Supplementary Material- Deriving the General XSlit Lens Operator

We start with analyzing a single cylindrical lens. In the general case when the cylindrical lens is neither horizontal nor vertical, we assume it rotates θ off the x axis. Alternatively, we can rotate the uv and st coordinate by $-\theta$ but treat the lens as horizontal. By applying a rotation matrix $\mathrm{R}(\theta)$ on the horizontal CLO $\mathrm{C}_h(f)$, we have the general CLO $\mathrm{C}(f,\theta)$ as

$$
\begin{aligned}
[u_o, v_o, s_o, t_o]^\top &= \mathrm{R}(\theta)\mathrm{C}_h(f)\mathrm{R}^{-1}(\theta)[u_i, v_i, s_i, t_i]^\top \\
&= \mathrm{C}(f,\theta)[u_i, v_i, s_i, t_i]^\top \\
\text{where } \mathrm{R}(\theta) &= \begin{pmatrix} \cos\theta & -\sin\theta & 0 & 0 \\ \sin\theta & \cos\theta & 0 & 0 \\ 0 & 0 & \cos\theta & -\sin\theta \\ 0 & 0 & \sin\theta & \cos\theta \end{pmatrix} \\
\mathrm{C}(f,\theta) &= \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ \frac{-\sin^2\theta}{f} & \frac{\sin\theta\cos\theta}{f} & 1 & 0 \\ \frac{\sin\theta\cos\theta}{f} & \frac{-\cos^2\theta}{f} & 0 & 1 \end{pmatrix}
\end{aligned}
\tag{1}
$$

In the general case when the two cylindrical lenses are not orthogonal, we follow similar derivation in the POXSlit case and apply the general CLO . Assume the front lens forms angle θ_1 with the x axis and the rear lens θ_2. We apply the general C-LOs, $\mathrm{C}(f_1,\theta_1)$ and $\mathrm{C}(f_2,\theta_2)$, on the two cylindrical lenses. We then concatenate the transforms using the 2PP reparameterization matrix $\mathrm{L}(l)$. The General XSLO can be therefore written as

$$
\begin{aligned}
[u_o, v_o, s_o, t_o]^\top &= \mathrm{L}(l)\mathrm{C}(f_2,\theta_2)\mathrm{L}^{-1}(l)\mathrm{C}(f_1,\theta_1)[u_i, v_i, s_i, t_i]^\top \\
&= S(f_1, f_2, \theta_1, \theta_2, l)[u_i, v_i, s_i, t_i]^\top
\end{aligned}
\tag{2}
$$