SPL Wire Position Monitor System

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Linacs for High Power Proton Beams
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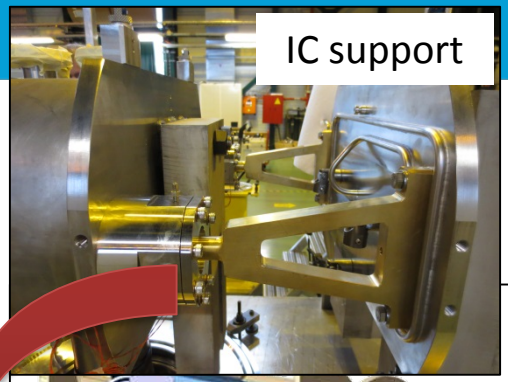
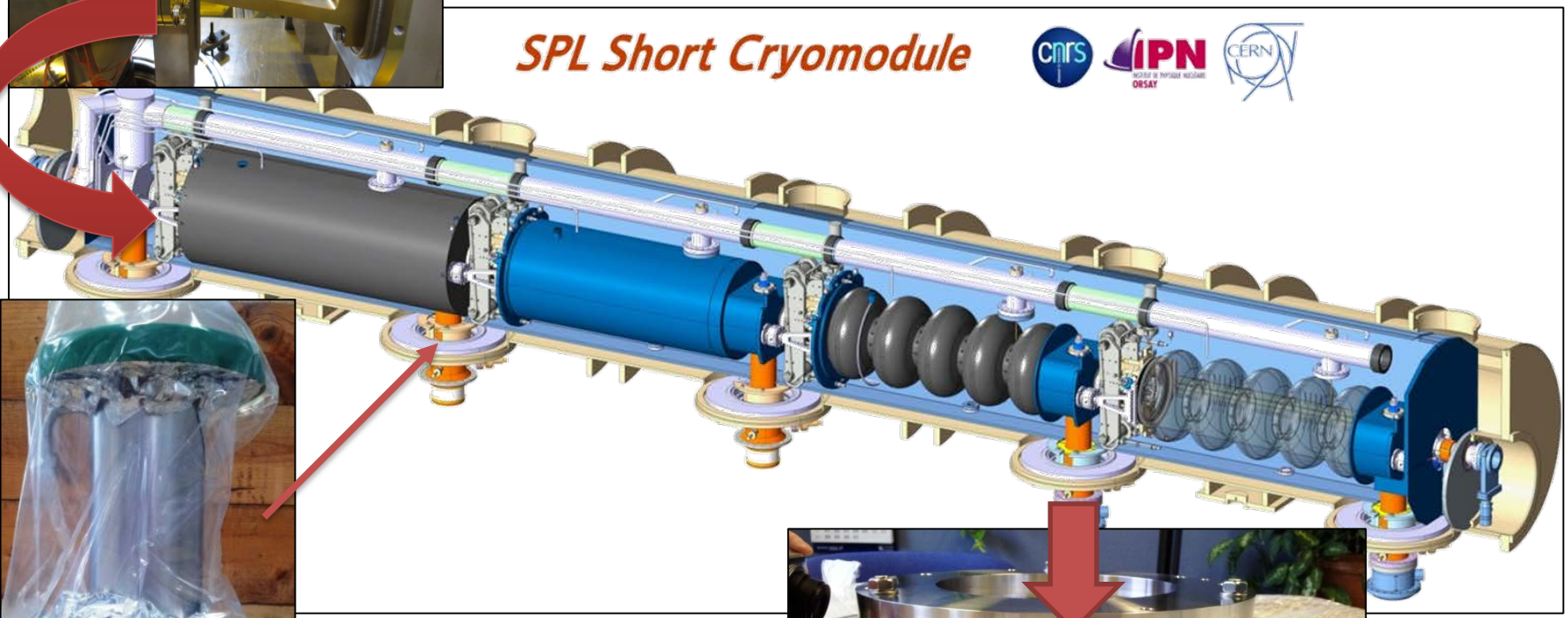
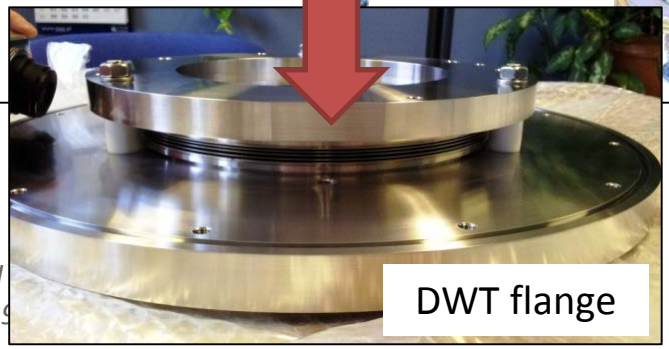
Outline

- SPL Short Cyromodule
- Application of the OWPM in the SPL Mock-up
- Idea of the Optical Wire Position Monitor
- Calibration at warm
- Tests at liquid nitrogen
- Intermediate conclusions
- Fiber optics
- Future steps

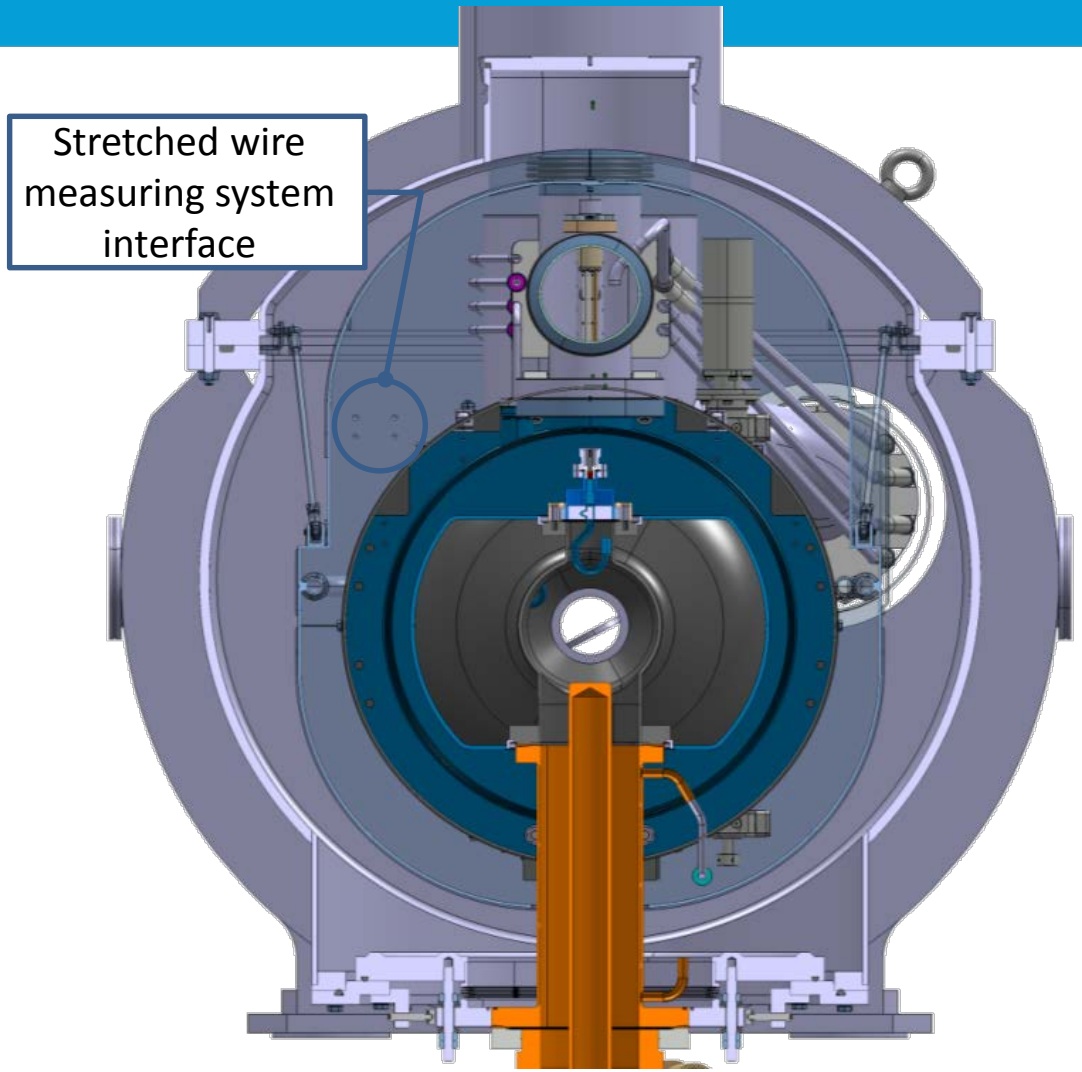
SPL Short Cryomodule







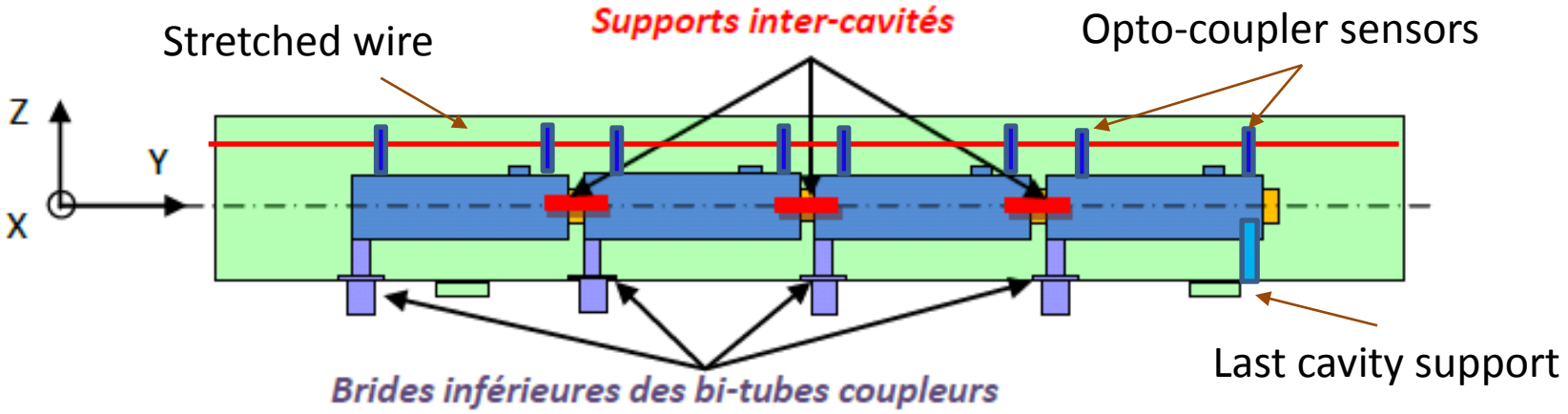
OWPM position on the SPL SCM



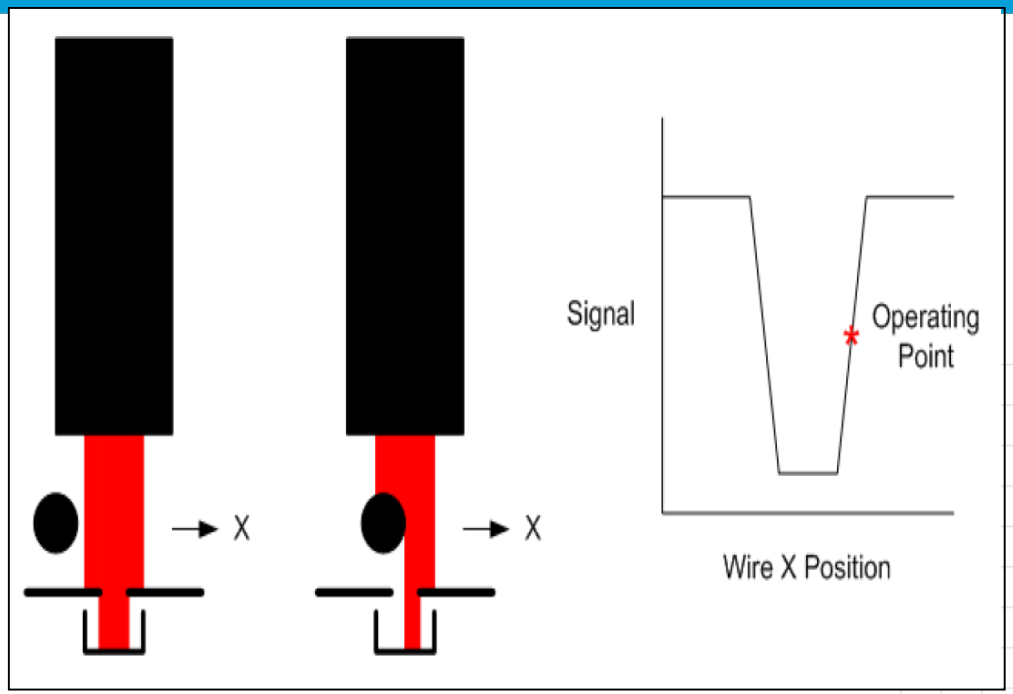
Courtesy of CNRS

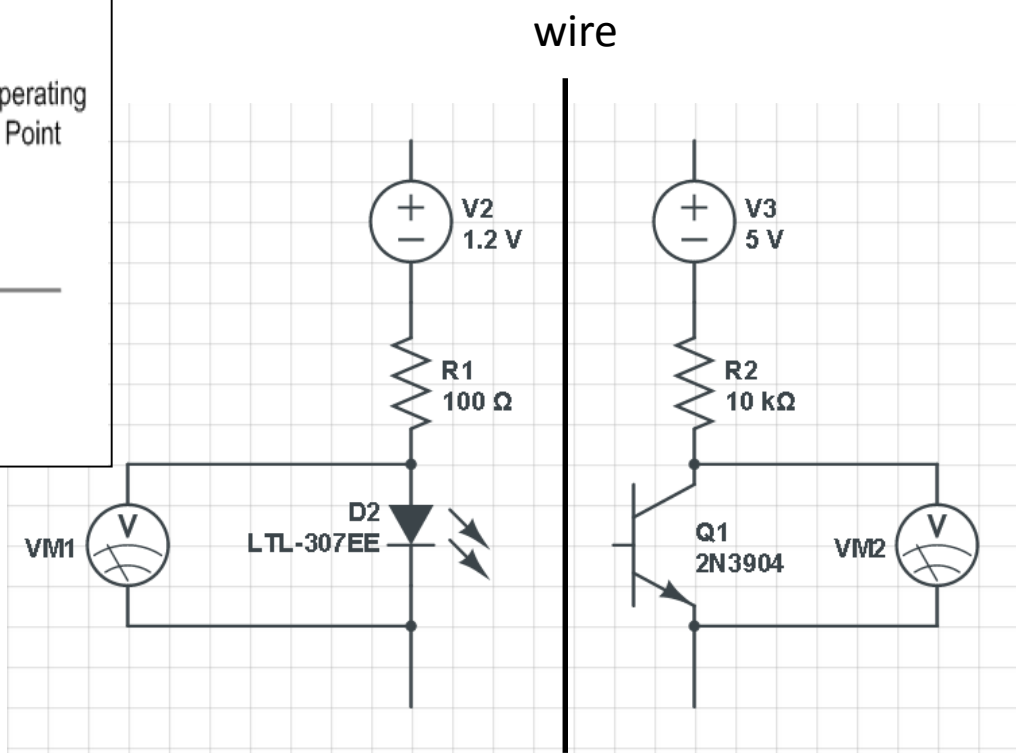
SPL SCM Cavity position monitoring specs:

- Static position or slow movements: absolute movements (x,y,z) of each of 4 cavities during steady state operation and cool-down/warm-ups (300-2K)
- Vertical range 0-2 mm
- Precision < 0.05 mm
- Resolution < 0.01 mm
- Possibly vibration measures (0-1 kHz)



How does it work?





LED and photo-transistor

GaAlAs Infrared Emitters (880 nm)
Lead (Pb) Free Product - RoHS Compliant

SFH 484
SFH 485

SFH 484

Features

- Very highly efficient GaAlAs-LED
- High reliability
- Spectral match with silicon photodetectors

OSRAM

Silicon NPN Phototransistor
Lead (Pb) Free Product - RoHS Compliant

SFH 300 FA

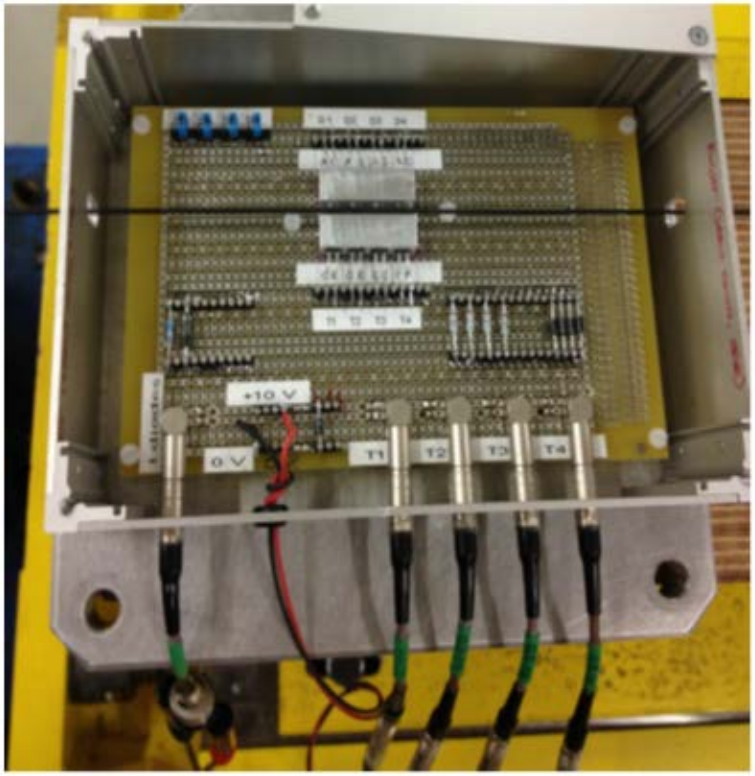
Features

- Especially suitable for applications from 450 nm to 1100 nm (SFH 300) and of 880 nm (SFH 300 FA)
- High linearity
- 5 mm LED plastic package
- Available in groups

Applications

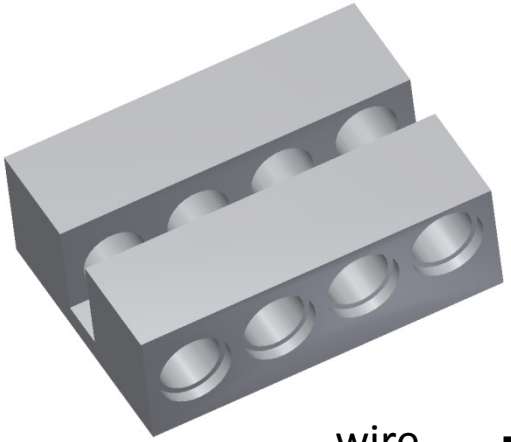
- Computer-controlled flashes
- Photointerrupters
- Industrial electronics
- For control and drive circuits

Tests setup for room temp

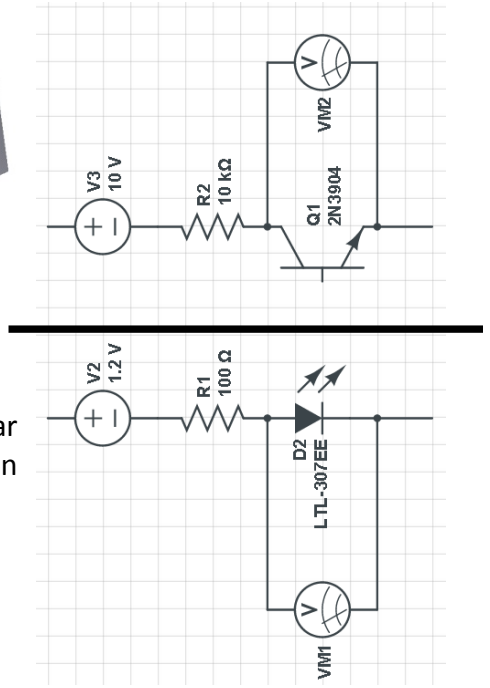


Box to shield the environment light noise, setup with 2.5mm wire

We expect to cover 0.5 mm range with one LED and phototransistor, to fullfill requirement our sensor will be equiped with 4 set

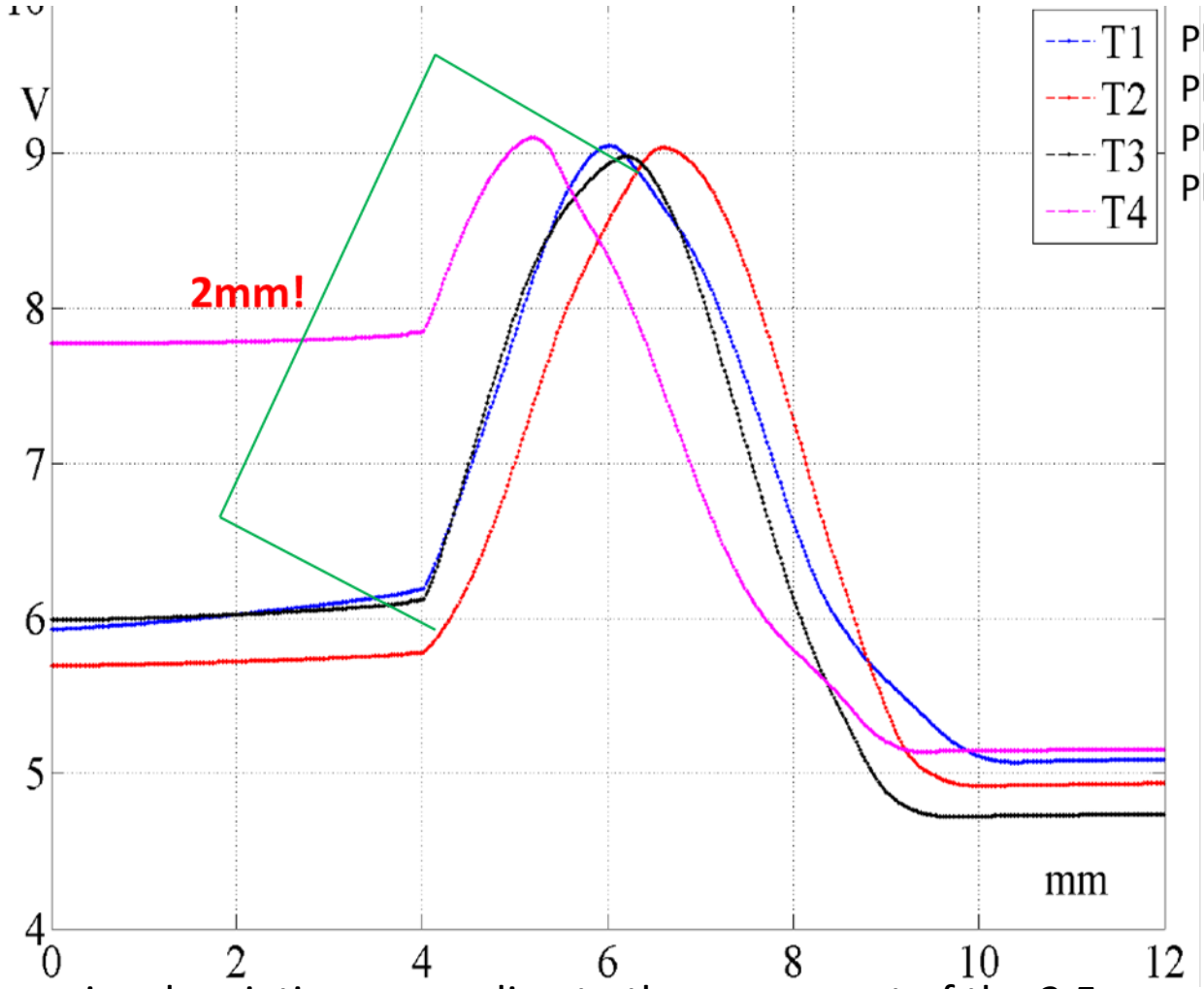


wire



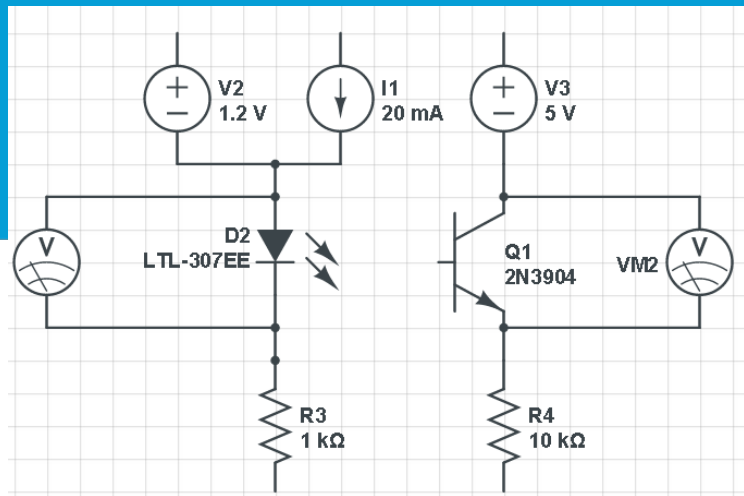
Wire was move by high-precision, linear stages, providing an accuracy of 1 µm on 150 mm maximum displacement.

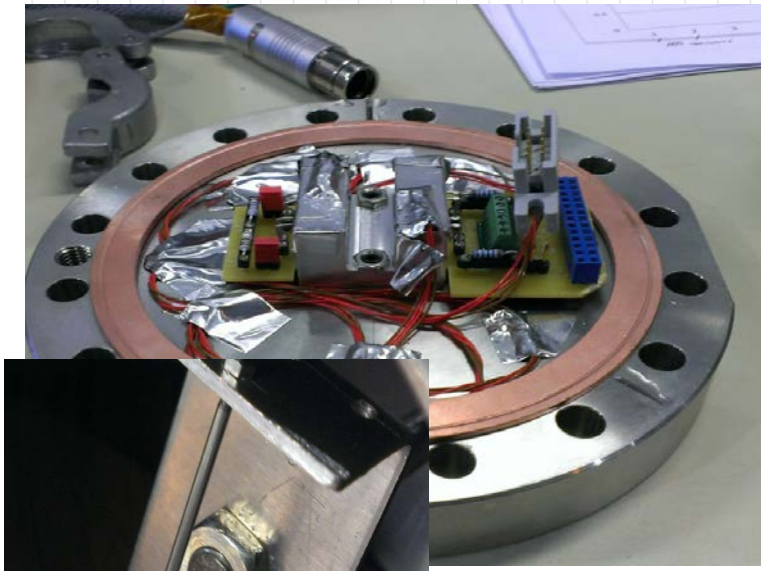
Results



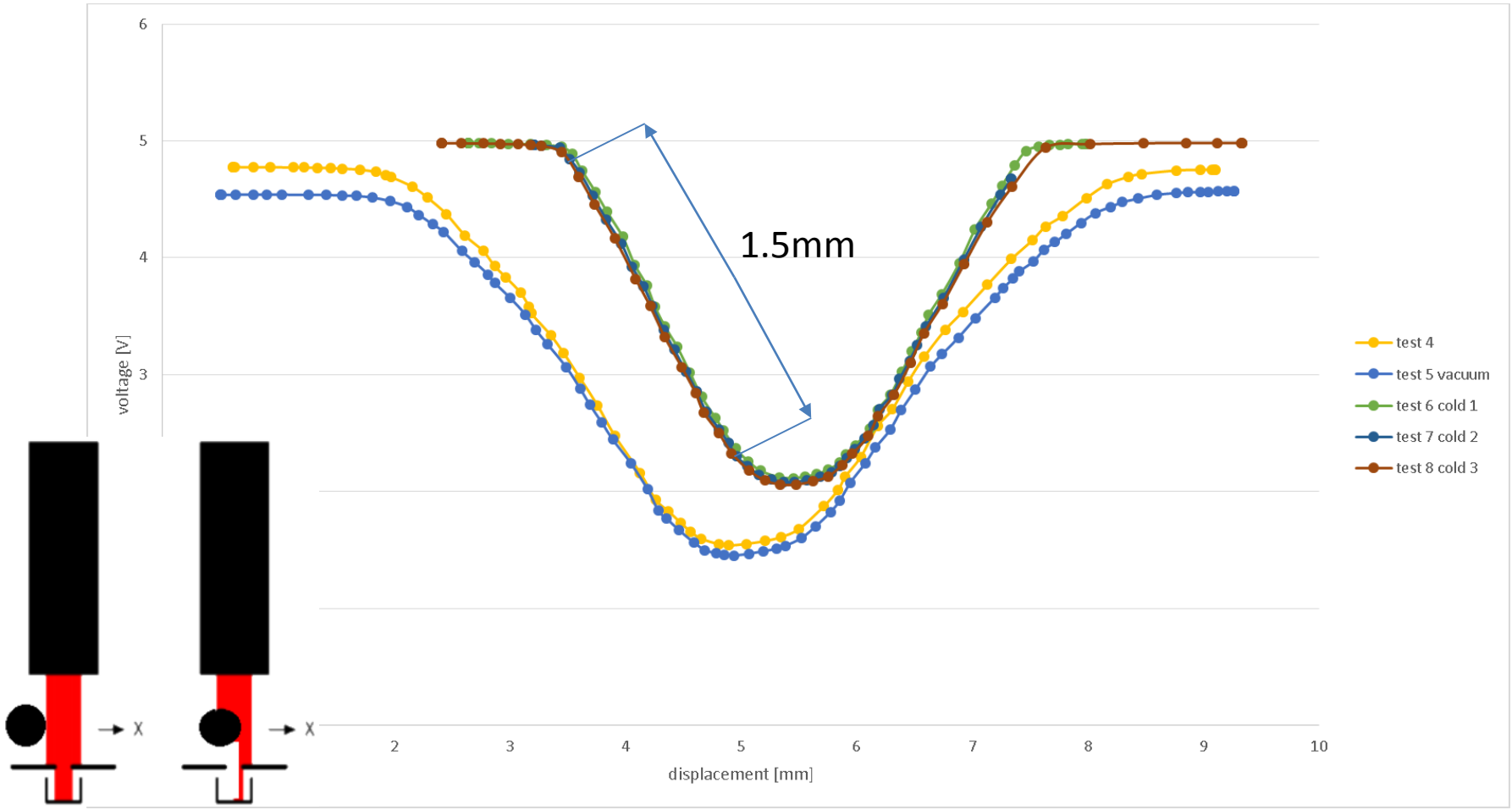
Output voltage signal variations according to the movement of the 2.5mm wire

Test setup for LN

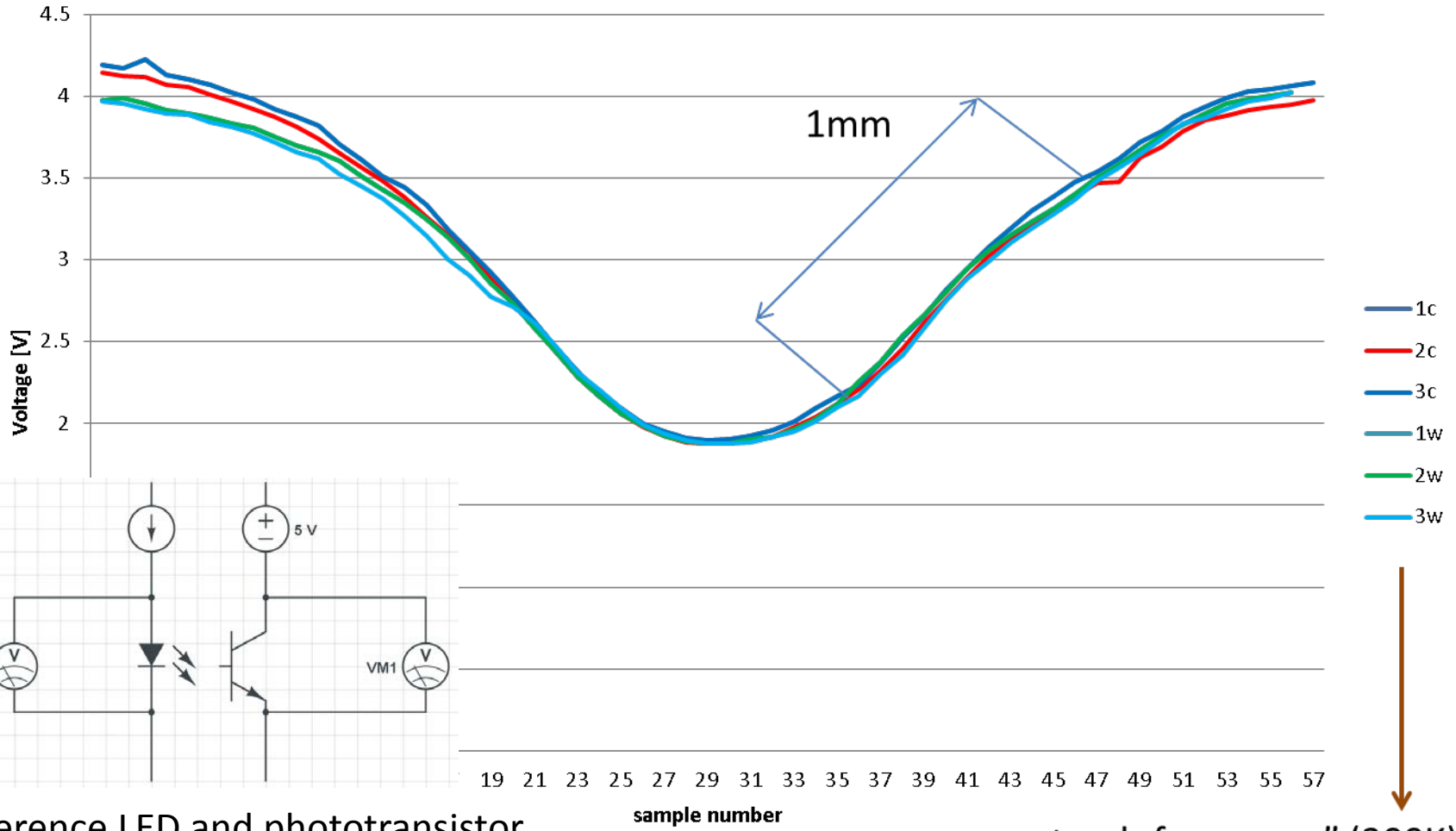




Results of tests in LN (ϕ2.5 mm wire, no current adjusting: no reference LED and phototransistor)



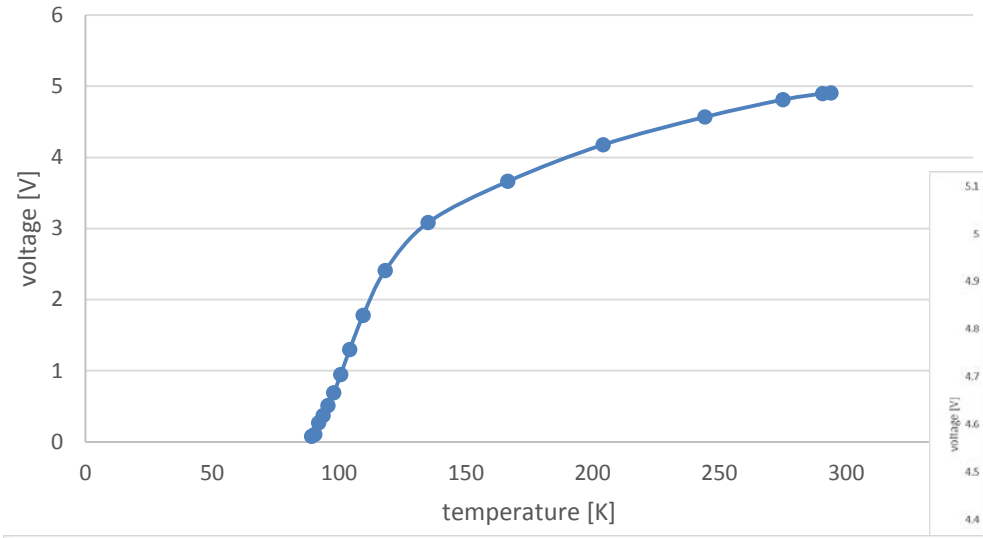
Results of tests in LN (ϕ1.5 mm wire, adjusting current: system equipped with reference LED and phototransistor)

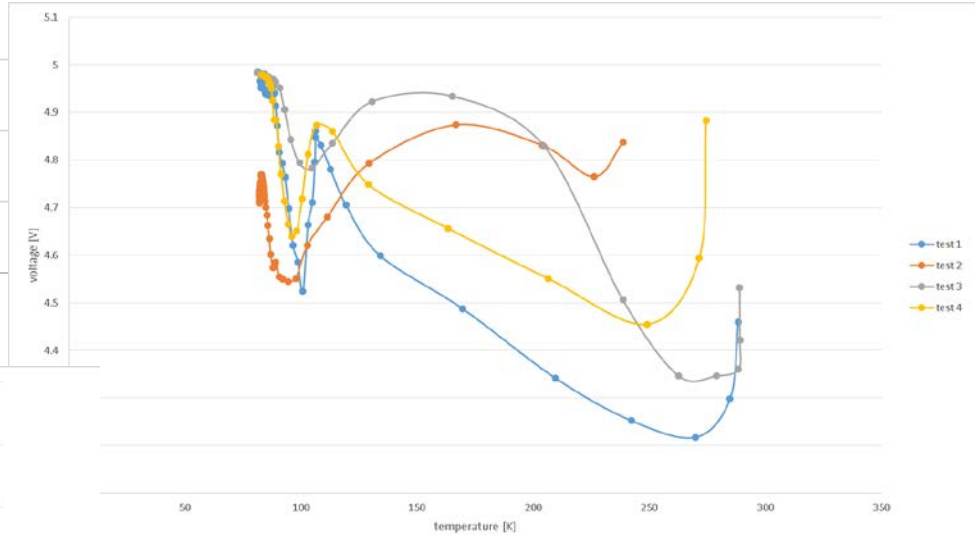


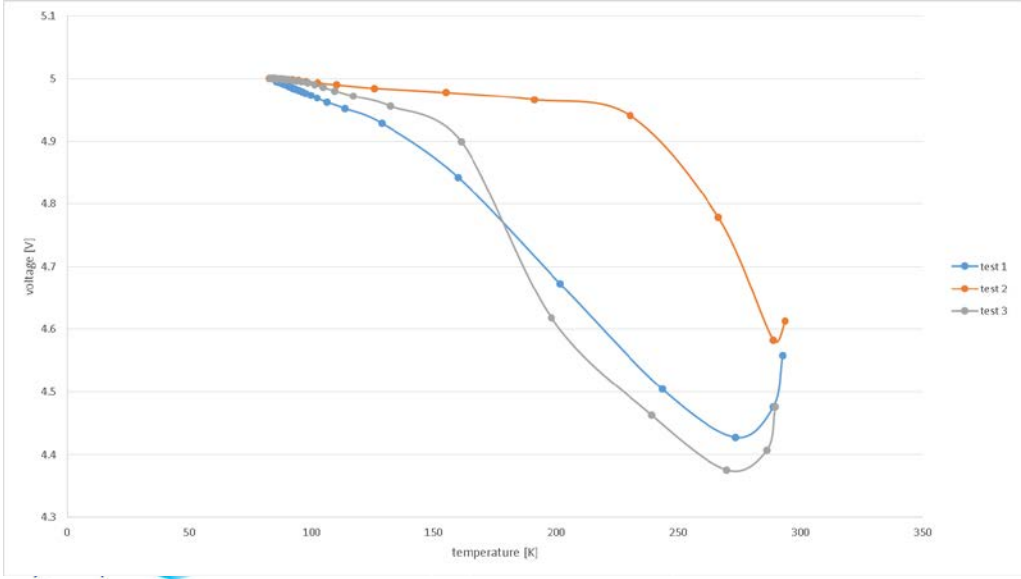
Reference LED and phototransistor

w stands for „warm" (300K)
c stands for „cold" (77K)

Voltage drop over time for phototransistors

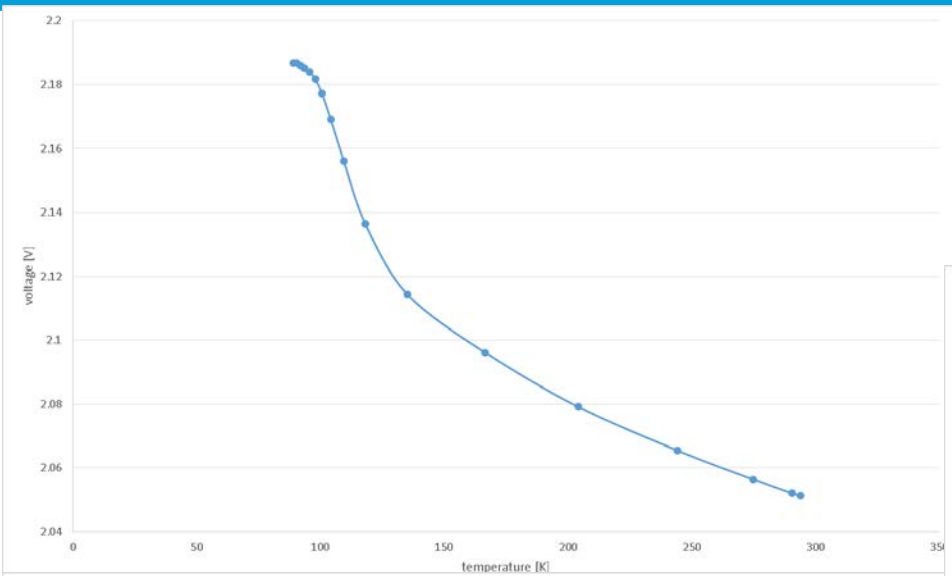


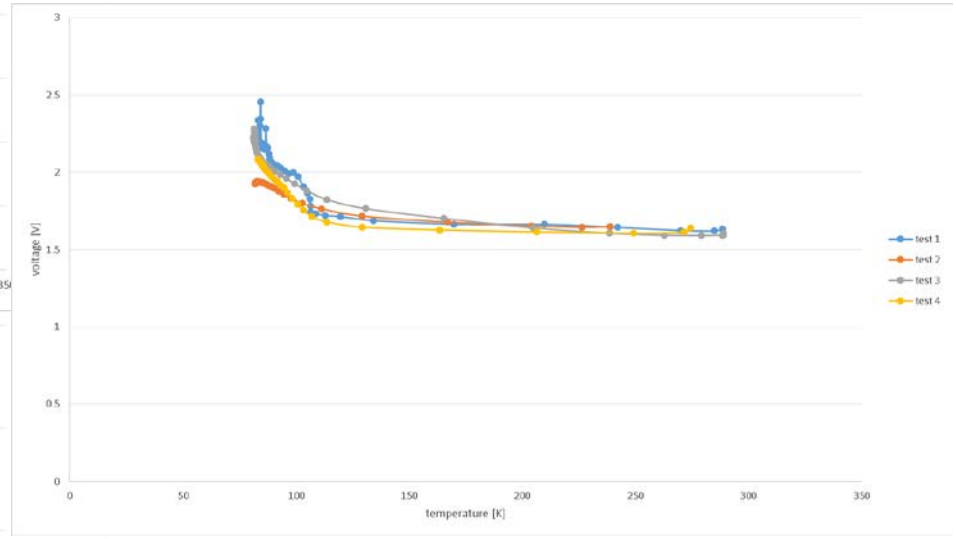


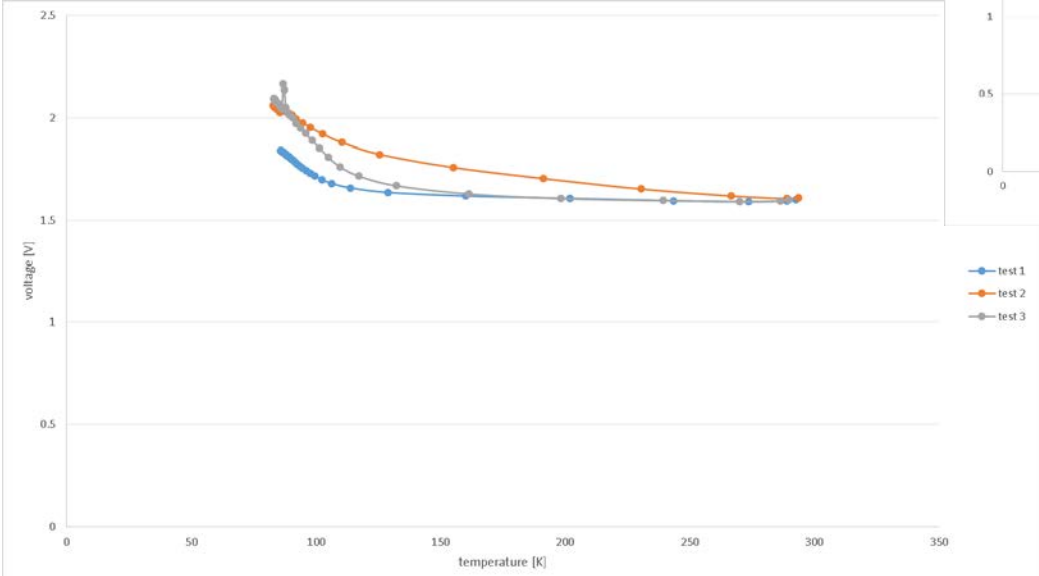


NO linear response and **unreproducible** behavior with temperature

Voltage drop over time for LEDs







NO linear response and **unreproducible** behavior with temperature

Intermediate conclusions

- Despite quite good results at room temperature and steady state conditions in low temperature the are some disadvantages:
- No linear reaction with temperature
- We're "blind" during transient period
- Properties of phototransistors and LEDs strongly depends on the temperature
- Receiver/LED has different behavior even from the same series
- We need "Cinderella" to find enough pairs for our sensors (64 in total)
- Sensors should be equipped with a temperature sensors
- Final application: 64 sensors => 10 wires each => 640 cables

temperature independent sensor

put as much as possible electronic outside the cryostat

Fibre optic

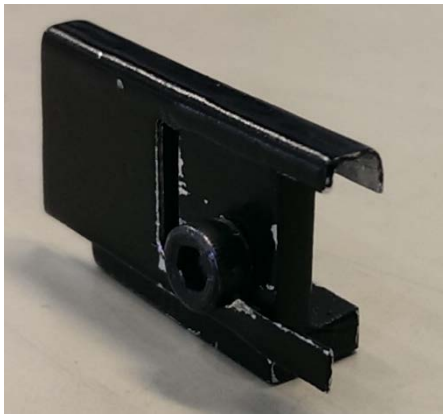
Commercially available product:

- Out of the shelf
- Relatively inexpensive
- Really easy to use
- Flexible in configuration

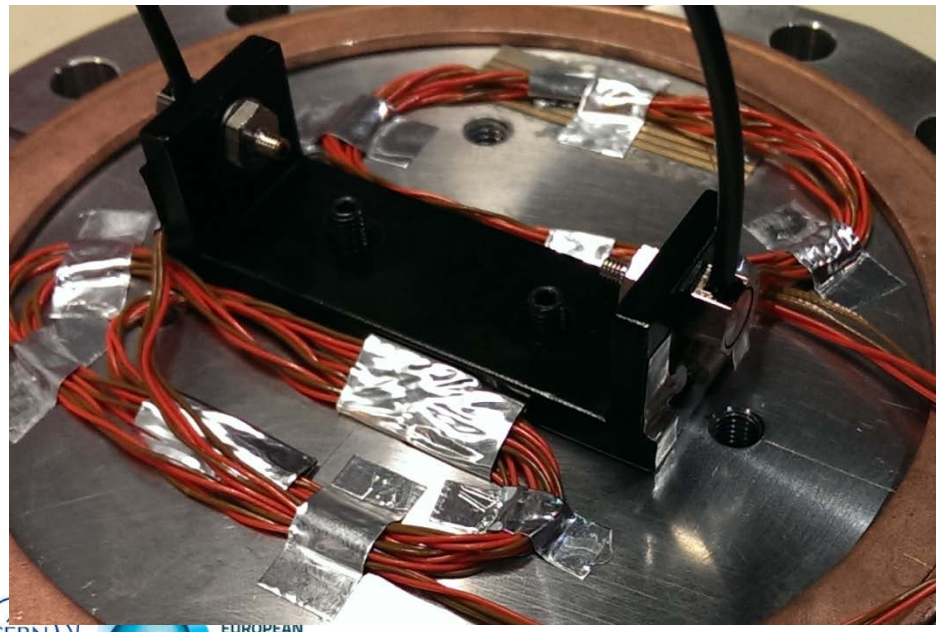
But never:

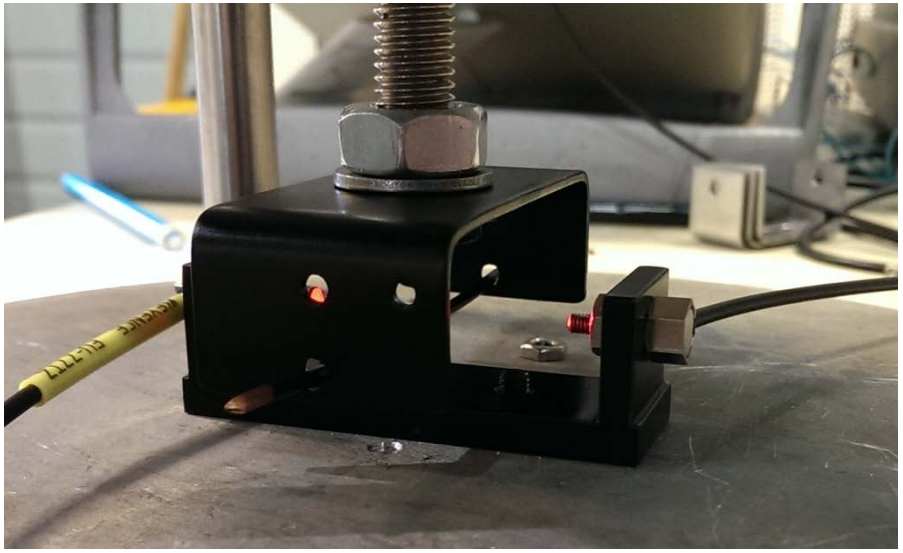
- tested in cryogenic temperature
- used for this application

Couresty of Keyence Corporation



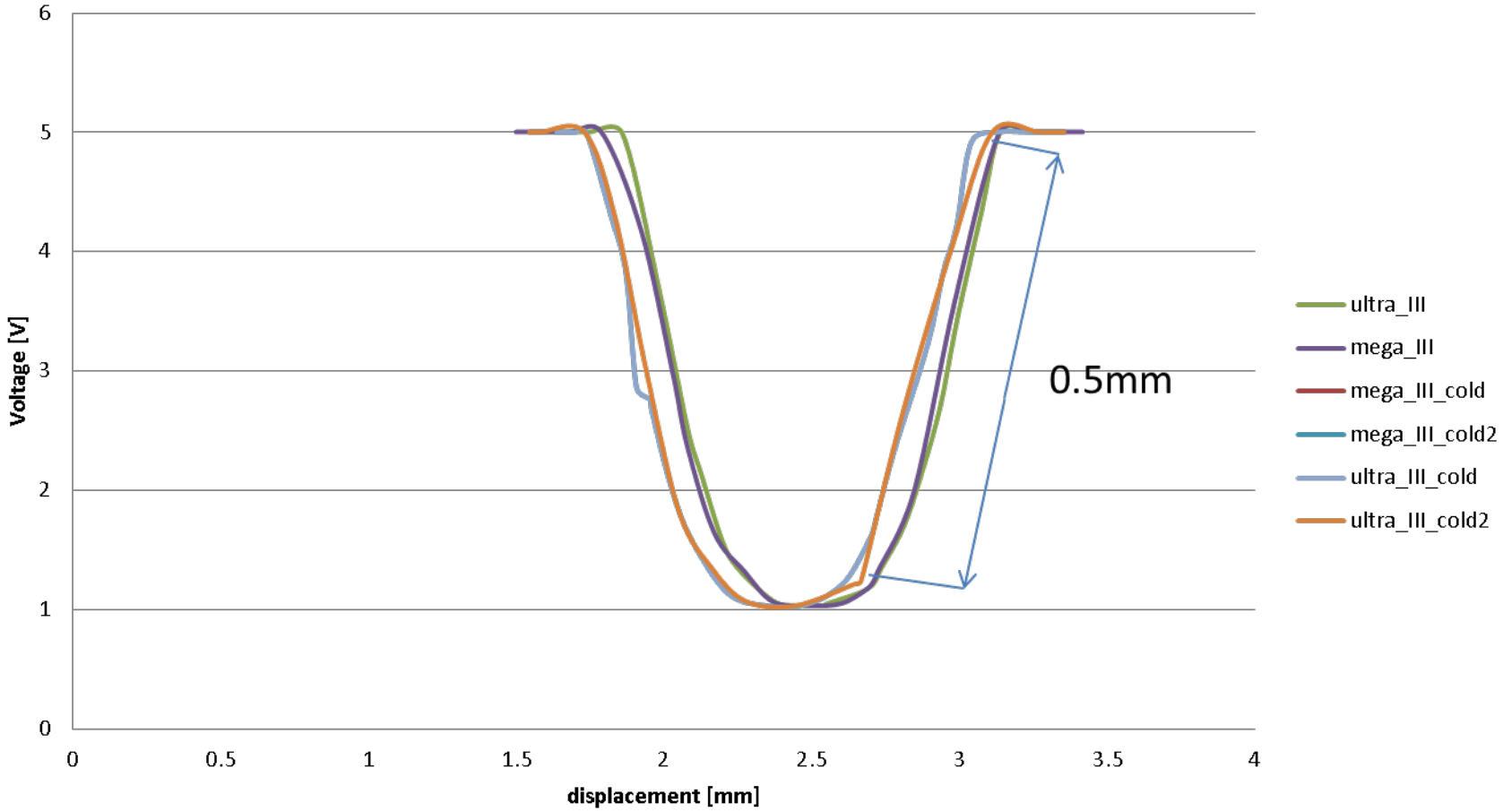
Collimator





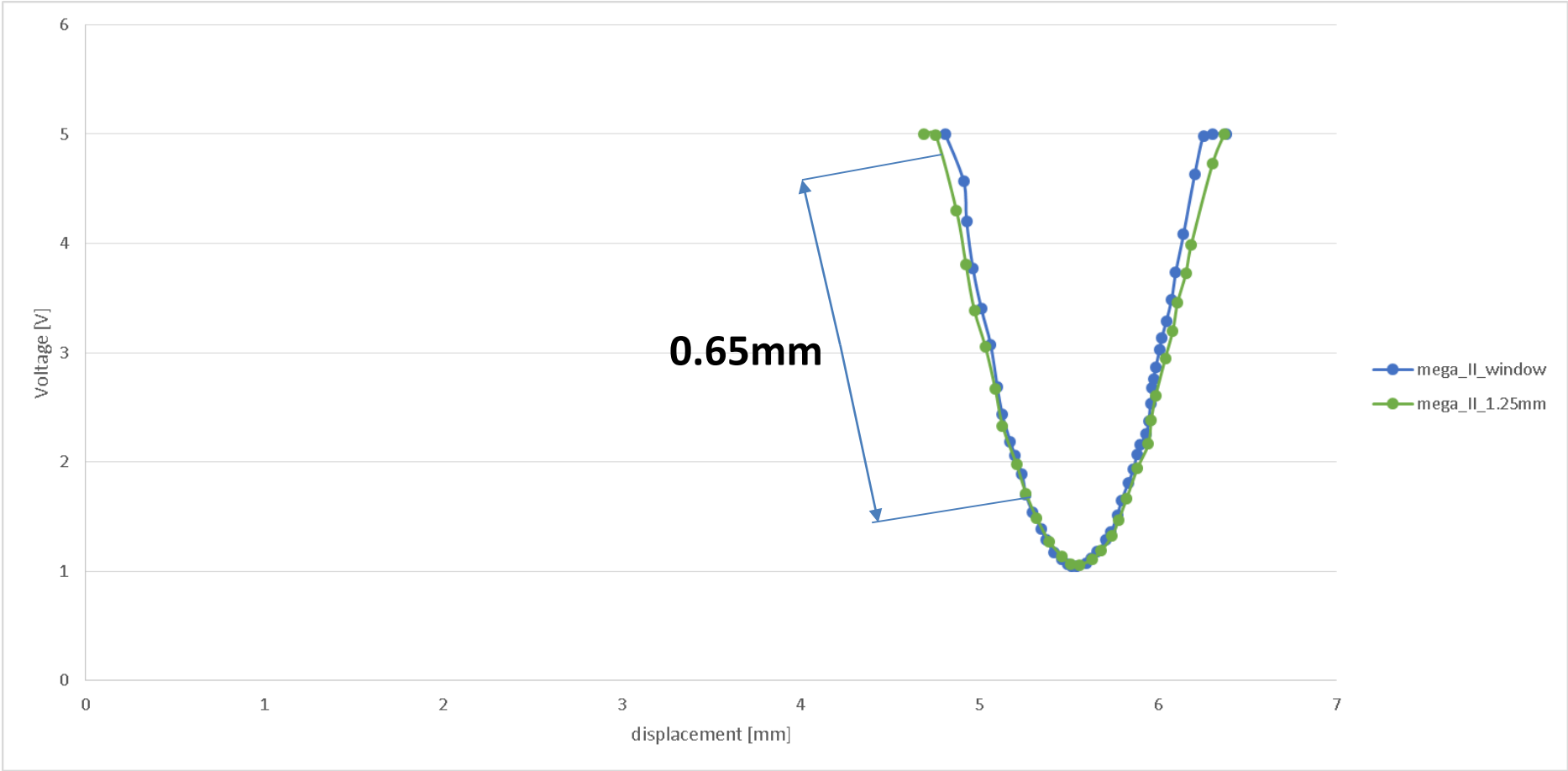
Most of the parts have been anodized in black optic

Results (ϕ1mm wire, ϕ1.3mm fiber)

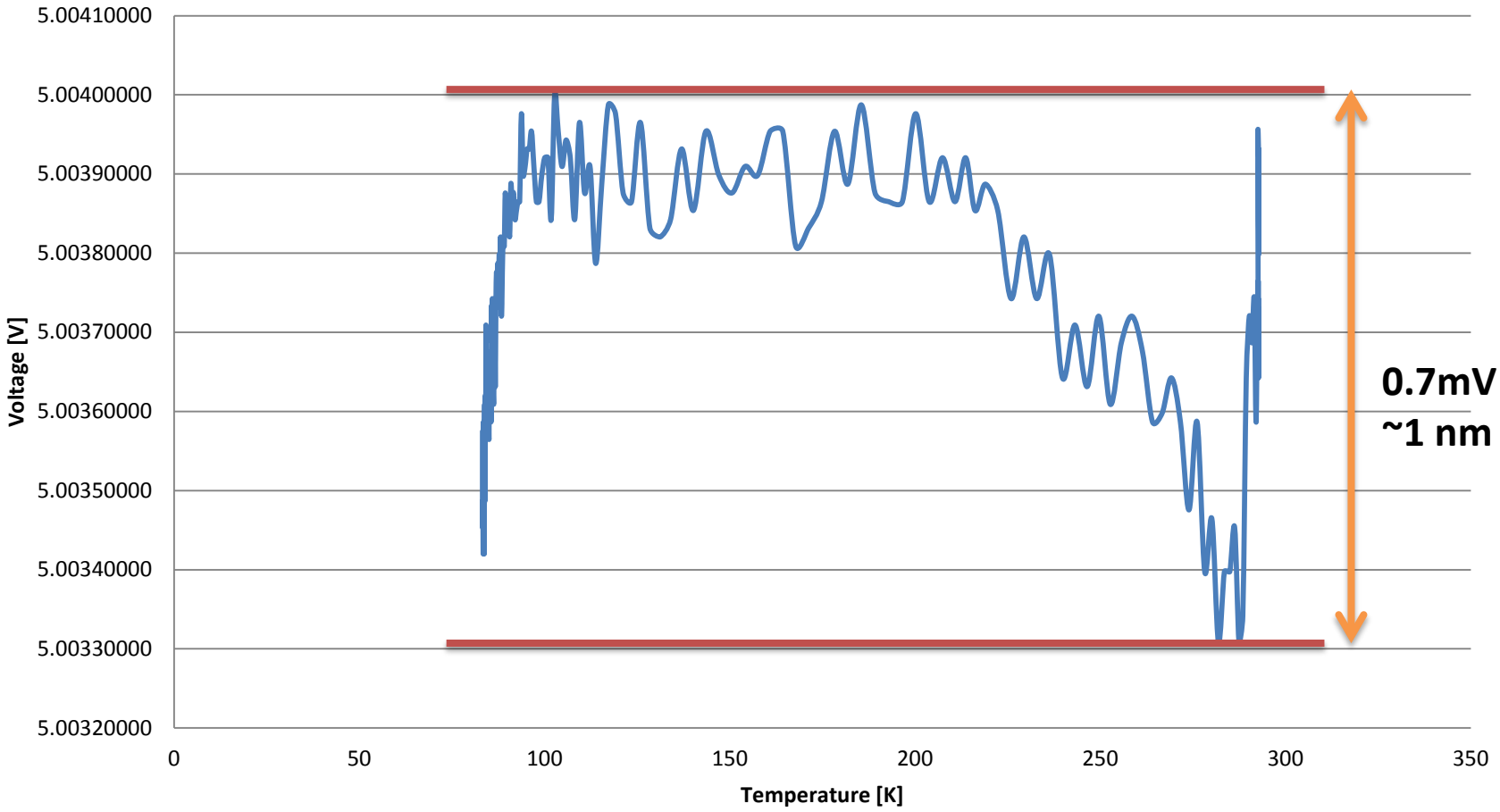


NO change after ~20 thermal cycle

Results (ϕ1.3mm wire, fiber ϕ1.5mm)



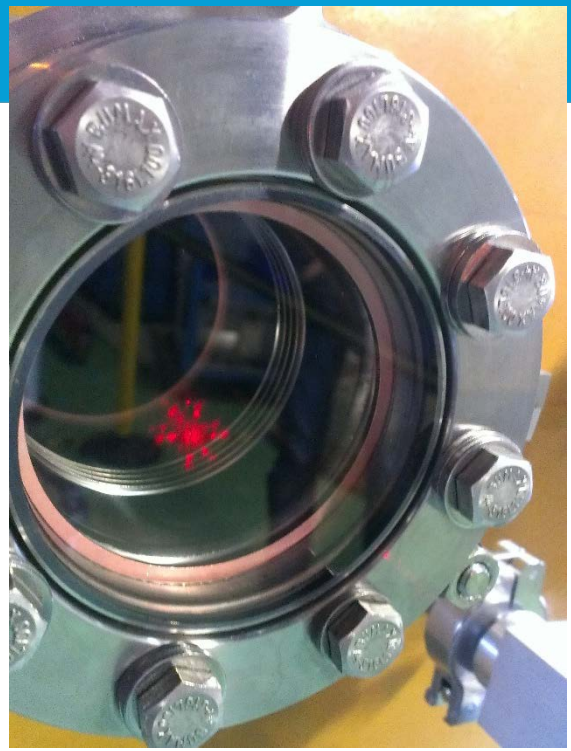
Voltage change with temperature for fibre optic

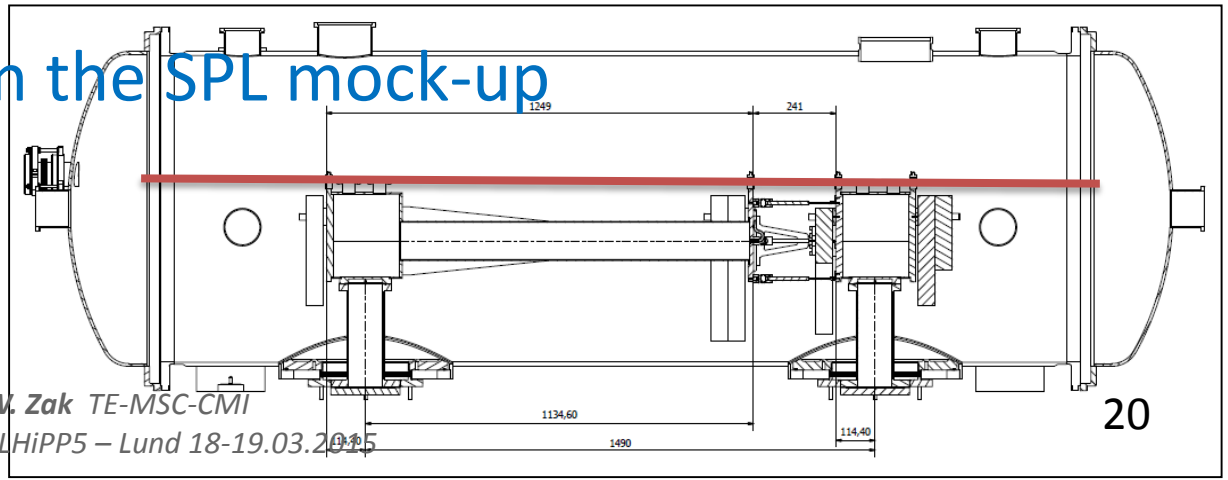


Temperature **INDEPENDENT**

Future steps

- Test bigger fibers (ϕ2 mm internal)
- Build the feed thru
- Check cross-talk
- Procure more components
- Try to make a test in helium
- Cross-check with laser tracker
- Test everything in the SPL mock-up





- Thank you for you attention!

- Questions?