

Interferometry at cm – (sub)mm wavelengths

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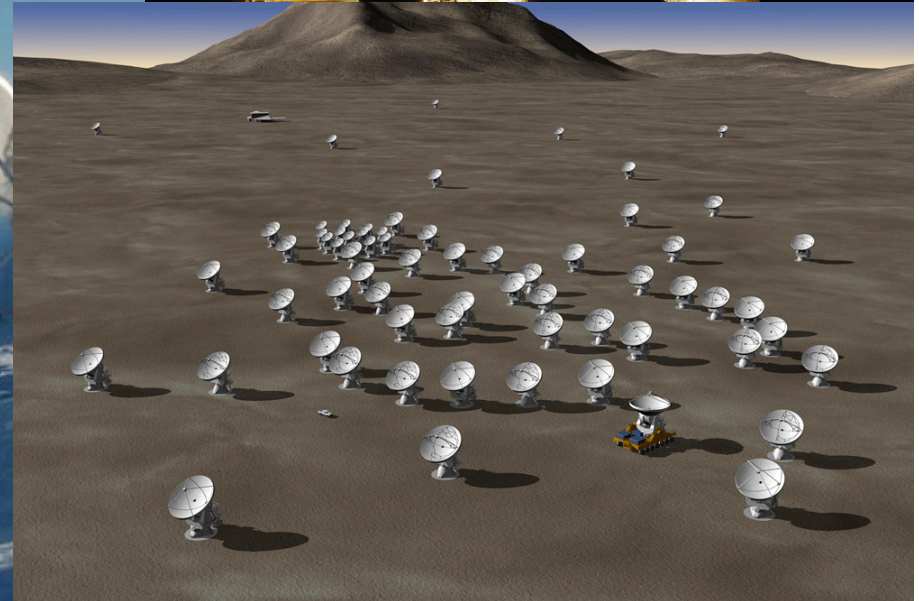
Content

- Current instruments
 - cm wavelengths: VLA – ATCA
 - mm wavelengths: PdBI, SMA, CARMA
 - Sub-mm wavelengths: SMA
- ALMA

What is needed to study circumstellar disks at cm-submm frequencies?

- **High spatial resolution:**
the size of a disk is hundreds AU ($<0.1''$ at 3kpc).
Spectroscopic observations must disentangle the emission of the red- and blue-shifted parts of the disk
- **High velocity resolution:**
 $\sim 0.1 \text{ km s}^{-1}$ (linewidths of a few km s^{-1})
- **High sensitivity**

cm and mm interferometers



Very Large Array (soon EVLA)

26 antennae (D=25m)

4 different configurations (max. A=36 km, B=10 km, C=3.6 km, D= 1km).

**Receivers from 1.3 GHz (~20 cm) to 43 GHz (~7mm).
Interesting for disks, NH_3 at 1.3 cm and the continuum at 7mm**

Highest resolution: from 1.4'' (20 cm) to 0.05'' at 7mm.

**Northern hemisphere
(but observations till 8° above the horizon).**

Australia Telescope Compact Array (but up to 3mm)

6 antennae ($D=22$ m)

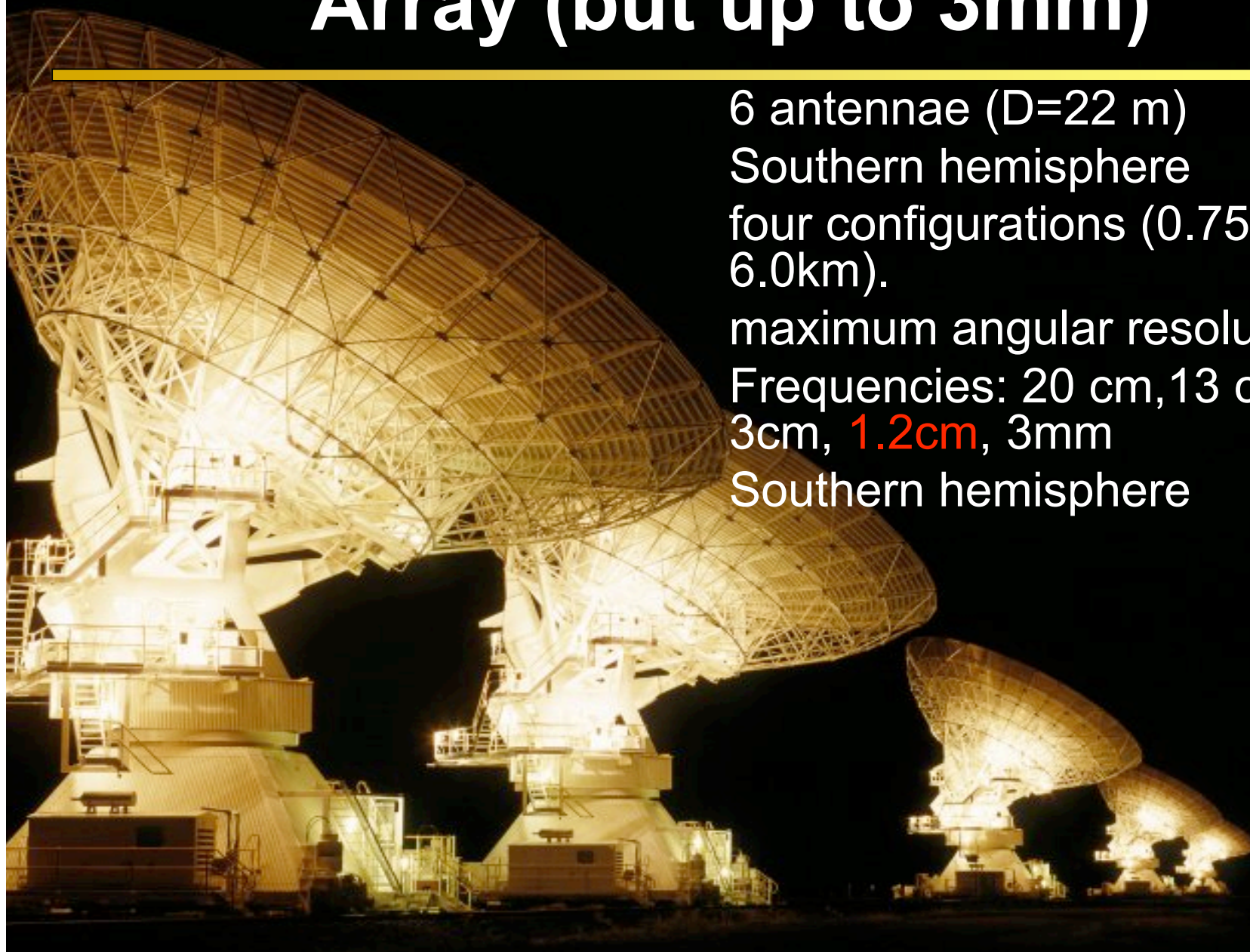
Southern hemisphere

four configurations (0.75, 1.5 and 6.0km).

maximum angular resolution of $1''$

Frequencies: 20 cm, 13 cm, 6 cm, 3cm, **1.2cm**, 3mm

Southern hemisphere



IRAM Plateau de Bure Interferometer

6 antennae of 15m.

Two bands (3mm and 1mm).

four configuration with angular resolution from 0.35'' (1mm) to 7'' at 3mm.

Interesting bands for disk studies: CO 115 GHz, 230 GHz (low masses), CH₃CN 110 GHz, 220 GHz (high masses)

Different spectral resolution modes, but limited bandwidth.

Northern hemisphere.

Combined Array for Research in Millimeter-wave Astronomy (CARMA)

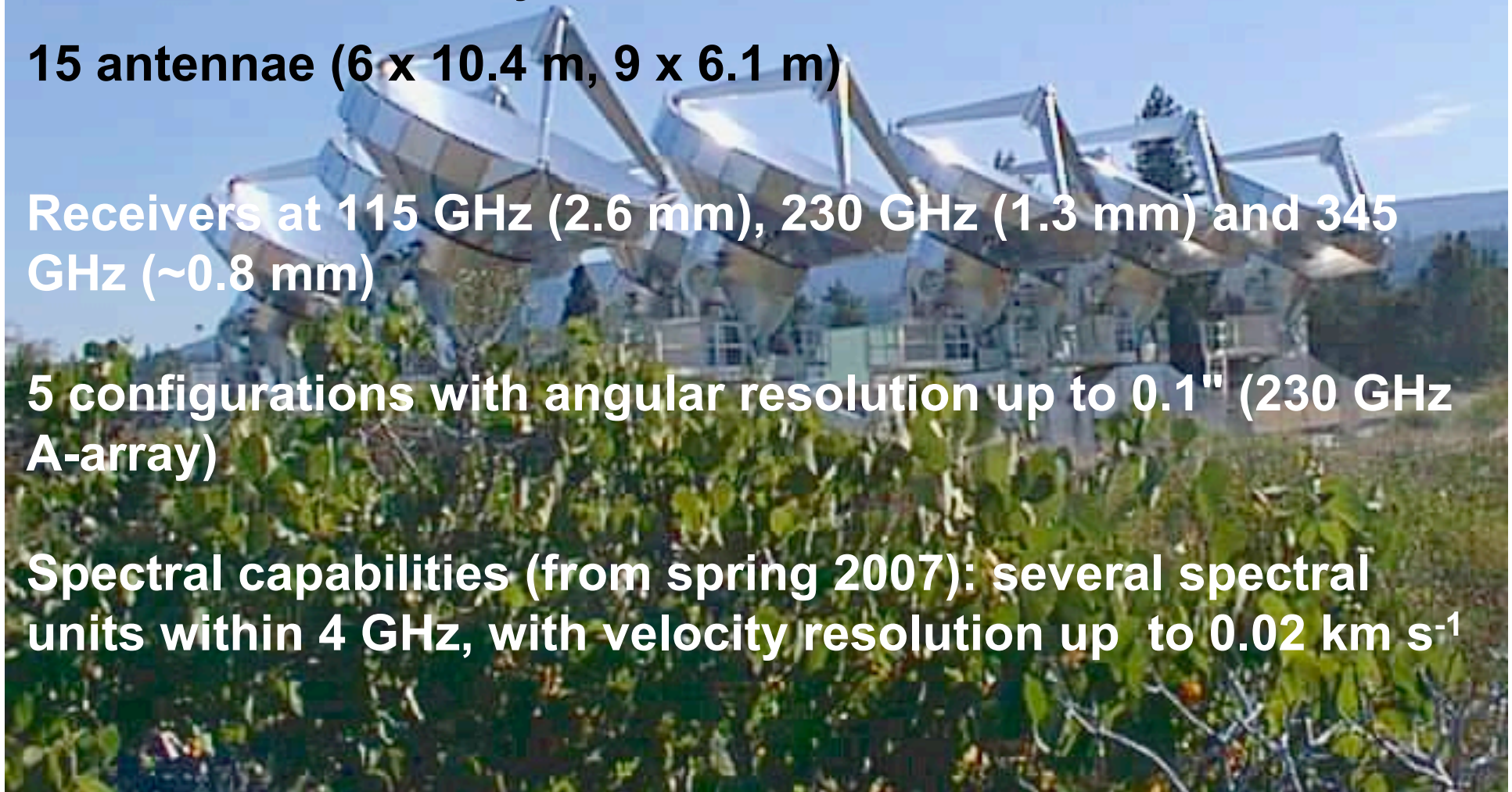
Merger of two arrays: the OVRO millimeter array and the BIMA millimeter array

15 antennae (6 x 10.4 m, 9 x 6.1 m)

Receivers at 115 GHz (2.6 mm), 230 GHz (1.3 mm) and 345 GHz (~0.8 mm)

5 configurations with angular resolution up to 0.1" (230 GHz A-array)

Spectral capabilities (from spring 2007): several spectral units within 4 GHz, with velocity resolution up to 0.02 km s⁻¹



Submillimeter Array

8 antennae of 6m, located atop Mauna Kea in Hawaii.

Operating frequencies: from 180 GHz (2mm) to 900 GHz (350 μ m).

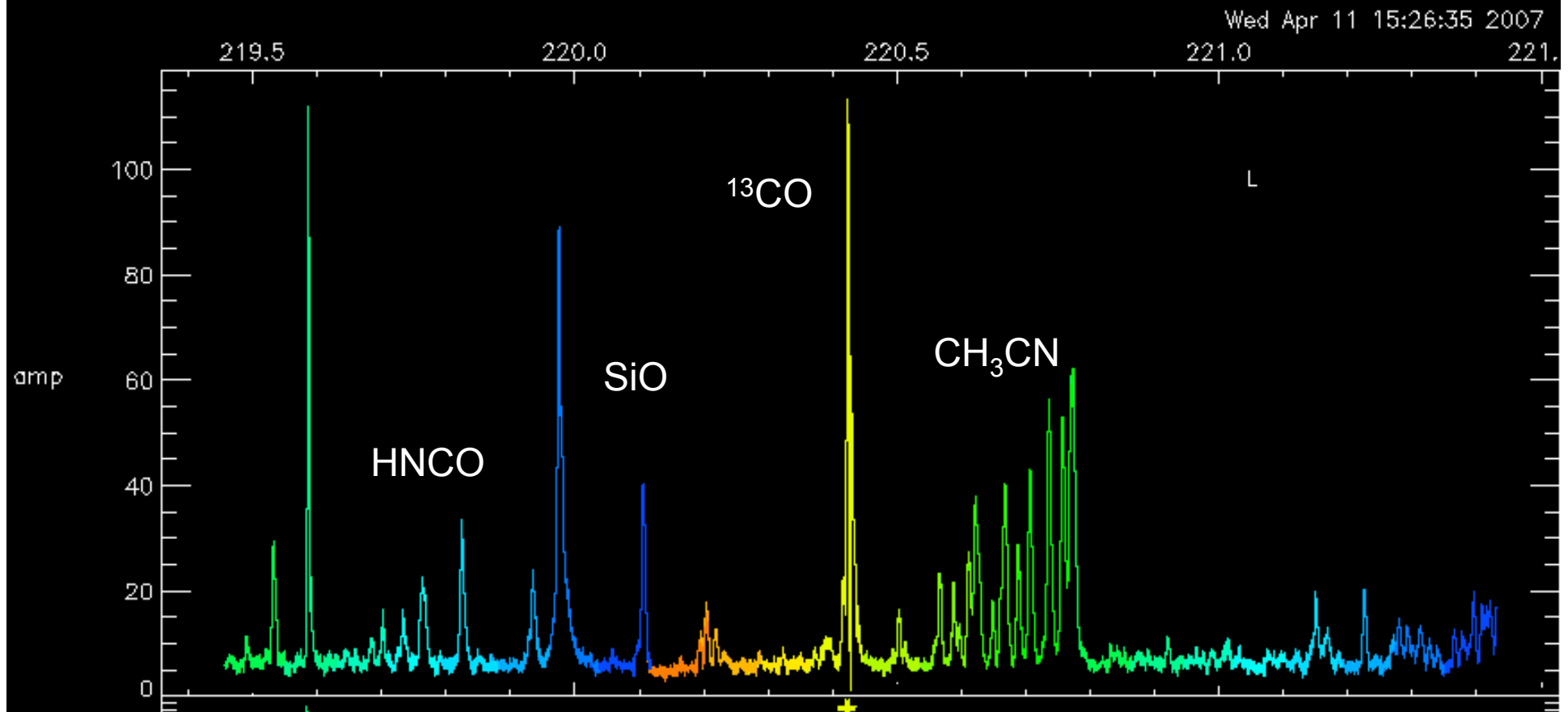
4 array configurations with resolutions at 345 GHz from 5" to 0.3"

Very flexible spectral capabilities: 2 GHz of bandwidth per sideband, with up to 0.35 km s⁻¹ resolution at 345 GHz.

8/8/2001 2:49pm

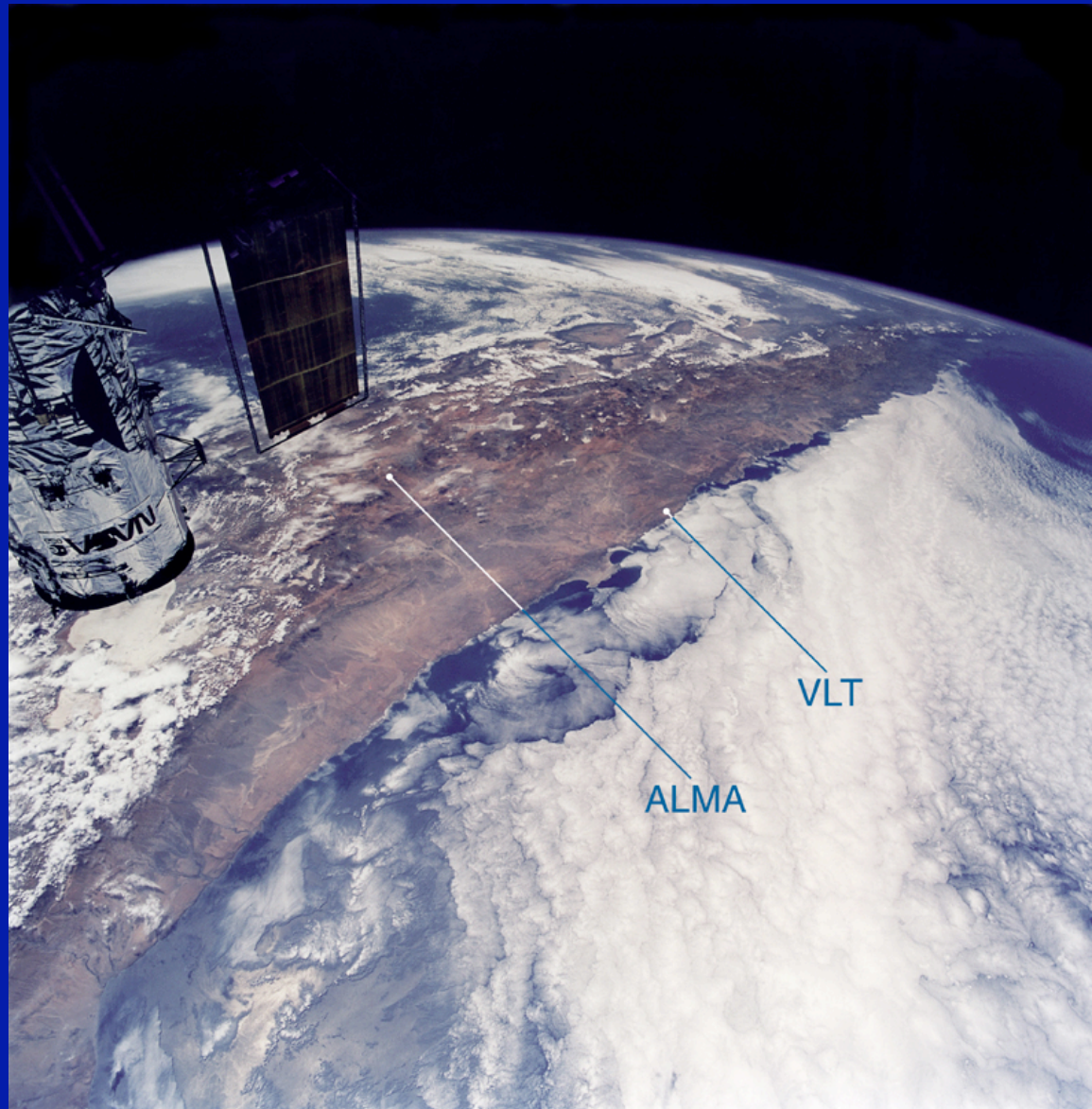
SMA@220GHz, IRAS 17233-3606

BUT...SMA has the collective area of a few ALMA antennae!!!



ALMA

- 54 12-m antennae, 12 7-m antennae, at 5000 m altitude site.
- Array configurations between 150m to ~15 -18km (@345 GHz down to $\sim 0.01''$, \sim AUs at 150 pc, ~ 10 s AU at 3 kpc).
- 10 bands in 31-950 GHz
- Flux sensitivity 0.2 mJy in 1 min at 345 GHz



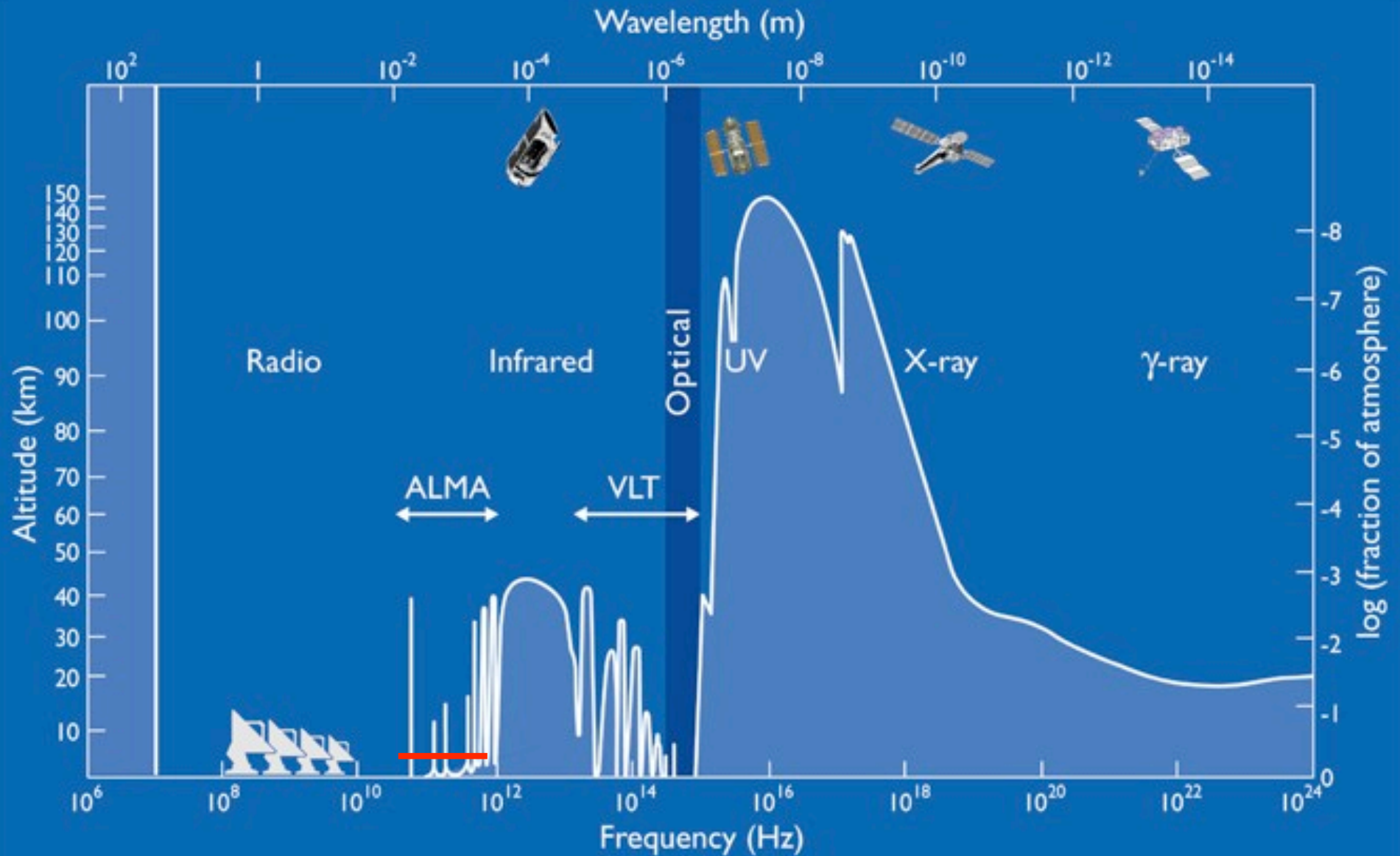
View of Northern Chile (NASA Space Shuttle)

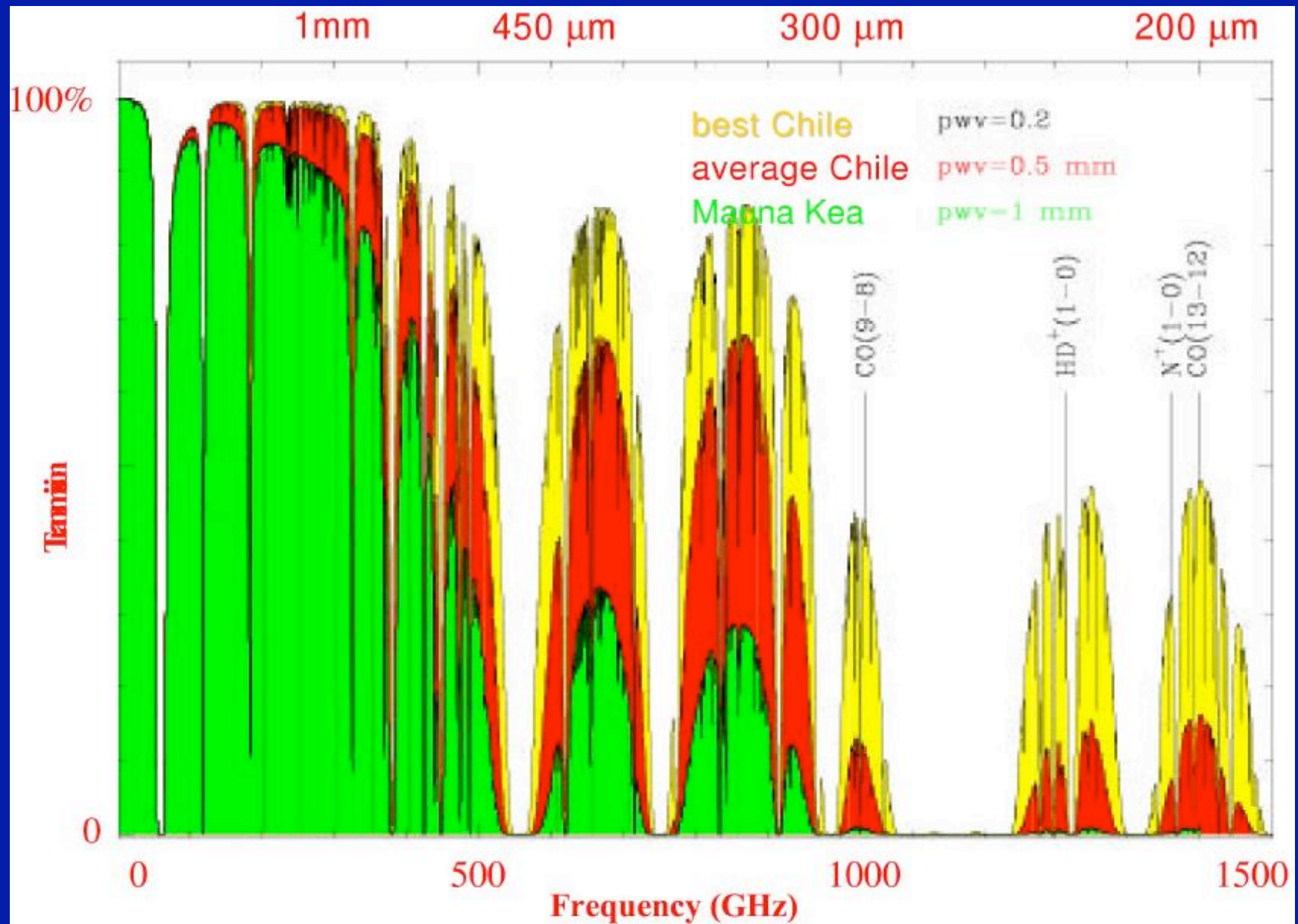
ESO PR Photo 24b/99 (8 June 1999)

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ALMA





ALMA BANDS

Band 1	1 cm	31-45 GHz	Not funded
Band 2	4 mm	67-90 GHz	Not funded
Band 3	3 mm	84-116 GHz	
Band 4	2 mm	125-163 GHz	
Band 5	1.8 mm	163-211 GHz	6 antennae
Band 6	1.3 mm	211-275 GHz	
Band 7	0.9 mm	275-373 GHz	
Band 8	0.6 mm	385-500 GHz	
Band 9	0.5 mm	602-720 GHz	
Band 10	0.3 mm	787-950 GHz	Development study

ALMA Science requirements



High Fidelity Imaging.



Precise Imaging at 0.1" resolution.



Routine Sub-mJy Continuum Sensitivity.



Routine mK Spectral Sensitivity.



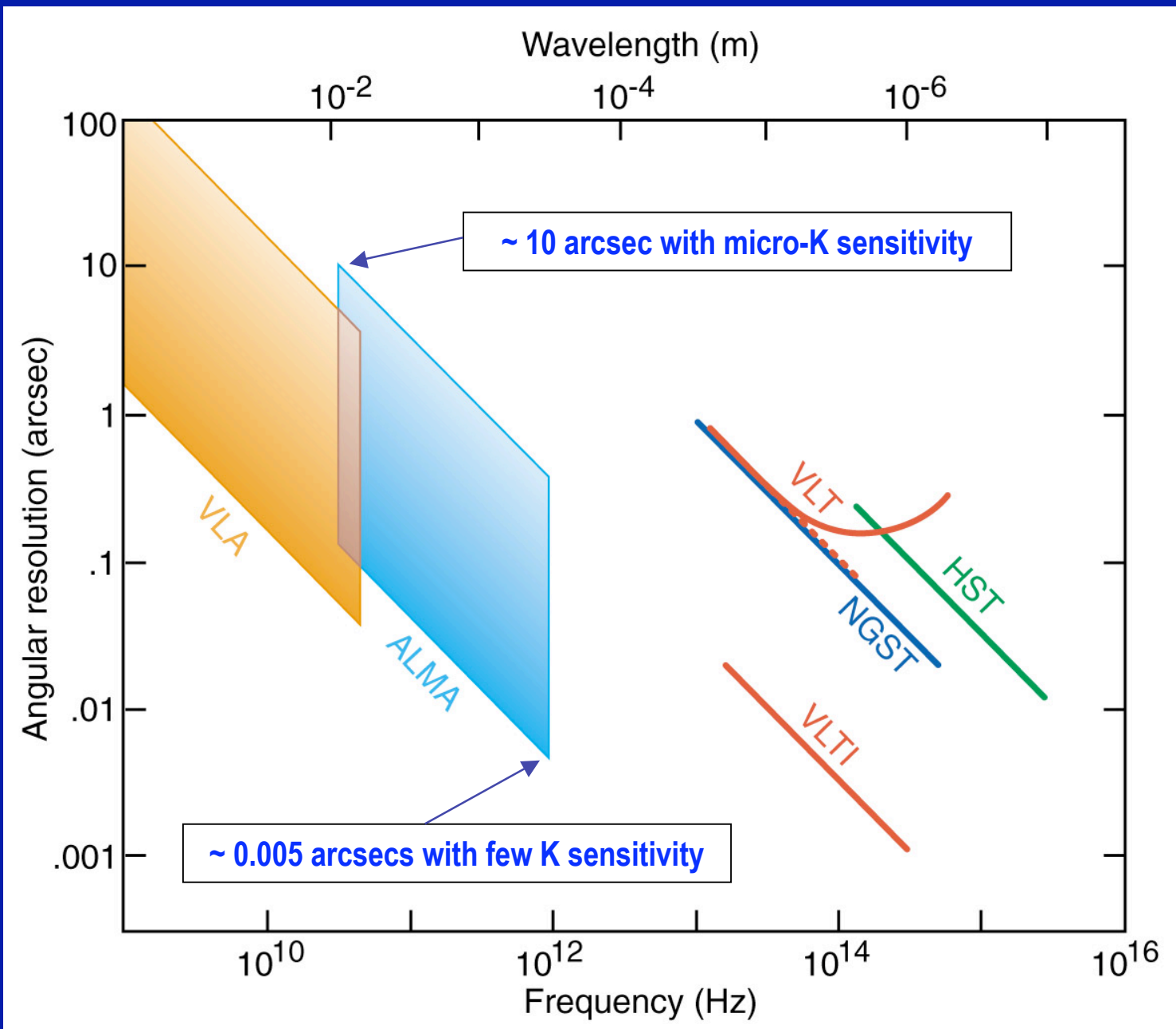
Wideband Frequency Coverage.



Wide Field Imaging Mosaicing.



Full Polarization Capability.



- First Interferometry at AOS: 2009
- Call for Proposals and Early Science: 2010 (16 antennae, 6 frequency bands)
- Full Operations:2012

First American antenna already in Chile

06 June 2007

VLTl summ

