Antenna Noto Drive: Tracking Errors with 'Position Track' and 'Preset' ACU Modes

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Abstract

Measurements have been realized in order to determine the difference between two modes available to drive the antenna using the new Vertex ACU. The two methodes under comparison are the 'Preset' and the 'Position Track', as defined by the ACU firmware, and they are evaluated in order to determine performance in terms of tracking errors.
Some conclusion are reported with the planned actions for improving antenna operations.

1. Introduction

The aim for performing the test we describe in this memo is mainly motivated by the necessity to compare the performance of two possible modes to drive the antenna, as offered by the new Vertex ACU. The first method is the simplest one and is identical to the mode used with old system. In such case single commands are sent to the antenna control unit, having as information the desired coordinates where the antenna would be desired to stay. Then at the appropriate time the PC deputed to calculate the trajectory is sending to the ACU the position where the antenna has to point. In Noto the driving software is working in a real-time fashion, operating under a not multitasking operating system, the DOS with the hardware synchronization with the station 1PPS. The antenna control program is calculating ten times per second the new coordinates with high accuracy and is, at present, sending the information to the antenna with the precision of 0.001 degrees in both azimuth and elevation.
The pointing trajectory is then composed by the sequence of ten coordinates in one second in steps. Such method implicitely produces an offset depending on the velocity required by the antenna to follow the source on the sky. In other terms, depending on the speed the antenna is having a tracking error will be present, with very small values (few units of 10-3 degrees) at low velocities, up to larger values (some units of 10-2 degrees), degradating the tracking performance.
In order to avoid such effect different driving methods are introducted in the ACU and the simplest one is making use of the socalled feed-forward, where an estimation of the antenna speed is used to give a prevision of the coming coordinate to be pointed. Such value needs to be 'credible' by the control loop, with respect to the coordinates sent, so that it needs to be finely tuned with such coordinates. The driving method is called 'Position Track'.
In the case of the Noto antenna drive program the velocity estimation is calculated from a sequence of the last ten values, then with a 1 sec delay for each tenth of second and sent to the ACU ten times a second togheter with the coordinates.
Some measurements have been realized of the position error in azimuth and elevation with different velocities using the 'Preset' and 'Position Track' modes, on order to evaluate the possible differences.

2. Measurements

The position errors are evaluated by the ACU as difference between the position where the antenna is expected to point with respect to the one where the antenna is pointing. Such value is available as voltage output by the ACU, similarly to several other parameters and can be easily monitored with a chart recorder.
In the figures are reported some of the measurements that have been realized in Noto, having as parameter the axis speed. It can be seen as driving with the 'preset mode' produce an offset depending on the antenna speed. Such effect is removed with the 'position mode' selected, because of the feedforward introduction. The effect it's particularly severe for high elevations, when the source trajectory requires a large speed in azimuth. No significative differences are noticed with respect to the tracking noise, even if a small increment seems to be present in some position track graphs.
Fig.1 shows the pointing error for the elevation axis with speed 0.002 degree/s. One voltage unit is equivalent to 1 mdegree. Position track and preset modes are reported and is evident as while in position track the offset is around zero, in preset, even if less noisy, hte error is stably around one unit.
In fig.2 the azimuth axis is reported at low speed, 6 mdegree/s. Still is evident as in preset mode an offset appears, and this is significately more evident as speed increases in fig. 3 and 4, with 15 and 35 mdegree/s respectively. Tracking noise is more evident in the position mode drive method

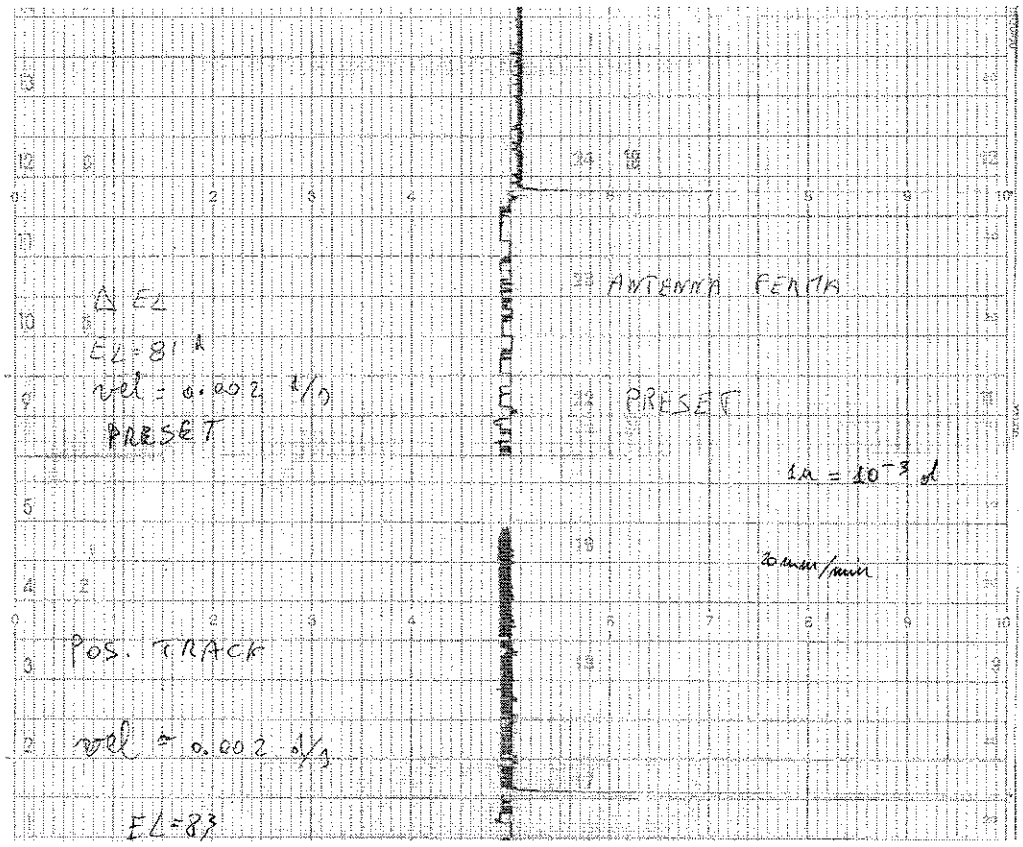
ANTENNA FERMI
PRESET
1m = 10⁻³ d
2mm/min
POS. TRACK
EL=81°
vel = 0.002 °/s
PRESET
vel = 0.002 °/s
EL=83°

Fig. 1

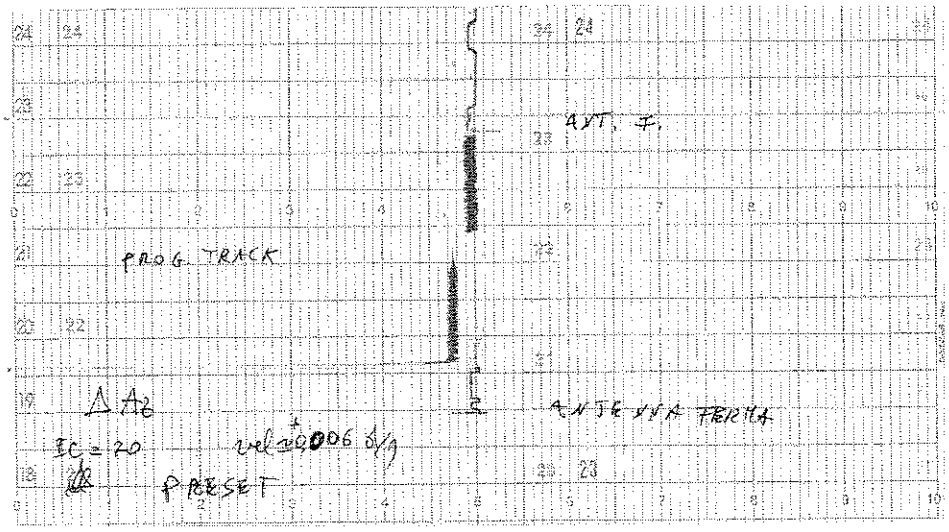
ANT. F.
PROG. TRACK
ANTENNA FERMI
EL=20°
vel=0.006 °/s
PRESET

Fig. 2

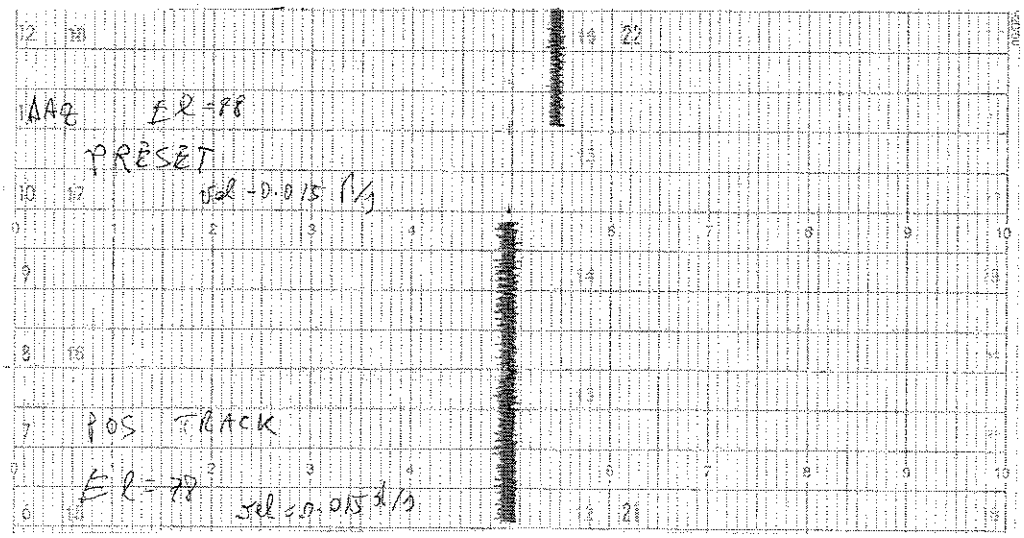
ΔAz
ER=78
PRESET
vel=0.015 d/s
POS TRACK
ER=78
vel=0.015 d/s

Fig. 3

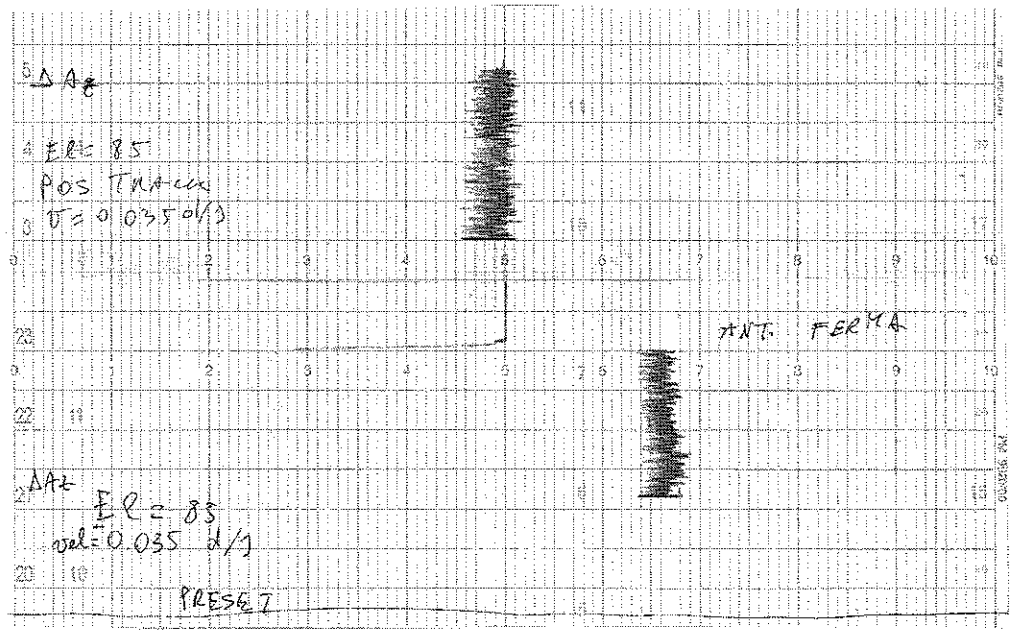
ΔAz
ER=85
POS TRACK
v=0.035 d/s
ANT. FERMA
ΔAz
ER=85
vel=0.035 d/s
PRESET

Fig. 4

3. Conclusions

In our opinion some improvement need to be done in the antenna driving system, and in particular seems to be essential:

a) continuing to produce drive commands with a real-time like system, for getting regularity in the calculation and command sending;

b) to use not less than ten command per second, in order to maintain a velocity estimation coherent with the calculated positions, as the ACU requires;

c) the drive software need to send pointing coordinates with more precision, as the calculation is producing. Modification in the drive generation and interface software will be introduced;

d) the 'program mode' available in the ACU will be used only for the highest frequencies, only in tracking mode, in order to reduce the tracking noise;

e) investigate on the tracking noise in the different modalities.

Few other improvements will be introduced:

f) pointing parameters automatically selected in the pointing computer, under FS control;

g) antenna 'setup' and 'autostow' inside the drive cycle, so to allow antenna remote control even in the parking and start of functionalities;

h) different additional scanning methods for mapping and fast data acquisition;

i) antenna real-time image on a web page for remote check;

j) automatic oscillation recognition with antenna recovery.

The presence of wind seems to be related to the oscillation problem. Regardless of the oscillation trigger condition it looks useful to monitor in different significative points the antenna acceleration. For such purpose a dedicate and simple hardware will be installed, and measurements will be reported in an other document.