LOTUS III
Clinical Application of 'Multi-pulsed Er:YAG Laser'

Jiehoon Kim, M.D.

Dr. Kim’s Skin & Laser Clinic
Suwon, Korea
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✓ about LASEROPTOEK Co.
✓ Advantages of LOTUS III
✓ Clinical Applications
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2,940 nm Er:YAG laser

Laser-Tissue Absorption Spectrum

- Red: Oxyhemoglobin
- Purple: Deoxyhemoglobin
- Brown: Melanin
- Light blue: Water

Wavelength (nm):
- 2,940 nm
- 10,600 nm

Relative Absorption

<table>
<thead>
<tr>
<th>Wavelength (nm)</th>
<th>Relative Absorption</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>0.0</td>
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<tr>
<td>400</td>
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<tr>
<td>700</td>
<td>1.0</td>
</tr>
<tr>
<td>1000</td>
<td>10.0</td>
</tr>
<tr>
<td>5000</td>
<td>20000</td>
</tr>
<tr>
<td>10,000</td>
<td>10,000</td>
</tr>
</tbody>
</table>
2,940 nm Er:YAG laser

Solid state laser

The 2,940 nm wavelength emitted by the Er:YAG laser is absorbed 10~12 times better in water compared with the 10,600 nm CO₂ laser

→ Rate of Er:YAG laser absorption in tissue is thus significantly higher than the CO₂ laser.
Er:YAG laser: Thermal injury is minimal and we can effectively and precisely ablate the skin.

- **2,940 nm Er:YAG laser**
  - Normal ablation: 30 µm
  - Thermal injury: < 10 µm

- **10,600 nm CO2 laser Ultra Pulse mode**
  - Ablation: 100 µm
  - Thermal injury: < 70 µm

- **10,600 nm CO2 laser Continuous Wave mode**
  - Ablation: 50 µm
  - Thermal injury: < 160 µm
Characteristics of lasers targeting water (e.g., CO$_2$ or Er:YAG lasers): Irradiation of living tissue leads to ablation of or thermal damage to the targeted tissue.

The Er:YAG laser in comparison with the CO$_2$ laser (Advantages):

1) Zone of thermal injury is relatively smaller
2) Erythema is less
3) Recovery time is shorter
4) Re-epithelization is more rapid
5) Complications including pain are minimal
6) Treatment with the Er:YAG laser is much less stressful for patients
As sharp as a carpenter’s chisel
Treatment of Epidermal Nevus

2,940 nm Er:YAG laser

As sharp as a carpenter’s chisel
Treatment of Epidermal Nevus
Er:YAG laser: Advantages & Indications

- Lower risk of PIH because of smaller coagulation zone in comparison with CO₂ laser
- Rapid re-epithelization
- Lower risk of pain, ecchymosis, edema
- Rapid return to normal daily activities because of short downtime
- Safer than chemical peeling
- Lower risk of erythema post-treatment
- Easy and effective to treat pigmented lesions occupying large areas (e.g., Seborrheic keratosis, epidermal nevi)
- Flat top beam profile: predictable and homogeneous results.
- Safer treatment because there is less residual thermal damage which can induce unwanted side effects and increase downtime.
Er:YAG laser: Disadvantages

- Poor coagulative effect in tissue → Heavy bleeding
- Minimal thermal injury → Subsequent limitation in induction of collagenesis and tissue remodelling
- Relatively expensive market price → One of the barriers to purchase
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✓ Conclusion
Company overview:

<table>
<thead>
<tr>
<th>Established</th>
<th>In 2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEO</td>
<td>Hong Chu</td>
</tr>
<tr>
<td>Employee</td>
<td>31</td>
</tr>
<tr>
<td>Capital</td>
<td>4.8 billion</td>
</tr>
<tr>
<td>Overseas distributors</td>
<td>42</td>
</tr>
<tr>
<td>Main Products</td>
<td>Medical lasers(Helios III, Helios II, Lotus II, Hyperion, Zelos, Pallas) Industrial lasers(Q-switched Nd:YAG lasers: 4 mJ to 2.2 J/pulse) : order made</td>
</tr>
</tbody>
</table>
CEO:

✔ Chu Hong, Ph.D.
✔ Engineer
✔ Graduated KIST
✔ 1st Er:YAG laser developer in Korea

단 7명의 소수정예 인원으로 100% 수업에 의존하고 있는 국내 레이저 시장을 둡은 회사가 있다. 레이저업체 주를 대표하는 한국과학기술연구원(KIST) 시절 국내 최초로 순수 국산기술의 레이저를 개발한 주인공이다. 2000년 이 기술을 바탕으로 산업용 레이저용 레이저를 생산하는 레이저업체를 설립했다.

“레이저는 미래산업의 핵심입니다. 모든 평일과중에도 레이저가 사용되기 때문에 이를 국산화하는 것이 국가적으로도 시급한 과제였죠.”

레이저업체의 매출과는 레이저는 미래에서도 고주파로 가장 높은 가속력이 요구되는 데다. 산업용 레이저의 각각 매출의 50%에 이를 차지한다. 이 회사는 설립한 레이저는 주로 반도체 세척 및 보수 공정에 이용되며 이전까지 반도체 공정에서 사용하던 화학액품 대체하면서 환경오염을 크게 줄이는 데도 일등공신 역할을 했다.

의료용으로는 색소제거와 의료용, 제조 등의 피부과 치료 및 외과 수술, 산업용 비디오 카메라 등에도 널리 이용된다. 레이저는 피부를 자른다 간편하게 의료용 수술 할에 비해 100분의 1에 불과한 열량을 이용함으로써 연속으로 자극이 가능하다.

최근엔 산업 외부에서 레이저를 쓰아 지방제거를 했다는 기술이 향후 개발 중이다.

산업용, 의료용에서 레이저 시장을 담당하는 레이저는 3~4개에 불과하다. 블루오 선생이 레이저용 산업용 레이저를 생산하는 회사는 3~4개에 불과하다. 블루오 선생은 레이저는 수업내에 못이나 해외시장에서 늦을 줄거웠다는 계획을 갖고 있다.
Global Laseroptek: 2016. 1.(42countries)

Advertisement in Argentina Airplan (2012)
Helios series (Q-switched Nd:YAG Laser, 1064/532nm)

Best Seller

2013 2007

Lotus series (Fractional Er:YAG Laser, 2940nm)

NEW

2015 2007

PALLAS (Solid state UV Laser, 311nm)

NEW

2015

Applications
- Vitiligo
- Psoriasis
- Atopy dermatitis

Zelos (Alexandrite Laser, 755nm)

2014

Hyperion (Long pulse Nd:YAG Laser, 1064nm)

2012
UV Laser: PALLAS

Specifications of Pallas

<table>
<thead>
<tr>
<th>Laser type</th>
<th>Ti:Sapphire</th>
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<tr>
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<td>311 nm</td>
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<tr>
<td>Pulse duration</td>
<td>&lt;17 ns</td>
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<tr>
<td>Pulse Energy(Fluence)</td>
<td>3mJ/cm²</td>
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<tr>
<td>Repetition rates</td>
<td>100 Hz</td>
</tr>
<tr>
<td>Spot size</td>
<td>Collimator hand piece: φ1~20 mm</td>
</tr>
<tr>
<td>Display</td>
<td>10.4” TFT LCD Touch panel</td>
</tr>
<tr>
<td>Electrical control</td>
<td>ARM processor</td>
</tr>
<tr>
<td>Cooling system</td>
<td>Closed cycle water to air heat exchanger</td>
</tr>
<tr>
<td>Electrical power</td>
<td>220V, 50~60Hz</td>
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- Solid state UV laser substitutes Excimer Laser (308 nm)
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### Specifications of LOTUS II

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<tr>
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<th>Er :YAG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wavelength</td>
<td>2,940 nm</td>
</tr>
<tr>
<td>Pulse duration</td>
<td>Short pulse: 350 us, Long pulse: 1 ms</td>
</tr>
<tr>
<td>Pulse Energy(max.)</td>
<td>Short pulse: 1.5J, Long pulse: 1 J</td>
</tr>
<tr>
<td>Repetition rates</td>
<td>Short pulse: 3-10 Hz, Long pulse: 3-10 Hz</td>
</tr>
<tr>
<td>Spot size</td>
<td>Zoom hand piece: 1-7 mm</td>
</tr>
<tr>
<td></td>
<td>Fractional hand piece: 8x8 mm²</td>
</tr>
<tr>
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</tr>
</tbody>
</table>
### Specifications of LOTUS III

**LOTUS II VS all new innovative LOTUS III**

<table>
<thead>
<tr>
<th></th>
<th>LOTUSII</th>
<th>LOTUSIII</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Laser Type</strong></td>
<td>Er:YAG</td>
<td>Er:YAG</td>
</tr>
<tr>
<td><strong>Wavelength</strong></td>
<td>2940nm</td>
<td>2940nm</td>
</tr>
<tr>
<td><strong>Pulse Duration</strong></td>
<td>Short, Long pulsed</td>
<td>Multi pulsed</td>
</tr>
<tr>
<td></td>
<td>Short pulsed: 350µs</td>
<td>40µs, 200µs, 600µs</td>
</tr>
<tr>
<td></td>
<td>Long pulsed: 1ms</td>
<td>1ms, 5ms/multipulse (smooth mode)</td>
</tr>
<tr>
<td><strong>Pulse Energy(max)</strong></td>
<td>1.5J</td>
<td>4.6J</td>
</tr>
<tr>
<td><strong>Repetition Rate</strong></td>
<td>3 ~ 10Hz</td>
<td>M3, M5, Single, 1~40Hz</td>
</tr>
<tr>
<td><strong>Spot Size</strong></td>
<td>Fractional - 8*8㎟</td>
<td>Fractional - 8*8㎟</td>
</tr>
<tr>
<td></td>
<td>Collimator - 15mm</td>
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</tr>
<tr>
<td></td>
<td>Zoom - 1064nm 1~7mm</td>
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<tr>
<td><strong>Display</strong></td>
<td>10.4inch TFT LCD</td>
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<tr>
<td><strong>Aiming Beam</strong></td>
<td>Laser Diode, 635nm/1mW</td>
<td>Laser Diode, 655nm/5mW</td>
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<tr>
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<tr>
<td><strong>Electrical Power</strong></td>
<td>220V, 50/60Hz</td>
<td>220V, 60Hz</td>
</tr>
<tr>
<td><strong>Auto sensing</strong></td>
<td>O</td>
<td>O</td>
</tr>
</tbody>
</table>
Specifications of LOTUS III
Specifications of LOTUS III

- Power up!
- Multi-pulsed technology
- All new innovation
- Multi-functions
- Easy & safe mechanism
## Specifications of LOTUS III

<table>
<thead>
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<th><strong>Laser type</strong></th>
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<tr>
<td><strong>Wavelength</strong></td>
<td>2,940 nm</td>
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<tr>
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<td>40 μsec ~ 5 msec (40μs, 200μs, 600μs, 1ms, 5ms)</td>
</tr>
<tr>
<td><strong>Pulse Energy(max.)</strong></td>
<td>4.6 J</td>
</tr>
<tr>
<td><strong>Repetition rates</strong></td>
<td>Single, 1 to 40 Hz</td>
</tr>
</tbody>
</table>
| **Spot size**    | Zoom hand piece : 1-7 mm  
|                  | Zoom collimator handpiece :1-3 mm  
|                  | Collimator handpiece:15 mm  
|                  | Fractional hand piece : 8x8 mm² |
| **Display**      | 10.4” TFT LCD Touch panel |
| **Electrical control** | ARM processor |
| **Cooling system** | Closed cycle water to air heat exchanger |
| **Electrical power** | 220V, 50~60Hz |
## Specifications of LOTUS III

### Multi-pulsed Er:YAG laser

<table>
<thead>
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</table>

### Ultra short pulse mode:
- Pulse duration: 40 µsec
- Deep ablation depth
- Cold ablation:
  - minimal thermal damage
  - little pain
  - less side effect

### Ultra long pulse mode:
- Pulse duration: 5 msec
- Shallow ablation
- Strong thermal effect
- Coagulation
Specifications of LOTUS III

- Zoom handpiece
- Fractional handpiece
- Micro Laser Peeling handpiece
All New Innovative
LOTUS III
advantages
Advantages of LOTUS III

- Power up!
- Ultra short pulse mode: 40 μsec
- Ultra long pulse mode: up to 5 msec
- DOE fractional mode
- User friendly GUI & Conveniency
- Easy & variable clinical applications
- Safety mechanism (auto sensing)
# Advantages of LOTUS III

▶ **Power up!**

<table>
<thead>
<tr>
<th></th>
<th>LOTUS II</th>
<th>LOTUS III</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>

Multi-pulsed (ultra short & ultra long)
High pulse energy
Stable energy at 10 Hz
Advantages of LOTUS III

▶ Ultra short pulse mode: 40 μsec

◆ Specifications of LOTUS III

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<tr>
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<tbody>
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</table>
Advantages of LOTUS III

▶ Ultra short pulse mode: 40 µsec

LOTUS III Wave form (40 µs)
Advantages of LOTUS III

▶ Ultra short pulse mode: 40 μsec

2,940nm Er:YAG laser normal ablation
Advantages of LOTUS III

Ultra short pulse mode: 40 μsec

- **2,940nm Er:YAG laser**
  - Normal ablation: 30 μm
  - Thermal injury: < 10 μm

- **10,600nm CO2 laser**
  - Ultra Pulse mode: 50 μm
  - Thermal injury: < 160 μm
  - Continuous Wave mode: 100 μm
  - Thermal injury: < 70 μm

**Advantages of LOTUS III**

- Ultra short pulse mode: 40 μsec
Advantages of LOTUS III

- **Ultra short pulse mode:** 40 μsec

- **2,940nm Er:YAG laser**
  - Cold Ablation: < 30 μm
  - Thermal injury: < 5 μm

- **2,940nm Er:YAG laser**
  - Normal Ablation: 30 μm
  - Thermal injury: < 10 μm

- **10,600nm CO2 laser**
  - Ultra Pulse mode: 100 μm
  - Thermal injury: < 70 μm

- **10,600nm CO2 laser**
  - Continuous Wave mode: 50 μm
  - Thermal injury: < 160 μm
Advantages of LOTUS III

- **Ultra short pulse mode:** 40 μsec
Advantages of LOTUS III

- **Ultra short pulse mode**: 40 μsec

- **Pulse duration**: 40 μsec

- **Deep ablation depth**

- **Cold ablation**:
  - Minimal thermal damage
  - Little pain
  - Less side effect
## Advantages of LOTUS III

- **Ultra long pulse mode:** up to 5 msec

## Specifications of LOTUS III

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Laser type</strong></td>
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</table>
Advantages of LOTUS III

▶ Ultra long pulse mode: up to 5 msec

LOTUS III Wave form (5ms)

True long pulse
(not envelope method)
Advantages of LOTUS III

- Ultra long pulse mode: up to 5 msec

**Envelope method**

**True long pulse method**
Advantages of LOTUS III

▶ Ultra long pulse mode: up to 5 msec

- Ultra long pulse mode:
  - Pulse duration: up to 5 msec
  - Shallow ablation
  - Strong thermal effect
  - Coagulation

→ substitute CO2 fractional laser
Advantages of LOTUS III

DOE fractional mode

Fractional Photothermolysis

Intradermal focusing of near-infrared optical pulses: a new approach for non-ablative laser therapy

Huzaira M, Anderson RR, Sink K, Manstein D

Lasers Surg Med; 2003, 32 (Suppl 15) : 17–38
Advantages of LOTUS III

▶ DOE fractional mode

Mechanism of Fractional Photothermolysis:

Targeting Fractions of the skin

→ the surrounding normal tissue is not involved
→ fast epidermal repair via migration of the surrounding viable cells
→ permitting rapid epidermal repair with minimal downtime
Advantages of LOTUS III

DOE fractional mode

Classifications of fractional photothermolysis:

- **Non-Ablative** Fractional Photothermolysis
- **Ablative** Fractional Photothermolysis

Non-Ablative Fractional Laser

- 1,550 nm Erbium Glass Fractional Laser (NIR Fx)

Ablative Fractional Laser:

- 10,600 nm CO$_2$ Fractional Laser (CO$_2$ Fx)
- 2,940 nm Er:YAG Fractional Laser (Er:YAG Fx)
Advantages of LOTUS III

▶ DOE fractional mode

● Characteristics of Fractional Lasers

▶ Water absorption: Er:YAG Fx > CO2 Fx

▶ Lateral heat diffusion: Er:YAG Fx < CO2 Fx

▶ Penetration Depth: CO2 Fx > Er:YAG Fx
Advantages of LOTUS III

▶ DOE fractional mode

Methods of Fractional Filter

(1) Slit

(2) Micro Lens Array (MLA)

(3) Diffraction Optical Element (DOE)
Advantages of LOTUS III

- DOE fractional mode

- Collimated beam from resonator

- Fractional Filter

- Fractional beam
Advantages of LOTUS III

DOE fractional mode

Collimated beam from resonator
Advantages of LOTUS III

DOE fractional mode

Collimated beam from resonator

Fractional Filter
Advantages of LOTUS III

▶ DOE fractional mode

Collimated beam from resonator

Fractional Filter

Fractional beam
Advantages of LOTUS III

▶ DOE fractional mode

Methods of Fractional Filter

(1) Slit
Advantages of LOTUS III

▶ DOE fractional mode

Methods of Fractional Filter

(2) Micro Lens Array (MLA)

Collimated beam from resonator

MLA filter

Fractional beam
Advantages of LOTUS III

▶ DOE fractional mode

Methods of Fractional Filter

(3) Diffraction Optical Element (DOE)
Advantages of LOTUS III

Methods of Fractional Filter

(3) Diffraction Optical Element (DOE)
The advantage of the laser spot formed by DOE:

Fluence or energy of each individual fractional beam is **optically uniform**

→ resulting in **equal distribution of the fractional energy to the skin**

→ **ablation of the skin in an uniform pattern**

→ lowering the risk of PIH, burns, and hypo-pigmentation.
Advantages of LOTUS III

▶ User friendly GUI & Conveniency

- User friendly GUI
- Short learning curve
- Fast application

✓ Convenient storage space
Advantages of LOTUS III

Safety mechanism (auto sensing)

→ Auto sensing beam diameter
→ Detect at Control panel

→ Zoom handpiece
→ Locking system
Contents

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✓ about LASEROPTEK Co.
✓ Advantages of LOTUS III
✓ Clinical Applications
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Lotus III®

Multi-functional & multi-pulsed 2,940 nm Er:YAG laser

The multi-pulsed Lotus III can ablate various epidermal lesions with the cold ablation mode at 40us.

Patients are able to see remarkable improvement of fine lines, wrinkles, acne scarring, and pore reduction.
Seborrheic Keratosis
Seborrheic Keratosis

- Female
- 45 yrs old
- Seborrheic keratosis on cheek
- note: skin type IV~V with melasma
Seborrheic Keratosis

- LOTUS III
  - Ultra short pulse mode
    (pulse duration: 40 μsec)
  - Spot size: 4 mm
  - Fluence: 1.41 J/cm$^2$
  - Repetition: 5 Hz
  - Single treatment
▶ Female
▶ 53 yrs old
▶ SK, milium, lentigines
SK, milium, lentigines

LOTUS III
- Ultra short pulse mode
  (pulse duration: 40 μsec)
- Spot size: 4 mm
- Fluence: 1.41 J/cm²
- Repetition: 5 Hz
- Single treatment
- note: Milium extraction
  Lentigines treated with
  Q-switched Ruby laser
SK milium syringoma

Before

After
▶ SK milium syringoma

Before

After
Epidermal nevus

Before

After
Syringoma: Drilling technique

- Drilling technique on syringoma:
  Combination treatment with 2,940 nm Er:YAG laser and 10,600 nm CO2 laser

- Lotus III single treatment
  → Combination treatment with **ultra short pulse mode** + **ultra long pulse mode**
Syringoma: Drilling technique

1) External mass of syringoma: ablate with Er:YAG laser (ultra short pulse mode)
2) Ablation level: surrounding normal tissue
3) Syringoma core: Stroma which is different from surrounding normal tissue
4) Ablate Syringoma core with CO2 laser (substitute with ultra long pulse mode)
5) Apply topical antibiotics or occlusive dressing materials
Advantages of Drilling technique

✓ Minimize the tissue shrinkage
✓ Maximize the target tissue damage
✓ Prevention of non-specific tissue damage
✓ Minimize the surrounding normal tissue damage
✓ Prevention of hypertrophic and atrophic scar
✓ Minimize the risk of PIH
✓ Minimize the recurrence rate
✓ Cosmetically acceptable
Syringoma: Drilling technique

- **LOTUS III**
  - **Ultra short pulse mode**
    - (pulse duration: 40 μsec)
    - Spot size: 4 mm
    - Fluence: 1.41 J/cm²
    - Repetition: 5 Hz
  - **LOTUS III**
    - **Ultra long pulse mode**
      - (pulse duration: 5 msec)
      - Spot size: 4 mm
      - Fluence: 12.73 J/cm²
      - Repetition: 2 Hz
- **Single treatment**
Syringoma: Drilling technique

- **LOTUS III**
  - Ultra short pulse mode
    - (pulse duration: 40 μsec)
    - Spot size: 4 mm
    - Fluence: 1.41 J/cm$^2$
    - Repetition: 5 Hz
  - Single treatment

- **LOTUS III**
  - Ultra long pulse mode
    - (pulse duration: 5 msec)
    - Spot size: 4 mm
    - Fluence: 12.73 J/cm$^2$
    - Repetition: 2 Hz

*Before*

*After*
Syringoma: Drilling technique

Before

After
Syringoma: Drilling technique
Syringoma, Pig N, SK, Lentigines

Before

After
Syringoma, Pig N, SK, lentigines

Before

After
Syringoma, Pig N, SK, lentigines

Before

After
Depressed scar

- LOTUS III
  - Ultra short pulse mode
    (pulse duration: 40 μsec)
  - Spot size: 4 mm
  - Fluence: 1.41 J/cm²
  - Repetition: 5 Hz

- 3 months interval
- 3 sessions
Contents

✓ Introduction
✓ about LASEROPTEK Co.
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2,940 nm Er:YAG laser

- Thermal injury is minimal and effectively and precisely ablate the skin
- Lower risk of PIH & erythema
- Essential laser in laser clinic

✓ All new innovative LOTUS III ;
  developed by Laseroptek (1st Er:YAG developer in Korea from 2000 yrs)
All New Innovative LOTUS III

- Power up!
- Ultra short pulse mode (40 μsec, Cold ablation)
- Ultra long pulse mode (5 msec, true long pulse) → substitute CO2 laser
- **DOE fractional mode** (1st in Korea)
- User friendly GUI & Conveniency
- **Easy & variable clinical applications**
- Safety mechanism (auto sensing)
Thank you for listening!

All New Innovative

Lotus III

LASEROPTEK Co. Sungnam, Korea