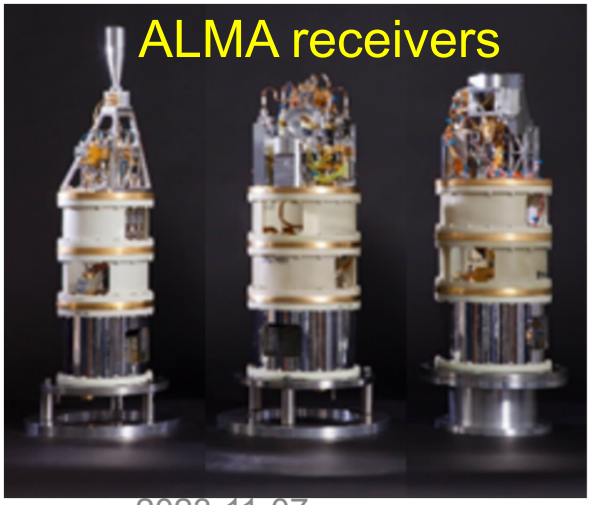
1) Instruments for Subaru Telescope:
Suprime-Cam (Prime focus camera), Adaptive optics, Hyper Suprime Cam (1.5 deg FOV prime focus camera for 8m telescope), etc

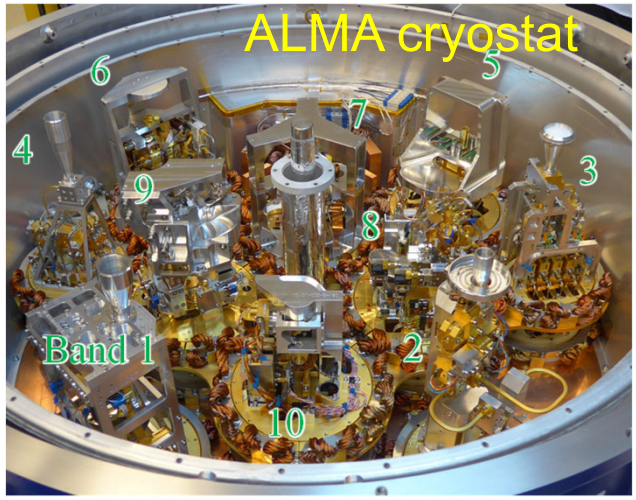




2) ALMA receivers:
Bands 4, 8, 10 receivers, 73 units for each band and 219 in total. Band 10 was the most challenging high frequency receiver for ALMA. ATC developed all the mixers and the systems in-house.

3) Space programs
Hinode (Solar telescope 50 cm), CLASP (rocket launched Ly-α spectrograph)



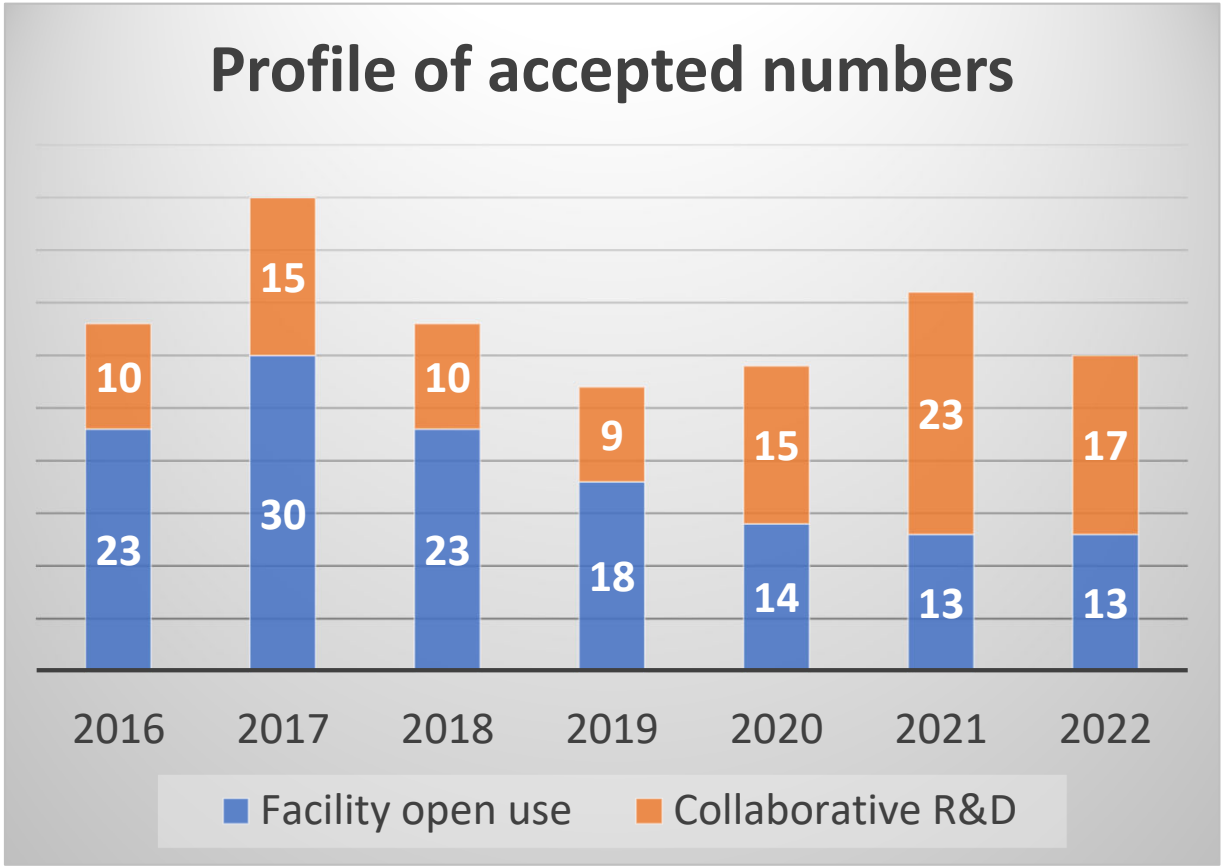


Past Projects and ATC's Role

Project	Instrument	Design	Manufacturing	Assembly	Integration	Test
Subaru	Suprime-Cam	✓	✓	✓	✓	✓
	Adaptive Optics	✓	✓	✓	✓	✓
	Hyper Suprime-Cam	✓	✓	✓	✓	✓
ALMA	Band 4 Receiver	✓	✓	✓	✓	✓
	Band 8 Receiver	✓	✓	✓	✓	✓
	Band 10 Receiver	✓	✓	✓	✓	✓
	Band 1 Receiver (optics)	✓	✓ (partial)			✓ (partial)
Hinode	Science Instrument			✓	✓	✓
KAGRA	Vibration Isolator	✓	✓	✓	✓	✓
	Optics	✓	✓	✓	✓	✓
CLASP	Science Instrument		✓	✓	✓	✓
CLASP2	Science Instrument	✓	✓	✓	✓	✓
Sunrise-3	Science Instrument	✓	✓	✓	✓	✓
FOXSI-4	Science Instrument		✓			✓

Accepted open use and collaborative R&D

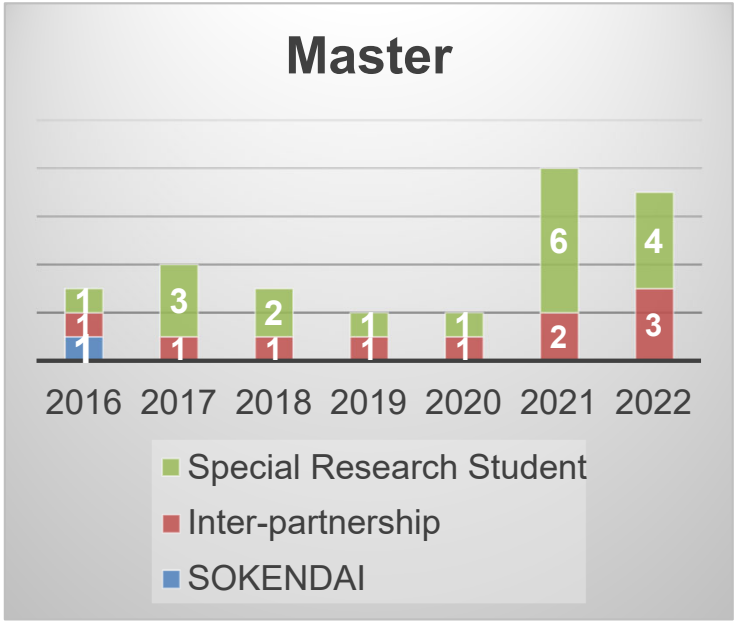
- The ATC accepts applications from and universities and research institutes in two categories: facility open use and collaborative R&D.
  - Collaborative R&D: R&D conducted in collaboration with the ATC staff
  - Facility open use: Use of the ATC facilities or laboratories

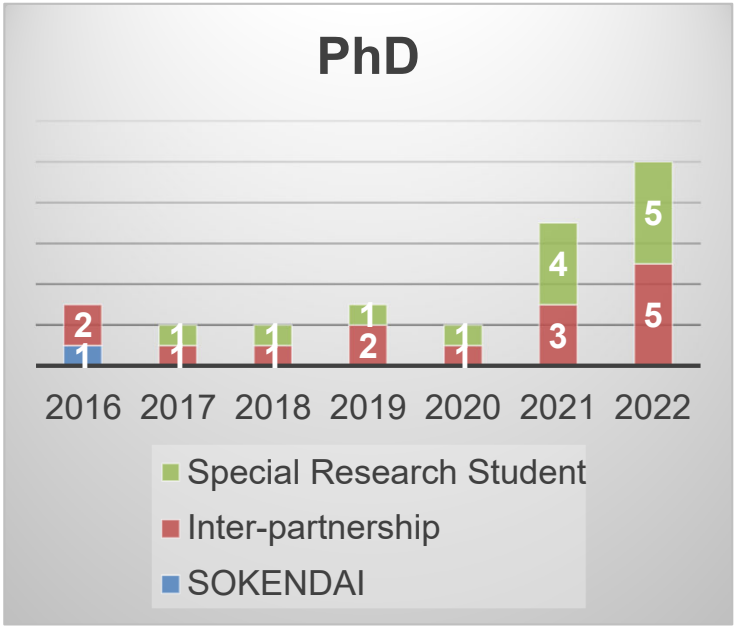


Accepted students

●There are three graduate-education system to accept students at the ATC: the Graduate University for Advanced Studies (総合研究大学院大学：SOKENDAI), Inter-partnership universities（連携大学院）, and Special Research Students (特別共同利用研究員) from the other universities. Accepted students can take full advantage of opportunities to participate in state-of-the-art astronomical instrument programs, and to obtain know-how from researchers and engineers with broad experience in research and development. We also support undergraduates who are interested in the development of astronomical instruments through various opportunities such as summer student programs.

FY	Under graduate	Master	PhD	Total
2016	1	3	3	7
2017	0	4	2	6
2018	1	3	2	6
2019	3	2	3	8
2020	4	2	2	8
2021	3	8	7	18
2022	1	7	10	18

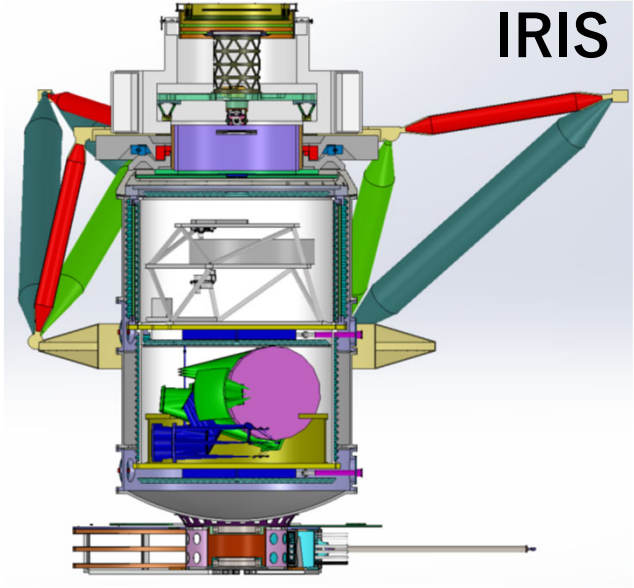


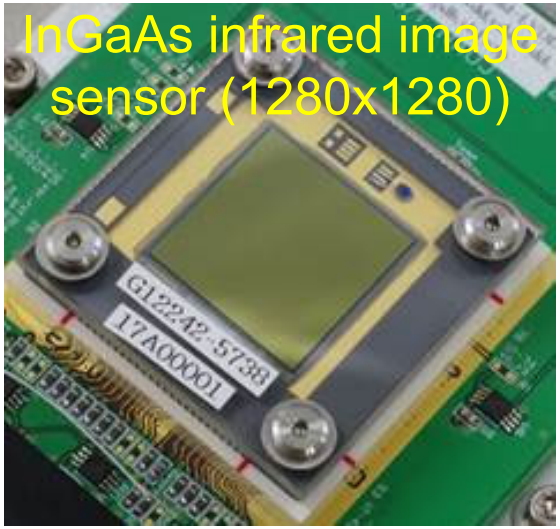


ATC is aggressively increasing the numbers through the efforts of its research staff. Most of the students accepted are Special Research Students and from Inter-partnership universities.

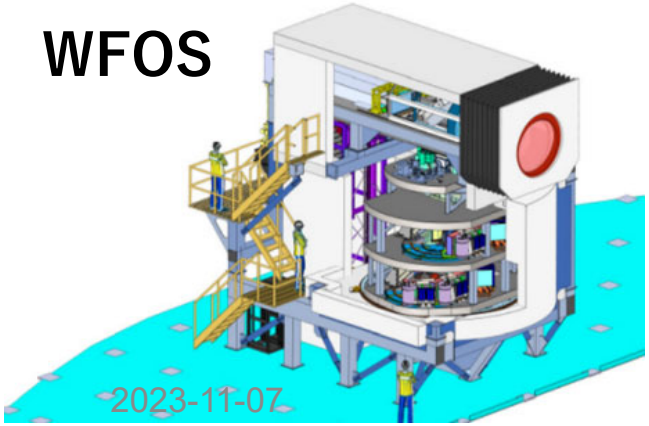
Current activities

1) **TMT instruments:** IRIS (IR imager& spectrograph) imager and WFOS
2) **KAGRA:** Optical system and vibration isolation system -> O4 observation
3) **ALMA2:** Upgrade of Band 8 & Band 10, support of Band 2, Multi-beam, etc.
4) **Infrared detector**: InGaAs image sensor with low-noise CMOS readout circuit
5) **Space programs:** SOLAR-C (EUVST), JASMINE/Detector Box Assembly

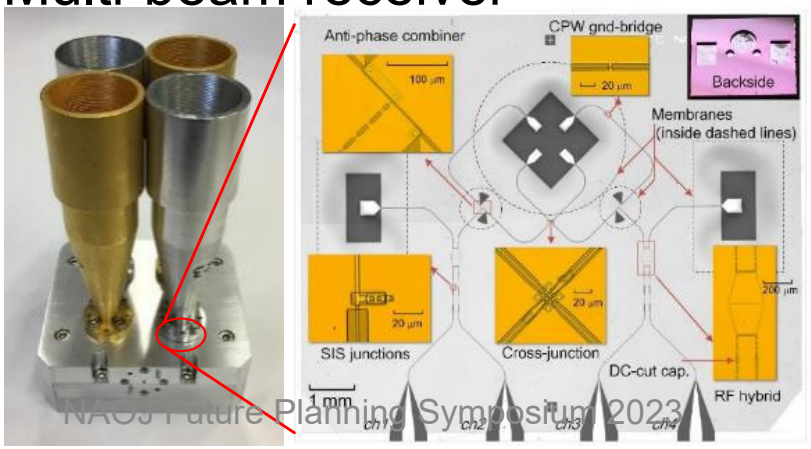


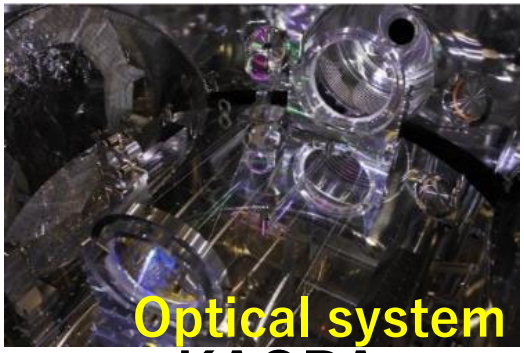


WFOS



Multi-beam receiver





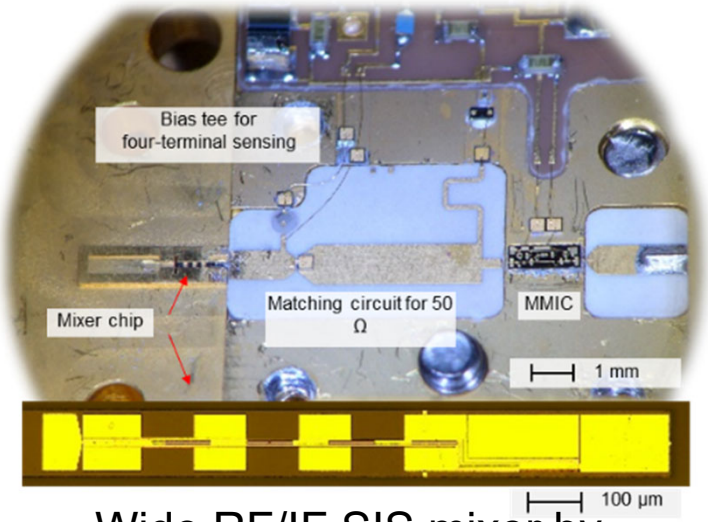
KAGRA

Ongoing Projects and ATC's Role

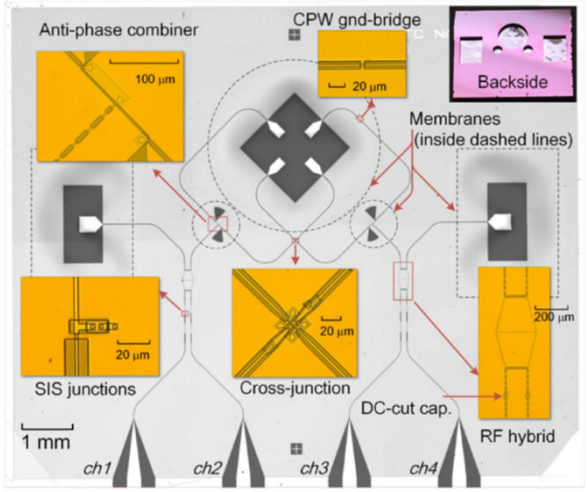
Project	Instrument	Design	Manufacturing	Assembly	Integration	Test
Subaru2	GLAO	✓	(✓)			
ALMA2	Band 8 Receiver	✓	✓	✓	✓	✓
	Band 10 Receiver	✓	✓	✓	✓	✓
ALMA	Band 2 optics	✓	✓	✓		✓
TMT	IRIS Imager	✓	✓			
	WFOS System	✓			✓	✓
	System structure	✓				
KAGRA	Small Isolator	✓	✓			
SOLAR-C	Mission subsystem	✓	✓	✓	✓	✓
JASMINE	Detector subsystem	✓	(✓)	(✓)	(✓)	(✓)
NINJA		(✓)	✓		✓	✓

Promising technology 1

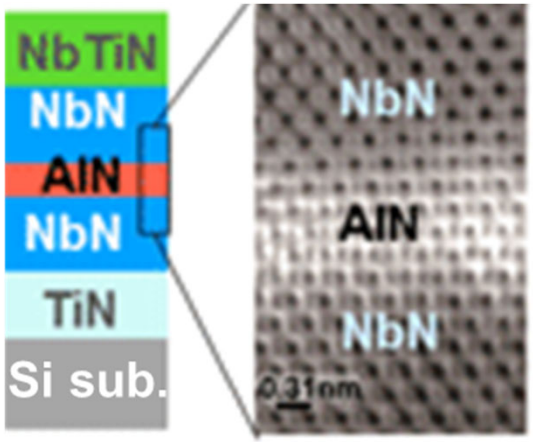
- Radio-wave field
  - Direction of technology development: wideband, multibeam, high frequency



Wide RF/IF SIS mixer by T. Kojima



SIS mixer IC for multi-beam by W. Shan & S. Ezaki

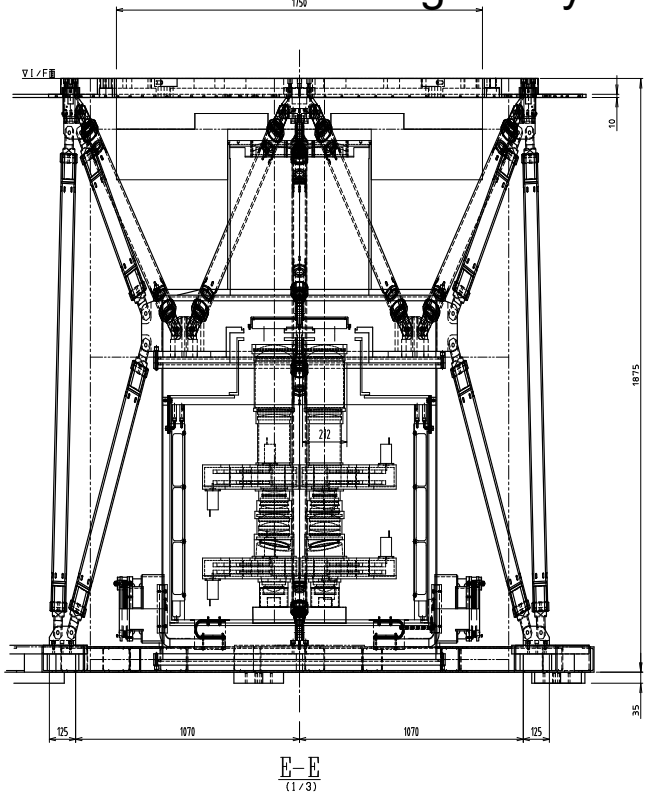


Epitaxial NbN SIS junctions by K. Makise

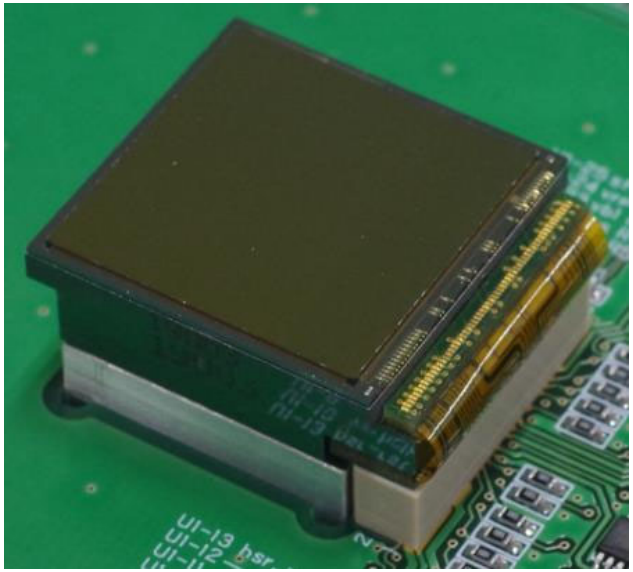
- Superconducting device fabrication technology is essential.

Promising technology 2

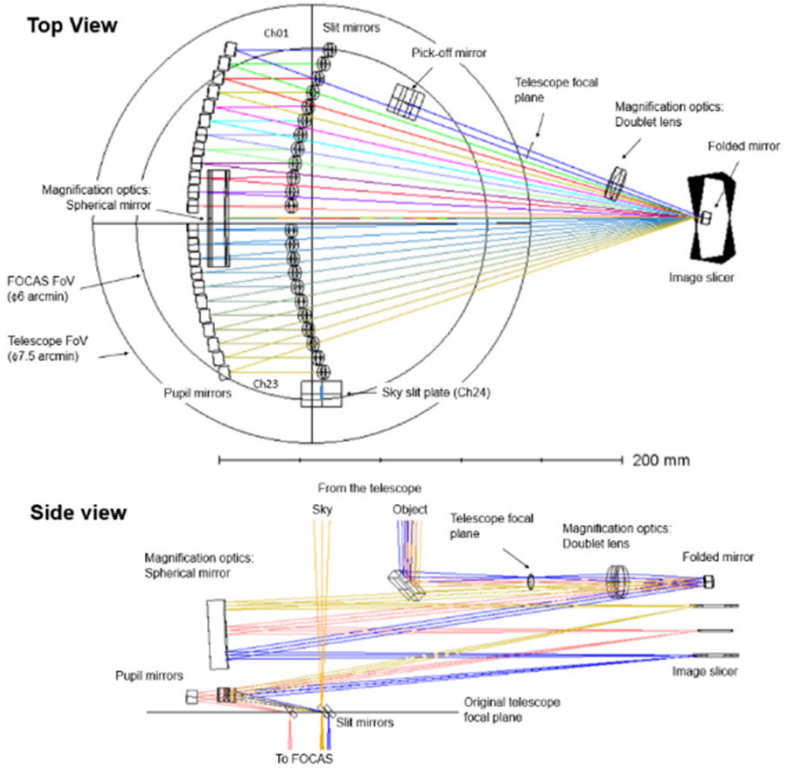
- Optical and IR field
  - Direction of technology development: high sensitivity, high resolution, wide field of view, spectroscopy, but impossible to cover everything at ATC
  - Identified technologies: System integration, detector, IFU, optical design, adaptive optics



Wide Field Imager for ULTIMATE Subaru / design led by K. Motohara



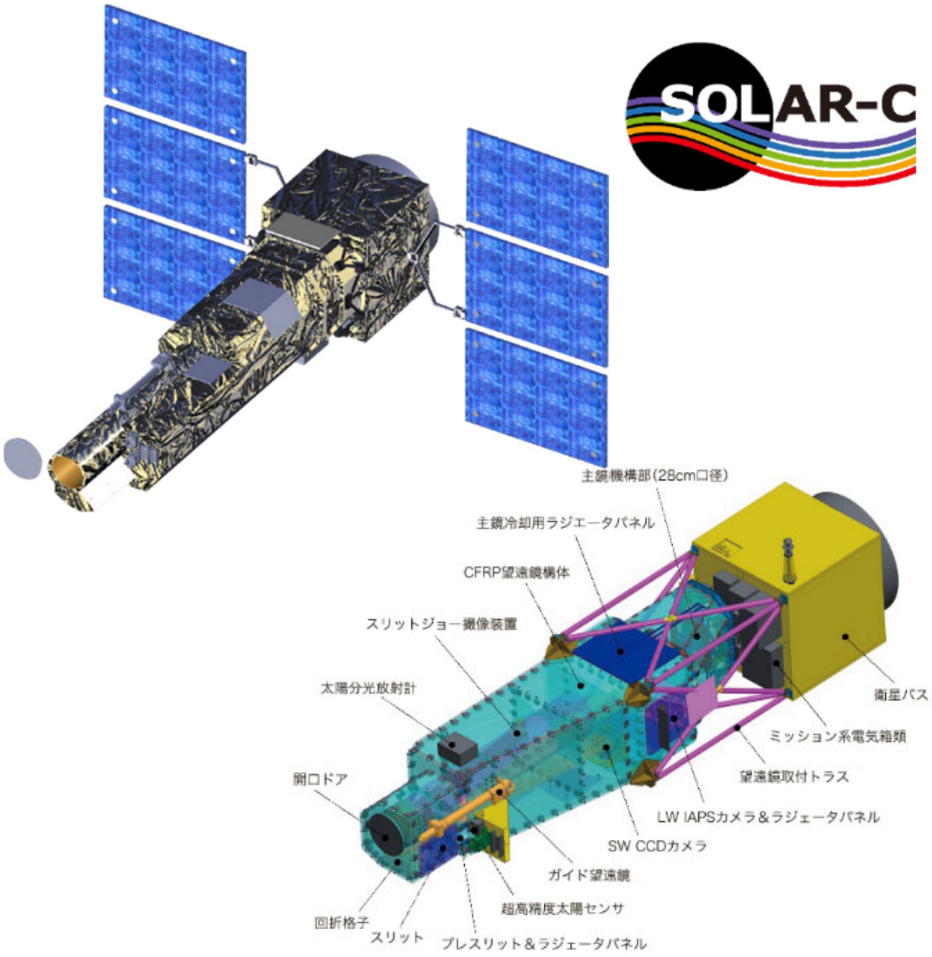
InGaAs infrared image sensor (1280x1280) developed by H. Nakaya



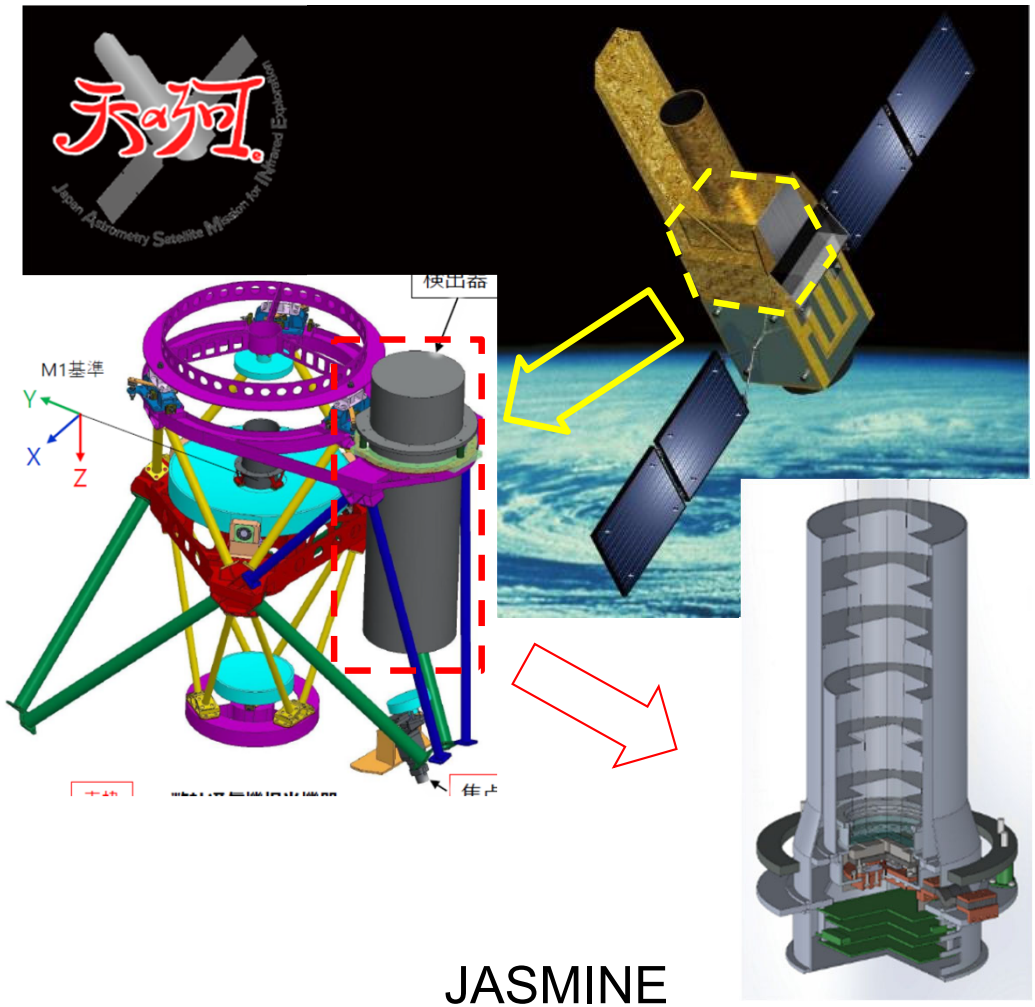
FOCAS IFU designed by S. Ozaki, T. Tsuzuki et al.

Promising technology 3

- Space mission filed
  - Direction of technology development: to participate in future international large space mission
  - There are JASMINE and SOLAR-C projects to obtain necessary fundamental technologies



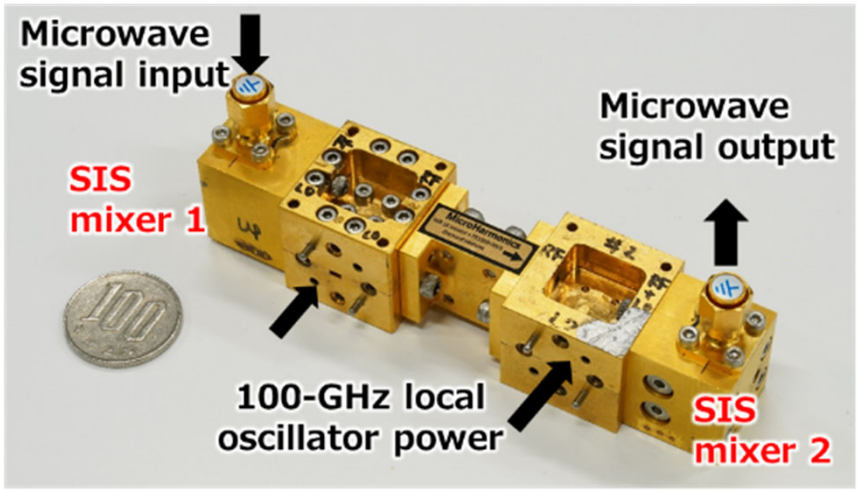
SOLAR-C



JASMINE

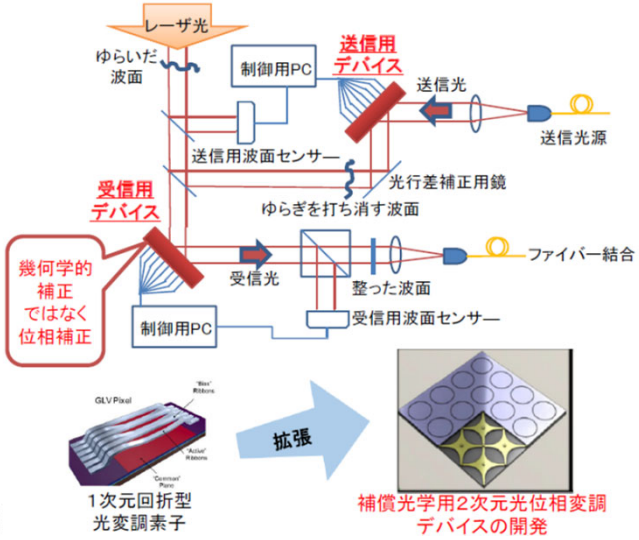
Social Implementation Program

- From technologies for astronomical observation instruments to the society
  - Collaborating with the Industry Liaison Office of NAOJ
- Quantum computer implementation project team
  - In radio telescopes, radio waves arriving from various celestial objects are received by receivers using superconducting technologies.
  - The technologies can be applied to ultra-low-noise amplifiers or isolators for fault-tolerant quantum computers.



An “SIS amplifier” using two SIS mixers

- Adaptive optics application team
  - To apply the adaptive optics technology developed mainly in the Subaru Telescope to microscopes and other optical instruments, and communication technology.
  - Participating in MIC「衛星光通信用次世代補償光学デバイスの研究開発」
    - Development of high-speed, high-tolerance, compact AO wavefront control devices for satellite-to-ground communications



Evaluation of ATC engineering capabilities

	Item	SRON (~200 staffs)	UK ATC (~120 staffs)	ATC (~60 staffs)	Evaluation
Capability of developing instrument	Mechanical design	Yes	Yes	Yes	Fair
	Mechanical production	Yes	Yes	Yes	Fair
	Electrical design	Yes Both analog and digital	Yes	No Few staff	Needs improvement
	Electrical production	Yes	Yes	No Outsourcing	Needs improvement ⇨ Outsourcing
	Optical design	Yes Included in the instrument science group	Yes	Yes Few staff	Good
	Software design	Yes Included in electrical design	Yes	No Designed by project members or ADC	Needs improvement
	Systems engineering	No Assigned among project members	Yes	Yes Just started, Few staff	Needs improvement
	Safety and product assurance	Yes (6 staffs, 1 proper staff) Rich in experiences	Yes (1 proper staff)	Yes Engineering Promotion Office is preparing	Needs improvement ⇨ Outsourcing
Experience	Spaceborne instrument	Rich	Herschel/SPIRE, JWST/MIRI, etc.	SOLAR-B Not so rich	Needs improvement
	Large ground-based instrument	Not so rich	Rich	Rich	Good

Strength: Close communication between mechanical/optical designs and mechanical production teams.

Weakness: Electrical engineering, systems engineering, spaceborne instrument

Recommendations in external evaluation

- External evaluation was held in March 2022
- Committee member: M. Hidaka (AIST), N. Iyomoto (Kyushu Univ.), N. Kuno (Univ. of Tsukuba), A. Lee (UCB), A. Moore (ANU), T. Shimizu (ISAS), W. Wild (CTA Obs.)

Recommendation from the committee	Action plan of ATC
ATC experiences a shortage of staff particularly in two main areas: maintenance and servicing of the clean room, and too few engineering staff in the area of electrical engineering. To maintain and strengthen the world-leading role of the ATC, the panel recommends considering improvements in these two areas of staff shortage.	**ATC hired an engineer and is hiring several technical staff for clean room maintenance and operation.** **ATC hired a professor and is requesting a research engineer in electrical engineering.**
Considering that good systems engineering is a key element in handling technically complex instrumentation, the committee encourages the ATC and NAOJ to consider establishing and strengthening a common system engineering effort within ATC.	Participate in SE training course. (11 people from ATC in 2022) **ATC hired a research engineer in systems engineering. Started OJT in Subaru2/GLAO and JASMINE.**

Recommendations in external evaluation

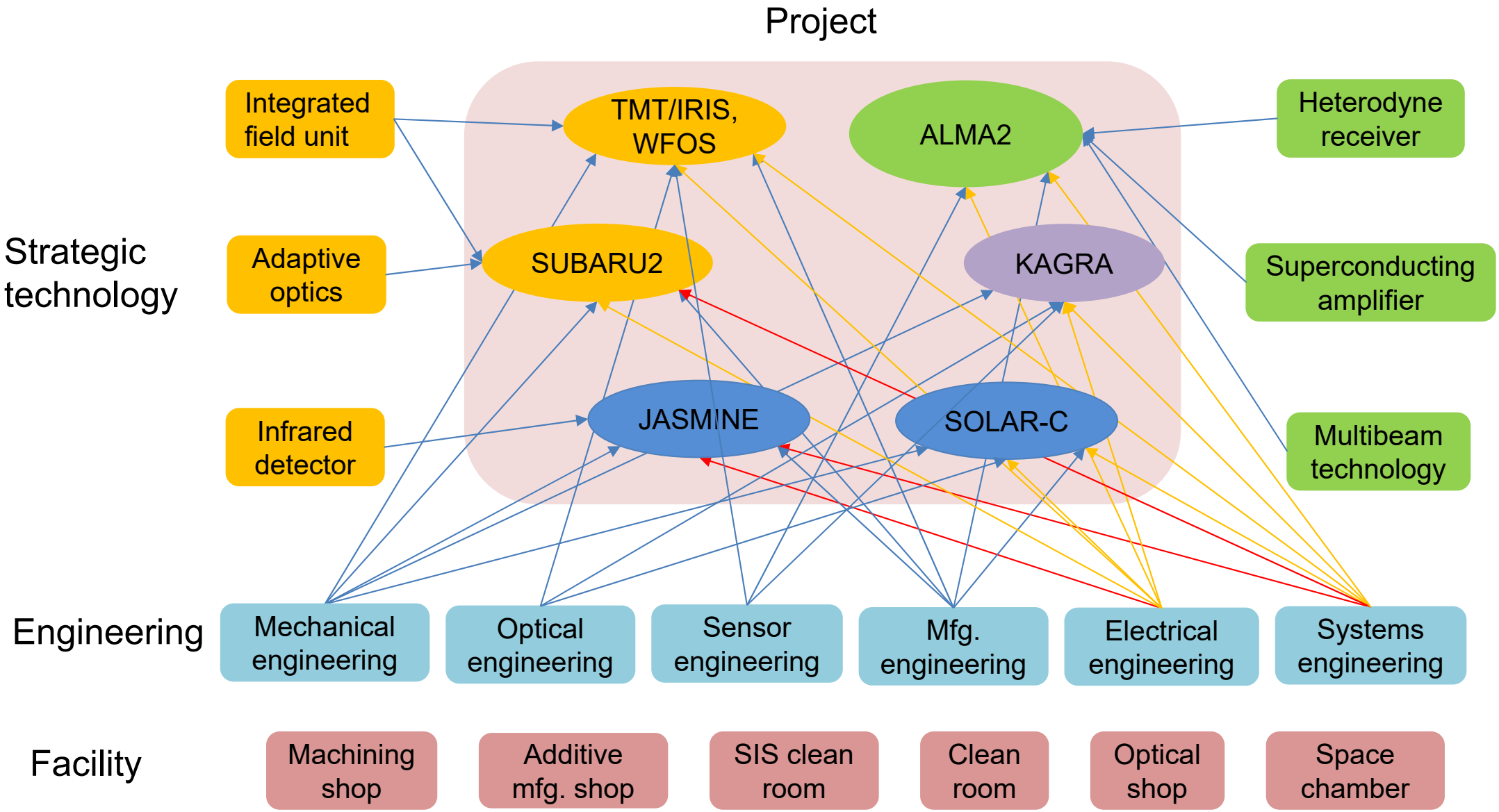
Recommendation from the committee	Action plan of ATC
The ATC plays a very important role in the education of undergraduate and graduate students. The number of accepted students increased in 2021 by the efforts of ATC staff, and the committee encourages the ATC to continue this effort.	Enhance publicity of “open-facility program, joint R&D program”.
There have been no students at SOKENDAI in the last few years. The committee encourages the ATC to more proactively and aggressively advertise to undergraduate students the opportunities at ATC. ATC could also increase the number of master students in engineering disciplines.	Enhance publicity of ATC at the guidance of Sokendai. Raise the profile of ATC academic staff in Sokendai. General PR activity. (ex. renewal of HP)

Report of the External Evaluation Committee (EEC) for the NAOJ Advanced Technology Center, May 2022

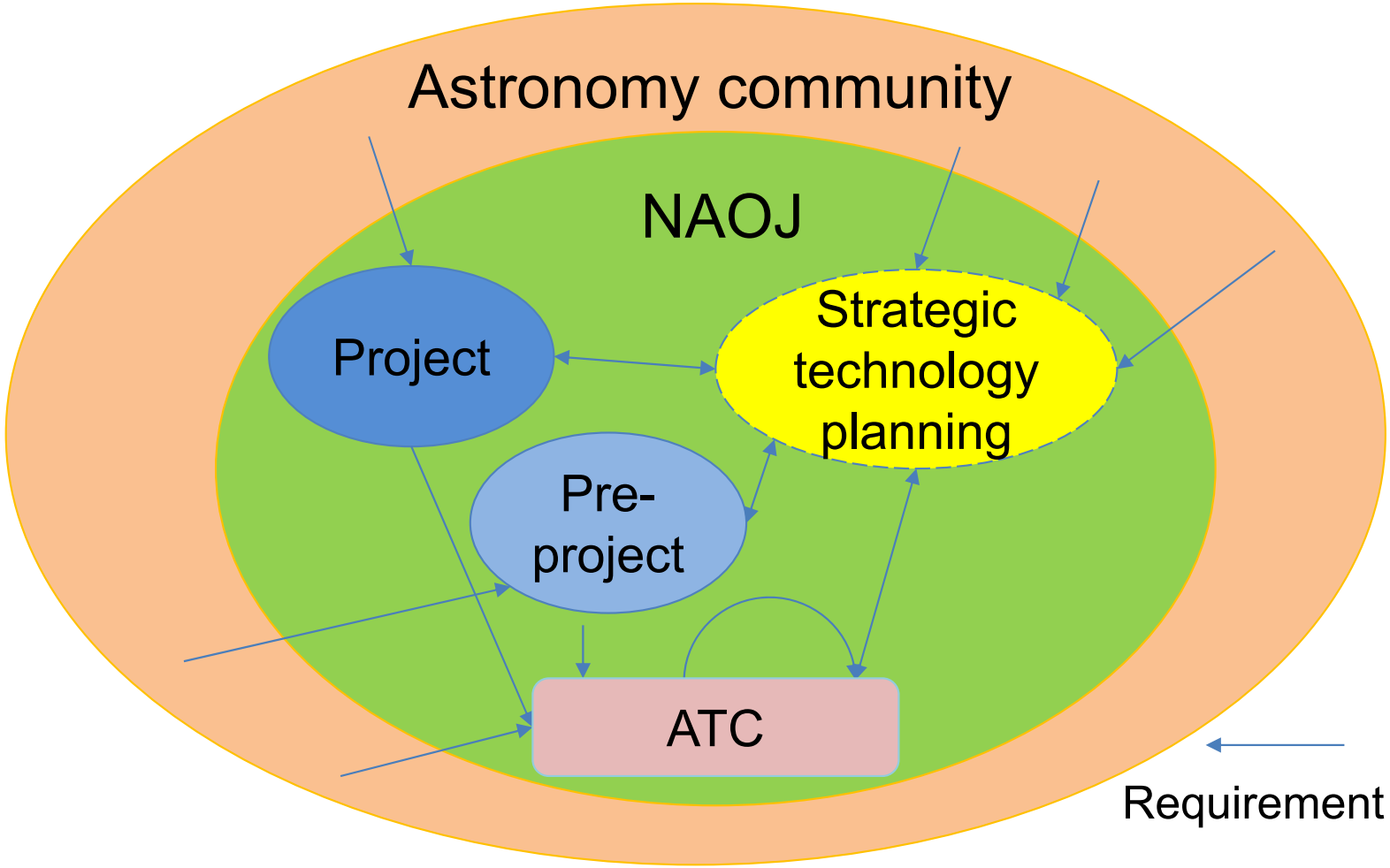
Issues after 2 years of Matrix Organization

- Coordination of project requests and ATC resource allocation
  - Currently arranged based on project sheets once per year
  - ⇒Periodic coordination meetings between all the related project directors and ATC group leaders are being prepared.
    - Ref: SRON (4 times per year), UK ATC (6 times per year)
- Sharing of common technologies between optical and infrared, gravitational wave, and radio wave, e.g. electronics, cryogenic technology, strain suppression
  - ⇒Re-allocation of staff, mutual participation in reviews?

Technology map



How to make a strategic technology roadmap?



ATC selects strategic technologies through discussions with its staff and NAOJ projects.
=> Strategic technology planning organization which establishes a technology roadmap as NAOJ from a wider view is preferable