

# Time resolution studies for the PANDA barrel DIRC



# Overview

## 1. Electronics

- i) TrBs (Version 2), ToF AddOns

## 2. Measurements with electronics

- i) Procedure
- ii) Timing performance of electronics

## 3. Dispersion; Problem or no problem ?

## 4. Measurements with photons

- i) MCP(s)
- ii) Diffuser-/no diffuser- measurements

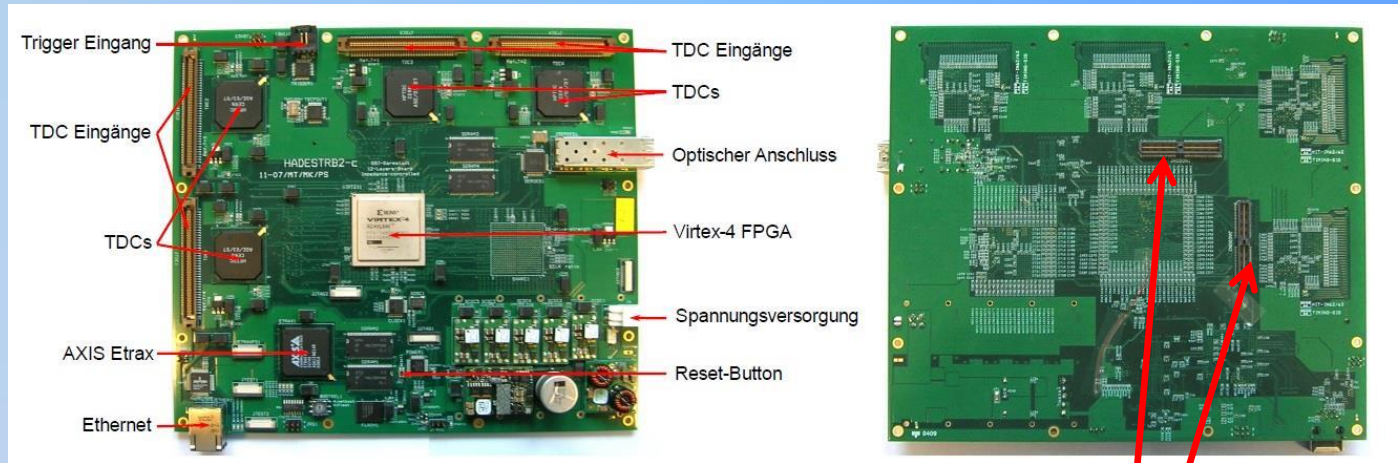
## 5. Summary & Outlook

# Overview

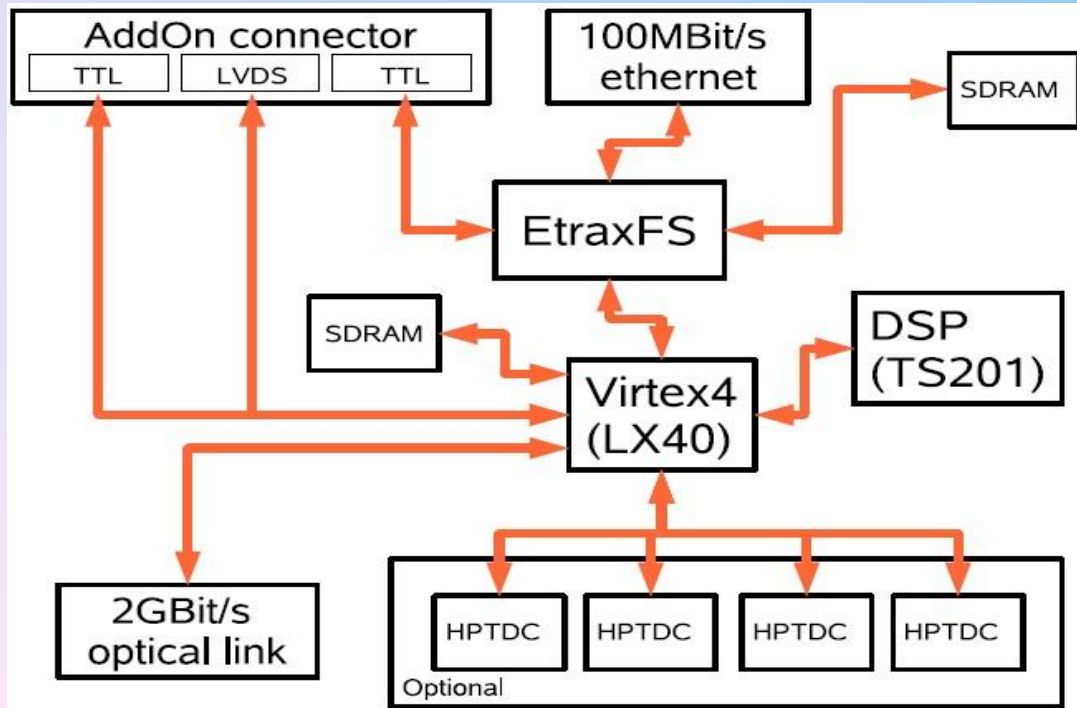
## **1. Electronics**

### ***i) TrBs (Version 2), ToF AddOns***

# Electronics



Connections for different AddOn boards,

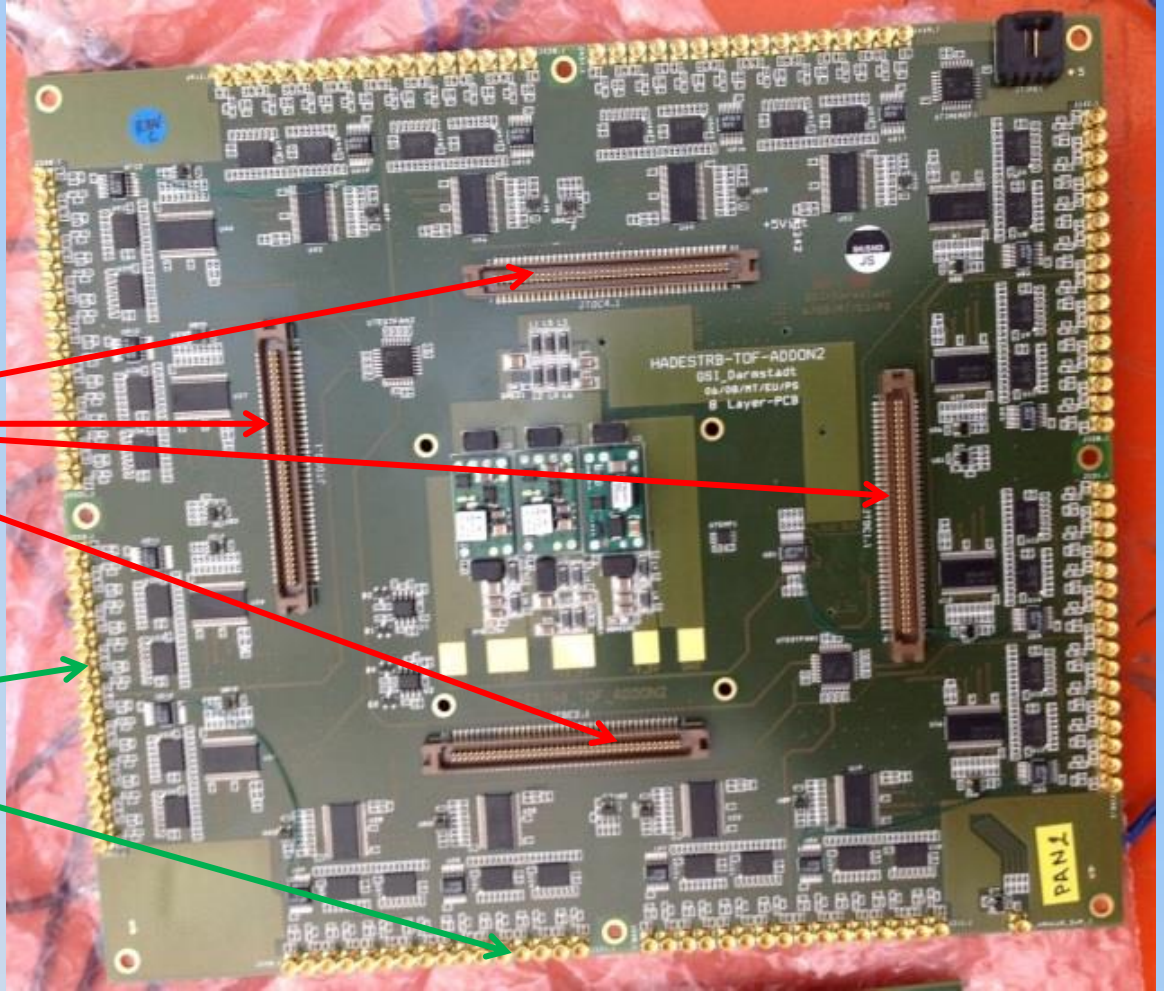


# Electronics

ToF AddOn boards:  
PAN2

HPTDC  
connections

Connection to  
Photodetector  
or other  
source



# Overview

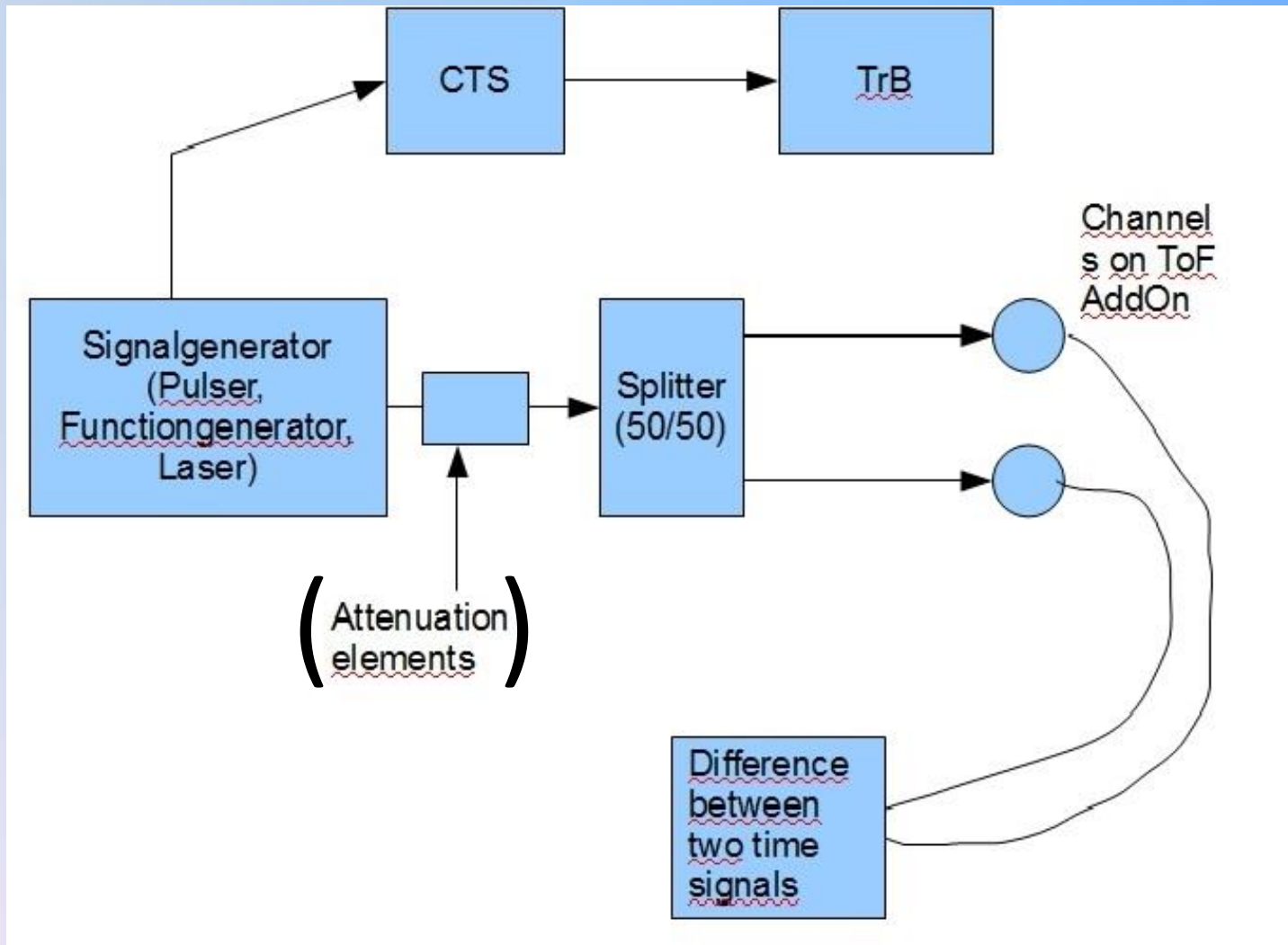
## 1. Electronics

i) TrBs (Version 2), ToF AddOns

## ***2. Measurements with electronics***

***i) Procedure***

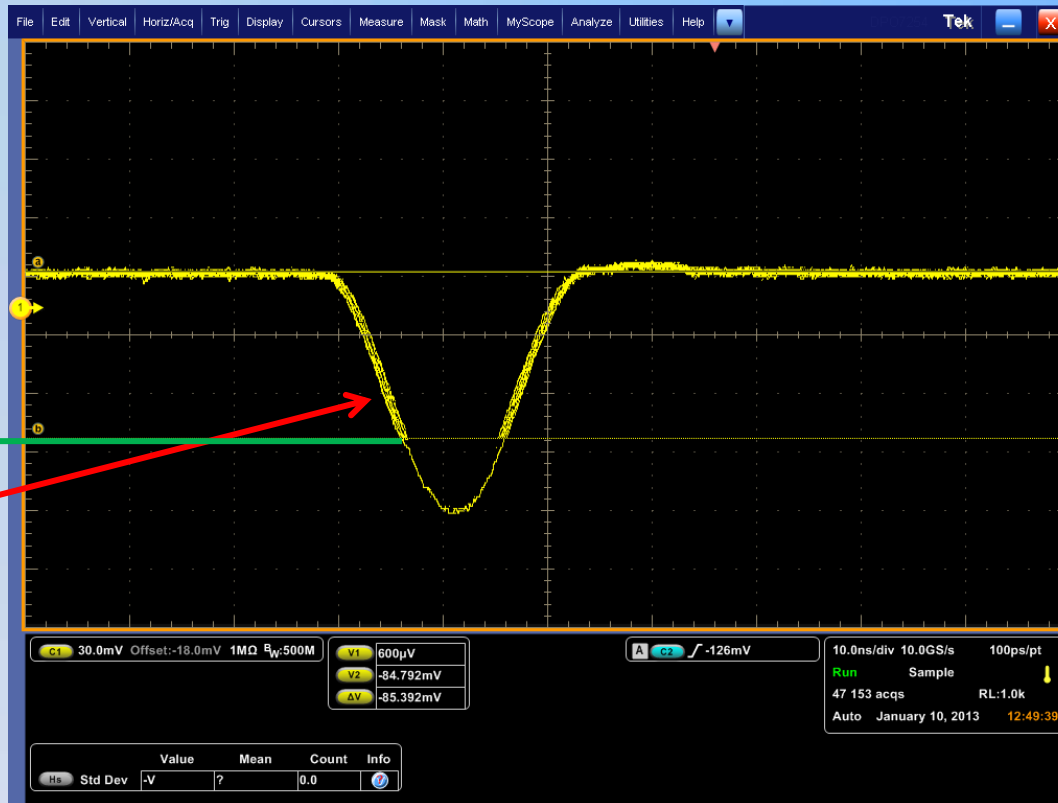
# Measurements with electronics



# Measurements with electronics

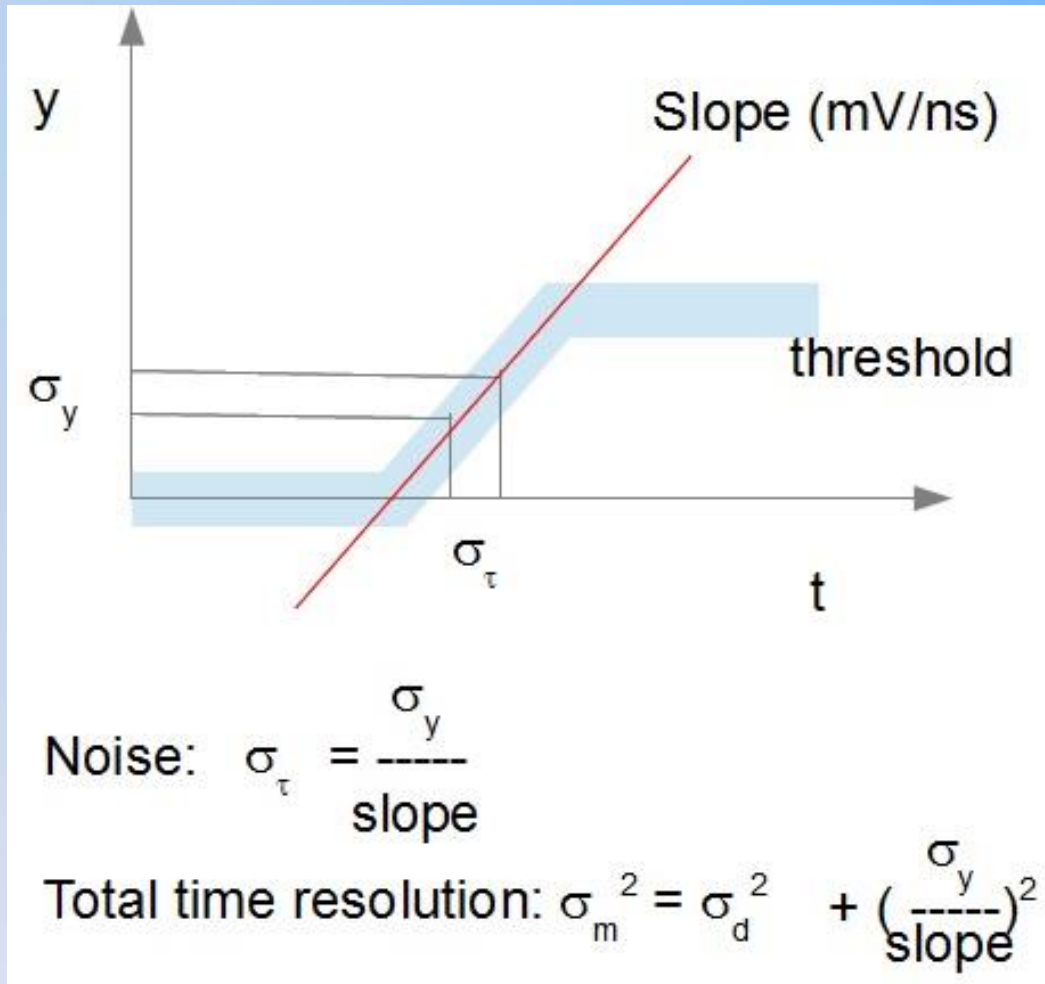
Gauss-shaped signal from the function generator

Discr. Thresh.  
Leading edge





# Measurements with electronics

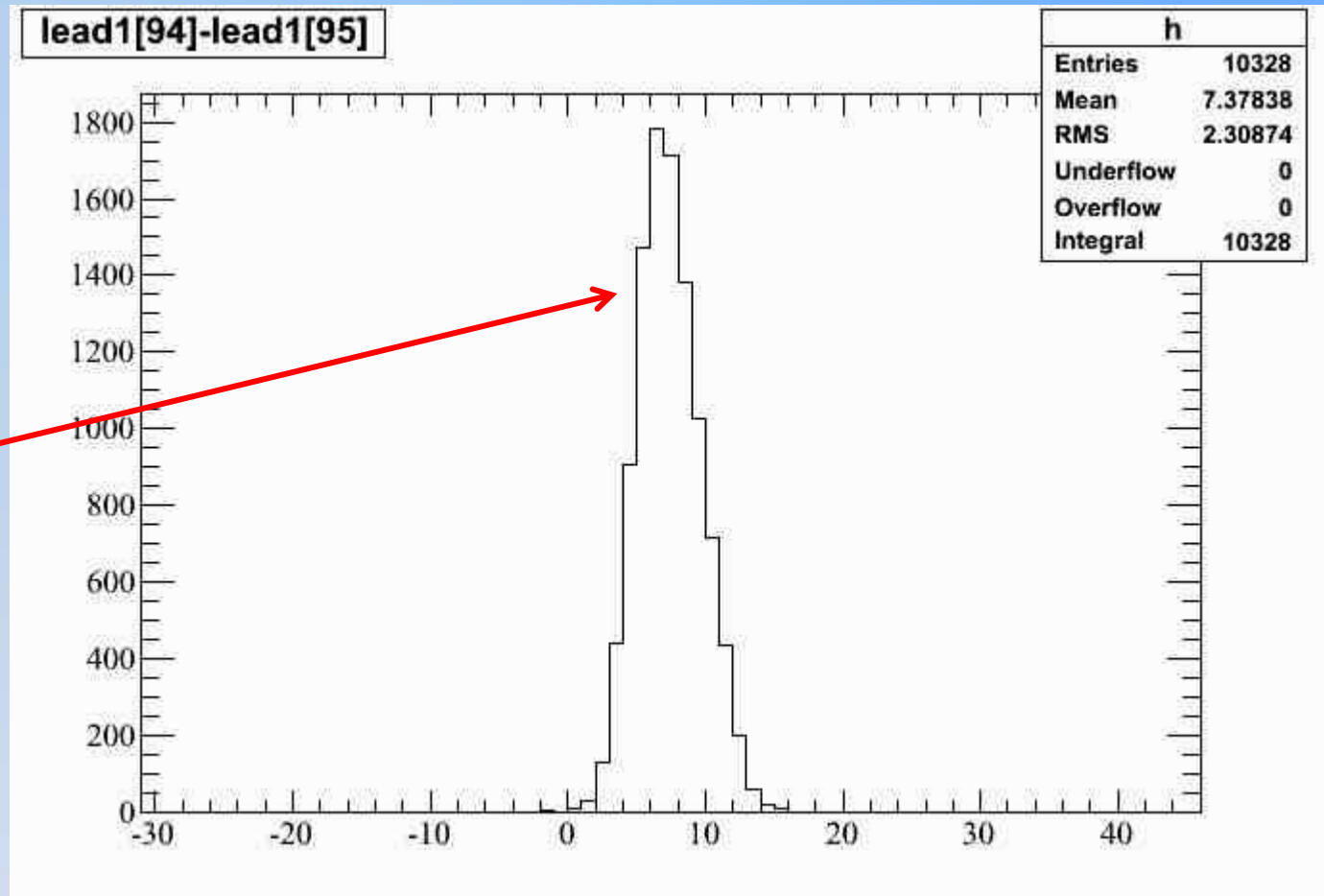


# Measurements with electronics

For time difference method:

-> The time difference between two leading edges on two different channels is plotted here

The sigma of the gauss-fit gives the actual time resolution



02/2011, pocket pulser

# Overview

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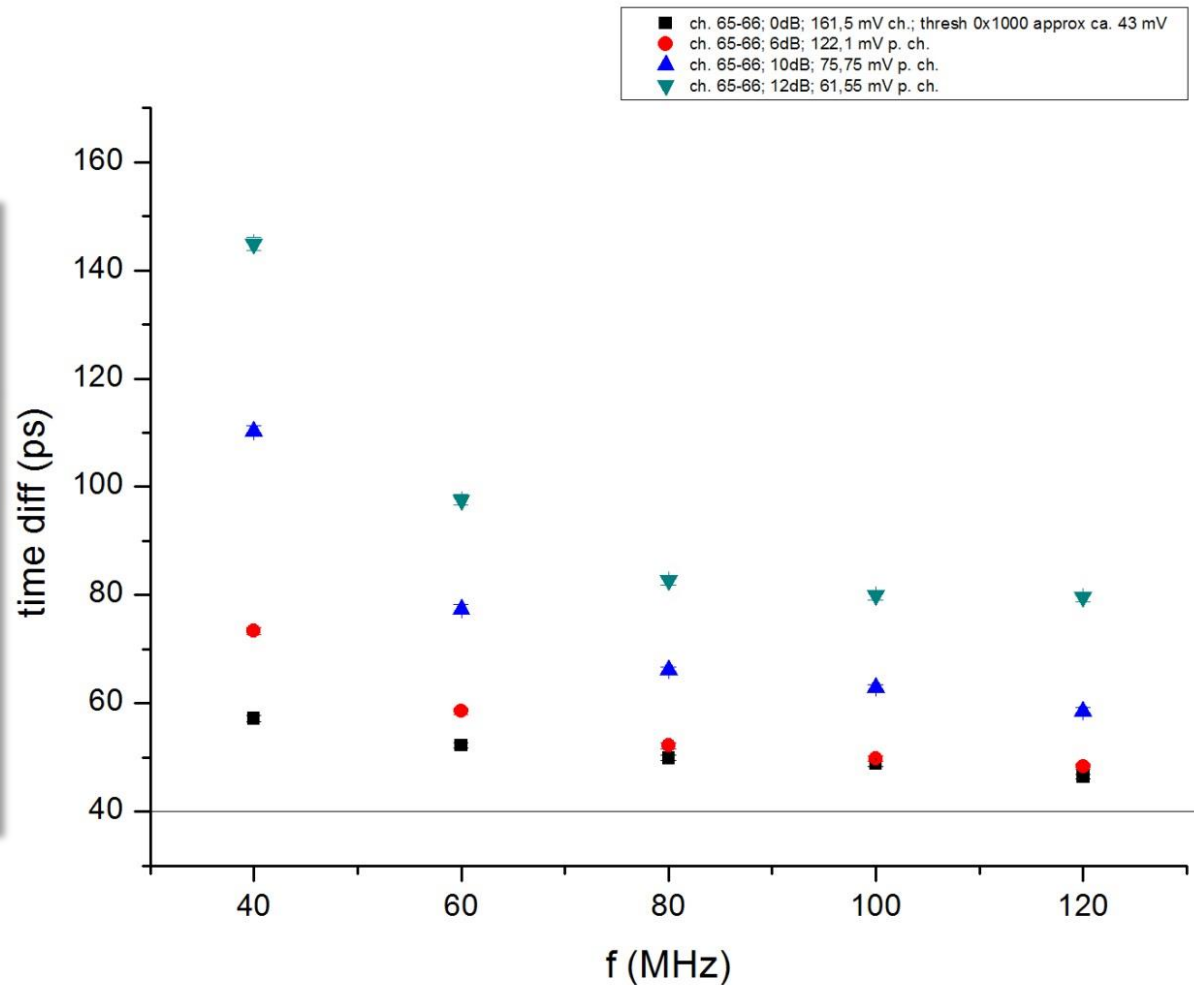
## 2. Measurements with electronics

i) Procedure

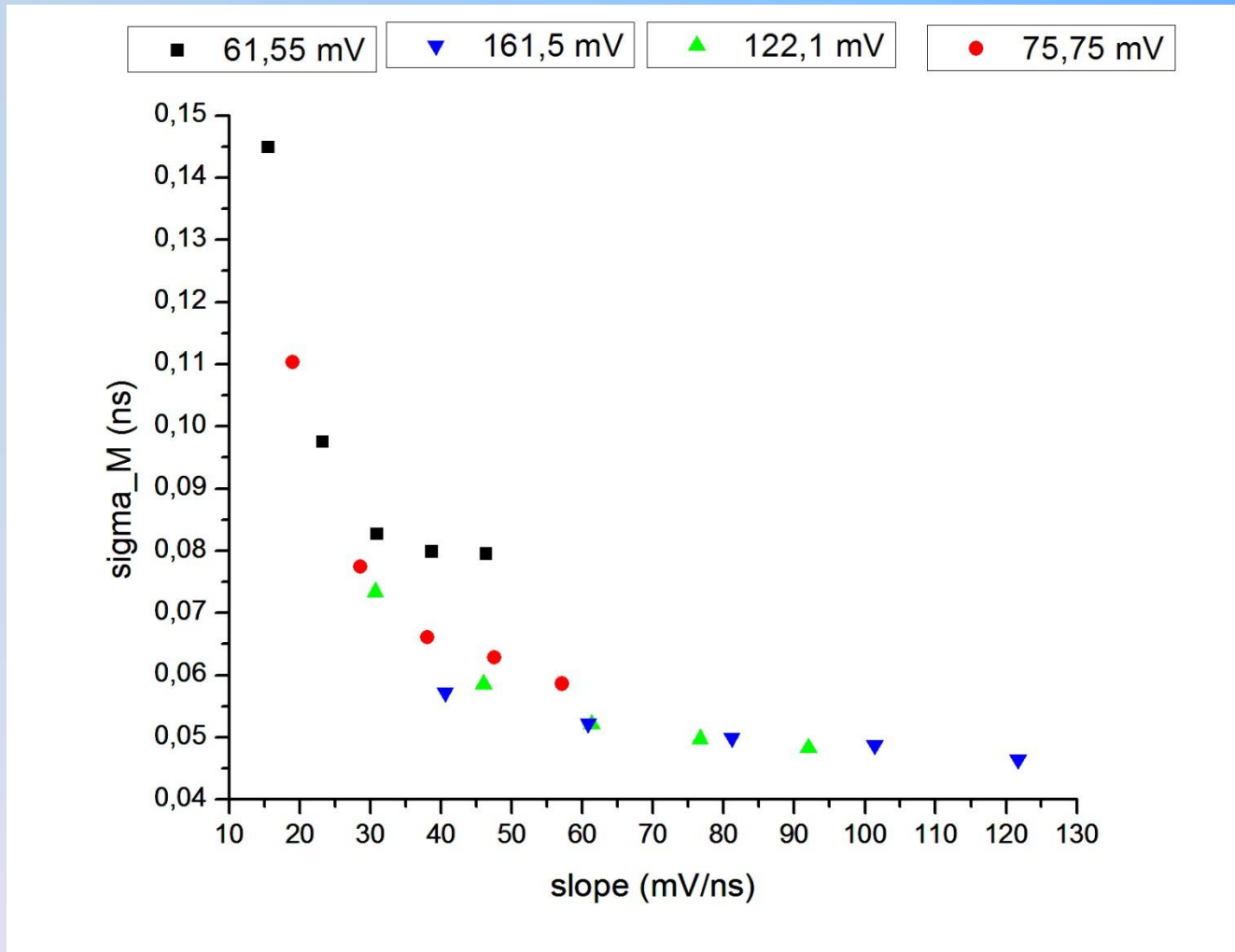
***ii) Results of timing performance of electronics***

# Measurements with electronics

Board	TrBv2
AddOn	02/2011
Properties	Diff. Signals amplitudes;  x-axis: Values for the (adjustable) slope of the output signal



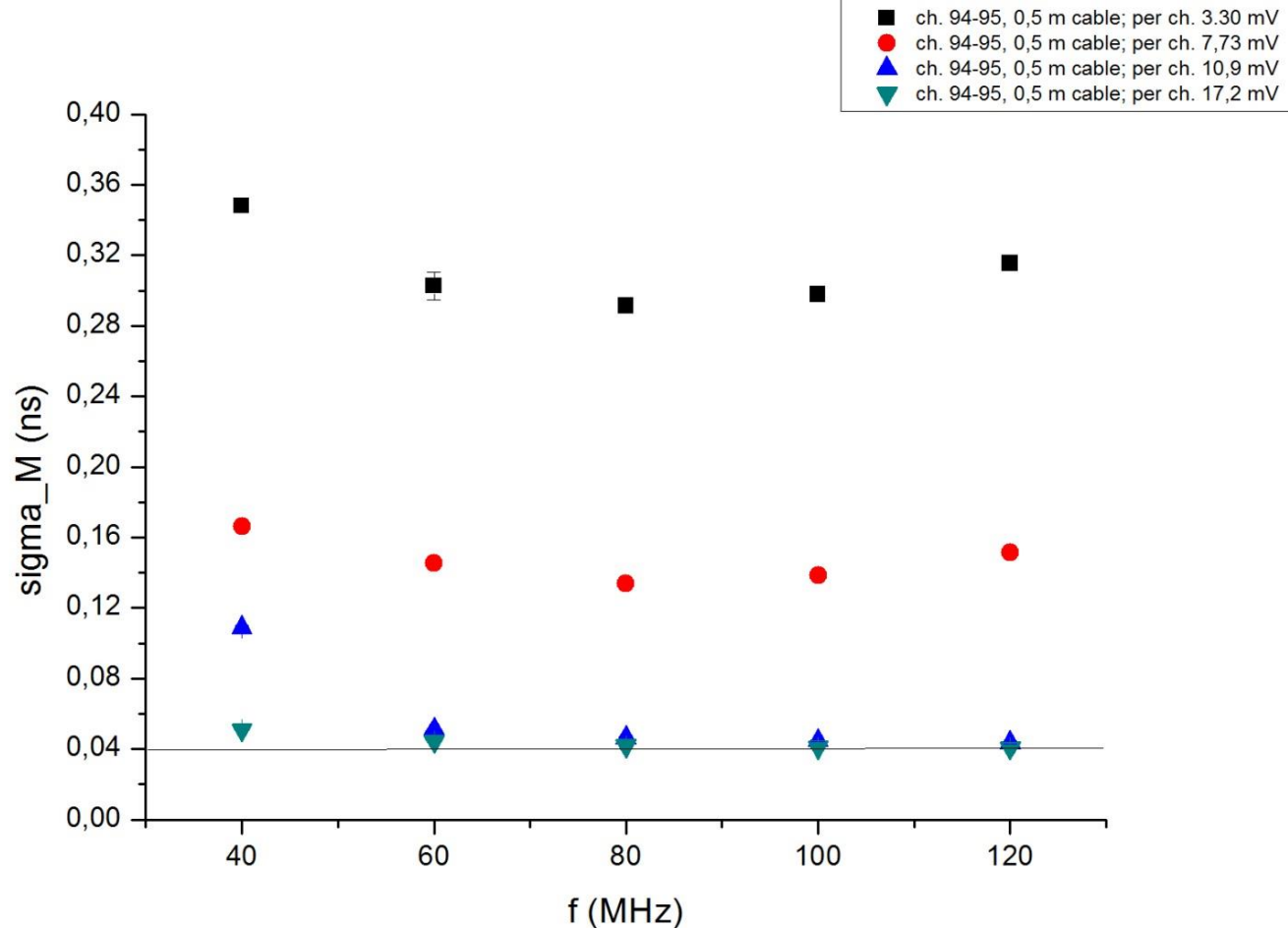
# Measurements with electronics



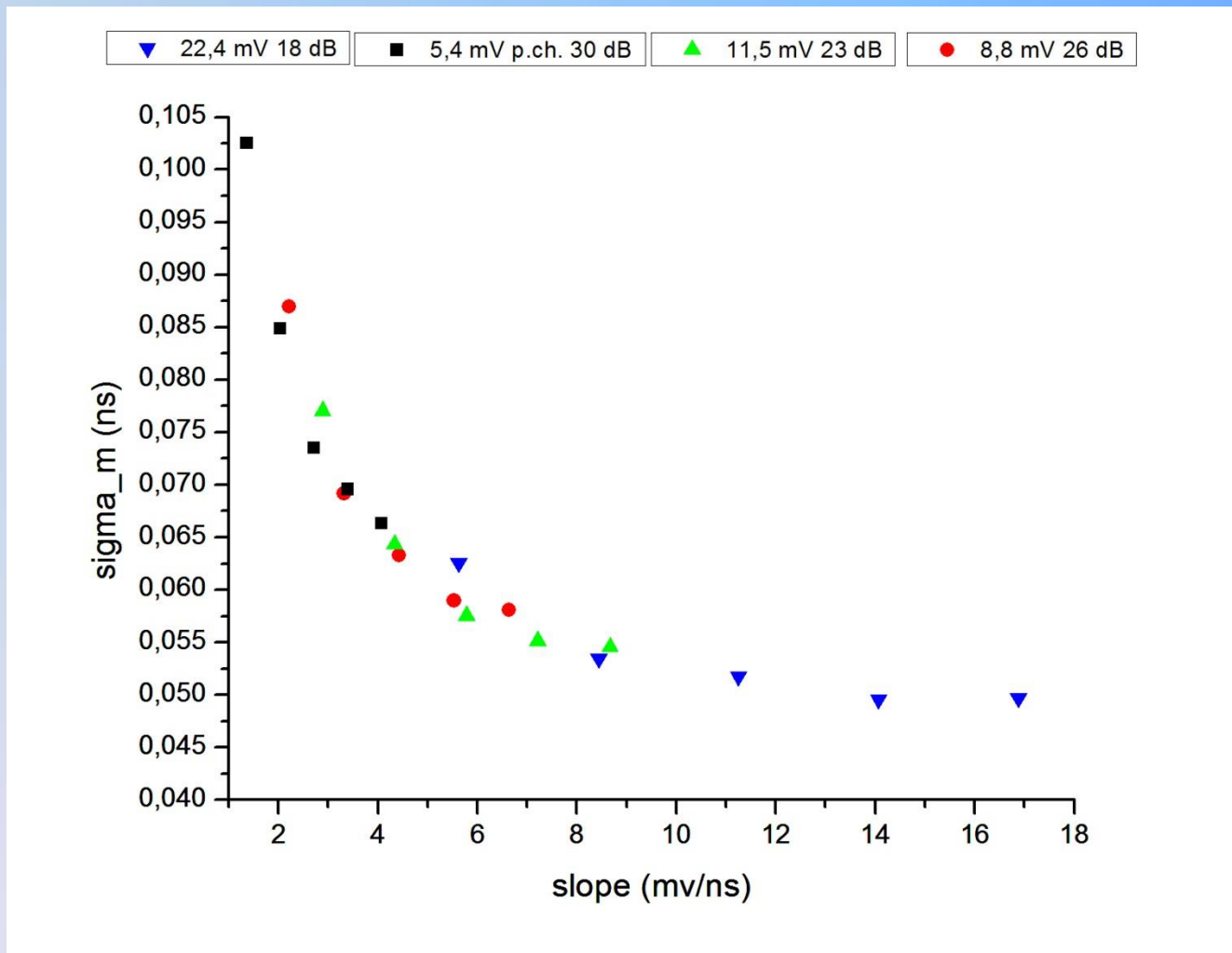
02/2011, slope vs. Sigma\_M

# Measurements with electronics

Board	TrBv2
AddOn	PAN2
Properties	Diff. Signals amplitudes; Cablelength fixed; x-axis: Values for the (adjustable) slope of the output signal



# Measurements with electronics



PAN2, slope vs. Sigma\_M

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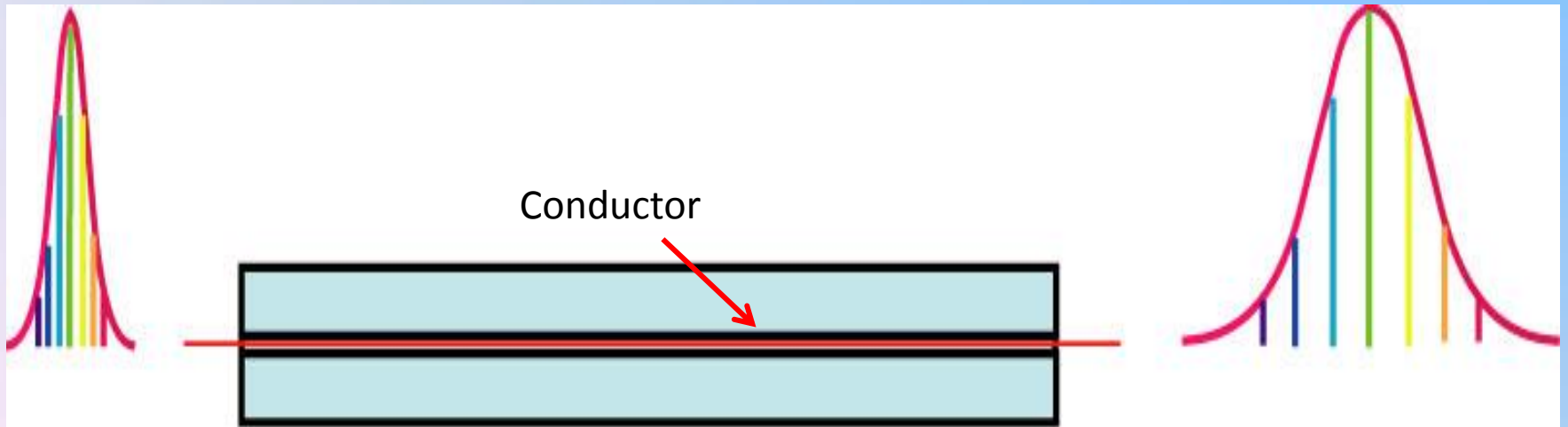
***3. Dispersion; problem or no problem ?***



# Chromatic Dispersion

-> Chromatic Dispersion occurs when a (light)wave passes a medium

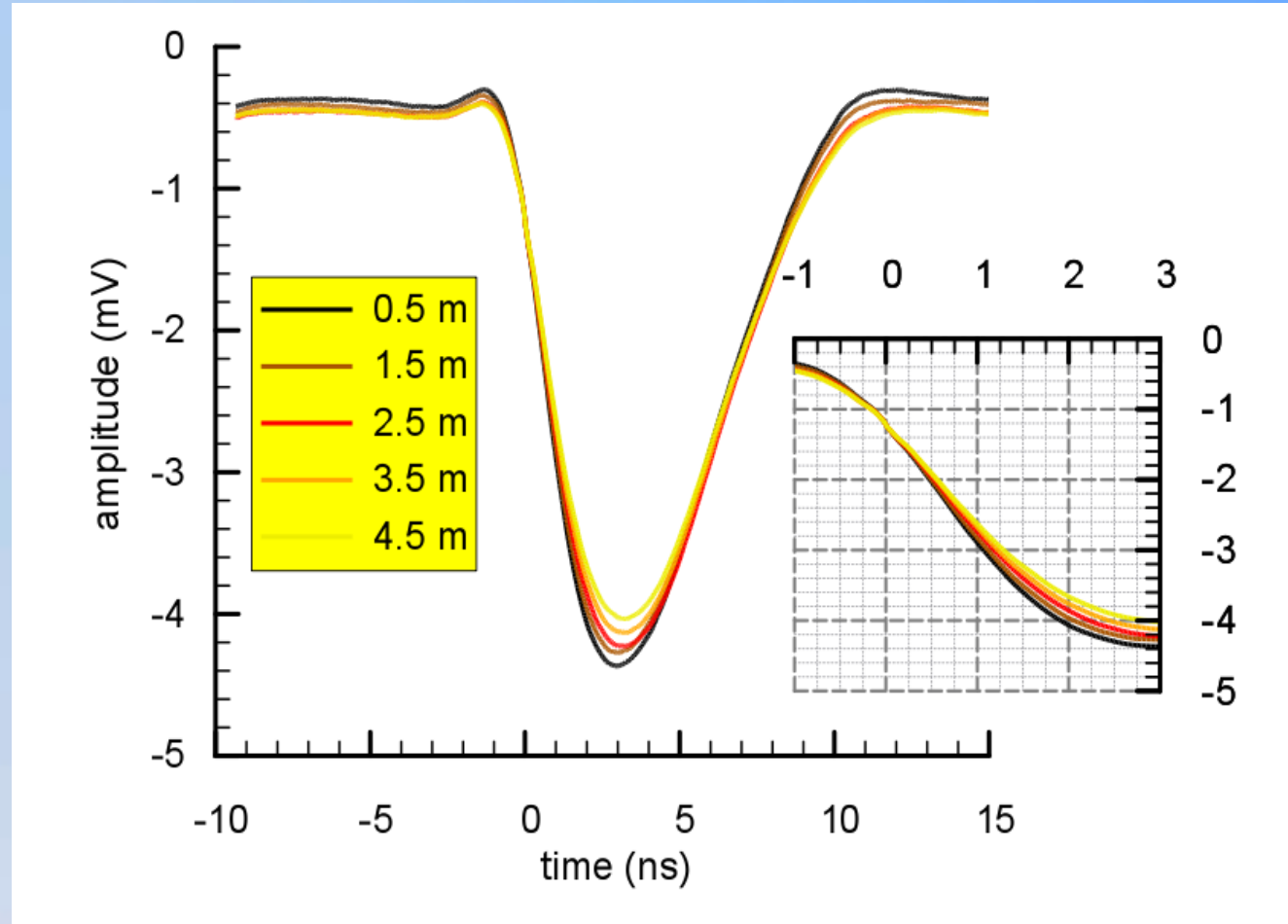
-> Causes broadening of the signal



# Chromatic Dispersion

-> Very small effect for our used cable lengths

**=> No problem for the time resolution in our case**



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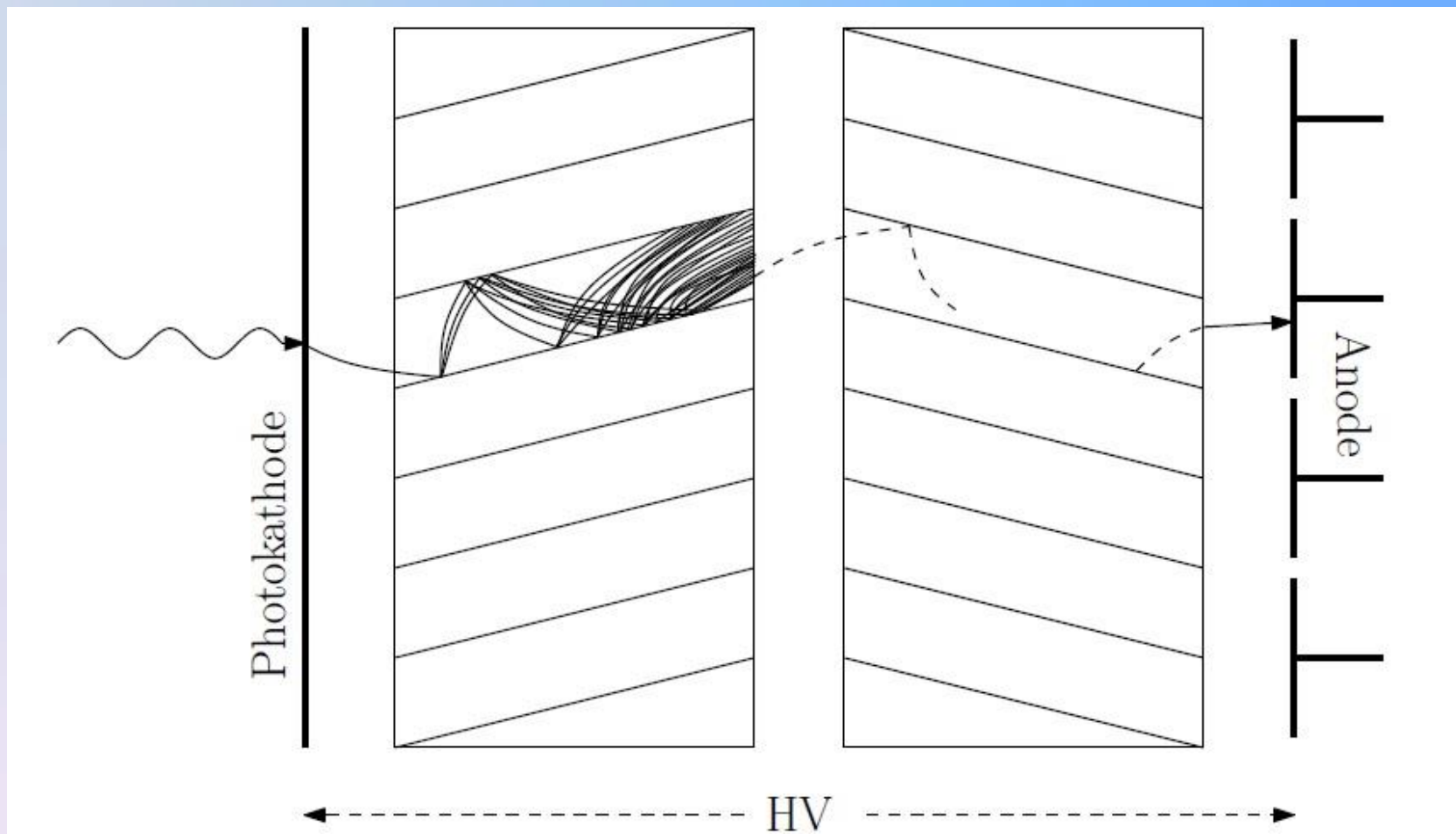
## 3. Dispersion, problem or no problem ?

## ***4. Measurements with photons***

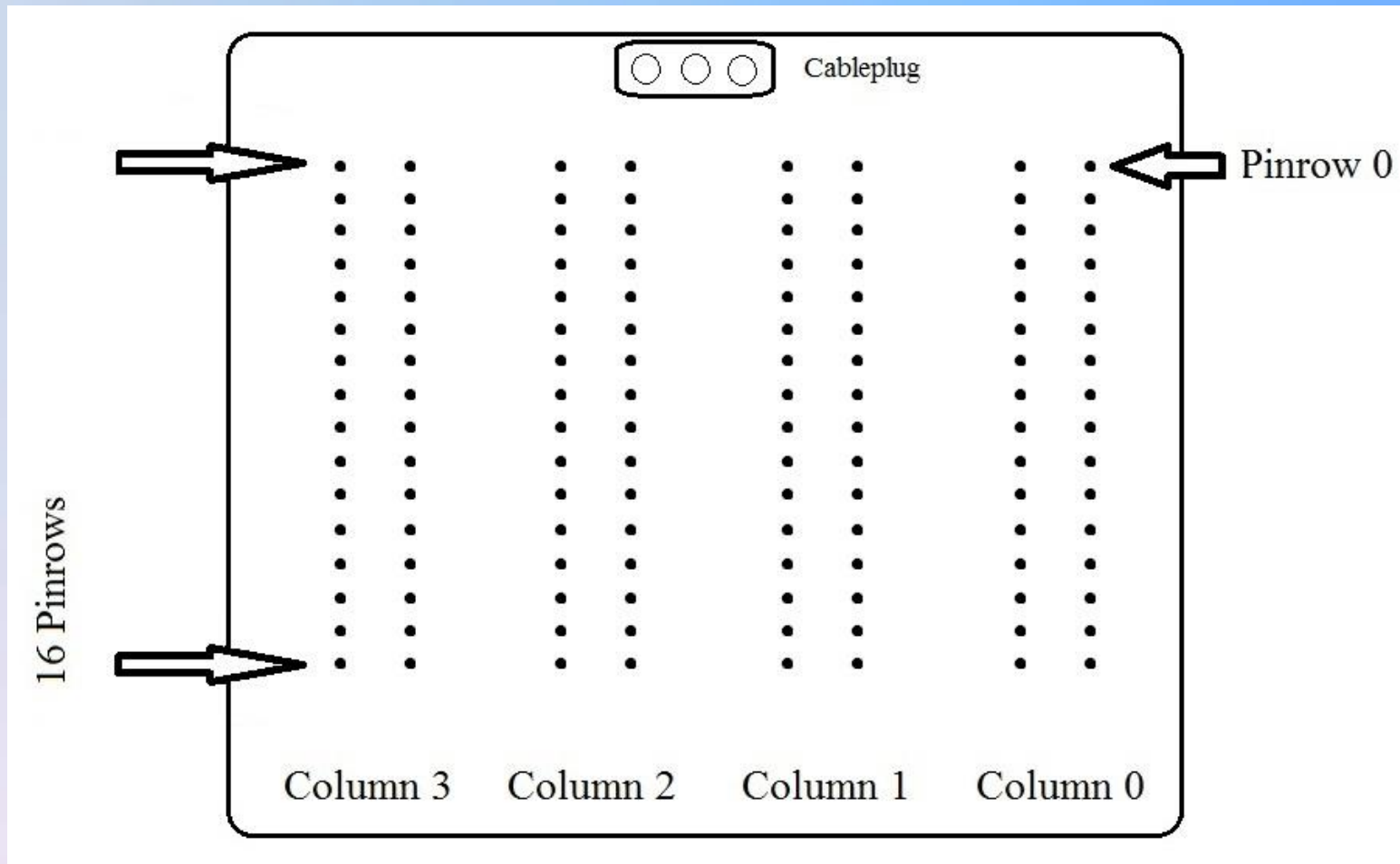
- i) MCP(s)***

- ii) Diffuser-/no diffuser- measurements***

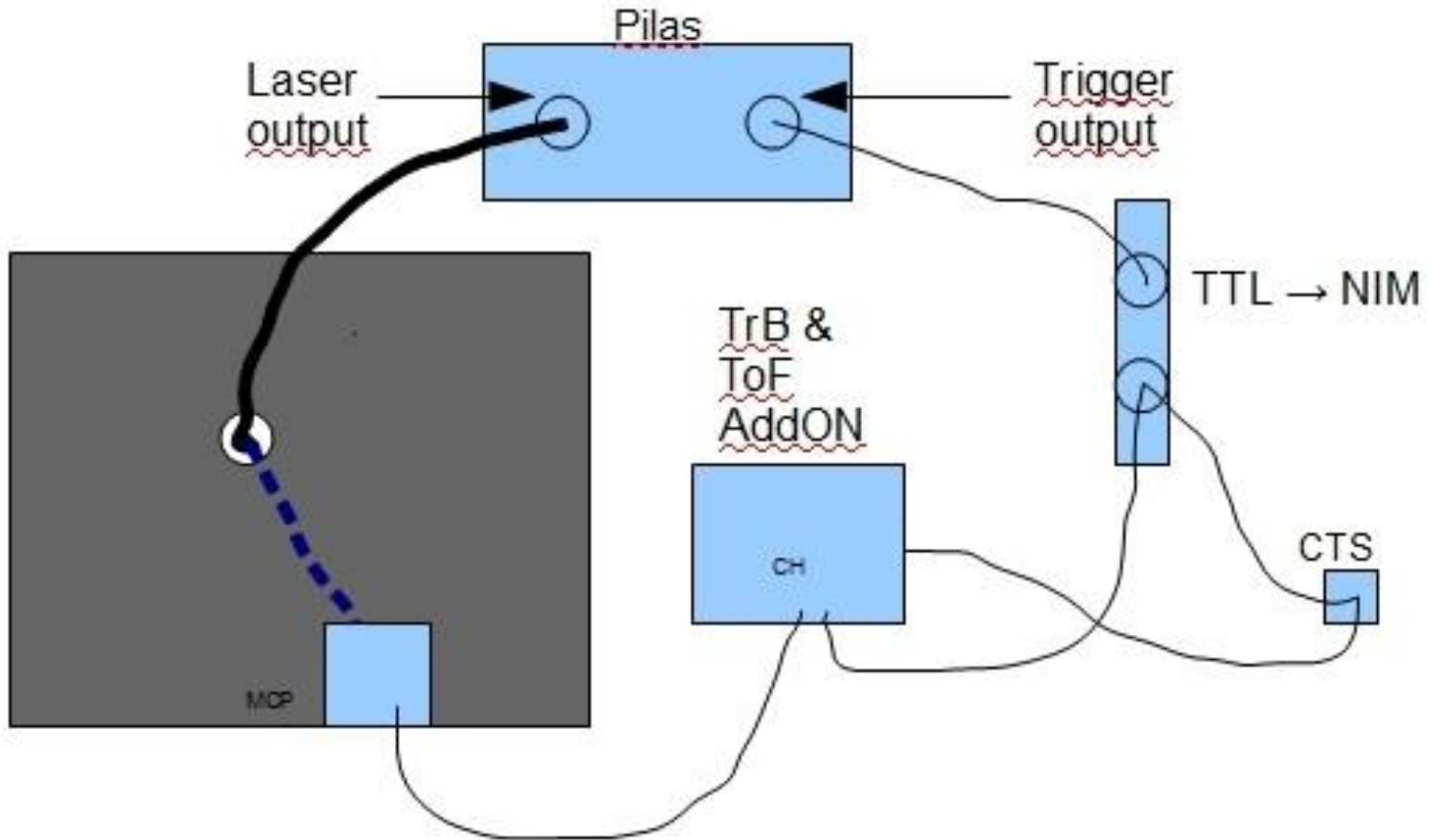
# MCP-PMT (schematic view)



# MCP-PMT backview

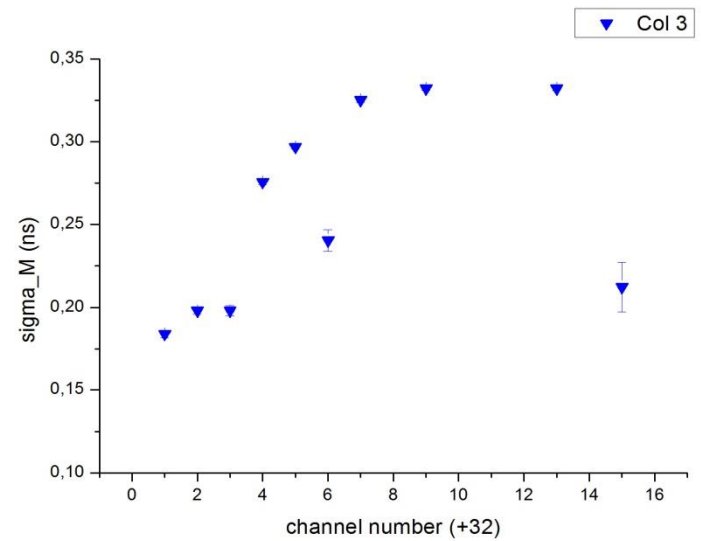
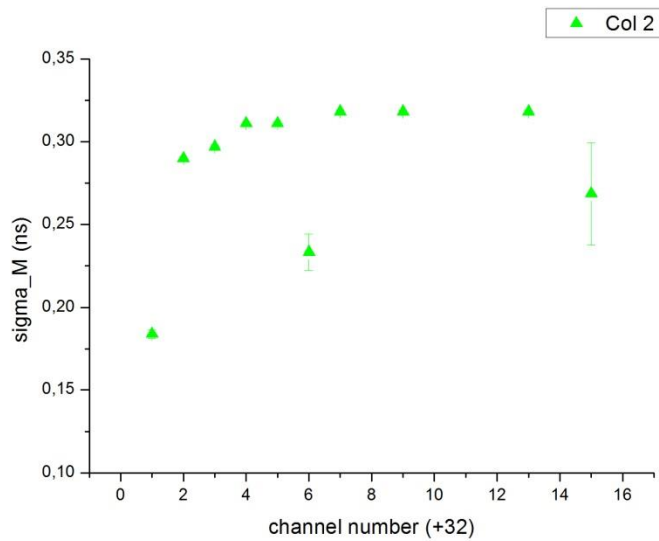
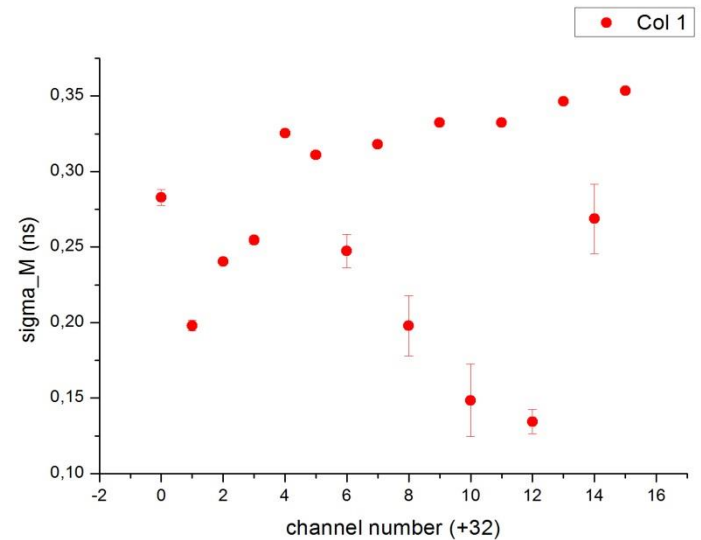
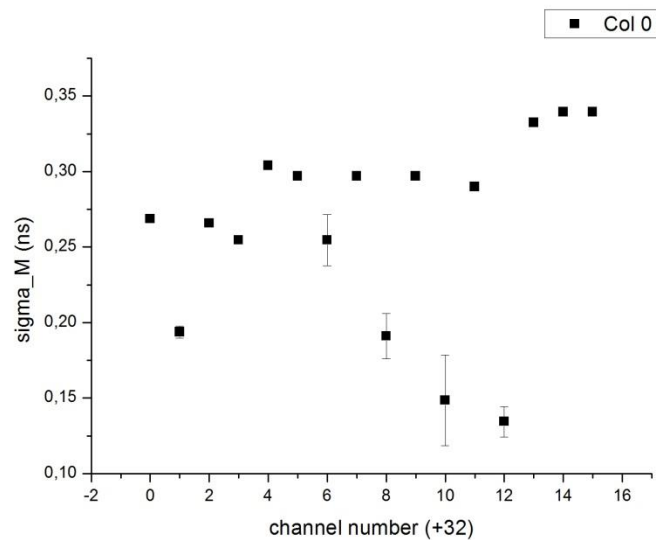


# Measurements with MCPs



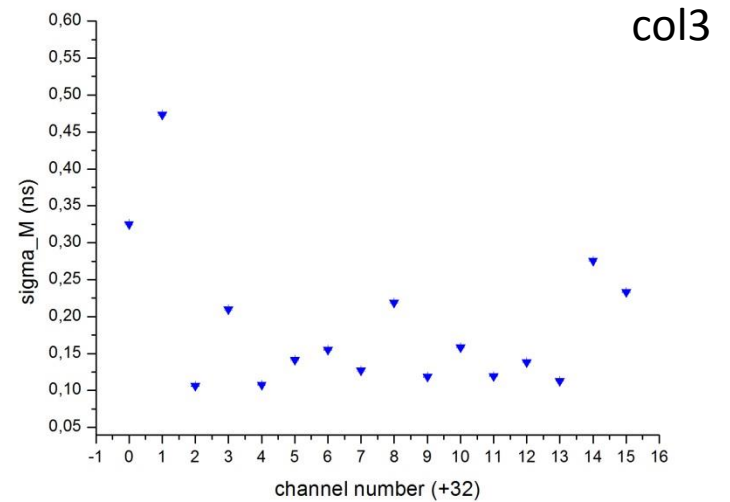
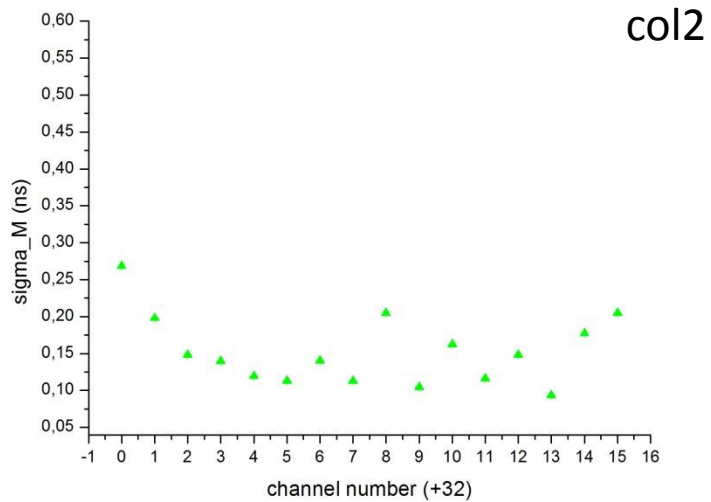
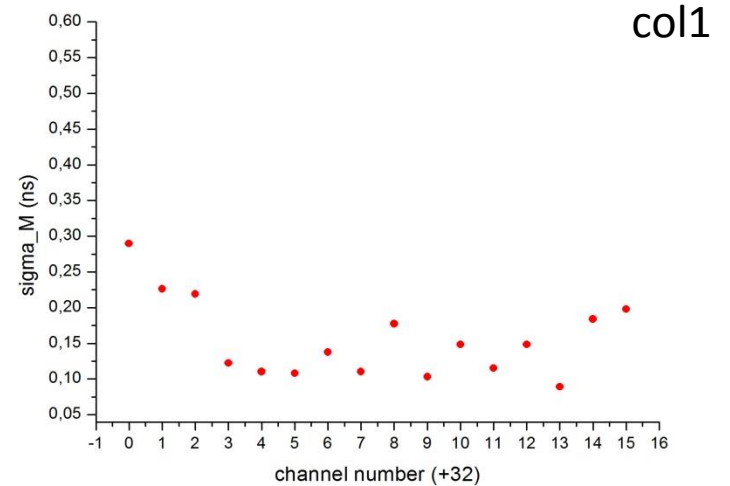
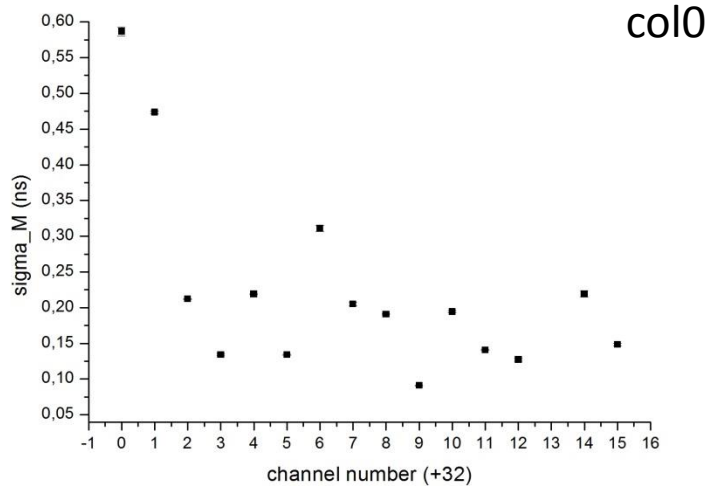
No diff

# Measurements with MCPs



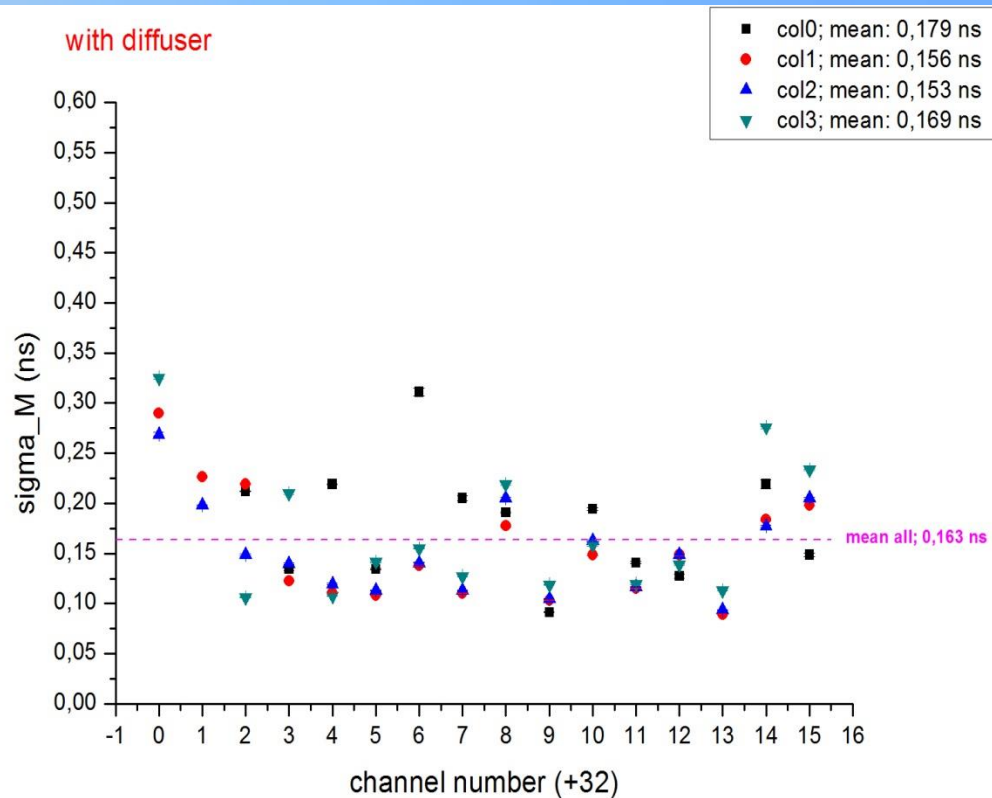
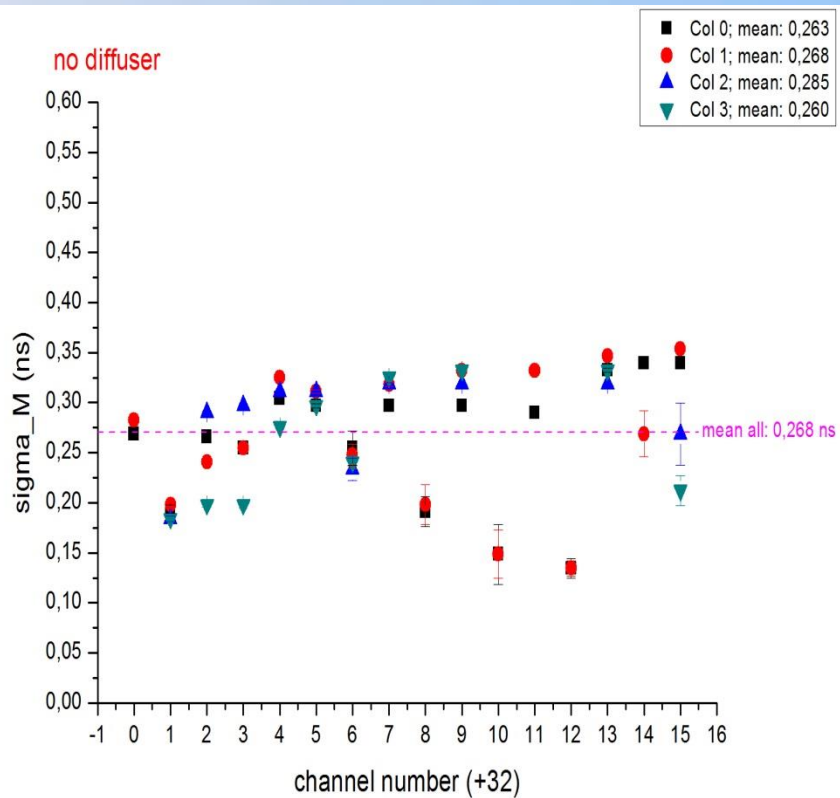
with diff

# Measurements with MCPs





# Measurements with MCPs



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## ***5. Summary and Outlook***

# Summary and Outlook

- > Dispersion does not play any role in our case
- > Higher and steeper signals deliver better resolution (-> valid for 02/2011 and PAN2)
- > Pure electronics measurements gave time resolution of max. 50 ps (02/2011); 40 ps (PAN2)
- > MCP measurements (mean):  $150\text{ps} < t < 250\text{ps}$  (-> Best values around 90 ps)

## Outlook:

- > TrB version 3 boards are ready to be measured
- > Promise a improvement in time resolution (approx. 15 ps for pulser signals)
- > Resolution with MCPs should be  $< 100$  ps
- > Further studies and analysis of the test beam data CERN 2012 are ongoing



**Thanks for your attention!**

# Backup slides

Sqrt 2 correction:

Measuring  $(t_1-t_2)$ , both contain errors, assumption: both errors are equally large  
 $dt_1=dt_2$

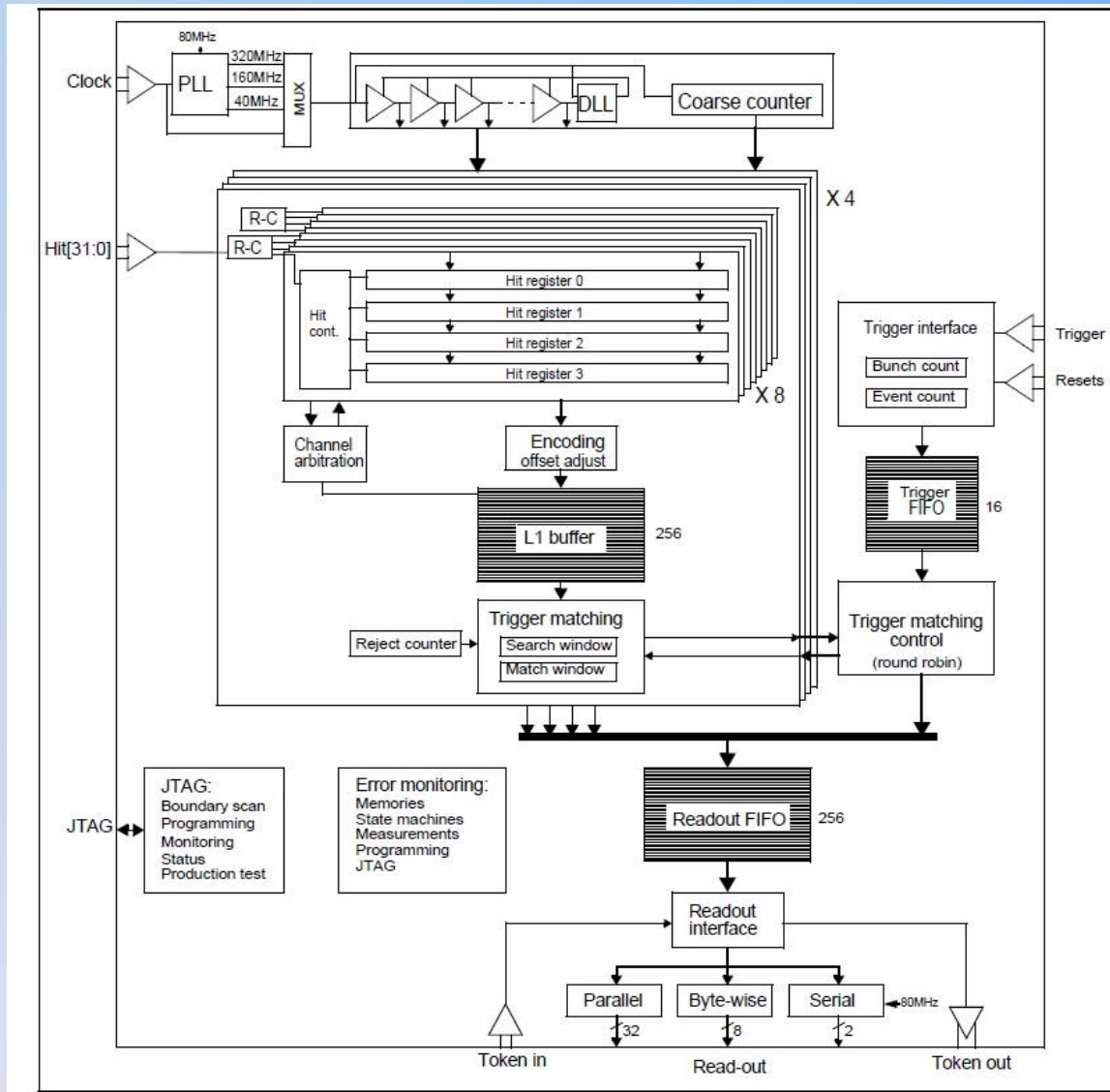
Error propagation: calculation of the complete error

$$d(t_1-t_2)^2 = 2*(dt_1^2+dt_2^2)=2*(dt_1^2)$$

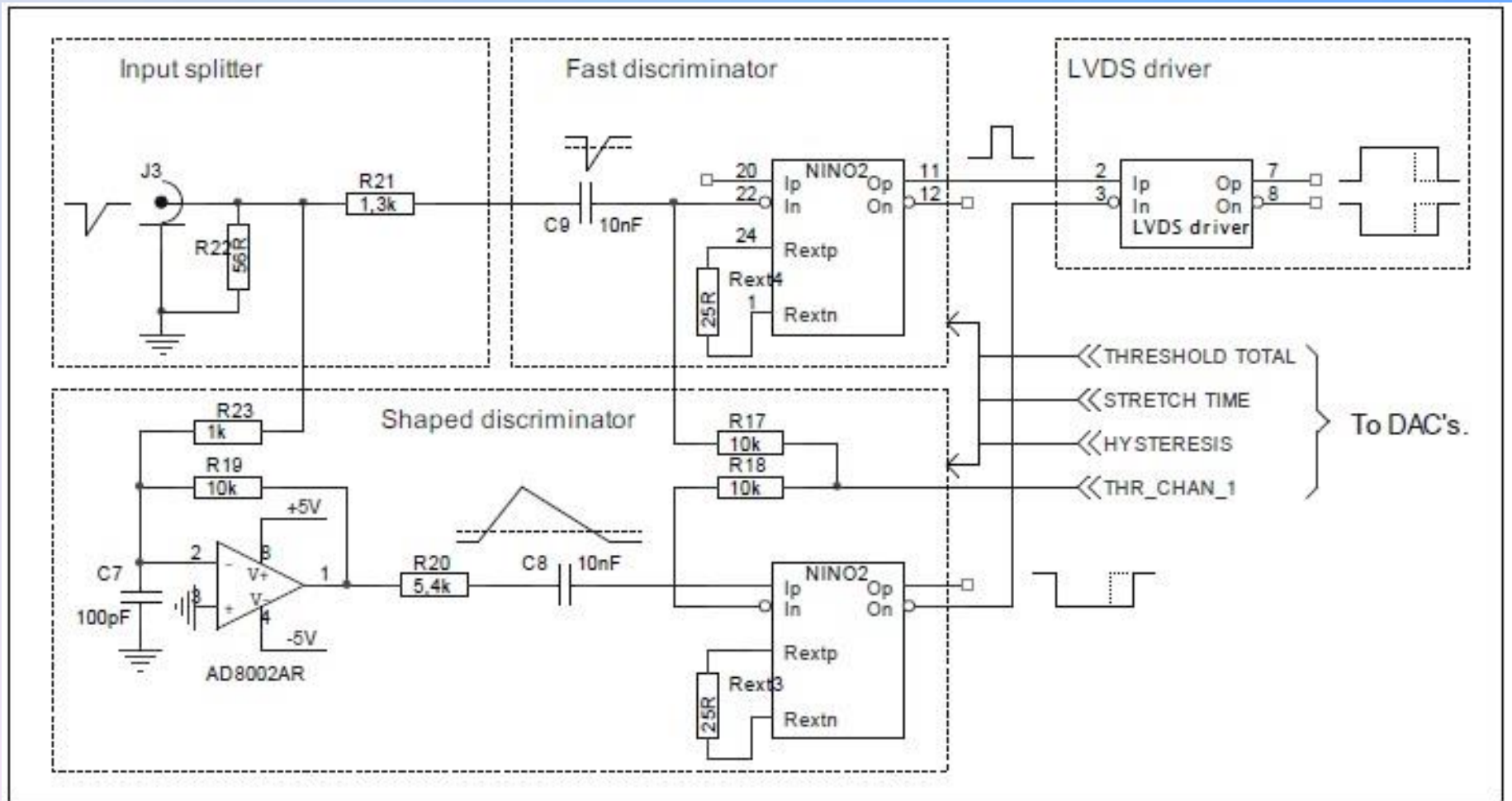
$$d(t_1-t_2)=\sqrt{2}*(dt_1)$$

$$d(t_1-t_2)/\sqrt{2}=dt_1$$

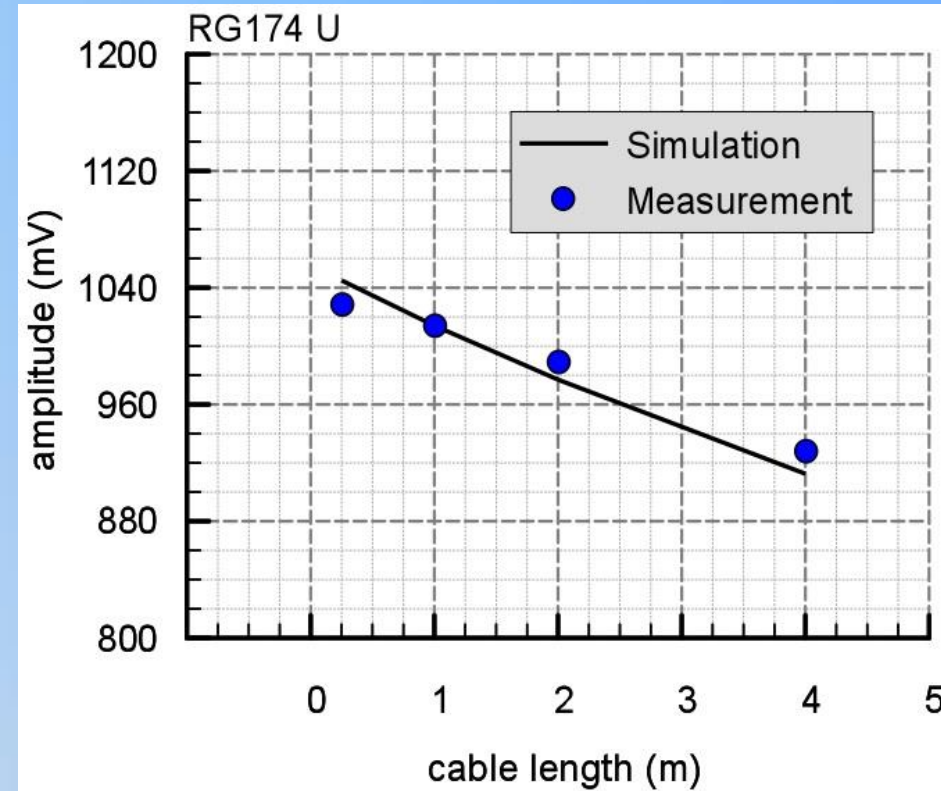
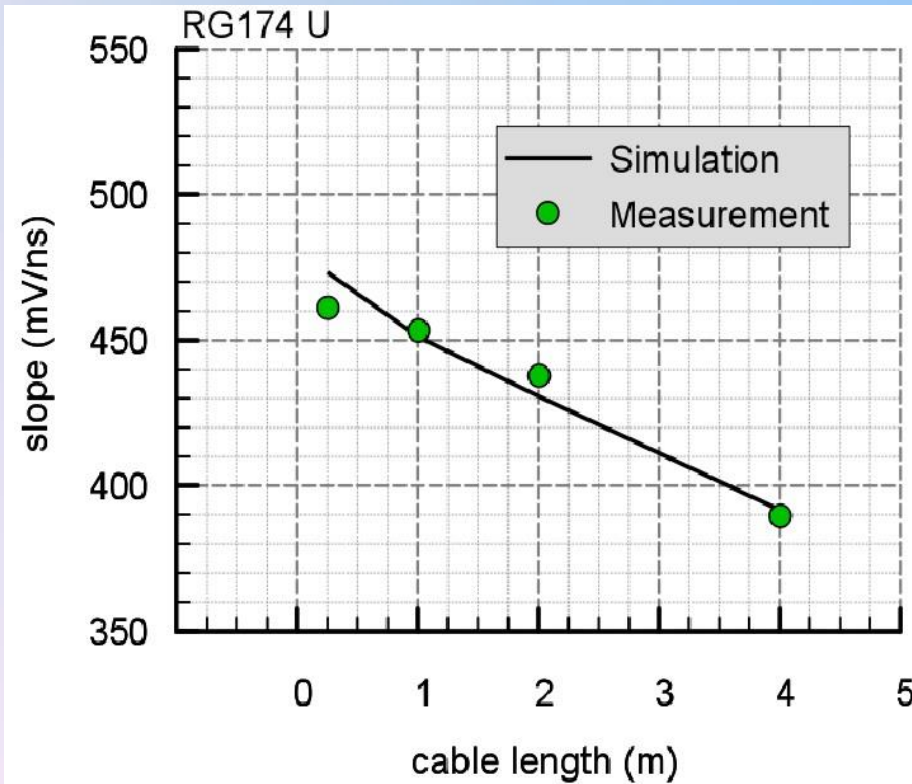
# HPTDC scheme



# Amplifier discriminator



# Changes in the amplitude of a fixed output signal by varying the cable length





## TrB v2 Scheme

