

# Latest results from T3B

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Tungsten Timing



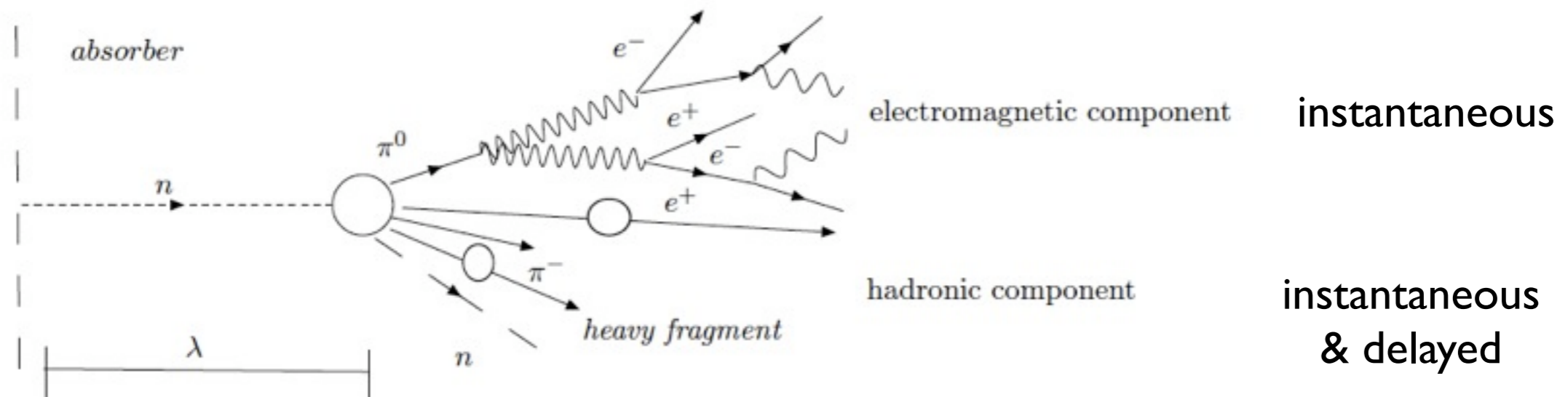
# Outline

1. Introduction
2. Calibration: Afterpulsing Studies
3. First peek at june/july 2011 testbeam period muon data
4. Preparations and Plans for the upcoming Testbeam



# Introduction

- Future electron positron linear collider: CLIC
  - New accelerator technology
    - Bunch spacing of 0.5ns → Pileup
  - Detector concept for Particle Flow:
    - All subdetectors within coil
    - Very dense absorber @ (hadronic) calorimeter: Tungsten
- Hadronic showers have several components
  - Integration time has influence on energy resolution
  - Tungsten: only simulation available → T3B



# The T3B Experiment

## CALICE W-AHCal

- 5mm Scintillator active medium, readout via SiPM
- 10mm Tungsten absorber

## T3B: Tungsten Timing Testbeam

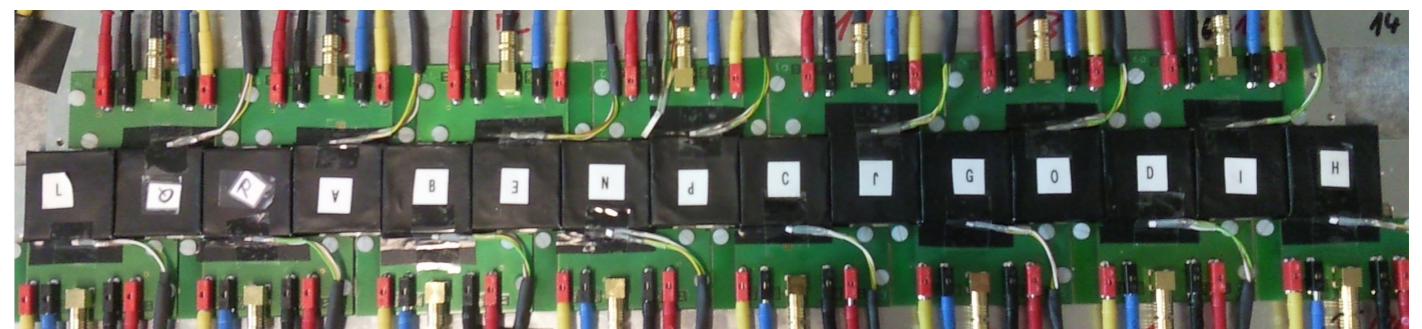
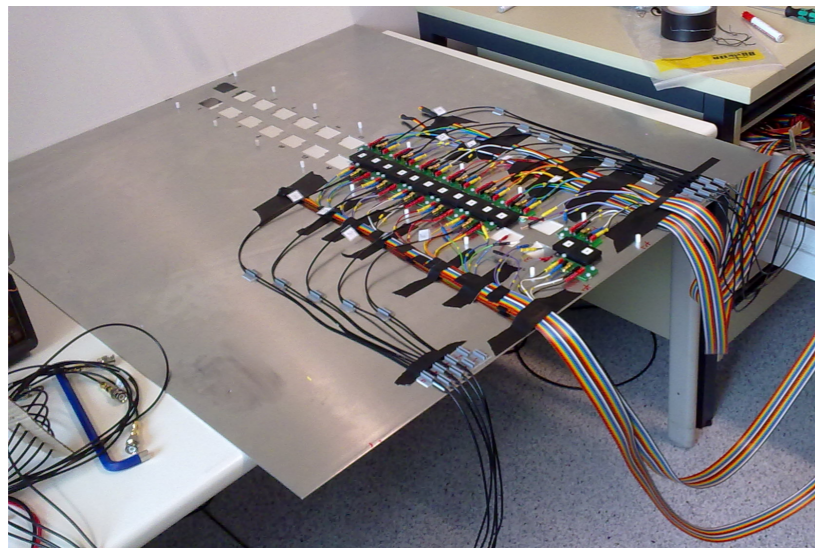
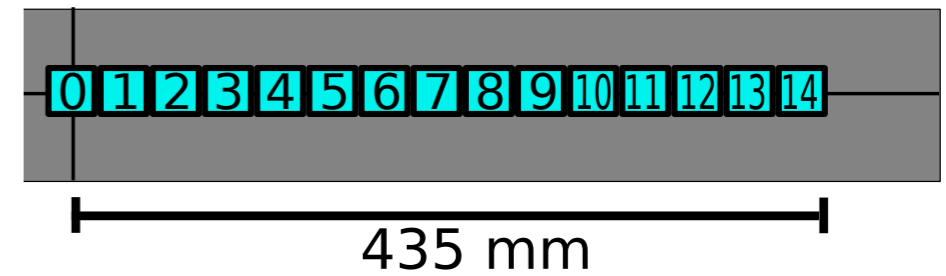
- Goal: Measure time structure of hadronic showers
- Use similar readout to W-AHCal (5mm Scintillator with SiPM)
- Record signal over long time window ( $> 2\mu\text{s}$ )
  - Use only 15 tiles (data amount!)

Tungsten Timing



# The T3B Setup

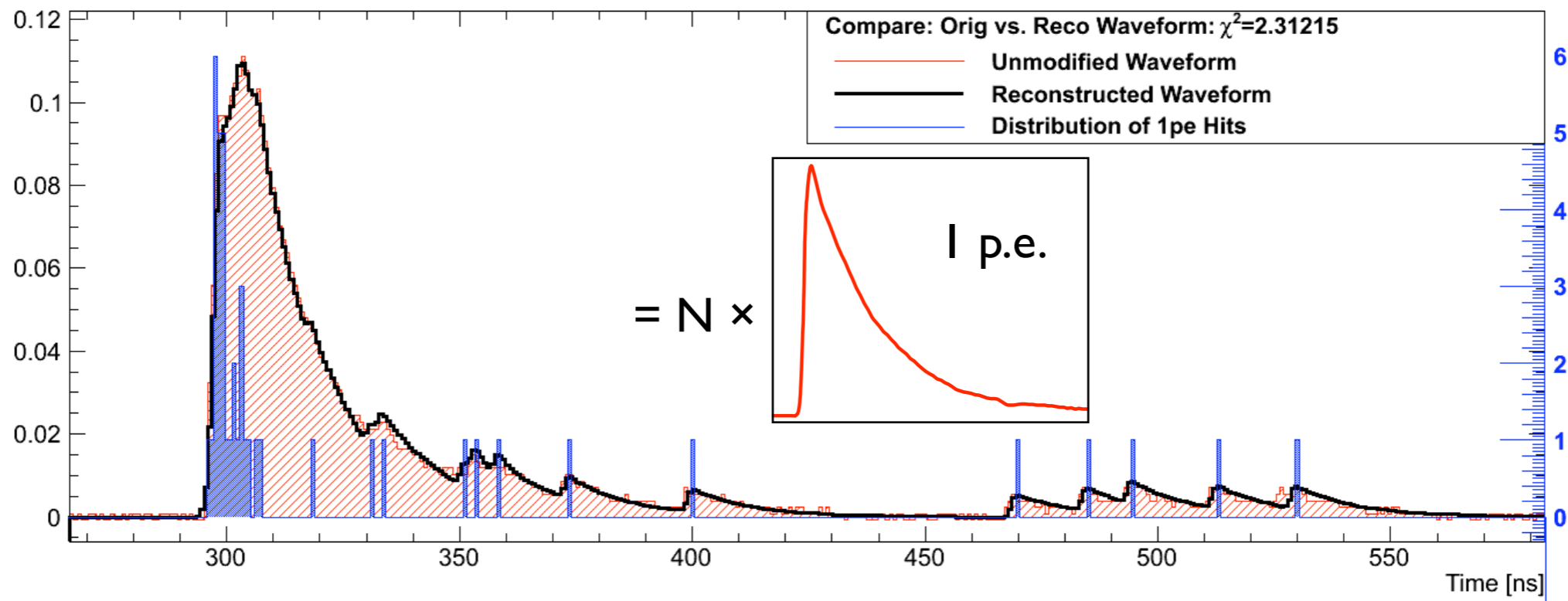
- 15 Tiles:  $30 \times 30 \times 5 \text{ mm}^3$ , with tile 0 at beam axis
- Readout via 4 USB 1.25GS Oscilloscopes
  - $> 2.4 \mu\text{s}$  integration time
- Calibration triggers on dark noise between spills
- 2 operation modes:
  - Triggered by CALICE W-AHCaI
    - common analysis possible
  - Standalone (Triggered by  $10 \times 10 \text{ cm}^2$  coincidence)
    - data rate  $> 200 \text{ Hz}$  possible



# T3B Analysis & Calibration

Between Spills: Take Darkrate pulses → Live SiPM Gain Calibration

Waveform decomposition:

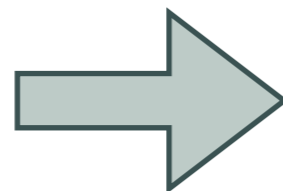


Identify single p.e. waveforms in full signal waveform

Missing for full data analysis: Statistical subtraction of ...

Thermal Darkrate

SiPM Afterpulses



Dedicated studies in climate chamber with T3B tiles  
(Done by Diploma student Simon Pfau)



# T3B Calibration: Darkrate

## Thermal Noise (Darkrate) Study:

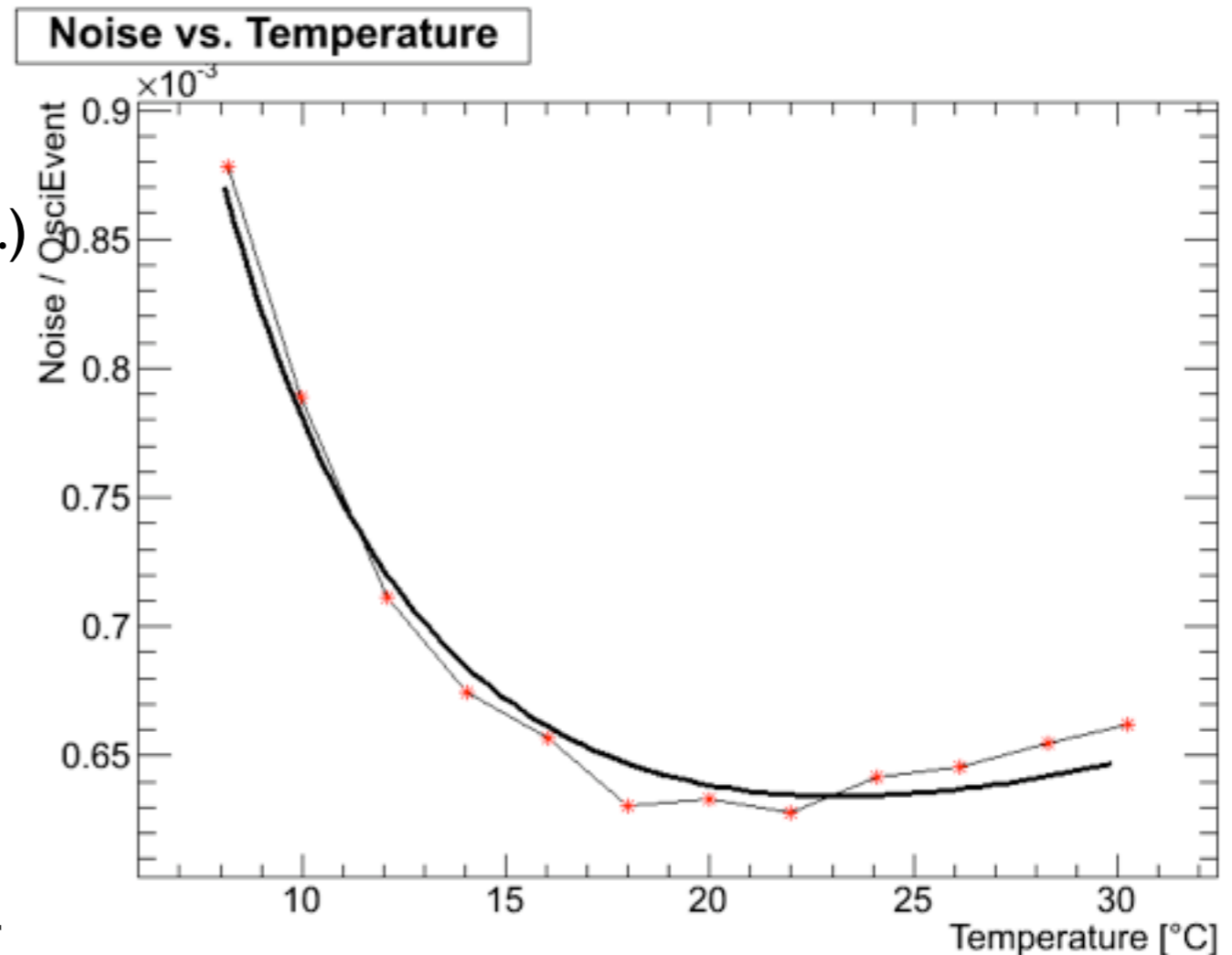
- Random triggered data
- Temp range: 8-30 C (2 deg step)
- Incl. waveform decomposition (Gain calib.)

## Several contributions

- Effective changing overvoltage
- Breakdown efficiency
- Thermal noise
- ...

## Plan:

- Remove effect of changing breakdown eff.
- Redo measurement with constant overvoltage



# T3B Calibration: Afterpulsing

- Data: Darkrate (Thermal Noise) of at least 1,...,6 photon equivalents
- Incl. waveform decomposition (Gain calib.)
- Darkrate subtracted

— Filter peaks with exactly 1,...,6 p.e within event window (3.2 ns)

— Normalized on No. events

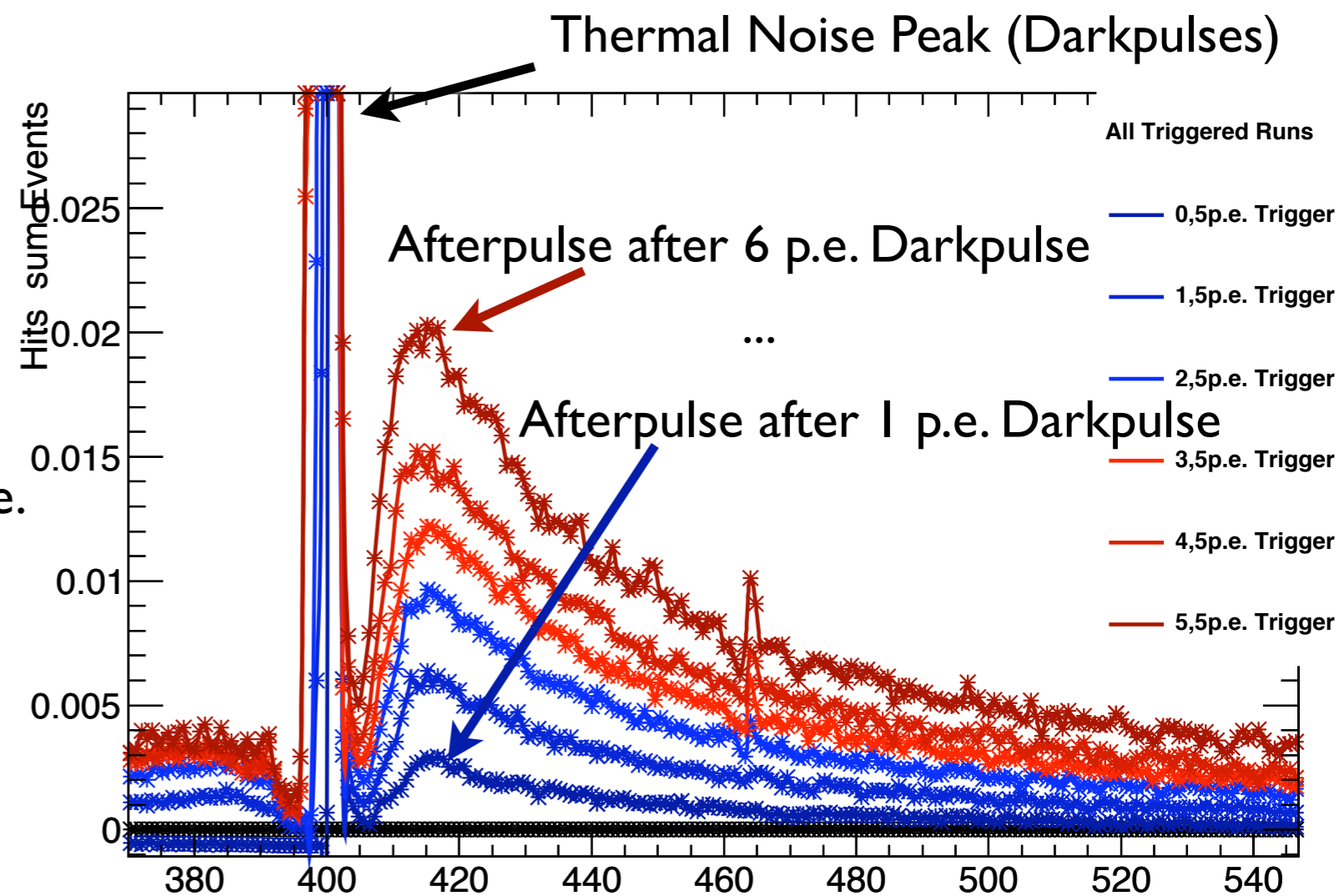
→ Probability of an afterpulse after an 1,...,6 p.e. event

— Normalization on no. of pixel

— 6 p.e. event = 6 pixels firing

→ 6 times the probability of 1 p.e.

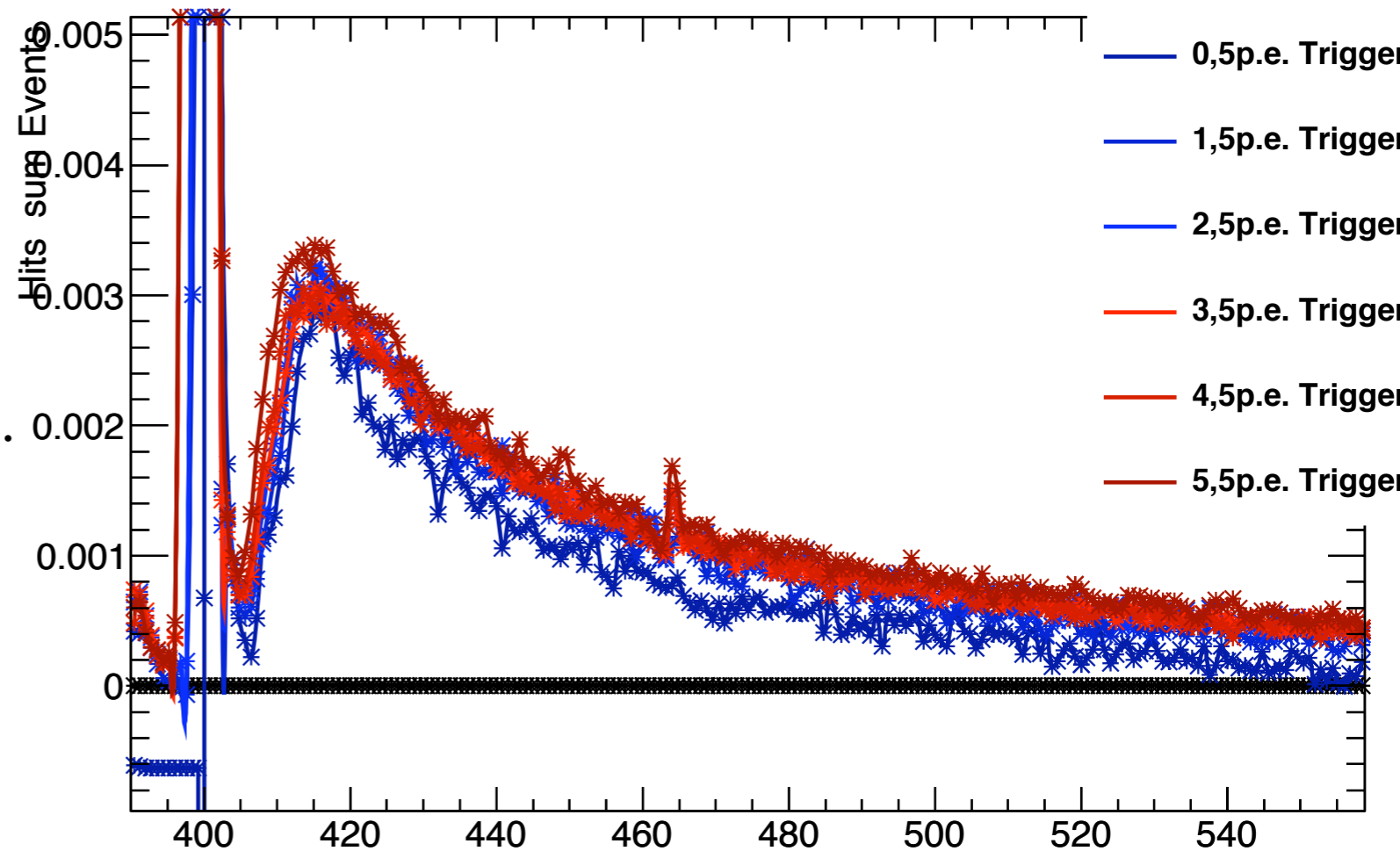
— Bias by subtracting the Darkrate from prev. measurement





# T3B Calibration: Afterpulsing

- Data: Darkrate (Thermal Noise) of at least 1,...,6 photon equivalents
  - Incl. waveform decomposition (Gain calib.)
  - Darkrate subtracted
- Filter peaks with exactly 1,...,6 p.e within event window (3.2 ns)
- Normalized on No. events
  - Probability of an afterpulse after an 1,...,6 p.e. event
- Normalization on no. of pixel
  - 6 p.e. event = 6 pixels firing
  - 6 times the probability of 1 p.e.
  - Bias by subtracting the Darkrate from prev. measurement



# First T3B results: Muon data from 2011

— Muon Langau MIP Peak

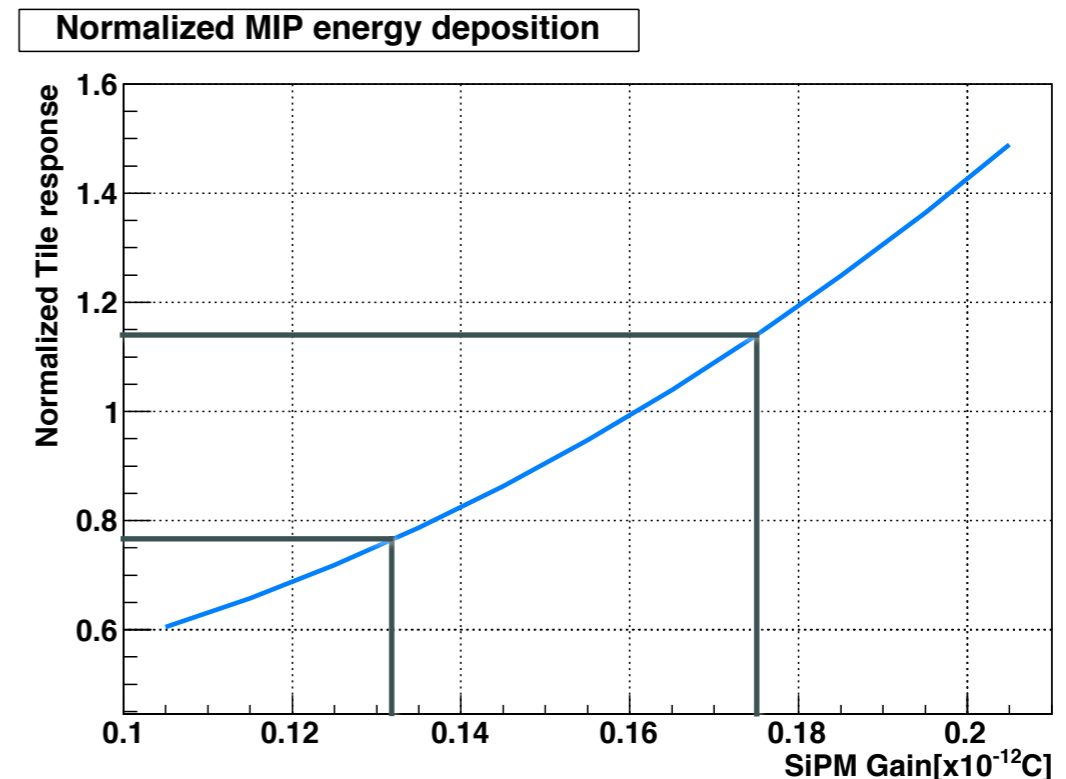
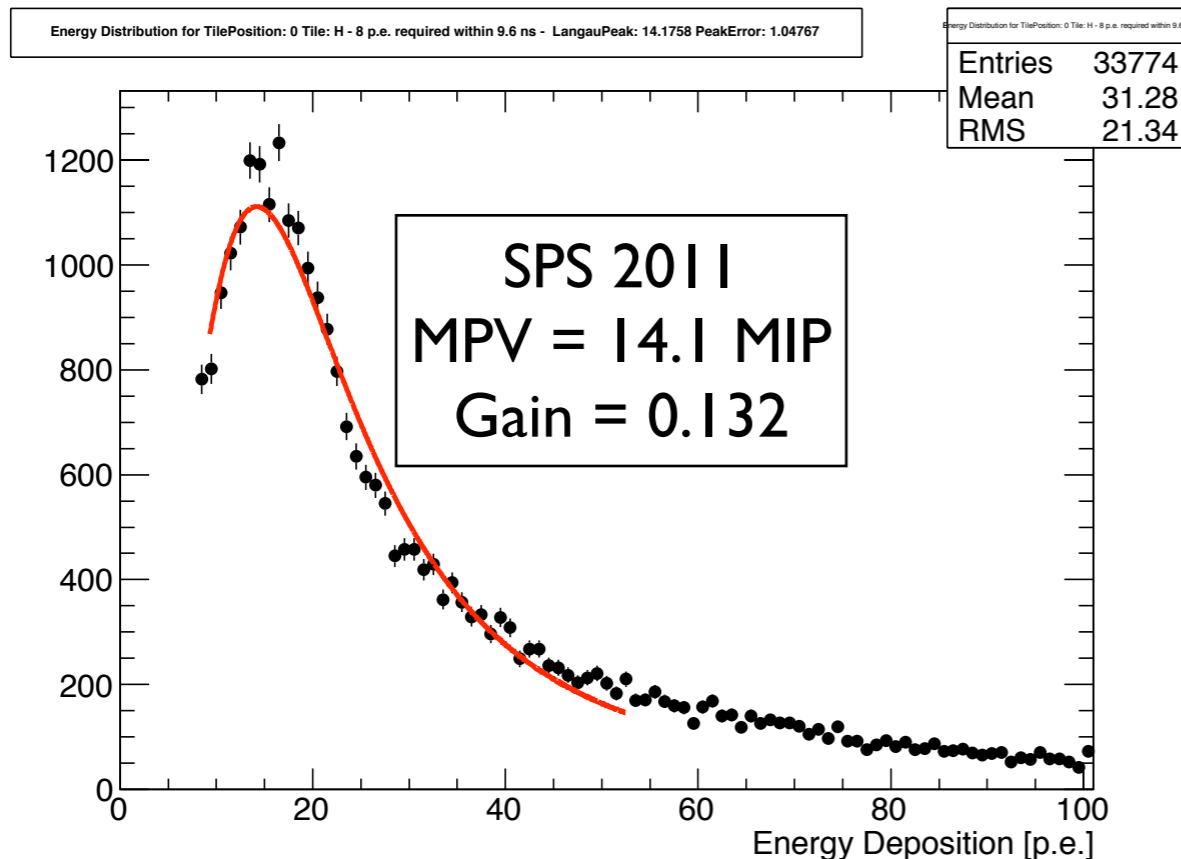
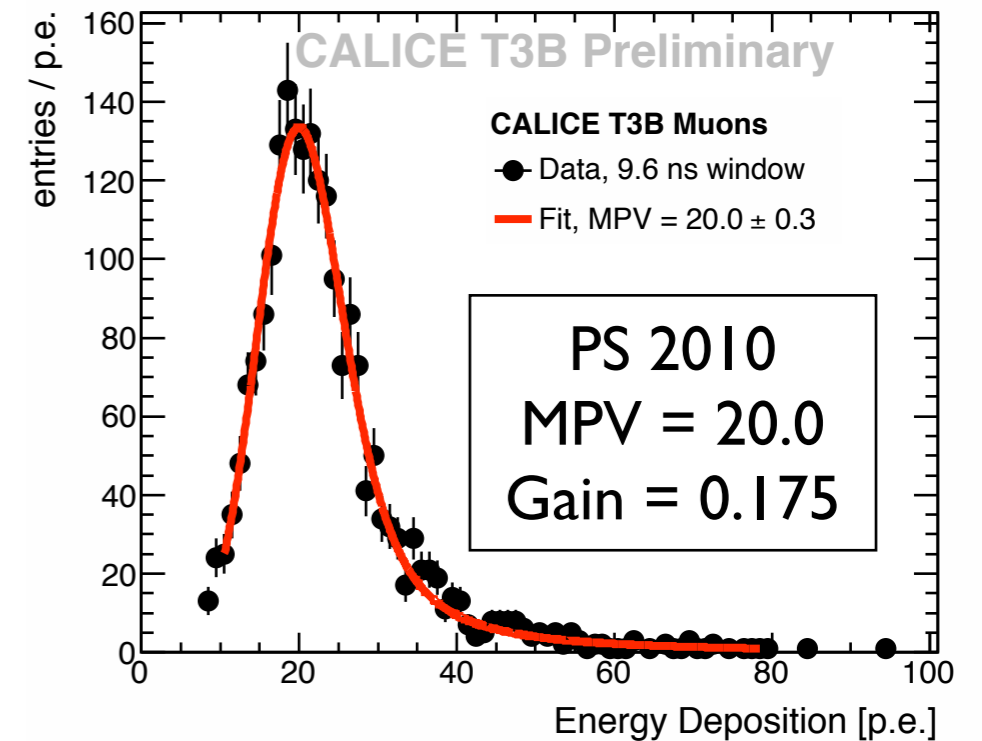
— Integration time 9.6ns

— Change in Gain PS2010  $\rightarrow$  SPS2011: 0.175  $\rightarrow$  0.132

— Expected change in MPV: 1.14  $\rightarrow$  0.77 (0.67)

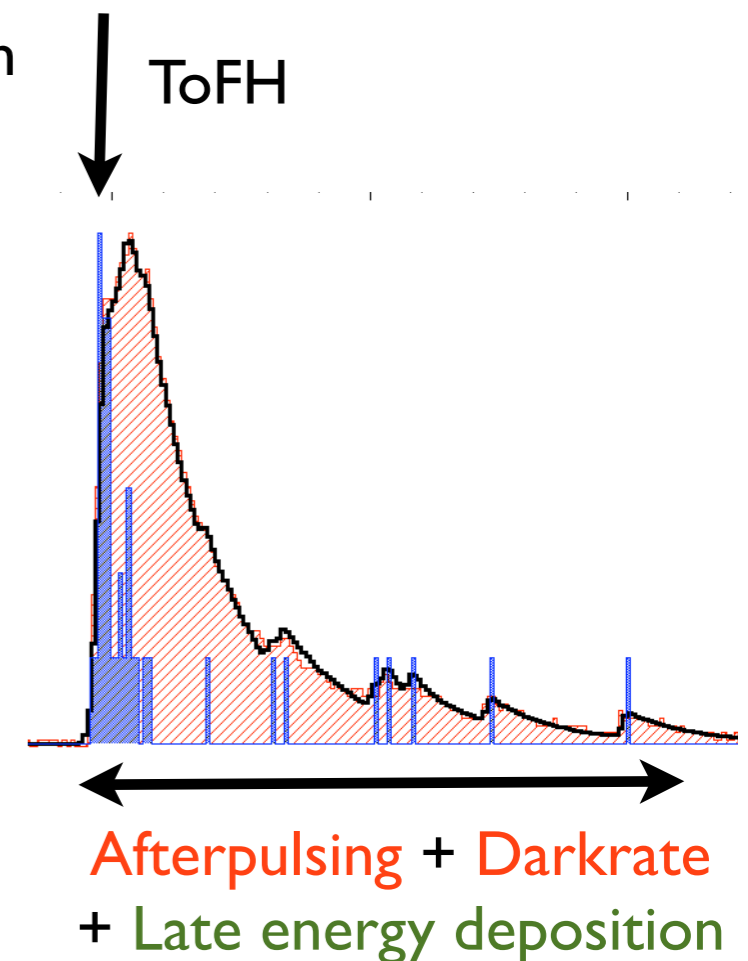
— True change in MPV: 20.0  $\rightarrow$  14.1 (0.705)

— Even after Gain correction: significant change in MPV



# T3B: Status and Plans

- Successful data taking periods with W-AHCal
  - PS 2010: 21 mio triggers
  - SPS 2011: June+July: 16.3 mio trigger (12.3 in sync with HCal)
  - Upcoming Testbeam: Maybe redo measurements with higher Gain
- First results: CAN 033
  - Based on „Time of First Hit“ of PS 2010 data
- More sophisticated analysis:
  - Analysis of late energy depositions requires complete calibration → ongoing
  - Correlation with shower start point:
    - Needs synchronisation with CALICE W-AHCal
    - Will be done after upcoming testbeam
- Missing: Comparison to steel



# T3B Plans: Comparison to steel

## — [ CALICE SD-HCal

- Based on RPC technology
- Absorber material: steel
- No need for external trigger (self triggered)
- Ongoing data taking at PS testbeam
- Plan: Use first week of upcoming testbeam period at SPS

## — [ T3B as parasite to SD-HCal

- No easy way to get SD-HCal trigger (if in self trigger mode)
  - T3B: Standalone run mode (no Synchronization possible)
    - No information on shower start available
- Maybe: Few runs with external trigger system (e.g. 2 10x10cm<sup>2</sup> scintillators)
- Synchronization might be possible



# Summary

- T3B: Measuring time structure of hadronic showers within tungsten
- As Parasite to the W-AHCal:
  - Successful data taking period @ PS Nov 2010 and SPS June/July 2011
  - CAN-033 done based on „Time of First Hit“

- Calibration

- Live monitoring of Gain
- For sophisticated analysis needed:

- SiPM Afterpulsing
  - SiPM Darkrate
- Simon Pfau  
(Diploma student)



- Plan:

- Comparison to steel data for ToFH
- Upcoming testbeam Sep/Oct 2011:
  - Parasite to SD-HCal
  - (Backup solution if possible: Measure standalone on steel block)

