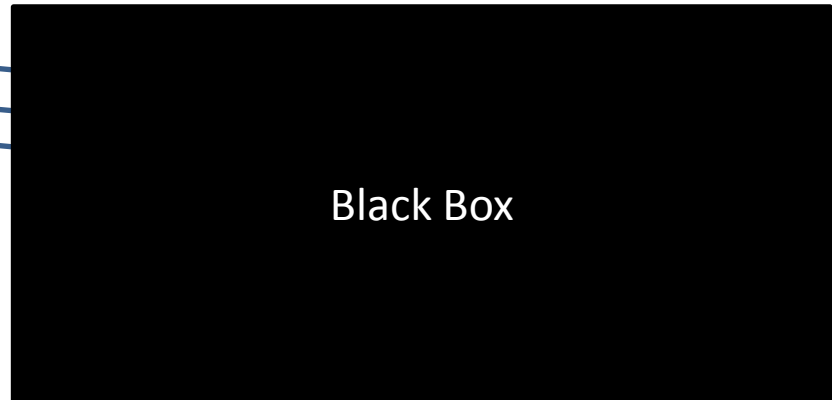
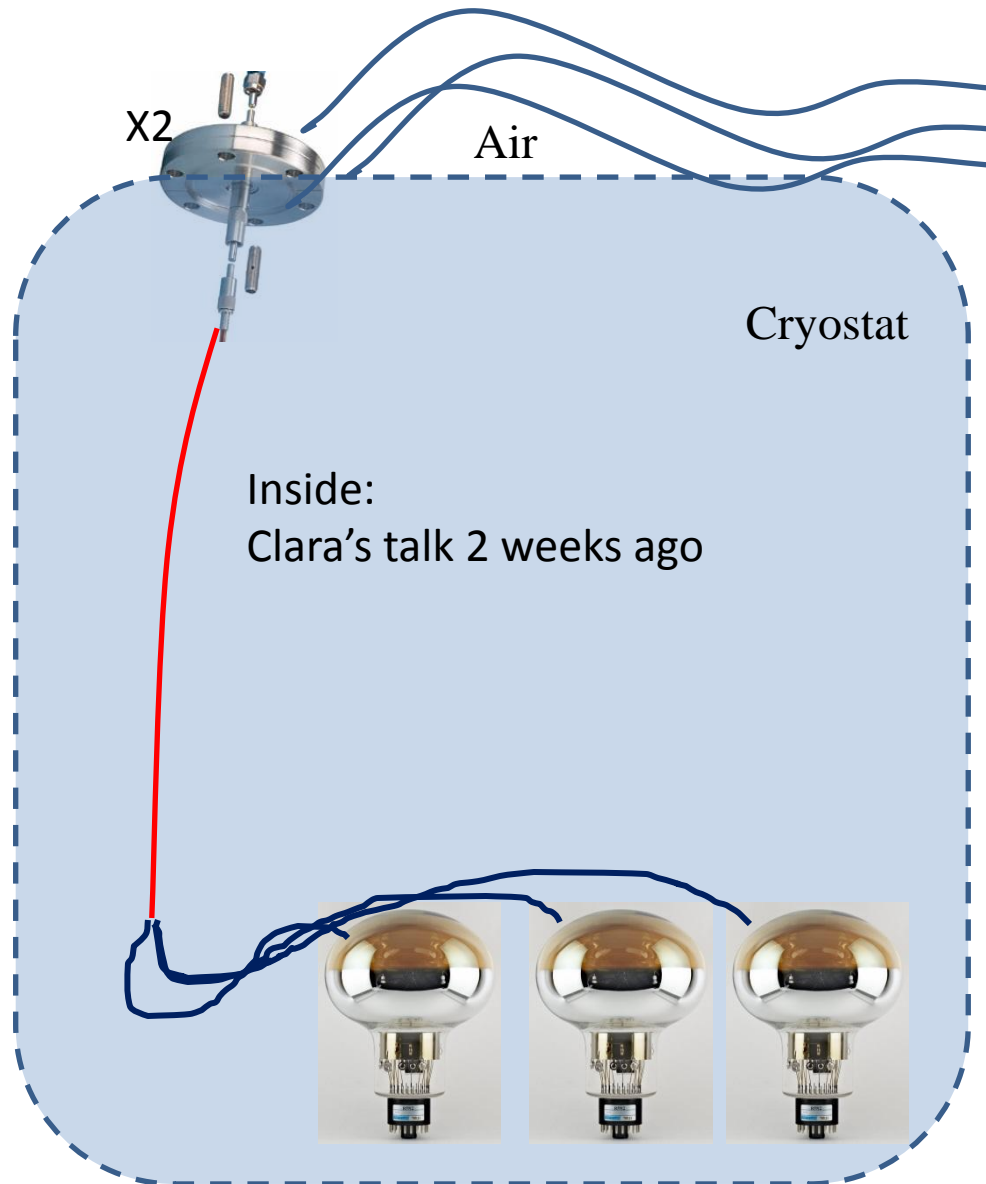


# Light Calibration System

Thorsten Lux

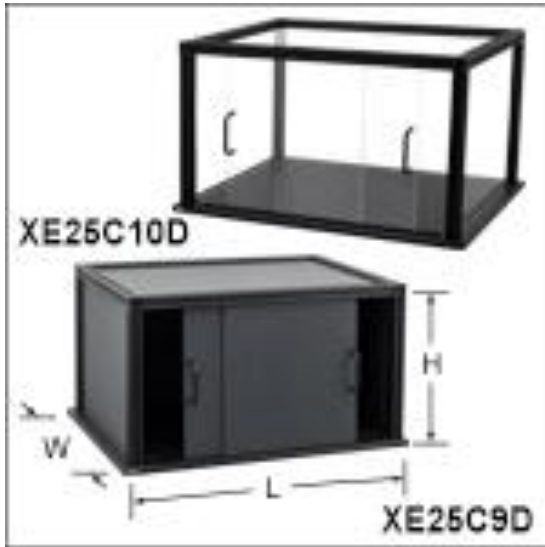


# Overall Conceptual Design



- 2 feedthroughs CF40, each with 3 optical feedthroughs
- 6 SMA optical fibers from feedthrough to black box
- black box containing light source
- black box on top of cryostat

# Components



- Commercial box from Thorlabs: 525 mm x 375 mm x 300 mm (L x W x H)

- Kaputschinsky LED drivers as light source (<https://arxiv.org/ftp/physics/papers/0410/0410281.pdf>)

- Provides fast pulses of few ns

- Rate: 1 kHz (possible to increase to around 10 kHz)

- 2 voltages needed:

- DC between 0 and -20 V for intensity

- pulsed to trigger light pulse

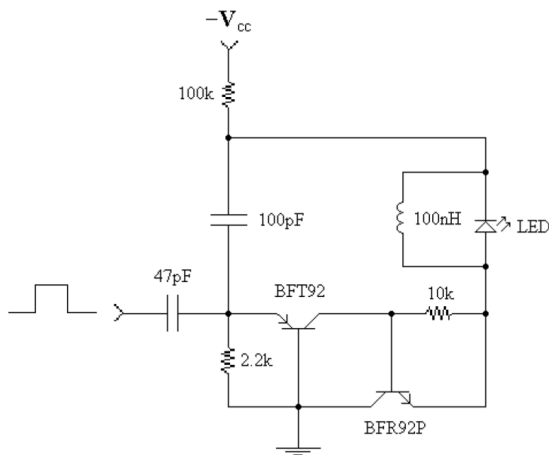
- Default LED: NSPB300B (465 nm) (more later)

- BeagleBoard (BeagleBoard.org)

- Easy control via ethernet e.g. with Python

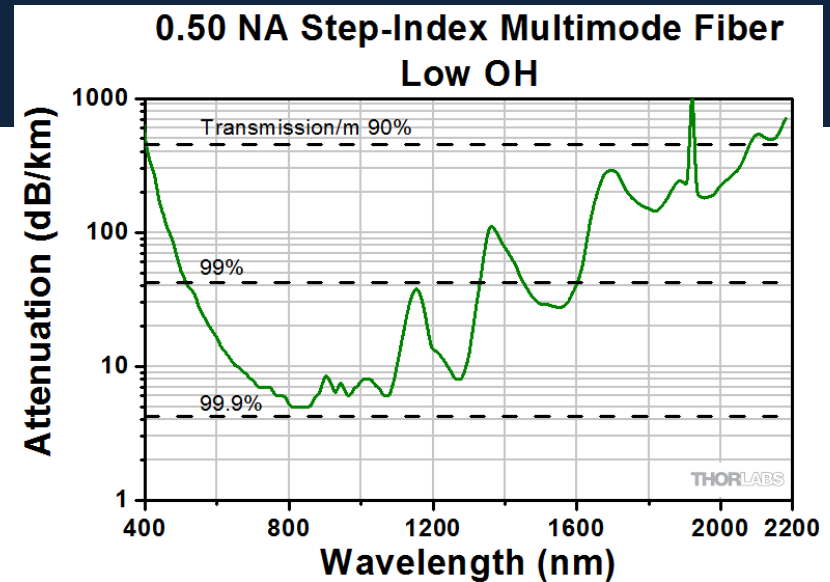
- 8 outputs to provide pulses for Kaputschinsky and also TTL signal for trigger

- 7 ADC channels e.g. to read temperature sensor

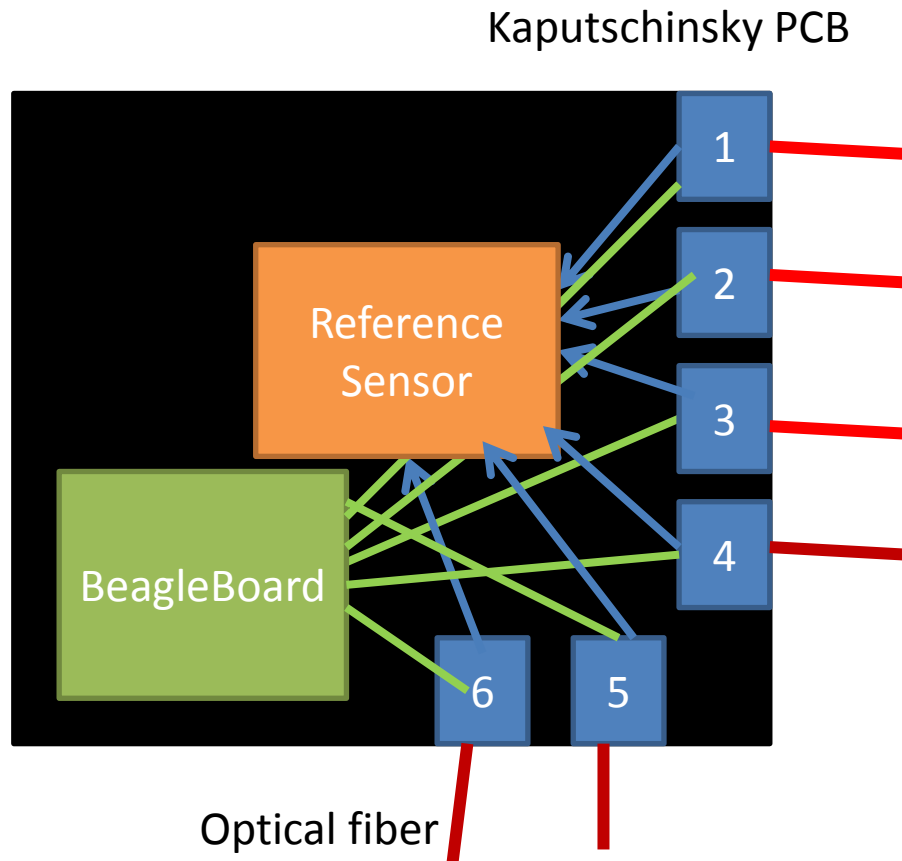


# Components

- SMA-SMA fiber from Thorlabs (1000 um diameter): **M59L**
- SMA-SMA feedthrough from Thorlabs: **ADASMA**
- Optical fiber on one side – LED directly on other side
- Reference sensor still open point
- Powermeter seem not to work (see later)
- Either SiPM or PMT
- In contact with Cayetano to check if spare readout channel is available to digitize reference sensor
- Alternative: use ADC of BeagleBoard

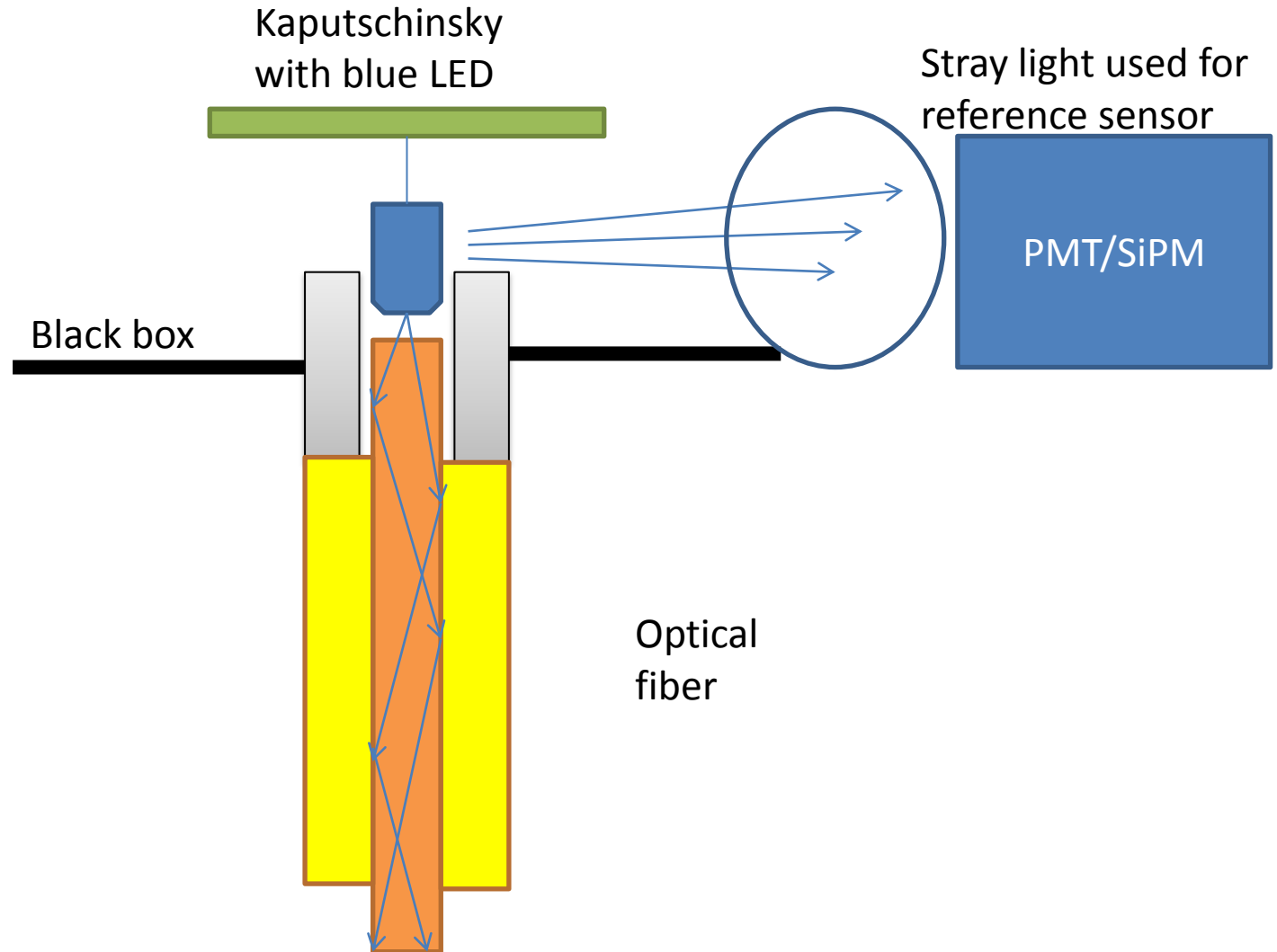


# Black Box

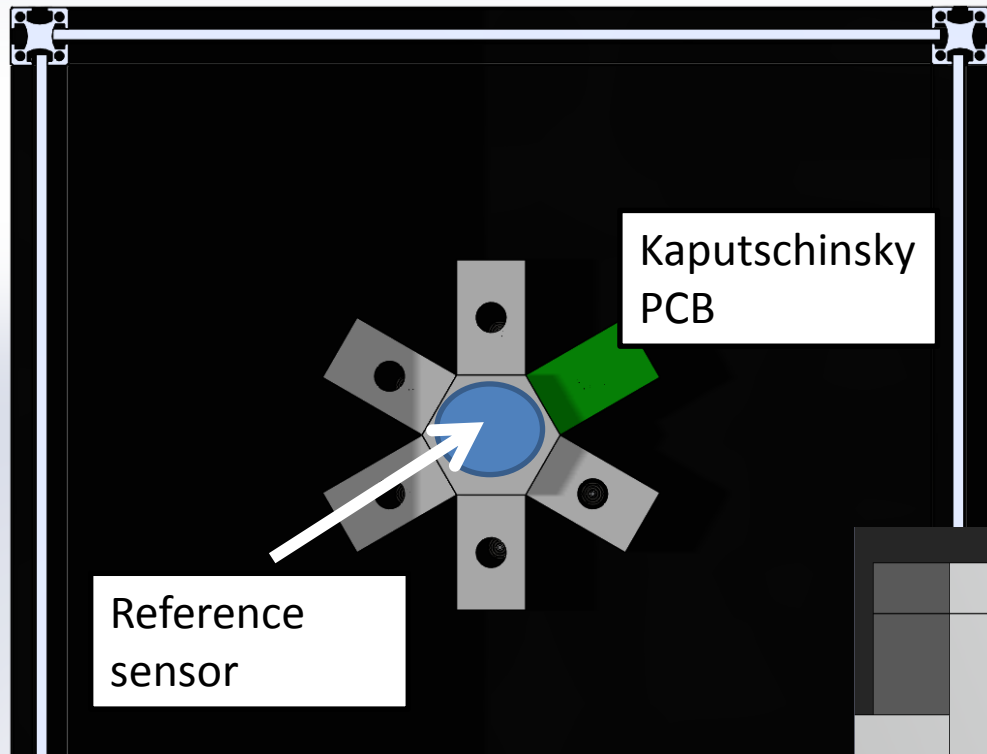


- 6 Kaputschinsky LED driver
- All 6 controlled by 1 BeagleBoard
- LEDs can be switched on individually, in groups or all together
- each LED coupled to an individual SMA optical fiber
- 3 fibers going to one CF40 flange
- One DC voltage for all 6 Kaputschinsky

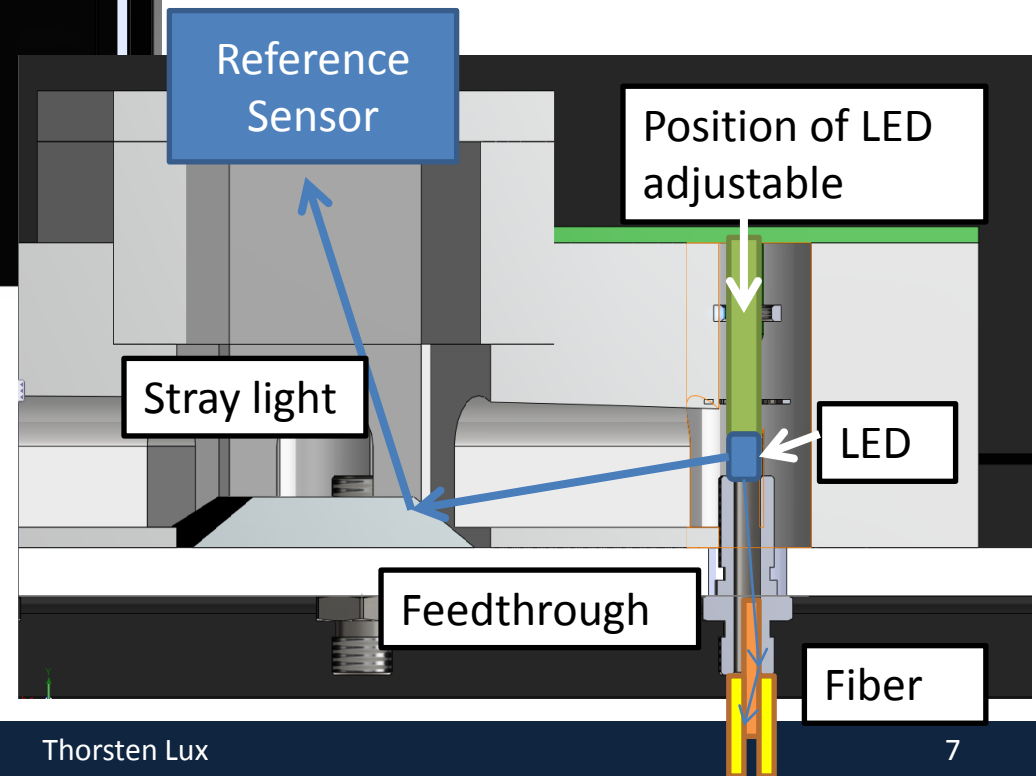
# LED Coupling to Optical Fiber



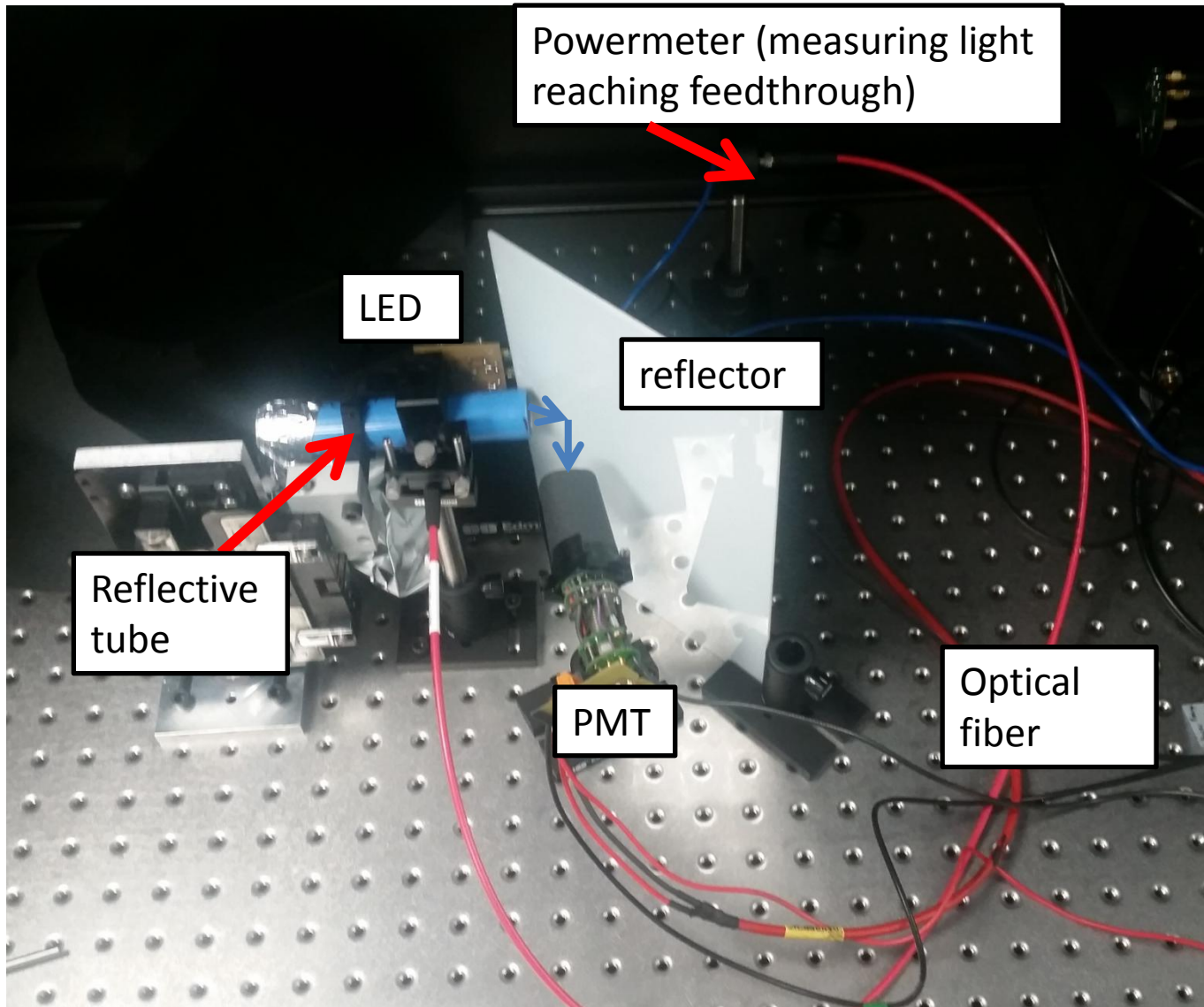
# Implementation (Conceptual)



- 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



# Proof-of-Principle Tests

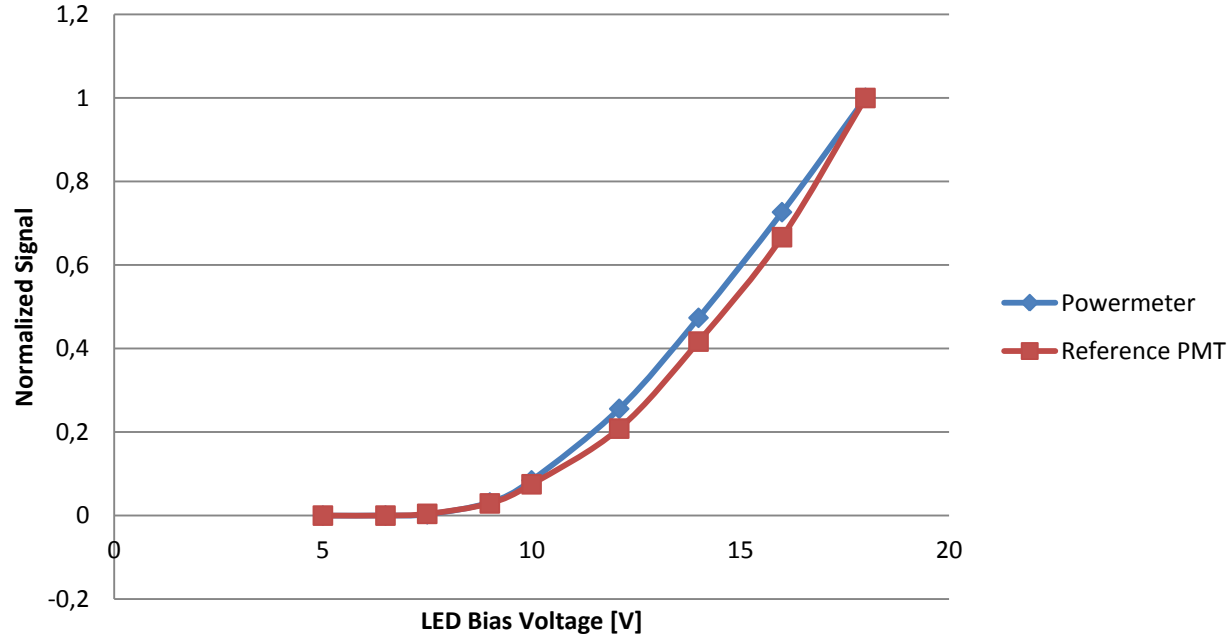




# Comparison PMT and Powermeter

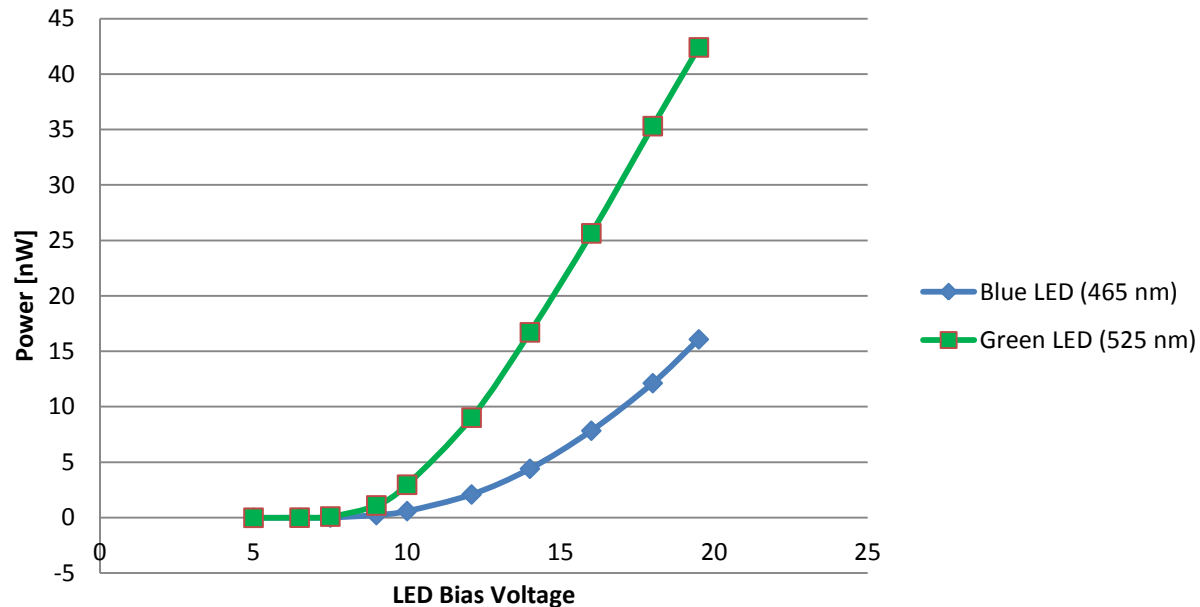
- Signal from PMT compared with signal from powermeter
- normalized to largest signal
- similar shape (amplitude of PMT read by eye from oscilloscope => large error)

=> “stray light” detected by reference light will allow to estimate injected light to PMTs

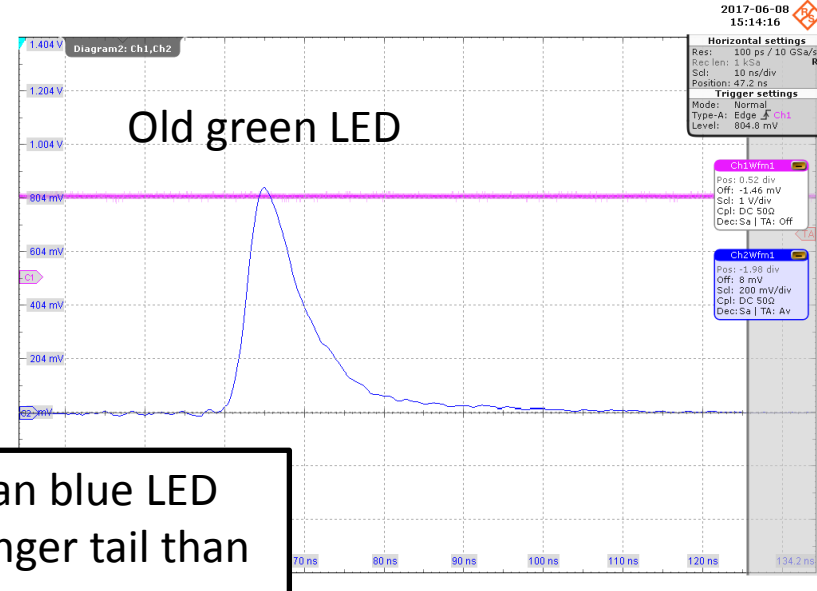
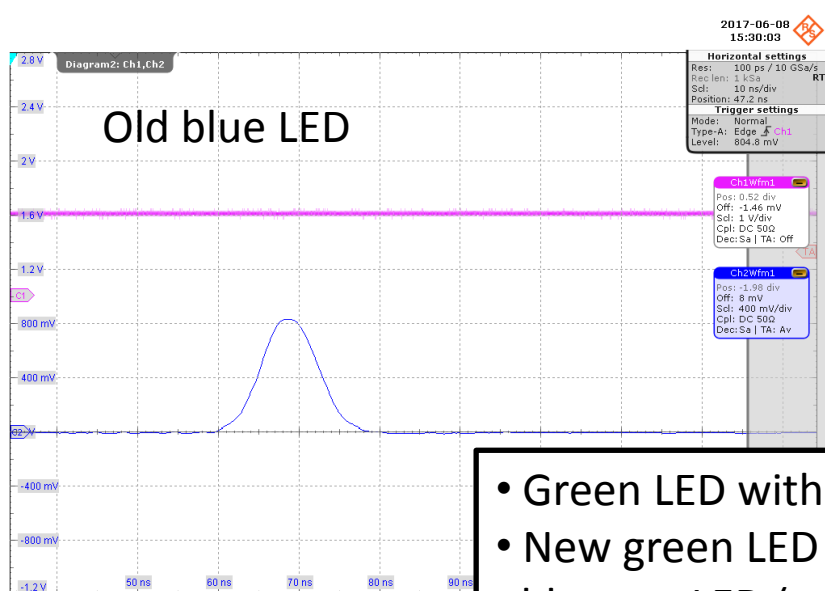


# Testing various LEDs

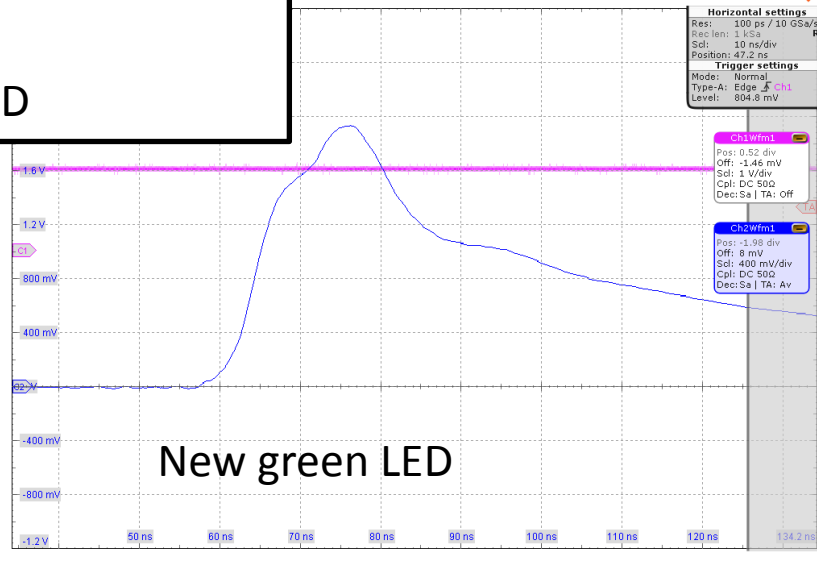
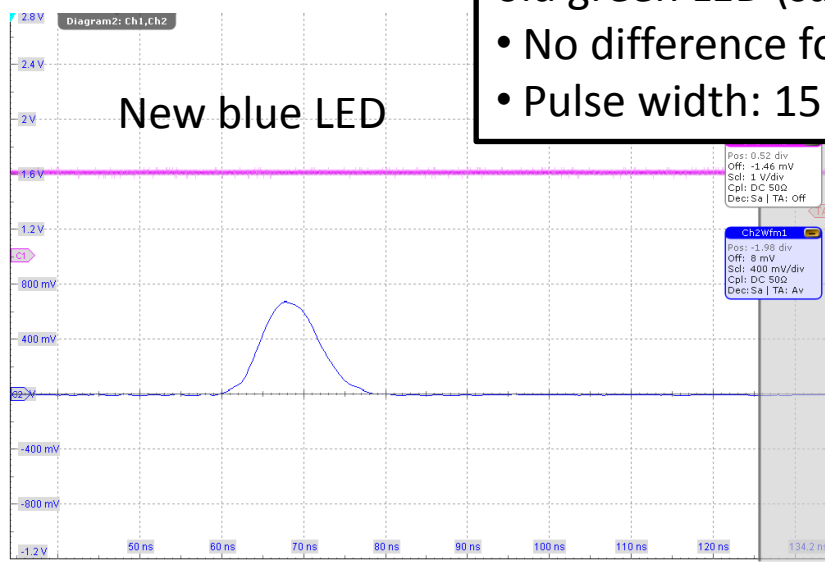
- Testing various LEDs: 465 nm, 525 nm, 3 of 430 nm
- the 3 LEDs of 430 nm do not/ almost not work with Kaputschinsky
- Trying to find other 430 nm LEDs
- Green LED more power than blue LED
- 15 nW (blue) correspond to  $3.5E10$  photons of 465 nm per pulse (1 kHz) reaching the feedthrough on top of the cryostat



# Time Structure of Light Pulse



- Green LED with longer tail than blue LED
- New green LED with much longer tail than old green LED (same model)
- No difference for blue LEDs
- Pulse width: 15 ns for blue LED



# Summary

- The light calibration system be based on 6 Kaputschinsky LED driver
- Blue LED (465 nm) default choice currently
- BeagleBoard will allow to control drivers (individually, groups, all together)
- 1 reference sensor: **SiPM** or PMT
- Either standard ADC to digitize signal or built-in ADC
- Needed cables:
  - 3 BNC cables
  - 1 Ethernet cable
  - 1 trigger out cable
  - 2 spare cables
- Simplified test of the principle performed successfully
- Most of the commercial parts ordered
- Production drawings in process for light cavity and LED driver PCB