Herzlich willkommen

Let's CONNECT

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Messen ist Wissen

4. Reflected lights

Hi Res Reflektometrie

Paul O‘Reilly

LUNA Innovations Inc.

Sales Director EMEA, Photonics Test and Control

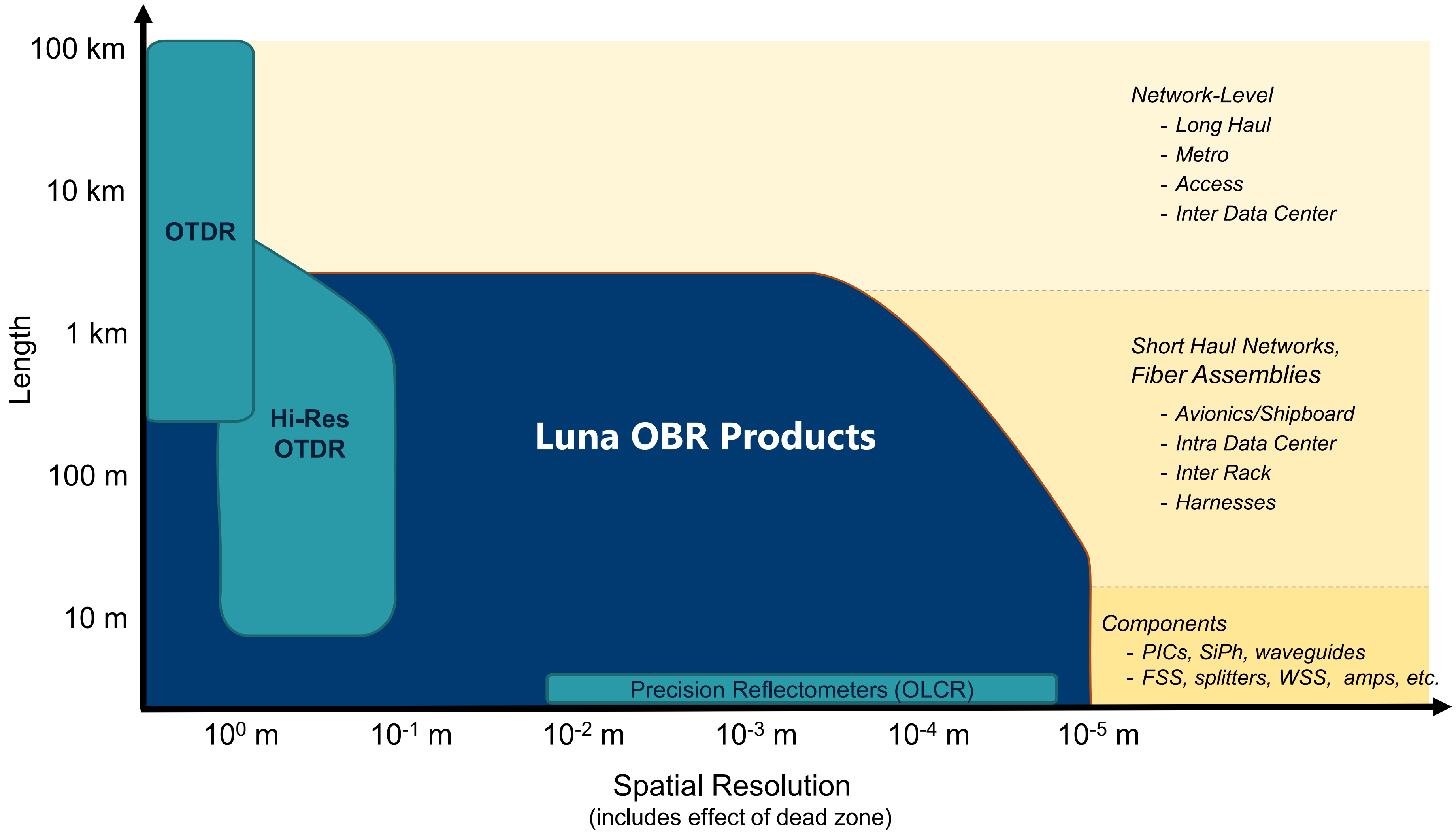
Optical Communications Test

OFDR Test Solutions

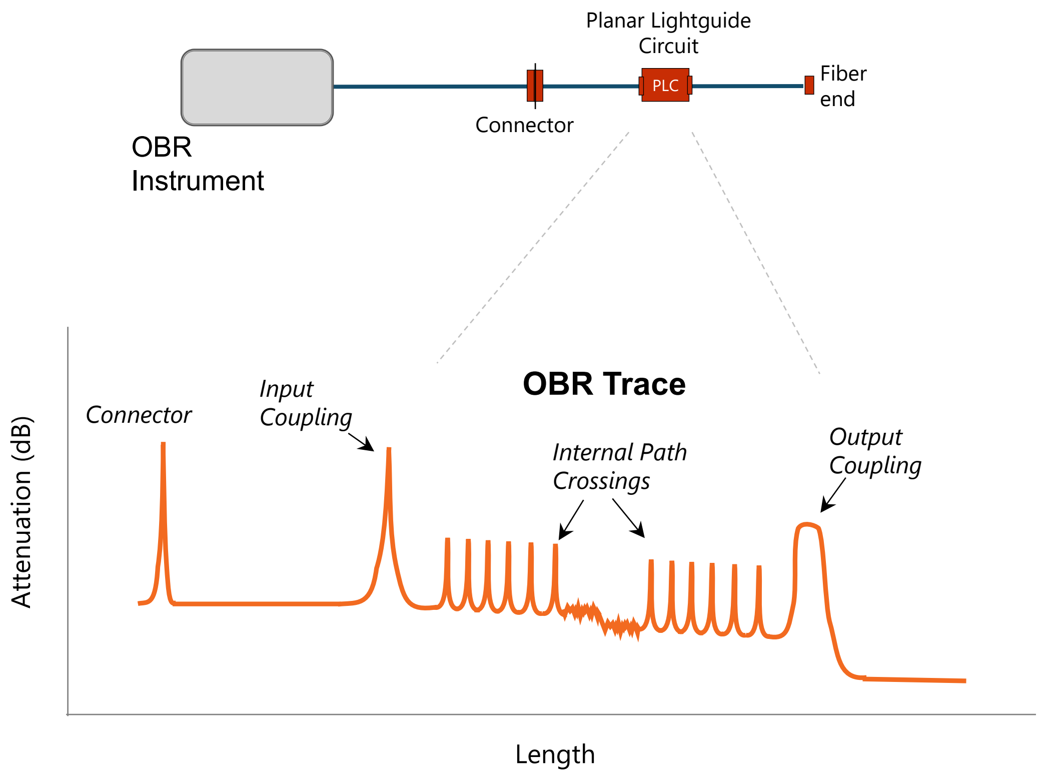
I can see clearly now

June 02, 2025

Reflectometry technologies



What is optical backscatter reflectometry (OBR)?

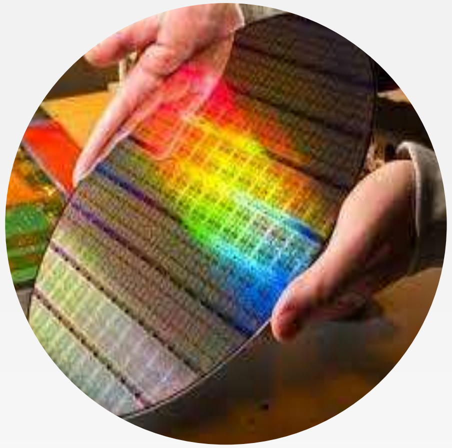


"See inside" integrated components and networks

- Measures distributed reflectance as a function of length
- OFDR technique enables very high spatial resolution
  - Down to 10 um resolution over 30 m
  - 1 mm resolution over 2 km
- Does not suffer from "dead zones" typical to OTDRs
- Combines high-resolution and backscatter-level sensitivity
- Identify reflection and loss events, bends, breaks, splices…
- Certify lengths with unprecedented accuracy for latency verification

Target Markets

Photonics Integrated Circuits (PICs)



OVA 5100, OBR 4600, LWA 7600

Component Tester

LWA 7600 platform with dedicated functions and measurement capabilities for testing PICs in R&D and potentially in manufacturing environments

Optical Fiber Connectivity

OBR 4600, LWA 7600

Cable Tester

LWA 7600 platform with dedicated functions and measurement capabilities for testing short fiber networks up to 2km (IL,RL, Distance) in R&D and manufacturing environments

Short Field Fiber Network

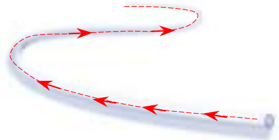
OBR 6200

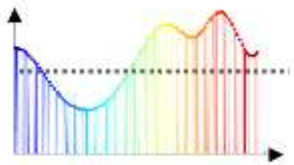
Field Cable Tester

OBR 6200 platform with dedicated functions and measurement capabilities for troubleshooting short fiber networks up to 500m (IL,RL, Distance) in the field

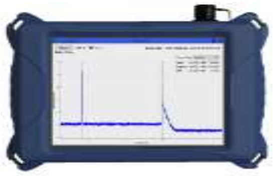
OFDR-based analyzers and reflectometers

Luna's test instrumentation focuses on delivering the highest level of sensitivity, resolution, and polarization capability on the market





Reflectometers



OBR 6200

- Ultra-high spatial resolution in portable and rugged package
- Ideal for field maintenance and data center applications

OBR 4600

- Micron-level resolution to see inside components and networks
- Polarization and phase measurements
- Full-functionality for lab and manufacturing applications

Component Characterization

LWA 7600

- Component analyzer with both reflection (OBR) and transmission measurements
- Fast and robust system optimized for production test

OVA 5100

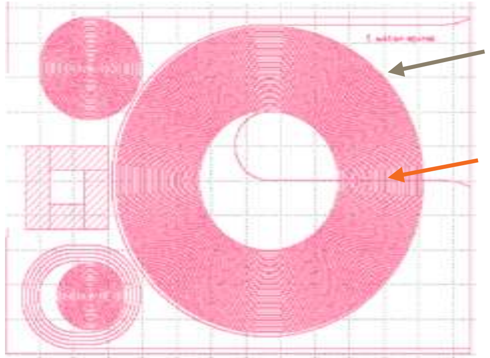
- Complete characterization of optical components.
- All-parameter analysis in a single scan
- OFDR time domain analysis is optional

Measuring distributed loss INSIDE a silicon photonic integrated chip

UCSB

A one meter spiral delay line fabricated on a silicon platform

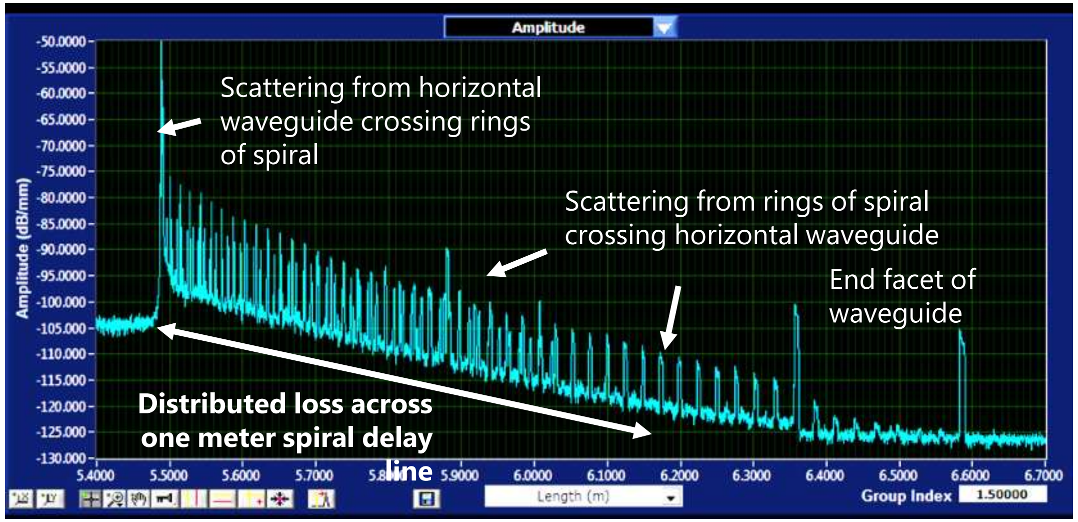
"Blumenthal and Bowers Optoelectronics Research Groups"

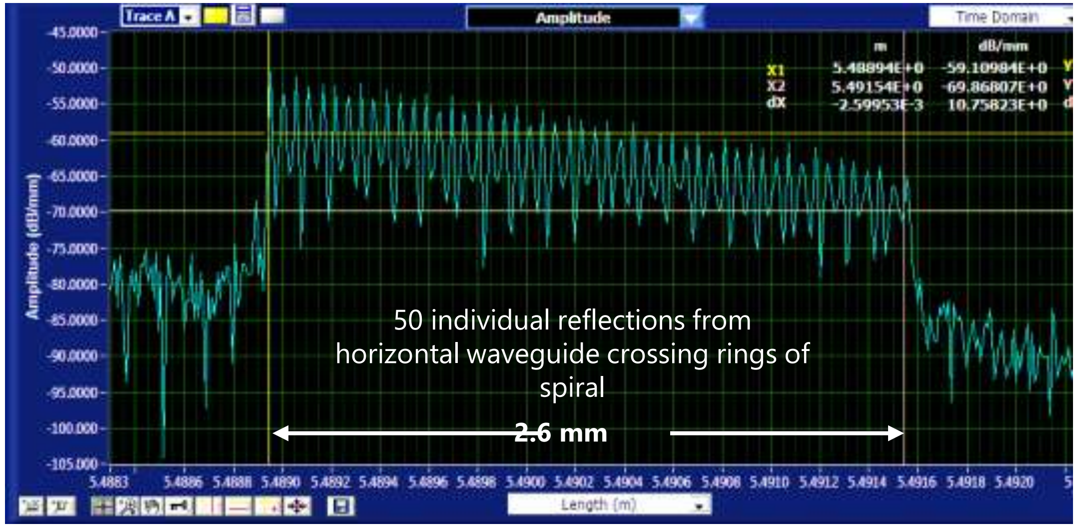


One meter long spiral

Horizontal Waveguide crossing spiral

Actual size of spiral delay line on PIC - 1 cm^2





The Results

- At the entry waveguide crossings reflective events spaced just 50 microns apart are clearly visible
- The OBR 4600 allows you to see inside the device with a high level of detail
- Higher visibility means less prototype iterations and faster time to market
- **You can't fix what you can't see!**

5. Look both ways

OTDR BiDi Messung

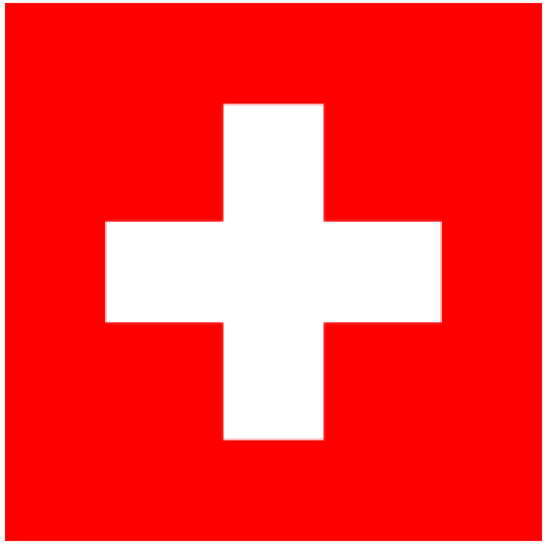
Marcel Guertner

Mesomatic Messtechnik AG

Technical Sales Engineer / Product Manager

Bild aus meinen Skiferien in Italien. Bei welcher Farbe beim Stiefel sind wir?

Schnappschuss vom Matterhorn aus dem Dorf Zermatt CH



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Credo:
Immer beide Seiten anschauen, bzw. messen

«Look both ways»

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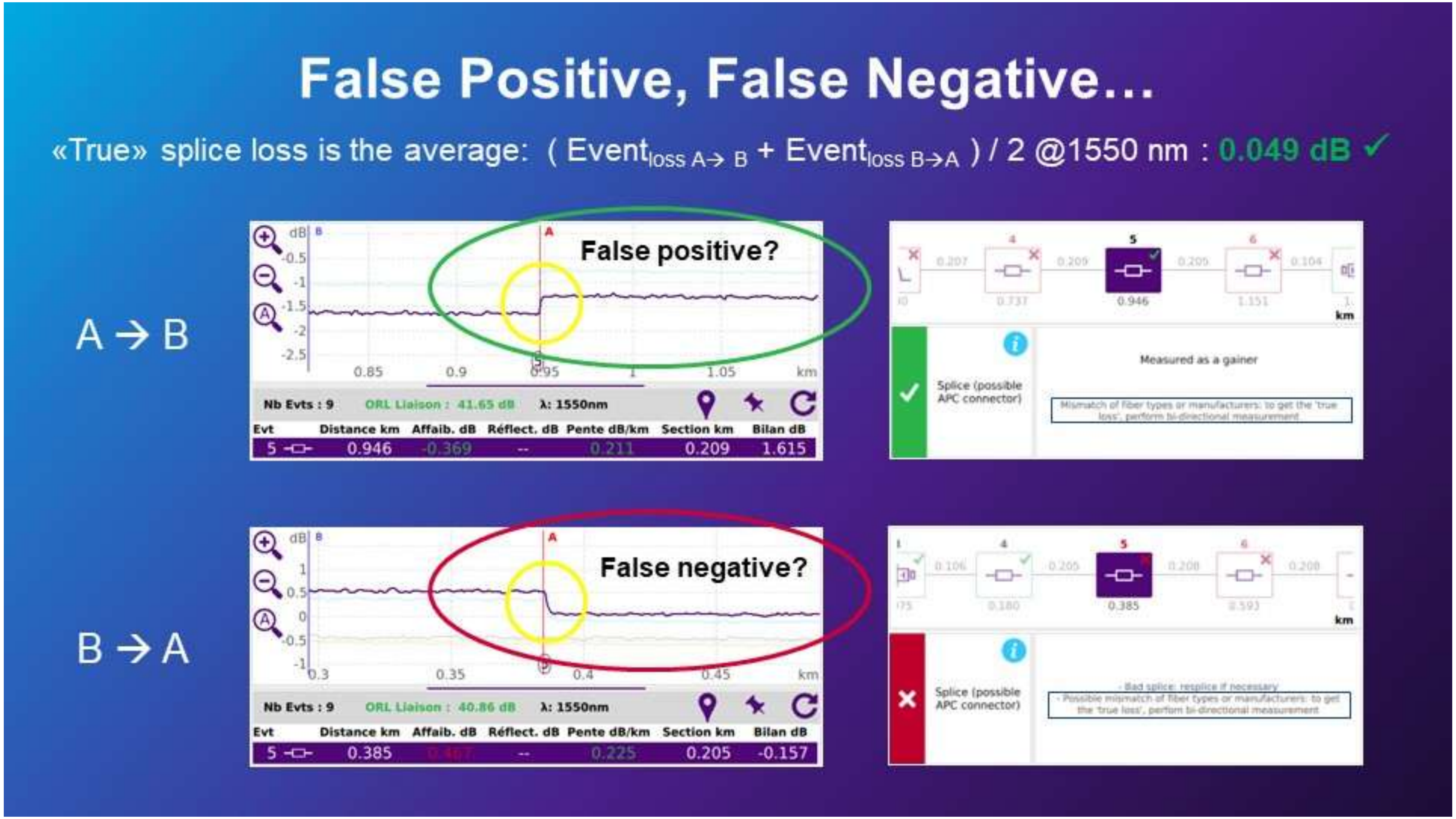
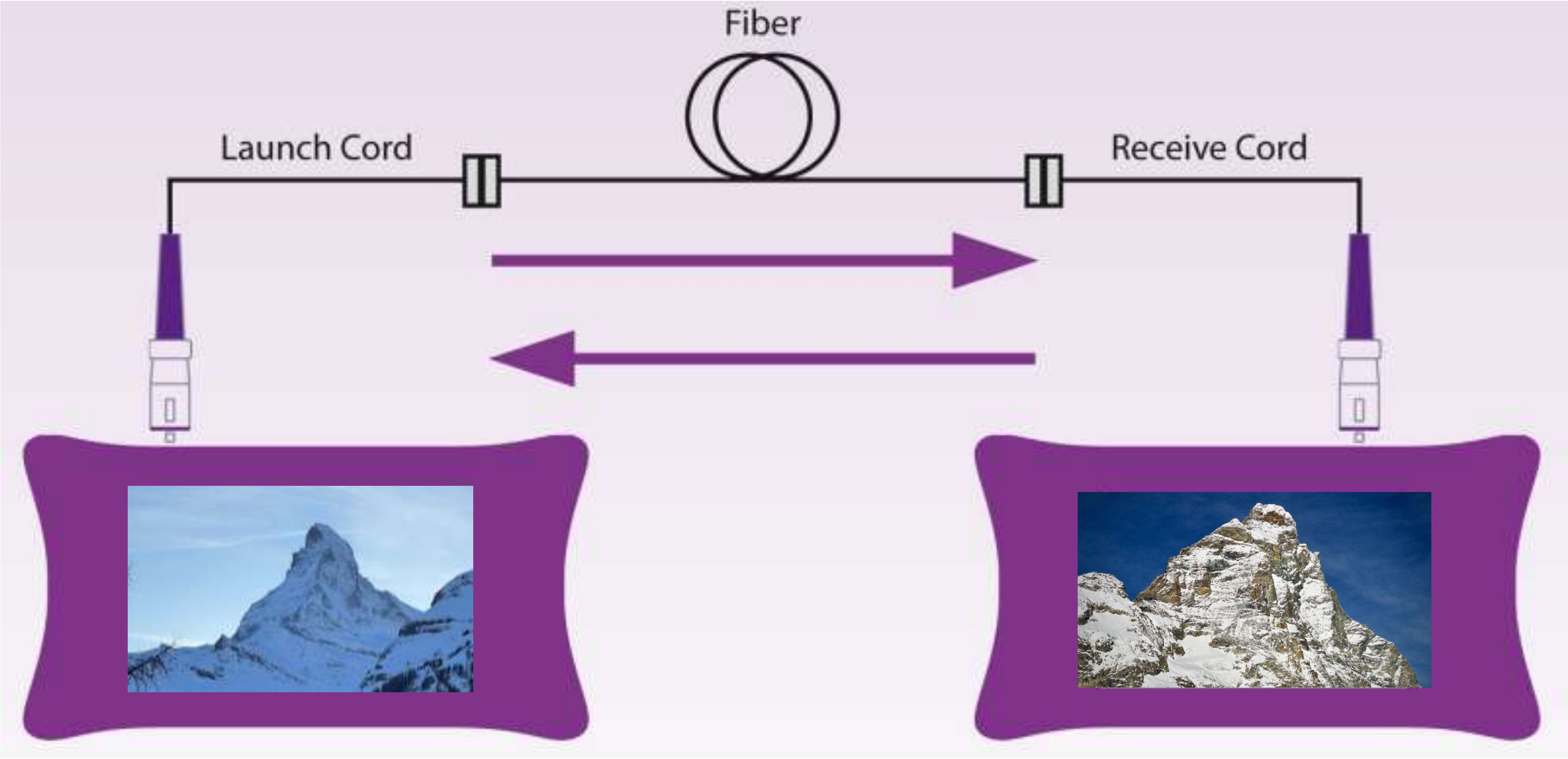
Grundlage



False Positive, False Negative…
«True» splice loss is the average: (Event loss A→ B + Event loss B→A) / 2 @1550 nm : 0.049 dB ✓
A → B
False positive?
Nb Evts : 9
ORL Liaison : 41.65 dB
λ: 1550nm
Evt Distance km Affaib. dB Réflect. dB Pente dB/km Section km Bilan dB
5 0.946 -0.369 -- 0.211 0.209 1.615
Splice (possible APC connector)
Measured as a gainer
B → A
False negative?
Nb Evts : 9
ORL Liaison : 40.86 dB
λ: 1550nm
Evt Distance km Affaib. dB Réflect. dB Pente dB/km Section km Bilan dB
5 0.385 -- 0.225 0.205 -0.157
Splice (possible APC connector)

BiDirektional messen mit zwei Viavi OTDRs – TrueBiDir Lizenz



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True BiDir bei allen VIAVI OTDR Plattformen ausser SmartOTDR

SmartOTDR

MTS-2000 V2

MTS-4000 V2

ONA-800

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BiDi- Berechnung mit gleichen Fasertypen zB. G.652d G.652d

A | B

Dämpfung IL:
0.3 dB

B | A

Dämpfung IL:
0.2 dB

Dämpfung IL: 0.3 dB + Dämpfung IL: 0.2 dB = $\frac{\text{Dämpfung IL: 0.5 dB}}{2}$ = Dämpfung Ø: **0.25 dB**

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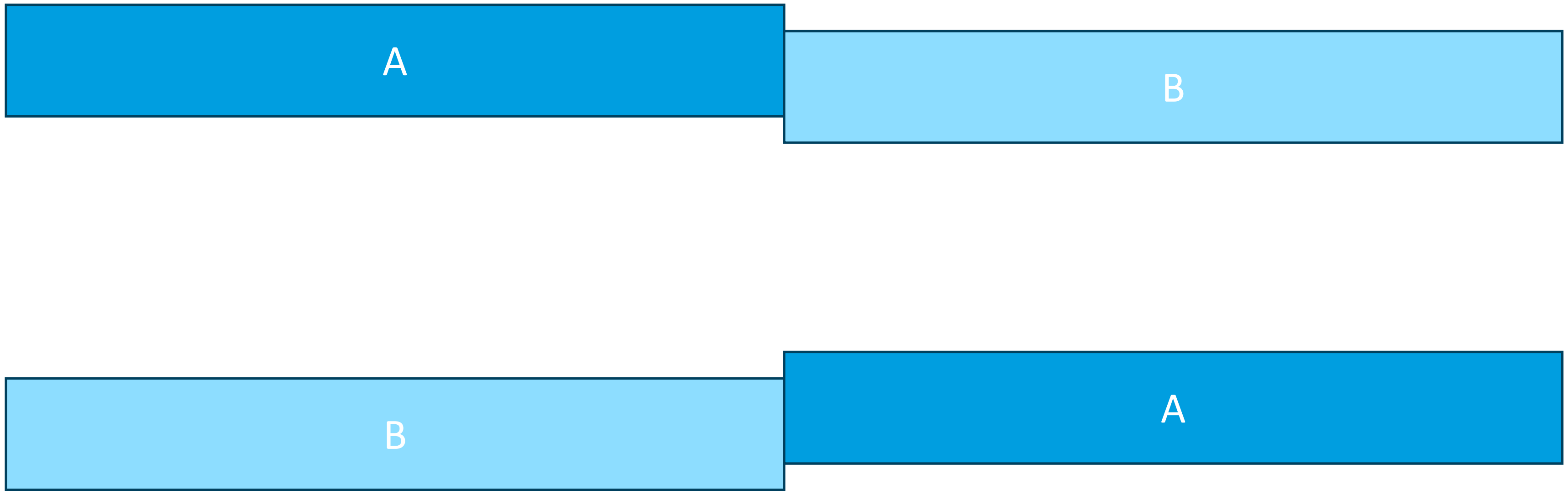
BiDi- Berechnung mit ungleichen Fasertypen zB. G.652d G.657A1



Dämpfung IL: 0.3 dB

Dämpfung IL: -0.2 dB

Dämpfung IL: 0.3 dB + Dämpfung IL: -0.2 dB = Dämpfung IL: 0.1 dB / 2 = Dämpfung Ø: **0.05 dB**

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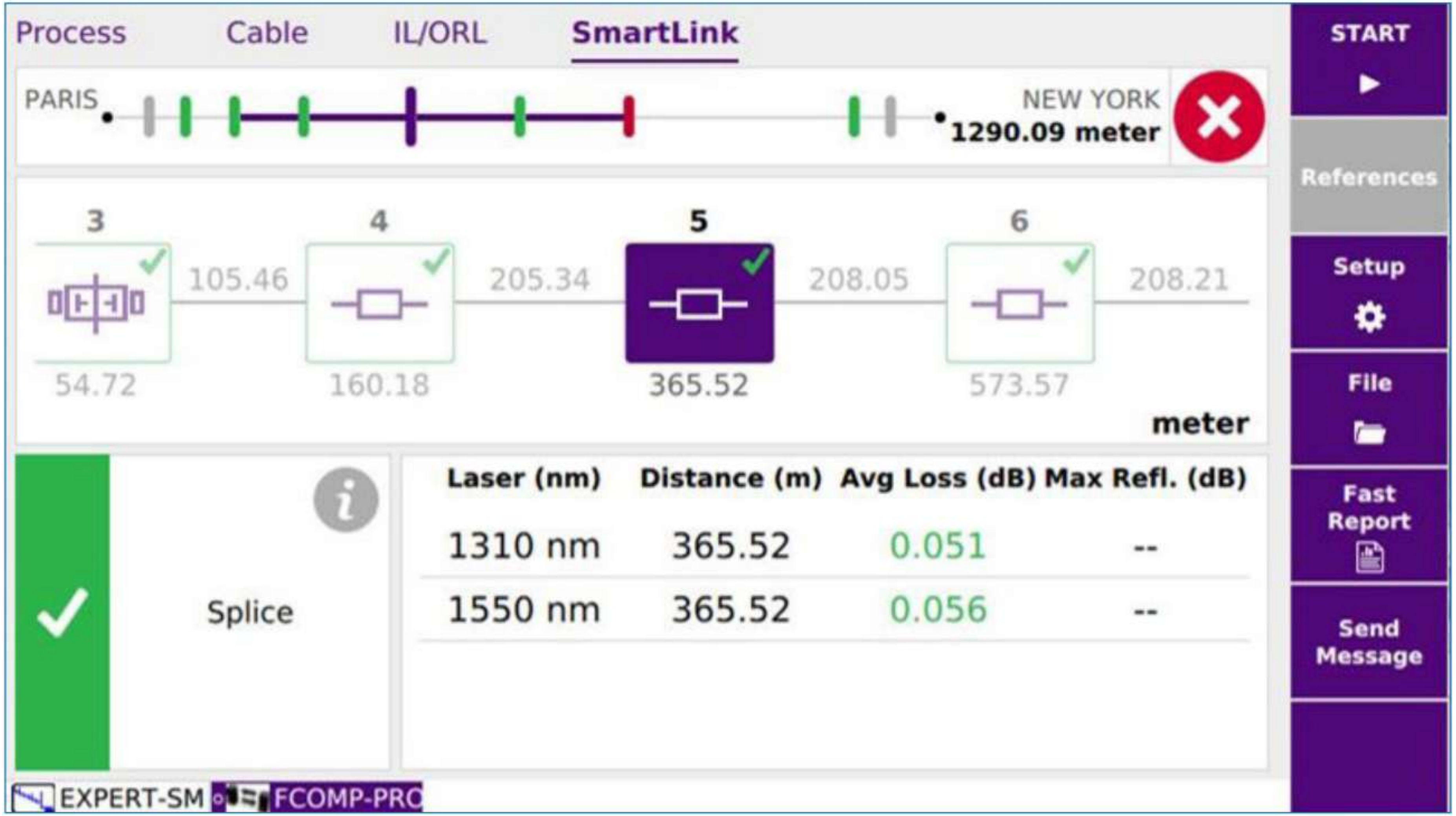
BiDi- Berechnung fertig ausgewertet pro Event



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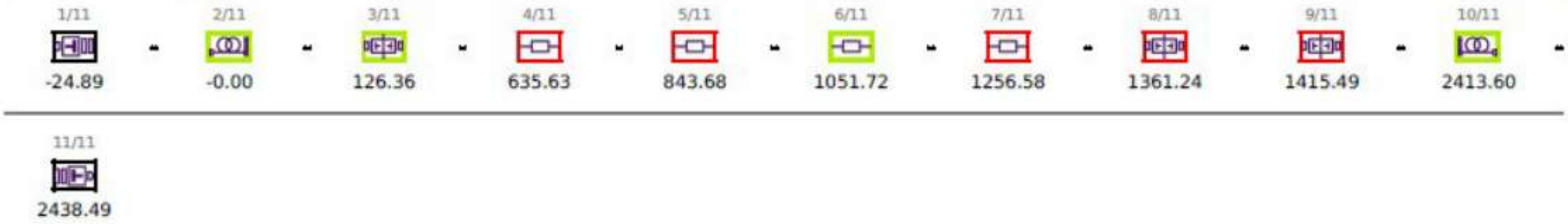
UniDi-Berechnung klassisch

LOC A -> LOCB

Fib # 1

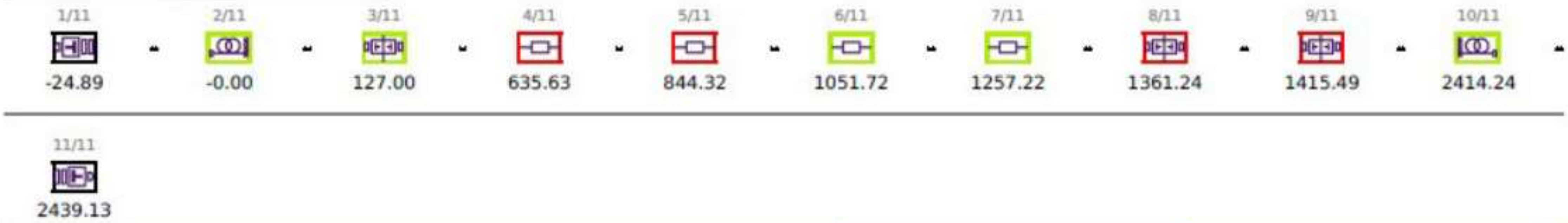


Event	Distance meter	Wavelength nm		Loss dB	Reflect. dB	Slope dB/Km
1	-24.89	1550			-70.49	
2	-0.00	1550		-0.010		
3	126.36	1550		0.053	-71.13	0.200
4	635.63	1550		0.991		0.207
5	843.68	1550		0.259		0.217
6	1051.72	1550		-0.272		0.232
7	1256.58	1550		0.329		1.272
8	1361.24	1550		0.209	-52.74	0.288
9	1415.49	1550		0.351	-58.10	0.385
10	2413.60	1550		-0.015		0.188
11	2438.49	1550		0.185	-74.79	0.350

BiDi-Berechnung Avg (avarage = Durchschnitt)

LOC A -> LOCB

Fib # 2



Event	Distance meter	Wavelength nm		Avg Loss dB	Max Refl. dB	Slope dB/Km
1	-24.89	1550			-72.96	
2	-0.00	1550		0.000		**0.182**
3	127.00	1550		0.144	-67.92	**0.222**
4	635.63	1550		**0.987**		**0.187**
5	844.32	1550		**0.263**		**0.199**
6	1051.72	1550		0.034		**0.197**
7	1257.22	1550		0.034		**0.257**
8	1361.24	1550		**0.269**	-52.44	**0.359**
9	1415.49	1550		**0.242**	-55.21	**0.732**
10	2414.24	1550		-0.007		**0.195**
11	2439.13	1550		0.209	-74.73	

Grösster Vorteil: Zeitersparnis

Unidirektional im Team:

- Messung A → B
- Messung B → A
- Auswertung nachträglich (aufwendig)

Bidirektional im Team:

- Einmal vorbereiten
- Erfahrungswerte: Modul 12x E2000
  → **15min inkl. Steckerreinigung**
  alles erledigt

In diesem Sinne: always look both ways

Marcel Guertner

mesomatic
fiberoptics

6. Speed of lights

High Speed Testing

Thomas Käch

Mesomatic Messtechnik AG

Geschäftsleitung

Speed of Light

High Speed Testing

mesomatic fiberoptics

Emitec Group
#1 in Test & Measurement, worldwide.

Schneller, besser, weiter…

- Aber warum?
- Wer braucht mehr Speed?

Heidi Ulrich: Speedsurferin, Weltmeisterin und Weltrekordhalterin

Applikationen wie:

- Künstliche Intelligenz
- Datacenter & Cloud
- Supercomputer
- Quantencomputer

Enorme Datenmengen verarbeiten in kurzer Zeit mit wenig Latenz und möglichst kleiner Dämpfung übertragen.

Generiert mit CT AI, Timon Käch

Wichtige Faktoren:

- **Bandbreite**
  Durchsatz
- **Latenz**
  Verzögerung
- **Dämpfung**
  Verlust und Energie

Präzise Messtechnik ist gefragt.

Bandbreite

Durchsatz

Bandbreitenbedarf ist da

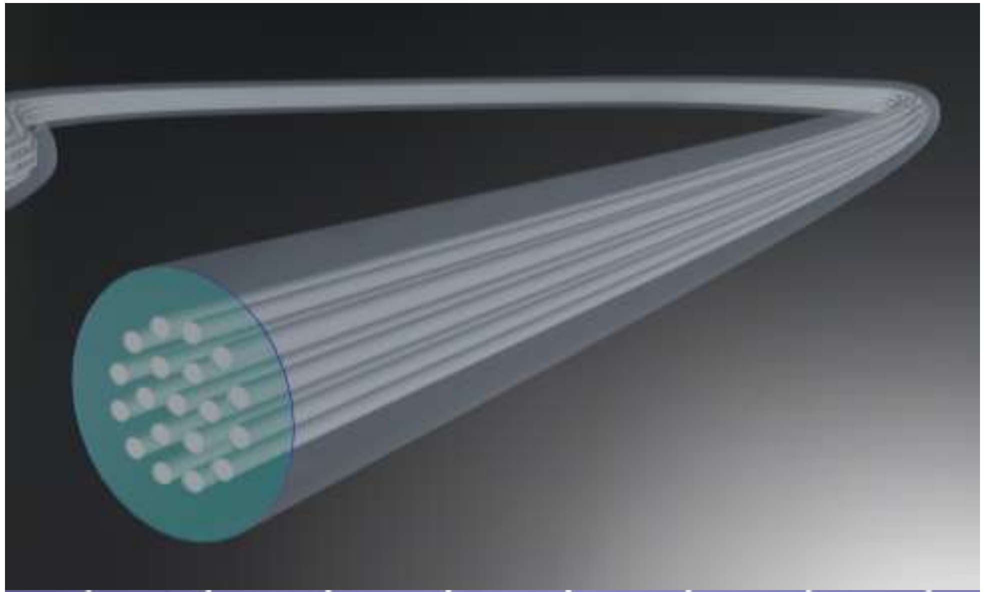
- **NVIDA AI Factory Plattform**
  72 GPU mit je 800Gbps

- **Top 5 Cloud Provider**
  Wachstum um 20% im 2024 und es geht so weiter

Cloud Provider	Invest 2025	Markanteil
AWS (Amazone)	> 100 Mrd. USD	ca. 33 %
Microsoft Azure	ca. 90 Mrd. USD	ca. 22 %
Google Cloud	ca. 40–50 Mrd. USD	ca. 9 %
Alibaba Cloud	ca. 10–12 Mrd. USD	ca. 4 %
Huawei Cloud	ca. 5–6 Mrd. USD	ca. 2 %

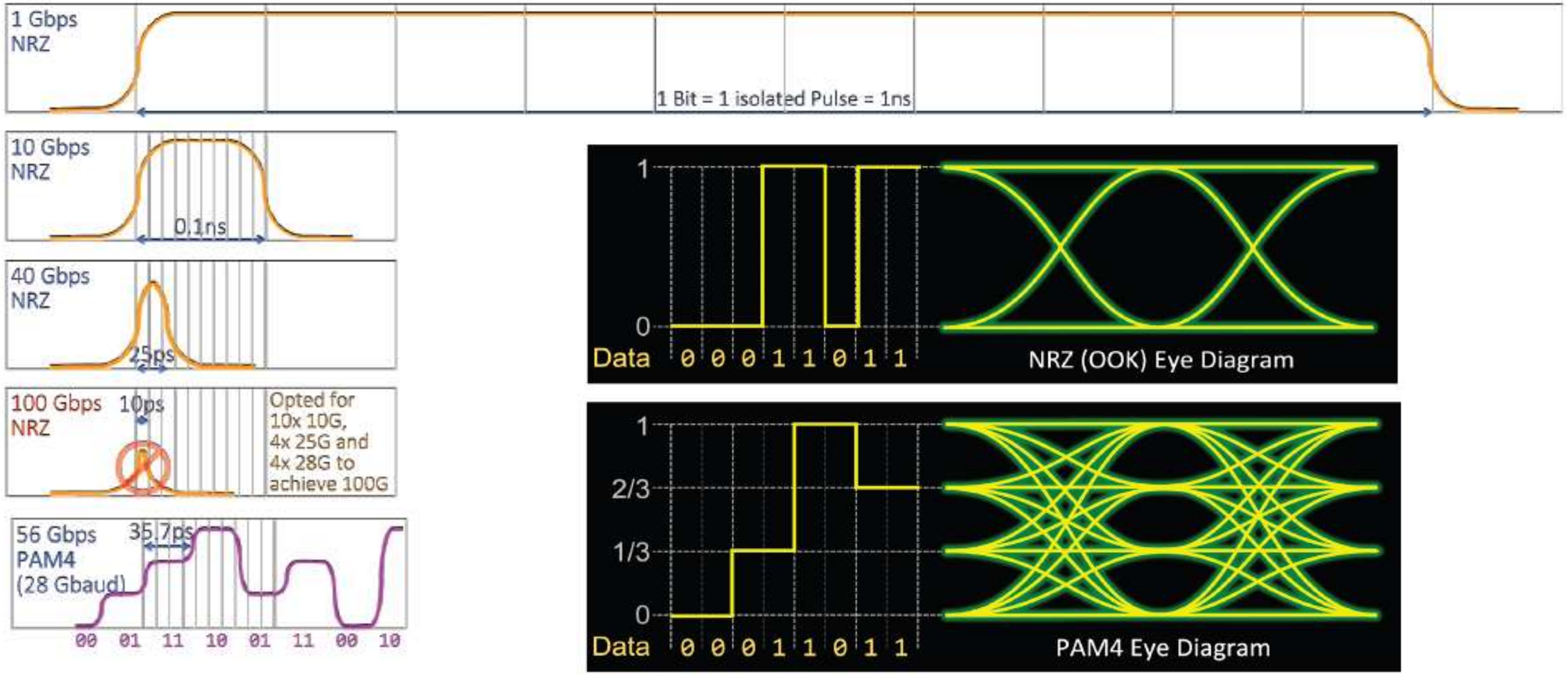
High Speed Datenkommunikation

- **400G, 800G, 1.6T…**
- Aktuell gilt der **Speed Rekord**:
  Japan (NICT) 2025:
  1.02 Petabit/s
  1’808 km
- 19 Multi-Core Fiber
- EDFA
- WDM
- Modulation
- FEC



Modulation

- NRZ
- PAM 4
  doppelte Datenrate
- Kohärente Transceiver
- Braucht FEC



Coming soon:

FEC

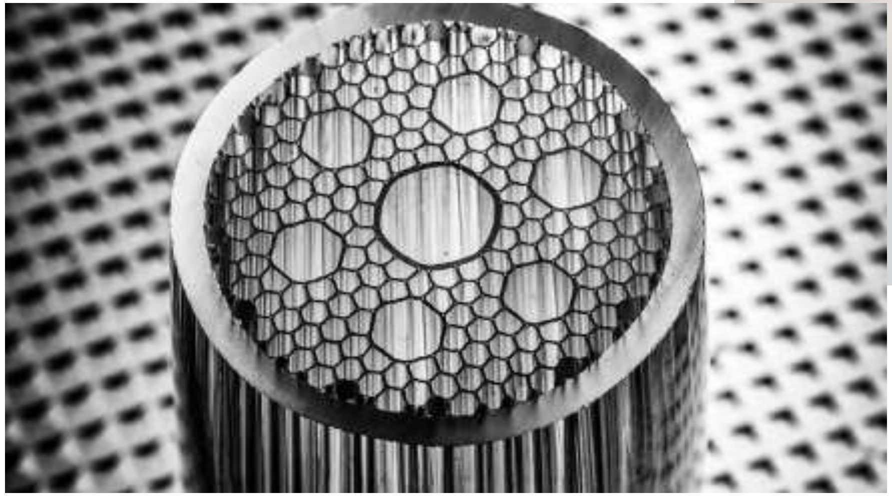
- **Forward Error Correction**
- Bei PAM 4 gibt es immer Fehler.
- Die Frage ist: Korrigierbar, oder nicht?

Latenz

Verzögerung

Latenz

- Näher ran (Edge DC)
- Schnelleres Medium
  Hollow Core Fiber



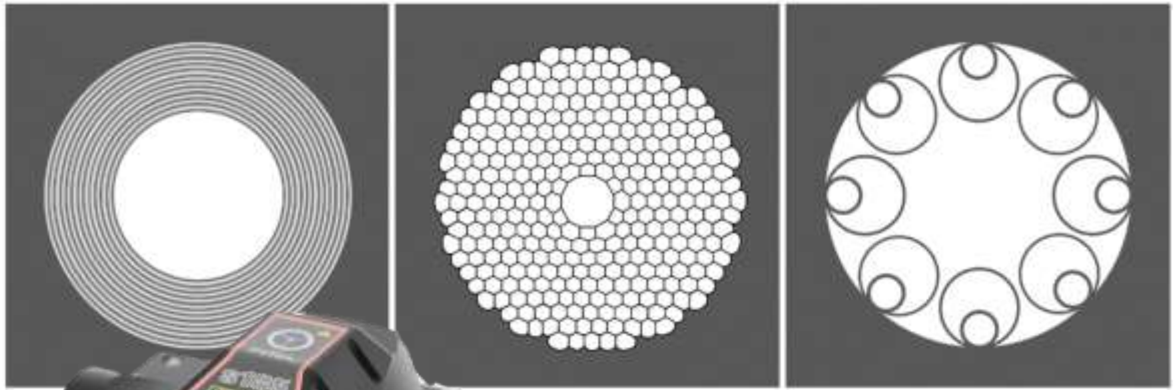
Hollow Core Fiber

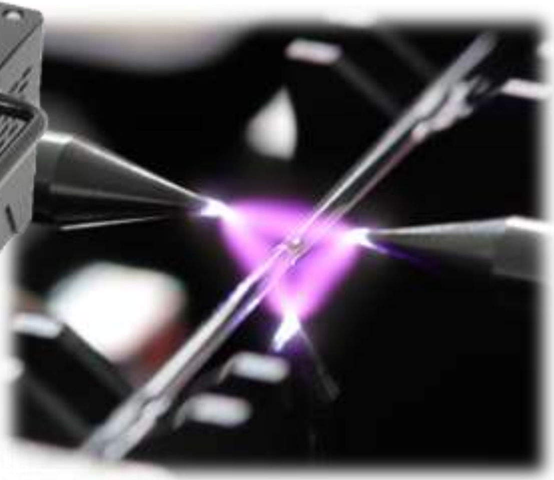
- Luft/Gas statt Glas im Kern
  Kleinere Latenz (Lichtgeschwindigkeit)
- Weniger Dämpfung
  Längere Strecken möglich
  (0.11dB/km 0.02dB/km möglich)
- Breites Spektrum bis 2100nm
- Vernachlässigbare Nichtlinearität
- Können hohe Leistungen übertragen
- Braucht spezielle Spleissgeräte
  zum Glück 😉

Bragg Fibers

(HC-PBGF)
Photonic Bandgap Fibers
''Photonic Crystal''

(ARF) **(NANF)**
Anti-Resonant Fibers
Nested Anti-resonant
Nodeless Fiber



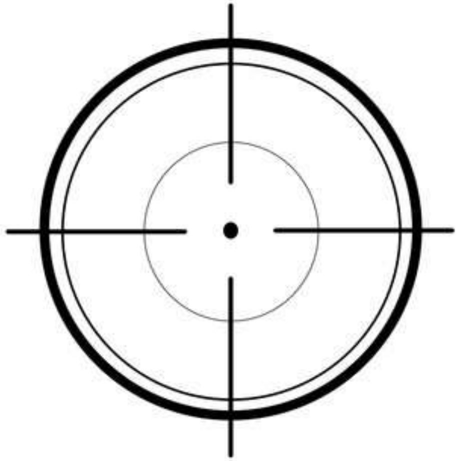


Dämpfung

Verlust und Energieverbrauch

Ultra Low Loss Connector

- Quantum Optik fordern weniger Dämpfung bei Glasfaserstecker.
- Präzisere und robustere Stecker sind gefragt.



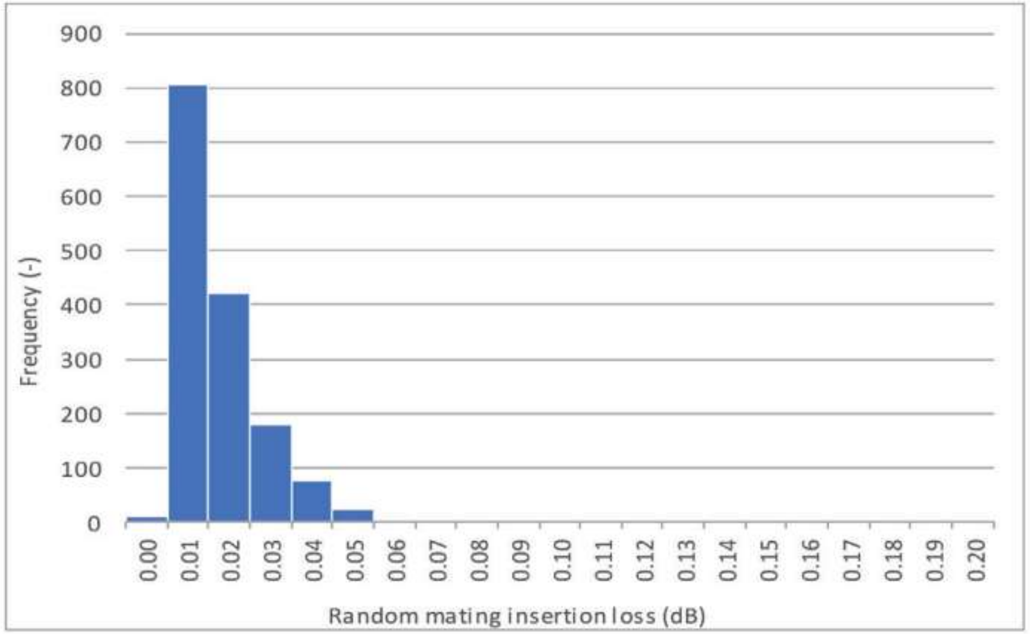
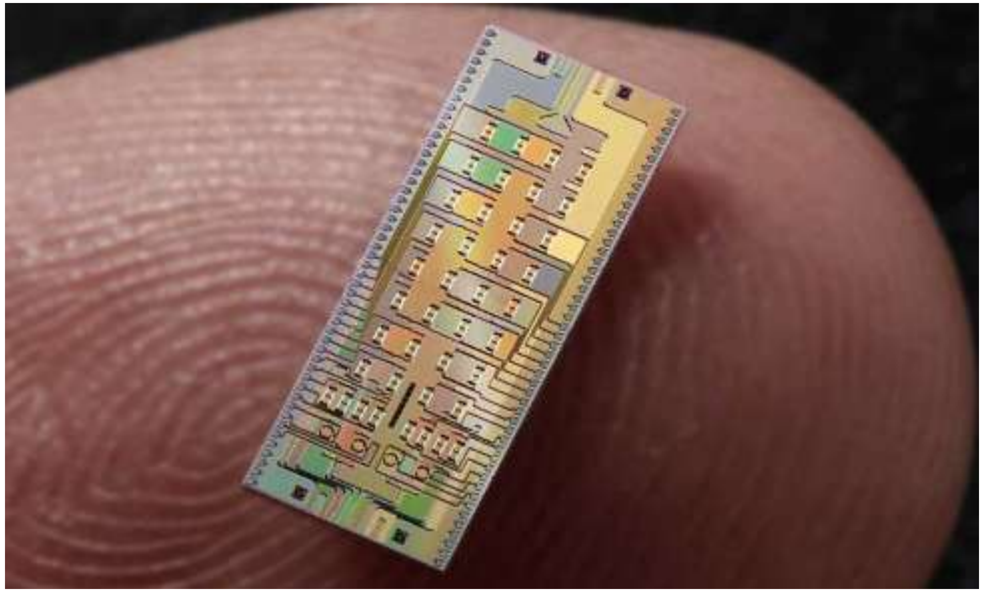


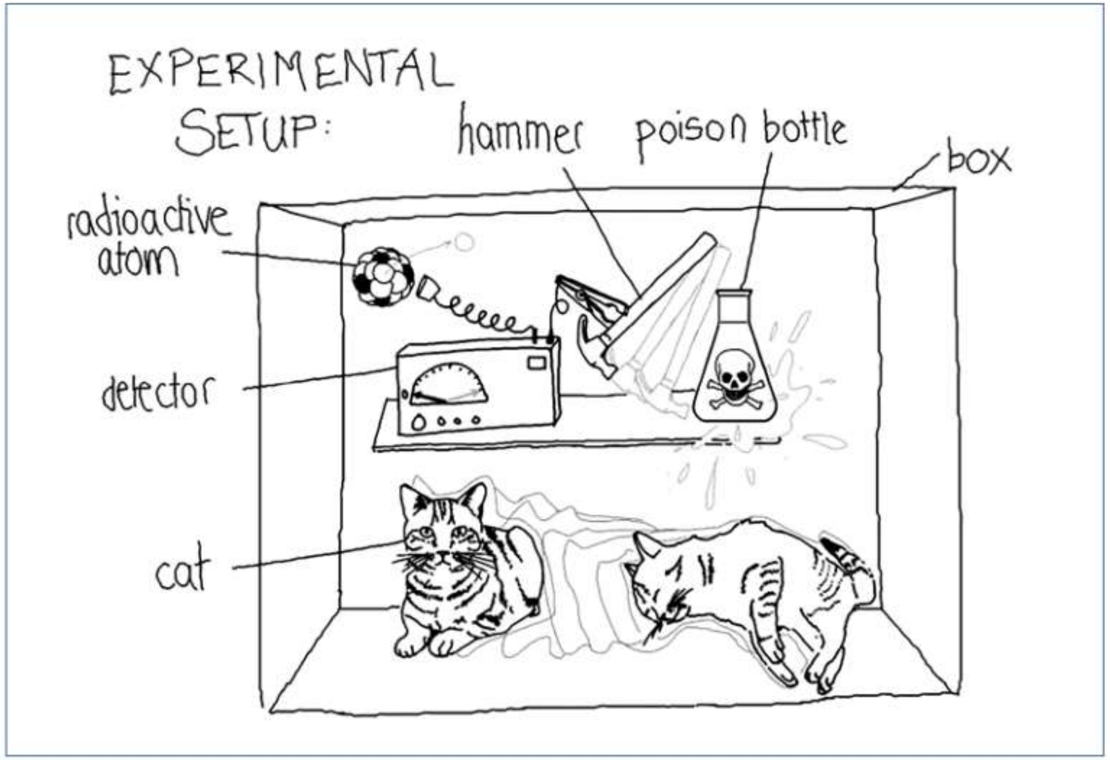
Figure 2: Random mating insertion loss measurements at 1550 nm on a batch of 40 E-2000® Ultra-Low Loss connectors.

PIC

- Photonic Integrated Circuit
- Leiterbahnen für das Licht auf einem Chip
- Bis zu 90% weniger Energieverbrauch



- **Quantenphysik einfach erklärt, damit es jeder versteht.**



Vielen Dank

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