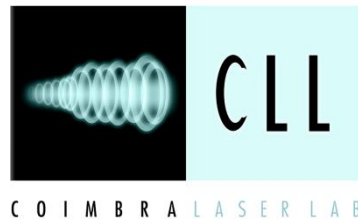


# Development of piezophotonic materials: a trip from the laboratory bench to the market

Carlos Serpa, Gonalo F . F. S, Luis G. Arnaut

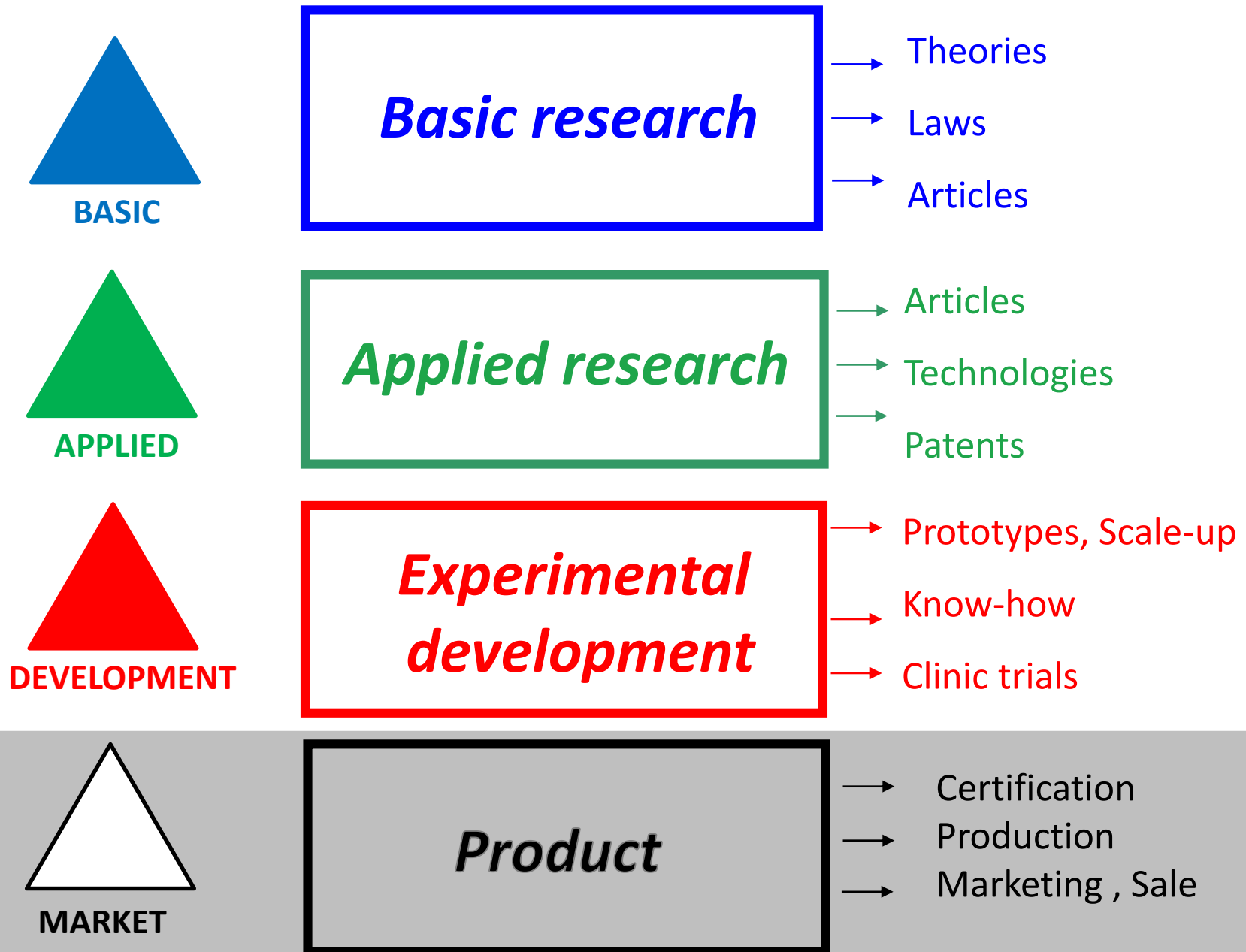


**L**LASERLEAP

**Coimbra Laser Lab**  
**Chemistry Department**  
University of Coimbra  
PORTUGAL  
serpaso@ci.uc.pt

**LaserLeap Technologies**  
Instituto Pedro Nunes  
Rua Pedro Nunes, S/N  
3030-199 Coimbra  
PORTUGAL  
cserpa@laserleap.com

# ***Frascati Manual*** research nomenclature





1990 From the LAB BENCH...



University of Coimbra  
**Photoacoustics**  
Laboratory

**Basic research: 10-20 years**

2008 **The problem:** *Non-invasive method to enhance skin permeation of photosensitizers*

**Applied research: 3 years**

2011 **LASERLEAP**

**Experimental development: 5 years**

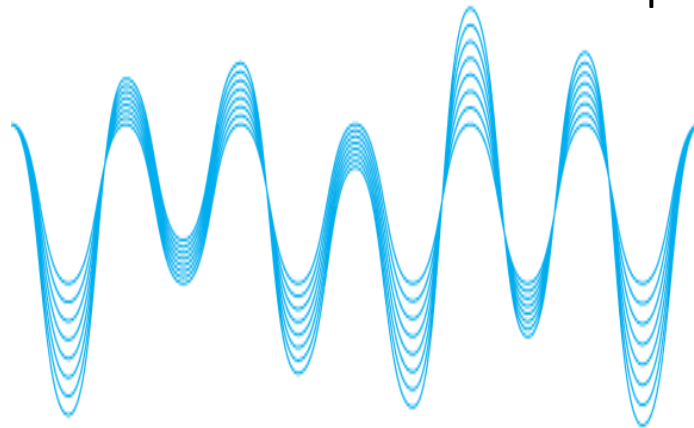
2016 ...to the MARKET

# pressure waves

## Production and characterization

### Photo.....acoustics

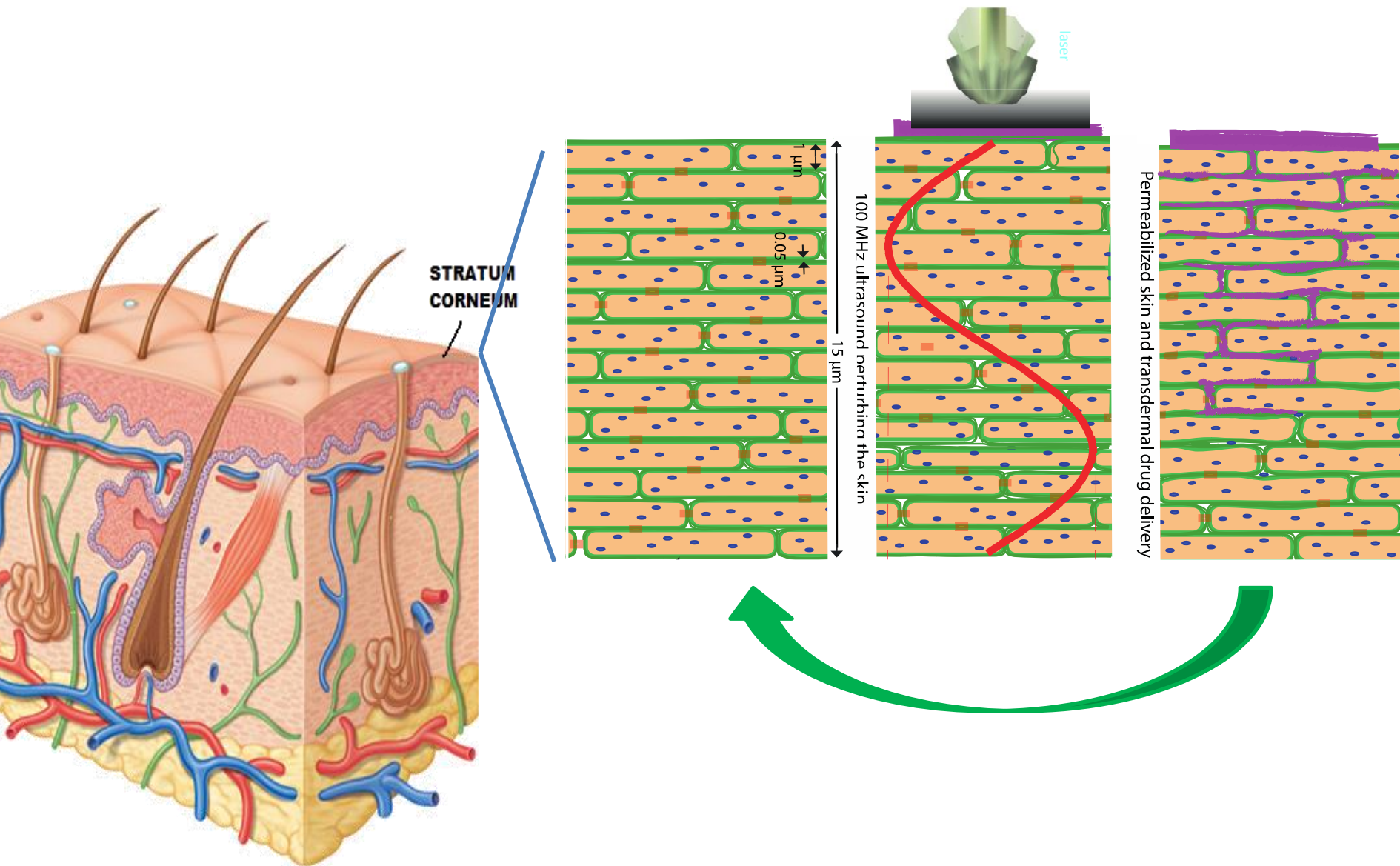
pulse duration  
wavelength  
fluence

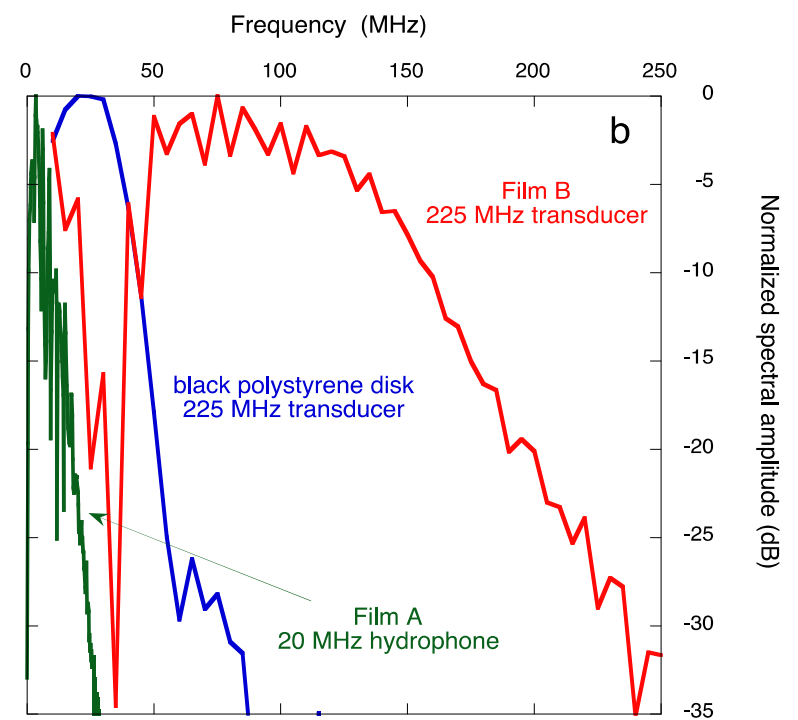
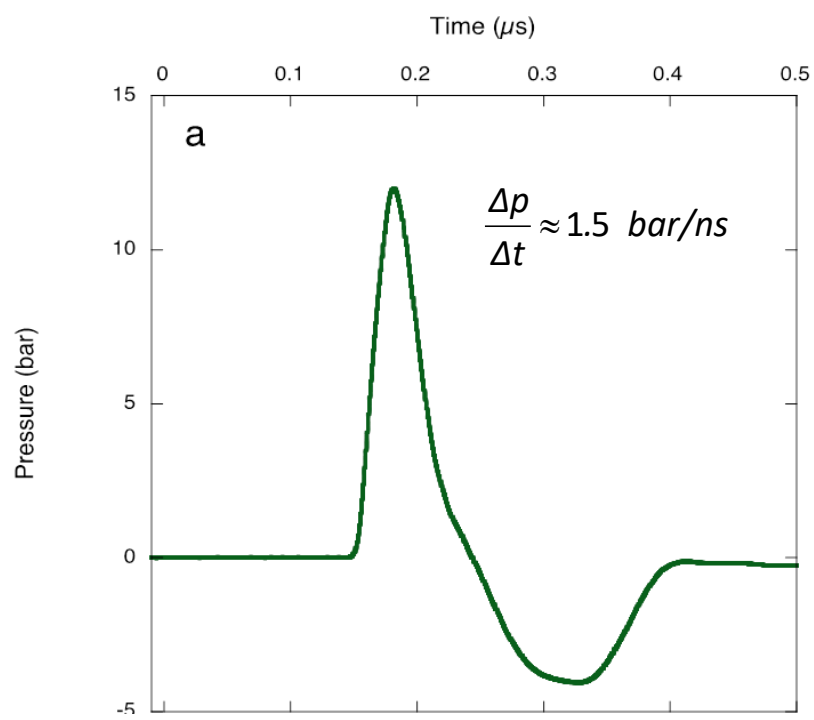


frequency distribution  
peak pressure  
rise time  
duration



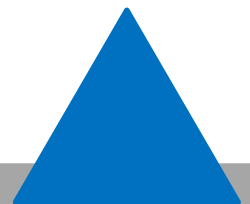
**The problem:** *Non-invasive method to enhance skin permeation of photosensitizers*

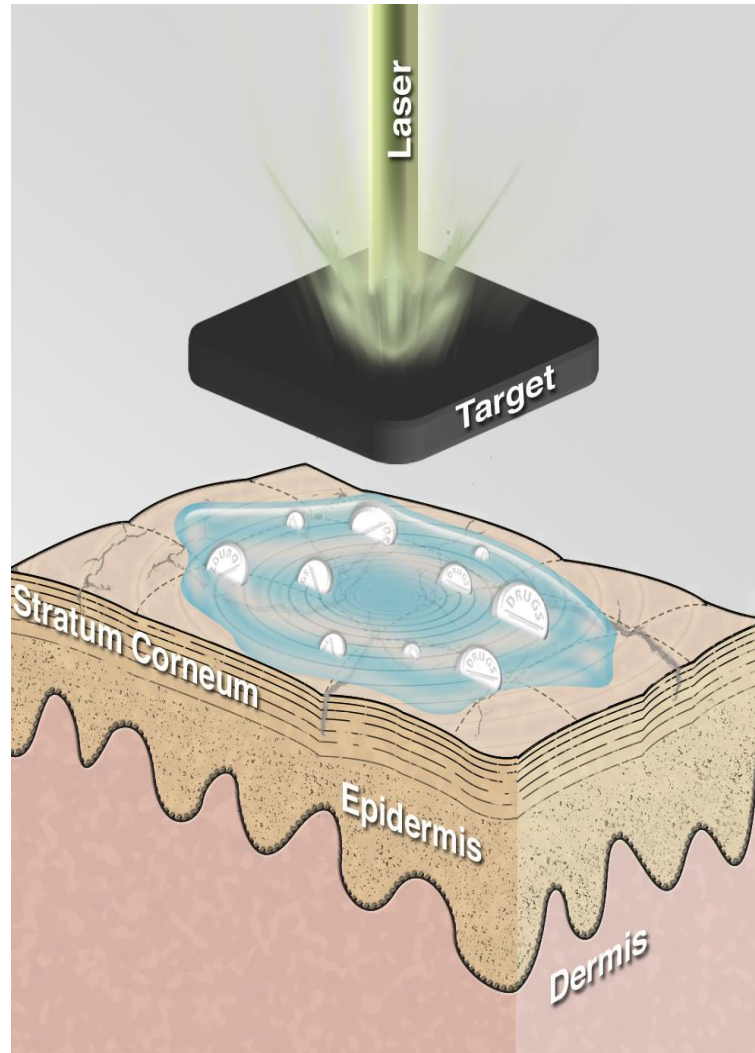




## Piezophotonic materials

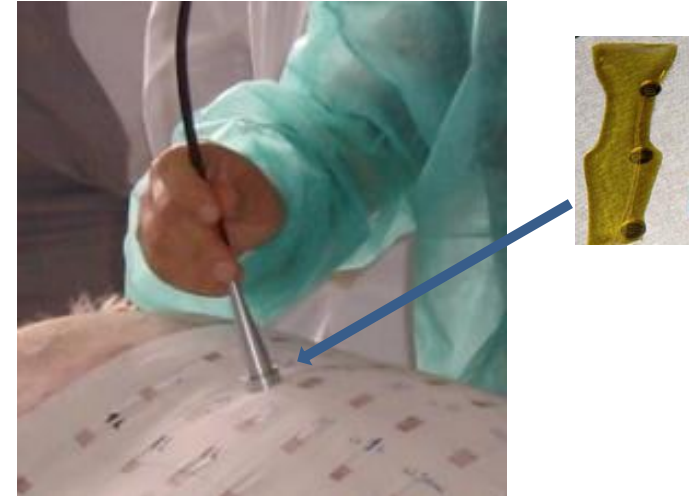
*Laboratory bench, circa 2010*





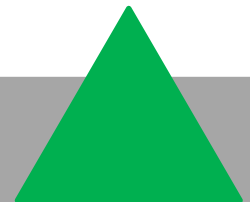


# Pre-clinic



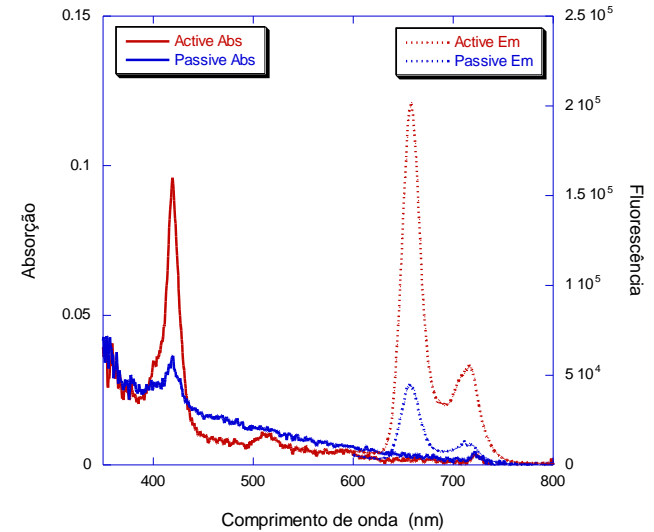
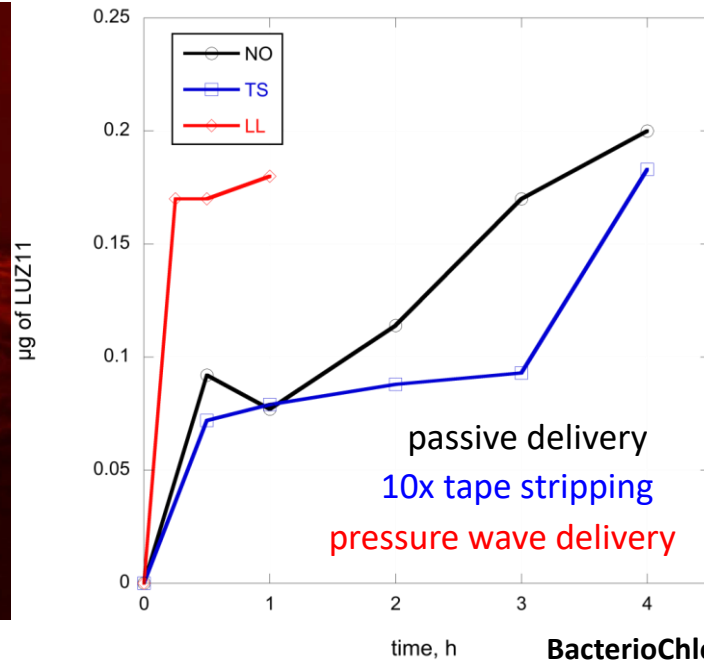
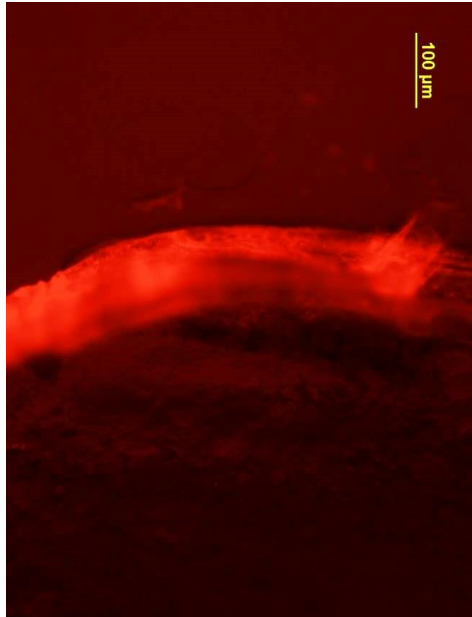
laser pulses of  $20-60 \text{ mJ/cm}^2$   
6-8 ns pulses of a Nd:YAG laser (532 nm)  
laser coupled to a optical fiber

APPLIED



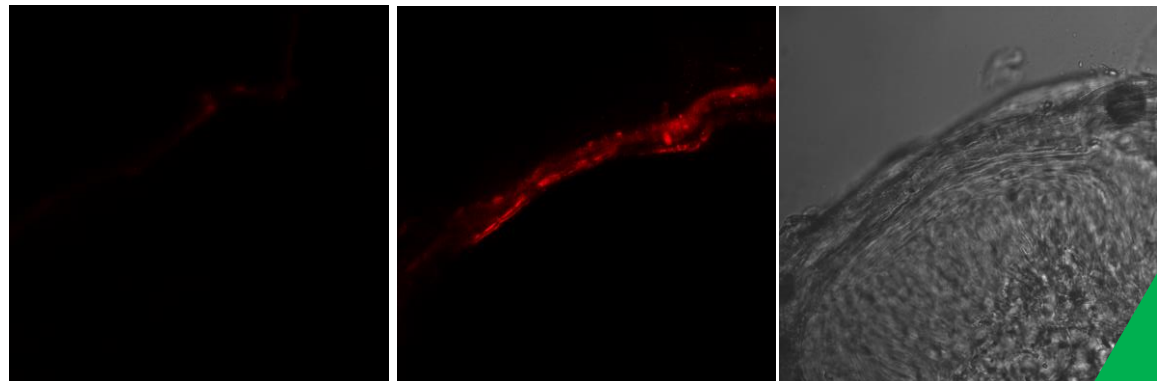


# Pre-clinic

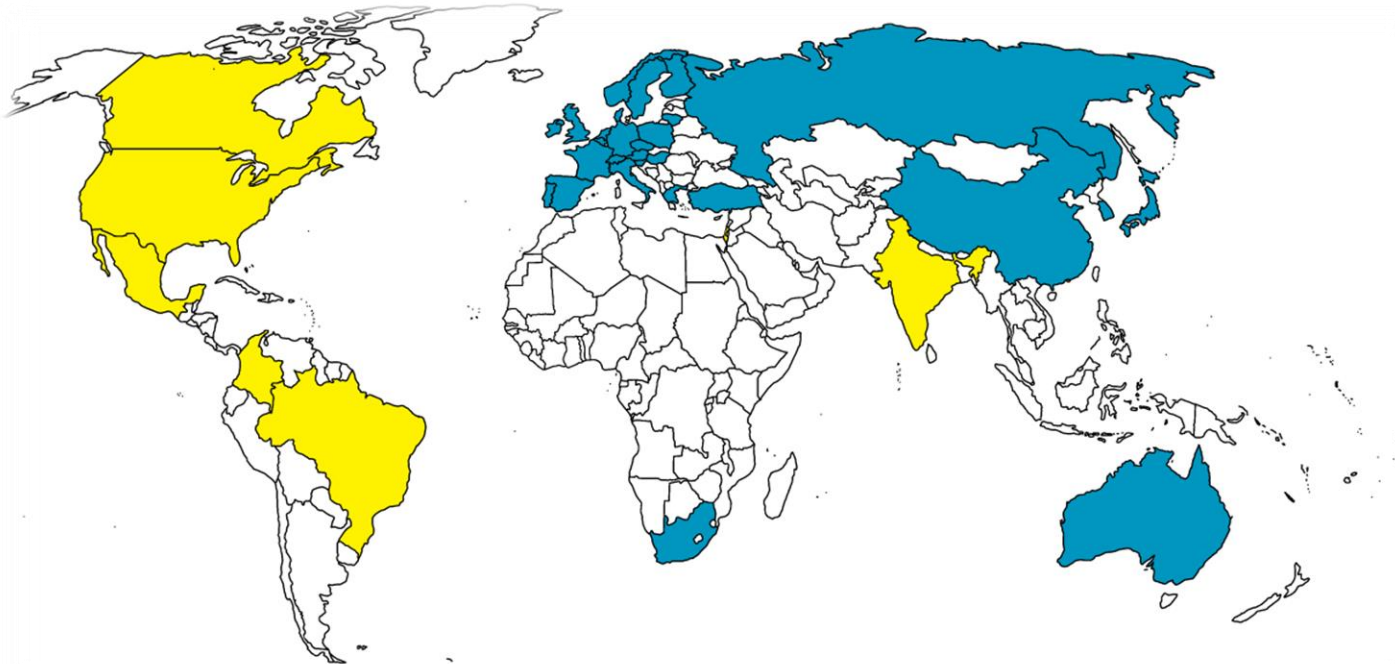


Stratum corneum  
permeabilization with  
photoacoustic waves  
generated by piezophotonic  
materials

G.F.F. Sá, C. Serpa, L.G. Arnaut,  
J. Control. Release, 167 (2013)  
290-300.



# Intellectual Property and Patents



**INPI** Instituto Nacional da Propriedade Industrial

Centro de Patentes - 22045-900, Fátima, Portugal  
Tel: +351 21 391 92 01 / 21 391 92 02 / 21 391 92 03 / 21 391 92 04 / 21 391 92 05 / 21 391 92 06 / 21 391 92 07 / 21 391 92 08 / 21 391 92 09 / 21 391 92 10 / 21 391 92 11 / 21 391 92 12 / 21 391 92 13 / 21 391 92 14 / 21 391 92 15 / 21 391 92 16 / 21 391 92 17 / 21 391 92 18 / 21 391 92 19 / 21 391 92 20 / 21 391 92 21 / 21 391 92 22 / 21 391 92 23 / 21 391 92 24 / 21 391 92 25 / 21 391 92 26 / 21 391 92 27 / 21 391 92 28 / 21 391 92 29 / 21 391 92 30 / 21 391 92 31 / 21 391 92 32 / 21 391 92 33 / 21 391 92 34 / 21 391 92 35 / 21 391 92 36 / 21 391 92 37 / 21 391 92 38 / 21 391 92 39 / 21 391 92 40 / 21 391 92 41 / 21 391 92 42 / 21 391 92 43 / 21 391 92 44 / 21 391 92 45 / 21 391 92 46 / 21 391 92 47 / 21 391 92 48 / 21 391 92 49 / 21 391 92 50 / 21 391 92 51 / 21 391 92 52 / 21 391 92 53 / 21 391 92 54 / 21 391 92 55 / 21 391 92 56 / 21 391 92 57 / 21 391 92 58 / 21 391 92 59 / 21 391 92 60 / 21 391 92 61 / 21 391 92 62 / 21 391 92 63 / 21 391 92 64 / 21 391 92 65 / 21 391 92 66 / 21 391 92 67 / 21 391 92 68 / 21 391 92 69 / 21 391 92 70 / 21 391 92 71 / 21 391 92 72 / 21 391 92 73 / 21 391 92 74 / 21 391 92 75 / 21 391 92 76 / 21 391 92 77 / 21 391 92 78 / 21 391 92 79 / 21 391 92 80 / 21 391 92 81 / 21 391 92 82 / 21 391 92 83 / 21 391 92 84 / 21 391 92 85 / 21 391 92 86 / 21 391 92 87 / 21 391 92 88 / 21 391 92 89 / 21 391 92 90 / 21 391 92 91 / 21 391 92 92 / 21 391 92 93 / 21 391 92 94 / 21 391 92 95 / 21 391 92 96 / 21 391 92 97 / 21 391 92 98 / 21 391 92 99 / 21 391 92 00

| Nº            | CÓDIGO | DATA E HORA DE RECEÇÃO | MODALIDADE | PROCESSO RELACIONADO |
|---------------|--------|------------------------|------------|----------------------|
| 2011100000026 | 0168   | 2011/04/19-16:26:52    | PAT        | 128538 S             |

REGISTAMENTO CONFIRMADO

PEDIDO DE PATENTE, MODELO DE UTILIDADE OU DE TOPOGRAFIA DE PRODUTOS SEMICONDUCTORES

**1. REQUERENTE**

Código 503356 Nacionalidade PORTUGUESA  
 Nome UNIVERSIDADE DE COIMBRA  
 Endereço RUA DE PAÇO DAS ESCOLAS  
 Localidade COIMBRA  
 Telefone  
 Email ITC@UCP.PT  
 Actividade (CAE)  
 NIF

Tipo de Representação Agente Oficial da Propriedade Industrial ou Procurador Autorizado  
 Nome GONÇALO DA CUNHA FERREIRA  
 Endereço para este pedido

**2. MODALIDADE / TIPO DE PEDIDO**

Modalidade: PEDIDO PROVISÓRIO DE PATENTE  
 Realizado de acordo com o NPI: 51/1

**3. EPIGRAFE OU TÍTULO**

DEVICE FOR EFFICIENT DELIVERY OF COMPOUNDS TO OR THROUGH THE SKIN OR BIOLOGICAL BARRIERS, (BIO) LIGHT-ASSISTED TISSUE FILLS

**4. RESUMO**

**5. FIGURAS**

**6. INVENTORES**

Nome GONÇALO FERNANDO FERREIRA DE SÁ  
 Endereço RUA MARIA VITORIA BORBON BOBONE, LOTE 20 S R/C O  
 Localidade COIMBRA  
 Telefone 351 213 800 910  
 Email GCF@SARRIQUES.COM  
 NIF 212104285  
 Nacionalidade PORTUGUESA

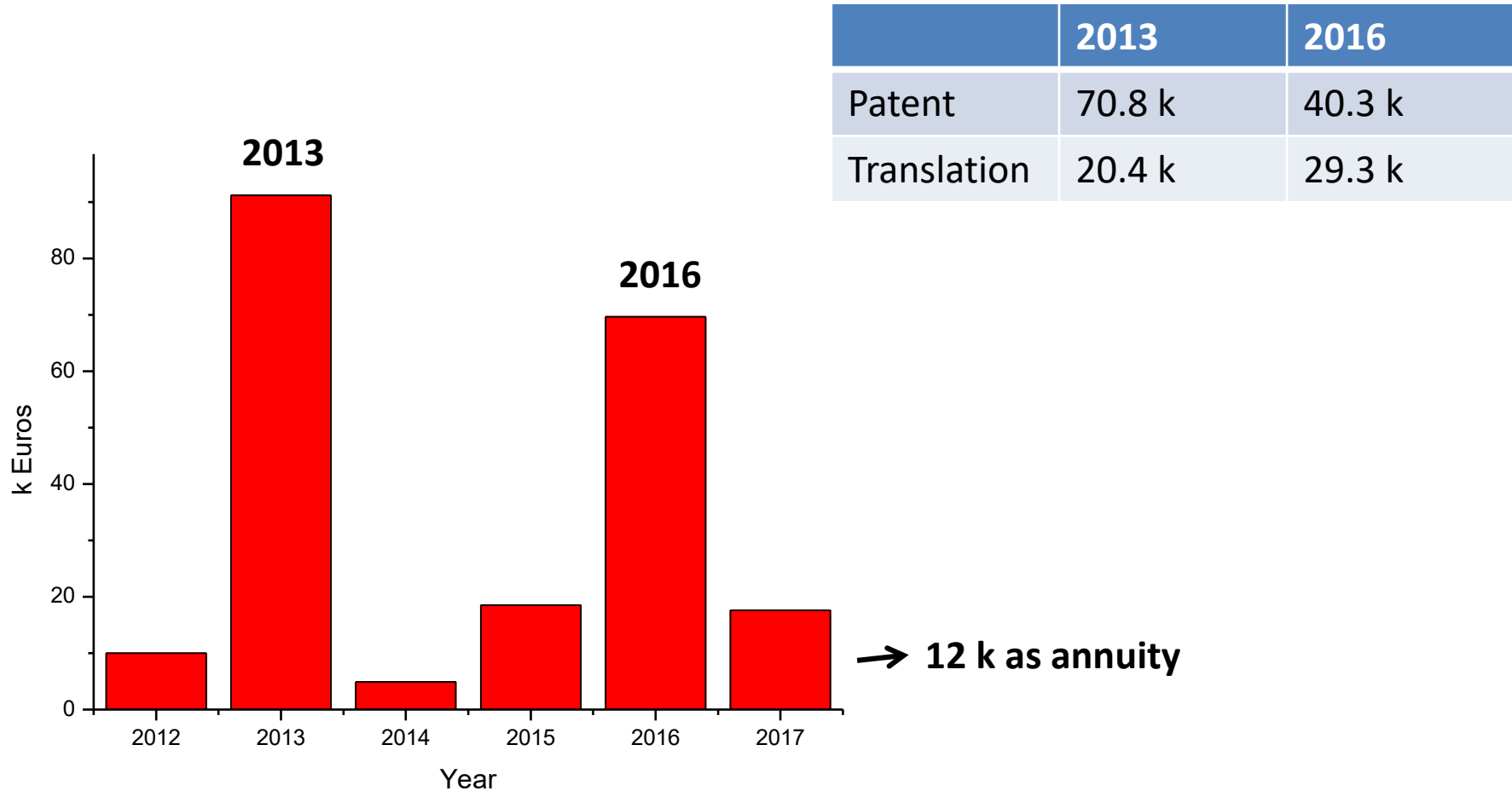
Nome CARLOS ALBERTO LOURENÇO DE SERRA SOARES  
 Endereço RUA GIL VICENTE, 92 / CAVE  
 Nacionalidade PORTUGUESA

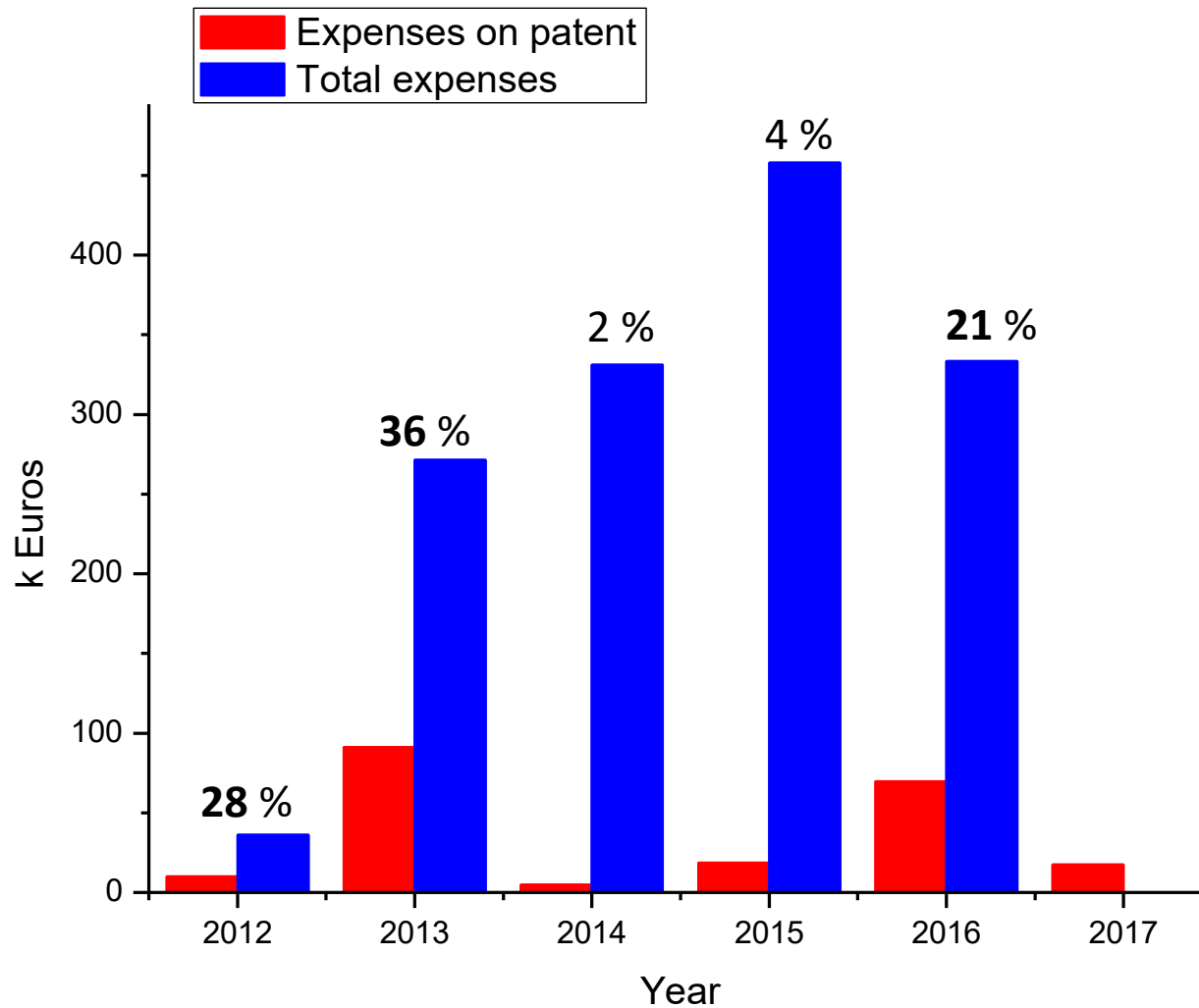
2011100000026 - 2011/04/19-16:26:52

- University of Coimbra has filed patent applications in 36 countries and territories in 2012
- In 2013 the European patent was validated in 22 European countries, signatories of the European Patent Convention
- The patent has also been granted in Australia, China, Japan, Republic of Korea, Russia, South Africa, and Turkey
- A patent application in the US, Canada, Mexico and Colombia was filed on October, 2013 and subsequently approved
- No news from Brazil and India

## Patent finances: expenses on patent

LASERLEAP





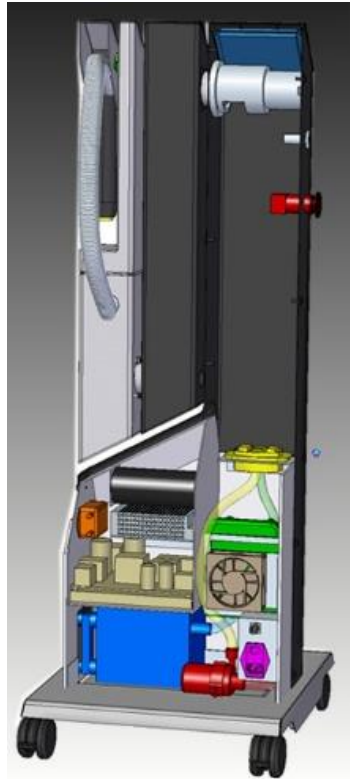
# Prototype to certified products



alfa



beta

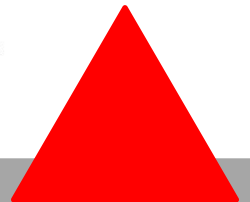


Product

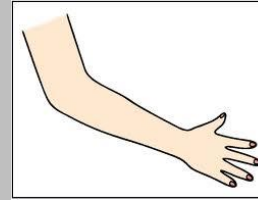


CE

DEVELOPMENT



# Painless and safe



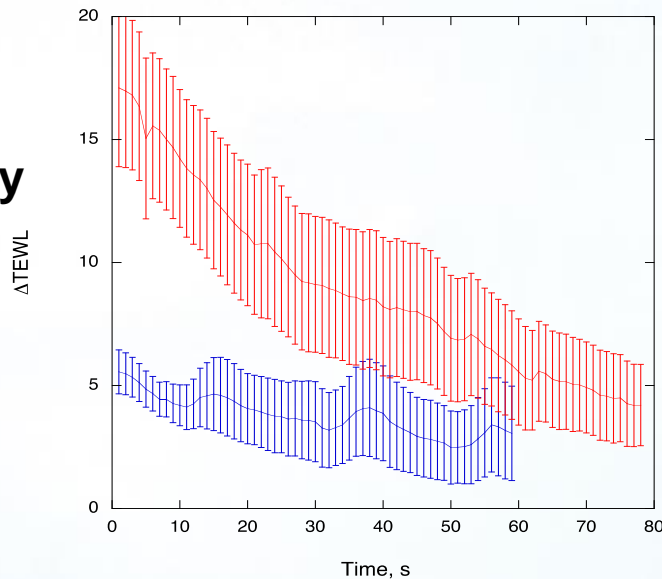
Blind experiment  
Exposition of 2 minutes  
(0) no pain to (10) worst pain



**Painless and safe  
for human use**

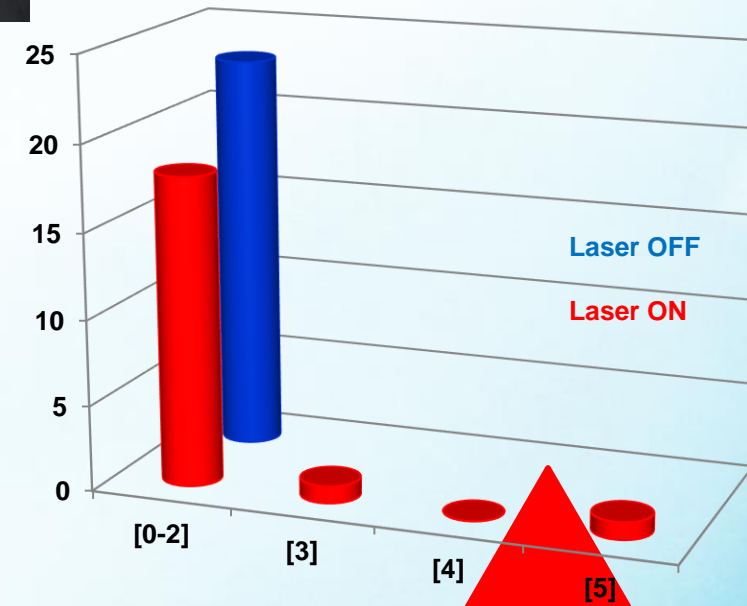
**Completely  
reversible  
process**

**Without  
footprint**



**TEWL**

Measuring the amount of water released from the inside to the outside of the skin



**DEVELOPMENT**



# LASERLEAP

Therapeutics

Analgesics

Vaccines &  
Biotech

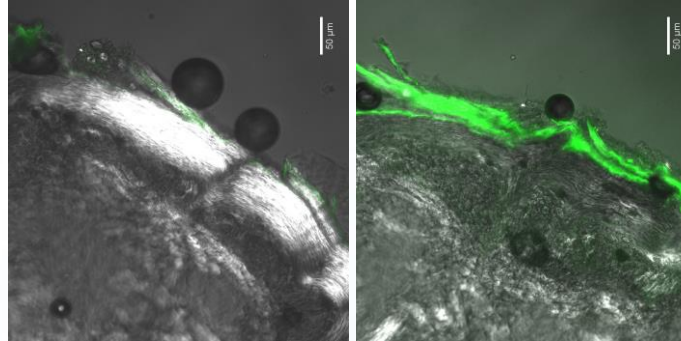
Cosmetics

DEVELOPMENT



# Effective: Trials in clinical environment

≥ 30 Million Hyaluronic Acid treatments per Year



*"Photoacoustic Waves as a Skin Permeation Enhancement Method"*

G.F.F. Sá, C. Serpa, L.G. Arnaut in *Percutaneous Penetration Enhancers: Physical Methods in Penetration Enhancement*. N. Dragicevic-Curic, H.I. Maibach (Editors), Berlin Heidelberg, Springer-Verlag, 2017, 175-191.

Trials with **hyaluronic acid** for anti-aging in 3 medical facilities.  
*(Face-split, randomized, placebo-controlled test)*

*"With LaserLeap treatment, my skin became firmer and my wrinkles diminished."*

Maria João

*"I feel the right side of my face renewed and more hydrated."*

Paula

*"The wrinkles in the right side of my face diminished and the scar as attenuated."*

Lúcia



# Effective: Trials in clinical environment

## Clinical Studies Skin Whitening



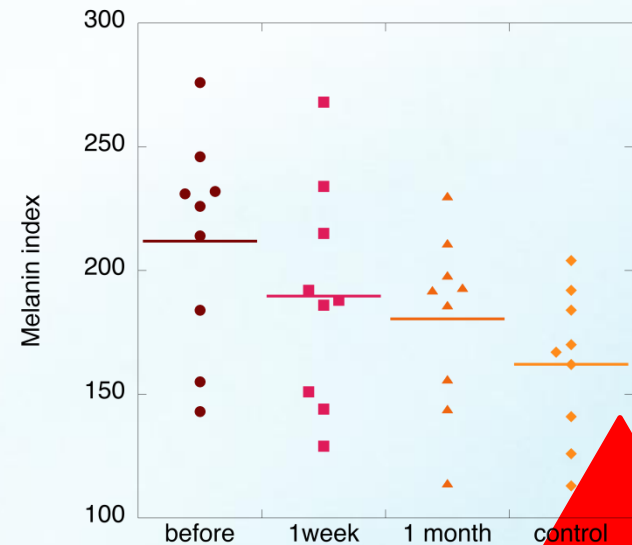
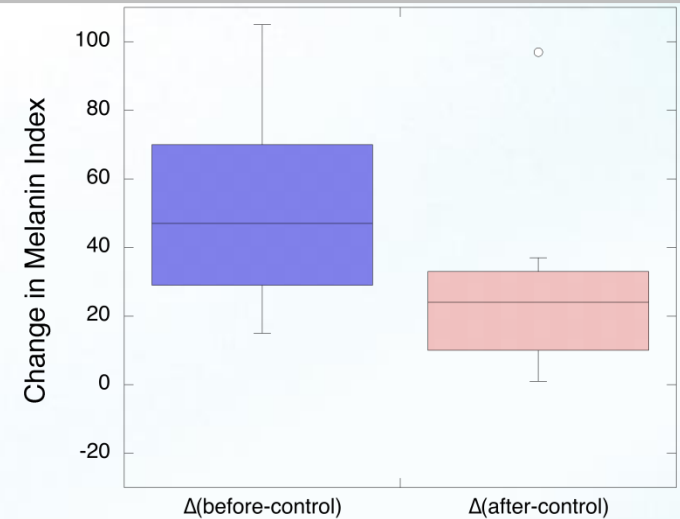
Before |



| After 30 days

After 1 session

Protocol – 10 min of exposition, 10 cm<sup>2</sup>, 10 mL formulation



DEVELOPMENT

Aconselhamento do  
Infarmed e autorização  
regulamentar



Angariação de  
investidores



Prova de conceito em  
modelos pré-clínicos



Segurança em  
voluntários



Fabricação de  
protótipos e  
otimização de  
produtos

Validação clínica

Ensaios com  
rosto dividido,  
randomizados e  
controlados por  
placebo



Patente da tecnologia

- EP2699304 (A2)
- WO2012144916 (A3)



Marcação CE

2009

2011

2013

2015

2016-17

Solução disruptiva

Lançamento  
no mercado

+ 15 anos de  
investigação  
fundamental e  
aplicada  
alicerçada em  
teses de PhD



Hovione  
Capital for Health.



Investimento  
privado:  
1 100 000 €





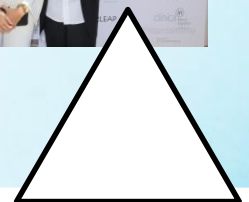
# LASERLEAP

PIEZOPORATION® TECHNOLOGY

Lab bench, *circa* 2010



SimSmile Clinic  
*circa* 2017



**MARKET**