Dispersion Compensation in Mode-locked Thulium/Holmium Doped Fiber Laser

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Mid-infrared Ultra-short Pulse Lasers

…can measure ultra-short timescales!
  • Chemical reactions
  • Biological processes
  • etc.

…can measure absorption over a wide wavelength range!
Mode-locking
Group Velocity and Third-order Dispersion

\( \beta_2 \) - Group velocity dispersion parameter
- Related to 2nd derivative of Sellmeier equation

\( \beta_3 \) - Third-order dispersion parameter
- Derivative of \( \beta_2 \) with respect to frequency
Dispersion Management
(Dispersion Management, cont.)

Net Cavity GVD (with no compensation fiber)

\[
\beta_{2,\text{TM}} L_{\text{TM}} + \beta_{2,\text{SMF}} L_{\text{SMF}} = (0.01 \text{ ps}^2 / \text{m}) (1.24 \text{ m}) + (-0.085 \text{ ps}^2 / \text{m}) (4.46 \text{ m}) = -0.366 \text{ ps}^2
\]

Net Cavity TOD (with compensation fiber)

\[
\beta_{3,\text{TM}} L_{\text{TM}} + \beta_{3,\text{SMF}} L_{\text{SMF}} + \beta_{3,\text{UHNA7}} L_{\text{UHNA7}} = 0
\]
Ultra-high Numerical Aperture Fiber

Required UHNA-7 Length

\[ L_{UHNA7} = \frac{NCD - \beta_{2, TM} L_{TM} - \beta_{2, SMF} L_{SMF}}{\beta_{2, UHNA7}} \]
Laser Setup
Spectrum: No UHNA-7

Spectrum 1 for Tm/Ho laser (1983nm)

Spectrum 2 for Tm/Ho laser (2028.5nm)
Spectrum: with UHNA-7

Length of Tm/Ho fiber: 1.24m
Length of UHNA-7: 2.889m
Length of SMF: 3.628m
**TOTAL cavity length:**
\[ L = 7.757 \text{m} \]

Total cavity length from repetition rate:
\[ \gamma = \frac{c}{n} = \frac{L}{T} \]
\[ L = 7.85 \text{m} \]
Single Peak
What’s Next?

- Temporal pulse measurements
- Cut back UHNA-7 and see how the pulse changes
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References
