Current Status of Advanced Technology Center (ATC)

2025-12-04
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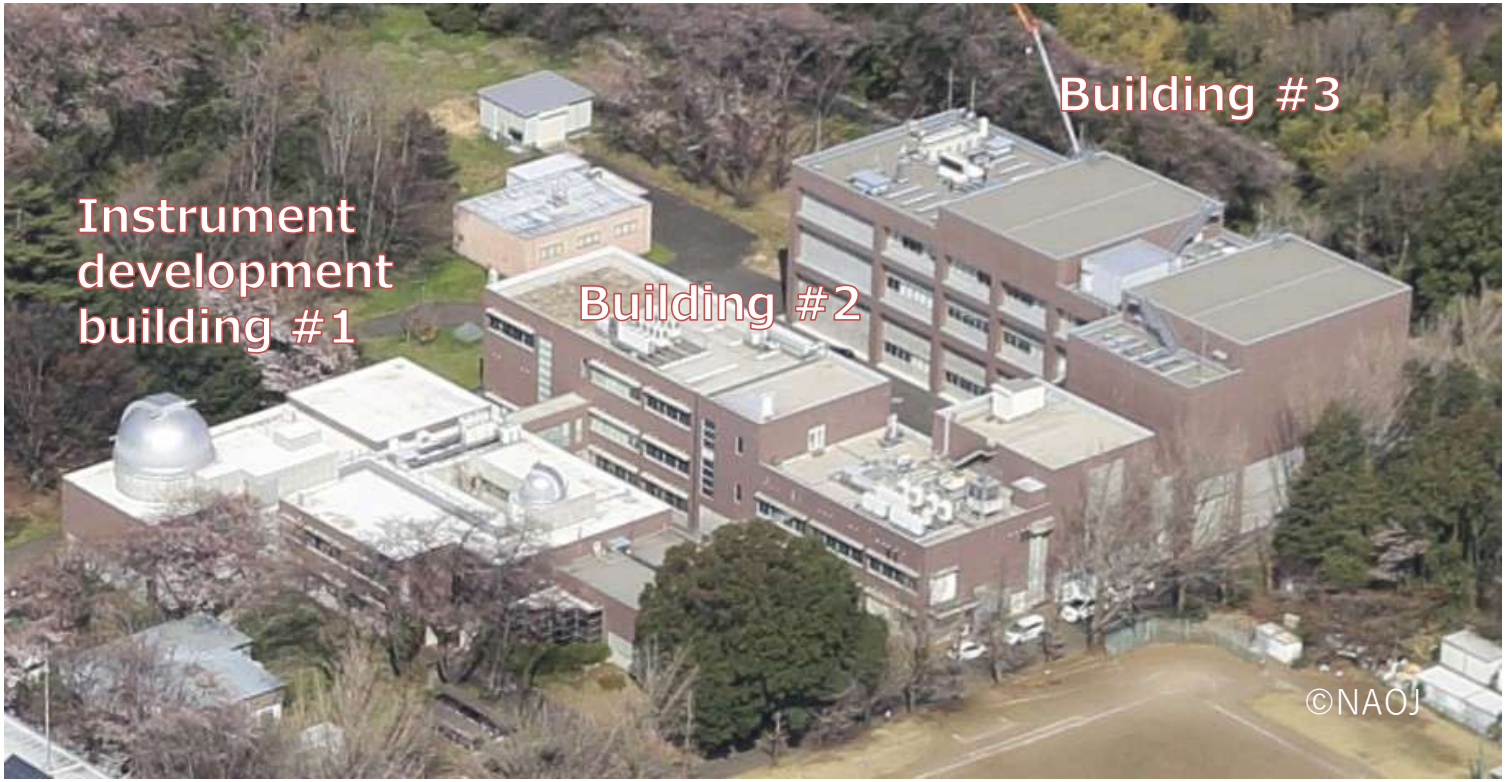
Advanced Technology Center
National Astronomical Observatory of Japan

A brief overview of ATC

ATC is the center of instrument development for ground base and space telescopes at NAOJ.
ATC 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 SUBARU, ALMA, TMT, KAGRA, SOLAR-C, JASMINE, etc.
ATC has now 60+ employees (research, engineering, and support staff).



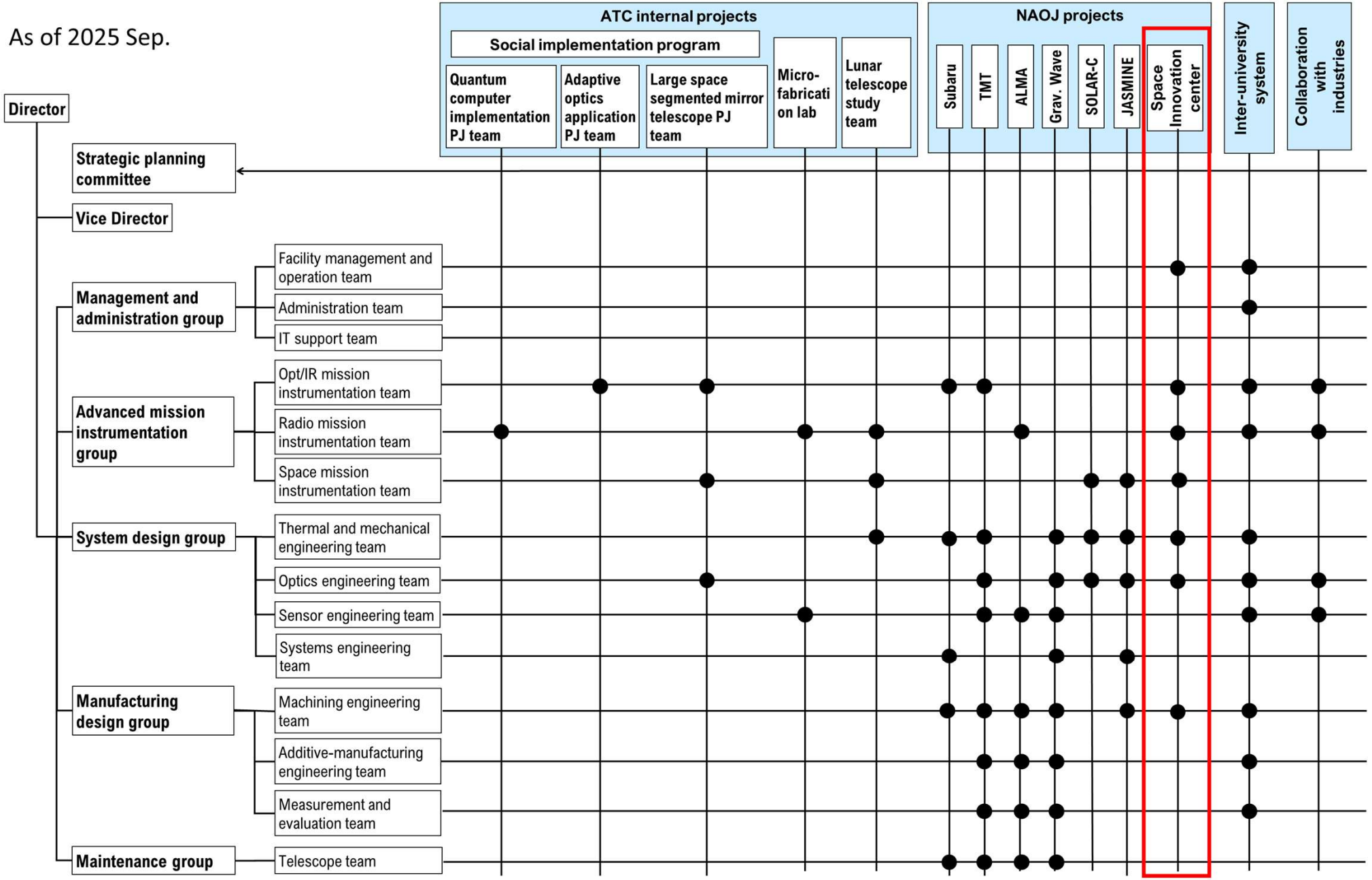
Missions

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).

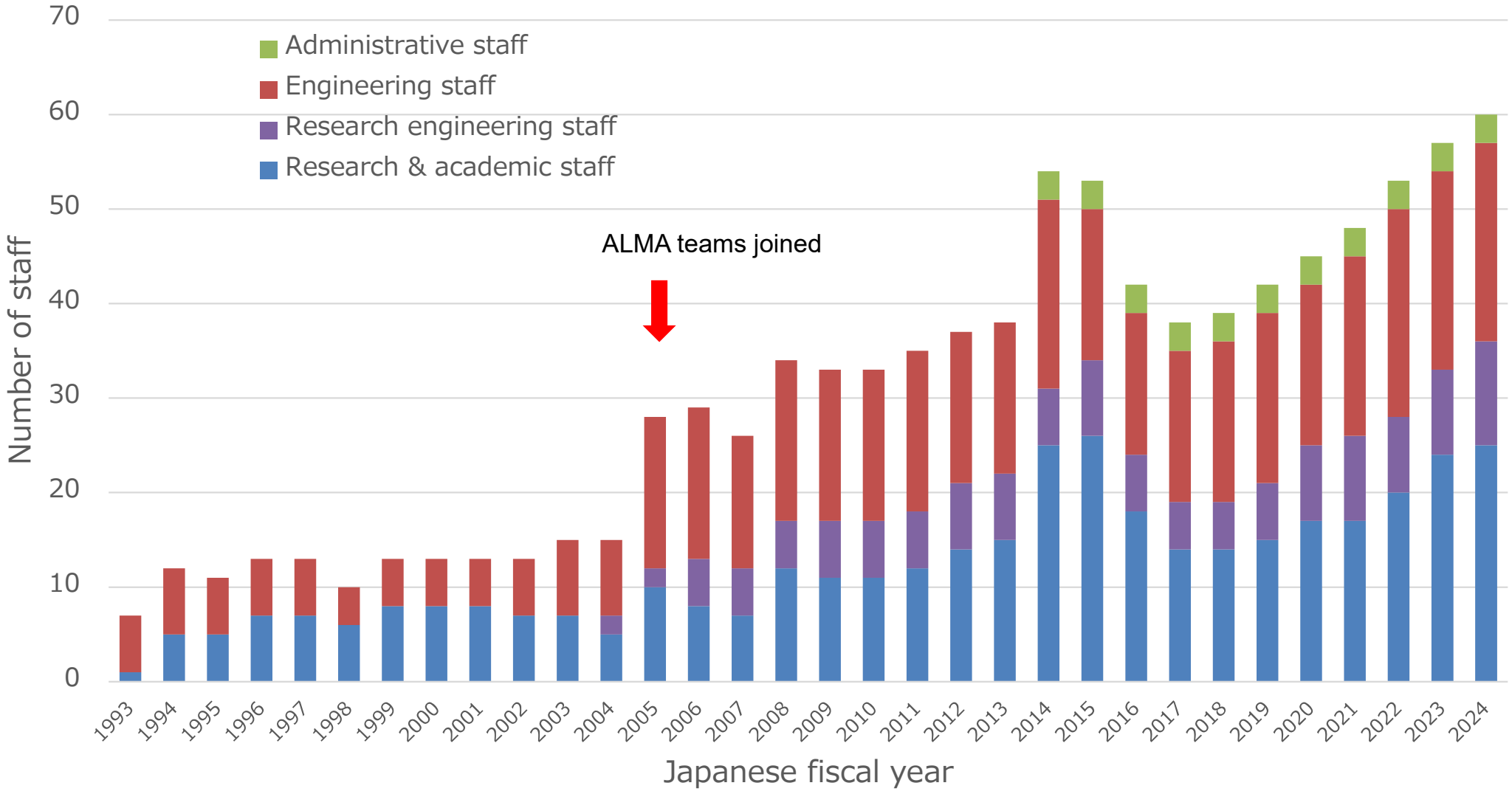
from ATC-TD-001

Organization of ATC

As of 2025 Sep.



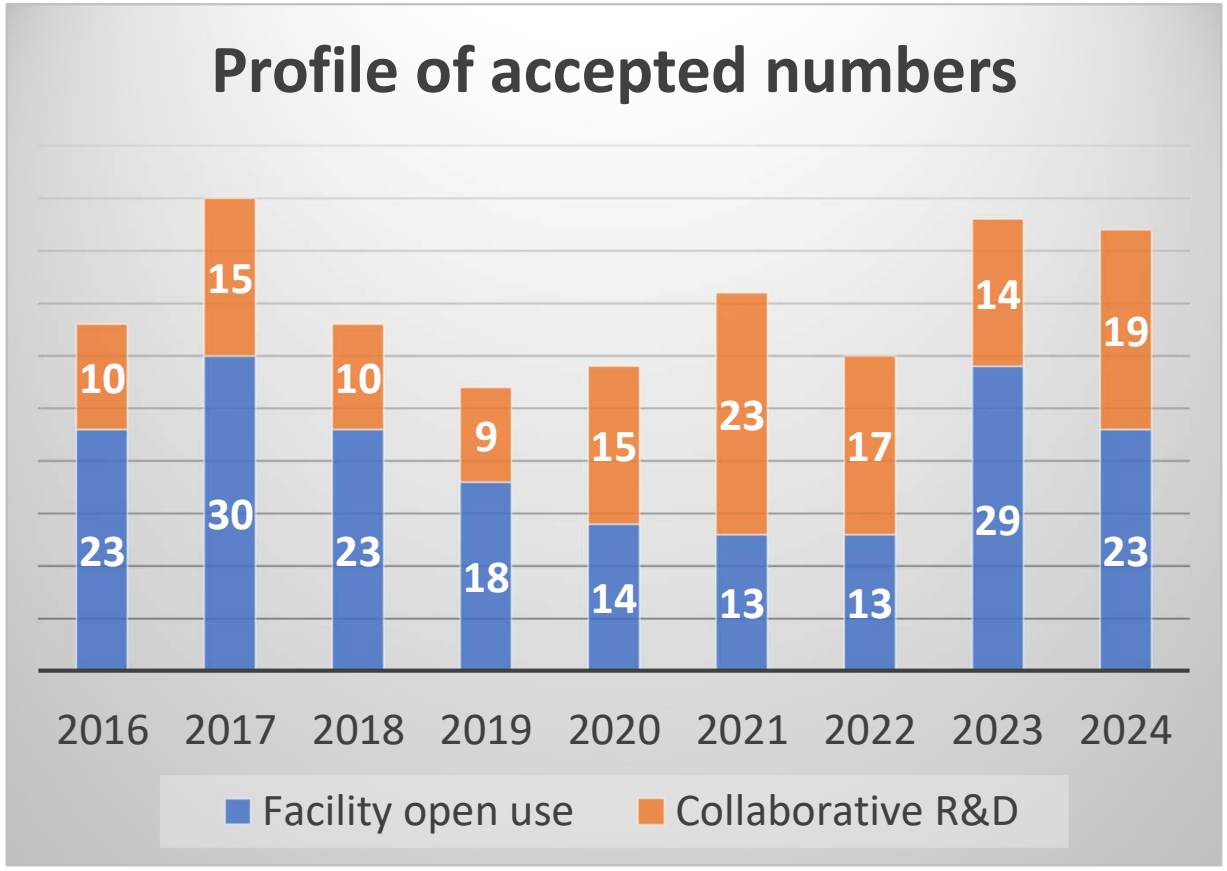
Number of Staff



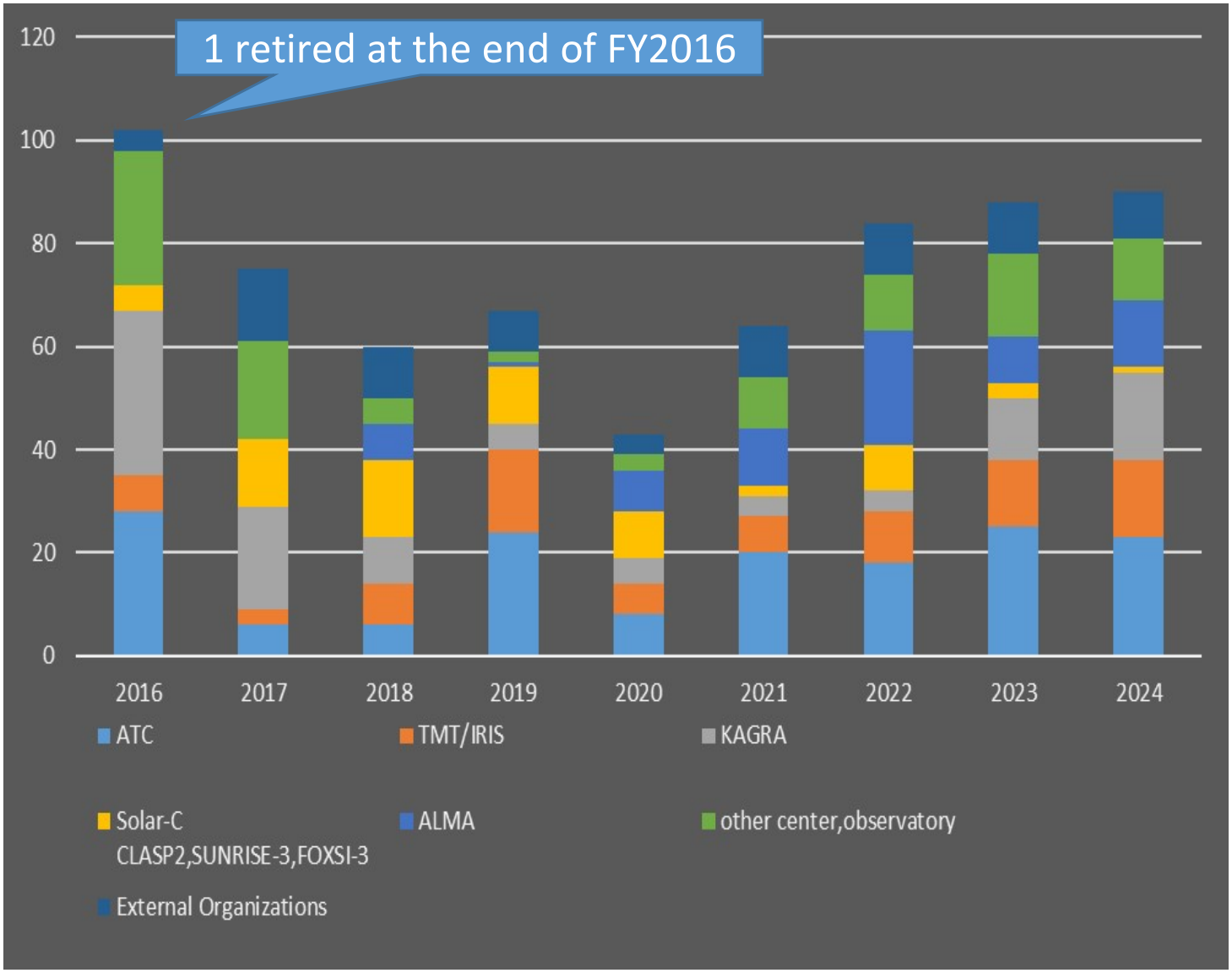
ATC has been requesting NAOJ top management to hire necessary staff, resulted in increasing the number.

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



Number of work requests (Manufacturing)



- Main machines

Two Wire-EDMs

5-axis machining center

Current NAOJ projects (1)

Project	Instrument	Activities in 2025	Milestones	Related teams
ULTIMATE-Subaru/GLAO	Wavefront sensor (WFS) LASER guide star facility (IGSF)	・Design of thermally insulated electric cabinet ・Desing of platforms to attach LGSF to the telescope ・Design of cooling system for LGSF ・Design of wind-shield for Laser Launching Telescope ・Manufacturing of the opto-mechanical components for the prototype WFS light source ・Systems engineering	2026-03 CDR	Opt/IR mission inst. Thermal and mech. eng. Machining eng. Systems eng.
ULTIATE-Subaru/WFI	Imager	• Final design of cryostat and optics • Procurement of the first H4RG detector		Opt/IR mission inst.
TMT/IRIS	Imager	・Detailed design ・Thermal analysis	2025-03 CDR2 2028 Delivery	Opt/IR mission inst. Thermal and mech. eng. Systems eng. Machining eng.
	NFOS	・Preliminary design ・Element test		
TMT/WFOS	Integrated field unit (IFU)	・3D printing for a fit check of Tech IFU		Opt/IR mission inst. Additive mfg. eng.
KAGRA	Output Mode Cleaner Vibration Isolation Stage (OMC-VIS)	・Concpetual design and detailed design	2026.3 Complete detailed drawings	Thermal and mech. eng.
	Type-B suspension intermediate mass dampers	・Concept design and detailed design; to be installed	2026.3 Installation	Thermal and mech. eng.

Red letters indicate funded national projects

Current NAOJ projects (2)

Project	Instrument	Activities in 2025	Milestones	Related teams
SOLAR-C	Telescope subsystem	・Stray light analysis inside the telescope ・Alignment study ・Planning of performance test for the telescope ・Structure and thermal: Establish and confirm IF specification	FY2024 PDR FY2026 CDR FY2028 launch	Thermal and mech. eng. Optics eng.
JASMINE	Mission instrument	・Planing of optical alignment and performance test for the telescope ・Concept design of the detector box unit, including element tests, BBM design, and systems engineering	FY2024-07 MDR FY2026 SDR FY2028 PDR FY2029 CDR FY2031 launch	Thermal and mech. eng. Optics eng. Systems eng.
	Mission detector & electronics	・Development of IR detector ・BBM design and test of analog components ・Onboard data processing study		Space mission inst.
ALMA2	Band8v2	・Preliminary design and investigation ・Test fabrication and evaluation of SIS devices	2026 Q2 PDR	ALMA project*
	Band2	・In production phase		
	Data Transmission System (DTS)	・Critical design of the DTS unit	2026 Q4 CDMR	
	Band4,Band8,Band10, Band1	・Maintenance of receivers (repairment)	N/A	

Red letters indicate funded national projects

* ALMA2 development team temporary moved to ALMA project in Jan. 2025 to maximize the efficiency and outcomes at the critical stage.

FTE assignment to Projects

Based on subjects sharing sheet. Thermal and mechanical engineering team is based on back log.

As of beginning of FY2025

Team	ULTIMATE -Subaru	TMT/ IRIS	TMT/ WFOS	TMT/ other	ALMA2	ALMA	KAGRA	SOLAR-C	JASMINE	Other	Co-research	SIC
Director									0.20	0.50		0.84
Facility mng. & Op.												
Opt/IR inst.	0.92	0.40	0.10							4.03		0.05
Radio wave inst.										3.00		0.05
Space inst.									0.40	0.55		0.05
Thermal & mech. eng.	2.03	2.08		0.30			0.59	0.54	0.83	1.08		0.05
Optics eng.							1.12	0.40	0.02	0.25	1.11	0.10
Detector eng.						0.60				1.40		
Systems eng.	0.30	0.30							0.30			0.05
Machining eng.	1.25		0.08	0.66	1.00			0.42		0.50	0.50	0.05
Additive mfg. eng.					1.00					0.50		0.05
Total	4.50	2.78	0.18	0.96	2.00	0.60	1.71	0.84	1.75	12.33	1.61	1.29

Other requirements from current NAOJ project (1)

Project	Requirements	Related resources
Solar Science	Test engineer to monitor requirements from mission, plan the test, and design test jigs. Maintenance engineer for clean room, vacuum facilities	Thermal and mech. eng. ? Facility mgmt. and op.
JASMINE	Accumulation of detector electronics development technologies and support	Opt/IR mission inst. Space mission inst.
	Preserving (space) telescope development technologies	Opt/IR mission inst. Thermal and mech. eng. Opt. eng.
	Development of drive mechanism of M5	Thermal and mech. eng. Opt. eng.
	Development of (Space) control electronics - Software - Hardware	Space mission inst. (Electric eng.)
ULTIMATE-Subaru/GLAO	Mechanical design of WFS main part	Thermal and mech. eng.
	Optical design and evaluation of IR instrument	Opt. eng.
	Electrical design of simple circuits (parts selection, wiring diagram etc.)	(Electric eng.)
	Design of software	Space mission inst. (Electric eng.)
	Engineering work for AIT of whole GLAO system	Thermal and mech. eng. Opt. eng. (Electric eng.) Mfg. design group
	Area for AIT of whole GLAO system	Facility

Other requirements from current NAOJ project (2)

Project	Requirements	Related resources
ASTE	Maintenance and operation of ASTE telescope	Maintenance gr./ Telescope
Gravitational Wave	Dedicated engineers for gravitational wave tests (ex. maintenance and operation engineers for TAMA 300) Strengthening electronics team Strengthening optics engineering teams Support in systems engineering for projects especially KAGRA	Thermal and mech. eng. (Electric eng.) Opt. eng. Systems eng.
	Development of beam diverter for vacuum use Development of fast shutter for vacuum use Development of optical detector pods for vacuum use	Thermal and mech. eng. (Electric eng.)
	Modification of input optical system Development of small suspension system (suspended due to prioritize) Modification and development of large suspension system (open-type GAS filter, improvement of maintainability of whole suspension system)	Thermal and mech. eng. Opt. eng.
	Introduction and maintenance of stray light measurement instrument Installation of outgassing rate measurement system Heat treatment system Polishing facility Renovation of mirror coating facility	Facilities

Various requirements from current projects are not realized due to the restricts of human resources and facilities.

Requirements of space from SRM proposals (1)

Unit: m^2

No	Proposal	5th med. term (current)	5th med. term (addition)	6th med. term	Remarks
2	Advanced R&D hub for future GW detectors with TAMA300	203	39	242	
5	Promoting gravitational wave astronomy with the gravitational wave telescope, KAGRA	Included in No.2	Included in No.2	Included in No.2	
6	Third generation gravitational wave telescope (3G)	Included in No.2	Included in No.2	Included in No.2	
7	Ultra-Doppler: Ultra High Precision Radial Velocity Instrument for Nearby Solar Twins Search	0	10	0	
9	"The Next Generation Very Large Array(ngVLA)"	Includced in No.21	0	Includced in No.21	
12	The LAPYUTA (Life-environmentology, Astronomy, and PlanetarY Ultraviolet Telescope Assembly) mission	TBD	TBD	0	
13	The Thirty Meter Telescope TMT	143	339 (Build.3 CR)	90	
14	Exploring the Chemodynamical Evolution of the Milky Way and the Local Group through Wide and Deep Stellar Surveys	TBD	TBD	TBD	
16	SILVIA: In-Orbit Demonstration of Ultra-Precision Formation Flying	0	5	0	
17	Participation in the NASA Habitable Worlds Observatory	TBD	TBD	TBD	
21	ALMA2: Atacama Large Millimeter/submillimeter Array in Exploration of the Origins of the Universe and Life	1,252	0	1,252	1st and 2nd floor of Bldg.2
22	From Subaru and beyond : Subaru 3	TBD	0	0	
23	Center for multi-messenger astronomy	TBD	0	0	
25	Elucidating formation and evolution of celestial bodies using far-infrared and terahertz interferometers	120	0	120	
26	JASMINE: Japan Astrometry/photometry Satellite Mission for INfrared Exploration	64	130 (CR)	64	

Yellow cell: large clean room

Requirements of space from SRM proposals (2)

Unit: m^2

No	Proposal	5th med. term (current)	5th med. term (addition)	6th med. term	Remarks
28	Characterization of exoplanets by synergy with space and ground-based telescopes	65	0	65	
30	Study of the formation of astronomical objects and structures through the promotion of the LST/AtLAST project and multi-dimensional submillimeter survey observations	94	0	TBD	
31	Exoplanet Imaging and Characterization with Subaru SCExAO and TMT-PSI	TBD	TBD	TBD	
37	Solar flare X-ray focusing imaging spectroscopy	Included in No.38	0	281 (Build.2 CR)	
38	The SOLAR-C Mission : a satellite mission for a high-throughput EUV Imaging Spectroscopy of the Sun	281 (Build. 2 CR)	99	0	
39	Large Space Optical Infrared Telescope	0	30	30	
40	Continuous observations of solar activity: HINODE, Mitaka ground-based telescopes, and build-up for future observations	Included in No.38	TBD	TBD	
	Total of requirements of space	**2,222**	**712**	**2,457**	
	Current space assigned to NAOJ projects		**1,943**		
	Current space assigned to ATC staff and common use		**1,456**		
	Current space assign to Open Use by external users		**206**		

Yellow cell: large clean room

22 out of 42 proposals (52%) are requiring experimental space for ATC.
The total required space exceeds the current space assigned to NAOJ projects.
(Note: This total doesn't include TBD from several projects => potential risk)

Additional ATC space (new building) or prioritize of projects is necessary.
Using warehouses may alleviate the shortage of experimental space.

Requirements of FTE from SRM proposals for 5th med. term plan (1)

No	Plan	Inst.	Eng.	Mfg.	Device fab.	Receiver	Maint.	
5	Promoting gravitational wave astronomy with the gravitational wave telescope, KAGRA		mech: 0.8					
6	Third generation gravitational wave telescope (3G)		Included in ID5					
9	The Next Generation Very Large Array (ngVLA)		TBD					
12	The LAPYUTA (Life-environmentology, Astronomy, and PlanetarY Ultraviolet Telescope Assembly) mission		0.1					
13	The Thirty Meter Telescope TMT	2	Detect: 0.5 Mech: 0.5 Test : 1 Elec: 0.3 Sys: 0.5	1				
14	Exploring the Chemodynamical Evolution of the Milky Way and the Local Group through Wide and Deep Stellar Surveys		Sys: 0.2 Test: 0.2					
16	SILVIA: In-Orbit Demonstration of Ultra-Precision Formation Flying		Opt: 0.05					
17	Participation in the NASA Habitable Worlds Observatory		Sys:2 Mech: 3 Opt:1					
20	Study of the formation of astronomical objects and structures using wide-area/wide-band observations with the Atacama Submillimeter Telescope Experiment (ASTE)						0.4	
21	ALMA2: Atacama Large Millimeter/submillimeter Array in Exploration of the Origins of the Universe and Life	TBD	TBD		TBD	TBD	TBD	
22	From Subaru and beyond : Subaru 3		5.1	0.15			0.2	

Requirements of FTE from SRM proposals for 5th med. term plan (2)

No	Project	Inst.	Eng.	Mfg.	Device fab.	Receiver	Maint.	
23	Center for multi-messenger astronomy	1						
25	Elucidating formation and evolution of celestial bodies using far-infrared and terahertz interferometers	2			1			
26	JASMINE: Japan Astrometry/photometry Satellite Mission for INfrared Exploration		Detect: 0.5 Mech: 0.8 Opt: 0.5					
27	Large Scale Wide Field Observation Study Team (tentative)	0.5						
29	Astronomy with Super-Precise Spectroscopic Observations		Opt: 0.1					
30	Study of the formation of astronomical objects and structures through the promotion of the LST/AtLAST project and multi-dimensional submillimeter survey observations	0.5			0.5			
31	Exoplanet Imaging and Characterization with Subaru SCExAO and TMT-PSI		Mech.: 1 Opt: 1 Soft: 1					
32	Okayama Telescope Cluster: A Hub for Time-Domain Astronomy and Global Collaboration		Opt: 0.1					
34	GREX-PLUS: Galaxy Reionization EXplorer and PLanetary Universe Spectrometer	2.1	0.6					
36	Antarctica 30-m Terahertz Telescope Project	1				2		
37	Solar flare X-ray focusing imaging spectroscopy		Mech: 0.05 Opt: 0.05	0.1				
38	The SOLAR-C Mission： a satellite mission for a high-throughput EUV Imaging Spectroscopy of the Sun		Mech: 0.125 Opt: 0.08				0.1	

Requirements of FTE from SRM proposals for 5th med. term plan (3)

No	Project	Inst.	Eng.	Mfg.	Device fab.	Receiver	Maint.	
39	Large Space Optical Infrared Telescope	TBD	TBD	TBD	TBD	TBD	TBD	
40	Continuous observations of solar activity: HINODE, Mitaka ground-based telescopes, and build-up for future observations	TBD	TBD	TBD	TBD	TBD	TBD	
	Total of requirements of FTE	9.1	21.2 Mech: 6.3 Opt: 2.9 Detect: 1.0 Sys: 2.7 Test: 1.2 Elec: 0.3 Soft: 1.0 TBR: 5.8	1.25	1.5	2	0.7	
	Current number of ATC staff	Opt/IR 7 Radio wav 6 Space 4	Mech 7.5 Opt 3 Detect 1.5 Sys 1.5	7	1	0	<1	

25 out of 43 plans (58%) are expecting FTE of ATC
Instrumentation researcher, engineering staff, device fabrication engineer, receiver engineer, maintenance staff are insufficient.
Additional ATC human resources or prioritize of projects is necessary.

Requirements of FTE from SRM proposals for 6th med. term plan (1)

No	Plan	Inst.	Eng.	Mfg.	Device fab.	Receiver	Maint.	
5	Promoting gravitational wave astronomy with the gravitational wave telescope, KAGRA		mech: 0.8					
6	Third generation gravitational wave telescope (3G)		Included in ID5					
9	The Next Generation Very Large Array (ngVLA)		TBD					
12	The LAPYUTA (Life-environmentology, Astronomy, and PlanetarY Ultraviolet Telescope Assembly) mission		0.1					
13	The Thirty Meter Telescope TMT	2	Detect: 0.2 Mech: 0.1 Elec: 0.1 Sys: 0.3	1				
16	SILVIA: In-Orbit Demonstration of Ultra-Precision Formation Flying		Opt: 0.05					
17	Participation in the NASA Habitable Worlds Observatory		Sys:2 Mech: 3 Opt:1					
20	Study of the formation of astronomical objects and structures using wide-area/wide-band observations with the Atacama Submillimeter Telescope Experiment (ASTE)						TBD	
21	ALMA2: Atacama Large Millimeter/submillimeter Array in Exploration of the Origins of the Universe and Life	TBD	TBD		TBD	TBD	TBD	
22	From Subaru and beyond : Subaru 3		1.1	0.15			0.2	

Requirements of FTE from SRM proposals for 6th med. term plan (2)

No	Project	Inst.	Eng.	Mfg.	Device fab.	Receiver	Maint.	
25	Elucidating formation and evolution of celestial bodies using far-infrared and terahertz interferometers	2			1		1	
26	JASMINE: Japan Astrometry/photometry Satellite Mission for INfrared Exploration		Detect: 0.5 Mech: 0.8 Opt: 0.5					
27	Large Scale Wide Field Observation Study Team (tentative)	TBD						
29	Astronomy with Super-Precise Spectroscopic Observations		Opt: 0.1					
30	Study of the formation of astronomical objects and structures through the promotion of the LST/AtLAST project and multi-dimensional submillimeter survey observations	TBD			TBD			
31	Exoplanet Imaging and Characterization with Subaru SCExAO and TMT-PSI		Soft: 1					
32	Okayama Telescope Cluster: A Hub for Time-Domain Astronomy and Global Collaboration		Opt: 0.1					
34	GREX-PLUS: Galaxy Reionization EXplorer and PLanetary Universe Spectrometer	4.9						
36	Antarctica 30-m Terahertz Telescope Project	0.5				1		
37	Solar flare X-ray focusing imaging spectroscopy		Mech: 0.05 Opt: 0.05	0.1				
39	Large Space Optical Infrared Telescope	TBD	TBD	TBD			TBD	
40	Continuous observations of solar activity: HINODE, Mitaka ground-based telescopes, and build-up for future observations	TBD	TBD	TBD			TBD	

Requirements of FTE from SRM proposals for 6th med. term plan (3)

No	Project	Inst.	Eng.	Mfg.	Device fab.	Receiver	Maint.	
	Total of requirements of FTE	9.4	11.9 Mech: 4.8 Opt: 1.8 Detect: 0.7 Sys: 2.3 Test: 0.0 Elec: 0.1 Soft: 1.0 ?: 1.2	1.25	1	1	1.2	
	Current number of ATC staff	Opt/IR 7 Radio wav 6 Space 4	Mech 7.5 Opt 3 Detect 1.5 Sys 1.5	7	1	0	<1	

22 out of 43 plans (51%) are expecting FTE of ATC
Instrumentation researcher, engineering staff, receiver staff, maintenance staff are insufficient.
Additional ATC human resources or prioritize of projects is necessary.

History of the SX Research and Development Site "NAOJ Space Innovation Center Initiative"

- Jan 31, 2025
  - Proposal "NAOJ Space Innovation Center Initiative" selected under the 1st call for SX R&D Site by the Space Strategy Fund
    - Acceptance rate approx. 10:1
- May 14, 2025
  - Contract signed with JAXA
    - Project period: May 2025 – March 2033
      - Mid-term review in Year 3. Stage-gate review in Year 5
    - Budget: Initial 3-year contract: 1.33 billion yen
      - Up to 2.2 billion yen over 8 years (including indirect costs)
- Sep 1, 2025
  - Revised NAOJ organizational regulations and **formally established the Space Innovation Center as an official organization**.

NAOJ Space Innovation Center Initiative

Based on the world-class, cutting-edge observational instrument technology for ground-based and space telescopes NAOJ has developed and refined over the years, we **established a hub to support technology development** listed in the 'Space Technology Strategy' **conducted by startup companies and others**.
With a core focus on optical systems, receivers, and detection technologies covering a wide wavelength range from visible light to radio waves and leveraging the cooperation of universities and institutions across various fields, this initiative aims to **contribute to solving social issues, expanding the space market, strengthening international competitiveness and economic security, and fostering the development and broadening of human resources in space exploration.**

Development of technology for inclusion in the "Space Technology Strategy" by start-up companies, etc.

- Social implementation by companies and other entities
- Expansion and development of human resources in space development

- Enhancing competitiveness and expanding the market through innovative technologies
- Solving social issues such as extreme weather and high-speed communication

Universities → Support Development ← R&D Institutes

NAOJ Space Innovation Center

Heritage of ground-based telescopes


Subaru


ALMA


TMT

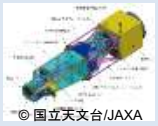

KAGRA

Heritage of space-born telescopes


©国立天文台、JAXA、NASA/MSFC
CLASP


HINODE


SUNRISE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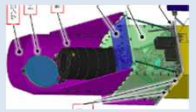
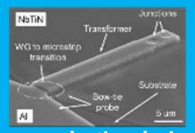
SOLAR-C


JASMINE

SX Innovation Center (Bdg)


© Higgs Centre for Innovation
Example: UK ATC's Higgs Center of Innovation

Promoting development of cutting-edge detectors and instrument



Superconducting devices for milli and sub-milli wave detection


Infrared sensor


Adaptive Optics


Cryogenic Instruments

Expanding facilities for cutting-edge R&D


Optical test facilities


Metal 3D printer


Clean room for superconducting devices


Clean room for ground and space base instruments

Technology
Engineering
Economic Security

Recent Progress in SIC (1)

機密性2

- Establishment of internal structure at NAOJ
  - Prepared template contracts for academic (technical) consultations and NDA.
  - Drafted template for joint development/research with users of SIC is currently under review by the National Institutes of Natural Sciences.
  - Clarified cost-sharing arrangements with companies.
    - Decided that equipment usage fees for SIC-utilizing companies will be covered by this project's budget, so users will bear no cost for the time being.
- Support for space equipment development for SIC users
  - Held meetings with more than 30 companies.
  - Currently providing technical support to several companies in the form of academic consultations including usage of measurement instrument.

Recent Progress in SIC (2)

機密性2

- Public Relations and Promotion
  - NAOJ website:
    - Posted an article on SX R&D Site adoption and kickoff meeting on July 24
  - Press release:
    - Distributed the above article to relevant media.
    - Responded to interviews from media outlets, including Nikkei.
  - Exhibitions and Conferences
    - July 8–10: SPACETIDE 2025
    - July 30–August 1: 2nd SPEXA International Space Business Expo
    - October 28–31: NIHONBASHI SPACE WEEK 2025
    - November 25–28: 69th Space Science and Technology Conference @Sapporo
  - Special open day for candidate users
    - Scheduling in January.
  - SIC website
    - SIC website was launched on October 28th.

Exhibition at SPEXA

SPEXA

International Space Business EXPO

○July 30 – August 1, 2025 at Tokyo Big Sight

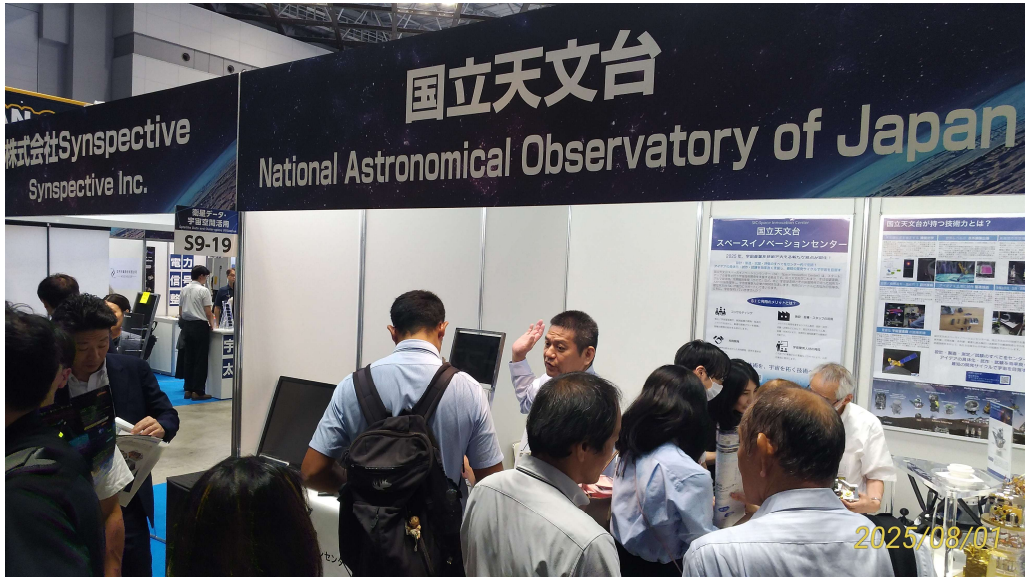
○Exhibit Contents

- ◇ALMA Band8 receiver
- ◇TMT/IRIS model
- ◇SOLAR-C model
- ◇Metal 3D-printed products
- ◇Machining samples, etc.

○Booth Activity

- ◇More than 1,000 visitors to the booth
- ◇Distributed over 1,000 SIC introduction flyers and more than 300 ATC pamphlets

Display at the booth



With the support of the Vice-DG, Director of Engineering, and Director of Research Coordination, we assisted visitors at the booth.

Introduction of SIC by the director at the pitch stage

Enforcement of Personnel and facilities

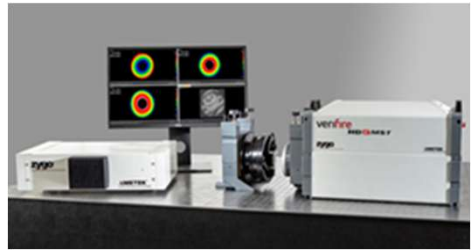
SIC will hire following staff in addition to the current researchers and engineers

- Administration group （2 staff)
- Technology group (2 researchers for optical & IR instrument)
- Engineering group (1 optical engineer, 1 mechanical engineer, 1 manufacturing engineer, 1 facility operation and maintenance engineer)

SIC will install following new facilities.

- **Clean room in building #3**
  Class 100,000
  Used for AIT of satellites

- **Laser interferometer**



© Zygo

- **Combined machining machine**

© 中村留精密工業株式会社

- **Scattering measurement system**

©日本シノプシス合同会社

- **High precision 3D measurement machine**

© 株式会社ミツトヨ

- **Cryogenic test system -> Space chamber**

© Quantum Design Japan, Inc.

- **Additive function to existing metal 3D printer**

Information

- Replacement of the cooling water circulation system for building #1 and #2 completed in March. However, the new cooling system has problem of high pressure (~0.8 MPa) and unstable flow rate. ATC and Facilities Group are working together to solve the problems, however it will take more time.
- Large clean room in building #2 will be occupied by SOLAR-C project until 2028 launch.
- SIS clean room is temporary managed by ALMA project to accelerate ALMA2 device development.

Summary

- ATC has been contributing to the success of projects in NAOJ from both technological and engineering aspects and will play the same role in the future.
- Even now, capacity and capability of ATC is not sufficient compared to requirements from various projects.
- **Investing to facilities and human resources of ATC is essential to support proposals in SRM for the future.**
- In order to identify the strategic technologies, we need to implement technological discussion in the process of establishing the science road map of NAOJ.

Thank you for your attention!