The ESS WS OFE

Sandi Grulja

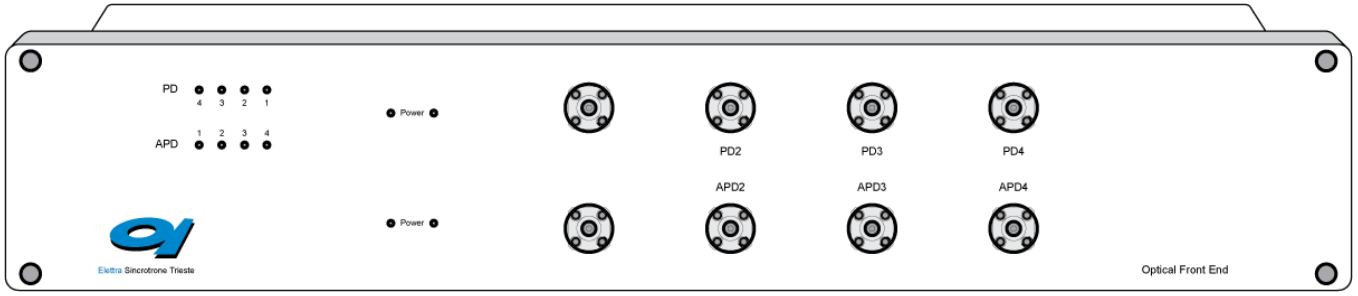
Introduction

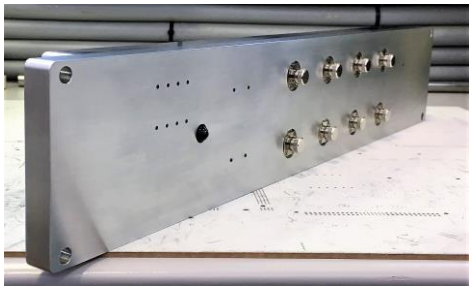
Themes:

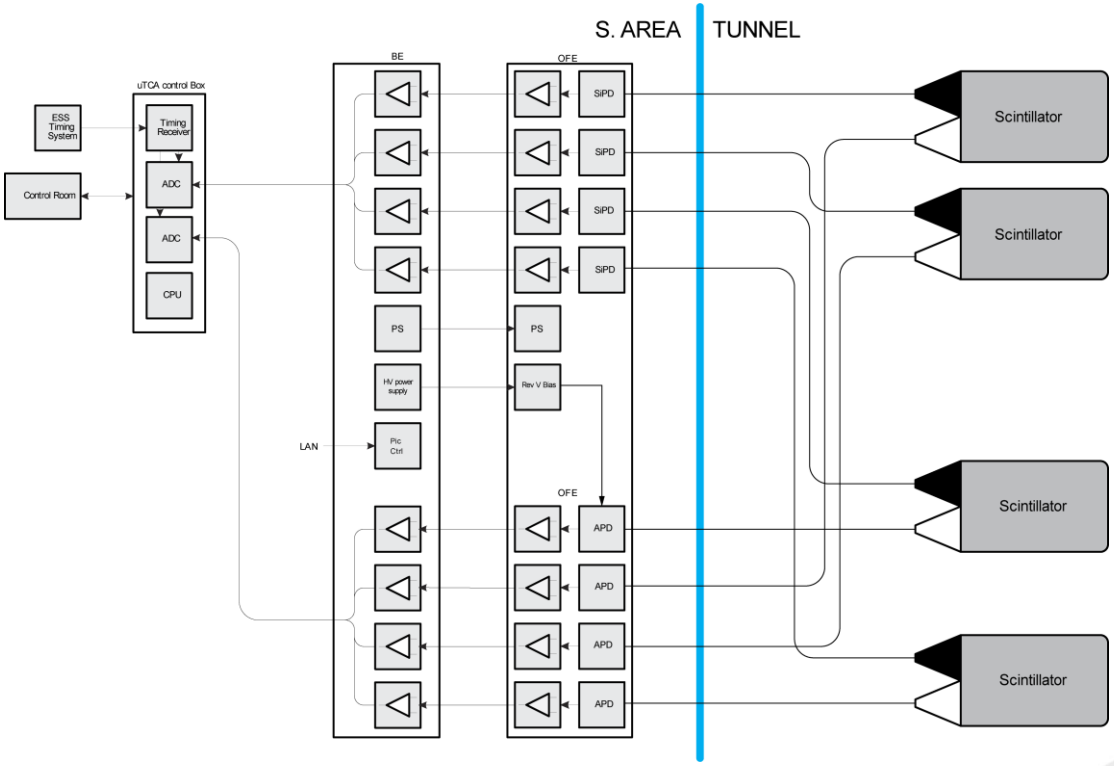
- OFE Component specifications and schematic design
- OFE electrical tests
- OFE Hardware and assembly
- OFE Mechanical design

Optical Front End

Block schematics







General Technical specifications

OFE tech specifications:

- low-voltage noise JFET-input stage	
- Power supply	-5V to +5V
- High Gain Bandwidth Product	1.6 GHz
- High Bandwidth	275 MHz
- Slew Rate	700 V/µs
- Operating Temperature Range	–40◦C to 85◦C
- Low-Input Offset Voltage	±250 µV
- Low-Input Bias Current	2 pA
- Low-Input Voltage Noise	4.8 nV/√Hz
- Input noise current	1.8 pA/√Hz
- High-Output Current	70 mA
- Output voltage range	0 to - 4.5 V
- Optical power sensitivity	1nW
- Optical power range	1nW – 60uW

Si Photo Diode (PD) Hamamatsu S1226-44BQ

- Photo sensitivity area	3.6 x 3.6 mm
- Operating temperature	-20 to +60 deg. C
- Spectral response range	190 to 1000 nm
- Peak sensitivity wavelength	720 nm
- Photosensitivity	0.36 A/W
- Dark current	10 pA
- Terminal capacitance	500 pF

Avalanche Si Photo diode (APD) Hamamatsu S5544

- Photo sensitivity area	fi 3.0 mm
- Operating temperature	-20 to +60 deg. C
- Spectral response range	200 to 1000 nm
- Peak sensitivity wavelength	620 nm
- Photosensitivity	0.42 A/W
- Dark current	Typ 1 nA max 30 nA
- Terminal capacitance	120 pF
- Break down voltage	typ 150V max 200V

Power Supply

- Main power supply (BE)	-5V / +5V
- Main current max	-100 mA / +200 mA
- Bias High Voltage (BE)	0 V to max +200V must be software limited to +150V
- Internal Bias High Voltage	0 V to max +200V

Mechanical specifications

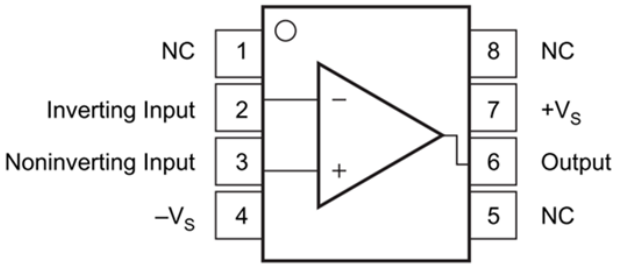
- Aluminum milled unibody case	
- Mechanical dimension	19 inch 1U rack mount case W-483mm H-88mm D-50mm
- Weight	1934.35 g

OFE IC specifications

OPA657 1.6-GHz, Low-Noise, FET-Input Trans Impedance Amplifire

Features:

- High Gain Bandwidth Product: 1.6 GHz
- High Bandwidth 275 MHz
- Slew Rate 700 V/µs
- Operating Temperature Range: –40° C to 85° C
- Low-Input Offset Voltage: ±250 µV
- Low-Input Bias Current: 2 pA
- Low-Input Voltage Noise: 4.8 nV/√Hz
- Low input noise current of 1.8 pA/√Hz
- High-Output Current: 70 mA



Supply voltage:

±5 V DC

OFE Photo detector Characteristics

SiPD - HAM S1226-44BQ Characteristics:

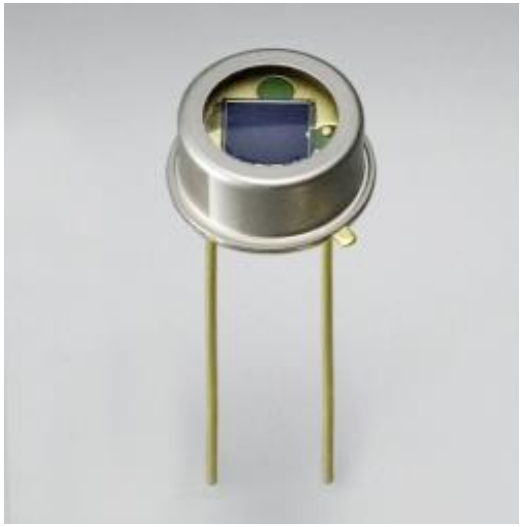
- Active Area of photo diode 3.6 x 3.6 mm
- Reverse bias voltage 5V
- Wave length 190 to 1000nm peak 720nm
- Photo sensitivity - 0.36A/W
- Dark current Id 10pA
- Cd 500pF

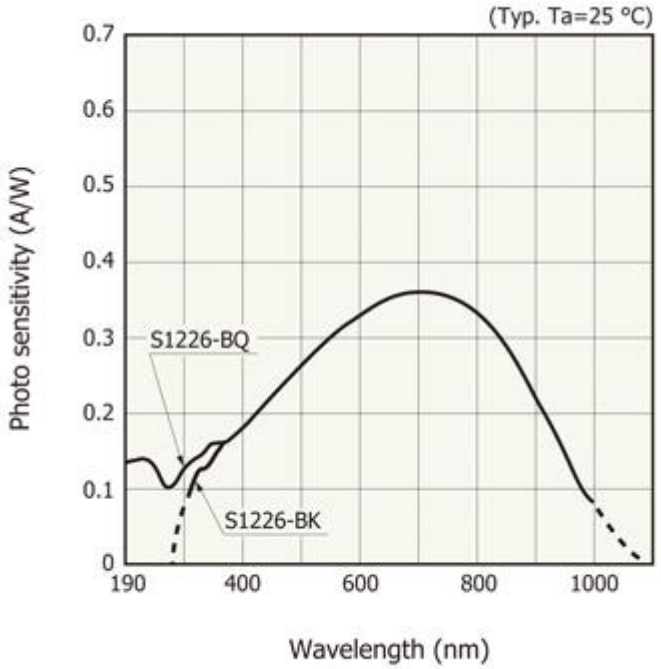
$$Responsivity_{PhD} = \frac{I_d}{W}$$

$$Area = a^2(cm^2)$$

$$O_p = \frac{W}{Area}$$

SiPD Id 5uA = 107.25uW of optical power





OFE Photo detector Characteristics

SiAPD - HAM S5344 Characteristics:

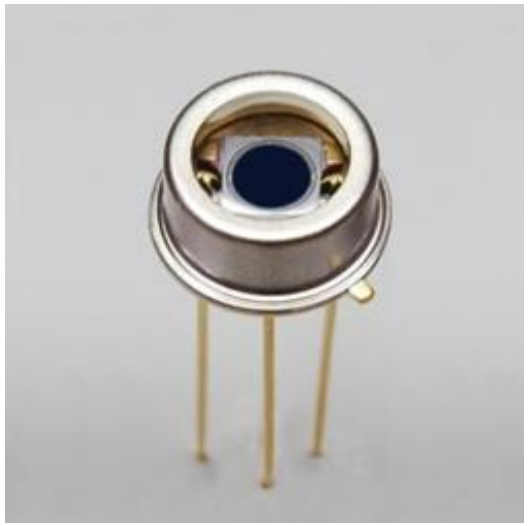
- Active Area of photo diode fi 3mm
- Breakdown voltage 150V Id 100uA
- Wave length 200 to 1000nm peak 620nm
- Photo sensitivity - 0.42A/W
- Dark current Id 1nA
- Cd 120pF

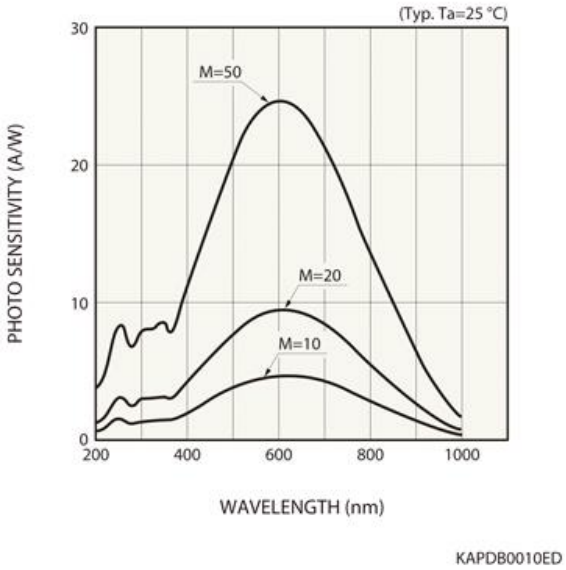
$$Responsivity_{PhD} = \frac{I_d}{W}$$

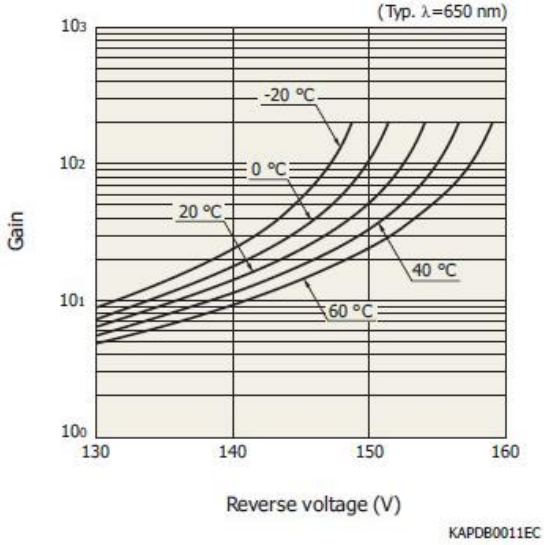
$$Area = \pi r^2 (cm^2)$$

$$O_p = \frac{W}{Area}$$

SiAPD Id 5uA = 168.36uW of optical power



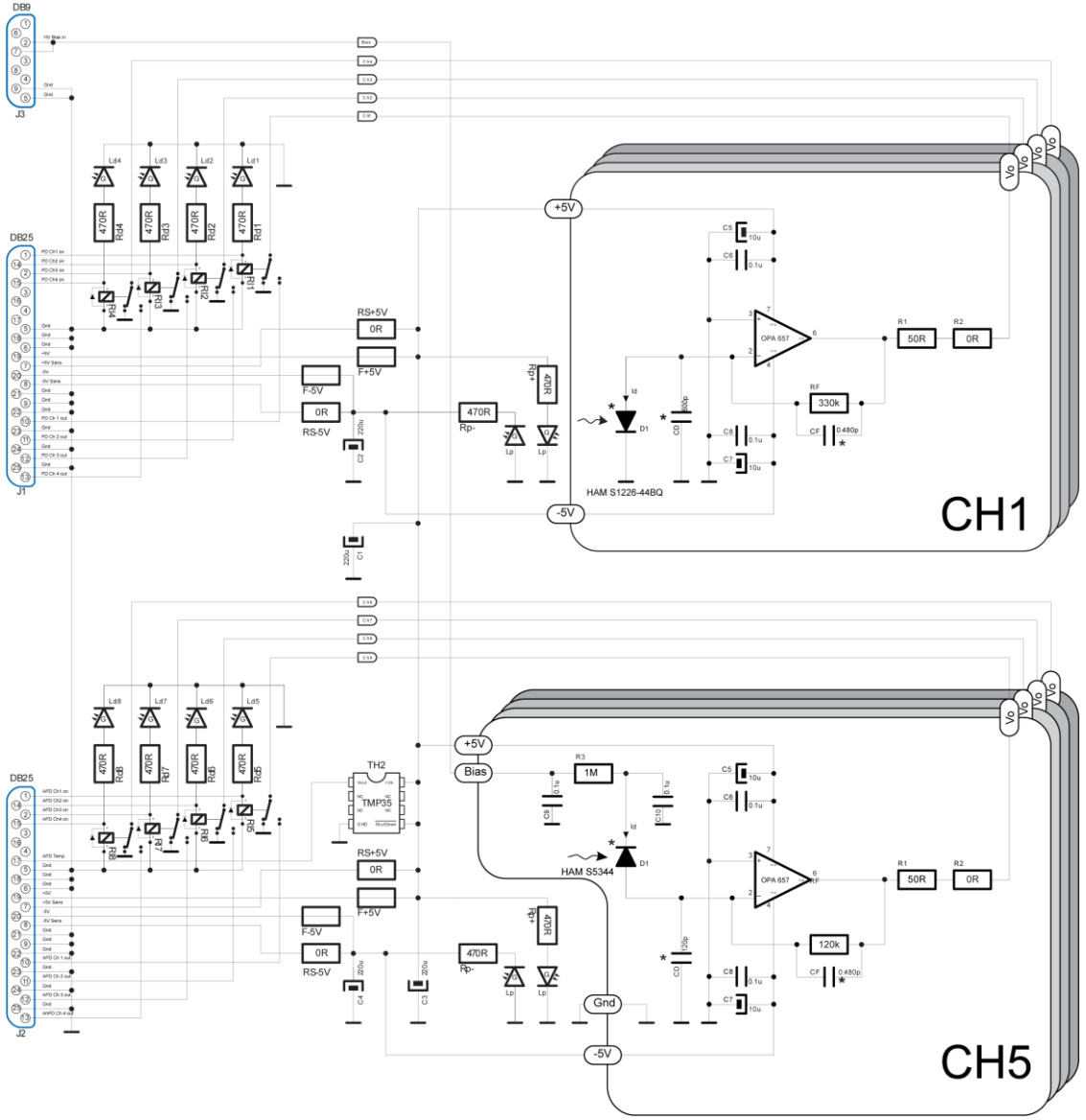




Optical Front End

Electrical schematic

- Single pcb design
- Temperature sensor
- Input selector with led indicators
- Power supply led indicators
- Chanel selector

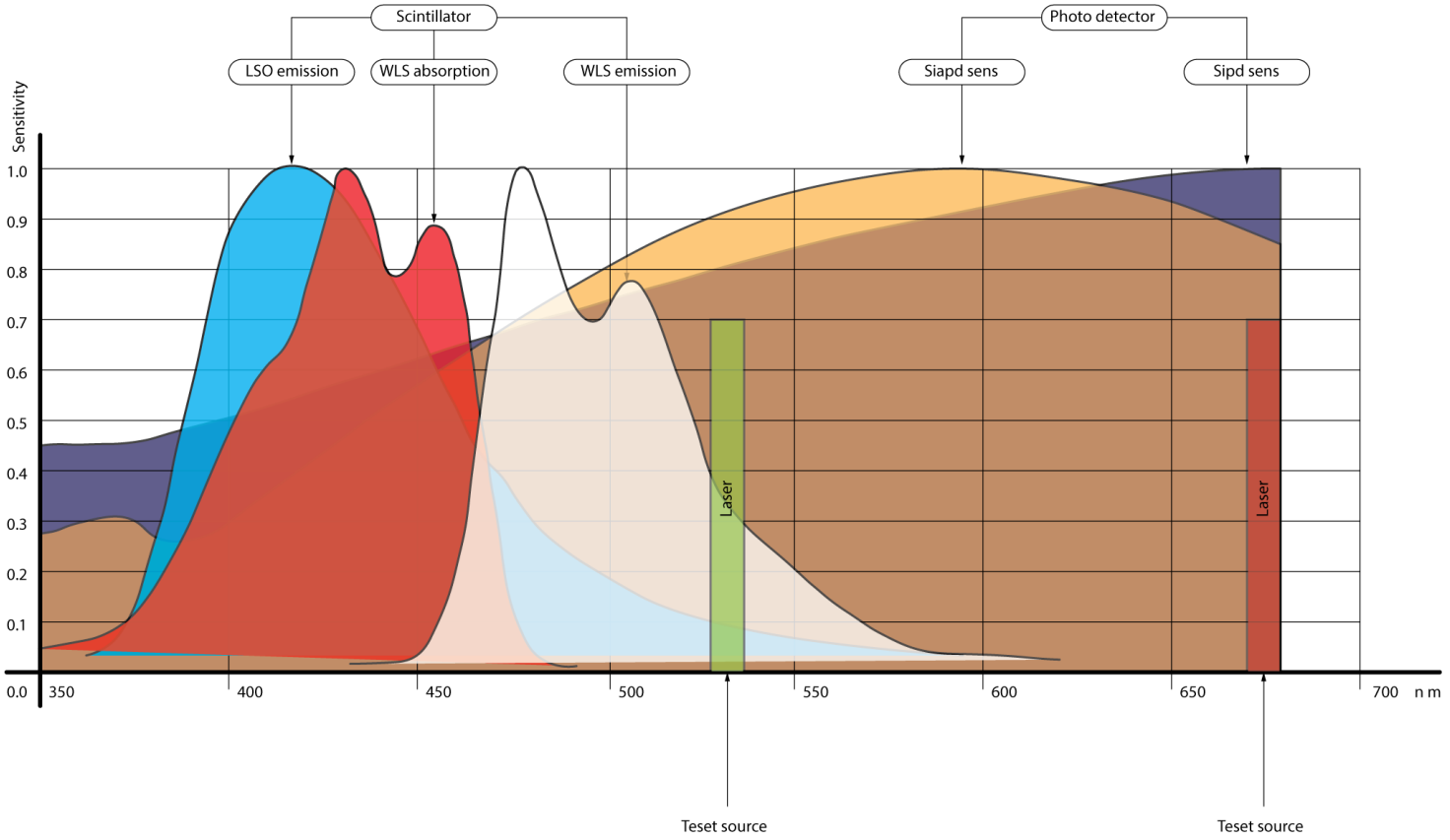


4 ch Si PD amp

4 ch Si APD amp

Optical Front End

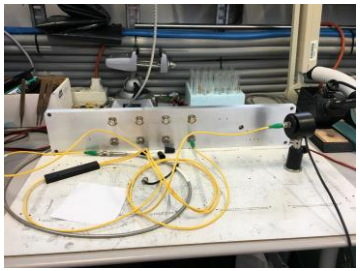
Opto - Electrical test



The light wave length specter expected from scintillator to optical fiber transported to silicon photo detectors

Optical Front End light measurement

Keithley multimeter



With SiPD 1nW light power easily measured

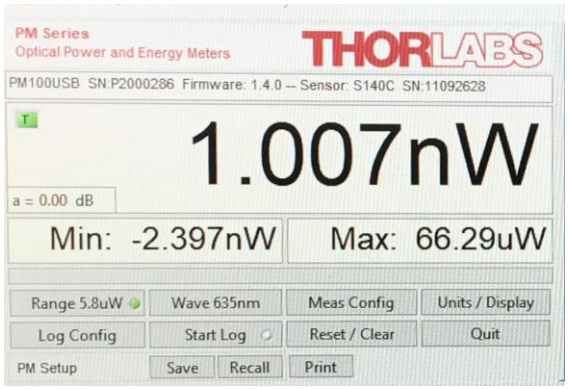
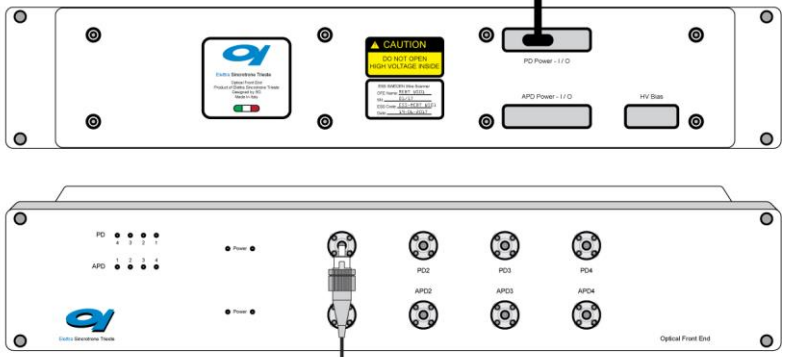
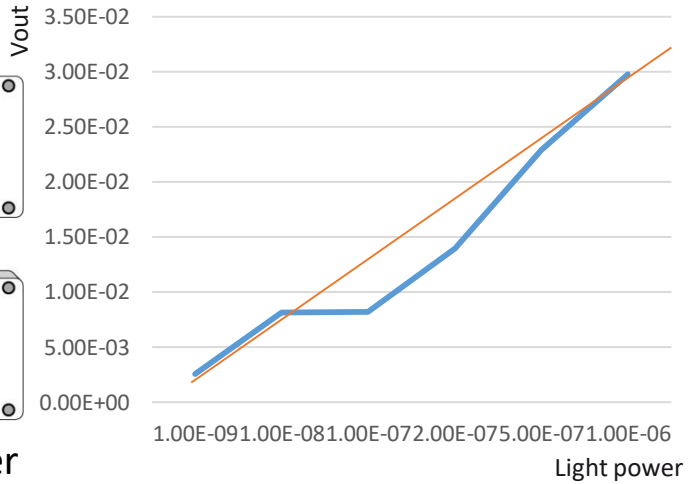


Image of the measured light power



SiPD output

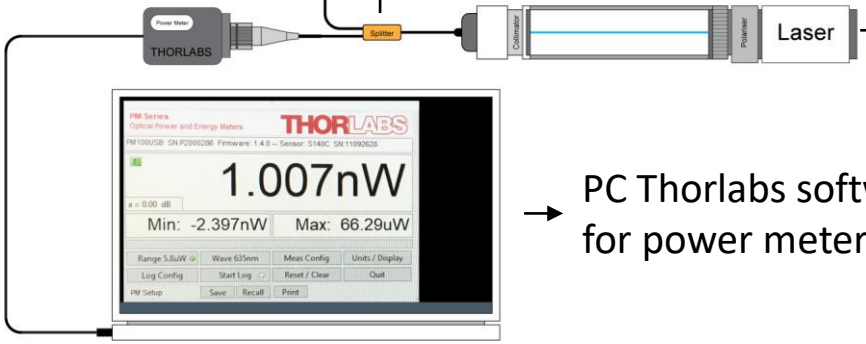


→ Optical fiber

Polarizer for light power regulation

Thorlabs power meter

Fiber splitter



→ Thorlabs 5 mW - 670 nm laser

Light power from 1nW to 60 uW

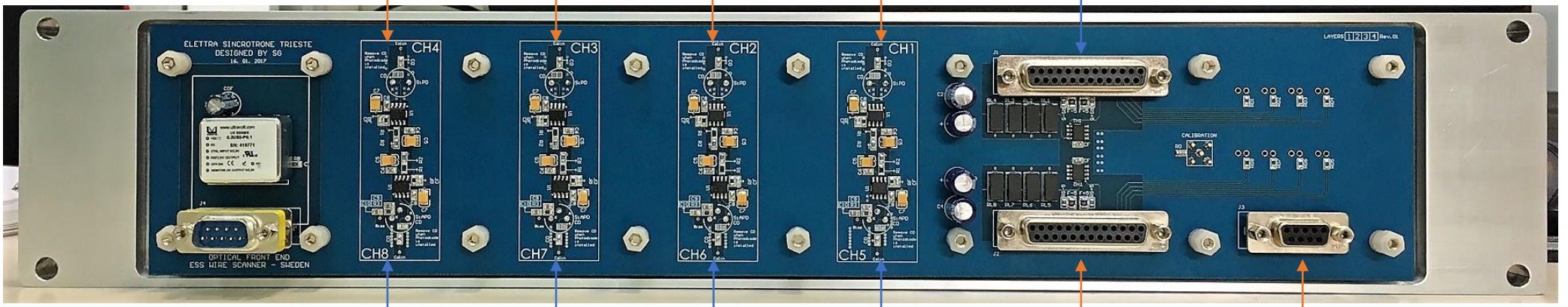
→ PC Thorlabs software for power meter

Optical Front End hardware

Assembled OFE electronics in Aluminum milled body

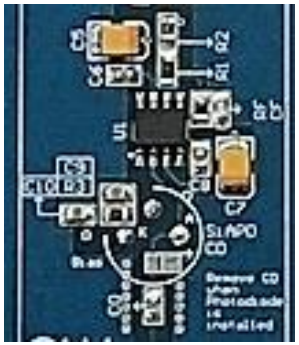
SiPD amplifier

Back End controlled PS, CH selector, and Signal Output



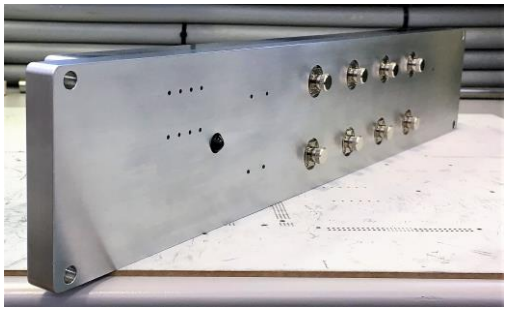
SiAPD amplifier

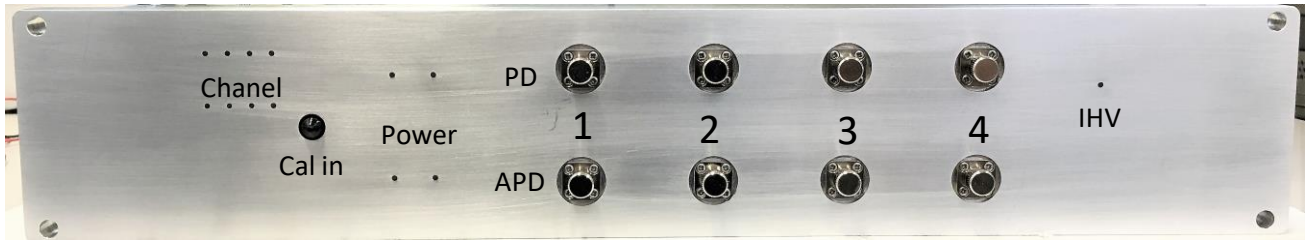
Back End controlled PS, HV biasing, CH selector, Signal Output and Temp measurement



Assembled detail

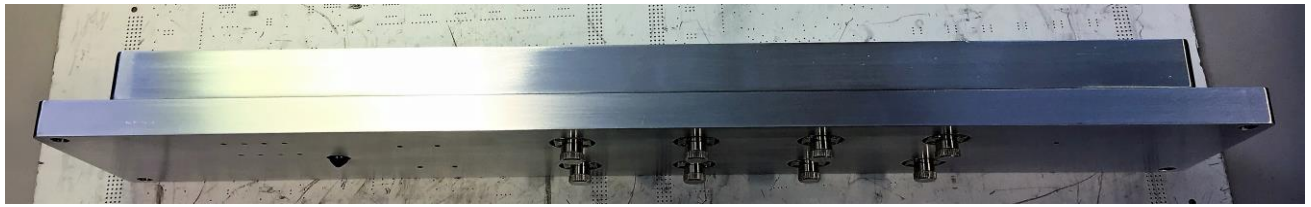
Optical Front End





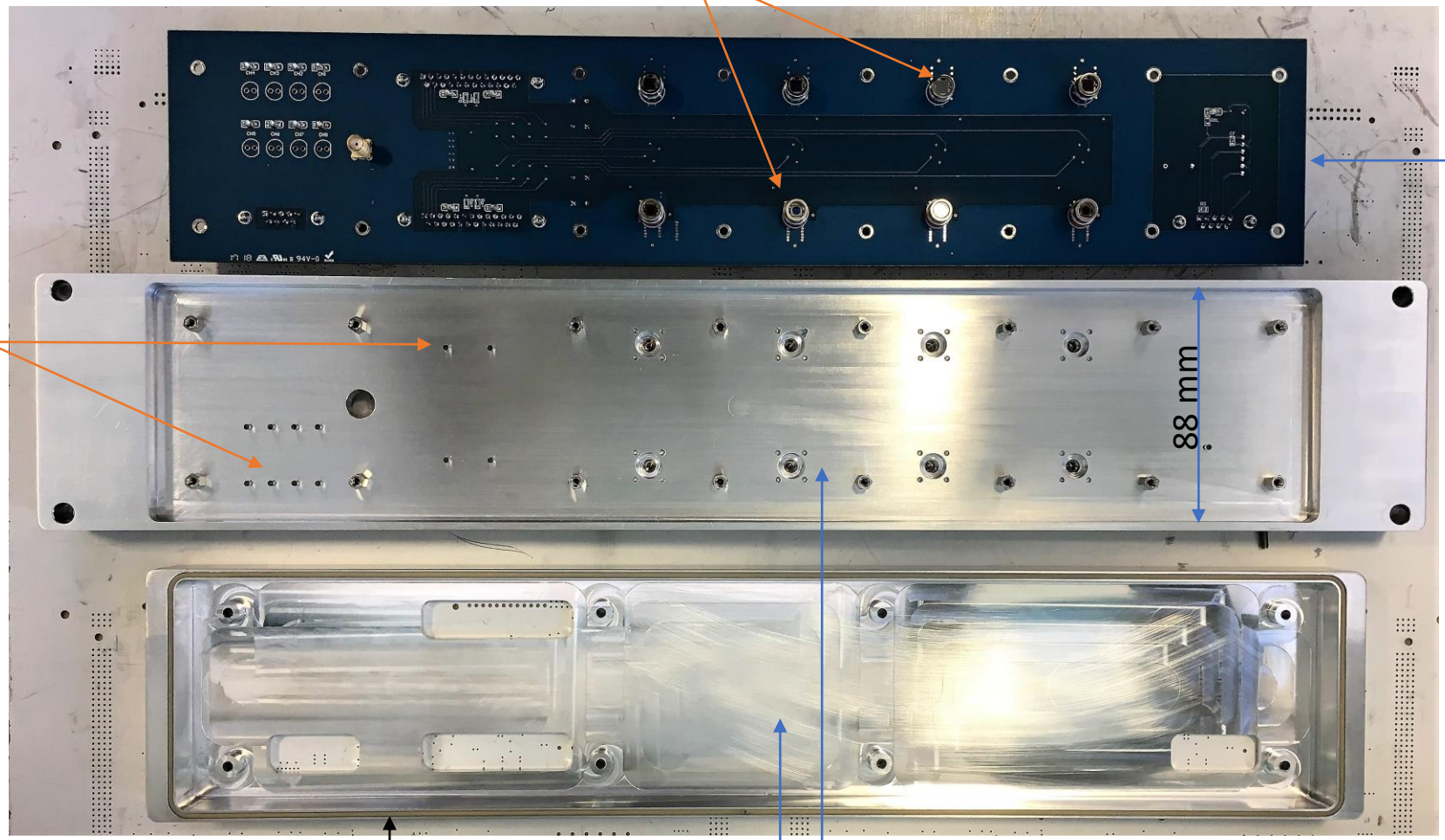
Aluminum milled body

Connections on the back



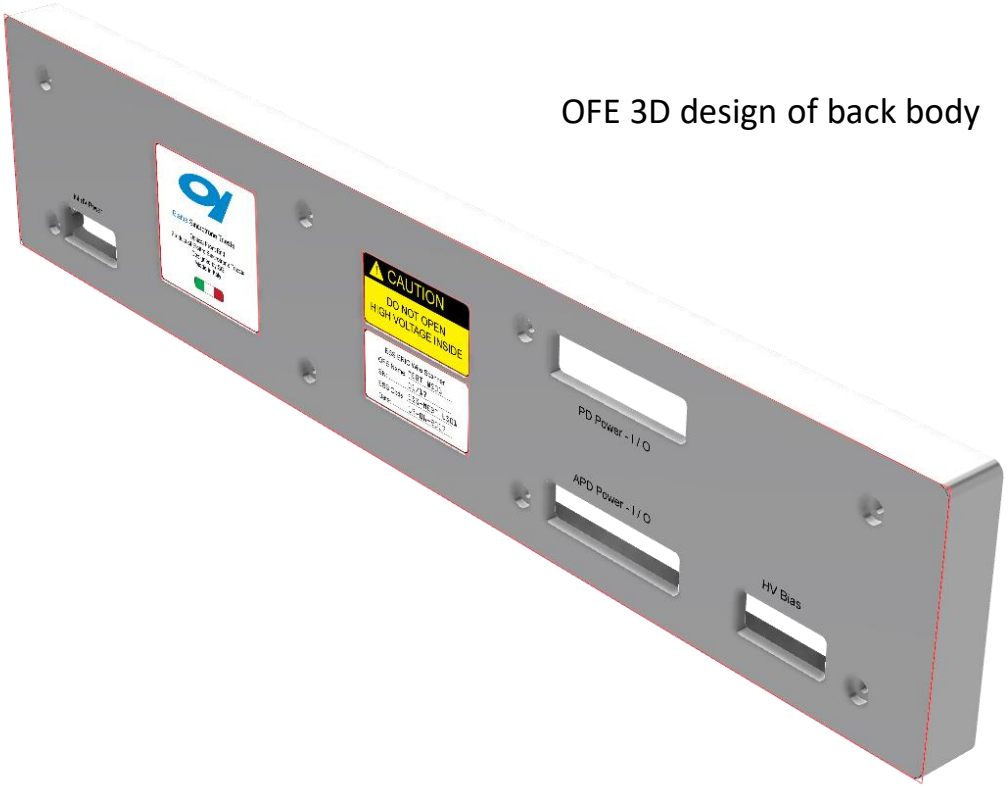
Slim and compact design

Optical Front End hardware

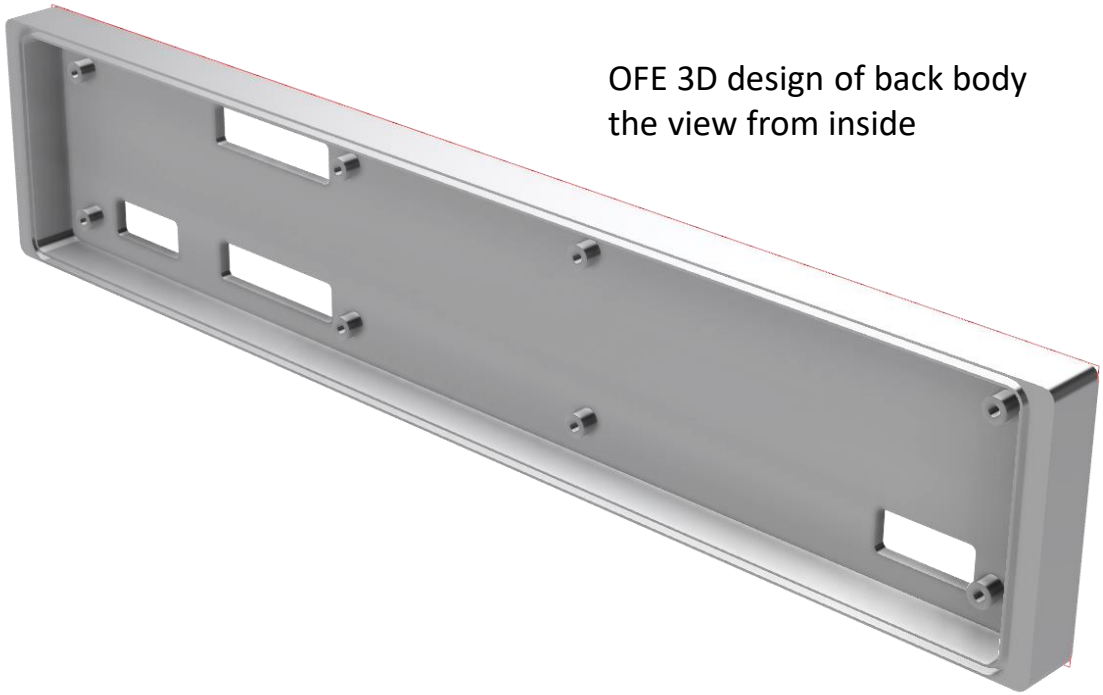


Optical Front End Mechanical design

OFE 3D design of back body

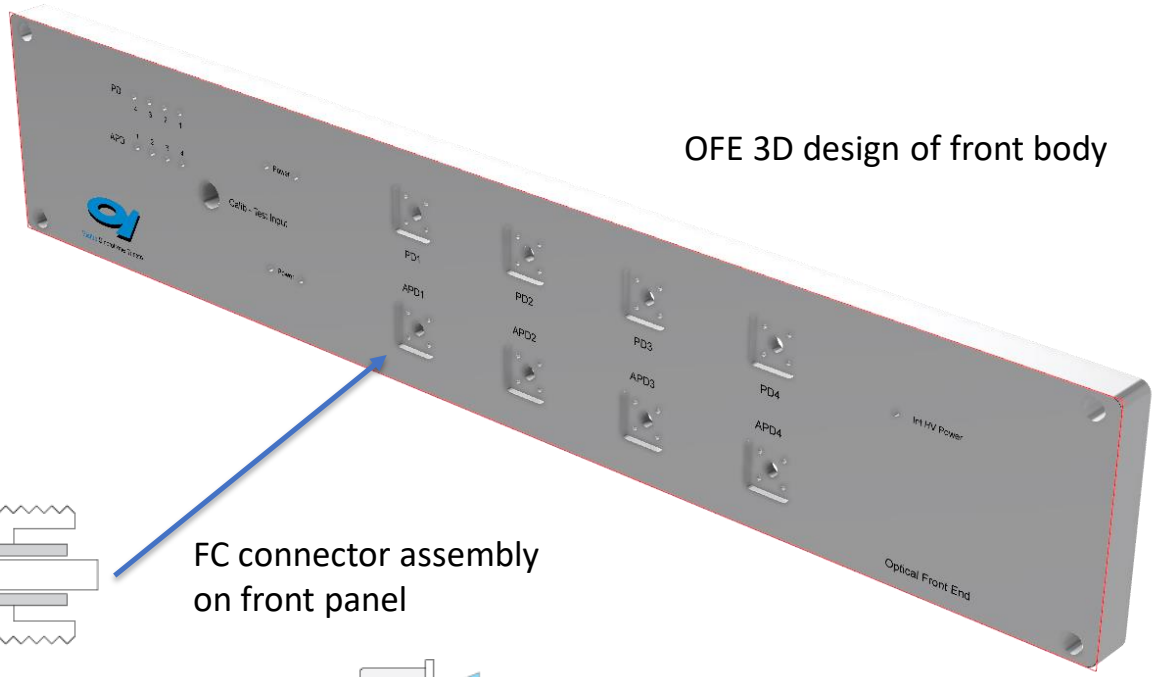


Optical Front End Mechanical design

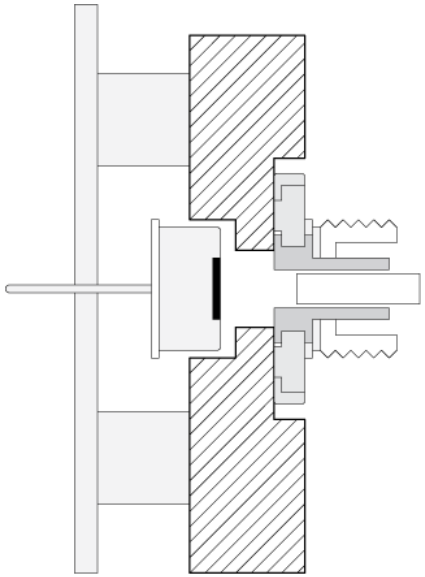


OFE 3D design of back body
the view from inside

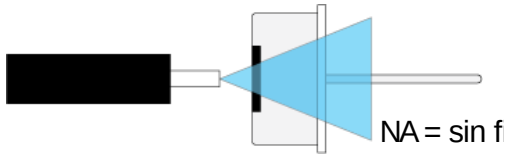
Optical Front End Mechanical design



OFE 3D design of front body

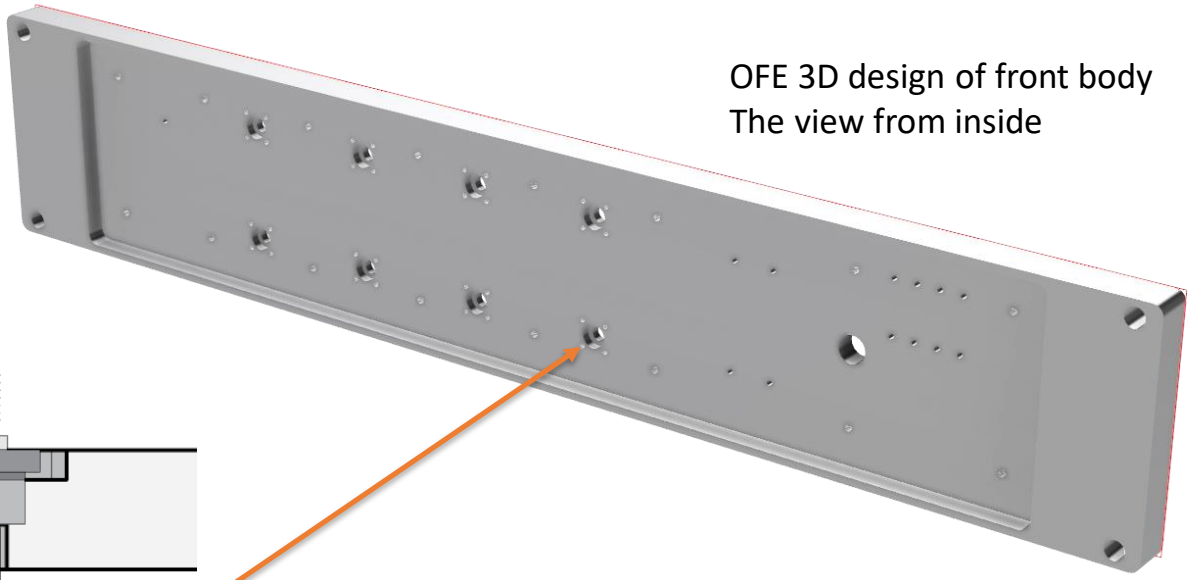


FC connector assembly
on front panel



Numerical Aperture of Optical Fiber

Optical Front End Mechanical design



OFE 3D design of front body
The view from inside

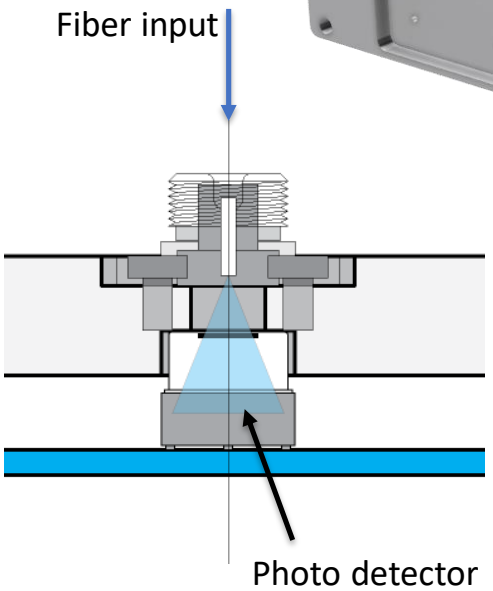


Photo diode - FC connector assembly design

Thank you !