Q4 Testbeam data analysis

Status report

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Outlook

DAQ problems ⇒ Times OK but wrong polarity/cell/layer assignation

First solution ⇒ CIEMAT correction algorithm

Now ⇒ Common correction program defined (new algorithm)

⇒ It provides new ntuples with DT + BTI + BC info

(http://warco.pd.infn.it/cms/testbeamQ4/ntupla.txt)

- ⇒ Common ntuples structure
- ⇒ Comparison common ntuples - CIEMAT ntuples
- ⇒ Bugs
- ⇒ Efficiencies

```
*****************************************************************
* Ntuple ID = 2      Entries = 51279     TestBeam-BTI-ntuple
*****************************************************************
* Var numb * Type * Packing *    Range     *  Block   *  Name    *
*****************************************************************
*      1   * I*4  *         *              * GENERAL  * Run
*      2   * I*4  *         *              * GENERAL  * Spill
*      3   * I*4  *         *              * GENERAL  * Event
*      1   * U*4  *    16   * [0,65535]    * TRTIME   * trigT
-----------------------------------------------------------------
*      1   * I*4  *         * [0,127]      * DTBX     * Nhits
*      2   * U*4  *    3    * [0,4]        * DTBX     * hlay(Nhits)
*      3   * U*4  *    6    * [0,63]       * DTBX     * htube(Nhits)
*      4   * U*4  *    16   * [0,65535]    * DTBX     * htime(Nhits)
*      5   * U*4  *    1    * [0,1]        * DTBX     * hflag(Nhits)

          0 = first front (leading)
          1 = second front (trailing)

-----------------------------------------------------------------
*      1   * I*4  *         * [0,15]       * BTI      * Nbti
*      2   * U*4  *    3    * [0,7]        * BTI      * bqual(Nbti)
*      3   * U*4  *    4    * [0,15]       * BTI      * bnum(Nbti)
*      4   * U*4  *    1    * [0,1]        * BTI      * bcod(Nbti)
*      5   * U*4  *    8    * [0,255]      * BTI      * bslot1(Nbti)
*      6   * U*4  *    8    * [0,255]      * BTI      * bslot2(Nbti)
*      7   * I*4  *    8    * [-63,64]     * BTI      * bk(Nbti)
*      8   * U*4  *    7    * [0,64]       * BTI      * bx(Nbti)
*      1   * U*4  *    16   * [0,65535]    * SCTIME   * scintT
*      1   * I*4  *         * [0,200]      * BCH      * Nbch
*      2   * I*4  *         *              * BCH      * chtime(Nbch)
*      3   * I*4  *         *              * BCH      * chamber(Nbch)
-----------------------------------------------------------------
*      1   * U*4  *    2    * [0,2]        * FLAGS    * tdcflag
*      2   * U*4  *    2    * [0,3]        * FLAGS    * btiflag
*****************************************************************
```

tdcflag

2 = (BAD) original event but with wrong sequence (not correctable) ($\sim 7\%$)

1 = (OK) event identified with bug and corrected for the bug ($\sim 92\%$)

0 = (OK) original event identified as ok ($< 1\%$)

Common ntuples structure

Common ntuples have still several avoidable bugs

⇒ Events identified as OK (tdcflag = 0) have assignation mistakes

RUN 769

tdcflag = 0

spill	event	htube	hlay	hflag	htime
163	26				
		12	3	0	2515
		12	3	1	2296
		12	1	0	2523
		12	1	1	2298
		9	4	0	2653
		13	4	0	2399
		13	2	0	2650
		13	2	1	2396
164	218				
		9	3	0	2641
		11	3	1	2423
		12	1	0	2636
		12	1	1	2410
		9	4	0	2532
		13	4	0	2279
		13	4	0	2534
		13	2	1	2281

It occurs in ∼ 60 % of ”good flagged” non-empty events (less than 0.5 % of the total number of events)

Bugs

⇒ Wrong polarity assignation

RUN 769

tdcflag = 1

spill	event	htube	hlay	hflag	htime
163	48				
		12	3	0	2542
		12	3	1	2323
		12	1	0	2539
		12	1	1	2315
		13	4	0	2636
		13	4	0	2382
		13	2	0	2634
		13	2	1	2380

(tdcflag = 1 ⇒ Corrected events)

Bugs

⇒ Several correction mistakes in cell number

```
-------------------------------------------
  SPILL  163 Event 39. Found 12 DTBX Hits
 HIT 0 ----  Layer 4 Cell 13 Pol 0 Time 2725
 HIT 1 ----  Layer 4 Cell 14 Pol 1 Time 2472
 HIT 2 ----  Layer 2 Cell 14 Pol 0 Time 2721
 HIT 3 ----  Layer 4 Cell 9 Pol 0 Time 2465
 HIT 4 ----  Layer 3 Cell 14 Pol 0 Time 2442          RUN 769
 HIT 5 ----  Layer 3 Cell 14 Pol 1 Time 2186          RAW DATA
 HIT 6 ----  Layer 1 Cell 14 Pol 0 Time 2448
 HIT 7 ----  Layer 1 Cell 14 Pol 1 Time 2191
 HIT 7 ----  Layer 4 Cell 26 Pol 0 Time 2576
 HIT 7 ----  Layer 4 Cell 26 Pol 1 Time 2288
 HIT 7 ----  Layer 4 Cell 20 Pol 1 Time 2704
 HIT 7 ----  Layer 4 Cell 20 Pol 0 Time 1624
-------------------------------------------
        COMMON NTUPLE DATA
+------------+------------+------------+------------+------------+------------+
|   spill    |   event+1  |   hlay     |   htube    |   htime    |   hflag    |
+------------+------------+------------+------------+------------+------------+
|  163       |  39        |            |            |            |            |
|            |            |  4         |  13        |  2725      |  0         |
|            |            |  4         |  14        |  2472      |  1         |
|            |            |  2         |  14        |  2721      |  0         |
|            |            |  2         |  14        |  2465      |  1         |
|            |            |  3         |  14        |  2442      |  0         |
|            |            |  3         |  14        |  2186      |  1         |
|            |            |  1         |  14        |  2448      |  0         |
|            |            |  1         |  14        |  2191      |  1         |
+------------+------------+------------+------------+------------+------------+
```

... and combinations of them

Bugs

Comparison common ntuples - CIEMAT ntuples

To check the effect of these bugs, a visual scan in 350 events comparing common ntuples data with CIEMAT data was performed.

Discrepancies after fits found in 39 events.

From these 39 events :

	Common nt	CIEMAT nt
Rejected events	2	33
Good events	24	4
Wrong events	13	2

According to the scan in 350 events :

	Common nt	CIEMAT nt
Recovered events	93 %	80 %
% of recovered events with identified bugs	5 %	< 1 %

$\Rightarrow$ Common algorithm recovers more efficiently

$\Rightarrow$ Fraction of wrong events is $\sim$ 5 times larger

Comparison

Efficiency

Average cell efficiencies

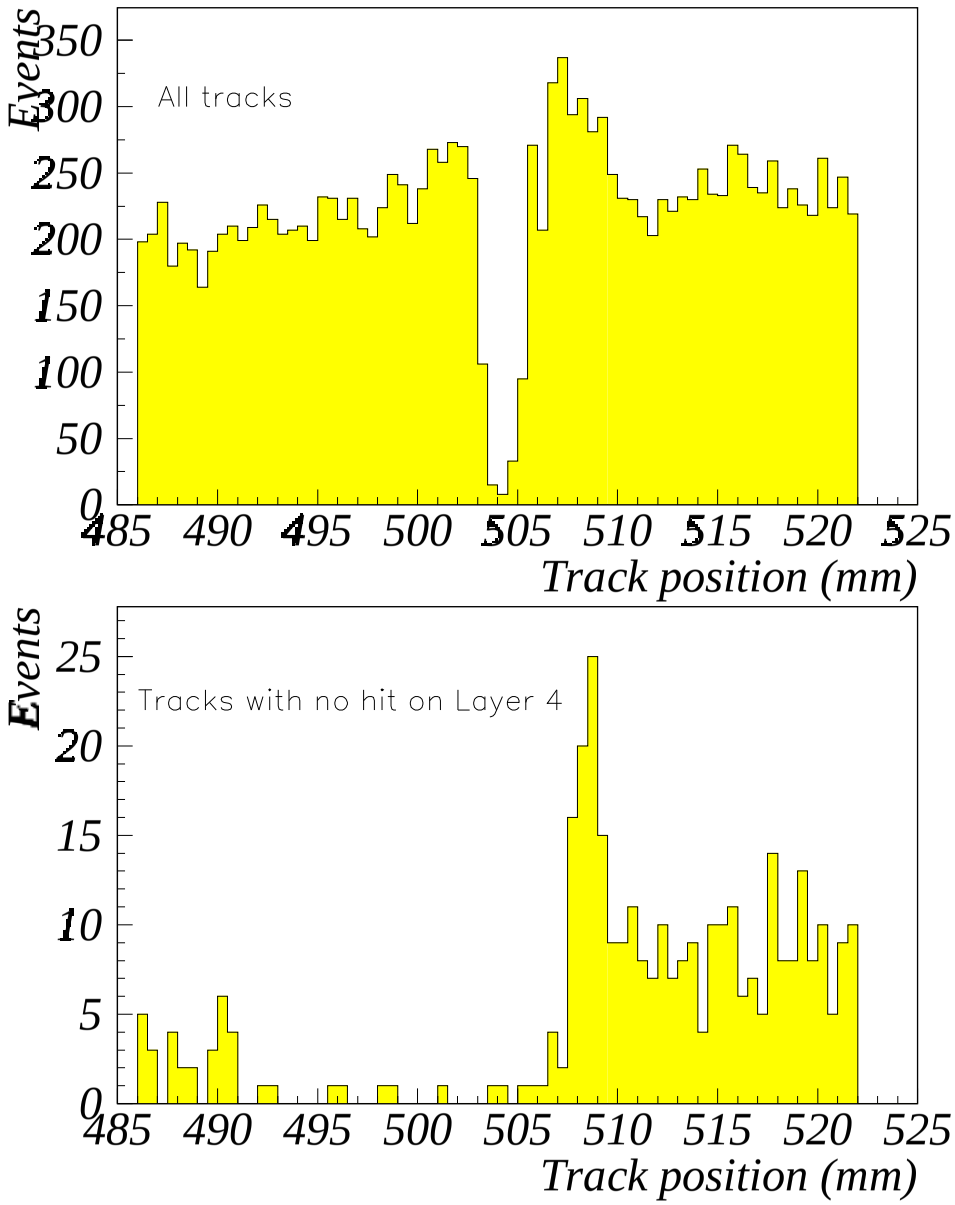
	$\theta = 0°$ thr = 6 mV	$\theta = 0°$ thr = 9 mV	$\theta = 35°$ thr = 9 mV
CIEMAT	99.43 %	99.35 %	99.45 %
Common	99.20 %	98.93 %	98.51 %

The algorithm seems to become worse for inclined tracks...

By looking at the inefficiency distribution...

Most of the lost hits are located on the right half of cells in layers 3 and 4.

Position of reconstructed tracks crossing C12L4

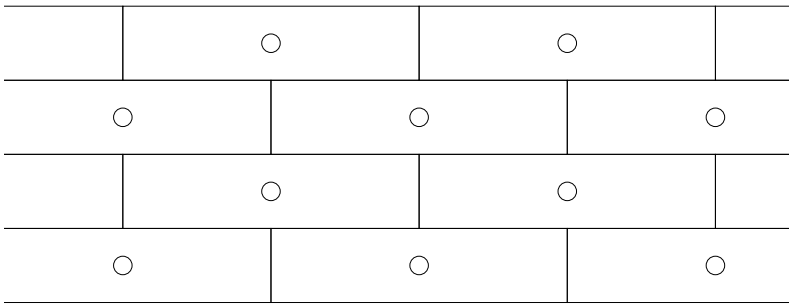


Inefficiency for Layers 3-4

The explanation ...

Most of the times, the inefficiencies are caused by a lost in the first recorded hit of the track:

hlay	htube	htime	hflag
4	10	2745	0
4	12	2517	1
2	12	2743	0
2	12	2518	1
3	12	2424	0
3	12	2205	1
1	12	2364	0
1	12	2138	1



hlay	htube	htime	hflag
3	11	2556	0
3	12	2338	1
1	12	2577	0
1	12	2351	1
4	13	2596	0
4	13	2342	1
2	13	2601	0
2	13	2347	1

It corresponds to the right half of cells either in layer 4 or in layer 3

Inefficiency for Layers 3-4

Summary

- ⇒ Common algorithm is able to recover up to 93% of the original events. $\sim$ 95% of recovered events are reliable.
- ⇒ Careful with biased zones (right half of cells in L3 and L4). Specially for efficiency measurements, they have to be ”cut off”.
- ⇒ Problem on first hit assignation becomes more important for inclined tracks.

Still missing...

External references ??

⇒ BC do not match (Trigger is probably in different muons)

⇒ No matching DT-SiBT with available information...

If external references could be used, further and more precise measurements of linearity and cell efficiency could be done

They can also help in the recognition of possible additional biases of the correction algorithm

Still missing...