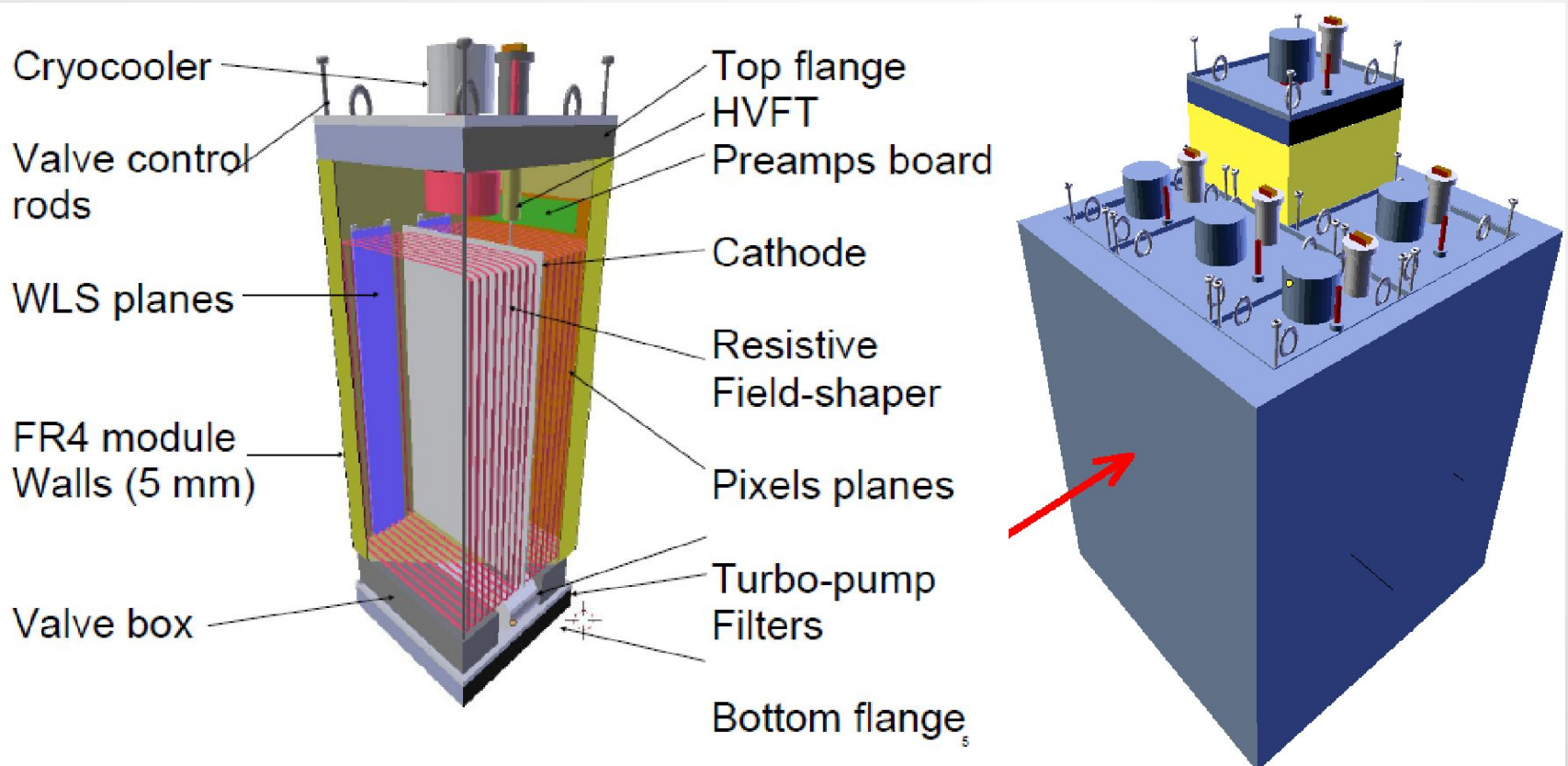


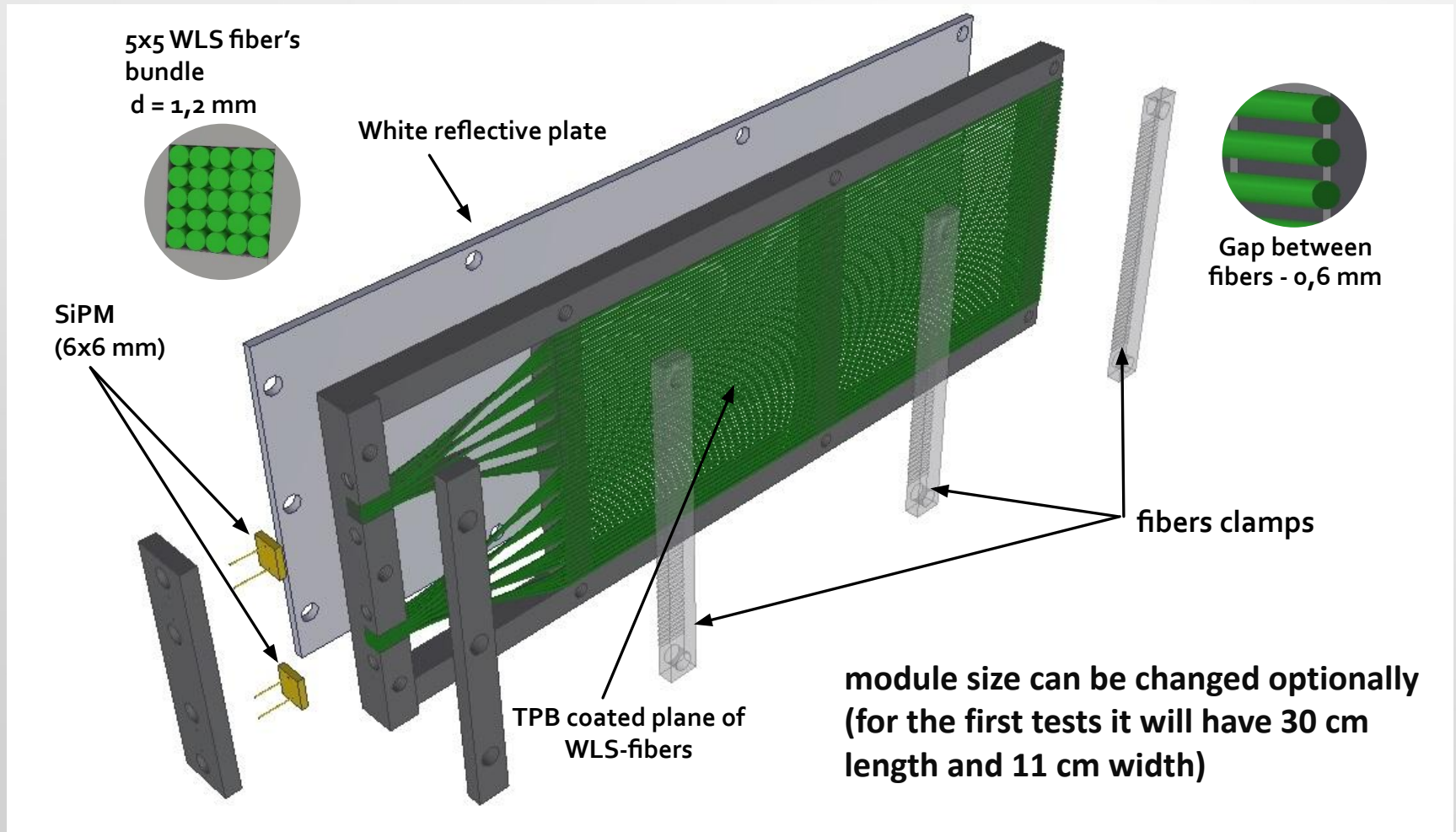
*Sergey Sokolov, DLNP, JINR*

# **Development of the optical module's prototype for ArgonCube**

# ArgonCube LAr TPC concept

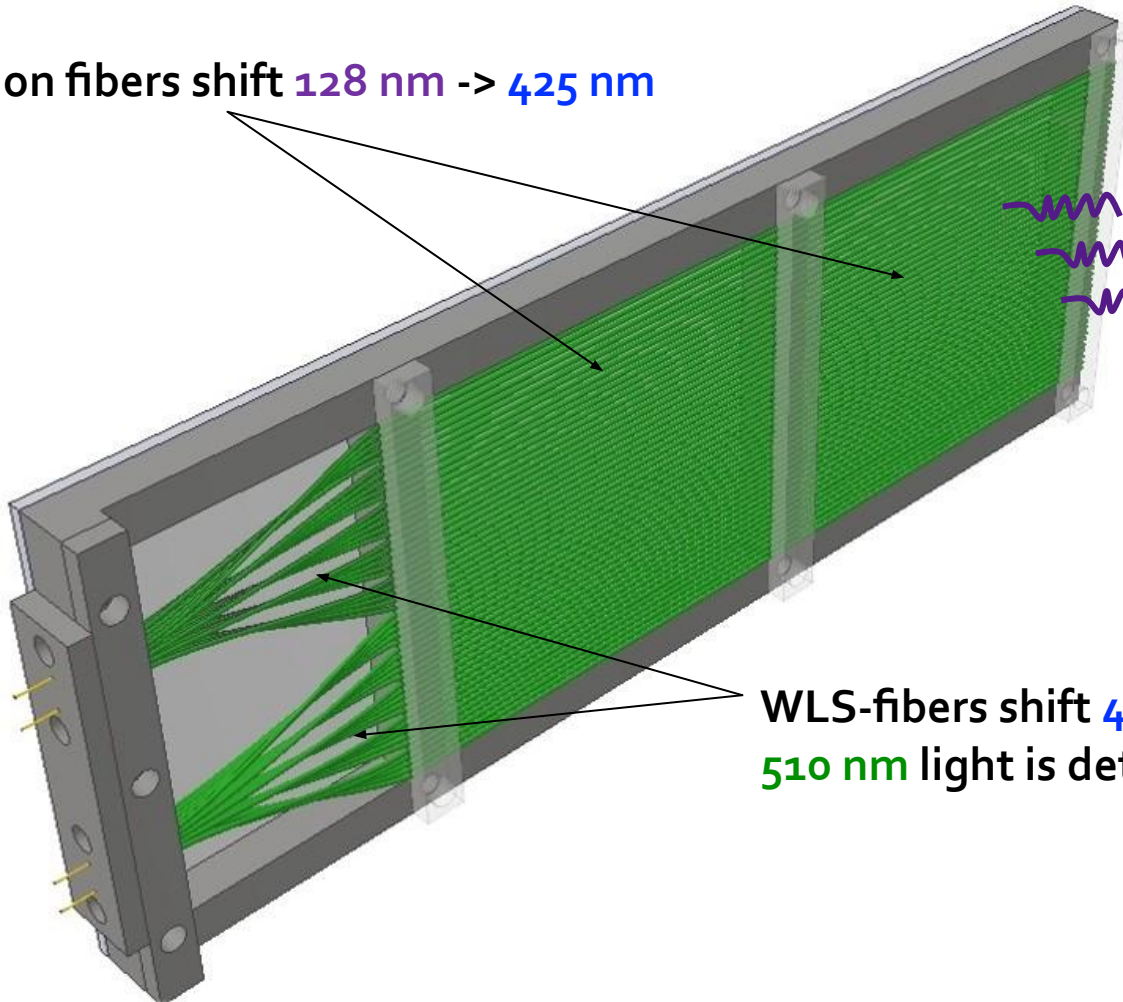


# Design of the optical module prototype



# The mechanism of light collection

TPB on fibers shift  $128 \text{ nm} \rightarrow 425 \text{ nm}$



$128 \text{ nm}$

LAr scintillation light

WLS-fibers shift  $425 \text{ nm} \rightarrow 510 \text{ nm}$ ,  
 $510 \text{ nm}$  light is detected by SiPM

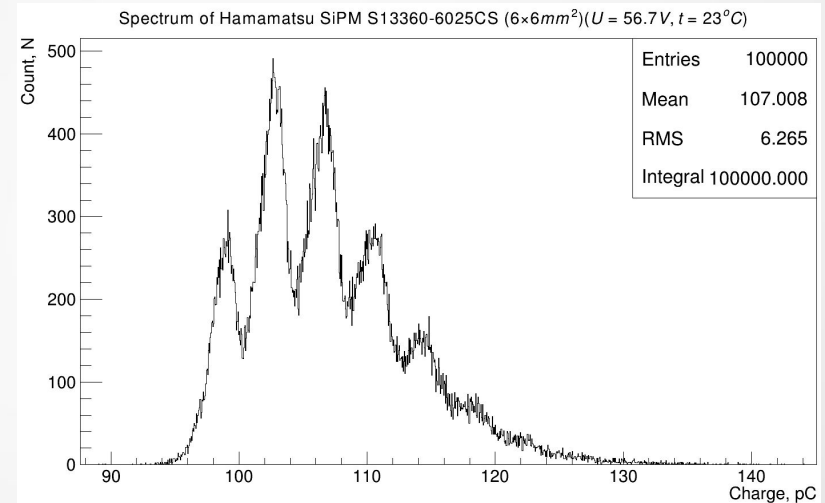
# Performance of Hamamatsu SiPM S13360 - 6025CS in liquid nitrogen



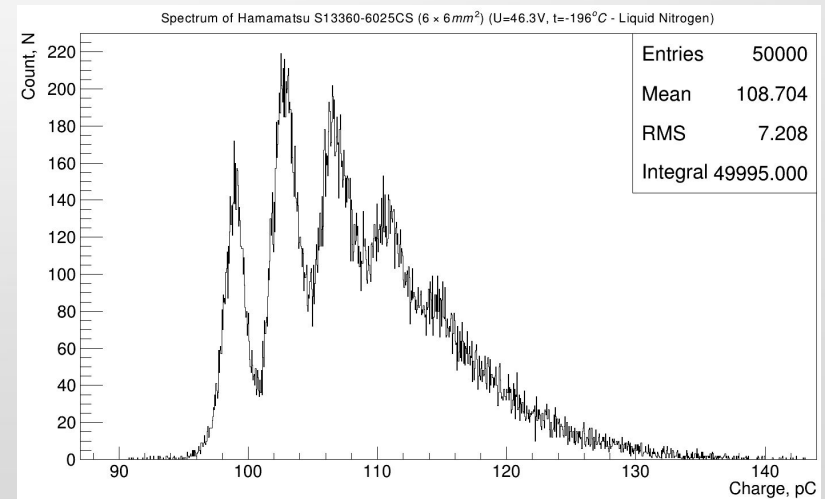
SiPM size - 6x6 mm (57600 pixels)

PDE (at 510 nm)  $\approx$  24 %

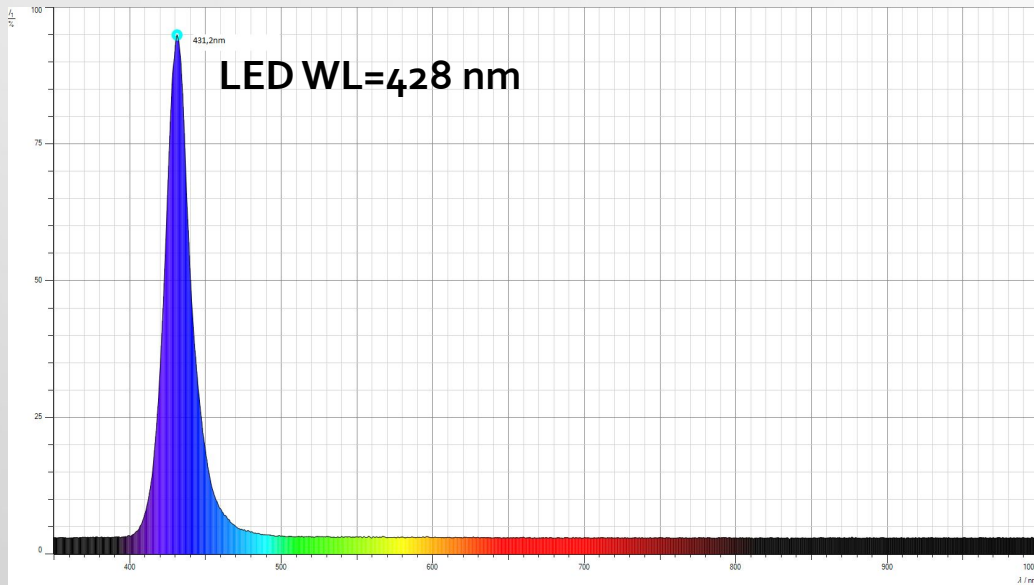
Spectrum of SiPM  
at room temperature



Spectrum of SiPM  
at liquid nitrogen  
temperature ( $-196 \text{ deg. of C}$ )



# LED source

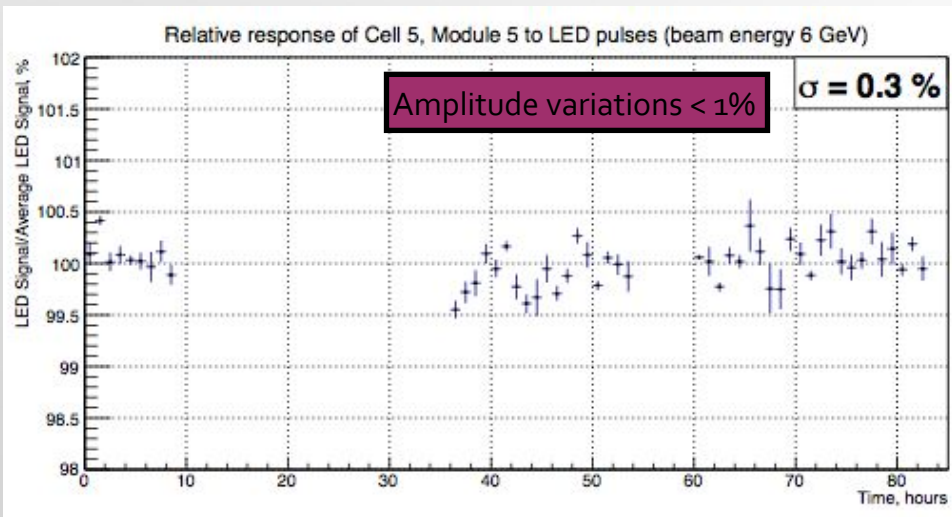


**Light diffusing by Teflon (PTFE) layer**



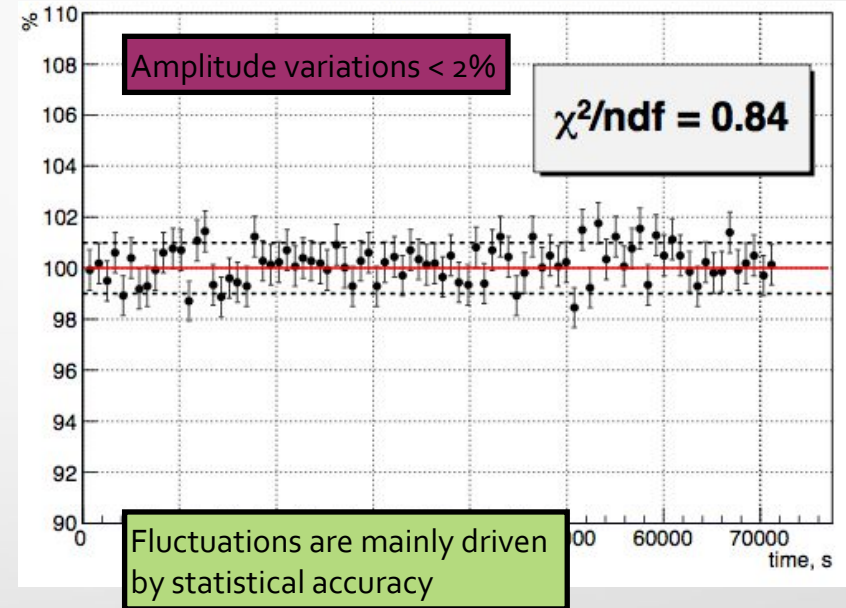
# LED stability

High light intensity  $\sim 10^3$  ph.e



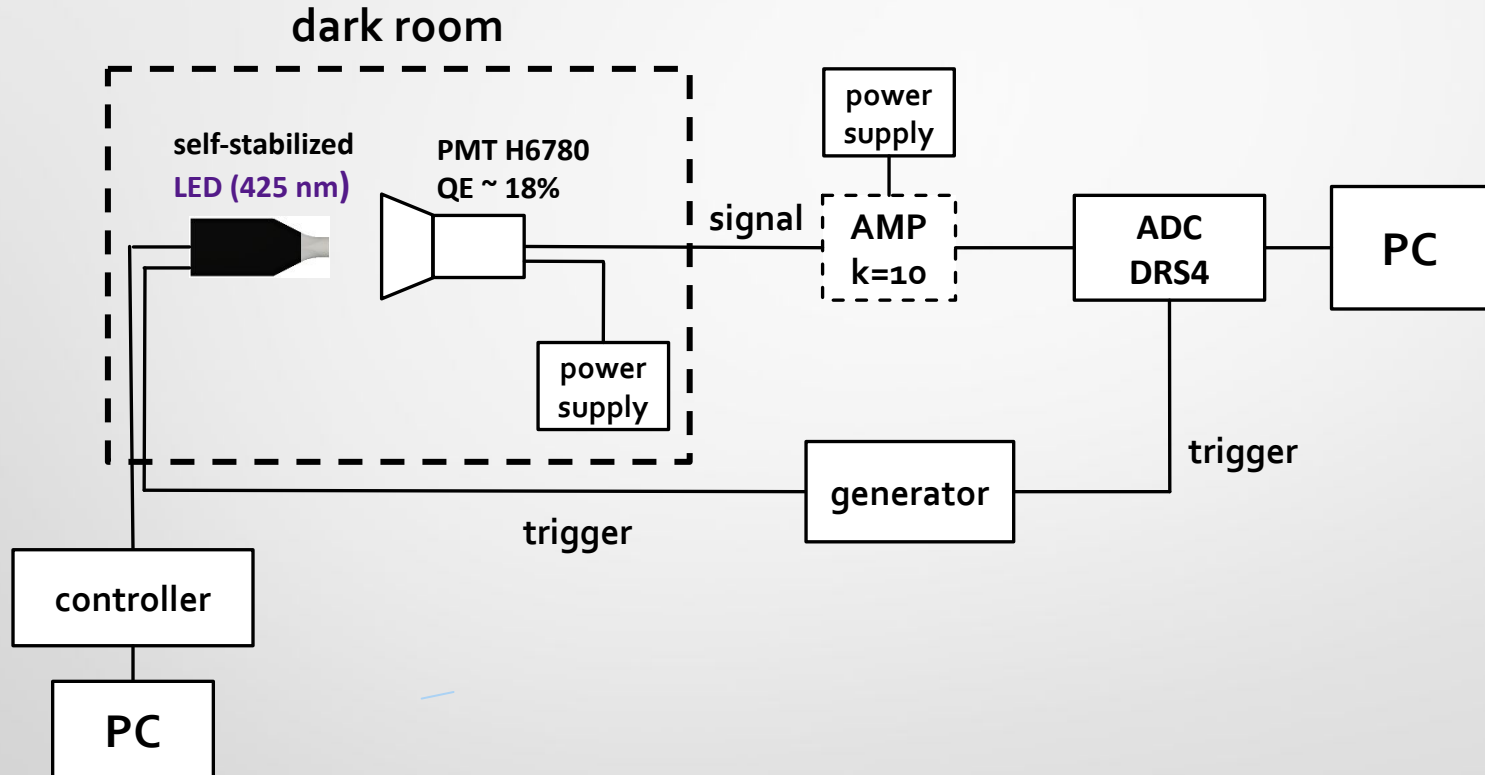
LED source stability measured by ECALo prototype for the COMPASS experiment (Has precise photosensor temperature stabilization < 10 mdeg) in june-july 2015 @ T10 (CERN).  
Temperature variation in the hall: 24 (night) - 38 (day)

Low light intensity  $\approx 1.75$  ph.e



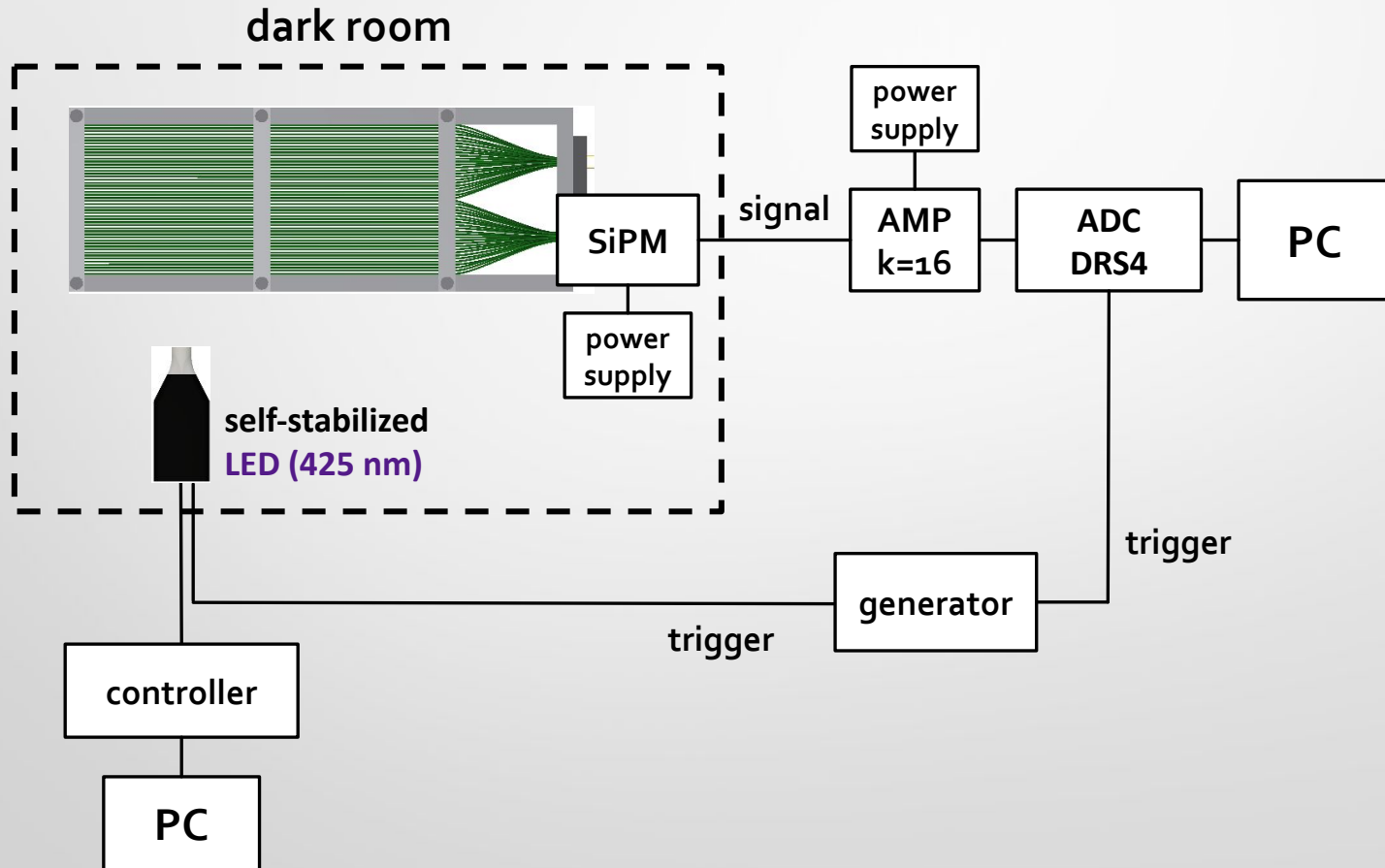
LED source stability measured by 20" Hamamatsu 12860 HQE PMT in a single point

# LED calibration scheme

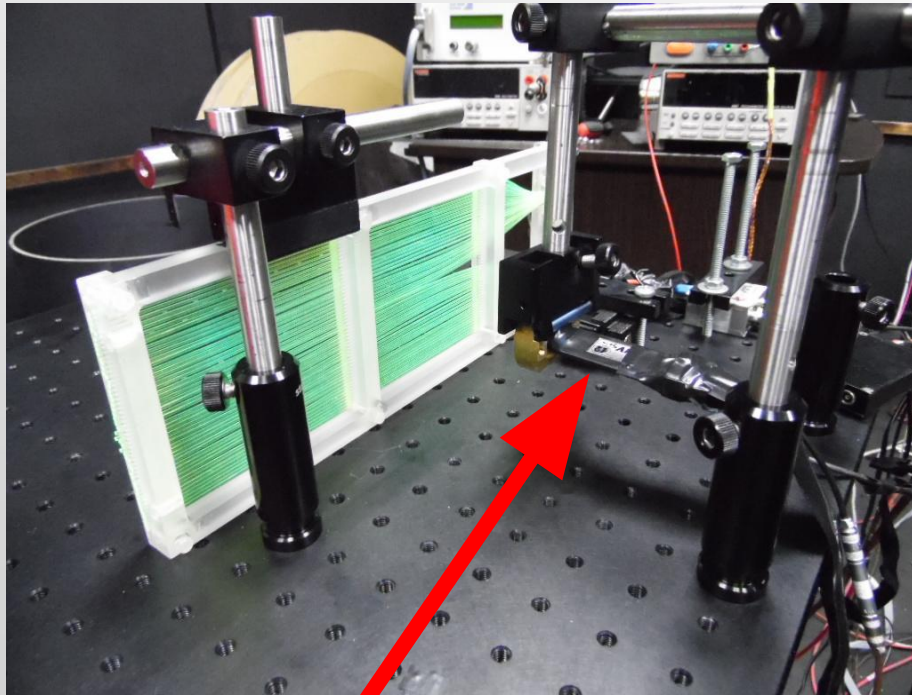




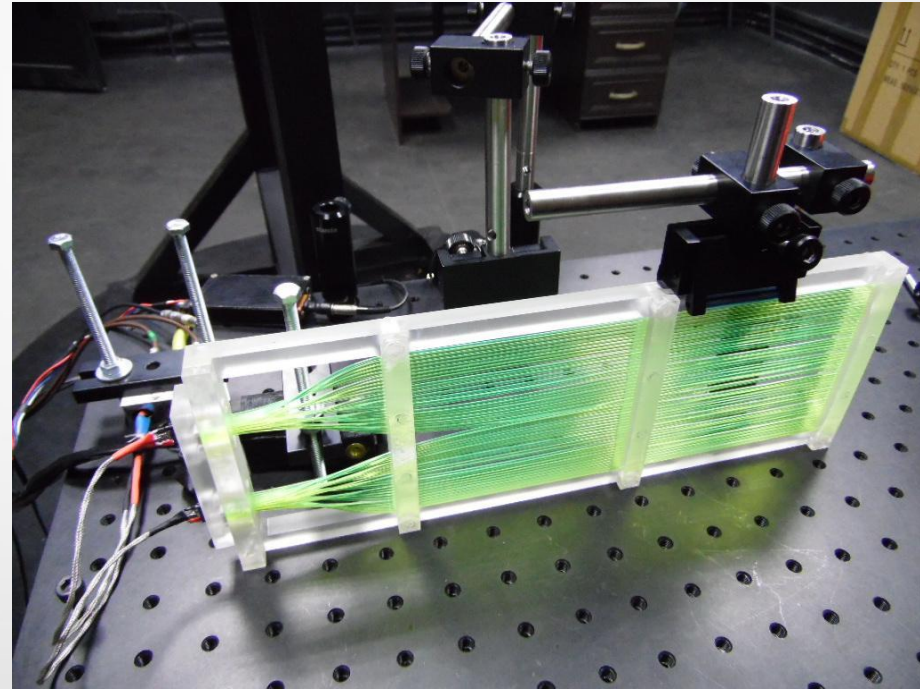
# Room temperature testing scheme



# Room temperature testing scheme

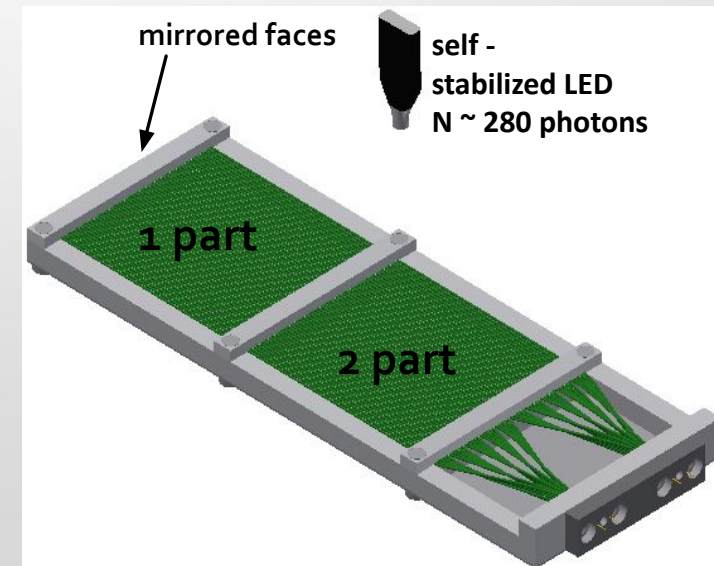
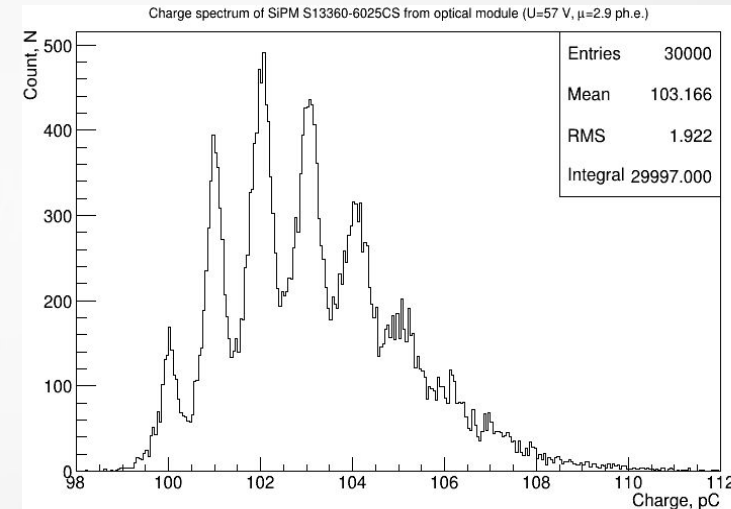


LED source

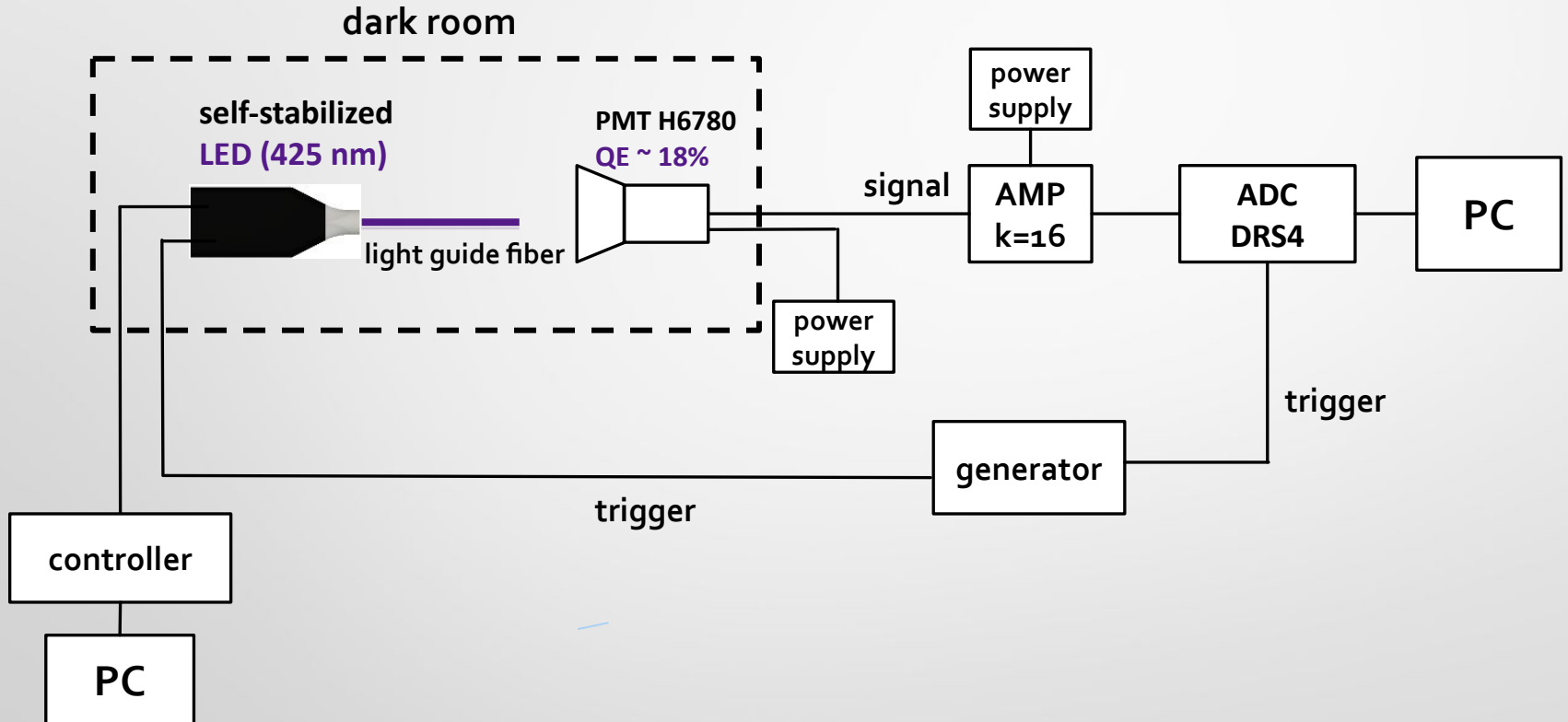


# Results of testing under room temperature conditions

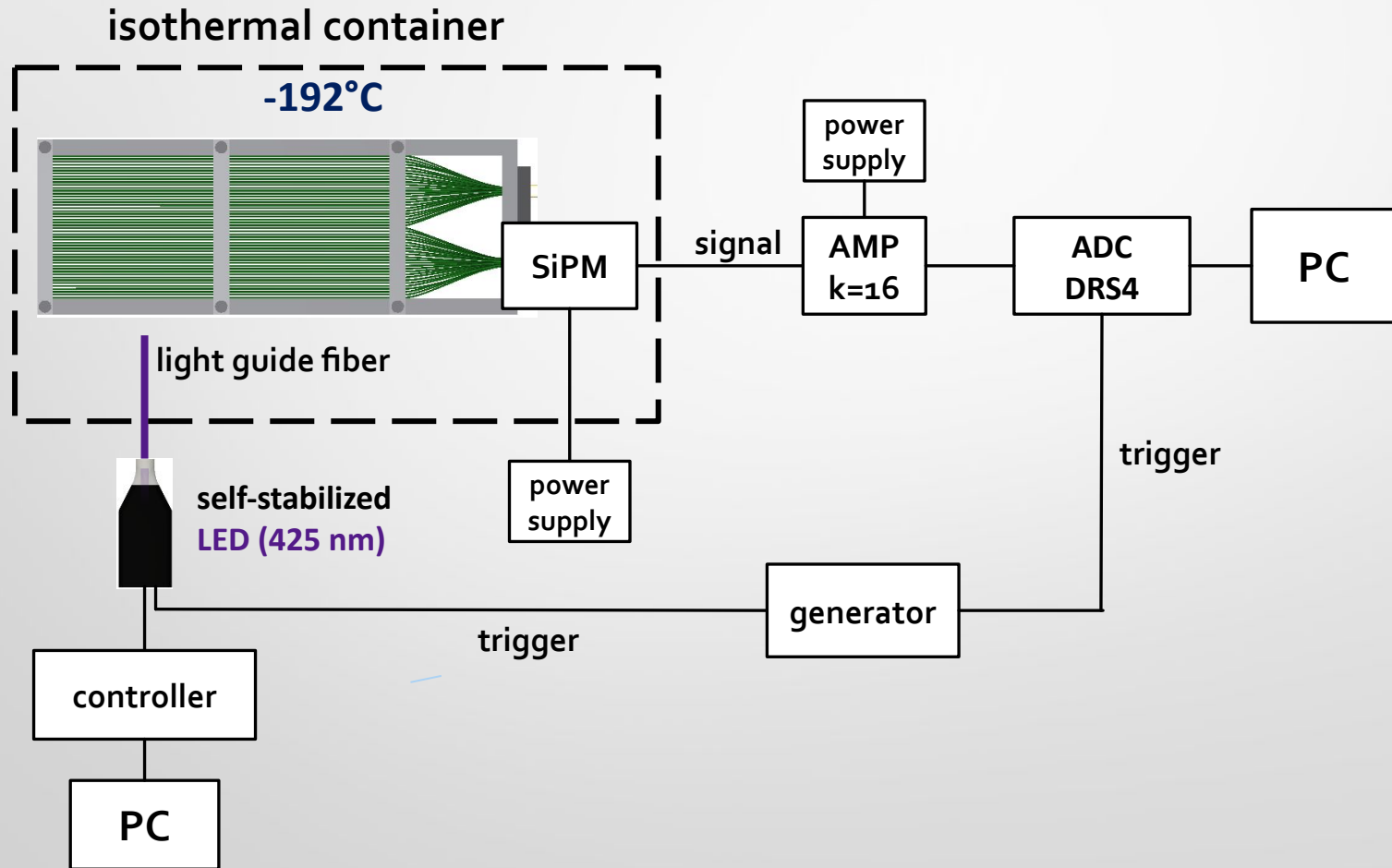
|  | U, V | 2 part |        | 1 part |        |
|--|------|--------|--------|--------|--------|
|  |      | $\mu$  | PDE, % | $\mu$  | PDE, % |
| frame with fibers                                | 57   | 2,36   | 0,84   | 2,07   | 0,74   |
| frame with fibers + white plate                  | 57   | 3,14   | 1,12   | 2,85   | 1,02   |
| frame with fibers + mirrored faces               | 57   | 3,55   | 1,26   | 3,45   | 1,22   |
| frame with fibers + white plate + mirrored faces | 57   | 4,94   | 1,76   | 4,84   | 1,72   |
| frame with fibers + mirrored faces + TPB         | 57   | 3,50   | 1,25   | 3,18   | 1,13   |



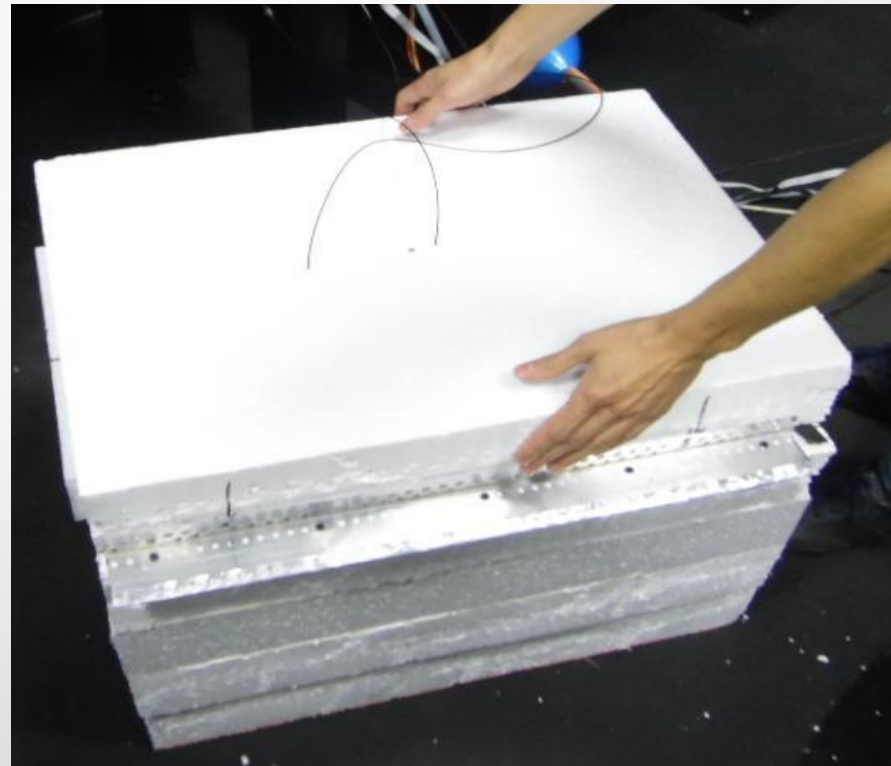
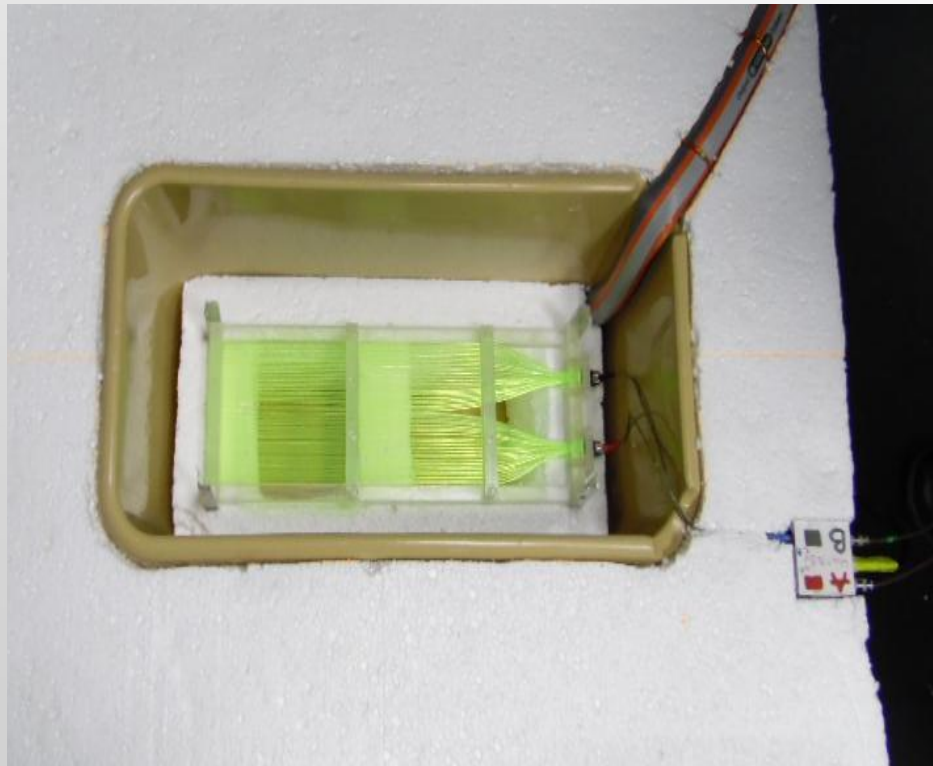
# Light guide fiber calibration scheme



# Nitrogen low temperature testing scheme

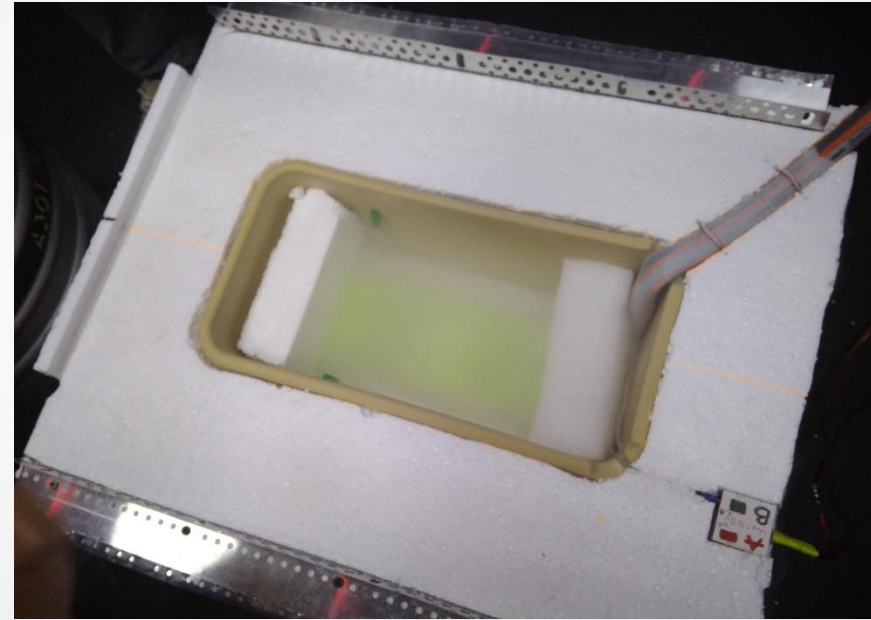
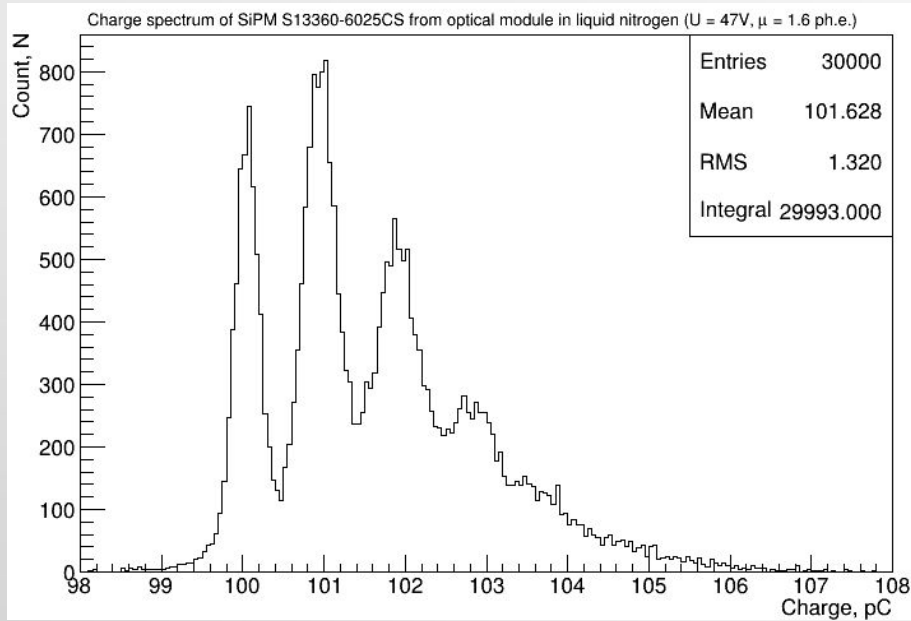


# Nitrogen low temperature testing scheme





# Results of testing under liquid nitrogen conditions



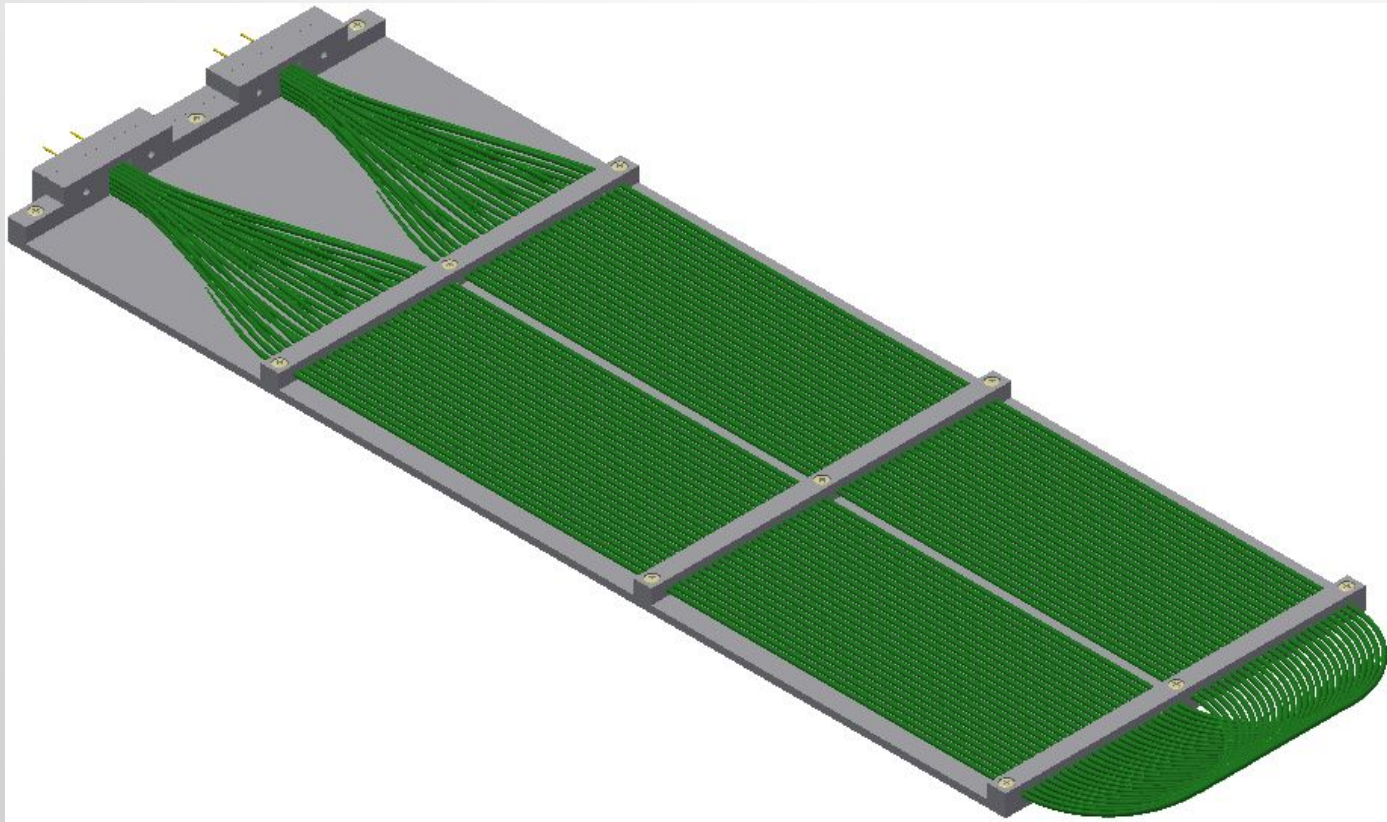
|   | <b>U, V</b> | <b><math>\mu</math>, ph.e.</b> | <b>PDE, %</b> |
|---|-------------|--------------------------------|---------------|
| <b>frame with fibers +<br/>mirrored faces<br/>+TPB+LN</b> | <b>46</b>   | <b>5,57</b>                    | <b>1,99</b>   |
|   | <b>46,5</b> | <b>5,9</b>                     | <b>2,09</b>   |
|   | <b>47</b>   | <b>6,16</b>                    | <b>2,19</b>   |
|   | <b>47,5</b> | <b>6,38</b>                    | <b>2,26</b>   |
|   | <b>48</b>   | <b>6,58</b>                    | <b>2,34</b>   |

# The advanced prototype design

Maximum thickness ~ **10 mm** (place to install SiPM )

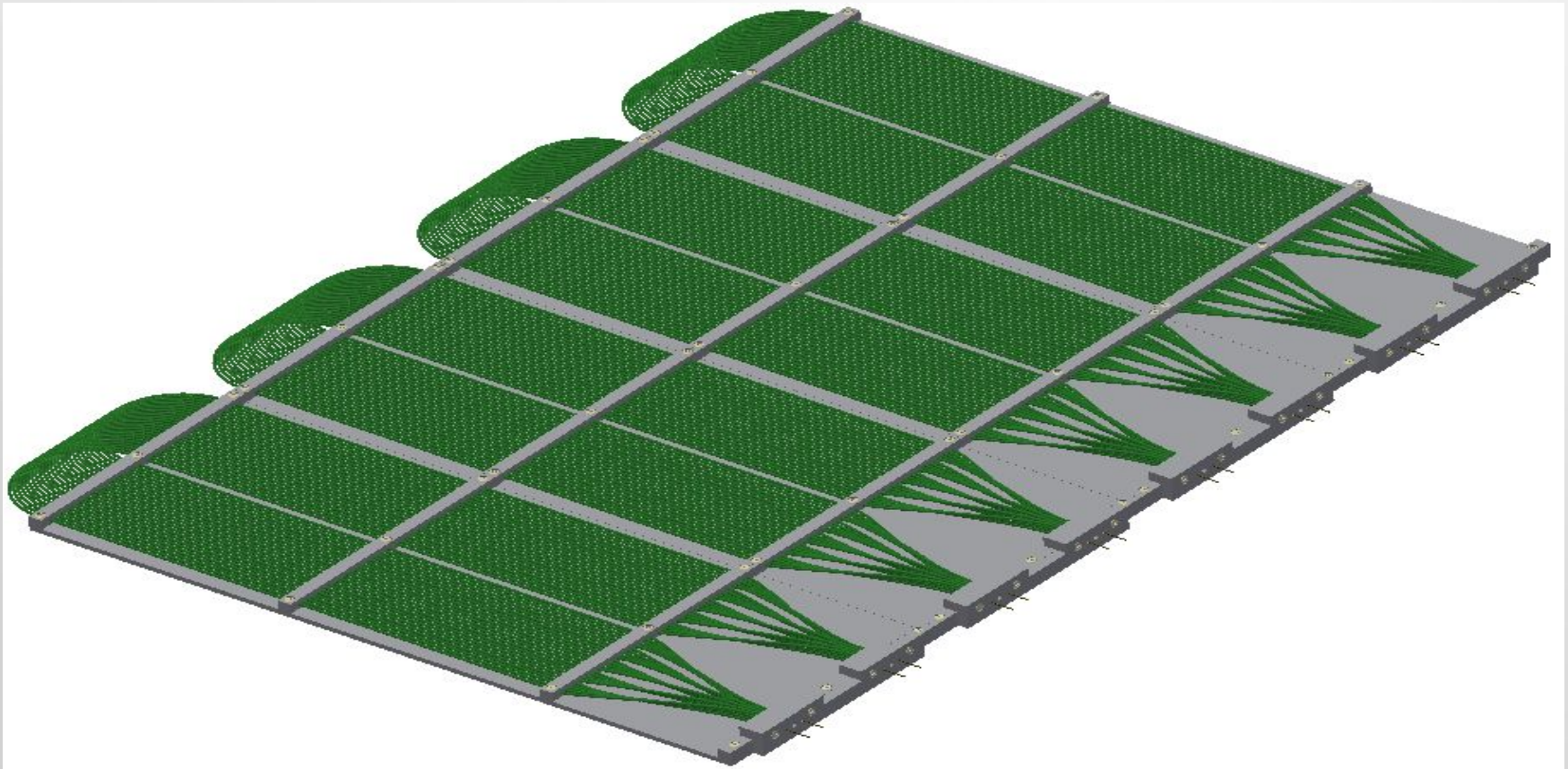
The rest thickness of module ~ **6 mm**

The ends of the optical fibers will be round that will give us to increase the light yield ~ 20 %



# Assembling of prototypes

The next step will be to assemble the detector, what consist of 4 similar module  
The size of the assembling will be 30\*40 mm



# Conclusion

- Optical module prototype reveals a good performance under liquid nitrogen conditions
- Mirrored fiber faces and white plate usage lead to PDE increasing
- PDE in liquid nitrogen is higher than in the air, because of different refractive indices
- TPB cover has no impact on prototype performance
- The tests of optical module prototype have shown a good light collection performance
- The advanced prototype of the optical module is already under construction