



Academy of Sciences

**Institute of Photonics and
Electronics v.v.i. (www.uFe.cz)**

Technology of Optical Fibers

www.uFe.cz/dpt240

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Institute of Photonics and Electronics

v.v.i. = non-profit public research institution
a legal body of ASCR = non-university research

ufe - medium-size institute
~ 100 employees (FTE)
~ 4 M€ turnover
~ 50 % inst. budget



*Prof. Jiří Homola
Head of UFE*

Institute of Photonics and Electronics

FUNDAMENTAL RESEARCH

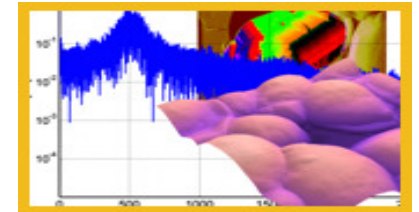
Optical Biosensors (SPR Homola)

Fiber Lasers and Non-linear Optics (Honzatko)

Nanomaterials (SIMS Lorincik)

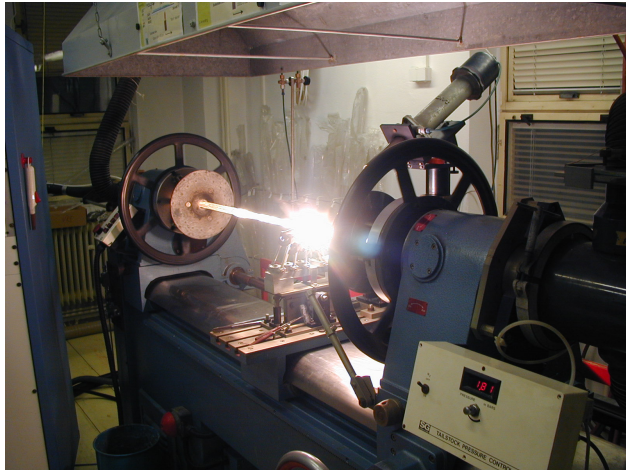
Bioelectrodynamics (Cifra)

National Time and Frequency Standard (Kuna)



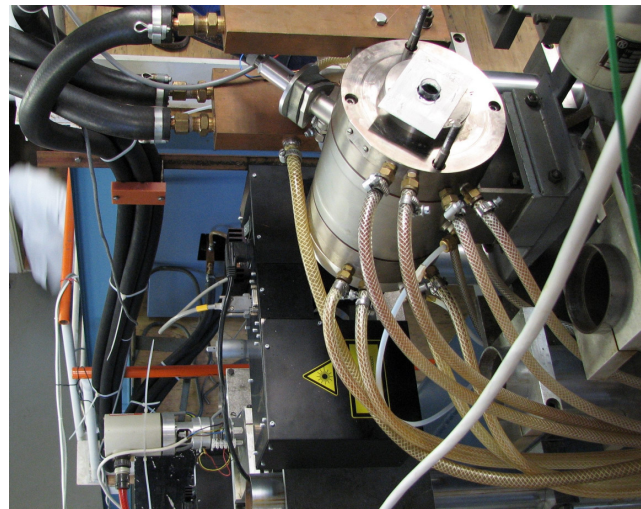
Technology of Optical Fibers

Special optical fibers and fiber components of novel materials or structures for fiber lasers (sensors)



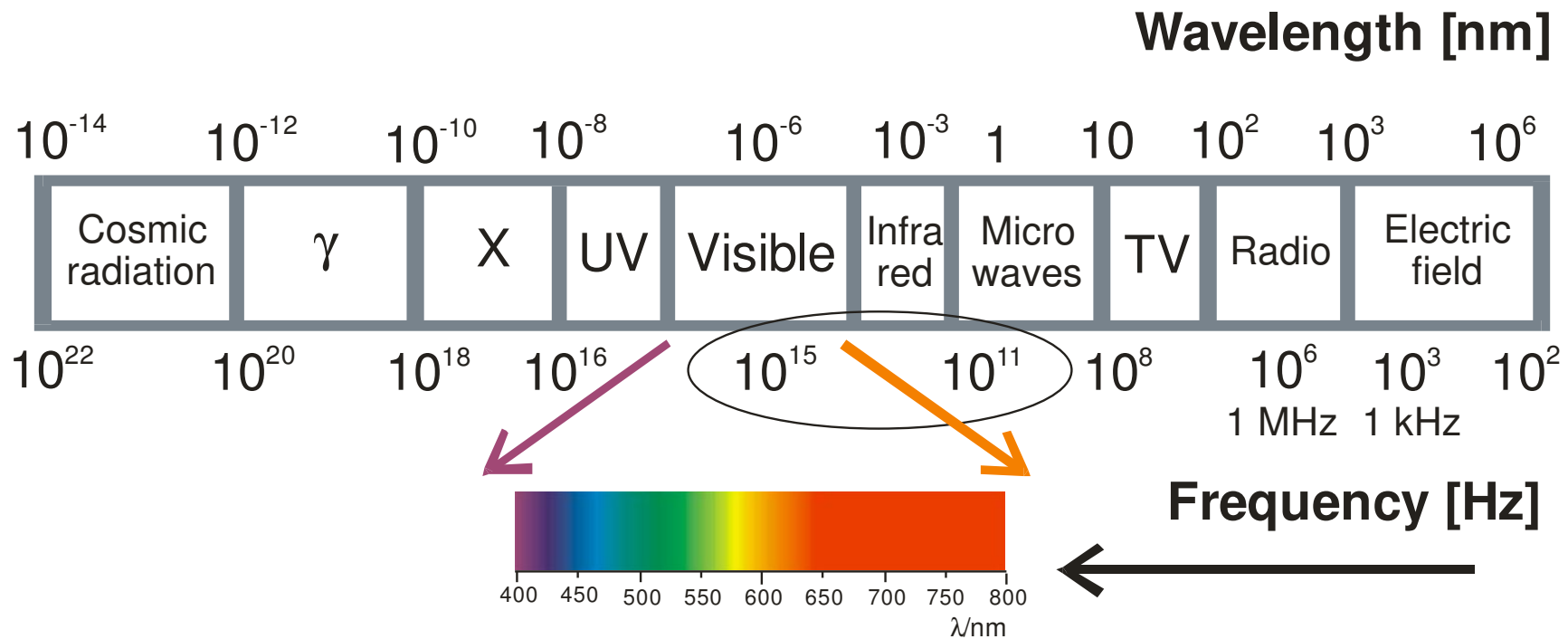
Preform
fabrication
(MCVD)

Fiber drawing
since 1979



Sol-gel
coatings

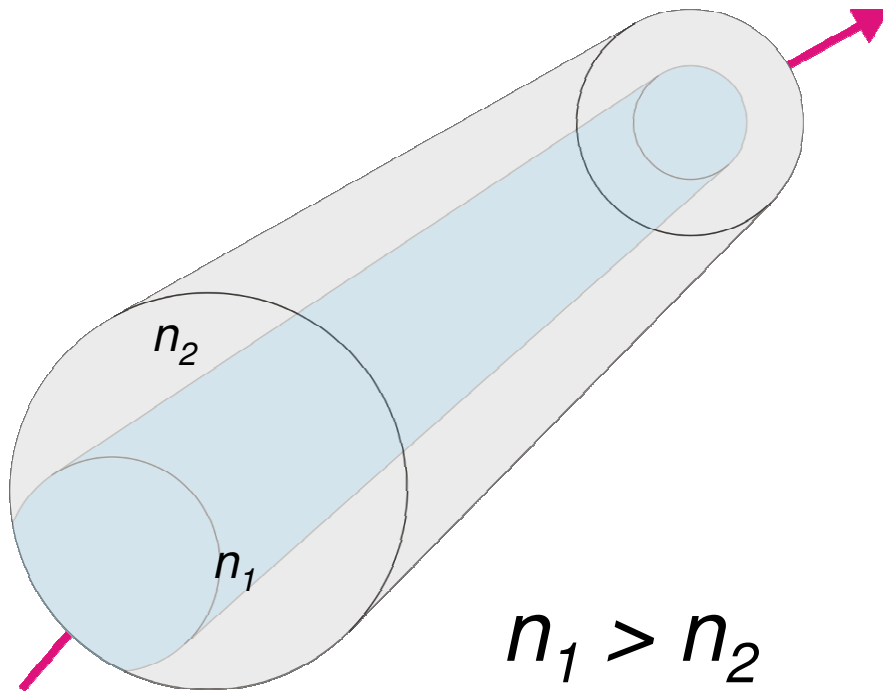
Why OPTICAL communication (fibers) ?



$$f = c / \lambda$$

c = speed of light

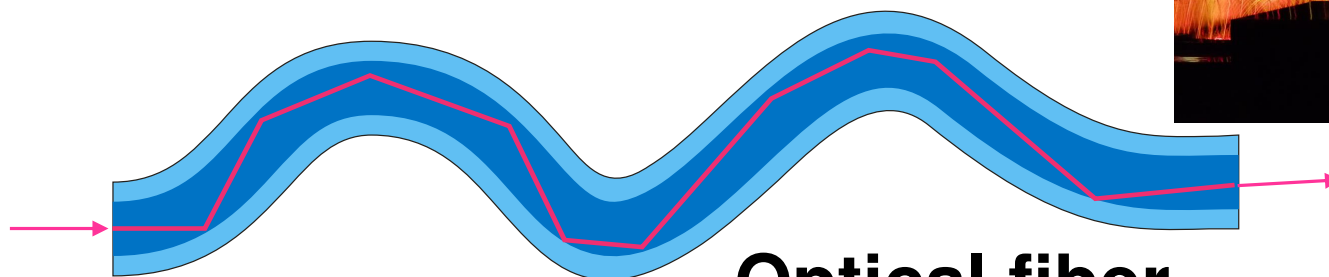
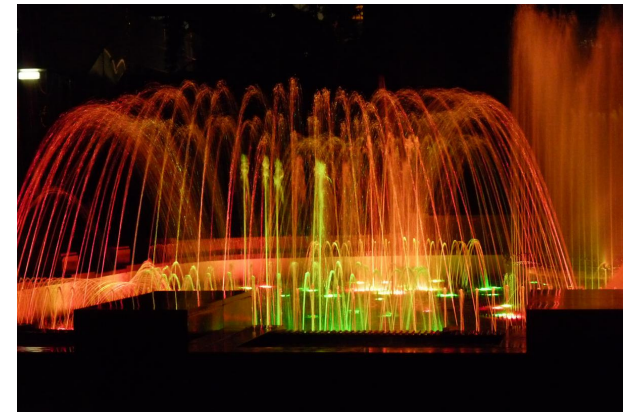
Waveguiding principle → optical fiber



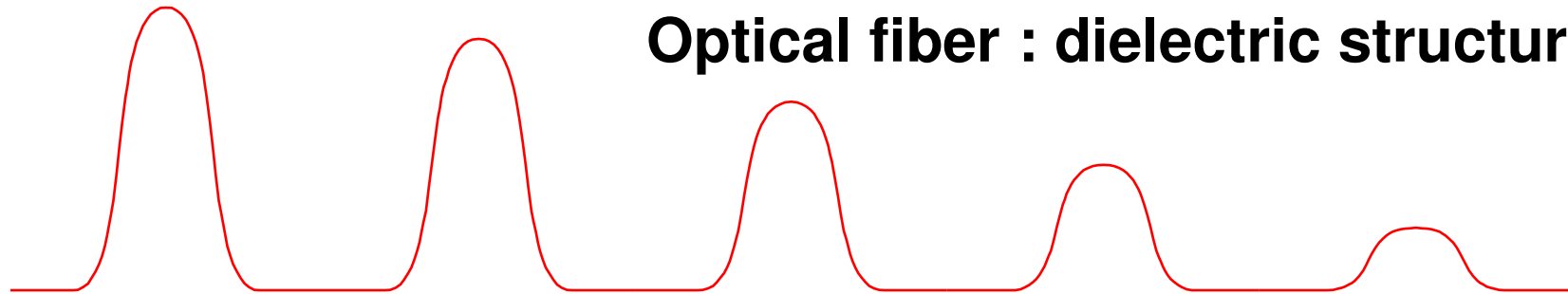
W. Snell (~1620) : total reflection

J. Tyndall (1853) : **waveguide**

$n_{\text{water, glass, plexi}} > n_{\text{cladding, surroundings}}$



Key issue : purity of material (↓ losses)



Optical fiber : dielectric structure ...

Optical losses in optical fibers

- the best : 0.2 dB/km ~ power losses only about 5% per km
- transparency of 3 mm of window-glass \approx 2 km of optical fiber



Charles K. Kao

**Nobel prize
2009**

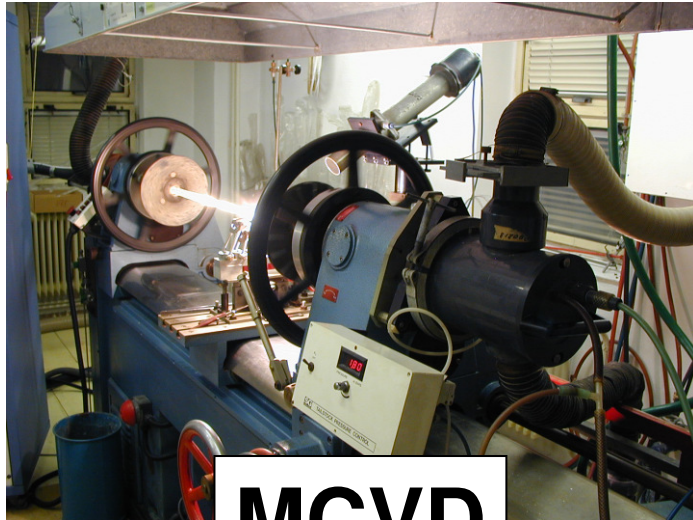


high-purity materials
max impurities
acceptable in ppb (10^{-9})

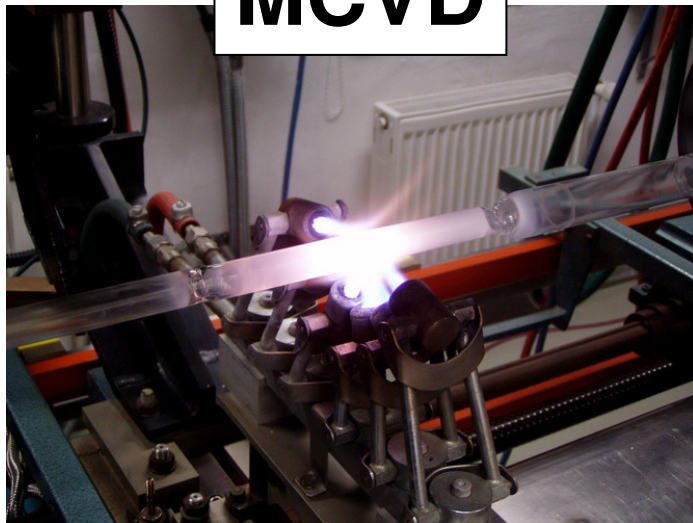


ULTRA-PURE TECHNOLOGIES

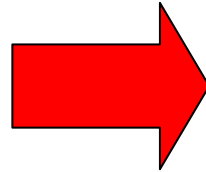
Optical fiber preparation



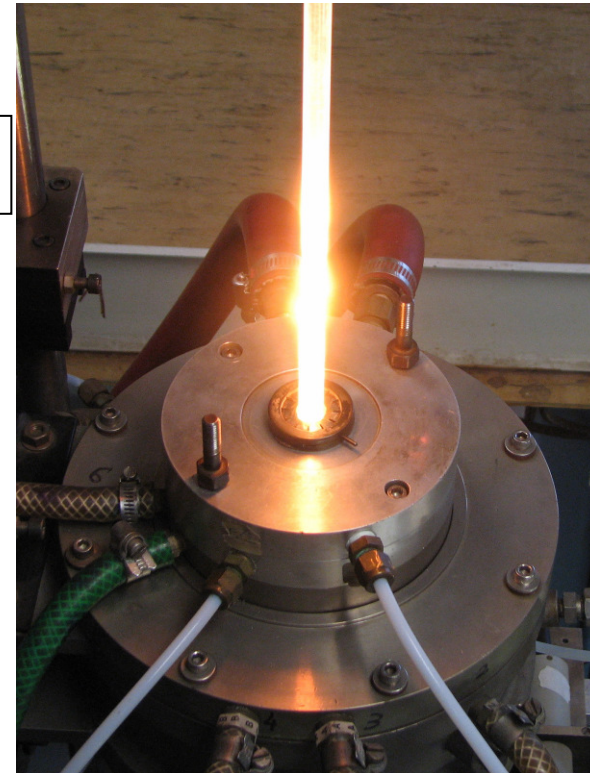
MCVD



1. Preform



2. Fiber drawing

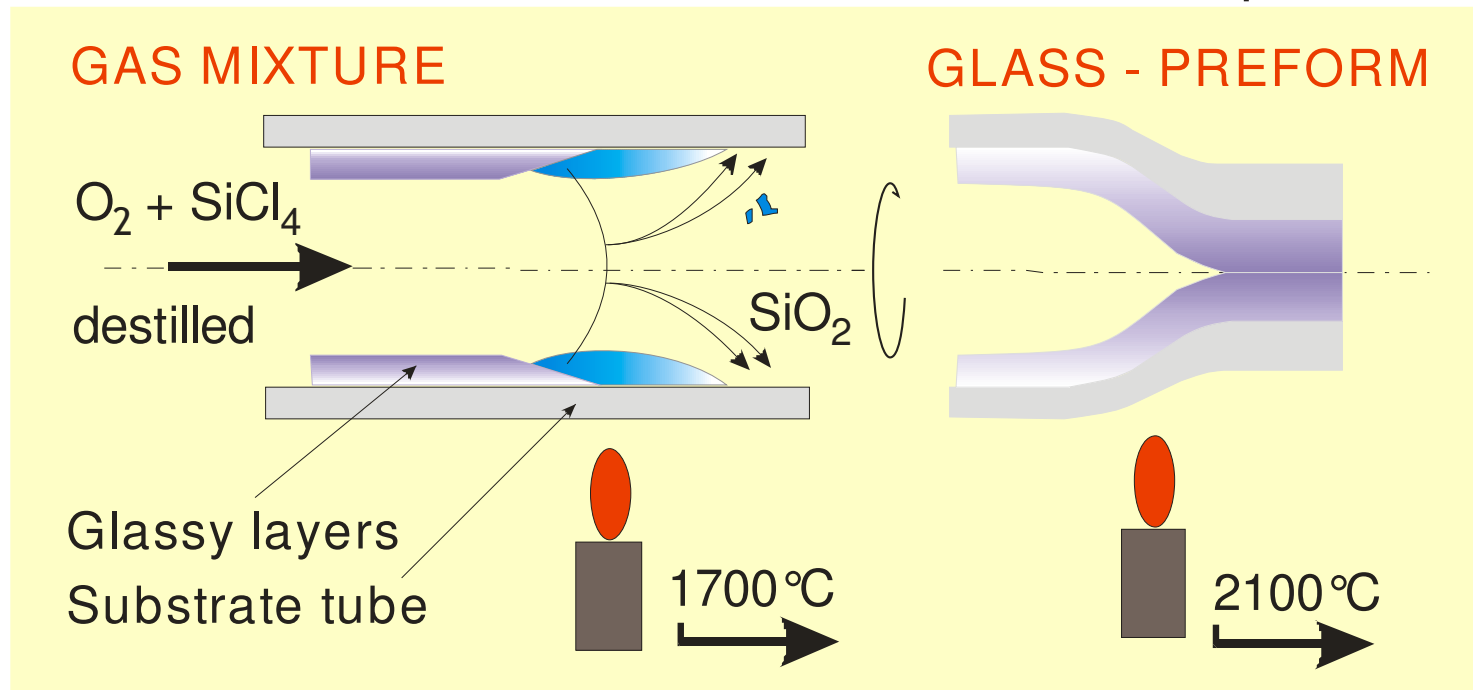


Ultra-pure technologies : preform

MCVD – Chemical Vapor Deposition

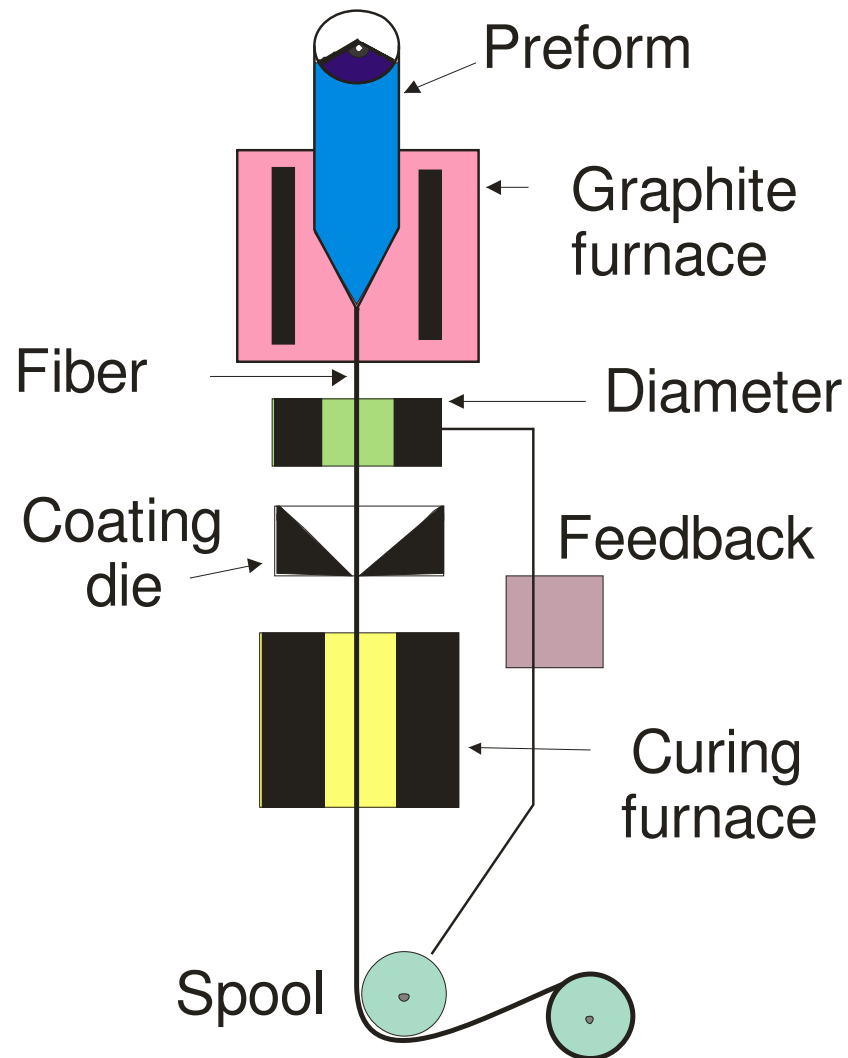
1. Deposition of layers

2. Collapse



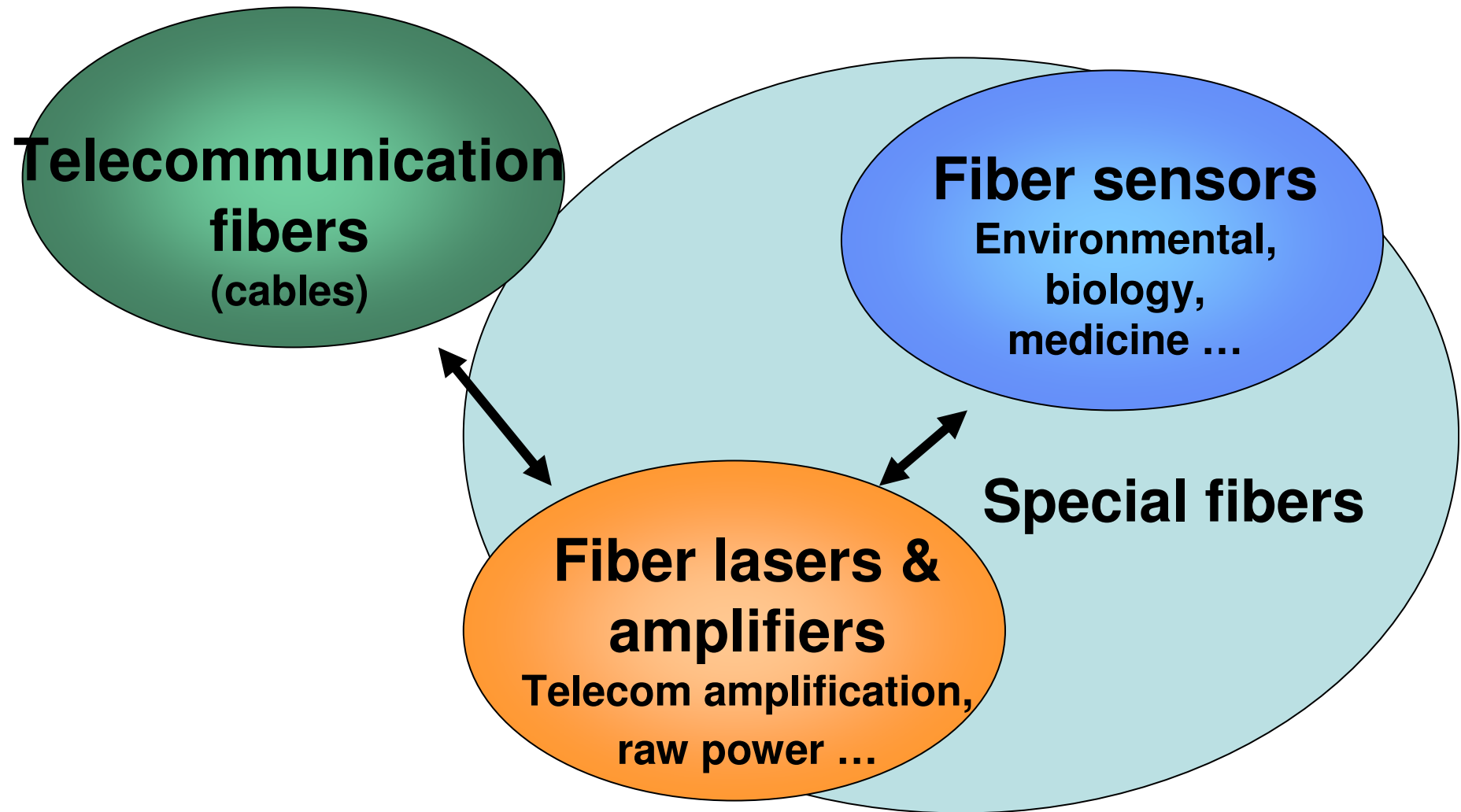
- Sequential deposition of thin ($\sim 1-20 \mu m$) glassy layers onto inner wall of silica tube => preform (rod)
- high purity (ppb impurities), high precision ($>1 \%$) material

Drawing of optical fiber from preforms



- Diameter
80-1000 μm
- Temperature
1800-2100 $^{\circ}\text{C}$
- No textile
- No thermo-insulation

Application

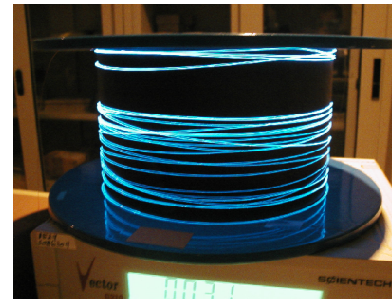
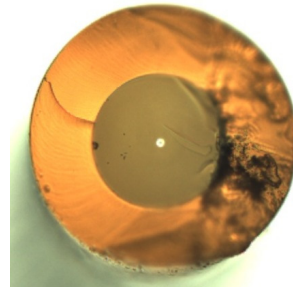


Telecommunication optical fibers

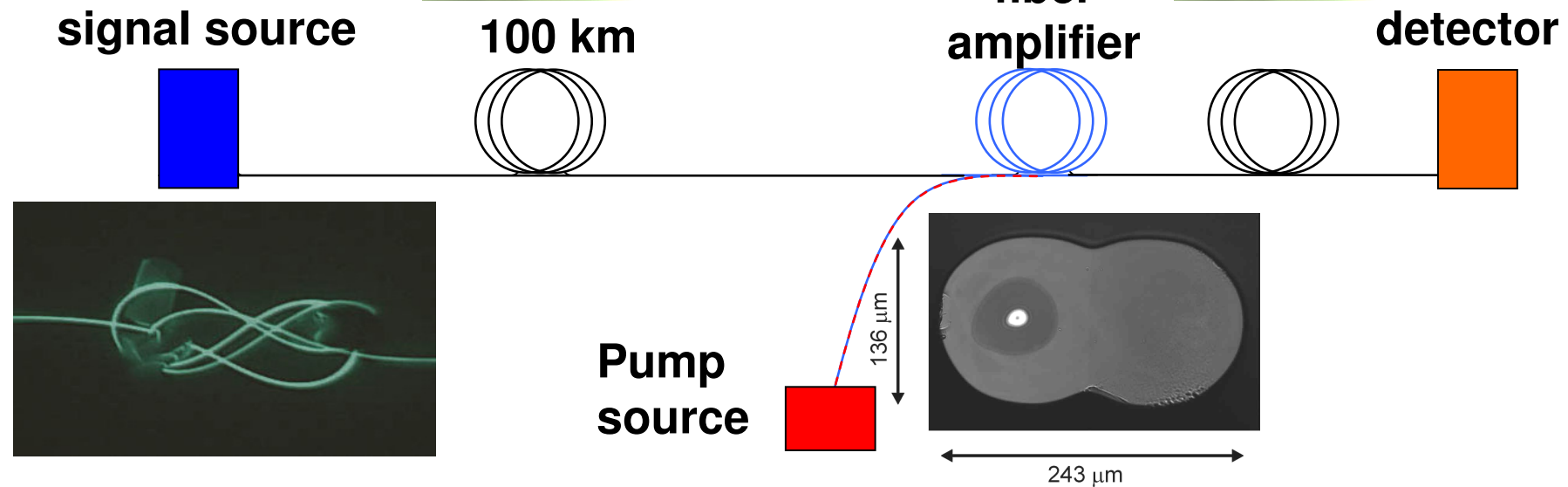
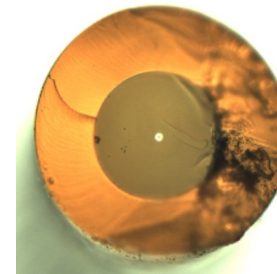
Fiber lasers and amplifiers

Doped fibers
Double-clad
Multicore fibers

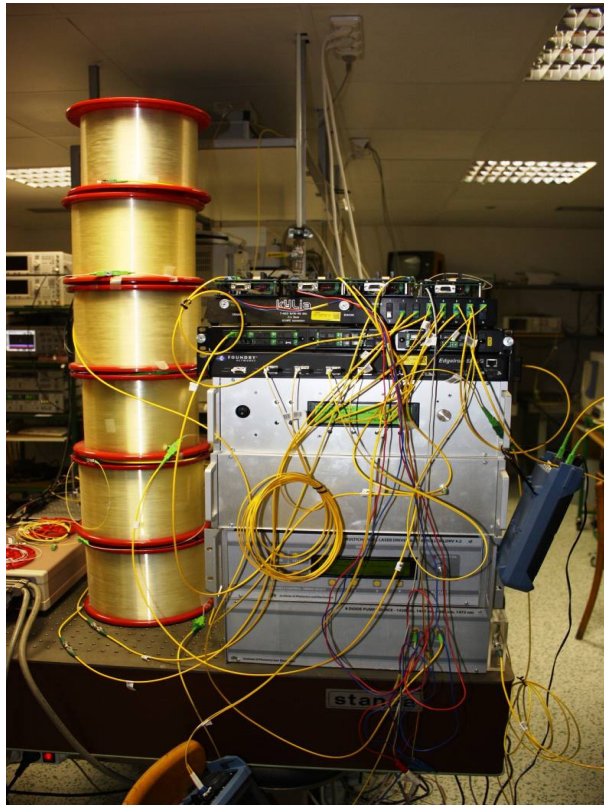
conventional fiber



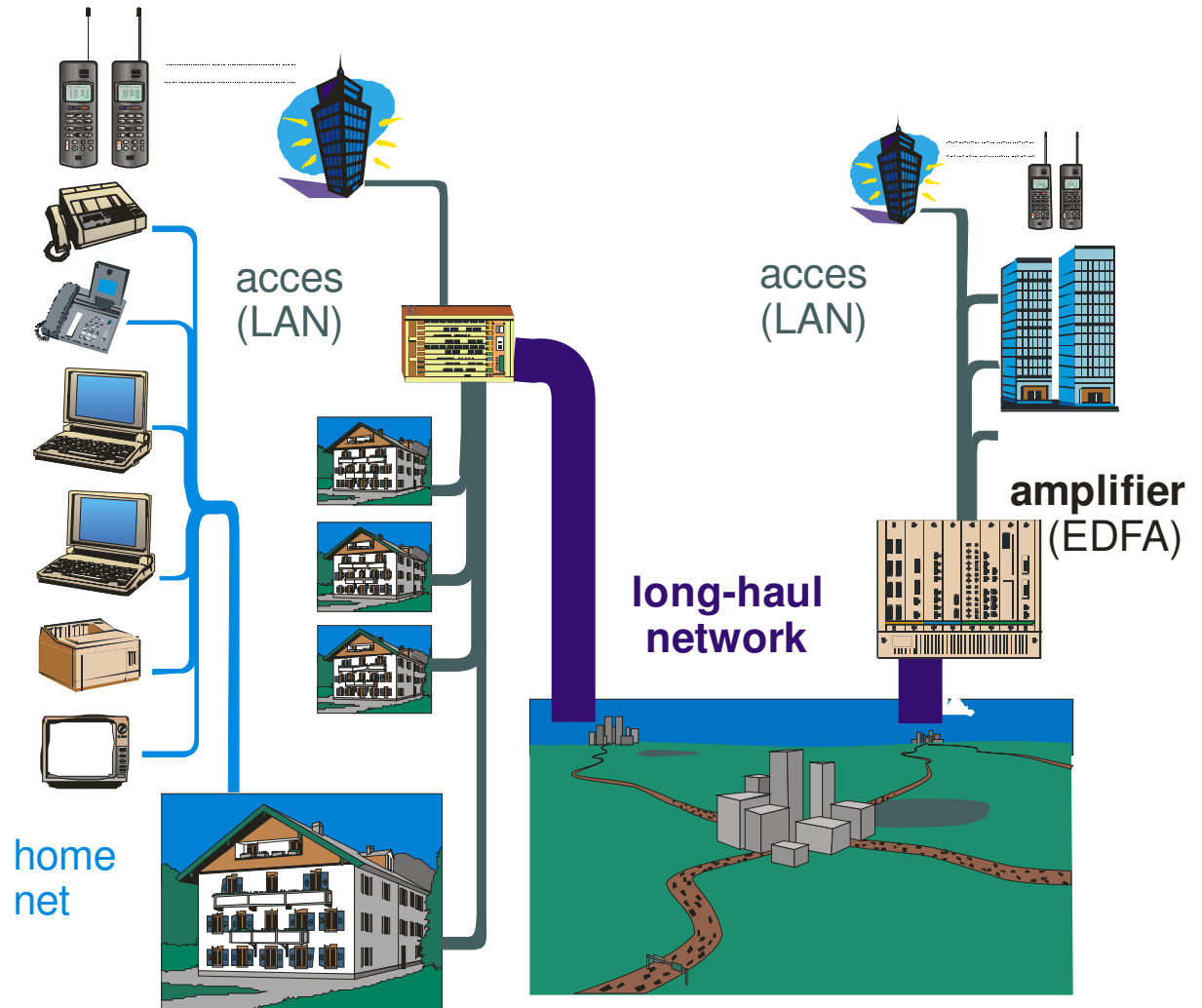
conventional fiber



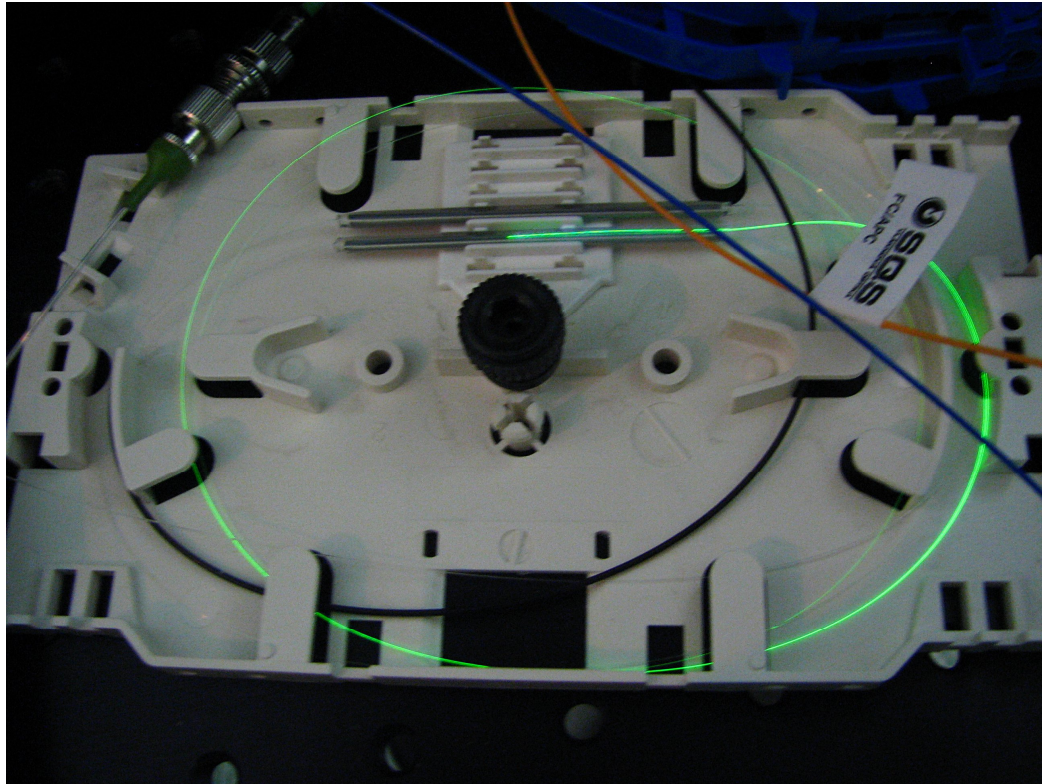
Telecommunication optical lines



200 km telecom line testing



High-power fiber lasers

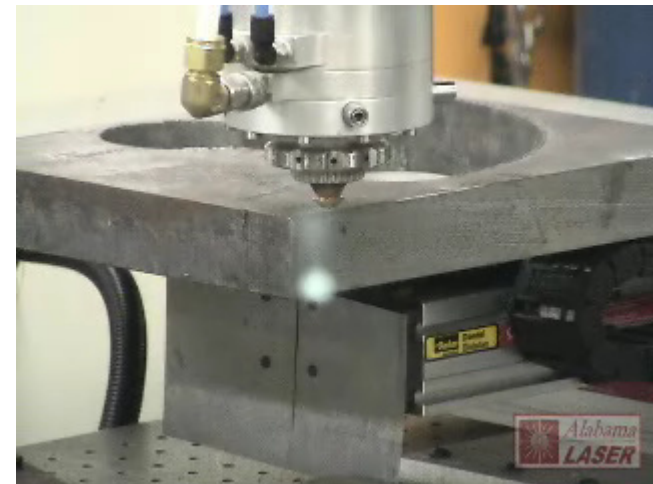


Er- fiber laser,
pulsed 197 fs,
5m rezonator
Liekki

PALS

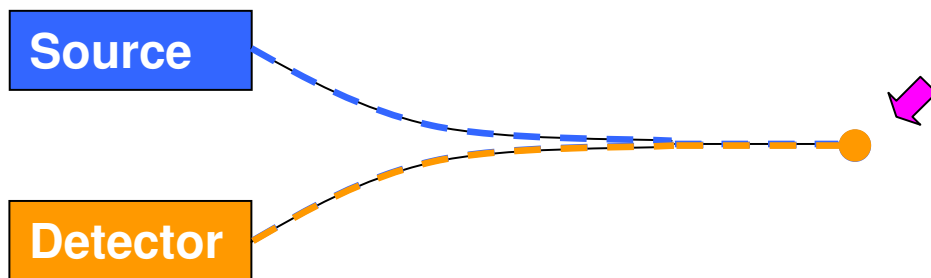
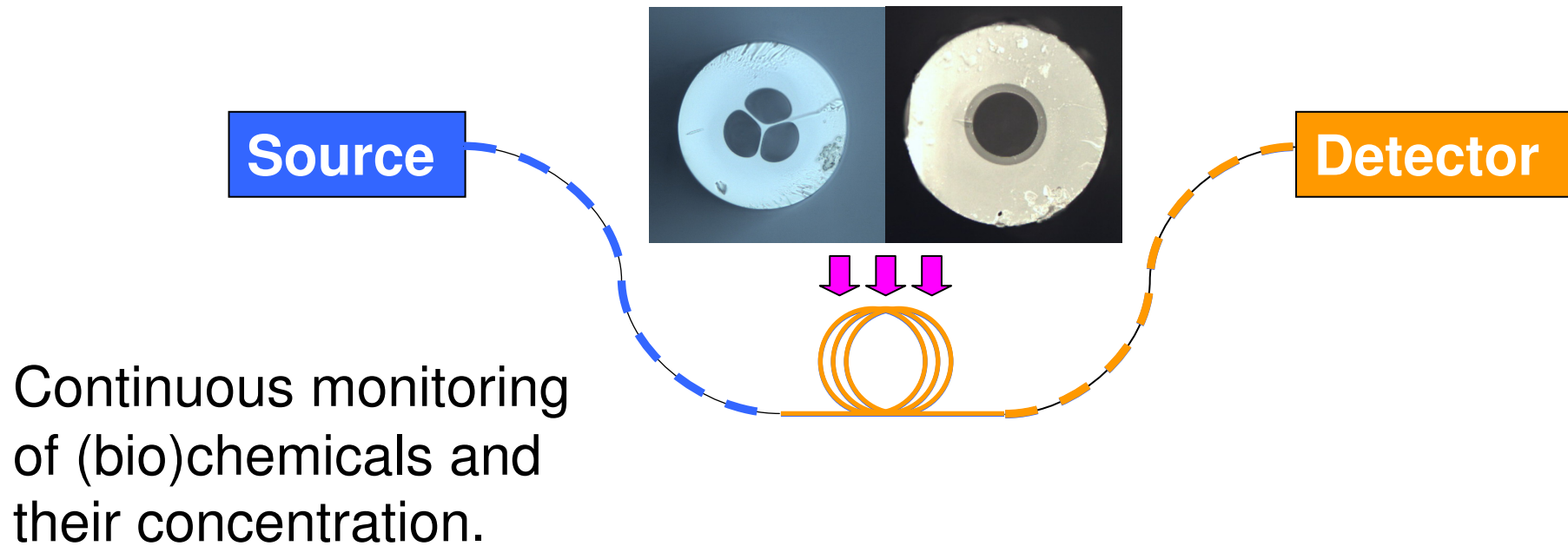


Light intensity
Sun 63 MW/m²
Optical fiber 12.7 GW/m²



Welding, cutting < 2kW

Optical fiber sensors



Suitable for :

- remote sensing
- flammable or explosives
- in high-voltage areas
- human body
- distributed sensing

Refractometric sensor of hydrocarbons

Early warning system of petroleum leakage

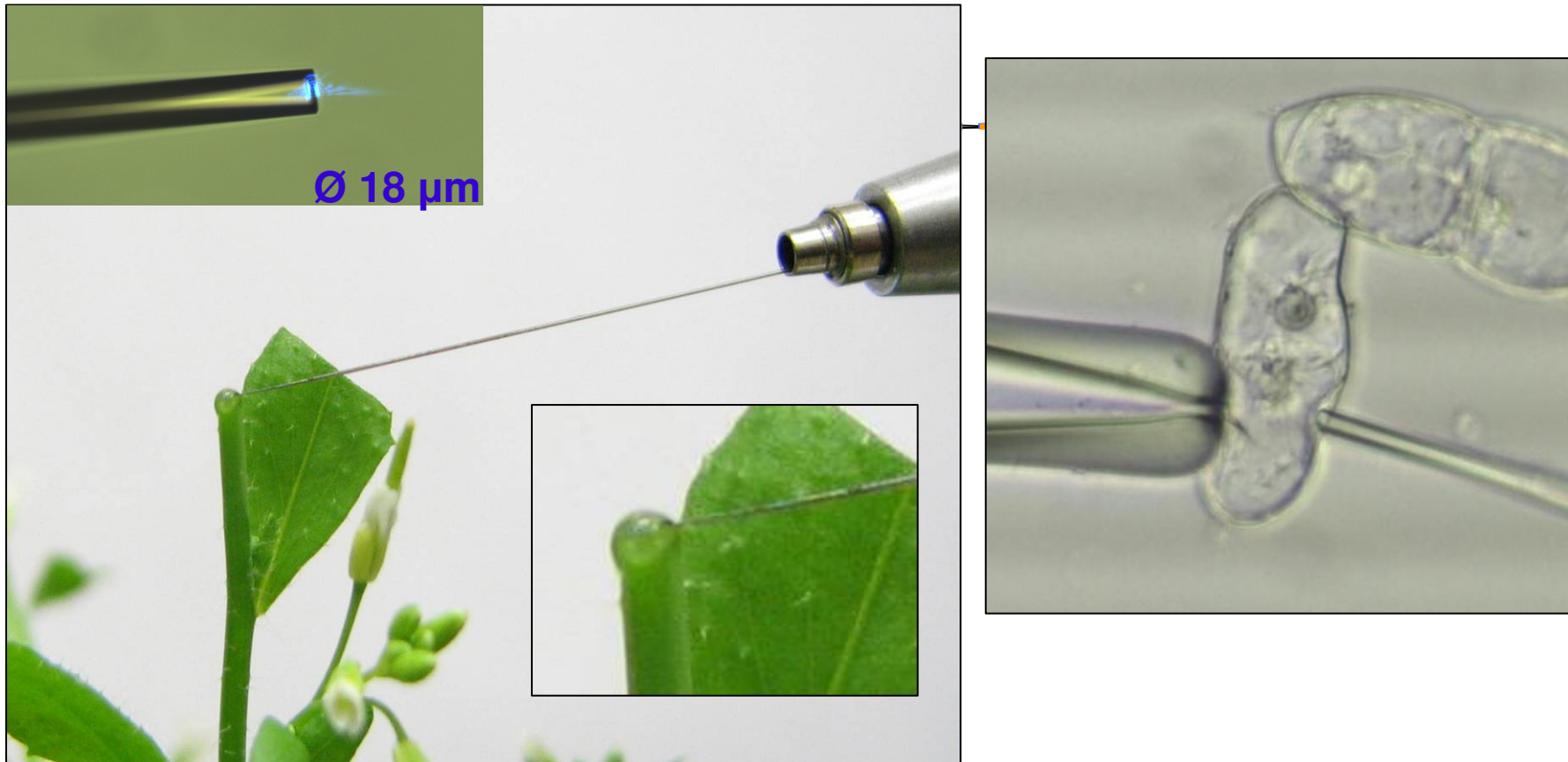


Limit of detection ~ 3-5 mg/l (EU limits)

Response time ~seconds

Optical fiber sensors

Detection of pH in small samples (droplets, cells)



Be UFE !

- **STUDY** (diploma, thesis)

Czech Technical University

Charles University

Institute of Chemical Technology



- **PROJECTS** - partners CZ



- **INTERNATIONAL** - collaboration



Be carefull !



Investigative journalist = investigative chemist ?

EXCURSION

1. Preform preparation (MCVD) + 2. Fiber drawing

Thank you for attention

Collaboration – international

Projects :

- UMIST [Manchester](#) – Dr. Kwasnik, Dr. Scully
- Universite de [Nice](#) – Sophia Antipolis - Dr.Dussardier, Dr.Monnom, Dr. Blanc
- Universite Claude Bernard, [Lyon](#) - Dr. Jaffrezic-Renault
- Ecole Centrale de [Lyon](#) - Dr. Salvia
- Universite Jean Monnet [Saint- Etienne](#) -Prof. Trouillet, Prof.Gagnaire
- Universite de [Rennes](#) - Prof. Spanhel, Prof. Poulain
- [Fraunhofer](#) Institut Silicatforschung, SCI Wurzburg - Dr. Rose
- Institute of Physical Chemistry, [Bucharest](#) - Dr.Zaharescu, Dr. Barau
- University of [Pecs](#) - Dr. Kovacs, Dr. Nagy
- IPHT [Jena](#) - Dr. Bartelt, Dr. Willsch, Dr. Kirchhof, Dr. Schuster

Contacts :

CGCRI (Dr. Sen, Dr. Gangopadhay, Dr. Das & Dr. Dhar)

Optacore (Dr. Lenardic)

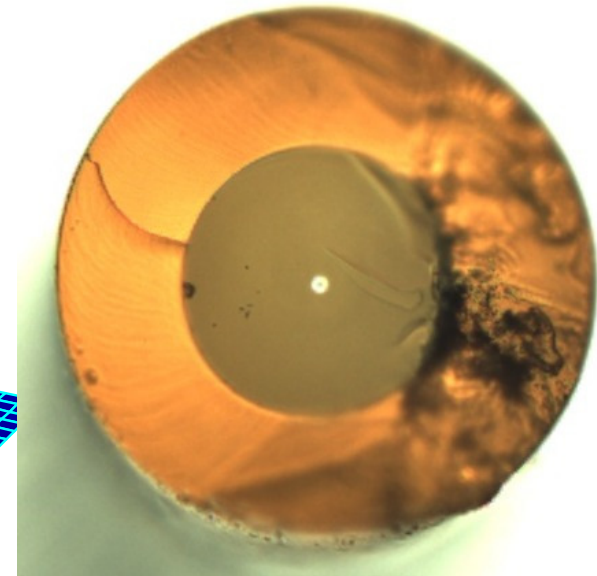
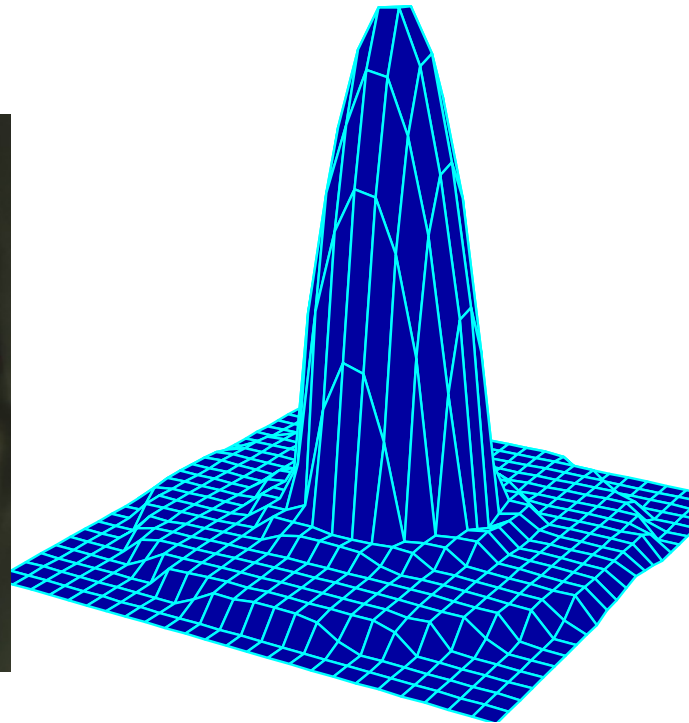
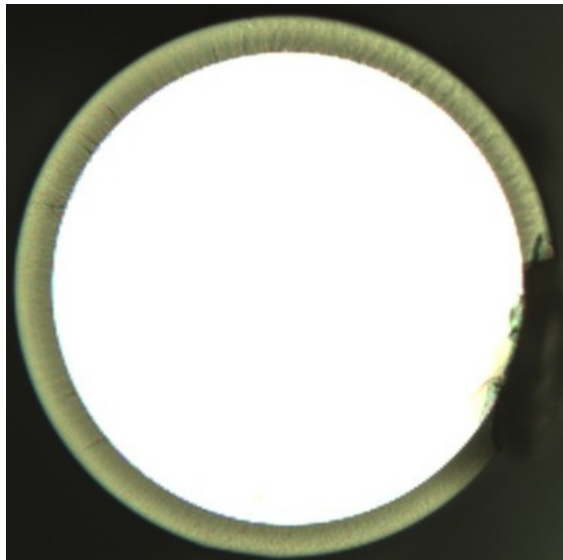
Yonsei univ. (Prof. Oh)

Fraunhofer Stuttgart (Dr. Oehr)

IFAC CNR (Dr. Baldini, Prof. Righini)

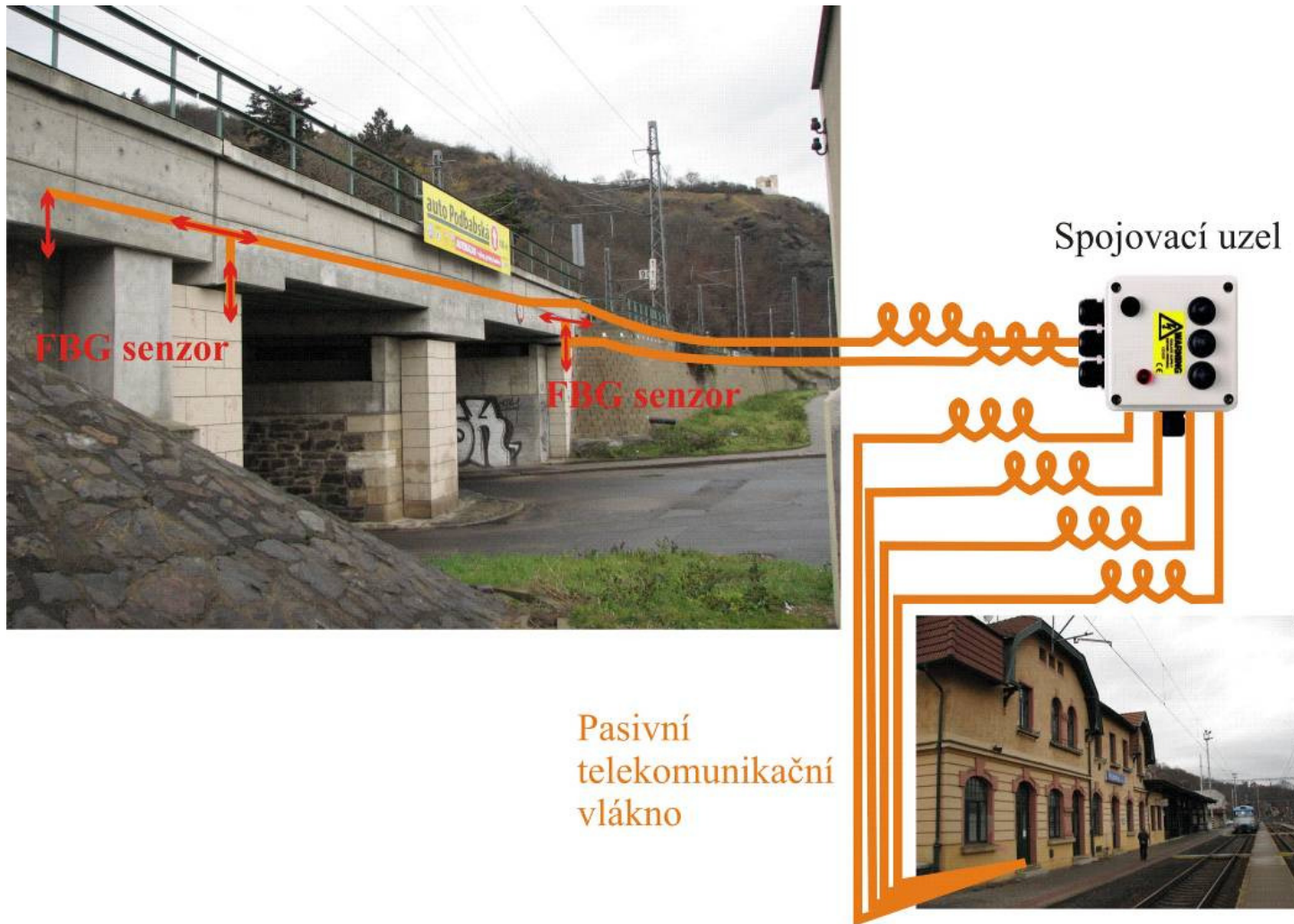
GPI & IPE Moscow (Dr. Bubnov, Dr. Ivanov, Dr. Blinov)

OPTICAL FIBERS - TELECOM



PCS Ø 200 – 600 um GI - transfer of technology,
transfer of technology VÚSU Teplice, Hesfibel SM 1300, 1550 nm
VÚSU Teplice

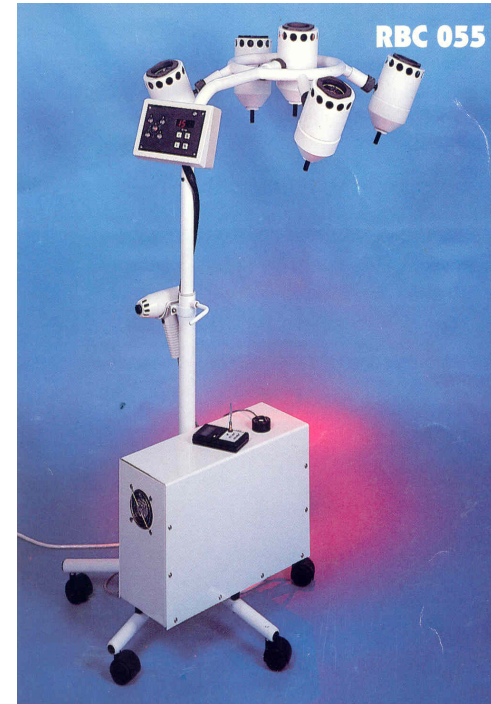
Health monitoring



Fibers for medicine

In

collaboratio
n



- Angioplastics
- Recovering of arteries (legs, hearth) by application of intensive laser pulse (~ 1 W) followed by enlargement by balloon.

- Fotodynamic diagnosis and therapy
- Prevention and cure of malignant tumors.