Communication over few-mode fibers

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Content

- Introduction – Communication fiber link
- Different wavelengths, advantages and disadvantages
- Modes and Modal Dispersion
- Stokes Parameters and Poincaré sphere
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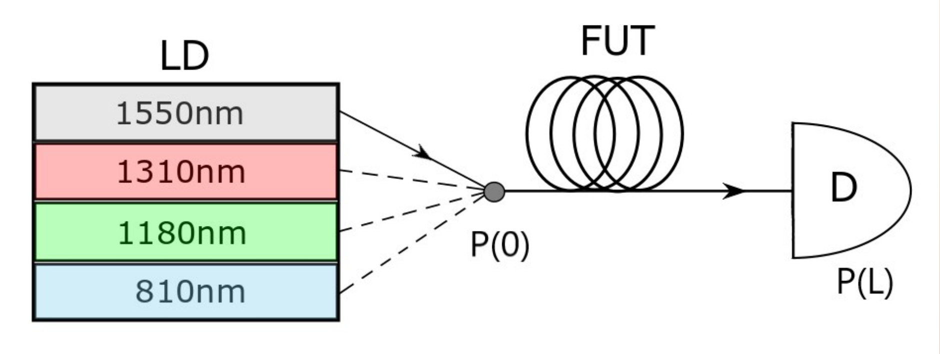
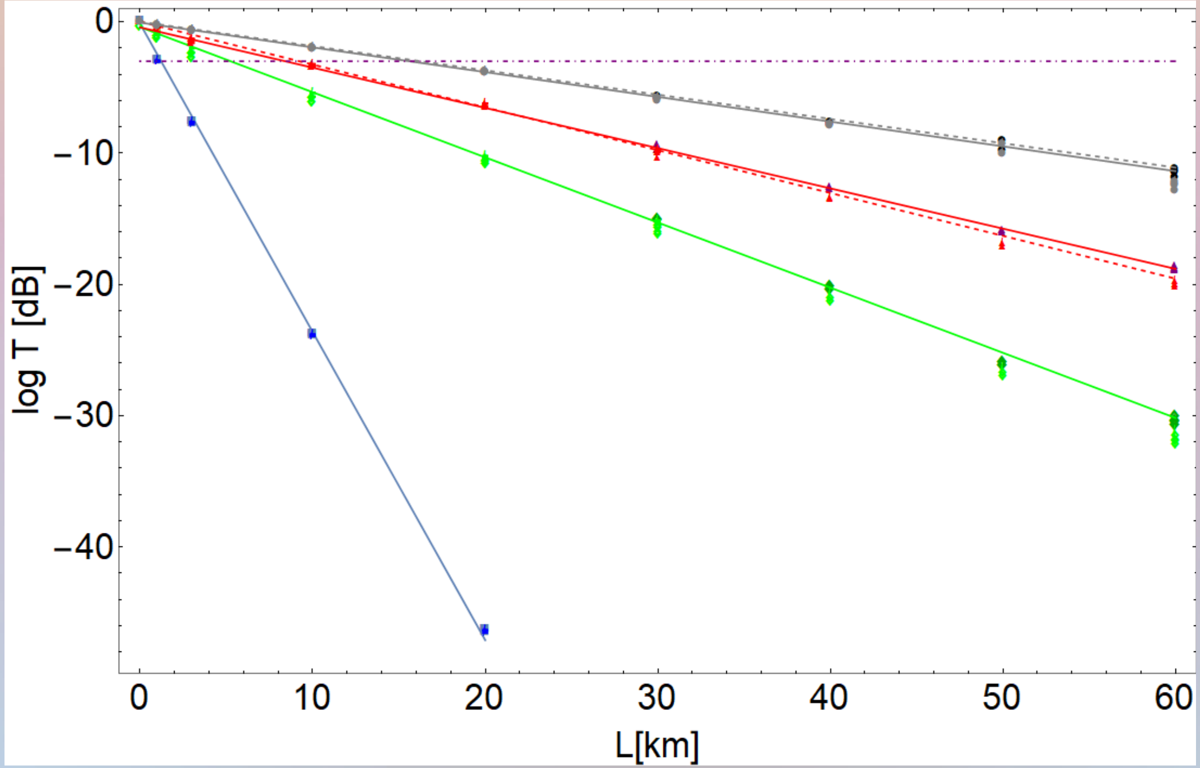
Telecommunication fibers

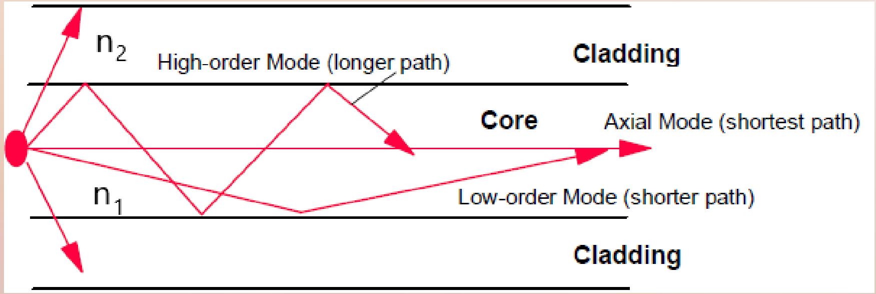
Dependence of the fiber transmission on the length of the fiber for four different wavelengths

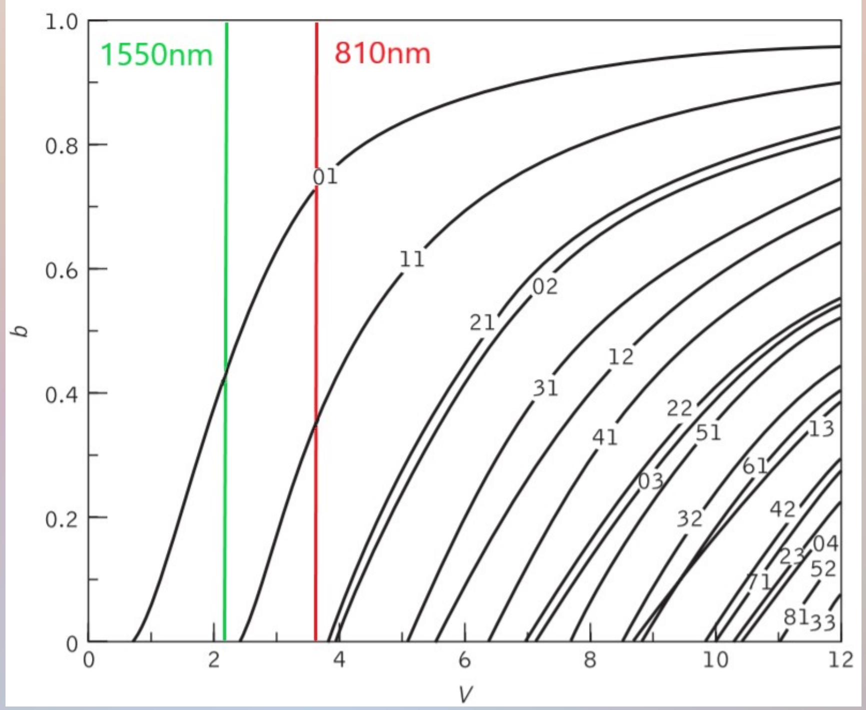


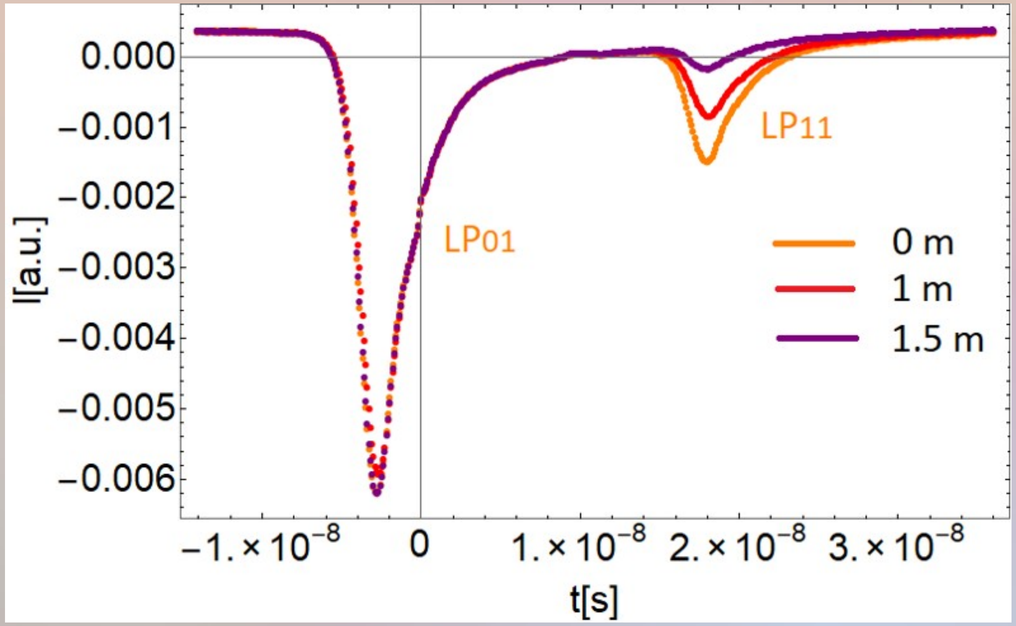


Multimode behavior

Classical telecommunication fiber shows multimode behavior for 810 nm. This unwanted effect can destroy the transmitted information.







Stokes parameters and Poincaré sphere

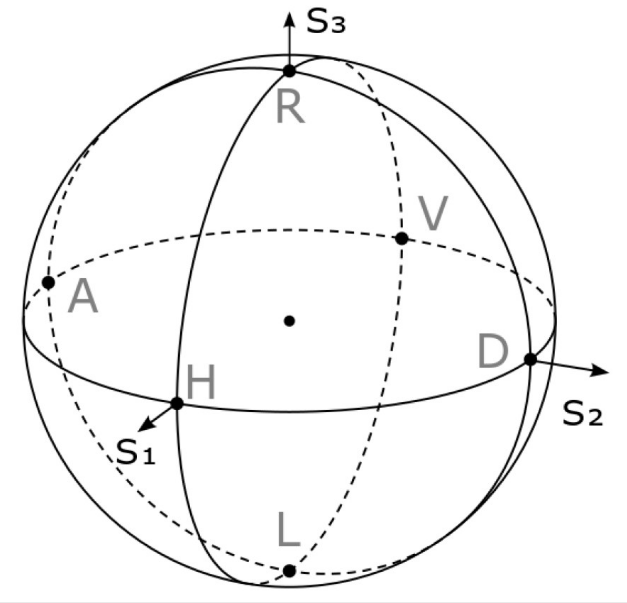
$$S_0 = \langle A_x^2 \rangle + \langle A_y^2 \rangle$$

$$S_1 = \langle A_x^2 \rangle - \langle A_y^2 \rangle$$

$$S_2 = \langle 2A_x A_y \cos\delta \rangle$$

$$S_3 = \langle 2A_x A_y \sin\delta \rangle$$

A_x and A_y are amplitudes of the electric field and $\delta = \delta_y - \delta_x$, where $-\pi < \delta \leq \pi$, is initial phase

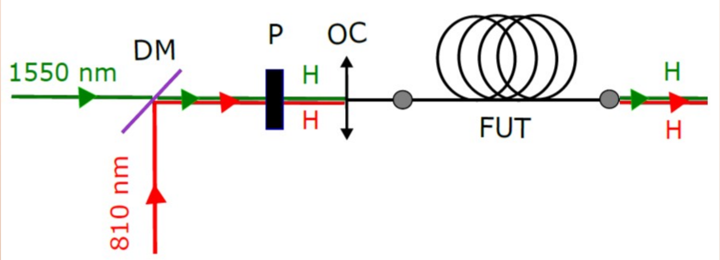


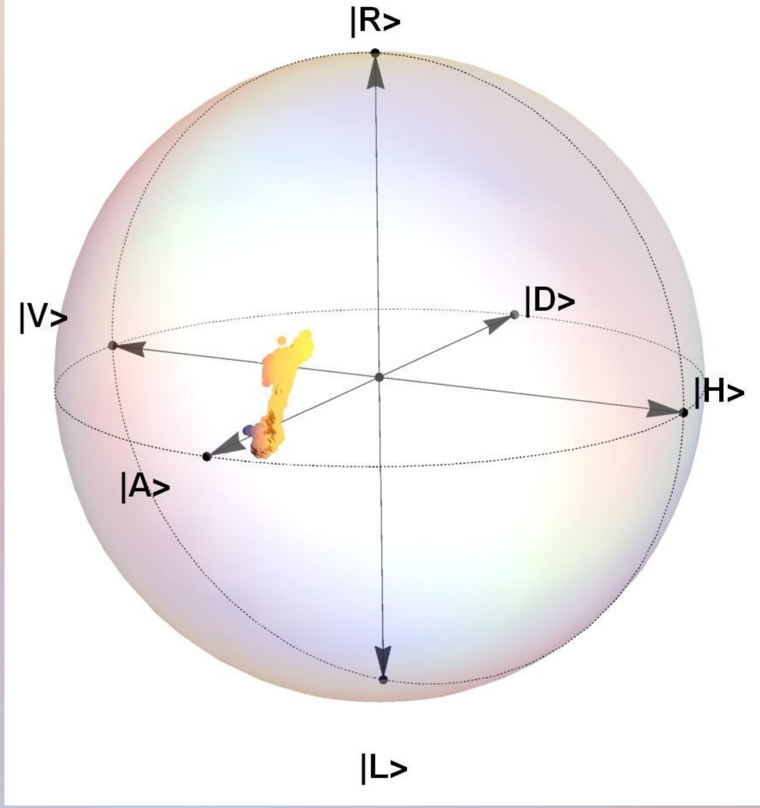
$$DOP = \frac{\sqrt{S_1^2 + S_2^2 + S_3^2}}{S_0}$$

Polarization	H	V	D	A	R	L
Stokes vectors $\begin{bmatrix} S_0 \\ S_1 \\ S_2 \\ S_3 \end{bmatrix}$	$\begin{bmatrix} 1 \\ 1 \\ 0 \\ 0 \end{bmatrix}$	$\begin{bmatrix} 1 \\ -1 \\ 0 \\ 0 \end{bmatrix}$	$\begin{bmatrix} 1 \\ 0 \\ 1 \\ 0 \end{bmatrix}$	$\begin{bmatrix} 1 \\ 0 \\ -1 \\ 0 \end{bmatrix}$	$\begin{bmatrix} 1 \\ 0 \\ 0 \\ 1 \end{bmatrix}$	$\begin{bmatrix} 1 \\ 0 \\ 0 \\ -1 \end{bmatrix}$

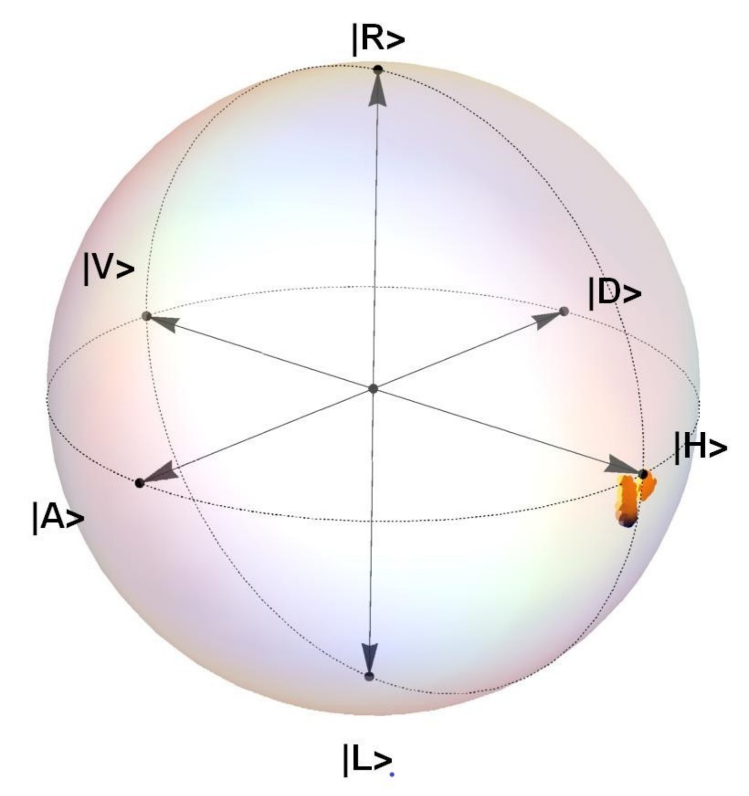
Polarization Analysis

We want the same polarization state as the input one at the output of the fiber



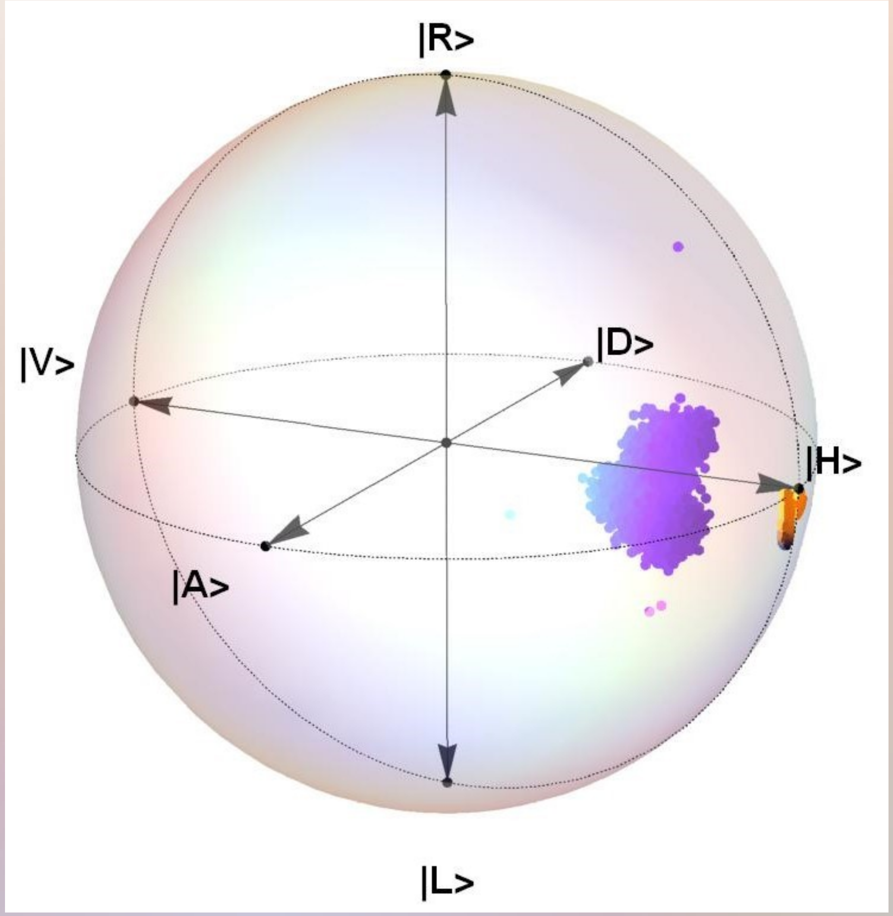


1550 nm without correction

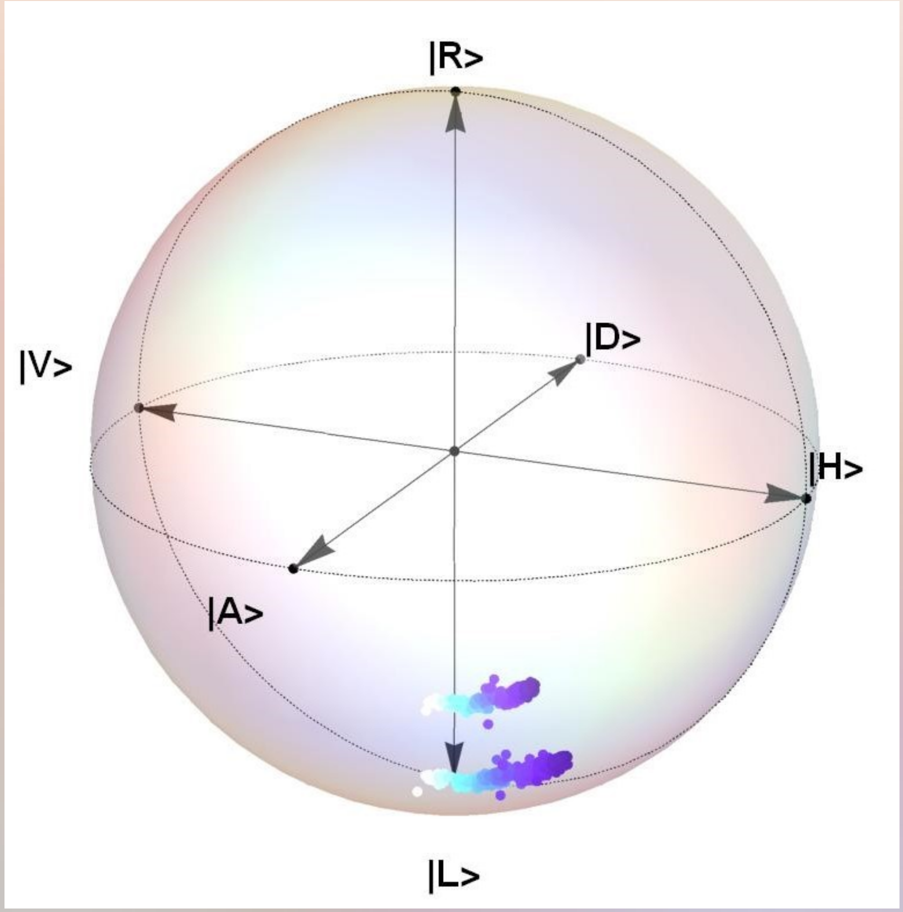


1550 nm with correction

Polarization Analysis

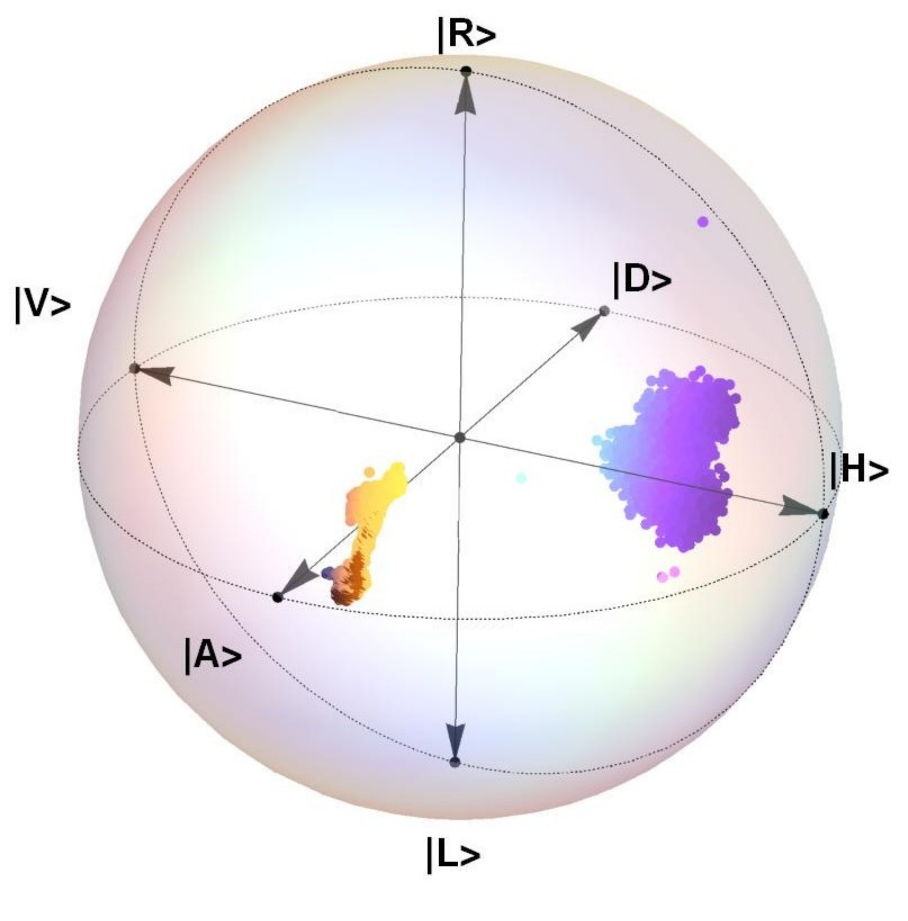


810 nm without correction

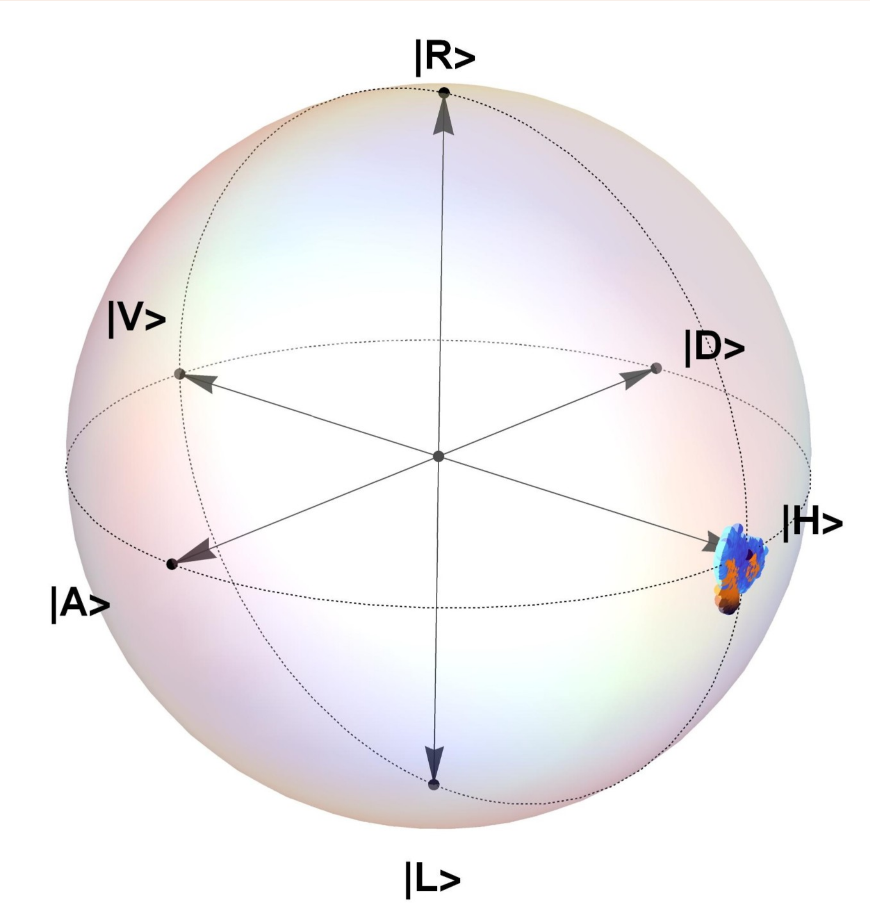


810 nm time filtration

Polarization Analysis

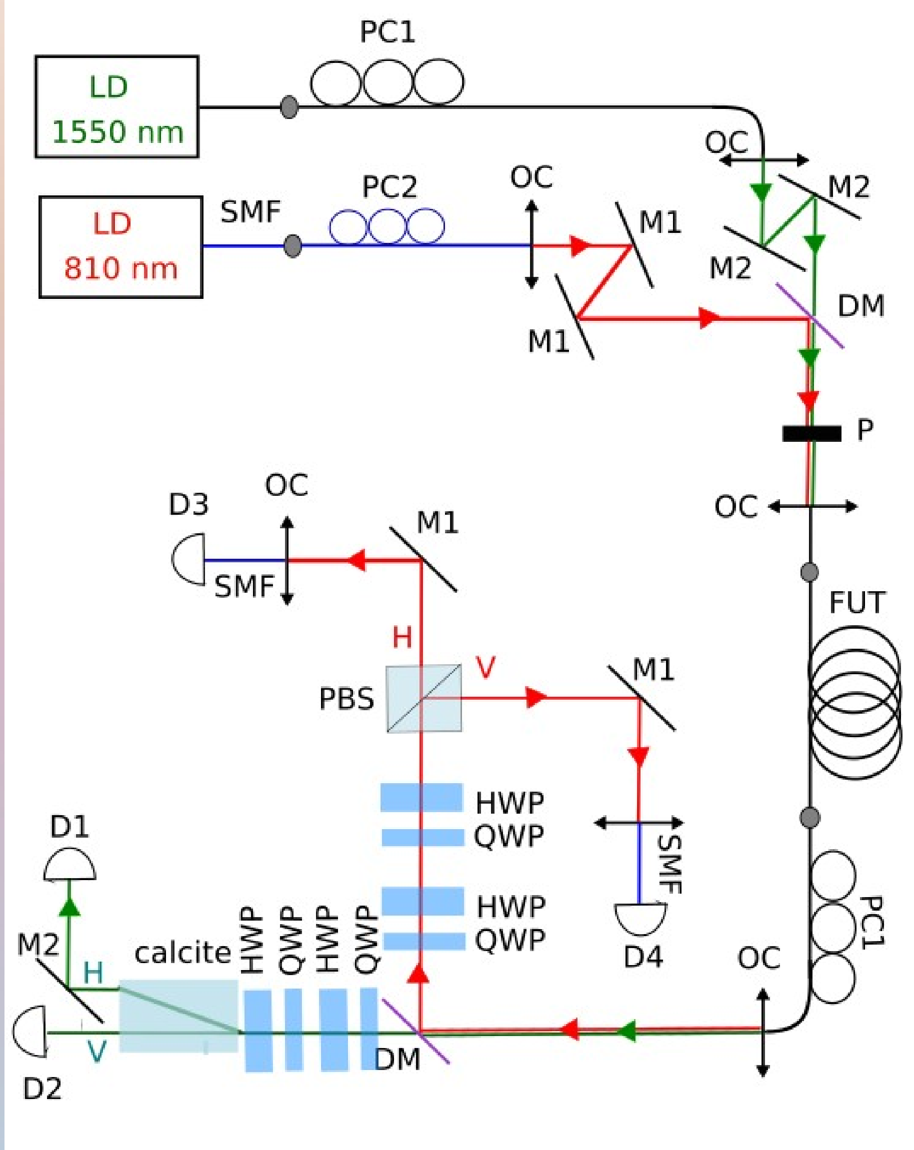


Both without correction

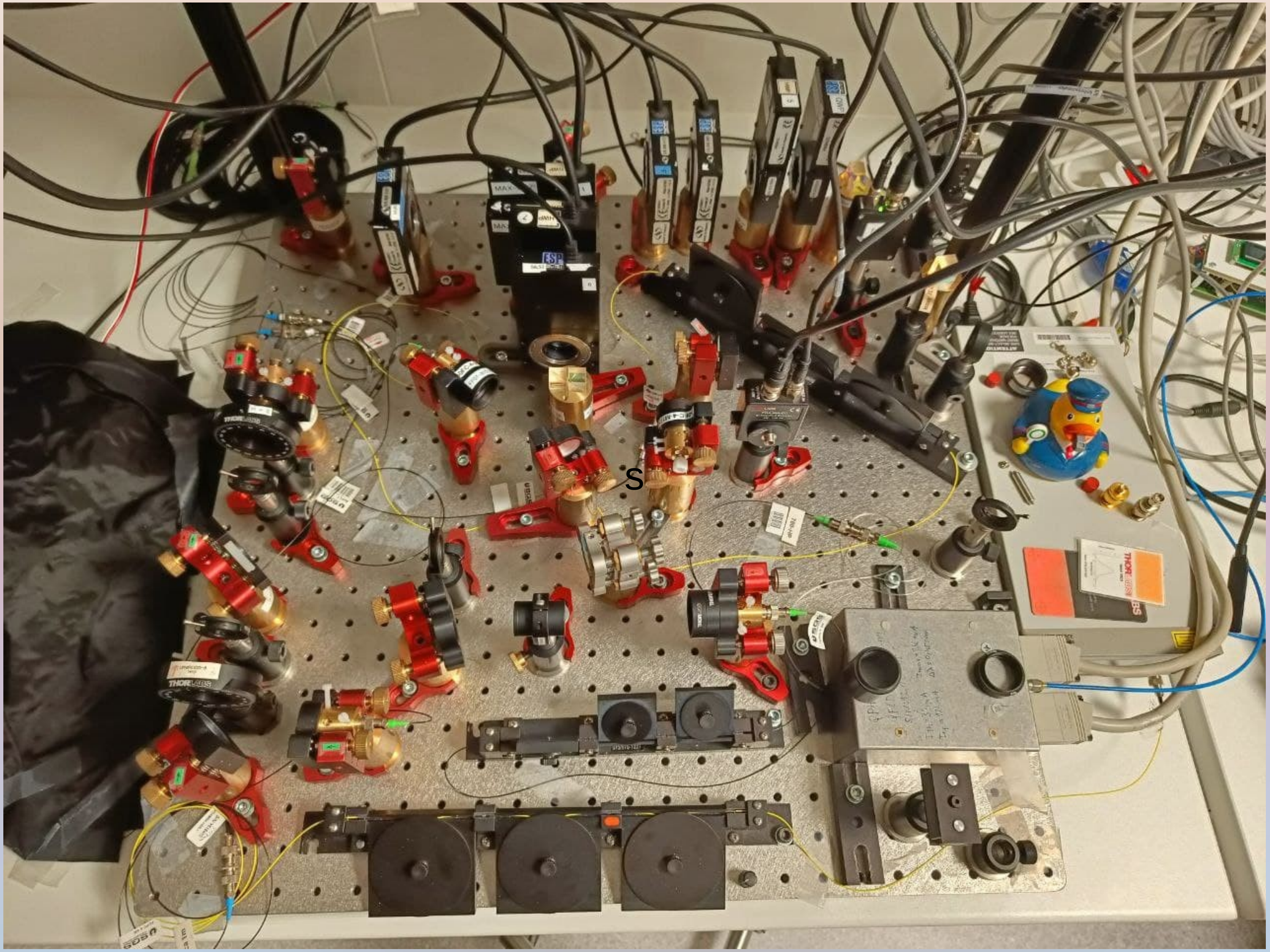


Both with correction

Fiber link


PC1
LD
1550 nm
OC
M2
LD
810 nm
SMF
PC2
OC
M1
M2
DM
M1
P
OC
D3
OC
M1
SMF
FUT
H
PBS
V
M1
HWP
QWP
HWP
QWP
SMF
D1
D4
PC1
M2
calcite
HWP
QWP
HWP
QWP
OC
H
V
DM
D2

Communication



Thank you for your attention