

Magnetische Mikrosysteme und Nano-Effekte

IEEE-Chapter meeting,
31.3.2006, Wetzlar

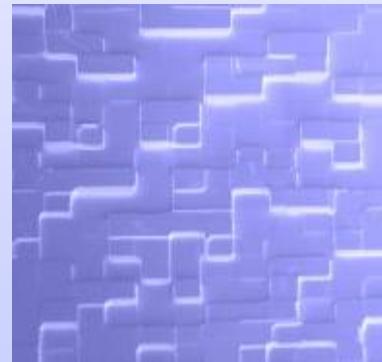
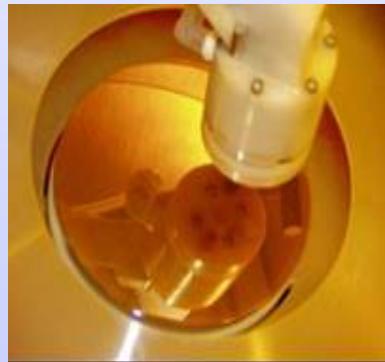
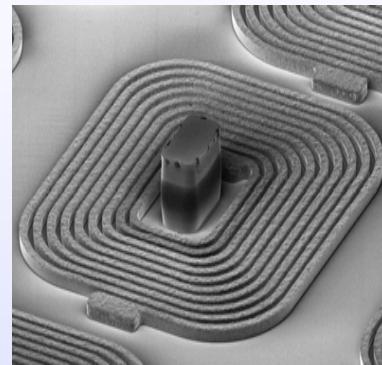
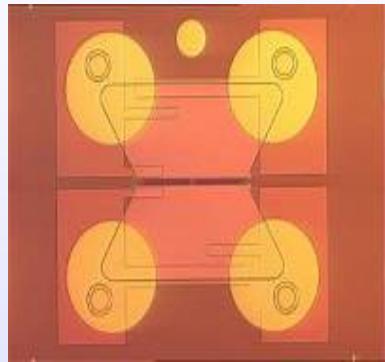
Outline

- Sensitec Naomi
- technology overview
- inductive elements
- GMR applications



Foundry for magnetic microsystems
Jan Marien

Business Area



- AMR and GMR Sensor Technology
- Special Heads (Read/ Write/ Print)
- Foundry Services
 - Thin Film Deposition
 - Photo LithographyProcesses in Nanometer Scale

You need...

... Thin Film Deposition

- sputtering (seed layer, passivation, interconnection layer, GMR sensors)
- ion beam deposition (AMR sensor layers)
- electroplating (thick metal layers, e.g. Cu, NiFe, Ni, Au)

... Etching Facilities

- physical etching (sputter etching, ion beam milling)
- chemical etching (Cr, Al₂O₃, Cu, NiFe)
- planarization (lapping, CMP)
- lift off

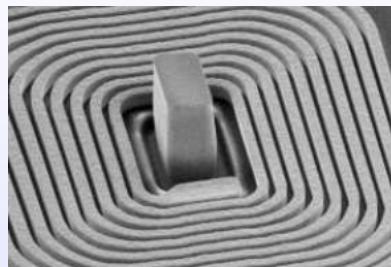
... Mikro Patterning

- resist processing
- optical lithography
- thermal processing

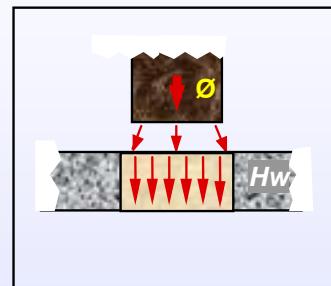


Magnetic printing

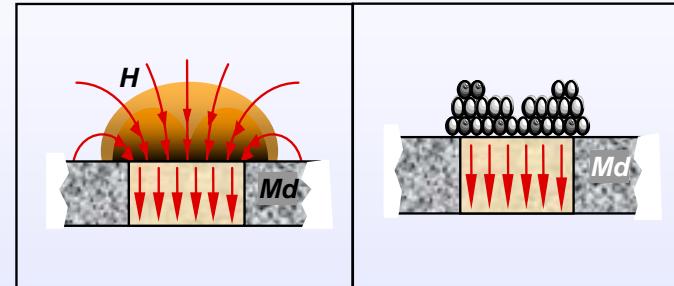
A writing head contains 616 Poles with a coil



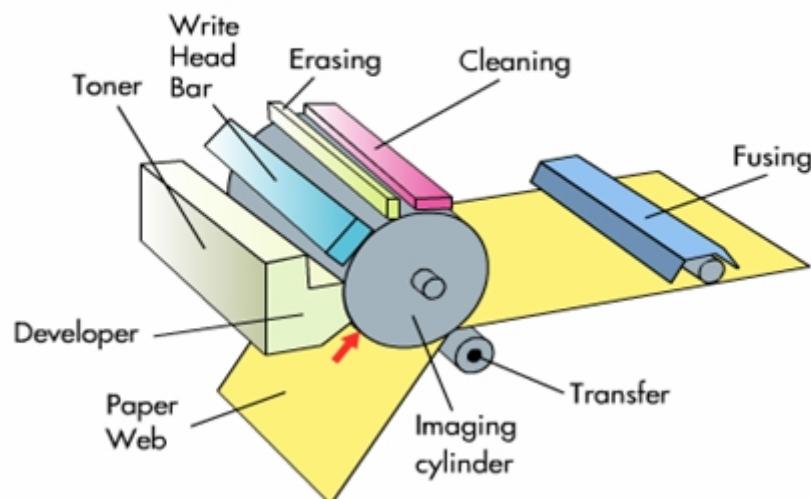
Activation pole \Rightarrow magnetic imprint on the drum (magnet)



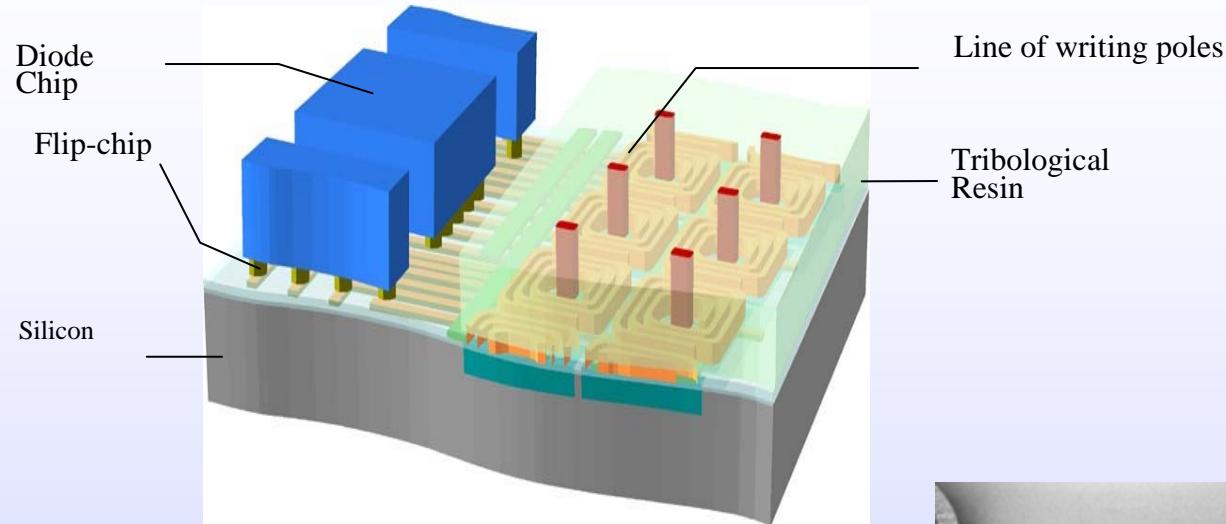
Magnet \Rightarrow a magnetic field-force to attract the toner particles



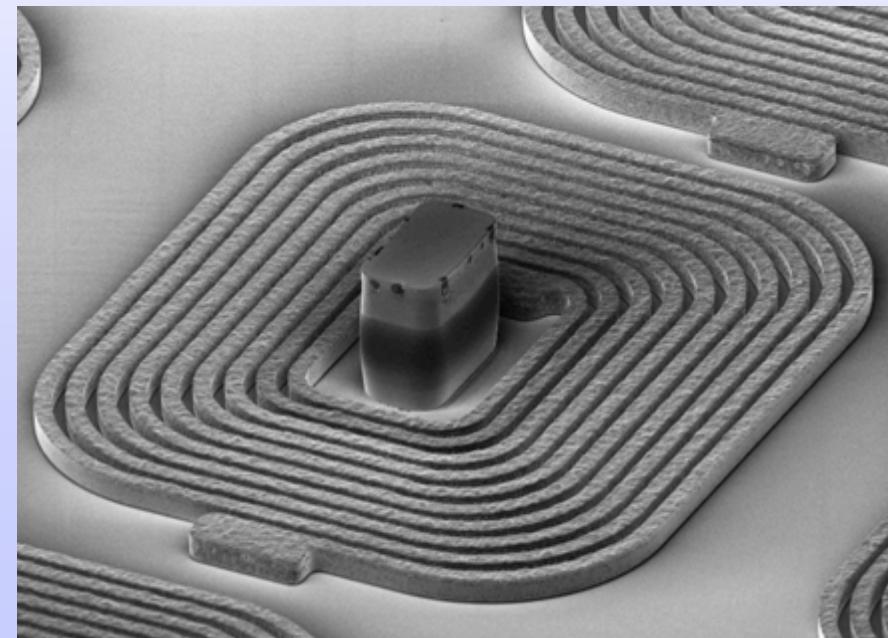
How it works



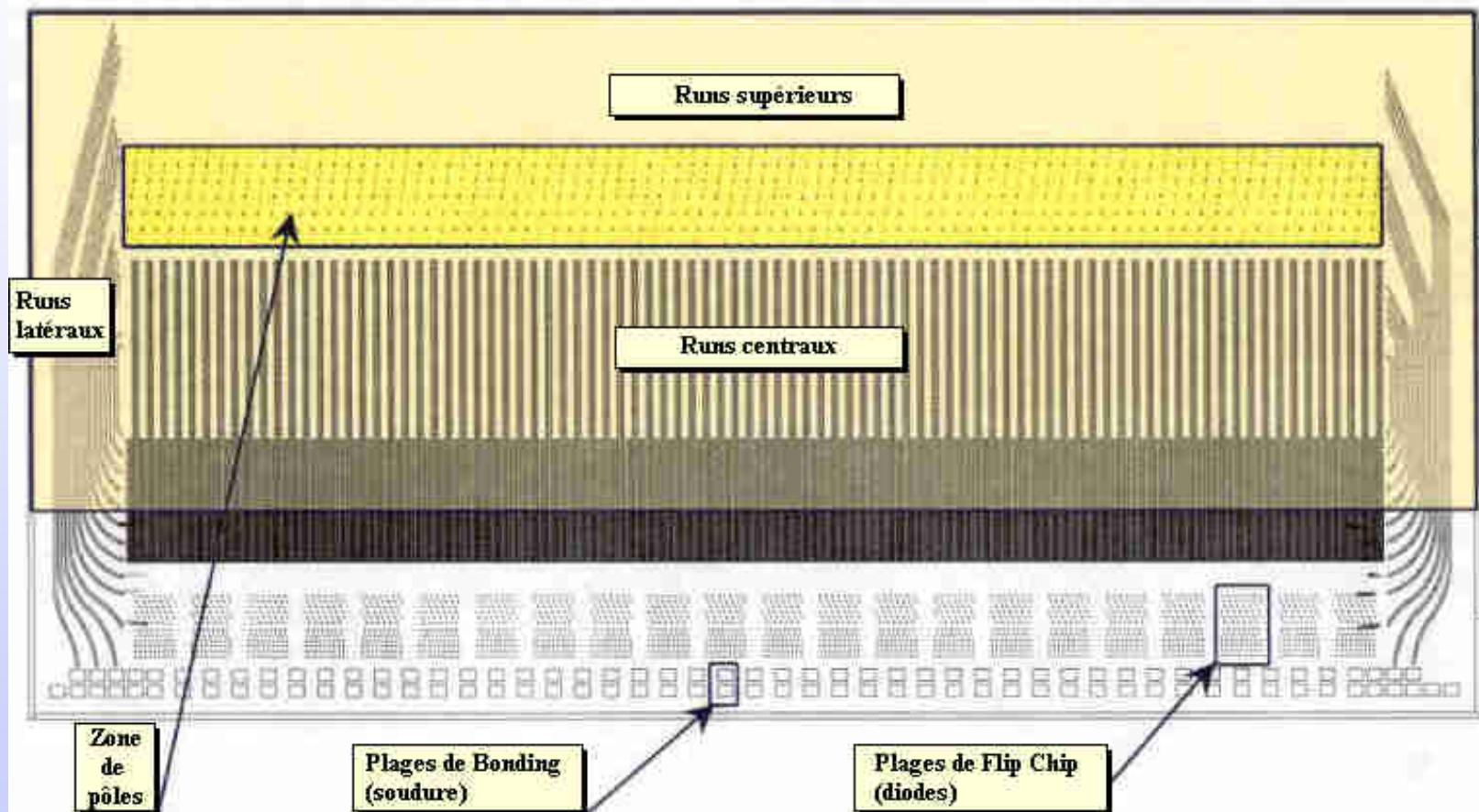
Complex magnetic MEMS structures



- Customized design of magnetic write head
- 616 individual coils / yoke per chip
- 3 layer BCB
- 50 µm high write pole
- Tribology resin processing

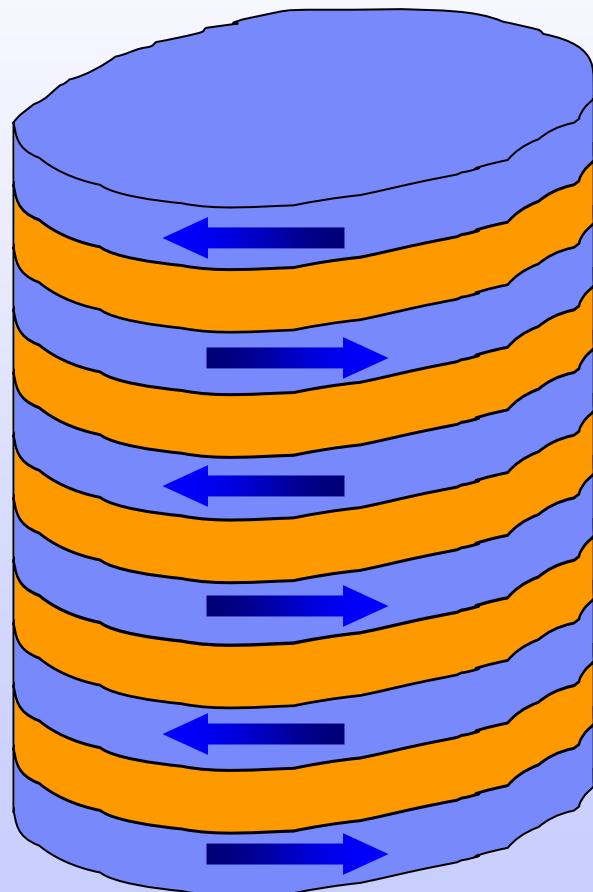


Magnetic printing head

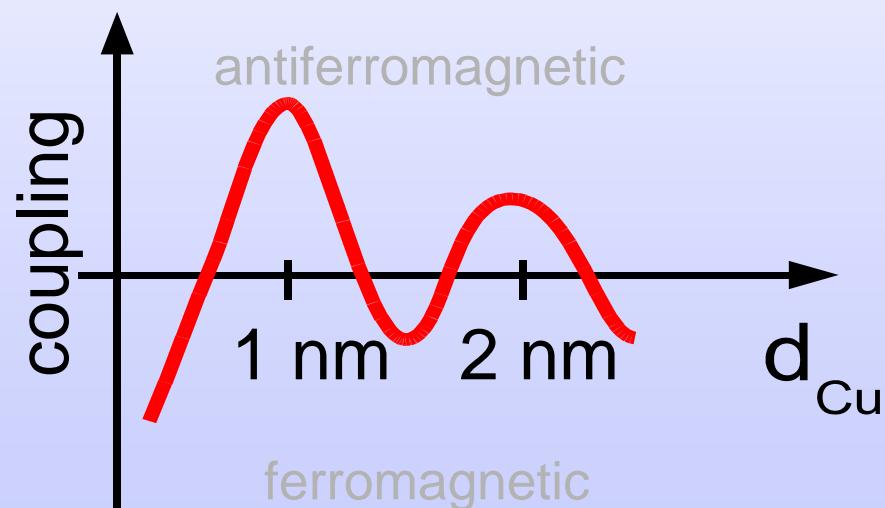


GMR Effect – Magnetics I

Giant Magneto Resistance



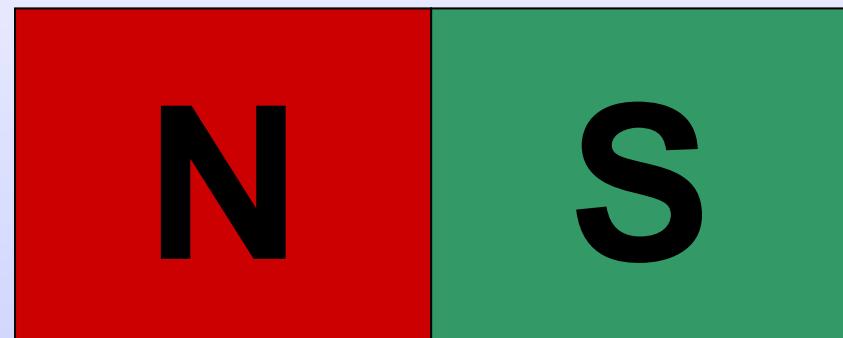
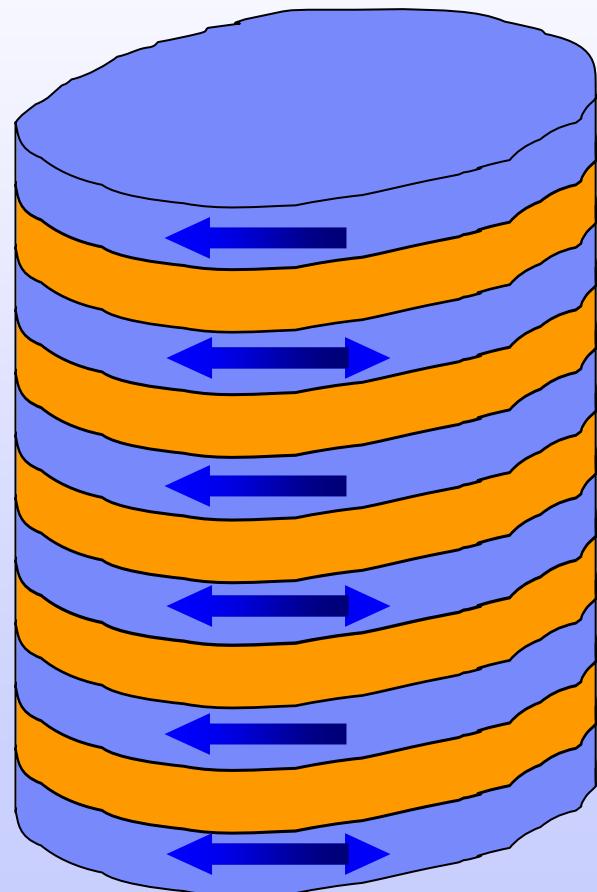
Orientation of magnetization depends on spacer layer thickness;
"interlayer exchange coupling"



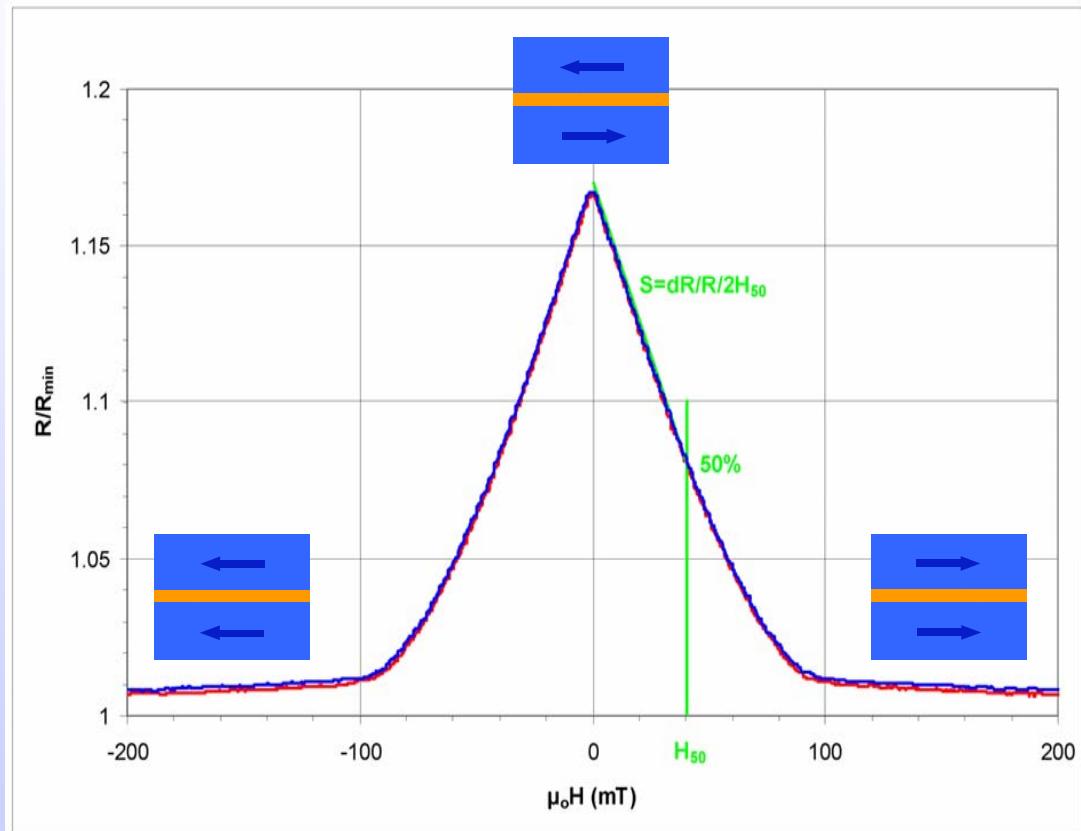
GMR Effect – Magnetics II

Giant Magneto Resistance

Coupling can be overcome by external magnetic fields.



GMR Effect



Multilayer properties can be designed by:

- thickness of interlayer
- thickness of magnetic layer
- different magnetic material
- number of layers

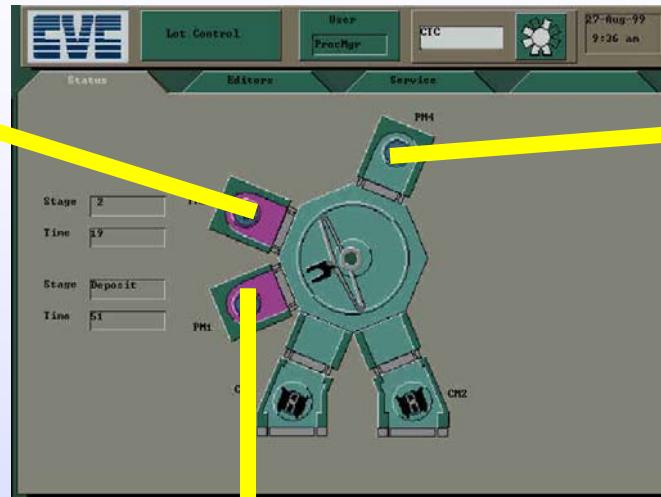
GMR Multilayer III

Sputter deposition cluster tool

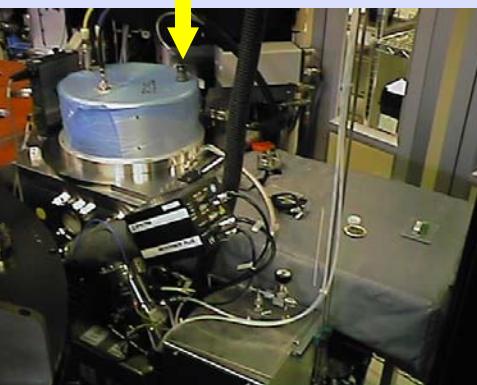
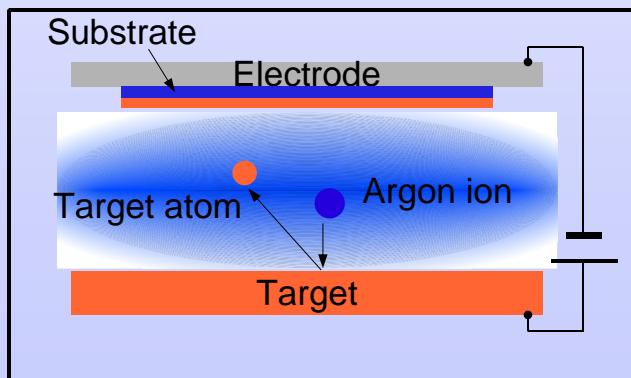
SENSITEC
N A O M I



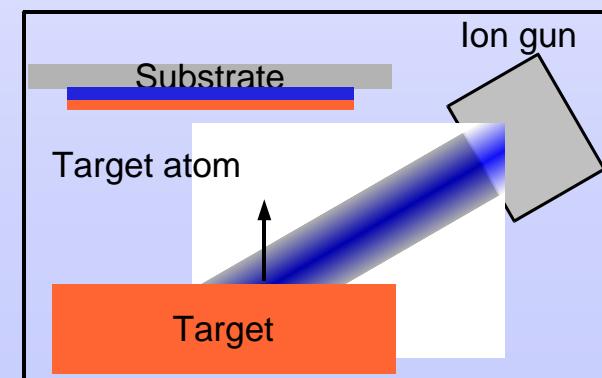
6 Target PVD



6 Target IBD

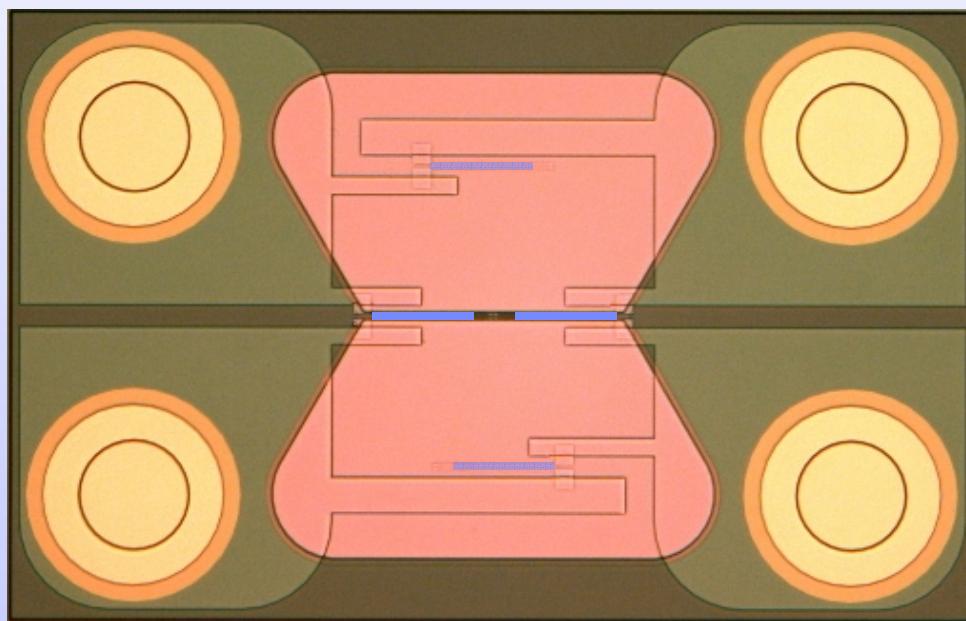
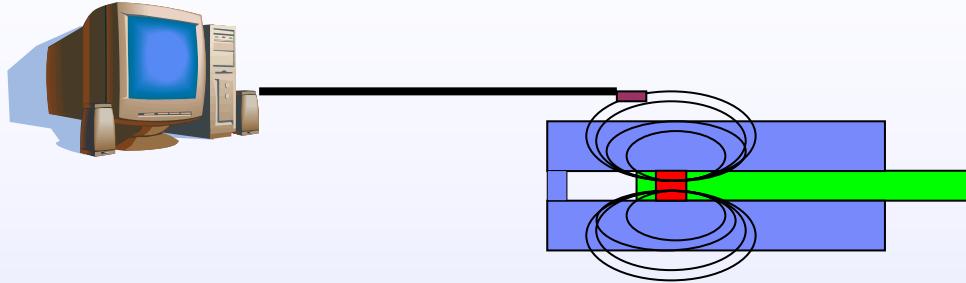


reactive PVD

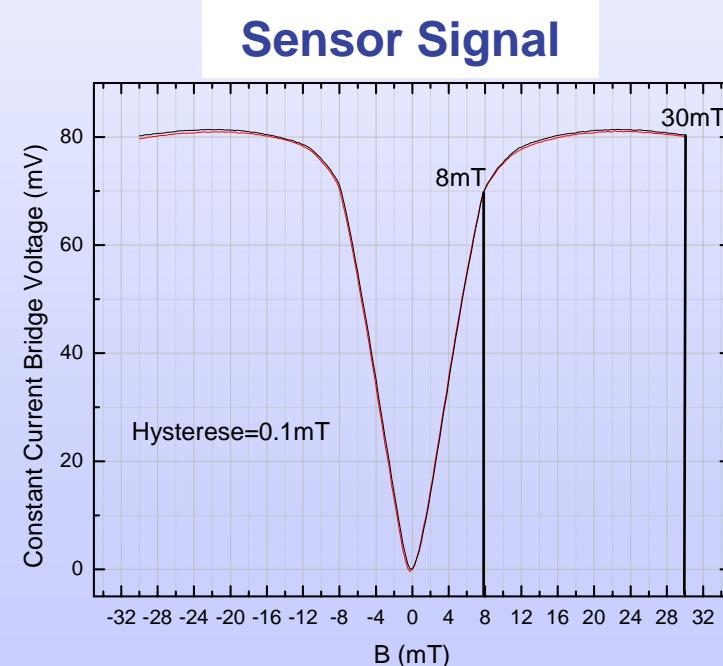
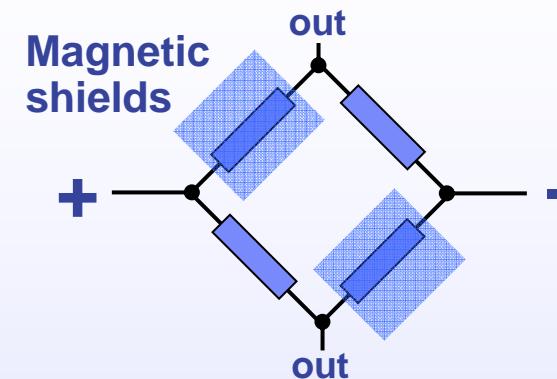


GMR Field Sensors

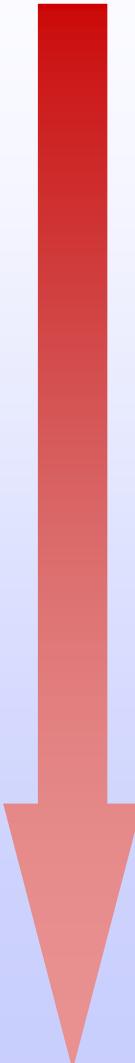
Position Detection



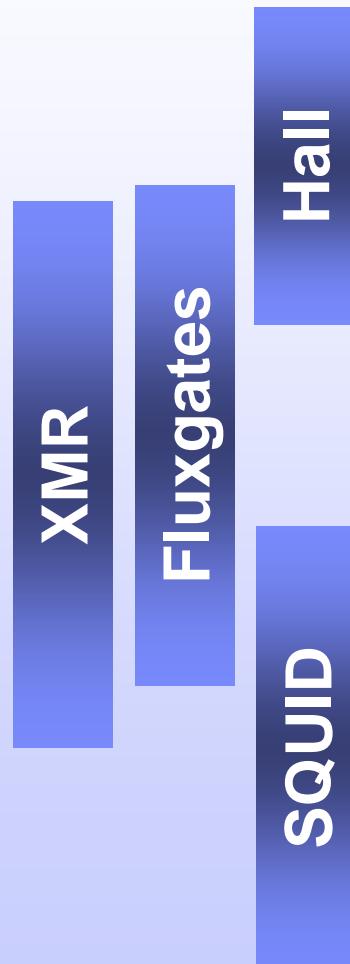
SENSITEC
N A O M



Magnetic fields



10^{11} T		Neutron stars
...		
10^1 T		Superconducting research magnets
10^0 T		tomography
10^{-1} T		
10^{-2} T		
10^{-3} T	(mT)	Field of a HDD bit
10^{-4} T		
10^{-5} T		Earth magnetic field
10^{-6} T	(μ T)	
10^{-7} T		
10^{-8} T		
10^{-9} T	(nT)	
10^{-10} T		
10^{-11} T		heart
10^{-12} T	(pT)	
10^{-13} T		
10^{-14} T		brain
10^{-15} T	(fT)	
10^{-16} T		



Application fields

of high sensitive sensors (up to now: SQUID)



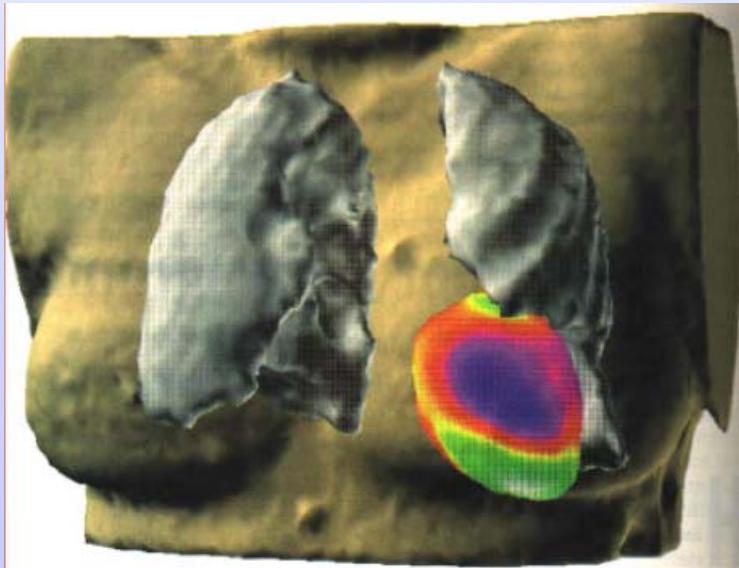
- **Magneto cardiogram (MCG):**

- some pT (10^{-12} T)
- small sensor array (9-36 pc.)
- portable

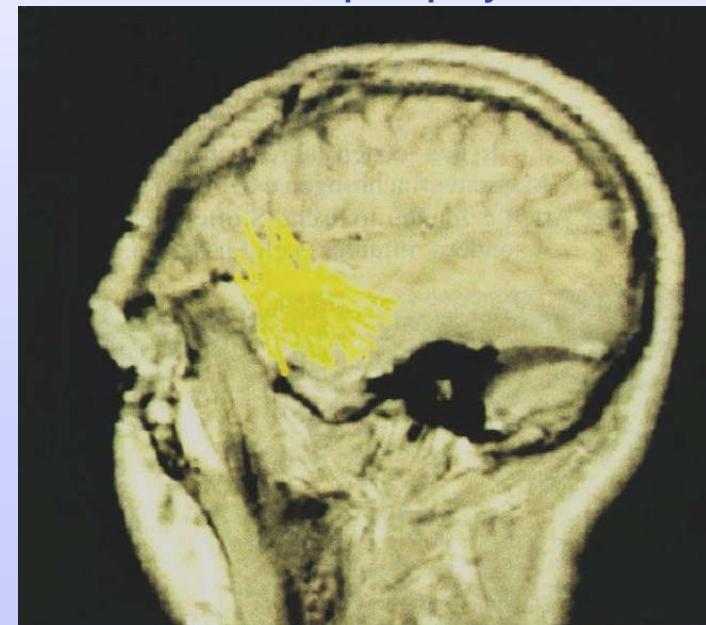
- **magneto-encephalogram (MEG):**

- some fT (10^{-15} T)
- big sensor array (300 pc.)
- shielded environment necessary

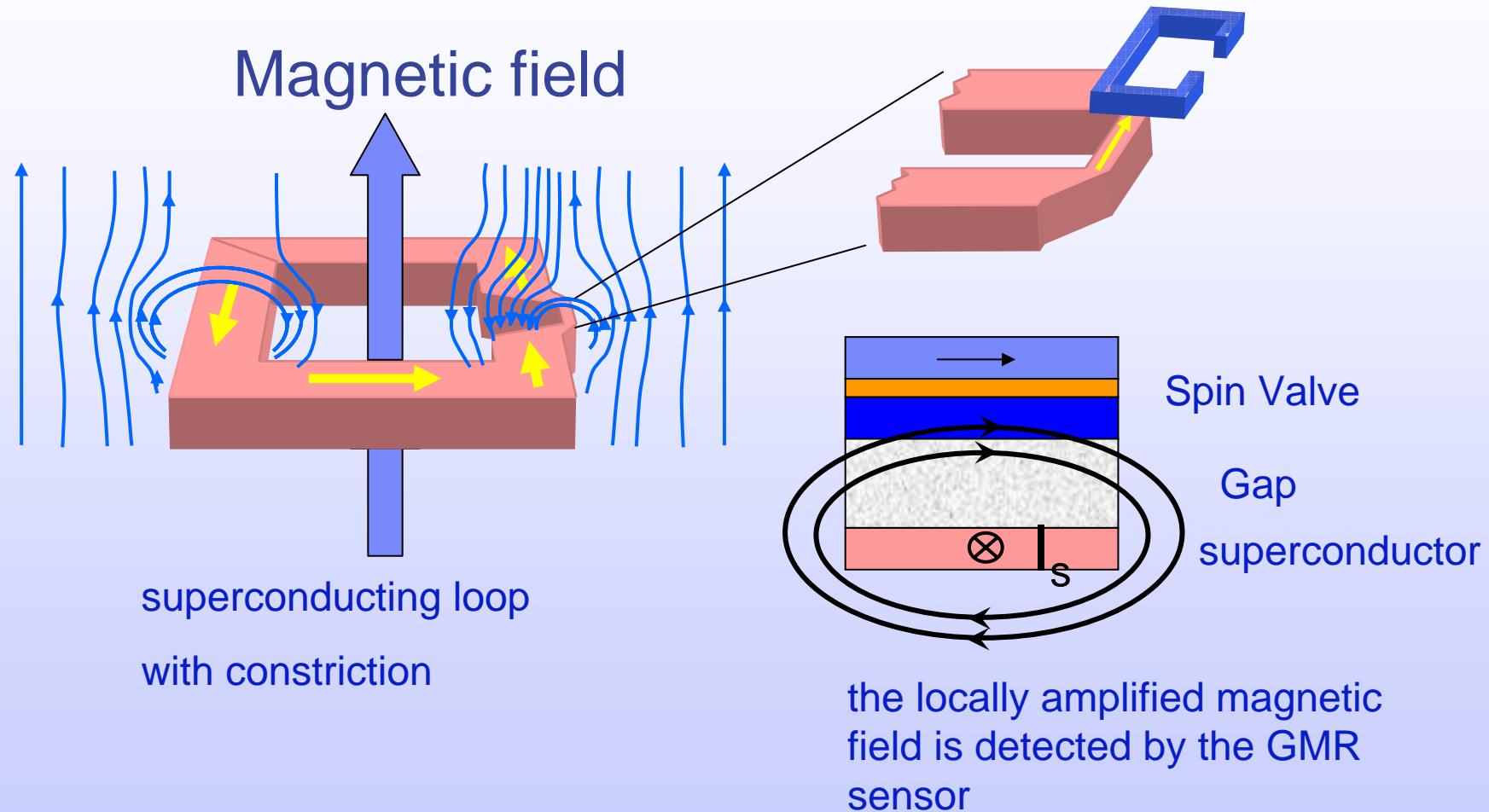
Antechamber infarct



focal epilepsy



Mixed Sensor Prinzip



Science, 304 (2004) 1648, Pannetier et. al

demonstrators

exists already

SENS*i*TEC
N A O M

