EVLA Memo #81

Azimuth Cable Wraps and E-Array Layout

Jim Ruff
7/13/2004

Abstract

Implementation of the EVLA Fiber Optic Cable wrap has led to improvements in azimuth motion control. The effect of foundation pad orientation on azimuth coverage is detailed.

Introduction

Adding the 'watch-spring' fiber cable wrap has caused us to change some traditional operating procedures. These changes will result in easier and safer arm-to-arm antenna moves. The emails included here as Appendix 1 give an idea of what has been done and why.

These changes have resurrected the question of Az wrap effect on E-Array layout. This memo will explain all in excruciating detail. But first, allow me to state one fact:

The Watch-spring cable wrap does not restrict azimuth motion.

Azimuth motion is limited by the original 'maypole' cable wrap. This wrap, if carefully set up, can allow just over 660° of azimuth motion. The watch-spring wrap allows the same, or slightly more, travel.

History and Recent Developments

The original VLA spec called for azimuth travel of +/- 270°.

When an antenna changed arms, the cable wrap was rotated to center the azimuth travel due south. The azimuth limit switches - attached to the cable wrap - moved accordingly. This method was simple and reliable. It was also a pain in the neck to move the heavy cable wrap structure, and the limit switch arrangement was less than ideal.

A few years ago, the limit switches were moved from the cable wrap to the 'Limit Switch Tree'. This protected the switches from accidental bumping and simplified adjustment. The tree allowed +/-270° of travel and was adjusted after arm-to-arm moves to center the travel due south. But the switches were no longer mounted directly to the cable wrap they were protecting.

Concurrently, the cable wrap adjusters were adjusting the wraps to work on all four arms. By setting the wrap tight CW on the west arm and tight CCW on the North arm, the South and East arms would fall in between and the awkward cable wrap would not need to be moved.

This was the situation until EVLA. It worked well.

Enter Fiber Optics

The EVLA watch-spring wrap mounts to the moveable part of the maypole wrap. It needs to be well centered relative to the maypole. This means that it is no longer practical to readjust the maypole wrap for arm-to-arm moves. In order for the watch-spring wrap to work reliably, it and the maypole wrap both need to accommodate the full range of antenna motion without adjustment.

The full range of antenna motion turns out to be 660°. This motion is fixed w.r.t. the antenna pedestals as shown by the black spirals in figure 1. Setting both cable wraps correctly allows at least +/-270° azimuth motion from due south in all four arms. In fact, even more motion is possible. For example, the north arm can go from 270° CCW to 390° CW from due south.

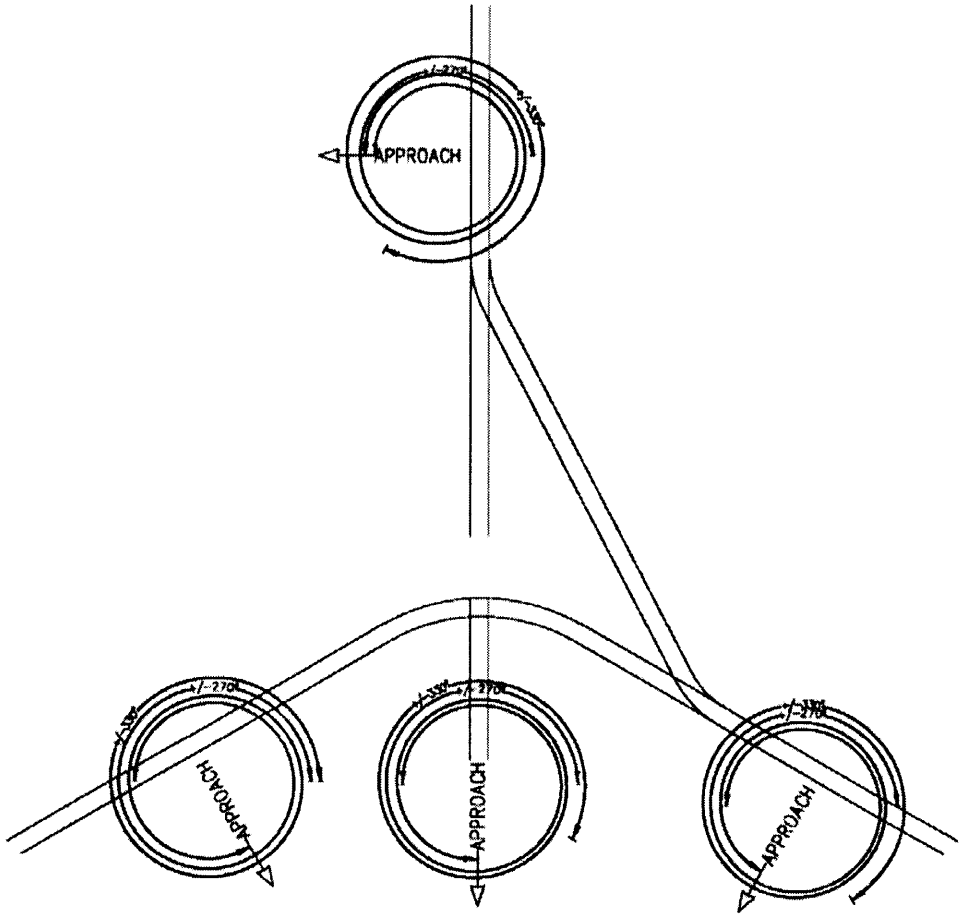

Figure 1

Since the cable wraps are never again to be adjusted, there is no longer a need to adjust the end-of-travel limit switches. Luckily, the existing L.S. trees can be easily stretched to handle 660° of travel. This has been done for A13 and is in progress for A14.

E-Array

E-Array construction cost can be minimized by using existing track as much as possible. This makes it desirable to approach the new pads from different directions. Some of these approaches will result in less than 270° travel from due south.

For example, antennas on pads east of the North arm would go from 210° CW to 450° CCW. Antennas west of the northwest arm would go from 420° CW to 240° CCW. See figure 2.

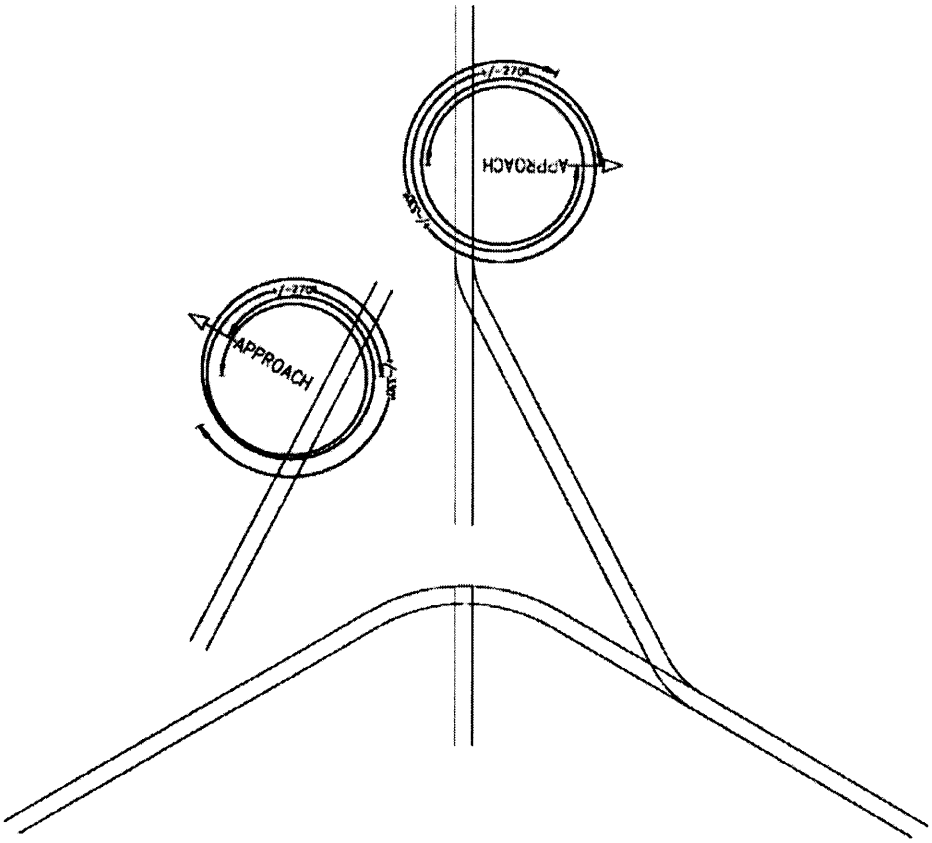

Figure 2

There are several alternatives for dealing with this, but getting more travel out of the azimuth wraps is not among them. Neither wrap will support more travel reliably in its present configuration.

Some possible solutions include:

Software. Scan observe files prior to running. Flag or auto-correct if necessary.
Hardware. Replace or modify cable wraps for more travel. (Feasibility unknown.)
Civil works. Align new pads between SSE and W. (Expensive!)
Do nothing. Antennas would occasionally go into az limits. How often? Once a year or once a week?

Appendix 1: Two emails

Subject: **Ant.13 Az. cable wrap**
From: Jim Ruff <jruff@aoc.nrao.edu>
Date: Tue, 06 Jul 2004 15:29:46 -0600

Folks,
Events in the last week or two have pointed out a problem in the way we control antenna azimuth travel. This problem must be corrected or it's only a matter of time until we have a costly accident.

Here's the problem: The limit switch tree accommodates 540d of travel. The antennas have to accommodate 660d of travel to allow them 540d on any arm. We have been handling this by moving the limit switch actuator when changing arms. Do it wrong, and the antenna can go beyond where it's supposed to go - with dire consequences. This almost happened to A13 two weeks ago.
Here's the solution: Modify the limit switch tree to accommodate 660d, place the travel limits at each end, and never move them or the actuator again. Then we can set the az wraps to work within that range of travel with confidence that the antenna won't go beyond.

We should know better tomorrow how long all of this will take.

Things left unsaid:
Actual total travel is 660d plus a bit - say 670d. Same for 540d for any arm.
The old cable wrap on A13 may not be set up quite right.
A6 and A14 will need their L.S. trees modified, but the az wraps should be OK.
We will need to do this for all antennas. The sooner the better.
The center of absolute antenna travel is at 272-332 = 300d with the ACU set for West arm.

Subject: **Re: Ant.13 Az. cable wrap: Update**
From: Jim Ruff <jruff@aoc.nrao.edu>
Date: Thu, 08 Jul 2004 15:27:27 -0600

Folks,
The limit switch mods and cable wraps in A13 are ready to go. Fiber group is connecting now. The lead/lag switches still need adjustment.
It is no longer necessary to adjust the limit switch tree when changing arms. In fact, once the lead/lag switches are set, no one should even touch it unless something on it breaks.

Following is a "for the record" description of what we did. Most of you probably want to stop reading here...

1) Check 3-ball az position.
2) Set ACU to west arm and go to 300d. This is the mid point of azimuth motion.
3) The maypole cable wrap should be straight.
4) Swap L.S. Tree with one modified for full travel and slotted switch mounting. Set the actuator on the new tree near the center scribe mark (+/-1/8"). Leave the first limits off for now.
5) Go CW to 275d. This is the absolute CW limit. Make sure the maypole cable wrap is tight but not too tight. 6) Set the CW#2 limit to trigger at 275+/-1d. Run into this limit several times to make sure it's right.
7) Wind the fiber wrap tight on the outer ring. Bring the inside end to the inner ring & attach with a small amount of slack: 1-2 inches.
8) Back up to 272d. Set the CW#1 limit to trigger at 272+/-1d. Run into this limit several times to make sure it's right.
9) Go CCW to 325d. This is the absolute CCW limit. Watch the fiber wrap to make sure it doesn't run out of slack. Make sure the maypole cable wrap is tight but not too tight. 10) Set the CCW#2 limit to trigger at 325+/-1d. Run into this limit several times to make sure it's right. 11) Back up to 328d. Set the CCW#1 limit to trigger at 328+/-1d. Run into this limit several times to make sure it's right.
12) Go limit to limit several times to make sure everything is working smoothly.