NPS VTP Event Format

Benjamin Raydo
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1. Readout Data Format

VTP Module Data

Data will be reported from each nps-vtp (1-5). Each VTP processes different regions of the NPS calorimeter, so the data from all VTP should be combined to see the full event information. This data will be wrapped in an EVIO formatted data bank which is not described in this document. Refer to the CODA configuration for ROC ID assignments and the readout list for the EVIO bank types/tags used to encapsulate the following described data.

Data Word Categories

Data words from the module are divided into two categories: <u>Data Type Defining</u> (bit 31 = 1) and <u>Data Type Continuation</u> (bit 31 = 0). Data Type Defining words contain a 4-bit data type tag (bits 30 - 27) along with a type dependent data payload (bits 26 - 0). Data Type Continuation words provide additional data payload (bits 30 – 0) for the *last defined data type*. Continuation words permit data payloads to span multiple words and allow for efficient packing of various data types spanning multiple data words. Any number of Data Type Continuation words may follow a Data Type Defining word.

Data Type List

0	Block Header
1	Block Trailer
2	Event Header
3	Trigger Time
12	Expanded (Data SubType)
12.11	NPS Cluster
13	Trigger Decision
14	Data Not Valid (empty module)
15	Filler Word (non-data)

Data Type: Block Header

	Type:	0
	Size:	1 word
	Description:	Indicates the beginning of a block of events. (High-speed readout of a board or a set of boards is done in blocks of events)

31	30	29	28	27	26	25	24
1	0	0	0	0	SLOTID		

23	22	21	20	19	18	17	16
SLOTID		UNDEFINED			EVENT_PER_BLOCK		

15	14	13	12	11	10	9	8
EVENT_PER_BLOCK					UNDEFINED		

7	6	5	4	3	2	1	0
BLOCK_CNT							

BLOCK_CNT:
Event block number (used to align blocks when building events)
EVENT_PER_BLOCK:
Number of events in block
SLOTID:
Slot ID (set by VME64x backplane)

Data Type: Block Trailer

	Type:	1
	Size:	1 word
	Description:	Indicates the end of a block of events. The data words in a block are bracketed by the block header and trailer.

31	30	29	28	27	26	25	24
1	0	0	0	1	SLOTID		

23	22	21	20	19	18	17	16
SLOTID		UNDEFINED		NUM_WORDS			

15	14	13	12	11	10	9	8
NUM_WORDS							

7	6	5	4	3	2	1	0
NUM_WORDS							

NUM_WORDS:
Total number of words in block of events
SLOTID:
Slot ID (set by VME64x backplane)

Data Type: Event Header

	Type:	2
	Size:	1 word
	Description:	Indicates the start of an event. The included trigger number is useful to ensure proper alignment of event fragments when building events.

31	30	29	28	27	26	25	24
1	0	0	1	0	UNDEFINED		

23	22	21	20	19	18	17	16
UNDEFINED					TRIGGER_NUMBER		

15	14	13	12	11	10	9	8
TRIGGER_NUMBER							

7	6	5	4	3	2	1	0
TRIGGER_NUMBER							

TRIGGER_NUMBER:
Accepted event/trigger number

Data Type: Trigger Time

Type:	3
Size:	2 words
Description:	Time of trigger occurrence relative to the most recent global reset. The time is measured by a 48bit counter that is clocked from the 40MHz system clock. The assertion of the global reset clears the counter. The de-assertion of global reset enables counter and thus sets t=0 for the module. The trigger time is necessary to ensure system synchronization and is useful in aligning event fragments when building events.

Word 1:

31	30	29	28	27	26	25	24
1	0	0	1	1	UNDEFINED		
23	22	21	20	19	18	17	16
TRIGGER_TIME_H							
15	14	13	12	11	10	9	8
TRIGGER_TIME_H							
7	6	5	4	3	2	1	0
TRIGGER_TIME_H							

TRIGGER_TIME_H:

This is the upper 24bits of the trigger time

Word 2:

31	30	29	28	27	26	25	24
0	UNDEFINED						
23	22	21	20	19	18	17	16
TRIGGER_TIME_L							
15	14	13	12	11	10	9	8
TRIGGER_TIME_ L							
7	6	5	4	3	2	1	0
TRIGGER_TIME_ L							

TRIGGER_TIME_ L:

This is the lower 24bits of the trigger time

Data Type: NPS Cluster
Type: 12.11
Size: 2 words
    Description: This data type identifies a cluster

Word 1:

31	30	29	28	27	26	25	24
1	1	1	0	0	0	0	1

23	22	21	20	19	18	17	16
0	-	-	-	-	-	-	-

15	14	13	12	11	10	9	8
-	-	E					

7	6	5	4	3	2	1	0
E							

    E: 14bit unsigned cluster energy

Word 2:

31	30	29	28	27	26	25	24
0	-	-	-	-	-	Y	

23	22	21	20	19	18	17	16
Y				X			

15	14	13	12	11	10	9	8
X	N				T		

7	6	5	4	3	2	1	0
T							

    X: 5bit unsigned cluster X coordinate
    Y: 6bit unsigned cluster Y coordinate
    T: 11bit cluster time in 4ns units referenced from the beginning of the readout window
    N: 4bit number of hits in the cluster

Data Type: Trigger Decision

Type:	13
Size:	2 words
Description:	This data type reports trigger decision made. A 32bit trigger bit pattern is reported with 4ns timestamp relative to the readout window indicates where the VTP found a valid trigger. If multiple triggers happen at the same time then multiple bits will be set in the 32bit trigger bit pattern word. A trigger decision pattern will be recorded for each unique time in the VTP readout window.

Word 1:

31	30	29	28	27	26	25	24
1	1	1	0	1		T	
23	22	21	20	19	18	17	16
			T				
15	14	13	12	11	10	9	8
			TRIGBITS_L				
7	6	5	4	3	2	1	0
			TRIGBITS _L				

TRIGBITS_L: Trigger bits 15:0
T: 11bit trigger bit pattern time in 4ns units
(referenced from the beginning of the readout window)

Word 2:

31	30	29	28	27	26	25	24
0	-	-	-	-	-	-	-
23	22	21	20	19	18	17	16
-	-	-	-	-	-	-	-
15	14	13	12	11	10	9	8
			TRIGBITS_H				
7	6	5	4	3	2	1	0
			TRIGBITS_H				

TRIGBITS_H: Trigger bits 31:16

Note: For NPS, the following trigger bits have been defined:
TriggerBit0: NPS Cluster Trigger, cluster >= threshold
TriggerBit1: Cosmic scintillator trigger, or(ScintTop) and or(ScintBot)
TriggerBit2: Cosmic calorimeter column trigger, or(mult(Column$_n$) > mult_min)
These trigger bits from each nps-vtp will be processed in an additional stage using a CAEN
V1495 FPGA module so the mapping of these bits into the Trigger Supervisor will be different
from above (this should be documented in the NPS DAQ trigger setup when implemented).

Data Type: Data Not Valid

Type:	14	
Size:	1 word	
Description:	Module has no data available for readout. This can if the module is being read out too quickly after receiving (event building is in process and no data words have been put into the buffer yet) a trigger or if the module doesn't have any events to report.	

31	30	29	28	27	26	25	24
1	1	1	1	0	UNDEFINED		

23	22	21	20	19	18	17	16
UNDEFINED							

15	14	13	12	11	10	9	8
UNDEFINED							

7	6	5	4	3	2	1	0
UNDEFINED							

Data Type: Filler Word

Type:	15	
Size:	1 word	
Description:	Non-data word appended to the block of events. This is used to force the total number of 32-bit words read out of a module to be a multiple of 2 or 4 when	

31	30	29	28	27	26	25	24
1	1	1	1	1	UNDEFINED		

23	22	21	20	19	18	17	16
UNDEFINED							

15	14	13	12	11	10	9	8
UNDEFINED							

7	6	5	4	3	2	1	0
UNDEFINED							