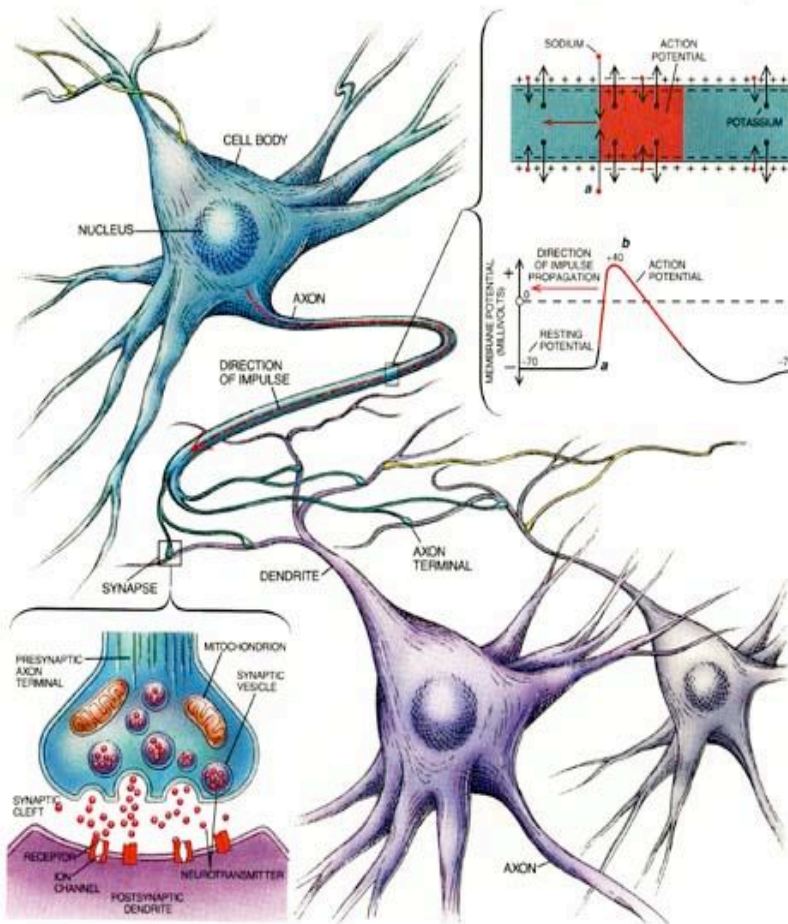


To better understand brain function, advances in our available measurement and engineering toolsets are needed



©Scientific American, 1988

Measuring the brain from synapse to thought break-out discussion group

Irv Epstein

Chris Gall

Martha Gillette

Lingjun Li

Anna Lin

Tom Meade

Gordon Shepherd

Jonathan Sweedler

Harold Szu

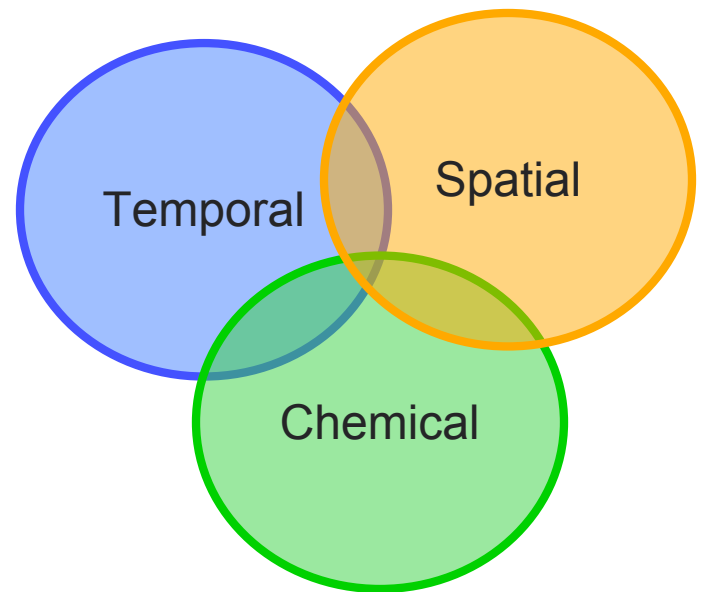
Mark Wightman

Integration between the ideas of the
working groups is crucial

Measuring the Brain: from Synapse to Thought

WHY NOW? Critical questions remain unanswered in areas ranging from neuronal development to neuroethology across a range of hierarchical levels because the required measurements are not possible.

- Higher resolution optical imaging
- Better chemical imaging
- Imaging in living animals
- Analysis at all levels, from organism to subcellular
- Multimodal analysis with coregistration
- The mechanisms of measurement tools
- Systems with multiple time and length scales
- A parts list of the brain



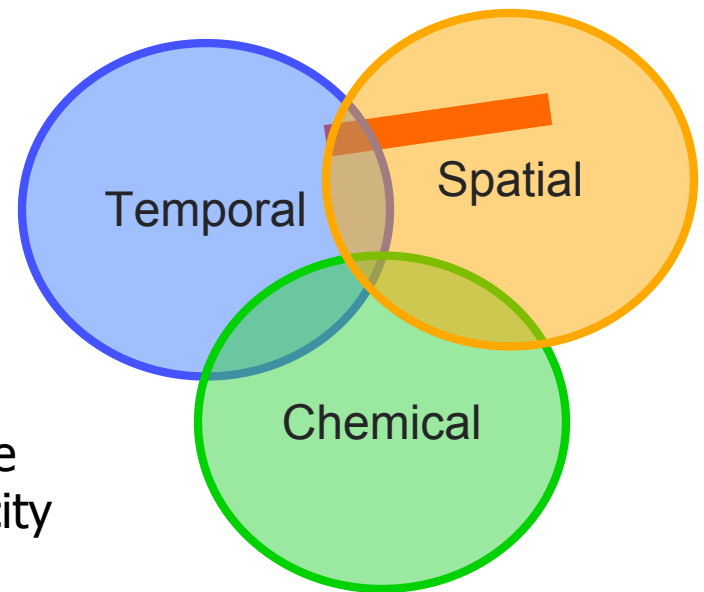
Measuring the Brain: from Synapse to Thought

WHY NOW? Critical questions remain unanswered in areas ranging from neuronal development to neuroethology across a range of hierarchical levels because the required measurements are not possible.

Imaging plasticity at the level of dendritic spines



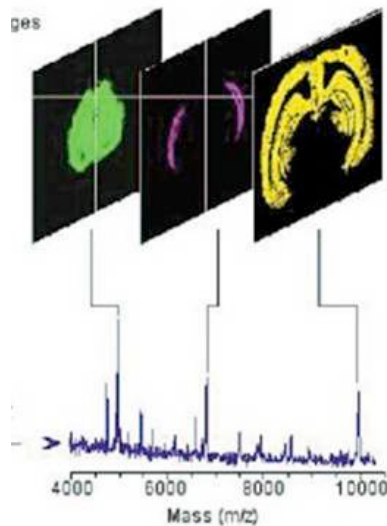
Defining the site of plasticity



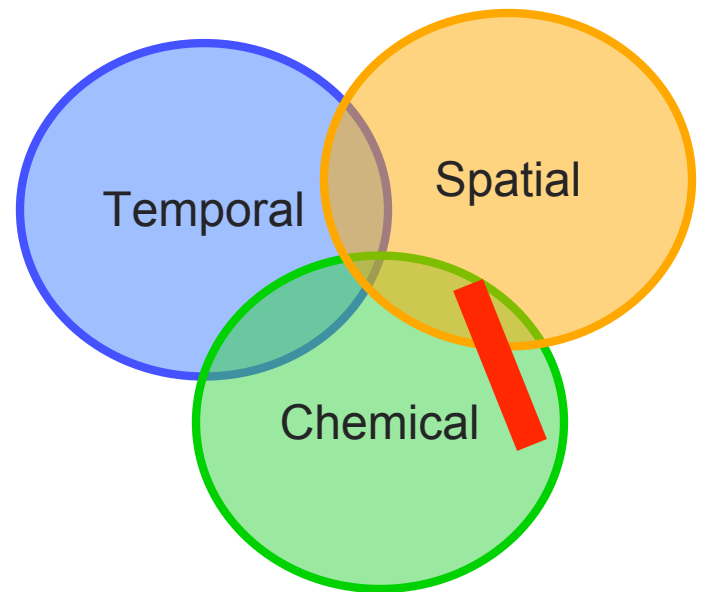
Measuring the Brain: from Synapse to Thought

WHY NOW? Critical questions remain unanswered in areas ranging from neuronal development to neuroethology across a range of hierarchical levels because the required measurements are not possible.

Imaging Mass Spectrometry



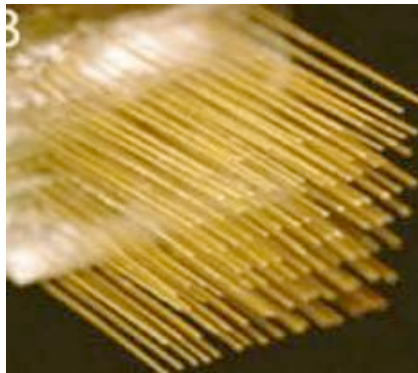
Defining the
parts list



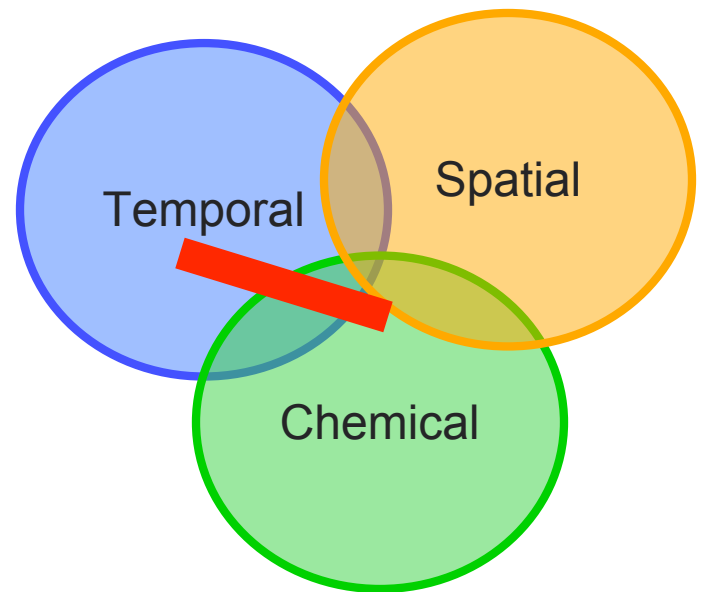
Measuring the Brain: from Synapse to Thought

WHY NOW? Critical questions remain unanswered in areas ranging from neuronal development to neuroethology across a range of hierarchical levels because the required measurements are not possible.

From arrays of microelectrodes to
sensor arrays for neurotransmitters
to new probes



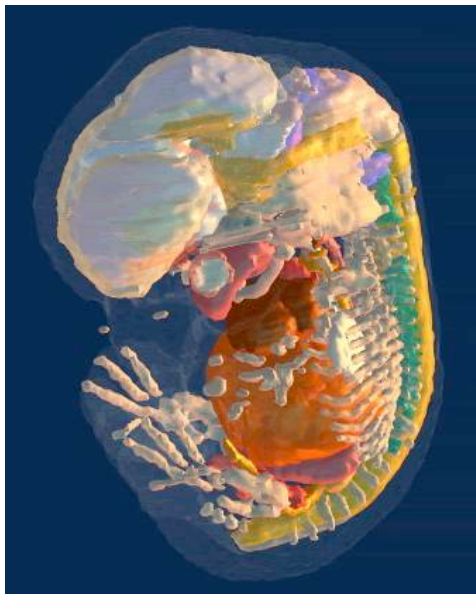
Understanding the
dynamics of the
brain



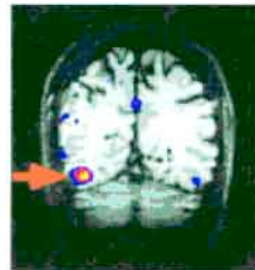
Measuring the Brain: from Synapse to Thought

WHY NOW? Critical questions remain unanswered in areas ranging from neuronal development to neuroethology across a range of hierarchical levels because the required measurements are not possible.

Magnetic Resonance Imaging

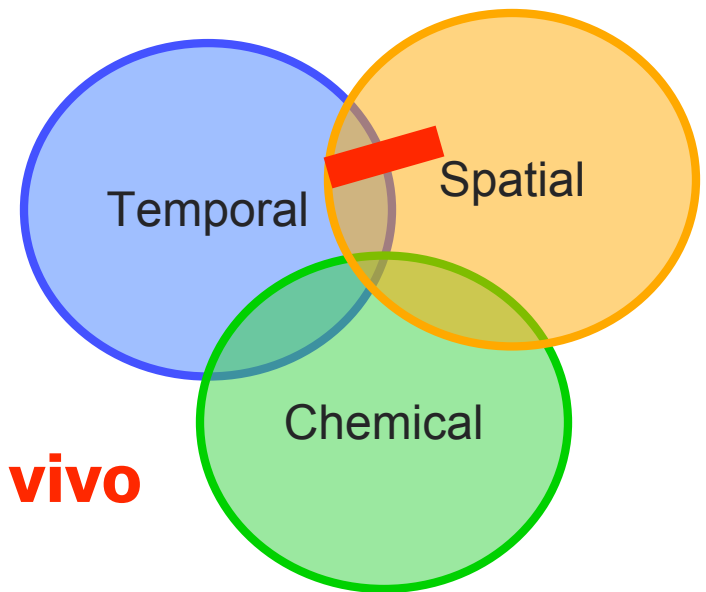


fMRI



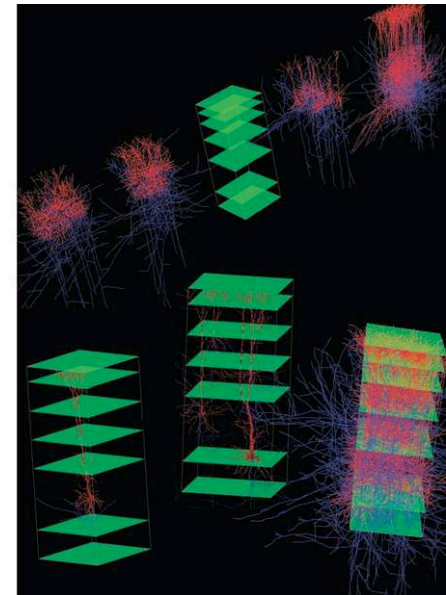
In vivo

But what's the Bold signal?



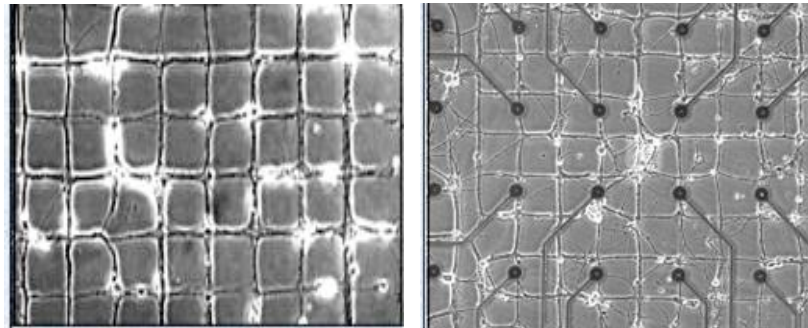
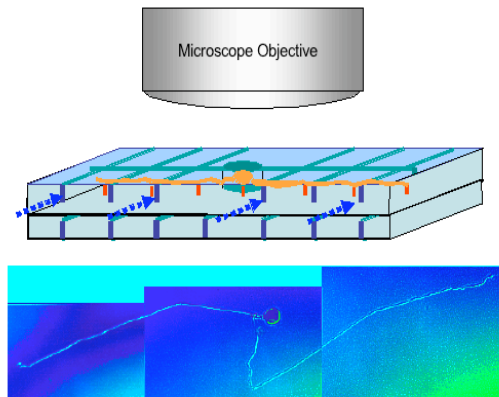
How do we analyze and use the data that we acquire?

- Need new mathematical and statistical methods to analyze immense data sets
 - ❑ Filtering out insignificant data?
 - ❑ Dealing with systems with multiple time and length scales
 - ❑ Clustering of variables into classes
 - ❑ Pattern recognition and comparison
 - ❑ Dealing with incomplete data sets
- Data sharing and archiving
 - ❑ Support for experiments and simulations
 - ❑ Long term commitment to replace Human Brain Project
 - ❑ Hierarchical levels of data needed
 - ❑ Integrate across different animal models—
invertebrates and vertebrates

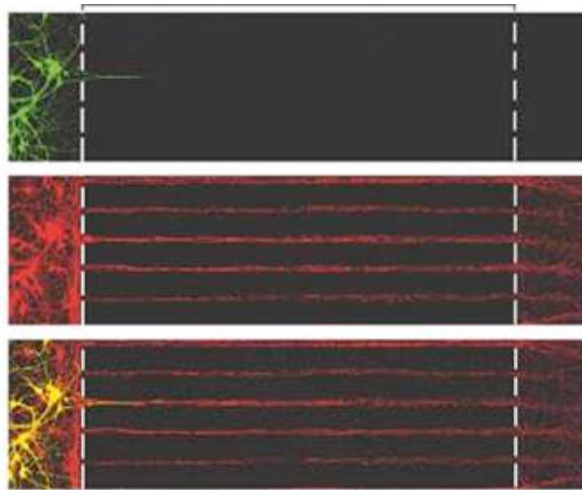


H. Markram's Blue Brain Project
Nature Neuroscience 7, 153, 2006

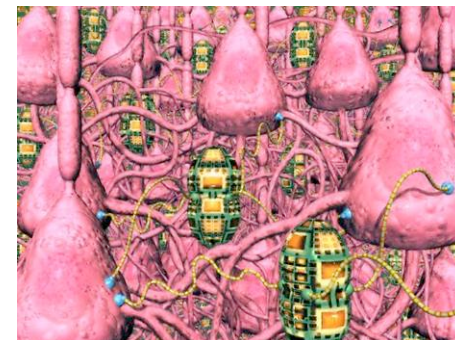
Reverse engineering the brain: from understanding the design principles, new methods of neuronal control, to tissue engineering



From B. Wheeler, UIUC



From simple,
to complex, to
science fiction



www.nanotech-now.com/Art_Gallery/tim-fonseca.htm

Educational opportunities



It's the People!

Promote cross-training across disciplines

While NSF training opportunities exist, they tend to be divisional or disciplinary

How to remove barriers

- Graduate student training plans outside of centers or defined plans

- Postdoctoral training across fields

- Release time for faculty to study in a new discipline