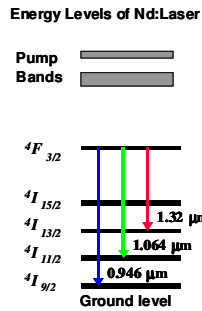


Project Title: Intracavity Frequency-Tripled 1319-nm Nd:YAG Blue Laser at 440 nm

PIs: Xiaodong Mu & Yujie J. Ding, Lehigh University

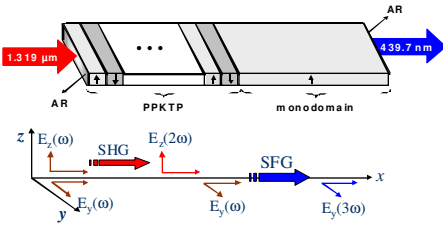
I. Introduction

- 1319-nm Nd:YAG laser
- Four-level system
- Low threshold
- Stable output
- 440-nm blue light after frequency tripling



II. KTP Blue Laser Converters

Mechanism



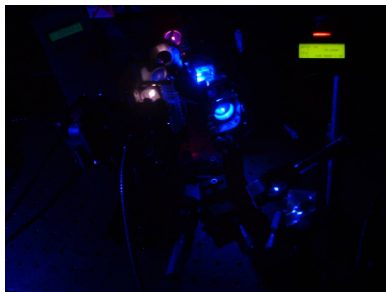
- PP-KTP for QPM SHG: $E_z(\omega) + E_z(\omega) \rightarrow E_z(2\omega)$
- Monodomain KTP for SFG: $E_z(2\omega) + E_y(\omega) \rightarrow E_y(3\omega)$

PP-KTP Used in Our Experiment

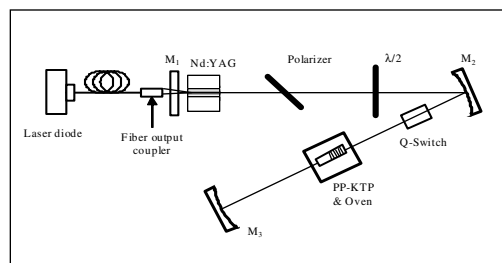
PPKTP	KTP length	KTP Length	Coating at PPKTP side	Coating at KTP side
KTP#1	5 mm	5 mm	HR at 660 & 440 nm AR at 1319 nm	HR at 660 nm AR at 440 & 1319 nm
KTP#2	10 mm	10 mm	HR at 660 nm AR at 1319 nm	AR at 1319 & 440 nm

- KTP#1 designed with Fabry-Perot cavity to increase pump intensity at 660 nm

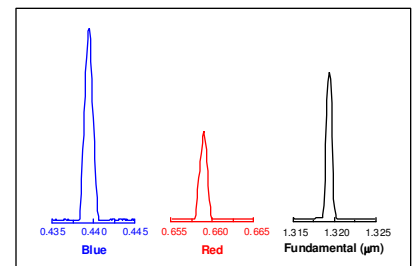
III. Diode-Pumped Coherent Blue-Light Converter



Setup for Intracavity Frequency-Tripling

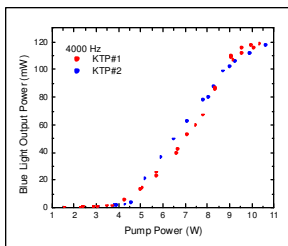


Spectrum of Blue-Light Output



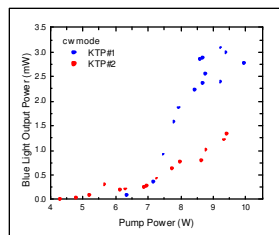
- Output wavelength at 439.5 nm, 659.2 nm, 1319.4 nm

Blue-Light Output at 4000 Hz



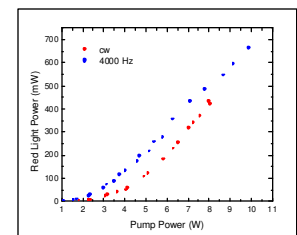
- 118 mW at pump power of 10 W
- Overall conversion efficiency 1.2%
- Blue light is enhanced by 3~4 times with Fabry-Perot cavity

CW Blue-Light Output



- 3 mW at pump power of 9 W
- Overall conversion efficiency: 0.3%

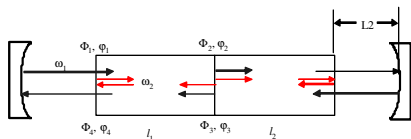
Coherent Red-Light Output at 660 nm



- 668-mW pulsed output with overall conversion efficiency of 6.7%
- 450-mW cw output with overall conversion efficiency of 5.7%

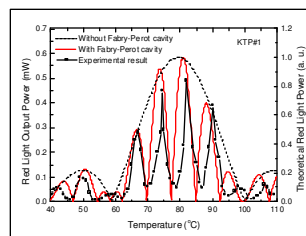
IV. Discussion

Intracavity phase-matching conditions for SHG with Fabry-Perot cavity



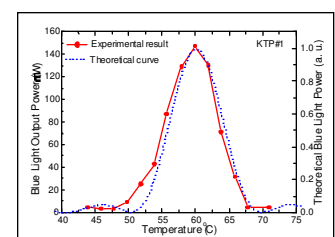
- $2\pi/\lambda = K_2 - K_1$
- $K_0 L_2 + K_1 (l_1 + l_2) = (2M+1)\pi/4$

Phase-Matching Temperature for SHG

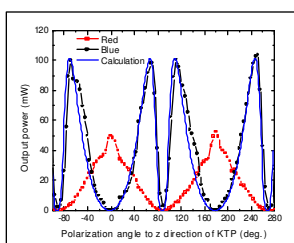


- With Fabry-Perot cavity at 660 nm, intracavity SHG has 4 narrow phase-matching peaks

Phase-Matching Temperature for SFG

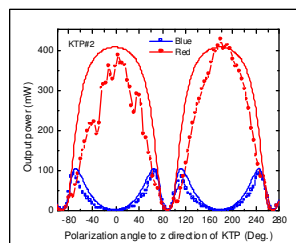


Pump Polarization vs. Output Power for KTP#1



- Maximum blue output at 70 degrees

Pump Polarization vs. Output Power for KTP#2



- Maximum blue output at 68 degrees

V. Conclusion

- Designed KTP-based coherent blue-light converters by frequency-tripling of 1319-nm emission line of Nd:YAG laser
 - SHG + SFG in one partly periodically poled KTP crystal
- Achieved high conversion efficiency for coherent blue light by using laser diodes as pump & based on mechanism of intracavity-frequency-tripling (dual-color output at blue and red)
 - Blue light: 118 mW at pump power of 10 W
 - Red light: 668 mW at pump power of 10 W
- Higher blue-light output power can be achieved in the future
 - Optimizing KTP length
 - Decreasing pulse width
 - Increasing pump power