BIOGRAPHICAL SKETCH

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NAME: Palanker, Daniel V.

eRA COMMONS USER NAME (credential, e.g., agency login): PALANKER.DANIEL

POSITION TITLE: Professor

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
Yerevan State University, Armenia, USSR	M.Sc.	06/1984	Physics
Hebrew University of Jerusalem, Israel	Ph.D. (Summa Cum Laude)	06/1994	Applied Physics (Biomedical Optics)
Stanford University, CA	Postdoctoral	12/1997	Applied Physics (Multiphoton and near-field imaging)

A. Personal Statement

I work in the field of retinal prosthetics for more than a decade, and my group developed a very successful approach to restoration of sight based on subretinal photovoltaic arrays [1,2]. We have demonstrated that such implants can retain several important features of the retinal signal processing and provide spatial resolution down to theoretical limit of the pixel pitch – 55 μm with the current implants in rats. Recent clinical trials in patients blinded by age-related macular degeneration using 100μm pixel arrays confirmed that visual acuity is limited by the pixel pitch. We propose to advance this technology further and enable much higher resolution for highly functional restoration of sight.

I have experience managing federal research grants and technology transfer to commercialization and clinical use. The photovoltaic retinal prosthesis, developed under NEI and DoD grants, has been commercialized by Pixium Vision (PRIMA™), and is undergoing a very successful clinical trial. We developed the patterned scanning laser system for retinal therapy (PASCAL™), which became widely accepted in clinical practice world-wide, and now manufactured by Topcon. Under NEI and AFOSR grants, we developed the most precise electrosurgical tool - Pulsed Electron Avalanche Knife, which is currently manufactured by Medtronic (Plasma Blade™) and broadly used in several surgical specialties. In the field of ultrafast lasers, we developed the OCT-guided Femtosecond Laser system for Cataract Surgery, which is currently manufactured by Johnson&Johnson (Catalys™), and is broadly used world-wide. In addition, under NEI funding, we studied the mechanisms of electrical stimulation of lacrimal gland and developed neurostimulator for treatment of Dry Eye disease. The system is now manufactured by Allergan (TrueTear™) and approved for clinical use world-wide. In summary, I have the expertise, experience, and motivation necessary to successfully carry out the proposed research and transfer the knowledge to clinical implementation.

1. Photovoltaic retinal prosthesis with high pixel density. K. Mathieson, … and D. Palanker; *Nature Photonics* 6(6): 391–397 (2012)
2. Photovoltaic Restoration of Sight with High Visual Acuity. H. Lorach, … and D. Palanker. *Nature Medicine* **21**:476–482 (2015).

B. Positions and Honors

Positions and Employment

1994 – 1996 Research Scientist, Laser Center of the Hadassah Hebrew University Hospital, Jerusalem.
1996 – 1997 PostDoctoral Fellow, Picosecond Free Electron Laser Center, Stanford University.

1998	Research Associate, Hansen Experimental Physics Laboratory, Stanford University.
1999 - 2000	Senior Research Scientist, Hansen Experimental Physics Laboratory and Department of Ophthalmology, Stanford University.
2001 - 2006	Assistant Professor (Research), Department of Ophthalmology, Stanford University.
2007 - 2014	Associate Professor (Research), Department of Ophthalmology, Stanford University.
2014 -	Professor, Department of Ophthalmology, Stanford University.
2016 -	Director, Hansen Experimental Physics Laboratory, Stanford University.

Other Experience and Professional Memberships

2004 - 2011	VA Scientific Merit Review Panel
2004 -	NIH Scientific Peer Review Committees
2004 -	Member, Organizing committee, Ophthalmic Technologies Conference, BIOS, SPIE.
2004 -	Member of the Editorial Board, *Expert Review of Medical Devices*.
2010 -	Member of the Editorial Board, *Clinical & Experimental Ophthalmology*.
2012 -	Member of the Editorial Board, *Translational Vision Science & Technology*.
2014 -	Member of the Editorial Board, Scientific Reports (Nature Publishing Group).

Honors

2000	First Place Award in *Instrumentation, Pharmaceuticals and Devices*, US Vitreous Society. Awarded for "Plasma-based Cutting Instrument for Vitreoretinal Surgery" (with M.S. Blumenkranz and S. Sanislo).
2001	Winner of the *Collegiate Inventors Competition* of the US National Inventors Hall of Fame (advisor of D. Fletcher).
2004	*Pascal Rol* award for the best paper on Ophthalmic Technologies Conference, SPIE meeting BIOS (Photonics West).
2007	*R&D 100* award for invention and development of the Pattern Scanning Laser Photocoagulator (PASCAL), with M. Blumenkranz and OptiMedica Inc.
2009	Medical Design Excellence Award for invention and development of the Pulsed Electron Avalanche Knife (PEAK), with PEAK Surgical Inc.
2012	R&D 100 award for invention and development of the OCT-Guided Femtosecond Laser System for Cataract Surgery, with OptiMedica Inc.
2014	*SPIE Translational Research Award* for development of the Non-damaging Retinal Laser Therapy. (SPIE - International Society for Optics and Photonics).
2016	Bressler Prize for Vision Science, by Lighthouse Guild.
2016	Alcon Research Institute Scientific Achievement Award.

C. Contribution to Science

1. My group developed **electrosurgical instrument, called Pulsed Electron Avalanche Knife, with the ultimate surgical precision – a single cell**. Confinement of the exposed part of the electrode to a few micrometers in width and pulse duration to a few microseconds limited the interaction zone to cellular size. On the other hand, the large length of the blade provided convenience of a macroscopic surgical instrument, similar to scalpel. Collateral damage zone of this “Plasma Blade” did not exceed a single cell width. Increasing the pulse duration to milliseconds enabled deeper heating - sufficient for hemostasis. This instrument was successfully tested in the retinal and cataract surgeries, and later commercialized, with applications to plastic surgery, ENT, orthopedic, spine surgery and many other fields. The device is manufactured by Medtronic (Plasma Blade ™).

a. Electrosurgery with Cellular Precision. D. Palanker, A. Vankov, P. Huie. *IEEE Transactions on Biomedical Engineering,* 55(2): 838-841 (2008).
b. On Mechanisms of Interaction in Electrosurgery. D. Palanker, A. Vankov, P. Jayaraman. *New Journal of Physics*. 10: 123022 (15pp) (2008).
c. Comparative Healing of Surgical Incisions Created by the PEAK PlasmaBlade, Conventional Electrosurgery, and a Scalpel. S.A. Loh, G.A. Carlson, E.I. Chang, E. Huang, D. Palanker, G.C. Gurtner. *Plastic and Reconstructive Surgery*, 124 (6): 1849-1859 (2009).
d. Anterior Capsulotomy with a Pulsed Electron Avalanche Knife (PEAK). D. Palanker, H. Nomoto, P. Huie, A. Vankov, D.F. Chang. *Journal of Cataract and Refractive Surgery*, 36(1): 127-132 (2010)

2. Retinal degenerative diseases can lead to blindness due to loss of photoreceptors, while inner retinal neurons are relatively well-preserved. Electrical stimulation of the inner retinal neurons allows reintroducing information into the visual system, thereby enabling restoration of sight. We developed a **high-resolution photovoltaic retinal prosthetic system**, and successfully tested it *ex-vivo* and *in-vivo*. In this system, processed images from video camera are displayed on video goggles, and projected through the eye optics onto the retina using pulsed near-infrared (880nm) light. Each pixel in the subretinal photovoltaic array converts light into electric current, which stimulates the nearby neurons. NIR light does not affect remaining photoreceptors and thus allows full utilization of the residual peripheral vision. Optical transmission of information to all pixels simultaneously allows for scaling up the number of electrodes to thousands. Lack of any wiring greatly simplifies the surgery and allows implanting multiple modules via small retinotomy to tile a large visual field. Optical projection of the images into the eye preserves the natural link between eye movements and visual information. We have demonstrated that arrays with 70μm pixels can restore sight in rats blinded by retinal degeneration, with spatial resolution matching the pixel pitch. This system (PRIMA™) has been commercialized by Pixium Vision, and is now undergoing a very successful clinical trial.

a. Design of a High Resolution Optoelectronic Retinal Prosthesis. D. Palanker, A. Vankov, P. Huie, S. Baccus, *J Neural Engineering*, 2: S105-S120 (2005).
b. Photovoltaic Retinal Prosthesis with High Pixel Density. K. Mathieson, J. Loudin, G. Goetz, P. Huie, L. Wang, T.I. Kamins, L. Galambos, R. Smith, J.S. Harris, A. Sher, D. Palanker. *Nature Photonics*, 6(6): 391-397 (2012).
c. Cortical Responses Elicited by Photovoltaic Subretinal Prostheses Exhibit Similarities to Visually Evoked Potentials. Y. Mandel, G. Goetz, D. Lavinsky, P. Huie, K. Mathieson, L. Wang, T. Kamins, L. Galambos, R. Manivanh, J. Harris, D. Palanker. *Nature Communications* 4: 1980- (2013).
d. Photovoltaic Restoration of Sight with High Visual Acuity. H. Lorach, G. Goetz, R. Smith, X. Lei, Y. Mandel, T. Kamins, K. Mathieson, P. Huie, J. Harris, A. Sher, and D. Palanker. *Nature Medicine*, 21: 476-482 (2015).

3. Retinal laser therapy is effective means in treatment of retinopathies. Unfortunately, side effects of conventional photocoagulation include scotomata, decreased peripheral and night vision, and retinal scars that can enlarge causing additional loss of visual field. We developed Pattern Scanning Laser (PASCAL) which enabled **three strategies to minimize or even eliminate the current deleterious side effects and increase clinical efficacy**:

A) We found that selective coagulation of photoreceptors is small spots allows photoreceptors from adjacent areas to shift into the lesion, thereby avoiding retinal scotomata and scarring. We discovered that **shifting photoreceptors rewire to the local inner retinal neurons, thereby** restoring not only retinal sensitivity but also normal structure of the retinal neural network.

B) We developed a new approach to **selective treatment of retinal pigment epithelium (RPE) with microsecond exposures using fast scanning laser**. We demonstrated that it induces proliferation and migration of RPE, while avoiding damage to Bruch's membrane, photoreceptors and inner retina. This approach allows multiple re-treatments with full restoration of RPE continuity within a few days after the procedure. Such rejuvenation of RPE will be tested clinically for treatment of the diseases associated with RPE dysfunction, such as Central Serous Chorioretinopathy and early AMD.

C) We discovered that heat shock protein is expressed in RPE below the retinal damage threshold, and developed an **algorithm which defines the non-damaging laser settings** based on titration to a visible laser lesion. This algorithm (EndPoint Management™) is now being included in PASCAL laser system. We demonstrated clinical efficacy of this non-damaging treatment for chronic Central Serous Chorioretinopathy. Lack of damage allows (a) much higher spot density than conventional photocoagulation, thereby greatly enhancing clinical efficacy; (b) treatment in the fovea, and (c) retreatments, which are essential for management of the chronic diseases. This approach is now being tested in treatment of many other macular diseases, including diabetic macular edema and early AMD.

a. Semi-Automated Pattern Scanning Laser for Retinal Photocoagulation. M.S. Blumenkranz, et.al, *Retina*, 26(3): 370-376 (2006).
b. Selective Retinal Therapy with Microsecond Exposures Using a Continuous Line Scanning Laser. Y.M. Paulus, et.al. *Retina* 31(2): 380-388 (2011).
c. Restoration of Retinal Structure and Function after Selective Photocoagulation. A. Sher, et.al. *The Journal of Neuroscience* 33(16): 6800 - 6808 (2013).

d. Non-Damaging Retinal Laser Therapy: Rationale and Applications to the Macula. D. Lavinsky; et.al. *Investigative Ophthalmology and Visual Science* 57 (6): 2488-2500 (2016).

4. Until recently, cataract surgery was performed manually, which limited precision of the IOL centration, its overlap with the anterior capsule, and was prone to difficulties in cases of poor visibility, as well as in cases of weak zonules in elderly patients and very elastic capsule in pediatric cases. We developed an **OCT-guided femtosecond laser system** which performs all the cutting in the cornea, lens capsule and segmentation of the lens itself. After capturing the 3-D image of the eye, system defines placement of all the cutting patterns, which eliminates dependence on surgical skills, tissue properties and visibility. It also reduces the ultrasonic energy during lens emulsification, thereby preserving corneal endothelial cells. The system (Catalys™) is now manufactured by Johnson&Johnson, and is in clinical use world-wide.

a. Femtosecond Laser-Assisted Cataract Surgery with Integrated Optical Coherence Tomography. D.V. Palanker, M.S. Blumenkranz, et.al. *Science Translational Medicine* 2 (58): 1-9 (2010).
b. Optical breakdown in transparent media with adjustable axial length and location. I. Toytman; D. Simanovski; D. Palanker. *Optics Express*. 18(24): 24688-98 (2010).
c. Multi-Focal Laser Surgery: Cutting Enhancement by Hydrodynamic Interactions Between Cavitation Bubbles. I. Toytman, A. Silbergleit, D. Simanovski, D. Palanker. *Physical Review E* (2010)
d. Femtosecond laser capsulotomy. Friedman NJ, Palanker DV, et.al . *J Cataract Refract Surg* 37(7): 1189-98 (2011).

5. Millions of patients suffer from Dry Eye Disease – a debilitating condition with no effective treatment. Insufficient tear volume on the ocular surface caused by deficient tear production or excessive tear evaporation leads to tear hyperosmolarity, causing inflammation and damage to sensory nerve endings in the cornea. We have demonstrated that electrical stimulation of lacrimal gland results in a dramatic increase in tear production. We developed neural stimulator (TrueTear™, now manufactured by Allergan) which demonstrated excellent results in clinical trials, and is now approved for clinical use world-wide.

Another example of the electronic control of organs we study is electrical vasoconstriction. Sub-millisecond pulses of electric current can lead to vasoconstriction, thereby enabling hemostasis in arteries and veins without damage to surrounding tissues. Upon termination of stimulation, the blood vessels dilate back to normal size within minutes. This technology could be used for reduction in bleeding during surgery or injury, especially in non-compressible wounds.

a. Enhanced Tearing by Electrical Stimulation of the Anterior Ethmoid Nerve. M. Brinton; et al. *IOVS* 58(4): 2341-2348. (2017)
b. Miniature Electrical Stimulator for Hemorrhage Control. M. Brinton, et.al, *IEEE Transactions on BioMedical Engineering* 61(6):1765-1771 (2014).
c. Electronic Enhancement of Tear Secretion. M. Brinton, et al. *Journal of Neural Engineering* 13: 016006 (8pp) (2016).

Complete List of Published Work:
http://www.ncbi.nlm.nih.gov/sites/myncbi/daniel.palanker.1/bibliograpahy/40721380/public/?sort=date&direction=descending

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D. Research Support

Ongoing Research Support

1 R01 EY0277860 (NIH) D. Palanker (PI) 07/01/2017– 04/30/2022
Title: “Photovoltaic Subrentinal Prosthesis with High Pixel Density”
Development of the photovoltaic subretinal prosthesis with flat pixels of 40 and 55um in width and testing its performance in rodent models of retinal degeneration.

U01 EY025501 (NIH) A. Roorda (PI) 05/01/2015 –04/30/2020
Title: “Interferometric Optophysiology of the Human Retina”.
The goal of this project is to develop interferometric system for optical monitoring of neural activity in the retina.
Role: Co-Investigator

FA9550-17-1-0237 (AFOSR) D. Palanker (PI) 04/01/2017– 03/31/2020

Title: “Transplantation of Photoreceptors for Restoration of Sight”.
The goal of this project is to transplant sheets of photoreceptors into subretinal space of rats with retinal degeneration and study their integration with the host retina.

Completed Research Support

W81XWH-15-1-0009 (DoD) D. Palanker (PI) 02/01/2015 – 01/31/2018
Title: “Photovoltaic Retinal Prosthesis for Restoring Sight to Patients Blinded by Retinal Injury or Degeneration”.
Verification of biocompatibility and safety of the photovoltaic retinal prosthesis for its transfer into clinical testing.

FA9550-14-1-0074 (AFOSR) D. Palanker (PI) 05/01/2014 – 04/30/2018
Title: "Electronic Control of Hemorrhage in Non-compressible Wounds”.
Development and testing of the microstimulator for vasoconstriction of arteries and veins in animal models of vascular injury.

5 R01 EY018608 D. Palanker (PI) 07/01/2013 – 06/30/2018
Title: "High Resolution Photovoltaic Retinal Prosthesis".
Development of the high-resolution photovoltaic retinal prosthesis for restoration of sight, and testing its performance in animal models of retinal degeneration.

5 R01 EY023020 (NIH) A. Sher (PI) 01/01/2013 – 12/31/2017
Title: "Restoration of retinal structure and function after selective photocoagulation of photoreceptors".
Structural and functional studies of the retinal plasticity following retinal injury, including rewiring of the photoreceptors shifting into the damage area.
Role: Co-Investigator

5 R01 EY023259 D. Palanker (PI) 04/01/2013 – 03/31/2017
Title: "Electronic Stimulator of Lacrimal Gland".
Studing response of the lacrimal gland to electrical stimulation of the afferent and efferent neurons innervating the lacrimal system, and development of microstimulator for treatment of Dry Eye disease.

W81XWH-12–10575 (DoD) D. Palanker (PI) 10/1/2012 – 03/31/2014
Title: “Restoration of the Retinal Structure and Function after Injury”.
Establishment of the animal models of retinal injury resulting in local selective loss of photoreceptors, and assessment of the maximum extent of their migration into the lesion.

5 R01 EY018608 D. Palanker (PI) 07/01/2009 – 06/30/2013
Title: "High Resolution Optoelectronic Retinal Prosthesis".
Development of the high-resolution photovoltaic retinal prosthesis and testing its performance in-vitro.