IEEE Brain Initiative
- IEEE Magnetic Society Perspectives

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Magnetic Technologies for IEEE Brain Initiatives

- **Magnetic Imaging**
  - **Magnetic Resonance Imaging**
  - **Magnetic Particle Imaging**
  - **Magnetoencephalography (MEG)**
- **Magnetic Stimulation**
  - **Transcranial Magnetic Stimulation (TMS)**
  - **Minnesota Magnetic Brain Array (MMBA)**
- **Magnetic Sensing**
- **Magnetic (Spin) Neuromorphic Computation**
- **Magnetogenetic**
- **Magnetic Nanofabrication**

IEEE Magnetic Society Effort Related with IEEE Brain Initiatives

- Special Sessions on Biomagnetics/Bio instrumentation Related with BMI
  - IEEE International Conference on Magnetics
  - Annual Conference on Magnetism and Magnetic Materials
  - Scientific and Clinical Applications of Magnetic Carriers
- To plan a joint conference with Biomedical Community
- IEEE Magnetic Society Distinguished Lecturers on Biomagnetics
- IEEE Magnetic Summer School with a Specific Lecturer on Biomagnetics
- IEEE Transaction on Magnetics
- IEEE Magnetic Letters
- Joint Effort with IEEE Nano Council

IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Current/Commercial Coil Designs

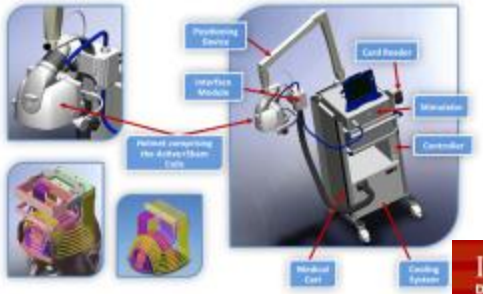
NeuroStar:

- Figure of eight coil with a ferromagnetic core
- Good focality for cortical Stimulation
- Treats: Depression

http://www.tmslosangeles.com/WhatisTMS.html

Hesed Coil (Brainsway):

- Multiple coils surrounding the head
- Deep brain stimulation but with large magnetic field dispersion in the brain
- Treats: Depression, Parkinson's disease and PTSD



http://bioluesdays.com/2011/11/01/journey-to-the-center-of-the-brain/tms-syst

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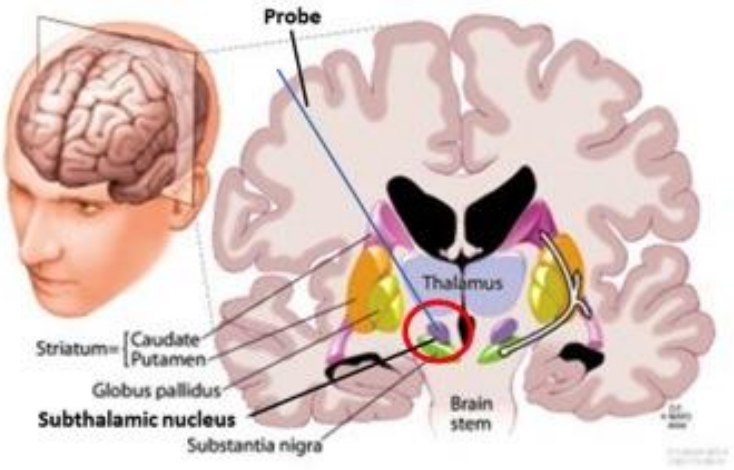

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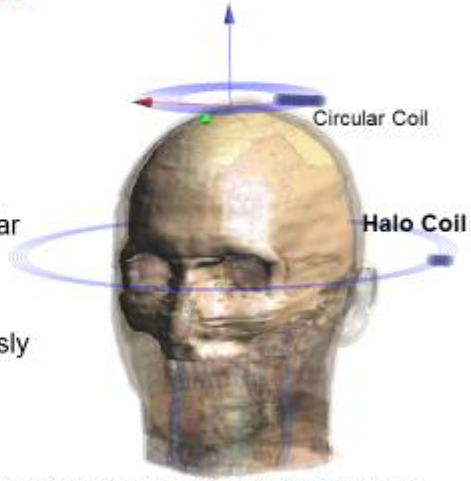
New Halo Coil Design

- Aim: increase depth of neuronal activation achievable with TMS
- Halo coil: **Diameter 290 mm, 5 turns**
- Used in conjunction with - Circular coil: Diameter 90 mm, 14 turns
- Both coils operated simultaneously



L. J. Crowther, P. Marketos, P. I. Williams, Y. Melikhov, D. C. Jiles, and J. H. Starzewski, "Transcranial magnetic stimulation: Improved coil design for deep brain investigation," *J. Appl. Phys.*, vol. 109, no. 7, p. 07B314, 2011.

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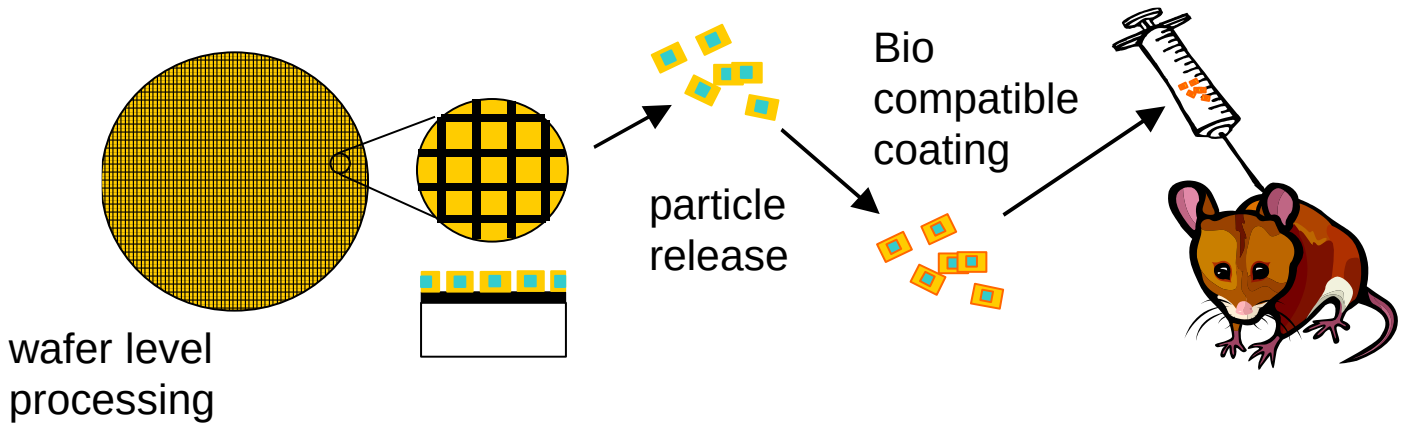
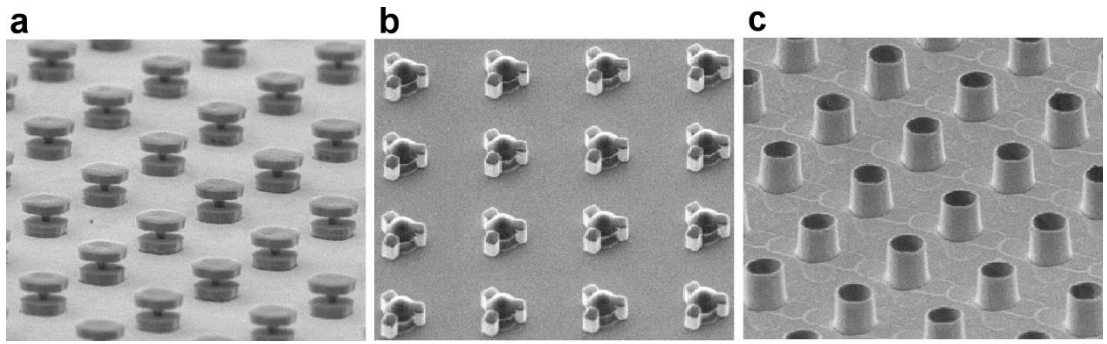
D. C. Jiles
Iowa State University

Engineered MRI probes using microfabrication methods for in vivo imaging of local physiology - NIST





Electroplated Ni plates with Cu post

Thin film vapor deposited Ni plates with three photo epoxy posts

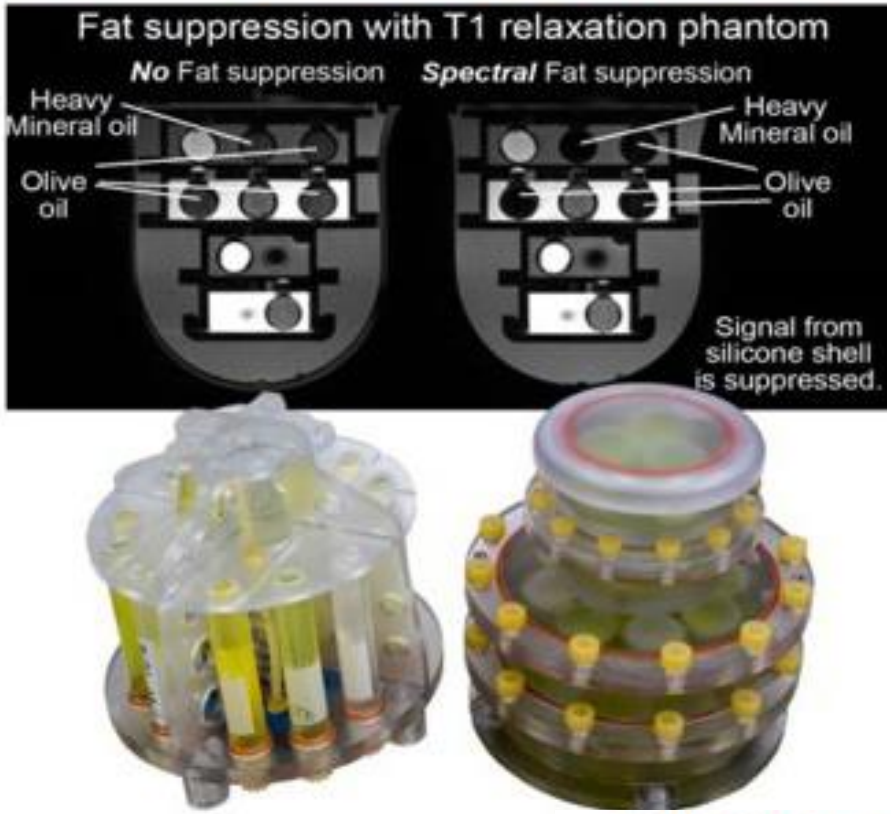
Thin film vapor deposited Ni shells

Gary Zabow, Stephen Dodd, **John Moreland,** and Alan Koretsky, Micro-engineered local field control for high-sensitivity multispectral MRINature 453, 1058-1063 (19 June 2008).

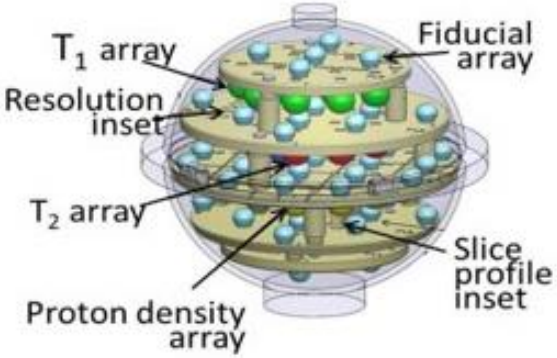
Gary Zabow, Stephen Dodd, and Alan Koretsky, Shape-changing magnetic assemblies as high-sensitivity NMR-readable nanoprobes, Nature 520, 74-76 (2 April 2015).

NIST/RSNA/NCI diffusion phantom

NIST/UCSF/NCI system phantom



NIST/ISMRM system phantom

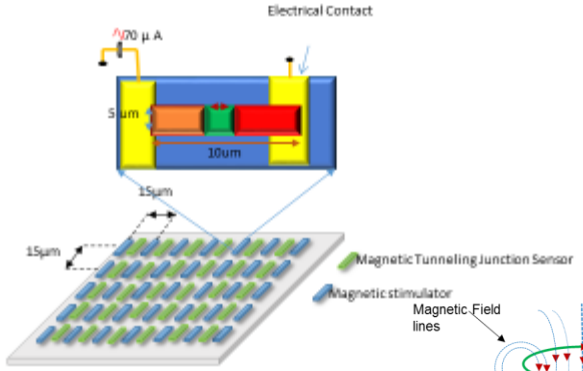


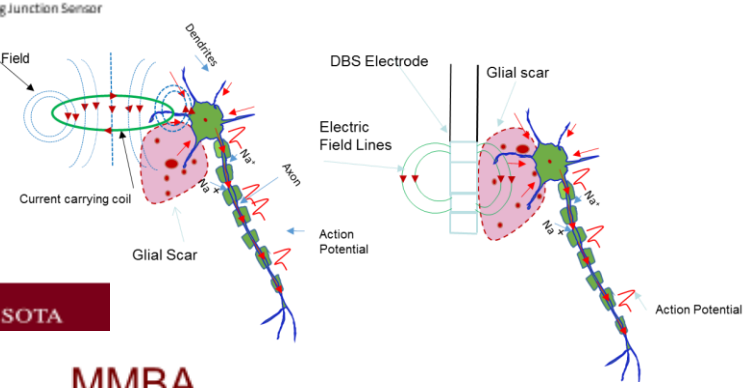
Developing calibration structures (phantoms) and validating quantitative imaging protocols for magnetic resonance imaging (MRI); focusing on standards for cancer, brain, and multimodal imaging

http://www.nist.gov/pml/div686/grp08/biomagnetics.cfm

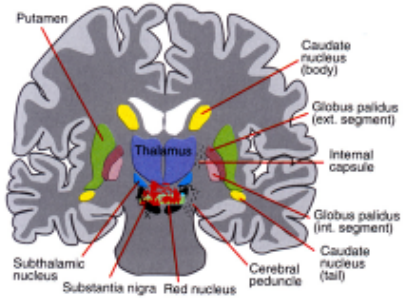
Minnesota Magnetic Brain Array (MMBA)

- Minnesota Magnetic Brain Array (MMBA) is a magnetic nanostructured device for stimulating neurons as well as for recording their activities.
- It can stimulate neurons locally and selectively and it consumes low power than currently existing technique.





MMBA



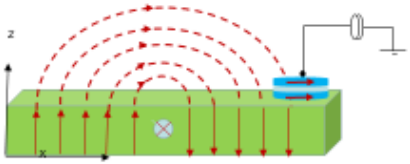


Fig. GMR integrated magnetic Nano-Wire

- Magnetic stimulator is a magnetic nano-wire into which alternating current of the order of micro-Amps is passed which produces fluctuating magnetic field due to domain wall motion. This fluctuating magnetic field is used to stimulate neurons.

Disease	Targeted Area
Parkinson	Subtahalamic Nucleus or GPI
Dystonia	Thalamus or GPI
Essential Tremor	Ventral Intermediate Nucleus of Thalamus

Figure: http://www.intechopen.com

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Summary

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