

**Drive small
THINK BIG!**



Mobile HDD Technology and Future Prospects

Maciek Brzeski

Storage Device Division

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Mobile business scenes



▶ Office on the go

- Notebook / UMPC with powerful multimedia functionality
- Ample storage capacity
- Ultra portability to anywhere
- Secure

▶ Technical requirements

- Increased capacity or high areal recording density
- Performance
- Shock and vibration robustness

Entertainment scenes



- ▶ Fun with consumer electronics
 - Portable music / video player
 - Digital video camcorder
 - Gaming

- ▶ Technical requirements
 - Thinner and lighter body by higher density recording
 - Shock and vibration robustness
 - Low power consumption

Active scenes



▶ Technical requirements

- Wider temperature range
- High altitude
- Shock and vibration robustness
- Low power consumption

▶ Hot and cool

- Hot beach in summer
- Cold downhill in winter
- High mountain
- Longer battery life



Automotive scenes



▶ Technical requirements

- High capacity for multiple applications
- Extremely-wide temperature range
- Vibration robustness
- Longer product life-cycle

▶ Navigation

- 3D-graphics mapping
- Quick route search

▶ Entertainment

- Music and video
- Gaming



Communication scenes



- ▶ Cellular phones
 - Digital music / photo / video
 - Internet download

- ▶ PDA
 - Wireless communication
 - Internet accessibility
 - Sub-PC functions

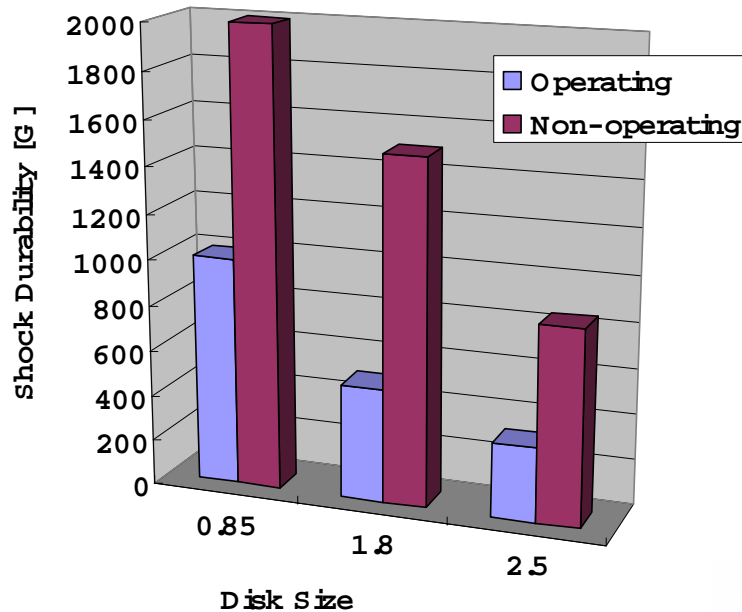
- ▶ Technical requirements
 - Ultra-small body
 - Larger capacity per size
 - Shock robustness

Drive Small THINK BIG!



- ▶ Focus on the small form factor mobile market
 - 2.5-inch, 1.8-inch, 0.85-inch
- ▶ Pursue leading-edge technologies and products
 - First-to-market with perpendicular magnetic recording
- ▶ Create new markets and increase industry value
 - HDD for new applications

Mobile HDD Shock Robustness



- ▶ Small form factor benefits shock robustness.
 - Small disk spinning
 - Light weight and inertia
 - Short suspension arm for higher shock robustness

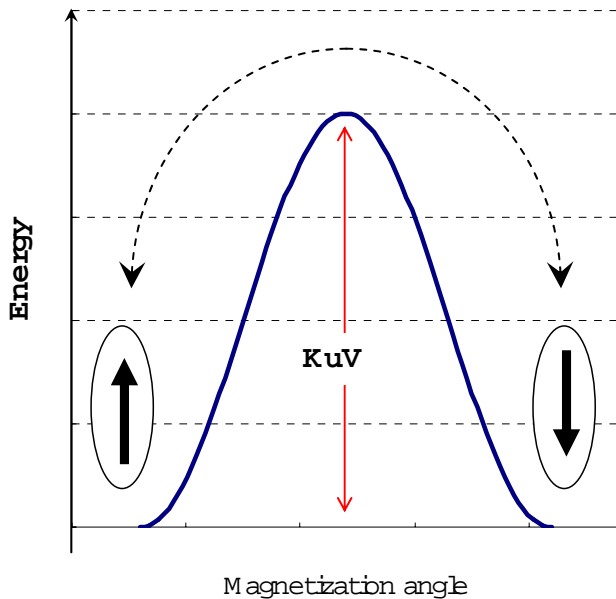


Anti-vibration tracking servo

- ▶ Advanced tracking servo to position heads at the track center
- ▶ Detection and offset of disturbance caused by vibration
- ▶ Minimizes errors caused by off-track



What limits areal density?



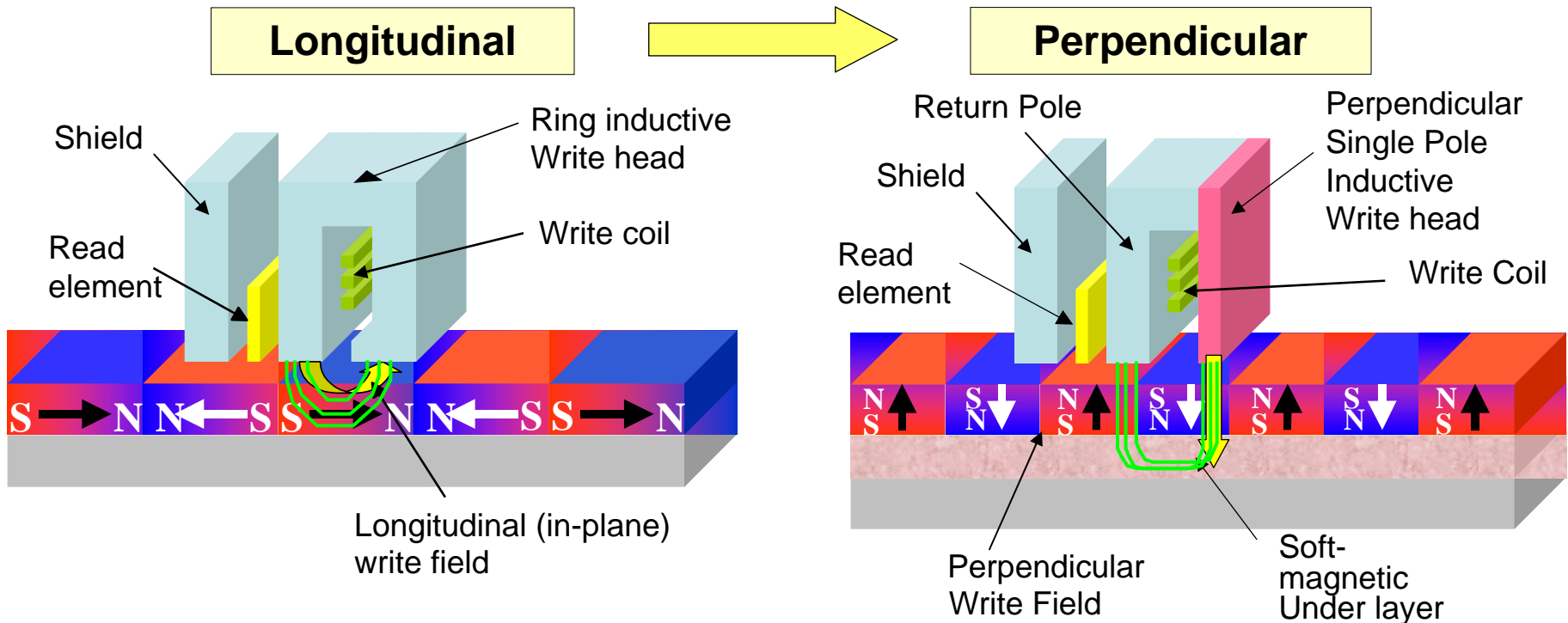
K_u : anisotropy coefficient
 V : volume of particle
 k : Boltzmann constant
 T : temperature

- ▶ Superparamagnetic effect
 - Thermal agitation of the magnetic bits
 - The ratio of magnetic anisotropy energy “ KuV ” and thermal energy “ kT ” needs to be controlled to keep stability of magnetization.

- ▶ Longitudinal magnetic bit alignment worsens the situation
 - “End to end” alignment
 - Repelling nature of magnetics

Perpendicular Magnetic Recording (PMR)

- ▶ Magnetic bits stand on end
 - Reinforce strong magnetic coupling to keep data stability



Benefits of PMR

- ▶ High density recording performance
 - Pack more data on increasingly smaller disks
 - Stable at higher recording densities
- ▶ Highly robust product
 - Decreased rate of thermal decay - improved stability
 - Superb write performance potentially enables wider temperature range than longitudinal recording
 - Less sensitive to head-media spacing change



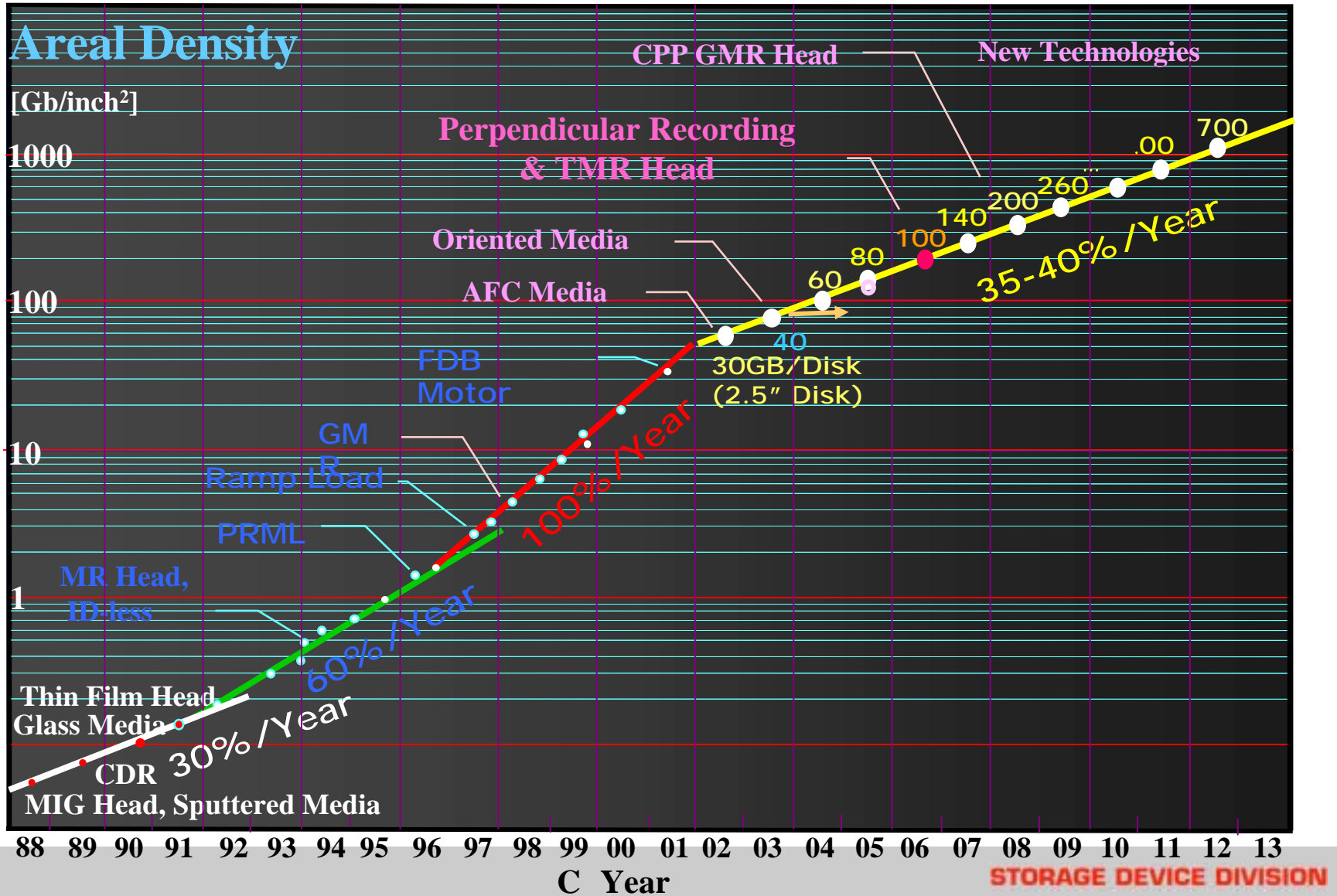
*TOSHIBA ships the world-first
PMR HDD: May/05
40GB, 1.8-inch HDD
(MK4007GAL)
133 gigabits per square inch*

The new Toshiba PMR drive



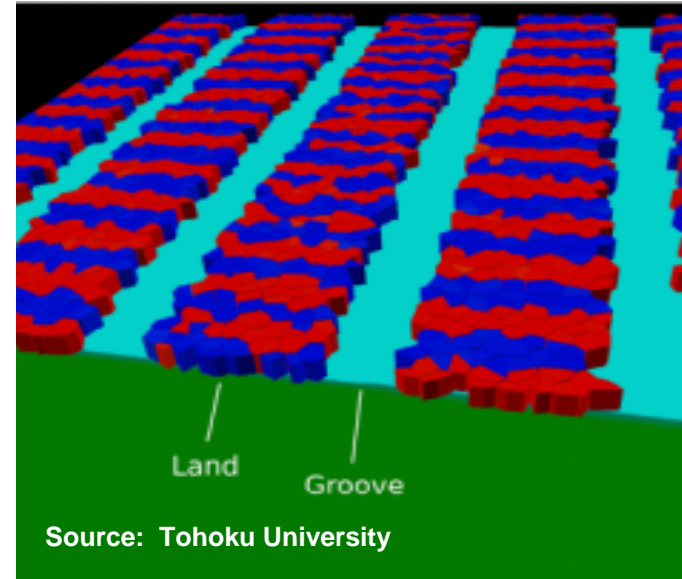
- ▶ Market-leading storage capacity 2.5-inch 200GB
 - 100GB per platter design
 - SATA, 4200rpm
 - Standard footprint including 9.5 mm z-height
- ▶ World's highest areal density 178.8 gigabits per square inch as a commercial product
 - The second generation PMR technology

Recording density extension



Future recording technology candidates

- ▶ Discrete track recording
 - Minimizing inter-track interference for improved data quality and high track density
- ▶ Composite recording media
 - Enhance thermal stability at ultimate recording density
- ▶ Advanced TMR/CPP-GMR
 - Extremely-narrow and high sensitivity reader



Summary



- ▶ Key factors for mobile storage are high density recording performance using PMR, and shock & vibration robustness design of small form factor HDDs
- ▶ Extended environmental robustness such as wider temperature ranges will enable the creation of new markets