

UPDATE ON FAST SWITCHING PHASE CALIBRATION FOR
ALMA

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Chajnantor is a premiere sub-millimeter site, but phase stability is still a problem. 230GHz 300m baseline observations during median conditions lose half the sensitivity to decorrelation if phase errors are uncorrected. ALMA baselines will go to 19km, so we need Fast Switching and Water Vapor Radiometry (WVR) phase compensation.

Fast switching entails frequently slewing to a nearby calibrator, detecting atmospheric phases at 90GHz with high SNR, quickly slewing back to the target source while switching to the target source observing frequency, scaling the 90GHz phases to the target frequency, and applying those phases to the target source. The phase errors as a function of the distance to calibrator, the SNR on the calibrator, and the calibration cycle time are well understood.

Fast Switching places several demands on the ALMA design: Antennas slew and settle quickly (1.5deg in 1.5s). The 90GHz receiver is always ready to observe. Observing bands can be changed in 1.5s. Phase stability across observing bands must be maintained. A catalog of 10,000 - 30,000 calibrator sources is needed. Flexible choice of the calibrator (the closest brightest source) and optimal calibration details (the cycle time which maximizes efficiency) must be considered by the dynamic scheduling.

Without WVR, a switching cycle will typically be 25s: 3s spent slewing, under 1s spent on calibrator detection, and 21s spent observing the target source. Fast switching efficiency, considering decorrelation and duty cycle, will range from 0.80 to 0.90. Below 300GHz, calibration will often be done at the target frequency. Above 300GHz, calibration will usually be done at 90GHz, and an extra cross-band instrumental phase calibration sequence will be performed.

Fast switching with a cycle time of 25s will correct for phase fluctuations on time scales down to about 10s through interpolation. As fast switching cannot correct for phase fluctuations on timescales less than 10s, WVR can effectively reduce the decorrelation from residual phase errors. Fast switching and WVR can work together: WVR is designed to recover phase increments, but not the absolute phase, and hence requires some form of fast switching. WVR will increase the switching cycle time and will also reduce the decorrelation losses, thereby improving the sensitivity.

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