James A. Bain

Professor
Department of ECE
Data Storage Systems Center
http://www.ece.cmu.edu/~jbain

Courses:

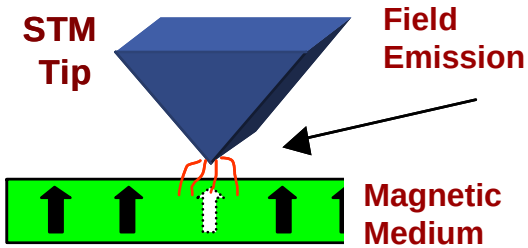
18-202: Mathematical Foundations of EE

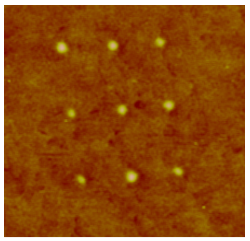
18-416: information Storage Systems

18-517: Information Storage Systems Design

Information Storage Device Physics

Probe Recording



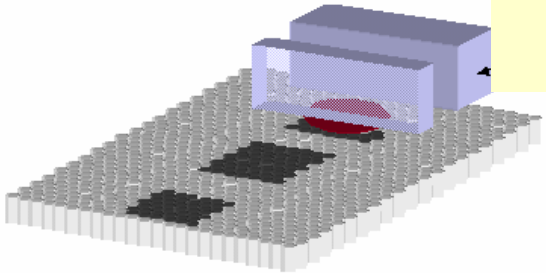


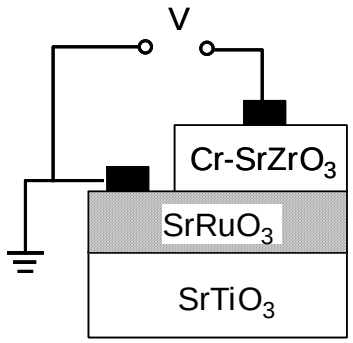
Magnetic Marks

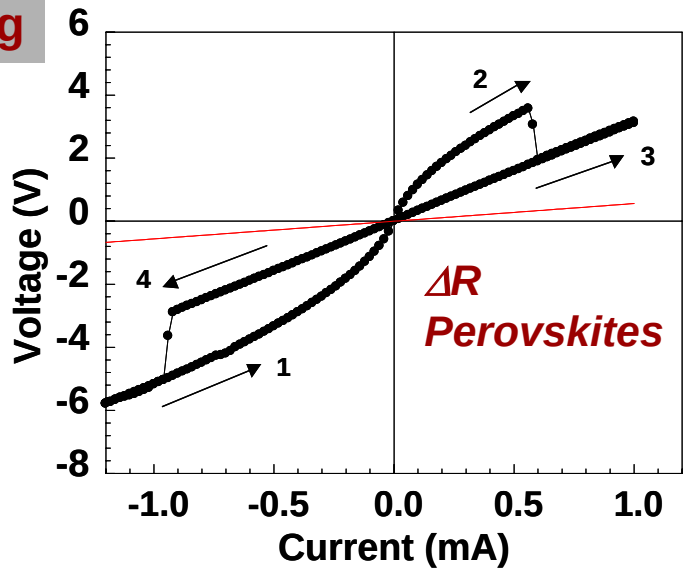
MFM

- Energy localization
- Storage materials
- Hysteretic phenomena
- High frequency switching

Heat Assisted Magnetic Recording







Electrical & Computer ENGINEERING

jbain@ece.cmu.edu

ECE Advising:
Getting Your Questions Answered

James A. Bain

Electrical & Computer ENGINEERING

Outline

- Logistics of the advising and mentoring process
- Objectives of the advising and mentoring process
- Advising summary
- Data storage technology overview ...

Logistics of Advising Process

- Fall Sophomore Year
  - Take 18-200: Emerging Trends in ECE
  - Receive advisor assignment
  - Complete advising preparation worksheet
  - Meet with advisor (possibly more than once)
  - Select classes for Spring 05
- Spring Sophomore Year
  - Meet with advisor (possibly more than once)
  - Request/select a faculty mentor
  - Meet with faculty mentor
  - Select classes for Fall 06
- Junior and Senior Years
  - Meet with faculty mentor as desired
  - Select classes for each semester
  - Plan for post-graduation:
    internships, jobs, fellowships, grad schools, etc.

ECE Undergraduate Advising Committee


Prof. Shawn Blanton

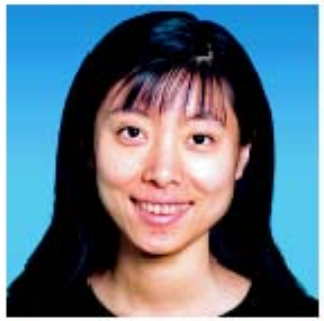

Prof. Tsuhan Chen


Prof. Dave Greve


Prof. José Moura


Prof. Priya Narasimhan


Prof. Dave O'Hallaron


Prof. Dawn Song


Prof. Peter Steenkiste


Prof. Tom Sullivan


Prof. Don Thomas


Prof. Elias Towe


Janet Peters

Electrical & Computer ENGINEERING

Undergraduate Program Staff

Bruce Krogh

Associate Department Head

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Janet Peters- jmpeters@ece.cmu.edu
HH 1110, 8-3666
Assistant for Undergraduate Education
Monitors student academic progress, handles procedural and policy information and information on Co-op, IMB, Double Majors and Minors, Career Center, Health Center, etc. Coordinates advising process

Leona Kass-O'Rourke- lkass@andrew.cmu.edu
HH 1109, 8-2496
Educational Program Assistant
Assists associate department head in class scheduling, waitlists, etc.

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Name _____ Advisor_____ Date_____

Preparing for your first advising appointment

When meeting with your faculty advisor for the first time, it is essential that you be as prepared as possible to make the most of your advising session. The preparation can be divided into three categories: ***Think***, ***Investigate***, and ***Plan***.

Bring this completed sheet to your first appointment!

Think

- What are your areas of interest? _____

  _____
- Are you thinking of completing an Additional Major/Minor? Y N If Yes, What? _____
- Are you thinking of doing any internships? Y N If yes, When? _____
- Are you thinking of doing a Co-Op? Y N If Yes, When? _____
- Are you thinking of Studying Abroad? Y N If Yes, where and for how long? _____
- What are your post-graduation goals? IMB MS elsewhere PhD Industry Other_____
- What time constraints are you facing (work, extra-curricular activities, family, friends, etc.)

  _____

Investigate

- Look at the requirements and options for the ECE degree at http://www.ece.cmu.edu/users/shared/primer/index.php
- Find out what the requirements are for any Additional Major(s)/Minor(s)

Plan

- List all requirements for ECE and any Additional Major(s)/Minor(s) in the boxes below
- Fill out plan for remaining semesters
- See if plan is reasonable, given constraints you face
- Modify plan as necessary (go back to *Think* stage if needed)

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ECE at Carnegie Mellon University

Academic Plan

Name:_____ Date:_____ Advisor:_____

1st Year Fall	1st Year Spring	Sophomore Fall	Sophomore Spring	Junior Fall	Junior Spring	Senior Fall	Senior Spring	5th Year Fall	5th Year Spring
Units Carried: QPA:	Units Carried: QPA:	Units Carried: QPA:	Units Carried: QPA:	Units Carried: QPA:	Units Carried: QPA:	Units Carried: QPA:	Units Carried: QPA:	Units Carried: QPA:	Units Carried: QPA:
Summer Plans:									
Summer Plans (cont.)									

Updated 09/04, JP & SLM

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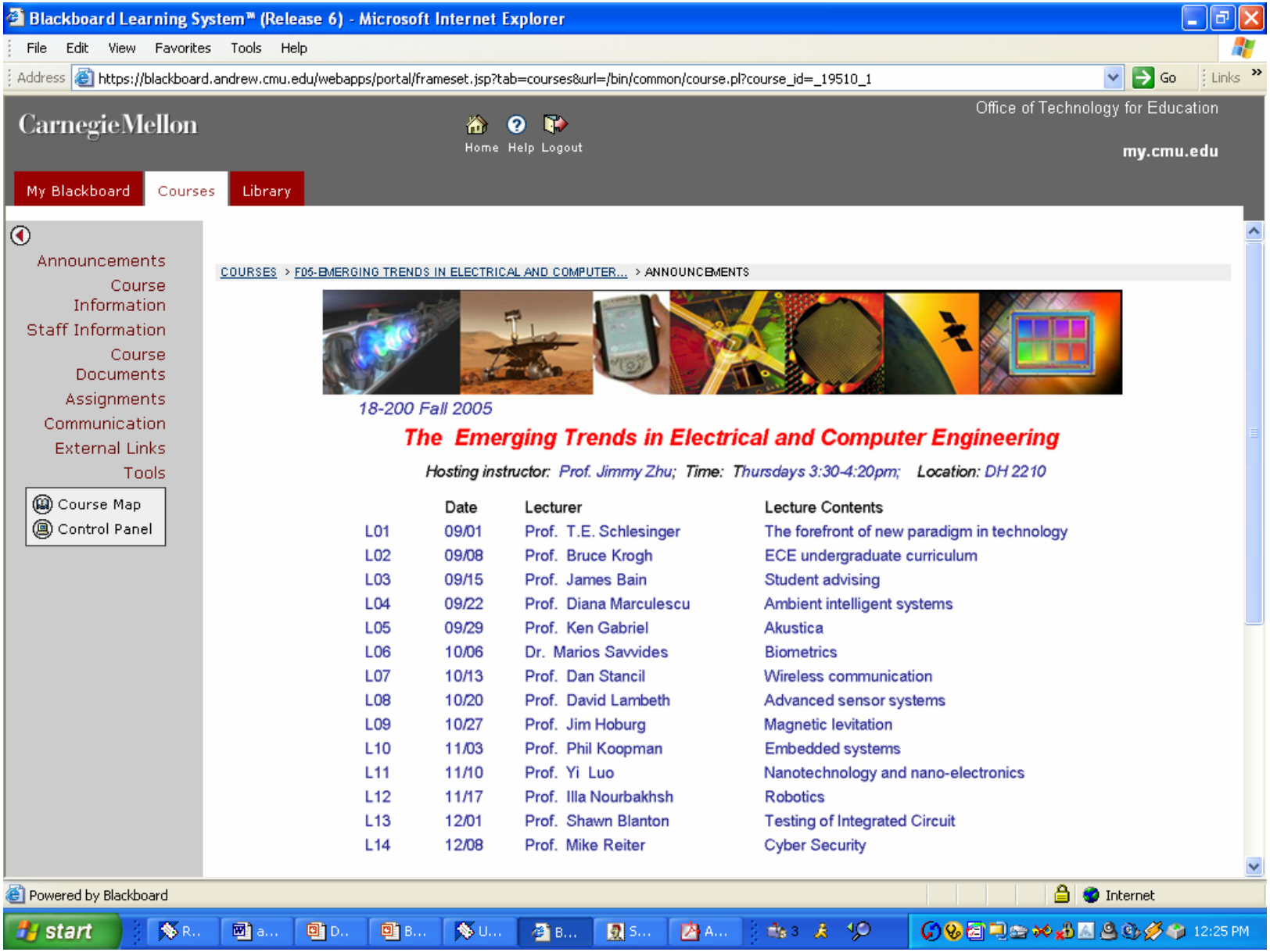


Electrical & Computer ENGINEERING

Myths about meeting with your advisor

- Myth I: Advisors are judging you, so don't say anything stupid...
  ...even if that means that you say nothing

- Myth II: Advisors have all the answers

- Myth III: Advisors are looking to criticize your performance...
  ... so avoid them if things aren't going well

- Myth IV: Advisors are looking to criticize your performance...
  ... so you don't need to see them if things are going well

Objectives of Advising Process

Treat students such that they would ENTHUSIASTICALLY advise their loved ones to enroll in ECE at CMU

Top 10 Reasons for Intensive Advising

1. Our students sometimes need some questions answered
2. Our students sometimes need some reassurance
3. Our students want to feel heard and connected
4. Our students may not know all the questions they have
5. Our students are not aware of all of their opportunities
6. Our students don't know all of the faculty members
7. Our students benefit from thinking and planning ahead
8. Our students have varying ways in which the want to receive information
9. Our students are human beings who need preparation for life
10. We want to know our students

Why look to your advisor for answers ...

or

Galadriel

Ale
(ho

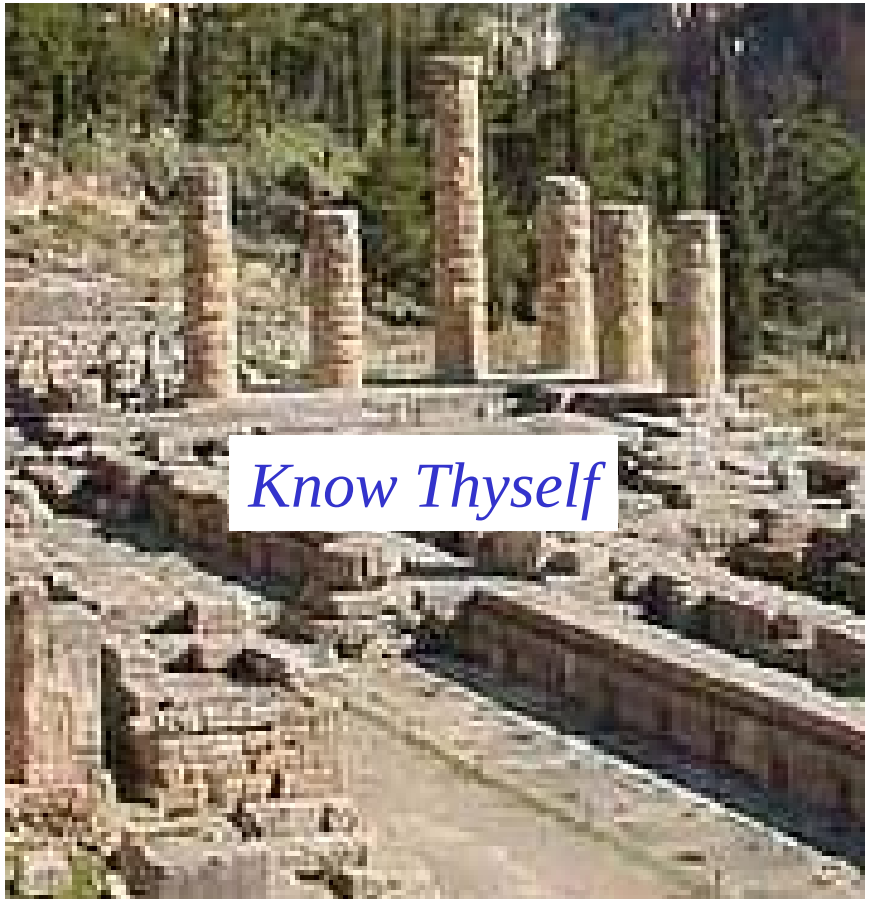
or

Gandalf

d
)

Actually, advisors give ADVICE not answers...

The Oracle at Delphi



Think of advising as a resource

Think, Investigate, Plan

- Initiate contact
- Be patient but persistent with your advisor
- Come prepared with questions

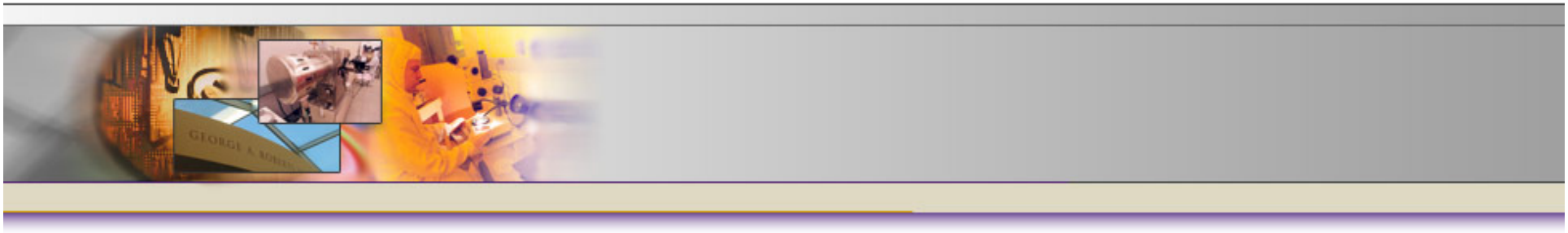
Summary

- The ECE advising system is designed to provide you with resources
- Advisors are assigned and will help connect you with mentors
- Mentors will be in one area of your interest and will guide you as juniors and seniors
- The more we know about you and the more you know about the department, the more effectively we can help you find answers
- Ultimately, YOU are going to provide your own answers NOT get them from someone else

Introduction to
The Information Storage Technology at CMU

James A. Bain, *Associate Director, DSSC*

Jimmy Zhu, *Director, DSSC*

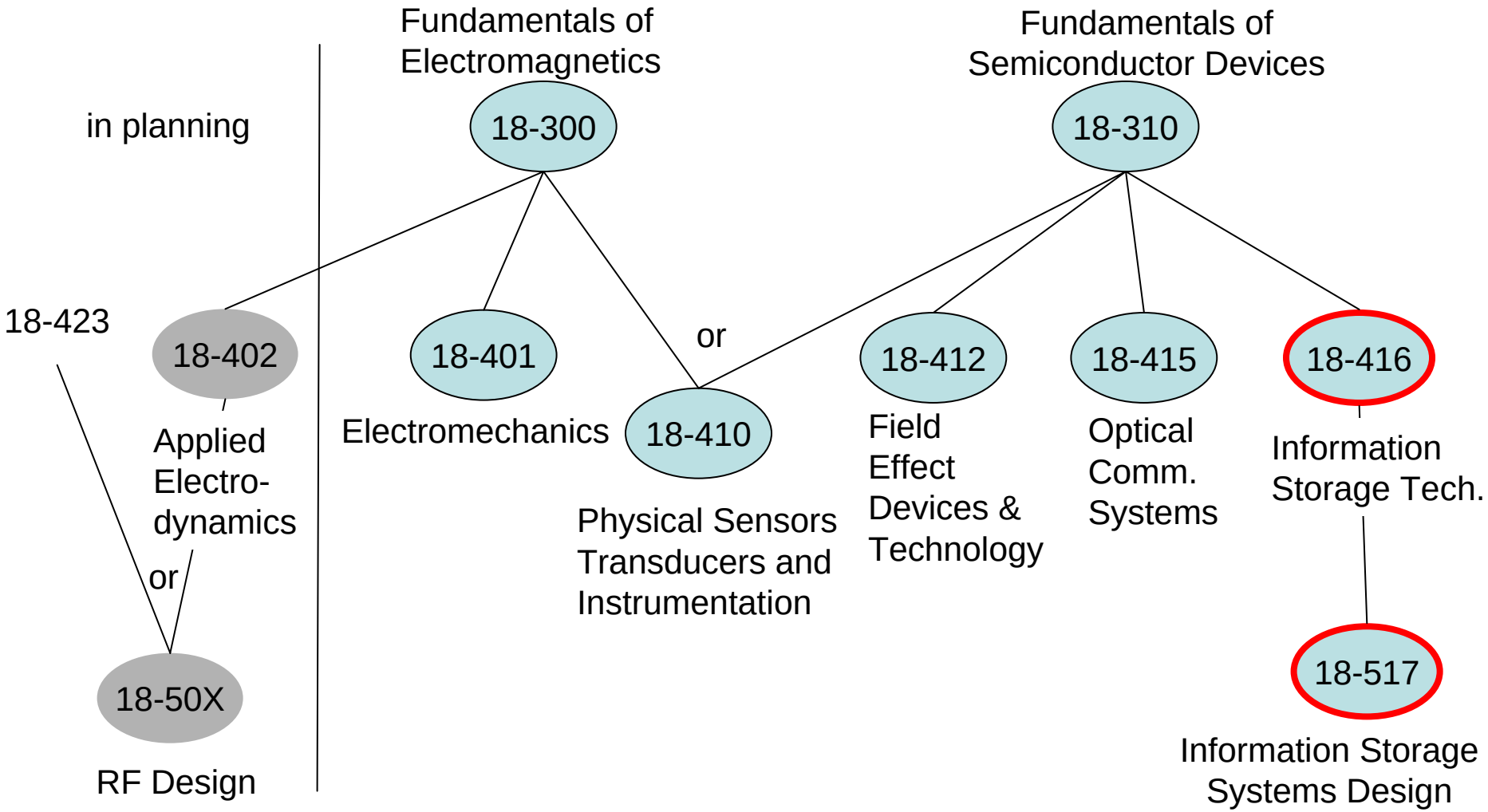


DSSC
The Data Storage Systems Center

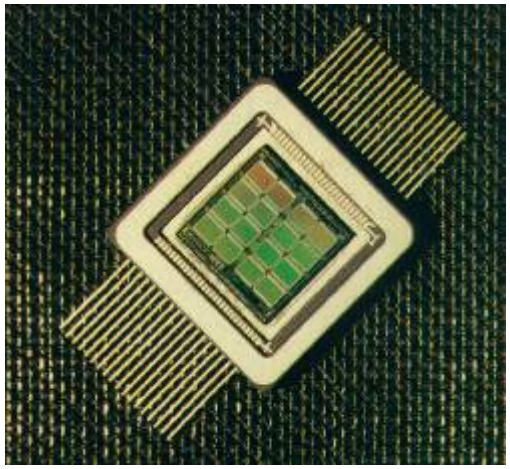
Electrical & Computer ENGINEERING

Carnegie Mellon

Applied Physics Courses



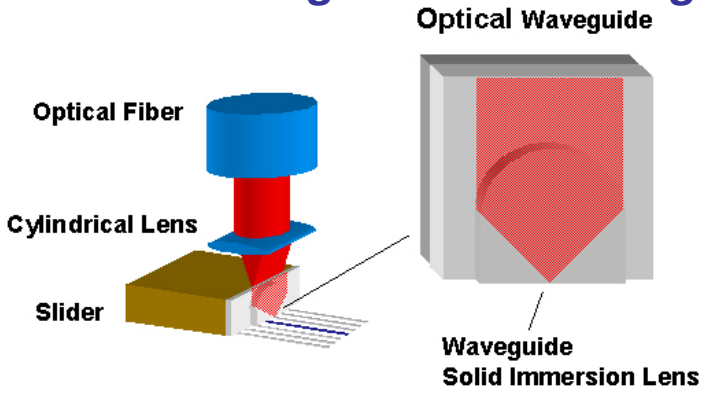
Data Storage Technologies



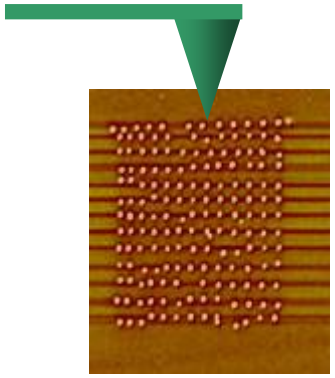
Nonvolatile RAM
(MRAM, FLASH, etc.)

Hard Disk Drives

Heat Assisted Magnetic Recording



Digital Tape Recording



Probe Based Storage

Optical Recording

Data Storage Systems Center

- ***30 Faculty Members in***
  - *Electrical and Computer Engineering*
  - *Material Science and Engineering*
  - *Mechanical Engineering*
  - *Physics*
  - *Chemical Engineering*
  - *Chemistry*
- ***15 Postdocs and Visiting Researchers***
- ***45+ Graduate Students (PhD and MS)***
- ***60+ DSSC Research Projects***

DSSC Industrial Affiliates: 13 (+2)

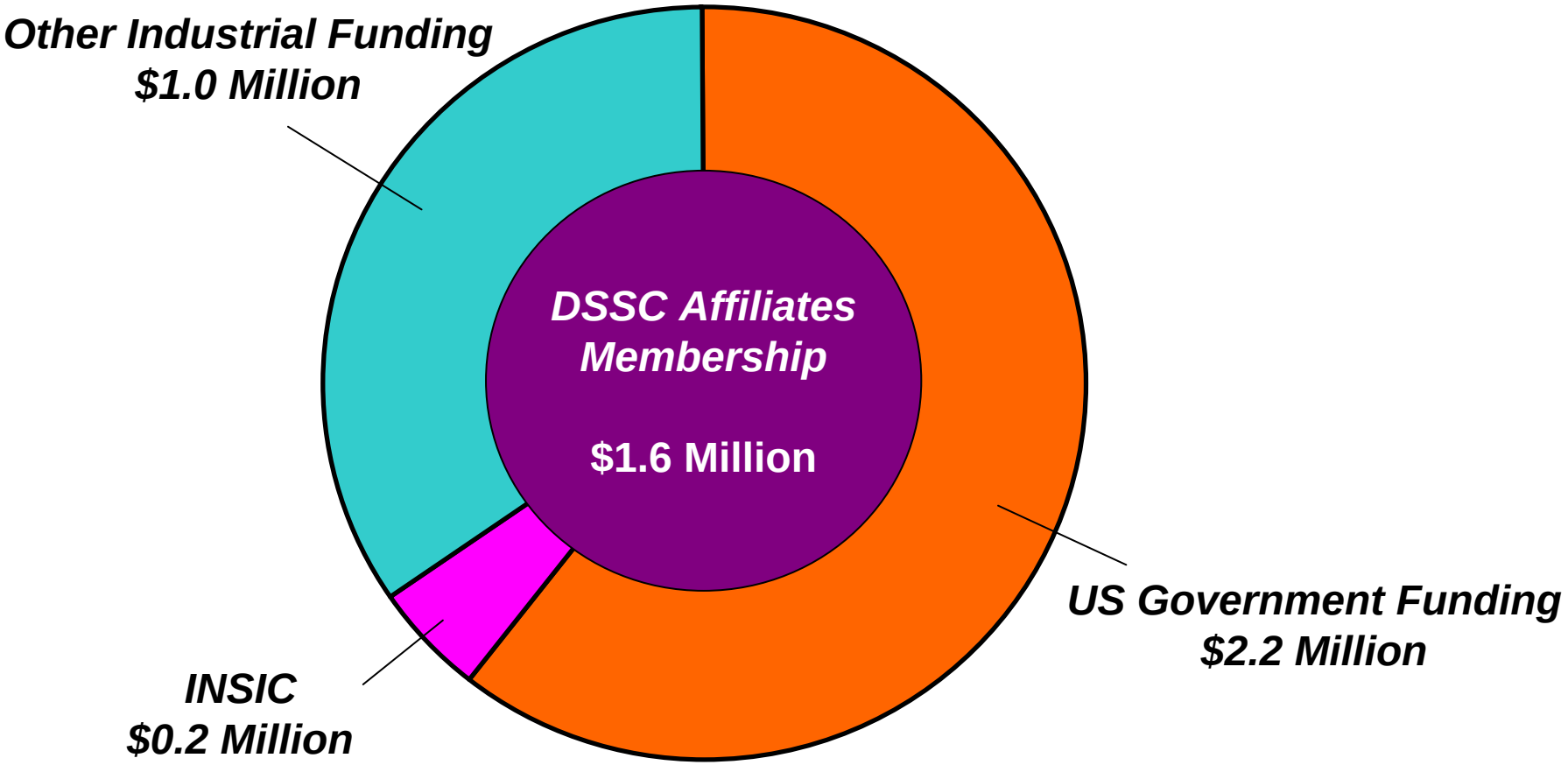
(+ 

+ 

)

Year 2005 Research Funding

Total Funding: $5 Million



Targeted New Affiliates

ALPS

FUJIFILM

IBM

Hitachi Global Storage Technologies

HOYA

TOSHIBA

TEIJIN

TORAY

TDK

KOMAG

SAMSUNG

Notable laboratory facilities

- ***Materials fabrication***
  - *Extensive deposition facility (13 machines)*
  - *Tape fabrication system*
  - *Langmuir-Schafer trough for nanoparticle arrays*
  - *Electrodeposition*
  - *Sputtered Tape Coating Facilty*
- ***Materials analysis***
  - *Magnetometry*
  - *TEM (extensive)*
  - *X-ray*
  - *Various chemical analysis*
- ***Device Fabrication***
  - *Optical lithography (1 um)*
  - *E-beam lithography (35 nm)*
  - *Focused ion beam (35 nm)*
  - *Chemical mechanical polishing (CMP)*
- ***Device testing***
  - *Drag tester*
  - *Tape Drum Tester*
  - *Scanning Kerr microscope*
  - *HAMR spin stand*
  - *Scanned probe microscope (w/ conducting AFM)*

alleghenyconference
ON COMMUNITY DEVELOPMENT

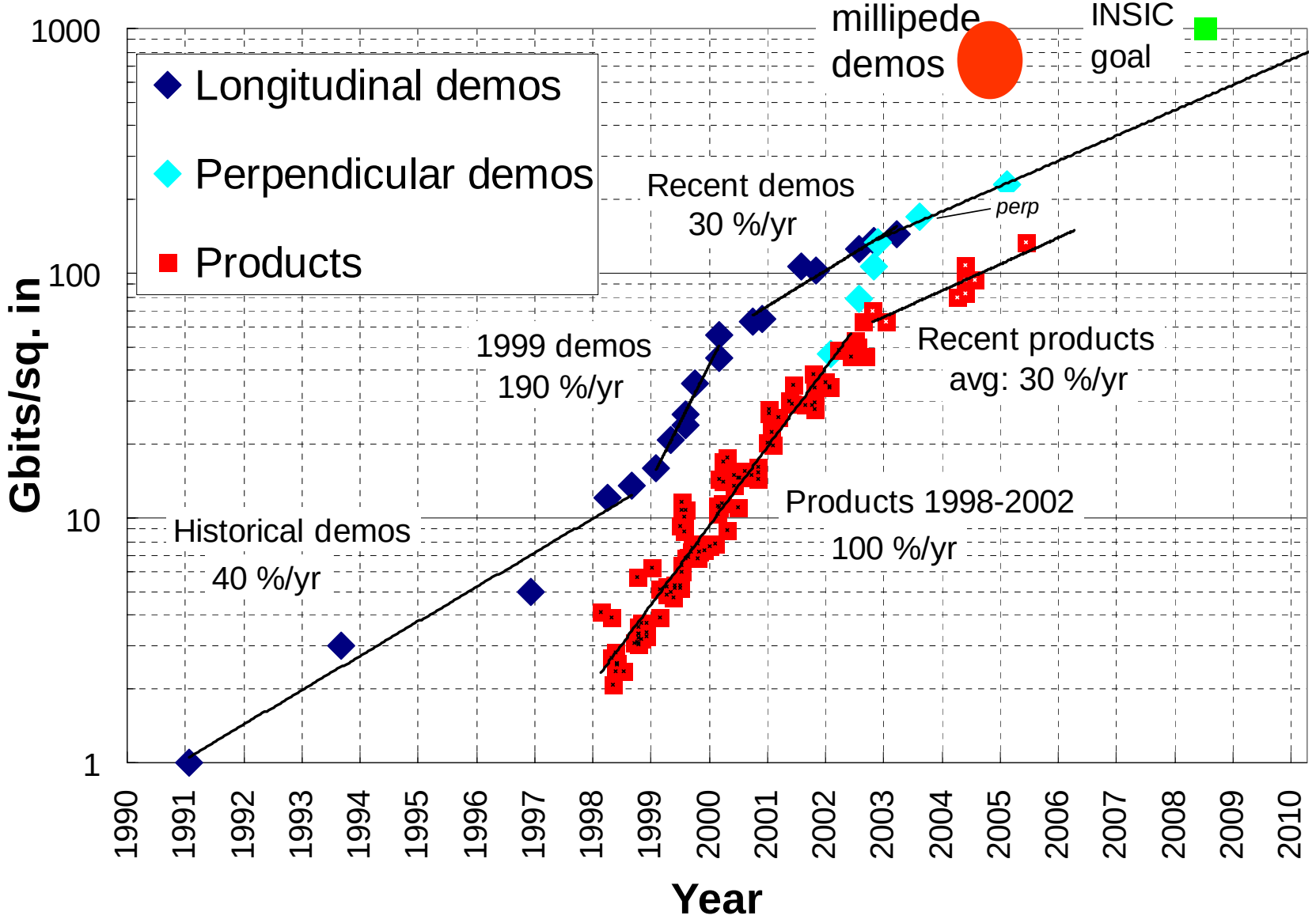
PITTSBURGH REGIONAL ALLIANCE • GREATER PITTSBURGH CHAMBER OF COMMERCE • PENNSYLVANIA ECONOMY LEAGUE – WESTERN DIVISION

Developing a Storage Industry Cluster in Pittsburgh, Pennsylvania

April 26, 2005

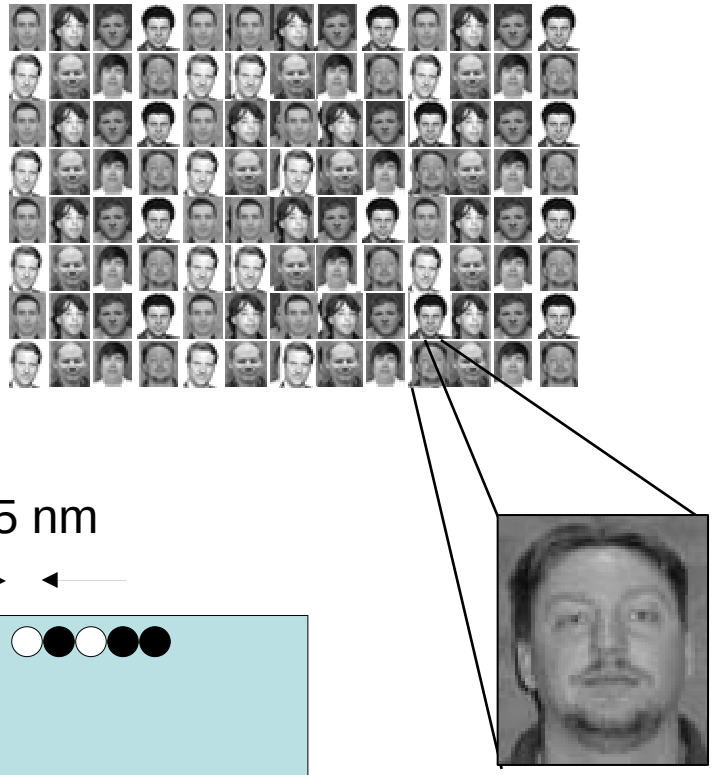
pittsburgh regional alliance
greater pittsburgh chamber of commerce
PENNSYLVANIA ECONOMY LEAGUE

Storage technology progress



...Beyond 1 Tbit/in^2

- *At 1 Tbit/in2 you can save a picture of every man, women and child on earth on a disk the size of a Compact Disk*



750 byte
30 x 30 pixel
8 bit grayscale
.jpeg image

Measuring magnetic marks

Y. Zhou (Zhu)

Perpendicular recording

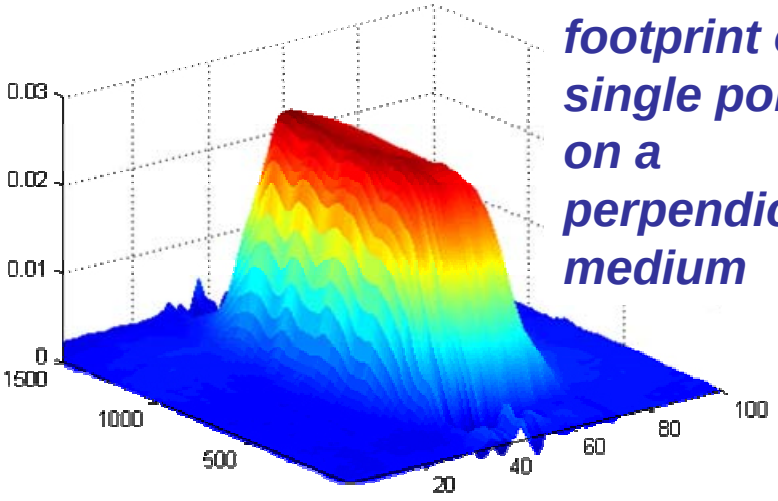
SV Readback

Size: 13 X 13 um²

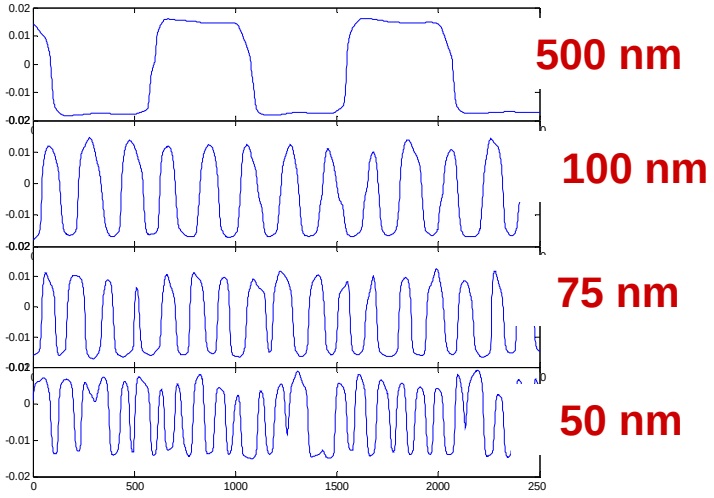
Write: 75 nmx75 nm pix.

Read: 10 nm x 1 nm

Perpendicular Recording

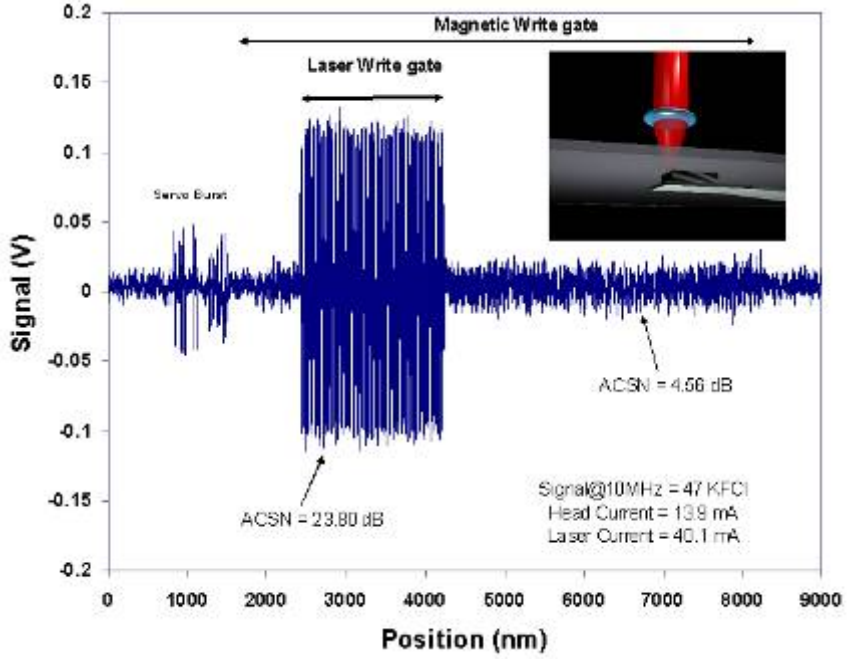


Recorded footprint of a single pole head on a perpendicular medium

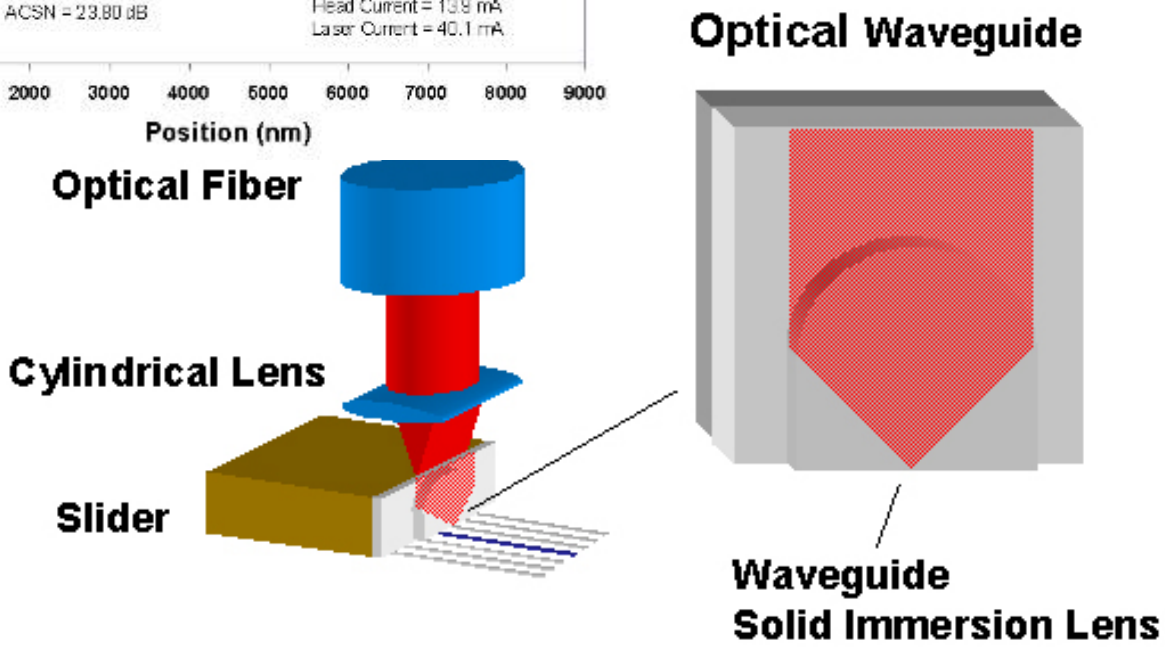


Heat Assisted Recording

L. Zhou, E. Black, B. Knight
(Bain, Stancil, Schlesinger)

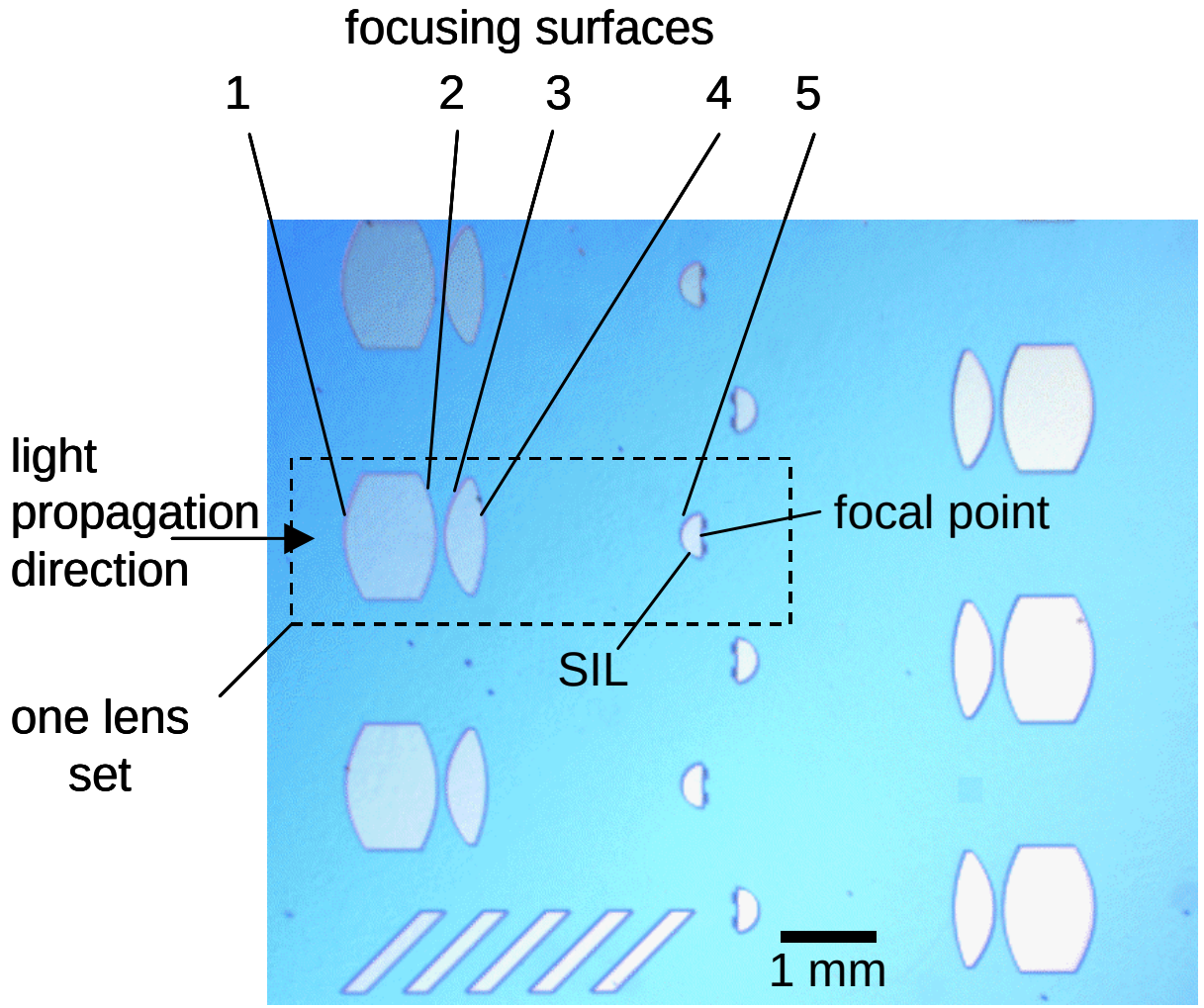


- *Heating medium locally and temporally to enable data writing.*
- *The data retention time is significantly increased .*



Mode Index Lenses

L. Zhou, (Bain, Schlesinger)



Materials deposition

Optical design

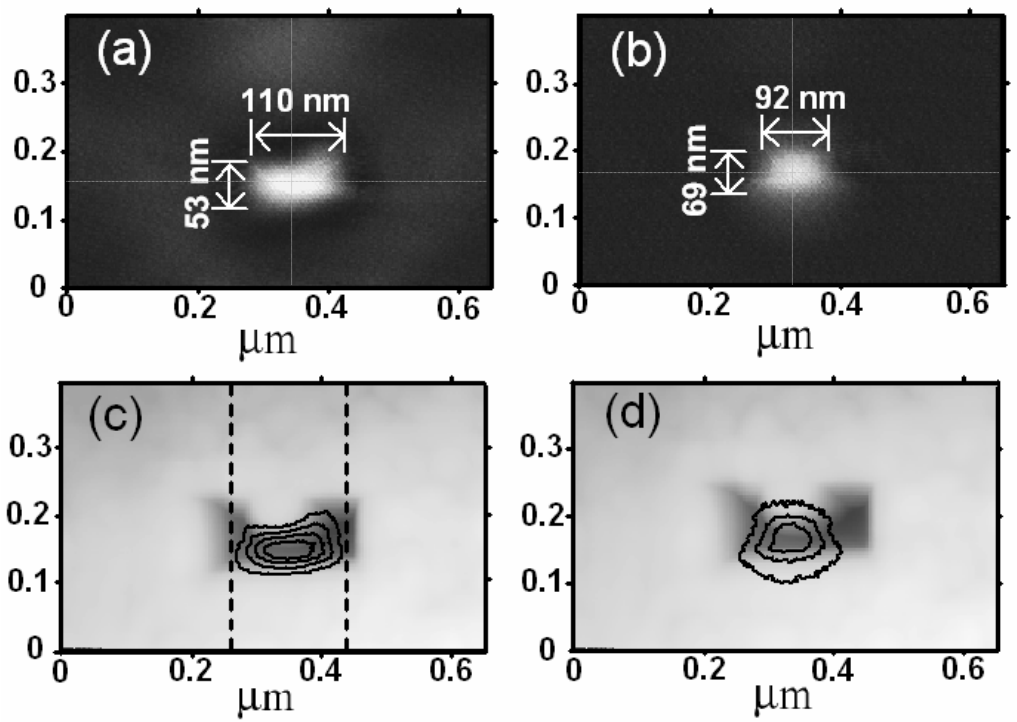
Fabrication

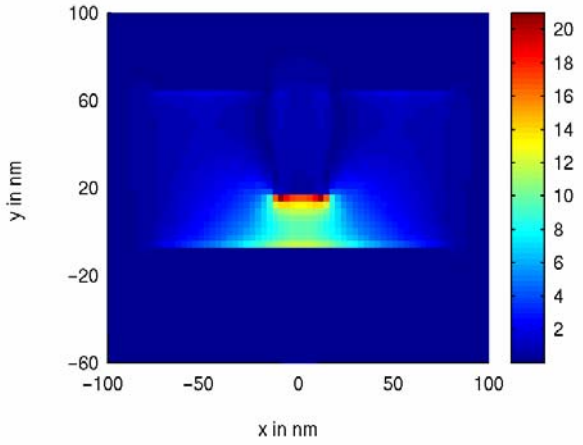
Testing

Integration

Nanophotonics

T. Ohno, (Bain, Schlesinger, Stancil)





Experiment:

Very small aperture lasers

Advanced "aperture" and resonant structure design

Metrology at the nanoscale

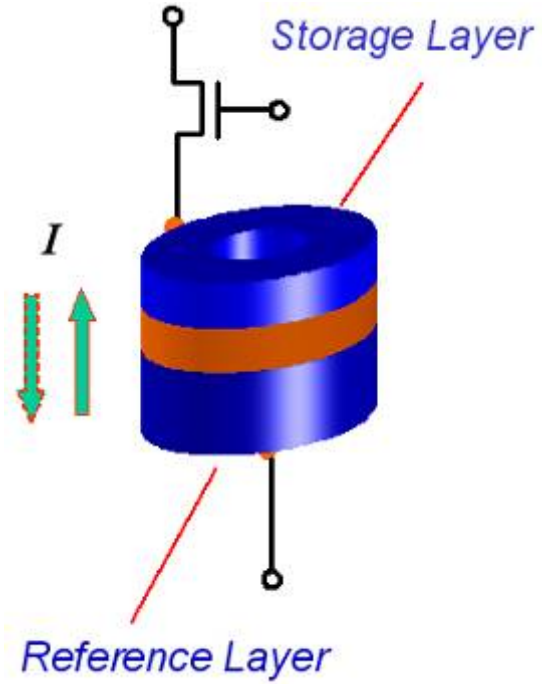
AND

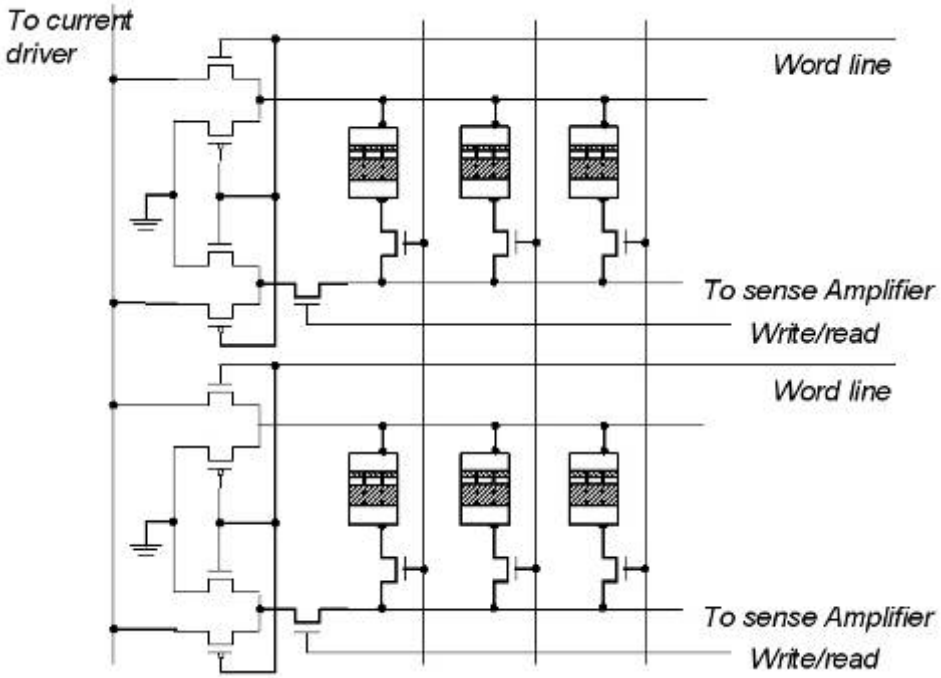
Theory/Modeling

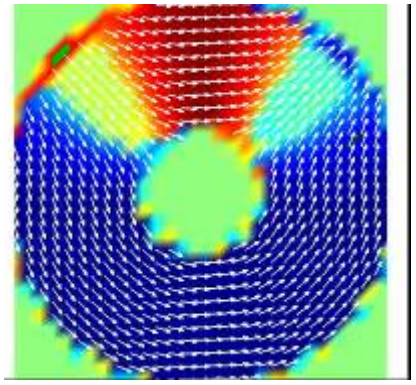
Magnetic Random Access Memory (MRAM)

M. Moneck, X. Zhu (Zhu)

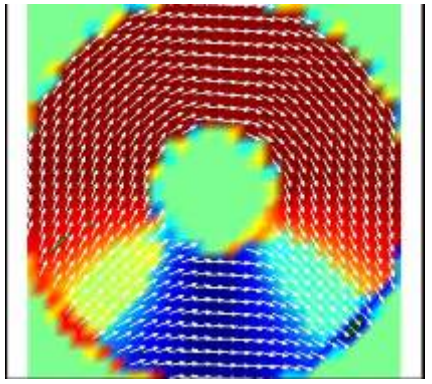
- *Nonvolatile: data retention without power.*
- *Enables "instant-on" feature for computers.*
- *Enables single chip computer systems.*
- *A universal memory with potential to replace SRAM, DRAM, FLASH, and partially disk drives.*







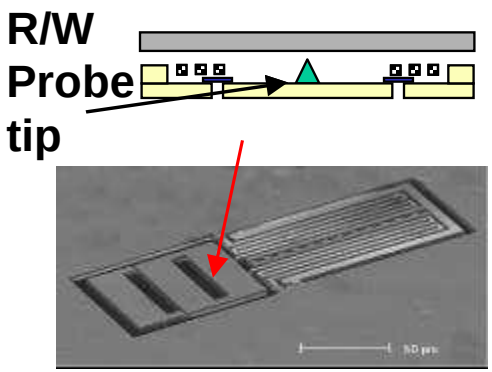
$0 \Rightarrow 1$



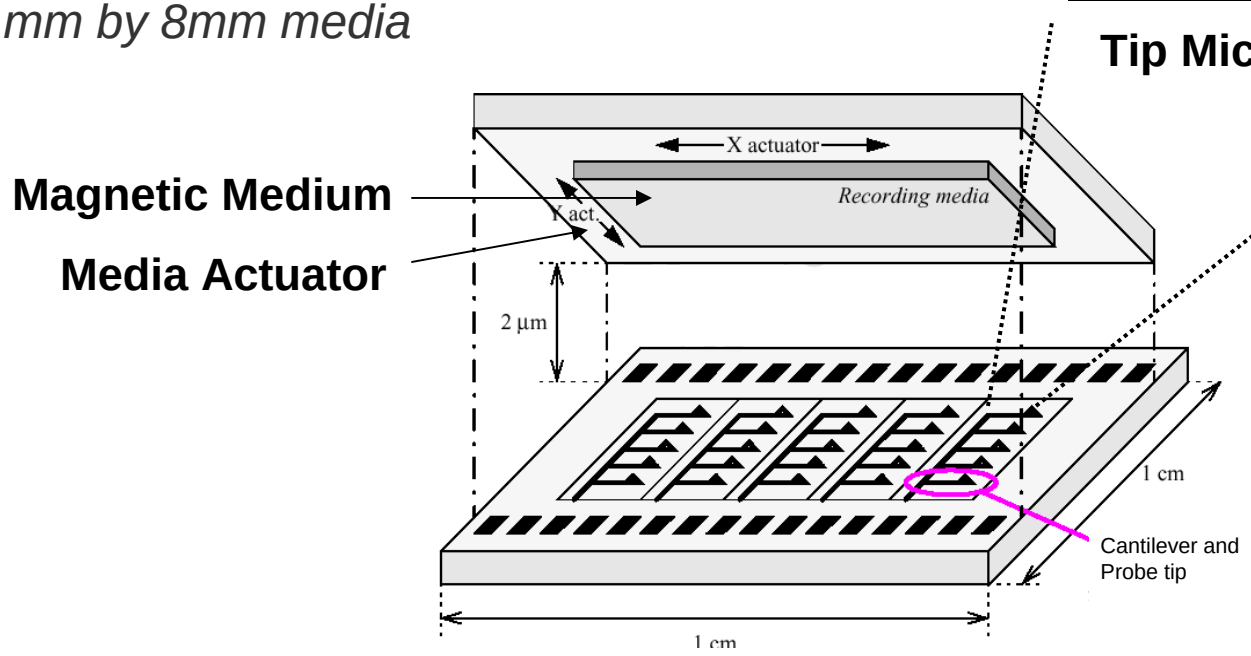
$1 \Rightarrow 0$

Probe Storage

- ***Array of micro-actuated probe heads***
  - *80 x 80 array*
  - *7-50 GBytes capacity*
- ***Magnetic probe recording***
  - *10 nm by 10 nm bits*
  - *8 mm by 8mm media*

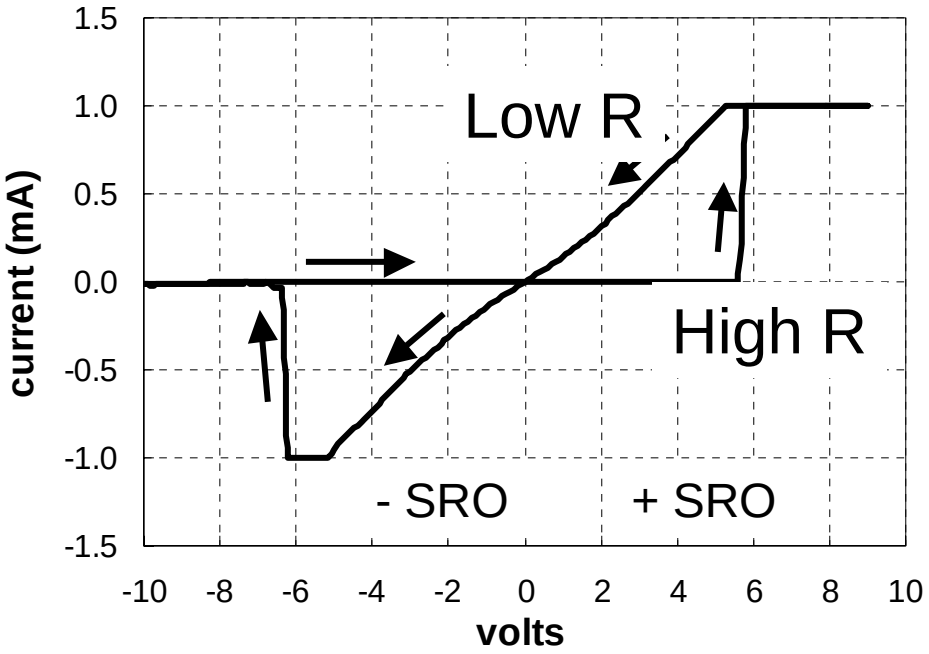


Tip Microactuator

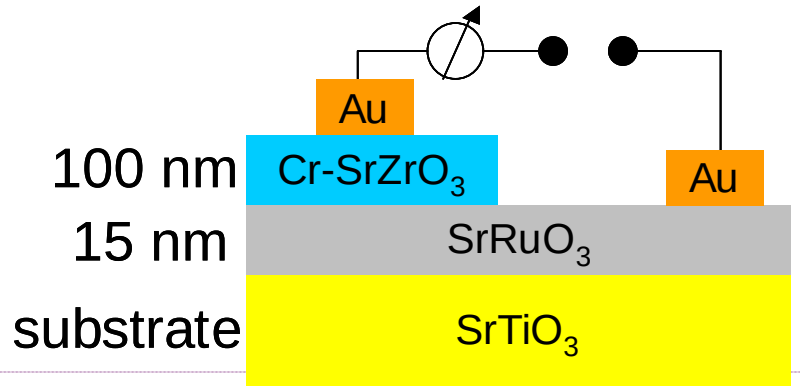


Resistance change oxides

S Choi/H Lee (Bain/Salvador)



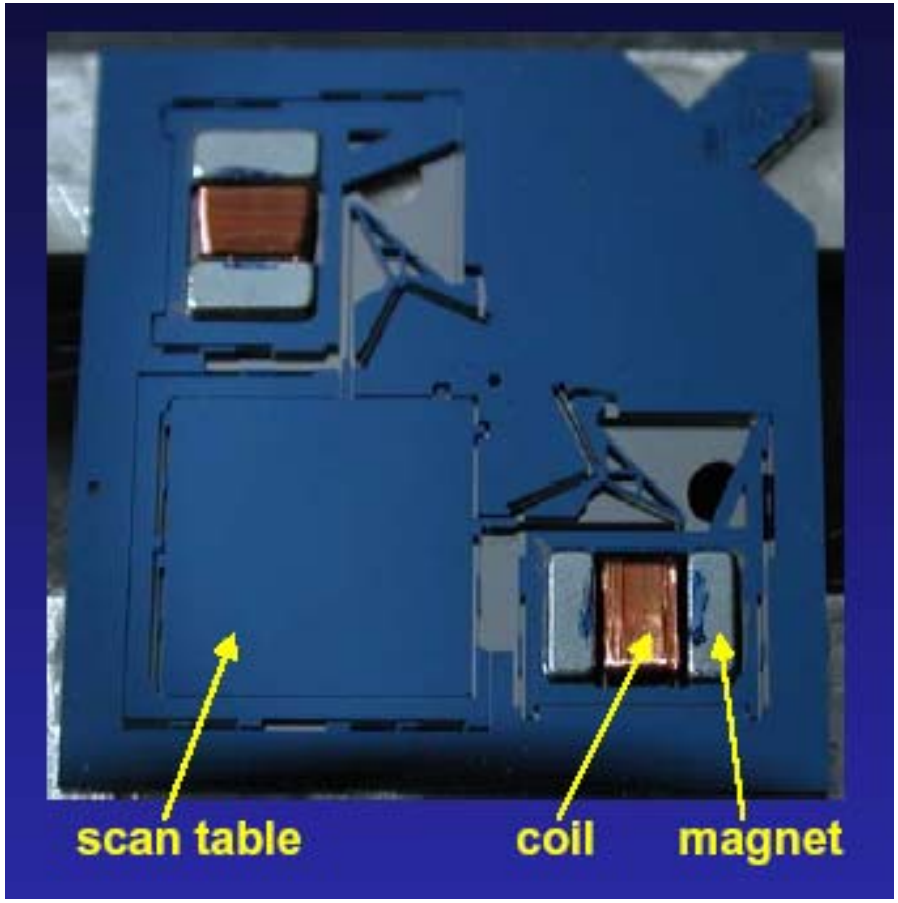
- ***Material results only***
- ***Resistance change phenomenon demonstrated by several groups***
- ***Potentially low power***
- ***No engineering model of behavior yet ...***



Beck, A., Bednorz, C. Gerber, C. Rossel, and D. Widmer, *Reproducible switching effect in thin oxide films for memory applications.* Applied Physics Letters, 2000. **77**: p. 139-141.

Electromagnetic actuation, IBM

Aggeliki Pantazi, et al



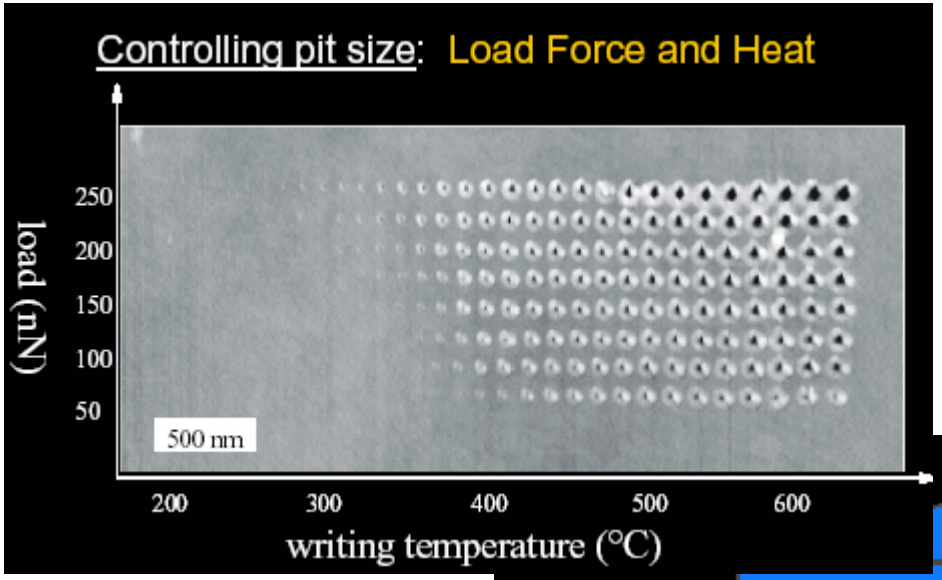
- ***Power levels meet product specifications***
- ***Shock tolerance addressed***
- ***Maximum displacement and rates are acceptable***
- ***Extensive systems integration***

1 cm

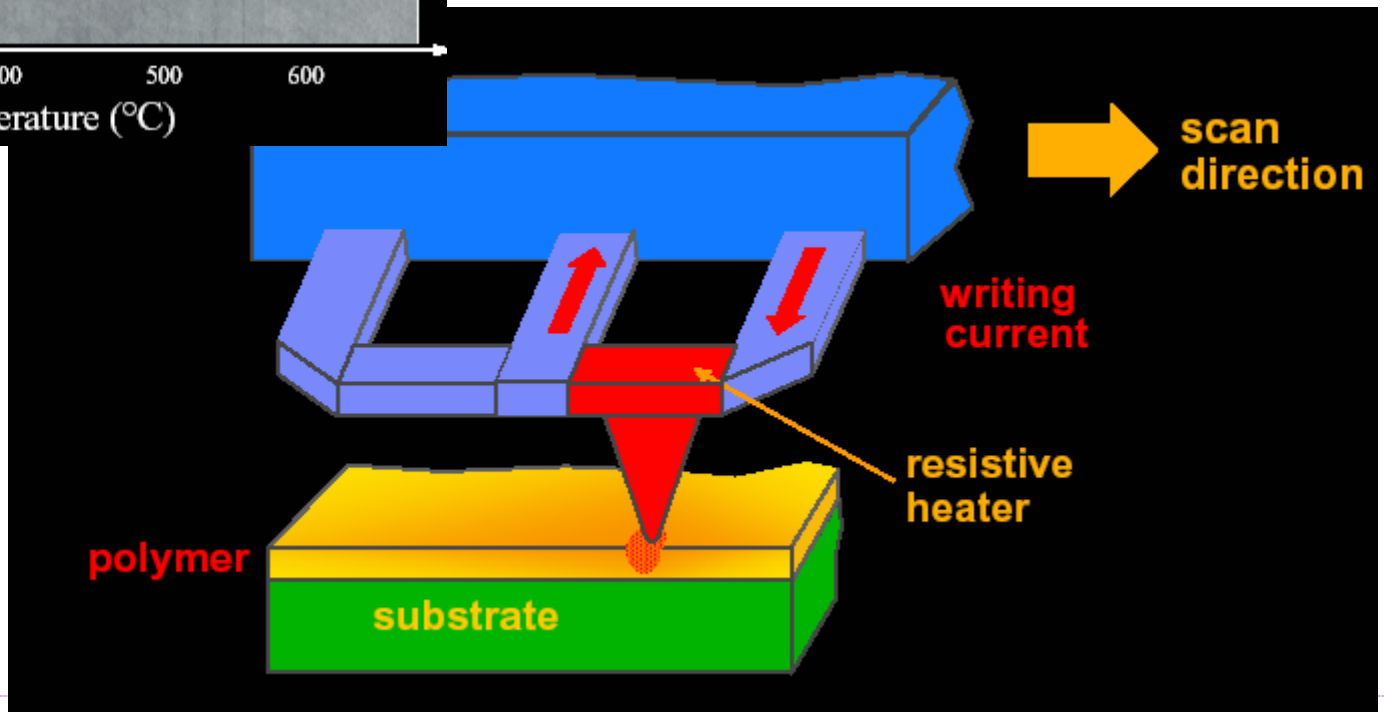
IBM

Polymer media, IBM

Urs Dürig, et al

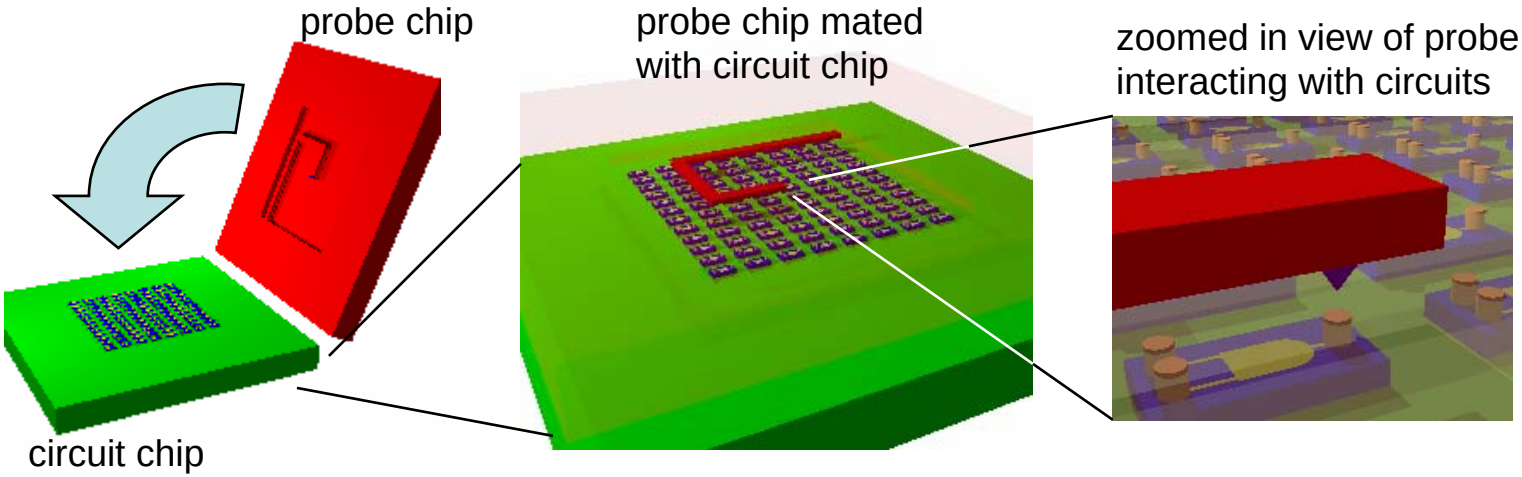


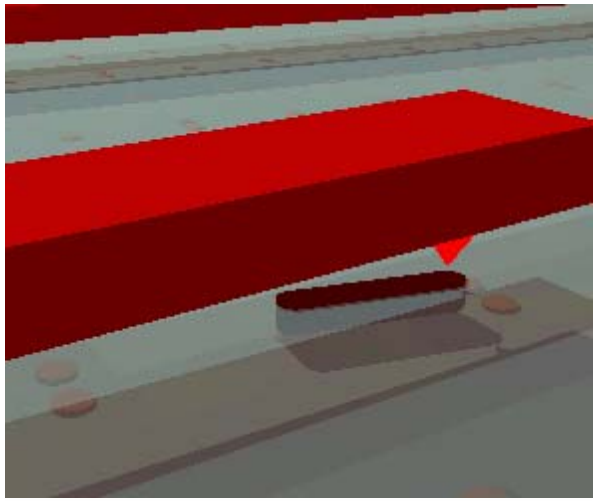
- *Detailed understanding of physics has been developed*
- *Stability has been examined and is not a showstopper*
- *10 Tbits/in² is feasible*



MISC-IC Technology

Memory Intensive Self-Configuring IC's





Gen I Technology: Reconfigurable Logic (0-5 yrs)
Probe reconfigurable interconnect (non-volatile)
Probe configurable logical blocks (non-volatile)

Gen II Technology: Integrated Probe Storage (4-7 yrs)
Large non-volatile memory with access time < 500 us)

Gen III Technology: Integrated nanodevices (7-10 yrs)
Probe activation of self-organized nanofabric

Summary

- ***DSSC has a broad spectrum of research in materials, devices and applied physics***
- ***Information storage is a rich field of application with a lot of participation from ECE faculty***
- ***$100 Billion storage industry can make of wide spectrum of ECE graduates in applied physics areas as well a signal processing***