Proposal of New LCT Data Format

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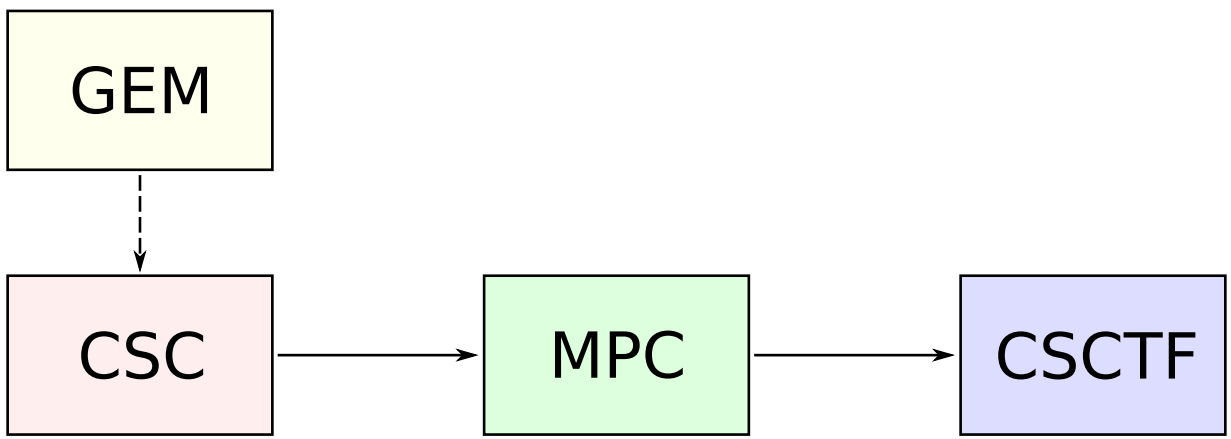
Introduction

Post LS2: two implementations of addition of GEM information to the current muon trigger system GEM-CSC integrated local trigger

- Standalone GEM trigger
- GEM-CSC integrated local trigger

GEM-CSC integrated local trigger

- When we would start taking advantage of GEM during trigger stubs reconstruction, we would have to re-define the LCT raw data format to store some GEM-related information
- This data is transferred from TMB to MPC and is further passed on to CSCTF



Current LCT Data Format

- Every BX CSC TMB sends up to 2 LCTs to MPC
- Each LCT is described by the following 32 bits*

Data Field	Size (bits)	Description
alct_key	7	ALCT key layer wiregroup
clct_pat	4	CLCT bend pattern
lct_quality	4	LCT quality
lct_vpf	1	LCT valid pattern flag
clct_cfeb	3	CLCT (D)CFEB
clct_key	5	CLCT key layer half-strip
clct_bend	1	Direction of CLCT bend
clct_sync_err & tmb_sync_err_en	1	Combined sync. err. flag
alct_bxn[0]	1	ALCT BX flag
clct_bx0	1	CLCT BX flag
csc_id	4	Trigger ID of a chamber

* — current data format is described on page 15 of the CSC TMB Manual

Proposed Changes in LCT Data Format (1/3)

New LCT data format:

- Do not change size of any data field
- Redefine the following data fields:

Data Field	Size (bits)
clct_pat	4
lct_quality	4
lct_vpf	1
clct_bend	1

Usage of new LCT data format depends on existence of a GEM match to CSC stub:

- If there is no GEM match, keep using current LCT data format (see previous slide)
- If there is a GEM match, use new LCT data format

Proposed Changes in LCT Data Format (2/3)

Data Field	Size (bits)
clct_pat	4
lct_quality	4
lct_vpf	1
clct_bend	1

Change #1: **clct_pat**

4 bits allow us to encode 16 values for CLCT (CLCT-GEM) patterns

- 11 values out of 16 are reserved for current CLCT patterns (0–10)
- 5 values are not used (11–15)

If there is CLCT:

- We can calculate CSC-GEM bending angle and corresponding stub pt
- Use 5 available values to encode stub pt bin: [0-3], [3-5], [5-10], [10-20], [20-∞] GeV

If there is no CLCT:

- We can't calculate CSC-GEM bending angle: set pattern ID to 0

Proposed Changes in LCT Data Format (3/3)

Data Field	Size (bits)
clct_pat	4
lct_quality	4
lct_vpf	1
clct_bend	1

- Change #2: **lct_quality**
  - See current and new definitions of LCT quality on slides 7 and 8
- Change #3: **lct_vpf**
  - Shows if there was a GEM match (lct_vpf $\equiv$ 1)
- Change #4: **clct_bend** $\rightarrow$ **cscgem_bend**
  - Encode direction of CSC-GEM bending angle

There is a way to uniquely find out if the new data format was used:

- If ID $\in$ [11,12,13,14,15]
- If ID $=$ 0 and lct_vpf $=$ 1

Current definition of LCT quality

Q = **0** — There are no ALCT, CLCT (this should never happen)
Q = **1** — There is ALCT, no CLCT
Q = **2** — There is CLCT, no ALCT

There are ALCT and CLCT:

- if (CLCT pattern == 1) Q = **3**
- else:
  - if (ALCT has at least 4 layers with hits) A4 = 1 else A4 = 0
  - if (CLCT has at least 4 layers with hits) C4 = 1 else C4 = 0
  - Q = **5** — !A4 and !C4
  - Q = **6** — A4 and !C4
  - Q = **7** — !A4 and C4
  - A4 and C4:
    - Q = **11** — CLCT pattern == 2 or 3
    - Q = **12** — CLCT pattern == 4 or 5
    - Q = **13** — CLCT pattern == 6 or 7
    - Q = **14** — CLCT pattern == 8 or 9
    - Q = **15** — CLCT pattern == 10

New definition of LCT quality

A straw man proposal (more studies needed to optimize it):

- if (ALCT has **at least 4 layers** with hits) A4 = 1 else A4 = 0
- if (CLCT has **at least 3 layers** with hits) C3 = 1 else C3 = 0

CSC-GEM bending angle bin	A4	C3	Q
—	0	0	0
—	1	0	1
[0-3]	0	1	2
[0-3]	1	1	3
[3-5]	0	1	4
[3-5]	1	1	5
[5-10]	0	1	6
[5-10]	1	1	7
[10-20]	0	1	8
[10-20]	1	1	9
[20-∞]	0	1	10
[20-∞]	1	1	11

Effects on MPC and CSCTF

MPC:

- There is no MPC sorting: output all valid LCTs to CSCTF (up to 18 LCTs)
- lct_quality is not used by MPC
- Natural extension of lct_vpf: transmit LCTs with valid CLCT or GEM information

CSCTF:

- lct_quality is not used by CSCTF

Conclusions

Summary of the new LCT data format:

- Minimal changes
  - The sizes of all data fields are not changed
- Natural extension of the current LCT data format
  - 5 unused values of clct_pat for GEM-CSC bending patters
  - lct_vpf shows if there is a valid CLCT or a GEM information
  - lct_bend shows CSC (CSC-GEM) bending direction
  - Simplified lct_quality assignment (not used by MPC and CSCTF)
- New LCT data format is used only when there is a GEM match to CSC stub
  - There is a way to uniquely identify which data format is used

BACKUP SLIDES

CLCT Patterns

Pattern Finding:

For each of 160 key ½-strips consider the 42 neighboring ½-strips (i.e. on key 5 use the following ½-strips)

```
hs              0123456789A
ly0[10:0]       xxxxxkxxxxx     5+1+5 =11
ly1[ 7:3]          xxkxx        2+1+2 = 5
ly2[ 5:5]            k          0+1+0 = 1
ly3[ 7:3]          xxkxx        2+1+2 = 5
ly4[ 9:1]         xxxxkxxxx     4+1+4 = 9
ly5[10:0]       xxxxxkxxxxx     5+1+5 =11
```

For each of 160 key ½-strips, count layers with hits matching the 9 pattern templates
Pattern ID=1 is a layer-OR trigger, Pattern ID=0 is no-pattern-found

```
Hit pattern LUTs for 1 layer: - = don't care, xx= one hit or the other or both
Pattern       id=2        id=3        id=4        id=5        id=6        id=7        id=8        id=9        idA
Bend dir      bd=0        bd=1        bd=0        bd=1        bd=0        bd=1        bd=0        bd=1        bd=0
              |           |           |           |           |           |           |           |           |
ly0      --------xxx xxx-------- -------xxx- -xxx------- ------xxx-- --xxx------ -----xxx--- ---xxx----- ----xxx----
ly1      ------xx--- ---xx------ ------xx--- ---xx------ -----xx---- ----xx----- -----xx---- ----xx----- -----x-----
ly2 key  -----x----- -----x----- -----x----- -----x----- -----x----- -----x----- -----x----- -----x----- -----x-----
ly3      ---xxx----- -----xxx--- ---xx------ ------xx--- ----xx----- -----xx---- ----xx----- -----xx---- -----x-----
ly4      -xxx------- -------xxx- -xxx------- -------xxx- ---xx------ ------xx--- ---xxx----- -----xxx--- ----xxx----
ly5      xxx-------- --------xxx -xxx------- -------xxx- --xxx------ ------xxx-- ---xxx----- -----xxx--- ----xxx----
              |           |           |           |           |           |           |           |           |
```