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NCS GISMO Features

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About this document

Notes about work done during Technical Time for the NCS 2008-09, to support special observing features requested for GISMO. This documents assumes the reader is familiar with the previous discussions we have had about “curves” and the definition of Lissajous subscans.

Lissajous Curves and “do-nothing” Subscans

Experimental support for Lissajous curves is implemented in the development versions of antennaMD (v 2008-05-31) and pako (v 1.0.10), as well as in coordinator and data handling software.¹

Pako Commands

To request a scan with 2 “do-nothing” subscans and one Lissajous subscans, enter, e. g., in a pako script:

```
diy /clear
subscan -1800 0 /ts 12 /cr "R" /sys trueHorizon
subscan 360 360 0.01 0.02 0.0 0.0 0.0 0.0 /to 67.0 /cr "0" /sys trueHorizon
subscan 1800 0 /ts 12 /cr "R" /sys trueHorizon
diy
PAUSE "good to go? [c/q]"
start subscan
```

The 1st and 3rd **subscan** are “do-nothing” subscans at offsets (-/+) $1800\ 0$ [arc sec] in the “true-angle” horizontal system; **/ts 12** sets the time per subscan to 12 [s]; **/cr “R”** means reference (“do-nothing”; maybe we should introduce a new code specifically for GISMO “do-nothing”?)

The 2nd **subscan** is a Lissajous subscan with parameters, each for x and y: amplitudes in [arc sec]; frequencies in [Hz]; center positions in [arc sec]; and phase shifts in [rad]. **/to 67** sets a time per OTF subscan of 67 [s]. **/cr “0”** means “on-source” (“do-something”).

diy without options lists the defined subscans in the command-line window.

start subscan submits the defined DIY list of subscans to the queue; the name of the observing mode given in the XML file is “DIY”.

(**diy /clear** clears any previously defined subscan sequences.)

These pako commands are under development and possibly will be somewhat modified before release (to make them “easier” / more flexible), but they should keep essentially the same functionality.

¹ For the GISMO tests there will of course be instructions how to start the correct versions of the software.

Tests in TT NCS 2008-09-05 and -08

We defined test scans similar to the one described above and checked in the resulting data files:

1. if the commanded position offsets correspond to the expected Lissajous curve
→ conclusion: OK
2. the tracking errors

Scan 2008...	Slow loop	Amplitude	Omega	Elev.	max absolute track error ~
	[Hz]	['']	[rad/s]	[deg]	['']
0905s133	1	60 60	0.1 0.2	27	1
0905s144	1	120 120	0.1 0.2	40	2
0908s146	1	240 240	0.1 0.2	48	2
0908s148	1	360 360	0.1 0.2	34	2
0905s134	1	600 600	0.1 0.2	28	5
0905s138	1	60 60	0.314 0.628	33	2
0905s140	1	120 120	0.314 0.628	35	4
	1	240 240	0.314 0.628		Not possible
	1	600 600	0.314 0.628		Not possible
0908s151	1	1200 1200	0.0314 0.0628	31	8 in az. 2 in el.
0905s142	1	60 60	0.3 0.4	36	3

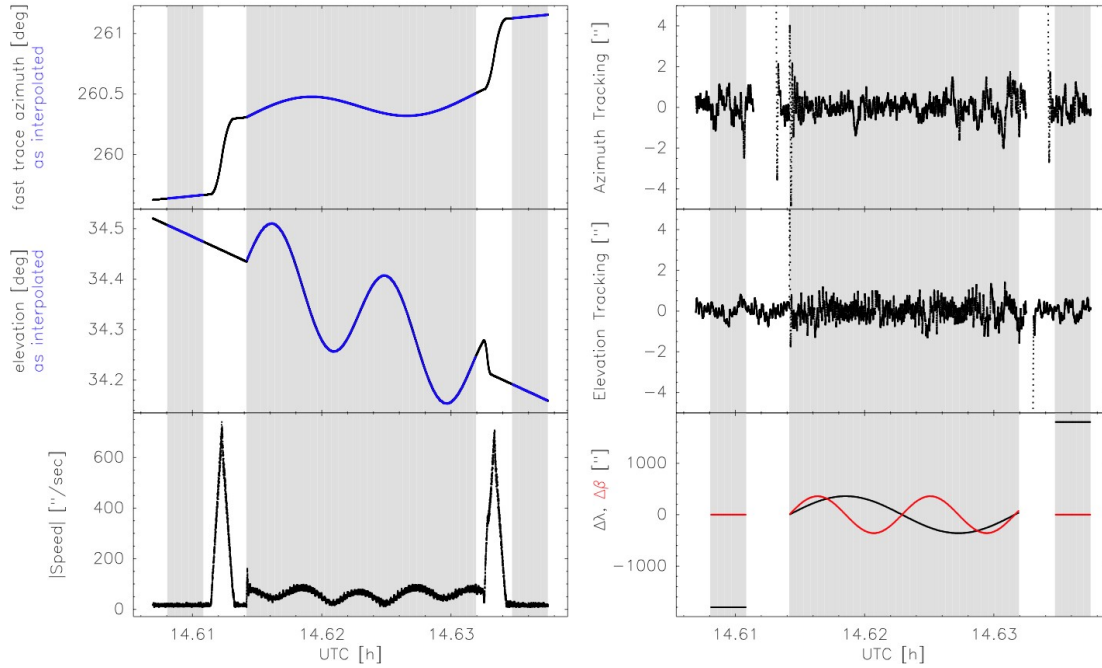
The above would imply that practical limits on the amplitude are,
if one allows somewhat enlarged tracking errors:

about 120 [arc sec] for frequencies around 1/10 [Hz]

about 400 – 600 [arc sec] around 1/30 [Hz]

about 1000 – 1200 [arc sec] around 1/100 [Hz]

Note that this corresponds approximately to the dashed light blue line in the diagram of the Lissajous parameter space (email HU 2008-04-23).



The figure shows as an example scan 20080908s148: azimuth, elevation, speed, tracking error, and offsets. The time range of the subscans is indicated by the grey background; the middle subscan is the Lissajous curve. Note the increased tracking error at the start of the Lissajous curve; this is generally seen, but more extreme for larger amplitudes or frequencies. Note: this and the other plots were made using the MIRA software (HW); the values of the positions during the subscans are interpolated to the times of the readout of the backend data; the tracking errors are as delivered from the antenna MD software.

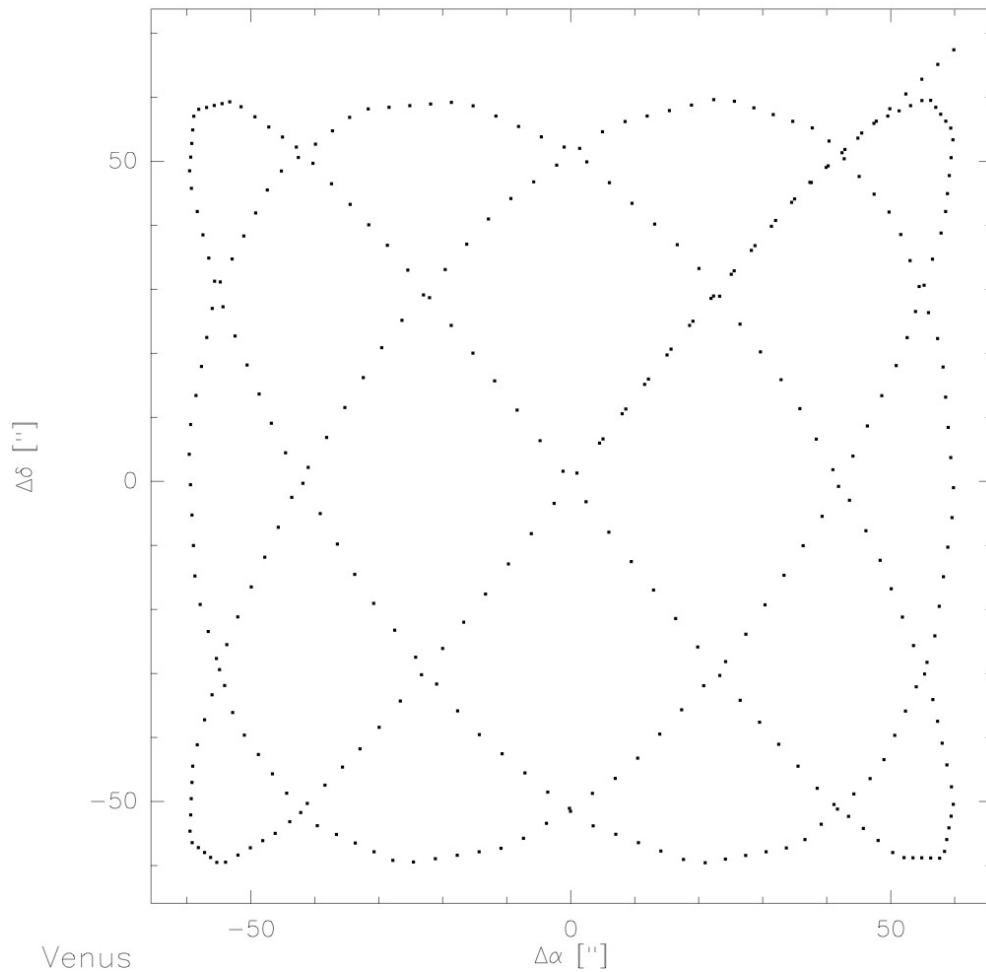
We also did a few tests running the “slow loop” at a rate higher than the standard 1 [Hz]. As expected, this results in smoother curves and allows higher accelerations, therefore higher amplitudes at a given frequency:

Scan 2008...	Slow loop	Amplitude	Omega	Elev.	max absolute track error ~
	[Hz]	['']	[rad/s]	[deg]	['']
0905s163	4	600 600	0.1 0.2	49	2
0905s166	4	1200 1200	0.1 0.2	48	2, higher at start
0905s164	4	240 240	0.314 0.628	49	2
0905s165	4	600 600	0.314 0.628	48	3, higher at start
0905s168	4	3600 3600	0.0314 0.0628	47	2
	4	3600 3600	0.0628 0.1257	48	not possible elev.
0905s162	4	60 60	0.3 0.4	46	2
0905s172	8	600 600	0.314 0.628	46	3, higher at start
0905s169	8	60 60	0.3 0.4	46	2

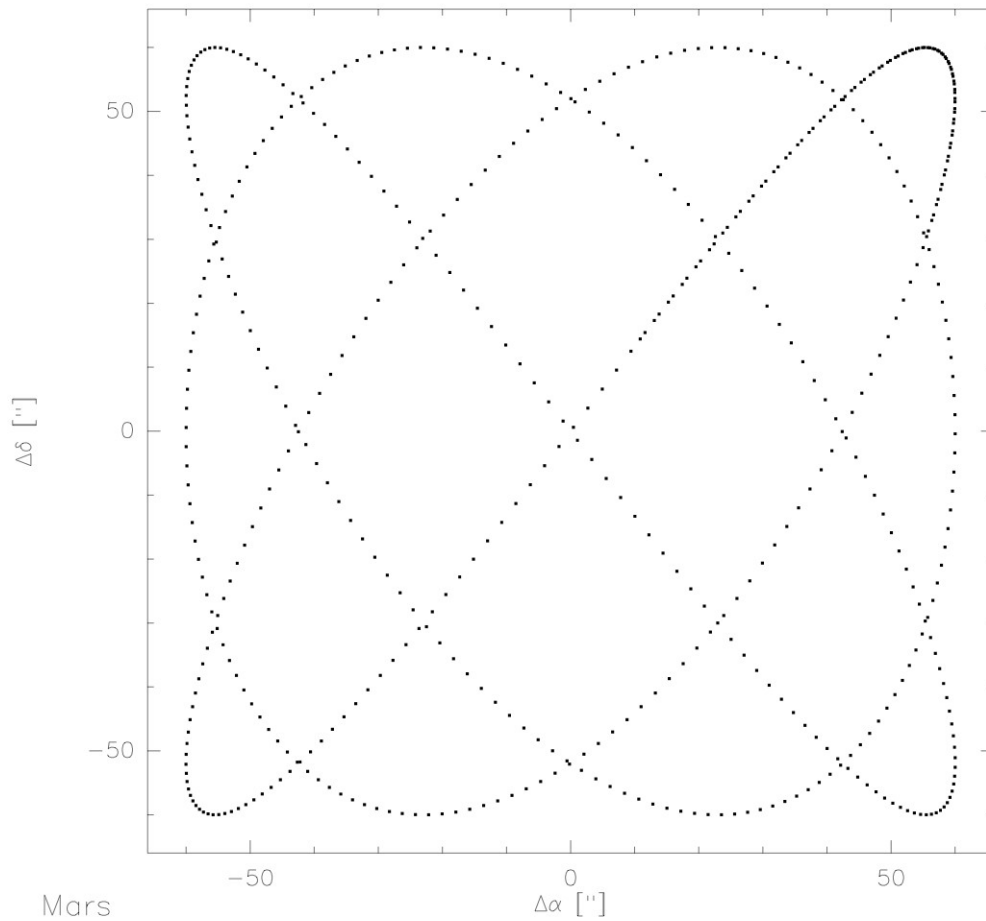
A faster rate for the slow loop is also expected to have additional benefits, e. g., when changing between subscans.

However, running the slow loop at rates higher than 1 Hz is a fundamental change in the antenna MD software, may require additional code changes, and *will require many more extensive tests of all observing modes.*²

² Lissajous curves and higher rates for the slow loop are both implemented in the same development version of antenna MD. The slow rate can be selected.



Position offsets during a more complex Lissajous curve, interpolated to the times of the data readout from the backends. The slow loop rate is 1 [Hz]; note the "straight line segments" of about 1 [s] duration, especially visible near the turn-around points.



As the previous figure, however with a slow loop rate of 8 [Hz]: the curve is much “smoother”. Remember that the position offsets are interpolated to the times of the data readout from the backends.³

³ This means that their spacing does not directly reflect the slow loop rate!

Azimuth, Elevation, and “do-nothing” subscans in one scan

Similar to the pako example for “do-nothing” with Lissajous, we can do-nothing with subscans in azimuth and elevation:

```
diy /clear
!
clear plot
box
!
subscan -400 0 /ts 12 /cr "R" /sys trueHorizon
!
subscan -200.0000 -10.00000 200.0000 -10.00000 /to 30 /cr "0" /sys trueHorizon
subscan 200.0000 0.00000 -200.0000 0.00000 /to 30 /cr "0" /sys trueHorizon
subscan -200.0000 10.00000 200.0000 10.00000 /to 30 /cr "0" /sys trueHorizon
!
subscan -10.0000 200.00000 -10.0000 -200.00000 /to 30 /cr "0" /sys trueHorizon
subscan 0.0000 -200.00000 0.0000 200.00000 /to 30 /cr "0" /sys trueHorizon
subscan 10.0000 200.00000 10.0000 -200.00000 /to 30 /cr "0" /sys trueHorizon
!
subscan 400 0 /ts 12 /cr "R" /sys trueHorizon
!
diy
!
PAUSE "good to go? [c/q]"
start subscan
!
```

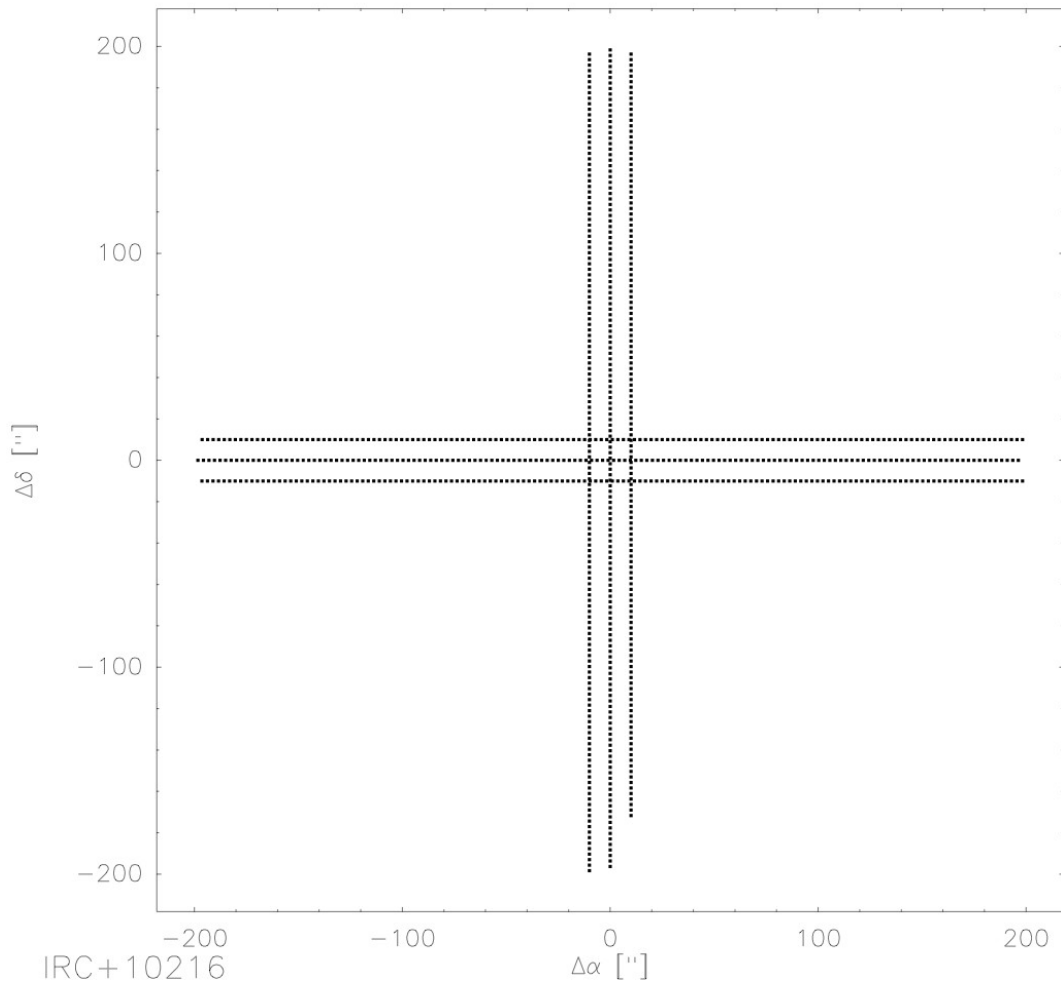
For example

```
subscan -200.0000 -10.00000 200.0000 -10.00000 /to 30 ...
```

requests an OTF subscan from offsets azimuth -200 / elevation -10 to offsets azimuth 200 / elevation 10 [arc sec] with a time for the OTF subscan of 30 [s].

Test example: scan 20090908s140

2008-09-08 /SCAN 140



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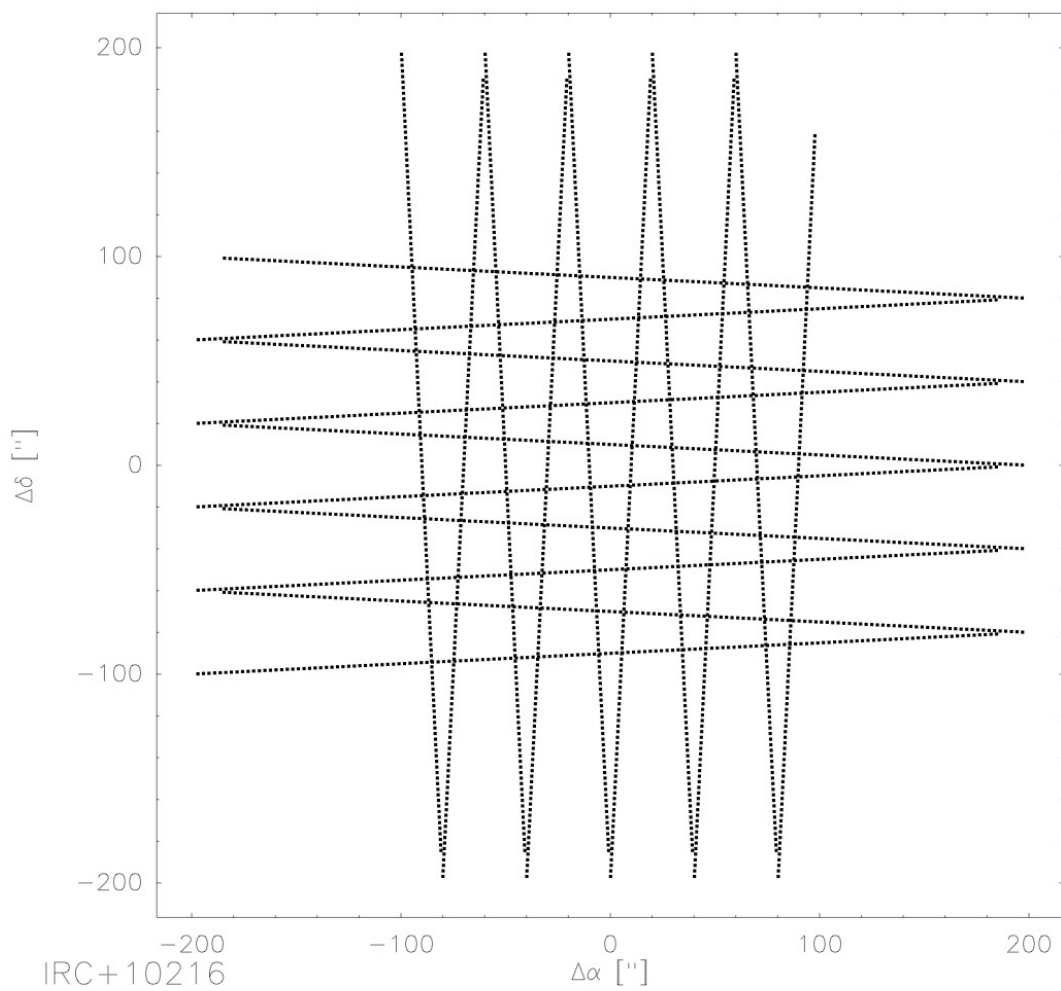
_ Some "expected" points may be missing because the data handling software is very conservative as to which data are valid at the ends of subscans.

Azimuth & Elevation “zigzag” and “do-nothing” in one scan

The azimuth and elevation subscans do not need to be parallel:

```
diy /clear
!
clear plot
box
!
subscan -444 0 /ts 12 /cr "R" /sys trueHorizon
!
subscan -200.0000 -100.0000 200.0000 -80.0000 /to 30 /cr "0" /sys trueHorizon
subscan 200.0000 -80.0000 -200.0000 -60.0000 /to 30 /cr "0" /sys trueHorizon
subscan -200.0000 -60.0000 200.0000 -40.0000 /to 30 /cr "0" /sys trueHorizon
subscan 200.0000 -40.0000 -200.0000 -20.0000 /to 30 /cr "0" /sys trueHorizon
subscan -200.0000 -20.0000 200.0000 0.0000 /to 30 /cr "0" /sys trueHorizon
subscan 200.0000 0.0000 -200.0000 20.0000 /to 30 /cr "0" /sys trueHorizon
subscan -200.0000 20.0000 200.0000 40.0000 /to 30 /cr "0" /sys trueHorizon
subscan 200.0000 40.0000 -200.0000 60.0000 /to 30 /cr "0" /sys trueHorizon
subscan -200.0000 60.0000 200.0000 80.0000 /to 30 /cr "0" /sys trueHorizon
subscan 200.0000 80.0000 -200.0000 100.0000 /to 30 /cr "0" /sys trueHorizon
!
!
subscan -100.0000 200.0000 -80.0000 -200.0000 /to 30 /cr "0" /sys trueHorizon
subscan -80.0000 -200.0000 -60.0000 200.0000 /to 30 /cr "0" /sys trueHorizon
subscan -60.0000 200.0000 -40.0000 -200.0000 /to 30 /cr "0" /sys trueHorizon
subscan -40.0000 -200.0000 -20.0000 200.0000 /to 30 /cr "0" /sys trueHorizon
subscan -20.0000 200.0000 0.0000 -200.0000 /to 30 /cr "0" /sys trueHorizon
subscan 0.0000 -200.0000 20.0000 200.0000 /to 30 /cr "0" /sys trueHorizon
subscan 20.0000 200.0000 40.0000 -200.0000 /to 30 /cr "0" /sys trueHorizon
subscan 40.0000 -200.0000 60.0000 200.0000 /to 30 /cr "0" /sys trueHorizon
subscan 60.0000 200.0000 80.0000 -200.0000 /to 30 /cr "0" /sys trueHorizon
subscan 80.0000 -200.0000 100.0000 200.0000 /to 30 /cr "0" /sys trueHorizon
!
subscan 444 0 /ts 12 /cr "R" /sys trueHorizon
!
diy
!
PAUSE "good to go? [c/q]"
start subscan
!
```

Test example: scan 20090908s142



TBD

Improve pako commands for DIY subscan sequences⁴:
more checks and convenience features.

Check curve execution and positions on source (astronomical tests).

Test more parameter space in frequency, amplitude, and elevation.

Check and improve details of execution and messages at start and end of OTF subscans, in particular curves.

More tests, and maybe debugging, of “fast slow loop” with 2, 4, 8 Hz.

Gentle start into fast curves.

Notes

The maximum rate for the “fast trace” data is 128 Hz, the rate of the fast loop. This includes data for azimuth and elevation and tracking errors.

The maximum rate of the slow loop, and of the “slow trace” data, is 8 Hz. This includes data for the commanded position offsets.

⁴ So far they are functional, but very rudimentary

Appendix

Messages

The messages produced during the execution of a DIY subscan sequence are, e. g.:

```
<TR><TD>rxCS:2008-09-05.140:scanDone</TD><TD>2008-09-05T10:51:15.917</TD></TR>
<TR><TD>beCS:2008-09-05.140:scanDone</TD><TD>2008-09-05T10:51:15.896</TD></TR>
<TR><TD>beCS:2008-09-05.140.3:subscanDone</TD><TD>2008-09-05T10:51:15.893</TD></TR>
<TR><TD>masterCS:2008-09-05.140:scanDone</TD><TD>2008-09-05T10:51:15.758</TD></TR>
<TR><TD>antCS:2008-09-05.140:scanDone</TD><TD>2008-09-05T10:51:15.757</TD></TR>
<TR><TD>masterCS:2008-09-05.140.3:subscanDone</TD><TD>2008-09-05T10:51:15.637</TD></TR>
<TR><TD>antMD:2008-09-05.140.4:subscanStarted</TD><TD>2008-09-05T10:51:15.000</TD></TR>
<TR><TD>antMD:2008-09-05.140.3:subscanDone</TD><TD>2008-09-05T10:51:15.000</TD></TR>
<TR><TD>antMD:2008-09-05.140.3:backOnTrack</TD><TD>2008-09-05T10:51:02.000</TD></TR>
<TR><TD>beCS:2008-09-05.140.2:subscanDone</TD><TD>2008-09-05T10:51:00.484</TD></TR>
<TR><TD>masterCS:2008-09-05.140.3:subscanStarted</TD><TD>2008-09-05T10:51:00.224</TD></TR>
<TR><TD>masterCS:2008-09-05.140.2:subscanDone</TD><TD>2008-09-05T10:51:00.221</TD></TR>
<TR><TD>antMD:2008-09-05.140.2:subscanDone</TD><TD>2008-09-05T10:51:00.000</TD></TR>
<TR><TD>antMD:2008-09-05.140.3:subscanStarted</TD><TD>2008-09-05T10:51:00.000</TD></TR>
<TR><TD>antMD:2008-09-05.140.2.1:segmentDone</TD><TD>2008-09-05T10:51:00.000</TD></TR>
<TR><TD>antMD:2008-09-05.140.2.1:segmentStarted</TD><TD>2008-09-05T10:50:36.000</TD></TR>
<TR><TD>antMD:2008-09-05.140.2.1:backOnTrack</TD><TD>2008-09-05T10:50:34.000</TD></TR>
<TR><TD>beCS:2008-09-05.140.1:subscanDone</TD><TD>2008-09-05T10:50:32.470</TD></TR>
<TR><TD>masterCS:2008-09-05.140.2:subscanStarted</TD><TD>2008-09-05T10:50:32.358</TD></TR>
<TR><TD>masterCS:2008-09-05.140.1:subscanDone</TD><TD>2008-09-05T10:50:32.209</TD></TR>
<TR><TD>antMD:2008-09-05.140.1:subscanDone</TD><TD>2008-09-05T10:50:32.000</TD></TR>
<TR><TD>antMD:2008-09-05.140.2:subscanStarted</TD><TD>2008-09-05T10:50:32.000</TD></TR>
<TR><TD>antMD:2008-09-05.140.1:backOnTrack</TD><TD>2008-09-05T10:50:19.000</TD></TR>
<TR><TD>rxCS:2008-09-05.140.1:synthesizersAdjusted</TD><TD>2008-09-05T10:50:18.593</TD></TR>
<TR><TD>masterCS:2008-09-05.140.1:subscanStarted</TD><TD>2008-09-05T10:50:18.151</TD></TR>
<TR><TD>masterCS:2008-09-05.140:scanStarted</TD><TD>2008-09-05T10:50:18.149</TD></TR>
<TR><TD>antMD:2008-09-05.140.1:prepared</TD><TD>2008-09-05T10:50:18.000</TD></TR>
<TR><TD>antMD:2008-09-05.140.1:subscanStarted</TD><TD>2008-09-05T10:50:18.000</TD></TR>
<TR><TD>antMD:2008-09-05.140.1:preparing</TD><TD>2008-09-05T10:50:09.000</TD></TR>
<TR><TD>swCS:2008-09-05.140:prepared</TD><TD>2008-09-05T10:49:51.226</TD></TR>
<TR><TD>rxCS:2008-09-05.140:prepared</TD><TD>2008-09-05T10:49:50.555</TD></TR>
<TR><TD>rxCS:2008-09-05.140:scanStarted</TD><TD>2008-09-05T10:49:50.554</TD></TR>
<TR><TD>rxCS:2008-09-05.140:synthesizersAdjusted</TD><TD>2008-09-05T10:49:50.553</TD></TR>
<TR><TD>swCS:2008-09-05.140:preparing</TD><TD>2008-09-05T10:49:50.288</TD></TR>
<TR><TD>coordinatorCS:2008-09-05.140:scanLoaded</TD><TD>2008-09-05T10:49:49.924</TD></TR>
```