Current Status of Advanced Technology Center (ATC)

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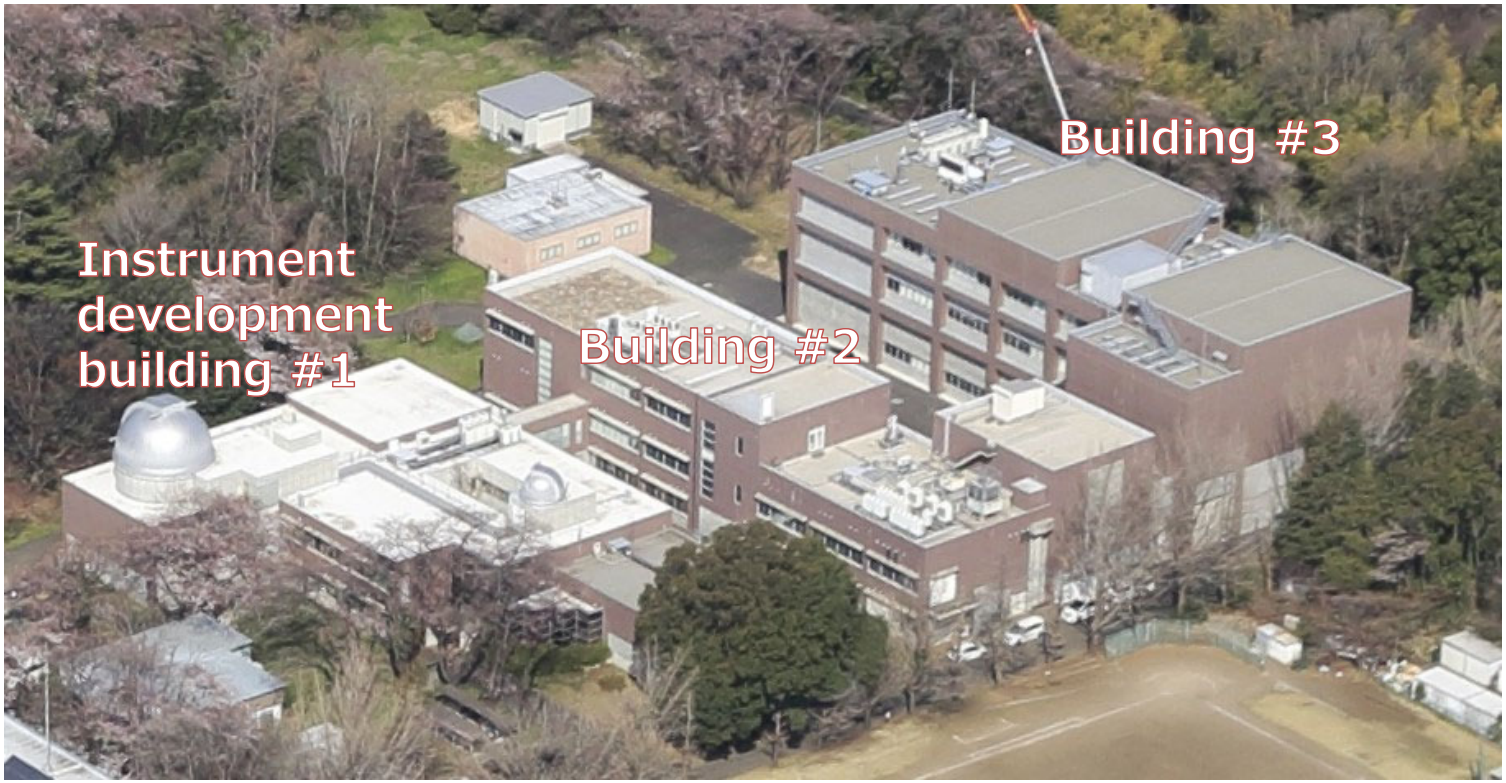
A brief overview of ATC

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 SUBARU, ALMA, TMT, KAGRA, SOLAR-C, JASMINE, etc., and has now 60+ employees (research, engineering, and support staff).



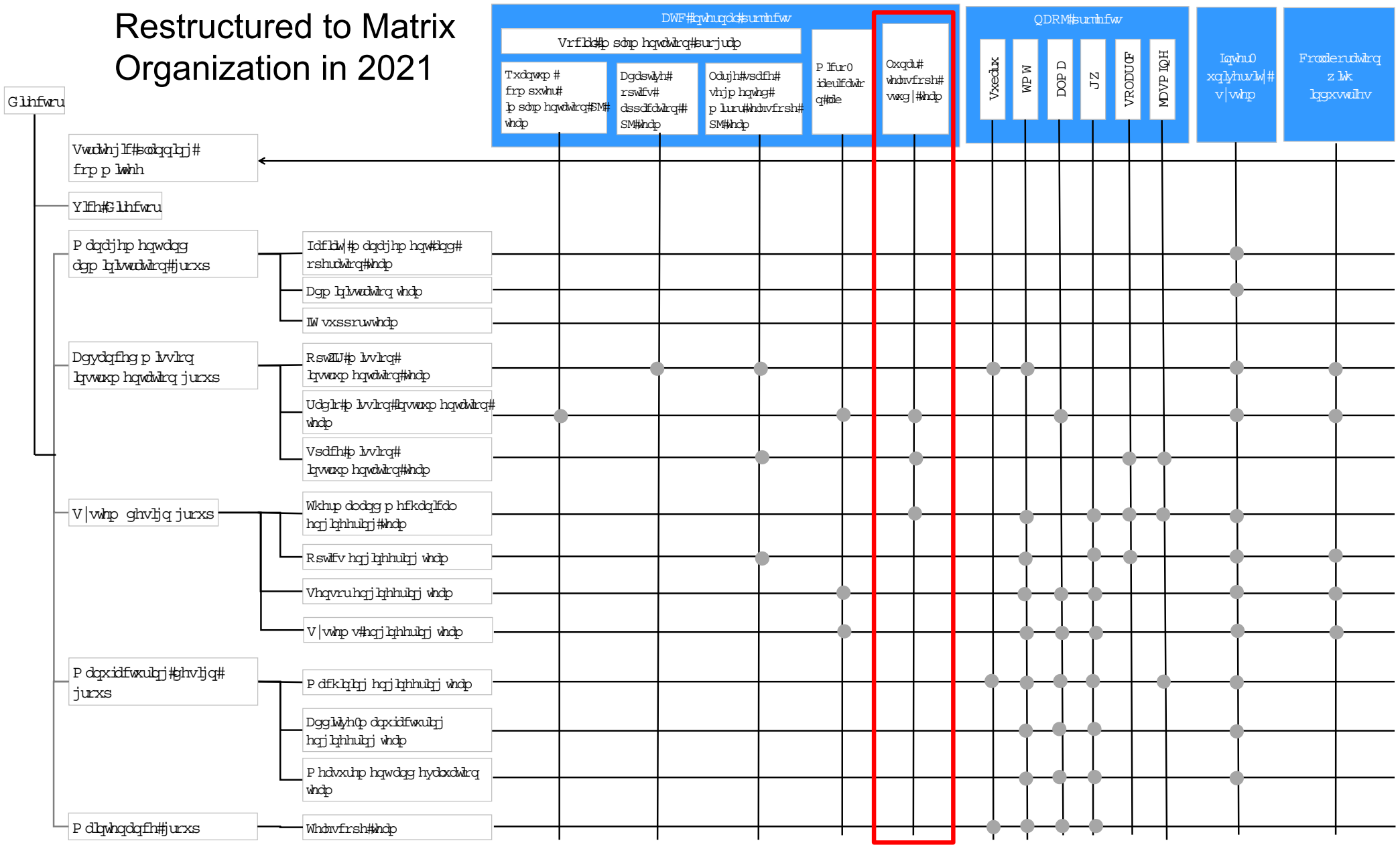
Missions

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).

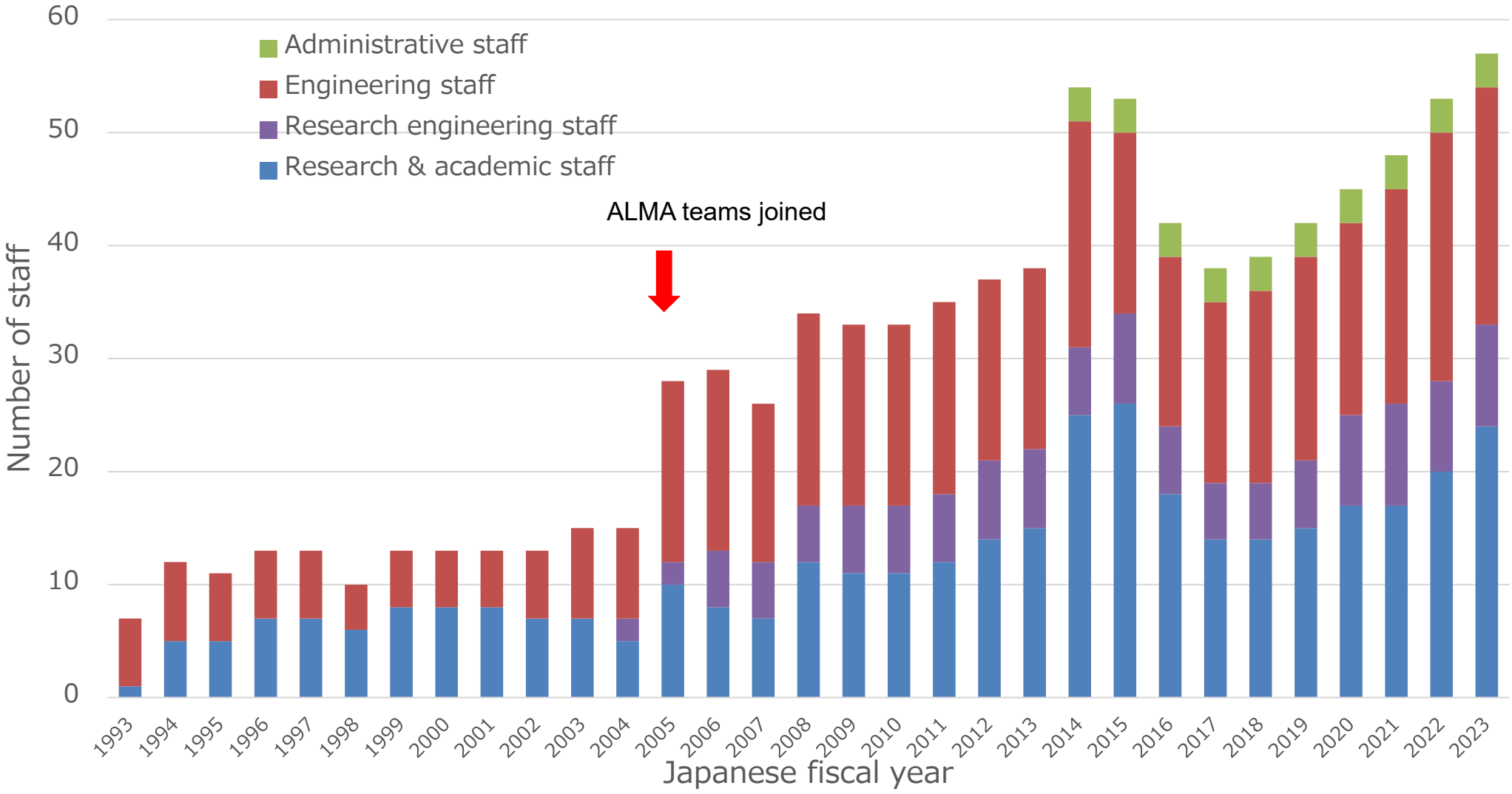
from ATC-TD-001

Organization of ATC

Restructured to Matrix Organization in 2021



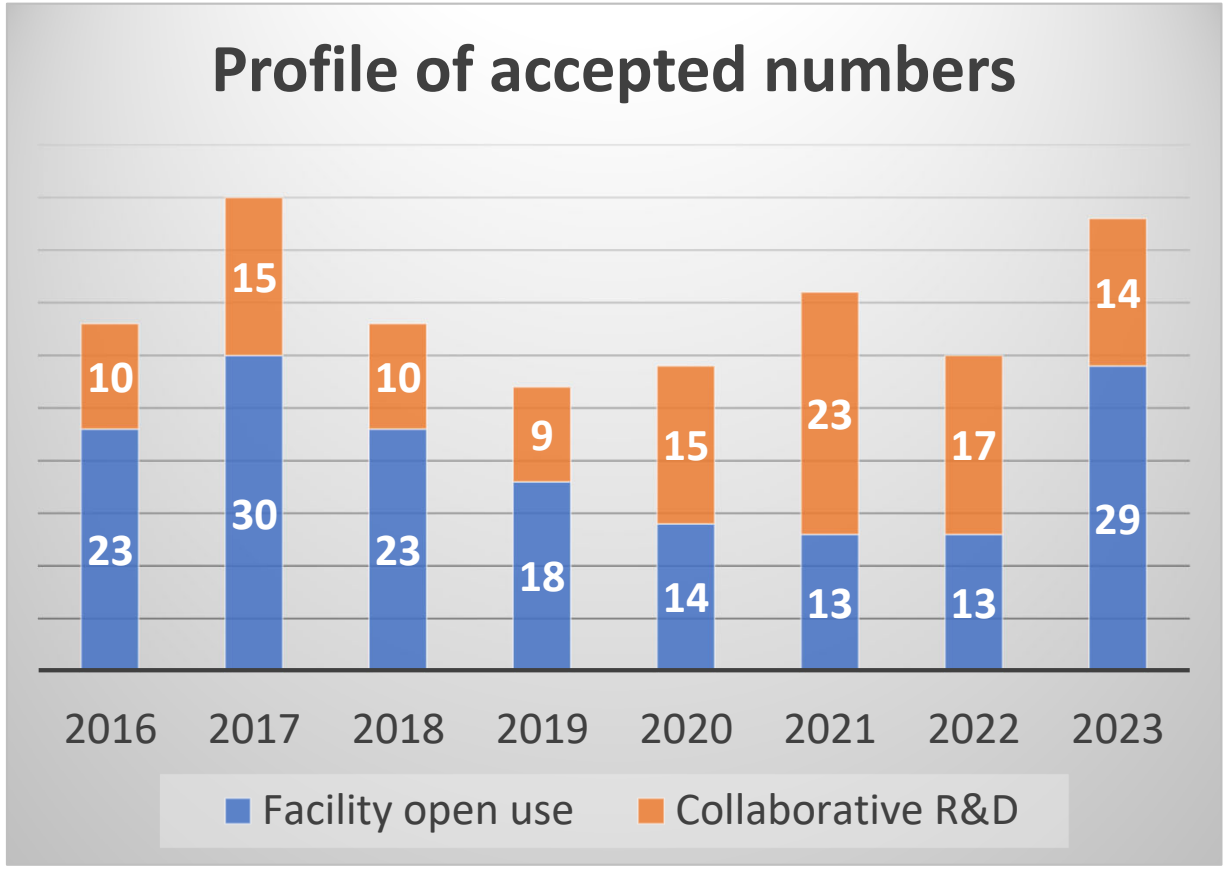
Number of Staff



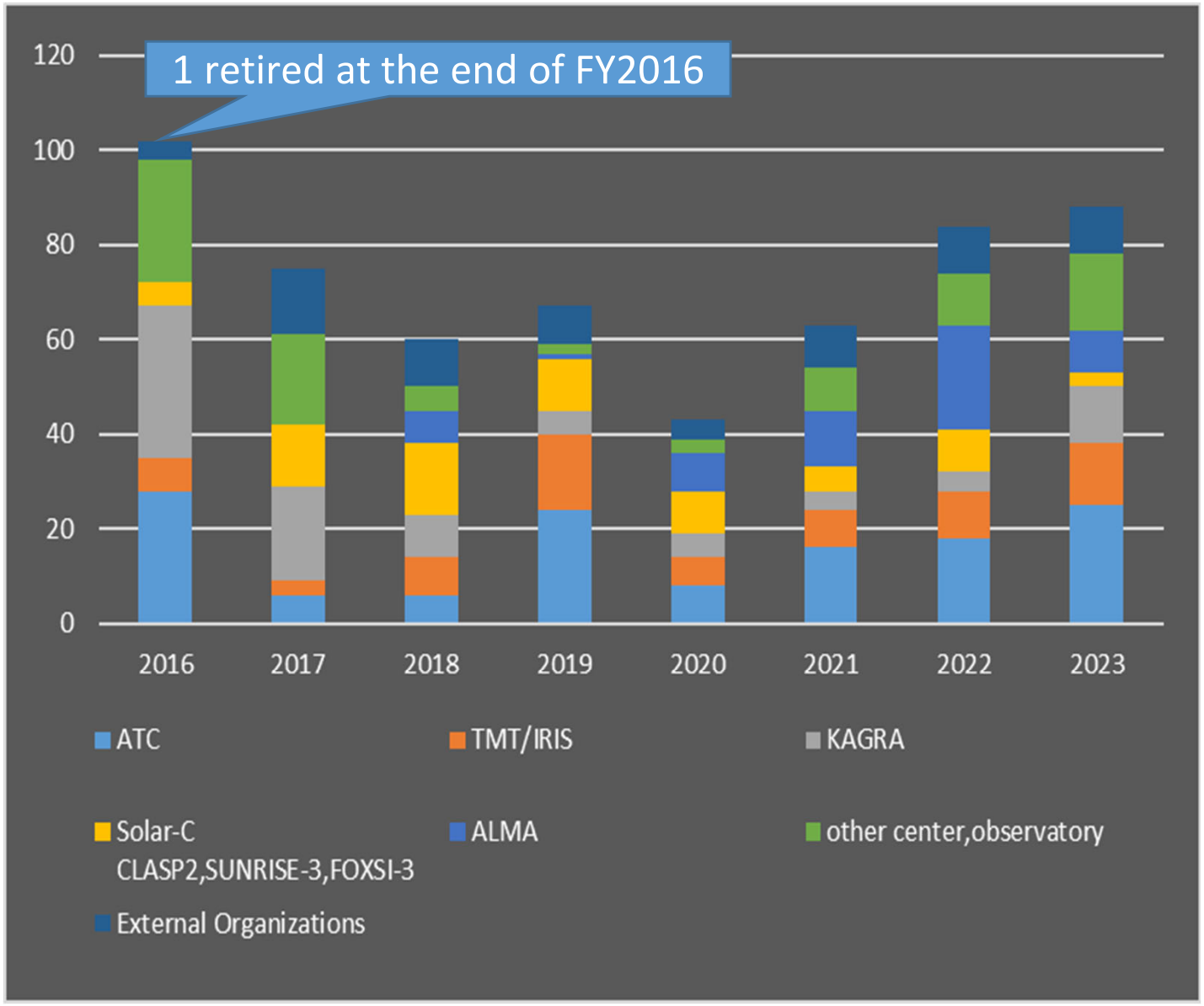
ATC has been requesting NAOJ top management to hire necessary staff, resulted in increasing the number.

Accepted open use and collaborative R&D

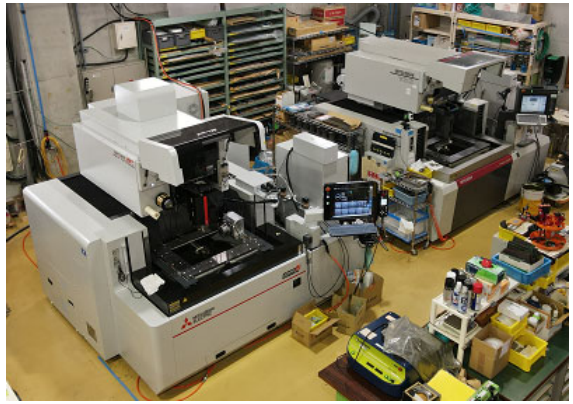
- The ATC accepts applications from and universities and research institutes in two categories: facility open use and collaborative R&D.
  - Collaborative R&D: R&D conducted in collaboration with the ATC staff
  - Facility open use: Use of the ATC facilities or laboratories



Number of work requests (Manufacturing)



- Main machines



Two Wire-EDMs

5-axis machining center

Current NAOJ projects (1)

Project	Instrument	Activities in 2024	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 ・Systems engineering	2025-03 CDR	Opt/IR mission inst. Thermal and mech. eng. Machining eng.
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)	・Mechanical design		Opt/IR mission inst. dev. Thermal and mech. eng.
ALMA2	Band8v2	・Preliminary design of the receiver ・Test fabrication and evaluation of SIS devices	2025-03 PDR 2028 Delivery	Radio mission inst. Sensor eng. Additive mfg. eng.
	Band2	・Desing study of optics ・Design, manufacturing and test of optical parts (cancelled)		Radio mission inst. Machining eng.
ALMA	Band4,Band8,Band10,Band1	・Maintenance of receivers (repairment)	N/A	Sensor eng.

Red letters indicate funded national projects

Current NAOJ projects (2)

Project	Instrument	Activities in 2024	Milestones	Related teams
KAGRA	OMC shroud	・Detailed design and assembly	2024-08 delivery	Thermal and mech. eng. Optics eng.
	Compact vibration insulation system	・Concept design, manufacturing and test of prototype model, preliminary design		Thermal and mech. eng.
	OFI pendulum and shroud	・Concept design and preliminary design		Thermal and mech. eng.
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 subsystem	・Development of IR detector ・Concept design of the detector box unit ・Element test ・Design of BBM ・Systems engineering	FY2024-07 MDR FY2027 PTR FY2029 CDR FY2031 launch	Opt/IR mission inst. Thermal and mech. eng.
	Mission electronics subsystem	・Concept design		Space mission inst.

Red letters indicate funded national projects

Requirements from LOI to ATC

No	Plan	Experiment area	Engineering	Manufacturing	Device fabrication	Radio Receiver	Test	Maitenance
1	Square Kilometre Array Phase 1						✓	
2	Advanced R&D hub for future GW detectors with TAMA300	✓	Mechanical Electrical	✓				
3	Optical and Infrared Synergetic Telescopes for Education and Research (OISTER)	✓	✓	✓			✓	
5	Promoting gravitational wave astronomy with the gravitational wave telescope, KAGRA	✓	✓	✓			✓	
6	Third generation gravitational wave telescope (3G)	✓						
7	Ultra-Doppler: Ultra High Precision Radial Velocity Instrument for Nearby Solar Twins Search	✓						
8	Developing Far-Infrared Astronomy with PRIMA	(✓)	(✓)	(✓)			(✓)	
12	The LAPYUTA (Life-environmentology, Astronomy, and PlanetarY Ultraviolet Telescope Assembly) mission		✓				✓	
13	The Thirty Meter Telescope TMT	Clean room	✓	✓			✓	
16	SILVIA: In-Orbit Demonstration of Ultra-Precision Formation Flying	(✓)	✓	✓			✓	
17	Participation in the NASA Habitable Worlds Observatory	Clean room	✓	✓			✓	
18	Exoplanet Research Hub	✓						
19	Revealing the evolution from star and planet forming regions to planetary systems with radio and infrared observations x theory				✓			

Requirements from LOI to ATC

No	Project	Experiment area	Engineering	Manufacturing	Device fabrication	Radio Receiver	Test	Maitenance
20	Study of the formation of astronomical objects and structures using wide-area/wide-band observations with the Atacama Submillimeter Telescope Experiment (ASTE)					✓		
21	ALMA2: Atacama Large Millimeter/submillimeter Array in Exploration of the Origins of the Universe and Life	✓	✓	✓	✓	✓	✓	
22	From Subaru and beyond : Subaru 3	✓	✓	✓			✓	
23	Center for multi-messenger astronomy	✓	✓	✓			✓	
25	Elucidating formation and evolution of celestial bodies using far-infrared and terahertz interferometers	✓	Optical	✓	✓	✓	✓	
26	JASMINE: Japan Astrometry/photometry Satellite Mission for INfrared Exploration	✓	Mechanical Electrical	✓			✓	
28	Characterization of exoplanets by synergy with space and ground-based telescopes	✓	Mechanical Optical	✓			✓	
30	Study of the formation of astronomical objects and structures through the promotion of the LST/AtLAST project and multi-dimensional submillimeter survey observations	✓			✓	✓	✓	
32	Okayama Telescope Cluster: A Hub for Time-Domain Astronomy and Global Collaboration		Optical					
33	Nobeyama 45-m telescope: experimental field for next-generation technologies and astronomy with large-aperture millimeter-wave telescope	✓			✓	✓	✓	

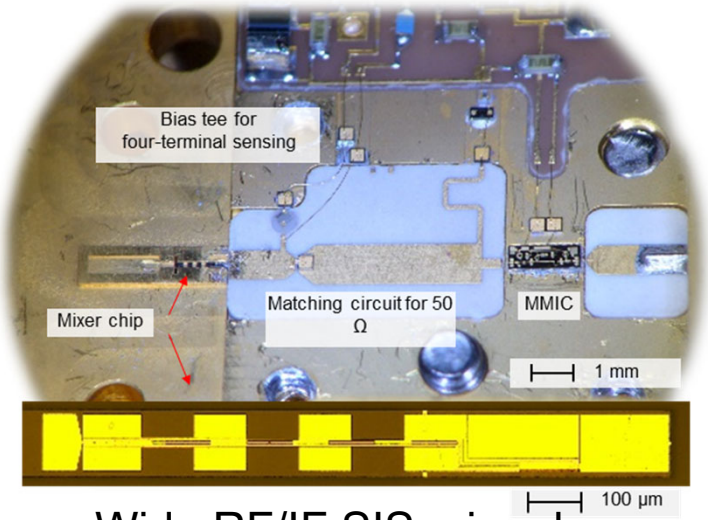
Requirements from LOI to ATC

No	Project	Experiment area	Engineering	Manufacturing	Device fabrication	Radio Receiver	Test	Maintenance
34	GREX-PLUS: Galaxy Reionization EXplorer and PLanetary Universe Spectrometer	?	?	?	?	?	?	
36	Antarctica 30-m Terahertz Telescope Project	✓	Antenna	✓	✓	✓	✓	
37	Solar flare X-ray focusing imaging spectroscopy	Clean room	Mechanical	✓			✓	
38	The SOLAR-C Mission： a satellite mission for a high-throughput EUV Imaging Spectroscopy of the Sun	Clean room	Mechanical Optical	✓			✓	
39	Large Space Optical Infrared Telescope	✓	✓	✓			✓	
40	Continuous observations of solar activity: HINODE, Mitaka ground-based telescopes, and build-up for future observations	Clean room	✓	✓			✓	
41	Radio astronomy with ultra-high angular resolution using EAVN and beyond							✓

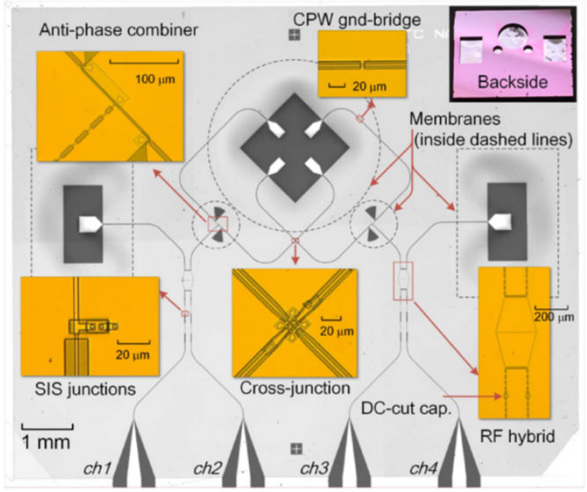
30 out of 43 plans (70%) are expecting support from ATC
Too many requirements compared to ATC capability => Prioritization is inevitable

Promising technology 1

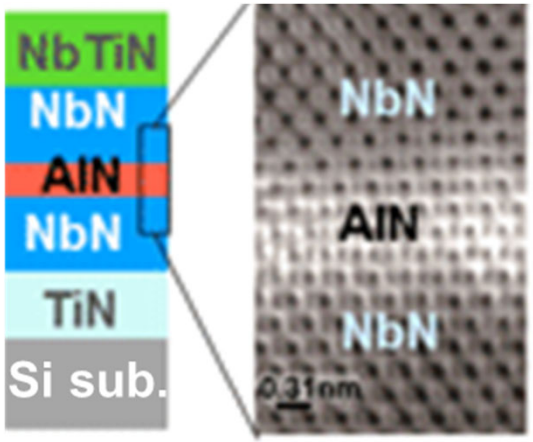
- Radio-wave field
  - Direction of technology development: wideband, multibeam, high frequency



Wide RF/IF SIS mixer by T. Kojima



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



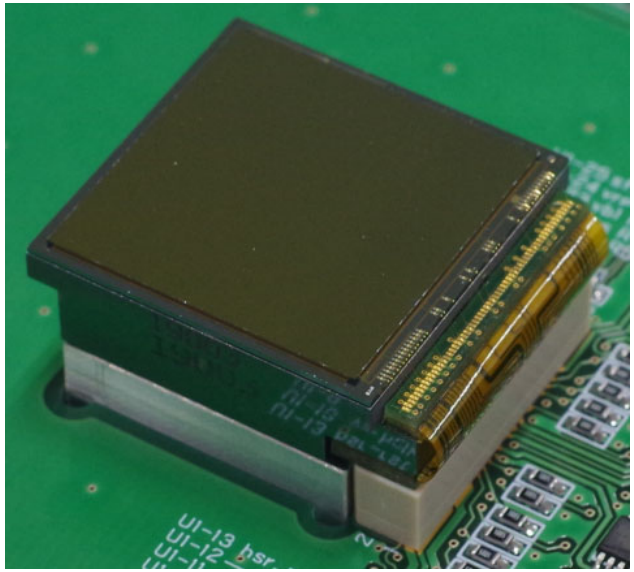
Epitaxial NbN SIS junctions by K. Makise

- Superconducting device fabrication technology is essential.

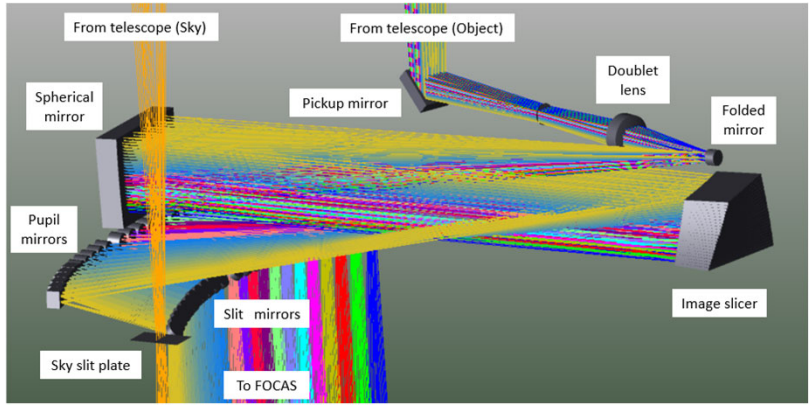
Promising technology 2

- 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, adoptive optics

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



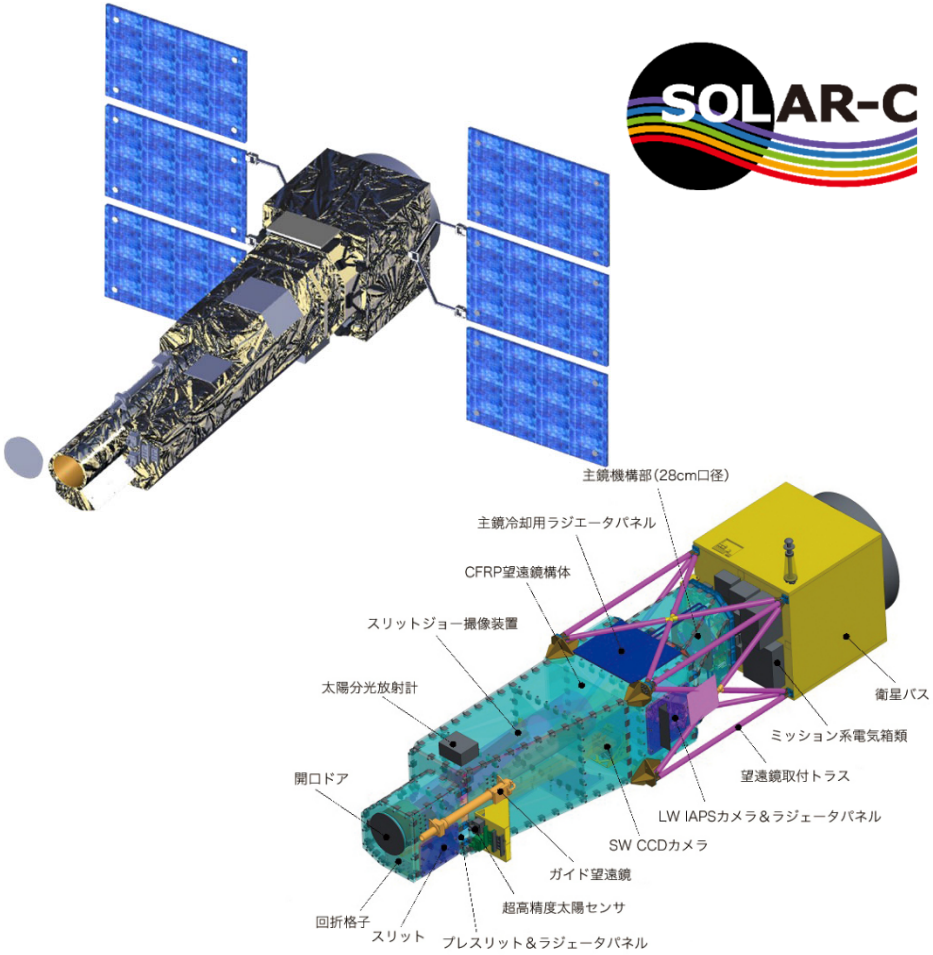
InGaAs infrared image sensor (1280x1280) developed by H. Nakaya



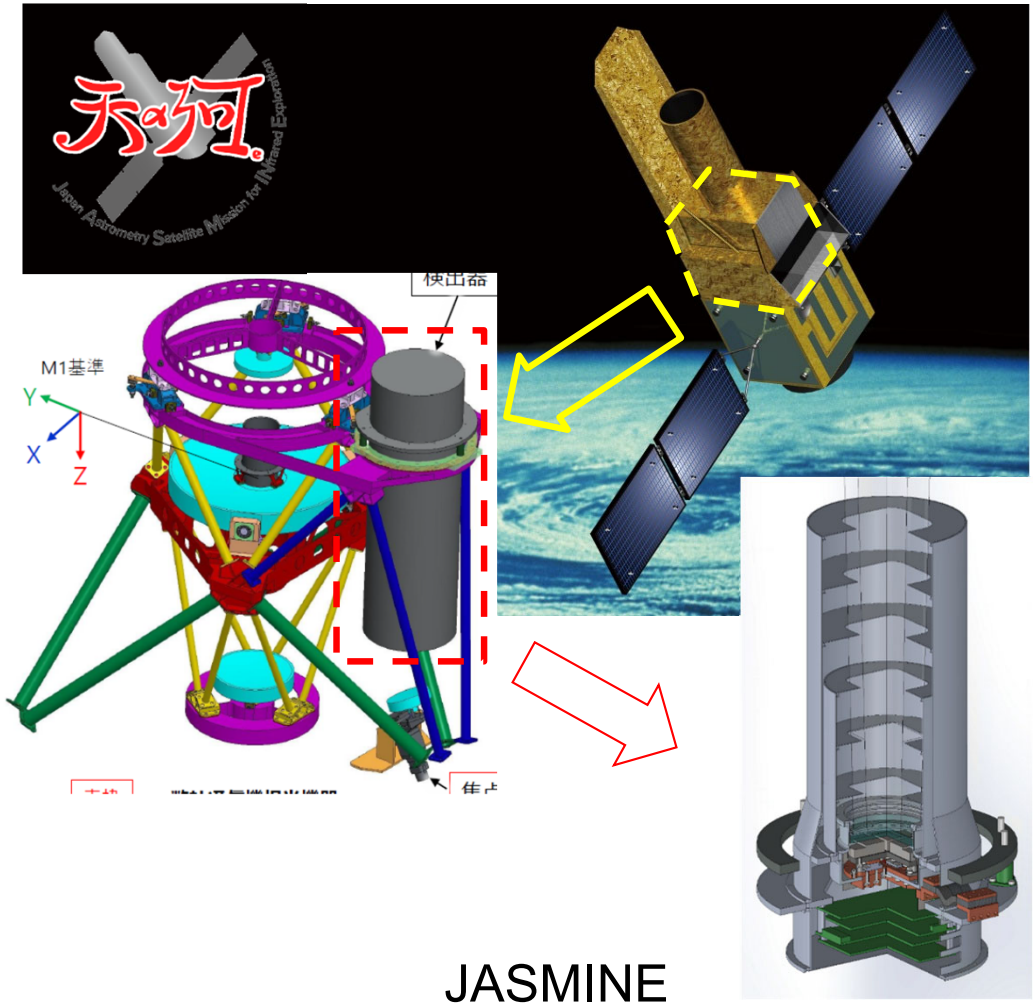
FOCAS IFU designed by S. Ozaki, T. Tsuzuki et al.

Promising technology 3

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



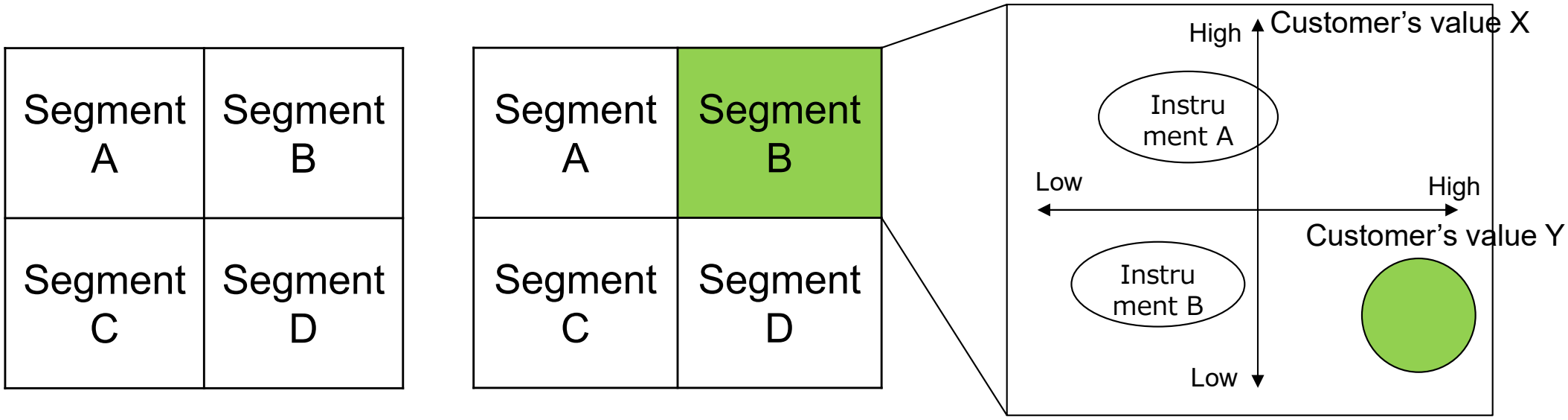
SOLAR-C



JASMINE

Strategic Technology of ATC

- What should be the strategic technologies of ATC for the future?
- Closely related to the science road map of NAOJ
- Analogy of marketing
  - Segmentation => Targeting => Positioning



SX research and development site

【分野共通】17.SX研究開発拠点（文部科学省）

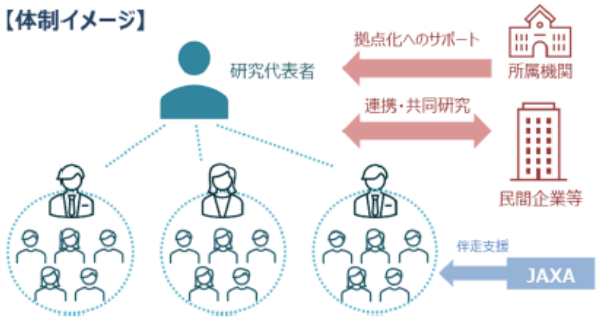
支援規模：110億円程度

背景・目的

これまで我が国の宇宙産業は、JAXA及びJAXAと緊密な協力関係にある幾つかのプライム・コントラクターを中心に発達してきたが、激化する国際競争に伍していくためには、特色ある技術や領域において、**JAXAを超える水準の宇宙分野のクラスター**を形成し、持続的なイノベーションの創出や競争力の確保につなげていく必要がある。また、成長産業である宇宙分野における**人的基盤の強化や非宇宙分野からの人材の流入拡大**に向けた取組も緊要である。

こうした中、我が国の**大学等研究機関の役割**を、宇宙分野のクラスター形成に向けて強化する必要があり、このためには、我が国を牽引する研究者が先進的な研究開発に専念できる環境を確保しつつ、創出された技術や輩出された人材が、宇宙市場の獲得等に向けて切れ目なくつながっていくような**「人材・技術・資金の好循環」**を形成していくことが重要である。

【体制イメージ】



そこで本テーマでは、宇宙分野の先端技術や、同分野に活用可能な非宇宙分野の技術を有する大学等所属の研究者を対象に、当該研究者等を中核とした体制により、**宇宙分野の裾野拡大を図りつつ、特色ある技術や分野においてJAXAを超えるような革新的な研究開発成果**を創出・社会実装していくための戦略的な構想を推進する。提案に際しては、宇宙技術戦略を参照しつつ、**卓越した研究者を中核とした牽引型の推進体制**、または**高度な研究開発環境を中核とした共用型の推進体制**のいずれかの構想を募集する。特色ある技術や領域における大学等の研究者や研究グループと民間事業者等との連携を構築しつつ、その取組の自走化や拡大を通じて、**将来の我が国の宇宙開発において最先端を担う研究開発拠点への発展**を目指す。

（参考）宇宙技術戦略での記載

宇宙機の基盤技術における競争力の源泉は、コンポーネント・部品・材料・アプリケーション・システム開発技術である。しかし、技術成熟度がまだ低く、上記に分類できない先端技術を、いち早く宇宙分野に応用することも重要である。そのため、開発支援を行う政府・関連機関は、宇宙関連の先端分野に加え、宇宙以外の先端分野の関連学会や大学に関しても関連を密にし、宇宙・非宇宙先端技術の宇宙への適用を促すための連携の機会を探ることも重要である。また、こうした技術の研究開発や実装の担い手として需要が拡大する宇宙人材を確保することは、衛星、宇宙科学・探査、宇宙輸送の分野に共通する課題である。そのため、宇宙機器の製造分野に加え、リモートセンシング等のデータ利用側を含めた民間事業者のニーズ等を継続的に把握しつつ、産学官における技術開発や教育・研修等を通じた高度な技術者の育成や、宇宙人材の流動化促進、他産業の人材の宇宙分野への流入促進を図ることが重要である。(5.(3))等

本テーマの目標

2030年代早期までに、下記の技術に関してJAXAを超える研究成果（TRL４相当以上）を創出することにより、我が国の国際競争力を強化するとともに、将来の我が国宇宙産業・宇宙開発を支える人材の裾野を、非宇宙分野からの参画も含め拡大する。また、各実施体制を中核とした拠点化の推進により、宇宙分野における我が国のクラスターを形成しつつ、持続的なイノベーション創出や人材輩出につなげる。

（輸送）低コスト構造の宇宙輸送システムや新たな宇宙輸送システムの実現に必要な革新的技術
（衛星等）国際競争力のある衛星システム（衛星事業や軌道上サービス等）やその基盤として必要となる革新的技術
（探査等）月以遠探査や人類の活動範囲拡大または地球低軌道利用における事業の創出・拡大に必要な革新的技術

技術開発実施内容

宇宙技術戦略を参照とした内容であり、卓越した研究者を中核とした「牽引型」または高度な研究開発環境を中核とした「共用型」の研究推進体制によって、将来の拠点化を見据えつつ、特色ある技術や分野においてJAXAを超えるような技術等の成果創出を目指す研究開発を進める。

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Information

- Pre-registration system for the visitors from outside of NAOJ to ATC started in February 2024.
- The lobby of the ATC building is being renovated.
- Replacement of the water cooling system for building #1 and #2 is being held. The cooling system is not available from December 2nd to the end of March 2025.

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.
- As for the development of the future technology, the resources of ATC are limited, thus we must focus on the competitive technologies or strategic technologies.
- 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!