

HARD DISK RECORDER

Presentation: Alain QUEAU

Contribution: Jacques DESSERRE

THIC MEETING JULY98

Ref. :2THIC 07/23/98

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**

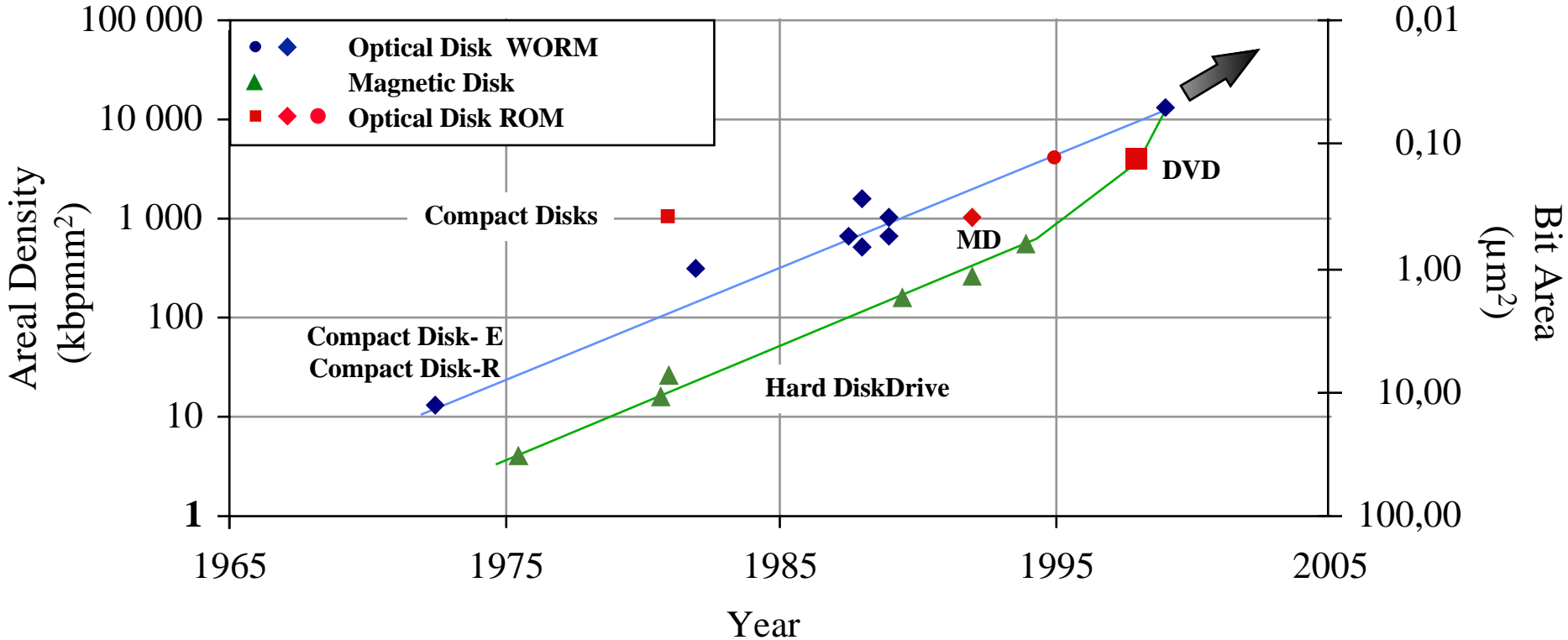
SOLID STATE MEMORY RECORDERS

- **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

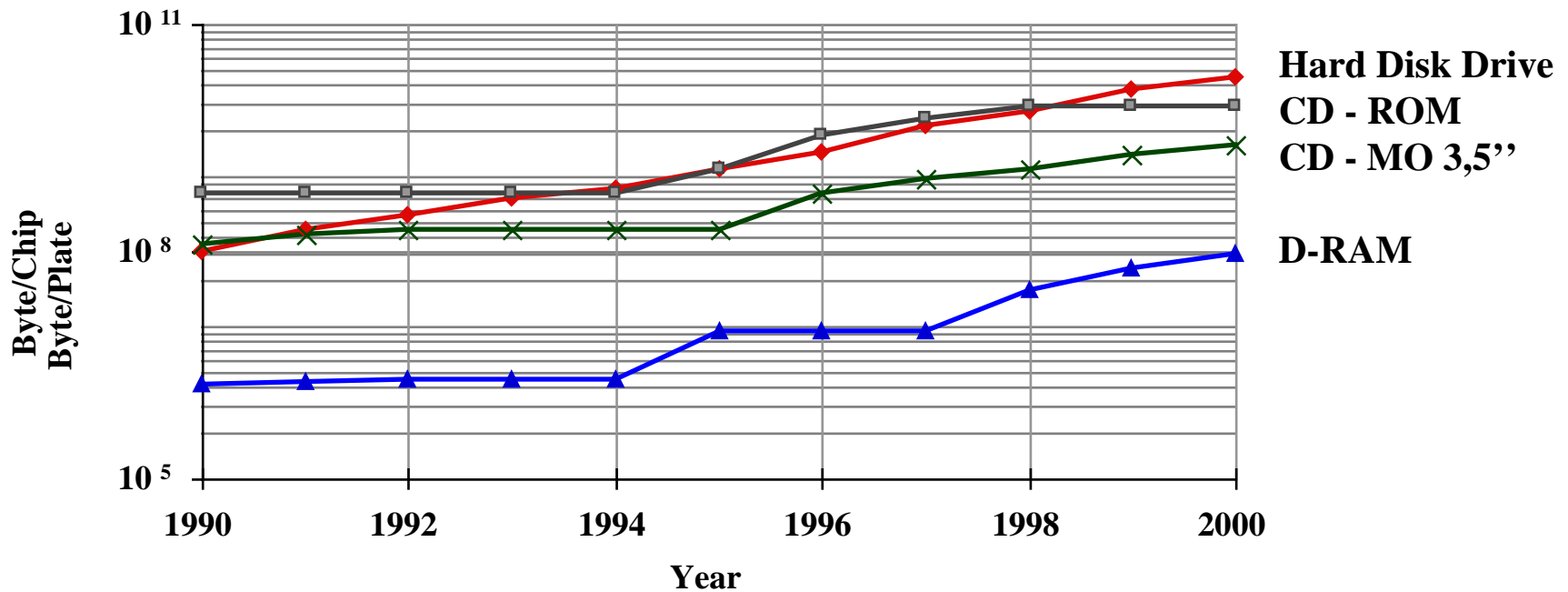
- **FAST DATA RATE THROUGH RAID TECHNOLOGY**
- **STORAGE CAPACITY 20 GB in 1998**
- **READ WRITE RANDOM ACCESS**
- **CHEAP DRIVE AND SMALL DIMENSIONS**
- **OPERATE IN HARSH ENVIRONMENT**
- **CHEAP MEDIA : 100\$ / GB, 30\$ / GB in 2000**
- **STANDARD HW & SW INTERFACES**
- **NICE ROAD MAP FOR THE FUTURE**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

STORAGE DENSITY VS DISK TECHNOLOGY



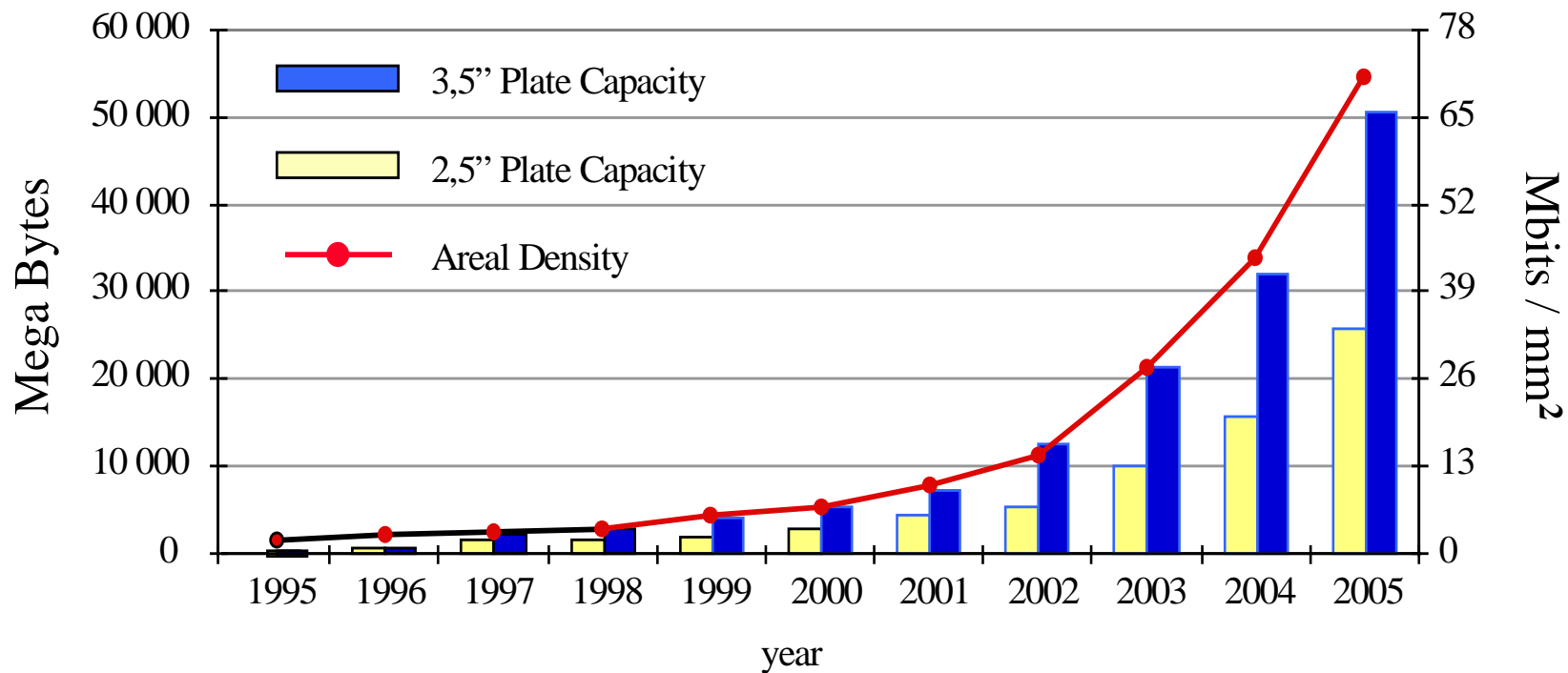
Ref. :2THIC 07/23/98

STORAGE DENSITY VS MEDIA



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

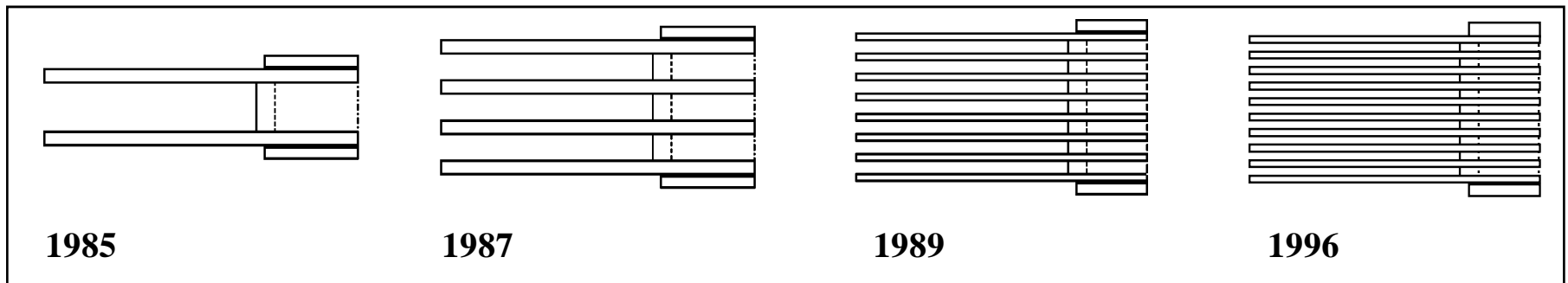
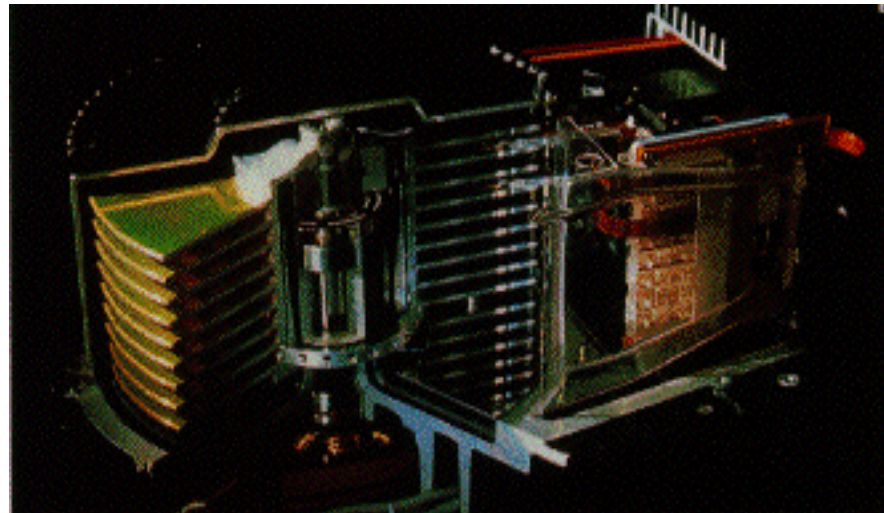
PLATE CAPACITY VS AREAL DENSITY



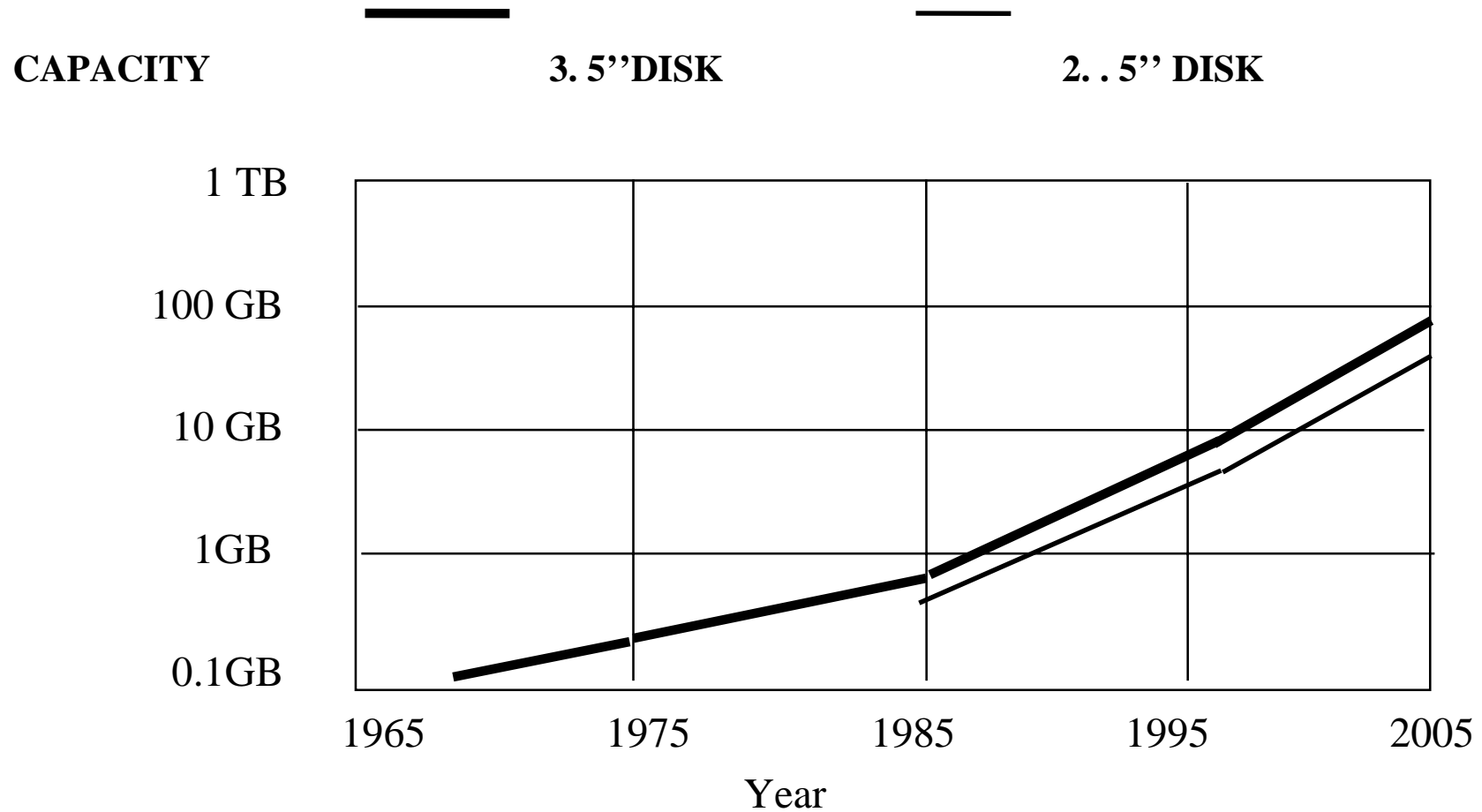
INCREASING THE MAGNETIC AREA

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”

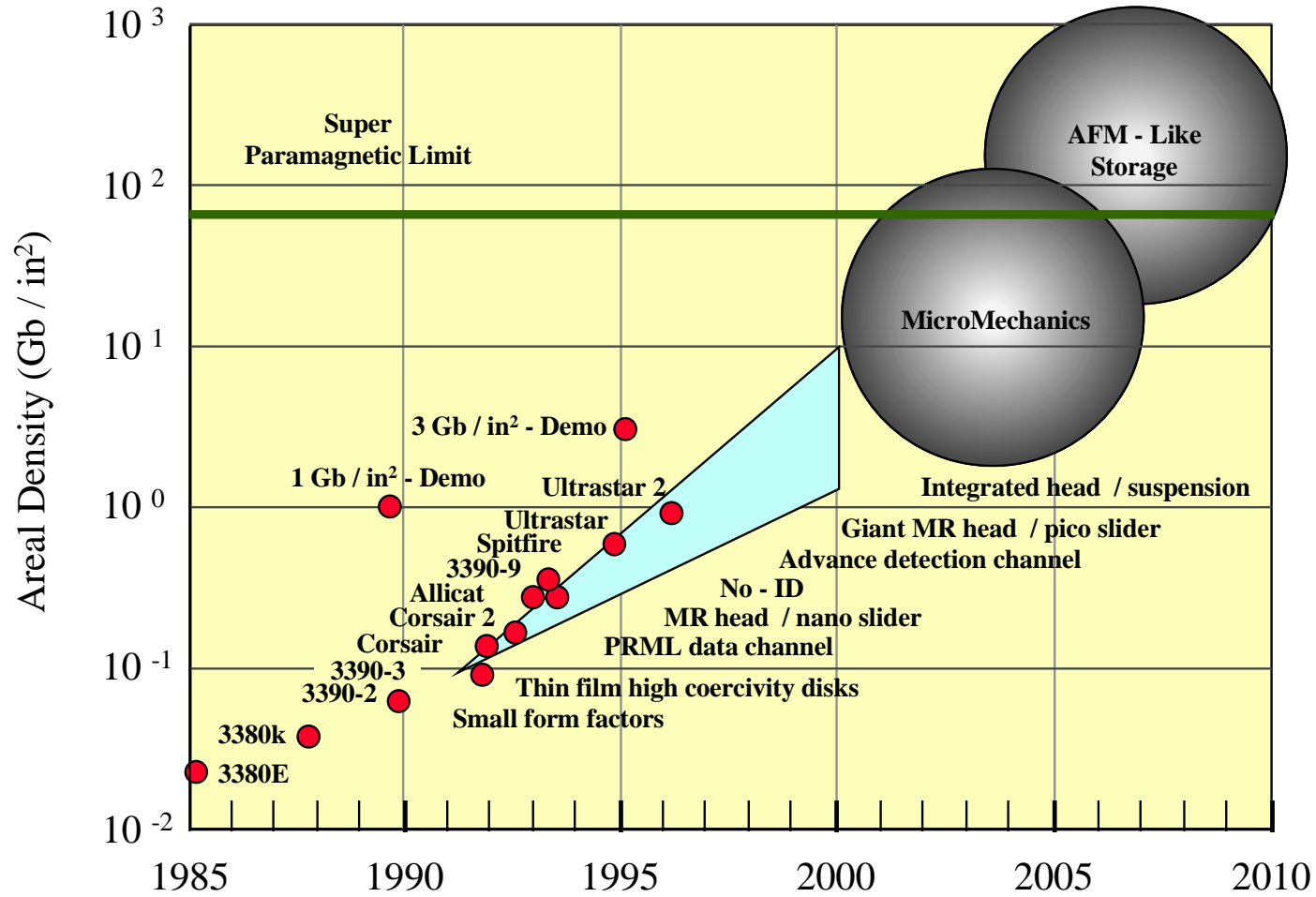


DISK CAPACITY ROAD MAP



Ref. :2THIC 07/23/98

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 :

minimum elementary 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

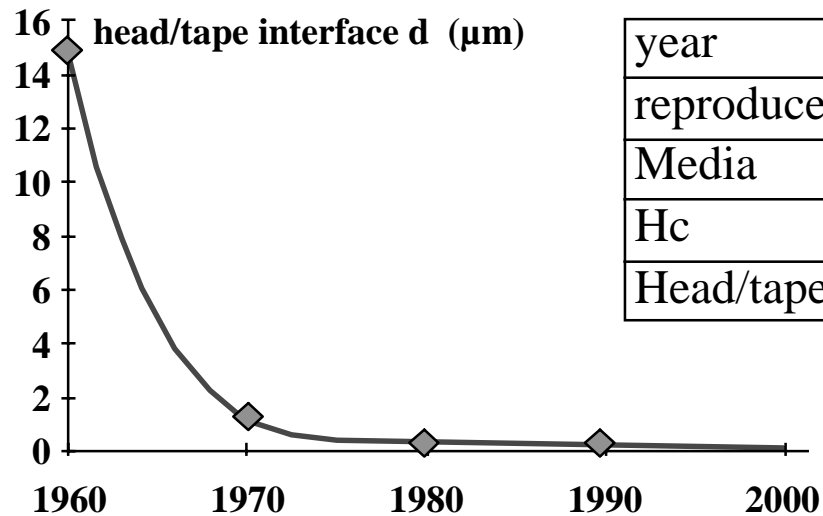
HEAD / TAPE INTERFACE OPTIMIZATION

OPTIMIZING DISK COATING FOR SMOOTHNESS

INCREASES AREAL DENSITY (fc mm x tp mm)

CONSEQUENCES :55 x d/lambda heavily reduced

d =tape / head interface , λ =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 LIKELIHOOD (0.44)
decreases the interaction between 2 side / side magnetic bits.

SERVO

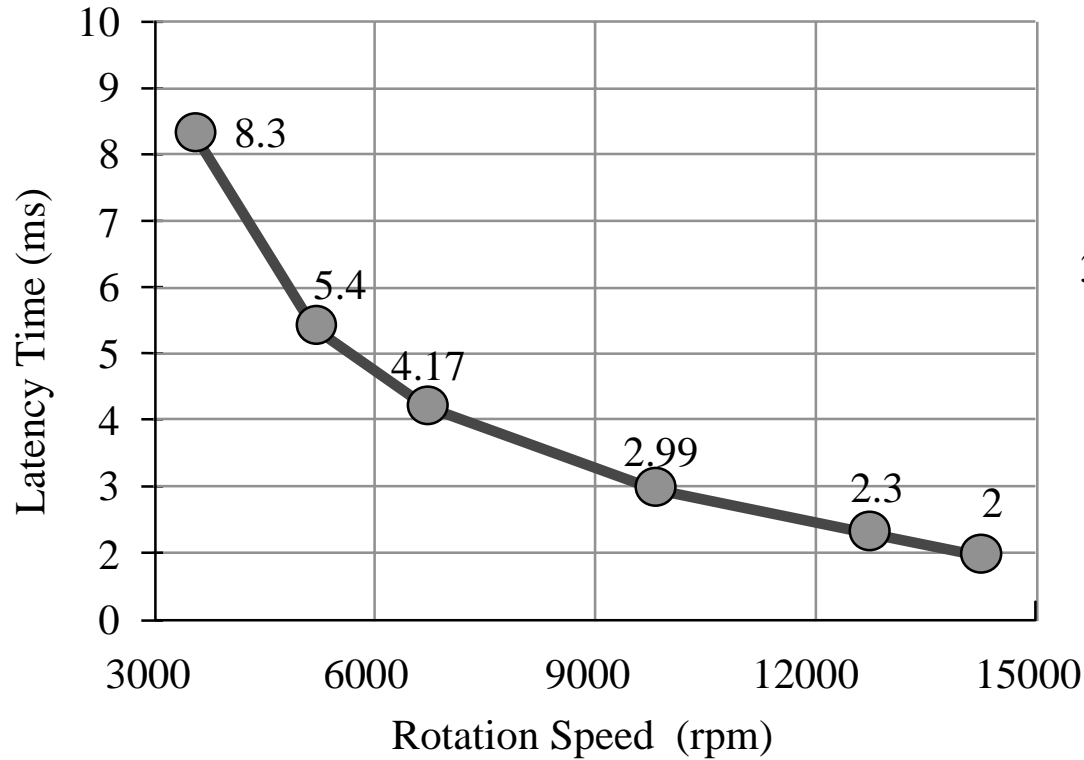
SERVOING EACH PLATE / INTERLACING PLATE SERVO

ADDITION OF MECHANICAL SERVO PATTERN

INCREASING PLATE STIFFNESS DECREASES

HEAD / TAPE FLUTTER

ACCESS vs ROTATION SPEED



<u>Evolution</u>	<u>Gain</u>
3600 to 5400 ms	2.76 ms
7200 to 10000 ms	1.8 ms

	<u>Rotation Speed</u>	<u>Latency time</u>	<u>Internal Data Rate</u>
1997 :	10000 rpm - Ø 3.5"	~3 ms	16.8 MB/s
2005 :	13000 to 15000 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)**

Ref. :2THIC 07/23/98

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**

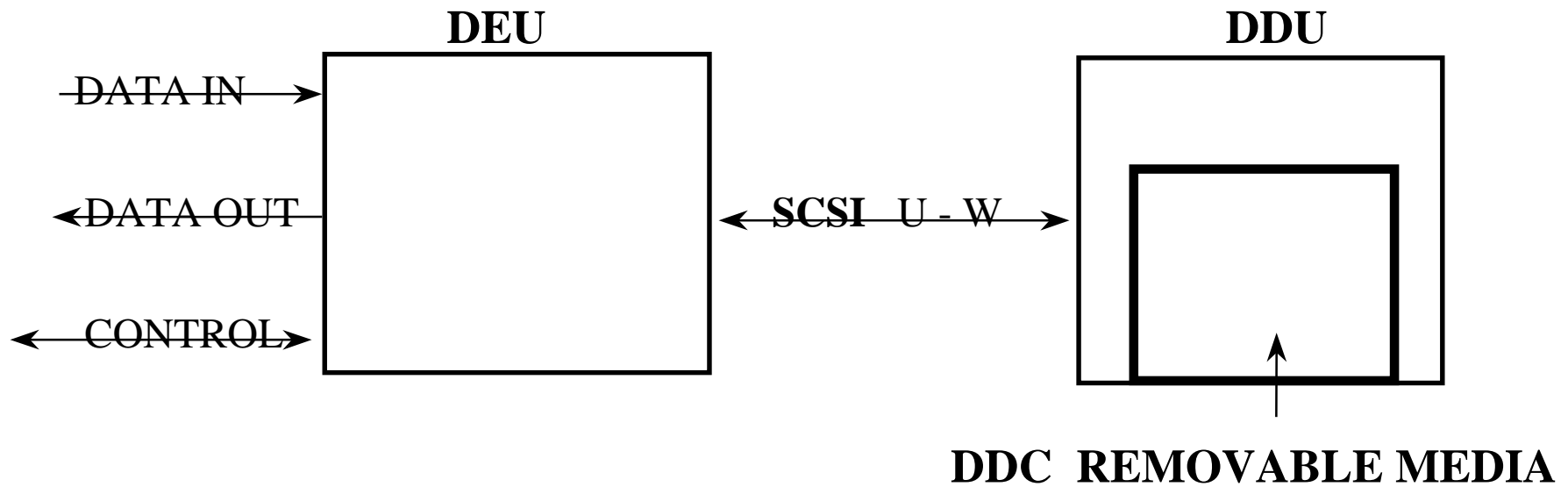
HARD DISK DATA RECORDER SPEC. (3)

MODULAR CONCEPT

2 L R U' S

DISK ELECTRONIC UNIT

DISK DRIVE UNIT



DIMENSIONS (mm): 191 H x 248 W x 239 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

Ref. :2THIC 07/23/98

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