

# Experimental observation of the geometric phase in nonlinear frequency conversion: supplementary material

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The design and fabrication of the nonlinear Mg:CLN poling patterns are illustrated in Figs. S1 and S2. In Fig. S1, the two designs for the wedge scheme are depicted for the case of the HG01 and lens crystals. In both designs, the apodization of the poling period (Fig. S1a) together with the variation of the domain length, ensures that the surface in parameter space on which the magnetic field equivalent  $\mathbf{B}$  is rotated becomes elongated, thus increasing the interaction bandwidth (see main text for further discussion). Figs. S1b1-2 depict the variation of the duty cycle and poling period at the beginning and end of the crystal for the HG01 design. Figs. S1c-d depict the corresponding transverse phase profiles.

For the circular rotation design, the variation of the poling period and duty cycle (Fig. S2a) and the phase profile (Fig. S2b) is different due to the different trajectory implemented. All three parameters are varied simultaneously to ensure that the vector  $\mathbf{B}$  resides on a sphere in parameter space (see main text for further discussion).

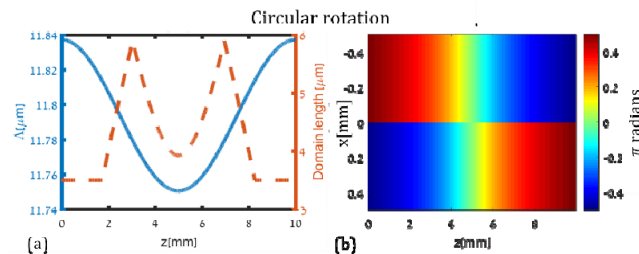


Figure S2: Crystal design for mode converter based on circular rotation. (a) duty cycle (domain length, orange) and poling period (blue) along the crystal. (b) the phase  $\phi$  along the crystal.

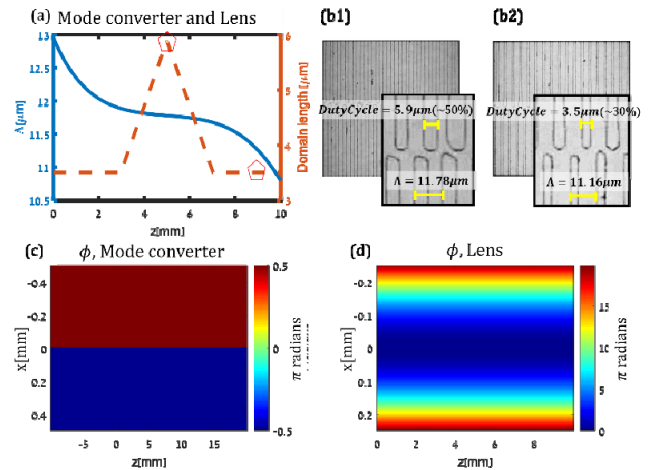


Figure S1: Crystal design for mode converter and lens, based on wedge rotation. (a) duty cycle (domain length, orange) and poling period (blue) along the crystal. (b1,b2) microscopic pictures of the wedged crystal in two different locations along the  $z$  axis, denoted by the red polygons in (a), (b1) for the centered one and (b2) for the right edge.

(c) and (d) the phase  $\phi$  along the crystal for the mode converter and the lens, respectively.