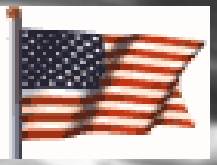


Understanding Light Curing Improved Clinical Success

Howard E. Strassler, DMD, FADM, FAGD
Professor, Division of Operative Dentistry
University of Maryland School of Dentistry
hstrassler@umaryland.edu

UNIVERSITY of MARYLAND SCHOOL OF DENTISTRY

View2Learn

Special thank you to

Richard Price, DDS, MSc, PhD
Professor, Prosthodontics
& Biomedical Engineering

DALHOUSIE UNIVERSITY
Inspiring Minds

Disclosure

- Advisory Board BlueLight Analytics
- San Francisco Giants fan
- Supporter of Baltimore Orioles

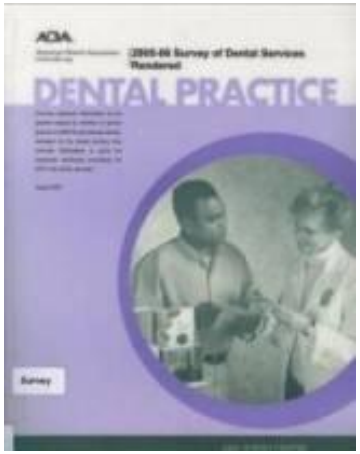
What are we light curing?

- Adhesives
- Restorative composites
- Sealants
- Ceramic veneers
- Ceramic inlays/onlays
- Fiber posts
- Bases-liners
- Tray materials
- Denture base materials
- Prosthodontic provisional materials
- Desensitizing agents
- Bleaching agents

Majority of direct restorations placed *Composite Resins*

- 130,054 General Dentists in US
- >122 million direct resin restorations
- **Plus veneers + orthodontics**

All used light curing!



ADA 2005-6 Survey of Dental Services

National Institute for Dental and Craniofacial Research, 2009

"Despite steady progress in learning how to better **formulate and cure**, or harden, dental composites… Studies have shown that dental resin **composites have an average replacement time of 5.7 years** due to secondary decay and fracture of the restoration."

Understanding Light Curing

Science of light curing

Yap AU, Wong NY, Siow KS. Composite cure and shrinkage associated with high intensity curing light. Oper Dent. 2003; 28:357-64.

Schattenberg A, Lichtenberg D, Stender E, Willershausen B, et al. Minimal exposure time of different LED-curing devices. Dent Mater. 2008; 24:1043-9.

Fan PL, Schumacher RM, Azzolin K, Gerary R, et al. Curing-light intensity and depth of cure of resin based composites tested according to international standards. J Am Dent Assoc. 2002; 133:429-34.

Yap AU, Seneviratne C. Influence of light energy density on effectiveness of composite cure. Oper Dent. 2001; 26:460-6.

Calheiros FC, Kawano Y, Stansbury JW, Braga RR. Influence of radiant exposure on contraction stress, degree of conversion and mechanical properties of resin composites. Dent Mater. 2006; 22:799-803.

Composite Use

- 122,666,950 direct resin restorations a year
  ADA 2005-6
- One third of dentists have eliminated amalgam.
  Christensen, Dental Economics Jan 2011
- In the last 12 months in the U.S., the ratio of composite placed compared to amalgam placed was two Class II composites for every one Class II amalgam.
  Limoli and Associates, Oct 2010

Did you know?

- 122,666,950 direct resin restorations a year: ADA 2005-6
- 50 working weeks a year x 5 days = 250 working days
- 490,667 resins a day
- 490,667 times a curing light was used
- 490,667 times @ $200 each
- **$98,133,560 a day in the US ALONE**
- **$24.5 BILLION a YEAR**

Light-curing… so easy a caveman can do it!

The Problem

Process of “light-curing” is

treated with “*little regard”* to the exacting science it really is.

“Too easy” and minimal attempts seem to produce an acceptably “hard” restoration.

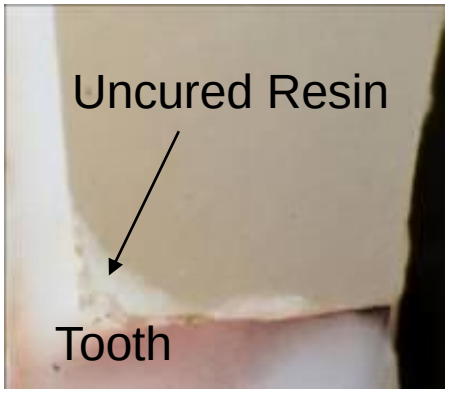
Understanding the challenge

Teach students-clinicians how to use their light properly and what affects the extent of cure of *THEIR RESTORATIONS* :

- What "spectral output" of the light means
- What are the "spectral needs" of the resin
- What is the difference between irradiance and energy density
- How exposure duration and spectral delivery affect final restoration cure

The Problem:
not curing composite completely

- Lower bond strength
- Increased microleakage
- Increased recurrent caries
- Increased staining-color changes
- Increased wear

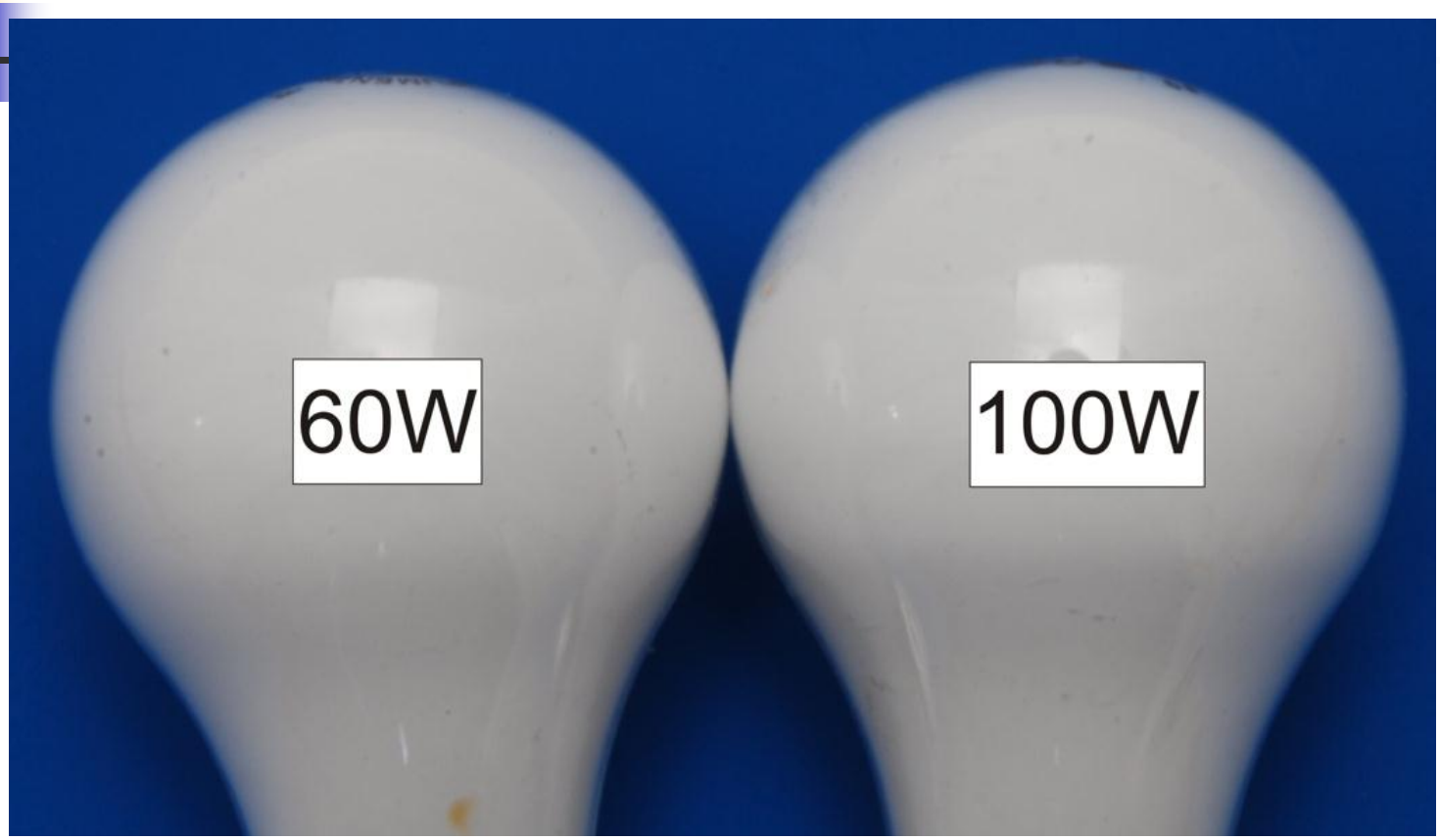


- Premature restoration failure!

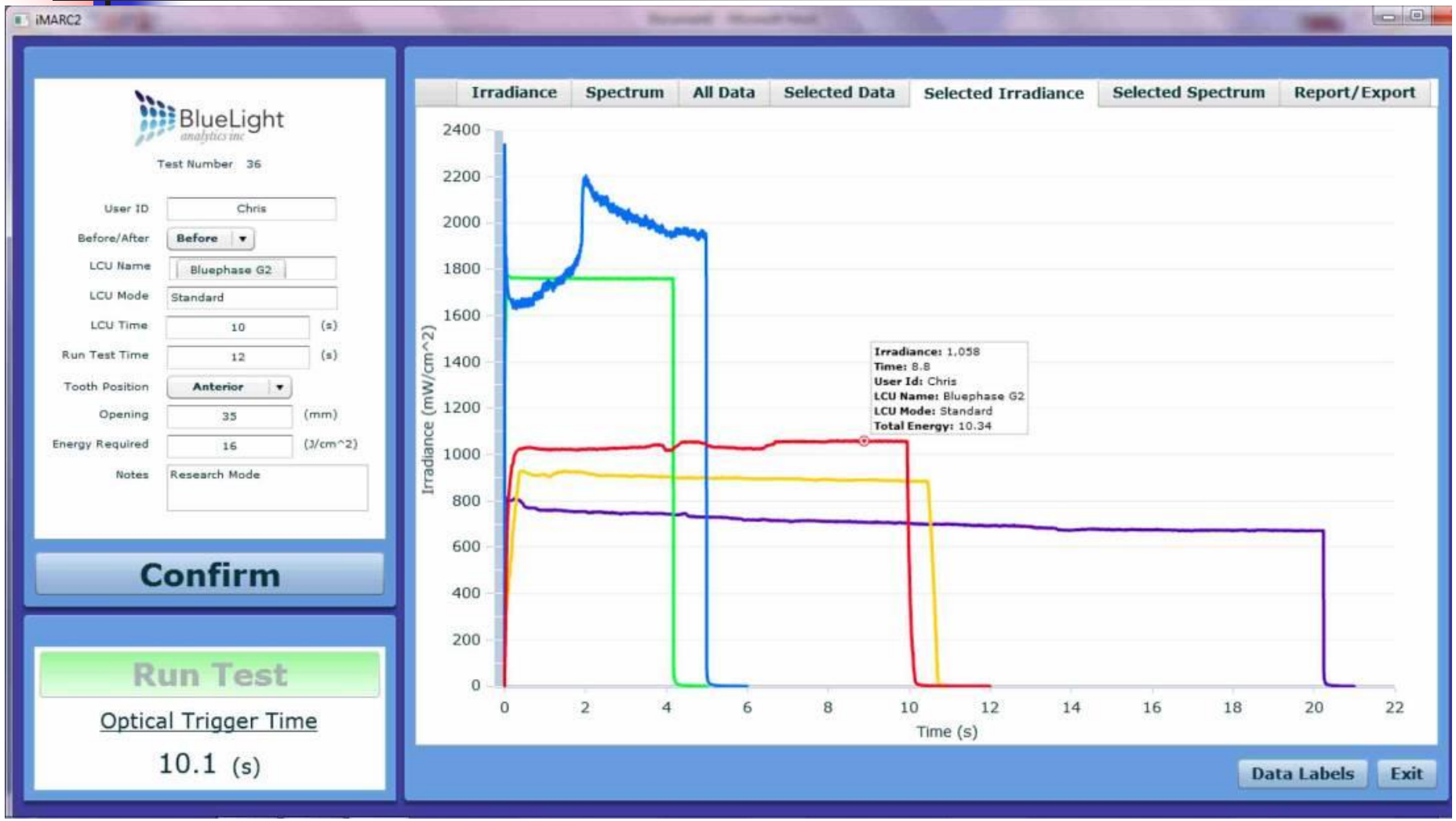
Not all curing lights are the same

Understanding The Differences

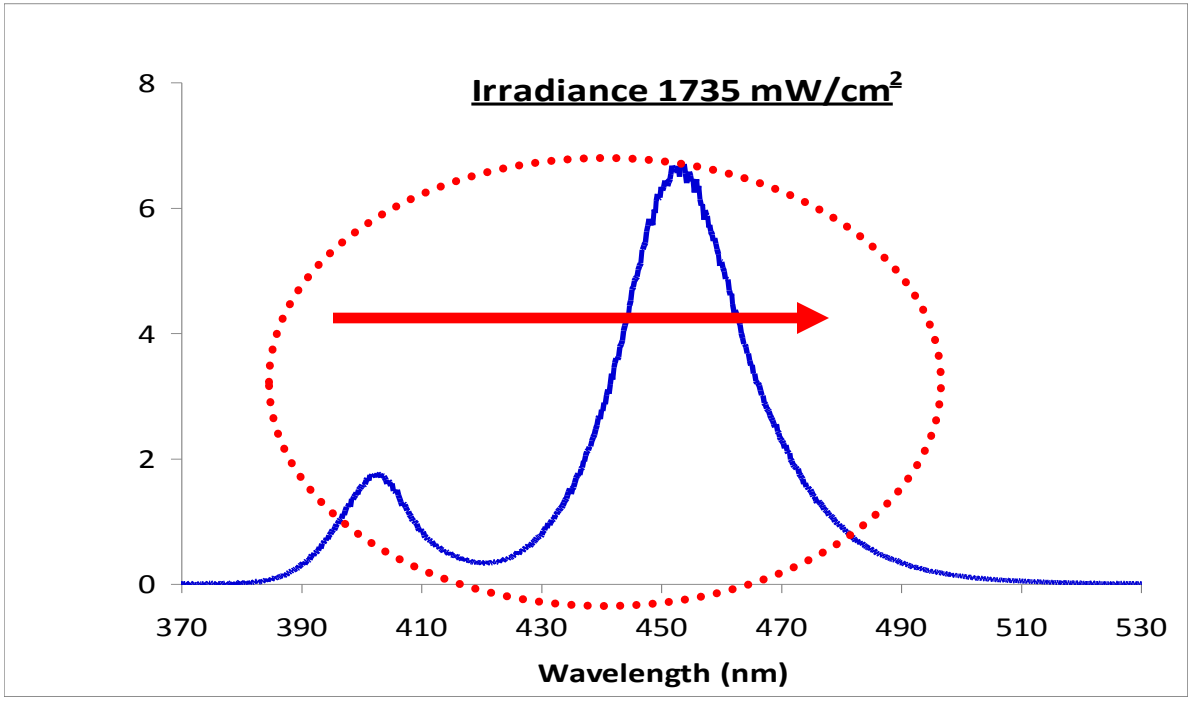
Power = mWatts



Irradiance (Power/Unit Area) mW/cm^2



Spectral Radiant Power mWatts/nm



Understanding

- Power: mWatts
- Irradiance: (Power/Unit Area) mW/cm^2
- Spectral Radiant Power: mWatts/nm
- Energy Density = Irradiance x Time: 8 - 16 J/cm^2

3M ESPE

Filtek™ Supreme Ultra
Universal Restorative

7. Curing: This product is intended to be cured by exposure to a halogen or LED light with a minimum intensity of 400mW/cm² in the 400-500nm range. Cure each increment by exposing its entire surface to a high intensity visible light source, such as a 3M ESPE curing light. Hold the light guide tip as close to the restorative as possible during light exposure.

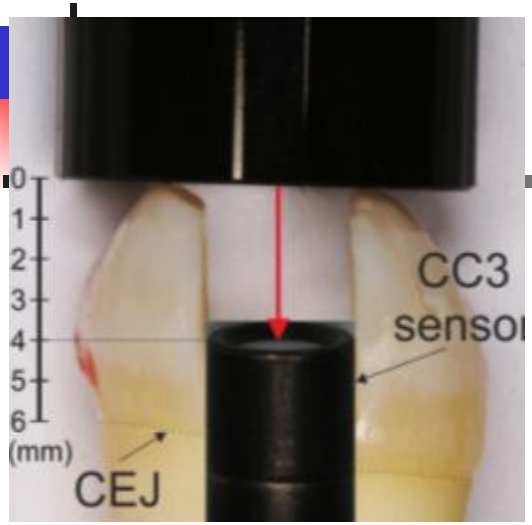
Shades	Incremental depth	Cure time
Body, Enamel, Translucent	2.0mm	20 sec.
Dentin, A6B and B5B	1.5mm	40 sec.

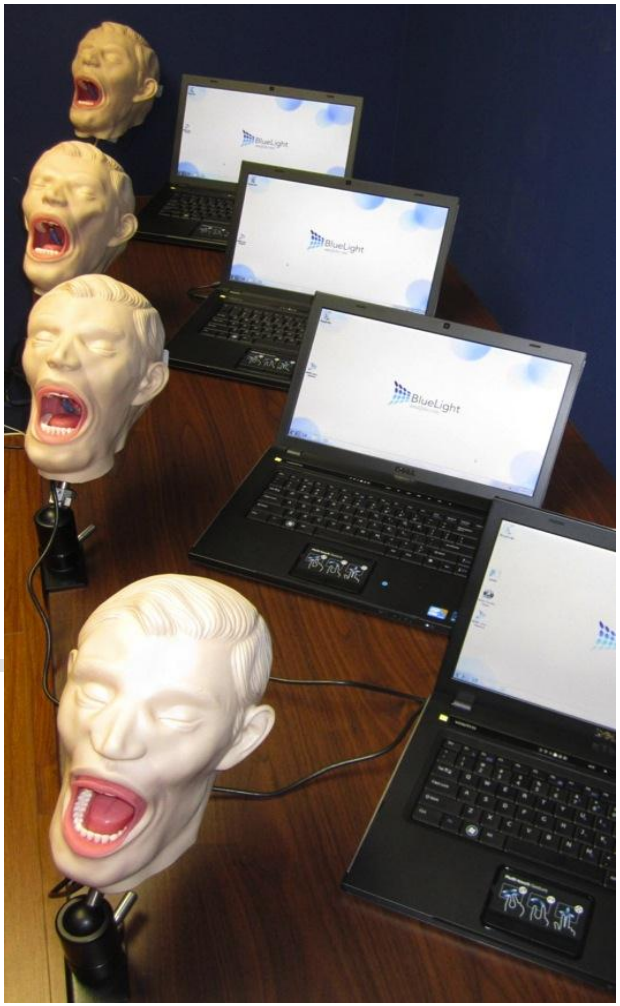
MARC (BlueLight Analytics)

- BlueLight makes MARC™– Managing Accurate Resin Curing.
- MARC™ was invented by Dr. Richard Price and his research associate, Chris Felix, at Dalhousie University.
- MARC™ is the first and only scientifically accurate, clinically relevant and easy-to-use energy measurement system for measuring what resin actually receives.

Who is MARC™?

MARC™ Patient Simulator
quantifies energy delivery to resin

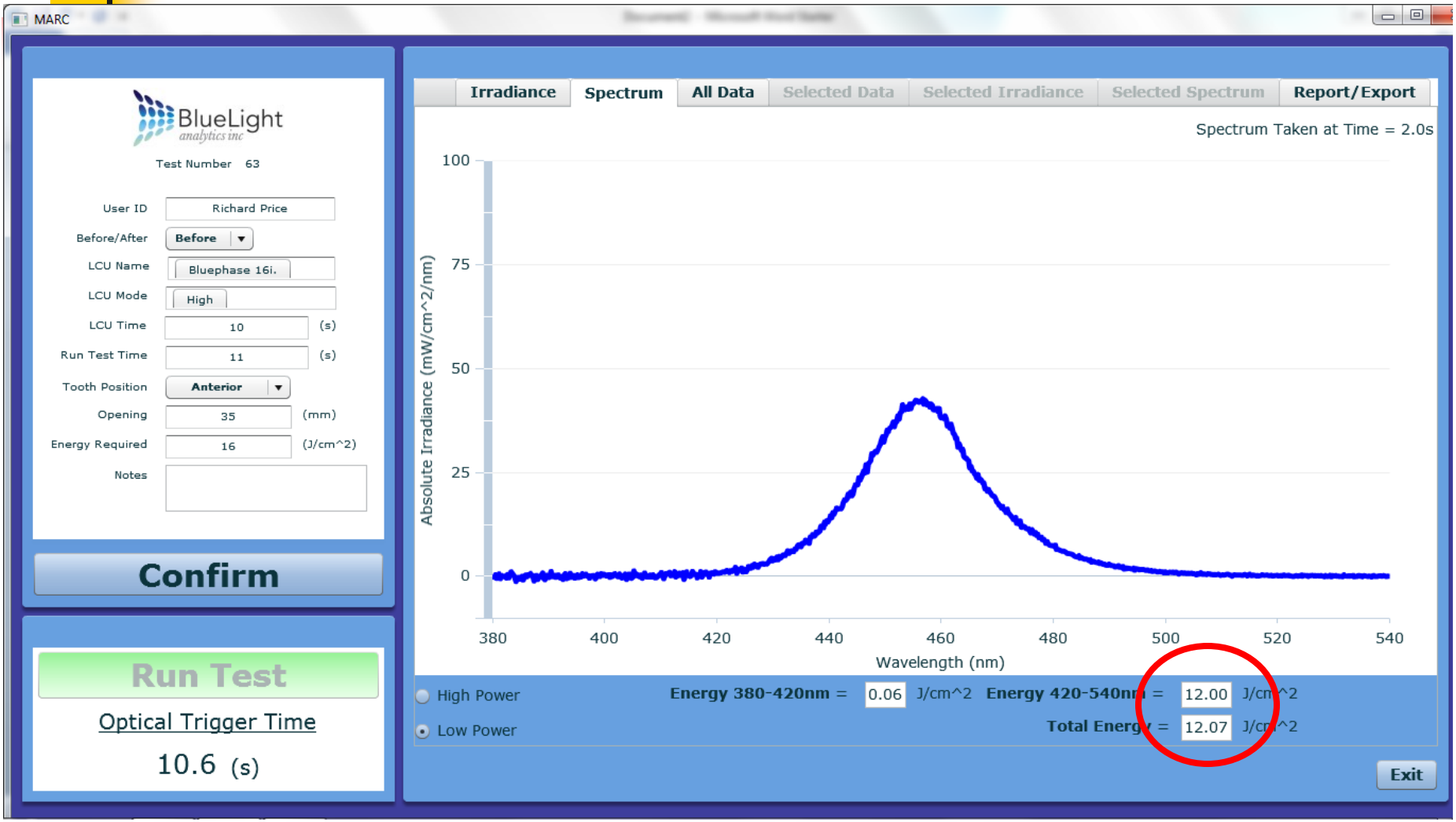




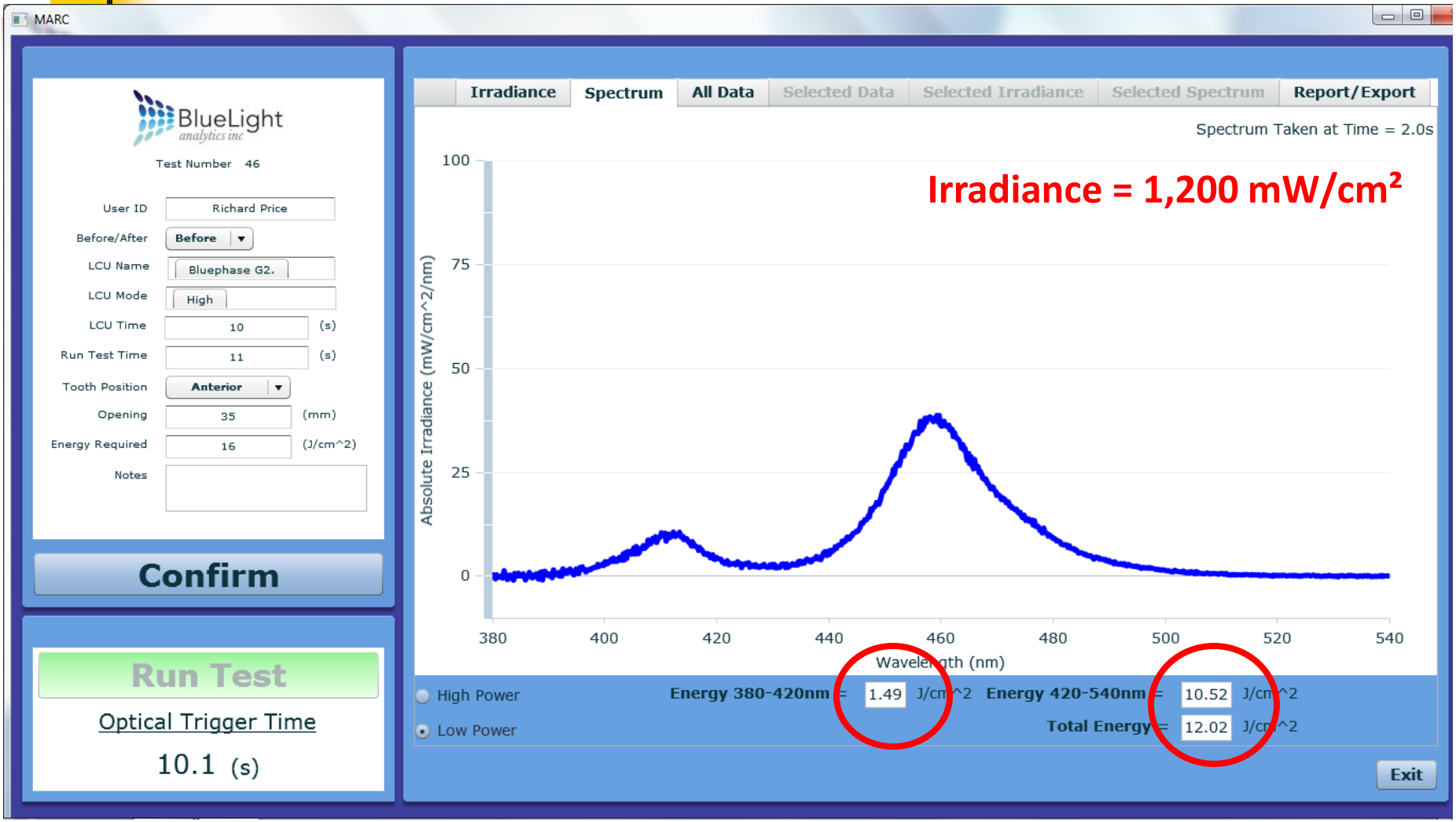
Scientifically accurate,
clinically relevant
& easy-to-use

Consistent calibration enables
apples:apples comparisons

LIGHT SPECTRUM



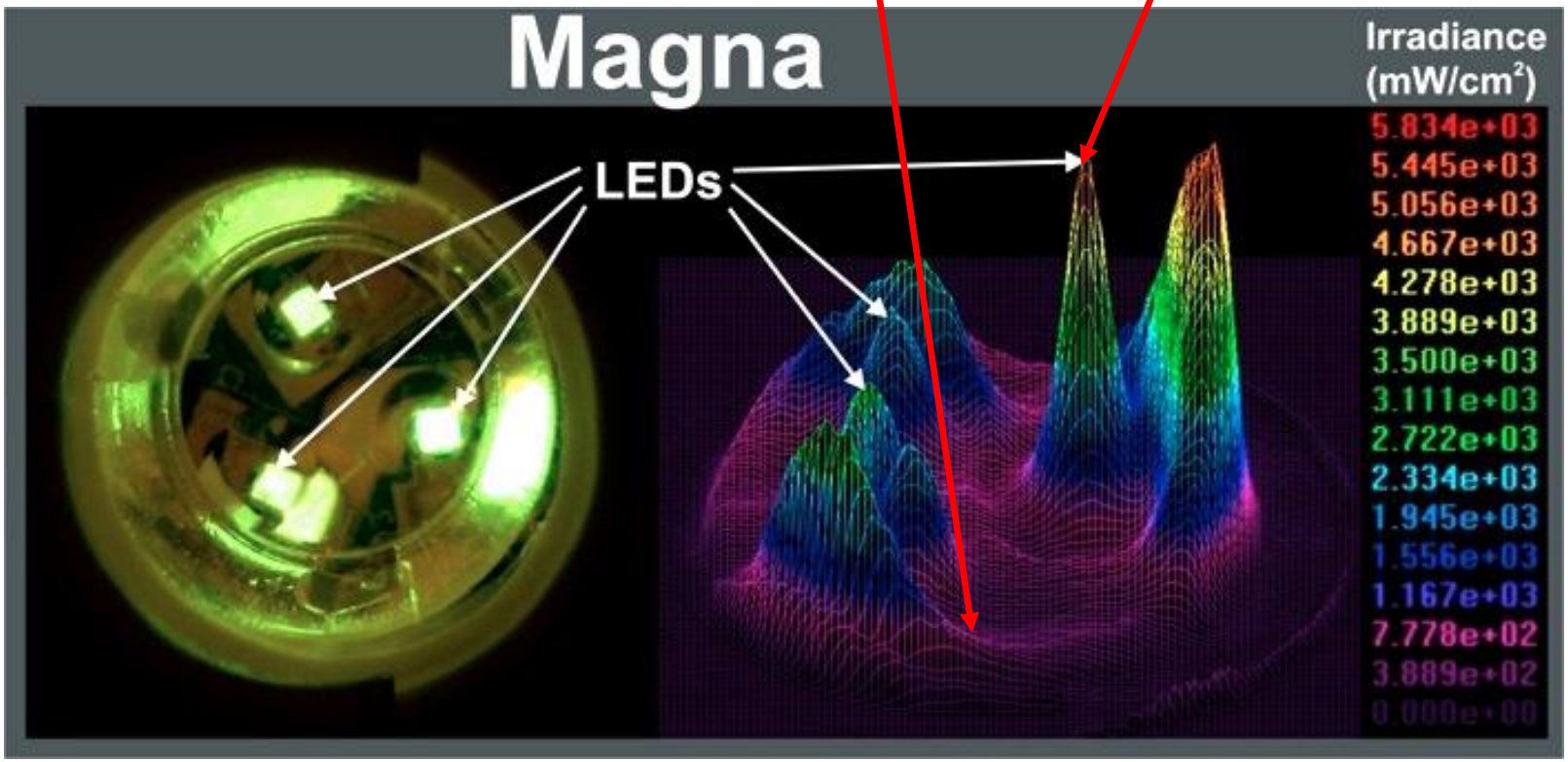
LIGHT SPECTRUM



Irradiance not uniform

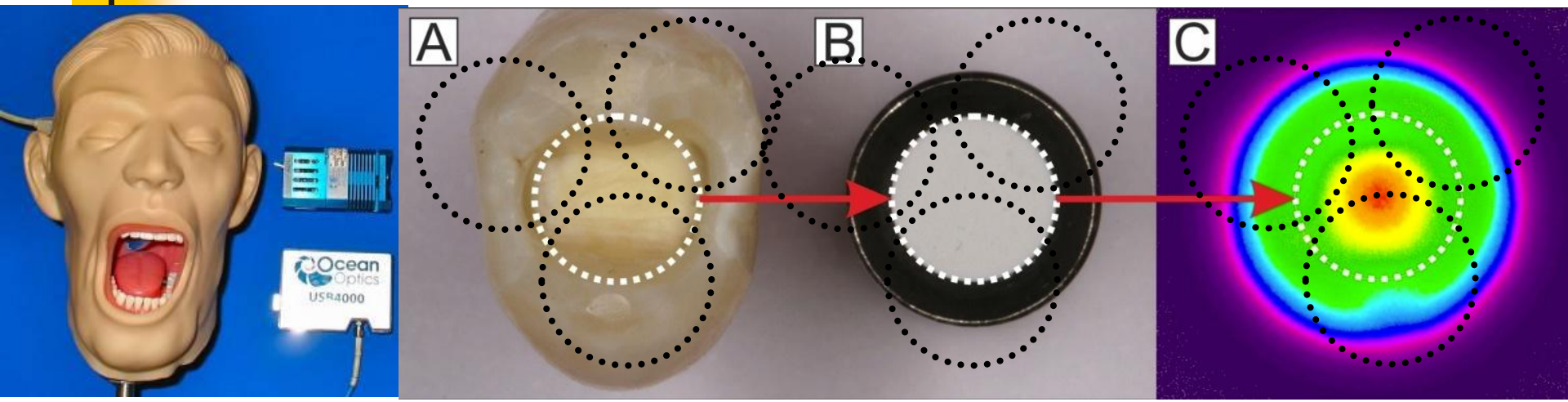
What is the beam profile?

1200 mW/cm^2 388 mW/cm^2 5,834 mW/cm^2

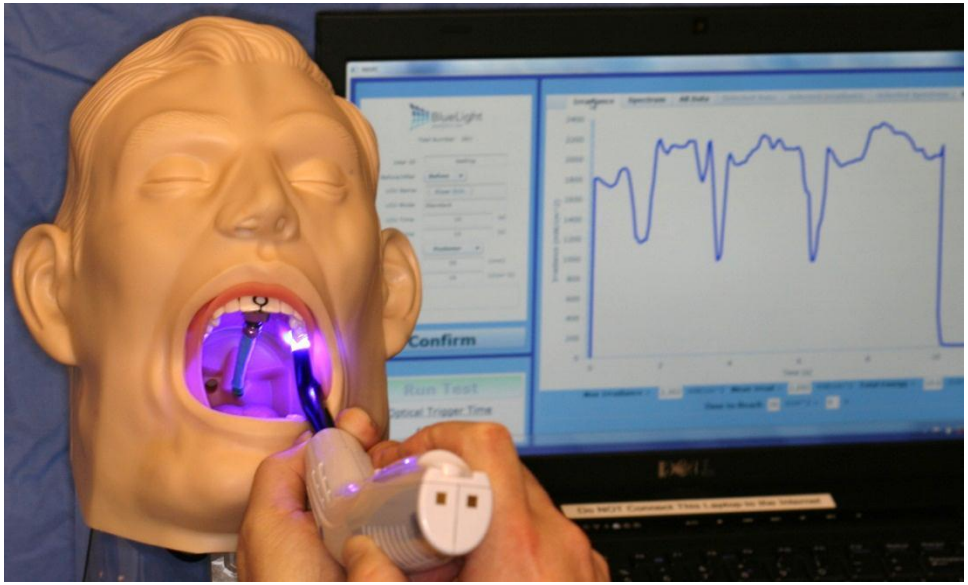


Price, Rueggeberg et al. **J Esthetic and Restorative Dentistry** 2010

Detects uneven beam distribution hot spots-cold spots



Operator technique evaluation



Bottom line…

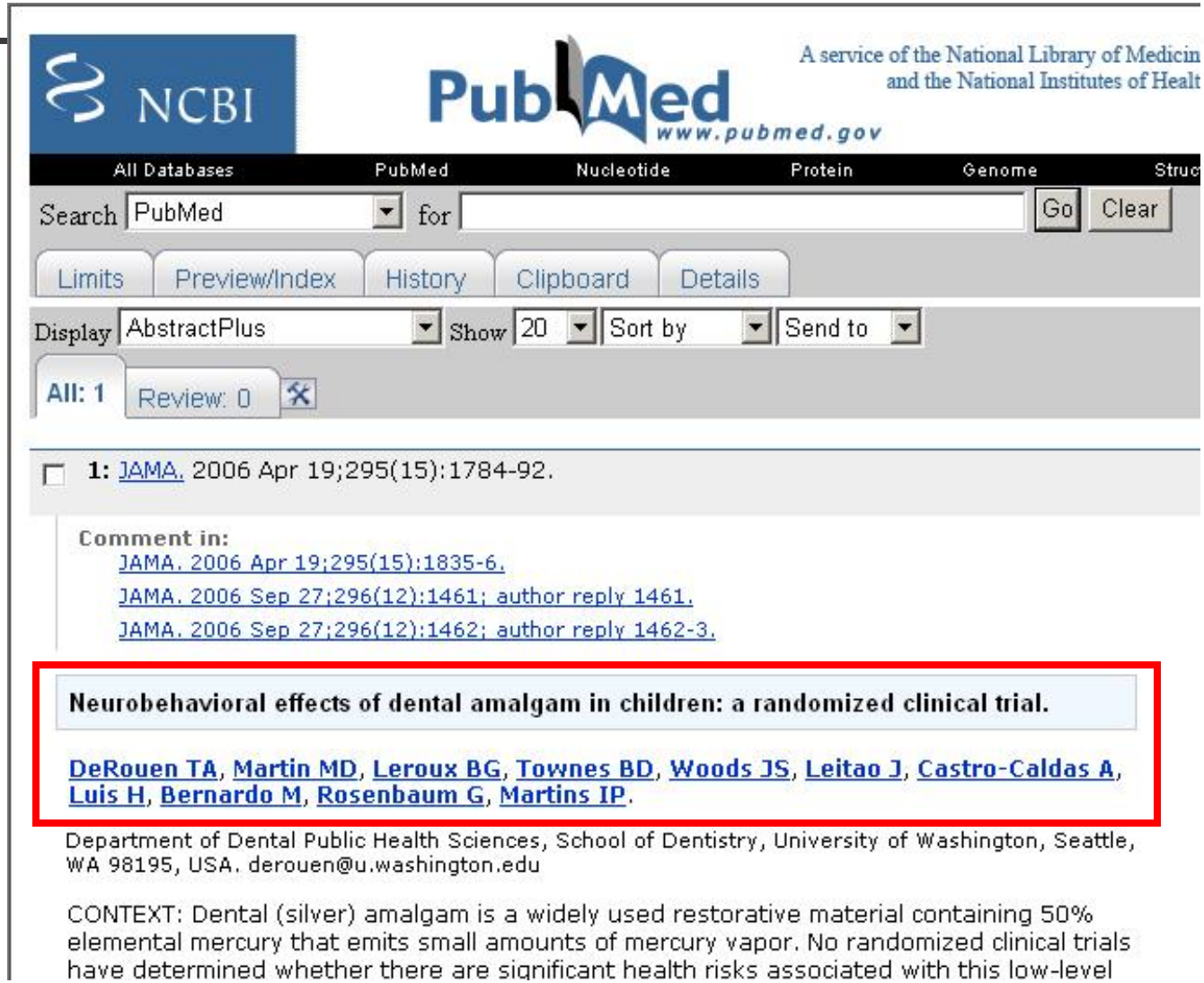
How do we make the science relevant and create value during a student's/clinician's education?

For a clinical procedure light curing = 15-60 sec

Understanding leads to improved clinical success

Light energy matters!

Safety concerns



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1: JAMA. 2006 Apr 19;295(15):1784-92.

Comment in:
JAMA. 2006 Apr 19;295(15):1835-6.
JAMA. 2006 Sep 27;296(12):1461; author reply 1461.
JAMA. 2006 Sep 27;296(12):1462; author reply 1462-3.

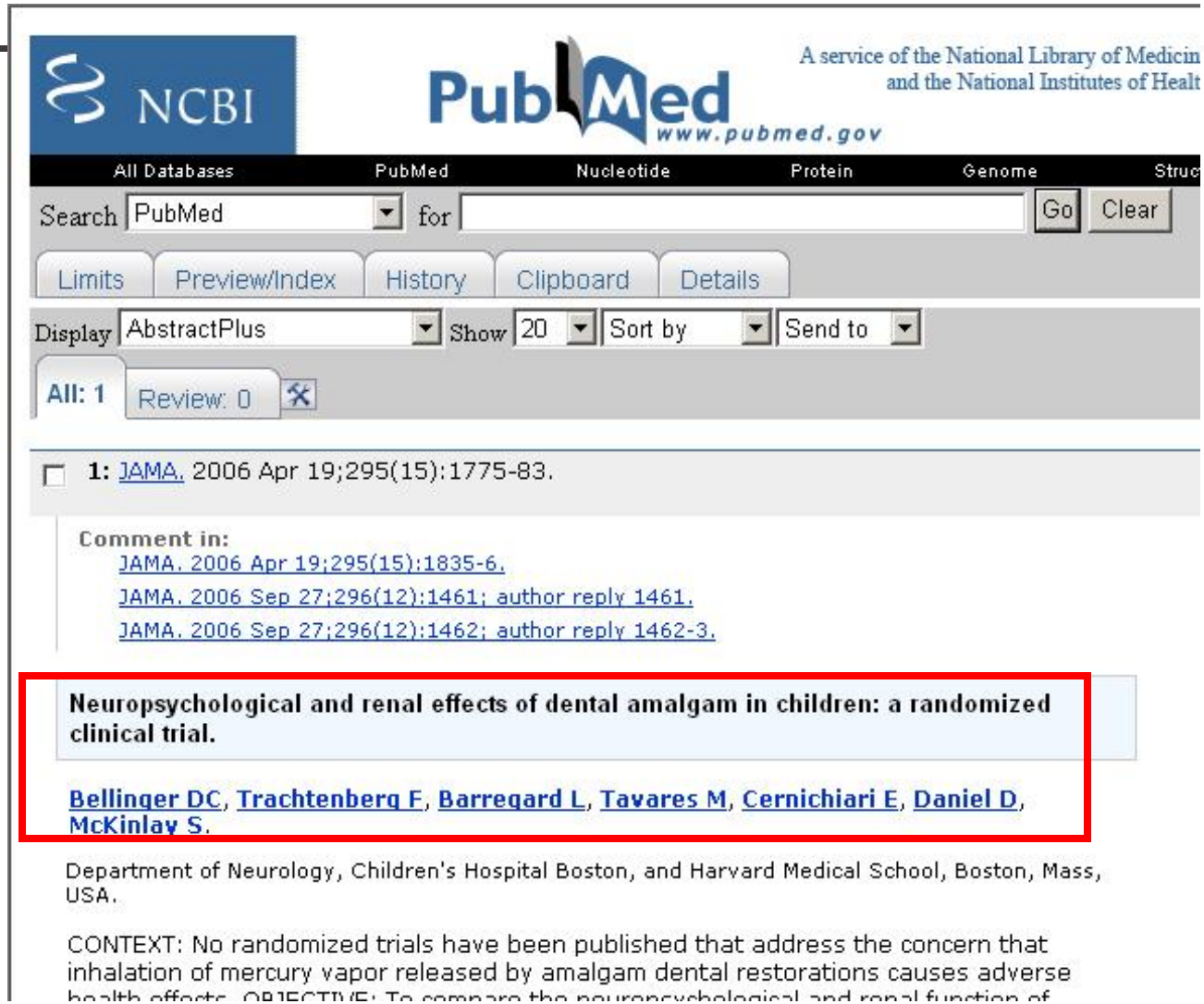
Neurobehavioral effects of dental amalgam in children: a randomized clinical trial.

DeRouen TA, Martin MD, Leroux BG, Townes BD, Woods JS, Leitao J, Castro-Caldas A, Luis H, Bernardo M, Rosenbaum G, Martins IP.

Department of Dental Public Health Sciences, School of Dentistry, University of Washington, Seattle, WA 98195, USA. derouen@u.washington.edu

CONTEXT: Dental (silver) amalgam is a widely used restorative material containing 50% elemental mercury that emits small amounts of mercury vapor. No randomized clinical trials have determined whether there are significant health risks associated with this low-level

Safety concerns



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COSTELLO TO PERFORM HIS OWN CLASSICAL COMPOSITION

>>>> IN TODAY

INDIANS RIP O'S, 15-1

STARTER BRUCE CHEN GIVES UP 8 RUNS IN ROUT; NATIONALS TOPPLE PHILLIES, 10-3 >>>> IN SPORTS

NEW MOMS

FIRMS DON'T WANT TO LOSE PRIZED WORKERS

>>>> IN WORKING

Doubts are raised on re-regulation

BY PAUL ADAMS
[SUN REPORTER]

Re-regulating Maryland's power industry might be politically popular in the face of rising rates, experts say, but would be legally complicated, potentially costly and would not necessarily result in lower energy prices.

The idea of re-regulation has gained steam during the past month as the prospect of a 72 percent rate increase this summer by Baltimore Gas and Electric Co. all but consumed the recent session of the Maryland legislature.

On Monday, Douglas M. Duncan, the Montgomery County executive and Democratic gubernatorial candidate, called for re-regulating the power industry and imposing rate limits, setting himself apart from the other major candidates in the race, Republican Gov. Robert L. Ehrlich Jr. and Democratic Baltimore Mayor Martin O'Malley.

Two bills introduced during the legislative session also called for some form of re-regulation to counter rising energy costs, but they fizzled as officials focused on the more immediate problem of easing this summer's rate increase.

Ehrlich is negotiating with Constellation Energy Group Inc., the parent of BGE, on a possible phase-in for the rate increase.

[Please see POWER, 7A]

RATES RECAP

- In 1999, Maryland lawmakers deregulated the electric industry and imposed a cap on BGE rates for six years as part of the transition to free markets. With those caps expiring, customers face a possible 72 percent price increase this summer because BGE must pay more for the power it delivers.
- Montgomery County Executive Douglas M. Duncan, a Democratic gubernatorial candidate, has called for re-regulating the power industry and imposing rate caps.
- Supporters of re-regulation say it could result in lower costs by removing free-market price volatility and putting limits on power suppliers' charges.
- Skeptics say it would be costly and legally questionable to try to buy back power plants that BGE and other utilities had to give up as part of deregulation, and that building plants would cost billions of dollars. Electricity might end up costing more as a result, they say.

SILVER FILLINGS FOUND KID-SAFE

Traditional tooth care contains mercury but doesn't harm children, major studies indicate

BY JONATHAN BOR
[SUN REPORTER]

Rare whale lands in rarer venue: Baltimore

DENTAL RESEARCH & APPLICATIONS

Practical interpretations of current investigations.

Commentary by Howard E. Strassler, DMD

Howard E. Strassler, DMD

Professor and Director of Operative Dentistry, Department of Endodontics, Prosthodontics and Operative Dentistry University of Maryland Dental School, Baltimore, Maryland

Neurobehavioral Effects of Dental Amalgam in Children: A Randomized Clinical Trial

DeRouen TA, Martin MD, Leroux BG, et al. JAMA. 2006;295(15):1784-1792.

ABSTRACT

CONTEXT: *Dental (silver) amalgam is a widely used restorative material containing 50% elemental mercury that emits small amounts of mercury vapor. No randomized clinical trials have determined whether there are significant health risks associated with this low-level mercury exposure.* OBJECTIVE: *To assess the safety of dental amalgam restorations in children.* DESIGN: *A randomized clinical trial in which children requiring dental restorative treatment were randomized to either amalgam for posterior restorations or resin composite instead of amalgam. Enrollment commenced February 1997, with annual follow-up for 7 years concluding in July 2005.* SETTING AND PARTICIPANTS: *A total of 507 children in Lisbon, Portugal, aged 8 to 10 years with at least 1 carious lesion on a permanent tooth, no previous exposure to amalgam, urinary mercury level < 10 µg/L, blood lead level < 15 µg/dL, Comprehensive Test of Nonverbal*

suggest that amalgam should remain a viable dental restorative option for children.

Neuropsychological and Renal Effects of Dental Amalgam in Children: A Randomized Clinical Trial

Bellinger DC, Trachtenberg F, Barregard L, et al. JAMA. 2006;295(15):1775-1783.

ABSTRACT

CONTEXT: *No randomized trials have been published that address the concern that inhalation of mercury vapor released by amalgam dental restorations causes adverse health effects.* OBJECTIVE: *To compare the neuropsychological and renal function of children whose dental caries were restored using amalgam or mercury-free materials.* DESIGN AND SETTING: *The New England Children's Amalgam Trial was a 2-group randomized safety trial involving 5 community health dental clinics in Boston, Mass, and 1 in Farmington, Me, between September 1997 and March 2005.* PARTICIPANTS AND INTERVENTION: *A total of 534 children aged 6 to 10 years at baseline with no prior amalgam restorations and 2 or more posterior teeth with caries were randomly assigned to receive dental restoration of baseline and incident caries during a 5-year follow-up period using either amalgam*

CONCLUSIONS: *In this study, there were no statistically significant differences in adverse neuropsychological or renal effects observed over the 5-year period in children whose caries were restored using dental amalgam or composite materials. Although it is possible that very small IQ effects cannot be ruled out, these findings suggest that the health effects of amalgam restorations in children need not be the basis of treatment decisions when choosing restorative dental materials.*

Survivability
Amalgam vs Composite

THE JOURNAL OF THE AMERICAN DENTAL ASSOCIATION
J A D A

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J Am Dent Assoc, Vol 138, No 6, 775-783.

CLINICAL PRACTICE

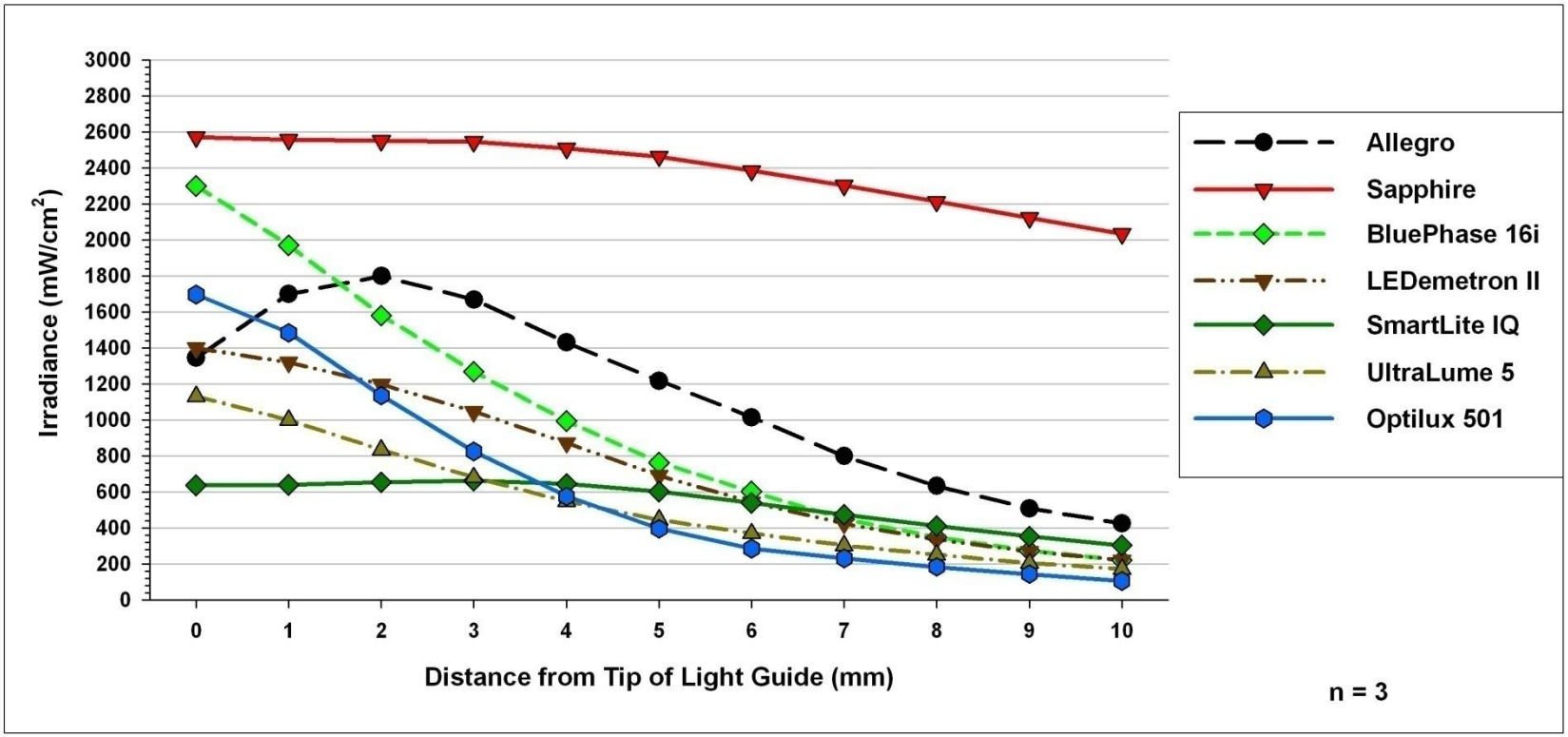
JADA Continuing Education

Survival and reasons for failure of amalgam versus composite posterior restorations placed in a randomized clinical trial

Mario Bernardo, DMD, PhD, Henrique Luis, MS, Michael D. Martin, DMD, MSD, MPH, MA, PhD, Brian G. Leroux, MSc, PhD, Tessa Rue, MS, Jorge Leitão, MD and Timothy A. DeRouen, PhD

up to seven years. Overall, 10.1 percent of the baseline restorations failed. The survival rate of the amalgam restorations was 94.4 percent; that of composite restorations was 85.5 percent. Annual failure rates ranged from 0.16 to 2.83 percent for amalgam restorations and from 0.94 to 9.43 percent for composite restorations. Secondary caries was the main reason for failure in both materials. Risk of secondary caries was 3.5 times greater in the composite group. CONCLUSION: Amalgam restorations performed better than did composite restorations. The difference in performance was accentuated in large restorations and in those with more than three surfaces involved. CLINICAL IMPLICATIONS: Use of amalgam appears to be preferable to use of composites in multisurface restorations of large posterior teeth if longevity is the primary criterion in material selection.

Effect of Distance from the Light Guide on the Irradiance Received



Felix CA, Price RB. Effect of Distance on Power Density from Curing Lights. Journal of dental research 2006;85:abstract 2486 (www.dentalresearch.org).

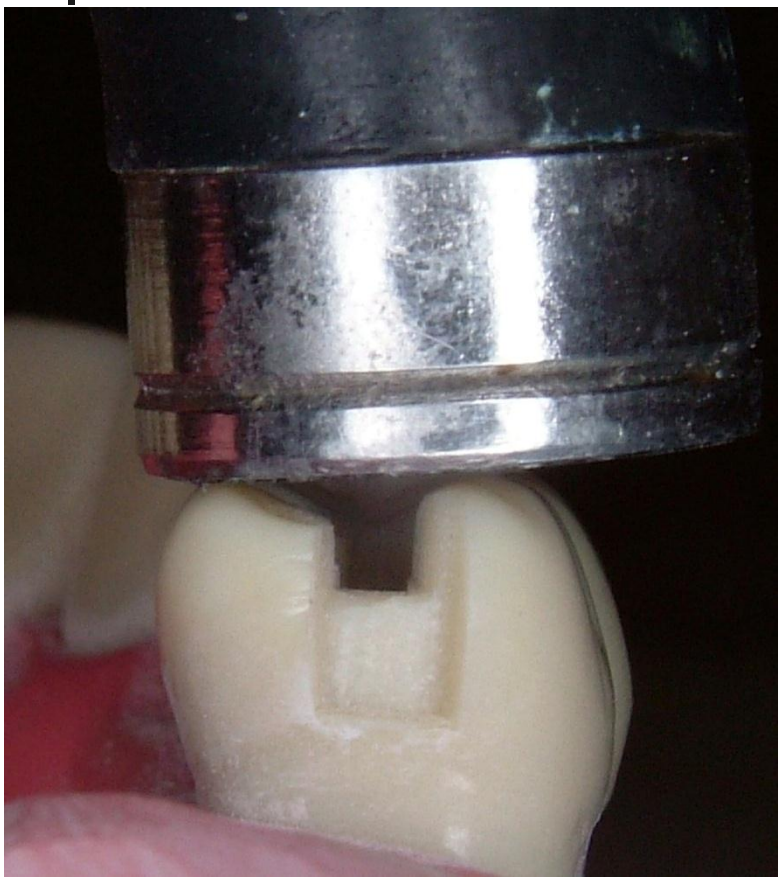
When curing adhesives in deep proximal boxes with quartz halogen light (600 mw/cm2) curing time should be increased to 40-60 seconds to ensure optimal polymerization

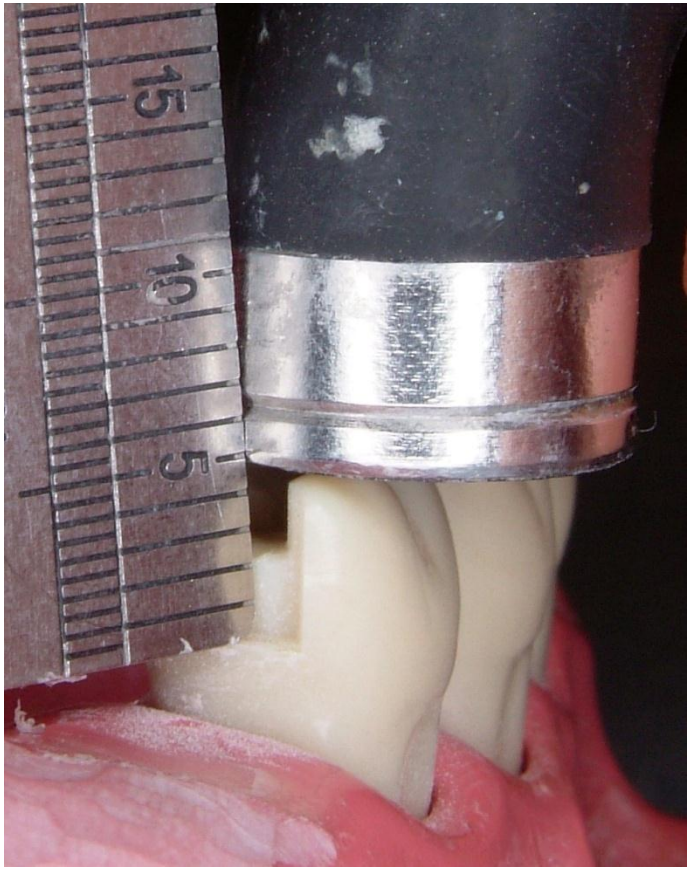
Xu X, Sandras D, Burgess JO. Shear bond strength with increasing light-guide distance from dentin. J Esthet Restor Dent 2006

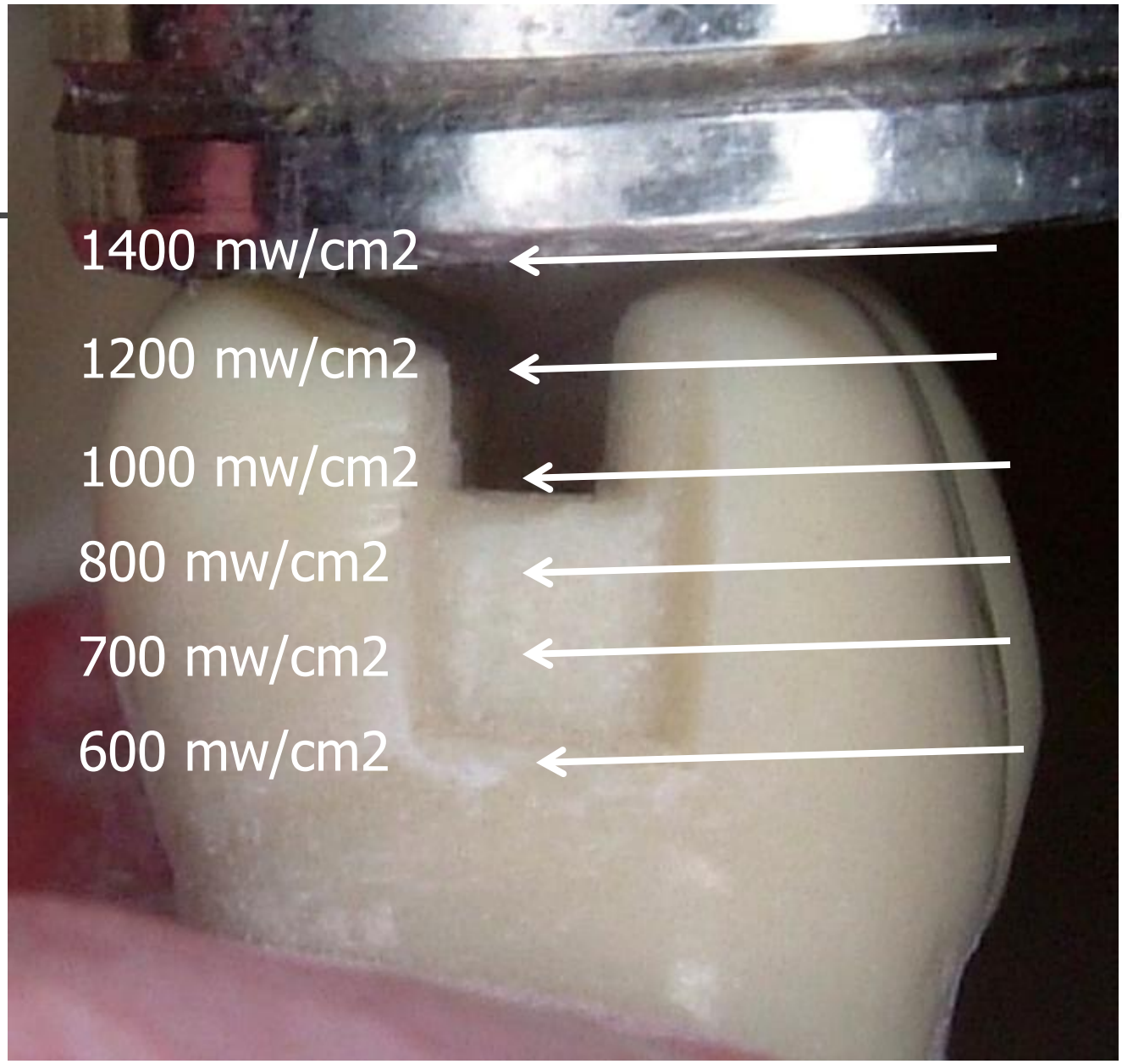
To maximize the energy delivered, the operator should wear eye protection, should watch what he or she is doing and should hold the light both close to and perpendicular to the restoration.

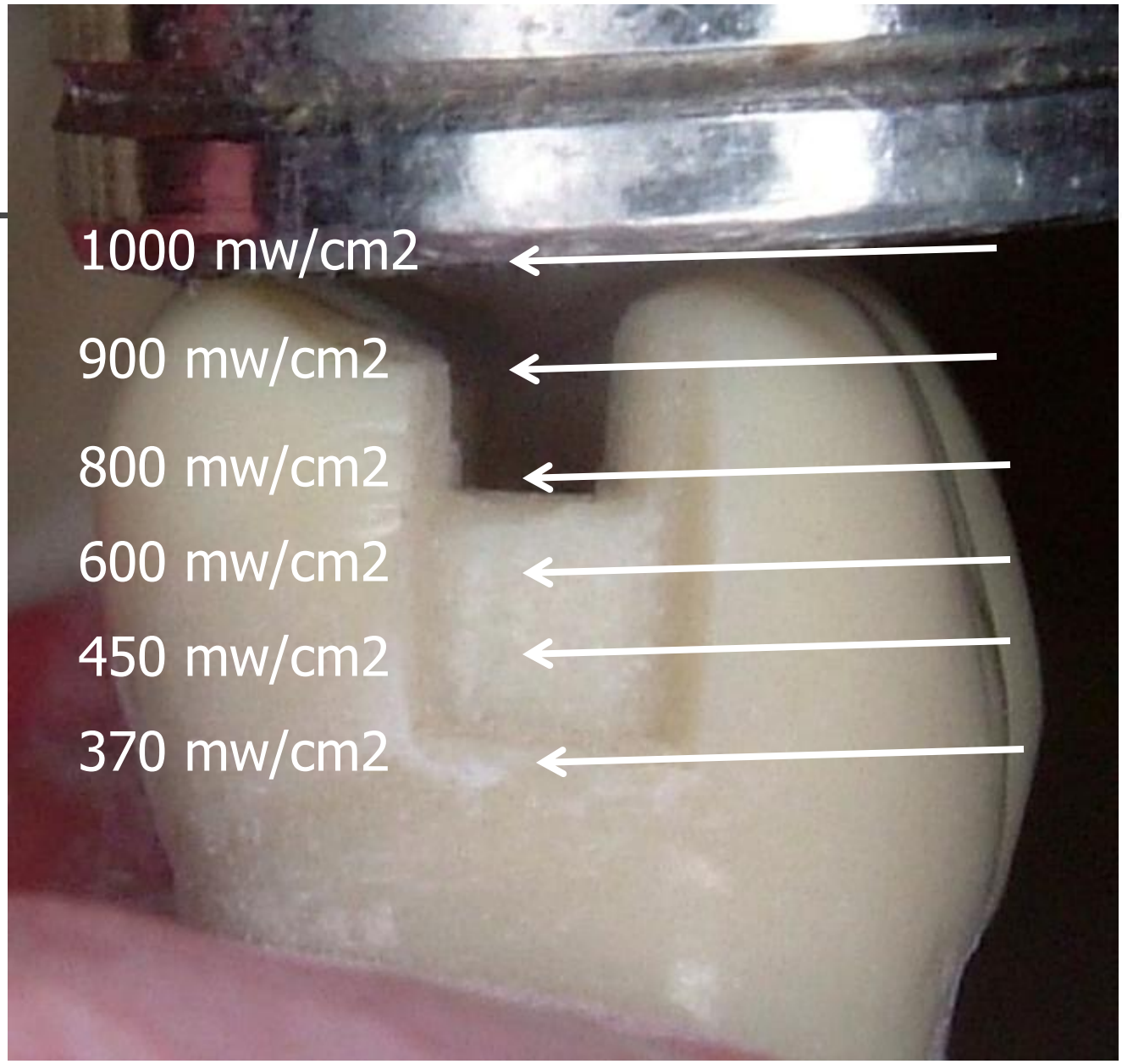
Price RB, McLeod ME, Felix C Quantifying light energy delivered to a Class I restoration J Can Dent Assoc 2010

Where is the light relative to what it is curing?



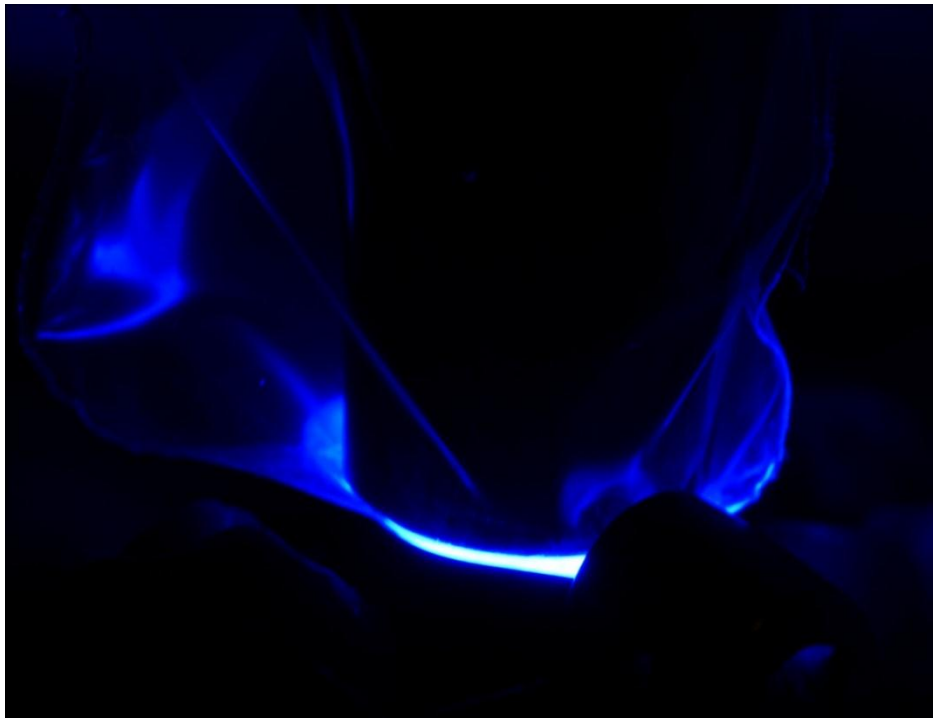



1400 mw/cm2
1200 mw/cm2
1000 mw/cm2
800 mw/cm2
700 mw/cm2
600 mw/cm2


1000 mw/cm2
900 mw/cm2
800 mw/cm2
600 mw/cm2
450 mw/cm2
370 mw/cm2

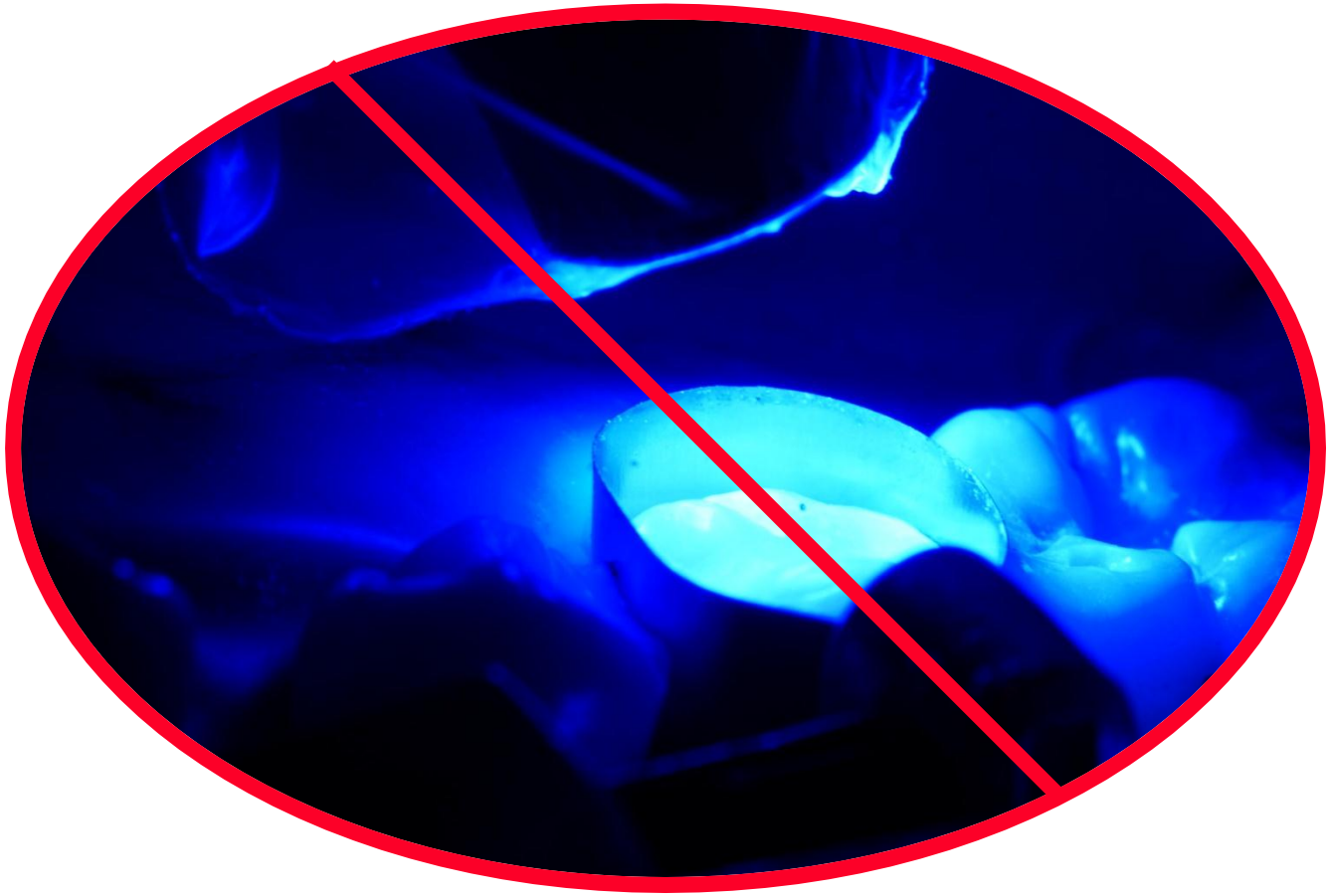
Orientation of the Light

**Right angle
**Close to the tooth
as is possible



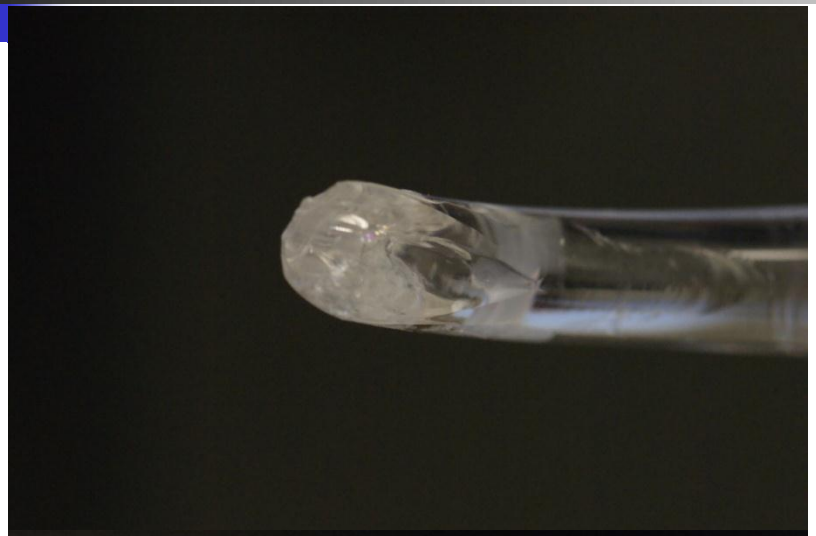
Matrix band moves
The light further away!

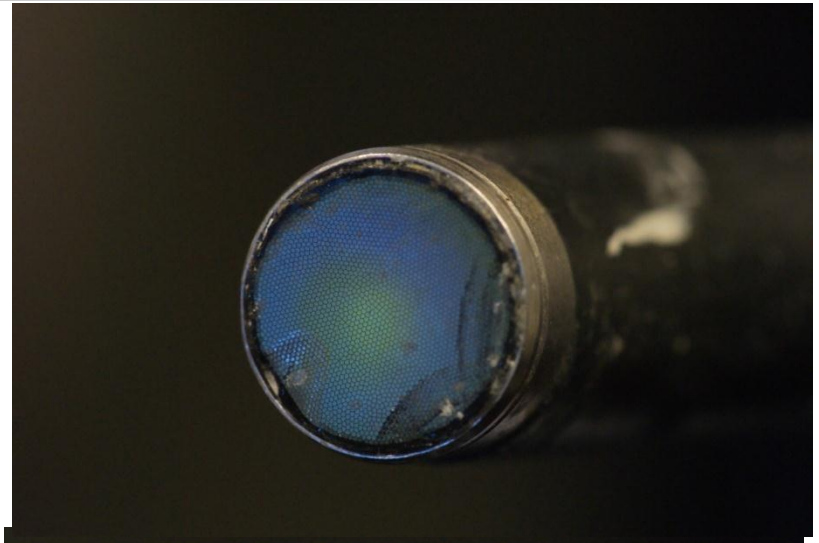
Mis-Orientation of the Light

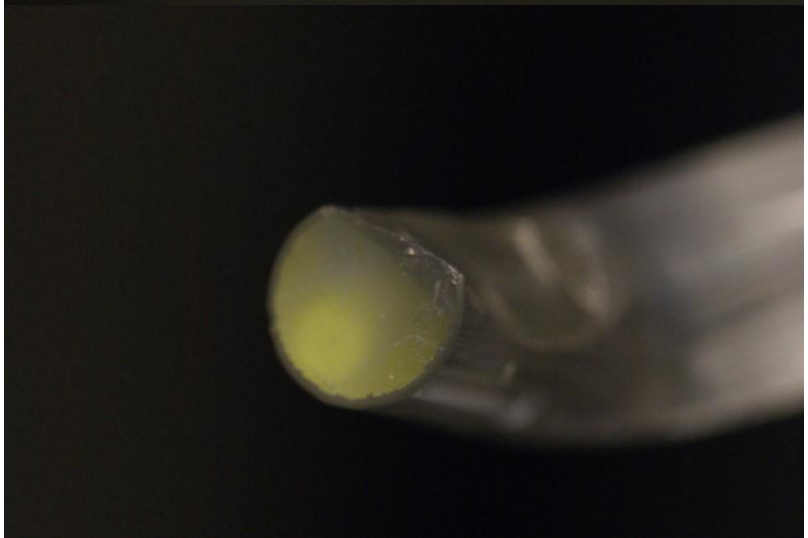


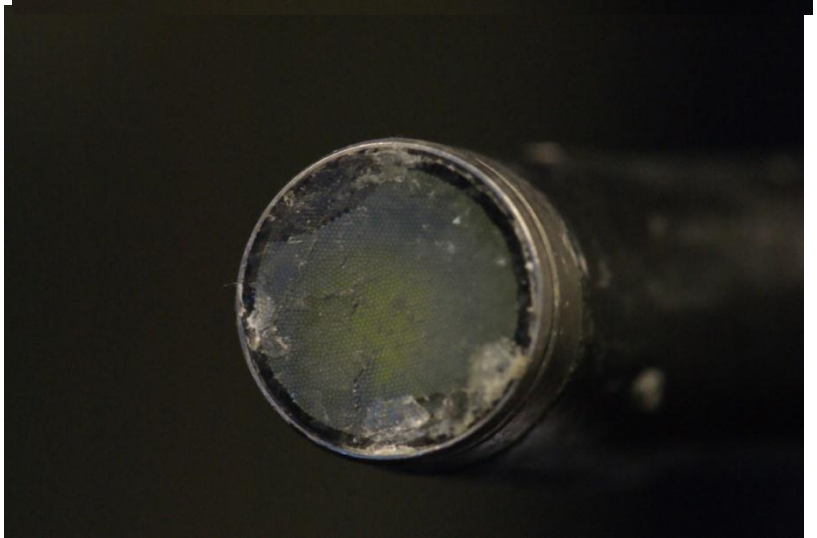
Note the height of the matrix

Lights not working optimally









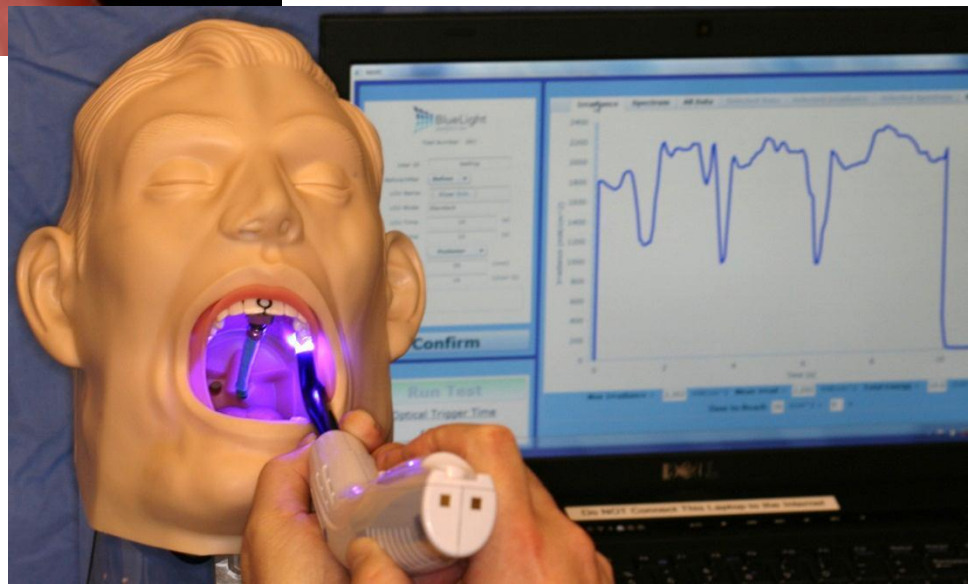
MARC

Scientifically accurate- clinically relevant device.
Measures:

- Irradiance
- Spectral emission
- Energy values

MARC for light curing training

Operator technique



Good light curing habits CORE

Curing Light

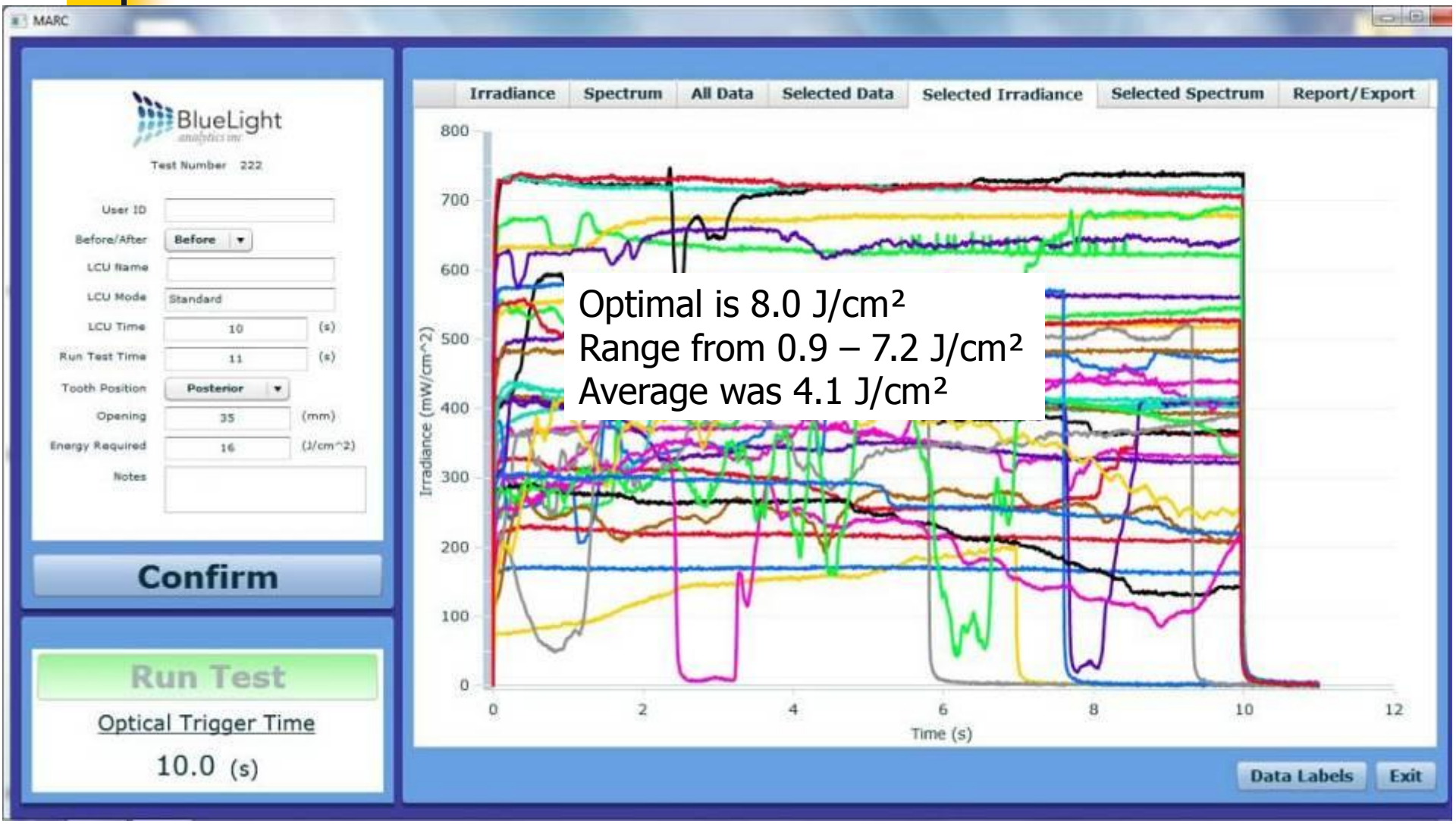
Operator Technique

Restoration (location, depth, size, opening)

Energy Requirement

Know your Curing light

37 Operators
Same Light, Same Tooth, Same Time

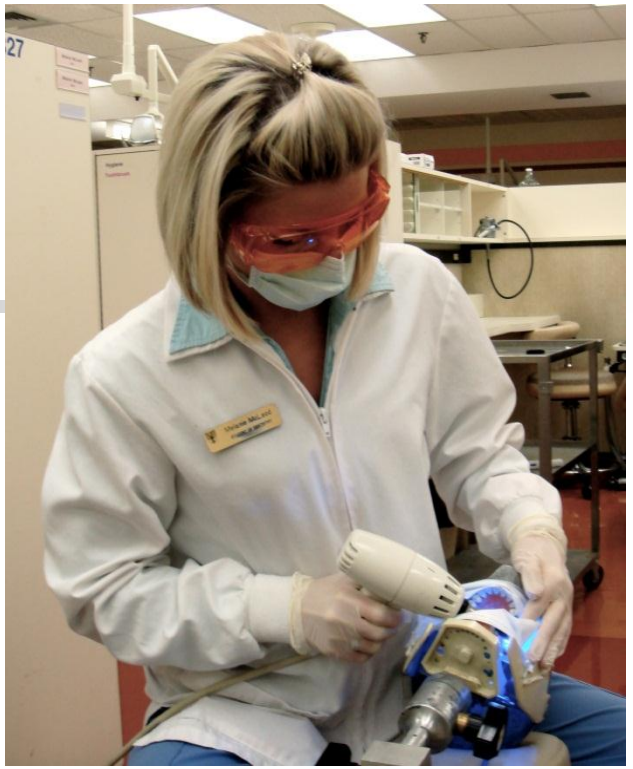


Teaching and Evaluating Light Curing

Before Instruction

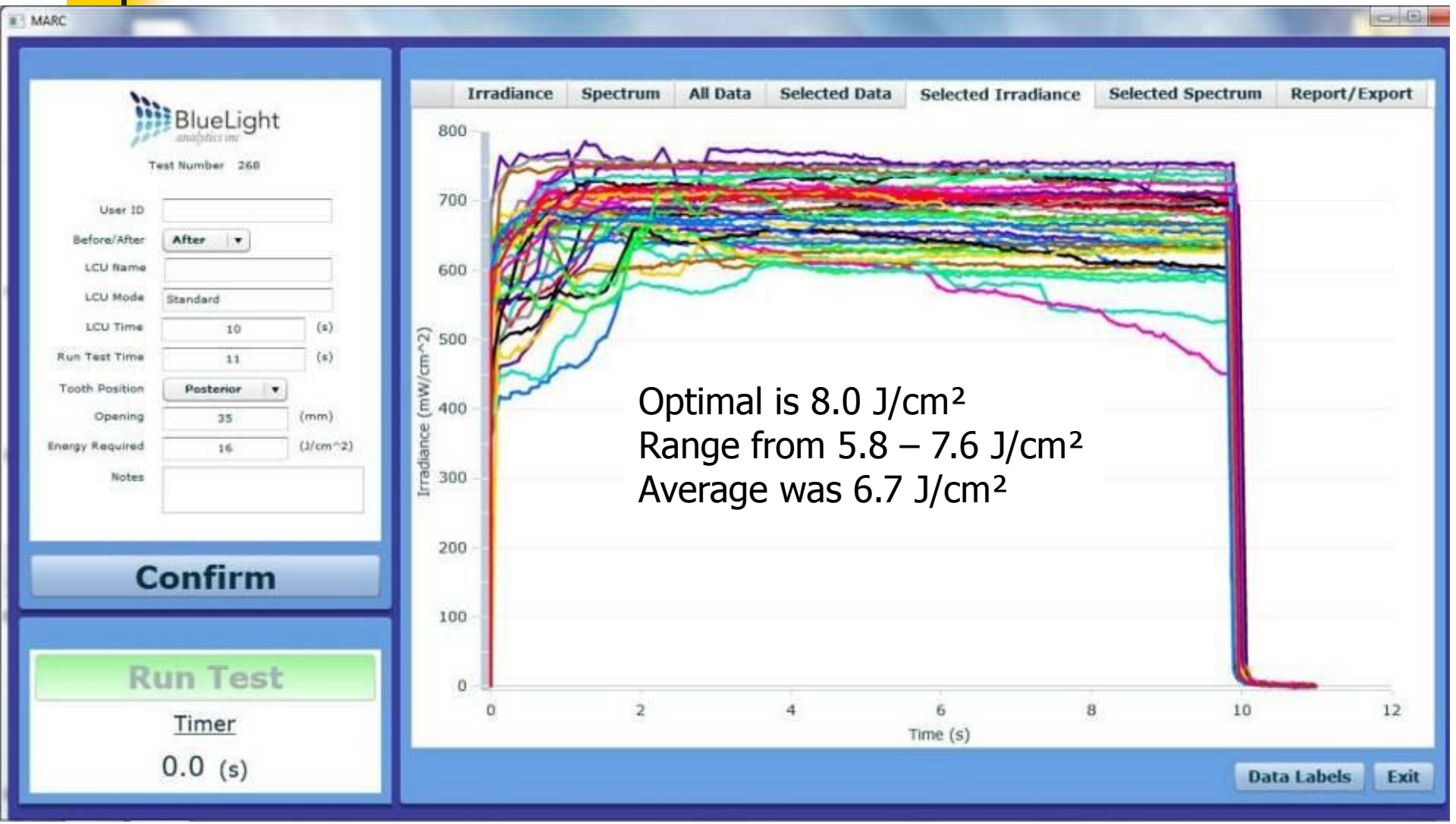
- NOT looking, NOT stabilizing,
- NOT wearing eye protection!

After Instruction



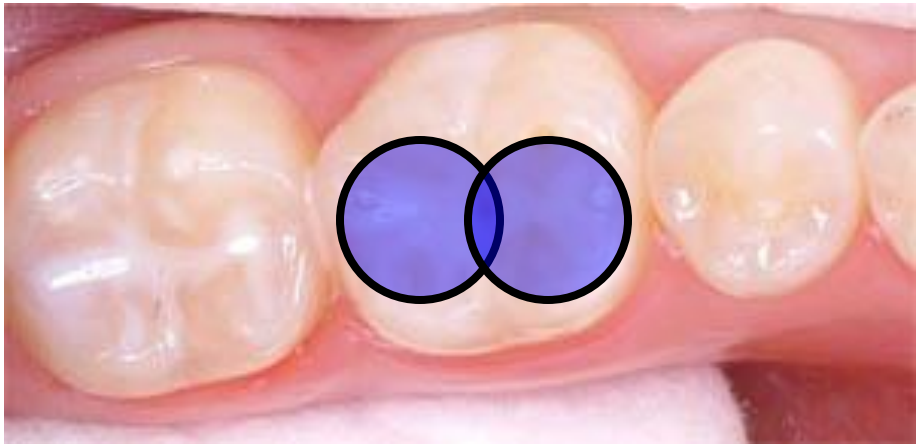
Wearing eye protection, looking, stabilizing!

After Group Instruction

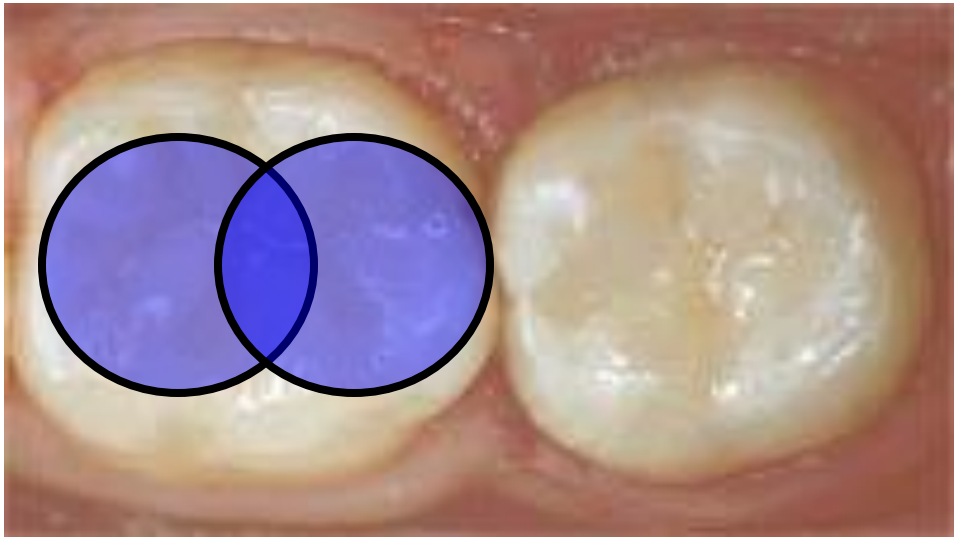


Operator controlled Light tip diameter of 7.5 mm

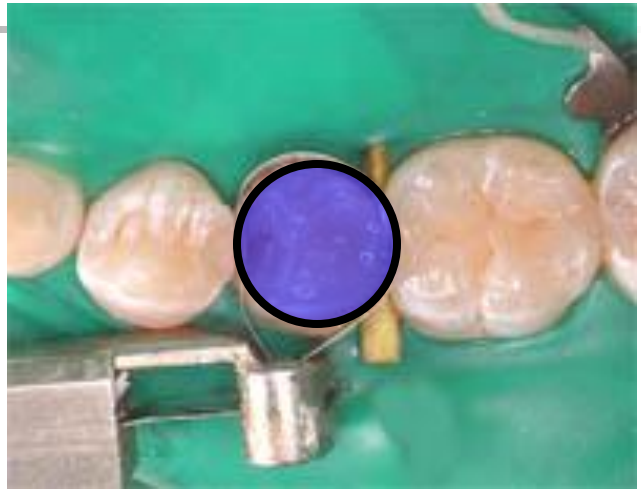
- Sealant on molar- 2 cycles (overlapping tip)



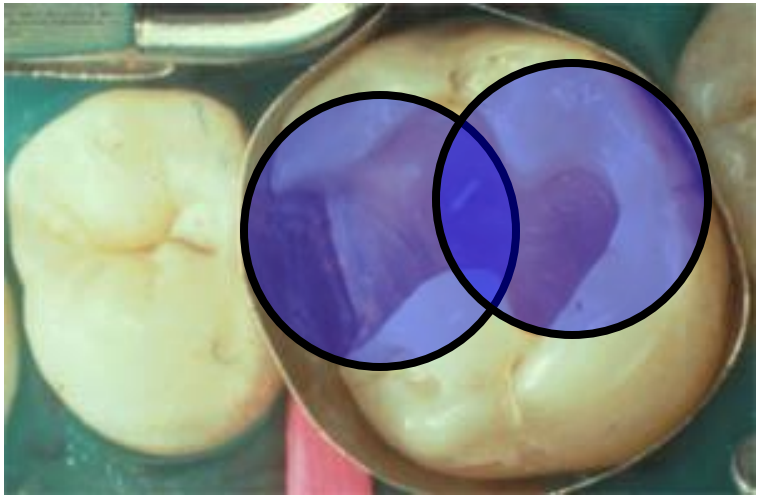
- Occlusal Class I- 2 cycles (overlapping tip)



- Class I or II premolar- 1 cycle no overlap needed unless the premolar is larger than normal

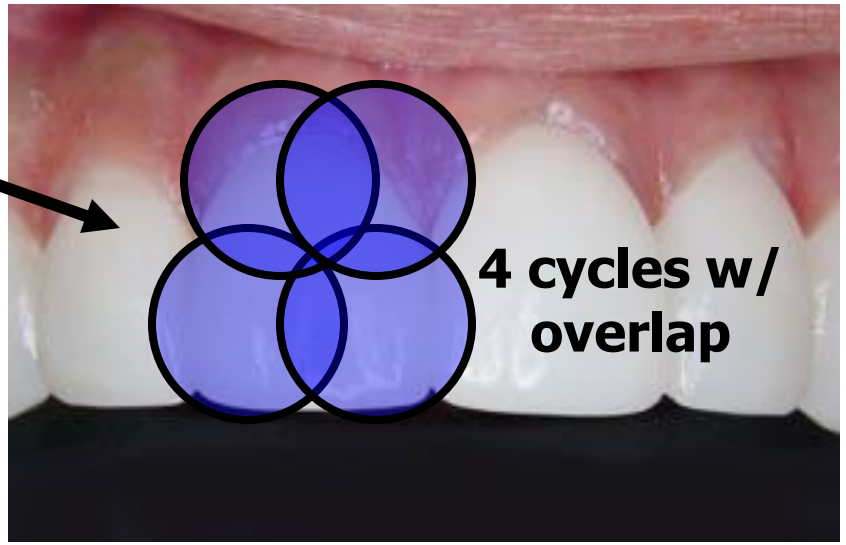


- Class II molar- 2 cycles (overlapping tip)

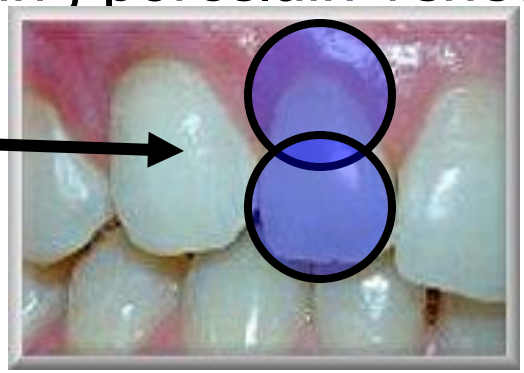


Facial of a maxillary central incisor two or four cycles with overlap

- Facial veneer
  - Direct composite
  - Porcelain veneer
- Class IV
- Light cure facial and lingual
- A maxillary lateral incisor two cycles



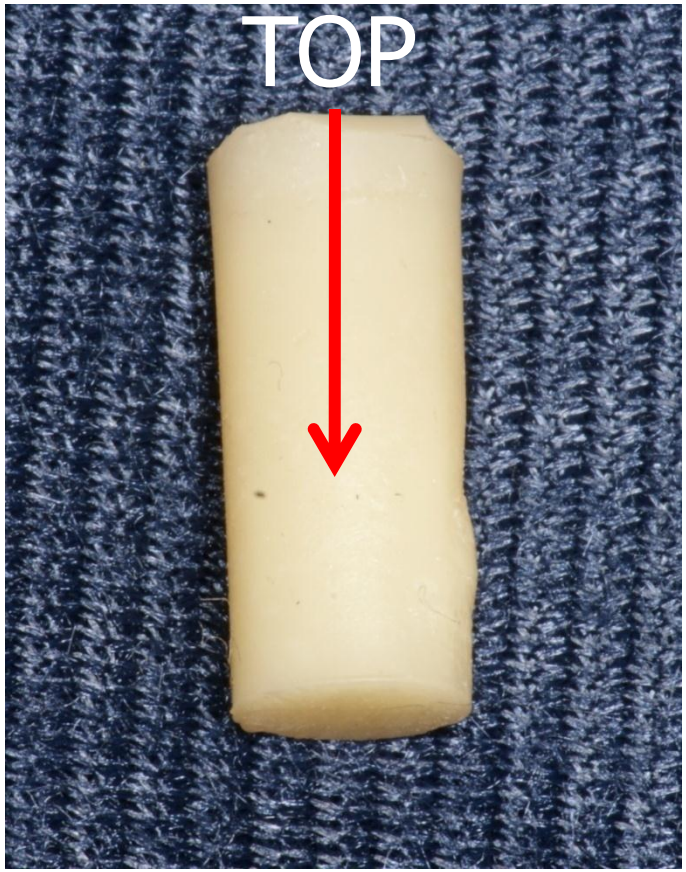
Curing porcelain veneers

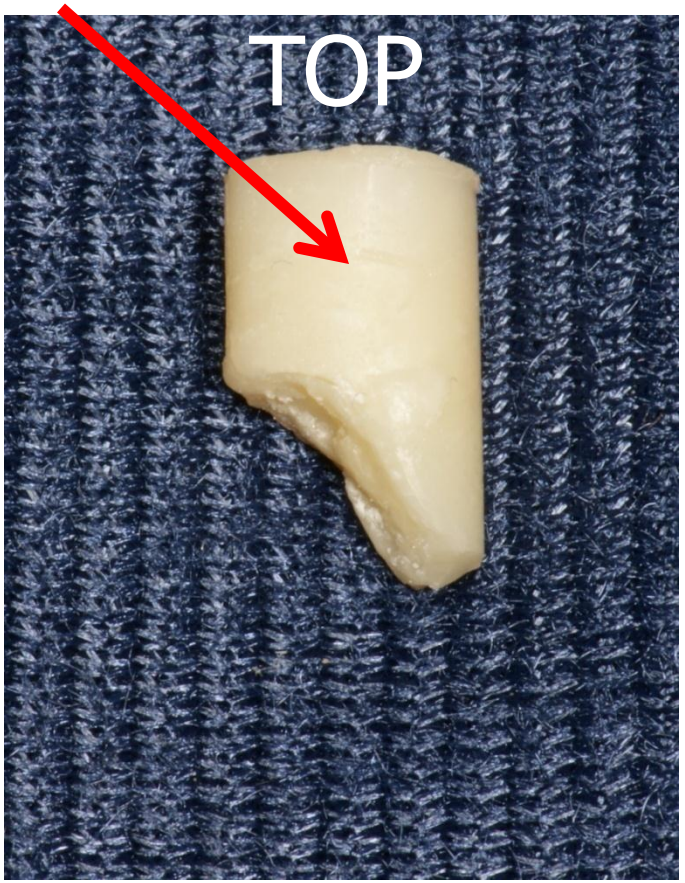


Negative effects-Restoration
Light angulation-Light movement

A 30° angle can reduce energy delivery by **26%**

Change the angulation
Change the cure





Energy requirement

- Power: mWatts
- Irradiance: (Power/Unit Area) mW/cm^2
- Spectral Radiant Power: mWatts/nm
- Energy Density = Irradiance x Time: 8 - 16 J/cm^2

3M ESPE

Filtek™ Supreme Ultra
Universal Restorative

7. Curing: This product is intended to be cured by exposure to a halogen or LED light with a minimum intensity of 400mW/cm² in the 400-500nm range. Cure each increment by exposing its entire surface to a high intensity visible light source, such as a 3M ESPE curing light. Hold the light guide tip as close to the restorative as possible during light exposure.

Shades	Incremental depth	Cure time
Body, Enamel, Translucent	2.0mm	20 sec.
Dentin, A6B and B5B	1.5mm	40 sec.

7 Steps to Ensure Better Light Curing

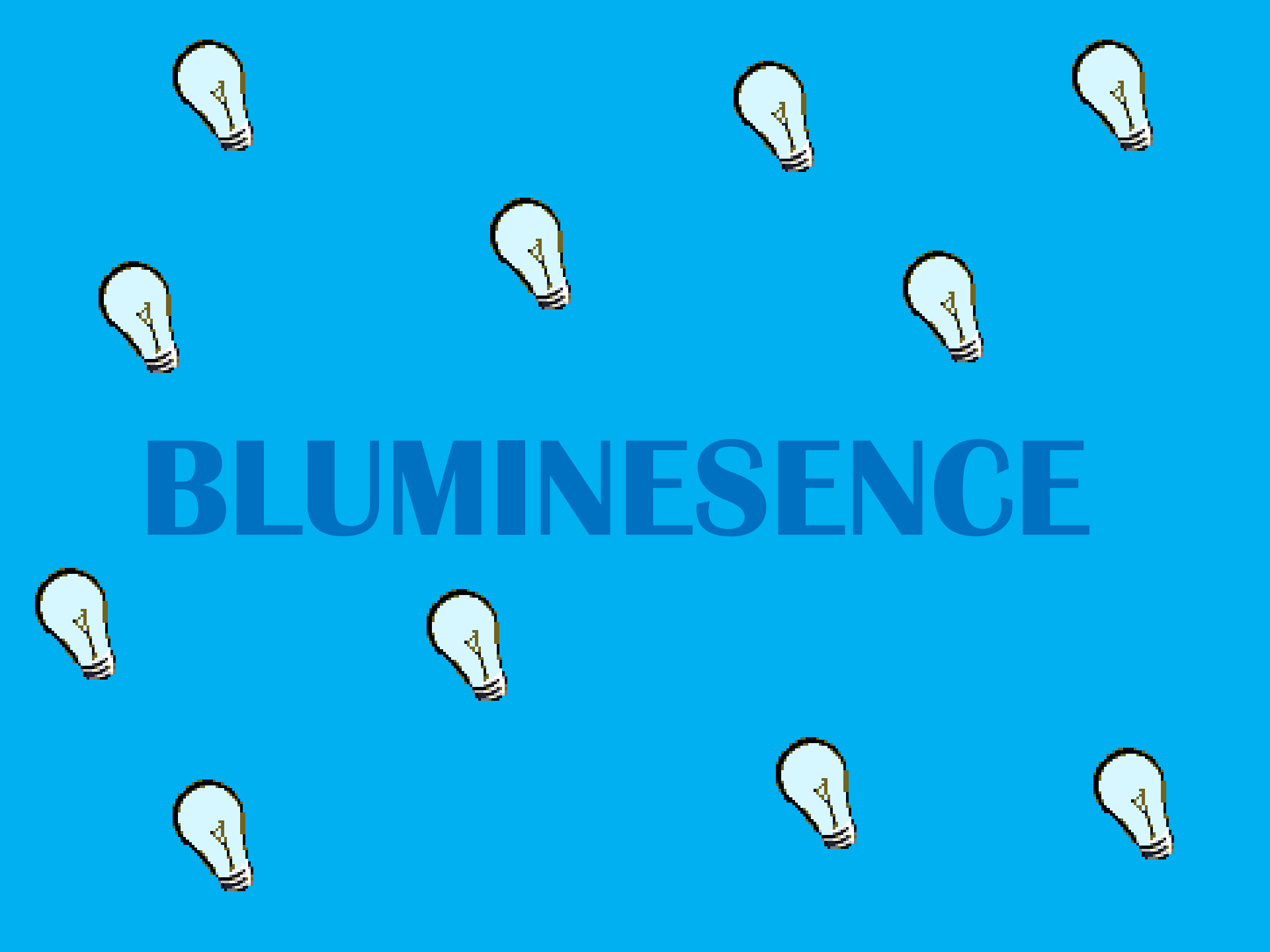
1. Wear orange glasses (blue light blocking) for safety and so you can watch what you are doing
2. Re-position the patient so you can easily see the restoration and access it with the curing light
3. Position yourself comfortably so you can stabilize the curing light directly over the preparation

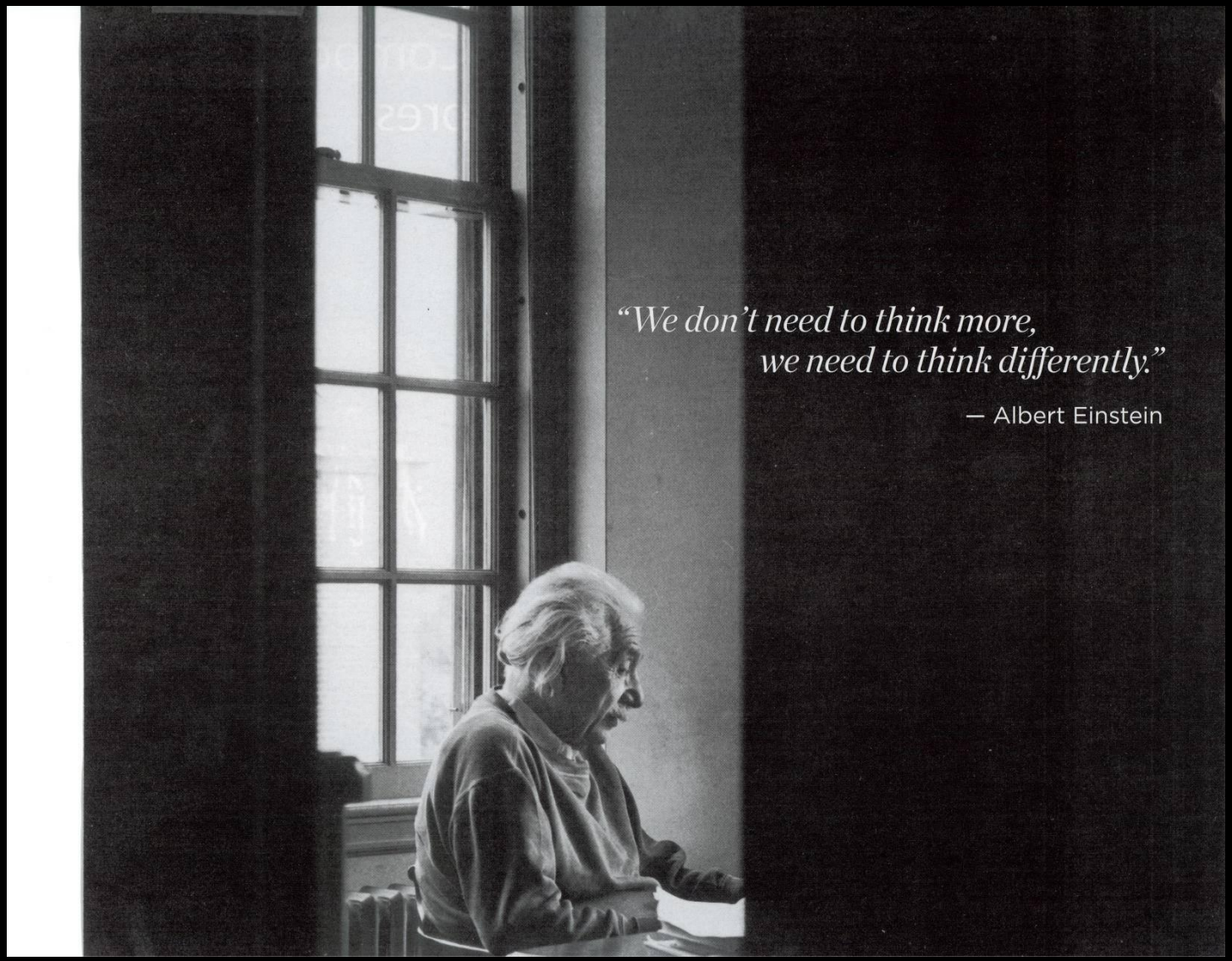
7 Steps to Ensure Better Light Curing

4. Adjust the light guide so you can operate the light comfortably. Clean the tip as needed.
5. Stabilize the curing light so the beam is perpendicular to the surface of the resin
6. Begin curing 1mm away from resin and then move as close as possible after 1 second
7. Air-cool or wait between each curing cycle; test the temperature rise from the light on the back of your hand.

Understanding leads to improved clinical success

Light energy matters!


BLUMINESENCE


"We don't need to think more,
we need to think differently."
— Albert Einstein