



ECC with 32 Track Data Interleave For High Density Tape Recorder

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Storage by Sony



Why Tape in 21st Century

Removable Inexpensive Media of High Volume Density for High Data Rate Recorder

- Transportation of Raw Data
- Raw Data Storage
- 24 Hours Continuous Recording

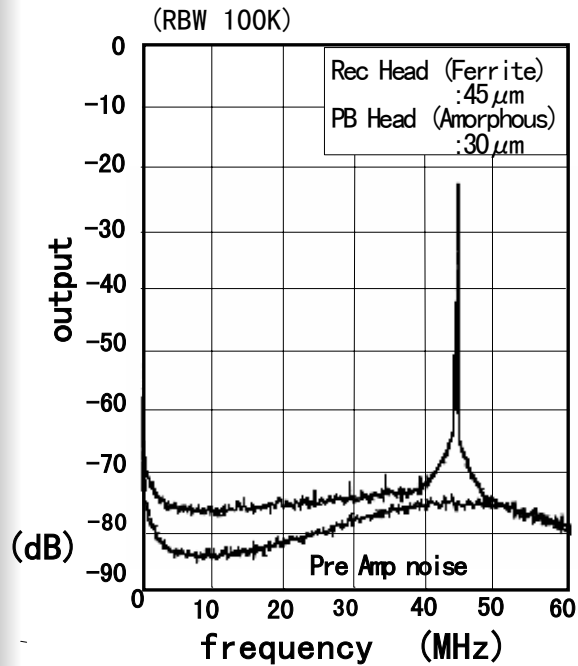
Specifications and Parameters

Format	ANSI ID-1	Super ID-1 ID-1 Read Compatible
Storage Capacity (L) (Recording Time)	100 GByte (25 min at 512 Mbps)	600 GByte (80 min at 1024 Mbps)
Tape Width	19 mm	19 mm
Media	Co-oxide	New Metal Particle
Media Coercive Force (Hc)	900 Oe	2300 Oe
Shortest Wavelength	0.89 μm	0.45 μm
Track Pitch	45 μm	19 μm
Tape Thickness	16 μm	11 μm
Bit Error Rate	1 x 10E-10 (Excluding two burst errors /L-cassette tape)	

Noise Performance

- Matured Metal Particle Tape (new for 19mm tape)
- New Head Technology
(Embedded Thin Film Head, Trench Head Technology)

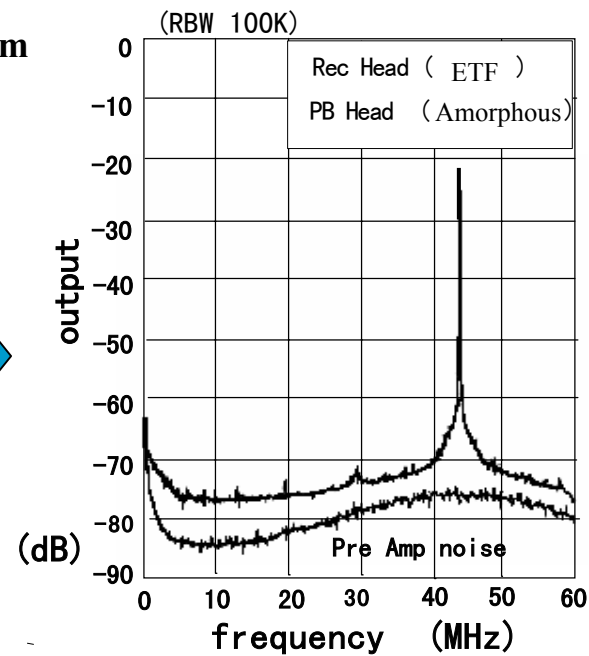
$\lambda=0.89 \mu\text{m}$ (ANSI ID-1 Format)



TP = 45 μm



$\lambda=0.445 \mu\text{m}$ (Super ID-1 Format)



TP = 19 μm

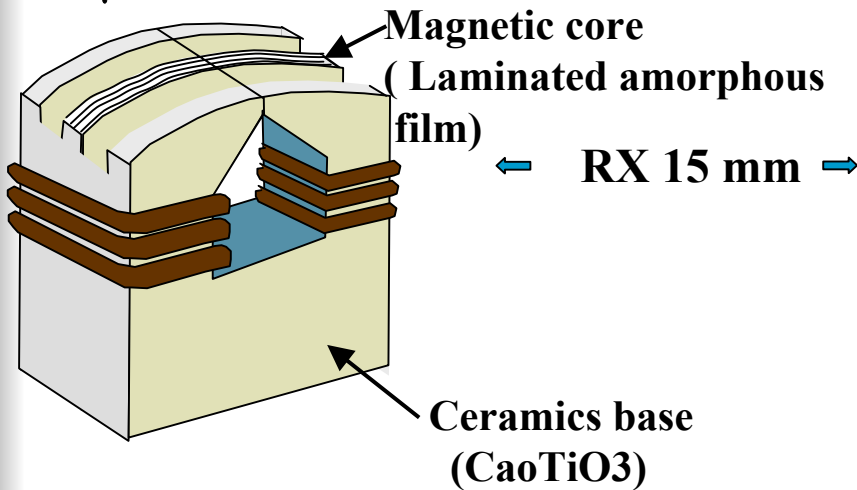
Recording of shortest wavelength

Storage by Sony

Trench Head New Design Head

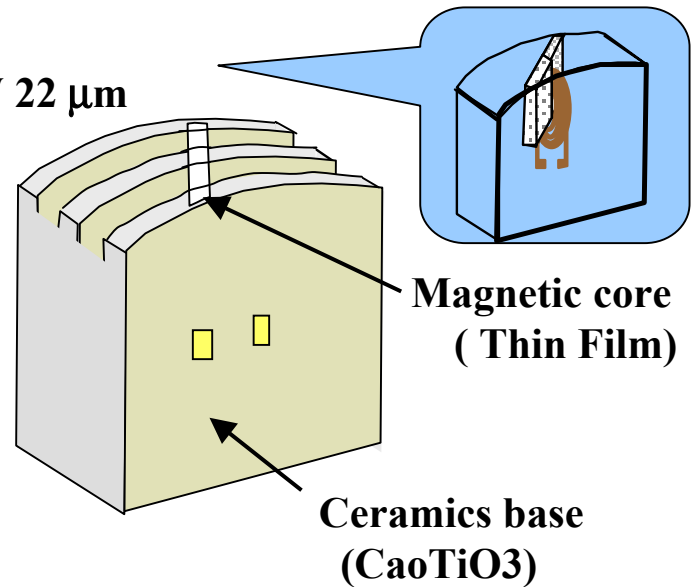
Playback Head
(Laminated Amorphous)

TW 30 μ m

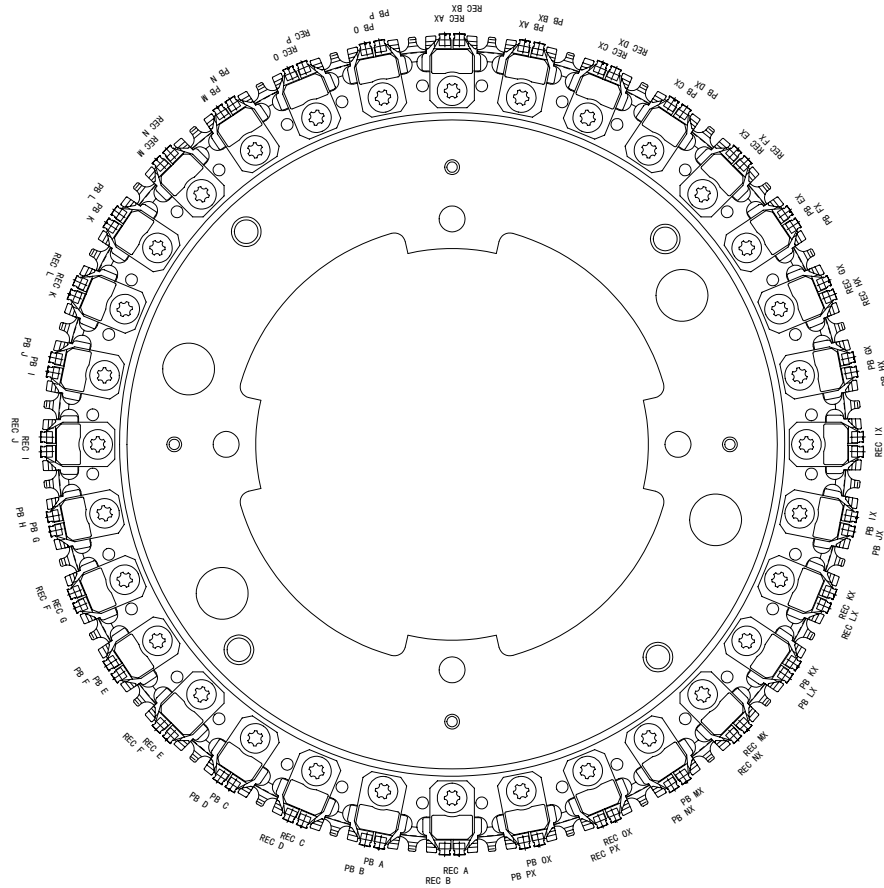


Record Head
(ETF , Embedded Thin Film)

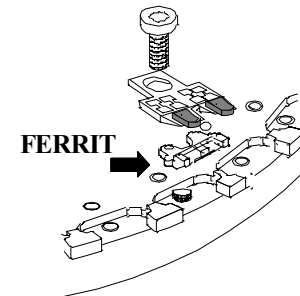
TW 22 μ m



Head Configuration Example



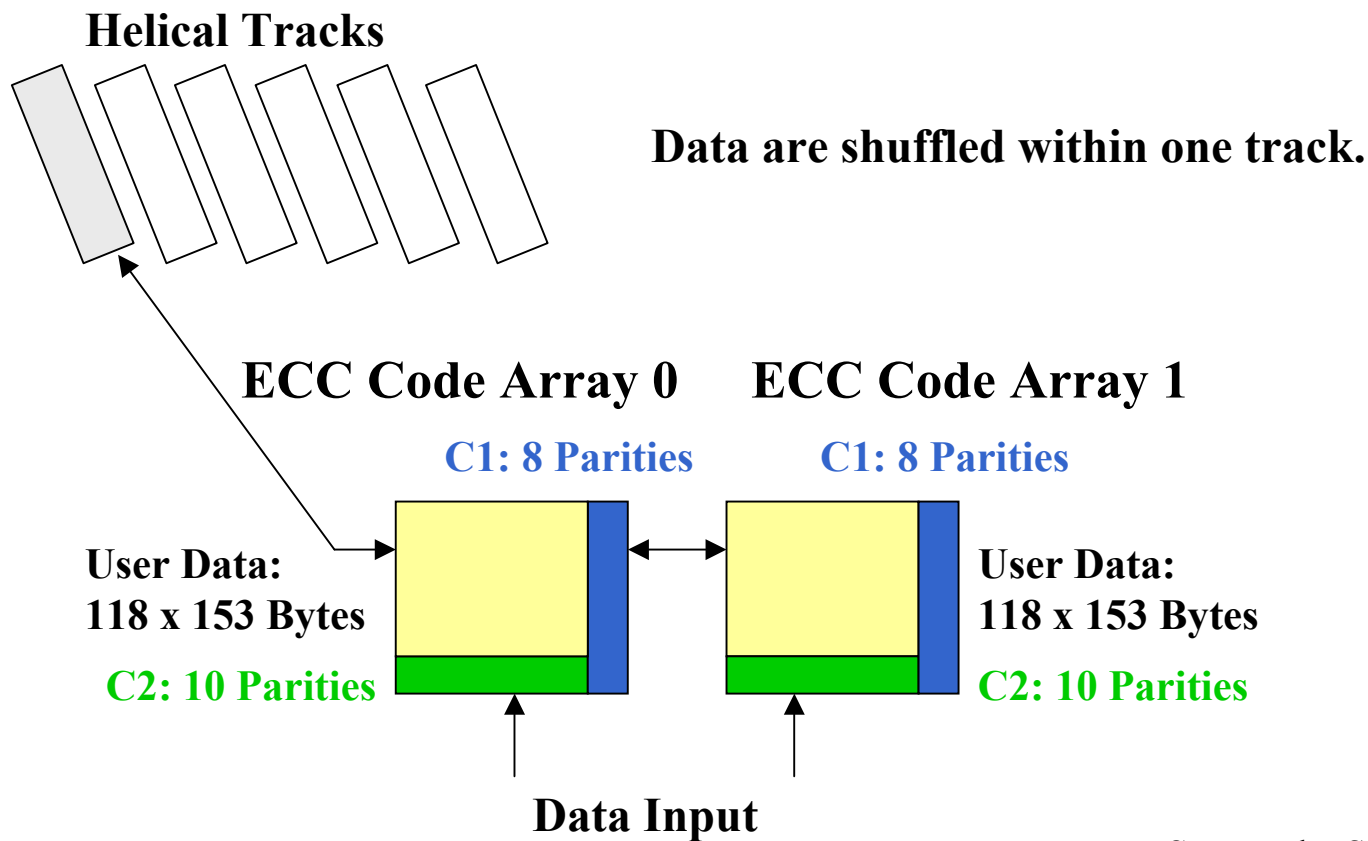
2 chips / base
Rec Head n=32
PB Head n=32



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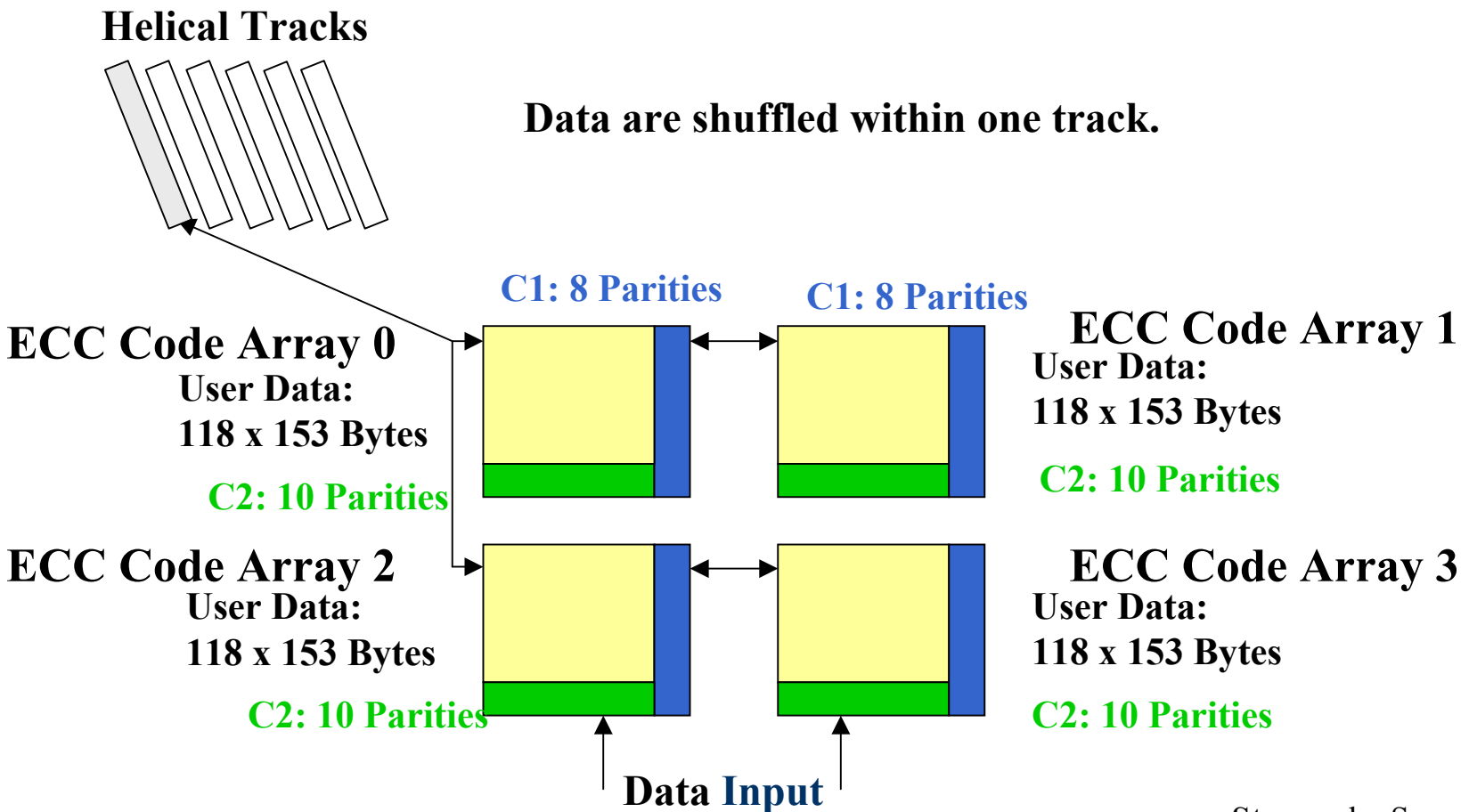
ID-1 Tape Format (100 GB) ECC Interleave

Double Reed-Solomon. C1: 8 Parities, C2: 10 Parities
Interleave among one track (36,108 Bytes)



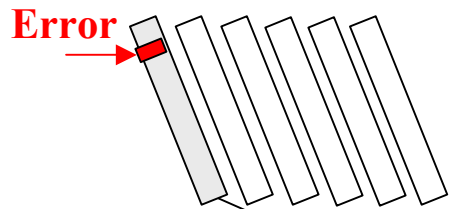
ECC Interleave Among One Track (1) (600 GB)

Double Reed-Solomon. C1: 8 Parities, C2: 10 Parities
Interleave among one track (72,216 Bytes)



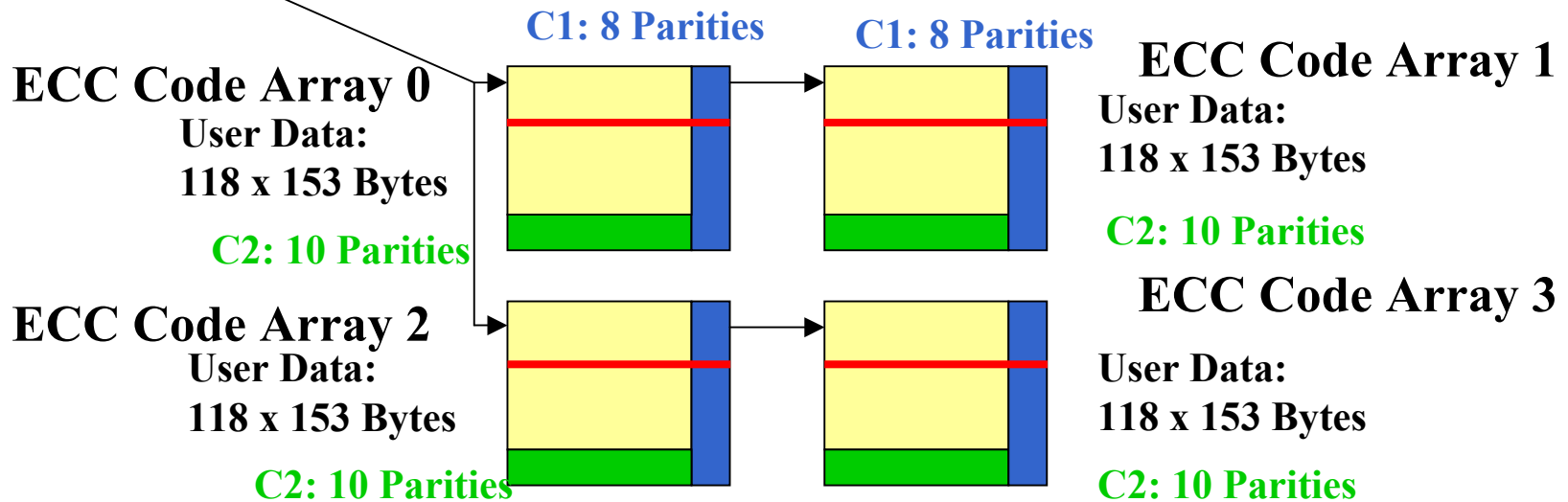
ECC Interleave Among One Track (2) (600 GB)

Double Reed-Solomon. C1: 8 Parities, C2: 10 Parities
Interleave among one track (72,216 Bytes)



Helical Tracks

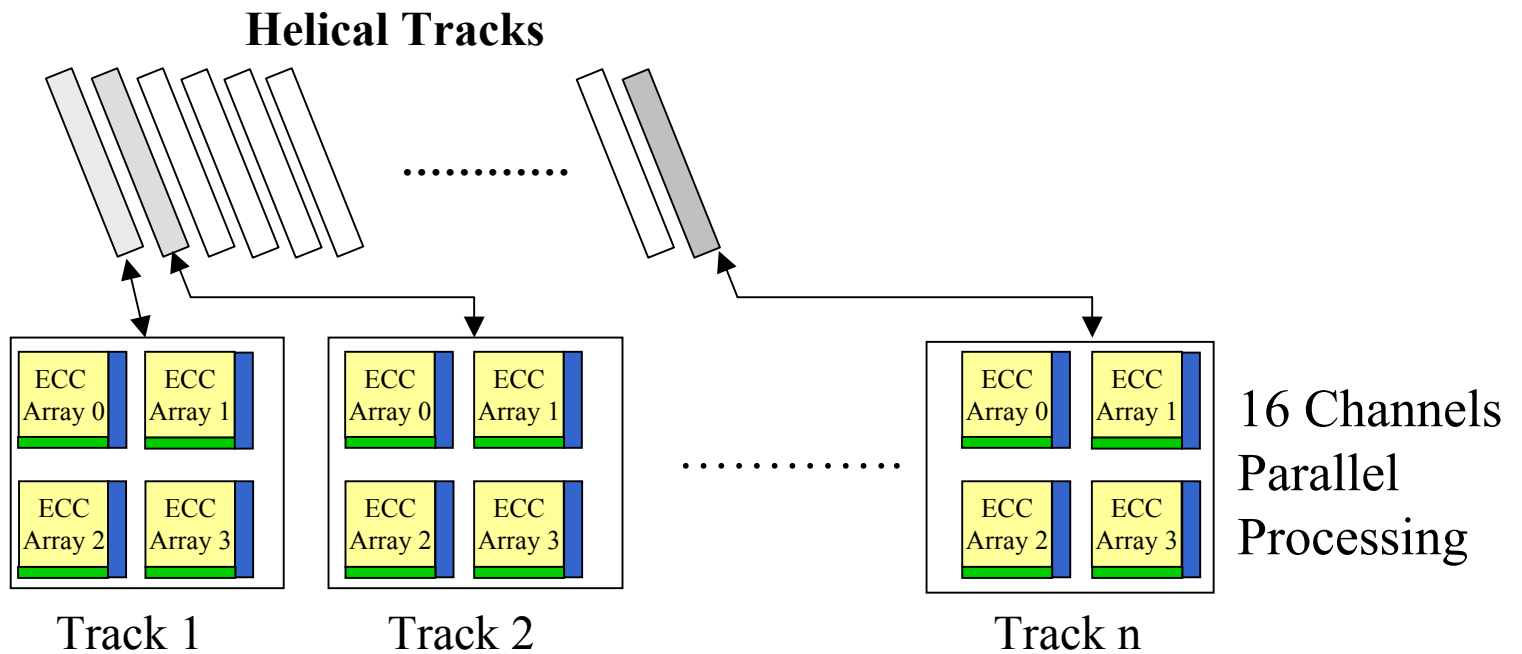
If burst errors are less than 8 % of data in one track, they are corrected.



Errors are distributed among 4 ECC Code Arrays for better correction

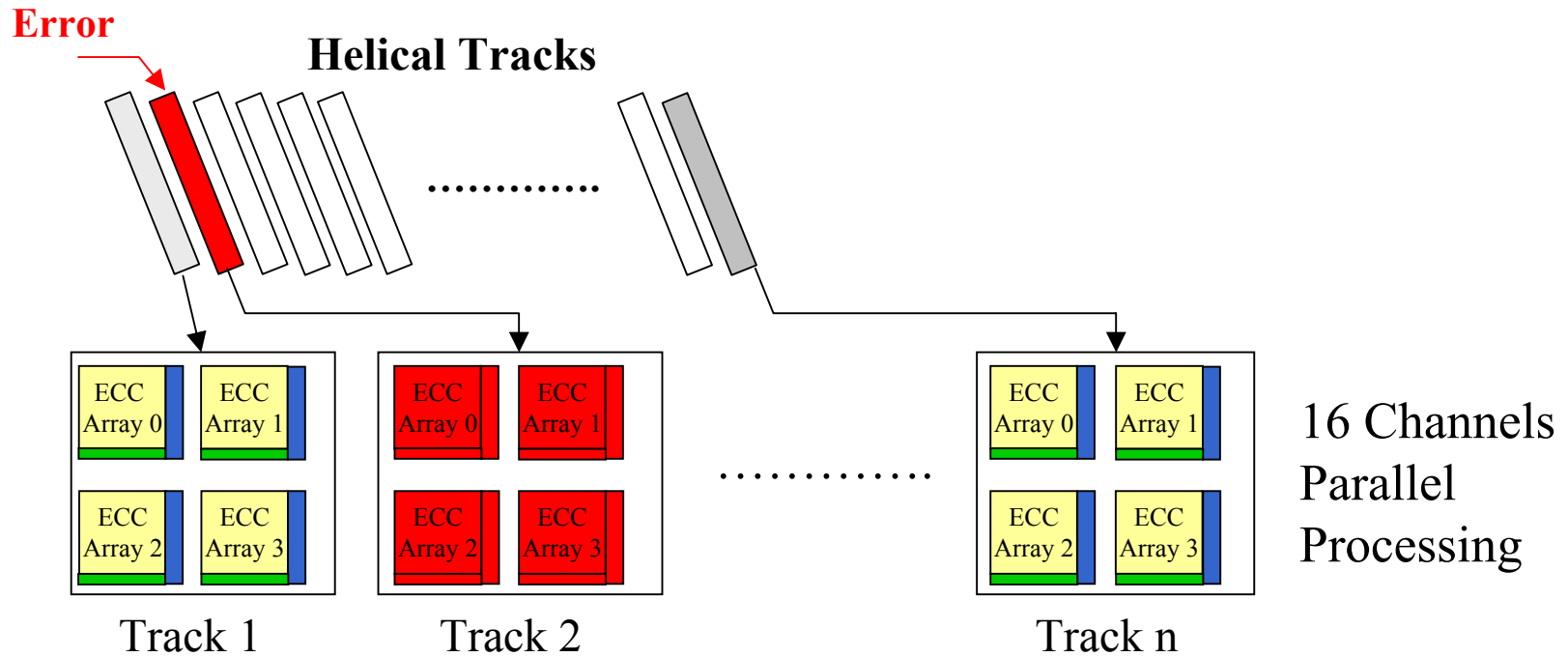
ECC Interleave Among One Track (3) (600 GB)

Double Reed-Solomon. C1: 8 Parities, C2: 10 Parities
Interleave among one track (72,216 Bytes)



ECC Interleave Among One Track (4) (600 GB)

Double Reed-Solomon. C1: 8 Parities, C2: 10 Parities
Interleave among one track (72,216 Bytes)

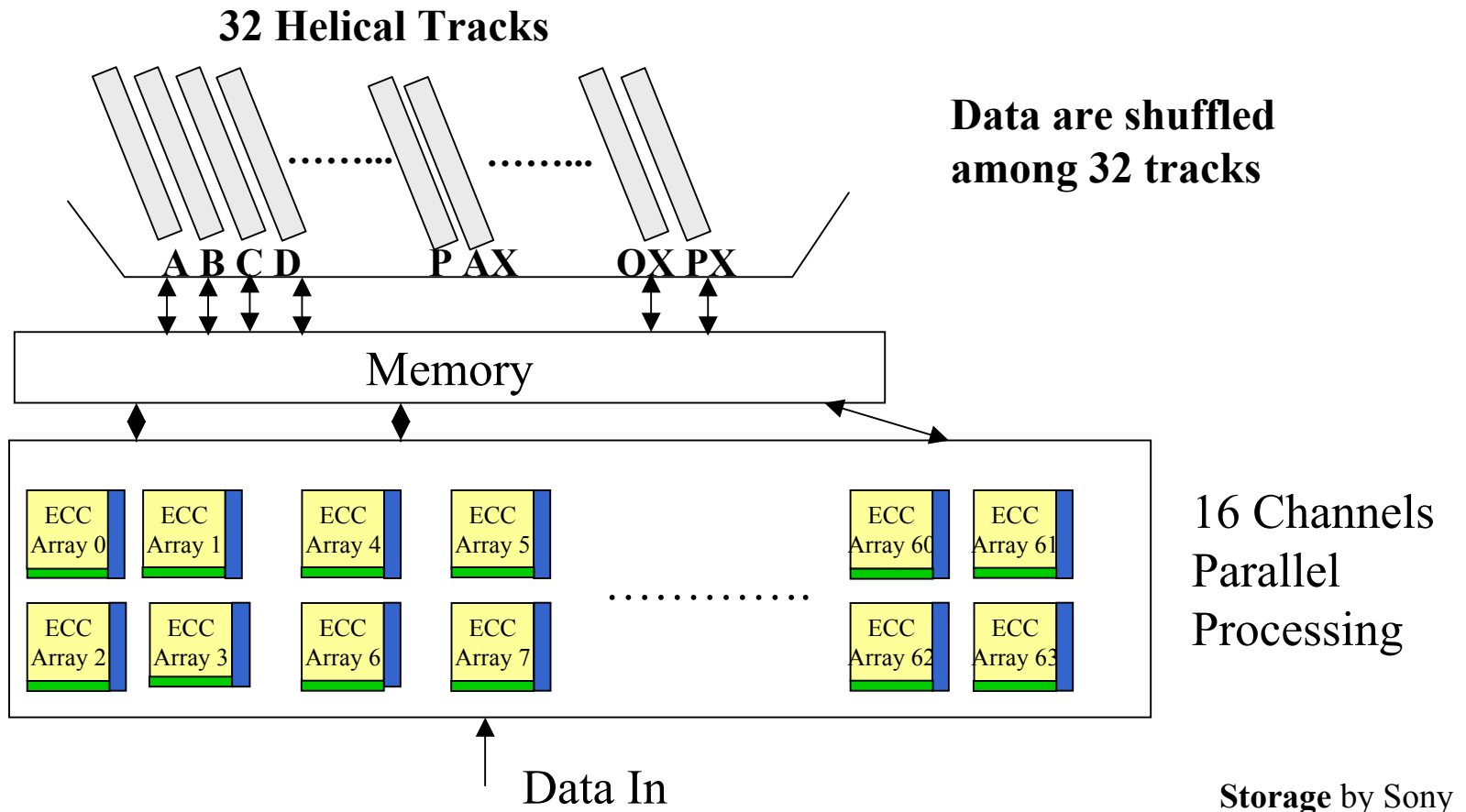


One head has clogging for the entire track

Super ID-1 Format (1)

ECC Interleave

Double Reed-Solomon. C1: 8 Parities, C2: 10 Parities
Interleave among 32 tracks (2,310,912 Bytes)

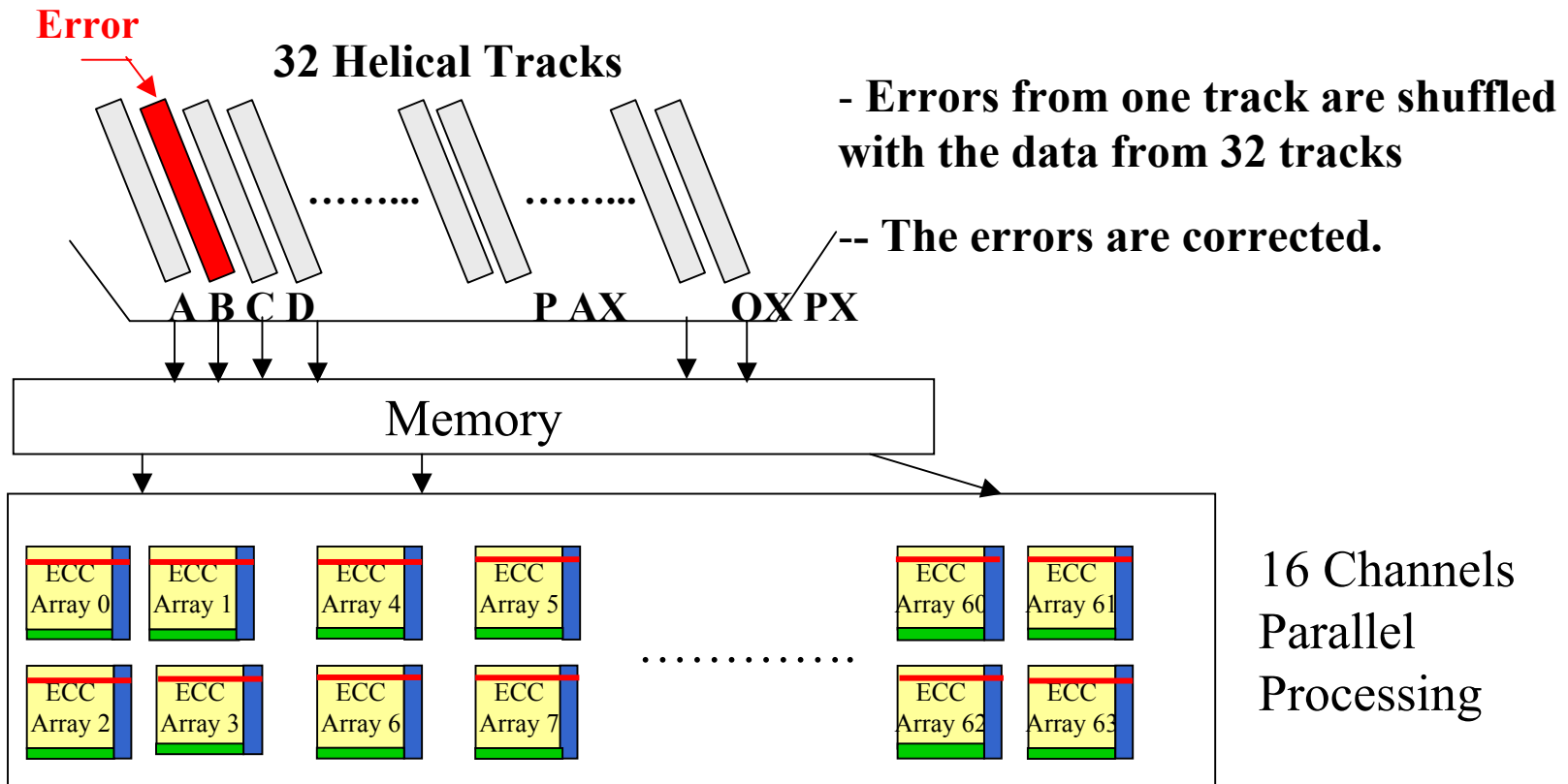


Super ID-1 Format (2)

ECC Interleave

Double Reed-Solomon. C1: 8 Parities, C2: 10 Parities

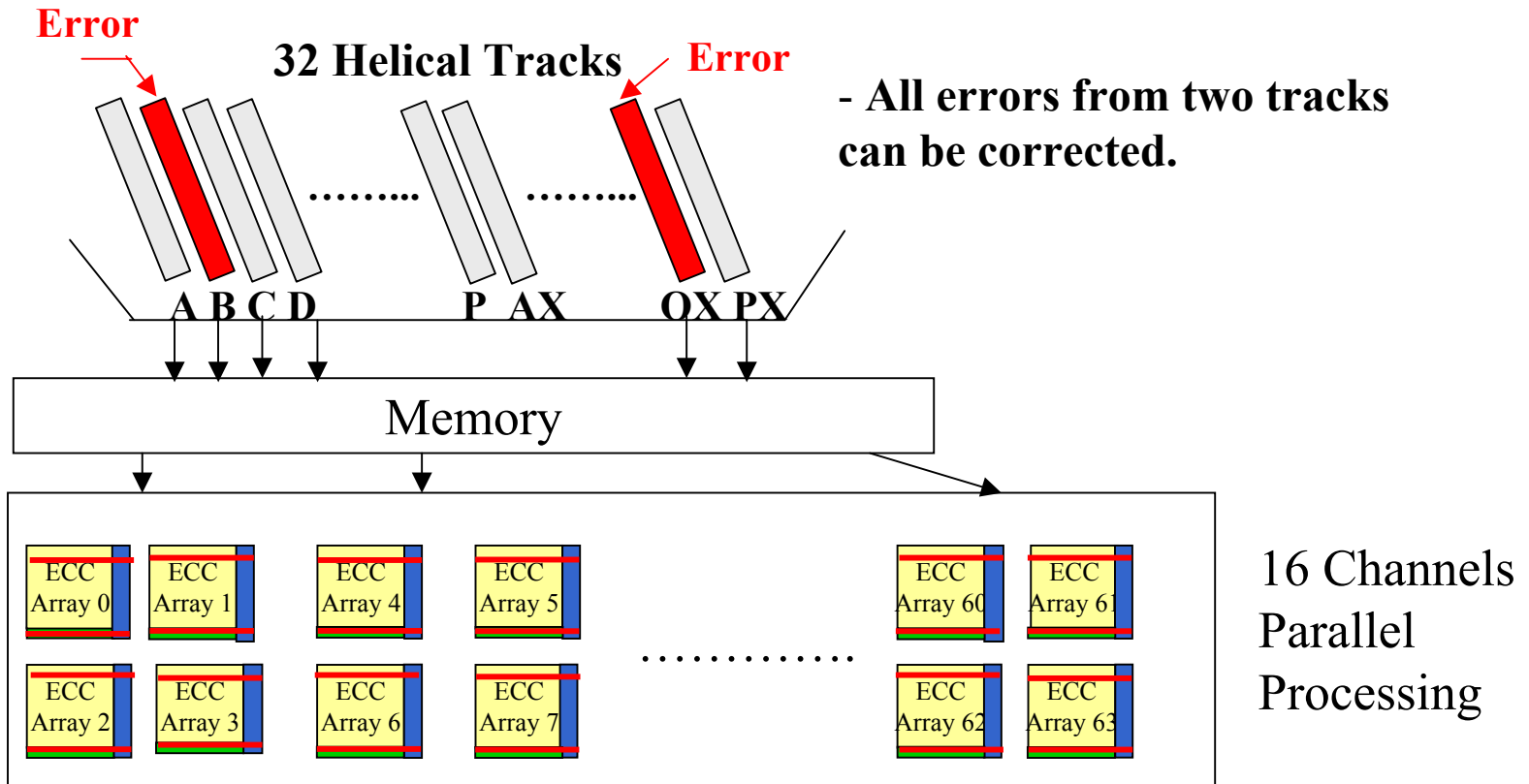
Interleave among 32 tracks (2,310,912 Bytes)



Super ID-1 Format (3)

ECC Interleave

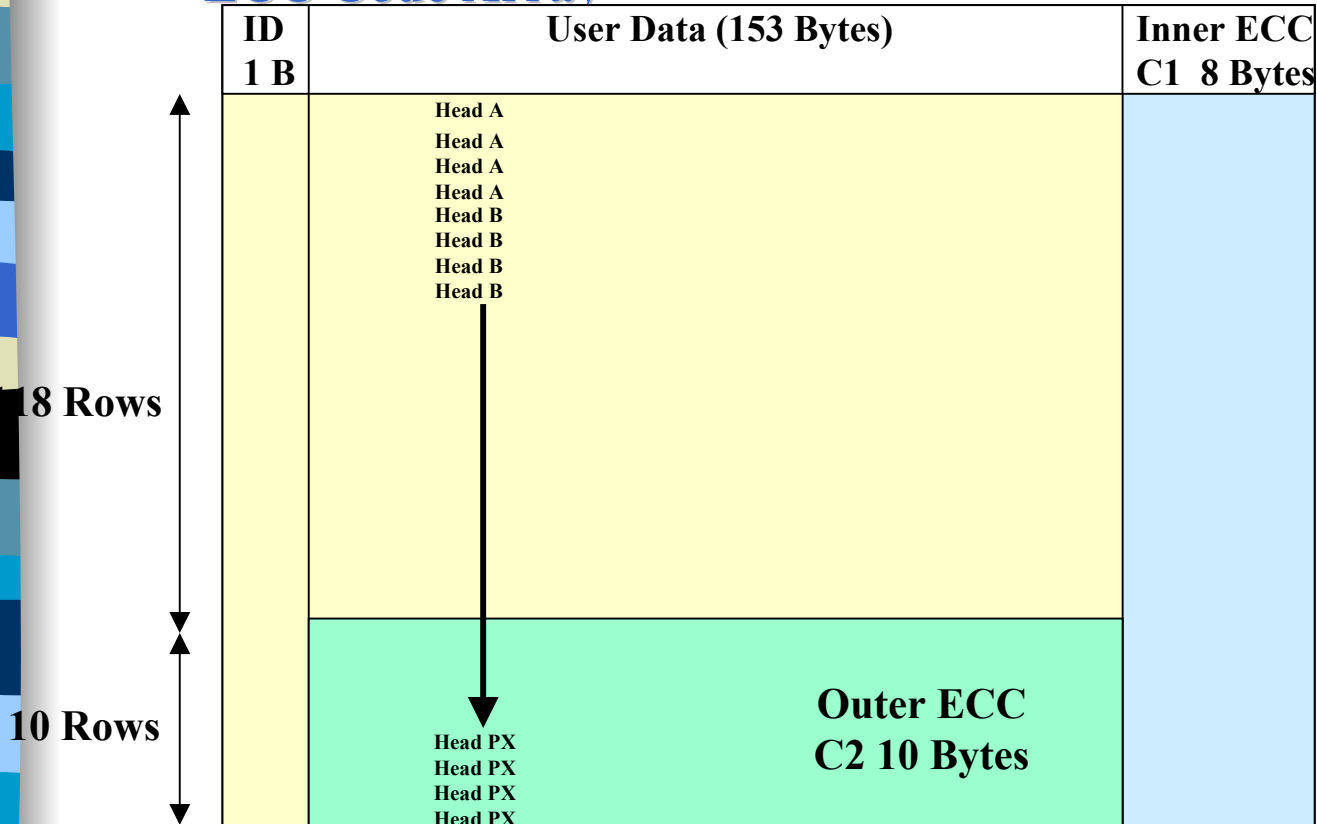
Double Reed-Solomon. C1: 8 Parities, C2: 10 Parities
Interleave among 32 tracks (2,310,912 Bytes)



Super ID-1

32 Track Data Shuffling (1)

ECC Code Array

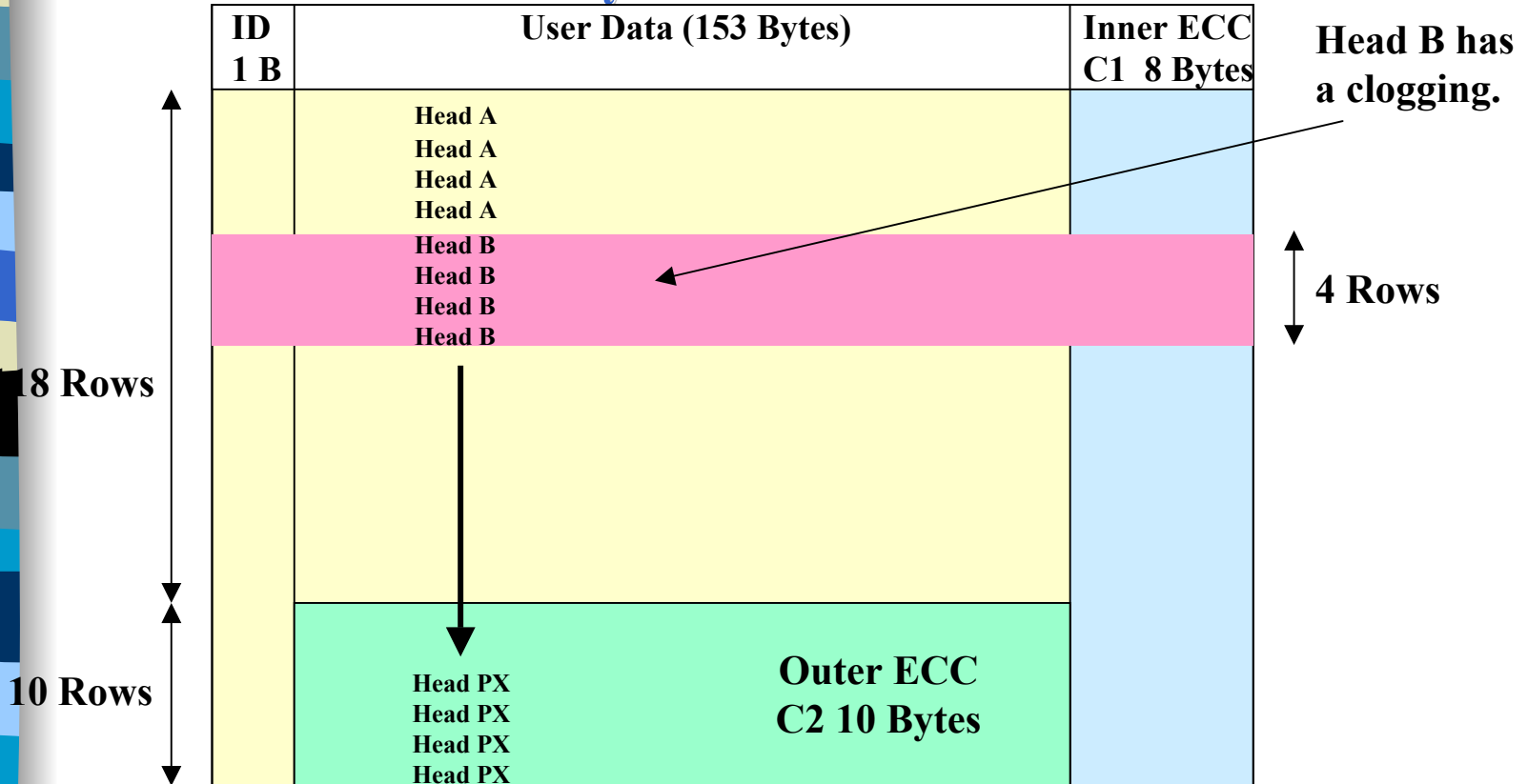


4 Rows x 32 Tracks
= 128 Rows

Super ID-1

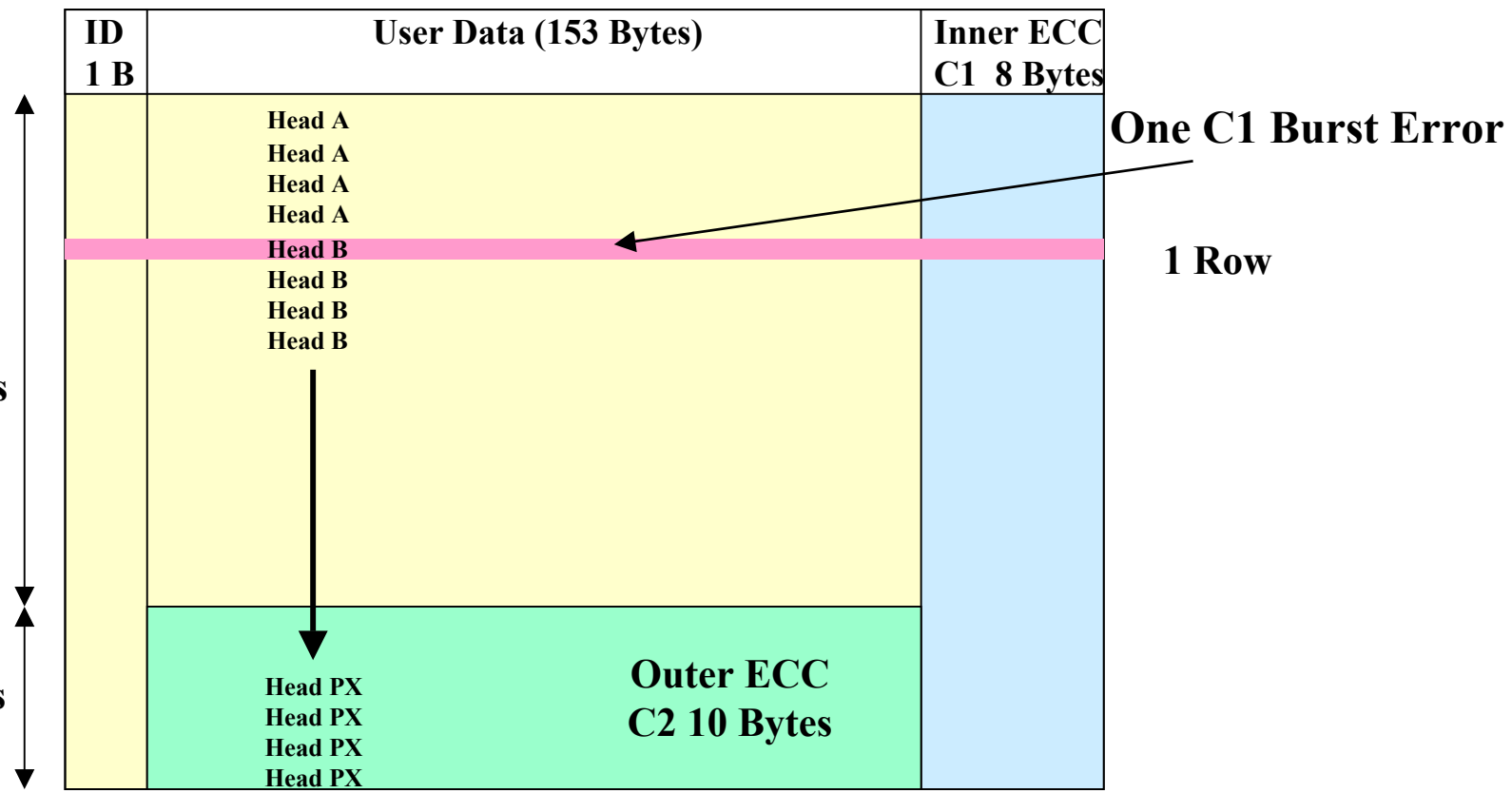
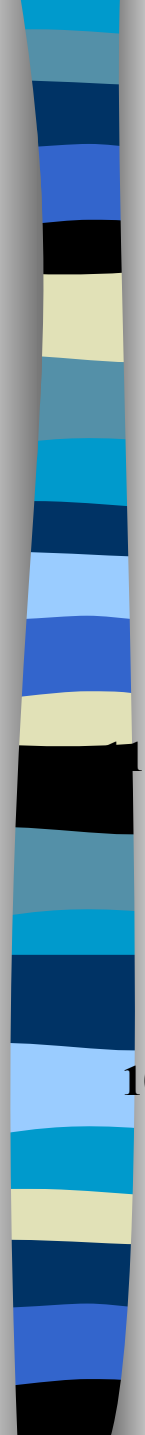
32 Track Data Shuffling (2)

ECC Code Array



The correction capability is up to 10 error rows per ECC Code Array

ECC Code Array

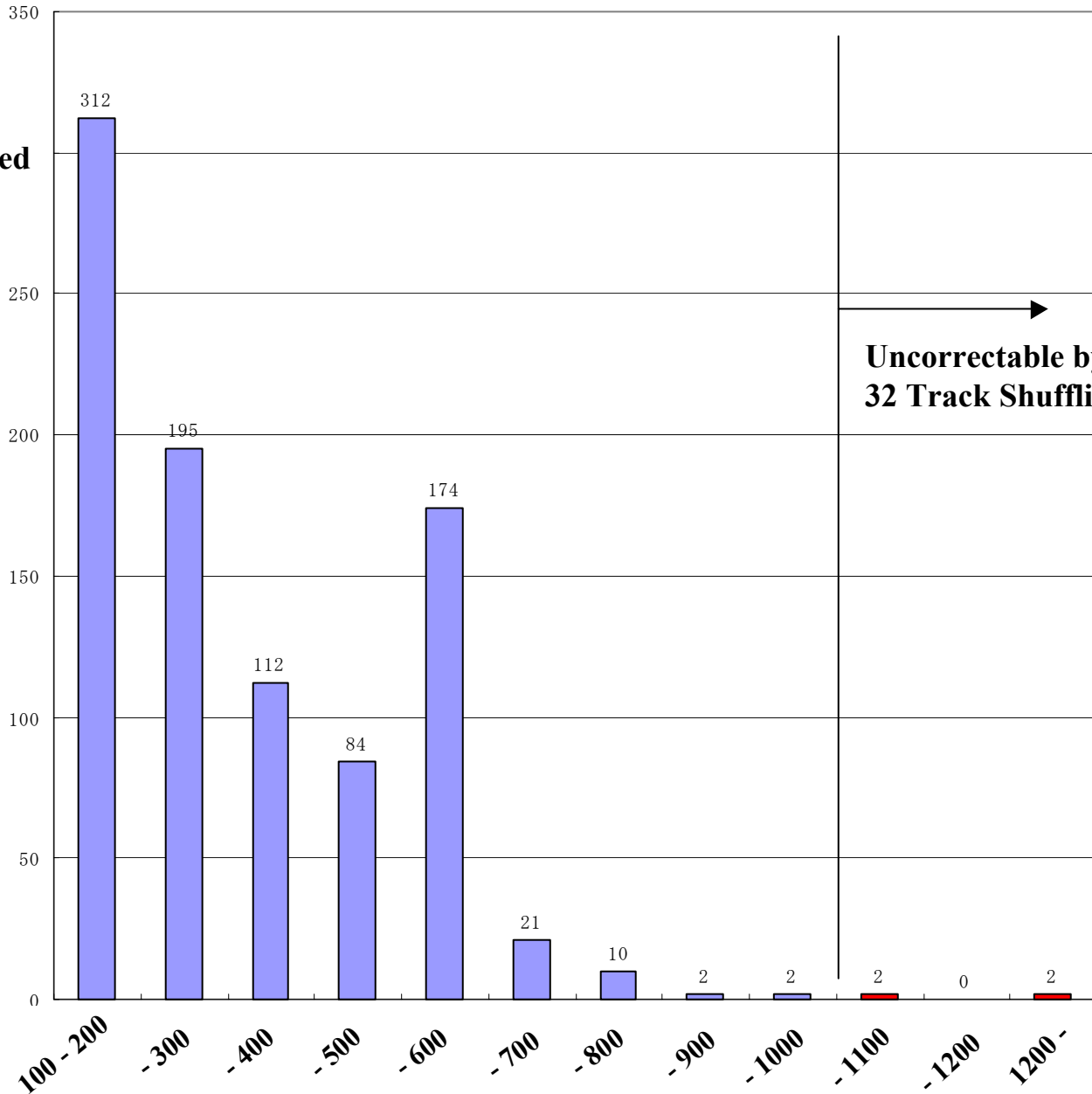


4 x 32 = 128 ECC Code Arrays for 32 Tracks (one rotation)

Distribution of C1 Burst Error Occurrences (1)

Number
Of
Occurrences

50 Tapes Tested



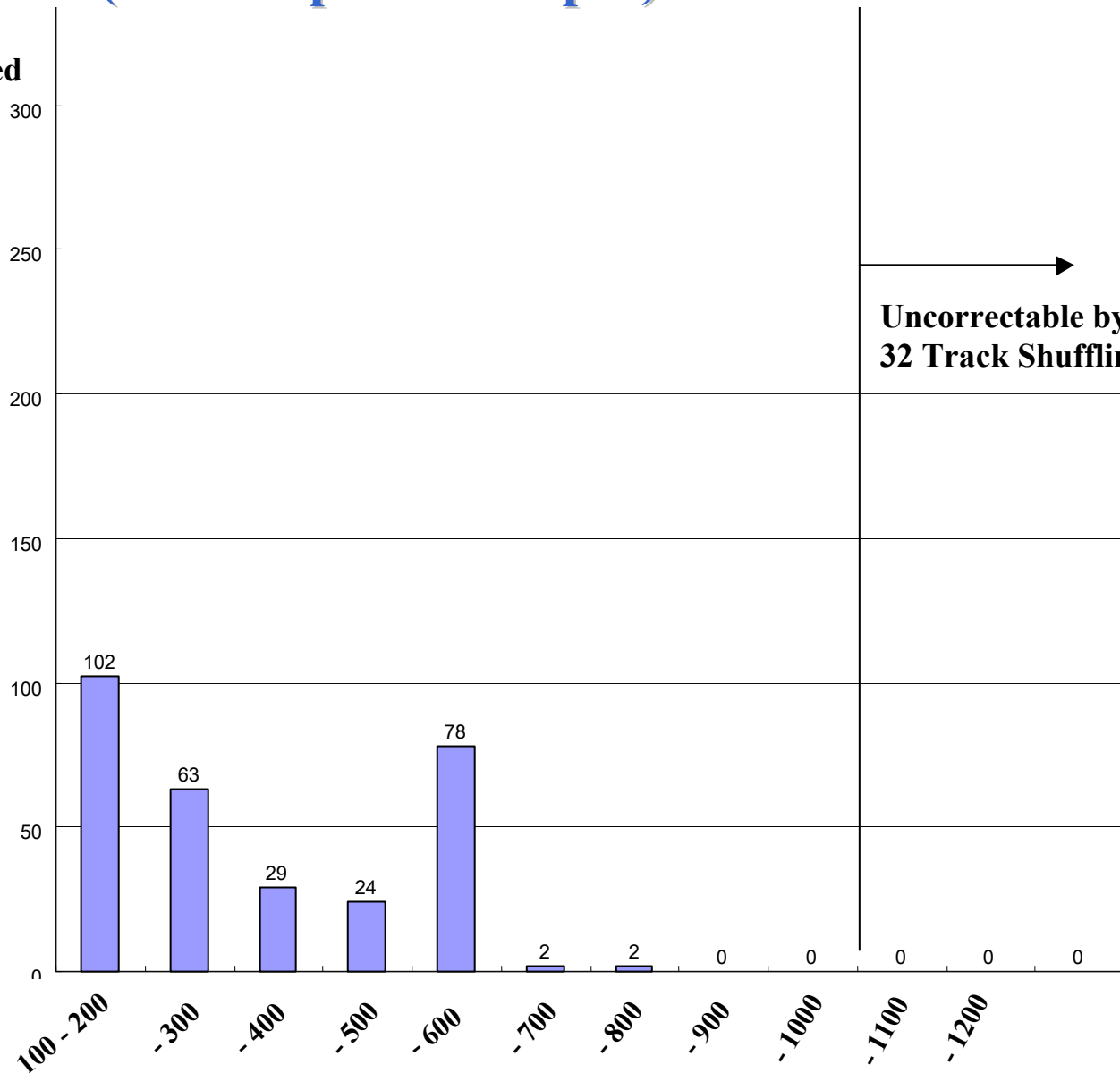
Uncorrectable by
32 Track Shuffling

C1 Burst Errors
Per 32 Tracks
(one rotation)

Distribution of C1 Burst Error Occurrences (2)

(New Improved Tapes)

Number Of Occurrences
30 Tapes Tested



Uncorrectable by
32 Track Shuffling

C1 Burst Errors
Per 32 Tracks
(one rotation)



Conclusion

- Super ID-1 Format is proposed for higher density and higher data rate.
- ECC with 32 track data shuffling is very effective to reduce burst errors for an instrumentation data recorder.
- New tape and head technologies contribute to the design of high performance tape recorders.