ALMA Cycle 2 Relative Integration times for 12-m, 7-m, and Total Power Arrays

B. Mason, C. Brogan & the ALMA imaging team

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BSM updated Sep.2015 explaining what was actually done in cycles 2 & 3

We have used the criteria described in NAASC Memo 113/ALMA Memo 598 (Mason & Brogan, 2013) to compute the relative integration times for the ALMA 12-m, 7-m, and Total Power arrays that provide approximately matched sensitivities for overlapping angular scales. We use Eq. 17, which states:

$$\frac{t_{tot,2}}{t_{tot,1}} = \left(\frac{D_1}{D_2}\right)^2 \frac{N_{bas,1}}{N_{bas,2}} \tag{1}$$

Here $t_{tot,1}$ is the total integration time spent with array 1 for the region of interest, in general comprising a mosaic of many individual pointings of array 1; D_1 is the diameter of the antennas in Array 1; and $N_{bas,1}$ is the number of baselines which array 1 has falling within the overlap region of uv space between array 1 and array 2; and similarly for array 2. For arrays with a substantial mismatch in angular scale sensitivity between the 12-m array and the ACA, we assume an intermediate "transitional" configuration in addition. We describe below how the integration time for this transitional configuration is computed. Consistent with current plans, we assume 34 12-m antennas (configurations `C34-1.cfg` through `C34-7.cfg` provided by JAO at the end of July, 2013); 9 7-m antennas (`ACA-9-02.cfg` provided by JAO at the same time); and two 12-m total power antennas. Consistent with current recommendations for high quality imaging, we consider the following combinations valid: C34-1 + ACA; C34-2 + ACA; C34-3 + ACA; C34-4 + C34-1 + ACA; C34-5 + C34-2 + ACA; C34-6 + C34-3 + ACA; C34-7 + C34-3 + ACA.

In general we take as given some required integration time for the *most extended* 12-m array, and compute the additional integration time required in more compact configurations or arrays. For the case of only two configurations (C34-2 and the ACA, for instance) this is a straightforward application of Equation 1 (Eq. 17 of the original memo). When there is a transitional configuration we do the following:

1. Compute the integration time for the transitional configuration (*i.e.*, the more compact 12-m configuration) using Eq. 1, considering the overlap region of these two 12-m configurations in uv space.

2. Compute the 7-m array integration time required to match the transitional configuration sensitivity, considering the uv range defined by the 7-m and transitional 12-m configuration overlap, but also including the contribution of the more extended 12-m array to $N_{bas,12-m}$ in that range. The inclusion of the extended array baselines in the 7-m/transitional overlap region causes at most at 20% correction in the needed 7-m integration time.

Results are presented in Table 1. Note that the increase in 7-m array time for the 4/1 hybrid configuration is due to the presence of the most compact 12-m array, which greatly increases the surface brightness sensitivity of the 12-m data.

Using the criteria described in the original memo we find that the total power array total integration time— *i.e.* the total time spent by *each* of the two total power dishes— is 2.0× the total 7-m array time, not counting any additional penalty due to frequency or position switching.

Extended (X) 12-m Configuration	Transitional 12-m cfg. (C)	$t_{12m,C}/t_{12m,X}$	$t_{7m}/t_{12m,X}$
1	n/a	n/a	7.88
2	n/a	n/a	3.47
3	n/a	n/a	1.87
4	1	0.40	3.69
5	2	0.57	2.51
6	3	0.57	1.07
7	3	0.42	0.78

Table 1: Relative integration times for 12-m ($t_{12m,X}$), 12-m transitional ($t_{12m,C}$), and 7-m (t_{7m}) arrays. The total power array integration time required for cycle 2 is $2 \times t_{7m}$ (see text).

Note added September 2015: For Cycle 2 and Cycle 3 observing, the time ratios actually used were a compromise fixed set of ratios 4 : 2 : 0.5 : 1 (TP:7m:12m-compact:12m-extended). If there was only one 12m config, the 7m:12m ratio was 2 : 1.