



# **ECC with 32 Track Data Interleave**

## **For High Density Tape Recorder**

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**Storage by Sony**



## Why Tape in 21<sup>st</sup> Century

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

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

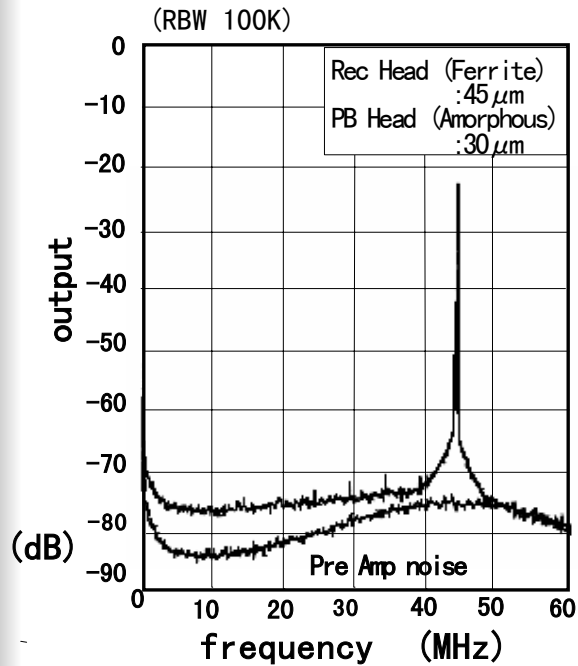
## Specifications and Parameters

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 $\mu\text{m}$	0.45 $\mu\text{m}$
Track Pitch	45 $\mu\text{m}$	19 $\mu\text{m}$
Tape Thickness	16 $\mu\text{m}$	11 $\mu\text{m}$
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)

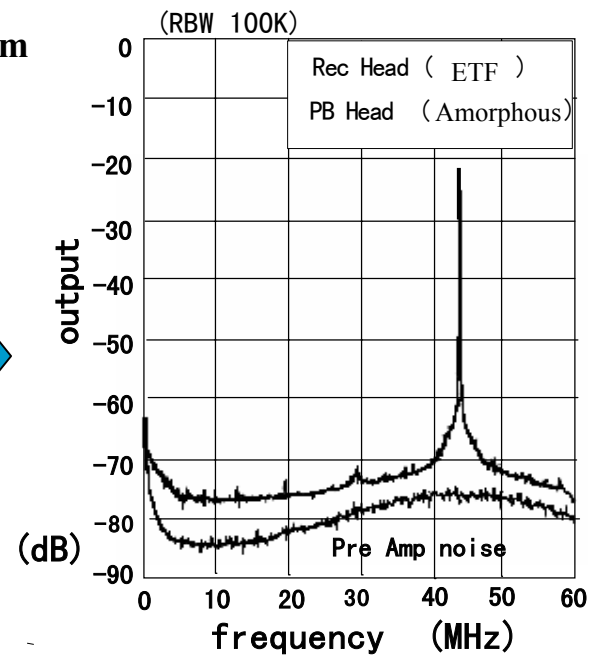
$\lambda=0.89 \mu\text{m}$  (ANSI ID-1 Format)



TP = 45 $\mu\text{m}$



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



TP = 19 $\mu\text{m}$

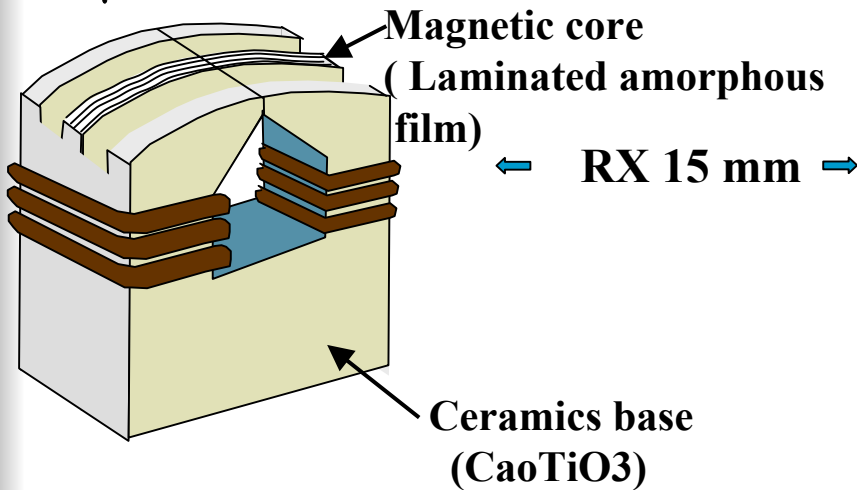
Recording of shortest wavelength

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# Trench Head New Design Head

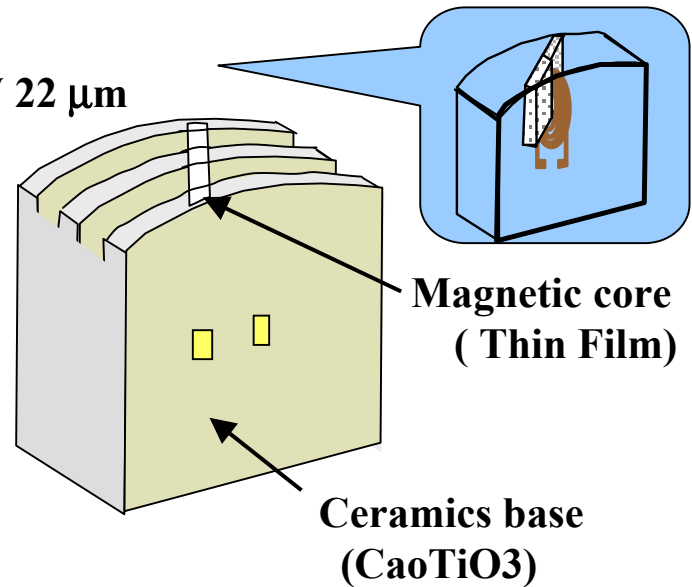
**Playback Head**  
( Laminated Amorphous )

TW 30 $\mu$ m



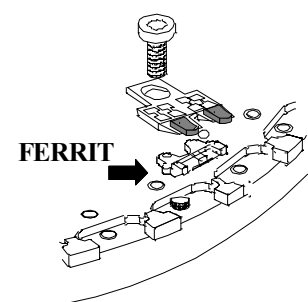
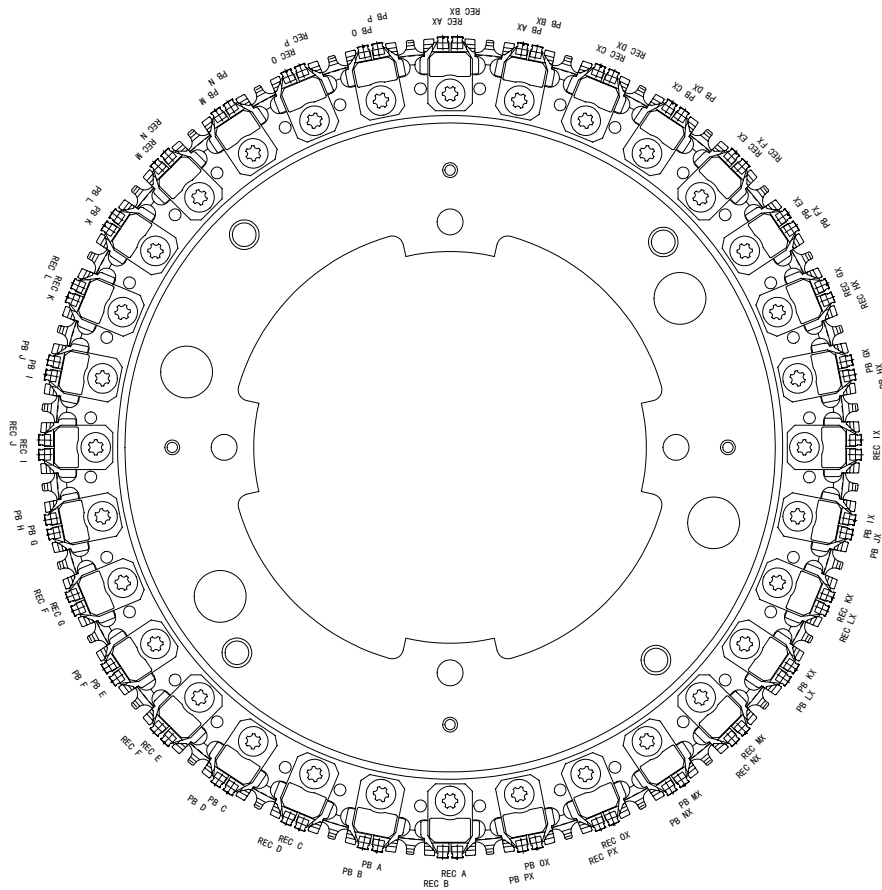
**Record Head**  
( ETF , Embedded Thin Film )

TW 22  $\mu$ m



# Head Configuration Example

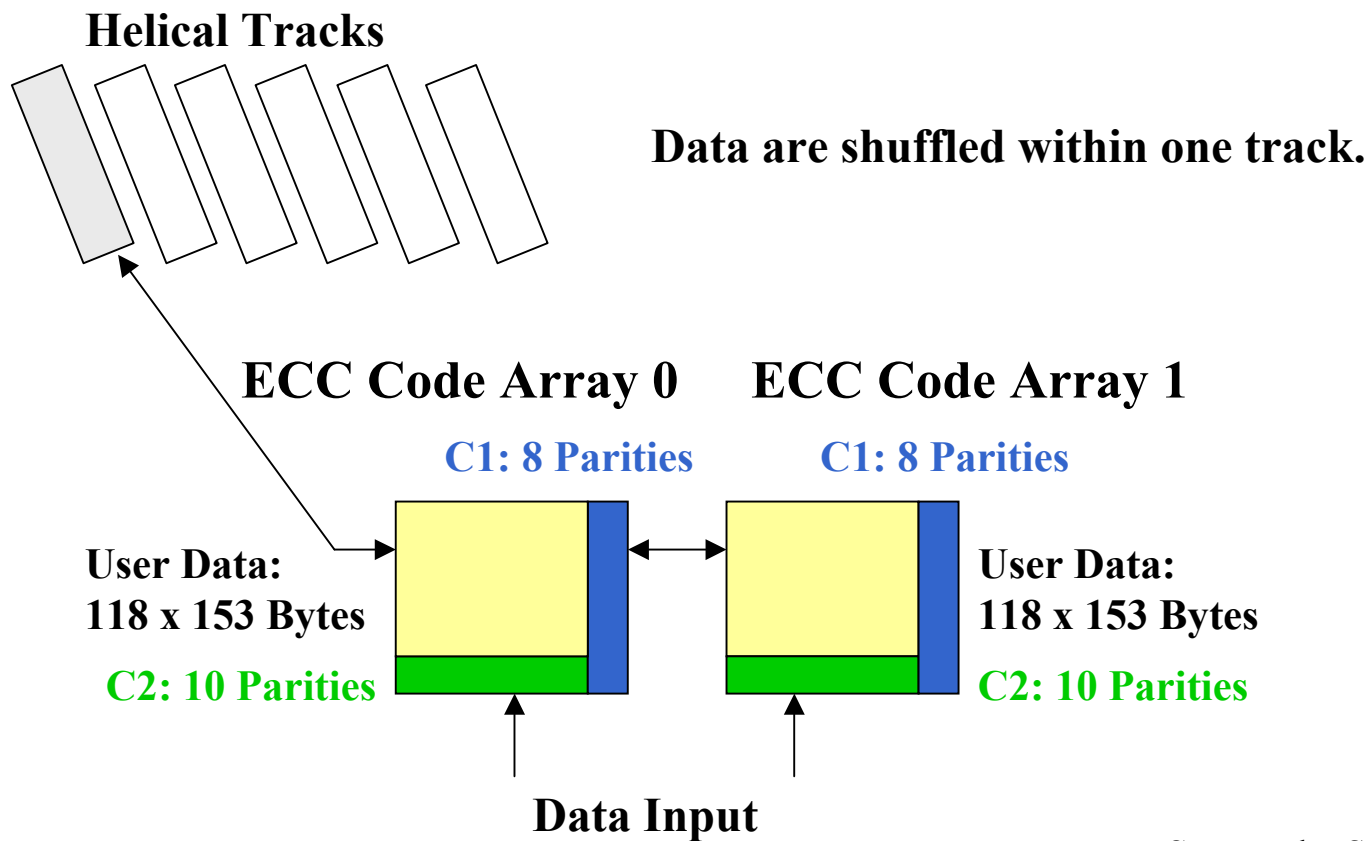
2 chips / base  
Rec Head n=32  
PB Head n=32



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# ID-1 Tape Format (100 GB) ECC Interleave

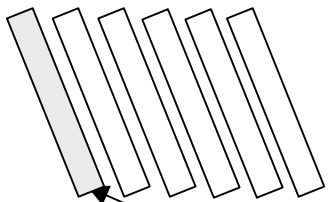
**Double Reed-Solomon. C1: 8 Parities, C2: 10 Parities**  
**Interleave among one track (36,108 Bytes)**



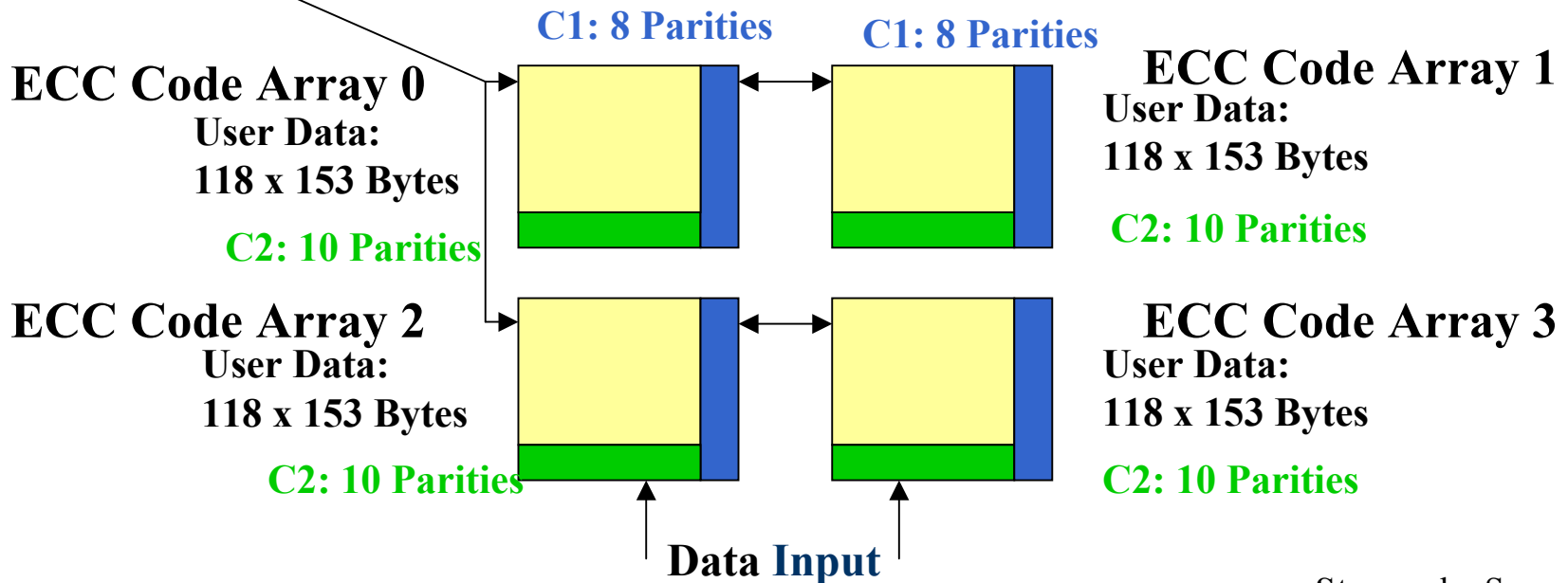
# ECC Interleave Among One Track (1) (600 GB)

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

**Helical Tracks**



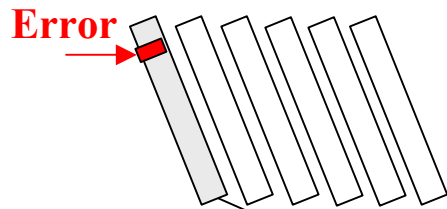
**Data are shuffled within one track.**





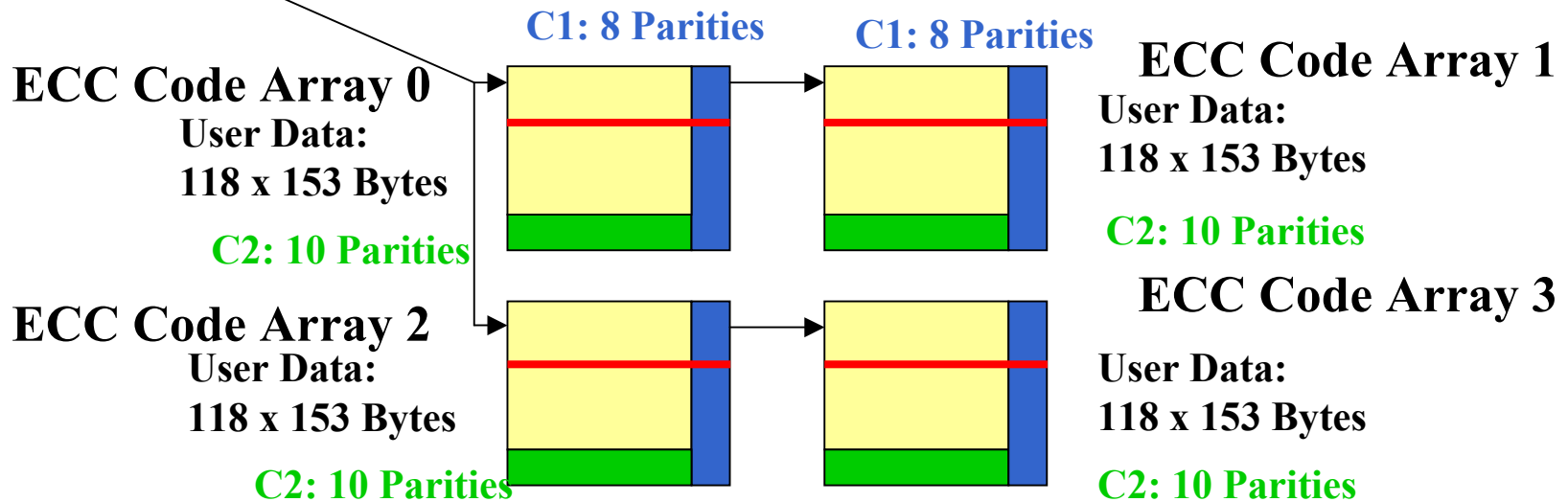
# ECC Interleave Among One Track (2) (600 GB)

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



**Helical Tracks**

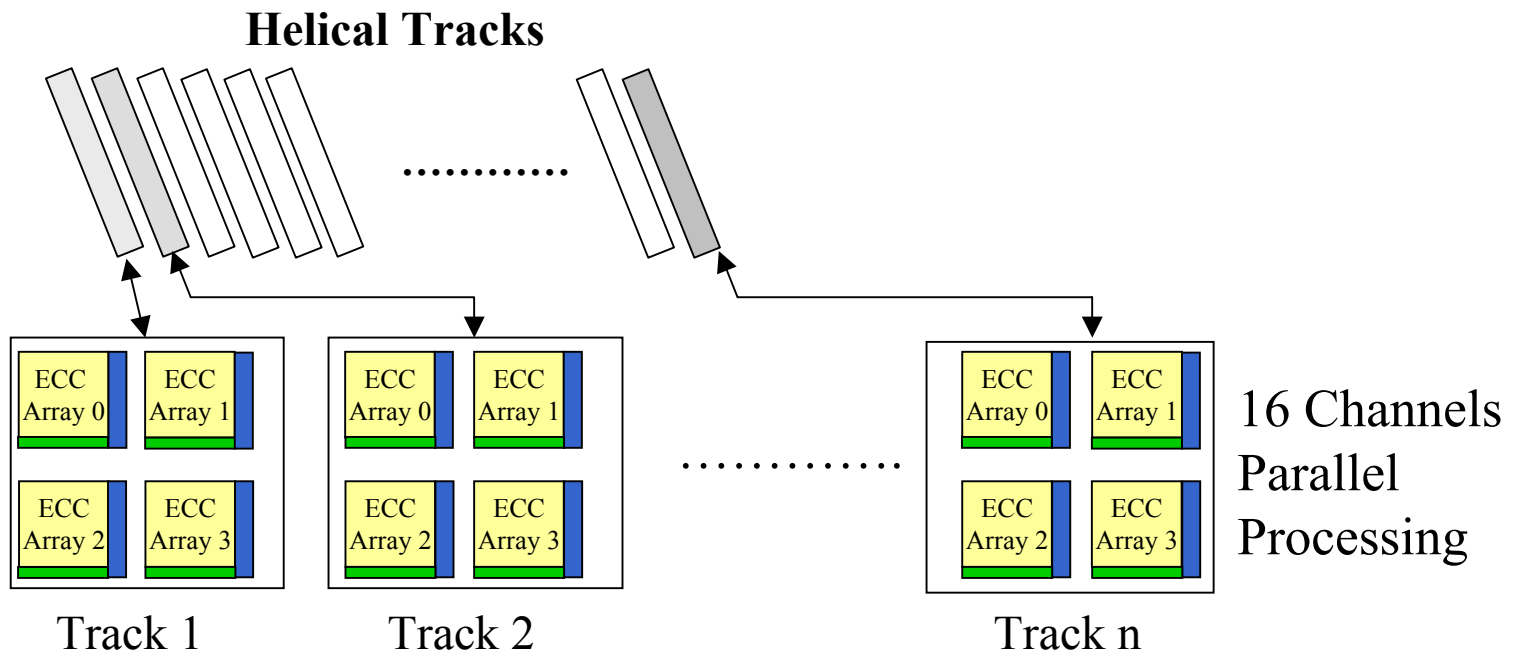
If burst errors are less than 8 %  
of data in one track, they are  
corrected.



**Errors are distributed among 4 ECC Code Arrays for better correction**

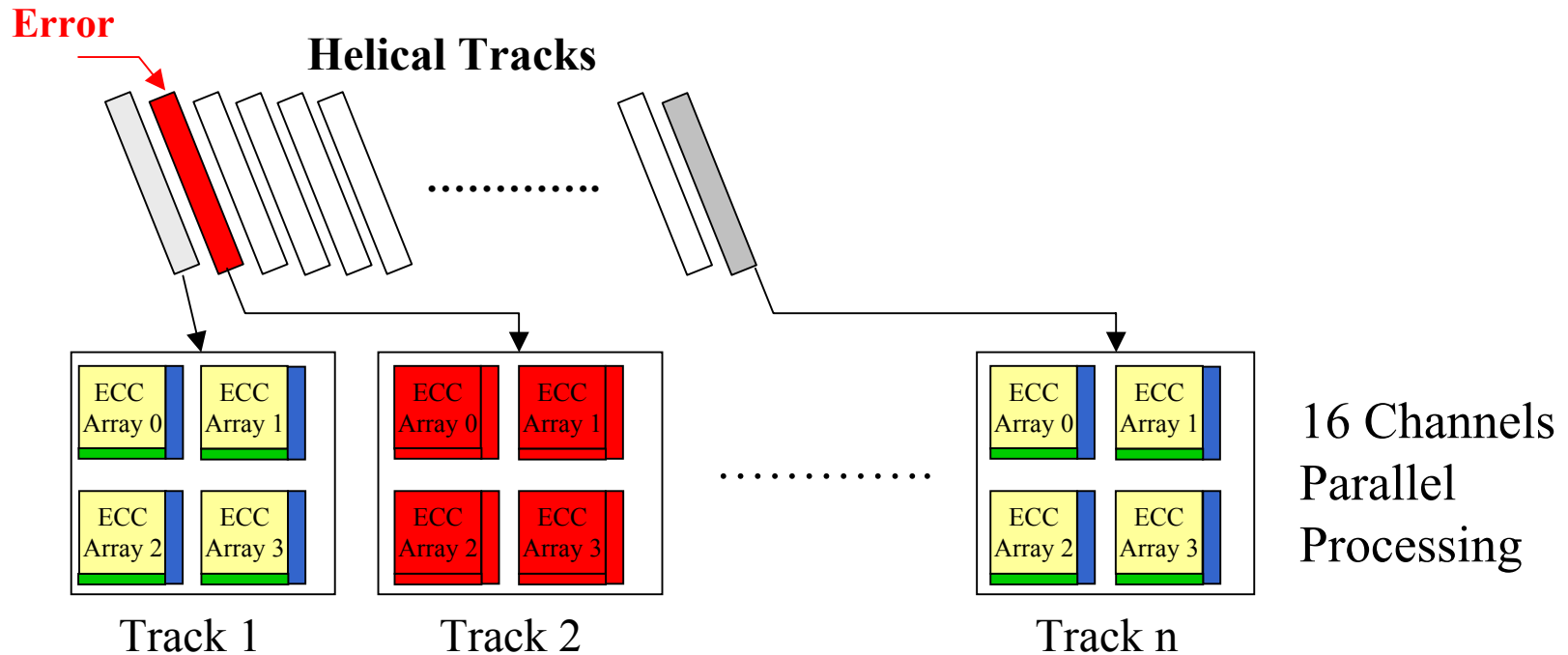
# ECC Interleave Among One Track (3) (600 GB)

**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)

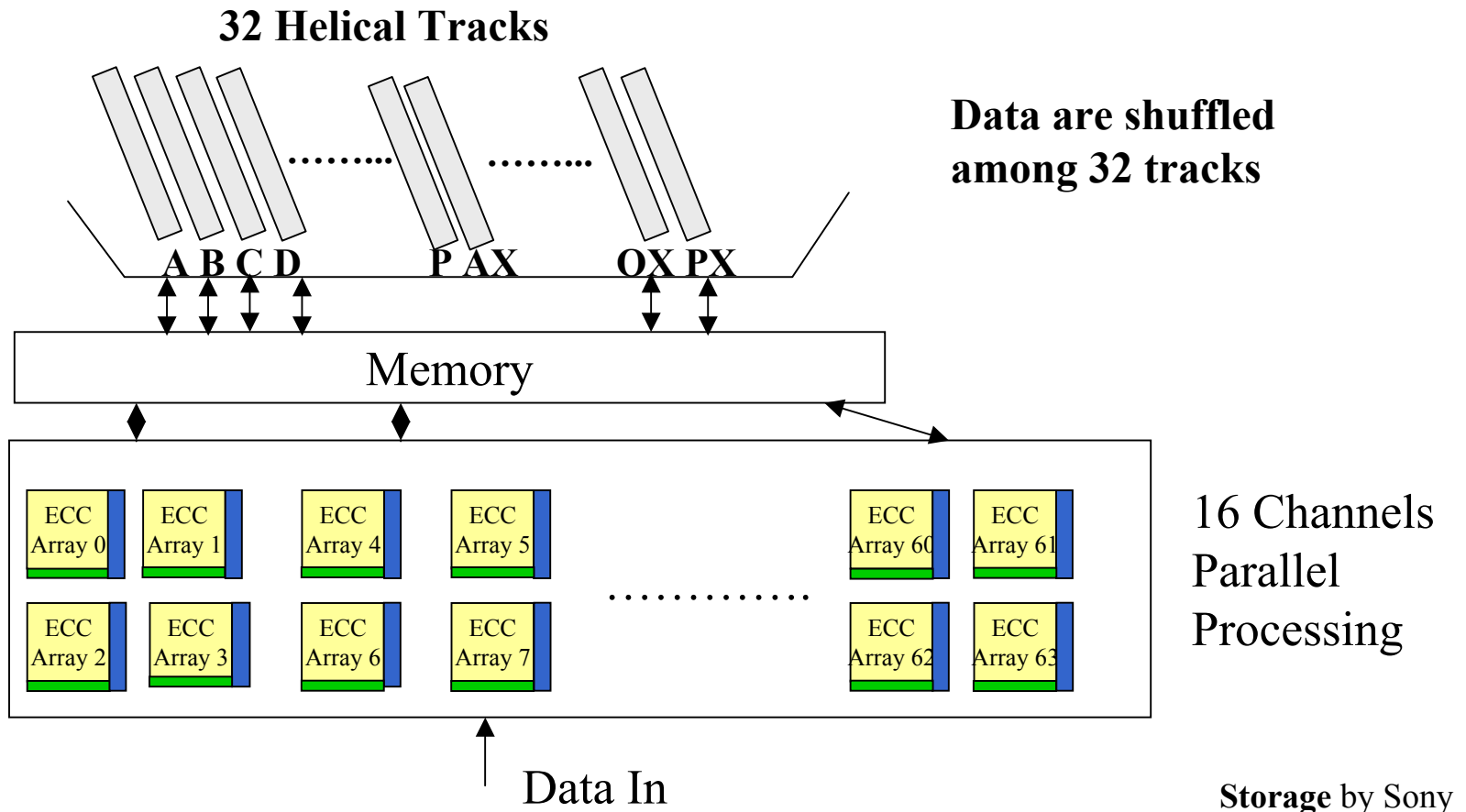


**One head has clogging for the entire track**

# Super ID-1 Format (1)

## ECC Interleave

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

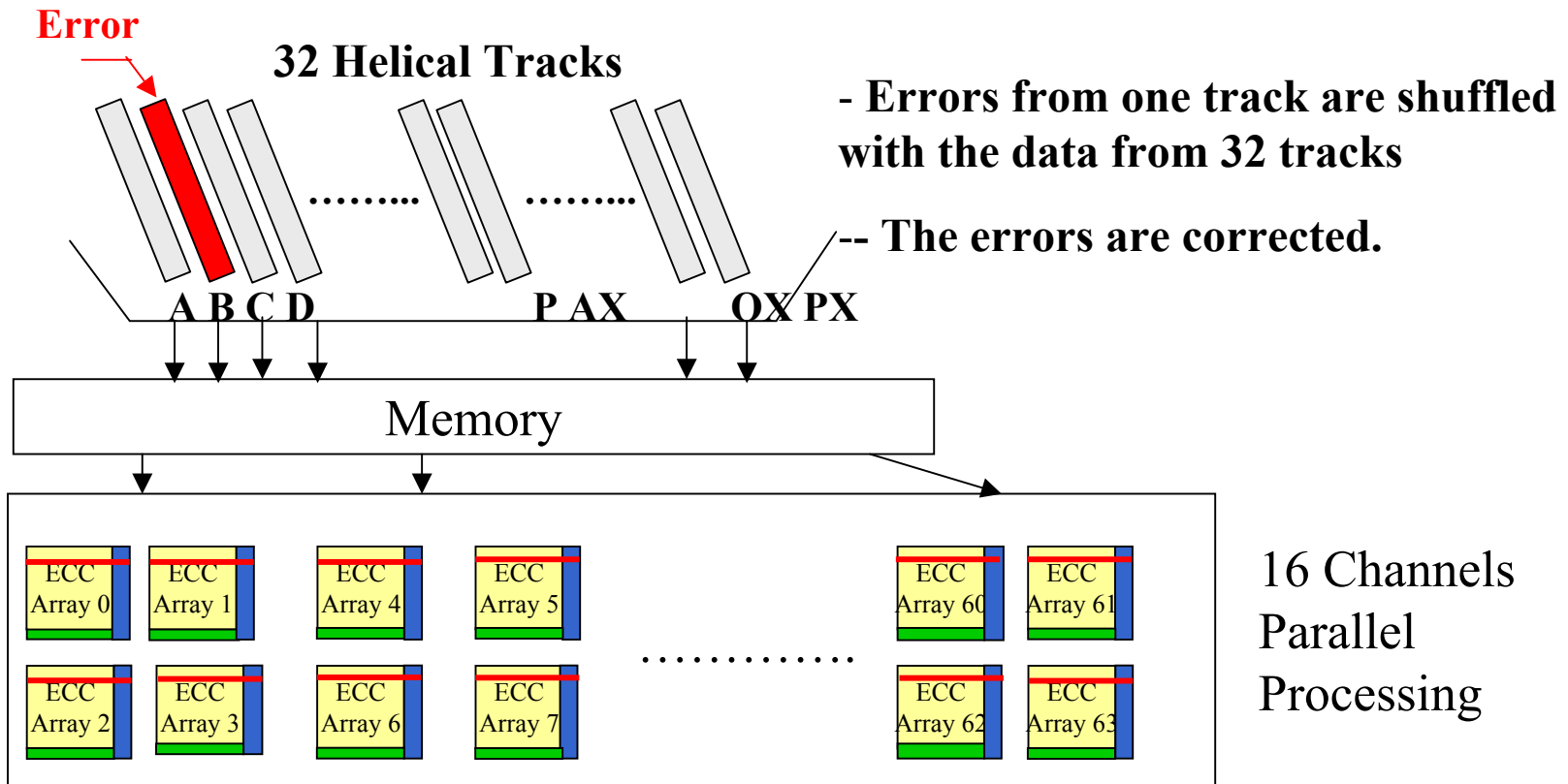


# Super ID-1 Format (2)

## ECC Interleave

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

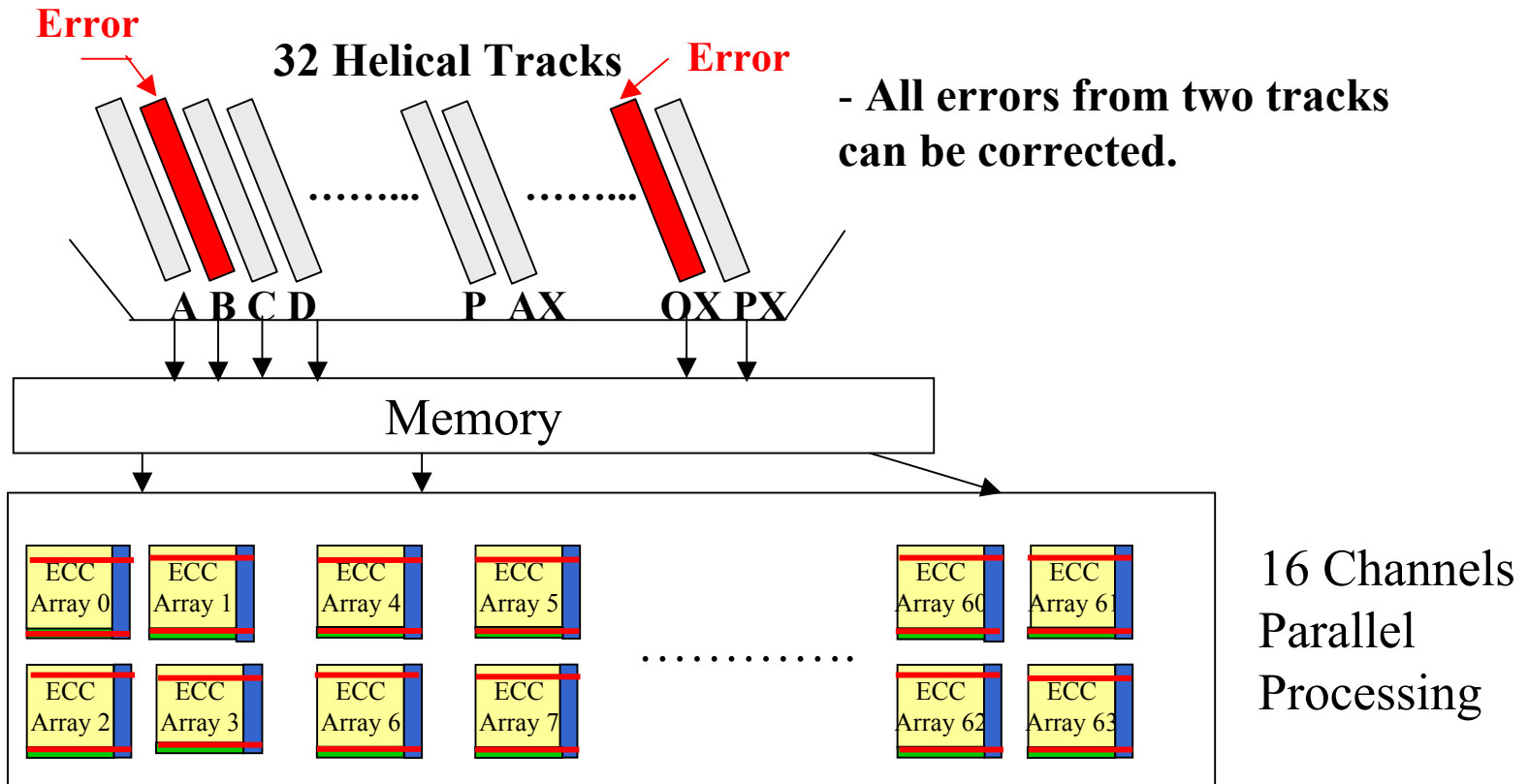
Interleave among 32 tracks (2,310,912 Bytes)



# Super ID-1 Format (3)

## ECC Interleave

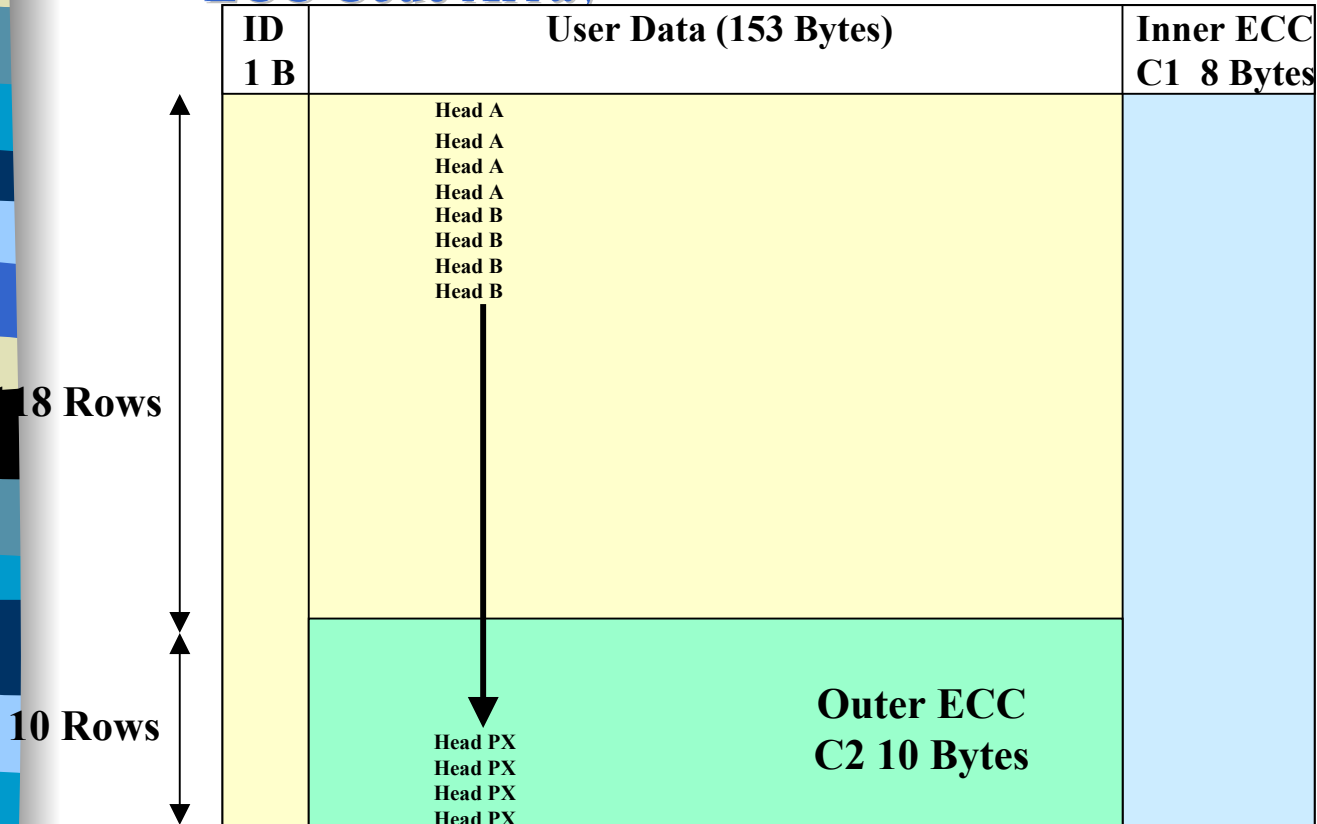
**Double Reed-Solomon. C1: 8 Parities, C2: 10 Parities**  
**Interleave among 32 tracks (2,310,912 Bytes)**



# Super ID-1

## 32 Track Data Shuffling (1)

### ECC Code Array

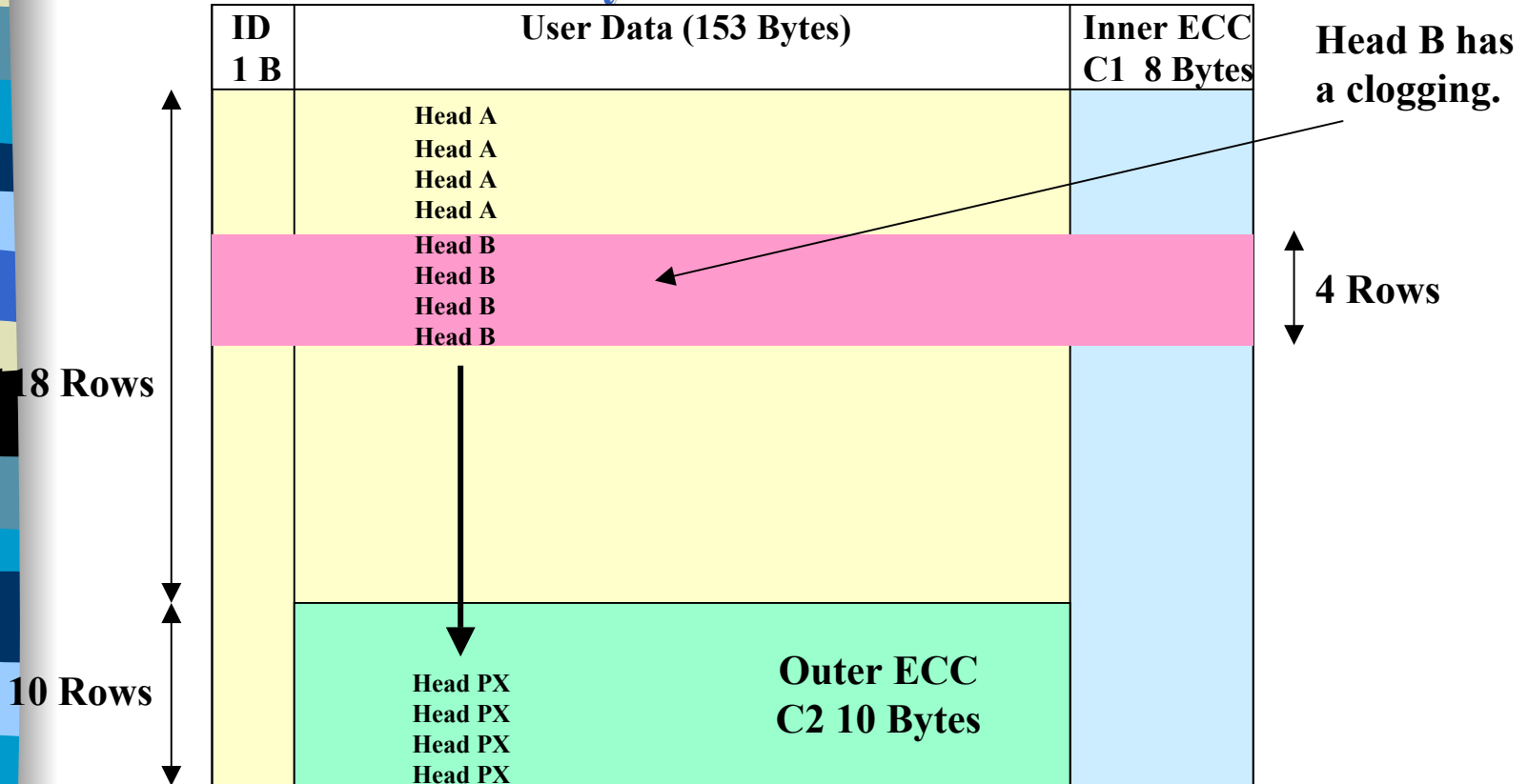


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# Super ID-1

## 32 Track Data Shuffling (2)

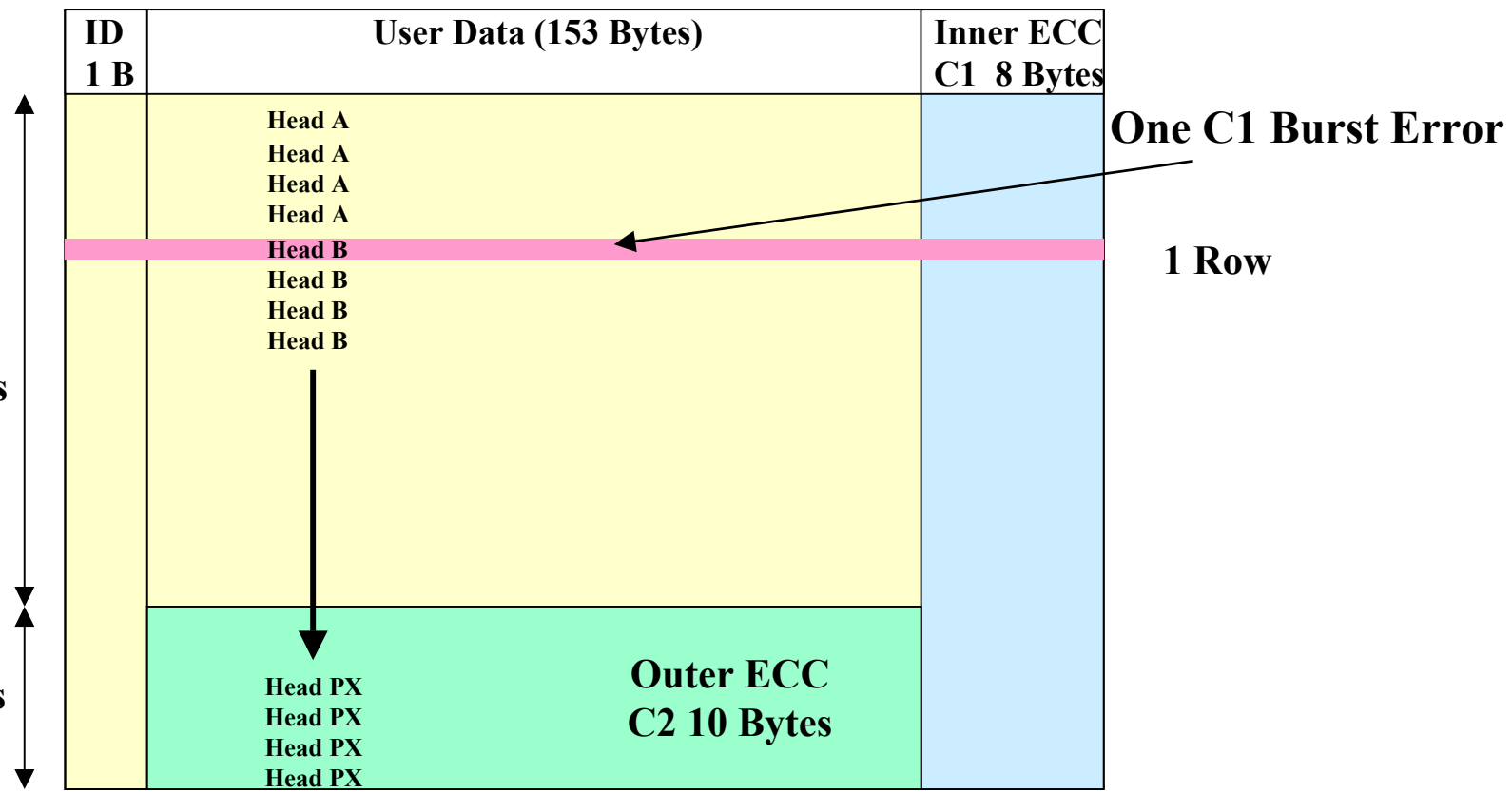
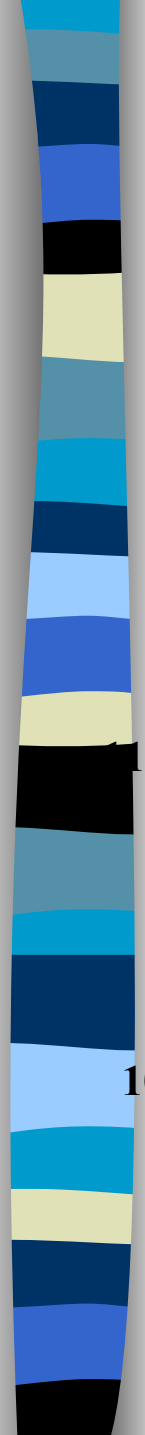
### ECC Code Array



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



# ECC Code Array

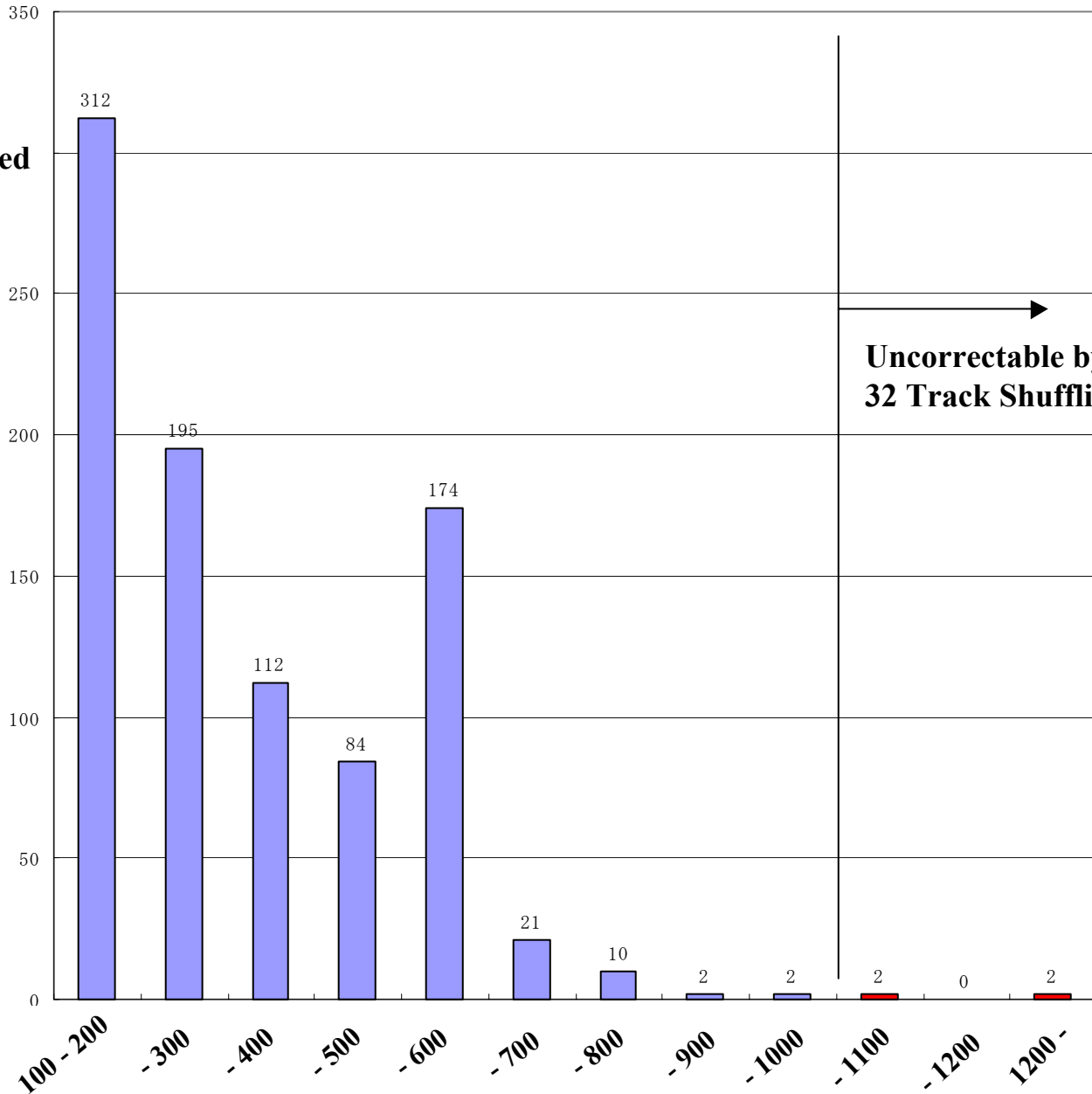


4 x 32 = 128 ECC Code Arrays for 32 Tracks (one rotation)

# Distribution of C1 Burst Error Occurrences (1)

Number  
Of  
Occurrences

50 Tapes Tested



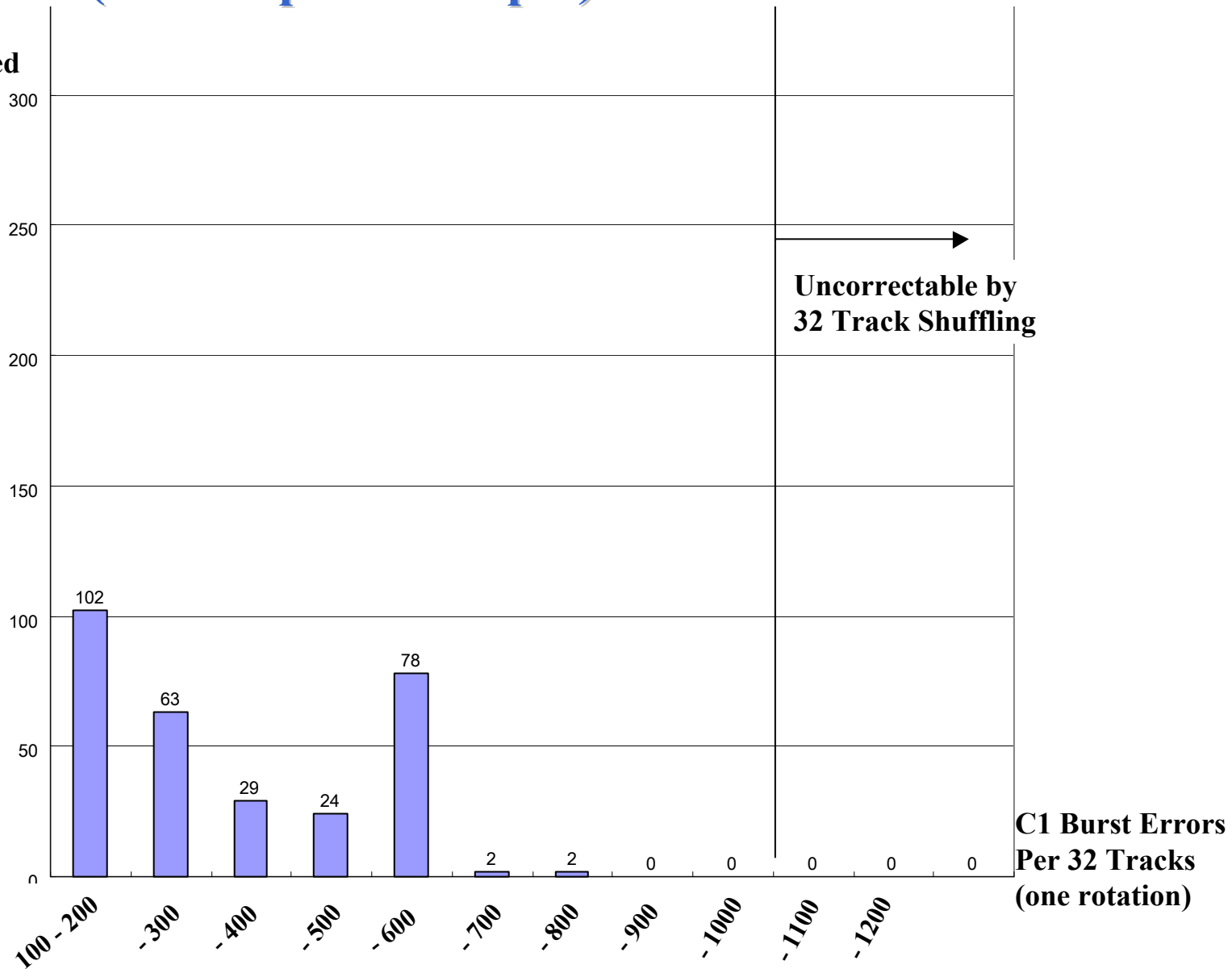
Uncorrectable by  
32 Track Shuffling

C1 Burst Errors  
Per 32 Tracks  
(one rotation)

# Distribution of C1 Burst Error Occurrences (2)

## (New Improved Tapes)

Number Of Occurrences  
30 Tapes Tested





## 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.