Temperature regulation and measurements on silicon detectors with red & infrared laser beams

An internship with the SSD Team
(PH-DT-DD)

Annika Altwein

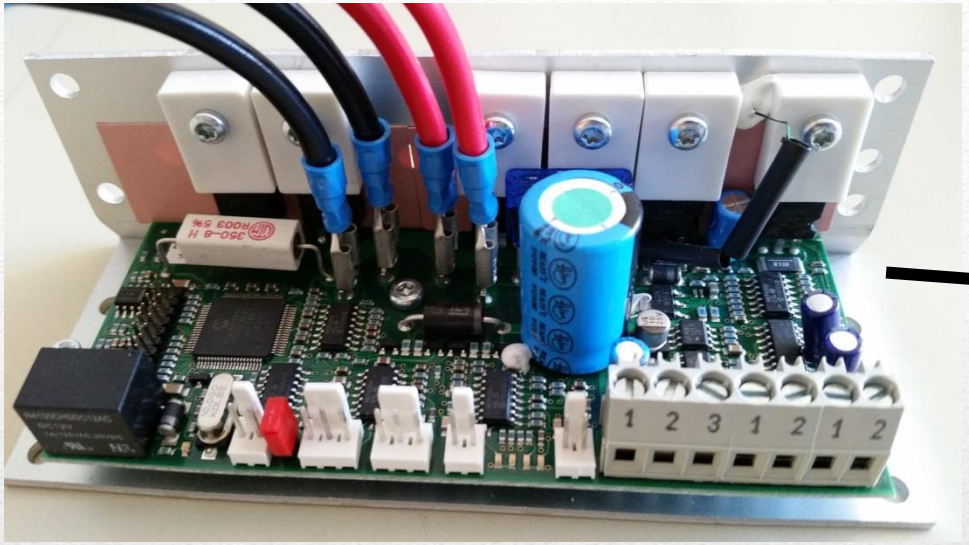
- Set up
- Components
- PID controller
- Measuring data
- Further options

- TCT measurements
- Setting
- Measuring data

- sources

agenda

Set up



Control engineering

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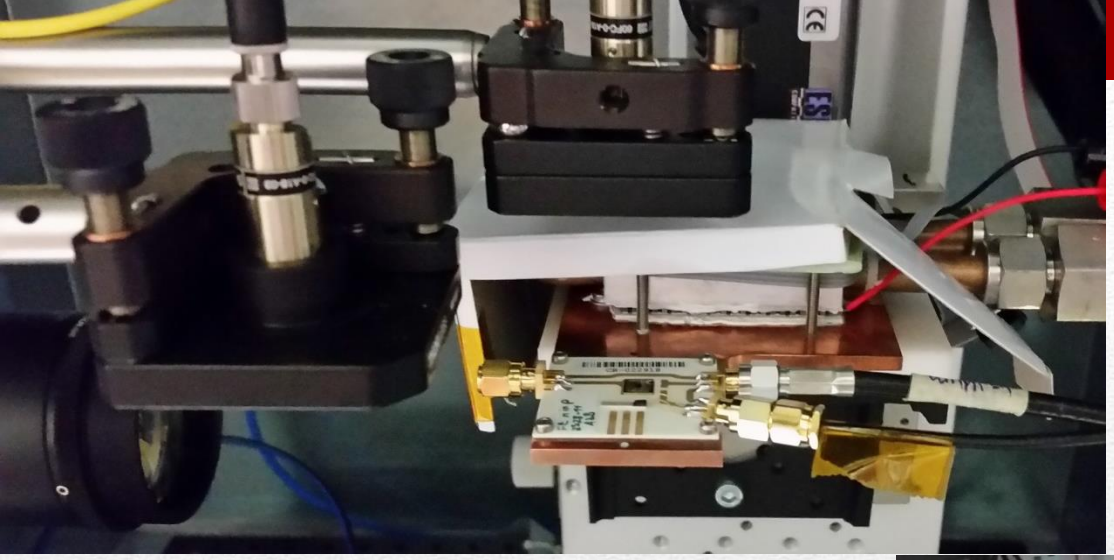
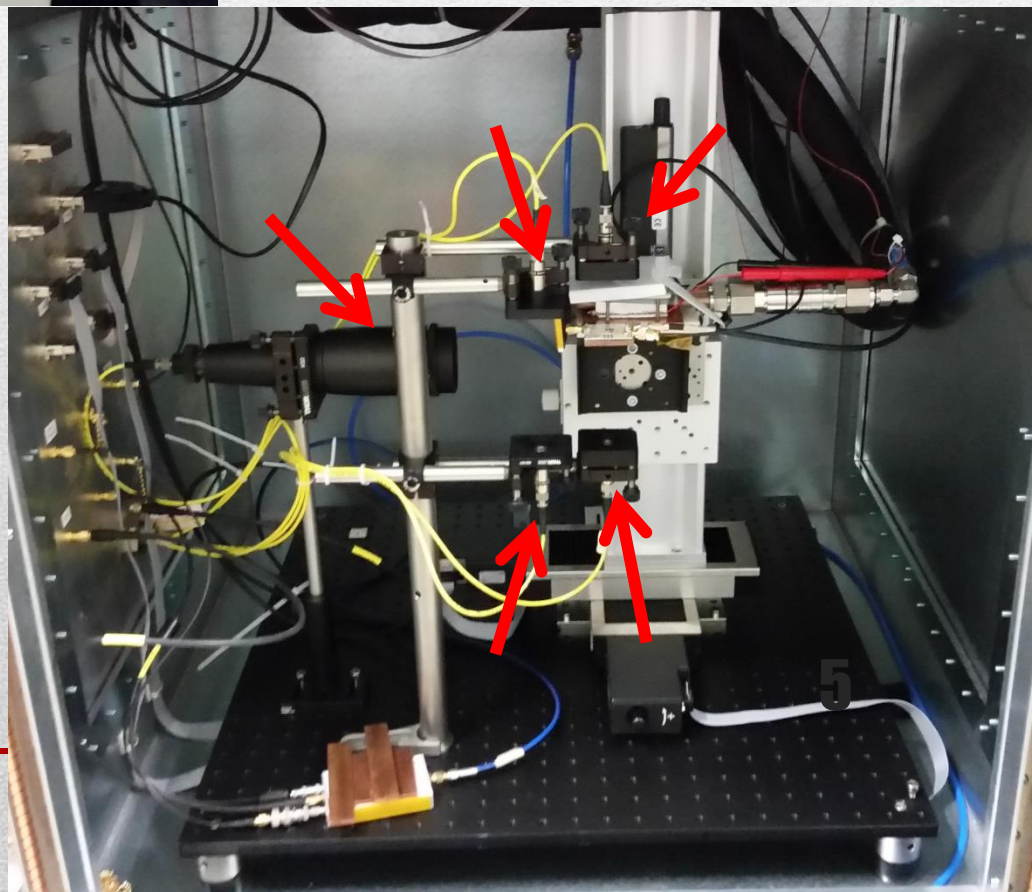


Inside the box



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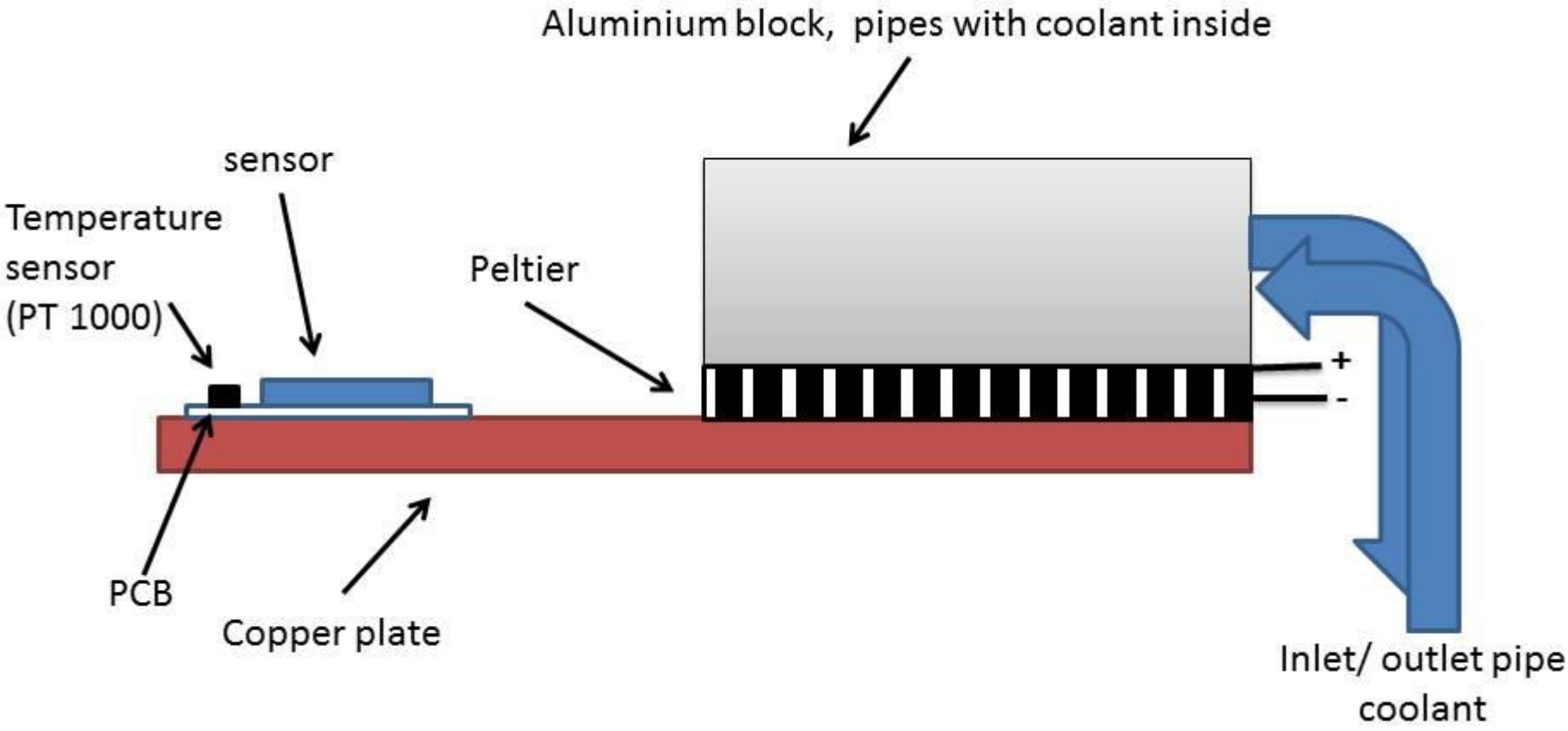

Temperature control system 6

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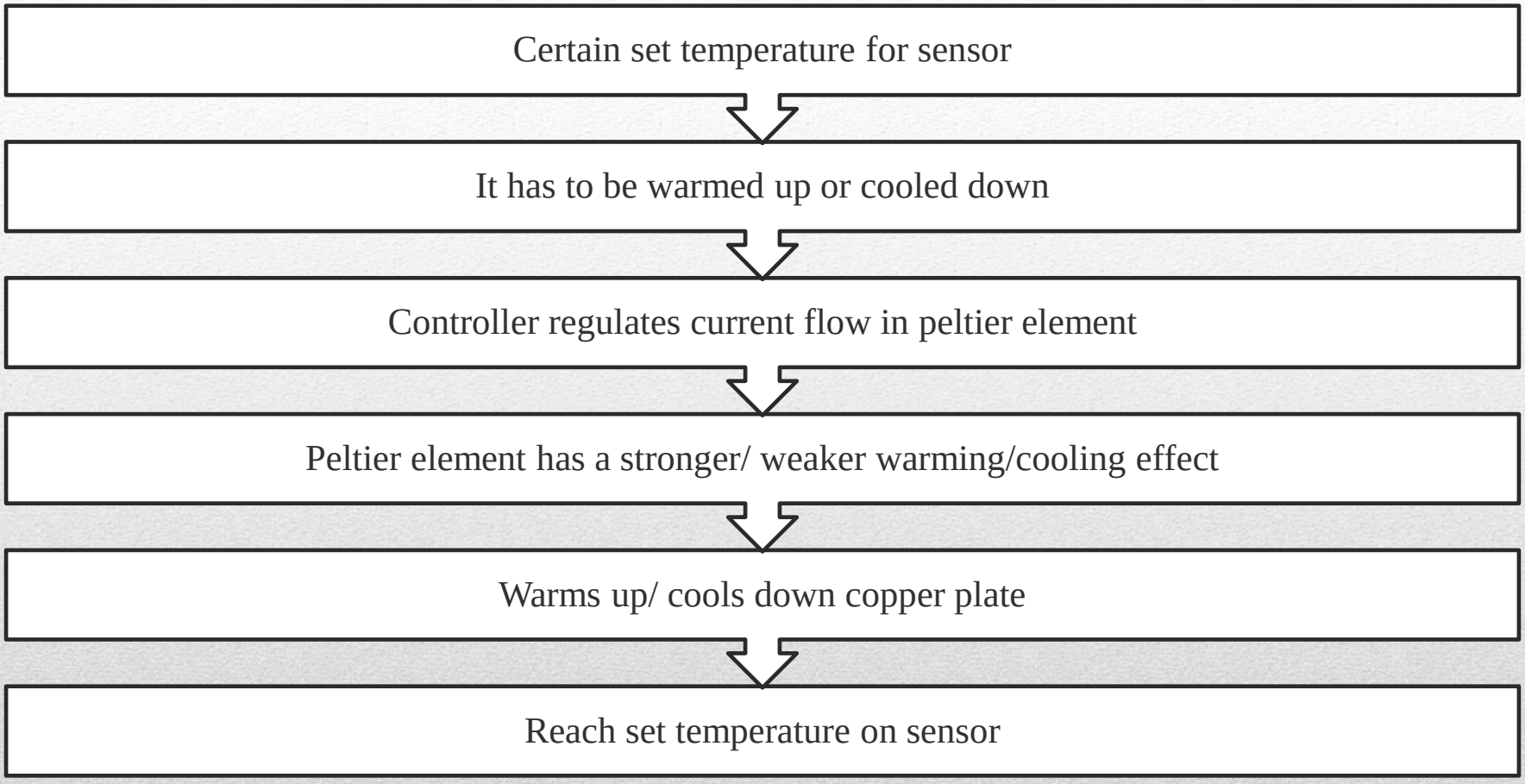
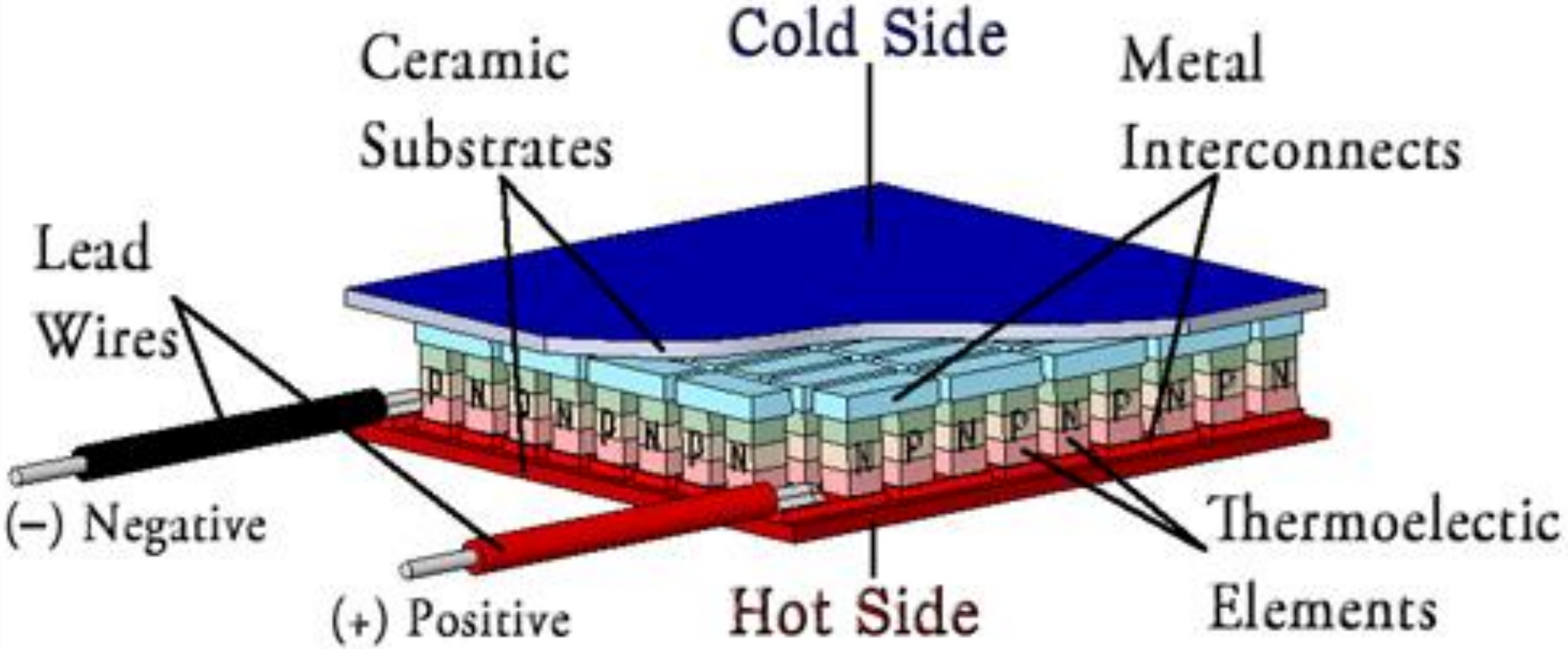


How does it work



Peltier element

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http://home.arcor.de/glaube.u/spf-modul/images/tem_3.png

- Temperature control
- Set to the inertia of the system

→reach set temperature as fast as possible

→compensates disturbances/ errors

PID Controller

Three parameters for the controller:

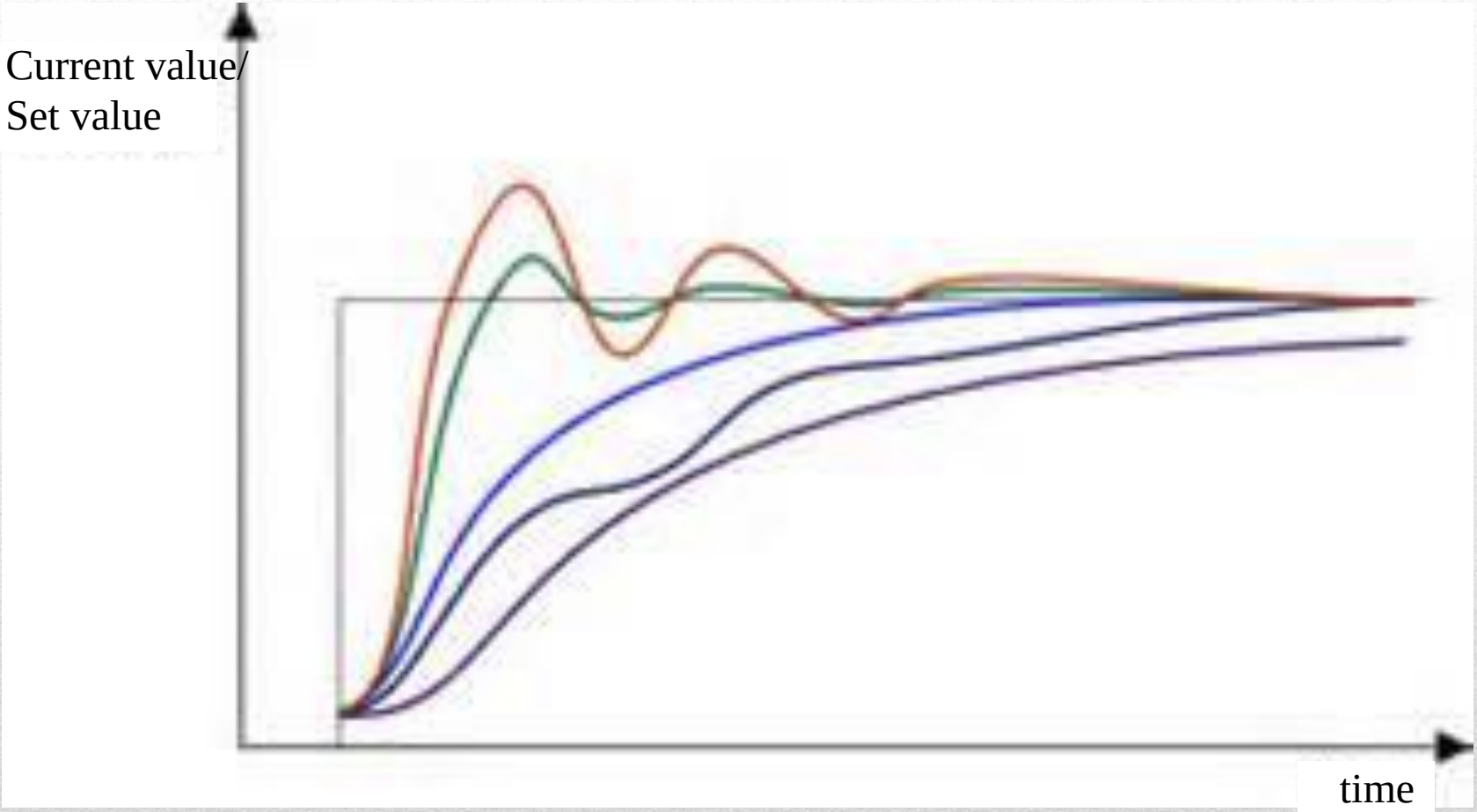
- **P** (**p**roportional)–controller → focusses on present variance
  - Reacts immediately
  - only reaction in case of present error
- **I** (**i**ntegral)–controller → eliminating steady-state deviation
  - Delayed reaction
  - No impact only in case of constant value without deviation
- **D** (**d**erivative)–controller → prediction due to current change
  - Fast reaction
  - Reacts only to changes, not to deviations in general

PID Controller

Weighting of the parameters→ specific contributions will be summated

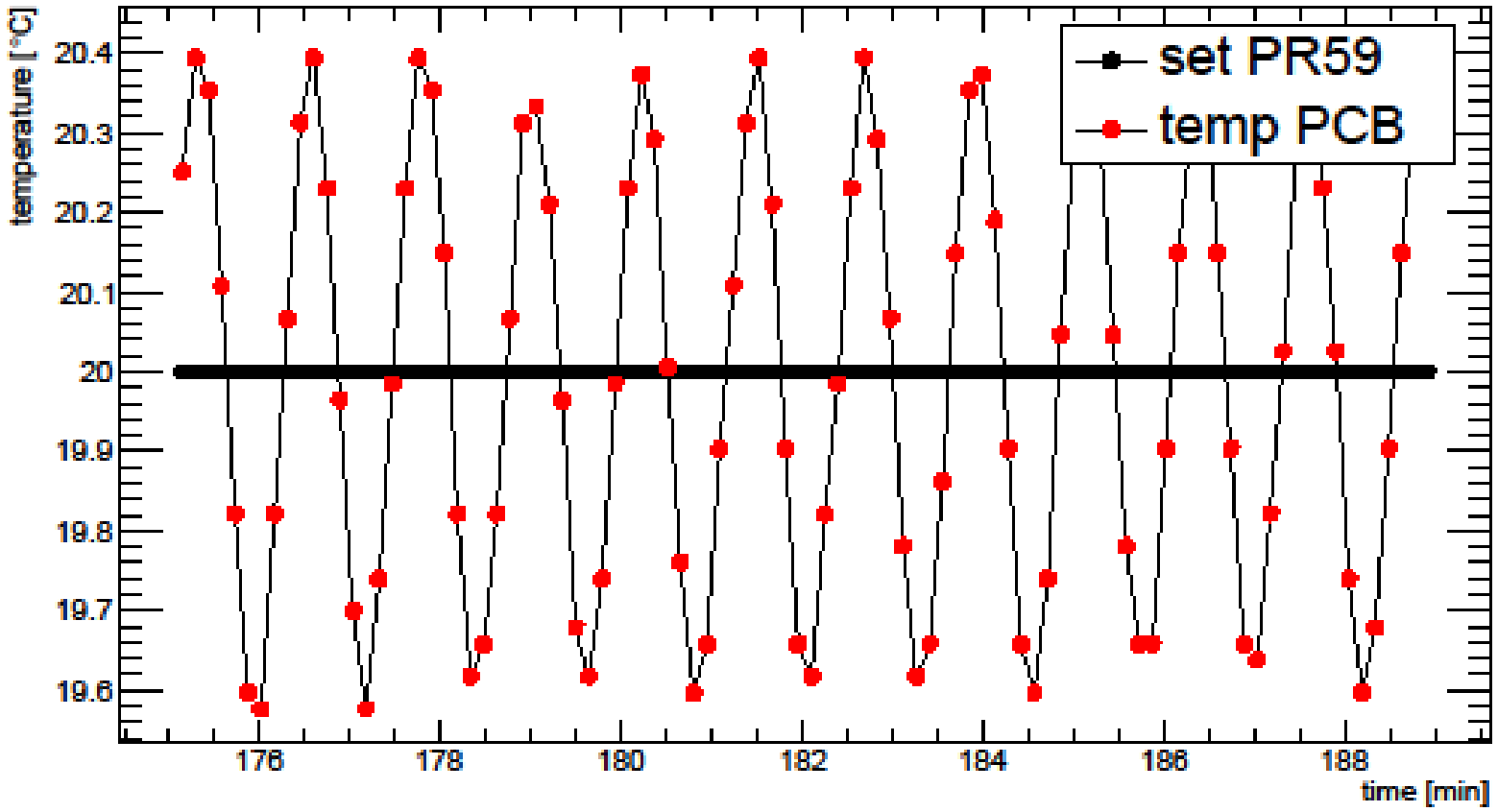
$$\underbrace{K_p \cdot e(t)}_{\mathbf{P}} + \underbrace{K_i \cdot \int_{t1}^{t} e(\tau)d\tau}_{\mathbf{I}} + \underbrace{K_d \cdot \frac{d}{dt} e(t)}_{\mathbf{D}}$$

functioning



What it should look like

https://sp.yimg.com/ib/th?id=JN.Wvn5%2bDHe%2bNcYiS0EA7aP0w&pid=15.1&P=0



How does it look

- Find out specific parameters due to curve tracing
- Brute-force-method to find fitting values

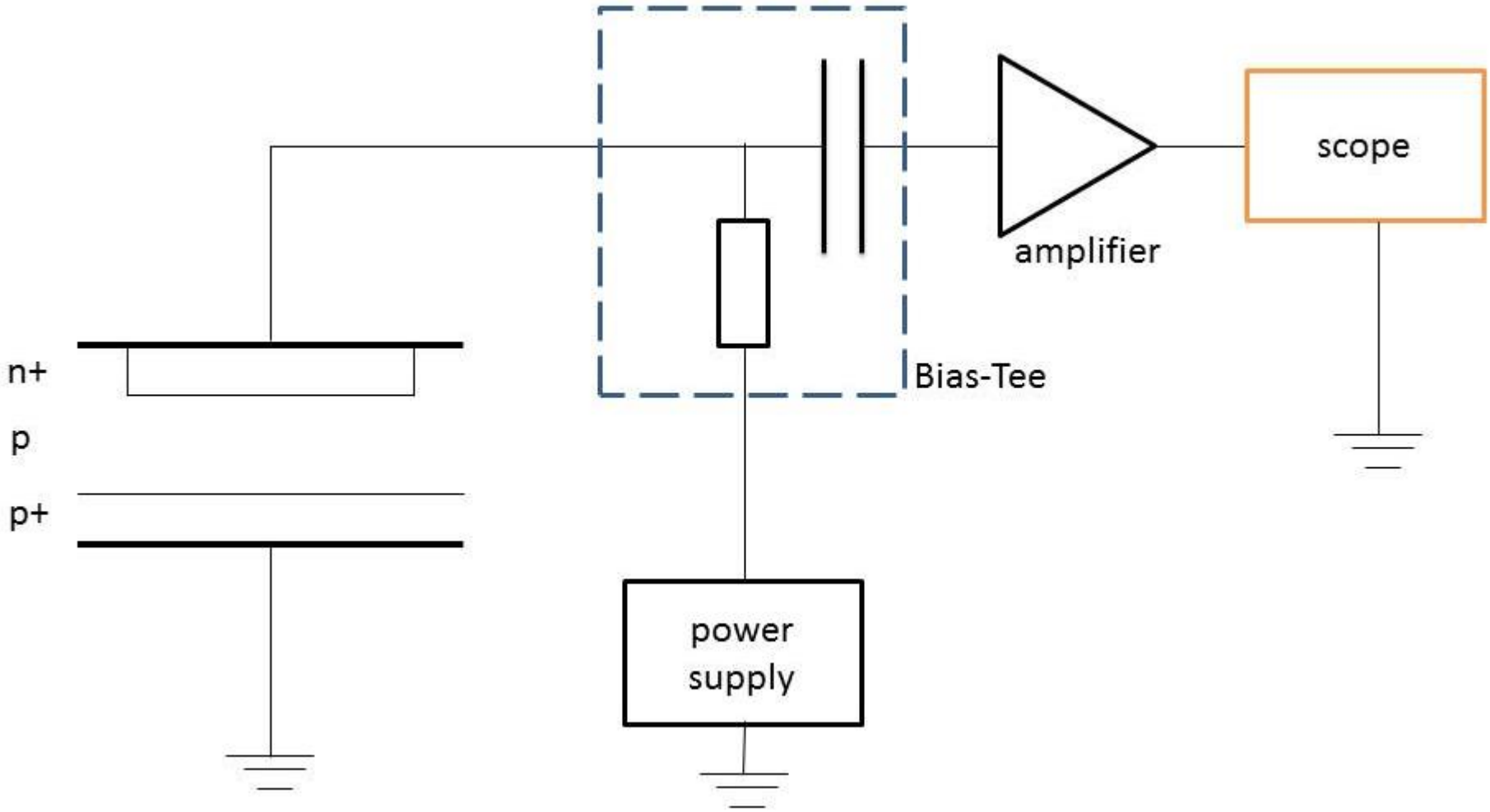
→bigger project than expected, needs more time

Further options

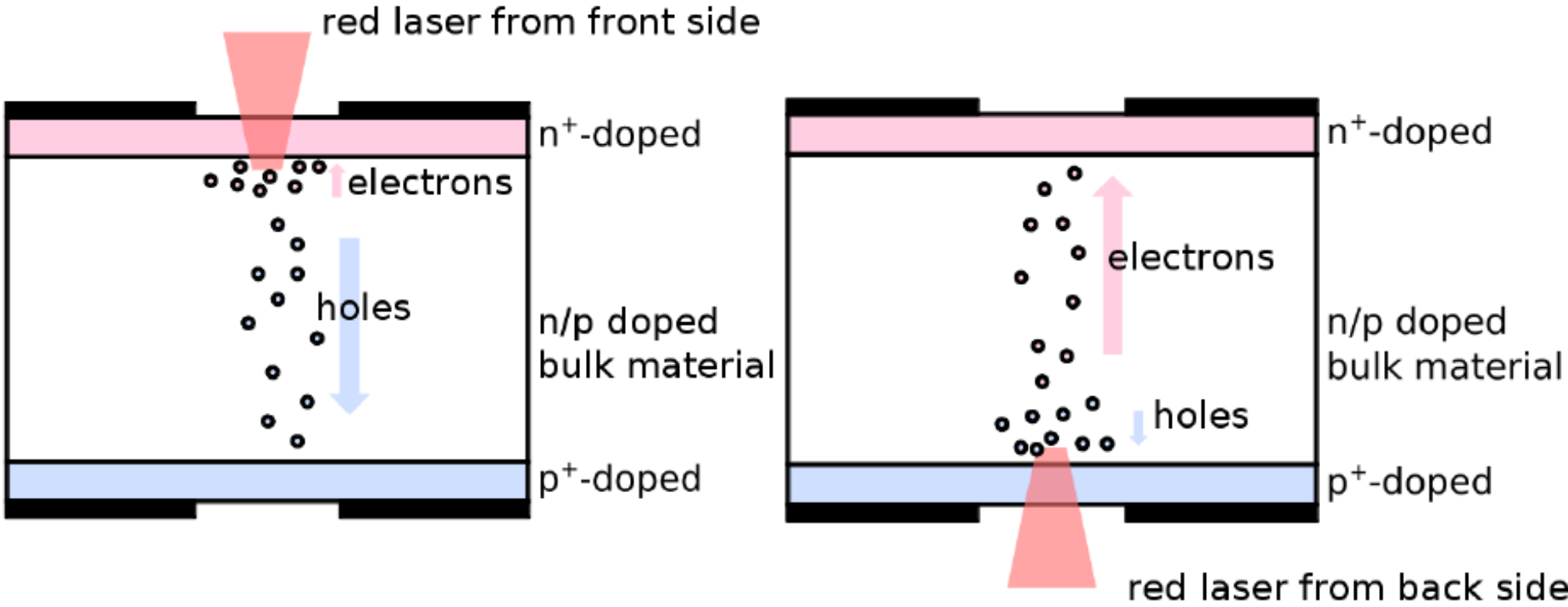
Connection between fluence and charge

- measurements with a set of irradiated sensors and laser beams
- comparing the induced current signal caused by charge carriers

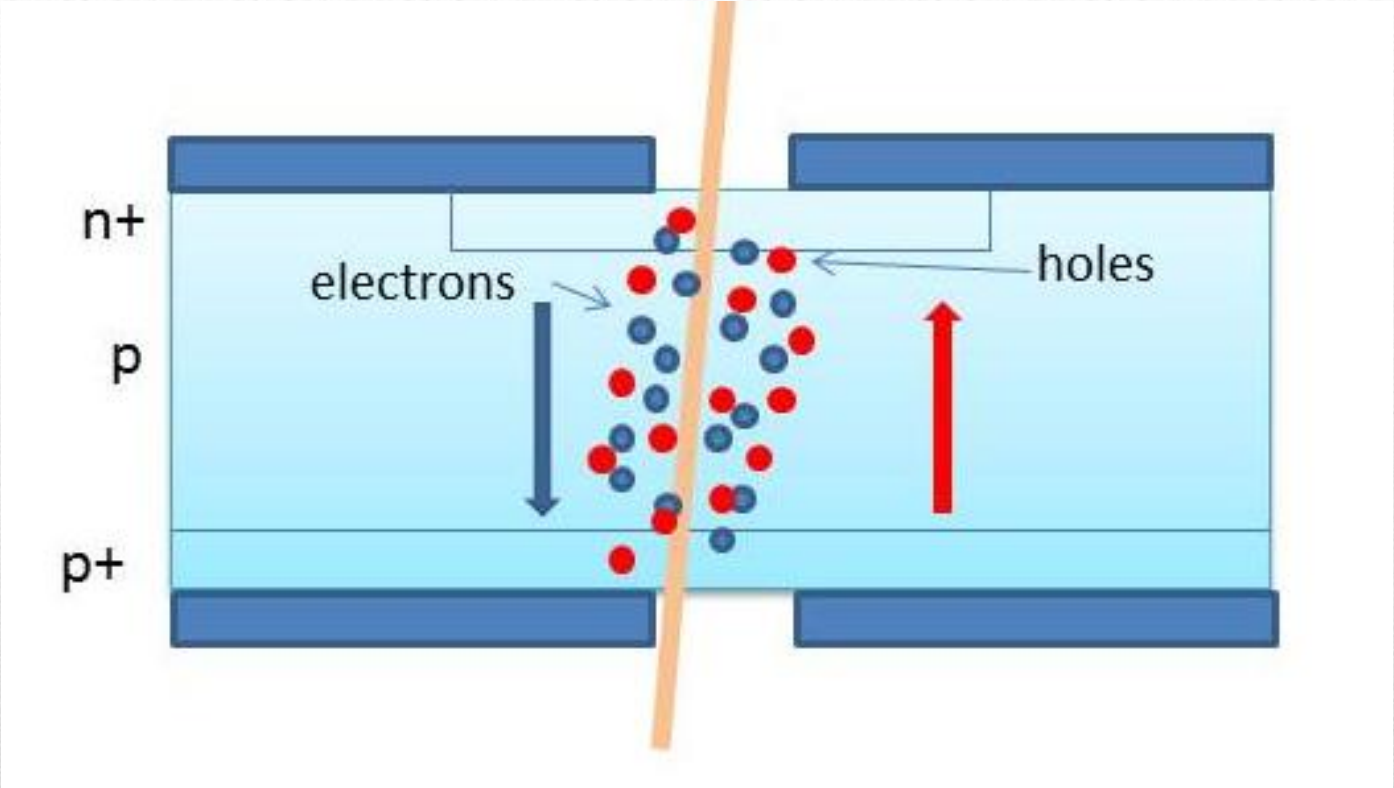
TCT measurements



main idea



red laser from both sides

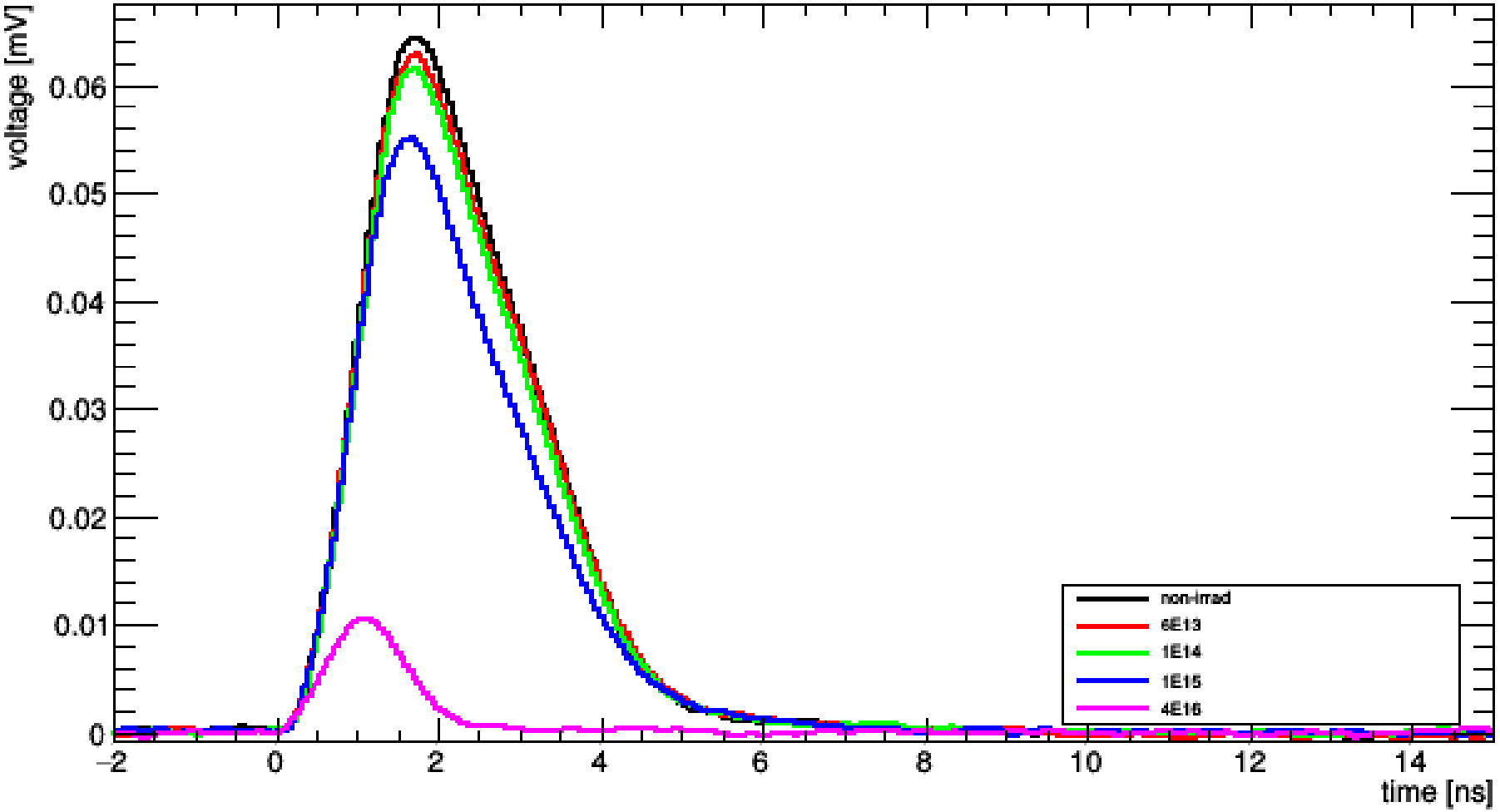


Radiation with infrared

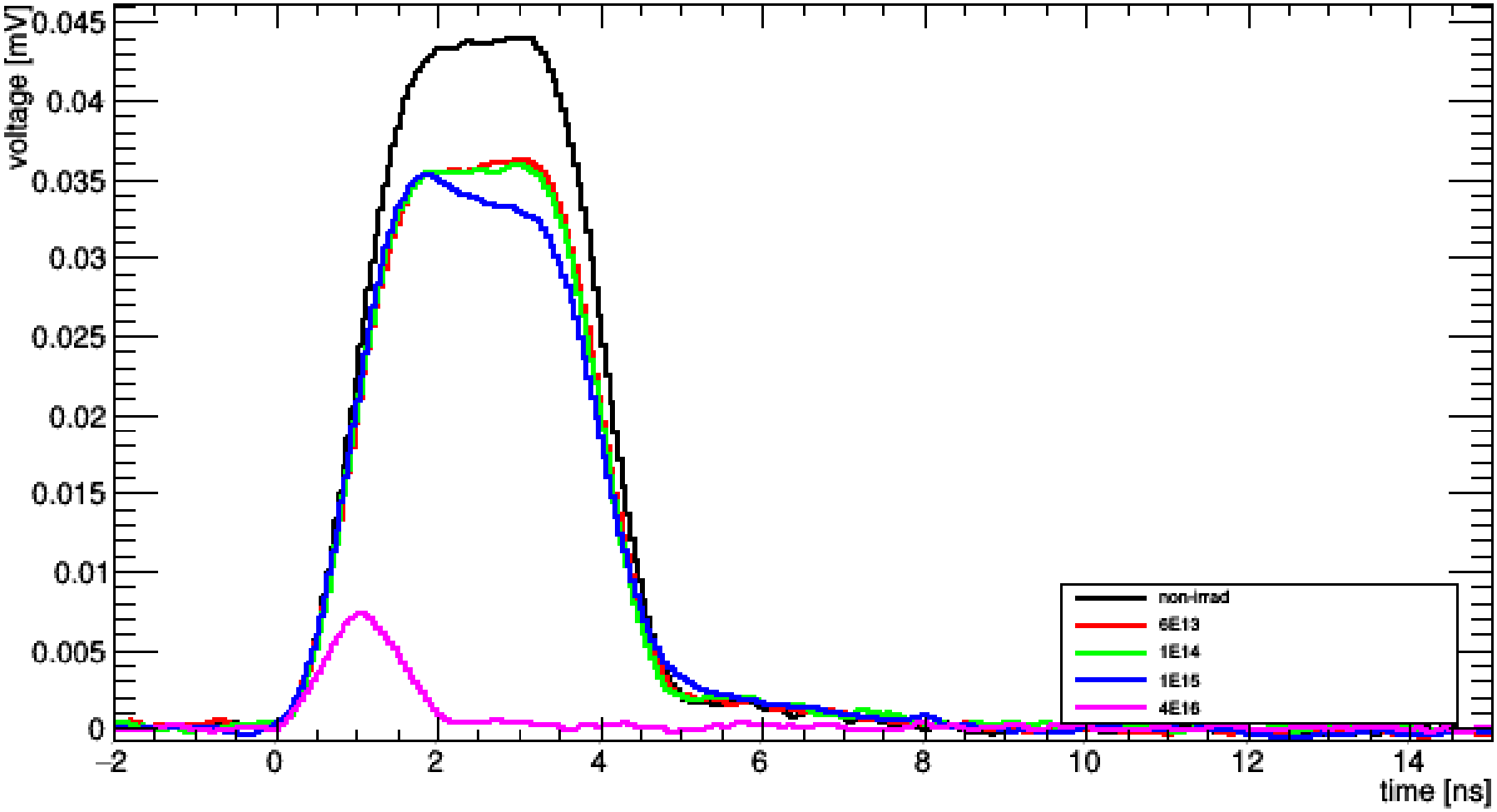
Name	Fluence ($\frac{P}{cm^2}$)
4 (in the plot)	Non-irradiated
A2B (in the plot)	$6 \cdot 10^{13}$
B2B (in the plot)	$1 \cdot 10^{14}$
C1A	$5 \cdot 10^{14}$
D1 (in the plot)	$1 \cdot 10^{15}$
E1	$2 \cdot 10^{15}$
O1A (in the plot)	$4 \cdot 10^{16}$

Proton irradiated, PS 24GeV/c
Float Zone n-in-p

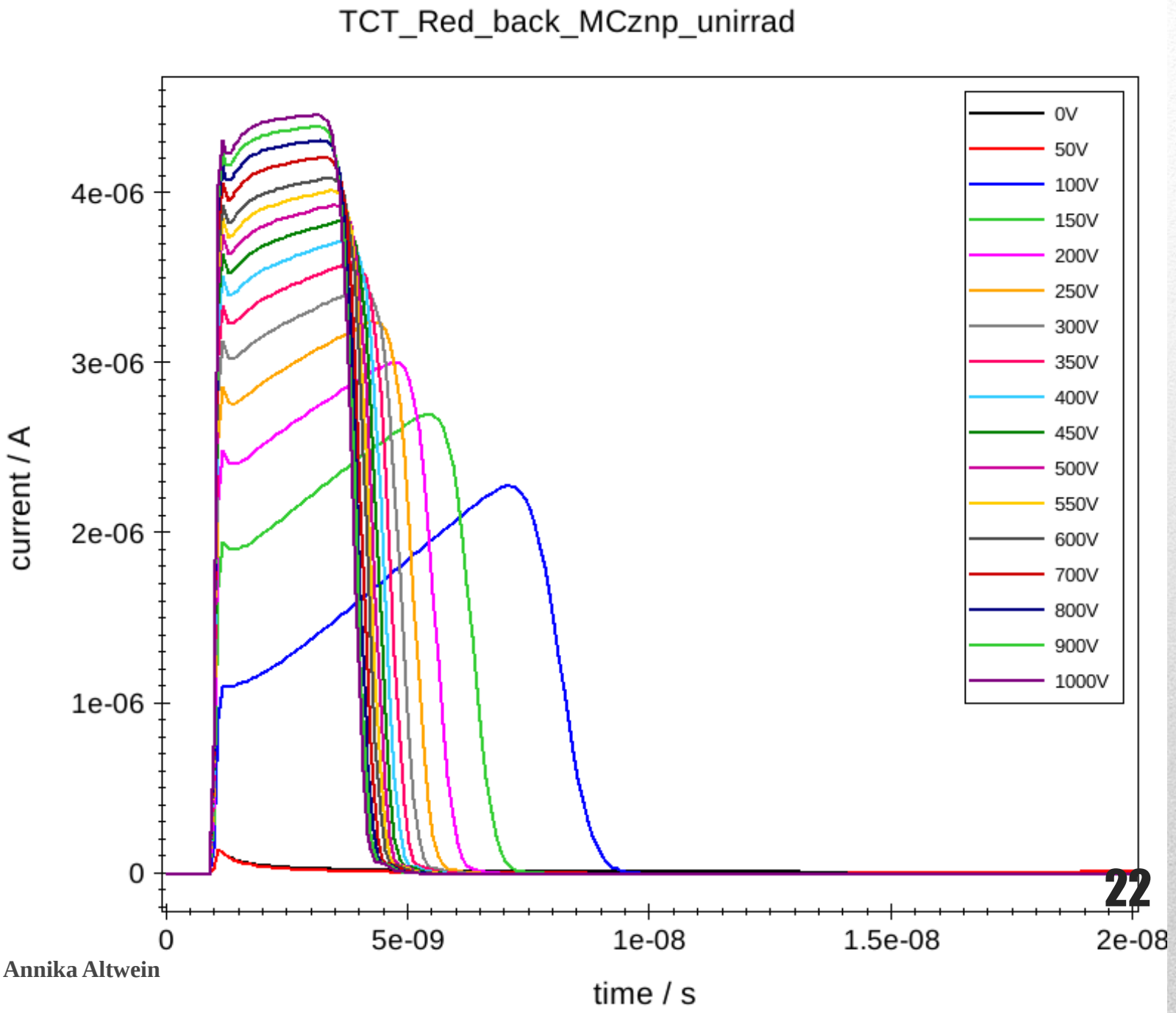
Radiated sensors

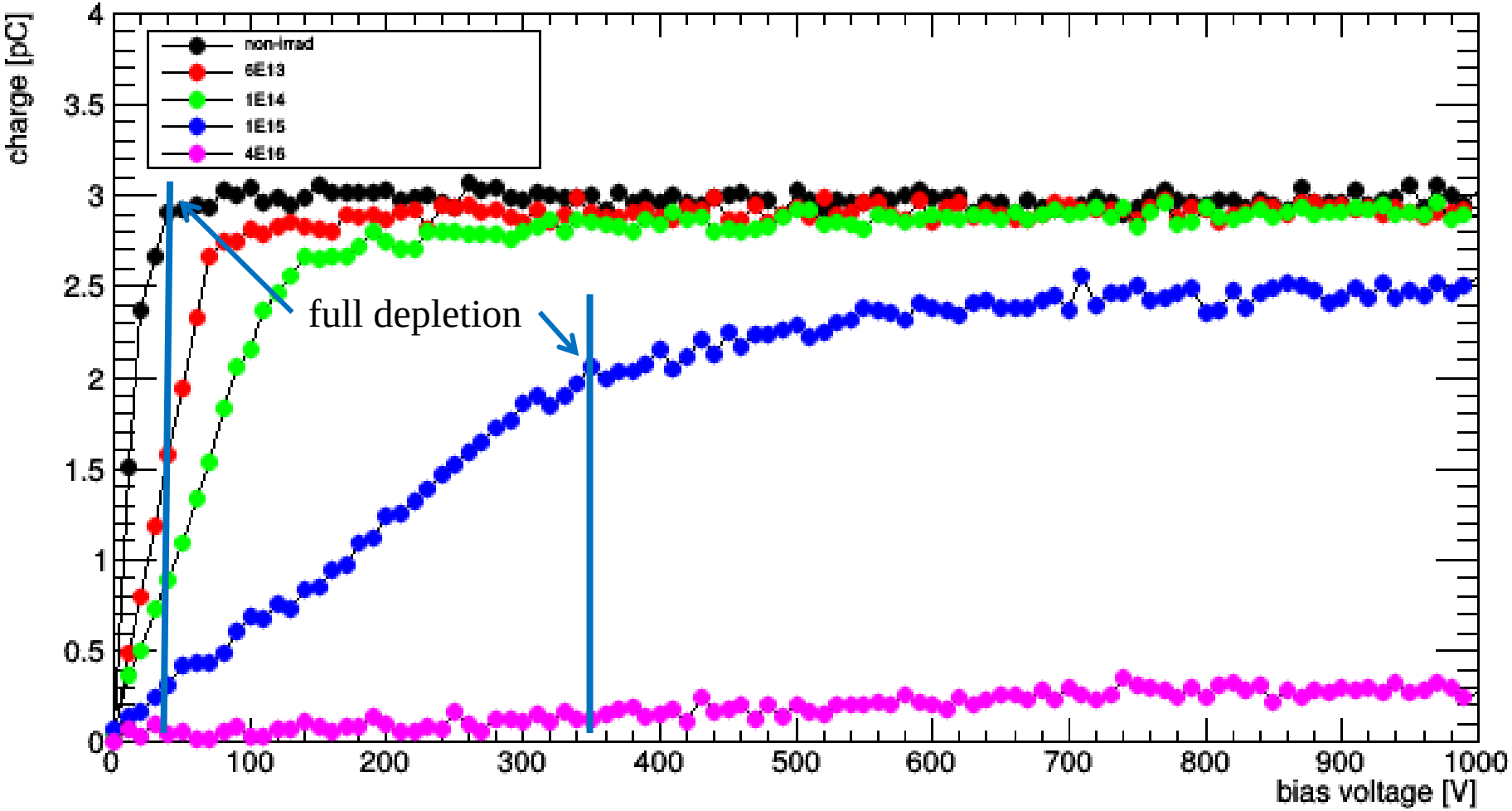


Infra-red from front side (1000V)



Red from back side (1000V)


TCT_Red_back_MCznp_unirrad
current / A
4e-06
3e-06
2e-06
1e-06
0
0
5e-09
1e-08
1.5e-08
2e-08
time / s
0V
50V
100V
150V
200V
250V
300V
350V
400V
450V
500V
550V
600V
700V
800V
900V
1000V



Infrared from front side

Thank you Sascha for the organization and Christian and the SSD group for my great internship

https://www.samson.de/pdf_de/l102de.pdf
http://www.chemgapedia.de/vsengine/vlu/vsc/de/ch/7/tc/regelung/grundlagen/regelung_grundlagen.vlu/Page/vsc/de/ch/7/tc/regelung/grundlagen/regler/pid_ctrl.vscml.html
http://www.physik.uni-augsburg.de/~sausemar/FP14/FP14.pdf
http://en.wikipedia.org/wiki/PID_controller
http://www.hephy.at/fileadmin/user_upload/Publikationen/thesis_auzinger.pdf

Christian Gallrapp

Own measurements

Pictures: own pictures (if not documented differently)

Sources

- Reaction in case of current error

  →reacts immediatly
- Grave errors – strong reaction, little errors– little reaction

P-controller

- focusses on preceded errors

  →delayed reaction
- Strong reaction in case of short times of integration, long times of integration lead to less reaction
- Only put out of the running if measured value constant and no error left

I-Controller

- Focusses only on present change of error, anticipates development

  →fast reaction
- High rate of change leads to strong counteraction
- Responds only to changes, not in case of constant errors (put out of the running)

D-controller