ALICE TRD DAQ Data Format

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Last update: May 23, 2008

This document describes the structure of the data stream sent from the ALICE Transition Radiation Detector to DAQ/HLT.

1 DDL Data Format

For each event, the following data structure is transmitted via each of the 18 DDLs. It consists of a header structure of header and index words and the concatenated data content from up to 5 stacks.

Each data word consists of 32 Bit.

Size/Words	Content	
8	Common Data Header (CDH, according to DAQ specification)	
1	Supermodule Index Word	
variable ($\mathtt{s}$)	Supermodule Header	
1	Stack #0 Index Word	} only present if $\mathtt{m}[0]$ = '1'
variable ($\mathtt{s}_0$)	Stack #0 Header	
1	Stack #1 Index Word	} only present if $\mathtt{m}[1]$ = '1'
variable ($\mathtt{s}_1$)	Stack #1 Header	
1	Stack #2 Index Word	} only present if $\mathtt{m}[2]$ = '1'
variable ($\mathtt{s}_2$)	Stack #2 Header	
1	Stack #3 Index Word	} only present if $\mathtt{m}[3]$ = '1'
variable ($\mathtt{s}_3$)	Stack #3 Header	
1	Stack #4 Index Word	} only present if $\mathtt{m}[4]$ = '1'
variable ($\mathtt{s}_4$)	Stack #4 Header	
variable	Stack 0 Data Content	only present if $\mathtt{m}[0]$ = '1'
variable	Stack 1 Data Content	only present if $\mathtt{m}[1]$ = '1'
variable	Stack 2 Data Content	only present if $\mathtt{m}[2]$ = '1'
variable	Stack 3 Data Content	only present if $\mathtt{m}[3]$ = '1'
variable	Stack 4 Data Content	only present if $\mathtt{m}[4]$ = '1'

1.1 The Supermodule Index Word

The Supermodule Index Word is a 32-Bit word with the following structure:

Supermodule Index Word						
ssssssss ssssssss		vvvv	rrrr r	d	t	mmmmm
31	16	15 12	11 7	6	5	4 0

s	(Bits 31..16)	Size of the Supermodule Header
v	(Bits 15..12)	Supermodule Header Version
r	(Bits 11..7)	Reserved for future use
d	(Bit 6)	Track Data Enabled Bit
t	(Bit 5)	Tracklet Data Enabled Bit
m	(Bits 4..0)	Stack Mask

The *Size of the Supermodule Header* s is an unsigned short number specifying the number of words in the Supermodule Header. This value can be zero. The *Reserved Bits* r are currently undefined but may be used in the future. Do not use them unless an updated version of this document specifies their meaning. The *Tracklet Data Enabled Bit* t specifies if tracklet data words are included in the data content or not. The *Stack Mask* m is a bit mask specifying the TRD stacks of this Supermodule contributing to the event. Data from stack #i is included if bit #i of the Stack Mask is set. Otherwise, this stack is skipped in the data stream.

1.2 The Supermodule Header

The Supermodule Header contains additional information regarding hardware design and the event added by the global tracking unit. When processing the data stream, skip these words. The Supermodule Header Words look as follows:

Supermodule Header – Version 0xA, Word 0				
rrr	c	vvvv vvvvvvvv vvvv	rrrr	bbbbbbbb
31 29	28	27 12	11 8	7 0

r	(Bits 31..29)	Reserved for future use
c	(Bit 28)	Clean Checkout Flag
v	(Bits 27..12)	Hardware Design Revision
r	(Bits 11..8)	Reserved for future use
b	(Bits 7..0)	Physical Board ID

The Board ID b is an unsigned short number uniquely identifying each hardware board. The Design Revision v and the Clean Checkout Flag c relate to the GTU development repository.

Additional header words will be present in the future. A section listing the reconstructed tracks will be added soon.

1.3 The Stack #i Index Word

The Stack #i Index Word is a 32-Bit word with the following structure:

Stack #i Index Word		
ssssssss ssssssss$_i$	vvvv$_i$	mmmm mmmmmmmm$_i$
31 16	15 12	11 0

s$_i$	(Bits 31..16)	Size of the Stack #i Header
v$_i$	(Bits 15..12)	Header Version
m$_i$	(Bits 11..0)	Link Mask

The *Size of the Stack* s$_i$ is an unsigned short number specifying the number of words in the Stack #i Header. This value can be zero. The *Reserved Bits* r$_i$ are currently undefined but may be used in the future. Do not use them unless an updated version of this document specifies their meaning. The *Link Mask* m$_i$ is a bit mask specifying the TRD optical data links of stack #i contributing to the event. Data from link #j is included if bit #j of the Link Mask is set. Otherwise, this link is skipped in the data stream.

1.4 The Stack #i Header

The Stack #i Header can contain additional information regarding event related information of the associated stack as well as hardware information. The Stack Header Words look as follows:

Stack Header – Version 0xA, Word 0			
vvvvvvvv vvvvvvvv	bbbbbbbb	rrrr rrr	c
31 16	15 8	7 1	0

v	(Bits 31..16)	Hardware Design Revision
b	(Bits 15..8)	Physical Board ID
r	(Bits 7..1)	Reserved for future use
c	(Bit 0)	Clean Checkout Flag

This word is followed by six words containing status and information flags regarding the twelve individual data links from the half chambers of one stack.

Stack Header – Version 0xA, Word 6...1							
dddd$_{i+1}$	rrrr rr	tt$_{i+1}$	mmmm$_{i+1}$	dddd$_i$	rrrr rr	tt$_i$	mmmm$_i$
31 28	27 22	21 20	19 16	15 12	11 6	5 4	3 0

$\mathtt{d}_i$	(Bits 15..12)	Link Debug Flags
$\mathtt{r}$	(Bits 11..6)	Reserved for future use
$\mathtt{t}_i$	(Bits 5..4)	Link Data Type Flags
$\mathtt{m}_i$	(Bits 3..0)	Link Monitor Flags

The Link Monitor Flags indicate errors found by the Link Monitors – a value of 0x0 indicates a properly operating link. The Link Data Type Flags indicate whether the data is real data from the Supermodule or synthetic loopback data from generators/event replay within the GTU itself – a value of 0x0 indicates real data from the front-end electronics. **Caution:** The Link Monitor and Data Type Flags must be evaluated by physics readers. Only data with both flags zero are valid for physics analysis!

1.5 The Stack #i Data Content

Data from all contributing links of a stack is directly concatenated ordered by ascending link number. There are two links per layer, links $\#(2i)$ and $\#(2i+1)$ carry the data from layer i.

Size/Words	**Content**	
variable	Stack #i Link #0 Data Content	only present if $\mathtt{m}_i[0]$ = '1'
variable	Stack #i Link #1 Data Content	only present if $\mathtt{m}_i[1]$ = '1'
variable	Stack #i Link #2 Data Content	only present if $\mathtt{m}_i[2]$ = '1'
variable	Stack #i Link #3 Data Content	only present if $\mathtt{m}_i[3]$ = '1'
variable	Stack #i Link #4 Data Content	only present if $\mathtt{m}_i[4]$ = '1'
variable	Stack #i Link #5 Data Content	only present if $\mathtt{m}_i[5]$ = '1'
variable	Stack #i Link #6 Data Content	only present if $\mathtt{m}_i[6]$ = '1'
variable	Stack #i Link #7 Data Content	only present if $\mathtt{m}_i[7]$ = '1'
variable	Stack #i Link #8 Data Content	only present if $\mathtt{m}_i[8]$ = '1'
variable	Stack #i Link #9 Data Content	only present if $\mathtt{m}_i[9]$ = '1'
variable	Stack #i Link #10 Data Content	only present if $\mathtt{m}_i[10]$ = '1'
variable	Stack #i Link #11 Data Content	only present if $\mathtt{m}_i[11]$ = '1'

1.6 The Stack #i Link #j Data Content

For each link of each stack, the transmitted data payload can consist of tracklet data and raw data – each separated by specific end marker data words. Tracklet information consists of a small (usually not more than 20) number of tracklet data words following the format described in section **??**. The tracklet data words are followed by exactly two tracklet data end markers (0x10001000).[1] Tracklet data (including the end marker) is left out if the $\mathtt{t}$ flag in the Supermodule Index Word is not set.

[1] In a preliminary version of the TRAP code a different end marker has been used (0xaaaaaaaa) which might still occur in development setups.

The raw data end marker consists of 1–4 words of constant zeroes (0x00000000).

Size/Words	Content
variable	Stack #i Link #j Tracklet Data Words
2	Tracklet Data End Marker (0x10001000)
variable	Stack #i Link #j Detector Raw Data
1–4	Raw Data End Marker (0x00000000)

} only present if `t` = '1'

1.7 The Stack #i Link #j Tracklet Data Words

Each Tracklet Data Word is a 32-Bit word with the following structure:

Supermodule Index Word			
pppppppp	zzzz	ddddddd	yyyyy yyyyyyyy
31 24	23 20	19 13	12 0

`p`	(Bits 31..24)	PID Signature
`z`	(Bits 23..20)	Pad Row Number
`d`	(Bits 19..13)	Deflection Length (1/140 μm)
`y`	(Bits 12..0)	Y Position (1/160 μm)

The 8-Bit PID Signature `p` contains the probability (deduced from the charge distribution measured in the TRAP chips) of the respective particle being an electron. A value of 1 (0x01) corresponds to a probability of 1/256. The Pad Row Number `z` is the number of the pad row (0..15) sending the tracklet. Both Deflection Length `d` and Y Position `y` are singed numbers in two's complement representation defining position and slope of the tracklet. Detailed information about the tracklet data format can be found in [**?**].

1.8 The Stack #i Link #j Detector Raw Data Words

The Detector raw data consists of either uncompressed or compressed detector ADC values. It is a stream of 16-Bit words, formatted into 32-Bit words by the GTU. The final word may be padded with 16 Bit of zeroes (0x0000). For a description of the format of the detector raw data, please see other documentation available on this subject [**?**].

References

[1] J. de Cuveland, "Development of the Global Tracking Unit for the ALICE Transition Radiation Detector at LHC (CERN)" (Diploma Thesis, 2003, KIP, Heidelberg)

[2] K. Oyama et al., “ALICE TRD Raw Data Format Specification” (Internal Note, 2007, PI, Heidelberg)