Subject: Just to be paranoid, here's a potential source of pointing errors associated with switching to Antonio feeds
From: Ron Maddalena <rmaddale@citlink.net>
Date: 3/4/2021, 15:34
To: Alex Pollak <apollak@seti.org>, David Robert DeBoer PhD <ddeboer@berkeley.edu>
CC: Franklin Antonio <franklin@franklinantonio.org>, Wael Farah <wael.a.farah@gmail.com>, Andrew Siemion <andrewpvsiemion@gmail.com>

Alex & David,

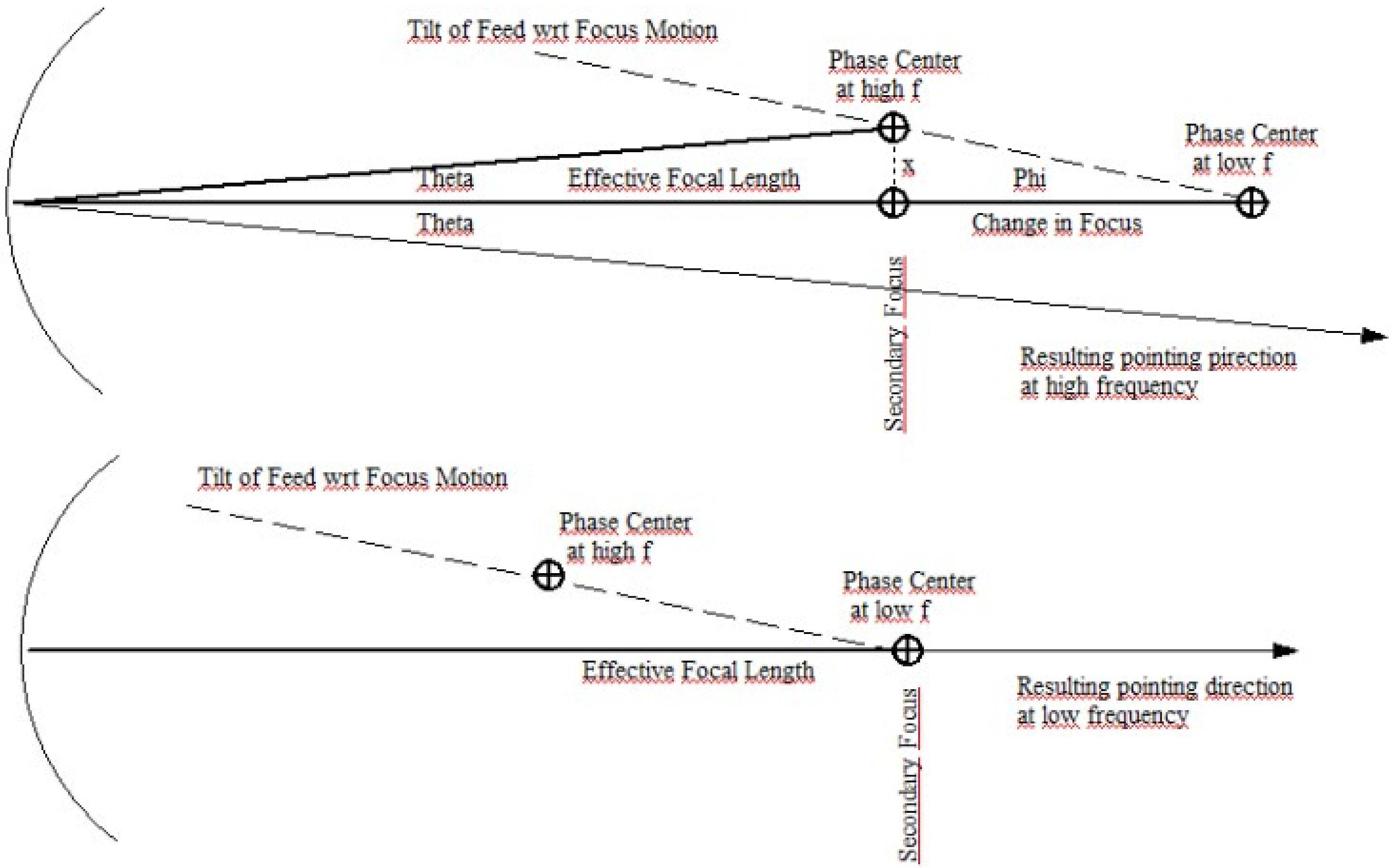
There's one potential cause of pointing errors that I'm sure the designers of the ATA took into consideration but that, over time, might have been undone. It's the spec for the alignment of the axis of the feed with respect to the axis of the focus drive. Below, I'm ball-parking that the alignment of the feed axis must be about 0.5d of perfect alignment in order to eliminate a significant '**frequency-dependent**' pointing error. Alex should be able to refine my estimate by using better values than I have. Since feeds have been replaced, was there a way that the feed alignment was kept to this kind of spec when they were assembled?

This is unique in my experience. Details....

In order to keep the phase center of the feed at the secondary focal point, and since the phase center moves up the feed as one increases the observing frequency, observing scripts move the feed away from the secondary mirror as tuning frequency increases.

If the feed alignment is not sufficiently accurate, the phase center of the feed will shift laterally as the focus changes. The larger the focus change (i.e., frequency change), the larger the lateral shift for a misaligned feed. And, since a lateral shift of the phase center is a change in the telescope's pointing, a tilted feed would produce a pointing offset that is frequency dependent. Thus, if there are tilts, then deriving a perfect pointing model from measurements of GPS satellites at 1.8 GHz may actually produce large pointing errors at high frequencies. One way to compensate for a misaligned feed would require measuring a pointing model at both low and high frequencies. And, that would increase the work needed.

Here's how I came up with an estimate. The following sketch, which is way out of scale, shows how a tilt of the feed wrt the focus drive at high frequency (top panel) produces a pointing change relative to a low frequency observation (lower panel).



In the top panel, theta is the pointing error that results from the lateral displacement of the phase center by x. Phi is the error in feed tilt. So:

phi = theta * Change in Focus / EFL.

If we want 5% accuracy between antenna in Trcvr measurements at 11 GHz when observing point sources, the beam pattern determines that theta must be < 2.4 arcmin. EFL is about 5m, I don't know the full range for the shift of the feed phase center with frequency but, I guess it is something like 0.5m. Thus, if my values aren't too off, the accuracy of the feed tilt must be better than about 0.5 degrees. And, x must be under about 3.5 mm.