DATA IS POTENTIAL

Seagate Storage Update

Designing Storage Architectures for Digital Collections

US Library of Congress

September 9th, 2019

Jon Trantham
Principal Technologist
Seagate Research

SEAGATE

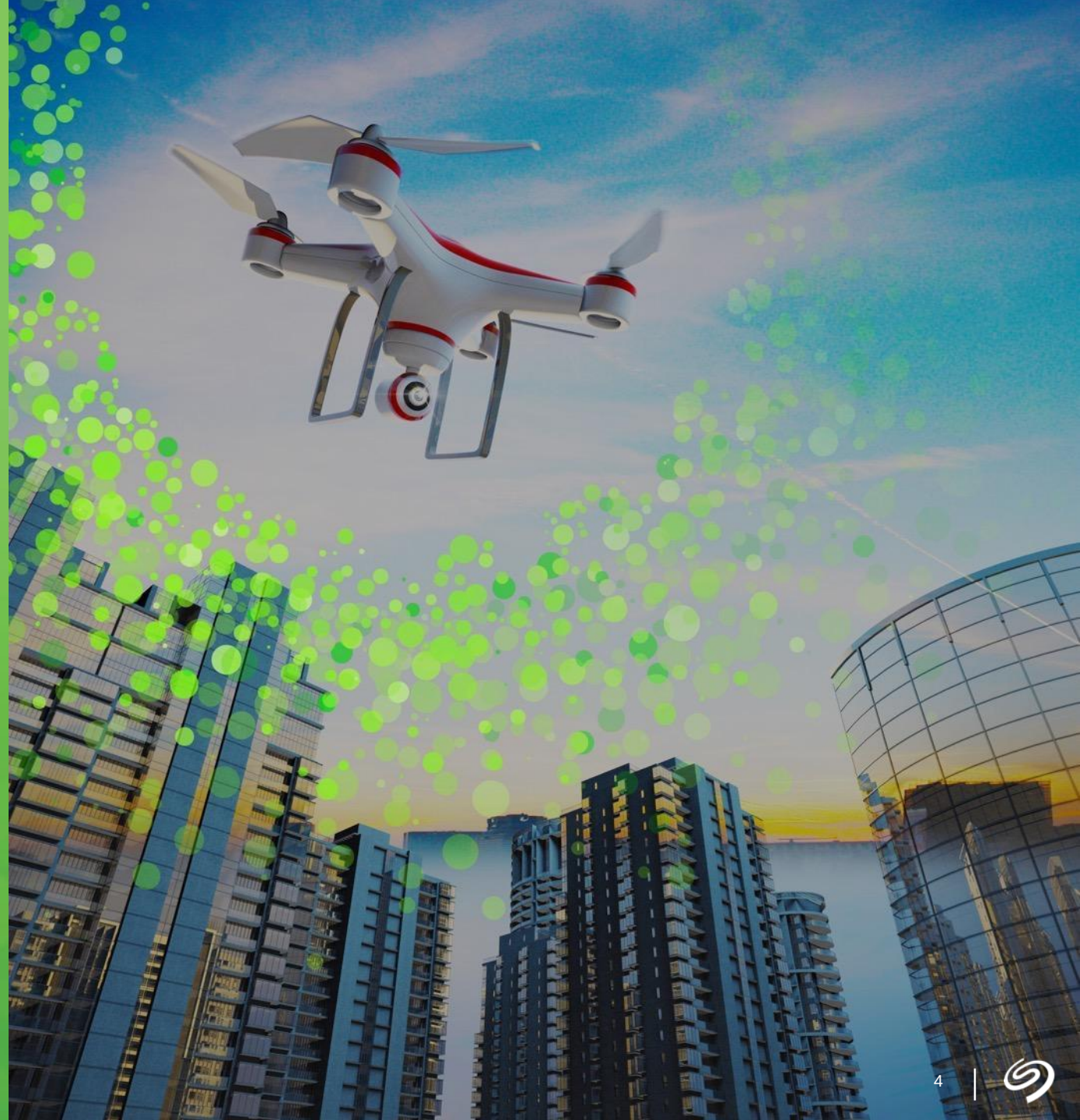
Disclaimer

Information presented herein represents the author's personal opinion and understanding of the relevant issues involved. The author and Seagate Technology do not assume any responsibility or liability for damages arising out of any reliance on or use of this information. Some products and technologies are under research and development and may never be manufactured or sold. No warranties expressed or implied. Use at your own risk.

Contents

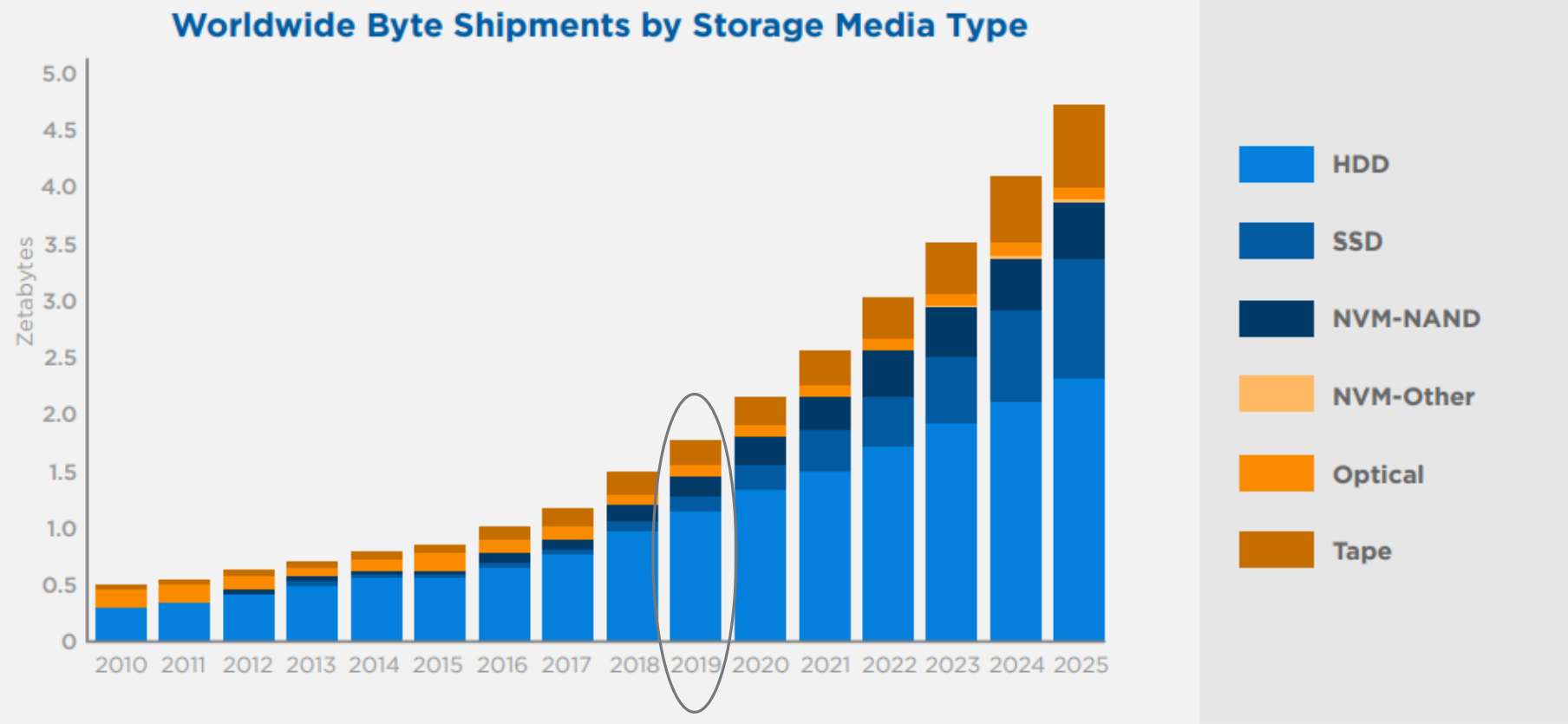
- Industry Update
- Recording Technology Update
- Dual actuator drives
- Archival Storage Development

Storage Industry Update



Industry Update

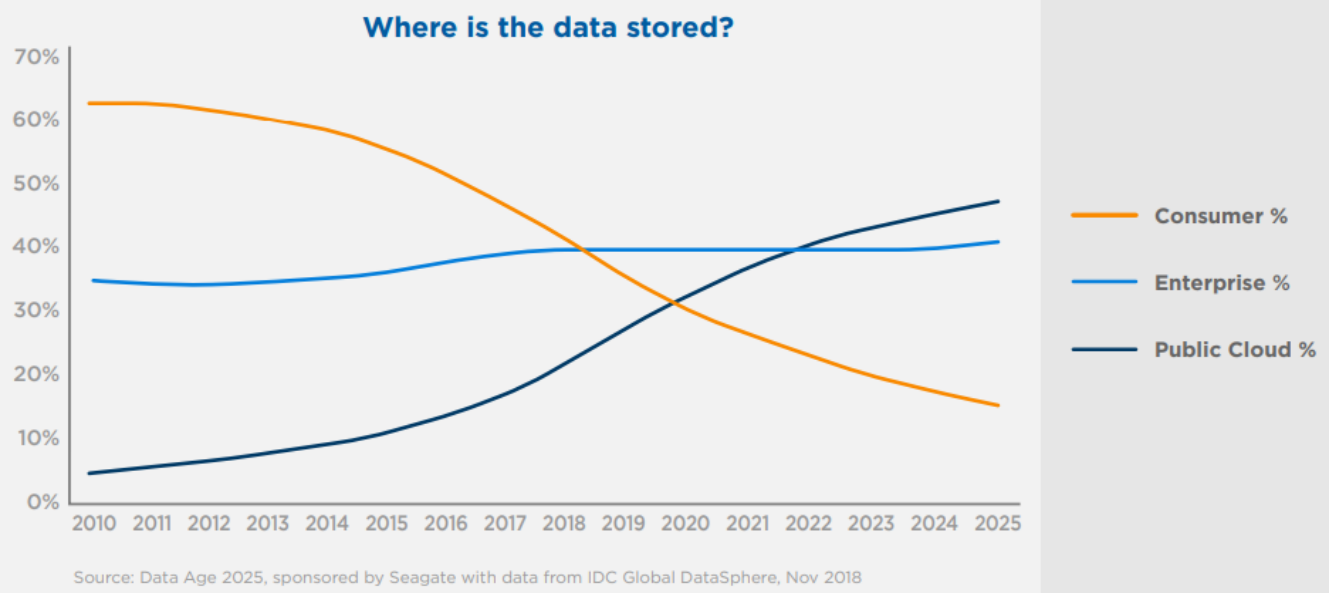
- Hard Disk Drives remain the predominate store of data, but SSD is growing
- Hard drive shipments are approaching 1ZB / year and should cross next year
- NAND was in oversupply and is now in-balance. We expect firm pricing this year.

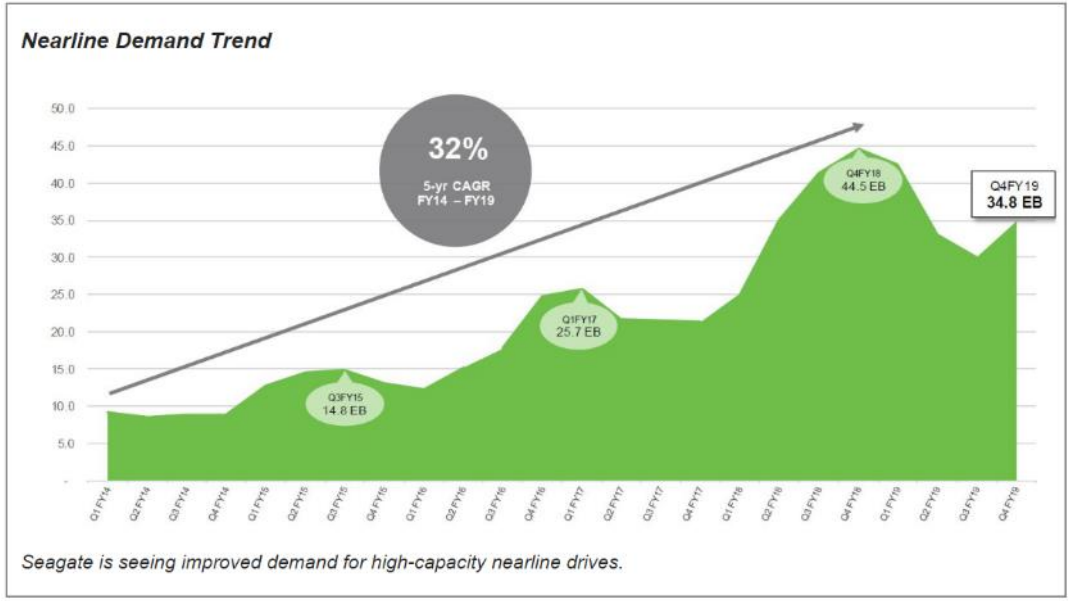


Source: Data Age 2025, sponsored by Seagate with data from IDC Global DataSphere, Nov 2018

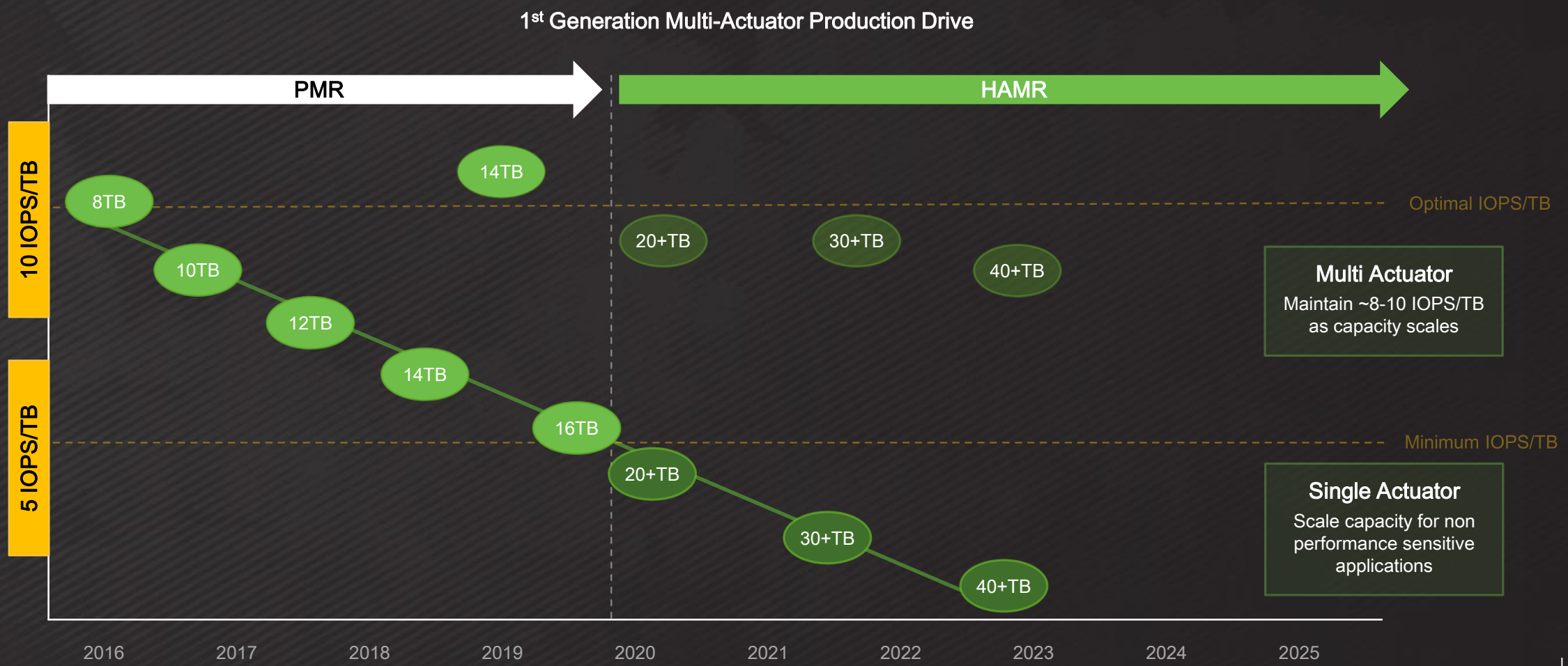
Where are data located?

- Data continues to shift to the cloud
- If trends continue, IDC projects cloud to overtake consumer in 2020, and enterprise in 2022
- However, edge networking constraints will place a limit on this shift, unless solutions are found





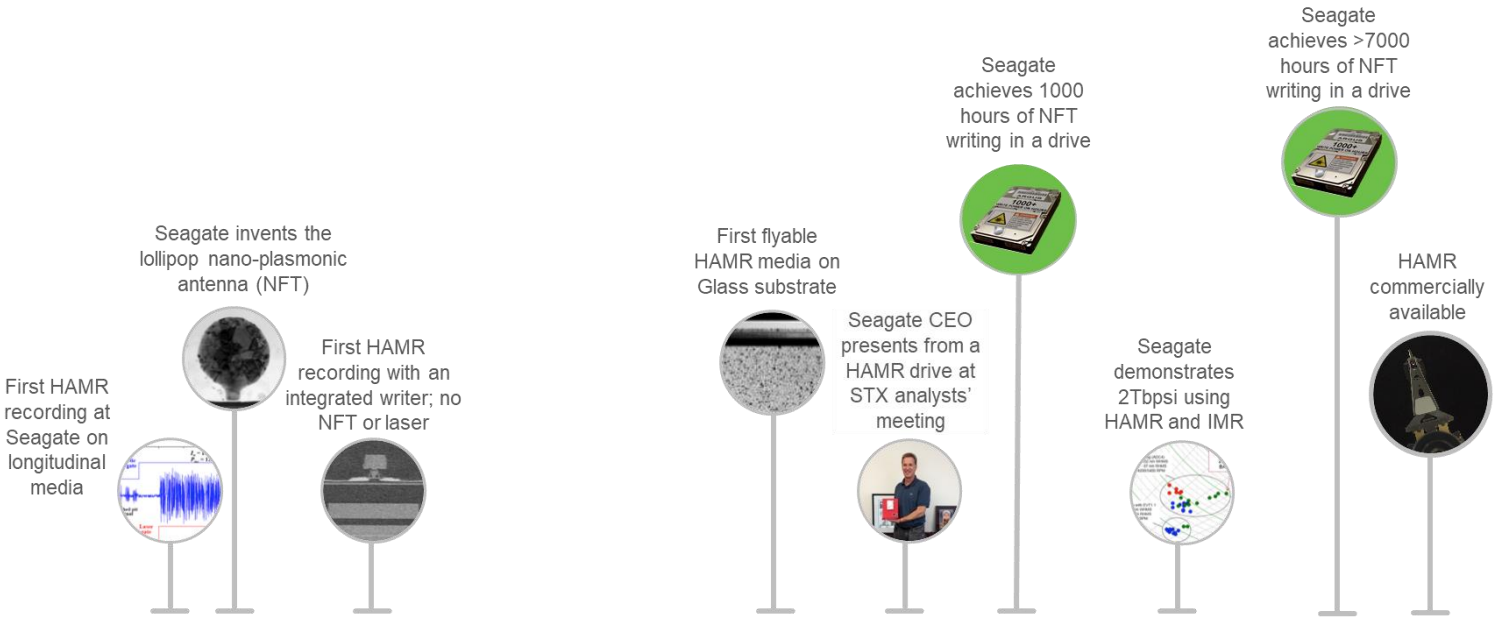
Hard Drive Product Deployment Timeline



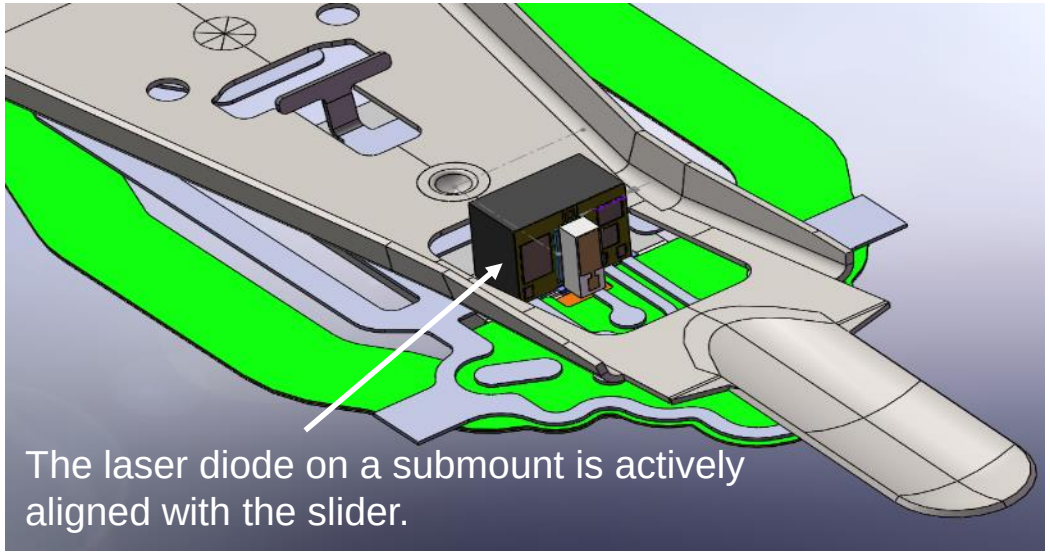
Recording Technology

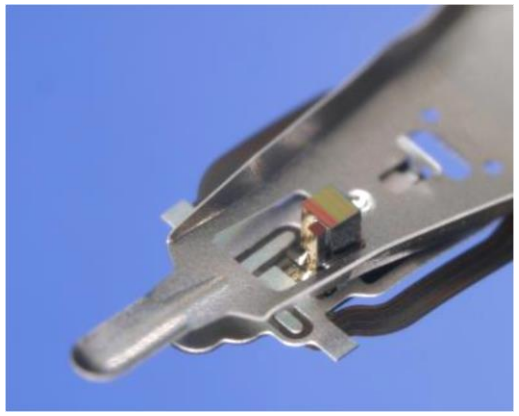
HAMR Technology Update

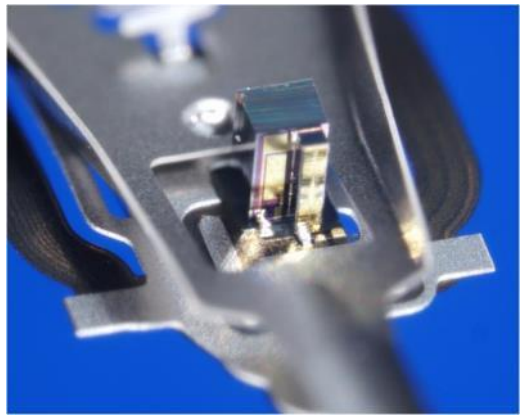
- HAMR = Heat-Assisted Magnetic Recording
- Seagate is now shipping HAMR drives in limited quantities to lead customers
- HAMR will be required for 20TB drives next year to avoid some radical mechanical changes
- Some of the challenges of ramping HAMR technology follow on the next few slides

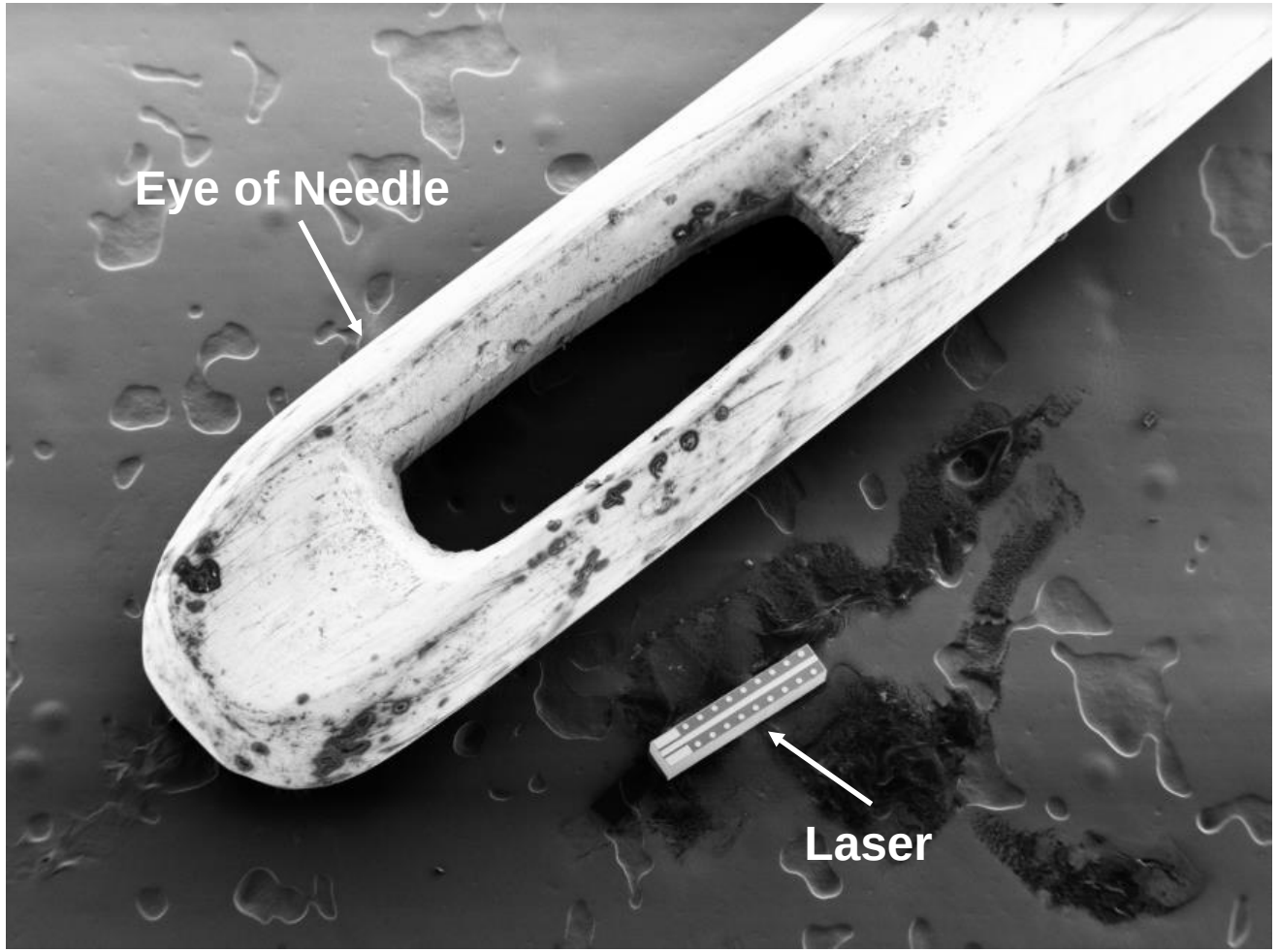


Laser on Slider









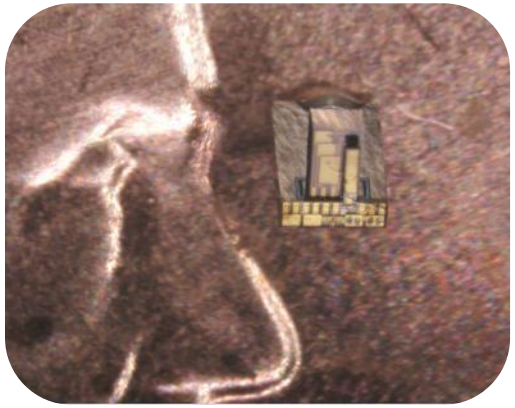
Precision Manufacturing

The height from the bottom of the slider to the top of the laser module is less than 500 um

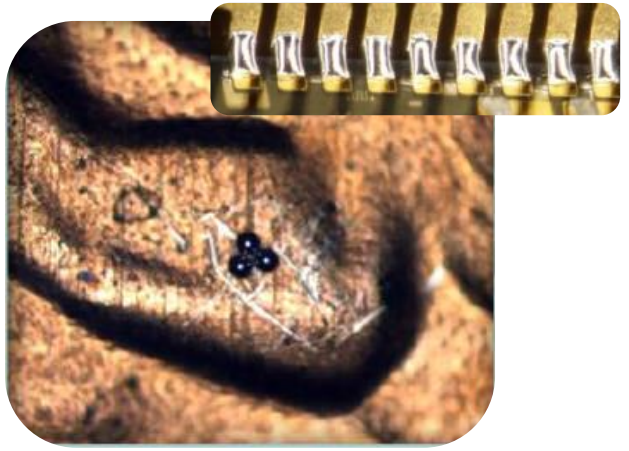
The slider will fly over the disk with an air-gap of only 1-2 nm

As HAMR progresses we will continue to shorten this height

Also shown are the TIC bonds which electrically connect the slider to the head.



HAMR Slider



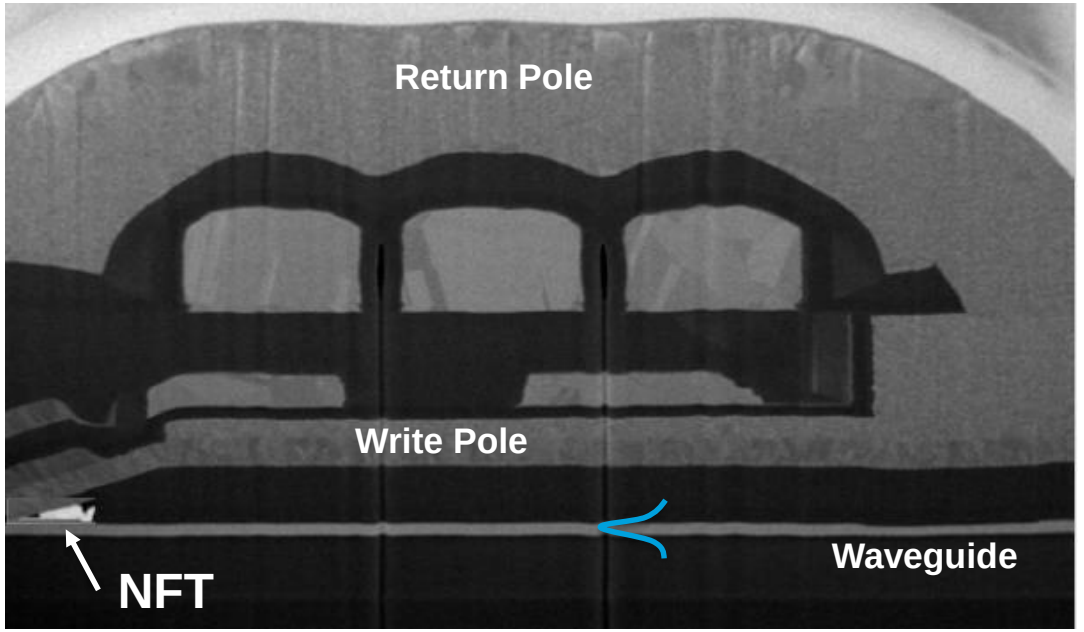
TIC Bonds

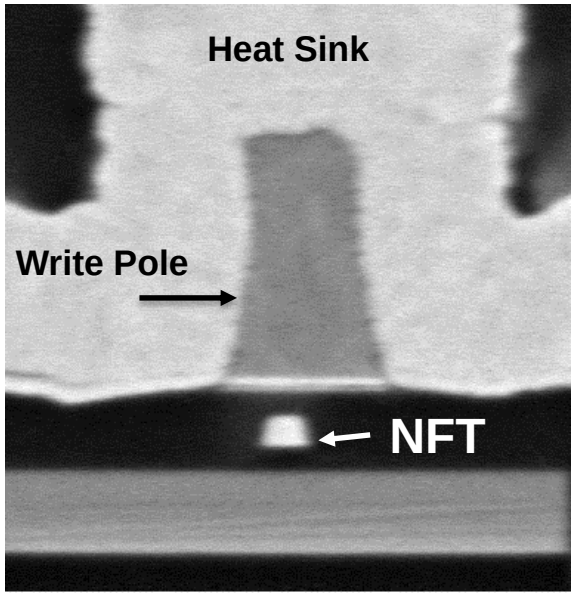
The Integrated HAMR Head

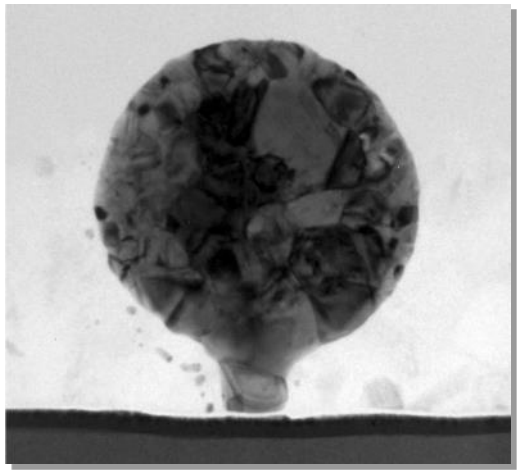
The writer still delivers flux to the media but there are major changes to the design to accommodate the waveguide and NFT.

The NFT delivers the EM energy to the media before it experiences the peak magnetic field from the write pole. As the media cools, the magnetic orientation is frozen with the applied field direction.

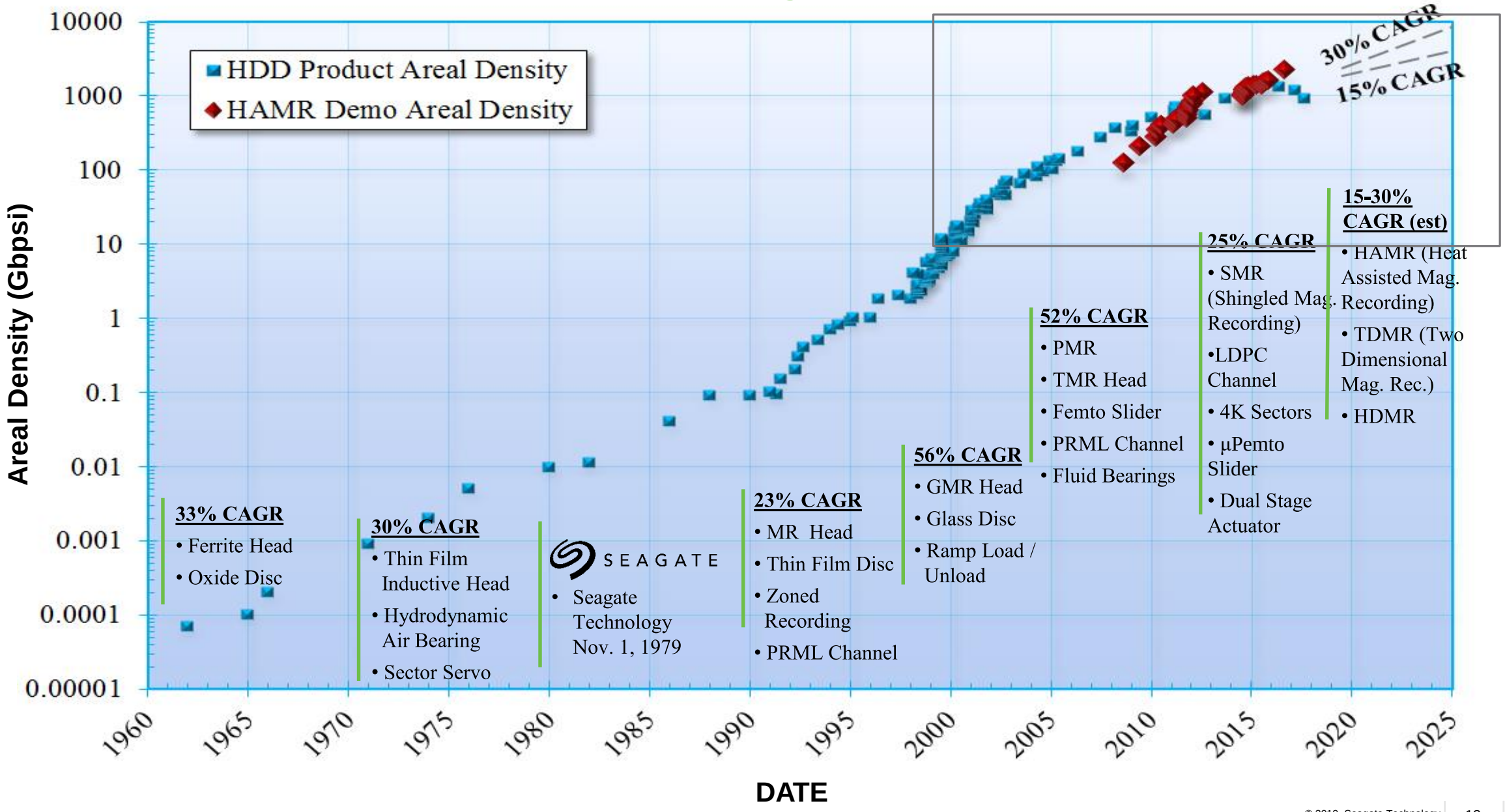
We have made millions of HAMR heads during the life of the program.







Succession of HDD Technology S-curves



Latest Areal Density Advancements

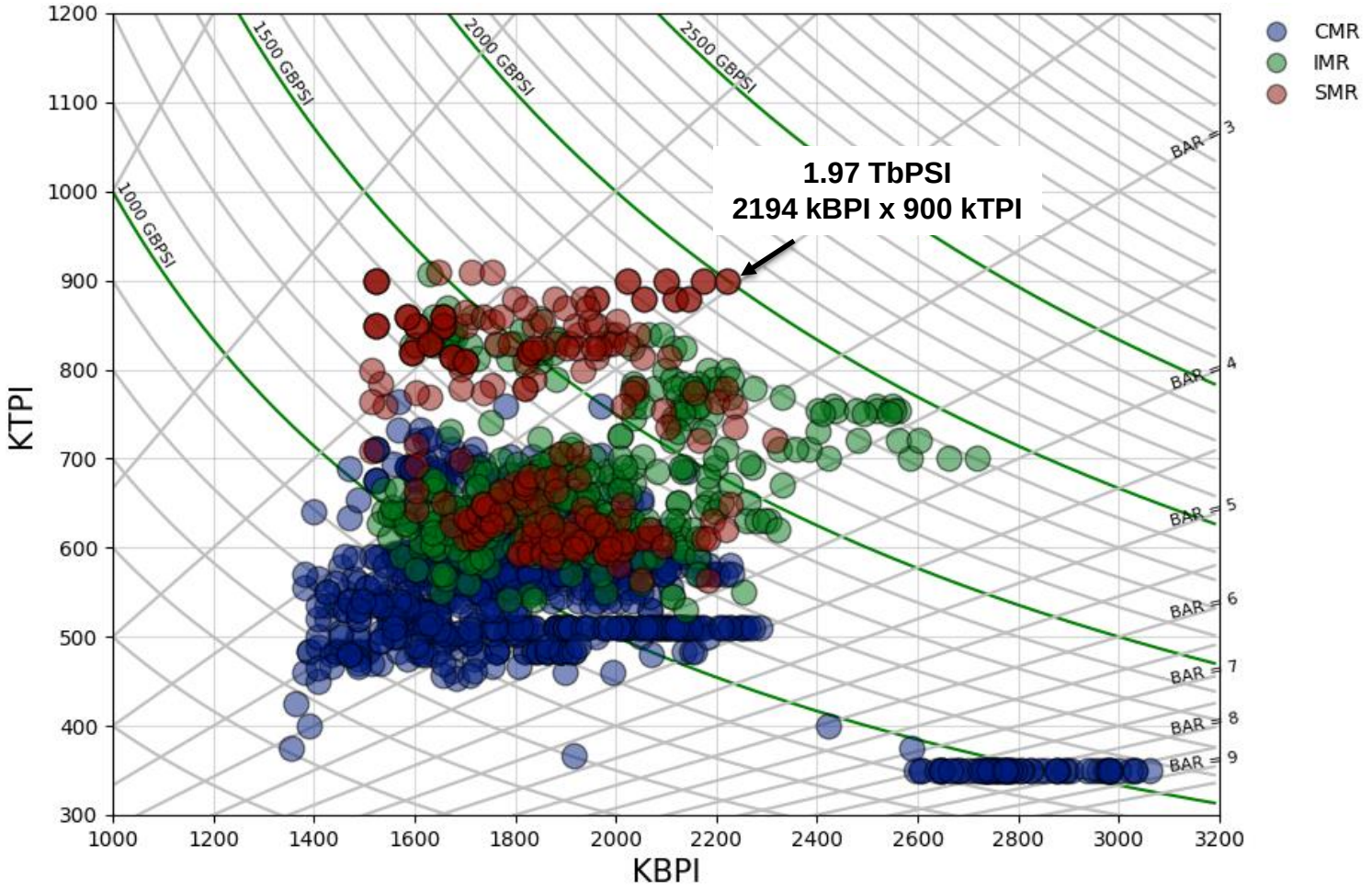
With recent head and media advancements we were able to demonstrate **2 TbPSI** with Shingled Magnetic Recording (SMR) and Interlaced Magnetic Recording (IMR), and 3000 kBPI (3400 kfci) with Conventional Magnetic Recording (CMR)

This is close to 2X today's product ADC

With this areal density 3.5" drives could exceed **30 TB**

Measurement Criteria Details:
These measurements comply with the ASTC demo criteria that was co-developed by Seagate & Western Digital. The criteria essentially requires no errors in 10^5 sectors written and read back.

ASTC ADC for CMR, SMR, and IMR

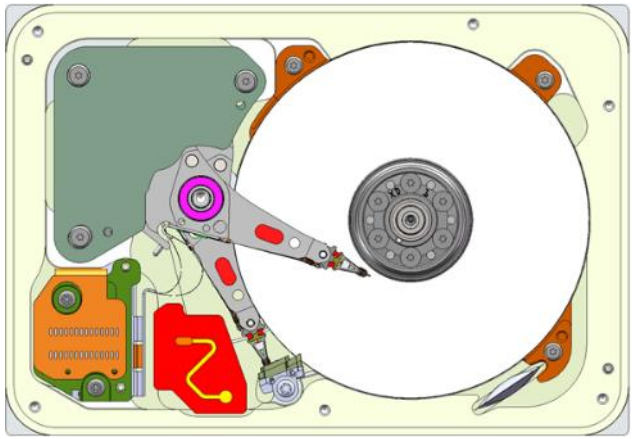


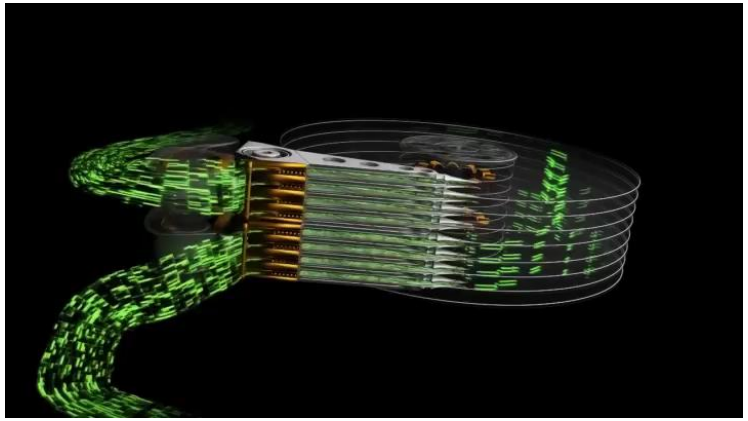
"Definition of an Areal Density Metric for Magnetic Recording Systems," Steven D. Granz, Tue Ngo, Tim Rausch, Richard Brockie, Roger Wood, Gerardo Bertero, Edward C. Gage, IEEE Trans. Magn. Vol. 53, Issue: 2, Feb. 2017

Dual Actuator

2019 Update: Dual-Actuator Hard Drives

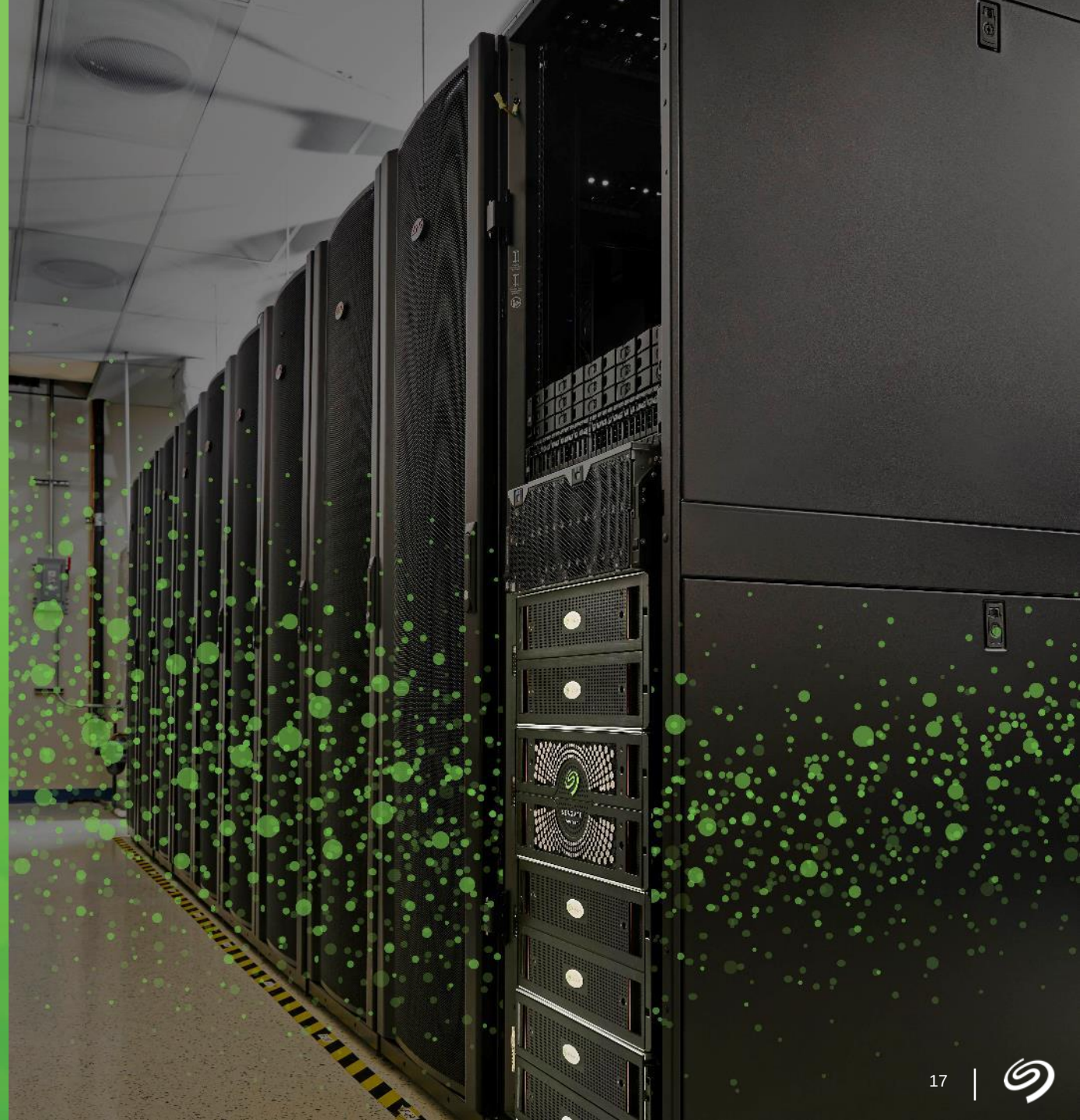
- SAS Dual-actuator drives are now **shipping in-volume**
- These drives are essentially two drives in one package
  - Each actuator is an independent LUN
  - With proper data placement:
    - Doubles random IOPs / TB
    - Doubles sequential MB/s





Workload	Compared to Nearline				
	1X	1.25X	1.5X	1.75X	2X
4K Rand Reads (Q1)					⇔
4K Rand Writes (Q1)					⇔
1M Rand Writes (Q1)					⇔
4K Rand Writes (Q64)					⇔
Seq Reads					⇔
Seq Writes					⇔

Archival Technology Research



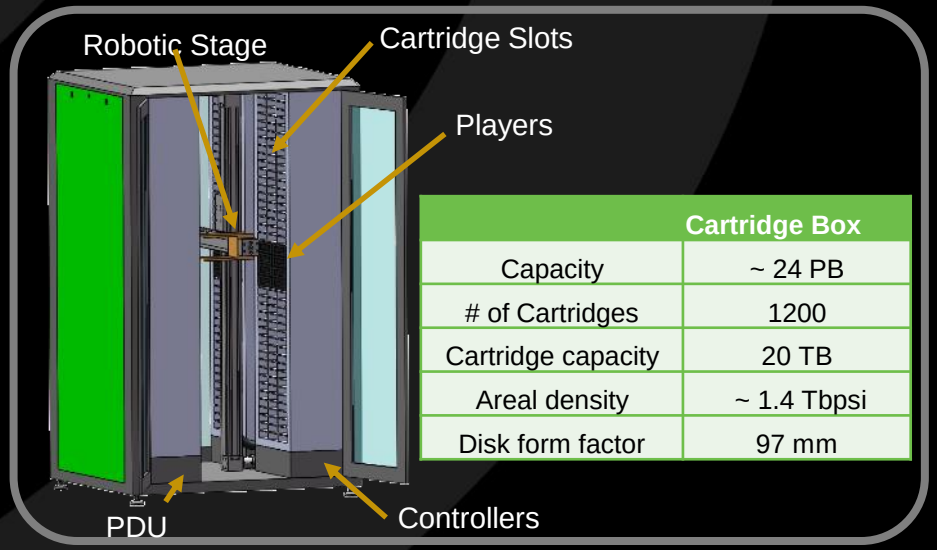
Cartridge Storage

Cartridge Storage Research

- Cartridge storage development work continues at Seagate
- Separates the electronics from the drive to reduce total costs

CLASS: Cartridge Library Archival Storage System

- A robotic library for hard disk drive cartridges
- Leverages Seagate's robotics strengths to move cartridges around
- Can be a compelling tape replacement



	Cartridge Box
Capacity	~ 24 PB
# of Cartridges	1200
Cartridge capacity	20 TB
Areal density	~ 1.4 Tbpsi
Disk form factor	97 mm

SEAGATE

Conclusion

Summary

- Data storage demand is strong and growing
- Dual-actuator drives have emerged and are shipping in volume
- First HAMR drives have shipped in small volumes
- Expect for 2020 to be a transitional year for storage