## Breakout Session 1

### Group 1.1

*Topic: Super-resolution methods*

How can super-resolution methods be translated to organismal applications? Can multiple scattering interference be mitigated when transitioning these techniques into in vivo applications?

**Facilitator(s): Kristen Maitland**

- **Josh Brake**
- **Dylan Burnette**
- **Uzay Emir**
- **Candace Fleischer**
- **Matthew Lew**
- **Qian Liu**
- **Aseema Mohanty**
- **Luke Mortensen**
- **Stefan Wilhelm**
- **Sixian You**

### Group 1.2

*Topic: Machine Learning and Artificial Intelligence*

3D imaging can yield massive data sets, too large to quantitate or fully scrutinize manually. What data are required to effectively train AI/ML algorithms to assess these data sets? Can AI/ML be deployed to enhance data acquisition to improve the quality or resolution of key loci within data sets? What level of algorithmic errors (e.g. false positives, false negatives, etc.) are acceptable and how should that be balanced by selecting the most appropriate frames for human analysis?

**Facilitator(s): MaryEllen Giger**

- **Shiva Abbaszadeh**
- **Carolyn Bayer**
- **Ulugbek Kamilov**
- **Kathryn Keenan**
- **Girgis Obaid**
- **Paris Perdikaris**
- **Shannon Quinn**
- **Alex Walsh**
- **Lu Wei**

### Group 1.3

*Topic: Label-free Imaging*

Are there metabolites or other intrinsic molecules (native or engineered) that can be used to provide contrast or specificity to in vivo imaging? What optimization or validation will be needed to ensure accuracy of the interpretations?

**Facilitator(s): Wei Min**

- **Kevin Cash**
- **Larry Cheng**
- **Mini Das**
- **Joyoni Dey**
- **Sapun Parekh**
- **Lisa Poulikakos**
- **Aniruddha Ray**
- **Lingyan Shi**
- **Bo Zhen**

### Group 1.4

*Topic: Imaging Biological Networks*

How do we improve the tracing of interconnected cells such as neurons involved in spatially resolved networks? Can this be done over large distance scales or will it require assembly from many overlapping frames? How do we follow temporal networks, such as those resulting from kinase activity or cell-cell communication pathways? What about networks based on metabolite distribution that include stochastic processes like receptor binding? Can these be traced effectively?

**Facilitator(s): Matt Bogyo, Anna Moore**

- **Benjamin Bartelle**
- **Molly Bright**
- **Jazz Dickinson**
- **Matthew Lovett-Barron**
- **Dylan McCreedy**
- **Doug Shepherd**
- **Barbara Smith**
- **Bryan Spring**
- **David Van Valen**

### Group 1.5

*Topic: Tracking Movement of Particles Within Cells*

Are there label-free ways to track particles in vivo? For probe-based applications, how do we balance the perturbation of labeling with the need to retain nominal activity and dynamic behavior? For dynamic particles that exchange constituents during their function (e.g. spliceosomes, ribosomes, etc.), how many components must be tracked to accurately study particle motion and activity? How do we deal with heterogeneity among the particles, especially when such variation provides differential function in situ?

**Facilitator(s): Jin Zhang, Sam Achilefu**

- **Domenico (Nick) Galati**
- **Anna-Karin Gustavsson**
- **Yevgenia (Genia) Kozorovitskiy**
- **Melike Lakadamyali**
- **Morteza Mahmoudi**
- **Seunghyun (Seu) Sim**
- **Ellen Sletten**
- **Gokul Upadhyayula**
- **Katharine White**

### Group 1.6

*Topic: Tracking Cellular Migration and Movements*

Are there ways to mark single cells or sets of cells in vivo to follow them as they migrate? What probes or labels can be brought to bear to the problem of tracing cellular or subcellular movements throughout an organism?

**Facilitator(s): Brad Smith, Brian Pogue**

- **Fanny Chapelin**
- **Shwetadwip Chowdhury**
- **Allison Dennis**
- **Arnold Hayer**
- **Crystal Rogers**
- **Mimi Sammarco**
- **Ferdinand Schweser**
- **Mark Sellmyer**
- **Ping Wang**

## Breakout Session 2

### Group 2.1

*Topic: Imaging across temporal and spatial domains*

How do we balance the issues of imaging across domains of time and space? Can we collect data at high resolution and across large spatial regions simultaneously like the way QM/MM methods span time and resolution methods in computational chemistry?

**Facilitator(s): Kristen Maitland, Jin Zhang**

- **Joyoni Dey**
- **Domenico (Nick) Galati**
- **Arnold Hayer**
- **Melike Lakadamyali**
- **Qian Liu**
- **Matthew Lovett-Barron**
- **Aseema Mohanty**
- **Mimi Sammarco**
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- **Jazz Dickinson**
- **Luke Mortensen**
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- **Gokul Upadhyayula**
- **David Van Valen**
- **Alex Walsh**
- **Lu Wei**
- **Stefan Wilhelm**

## Group 2.3

*Topic: From models to humans and image-guided therapies*

> How can we take advances developed for in vitro or ex vivo approaches rapidly to the clinic? Are there approaches that can help improve the pipeline from the discovery of new photophysics to practical deployment in the clinic? What are the obstacles to successful monitoring of drug delivery? Can imaging of drug delivery and imaging of therapeutic response be combined? Can we integrate imaging across time to see the impact of a previous dosing over weeks or months?

**Facilitator(s): Anna Moore**

- **Benjamin Bartelle**
- **Molly Bright**
- **Dylan Burnette**
- **Morteza Mahmoudi**
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- **Katharine White**
- **Bo Zhen**

### Group 2.5

*Topic: Multimodal Imaging*

Which imaging modalities are most compatible for simultaneous data acquisition and integration? Can orthogonal methods provide both high resolution and deep tissue penetration? Are there new combinations of imaging modalities that might yield new untapped potentials?

**Facilitator(s): Sam Achilefu, MaryEllen Giger**

- **Shiva Abbaszadeh**
- **Uzay Emir**
- **Candace Fleischer**
- **Anna-Karin Gustavsson**
- **Ulugbek Kamilov**
- **Sapun Parekh**
- **Ferdinand Schweser**
- **Ellen Sletten**
- **Ping Wang**

### Group 2.6

*Topic: Synthetic Probes and Contrast Agents*

Each mode of imaging requires its own class of probes or contrast agents. Nanoparticles, quantum materials and synthetic fluorophores with engineered photophysical properties have great potential to improve image quality; what opportunities are available for new ways to generate contrast? What basic science is needed to elucidate the design principles for novel probes? Are there new classes of molecules that may have superior contrast properties?

**Facilitator(s): Matt Bogyo, Brad Smith**

- **Kevin Cash**
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- **Matthew Lew**
- **Dylan McCreedy**
- **Girgis Obaid**
- **Aniruddha Ray**

## Breakout Session 3

### Group 3.1

*Topic: Imaging Metabolites and Metabolic Processes*

Since metabolic changes often precede physiological changes, can metabolic imaging be used diagnostically? Mass spec imaging is leading the way; is it best used in a stand-alone manner or in conjunction with other imaging methodologies? Can aptamers or other probes be generated that allow quantitative imaging of small molecules with spatial resolution in situ?

**Facilitator(s): Jin Zhang, Matt Bogyo**

- **Molly Bright**
- **Kevin Cash**
- **Allison Dennis**
- **Candace Fleischer**
- **Lingyan Shi**
- **Seunghyun (Seu) Sim**
- **Alex Walsh**
- **Ping Wang**
- **Lu Wei**
- **Katharine White**

### Group 3.2

*Topic: Quantitative Imaging*

How can we get the most information out of an image or set of images? Can algorithmic scoring of imaging data provide searchable and archivable records of image data sets? How can image matching be optimized to stitch together datasets collected at different times or with different modalities?

**Facilitator(s): MaryEllen Giger**

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### Group 3.3

*Topic: Deep Tissue Imaging*

Are there methods beyond confocal and light sheet microscopy to address 3D regions deep within a tissue sample? What integrative techniques allow wide field screening of tissue to identify a region of interest, which can be subsequently imaged at very high magnification and perhaps super resolution? Are there adaptive optics that would allow corrections to improve image quality? What filtering methods can be developed that will reduce noise from overlapping emitters or high background? Can nanoparticles be used to develop confined evanescent fields to illuminate samples deep within a tissue? What technological advances are needed to make this a reality?

**Facilitator(s): Brad Smith**

- **Carolyn Bayer**
- **Jazz Dickinson**
- **Yevgenia (Genia) Kozorovitskiy**
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- **Ellen Sletten**
- **Bryan Spring**
- **Stefan Wilhelm**

### Group 3.5

*Topic: 3D imaging and Tomography*

What are the bottlenecks that prevent rapid analysis of 3D image datasets? PET and X-ray CT are widely used but are there other imaging modalities that lend themselves to 3D analysis as well? What technological advances are needed to make these practical? Can multimodal approaches be used to take advantage of the best properties of each method?

**Facilitator(s): Brian Pogue, Kristen Maitland**

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