BIOGRAPHICAL SKETCH

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NAME: Palanker, Daniel V.

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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
State University of Armenia, Yerevan, USSR	M.Sc.	06/1984	Physics
Hebrew University of Jerusalem, Israel	Ph.D.	06/1994	Applied Physics (optics)
Stanford University, CA	Postdoctoral	12/1997	Physics (multiphoton and near-field imaging)

A. Personal Statement

I work in the field of retinal prosthetics for more than 15 years, and my group developed a very successful approach to restoration of sight based on subretinal photovoltaic arrays [1-3]. We have demonstrated that such implants can retain many important features of the retinal signal processing and provide spatial resolution matching the pixel pitch in animals and in human patients. While we transferred the first generation of this technology to commercial development and clinical trials (PRIMA), we continue working on advancing it further to enable higher resolution, exceeding the 20/100 level. This would extend its applicability to a much larger patients' population than the current implants could benefit.

I have experience managing research grants and technology transfer to commercialization and clinical use. The photovoltaic retinal prosthesis, developed primarily under the NEI grants, is now being commercialized by Pixium Vision (PRIMA™), and is undergoing very successful clinical trials. The patterned scanning laser system for retinal therapy (PASCAL™) we developed became widely accepted in clinical practice world-wide. Under R01 NEI grant, we developed the most precise electrosurgical tool - Pulsed Electron Avalanche Knife, which is currently used in several surgical specialties (Plasma Blade™). In the field of ultrafast lasers, we developed the OCT-guided Femtosecond Laser system for Cataract Surgery (Catalys™), which is in clinical use world-wide. In addition, following the studies of the electrical stimulation of lacrimal gland under NEI funding, we developed neurostimulator for treatment of Dry Eye disease (TrueTear™). In summary, I have the expertise, experience, and motivation necessary to successfully carry out the proposed research and development.

1. Photovoltaic Restoration of Sight with High Visual Acuity. *Nature Medicine* **21**:476–482 (2015). PMCID: PMC4601644
2. Photovoltaic Restoration of Central Vision in Atrophic Age-Related Macular Degeneration. *Ophthalmology* **127**:1097-1104 (2020). PMCID: PMC7384969
3. Simultaneous Perception of Prosthetic and Natural Vision in AMD Patients. *Nature Comm*. **13**:513 (2022). PMCID: PMC8792035

B. Positions, Scientific Appointments, and Honors

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 - Professor by courtesy, Department of Electrical Engineering, Stanford University.
2016 - 2020 Director of the Hansen Experimental Physics Laboratory, Stanford University.

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, by SPIE - International Society for Optics and Photonics.
2016 Bressler Prize for Vision Science, by Lighthouse Guild.
2016 Alcon Research Institute Scientific Achievement Award.
2019 Bartimaeus Award, by the World Congress on Artificial Vision “The Eye and The Chip“.
2022 Elected as a Silver Fellow by the Association for Research in Vision and Ophthalmology (ARVO).
2024 *Translational Research Award* for Restoration of Sight in Age-Related Macular Degeneration, by SPIE - International Society for Optics and Photonics.

C. Contributions to Science

1. 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 in preclinical studies and in a clinical trial. In this system, processed images from video camera are displayed on video goggles and projected 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 secondary retinal 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 optical projection of the images into the eye preserves the natural link between eye movements and visual information. We have demonstrated that spatial resolution of prosthetic vision with pixels of 100μm in human patients (PRIMA) and down to 40μm in animals matches the pixel pitch.

a. Design of a High Resolution Optoelectronic Retinal Prosthesis. *J Neural Eng.* **2**: S105-S120 (2005). PMID: 15876646
b. Photovoltaic Retinal Prosthesis with High Pixel Density. *Nature Photonics*, **6(6)**: 391-397 (2012). PMCID: PMC3462820
c. Photovoltaic Restoration of Sight with High Visual Acuity. *Nature Medicine*, **21**: 476-482 (2015). PMCID: PMC4601644
d. Simultaneous Perception of Prosthetic and Natural Vision in AMD Patients. *Nature Comm*. **13**:513 (2022). PMCID: PMC8792035

2. 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 is being 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 and Macular Telangiectasia. 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 for treatment of other macular diseases, including diabetic macular edema and early AMD.

a. Semi-Automated Pattern Scanning Laser for Retinal Photocoagulation. *Retina*, 26(3): 370-376 (2006). PMID: 16508446
b. Selective Retinal Therapy with Microsecond Exposures Using a Continuous Line Scanning Laser. *Retina* 31(2): 380-388 (2011). PMID: 20930656
c. Restoration of Retinal Structure and Function after Selective Photocoagulation. *The Journal of Neuroscience* 33(16): 6800 - 6808 (2013). PMCID: PMC3865506
d. Non-Damaging Retinal Laser Therapy: Rationale and Applications to the Macula. *Investigative Ophthalmology and Visual Science* 57 (6): 2488-2500 (2016). PMCID: PMC5995023

3. 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 a clinical use world-wide.

a. Femtosecond Laser-Assisted Cataract Surgery with Integrated Optical Coherence Tomography. *Science Translational Medicine* **2 (58)**: 1-9 (2010). PMID: 21084720
b. Optical breakdown in transparent media with adjustable axial length and location. *Optics Express* **18(24)**: 24688-98 (2010). PMID: 21164815
c. Femtosecond laser capsulotomy. *J Cataract Refract Surg* **37(7)**: 1189-98 (2011). PMID: 21700099

4. 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 the size of a single cell. On the other hand, the large length of the blade provided convenience of macroscopic surgical instrument, similar to a 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. *IEEE Trans. on Biomedical Eng.,* **55(2)**: 838-841 (2008). PMID: 18270030
b. On Mechanisms of Interaction in Electrosurgery. *New Journal of Physics* **10**: 123022 (15pp) (2008).
c. Comparative Healing of Surgical Incisions Created by the PEAK PlasmaBlade, Conventional Electrosurgery, and a Scalpel. *Plastic and Reconstructive Surgery* **124 (6)**: 1849-1859 (2009). PMID: 19952641

d. Anterior Capsulotomy with a Pulsed Electron Avalanche Knife (PEAK). *Journal of Cataract and Refractive Surgery* **36(1)**: 127-132 (2010) PMCID: PMC2818865

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 nerve damage. We have demonstrated that **electrical stimulation of lacrimal gland results in a dramatic increase in tear production**. We developed neural stimulator (True Tear^{TM}) which demonstrated excellent clinical results and was approved by FDA.

Another example of the electronic control of organs is the electronic control of vasculature. Sub-millisecond pulses of electric current can lead to temporary vasoconstriction. This way hemostasis can be produced in arteries and veins without damage to the surrounding tissue. At the end 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. *IOVS* **58(4)**: 2341-2348. (2017) PMCID: PMC5398789
b. Miniature Electrical Stimulator for Hemorrhage Control. *IEEE Trans. BioMedical Eng.* **61(6)**:1765-1771 (2014). PMID: 24845287
c. Electronic Enhancement of Tear Secretion. *Journal of Neural Engineering* **13**: 016006 (8pp) (2016). PMCID: PMC6492550

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