NREL
NATIONAL RENEWABLE ENERGY LABORATORY
Innovation for Our Energy Future

NREL's LASER Safety Program 5 years after Eye Injury Event

DOE LSO Workshop

Barb O'Kane

Deana Luke

July 27, 2010

1:20-1:50 pm

NREL Research

Solar

Wind

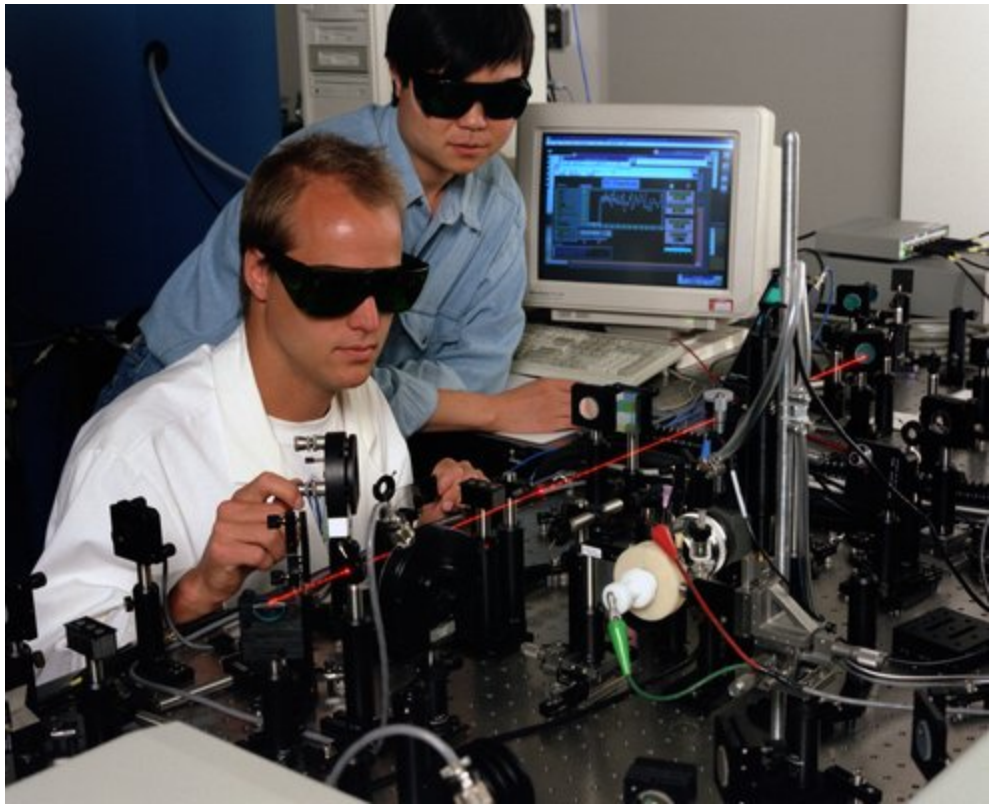
NREL Research

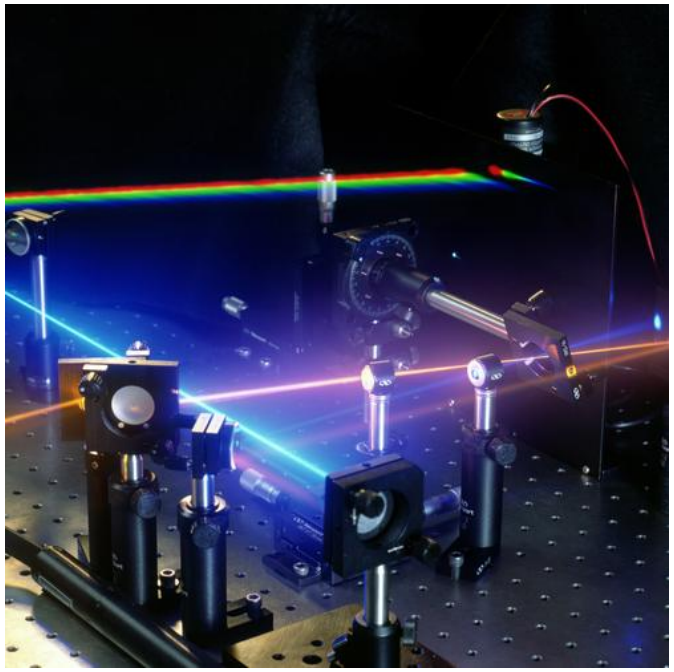
Transportation

Hydrogen Technology

Alternative Fuels
& Biomass

LASERS at NREL





Characterization, modeling, material production (nanoparticles), deposition systems

Laboratory Status

Aspect	2005	2010
Lab population	1200	2050
# of 3B/4 Laser Systems	84	160 in use (192 registered)
# of Laser Labs	26	35
# of Laser Operators	80	120
Laser Safety Support	1	CLSO, Alternate LSO
% of open-beam systems	33%	25%

Event description – From ORPS Summary

January 19, 2005 National Renewable Energy Laboratory - Golden Field Office

A researcher sustained a retinal burn to his right eye while operating a Class 4 Yttrium Aluminum Garnet laser. At the time of the incident, the researcher and his team leader were testing new sample instrumentation when a problem occurred with the instrumentation. While the team leader went to another part of the lab to obtain a different test sample, the researcher removed the neutral density filters to obtain a response from the test sample using full beam power. The researcher was not wearing his eye protection as he manipulated the test sample with a pair of stainless steel tweezers. At this point, he experienced seeing a flash of light off the test sample. (ORPS Report GO--NREL-NREL-2005-0001)

Report publically available:
https://orpspublic.hss.doe.gov/orps/reports/displayReport2.asp?crypt=%87%C3%95%9Ba%94zisb

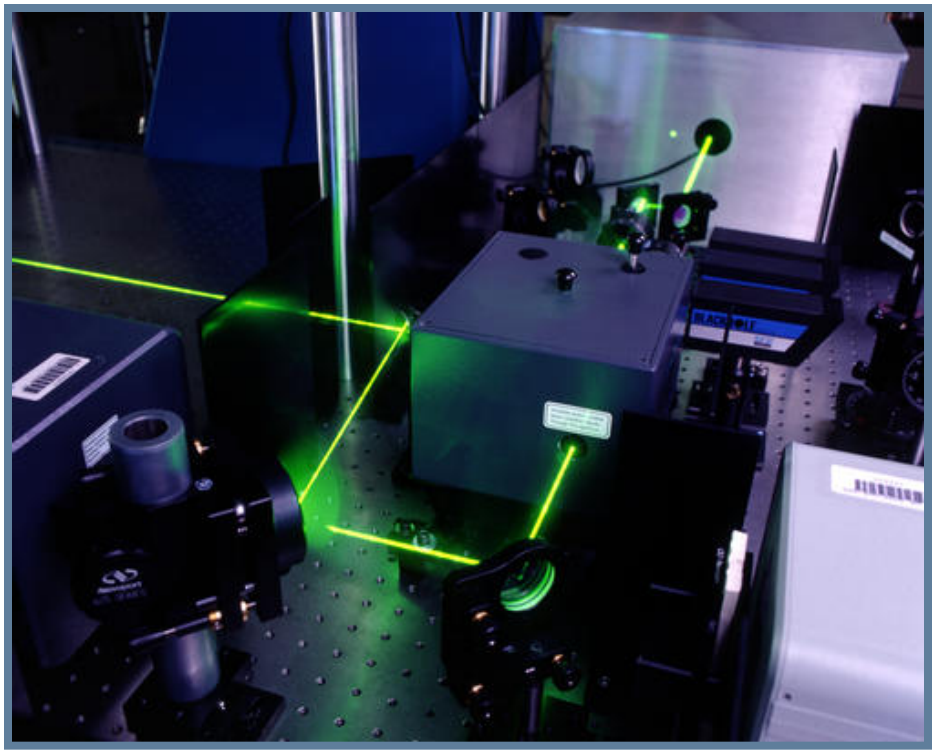
Laser Information

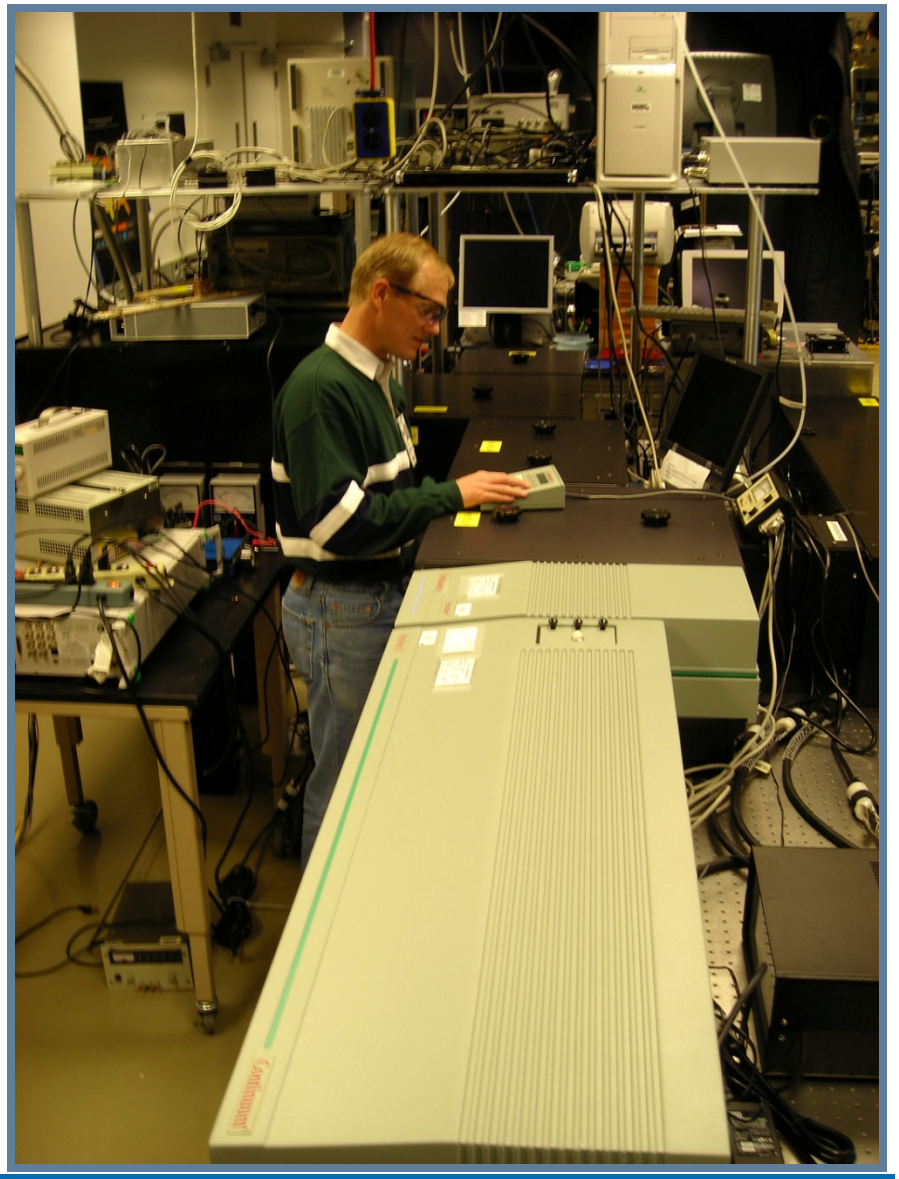
Minority Carrier Lifetime Measurement and Time-Resolved MW Conductivity

Class 4 lasers – Nd:YAG; OPO

Beam paths are now enclosed

Operated as a Class 1 system





Corrective Actions, per report

1. Improve mentoring and lab supervision
2. Increase the level of Laser Safety learning
3. Verify completion of laser safety and site specific training (recordkeeping)
4. Perform comprehensive assessment of Laser Program
5. Revise SOP format
6. Strengthen LSO support
7. Restart process (took 6 months to get everyone back up)

Training & Mentoring

Book/Classroom learning

- On line computer based training
- Using LLNL course
- Refresher training every 2 years

Hands on training & mentoring

- Mentoring responsibilities defined in procedure
- Appoint Laser System Supervisors – knowledgeable and willing to take the time to train others
- LSS works with all new laser operators
- Qualification process with LSS and line manager

Program Assessments and Improvements

Written Program Improvements

"Quick Reference Guide" – the how to on one page

Roles and responsibilities better defined

Easy to use and reference SOP template

Assessments

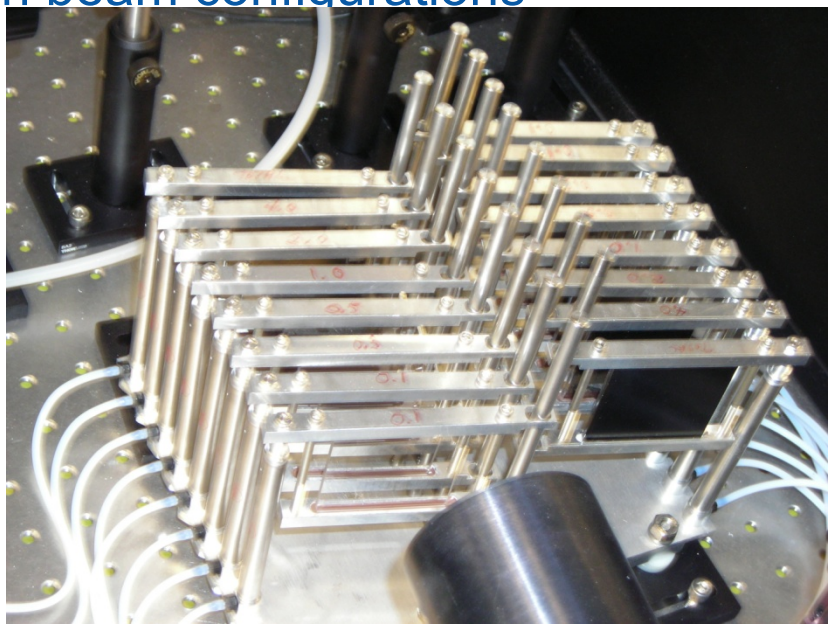
External assessments every couple of years

Self assessments by every 3B/4 laser lab annually

Spot check a subset annually

In Addition to Corrective Actions Other Good Stuff

1. Strong management support continues
2. Laser Safety Panel
3. Additional help – ALSO
4. SOP improvements
   - LOTO section
   - Semi-annual inspections for eyewear and interlocks
5. New systems being designed with full enclosures
6. Creative staff find ways to avoid open beam configurations



Can’t Relax – We still have bumps in the road

Laser Lab Entry Events

“New eyes” see things –

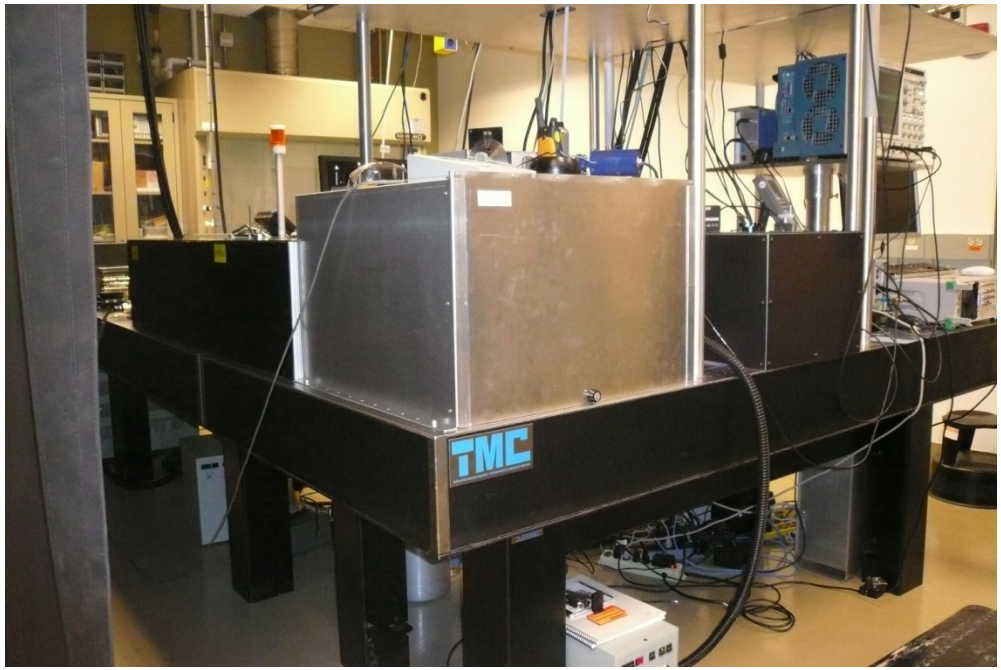
SERF E134 (800 nm output & LPE)

SERF E217 Qualification and LPE Use

The latest continuous improvement effort – Laser Safety Initiative Fund

Money awarded by EHS office for laser safety improvements.

Awardees selected by laser safety panel.



Proposal Requirements

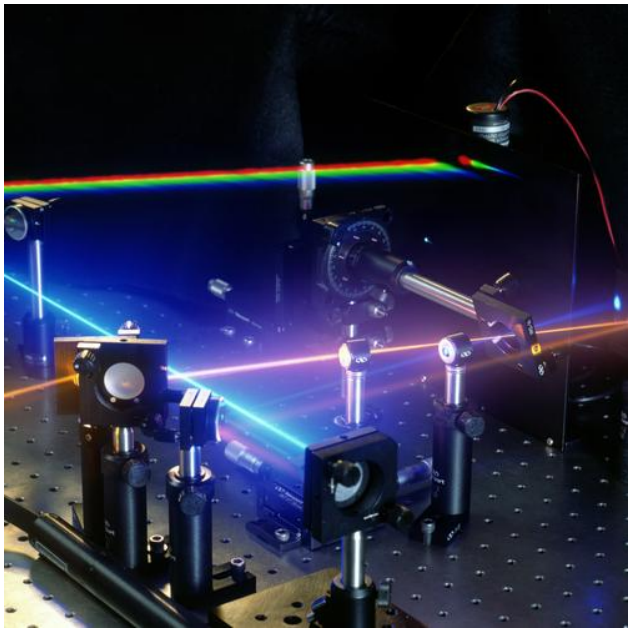
Laser systems must contain Class 3B or 4 lasers

Improvement must:

- Decrease level of risk to lab staff

  OR

- Increase efficiency and ease in complying with NREL and ANSI laser safety requirements



2009 Budget was $22,000

4 projects were awarded

LSIA Project #1

Laser Scribing System

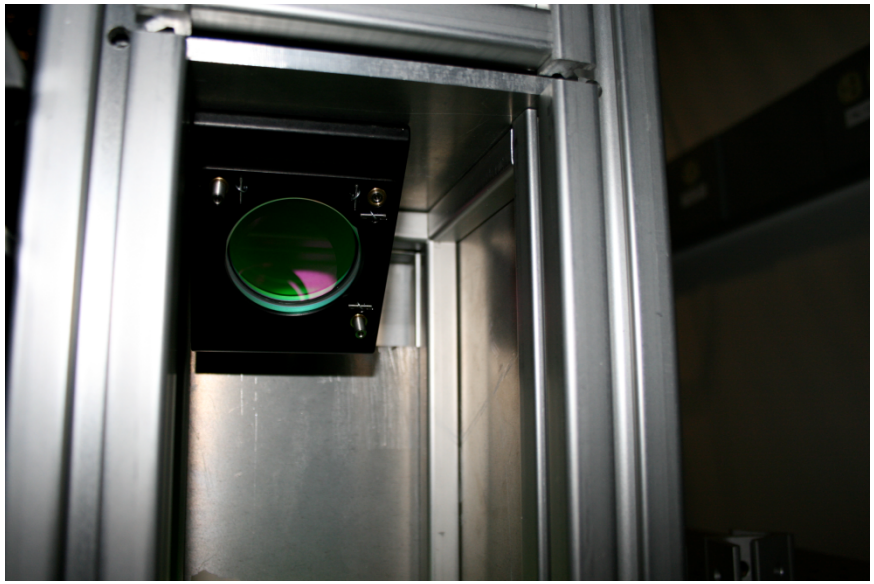
Class 4 Nd:YAG Pulsed Laser System

Improvement allows for laser alignment while beam is fully-enclosed using cameras to view beam location

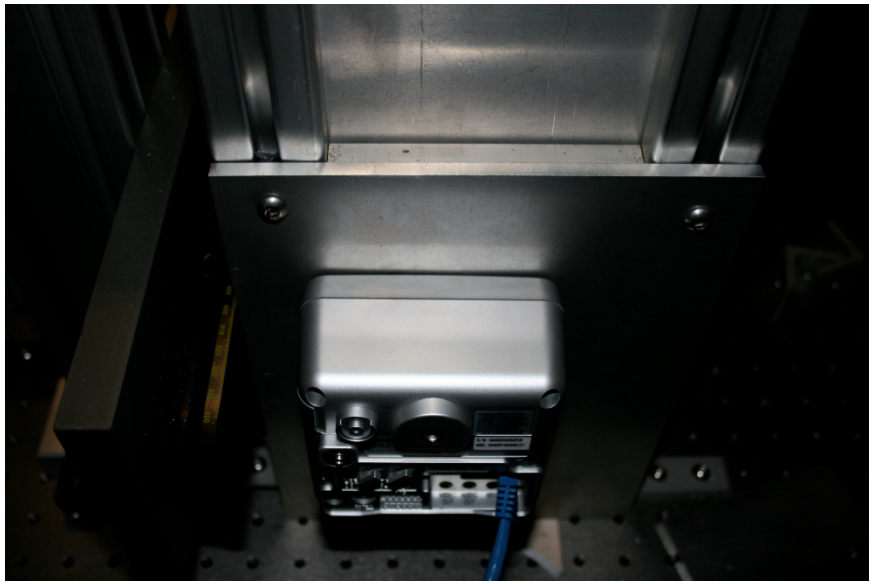
Total Cost $3600

2nd Mirror Setup

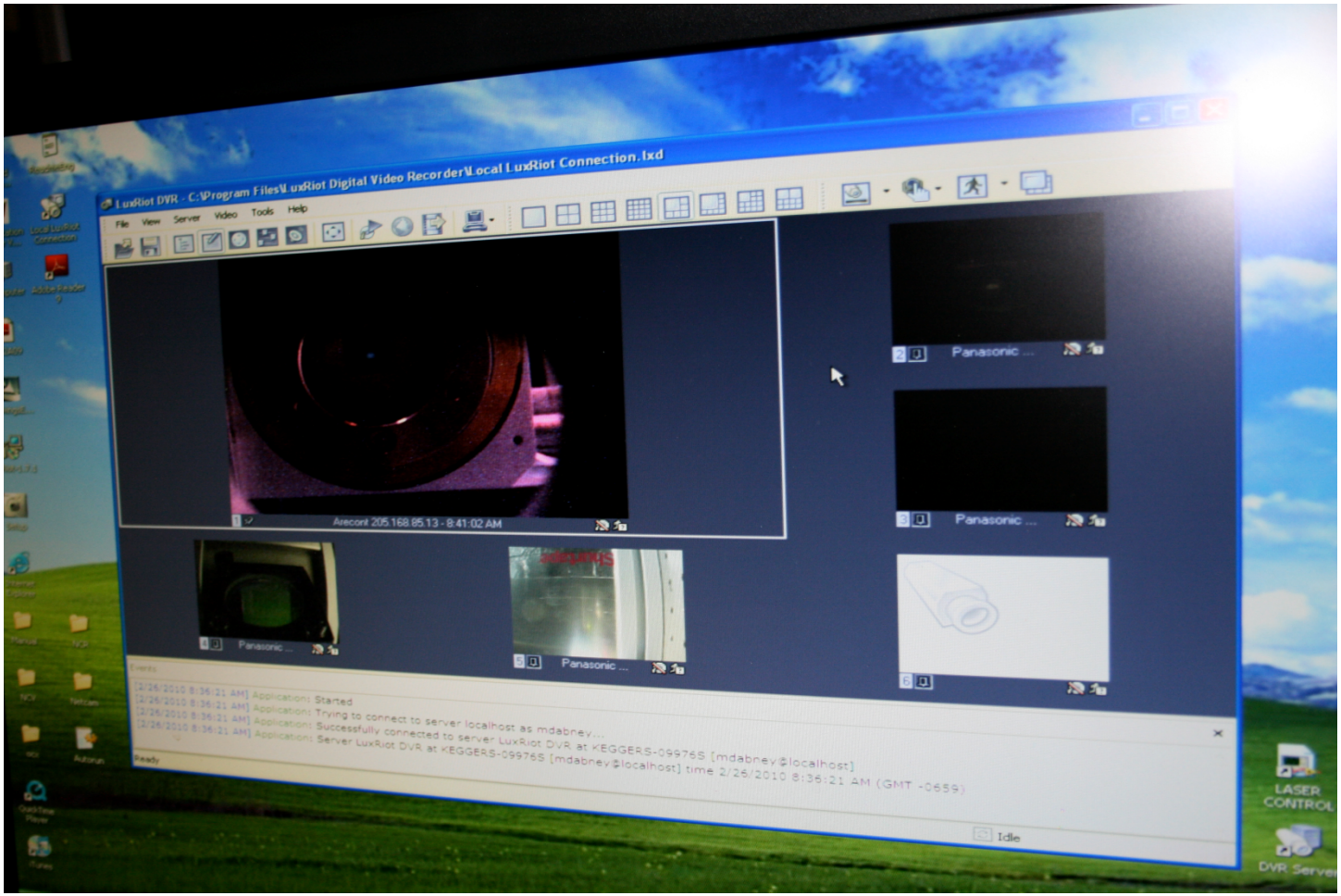
Before



After



Beam Location Viewed on Computer Screen



LSIA Project #2

Laser Degradation Experiment

Class 4 Continuous Wave Diode Laser

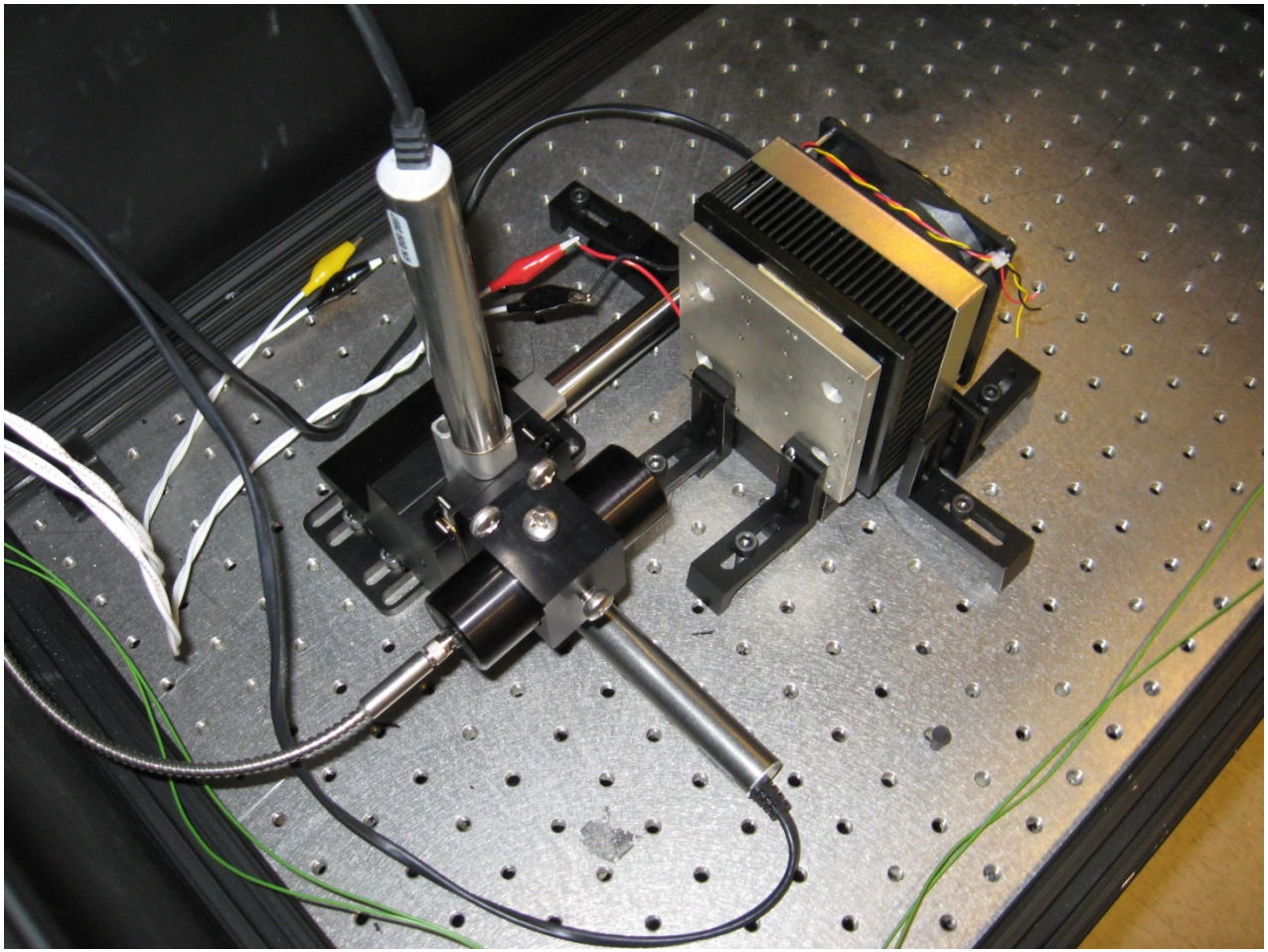
Improvement allows for fully-enclosed system during alignment

System operates as Class 1 system during normal operation and alignment

- No exposure to laser energy
- Allows for relaxed control measures (reduces risk and costs)
- Desirable for a multi-user lab

Total Cost $7290

Laser Collimator Mounted on Micro-Positioner



LSIA Project #3

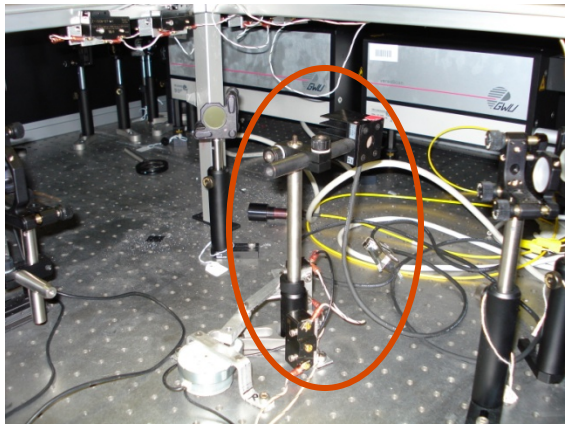
Photoionization Laser System

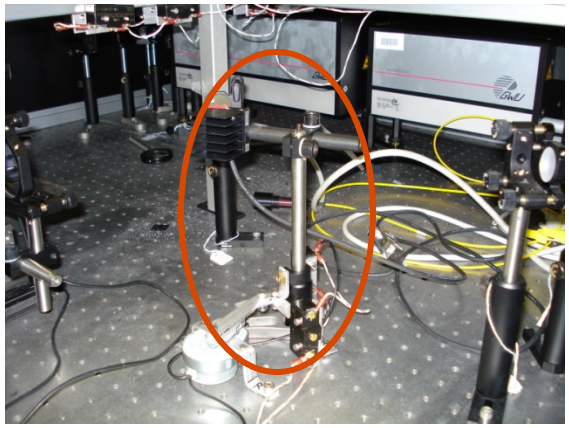
Class 4 Pulsed Lasers (Nd: YAG with OPO)

Improvement provides for:

- Class 1 operation by
  - Enclosing beam with beam tubes
- Alignment with fully-enclosed beam
  - Installed motorized actuators to allow for remote alignment of optics
  - Flip mirrors for collecting power measurements

Total Cost $5100

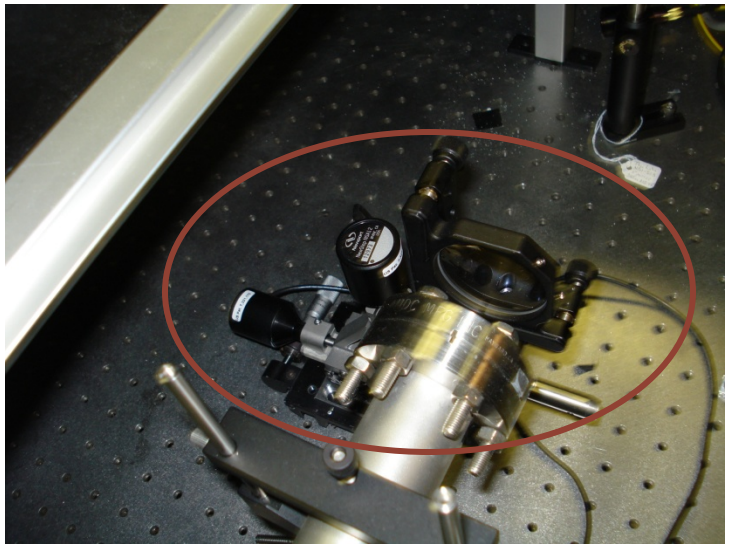




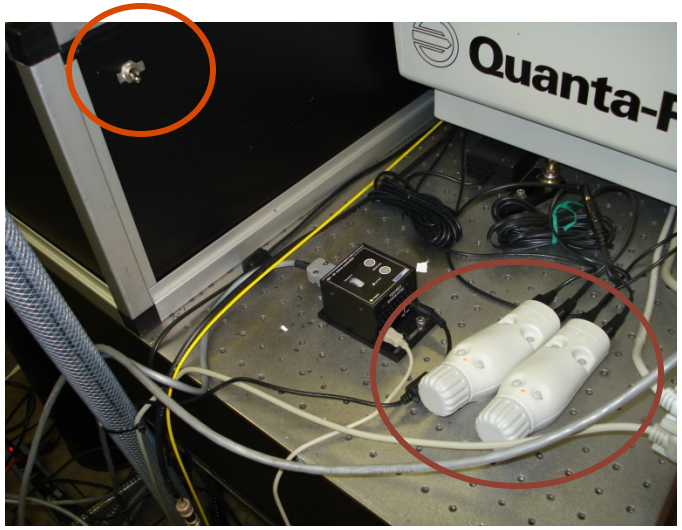
Externally controlled

rotation stages

And translation stages



With easy access switches and controls.



LSIA Project #4

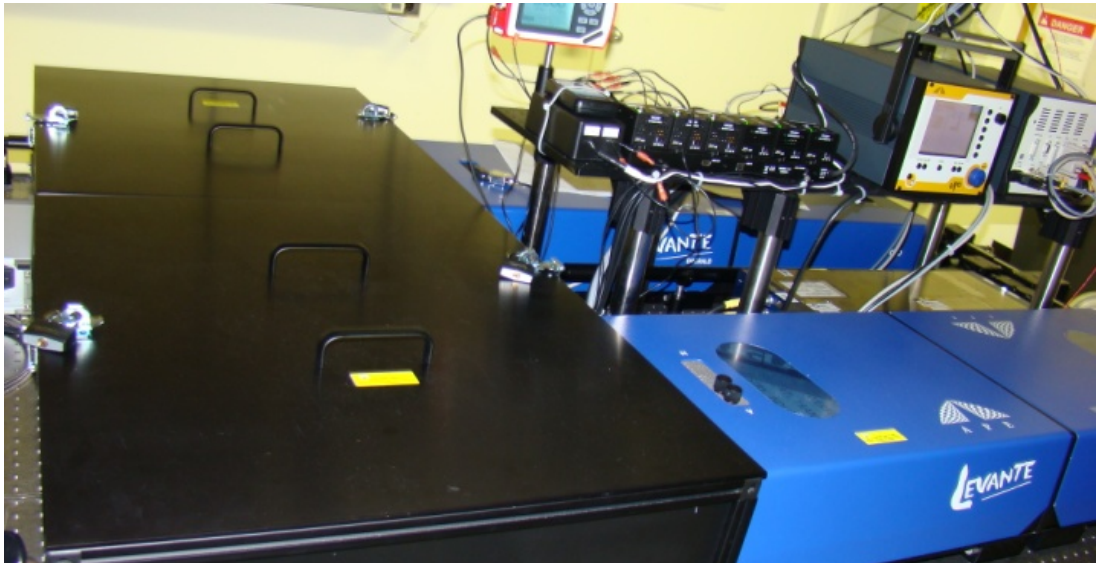
Coherent Anti-Stokes Raman Scattering (CARS) Microscopy

Class 4 Pulsed Lasers (Nd:VAN with OPO)

Improvement allows for daily power measurements and beam attenuation to be conducted remotely with fully-enclosed beam

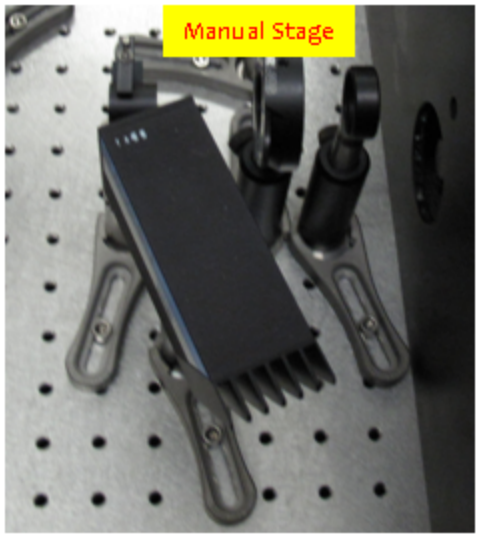
Total Cost $10,400

CARS Laser System

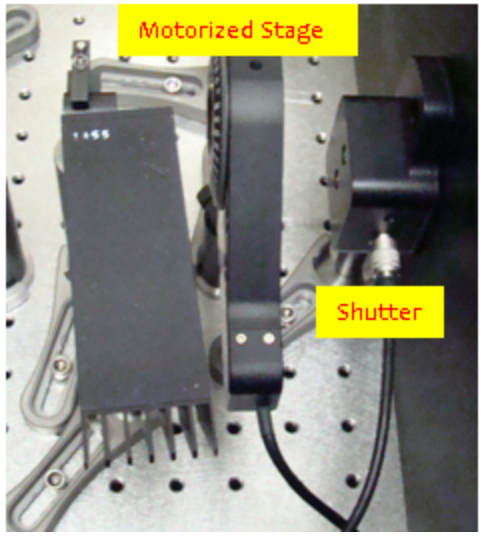


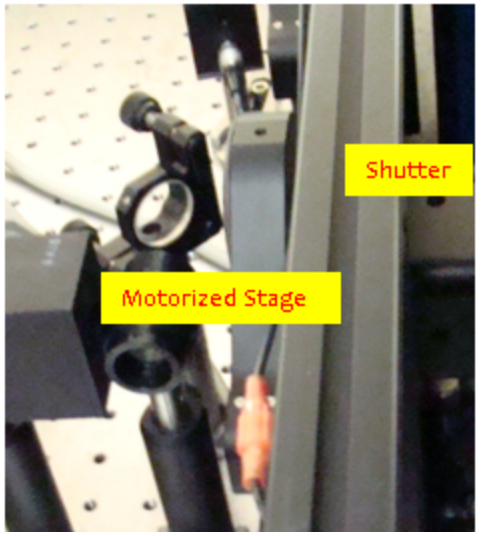
System Improvements

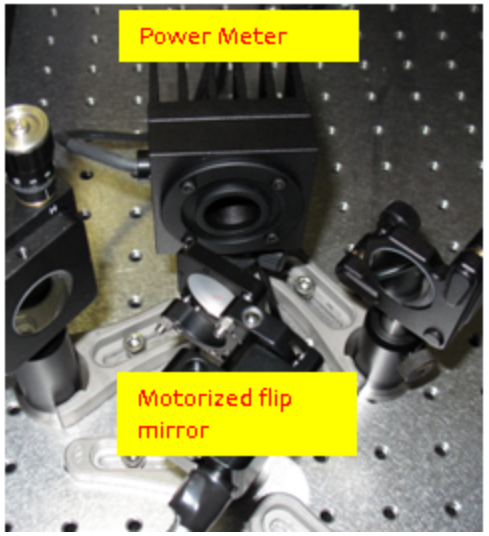
BEFORE



AFTER







Results of Laser Safety Initiative Award

Improves safety to lab staff
- Eliminates need for open-beam operation/alignment
- Safe laser use in multi-user labs

Provides model for safe, state-of-art system design
- Future NREL laser systems
- Organizations outside of NREL

Improves efficiency

In some cases, may eliminate need for other costly laser safety controls

Funded Program again for 2010