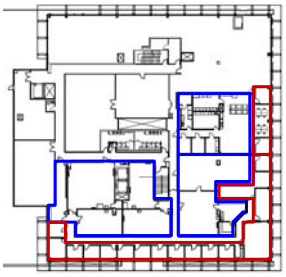
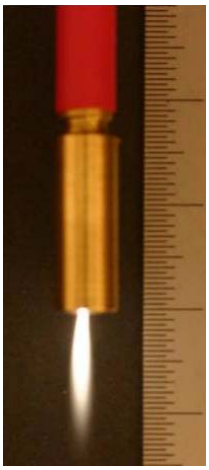
Frank Reidy Research Center for Bioelectrics
Old Dominion University

•Established in 2002 as an interdisciplinary (Biology-Physics-Engineering) research center for Bioelectrics. Leader in an International Consortium on Bioelectrics: including research groups in Japan and Germany.

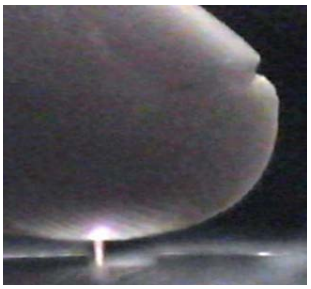
•Approximately 25 researchers from more than 10 countries work in the 14,000 sqft center on research topics reaching from bacterial decontamination of food to novel cancer therapies.



COLD PLASMA



room temperature air plasma operated at atmospheric pressure

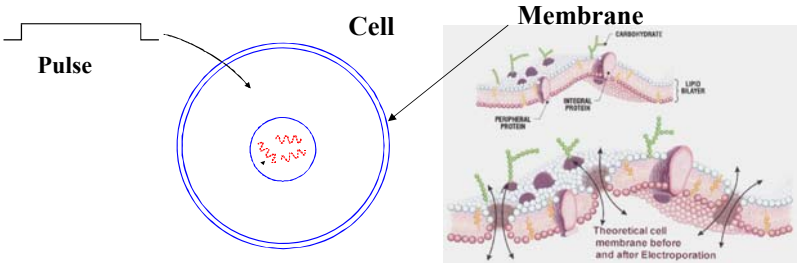


Applications:

- **Bacterial decontamination of heat sensitive surfaces**
- **Treatment of fungal diseases**

Pulsed Power

Electrical pulses cause "electroporation" of the cell membrane.



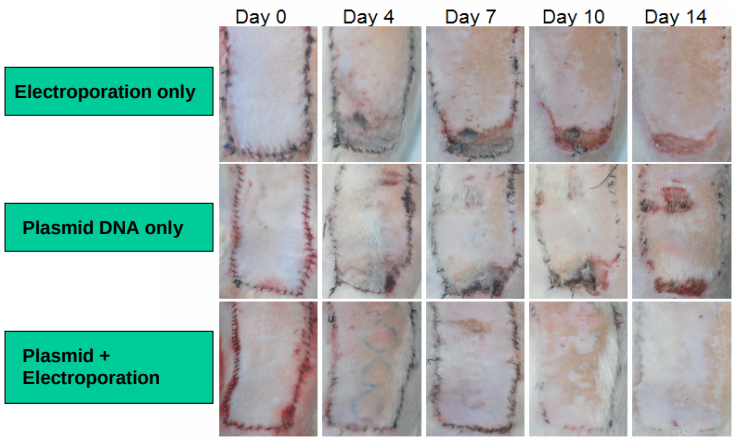
When the applied electric field is increased to values such that the voltage across the cell membrane approaches **1V** the membrane becomes permeable for large ions, e.g. DNA.

IMMUNO GENE THERAPY FOR CANCER

6 WEEKS AFTER TREATMENT, 4 SITES TREATED WITH PIL-12 AND ELECTROPORATION

6 MONTHS AFTER TREATMENT, 4 TREATMENT SITES SURGICALLY REMOVED. UNTREATED SITES RESPONDED TO IMMUNE RESPONSE

WOUND HEALING

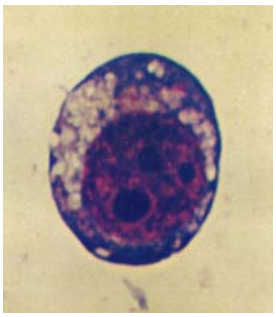


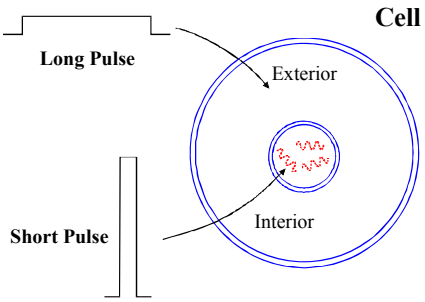
Plasmid = Vascular Endothelial Growth Factor

4 sites treated

Pulsed Power: Nanopulses Affect Cell Functions

[from release of calcium to inducing apoptosis]

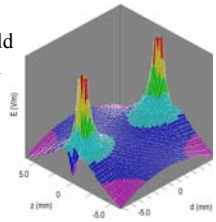




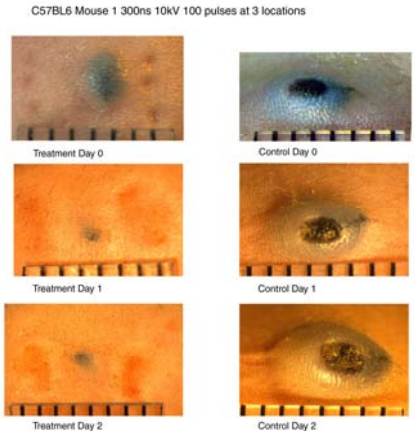
Apoptosis → Tumor Treatment

Needle Electrodes

Electric Field Distribution



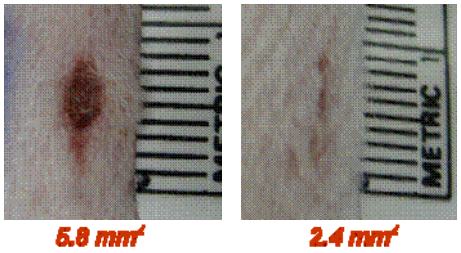
Model system:
Injection of 10^6 B16 Murine melanoma cells underneath the skin of a mouse



Calcium Release → Wound Healing

Nanopulses cause aggregation of platelets and release of growthfactors.

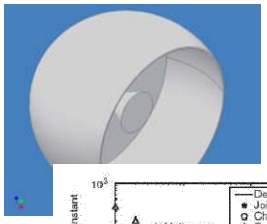
72 hours after incision

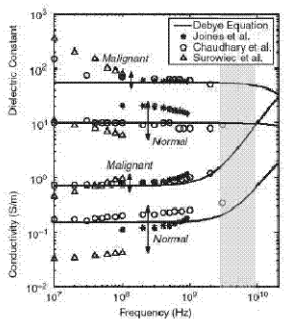


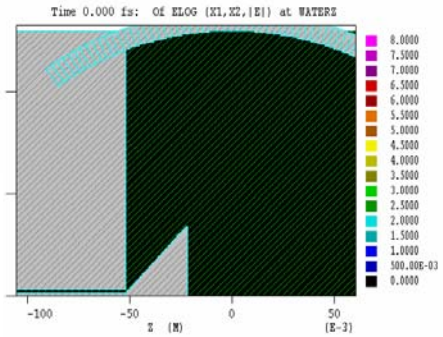
control **with nanopulse activated platelet gel**

Nanopulse activated platelet gel
→ rapid wound healing

From Electrodes to Antennas
for Treatment and Medical Imaging



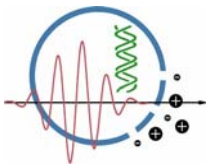




Fear et al. IEEE Trans. Microwave Theory Tech., 51,887(2003)

Since tumors differ in their electrical properties from healthy tissue, scattered electromagnetic waves carry information on status of tumor growth – "medical radar".

Medical and Environmental Applications



Electroporation -Gene Therapy

Cancer therapy	**NIH funding**
Wound healing	**NIH funding**
Coronary Artery Disease	**NIH Funding**

Nanosecond Pulsed Electric Fields

Cancer therapy	**NIH funding; license negotiations are underway**
Tissue ablation	**licensed**
Neuromuscular effects	**ONR funding**
Wound healing	**Internal funding**
Medical Imaging	**AFOSR and Industry funding**
Bacterial Decont. of Food	**Industry funding**

Cold Plasma

Bacterial decontamination of surfaces Internal Funding

From Research to Education

New Course: ECE 495/595

Introduction to Bioelectrics

A one-semester course covering the electrical properties of cells and tissues as well as the use of electricity and magnetism in the diagnosis and treatment of disease. Typical topics to be covered include basic cell physiology, endogenous electric fields in the body, electrocardiography, cardiac pacing, defibrillation, , electroporation, electrotherapy in wound healing. In addition, ultrashort electrical pulses for intracellular manipulation and the application of plasmas to biological systems will be covered.