Preliminary results from Quad test beam



Kees Ligtenberg

LC-TPC Colloboration meeting

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Results from Quad test beam

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Table of Contents



2 Synchronization issues



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Introduction

- Quad is a module consisting of 4 Timepix3 chips, with all services under the active area
- Quad detector is put inside a test box with guards and field shaping, filled with T2K gas



See also introduction talk by Peter Kluit



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January 7, 2019 2 / 14

Test beam setup

- 2.5 GeV electrons provided by the ELSA facility (Bonn) at a 10 kHz rate
- Events are triggered by a scintillating plane
- $\bullet\,$ The telescope consist of 6 mimosa planes with $18.4\,\mu m \times 18.4\,\mu m$ sized pixels





Results from Quad test beam

January 7, 2019 3 / 14

Timepix readout procedure

Timepix readout procedure

- The Timepix3 registers the fine time of a hit and stores it near the pixel to be read out.
- 4 Timepix3 chips are connected with one 160 Mb/s link to the SPIDR each
 - ▶ 12 links with a maximum speed of 640 Mb/s per link are available
- The SPIDR boards adds a course time stamp (409.6µs per tick) to each hit and transmits it to the DAQ PC.
- Hits that arrive too late at the SPIDR board receive the wrong course time

Because the link speed was not fast enough for the rates, a maximum of 1.3 MHits/s was read out per chip

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January 7, 2019 4 / 14

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Synchronization issues



The number of hits per 409.6 μs does hardly fluctuate

(Teal represents the 2017 single chip)



Hits after selection: some hits are not read out until after 160 cycles of 409.6 μs

The solution is to stack hits from up to 200 cycles after the original trigger

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January 7, 2019 5 / 14

Selections

Use runs 668, 672, and 676 (center, right, left respectively):

- $V_{drift} = 400 \text{ V/cm}$, which is near the maximum drift velocity because of a water vapor concentration of around 4000 ppm
- $V_{\text{Grid}} = 330 \text{ V}$
- Threshold at \sim 550 e (55 DAC counts above noise)

Selection

$$\begin{array}{l} -500 \ \mathrm{ns} < t_{\mathrm{hit}} - t_{\mathrm{trigger}} < 500 \ \mathrm{ns} \\ \mathrm{Hit} \ \mathrm{ToT} > 0.10 \ \mathrm{\mu s} \\ \mathrm{Reject} \ \mathrm{outliers} \left(\ r_x < 1.5 \ \mathrm{mm}, r_z < 3 \ \mathrm{mm} \ \right) \\ N_{\mathrm{hits}} > 20 \\ \left(N_{r_x < 1.5 \ \mathrm{mm}} \ / \ N_{r_x < 5 \ \mathrm{mm}} \right) > 0.8 \\ \overline{x_{\mathrm{hit}}} - x_{\mathrm{track}} < 0.3 \ \mathrm{mm} \end{array}$$

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January 7, 2019 6 / 14

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Hit maps





Run 672

-5 0 5

÷210

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200

195

190

185

180

175



Run 676

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220

200

180

160

140

120

100

80

40

20

10 15 x-position [mm]

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January 7, 2019 7 / 14

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Drift velocity

- Because of water vapor content (0.6%), the drift velocity is expected to be slower than normally for a T2K gas
- The measured drift speed (55 μ m/ns) is slightly smaller than expected for this water vapor concentration (60 μ m/ns)



Time walk correction?

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Resolution in the transverse direction



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January 7, 2019 10 / 14

Resolution in the drift direction



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January 7, 2019 11 / 14

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Deformations in the pixel plane

- Calculate the mean x-residual per 4 × 4 pixels
- Alignment problem in the left two chips will be looked at before Thursday



Deformations after correction

To be added before Thursday

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Conclusions

- A good set of data with the Quad was taken using 2.5 GeV electrons
- A synchronization problem was identified, and a work-around is in place
- The hit resolution will be further investigated
- In the first diagrams, systematic deformations are small

Analysis is well under way

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Deformations in the drift direction

without per column calibration



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