A high power frequency doubled fiber laser

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The research described in this paper was carried out by the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration.

Goal: Develop a high power 780 nm laser suitable for space applications of laser cooling

•Three LCAP experiments, RACE, CLASS and QuITE, require high power 780 nm lasers

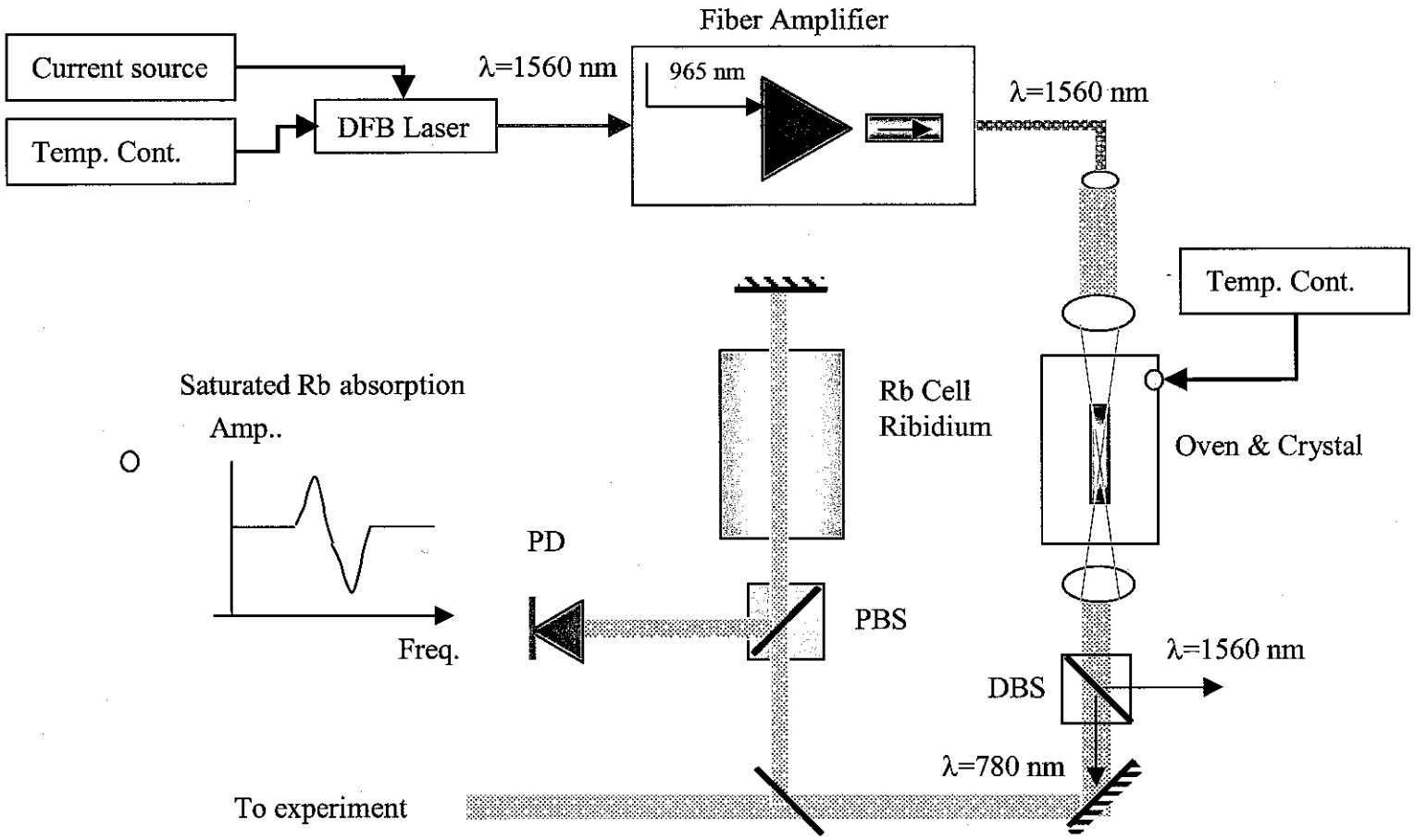
•Currently no suitable lasers are commercially available

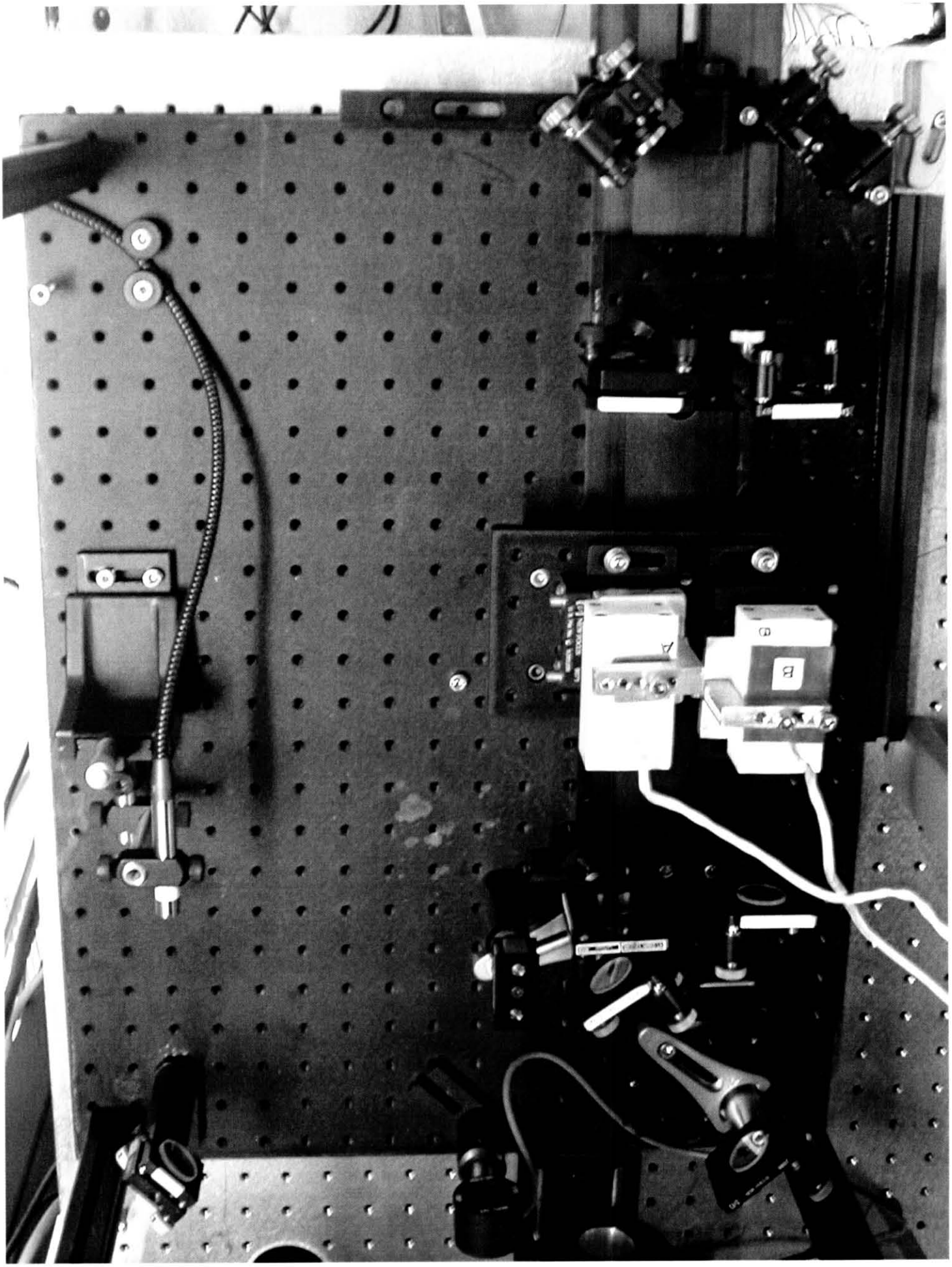
•Requirements include high power (>500 mW), narrow linewidth, high electrical efficiency, ruggedness, and reliability

A possible solution: frequency doubling of high power 1560 nm telecom lasers

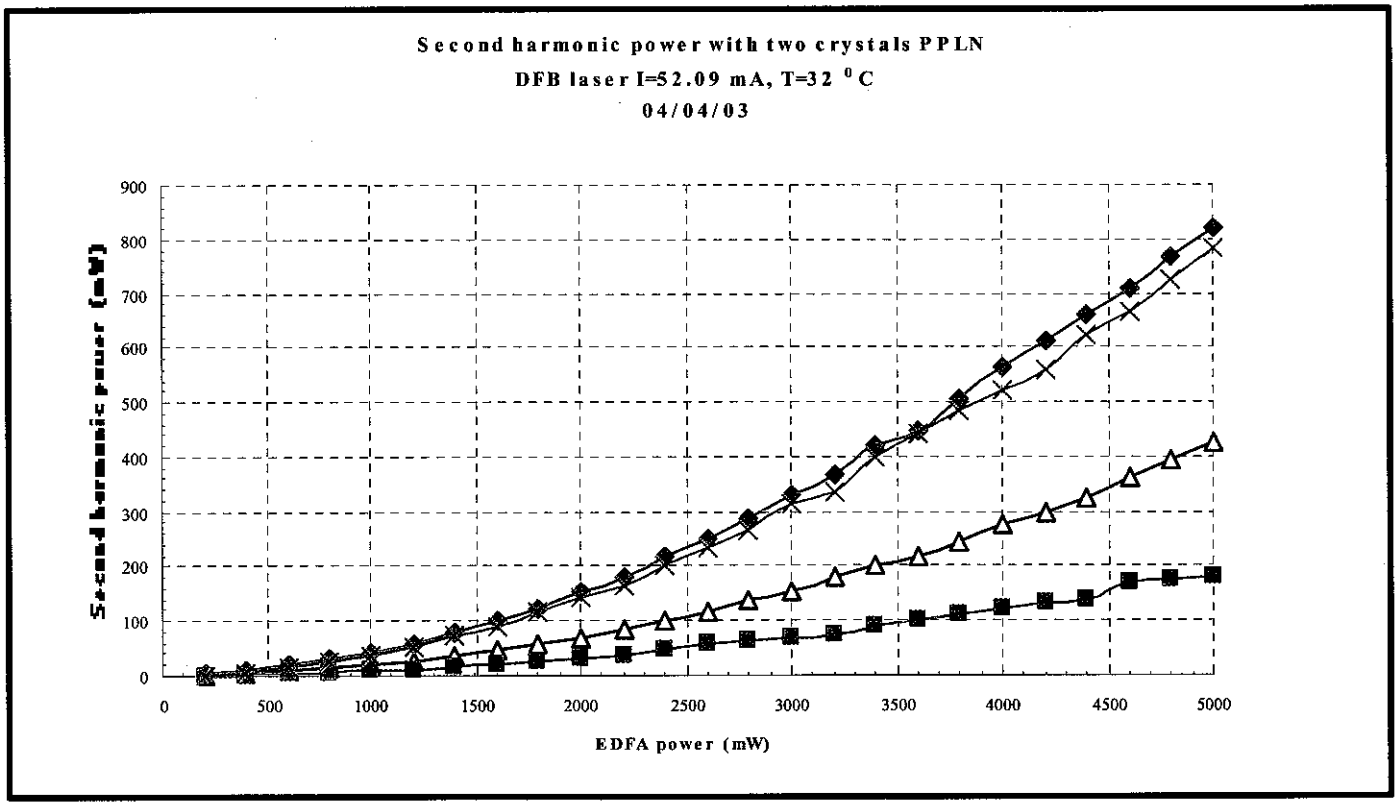
01/22/03

Frequency Conversion Diagram




A
B

Second Harmonic Generation in One Crystal



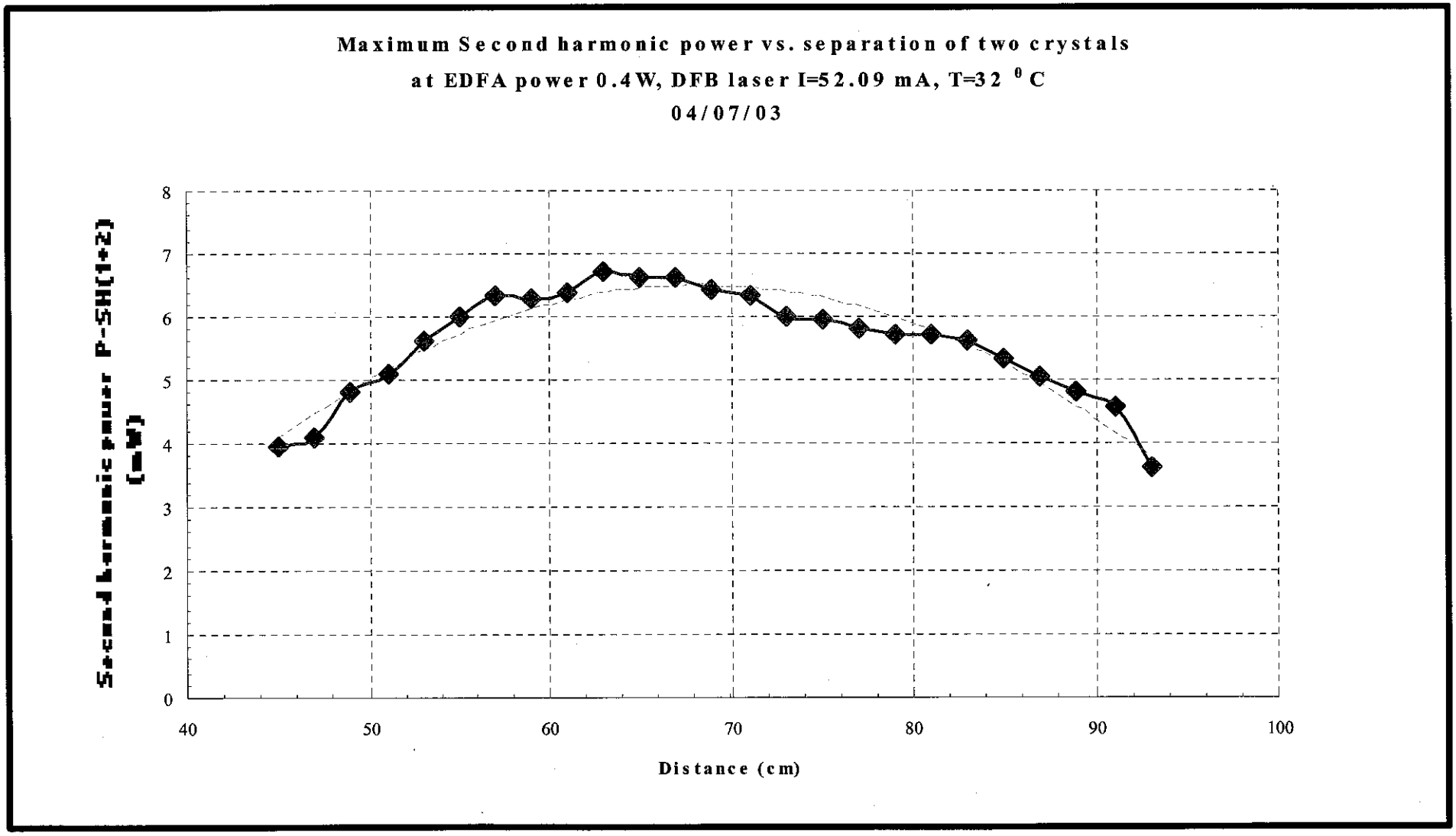
Cascading Crystals

- **Second harmonic power is proportional to the length squared of the crystal, divided by the area of the pump beam. Using a longer crystal increases the power only linearly, since you can't focus as tightly in a longer crystal.**

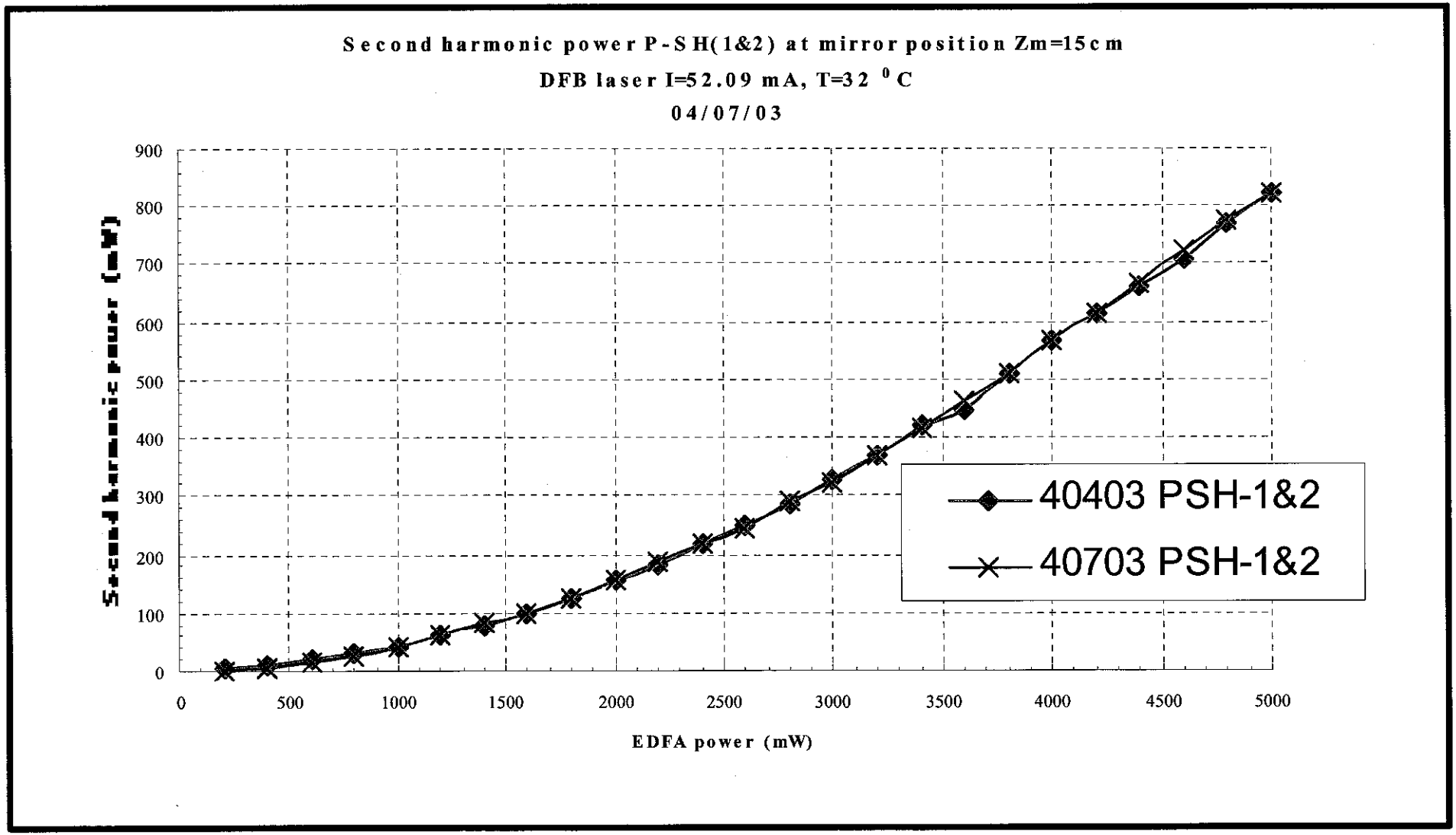
- **Refocusing the crystal into another crystal allows you to effectively increase the length without increasing the area of the focus. Ideally (optimal focusing and no losses), two crystals will give four times the power of one.**

- **In some cases, this can be a reasonable alternative to a build-up cavity.**

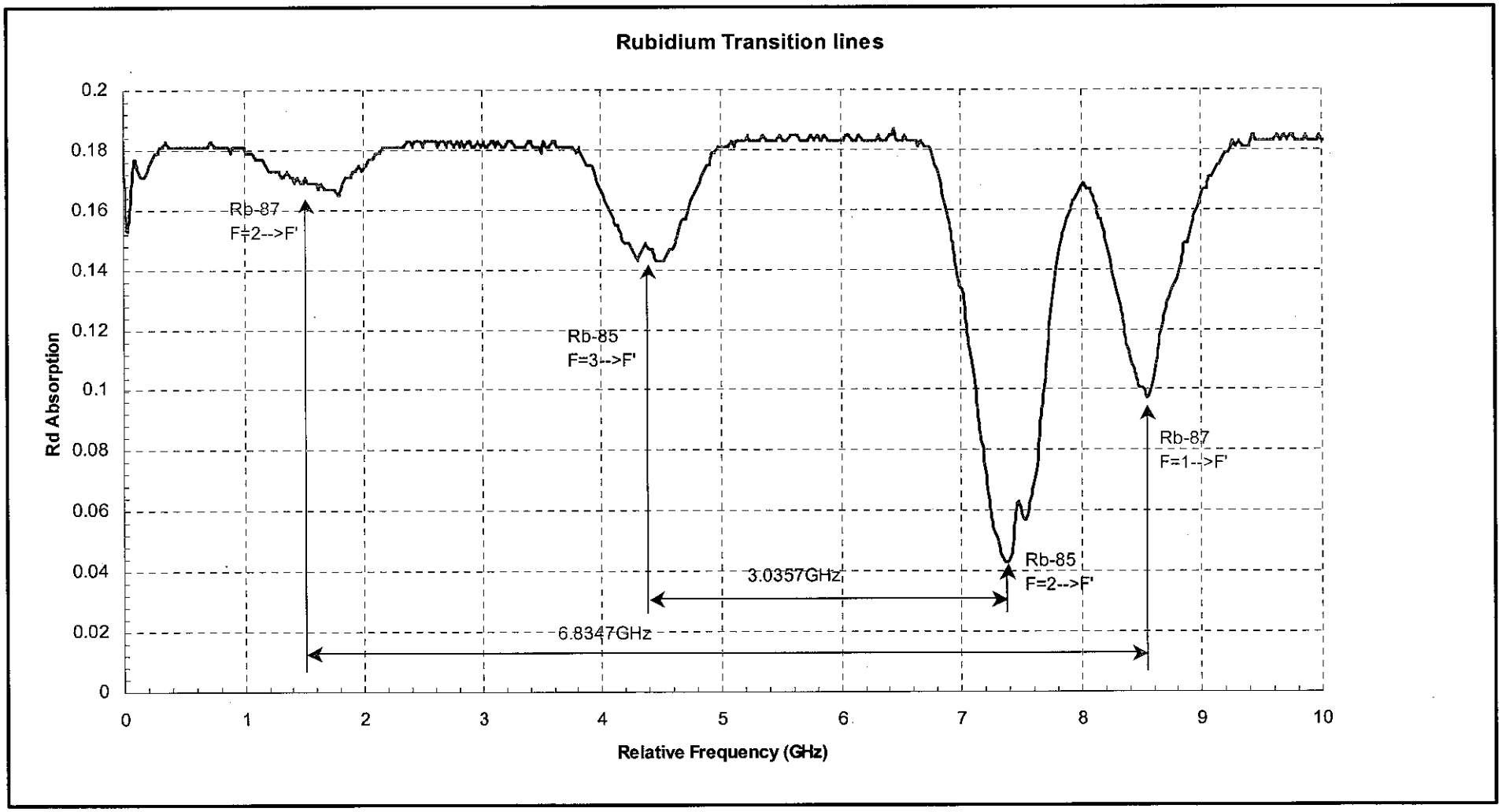
Second Harmonic Power as a Function of Distance Between Crystals



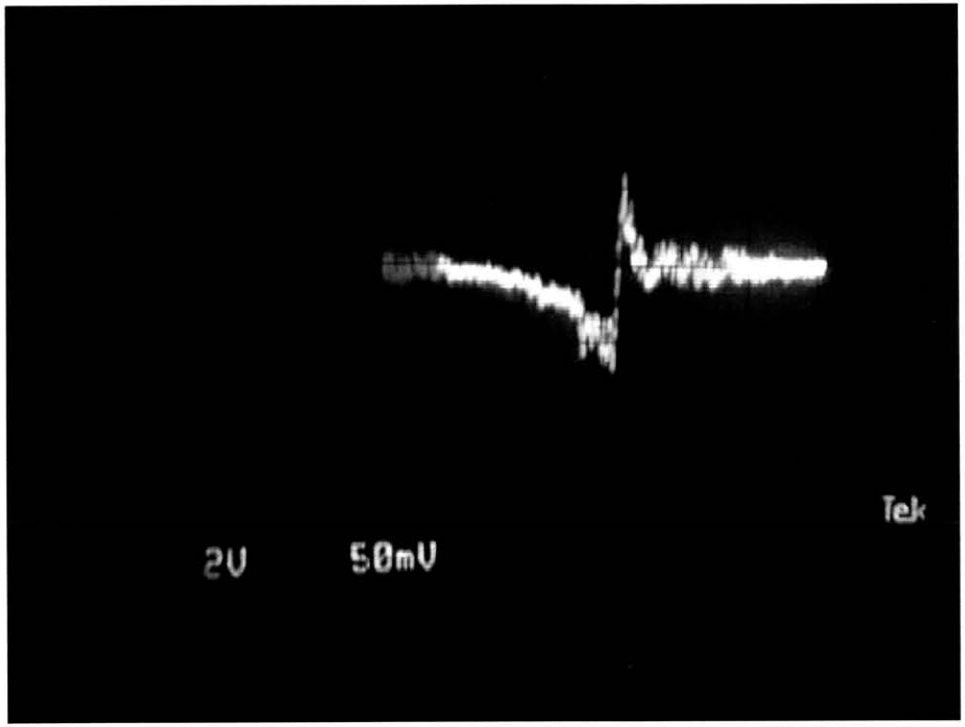
Second Harmonic Power Vs. Pump Power



Tunability of Laser System



Rubidium 87 D2 error signal



Laser Cooling Images

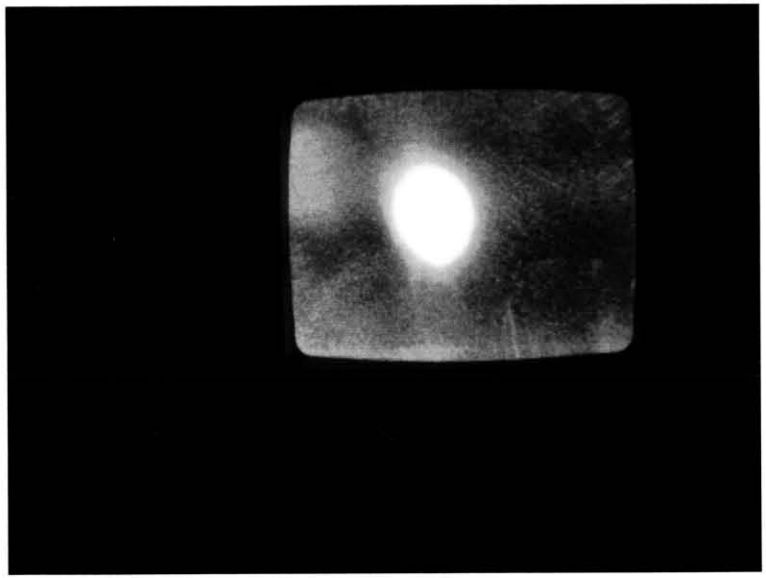


Image of UHV MOT

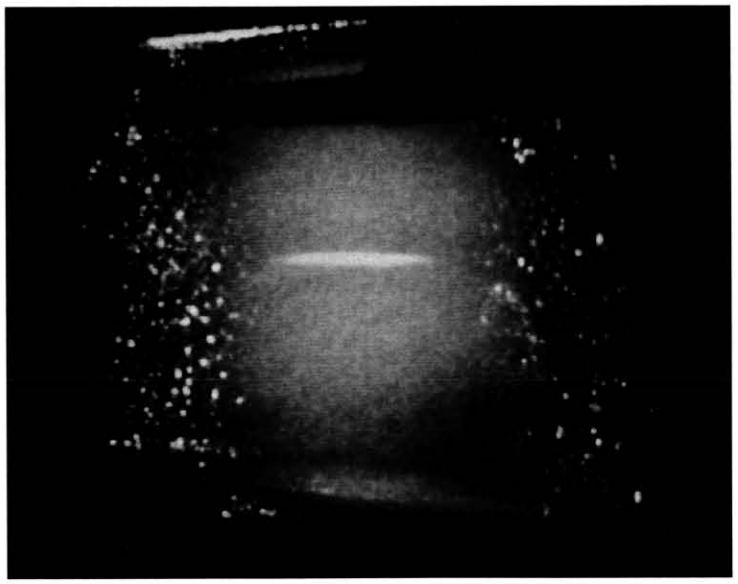
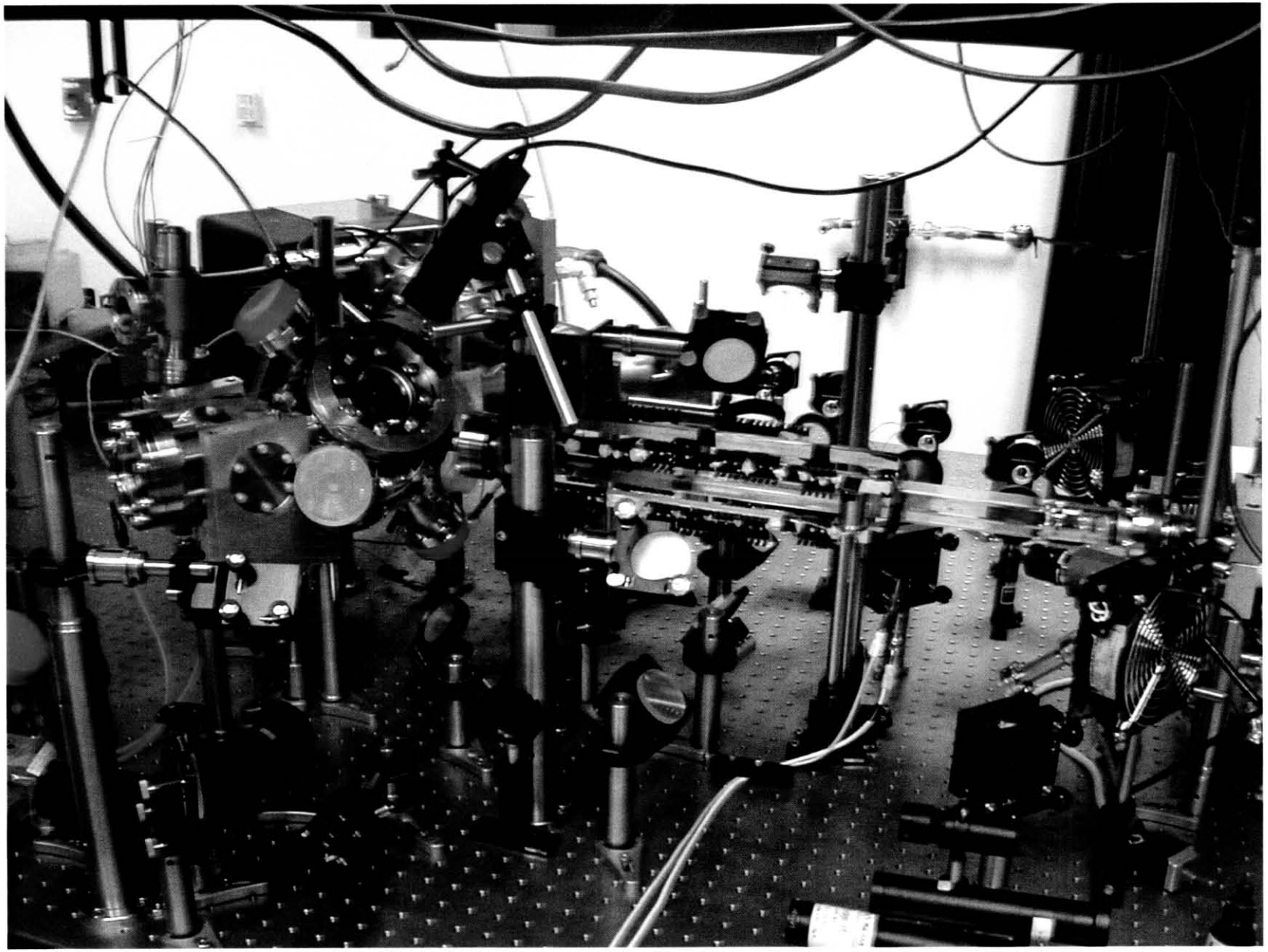


Image of 2-D MOT

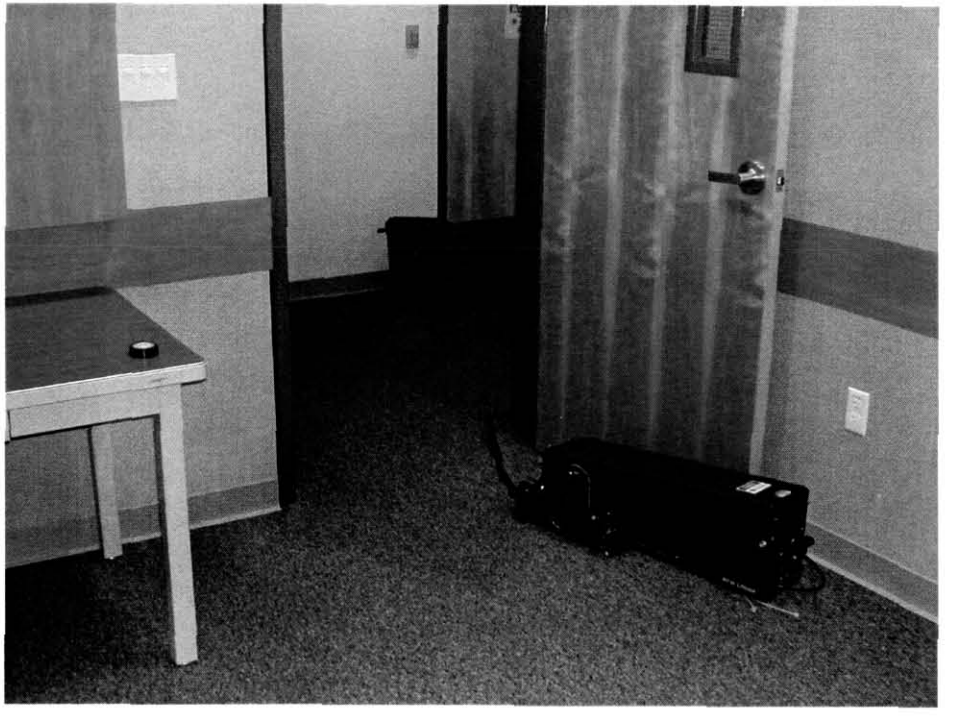
Using the doubled laser in a laser cooling experiment



Future Work

- **Replace DFB seed laser with ECDL laser**

- **Explore other wavelengths. High power fiber lasers are available at 1178 nm, 1340 nm**

- **In particular 589nm is of significant interest for laser guide stars**

- **Find new applications for existing Ti:Sapphire systems**