The TCT+ setup – a system for TCT, eTCT and timing measurements

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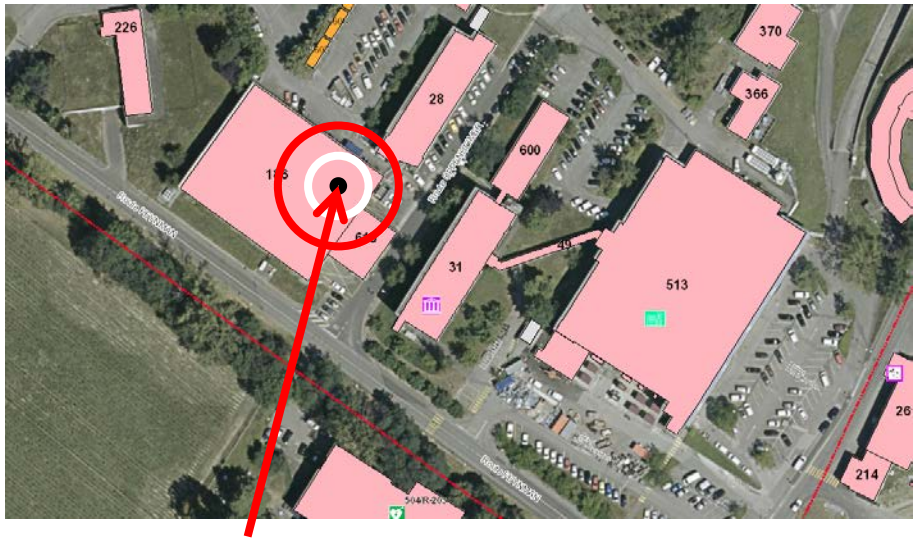
Outlook

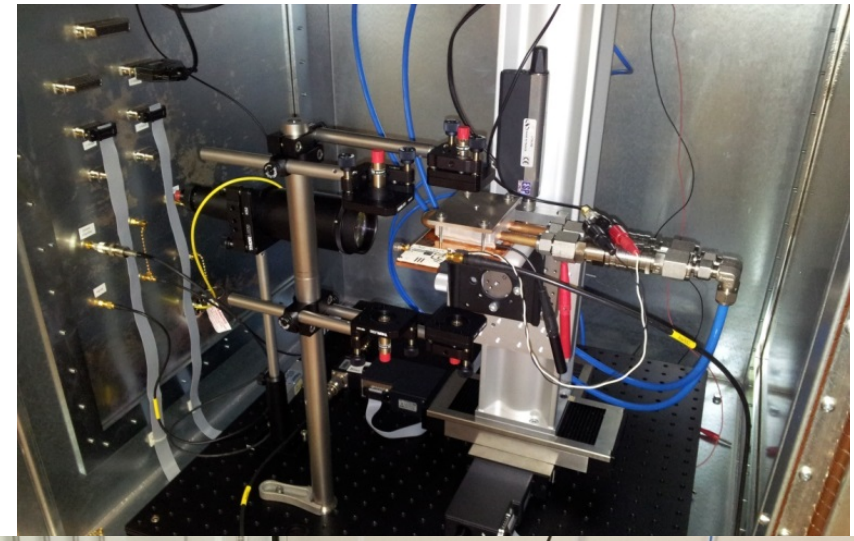
- The TCT+ setup
  - Optical System
  - Electrical and Readout System
  - Cooling System
  - Linear Stage System
- Special TCT+ components
  - PCBs
  - LabView Software
- TCT+ measurements and discussion
  - TCT
  - eTCT
  - Timing

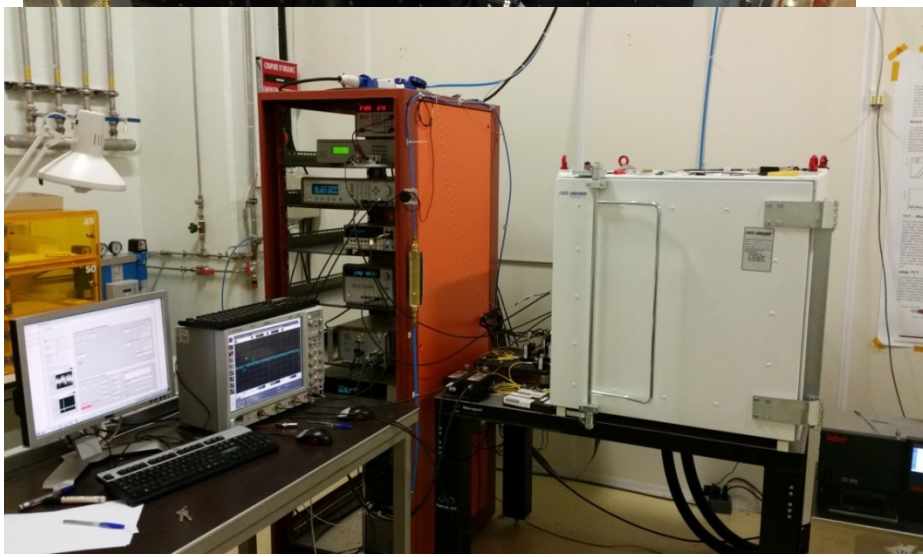
The TCT+ setup

Presentation of the setup and its subsystems

The TCT+ system







CERN 186/R-G25

Same building as the wire bond lab and close to restaurant 2.

Interested in TCT/eTCT measurements at the Solid State Detector Lab (SSD) of the PH-DT group at CERN?

Talk to us:

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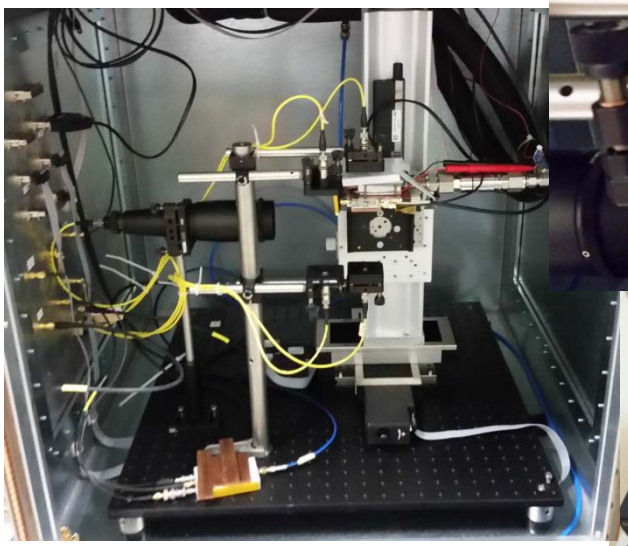
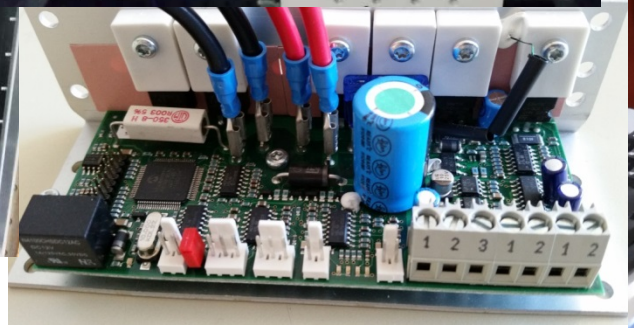
Sofía Otero Ugobono – sofia.otero.ugobono@cern.ch

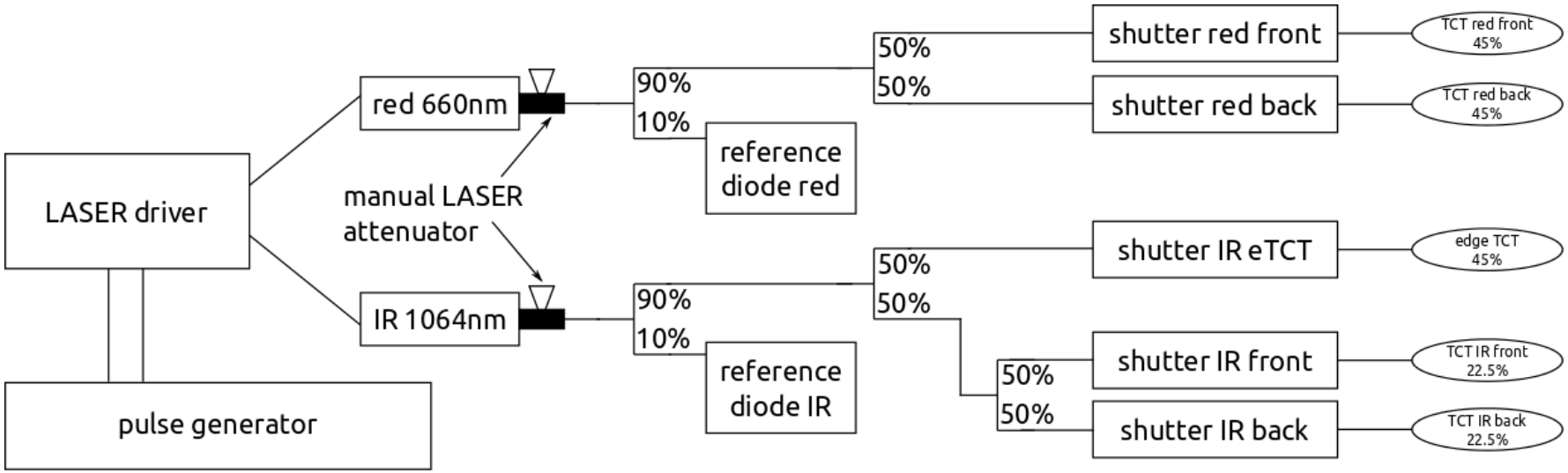
TCT+ sub-systems

- Optical System
- Electrical and Readout System
- Cooling System
- Linear Stage System





TCT+ setup: Optical System

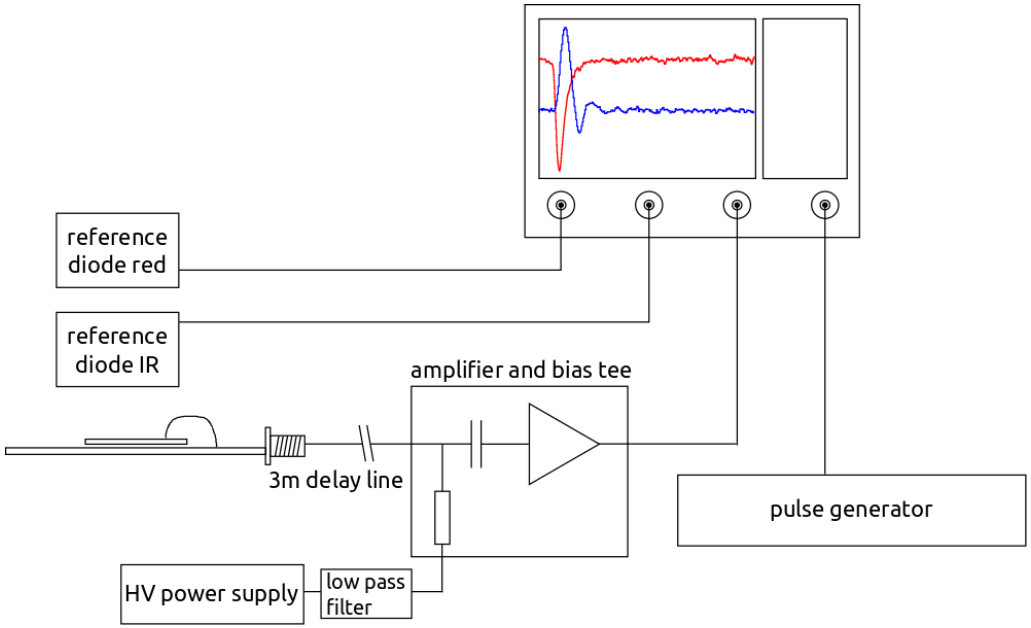


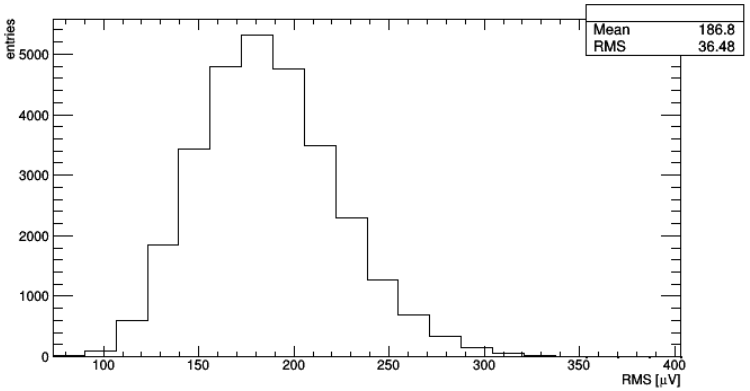
- LASER
  - 660nm (red) and 1064nm (IR)
- TCT & eTCT optics
  - Red front and back
  - IR front and back
  - IR eTCT
- Manual LASER attenuator

- Fused fiber splitter system
- Reference diodes (red, IR)
- Shutter system to select LASER channel
- eTCT: Beam Expander
- TCT: Fiber Collimator and Micro-focus

TCT+ setup: Electrical and Readout System

- 2.5GHz digital oscilloscope
- High bandwidth amplifier
- Bias-Tee
- Bias voltage range up to 1800V (tested)
- Two channel readout for DUT and reference diode

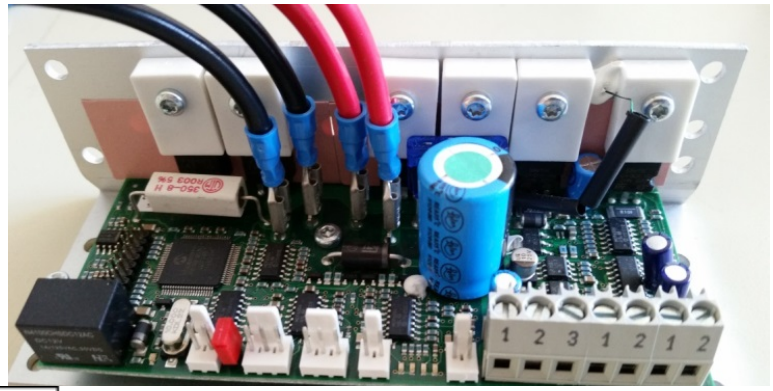


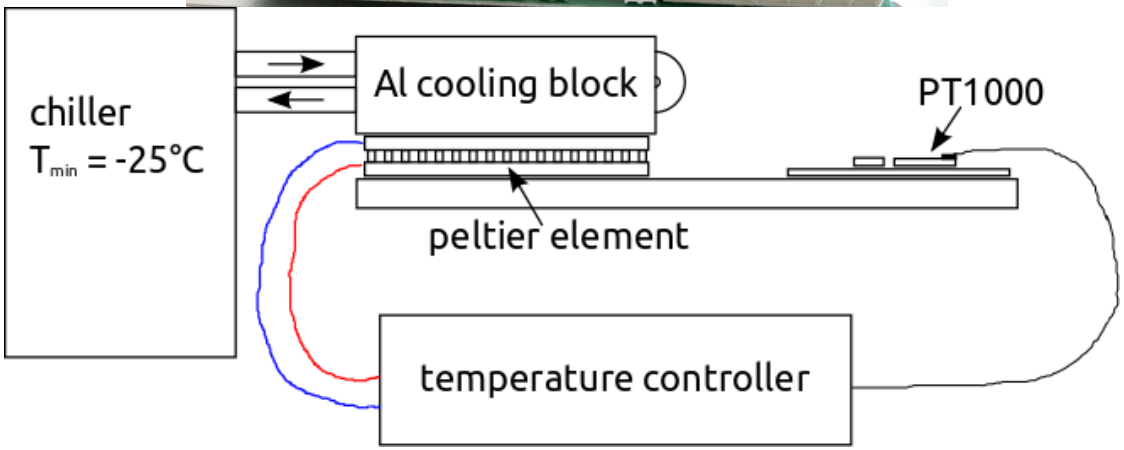


- Averaging: 256
- Mean noise level < 200µV

TCT+ setup: Cooling System

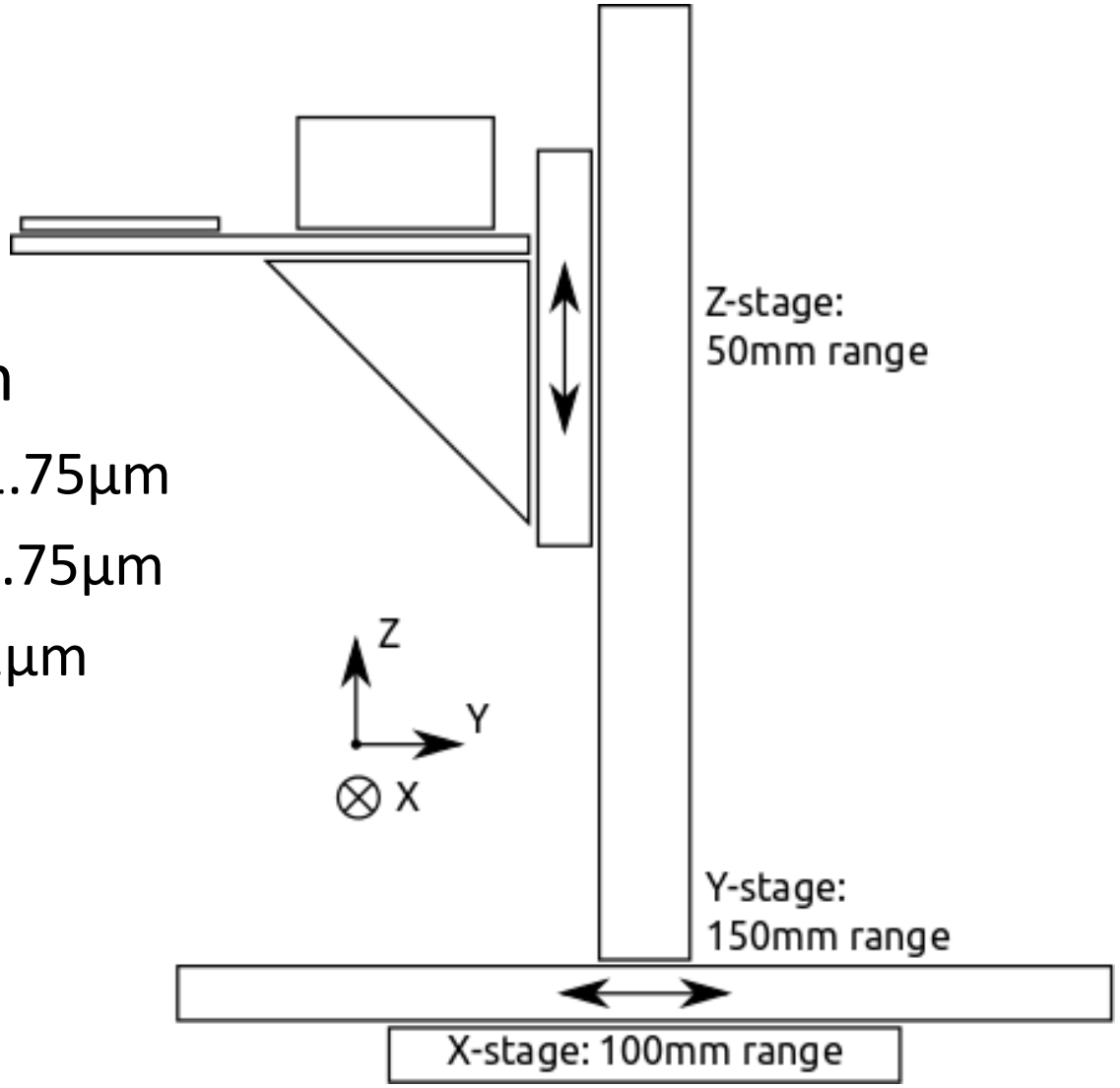
- Chiller
  - Ethanol/Water
  - T_{min} = -25°C (in the chiller)
- PID Temperature Controller
  - Peltier-Element 112W
  - PT1000 on the PCB
  - Minimum Sample Temperature = -22°C
- PR-59 temperature controller
  - LabView Software available on our website





TCT+ setup: Linear Stage System

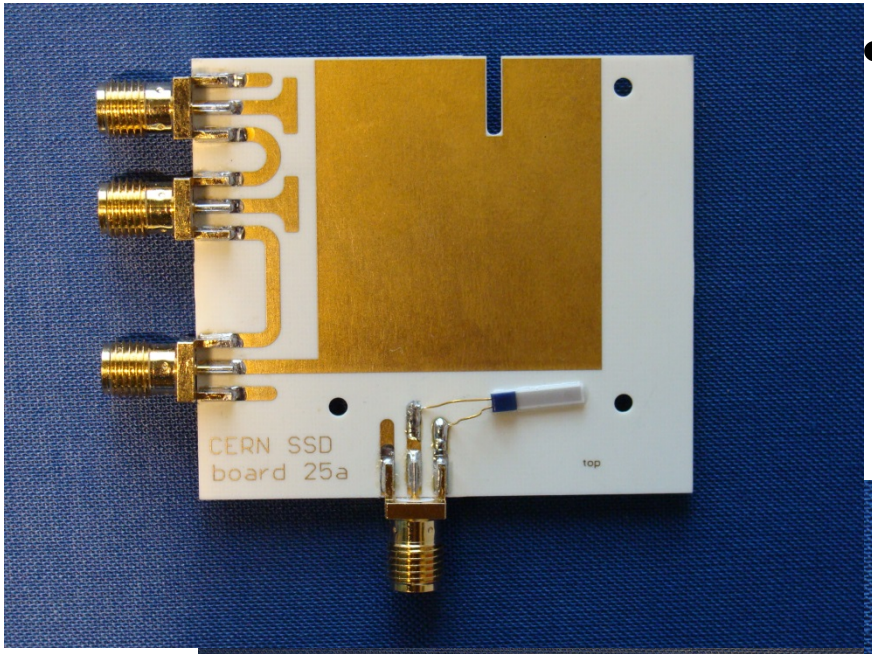
- Three stage system
  - X: repeatability ± 1.75µm
  - Y: repeatability ± 1.75µm
  - Z: repeatability ± 1µm

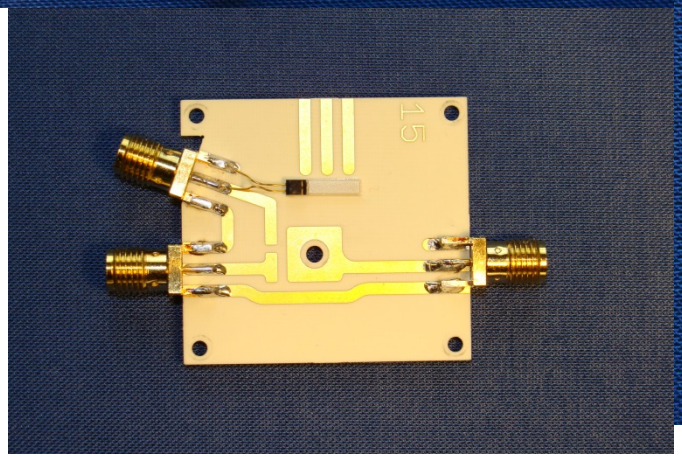


Special TCT+ components

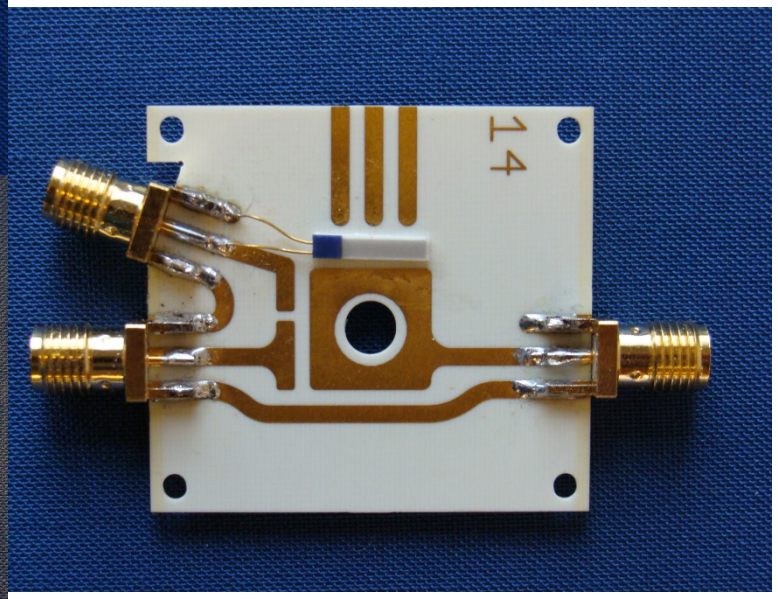
Things you can’t buy in a shop

PCBs





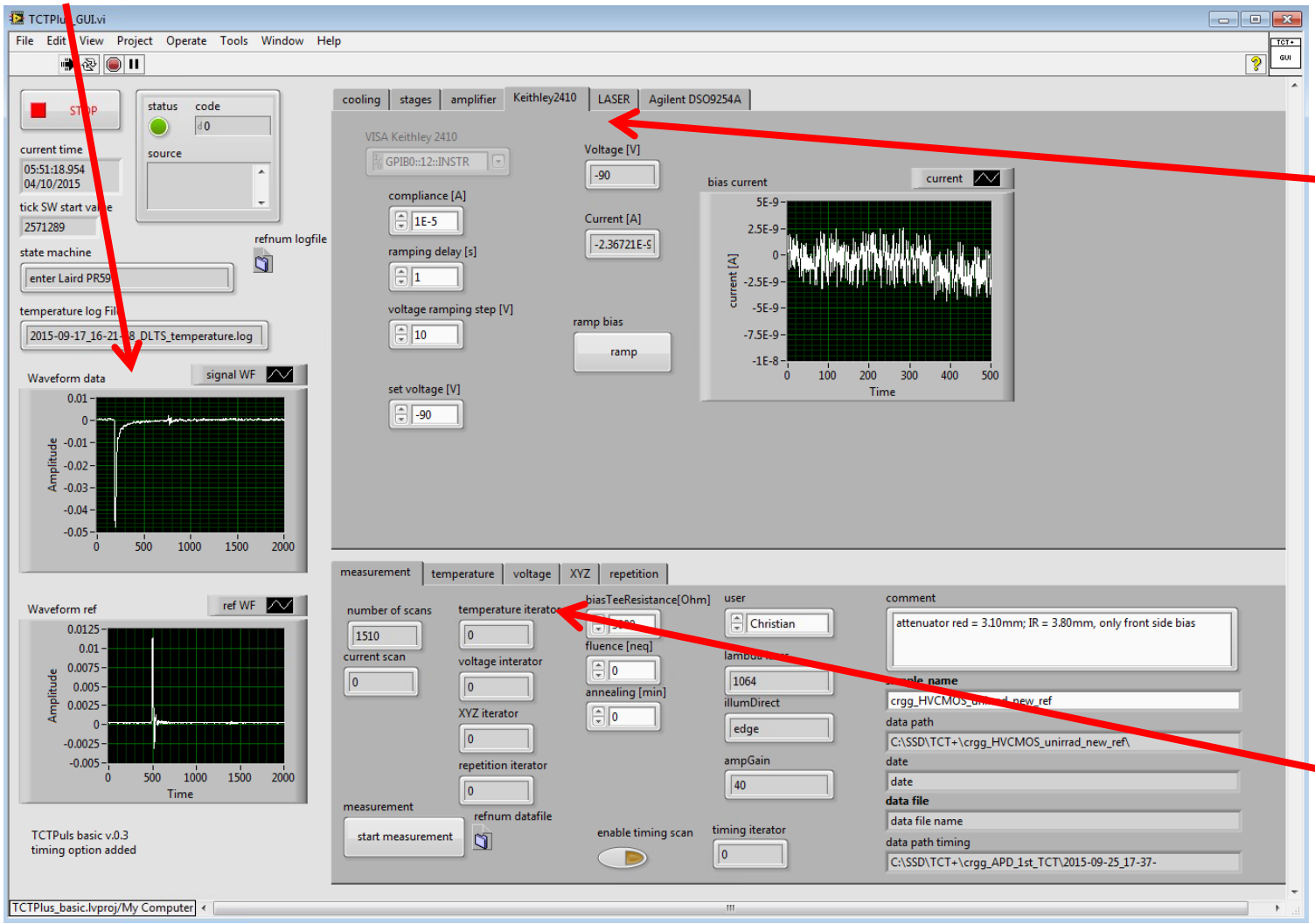
- Rogers Material
  - RO 4350 B
  - Panel size: 24"x18“
  - Dielectric thickness: 0.030“
  - Copper cladding: 1/2oz



J. Coonrod, “Improved Thermal Management of Microwave PCBs Using Advanced Circuit Materials”, Microwave Journal 2011, Vol. 54 Nr. 11

LabView Software

Online Feedback

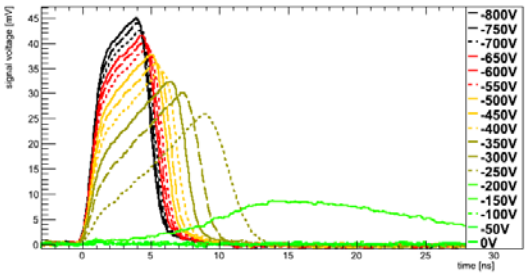


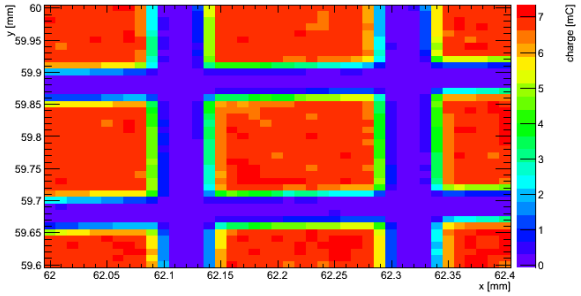
TCT+ measurements and discussion

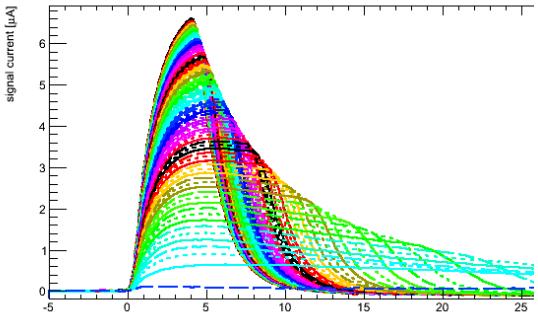
A few things to talk about – some eye candy

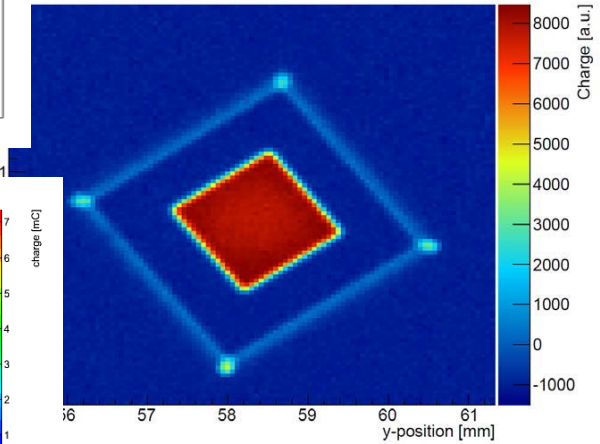
TCT

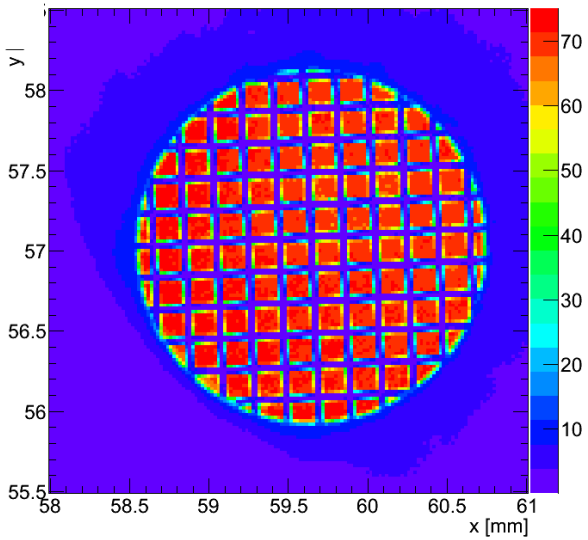
Discussion: TCT Biasing



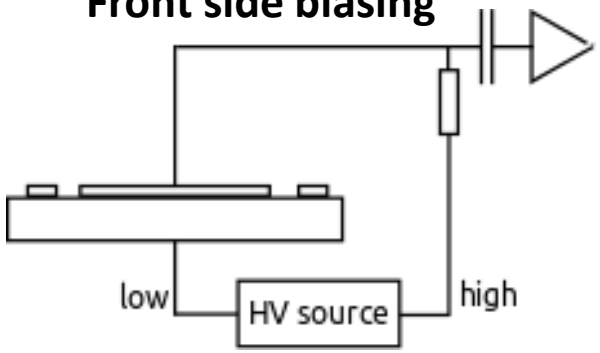




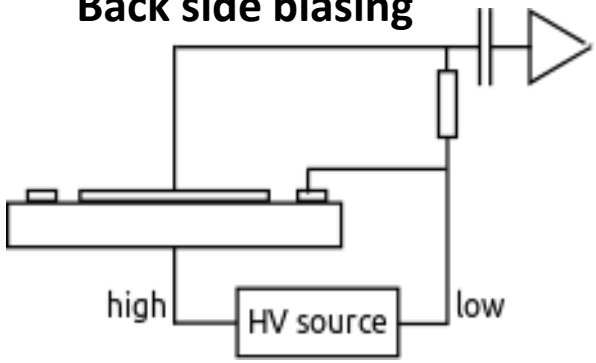




Front side biasing



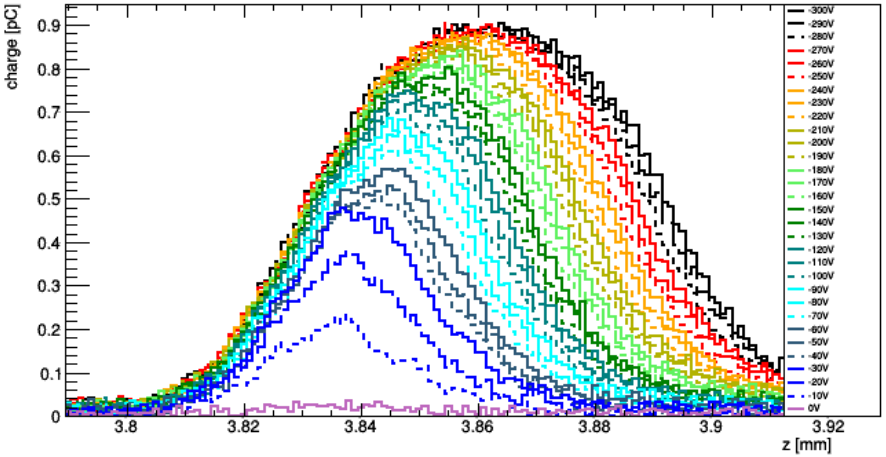
Back side biasing

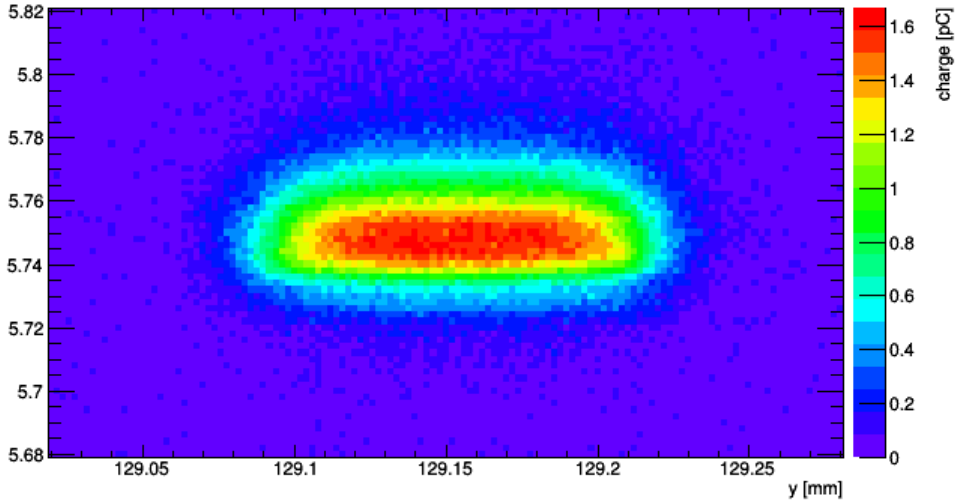


Reduce leakage current in the readout circuit

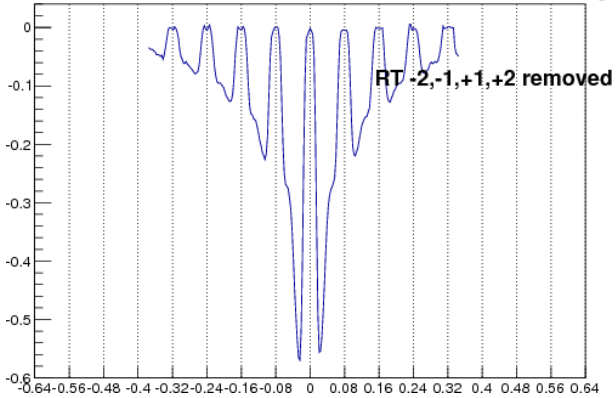
eTCT

There is a presentation from Gregor about eTCT biasing but I couldn't find the link anymore.

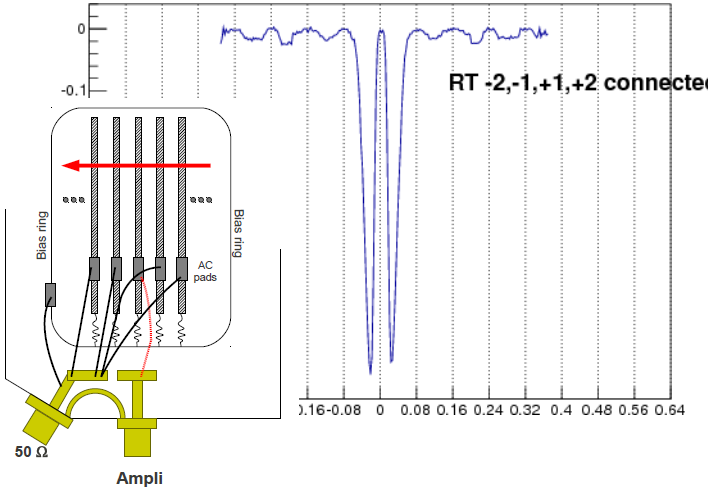




- Discussion: eTCT Biasing

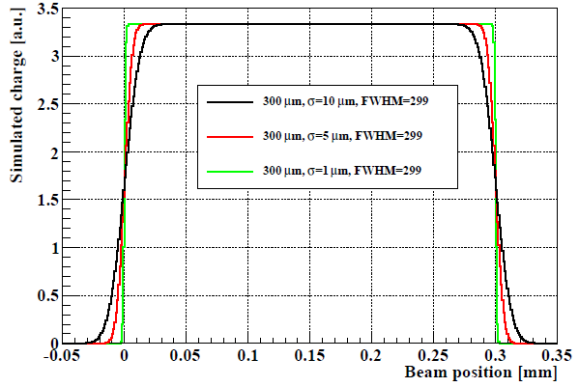


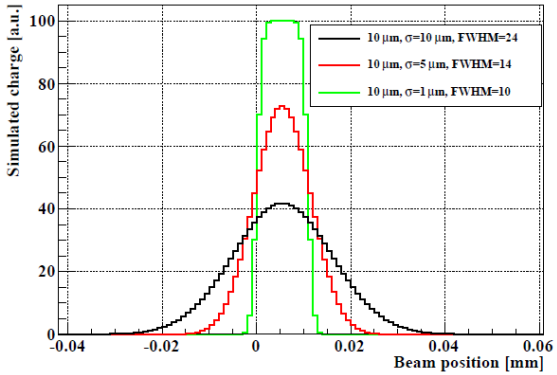
Bias the two neighbor strips



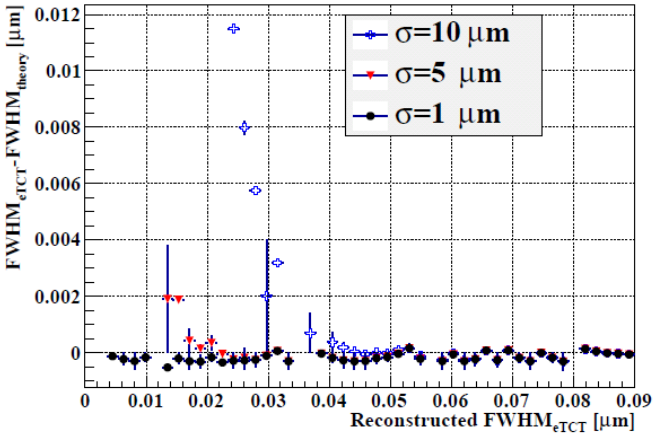
eTCT

- Discussion: depletion thickness
  - Gaussian Beam convoluted with depletion zone (Box)



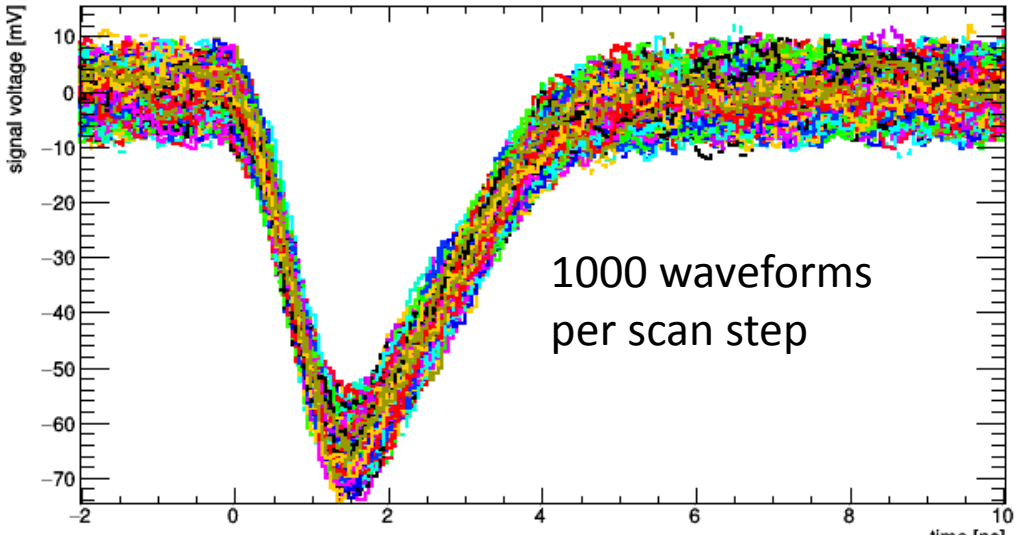


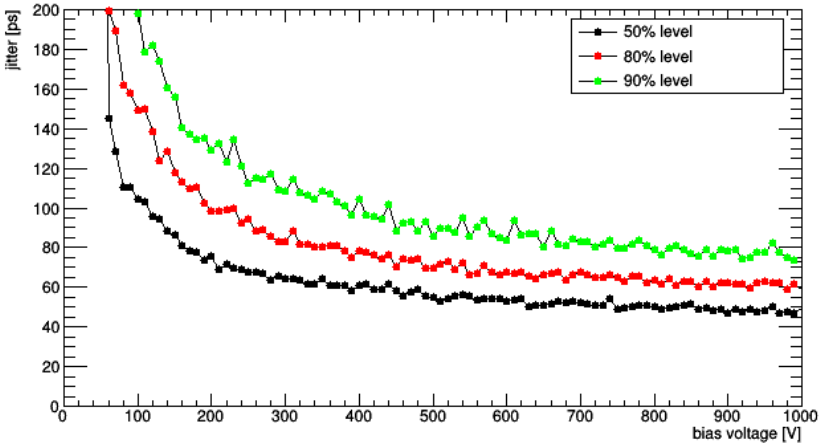
  - How to determine the beam width (see discussion focusing)
  - Smallest possible resolution
    - four times σ_{LASER} without overestimation of the depletion thickness due to laser beam width

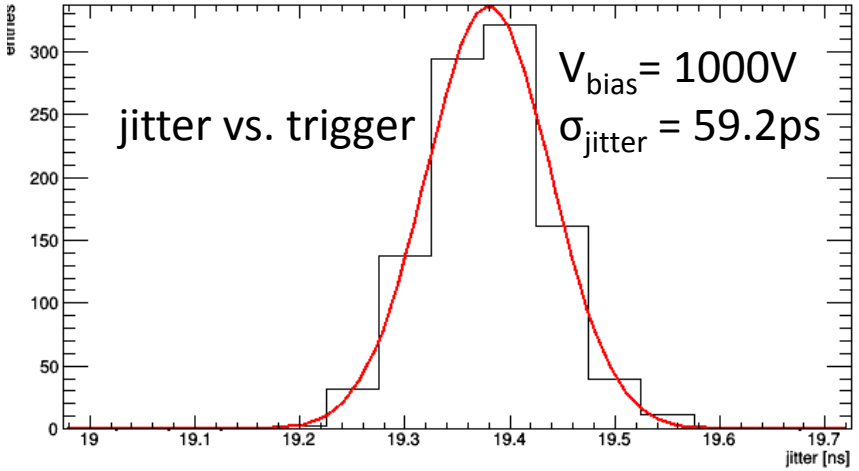


Timing measurements with TCT+

- No Averaging
- 1000 waveforms per scan step
- Jitter vs. LASER trigger
  - Upgrade: vs. reference diode
- Adjust LASER intensity for MIP intensity

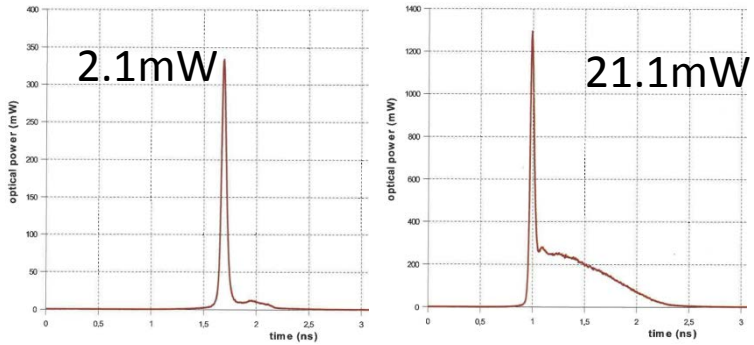




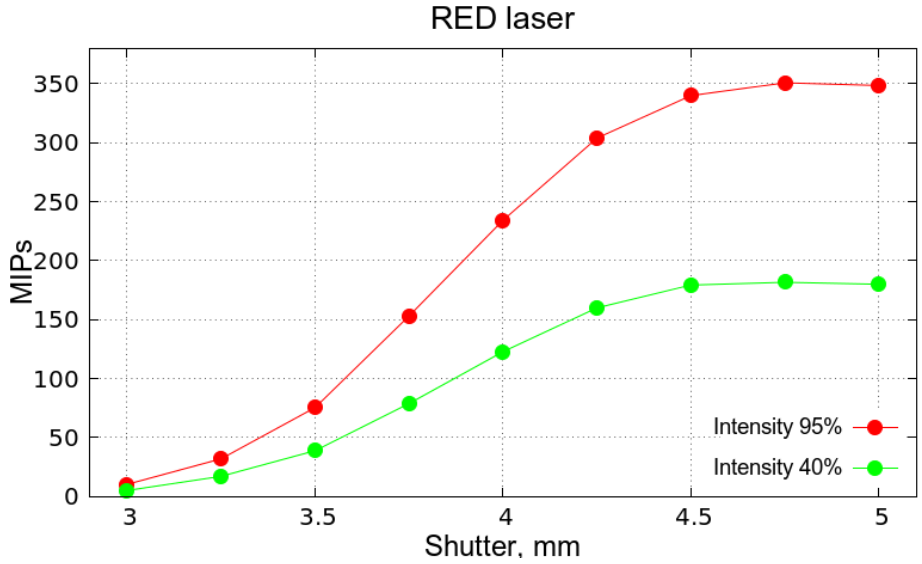


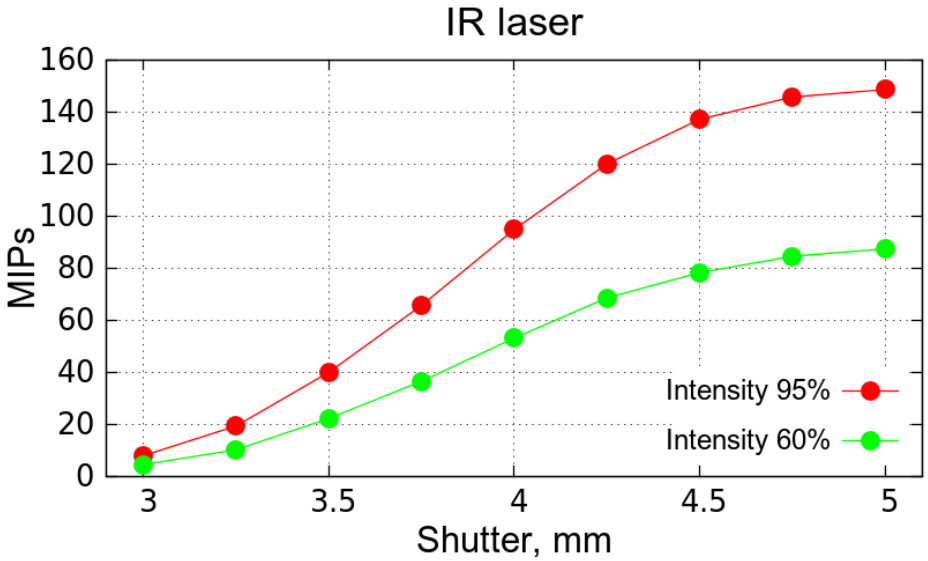
LASER intensity

- Discussion: LASER intensity regulation
  - Manual LASER attenuator
  - Intensity setting LASER driver



- Alternative
  - Optical Filters





Thanks for your attention

Acknowledgements

- The Ljubljana group
- Marlen Bentner and Anika Altwein
- Sven Wonsak
- Alexander Bitadze

Backup

Some stuff which might be useful for someone

Equipment list

- Optical System
  - PicoQuant laser head LDH-P-C-660
  - PicoQuant laser head LDH-P-C-1060
  - PicoQuant laser driver Sepia
  - Thorlabs reference diode red DET01CFC/M
  - Thorlabs reference diode infra red DET02AFC/M
  - OZ OPTICS beam splitter 40930 FUSED-12-1064-6/125-90/10-3S3S3S-1-1
  - TCT
    - Schäfter+Kirchhoff Fiber Collimator for 660 nm (60FC-0-A18-02)
    - Schäfter+Kirchhoff Micro-focus optics 660 nm (5M-M60-26-S)
    - Schäfter+Kirchhoff Fiber Collimator for 1064 nm (60FC-0-A18-03)
    - Schäfter+Kirchhoff Micro-focus optics 1064 nm (5M-M40-37-S)
  - eTCT
    - Thorlabs Fiber Collimation Pkg. F220FC-1064 - 1064 nm, f = 11.17 mm, NA = 0.25 FC/PC
    - Thorlabs BE15M-C Galilean Beam Expander
    - Thorlabs SM2D25D Iris Diaphragm
    - Thorlabs LA1050-C - N-BK7 Plano-Convex Lens
- Linear Stage System
  - Newport ESP301-3N stage controller
  - Newport UTS100CC stage
  - Newport UTS150CC stage
  - Newport LTA-HS stage
- Electrical and Readout System
  - Agilent Oscilloscope DSO9254A 2.5GHz
  - iseg SHQ 222M HV power supply
  - Keithley 2410 HV power supply
  - Amplifier
    - Particulars AM-01 A
    - Cividec C2
    - Miteq 1309, 1622, 1660
    - Phillips 6954
  - Bias Tee
    - Picosecond Pulse Labs 5530B-104
    - Picosecond Pulse Labs 5531-901
- Cooling System
  - Adaptive Peltier-Element 112.7W
  - Laird Technologies Supercool PR-59 temperature controller
  - TTI Power supply TSX-P Series 35V/10A
  - huber chiller CC 505

TCT+ related references

- S. Fernandez-Perez, et al. – Charge Collection Properties of a Depleted Monolithic Active Pixel Sensor using a HV-SOI process – Proceeding of International Workshop on Radiation Imaging Detectors 2015 (submitted)
- G. Pellegrini, et al. – Recent developments on LGAD and iLGAD detectors for tracking and timing applications – 10th International "Hiroshima" Symposium on the Development and Application of Semiconductor Tracking Detectors 2015
- S. Fernandez-Perez, et al. – Charge Collection Properties on a Depleted Monolithic Active Pixel Sensor using a HV-SOI process – TWEEP 2015
- D. Münstermann, et al. – A preliminary look at HV-CMOS eTCT data after p-irradiation – 26th RD50-meeting
- M. Fernandez Garcia, et al. – Radiation hardness of neutron irradiated HVCMOSv3 – 26th RD50-meeting
- C. Gallrapp, et al. – TCT measurements on neutron and proton irradiated LGAD diodes – 26th RD50-meeting
- E. Curras, et al. – Characterization after neutron irradiation of Silicon Diodes for the CMS High Granular Calorimeter (HGCAL) – 25th RD50-meeting
- R. Carney – Investigation of Magnetic Czochralski diodes using novel TCT setup for future silicon detectors – Master Thesis, University of Edinburgh 2014
- S. Wonsak, et al. – Status of Silicon Strip Sensor Measurements at Liverpool – 24th RD50-meeting
- V. Greco, et al. – Preliminary results on proton irradiated LGAD PAD detectors – 24th RD50-meeting