Poster Session Abstracts

Mechanical Properties of Nanocrystalline Ni Nanopillars

Eli E. Alster

Mentors: Julia Greer and Jie Lian

Materials sized on the order of nanometers possess mechanical properties far divergent from their bulk analogs. In order to quantify the effects of microstructural dimension and external scale on materials' mechanical properties, both grain size and sample size were varied across the nanometer range and plotted against yield strength to help form a three dimensional plot. Fabrication of the nanopillars was accomplished through electrodeposition of Ni in template microarrays and mechanical properties tested through uniaxial compressions by a Hysitron nanoindenter with a flat punch tip. Original and post-deformation images were taken with either the Nova-200 or Nova-600 scanning electron microscope (SEM). Grain size was determined through the lift-out procedure and transmission electron microscopy (TEM). Molecular dynamics simulation work was also undertaken using the LAMMPS software package to investigate the nucleation and movement of dislocations, which are difficult to capture from experimental observations. These efforts were designed to gain insight into the not yet understood mechanisms which drive deformation at nanoscale.

Patterns of Nanog Sub-State Switching in Single Mouse Embryonic Stem Cells

Chih-Ping Chen

Mentors: Michael Elowitz and John Yong

Nanog is a transcription factor thought to safeguard embryonic stem cells from differentiating. However, it is found to be expressed heterogeneously even in undifferentiated populations between a high-Nanog state and a low-Nanog state. Of particular interest for this project, it has been observed that individual cells can switch between high-Nanog and low-Nanog states while remaining undifferentiated. Using time-lapse fluorescent imaging, it is possible to track Nanog transcription in single cells through multiple cell cycles. From analyzing these tracks, we seek to characterize the frequency, time-scale and pattern of inheritance of the switch. These patterns are being compared to establish the uniqueness of the way Nanog transcription is being regulated. This analysis will serve as the basis for further study of the phenomenon under various culture conditions.

Towards the Use of Formal Methods for Dexterous Robotic Manipulation

Sandeep Chinchali

Mentors: Joel Burdick, Scott Livingston, and Ufuk Topcu

We apply advances in formal methods and symbolic motion planning to synthesize robust, generalized control strategies for the canonical problem of finger gaiting in dexterous manipulation. In this scheme, fingers on a hand move continuously to re-orient an object until they encounter joint limitations, at which point the constrained fingers must be repositioned while always maintaining a force closure (FC) grasp.

The problem of gaiting an object in the midst of external perturbations is modeled as a two person Generalized Reactivity (1) game between a control system (the robotic hand) and adversarial environment. Desired behavior of the system is specified using linear temporal logic (LTL) and a correct-by-construction control strategy in the form of an automaton is synthesized. Finally, results from a kinematics simulation of a planar robotic hand manipulating an object are presented to illustrate the efficacy of this approach.

Using Rubredoxin From *Pyrococcus furiosus* as a Model for Determining Oxidation States of Individual Fe Atoms in Nitrogenase as a Means for Probing the Mechanism of Biological Nitrogen Reduction

Connor W. Coley

Mentors: Douglas C. Rees and Limei Zhang

Nitrogenase is the enzyme responsible for biological nitrogen reduction. The oxidation states of individual Fe in nitrogenase can be assigned using the multi-wavelength anomalous diffraction technique, which is critical to understand the functional mechanism of nitrogenase. The single Fe-bound Rubredoxin from *Pyrococcus furiosus* is used as a model for optimizing data collection and data analysis for such a goal. In this project, the wild type Rubredoxin from *Pyrococcus furiosus* has been successfully overexpressed, and purified with high homogeneity using anion exchange and size-exclusion chromatography. Crystallization methods have also been refined, yielding single crystals up to 1 mm in diameter through a combination of microseeding and macroseeding. Any high quality crystals produced in this study will be applied to refining data collection strategy in the future. Analysis of multi-wavelength anomalous diffraction data of PfRd collected previously will also help to improve the algorithms for data analysis in the subsequent studies.

Telemedicine and the 10-Cent Checkup
Alex Fandrianto
Mentors: K. Mani Chandy and Julian J. Bunn

We construct the framework for a remote medical checkup by developing an otoscope, stethoscope, and electrocardiogram (ECG) device. The otoscope and stethoscope devices are adapted to Nexus One Android phones. The otoscope casing covers the phone's camera and contains a small lens and fiberoptic cable to shine the phone's camera light out of its aperture. Acoustic signals sensed by the stethoscope head are converted to electrical signals by a microphone in a casing attached to the stethoscope; the electrical signals are fed to the microphone input of a phone or computer. ECG recordings from the 3-electrode ECG are taken by a laptop. Recordings are saved locally with associated medical metadata and can be uploaded to the Amazon Web Server (AWS) where they can be viewed securely from a browser. The ECG data is contaminated with 60 Hz power line noise; various filters are applied to improve the signal-to-noise ratio (SNR). The filtered data can then be used to detect pulse via triggering. The system performance of each device is determined by comparing its recordings against the medical ideal.

Symmetries of Unrooted Polygons and Multiple Logarithms
Meng Ge
Mentor: Susama Agarwala

Multiple polylogarithms are important algebraic objects. They have applications in number theory (mixed –Tate motives) and they also apply in the calculations of Feynman diagrams in physics. Previous papers have calculated dihedral group actions on rooted polygons, namely, σ which rotates the index of the sides of the polygon by 1, and τ which is the action of reflection. In this paper, we study the effect of transposition, denoted as ρ, on rooted polygons. We know that for a three-gon Q, $\rho Q=\tau Q$. Using induction, we can relate the action of (O_b, V) of a polygon, which is defined in previous published papers, to that of its subpolygons.

Proton Exchange Membranes With Through-Plane Aligned Ion Conducting Channels: A Study of Ionic and Electric Conductivity
Mengyu (Kelly) Guan
Mentors: Seung-Hyeon Moon and Sung-Hyun Yun

Proton exchange, or polymer electrolyte, membranes (PEM) are semi-permeable membranes used in proton exchange membrane fuel cells (PEMFC). PEMs function to separate the reactants and transport protons across the membrane while blocking electrons. Current research focuses on improving membrane properties by (i) using different ionomers and (ii) modifying the structural properties of the membranes. Sulfonated poly(phenylene oxide) (SPPO) has been shown to be a promising PEM candidate, while applying an electric field perpendicular to the membrane surface may improve proton conductivity and PEMFC performance. In order to study the effects of applying an electric field along the membrane thickness direction, a series of SPPO membranes, with a target thickness of ~50 μm, was fabricated under an applied electric field and characterized. Since electrical insulation becomes an issue with thin membranes, this study will also attempt to measure the effects of electron transport across PEMs by electrical impedance spectroscopy. Finally, the optimal membrane will be tested for PEMFC performance against a commercially available Nafion membrane to compare and further optimize membrane properties.

Dinosaur Body Temperatures From Clumped Isotope Paleothermometry in Carbonate From Eggshells
David Hu
Mentors: John Eiler and Rob Eagle

The nature of the physiology and thermal regulation of non-avian dinosaurs is the subject of debate and arguments have been made for both endothermic and ectothermic metabolisms. Here clumped isotope thermometry of carbonate is used to show modern bird and reptile eggshells record the body temperatures the female experienced prior to egg laying. The method is applied to well preserved cretaceous oviraptor eggshells. The body temperatures of oviraptors are determined to be 29-33C, similar to modern reptiles. Soil nodules found near the cretaceous shells estimate paleoclimate temperatures at 21-25C. Evolutionarily, oviraptors are close relatives of modern day birds suggesting avian endothermy developed late on the evolutionary timeline of birds. It also suggests most dinosaurs were ectothermic and previous endothermic-like results in larger dinosaurs are the product of gigantothermy.

Post-WWI Scientific Communication Networks as Seen Through Albert Einstein's Correspondence

Xiao (Dawn) Jin
Mentor: Diana Kormos-Buchwald

Einstein's correspondence during the post WWI period grew exponentially. His correspondents also diversified, ranging from Zionist leader Chaim Weizmann to celebrated author Stefan Zweig. In my project I utilize Einstein's immense amount of letters as my primary sources, and examine both the reach and depth of his connections with colleagues, family, politicians et al. The most important method I use is statistics. I record the identities of Einstein's correspondents, including nationality, occupation, family backgrounds, and relations to Einstein, in addition to frequency of correspondence. Then I carry out some typical statistical analyses such as sorting and distribution analysis. My project will expectedly reveal something new about the process of the science center shifting from Germany to the outside (possibly America), and the post-WWI scientific community in general.

Interactive Image Segmentation Toolset: An Application for Crowdsourcing a New Benchmark Segmentation Dataset

Alex Jose
Mentor: Pietro Perona

Image segmentation is an area of study in computer vision, usually referring to computer-generated partitioning of an image into regions. The goal of segmentation is typically to simplify the information in an image from a large set of unorganized pixels to a set of more manageable and meaningful areas. In creating algorithms for image segmentation, it is useful to have a base set of reference images such that the performance of multiple algorithms can be compared. This project aims to create a segmentation toolset that will enable the Vision Lab to generate such a dataset. This toolset will consist of programs enabling humans to quickly segment images, and will be distributed through Amazon's Mechanical Turk crowdsourcing program. The tasks will be divided among participants who will complete small portions of the overall segmentation - such as outlining part of a single image - for a small amount of money. Ideally, from this process we will not only generate a new dataset but will elucidate some of the intricacies of human approaches to segmentation.

Elastostatic Solutions for Realistic Slip and Stress Around Mode II and III Cracks

Valère R. Lambert
Mentors: Jean-Philippe Avouac and Sylvain Barbot

A common practice for analyzing the displacement and stress caused by slip on buried faults is to discretize the fault area into finite size patches of assumed uniform slip and use the corresponding Green's functions to predict strain at the surface or within the bulk of the medium. This formalism is commonly used to invert observation of co-seismic deformation for fault slip, in afterslip analyses, stress transfer studies and in numerical models of the seismic cycle, such as the Uniform California Earthquake Rupture Forecast (UCERF). The discretization of the fault into areas of uniform slip introduces stress singularities at the edges of each patch, which might make the results quite sensitive to the choice of the discretization scheme. Yet, little attention has been paid to this issue so far. Here, we derive analytic expressions of the Green's functions, for which the Okada's solution is a special case. We derive a full-space formulation for linearly interpolated fault slip distributions, which allows discretization of any fault slip distributions without introducing stress singularities. We investigate the case of a finite crack with a uniform distribution of stress on the fault. We show that the Okada solution provides an inadequate representation of the stress distribution for mode II and III cracks, even in the limit of infinitely small discretization. We introduce a critical size of fault discretization below which stress singularities dominate and bias the distribution. Our tapered-slip solution does not suffer from these shortcomings, suppresses all singularities and converges to a uniform stress with smaller discretization. Our results demonstrate the need to resolve the areas of stress concentration in our models of fault slip evolution.

2011 Solar Decathlon: Building Control Subsystem

David Lu
Mentor: Richard Murray

Abstract is not available.

Study of *Z boson + Higgs* → *Z boson W boson W* boson* → *leptons + neutrinos* at the International Linear Collider
James Macdonald
Mentors: Maria Spiropulu and Barry Barish

This project studies the Higgs decay channel $H \to WW^*$ with either two or four lepton plus neutrino final states at a proposed International Linear Collider (ILC), an electron positron collider with center of mass energy 250 GeV and an integrated luminosity of $250\,fb^{-1}$ as assumed in the ILC Letters of Intent. To accomplish this we produced Monte Carlo data for Higgs production events as well as standard model background. The objective is to extract the Higgs signal from the dominant standard model background of ZZ and WW dibosons and possibly from "Higgs look-alikes." Ultimately we would like to develop handles to distinguish a standard model Higgs from its look-alike states and improve on the selection criteria by using angular and other new kinematic variables.

Proteomic Analysis of Histone Post-Translational Modifications and Their Cellular Targets
Neeli Mishra
Mentors: Benjamin A. Garcia and Jack L. Beauchamp

Histones are small proteins that function to package genomic DNA into the basic unit of chromatin, the nucleosome. Post-translational modifications (PTMs) of histones are called epigenetic (heritable changes in gene expression that occur without alterations in gene sequence). Histone PTMs occur on multiple but specific sites, suggesting that histones can act as a signaling platform for nuclear events. A "histone code" hypothesis has been put forward to explain how these PTMs are responsible for the regulation of transcriptional activity through the alteration of chromatin states. In the first study, we seek to investigate the impact of epigenetic gene expression on both histone modifications and the nuclear proteome. The project focuses on the knockdown cell line of EZH2, a clinically significant histone methyltransferase associated with developing tumors. Using proteomics to directly investigate the cellular function, we combine SILAC labeling and mass spectrometry (MS) to characterize the alterations in abundances for nuclear proteins in these epigenetically modified cells. Histones are typically studied using electron capture/transfer dissociation or collision-induced dissociation MS. The second study focuses on testing an alternate, recently developed free-radical initiated peptide sequencing (FRIPS) technique to selectively cleave peptides at specific amino acid residues and potentially improve histone PTM analysis.

The Incidence of Active Galactic Nuclei in Galaxy Groups
Eric Mukherjee
Mentors: Christine Jones, Andrew Goulding, and Fiona Harrison

Properties of Active Galactic Nuclei (AGNs) are linked to properties of their host galaxies. Reseach suggests AGNs are the result of accreting black holes at centers of galaxies, and affect properties like star formation rate, stellar mass, and galaxy color. Knowing how the large scale environment influences AGN evolution may further our understanding of this relationship. We seek to constrain AGN environments in the 9 square degree Chandra Bootes survey. We used ~15,000 optically observed galaxies in the AGN and Galaxy Evolution Survey (AGES) catalog to determine whether AGN form in groups. We developed a friends-of-friends algorithm to locate galaxy groups associated by distance and velocity, and a matching program to associate groups with possible X-ray detections. We found 4,758 (~30%) galaxies in 1,554 groups in the AGES catalog with $0.01<z<0.8$. Of 213 X-ray galaxies, 49 were in groups with $0.01<z<0.6$, with 23 isolated galaxies at $z>0.6$. The redshift distribution of these X-ray sources was proportional to the redshifts of all groups. AGNs in groups were found at mean luminosities of $\sim 1.8 \times 10^{42}$erg/s in the soft band and $\sim 8.5 \times 10^{41}$erg/s in the hard band with groups larger than 4 appearing only at $z<0.4$.

Using Uncertainty Quantification to Maximize the Efficiency of Parallel Resources
Andrew C. Rodriguez
Mentor: Mike McKerns

When dealing with any batch computation across parallel resources, a common problem is encountered: the computation time for the batch is extended by calculations that take longer than the rest. More so, we find that with parallel computation for the process to continue, we must allow for the final computations to finish. Though each calculation within the batch may not take much time individually, compounded, we find that, overall, a lot of time is taken waiting for the final few computations. We can reduce overall computation time through use of completion criteria. By deeming a batch "complete" when certain criteria are met, we find that we both make a better use of resources and save time. And so, we are creating a "Completion" data structure that shall manage such features for use within mapping functions. Criteria shall include, but not be limited to, a simple "percent completion" condition and use of statistical methods to terminate based on the confidence of the collected results. This would increase efficiency and save overall computation time. This is important since even a simple 10% time reduction allows for us to save 2.4 hours on a computation that would normally take 24 hours.

Creating a Peptide Capture Agent Against IgG Fc

Errika C. Romero
Mentors: Jim Heath and Jessica Pfeilsticker

Inexpensive and robust HIV tests are needed for effective point-of-care diagnostics in many developing countries. Current HIV diagnostic assays employ monoclonal antibodies, which are expensive and inconsistent. Instead, peptides, which are low-cost and whose chemical properties are easily tuned, can be designed to bind with comparable affinity and selectivity to anti-HIV antibodies similar to monoclonal antibodies that were raised against the same target. Previous research has identified a 13 residue cyclic peptide, monikered Wells' peptide, which binds to the IgG Fc region of HIV antibodies. There are two binding pockets on every Fc molecule, so we created a dimer of Wells' peptide using standard amide coupling to interact with both pockets simultaneously. Affinity and selectivity assays are performed to determine the ideal dimer linker length and to measure the dimer's efficacy in binding to IgG Fc.

Fabrication of Silicon-Based Nanopore Membranes for DNA Nucleotide Characterization

Bhargav Setlur
Mentors: Axel Scherer and Aditya Rajagopal

In this ongoing project, we focus on the design and fabrication of a silicon-based nanopore for use in single stranded DNA sequencing. We start by defining the nanopore geometry using a multiphysics modeling program, which automatically calculates various electrical and capacitive parameters relating to the structure. Then, based on the idealized design, we demonstrate fabrication of the silicon nanopore using nanofabrication equipment located in the Kavli Nanoscience Institute in the sub-basement of Steele Building. Fabrication processes involve boring nanoscale holes in silicon using a transmission electron microscope to bore holes in silicon, as well as an SEM to beam-write patterns. Finally we fit the nanopore structures with electrical contacts and integrate them into the structure.

Construction of a Polarization Sensitive Optical Coherence Tomography System

Jeffrey D. Sherman
Mentors: Scott Fraser and Reza Motaghian

Neural degenerative diseases result in tissue damage and cause discomfort, disease, and death. Preemptively diagnosing these degenerative diseases and visualizing them will help in diagnostics as well as the search for cures and treatments. Recent advances in optical techniques have led to Optical Coherence Tomography (OCT), a noninvasive imaging technique without the use of ionizing radiation, particularly in the eye. The birefringence of tissue can act as a surrogate biomarker, allowing for an analysis of tissue structure and health. Polarization Sensitive OCT (PS-OCT) has emerged as an extension of OCT for capturing birefringence, particularly in the eye. Using PS-OCT, it is possible to detect the initiation of neural degeneration. Since the method is noninvasive, a longitudal analysis can be performed to monitor the progression of these degenerations and adjust therapies to better help the patient. A PS-OCT system was constructed in free space on optical breadboards for modularity. To verify the effectiveness of the system, eye scans taken by a Swept Source OCT system at 1060nm will be compared with scans that will be taken by the newly constructed PS-OCT system at 1060nm. If the PS-OCT system reveals tissue organization better than standard OCT, then the construction of the system will be considered a success.

Formation of Membrane Protein Nanocrystals Through Laminar Flow

Kelsey M. Spaur
Mentors: Michael Stowell, Rob Phillips, and Ray (Hsin-Jui) Wu

Membrane proteins play a critical role in transport across membranes. The ability to easily determine membrane protein structures can greatly benefit the pharmaceutical world as well as enhancing our knowledge of the human body in general. The project focuses on using a microfluidic device to mix protein and lipid and then induce the diffusion of detergent through laminar flow to allow the membrane protein to form. To make this methodology operational, tests were performed to prove that the protein and lipid mix at the designated ratio and to determine the mixing ratios and flow rates that best formed membrane proteins. Results indicate that the device reliably mixes protein and lipid at the desired range of ratios. At this point, the flow rate ratios of 1 to 100 and 1 to 500, protein/lipid combination to buffer respectively, have produced membrane proteins. Determining the diffusion rate of the detergent would be valuable supporting information about the process. Tests should be run with ratios near these values, 1 to 90 and 1 to 120 for example, to narrow in on the best ratios. Tests should also be performed with different protein/lipid mixing ratios.

Optical Feedback Cooling of a "Zipper" Optomechanical Cavity
Aiden Sullivan
Mentors: Oskar Painter and Alexander Krause

In an optomechanical cavity, such as the "zipper" cavities used in this investigation, the circulating optical field gives rise to a radiation pressure force that can drive the mechanical modes of the cavity. In turn, the mechanical oscillations deform and detune the optical cavity and thus modulate the optical field. Such coupling of the electromagnetic and mechanical degrees of freedom allows energy and information transfer between the optical and mechanical modes. Cavity optomechanics allows for unprecedented tests of quantum mechanics at the mesoscale. However, the mechanical mode must be close to its quantum mechanical ground state for quantum effects to be apparent.

Cryogenic cooling alone cannot sufficiently cool the mechanics. In order to cool further, we create a damping force with feedback. We measure the position of the mechanics with the light modulated by the cavity, and modulate the light going into the cavity to drive the mechanics with a force proportional to the velocity of the mechanics. We are working towards an implementation of such a feedback loop, and have developed a design that uses analog electronics to accomplish this. Further work includes implementation and tests of this design, as well investigating the possibility of using DSP technology to accomplish feedback.

Cryogenic Impact Testing of Tin (Sn) Solders and Bulk Metallic Glass Composites
Adam R. Ullah
Mentors: Marios Demetriou, Doug Hofmann, and Scott Roberts

Providing a protective shielding for space-deployed technologies is crucial when trying to ensure multi-component function and communication at different positions in space, in orbit and in other planets. At the California Institute of Technology, Vitreloy 1 ($Zr_{41.2}$, $Ti_{13.8}$, $Cu_{12.5}$, $Ni_{10.0}$, $Be_{22.5}$), GHDT ($Zr_{59.6}$, $Ti_{26.8}$, $Cu_{8.90}$, $Be_{4.63}$), DH3 ($Zr_{39.6}$, $Ti_{33.9}$, $Nb_{7.60}$, $Cu_{6.40}$, $Be_{12.5}$) and Tin (Sn) were cryogenically tested on a Charpy Impact Tester to determine their mechanical performance on a temperature scale from (-186.5°C to +22°C). At these temperature ranges, DH3 was compared to the monolithic glasses (Vitreloy 1 and GHDT). The dislocation motion in the BCC-phase of DH3 decreases at lower temperatures but does not perform worse than monolithic glasses Vitreloy 1 and GHDT. There is a ductile to brittle transition in the mechanical performance of DH3; however, the ductile to brittle transition is small in comparison to other contending BCC metals. DH3 is capable of protective cryogenic shielding.

Test Bench for a Retinal Prosthesis Neurostimulator IC
Angie Wang
Mentors: Azita Emami and Manuel Monge

Patients affected by diseases like retinitis pigmentosa (RP) and age-related macular degeneration (AMD) incur severe vision loss as retinal photoreceptor cells degrade, causing less visual information to be transmitted to the brain. However, it is possible to bypass damaged photoreceptors and stimulate the remaining retinal neurons with visual information directly through the use of charge-balanced biphasic currents generated by a retinal prosthesis implant, restoring vision to the blind. A system to test the functionality of the current-based neurostimulator IC that drives the retinal implant's 1024-channel electrode array is being developed. Digital logic blocks designed in VHDL and implemented on an Altera Cyclone II FPGA along with radio-frequency analog components are utilized to wirelessly transmit and receive data between the test system and the retinal implant. Image data from a 5-megapixel camera placed in close proximity to the implant is encoded for use as stimulus control signals that are sent to the implant using a quadrature phase-shift keying (QPSK) modulation scheme. The resultant stimulus driver output is verified by the test bench.

Strong and Tough Graphene-Polymer Composites
Amy Wat
Mentors: Julia R. Greer and Wendy Gu

The strength and toughness of a graphene-polymer composite are optimized by emulating the nacre structure, which calls for graphene platelets dispersed in a polymer film. The graphene was grown on a copper rod using chemical vapor desposition and extracted off the copper rod by sonication. Raman Spectrometry reveals that a small flake of graphene was obtained. The surface of the copper rod was also etched off, but there is no indication that graphene was obtained. Graphene was also obtained through liquid exfoliation, which is sonication of graphite in a solvent followed by vacuum filtration. This created a mixture consisting of a low yield by weight of graphene platelets. The composites were created by spincoating a thin polymer film layer and then applying a graphite layer, which interfered with creating consistent uniform thin films. Composites were also made by applying graphite onto a polyisoprene disc, which was cut into four pieces and stacked on top of each other then flattened, which allows the creation of many thin bilayers of graphene and polymer each time the process is repeated. Through this project, we found the difficulty of mass producing graphene and how graphite affects the polymer strength and toughness.

Establishing an Efficient Cell Sorting and Release Protocol

Christine E. Wu
Mentors: James R. Heath and Young Shik Shin

Between each cell in human tumors, many genetic and epigenetic differences exist. Consequently, every cancer cell may respond differently to treatment, with some resistant to certain drugs. In order to fully study the drug resistant pathways in primary cancers, different cells must be sorted to be examined separately. The Heath Lab has developed the technique of DNA Encoded Antibody Libraries, which uses a chip-based microarray platform for cell sorting. Through this procedure, an antibody array is generated by hybridizing single-stranded DNA antibody conjugates onto slides patterned with complementary single-stranded DNA. The cell mixture is then applied to the antibody array and cells with surface markers of interest will adhere to the chip. While this technique has successfully isolated cells which overexpressed the epidermal growth factor receptor from primary glioblastoma biopsies, the releasing of the desired cells from the plate was met with some problems. With a combination of trypsin and DNase, coupled with a wash by pipetting, cells from a mouse model were successfully released from the slides and then applied to a single-cell barcode chip for protein detection. With the ability to release captured cells, isolating and studying certain cell types within a cancer can be easier to accomplish.