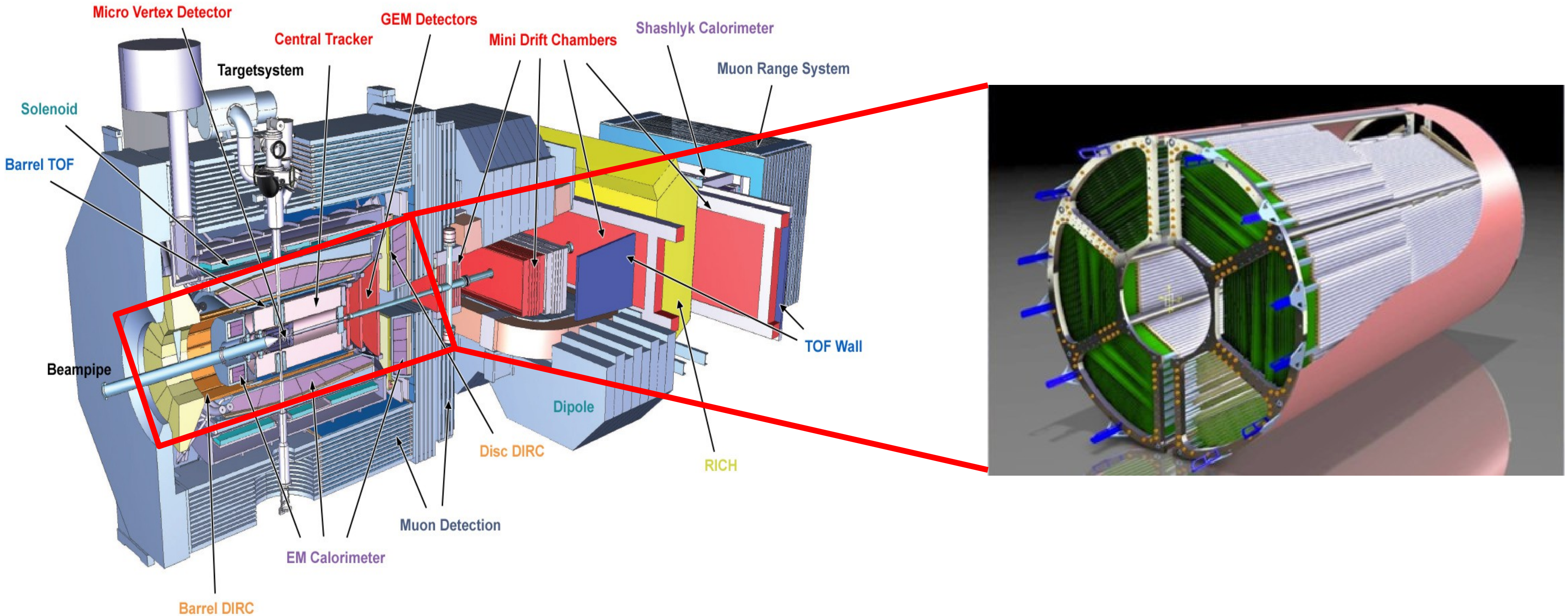
# P̄ANDA Collaboration Meeting

## Experimental Determination of the Time Resolution of a Flash-ADC System for the P̄ANDA STT

12. März 2013 | Timm Preuhs

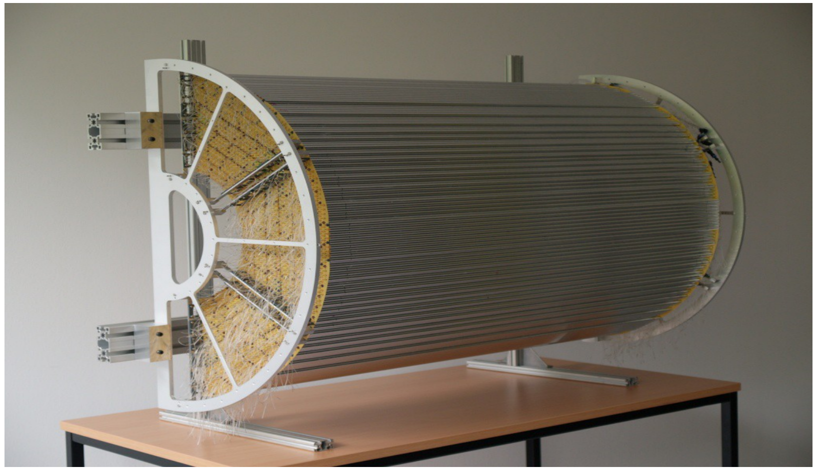
# $\overline{\text{P}}$ANDA Detector

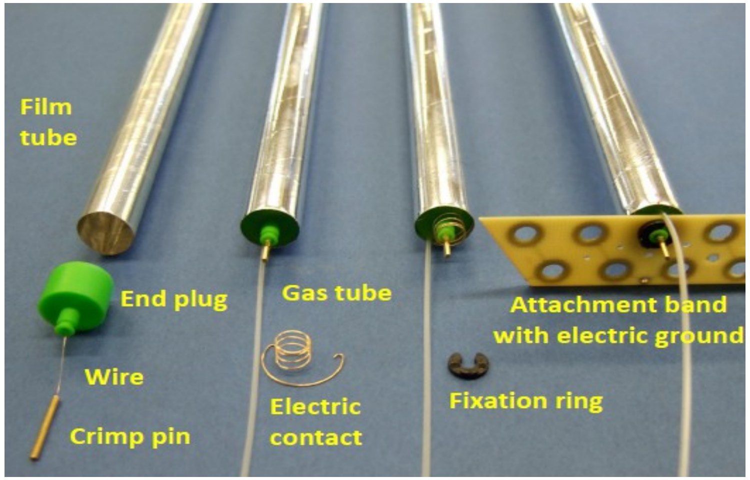



**Straw Tube Tracker:**

- 4096 straws
- Self-supporting, gas filled, over-pressure 1 bar
- Length of 1.5 m
- Surrounding the Micro Vertex Detector

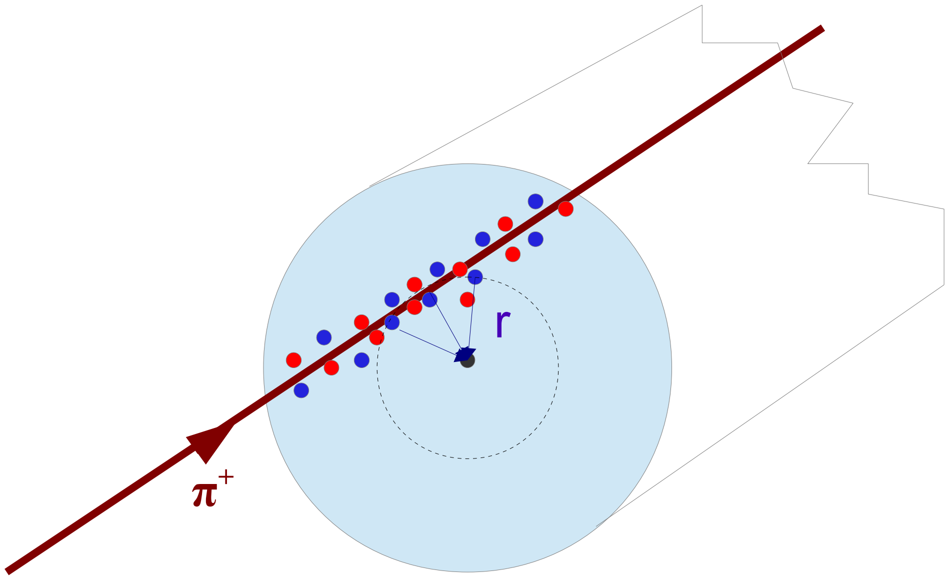
# $\overline{\text{P}}$ANDA Detector






**Straw Tube Tracker:**

- Conductive inner layer: cathode
- Wire: anode
- Measured drift time gives spatial position (isochrone)
- Required time resolution < 1 ns
- => Requirements on the Fast Charge to Digital Converter



# Properties of the FQDC

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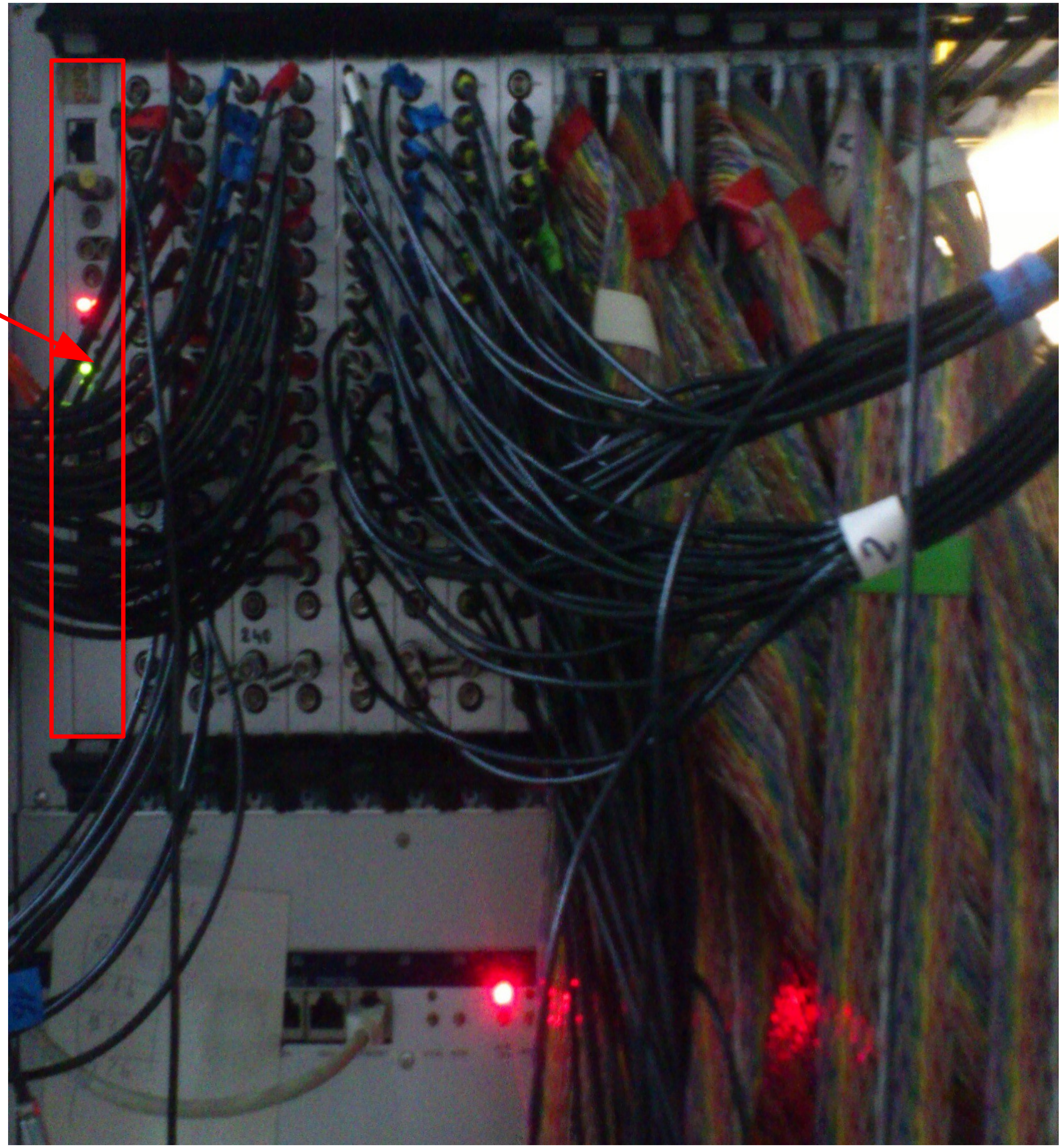
- High sample rate of 240 MHz
- Simultaneousely measure-ment of charge and time
- 12 bit resolution (ADC: LTC2242)

System Controller

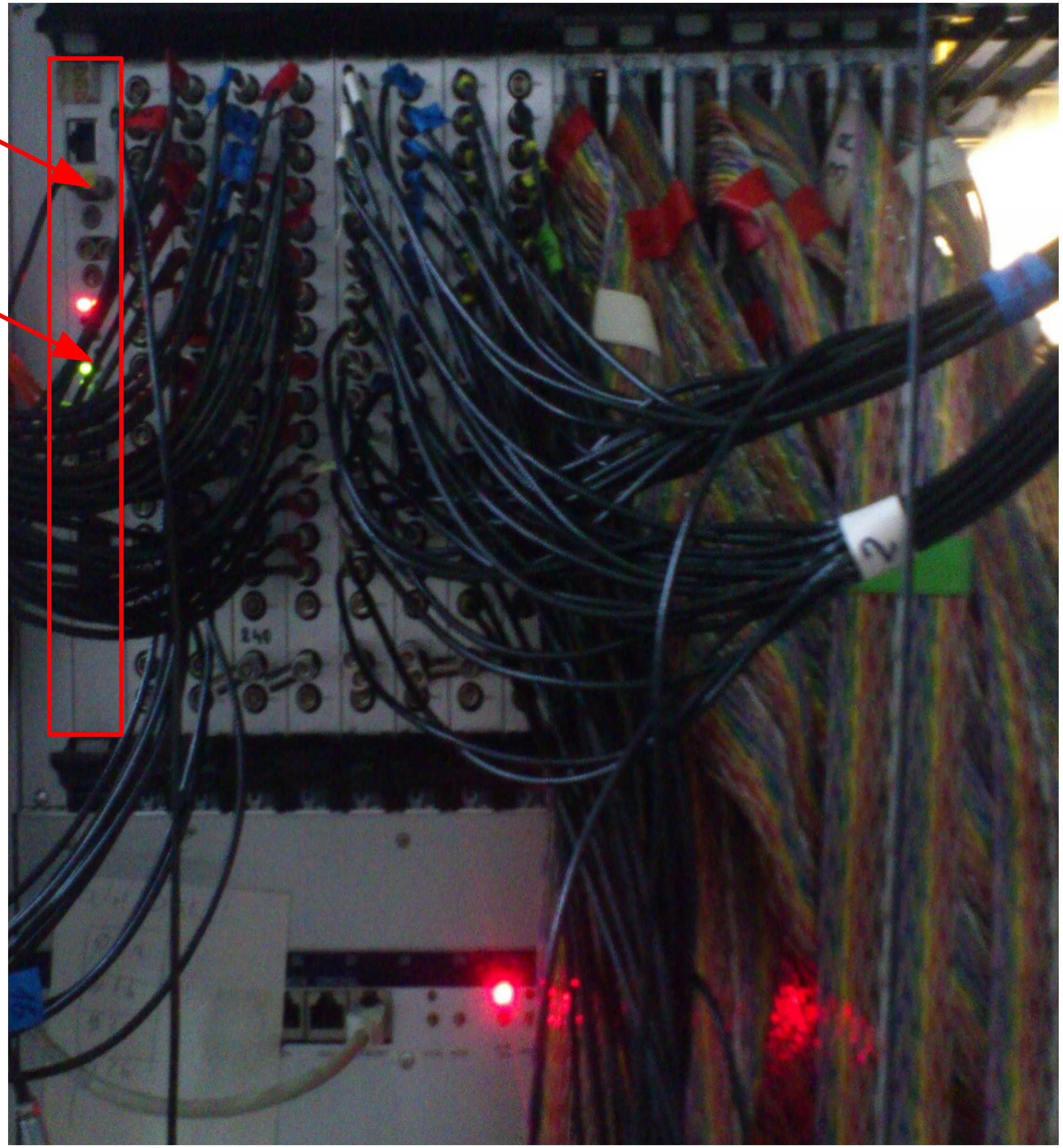


# Properties of the FQDC



Trigger input

System Controller



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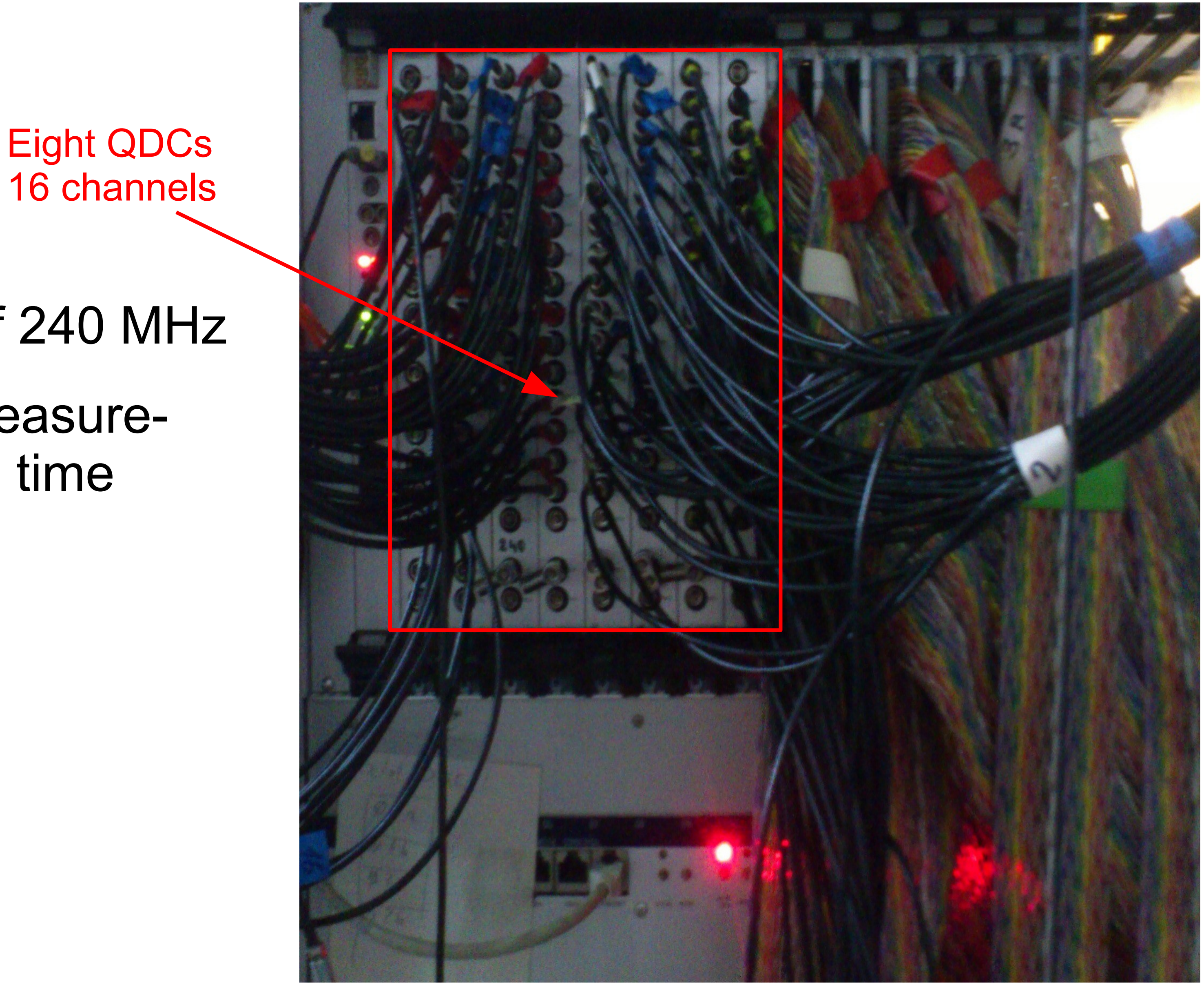

# Timing Methods

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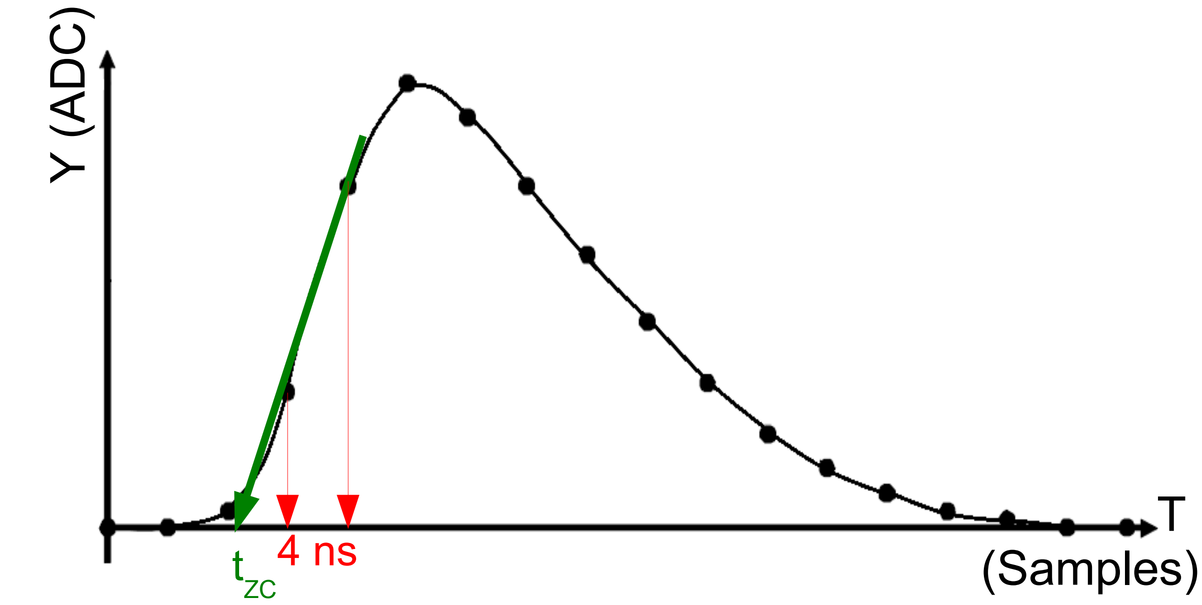
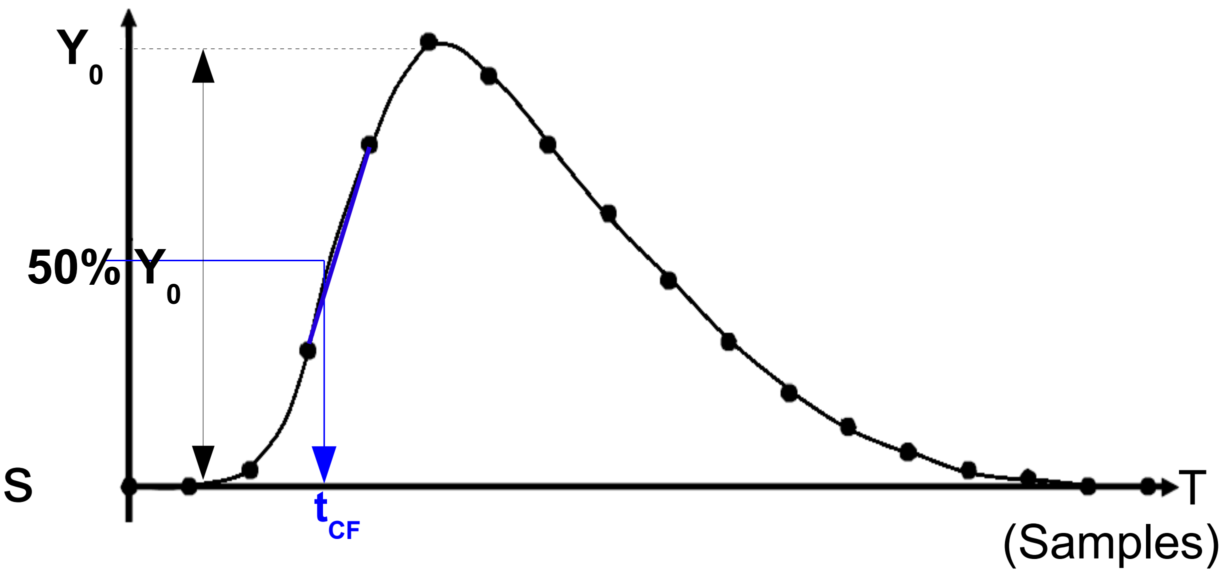
### Zero Crossing:

- Projection of the highest slope on the time axis




### Constant Fraction:

- Half of maximum amplitude
- Find two nearest samples
- Interpolate between them
- Take time value that belongs to 50% of $Y_0$



# Experimental Setup

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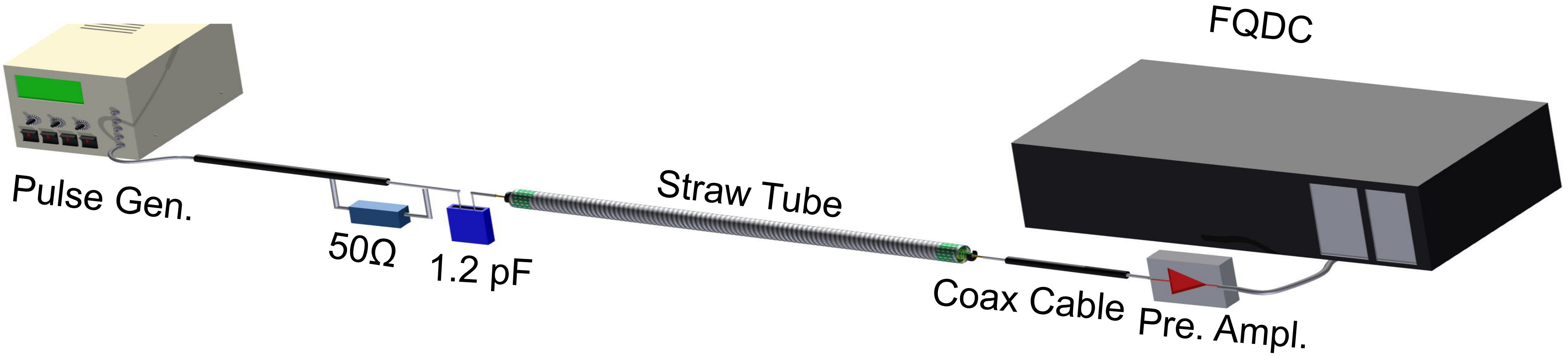


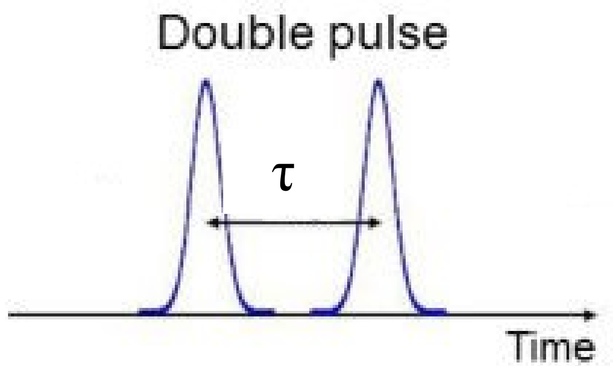


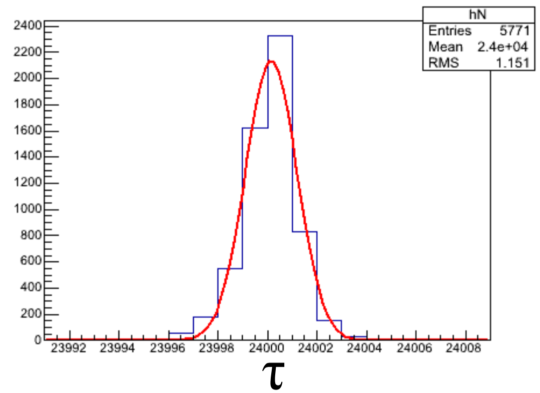

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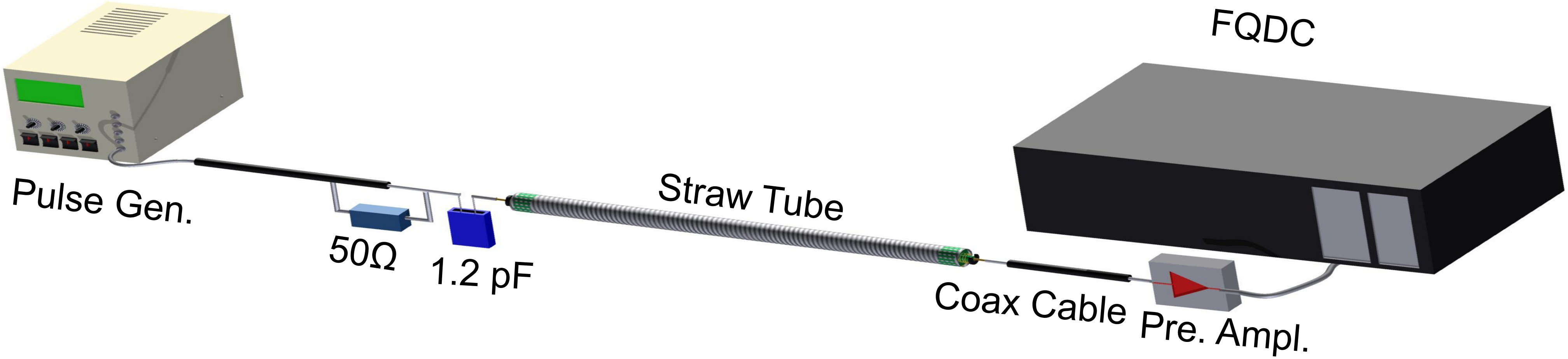


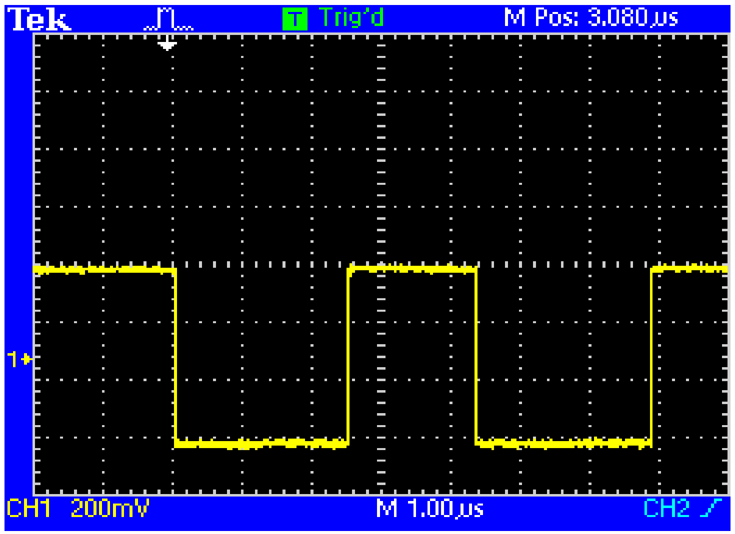

# Time Resolution

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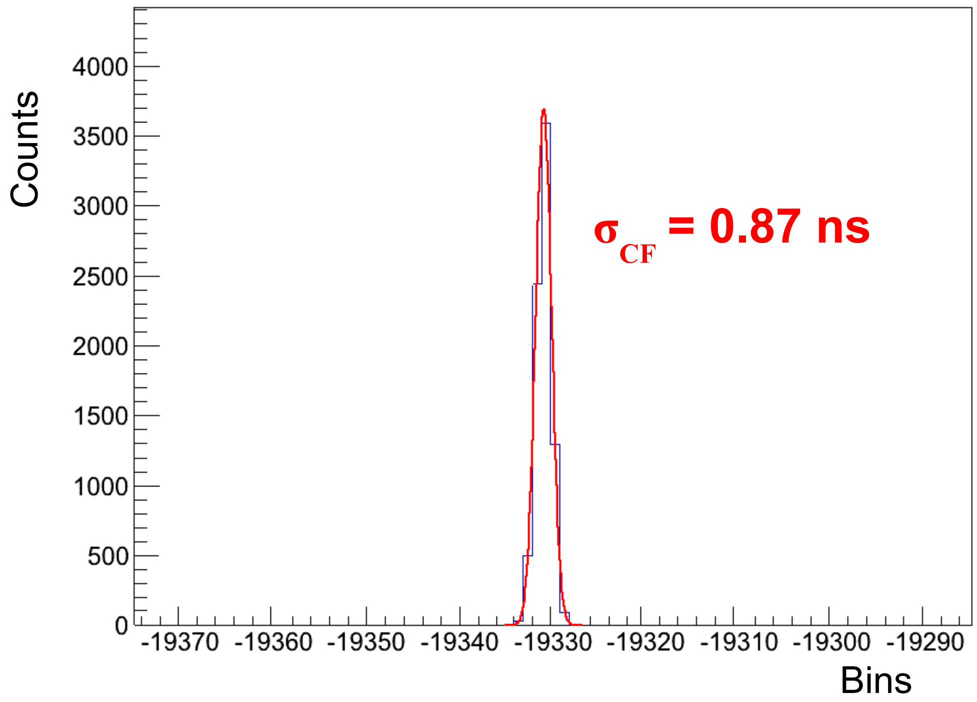
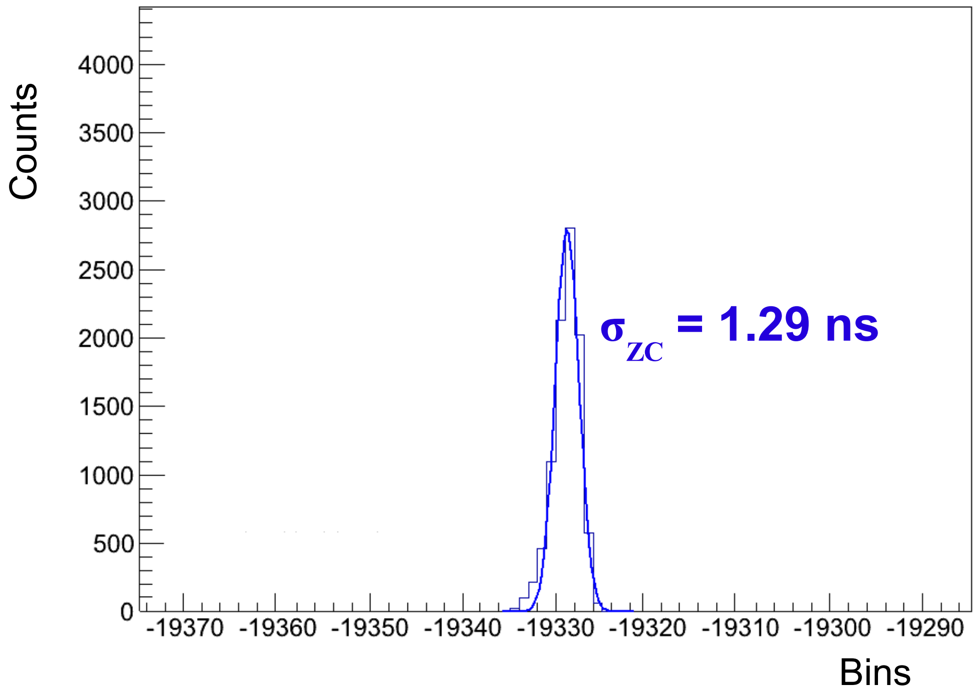
- Comparison of the two different timing methods:



# Time Resolution

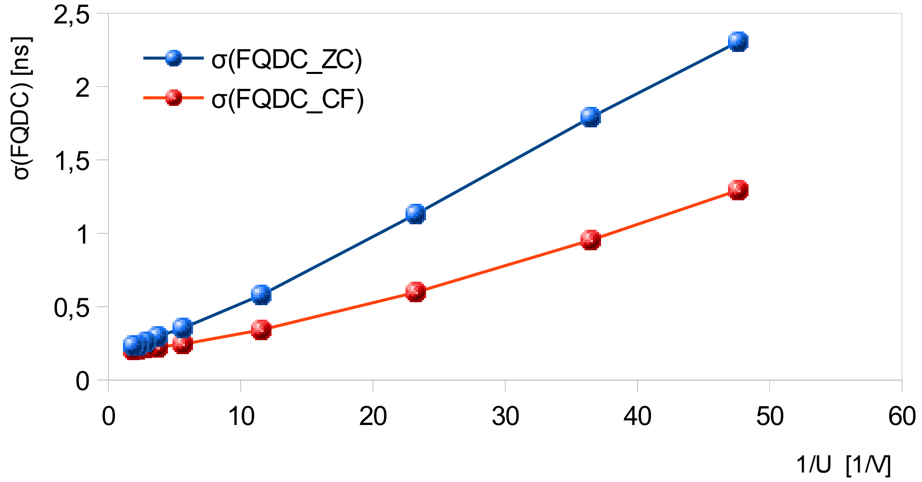
- The measured time resolution $\sigma_t$ consists of two independent contributions:
  - $\sigma_0$ noise of the setup excluding the FQDC
  - $\sigma_{FQDC}$ noise of the FQDC
- $\sigma_0$ is given as $\sigma_0 = \frac{\sigma_R}{(\Delta U / \Delta t)}$
- $\sigma_R$ is measured noise of the system without FQDC, with an oscilloscope
- They are connected by the gaussian error propagation law:

$$\sigma_t = \sqrt{2\sigma_0^2 + \sigma_{FQDC}^2}$$

# Time Resolution

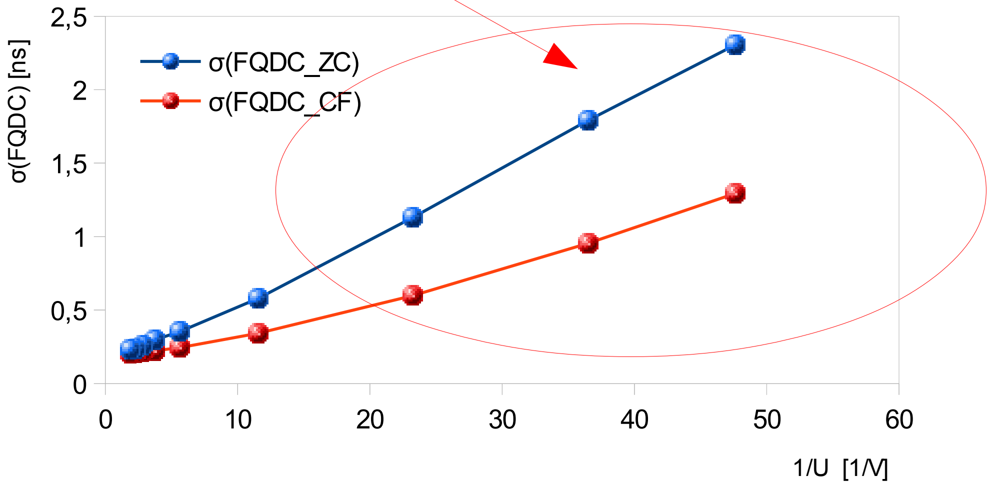
$$\sigma_{FQDC} = \sqrt{\sigma_t^2 - 2 \cdot \left( \frac{\sigma_R \cdot \Delta t}{\Delta U} \right)^2}$$

- Plot $\sigma_{FQDC}( 1/\Delta U)$



# Time Resolution

- $\sigma_{FQDC}$ is proportional to 1/U
- $\sigma_{FQDC}$ has a constant component of about 0.2 ns



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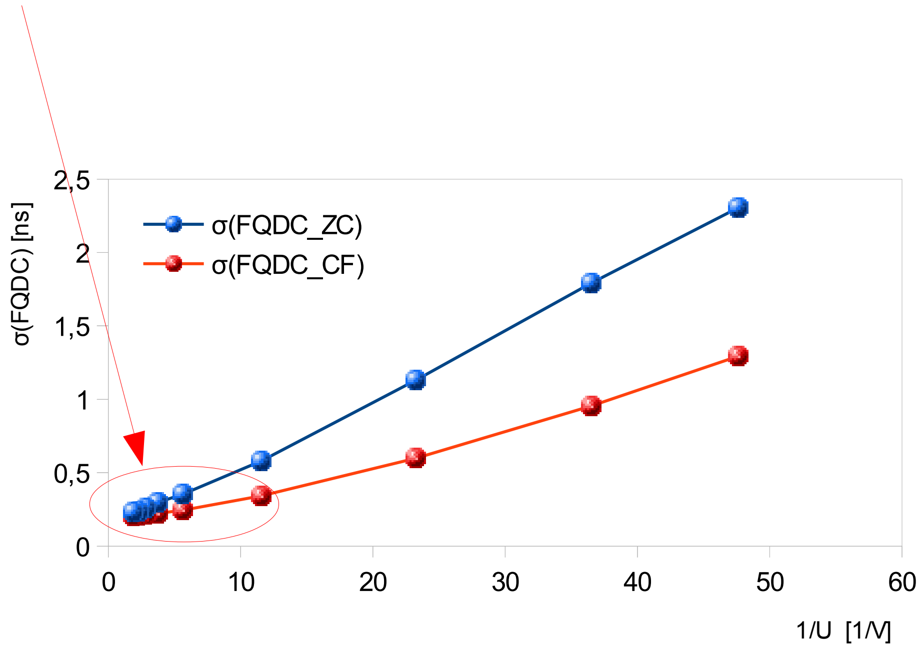
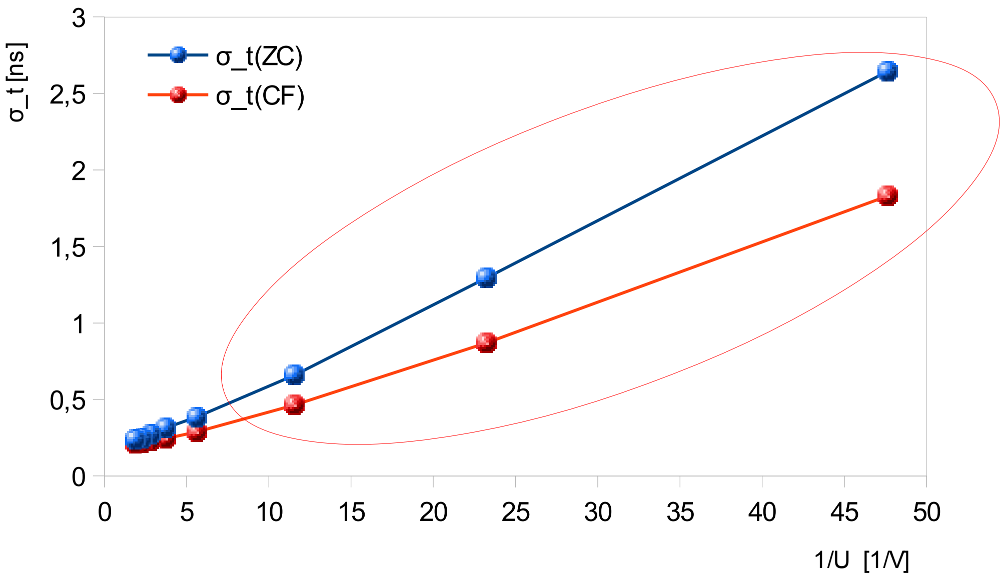


# Time Resolution

- Therefore the measured time resolution in the linear region can be discribed by the formular

$$\sigma_t = \sqrt{2 \cdot \left( \frac{\sigma_R \cdot \Delta t}{\Delta U} \right)^2 + \left( \frac{\alpha}{\Delta U} \right)^2}$$



# Summary

- Check the time performance of the electronic, coax cable
- A time resolution below 1 ns is achievable
- Constant fraction is more precise than zero crossing
- $\sigma_{FQDC}$ is proportional to 1/U

# Thank you!!!

„All succumb to the physical fascination"