Overview of the Atacama Compact Array, ACA

East Asia ALMA Regional Center,

EA-ARC Manager

Sachiko K. Okumura

Atacama Large Millimeter / submillimeter Array

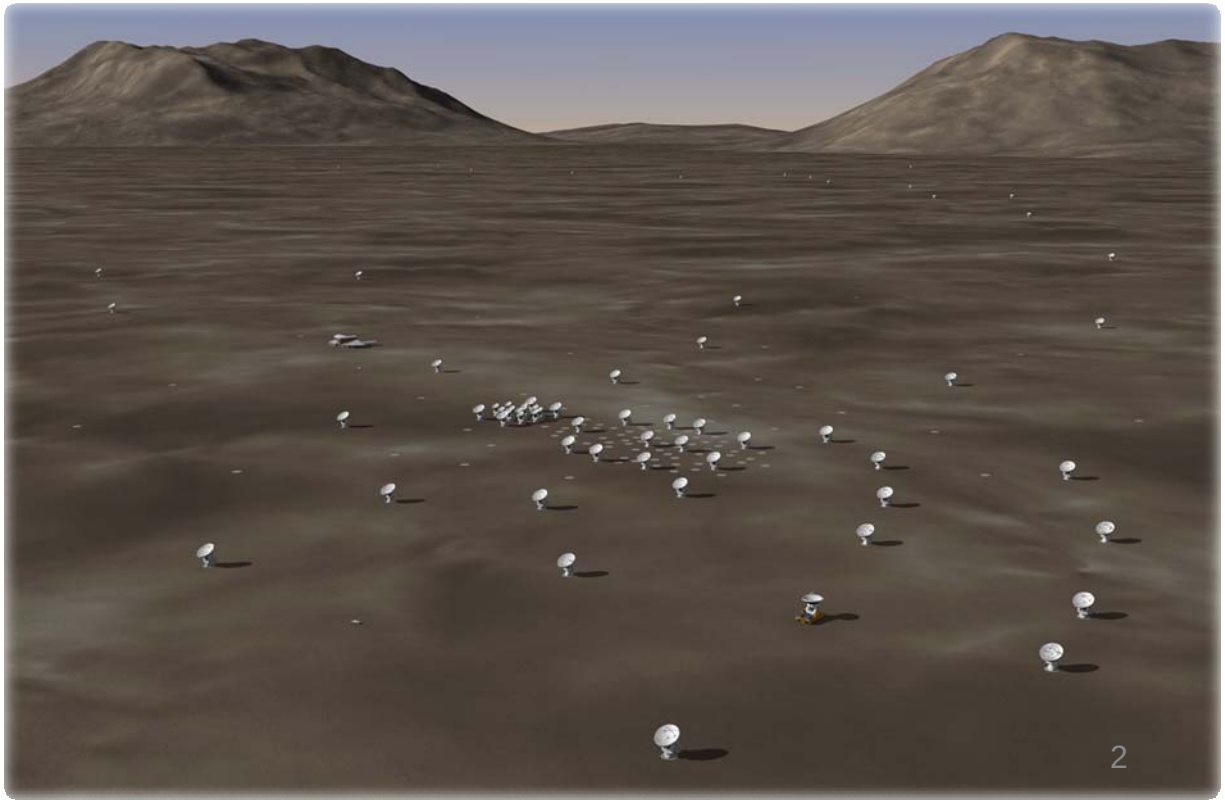
ALMA

Today's Outline

国立天文台 NAOJ National Astronomical Observatory of Japan

- **What is "ACA" ?**
  - Hardware system
  - Role of ACA

- **ACA in Cycle 1**



What is “ACA” ?

- ALMA-Japan (NAOJ) participated in ALMA, and the main contribution to the ALMA construction is **“ACA”;**

  - **Four additional 12-m antennas (total power)**
  - **Twelve 7-m diameter antennas**
  - **Separate ACA correlator**
  - **Receiver: Bands 3, 4, 6, 7, 8, 9,10 (installed for all the ALMA antennas)**

Atacama Compact Array – ACA

Significantly improves low surface brightness sensitivity of ALMA; add precise total power data !

Atacama Large Millimeter / submillimeter Array

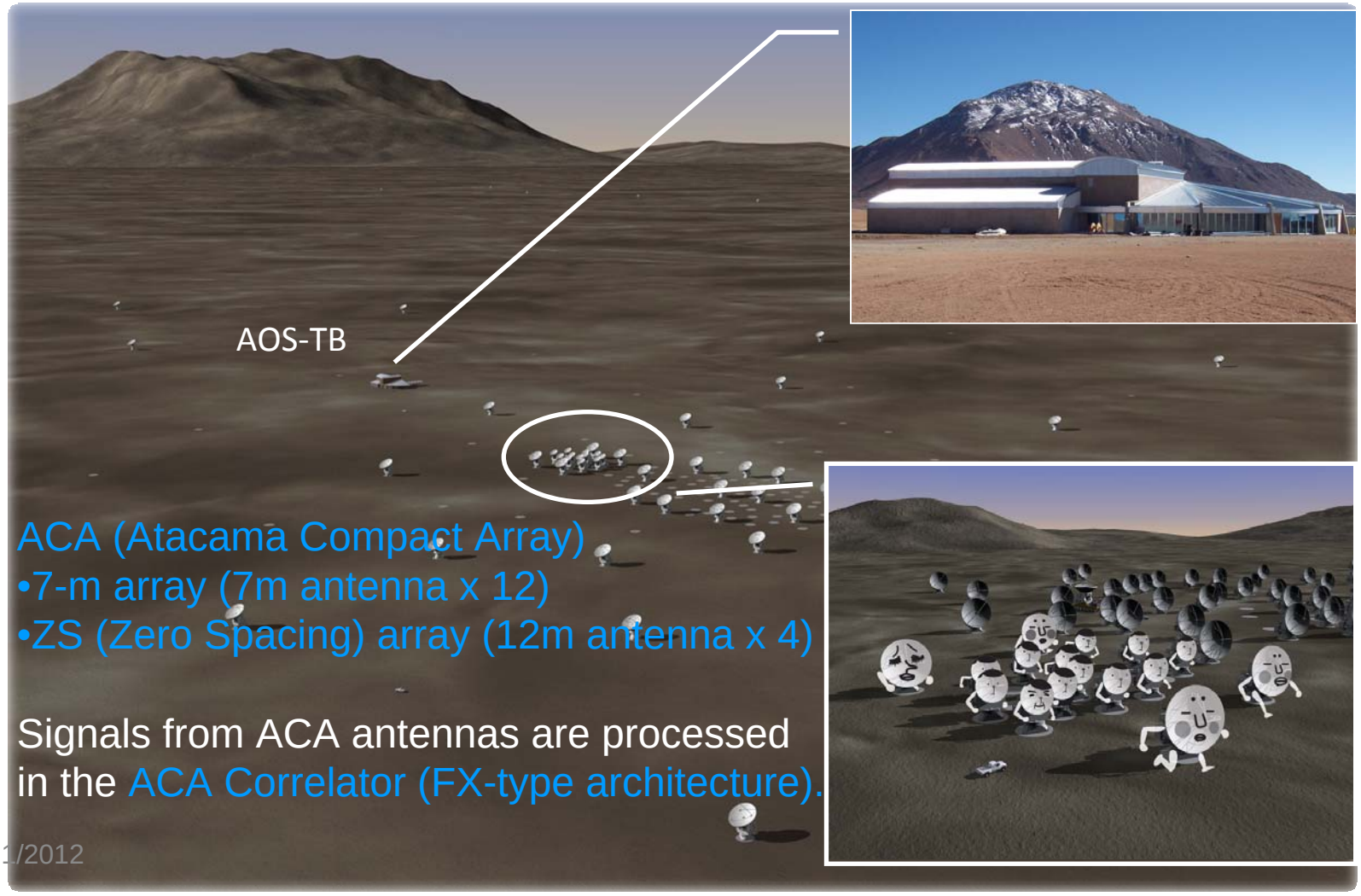
What is “ACA” ?

- Hardware system -

National Astronomical Observatory of Japan

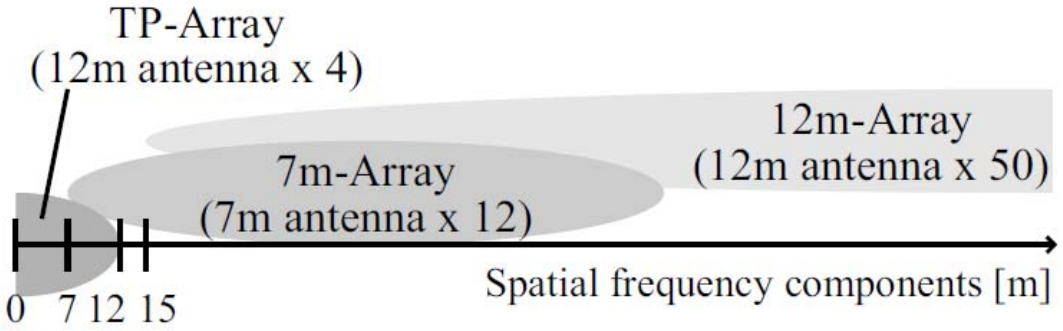

Receiver cartridge

What is “ACA” ?


AOS-TB
ACA (Atacama Compact Array)
•7-m array (7m antenna x 12)
•ZS (Zero Spacing) array (12m antenna x 4)
Signals from ACA antennas are processed in the ACA Correlator (FX-type architecture).

What is “ACA” ?

- Role of ACA -



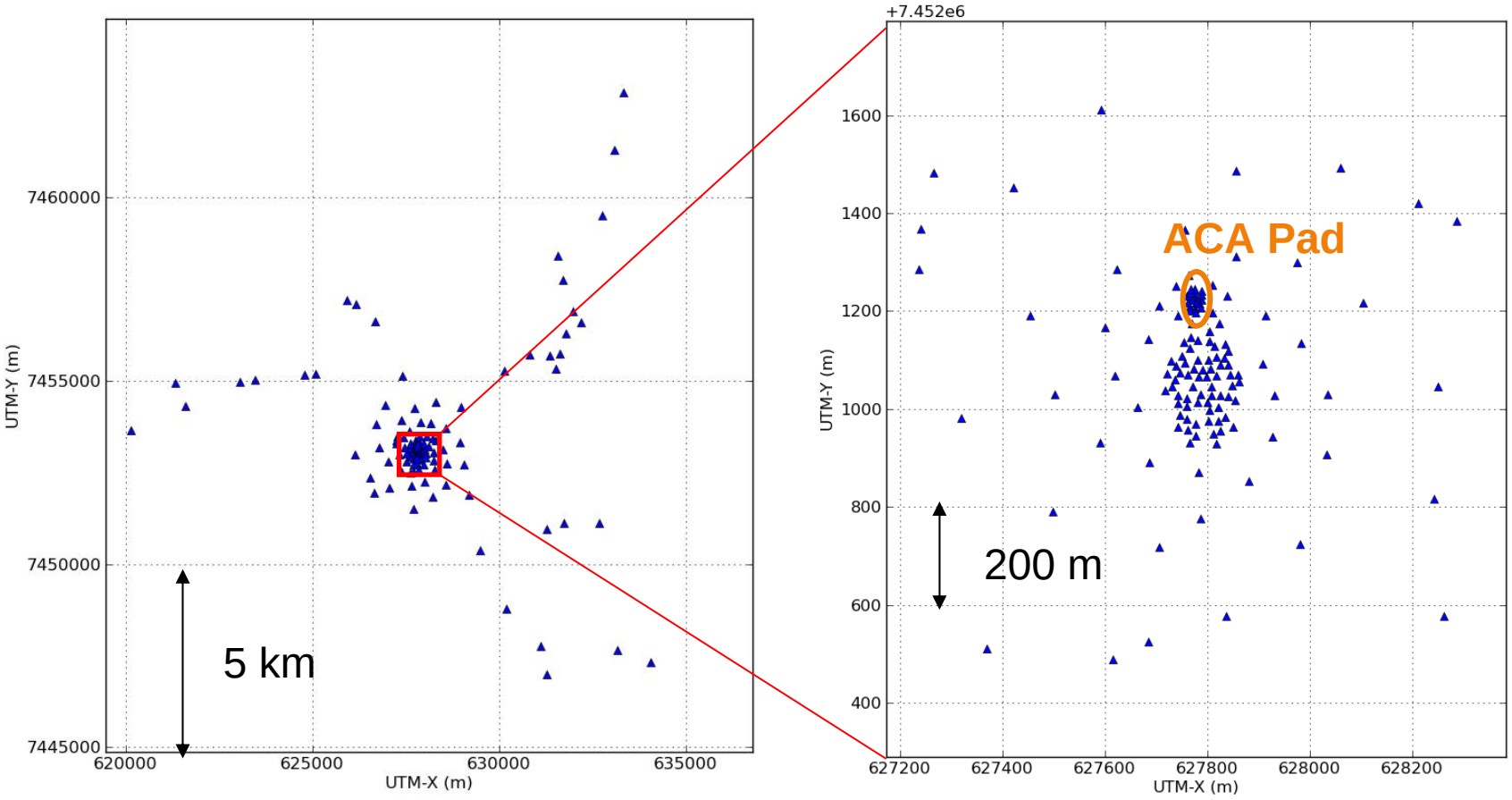
ALMA consists of:

- 12m-Array composed of fifty 12-m antennas
  to obtain spatial frequency components between 15m and the maximum baseline (by interferometer observations)
- and the **Atacama Compact Array (ACA)**
  to obtain short spatial components including zero-baseline length (in interferometer and single-dish observations)

The obtained the data by the three arrays are combined to construct high fidelity images of the target objects.

What is “ACA” ?

- Role of ACA -



12-m array, ACA Pad position

What is “ACA” ?

- Role of ACA -

Configuration of ACA

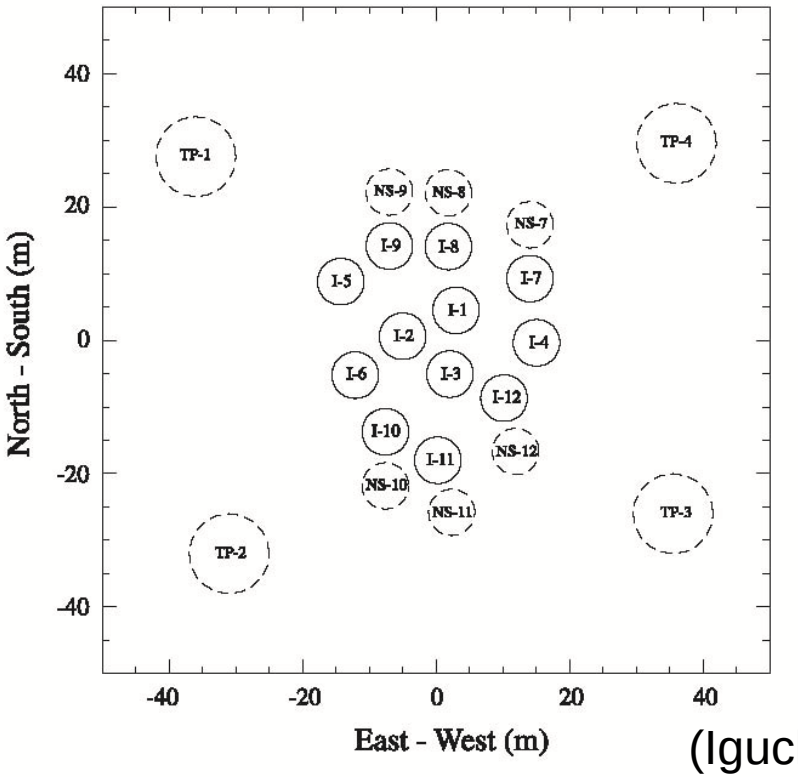
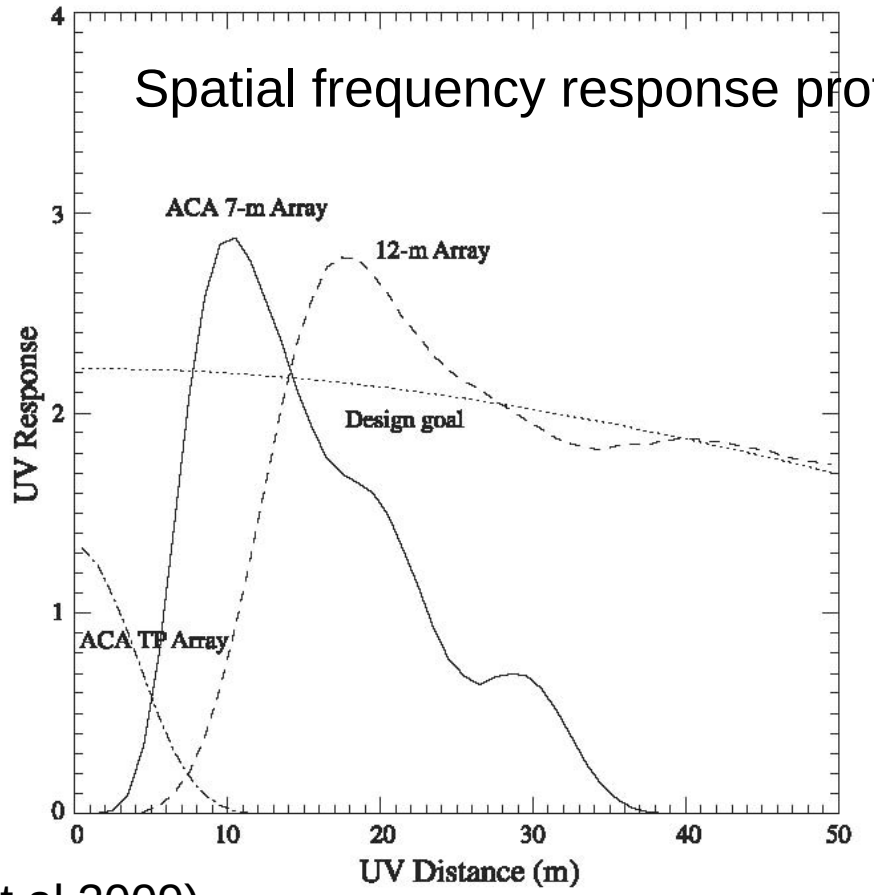


Fig. 2. Configuration of ACA: the Inner Array (solid line), the NS Array (dashed line), and TP Array (dashed line). Antenna pad positions are listed in table 1. The circles are proportional to the sizes of the antennas.

Spatial frequency response profiles

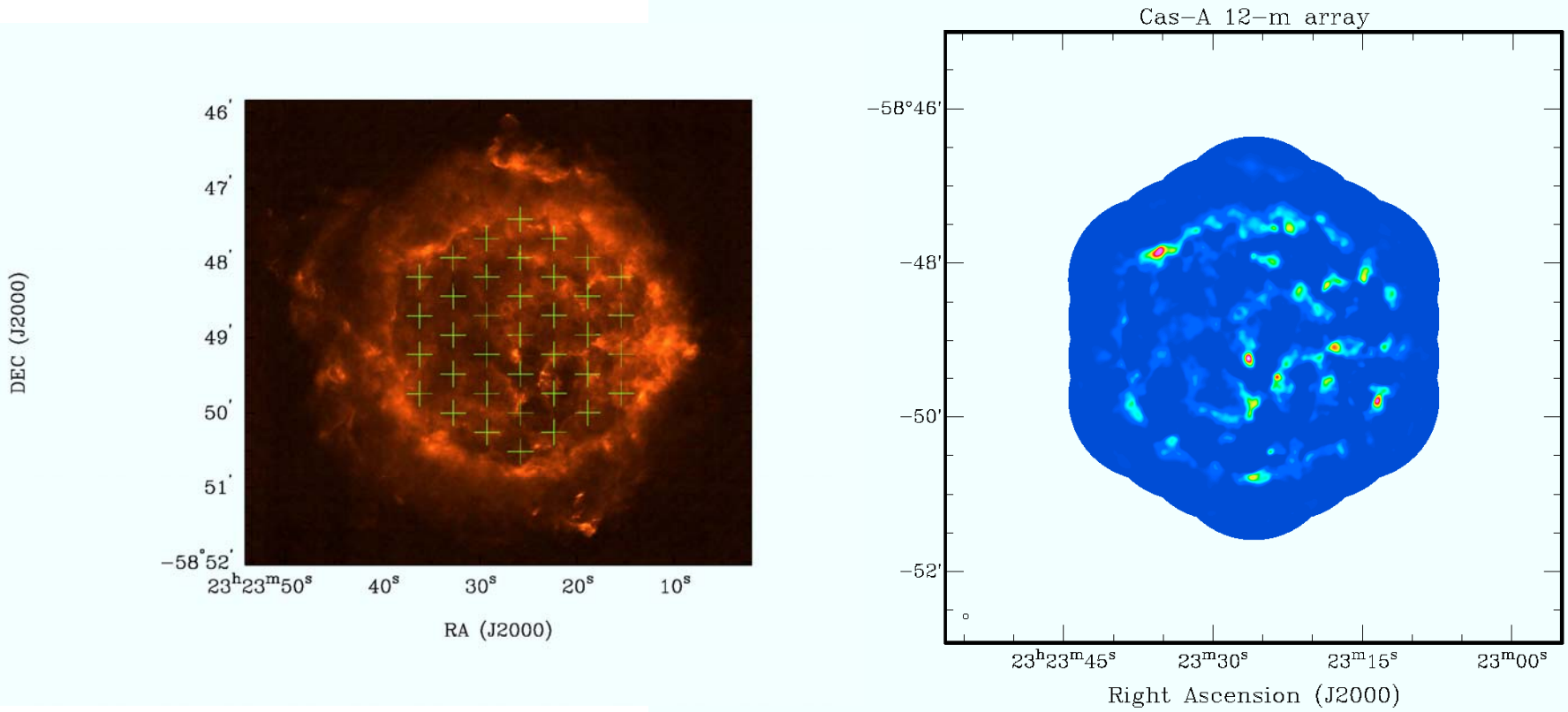


(Iguchi et al 2009)

Fig. 3. The *uv* response profiles of a best fit Gaussian as a design goal (dotted line) and the most compact configuration of the 12 m Array (dashed line), the 7 m Array (solid line) and TP Array (dash-dotted line). ACA was added into figure 1.

What is “ACA” ?

- Role of ACA (image simulation) -



12-m array simulation by Yasutake Kurono (50 antennas, the most compact configuration; HA=+- 0.5 h)

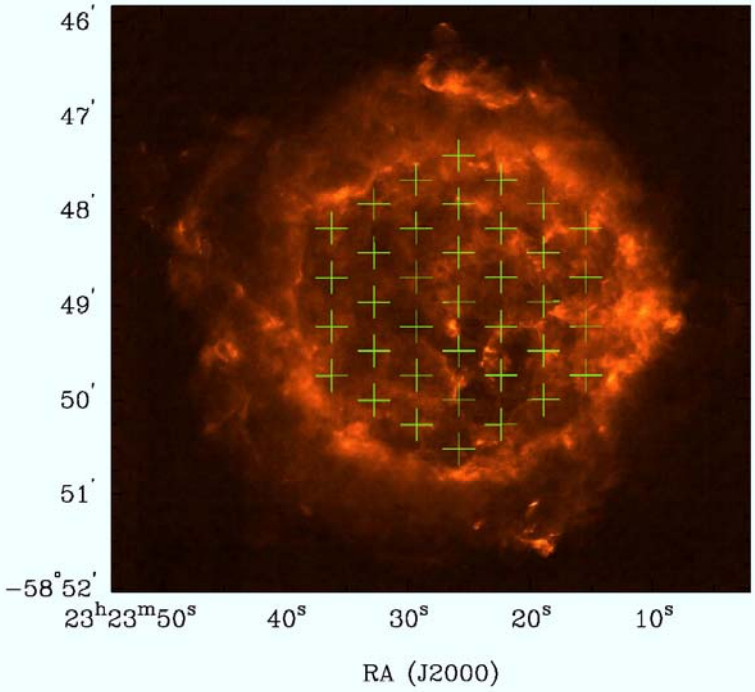
- *Cassiopeia A*
- *Field of View of ALMA 12-m antenna :62’’ (@ 100 GHz)*
- *Mosaic observations :37 (hexagonal grid) pointings*

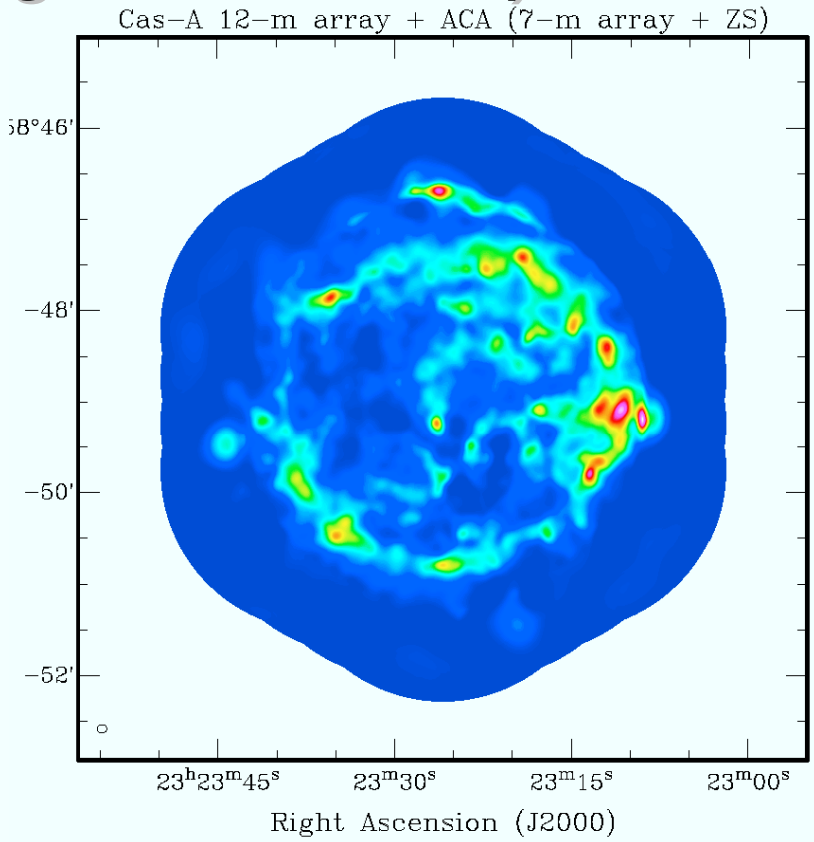
Atacama Large Millimeter / submillimeter Array

What is “ACA” ?

National Astronomical Observatory of Japan

- Role of ACA (image simulation) -



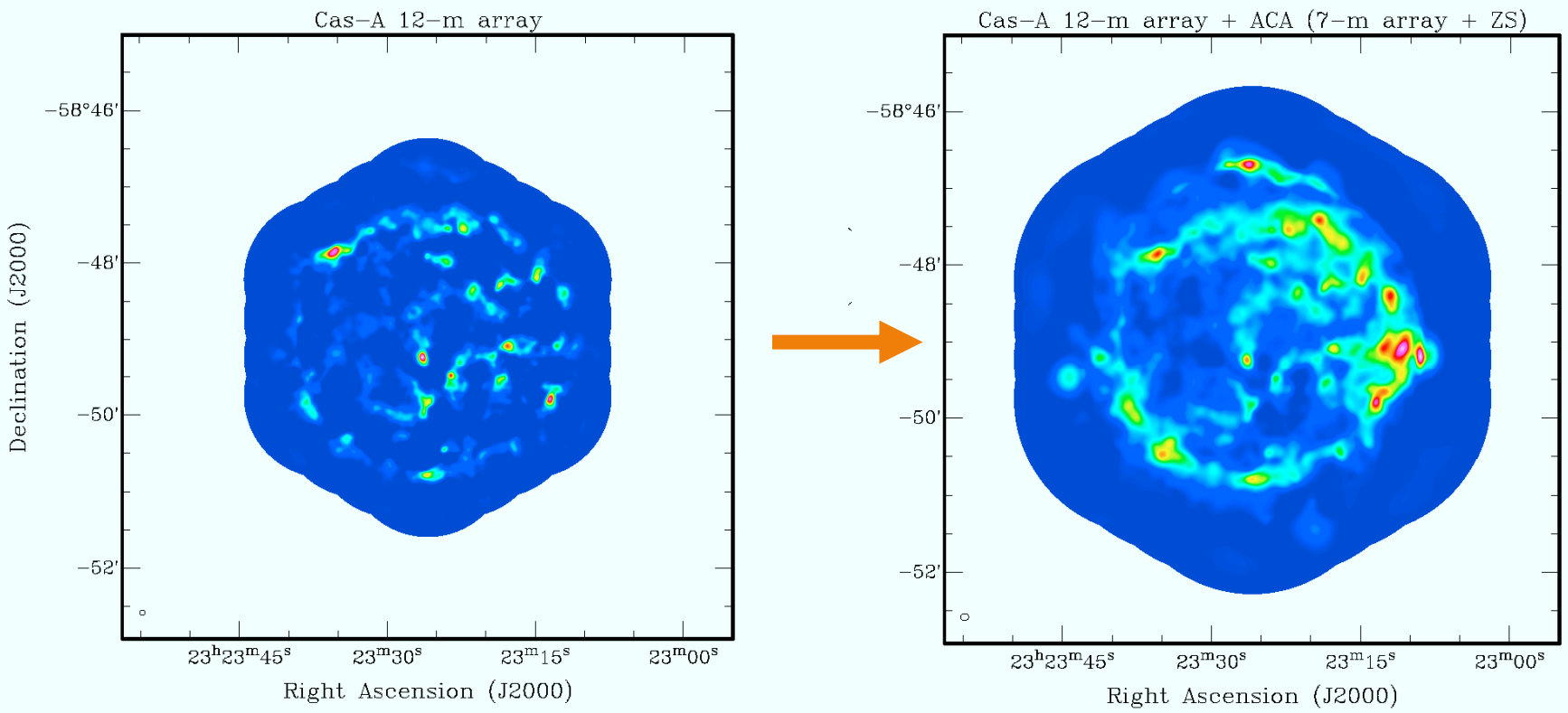


12-m array (50 antennas, most compact configuration)

+ ACA simulation by Yasutake Kurono (7-m + Zero Spacing; HA=+- 1.5 h)

What is “ACA” ?

- Role of ACA (image simulation) -

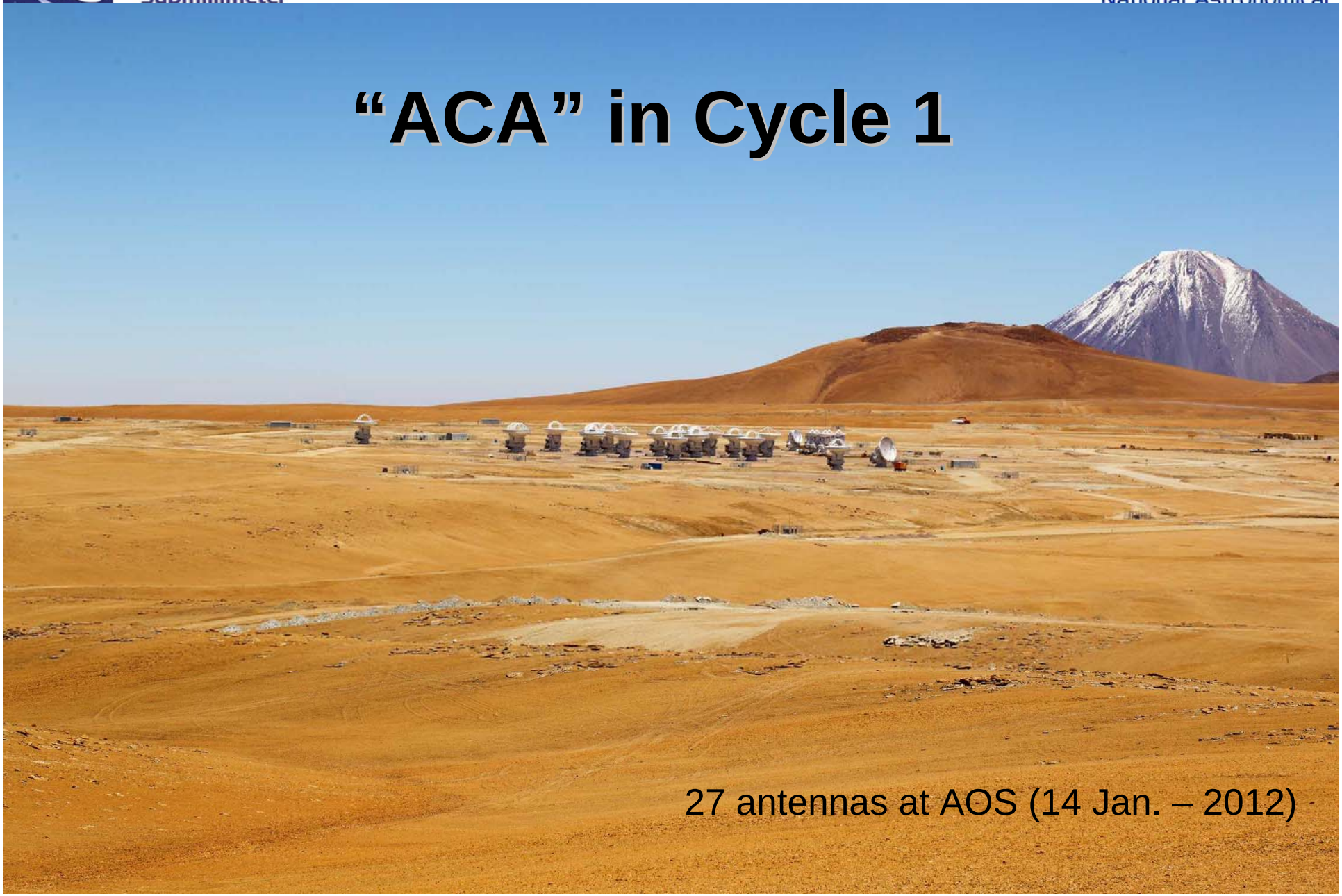


ACA significantly improves low surface brightness image and construct high fidelity images of the target objects ！

Atacama Large Millimeter / submillimeter

国立天文台 NAOJ National Astronomical

“ACA” in Cycle 1



27 antennas at AOS (14 Jan. – 2012)

Atacama Large Millimeter / submillimeter Array

“ACA” in Cycle 1

National Astronomical Observatory of Japan

- ***Draft Capability of ACA***

Number of antennas:

– ZS antenna x **2 (maximum)**

– 7-m antenna x **(6=>) *9***

Array combination, observing mode:

– 12-m array only

– 12-m array + 7-m array

– 12-m array + full ACA (7-m + ZS array)

– **“Coordinated observations” : 12-m array observations and ACA ones are scheduled separately.**

– **No “Stand-Alone” mode, no heterogeneous array (“Combined”) mode**

Operation:

– Observations with each array (12-m, 7-m and ZP Arrays) will be performed with independent observations.

"ACA" in Cycle 1

- ***Draft Capability of ACA (continue)***

7-m array observations:

– ***One configuration***

– Single-field or mosaic interferometer observation

– WVR calibration is not available

ZS array (single-dish) observation:

– Raster OTF (On-the-Fly) mapping, only for spectral line obs., not continuum obs.

Observing time :

– ***Use FIXED ratio of observing time between 12-m array and ACA***

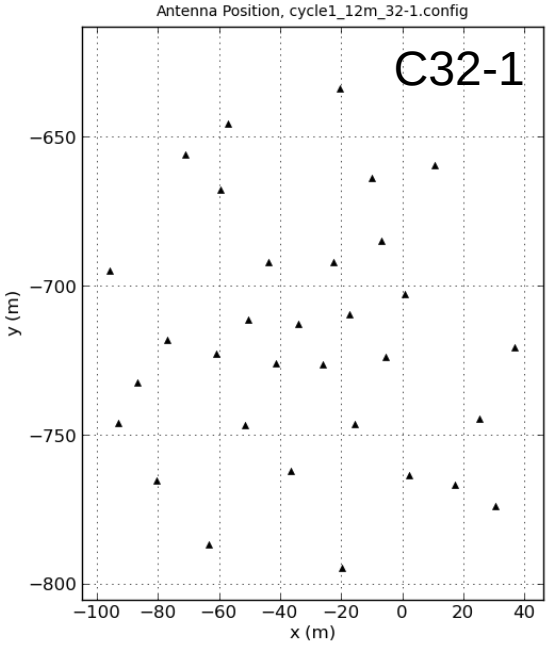
→ We aim to minimize the amount of variables needed as inputs from proposers in Cycle 1. A single science goal (SG) will be entered for the 12-m array, and once ACA is required, the ACA inputs will be automatically determined as much as possible. (On-going activity)

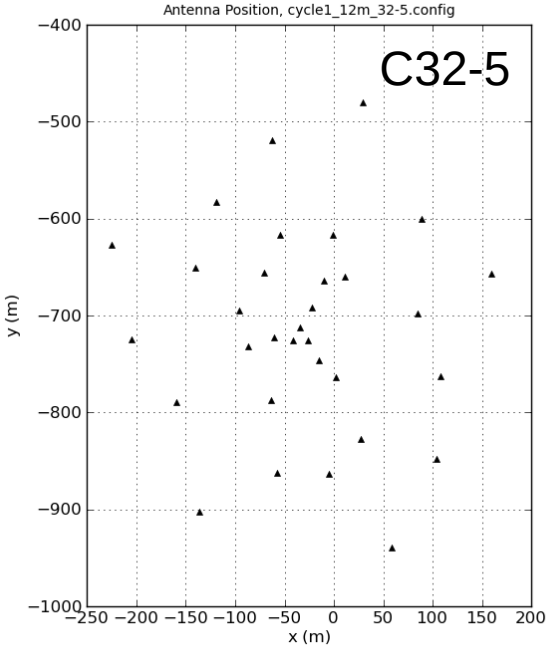
“ACA” in Cycle 1

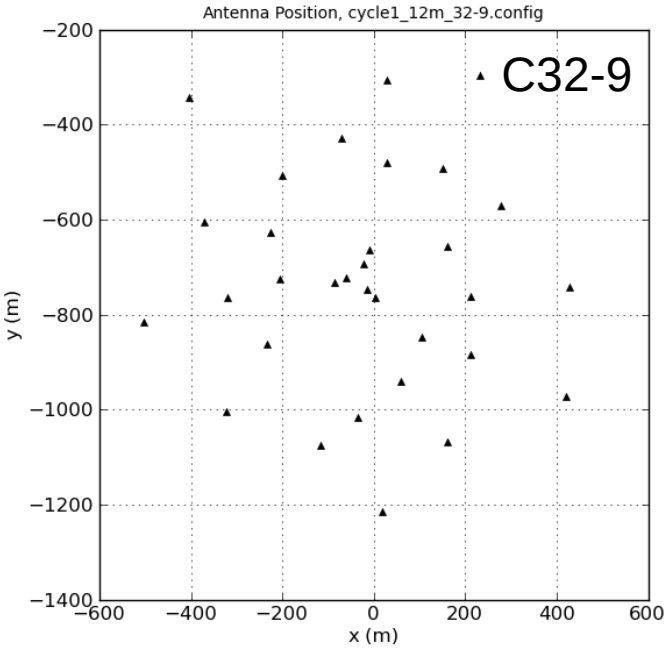
- Array Config. in Cycle-1 (12-m array) -

- **Array configuration for 12-m array**

Config. ID	C32-1	C32-2	C32-3	C32-4	C32-5	C32-6	C32-7	C32-8	C32-9
Min. base (m)	13.4	13.4	13.5	13.5	13.5	23.0	23.0	23.0	23.0
Max. base (m)	160.7	229.7	312.7	368.6	460.0	555.6	649.6	809.8	1039.4



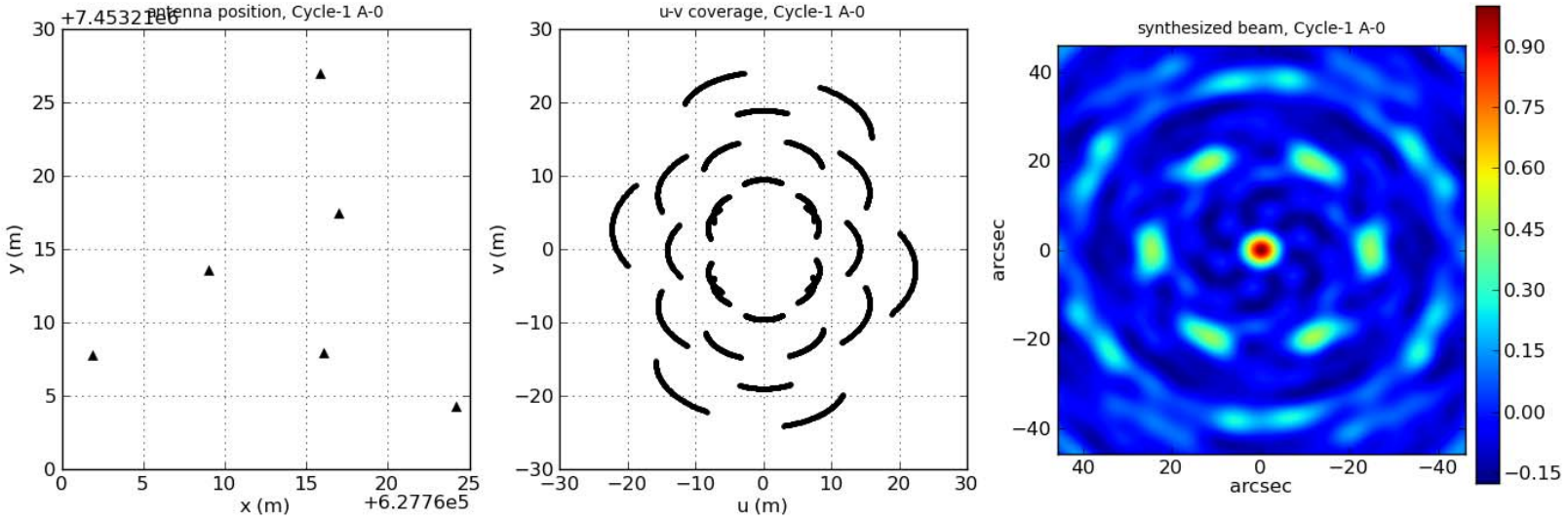




"ACA" in Cycle 1

- Array Config. in Cycle-1 (7-m array) -

- Array configuration for ACA 7-m array ***(sorry, 6 antenns!)*** and synthesized beam performance



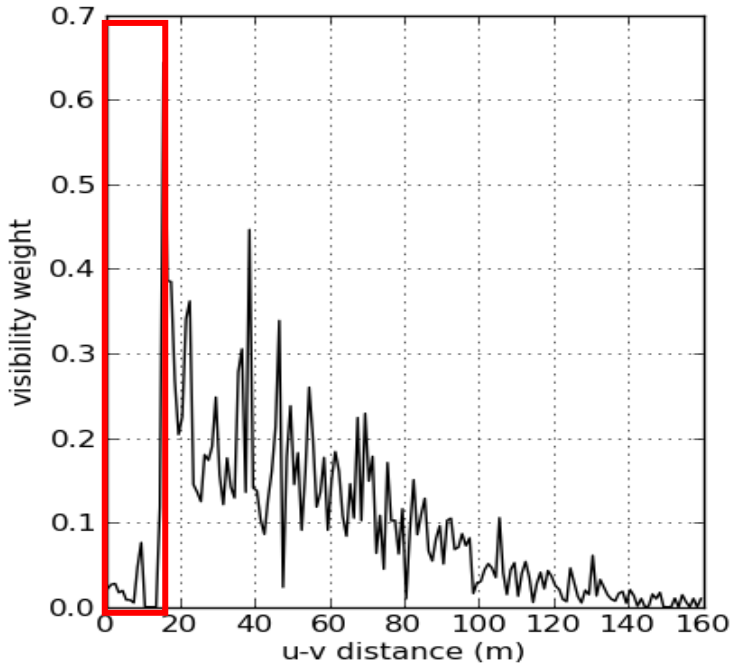
Now we are preparing 9-antenna configulation!

"ACA" in Cycle 1

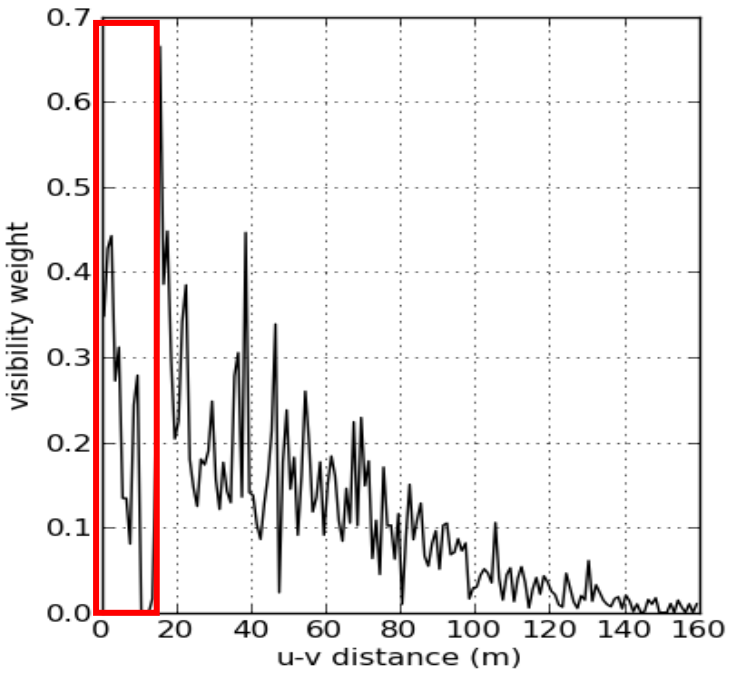
- Observing Time Ratio -

- Observing time ratio and imaging performance

12-m array : ACA = 1 : 1



12-m array : ACA = 1 : 4



12-m array : 32-1

ACA 7-m array : A-0 (6 antennas !)

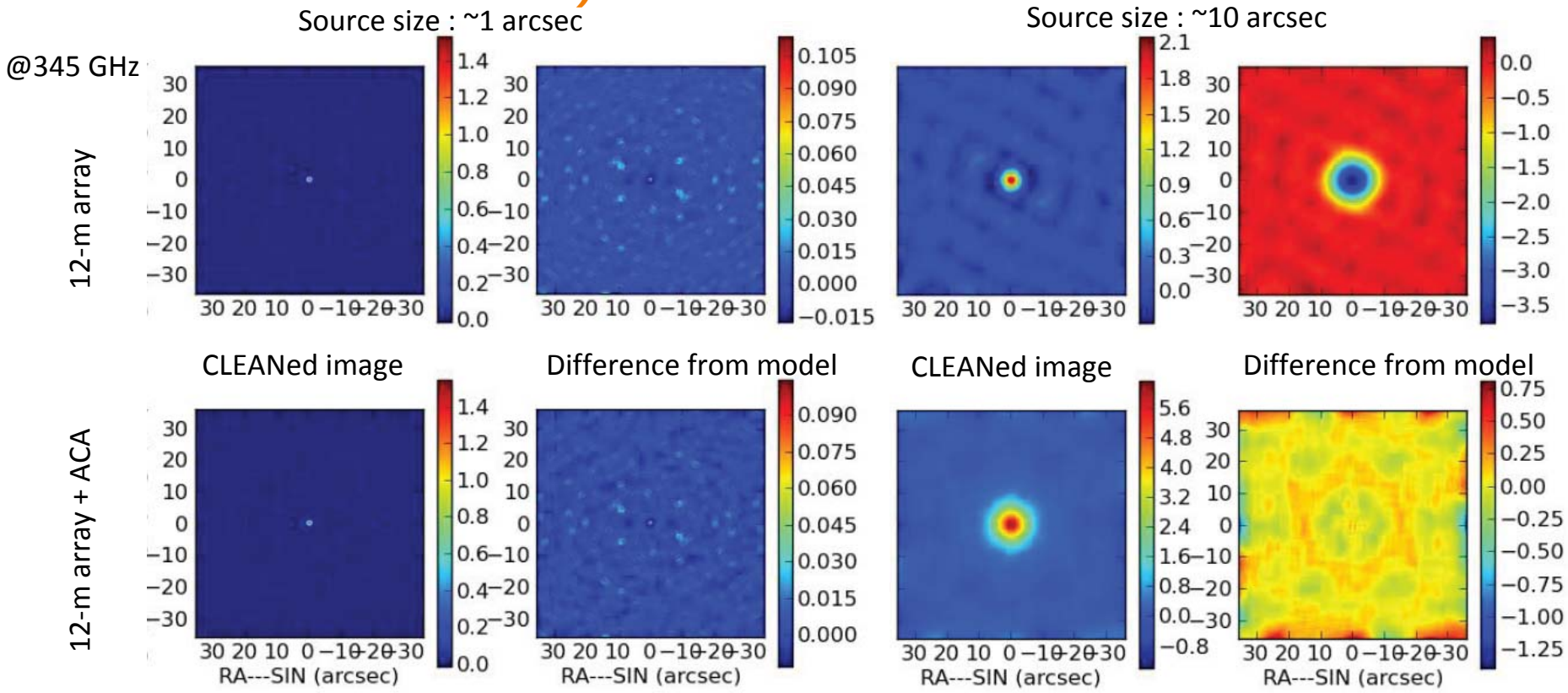
X=u-v distance, Y=visibility weight

1:N; N >=2 (on-going discussion)

"ACA" in Cycle 1

- "Use ACA or not ?" -

Angular Size of the object and Flux recovery/CLEANed image (Simulation *with 6 7-m antennas !)*



12-m array : 32-1

ACA 7-m array : A-0 (6 antennas !)

Atacama Large Millimeter / submillimeter Array

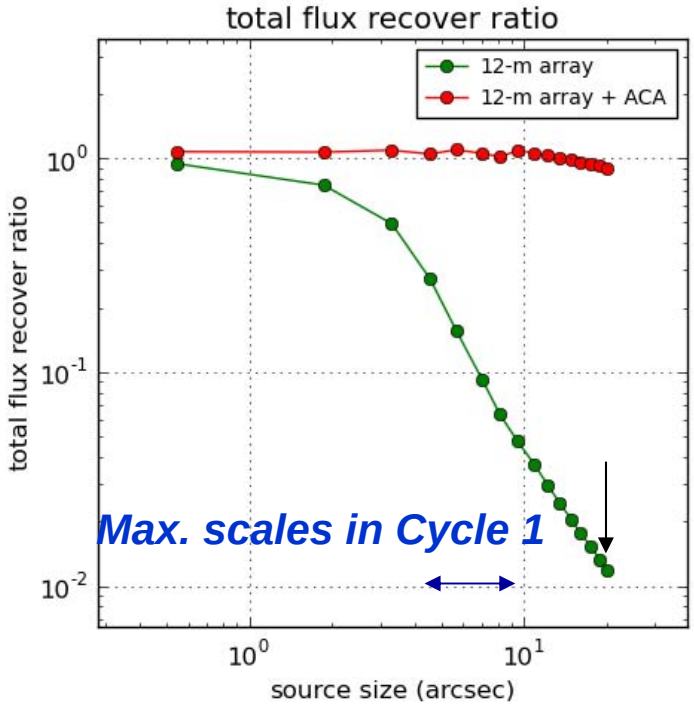
"ACA" in Cycle 1

- "Use ACA or not ?" -

国立天文台 NAOJ National Astronomical Observatory of Japan

Angular Size of the object and Flux recovery ratio (by Yasutake Kurono)

@345 GHz



12-m array : 32-1

ACA 7-m array : A-0 (6 antennas !)

Draft plan of OT function to use ACA in Cycle 1:

- ***Key parameter is "Largest Angular Size" .***
- ***For example, proposers***
  - ***1) Input necessary "Angular resolution" first.***

  => determine the 12-m array config.
  - ***2) Input "Largest Angular Size (LAS)" .***

  => If LAS > Max. scale of the requested 12-m array config., then ACA required !

"ACA" in Cycle 1

- Data combine -

- ***Capabilities on the data combine with single-dish and interferometer observations will be limited – e.g. "feathering".*** *No commitment to joint de-convolution.*
  - **Feathering**
    - Installed in CASA.
  - **CLEAN with initial model**
    - Installed in CASA. *(But there has not been actual results…)*
  - *Joint de-convolution*
    - Not yet installed in CASA. (Some experiances in PdBI and NMA.)
  - Pseudo visibility method
    - Not yet installed in CASA.

Summary

- **What is “ACA” ?**

The ACA System is composed of **twelve 7-m antennas for interferometry (7-m array) and four 12-m antennas for zero spacing observations (ZS array).** The short-spacing of the 7-m array samples is the intermediate range from 6m to 15 m, while the zero-spacing of the ZS array is the range from 0m to 12m. The extended 12-m array have almost no sensitivity for the above spacing ranges.

The ACA improves low surface brightness sensitivity of ALMA significantly and to add precise total power data.

Summary

- ***ACA capabilities in Cycle 1 (draft)***

Especially for Cycle 1, the ACA system (7-m array and ZS array) has not been completed and we expect the limited image performance with ACA in Cycle 1 compared to that in full operation. ***Thus we minimize the amount of variables needed as inputs from proposers in Cycle 1.*** Nevertheless, we think that the use of ACA is benefit for proposers to observe more extended sources in Cycle 1.

We, ALMA operation group and ARCs, are now revising user-friendly documents (Proposers Guide, Technical Hand Book and Primer) including examples of ACA science cases.

They will be available on CfP (May 2012) from ALMA Science Portal site.

www.almaobservatory.org

The Atacama Large Millimeter/submillimeter Array (ALMA), an international astronomy facility, is a partnership among Europe, North America and East Asia in cooperation with the Republic of Chile. ALMA is funded in Europe by the European Organization for Astronomical Research in the Southern Hemisphere (ESO), in North America by the U.S. National Science Foundation (NSF) in cooperation with the National Research Council of Canada (NRC) and the National Science Council of Taiwan (NSC) and in Japan by the National Institutes of Natural Sciences (NINS) in cooperation with the Academia Sinica (AS) in Taiwan. ALMA construction and operations are led on behalf of Europe by ESO, on behalf of North America by the National Radio Astronomy Observatory (NRAO), which is managed by Associated Universities, Inc. (AUI) and on behalf of East Asia by the National Astronomical Observatory of Japan (NAOJ). The Joint ALMA Observatory (JAO) provides the unified leadership and management of the construction, commissioning and operation of ALMA.