MEASUREMENT OF PULSE SHAPE IN SCT MODULES USING A LASER SETUP

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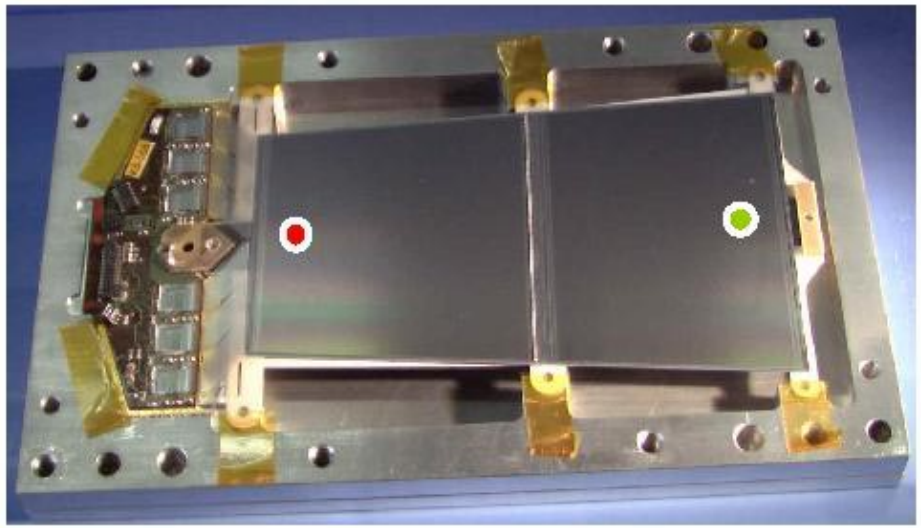
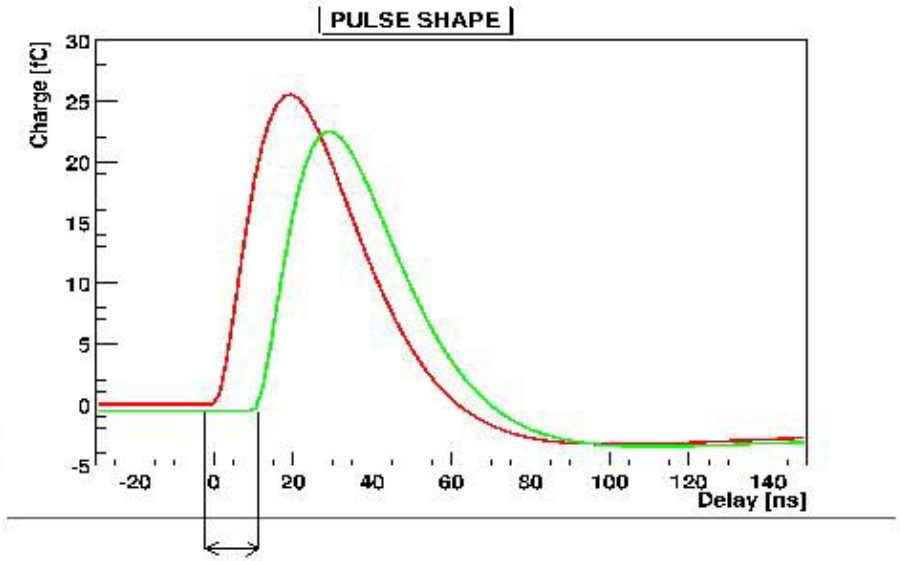
- the measurement setup
- fit of pulses, results
- conclusions

MOTIVATION

- measurement of pulse shapes at an output of amplifiers inside FE electronics
- comparison of measured pulses to theoretical shapes
- measurement of delay caused by signal propagation along the strips





DELAY

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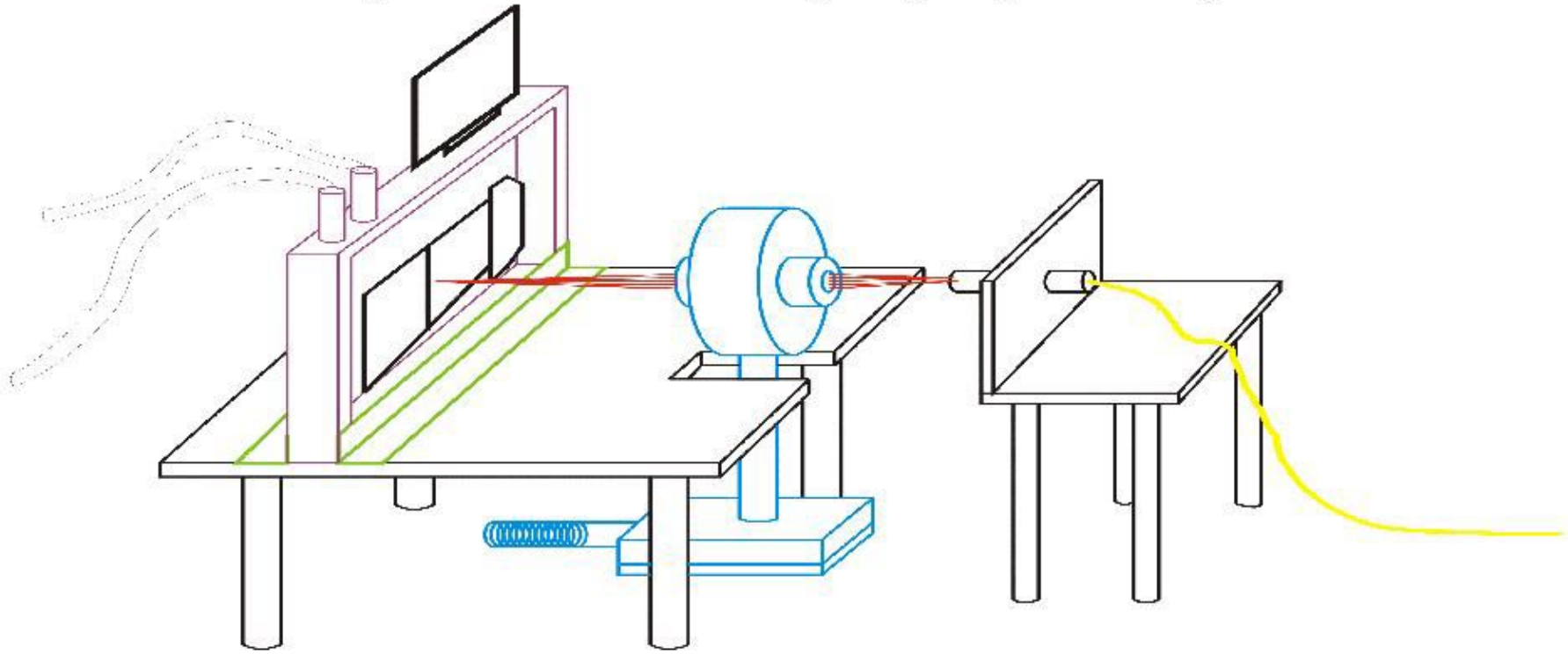
MEASUREMENT SETUP

- similar to the setup in Melbourne
- based on standard SCT readout setup
- synchronisation of the laser pulse with level 1 trigger:
  - busy signal from CLOAC card
    - used for triggering the laser
    - generated 75ns long pulse when receiving command L1A
    - L1A generated after certain number of clock cycles
  - phase of the laser pulse with respect to the clock of electronics
    - changed by hardware delay unit
- frequency of L1A during burst slowed down to 500Hz because of laser diode:
  - VCSEL 850nm - used for getting up system operational, amount of light reduced by mechanical attenuator, unstable
  - 1060nm - used for measurements - better stability, penetrates deep into the silicon detector

MECHANICAL SETUP

- module box inside light tight box
- light from optical cable focused on the detector plane
- distance between the lens and the detector changeable by micrometric screw
- in all directions along the detector surface only rough regulation of position



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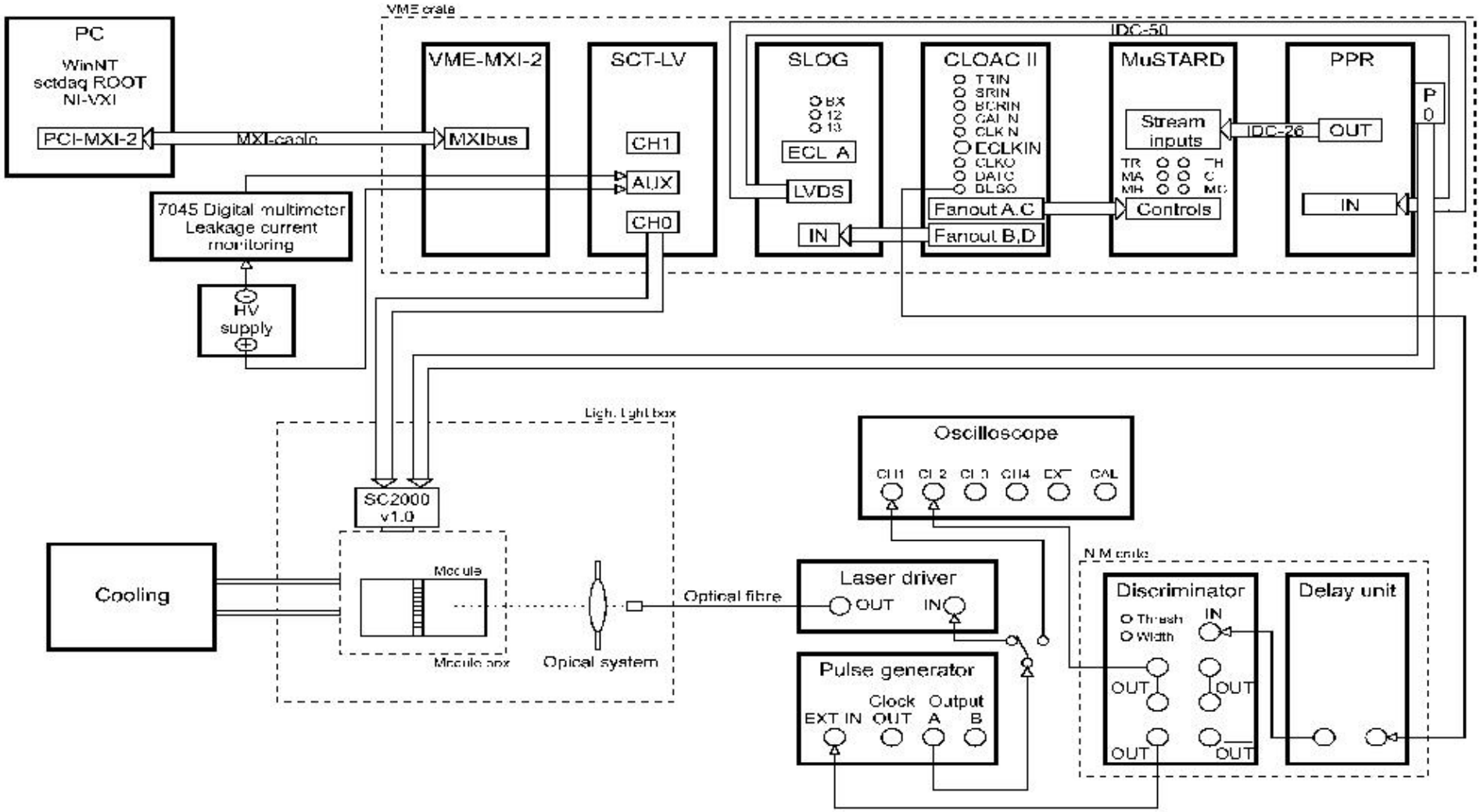
SCHEMATIC DIAGRAM



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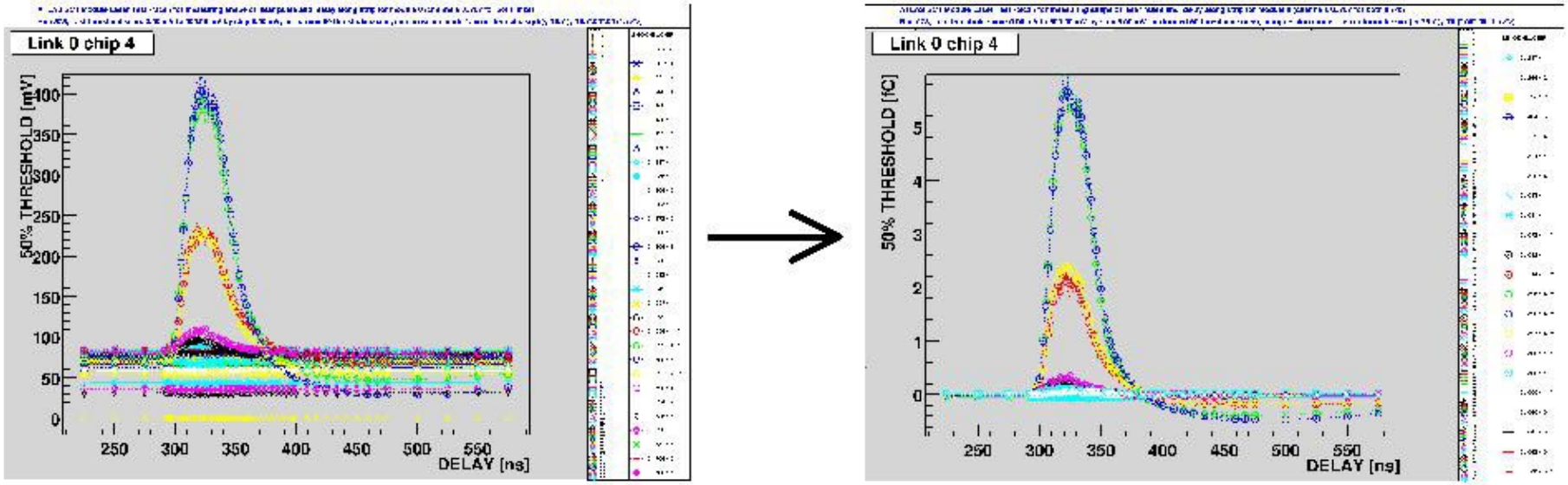
METHOD OF MEASUREMENT OF PULSE SHAPES

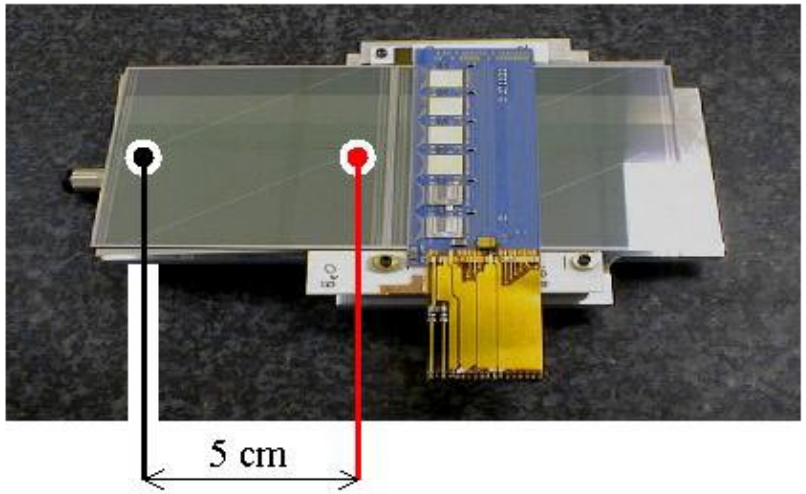
- scanning two delays: L1A in software (25 ns step) and hardware delay (smaller step)
- for every such delay threshold scan was done
- fitting of measured s-curves => threshold of 50% efficiency (vt50 points) were calculated
- these vt50 points were converted to appropriate charge using response curves

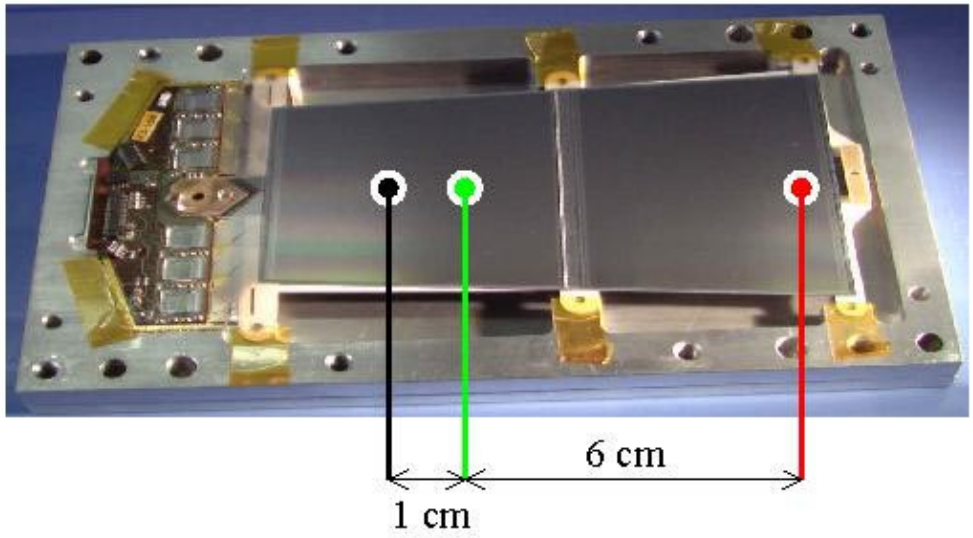


- charges for all channels (strips) hit by laser were summed => total generated charge in detector was gained
- curves of dependence of this total charge vs. delay were fitted

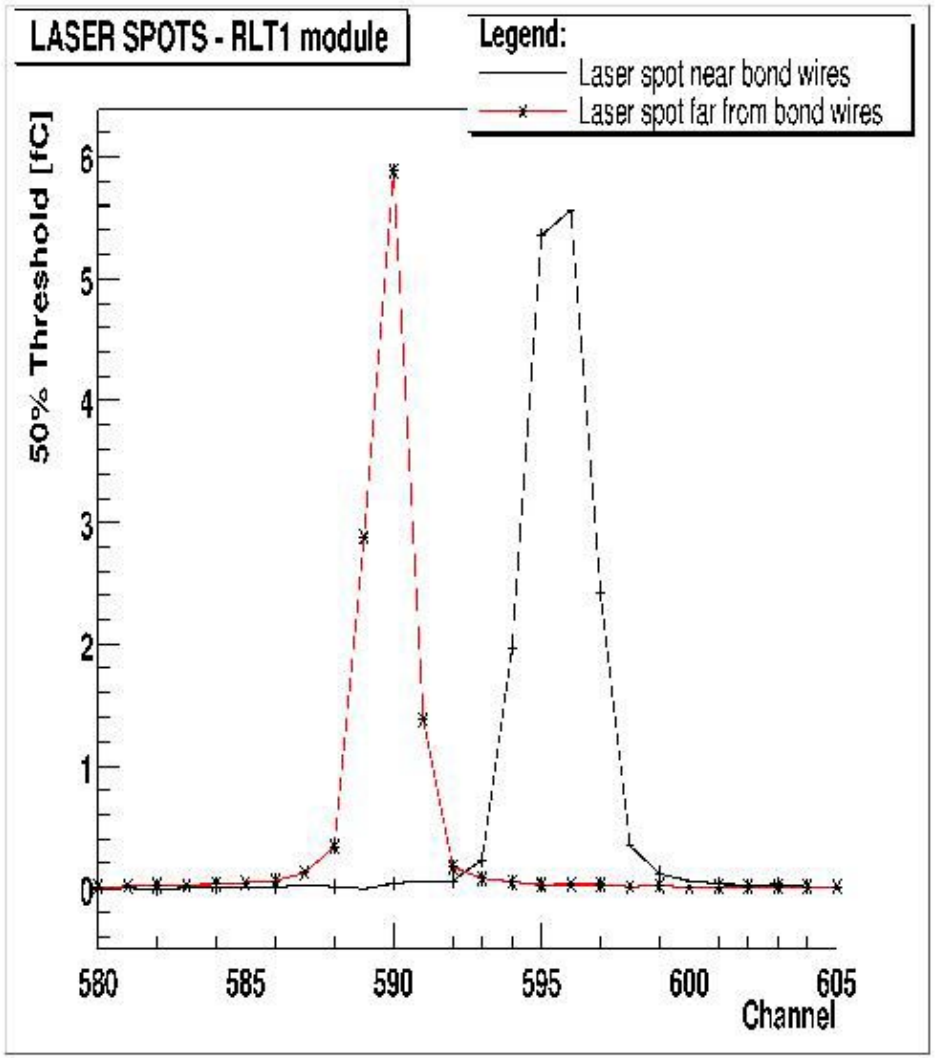
MEASUREMENT

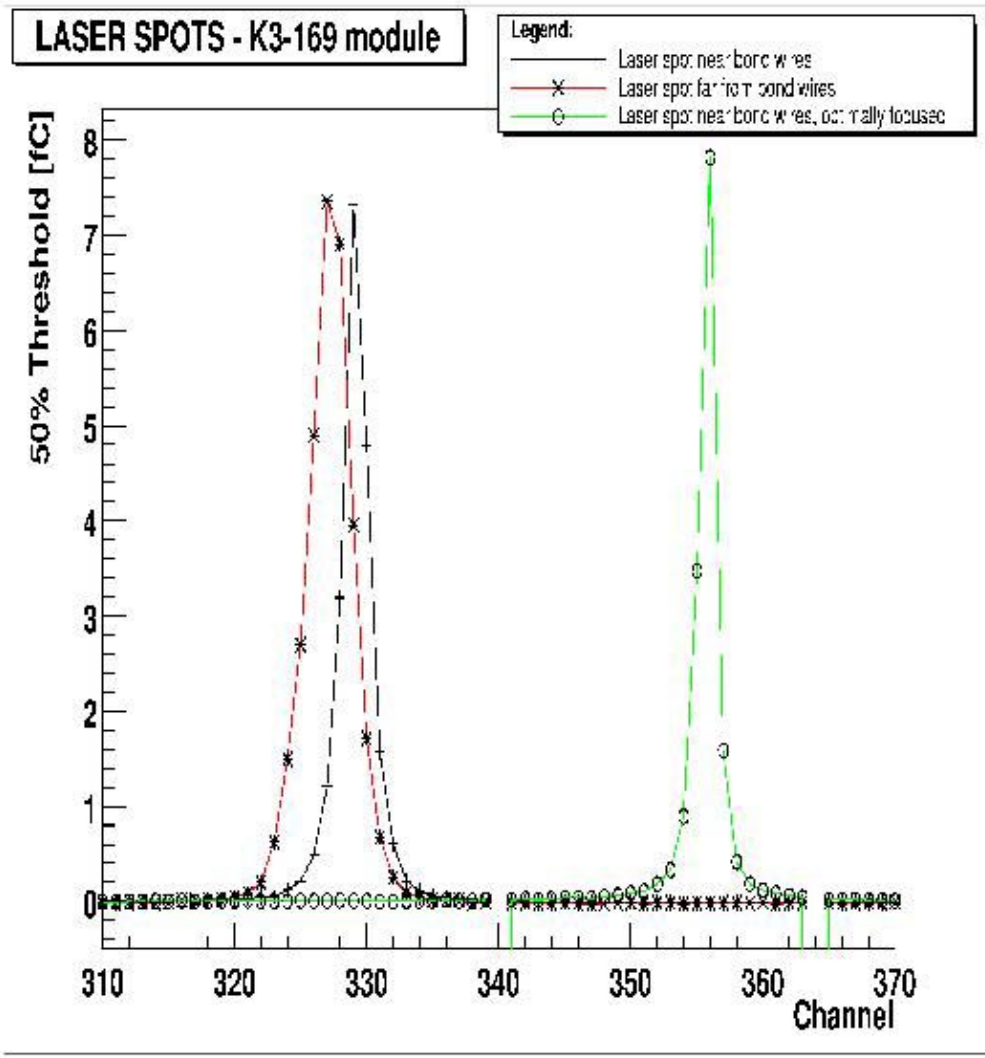
- modules: RLT1 - barrel type module, ABCD2T chips, Rutheford Appleton laboratory 1999
  K3-169 - forward type module, ABCD3T chips, University of Liverpool 2001
- cooling temperature: 15°C
- bias voltage: 100V
- laser pulse: gauss shape, FWHM 4ns
- compression mode: level - X1X
- changes to temperature on hybrids during measurement less than 1°C
- points not measured in order of the time delay values - detection of possible amplitude variations





EXAMPLE OF LASER SPOTS





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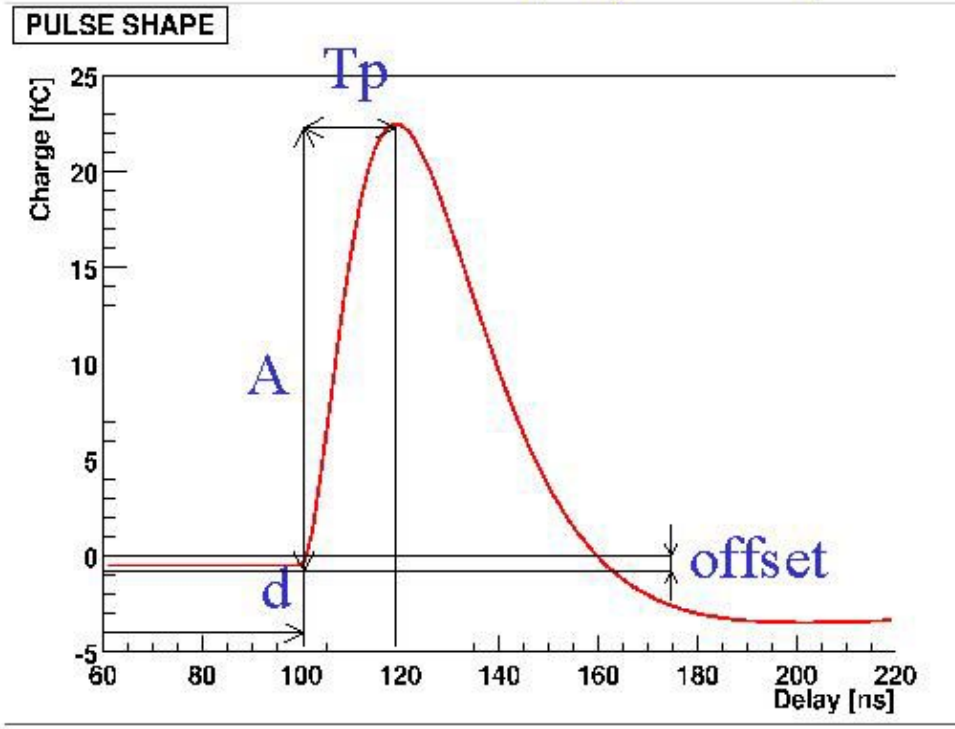
FITTING OF MEASURED PULSES

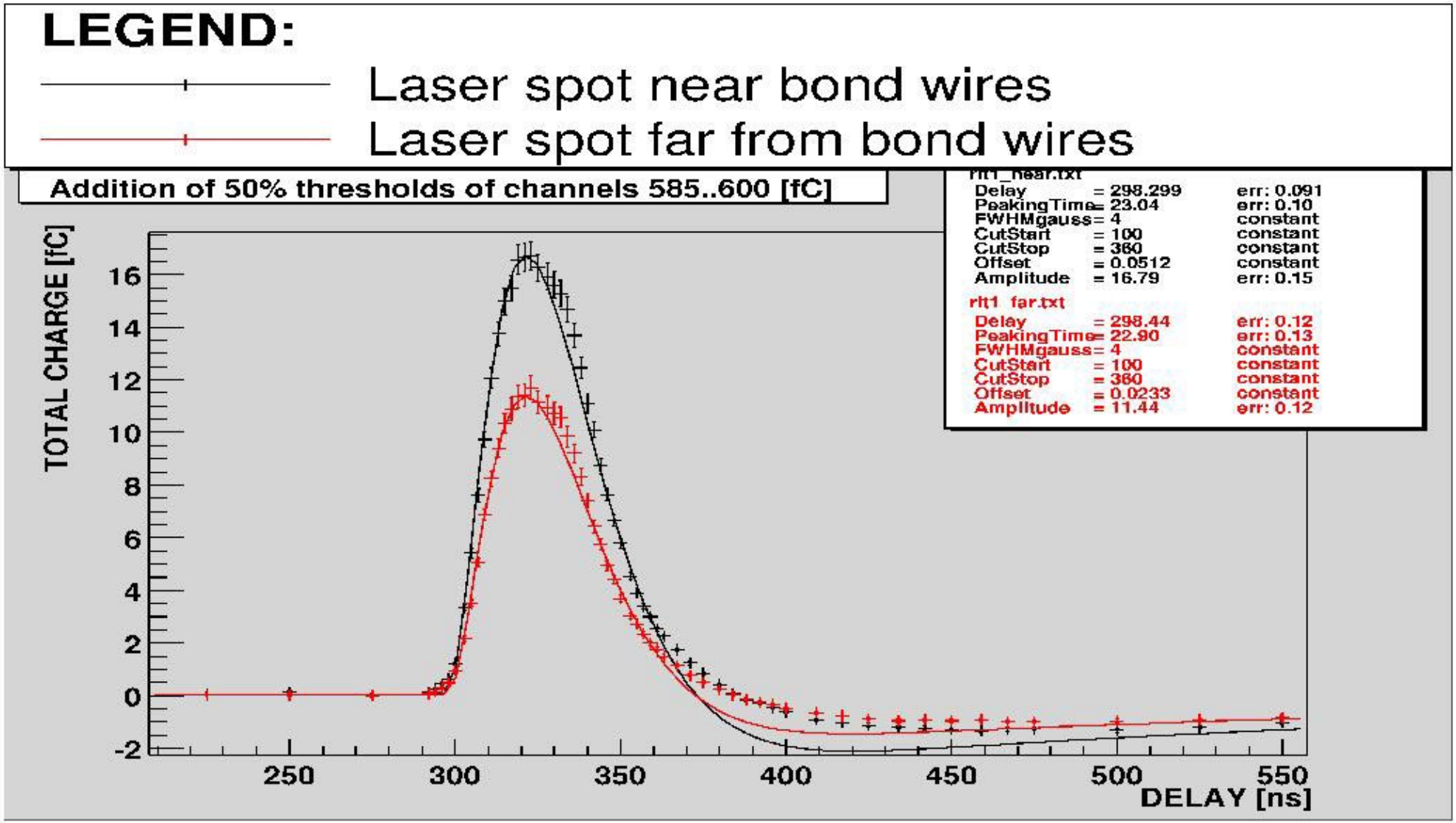
- pulses were fitted using function describing the response of amplifiers to a delta pulse:

$$a(t) = -5.83 \cdot 10^{-3} \cdot e^{-5 \cdot 10^{-3} \cdot t} + \left(5.26 \cdot 10^{-4} \cdot t^2 + 5.54 \cdot 10^{-4} \cdot t + 5.83 \cdot 10^{-3}\right) \cdot e^{-0.1 \cdot t}$$

- laser pulse = gauss pulse with about 4ns FWHM
- fit function = convolution of the gauss shape and function: $b(t) = A \cdot a\left(\frac{19.1}{Tp} \cdot (t - d)\right)$
- fitted parameters were amplitude of the pulse **A**, peaking time **Tp** and the start time of the pulse **d**:
- errors of fitted data were estimated from
- variations of measured vt50 values:
  - 5% of the measured signal
  - amplitude-independent error 1mV
- not fitted parameters:
  - OFFSET of the curve
  - FWHM of the laser pulse



Results on RLT1 module



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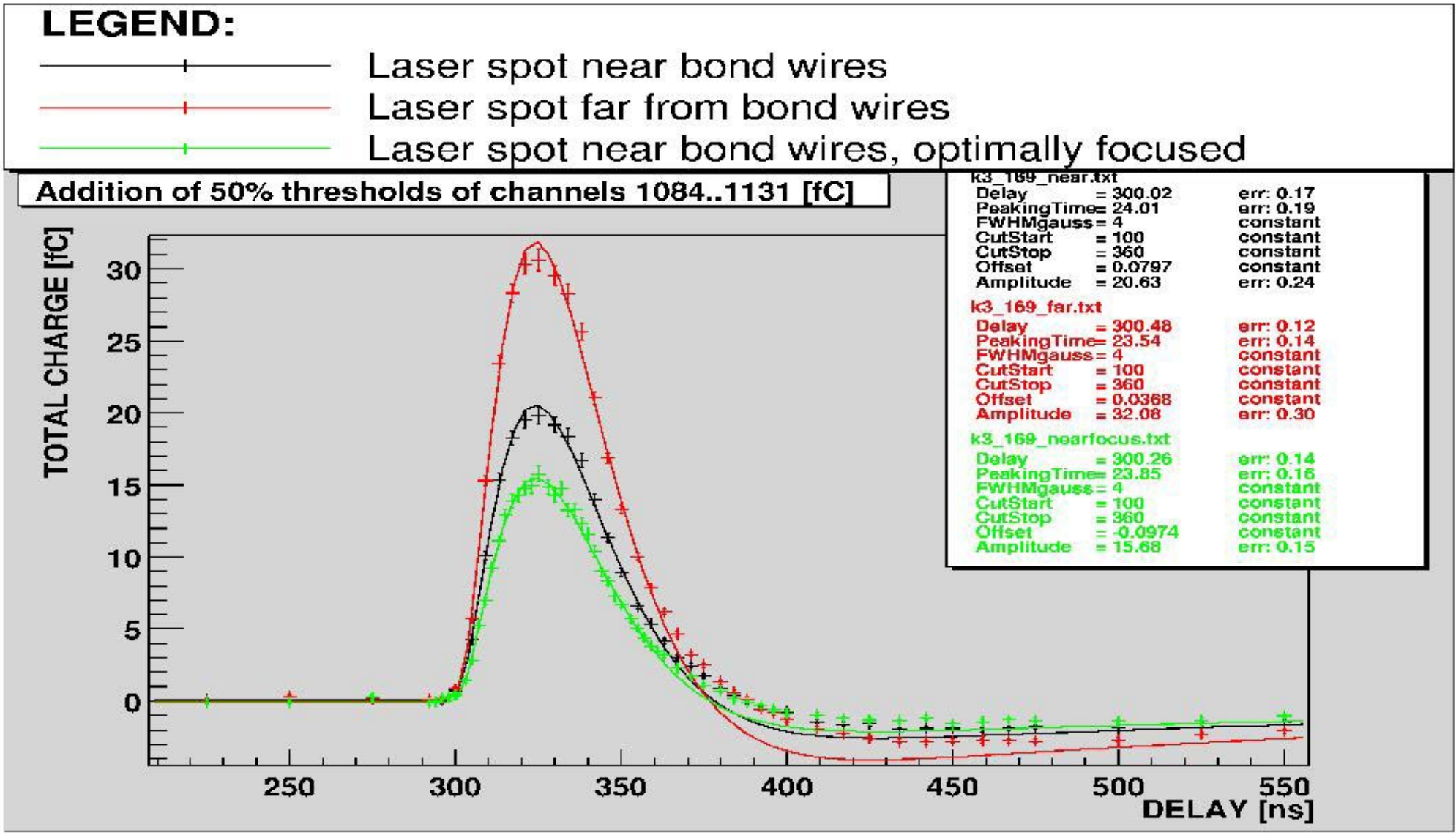
Results on K3-169 module



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RESULTS AND CONCLUSION

Module	Distance from laser spot to bond wires [cm]	Delay [ns]	Error on delay [ns]	Peaking time [ns]	Error on peaking time [ns]
RLT1	0.5	298.30	0.09	23.04	0.10
RLT1	5.5	298.44	0.12	22.90	0.13
K3-169	4.5	300.02	0.17	24.01	0.19
K3-169	11.5	300.48	0.12	23.54	0.14
K3-169	5.5	300.26	0.14	23.85	0.16

- a laser testing system based on standard SCTDAQ system was set up and tested
- the measured peaking time coming from fit is greater than theoretical 19.1 ns, but is the same (within the accuracy of measurement): for all pulses around 23.5 ns => no change of pulse shape
- there is no significant difference between the fitted values of delay - within the accuracy of measurement the delay of the pulse, that would be caused by signal propagation along the strips, is lower than 1 ns / 12cm long strip