

2.5-W single-frequency Tm,Ho:YLF ring laser

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- **Potential uses of multiwatt 2-um SLM laser light**
- **Specifications of system under development**
- **System design**
 - **Thermal management**
 - **Cavity layout**
 - **Performance as a function of crystal geometry**
- **System ruggedization**
- **Conclusions**



Funding

- **Advanced Research Projects Agency**
 - **SBIR Phase II**
 - **Contract #DAAH01-94-C-R012**
- **NASA Marshall**
- **Lockheed Martin**
 - **Subcontract ST30G4120M**

- **Ground State Absorption**
 - **Bleachable loss: proportional to laser mode volume in crystal and Holmium ion density.**
 - **Affects threshold of laser**
- **Up-conversion**
 - **Rate proportional to inversion density**
 - **Reduces effective upper-state lifetime**
 - **Affects threshold and slope**
 - **Limits maximum pumping level per unit volume**
- **Tm - Ho transfer rate/ inversion partition function**
- **Thermal lensing/ fracture**

ALL ARE TEMPERATURE DEPENDENT!



Potential uses of multiwatt 2-um SLM laser light

- **CW Coherent lidar**
 - Range out to 500 m
 - Wake vortex detection, wind mapping
 - Vibration monitoring (bridges)

- **Coherent Imaging**



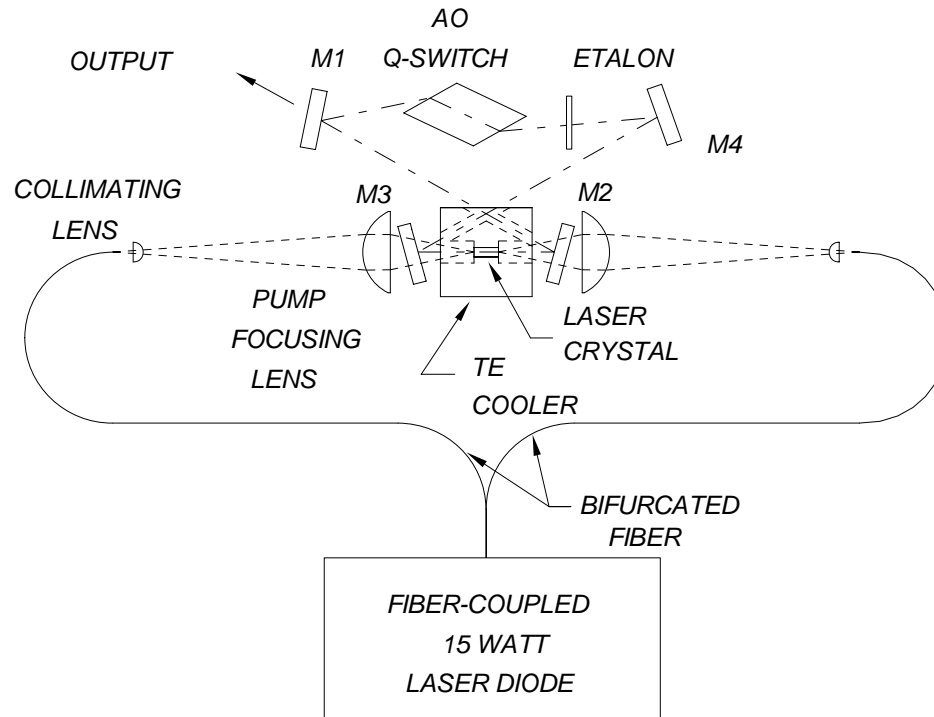
Specifications of system under development

- **>1 W single frequency laser**
- **<50 kHz linewidth (over 50 us)**
- **No mode hops over 1 hour of operation**
- **Low amplitude noise**
- **Operable on a Naval ship board environment**



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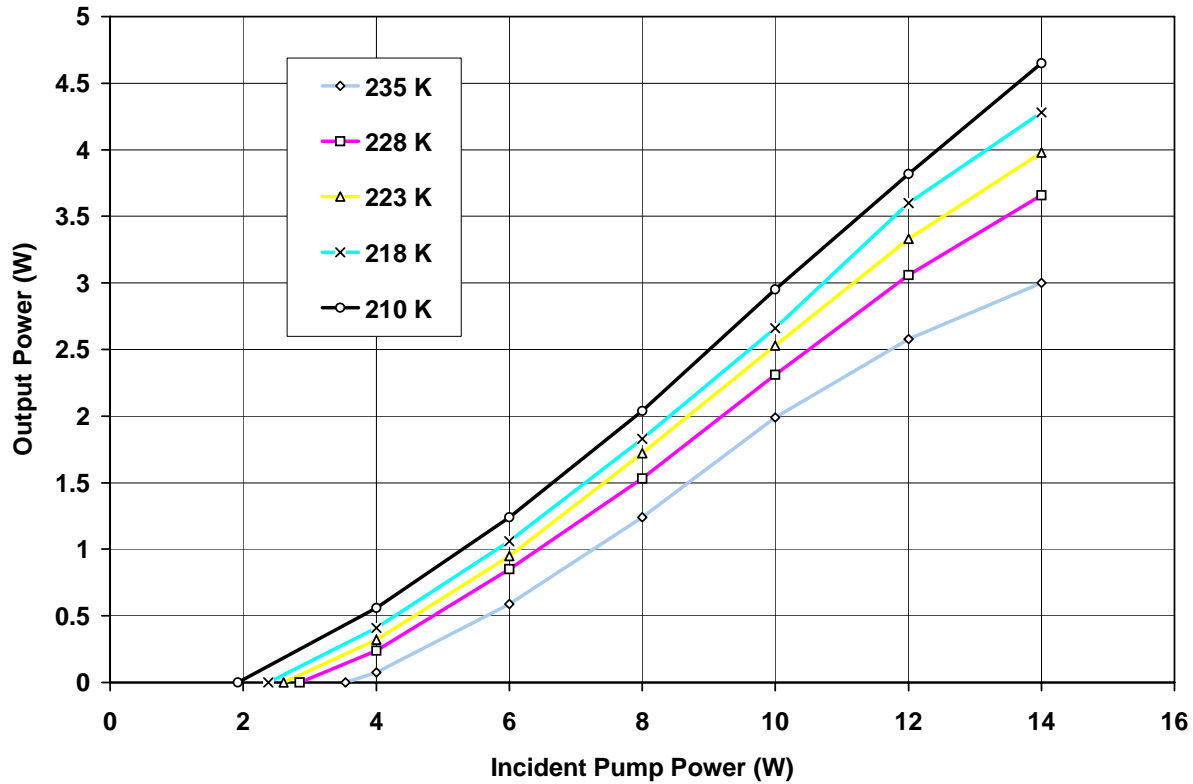
Schematic of Tm,Ho:YLF Ring Cavity





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Multi longitudinal mode CW performance of Ho,Tm:YLF ring laser vs temperature

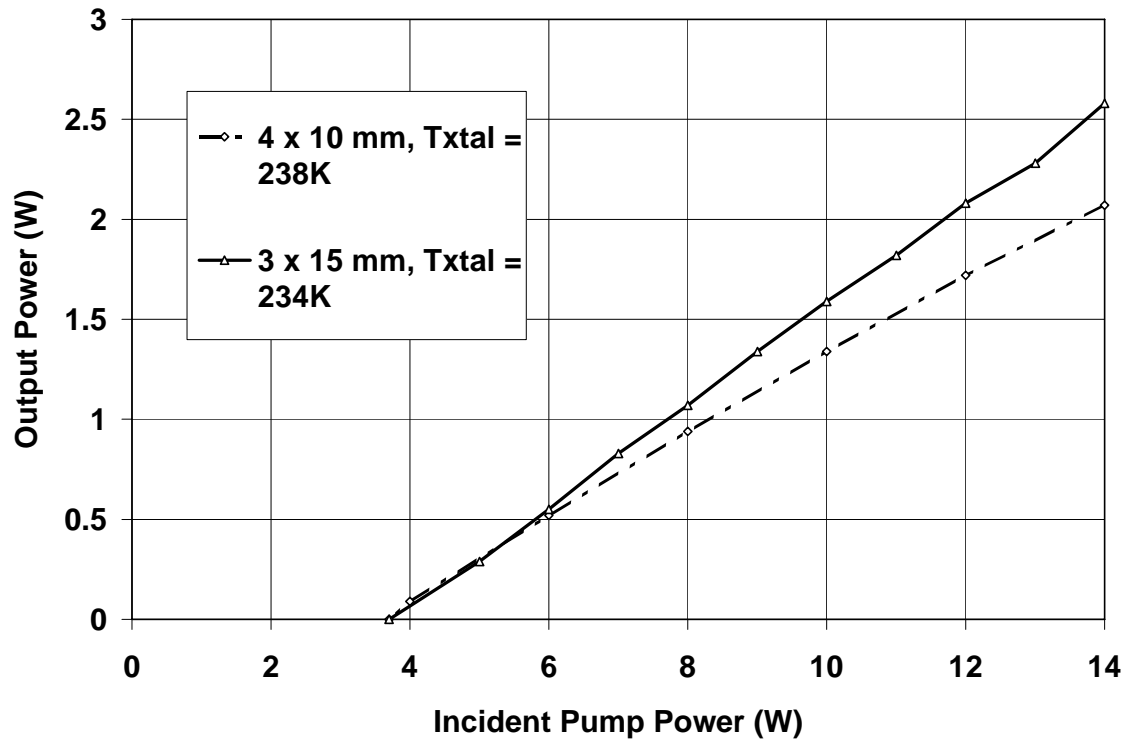


- **Previous work in Nd: Laser:**
 - W.A. Clarkson, A.B. Nielson, and D.C. Hanna, Opt. Lett. 17 601 (1992).*
 - M. K. Reed, W. K. Bischel, Opt. Lett. 17 691 (1992).*
- **Basic concept**
 - Operate modulator slightly away from Bragg angle to generate a differential loss between forward and reverse directions
 - Apply sufficient RF power to suppress one direction
- **Draw back:**
 - RF introduces effective insertion loss in the unsuppressed direction which is typically higher than Faraday based optical diodes
- **Advantages:**
 - Adjustable differential loss to accommodate feed back effects



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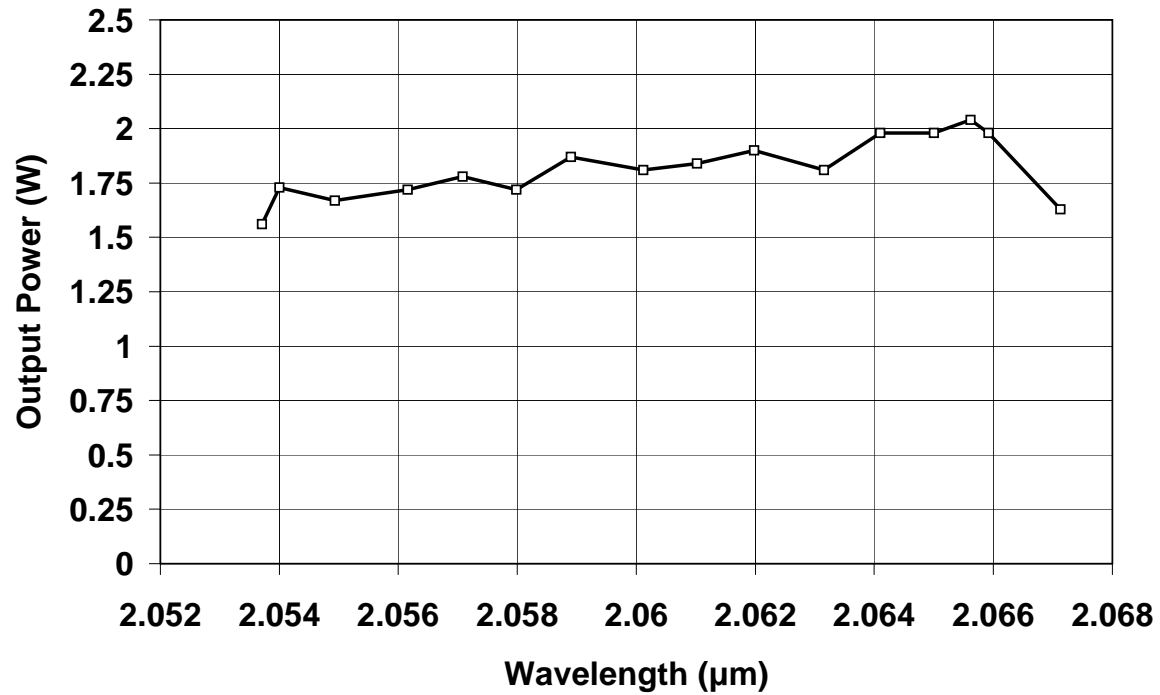
SLM CW performance as a function of crystal geometry





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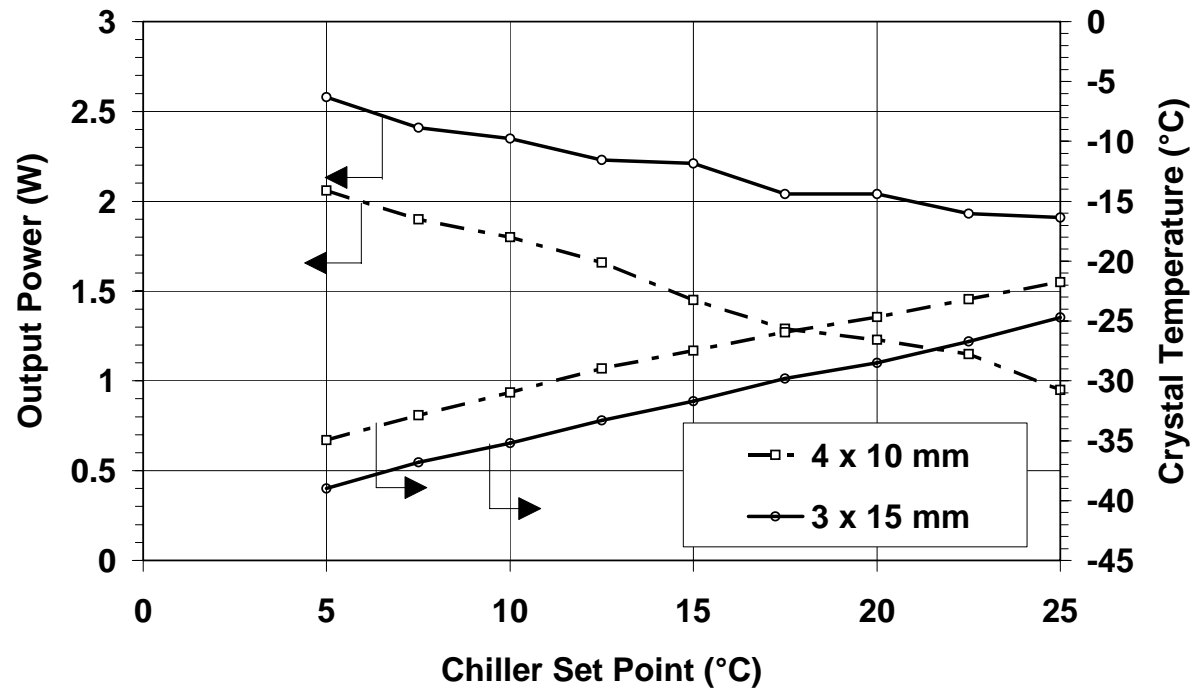
Tuning curve of Tm,Ho:YLF ring laser





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SLM performance and crystal barrel temperature as a function of chiller set point



- **System to be mounted on a user supplied cold plate maintained at $20 \pm 5^{\circ}\text{C}$**
- **Build whole cavity from Super Invar for temperature stability**
- **Hard mounted cavity optics**
- **Control laser crystal and Etalon temperature to better than 0.1 degrees**

- **AO modulator proved very reliable unidirectional device for 2-um applications**
- **Demonstrated >2.5 W SLM output from Tm,Ho:YLF laser**
- **Higher powers should be available by enhanced wing pumping**
- **Ring cavity design is a generic Lidar transmitter design which can operate as multi - mJ Q-switched or multi-Watt CW Single-frequency source**