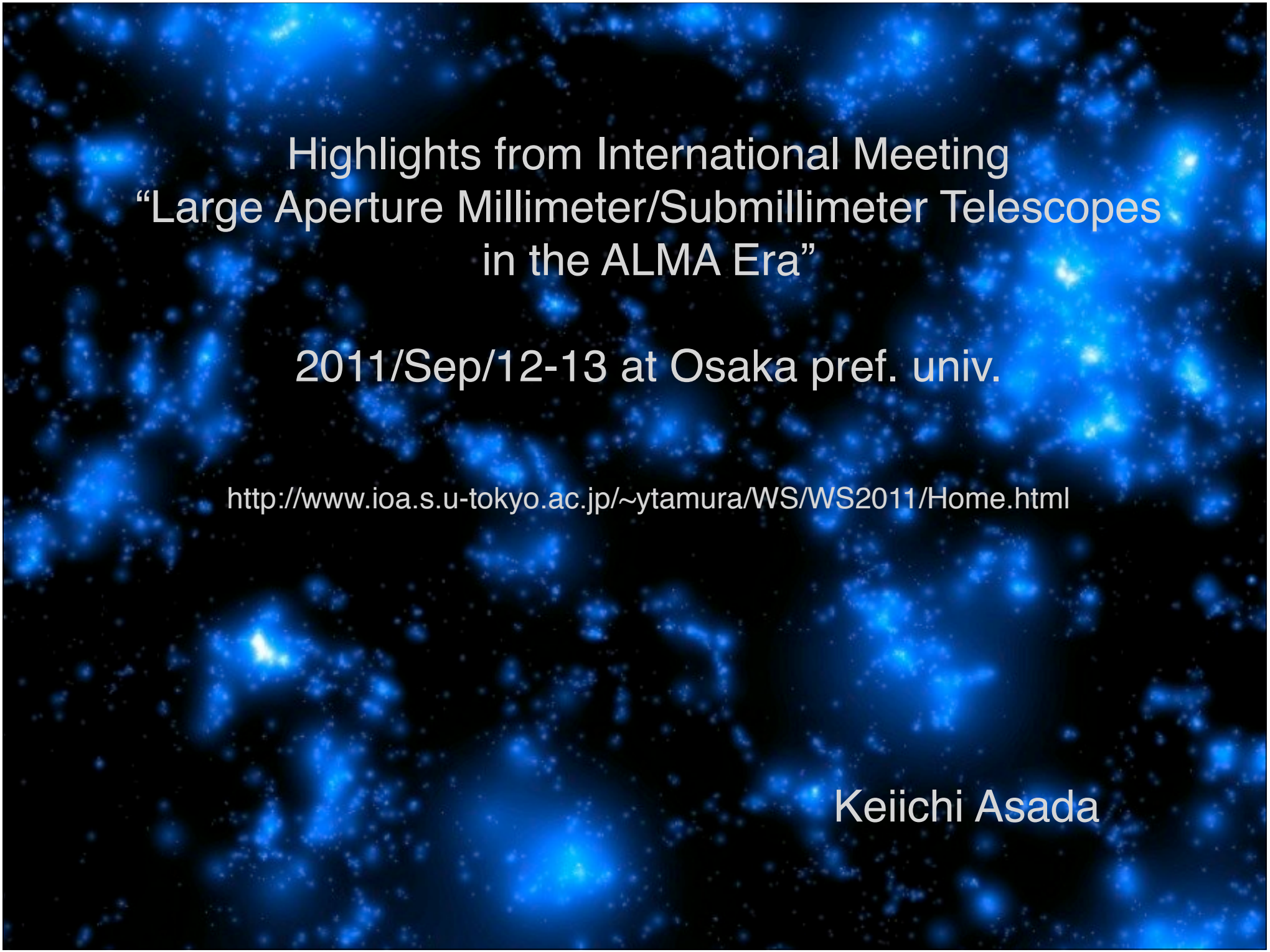
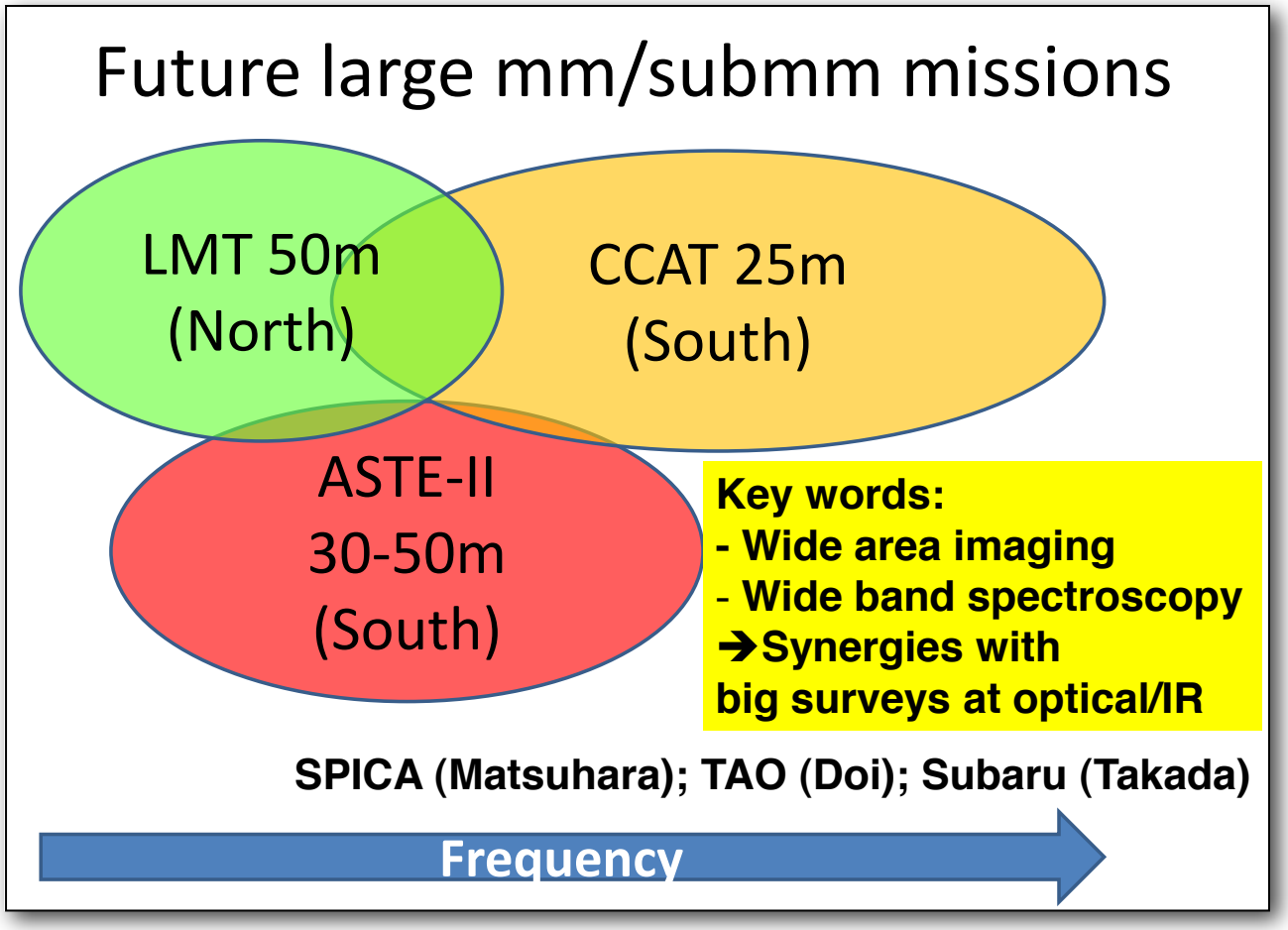

Highlights from International Meeting
“Large Aperture Millimeter/Submillimeter Telescopes
in the ALMA Era”
2011/Sep/12-13 at Osaka pref. univ.
http://www.ioa.s.u-tokyo.ac.jp/~ytamura/WS/WS2011/Home.html
Keiichi Asada

Summary of conference

1. Science drivers are introduced.
2. Latest status of the mm/submm large single dish telescopes are reported.
3. Latest status of the development of the detectors are reported as well.

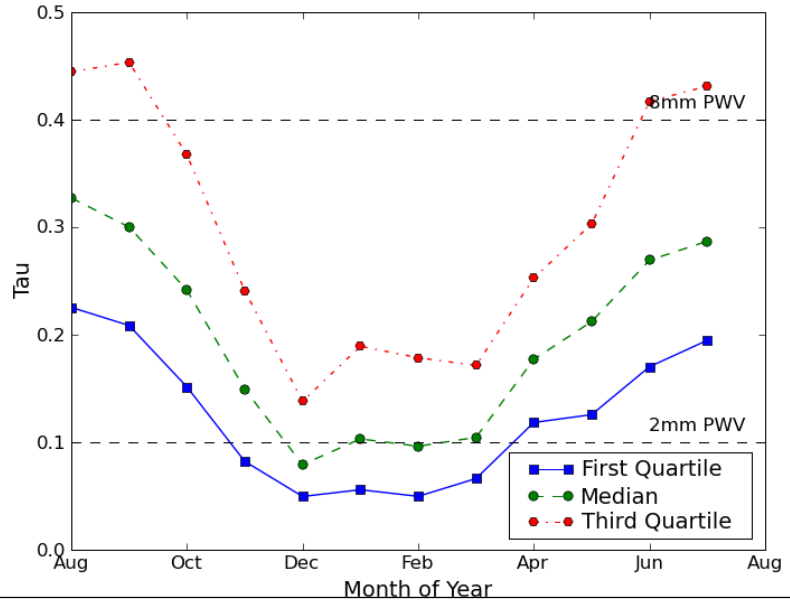


We confirmed that the next generation large single-dish telescopes with wide FoV and bandwidth will be extremely rich in discoveries, which is very complementary to ALMA.

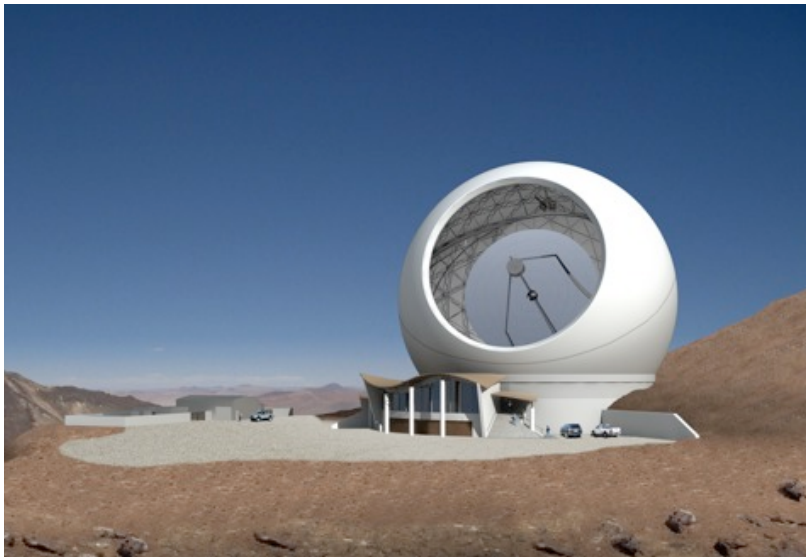
Large Millimeter Telescope (LMT)

LMT

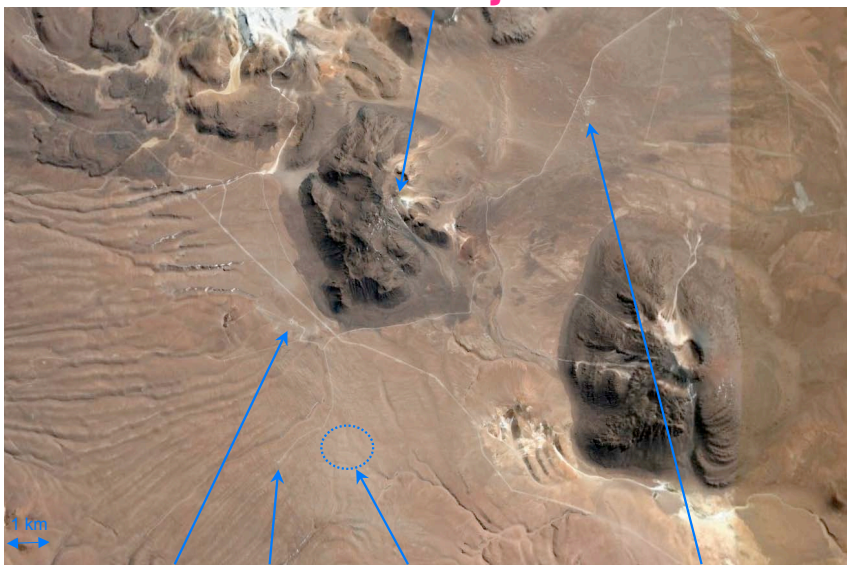
- **Diameter: 50 m**
- **Frequency: 70 - 400 GHz**
- **First Light: 2011 (with inner 32 m)**



CCAT & ASTE2



CCAT: Cerro Chajnantor 5612 m



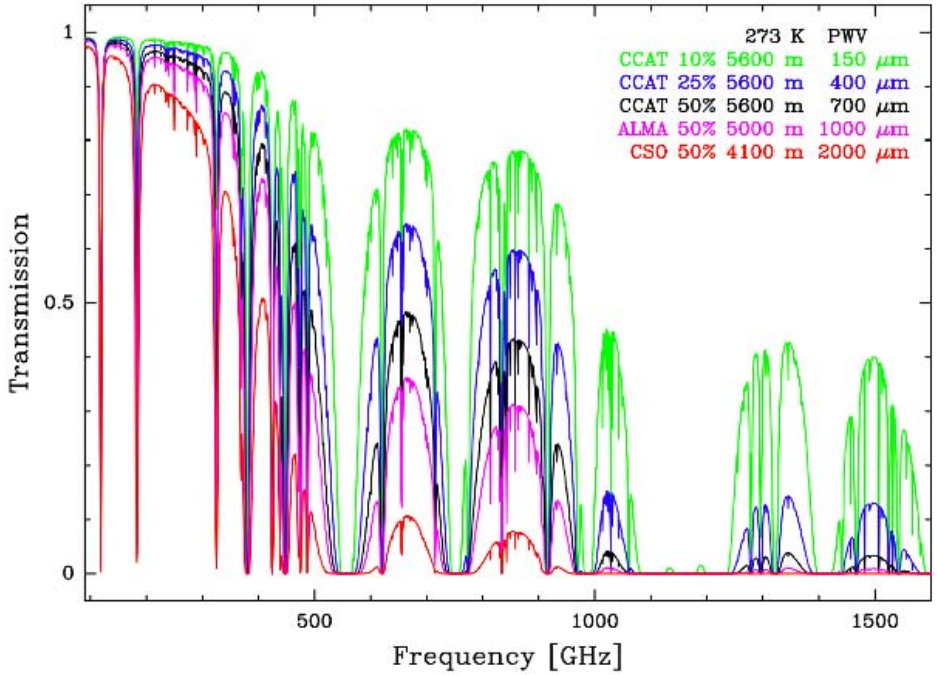
APEX ALMA ASTE2 @ 4900 m

CCAT:

- **Diameter: 25 m**
- **Frequency: 200 - 1500 GHz**
- **First Light: 2018?**

ASTE2:

- **Diameter: 30 - 50 m**
- **Frequency: 70 - 400 (1000) GHz**
- **First Light: 2018 - 20?**



Specs of the future large mm/submm telescopes

	LMT	CCAT	ASTE2	Greenland telescope
Status	constructing	partially founded	planning	planning
organization	UMass, INAOE	Cornell Univ, Caltech, ...	NAOJ	ASIAA, CfA, MIT, NRAO
site	Mexico (19° N)	Chile (23° S)	Chile (23° S)	Greenland (72° N)
sky coverage	-61° to 90°	-90° to 57°	-90° to 57°	-8° to 90°
altitude	4600 m	5600 m	4900 m	3200 m
Diameter	50 m	25 m	30 - 50 m	12 m
surface accuracy	75 μm	10 μm	? (15 μm?)	? (- μm)
Frequency	70 - 350 GHz	200 - 1500 GHz	70 - 1000? (400?) GHz	80 - 1500 GHz?
resolution	18 - 3.5 arcsec	12 - 1.6 arcsec	18 - 3.1 or 29 - 2.1 arcsec	64 - 3.4 arcsec
Field of view	8 arcmin	1 degree	wide (?)	?
Open sky?	20 - 25 %	?	?	no
PWV	1 mm (at best season)	< 0.5 mm	1 mm (typical) 0.74 mm (first 25 %)	< 0.5 mm @ winter? 1 - 2 @ summer?
First Light	2011 (with inner 32 m)	2018?	2018 - 2020?	? (2016?)

Key technologies

1. Submm Camera

From mauskopf's presentation.

Mm-wave/THz bolometer instruments in astronomy

1980s-90s - single pixel systems or multipixel assembled by hand (e.g. FIRAS, SCUBA - 37 pixels, BOOMERANG – 10 pixels)

1998 - First hybrid detector wafer: BOLOCAM - 144 pixels using Ge thermometers

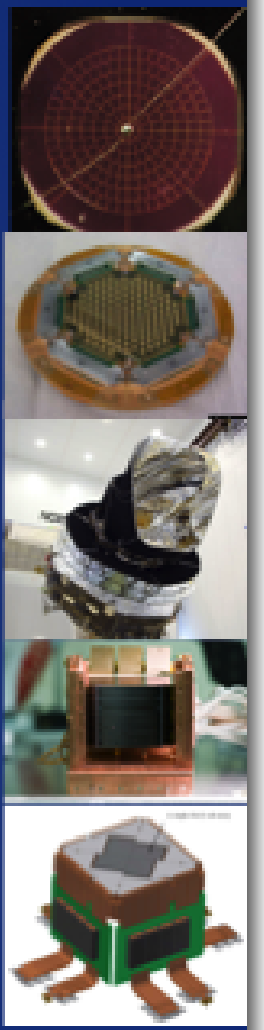
2009 - Bolometers on ESA satellites (HERSCHEL, PLANCK) including 64x64 micromachined pixel array (PACS) with CMOS multiplexed readout

2000s - Development of transition edge superconducting (TES) bolometers - no hybrid, all photolithographic (~10 steps for TES, 14 for SQUIDs)

2007- ACT, APEX, SPT SZ survey experiments with ~1000-3000 TES pixels

2011- SCUBA2 TES camera - 10,000 pixels with SQUID multiplexing

Sensitivities ~ 10^{-17} W/√Hz photon noise limited



Ten thousands pixels era will come !!

Key technologies

1. Submm Camera

AzTEC/LMT

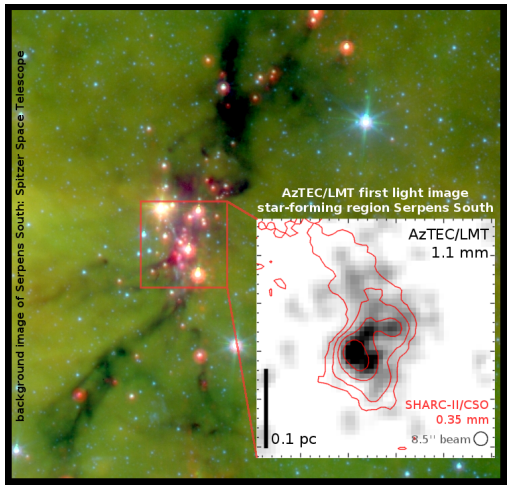
- TEC array
- 144 pixel for 270 GHz
- installed to LMT now

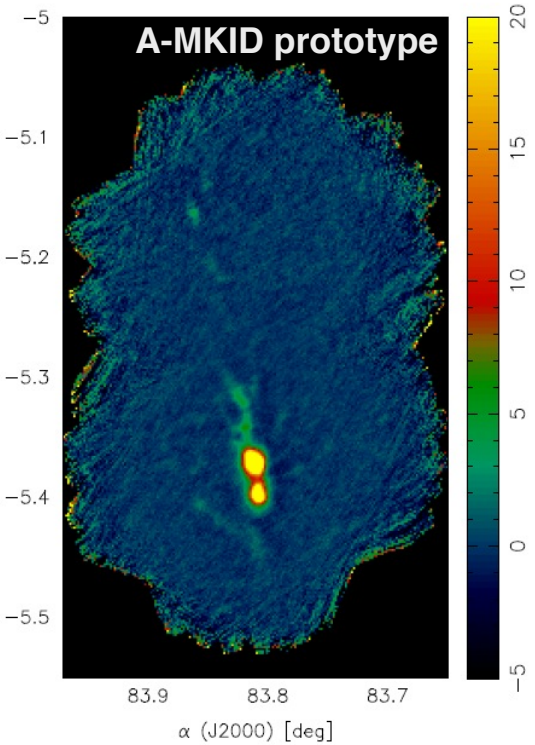
ATACamera

- TES sensed SQUID multiplexed arrays (or KID array)
- 5’ field-of-view
- 40,000 pixel for 870 GHz
- 10,000 pixel for 350 GHz
- (Firstly, it will be installed to CSO before CCAT)

A-MKID camera

- KID based detector
- 15’×15’ field-of-view
- 16000 pixel for 870 GHz
- 3500 pixel for 350 GHz
- prototype has already installed to APEX



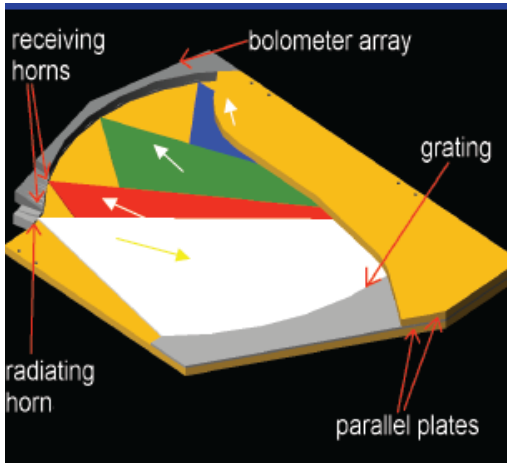


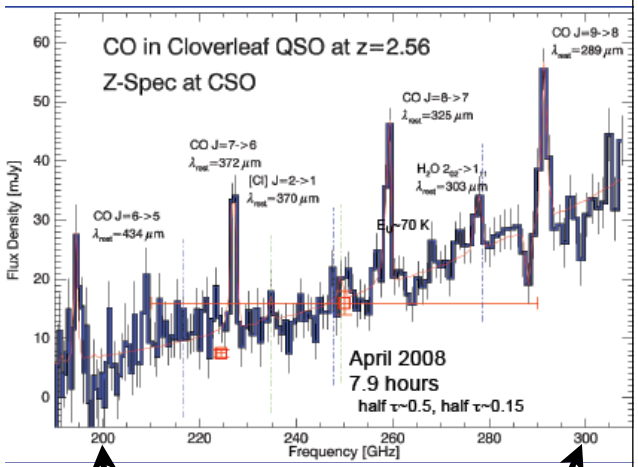
Orion M42 @ 350 GHz

Key technologies

2. Spectrometers

Z-spec
- grating spectrometer
- 200 - 300 GHz
- has installed to CSO





200 GHz　　300 GHz

Zeus-2
- grating spectrometer
- Δf/f ~ 1/1000
- 5 bands (350, 490, 670, 870 GHz and 1.5 THz) simultaneously
- will be installed at CSO in 2012 Jan., APEX later in 2012
- CCAT people are planning to install this type spectrometer

SEQUOIA
- 32 pixel heterodyne focal plane array
- 85 - 115 GHz
- will be installed to LMT

DESHIMA
- KID for spectrometer
- 300 - 950 GHz
- Δf/f ~ 1/1000
- 10 pixels × 1000 colors
- will be installed to ASTE2?

Summary and thoughts

1. Next generation 30 -50 m single-dish telescopes will have
   wide FoV (~ 10s arcmin [~10k pixels])
   and/or
   wide bandwidth (f/df ~ 1000).

2. It's mainly to find candidates for ALMA observations.

3. Number of the detectors >> Number of telescopes ?
   Telescope developer ≠ Detector Developer
   Guest instruments?

4. Sensitivity $\propto D^2, t^{1/2}$
   CCAT 25 m vs GLT 12 m.
   We need ~ 20 times longer observation time.
   Monitoring observation would be one of the possible ways.