HPS Trigger Configuration

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Here we document the format and location of the DAQ and trigger configuration files as used in HPS's 2015 Engineering Run.

I. CONFIGURATION FILE OVERVIEW

The configuration files are plain ascii with a format specific to Hall-B DAQ. They contain one key/value(s) pair per line. Each crate reads the full configuration but only uses the lines delimited by tags applicable to its crate.

The DAQ only reads files from the base path of $\$CLON\_PARMS/trigger$, so the DAQ GUI used by shifters starts from there.

Some specifics on the configuration files:

- The # character at the beginning of a line deontes a comment; any line starting with a # is completely ignored.
- Energies are always in units MeV, with no exceptions.
- Care must be taken with time units; it can be either ns or # samples, depending on who wrote the firmware for the given hardware.
- While each crate reads the entire configuration, they only interpret lines delimited by tags for its crate.
- In the case of multiple lines with equal keys, precendence always goes to the the last entry in the configuration file.

II. GTP SETTINGS

The GTP controls the clustering algorithm. The only configurable GTP parameters are clustering seed energy threshold and hit timing coincidence requirements. The energy threshold is in units MeV (in the example below it is 50 MeV). The two values for coincidence are number of FADC samples before and after seed hit (in the example below it is ± 4 samples $= \pm$ 16 ns), and currently the firmware requires these be equal.

```
GTP_CRATE all
GTP_CLUSTER_PULSE_THRESHOLD 50
GTP_CLUSTER_PULSE_COIN 4 4
GTP_CRATE end
```

III. TI SETTINGS

All TI trigger settings are defined in the TI section of the DAQ configuration files for crate `hps11`, between the following two lines:

```
TI_CRATE hps11
TI_CRATE end
```

A. Buffer and Block Sizes

```
TI_FIBER_DELAY_OFFSET 0x80 0xcf
```

Events are rea

```
TI_BUFFER_LEVEL 5
TI_BLOCK_LEVEL 10
```

B. Holdoff

The deadtime of the TI can be configured

C. Prescales

The six triggers can be independently prescaled in powers of 2. The TI numbers the trigger from 1 to 6:

TI Input #	Trigger Type
1	*singles-0*
2	*singles-1*
3	*pairs-0*
4	*pairs-1*
5	*calibration*
6	*pulser*

TABLE I. TI trigger input numbering.

The following lines in the trigger configuration file would set the *singles-0* prescale to 2^{13}, the *singles-1* and *pairs-0* triggers' prescales to 2^{11}, and leave all other trigger with no prescaling:

```
TI_INPUT_PRESCALE 1 13
TI_INPUT_PRESCALE 2 11
TI_INPUT_PRESCALE 3 11
TI_INPUT_PRESCALE 4  0
TI_INPUT_PRESCALE 5  0
TI_INPUT_PRESCALE 6  0
```

IV. SSP SETTINGS

The SSP numbers the triggers differently than the TI:

All SSP trigger settings are defined in the SSP section of the DAQ configuration files for crate `hps11`, between the following two lines:

```
SSP_CRATE hps11
SSP_CRATE end
```

SSP Input #	SSP Output #	Trigger Type
7	20	*singles-0*
8	21	*singles-1*
9	22	*pairs-0*
10	23	*pairs-1*
11	24/25	*calibration*
12	18	*pulser*

TABLE II. SSP trigger numbering. The two *calibration* IOs are LED/COSMIC, respectively.

A. FADC Trigger Window

The trigger reads from the FADC pipeline, with a window and latency defined in terms of number of FADC samples (4 ns):

```
SSP_W_WIDTH   50
SSP_W_OFFSET  757
SSP_HPS_LATENCY 475
```

V. ENABLING/DISABLING TRIGGERS

All 6 triggers are enabled and disabled with similar configuration lines:

```
SSP_HPS_SET_IO_SRC   7 20  # SINGLE-0 ENABLED
SSP_HPS_SET_IO_SRC   7  0  # SINGLE-0 DISABLED
SSP_HPS_SET_IO_SRC   8 21  # SINGLE-1 ENABLED
SSP_HPS_SET_IO_SRC   8  0  # SINGLE-1 DISABLED
SSP_HPS_SET_IO_SRC   9 22  # PAIR-0 ENABLED
SSP_HPS_SET_IO_SRC   9  0  # PAIR-0 DISABLED
SSP_HPS_SET_IO_SRC  10 23  # PAIR-1 ENABLED
SSP_HPS_SET_IO_SRC  10  0  # PAIR-1 DISABLED
SSP_HPS_SET_IO_SRC  11 24  # CALIB LED ENABLED
SSP_HPS_SET_IO_SRC  11 25  # CALIB COSMIC ENABLED
SSP_HPS_SET_IO_SRC  11  0  # CALIB DISABLED
SSP_HPS_SET_IO_SRC  12 18  # PULSER ENABLED
SSP_HPS_SET_IO_SRC  12  0  # PULSER DISABLED
```

VI. PULSER TRIGGER

There are three configuration lines that control the "random" pulser trigger. The frequency of the pulser trigger is defined in Hz. This line sets the pulser rate to 100 Hz:

```
SSP_HPS_PULSER 100
```

This line will enable the pulser trigger:

```
SSP_HPS_SET_IO_SRC  12 18  # PULSER ENABLED
```

and this line will disable the pulser trigger:

```
SSP_HPS_SET_IO_SRC  12  0  # PULSER DISABLED
```

VII. SINGLES TRIGGERS

Here is how to enable and disable the two singles triggers:

```
SSP_HPS_SET_IO_SRC   7 20  # SINGLE-0 ENABLED
SSP_HPS_SET_IO_SRC   7  0  # SINGEL-0 DISABLED
SSP_HPS_SET_IO_SRC   8 21  # SINGLE-1 ENABLED
SSP_HPS_SET_IO_SRC   8  0  # SINGLE-1 DISABLED
```

There are three possible cuts for each singles trigger:

1. Minimum cluster energy.
2. Maximum cluster energy.
3. Minimum number of hits in a cluster.

The first column denotes which singles trigger, 0 or 1. The second column is the cut value. The last column is 0/1 for disabled/enabled.

```
# Singles 0 trigger
SSP_HPS_SINGLES_EMIN  0  60   1
SSP_HPS_SINGLES_EMAX  0  2500 1
SSP_HPS_SINGLES_NMIN  0  3    1

# Singles 1 trigger
SSP_HPS_SINGLES_EMIN  1  400  1
SSP_HPS_SINGLES_EMAX  1  1100 1
SSP_HPS_SINGLES_NMIN  1  3    1
```

VIII. PAIRS TRIGGERS

Here is how to enable and disable the two pairs triggers:

```
SSP_HPS_SET_IO_SRC    9 22  # PAIR-0 ENABLED
SSP_HPS_SET_IO_SRC    9  0  # PAIR-0 DISABLED
SSP_HPS_SET_IO_SRC   10 23  # PAIR-1 ENABLED
SSP_HPS_SET_IO_SRC   10  0  # PAIR-1 DISABLED
```

There are nine possible cuts for each pair trigger:

1. Minimum cluster energy.
2. Maximum cluster energy.
3. Minimum number of hits in a cluster.
4. Minimum energy sum.
5. Maximum energy sum.
6. Maximum energy difference.
7. Maximum coplanarity angle.
8. Minimum energy/distance product.

The first column denotes which singles trigger, 0 or 1. The second column is the cut value. The last column is 0/1 for disabled/enabled.

```
# Pairs 0 trigger
SSP_HPS_PAIRS_TIMECOINCIDENCE  0  4
SSP_HPS_PAIRS_EMIN             0  54
SSP_HPS_PAIRS_EMAX             0  1100
SSP_HPS_PAIRS_NMIN             0  1
SSP_HPS_PAIRS_SUMMAX_MIN       0  2000 120 1
SSP_HPS_PAIRS_DIFFMAX          0  1000     1
SSP_HPS_PAIRS_COPLANARITY      0  180      0
SSP_HPS_PAIRS_ENERGYDIST       0  5.5  100 0

# Pairs 1 trigger
SSP_HPS_PAIRS_TIMECOINCIDENCE  1  3
SSP_HPS_PAIRS_EMIN             1  54
SSP_HPS_PAIRS_EMAX             1  630
SSP_HPS_PAIRS_NMIN             1  1
SSP_HPS_PAIRS_SUMMAX_MIN       1  860 180  1
SSP_HPS_PAIRS_DIFFMAX          1  540      1
SSP_HPS_PAIRS_COPLANARITY      1  30       1
SSP_HPS_PAIRS_ENERGYDIST       1  5.5  600 1
```

IX. CALIBRATION TRIGGER

This trigger can be used to trigger on the LED pulser or a coincidence of scintillators for cosmic calibration.

```
# HPS CALIBRATION COSMIC/LED -> TI TS5
#SSP_HPS_SET_IO_SRC  11 24  # CALIB LED ENABLED
#SSP_HPS_SET_IO_SRC  11 25  # CALIB COSMIC ENABLED
SSP_HPS_SET_IO_SRC   11  0  # CALIB DISABLED

# coinc time 10=40 ns
SSP_HPS_COSMIC_TIMECOINCIDENCE  10

# cosmic B0 and B1 (136<<8) + led trigger (254<<0)
SSP_HPS_COSMIC_PATTERNCOINCIDENCE   35070
```

Clustering	Seed Energy Threshold	50 MeV
	Hit Threshold	12 ADC
	Hit Time Coincidence	+/-16 ns
	FADC Window Size	200 ns
Singles-0	Hits Per Cluster Min	3
	Cluster Energy Min	60 MeV
	Cluster Energy Max	2500 MeV
	Prescale	2^{13}
Singles-1	Hits Per Cluster Min	3
	Cluster Energy Min	400 MeV
	Cluster Energy Max	1100 MeV
	Prescale	2^{11}
Pairs-0	Hits Per Cluster Min	1
	Cluster Time Coincidence	+/-16 ns
	Cluster Energy Min	54 MeV
	Cluster Energy Max	1100 MeV
	2-Cluster Energy Sum Min	120 MeV
	2-Cluster Energy Sum Max	2000 MeV
	2-Cluster Energy Diff Max	1000 MeV
	Coplanarity Max	n/a
	Energy-Dist Slope	n/a
	Energy-Dist Min	n/a
	Prescale	2^{11}
Pairs-1	Hits Per Cluster Min	1
	Cluster Time Coincidence	+/-12 ns
	Cluster Energy Min	54 MeV
	Cluster Energy Max	630 MeV
	2-Cluster Energy-Sum Min	180 MeV
	2-Cluster Energy-Sum Max	860 MeV
	2-Cluster Energy-Diff Max	540 MeV
	Coplanarity Maximum	30 deg
	Energy-Dist Slope	5.5 MeV/mm
	Energy-Dist Minimum	600 MeV
	Prescale	2^{0}
Pulser	Rate	100 Hz
	Prescale	2^{0}

TABLE III. Configuration for the V7 trigger used in HPS's 2015 1.056 GeV Commissioning Run.