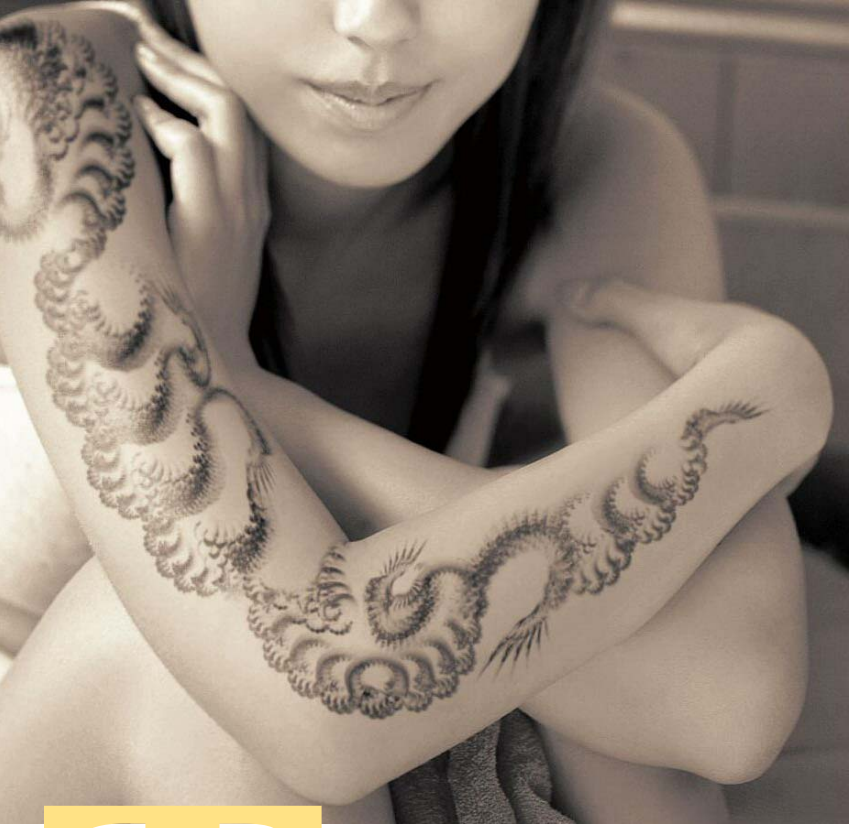

Fotona QX MAX

A VERSATILE AND POWERFUL DEVICE FOR THE TREATMENT OF PIGMENT

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Specialist in Dermatovenerology

The demand for tattoo removal treatments is undeniably growing. Up to 20 million people in the United States have at least one tattoo, and a recent survey suggests that 17% of people sporting a tattoo consider having it removed. The reasons for wanting to remove tattoos are plentiful and so is the multitude of treatments available to patients.

Lasers have certainly made their mark in this area in recent years; and there is a plethora of systems out there emphasizing various technical specifications and features, and most importantly carrying different price tags. Technological developments have not only furthered the treatment of tattoos but have also made the most advanced tattoo removal lasers extremely versatile and applicable in the treatment of various pigmented skin conditions and treatments in Asian skin types. How does laser tattoo removal work? And, as a practitioner looking into expanding your practice's treatment range, what kind of specifications and features should you look for? We aim to give you some guidance based on concrete practical experience.

Only until the late 1980s most tattoo removal modalities were abrasive and destructive.

TATTOO REMOVAL HISTORY AND MODALITY OVERVIEW

Tattooing has changed quite a bit since its early beginnings at the dawn of modern civilization. These days, tattoo artists use a myriad of tattoo pigments and technologies to produce impressive permanent works of body art. What has not changed is our human nature to change our minds. Tattoo Removal probably began as early as tattooing, and only until the late 1980s most tattoo removal modalities were abrasive and destructive. They did not only destroy the tattoo, unfortunately also the skin in which it was contained.

Developments in medical laser technology and the discovery of selective photothermolysis, based on the ability to selectively remove target structures without disrupting neighbouring structures, made it possible to remove tattoos without causing collateral damage to the surrounding skin. Theory

predicted and later studies confirmed that laser pulse durations in the nanosecond domain are optimal for tattoo removal. Quality-switched or Q-switched neodymium:yttrium-aluminum-garnet (Nd:YAG), alexandrite, and ruby lasers fulfilled this need.

Too often, older lasers or intense pulsed light sources are used to treat tattoos, often with significant scarring. Since the advent of the Q-switched lasers more than a decade ago, improvement in tattoo-removal lasers has been incremental. Developments leading to new tattoo inks, feedback systems to detect the absorbance characteristics of tattoo inks, dermal clearing agents, and perhaps even shorter pulse-duration lasers should result in improved results for the future.

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LASER TATTOO REMOVAL

It was hoped early on in the development of laser tattoo removal that lasers would provide a precise means of inducing predictable thermal necrosis to tattoo-containing tissue to avoid residual scarring. It was Goldman who first proposed using ruby and argon lasers in tattoo removal back in 1963. Initial reports of the normal mode ruby and then Q-switched ruby laser (QSRL) were relatively enthusiastic. In 1967 Goldman reported successful tattoo removal with ruby and Nd:YAG lasers.

A study of QSRL interaction with tattoo pigment appeared the same year, and further studies confirmed this specific laser-tissue interaction. These earliest positive findings were unfortunately ignored by laser practitioners as their attention was focused on the more widely applicable argon and CO_2 lasers, which certainly were not as clinically successful in tattoo removal as hoped or anticipated. The argon laser's tattoo removal process was based on non-selective thermal destruction.

Tattoo removal depended on inflicting widespread thermal necrosis to remove pigments. The resulting fibrosis altered light transmission through the dermis, thus obscuring the underlying residual pigment. Carbon dioxide lasers were reportedly more efficient in tattoo removal. They removed tattoo pigment by direct tissue ablation and thermal necrosis due to their inherent uncontrollable heating of adjacent tissue through non-selective thermolysis, as well as loss of residual pigment during the exudative healing process.

Anderson and Parrish's principle of selective photothermolysis revolutionized the treatment of unwanted tattoos. They proposed that if a wavelength is well absorbed by the target and the pulse duration was equal to or shorter than the target's thermal relaxation time, the generated heat will be confined to the target. According to this principle laser wavelength and pulse duration must be correctly chosen in order to specifically target tattoos and even more specifically tattoo colors.

It is now well understood that in order to effectively and efficiently remove tattoo pigments in the dermis, pulsed lasers must meet three criteria:

- the laser's wavelength must be well absorbed by the targeted tattoo pigment
- the generated heat should be spatially confined to the target
- the delivered energy must be sufficient to cause the desired effects

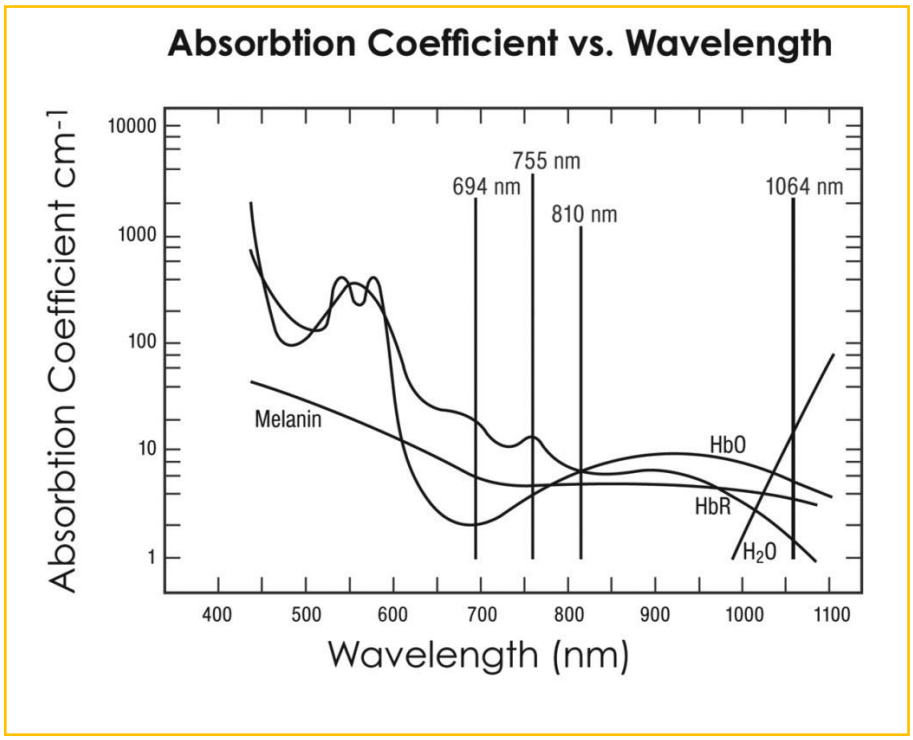
WAVELENGTH CHOICE

Laser wavelength is a critical consideration when removing tattoos, especially multi-colored tattoos. It determines in which tattoo pigment color the treating laser's energy will be predominantly absorbed to selectively destroy it. Absorption

of a particular wavelength is highest in its complementary color. In order to treat different tattoo pigment colors, various laser wavelengths thus need to be used in practice. The most commonly used wavelengths are 1064nm (Nd:YAG), 532nm (KTP), 694nm (ruby), 755nm (alexandrite), and 585nm and 650nm (dye polymer lasers).

The use and advantages of the 1064nm wavelength in aesthetic medicine are widespread and thoroughly researched and documented. One of its most attractive characteristics is that its wavelength is hardly absorbed in melanin, allowing it to be safely used in darker skin types.

Experts also believe that Nd:YAG lasers are more reliably converted to other wavelengths for tattoo removal, specifically to 532nm using a frequency-doubling KTP crystal and 585nm and 650nm using polymer dye handpieces. Allegedly the Nd:YAG laser rod is not sensitive to temperature changes and thus very stable and reliable during laser system operation which invariably creates a large amount of heat. Ruby and alexandrite laser rods contain Cr^{3+} ions and are, therefore, very sensitive to thermal and pumping inhomogeneities, which lead to unstable operation. In addition, ruby lasers need to be cooled down to sub-room temperatures, and alexandrite lasers need to be heated up to high temperatures before the lasers can be operated. Nd:YAG-based laser systems with a wavelength range covering 1064nm, 532nm, 585nm, and 650nm can effectively remove dark tattoo pigments, blues, browns and reds, orange and purples as well as sky blue and greens, which cover the large majority of popular tattoo colors.



It would be enormously expensive to have to buy a range of single wavelength laser systems to remove only a limited range of colors, so manufacturers combine different wavelengths in one system. It is common practice in these multi-source systems to convert a base wavelength through different technological means into other wavelengths to remove an additional range of colors. Many believe the 1064nm Nd:YAG laser is the ideal laser wavelength from which to start.

PULSE DURATION: Q-SWITCHED LASERS

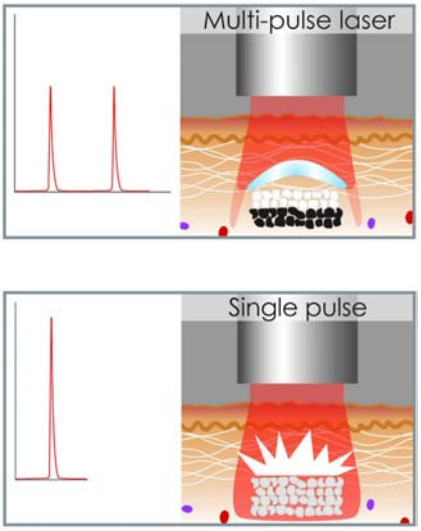
To avoid non-specific tissue damage during tattoo removal procedures, it is essential to avoid pigment particles being slowly heated so that they can conduct heat to adjacent tissue before they are destroyed. Quality-switched, or Q-switched lasers, deliver their energy in nanosecond-lasting pulses, which is now generally accepted as ideal for tattoo pigment removal. In those ultra-short pulses Q-switched lasers generate immensely high peak powers in the megawatt range which produce a photo-acoustic effect in the skin. The intense transient heat causes pigment particles that absorb the laser energy to shatter and kill the macrophages in which the pigment resides. The remaining fragments are eventually cleared through phagocytosis into the lymphatic system.

HIGHEST SINGLE PULSE POWER

In practice it is preferable that laser systems are capable of generating high energy as this enables the use of larger spot sizes during treatments. Larger spot sizes not only cover treatment areas faster, they allow laser energy to penetrate deeper into the skin to reach deeper-lying pigment, common in professional tattoos, by avoiding the scattering effect of laser light in the tissue. In smaller spot sizes the scattering effect is far more pronounced.

This inhibits laser light to travel deeper into the skin and creates a distinct Gaussian beam profile of intensity on the skin's surface in which fluence is not evenly distributed with lower central intensity. These effects can be the cause of many of the unwanted side effects of Q-switched lasers, such as excessive tissue splatter and bleeding, and textural changes. Larger spot sizes are thus more effective and efficient during treatments.

High energy generating capacity is also beneficial in the wavelength up-conversion process; i.e., from 532nm to 585nm and 650nm to be able to continue working effectively and efficiently with the newly generated wavelengths. Only a few laser systems are capable of generating adequately high powers in one single pulse. Laser systems with less advanced power-generating abilities need to generate these high powers in two or even more individual pulses. Short, single nanosecond pulses are capable of successfully removing tattoos without causing significant damage to the skin.



They avoid the optical shielding phenomenon during pigment destruction. Multiple pulse high energy lasers cannot reach and effectively treat underlying pigments in multi-layered professional tattoos due to this effect.

Optical shielding arises because high energy pulses generate a laser-induced plasma in the skin when the laser strikes the pigment. Gas and steam are formed by the rapid, micro-localized heating and destruction of the pigment. This phenomenon is seen as a white light flash during treatments with subsequent whitening or blanching of the skin. Single high fluence laser pulses are used to maximize tattoo removal treatment efficacy and efficiency in a single session; and, if necessary, the procedure can be repeated after the laser-induced whitening has disappeared.

BEAM PROFILE CONSIDERATIONS

In addition to high single pulse energy, the homogeneity of the laser beam profile is important in tattoo removal treatment. A homogeneous beam profile provides safety during treatment as energy is evenly distributed across the treated area and not focused on a single spot. It minimizes epidermal damage and decreases bleeding, tissue splatter, and transient textural change in the skin.

Achieving homogeneous beam profiles has been a serious challenge for the laser industry due to the non-linearity of Q-switched lasers. Advanced Q-switched systems, such as Fotona's QX MAX, rely on groundbreaking solutions such as patent-pending OPTOflex Technology combined with Vacuum Cell Technology to produce almost perfectly homogeneous beam profiles.

WHAT SYSTEM MAKES COMMON SENSE?

There seems to be consensus that the ideal tattoo removal system is without a doubt Q-switched laser based. It makes sense to choose a system with a wavelength that is easily and reliably up and down converted to other wavelengths to treat different tattoo colors. High single pulse generating capacity is preferable for effective wavelength conversion, and high single pulse generating lasers are more

efficient and effective in treatments as they avoid the optical shielding effect. To avoid unwanted splattering and skin texture changes during treatment, flat beam profiles are needed to ensure even energy distribution within single laser spots.

Tattoo removal in itself can be a rather narrow market for practices to target, so when purchasing a tattoo removal laser system it is worth considering its capabilities in other aesthetic treatment segments. For dermatology and aesthetic clinics lucrative areas are the treatment of vascular and pigmented skin lesions such as lentigines, café au lait macules, melasma, post-inflammatory hyperpigmentation, and seborrhoic keratosis.

To further expand treatment options several of the Q-switched Nd:YAG laser based systems offer a free-running Nd:YAG laser; i.e. without Quality-switching the Nd:YAG laser. This provides an added modality for non-ablative rejuvenation to treat fine lines and wrinkles, large pores, erythema, acne, and acne scarring.

It is worth noting that Q-switched Nd:YAG lasers are becoming increasingly popular modalities to provide skin rejuvenation treatments in Asian skin types because of their ultra-short pulses which reportedly decrease the risk of hyper- and hypo-pigmentation in this patient population. Manufacturers, such as Fotona, have played into this market and have developed rejuvenation specific technology solutions that have been integrated into their Q-switched laser systems.

Fotona's Accelera Nd:YAG laser is capable of delivering high energy at longer pulse durations than the Q-switched Nd:YAG laser, thus creating a photothermal instead of photoacoustic effect in the skin. Accelera pulses are used to provide FRAC3™ treatments, a self-induced skin rejuvenation effect that seeks out minuscule, age-related skin imperfection in the skin. FRAC3™ literally creates a three-dimensional treatment pattern in the skin; other fractional modalities are physically limited to only two dimensions. Accelera pulses can also be used to treat light thin hair, small diameter blood vessels, and active acne.

TREATING TATTOOS

Before attempting to treat a tattoo, it is important to evaluate its complexity in terms of being able to estimate the number of treatment sessions required to fully remove it, but also to assess the risk of unwanted side effects. Common side effects are erythema, pigmentary changes hyper-pigmentation and hypo-pigmentation, blistering and crusting, scarring, discomfort, purpura, and wound infection. Tattoo pigments can also paradoxically darken after being treated with laser light; such effects have been observed when treating permanent make-up tattoos.

The Kirby-Desai scale can be used to assess the complexity of the tattoo. In general, amateur tattoos require fewer treatment sessions and less aggressive treatment settings than professional tattoos, although amateur tattoos are less predictable because of the varying depths of the inserted pigments and tattoo pigment quality. Distally located tattoos are more difficult to remove, and older tattoos may or may not be easier to remove than newer ones. Bright-colored inks generally necessitate more treatment sessions.

Then again, the actual process of removing tattoos is rather simple. The laser beam using the right wavelength to remove a specific tattoo segment is moved across the tattoo segment while the laser is fired.

White raised spots on the skin indicate that laser energy is being absorbed and treated. After the treatment the treated area should be appropriately dressed to avoid any infection. Patients will usually feel a mild stinging sensation across the treated area.

Clinical Case: Amateur Tattoo

This tribal tattoo was treated using the Fotona's Q-switched Nd:YAG laser. Individual treatment sessions took no longer than 10 minutes, and 3 treatment sessions spread over 3 months were required to achieve complete removal after 4 months.

Photos courtesy of Fotona d.d.

Clinical Case: Professional Tattoo

This professional tattoo was removed using the Fotona QX MAX's Q-switched Nd:YAG laser for the dark tattoo segments and the KTP laser for the red colored sections. Complete clearance was achieved within eight months and a total of four treatment sessions was required spread at approx. six-week intervals.

Photos courtesy of Dr. Kozarev

TREATING PIGMENTED LESIONS

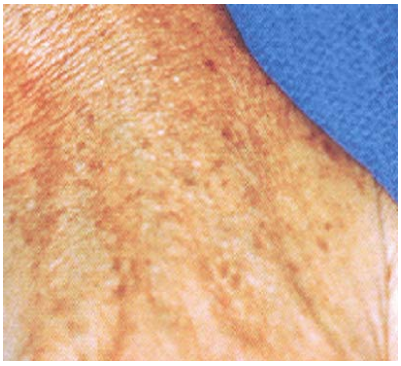
A wide variety of pigmented lesions can be successfully lightened or even completely removed with laser therapy. Studies even indicate that Q-switched laser therapy is superior to liquid nitrogen and argon therapy in terms of efficacy, side effects, and patient satisfaction for the removal of solar lentigines. The number of treatments needed to clear pigmented lesions depends on the lesion and skin type among other factors. Lentigines, café au lait macules, and freckles can usually be cleared in one or two sessions. Dermal pigmented lesions will usually require multiple treatment sessions.

Fotona QX MAX

Clinical Case: Solar Lentigines

Just one treatment with the QX MAX' KTP laser was needed to reach patient-satisfactory results.

Before



After

Photos courtesy of Dr. Kozarev.

Fotona
choose perfection

Clinical Case: Melasma

The ability to treat melasma is very important for a dermatology and aesthetic medicine practice. In the case below, QX MAX's Q-switched Nd:YAG was used; lower energy and fewer repetitions were adequate to produce a marked improvement. Epidermal melasma respond better and faster than dermal or mixed melasma. We expect complete clearance in more than 50% of epidermal melasma cases. Recurrence is common, and improvements are sustained with maintenance sessions.

Before

After

Photos courtesy of Dr. Kozarev.

Fotona QX MAX Handpiece

REJUVENATION TREATMENTS

Fotona offers an Accelera Nd:YAG laser in their QX MAX tattoo and pigment removal system. The Accelera Nd:YAG laser pulses, although classified as a "long pulse" laser, are extremely short and provide the ability to offer the FRAC3™ modality that produces a self-induced, 3D fractional rejuvenation effect in the skin. The FRAC3™ modality and its unique rejuvenation effects are used as maintenance treatments.

Results may often not be visually as pronounced as with more aggressive modalities, but patients do report high satisfaction with skin feeling tighter, more elastic and generally healthier. These treatments are ideal for patients who do not want vastly invasive treatments or for patients with skin types that need to be treated very conservatively.

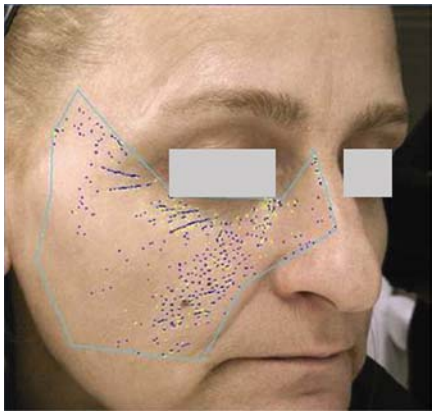
IN CONCLUSION

There is certainly a wanting market out there for tattoo removal systems. When choosing the right system for your practice, it is crucial to take into account the range of wavelengths it provides; you want to be able to treat all skin types and all popular tattoo colors, and not have to turn away customers.

The way maximum peak pulsed energy is generated affects treatment efficacy and efficiency, and flat laser beam profiles contribute to safer treatments with less risk of unwanted side effects. Lastly, it is worth considering what other popular aesthetic treatments the system can offer in order to get a maximum return on your investment.

Clinical Case: FRAC3

Before



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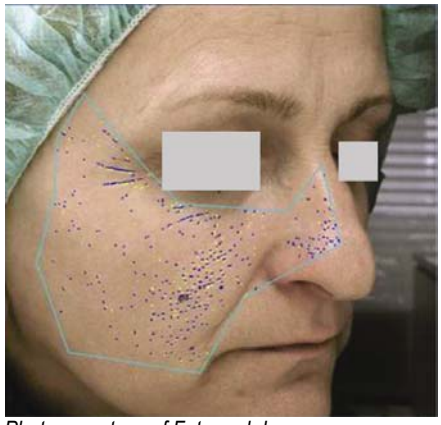
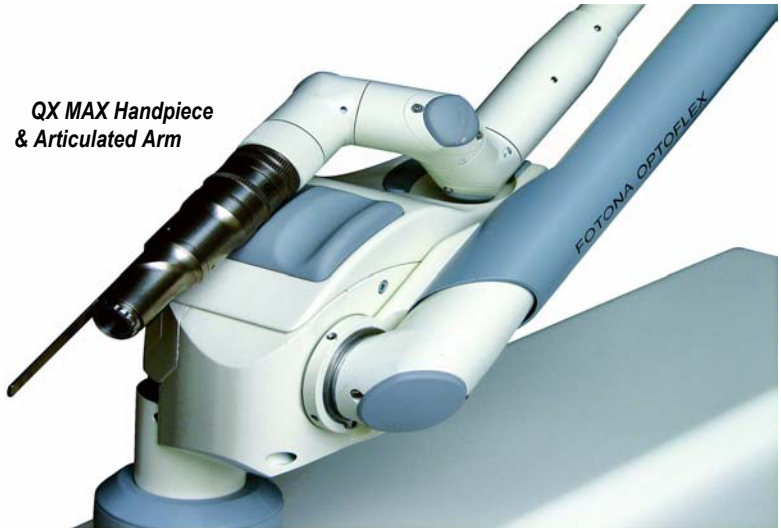


Photos courtesy of Fotona d.d.

About the Author

Jasmina Kozarev, M.D., is a graduate of Novi Sad's Faculty for Medicine and has over 15 years of clinical experience as a specialist in dermatovenerology. She is the founder of the Dr. Kozarev Dermatology Laser Clinic, Serbia, where she practices dermatology and aesthetic laser medicine. She was the first to perform CO_2 laser surgery in Serbia and has accumulated a wealth of clinical and academic experience in laser treatments throughout her career. Given her long-term experience with a tremendous variety of laser sources, Dr. Kozarev is a true expert in the field of Aesthetic Laser Medicine. She contributes to the field both from a practical, clinical point of view, as well as research and development of applications. For more information on the QX MAX, visit the Fotona website: www.fotona.com or call: 888.550.4113.



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The Highest Performance Q-Switched Laser in the World

More than Tattoos and Pigmented Lesions

Combining 5 laser sources in an advanced, high-powered solution, QX MAX effectively removes all common pigmented lesions and popular tattoo colors. Its Accelera Nd:YAG laser is designed to provide very effective skin rejuvenation, hair removal and acne treatments.

Innovation for Superior Efficacy and Safety

Only its highest, single pulse energy Q-switched pulses guarantee treatment efficacy at larger spotsizes, while less fluence is needed to achieve pigment clearance. The Fotona QX MAX, 5-in-1 laser system, is the ultimate solution in advanced Q-switched technology. Supporting OPTOflex Technology increases treatment precision, accuracy and safety. OPTOflex generates absolute uniform beam profiles, avoiding the unnecessary skin damage common in standard Q-switched technology treatments.

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