

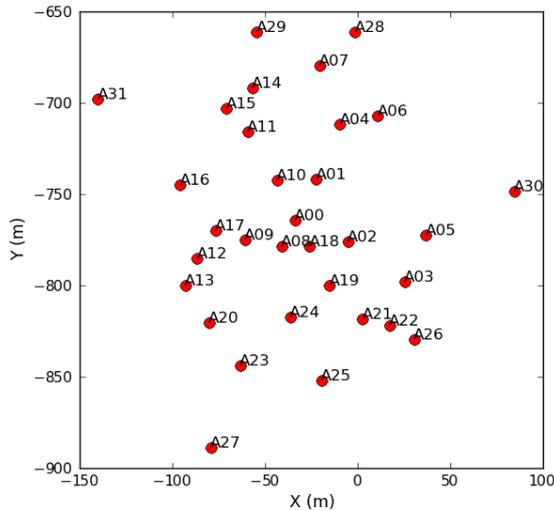
Total Power (and ACA) observations with ALMA

(Thomas Stanke, EU ARC, Garching)

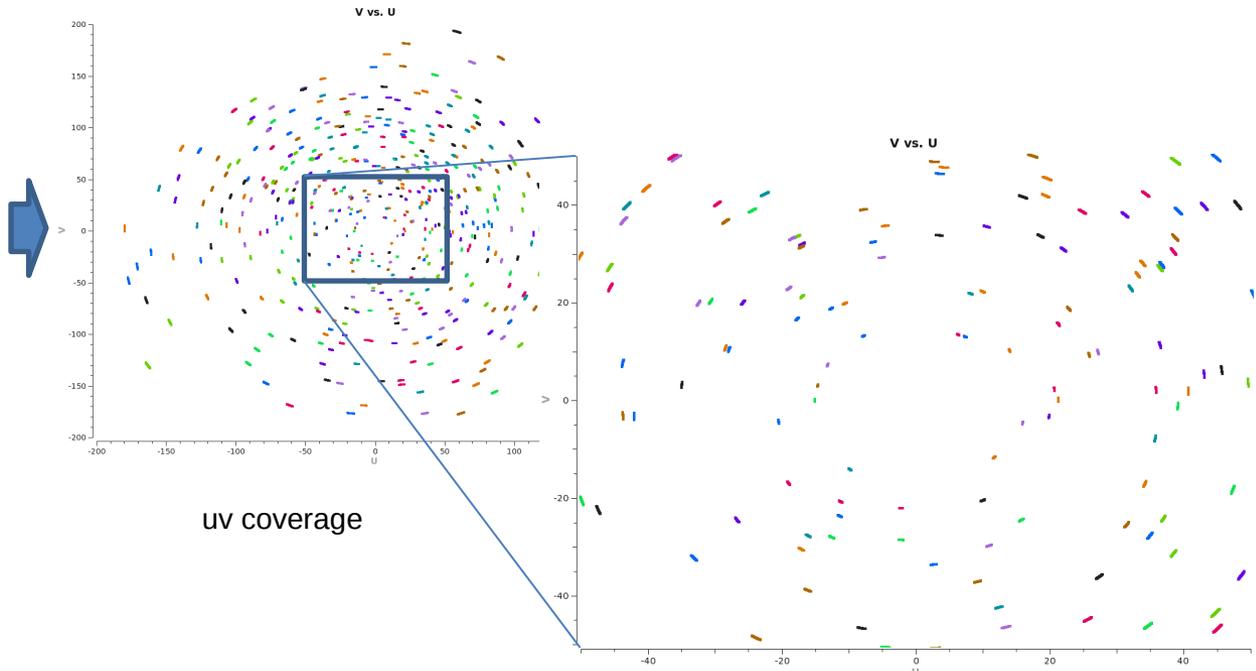
... Why?

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?

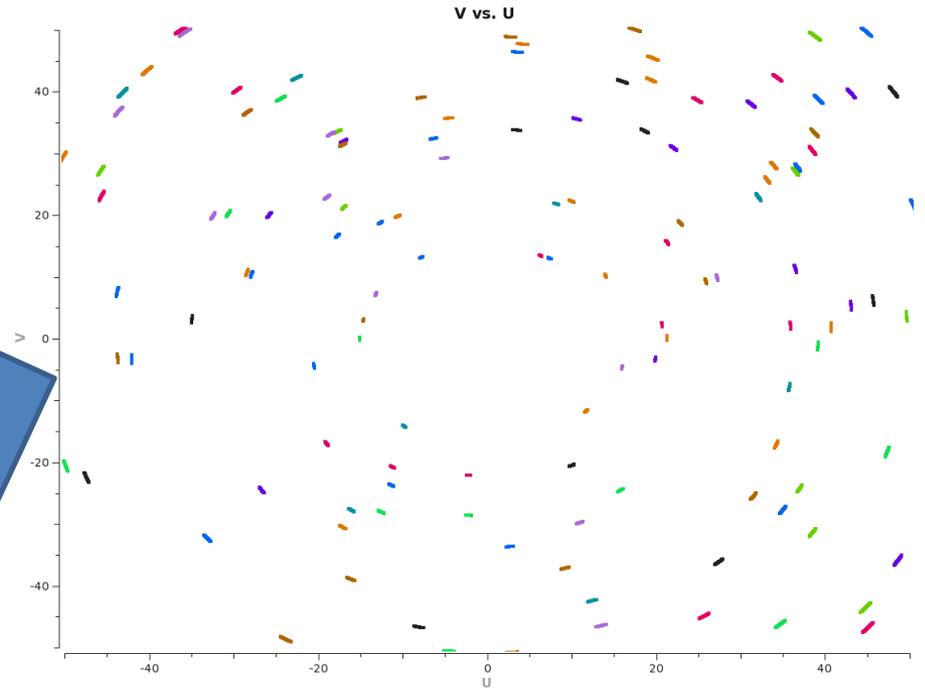
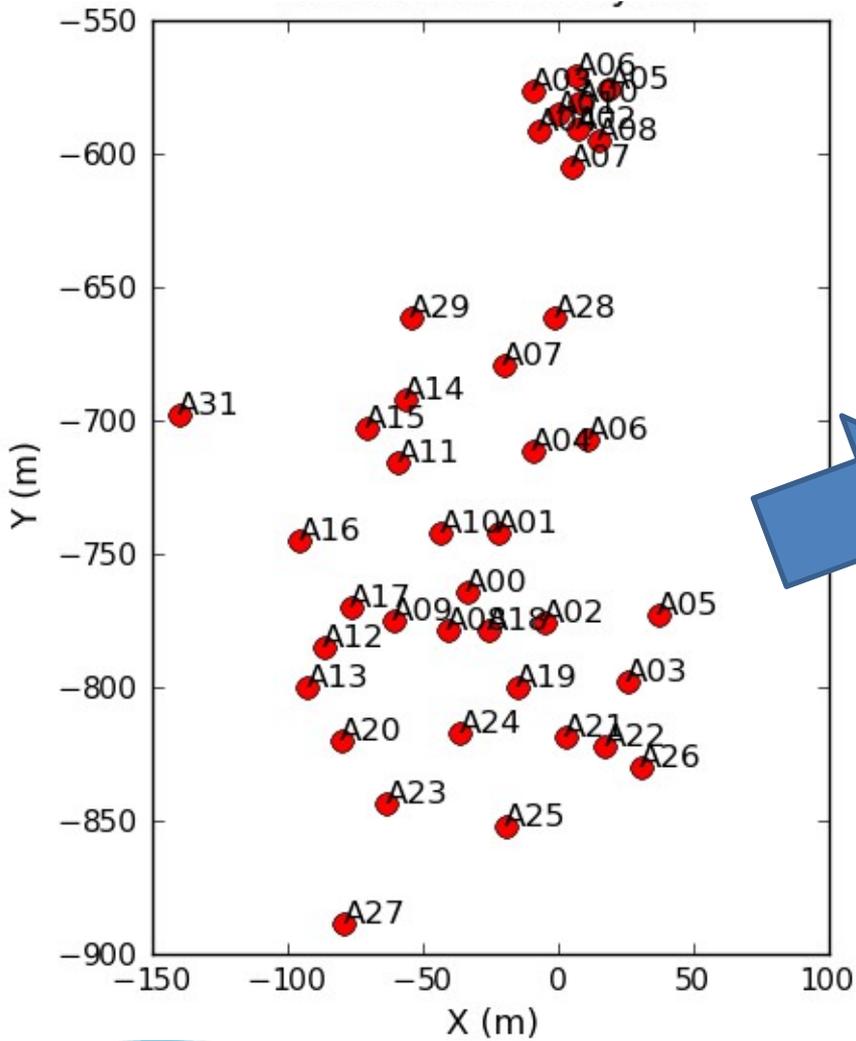
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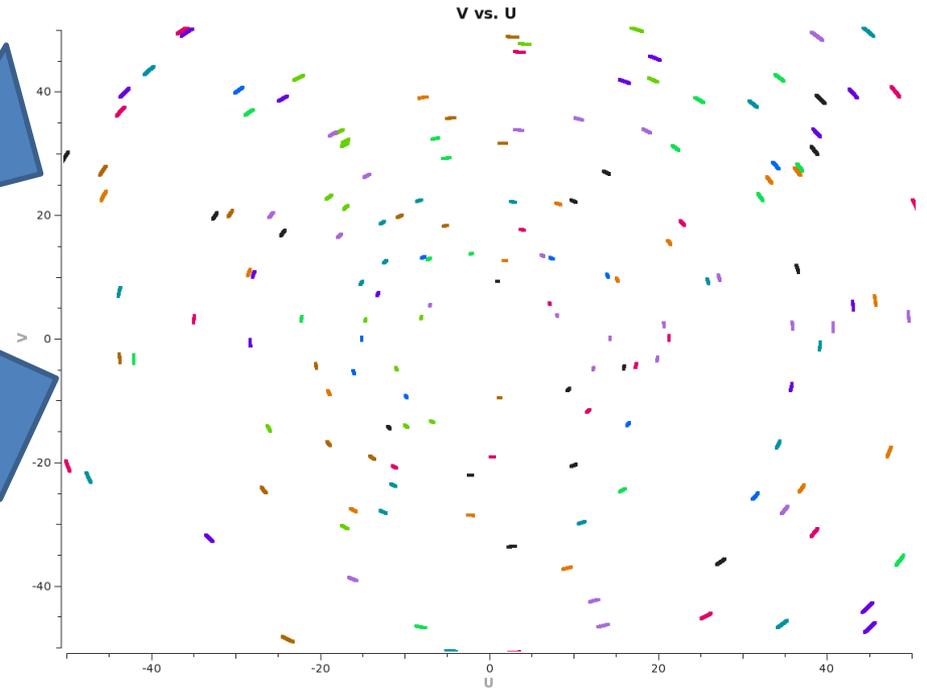
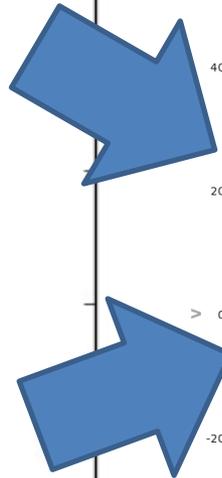
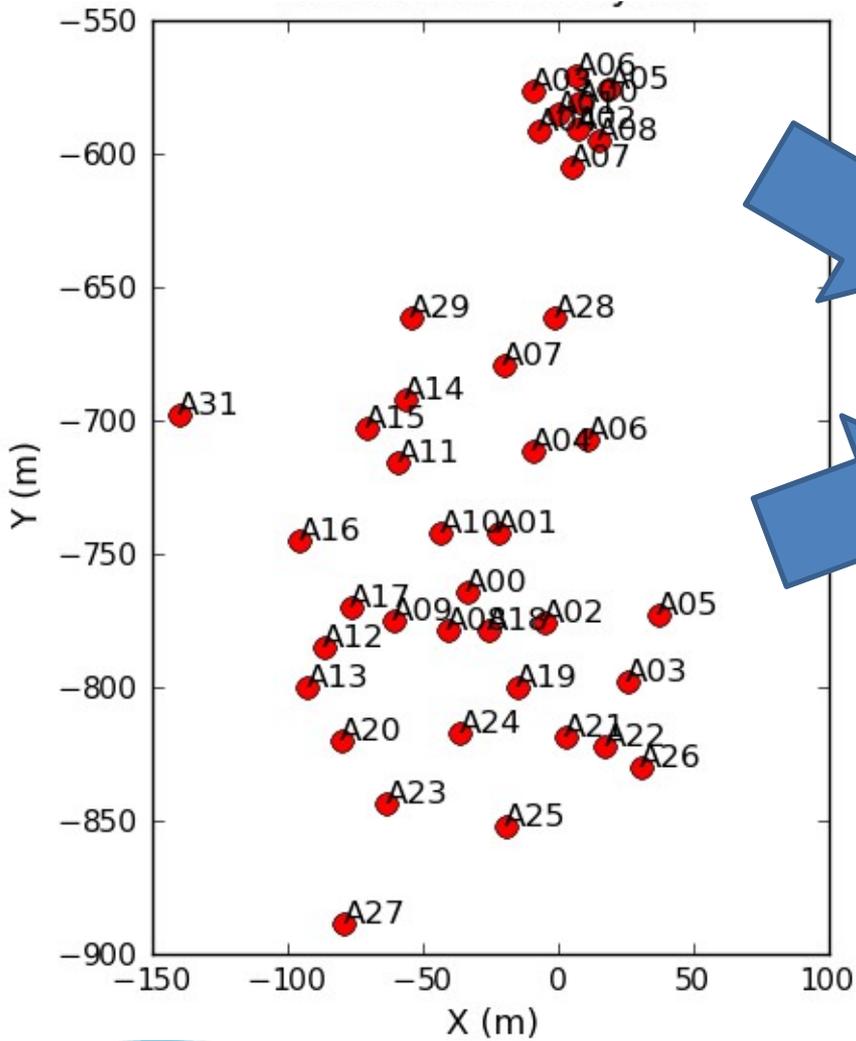
To recover emission on all angular scales, visibilities corresponding to shorter baselines have to be provided:

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

... Why?



... Why?



... Why?

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

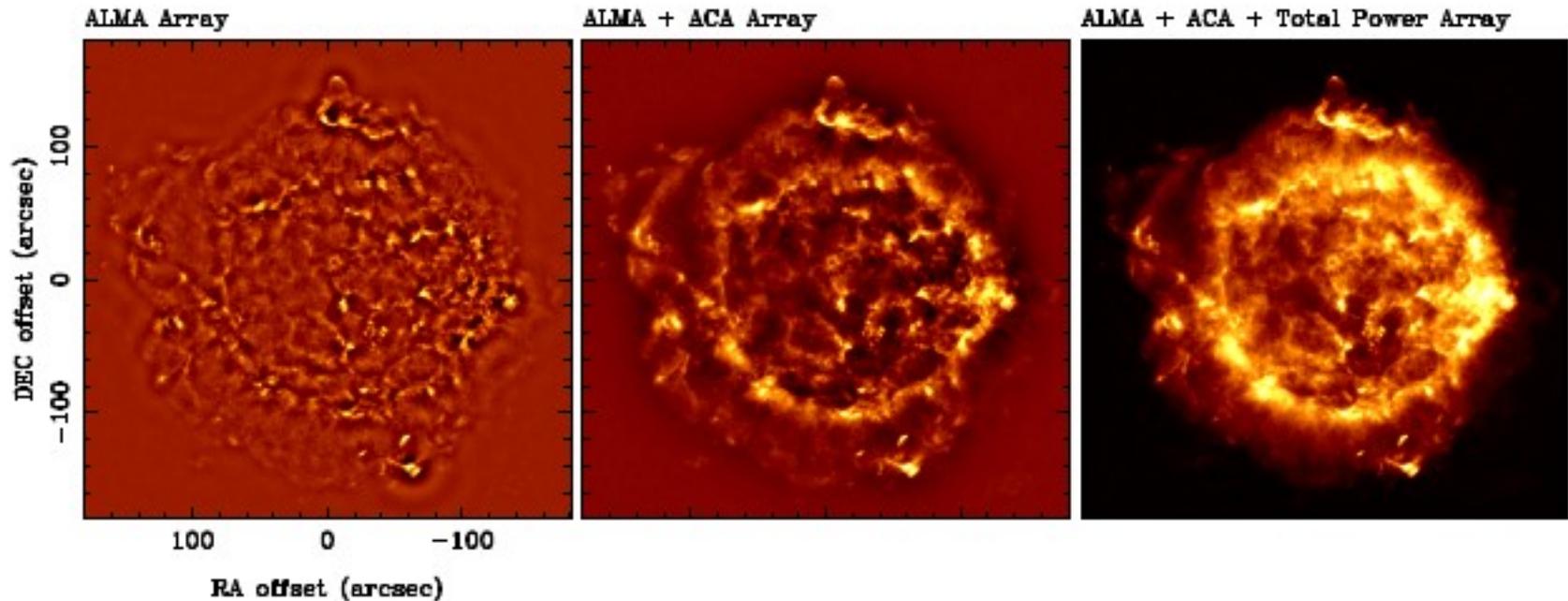
The largest angular scales on which emission can be recovered are given by the shortest baselines (i.e., \geq antenna diameter).

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

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Short spacings for ALMA main array data, Cycle-3

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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?

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

| 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 "Control and Performance" and contains the following configuration parameters:

These parameters are used to control various aspects of the observations, including the required antenna configurations and integration time.

Control and Performance

Configuration Information

| | | |
|---|-------------------|------------------|
| Antenna Beamsize ($1.13 * \lambda / D$) | 12m 16.840 arcsec | 7m 28.868 arcsec |
| Number of Antennas | 12m 36 | 7m 10 |
| Longest baseline (L_{max}) | 0.161 km | 6.074 km |
| Synthesized beamsize (λ / L_{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: Representative Window Resolution 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

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

Contextual Help:

- Please ensure you and your co-Is are registered with the [ALMA Science Portal](#)
- Create a new proposal by either:
 - Selecting *File > New Proposal*
 - Clicking on the icon in the toolbar
 - Or clicking on this [link](#)
- Click on the proposal tree node and complete the

Phase I: Science Proposal

New Science Proposal → Create Science Goals → Validate Science Proposal → Submit Science Proposal

Click on the overview steps to view the contextual help

Importing And Template Library Need More 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 contains several tabs: "Spectral", "Spatial", and "Control and Performance". The "Control and Performance" tab is active, showing configuration information for the observations.

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

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| 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

Contextual Help:

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Buttons: New Science Proposal, Create Science Goals, Valid Sci Proposal, Proposal, Importing And, Template Library, Need More, View Phase 2

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'...)