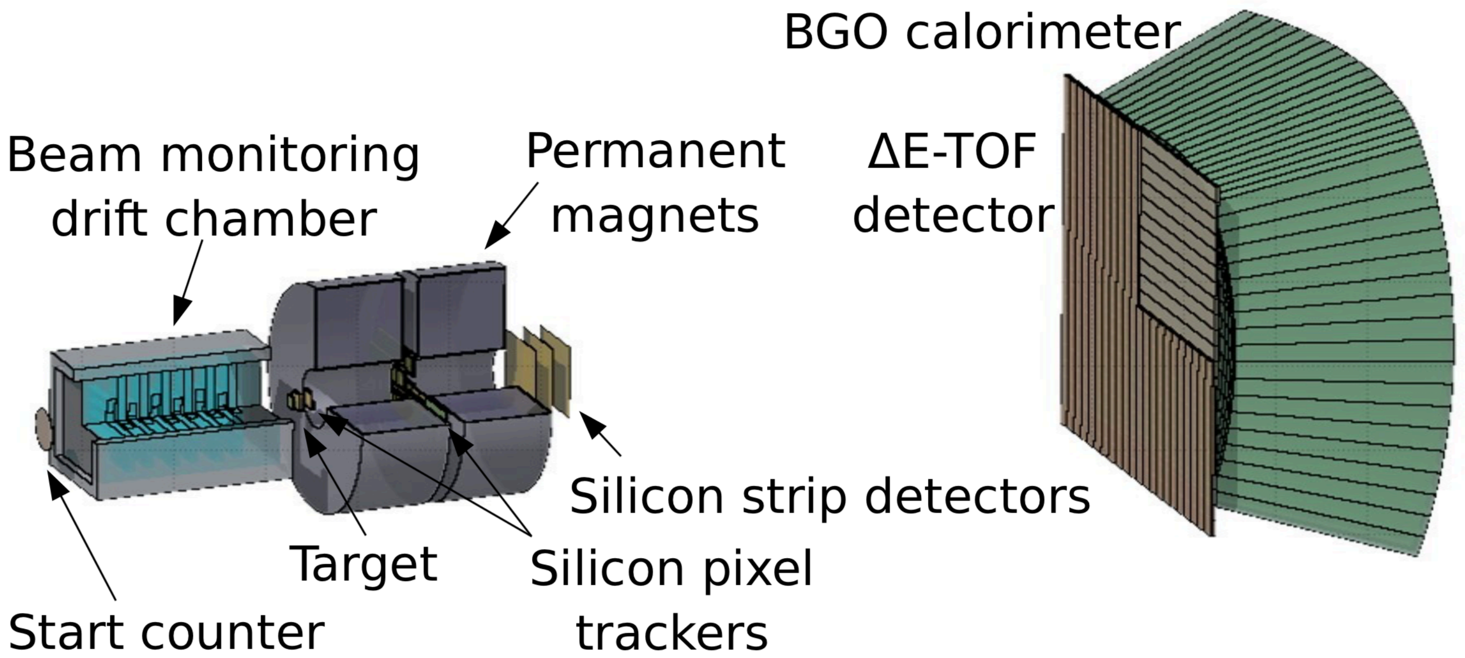
ΔE-TOF analysis check and updates on TDAQ



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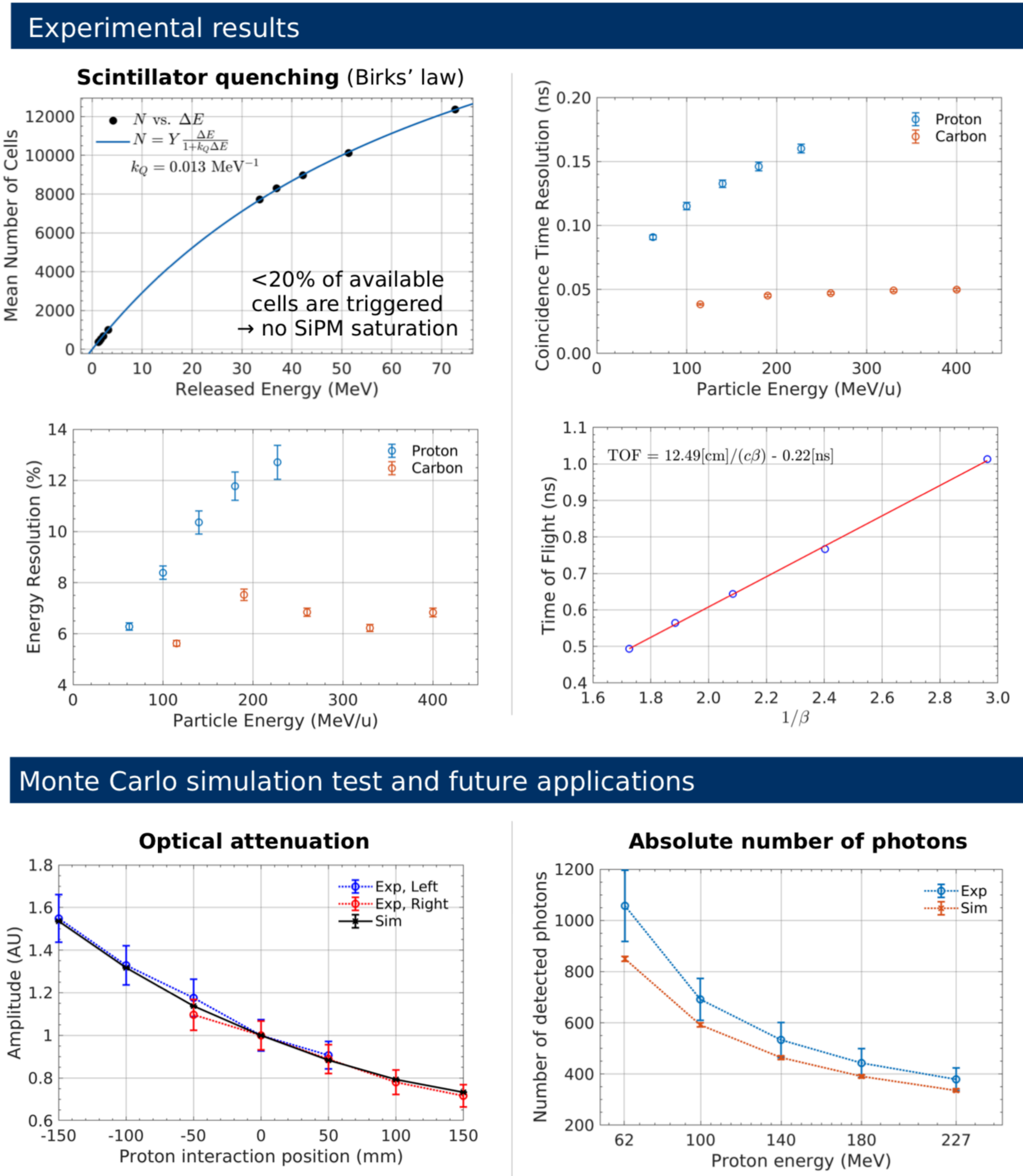
Aim

- Double check of previous results
  - *"different" people and reconstruction algorithms*
- Reconstruction code implementation in C++/ROOT

Ciarrocchi's poster at Pisa Meeting 2018



Data format

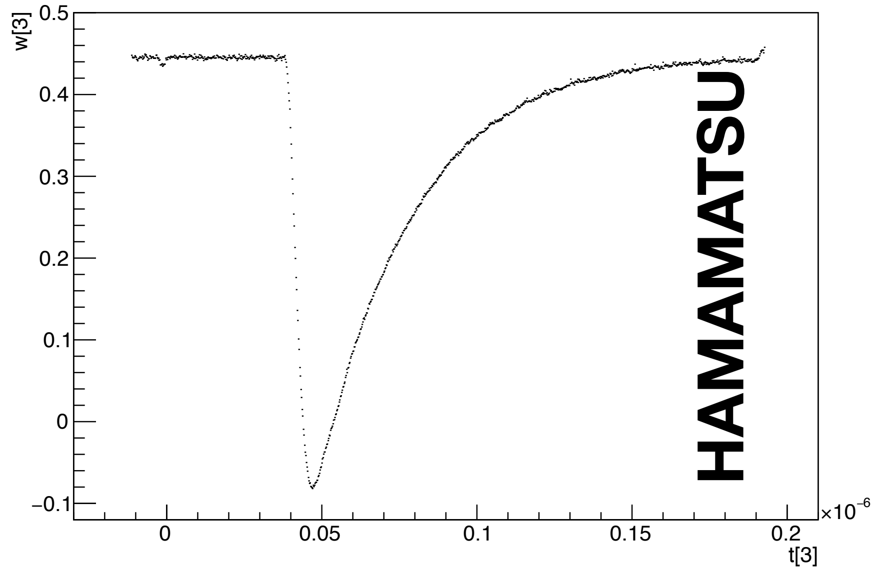
- C++ macro to decode to waveforms in root format
  - *to be copied and adjusted in SHOE*

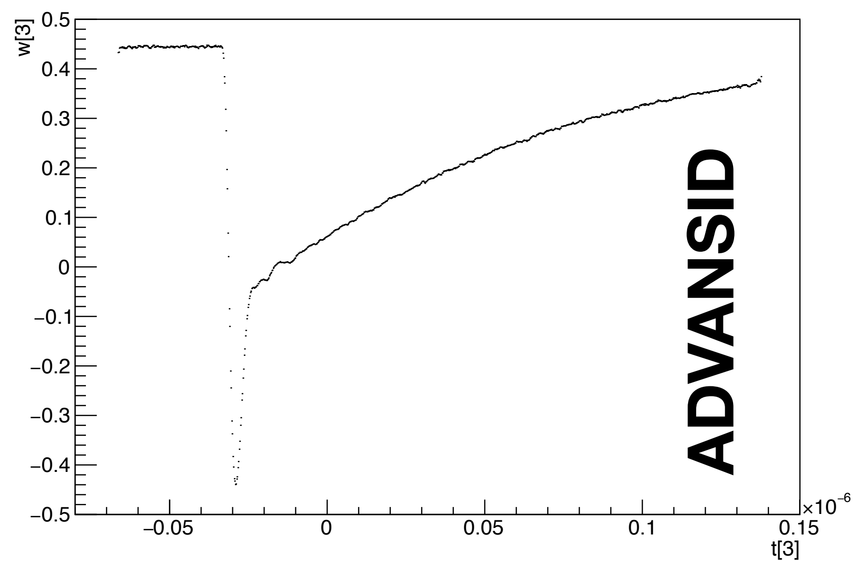
```
#include <string.h>
#include <stdio.h>
#include "TFile.h"
#include "TTree.h"
#include "TString.h"
#include "TGraph.h"
#include "TCanvas.h"
#include "Getline.h"

typedef struct {
   char           tag[3];
   char           version;
} FHEADER;

typedef struct {
   char           time_header[4];
} THEADER;

typedef struct {
   char           bn[2];
   unsigned short board_serial_number;
} BHEADER;

typedef struct {
   char           event_header[4];
   unsigned int   event_serial_number;
   unsigned short year;
   unsigned short month;
   unsigned short day;
   unsigned short hour;
   unsigned short minute;
. . . .
```


Word	Byte 0	Byte 1	Byte 2	Byte 3	Contents
0	'D'	'R'	'S'	'2'	File header, Byte 3 = version
1	'T'	'I'	'M'	'E'	Time Header
2	'B'	'#'	Board number		Board serial number
3	'C'	'0'	'0'	'1'	Channel 1 header
4	Time Bin Width #0				Effective time bin width in ns for channel 1 encoded in 4-Byte floating point format
5	Time Bin Width #1				
...	...				
1027	Time Bin Width #1023				
1028	'C'	'0'	'0'	'2'	Channel 2 header
1029	Time Bin Width #0				Effective time bin width in ns for channel 2 encoded in 4-Byte floating point format
1030	Time Bin Width #1				
...	...				
2052	Time Bin Width #1023				
2053	'E'	'H'	'D'	'R'	Event Header
2054	Event Serial Number				Serial number starting with 1
2055	Year		Month		Event date/time 16-bit values
2056	Day		Hour		
2057	Minute		Second		
2058	Millisecond		Range		Range center (RC) in mV
2059	'B'	'#'	Board number		Board serial number
2060	'T'	'#'	Trigger cell		Number of first readout cell
2061	'C'	'0'	'0'	'1'	Channel 1 header
2062	Scaler #1				Scaler for channel 1 in Hz
2063	Voltage Bin #0		Voltage Bin #1		Channel 1 waveform data encoded in 2-Byte integers. 0=RC-0.5V and 65535=RC+0.5V. RC see header.
2064	Voltage Bin #2		Voltage Bin #3		
...	...		...		
2574	Voltage Bin #1022		Voltage Bin #1023		
2575	'C'	'0'	'0'	'2'	Channel 2 header
2576	Scaler #2				Scaler for channel 2 in Hz
2577	Voltage Bin #0		Voltage Bin #1		Channel 2 waveform data encoded in 2-Byte integers. 0=RC-0.5V and 65535=RC+0.5V. RC see header.
2578	Voltage Bin #2		Voltage Bin #3		
...	...		...		
3088	Voltage Bin #1022		Voltage Bin #1023		

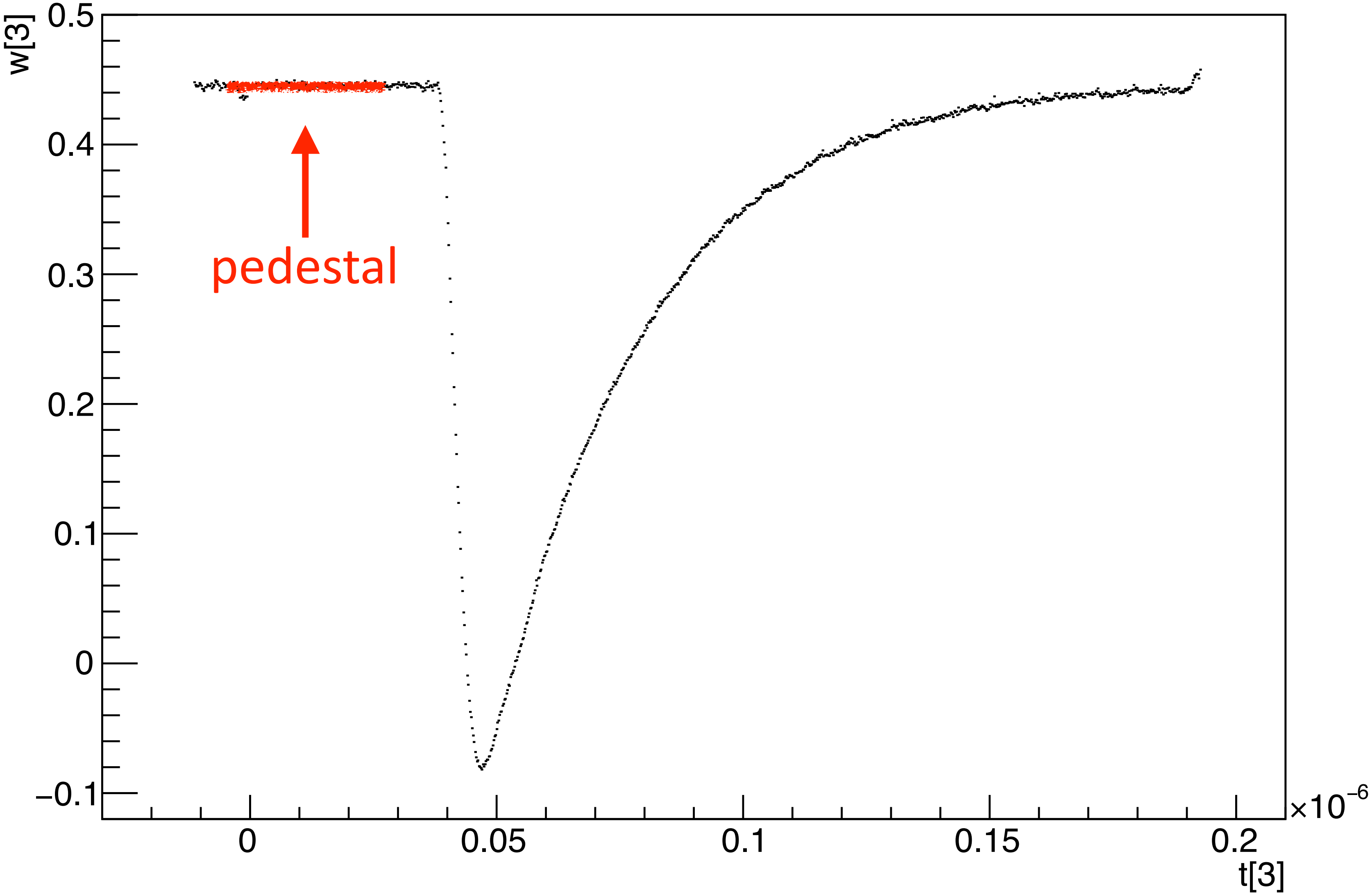
Waveform processing

- A waveform is two arrays
  - *an array of double for voltages*
  - *an array of double for times*
- charge (energy)and times (CTR, beta...) from WFM processing

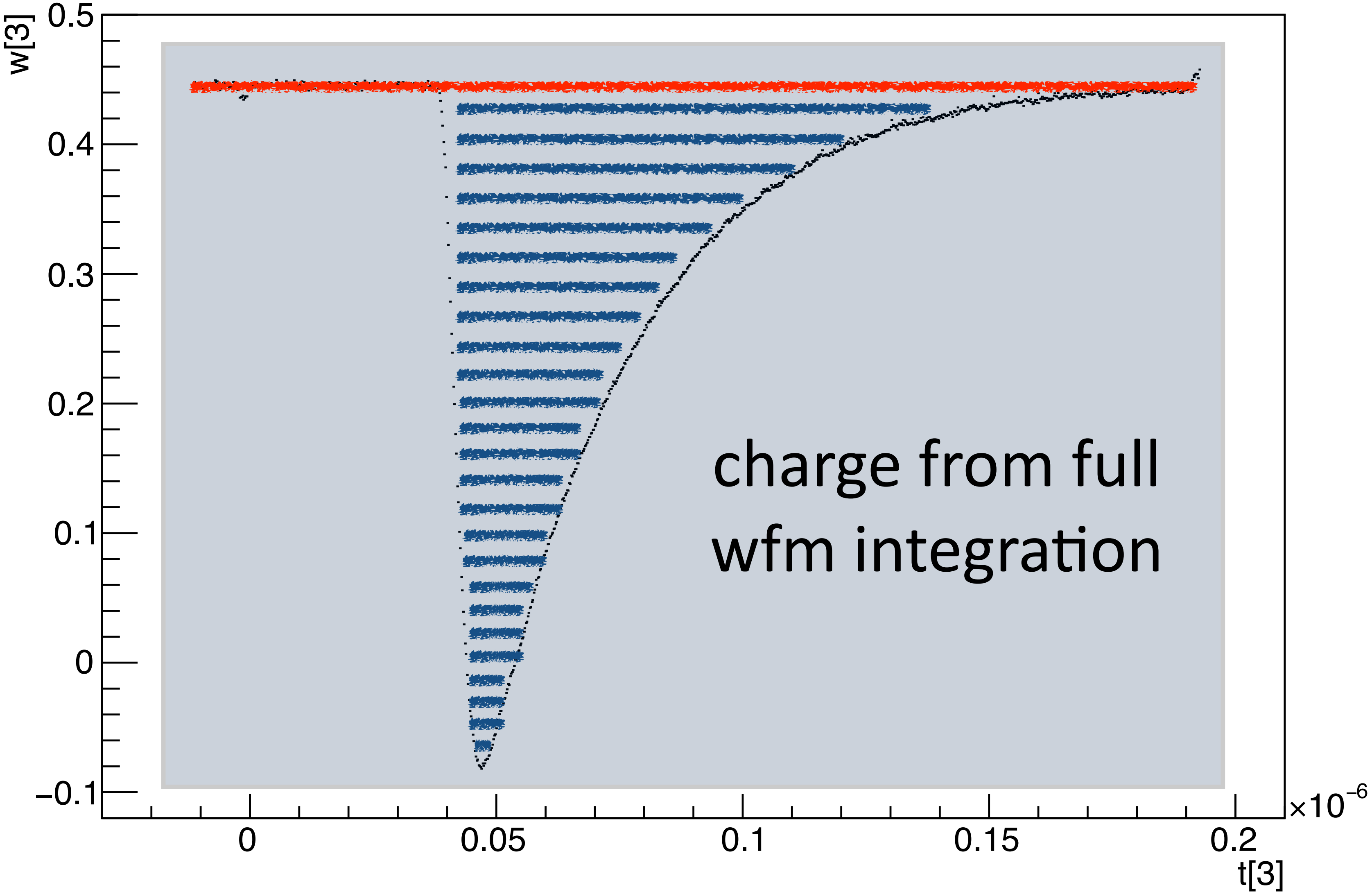




Charge

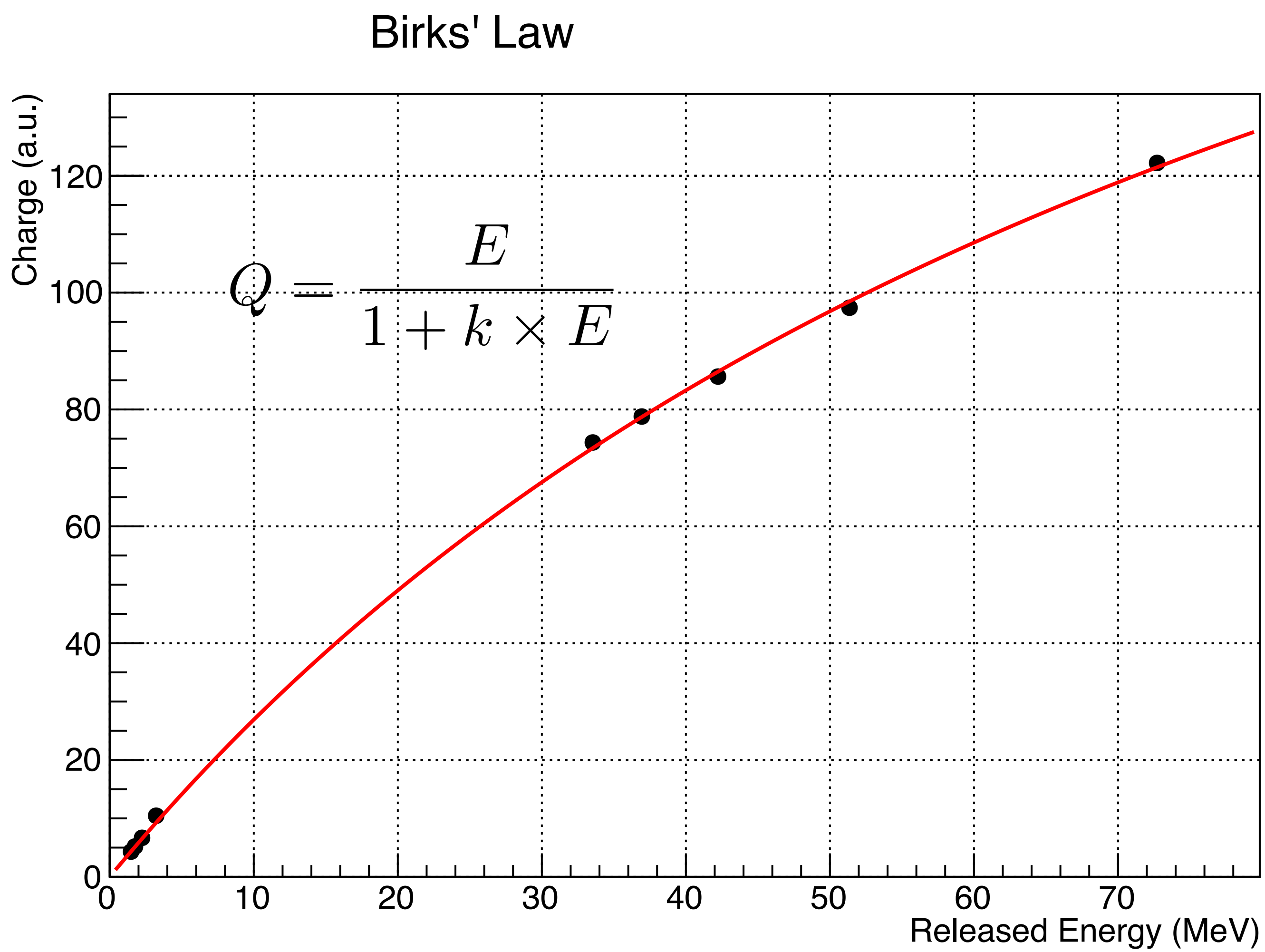


Charge


w[3]
0.5
0.4
0.3
0.2
0.1
0
−0.1
0
0.05
0.1
0.15
0.2
×10^{-6}
t[3]
charge from full wfm integration

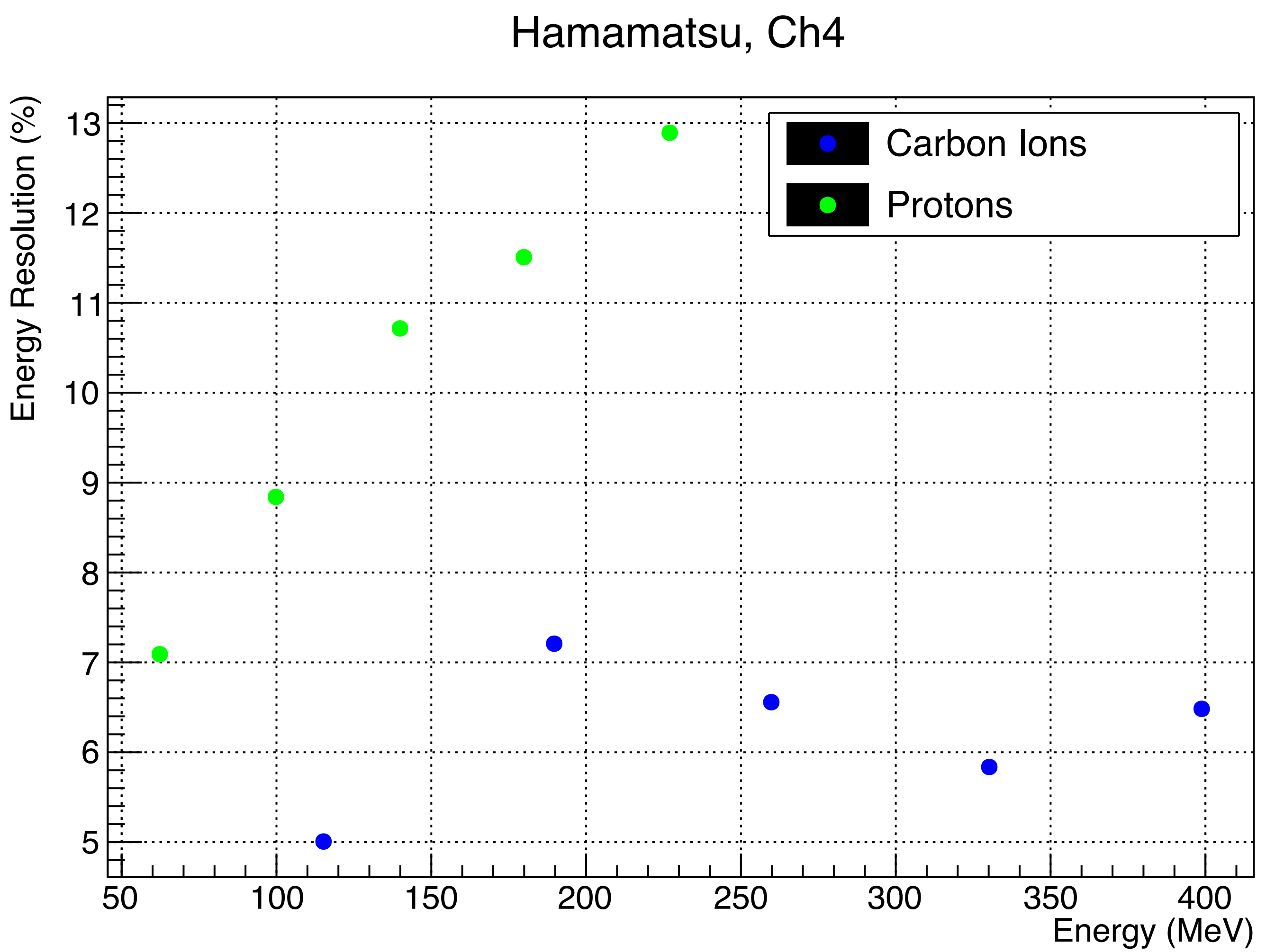
Saturation curve

- Measured energy corrected for the saturation
  - *k ~1.3 10^-2*
- Charge linearised to compensate for saturation accordingly

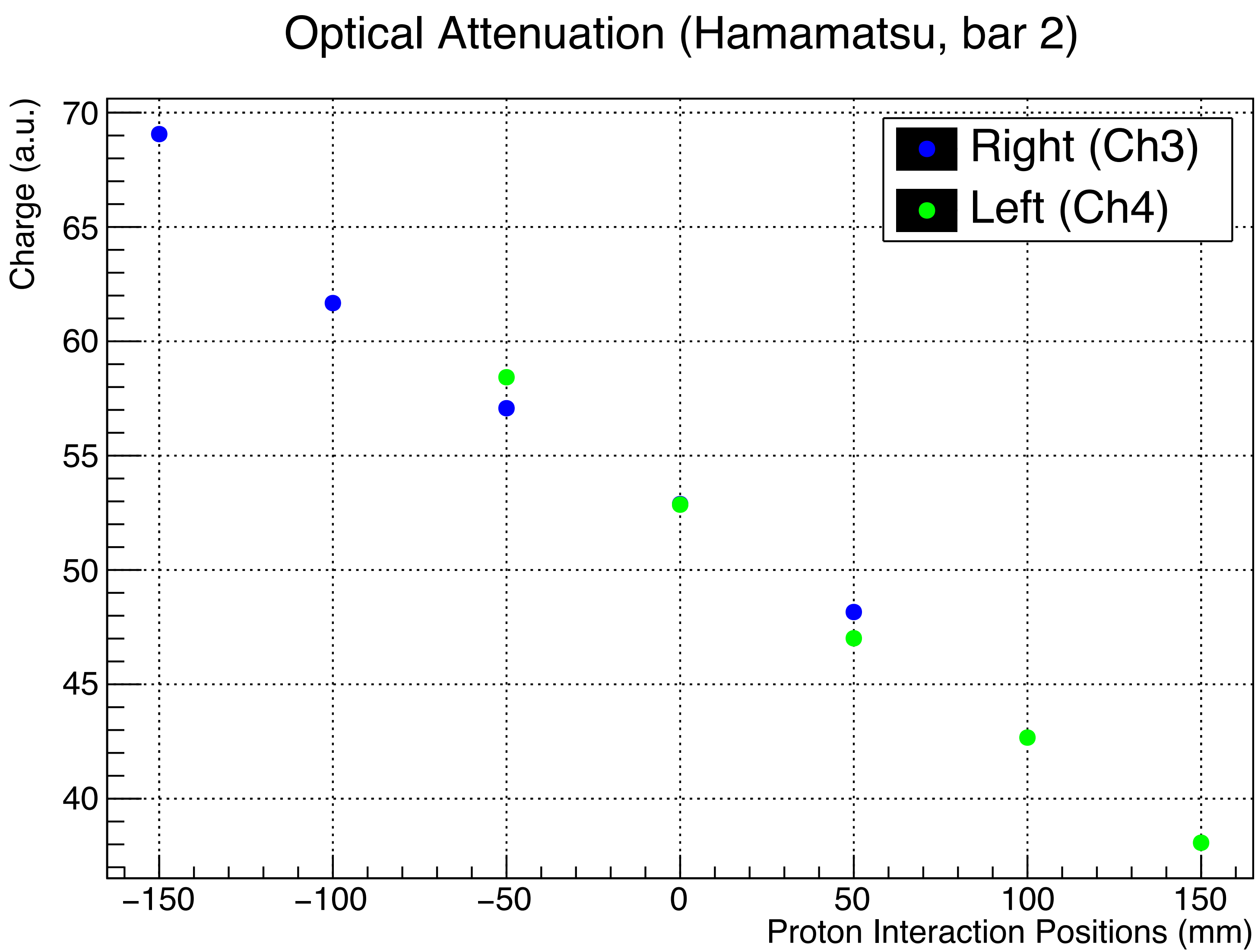


Energy resolutions

- Compatible with previous results

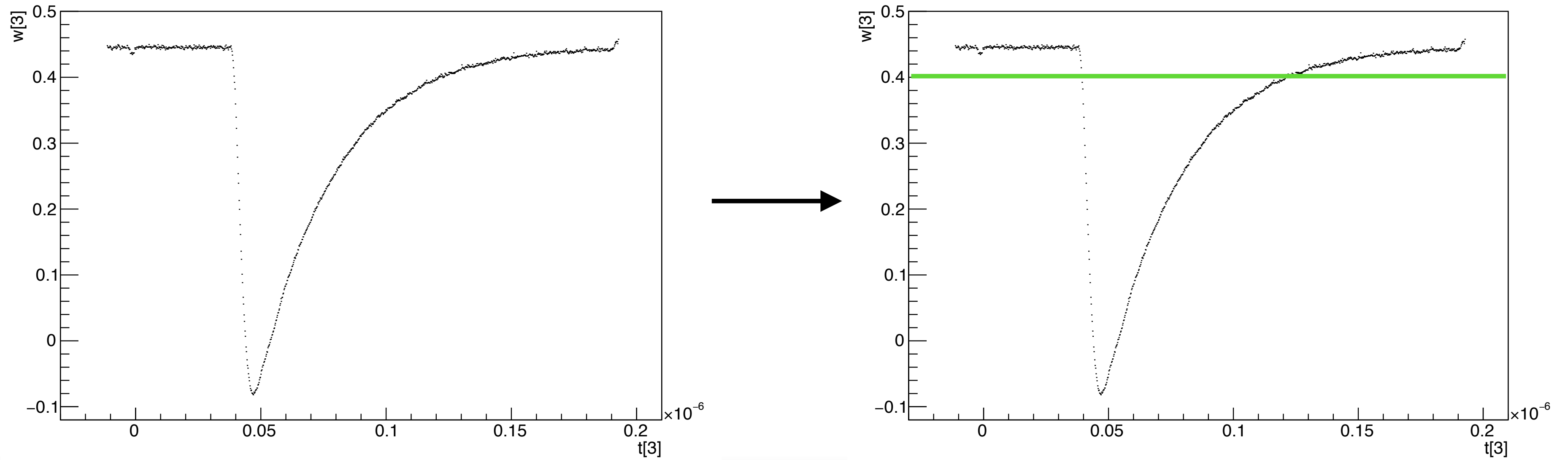


L/R light propagation



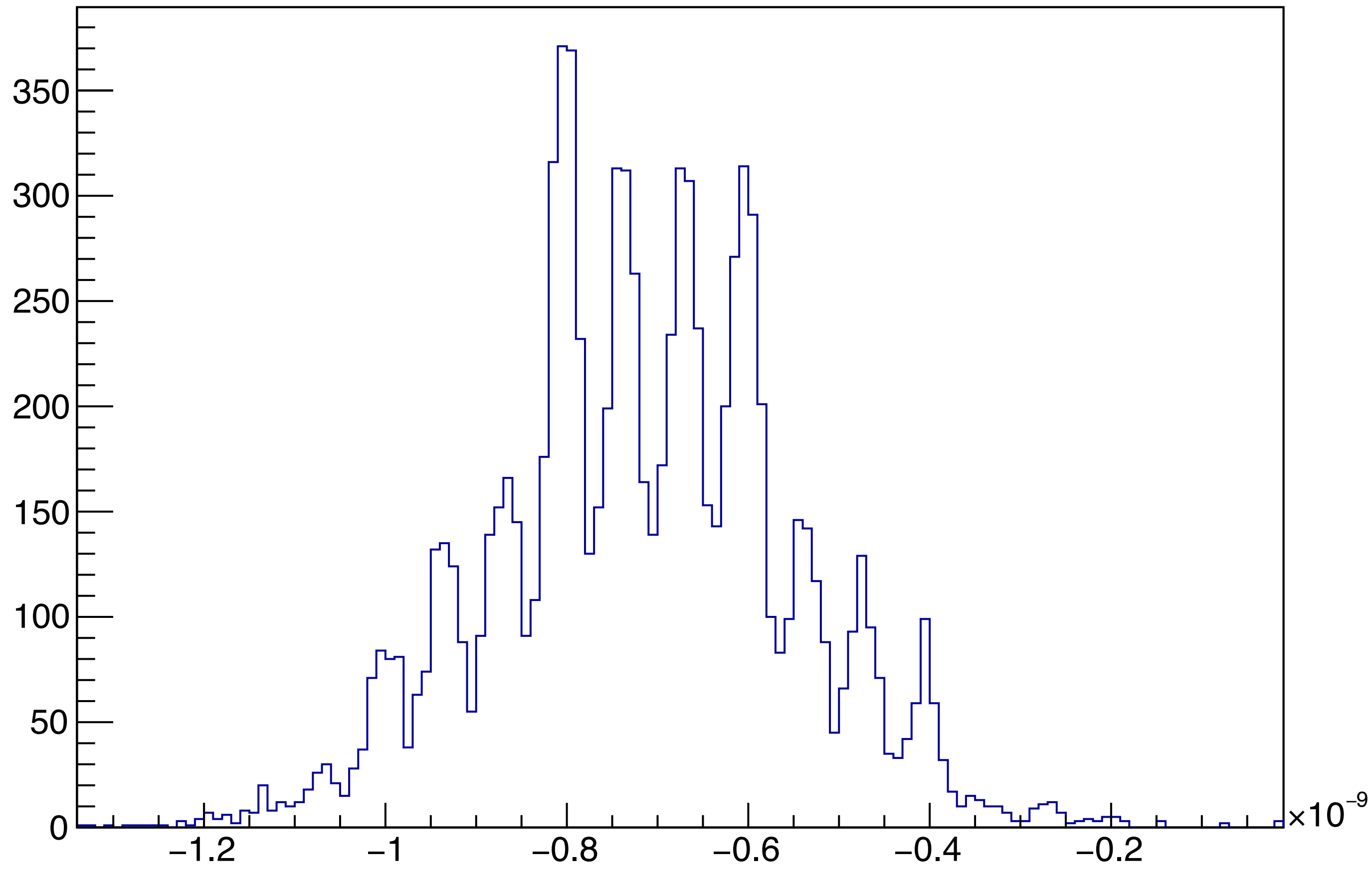
Raw time estimator

- fixed threshold 5 sigma larger than noise
- time from the first sample lower than the threshold
- suffers from several issues:
  - *time walk*
  - *binning quantisation (see next slide)*
  - *…*



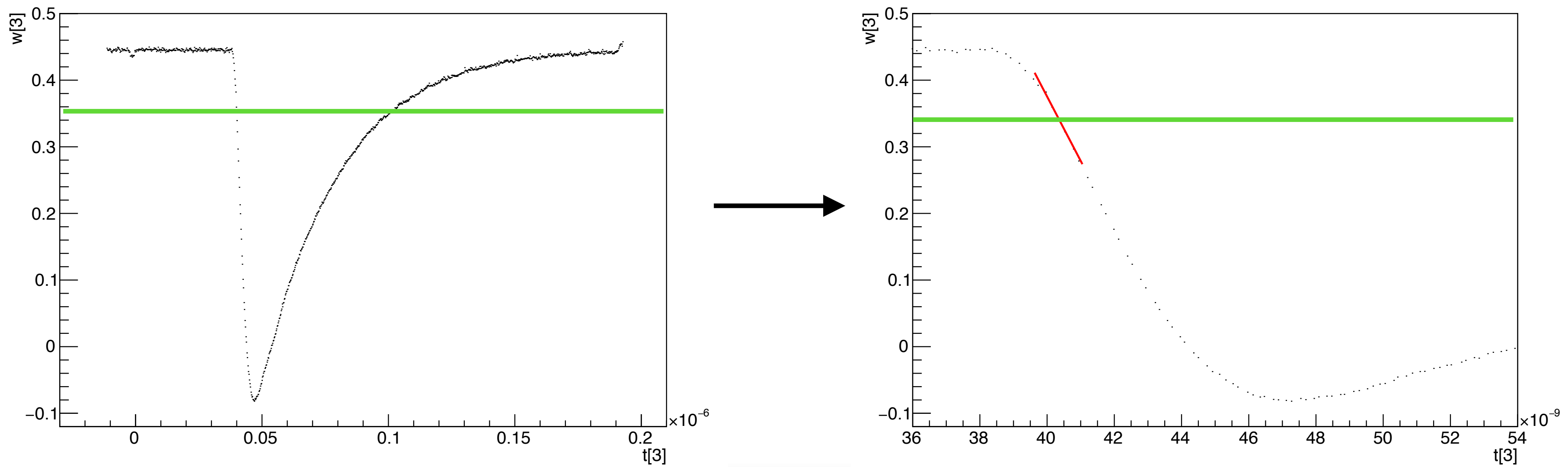
Binning quantisation

(time[1]+time[2])/2 - (time[3]+time[4])/2 definition



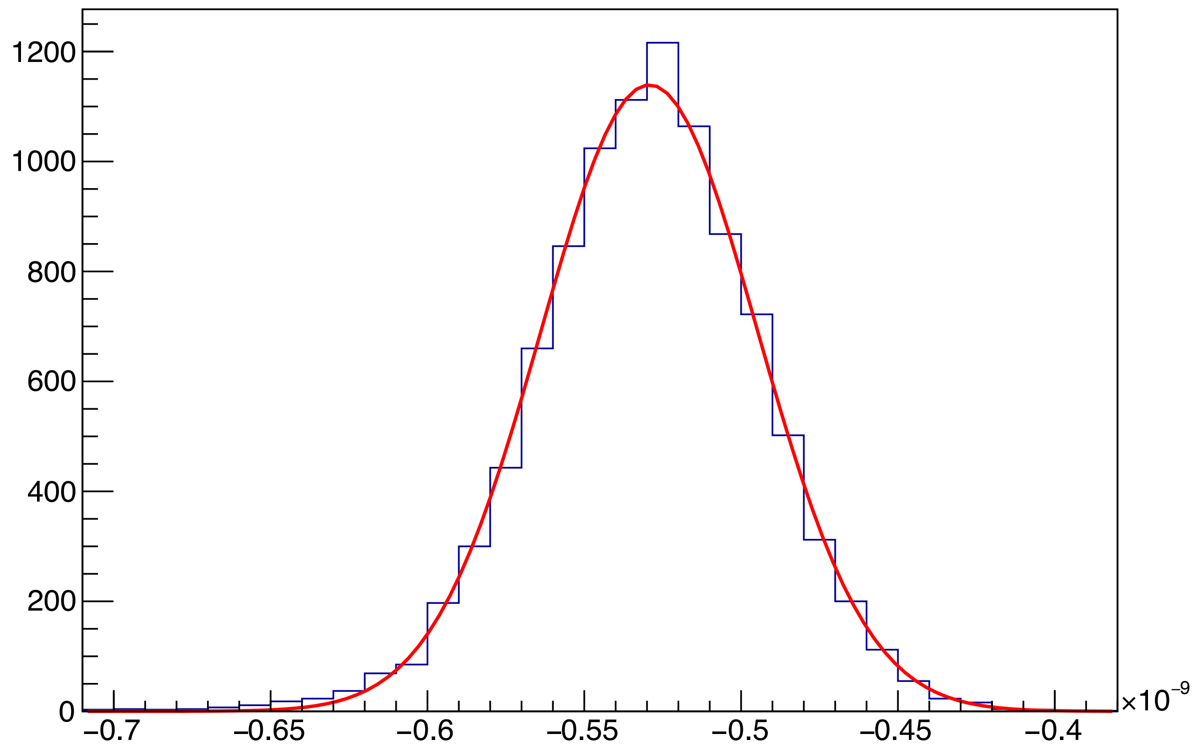
Best time estimator

- Time walk —> constant fraction discriminator
- Bin quantisation —> linear fit around crossing point

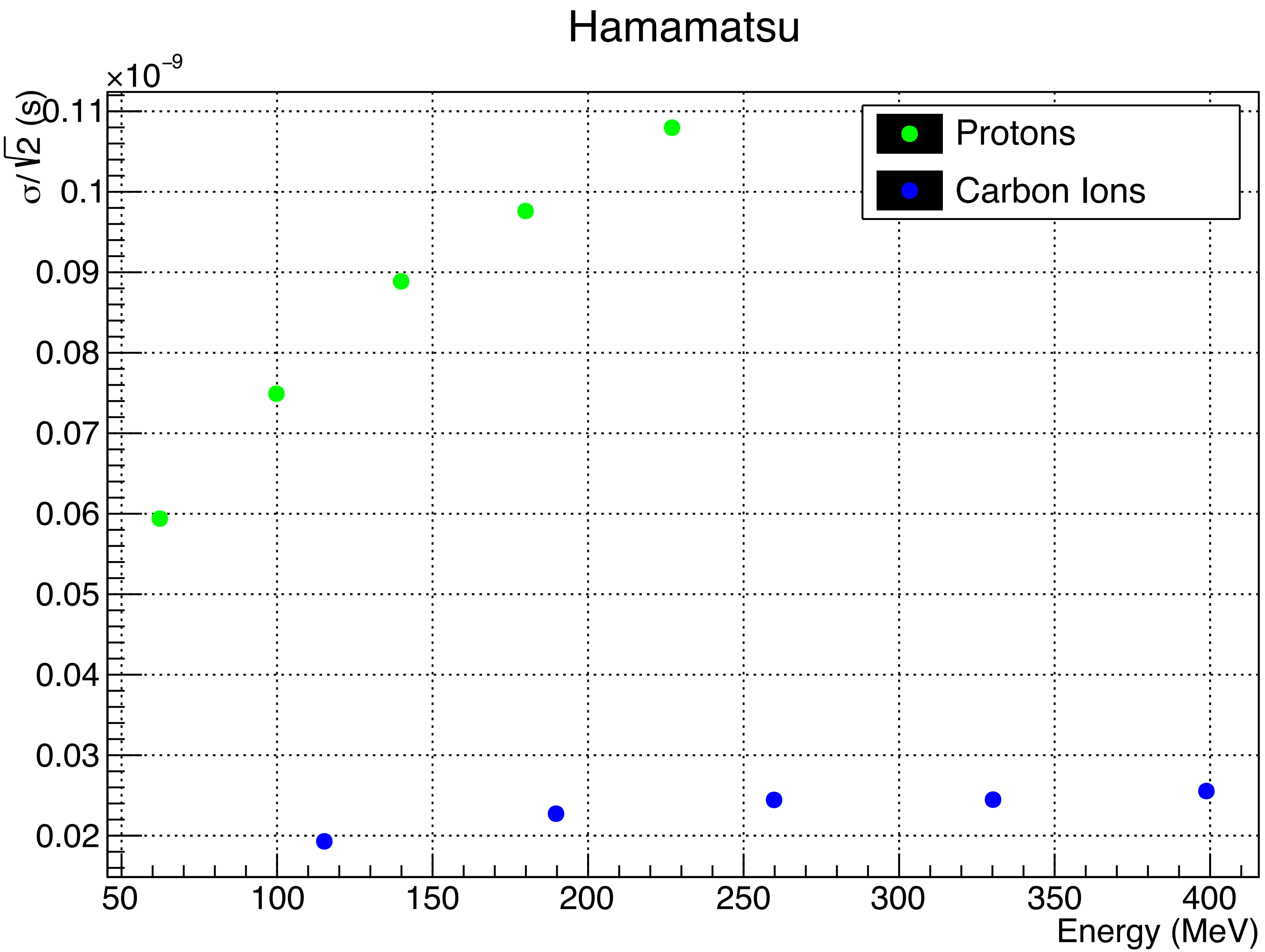


“New” gaussian

- more stable gaussian
  - *looks a good estimator (without asymmetric tails)*

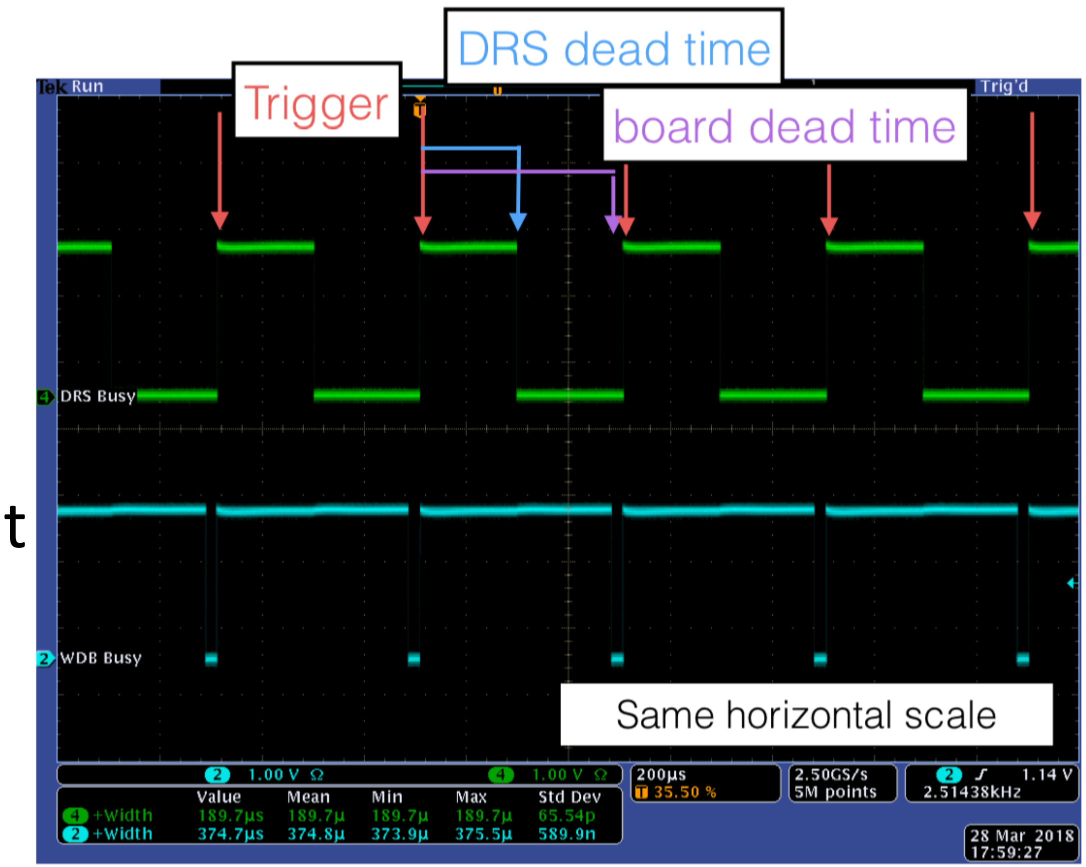


Time resolution @CNAO



Stand alone DAQ performance

- Stand alone DAQ to manage two WDBs and one TCB
  - *2 sources of deatime*
    - DRS read out: ~180µsec
    - WFMs packaging: ~200µsec
      - *total: ~380 spec —> 2.5kHz*
- In our test we had a full read out of 32 DRS WFMs, not far from FOOT situation (with 0 suppression)
  - *the goal of 1 kHz DAQ with minimum bis trigger looks OK*



Conclusions

- a C++/root based reconstruction SW has been developed
  - *compatible performance w.r.t. to other code*
  - *ready for being implemented in SHOE*
- Stand alone DAQ SW for the WDAQ readout developed
  - *read out speed OK*
  - *to be implemented in the FOOT TDAQ*
    - both HW and SW optimisation needed