

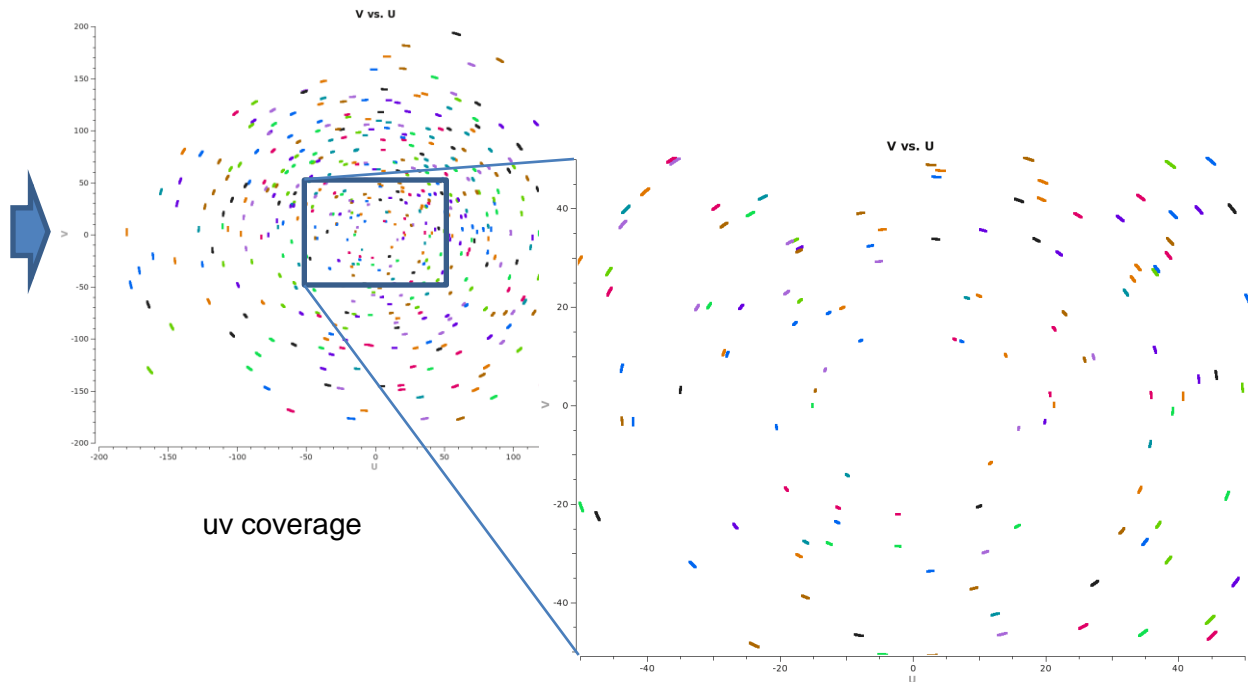
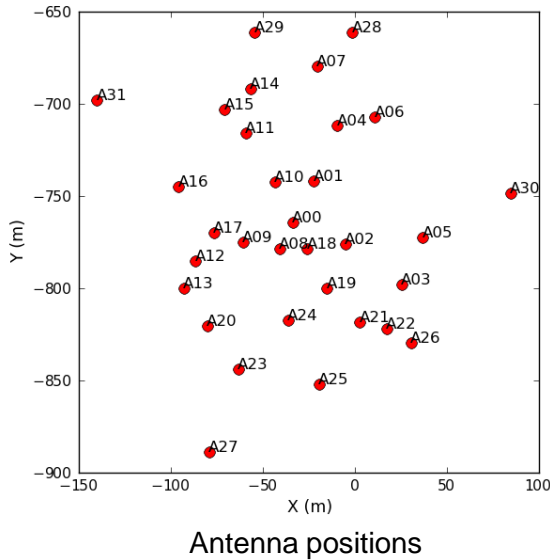
# Single Dish observations with ALMA

(Thomas Stanke, EU ARC, Garching)

# ... Why?

An interferometer does not record an image of the sky, but samples visibilities over a set of baselines defined by the antenna positions.

The largest angular scales on which emission can be recovered are given by the shortest baselines (i.e.,  $\geq$  antenna diameter).



## ... Why?

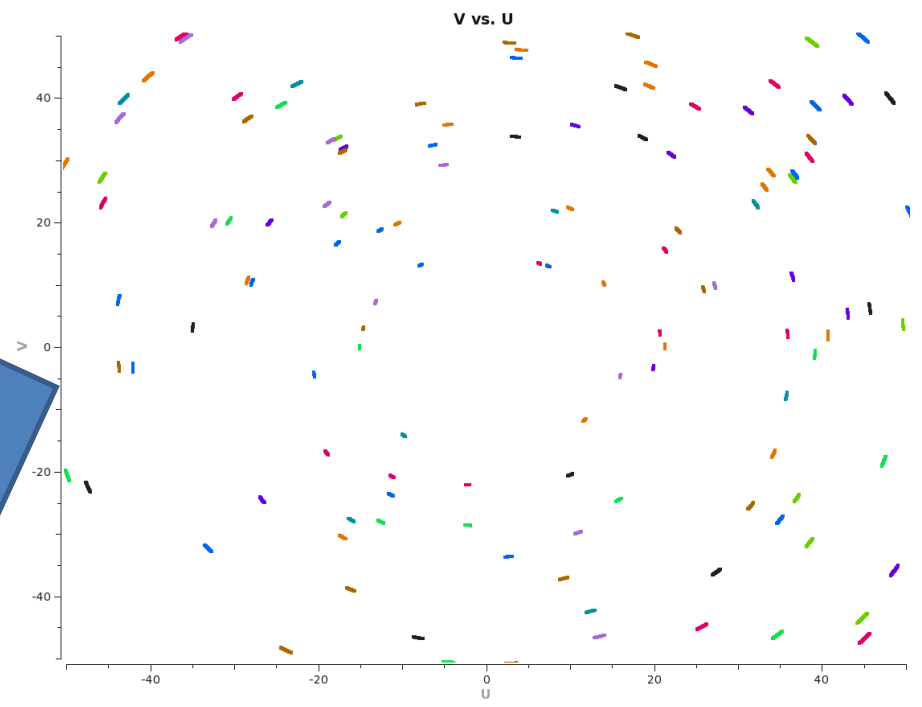
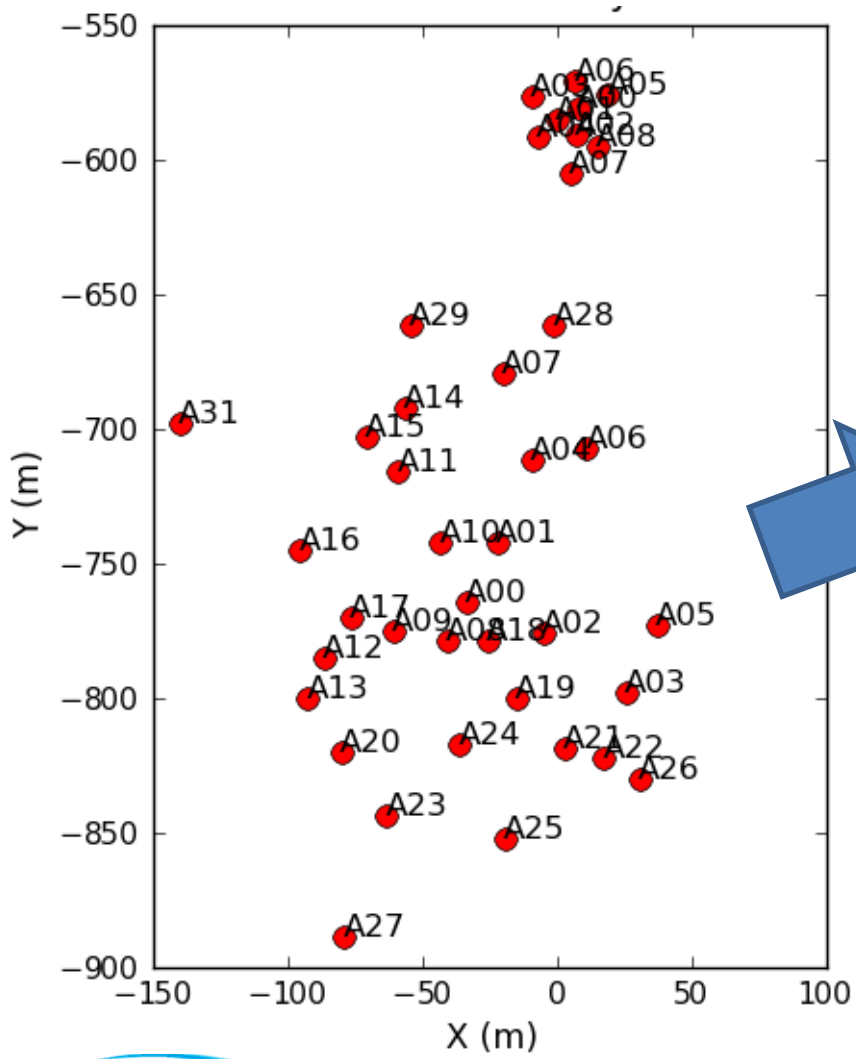
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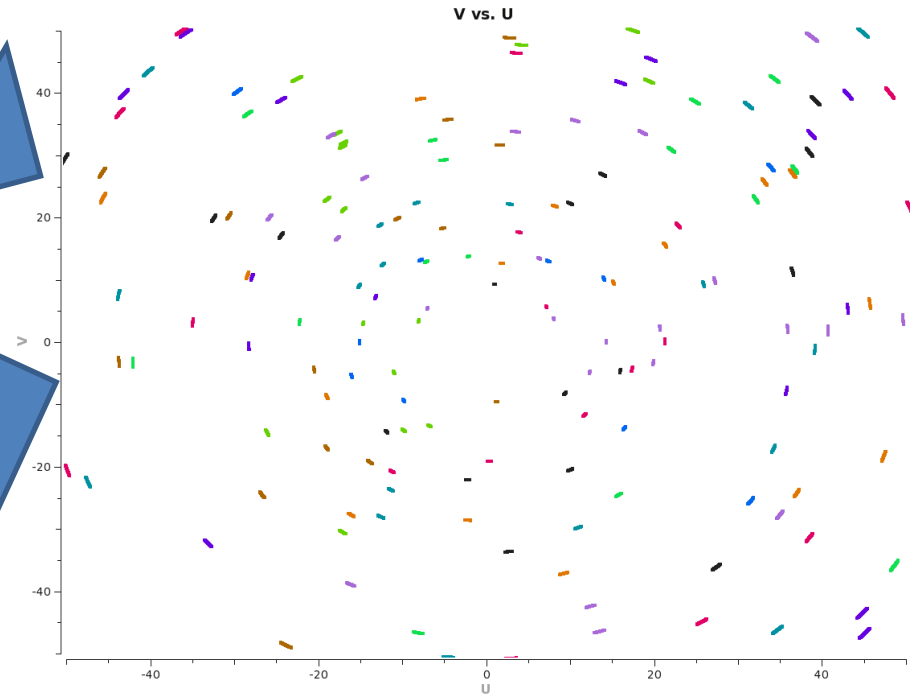
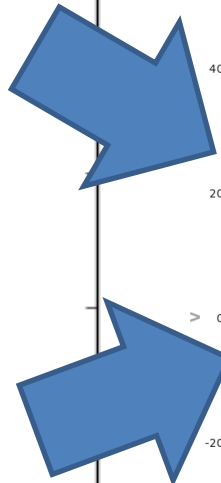
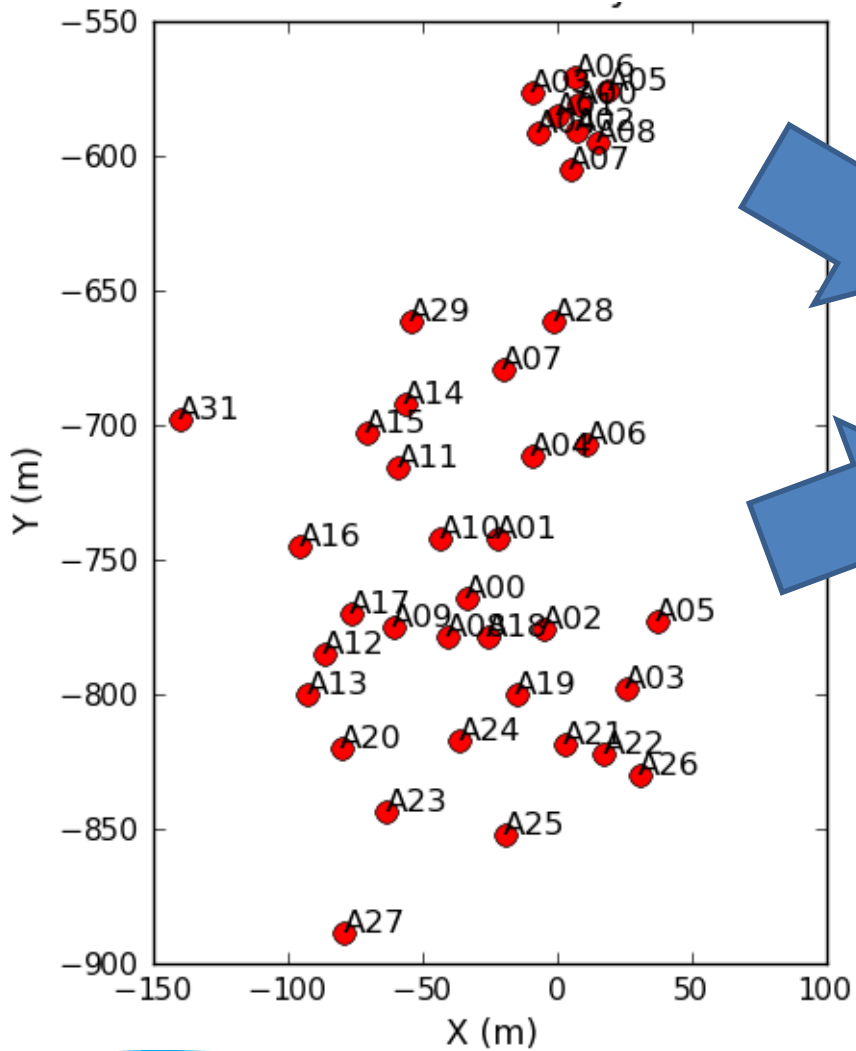
To recover emission on all angular scales, visibilities corresponding to shorter baselines have to be provided:

- Interferometric data on shorter baselines (i.e., using smaller antennas)

... Why?



... Why?



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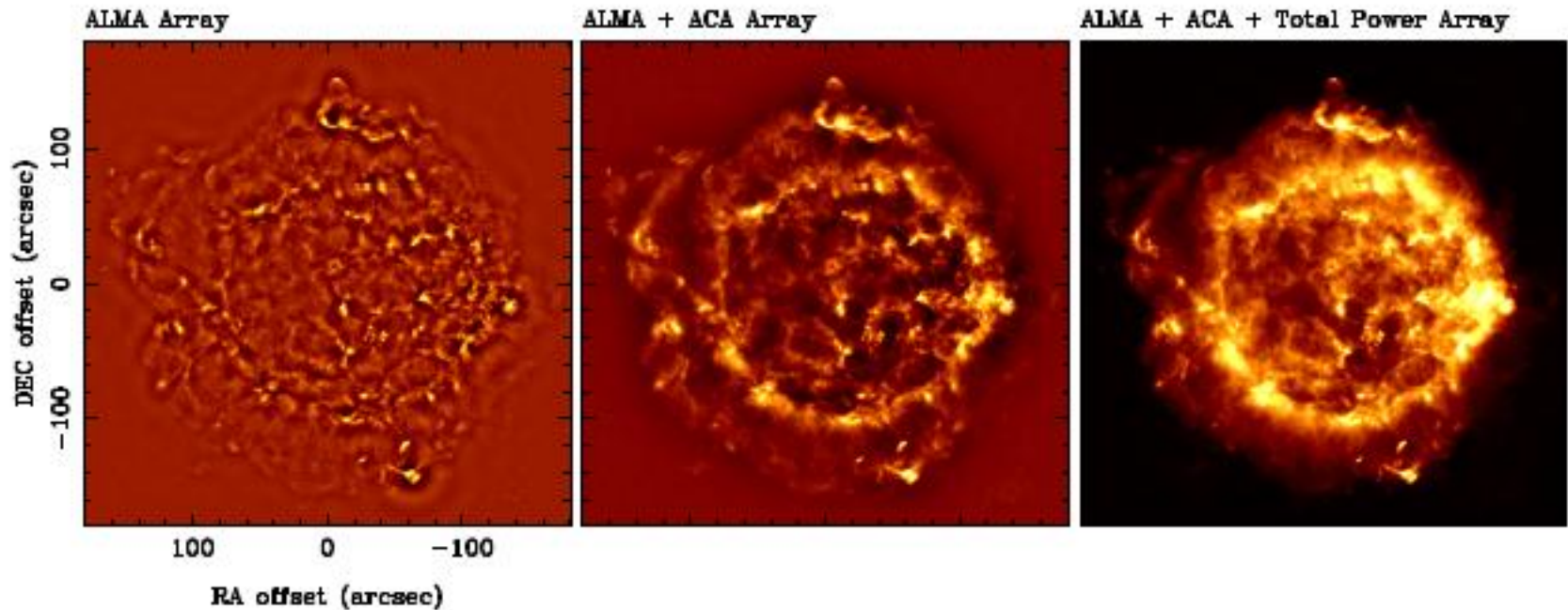
The largest angular scales on which emission can be recovered are given by the shortest baselines (i.e.,  $\geq$  antenna diameter).

To recover emission on all angular scales, visibilities corresponding to shorter baselines have to be provided:

- Interferometric data on shorter baselines (i.e., using smaller antennas)
- Single dish data ( $D \geq d_{\min}$ )

... Why?

An interferometer does not record an image of the sky, but samples visibilities over a set of baselines defined by the antenna positions.



simple simulation of ALMA observation by Y.Kurono

# Short spacings for ALMA main array data, Cycle-2

The ALMA Compact Array – ACA:

7m array:

≥ nine 7m antennas, operated as interferometer, baselines 9 to 30m  
(main array: baselines > 18m)

Bands 3-9, spectral line and continuum observations

Total power (TP) array:

≥ two 12m antennas, operated as Single Dish telescopes

Bands 3-8

Spectral line observations only



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# Short spacings for ALMA main array data, Cycle-2: ... do I need any?

Interferometer sensitive only for angular scales smaller than a 'Maximum Recoverable Scale', which is given by the shortest baselines (and the observing frequency):

$$\Theta_{\text{MRS}} \sim 0.6\lambda/L_{\text{min}} \text{ [radians]} \sim 37100/L_{\text{min}} \nu \text{ [arcsec]}$$

(... but this is not a 'hard' limit...)

1. What angular resolution do I need? -> main array configuration
2. Up to which scale do I need to recover emission?
  - main array configuration might be sufficient
  - a more compact main array configuration might have to be added
  - ACA 7m interferometric data might have to be added
  - ACA TP might have to be added

# Short spacings for ALMA main array data, Cycle-2: ... do I need any?

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Frequency (GHz)	Max Rec Scale, Without ACA (arcsec)	Max Rec Scale ACA 7m array (arcsec)
100	25	42
150	17	28
230	11	18
345	7.2	12
460	5.4	9.1
650	3.8	6.4

Short spacings for ALMA main array data, Cycle-2:  
... do I need any?  
if yes, how does it affect the total time needed?

What rms is needed in the final data? ->

integration time on main array (most extended configuration needed)

$t_{\text{int, MA}}$

- a more compact main array configuration is needed: -> add 50%
- ACA 7m interferometric data are needed -> add 200%
- ACA TP data are needed -> add another 200%

# Short spacings for ALMA main array data, Cycle-2:

Project - Observing Tool for ALMA, version Cycle2(u1)

File Edit View Tool Search Help Perspective 1

Project Structure: Unsubmitted Proposal, Project, Proposal, Planned Observing, ScienceGoal (Science Goal), General

Editors: Spectral, Spatial, Control and Performance

	Most extended 12m configuration	Most compact 12m configuration
Longest baseline ( $L_{max}$ )	1.508 km	0.166 km
Synthesized beamsize ( $\lambda/L_{max}$ )	0.117 arcsec	1.065 arcsec
Shortest baseline ( $L_{min}$ )	0.041 km	0.014 km
Coverable scale ( $0.6\lambda/L_{min}$ )	2.607 arcsec	7.460 arcsec

Performance:

Angular Resolution: 0.30000 arcsec

Angular Structure in source:  Point Source  Extended Source 5.00000 arcsec

Sensitivity per pointing: 0.50000 mJy equivalent to 0.05529 K

Bandwidth used for Sensitivity: AggregateBandWidth Frequency Width 7.500000 GHz

Request complementary ACA Observations?  Yes  No

Goal integration time estimate

Time required due to u,v coverage issues? (must be justified)  Yes  No

Observations time-constrained?  Yes  No

Validation History Log

Description	Suggestion

**ALMA OT - Information**

**Estimated time**

Requested sensitivity	0.5000 mJy
Bandwidth used for sensitivity	7.500 GHz
Representative frequency (sky, first source)	350.50 GHz
Precipitable water vapour (all sources)	0.658mm (2nd Octile)
<b>ALMA 12m Array - 34 antennas</b>	
Time on source per pointing (first source)	2.00 min
Total number of pointings (all sources)	1
Estimated number of tunings required	1
Total time on source	2.00 min
Total time on calibrators	16.15 min
Total overheads	12.57 min
Total 12m array time (inc. calibration & overheads)	30.72 min
<b>Calibration Breakdown</b>	
1 x SidebandRatio	1.68 min
3 x Pointing	54.00 s
1 x Amplitude (inc. AtmosphericCal)	3.27 min
1 x Bandpass (inc. AtmosphericCal)	5.77 min
1 x Phase (inc. AtmosphericCal)	2.27 min
1 x Delay	1.60 min
1 x Atmospheric	40.00 s
Additional calibration overheads	7.47 min
<b>Additional 12M Array Configurations</b>	
No of 12M Array Configurations	2
Additional overhead for extra configurations	15.36 min
<b>Estimated total time for science goal</b>	<b>46.07 min</b>

# Short spacings for ALMA main array data, Cycle-2:

Project - Observing Tool for ALMA, version Cycle2(u1)

File Edit View Tool Search Help Perspective 1

Project Structure Editors

ALMA OT - Information

**Estimated time**

Requested sensitivity	3.9119 mJy
Bandwidth used for sensitivity	0.977 MHz
Representative frequency (sky, first source)	230.53 GHz
Precipitable water vapour (all sources)	1.262mm (4th Octile)

**ALMA 12m Array - 34 antennas**

Time on source per pointing (first source)	8.29 min
Total number of pointings (all sources)	1
Estimated number of tunings required	1
Total time on source	8.29 min
Total time on calibrators	16.08 min
Total overheads	13.56 min
Total 12m array time (inc. calibration & overheads)	37.93 min

**Calibration Breakdown**

1 x SidebandRatio	1.68 min
3 x Pointing	54.00 s
1 x Amplitude (inc. AtmosphericCal)	3.27 min
1 x Bandpass (inc. AtmosphericCal)	5.77 min
2 x Phase (inc. AtmosphericCal)	2.53 min
1 x Delay	36.00 s
2 x Atmospheric	1.33 min
Additional calibration overheads	8.13 min

**Additional 12M Array Configurations**

No of 12M Array Configurations	2
Additional overhead for extra configurations	18.96 min

**Atacama Compact Array**

ACA 7m time estimate coefficient	2.0
ACA 7m time	1.26 h
ACA TP time estimate coefficient	4.0
ACA TP time	2.53 h
Total ACA time (max[t <sub>L7</sub> -m, t <sub>TP</sub> ])	2.53 h

**Estimated total time for science goal** 3.48 h

OK

Antennas 12m 34 7m 9 TP 2

Most extended 12m configuration Most compact 12m configuration

Baseline (L <sub>max</sub> )	1.508 km	0.166 km
Baseline beamsize ( $\lambda/L_{max}$ )	0.178 arcsec	1.619 arcsec
Baseline (L <sub>min</sub> )	0.041 km	0.014 km
Recoverable scale ( $0.6\lambda/L_{min}$ )	3.963 arcsec	11.343 arcsec

Angular Resolution 0.30000 arcsec

Angular Structure in source  Point Source  Extended Source 35.00000 arcsec

Sensitivity per pointing 1.00000 K equivalent to 0.00391 Jy

Bandwidth used for Sensitivity RepresentativeWindowResolution Frequency Width 0.976563 MHz

Do you want to request complementary ACA Observations?  Yes  No

Integration time estimate

Are you required due to u,v coverage issues? (must be justified)  Yes  No

Are observations time-constrained?  Yes  No

Validation History Log

Description	Suggestion

# Short spacings for ALMA main array data, Cycle-2

ACA 7m array will cover the same field as the 12m main array

ACA 12m total power antennas will observe a slightly larger field  
Reference position will be selected by observatory

Observations will use, if possible, the same calibrators

Single Dish data will include a map of a bright unresolved source to measure the beam shape

Observations will be done close in time, but not simultaneously with 12m main array

Data reduction:

7m array: similar to 12m main array

TP: pipeline reduced data cubes

Combination: CASA guides (still...) in preparation



# Summary

## Short spacings in Cycle-2:

- 7m array: spectroscopy, continuum, B3,4,6,7,8,9
- Total Power array: spectroscopy, B3,4,6,7,8
- All you need to think about: what is the largest scale I want to recover?
- OT will work out the rest!
  
- Future developments: B9, continuum (using 'nutators'...)