

# ALMA Science

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## What is the astrometric accuracy of ALMA?

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The absolute positional accuracy of an ALMA image, made with normal phase referencing depends, on the target signal to noise and the array resolution, but also on the quality of the phase calibration that depends on the atmosphere delay fluctuations and the proximity of the phase calibrator to the target. First, the signal-to-noise of the source image and the resolution of the observations provide a minimum obtainable astrometric precision. The relationship is given by

$$\Delta \rho = 60 \text{mas} * (100 \text{GHz} / \text{FREQ}) * (10 \text{km} / \text{BSL}) / \text{SNR}$$

where

$\Delta \rho$  = Theoretical accuracy limit by SNR only,

BSL = Maximum baseline length in km,

FREQ = The observing frequency in GHz,

SNR = The signal to noise at the source peak.

For example, at Band 7 (350 GHz), for the 1-km BSL configuration (C40-5), and for SNR = 40, the theoretical astrometric accuracy is 4.2 mas.

However, for a reasonably bright and compact source, the astrometric accuracy is often limited by the size and nature of the phase variations with time and over the array, rather than that from the SNR limit and array resolution. An estimate to the best positional accuracy of an ALMA observation with normal calibrations are: 1) from the SNR estimate given above; 2) 5% of the resolution; 3) or a limit of 3 mas, whichever is the largest. This limit is frequency independent.

[\(This is found in the ALMA Technical Handbook, Chapter 10.5.2 Astrometric Observations\)](#)