



Optické transceivery X Optické trasy

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Transceiver



- **Transmitter + Receiver = Transceiver**
- **Typy – výměnný / nevýměnný ... pluggable / fix**
 - Např SFP nebo SFF
- **Metalické nebo optické rozhraní**
- **Přenosová rychlost**
- **Typ pouzdra**
- **Typ konektoru**
 - Receptacle Modules
 - Coaxial Modules Fiber Pigtails



Optické rozhraní transceiverů



TO-CAN



TOSA/ROSA



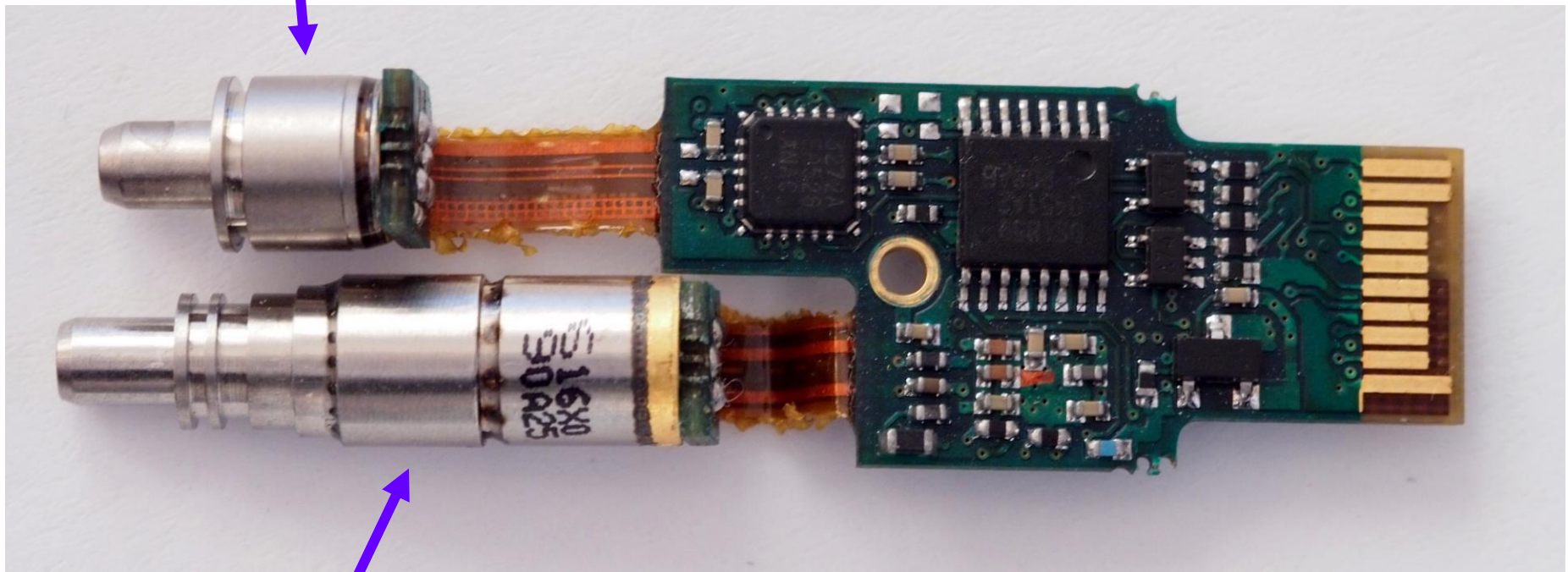
BOSA



ROSA TOSA BOSA



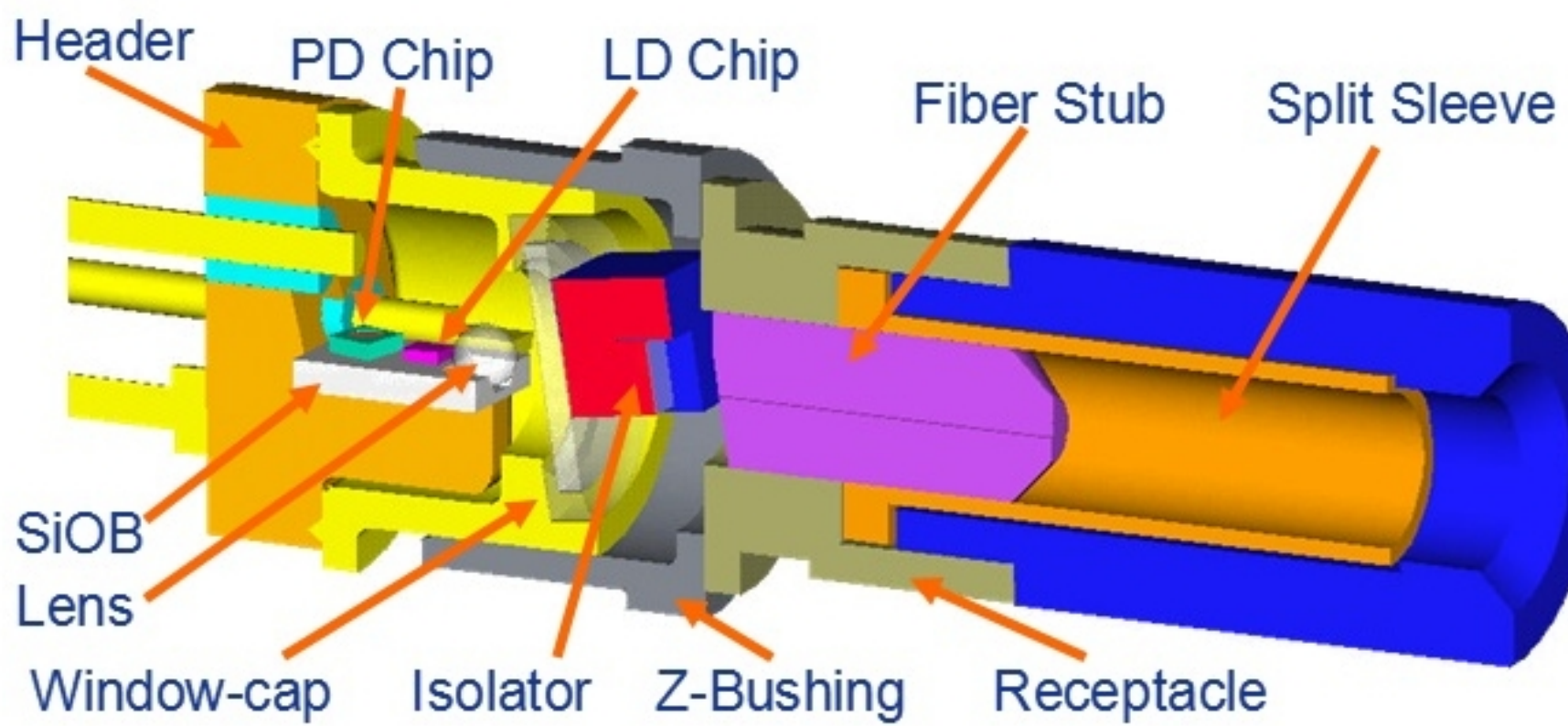
ROSA – Receiver Optical Sub-Assembly



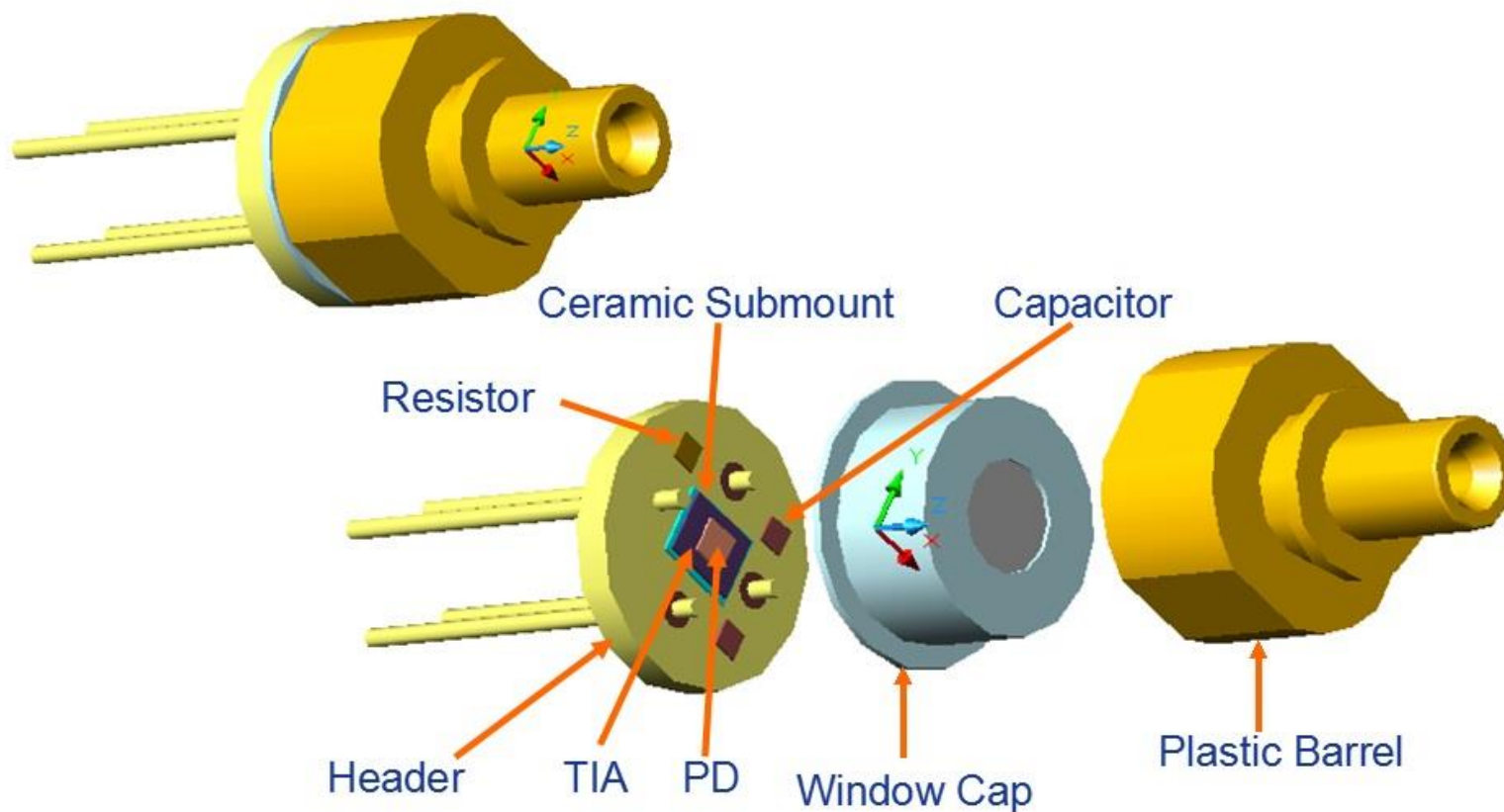
TOSA – Transmitter Optical Sub-Assembly



TOSA - struktura



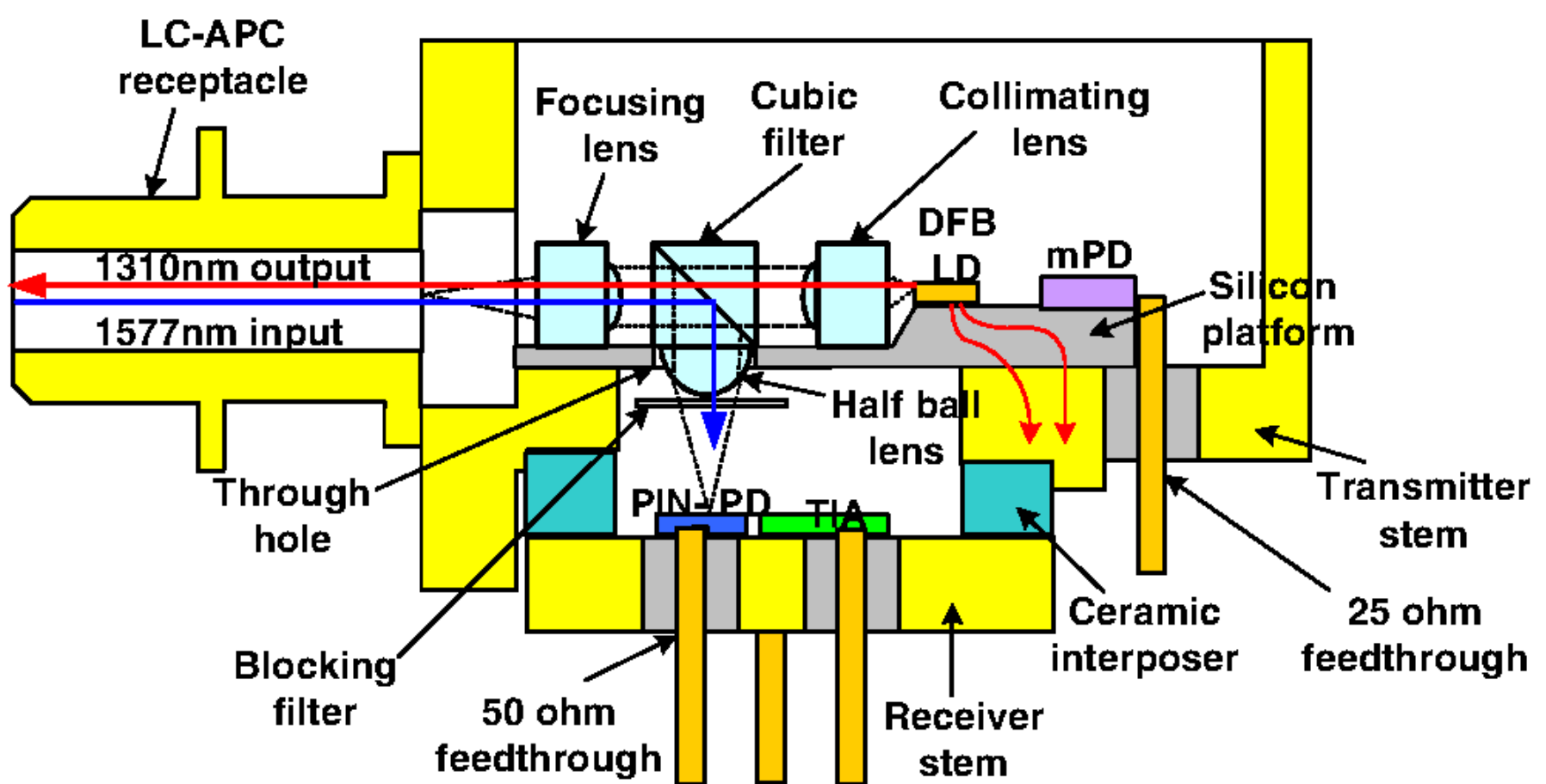
ROSA - struktura



BOSA - struktura



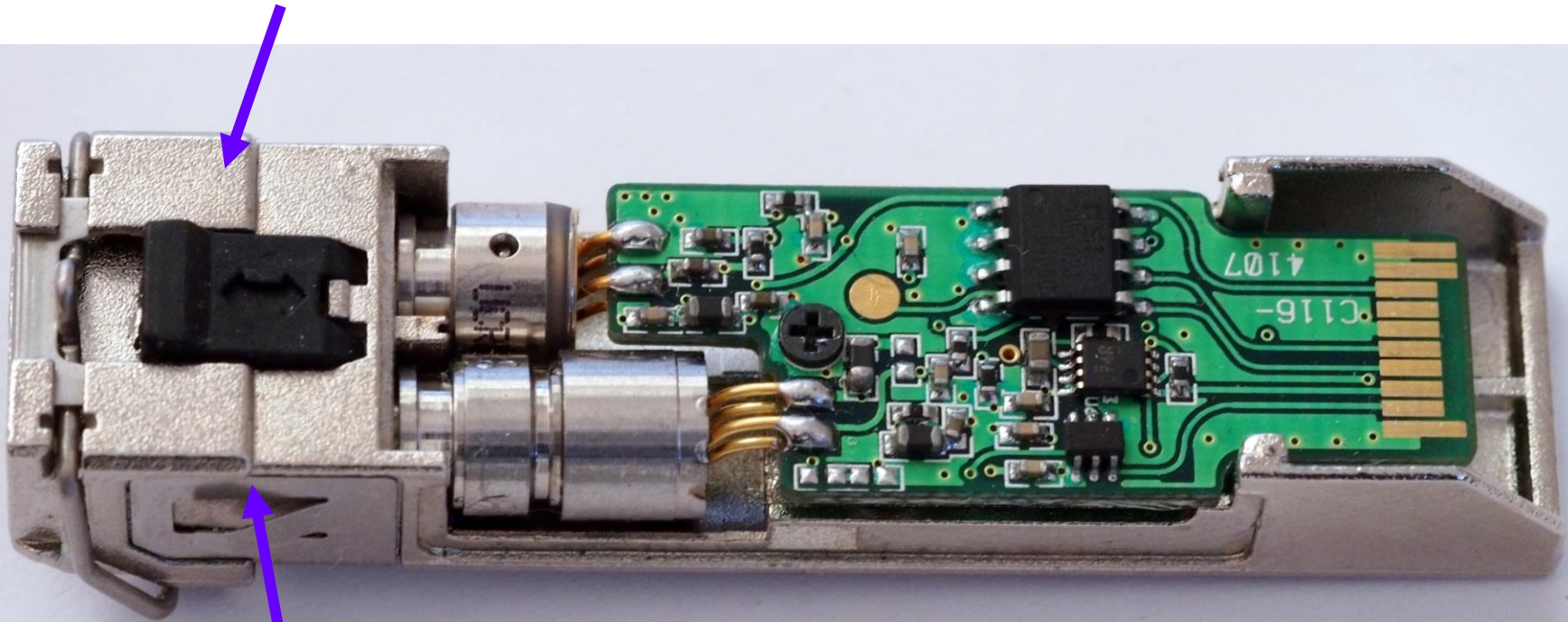
BOSA – Bi-Directional Optical Sub-Assembly



Transceiver komplet



Rx – Receiver



Tx – Transmitter



Co mne může zajímat?



- Typ fotodiody
- Typ laseru
- Vlnová délka
- Rychlost – přenosový protokol
- „Maximální“ vzdálenost
- Power Budget – vložený útlum k dispozici

- Disperze
- Příkon (Level I, Level II, Level III, ...)
- „Kompatibilita“

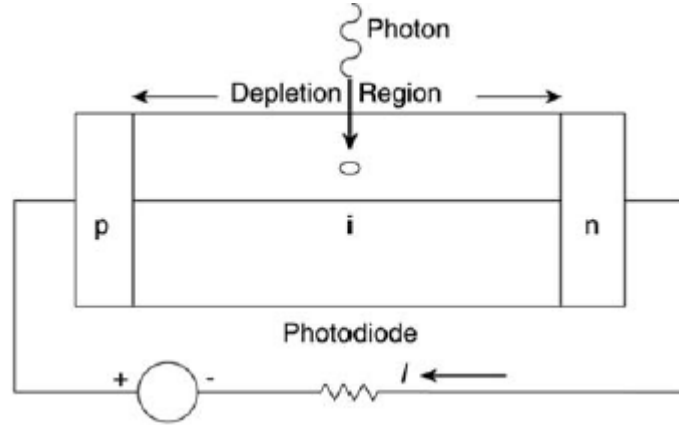
- Jak čistit transceivery ?



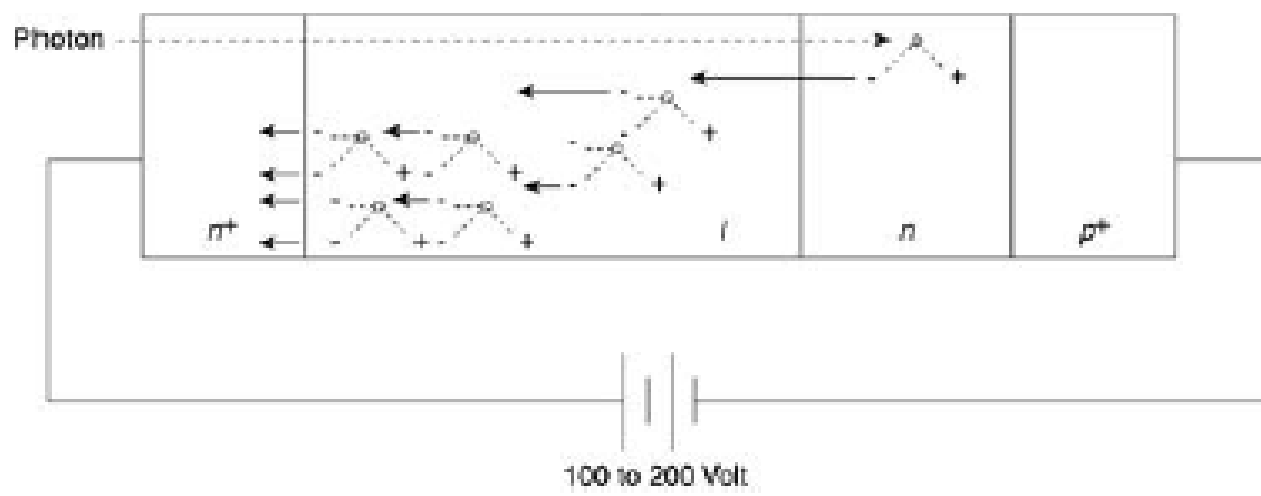
Optický detektor - fotodioda



- PIN fotodioda (Positive Intrinsic Negative)



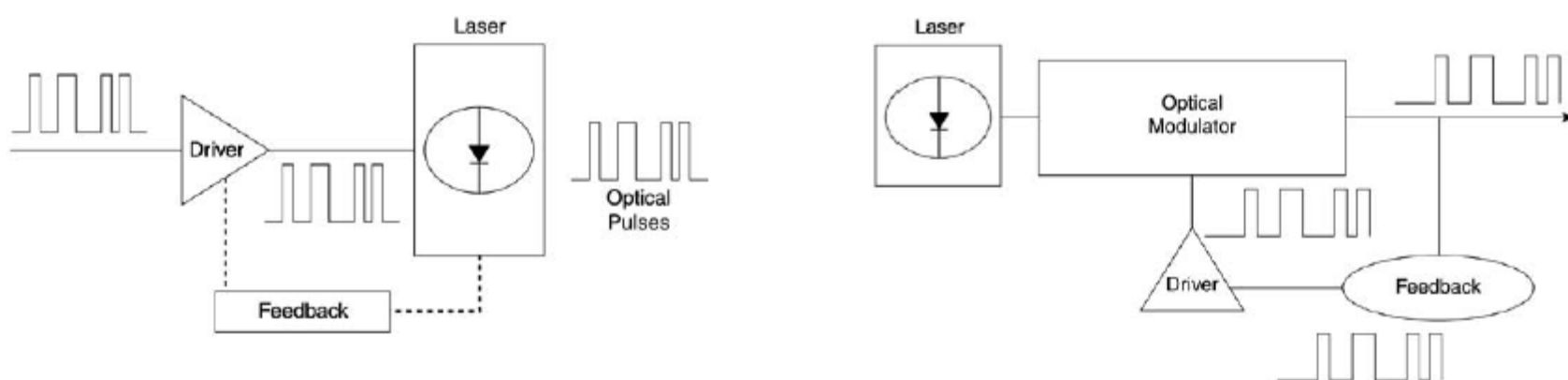
- APD fotodioda (Avalanche Photo Diode)



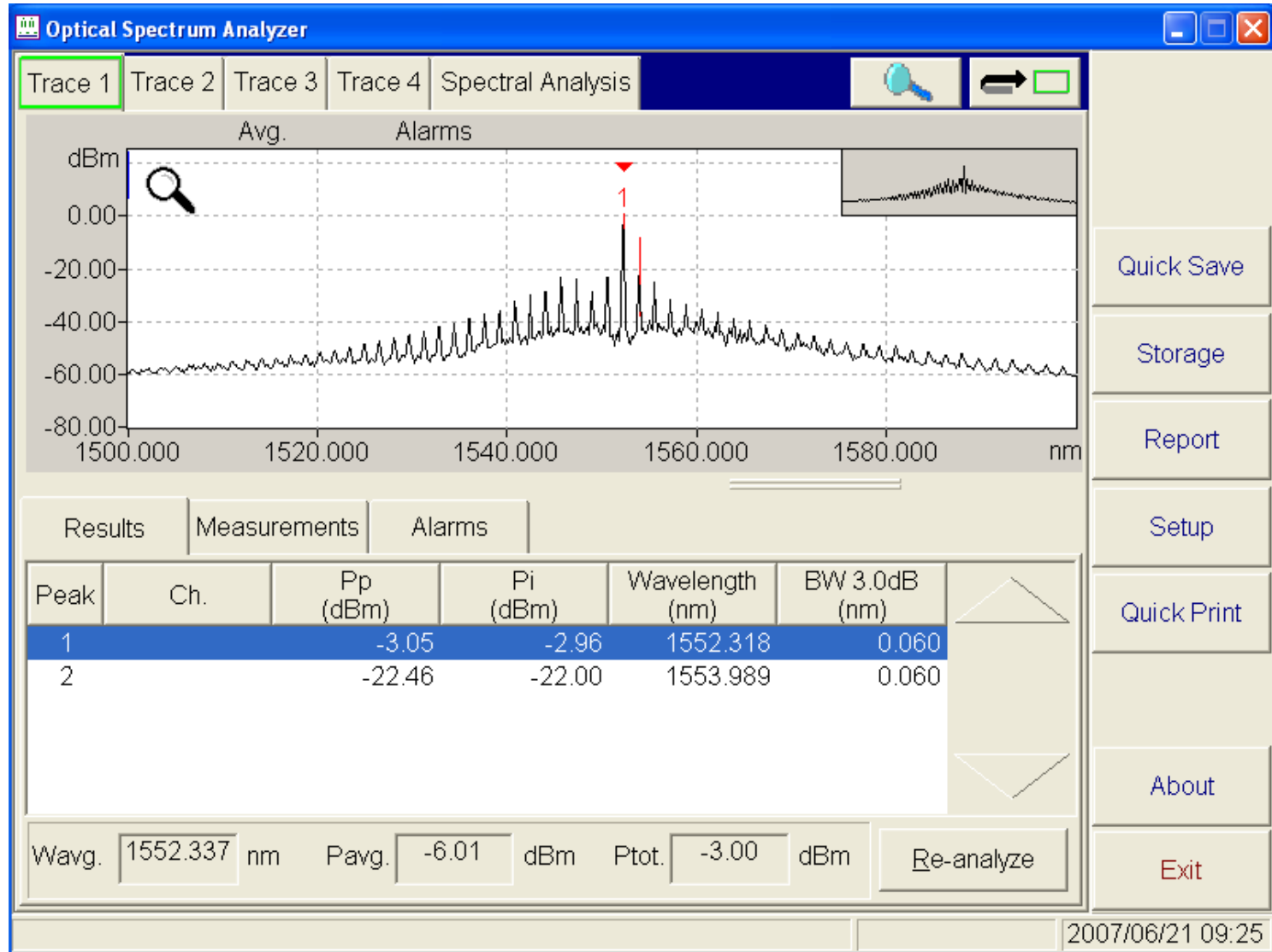
Laser - modulace



- LASER - Light Amplification by Stimulated Emission of Radiation
- Dosažená vzdálenost pro danou přenosovou rychlost závisí na typu a kvalitě laseru a způsobu modulace => odolnost vůči CD a PMD.
 - Přímá modulace – chirp (DML direct modulated laser)
 - Nepřímá modulace – externí modulátor (EML externally modulated laser)
 - NRZ (Non Return to Zero)
 - RZ (Return to Zero) - pro rychlosti 40Gbit/s a výše
 - ODB (Optical Duobinary)
 - DPSK (Differential Phase-Shift Keying)
 - DQPSK (Differential Quadrature Phase Shift Keying)
 - DP-QPSK Dual Polarization-Quadrature Phase Shift Keying

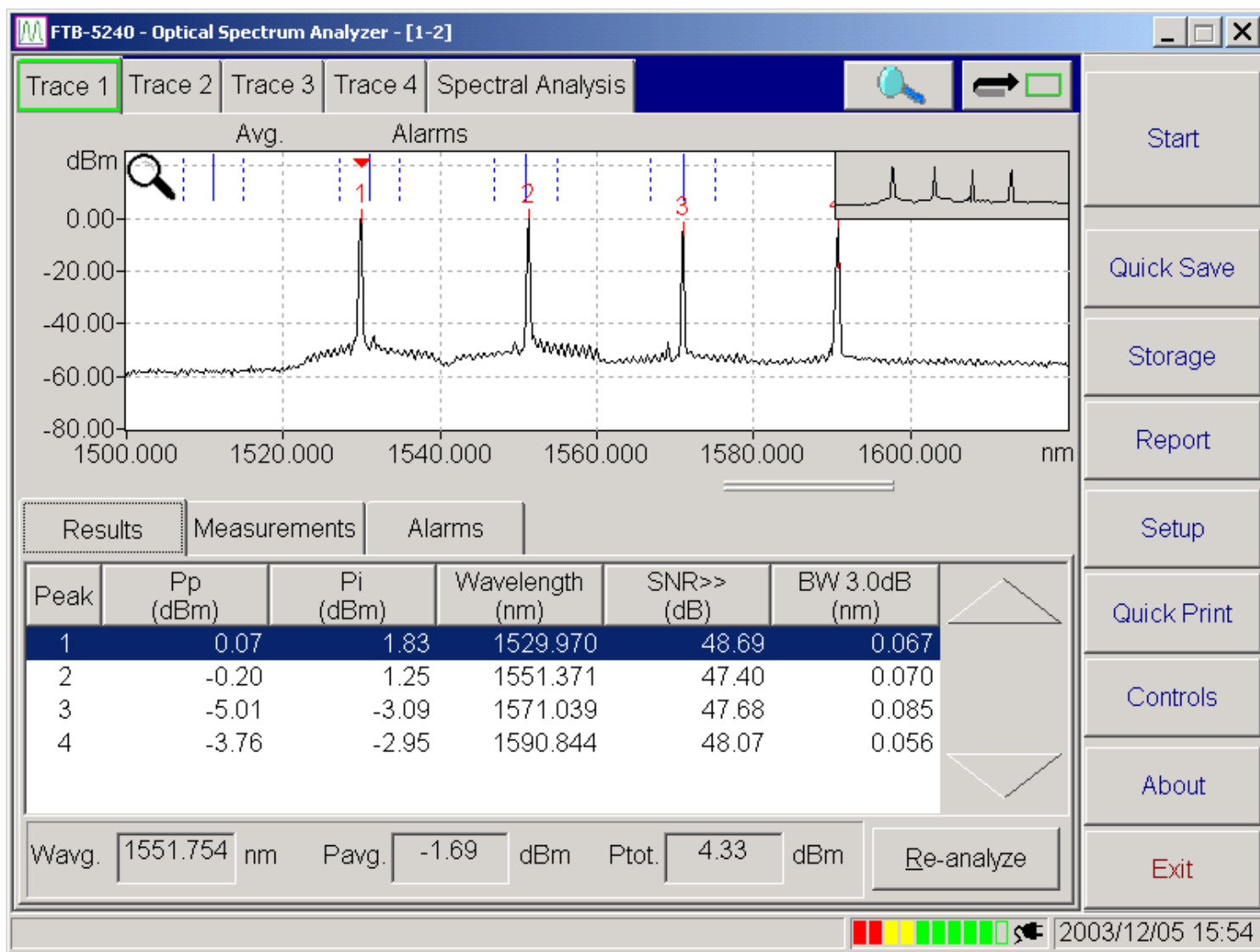


Spektrum – FP laser



FP Fabry-Perot Laser

Spektrum - DFB laser



DFB Distributed FeedBack Laser

Ferule transceiveru Rx nebo Tx



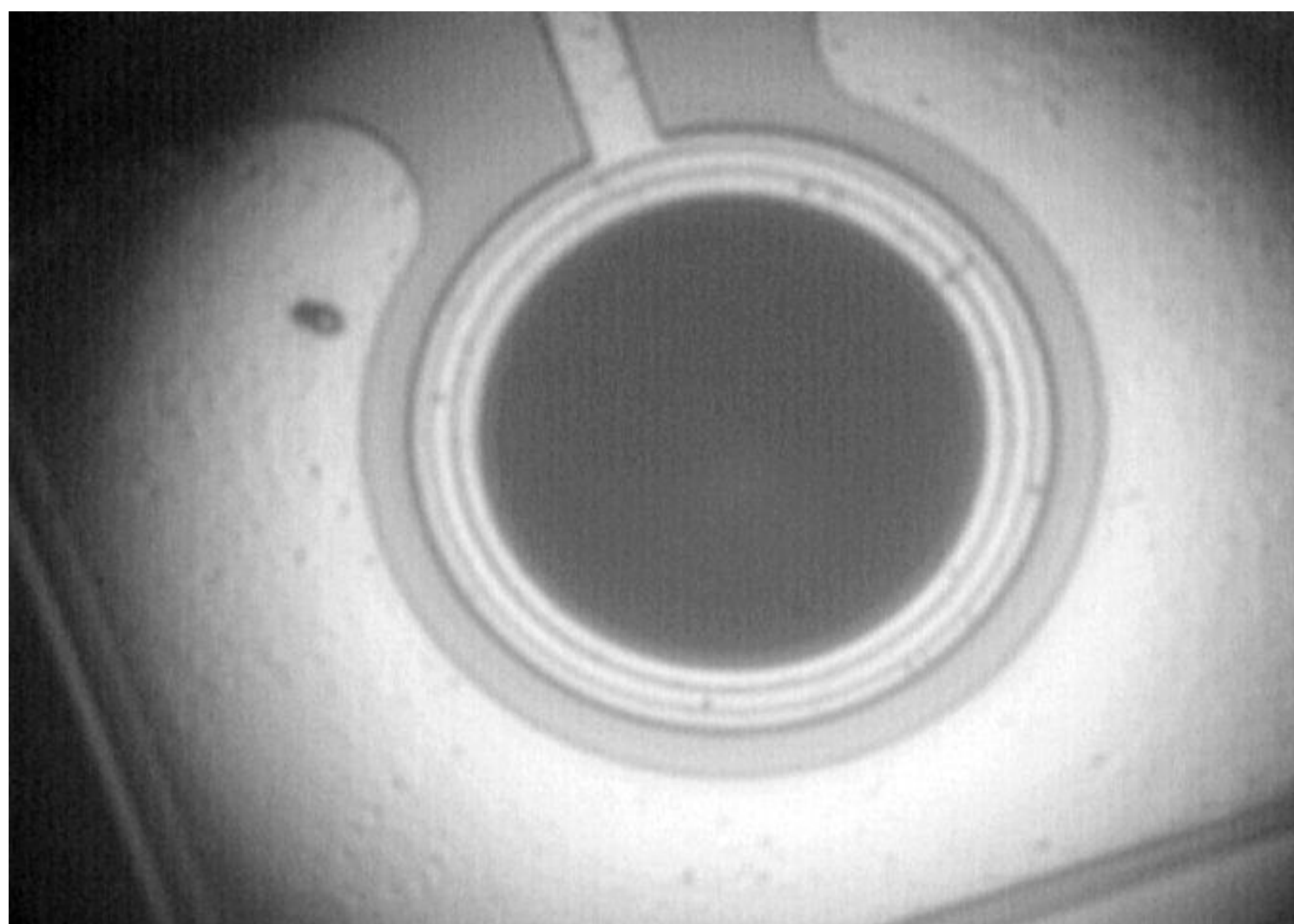
Ferule po vyčištění – 4x click



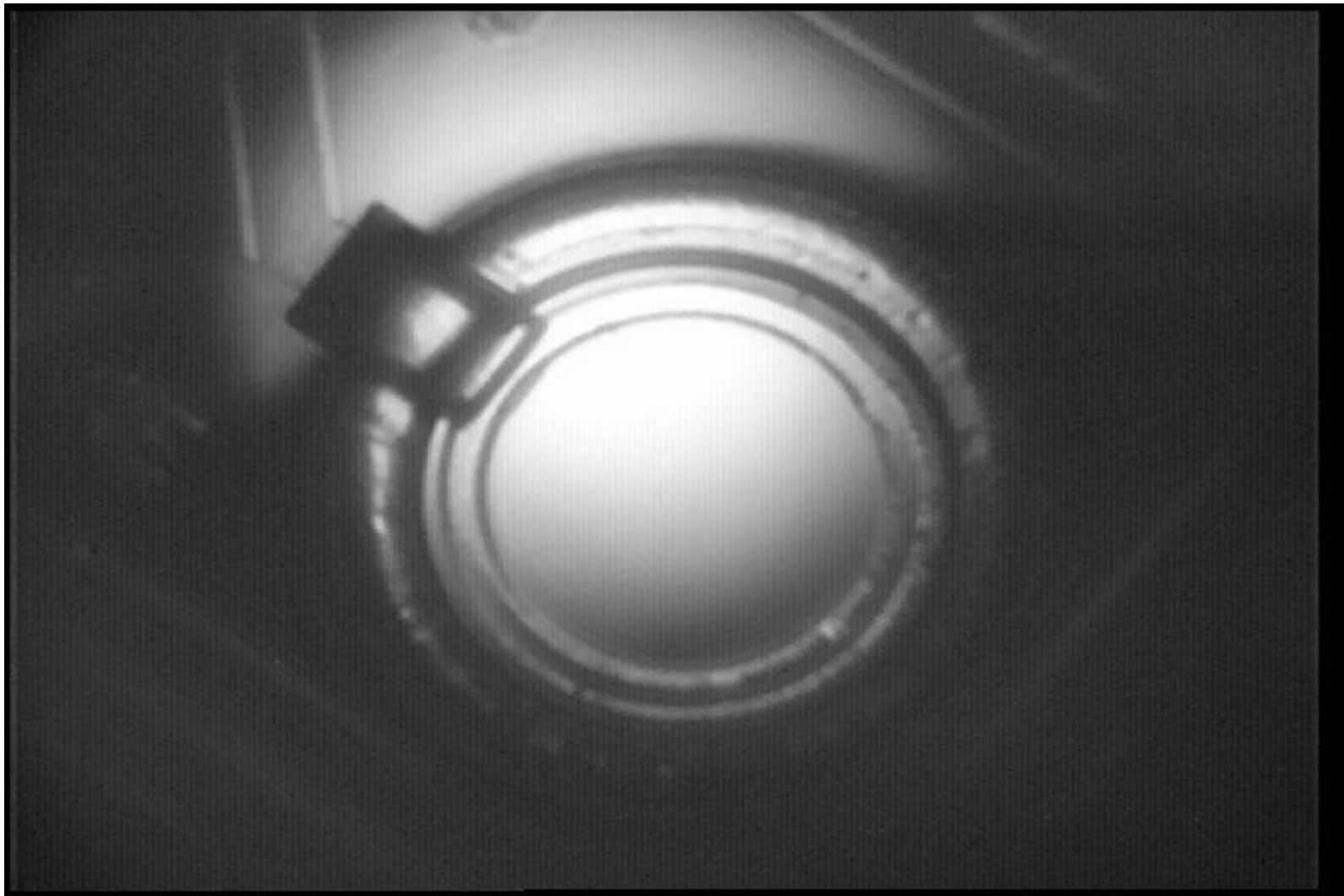
Rx fotodioda čočka/krytá



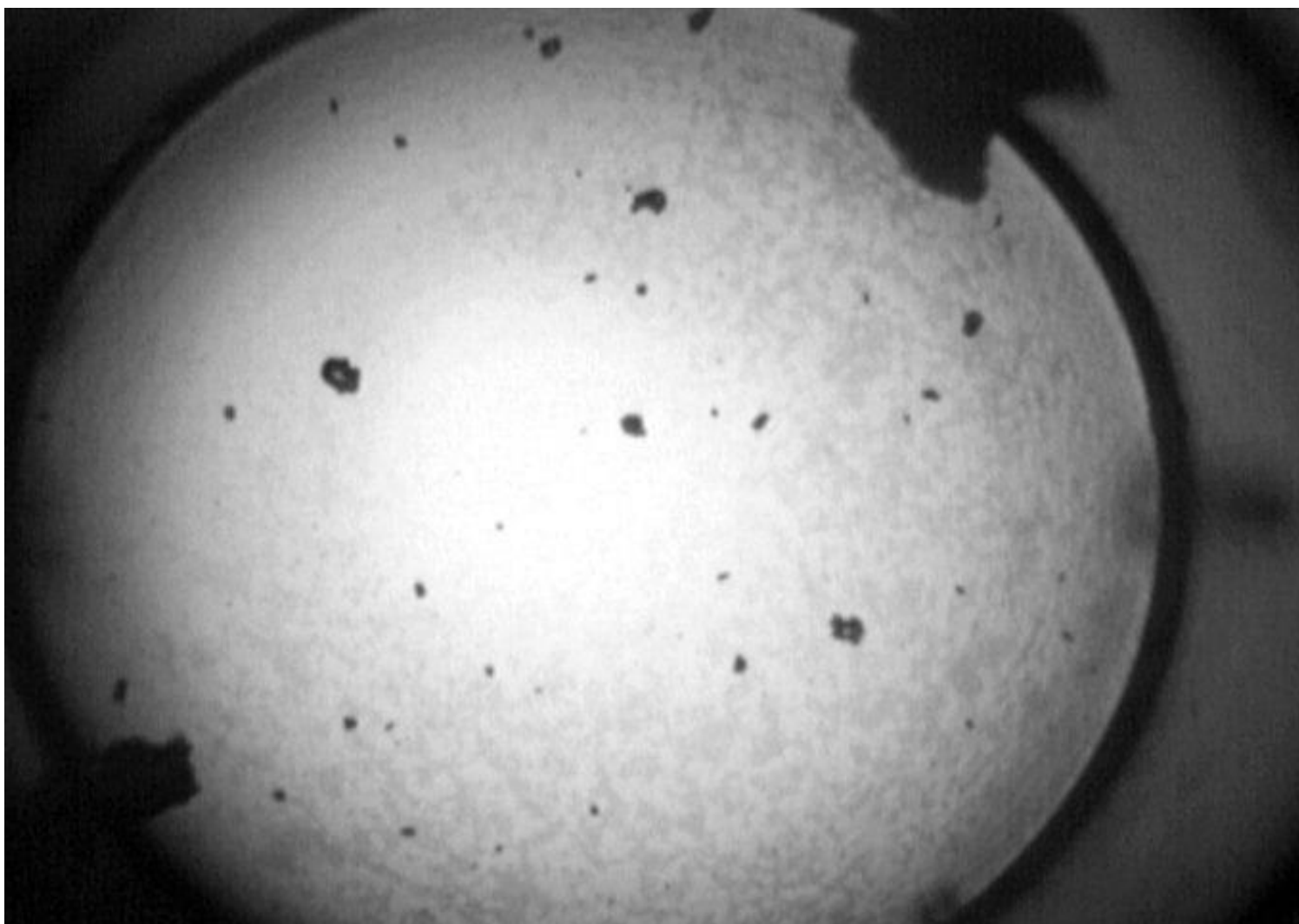
Rx fotodioda



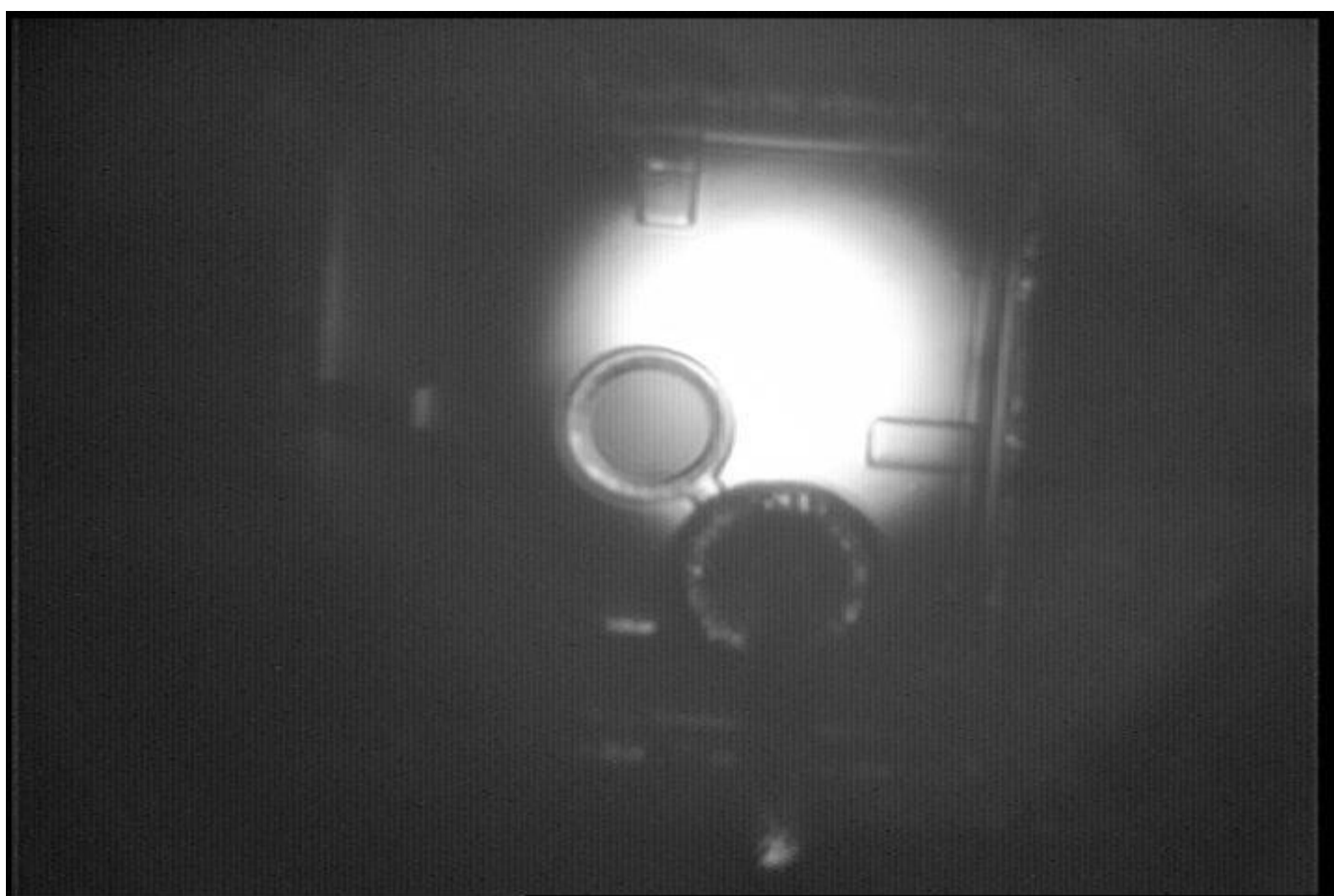
Rx fotodioda



Tx čočka



Tx MM laser



Tx MM laser



MSA multi-source agreement



- **GBIC Gigabit Interface Converter**
 - <ftp://ftp.seagate.com/sff/INF-8053.PDF>
- **XENPAK 10 Gigabit Ethernet Transceiver**
 - <ftp://ftp.seagate.com/sff/INF-8474.PDF>
- **SFP Small Form-Factor Pluggable**
 - <ftp://ftp.seagate.com/sff/INF-8074.PDF>
- **SFP+ Enhanced Small Form-Factor Pluggable**
 - <ftp://ftp.seagate.com/sff/SFF-8431.PDF>
- **XFP 10 Gigabit Small Form Factor Pluggable**
 - <ftp://ftp.seagate.com/sff/INF-8077.PDF>
- **QSFP+ 4x10G pluggable form factor (QSFP10)**
 - <ftp://ftp.seagate.com/sff/SFF-8635.PDF>
- **QSFP+ 4x28G pluggable form factor (QSFP28)**
 - <ftp://ftp.seagate.com/sff/SFF-8665.PDF>
- **CXP 12x10G pluggable form factor**
 - <ftp://ftp.seagate.com/sff/SFF-8642.PDF>
- **CFP 40G/100G pluggable form factor (CFP2, CFP4)**
 - <http://www.cfp-msa.org/index.html>



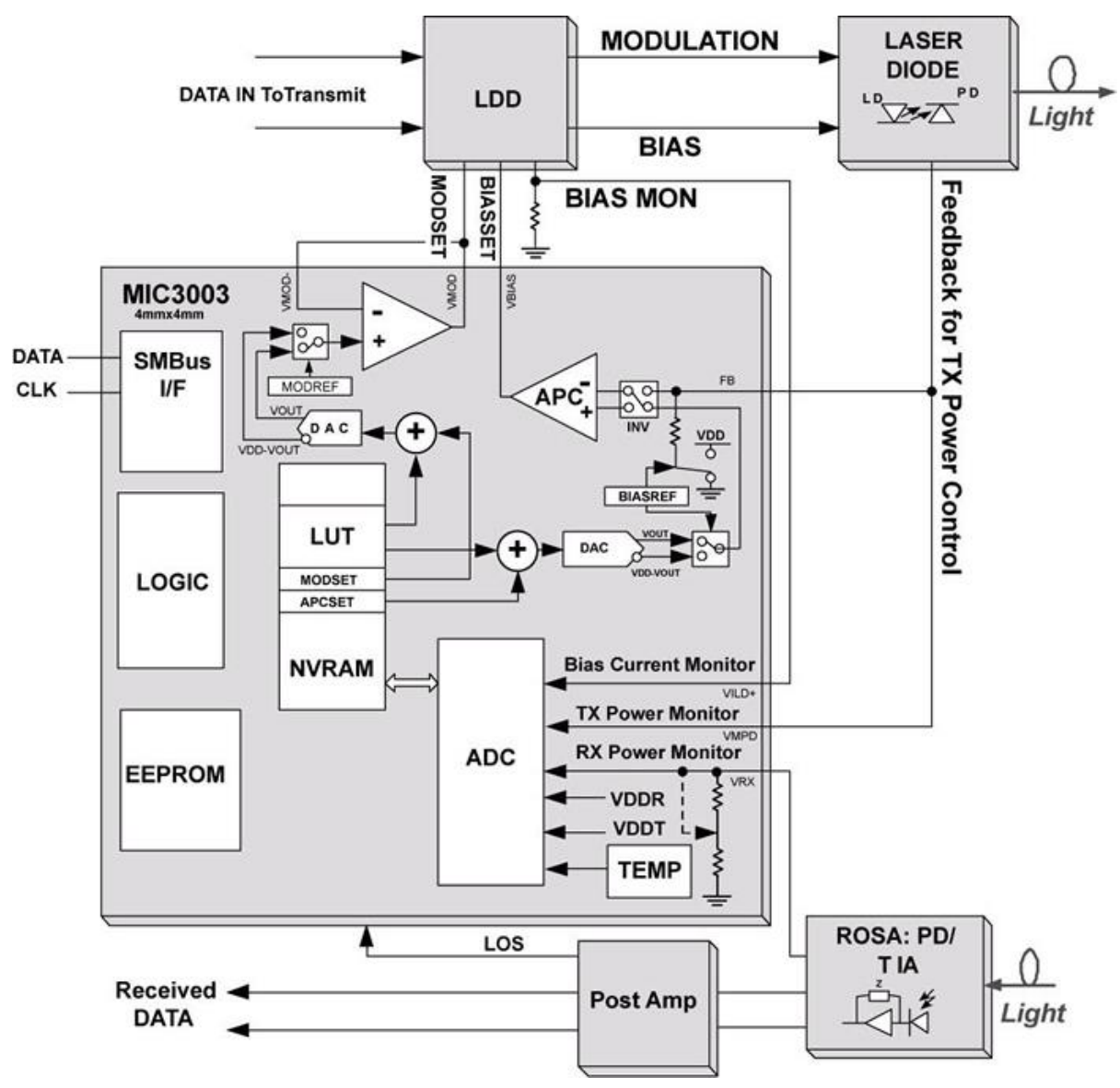
Digital Diagnostic Monitoring Interface



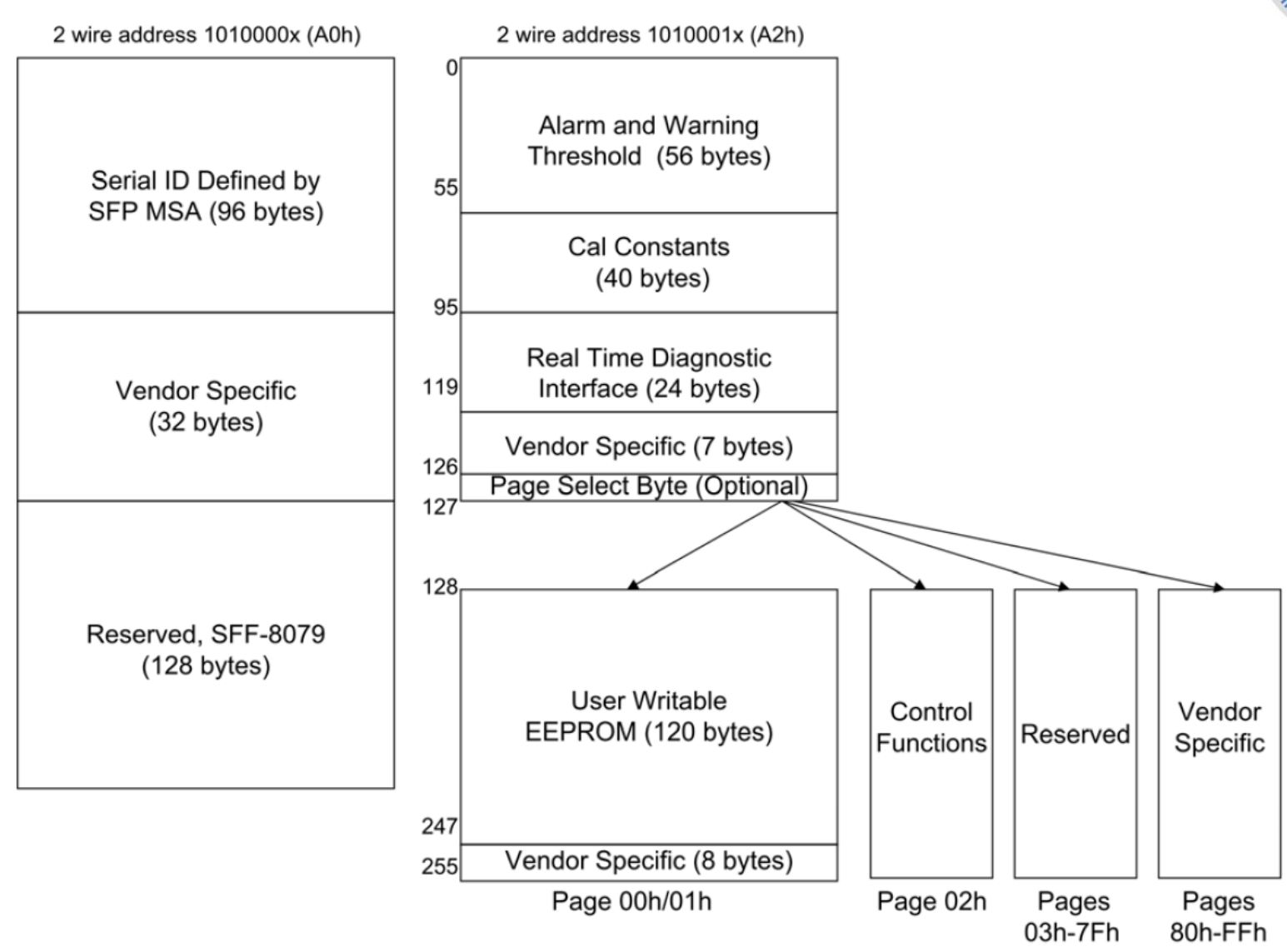
- **DDMI – Digital Diagnostic Monitoring Interface (DMI)**
 - <ftp://ftp.seagate.com/sff/SFF-8472.PDF>
- **2x 256-byte memory EEPROM (addresses 0xA0 and 0xA2)**
- **Monitoring**
 - Received power monitoring (Power nebo OMA)
 - Transmitted power monitoring
 - Bias current monitoring
 - Supply voltage monitoring
 - Temperature monitoring
 - Případně i Laser Temp/Wavelength, TEC current
 - Případně i Alarm a Warning thresholds



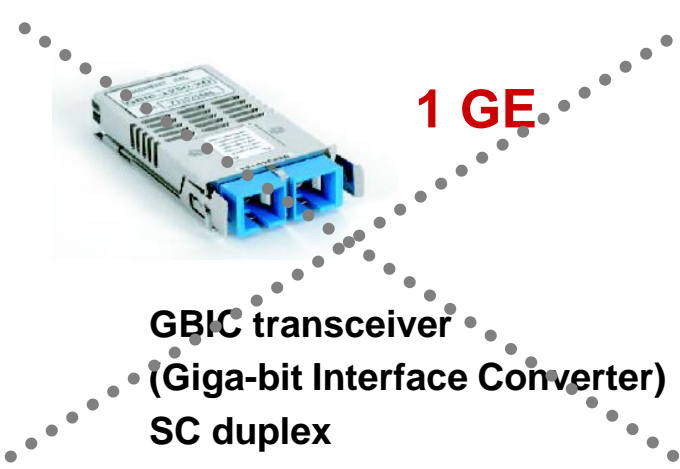
Digital Diagnostic Monitoring Interface



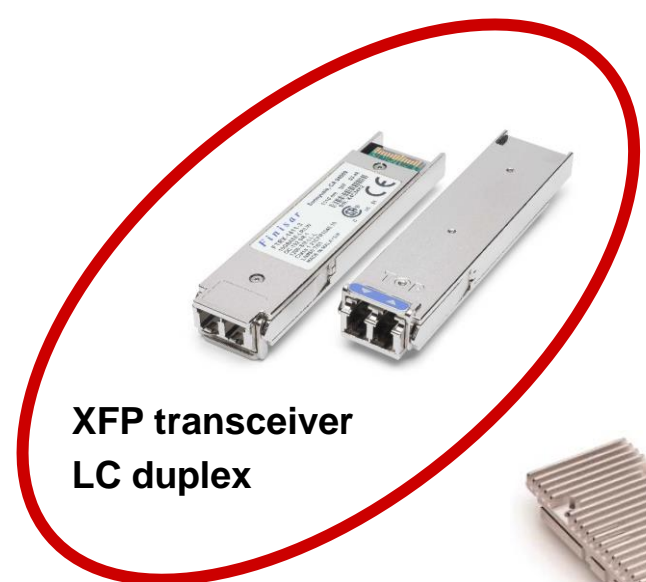
DDMI – obsah EEPROM



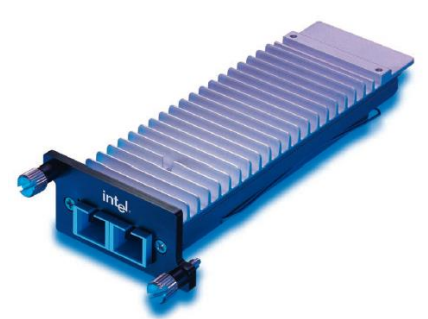
Transceiver



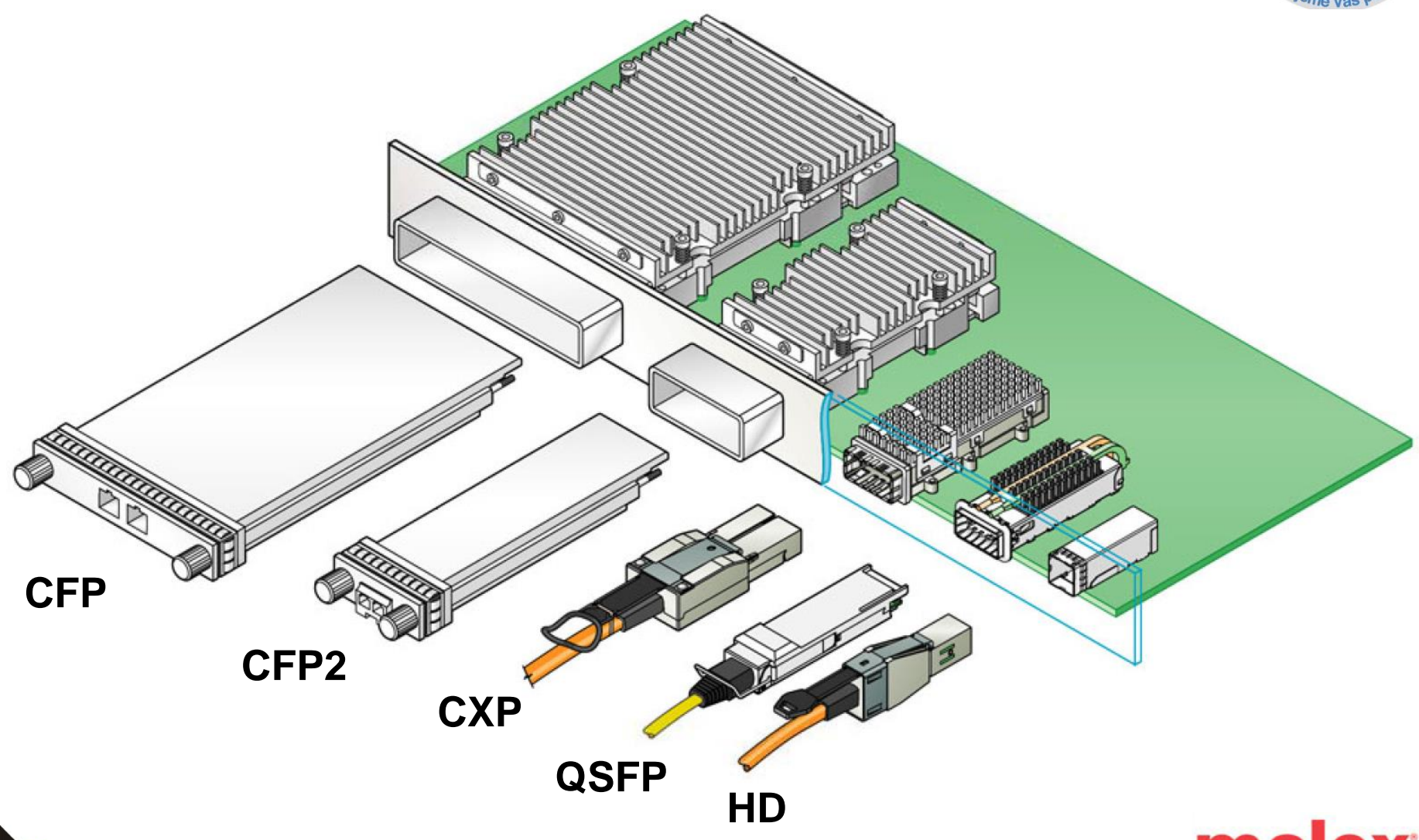
100 Mbit/s
1 Gbit/s
2,5/4/8 Gbit/s
10 Gbit/s (SFP+)



10 Gbit/s



Transceivery 40G a 100G



40G a 100G Transceivery



QSFP+



CXP



CFP transceiver



- Verze 40Gbit, 100Gbit
- Multimode nebo Singlemode
- DWDM CFP 100Gbit, C-band tunable, 800km



Finisar[®]

Typy transceiverů



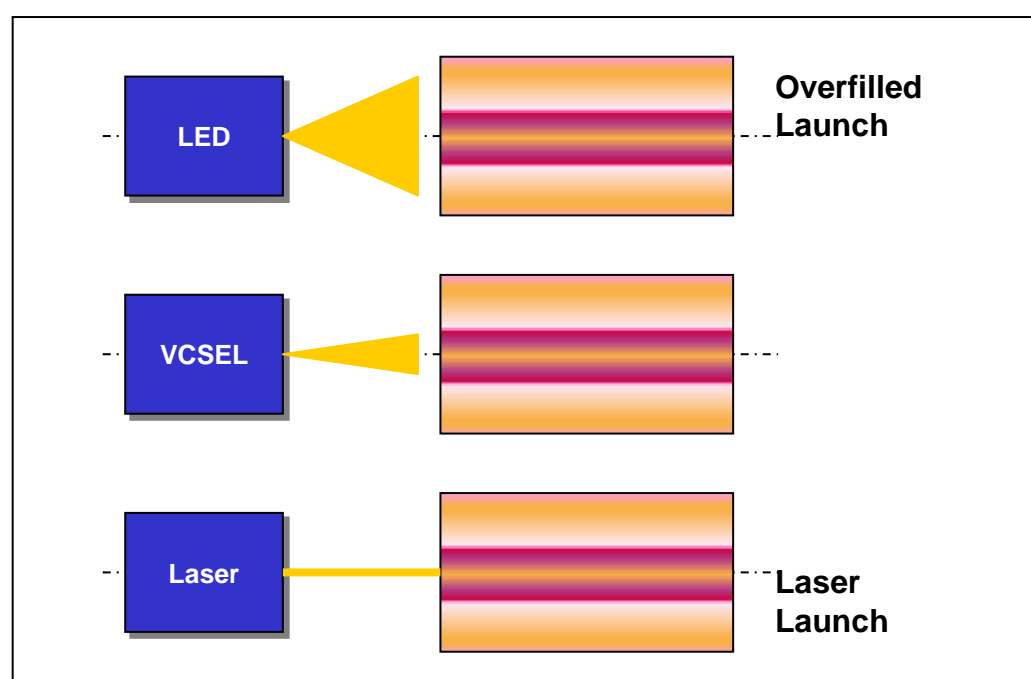
- **SFP-MM-GBE-85-0,5-HP**
 - 1000BASE-SX, 850nm, VCSEL, MM, 550m, 8dB, DDM, HP compatible
- **SFP-SM-GBE-31-20-O**
 - 1000BASE-LX, 1310nm, FP, SM, 20km, 15dB, DDM, Cisco compatible
- **SFP-SM-MR-BIDI-55-80-O**
 - STM-16 Multirate L-16.2 BX-D, BIDI 1550nm, DFB, APD, SM, 80km, 26dB
- **SFP+MM-85-0,3-HUA**
 - 10GBASE-SR, 850nm VCSEL, MM, 300m, Huawei 5xxx, 6xxx compatible
- **SFP+SM-DWDM-XXX-80-O**
 - 10GBASE DWDM 80km, 1530.33~1560.61nm DWDM EML, APD, SM, 80km, 23dB
 - Cisco Compatible



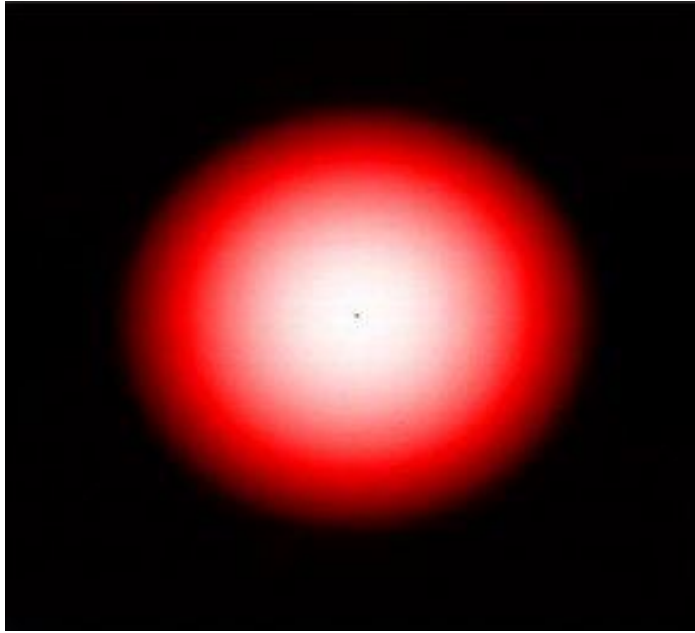
Šířka pásma – MM vlákno



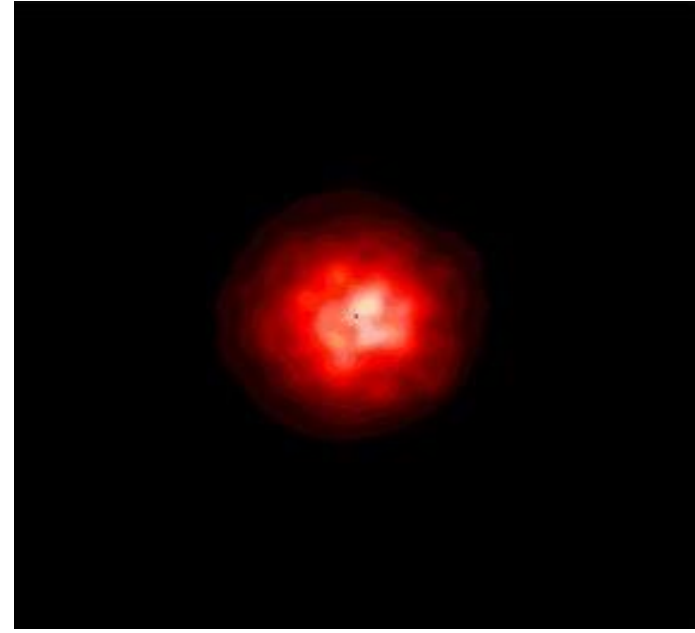
- **Pokles špičky přenášeného signálu o 3dB (na polovinu) při zvyšování modulační rychlosti**
- **U vícevidových - multimódových vláken se udává v MHz.km**
 - Standardní měření – **plně vybuzené vlákno** (LED)
 - Overfilled Launch Bandwidth
 - Měření s **podbuzeným vláknem** (laser)
 - Effective Laser Launch Bandwidth / Effective Modal Bandwidth



Buzení optických vláken



LED



VCSEL
laser



Standardy vláken pro LAN



Fiber Type	Industry Standards			
	ISO/IEC 11801 ANSI/TIA-568-C.3 (cable)	IEC 60793-2-10 (fiber)	TIA/EIA (fiber)	ITU-T (fiber)
62.5/125	OM1 ⁽¹⁾	A1b	492AAAA	---
50/125	OM2 ⁽²⁾	A1a.1	492AAAB	G.651.1
50/125	OM3	A1a.2	492AAAC	---
50/125	OM4	A1a.3	492AAAD	---
Std SM	OS1	B1.1	492CAAA	G.652.A or B
Low Water Peak SM	OS2 ⁽⁵⁾	B1.3	492CAAB	G.652.C or D

⁽¹⁾ OM1 is typically 62.5µm, but can also be 50µm

⁽²⁾ OM2 is typically 50µm, but can also be 62.5µm

⁽⁵⁾ OS2 is referenced in the standard **ISO/IEC 24702** "Generic Cabling for Industrial Premises"



Třídy MM vláken



• Třída	průměr jádra	šířka pásma [MHz.km]		
		OFL 850nm	OFL 1300nm	EMB laser 850nm
• OM 1	50 nebo 62,5 μm	200	500	--
• OM 2	50 μm	500	500	--
• OM 3	50 μm	1500	500	2000
• OM 4	50 μm	3500	500	4700

- OFL OverFilled Launch Bandwidth
- EMB Effective Modal Bandwidth



Ethernet 1GBE standardy



• <u>Rozhraní</u>	<u>Vlákno</u>	<u>Lambda</u>	<u>Vzdálenost</u>
• 1000BASE-SX	OM1	850 nm	220/275 m
• 1000BASE-SX	OM2	850 nm	550 m
• 1000BASE-LX	OS1,OS2	1310 nm	5 km
• <u>1000BASE-LX</u>	OM1	1310 nm	550 m
• <u>1000BASE-LX</u>	OM2	1310 nm	550 m

• Další typy rozhraní jsou mimo standard

- LX pro 10km, 20km, ..., -EX/ZX pro 40km, 80km, 120km
- 1GE CWDM, 1GE DWDM
- BiDi 1310/1550, BiDi 1310/1490



Ethernet 10GBE standardy



<u>Rozhraní</u>	<u>Vlákno</u>	<u>Lambda</u>	<u>Vzdálenost</u>
• 10GBASE-SR	OM1/ OM2	850 nm	26/33-82 m
• 10GBASE-SR	OM3	850 nm	300 m
• 10GBASE-SR	OM4	850 nm	550 m
• <u>10GBASE-LRM</u>	OM1/ OM2	1310 nm	220 m
• <u>10GBASE-LX4</u>	OM1/ OM2	1310 nm	300 m
• 10GBASE-LX4	OS1,OS2	1310 nm	10 km
• 10GBASE-LR	OS1,OS2	1310 nm	10 km
• 10GBASE-ER	OS1,OS2	1550 nm	40 km

• Další typy rozhraní jsou mimo standard

– 10GASE-ZR, 10GE CWDM, 10GE DWDM



IEEE 802.3 40G a 100G



• 40GBASE-KR4	1 m	backplane
• 40GBASE-CR4	7 m	copper cable
• 40GBASE-SR4	100 m	OM3
• 40GBASE-SR4	150 m	OM4
• 40GBASE-FR	2 km	OS1/OS2
• 40GBASE-LR4	10 km	OS1/OS2
• 100GBASE-CR10	7 m	copper cable
• 100GBASE-SR10	100 m	OM3
• 100GBASE-SR10	150 m	OM4
• 100GBASE-LR4	10 km	OS1/OS2
• 100GBASE-ER4	40 km	OS1/OS2

