

Lab Work
Russin Quantum Center

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1. Annotation

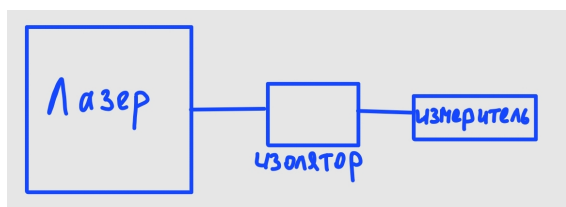
Purpose of the work: To master basic methods of working with optical equipment, to check the operation of beam splitters.

The work uses:

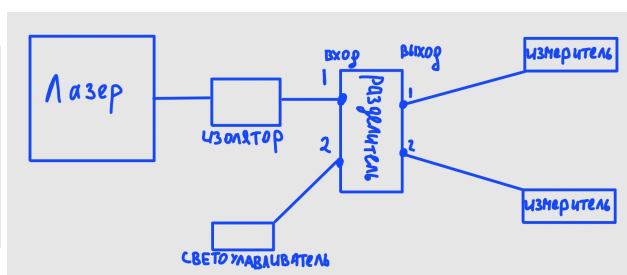
14 DFB Laser,
CLD1015 ThorLabs,
Fiber isolator IO-H-1550APC ThorLabs,
Power meter PM20CH ThorLabs,
Power meter FHP2B04 Grandway,
Integrating Sphere S416C,
Beamsplitters 90/10 and 99/1,
Single-mode fiber.

2. Experimental setup

The laser operates at a wavelength of 1550 nm. The isolator in the circuit is necessary to protect the laser diode from the reflected wave. Also, the light trap on the 2nd input channel of the splitter avoids the situation of accidental eye contact with the reflected wave. Two setups were used in this work:



Setup for calibration

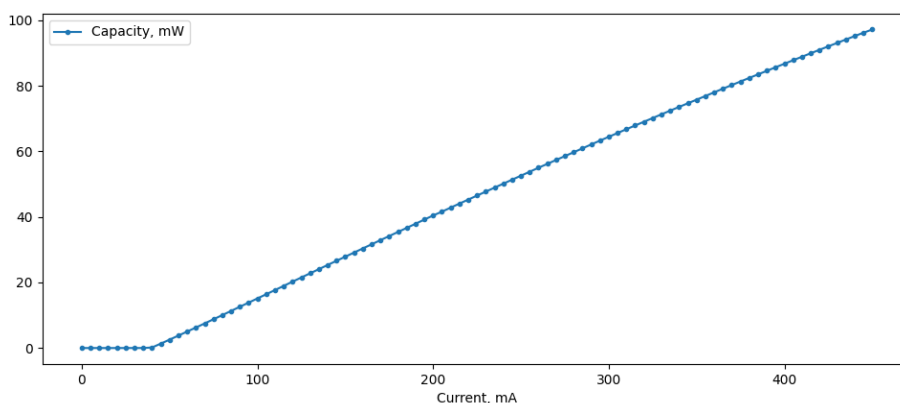


Setup for beam division ratio test

3. Measurement results and data processing

3.1. Calibration

In the course of calibration a calibration curve of $P(I)$ dependence was obtained. It can be seen that the minimum current for laser operation is 40 mA, values up to it are in the noise region. By the method of least squares the values from 45 mA to 450 mA were approximated.

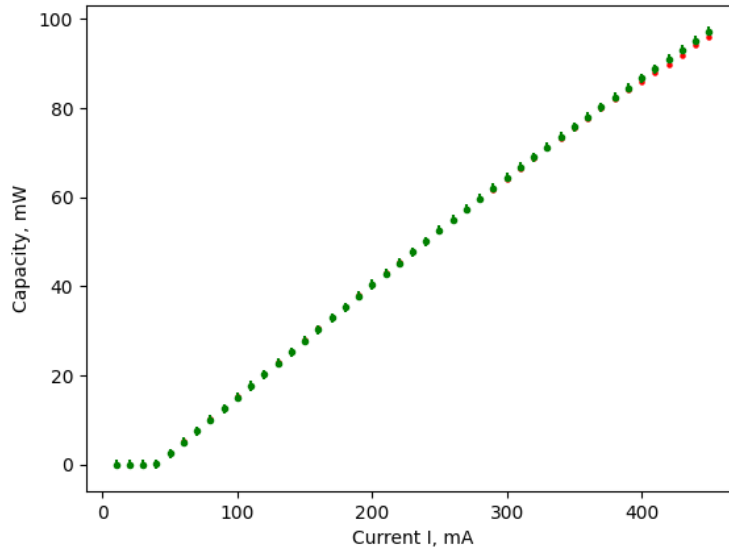


Calibration curve

3.2. Beamsplitters

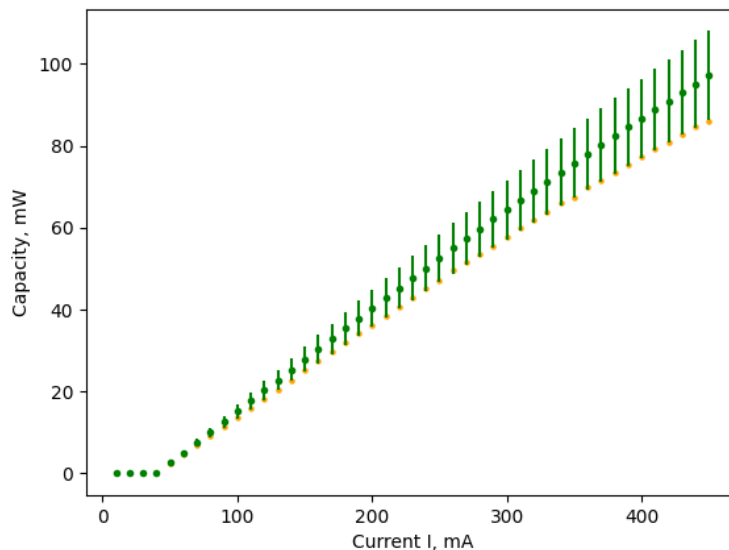
Before considering the beam splitting ratio, it is necessary to understand the output loss.

For the 99/1 beamsplitter the excess loss should be less than 0.15dB. The values are within the specified error limits.



BeamSplitter 99/1. Excess loss <0.15dB

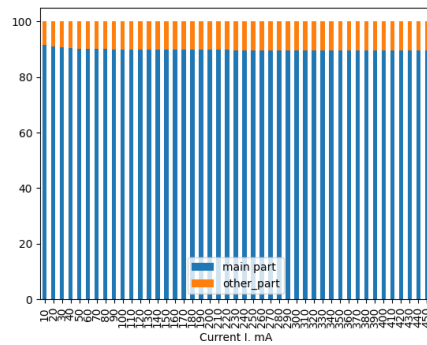
For a 90/10 beamsplitter, the excess loss should be less than 0.15dB. In this divider, one end of the fiber did not have a tip and therefore an integrating sphere was used. Also, when measuring the fiber with an open end, an integrating sphere was used, which has an error of 5%. There are also additional losses of about 3%, which can be considered as losses in the fiber.



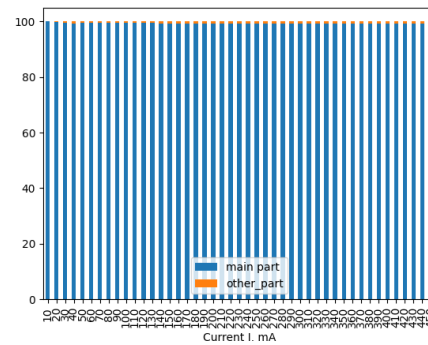
BeamSplitter 90/10. Excess loss <0.15dB

Now let's get to the part with measuring the beam splitting ratio of each beamsplitter.

Beam splitting (percentage)



Beamsplitter 90/10



Beamsplitter 99/1

The beam splitting ratio is within the stated limits and is independent of power after a value of 40 mA, which is the threshold value for a laser diode.

4. Conclusion

In the course of the Lab work the calibration of the setup was done. Excess losses due to splitters were measured, they are within the limits declared by the manufacturer. Beam splitting coefficients are also measured, they are within the limits declared by the manufacturer.

5. Specifications

TW1550R2A2		TW1550R1A2	
Coupling Ratio ^a	90:10	Coupling Ratio ^a	99:1
Coupling Ratio Tolerance	±2.5%	Coupling Ratio Tolerance	±0.6%
Center Wavelength	1550 nm	Center Wavelength	1550 nm
Minimum Bandwidth	±100 nm	Minimum Bandwidth	±100 nm
Insertion Loss ^a	≤0.8 dB / ≤11.5 dB	Insertion Loss ^a	≤0.3 dB / ≤24.2 dB
Excess Loss ^a	<0.15 dB (Typ.)	Excess Loss ^a	<0.15 dB (Typ.)
Uniformity ^a	≤0.6 dB	Uniformity ^a	≤0.8 dB
Polarization-Dependent Loss (PDL) ^a	≤0.15 dB	Polarization-Dependent Loss (PDL) ^a	≤0.15 dB
Optical Return Loss (ORL) / Directivity ^a	≥60 dB	Optical Return Loss (ORL) / Directivity ^a	≥60 dB

Beamsplitter 90/10

Beamsplitter 99/1

Parameter	Sym.	Condition	Min	Max	Unit
Storage Temperature	T _{STG}		-40	+85	°C
Operating Case Temperature	T _{OP}		-20	+70	°C
Laser Forward Current	I _F			350 500	mA@40-63mW mA@80-100mW
Laser Reverse Voltage	V _R			2	V
Photo Diode Photo Current	I _{PD}			10	mA
Photo Diode Reverse Voltage	V _{PD}			20	V
TEC Current	I _{TEC}			4	A
TEC Voltage	V _{TEC}			4	V
Thermistor Current				2	mA
Thermistor Voltage				5	V
Lead Soldering Time				10	s
Lead Soldering Temperature				250	°C
ESD		HBM		500	V

14 DFB Laser

Power meters

Model	FHP-3404	FHP-2804
Calibrated Wavelength	850/1300/1310/1490/1550/1625nm	
Detector Type	InGaAs	
Accuracy	±0.2dB±1mW	±0.2dB±10mW
Resolution	0.01dB	
Linearity	±5%	
Auto Power-off	Yes	
Back-light	Yes	
Reference Value	Yes	
Connector	Interchangeable FC/PC, SC/PC	
Measuring Range	70 to 10dBm@1550nm	50 to 26dBm@1550nm
USB Interface	Yes	
Data Storage	Yes	
Wavelength Recognition	Yes (±40dBm)	Yes (±20dBm)
Power Detection	270, 1k, 24W (±40dBm)	270, 1k, 24W (±20dBm)

Power meter FHP2B04 Gateway

Model	PM20A	PM20C	PM20CH
Sensor Specifications			
Optical Power Range	-60 dBm to +16 dBm	-65 dBm to +13 dBm	-50 dBm to +23 dBm
Spectral Range	400 to 1100 nm		800 to 1700 nm
Detector Type	Si	InGaAs	InGaAs
Sensor Size	3.6 x 3.6 mm	Ø 2 mm	
Input Aperture	3.6 x 3.6 mm	Ø 2 mm	
Aperture Thread	0.535-40 (SM05 Compatible) for PM20 Fiber Adapters FC Fiber Adapter Included		
Measurement Uncertainty	± 0.25 dB		
Measurement Standard	NIST Traceable		
Optical Damage Threshold	50 W/cm²		

Power meter PM20CH ThorLabs

ISOLATOR SPECIFICATIONS	
OPERATING WAVELENGTH	1550 ±20nm
POWER	≤ 300mW
MINIMUM ISOLATION (@ 25°C)	30dB
TYPICAL INSERTION LOSS (@ 25°C)*	≥ 0.5dB
MAXIMUM INSERTION LOSS 0~70°C	≤ 0.50dB
PDL (@ 23°C)	< 0.1 dB
RETURN LOSS (INPUT/OUTPUT)	≥ 60/50dB
OPERATING TEMPERATURE (°C)	0 ~+70
STORAGE TEMPERATURE (°C)	-40 ~+85

Fiber isolator IO-H-1550APC ThorLabs,

S146C	
Detector Type	InGaAs Photodiode
Wavelength Range	900 - 1650 nm
Optical Power Working Range	10 μW - 20 W
Max Average Power Density	2 kW/cm ²
Max Pulse Energy Density	7 J/cm ²
Linearity	± 0.5%
Resolution ^a	10 nW
Measurement Uncertainty ^b	±5%

Integrating Sphere S416C,