Agenda

Optics Research at Harz University

U. Fischer-Hirchert

ufischerhirchert@hs-harz.de

- Optical communications systems
- Optical packaging
- Opt. frequency references
- Equipment

Harz University of Applied Sciences

- **Founded in 1991**
- **3300 students**
- **Dept. of Automation and Computer Science**

Optical Communications Systems

- Photonic Packaging
- WDM-visible system
- Optical Frequency References

Address:
Harz University of Applied Sciences
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Fax: +49 3943 659 109

Vita

- **University**

  Freie Universität Berlin, 1976 bis 1982 Diplom-Physicist

  „Optical Determination of energy transport in Dibenzofuran/Anthrazen-mixed cristals“

- **Doktorarbeit**

  Freie Universität Berlin, 1983 bis 1988 Dr. rer. nat.

  „ Optical Determination of energy transport in organic molecular crystals with high disorder“

- **Scientific staff**

  Heinrich-Hertz-Institut Berlin, 1988 bis 1995

- **Head of packaging group**

  Heinrich-Hertz-Institut Berlin, 1995 bis 2001

- **Prof. for communications technology**
- **Prorektor for Research**

- **Habilitation February 2006, TU-Dresden**

Teaching

Telecommunication mit focus on optical communications systems
Teaching (since 2001)

- Electr. und opt. communications systems
- Measurement techniques in communications systems
- Photonic packaging
- Opt. transmission systems

- 14 years in the Heinrich-Hertz-Institut

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CT-Team


HOCHSCHULE
harz
Hochschule für angewandte
Wissenschaften

Research interests

- **Optical communications systems**
  - **Polymeric fiber systems and functional-key elements**
  - **Optical frequency refereneces for WDM-networks**
  - **Optical characterisation up to 10 Gbit/s**
  - **Teaching concepts for photonics systems**

- **Photonic Packaging**
  - **Far and near field characterisation of Lasers etc.**
  - **Fiber-Chip-coupling**
  - **Field analysing und Simulation of optical wave-guides (BPM)**
  - **Concepts for opt. moduls**
  - **ITG-Group within VDE**

POF-WDM-Technique

Application area of POF (I)

Multimedia in car communication (MOST):
"communication between e.g. mobile phone, GPS, receiver and DVD-player"

Automotive sector

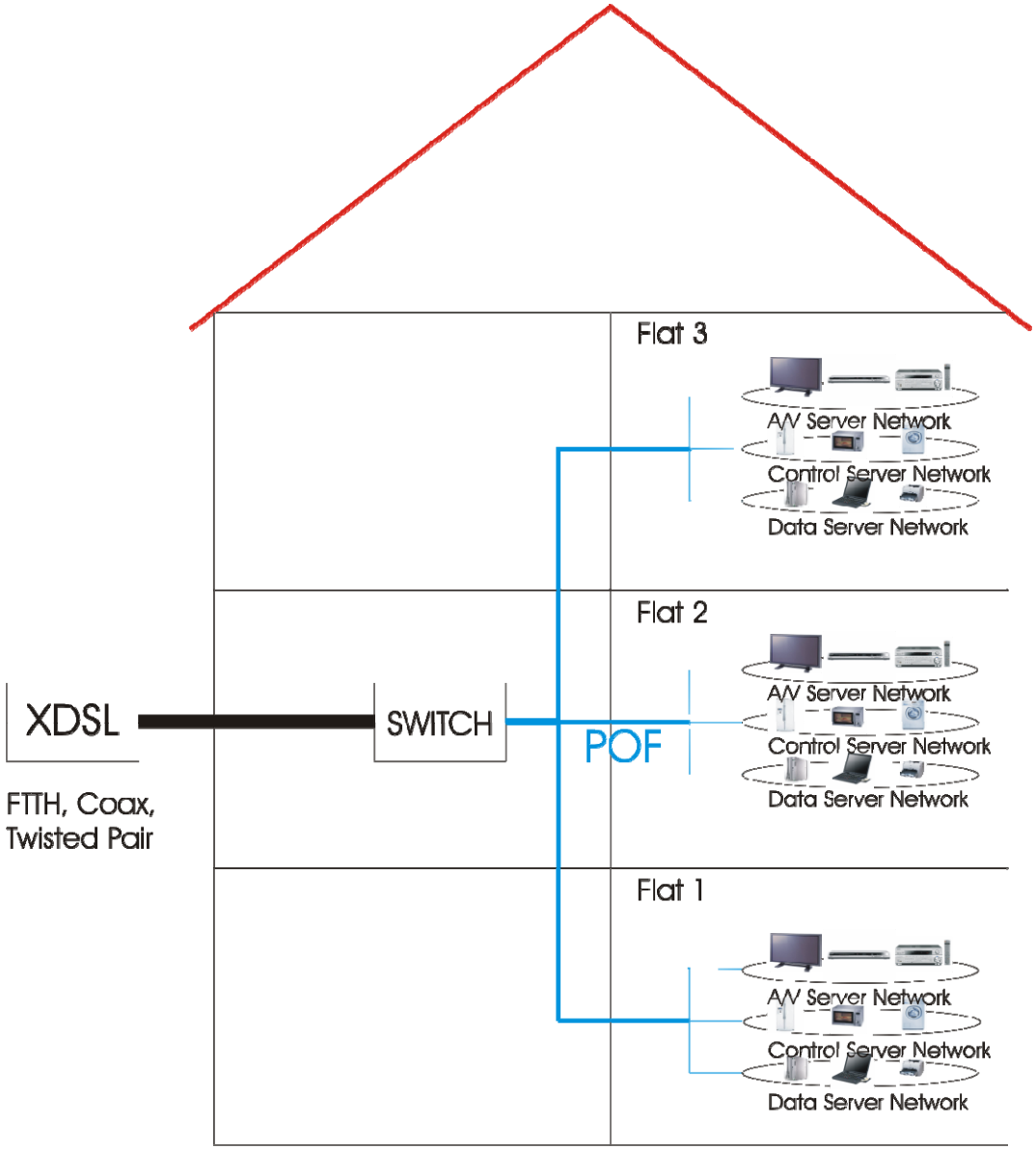
Application area of POF II

IP based Services ("Triple Play"):

- PC-Data
- VoIP
- IP-TV

In-house communication:

- "A/V Server Network" (communication between e.g. television, hi-fi-receiver and DVD-player)
- "Control Server Network" (messaging between e.g. refrigerator and stove)
- "Data Server Network" (data exchange between e.g. notebook and printer)



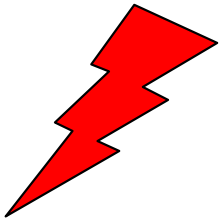
Motivation for VIS-WDM over POF (I)

The shown applications have high demand on bandwidth!

- Standard optical transmission system:

  One wavelength carries the information

  → limitation in bandwidth → Problem!

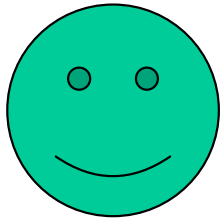


- New technology: VIS-WDM over POF

  Multiple wavelengths carry information

  → a multiple of bandwidth is possible

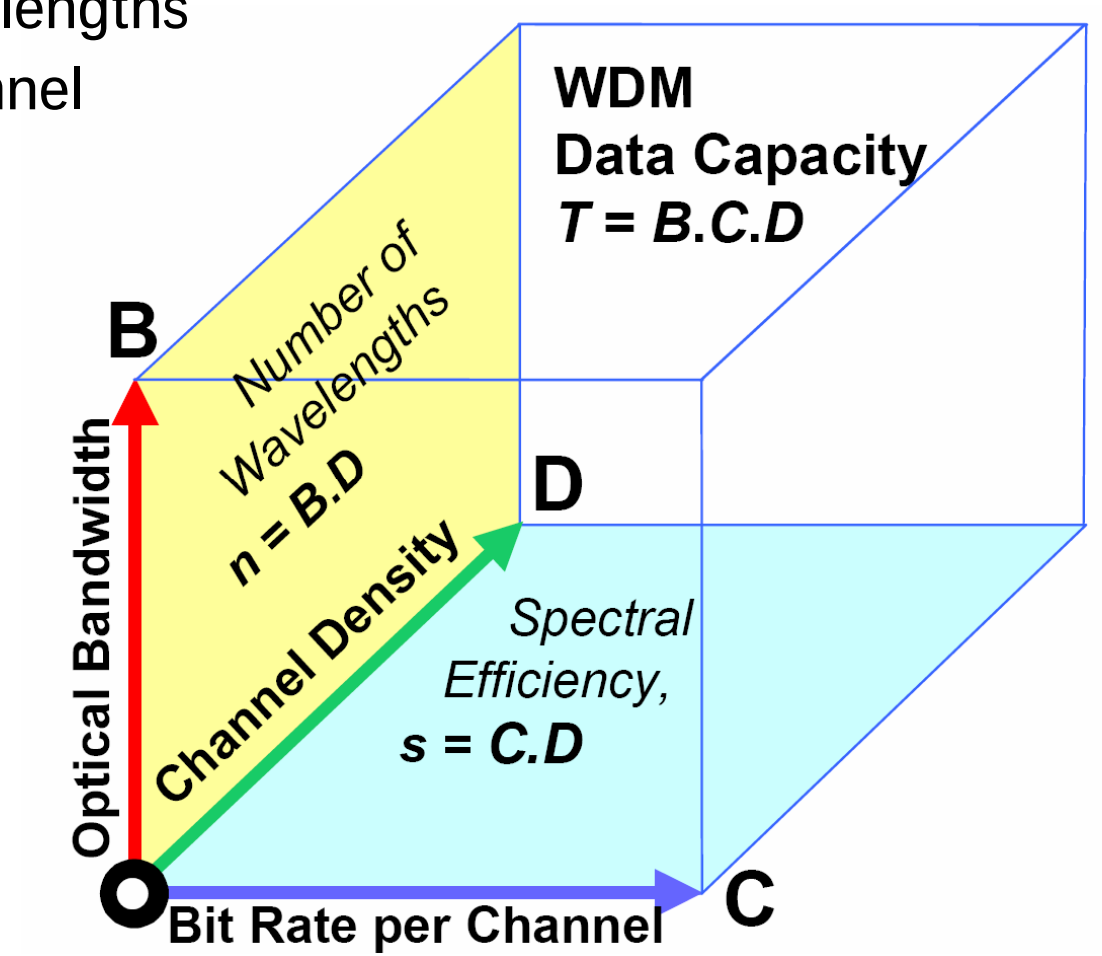
  → Multiplexer and Demultiplexer are needed



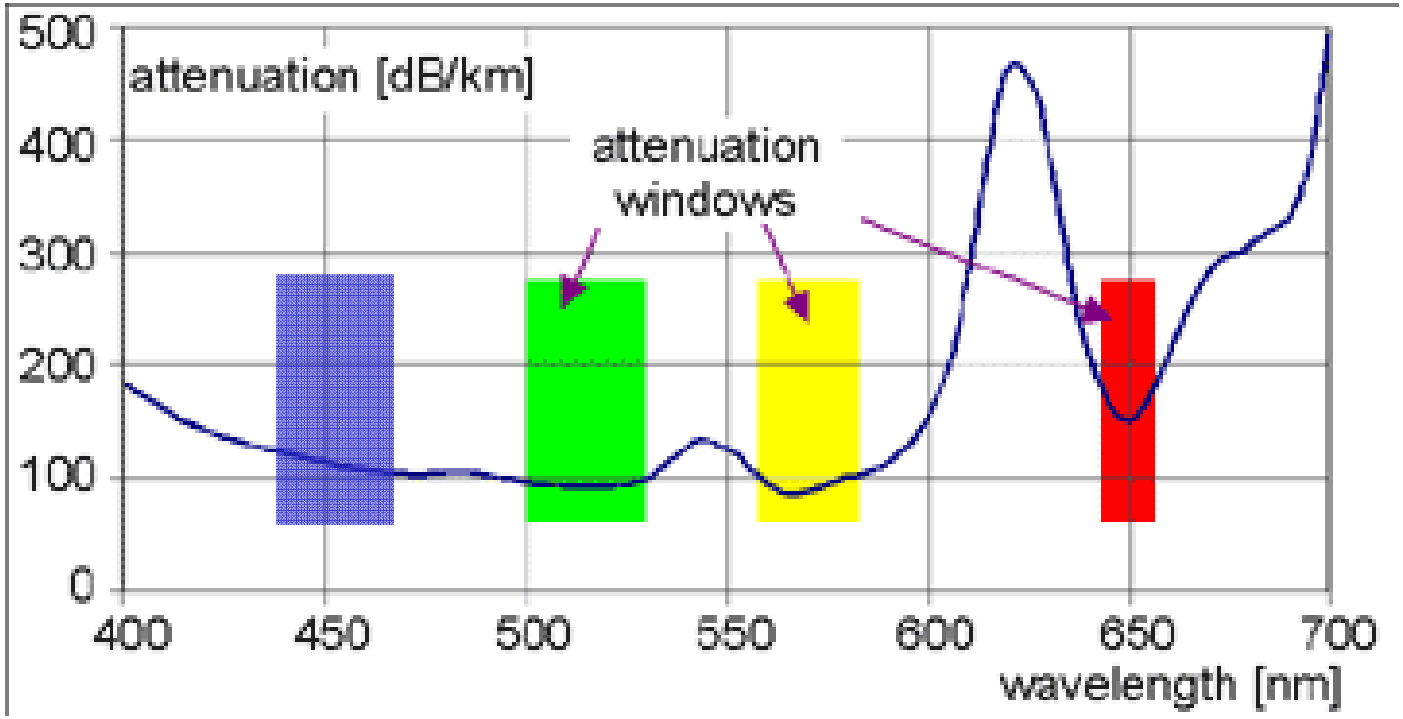
Motivation for VIS-WDM over POF (II)

WDM system capacity depends on:

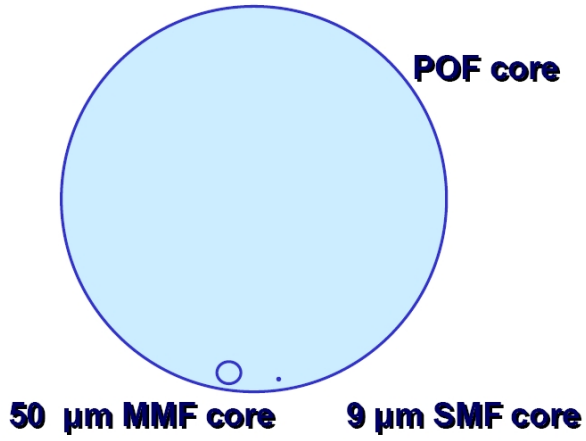
- Number of wavelengths
- Bit rate per channel
- Channel density



Advantages of POF systems



www.pofac.de



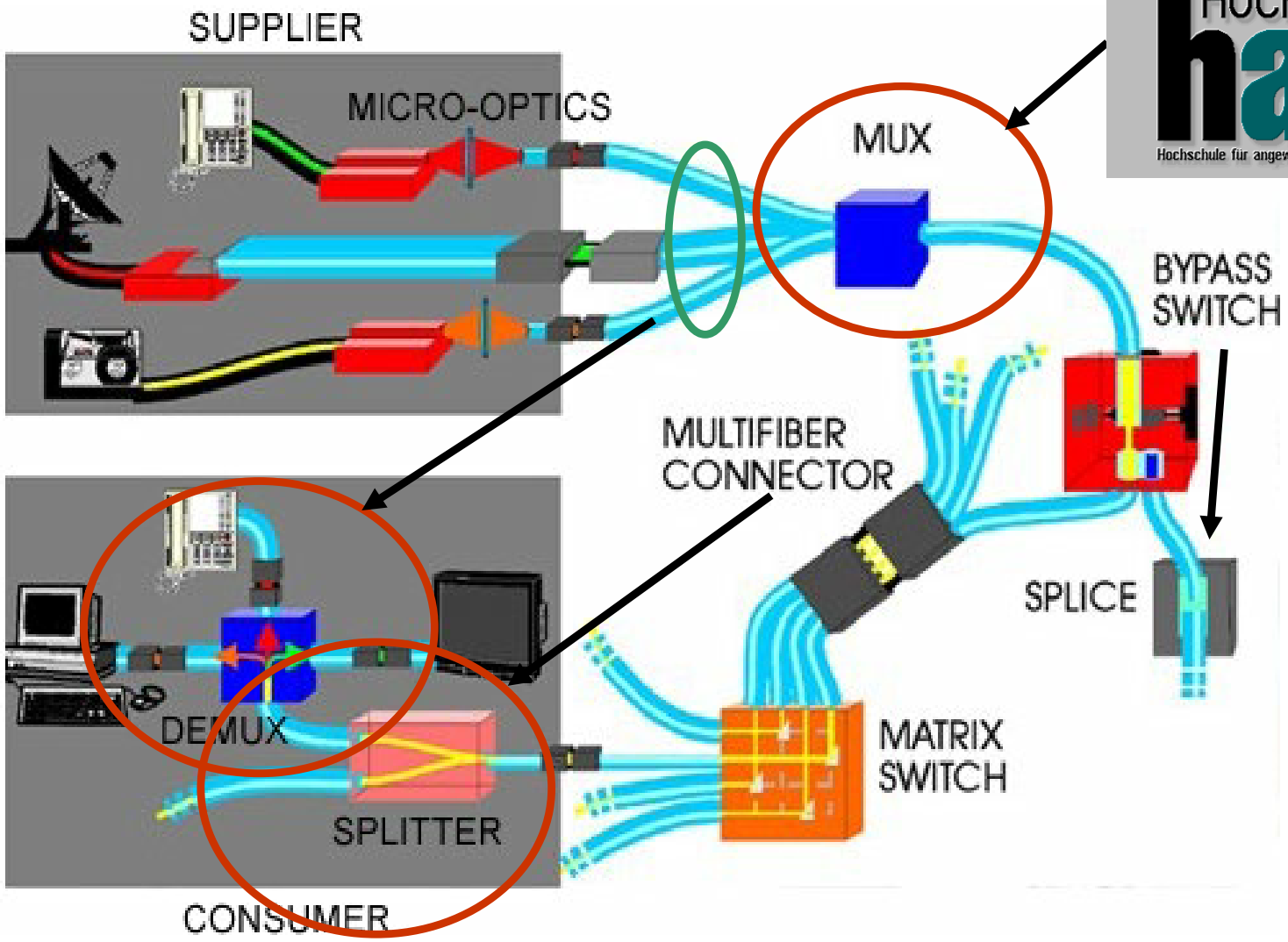
Comparison of different fiber diameters

+ Operates with visible light
+ Large core diameter (1 mm)
+ High numeric aperture (~ 0,5)
+ Easy to connect and to handle in comparison to glass fiber

disadvantage:

- high attenuation (125 dB/km)

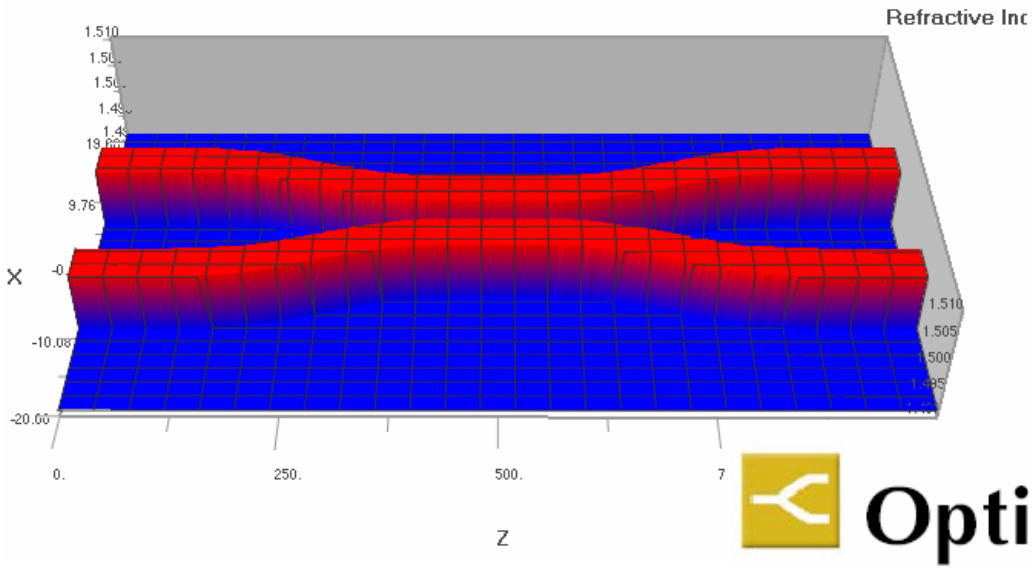
POF key elements

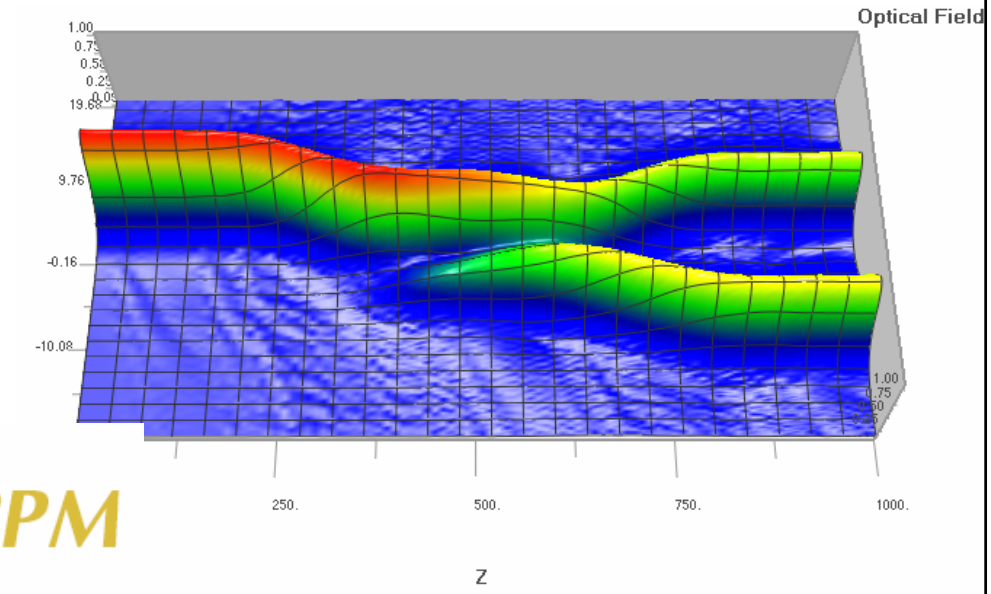


Quelle: Werner Daum, Jürgen Krause
„POF-Optische Polymerfasern
für die Datenkommunikation“, Springer-Verlag

Design of opt. Waveguides

- Ray-Tracing with **OpTaliX®** und TracePro
  - Calculation of POF-key elements
  - Analysis of POF wave guiding
- OPTIWAVE-BPM- program for simulation e.g. of fiber optics elements
  - Calculation of the wave equation within the waveguides





OptiBPM

Realisation of POF-WDM-DeMuxer by injection moulding

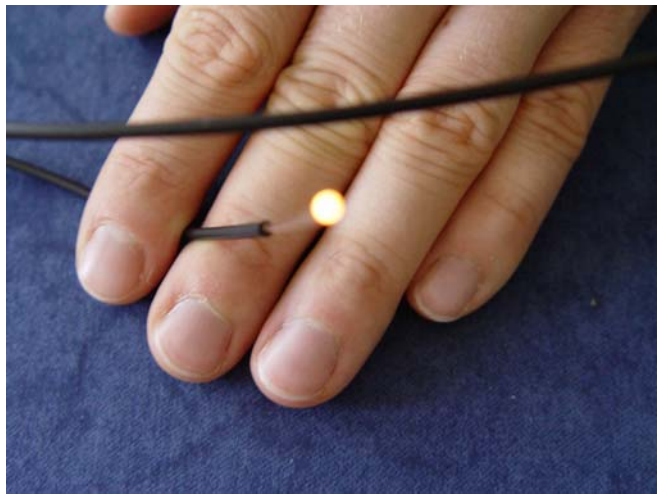
Dipl.-Ing. Matthias Haupt / U Fischer-Hirchert

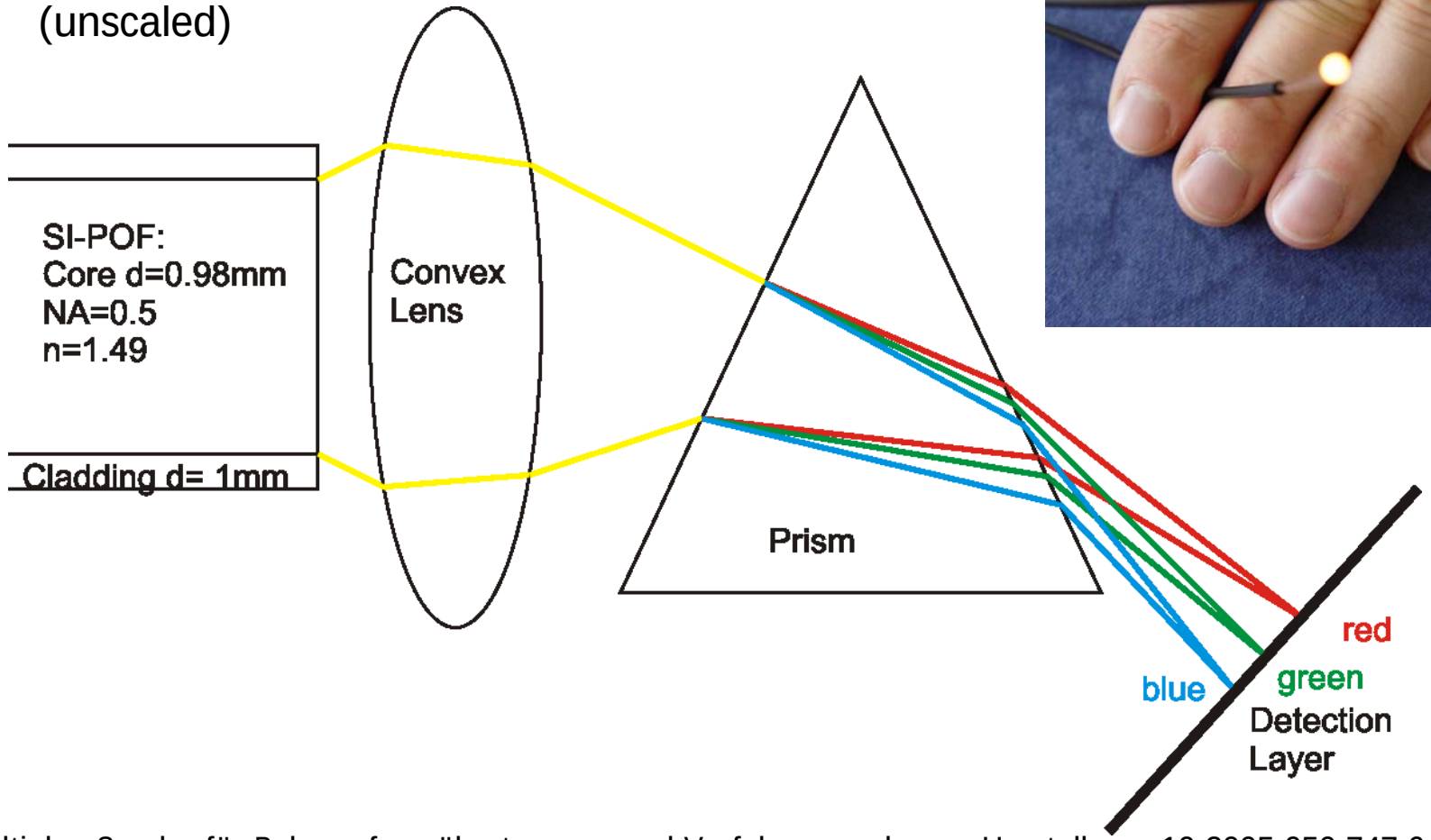
Patents pending:

1. *Multiplex-Sender für Polymerfaserübertragung und Verfahren zu dessen Herstellung, 10 2005 050 747.6 (Sender) 22.10.2005,*
2. *Demultiplex-Empfänger für Polymerfaserübertragung und Verfahren zu dessen Herstellung, 10 2005 050 739.5 (Empfänger), 22.10.2005*
3. *Multiplex-Transceiver für Polymerfaserübertragung und Verfahren zu dessen Herstellung,*

Patented basic concept

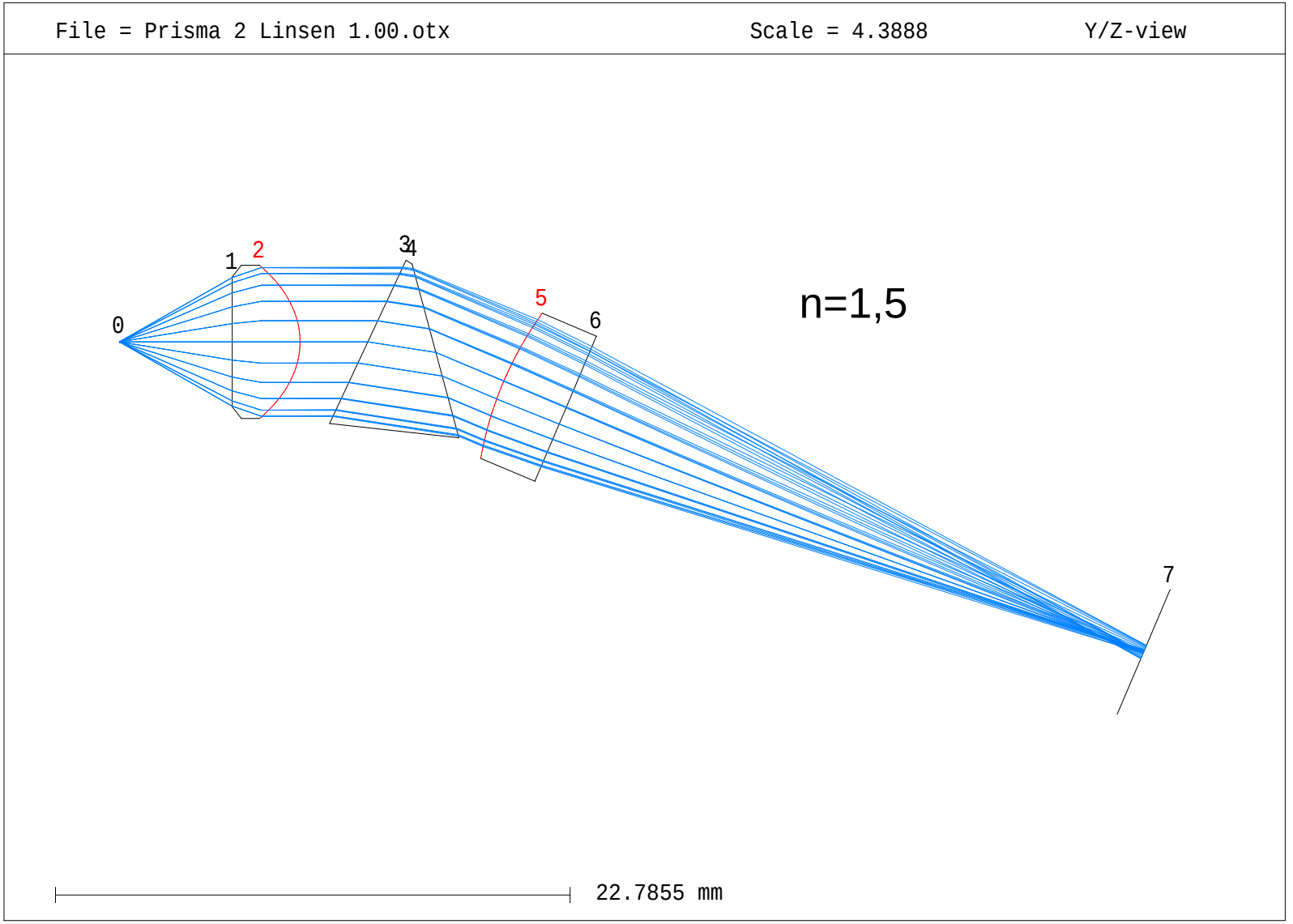
- Principle Sketch of a VIS-WDM Demultiplexer
  (unscaled)





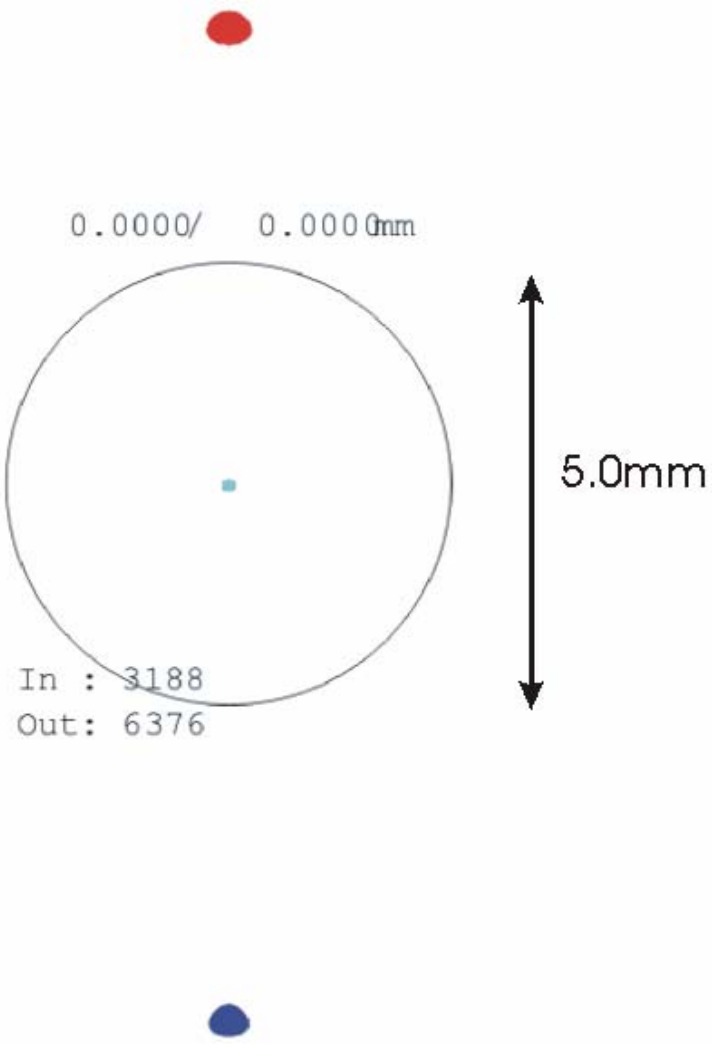
[1] Multiplex-Sender für Polymerfaserübertragung und Verfahren zu dessen Herstellung, 10 2005 050 747.6 (Tx) 22.10.2005,
[2] Demultiplex-Empfänger für Polymerfaserübertragung und Verfahren zu dessen Herstellung, 10 2005 050 739.5 (Rx), 22.10.2005
[3] Multiplex-Transceiver für Polymerfaserübertragung und Verfahren zu dessen Herstellung, 10 2006 009 365.8 (TRx)

1st attempt: realisation by transmission optics

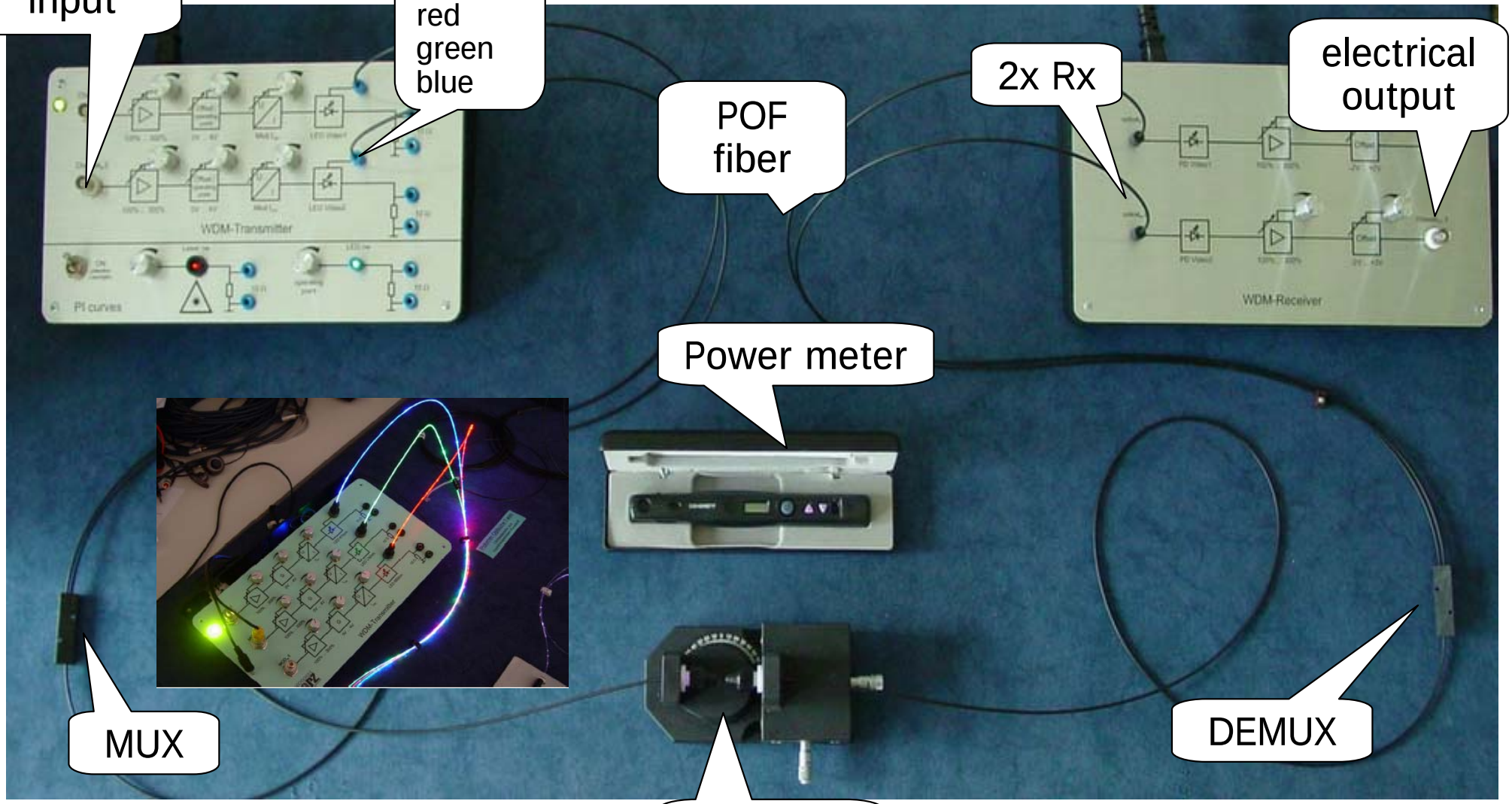


Best Results using integrated module with reflective grating

- Lower aberrations → all colors can be detected
- Gap between colors is large enough for photodiodes
- Cross-talk lower than 30dB

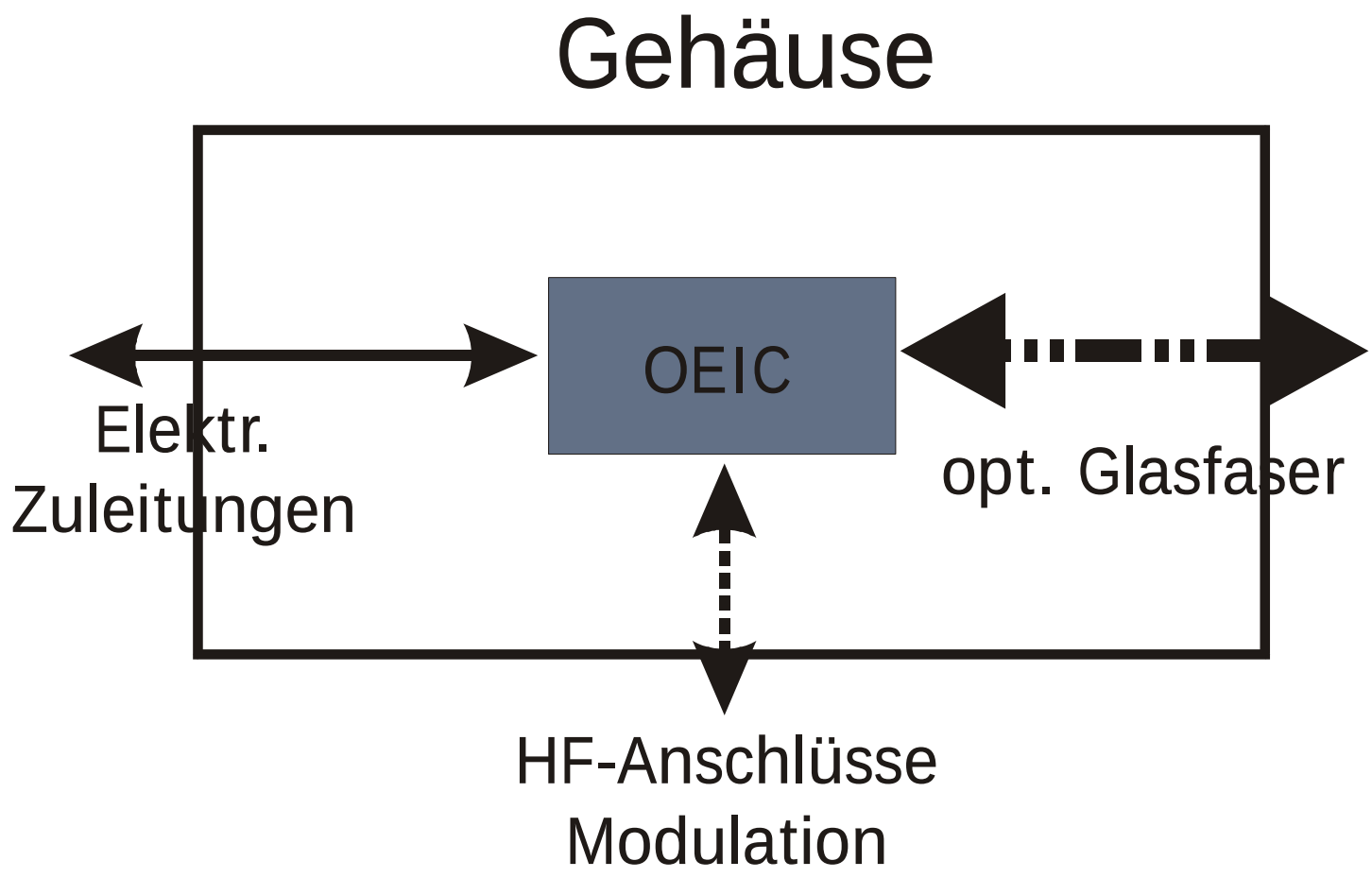


POF-teaching system HarzOptics

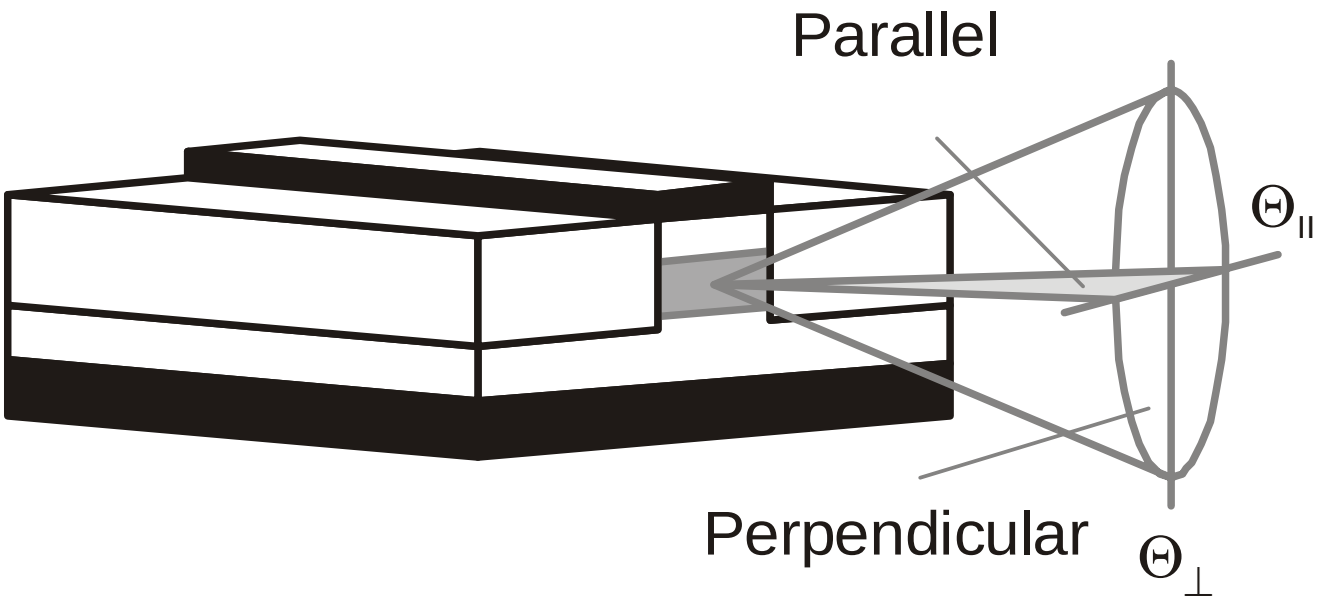


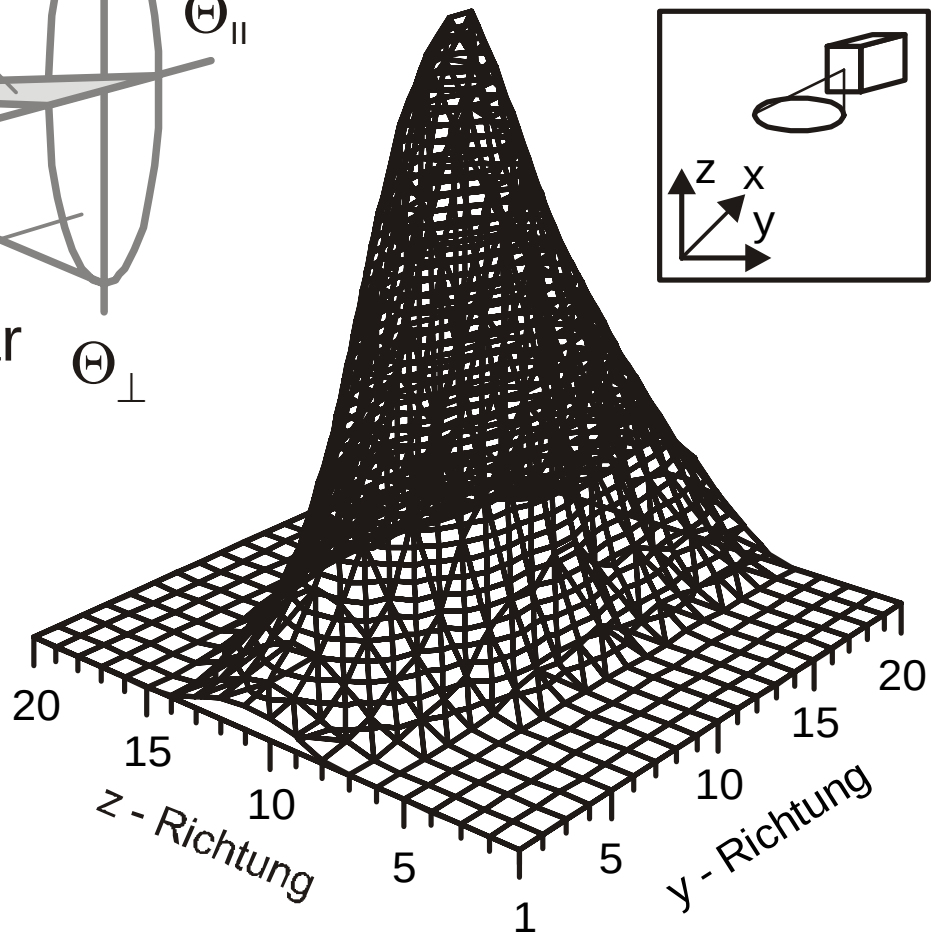
Photonic Packaging

Module basic set-up



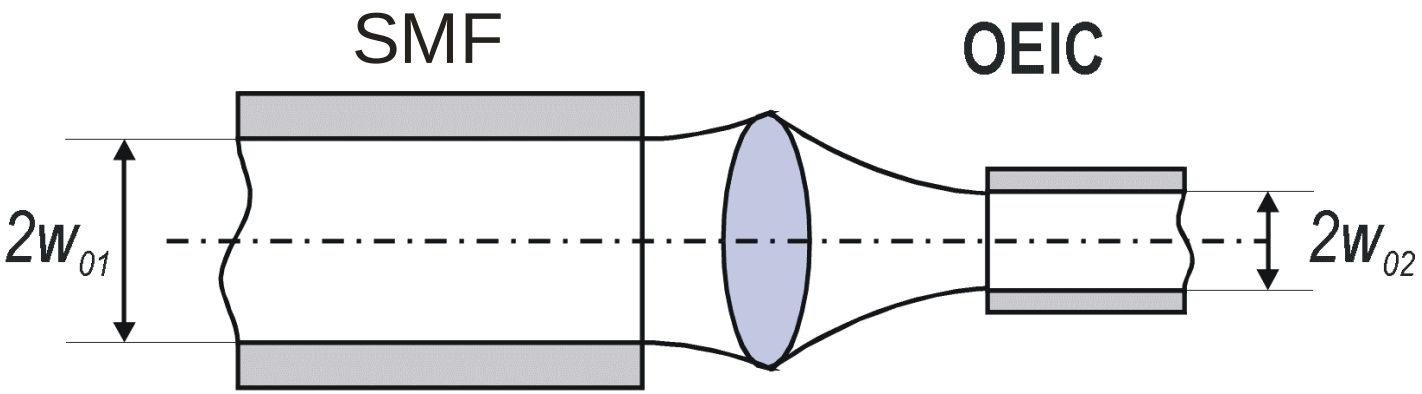
Field of a diode LASER



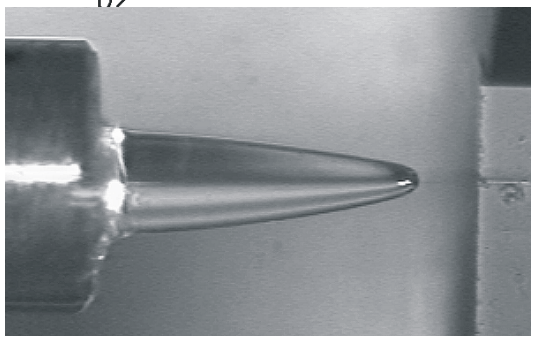


Adaptation of mode fields

- Mode field conversion of w_0 by lenses



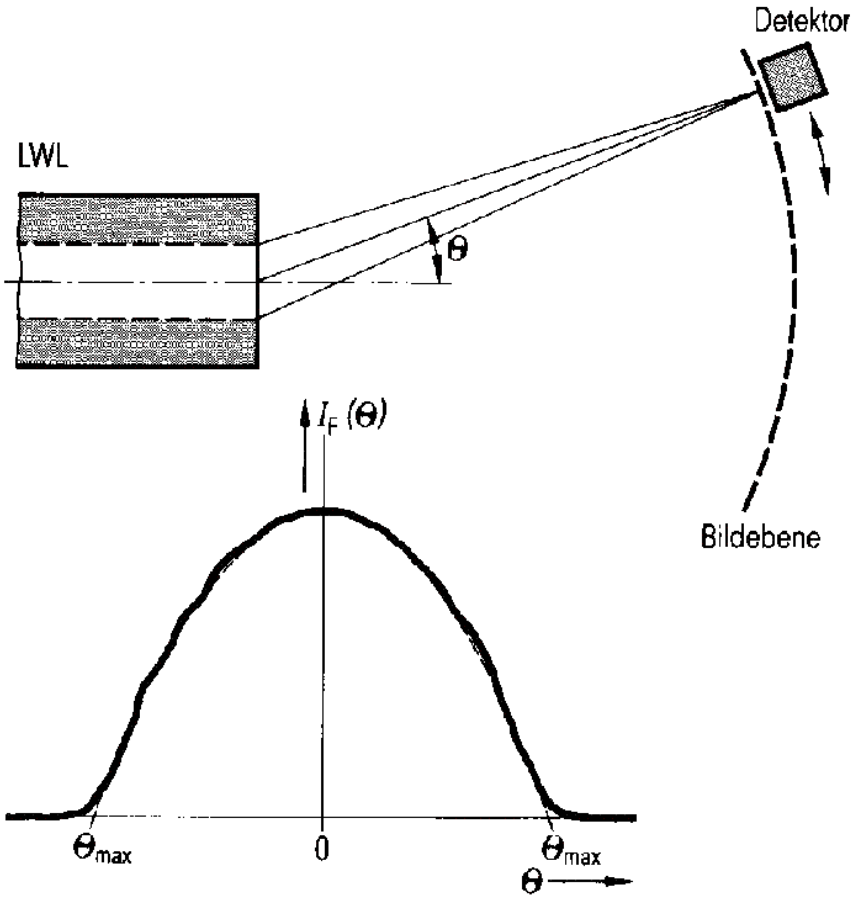
$w_{01} > w_{02}$



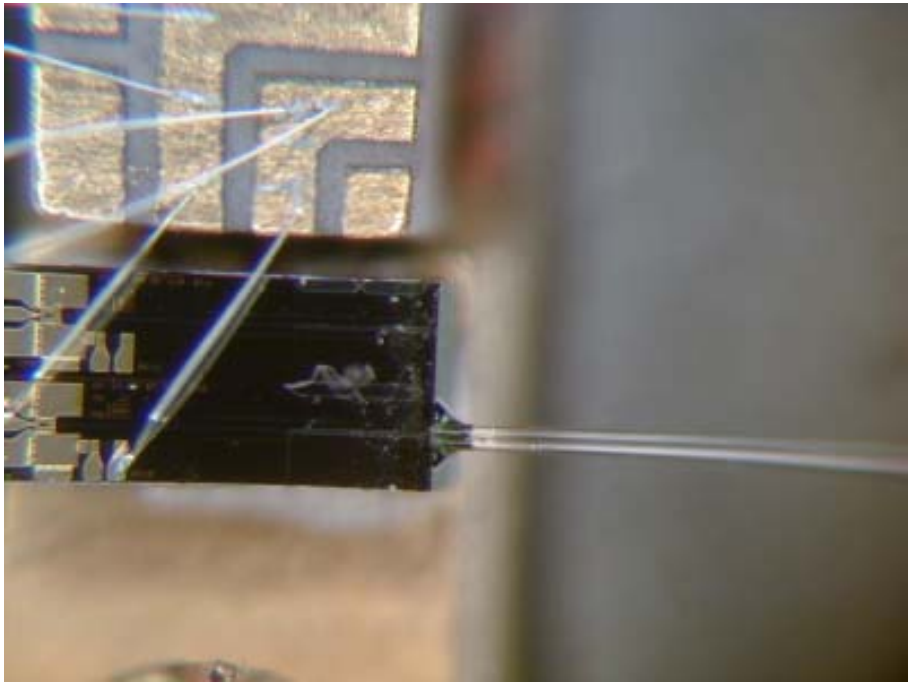
Realisation of spezific tapered fibers

Optical Field Characterisation

- **Far field methode**
  - Spherical scan
- **Near field methode**
  - Planar scan
- **Medianfield-methode**
  - Planar scan
  - High resolution

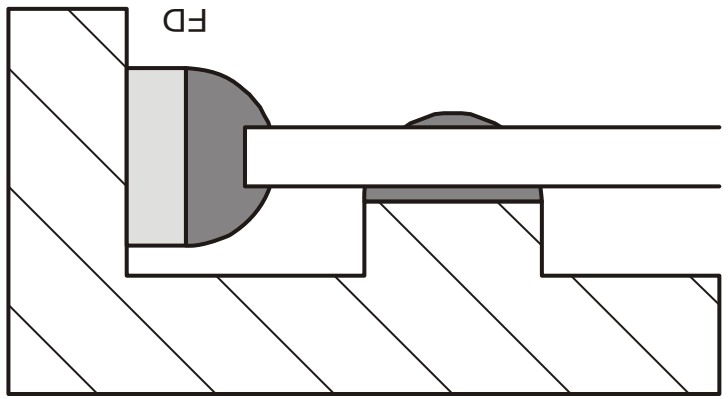


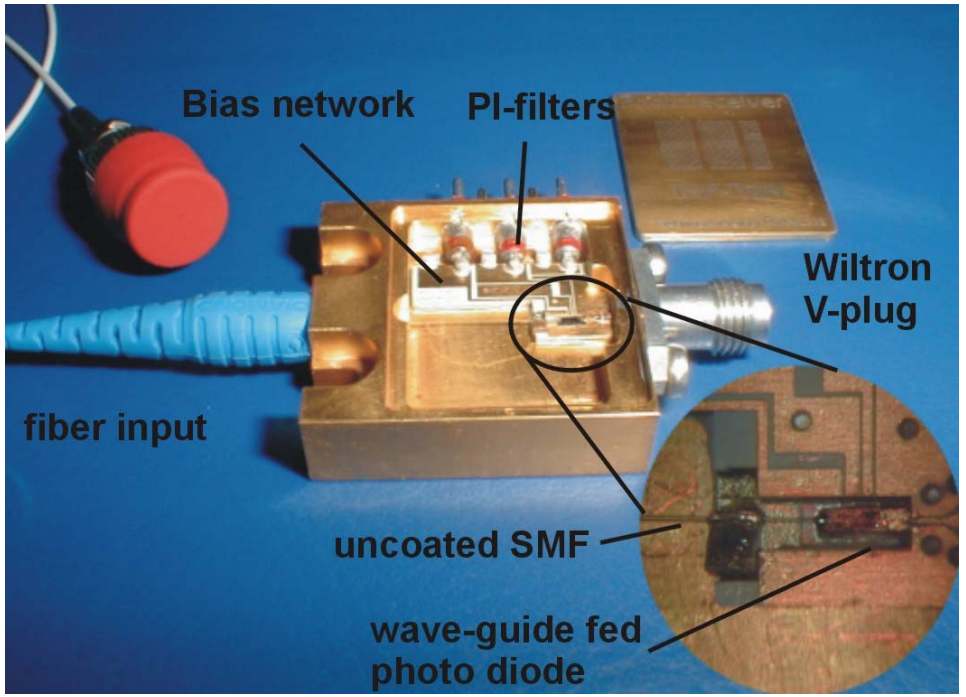
Front facet connection



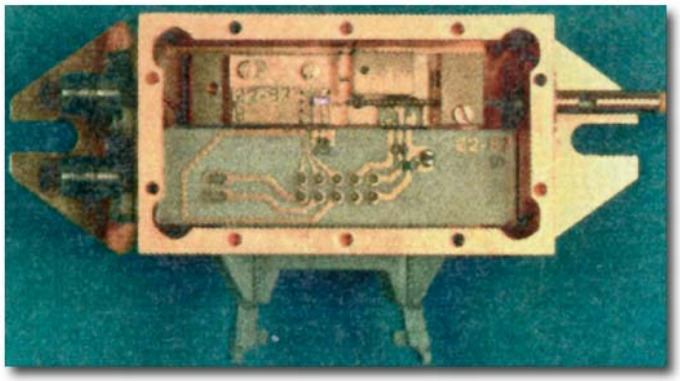
Photodiode module

- Max. frequency 40GHz
- Small opt. reflections
- Easy set-up Montage



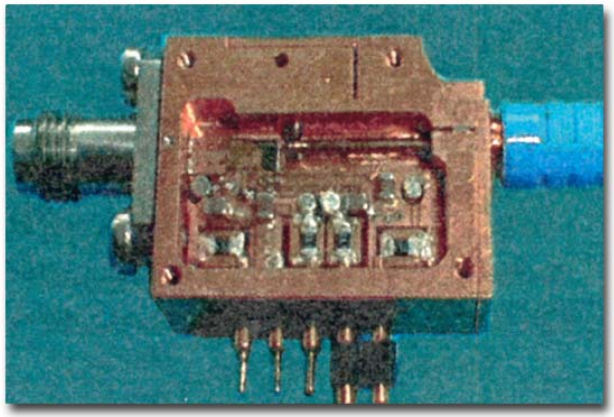


Modules



Laser module

50Gbit/s



Receiver module

40Gbit/s

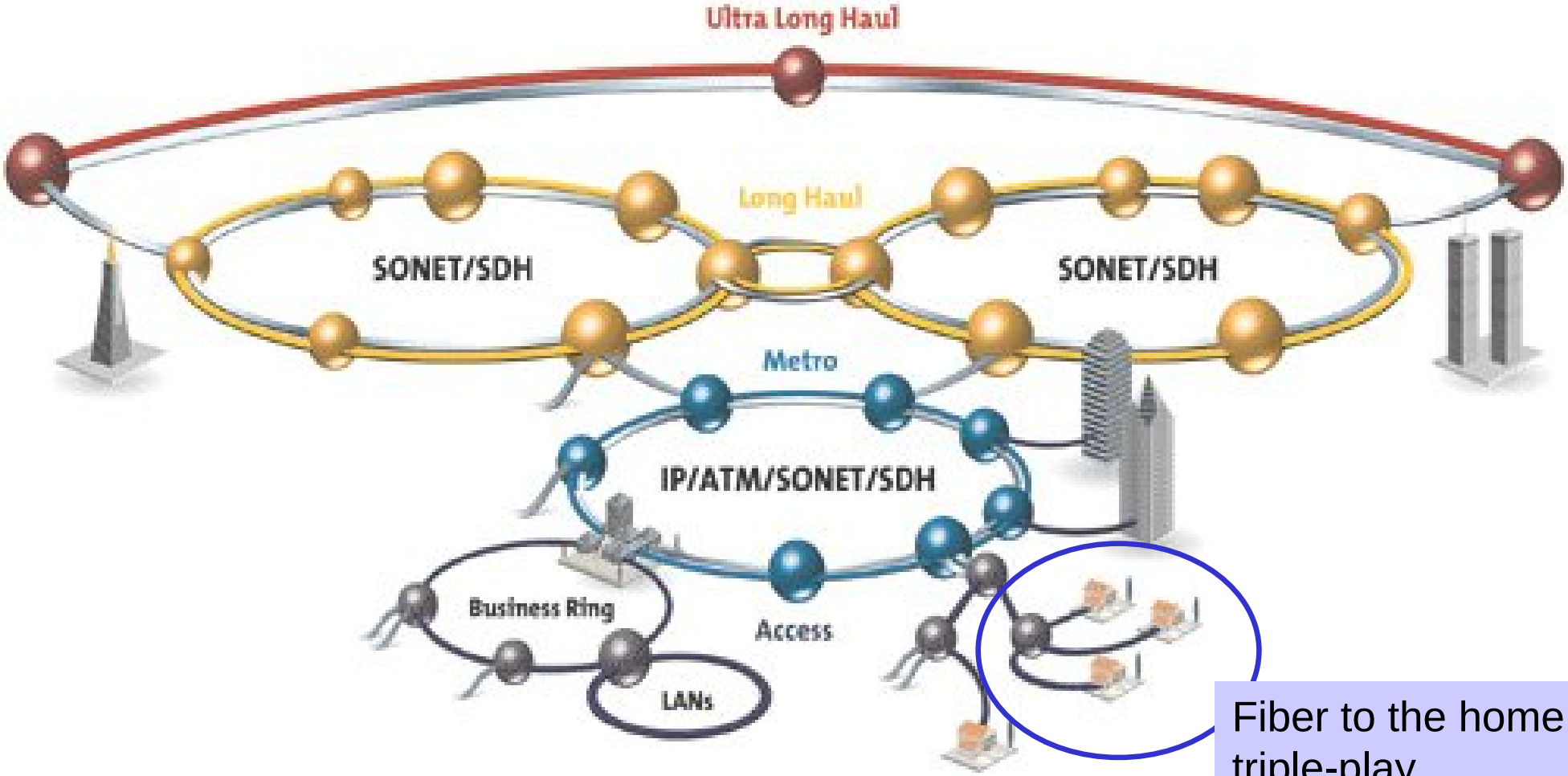
Multifiber module

16 x 16 fibers

Service for Universities and SME

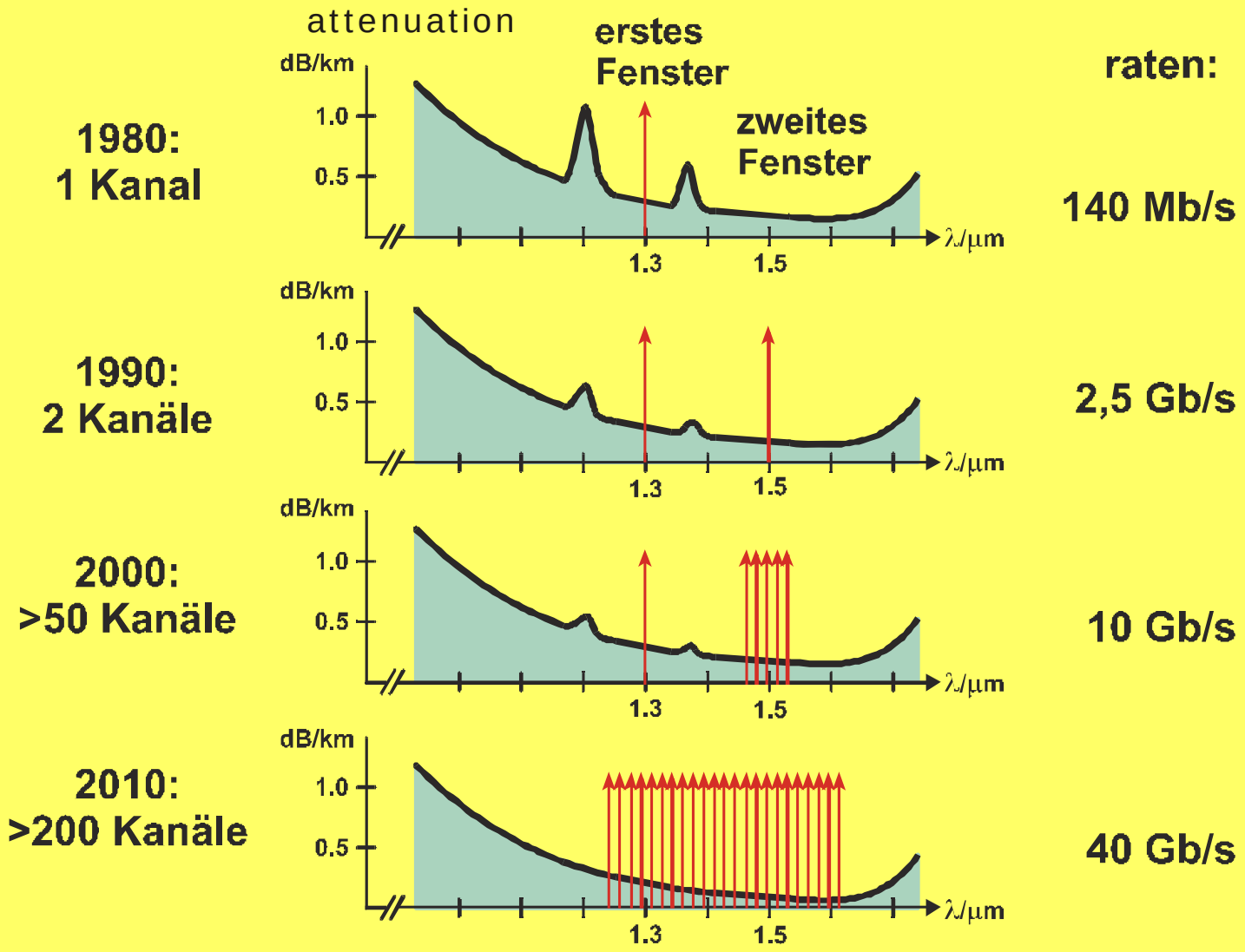
WDM-Frequency stabilisation

Hierarchic optical communications systems



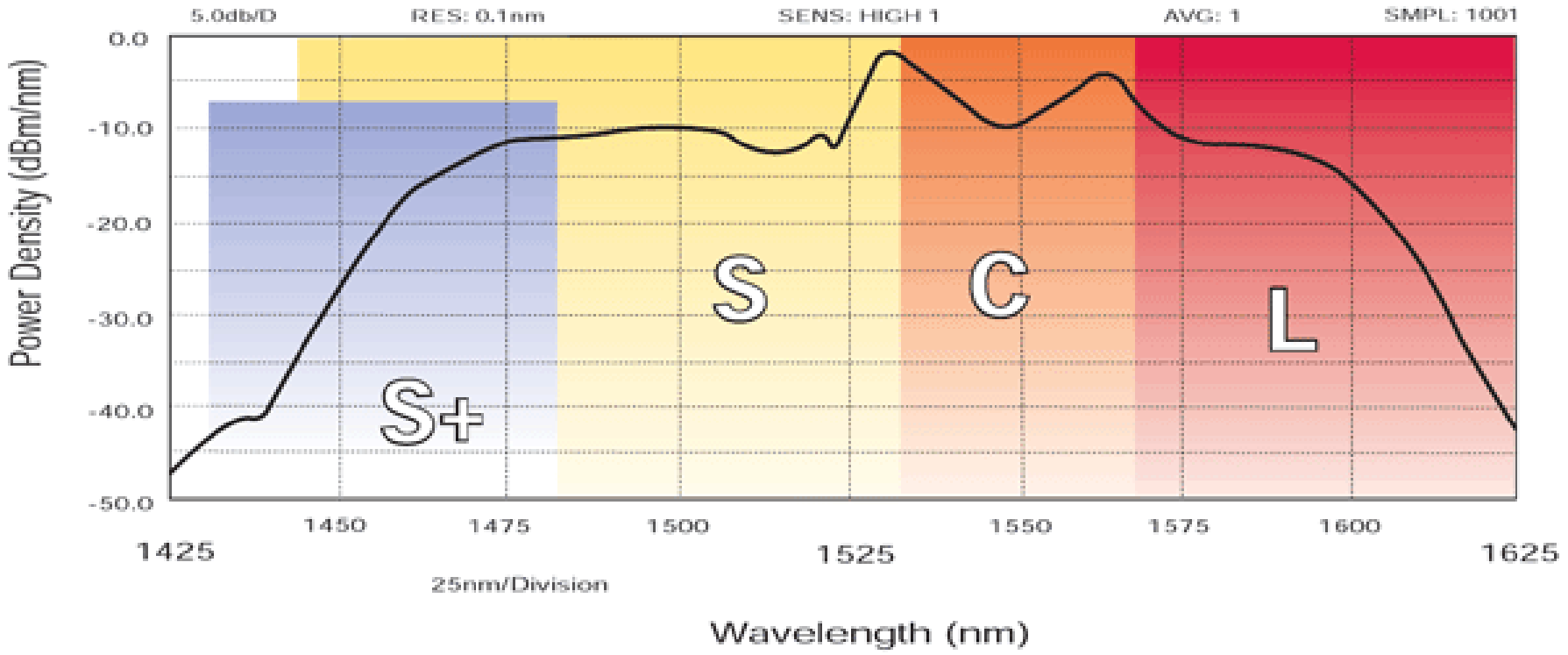
Fiber to the home:
triple-play
VoIP, IP-TV, IP-data

History of WDM-Technique

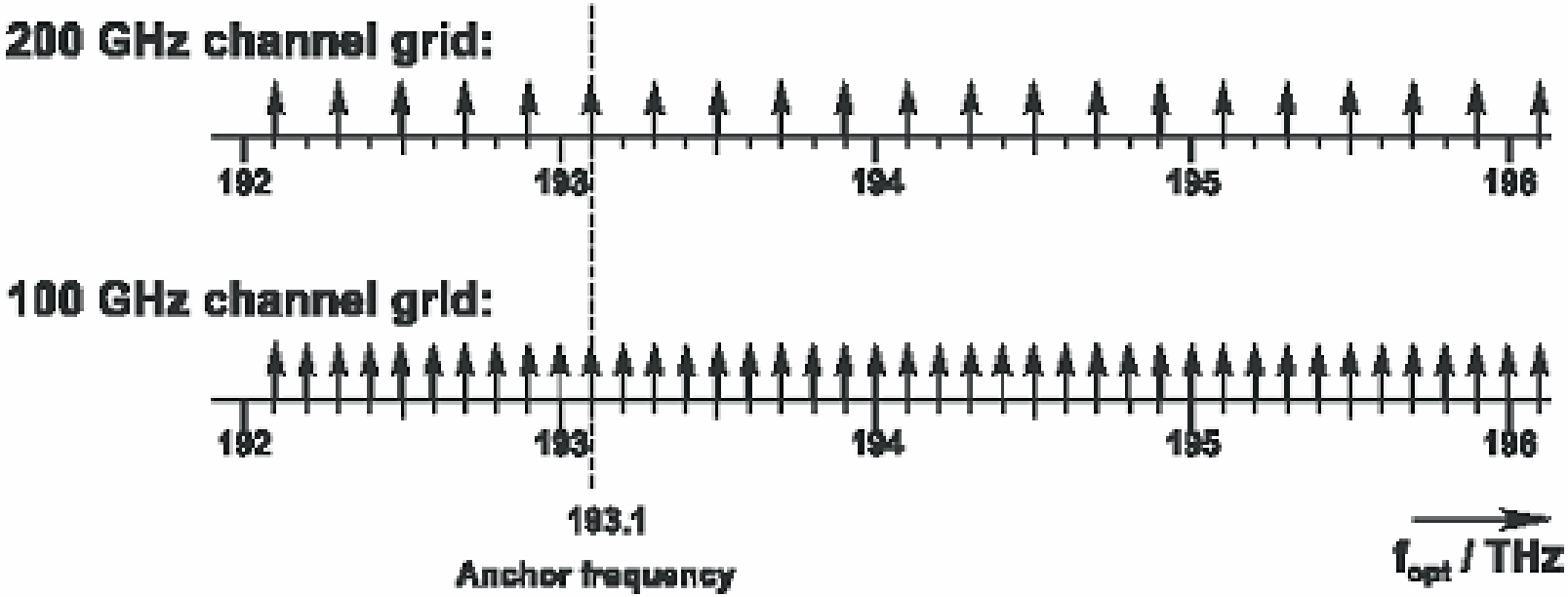


WDM- wavelength allocations

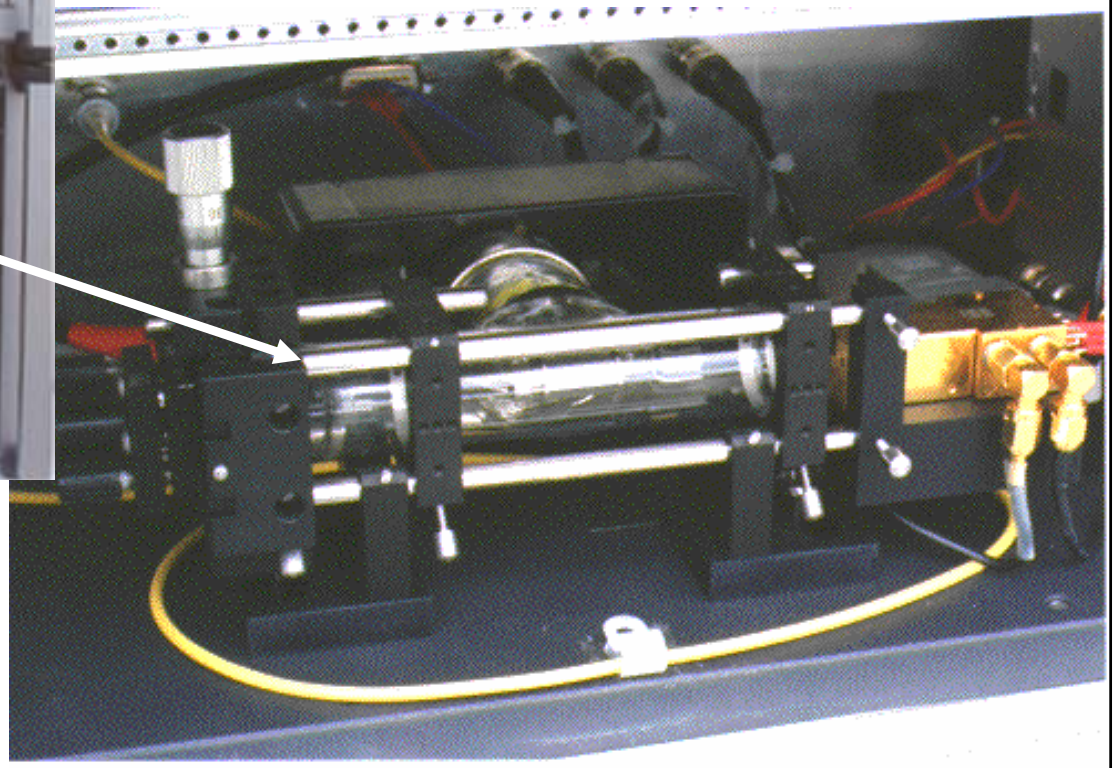
Technique	Channel distance	Opt. window
▸ CWDM	2-3 THz(20-25nm)	1. or 3.
▸ NWDM	800GHz(6.4nm)	3.
▸ DWDM	100GHz/200GHz (0.8nm/1.6nm)	3.
▸ HDWDM	50GHz(0.4nm)	3.



ITU-G652 Channel allocation



19“-Frequency stabilised Laser module



$\lambda = 1547{,}825\text{nm}$

$\lambda = 1533{,}839\text{nm}$

Equipment

measurement and test engineering

also as an offer of services

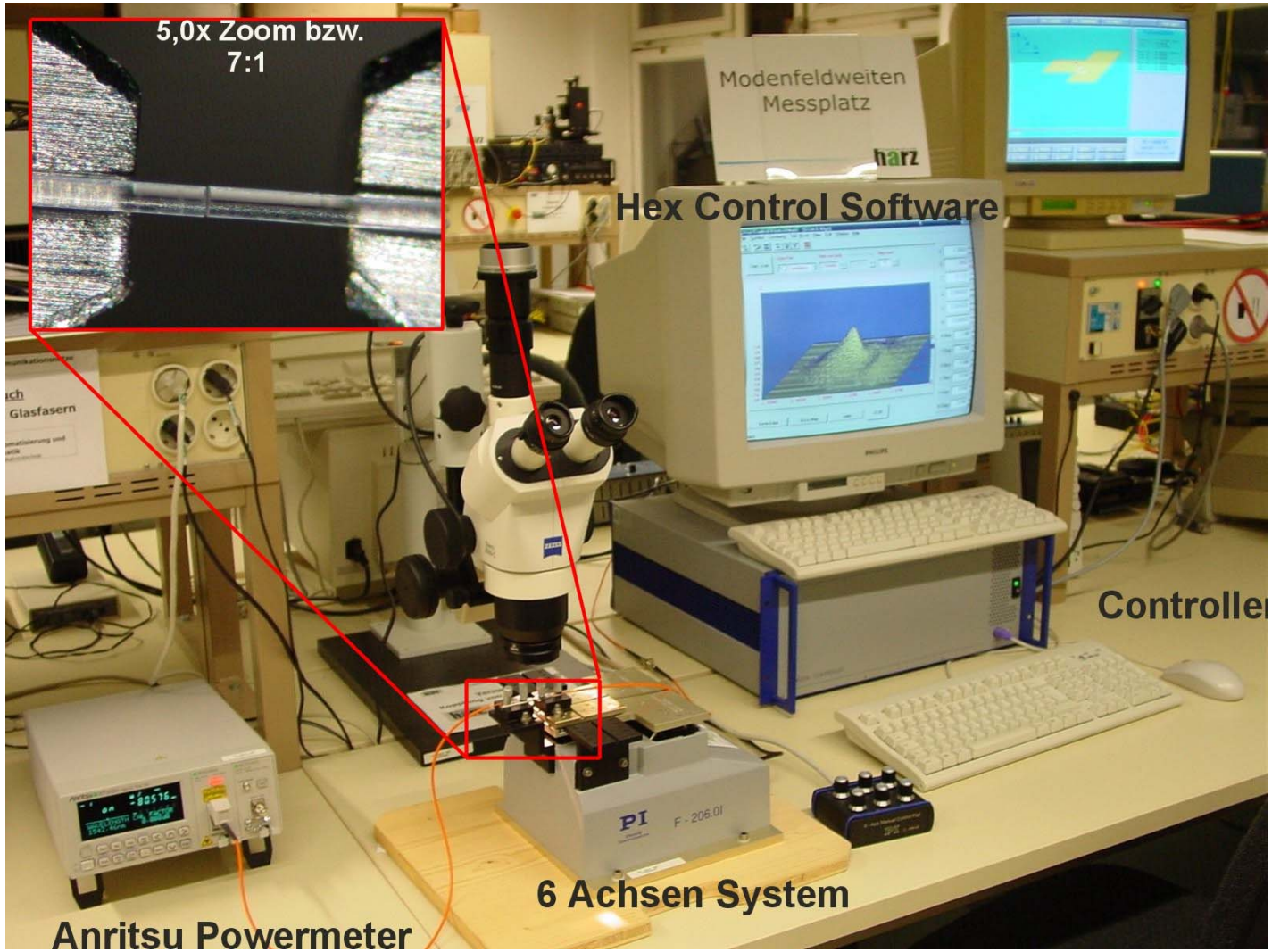
Test equipment for SMF

- **Optical bit error rate tester** bis 10GBit/s (STM 1-STM 48)
- **Optical Dispersion Analyzer**
  - **CD**
  - **DGD**
  - **PMD**
  - **IL**
  - **PDL**
- **Wavelengthmeter** 600-1700 nm
- **Tunable laser sources**
  - **1495-1640 nm**
  - **1240-1400 nm**
- **WDM-Testbed**
  - **4 x WDM-Transmitter up to 10Gb/s**
  - **100km SMF G692**
  - **Er+-amplifier**
  - **AWG-Splitter**
  - **Dispersion compensation DCF**
  - **Simulation von WDM-systems by VPI-simulation software**

Agilent 86038A Optical Dispersion Analyzer

Equipment for characerisation of Lasers

- **Moden field analysis**
- Determination of optical near and far fields of fibers, PMMA,fibers, LEDs, LDs, AWGs, PLCs
- Resolution better than 0.1µm
- POF-equipment for the characterisatoin of far fields
- Integrated spheres



Electrical Packaging

- **Soldering**
- **Glueing**
- **Bonding**
  - Wedge-Wedge
  - Ball-Wedge
  - Gold wire 25µm
- **Fiber-Chip-coupling solutions**
  - SMF/MMF
  - Fabrication of taperd fibers by customer request
  - Life cycle tests

Spectral analysys

- **Spektral analysis**
  - **Faser optic** und
  - **POF-systems**
  - **300nm – 1700nm**

- **Wavelenght meter**
  - **Fiber optic**
  - **600nm – 1700nm**

- **Optical linewidth characterisation**
  - **Laser diode (DFB)**
  - **Resolution 1kHz**

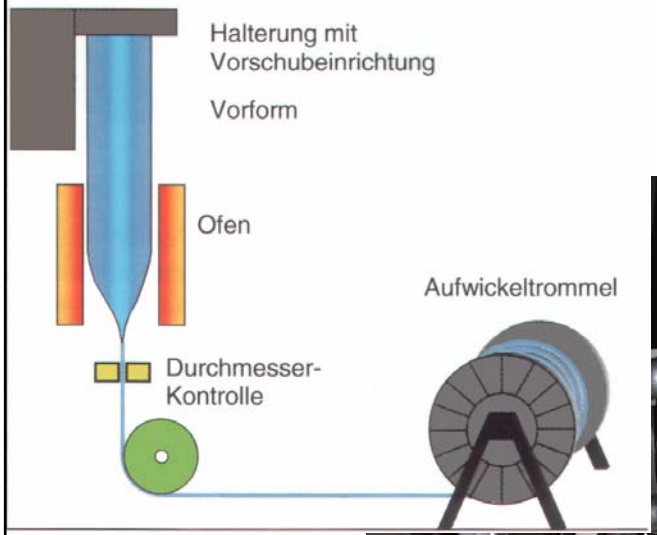
Polymeric fiber systems

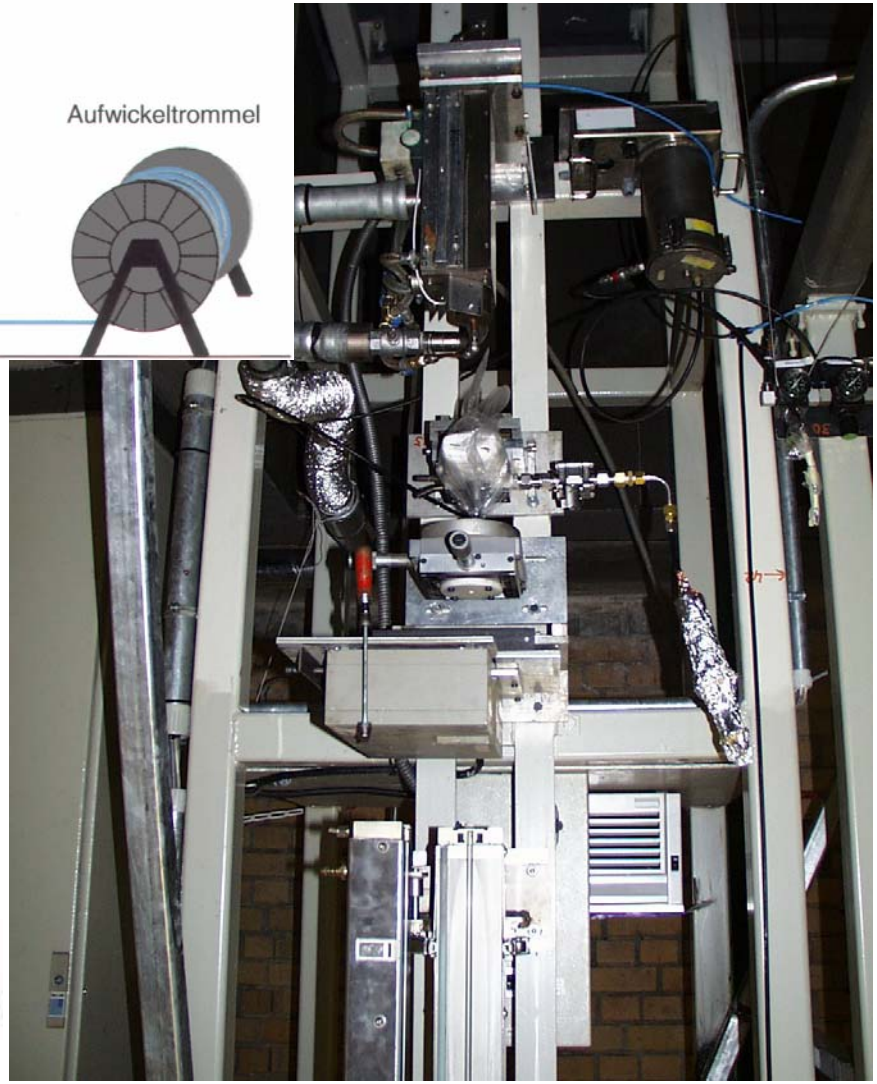
- Kalibrated Integrating Spheres with Powermeter

- White light source 200- 1000nm

- Photoreceiver und Puls sources > 2 GHz
- Optical spektrum analyser

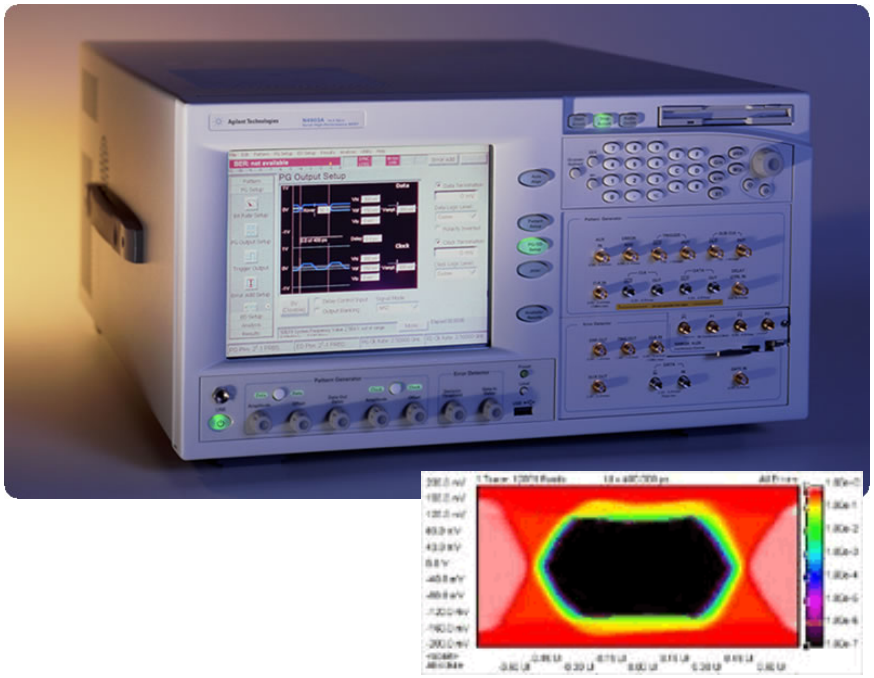
Drawing of Polymeric Fibers



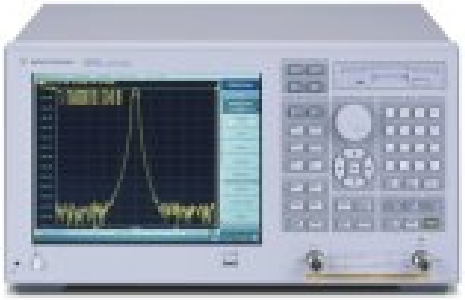


Electrical equipment

- **El. BERT** für
  - 150 Mb/s to 12.5 Gb/s
  - Eye-measurement



- **El. Network analyser**
  - **0-3GHz**
  - **4-Port**
  - **S-Parameter**



Climate test

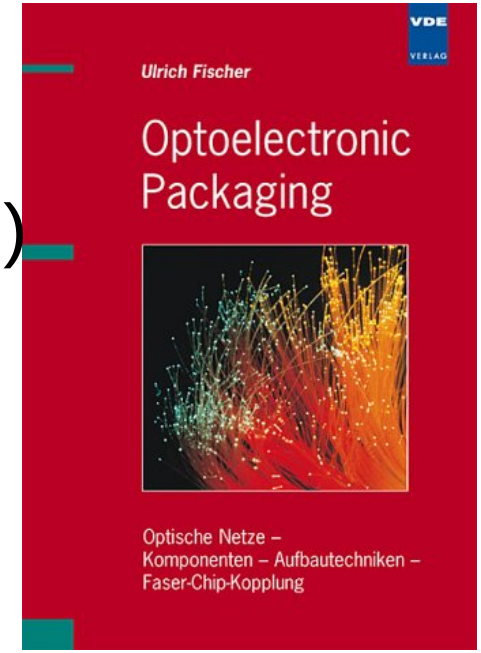
- fully automated
- Programming in LabView
- Characterisation of several modules
- Temperatur range -40°C < T < 180°C
- Humidity : 10% bis 98% r.F.

Regional cooperations partner

National and international partners

Hints

- VDE/ITG-Group for Photonic Packaging
  (http://www.vde.com/VDE/Fachgesellschaften/ITG/)
  - Goals:
    - Collecting the KnowHow in D/EU
    - Realising Workshops (1/year)
    - Automation of complete photonic module in collaboration with German industry
    - Standardisation of OEIC-interfaces
- Packaging-Service (soldering, glueing , bonding)
- Book about optoelektronic packaging
  (VDE-Verlag)



End of Presentation

Thanks

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