New Instruments

QUALITY IMPROVEMENT OF LASER TREATMENT (QUILT)
A New Retinal Laser Simulation System for Training in Resource-Poor Countries

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In resource-poor countries, there is a reported lack of quality and structured retinal laser training in residency and hospital eye programs. This unmet training need has been validated in current international diabetic retinopathy screening centers.[1] In our own experience, there is a lack of specialist laser expertise that is a barrier to high-quality and competent laser treatment delivery for patients in the developing world. Furthermore, with the introduction of new pattern scan laser technology, clinicians in the developing world have variable insights into new contemporary laser settings. One of the critical issues for a diabetic eye screening programs in the developing world is the significant risk of loss of vision from inadequate laser treatment despite successful eye screening and detection of sight-threatening diabetic retinopathy.

The Diabetic Retinopathy Study (DRS) reported that an eye with high-risk proliferative diabetic retinopathy (PDR) had a 50% chance of severe visual loss within 2 years and recommended panretinal laser photocoagulation treatment, treating an area of 157 mm^2 to 314 mm^2. The Early Treatment DRS[2] recommended treating an area of 236 mm^2 to 314 mm^2. The DRS and Early Treatment DRS recommendations are known as "conventional" long-pulse laser. However, laser therapy para-

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digms have changed over the last 10 years, and short-pulse (20–30 ms) laser is now used in clinical practice. This technology allows more rapid, higher density treatments with multisession delivery associated with less tissue damage and preserving visual function and visual field.[3–5] Macular laser photocoagulation is still important as first-line management in resource-poor countries despite the emergence of intravitreal therapies.

Quality Improvement of Laser Treatment (QUILT) is a novel laser photocoagulation simulator that contains modules for laser treatment of PDR, diabetic macular edema (DME), retinal vein occlusion, and laser retinopexy. The primary objective of the QUILT simulation is to introduce a new bespoke application to support practical skills training in retinal laser treatment in countries where laser training is suboptimal for ophthalmologists and trainees/residents. The application was first developed as an online application but has subsequently been developed as a standalone application that can be downloaded or copied onto individual laptops or computers, so that the training is not dependent on a good internet connection. This project was started in 2015 and piloted in four resource poor countries. Online training material is made available to students in advance of practical training, so that the fundamental principles are understood before use of the new practical training tool (Table 1).

The QUILT simulator presents images of validated fundus photographs (DME, PDR, and retinal vein occlusion) displayed with optical coherence tomography scans (when appropriate) to plan laser treatments (Figure 1). QUILT was devised using a revision of the English NHS Diabetic Eye Screening Programme current grading standards. The images allow the student to understand the key factors that influence the decision to laser and to plan treatments. Each scenario allows the student to understand the treatment thresholds for that image set that represents an individual patient and recognize features for DME and PDR. The student's learning objectives involve decision making for treatment regimens. After laser treatment, the trainer will assess treatments and provide feedback on treatment strategies, safety and correct clinical laser applications based on standardized laser protocols. Feedback explains how one might modify one's treatment in the presence of a PDR, DME, retinal vein occlusion, and a combination of PDR and DME, and a series of screenshots from QUILT are shown in Figures 1–4. The feedback also examines potential adverse effects of laser and explains methods to avoid them, and

Table 1. Overview of Laser Simulation Objectives

Step	Trainee	Live Mode	Trainer Feedback
1	Devise and use annotation tools to plan a treatment	Software monitors treatment speed and number/location of applied burns	Laser treatment reviewed remotely online or onsite by retina specialist
2	Choose a lens, spot size, power, pulse duration, and single-spot or multispot mode	Simulator uses annotation tools apply mock laser burns to the retinal image resembling an actual laser machine interface	Laser settings reviewed and treatment plan critique for clinical condition with imaging review
3	Titrate laser power threshold for treatment burn	A count of total number of burns in the applied session, and laser settings can be changed as with normal laser machine	Tutorial on laser burn tissue reactions and treatment strategy provided
4	Further training	Treatments saved on system for case-based discussions	Laser training certification can be applied

evaluates the circumstances of laser versus intravitreal injection treatment as an alternative for DME.

The laser simulator software has been designed to use published formula to titrate a laser-burn fluence and according to pulse duration and power. As the power increases for a set pulse duration, laser-burn intensity increases from subvisible (subthreshold), barely visible gray-white to intense white (suprathreshold). The laser simulation operates in a "live" mode to capture the real-time laser treatment experience for the student. The laser-treated area on the fundus photograph is compared with the conventional DRS (157–314 mm^2) and Early Treatment DRS (236–314 mm^2), recognizing that this first treatment plan may be applied over two sessions with severe high-risk PDR or retinal vein occlusion cases. A simulated module for emergency laser retinopexy is available where single-spot laser is used rather than a pattern spot short-pulse laser burn (Figure 3). After delivering the laser simulation treatment, the trainer reviews total treatment time during fixed sessions, assess laser settings, review the actual post-treatment images from the clinical case, and overlay trainee's treatment burns with actual post-treatment clinical
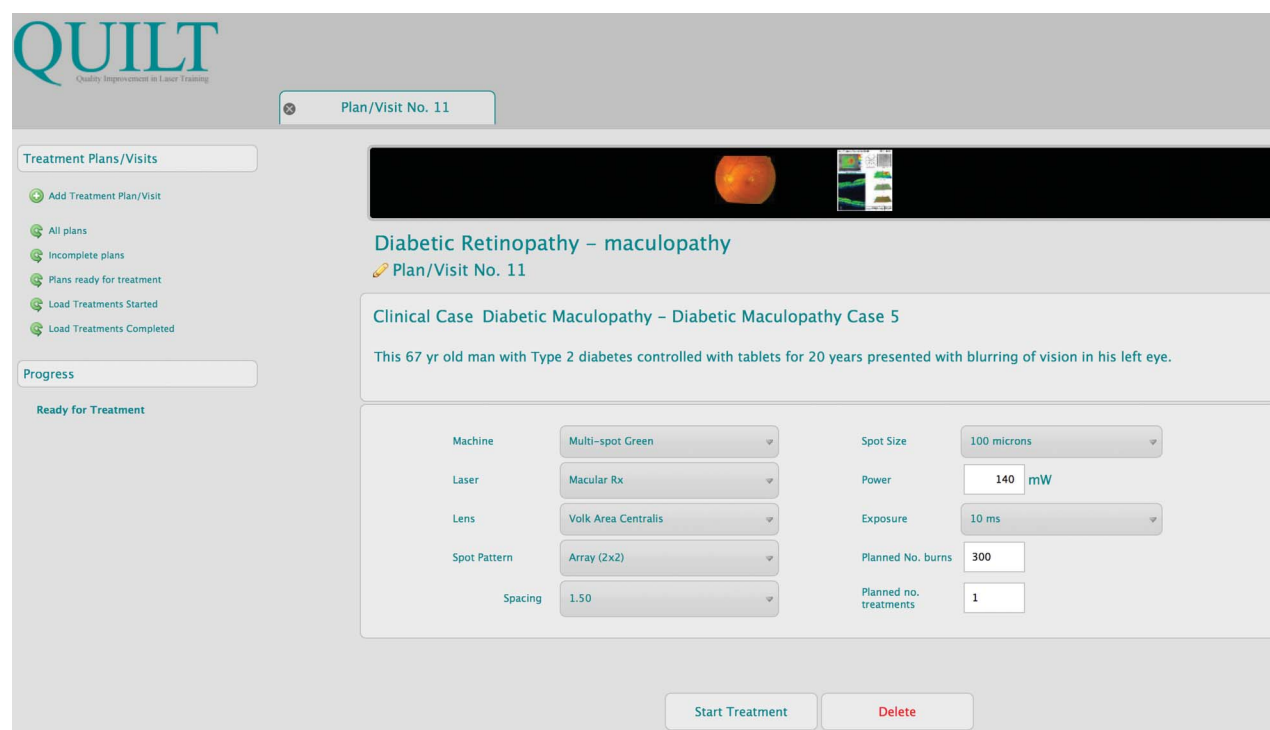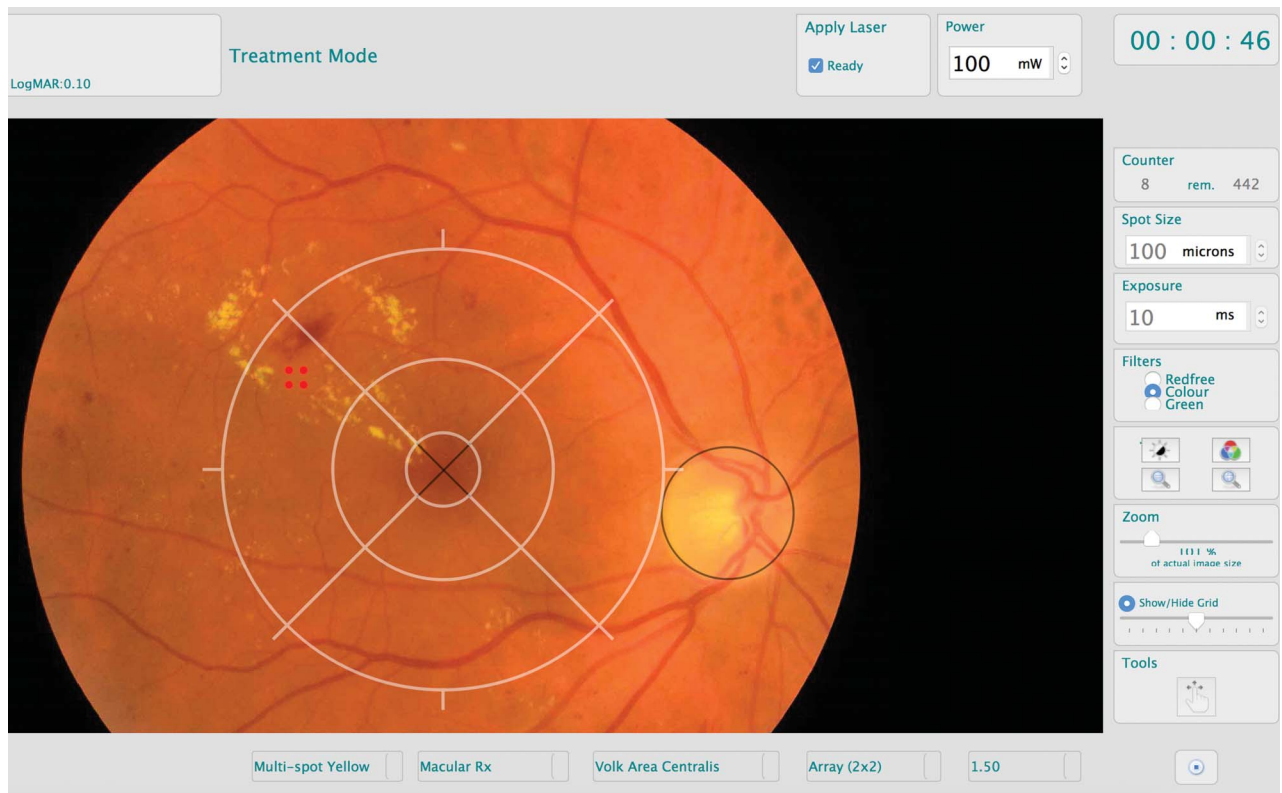

Fig. 1. Case of DME with fundus photograph and OCT scan. Opening screen for student to set up laser settings and devise plan treatment.

Fig. 2. Example of "live" macular laser mode with red 2 × 2-pattern grid, with red-pattern scan laser shown with Early Treatment DRS grid landmarks applied to assist student.

case images. This allows internal quality and assurance for the simulator system.

The intended impact of this simulation system innovation is higher quality laser treatment that meets current benchmarks of treatment.[4,5] The online training modules provide a synopsis of the latest laser guidelines for treating diabetic retinopathy including laser-burn tissue interactions for short-pulse laser that will enable a comprehensive understanding of contemporary treatment for ophthalmologists. Experience and feedback from residency and hospital teaching programs is the need for accreditation in laser photocoagulation. We are able to provide the student with a laser training accreditation/certificate issued to doctors who complete the laser training module that may be used as part of their continuing professional development portfolio in their hospital program.

This innovation was designed to build on the basic clinical training that is being provided in countries like Indonesia, Bangladesh, China, Botswana, and Tanzania, with the aim of continued improvement in quality of laser. Because of the success of these pilots and the increased incidence of diabetic retinopathy globally, the QUILT project received additional grant funding to scale up the laser simulation to other countries in the developing world with options to provide full translation for partner countries (http://www.quiltsystem.com).

This novel QUILT laser simulator system provides the trainee ophthalmologist with a comprehensive understanding of retinal laser application that can be delivered using conventional single-spot argon laser machines as well as newer pattern scan laser systems. The level of competence and expertise can be improved through simulator training. Through teleophthalmology using the online QUILT system, training of ophthalmologists can be remotely validated by specialists in the United Kingdom. Ophthalmologists in resource-poor countries have received enhanced training in the application of the new laser guidelines and techniques using the QUILT laser simulator at no cost to the host eye center in the developing country. Ultimately, this advanced simulator with teleophthalmology can lead to reduced complications and errors during laser treatment, lowering the risk of blindness in patients.
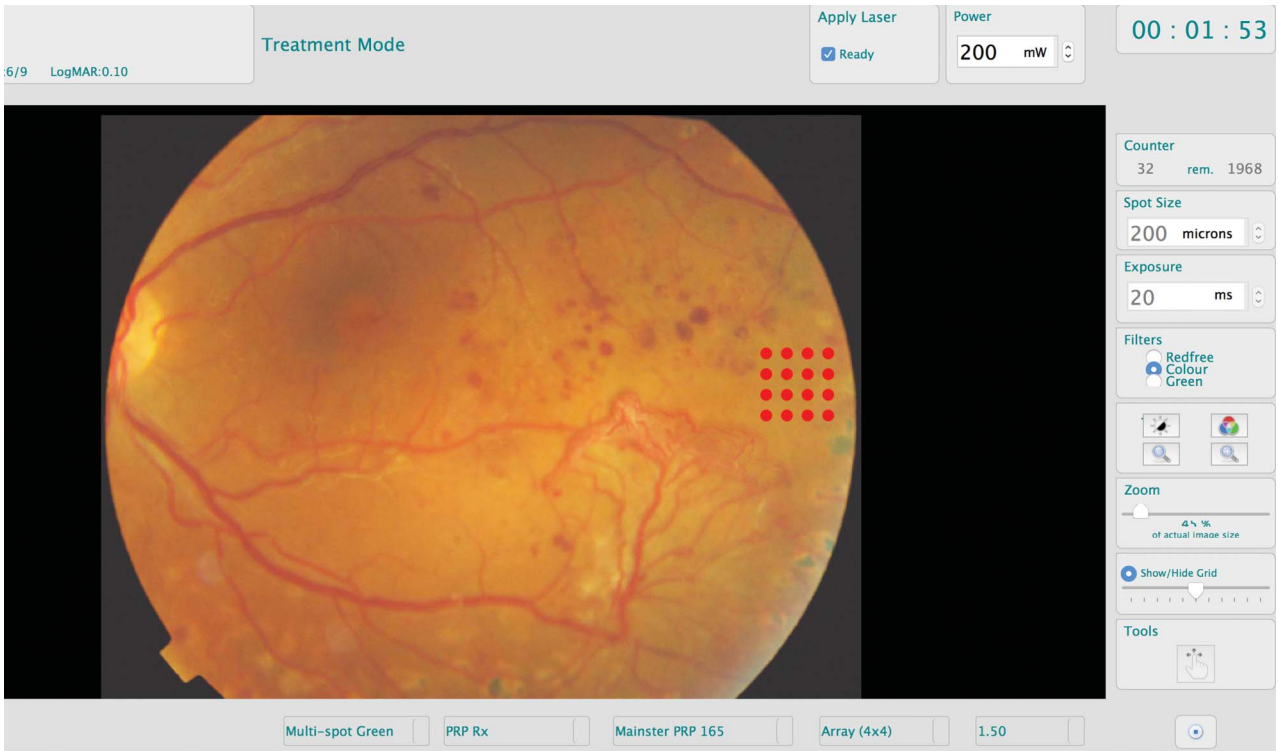
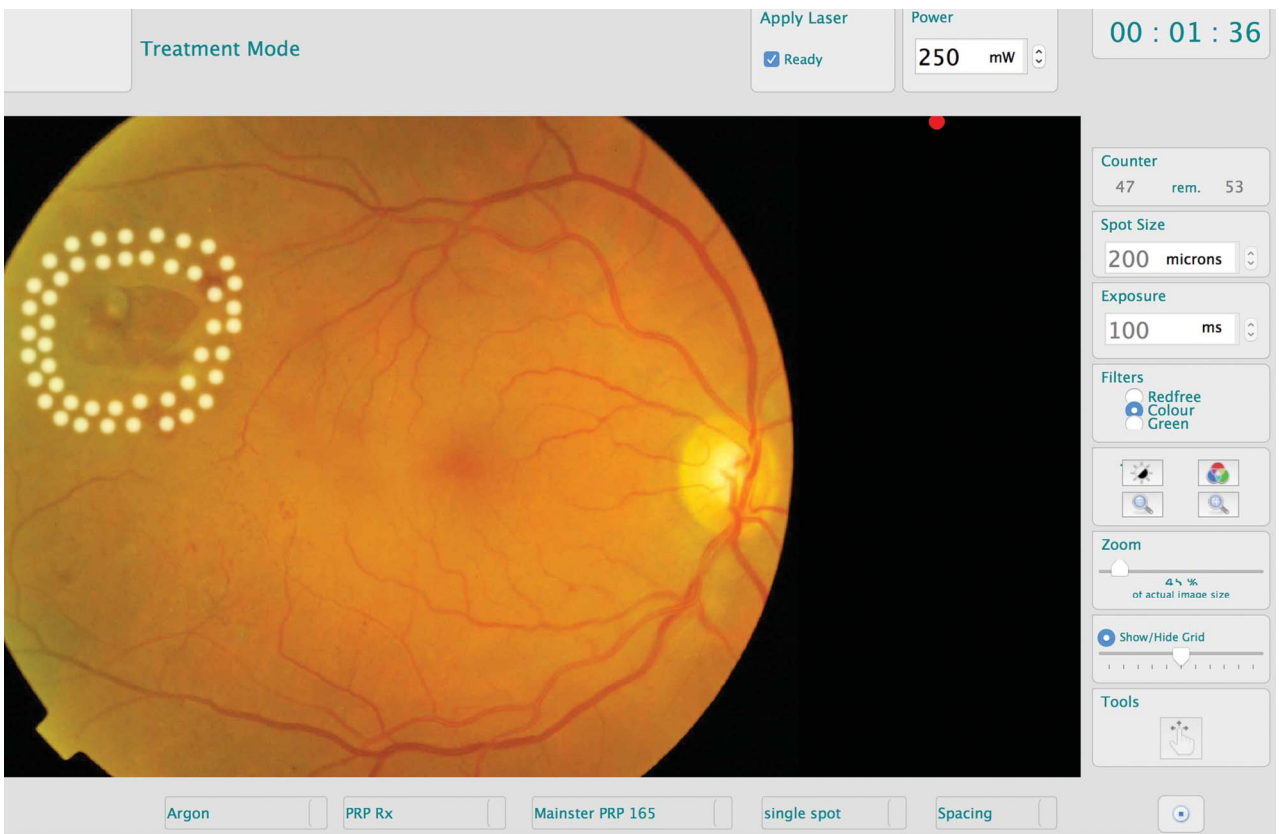**Fig. 3.** Example of "live" panretinal laser mode with red 5 × 5-pattern grid, with red-pattern laser.

Fig. 4. Case of laser retinopexy using single-spot 100-ms laser. The student has applied two rows of white laser burns to encircle the horse-shoe retinal tear.

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