東北大学
TOHOKU UNIVERSITY

TMRC 2025
(12th) Conference Technology Survey
July 2025, Tohoku University

Survey this year 1/2

Survey of opinions on technology intercepts for HDD and MRAM industry.

*** 1. Describe your affiliation ?**

- ○ HDD Industry Member
- ○ MRAM Industry Member
- ○ Academia
- ○ Vendor
- ○ Other

Survey issued continuously over the meeting period. Differs from pre/post survey past years.

•The response rate was lower this year, so we consolidated the pre and post conference survey into one.

*** 2. What is the Maximum Areal Density Capability expected for Perpendicular/Shingled/Two dimensional - magnetic recording extensions?**

3. What is the expected Year of Technology introduction to HDD Products ?

	2025	2026	2027	2028	2030	2032	2034	Never
BPM	○	○	○	○	○	○	○	○
HAMR	○	○	○	○	○	○	○	○
MAMR	○	○	○	○	○	○	○	○
HDMR(BPM+HAMR)	○	○	○	○	○	○	○	○
Multilayer Magnetic Recording	○	○	○	○	○	○	○	○
All Optical Recording	○	○	○	○	○	○	○	○
2 Heads per surface Write and Readback	○	○	○	○	○	○	○	○

Survey this year 2/2

4. Likely intercept of Rotating Storage as Practical Bulk Archive medium

2025	2026	2028	2030	2032	Never
○	○	○	○	○	○

5. Timing for the product delivery of 3D DRAM

2025	2026	2028	2030	2032	Never
○	○	○	○	○	○

6. What are the practical limits of the maximum number of NAND layers

- ○ 200
- ○ 500
- ○ 1000
- ○ Don't know

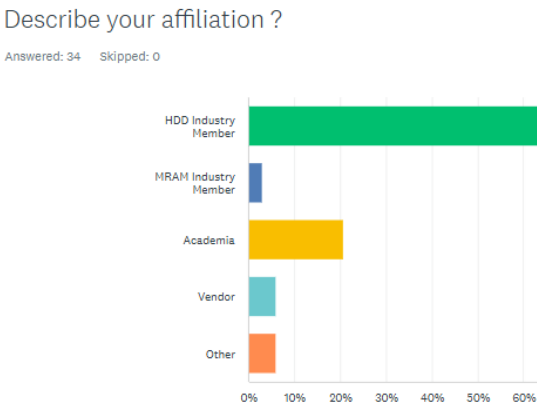
7. Which emerging memory will become the Future Storage Class Memory?

- ○ FRAM
- ○ ReRAM
- ○ MRAM
- ○ Other

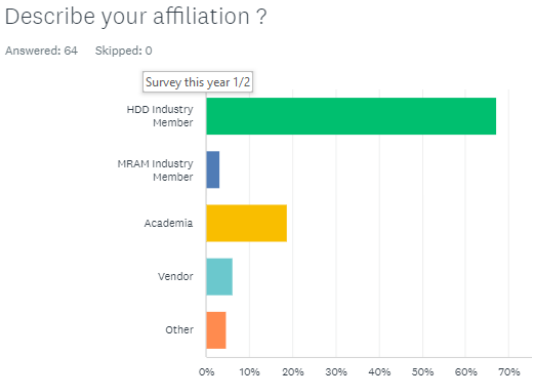
Population of respondents up to 07/30/25 (after conference)

As with 2015-24.
Dominant responses from HDD members.
Limited MRAM industry response so far this year.

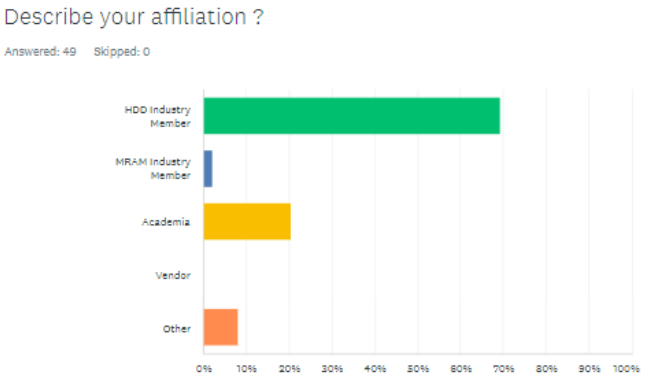
2025



2024



2023



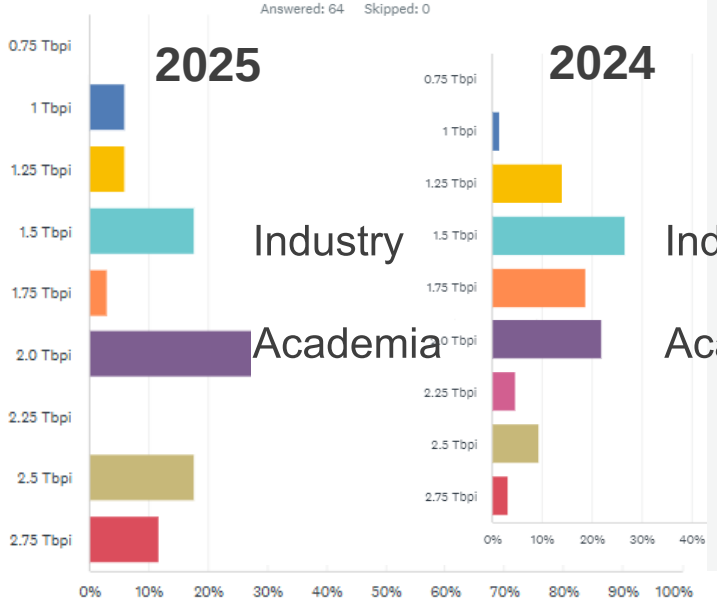
Maximum ADC, for conventional technology

- **Median +mean of 2 Tb/inch^2 +/-0.25**
- **A few optimistic voters for 2.5 Tb/inch^2, and above.**
- **Bimodality between Academia and Industry (lower mode for industry)**
- **Pattern very similar to 2018-2024**

Answered: 34 Skipped: 0

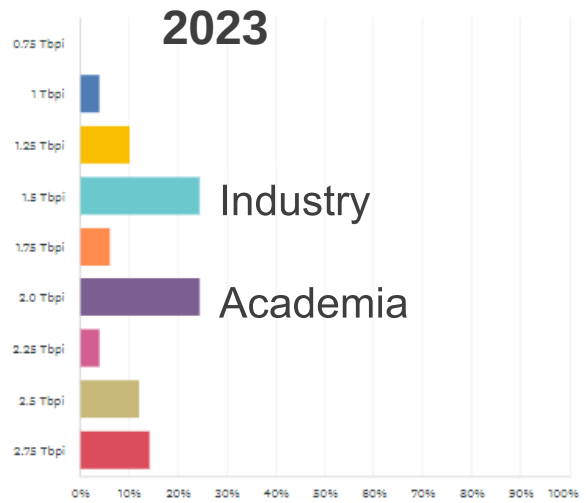
What is the Maximum Areal Density C
Perpendicular/Shingled/Two dimensic

Answered: 64 Skipped: 0



What is the Maximum Areal Density Capability expected for
Perpendicular/Shingled/Two dimensional - magnetic recording extensions?

Answered: 49 Skipped: 0



Expected introduction year

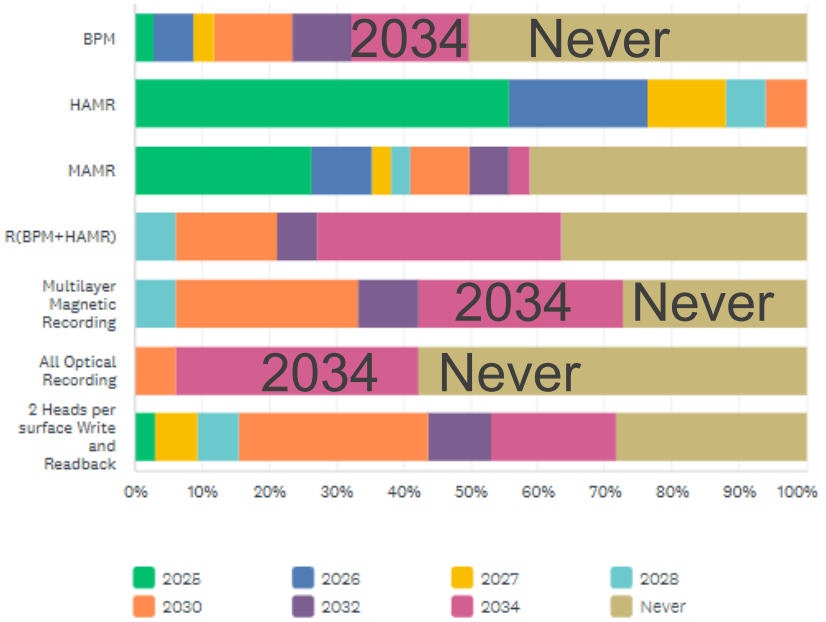
Pessimism for MAMR reduced in 2017, and improved 2018- drift back up 2019+ 2023 increased significantly

BPM/Heated Dot remains pessimistic

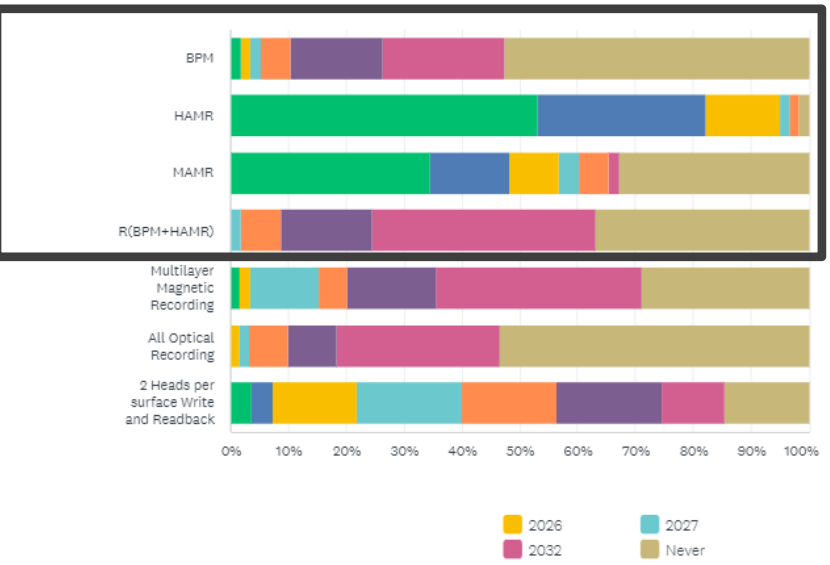
The last 5 years- MAMR and HAMR – is “soon”/”Now”.

Multilayer and all optical starts out as very immature and not ready.

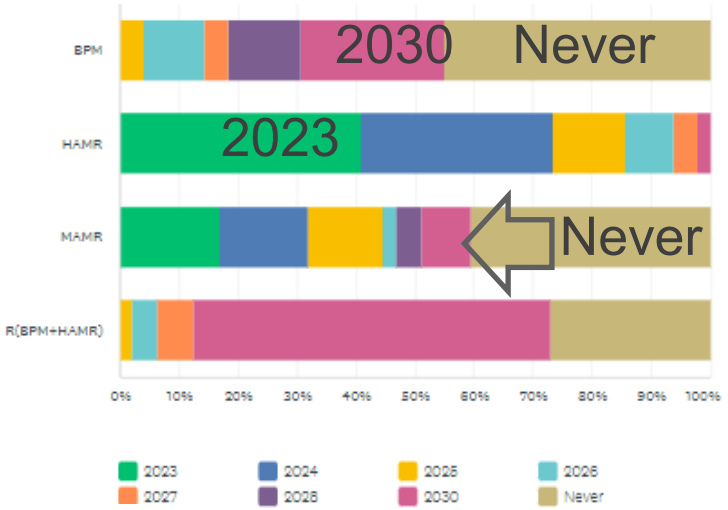
2025



2024



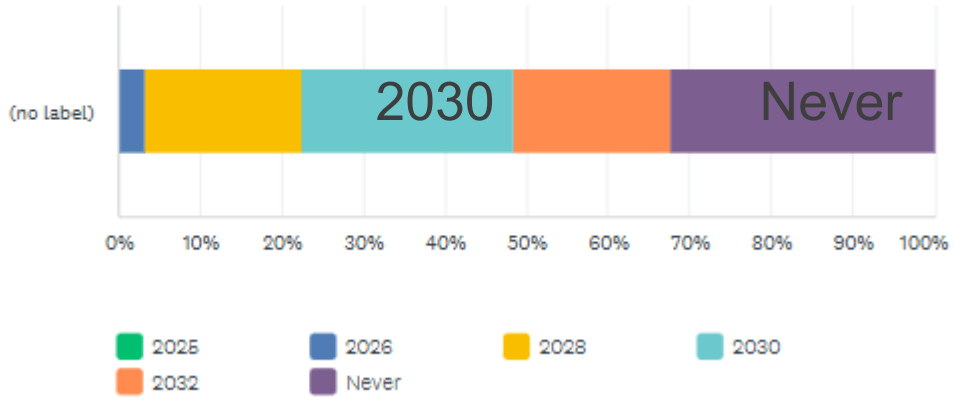
2023



Will HDD take over from Tape?

Likely intercept of Rotating Storage as Practical Bulk Archive medium

Answered: 31 Skipped: 3

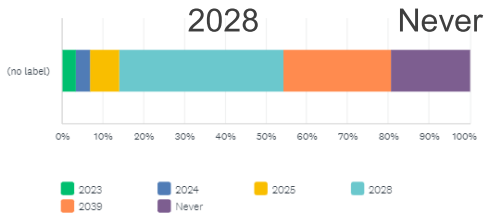


2024 Survey

2024 Survey

Likely intercept of Rotating Storage as Practical Bulk Archive medium

Answered: 57 Skipped: 7

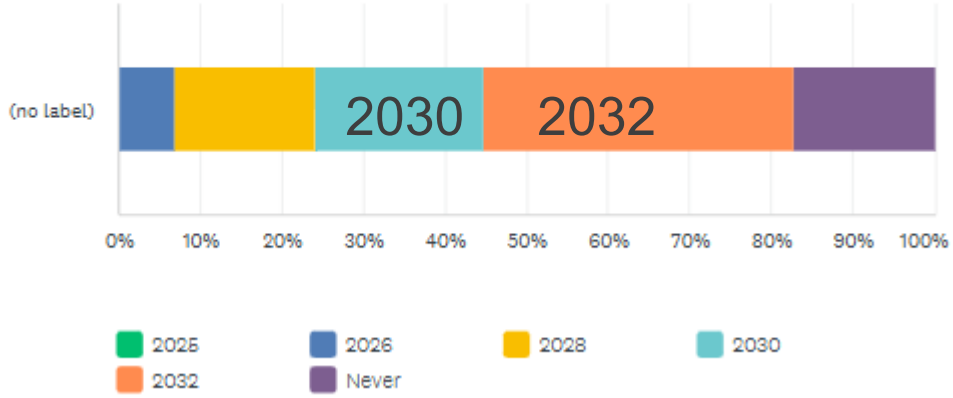


	2023	2024	2025	2028	2039	NEVER	TOTAL	WEIGHTED AVERAGE
(no label)	3.51% 2	3.51% 2	7.02% 4	40.35% 23	26.32% 15	19.30% 11	57	4.40

DRAM

Timing for the product delivery of 3D DRAM

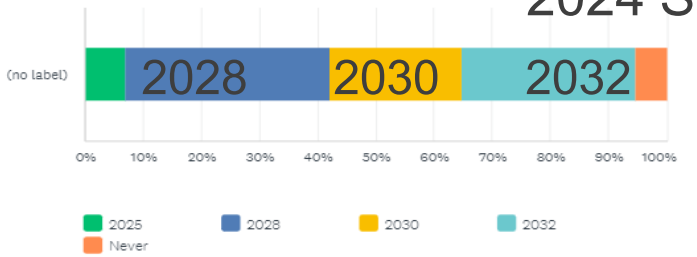
Answered: 29 Skipped: 5



Timing for the product delivery of 3D DRAM

Answered: 57 Skipped: 7

2024 Survey



	2025	2028	2030	2032	NEVER	TOTAL	WEIGHTED AVERAGE
(no label)	7.02% 4	35.09% 20	22.81% 13	29.82% 17	5.26% 3	57	2.91

NAND Question (the competing pressure).

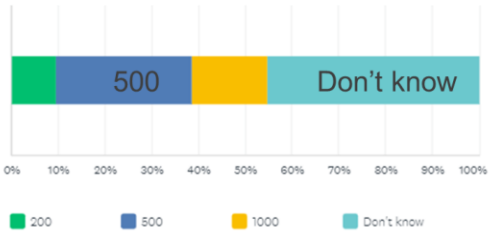
What are the practical limits of the maximum number of NAND layers

Answered: 30 Skipped: 4

2024

What are the practical limits of the maximum number of NAND layers

Answered: 62 Skipped: 2

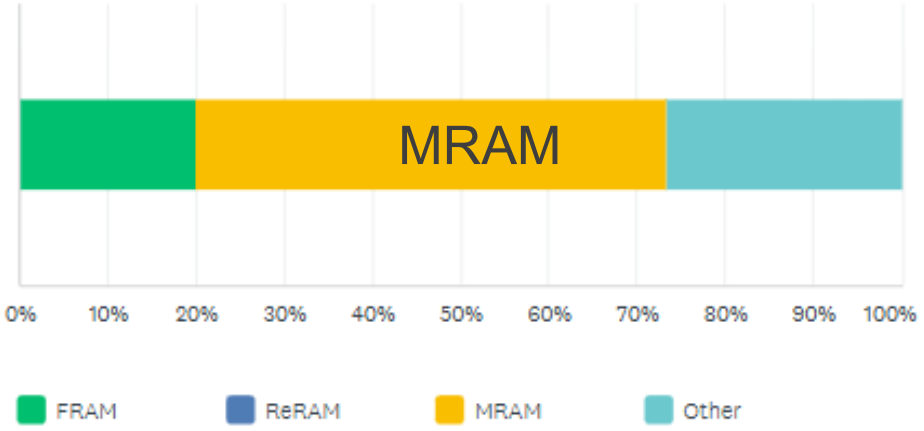


ANSWER CHOICES	RESPONSES	
200	9.68%	6
500	29.03%	18
1000	16.13%	10
Don't know	45.16%	28
TOTAL		62

New solid state Technologies.

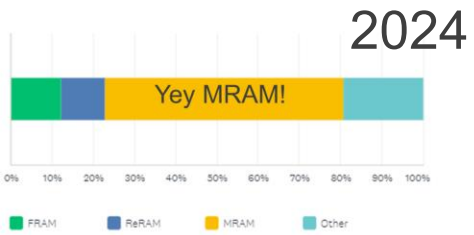
Which emerging memory will become the Future Storage Class Memory?

Answered: 30 Skipped: 4



Which emerging memory will become the Future Storage Class Memory?

Answered: 57 Skipped: 7



ANSWER CHOICES	RESPONSES	
FRAM	12.28%	7
ReRAM	10.53%	6
MRAM	57.89%	33
Other	19.30%	11
TOTAL		57

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THANK YOU

The Magnetic Recording Conference
Hosted by Tohoku University