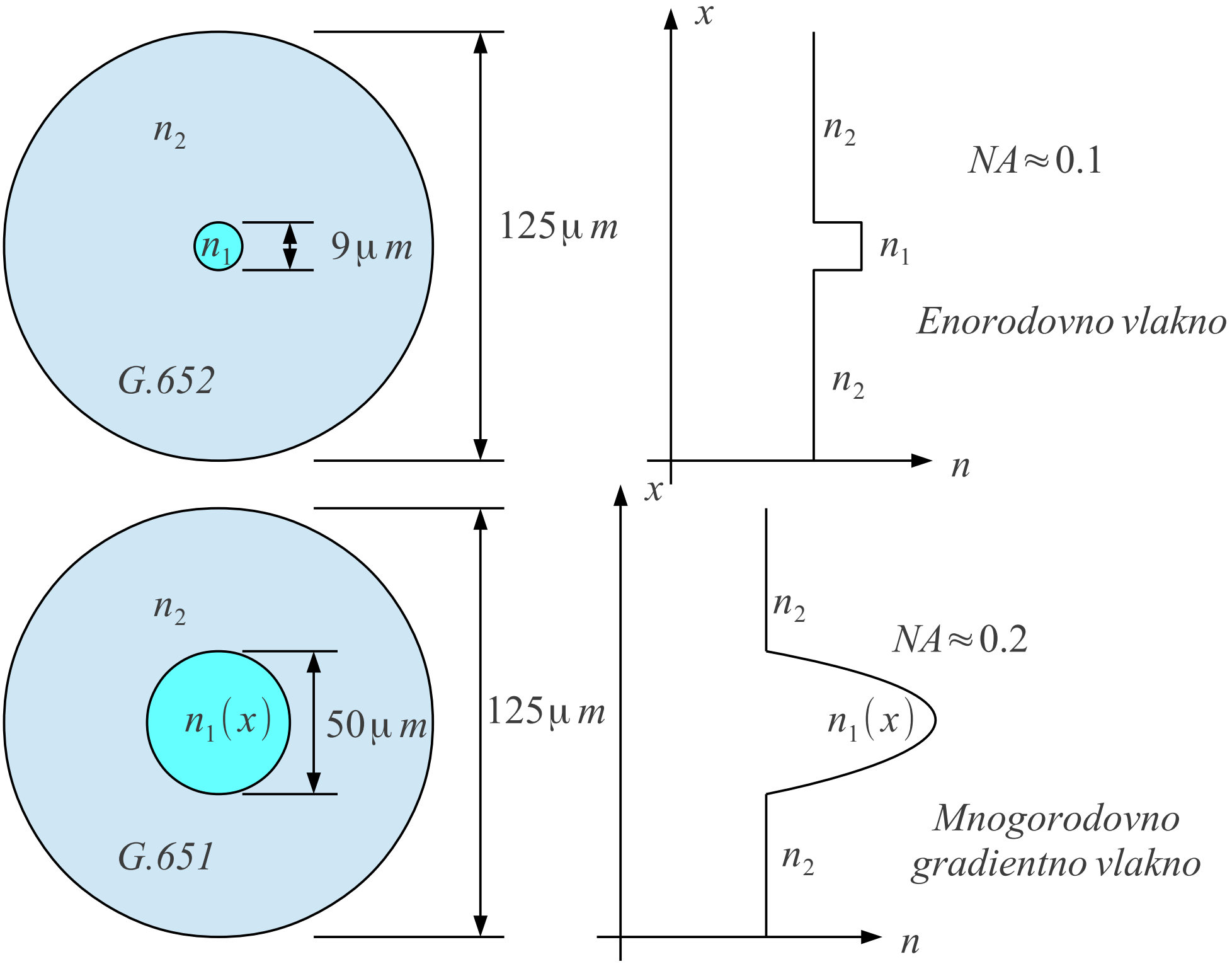
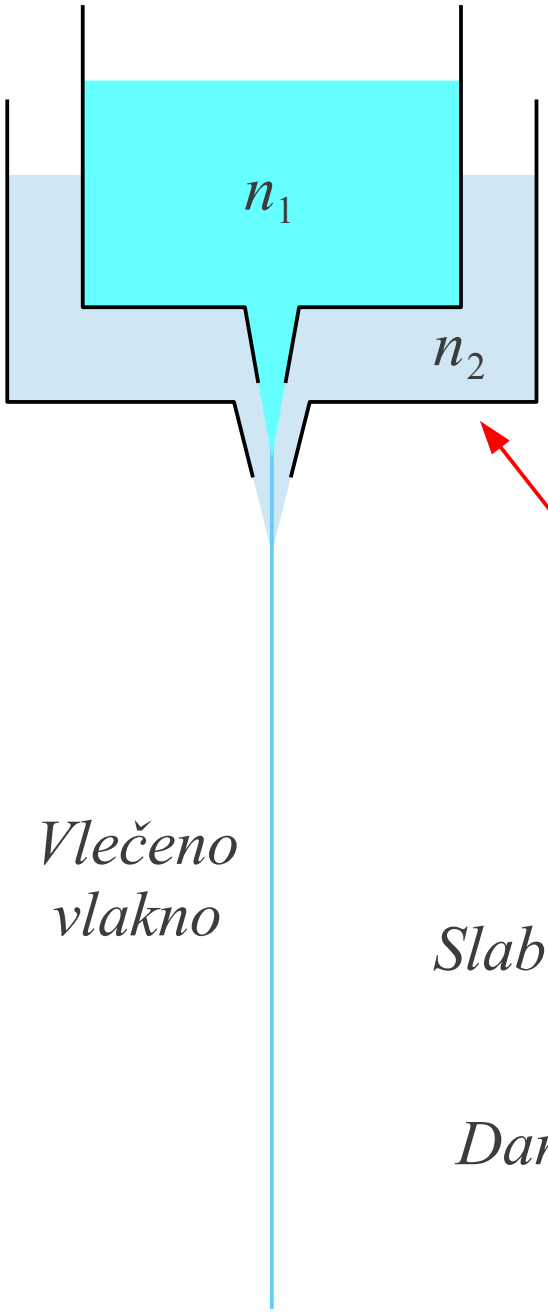
Optične komunikacije

Predavanje 5:

Izdelava in spajanje svetlobnih vlaken


n_2
n_1
$9\,\mu m$
$125\,\mu m$
G.652
x
n_2
n_1
n_2
n
$NA \approx 0.1$
Enorodovno vlakno
n_2
$n_1(x)$
$50\,\mu m$
$125\,\mu m$
G.651
x
n_2
$n_1(x)$
n_2
n
$NA \approx 0.2$
Mnogorodovno
gradientno vlakno

Talilni posodi



1960

Umazanija ! ! !

$Slabljenje \approx -1000\mathrm{dB}/km$

$Danes: plastična\ vlakna \quad a/l \approx 150\mathrm{dB}/km$

Čiste snovi : tekočine ali plini

$$SiCl_4(tekočina) + O_2(plin) + toplota \rightarrow SiO_2(prah) + 2\,Cl_2(plin)$$

Čisti $SiCl_4$ polprevodniki ! $100\,\$/kg$

Germanij → n ↑

$$GeCl_4(tekočina) + O_2(plin) + toplota \rightarrow GeO_2(prah) + 2\,Cl_2(plin)$$

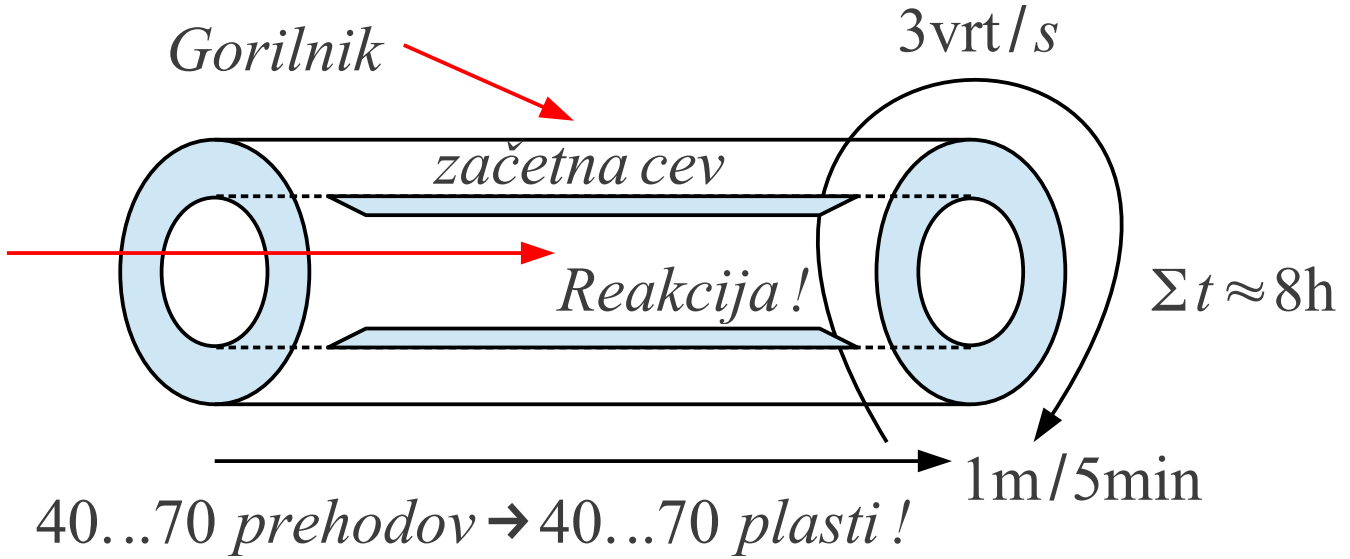
Fluor $F_2(plin)$ → fluoridna stekla → n ↓

Fosfor → T ↓

$$4\,POCl_3(tekočina) + 3\,O_2(plin) + toplota \rightarrow 2\,P_2O_5(prah) + 6\,Cl_2(plin)$$

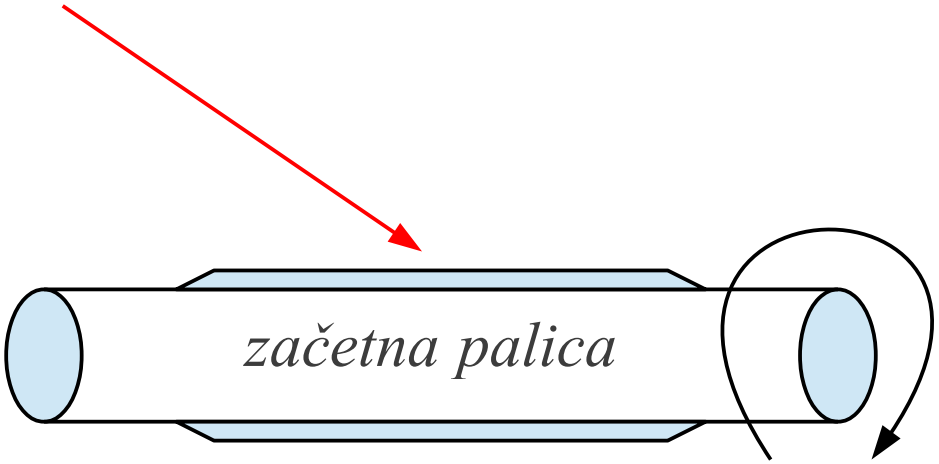
Kemikalije surovine → (1) *izdelava preforma* → (2) *vlečenje vlakna*

preform : *palica* $l = 1\text{m}$, $2r = 25\text{mm}$ → *vlakno* : *dolžina* $l = 40\text{km}$, $2r = 125\,\mu\,m$

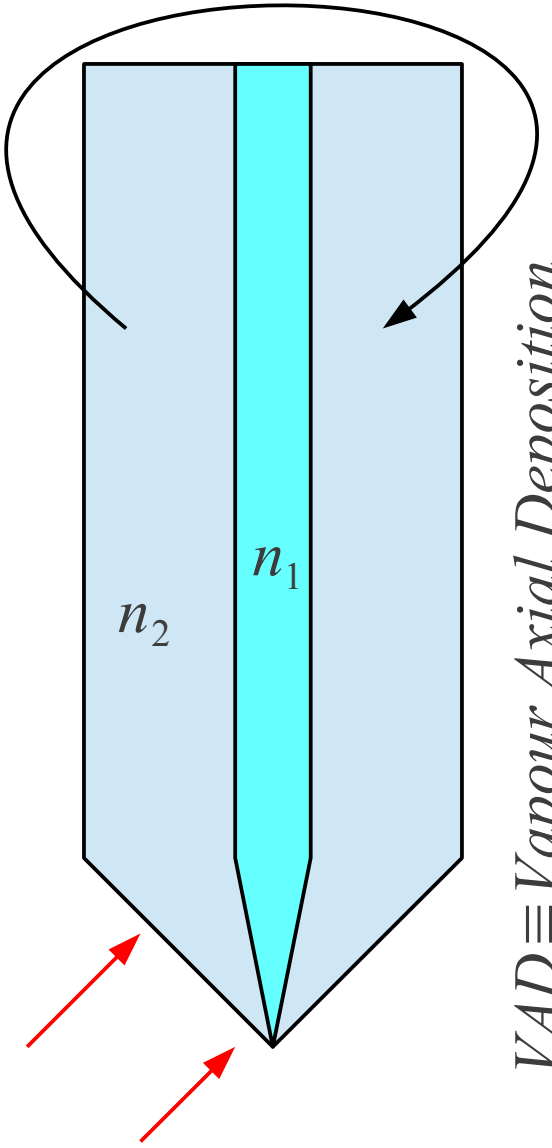


40…70 *prehodov* → 40…70 *plasti !*

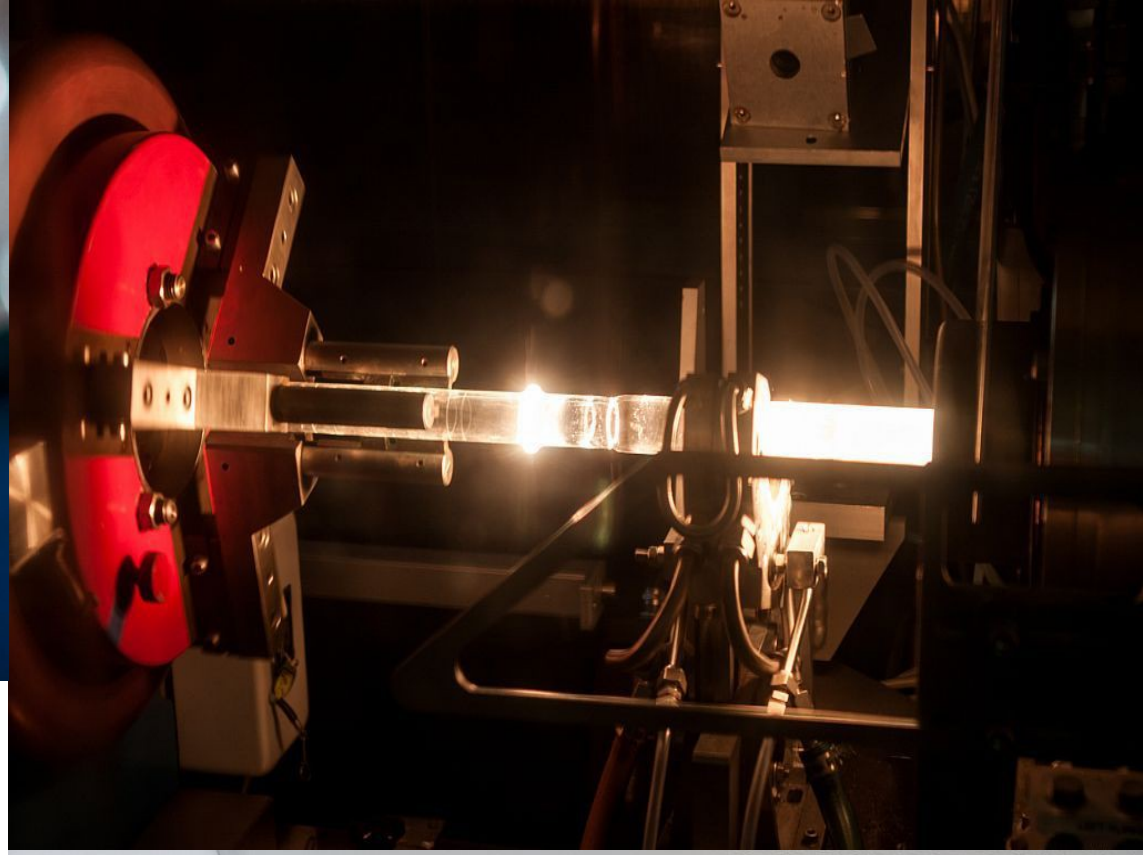
MCVD ≡ *Modified Chemical Vapour Deposition*

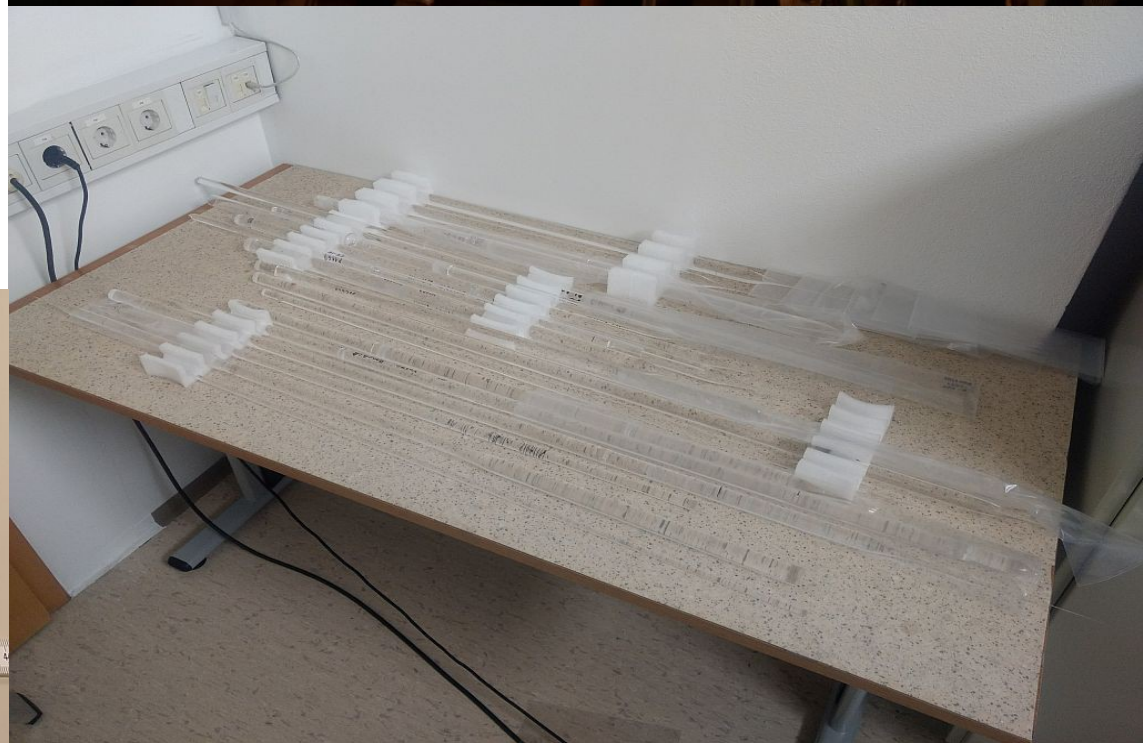


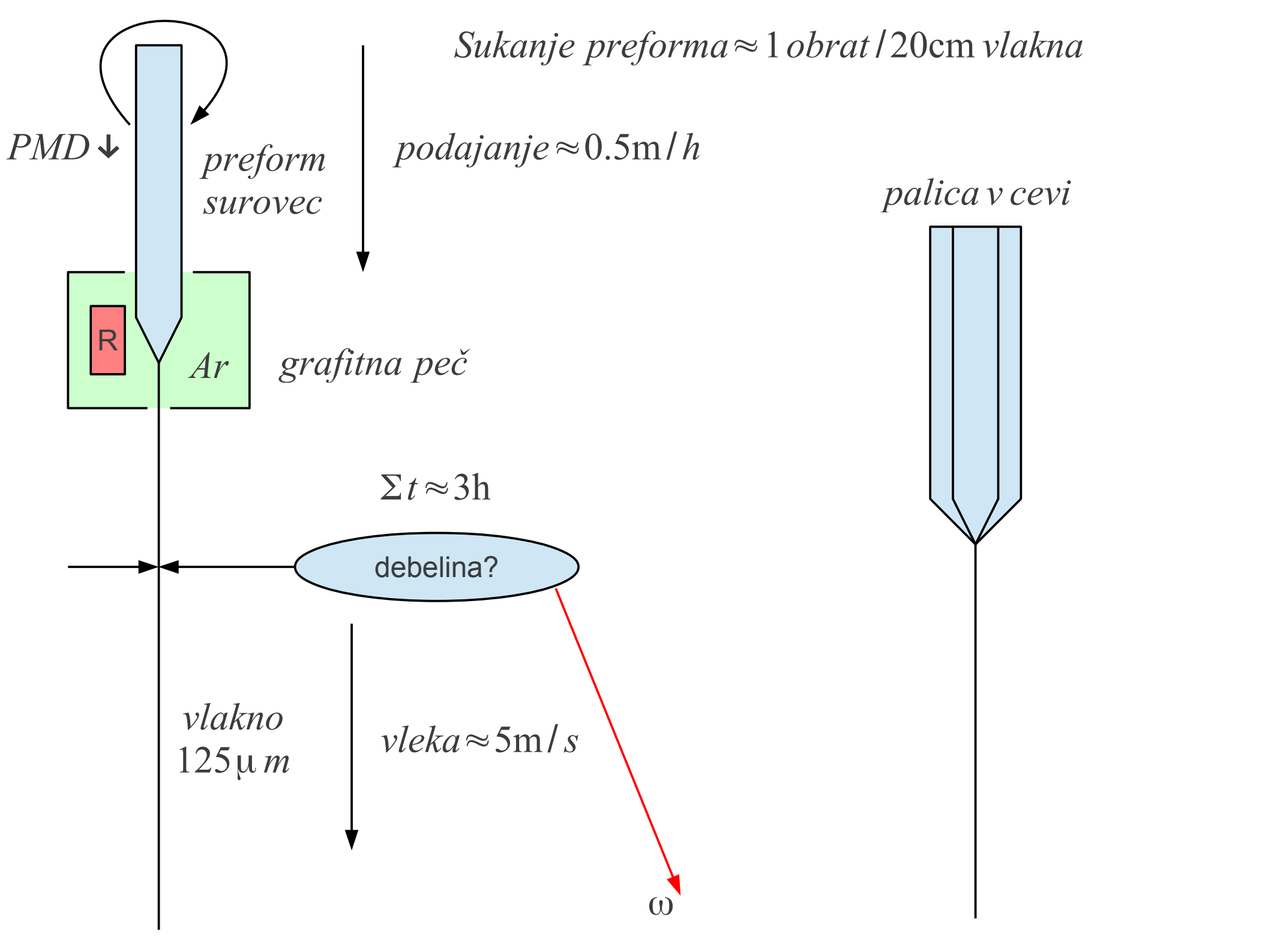
OCVD ≡ *Outside Chemical Vapour Deposition*

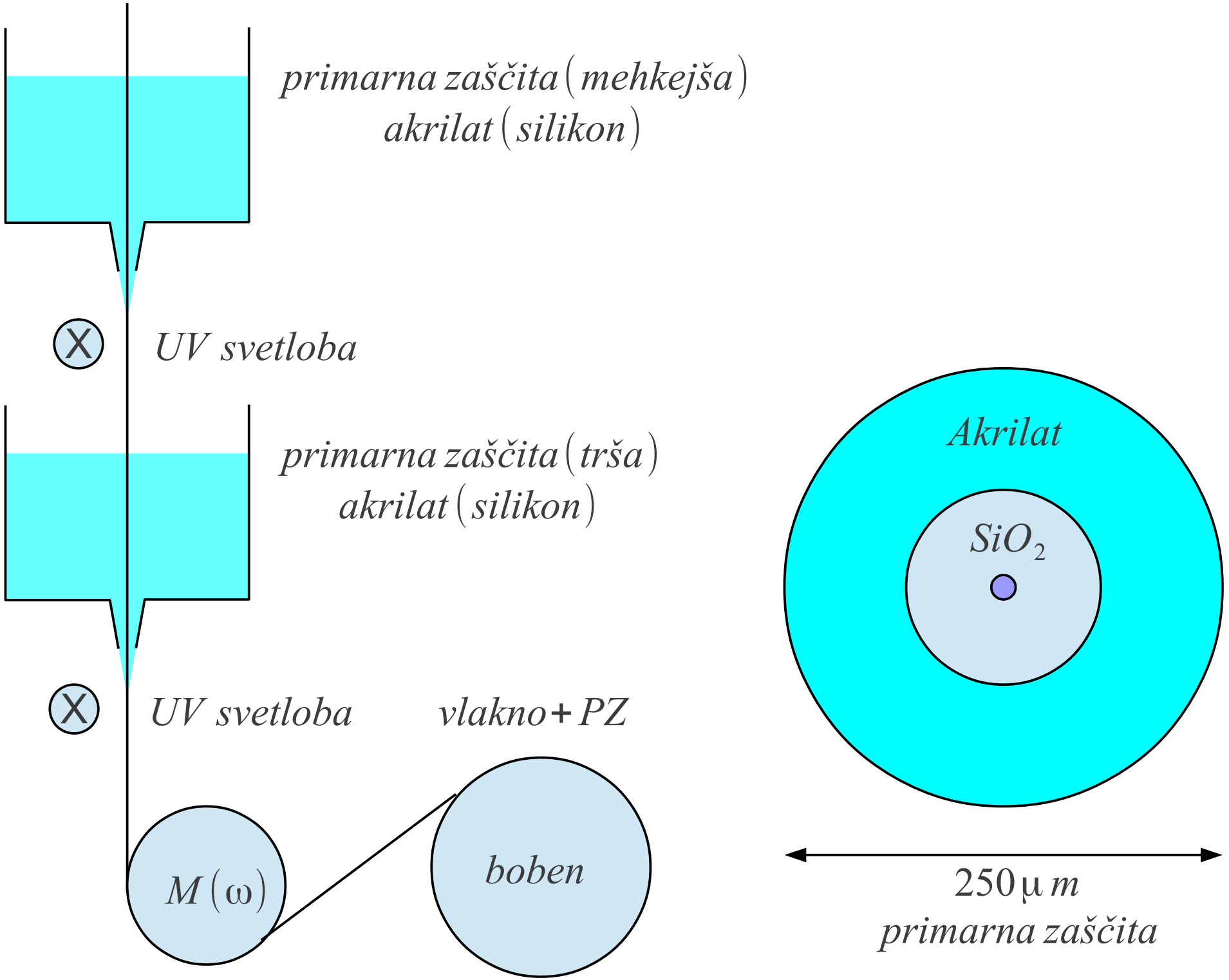


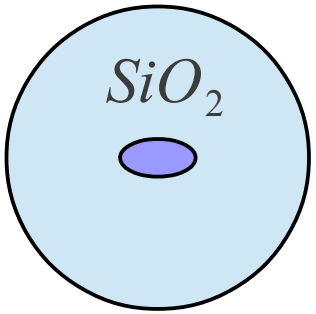
VAD ≡ *Vapour Axial Deposition*






Sukanje preforma ≈ 1 obrat / 20cm vlakna
PMD ↓
preform
surovec
podajanje ≈ 0.5m / h
palica v cevi
R
Ar
grafitna peč
Σ t ≈ 3h
debelina?
vlakno
125 μ m
vleka ≈ 5m / s
ω


primarna zaščita (mehkejša)
akrilat (silikon)
UV svetloba
primarna zaščita (trša)
akrilat (silikon)
UV svetloba
vlakno + PZ
M (ω)
boben
Akrilat
SiO2
250 μm
primarna zaščita



Eliptično jedro

$\Delta \ll 1$ *brez težav !*

Izrojenost HE_{11}

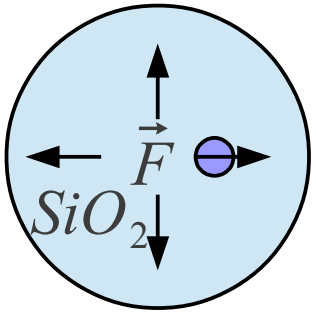
$PMD \equiv Polarization\ Mode\ Dispersion\ (2000)$

$\beta_{VP} \neq \beta_{HP}$ *!!!!!*

$\langle \Delta t \rangle = D_{PMD}\sqrt{l}$ $\qquad$ $D_{PMD}[ns/\sqrt{km}]$

$\vec{F}$ → *dvolomnost !*

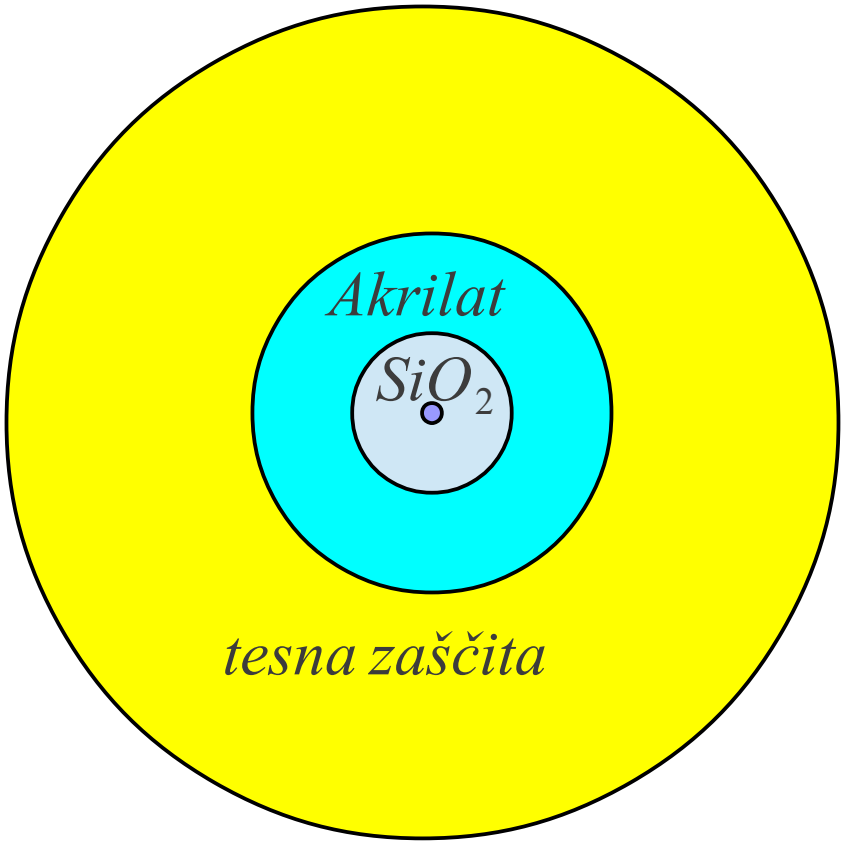
statistika velja $l > 1\text{km}$



Ekscentrično jedro

$D_{PMD} \approx 10\ ns/\sqrt{km}$ $\quad (1980)$

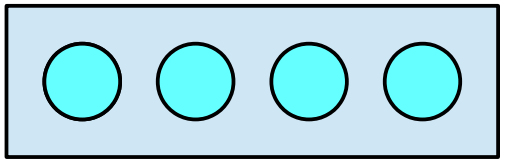
$D_{PMD} \approx 0.1\ ns/\sqrt{km}$ $\quad (2010)$



900 μ m

tesna sekundarna zaščita (tight)

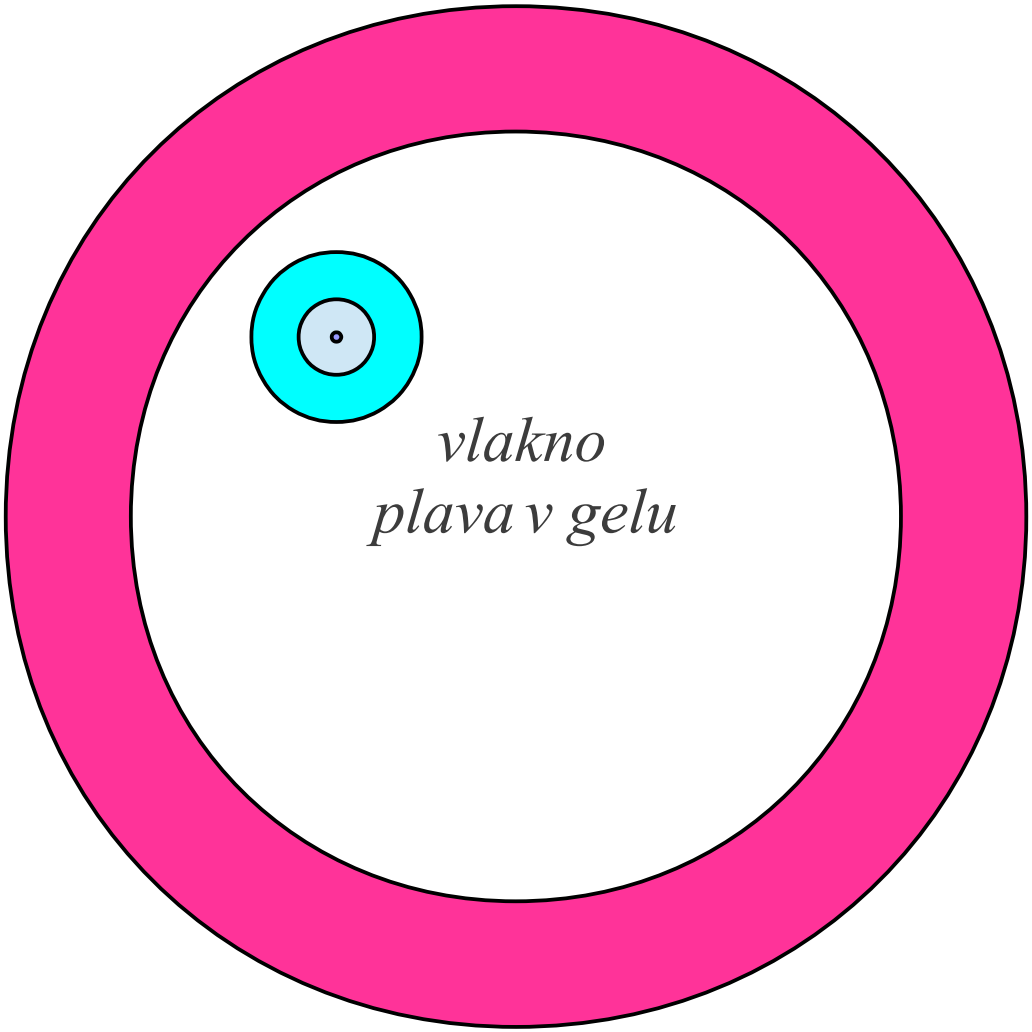
trak (ribbon) 4...24 vlaken



Vpihovanje 2mm kabla v 7mm cev

3 mm

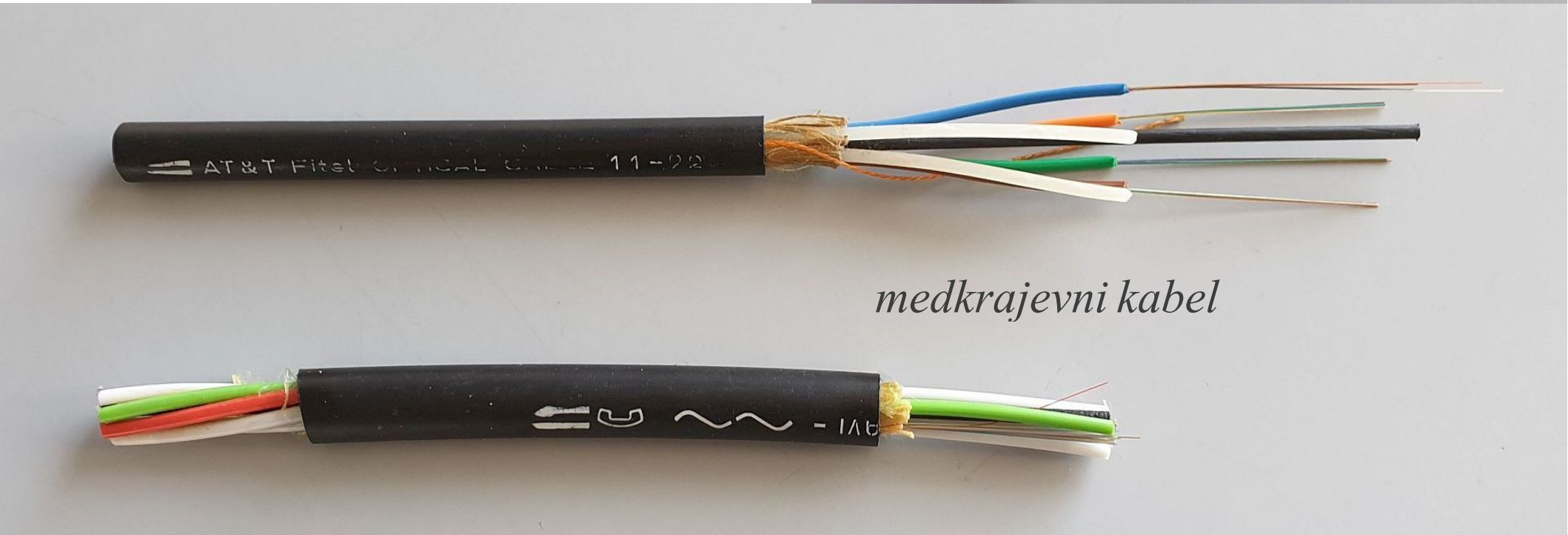
ohlapna sekundarna zaščita (loose)



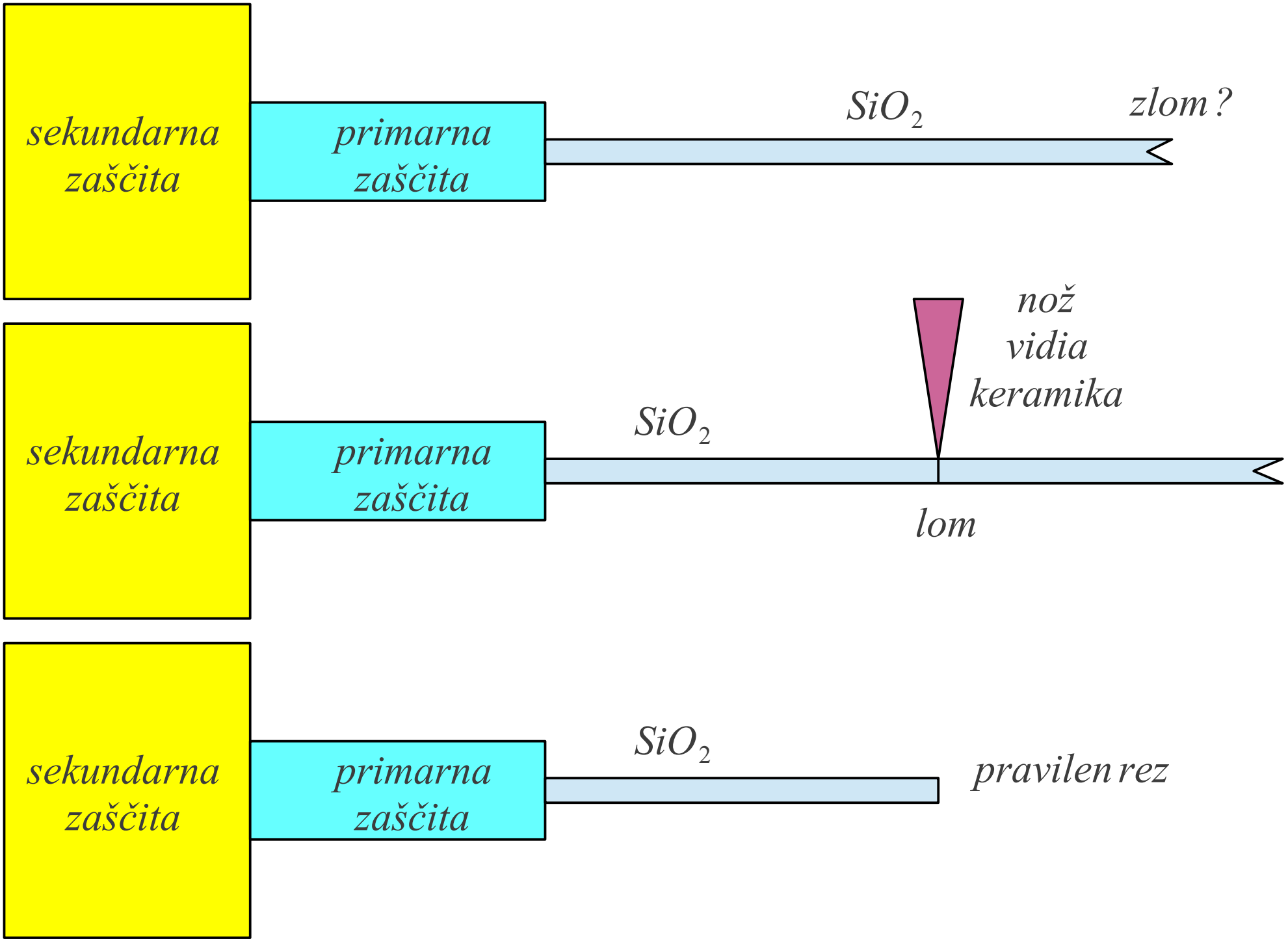

priključna vrvica
plašč 3mm
aramidna vlakna (Kevlar)
tight 0.9mm
vlakno SiO_2

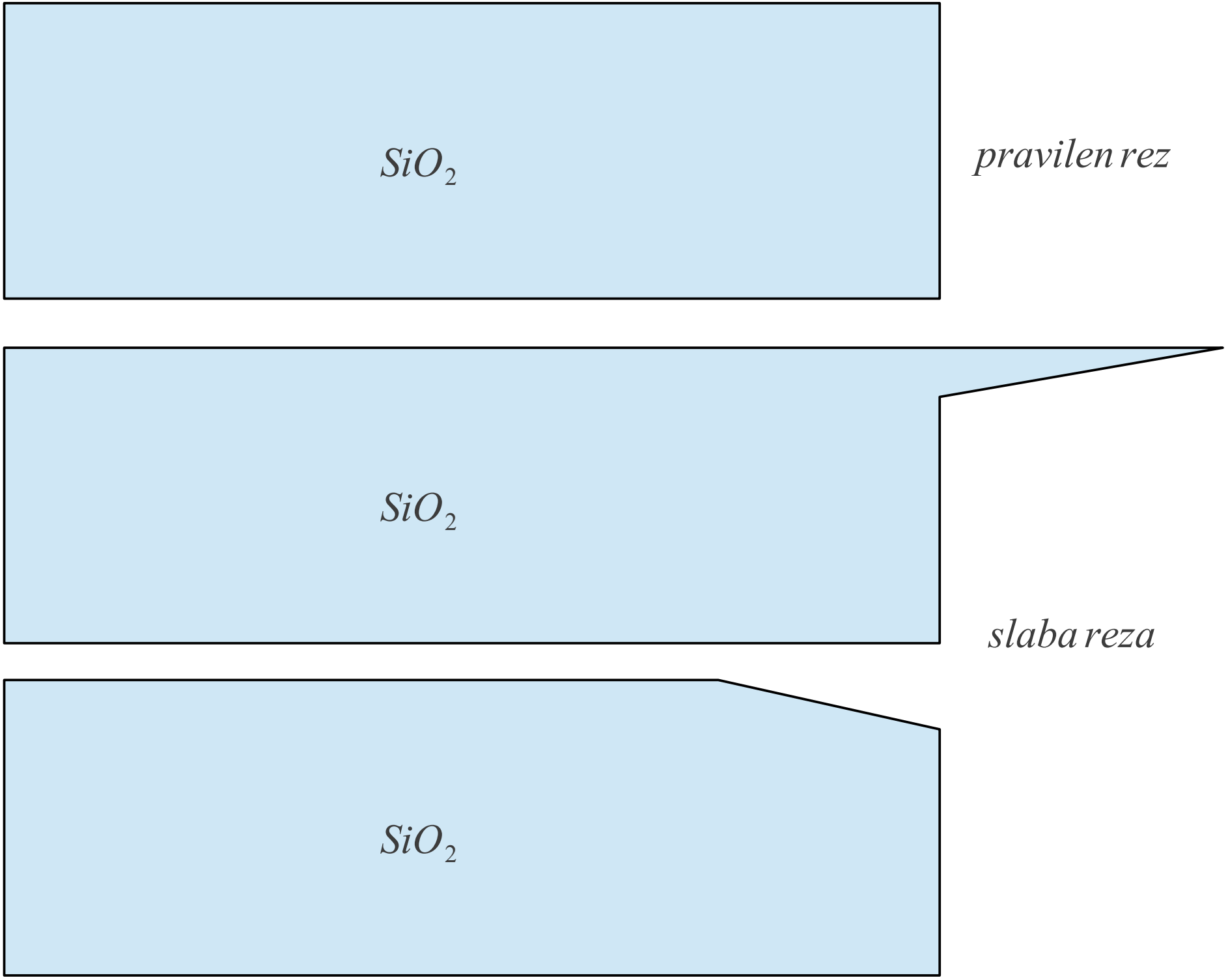
gradnik

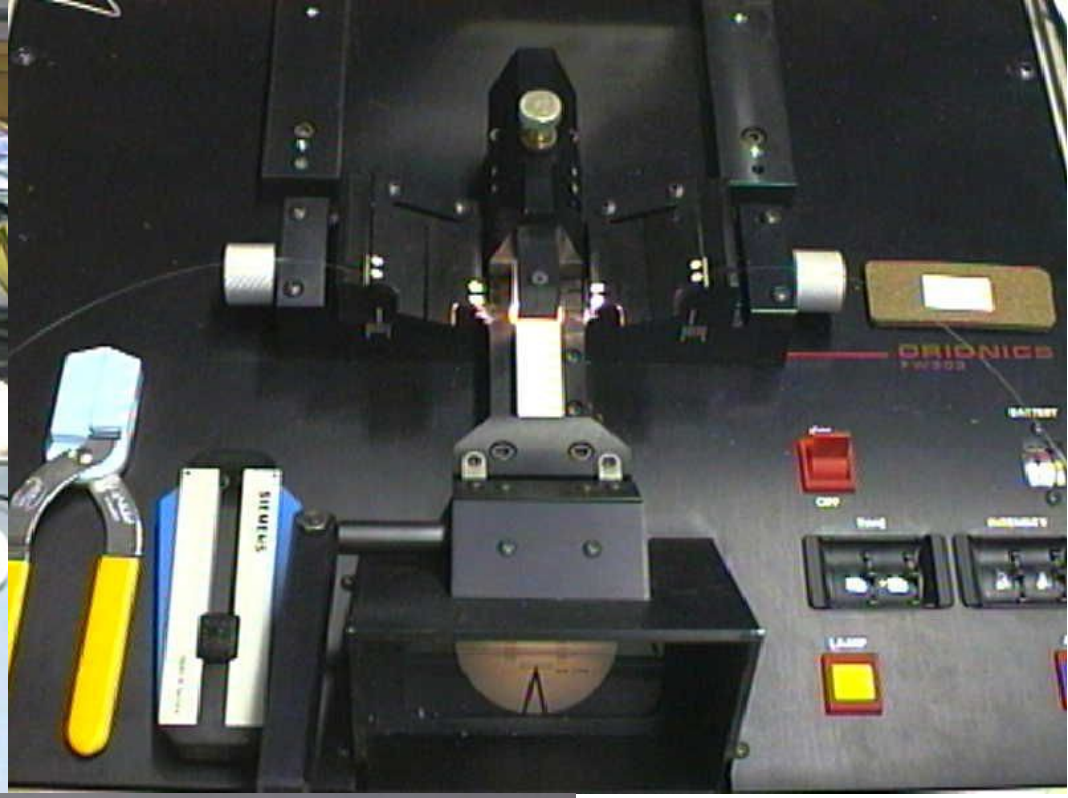
priključna vrvica



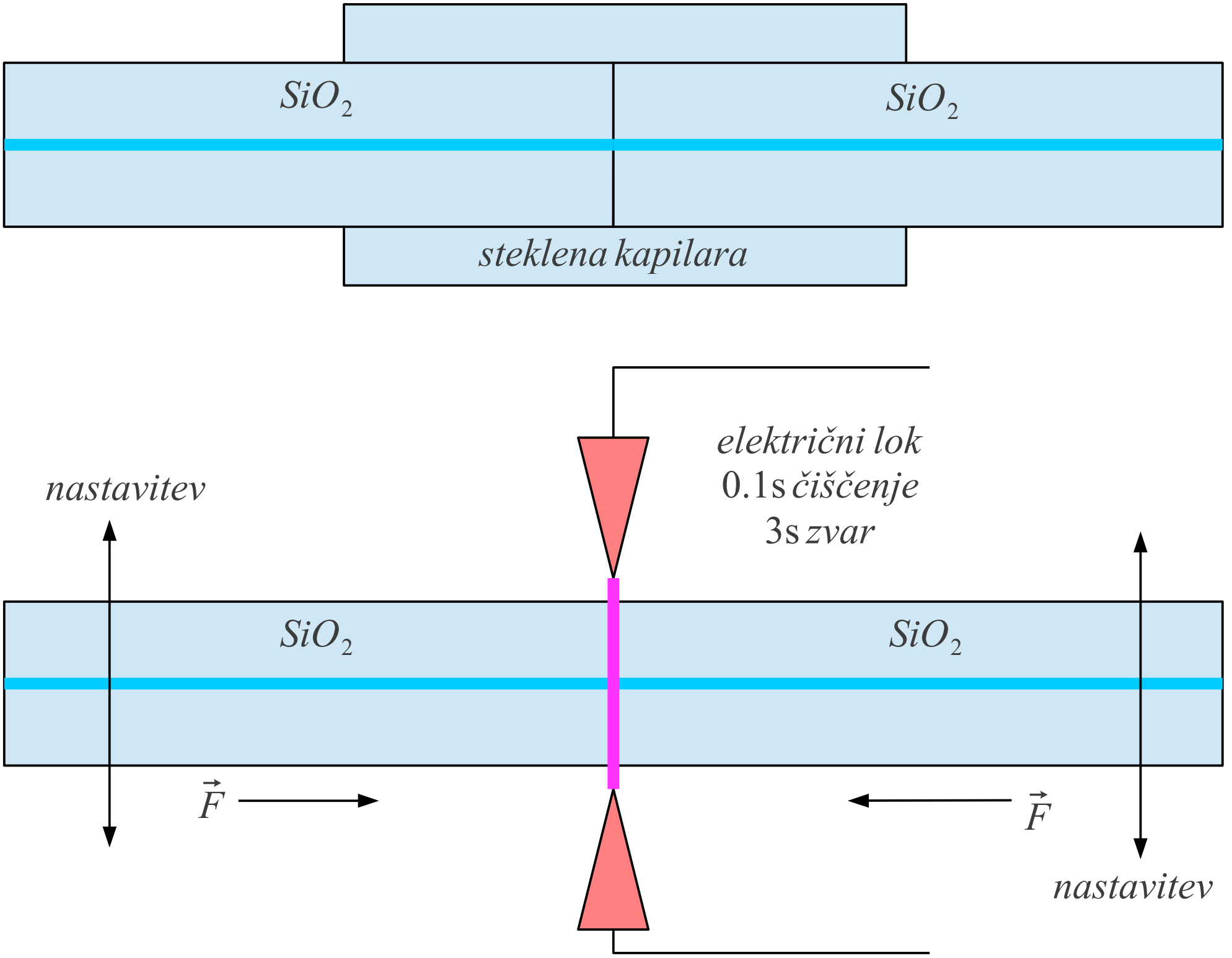
medkrajevni kabel

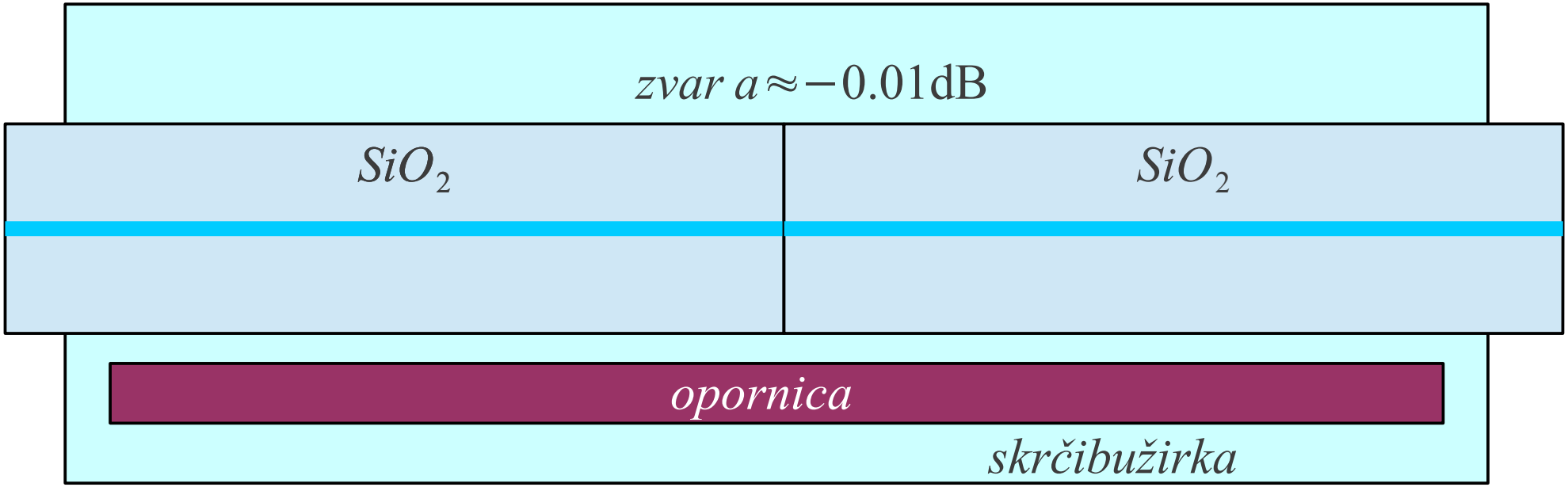

sekundarna zaščita
primarna zaščita
SiO_2
zlom ?
sekundarna zaščita
primarna zaščita
nož vidia keramika
SiO_2
lom
sekundarna zaščita
primarna zaščita
SiO_2
pravilen rez

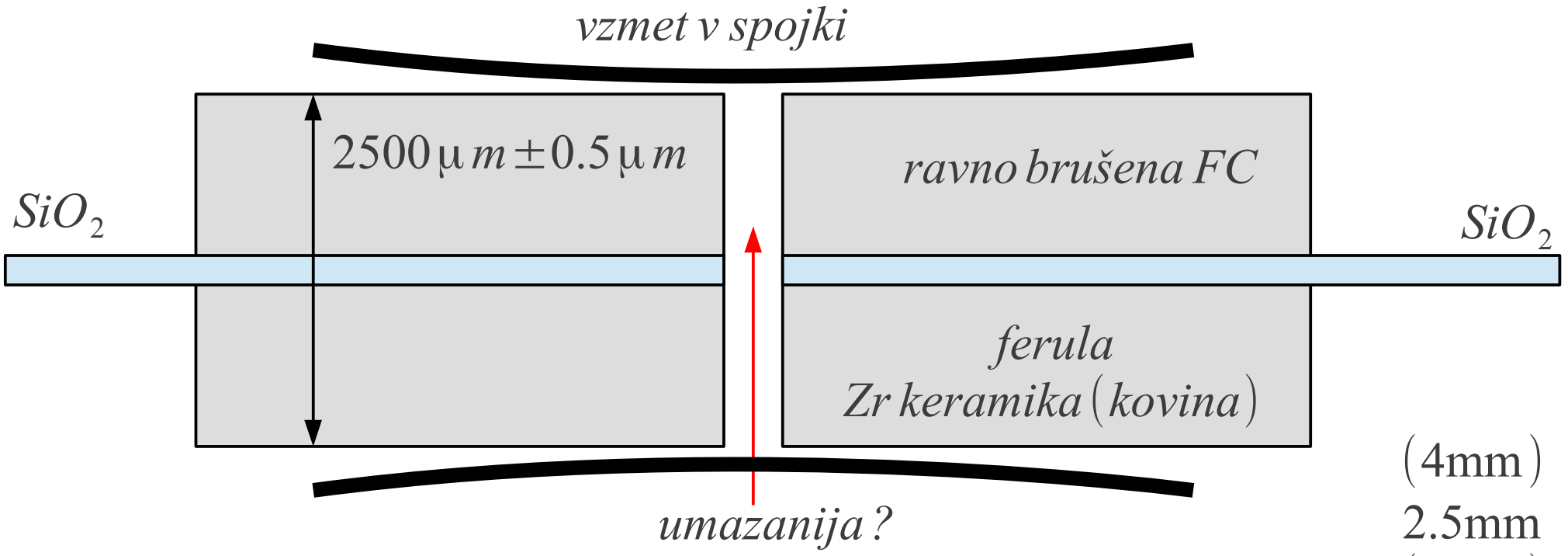

SiO_2
pravilen rez
SiO_2
slaba reza
SiO_2


ORIONICS

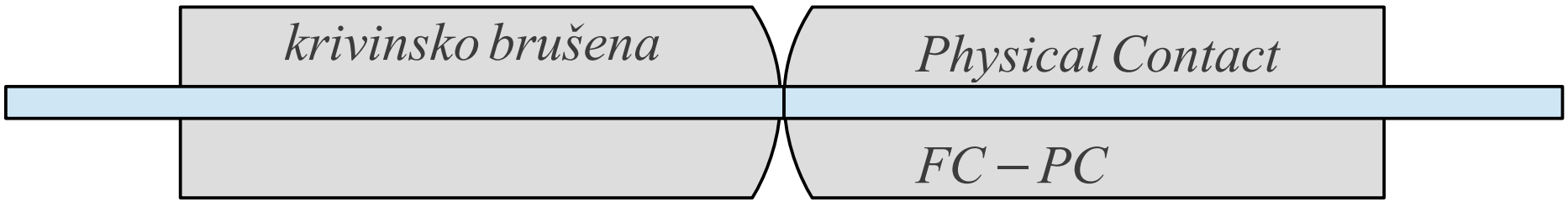

SIEMENS


SiO_2
SiO_2
steklena kapilara
električni lok
0.1s čiščenje
3s zvar
nastavitev
SiO_2
SiO_2
$\vec{F}$
$\vec{F}$
nastavitev

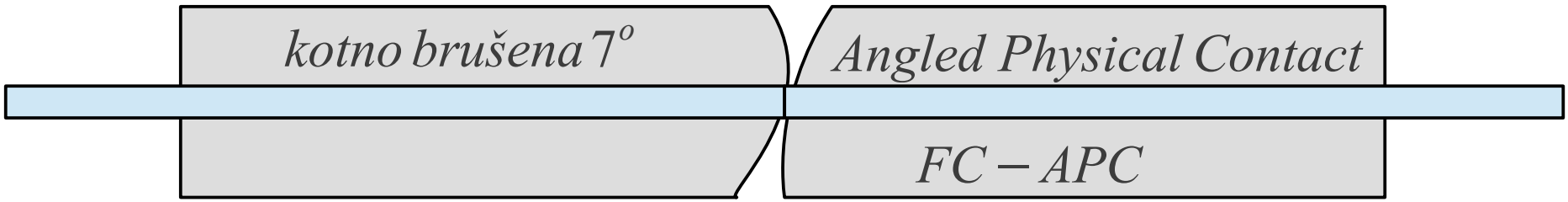

zvar a ≈ −0.01dB
SiO2
SiO2
opornica
skrčibužirka

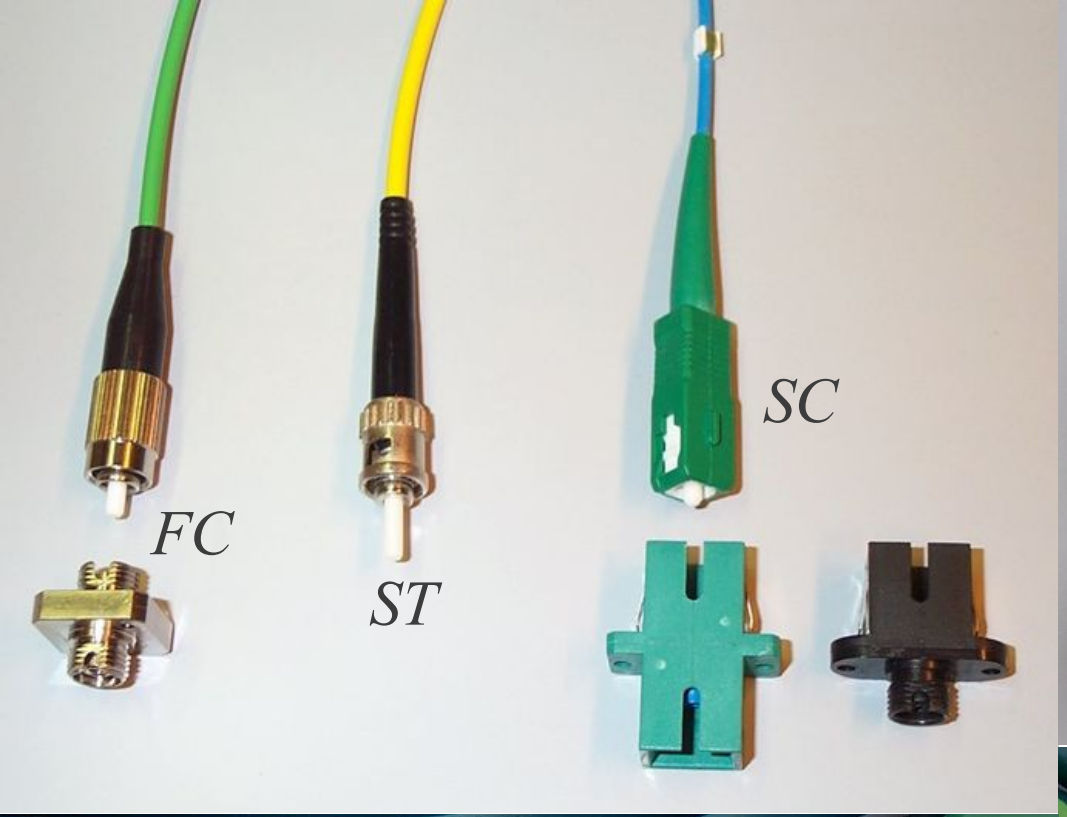


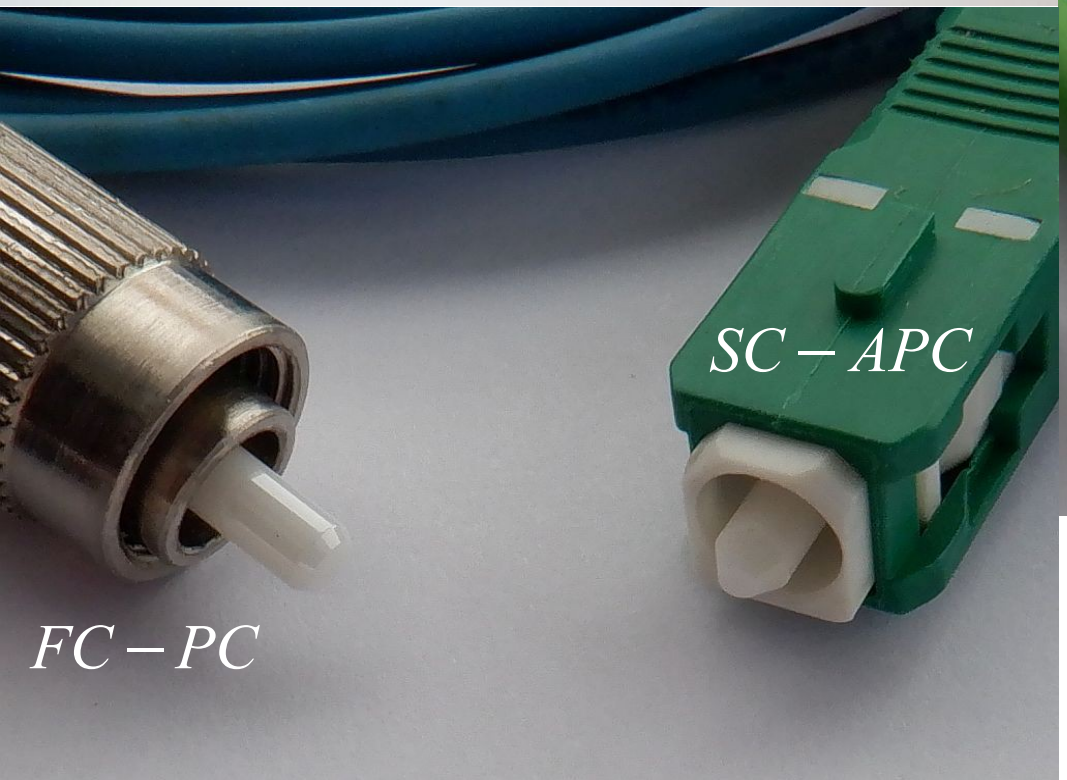
$FC-PC\ a \approx -0.2\text{dB}, \Gamma \approx -35\text{dB}$

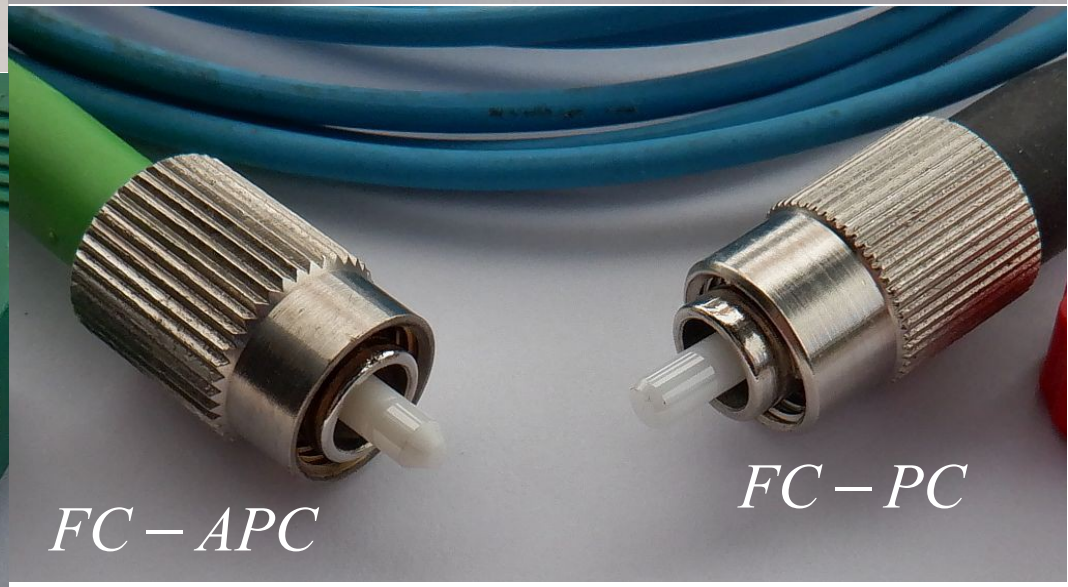


$FC-APC\ a \approx -0.5\text{dB}, \Gamma \approx -70\text{dB}$

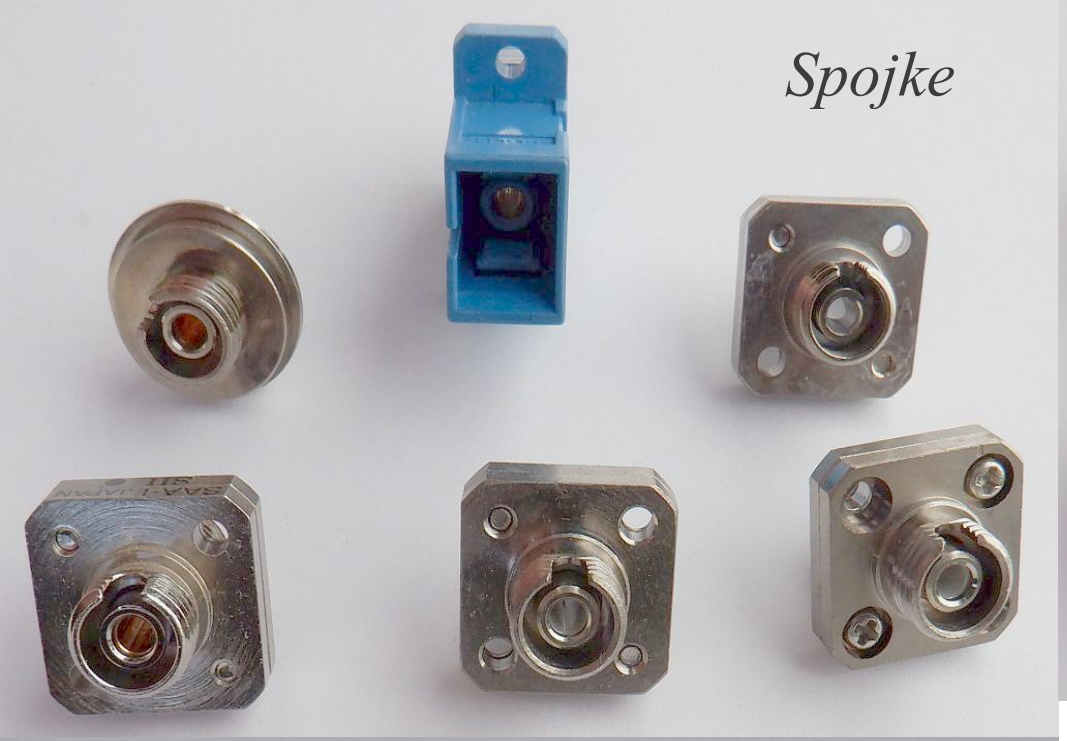


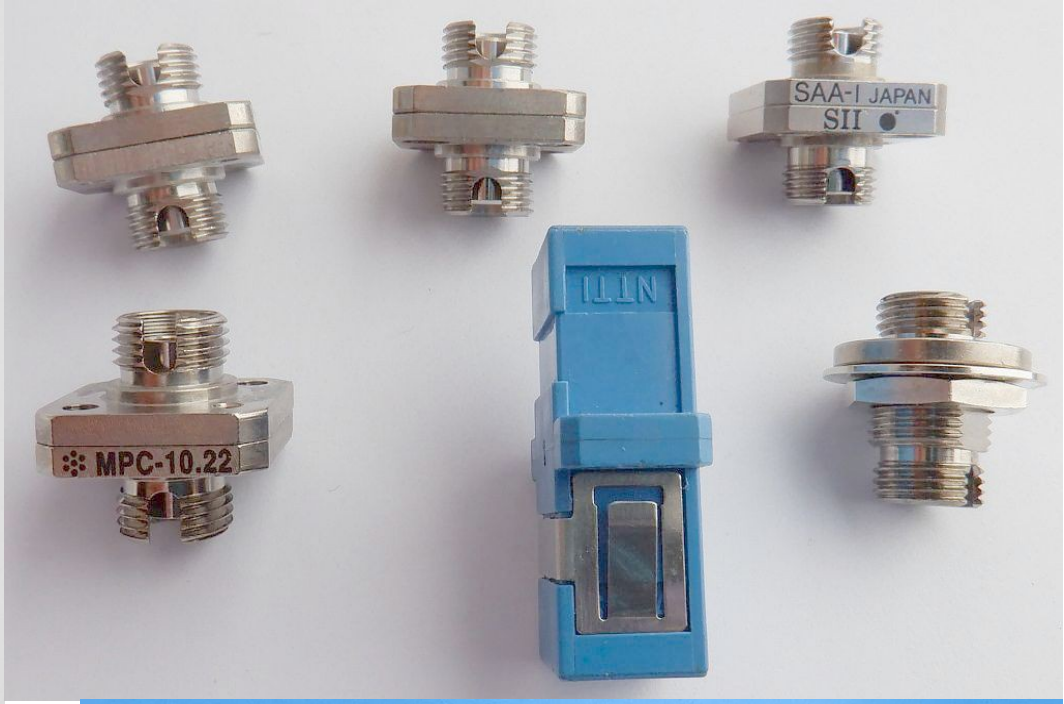


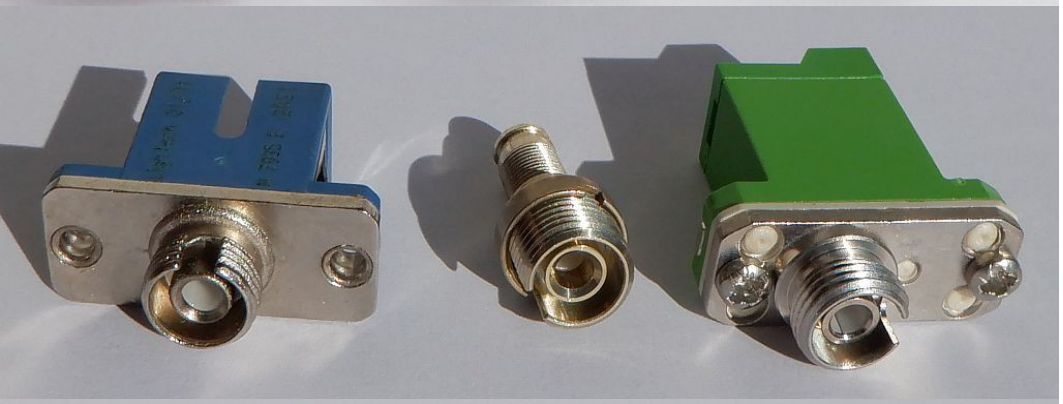




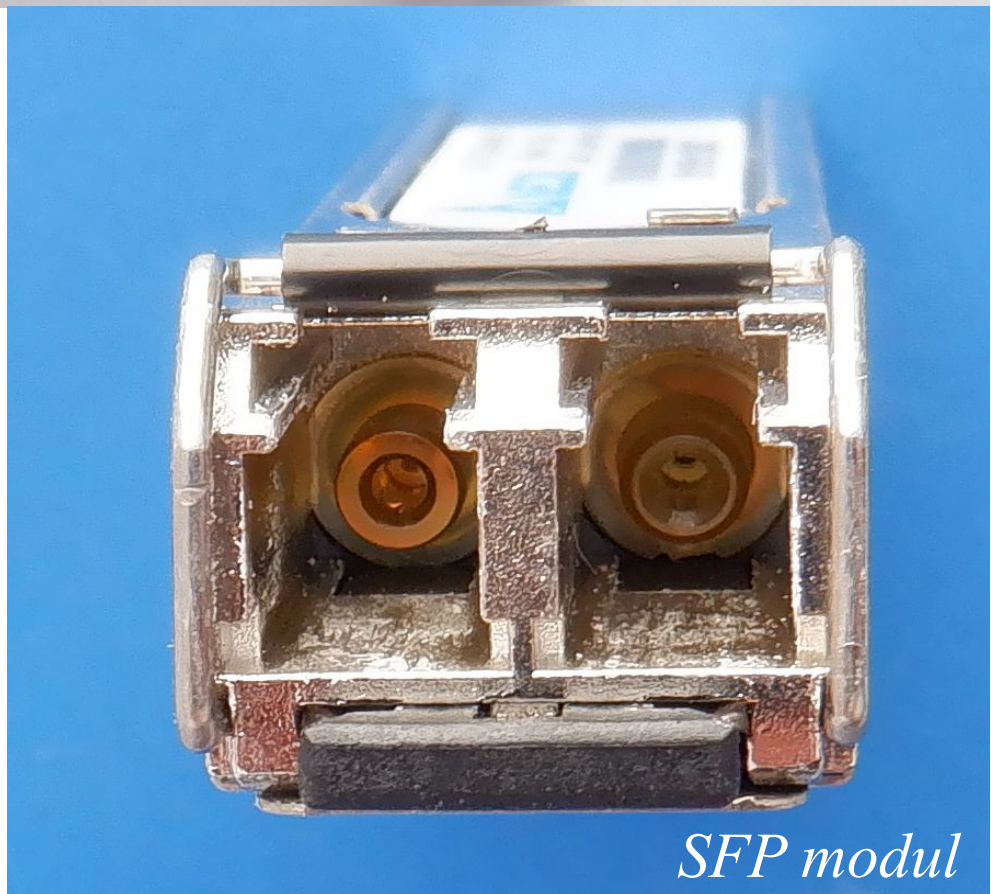
APC = zelen ! ! ! !


Spojke


SAA-I JAPAN
SII
MPC-10.22




Prehodi


SFP modul

Močno dvolomno vlakno – PANDA

$\beta_{VP} \neq \beta_{HP}$ *!!!!!*

Velika razlika – vlakno ohranja polarizacijo