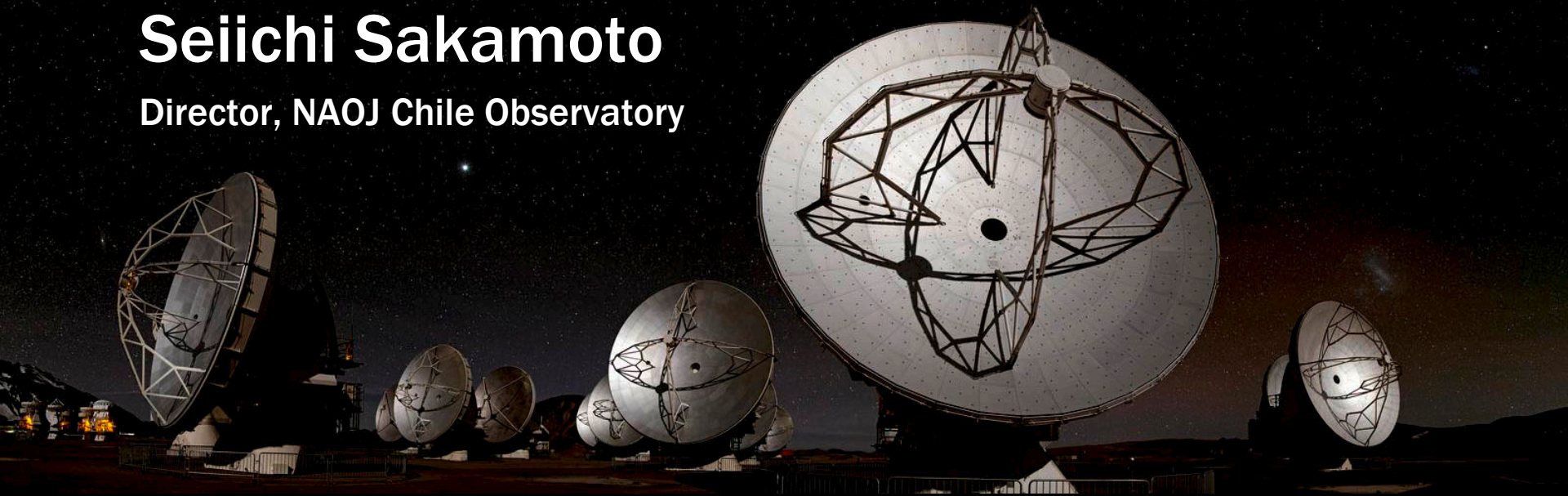


Japanese Contribution to ALMA

Seiichi Sakamoto

Director, NAOJ Chile Observatory



NAOJ branches

Okayama



Mitaka HQ



Mizusawa



VLBI stations



Nobeyama



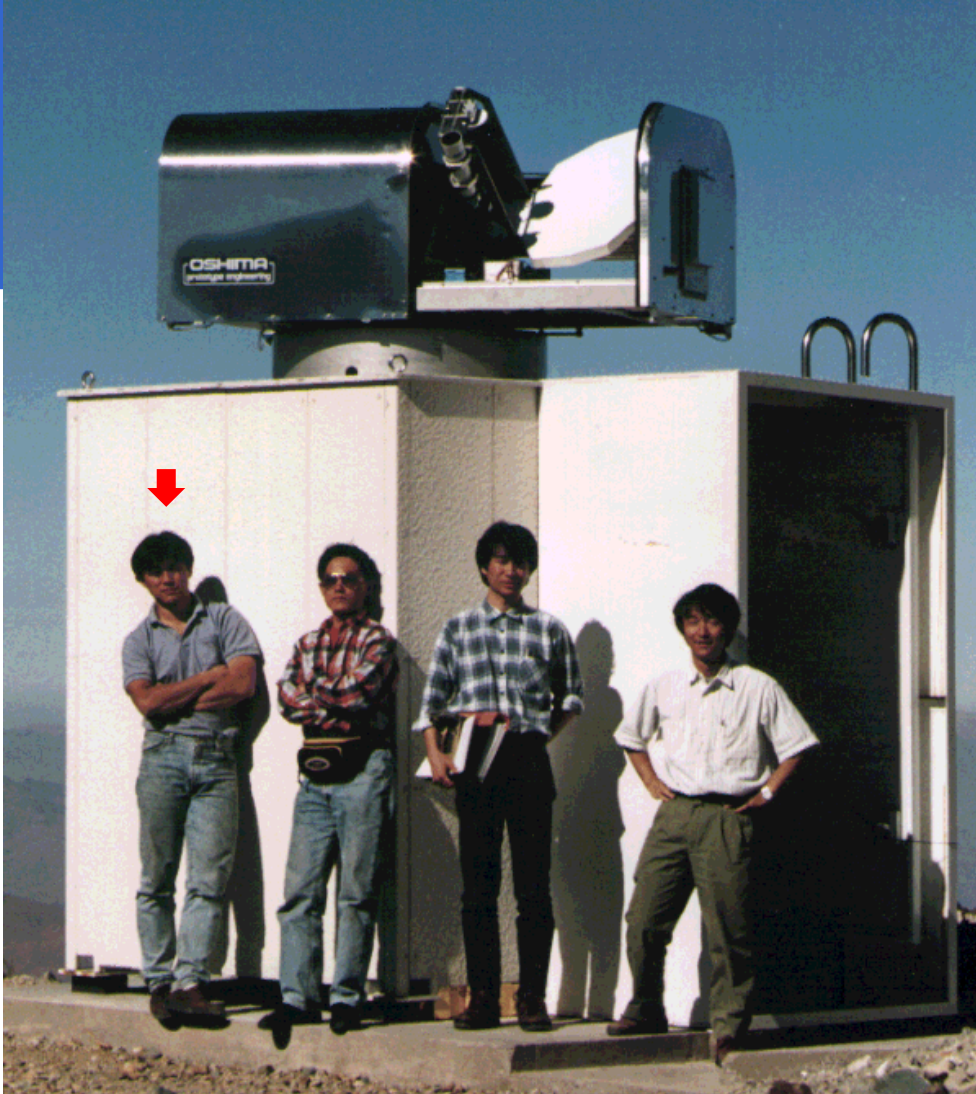
Hawaii



Chile

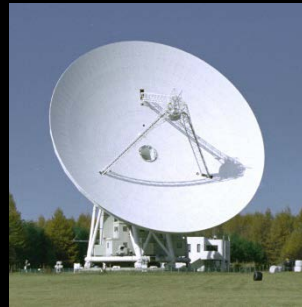
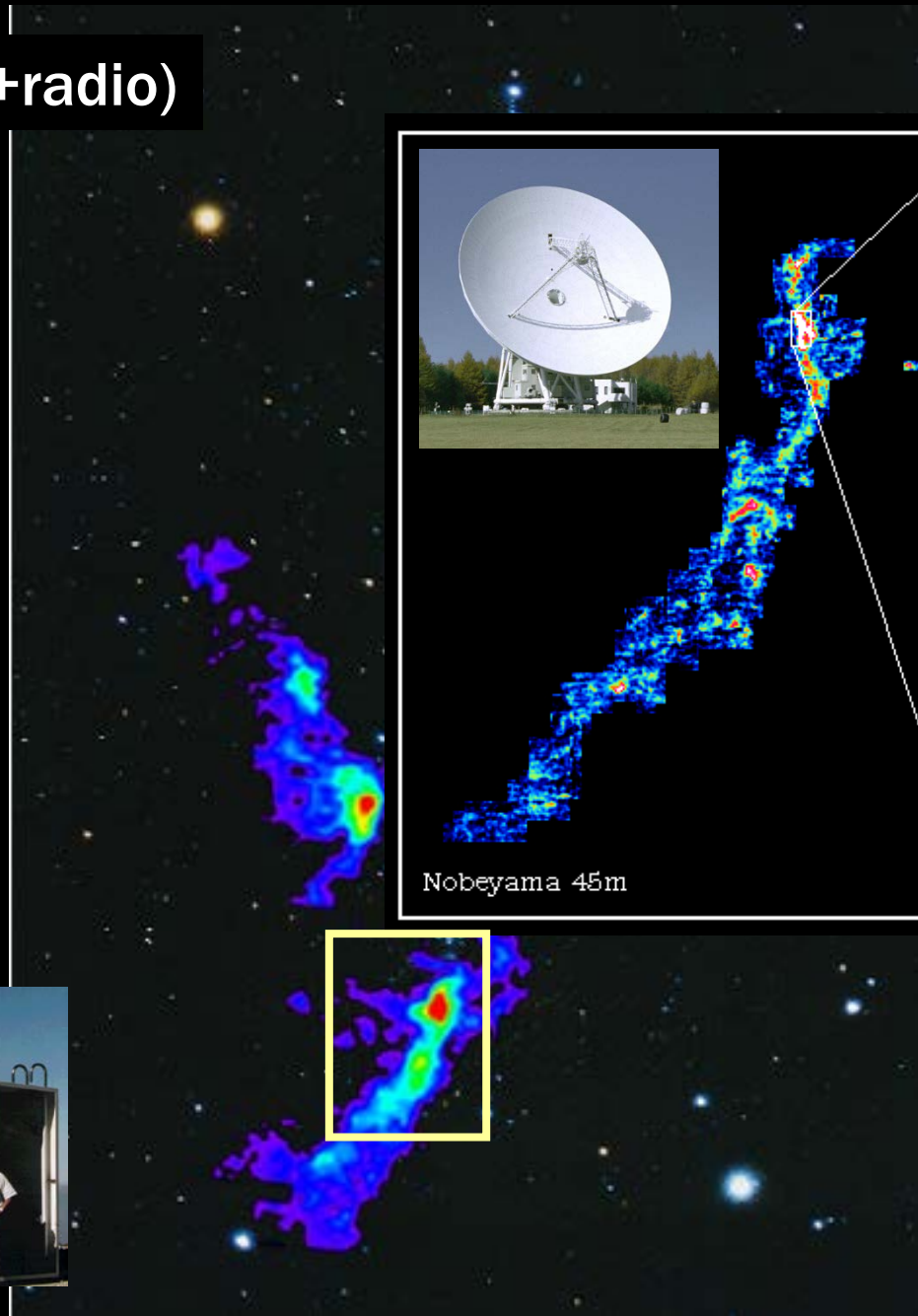


Very Small Telescope (VST) -2

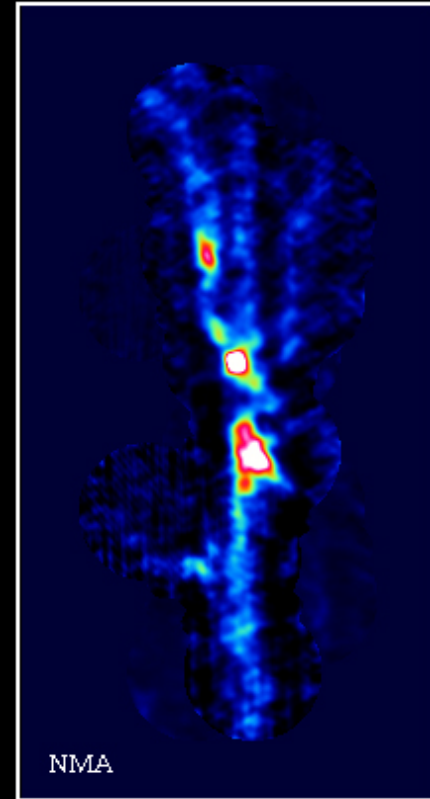


- ◆ A twin of VST-1 but for southern survey
- ◆ Led by U. Tokyo, with ESO, Onsala Space Obs, U. Chile
- ◆ Installed in 1994 at La Silla Observatory, near La Serena
- ◆ Started operations in 1996 July

Orion (optical+radio)



Nobeyama 45m



Concept of Large Millimeter Array



- ✓ First concept was to increase the number of 10m antennas from 5 to 30 at Nobeyama
- ✓ Japanese astronomers noticed importance of observations in submm-wave
- ✓ Survey for ideal sites started in early 1990's

Large Millimeter Array Projects

	LMSA	MMA	LSA
			
Array	10m × 50	8m × 40	16m × 50
Site	Chile	Hawaii→Chile	Chile
Altitude	>4000m	>4000m	~3000m
Partner	Japan	USA	ESO
Characteristics	higher frequency	higher image fidelity	larger collecting area in mm

Japanese Site Survey in Chile

High-response
anemometer

Field strength meter

Lightning locator

Radio seeing
monitors

Containers

Solar panels

Weather
stations

Soil thermometer

220GHz radiometer

Soil resistivity meter

- Temporal measurements:
- Fourier transform spectrometer
 - 490GHz radiometer
 - Radiosonde
 - UVA/UVB sensor
 - Gamma-ray dosimeter
 - Neutron dosimeter

Joint Site Testing Campaign

Seiichi Sakamoto
NAOJ (Japan)

Bryan Butler
NRAO (USA)

Lars-Ake Nyman
ESO (Europe)

1999 Nov.



Joint Site Testing Campaign

Seiichi Sakamoto
Director, NAOJ Chile

Bryan Butler
Head of Sci. Ops, VLA

Lars-Ake Nyman
Head of Sci. Ops, ALMA

17 years later



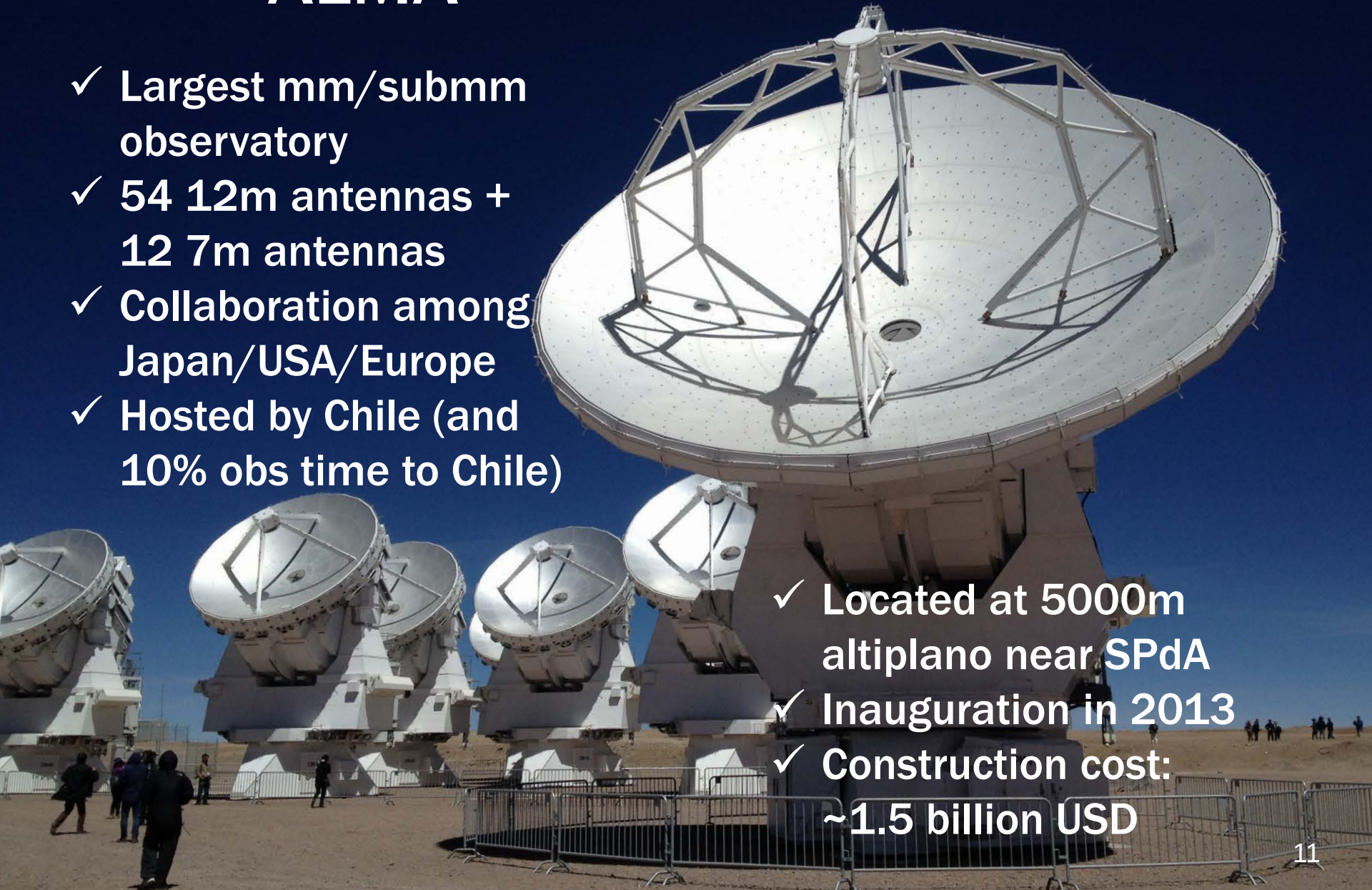
Large Millimeter Array Projects

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Altitude	>4000m	>4000m	~3000m
Partner	Japan	USA	ESO
Characteristics	higher frequency	higher image fidelity	larger collecting area in mm
	ALMA		
Array	12m × 50 + 7m × 12 + 12m(TP) × 4		

ALMA

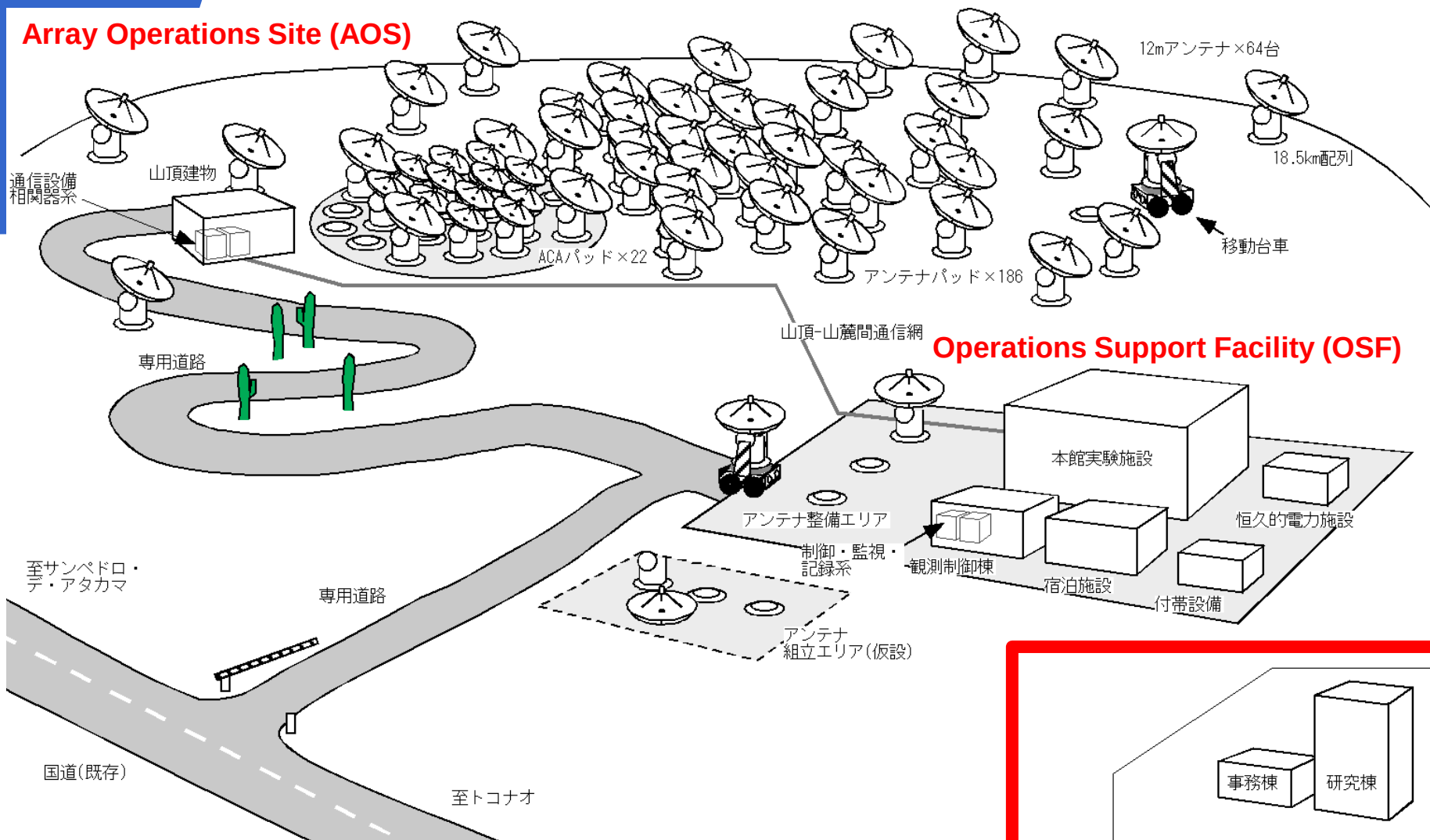
- ✓ Largest mm/submm observatory
- ✓ 54 12m antennas + 12 7m antennas
- ✓ Collaboration among Japan/USA/Europe
- ✓ Hosted by Chile (and 10% obs time to Chile)

- ✓ Located at 5000m altiplano near SPdA
- ✓ Inauguration in 2013
- ✓ Construction cost: ~1.5 billion USD



ALMA Facilities

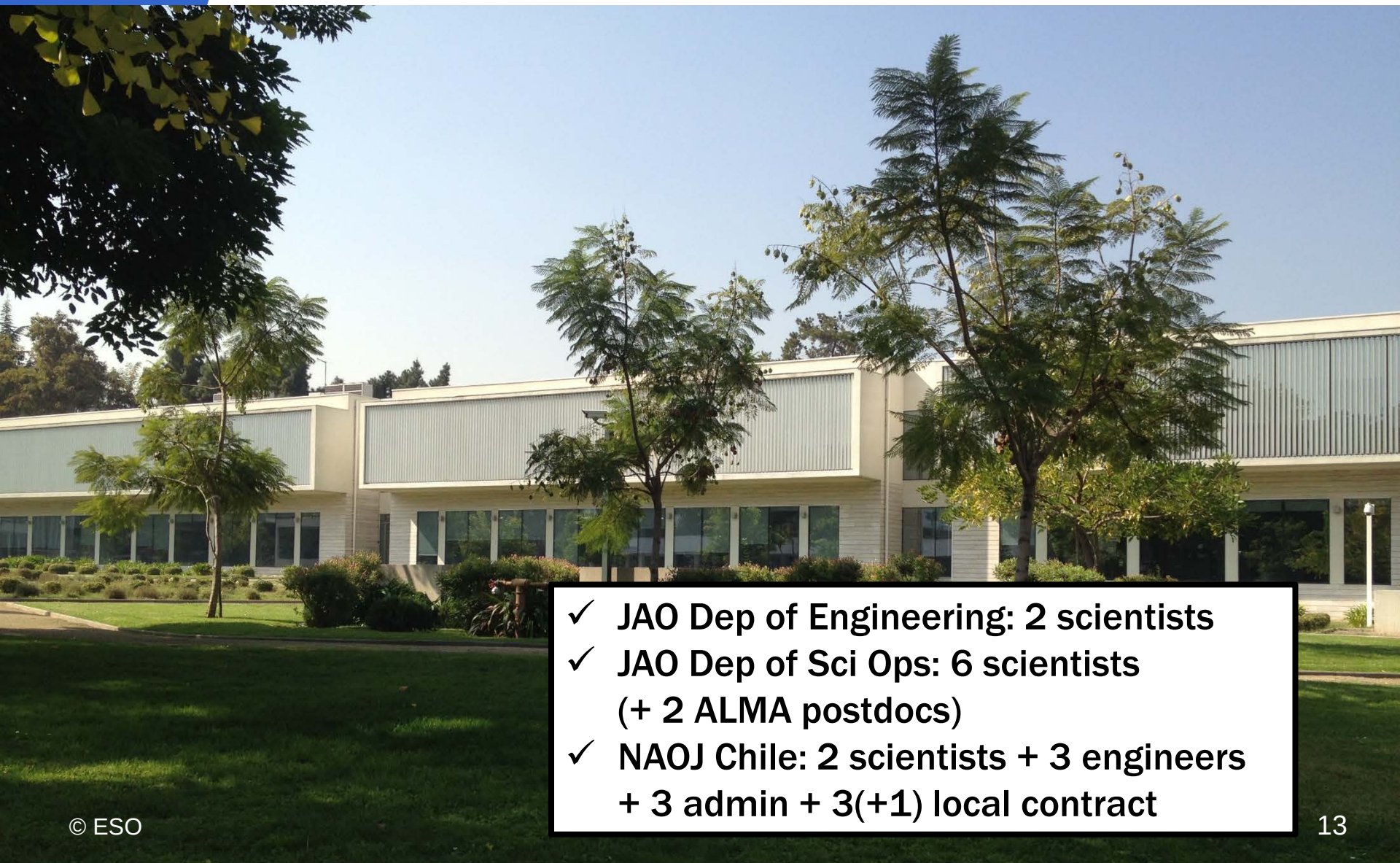
Array Operations Site (AOS)



Operations Support Facility (OSF)



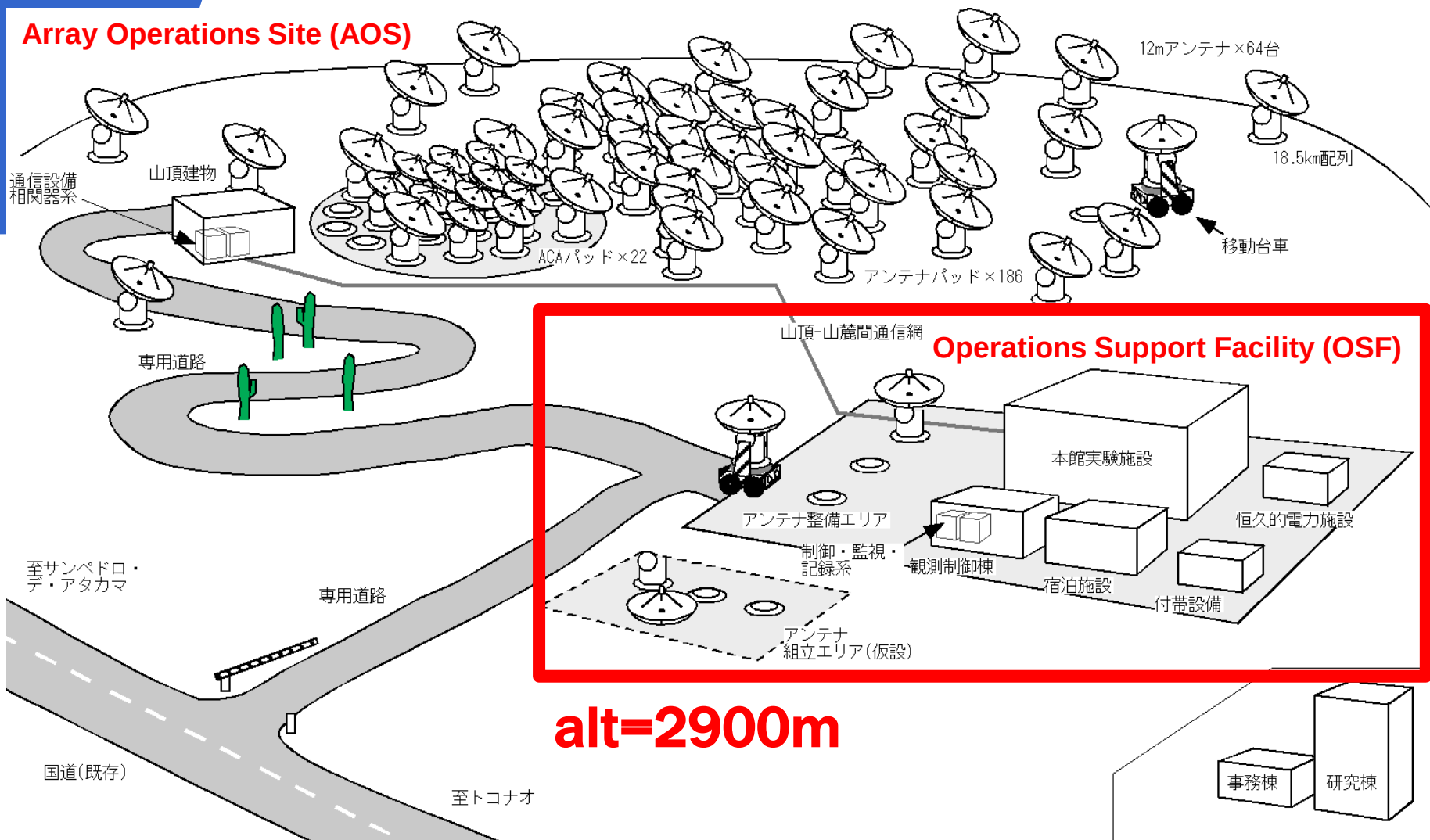
Santiago Central Office (SCO)



- ✓ JAO Dep of Engineering: 2 scientists
- ✓ JAO Dep of Sci Ops: 6 scientists
(+ 2 ALMA postdocs)
- ✓ NAOJ Chile: 2 scientists + 3 engineers
+ 3 admin + 3(+1) local contract

ALMA Facilities

Array Operations Site (AOS)



Santiago Central Office (SCO)

Trip to ALMA Site



Operations Support Facility (OSF)



Array Operations Site

Technical Building

Lodges

Sewage Facilities

Contractors' Area

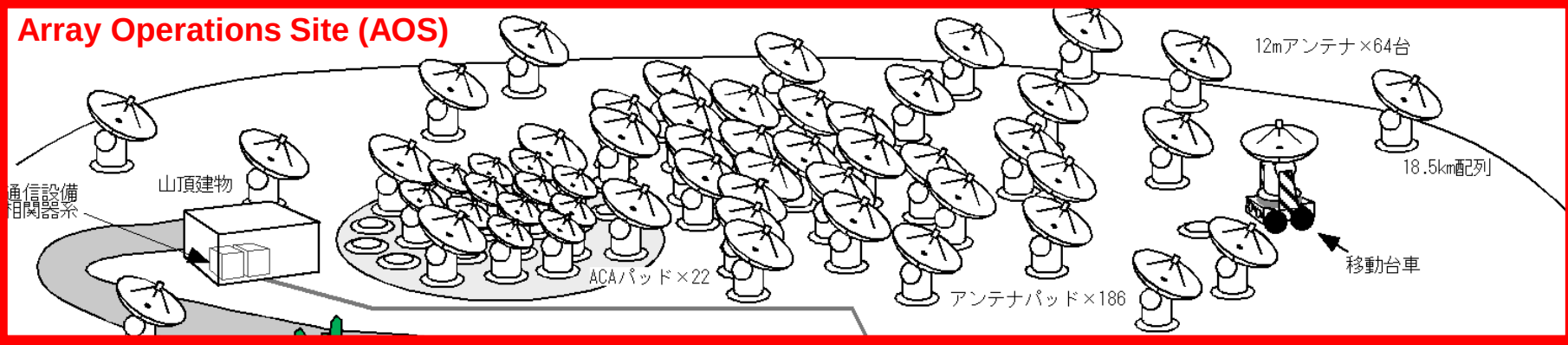
Antenna Construction Area
(to be decommissioned)

ALMA OSF Visitor Program

- ◆ **Saturdays/Sundays; free of charge**
- ◆ **Up to 40 persons/day; Age 4+**
- ◆ **Pre-registration from ALMA HP needed**
- ◆ **Guided tour in English/Spanish of
Technical Building (visitor center,
control room etc.)**
- ◆ **Telescope site is not open for general
public**

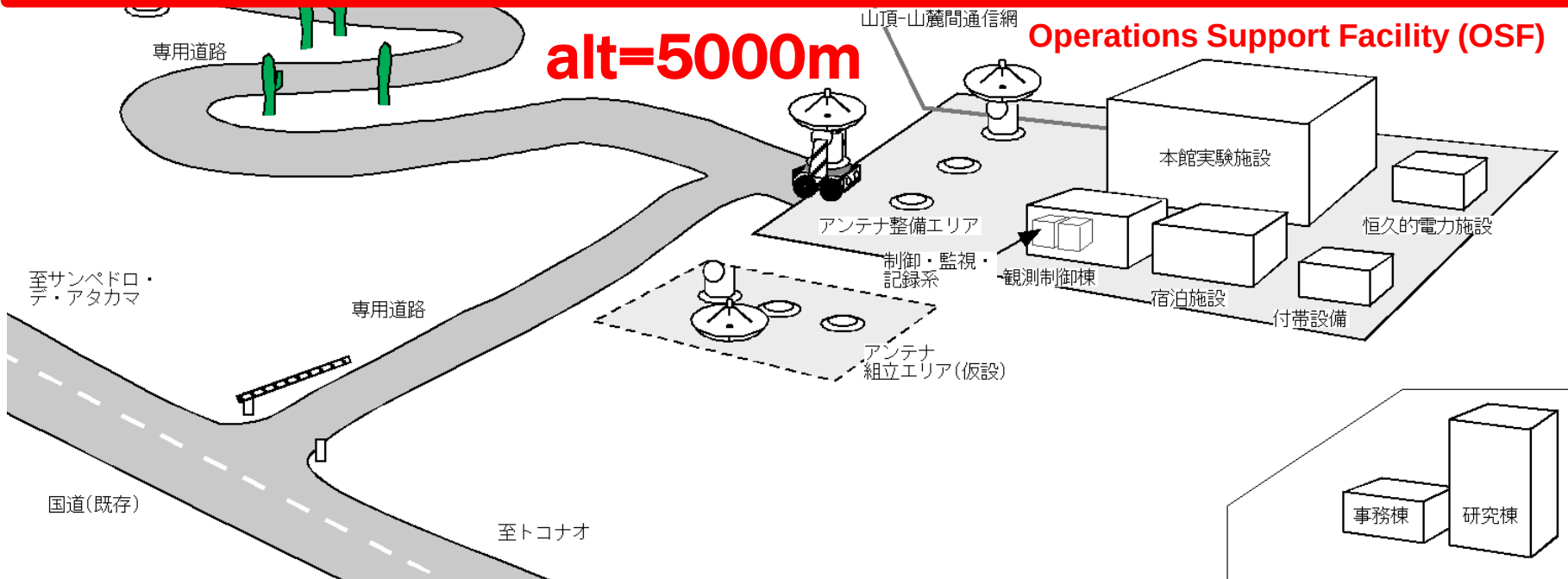
ALMA Facilities

Array Operations Site (AOS)



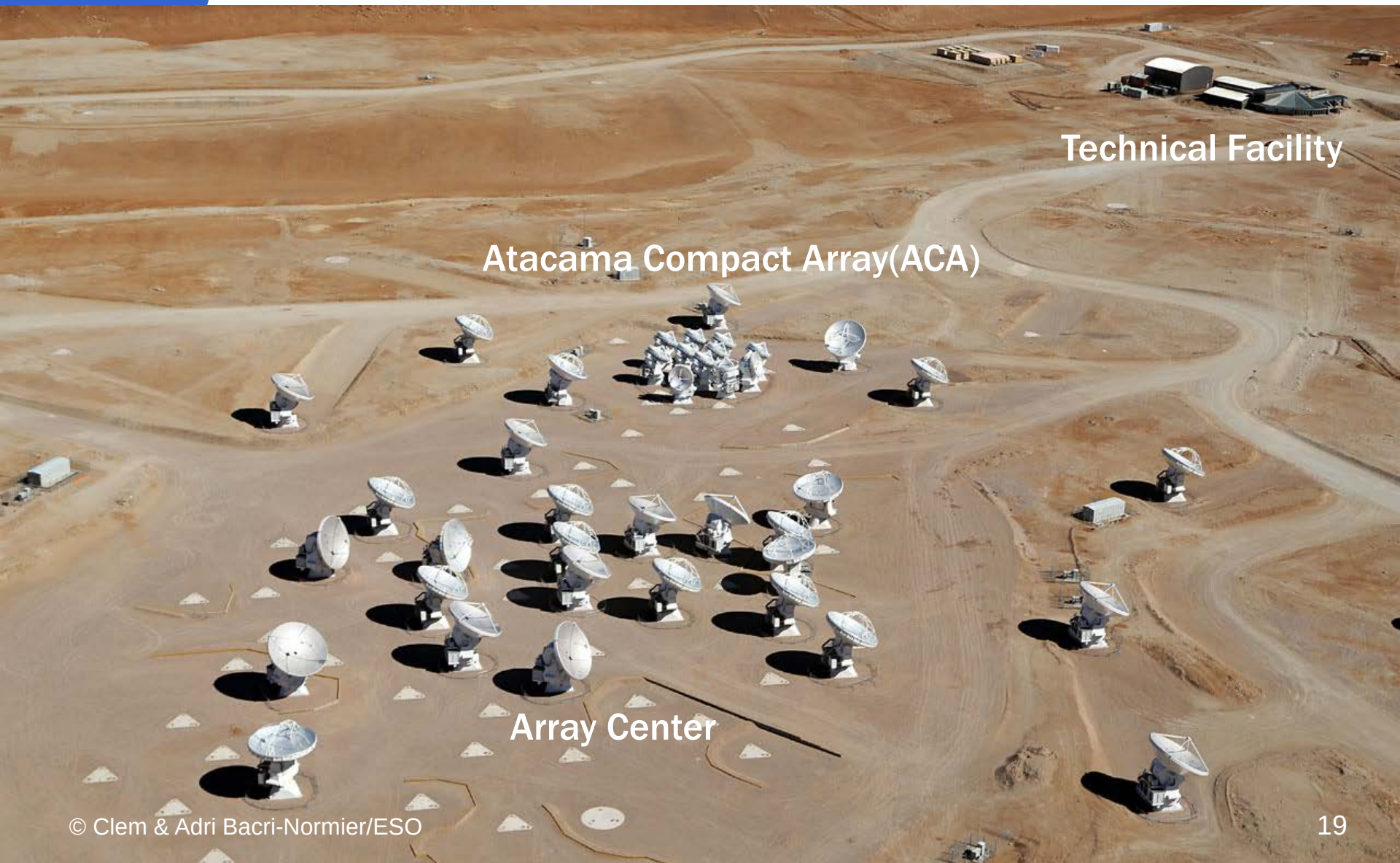
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Operations Support Facility (OSF)



Santiago Central Office (SCO)

Array Operations Site (AOS)

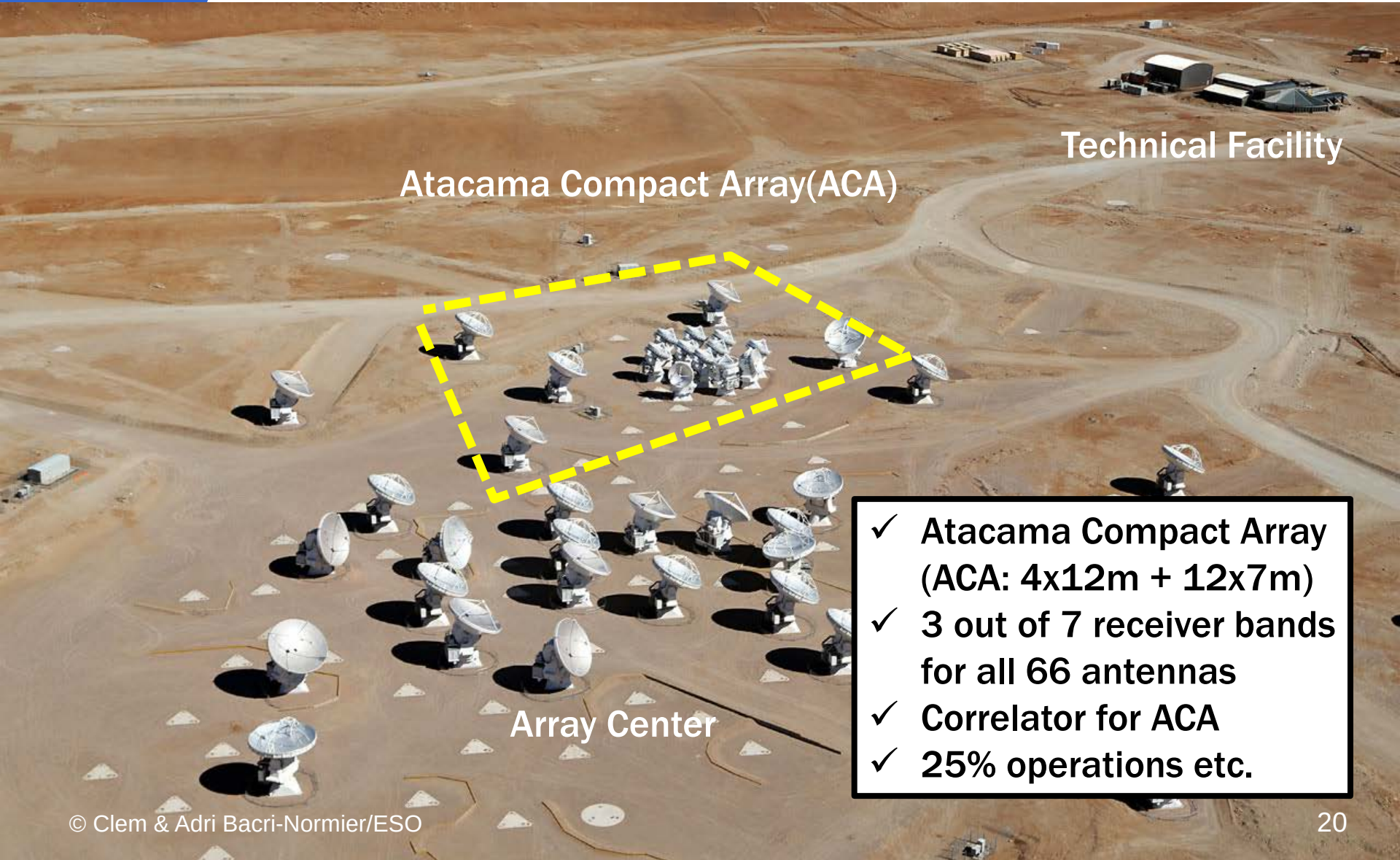


Technical Facility

Atacama Compact Array(ACA)

Array Center

Japanese Contribution to ALMA



Atacama Compact Array(ACA)

Technical Facility

Array Center

- ✓ Atacama Compact Array (ACA: 4x12m + 12x7m)
- ✓ 3 out of 7 receiver bands for all 66 antennas
- ✓ Correlator for ACA
- ✓ 25% operations etc.

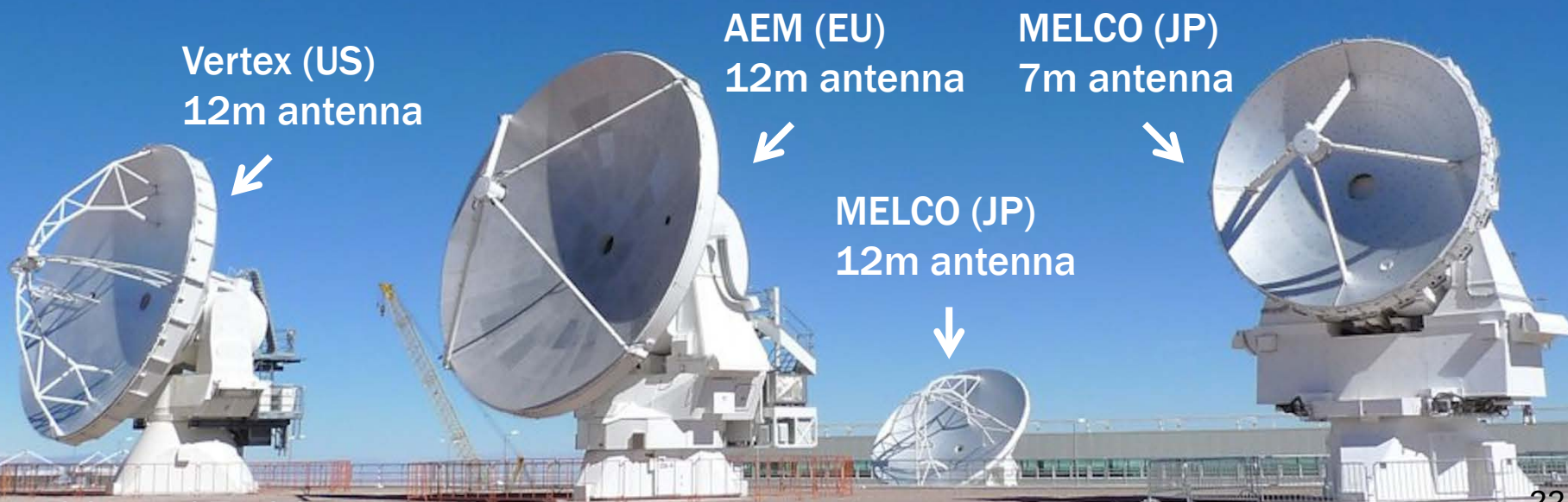
ALMA arrays

	12m Array	TP Array	7m Array	cf) NMA
Dia. × Num	12m × 50	12m × 4	7m × 12	10m × 6
Surf. error	<25μm	<25μm	<20μm	60μm
Pointing error		<0.6"(rel); <2"(abs)		3"-5"
Configuration	Spiral	Near 7m Array	Spiral	T-shaped
Baseline	15m-16km	N/A	8.5-33m	13-351m
Switching		6deg/s (Az); 3deg/s (El)		~0.5deg/s



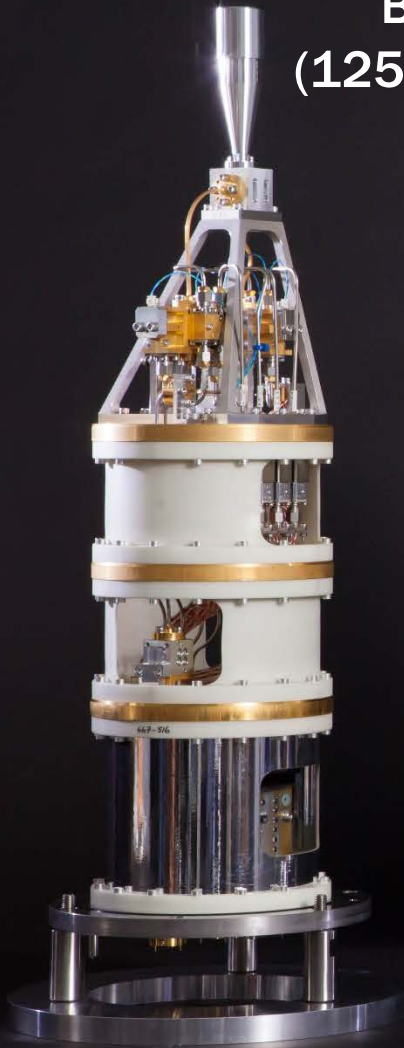
ALMA antennas

	7m antenna (JP:MELCO)	12m antenna (JP:MELCO)	12m antenna (US:Vertex)	12m antenna (EU:AEM)
BUS	Iron•truss	CFRP•truss	CFRP•box	CFRP•box
Subref stay	Normal•+	Arch•+	Arch•+	Normal•×
RX cabin	Iron•air cool	Iron•air cool	Iron•water cool	CFRP
Az/El drive	Direct	Direct	Gear	Direct

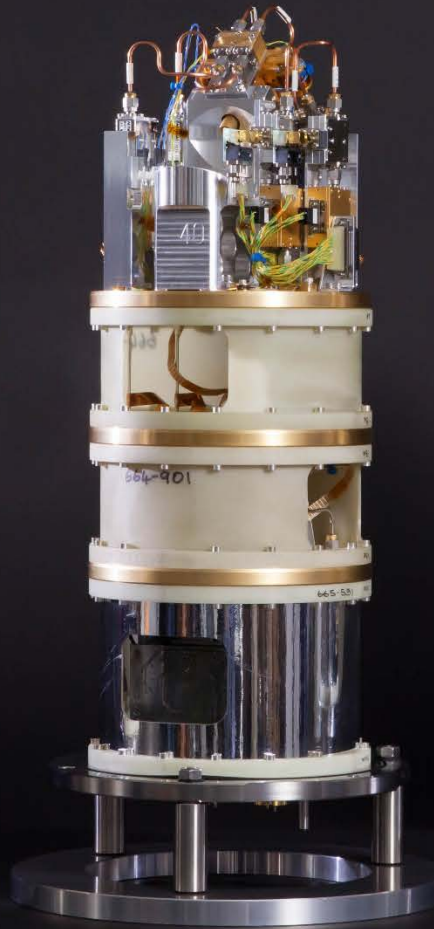


Receivers (CCA)

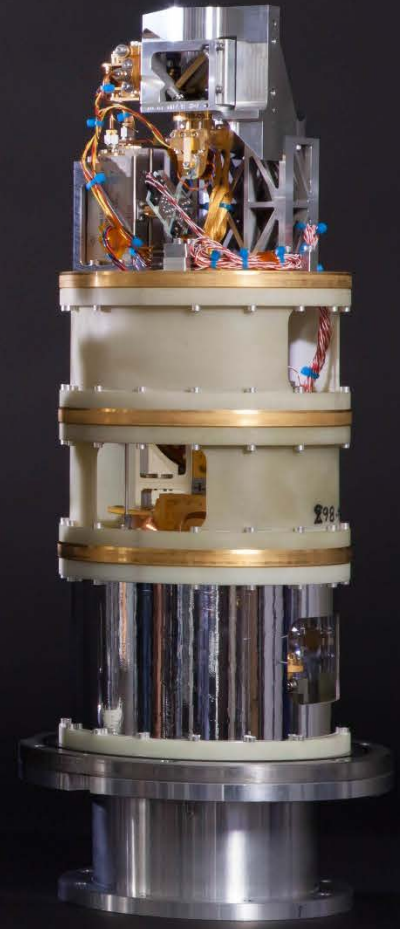
Band 4
(125-163 GHz)



Band 8
(385-500 GHz)



Band 10
(787-950 GHz)



ACA Correlator

	Baseline Correlator	ACA Correlator	cf) NMA Correlator	
Cross Corr.	1225 (50 elements)	66 (12 elements)	15 (6 elements)	
Bandwidth	8 GHz × 2 pol.	8 GHz × 2 pol.	1 GHz	32 MHz
# points	4096/IF	8192/IF	256/IF	1024/IF
Type	XF	FX	XF	FX



