

Rural Iowa Photonics Education

NSF DUE #1800935

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Introduction



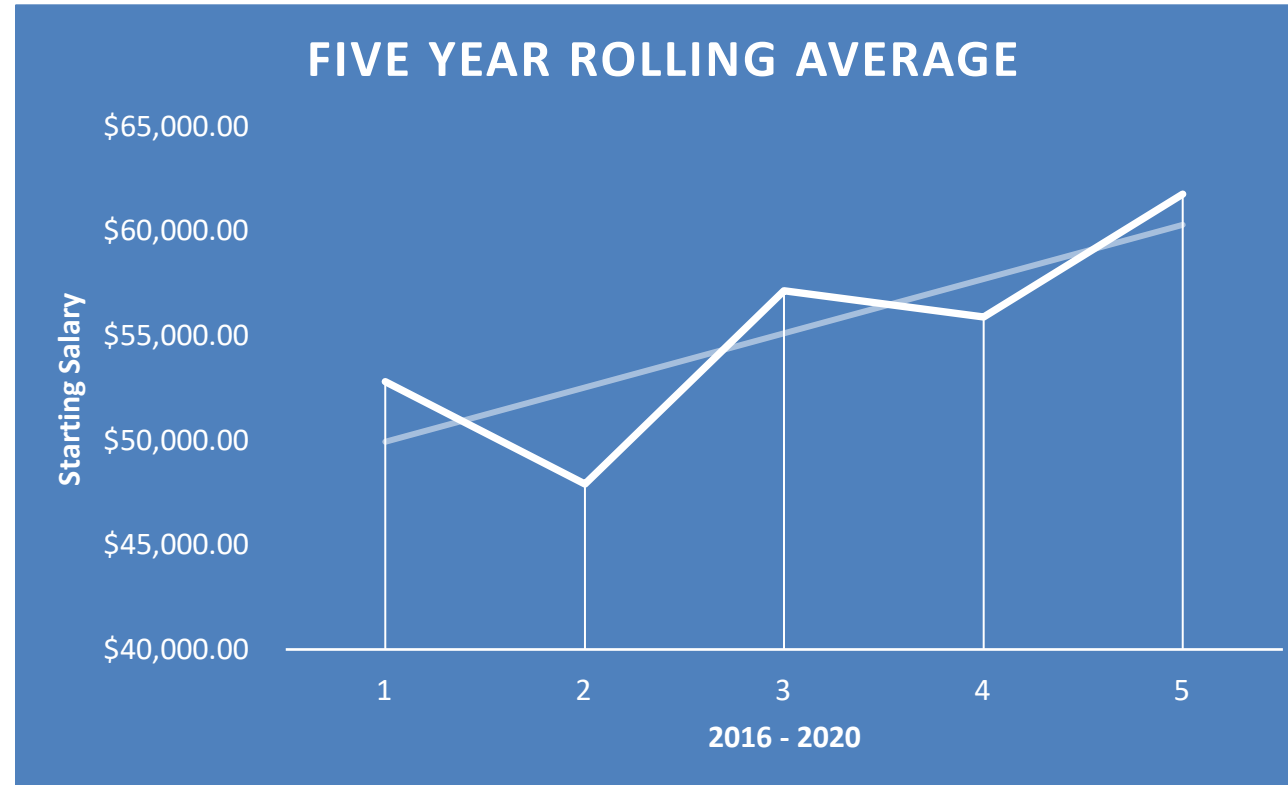
- Indian Hills Community College's (IHCC) Lasers & Optics Technology program began in 1985.
 - 21 - month program with ~20 graduates per year
 - Students from all over the U.S.
 - Graduates receives ~8 – 10 job interviews and ~4 – 5 job offers
 - Average starting wage for 2020 graduates: ~\$62k
- IHCC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

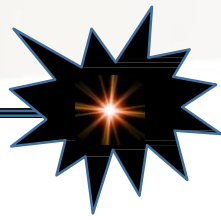


Introduction



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.

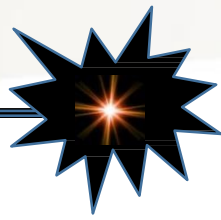




Introduction



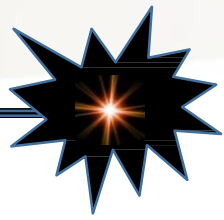
- 2018: The National Science Foundation Advanced Technology Education grant for the project *Developing Photonics Education in Iowa's Rural High Schools* was awarded to IHCC (2018 –2022).
- A four-year mission to bring educational programming in the high-growth, high-demand field of photonics to a population 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



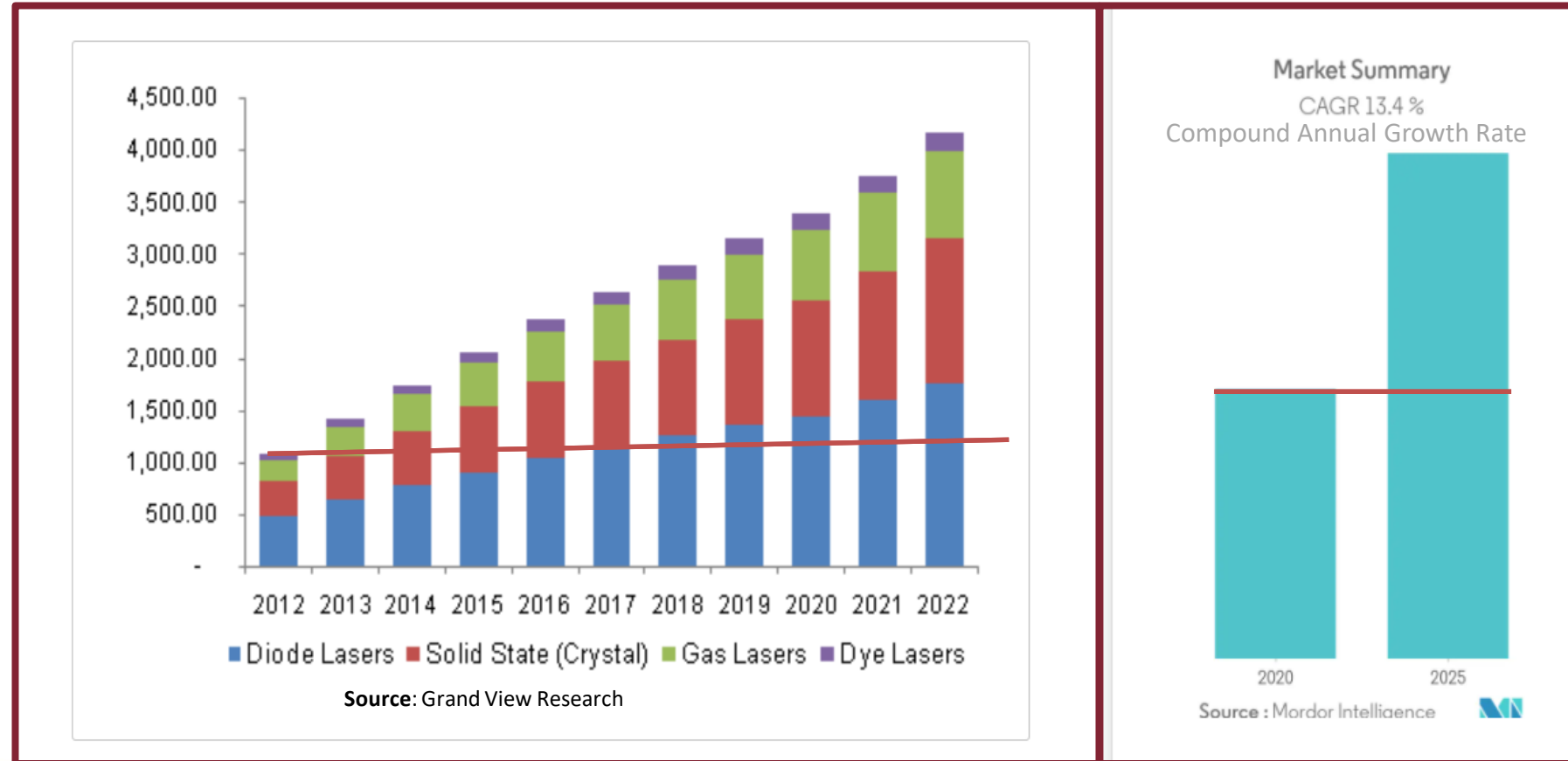
- Photonics (lasers & optics)
 - The study of laser light and how it reacts with and influences materials both organic (e.g. humans) and inorganic (e.g. metals).
- Photonics Techs
 - Build, test, maintain, repair lasers, optical and fiber optic equipment, application system install and test plus the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

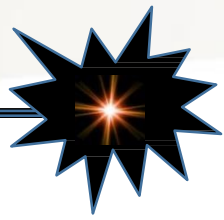


Laser & Optics Technicians



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

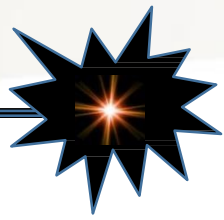




Laser & Optics Technicians



- 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



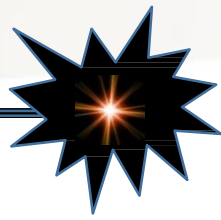
Photonics Fundamentals Curriculum Outline: (Text: *Fundamentals of Light & Lasers*)

- 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



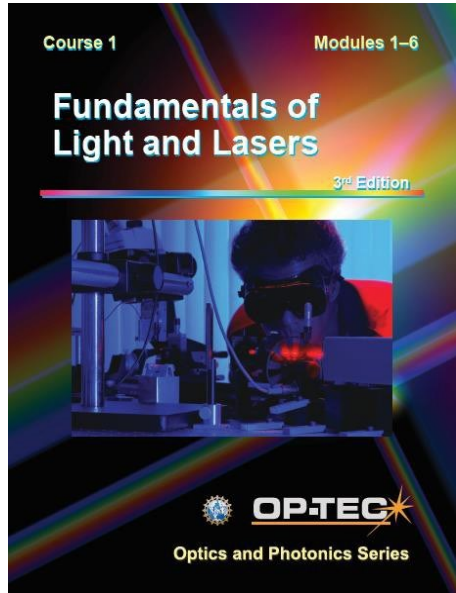
Photonics Fundamentals Curriculum Outline continued (Text: *Fundamentals of Light & Lasers*)

- 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

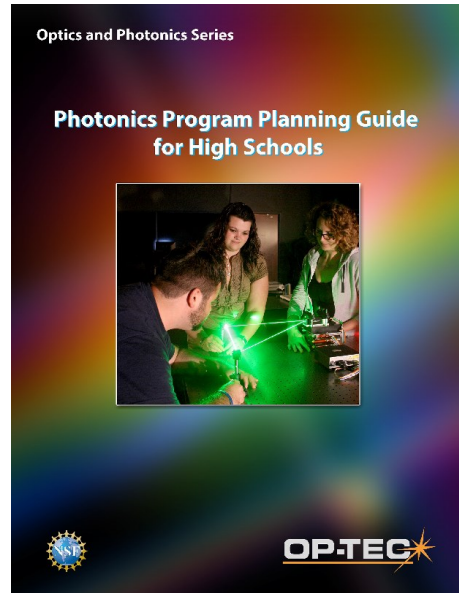


Course Materials

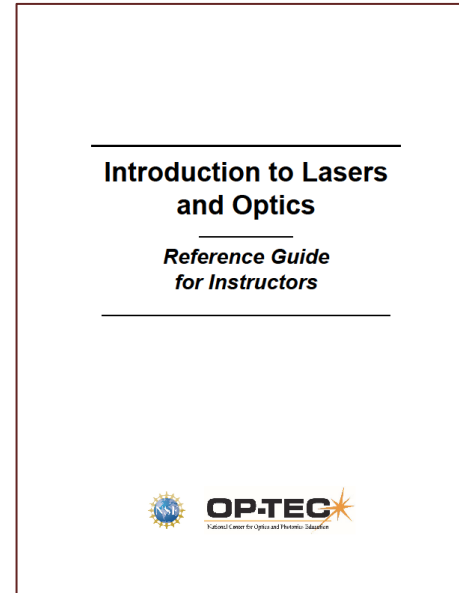
Textbook, booklets and pamphlets
for your reading pleasure.



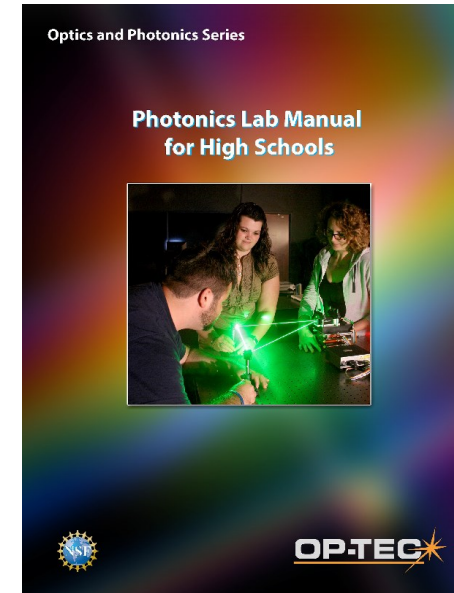
Fundamentals of Light & Lasers



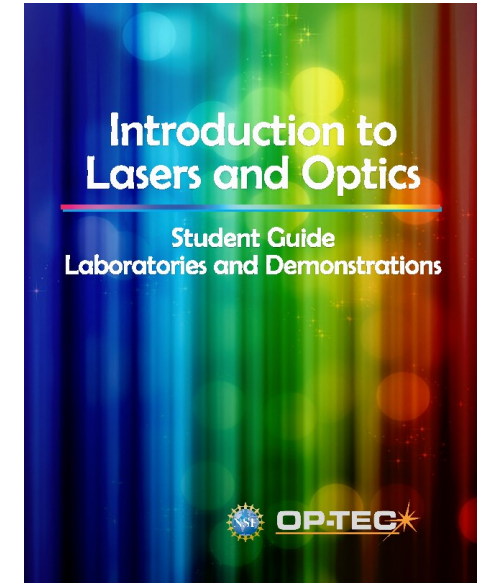
Photonics Program Planning
Guide of High Schools



Reference Guide of Instructors



Photonics Lab Manual for
High Schools



Student Guide
Laboratories & Demonstrations

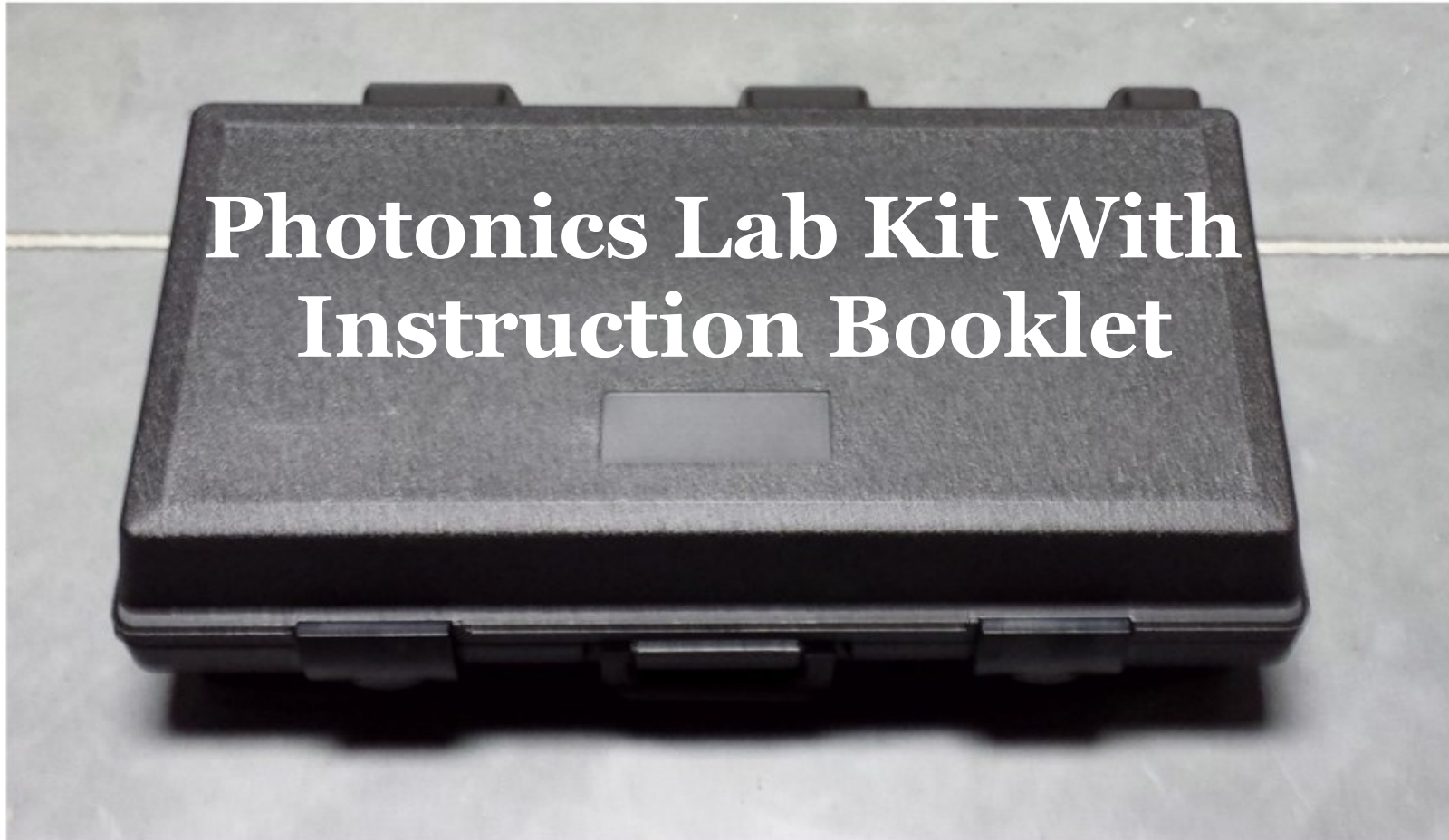
- The above and more at
 - <https://www.laser-tec.org/lesson-and-course-teaching-materials.html>
- Please feel free to contact me for any assistance you may need/want.
- The course is developed and ready for you to adapt.



Course Materials

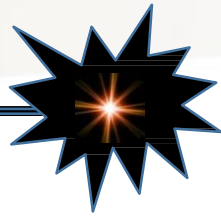


A list of components & equipment, vendors and approximate cost is available.



**Photronics Lab Kit With
Instruction Booklet**

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



Course Materials

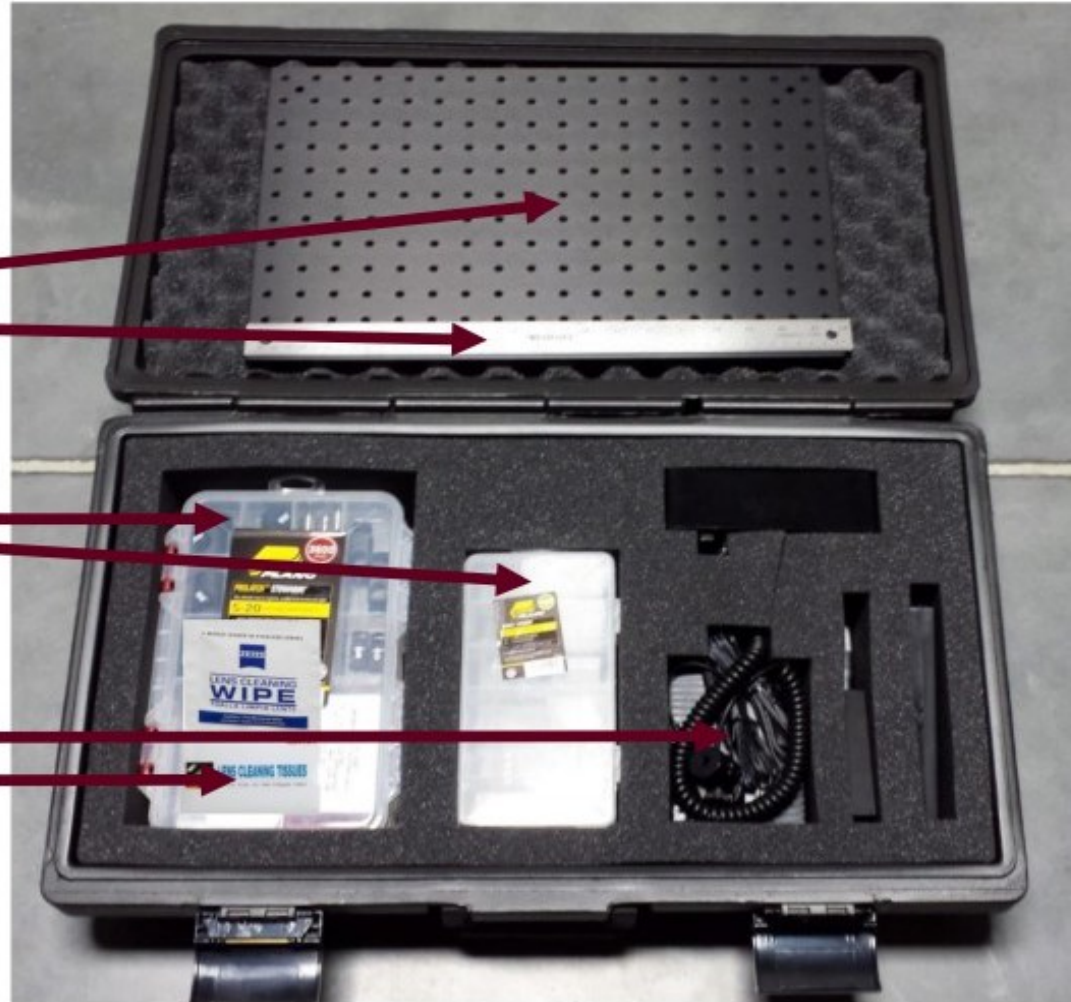


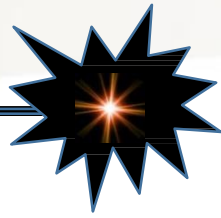
Optical
Breadboard/Plate &
45.7mm (18")
Stainless Steel Ruler

2 - large & 2 - small
storage boxes

Photometer Detector
with Thumb Screw &
Cord placement

Lens Cleaning
Wipes &
Tissues

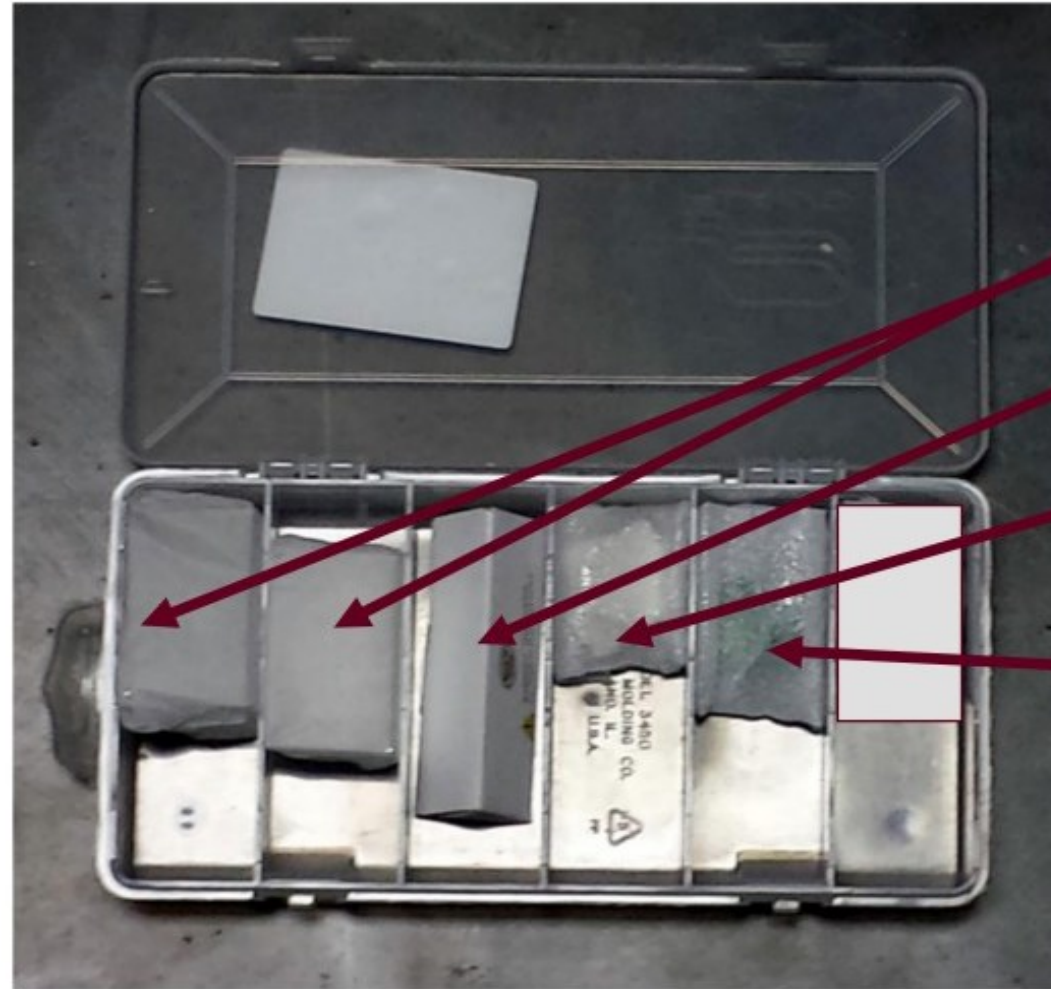




Course Materials



Location of
components in
Small Storage
Box #1

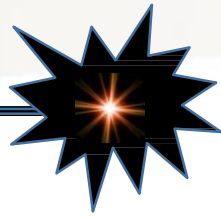


2 - Prism, Right
Angle

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 μ m
Precision
Pinhole

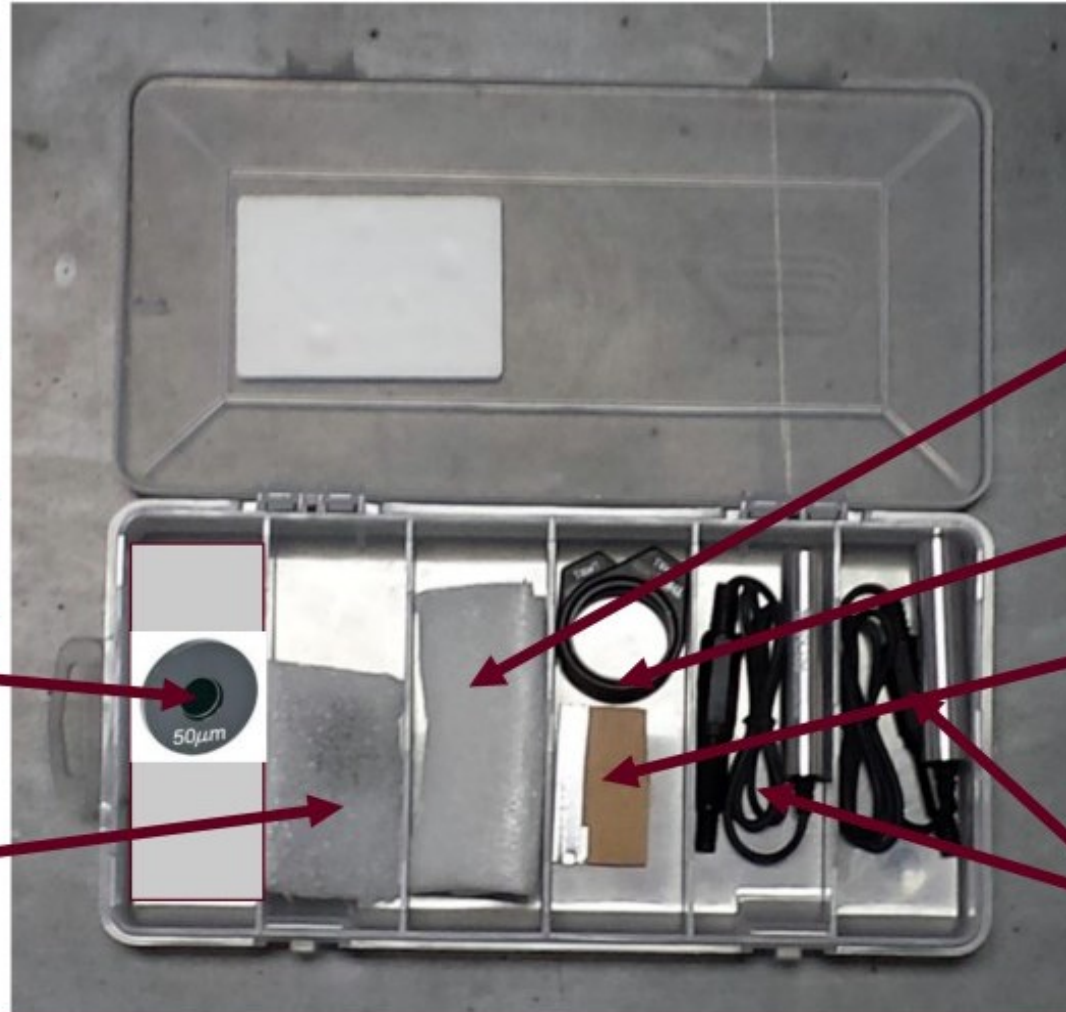
Polarizer,
Acrylic, green,
25mm
diameter

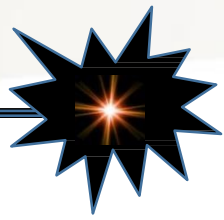
Microscope
Slide

2 - Lens
Mount, Fixed

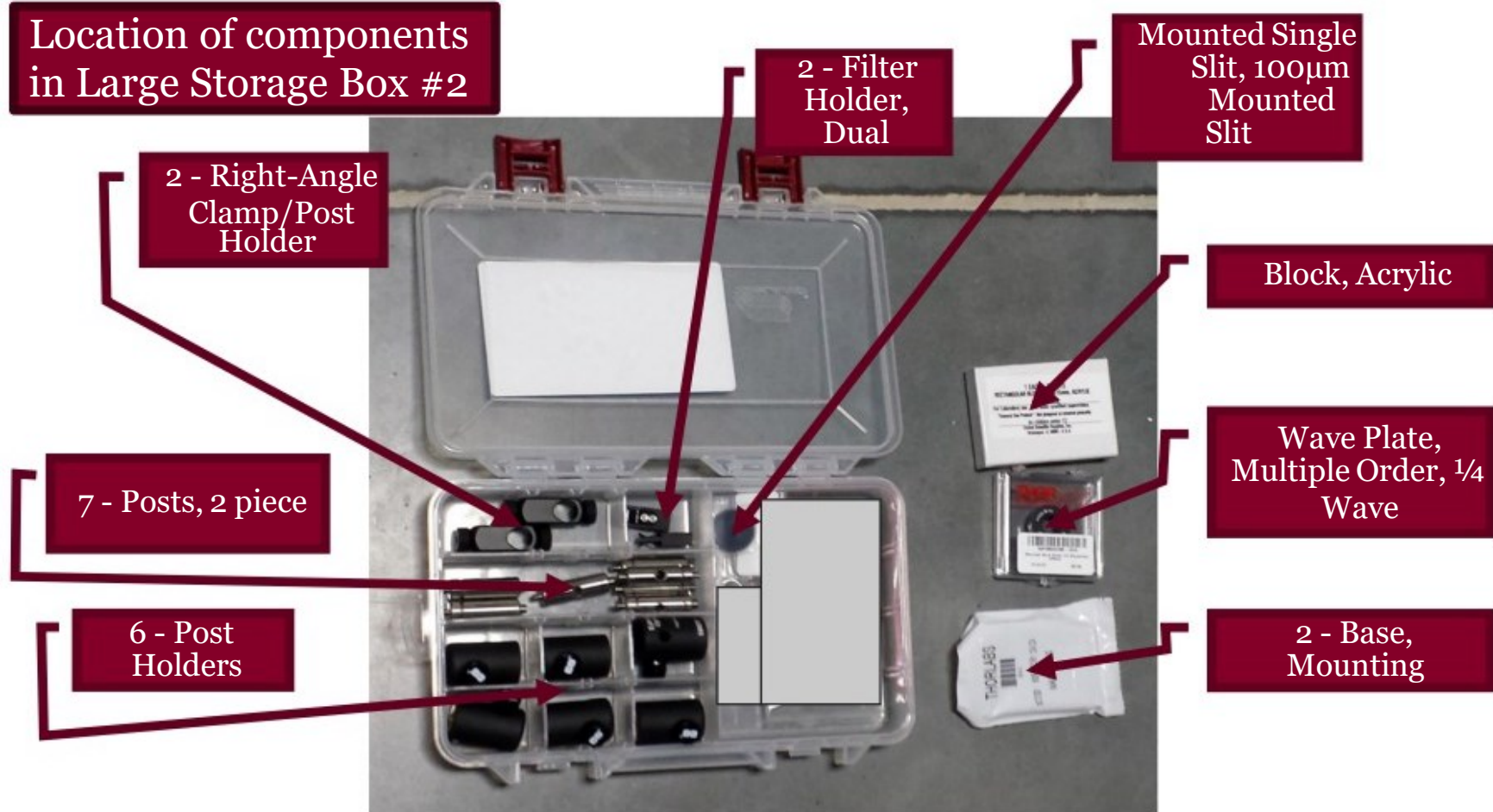
Razor blade

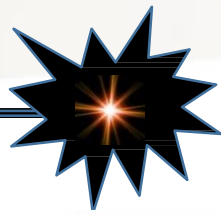
2 - Laser
Diodes with
cords neatly
wrapped





Course Materials

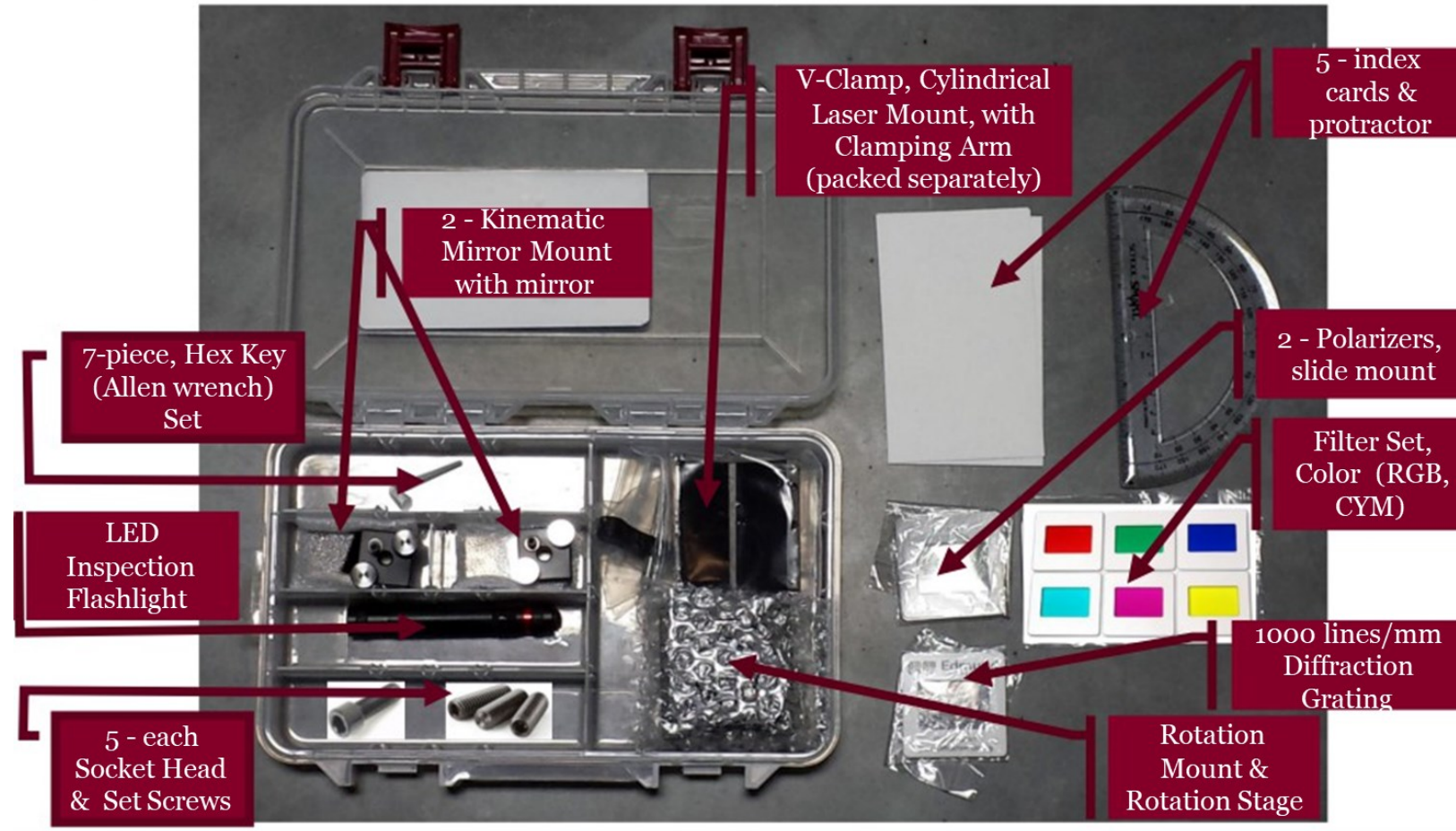


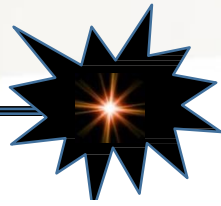


Course Materials



Location of components
in Large Storage Box #1





Course Materials



Placement with
storage boxes removed

2 - A/C Cords for Power
Supplies

Photometer,
Digital, Low
Power

All Equipment
Documentation

Photometer
Detector with
Thumb Screw &
Cord

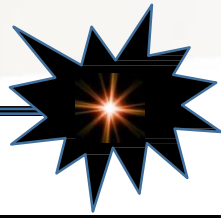
Translation
Stage, Single Axis

Spectroscope

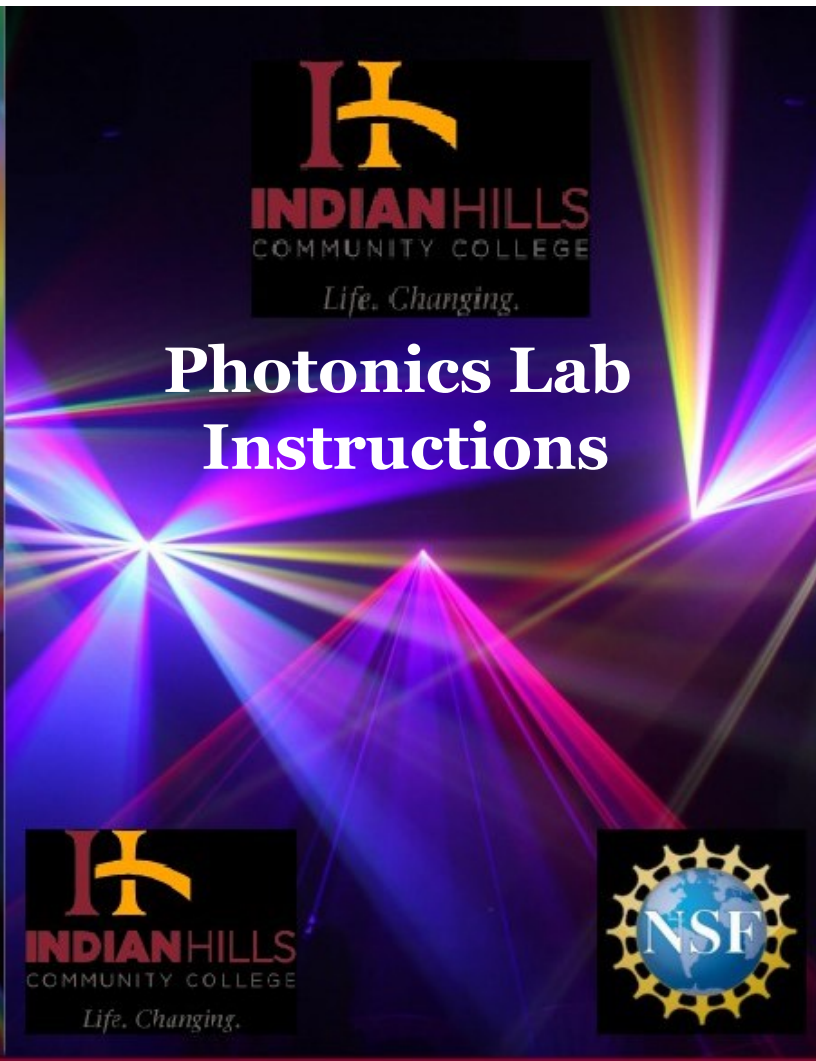
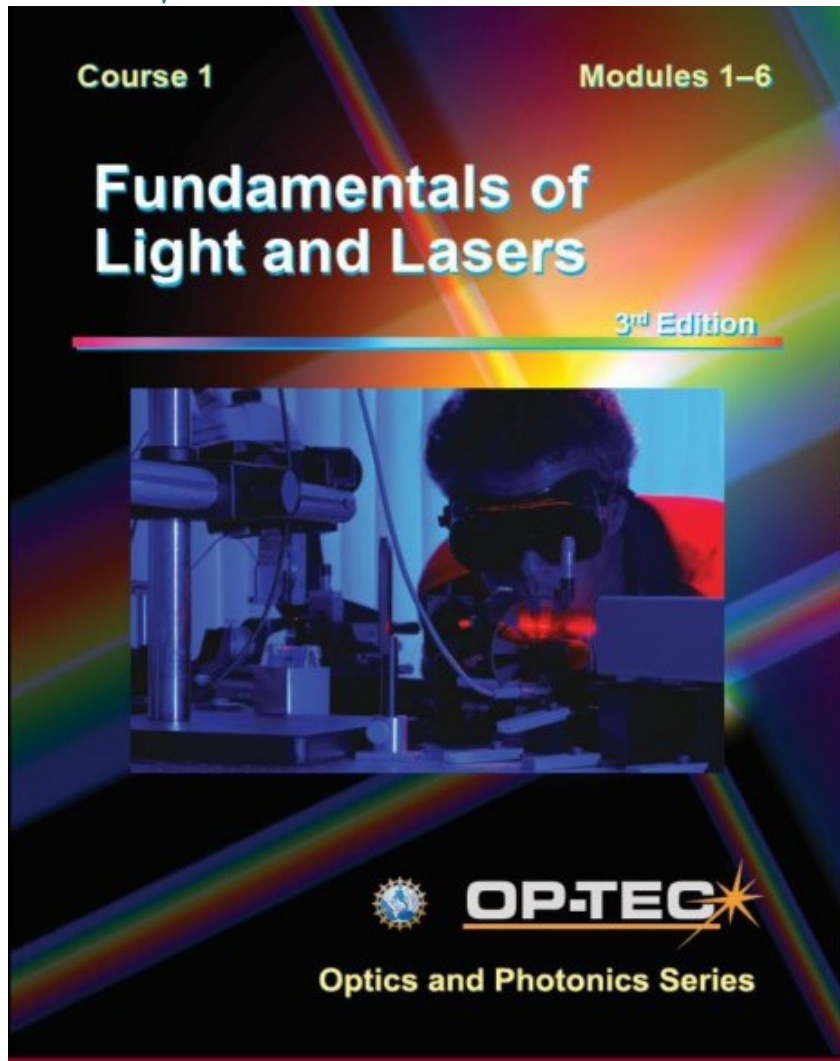
Base with Rod
for Optical
Detector

2 - Laser Diode Power
Supplies (bottom to
bottom) with cords neatly
wrapped





Course Materials



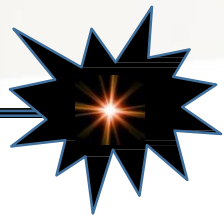


Course Pedagogy



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

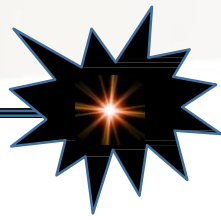


Course Pedagogy



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

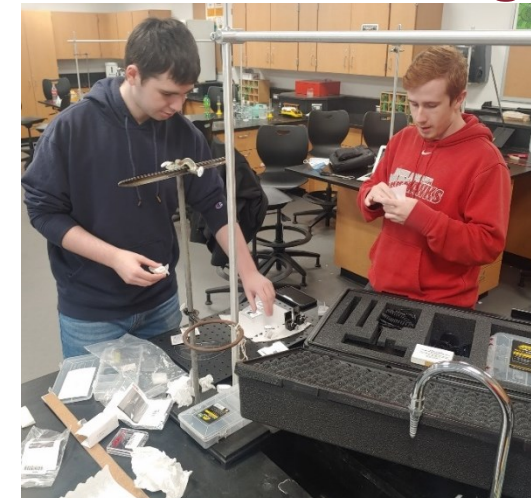
Hybrid (online & hands-on) High School Photonics Training



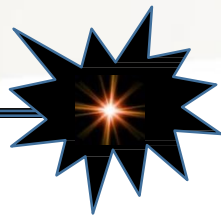
Davis County High School



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

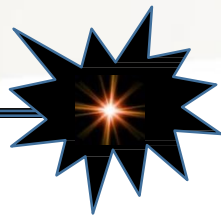
- **Sep 2019 – Aug 2020, Year 2 results** (continued)
 - *Then COVID happened*
 - 2020's summer events for teacher professional development cancelled
 - 4 – day Photonics Institute
 - 2 – day Photonics Symposium
 - Unable to contact and present at all high schools
 - Continued communicating with little 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



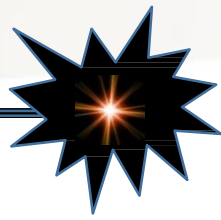
Results, Ongoing & Future



- **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



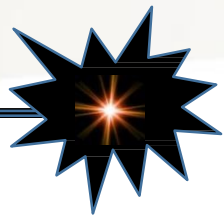
- **Sep 2021 – May 2022, Year 4:**
 - **UREKA!**
 - **Spring 2022 School Year**
 - **1 – high school has dedicated 1 – class period and 1 – teacher/facilitator for LEO102**
 - **18 – students registered for this and 2 - other IHCC dual credit courses.**
 - **Therefore it is assumed (hoped) the majority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



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Thank you for your attention.

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

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