Bossa Nova Tech

Calibration and performances report - SALSA Full Stokes camera

1 Calibration

The calibration matrix links the 4 raw frames acquired successively with the 4 Stokes parameters. The Stokes parameters (S_0, S_1, S_2, S_3) are calculated for each pixel of the imaged scene by multiplying the 4 raw frames by the calibration matrix.

$$\vec{S} = C * \vec{I}$$

$$\vec{S} = \begin{bmatrix} S_0 \\ S_1 \\ S_2 \\ S_3 \end{bmatrix} = \begin{bmatrix} 0.1935 & 0.3555 & 0.3249 & 0.1346 \\ 1.2827 & -1.1338 & -0.8719 & 0.7037 \\ 0.8640 & -1.0428 & -1.6195 & 1.7759 \\ -0.2958 & -0.4399 & 0.5381 & 0.2014 \end{bmatrix} \times \begin{bmatrix} I_{Frame0} \\ I_{Frame1} \\ I_{Frame2} \\ I_{Frame3} \end{bmatrix}$$

Condition number: **Cond(C) = 6.7**

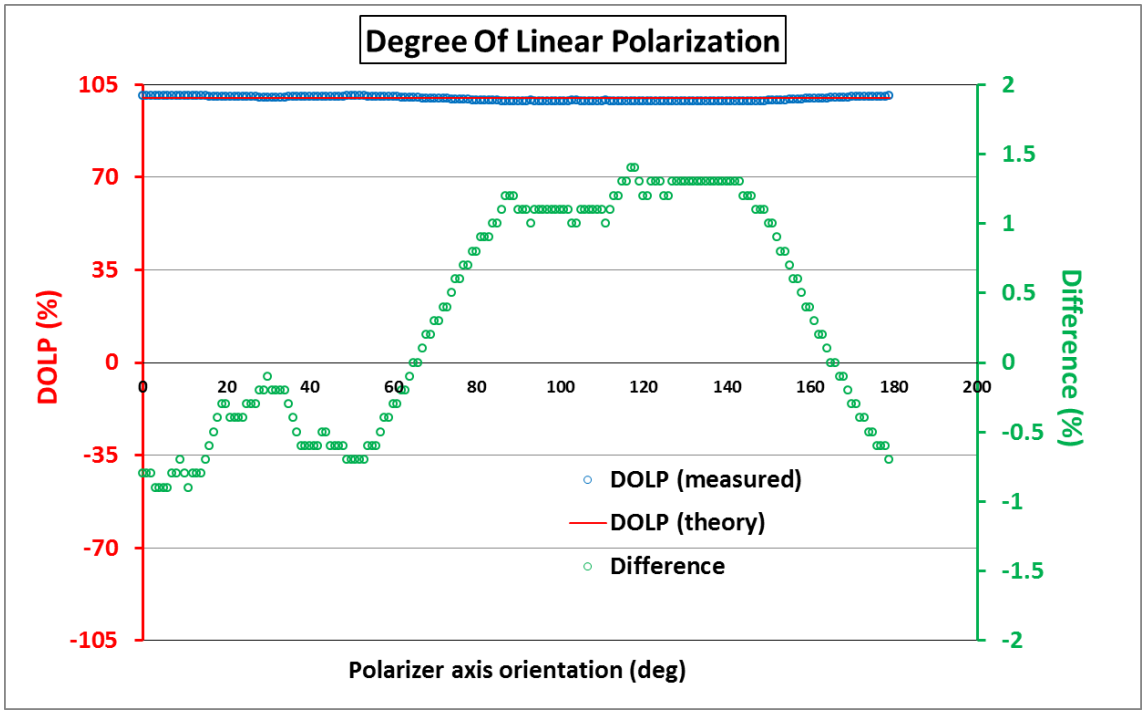
2 Performances

Many tests are performed in our lab in order to validate the camera's performances. Some of them are presented below. It evaluates the camera's response to basic polarization signature such as a pure linear polarization, elliptical or circular.

2.1 Linear polarization

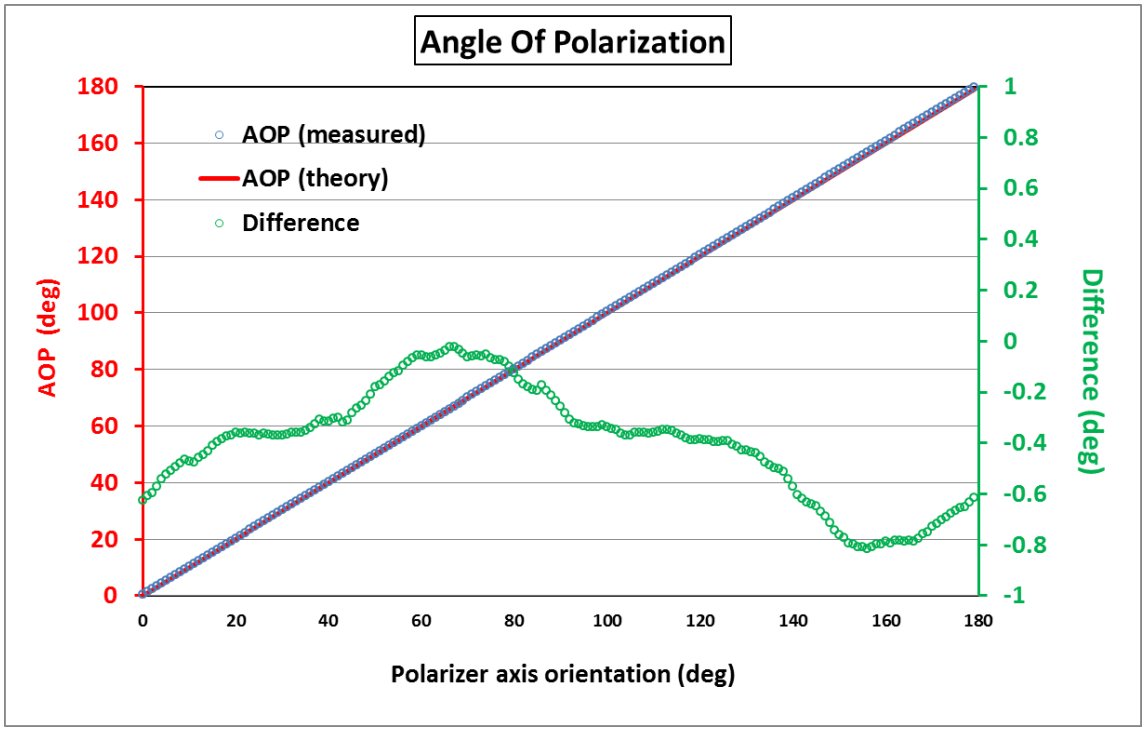
A linear polarizer with a high contrast ratio (>10,000) is rotated form 0° to 180° in front of the camera. Several parameters are measured and presented below. The Degree Of Linear Polarization (DOLP) and the Degree Of Polarization (DOP) are expected to be 100% all the time. The Angle Of Polarization (AOP) is supposed to follow the exact polarizer's orientation. The Degree Of Circular Polarization (DOCP) and the Ellipticity are expected to remain at 0% and 0° respectively.

2.1.1 DOLP



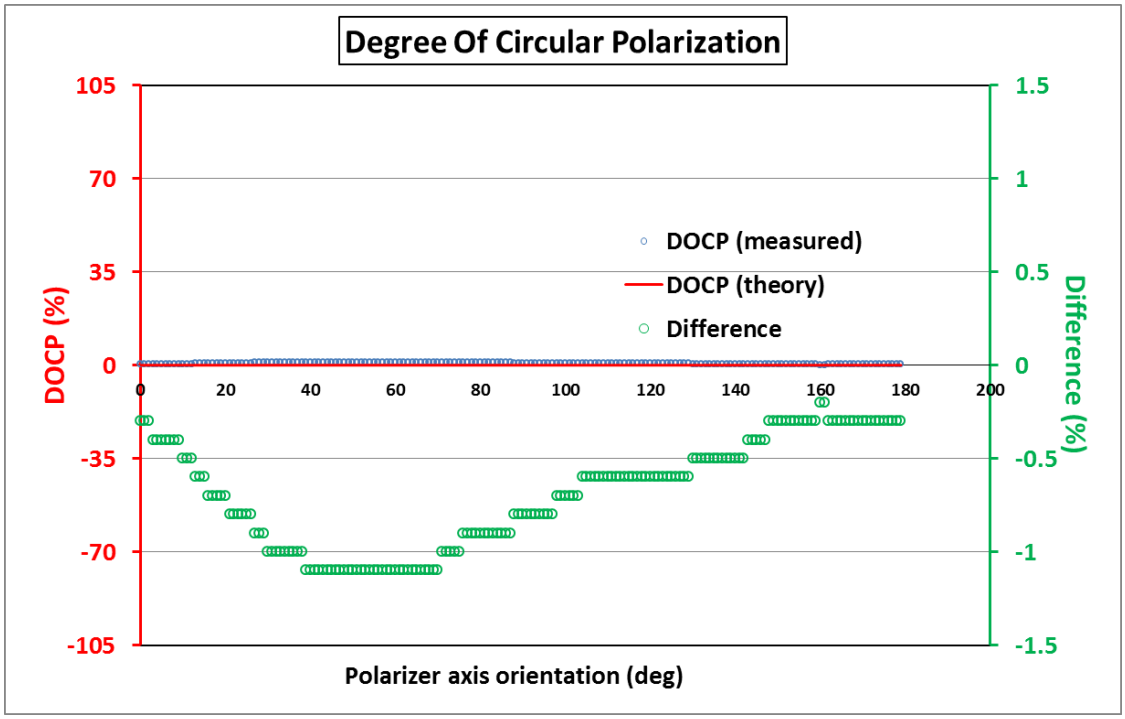
Deviation DOLP P-V: 2%
Deviation DOLP RMS: 0.8%

2.1.2 AOP



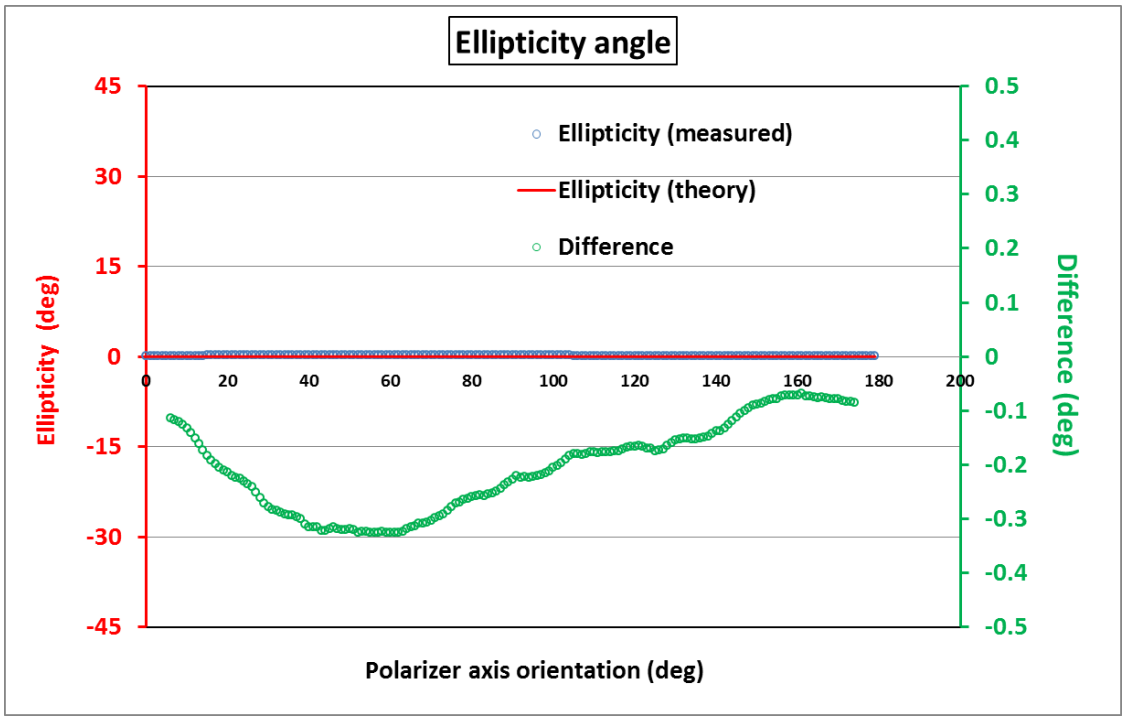
Deviation AOP P-V: 0.85°
Deviation AOP RMS: 0.22°

2.1.3 DOCP



Deviation DOCP P-V: 1%
Deviation DOCP RMS: 0.3%

2.1.4 Ellipticity

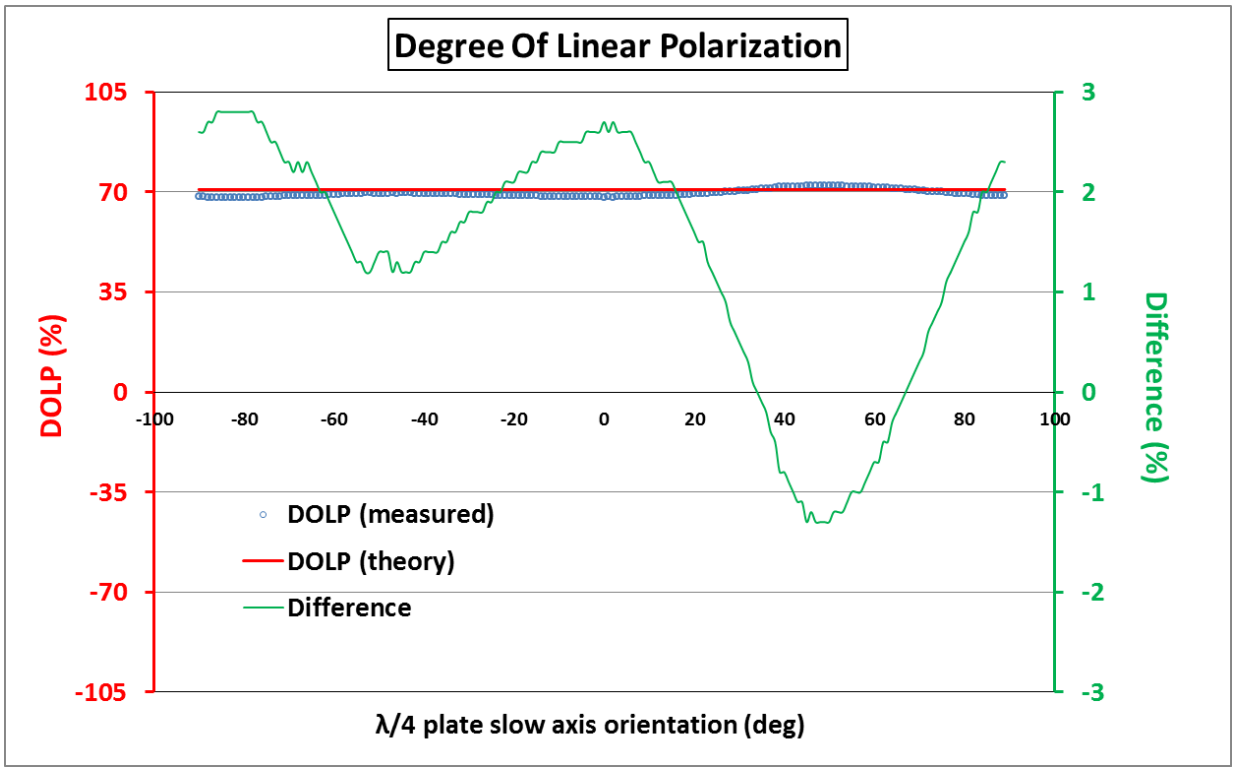


Deviation Ellipticity P-V: 0.3°
Deviation Ellipticity RMS: 0.1°

2.2 Elliptic polarization [1]: ε=22.5°, AOP = [-90°; 90°]

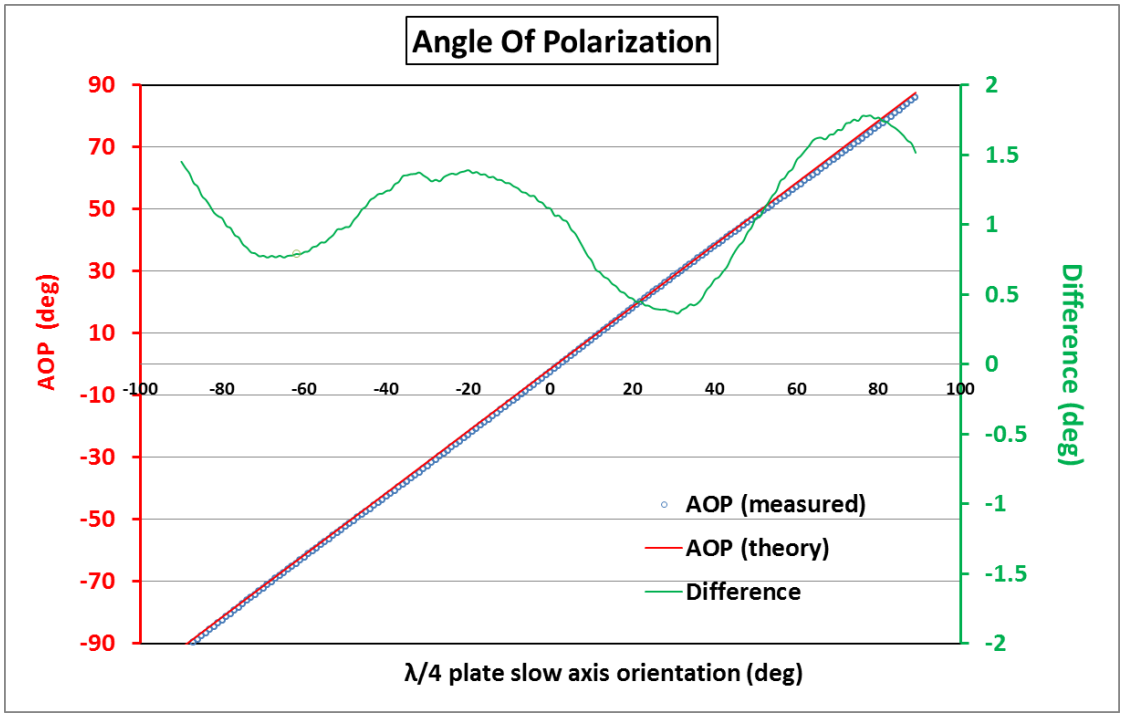
A linear polarizer with a high contrast ratio (>10,000) coupled with a quarter wave plate (QWP) are used to generate elliptic polarization states. The QWP slow axis' orientation fixes the Angle of Polarization (AOP) and the difference between the QWP slow axis orientation and the linear polarizer's axis fixes the ellipticity (-45° to 45°). Here the ellipticity remains **ε=22.5°** while the polarization ellipse's great axis will rotate from -90° to 90°.

2.2.1 DOLP



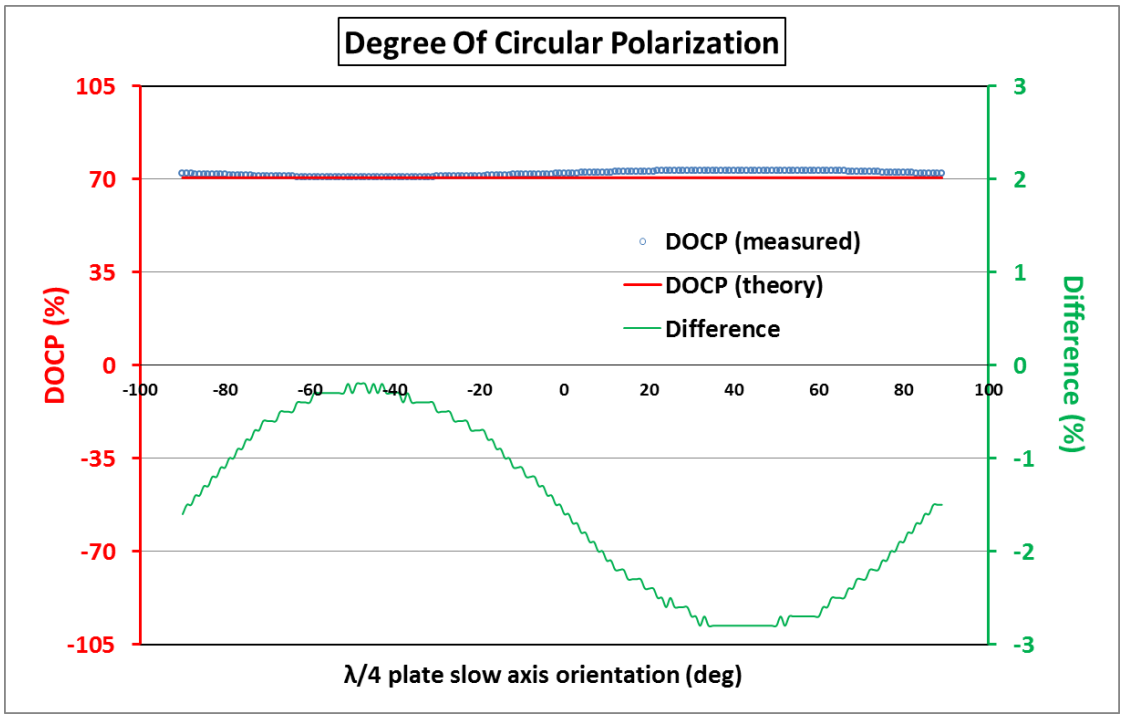
Deviation DOLP P-V: 4%
Deviation DOLP RMS: 1.2%

2.2.2 AOP



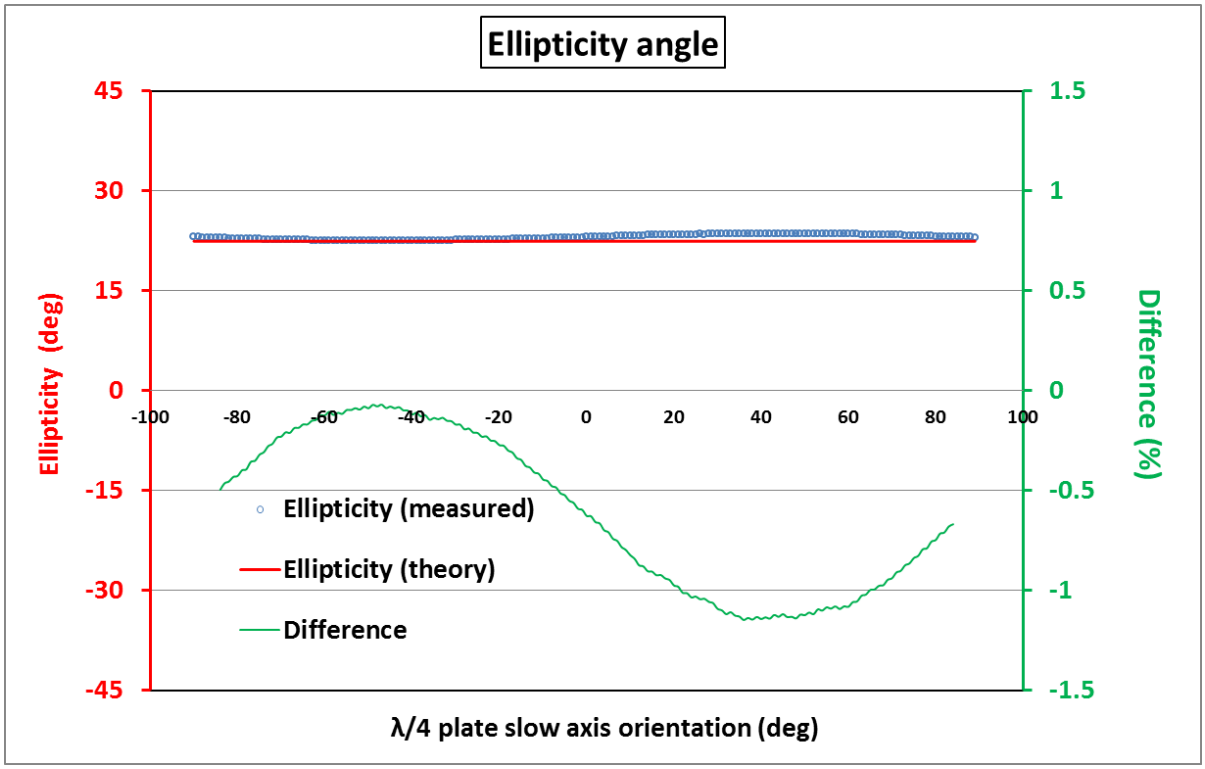
Deviation AOP P-V: 1.5°
Deviation AOP RMS: 0.4°

2.2.3 DOCP



Deviation DOCP P-V: 2.5%
Deviation DOCP RMS: 1%

2.2.4 Ellipticity

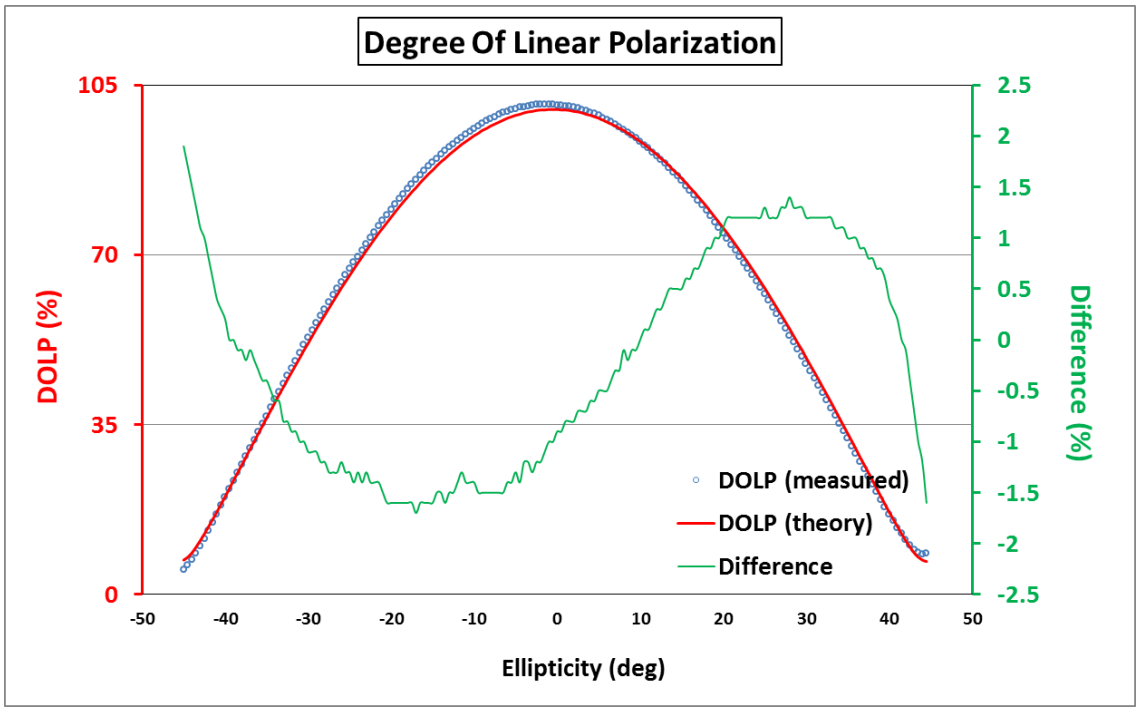


Deviation Ellipticity P-V: 1.2°
Deviation Ellipticity RMS: 0.4°

2.3 Elliptic polarization [2]: ε=[-45; 45°], AOP = 0°

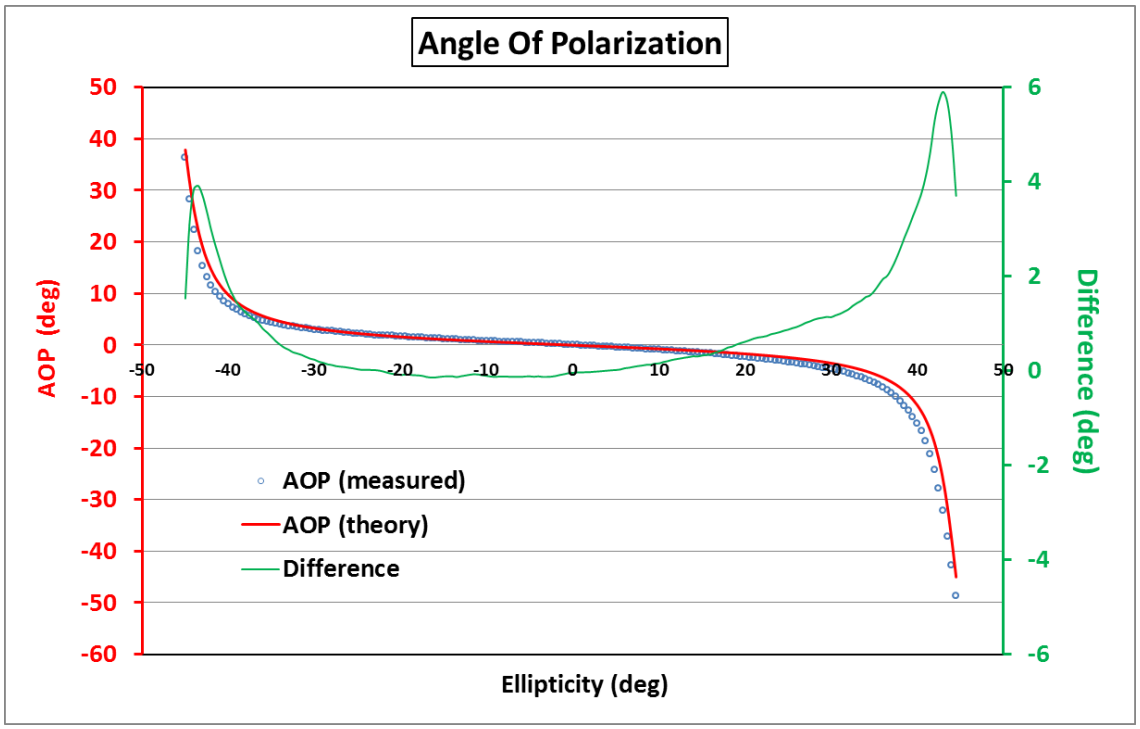
Here the AOP remains 0° while the linear polarizer's orientation goes from -45° to 45°. This generates elliptic states with an ellipticity angle from -45° (right-handed circular) to 45° (left handed circular).

2.3.1 DOLP



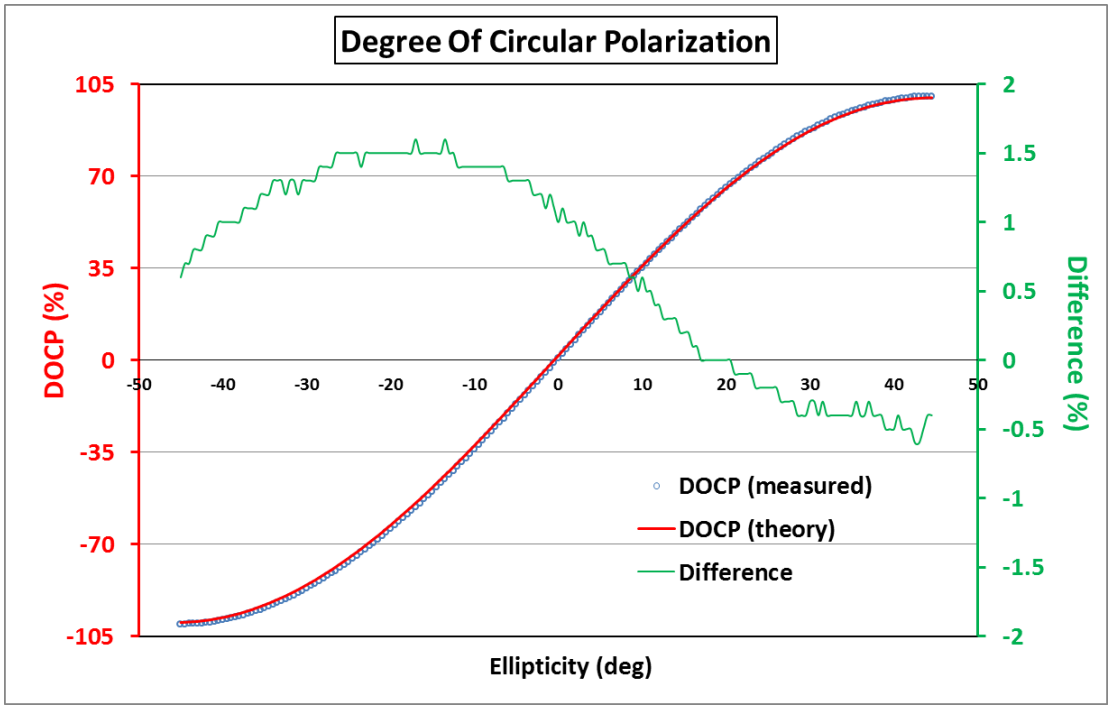
Deviation DOLP P-V: 3%
Deviation DOLP RMS: 1.06%

2.3.2 AOP



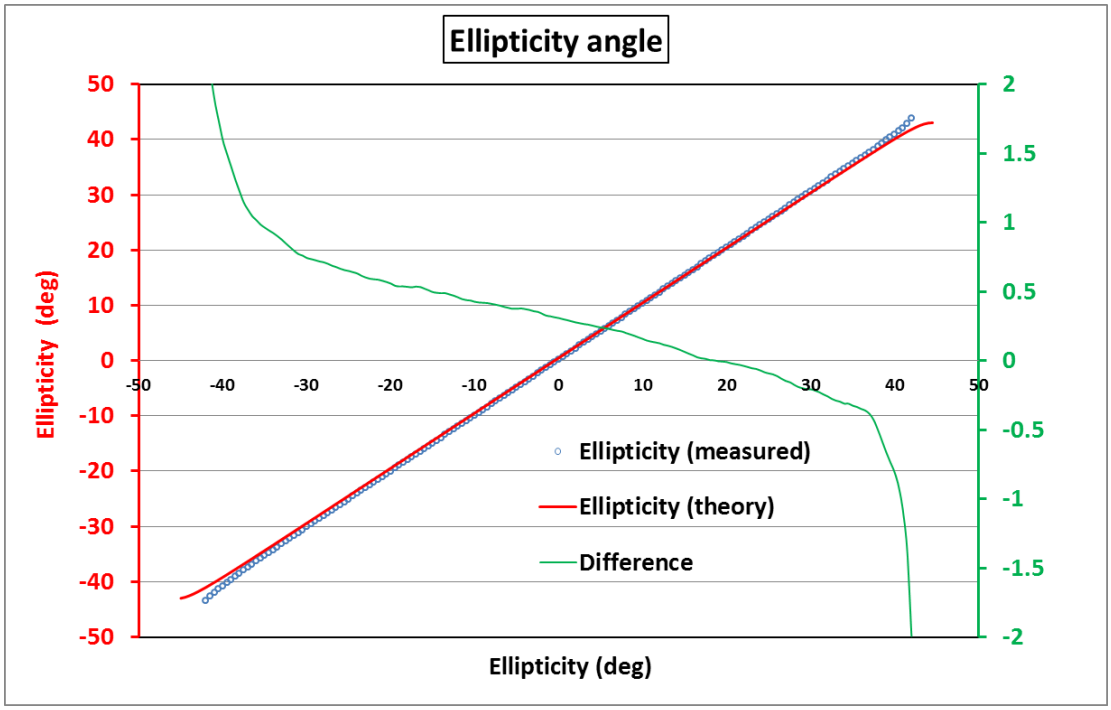
Deviation AOP P-V: 6°
Deviation AOP RMS: -

2.3.3 DOCP



Deviation DOCP P-V: 2%
Deviation DOCP RMS: 0.75%

2.3.4 Ellipticity



Deviation Ellipticity P-V: 4°
Deviation Ellipticity RMS: -

2.4 Result Summary

	Linear polarization		Elliptic polarization [1]		Elliptic polarization [2]	
	RMS	*PV*	*RMS*	*PV*	*RMS*	*PV*
DOLP (%)	0.80%	2.00%	1.20%	4.00%	1.00%	3.00%
DOCP (%)	0.30%	1.00%	1.00%	2.50%	0.75%	2.00%
AOP (°)	0.22°	0.85°	0.4°	1.5°	-	6°
Ellipticity (°)	0.1°	0.3°	0.4°	1.2°	-	4°