

# Achieving One Terabyte per Cartridge by breaking the tape areal density barrier

John Woelbern

Sony Electronics, Inc

3300 Zanker Rd, San Jose CA 95134-1940

Phone: +1-408-955-5496, FAX: +1-408-955-5533

E-mail: [john.woelbern@am.sony.com](mailto:john.woelbern@am.sony.com)

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Hotel

Silverdale WA 98383-9191

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**THIC Inc.**

The Premier Advanced Recording Technology Forum

# Sony's Advanced Tape Technology Roadmap



Achieving 1 TeraByte per Cartridge by  
Breaking Tape Areal Density Frontier

Presented at THIC, October 9th 2001

Silverdale, WA

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# Market Needs

- Strong Growth for Tape Demand Over Near-Term because:
  - Explosive growth of digital content
  - Increased Security Application Investments
    - Surveillance Systems
    - Intelligence Data Collection & Processing
    - Disaster Recovery

# Data Creation Trends

## *More Data Captured Electronically*

- Applications Generating 2X Storage Annually:
  - E-Commerce
  - E-Mail
  - Digital Imaging (Home & Business)
  - Healthcare Records & Insurance Processing
  - Education
  - Scientific Research
  - Printing & Publishing

# Evolving Digital Content

**Data Storage**

**Data & Image Storage**

**Automation**

**Software**

**Drives**

Back Up HSM Data Base

**Image Devices**

Document CG / Image

Film

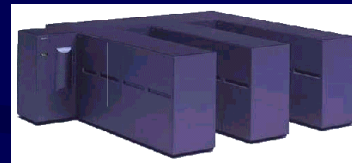
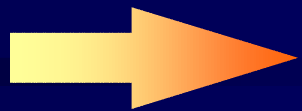
Projector

Security Camera

Industrial Camera

Printer

TV Conf.



# Market Requirements

## *Next 5 Years:*

- Tape Needs to Meet Evolving Needs for High Capacity Storage & Remain Competitive:
  - Substantial Areal Density Increase Needed
    - New Heads & Media Formulation Required
    - Efficient Formats & Encoding to Support Higher Densities
  - Need to Achieve 1TB per Cartridge (Uncompressed) to maintain Parity with Disk Trends
  - Future Disk Trends lead to Tape Requirement of 10TB by 2011

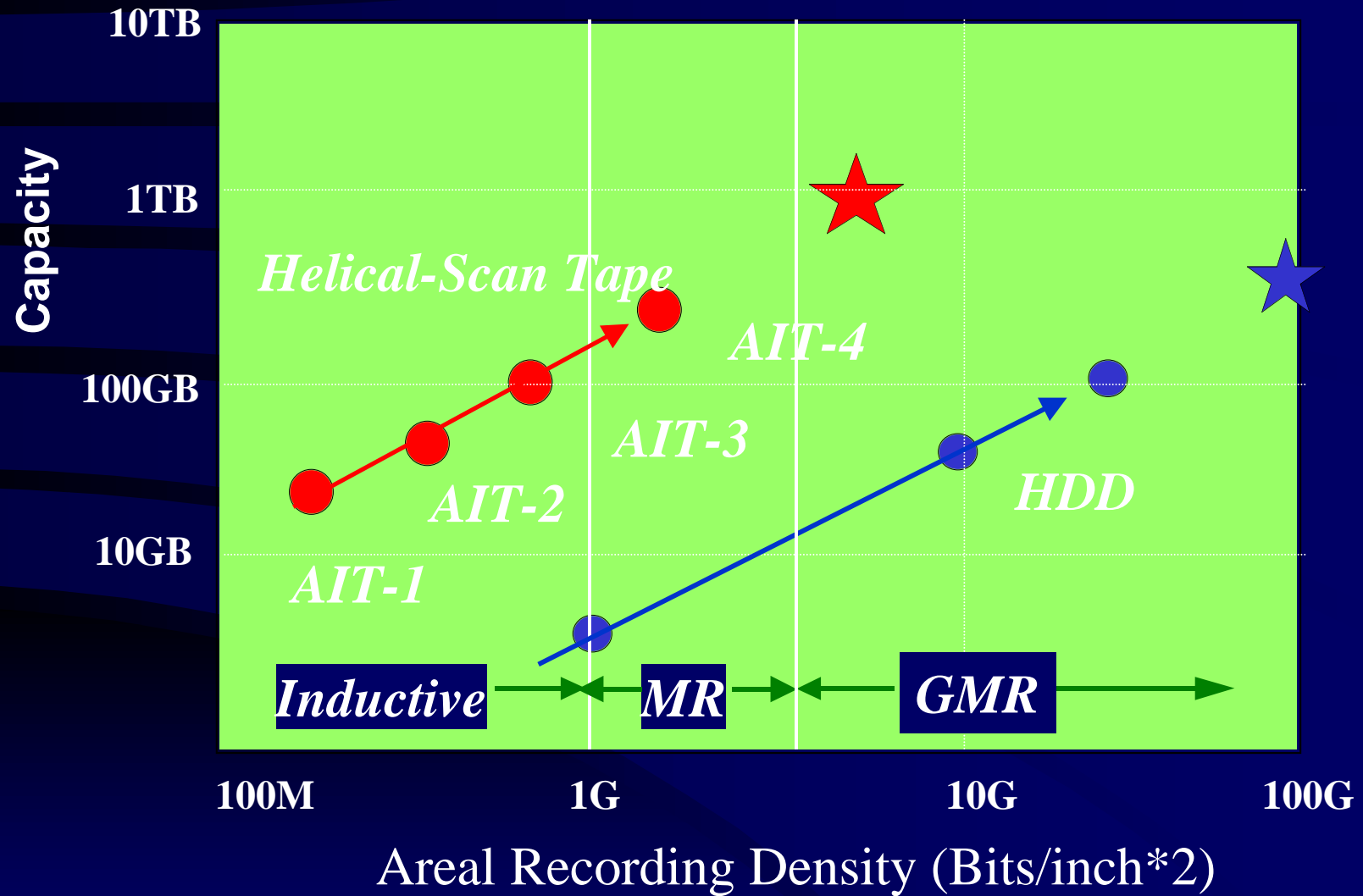
# M-R Head Use for Helical-Scan Recording

- Early Research (1996) Confirmed Feasibility:
  - 10dB Improvement over Inductive Head
  - Key Electrical & Mechanical Characteristics Verified
- Further Development with M-R Head Application in Test Drive Yielded:
  - Demonstrated 1Gbit/Sq. in. using Spherical Head with Sandwiched MR

# GMR Heads for Helical-Scan Recording

- More Recent Research & Demonstration (2000) Confirmed Feasibility of:
  - 6.5GBit/Sq. Inch
    - < 2 um Track Width, 30+K TPI
  - High-Output AME Media using 33 nm Magnetization Layer

# Areal Recording Density vs. Capacity



# Comparison of Inductive vs. AMR vs. GMR

## (Current 8mm Roadmap)

	<b>Inductive</b>	<b>AMR</b>	<b>GMR</b>
Areal Density (Gbit/inch*2)	0.7	1.6	6.5
Track density (KTPI)	4.6	9.3	31.8
SNR (pp/rms) *	18	22	24
Capacity(GB), 8mm Cartridge	100	200	1000

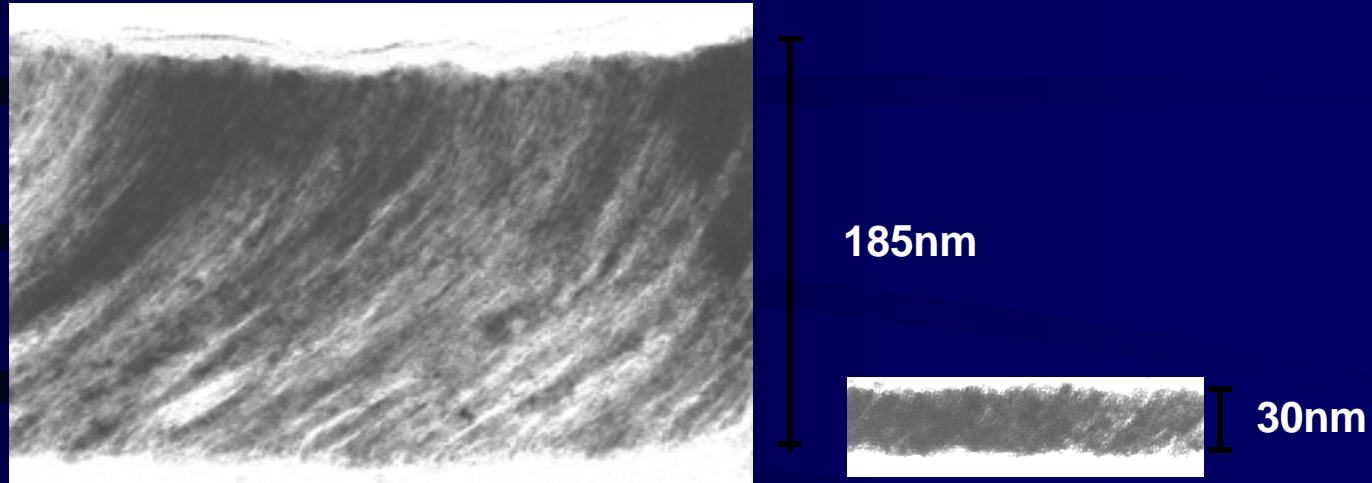
\* measured value



# Specifications of GMR Head for Tape System

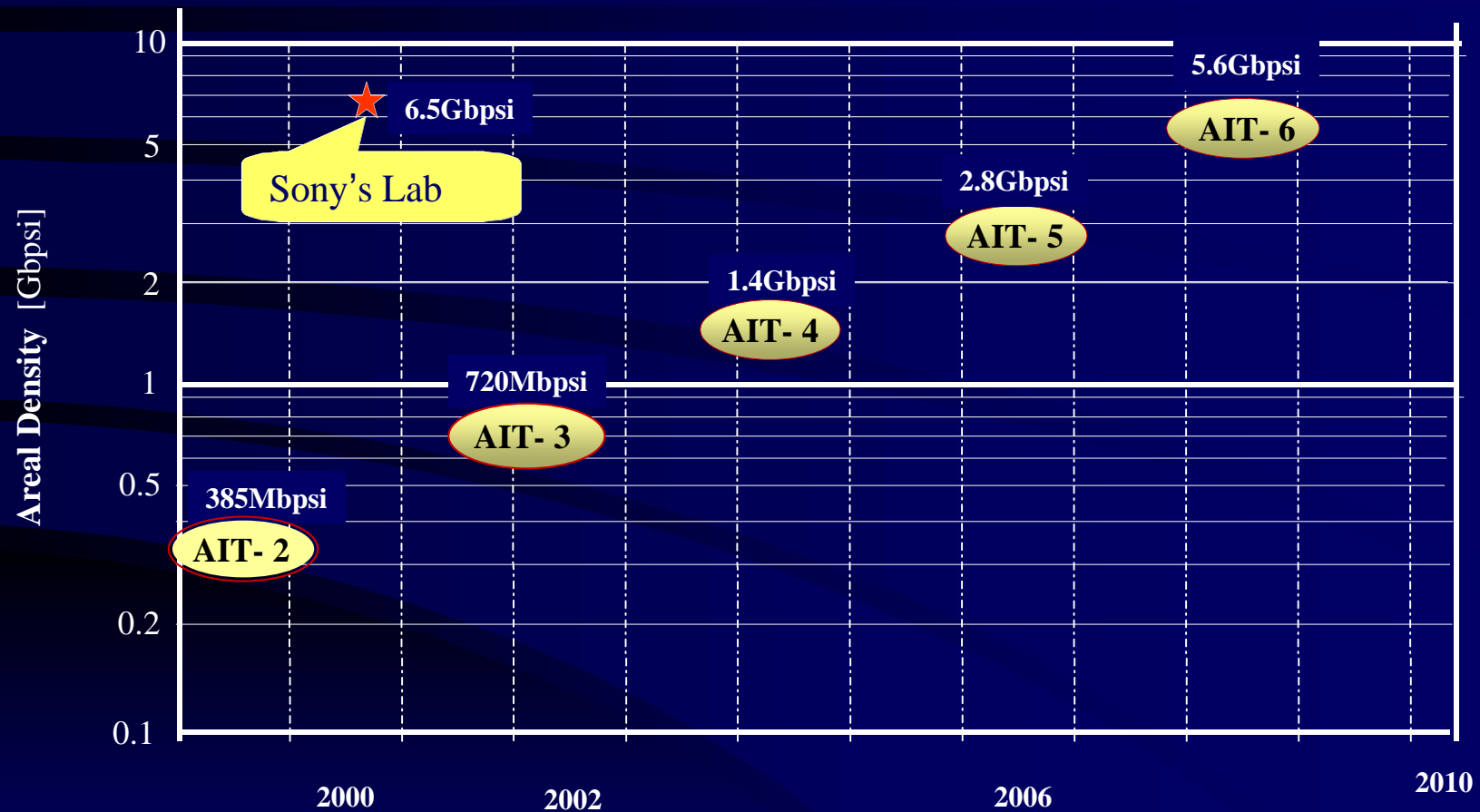
Type	Shield-Spin Valve GMR Head
Head Width	0.8 $\mu\text{m}$
Distance between Shields	0.18 $\mu\text{m}$
Sense Current	5mA
MR Electric Resistance	50 Ohm

# High-Output AME Media and GMR Head



<b>Metal Evaporated Tape</b>	
<b>Magnetic Layer</b>	<b>Cobalt-Cobalt Oxide</b>
<b>Thickness of Magnetic Layer (t)</b>	<b>33nm</b>
<b>GMR Head</b>	
<b>Type</b>	<b>Shield-Spin Valve GMR Head</b>
<b>Head Width</b>	<b>0.8Ém</b>
<b>Other</b>	
<b>Signal-to-Noise Ratio</b>	<b>26dB</b>

# Helical-Scan Areal Density Trends



# AIT Migration Plans



Tape	A-ME++	A-ME+++	A -ME++++
Head	AMR	AMR	GMR
Coding	Extended-TCPRML	Turbo	Turbo
Track Pitch	4 $\mu\text{m}$	< 4 $\mu\text{m}$	< 2 $\mu\text{m}$
Drum Speed	6400+ rpm	6000++ rpm	6000+++ rpm

# Future Tape Platform

## (to Achieve 1TB by 2006)

- Leverage Sony AIT Areal Recording Density Using Alternative Media Form-Factor:
  - If Media were Longer and Wider (eg. LTO/DLT - style) then other Capacity Points could be achievable (@ 5X Multiplier) at Constant Areal Density

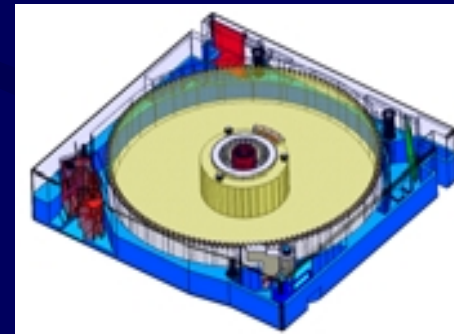
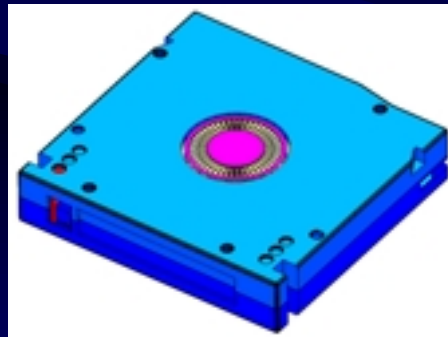
# Introducing “S-AIT”

- A New Entry Point for High Capacity Tape Storage
  - Performance to Match Capacity
- Closes the Gap between HDD & Conventional Tape Roadmaps
- Proven Helical Scan Technology
- Leverages AIT Density Roadmap for Future Scalability



# Library-Ready Cartridge

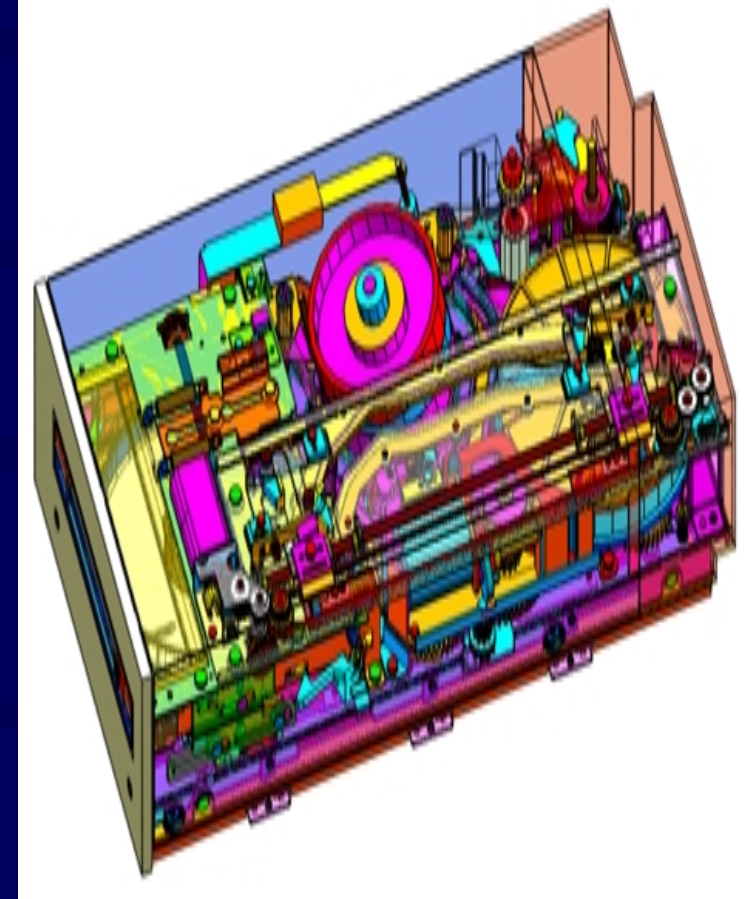
- 1/2 Inch Wide A-ME Media
- 1,800 Feet in Length
- Uses "Remote MIC" for Enhanced Identification and Access to Data
- Reliable Leader-Block Threading



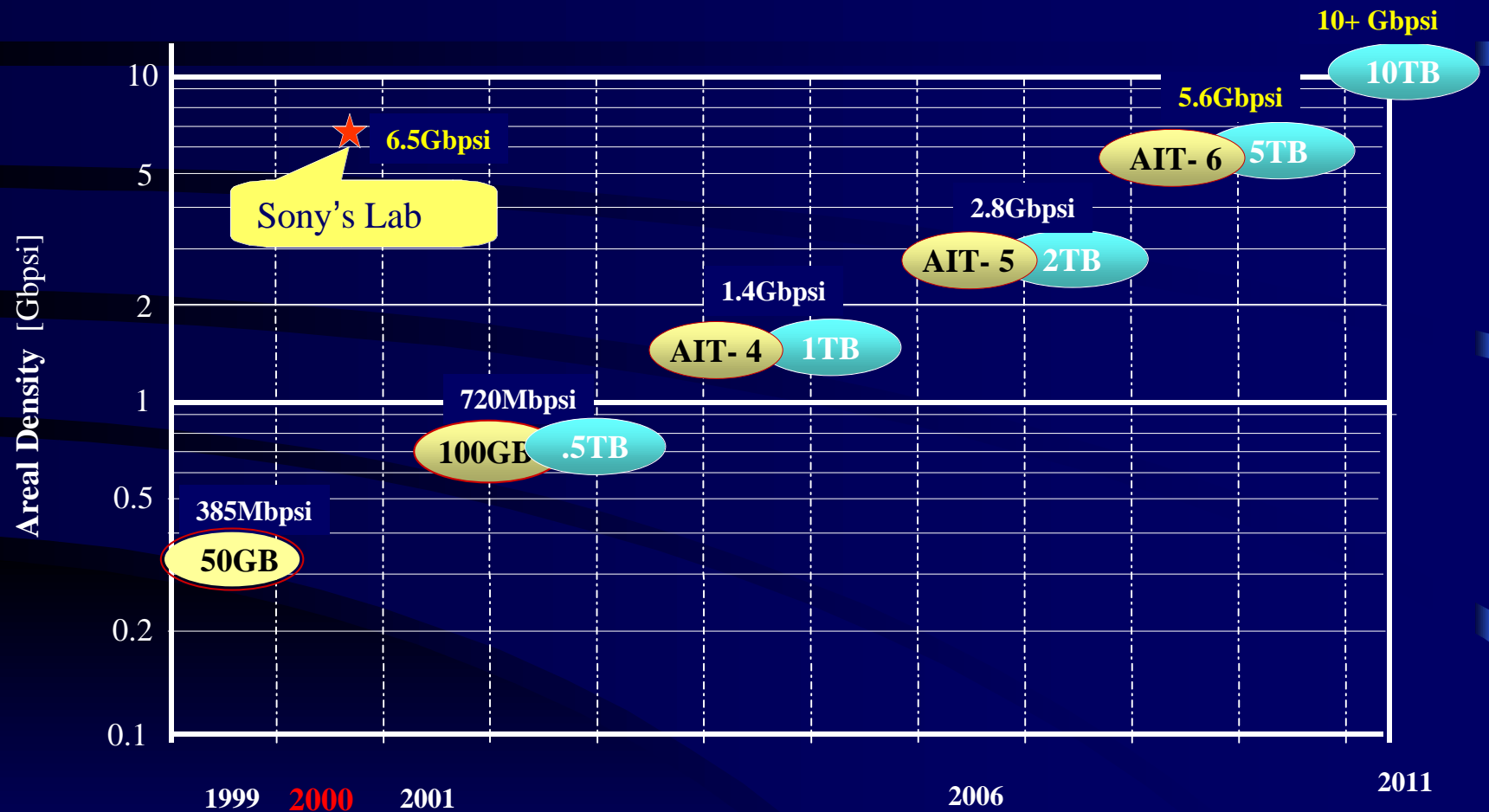
# First Product

## Specifications:

- 500 GByte (Native) in a Single-Reel, Tape Cartridge
- 30MByte/Sec Native Transfer Rate
- Fibre-Channel & SCSI Interfaces
- 5.25" FH Form Factor (Extended Length)



# Areal Density & Capacity Trends

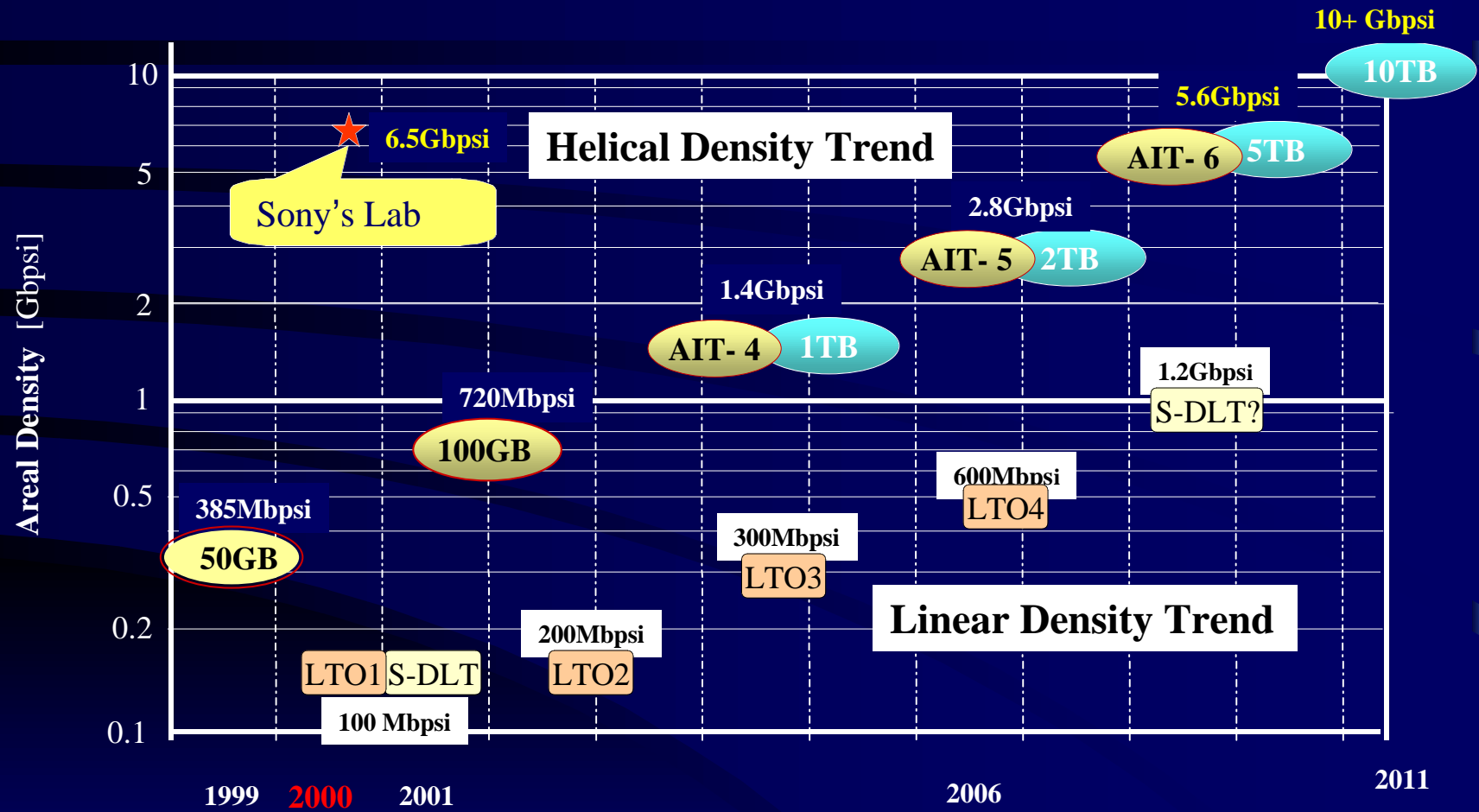


# Potential “S-AIT” Roadmap



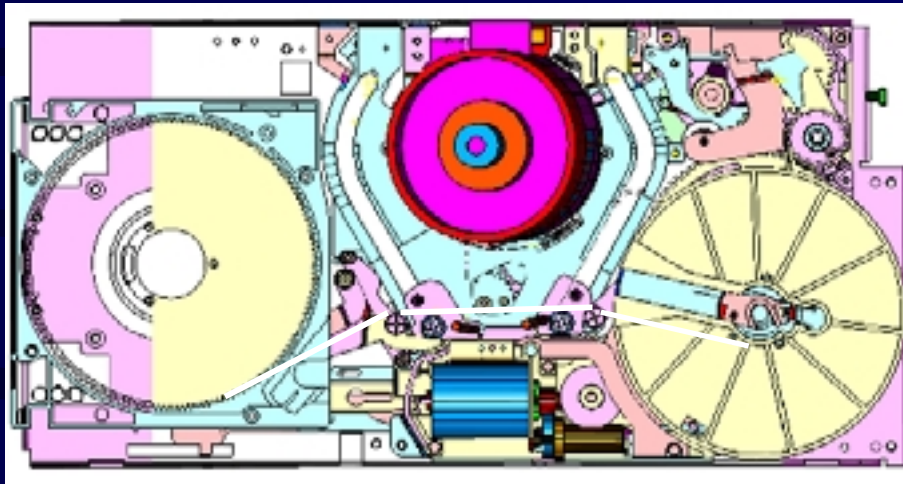
<b>Tape</b>	A-ME	A-ME	A-ME	A-ME
<b>Head</b>	Laminated+	Laminated++	MR	GMR
<b>Coding</b>	TCPR	TCPR	Turbo	Turbo
<b>Track Pitch (um)</b>	5.50	3.67	2.75	1.83
<b>Drum Speed (rpm)</b>	5000	6667	8889	10000

# Industry Density & Capacity Trends

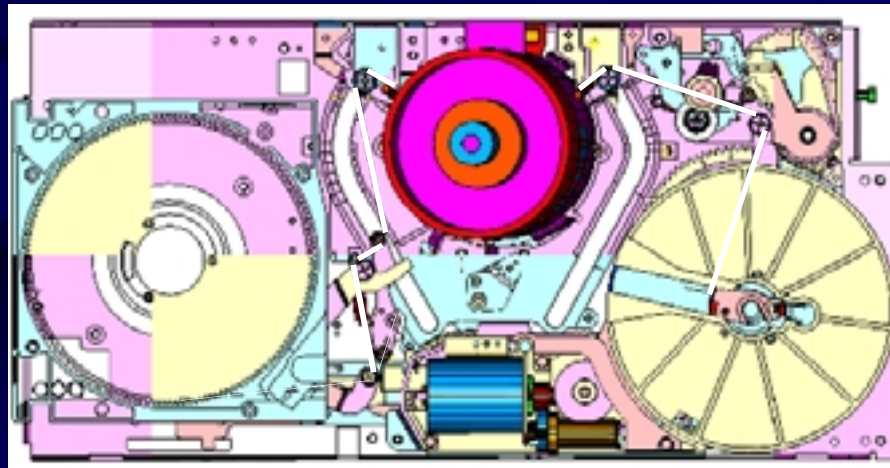


# Drive Operation Modes

Thread/Unthread



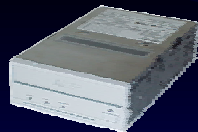
Read/Write



# Sony Tape Technology Family

(2002)

Technology Breadth



DDS  
1- 20 GB



AIT  
35-100 GB



**S-AIT**  
**500GB**



DTF  
200 GB



DIR  
100-250GB



# Summary

- Advanced Development and Application of New GMR Head Technology has Demonstrated 6.5 GBit/Sq In. Areal Density & Beyond
- Application of MR/GMR Head Technology with A-ME will Lead to:
  - AIT Technology Roadmap of up to 1TByte per 8mm Cassette
  - “S-AIT” 1/2” Technology Roadmap ranging from .5 to 10 TBytes per Cartridge

# Sony's Advanced Tape Technology



Achieving 1 TeraByte per Cartridge

[john.woelbern@am.sony.com](mailto:john.woelbern@am.sony.com)

[www.aittape.com](http://www.aittape.com), [www.sony.com/storagebysony](http://www.sony.com/storagebysony)

