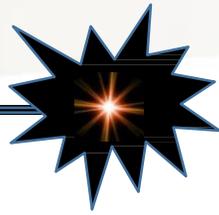


Rural Iowa Photonics Education NSF DUE #1800935

Professor Frank Reed
Grant Director, Principal Investigator
Indian Hills Community College (IHCC)
Ottumwa, Iowa
641-777-3538
frank.reed@indianhills.edu



Introduction



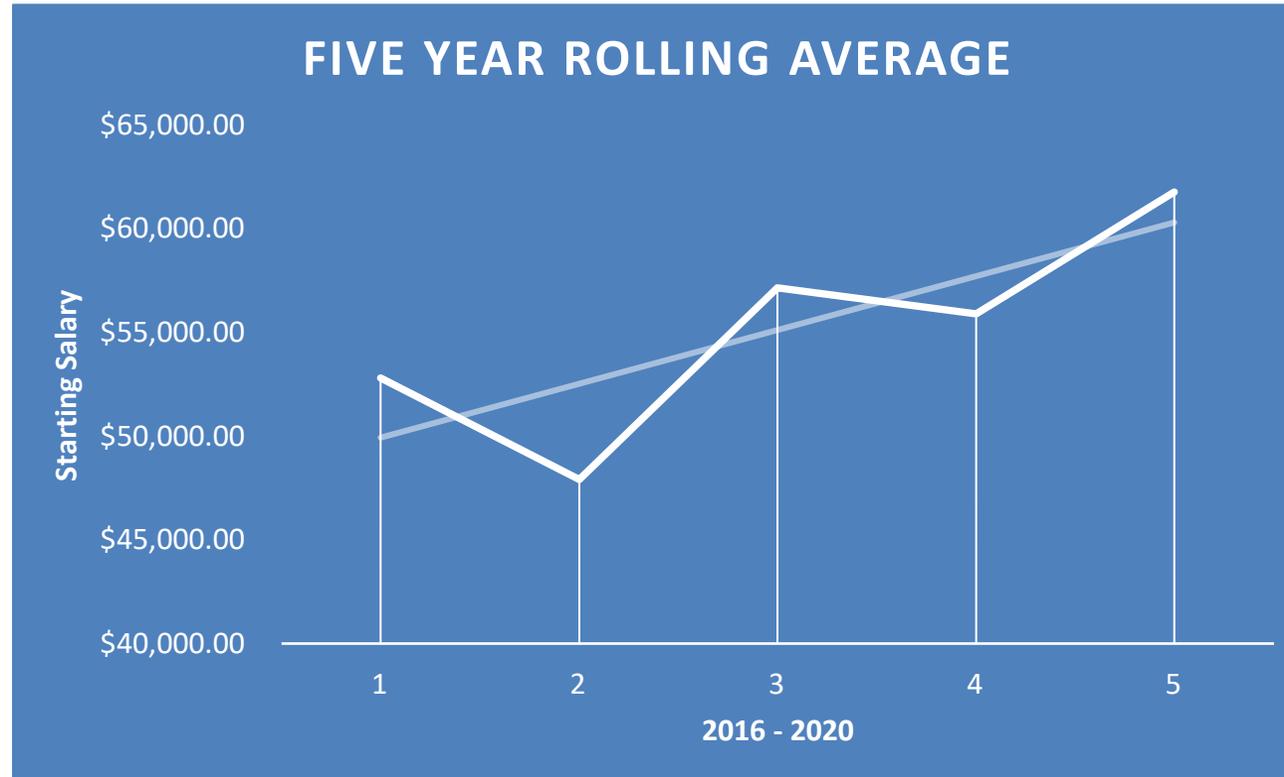
- Indian Hills Community College's (IHCC) Lasers & Optics Technology program began in 1985.
 - 21 - month program with ~20 graduates per year
 - Students from all over the U.S.
 - Graduates receives ~8 – 10 job interviews and ~4 – 5 job offers
 - Average starting wage for 2020 graduates: ~\$62k
- IHCC understands the national demand for Laser & Optics (photonics) technicians & seeks to increase the supply across the U.S.
- We hope you do also.

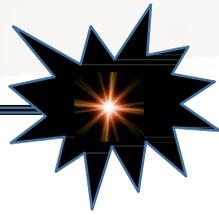


Introduction



IHCC's Lasers & Optics Technology (L.O.T.) program's five year rolling average for starting salaries. Trendline starts at ~\$50k and ends at ~\$60k giving an approximate salary increase of ~20%. The 2020 salary range was \$52k - \$70k. The education investment is ~\$30k. Invest \$30k, ROI \$60k. The U.S. needs photonics technicians, bunches of them.

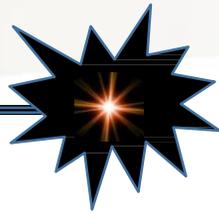




Introduction



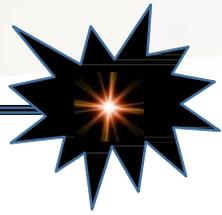
- 2018: The National Science Foundation Advanced Technology Education grant for the project *Developing Photonics Education in Iowa's Rural High Schools* was awarded to IHCC (2018 –2022).
- A four-year mission to bring educational programming in the high-growth, high-demand field of photonics to a population rarely afforded such opportunities: rural Iowa high school students and teachers.
- Goal #1: Our *primary goal* is to increase the number of rural Iowa high school students in the photonics technician pipeline.
 - Develop relationships with rural Iowa secondary schools and homeschool groups to build sustainability.



Introduction



- IHCC's Photonics Fundamentals course, LEO102.
 - 3 – credit course, with lecture and hands-on labs
 - Labs are emphasized
 - This is the foundation for the High School Photonics Fundamentals dual credit, hybrid course which is the focus of this presentation.
 - This course may be used in community colleges and high schools
 - It may also be adapted to middle schools.



Laser & Optics Technicians



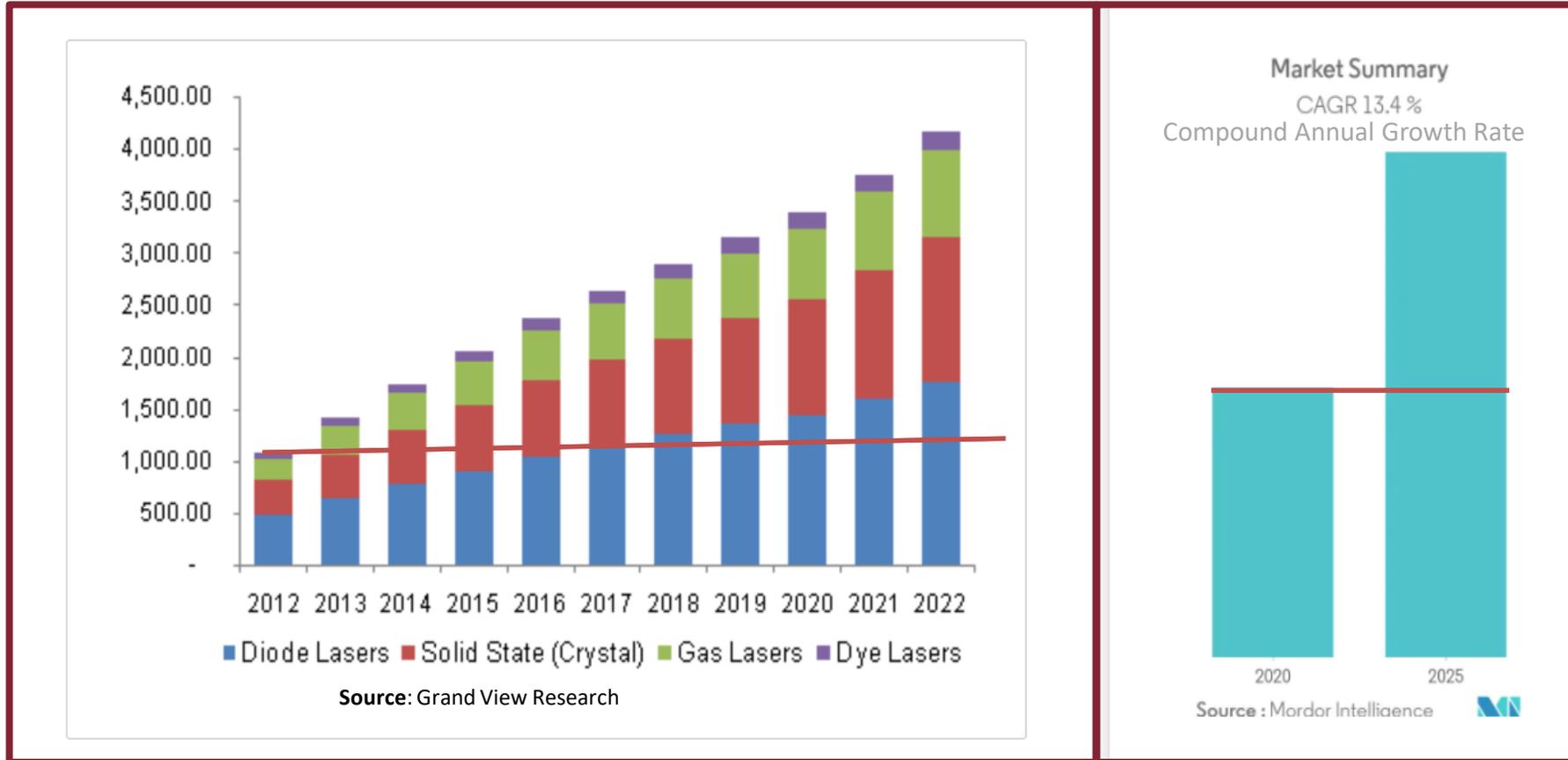
- Photonics (lasers & optics)
 - The study of laser light and how it reacts with and influences materials both organic (e.g. humans) and inorganic (e.g. metals).
- Photonics Techs
 - Build, test, maintain, repair lasers, optical and fiber optic equipment, application system install and test plus the utilization of spectrometers, interferometers, or related equipment.
- Demand for photonics technicians.
 - Currently the supply is ~20% of the demand.



Laser & Optics Technicians



Left graph: total laser market over 10 years: 2012 – 2022.
Right graph: amount of growth in 5 years: 2020 – 2025.

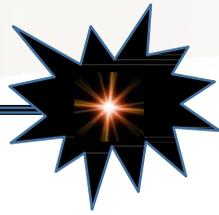




Laser & Optics Technicians

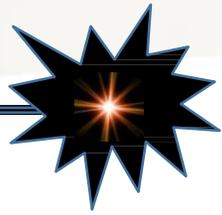


- IHCC's LOT's have been hired by over 140 companies in more than 40 states and 2 countries
 - In these sectors and their related areas but not limited to
 - Manufacturing
 - Materials Process/3D Printing
 - Military
 - Aerospace/Drones
 - Medical
 - Bio-Sciences
 - Research & Development
 - Nanotechnology
 - Communication/Entertainment
 - Fiber Optics



Photonics Fundamentals Curriculum Outline: (Text: *Fundamentals of Light & Lasers*)

- Six Modules
 - 1. Nature & Properties of Light
 - Define the nature and properties of light
 - Describe the dual nature of light to include scatter, transmission, absorption, reflection, and refraction
 - 2. Optical Components
 - Identify optical materials, properties, coatings and surface quality
 - Describe use of opto-mechanical components
 - 3. Light Sources & Laser Safety
 - Classify light sources
 - Understand the importance of laser safety



Photonics Fundamentals Curriculum Outline continued (Text: *Fundamentals of Light & Lasers*)

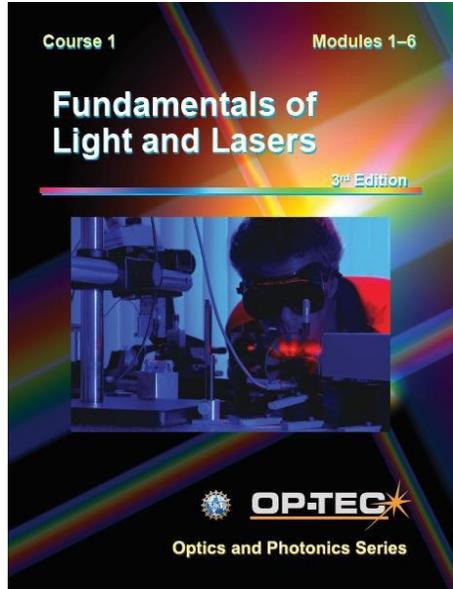
- 4. Geometrical (ray) Optics
 - Comprehend the laws of reflection and refraction
 - Recognize image formation with mirrors and lenses
- 5. Physical (wave) Optics
 - Explain light waves and physical optics
 - Distinguish between interference, diffraction, & polarization
- 6. Basic Principles of Lasers
 - Describe how laser light is generated
 - Identify laser types and beam modes



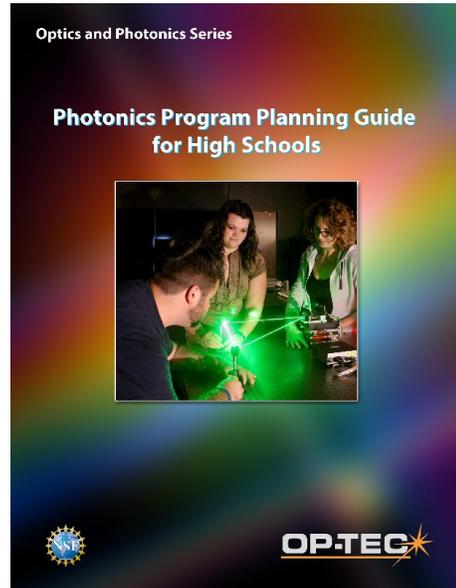
Course Materials



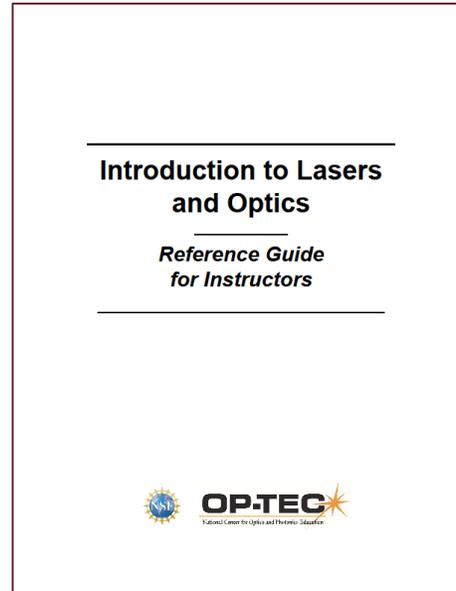
Textbook, booklets and pamphlets for your reading pleasure.



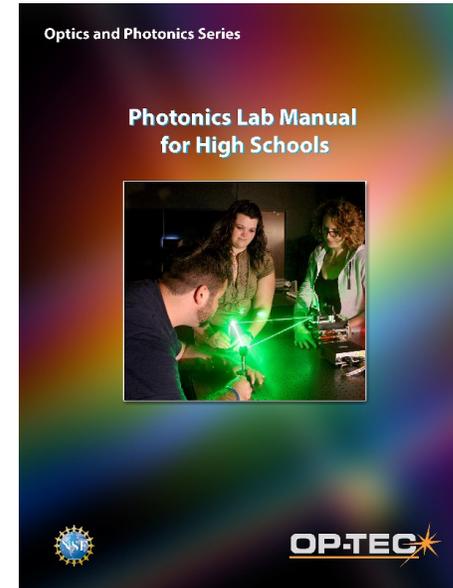
Fundamentals of Light & Lasers



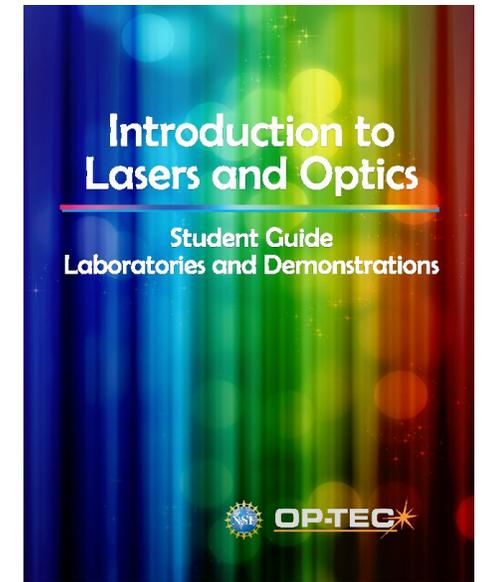
Photonics Program Planning Guide of High Schools



Reference Guide of Instructors



Photonics Lab Manual for High Schools



Student Guide Laboratories & Demonstrations

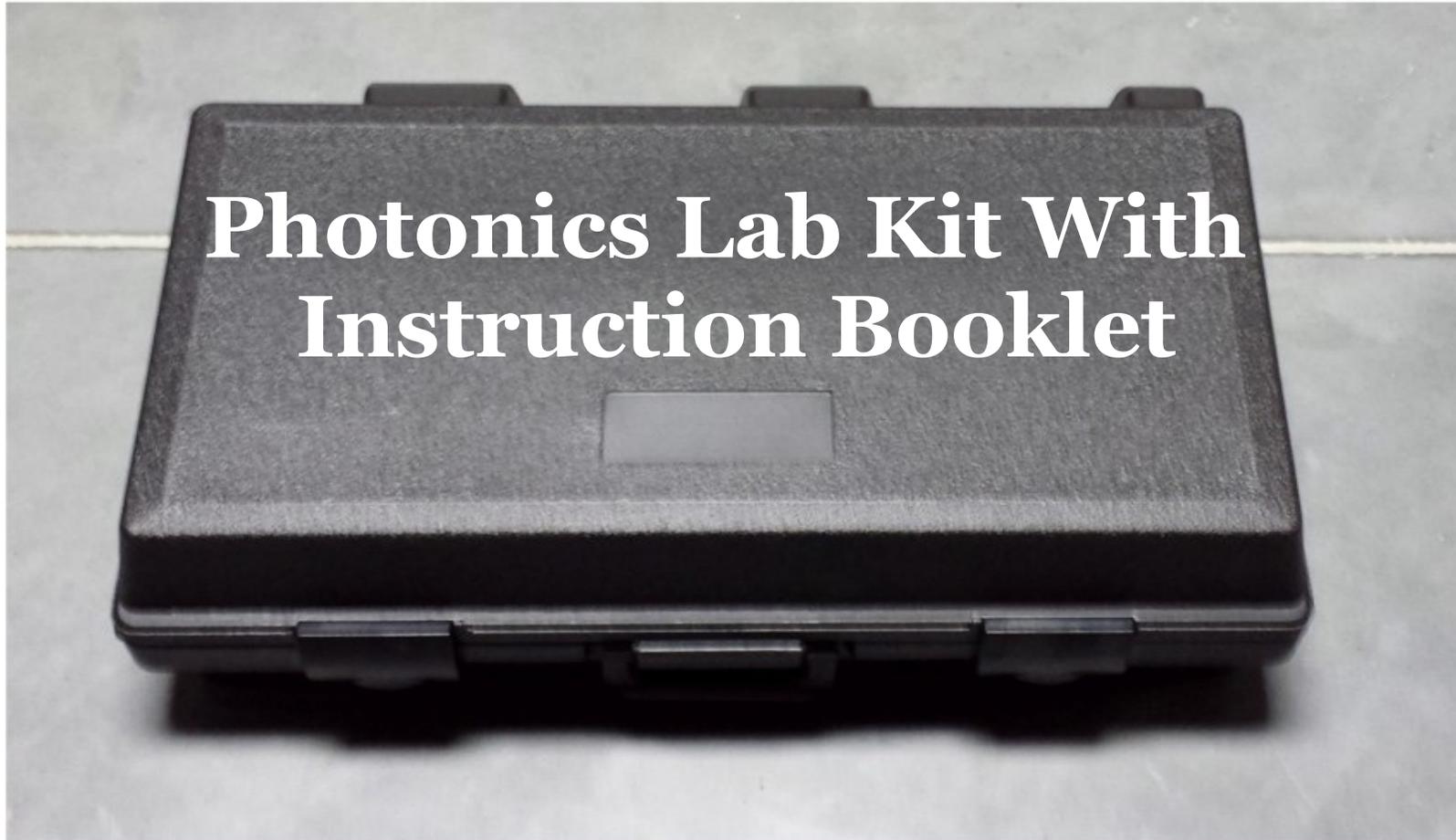
- The above and more at
 - <https://www.laser-tec.org/lesson-and-course-teaching-materials.html>
- Please feel free to contact me for any assistance you may need/want.
- The course is developed and ready for you to adapt.



Course Materials

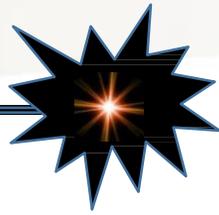


A list of components & equipment, vendors and approximate cost is available.



**Photronics Lab Kit With
Instruction Booklet**

**Kit Dimensions:
L 25.75" x W 15.75" x H 9.0", Weight 35 lbs.**



Course Materials

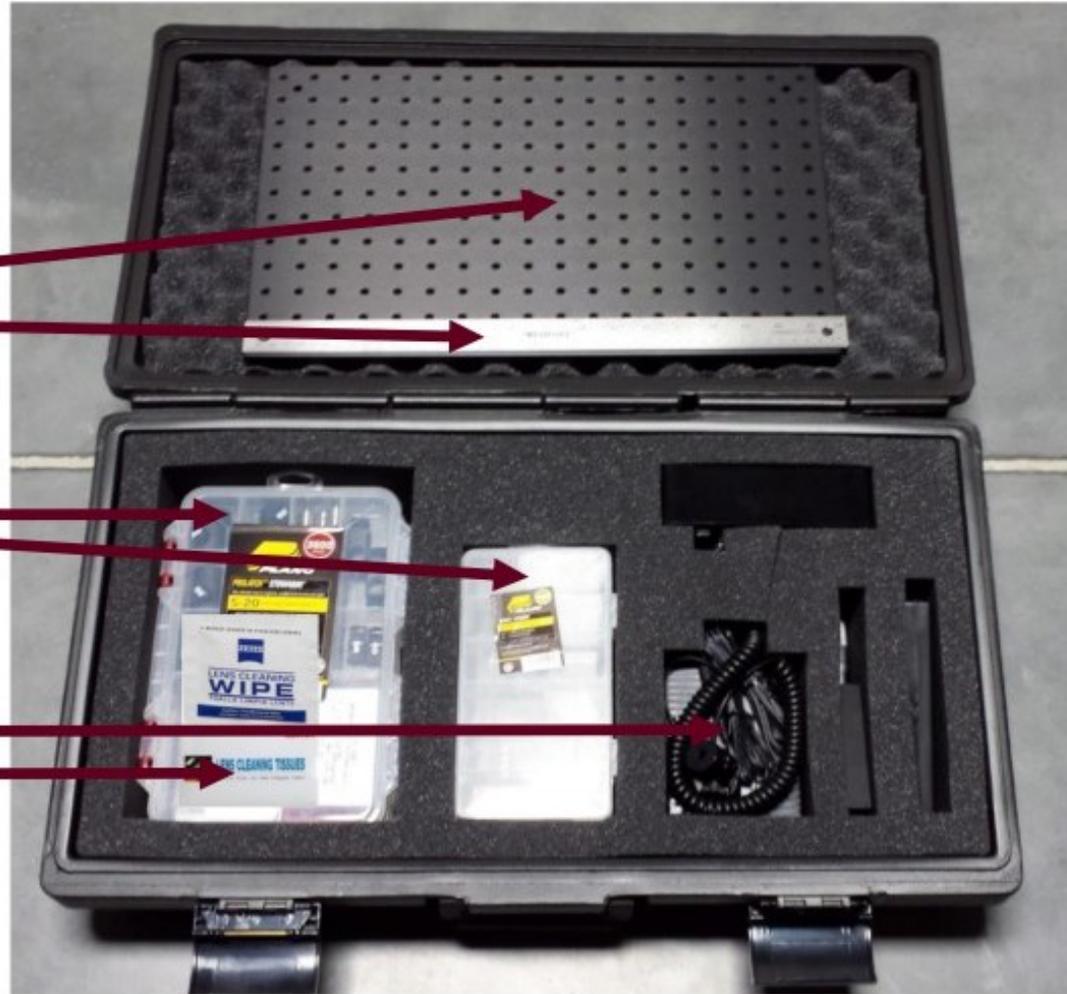


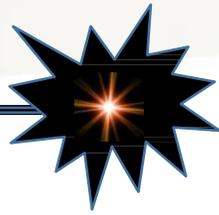
Optical
Breadboard/Plate &
45.7mm (18")
Stainless Steel Ruler

2 - large & 2 - small
storage boxes

Photometer Detector
with Thumb Screw &
Cord placement

Lens Cleaning
Wipes &
Tissues

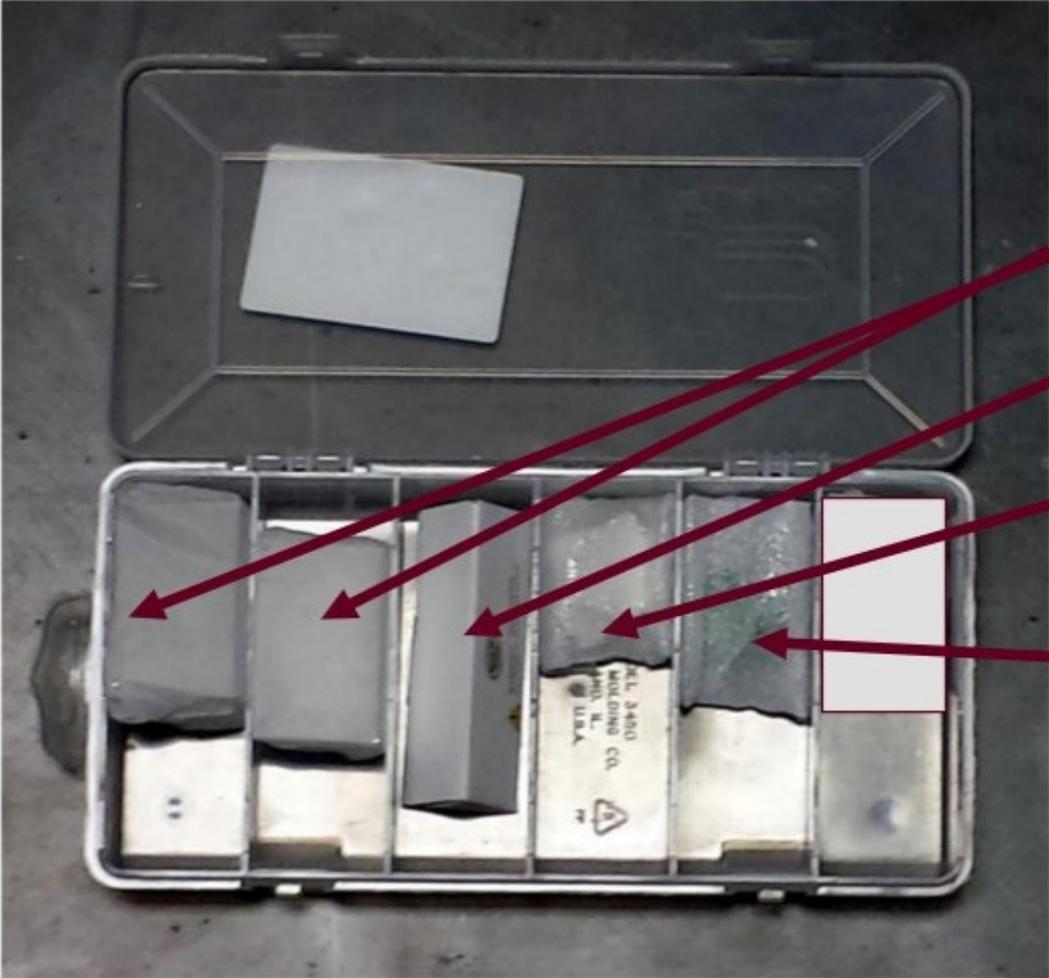




Course Materials



Location of components in Small Storage Box #1

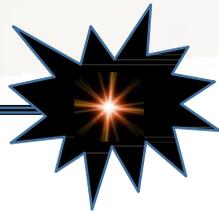


2 - Prism, Right Angle

Prism, Equilateral

Bi-Concave Lens $\text{Ø}25.4\text{mm}$
 $f = -25\text{mm}$

Bi-Convex Lens $\text{Ø}25.4\text{mm}$
 $f = 200.0\text{mm}$



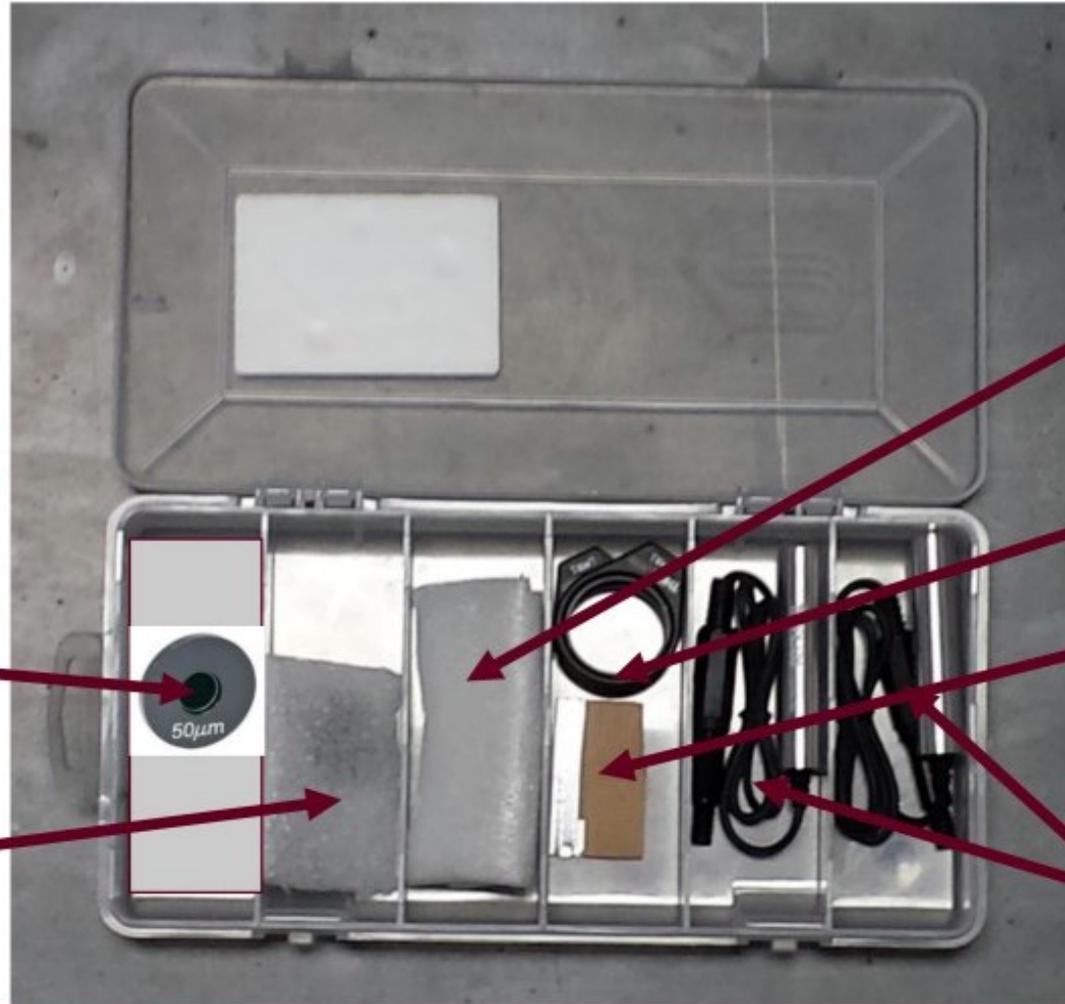
Course Materials



Location of components in Small Storage Box #2

Mounted 50 μm Precision Pinhole

Polarizer, Acrylic, green, 25mm diameter

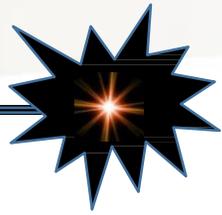


Microscope Slide

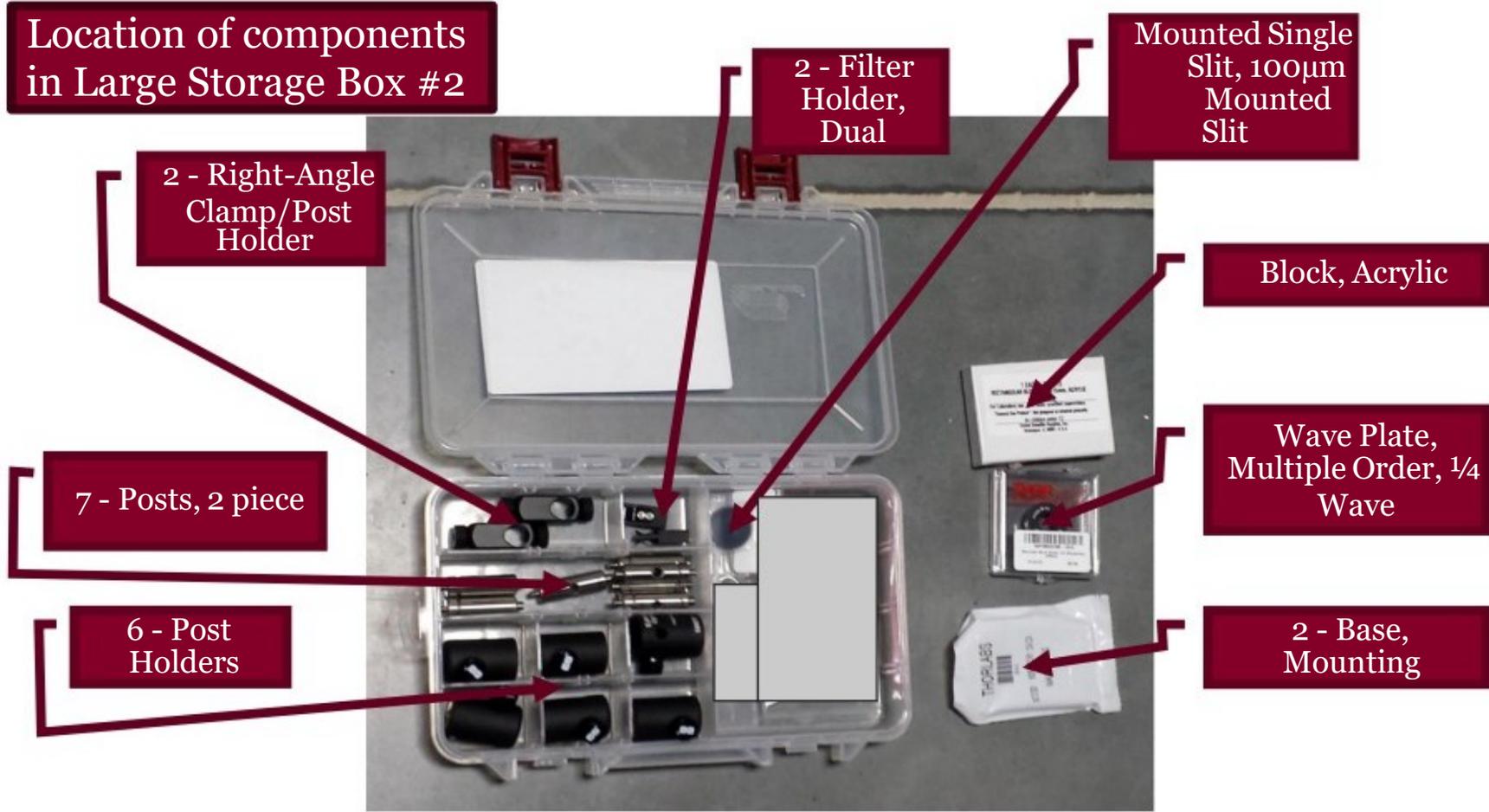
2 - Lens Mount, Fixed

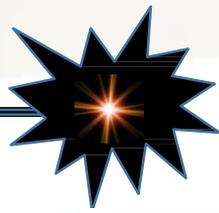
Razor blade

2 - Laser Diodes with cords neatly wrapped



Course Materials

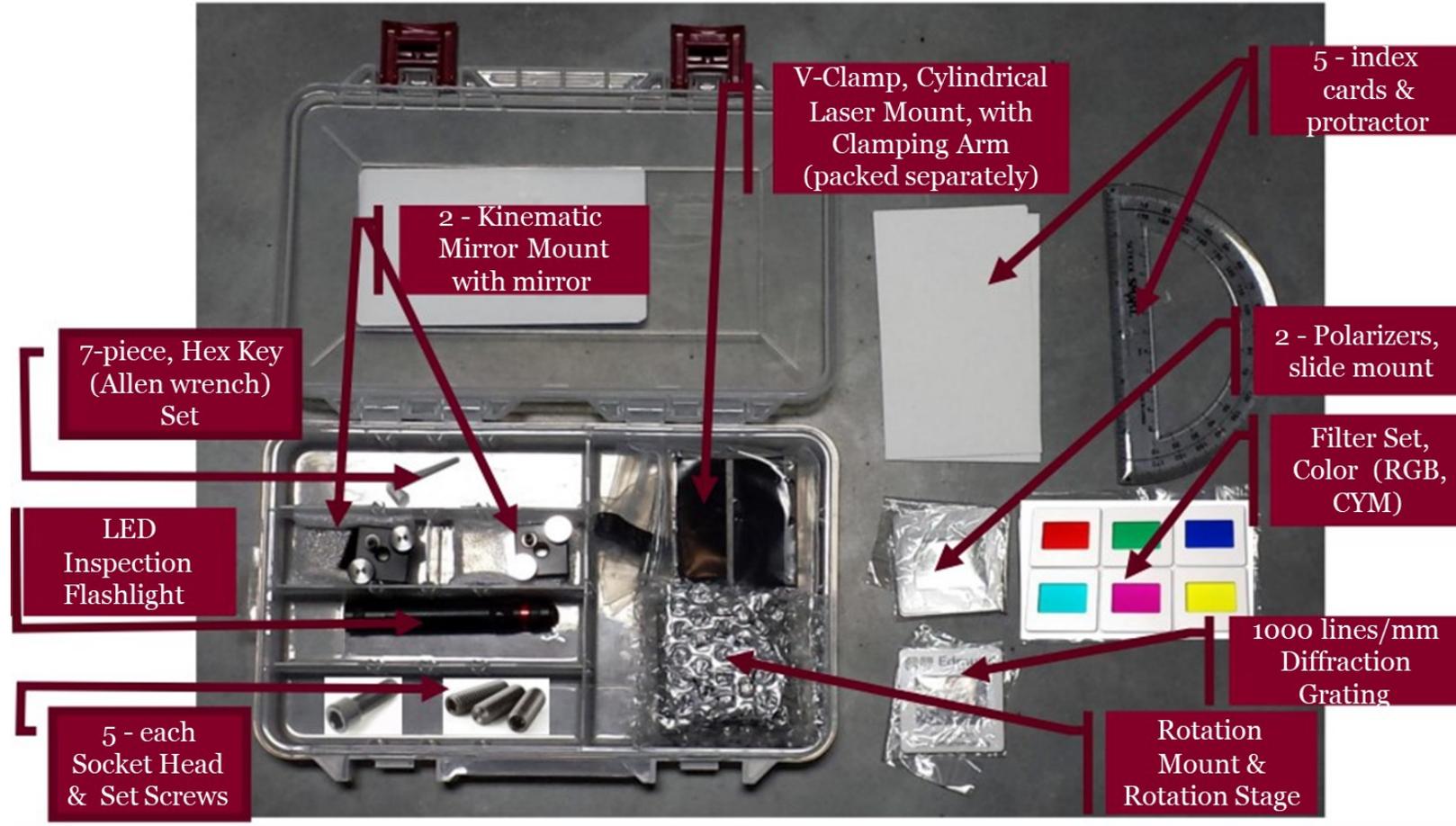


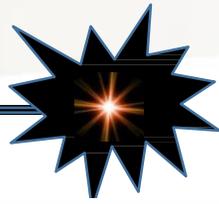


Course Materials

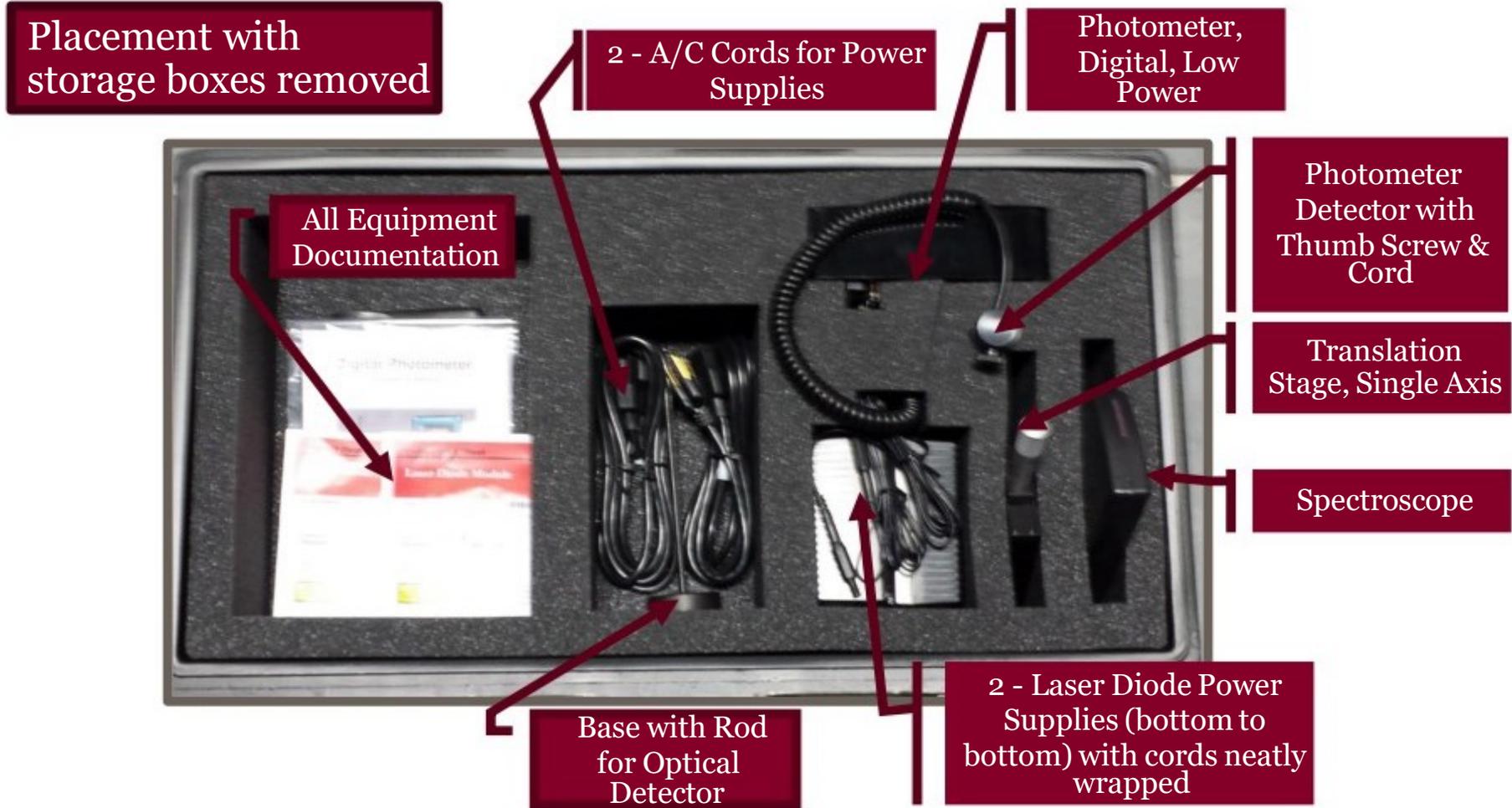


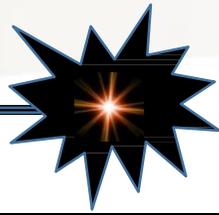
Location of components
in Large Storage Box #1



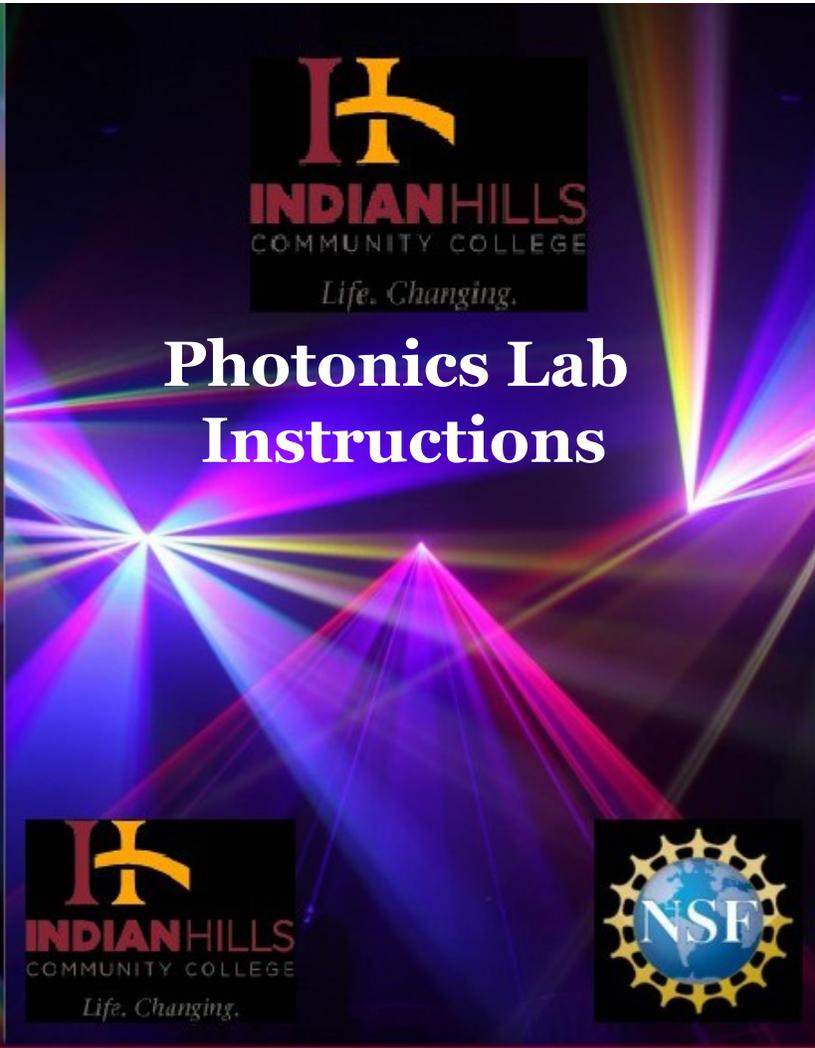
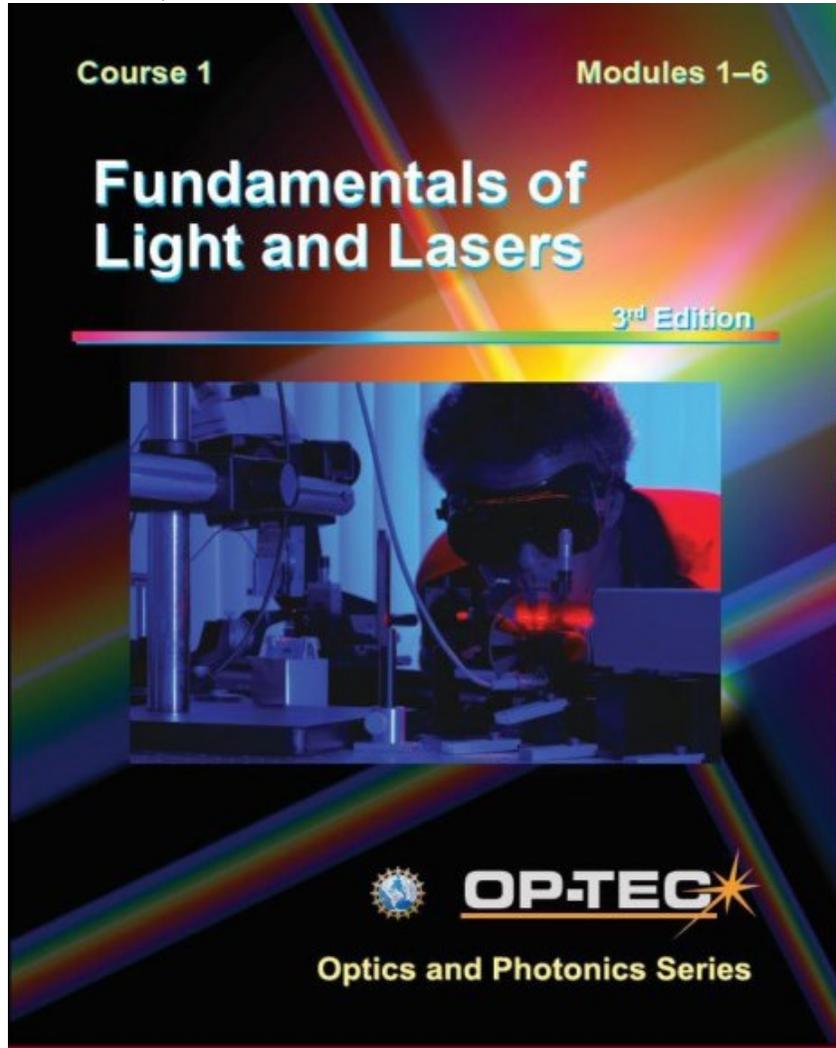


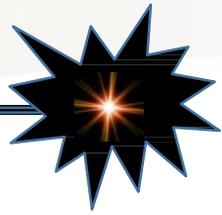
Course Materials





Course Materials





Course Pedagogy



Photonics *Fundamentals* Course and Lab development

- Hybrid
 - **Online** (virtual) and included in each of the six course modules
 - Introductory videos and instructions
 - Module presentations with audio and transcripts
 - Lab Instructions with 2 – demonstration videos each
 - Module Study Guide Assignments
 - Test (mostly multiple choice)
 - Students may use all module information
 - Each Module Test has a time limit

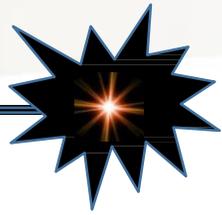


Course Pedagogy



Photonics *Fundamentals* Course and Lab development

- Hybrid (continued)
 - **Live** (face-to-face)
 - Photonics Kits are given to the high schools for student use during the course
 - Rural Iowa High Schools
 - Weekly/Monthly visits
 - Speak with High School counsellor, students and facilitator (teacher, etc.)



COVID Course Pedagogy



Teaching is always an adventure

Effects of and coping with COVID

- The high schools shut down and went virtual
 - This course was already online so was semi-virtual
 - Designed more “face-to-face” Blackboard Collaborate sessions.
- Unable to do live visits
 - Students could not access the lab kits as they were secured at their high school.
 - Sometime ago, I had developed an online “non-hands on lab” photonics course.
 - Resurrected that method for labs (sort of an early “interactive method”)
 - Took each lab video (2 – per lab) and watched them closely to develop questions that could only be answered when the video was viewed.
 - Created ~10 questions per lab to establish a basis for their lab write-up.
 - Lab Instructions were massaged to fit “virtual lab” lab write-up
 - Students thought this was a good alternative but liked the “hands-on” better.



Results, Ongoing & Future



Albia High School



Centerville High School



Davis County High School

Hybrid (online & hands-on) High School Photonics Training



Davis County High School

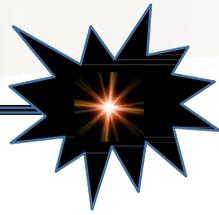


Ottumwa High School



North Mahaska High School



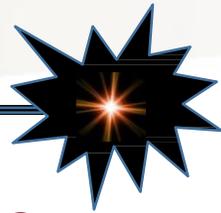


Results, Ongoing & Future



Three year NSF project

- **Sep 2018 – Aug 2019, Year 1:**
 - Prepare for 2019 – 2020 school year.
 - Contacted and presented project at 8 – area high schools.
 - 4 – participated for Fall 2019
- **Sep 2019 – Aug 2020, Year 2 results:**
 - 17 – students (sophomores, juniors & seniors)
 - 9 – completers
 - COVID pedagogy put into place March 2020
 - 1 – registered for IHCC Fall 2020
 - Early 2020: Contacted 21 - IHCC area high schools

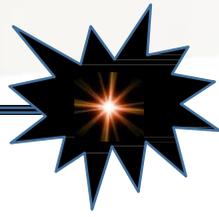


Three year NSF project

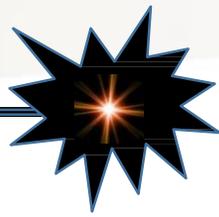
- **Sep 2019 – Aug 2020, Year 2 results** (continued)
 - *Then COVID happened*
 - 2020's summer events for teacher professional development cancelled
 - 4 – day Photonics Institute
 - 2 – day Photonics Symposium
 - Unable to contact and present at all high schools
 - Continued communicating with little or no response
 - Conducted two area wide ZOOM outreach meetings
 - Difficult for them to make decisions when not knowing what is on the horizon
 - 2 - high school did respond with 3 - students registering
 - IHCC's High School Programs Office anticipated more will register
 - Unfortunately, that did not happen



- **Sep 2020 – Aug 2021, Year 3 results and ongoing:**
 - 3 – students (juniors & seniors)
 - 1 – completer (junior)
 - Reportedly registering for Fall 2022
 - Submitted a supplemental grant proposal for 1 - year extension: NSF accepted
 - COVID eliminated the effectiveness of meeting the objectives
 - Early 2021: Contacted (continuing to do so) for Fall 2021
 - 39 – Great Prairie Area Education Association (GPAEA) of Iowa high schools
 - Also contacted 8 – greater Des Moines area high schools
 - Requested expansion rights: NSF allowed.
 - GPAEA highs schools did not permit career days
 - Combined Photonics Fundamentals I & II (LEO103 & 104) to equal IHCC's LEO102
 - Offering Photonics Fundamentals LEO 102 in Fall 2021 *and* Spring 2022.
 - Scheduled 1 – Photonics Symposium and 1 – Photonics Institute summer 2021
 - Will expand to 2 – of each if registration demands



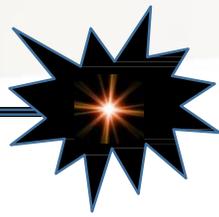
- **Sep 2021 – May 2022, Year 4:**
 - **UREKA!**
 - **Spring 2022 School Year**
 - **1 – high school has dedicated 1 – class period and 1 – teacher/facilitator for LEO102**
 - **18 – students registered for this and 2 - other IHCC dual credit courses.**
 - **Therefore it is assumed (hoped) the majority of these students will register for IHCC's Laser & Optics program.**



Summary



- Indian Hills Community College in Ottumwa, a small city in rural Iowa, has a premiere Laser & Optics Technology program.
 - Those that want a job, get a job.
- The National Science Foundation granted funds to IHCC to develop and conduct a Photonics (lasers & optics) Fundamentals dual credit High School course.
 - The demand for these technicians is 5 times the supply.
- To date there have been 20 - students registered with 10 - completers (2 - have registered for IHCC).
- *18 - have registered for the upcoming 2021 - 2022 school year!*
- What with COVID19 happening in the middle of this grant's lifetime, the outlook is good for sustainability.



Rural Iowa Photonics Education NSF DUE #1800935



Thank you for your attention.

Please email me your questions/comments
or feel free to give me a call.

Frank Reed

frank.reed@indianhills.edu

Mobile: 641.777.3538



"This material is based upon work supported by the National Science Foundation under Grant No. 1800935." "Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation."