THE SUBMILLIMETER ARRAY

Raymond Blundell

Mauna Kea Users' Meeting

October 4 2012

ADDITIONAL LAB SPACE IN SMA HILO BUILDING

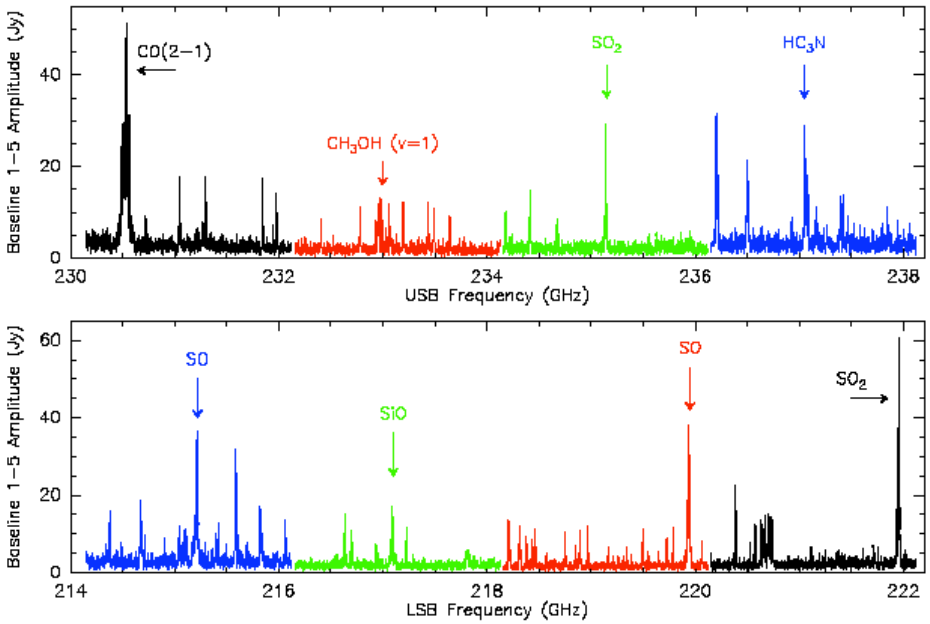
Section underneath conference room is now enclosed
Provides additional lab space – more electronics assembly done in Hilo
Much of the hardware for correlator upgrade designed and built in Hilo

KUSUNOKI

ADDITIONAL SORAGE SPACE AT SMA HANGAR ON MAUNA KEA

KUSUNOKI

NEW WIDE-BAND IF OPTIONS FOR THE SMA 1.3 mm RECEIVER BAND

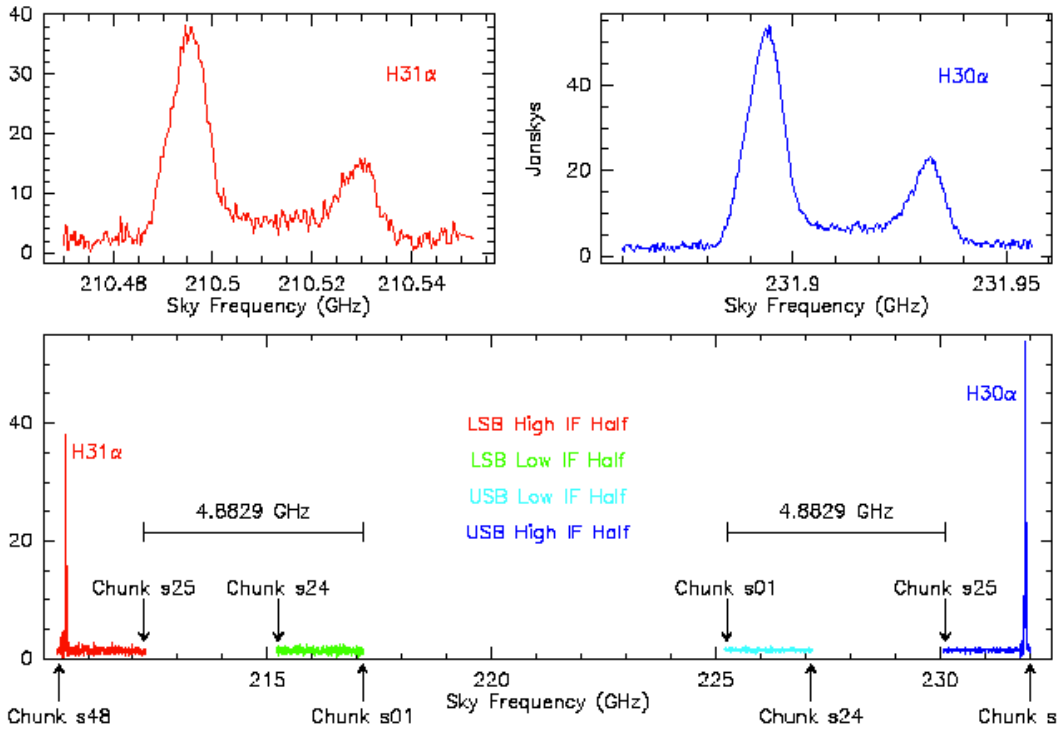


On-sky test observations towards Orion BN/KL on a single baseline: The black spectra show the original 4 – 6 GHz spectral region. The red spectra show the additional coverage obtained in the 'Bandwidth Doubled' mode of operation introduced in 2010, with the usual 12 GHz LO sent to the Bandwidth Doubler Assembly.

A 14 GHz LO provides spectral coverage over the 8 – 10 GHz IF range, shown in green, and a 16 GHz LO provides coverage over the 10 – 12 GHz range, shown in blue. Correlator will be upgraded during 2013 to handle x2 increase in receiver bandwidth

YOUNG & TONG

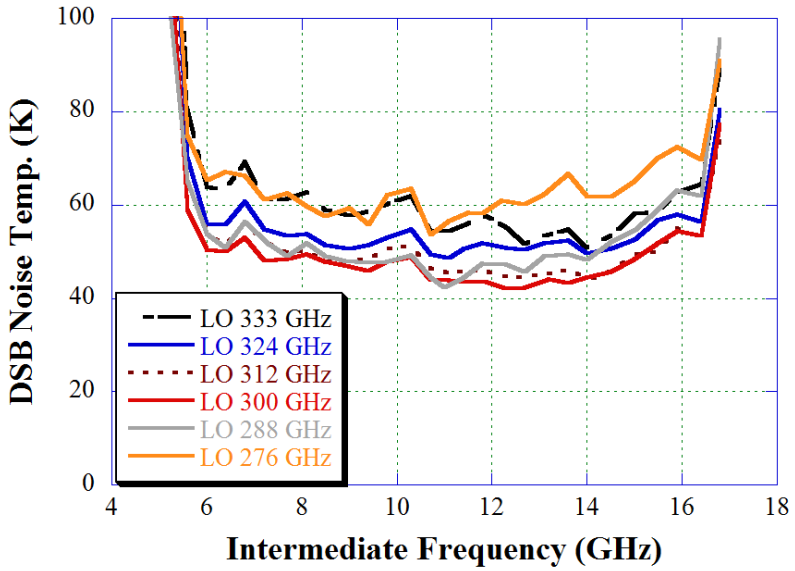
NEW OBSERVING MODE FOR THE 2012B SEMESTER

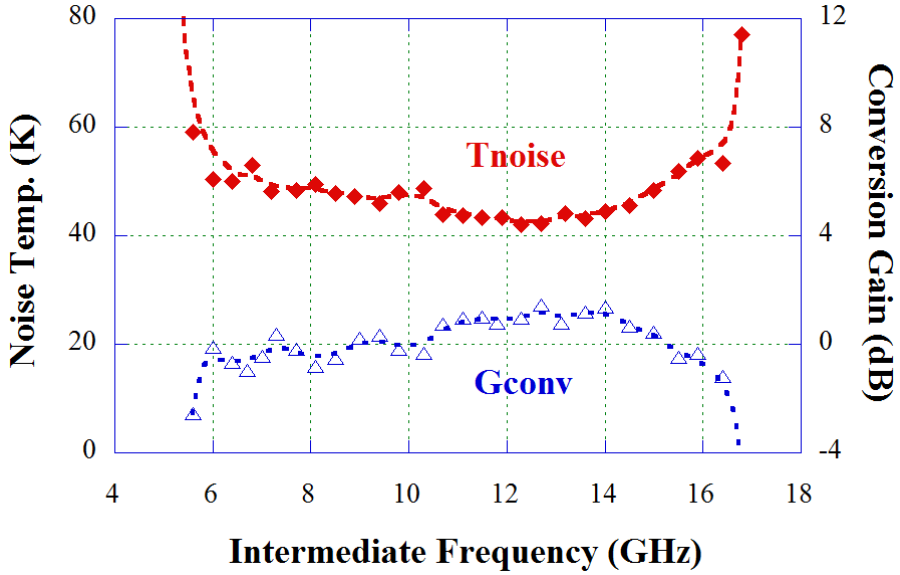


Because changing the LO to the Bandwidth Doubler Assembly allows the two halves of a sideband to span as much as 8 GHz, which is also the separation between the lowest USB frequency and the highest LSB frequency, one can now target any two spectral lines which are separated by less than 24 GHz, either by putting them both in one sideband, which offers coverage for up to 8 GHz separation, or by putting them in different sidebands for up to 24 GHz separation.

YOUNG & TONG

NEW WIDE-BAND RECEIVERS FOR THE 0.86 mm BAND



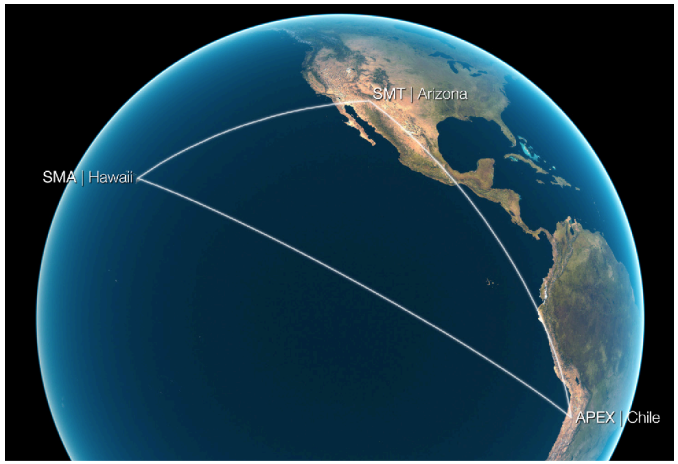


Following upgrades to 1.3 mm receivers, need to do the same with 0.86 mm receivers
New 0.86 mm receiver has low-noise across a 6 – 16 GHz IF compared to 4 – 8 previously
In addition, the noise at the band edges 260, 350 GHz is as low as at band center previously
However, need to work towards extending IF down to 4 GHz
Expect installation of new receivers to begin early 2013

TONG

SMA PLAYS KEY ROLE IN THE HIGHEST RESOLUTION ASTRONOMICAL INTERFEROMETRIC OBSERVATION EVER MADE

Astronomers connected three telescopes in Hawaii, Arizona, and Chile to make the highest angular resolution interferometric observation ever made in astronomy. This globe-spanning interferometer, called the Event Horizon Telescope (EHT), consists of a growing number of participating observatories. The latest observations made with the Submillimeter Array (SMA) in Hawaii, the APEX Telescope in Chile, and the Submillimeter Telescope (SMT) in Arizona achieved an angular resolution of 28 micro arcseconds.

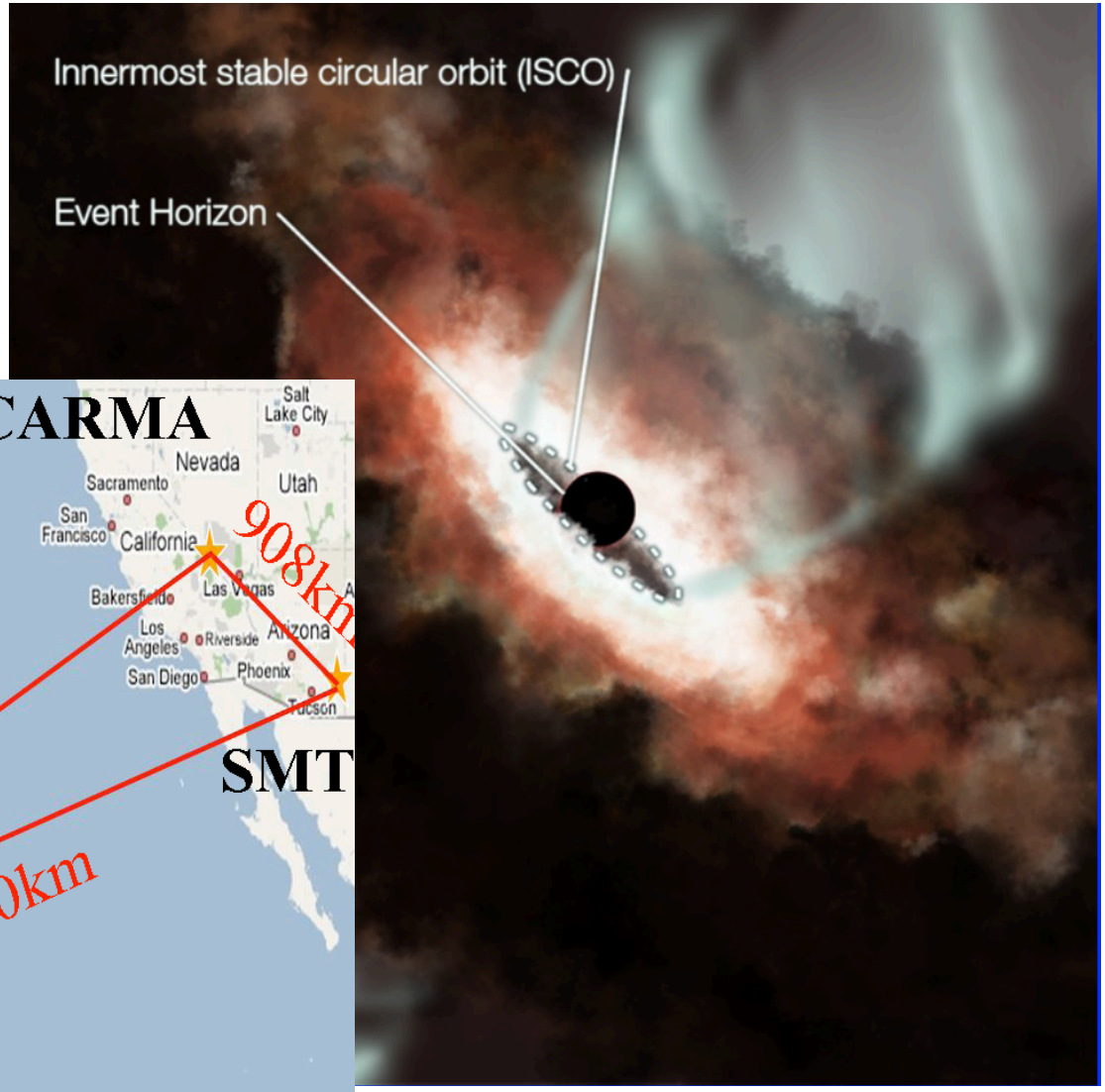


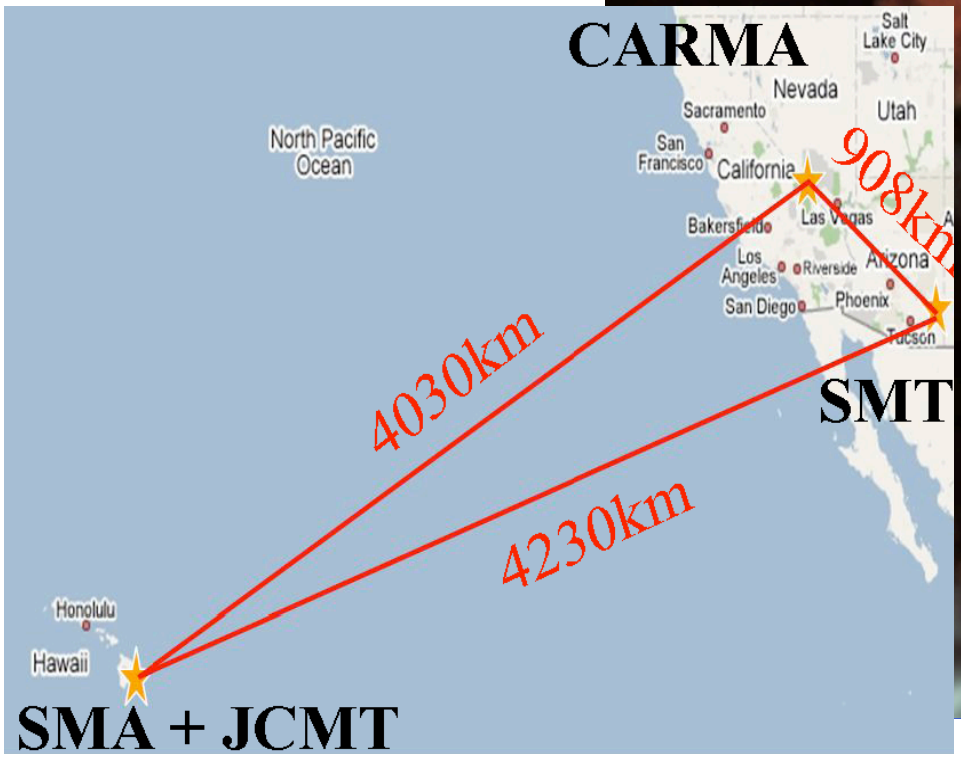
The quasar 3C 279 was chosen for the current observations even though it is too far away to resolve its event horizon. It is about 6 times brighter than the black hole in our Galaxy and 15 times brighter than M87. The observations of 3C 279 are important as a demonstration of the technology in the EHT, the technique of high angular resolution VLBI, and a step along the way toward the goal of imaging a black hole.

KRICHBAUM

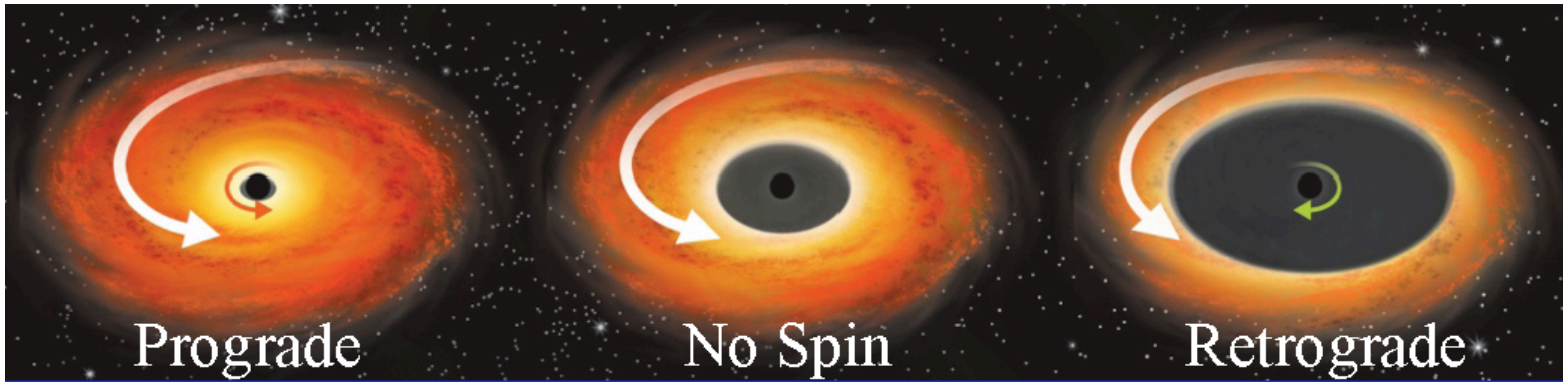
EVENT HORIZON TELESCOPE – OBSERVATIONS TOWARDS M87

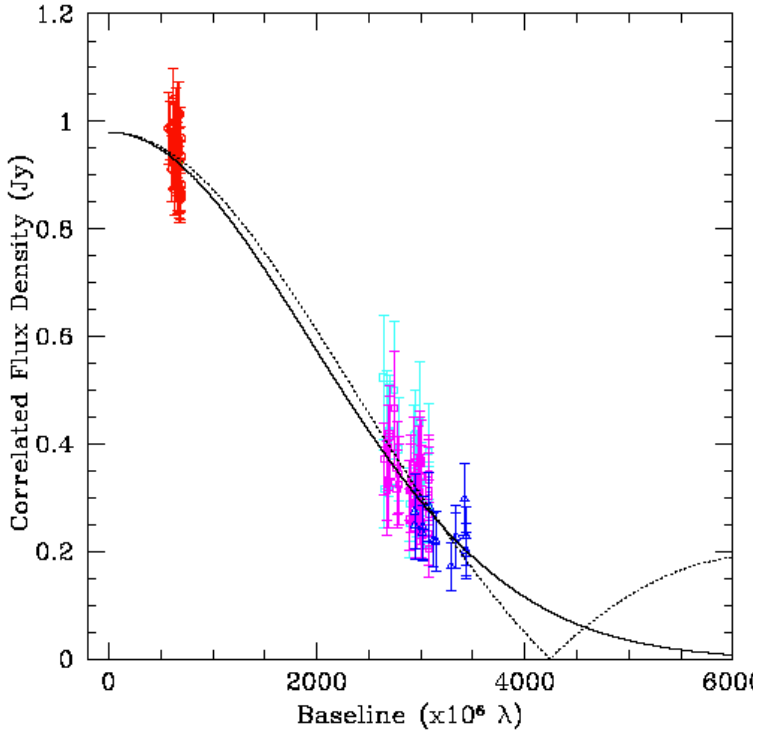
Quite different to SgrA*
7 billion solar masses
50 million light years distant
Candidate SMBH for mm VLBI



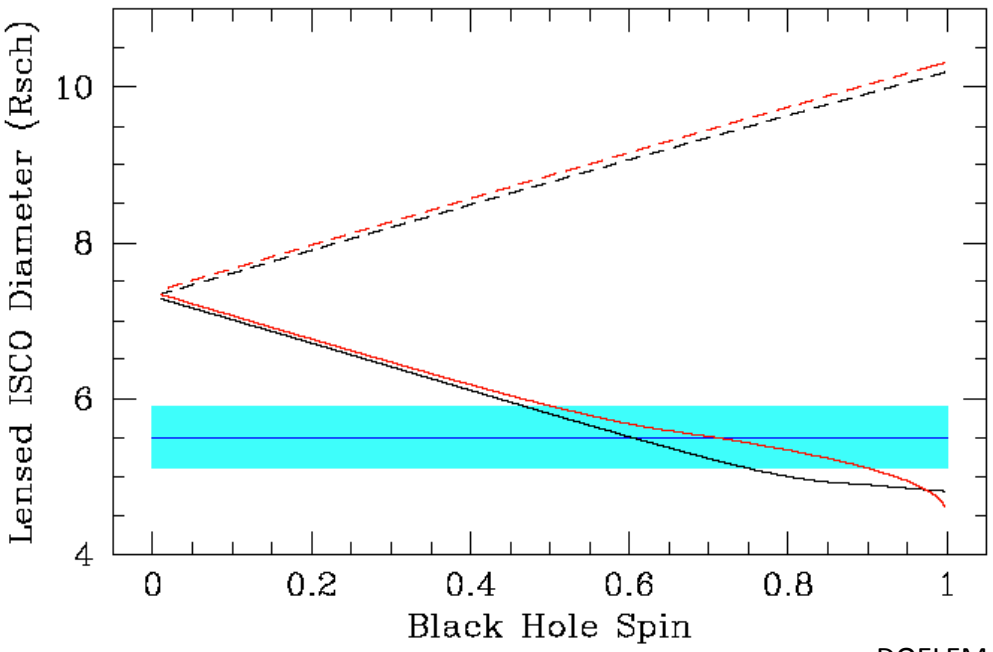


MEASURING THE INNERMOST STABLE CIRCULAR ORBIT OF M87



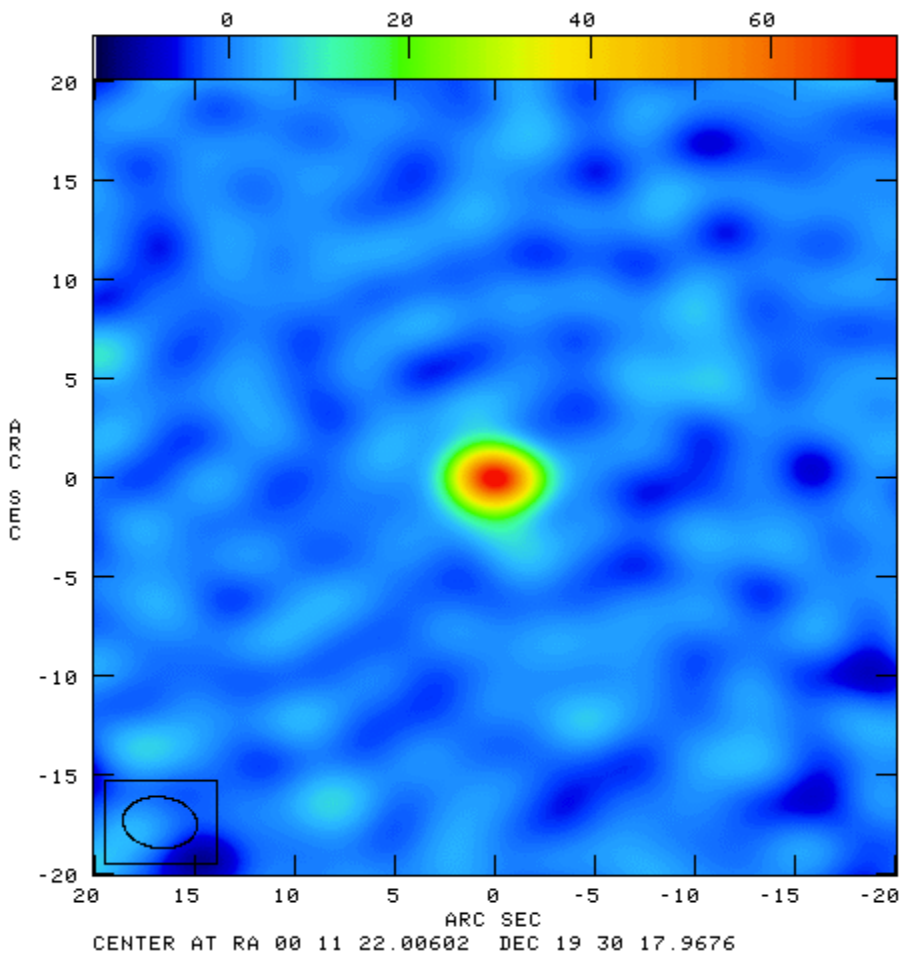


At 5.5 RSch the Accretion disk and black hole are prograde



DOELEMAN

SMA OBSERVATIONS OF NEAR EARTH ASTEROID 2005YU55

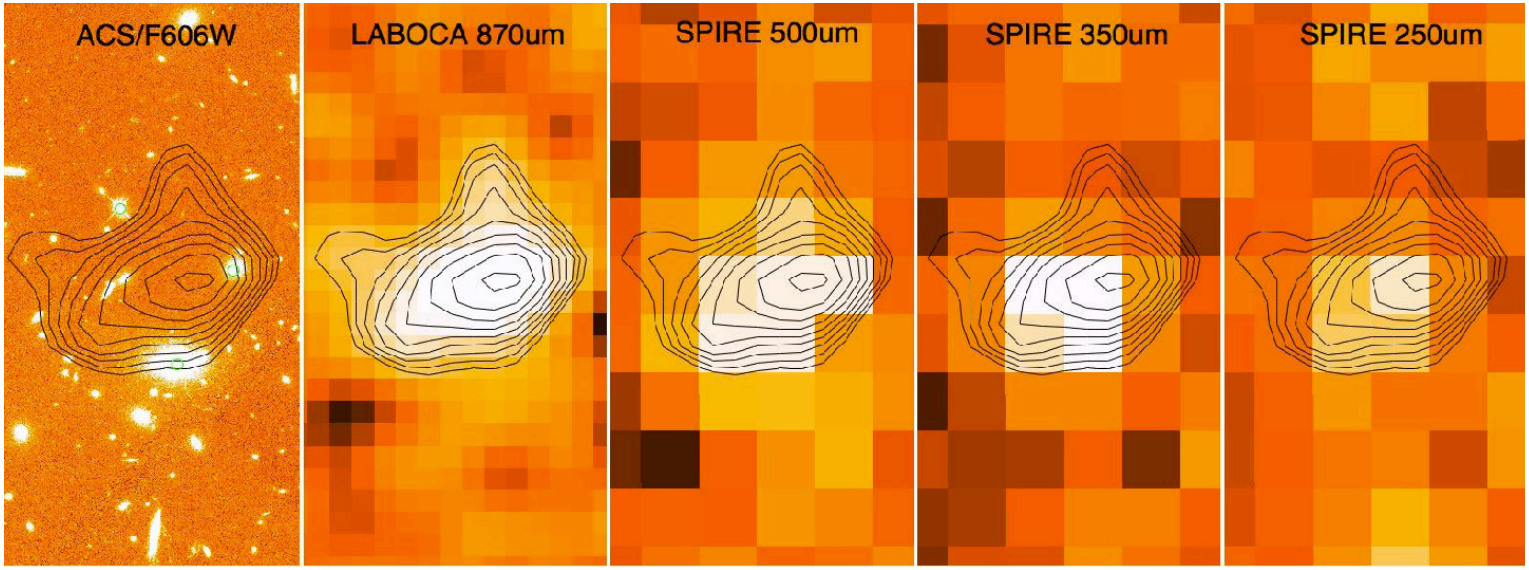


With an estimated diameter of around 400 m, 2005YU55 is a recently discovered asteroid whose orbit crosses the Earth orbital plane, and is therefore labeled as a potentially hazardous object. On November 8, 2011 it underwent a near-Earth event, passing within the orbit of the Moon

The observing conditions were poor as summit was fogged in for much of the first half of the night. The peak (and integrated) flux density of the asteroid averaged over the observing window is 74 mJy - significantly lower than expected. This suggests that the asteroid has a geometric mean diameter of 310±17 meters, 22.5% smaller than initially thought, which compares favorably with independent measurements obtained with *Herschel.*

GURWELL

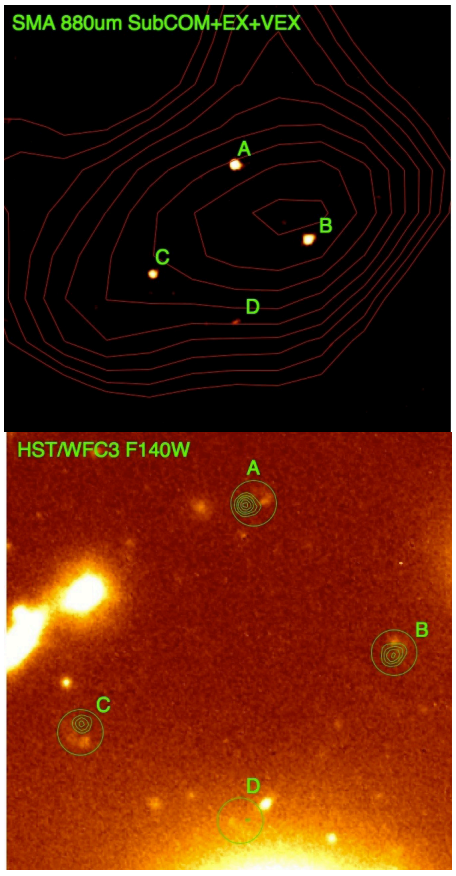
DISSECTING A BRIGHT CLUSTER-LENSED SUBMILLIMETER GALAXY AT z=4.7



Multi-wavelength images of a *z=4.7 galaxy first discovered as a bright SPIRE source with a peak flux density of 114 mJy at 500 μm near the center of a massive galaxy cluster at z=0.32. Such a bright SPIRE source is rare, and its proximity to the cluster center suggests that this source is likely to be gravitationally lensed by the foreground cluster. In the LABOCA image, the source is seen to be extended even with a spatial resolution of ~20", suggesting that this is possibly a multiply-imaged lensed system.*

DISSECTING A BRIGHT CLUSTER-LENSED SUBMILLIMETER GALAXY AT z=4.7

Fully-combined SMA map: sc, c, ex, vex, compared with the HST/WFC3 image
Offset in stellar and dust emission – may indicate background source is an interacting system



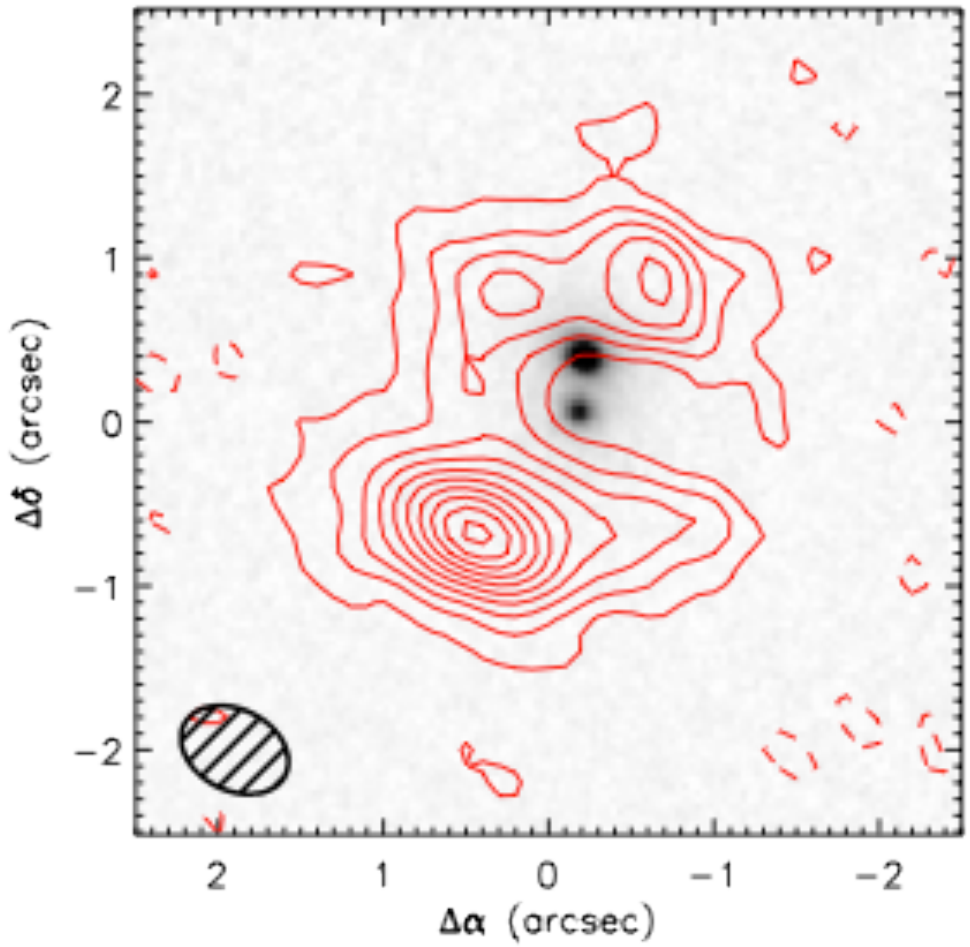
The SMA has resolved this bright SPIRE-LABOCA source into four separate components separated by 10-15”. The total flux density of these four components at is consistent with the LABOCA 870 μm flux density of 60 mJy, indicating that these four components are responsible for the observed SPIRE-LABOCA flux densities.

Each component is spatially compact and has a likely counterpart in the HST near-infrared image, but that the SMA and HST sources are offset from each other.

The offsets are consistent with what we would expect from our lensing model if we assume that each lensed image consists of two distinct components in the background source, one detected by the SMA and the other by the HST. In other words, the SMA signal is coming from a component that is invisible in the HST near-infrared image. The separation between the SMA and HST sources in the source plane is estimated to be 0.1” or 660 pc at *z=4.7.*

EGAMI

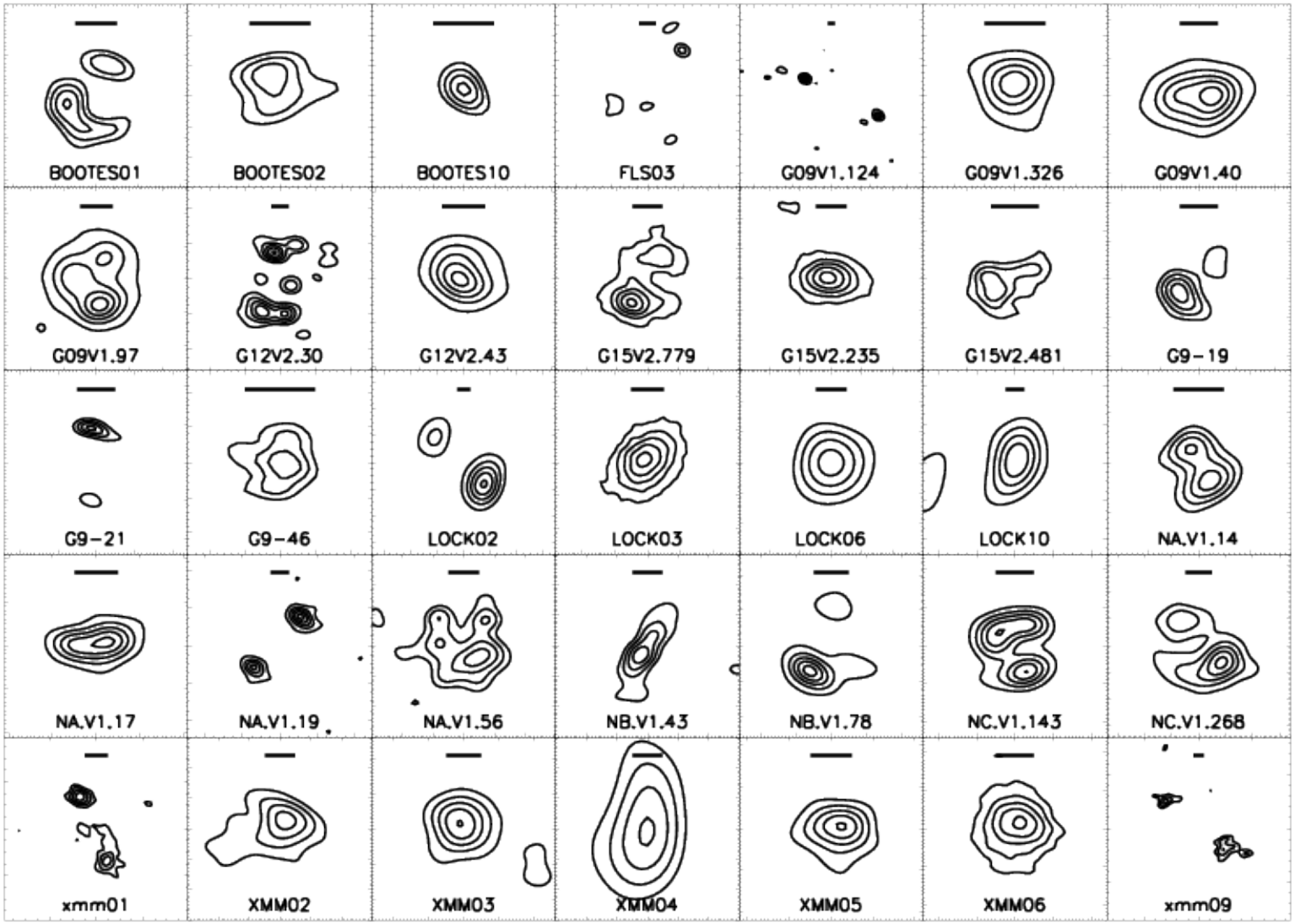
A MULTIPLY LENSED SUBMILLIMETER GALAXY AT z = 4.2



SMA – red contours (z = 4.2) Keck AO – grayscale (z = 0.6)
Lens not detected in SMA data, SMG not detected in Keck data
- Both observatories necessary to understand this system

BUSSMAN

HIGH RESOLUTION IMAGING OF 35 LENSED SMG's



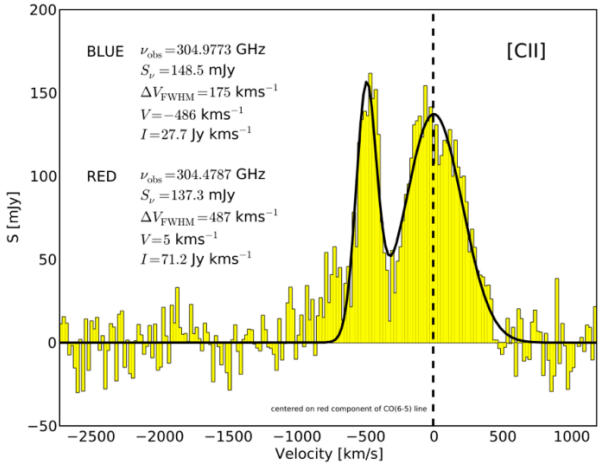
Bar above each frame is one arc-second in length

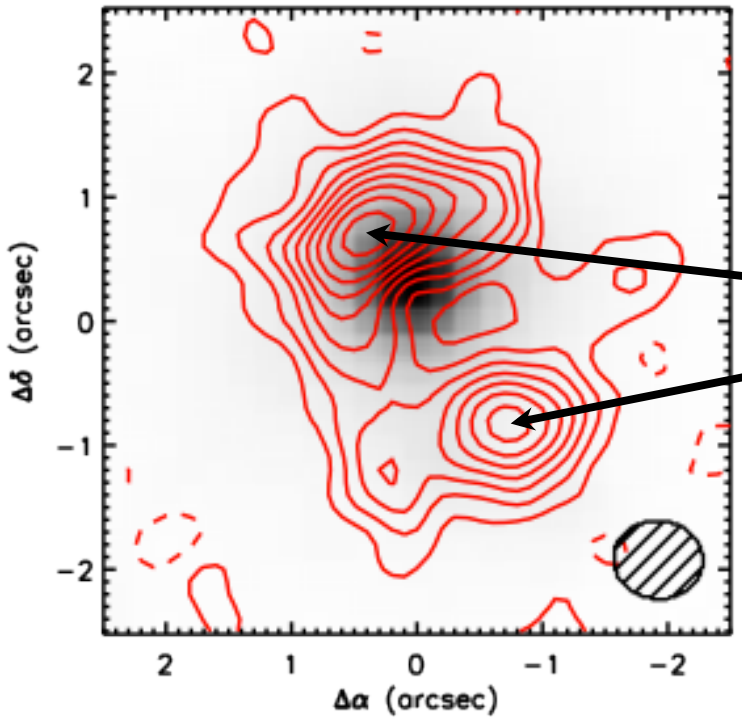
BUSSMAN

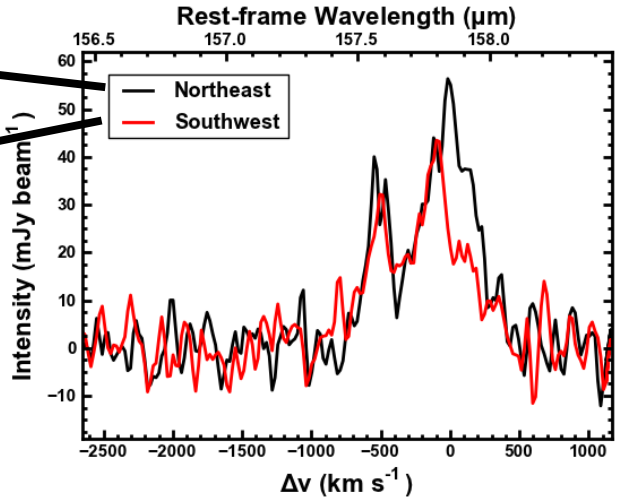
CII IN A SUBMILLIMETER GALAXY AT Z = 5.2

Right: unresolved CII spectrum at 304 GHz
Lower right: compact, extended, very extended
summed to resolve components

SMA – red contours (z = 5.2)
Subaru I band – grayscale (z = 0.6)







RAWLE

PROPOSAL STATISTICS 2011B (16 NOV 2011 – 15 MAY 2012)

The SMA received a total of 102 proposals (SAO and ASIAA: 95, UH: 7) requesting observing time in the 2011B semester. The proposals received by the joint SAO and ASIAA Time Allocation Committee are divided among science categories as follows:

Category	Proposals
low/intermediate mass star formation, cores	27
local galaxies, starbursts, AGN	20
high mass (OB) star formation, cores	11
protoplanetary, transition, debris disks	11
evolved stars, AGB, PPN	8
GRB, SN, high energy	6
submm/hi-z galaxies	6
galactic center	3
solar system	2
other	1

TRACK ALLOCATIONS BY WEATHER REQUIREMENT

PWV[1]	SAO+ASIAA	UH[2]
< 4mm	13A + 41B	10
< 2.5mm	31A + 29B	3
< 1 mm	10A + 9B	8
Total	**54A + 79B**	**21**

(1) Precipitable water vapor required for the observations.
(2) UH does not list As and Bs.

PROPOSAL STATISTICS 2012A (16 MAY 2012 – 15 NOV 2012)

The SMA received a total of 105 proposals (SAO & ASIAA: 99 and UH: 6) requesting observing time in the 2012A semester. The proposals received by the joint SAO and ASIAA Time Allocation Committee are divided among science categories as follows:

Category	Proposals
high mass (OB) star formation, cores	28
low/intermediate mass star formation, cores	17
local galaxies, starbursts, AGN	15
evolved stars, AGB, PPN	8
protoplanetary, transition, debris disks	8
GRB, SN, high energy	6
submm/hi-z galaxies	6
UH	6
galactic center	5
other	3
solar system	3

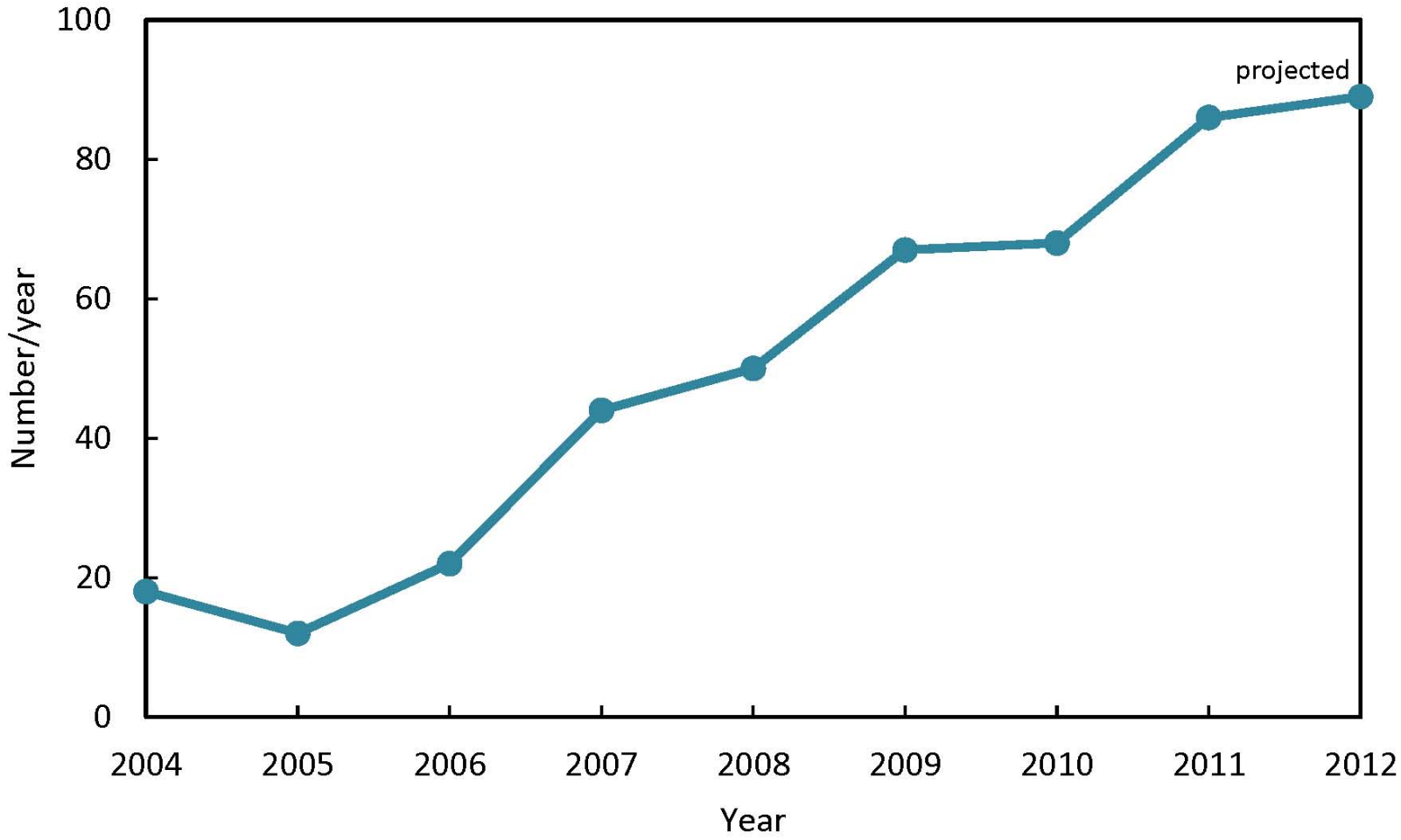
TRACK ALLOCATIONS BY WEATHER REQUIREMENT

PWV[1]	SAO+ASIAA	UH[2]
< 4mm	21A + 39B	8
< 2.5mm	35A + 31B	4
< 1 mm	10A + 3B	5
Total	**66A + 73B**	**17**

(1) Precipitable water vapor required for the observations.
(2) UH does not list As and Bs.

PROPOSAL SUBMISSIONS TO THE SMA REMAIN STEADY DESPITE EARLY SCIENCE WITH ALMA
208 SUBMITTED DURING 2009 – 2010 COMPARED TO 207 FOR 2011 – 2012
ALSO 98 SUBMITTED TO SAO/ASIAA FOR 2012B COMPARED TO 95 FOR 2011B AND 99 FOR 2012A

SMA PUBLICATION HISTORY 2004 - PRESENT



ZHANG

PLANS FOR 2013 AND BEYOND

SAO and ASIAA extended MoU for additional 15 years

Complete correlator upgrade to enable 16 GHz processed bandwidth

Upgrade 0.86 mm receiver bandwidth (good performance in lab)

Develop wider-band phased array processor for VLBI

Link Greenland Telescope to SMA (2017) for VLBI observations of M87