Controlling the Tevatron Helix using the TEVHLX Open Access Client

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Introduction

With the installation of 2 new separators during the 2006 shutdown, there are now 15 Tevatron electrostatic separator stations and polarity switches for their power supplies. In addition, all polarity switches can be controlled via CAMAC 465 ramp cards. Although this functionality allows greater operational flexibility, it also complicates how we put beam on the proton or pbar helical orbits during studies or tune-up. This note describes new polarity conventions for the separators and the Open Access Client (OAC) TEVHLX that facilitates switching from one helix to the other via the ACNET device T:HELIX. Other separator-related devices owned by the OAC will also be described.

Overview

The TEVHLX OAC uses due38 as its operational Data Acquisition Engine (DAE). TEVHLX owns and controls the "global helix" device T:HELIX whose properties are summarized in Tables 1-4. The OAC also determines the V:HELIX state device setting/reading as described in Table 5. The T:HELIX device can be used to turn the helix on or off and switch between the central orbit, proton helix and pbar helix. The T:HELIX digital status indicates whether all separators are correctly configured (on/off, proton/pbar polarity) and identifies the specific separators that are not. T:HELIX will post a digital alarm when: 1) one or more separator power supplies are unexpectedly on or off, 2) one or more separator

polarity switches are in the wrong polarity, 3) all separators are in the pbar helix polarity, or 4) one or more separators are in condition mode. Figure 1 shows the S53 digital status page for T:HELIX.

Opening and closing the helix

The helix can be turned off or on using the T:HELIX ON and OFF control commands. Issuing an ON turns on all separator power supplies, and sending an OFF turns off all supplies. The ON status attribute indicates the most recently sent control operation (ON or OFF). If all separator power supplies are on or off as expected, the T:HELIX READY/TRIPPED status will be READY; otherwise it will be TRIPPED, and T:HELIX will post a digital alarm. Extended status bits indicate which separators have supplies that are incorrectly on or off.

Changing the helix polarity

The helix polarity can controlled by the PLUS (proton helix) and MINUS (pbar helix) control commands of T:HELIX. The positive/negative status attribute indicates the last requested polarity; the proton helix is positive (+) and the pbar helix is negative (-). Note that the OAC will turn off the separator supplies when changing polarity, but it will not turn the supplies back on. (It could, if desired.)

<u>How the OAC changes the helix polarity</u>

1. Turn off all separator power supplies.
2. Write +1 (proton helix) or -1 (pbar helix) to all polarity switch ramp card H-table scale factors (sf 03) used in every ramp. The specific ACNET device is the second element of the S-device, e.g., C:B7HSPS[2] for the B17 separator polarity switch.

3. Issue the PLUS (proton helix) or MINUS (pbar helix) control command to all polarity switch devices, e.g., C:B7HSP for the B17 separator polarity switch, to trigger interrupt P (proton helix) or O (pbar helix) and play a time ramp with the new scale factor.

Separator kick polarity follows the same convention as the sign of DFG kick angle: upward/inward kick of protons is positive, downward/outward kick of protons is negative. The C49 file separator polarity switch physics parameters adhere to this convention, as well as the polarity bits of the positive separator power supplies.

Polarity Monitoring

The OAC continuously monitors the polarity of each separator and reports if any separator has an incorrect polarity based on the current value of C:LBSEQ. This feature should be valuable during or coming out of a study period to help ensure all polarity switches are correctly configured for HEP. The OAC automatically reads the polarity switch parameters for the squeeze ramp in the active C49 file whenever the Tevatron reaches the front porch (V:CLDRST = 1). Users can force a C49 file read at any time using the T:HELIX RESET control. The OAC compares the positive supply polarity bits to the polarities read from the C49 file for the given value of C:LBSEQ, taking into account the sign changes if on the proton or pbar helix. T:HELIX will alarm if any discrepancies are found. The OAC performs the polarity check whenever the C:LBSEQ reading changes or any of the separators' power supplies changes status.

Run/Condition Mode Monitoring

The OAC also checks if the separators are in run or condition mode by monitoring the polarity bit of the negative supply ramp card, e.g., C:B7SHM. If any separator is in condition mode, the T:HELIX basic status will indicate TRIPPED and a digital alarm will post. The T:HELIX extended status bits will also indicate which separators are in condition mode.

Reflected Polarity Bit Readings

The TEVHLX OAC owns and controls reading-only devices that are reflections of the positive power supply polarity bits. These devices, e.g., C:B7HSPB, either have readings of +1 if the corresponding separator is in the plus polarity, or -1 if the corresponding separator is in the minus polarity. Figure 2 shows a parameter page displaying these devices. The devices are useful because they allow the *actual* separator polarity to be datalogged. The polarity switch ramp card devices, e.g., C:B7HSP, do not necessarily show the actual polarity, because the polarity switches are interlocked to prevent switching when the separator power supply voltages are above the switching limit.

Special Handling for Reverse Injection

During reverse injection tune-up, proton beam is put onto the pbar helix to allow injection back into the Main Injector via the A150 line. Consequently, the separators' polarities are switched for the pbar helix. Not all separators are used for the 150 GeV injection helix, so changing polarities for those separators is not necessary and leads to needless wear-and-tear for those polarity switches. The TEVHLX OAC now reads the C49 "open helix" ramp tables to determine which separators actually have voltage for the 150 GeV helix. When switching to the pbar helix during reverse injection (V:CLDRST = 3) only, the unused separators

do not have their polarity switch ramp card scale factors changed to -1, so those separators do not physically change polarity. The T:HELIX digital status bits are changed appropriately to prevent spurious alarms for incorrect polarity. (At the present time, only the C49H, D48H, A49H, B48V, C49V, D11V, and A49V separators are not used for the 150 GeV helix.)

Summary

The TEVHLX OAC was developed to facilitate status and control of the Tevatron helix now that all 15 separator stations have polarity switches that are controlled by CAMAC 465 ramp cards. The OAC runs on DAE engine due38 and supports the T:HELIX and V:HELIX ACNET devices. T:HELIX can be used to turn all separators on and off, and the switch between the proton and pbar helices. The OAC monitors the status of all separator power supplies and reports problems in the on/off status or polarity via the T:HELIX status or the readings of T:HELIX or V:HELIX. TEVHLX reads the active C49 file to obtain the expected polarities as a function of C:LBSEQ.

Summary of ACNET Devices

Table 1 – Values of the T:HELIX reading and their definitions.

T:HELIX reading	meaning
0	central orbit (separators OFF)
+1	proton helix (separators ON)
-1	pbar helix (separators ON)
999	invalid configuration (separators OFF or ON)

Table 2 - Definitions of the T:HELIX control attributes.

T:HELIX control	meaning
RESET	Reread C49 active file and update device
ON	Turn on all separator power supplies
OFF	Turn off all separator power supplies
PLUS	Turn off all separator power supplies, change to PROTON polarity
MINUS	Turn off all separator power supplies, change to PBAR polarity

Table 3 – Definitions of the T:HELIX ON and READY status attributes.

T:HELIX "on" attribute	T:HELIX "ready" attribute	meaning
on, O (cyan O)	ready, . (green dot)	helix open, all separators on
off, c (white c)	ready, . (green dot)	central orbit, all seprators off
on, O (cyan O)	tripped, * (red asterisk)	invalid configuration - some separators off when all should be on, or some seps in condition mode
off, c (white c)	tripped, * (red asterisk)	invalid configuration - some separators on when all should be off, or some seps in condition mode

Table 4 – Definitions of the T:HELIX REMOTE and POLARITY status attributes.

T:HELIX "polarity" attribute	T:HELIX "remote" attribute	meaning
plus, + (cyan +)	remote, . (green dot)	proton helix; all supplies in correct polarity
minus, - (magenta -)	remote, . (green dot)	pbar helix; all supplies in correct polarity
plus, + (cyan +)	local, * (red asterisk)	some switches not in proton polarity as expected
minus, - (magenta -)	local, * (red asterisk)	some switches not in pbar polarity as expected

Table 5 – Definitions of the V:HELIX state device reading.

V:HELIX reading	meaning
0	undefined
1	central orbit (separators OFF)
2	proton helix (separators ON)
3	pbar helix (separators ON)
4	invalid configuration (separators OFF or ON)

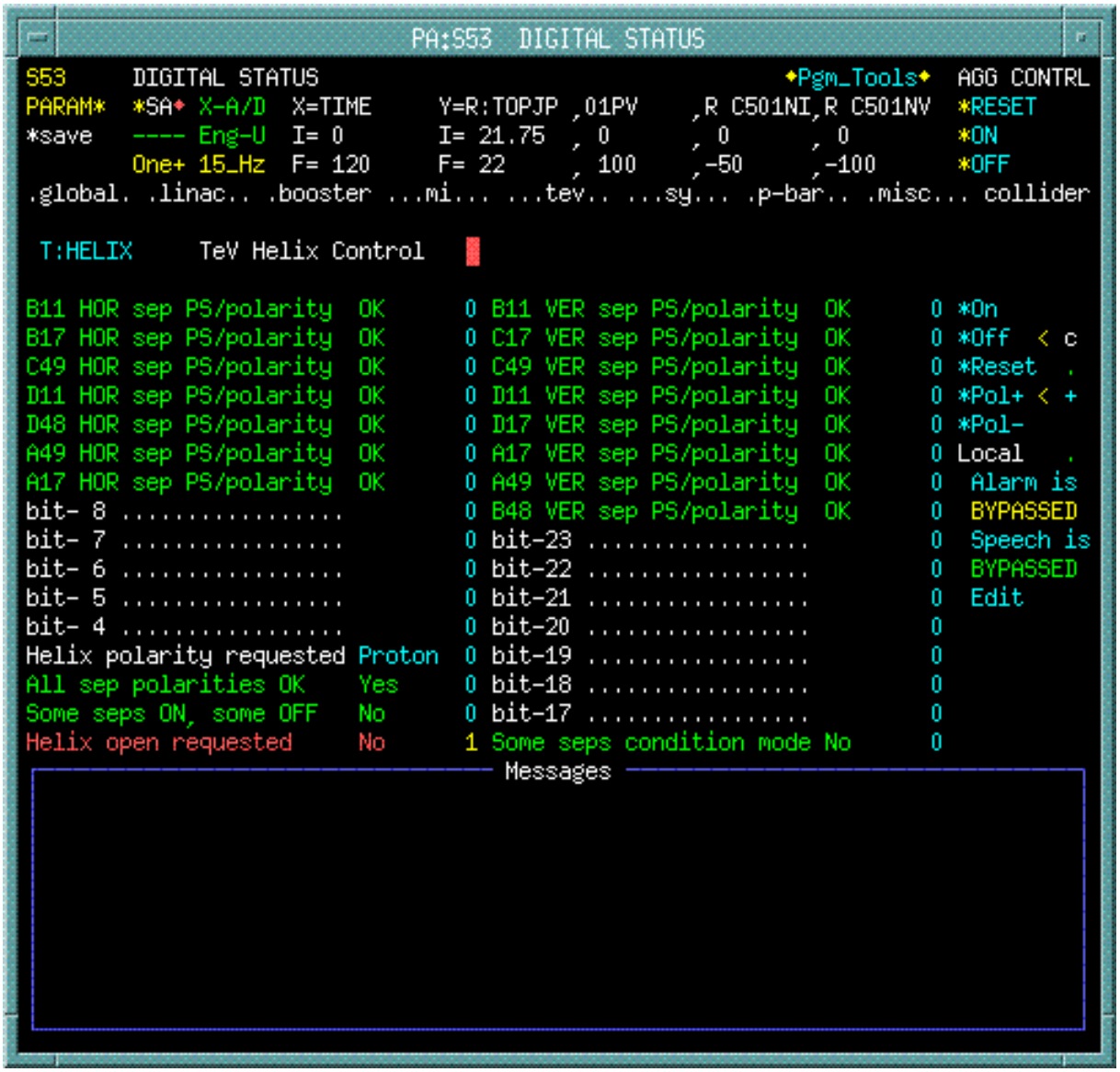

Figure 1 – Digital status page of T:HELIX. All separators are intentionally off, but in the proton helix polarity.

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Linux PA C16 SEPARATOR PARAMS
C16  POL BIT REFLECTION READINGS   SET     D/A   A/D  Com-U ◆PTools◆
-<FTP>+ *SA◆ X-A/D  X=TIME     Y=R:TOPJP ,01PV    ,R C501NI,R C501NV
COMMAND ---- Eng-U  I= 0       I= 21.75  , 0      , 0       , 0
-< 5>+  One+ 15_Hz  F= 120     F= 22     , 100    ,-50      ,-100
pwr sup global  HELIX.. sep vac ....... bumps.. .acl... misc...
 ! THE FOLLOWING READINGS REFLECT THE CORRESPONDING
 ! SEPARATOR POSITIVE SUPPLY POLARITY BIT
 ! +1 = POSITIVE POLARITY  -1 = NEGATIVE POLARITY
 C:B1HSPB     B11H sep polarity bit                1
 C:B7HSPB     B17H sep polarity bit               -1
 C:C4HSPB     C49H sep polarity bit               -1
 C:D1HSPB     D11H sep polarity bit                1
 C:D4HSPB     D48H sep polarity bit                1
 C:A7HSPB     A17H sep polarity bit                1
 C:A4HSPB     A49H sep polarity bit               -1
 C:B1VSPB     B11V sep polarity bit               -1
 C:C7VSPB     C17V sep polarity bit               -1
 C:C4VSPB     C49V sep polarity bit                1
 C:D1VSPB     D11V sep polarity bit                1
 C:D7VSPB     D17V sep polarity bit               -1
 C:A7VSPB     A17V sep polarity bit                1
 C:A4VSPB     A49V sep polarity bit               -1
 C:B4VSPB     B48V sep polarity bit                1


-C:B1SHP      +B11 HOR. SEPARATOR V        0     * 1.159  KV   *. +
-C:B7SHP      +B17 HOR. SEPARATOR V        0     *  .022  KV   *. -
-C:C4SHP      +C49 HOR. SEPARATOR V        0       -.101  KV   *. -
-C:D1SHP      +D11 HOR. SEPARATOR V        0       -.101  KV   *. +
-C:D4SHP      +D48 HOR. SEPARATOR V        0       -.906  KV   *. +
-C:A7SHP      +A17 HOR. SEPARATOR V        0        .264  KV   *. +
-C:A4SHP      +A49 HOR. SEPARATOR V        0       -.056  KV   *. -
-C:B1SVP      +B11 VER. SEPARATOR V        0     * -.101  KV   *. -
-C:C7SVP      +C17 VER. SEPARATOR V        0     *  .084  KV   *. -
-C:C4SVP      +C49 VER. SEPARATOR V        0     * -.191  KV   *. +
-C:D1SVP      +D11 VER. SEPARATOR V        0       -.056  KV   *. +
-C:D7SVP      +D17 VER. SEPARATOR V        0        .084  KV   *. -
-C:A7SVP      +A17 VER. SEPARATOR V        0       -.107  KV   *. +
-C:A4SVP      +A49 VER. SEPARATOR V        0     * -.99   KV   *. -
-C:B4SVP      +B48 VER. SEPARATOR V        0       -.006  KV   *. +
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Figure 2 – Parameter page showing the separator polarity bit reading devices and the corresponding positive power supply devices.