Research Update: Frequency Doubled Laser

Cameron Johnson
University of Washington
8/11/2015
Motivation

- Want to study $D^0X$ transitions of impurities in ZnO nanowires
- Transitions happen at 3.357 eV and 3.360 eV
- Requires laser tunable to 369±0.5 nm

Second Harmonic Generation

- BiBO nonlinear crystal, second order term in expansion of electric susceptibility is non-trivial
- Second harmonic proportional to square of incident E field and has twice the frequency

- Critical phase matching is sensitive to crystal orientation
- Spatial walk off is biggest cause for lack of efficiency
- Higher power and larger beam diameter increases beam quality

\[
P \neq \epsilon_0 \chi E; \quad E(\omega) = E_0 \sin(\omega t)
\]

\[
P = P_0 + \epsilon_0 \chi^{(1)} E(\omega) + \epsilon_0 \chi^{(2)} E(\omega)^2 + \cdots
\]

\[
P^{(2)}(\omega) = \epsilon_0 \chi^{(2)} E(\omega)^2 = \frac{\epsilon_0}{2} \chi^{(2)} E_0^2 (1 - \cos(2\omega t))
\]

\[
\Rightarrow E_{SHG}(2\omega) \propto P^{(2)}(\omega)
\]
• L1: f = 200mm crystal focusing lens
• L2: f = -25mm beam expanding lens
• L3: f = 200mm expanded beam collimating lens
• L4: f = 250mm re-focusing lens
• L5: f = -50mm re-collimating lens
• F1: 370nm+/-20nm single band filter
• FC1: Output fiber coupling

• M1: B Coated Mirror
• M2: A Coated Mirror
• I1: Optical Isolator
• C1: BiBO Crystal
369 nm Light

- Hard to get good beam quality, spatially maxed in enclosure
- Two modes out of the crystal (unresolved)
- Almost 20% efficiency SHG, 1.3 W 738 nm pump beam to 240 mW 369 nm light
- 15% efficiency fiber coupling, 150 mW input to 24 mW output
- At least 50% attenuation for all B-coated optics
Current Problems

• Ti:Sapphire is having stability issues
  – Won’t mode lock at max power regardless of pump power
  – Hard to find mode lock after tuning wavelength

• Tuning wavelength of Ti:Sapph causes beam steering, 0.5 nm adjustment -> 25% fiber loss