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How can we reduce the production costs of high-performance reflector antennas suitable for the sub-millimeter wavelength range as needed for future radio observatories?

A principal parameter determining ultimate sensitivity in radio telescopes is the so-called antenna collecting area: the larger the collecting area the more photons can be captured.

For sub-millimeter telescopes like the Atacama Large Millimeter/submillimeter Array (ALMA), operating in the wavelength range of 0.3 to 10 mm, parabolic reflector antennas have proven to be the best solution so far. To avoid degradation of the effective antenna collecting area the RMS surface accuracy, deviation from a perfect parabolic shape, of the antenna needs to be less than 10 %, preferably 5 %, of the operating wavelength.

This collecting area doesn't have to be provided by a single antenna but can be distributed among multiple, smaller, antennas. ALMA currently is composed of 66 antennas, 54 antennas having a diameter of 12 m and 12 antennas with 7 m diameter primary reflector. To enable future astronomy in the sub-mm wavelength range, requiring at least a 3-fold, but preferably 10-fold, increase of total antenna collecting area to what ALMA currently offers (~6500 m²), cost-effective antenna design, and manufacturing technology is what we are looking for. The challenge is to come up with novel concepts that result in substantially lower production and operational costs.

The goal is to reach normalized production costs substantially less than 25 % of the current ALMA antenna which are approximately 120 k€ per effective square meter of collecting area (@ 3 mm wavelength).

Some ideas that are on our mind and we are very interested in exploring with you are:

- Is an off-set, parabolic reflector, configuration, avoiding the shadowing effect by the subreflector in a symmetric configuration, contributing to our goal?
- Can novel production techniques like additive manufacturing, 3-D metal printing, instead of conventional CNC milling of the precision antenna reflector panels, be cost effective and a more sustainable solution (less waste)?

Considering the costs of the drive systems of an individual antenna what would be the cost per unit sweet spot for the primary reflector diameter, in the range of 10 to 30 m, for a total collecting area of 20.000 m²?