

# The cochlear dysfunction of Hyperacusis

A way to improve the cochlear homeostasis  
by LLLT (Low Level Laser Therapy).

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Spain

**OTOCLINICA**  
Centro Médico de Terapias Auditivas

 **AENORTA**  
Asociación Española de Normalización de Terapias Auditivas

ICH2 London 2015  
2<sup>nd</sup>. International Conference of Hyperacusis

A review of literature reflects the difficulty encountered to treat clinically the subjective complaint of hyperacusis.

Then the question is...

**Do different types of hyperacusis exist?**

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# Hyperacusis treatments. Update

- ❑ Proposed treatments are based on acoustic stimulation by a progressive introduction of sound (tinnitus retraining therapy TRT & CBT).
- ❑ Noise generators and hearing aids can be fitted also in severe cases for masking.
- ❑ The role of some drugs involved in the metabolism of the serotonin open new approaches for the management of hyperacusis.
- ❑ Recently, researches & laser therapists have published that low level laser irradiation produces a large improvement of tolerance to loud sounds in all hyperacusis patients after a few sessions of treatment.
- ❑ With all these therapies involved around hyperacusis another questions are:

# Hyperacusis questions

- Hyperacusis is “unusual tolerance to ordinary environmental sounds”. **If there are different aetiological disorders do they need different therapies?**
- Hyperacusis is a symptom in many inner ear disorders. **Is hyperacusis a symptom of a peripheral disorder?**
- Is Hyperacusis a pre-state of other cochlear dysfunctions?** (ie: Menière, Tinnitus, SNSHL,).
- or sometimes **Is hyperacusis a neuropathology of some central dysfunction?**
- Finally, People /patients ask: **Is there a cure for hyperacusis?** and how can we reply and give to them an efficiency treatment?

# INTRODUCTION. (a)

## Level of Hyperacusis or LDL (Loudness Discomfort Levels )

The degrees of hiperacusia according to the classification of:

*Barbara Goldstein and Shulman, 1996; Gothelf et al., 2006*, are in the following table:

classification of Hyperacusis for all frecuencies		
Hyperacusis degree	Dynamic Range	LDL (Loudness Discomfort Level)
No /Negative	60dB or greater	> 95dB
Mild	50-55 dB to all freq.	80-90 db at 2 or more freq.
Moderate	40-45 dB """"	65-75 dB at 2 or more freq.
Severe	35 dB or less	< 60 dB en 2 or more freq.



## INTRODUCTION (b)

Hyperacusis is present in most of the peripheral vestibular disorders and among them:



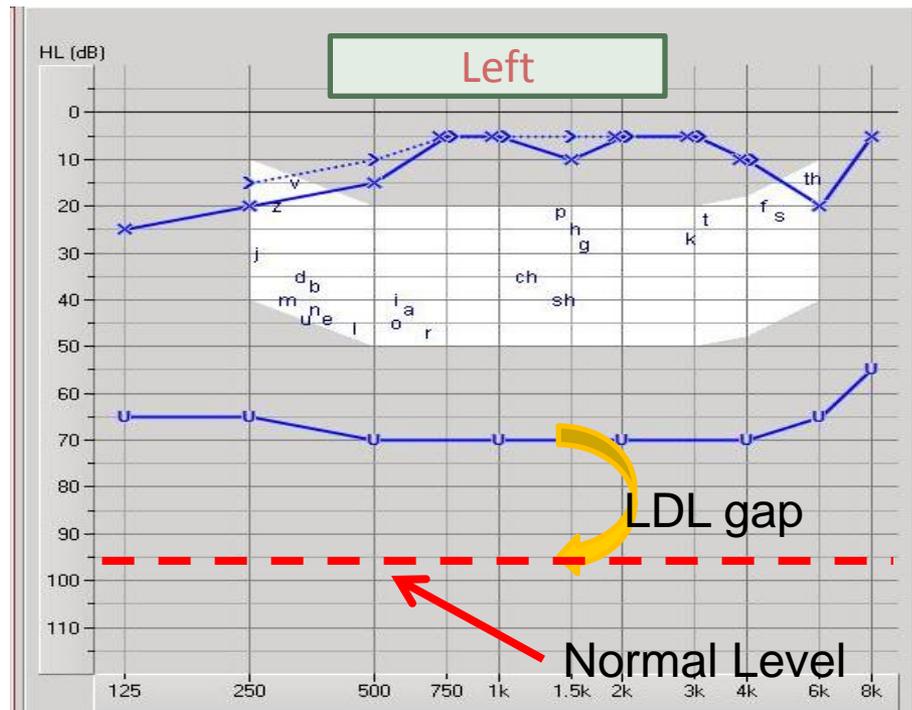
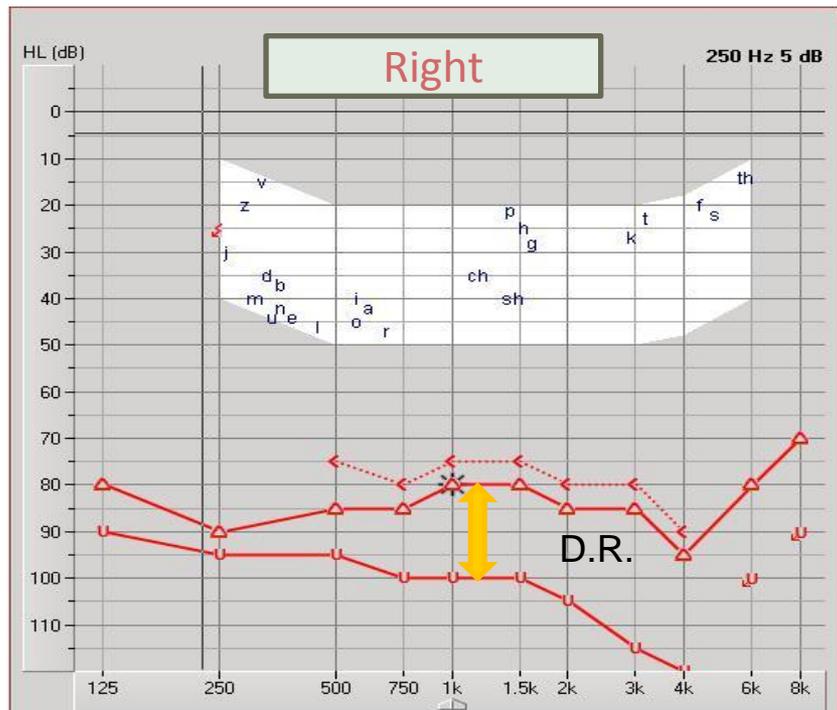
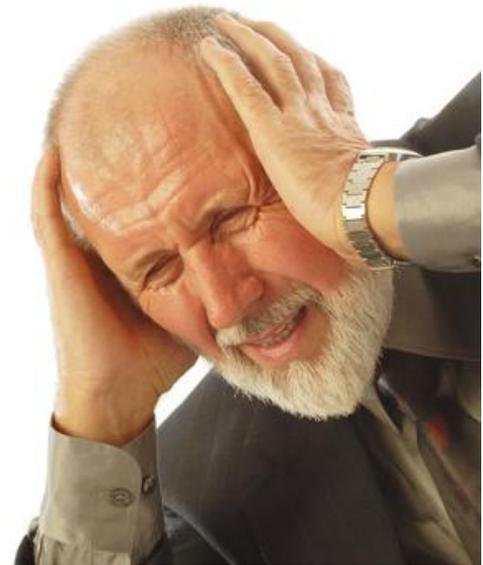
- **Menière's disease**
- **Endolymphatic Hydrops**
- **Labirynthitis**
- **Others** (migraine w/vertigo,..)

# INTRODUCTION. (c)

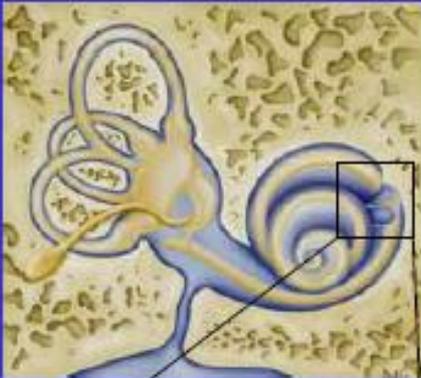
Hyperacusis of cochlear dysfunction is verified by audiometric test

Patient with vestibular disorder and hyperacusis

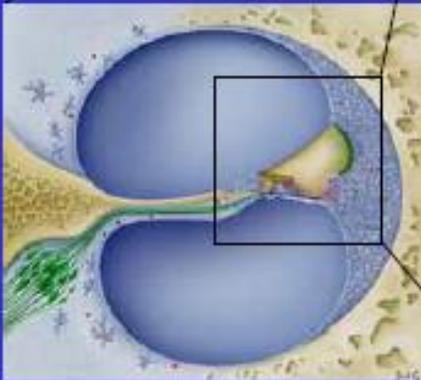
**Auditory test before therapy**



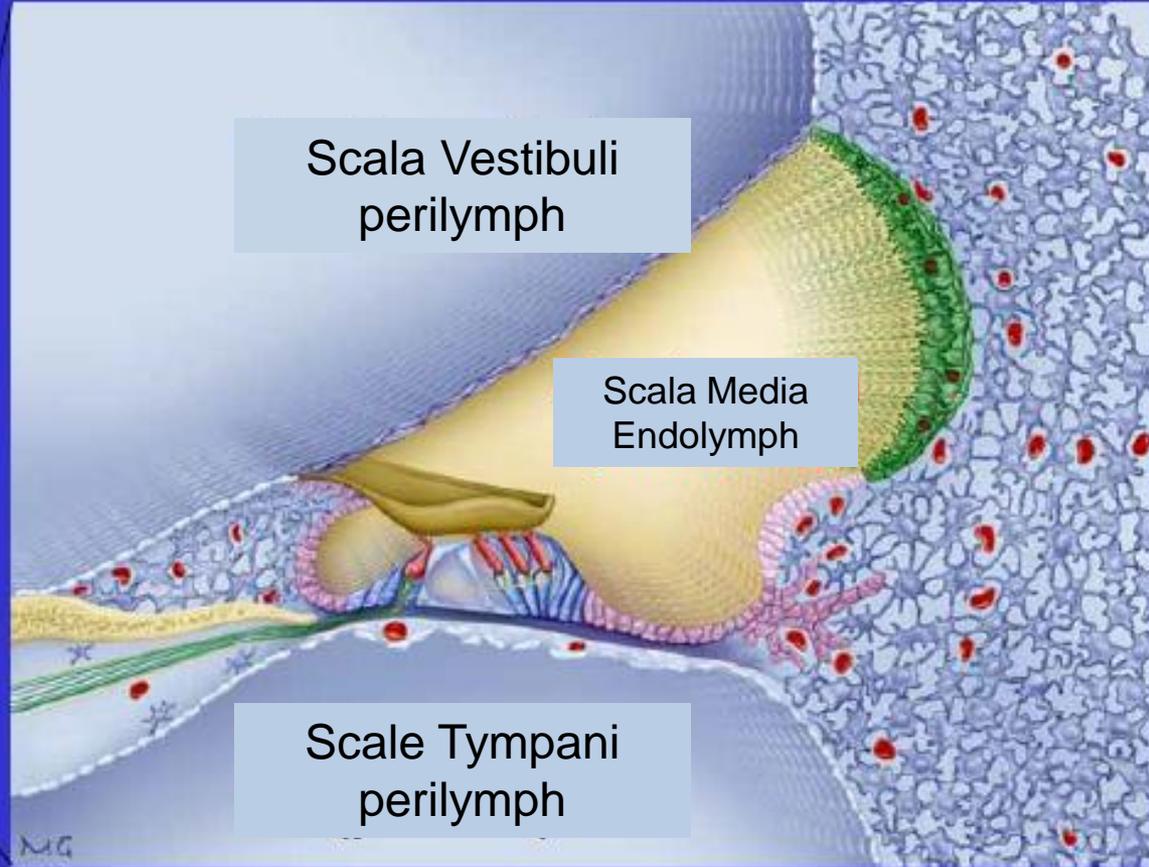
# Cochlear conduct lay-out



Inner Ear



Cochlear duct



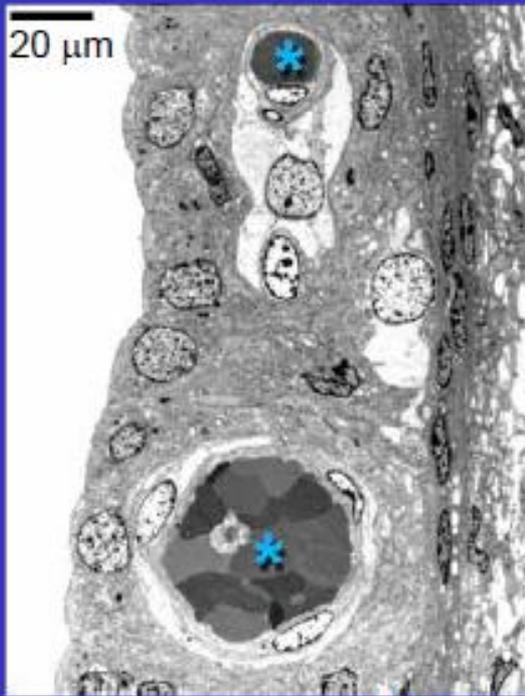
Scala Vestibuli  
perilymph

Scala Media  
Endolymph

Scale Tympani  
perilymph

Transversal section of cochlear duct and  
Basal Membrane

# Molecular model of Stria Vasularis

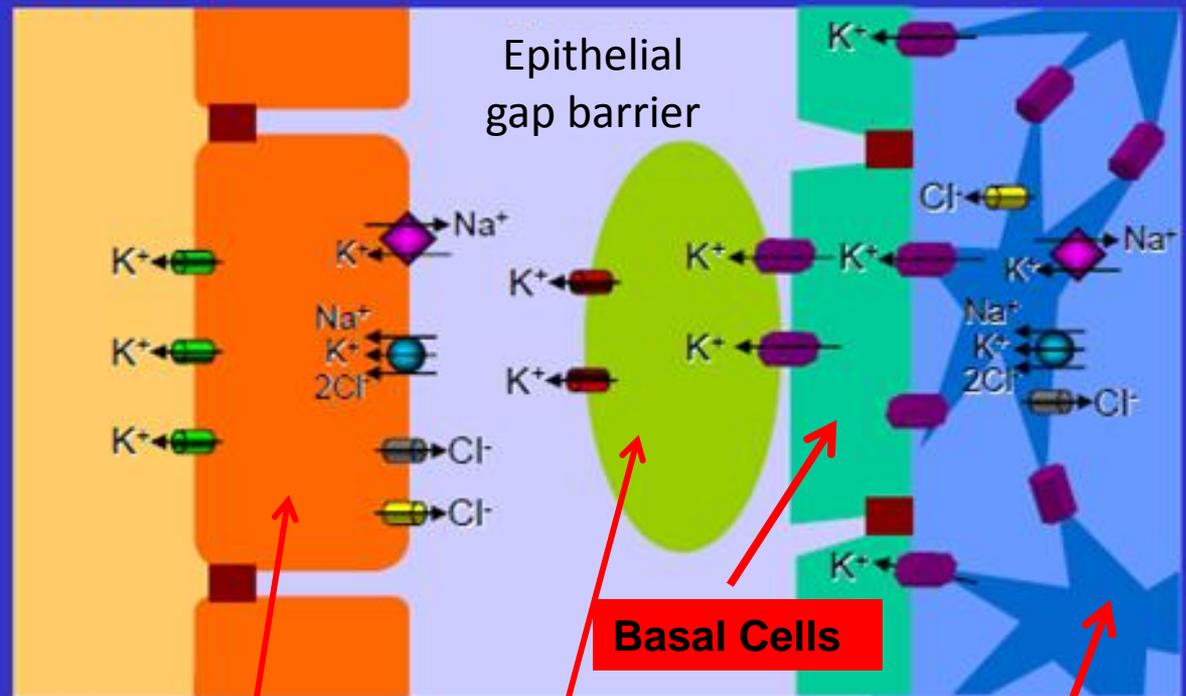


M. Lavigne

Cross Section of Stria Vasularis

Endolymph

Perilymph



Marginal Cells

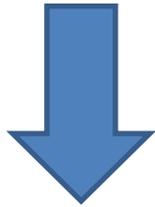
Melanocytes

Fibrocytes

Neuroepithelial Cells

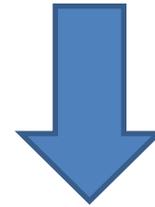
# Methods of light therapy based on photoacceptors in cells

## LOW POWER (LASER) LIGHT IN MEDICINE



*Exogenous (artificially introduced) photoacceptors*

- PHOTODYNAMIC THERAPY (PDT)
- PHOTOCHEMOTHERAPY (PUVA)



*Endogenous (natural) photoacceptors*

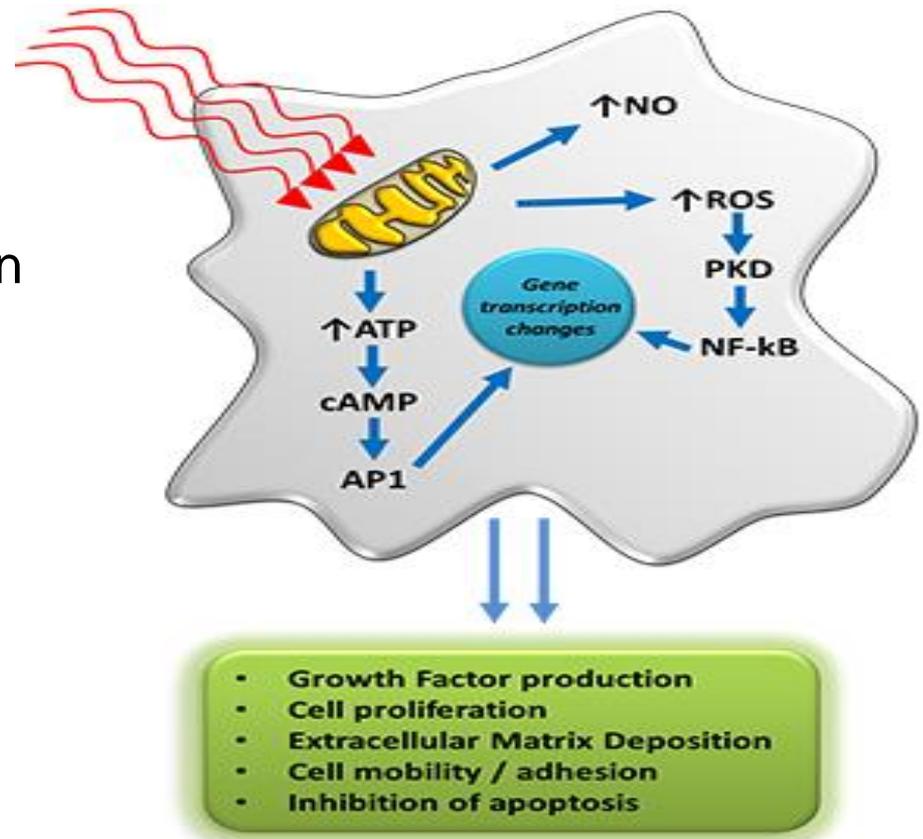
- PHOTOTHERAPY with UV
- LOW POWER LASER THERAPY  
**(Laser Biostimulation)**

# There are many results and photobiology research about mechanism into a cell when this is irradiated by a laser light.

The FDA has cleared the use of Infrared Light for:

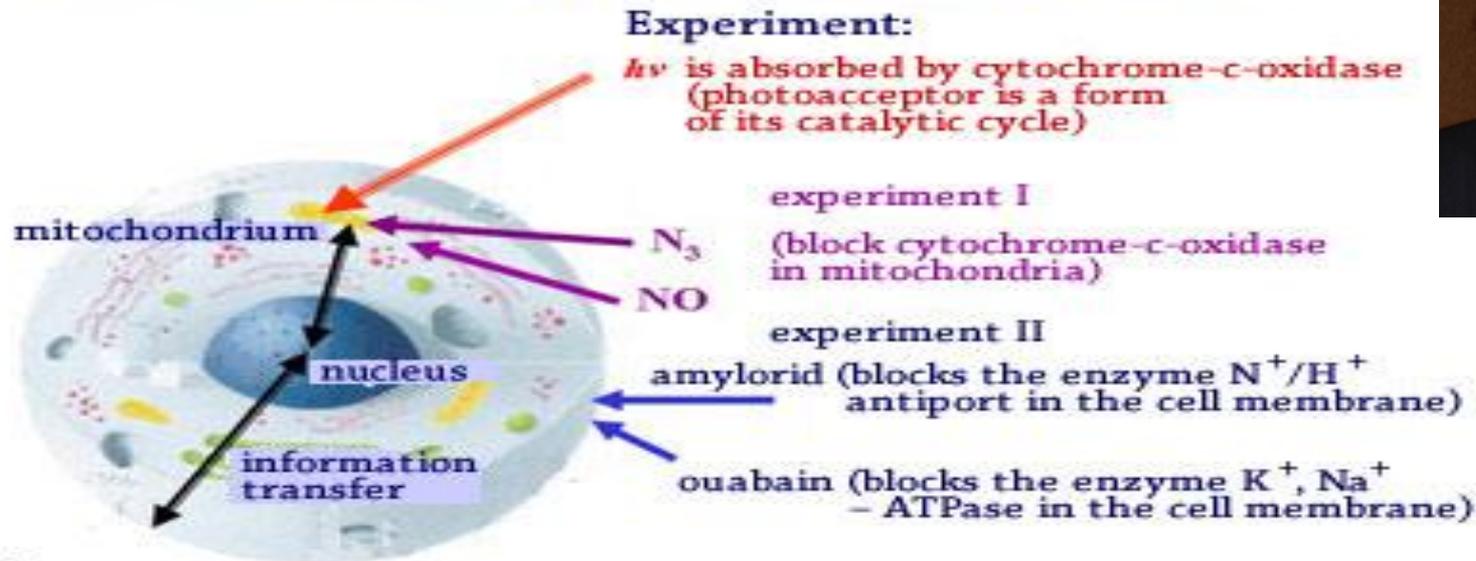
- Increase blood in local circulation (of inner ear)
- Pain and stiffness
- Relaxation of muscle spasms (tensor tympani)

**.. but there are other many photobiology effects in the cell.**



A new system of signal transmission between the respiratory chain and the membrane inside a living cell has been revealed and partially studied.

### Flowsheet of the experiment and its result



### Result:

Irradiation enhances the adhesive properties of the cell membrane depending on the light wave length ( $h\nu$  spectra). This spectrum is specifically modified by chemicals. Concentrations of the chemicals in use cause no changes in the adhesive properties of the membrane in the absence of irradiation.

For more than 40 years,  
LPT has been growing into World Laser Clusters

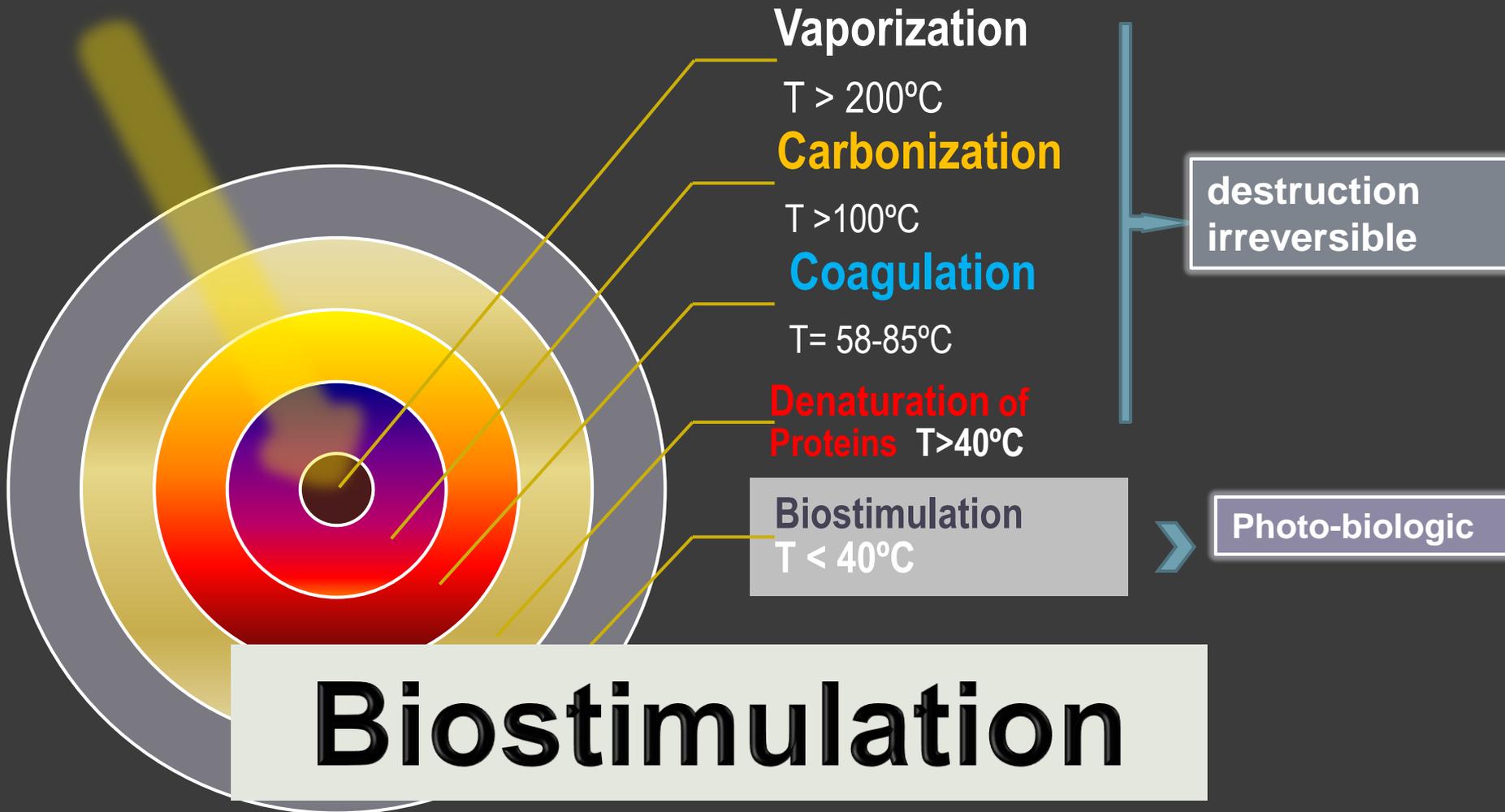


**Russia, Ukrania, Hungary, Croatia, Poland, Finland,  
Norway, R. Czech, Germany, UK, Italy and Asian  
countries (Korea, Japan), and USA, and Brasil...**

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# Laser Classification vs. thermal spot

and reaction/effects into the tissues



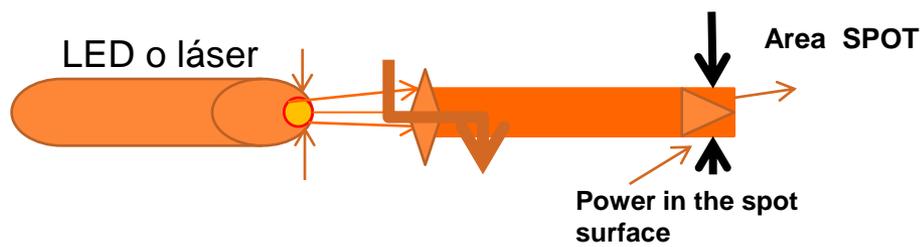
# Light Laser Energy:

Major and basic parameters of coherence Light

$$\text{Intensity} = I = \frac{P}{S} \quad [\text{Watt} / \text{cm}^2] = \text{Power density}$$

$$\text{Dose} = I \times t = (\text{watt} / \text{cm}^2) \times (\text{seg.}) = \text{Julios} / \text{cm}^2 = \text{Fluence}$$

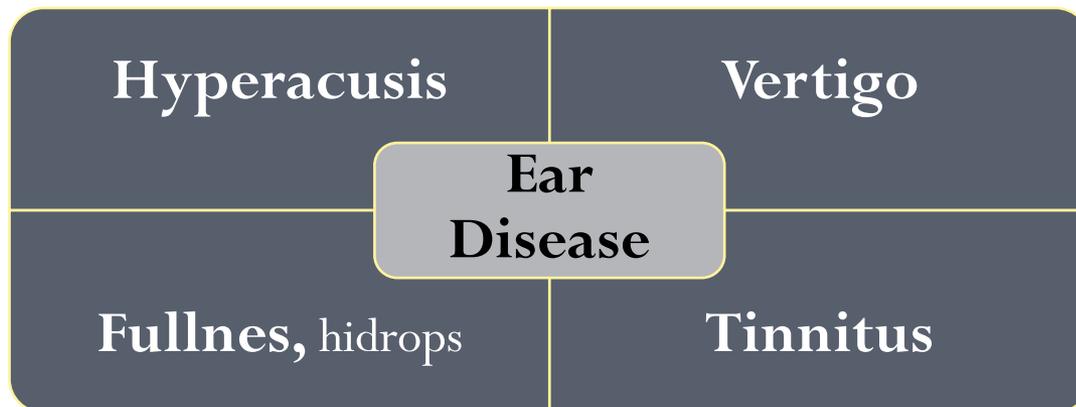
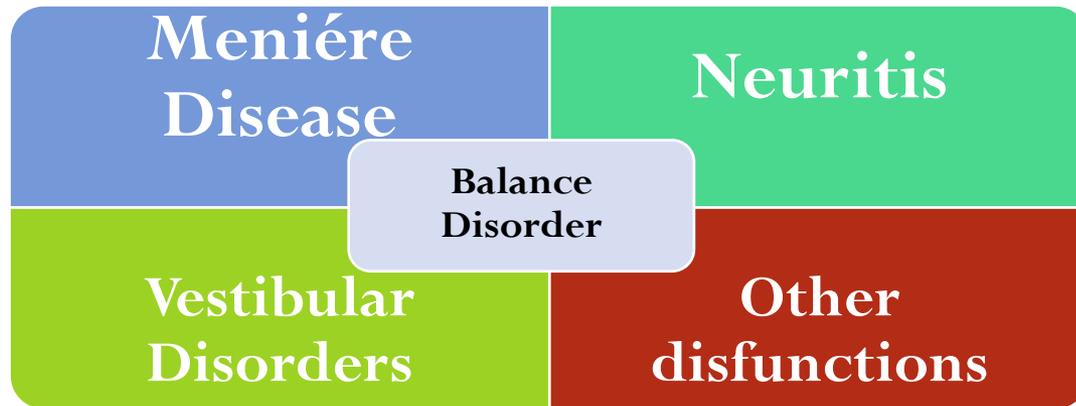
Treatments = function of ( Dose, No of sessions,  $\tau$  cycle)



Laser

$\Phi = 10 \text{ mm}$   
 $S = 0,785 \text{ cm}^2$   
 $P = 2 \text{ w.}$   
 $I = 2,54 \text{ w/cm}^2$   
**Biostimulation**

The laser is like a medicine or drug, and it requires the dose adapted for each disorder and/or patient.



**Main Active :**

**Laser wave length**

**Dose**

**Energy /Power density**

**Dosage:**

**Time- lapse sessions**

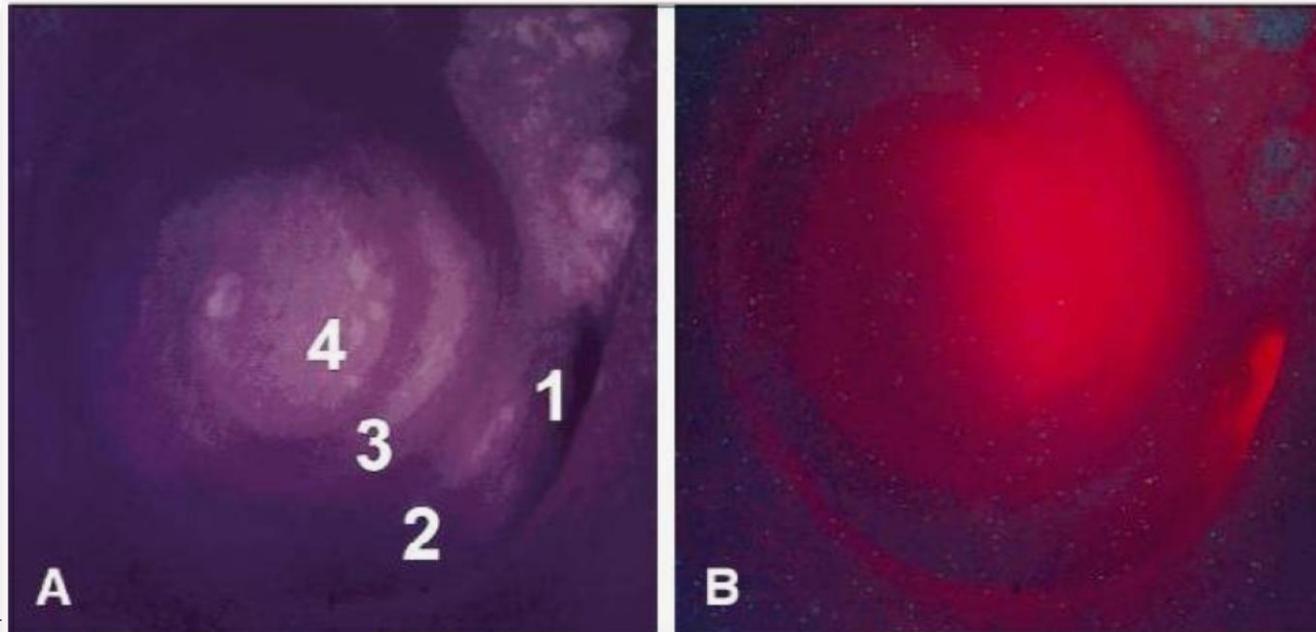
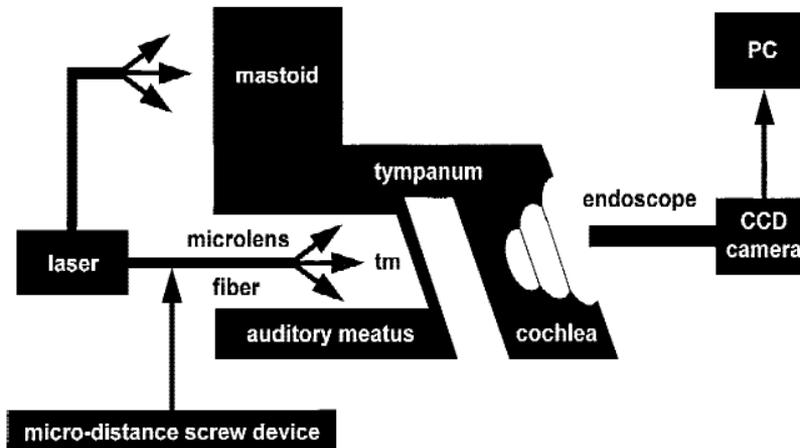


# Laser Photo-Therapy for inner ear disorders



Tauber S., et al, 2001.

# Lightdosimetric Quantitative Analysis of the Human Petrous Bone: Experimental Study for Laser Irradiation of the Cochlea. *Department of Otolaryngology, Head and Neck Surgery, and Laser Laboratory, University of Munich*



## Legend

1 – Oval Window  
2 - 3 y 4 ,  
helicotrem,  
espiras basal,  
media y superior

B. Inside Endoscope  
of cochlea with  
laser of 635 nm,  
at 1.5 cm from  
ear drum with  
ligh power of 1.7  
mw/cm<sup>2</sup>

# Thanks to many Researchers and Laser Scientifics..

Dr. Levon Gasparyan & Dr. Anu Mäkelä Dr. Jan Turner Dr. Lars Höde

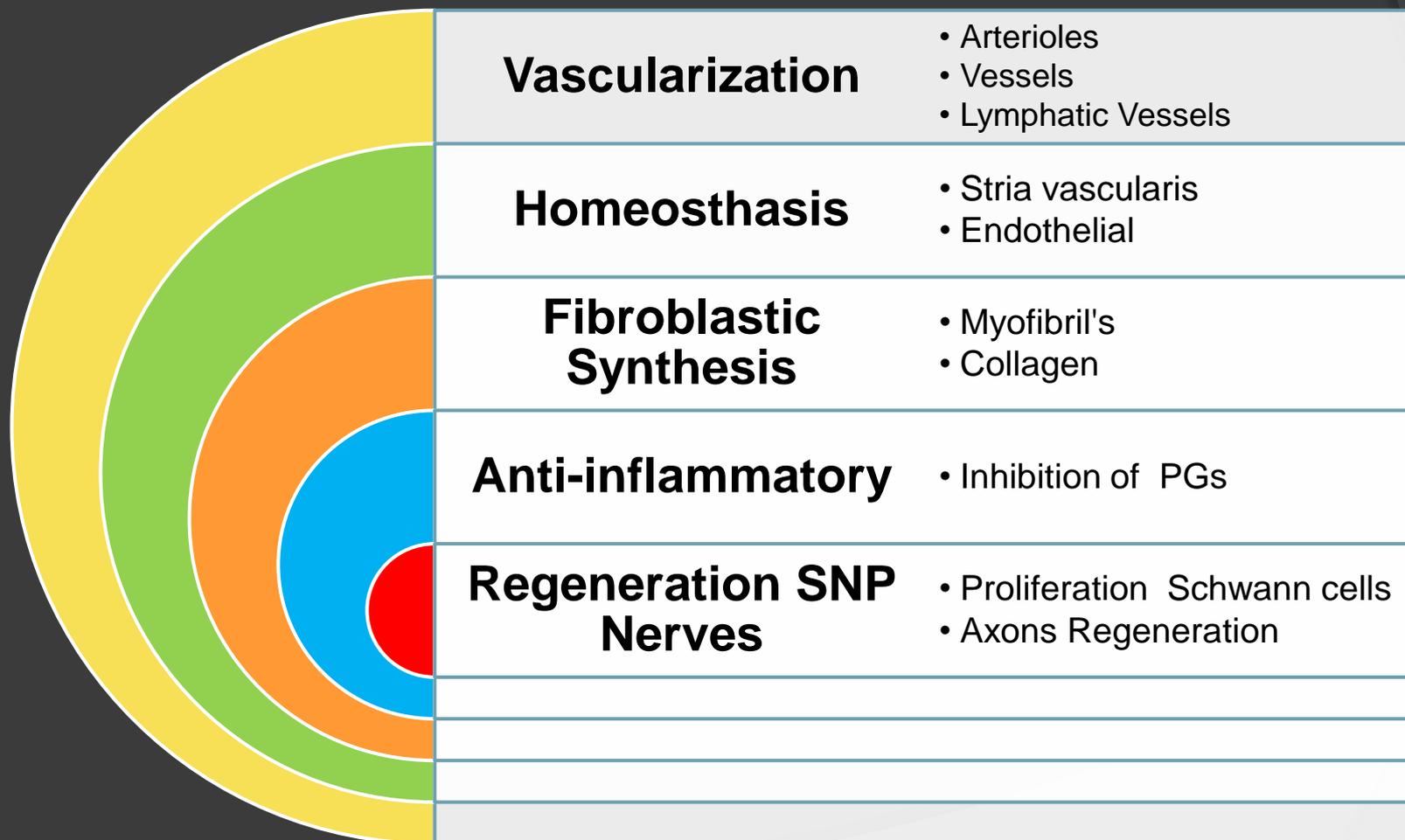
Prof. Hans Romberg, Prof. Gregory Brill, Dr. Mary Dyson, Prof & Dr. Tiina Karu

Dr. Zlatko Simunovic, Dr. Miroslav Procházka, Dr. Chukuka Enwemeka

Dr. Penny Smalley, Dr. Premysl Fryda, Dr. L. Wilden and ...

Sc. R.N. Michael Zazzio, and other...







**Laser: ...**

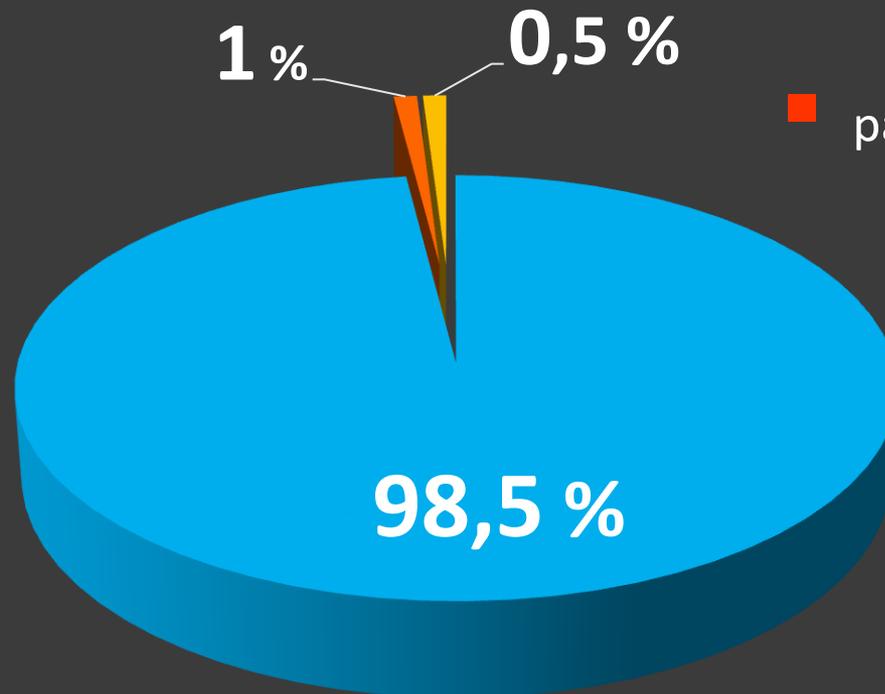
**Therapy or medicine**

# Hyperacusis disorder

■ Total improvement

■ No improvement

■ partial improvement



# Hyperacusis disorder

## Our research and results

See our published document at:

**[www.otoclinica.org](http://www.otoclinica.org)**

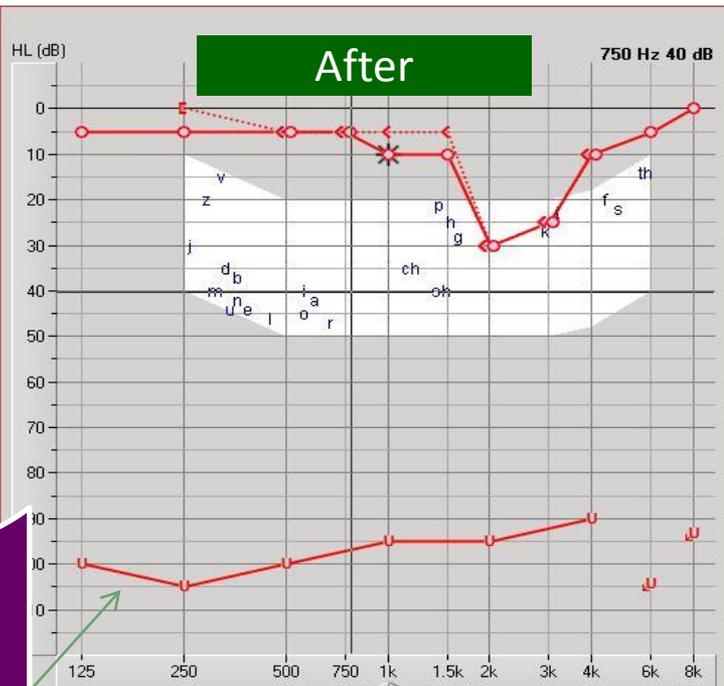
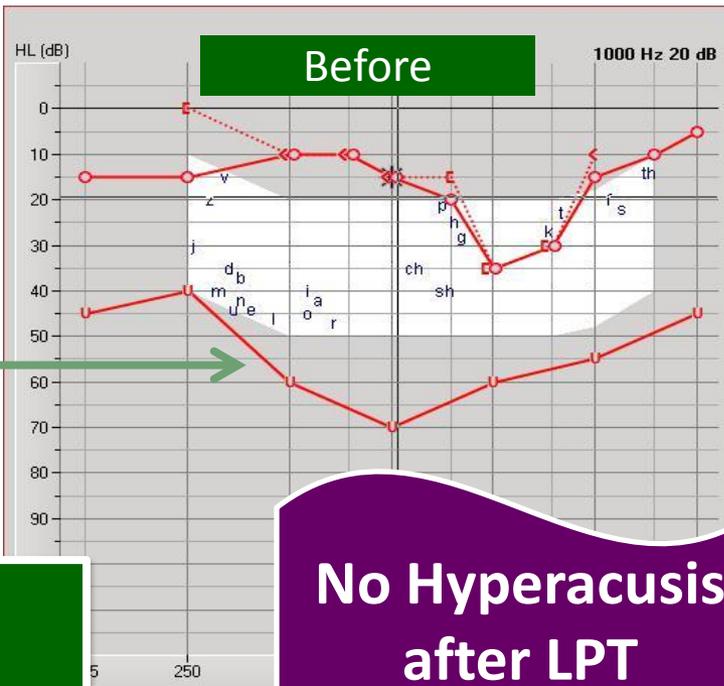
The Analysis of Audiometric Measurements before and after  
Low-Level Laser Therapy of Spanish Patients with  
Hyperacusis.

By

J. Prósper and Jan Graffelman

<http://www.otoclinica.org/#!/home/mainPage> (click at references)

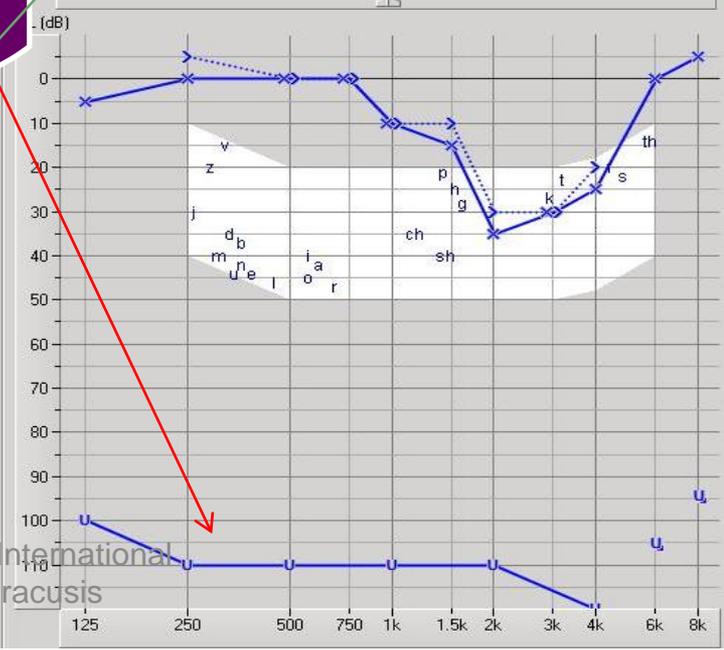
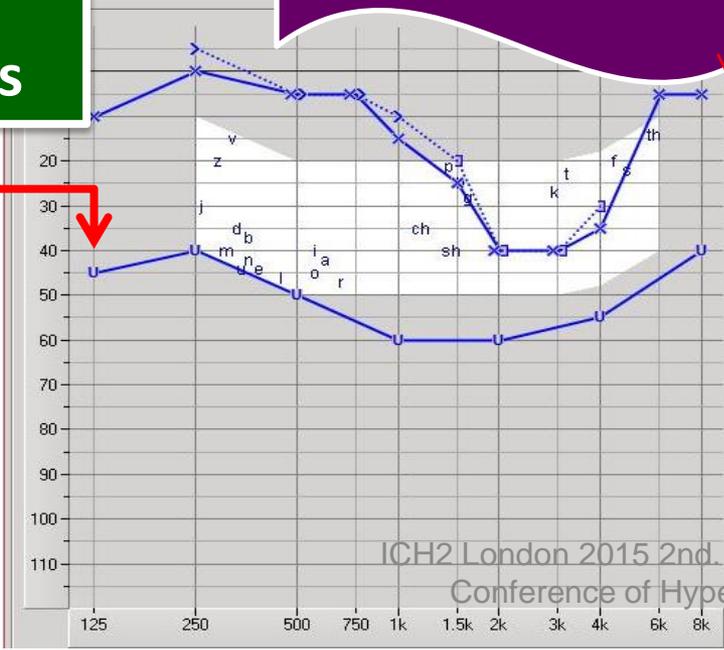
Righth Ear



Both ears, Severe hyperacusis

No Hyperacusis after LPT

Left Ear



# Our contribution and experience

Since long time ago we have been working with LPT for treatment of inner ear disorders.

**Laser Photo-Therapy** is a no risk treatment in our protocol.

- painless
- without adverse effects or interaction with other drugs
- No risk for patients
- and the most important guarantee “the comfortable success”



# Conclusion

The approach to cochlear disorders using the technique of irradiation with LPT (Laser Photo-Therapy) in the treatment of **hyperacusis**, is a very effective alternative to the current TRT & CBT.

# Many Thanks for your attention

This has been our small contribution for  
2015 International Year of Light

Contact for more information:

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(Vestibular & Tinnitus Disorders)

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