TOF Status

Matteo Bertazzoni

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Structure and Requirements

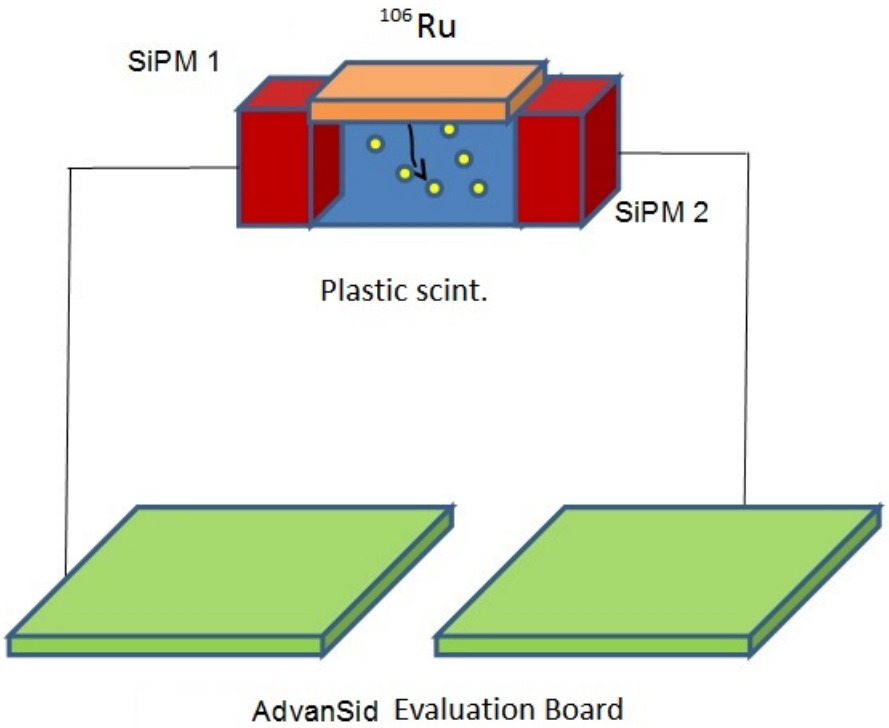
Structure

- 22+22 plastic scintillator bars arranged in two orthogonal layers
- Double side SiPM read-out
- 88 channels read-out in coincidence each-others and with the start counter

Requirements

- Time resolution of 70 *ps* (standard deviation)
- High energy resolution
- Data rate of few *kHz*/*chn*
- Synchronization with the start counter and with the other detector of the system

Preliminary Tests



Experimental Setup

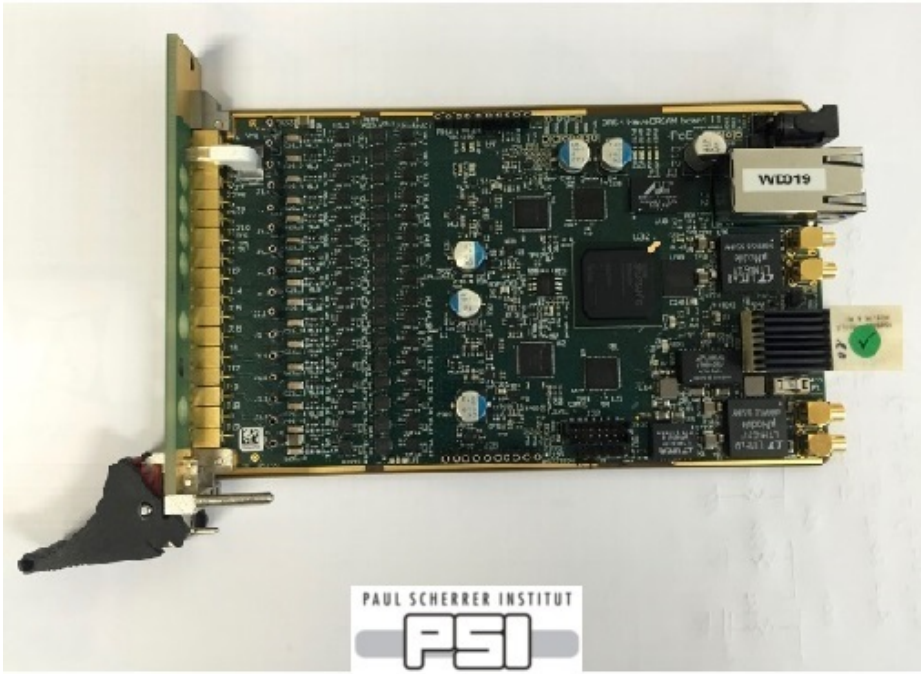
- Plastic scintillator 3x3x10 mm
- 2 SiPM Hamamatsu
- 2 SiPM Evaluation Board AdvanSid with low gain ($\sim$10)
- Power supply for SiPM and Evaluation Board
- ^{106}Ru source [EP:3.546 MeV (78,8 %), 2.412 MeV (9.82 %)]
- Digitizer DRS4 V3

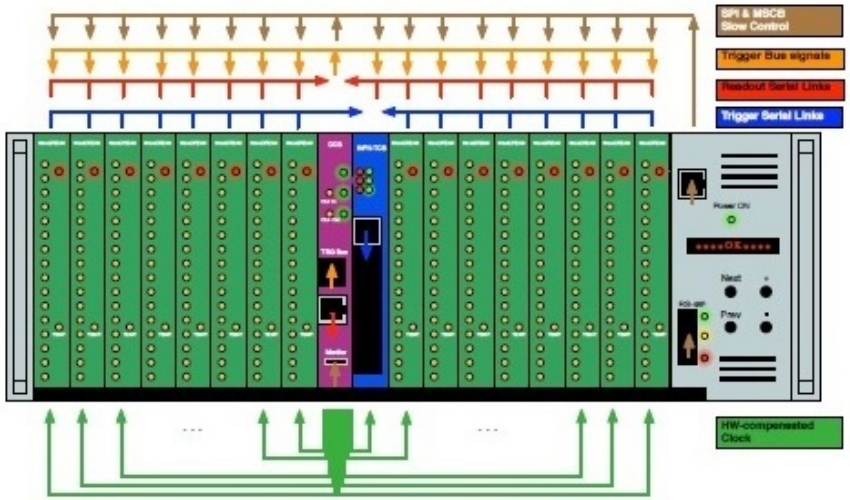
Digitizer

Main Features

- Sampling speed from 700 *MSPS* to 5 *GSPS* (1024 sampling)
- Single ended with 700 *MHz* bandwidth
- High SNR: 69 *dB* after offset correction
- Low Noise: 0.35 *mV* after offset correction

WaveDREAM and DAQ based on MEG





Main Features

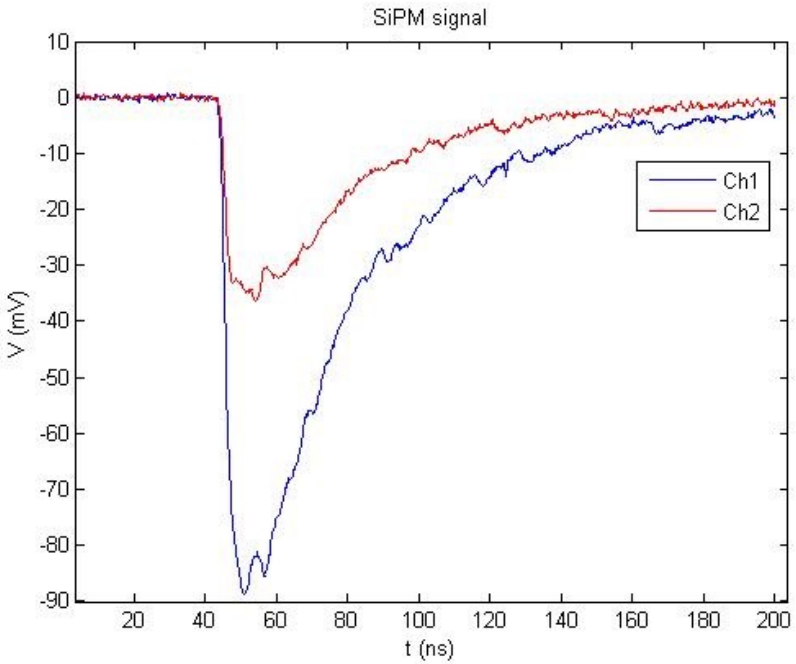
- Same chip of Evaluation Board (16 Ch.)
- Single ended $\sim$ 900 MHz bandwidth
- Power supply for SiPM and Evaluation Board
- Variable gain (1,10,100) with PZC
- System in development (info Stefan Ritt, PSI)

Contribution of

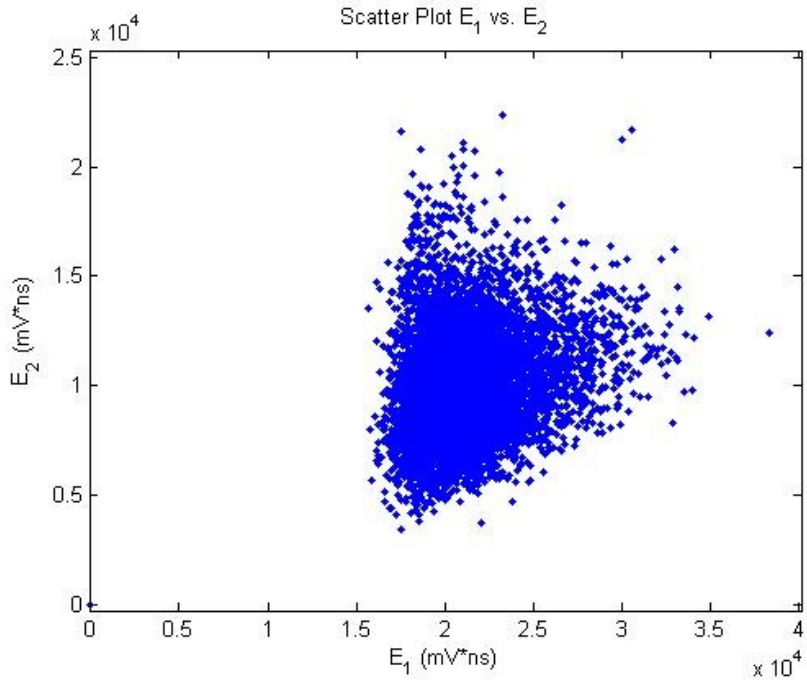
Marco Francesconi, Luca Galli and Donato Nicolò by INFN Pisa (MEG)

Data

SiPM Signals



Energy of the two signals



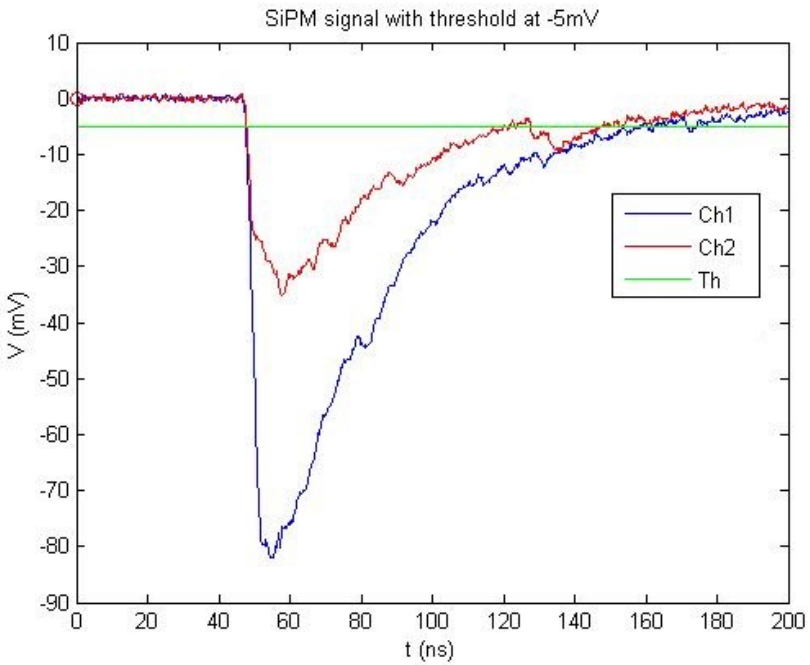
Starting sample

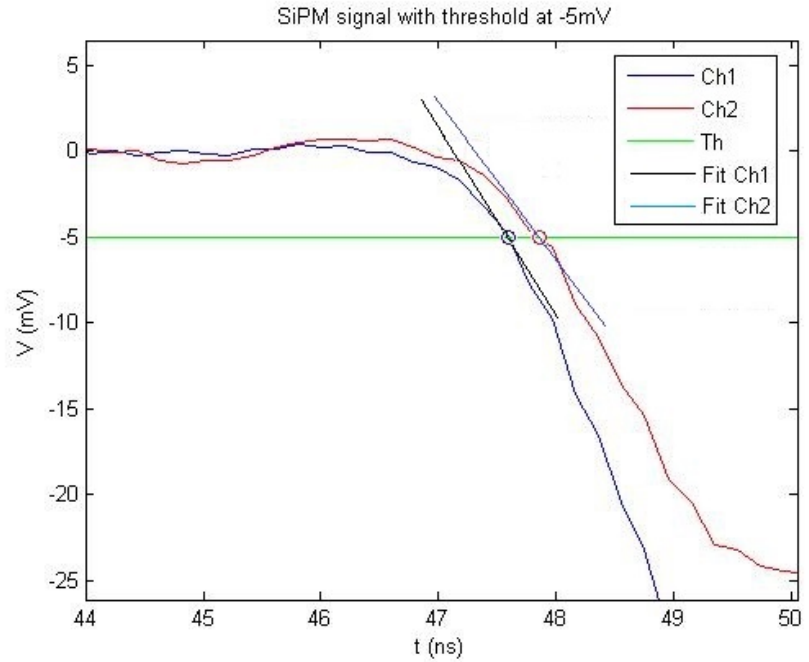
- Number of events: $\sim$ 6600
- Range amplitude signals from -20 to -100 mV

Problems

- Optical coupling
- Limited accouracy the selection of V_{ov}

Reconstruction Timing Method with Fixed Th

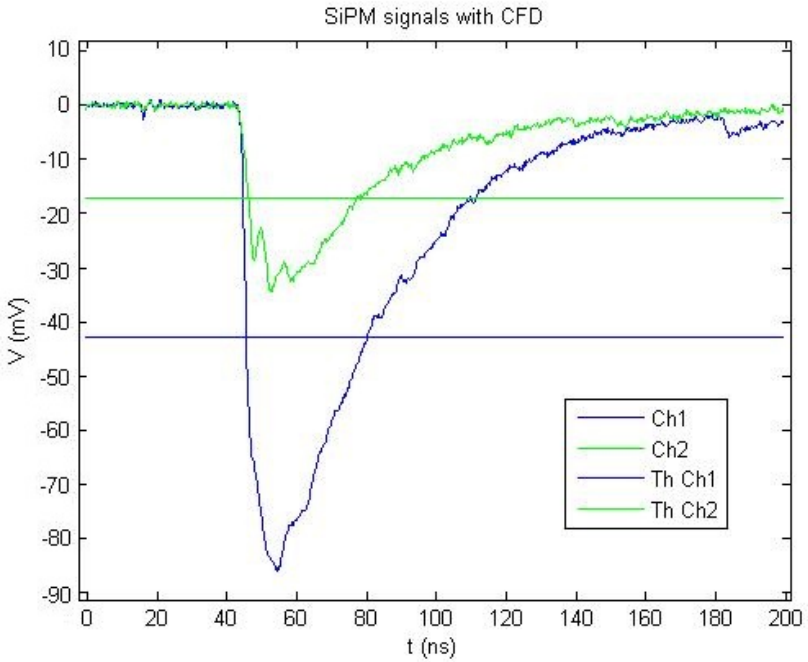


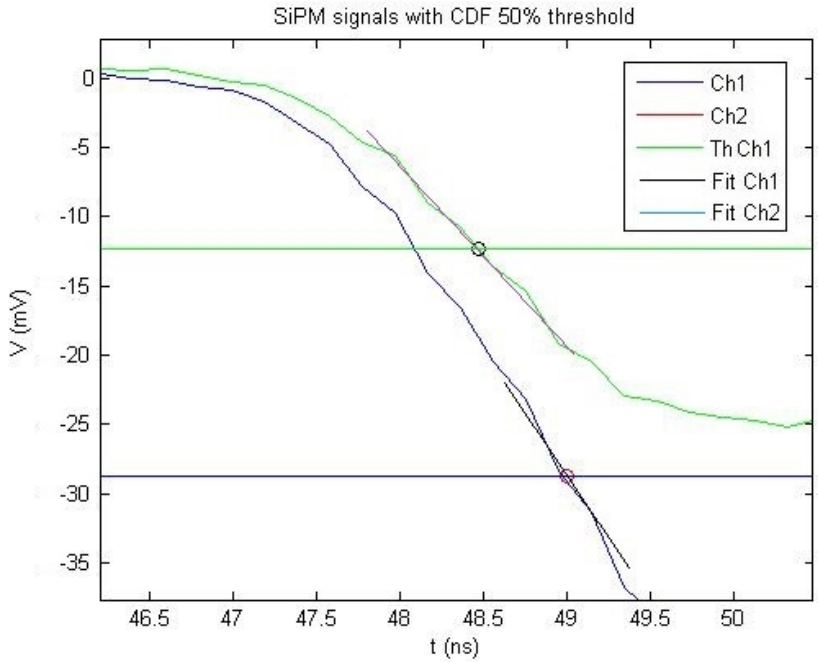


- Fix a threshold
- Consider two points before and two points after the threshold

- Extrapolate linear fit
- Intersect fit with the threshold
- Calculate time difference

Reconstruction Timing Method with CFD



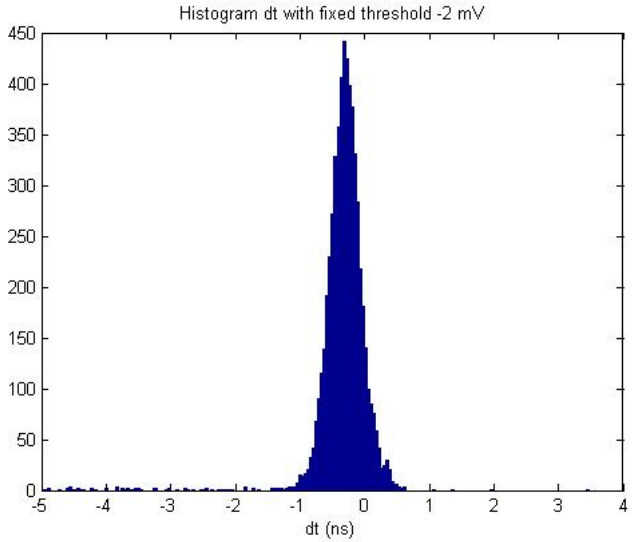


- Variable threshold depending on max signal amplitude
- Consider two points before and two points after the threshold

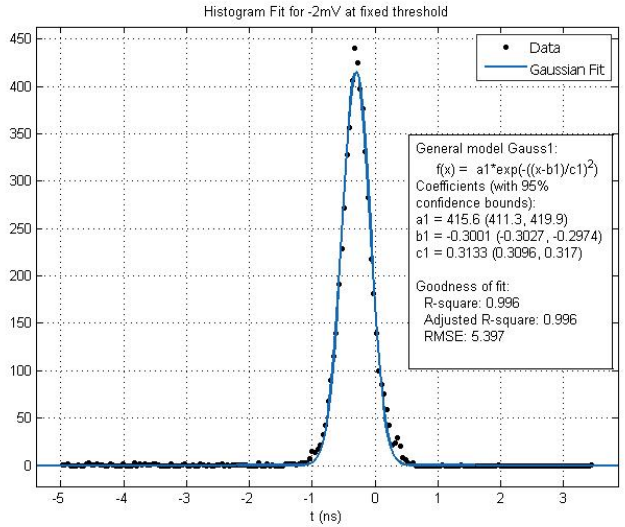
- Extrapolate linear fit
- Intersect fit with the threshold
- Calculate time difference

Histogram of dt

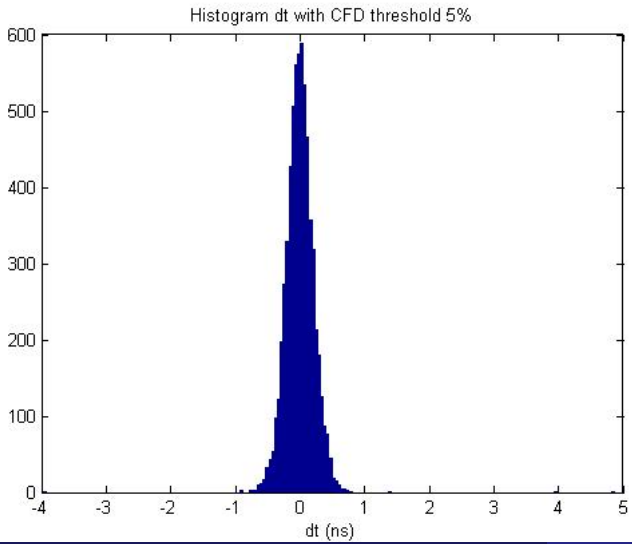
Histogram dt for fixed threshold



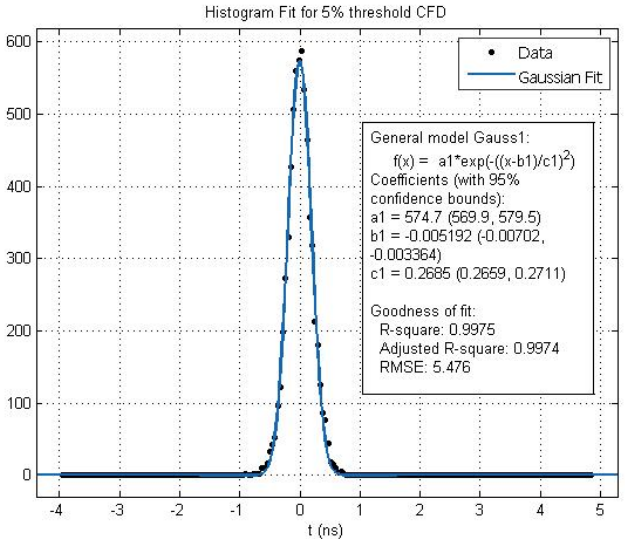
Gaussian Fit →



Histogram dt with CFD

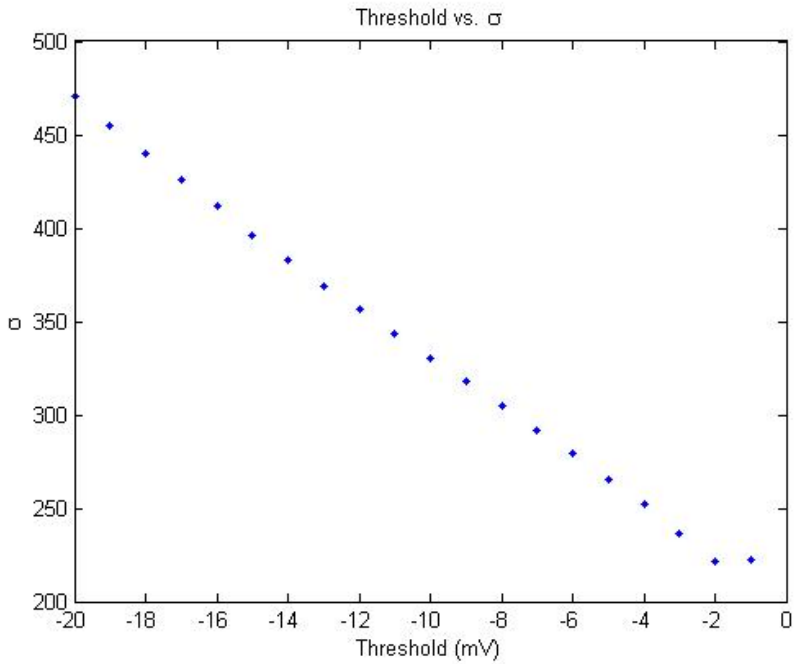


Gaussian Fit →

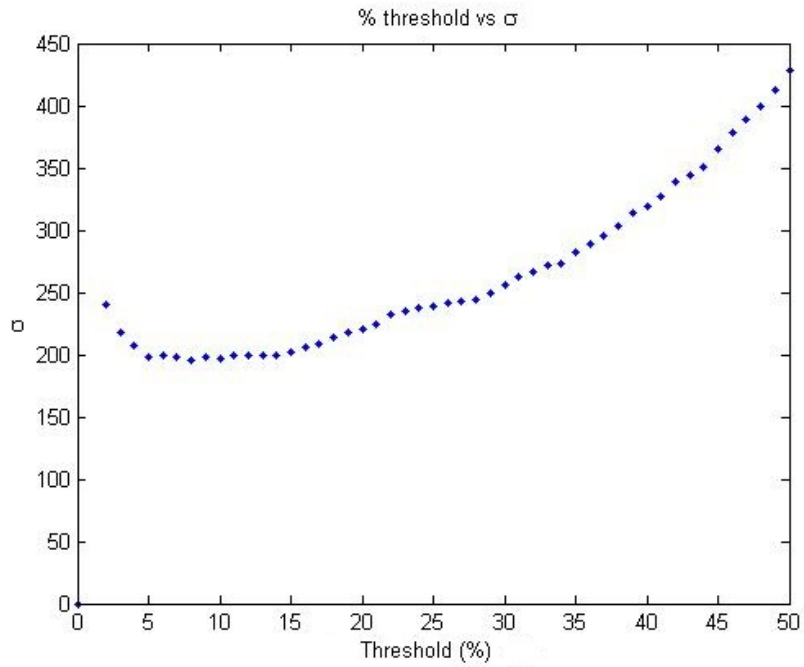


Optimal Threshold in the two Cases

σ vs. fixed threshold



σ vs. CFD threshold



Optimal threshold for best σ_{FT}

For Threshold$=-2mV$

$\downarrow$

$\sigma_{FT} = (221 \pm 10)ps$

Optimal threshold for best σ_{CFD}

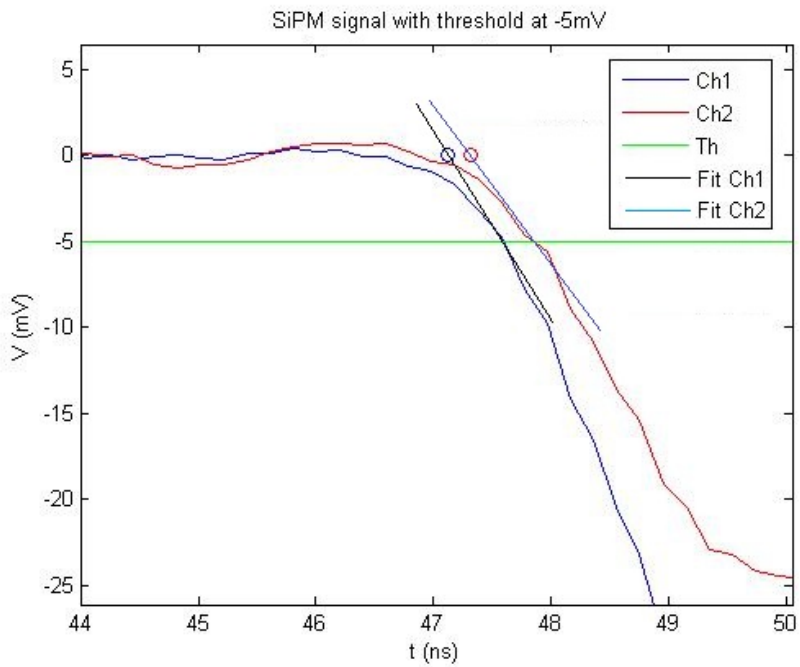
For Threshold$=5\%$

$\downarrow$

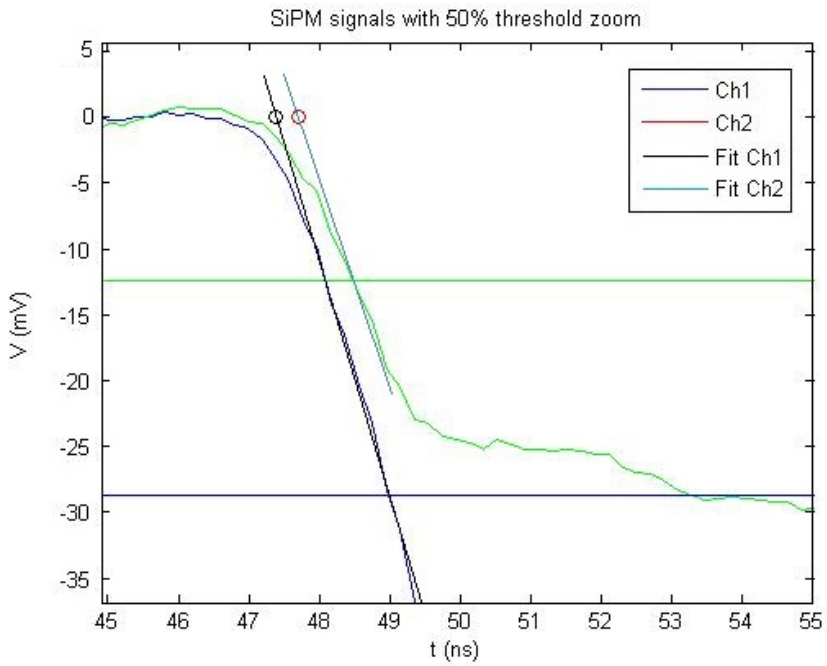
$\sigma_{CFD} = (189 \pm 6)ps$

Another Method

Fit with fixed threshold



Fit with CFD threshold



Optimal threshold for best σ_{FT}

For Threshold$=-5mV$

$\downarrow$

$\sigma_{FT} = (225 \pm 10)ps$

Optimal threshold for best σ_{CFD}

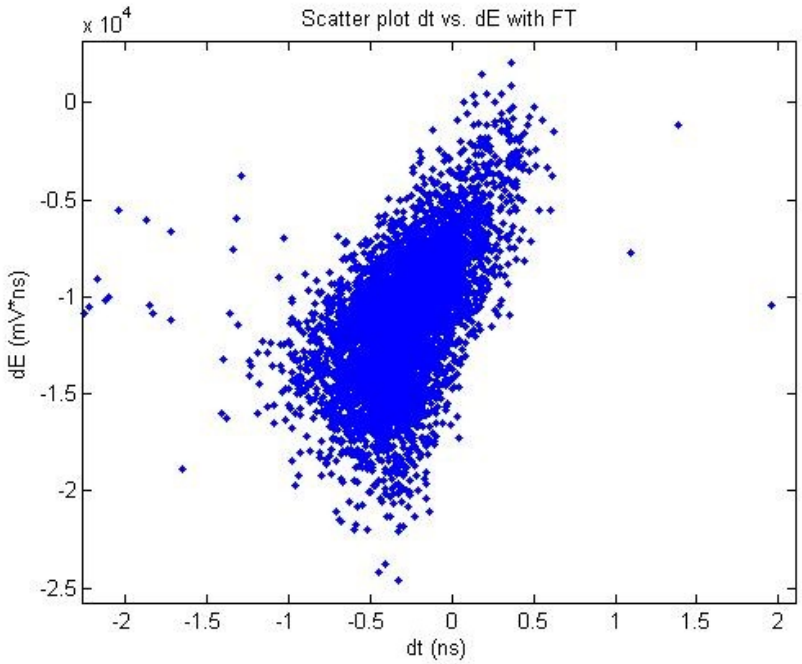
For Threshold$=10\%$

$\downarrow$

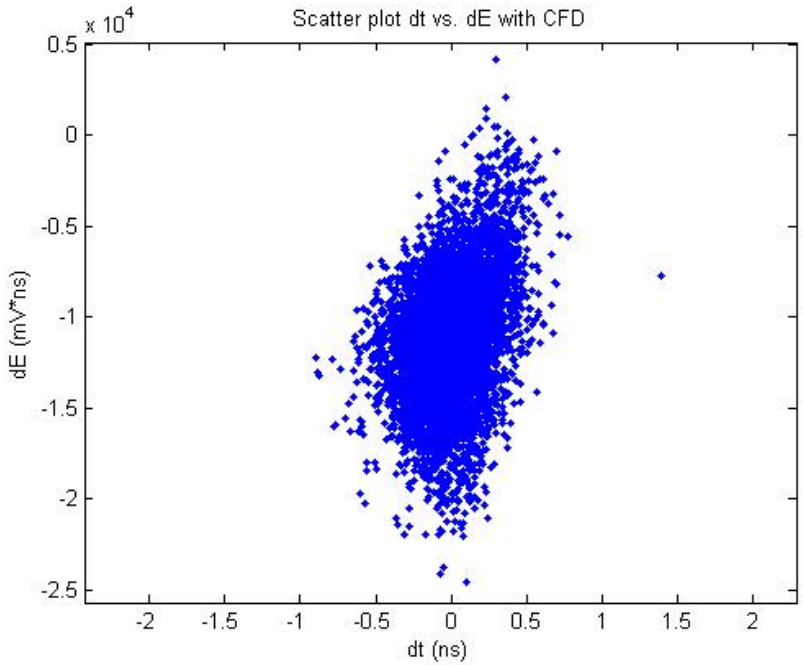
$\sigma_{CFD} = (197 \pm 9)ps$

Scatter plot dt vs. dE

Scatter plot dt vs. dE with FT



Scatter plot dt vs. dE with CFD

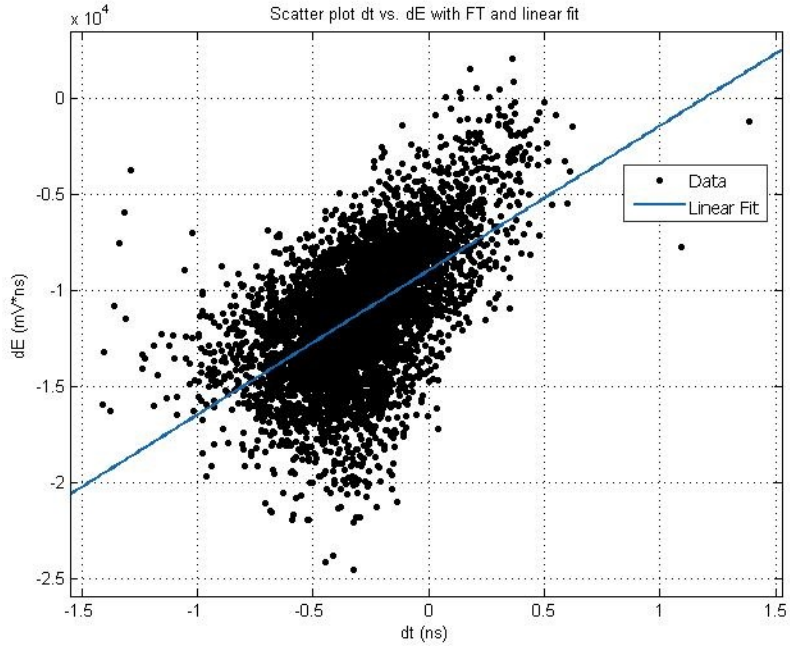


Similarities

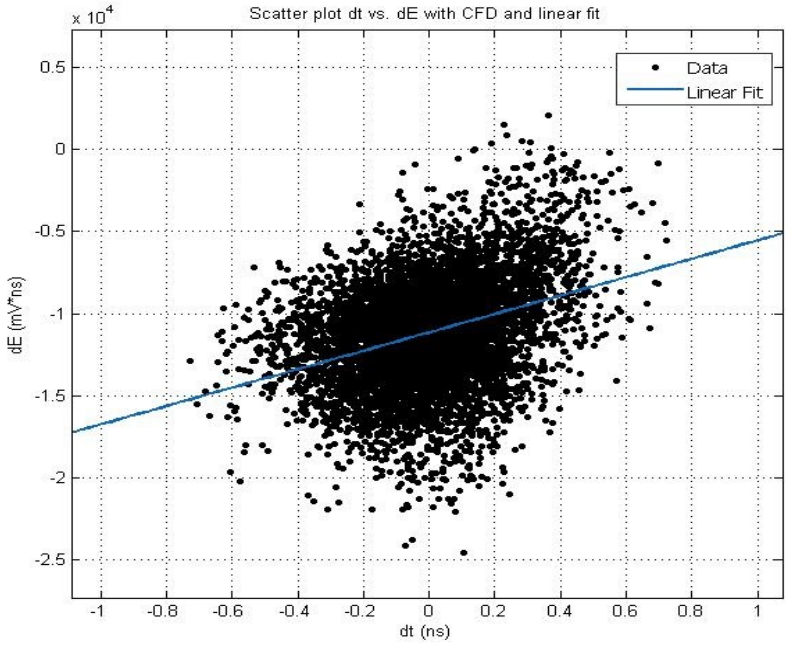
- Correlation with dt and dE (more evident in the case of FT)
- Effect has to be fix

Scatter plot correction

Scatter plot correction with FT



Scatter plot dt vs. dE with CFD



Improvement σ_{FT}

Before: $\sigma_{FT} = (221 \pm 10)ps$

$\downarrow$

After: $\sigma_{FT} = (189 \pm 10)ps$

Improvement σ_{CFD}

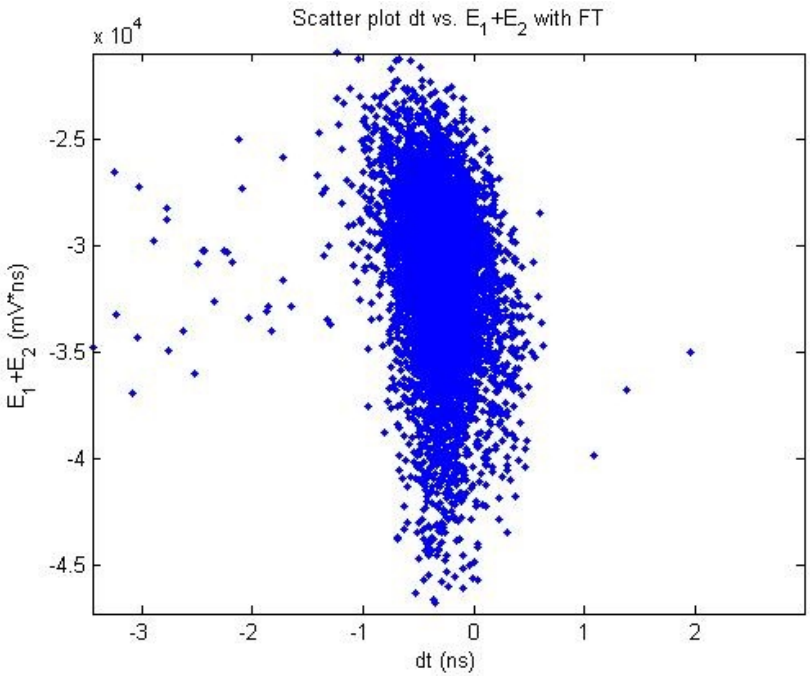
Before: $\sigma_{CFD} = (189 \pm 6)ps$

$\downarrow$

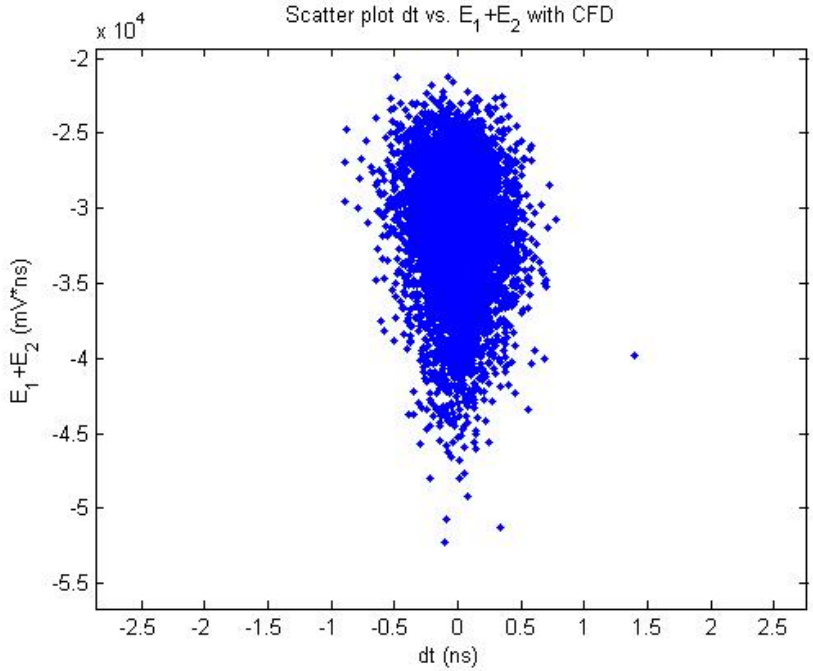
After: $\sigma_{CFD} = (181 \pm 6)ps$

Scatter plot dt vs. E_1+E_2

Scatter plot dt vs. E_1+E_2 with FT



Scatter plot dt vs. dE with CFD



Observations

- Considerable dispersion of points

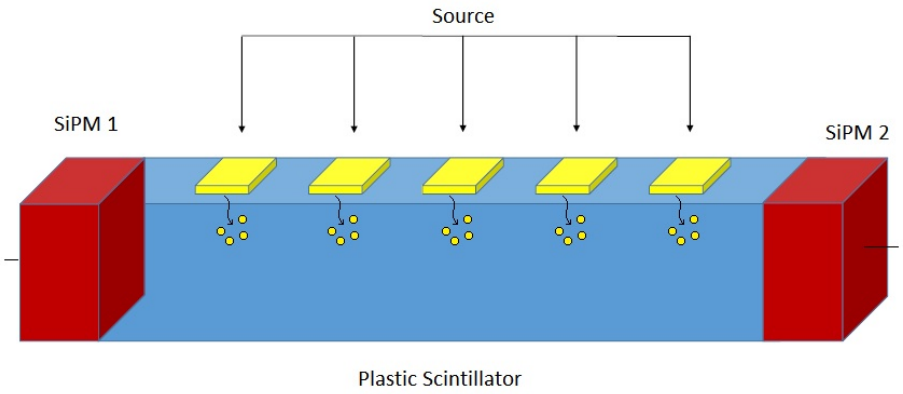
Observations

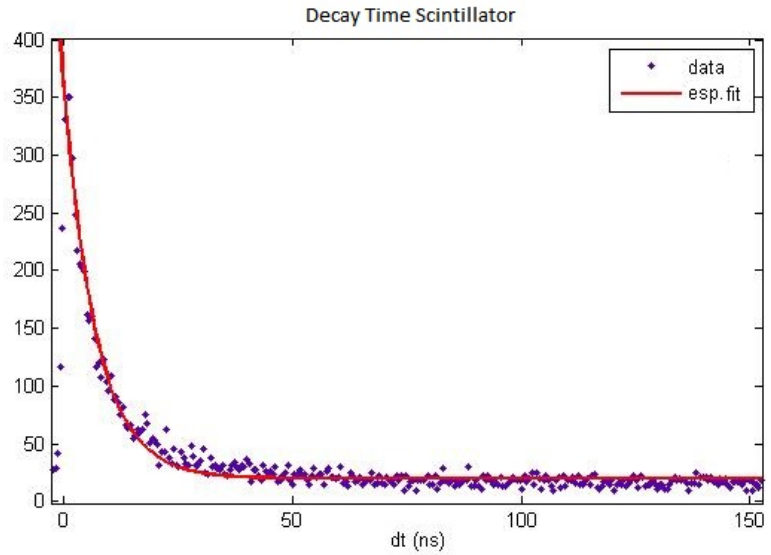
- Less dispersion of the points
- Remarkable "funnel" shape

Summary Results

	Threshold extrapolation		Zero extrapolation	
	with FT	with CFD	with FT	with CFD
Threshold	-2 mV	5%	-5 mV	10%
σ	221 ps	189 ps	225 ps	197 ps
σ with corr	189 ps	181 ps	195 ps	185 ps

Next Step: Simulation and Validation





Goals

- Performances vs position
- Simulation and validation

Expected results

- Arrival time probability of photons as a function of the scintillation point in the bar
- Development of the correction algorithm for the interaction position