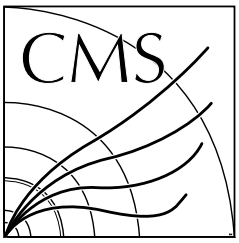

Definition uGT readout record

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July 5, 2023

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1 Definition uGT readout record

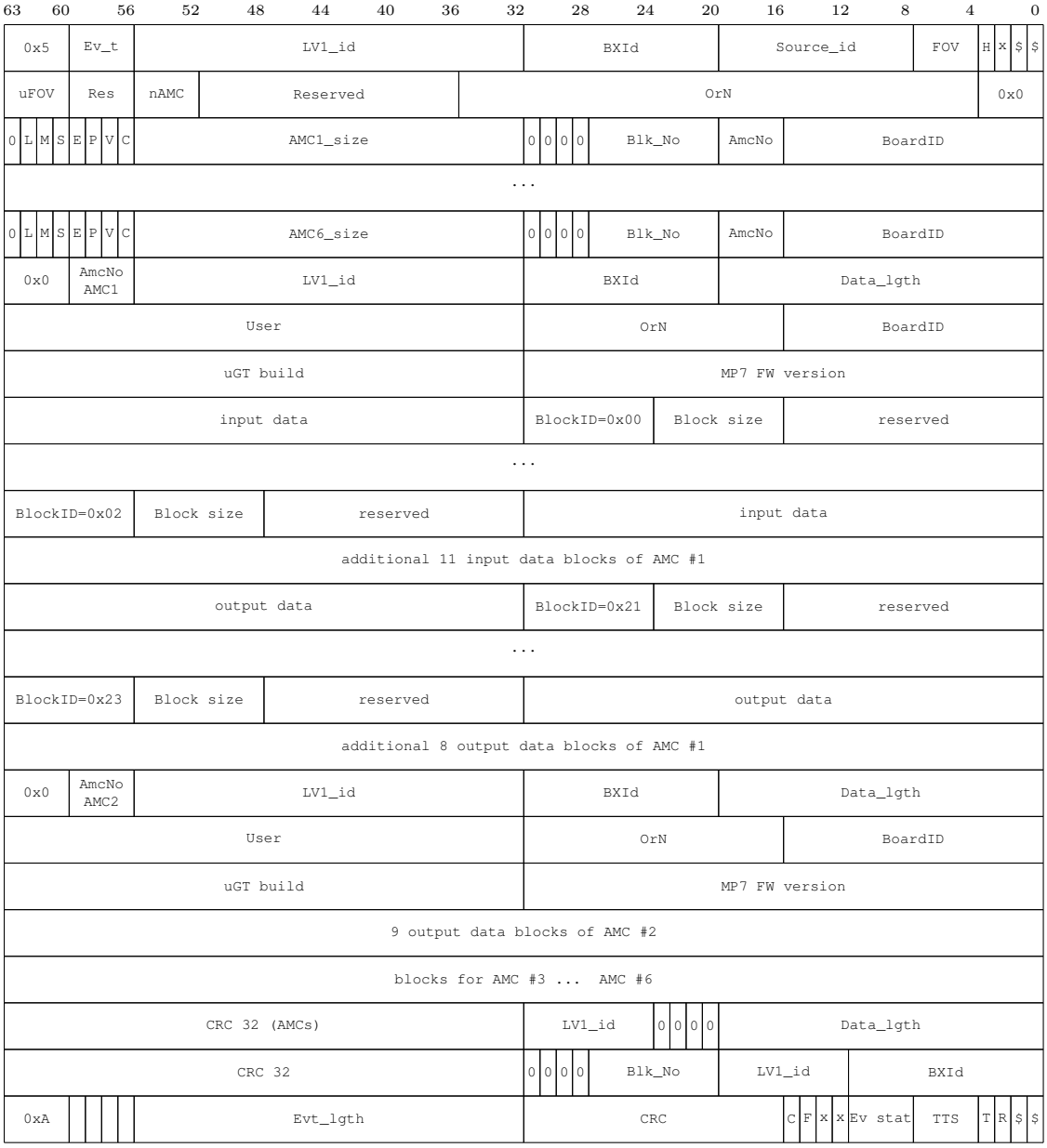
This document is a description of the structure of a uGT readout record.

In chapter "Event Builder Overview" of document [1] one can find a description about building a uGT readout record on AMC13.
The following description and explanations are based on documents [1] and [2].

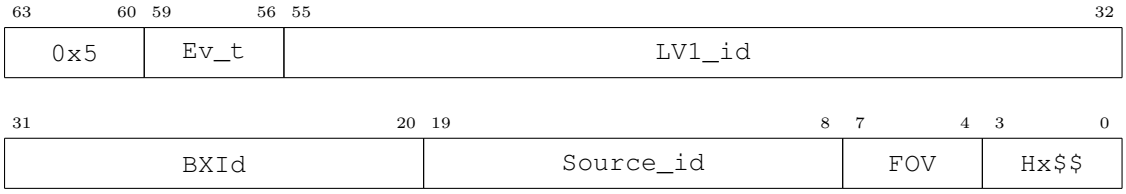
1.1 Overview of structure

In the following table the structure of the uGT readout record is shown:

- the first 8 lines contain AMC13 header information,
- followed by 3 AMC#1 header lines.
- Then the first block of input data (of AMC#1), containing a block header and 30 data words (32 bits), is shown.
- A certain number of input data blocks and output data blocks (each with the same block size) and a AMC#1 trailer line finish AMC#1 readout record.
- Data of AMC#2 to AMC#6 with output data blocks only
- and 2 AMC13 trailer lines fill up the readout record.


63 60 56 52 48 44 40 36 32 28 24 20 16 12 8 4 0
0x5 Ev_t LV1_id BXId Source_id FOV H x $ $
uFOV Res nAMC Reserved OrN 0x0
0 L M S E P V C AMC1_size 0 0 0 0 Blk_No AmcNo BoardID
...
0 L M S E P V C AMC6_size 0 0 0 0 Blk_No AmcNo BoardID
0x0 AmcNo AMC1 LV1_id BXId Data_lgth
User OrN BoardID
uGT build MP7 FW version
input data BlockID=0x00 Block size reserved
...
BlockID=0x02 Block size reserved input data
additional 11 input data blocks of AMC #1
output data BlockID=0x21 Block size reserved
...
BlockID=0x23 Block size reserved output data
additional 8 output data blocks of AMC #1
0x0 AmcNo AMC2 LV1_id BXId Data_lgth
User OrN BoardID
uGT build MP7 FW version
9 output data blocks of AMC #2
blocks for AMC #3 ... AMC #6
CRC 32 (AMCs) LV1_id 0 0 0 0 Data_lgth
CRC 32 0 0 0 0 Blk_No LV1_id BXId
0xA Evt_lgth CRC C F x x Ev stat TTS T R $ $

Line 1 - AMC13 header ("CDF header"):



[63:60] = fixed marker 0x5 (begin of readout record)

[59:56] = "Ev_t" (4) means event type (0x1 = physic events ?)

[55:32] = "LV1_id" (24) means "Level 1 ID" (hardware event number)

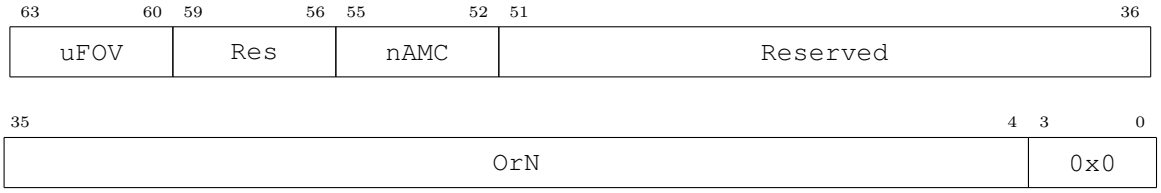
[31:20] = "BXId" (12) means bunch crossing number @ L1A

[19:8] = "Source_id" (12) is FED #

[7:4] = 0x0 ["FOV" (4) means "Format version" ?]

[3:0] = 0x0 ["Hx$$" (4) ?]

Line 2 - AMC13 header:



[63:60] = "uFOV" (4) means "Format version" = 0x1 (0 in all previous firmwares)

[59:56] = "Res" (4) reserved bits

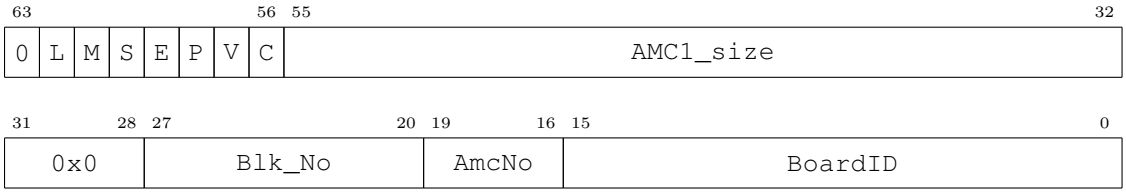
[55:52] = "nAMC" (4) numbers of AMC in readout record

[51:36] = "Reserved" (16) reserved bits

[35:4] = "OrN" (32) orbit number @ L1A

[3:0] = 0x0

Line 3 - AMC13 header (for AMC #1):



[63:56] = 8 bits with leading 0 and 7 bits for L, M, S, E, P, V, C. See [1] pg. 5 for details

[55:32] = "AMC1_size" (24) readout record length of AMC #1

[31:28] = 0x0

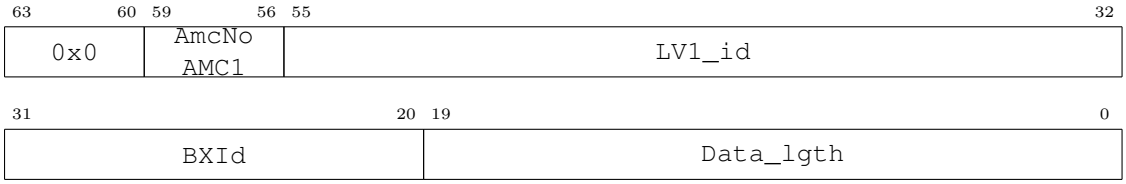
[27:20] = 0x00 ["Blk_No" (8) ?]

[19:16] = "AmcNo" (4) number of first AMC in record

[15:0] = 0x0000 ["BoardID" (16) ?]

Line 4 - AMC13 header for AMC #2
Line 5 - AMC13 header for AMC #3
Line 6 - AMC13 header for AMC #4
Line 7 - AMC13 header for AMC #5
Line 8 - AMC13 header for AMC #6

Line 9 - AMC#1 header:



[63:60] = 0x0

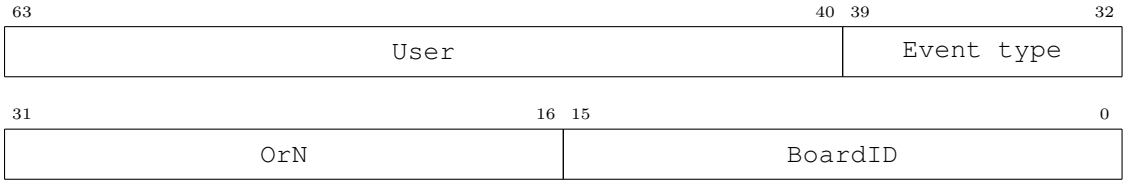
[59:56] = "AmcNo AMC1" (4) number of first AMC in record

[55:32] = "LV1_id" (24) means "Level 1 ID" (hardware event number)

[31:20] = "BXId" (12) means bunch crossing number @ L1A

[19:0] = "Data_lgth" (20) means readout record length of AMC #1

Line 10 - AMC#1 header:



[63:40] = 0x000000 ["User" (24) ?]

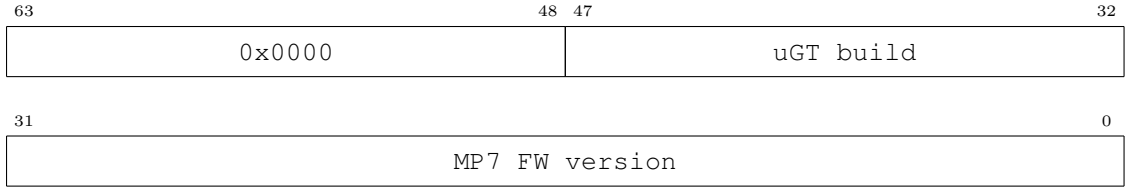
[39:32] = "Event type" (8) is set in configuration key: "ugt infra mp7 base" with

```
<param cmd="roLoadMenu" id="mode1:eventType" type="uint">0xc0</param>
```

[31:16] = "OrN" (16) least significant 16 bits of orbit number @ L1A

[15:0] = 0x0000 ["BoardID" (16) ?]

Line 11 - AMC#1 header:

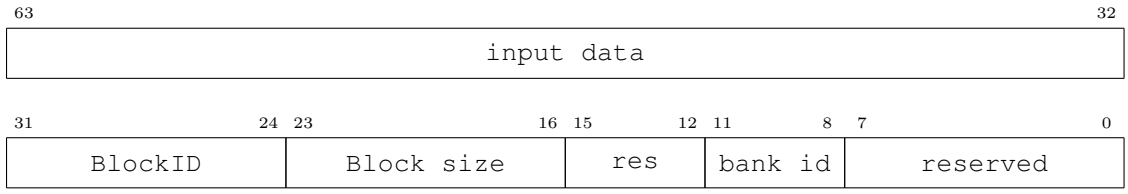


[63:48] = 0x0000

[47:32] = "uGT build" (16) uGT firmware build number

[31:0] = "MP7 FW version" (32) (e.g.: 0x00030202 means version 3.2.2)

Line 12 - AMC#1 uGT input data (in readout record):



[63:32] = "input data" - muon data, link 1, mgt channel 0x00, frame 0 (free), bx-2)

[31:24] = "BlockID" (8) mgt channel number of the link (=0x00, marker of first block of "input data")

[23:16] = "Block size" (8) from: "ugt infra mp7 base" with

```
<param cmd="roLoadMenu" id="mode0:capture0:readoutLength" type="uint">30</param>
```

which is 0x1e. (Similar commands for other modes and captures)

[15:12] = "res" (4) means reserved

[11:8] = Contains probably the "bank id" which is set in configuration key: "ugt infra mp7 base" with

```
<param cmd="roLoadMenu" id="mode1:capture1:bankId" type="uint">2</param>
```

=0x2 for input data and

```
<param cmd="roLoadMenu" id="mode1:capture0:bankId" type="uint">1</param>
```

=0x1 for output data

[7:0] = "reserved" (8)

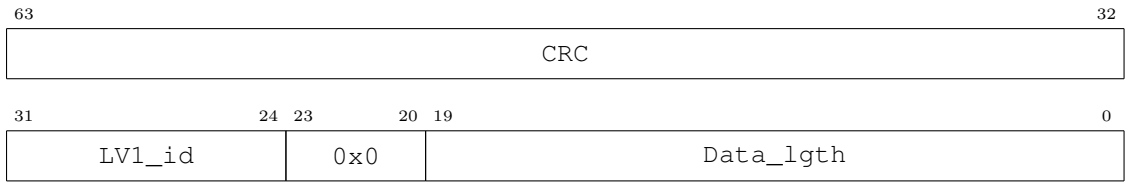
Line 13 [63:32] - AMC#1 uGT input data - muon data, link 1, channel 0x00, frame 2 (MU0[31:0]), bx-2
Line 13 [31:24] - ... frame 1 (MU0 & MU1 eta raw), bx-2
Line 14 [63:32] - ... frame 4 (MU1[31:0]), bx-2
Line 14 [31:24] - ... frame 3 (MU0[63:32]), bx-2
Line 15 [63:32] - ... frame 0 (free), bx-1
Line 15 [31:24] - ... frame 5 (MU1[63:32]), bx-2

Line 16 [63:32] - ... frame 2 (MU0[31:0]), bx-1
Line 16 [31:24] - ... frame 1 (MU0 & MU1 eta raw), bx-1
Line 17 [63:32] - ... frame 4 (MU1[31:0]), bx-1
Line 17 [31:24] - ... frame 3 (MU0[63:32]), bx-1
Line 18 [63:32] - ... frame 0 (free), bx
Line 18 [31:24] - ... frame 5 (MU1[63:32]), bx-1
Line 19 [63:32] - ... frame 2 (MU0[31:0]), bx
Line 19 [31:24] - ... frame 1 (MU0 & MU1 eta raw), bx
Line 20 [63:32] - ... frame 4 (MU1[31:0]), bx
Line 20 [31:24] - ... frame 3 (MU0[63:32]), bx
Line 21 [63:32] - ... frame 0 (free), bx+1
Line 21 [31:24] - ... frame 5 (MU1[63:32]), bx
Line 22 [63:32] - ... frame 2 (MU0[31:0]), bx+1
Line 22 [31:24] - ... frame 1 (MU0 & MU1 eta raw), bx+1
Line 23 [63:32] - ... frame 4 (MU1[31:0]), bx+1
Line 23 [31:24] - ... frame 3 (MU0[63:32]), bx+1
Line 24 [63:32] - ... frame 0 (free), bx+2
Line 24 [31:24] - ... frame 5 (MU1[63:32]), bx+1
Line 25 [63:32] - ... frame 2 (MU0[31:0]), bx+2
Line 25 [31:24] - ... frame 1 (MU0 & MU1 eta raw), bx+2
Line 26 [63:32] - ... frame 4 (MU1[31:0]), bx+2
Line 26 [31:24] - ... frame 3 (MU0[63:32]), bx+2
Line 27 [63:32] - AMC#1 uGT input data - "BlockID=0x02 (8), "Block size" (8), "res" (4), "bank id=0x2" (4), "reserved" (8)
Line 27 [31:24] - AMC#1 uGT input data - muon data, link 1, channel 0x00, frame 5 (MU1[63:32]), bx+2

Remark:
The order of frames and +/-2 bx has to be verified!
See an example for such a data block (line 12 - 27) in 1.3.

Blocks for additional input data and output data fill up the readout record of AMC#1.

AMC#1 trailer:



[63:32] = "CRC" (32) 32 bits CRC summary (of AMC #1 data)

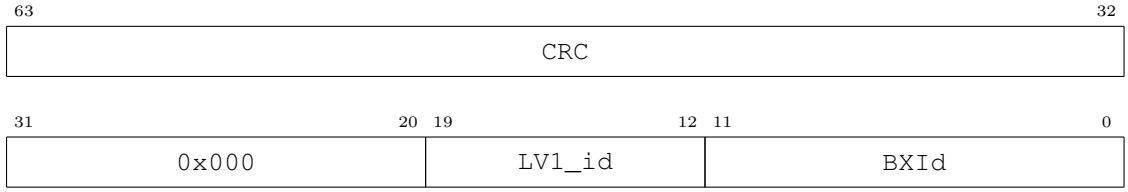
[31:24] = "LV1_id" (8) means "Level 1 ID" (hardware event number)

[23:20] = 0x0

[19:0] = "Data_lgth" (20) means readout record length of AMC #1

Readout records for AMC#2 - AMC#6, with output data only, fill up the readout record.

Last line - 1, AMC13 trailer:



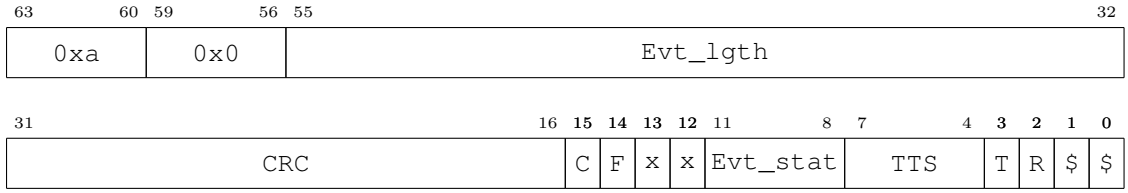
[63:32] = "CRC" (32) 32 bits CRC summary of data in entire record.

[31:20] = 0x000

[19:12] = "LV1_id" (8) means "Level 1 ID" (hardware event number)

[11:0] = "BXId" (12) means bunch crossing number @ L1A

Last line, AMC13 trailer ("CDF trailer"):



[63:60] = fixed marker 0xa (end of readout record)

[59:56] = 0x0

[55:32] = "Evt_lgth" (24) length of readout record (in 64 bits lines)

[31:16] = "CRC" (16) 16 bits CRC summary ?

[15:12] = 0x0 ["C, F, x, x" 4 bits ?]

[11:8] = 0x0 ["Evt_stat" (4) ?]

[7:4] = 0x0 ["TTS" (4) ?]

[3:0] = 0x0 ["T, R, $, $" 4 bits ?]

1.2 Readout record dump

Example of a readout record dump (with description):

```
5186f41767557c08 - AMC13 header:  Event type, LV1 id, BX id, FED#
1060424 0512ff30 - AMC13 header:  AMCs, Orbit nr (32 bits)
0f00014a00010000 - AMC13 header:  Data length, AMC#1
0f0000900002 0000 - AMC13 header:  Data length, AMC#2
0f00009000030000
0f00009000040000
0f00009000050000
0f00009000060000
0186f4176750014a - AMC#1 header:  AMC#1, LV1 id, BX id, Data length
000000c0ff300000 - AMC#1 header:  Ev.  type [0], Orbit nr (16 bits)
0000115200030202 - AMC#1 header:  uGT FW build, MP7 FW version
00000000001e0200 - AMC#1 input:  Block ID, Block size, "bankId"=input
.................  - AMC#1 muon input data
021e020000000000 - AMC#1 input:  Block ID, Block size, "bankId"
.................  - AMC#1 muon input data
00000000041e0200
.................  - AMC#1 muon input data
061e020000000000
.................  - AMC#1 muon input data
06000200081e0200
.................  - AMC#1 e/gamma input data
0a1e020006000200
.................  - AMC#1 e/gamma input data
000008000c1e0200
.................  - AMC#1 jet input data
0e1e020000000800
.................  - AMC#1 jet input data
02000200101e0200
.................  - AMC#1 tau input data
121e020002000200
.................  - AMC#1 tau input data
0002a02a141e0200
.................  - AMC#1 esums input data
181e02000006f000
.................  - AMC#1 ext cond input data
00000000211e0100 - AMC#1 output:  Block ID, Block size, "bankId"=output
.................  - AMC#1 algo output data
231e010000000000
.................  - AMC#1 algo output data
00000000251e0100
.................  - AMC#1 algo output data
271e01005ca70bcc
.................  - AMC#1 algo output data
```

```
00000000291e0100
.................  - AMC#1 algo output data
2b1e010000000000
.................  - AMC#1 algo output data
000000002d1e0100
.................  - AMC#1 algo output data
2f1e010000000000
.................  - AMC#1 algo output data
00000000311e0100
.................  - AMC#1 algo output data
9ac23b7617000014a - AMC#1 trailer:  CRC, LV1 id (8 bits), Data length
0286f41767500090 - AMC#2 header
000000c0ff300000 - AMC#2 header
0000115200030202 - AMC#2 header
00000000211e0100
.................  - AMC#2 algo output data
231e010000000000
.................  - AMC#2 algo output data
00000000251e0100
.................  - AMC#2 algo output data
271e01005ca70bcc
.................  - AMC#2 algo output data
00000000291e0100
.................  - AMC#2 algo output data
2b1e010000000000
.................  - AMC#2 algo output data
000000002d1e0100
.................  - AMC#2 algo output data
2f1e010000000000
.................  - AMC#2 algo output data
00000000311e0100
.................  - AMC#2 algo output data
cb79a76317000090 - AMC#2 trailer
0386f41767500090 - AMC#3 header
000000c0ff300000 - AMC#3 header
0000115200030202 - AMC#3 header
00000000211e0100
.................  - AMC#3 to AMC#6
36cb696317000090 - AMC#6 trailer
f6b9461200017675 - AMC13 trailer:  CRC, LV1 id (8 bits), BX id
a00004248468000 - AMC13 trailer:  Ev.  length, CRC (16 bits)
```

1.3 Data block

Description of a block with "block size" = 0x1e (6 frames [32 bits] @ +/-2 bx = 30) of a certain "Block ID" (0x00, 0x02, ..., 0x21, 0x23, ...):

```
00000000001e0200 - bx-2:  frame 0
0000000000000000 - bx-2:  frame 2, frame 1
0000000000000000 - bx-2:  frame 4, frame 3
0000000000000000 - bx-1:  frame 0, bx-2:  frame 5
0000000000000000 - bx-1:  frame 2, frame 1
0000000000000000 - bx-1:  frame 4, frame 3
0000000000000000 - bx:  frame 0, bx-1:  frame 5
0000000000000000 - bx:  frame 2, frame 1
0000000000000000 - bx:  frame 4, frame 3
0000000000000000 - bx+1:  frame 0, bx:  frame 5
0000000000000000 - bx+1:  frame 2, frame 1
0000000000000000 - bx+1:  frame 4, frame 3
0000000000000000 - bx+2:  frame 0, bx+1:  frame 5
0000000000000000 - bx+2:  frame 2, frame 1
0000000000000000 - bx+2:  frame 4, frame 3
021e020000000000 - bx+2:  frame 5
```

Remark:
The order of frames and +/-2 bx has to be verified!

References

[1] AMC13 Event Builder:
http://ohm.bu.edu/~hazen/CMS/AMC13/UpdatedDAQPath_2014-07-10.pdf 1, 1.1

[2] MP7 Readout & DAQ:
https://github.com/cms-l1-globaltrigger/mp7_ugt_legacy/blob/master/doc/read_out_record/MP7Readout.pdf 1