HARD DISK RECORDER

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THIC MEETING JULY98

DATA RECORDERS

TAPE RECORDERS

SOLID STATE MEMORY RECORDERS

HARD DISK RECORDERS

MISCELLANEOUS RECORDERS

TAPE RECORDERS

- MOST COMMONLY USED TODAY
- HIGH DENSITY AND HIGH CAPACITY (150GB)
- HIGH DATA RATE UP TO 1 Gb/s
- CHEAP MEDIA : 0.2 $ / GB
- CACHE MEMORY INCREASES BURST DATA RATE
- ROAD MAP FOR FUTURE MORE DATA RATE/CAPACITY
- SEQUENTIAL ACCESS TO DATA
- UPGRADE NOT SO EASY
- DRIVE QUITE EXPENSIVE

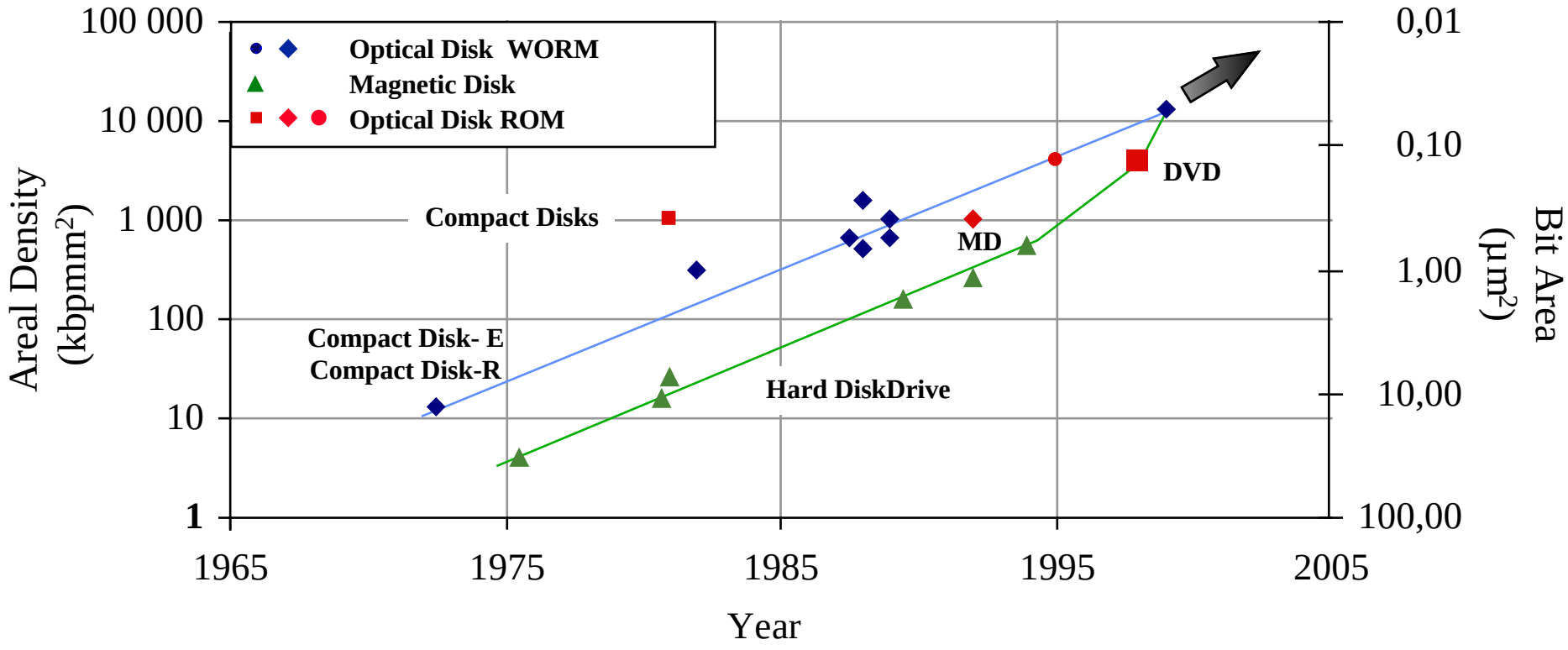
SOLID STATE MEMORY RECORDERS

- USE OF (EEPROM,FLASH) NON VOLATILE MEMORY
- EMERGING TECHNOLOGY UNDER QUALIFICATION
- NO MECHANICAL PARTS (MORE RELIABLE ?)
- RECORD REPRODUCE RANDOM ACCESS
- LOW DIMENSIONS /POWER CONSUMPTION
- POOR BIT /VOLUME EVEN WITH NEW PACKAGING
- EXPENSIVE MEDIA :5 K$ / GB
- SOPHISTICATED MEMORY INTERN'L ARCHITECTURE
- UPGRADE LINKED TO TECHNOLOGY

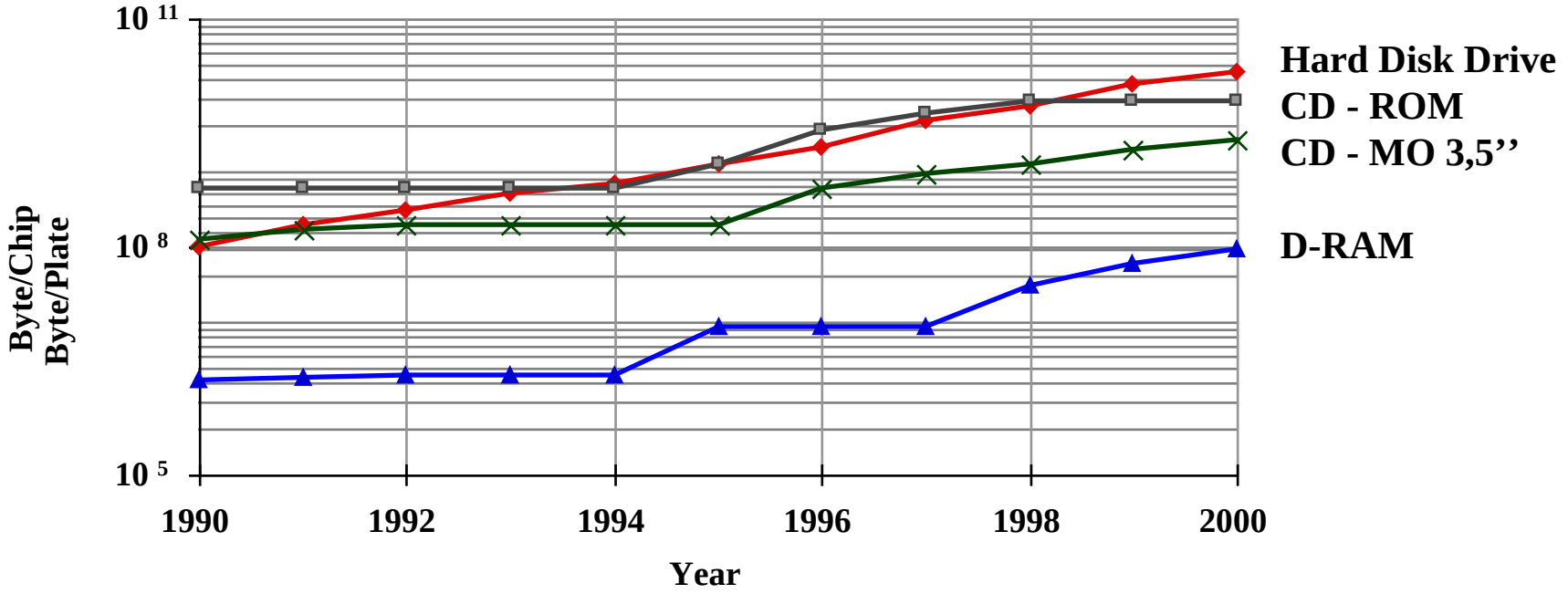
HARD DISK RECORDERS

- **FAST DATA RATE THROUGH RAID TECHNOLOGY**
- **STORAGE CAPACITY 20 GB in 1998**
- **READ WRITE RANDOM ACCESS**
- **CHEAP DRIVE AND SMALL DIMENSIONS**
- **OPERATE IN HARSH ENVIRONMENT**
- **CHEAP MEDIA : 100$ / GB, 30$ / GB in 2000**
- **STANDARD HW & SW INTERFACES**
- **NICE ROAD MAP FOR THE FUTURE**
- **UPGRADE VERY EASY**

STORAGE DENSITY VS DISK TECHNOLOGY

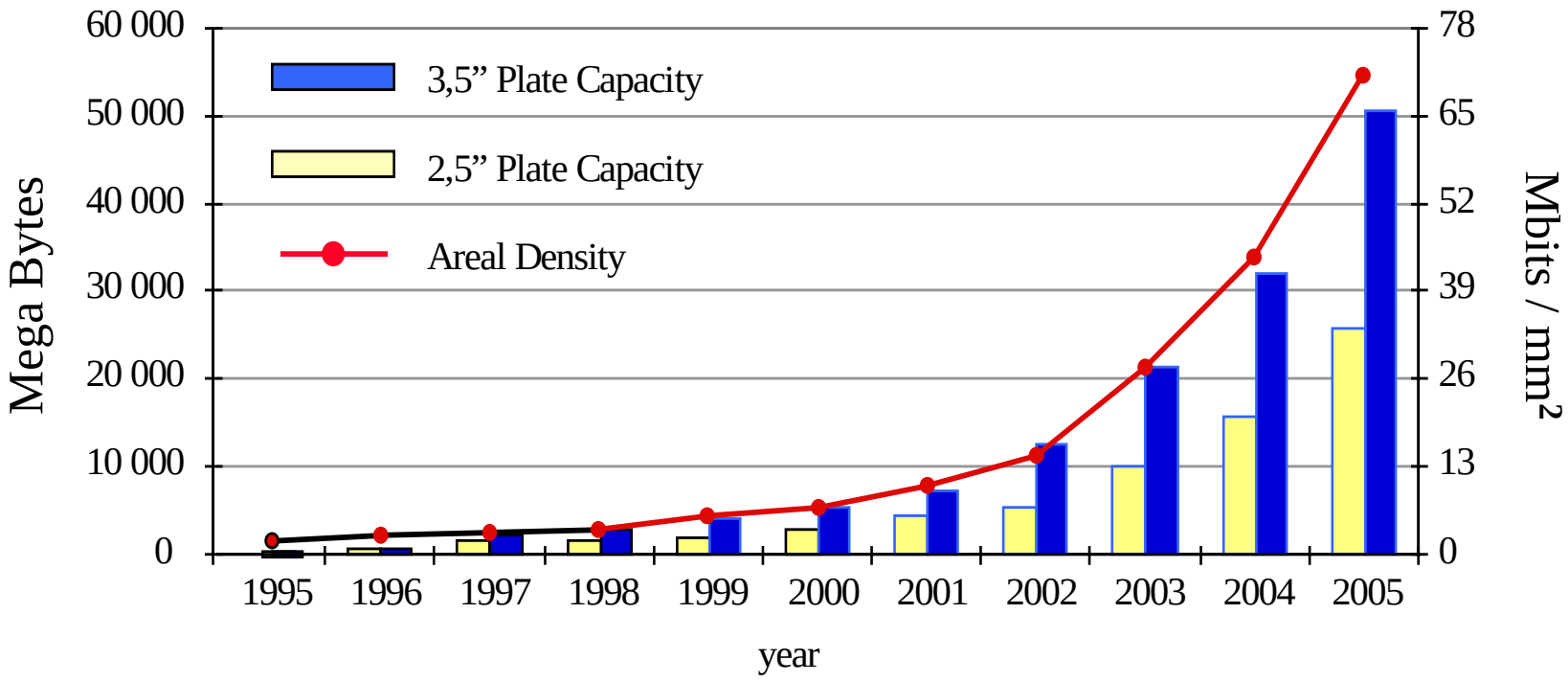


STORAGE DENSITY VS MEDIA



Note : FLASH non volatile memory has still a lowest density than D-RAM

PLATE CAPACITY VS AREAL DENSITY

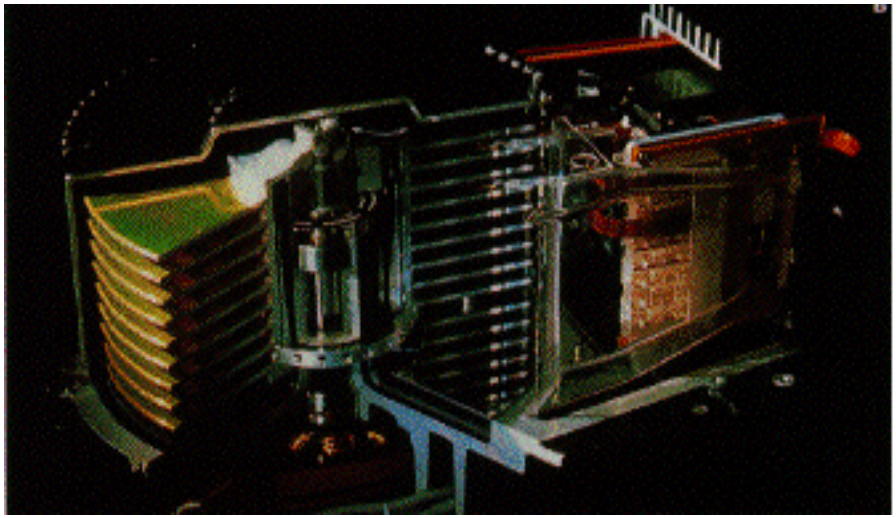


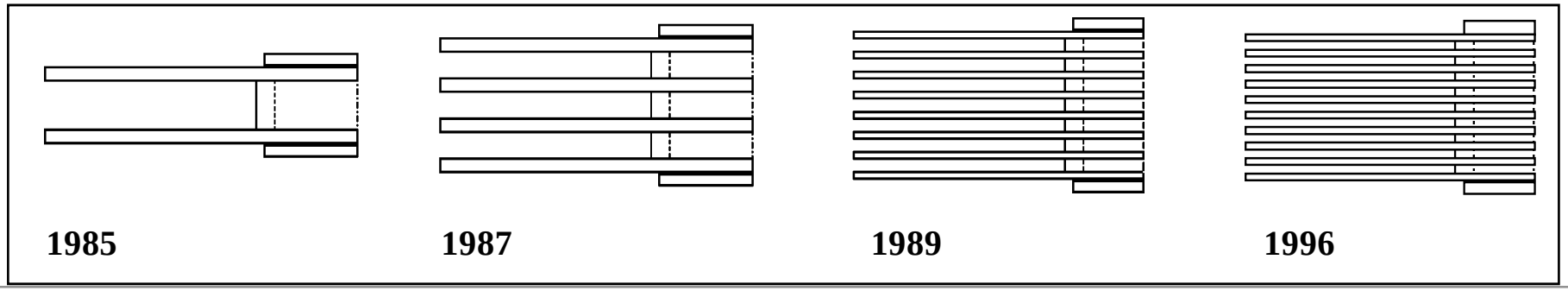
INCREASING THE MAGNETIC AREA

DOUBLED using both side of the plate and MULTIPLIED by the plate number

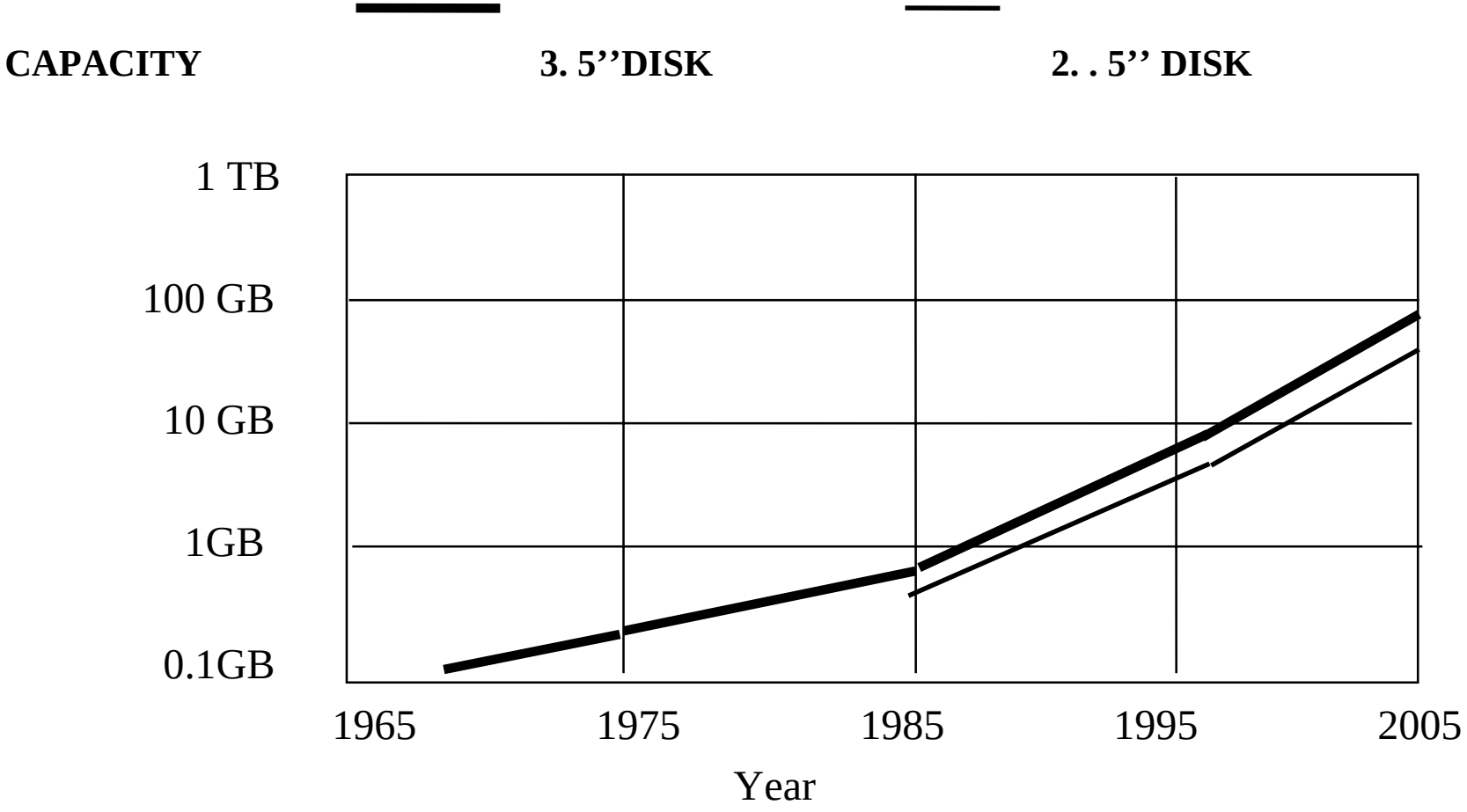
Achieved by decreasing : plate thickness (1.9 to 0.8mm) and interplate space

"Form Factor height evolution"

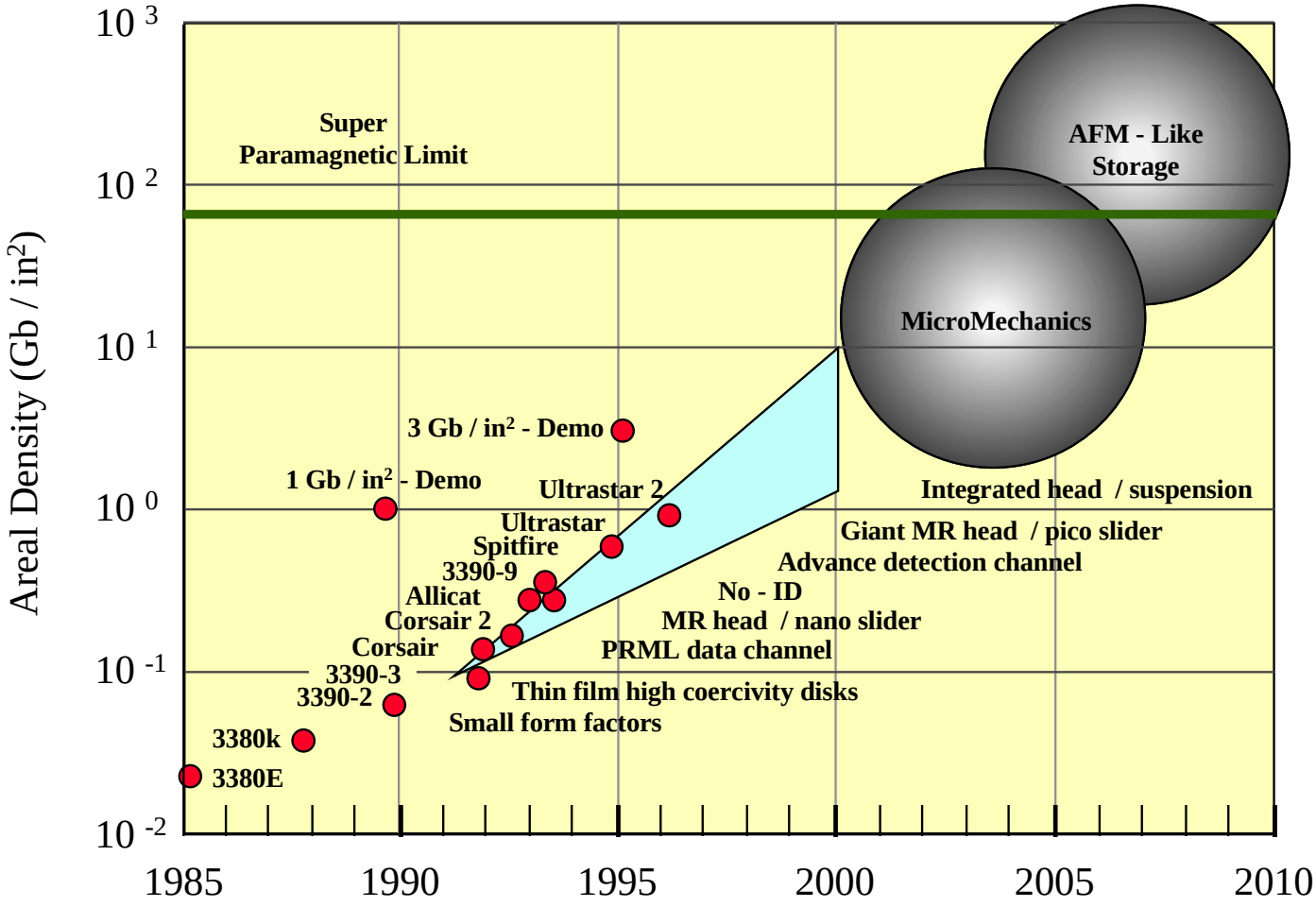




DISK CAPACITY ROAD MAP



Advanced Storage Map



GETTING CLOSE TO THE LIMITS

- **get close by increasing SNR when the bit size is decreasing by:**
- **Decreasing the HEAD TO TAPE INTERFACE**
- **Using MAGNETORESISTIVE HEAD**
- **Optimizing the ACCESS TIME**
- **Using specific signal coding (PRML)**
- **Optimizing the SERVO CONTROL**

STORAGE DENSITY LIMITATIONS

SUPER PARAMAGNETIC LIMIT :

minimumelementary bit size 9 nm

TRANSITION WIDTH between 2 neighbouring bits of opposite magnetization : minimum distance 40 to 80 nm

SIDE TRACK EFFECT asking for extra space between tracks

TRACKING more bits are tiny more difficult it is to read them

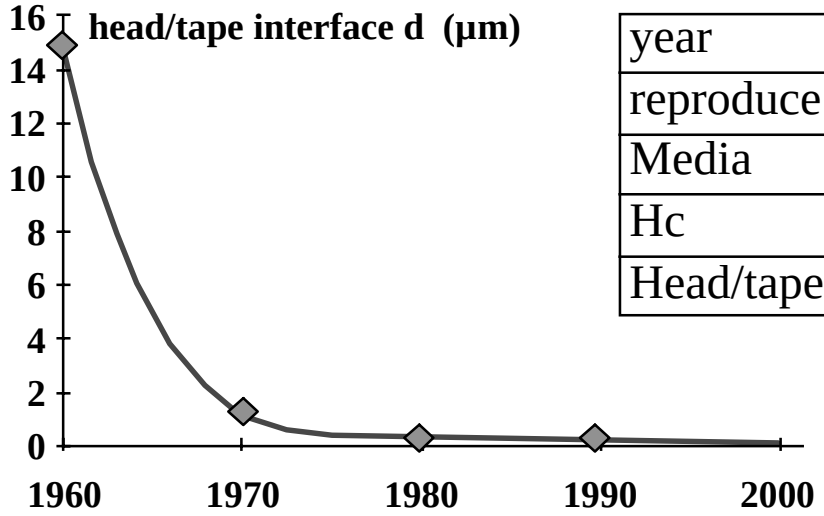
HEAD / TAPE INTERFACE OPTIMIZATION

OPTIMIZING DISK COATING FOR SMOOTHNESS

INCREASES AREAL DENSITY (fc mm x tp mm)

CONSEQUENCES :55 x d/lambda heavely reduced

d=tape / head interface , lambda =Wavelength



year	1970	1980	1990
reproduce heads	Ferrite	thin film	Magnetoresistive
Media	Particle	Electro-Plated	particle
Hc	350 Oe	600 à 700 Oe	1300 à 1600 Oe
Head/tape interf	430 nm	200 nm	100 nm

38 nm : IBM in laboratory (1996)
on thin filmdisk Co Pt Cr

IEEE Trans Mag Vol. 32, N°1, Janv. 1996

MAGNETORESISTIVE HEADS

MAGNETORESISTANCE

GIANT MAGNETORESISTANCE

COLOSSAL MAGNETORESISTANCE

SIGNAL CODING

PARTIAL RESPONSE / MAXIMUM LIKEHOOD (0.44)
decreases the interaction between 2 side / side magnetic bits.

SERVO

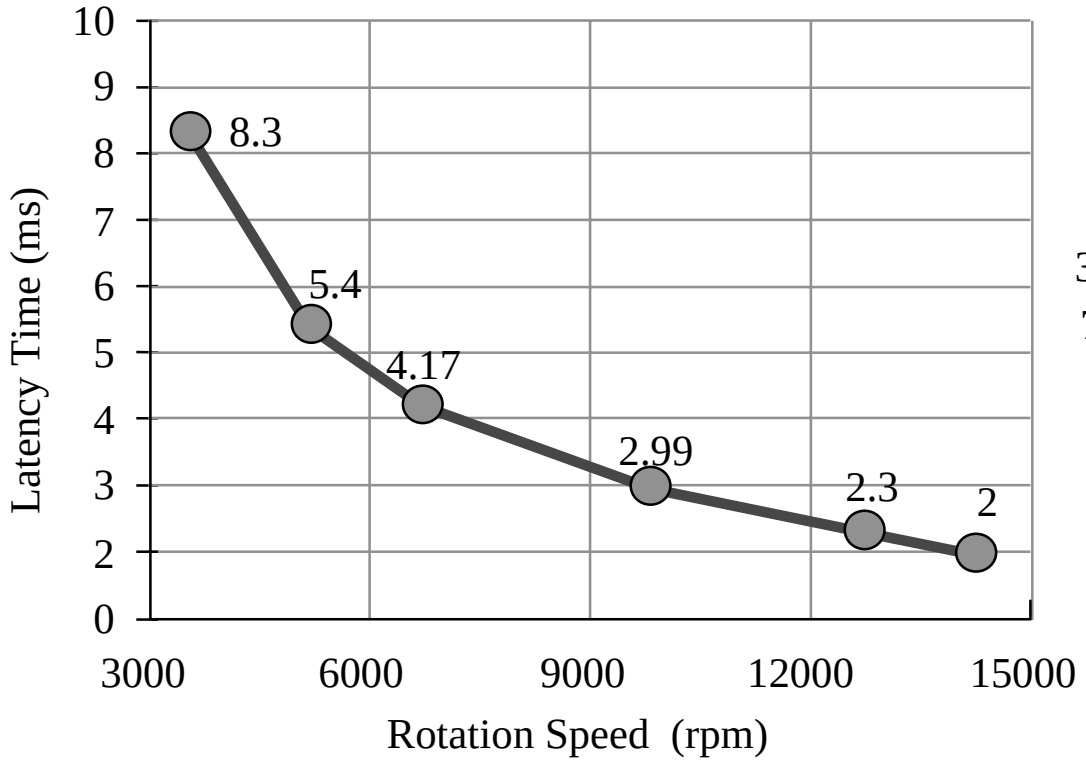
SERVOING EACH PLATE / INTERLACING PLATE SERVO

ADDITION OF MECHANICAL SERVO PATTERN

INCREASING PLATE STIFFNESS DECREASE S

HEAD / TAPE FLUTTER

ACCESS vs ROTATION SPEED



Evolution	Gain
3600 to 5400 ms	2.76 ms
7200 to 10000 ms	1. 8 ms

	Rotation Speed	Latency time	Internal Data Rate
1997 :	10000 rpm - Ø 3. 5”	~3 ms	16. 8 MB/s
2005 :	13000 to15000 rpm	2 to 2. 3 ms	32 MB/s

HARDWARE AND SOFTWARE INTERFACES

STANDARD INTERFACES

EIDE (ATA) Data Rate up to 33MB/s SCSI Narrow Data Rate up to 10 MB/s
SCSI 2 Fast /Wide Data Rate up to 20 MB/s SCSI Ultrawide Data Rate up to 40 MB/s
Ultra 2 SCSI Data Rate up to 80 MB/s Fiber Channel Arbitrated Loop up to 800 MB/s

IEEE 1394 MULTIMEDIA APPLICATIONS (APPLE,SUN,INTEL) 400MB/s
Serial Storage Architecture (IBM) 160 MB/s

DISK PARALLELIZATION

REDUNDANT ARRAY of INEXPENSIVE DISKS DATA RATE UP TO 240 MB/s
FAILURE RESISTANT DISK SYSTEMS DATA RATE UP TO 240 MB/s

MECHANICAL DIMENSIONS

STANDARDIZED WITH THE PC INDUSTRY

2. 5’’ DISK DRIVE

CAPACITY UNFORMATED 11GB FORMATED 8.1 GB
HEIGHT : 17 mm WIDTH 69.9 mm
DEPTH : 100 mm
MASS : 0.18 Kg

3. 5’’ DISK DRIVE

CAPACITY UNFORMATED 21GB FORMATED 18 GB
HEIGHT : 41 mm WIDTH 104.2 mm
DEPTH :147 mm
MASS : 1.4 Kg

ENVIRONMENTAL CHARACTERISTICS (1)

MAIN FRAME EQUIPPED WITH : HEAT SINK AND COOLING

BUILT-IN VIBRATION/SHOCK ISOLATORS

OPERATING CONDITIONS

- **TEMPERATURE**
  - **- 40°C to + 50°C CONTINUOUS OPERATION**
  - **AUTOMATIC WARM - UP FROM - 40°C TO +10°C**
- **HUMIDITY**
  - **5 TO 90% RH NONCONDENSING (WITHOUT SEALED CHASSIS)**
  - **UP TO 100 % RH (WITH SEALED CHASSIS).**
- **ALTITUDE**
  - **0 TO 40,000 FEET (WITHOUT SEALED CHASSIS)**
  - **UP TO 70,000 FEET (WITH SEALED CHASSIS)**

ENVIRONMENTAL CHARACTERISTICS (2)

- **RANDOM VIBRATIONS**

  UP TO 7.8gRMS:

  0.04 g2/ Hz FROM 5Hz TO 1,000 Hz

  6 dB / OCTAVE FROM 1,000 Hz TO 2,000 Hz

- **SHOCKS**

  HALF SINE 15 g ,11 ms , 3 AXES

- **LINEAR ACCELERATION**

  9 g , 3 AXES

- **ANGULAR ACCELERATION**

  UP TO 60°/s and UP TO 60° / s2

HARD DISK DATA RECORDER SPEC (1)

- **REMOVABLE MEDIA**

- **RECORD/REPLAY DATA RATE**
  - **0 TO 120 Mb/s SUSTAINED**
  - **ROAD MAP UP TO 200 Mb/s**
  - **BURST UP TO 480 Mb/s.**

- **RANDOM READ WHILE WRITE**
  - **WITH DATA RATE LIMITATION**
  - **READ RATE + WRITE RATE = NEAR MAX WRITE RATE**

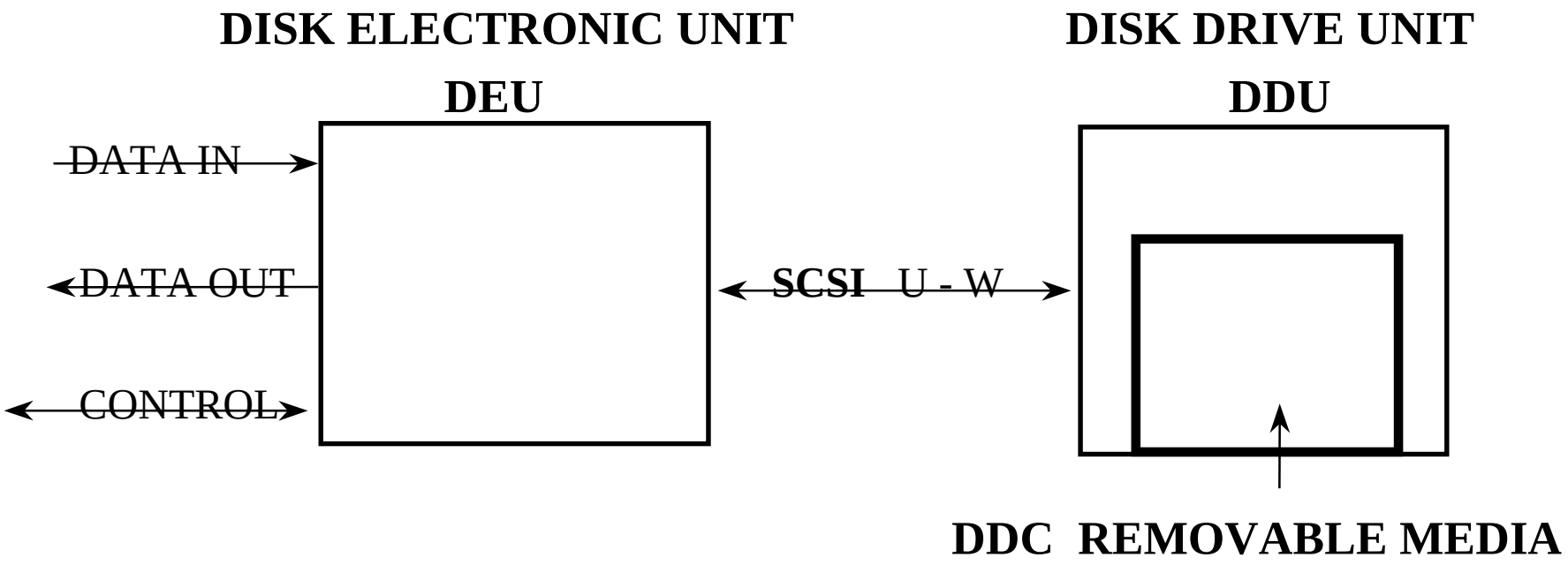
- **STORAGE CAPACITY WITHOUT COMPRESSION**
  - **36 GBYTES 2 DISKS IN // UP TO 72 GBYTES IN 2000**
  - **STORAGE CAPACITY X 2 USING LOSSLESS COMPRESSION**

HARD DISK DATA RECORDER SPEC. (2)

- **DATA I/O INTERFACE**
  - **8 BITS // + CLOCK + CONTROL SIGNAL**
  - **NRZ - L ECL DIFFERENTIAL**
  - **INPUT &OUPUT INTERFACES FULLY INDEPENDENT**
- **REMOTE CONTROL INTERFACE**
  - **RS422/RS232 SERIAL PORT**
- **INTERNAL LIBRARY FOR FAST SEARCH**
- **OPTIONAL IRIG -B TIME CODE INTERFACE**
  - **DATATION OF EVERY RECORDED DATA BLOCK**
- **OPTIONAL DIGITAL ANNOTATION UP TO 1Mb/s**

HARD DISK DATA RECORDER SPEC. (3)

MODULAR CONCEPT **2 L R U' S**



DIMENSIONS (mm): 191 H x 248 W x239 D **196 H x 250 W x 254 D**

DISK DRIVE CARTRIDGE (2 hard disk dimensions mm) **190 H x 115 W x 138 D**

HARD DISK VIDEO RECORDERS

MORE AND MORE DISKS ARE USED IN TV AS VIDEO SERVERS

ARE USING OR NOT DATA COMPRESSION LIKE MPEG 2

MPEG 2 (ISO/IEC 13818) INSURES :

A GOOD IMAGE QUALITY FOR A BIT RATE OF 4. 5 Mb/s

USING A 8 GIGABYTE CAPACITY HARD DISK

THE RECORDING TIME WILL BE

4 HOURS