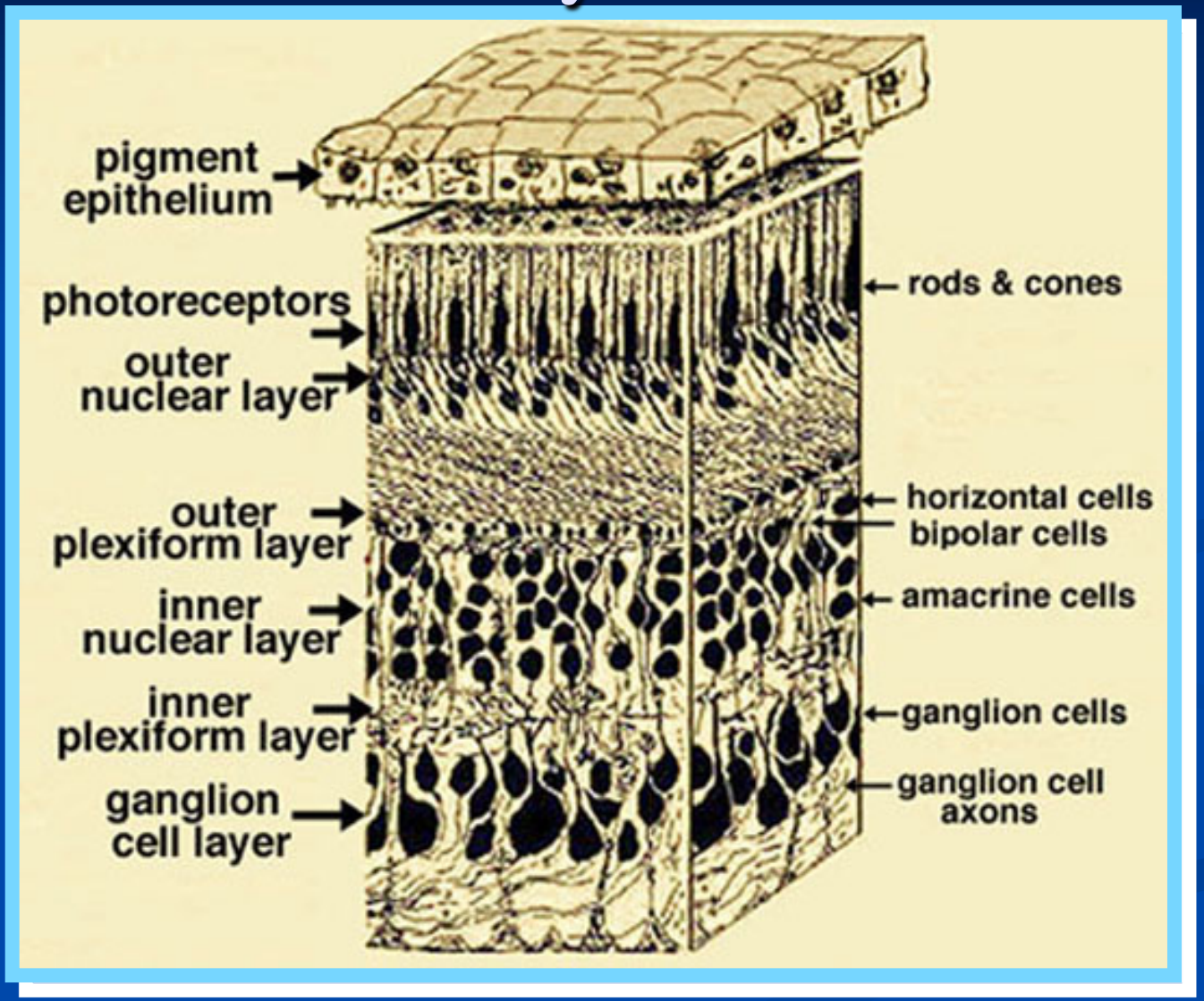
Artificial Vision

Introduzione

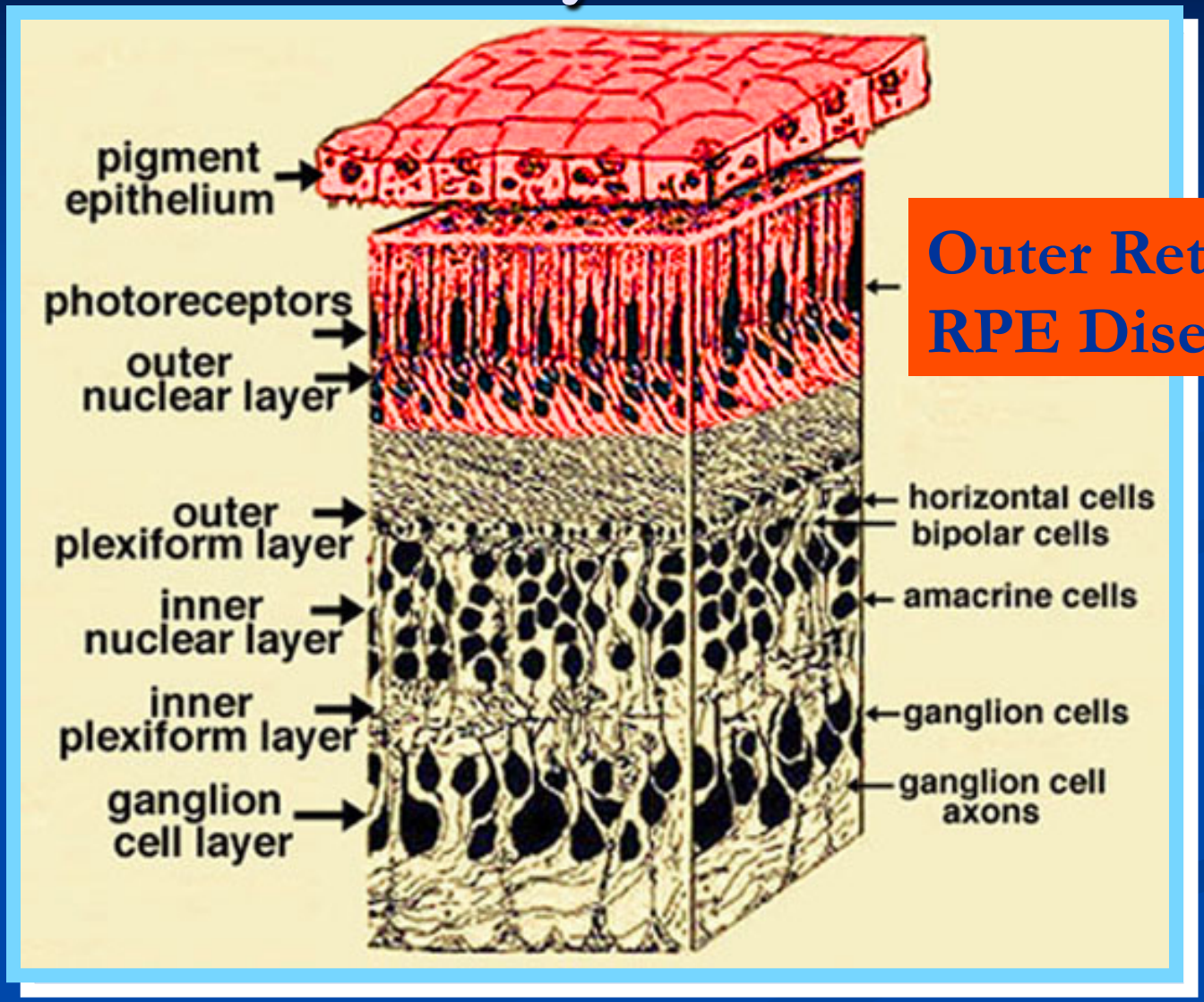
- La visione è una complessa forma di trasmissione dati che processa informazioni che dipendono da un importante neuro-processore: la retina umana.
- Le informazioni visive ottenute dalla retina (circa130 milioni di fotorecettori) sono compresse e trasformate in segnali elettrici veicolati da circa 1.2 milioni di cell ganglionari , neuroni specializzati i cui assoni formano il nervo ottico.

Chi ha bisogno di una retina artificiale?

Retinal diseases affect different layers



Retinal diseases affect different layers

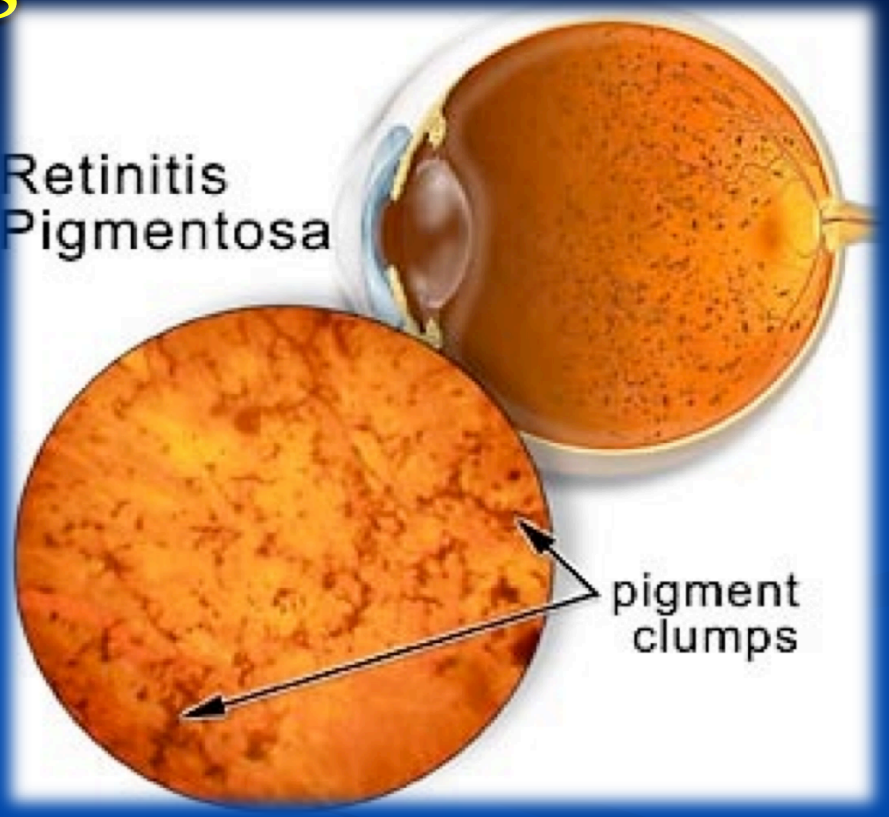


Retinite Pigmentosa

- Nella RP, la degenerazione periferica dei fotorecettori causa la riduzione del campo visivo,

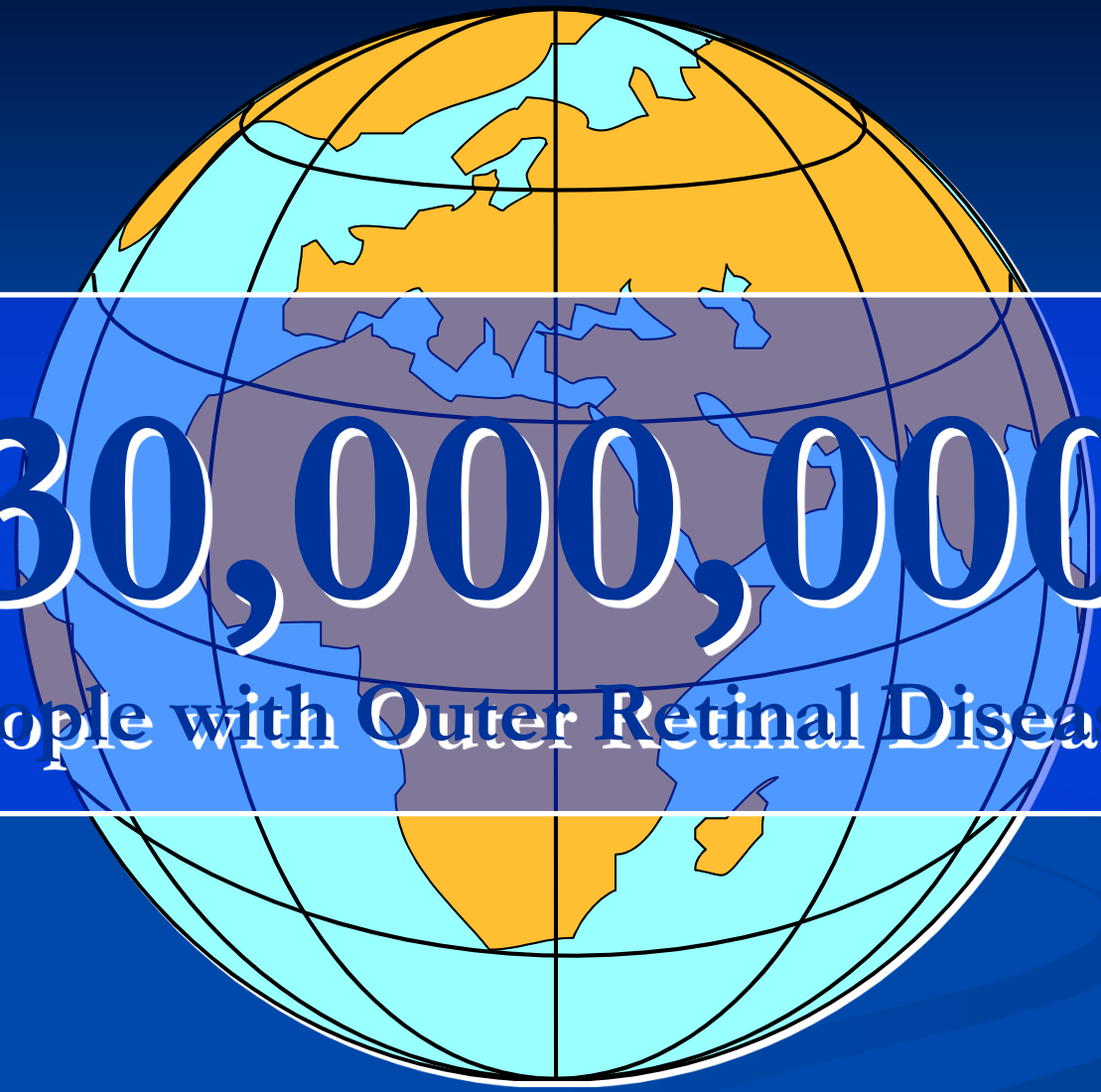
  mentre l'acuità visiva è inizialmente conservata

- Si sviluppa così l'aspetto classico del fondo con pigmento a spicole ossee



Successivamente anche i fotorecettori centrali degenerano, causando la perdita totale della visione

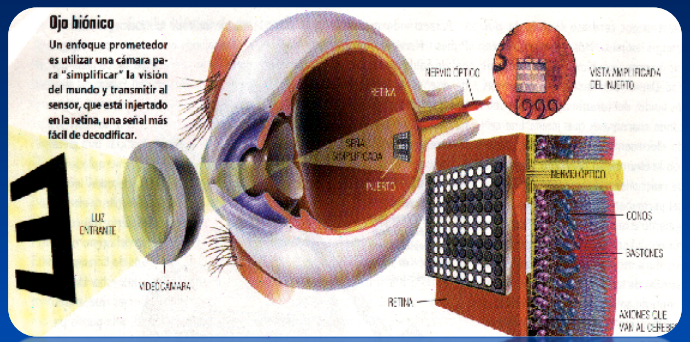
Developed Countries



30,000,000

People with Outer Retinal Diseases

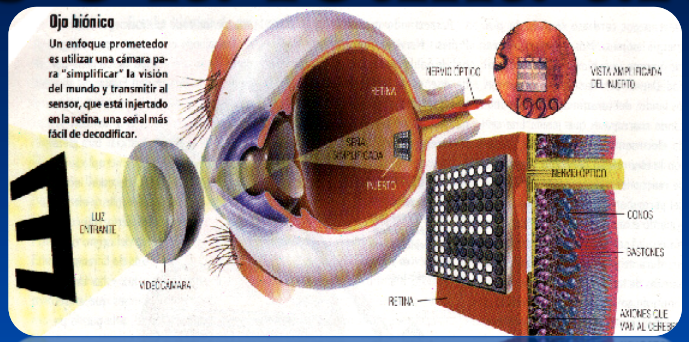
Che cos'è la retina artificiale?



Sistema che elabora il segnale luminoso trasformandolo in segnale elettrico che viene trasmesso alle cellule gangliari della retina e, di conseguenza, alle vie ottiche.

Vengono bypassati i fotorecettori

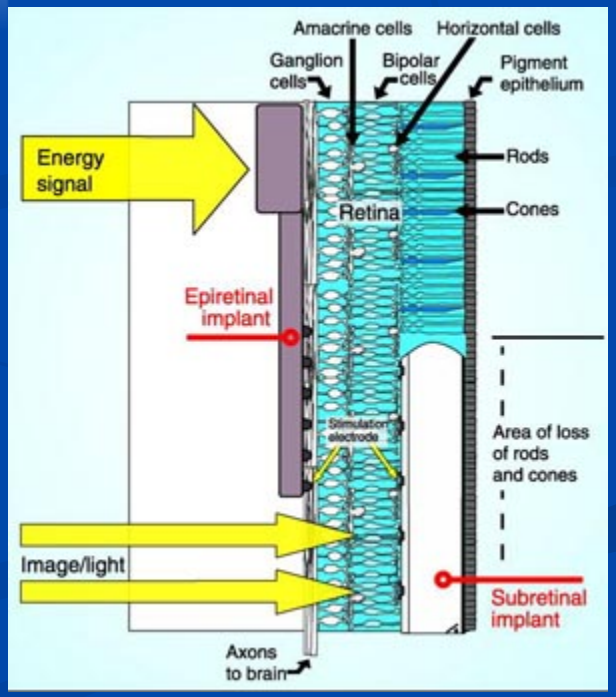
Che cos'è la retina artificiale?



Attualmente 2 diversi impianti:

-Epiretinico

-Sottoretinico

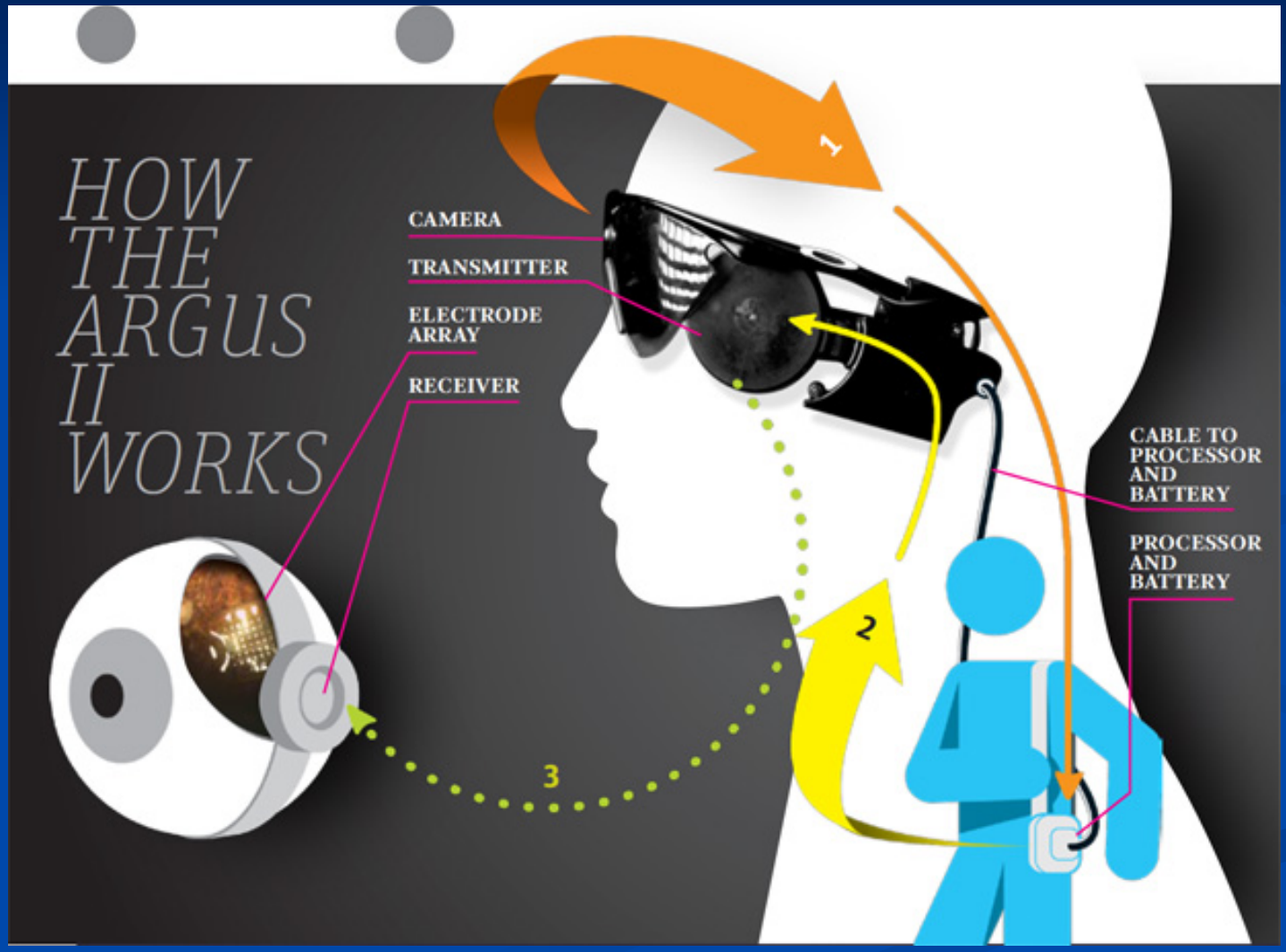


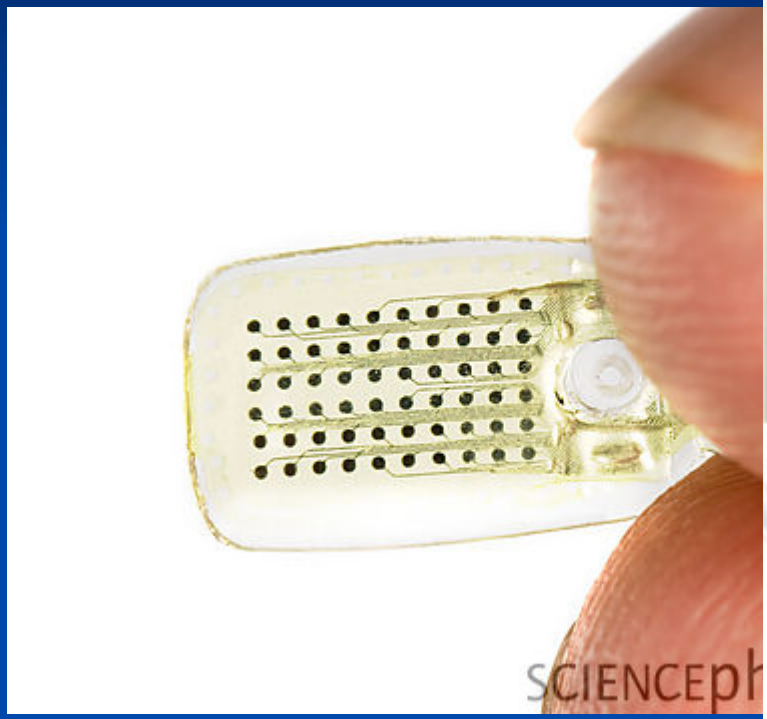
Doheny – USC & Second Sight

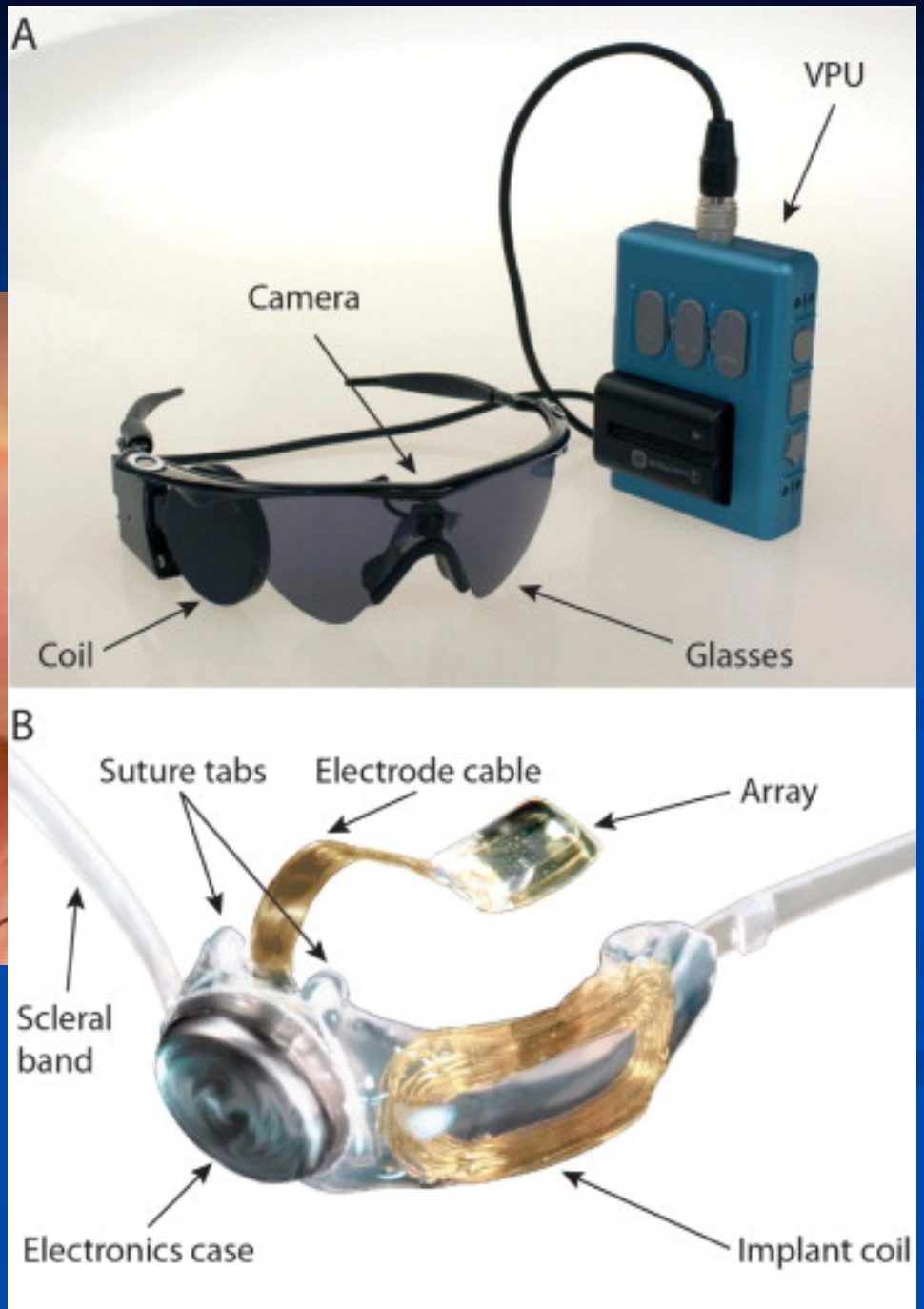
Los Angeles, CA

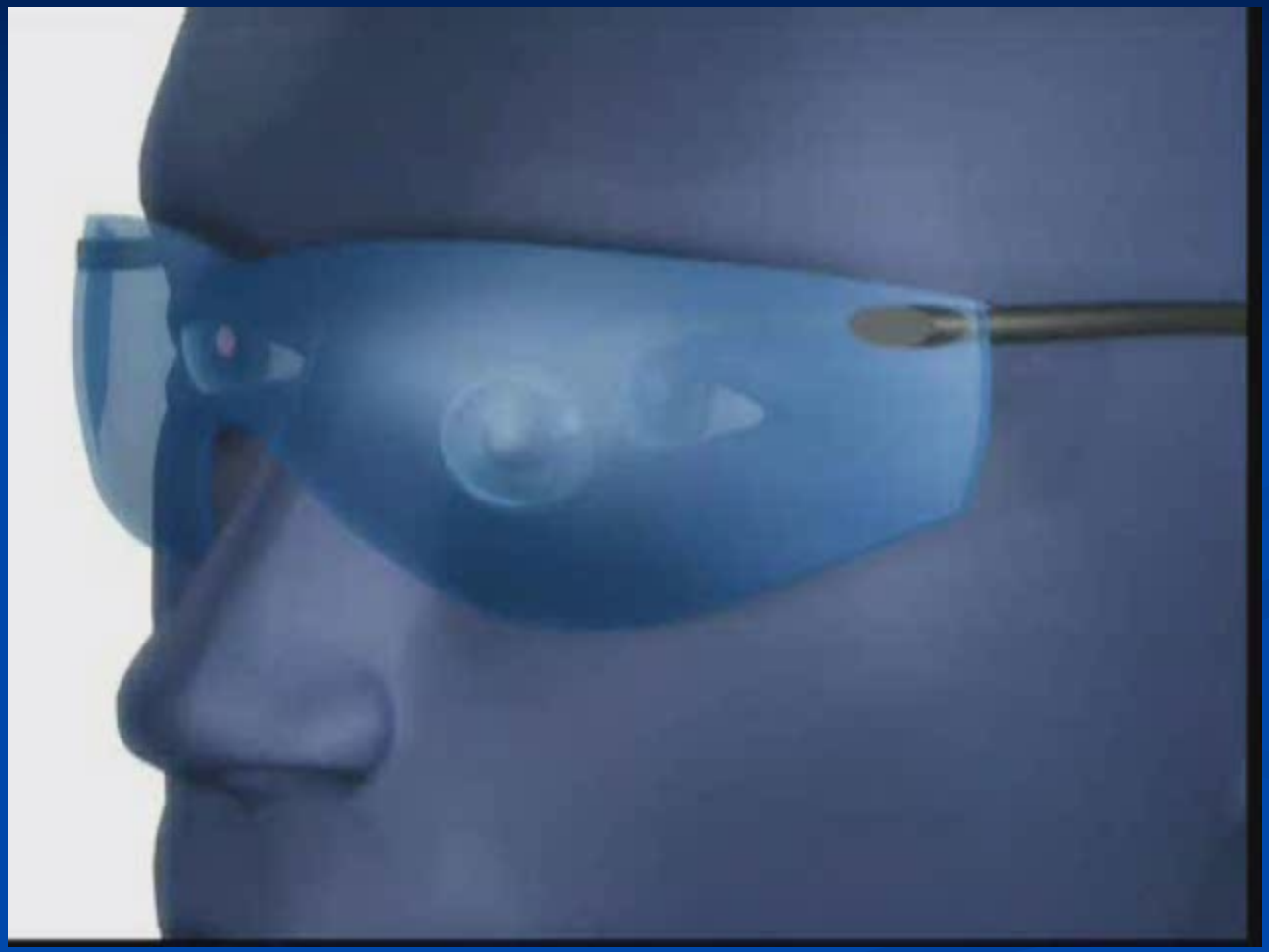
Mark Humayun, MD PhD

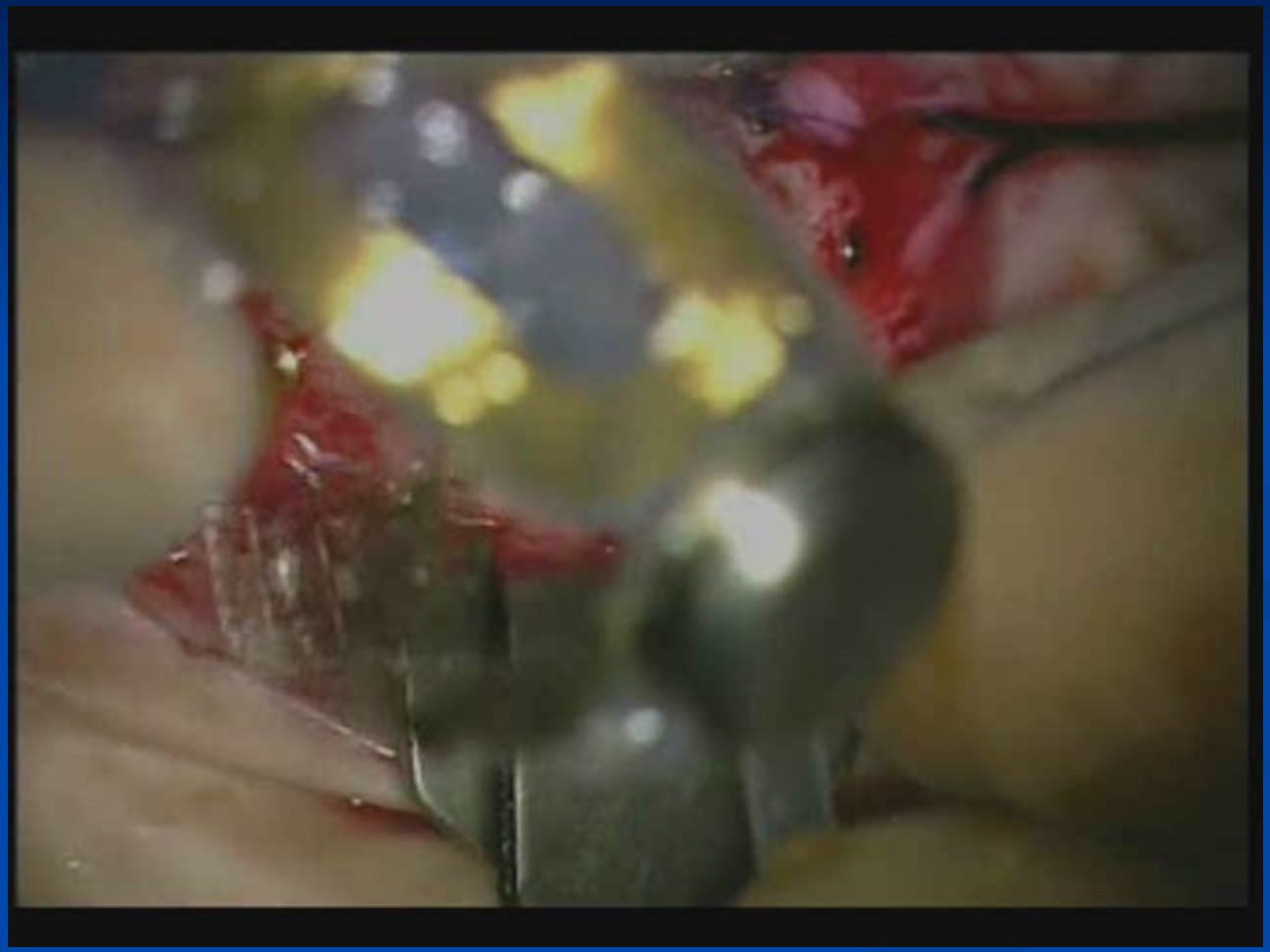
Meccanismo di Azione



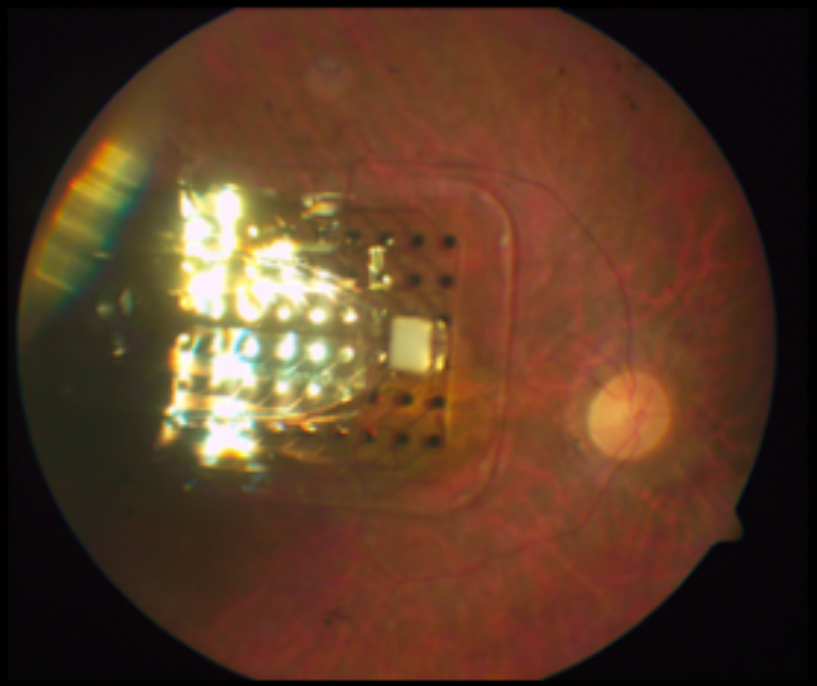



A
VPU
Camera
Coil
Glasses
B
Suture tabs
Electrode cable
Array
Scleral band
Electronics case
Implant coil





Argus 2



Dept of Energy 2009

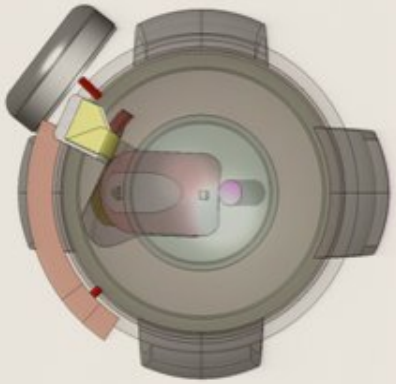
Two Devices, Two Trials

Argus I – feasibility study

- 16 electrodes
- 6 Subjects-single surgeon
- Practical Implant Proof of Concept – chronic stimulation over 6 years in patients.

Argus II – prospective trial

- 60 electrodes
- 32 subjects implanted to date
- Aimed at demonstrating safety and efficacy.



Argus I

Argus II

Performance with System

- All subjects see phosphenes
- All subjects use the system at home

- Object Localization
- Motion Discrimination
- Orientation and Mobility
- Visual Acuity Testing

Conclusions

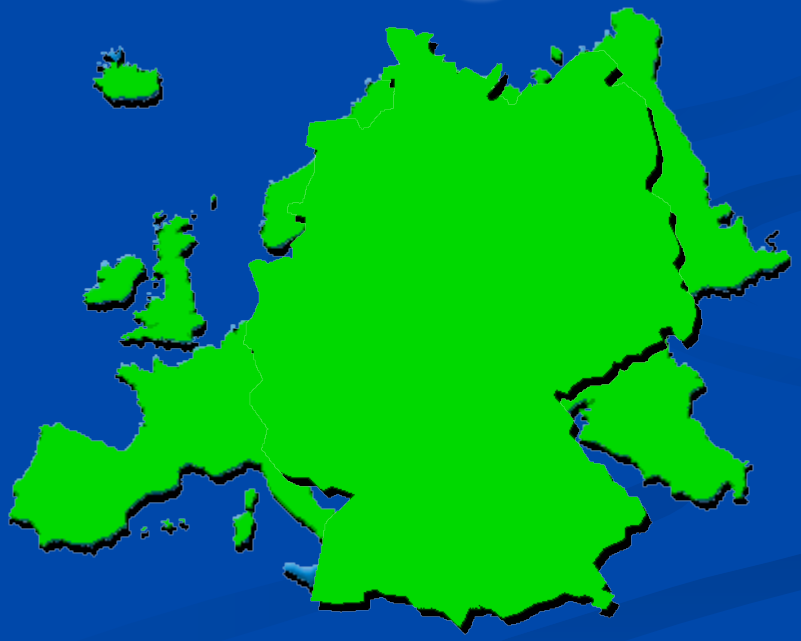
Argus II trial is the largest study of a retinal prosthesis to date and the only FDA-approved IDE study.

The results demonstrate that the Argus II system (like the Argus I) can reliably withstand long-term implant with a reasonable safety profile.

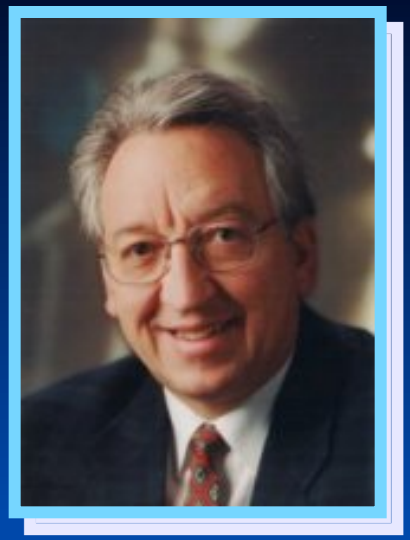
Using the system, all blind subjects are able to detect light and improve their performance on some visual tasks.

We look forward to presenting longer follow-up on even more Argus II subjects with the recent government expansion approvals in Europe and the US.

University of Tübingen



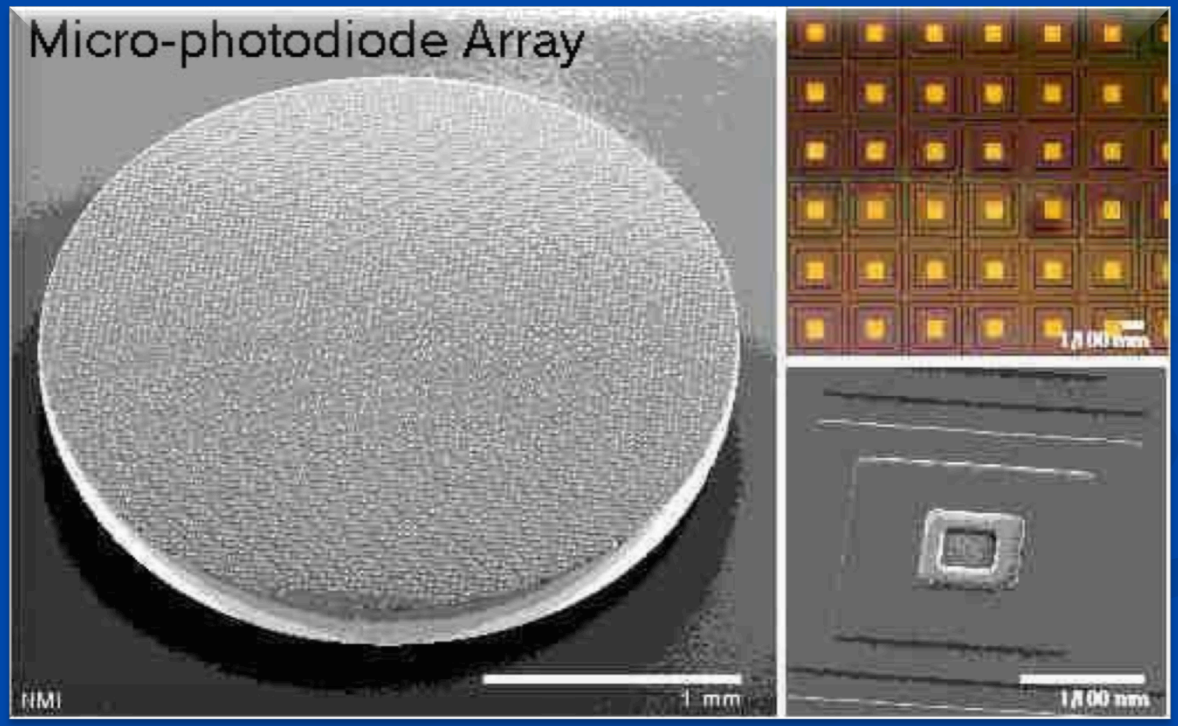
Tübingen, Germany



Subretinal Implant Project

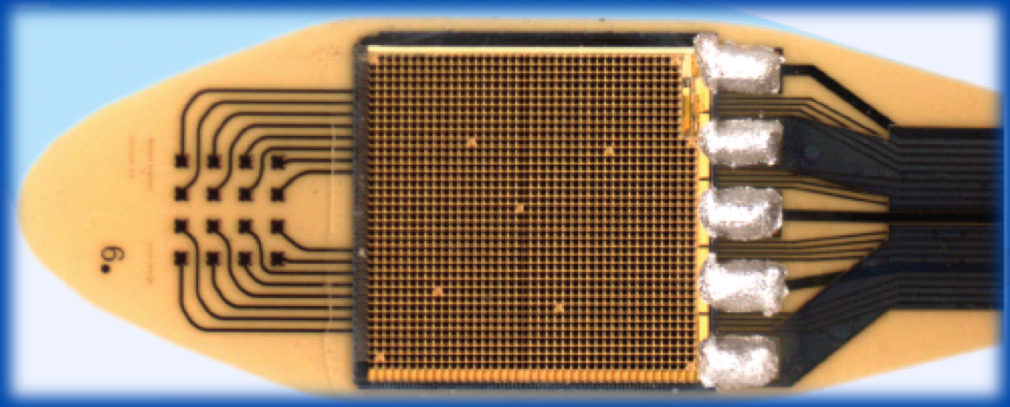
Prof. Dr. med. Eberhart Zrenner

University of Tübingen

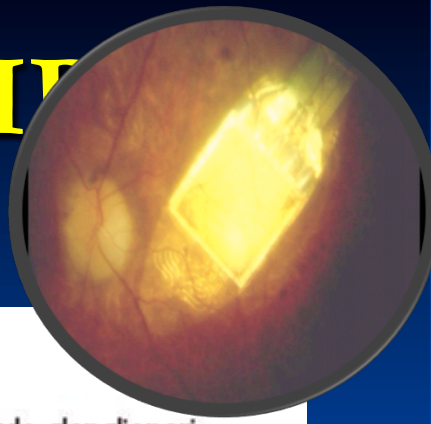


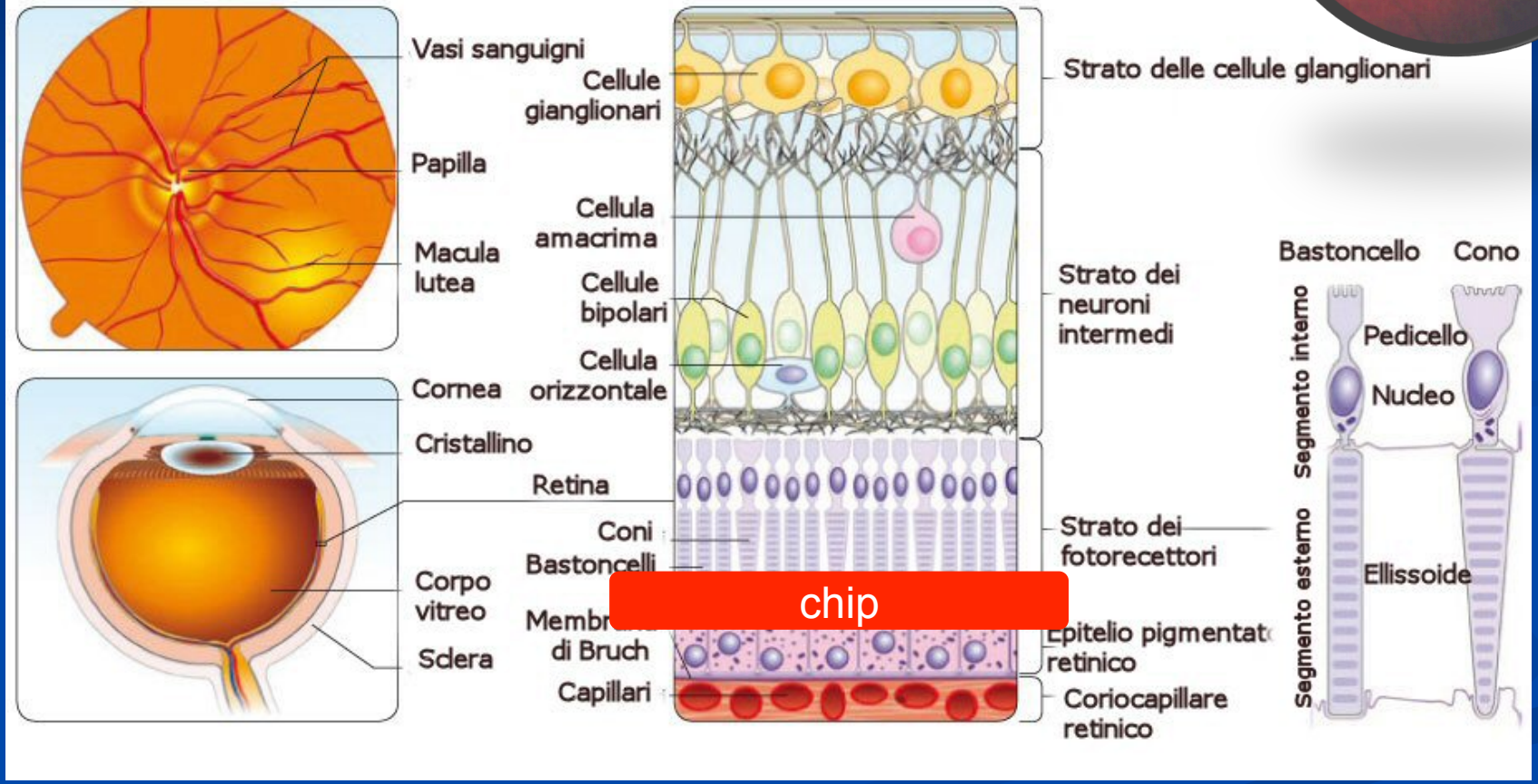
Come Funziona?

- Impianto ATTIVO con elementi sensibili alla luce capaci di sostituire in parte la funzione dei fotorecettori danneggiati lavorando a livello del corrispondente strato retinico.
- Ogni fotocellula sulla superficie del chip trasforma l'energia luminosa in energia elettrica in modo da stimolare la retina sulla base della intensità di stimolazione luminosa locale



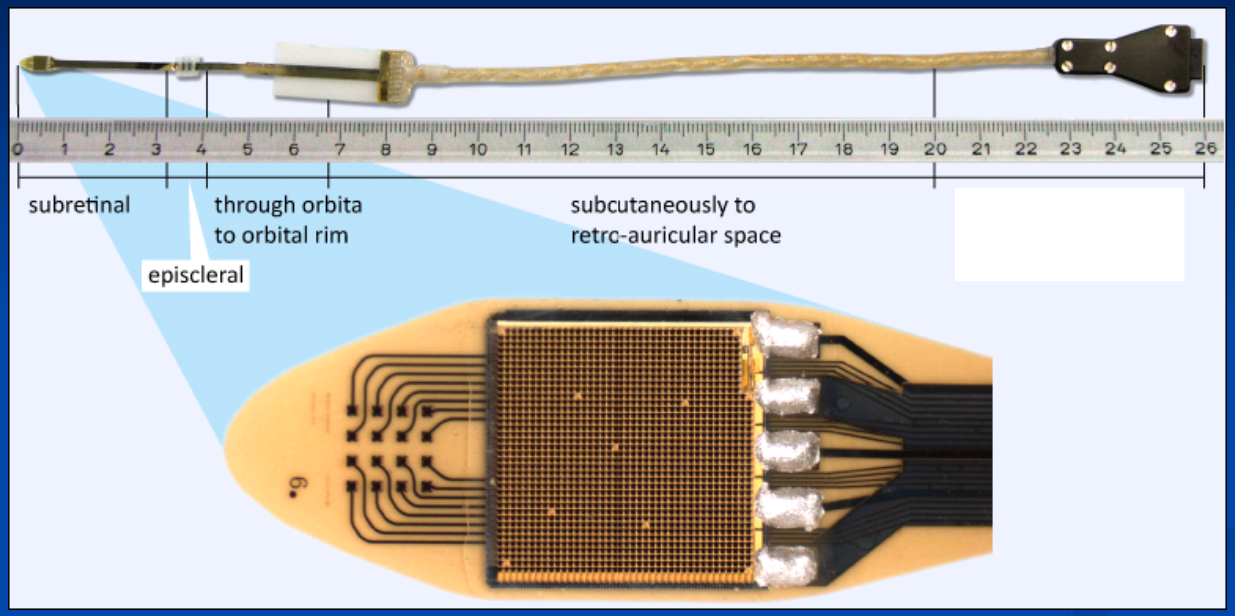
Dove si inserisce il CHIP ALPHA?

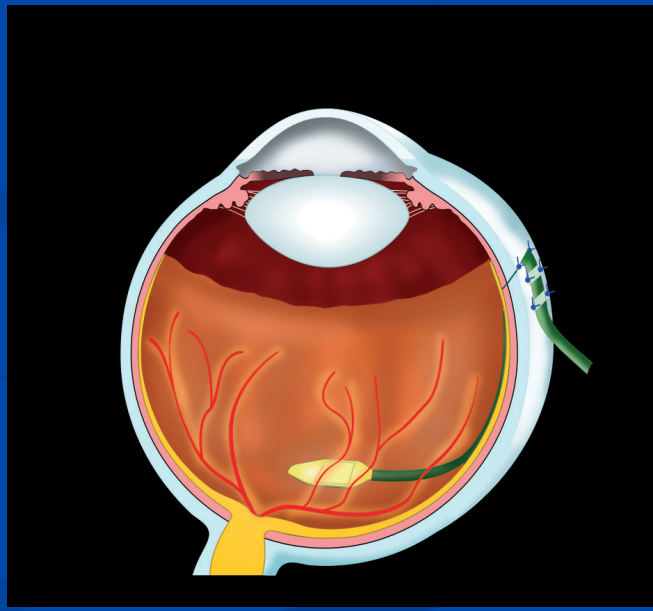




Spessore: 100 microns (1/10 mm), come un capello umano

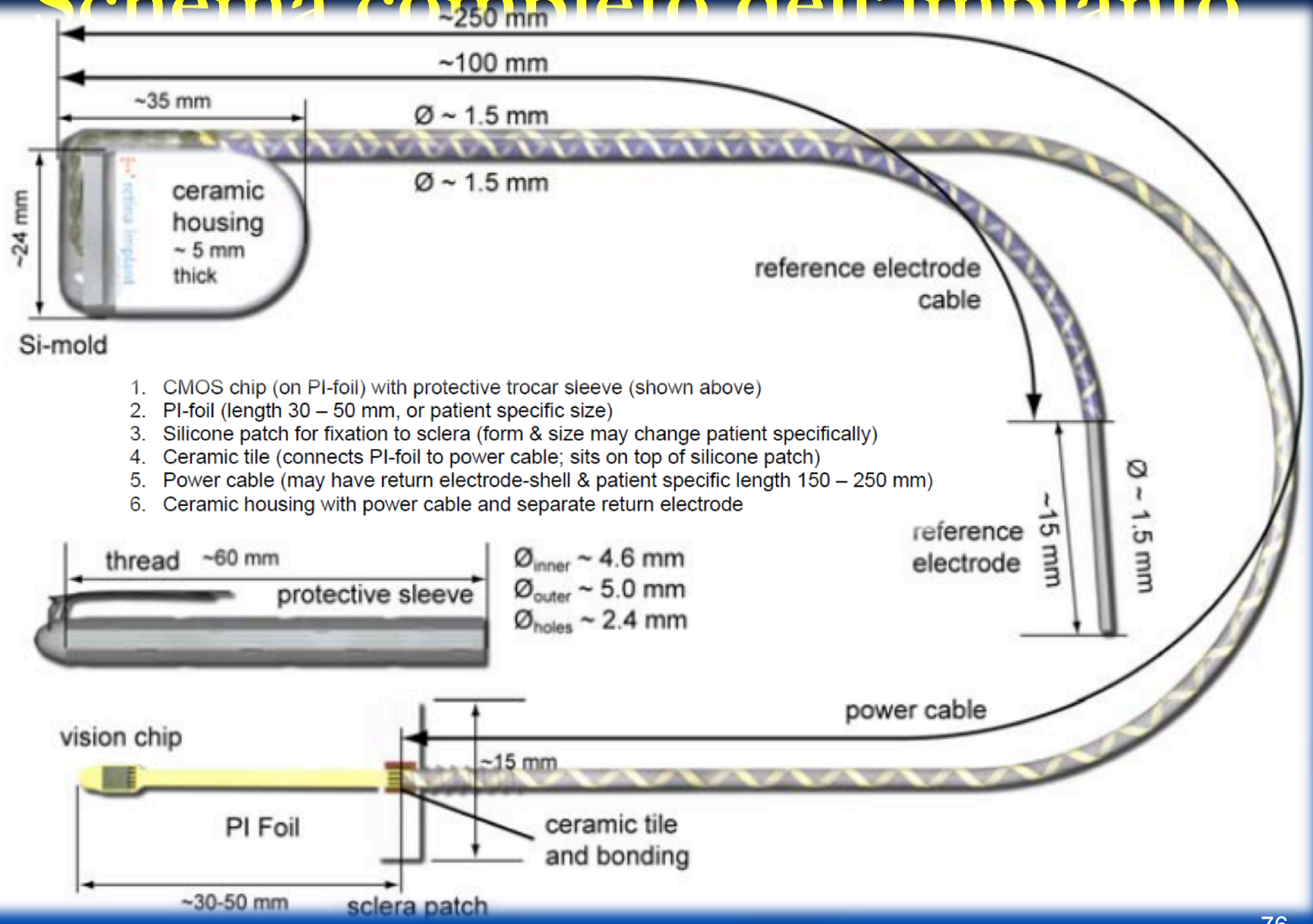
The complete subretinal implant



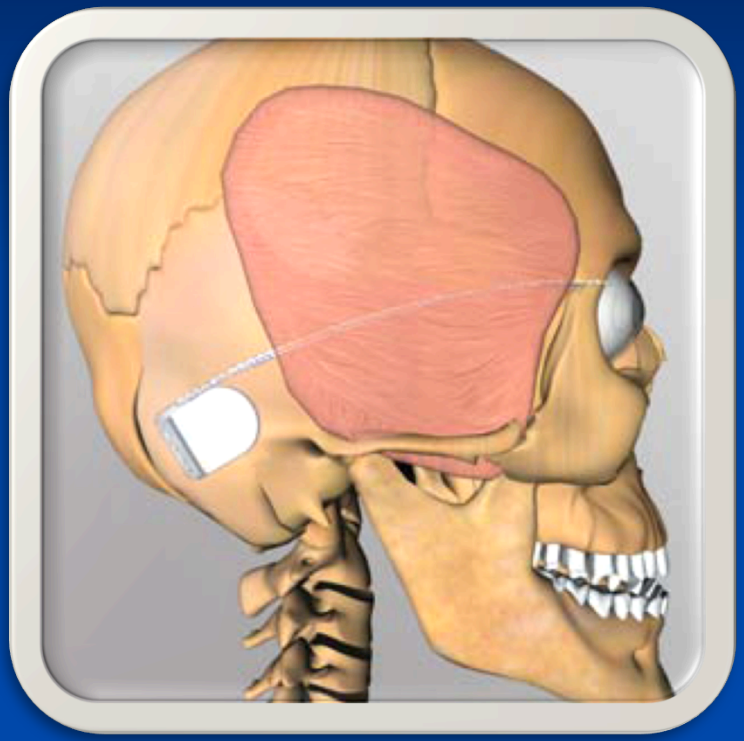


- **Chip:** 1500 Microphotodiodes, Amplifiers and TiN electrodes,

Schema completo dell'impianto



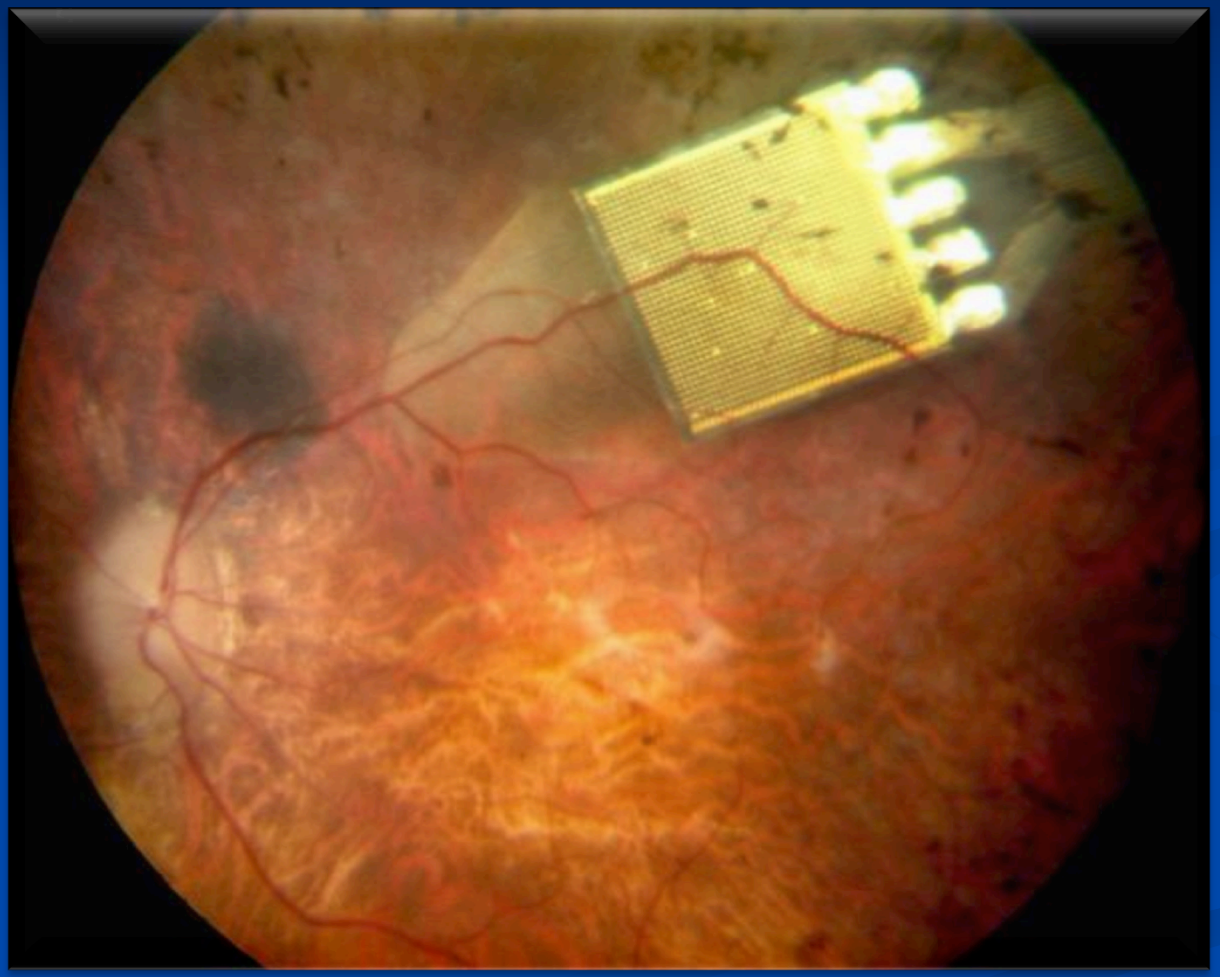
Come si alimenta ?



L'energia necessaria raggiunge il chip attraverso un cavo di silicone che è inserito sotto il muscolo massetere e connesso a una scatoletta di ceramica dietro l'orecchio sotto la cute

All'esterno non si vede niente

Tubingen sub-retinal implant



Prospective pilot study

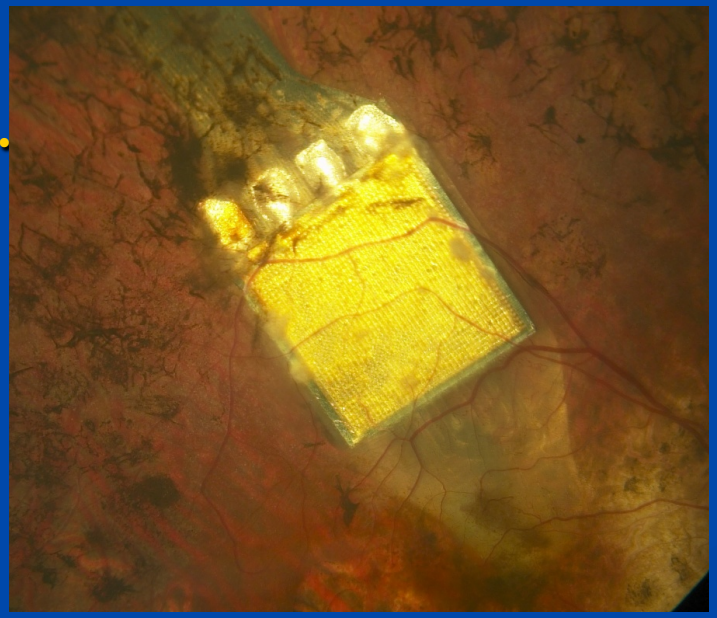
2005 -2008

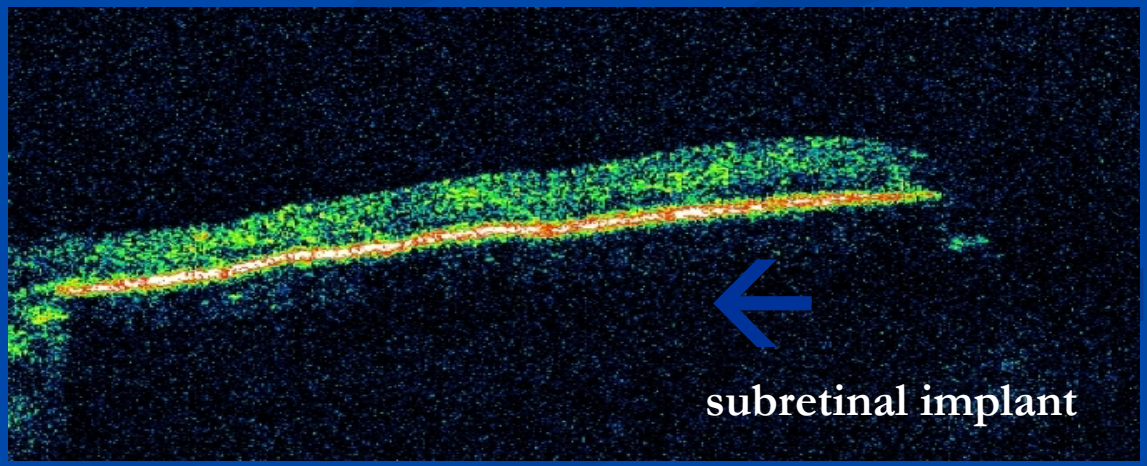
(after 10 years of preclinical work)

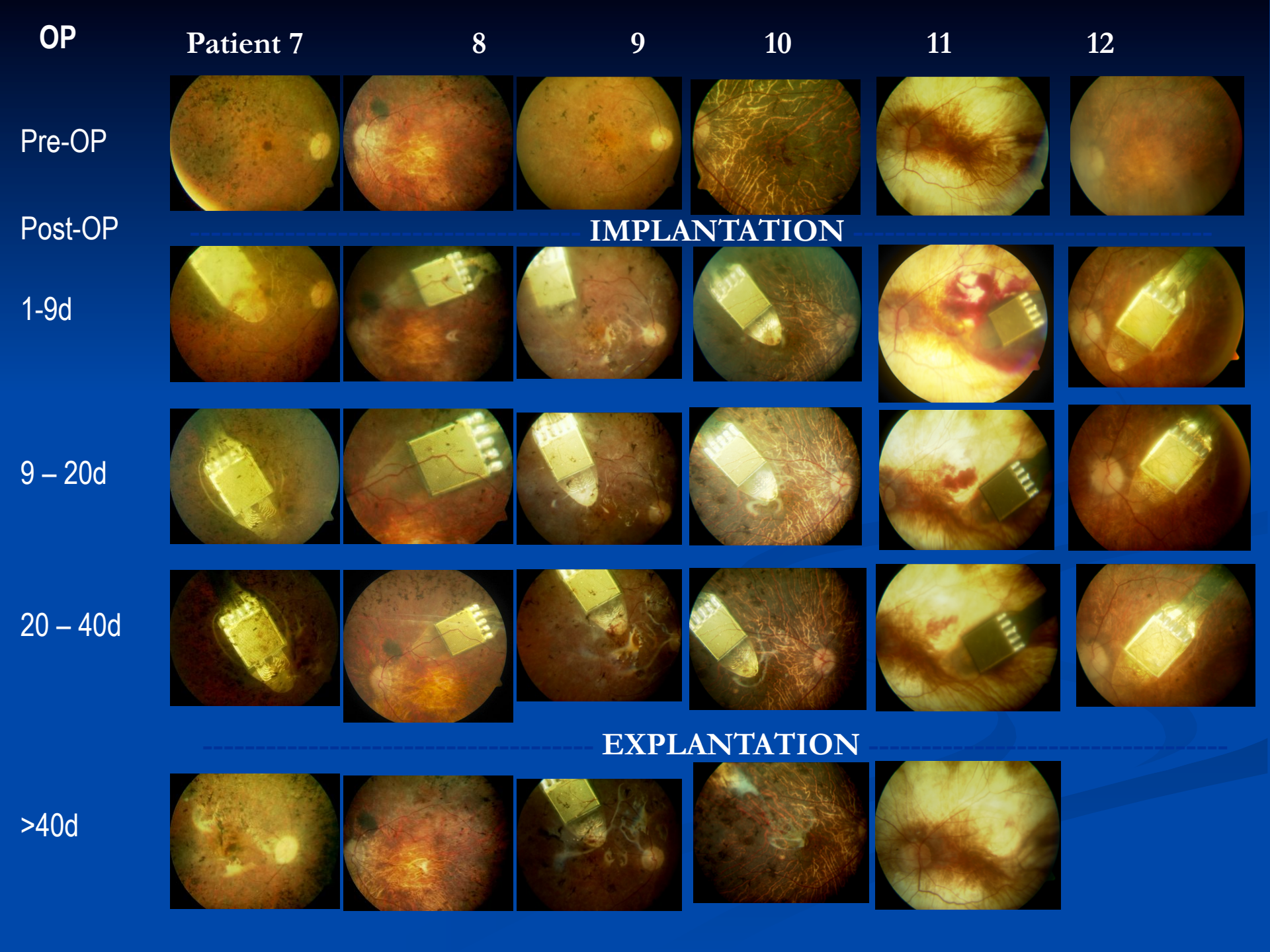
testing subretinal electrode arrays safety and efficacy

- Patients with hereditary retinal degeneration
- Blind, no useful vision (possibly light perception without localization)
- Implant testing period: 4 weeks, Pat. 1-8
  3 months, Pat. 9-12

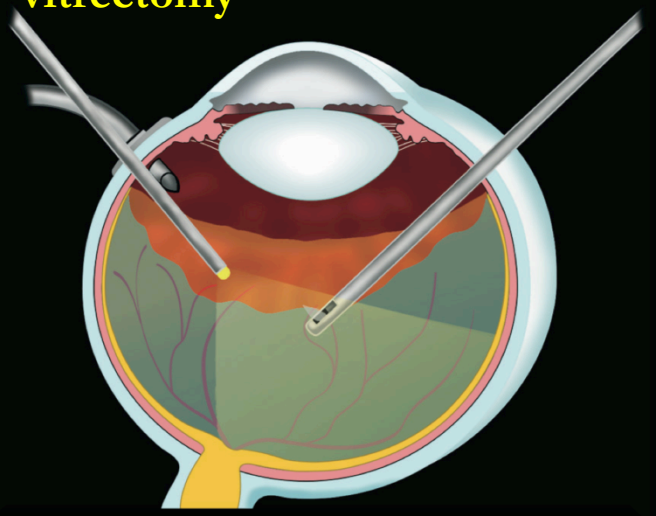
The Pilot Study results

- 11 patients have been implanted
- no significant negative effect on surrounding tissue could be detected
- 



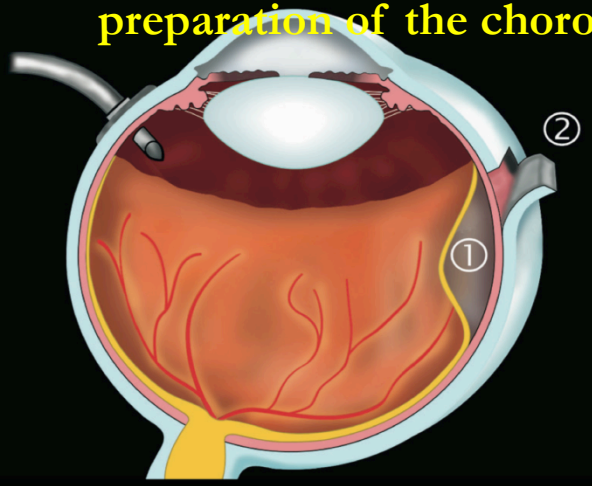

OP
Patient 7
8
9
10
11
12
Pre-OP
Post-OP
IMPLANTATION
1-9d
9 – 20d
20 – 40d
EXPLANTATION
>40d

vitrectomy

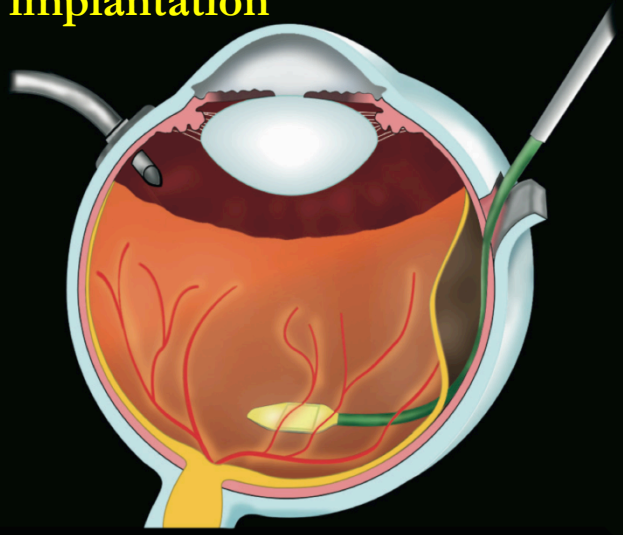


subretinal bleb

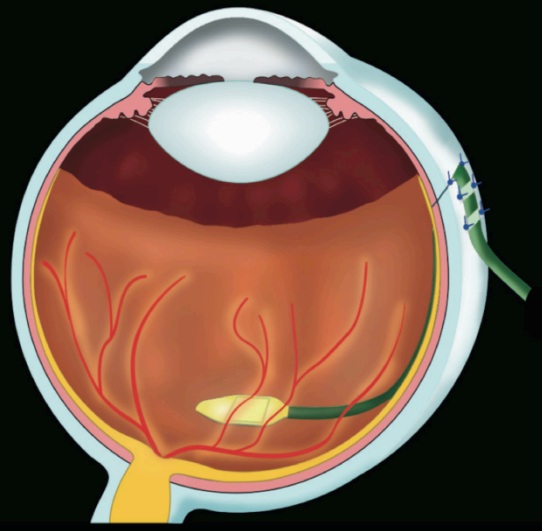
preparation of the choroid

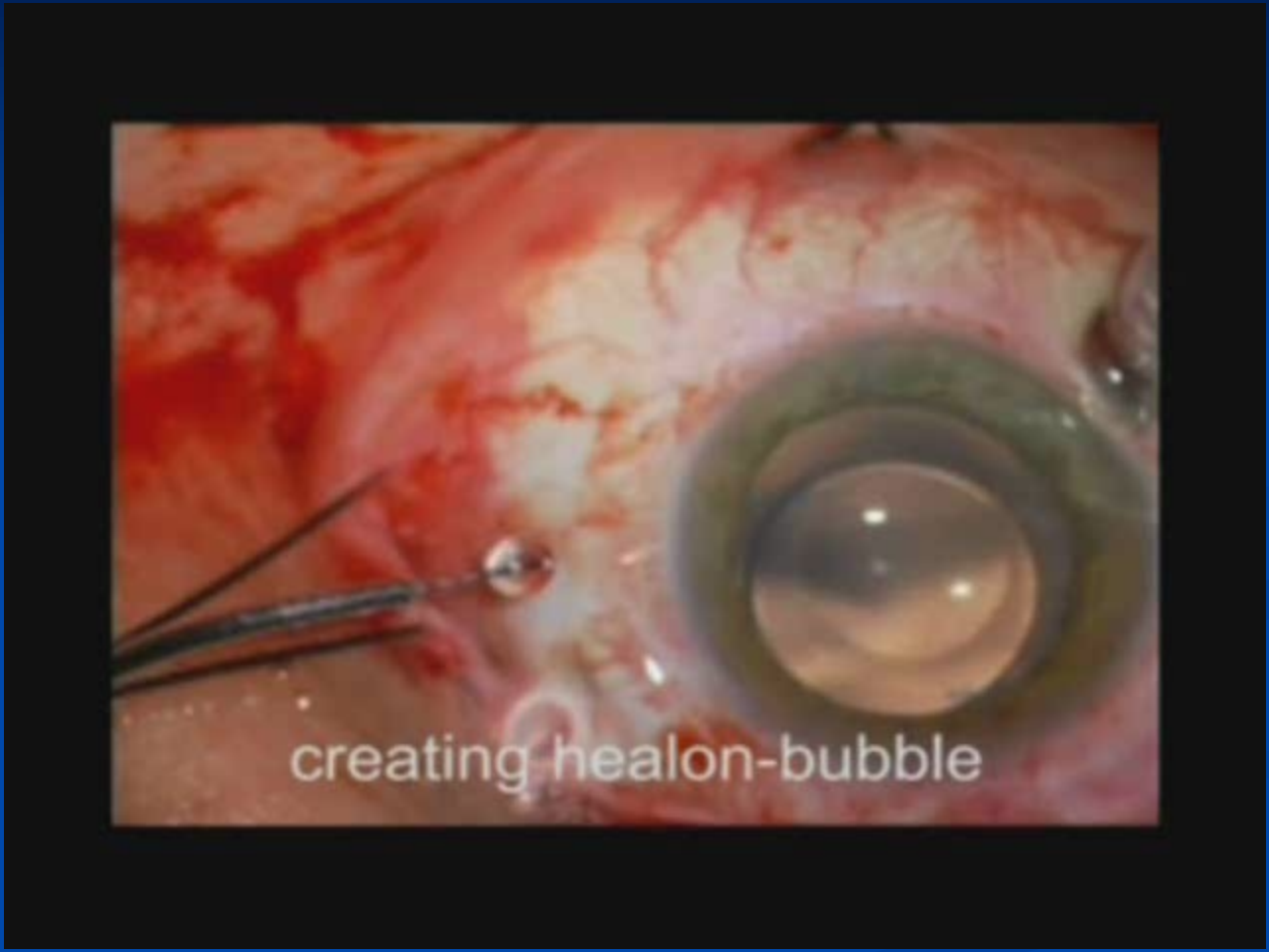


Transchoroidal implantation



Extraocular fixation

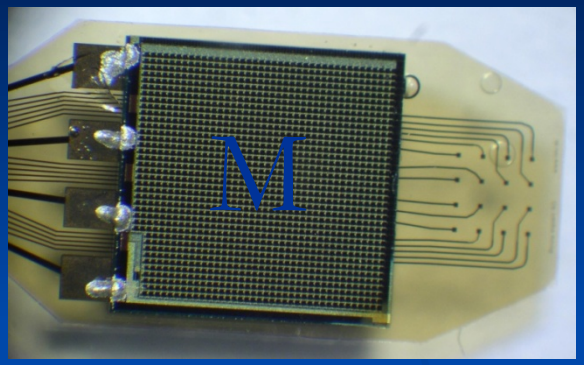



creating healon-bubble

Tests performed with the light stimulation of the „chip“
7 pictures per second, 0,5 ms duration, 1500 pixels

Continous perception of:

- Stripe patterns
- Landolt rings
- Objects
- Letters



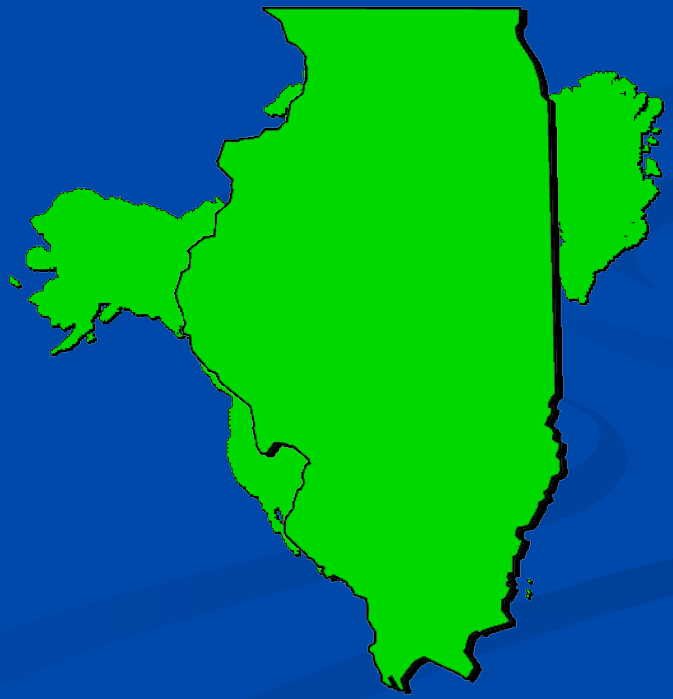
Four alternative forced choice test
With chip „ON“ and chip „OFF“

Video lettura

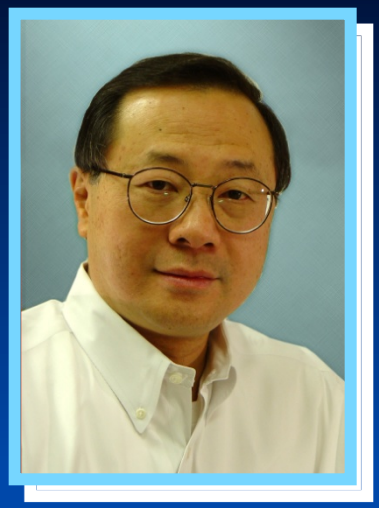
Conclusions

- It is apparently necessary to place the chip right under the macula, utilizing all the power of the papillomacular bundle that is highly represented in the brain
- It can be estimated that at least 1000 electrodes in a 10 degree field are necessary to achieve such spatial resolution
- Subretinal active implant is the only device worldwide so far that is able to provide this high spatial resolution to patients

Optobionics, Inc



Chicago, IL



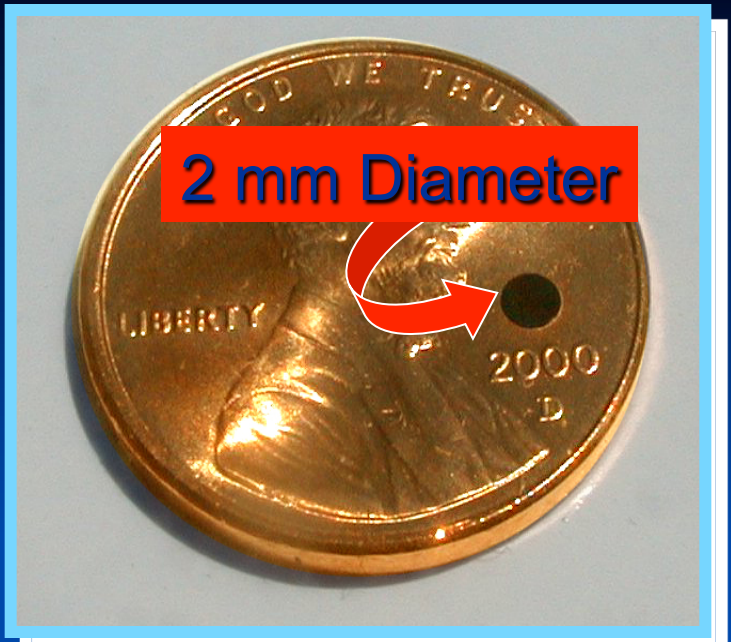
Subretinal Artificial Silicon Retina Microchip for Treatment of Retinitis Pigmentosa:

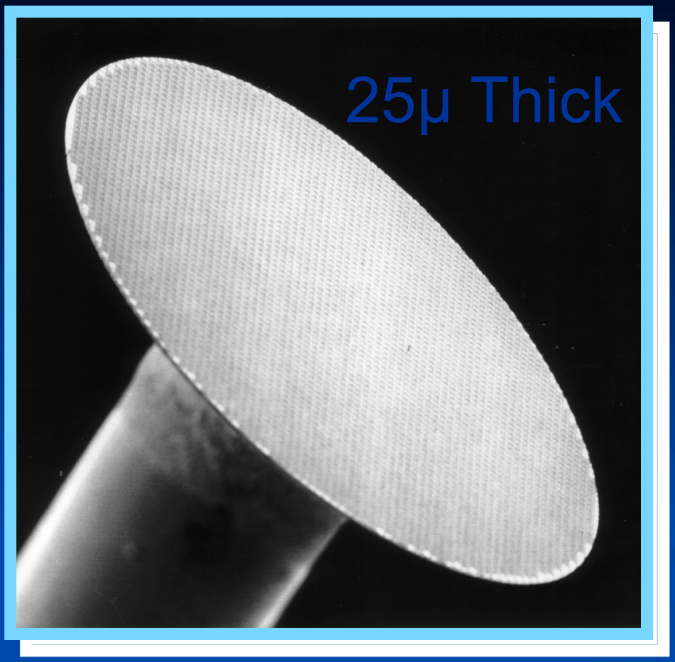
10 Patient Pilot Study – 2 ½ to 5 Yr Update

[1,2,*]A. Y. Chow, [2,*]K.H. Packo, [2,*]J.S. Pollack, [3]R. Schuchard

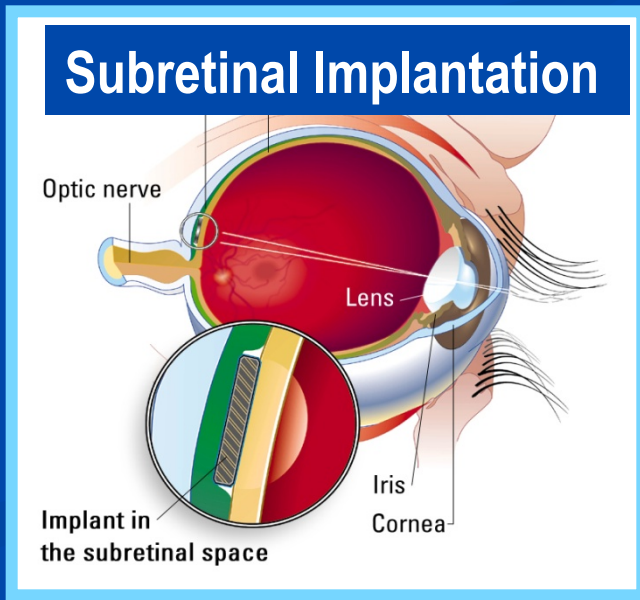
[1]*Optobionics Corporation*
[2]*Rush University Medical Center*
[3] *Atlanta VA Medical Center*
Emory University

* Financial Interest

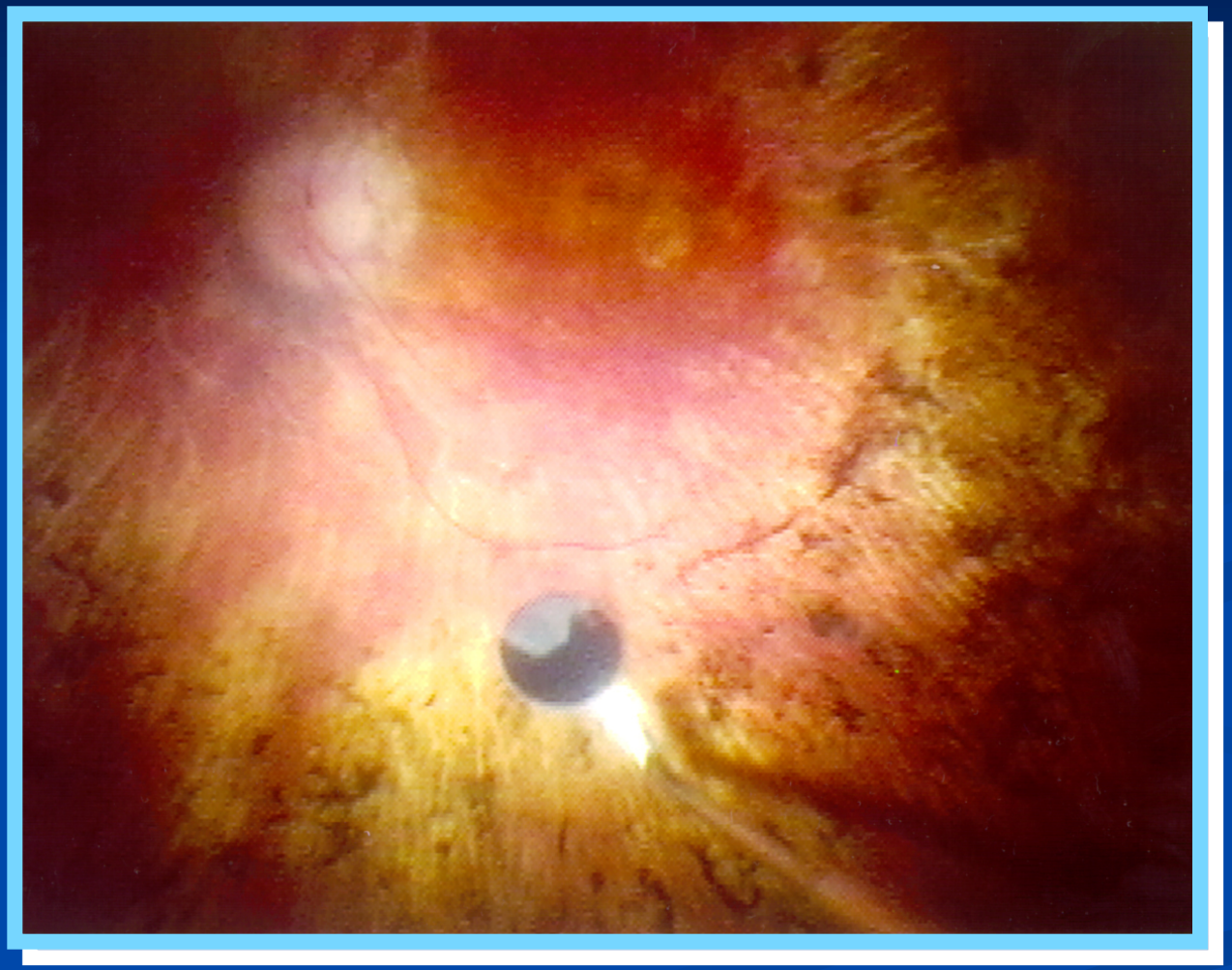

2 mm Diameter
LIBERTY
2000
D


25µ Thick


5000 isolated microphotodiodes


Subretinal Implantation
Optic nerve
Lens
Iris
Cornea
Implant in the subretinal space

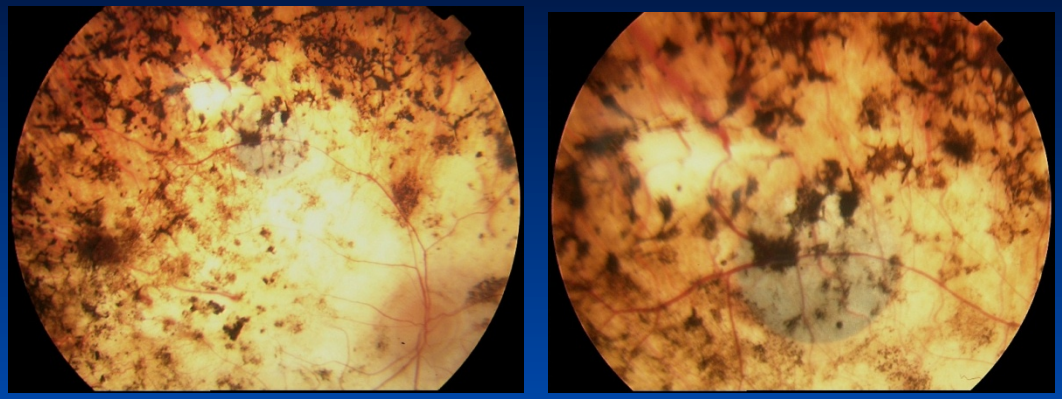
Retinal Prosthesis Implantation



Prosthesis partially introduced through retinotomy

ASR chip well tolerated after 4.5 - 5 years *(Patients 1-3)*

1



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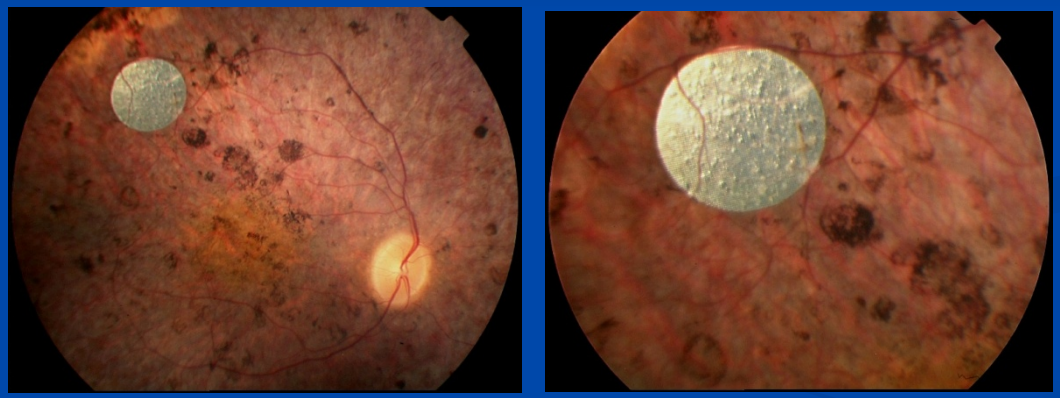

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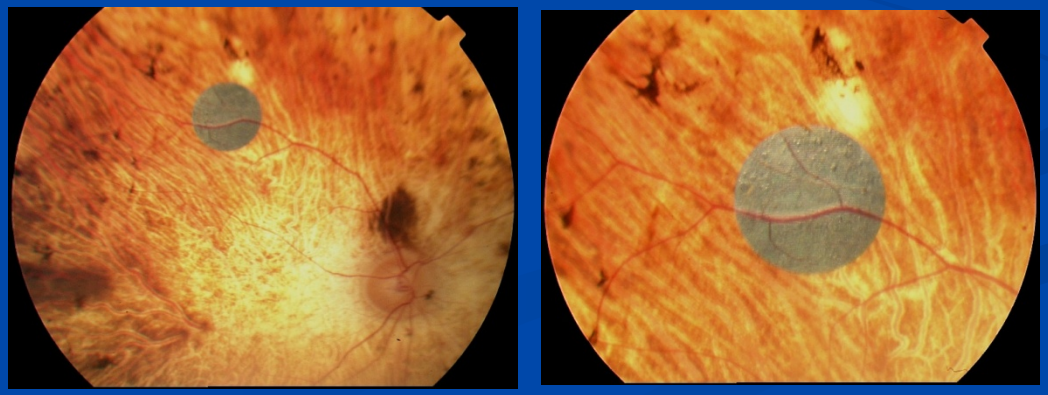
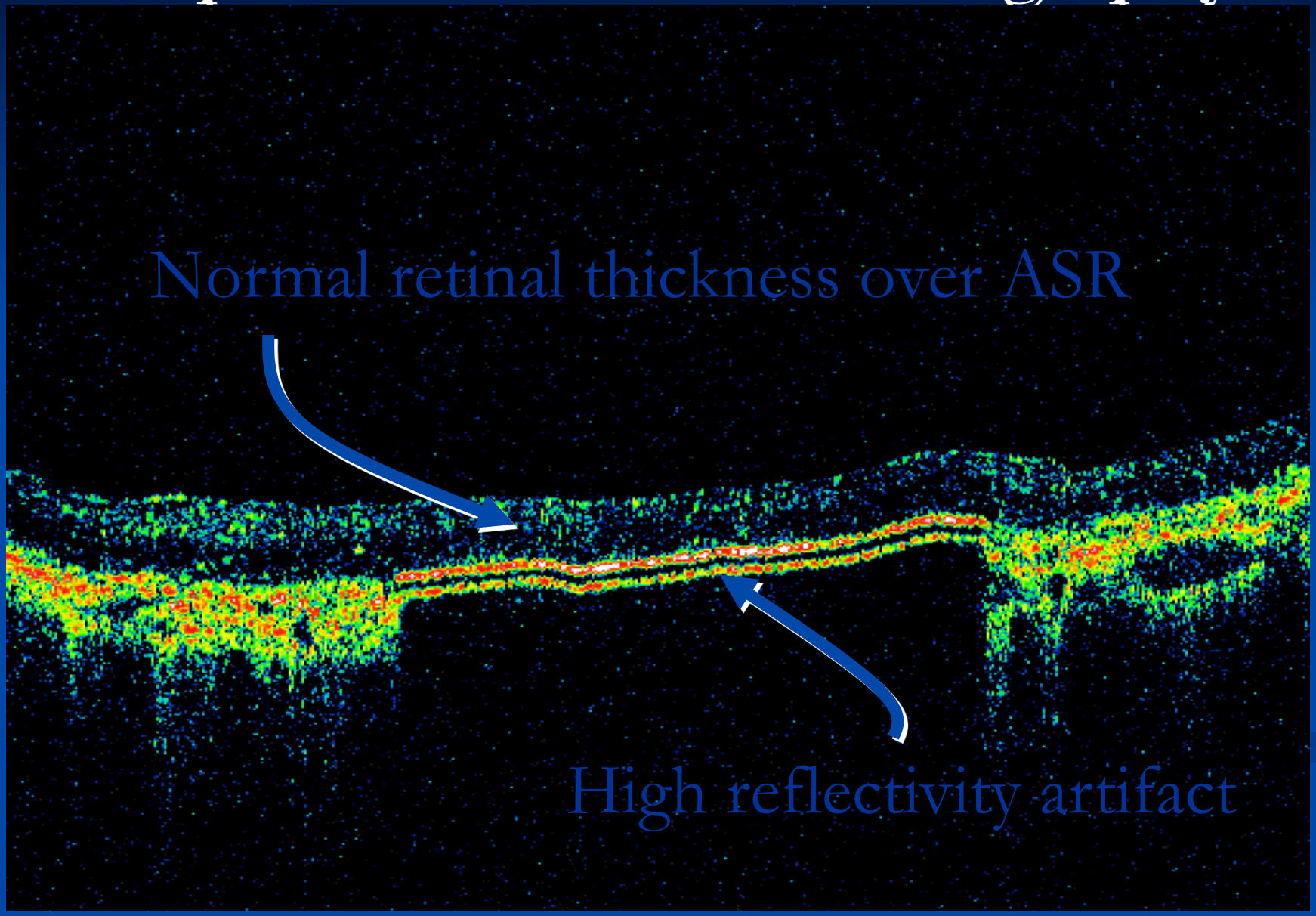


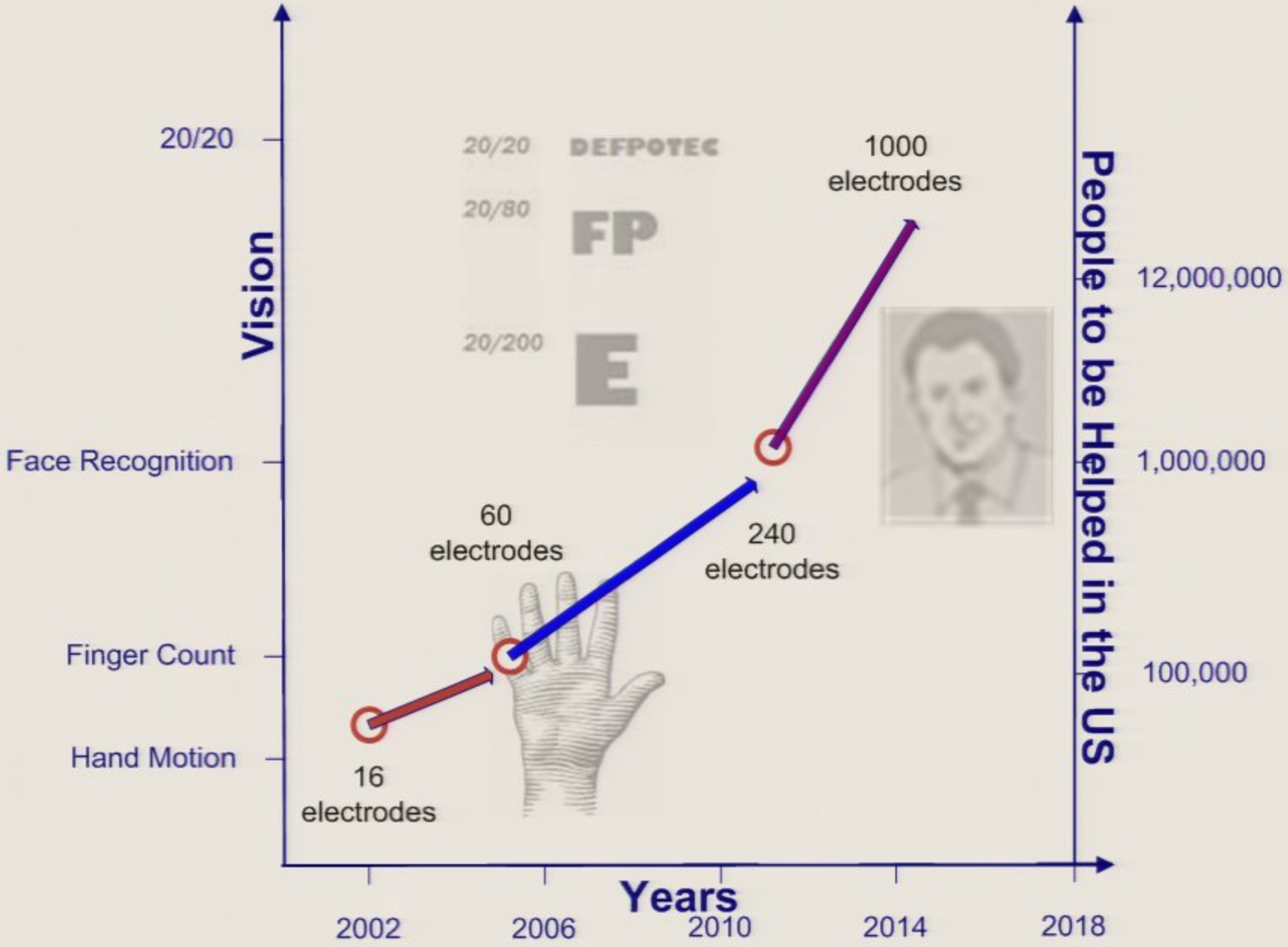
Optical Coherence Tomography



Reading ETDRS Chart

Zero Letters Read Preoperatively

Progress of the Artificial Retina




Grazie per
l'attenzione