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Spring 2013 –
Midterm Student Report

Project 1: Mathematical Modeling and Validation Experiments of Laser-Induced *in vitro* Cell Damage

- **Goals:**
  - Derive a new mathematical model for cell damage that considers a transitional damage state in addition to viable and dead cell populations based on thermodynamic principles
  - Design and conduct experiments in an established *in vitro* retinal model to produce high-replicate data
  - Validate and calibrate the novel mathematical model using the collected experimental data
- **Brief Description:**
  - Our objective is to develop a validated mathematical model that will advance our understanding of laser-induced non-isothermal effects on cell damage thus improving the accuracy of laser-tissue interaction predictions.

- **Heights of Achievements this semester:**
  - Wrote a proposal for an AFOSR grant (plan on submitting early May)
  - Attended training in the use of experimental equipment at Fort Sam Houston, Texas
  - Performed mock experiments to practice and understand the limits of the experimental apparatus

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Project 1: Novel Mathematical Model

- The probabilities of necrotic (N), apoptotic (A), and viable (V) cell populations after exposure to temperature T for exposure duration time τ:

$$N(\tau, T) = \frac{1}{1 + e^{-\phi(\tau,T)/\kappa T} + e^{-\phi(\tau,T)/2\kappa T}}$$

$$A(\tau, T) = \frac{e^{-\phi(\tau,T)/2\kappa T}}{1 + e^{-\phi(\tau,T)/\kappa T} + e^{-\phi(\tau,T)/2\kappa T}}$$

$$V(\tau, T) = \frac{e^{-\phi(\tau,T)/\kappa T}}{1 + e^{-\phi(\tau,T)/\kappa T} + e^{-\phi(\tau,T)/2\kappa T}}$$

- where $\phi(\tau, T)$ is of the form $\gamma - \big(\alpha + \beta(\tau)\big)T$.
- κ is Boltzmann's constant, and γ, α, and β are parameters that depend on the cell types and must be determined experimentally.

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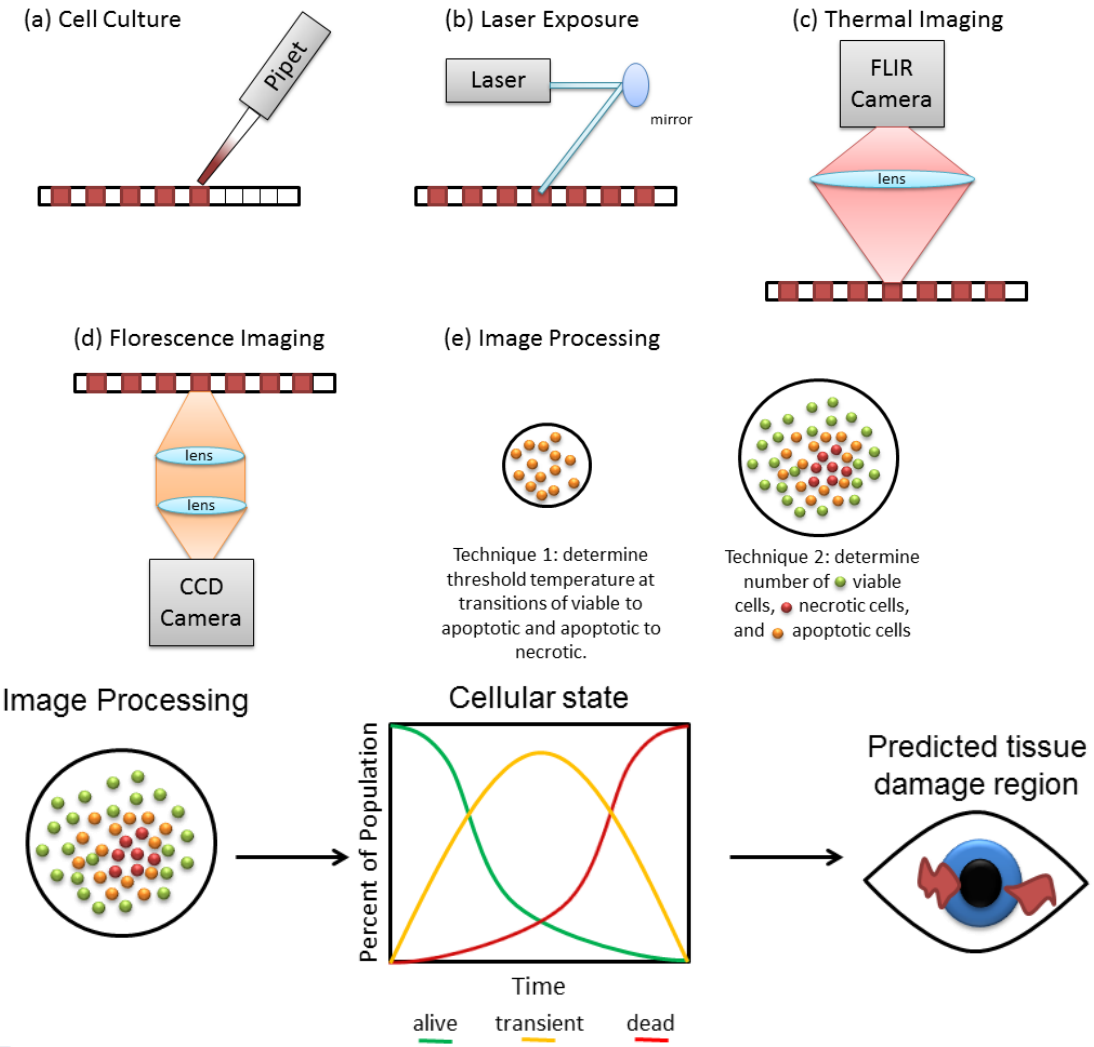
Project 1: Validation Experiments



Project 2: Cell Migration and Metastasis Simulation and *in vitro* Experimental Study

- **Goals:**
  - Develop a computational model using a hybrid mixture theory to investigate cell proliferation, migration, and interactions between cells and their extracellular matrix
  - Conduct *in vitro* cellular migration experiments to validate the model's capability for prediction of cell motion and influence of extracellular matrix properties on tumor cell adhesion, shape, and cytoskeletal arrangement, proliferation, and migration when cultured on collagen substrates.
- **Brief Description:**
  - Understanding the processes and mechanisms of cancer cell migration and metastasis is critical to the fields of oncology and drug delivery. It is our interest to understand the regulation and environmental factors that control these phenomena.

- **Heights of Achievements this semester:**
  - Simulations using COMSOL multiphysics now working in 3D
  - New approaches of adding vascular grafts to the computational simulation have been accessed
  - We are studying the multiscale attributes of the model (mesoscale, microscale, and nanoscale)
- **Problems/Concerns that prevent your progress:**
  - Nothing preventing progress

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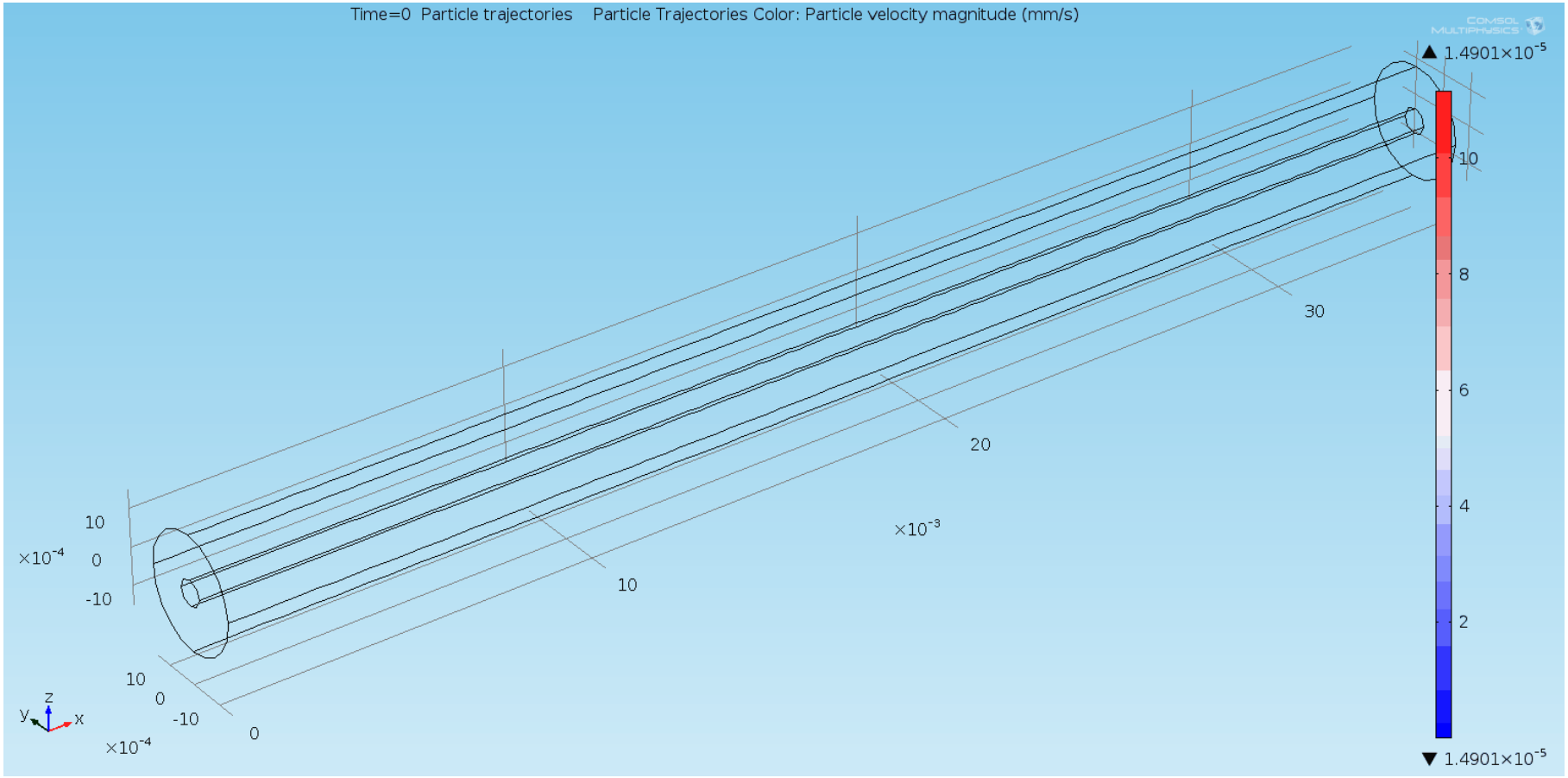
Project 2: Cell Migration and Metastasis Simulation and *in vitro* Experimental Study



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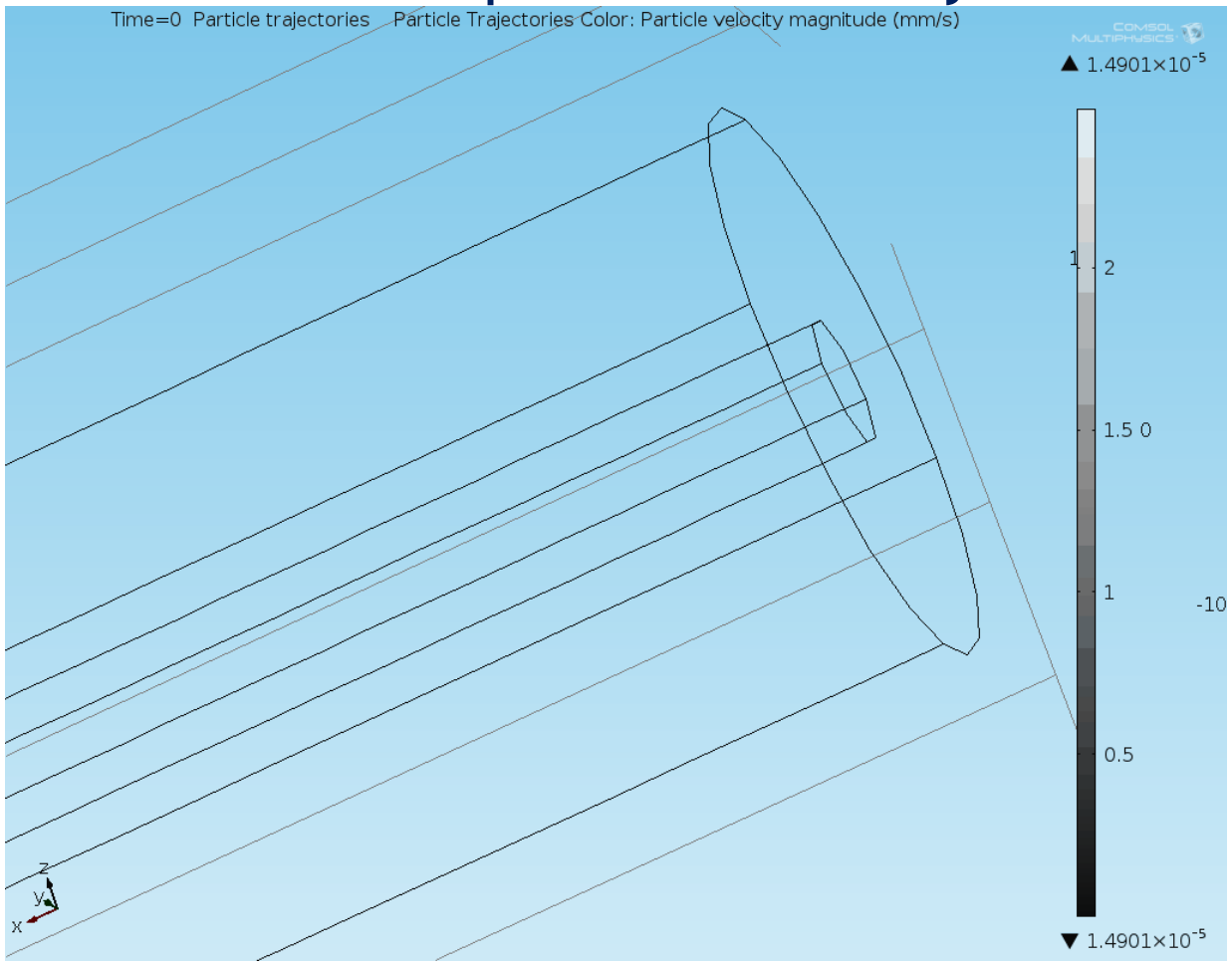
Project 2: Cell Migration and Metastasis Simulation and *in vitro* Experimental Study



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