

**DE NOVO CLASSIFICATION REQUEST FOR
MOLECU LIGHT i:X**

REGULATORY INFORMATION

FDA identifies this generic type of device as:

Wound autofluorescence imaging device. A wound autofluorescence imaging device is a tool to view autofluorescence images from skin wounds that are exposed to an excitation light. The device is not intended to provide quantitative or diagnostic information.

NEW REGULATION NUMBER: 21 CFR 878.4165

CLASSIFICATION: Class I (Exempt from premarket notification, subject to the limitations in 21 CFR 878.9)

PRODUCT CODE: QCR

BACKGROUND

DEVICE NAME: MolecuLight i:X

SUBMISSION NUMBER: DEN180008

DATE OF DE NOVO: February 16, 2018

CONTACT: MolecuLight Inc
101 College Street, Suite 200
Toronto, ON
M5G 1L7 Canada

INDICATIONS FOR USE

The MolecuLight i:X is a handheld imaging tool that allows clinicians diagnosing and treating skin wounds, at the point of care, to

- (i) view and digitally record images of a wound, and
- (ii) view and digitally record images of fluorescence emitted from a wound when exposed to an excitation light.

The MolecuLight i:X is for prescription use only.

LIMITATIONS

The sale, distribution, and use of MolecuLight are restricted to prescription use in accordance with 21 CFR 801.109.

This device can detect fluorescence at maximum depth of 0.8mm in a wound.

PLEASE REFER TO THE LABELING FOR A COMPLETE LIST OF WARNINGS, PRECAUTIONS, AND CONTRAINDICATIONS.

DEVICE DESCRIPTION

The MolecuLight i:X is a handheld, portable, and battery operated white light and fluorescence imaging tool. The MolecuLight i:X can (i) view and digitally record standard (ST) digital images of a wound.

Standard digital images/video capture the appearance of the wound under illumination of broad band white light, like regular photography. This Standard Imaging Mode does not require contact with the patient and the distance between the device and wound is kept consistent (8 – 12 cm) between imaging sessions through the use of the built in range finder

The MolecuLight i:X can also capture fluorescence features of wounds in real-time when used in Fluorescence Imaging Mode and it enables the user to document this fluorescence information. When the level of ambient light in the examination room is acceptable, an indicator light informs the user that fluorescence images (or videos) can be acquired. The distance between the device to the patient is maintained at 8 – 12 cm as guided by the range finder indicator light. The device has 450nm excitation light and is capable to detect fluorescence signals in 500-545 and 600-665nm wavelengths. The MolecuLight i:X is not intended to quantify the fluorescence emitted from a wound.



Figure 1: MolecuLight i:X

SUMMARY OF NONCLINICAL/BENCH STUDIES

BIOCOMPATIBILITY/MATERIALS

There are no patient contacting components.

SHELF LIFE/STERILITY

No component of the MolecuLight i:X is provided sterile.

The life-time of the MolecuLight i:X has been evaluated to be at least (b) (4)

Shelf-life of the system is greater than 2 years and is determined by the shelf-life of the lithium batteries installed in the product that may slowly discharge into a nonrecoverable state. Other components, such as plastics and electronic printed circuit boards and other circuitry, are not anticipated to degrade in this time, and the device contains no electrolytic capacitors.

REPROCESSING

The subject device is multi-patient, reusable and is provided non-sterile to the end user. There are no patient contacting components. To mitigate the risk of cross-contamination through indirect patient transmission mechanisms, the subject device is intended to be cleaned and intermediate level disinfected in between uses. The cleaning instructions were validated using an artificial test soil to represent the worse-case constituents (i.e. bloods and protein) of patient material that may contact the device during use. After soiling, the sample was allowed to dry for one hour undisturbed at room temperature. Then the device was cleaned using worst case implementation of the instructions in the user manual. The acceptance criteria of $\leq 6.4 \mu\text{g}/\text{cm}^2$ for residual protein and $< 2.2 \mu\text{g}/\text{cm}^2$ for residual hemoglobin on the device were met.

The disinfection instructions were validated by inoculating test devices with each of five test microorganisms in suspension with 5% Fetal Bovine Serum, and then disinfecting the device using worst case implementation of the instructions in the user manual. The results demonstrated a minimum 6-log reduction of *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Escherichia coli*, and *Klebsiella pneumoniae*, as well as a minimum 3-log reduction of *Mycobacterium terrae*, thus meeting the acceptance criteria. The testing and results are adequate to support the label cleaning and disinfection instructions for reuse of the MolecuLight i:X.

ELECTROMAGNETIC COMPATIBILITY AND ELECTRICAL/MECHANICAL/THERMAL SAFETY

The following Electrical/Mechanical/Thermal Safety and electromagnetic compatibility (EMC) testing has been performed:

- IEC 60601-1: 2005 +CORR.1:2006+CORR.2: 2007 + AM1:2012 or IEC 60601-1:2012 with US deviations, Medical electrical equipment – Part 1: General requirements for basic safety and essential performance.
- IEC 60601-1-2: 2007 (Edition 3), Medical electrical equipment Part 1-2 – General requirements for basic safety and essential performance – Electromagnetic compatibility.
- IEC 60601-1-6: Collateral Standard: Medical electrical equipment Part 1-6 – General requirements for basic safety and essential performance – Usability.

The MolecuLight i:X device and labeling passed all relevant portions of the testing.

The De Novo request submitted information regarding wireless and Bluetooth connectivity in accordance with the recommendations in the FDA guidance document “Radio Frequency Wireless Technology in Medical Devices.”

SOFTWARE

The device software is a mobile app, operating on Apple iOS operating system. It captures and reviews the standard (white light) and fluorescence images and videos. The software does not save any personal information of the patient. The device software will be upgraded via the Apple App Store.

All of the elements of software and cybersecurity information as outlined in FDA’s guidance documents “*Guidance for the Content of Premarket Submissions for Software Contained in Medical Devices*” (issued May 11, 2005) and “*Content of Premarket Submissions for management of Cybersecurity in Medical Devices*” were provided.

Overall, the software and cybersecurity documentation included in the De Novo request is in sufficient detail to provide reasonable assurance that the software will operate in a manner described in the specifications.

PERFORMANCE TESTING – BENCH

Bench testing was conducted to characterize the device performance.

Imaging field uniformity:

The spatial uniformity of the imaging field was tested with green (fluorescein dye (VWR, CAAAAL13251-22) and red (PpIX / Sigma Aldrich, P8293-1G) fluorescent agents integrated into an optical tissue phantom (made by intralipid solution and diluted hemoglobin in PBS). 2D intensity mapping was used to demonstrate the spatial non-uniformity of the illumination source and fluorescent imager.

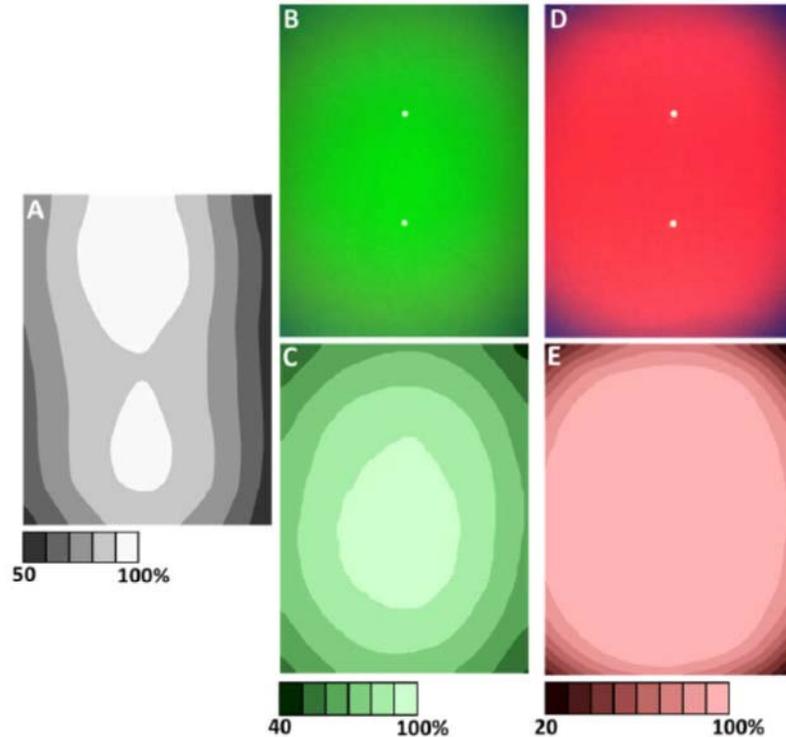


Figure 26: Image uniformity maps. White spots are reflections from the MolecuLight i:X LEDs. Color scales represent percentage intensity normalized to the maximum intensity in the image (excluding LED reflections). A) Quantized map of excitation source uniformity. B) Measured green fluorescence uniformity (actual i:X image). C) Quantized map of green fluorescence uniformity (derived from image B). D) Measured red fluorescence uniformity (actual i:X image). E) Quantized map of red fluorescence uniformity (derived from image D).

Detection depth:

A red fluorescent phantom (PpIX / Sigma Aldrich, P8293-1G - 1.6mm dia. x 2.5mm depth) was embedded at different depths inside a green fluorescent phantom (VWR, CAAAAL13251-22) both with the same optical tissue properties.

The results show the maximum detection depth of the device as 800 μ m.

Detection limits, linearity, Signal-to-Noise Ratio (SNR):

Different dilutions of green quantum dots (ThermoFisher Scientific, Q10143MP, emission 525 nm) and red quantum dots (ThermoFisher Scientific, Q22063, emission 625 nm) in PBS were used to determine the minimum and maximum fluorescence detection limit of the device at the lowest and highest intensity illuminated area of the imaging field. The same data were used to determine the device linearity and SNR of the device for each spectral bandwidth (green and red).

For each color, the background (B) was considered as mean of the detected fluorescence intensity across all pixels within a blank well (no fluorescent contrast agent). Signal (S) and noise (N) for each fluorescence concentration were considered as the mean and standard deviation of the detected fluorescence intensity across all pixels within the well, respectively. Based on these values, SNR was calculated as the signal with background subtracted, divided by the noise ($[S-B]/N$). The SNR for the minimum and maximum

fluorescence detection limit in the high and low illumination intensity section of the imaging field are provided in the tables below:

Fluorescence Imaging Detection Depth, Linear Range, and Detection Limits	
Item	Specification
Fluorescence Detection Depth	0.8 mm
Linear range, green, maximum illumination intensity	<ul style="list-style-type: none"> 1 – 88% of Full Scale Image Sensor Range 0 – 125 nM Quantum Dots (ThermoFisher Scientific, Q10143MP, emission 525 nm)
Linear range, green, minimum illumination intensity	<ul style="list-style-type: none"> 0 – 94% of Full Scale Image Sensor Range 0 – 250 nM Quantum Dots; ThermoFisher Scientific, Q10143MP, emission 525 nm)
Linear range, red, maximum illumination intensity	<ul style="list-style-type: none"> 3 – 90% of Full Scale Image Sensor Range 0.5 – 5.6 nM Quantum Dots (ThermoFisher Scientific, Q22063, emission 625 nm)
Linear range, red, minimum illumination intensity	<ul style="list-style-type: none"> 2 – 95% of Full Scale Image Sensor Range 0.5 – 7.7 nM Quantum Dots (ThermoFisher Scientific, Q22063, emission 625 nm)
Limits of detection, green, maximum illumination intensity	20-111 nM Quantum Dots (ThermoFisher Scientific, Q10143MP, emission 525 nm)
Limits of detection, green, minimum illumination intensity	20-182 nM Quantum Dots (ThermoFisher Scientific, Q10143MP, emission 525 nm)
Limits of detection, red, maximum illumination intensity	0.7 – 4.6 nM Quantum Dots (ThermoFisher Scientific, Q22063, emission 625 nm)
Limits of detection, red, minimum illumination intensity	0.5 – 5.6 nM Quantum Dots (ThermoFisher Scientific, Q22063, emission 625 nm)
Excitation Source Intensity Variation	100% to 52% at corners (See Figure 34A)

Fluorescence Imaging Signal-to-Noise Ratio			
Color	Illumination Intensity	SNR (At min limit of detection)	SNR (At max limit of detection)
Green	Maximum	2.2	8.5
Green	Minimum	2.4	8.3
Red	Maximum	1.2	7.8
Red	Minimum	1.8	6.3

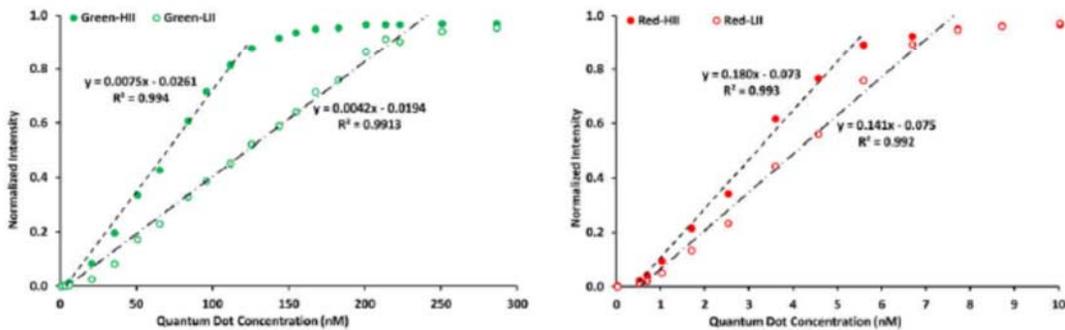


Figure 25: Linearity data for green and red fluorophores in areas of high and low illumination intensity. Signal normalized to the maximum output of the camera sensor. HII: high illumination intensity; LII: low illumination intensity; black dash lines: HII linear regression; black long-dash-dot lines: LII linear regression.

SUMMARY OF CLINICAL INFORMATION

Photographs of standard white light and fluorescent images from different wound types, sizes, and locations were taken with the device in human patients and reviewed to support the safety and effectiveness of MolecuLight i:X.

The standard white light and fluorescent images included diabetic foot ulcers, venous leg ulcers, pressure ulcers, surgical site wounds, and burns. Wound sizes ranged from small to large and the locations included were on the trunk, upper extremities, and lower extremities. The images were evaluated for quality and consistency.

Pediatric Extrapolation

In this De Novo request, existing clinical data were not leveraged to support the use of the device in a pediatric population. The device is not labeled for use in the pediatric population.

LABELING

Labeling has been included which consists of a user manual and quick start guide. The user manual and instructions for use include a description of the device, technical parameters, and principles of operation. These documents summarize the main steps for using the device as well as the necessary measures to clean the reusable components of the device.

RISKS TO HEALTH

The device is a non-contact autofluorescence imaging tool and uses visible excitation source. It does not use any exogenous contrast agent and does not provide any interpretation for the fluorescence signal. The risks associated with MolecuLight i:X include electrical/mechanical/thermal, EMC and optical safety of the device, and the error in fluorescence detection from the wound; these risks can be mitigated with general controls.

BENEFIT/RISK DETERMINATION

The probable benefits/risks of the device are based on nonclinical laboratory studies as well as photographs of wound images. The risk includes the error in fluorescence detection from the wound. However, this is a tool type device for capturing and recording white light and fluorescent images of a wound performing its function without any clinical claims. A benefit is seen with capturing and recording wound images to follow changes in wounds over time. No direct clinical benefit has been demonstrated from recording fluorescence, but a tool that records fluorescence images may provide additional information to a clinician. As only photographs were evaluated to see that the tool performs a function, there is no magnitude, probability, duration, or patient perspective of benefit. The probable benefits outweigh the probable risks.

Patient Perspectives

This submission did not include specific information on patient perspectives for this device.

Benefit/Risk Conclusion

In conclusion, given the available information above, the data support that for the previously stated indications for use, the probable benefits outweigh the probable risks for the MolecuLight i:X. The device provides a benefit and the risks can be mitigated using general controls.

CONCLUSION

The De Novo request for the MolecuLight i:X is granted and the device is classified as follows:

Product Code: QCR

Device Type: Wound autofluorescence imaging device

Class: I (Exempt from premarket notification, subject to the limitations in 878.9)

Regulation Number: 21 CFR 878.4165