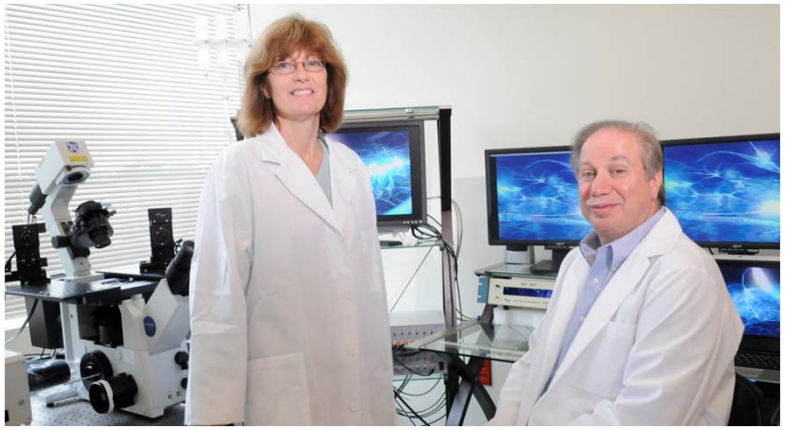
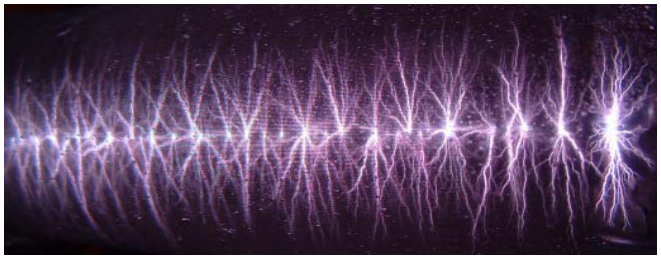
Frank Reidy Research Center for Bioelectrics

Dr. Richard Heller





OLD DOMINION
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IDEA FUSION

Frank Reidy Research
Center for Bioelectrics

Reidy Center for Bioelectrics

- University Level Research Center
  - Founded in 2002
  - 45 Researchers: Faculty, Post-docs, students, technicians and staff
- Leader in an International Consortium on Bioelectrics
  - Japan, Germany, France, Czech Republic, Slovenia and United States
- Over $3 Million in Annual Research Expenditures
  - Research sponsors include National Institutes of Health, US Department of Defense, National Science Foundation, Commonwealth of Virginia and Private Industry

Reidy Center for Bioelectrics

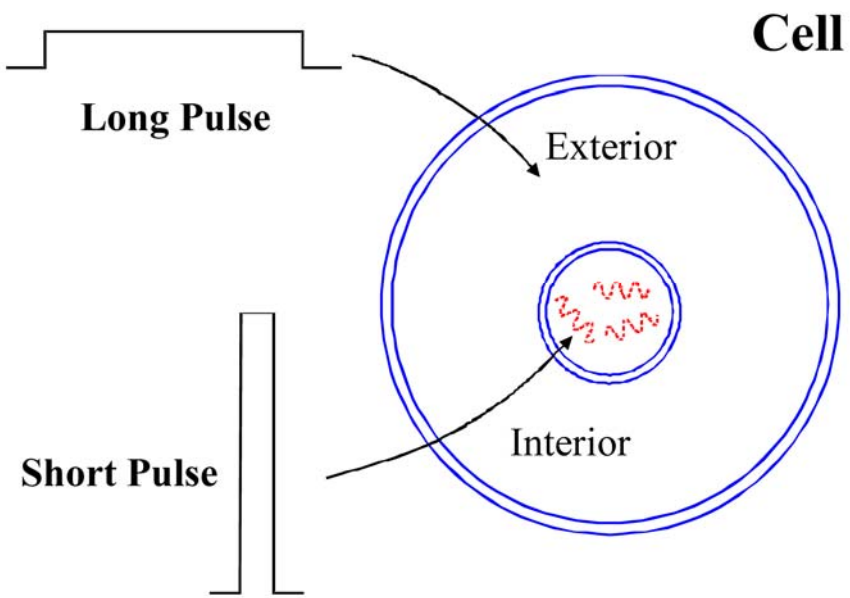
- Report by "Nature.com" – January, 2011.

  "The integration of physical sciences and engineering with biology is considered to be revolutionary, and will transform everything from health care to energy production to food."

- The Center for Bioelectrics is an example of such a revolutionary approach. By bringing together scientists with diverse backgrounds, but complementing expertise, the bioelectrics team has positioned itself as an internationally recognized leader in this rapidly growing field.

Pulsed Power: Affect Cell Functions

[from delivery of molecules to release of calcium and induction of apoptosis]



Bioelectric Applications

- Cellular interactions
- Wound healing
- Plasma medicine
- Cancer treatment
- Detection
- Cardiovascular
- DNA vaccines
- Neurological Applications

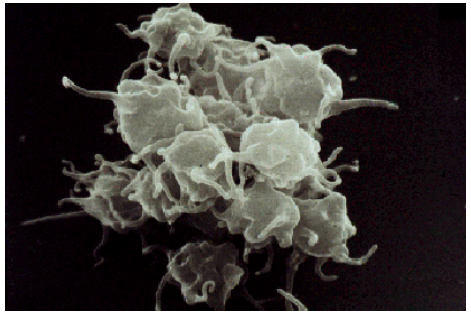
Bioelectric Applications

- Wound Healing
  - Platelet gels - nanosecond pulse electric fields to activate platelets
  - Gene therapy – delivery of plasmids encoding angiogenic factors to accelerate wound healing

Using Pulsed Power to Activate Platelets for Wound Healing

Platelets

Before Activation

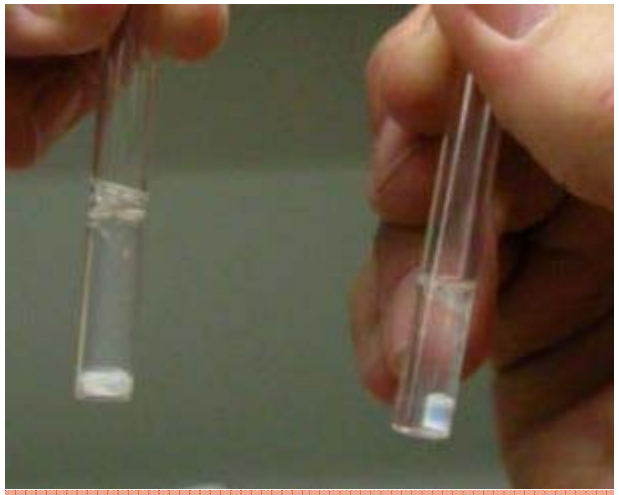


After Activation

Bovine Thrombin is used in current clinical trial

Problems of Using Bovine Thrombin

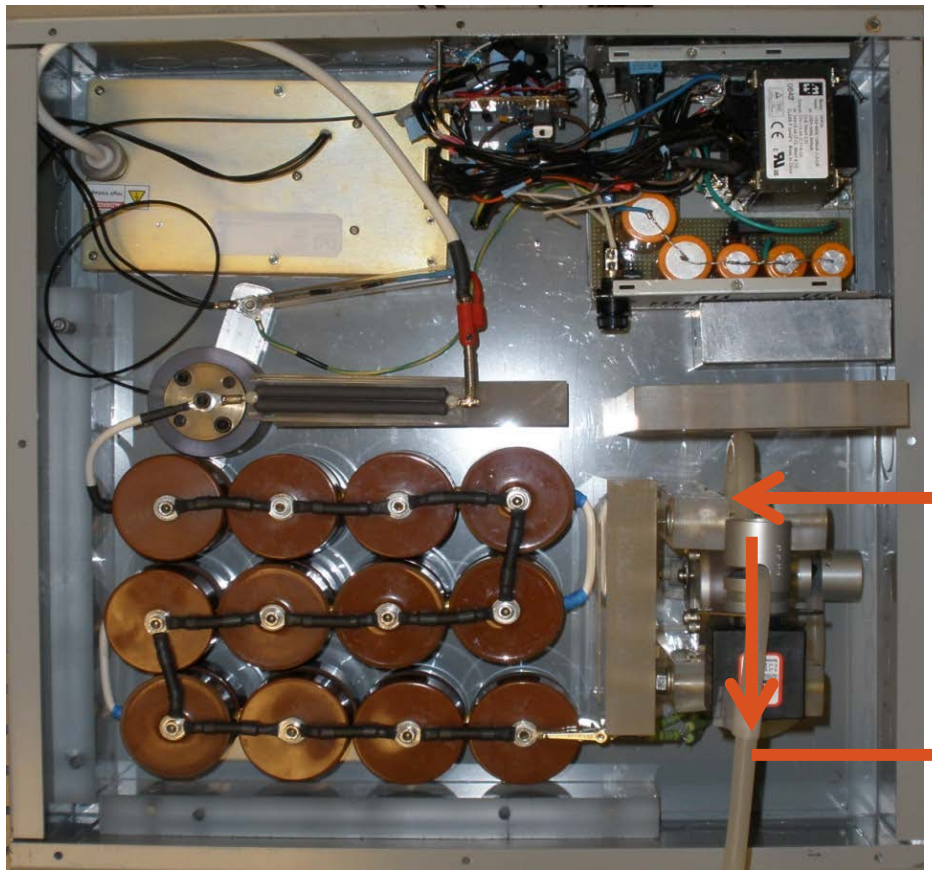
- possible allergies and complications
- potential risk of contamination of Creutzfeldt-Jakob's disease (Mad-cow disease)

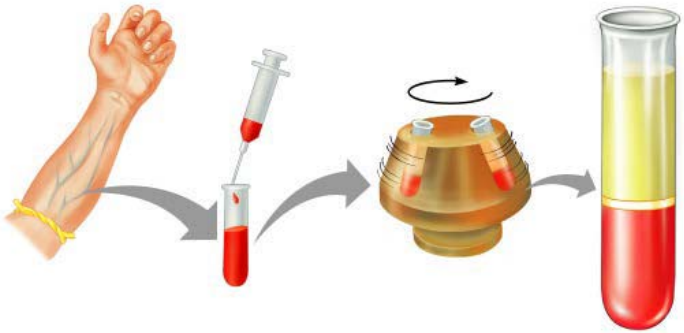


Thrombin activated gel

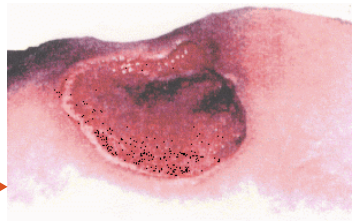
nsPEF activated gel

Compact Pulsed Power Generator for Platelet Gel Production in Doctor's Office





Platelet Rich Plasma (PRP)



(PRP) Gel

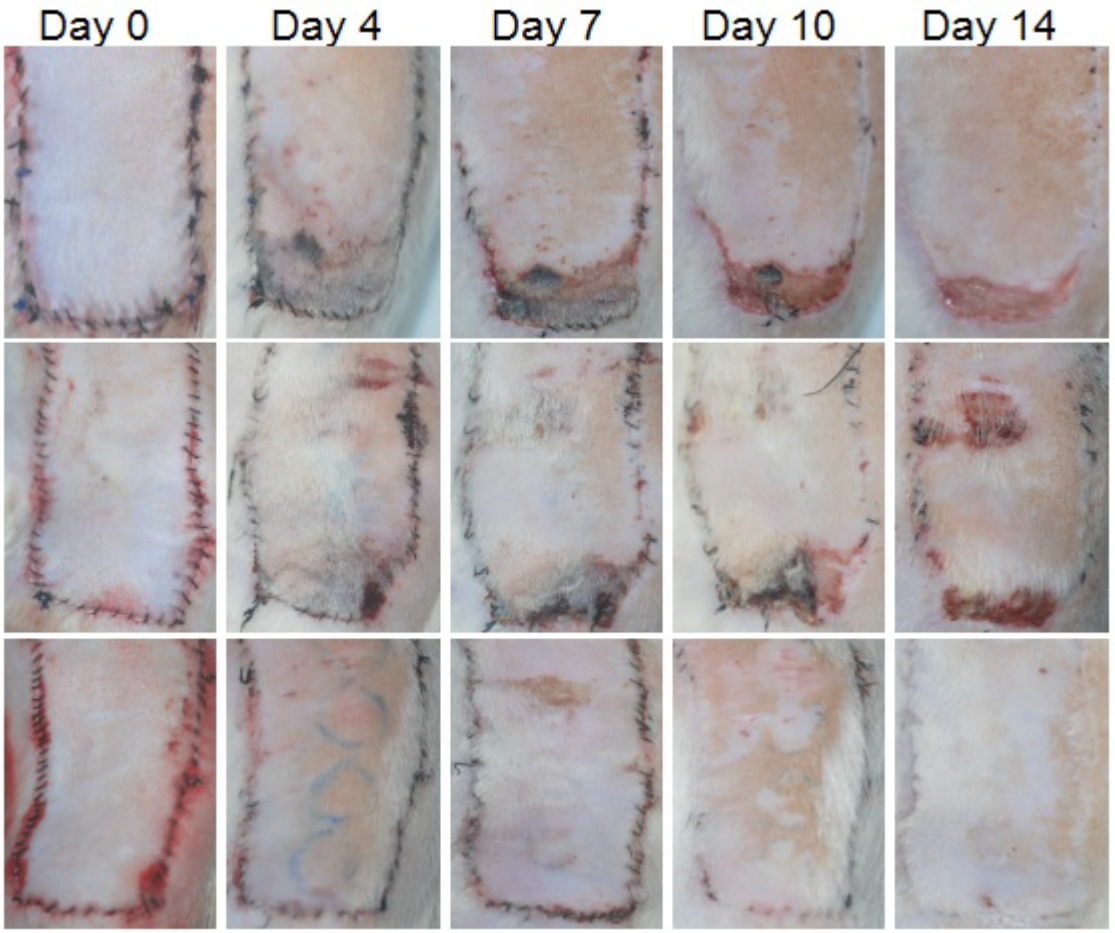
Wound

Pulse Duration: 300 ns ▪ Voltage: 20 kV
Electric field (for 4 mm chamber): 50 kV/cm
Repetition rate: 3 Hz

Commercial Opportunities

- Platelet Gel for Wound Healing (near term) & Ischemia (mid–long term)
  - Dental surgery, orthopedics and plastic surgery
  - Gel Advantages – accelerated healing, less bleeding (enhanced hemostasis) and bruising, less pain, lower risk of infection, less chance of fluid collection (seroma)

Wound Healing



Plasmid = Vascular Endothelial Growth Factor

Ferraro, et al Mol Ther. 17:651, 2009

Commercial Opportunities

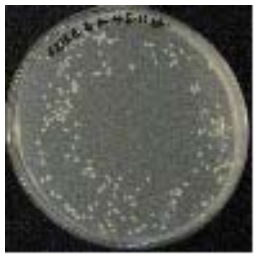
- Gene Therapy for Wound Healing (mid–long term)
  - Electroporation type pulses
  - Dependent on factor delivered
  - Utilizing gene transfer to the skin of an angiogenic factor
  - Utilized for large defects – flaps

Bioelectric Applications

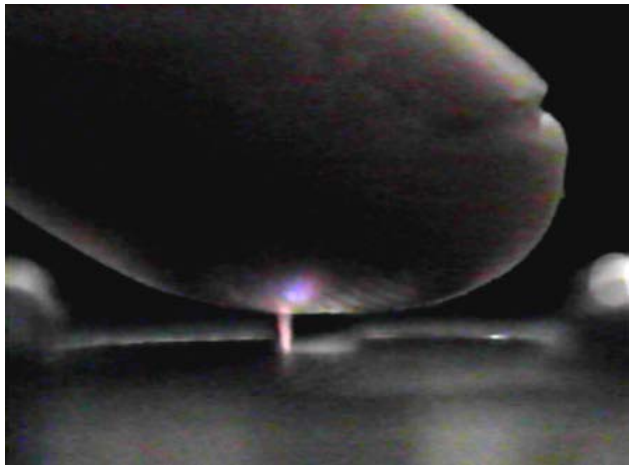
- Plasma
  - Use of cold plasma to destroy bacteria
    - Prevention of wound infections
    - Decontamination of food
    - Decontamination of surfaces

A. baumannii

P. aeruginosa

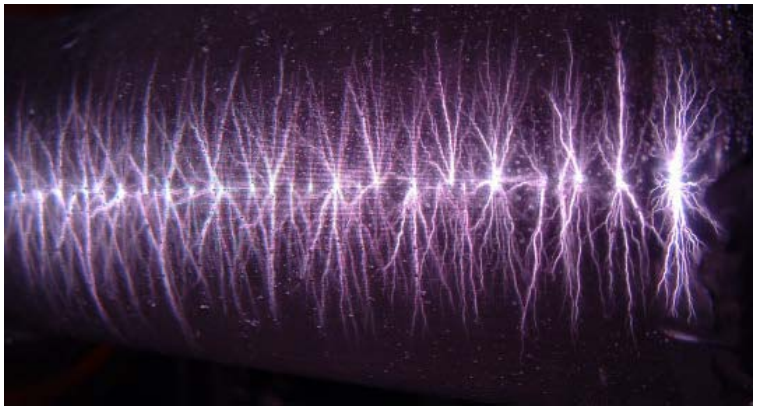


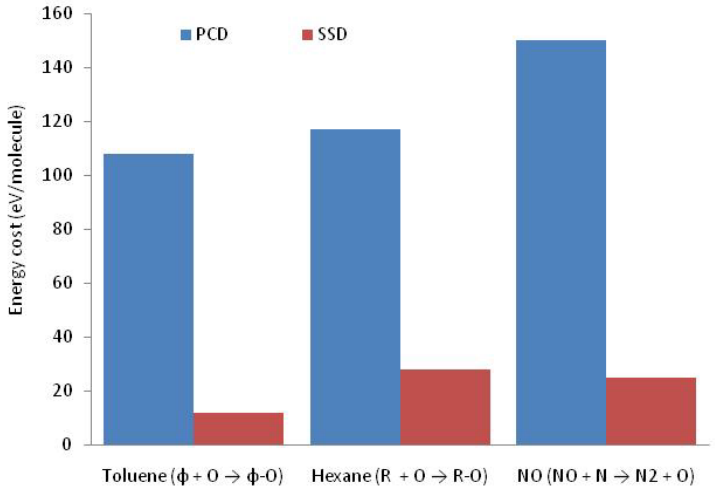
S. aureus



Bioelectric Applications

- Plasma
  - Other applications
    - Removal of nox from diesel exhaust
    - Air purification
    - Fuel reforming
    - Extraction of radioactive tritium





Commercial Opportunities

- Cold Plasma (near-mid term)
  - Destroy microorganisms including pathogenic bacteria
  - Decrease chance of infection in wound healing
  - Hand sanitizing or other surfaces
  - Disinfecting rooms – hospitals, schools
  - Dentistry applications
  - Decontamination of equipment
  - Decontamination of food

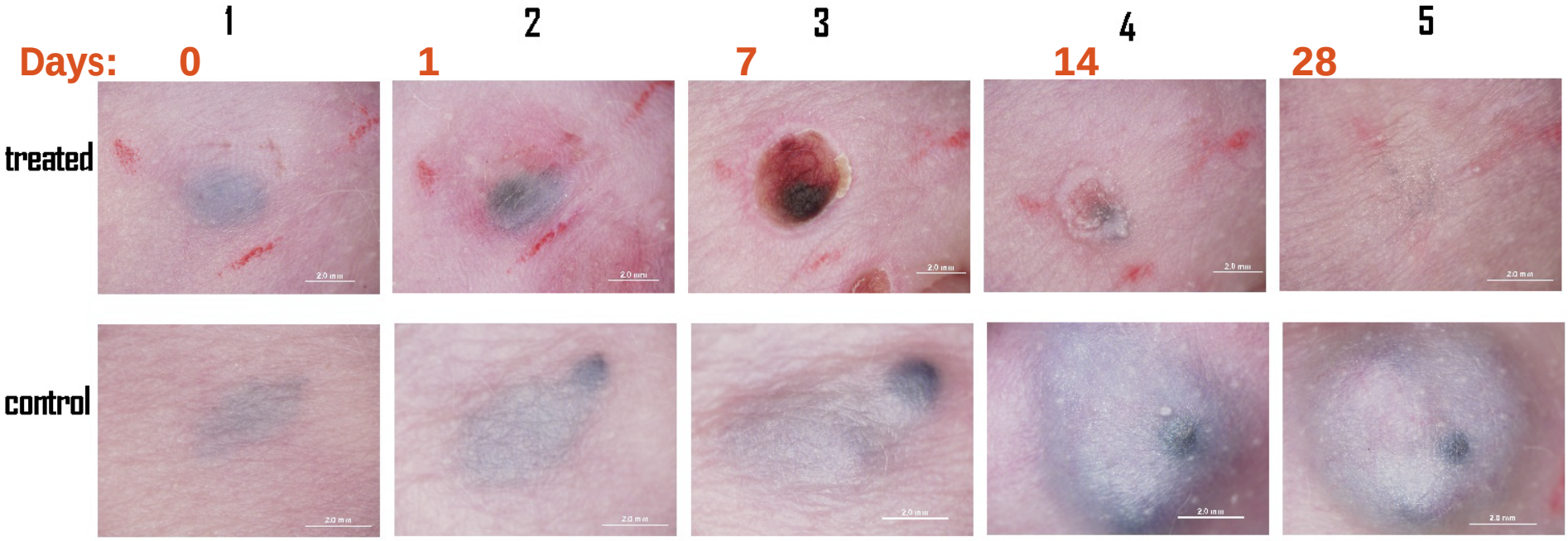
Commercial Opportunities

- Plasma Streamers with or without steam (near-mid term)
  - Remove nox from diesel exhaust
  - Air purification
  - Fuel reforming
  - Extraction of radioactive tritium

Bioelectric Applications

- Treatment of Cancer
  - Ablation therapy – nanosecond pulse electric fields to destroy tumor cells – work performed in melanoma, squamous cell carcinoma, liver cancer, pancreatic cancer and breast cancer
  - Gene therapy – micro-millisecond pulse electric fields to deliver plasmid DNA to stimulate immune system. Phase I clinical trial successfully completed. Phase II trial initiated.

NsPEFs Decrease B16F10 Tumor Size



Electrogene Transfer of pIL-12 to Melanoma Patients

Phase I does escalation study (0.1 – 1.6 mg/ml) to evaluate safety and tolerability of approach. Secondary objective is to evaluate response.

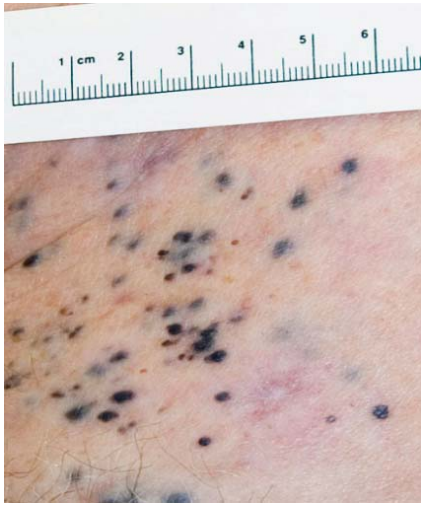
Patients with Stage III or IV malignant melanoma with cutaneous lesions. To enroll a patient must have at least two lesions and up to 4 can be treated.

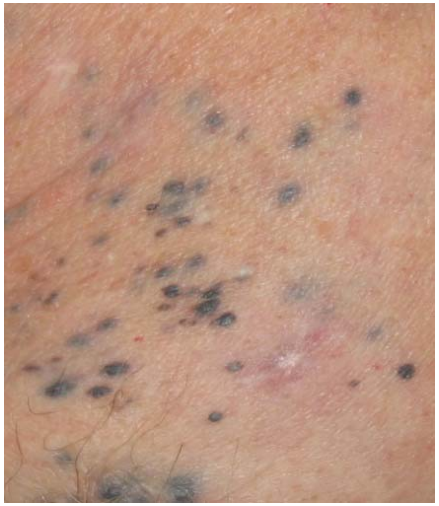
Patients receive 3 treatments (Days 1, 5 and 8). 1300 V/cm 100

Results

- Safety and tolerability
  - No serious adverse events related to therapy
  - Blood work all within normal ranges
  - No unanticipated adverse device effects
  - All subjects enrolled completed therapy

- Response
  - Increased levels of IL-12 following treatment
  - Histological evidence of tumor necrosis and lymphocytic infiltrate
  - 19 patients with additional disease
    - 3 had a complete response
    - 2 have long-term stable disease
    - 3 had stable disease for 4-6 months





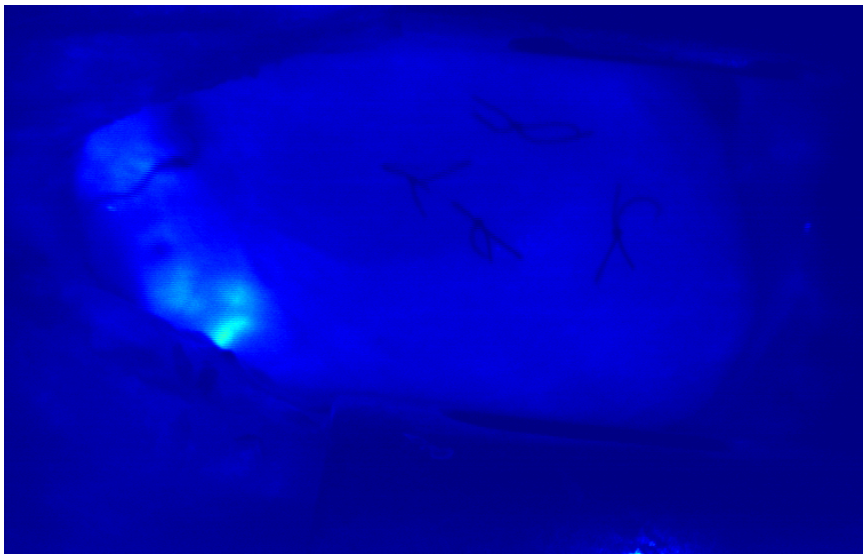

Daud, et al, J Clin Oncol, 2008

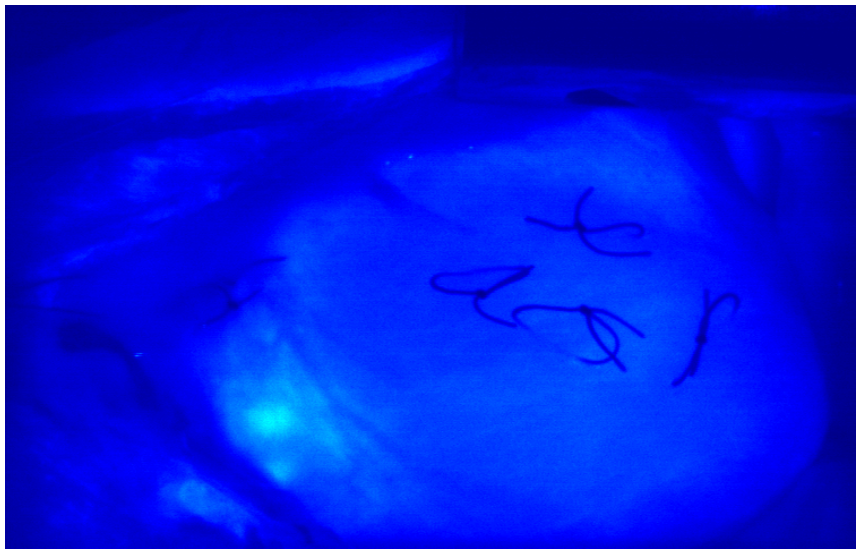
Commercial Opportunities

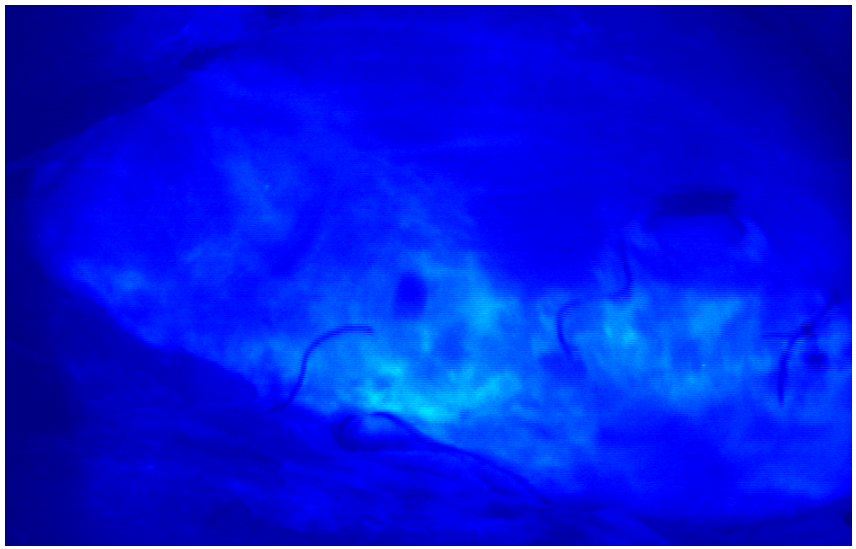
- Cancer Therapy
  - Ablation (near-mid term)
    - Nanosecond pulse electric fields – induce apoptosis
    - Any solid tumor
  - Gene Therapy (mid term)
    - Deliver genes encoding immune modifiers
    - Induce a systemic response from local treatment
    - Potential for most metastatic cancers

Bioelectric Applications

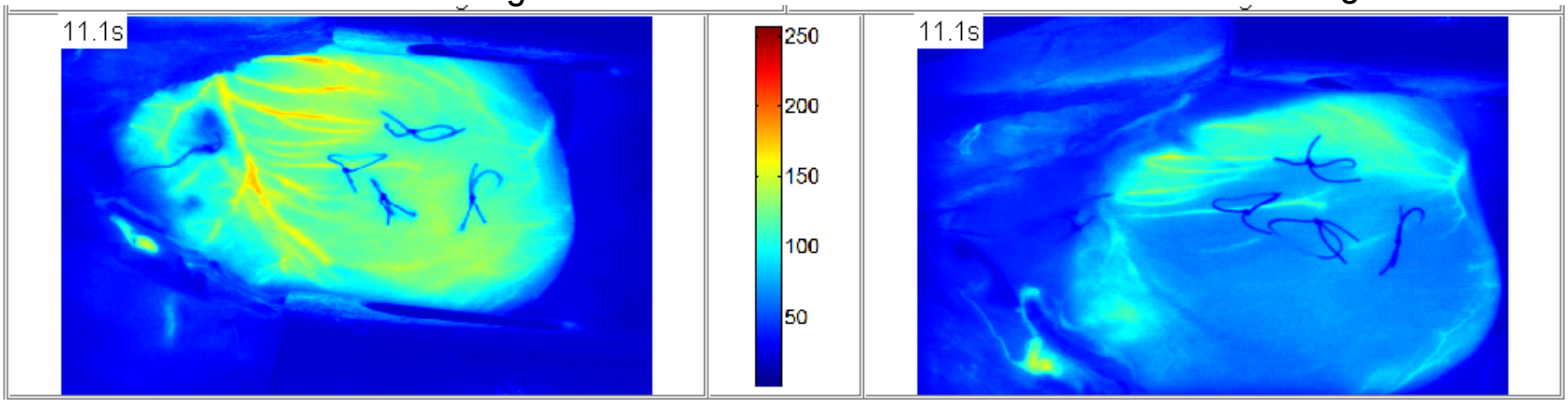
- Cardiovascular
  - Coronary artery disease – gene therapy to assist revascularization
  - Peripheral vascular disease – gene therapy to assist revascularization





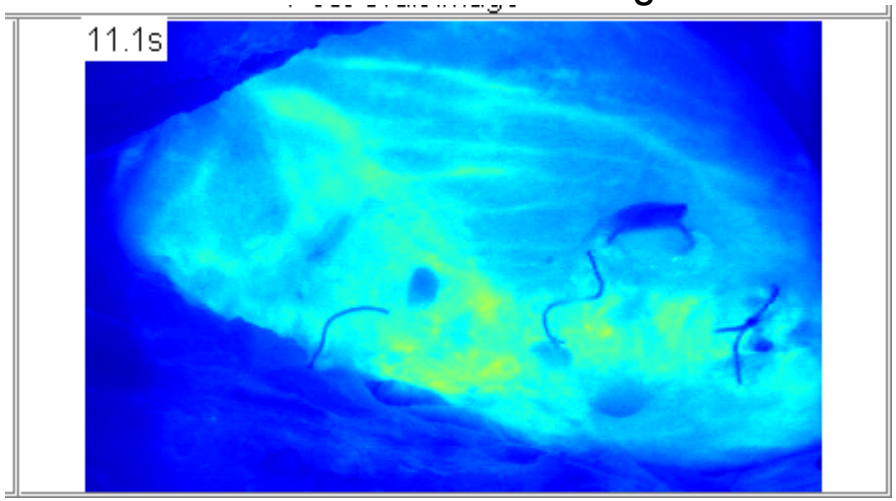


Pre Occlusion Image



Post Occlusion Image

Post Treatment Image



Commercial Opportunities

- Gene Therapy for Wound Healing

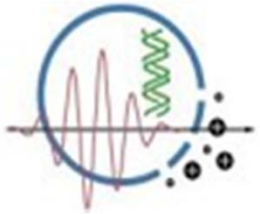
  (mid-long term)

  - Electroporation type pulses (long pulses)
  - Dependent on factor delivered
  - Peripheral vascular disease
  - Coronary artery disease

Center for Bioelectrics - Future

- Electric/electromagnetic fields are powerful tools
  - Tremendous translational opportunities
  - Multiple new applications
- Expansion
  - Recruit new faculty – target plasma, cancer biology, immunology, cardiovascular and neuroscience expertise
  - Additional space

Questions?



Frank Reidy Research Center for Bioelectrics

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odu.edu/engr/bioelectrics

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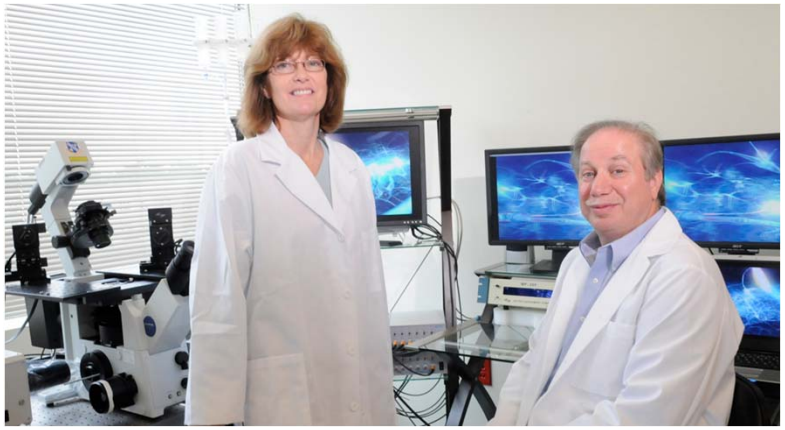

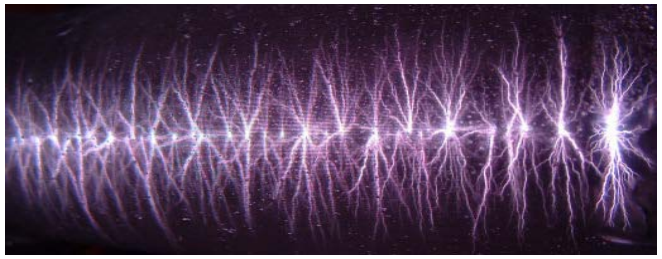

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