

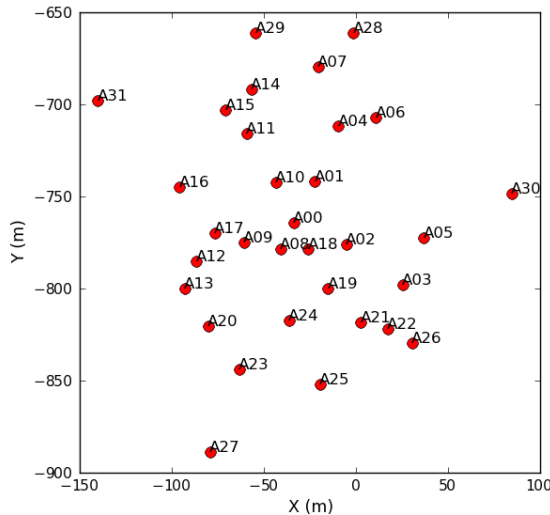
Total Power (and ACA) observations with ALMA

(Thomas Stanke, EU ARC, Garching)

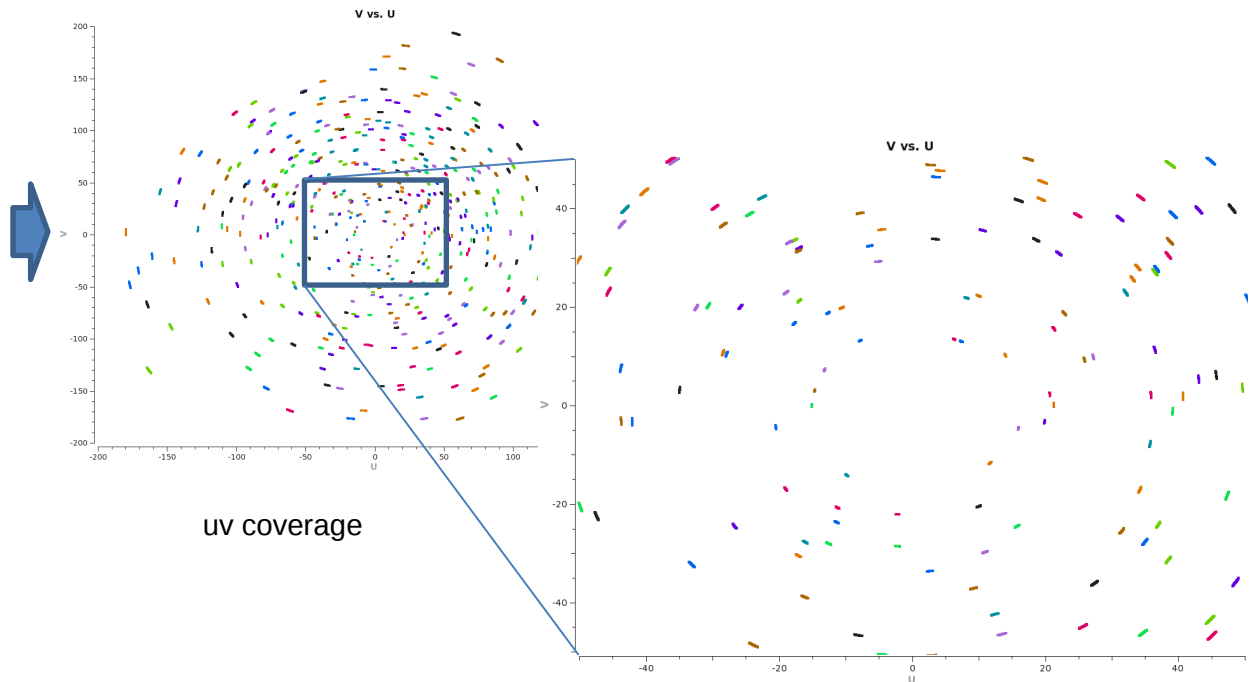
... Why?

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).



Antenna positions



uv coverage

... Why?

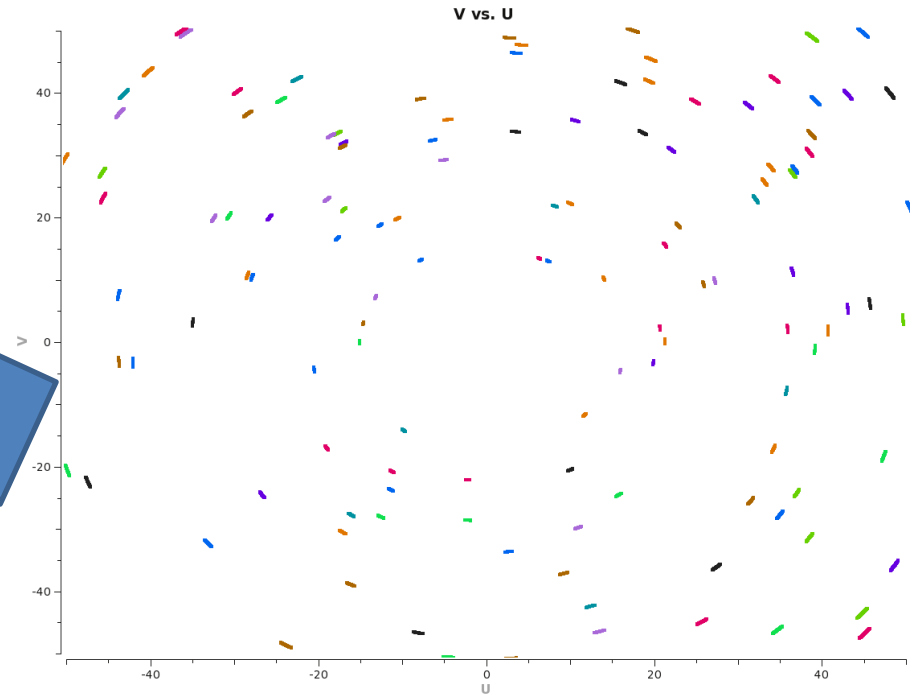
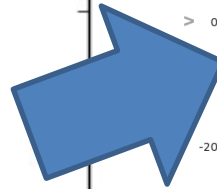
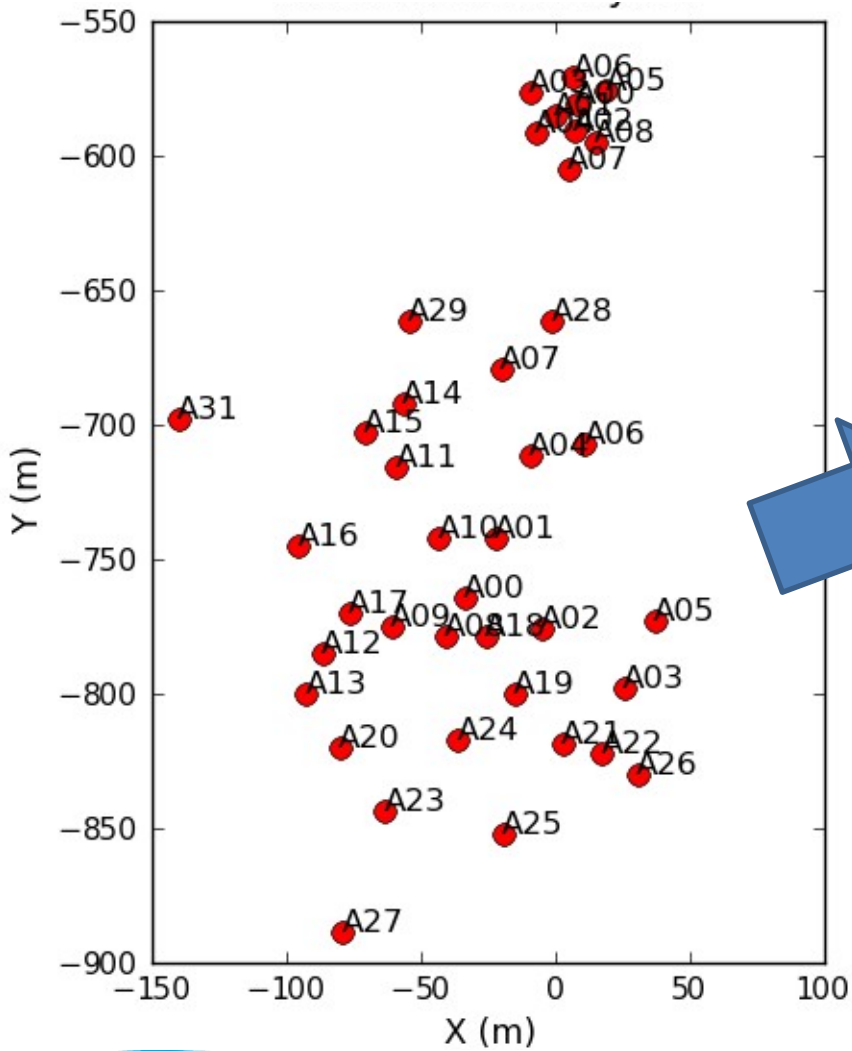
An interferometer does not record an image of the sky, but samples visibilities over a set of baselines defined by the antenna positions.

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

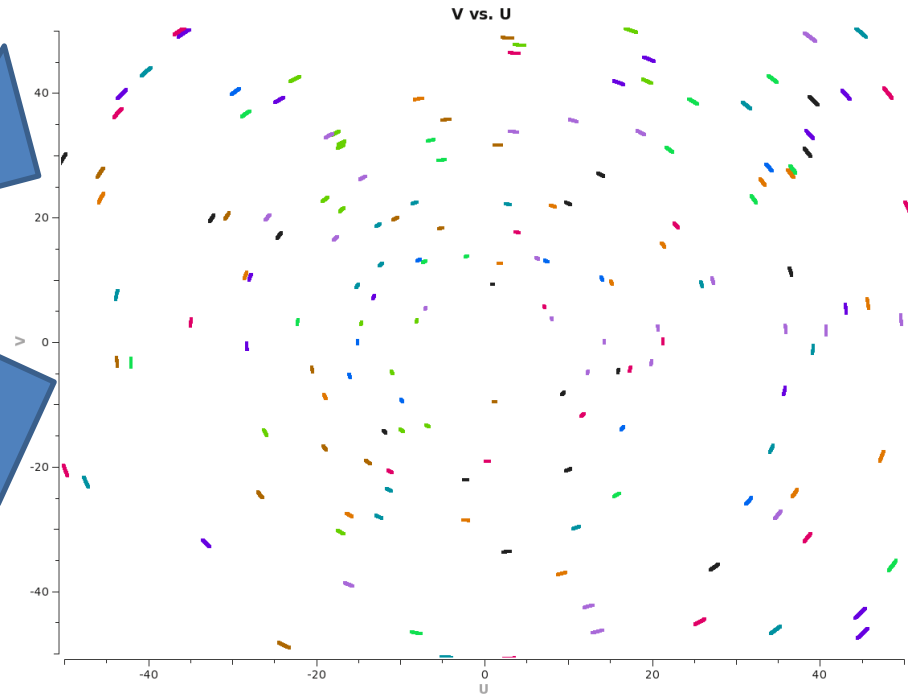
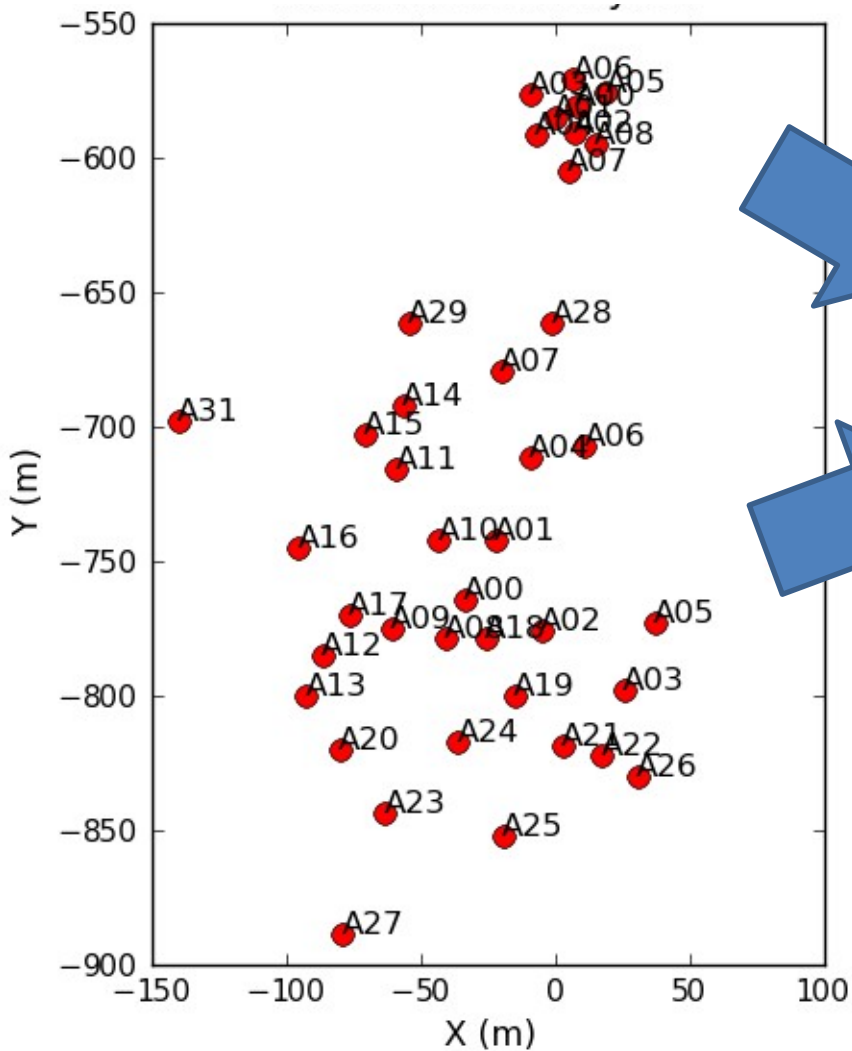
To recover emission on all angular scales, visibilities corresponding to shorter baselines have to be provided:

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

... Why?



... Why?



... Why?

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

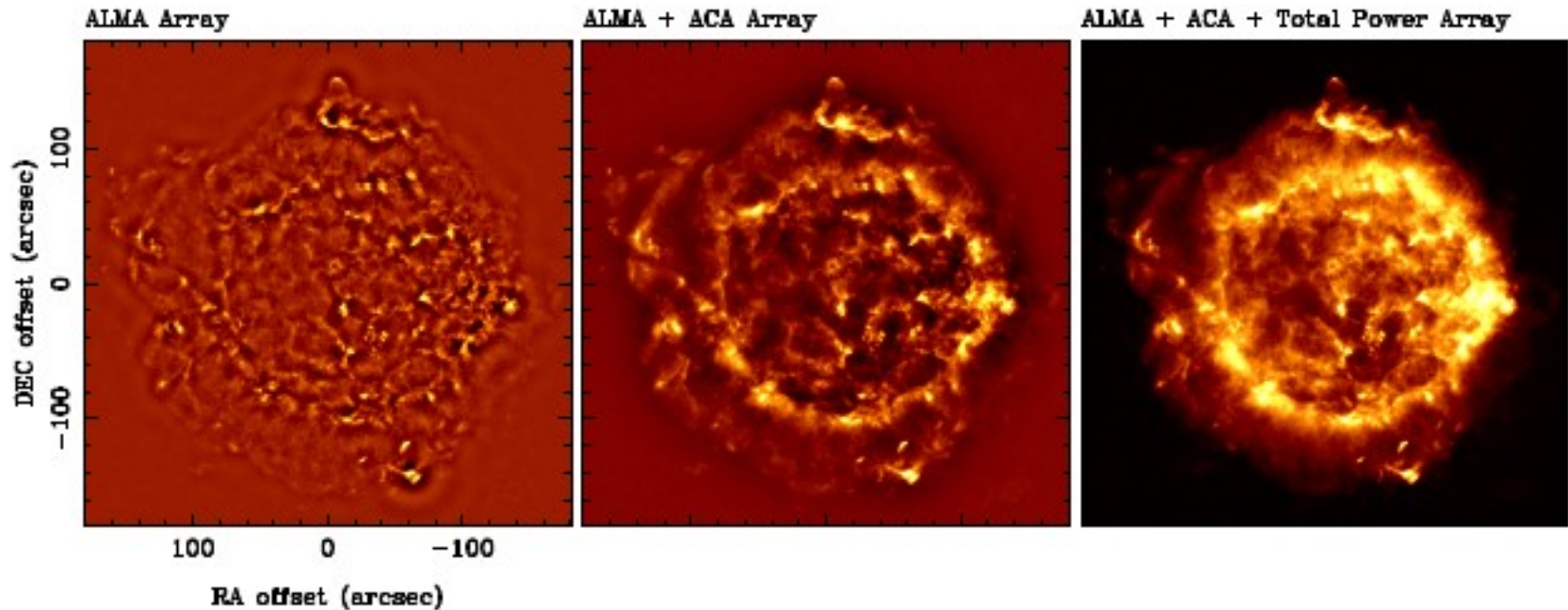
The largest angular scales on which emission can be recovered are given by the shortest baselines (i.e., \geq antenna diameter).

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-3

The ALMA Compact Array – ACA:

7m array:

≥ ten 7m antennas, operated as interferometer, baselines 9 to 32m
(main array: baselines > 15m)

Bands 3-10, spectral line and continuum observations

Total power (TP) array:

≥ two 12m antennas, operated as Single Dish telescopes

Bands 3-8

Spectral line observations only

Short spacings for ALMA main array data, Cycle-3

The ALMA Compact Array – ACA:

≥ ten 7m antennas, operated as interferometer, baselines 9 to 32m
(main array: baselines > 15m)

≥ two 12m antennas, operated as Single Dish telescopes (spectral line only)



Short spacings for ALMA main array data, Cycle-3

The ALMA Compact Array – ACA:

≥ ten 7m antennas, operated as interferometer, baselines 9 to 32m
(main array: baselines > 15m)

≥ two 12m antennas, operated as Single Dish telescopes (spectral line only)



Short spacings for ALMA main array data, Cycle-3: ... 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-3: ... 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):

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

Frequency (GHz)	Max Rec Scale, Without ACA (arcsec)	Max Rec Scale ACA 7m array (arcsec)
100	25	42.8
150	17	28.6
230	11	18.6
345	7.3	12.4
460	5.5	9.3
650	3.9	6.6
870	2.9	4.9

Short spacings for ALMA main array data, Cycle-3:
... 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%
(TP time = 4x 12m extended time, but will be observed parallel to ACA 7m observations)

Short spacings for ALMA main array data, Cycle-3:

The screenshot displays the ALMA Observing Tool (Cycle3) - Project interface. The main window is titled "Editors" and shows the "Control and Performance" tab. The interface is divided into several sections:

- Configuration Information:**
 - Antenna Beamsize ($1.13 * \lambda / D$): 12m 16.840 arcsec, 7m 28.868 arcsec
 - Number of Antennas: 12m 36, 7m 10, TP 2
 - Longest baseline (L_{max}): 0.161 km (Most compact 12m configuration), 6.074 km (Most extended 12m configuration)
 - Synthesized beamsize (λL_{max}): 1.015 arcsec, 0.037 arcsec
 - Shortest baseline (L_{min}): 0.015 km, 0.248 km
 - Maximum recoverable scale ($0.6\lambda L_{min}$): 8.111 arcsec, 0.470 arcsec
- Desired Performance:**
 - Desired Angular Resolution (Synthesized Beam): 0.30000 arcsec
 - Largest Angular Structure in source: 5.00000 arcsec
 - Desired sensitivity per pointing: 2500.0 uJy equivalent to 0.28405 K
 - Bandwidth used for Sensitivity: RepresentativeWindowResolution, Frequency Width 0.976563 MHz
 - Do you request complementary ACA Observations? Yes No
 - Science goal integration time estimate: [Time Estimate button]
 - Override OT's sensitivity-based time estimate (must be justified) Yes No
 - Are the observations time-constrained? Yes No

An "Estimated Time" window is open on the right, providing a summary of the parameters and time requirements:

- Note:** The time in brackets is that required to reach the sensitivity. Operational requirements often mean that the actual observed time is longer, especially for mosaics. Please see the User Manual for more details.
- Input Parameters:**
 - Requested sensitivity: 2.500 mJy
 - Bandwidth used for sensitivity: 0.977 MHz
 - Representative frequency (sky, first source): 345.79 GHz
 - Precipitable water vapour (all sources): 0.658mm (2nd Octile)
- Time required for largest 12-m array:**
 - Time on source per pointing (first source): 45,36 min (45,28 min)
 - Total number of pointings (all sources): 1
 - Number of tunings: 1
 - Total time on source: 45,36 min (45,28 min)
 - Total calibration time: 32,22 min
 - Other overheads: 7,25 min
 - Total time for 1 SB execution: 1,41 h
 - Number of SB executions: 1
 - Total time to complete SB: 1,41 h
- Calibration Breakdown per SB execution:**
 - 3 x Pointing: 36,00 s
 - 1 x SidebandRatio: 1,58 min
 - 1 x Amplitude: 2,50 min
 - 1 x Bandpass: 10,00 min
 - 7 x Phase: 3,50 min
 - 4 x Phase reference check source: 2,00 min
 - 8 x Atmospheric: 5,33 min
 - Calibration overheads: 6,70 min
- Additional Arrays:**
 - Number of additional 12-m configurations: 1
 - Time required for additional 12-m: 42,41 min
- Estimated total time for science goal 2,12 h**

At the bottom of the interface, there is a "Contextual Help" section with instructions for creating a new proposal and a "Phase I: Science Proposal" flowchart showing the steps: New Science Proposal, Create Science Goals, Validate Science Proposal, and Submit Science Proposal. There are also buttons for "Importing And", "Template Library", "Need More", and "View Phase 2".

Short spacings for ALMA main array data, Cycle-3:

The screenshot displays the ALMA Observing Tool (Cycle3) - Project interface. The main window is titled "Editors" and shows configuration parameters for observations. The "Control and Performance" tab is active, displaying various parameters for antenna configurations and integration time.

Configuration Information:

Parameter	12m	7m	TP
Antenna Beamsize ($1.13 * \lambda / D$)	16.840 arcsec	28.868 arcsec	
Number of Antennas	36	10	2
Longest baseline (L_{max})	0.161 km	6.074 km	
Synthesized beamsize (λL_{max})	1.015 arcsec	0.037 arcsec	
Shortest baseline (L_{min})	0.015 km	0.248 km	
Maximum recoverable scale ($0.6\lambda L_{min}$)	8.111 arcsec	0.470 arcsec	

Desired Performance:

- Desired Angular Resolution (Synthesized Beam): 0.30000 arcsec
- Largest Angular Structure in source: 35.00000 arcsec
- Desired sensitivity per pointing: 2.50000 mJy equivalent to 0.28405 K
- Bandwidth used for Sensitivity: RepresentativeWindowResolution, Frequency Width: 0.976563 MHz
- Do you request complementary ACA Observations? Yes No
- Science goal integration time estimate: [Time Estimate]
- Override OT's sensitivity-based time estimate (must be justified) Yes No
- Are the observations time-constrained? Yes No

Estimated Time Window:

Note: The time in brackets is that required to reach the sensitivity. Operational requirements often mean that the actual observed time is longer, especially for mosaics. Please see the User Manual for more details.

Input Parameters

Requested sensitivity	2.500 mJy
Bandwidth used for sensitivity	0.977 MHz
Representative frequency (sky, first source)	345.79 GHz
Precipitable water vapour (all sources)	0.658mm (2nd Octile)

Time required for largest 12-m array

Time on source per pointing (first source)	45.36 min [45.28 min]
Total number of pointings (all sources)	1
Number of tunings	1
Total time on source	45.36 min [45.28 min]
Total calibration time	32.22 min
Other overheads	7.25 min
Total time for 1 SB execution	1.41 h
Number of SB executions	1
Total time to complete SB	1.41 h

Calibration Breakdown per SB execution

3 x Pointing	36.00 s
1 x SidebandRatio	1.58 min
1 x Amplitude	2.50 min
1 x Bandpass	10.00 min
7 x Phase	3.50 min
4 x Phase reference check source	2.00 min
8 x Atmospheric	5.33 min
Calibration overheads	6.70 min

Additional Arrays

Number of additional 12-m configurations	1
Time required for additional 12-m	42.41 min
ACA 7-m time ($t_{12m} \times 2$)	2.83 h
ACA TP time ($t_{12m} \times 4$)	5.66 h
Total ACA time ($\max[t_{7-m}, t_{TP}]$)	5.66 h

Estimated total time for science goal 7.78 h

The interface also includes a "Project Structure" panel on the left, an "Overview" panel at the bottom, and a "Contextual Help" section with instructions for creating a new proposal.

Short spacings for ALMA main array data, Cycle-3

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

ACA 12m total power antennas will observe a slightly larger field

Observations will use, if possible, the same calibrators

Single Dish data will include a map of a bright unresolved source to measure the $K \rightarrow Jy$ conversion factor

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-3:

- 7m array: spectroscopy, continuum, B3,4,6,7,8,9,10
- 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: B9,10; continuum (using 'nutators'...)