Light Calibration System: Preliminary Characterization

Thorsten Lux

WA105: SETUP-SUMMARY

Light box

X2

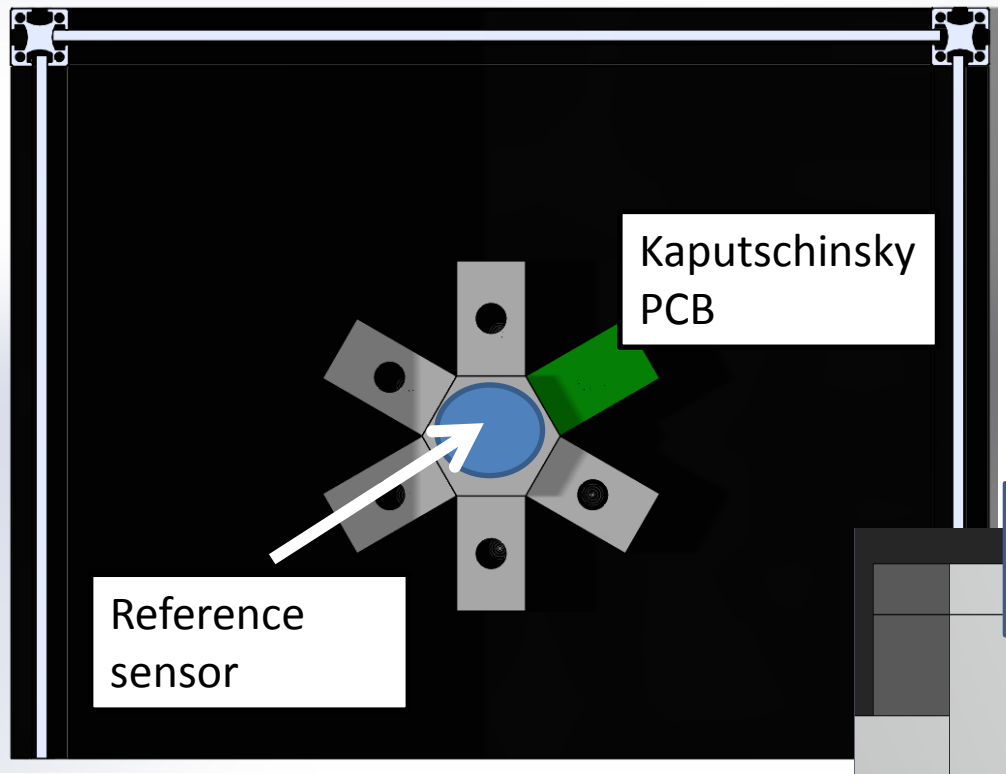
X2

Air

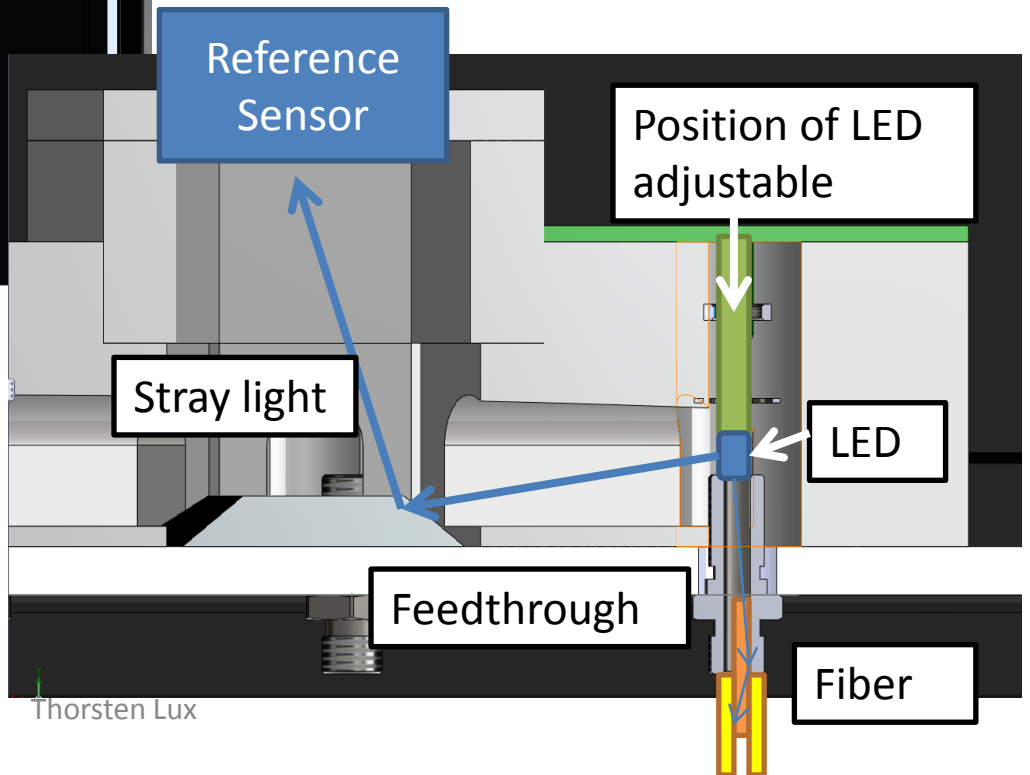
Ar

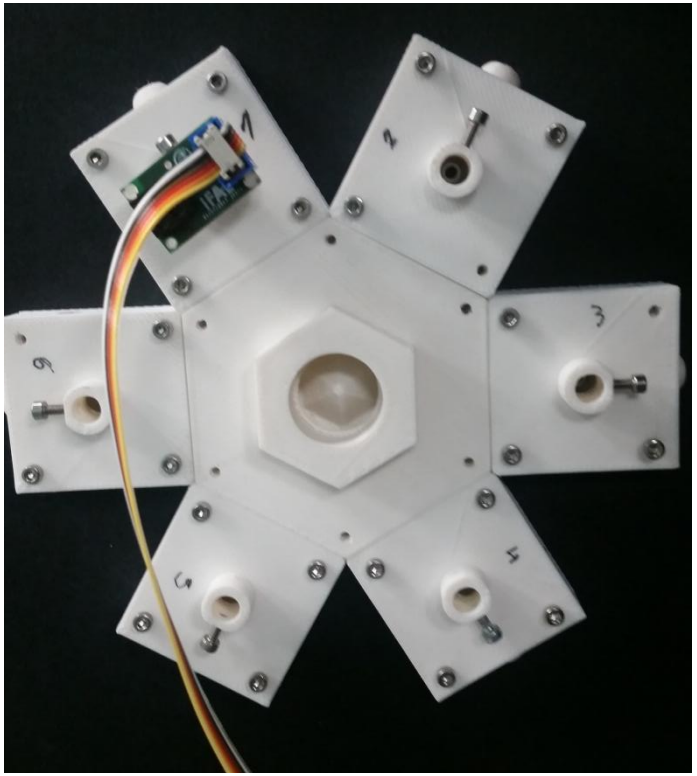
← CIEAMT | IFAE →

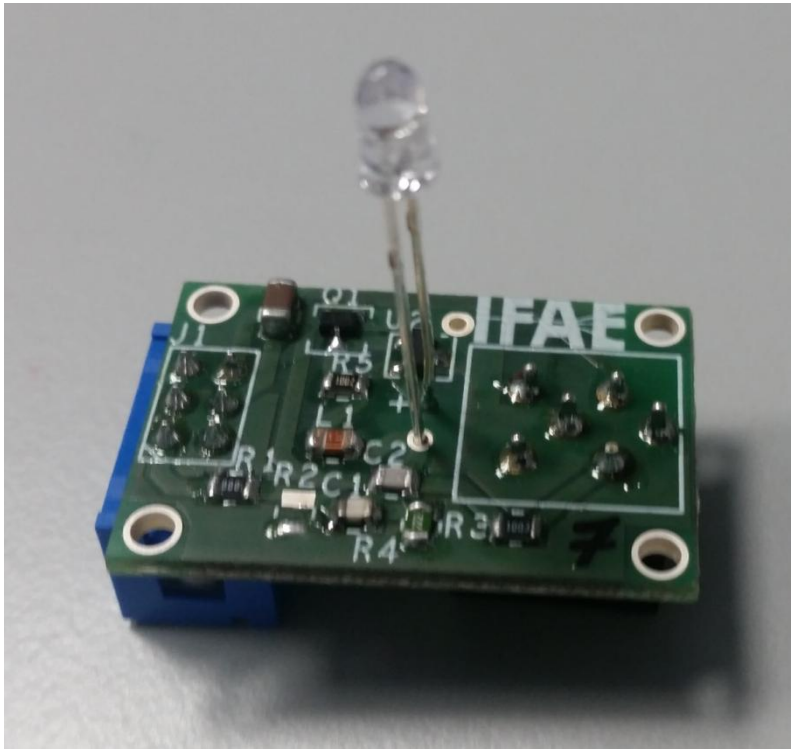
Implementation (Conceptual)

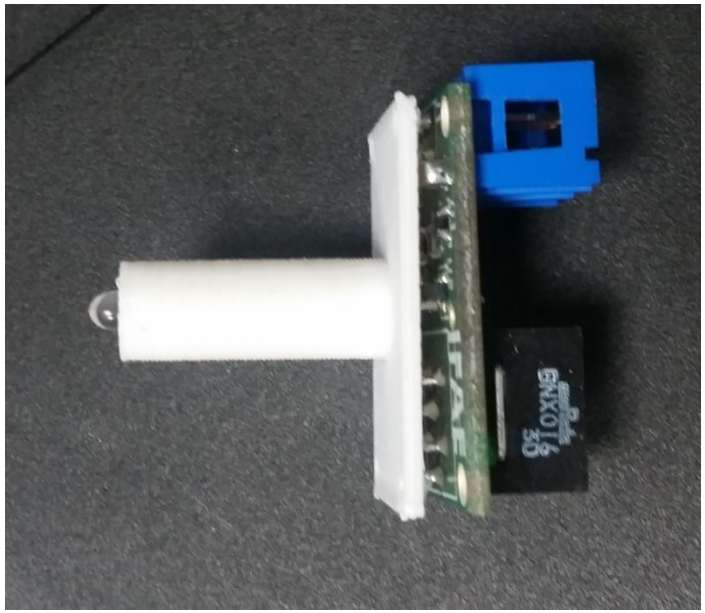


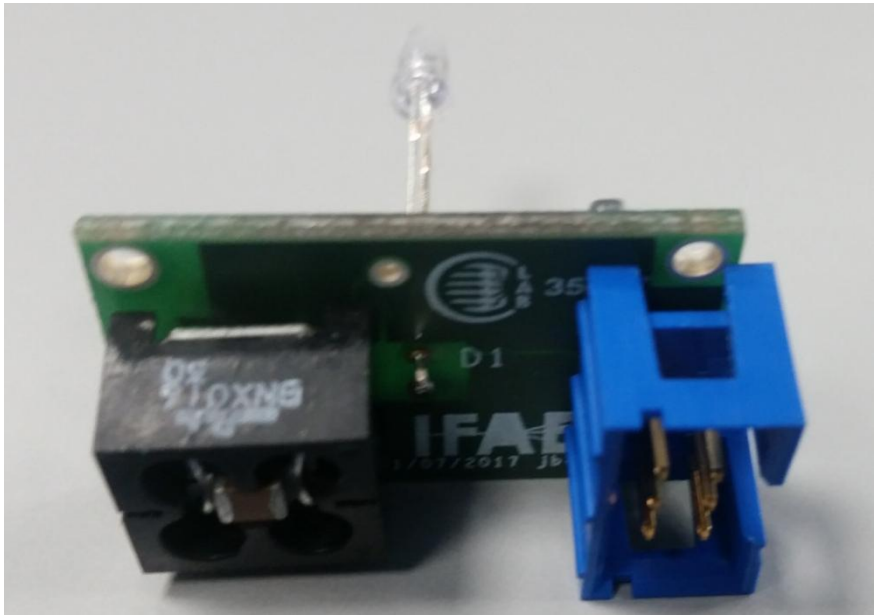
- central reference sensor
- 6 Kaputschinsky PCBs around
- each Kaputschinsky with light cavity to guide light to reference sensor
- material: either 3D printed plastic or aluminium



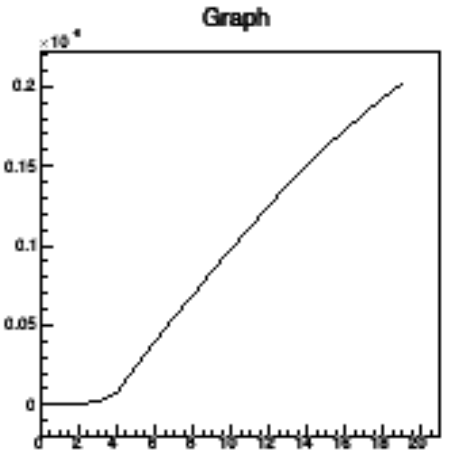

IFAE

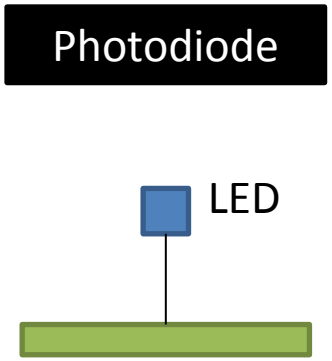

IFAE
R3
L1
C2
R1
R2
C1
R4
R3


IFAE

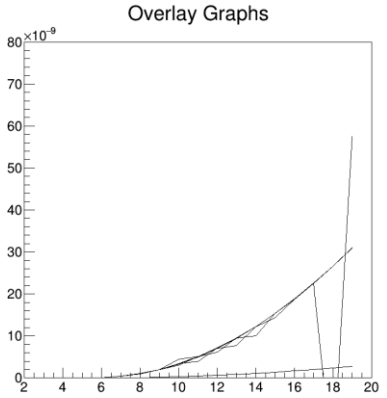

D1
IFAE

First PCB Test



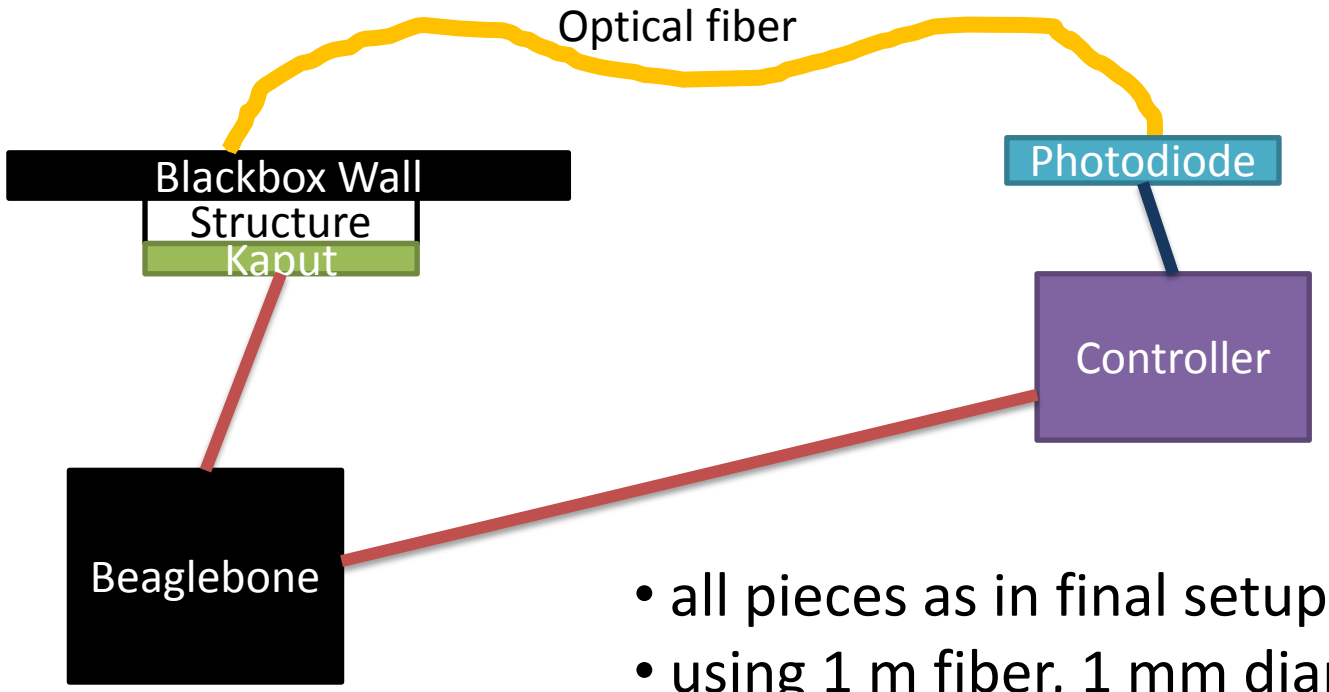


- 7 PCBs assembled
- tested directly in front of photodiode
- 2 of 5 showed strange behaviour (e.g. too much light)
- 5 additional will be assembled
- +/- 30% power output between PCBs

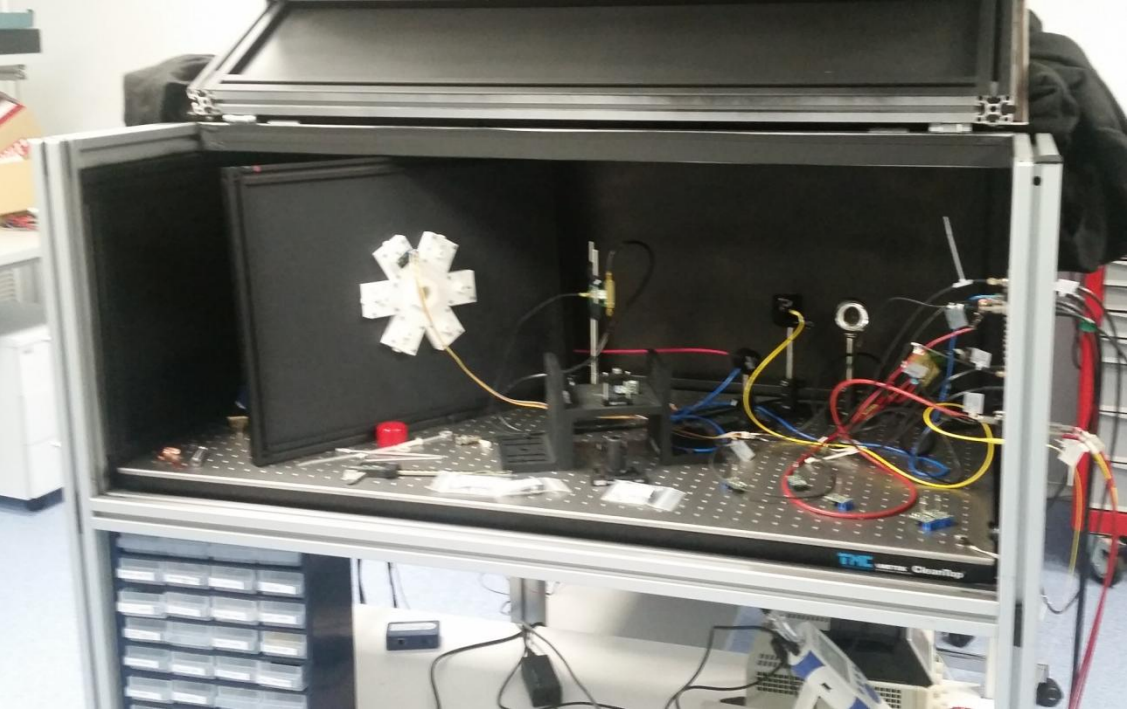


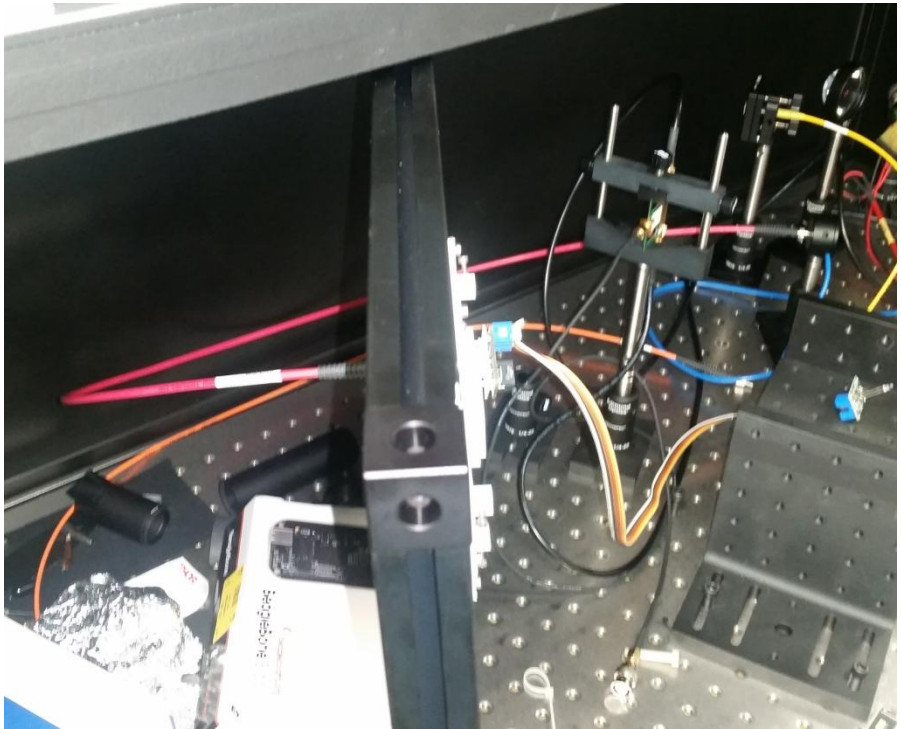
PCB	1	2	3	4	5	6	7
Max. Pulse Energy [pJ] @ 19 V	30.3	X	20.2	X	23.9	19.5	31.3
Max. Power@ 100 Hz [nW] @ 19 V	3		2		2.4	2	3.1

Test Setup

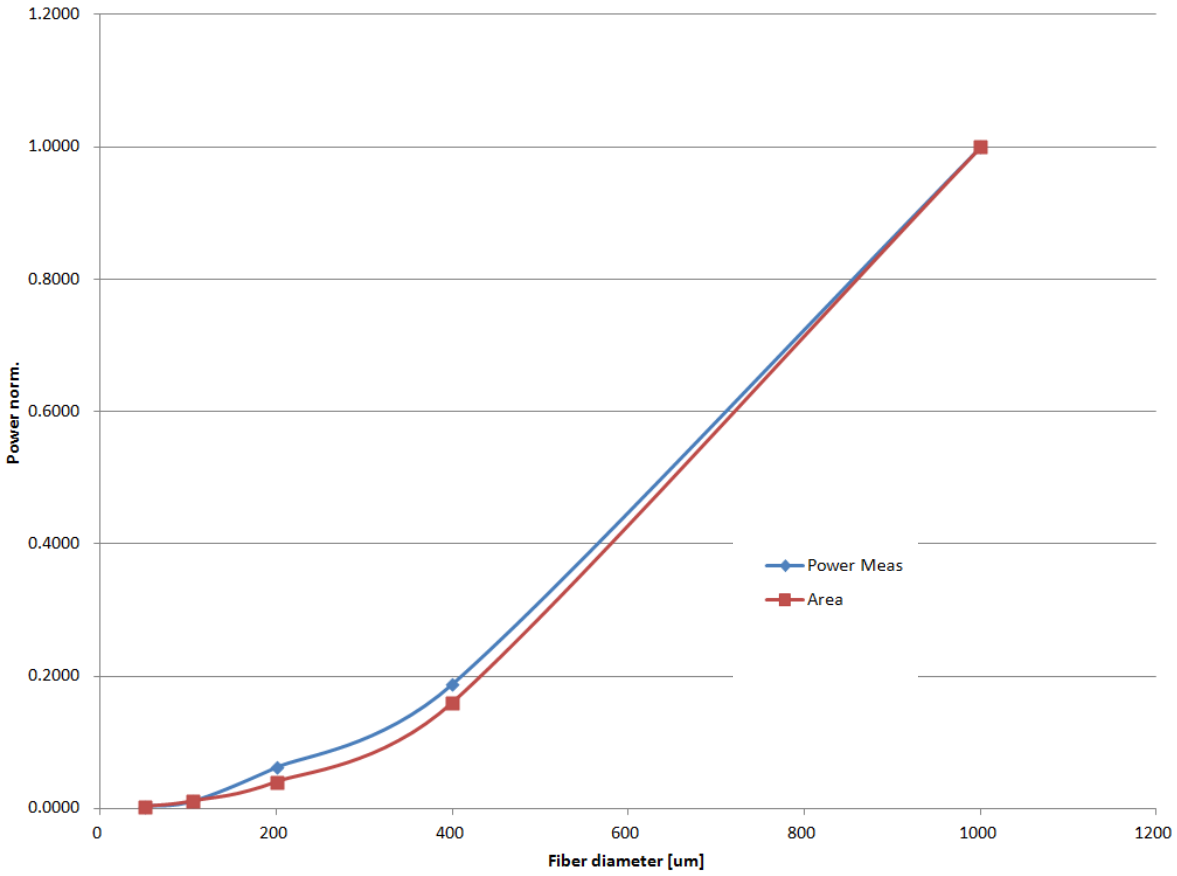


- all pieces as in final setup
- using 1 m fiber, 1 mm diameter reduces power to 1/3
- ~ 1 nW @ 100 Hz



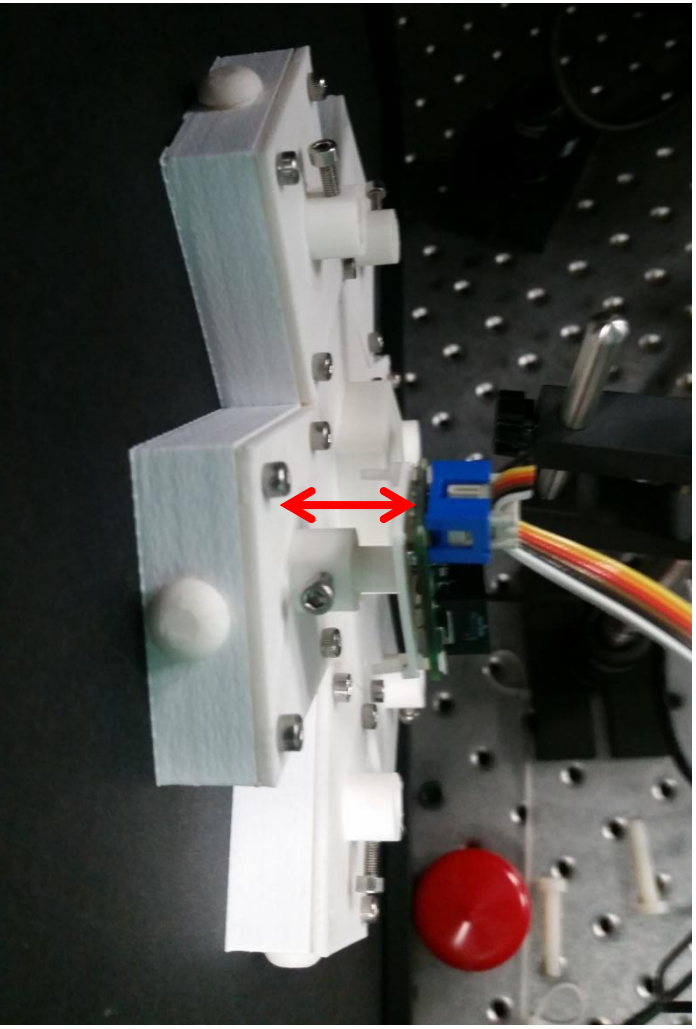


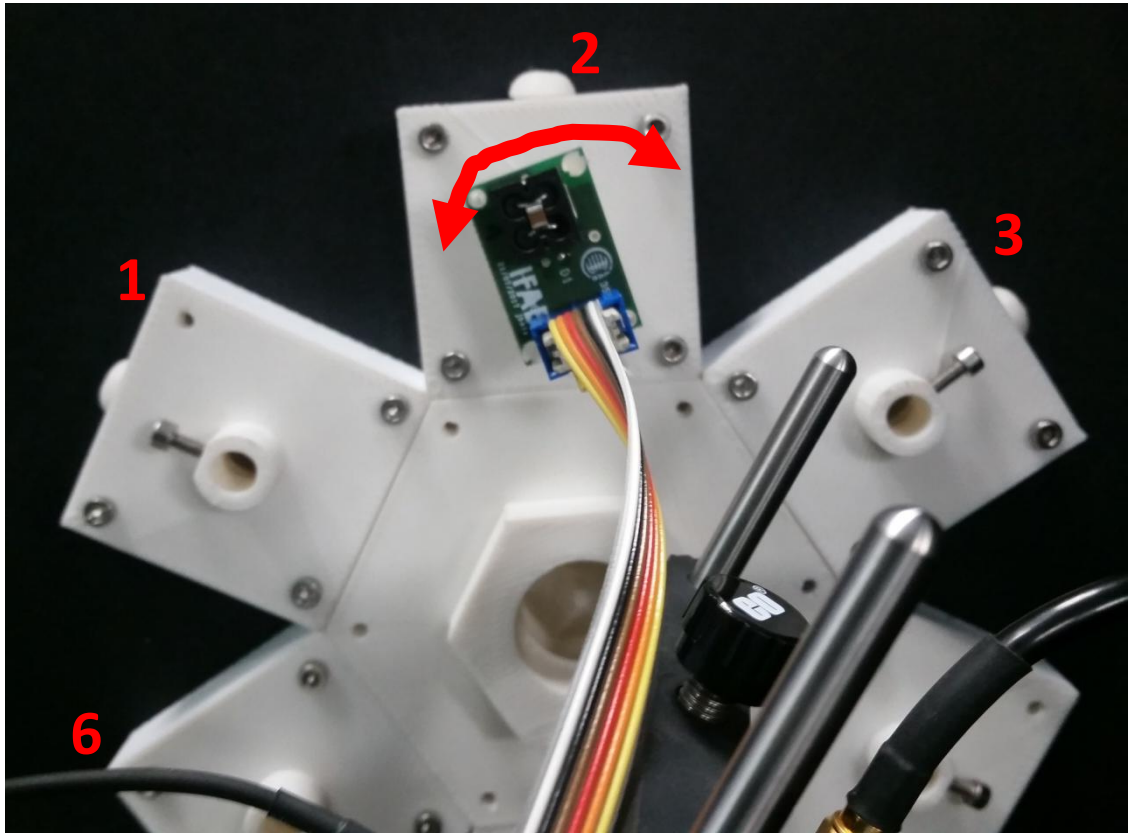
Fiber Diameter Dependence

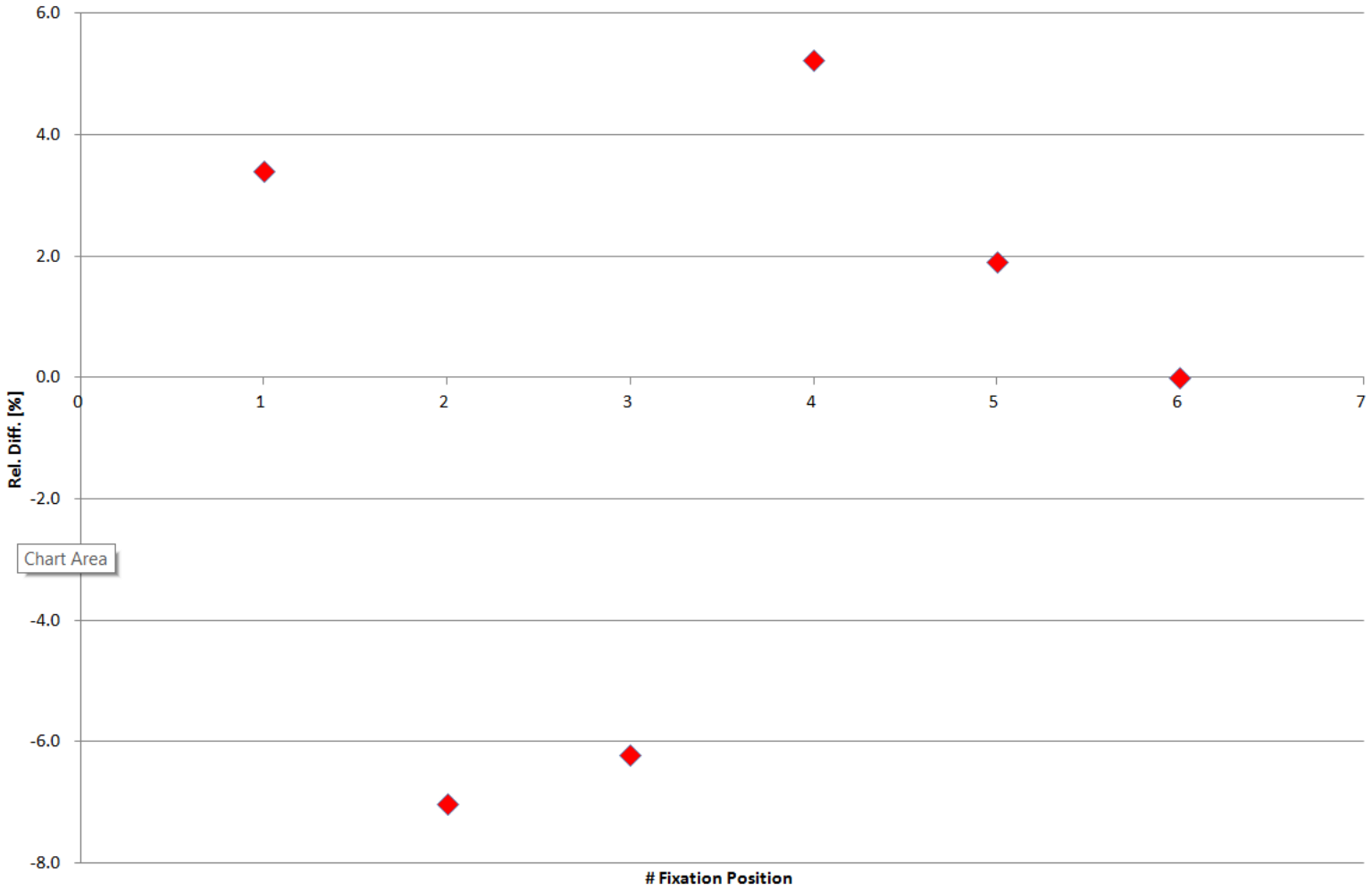


- smaller diameter => less power
- follows well cross section area
- using 50 um instead of 1000 um gives reduction factor of about 400

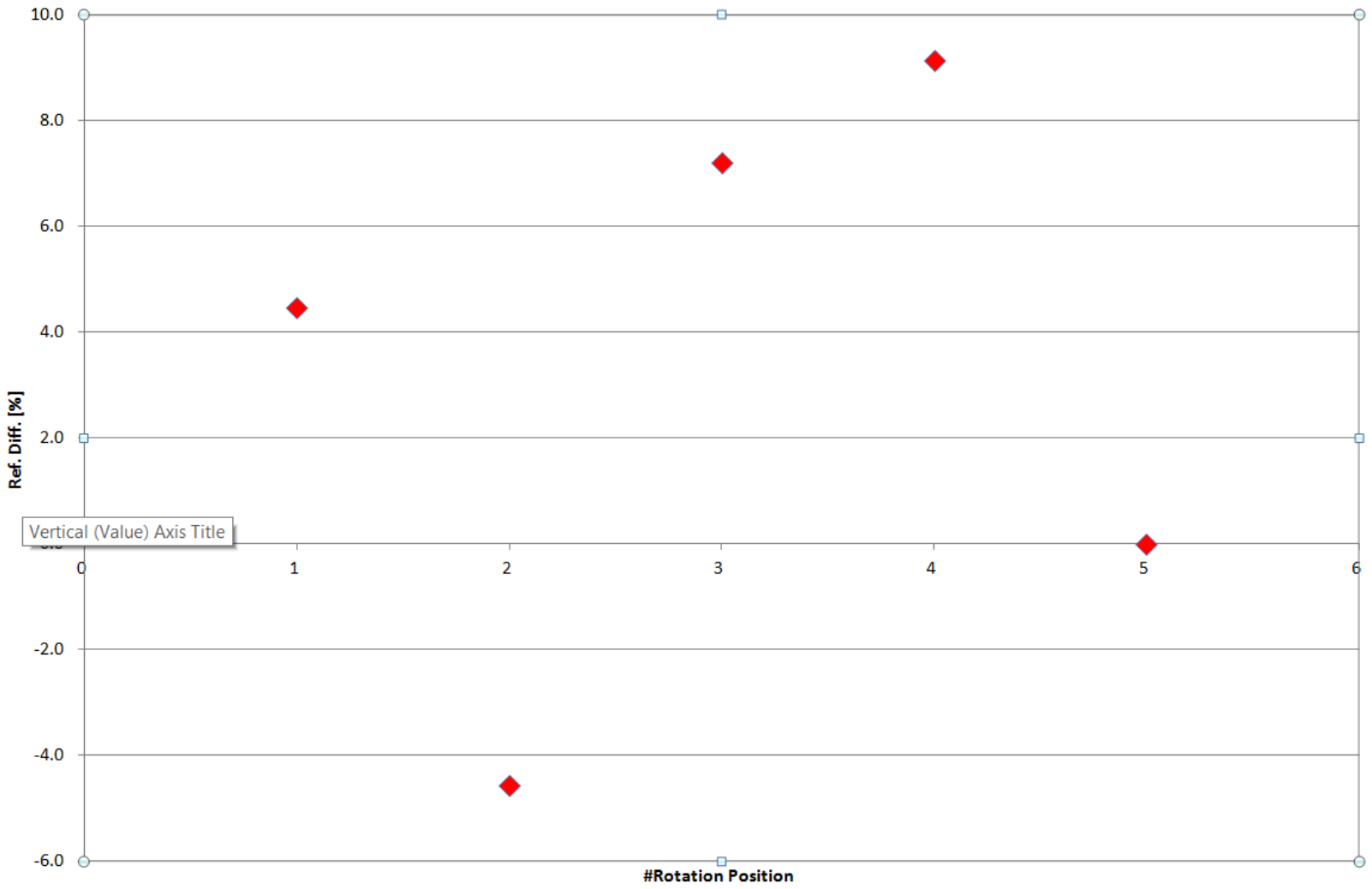
Positioning Effects



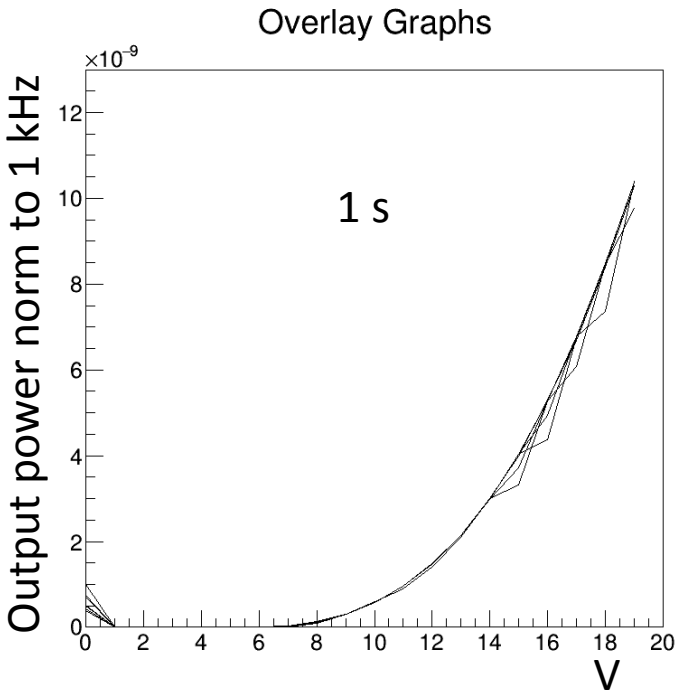




- same PCB and fiber used at all 6 positions
- difference between positions less than +/- 10%

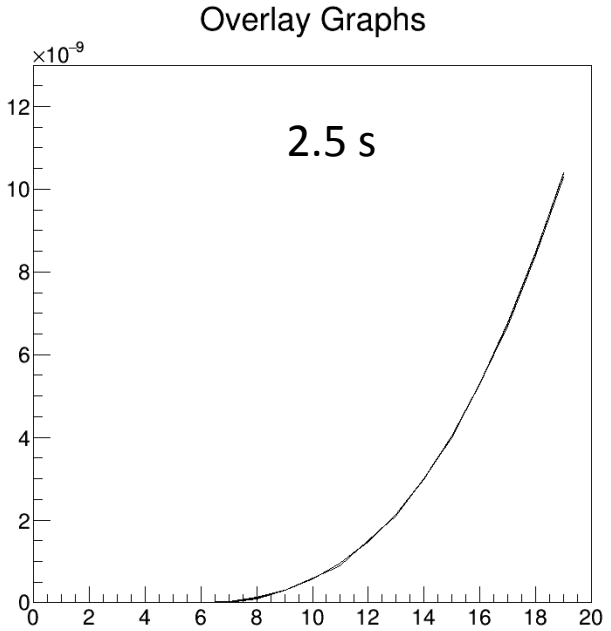


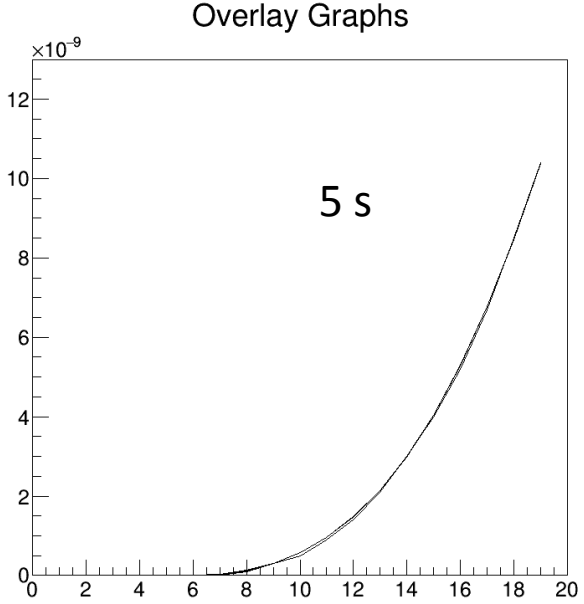
- same PCB, position and fiber used at all 5 rotation positions
- difference between positions less than +/- 10%

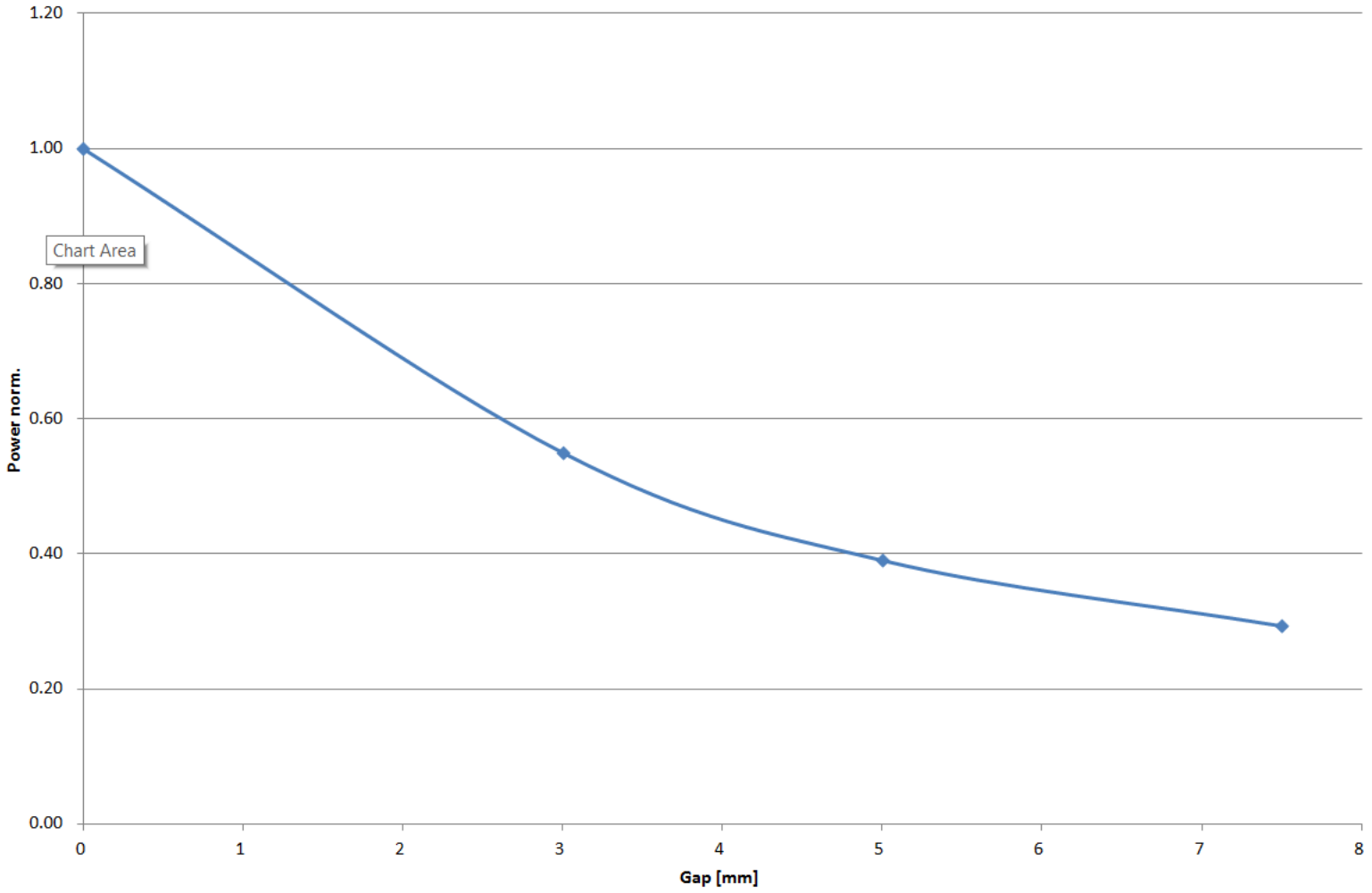


Frequency Sweep

- LED voltage increased from 0 to 19 V
- Output power at end of fiber measured with powermeter
- pulse rate varied between 100 and 10100 Hz
- for plot all power values normalized to 1 kHz
- some fluctuations at the beginning due to too short time between setting voltage and start reading => might contribute to previous variations
- all curves lay perfectly over the other => **system can be operated between 100 Hz and 10 kHz**

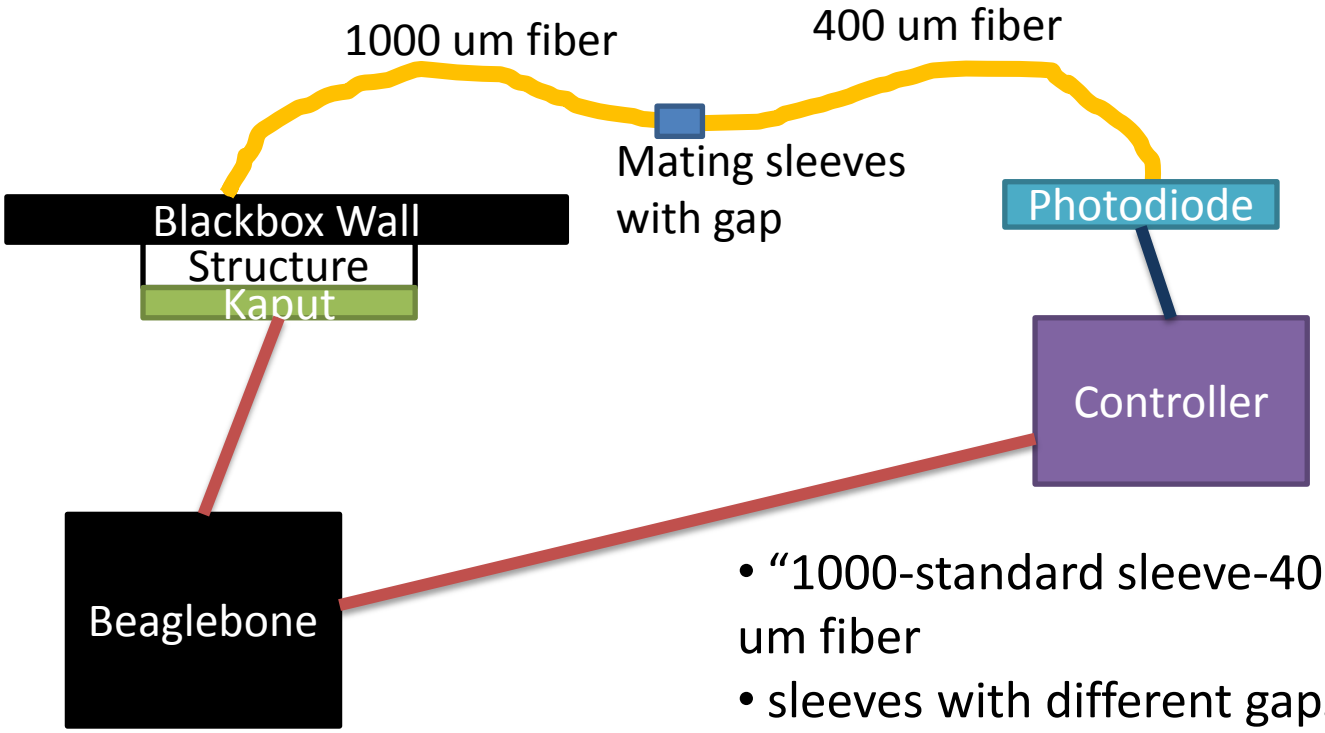




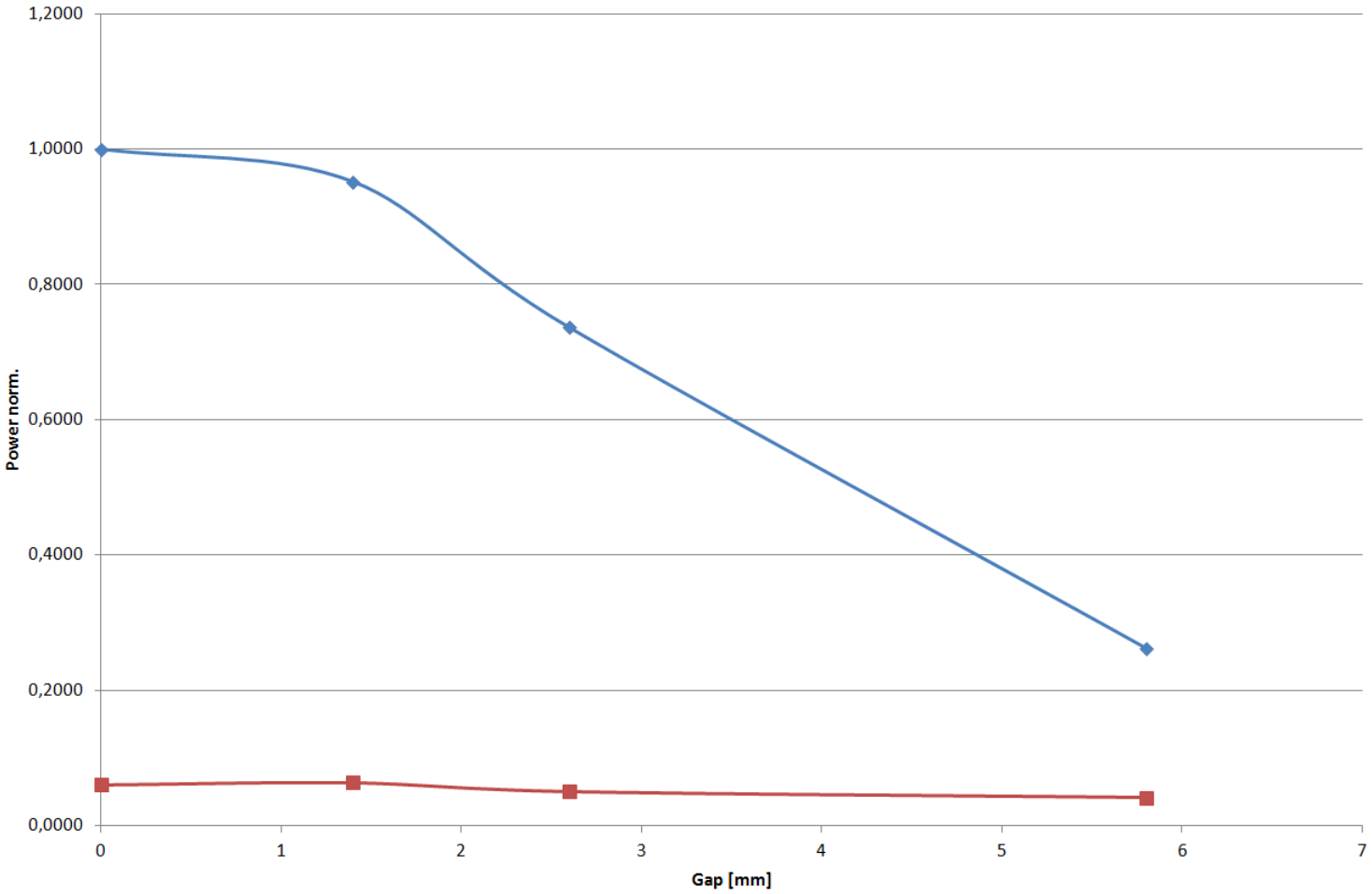


- same PCB, position and fiber used at different gaps
- Reduction factor from 0 to 7.5 mm gap about 3-4

Optical Attenuators



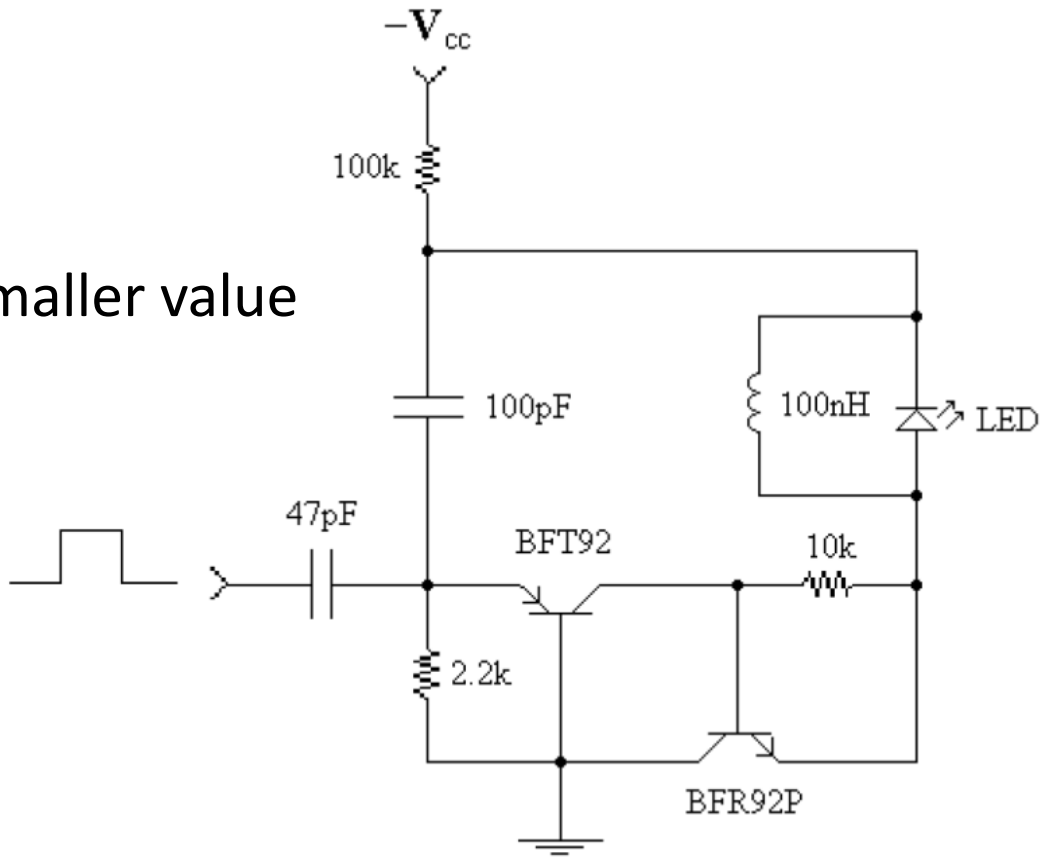
- "1000-standard sleeve-400" 70% of only 400 um fiber
- sleeves with different gaps available



- using 2 fibers (1000 and 400 um) with gap mating sleeve gives another reduction factor of 4-5
- using a standard SMA + gap + 400 um fiber gives a reduction factor of 20-25 => increasing hole in SMA does not seem to change this much

Alternative Reduction Idea

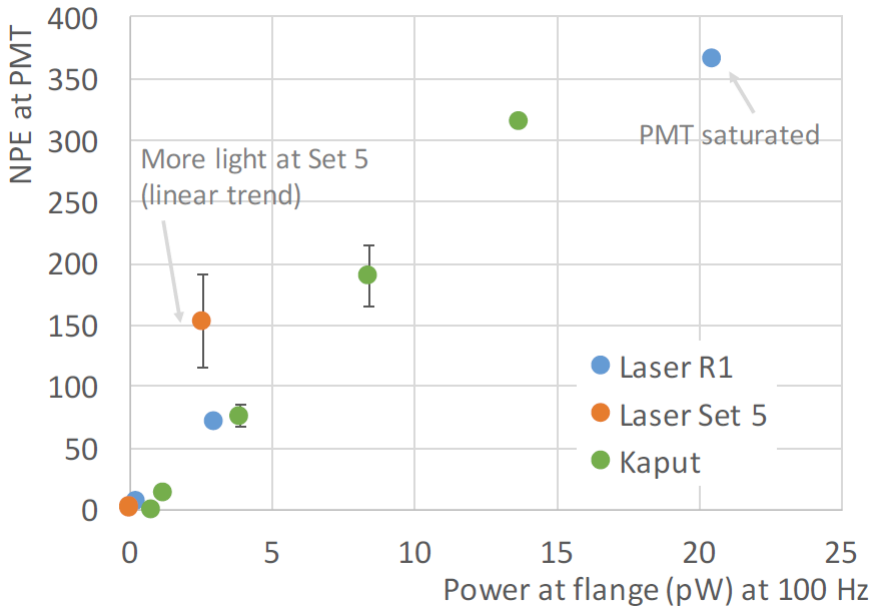
- replace 100 pF by smaller value



Requiered Power/ Pulse Energy

- up to ~ 1 nW@100Hz@19V with 1 mm diameter fiber => 10 pJ per light pulse
- up to 20 pW@100Hz requested => 0.2 pJ per light pulse
- large variety of options to match PCB output to required power at flange input
- simplest would be to use 400 um fiber instead of 1000 um fiber => 2 pJ per light pulse which could be reduced to 2/3 by positioning of PCB and finally limiting the LED voltage to up to 13 V instead of 19 V
- Open question for us still: makes 100 Hz limitation sense in detector with ~10 kHz of cosmics and ~200 kHz of Ar39?

From Clara's talk in September:



Recommendation:
Range required at flange: 0.02 – 20 pW

Status

- 20 PCBs were ordered, 7 assembled, 5 working and 5 additional are currently assembled
- PCBs were tested and the whole system characterized preliminary
- Differences between PCBs much larger than positioning issues
- Various reduction methods tested to match the output power to the one needed to get single photons
- Most of pieces at IFAE => final fibers to be ordered
- From this side on track for tests end of February
- Reference sensor/DAQ/... => Joan’s talk