Current Project Status in Japan

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ALMA Science Advisory Committee (March 19, Tokyo)

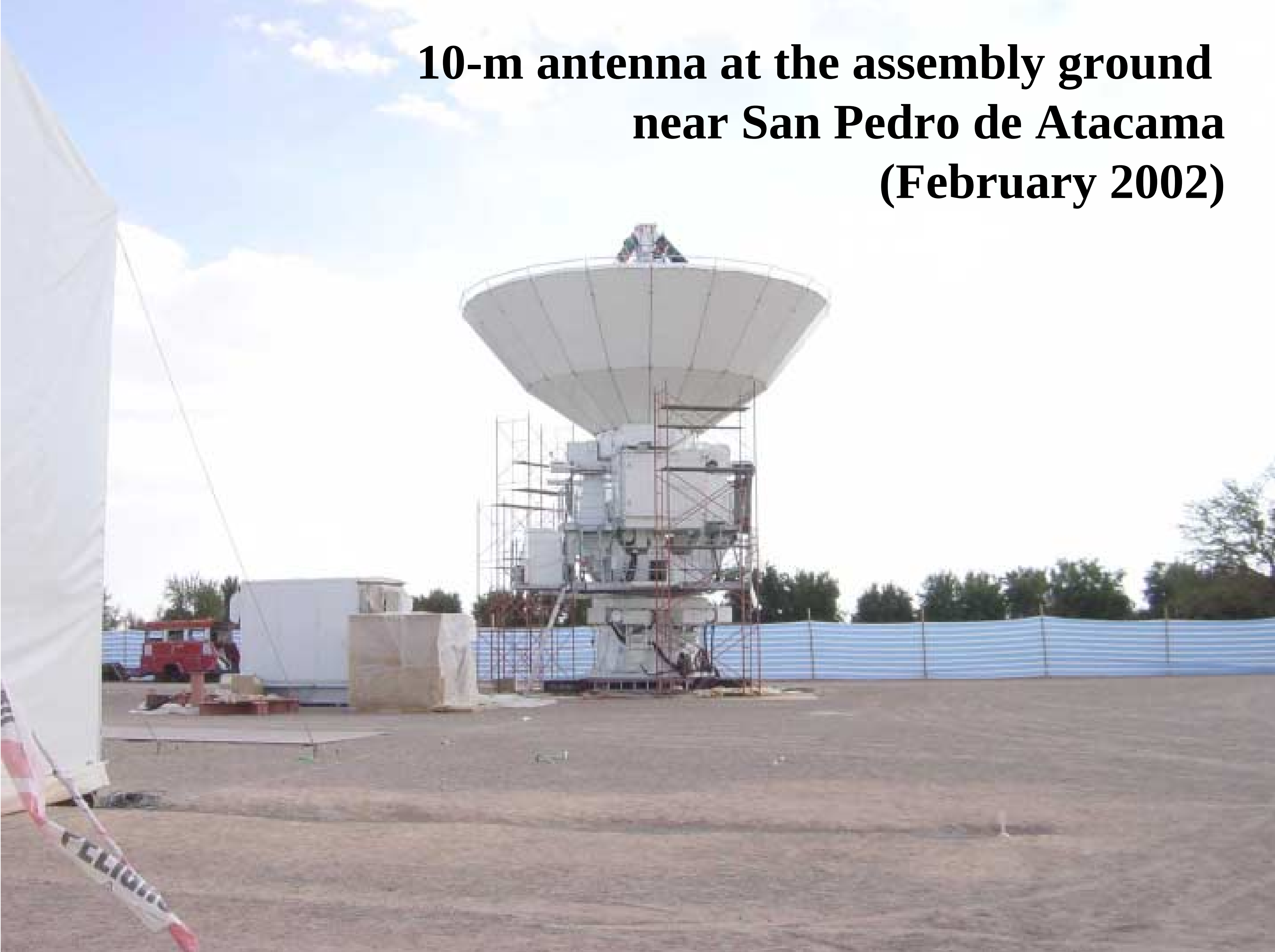
Outline of My Talk

- **ASTE Status**
- **ALMA-J Funding Status and Milestones**
- **ALMA-J Organization**
- **Technical Progress**

  Antenna, SIS Junction, FE, Cryostat, Photonic LO, Correlator, Computing

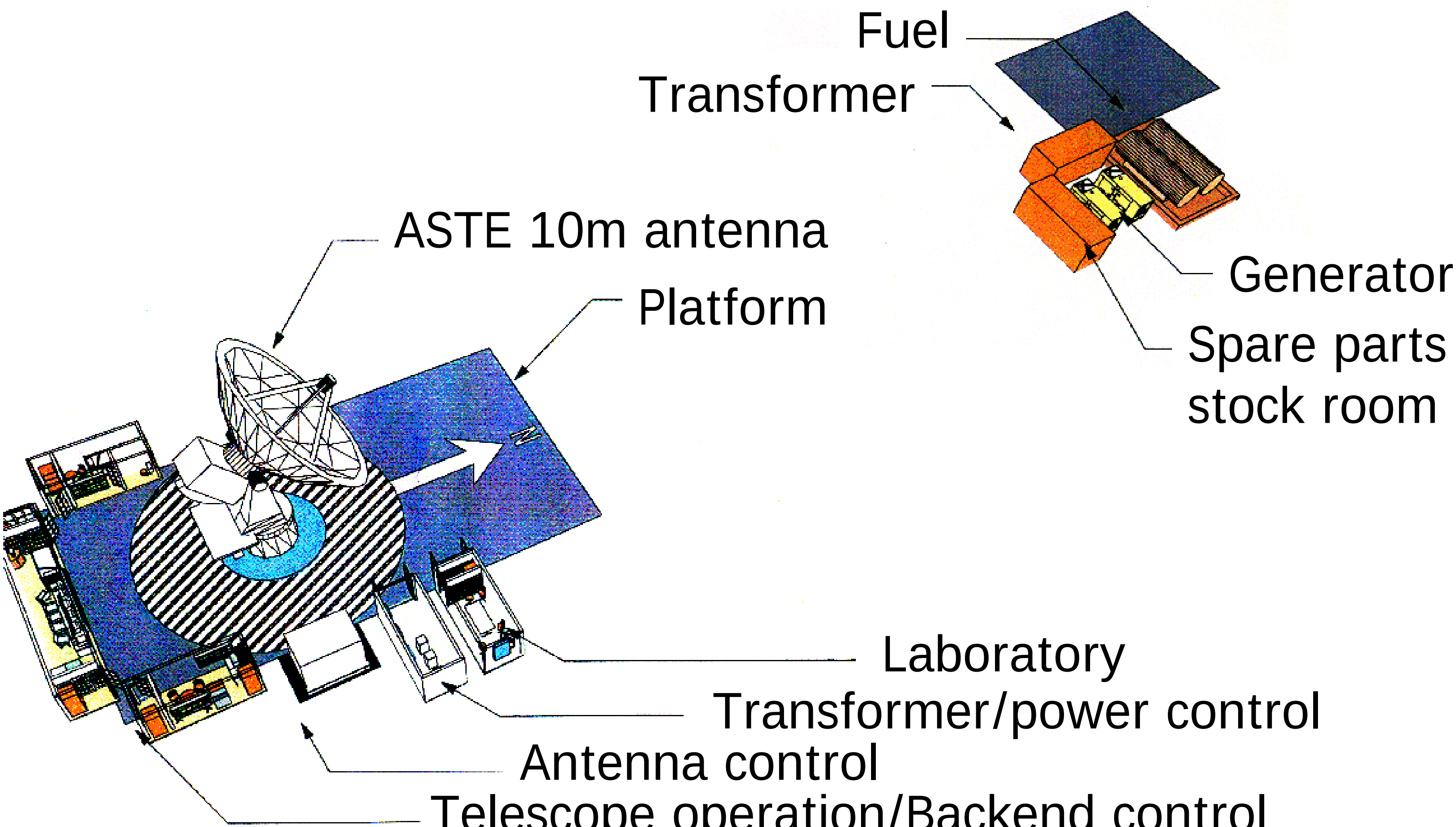
ASTE Status

- **High precision 10 m antenna**
  - **Assembly finished** near San Pedro de Atacama
  - Finish installation at Pampa la Bola site by the end of March
- **SIS receivers**
  - Evaluation RX (ready): 100, 230, 350GHz
  - ALMA(Cartridge)-type RX (2002-):
    band 8 (490 GHz), band 10 (810 GHz), & band 4
- **Digital spectrometer (shipped)**
  - 4 banks of 512 MHz/1024 channel XF type correlator
- **Infrastructure (ready)**
  - Power generator/satellite comm./control cabin



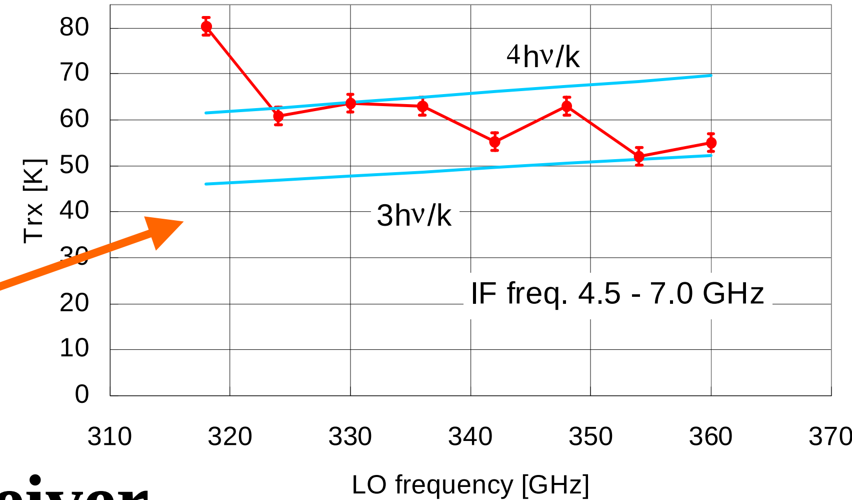
10-m antenna at the assembly ground near San Pedro de Atacama (February 2002)

ASTE Infrastructure



ASTE SIS Receivers

- **Evaluation receiver**
  - 100 GHz T(RX) = 20 K (DSB) for Holography etc.
  - 230 GHz T(RX) = 40 K (DSB)
  - 345 GHz T(RX) = 60 K (DSB)



- **ALMA (Cartridge) type receiver**
  - Compatible with ALMA cartridges
  - Band 8, 4, and 10 cartridges to be installed and tested in 2002
  - Band 8 T(RX) = 300 K (SSB) at present
  - Band 10 T(RX) = 600 K (DSB) at present

ALMA-J Funding Status

- **12-m prototype antenna is included in the FY2002 Budget!**

  The national budget will be approved shortly.

- **Resources for other D&D activities are being requested.**
- **New building (~1500㎡） at Mitaka approved!**

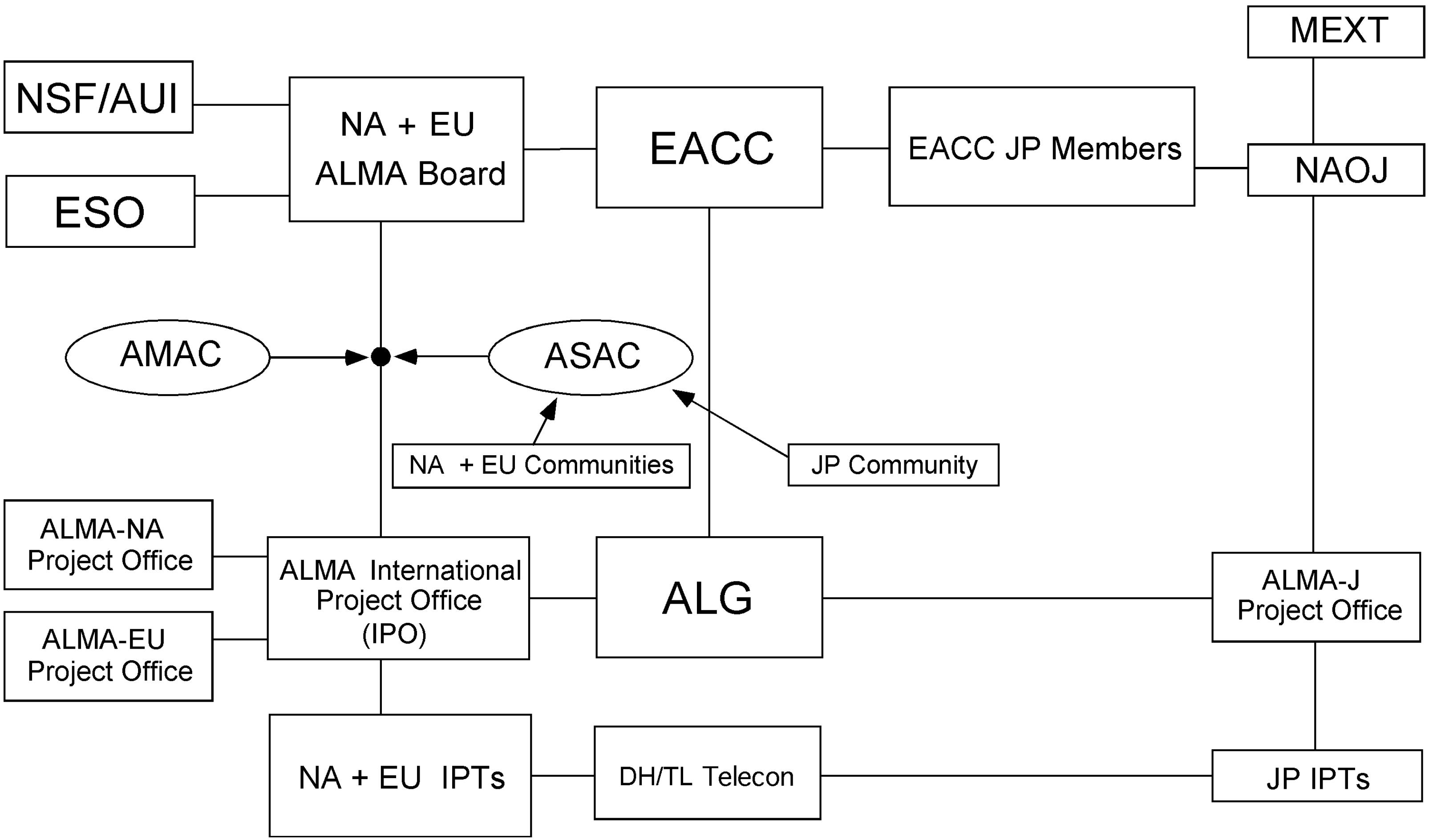
  Major part of the SIS fabrication facility in Nobeyama will be moved to Mitaka next year.

- **Negotiation with MEXT/Ministry of Finance for the ALMA-J construction budget (FY2004 or earlier)**

Milestones toward trilateral ALMA (draft)

CY	Japan	ASAC, EACC, etc.	Europe+North America
2002			(Nov) US approval of the ALMA construction
2002		(Mar) ASAC (Discussion toward Japanese participation)	
			(Apr) Delivery of the NA prototype antenna
	(Apr-) Procurement of the Japanese prototype antenna starts		
	(Apr-Dec) Assessment of the execution plan of the project by MEXT Science Council (interim/final reports)		
			(Jul) ESO approval of ALMA construction
			(Jul) Bilateral agreement
	(Aug-) Preliminary negotiation toward FY2004 ALMA construction budget request (w/ MEXT, MoF, EACC)		
		(Sept) ASAC (Recommendation toward Japanese participation plan)	
		(Oct) EACC (Japanese participation plan)	
2003	(Jan-) Negotiation toward FY2004 ALMA construction budget request		
		(Mar) ASAC (Recommendation on the trilateral plan)	
		(Apr) EACC (Japanese construction budget request plan/draft agreement)	
	(Apr) Delivery of the Japanese prototype antenna		(Apr) Delivery of the European prototype antenna
	(Jun) FY2004 budget request (NAOJ to MEXT)		
		(Sept) ASAC (Further recommendation on the trilateral plan if necessary)	
		(Oct) EACC (Fine tuning of Japanese participation plan/agreement draft)	
	(Dec) Unofficial notice of the FY2004 budget (1/7 of construction)		
		(Dec) Finish prototype antenna evaluation	
2004	(Mar) Approval of the FY2004 budget (1/7 of construction)		
		(Apr) Trilateral agreement	

ALMA Project (2002-2003)



ALMA-J Project Organization

PROJECT OFFICE

Project Director	Ishiguro
Project Manager	Kawabe
Project Scientist	Hasegawa
Project Engineer	Chikada
Administration	Sakamoto, Chiba Hashima, Ueshiba

Systems Engineering
Chikada

Science
Hasegawa

Site
Sakamoto

Antenna
Ukita
- Saito
- Ezawa
- Kohno
- Sato
- Ishizaki

Front End
Sekimoto /Noguchi
- Iwashita
- Inatani
- Ogawa

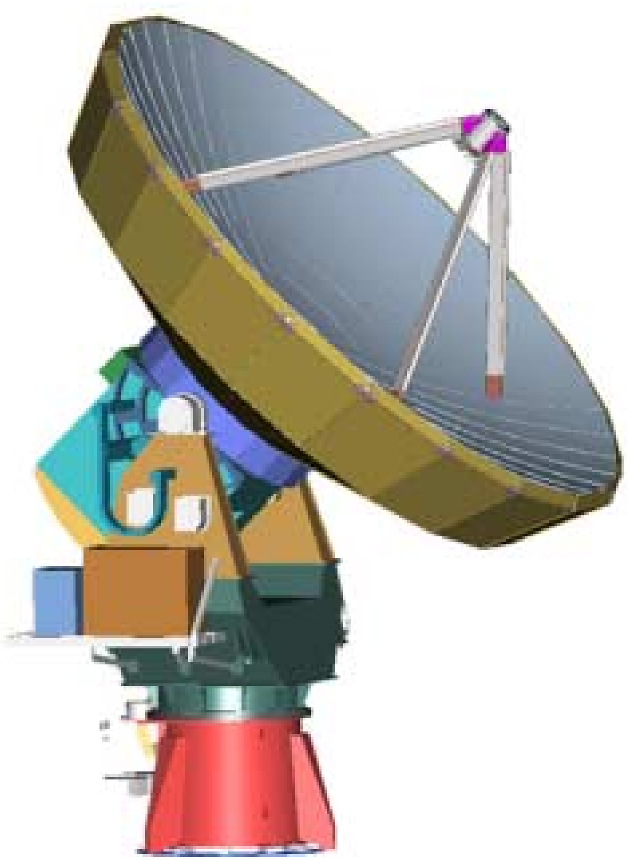
Photonics
Ueda
- Noguchi

Back End & Correlator
Iguchi/ Okumura
- Momose
- Okiura

Computing
Morita
- Tatematsu
- Hayakawa
- Handa
- Momose
- Onishi

Integ./ Oper.

12-m Prototype Antenna

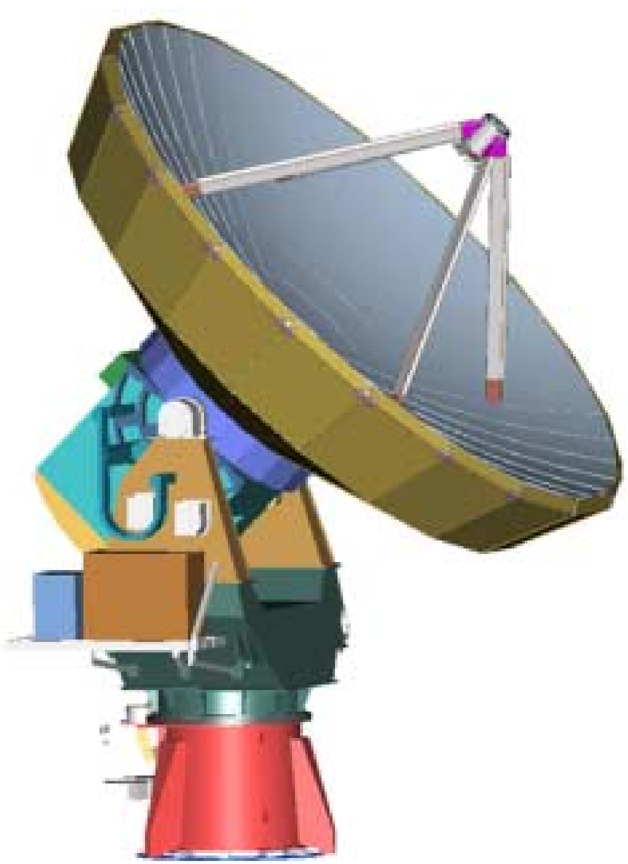


- Call for tender
- Bid on April 22, 2002

- Completion @ Socorro

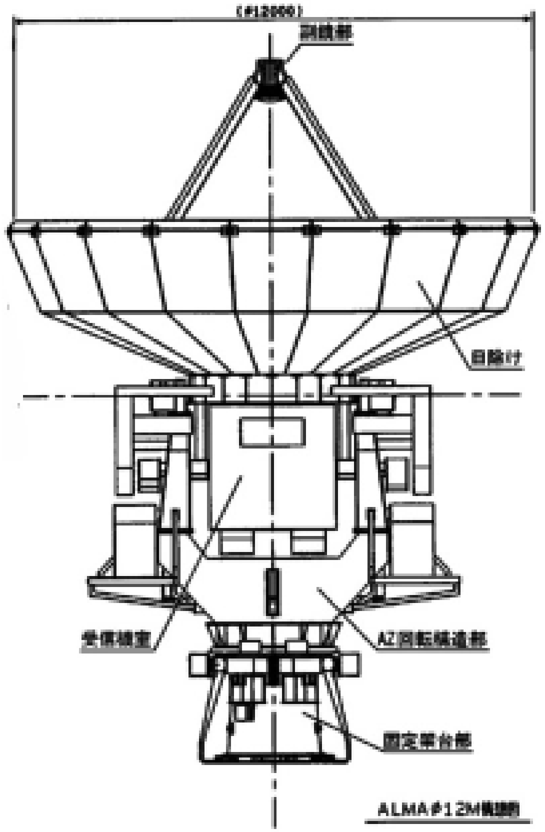
  Apr. 2003

ALMA-J 12-m Antenna



- **Main reflector**
  - 12 m diameter, ALMA optics layout
  - Surface accuracy: < 20 µm (rms)
- **Pointing accuracy**
  - 0.6 arcsec (rms)
- **Fast switching capability**
- **ALMA Interface**

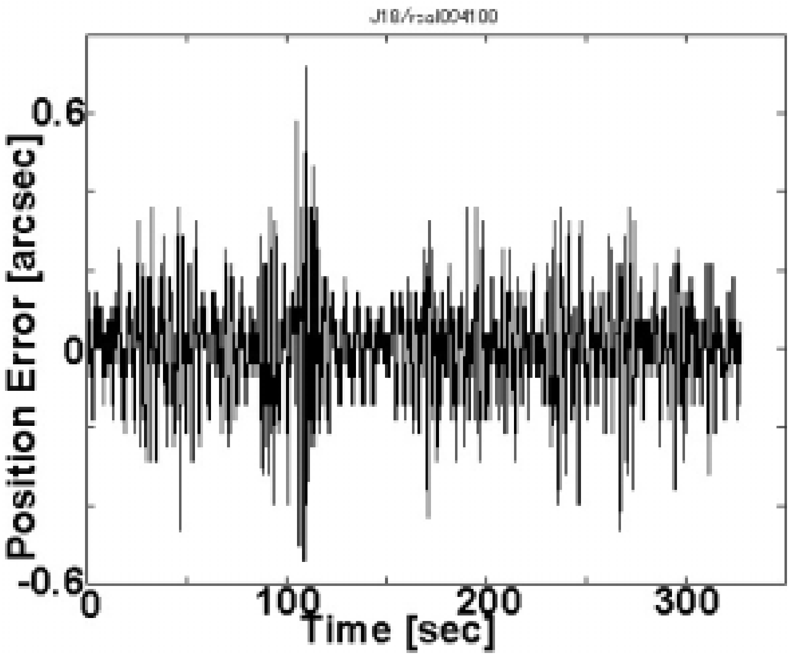
ALMA-J 12-m Antenna

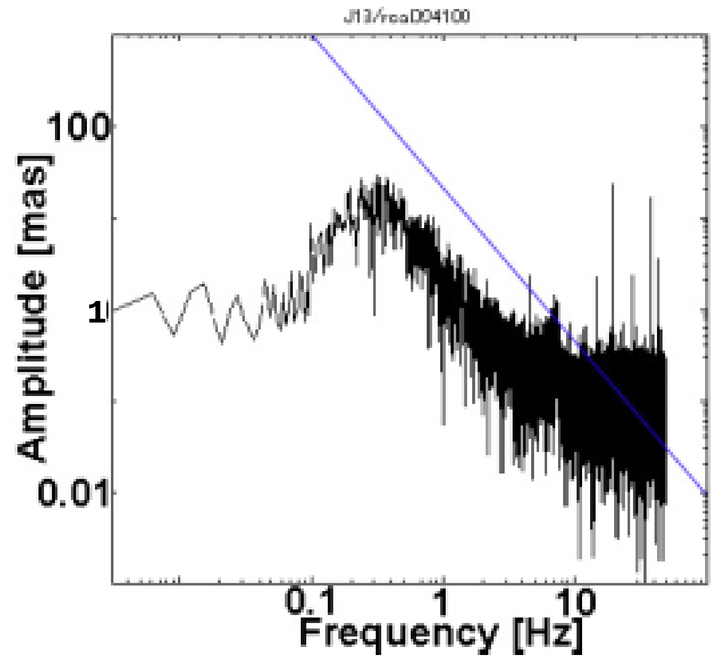


- **Main reflector**
  - Surface accuracy: < 20 μm (rms)
    - Al panel: 3 μm (rms), 11 kg m^{-2}
    - BUS: CFRP tubes and invar joints
      - Gravity: 8 μm (rms)
      - Thermal: 2 μm (rms)
- **Pointing accuracy**
  - Global → 2 arcsec (rms)
  - Local → 0.6 arcsec (rms)
- **Fast switching capability**
  - 6 deg s^{-1}, 24 deg s^{-2}
    - Gear Drive System
- **Total weight < 80 ton**

Drive Performance under Wind

Measurement of ASTE10m at Nobeyama





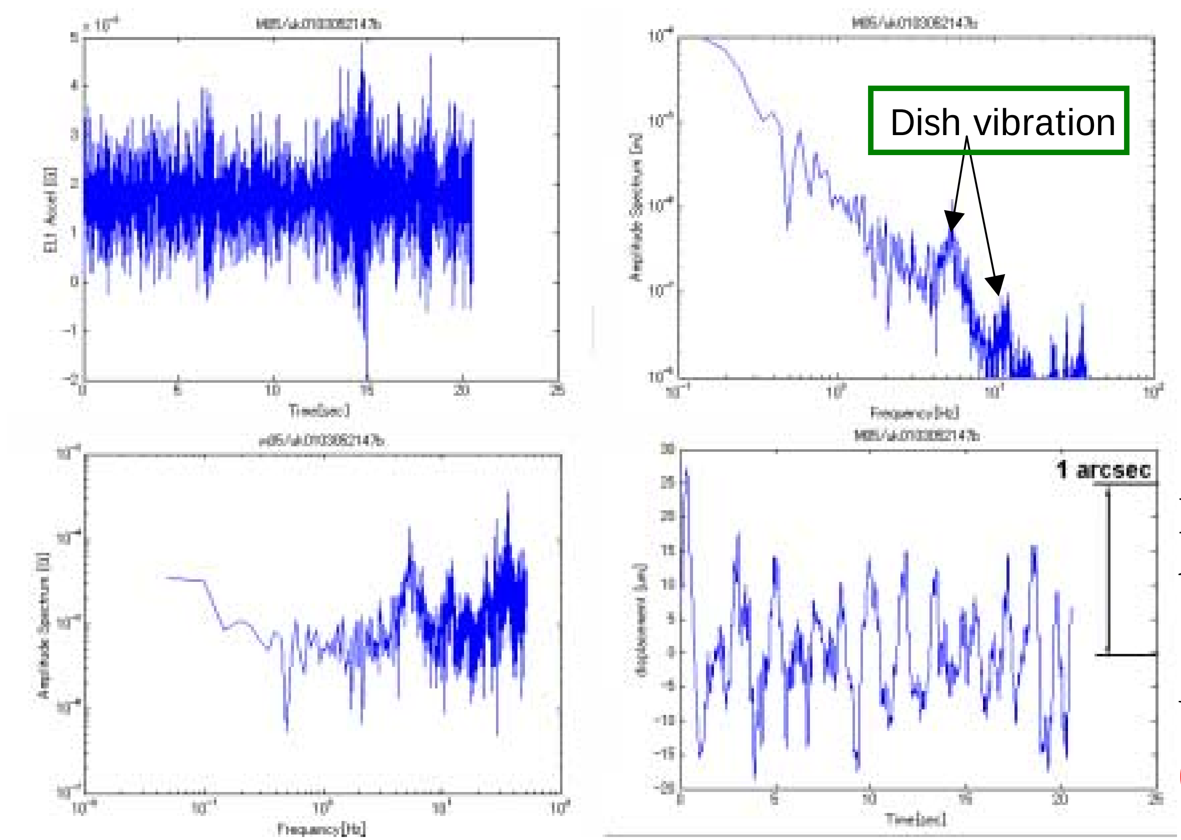
[Angle readout – command position]
every 10 milli-second

* Drive servo error = 124 mas,
under wind of velocity = 7.7 m/s

* Better performance can be achieved by an improved control technique.

Main Dish Vibration under Wind

Measurement of ASTE10m at Nobeyama

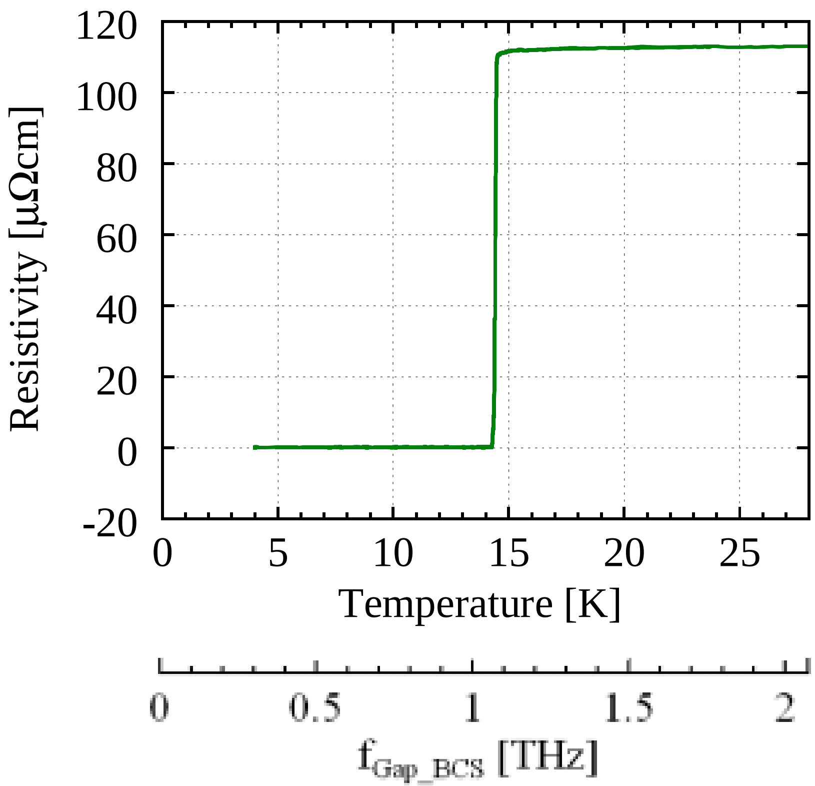


The ASTE telescope has 4 accelerometers on the main dish,
3 on the subreflector,
4 on the both ends of the elevation axis, etc.

Dish vibration relative to the ground
< 0.2 arcsec rms
under strong wind (average of ∼10 m/s).

Note that the main-dish vibration is small.

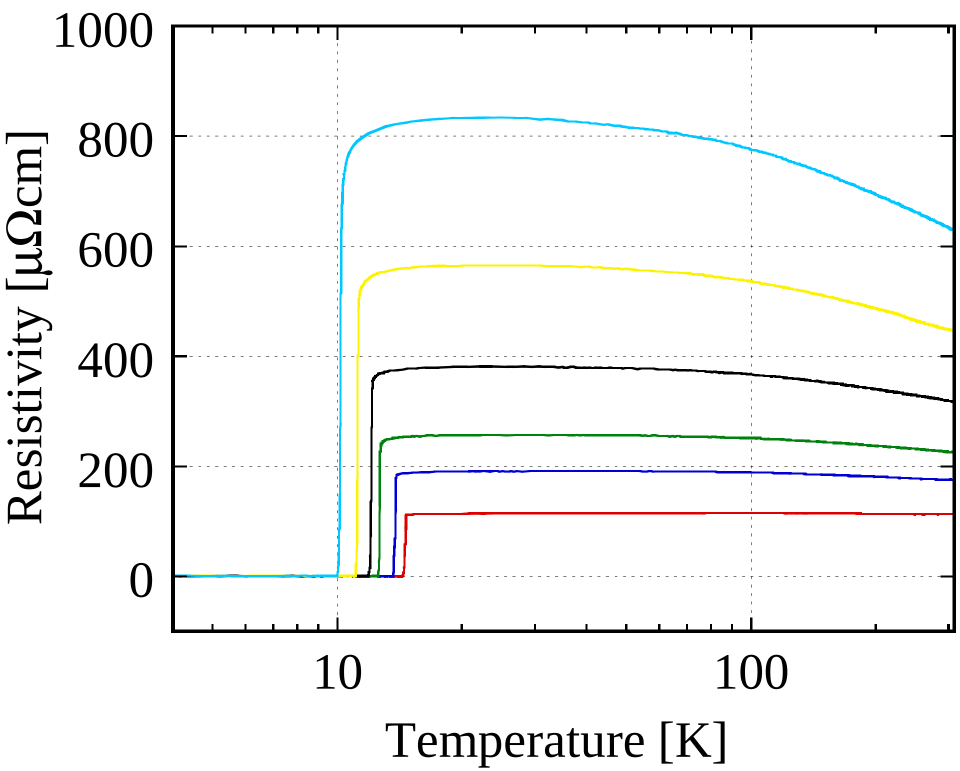
NbTiN at Nobeyama



Temperature dependence of the resistivity of NbTiN

Sputtering machine

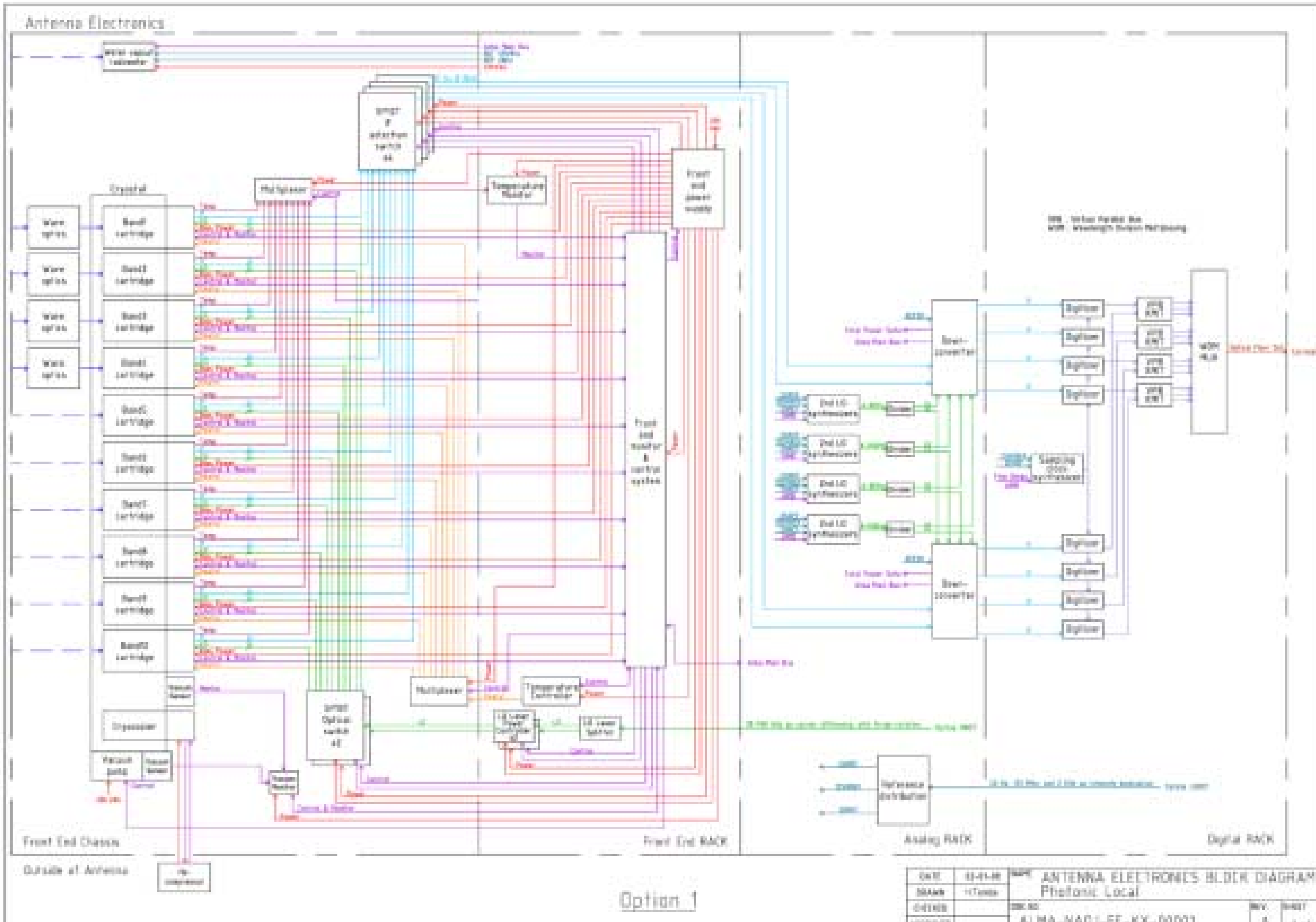
ρ-T Characteristics of NbTiN



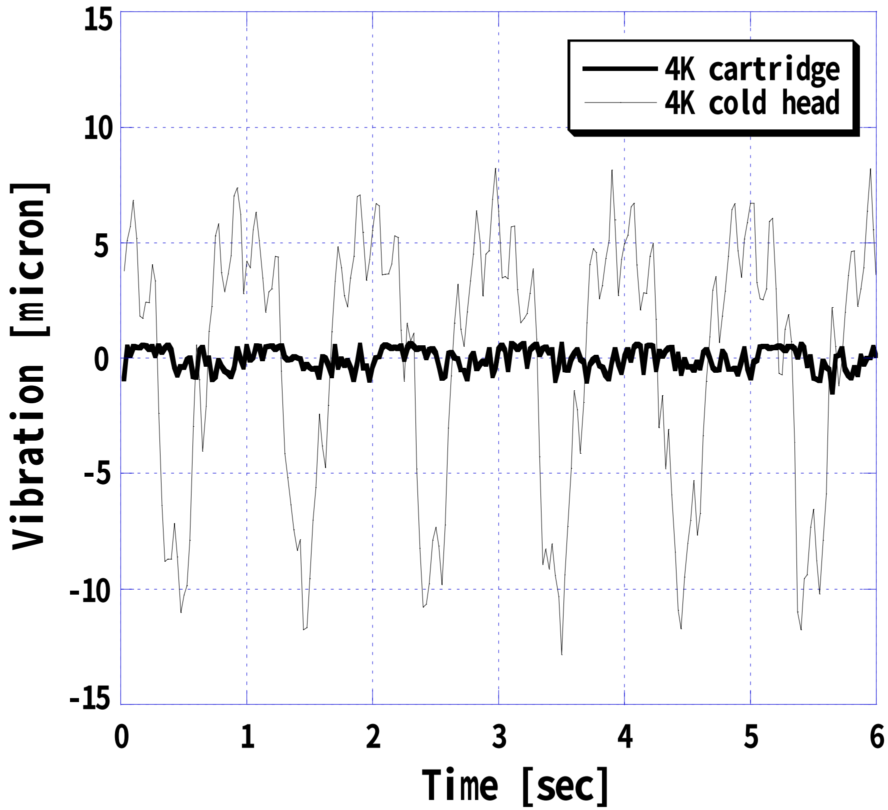
TC depends on sputtering bias voltage

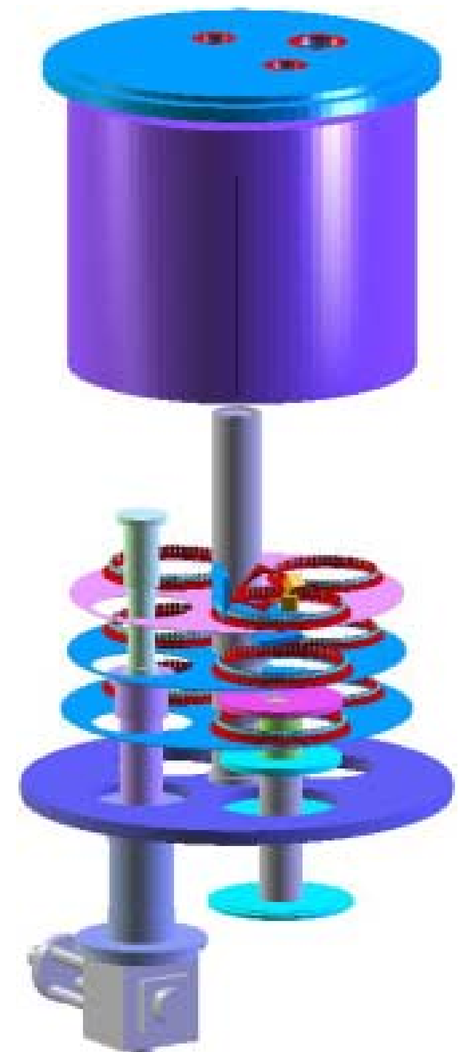
Dipstick measurement system

FE Block Diagram



ALMA-type Cryostat (3 cartridges)



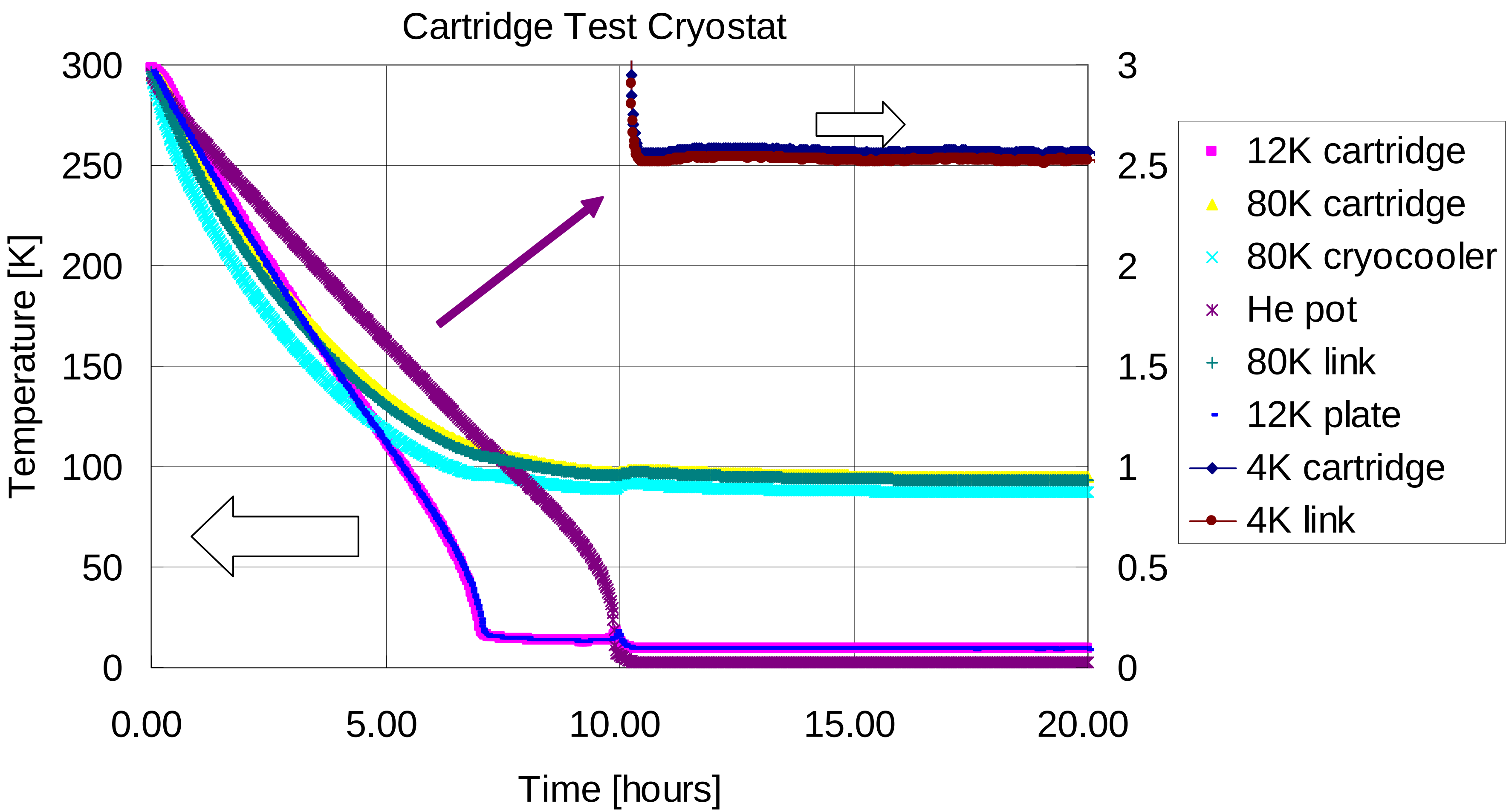


Cold Head; Peak to Peak - 20 μm
Cartridge;   Peak to Peak - 2 μm

Cartridge Test Cryostat

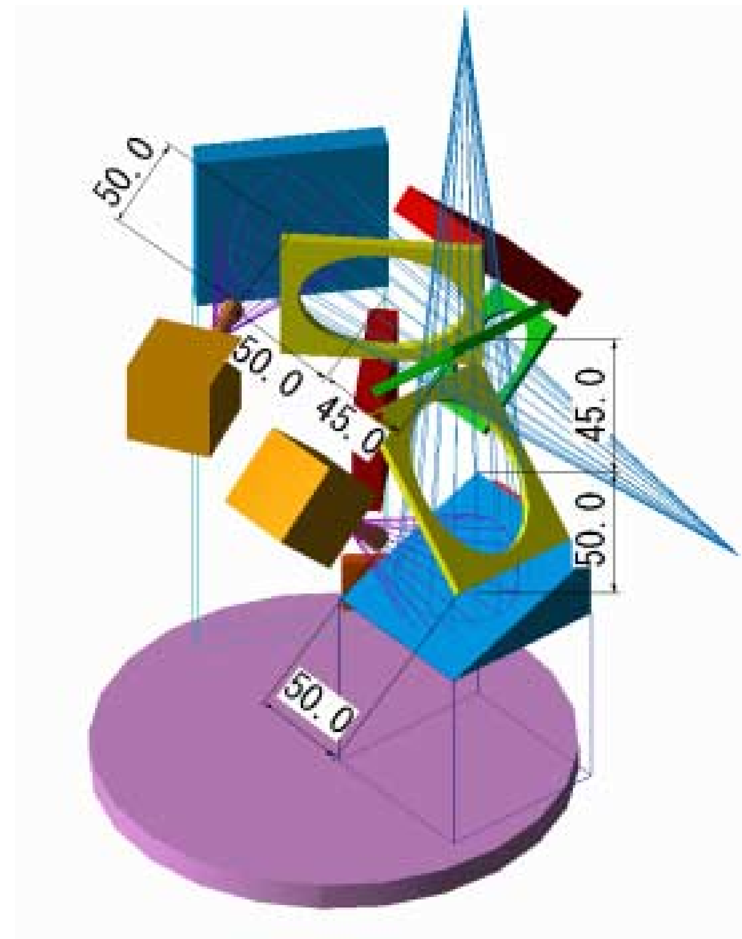
- **Cooling time 15 hours**
- **2.7 K (4 K stage)**

Cooling time of Cartridge

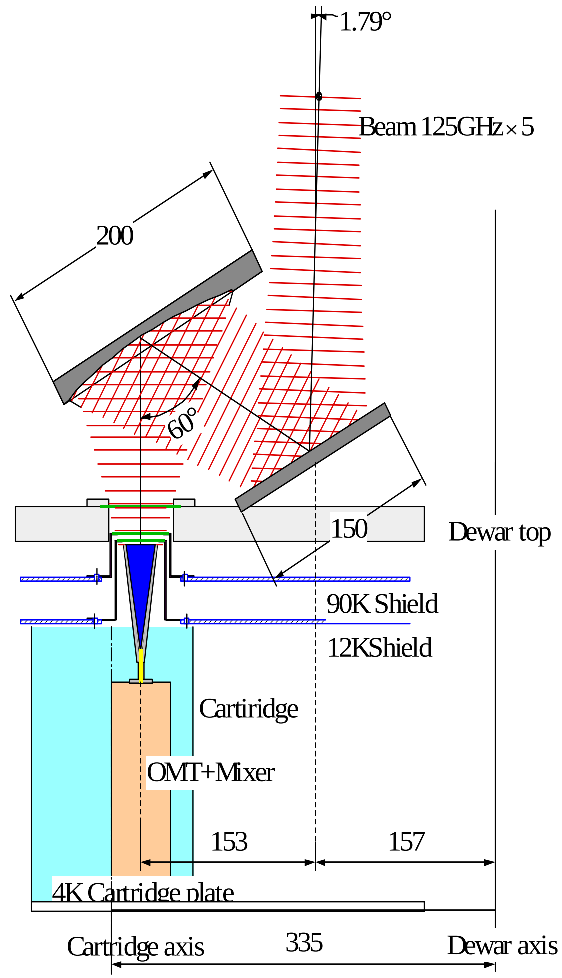


ALMA Band 8 Optics

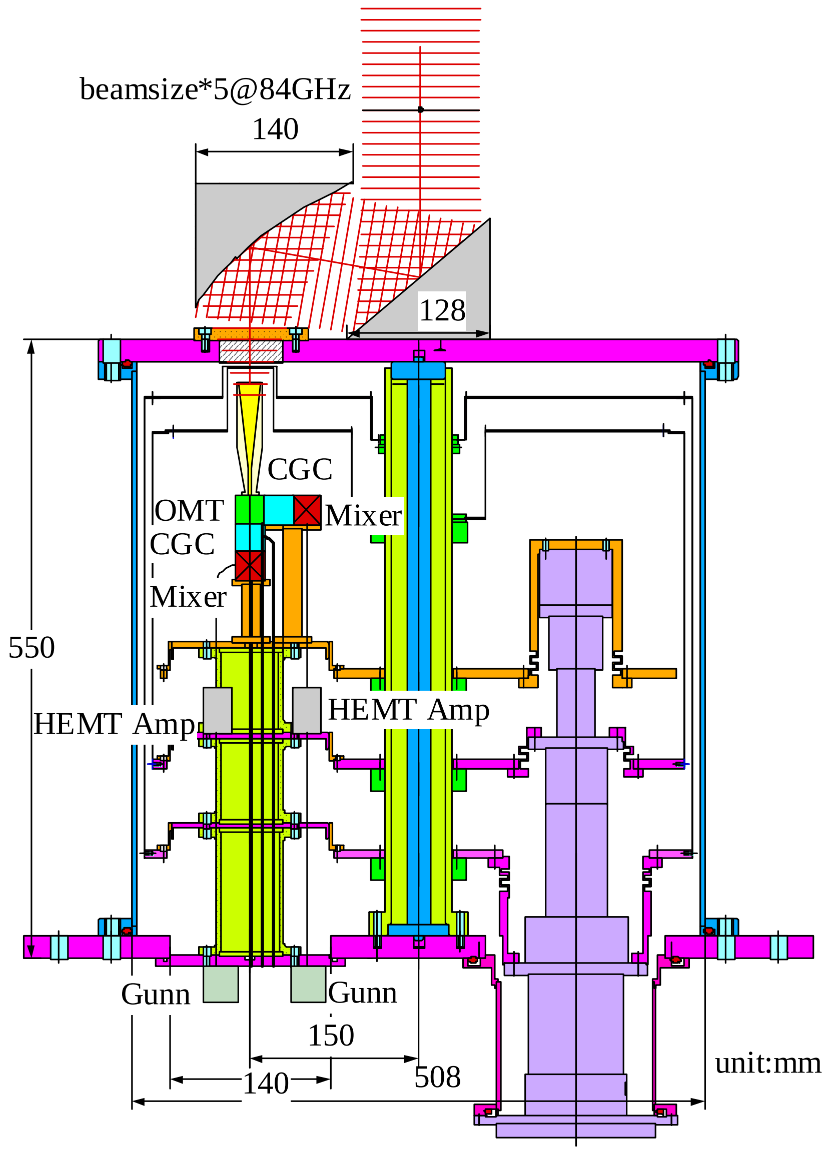
- **Prototyping for Band 10**

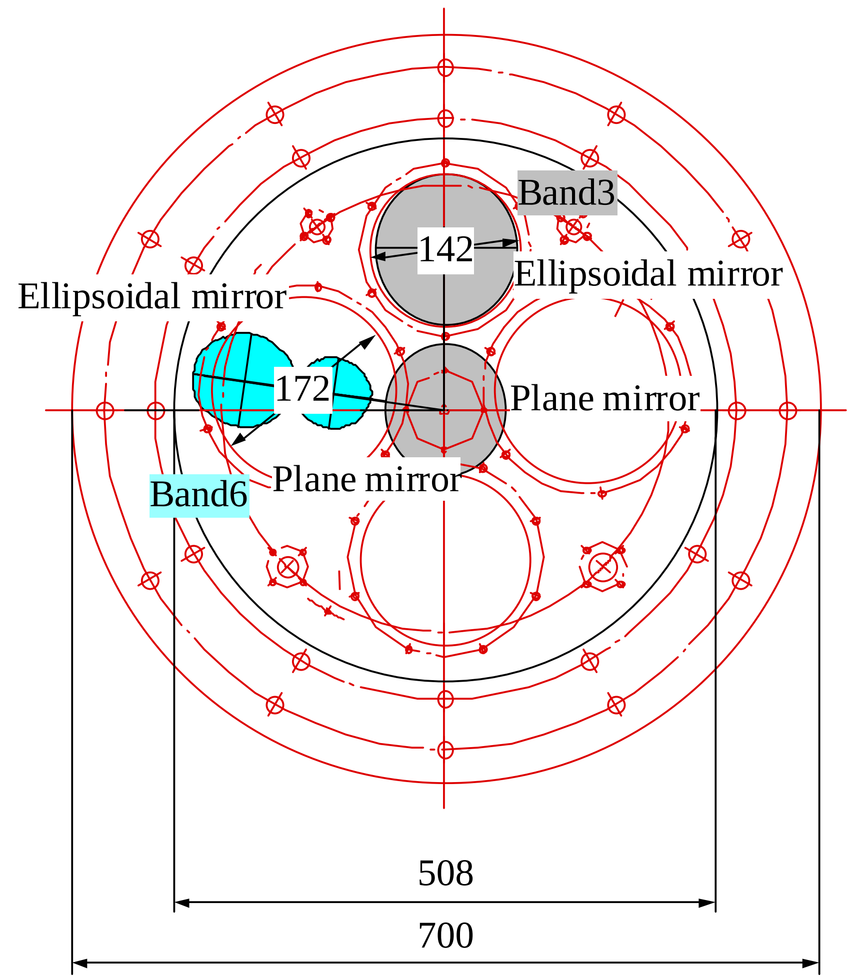


Band 4 Optics



Antenna Evaluation Rx





Photonic LO

Performance of 100GHz Photonic LO with UTC-PD

- **Output Power: ~2mW**

- Demonstration of **Direct Photonic LO** with a standard LO coupling method using a 20dB cross-guide coupler

  - **Noise Temperature ~56K** (cf. Gunn Osc. ~40K)

    ⇒Added Noise Temp. ~16K

[6-junction SIS, IF=5GHz, Two DFB Lasers(unlocked) +Fiber Amplifier]

Photonic LO

- UTC-PD Integarated onto a Logperiodic Antenna

Frequency	Measured Power at I_{photo}=0.35mA (V_b=1.5V)	Extrapolated to I_{photo}=15mA (V_b=1.5V)
200GHz	300 nW	550 μW
400GHz	40 nW	74 μW
800GHz	4 nW	7 μW

Photonic LO

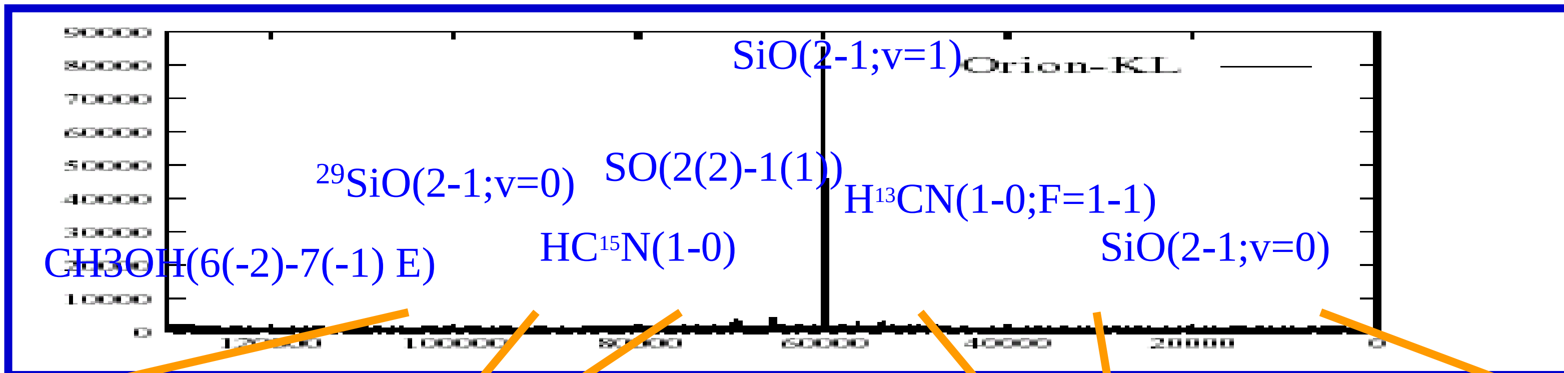
- **Design and Fabriaction of a 350GHz WG Photomixer**
  - RF design : completed
  - UTC-PD chip: completed
  - Mechanical design: completed and a photomixer module is under fabraication
  - Performance test : will be finished before the LO CDR in June
- **Performance Test at Cryogenic Temperature**
- **Development of a Master Laser System**
  - Comb Generation by Mode-Lock Laser

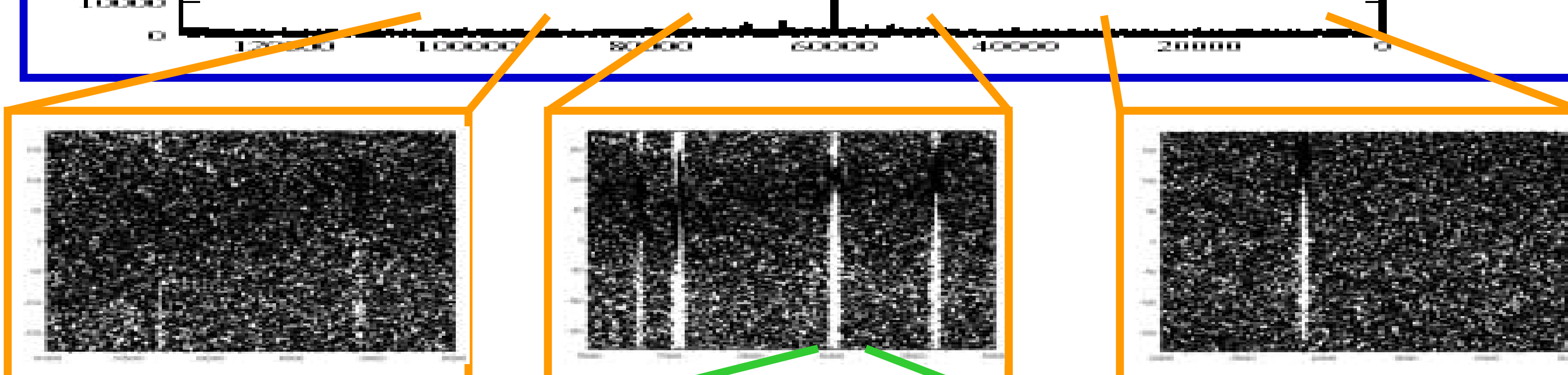
4-Gsps 2-bit FX Correlator

- **High-Speed Sampler**
  - 4-Gsps, 2-bit
- **Prototype Correlator**
  - 1-baseline
  - 15.625-kHz resolution (40m/s at 115GHz)
  - 131072-points/ 2GHz

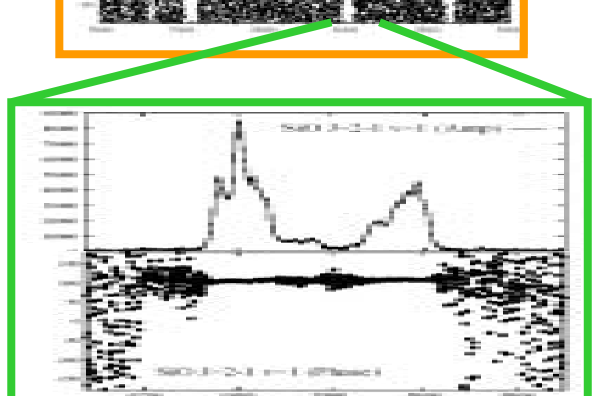
2GHz Spectrum of Orion-KL

AMPLITUDE





PHASE



Nobeyama Millimeter Array

ASAC 2002/3/19 *M.Ishiguro(NAOJ)*

Activity of ALMA-J Computing Team

- **Attending ALMA SSR Committee.**

- **Developing the control system for the ALMAJ prototype antenna.**

  Preparing to use TICS (Test Interferometer Control Software) and ACS (ALMA Common Software) developed by NRAO and ESO, respectively.

- **Collaboration with NAOJ Data Center on "Virtual Observatory".**

  Important step for ALMA archiving system!