STACKING MONITOR AND THE 4-8 GHZ STACKING THERMOSTAT

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INTRODUCTION

The new version of the Pbar VSA Secondary Application which is launched from P142 has a stacking monitor. It also contains a 4-8 GHz momentum thermostat to be used while stacking.

STACKING MONITOR

The stacking monitor is obtained when A:VSARST=12, or when the Stacking Monitor mode is selected on the function mode menu of P142 as shown in Figure 1. When in the stacking mode, the VSA SA will display the Stacktail profile as shown in Figure 2. The display shows three traces. The green trace is the Stacktail profile just prior to ARF1 turning on. The cyan trace is the Stacktail profile just after ARF1 has finished playing its ramp. The red trace is the ratio of the green trace to the cyan trace in dB. (Zero dB for the red trace is at the ninth division and positive values are erased.) When the VSA is running A:VSACNT will increment by one every time a new trace is obtained. The "Restart the Averaging", "Kill the VSA", VSA Heartbeat Check", and "Download Settings" menu items on P142 will also work when the VSA is in the stacking monitoring mode.

While collecting traces, the monitor outputs a number of values which can be found on P38-mcginni-15. A sample of the page is shown in Figure 3. The VSA traces are obtained from the same electronics that used for the D/A FFT. The devices under the SETUP comment are used for setting up the VSA in stacking mode. Most of the time, these devices do not need to be adjusted. The only parameter that might be of interest to the casual user is the device that setups up the number of averages, A:STMAVG. The program will only read in this device when the program is launched or the "Download Settings" item is selected (A:VSARST=11) on P142.

The out put devices are divided into three categories, Injection orbit calculations, Stacktail calculations, and Core calculations. A:IBMINJ is the amount of beam injected on the injection orbit. It is obtained by integrating the green trace from 628,740 Hz to 628,780 Hz. It is calibrated to the beam current using the scale factor in A:STMCAL (which to the date of this writing has not been calibrated). A:LFTOVR is the ratio of the integral of the cyan trace to the green trace over the above revolution frequency range. It is a measure of how much beam ARF1 leaves behind on the injection orbit as it ramps.

The VSA can also measure the average revolution frequency of the injected beam (green trace on the left hand side of the screen). This frequency is compared to the ARF1 VCO and the value A:RF1FIJD is the error between the two. This value can be used for correcting A:R1FINJ which is the injection frequency for the ARF1 program P153. The VSA also measures the r.m.s width of the injected beam and scales this parameter to A:R1LCSG which can be used as a guide for setting A:R1LCAP for ARF1.

Next the VSA calculates two parameters that estimate the amount of "backstreaming" of the Stacktail. A:DRIBL1 is the 20.0 minus the maximm ratio (in dB) between the cyan trace to the green trace in the vicinity of the deposition frequency. A low value of A:DRIBL1 means little backstreaming. A:DRIBL2 is the r.m.s width of the

red trace in the vicinity of deposition orbit (Note that in Figure 3, it has units of dB . This is an error. It should have units of Hz) Again, a low value of A:DRIBL2 means little backstreaming.

In the region between 628,840Hz and 628860 Hz, the VSA program fits for the slope and the mean value of the Stacktail profile. The slope is given in A:STMEDS and should have a value around 10 MeV. The mean value of the distribution at 628,850 is given in A:STMSTD.

The core calculations are done around the 20 dB points of the maximum density of the core. A:CENFRQ is the mean frequency of the core. A:PKFREQ is the core frequency at which the density is the highest. A:FRWDTH is the 4 x the r.ms. width of the core. (This is different from when the VSA is in the Shot Setup mode where a true 95% width is calculated) A:SIGMAP is the r.m.s width of the core scaled in energy.

STACKING 4-8 GHZ MOMENTUM THERMOSTAT

When the "Stack Mom Thermostat" is selected on P142 or A:VSARST is set to a value of 13, the 4-8 GHz momentum cooling will be monitored in a thermostat mode. The parameters for the thermostat mode are shown on P38-mcginni-13. A sample of this page is shown in Figure 4.

The desired or target frequency width for the thermostat is set in the array device A:CMFRWD. The program uses each index for every step of 10 mA. For example A:CMFRWD[2] is used in the stack range of 20-29.9 mA. If the thermostat encounters a value of -1 in array device, it will shut it self off when it reaches that index value. For example, if A:CMFRWD[10] = -1, then the thermostat will shut itself off (and the 4-8 GHz momentum system) when the stack reaches 100 mA. It will not turn itself back on unless manually turned on by the user.

Before the thermostat is turned on, the 4-8 GHz arrays are moved to the location specified by A:CMARPI and the attenuator (A:CMPA01) is set to the starting value specified in A:CMATST. The VSA also setups the microwave spectrum analyzer (SA11) to the 4-8 GHz arrays and asks the user to check the TV screen on Ch. 20 to see if the arrays look okay. When the user is satisfied with the array location, the user must interrupt on the VSA graphics screen to continue the VSA SA.

The minimum value of the attenuator A:CMPA01 that the thermostat will set is given by A:CMATMN. Also if the sum of the TWT power exceeds A:CMTMXP, the thermostat will turn the attenuator up to a greater value until the TWT power has been reduced. The maximum value the attenuator A:CMPA01 can be set to is given by A:CMATMX. If the thermostat would like a greater value than the maximum value because the frequency width is still smaller than the desired value, the thermostat, will turn off the pin switch A:CMPS01 until the frequency width comes in range. Hopefully, these precautions will prevent the core from being squeezed too small.

The strength of the thermostat gain is set by A:CMTSGN. The amount that the attenuator is changed is proportional to the difference between the frequency width and the desired width times the thermostat gain. Since the attenuator A:CMPA01 has only discrete values which is not suitable for a linear feedback loop, a pseudo-attenuator setting A:CMPAT1 is where the error signal of the thermostat is sent. The attenuator A:CMPA01 is set to this value within the resolution of the digital to analog convertor. If

the user changes A:CMPA01, the thermostat should sense this and adjust A:CMPAT1 to the new value.

The thermostat and the 4-8 GHz momentum system is turned off when A:VSARST is set back to 12 (Stacktail Monitor on P142).

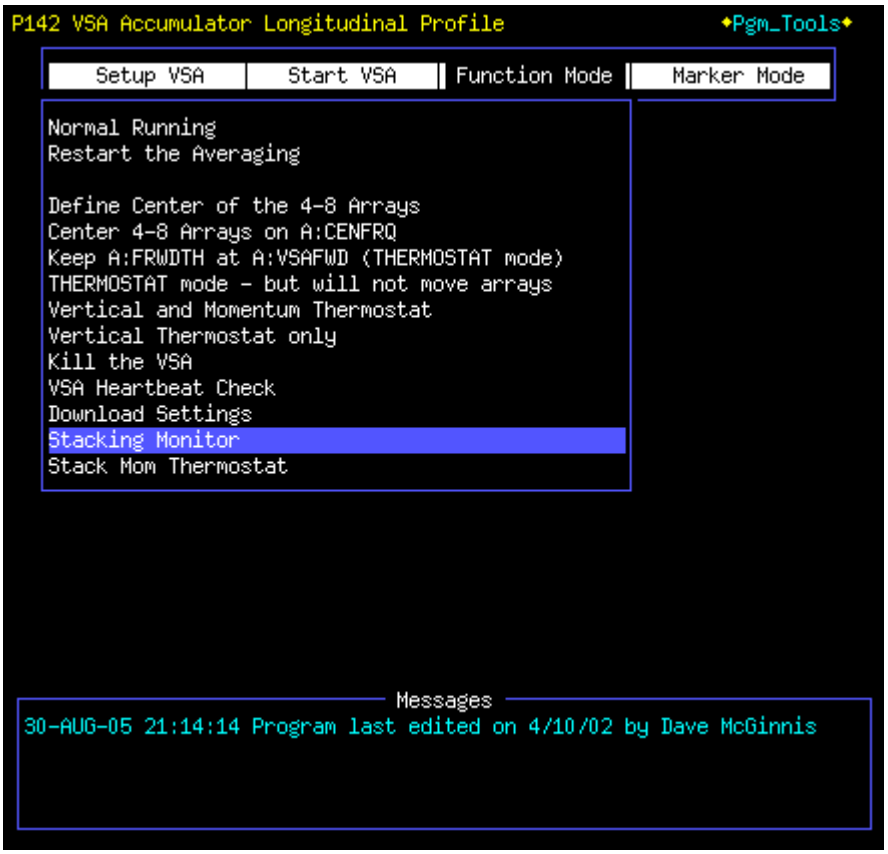

Figure 1. Function Mode menu on P142

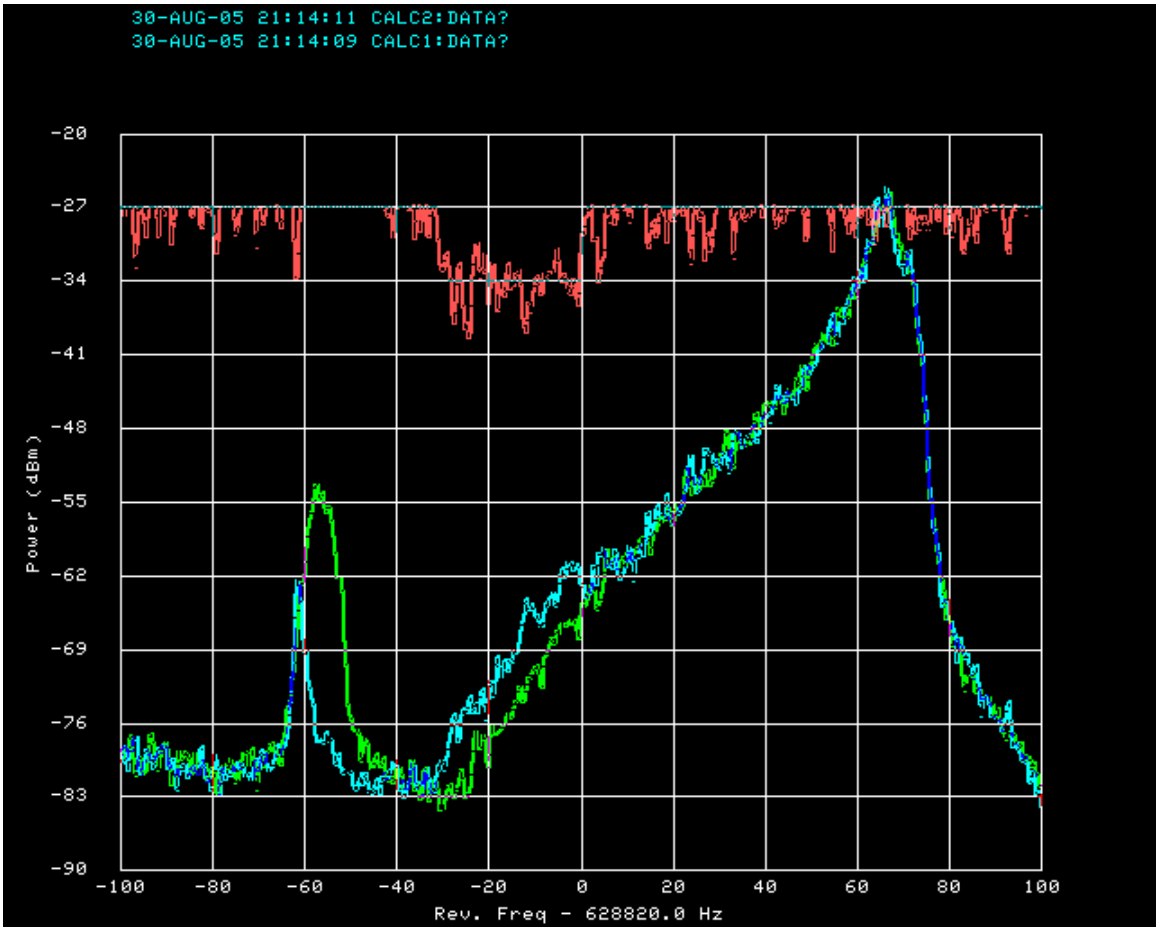

Figure 2. VSA SA display in the stacking monitor mode.

```
P38   VSA STACKING MONITOR          SET     D/A    A/D  Com-U ◆PTools◆
-<FTP>+ *SA◆ X-A/D  X=TIME      Y=C:B0Q6  ,C:D4SHM ,C:S4F2A ,C:B0ILUM
COMMAND ---- Eng-U  I= 0        I= 3600   , 0      , 20     , 0
-<15>+  One+ AUTO   F= 600      F= 4600   , 80     , 32     , 40
dampers emitmon mux_sw  plcs     java    ibeam    misc   MCGINNI
-A:VSARST      VSA #1 Restart  Con  1        0        0     DPM
 ! SETUP
-A:STMFRO      Stail mon dep freq offst     15000    15000  Hz
-A:STMFRF      Stail mon ref. rev fr  628764      628764    Hz
-A:STMRFL      Stail mon ref level         -60      -60     dBm
-A:STMSCL      Stail mon scale per div      5        5      dB
-A:STMCAL      Stail mon I dep cal fact     1        1
-A:STMAVG      Stail mon No. avg pulses     10       10
-A:R1LLFO      Freq offset for A:R1LLFR      .147     .147  Hz
-A:R1LCFX      Cal factor for A:R1LCSG      1        1

 ! INJ ORBIT CALC
-A:IBMINJ      Stail mon inject beam        10.77    10.77  e07
-A:LFTOVR      Stail mon left over beam     3.513    3.513  %
-A:R1FIJD      Inj. Freq. sugg. change      -.084    -.084  Hz
-A:R1LCSG      A:R1LCAP Suggestion          6.666    6.666  Hz
 M:TOR109      AP1 PQ9B Beam Toroid              -.035625   E12

 ! STACKTAIL CALC
-A:DRIBL1      Stail mon beam drib 50%      9.053    9.053  dB
-A:DRIBL2      Stail mon Beam Drib RMS      5.184    5.184  dB


 ! CORE CALC
-A:CENFRQ      Acc Center Rev Freque  628929.31   628929.32 Hz
-A:PKFREQ      Acc Peak Rev Frequenc  628929.38   628929.36 Hz
-A:FRWDTH      Accum Freq Width - VSA       5.525    5.525  Hz
-A:SIGMAP      Acc Momentum Width            .788     .788  MeVc

-A:STMEDS      Stacktail Profile Slope      12.14    12.14  MeV
-A:STMSTD      StackTail Dens @628850Hz    -51.67   -51.67  dBm




-A:VSACNT      VSA Counter                  494      494    dpm
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Figure 3. VSA Stacking monitor index page

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P38  CORE 48 STACKING THERM        SET     D/A    A/D  Com-U ◆PTools◆
-<FTP>+ *SA◆ X-A/D  X=TIME      Y=C:B0Q6  ,C:D4SHM ,C:S4F2A ,C:B0ILUM
COMMAND ---- Eng-U  I= 0        I= 3600   , 0      , 20     , 0
-<13>+  One+ AUTO   F= 600      F= 4600   , 80     , 32     , 40
dampers emitmon mux_sw  plcs    java    ibeam    misc   MCGINNI
 A:CMPS01      4-8 Momentum PIN Switch                              .
-A:CMPA01      4-8 Core Mom PIN Atten       12     * 12      dB     M
 A:CMTW01      4-8 Core Momentum TWT               *  .513  Watt ...
 A:CMTW02      4-8 Core Momentum TWT               *  .156  Watt ...

-A:CMARPI      dp 4-8 des. array pos       -36.4    -36.4   mm
-A:MARAYD      4-8 Core Mom Array DS       <     > *-36.42   mm  ...
-A:MARAYU      4-8 Core Mom Array US       <     > *-36.06   mm  ...

-A:VSARST      VSA #1 Restart  Control      12       12     DPM
-A:CMTSGN      dp 4-8 min thermo. gain       .1       .1    mag

-A:CMATST      dp 4-8 min startiing att     15       15     dB
-A:CMPA01      4-8 Core Mom PIN Atten       12     * 12      dB     M
-A:CMPAT1      dp 4-8 atten setting         14.65    14.65  dB
-A:CMATMN      dp 4-8 min atten. set        7        7      dB
-A:CMATMX      dp 4-8 max atten. set        31.75    31.75  dB
-A:CMTMXP      dp 4-8 max power thermo      1.5      1.5    W

-A:CENFRQ      Acc Center  628885.81  628885.88   628885.88 Hz
-A:FRWDTH      Accum Freq Width -   18.32   18.52    18.52  Hz
-A:SIGMAP      Acc Momentum Width   5.337   5.397    5.397  MeVc
-A:FWCORE      Accum CORE Freq Wid  18.32   18.52    18.52  Hz
 A:IBEAM       ACC 1ma=10**10pbar              * 81.805027 mA

-A:CMFRWD      dp 4-8 des. freq. width      18       18     Hz
-A:CMFRWD[1]   dp 4-8 des. freq. width      18       18     Hz
-A:CMFRWD[2]   dp 4-8 des. freq. width      18       18     Hz
-A:CMFRWD[3]   dp 4-8 des. freq. width      18       18     Hz
-A:CMFRWD[4]   dp 4-8 des. freq. width      18       18     Hz
-A:CMFRWD[5]   dp 4-8 des. freq. width      18       18     Hz
-A:CMFRWD[6]   dp 4-8 des. freq. width      18       18     Hz
-A:CMFRWD[7]   dp 4-8 des. freq. width      18       18     Hz
-A:CMFRWD[8]   dp 4-8 des. freq. width      18       18     Hz
-A:CMFRWD[9]   dp 4-8 des. freq. width      18       18     Hz
-A:CMFRWD[10]  dp 4-8 des. freq. width      18       18     Hz
-A:CMFRWD[11]  dp 4-8 des. freq. width      18       18     Hz
-A:CMFRWD[12]  dp 4-8 des. freq. width      18       18     Hz
-A:CMFRWD[13]  dp 4-8 des. freq. width      18       18     Hz
-A:CMFRWD[14]  dp 4-8 des. freq. width      18       18     Hz
-A:CMFRWD[15]  dp 4-8 des. freq. width      18       18     Hz
-A:CMFRWD[16]  dp 4-8 des. freq. width      18       18     Hz
-A:CMFRWD[17]  dp 4-8 des. freq. width      18       18     Hz
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Figure 4. Stacking monitor 4-8 GHz momentum thermostat index page