



Academia Sinica

Institute of Astronomy and Astrophysics

中央研究院 天文及天文物理研究所

A decorative graphic consisting of three overlapping squares (yellow, red, and blue) and a white crosshair.

ASIAA sub-mm VLBI Project

Dust Group Meeting 2001/08/22

Juan Carlos Algaba Marcos (林煥)

On behalf of the VLBI group

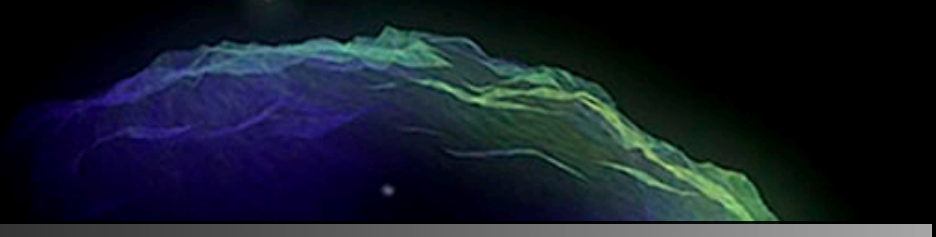


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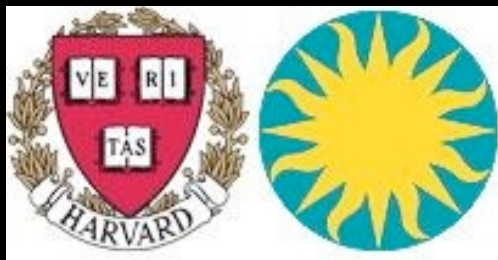


Introduction



■ Partners and Collaborators

- Academia Sinica Institute of Astronomy & Astrophysics (ASIAA)
- Harvard-Smithsonian Centre for Astrophysics (CfA)
- MIT Haystack Observatory (Haystack)
- National Radio Astronomy Observatory (NRAO)





Introduction

- Current ASIAA VLBI members
 - Algaba Marcos, Juan Carlos 林煥
 - Asada, Keiichi 淺田圭一
 - Chen, Chien-Ping 陳建賓
 - Chen, Ming-Tang 陳明堂
 - Ho, Paul 賀曾樸
 - Huang, Ted 黃耀德
 - Inoue, Makoto 井上允
 - Martin-Cocher, Pierre 馬柏翔

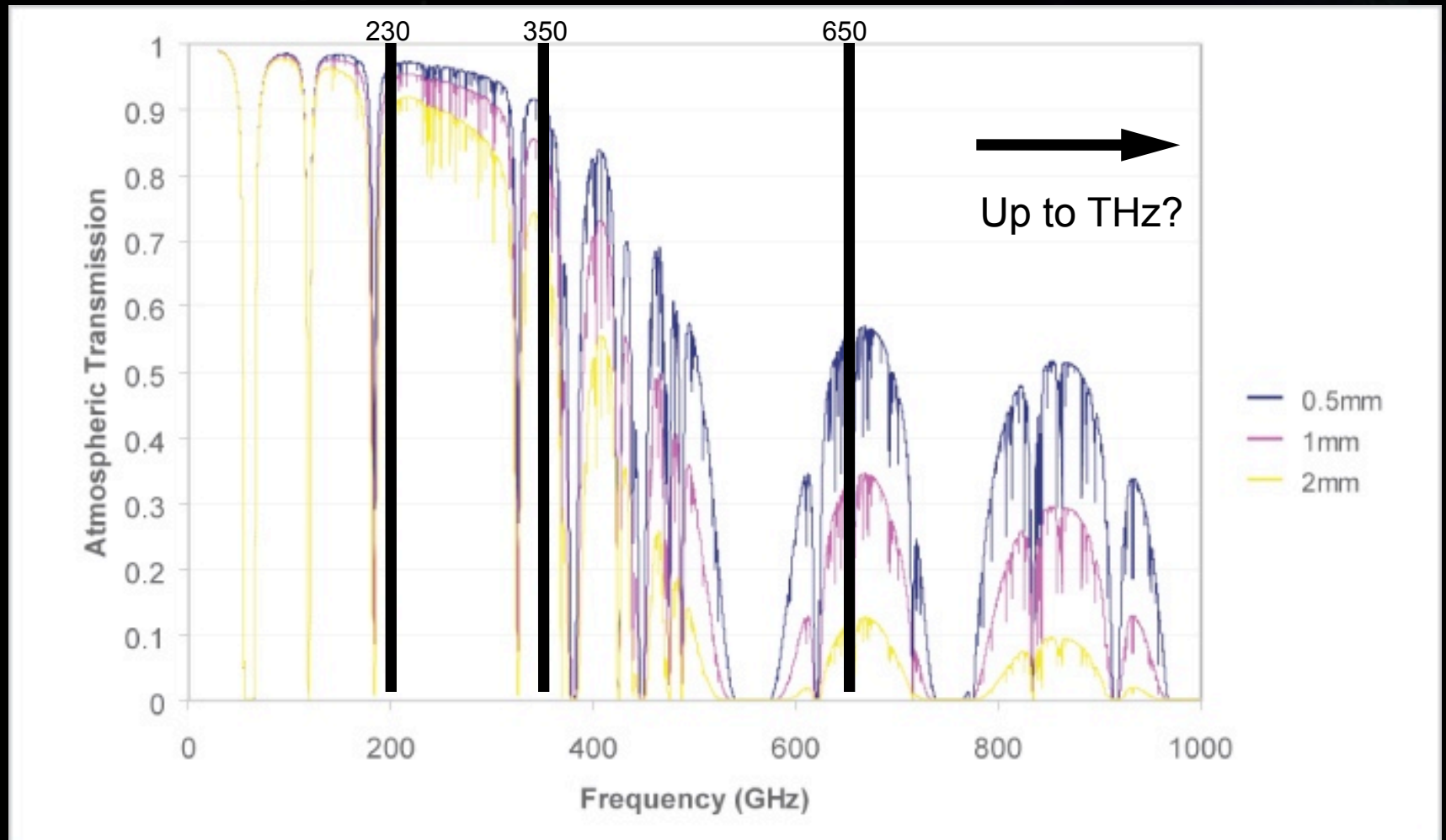
Introduction

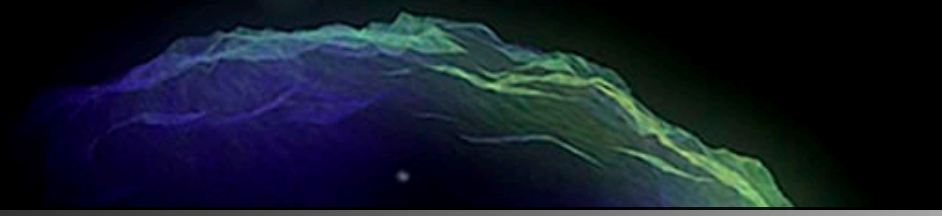
- Delegates from other institutes/observatories
 - Ray Blundell (CfA)
 - Jim Moran (CfA)
 - Shep Doeleman (MIT Haystack)
 - Vincent Fish (MIT Haystack)
 - Peter Napier (NRAO)
 - Walker Briskin (NRAO)

Introduction



- What frequencies are we interested in?





NA ALMA Prototype Antenna



NA ALMA Prototype Antenna

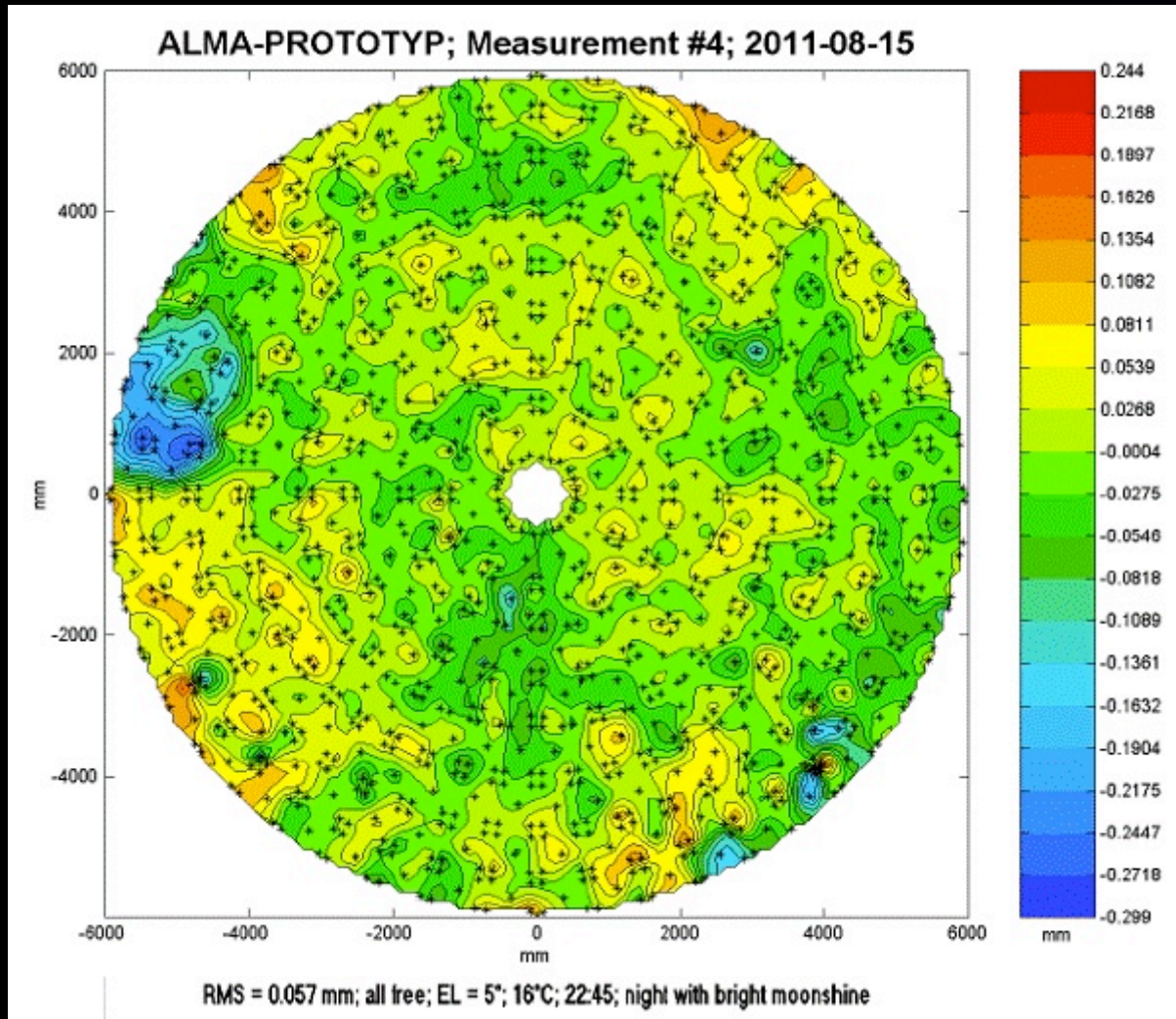
- May 2010: NSF USA released expression of interest for the Vertex NA ALMA prototype antenna
 - 12m radio antenna
 - Cassegrain Optics on an Alt-Azimuthal mount
 - Surface Accuracy for sub-mm observations
 - Operates from 30 to 950 GHz
- Jan 2011: ASIAA obtained antenna in collaboration with CfA, Haystack, NRAO
- Apr 2011: Meeting in Socorro to check status
- Aug 2011: Test and re-commissioning

NA ALMA Prototype Antenna



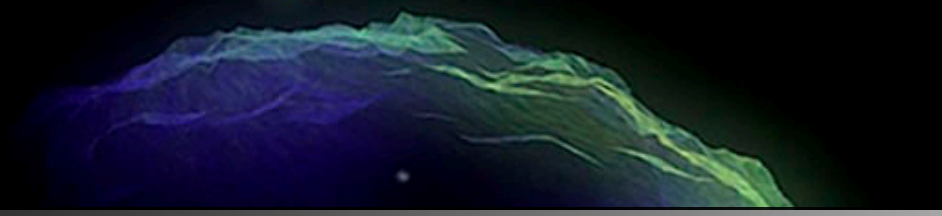
Image courtesy of NRAO/AUI/Kelly Gatlin/Patricia Smiley

NA ALMA Prototype Antenna





ASIAA



Site Selection

Site Selection

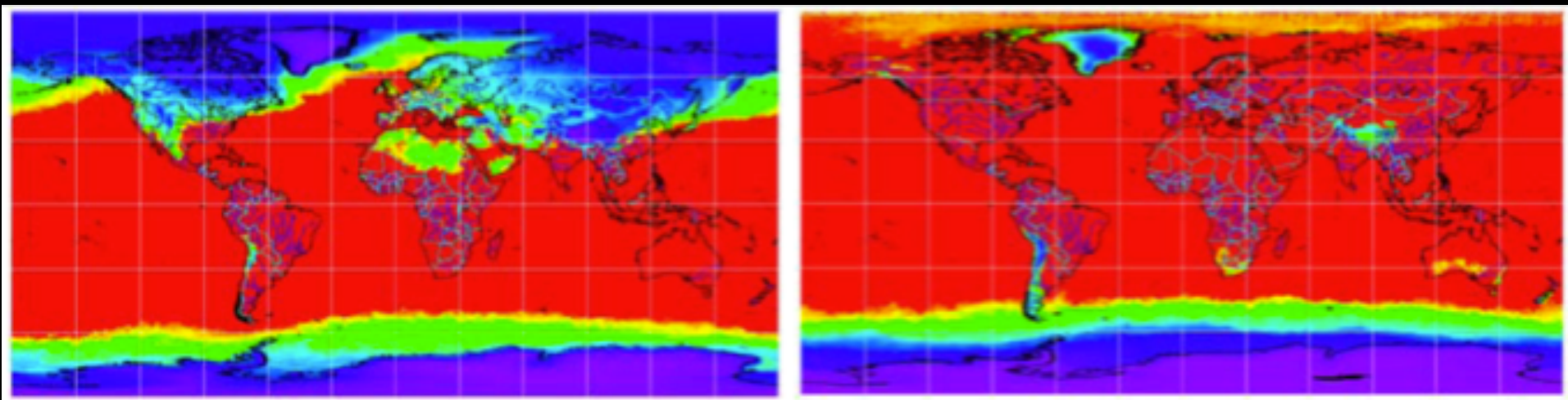
- For observations around hundreds of GHz:
 - Precipitable Water Vapour (PWV) < 1mm
 - Minimal atmospheric turbulence
 - Dry, cold weather, at high altitude
- For good UV coverage:
 - Common visibilities with other sub-mm telescopes
 - ALMA, SMA,...
 - Long baselines

Site Selection

- Precipitable water vapor (PWV) distribution

February

August

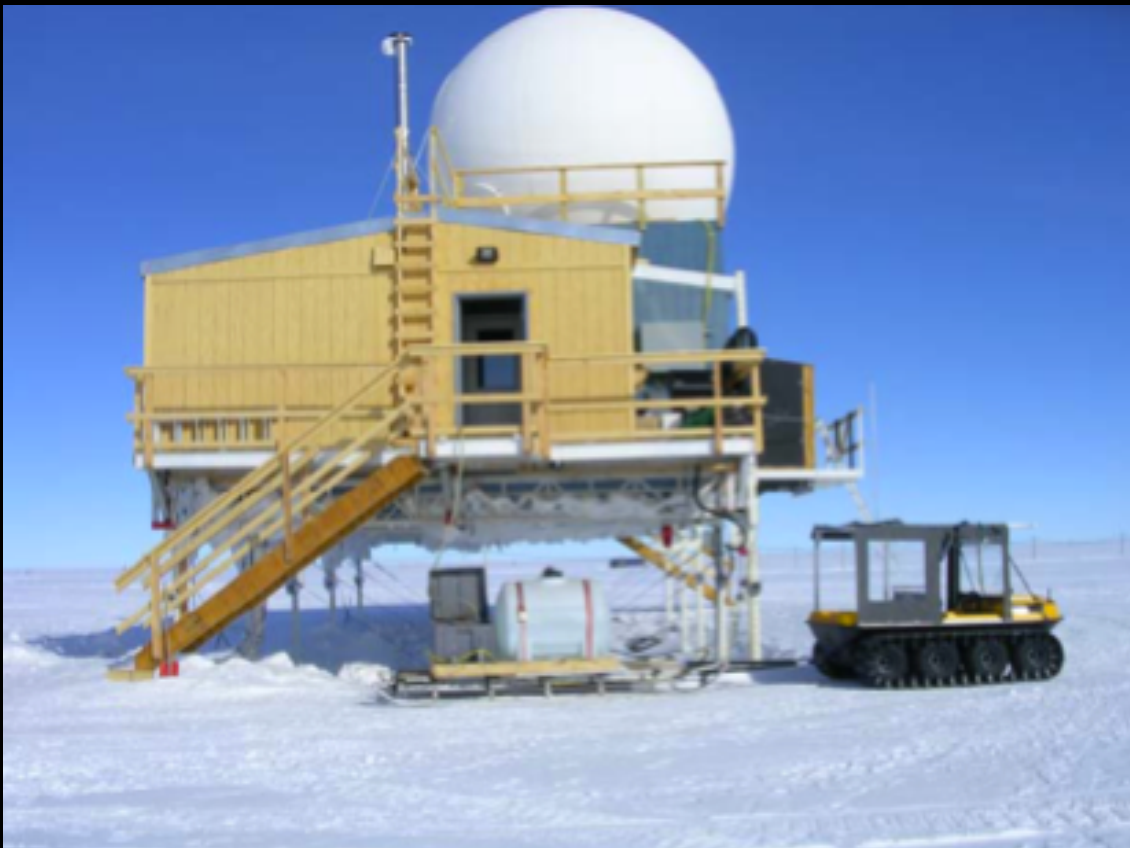


Satellite-based PWV data measured by NASA Aqua and Terra/MODIS

- Red area shows $PWV > 10$ mm.
- Greenland is excellent throughout year.

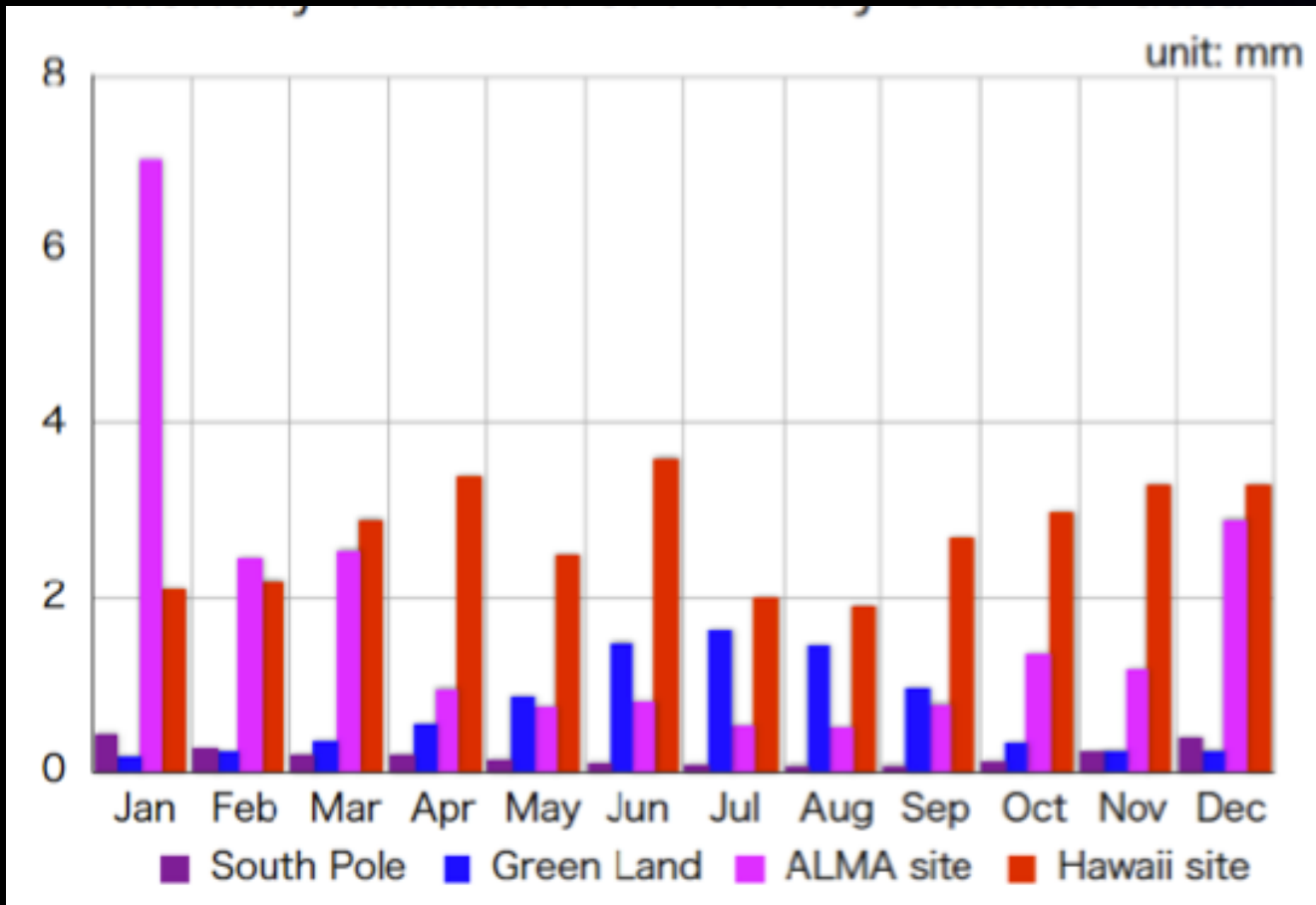
Site Selection

- Greenland has already facilities: Summit Station



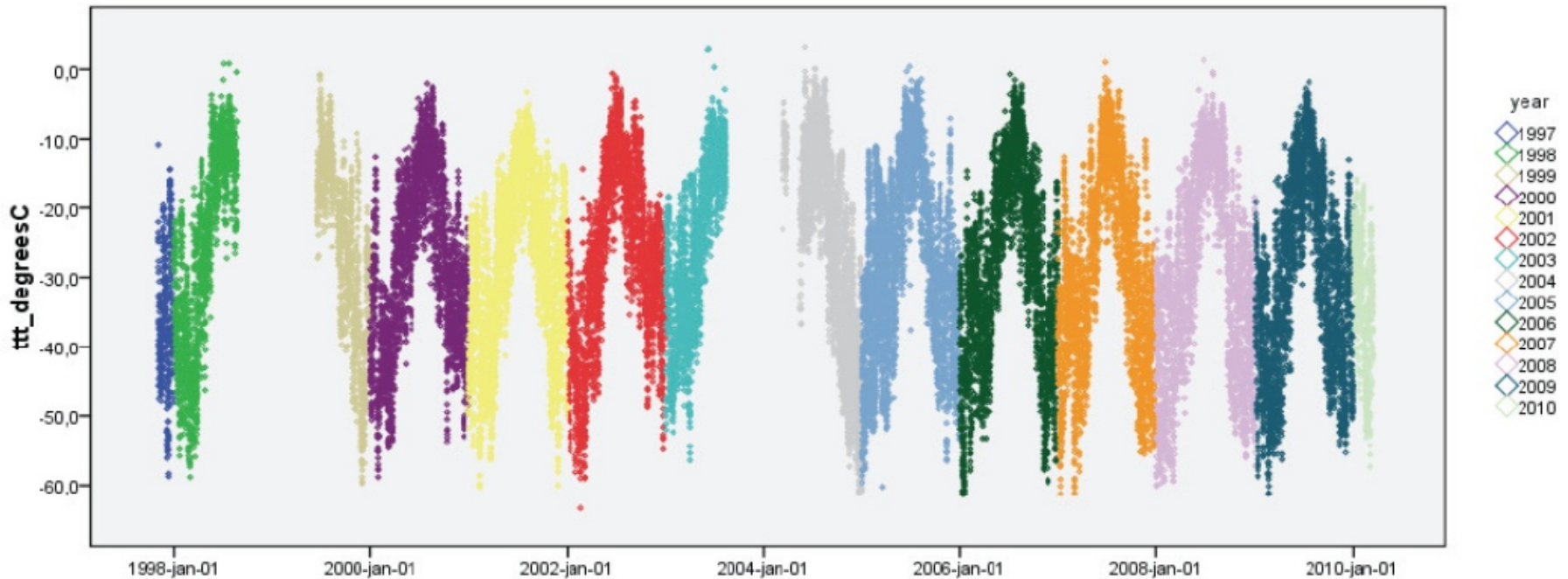
Site Selection

- Atmospheric Conditions: PWV



Site Selection

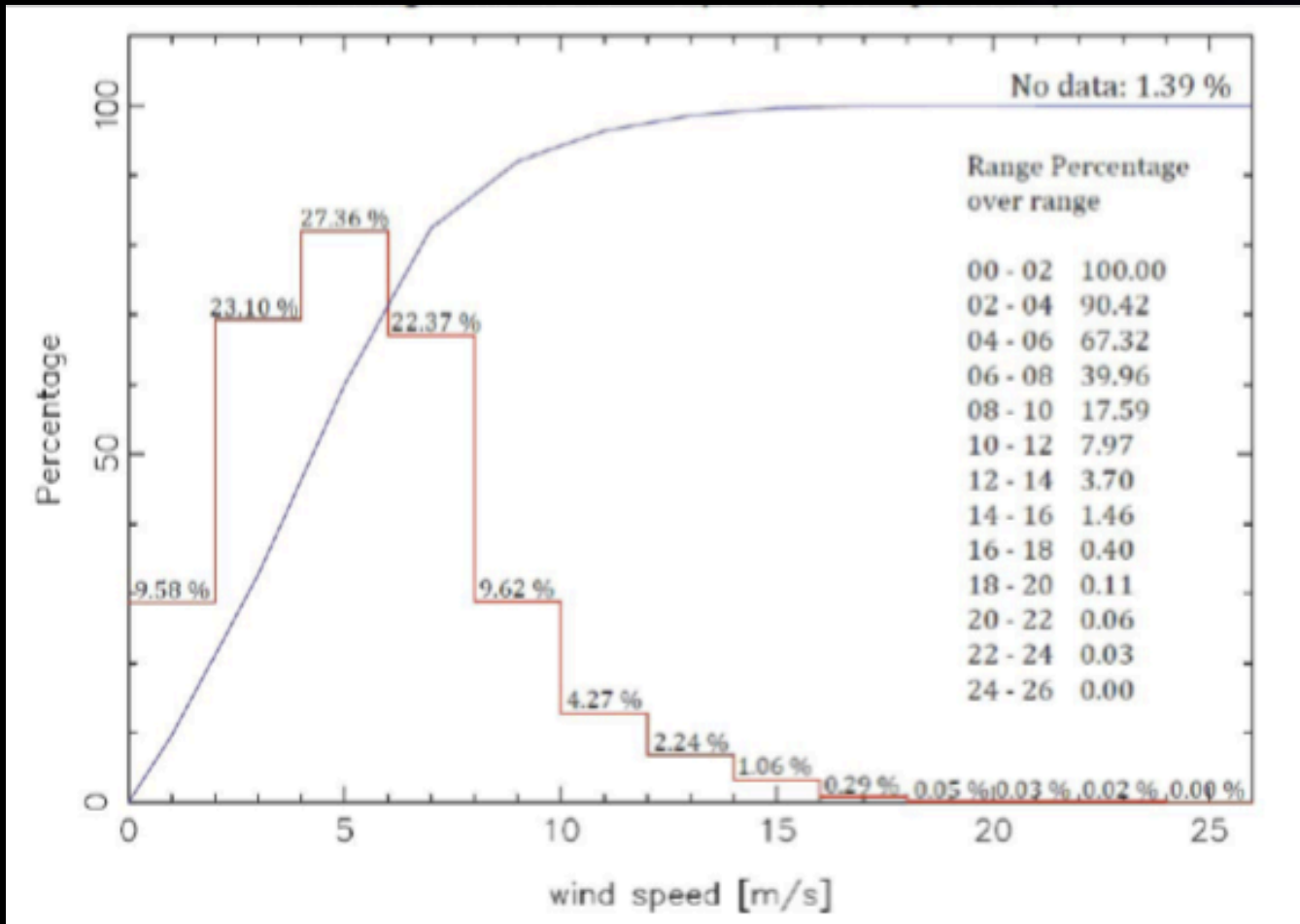
■ Atmospheric Conditions: Ambient Temperature



Long-term monitoring of ambient temperature at Summit Station

Site Selection

- Atmospheric Conditions: Wind Speed



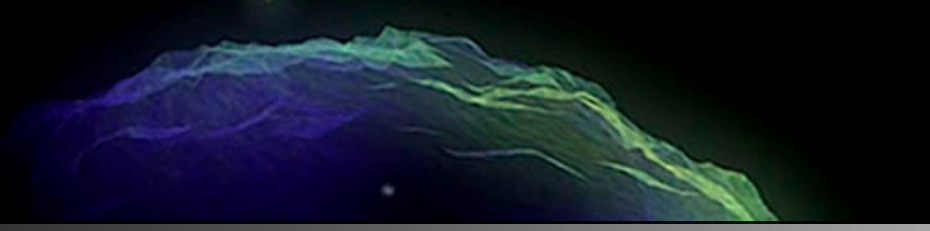
Site Selection

- Atmospheric Conditions: No data for opacity
- Deployment of our own radiometer
 - Testing in Eureka station (North Canada, 80°N, 82°W)
 - Collaboration with Canadian group
- Site testing
 - Radiometer tests in Summit last week
 - Remote Control from ASIAA HQ's





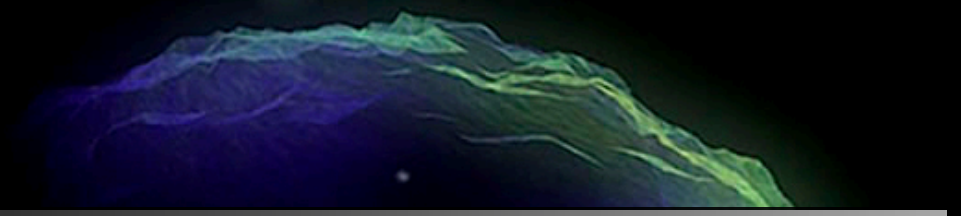
Timeline



Year	2010	2011	2012	2013	2014	2015
Site						
Development	█					
Site Information/Arrangements	█	█				
Site Survey		█	█			
Site Decision			█			
Infrastructure				█	█	
Telescope						
Acquisition		NSF Decision				
Refurbish Study/Design		█	█			
Refurbish			█	█		
Transportation					█	
RX Development	█	█	█			
Test Observation				█		
Deployment on Site					█	
Commissioning Test/Operation						█
Data Acquisition System						
Design	█	█	█			
Construction				█	█	Test Transport/upgrade
Correlator						
Design		Concept	Manufacturing			
Construction				█	█	Test Transport/upgrade
ALMA Phase-up						
Design		Concept	Manufacturing	█		
Construction				█	█	
Installation & Testing						█

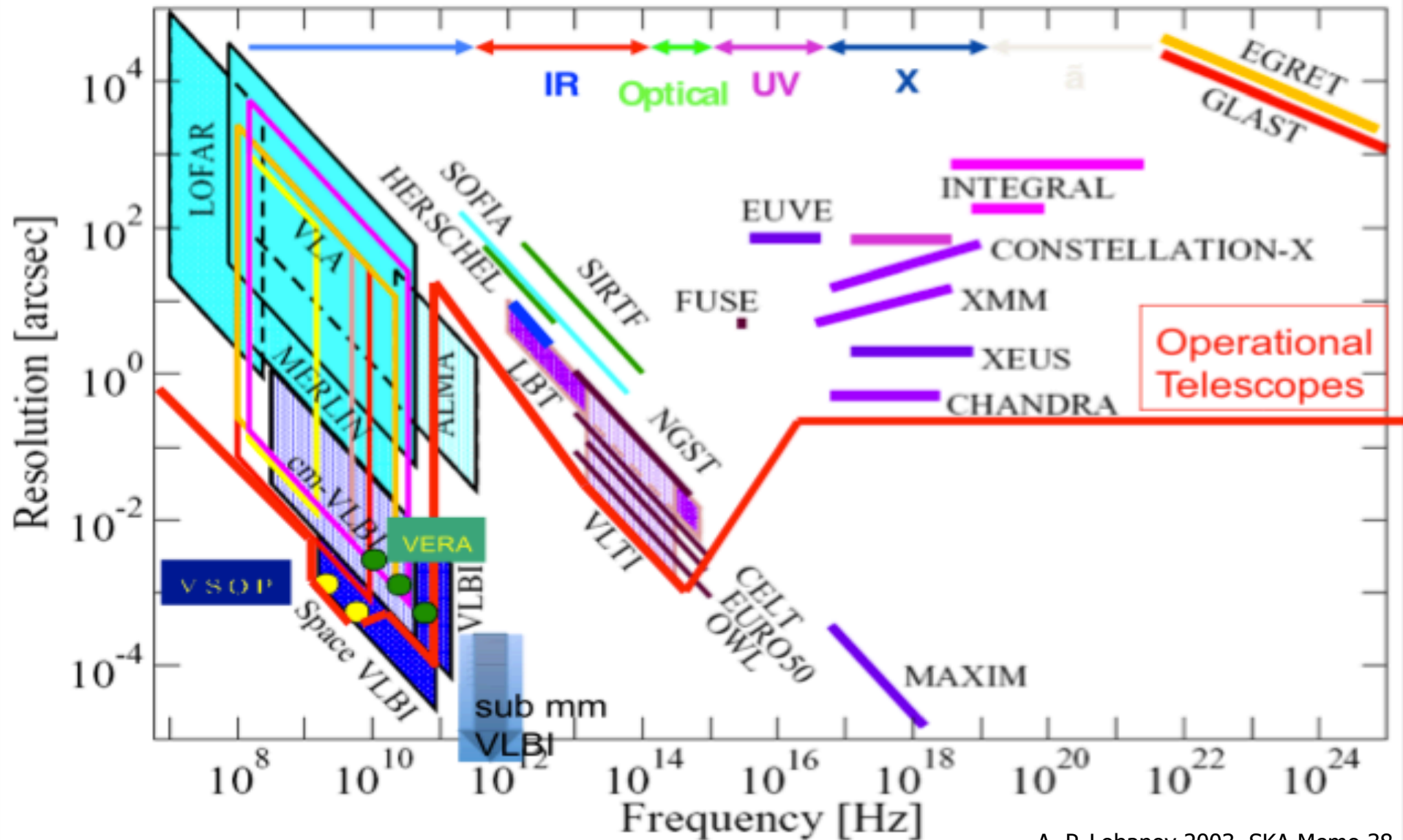
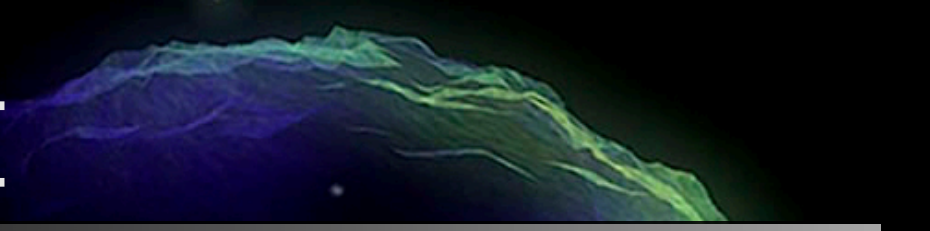


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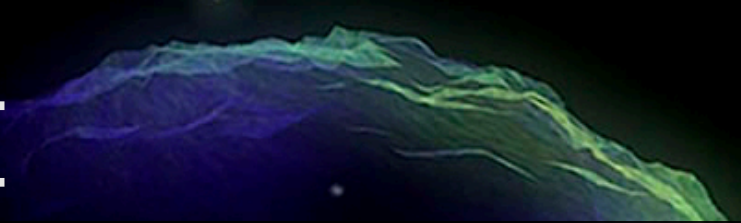


Sub-mm VLBI

Sub-mm VLBI

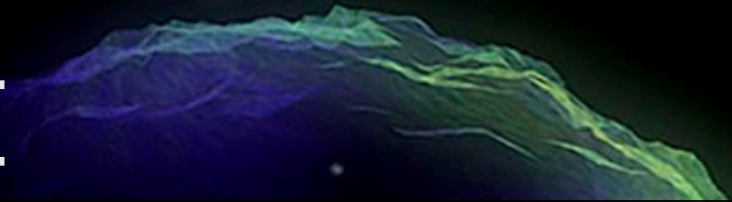


Sub-mm VLBI

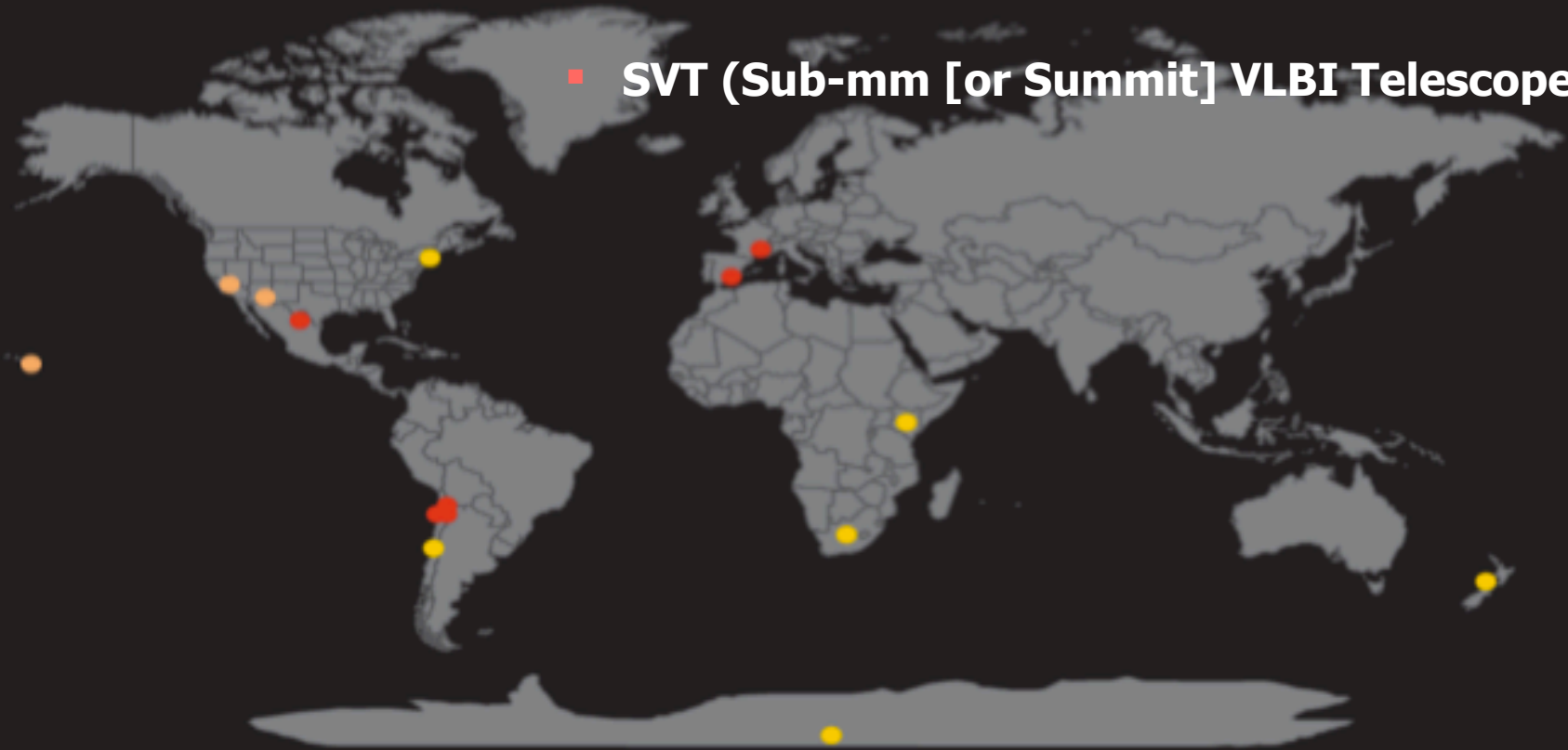


Telescope	Location	Effective Aperture	Status
ARO/SMT	Arizona	10m	Functional
CARMA	California	27m	Functional
SMA/CSO/JCMT	Hawaii	23m	Functional
IRAM 30m	Spain	30m	Functional
Plateau de Bure	France	37m	Functional
ASTE/APEX	Chile	10/12m	Telescope, no maser
LMT	Mexico	32m	Under construction
ALMA	Chile	85m	Under construction
MIT Haystack	Massachusetts	37m	Under construction
SPT	South Pole	10m	Telescope, no rcvr
SEST	Chile	15m	Telescope, no rcvr
---	New Zealand	12m	Potential
---	S. Africa	12m	Potential
---	Kenya	12m	Potential

Sub-mm VLBI



■ SVT (Sub-mm [or Summit] VLBI Telescope)



Signals that span the globe

Through a process called very long baseline interferometry, the Event Horizon Telescope would combine data from more than a dozen instruments operating in sync around the world, from Arizona to Spain to the South Pole.

- Currently used
- Planned member
- Possible additions

Imaging a Black Hole

- Angular resolution comparable with event horizon

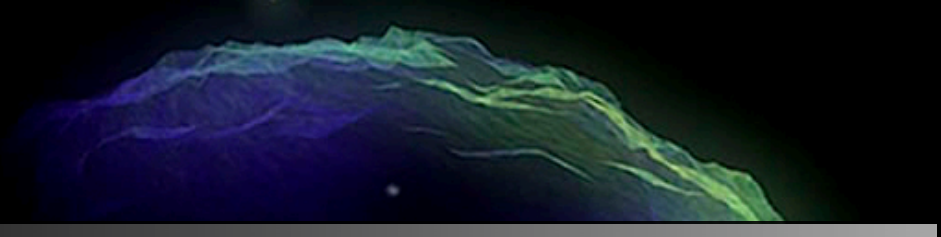
$$R_{\text{Sch}} = 2GM_{\text{BH}}/c^2$$

- Shadow size $\approx 5 \times R_{\text{Sch}}$

- Possible Candidates:

Target	Apparent size (5 R_{Sch}) [μas]	Mass [$10^8 M_{\text{sol}}$]	Distance [Mpc]
Sgr A*	52	0.04	0.008
M 87	40	64	16
NGC 4594 (M 104)	10	10	10
NGC 4374 (M 84)	9.7	17	18
IC 1459	9.6	26	27
Cen A	1.4	0.55	4.2

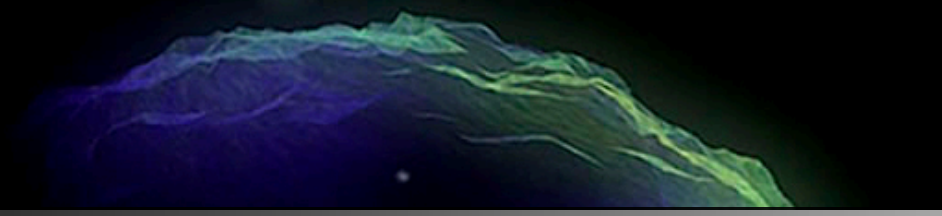
M87



- Timescale 2-18 days
 - Fixed structure over one day: good for Earth aperture synthesis
 - Dynamical events over days
- Unlike Sgr A*, M87 has a jet
 - Study on jet formation, structure & dynamics on horizon scales
 - Provides initial conditions for jet simulations

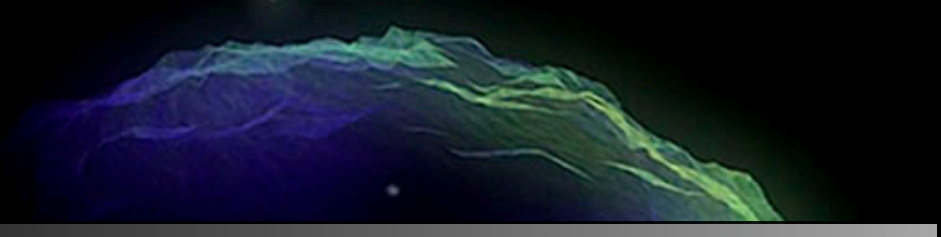


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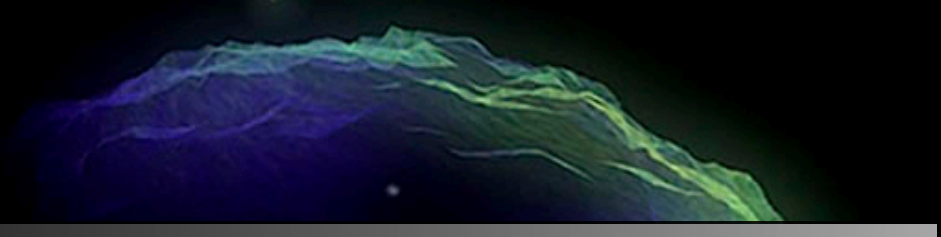
Single Dish Uses

Single Dish



- Single Dish Antenna
 - Summit station equivalent to south pole station
 - 12 metres: largest antenna in a polar station
 - Site Condition: One of the best in the world
 - Telescope Performance & Site condition: THz receivers

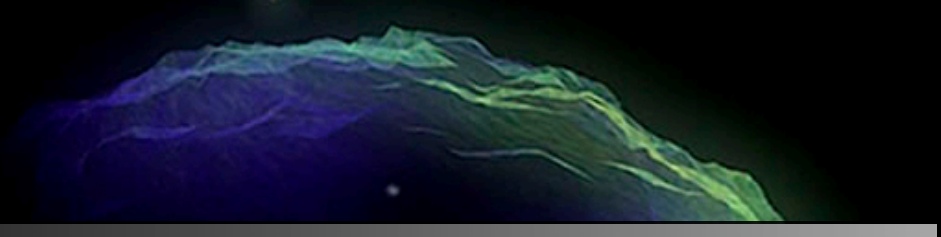
Single Dish



■ Possible Projects

- Mapping the Inter-cluster Medium
 - Wide Field & Deep Survey of High z Dusty Galaxies
 - Molecular Line Survey
 - New receiver development for THz region
 - Planet formation and disk around young stars (...grain disks?)
 - Dust production by evolved stars (cold dust is also interesting compared with hot IR dust)
 - Galactic Cirrus
 - Spinning dust emission at low frequencies ($\sim 30\text{GHz}/\text{band 1}$)
 - Maybe we cannot compete with other telescopes about this one
-
- Bring your proposals for next meeting!
 - Antenna/receiver/... requirements for these projects?

Summary



- The NA-ALMA Prototype antenna was acquired by ASIAA/SAO last January
- Primary Site Candidate: Summit Station, Greenland
- Creation of a sub-mm VLBI array
 - Baselines up to 12,000 Km
 - Frequencies 230, 350, 650 GHz
 - Implies a resolution of few tens of μas
- Primary Objective: Imaging the Shadow of the Black Hole in M87
- Use of the Antenna as a Single Dish



Contact us

- <http://www.asiaa.sinica.edu.tw/~vlbi>
- vlbi@asiaa.sinica.edu.tw



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Thank You