DØ Trigger I/O

November 11, 1997

Scope:

This document specifies data generated by trigger elements for consumption by other trigger elements. These specifications are tentative and may change with the trigger architecture. The document does not specify readout format although such raw data may be used by the MUON, CFT and SVT preprocessors. Fiber counts between the various elements will be determined at a later date as designs are finalized.

L1 $\Rightarrow$ Other L1 and L2PP's

Assumes packing such that:

- smallest fragment size for a variable within an object is **1 byte**
- object's total data size must be an **integer number of 4-byte words**

CALORIMETER:

The L1 output will consist of the $32\phi \times 40\eta = 1280$ trigger towers each for the EM and total E_T towers. This represents a total of 2560 bytes. These towers will have a LSB of 0.25 and 0.5 GeV for the EM and total E_T trigger towers, respectively. The total may increase to 3168 bytes if the trigger tower boundaries are repeated to save computation time at L2.

There will also be two trigger bitmasks, one for the EM towers and one for the total E_T towers. The bitmask will indicate which towers passed the lowest threshold set. Since there are 1280 towers each bitmask will require 160 bytes for a total of 320 bytes. The total may increase to 1600 bytes if a bitmask for all avialble reference sets is required at L2.

Calorimeter L1 to CALORIMETER Preprocessor	
Item	Bytes
Trigger bitmasks	160 Bytes $\times$ 2 refsets = 320
Total E_T TT	1280 TT $\times$ 1 B/TT = 1280
EM E_T TT	1280 TT $\times$ 1 B/TT = 1280
Total	2880 Bytes

The per event total may be multiplied by some number of interactions, $N_i \geq 4$, the esimated event size is then 10560 bytes/event. If the trigger tower repitition and extra bitmaps are included this will increase to 14272 bytes.

MUON:

There will be three MTCM cards with output to L2 muon preprocessors. Data transfer should take 4.75 μs.

Muon L1 to MUON Preprocessor	
Item	Bytes
Begin of File Character	1
Global Data Length (w/o Nulls)	2–3
Block Data Length	4–5
Turn (Rotation) Number	6–7
Spare	8–10
Bunch Crossing Number	11–12
Crate Trigger Decision	12–14
Card Trigger Data	15–46
Supplemental Card Trigger Data	47–78
MTCM Error	79–80
MTCM Status	81–82
Parity	83
End of File Character	84

Thus for the three MTCM cards there will be a total of 252 bytes.

CFT/CPS:

The Axial CFT Trigger will find track cadidates in each of 80 trigger sectors. Currently the data is sent to the L1 muon trigger and will include six track candidates from each sector – six candidates will be sent regardless of actual existence.

The data will also be sent to the CFT Trigger Manager (CFTTM) on an undetermined number of cables. The CFTTM then feeds the CFTpp or STTpp. (The cable number depends on the final trigger design and may be as low as 5-6 or as high as 80 cables. This document presumes the 80 cable configuration.)

CFT to MUON/CFTpp	
Track	Sixteen Bit Word
Highest P_T Track	1
	2
	3
	4
	5
Lowest P_T Track	6

CFT 16 Bit Format to CFTTM	
Item	Bit(Starting with MSB)
Track Found (set to 1)	15
CPS High Threshold Set	14
CPS Low Threshold Set	13
Spare	12–11
Sign	10
A Lyr Offset from H Lyr Bin	9–6
H Lyr ϕ Bin	5–0

A total of 960 bytes will be sent per event.

CFT 16 Bit Format to Muon L1	
Item	Bit(Starting with MSB)
Track Found (set to 1)	15
Spare	14–11
Sign	10
A Lyr Offset from H Lyr Bin	9–8
Spare	7–6
H Lyr ϕ Bin	5–2
Spare	1–0

Notice, the muon L1 transmission is a lower resolution version of the CFTTM transmission. A total of 960 bytes will be sent per event.

FORWARD PRESHOWER:

FPS to FPSpp Candidate Format	
Item	Byte
ϕ^{UP}	1
η^{UP}	2
E^{UP}_{iso}	3
E^{UP}_{cone}	4
ϕ^{DN}	5
η^{DN}	6
E^{DN}_{iso}	7
E^{DN}_{cone}	8

No bit level definitons for the FPS information have been specified. This depends on undefined readout specifications and L1 algorithm development. Current estimates are that four candidates will be found per event so a typical event size is 32 bytes.

Global L2 Input: L2 Preprocessors $\Rightarrow$ L2 Global

Assumes packing such that:

- smallest fragment size for a variable within an object is **1 byte**
- object's total data size must be an **integer number of 4-byte words**
- each pp will preface its data with an twelve byte header
- each pp will complete transmission with a four byte trailer
- where possible each pp object will be identified by rapidity, azimuth and E_T in that order
- the least significant bit for rapidity will be 0.05, for azimuth $2\pi/160$, and for transverse momentum 0.25 GeV/c

Preprocessor Header	
Item	Bytes
Header Length	1
Header Format	1
Object Length	1
Preprocessor ID	1
Rotation Number (high)	1
Rotation Number (low)	1
Bunch Number	1
Status	1
Run Switches	2
Event Switches	1
Number of Objects	1

Preprocessor Trailer	
Item	Bytes
Rotation Number (high)	1
Rotation Number (low)	1
Bunch Number	1
Preprocessor ID	1

CALORIMETER pp's:

The Cal preprocessors will transfer their data at 320Mbytes/sec nominally, hence a few μs transfer time for each preprocessor. The objects will be E_T ordered.

e,γ Calpp Objects	
Item	Bytes
η	1
ϕ	1
E_T	2
L1 Ref Set	1
Iso frac	1
EM frac	1
Spare	1
Total	8 bytes/object
var: ~ 2 obj/evt $\Rightarrow$ 16 bytes/evt	

jet Cal PP	
Item	Bytes
η	1
ϕ	1
E_T	2
L1 Ref Set	1
Spare	4
Total	8 bytes/object
var: ~ 4 obj/evt $\Rightarrow$ 32 bytes/evt	

$\not{E}_T$ Calpp	
Item	Bytes
η Slice	1
$\not{E}_{Tx}$	2
$\not{E}_{Ty}$	2
Spare	3
Total	8 bytes/object
fix: 8 obj/evt $\Rightarrow$ 64 bytes/evt	

The data is reported by rapidity bin so that any vertex knowledge can be applied in the Global processor.

CFT pp:

The minimal CFTpp will report only the P_T and ϕ of each candidate at shower maximum and at the A-Φ counters. The data may expand to include a r–ϕ fit to the axial fibers. Thus two spare bytes are included to carry fit quality information.

CFTpp	
Item	Bytes
Spare	1
ϕ_1	1
p_T	2
ϕ_2	1
CPS Energy/Isolated	1
Spare	2

Current estimates indicate that there may be a maximum of 150 tracks per event with a much smaller mean around 50. The maximum event size will be 1200 byte and the mean about 400.

PRESHOWER pp's:

The preshower information and multiplicity is not well understood at this time. Presumably, it will consist of the η and ϕ information for each hit.

Central Preshower PP	
Item	Bytes
η	1
ϕ	1
E	2
Spare	4
Total	8 bytes/object
var: ~ 5 obj/evt $\Rightarrow$ 40 bytes/evt	

Forward Preshower PP	
Item	Bytes
η	1
ϕ	1
E	2
Spare	4
Total	8 bytes/object
var: ~ 5 obj/evt $\Rightarrow$ 40 bytes/evt	

MUON pp:

The muon preprocessor will search for segments, A and B/C layers with hits, independent of what L1 muon found.

μ PP	
item	Bytes
η	1
ϕ	1
p_T	2
Algorithm	1
Quality	1
TOF	1
Direction	1
Total	8 bytes/object
var: $\sim$ 11 obj/evt $\Rightarrow$ 88 bytes/evt	

TOTAL PP's $\rightarrow$ GLOBAL:

Mean variable output to the L2 Global processor

Totals	
PP	variable bytes/evt
e/γ	16
jet	32
$\not\!\!E_T$	64
CFT	400
μ	88
CPS	40
FPS	40
Headers	56
Total:	736

L3 Input: L2G $\Rightarrow$ L3

Output of Global L2 consists of:

- Preprocessor OBJECTS
- Trigger decision information for each of 128 bits.

The objects lists follow as does a total estimate for the L2global output. All rapidities are in detector coordinates unless vertex information is available. In that case coordinates are given in physics rapidity. All E_T should be uncorrected.

e,γ	
item	bytes
η	1
ϕ	1
E_T	2
EM frac	2
Iso frac	2
Preshower	1
Track info	4
E/p	1
Spare	3
Total	20 bytes/object
var: $\sim$ 2 obj/evt $\Rightarrow$ 40 b/evt	

jet	
item	bytes
η	1
ϕ	1
E_T	2
Spare	4
Total	8 bytes/object
var: $\sim$ 4 obj/evt $\Rightarrow$ 32 b/evt	

$\not\!\!E_T$	
item	bytes
$\not\!\!E_T$	2
$\not\!\!E_{T\phi}$	1
$\not\!\!E_{Tx}$	2
$\not\!\!E_{Ty}$	2
Total	8 bytes/object
fix: 1 obj/evt $\Rightarrow$ 8 b/evt	

μ	
item	bytes
η	2
ϕ	2
p_T	2
Quality	1
Track info	4
Spare	2
Total	16 bytes/object
var: $\sim$ 5 obj/evt $\Rightarrow$ 80 b/evt	

Totals	
object	variable b/evt
e/γ	40
jet	32
$\not{E}_T$	8
μ	80
Term Bitmasks	16
Total:	176