Information Storage

Research at University of Plymouth, UK

Niihama April 2005

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Presentation Overview

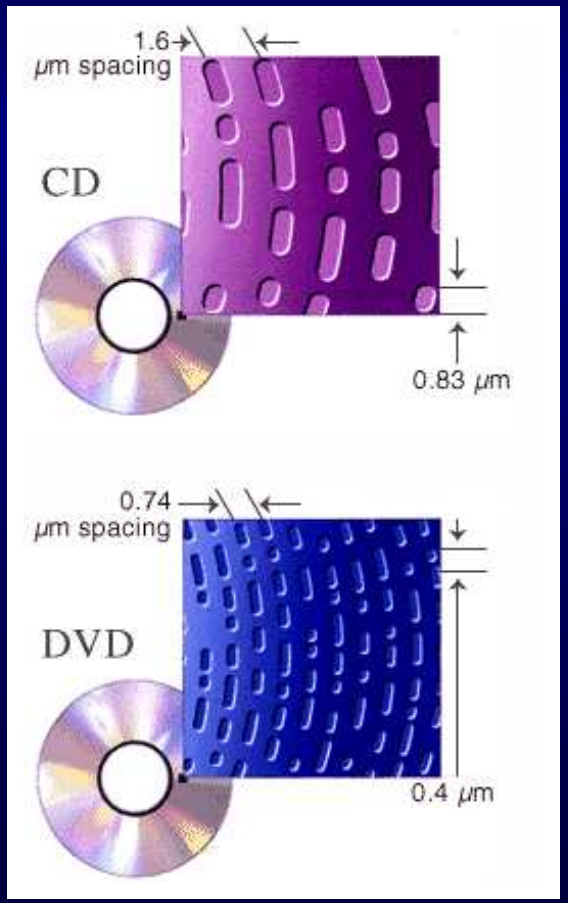
1. Introduction to Information Storage.
2. Research at the University of Plymouth
   - The Centre for Research in Information Storage Technology (CRIST)
   - Error Correction Coding and Signal Processing Research.
3. Conclusion & Future Work.

1 Introduction to Information Storage

Information Storage Market

The information storage market is projected to be worth 39 billion US dollars in 2010, from 19.8 billion US dollars in 2005. It is expected that optical and semiconductor storage will increase their share of the market.

Optical, CD/DVD



Mechanical, Gramophone (1887)

Mechanical, What is the dog listening to?

Mechanical

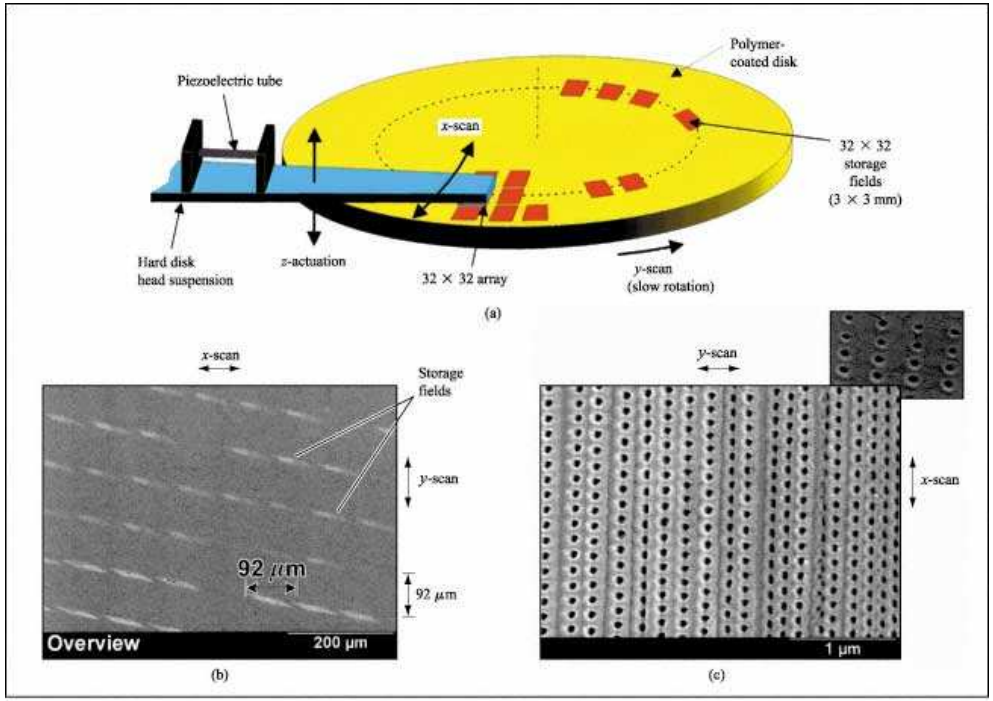
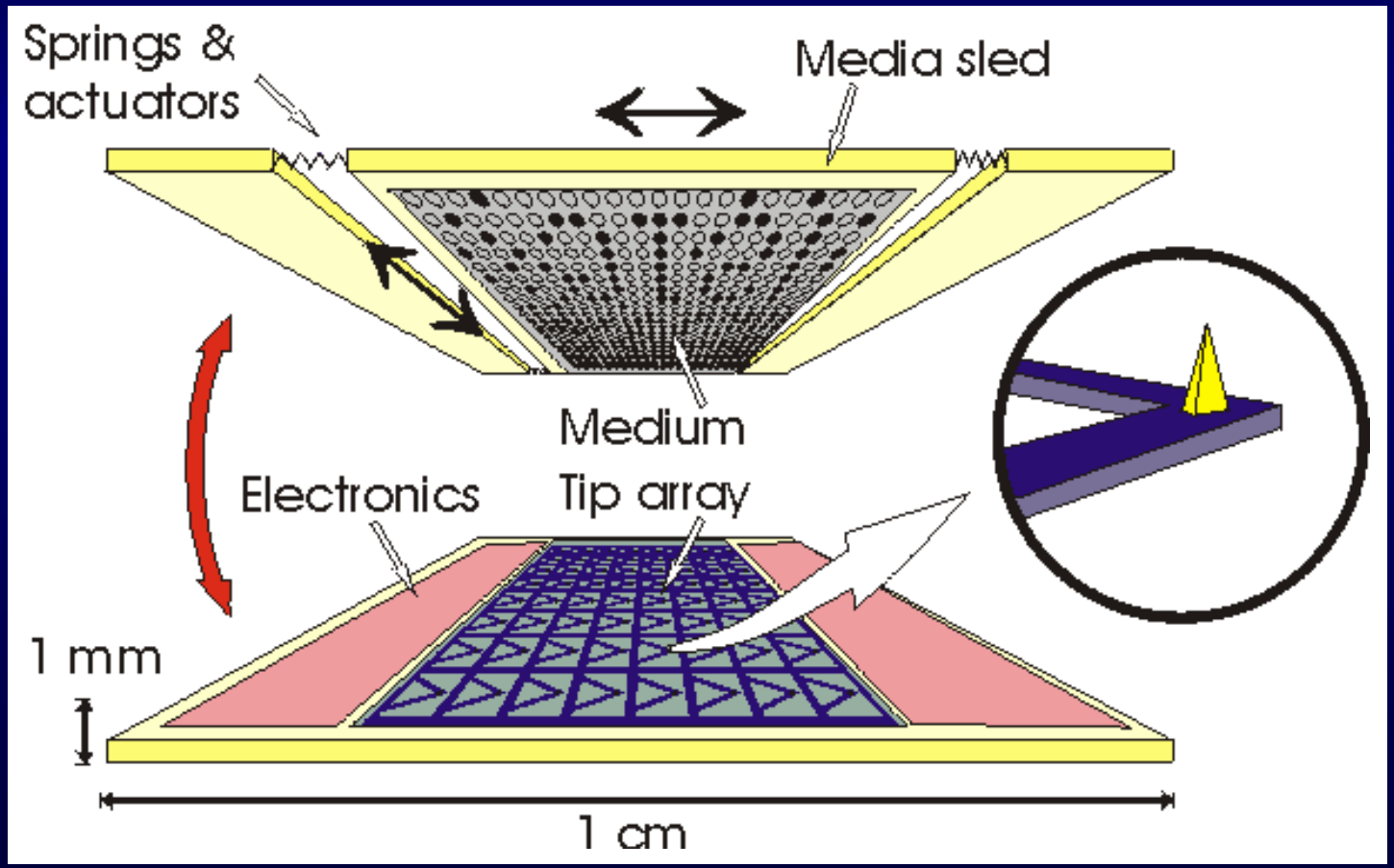


Figure 14

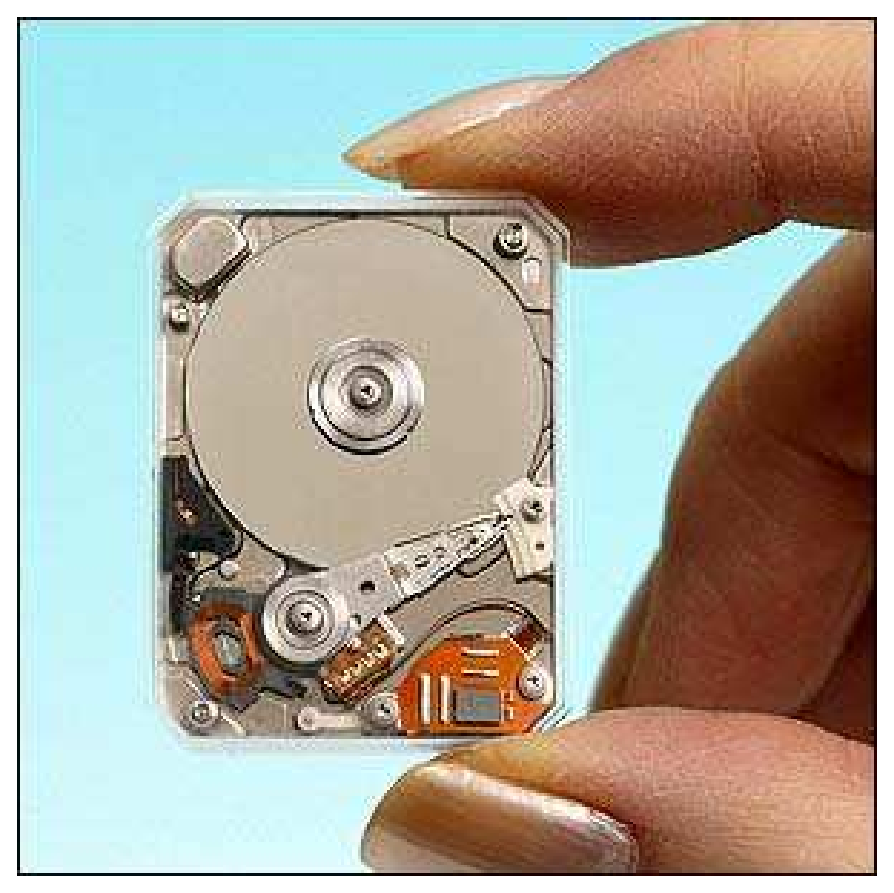
(a) Modified hard disk Millipede approach for array-chip scanning and displacement, and writing results: (b) SEM image of many storage fields; (c) magnified bit indentations in 100-nm-thick PMMA medium, equivalent to a storage density of 70–100 Gb/in.^{2} Note that the x/y scan directions are interchanged between (b) and (c).

Mechanical

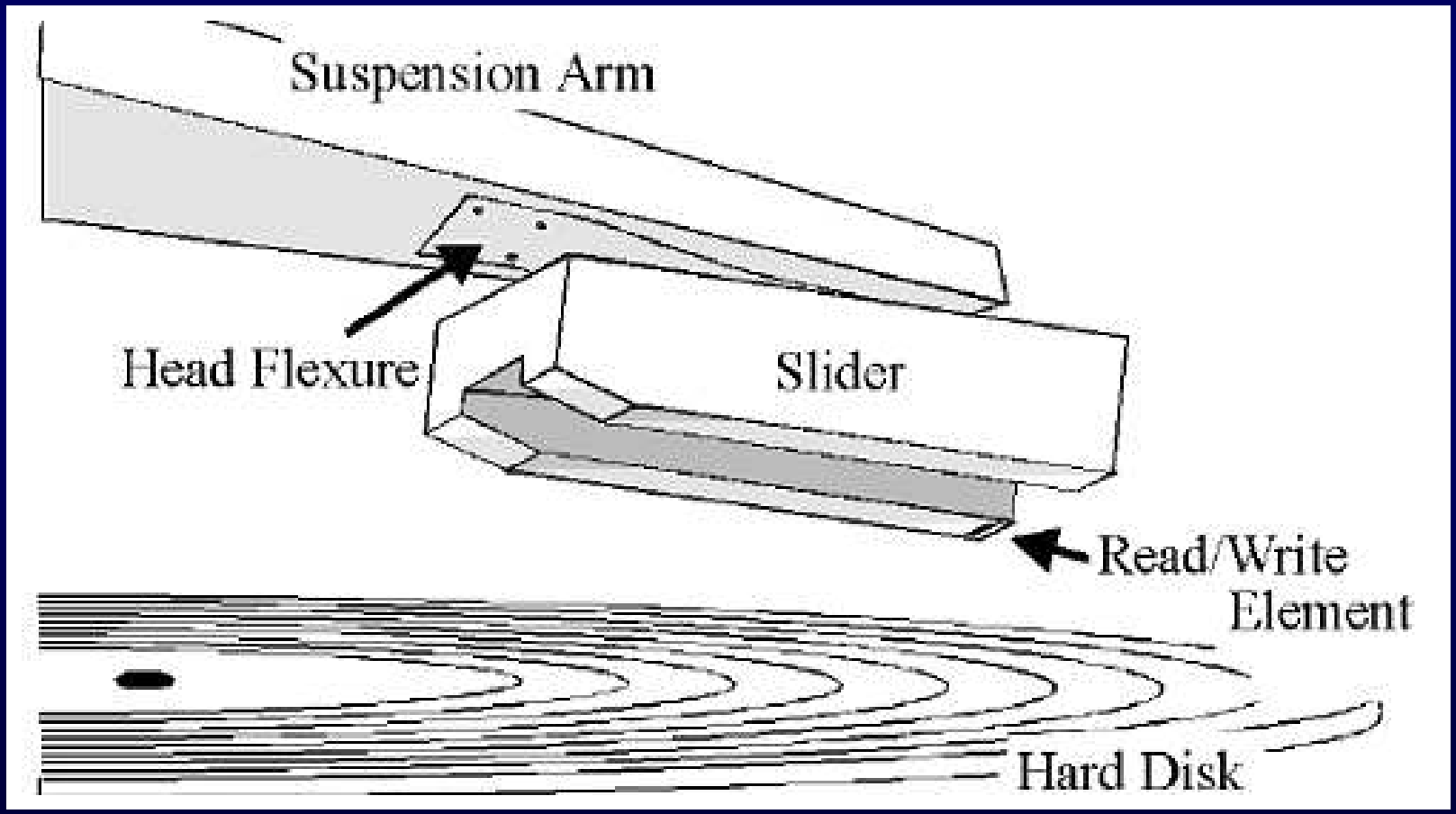

Springs &
actuators
Media sled
Medium
Electronics
Tip array
1 mm
1 cm

Magnetic Disks, IBM RAMAC

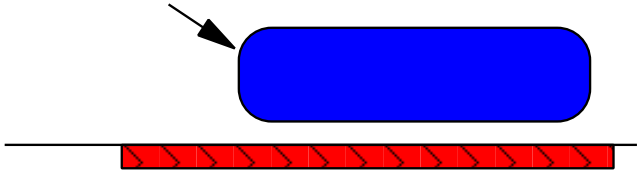
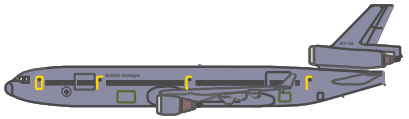
Magnetic Disks, Toshiba



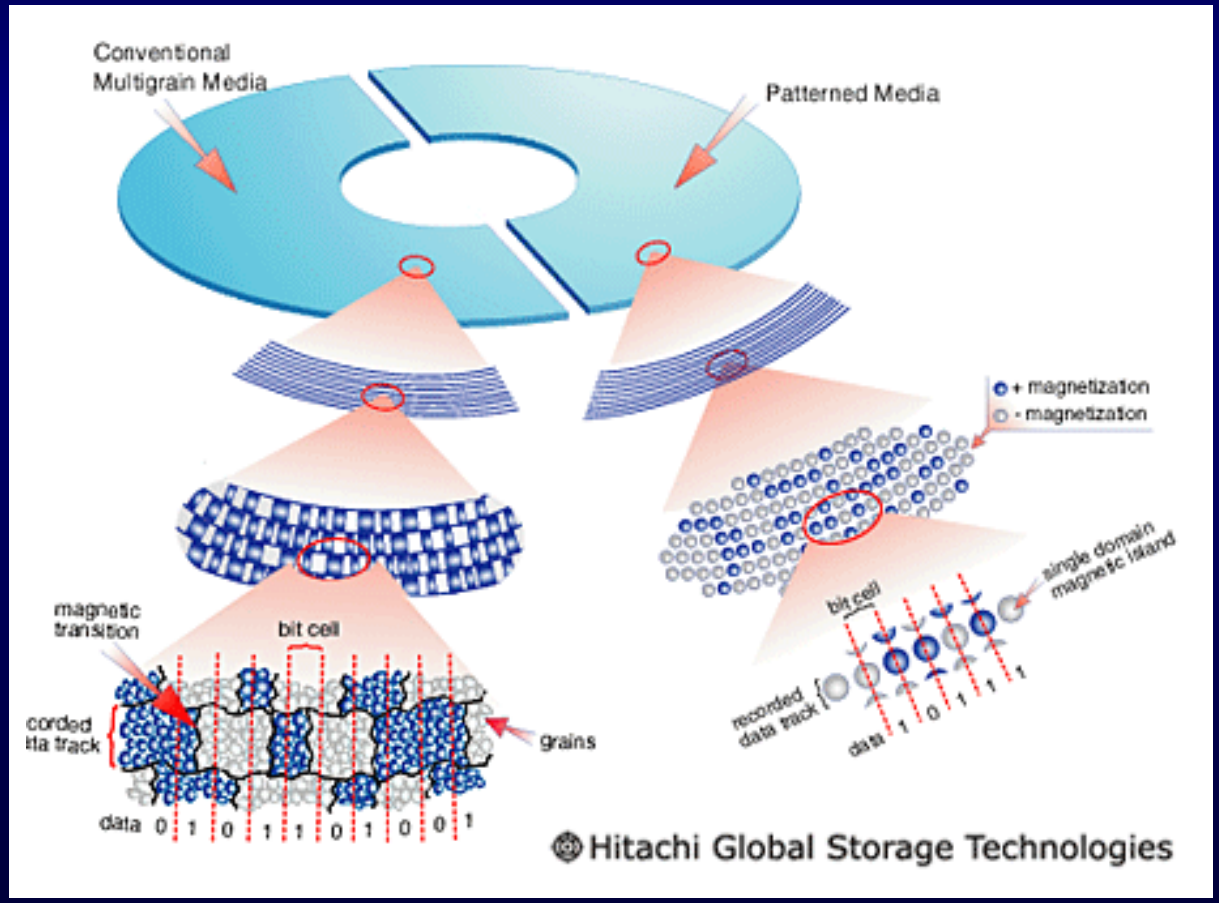
Head Disk Interface



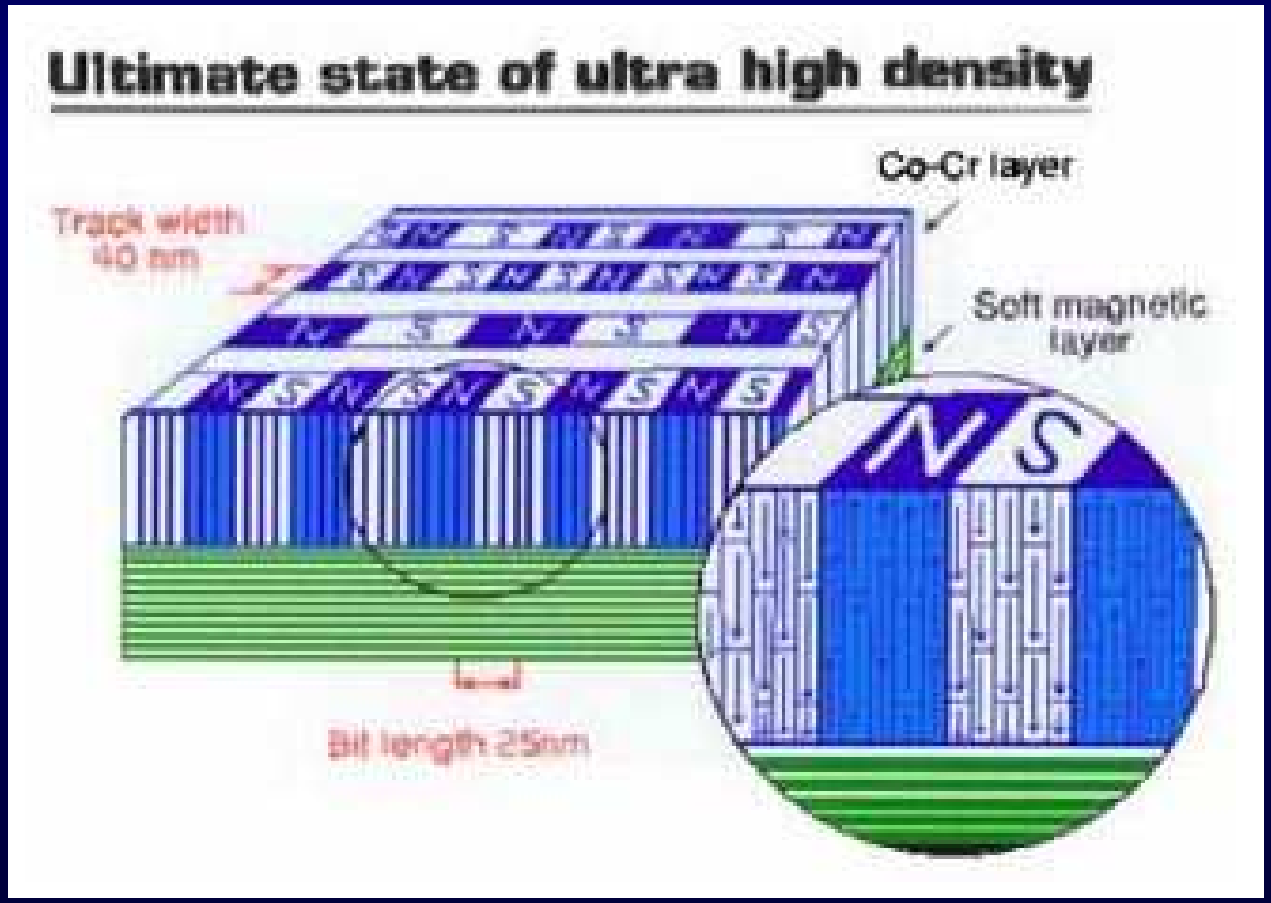
Head Disk Interface for 1Tb/in^2 Engineering Challenge

	MAGNETIC SLIDER	747 JUMBO JET
		
	MAGNETIC MEDIA	GROUND
Length	2mm	70m
Flying Height	6.5nm	0.91mm
Bit Length	11nm	1.54mm
Track Width	29nm	4.1mm
Linear Speed	41m/s	1464km/s

1Tb/in^2 Material Science Challenge

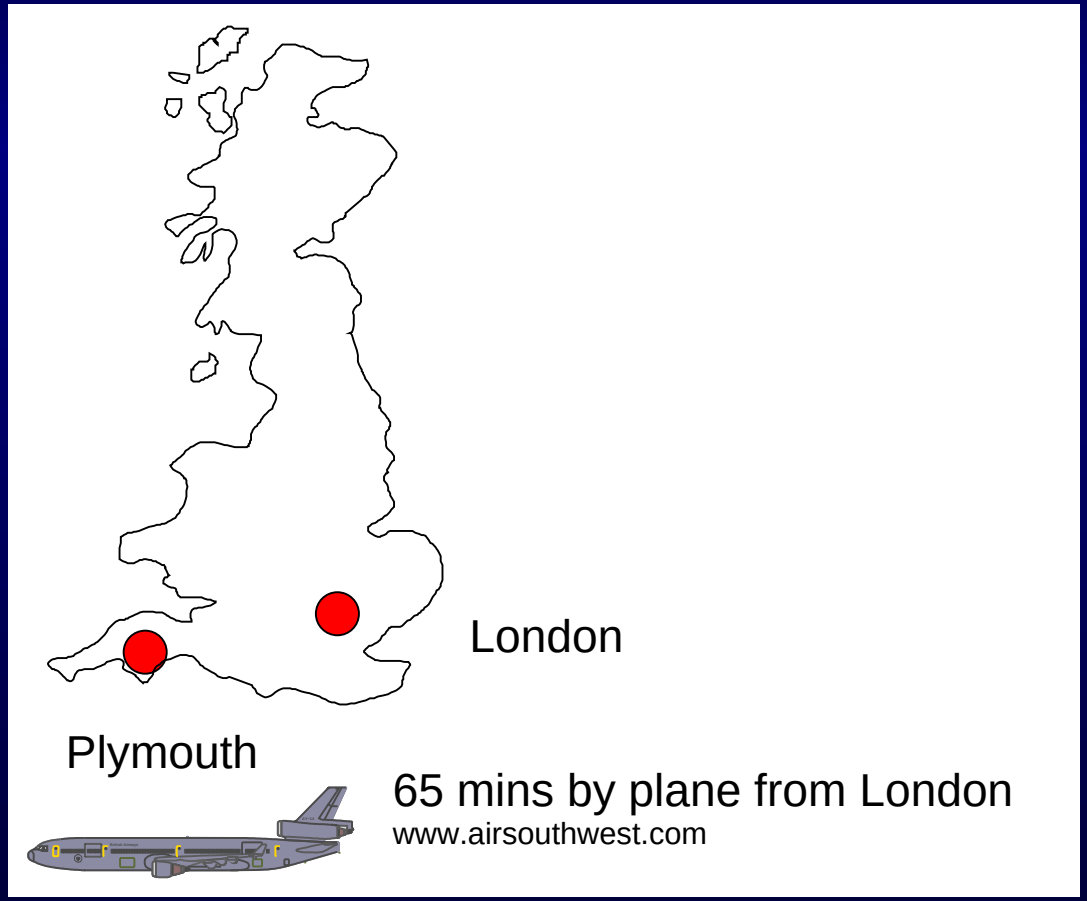


Communications Projects



2 Research at The University of Plymouth

Plymouth – Where? Who? What? – www.plymouth.ac.uk



2.1 The University of Plymouth

30000 students and 3000 staff, with campuses in the city of Exeter and Exmouth.

Setup as educational establishment in 1862, when Japan participated for the first time in the Great International Exhibition in London (similar to EXPO in Aichi). It is classed as on of the top three New Universities in the UK.

School of Computing Communications and Electronics

Research in the School

- Interactive Intelligent Systems.
- Network Research.
- Centre for Research in Information Storage Technology (CRIST).
- Robotics (Robot Football Champions of UK).
- Signal Processing and Multimedia Communications.
- Fixed and Mobile Communications.
- Institute for Digital Art and Technology.

CRIST

Started in 1990 by Prof Desmond MAPPS. Comprises of 11 members, Prof. Mapps, Prof. Panina, Dr. Pan, Dr. Davey, Dr. Ahmed, Dr. Jenkins, Dr. Makhnovskiy, Dr. Wilton , Dr. Shute, Mr. Fry and Mr. Brown.

The research facilities include

Grade 10 Clean Room (recently opened).

LeCroy 5005A Disk Drive Analyser (10GS/sec sampling).

Guzik Spinstand S1701.

Other facilities in the cleanroom are

- OAI500 mask aligner with 0.8 micron accuracy.
- 3 Nordiko multi–target sputtering machines.
- CVC Ion beam etcher.
- 2 Edwards Evaporation deposition machines.
- Micro–fabrication facility (wet and dry rooms) including photo–resist spinners and ovens with wet benches for developing and chemical etching.

Current work on Giant Magneto Impedance (GMI), spintronics, advanced heads, signal processing and error correction.

Cleanroom

Cleanroom People – ninja's

Fixed Communications

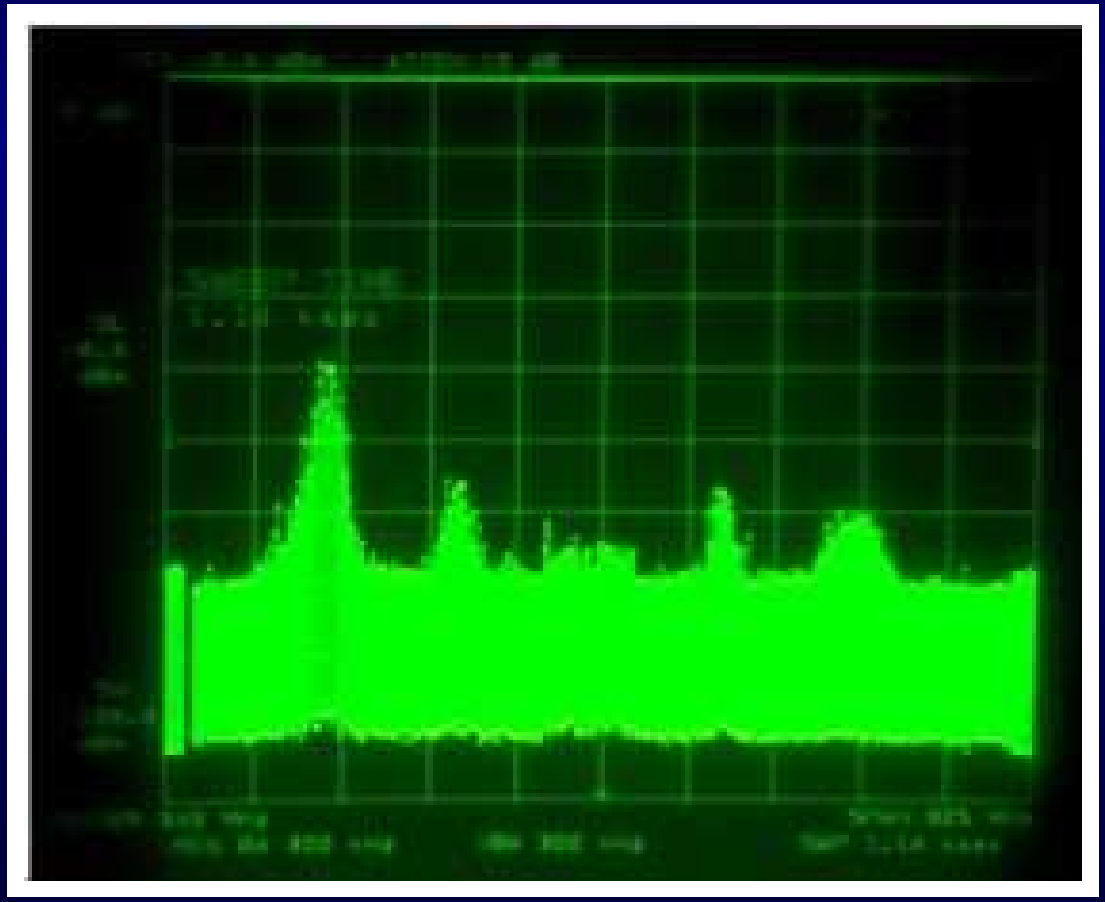
Started in 1983 by Prof Martin TOMLINSON. Focused research on error correction, with applications in response to industry trends. Comprises of 4 permanent members of staff, Prof. Tomlinson, Dr. Ambroze, Dr. Ahmed and Dr. Horan.

PhD Research Students

Communications Projects – Transmit Image

Communications Projects – Antenna

Communications Projects – Receive Signal



Communications Projects – Receive Image

Communications Projects – Decoded Image

Research Projects – Dr M Z Ahmed

As Part of PhD Supervision Team

Evangelos Papagiannis (Oct 2002): Investigation of iterative decoding of low–density–parity–check and turbo codes.

Andrew Rogers (Oct 2002): This project is concerned with the study of optimisation of Turbo codes.

Cen Jung Tjhai (Jan 2004): Algebraic and non–algebraic techniques for designing LDPC codes are investigated.

Jing Cai (Jan 2004): The research focuses on the error correcting codes for internet communications.

Xin Xu (Jan 2004): Novel watermarking and information hiding techniques

for static images are the focus of the research.

Purav Shah (Oct 2004): Research on the theoretical and practical aspects of multi–level information storage.

PhD Research Methodology

Starting with research into the decoding of LDPC codes (Evangelos) and Turbo codes (Andrew) and their optimisation, our PhD research efforts then focused on code construction and design from both code properties and decoder performance (Cen Jung). Extensions of this to the internet type communication channel and watermarking channel (Jing and Xin) is also being made.

The magnetic recording channel is the most difficult channel due to its constraints of inter–symbol interference, data dependant noise, low complexity decoders and required high reliability. Research on this is now being pursued to evaluate the performance and limits of the channel (Purav).

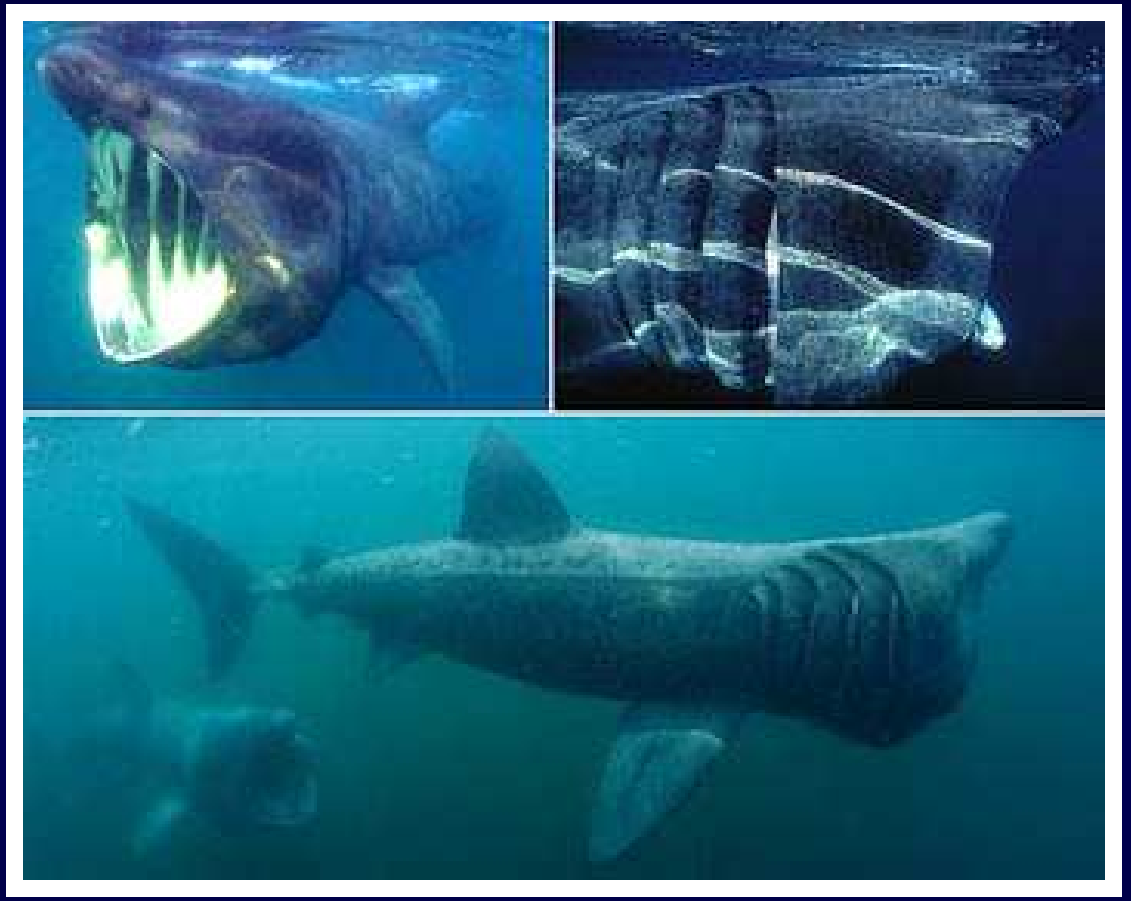
It is believed that there will always communications channels that require

research.

MRes (Master of Research) Students

Emily Sheppard (Jan 2005 – Sep 2005): Project on the diving behaviour of basking sharks.

Dr M Z Ahmed Research at Plymouth



This is a joint project with marine biology and studies the behaviour of basking sharks using signal processing methods.

Mario Lopez Garcia (Jan 2005 – Sep 2005): Project on the application of RLS algorithm for decoding BCH Codes.

MSc (Master of Science) Students

Vijaya G Wala (May 2005 – Sep 2005): Study of the Guruswami Sudan decoder for Reed Solomon codes.

Visiting Postgraduate Students currently in Plymouth

Keiko Takeuchi, from Ehime University, Japan (Oct 2004 – Oct 2005):
Work on noise prediction for Heat Assisted Magnetic Recording.

Andrea Tieghi, from Politecnico di Milano, Italy (Mar 2005 – Aug 2005):
Work on numerical stability of dual–MAP decoding for large extended Galois Fields.

3 In Conclusion; and In the Future

Information Storage

- Magnetic storage is facing renewed competition, relying on engineers to make it **cheaper**, smaller and more rugged.

Reliable communications, the challenge set by Shannon is now almost achieved for the simplest type of channel. The more esoteric and exotic channels are waiting!