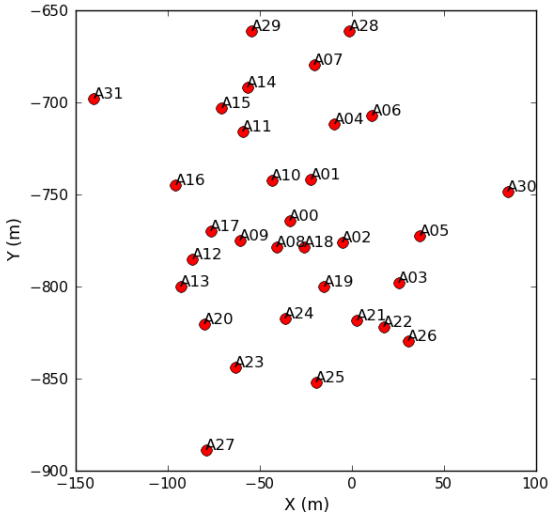
Total Power (and ACA) observations with ALMA

(Thomas Stanke, EU ARC, Garching)

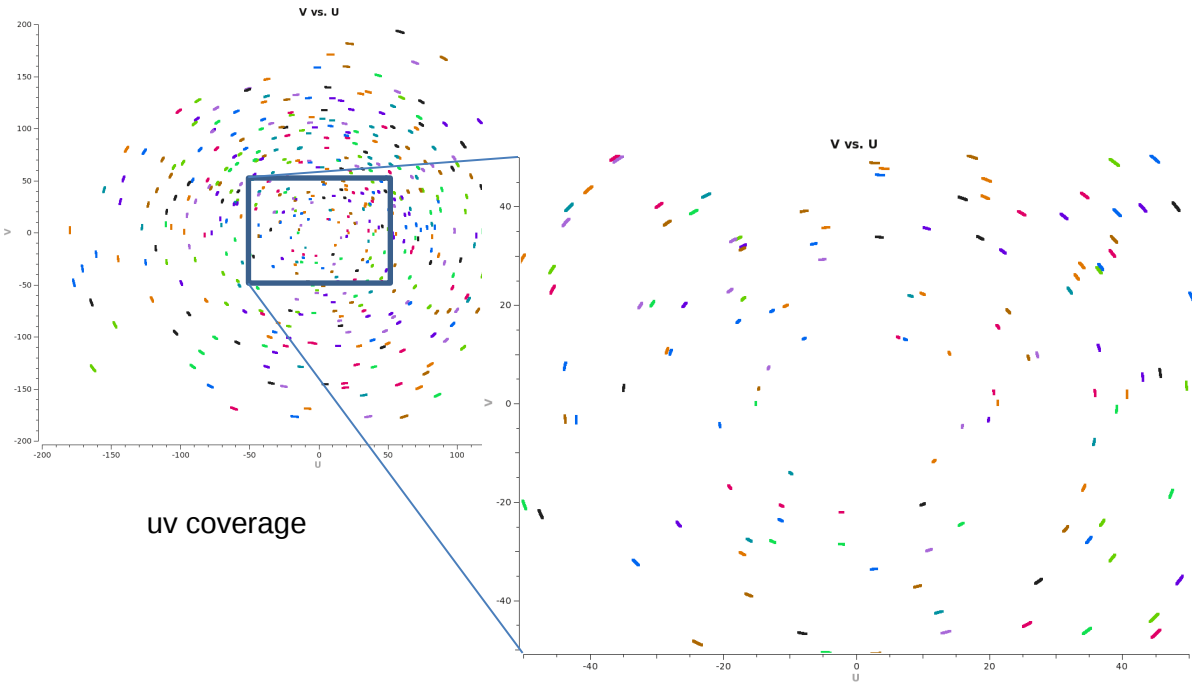
… Why?

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., ≥ antenna diameter).



Antenna positions



uv coverage

… Why?

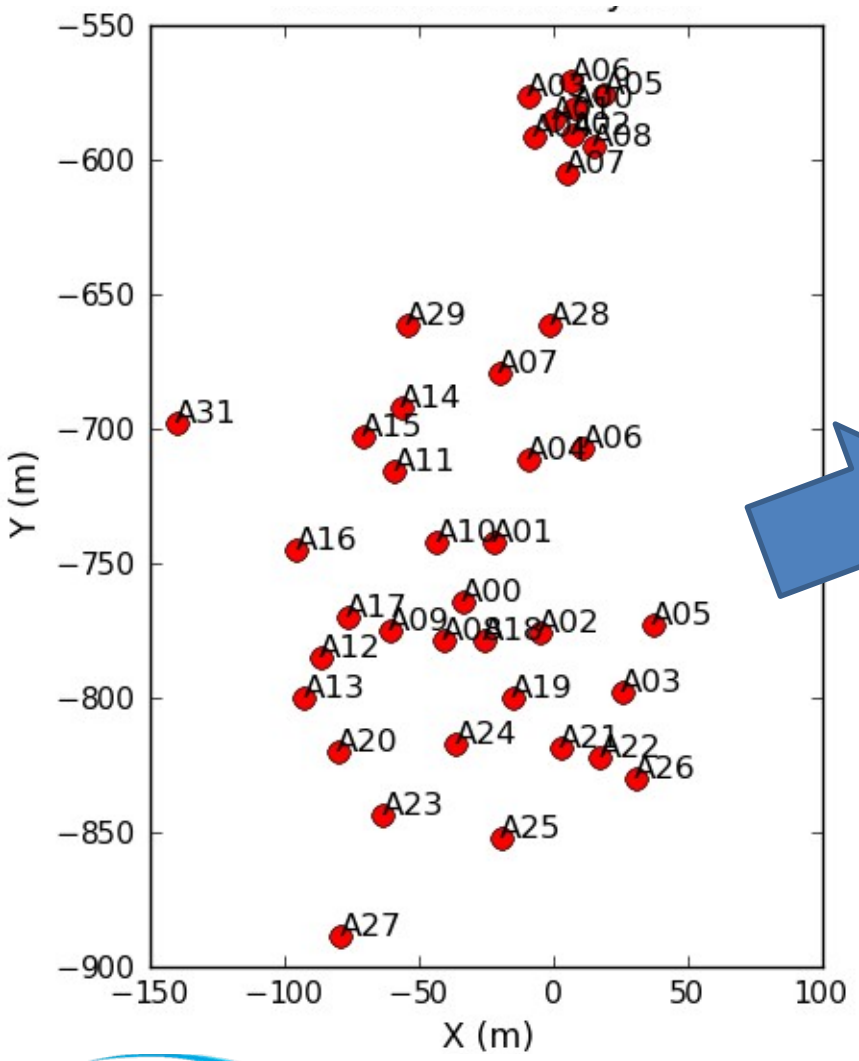
An interferometer does not record an image of the sky, but samples visibilities over a set of baselines defined by the antenna positions.

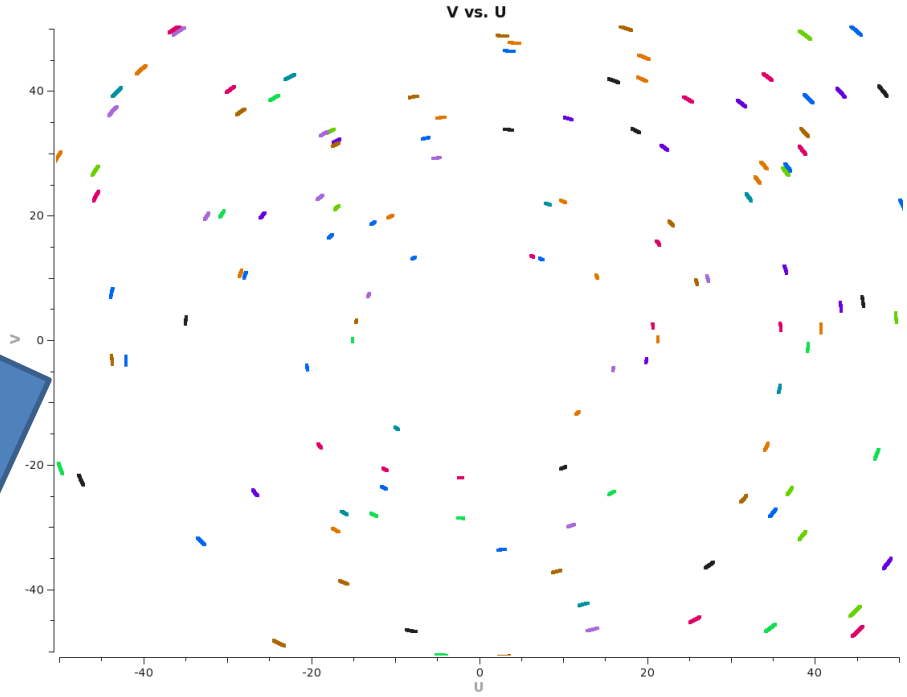
The largest angular scales on which emission can be recovered are given by the shortest baselines (i.e., ≥ antenna diameter).

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

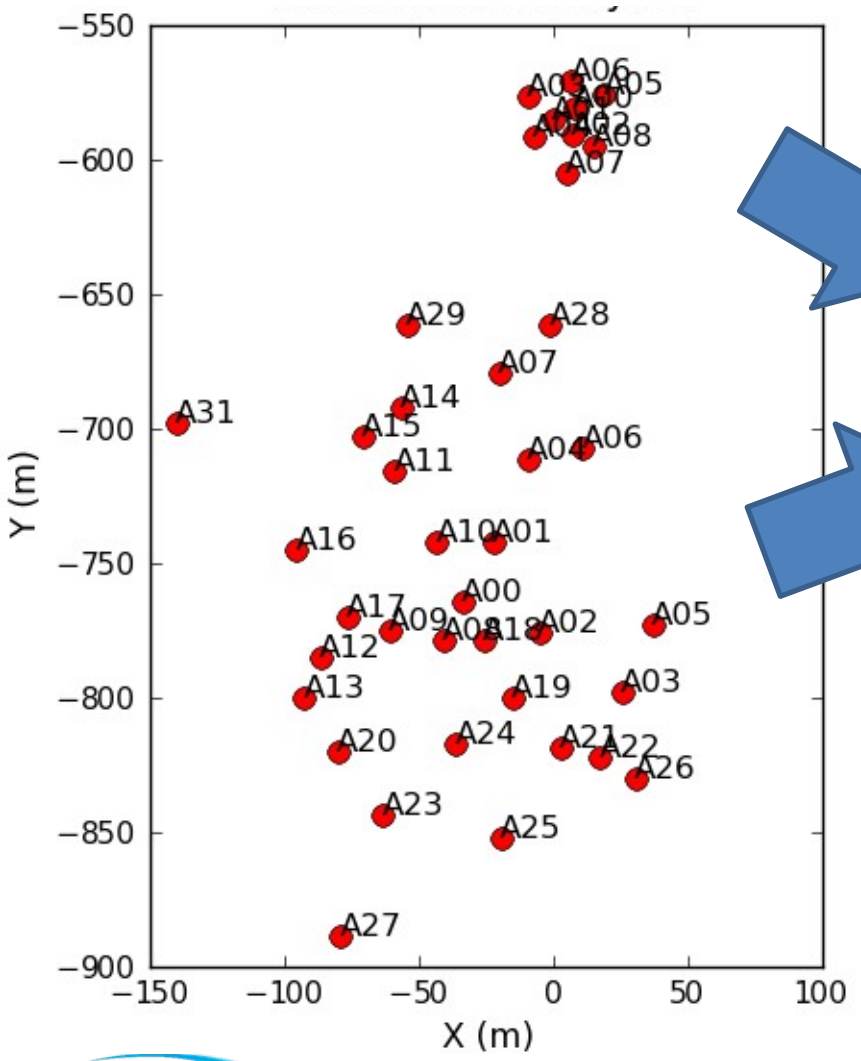
- Interferometric data on shorter baselines (i.e., using smaller antennas)

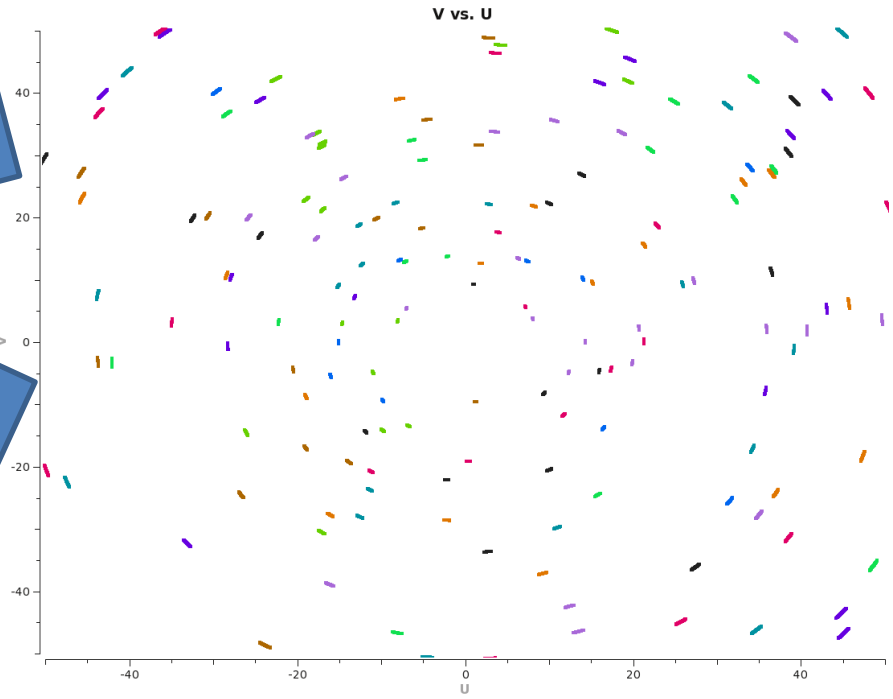
… Why?


A06
A05
A08
A07
A29
A28
A07
A14
A31
A15
A04
A06
A11
A16
A10
A01
A00
A17
A09
A18
A02
A05
A12
A13
A19
A03
A20
A24
A21
A22
A26
A23
A25
A27
−550
−600
−650
−700
−750
−800
−850
−900
−150
−100
−50
0
50
100
Y (m)
X (m)


V vs. U
40
20
0
-20
-40
V
-40
-20
0
20
40
U

… Why?


−550
−600
−650
−700
−750
−800
−850
−900
Y (m)
−150
−100
−50
0
50
100
X (m)
A06
A05
A08
A07
A29
A28
A07
A14
A31
A15
A04
A06
A11
A16
A10
A01
A00
A17
A09
A18
A02
A05
A12
A13
A19
A03
A20
A24
A21
A22
A26
A23
A25
A27


V vs. U
40
20
0
-20
-40
V
-40
-20
0
20
40
U

… Why?

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

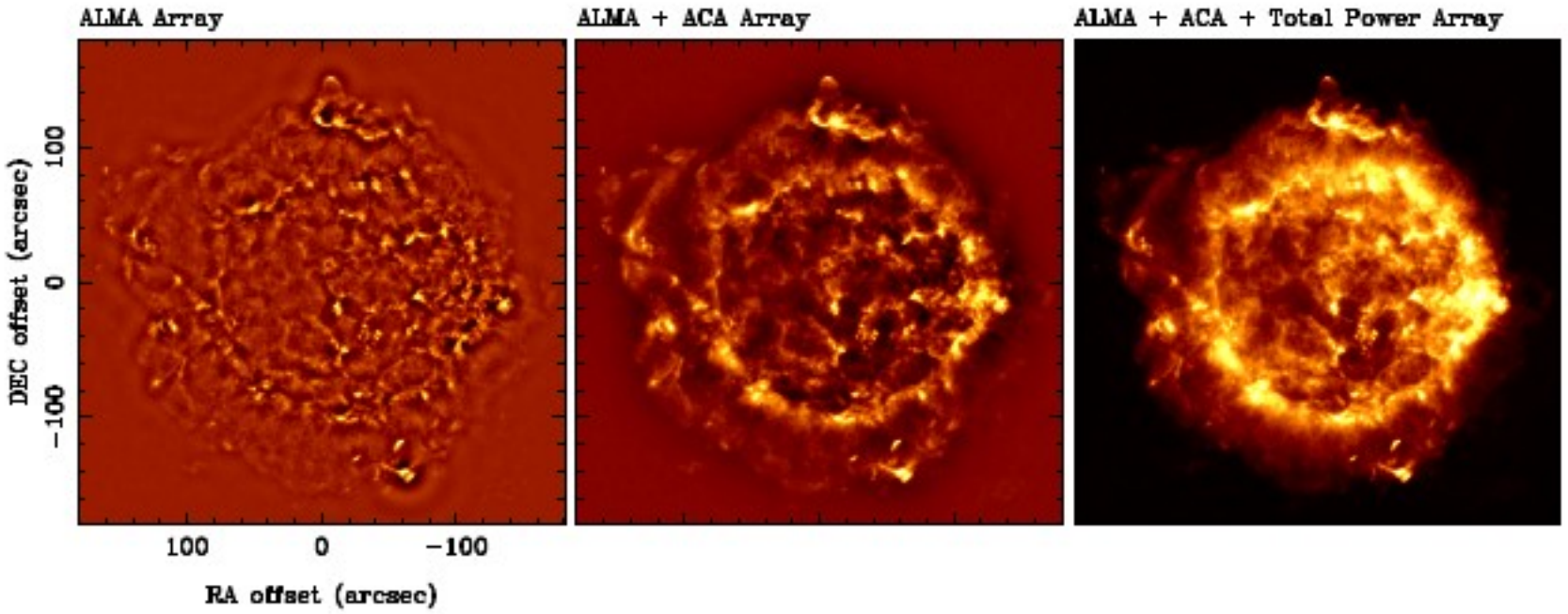
The largest angular scales on which emission can be recovered are given by the shortest baselines (i.e., ≥ antenna diameter).

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):

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

(… 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):

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

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? ->

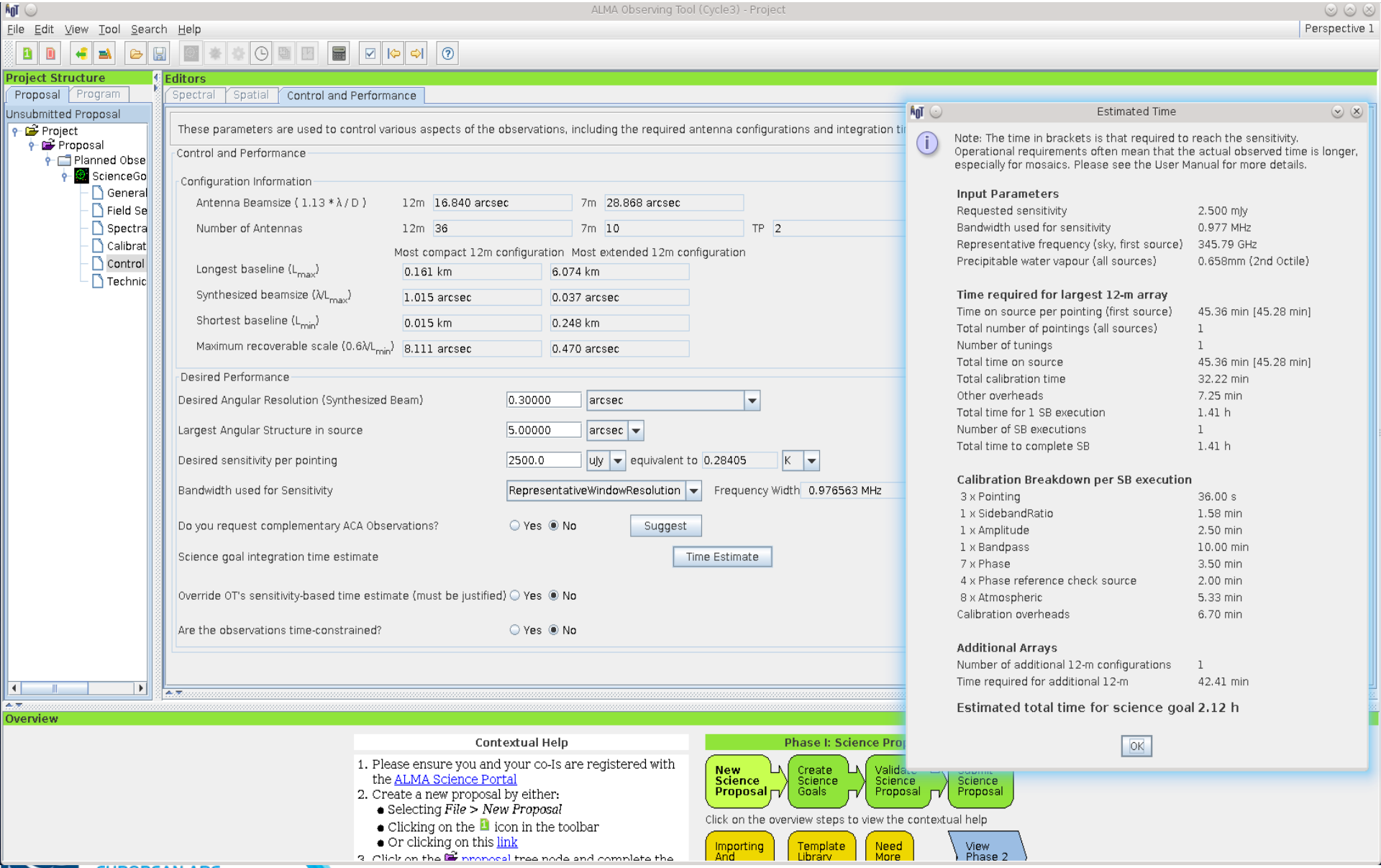
integration time on main array (most extended configuration needed)

$t_{int, MA}$

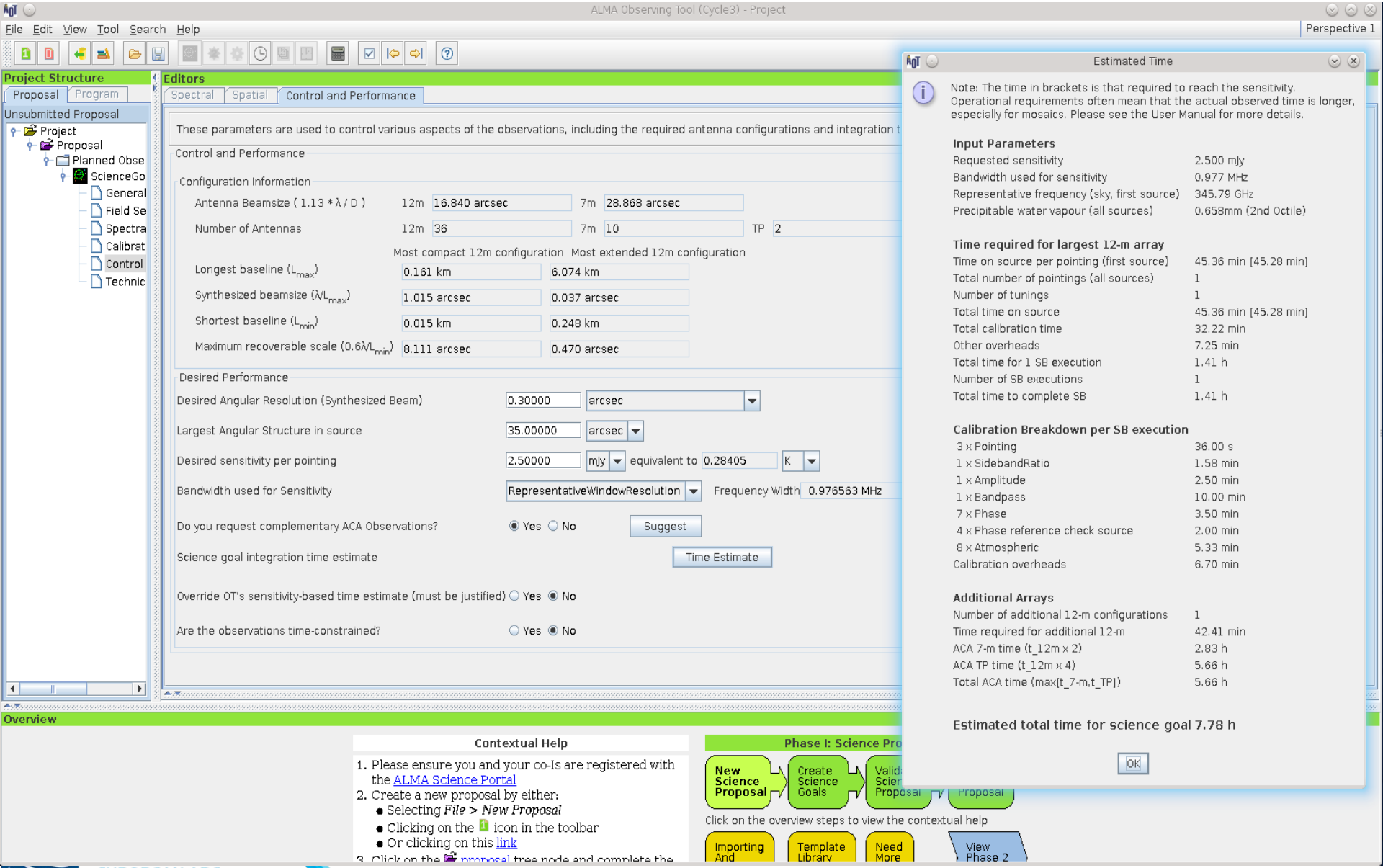
- a more compact main array configuration is needed: -> add 50%
- ACA 7m interferometric data are needed -> add 200%
- ACA TP data are needed -> add another 200%

  (TP time = 4x 12m extended time, but will be observed parallel to ACA 7m observations)

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



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



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 → 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’…)