THE FUTURE OF BIOLOGY
IMAGING INNOVATION THROUGH BIG DATA ANALYSIS

Marine Biological Laboratory | THE UNIVERSITY OF CHICAGO
THE NEED
Novel Shroff-designed dual-view light sheet microscope

Requires embedded algorithms to make best image of sample from multiple views

Requires algorithms to extract information. Then biologists ask for even better information!

It's difficult for scientists looking at living samples of cells to understand what's really going on inside them. Existing microscope instrumentation limits our ability to image live cells without destroying or damaging them.
THE COMPUTATIONAL IMAGING VIRTUOUS CIRCLE

The more advanced technology and microscope equipment is available, the more scientists are overwhelmed with the massive amount of output data produced with each image.

In an era of big data, images are the biggest data of all.
THE COMPUTATIONAL IMAGING VIRTUOUS CIRCLE

In biological science, computational methods and skills lag behind the pace of advances in microscopy development. We should have the same capability to recognize patterns in biological images as we have with facial recognition on Google, Facebook, and Apple software.

Without more automated or machine learning analysis we can’t distill the critical information from enormous amounts of data in a timely way. Algorithms and automated pattern recognition provide researchers with more reliable and quantitative results.

Embedding algorithms into hardware provides better image results

Better image results = New scientific questions

New scientific questions = Development of new tools to answer questions that can’t be answered with existing tools
MBL’S LONG-STANDING AND PRESTIGIOUS HISTORY

Impressive history in microscope development & biological imaging. MBL scientists have invented a lineage of nearly 10 groundbreaking, polarized light microscopes to reveal inner workings of the cell, including the first video microscope.

Recognition for award-winning science. MBL has opened its lab doors to 56 Nobel Prize winners, 124 Howard Hughes Medical Institute investigators, 263 Members of the National Academy of Sciences, and 219 Members of the American Academy of Arts and Sciences.

Strong mutually beneficial relationship with industry. More than 140 companies bring nearly $30 million worth of high-end microscopes, cameras, and other scientific instruments to the campus each summer for use and beta testing by advanced training students and faculty.
UNIQUE ACCESS TO RESOURCES

The Marine Resources Center provides access to over 200 species to researchers and to advanced training courses annually.

An affiliation with the University of Chicago and Argonne National Laboratory provides additional strength and resources in computation and image analysis of 3D or 4D datasets that require new solutions for data transmission, storage, and analysis.

A partnership with Woods Hole Oceanographic Institute and its Center for Marine Robotics provides additional engineering and manufacturing expertise and resources for both researcher labs and courses.

Existing relationship with industry expertise in computation and image analysis.
STRONG BRAND RECOGNITION FOR EDUCATION AND DISSEMINATION

MBL's advanced training programs are well-known within the scientific community and they attract the most promising students and renowned academic faculty.

Annually MBL hosts:

- 21 Advanced Courses
- 540+ students from 330+ institutions at 50+ countries
- 400 expert faculty members from 280+ institutions and 17 countries
- 200+ lecturers
- 250+ teaching assistants

The top 10 institutions that contribute faculty members and lecturers are MIT, Harvard University, California Institute of Technology, NIH, University of California, Berkeley, Duke University, University of Washington, University of California, San Francisco, Yale University, University of California, San Diego.

Faculty expertise includes researchers from commercial companies who bring their newest microscope systems for students to use in the cutting-edge curriculum.
COMBINING RESEARCH AND SERVICE WITH THE DUTY TO DISSEMINATE

Research: The Center will develop new computational microscopes and algorithms and host cutting-edge microscopes developed by researchers and industry partners. Users can test and developers can refine their instrument based on beta use in a trial-by-fire environment.

New developments will be possible through a collaborative process between microscope builders, physicists, biologists, and computation experts who work together to provide an iterative feedback loop of development and application.
**Service:** The Center will host resident and visiting researchers from around the country and enable them to collaborate and utilize the microscopes and computational expertise to answer pressing biological problems across disciplines.

**Education and Dissemination:** The Center will interact with all relevant MBL advanced training courses and develop new courses on microscope design and computational analysis.
THE IMPACT

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**ADVANCING BIOLOGICAL DISCOVERY**

**New instruments:** The development of new instruments with embedded capabilities to better answer scientific questions.

**Decreased timeframe from beta-testing to commercialization stages:** The high volume of diverse use enables novel instruments in beta-testing phase to move more quickly into commercialization.

**Educating and empowering future generations:** Providing aspiring and future generations of researchers interested in instrument development, image analysis, and computation with the required knowledge, tools and resources.

**Advanced instrumentation for the medical community:** Some of the technologies can be translated into medical applications, allowing quicker and more reliable diagnosis.
HOW CAN THE CENTER BECOME REALITY?

**People capital:** 250 scientists from 100+ institutions

**Engineering partnerships:** Advanced fabrication for instrument and model development

**Computational partnerships:** Image analysis, algorithm development, algorithm implementation into instruments

**Business enterprise:** Intellectual property, technology transfer, and start-up incubators

**Dissemination:** 21 advanced training courses, 400 faculty members from 280 institutions, 540 students, 250 teaching assistants, 200 lecturers
HOW CAN THE CENTER BECOME REALITY?

1. **INFRASTRUCTURE INVESTMENT**
   - Commonwealth of MA
   - $10M

2. **EQUIPMENT EXPANSION**
   - New instruments & software replacements + new industry loaned equipment
   - $5M+

3. **EDUCATION & TRAINING**
   - Private funding for programs; industry in-kind expertise
   - $1M+

4. **CUTTING-EDGE RESEARCH**
   - Federal and private grants; industry in-kind expertise
   - $10M+

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