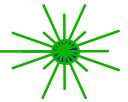


THIC Inc.

The Premier Advanced Recording Technology Forum

LOTS
TECHNOLOGY



HIGH DATA RATE OPTICAL TAPE RECORDING

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Center Carderock, 9500 MacArthur Blvd

West Bethesda MD 20817-5700

October 3, 2000



LOTS TECHNOLOGY CHARTER

**DEVELOP AND PRODUCE A FAMILY OF HIGH PERFORMANCE
LINEAR OPTICAL TAPE DRIVES
FOR THE DATA STORAGE AND VIDEO INDUSTRIES**

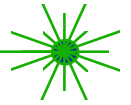
**BASED ON 3480 & DUAL REEL (DTF) SIZED MEDIA
BIDIRECTIONAL SERPENTINE FORMAT**

**USE PROPRIETARY TECHNOLOGY TO ESTABLISH POSITION
IN HIGH END MARKET :**

- 1) MULTI BEAM OPTICAL WRITING**
- 2) FAST TAPE TRANSPORT**

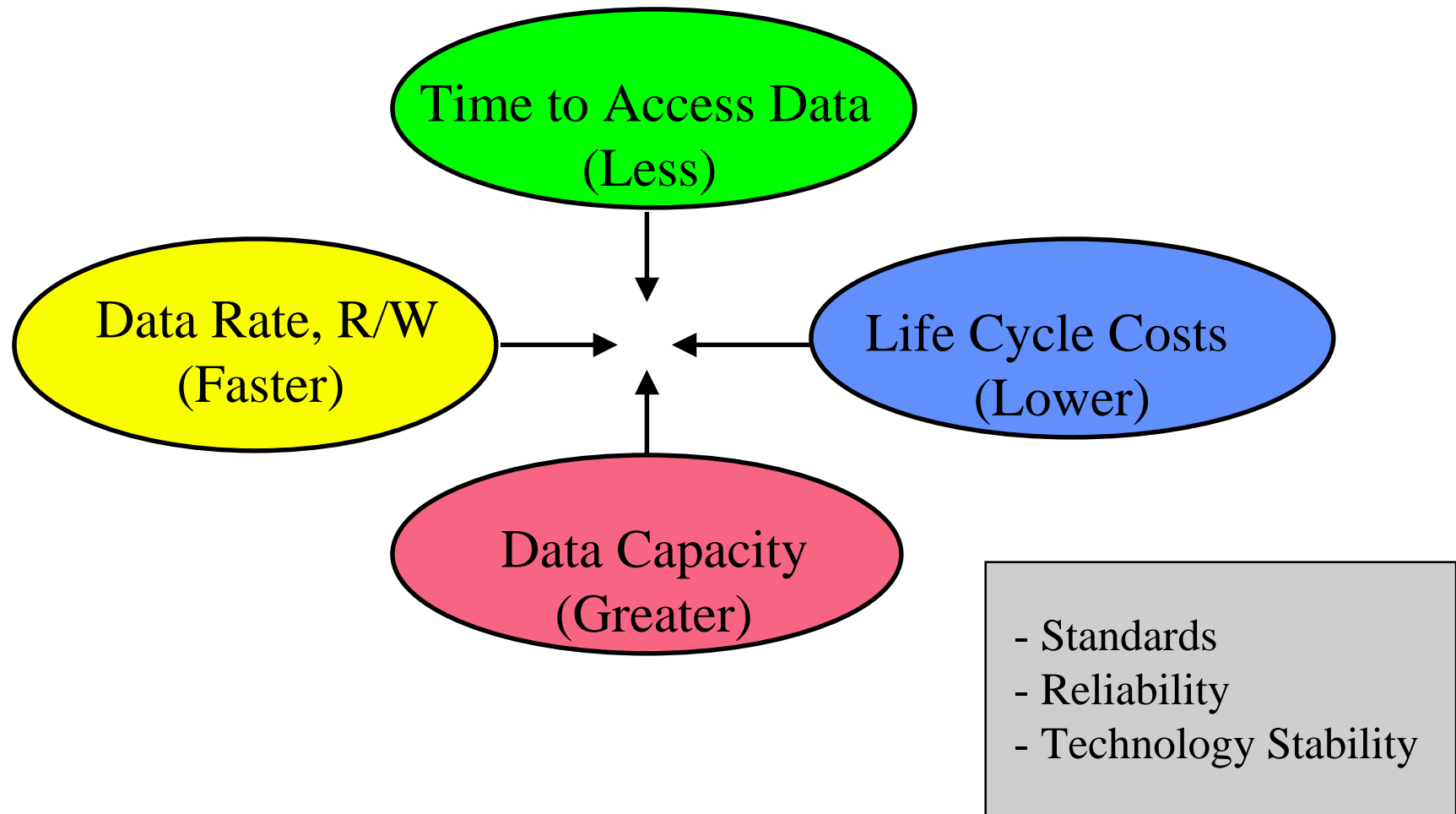
HIGH DATA RATE: 25 - 200+ Megabytes/s.

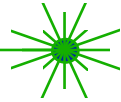
HIGH MEDIA CAPACITY : 1 TB Mono Reel, 2 TB Dual Reel



REQUIREMENT

- IMPROVE ALL SYSTEM PARAMETERS



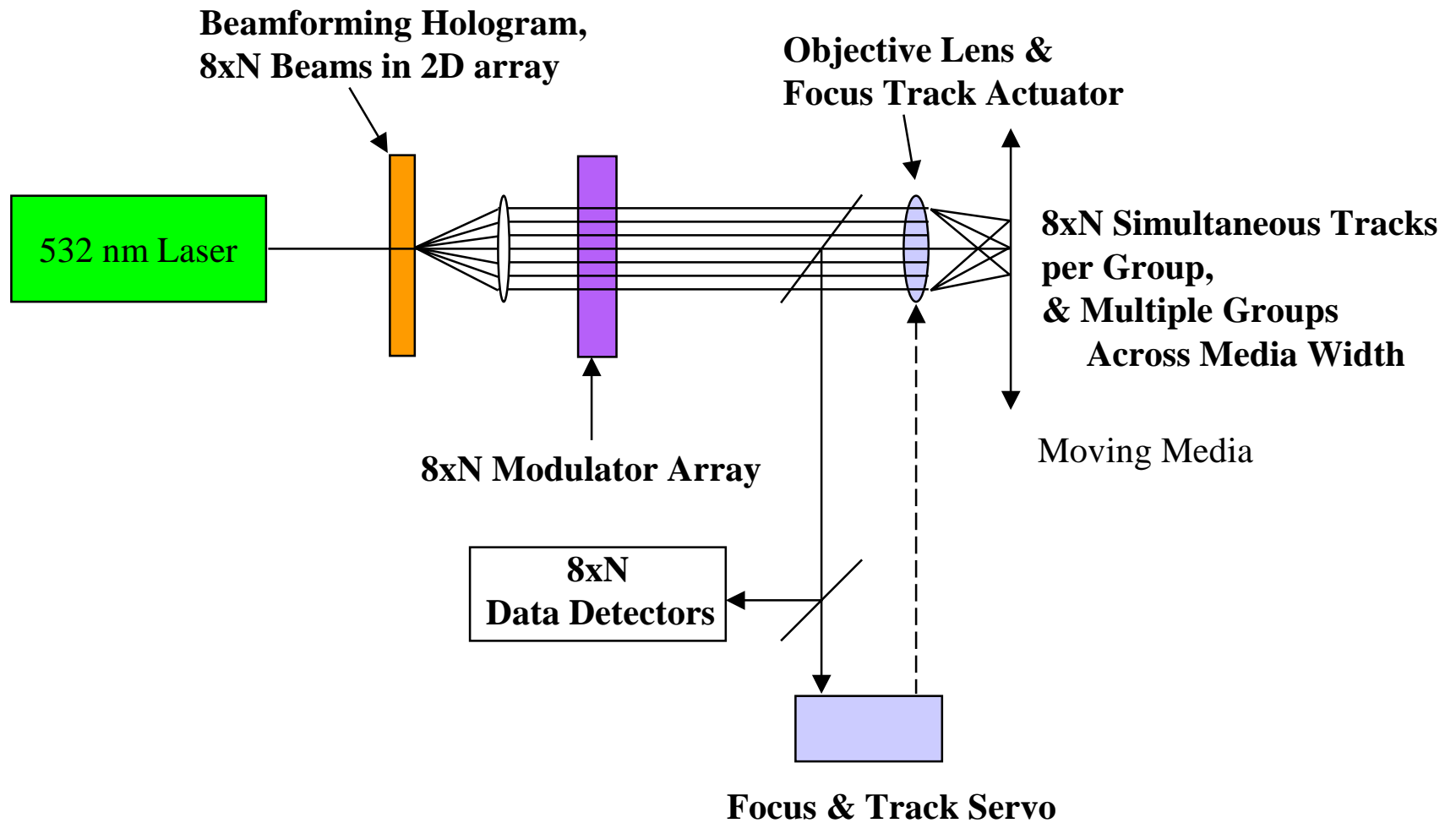


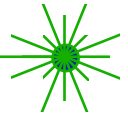
WHY OPTICAL TAPE?

- **Lower Costs, Much Higher Capacity/Media Unit**
= Less Media, Smaller Robots, Autoloader < 10TB.
- **Faster Data Access**
Due to Higher Data Density: Fast Fwd. @ 30 GB/Sec.
- **Higher Data Rates**
Due to Higher Data Density & Faster Tape
- **Archival** Media Now > 100 yr., **Rewritable** Media Later
- **Non Contact Recording** = Better Reliability
No Head Wear, Very Low Media Wear
- **Longer Lived Hardware** Due to Fewer Media Mounts

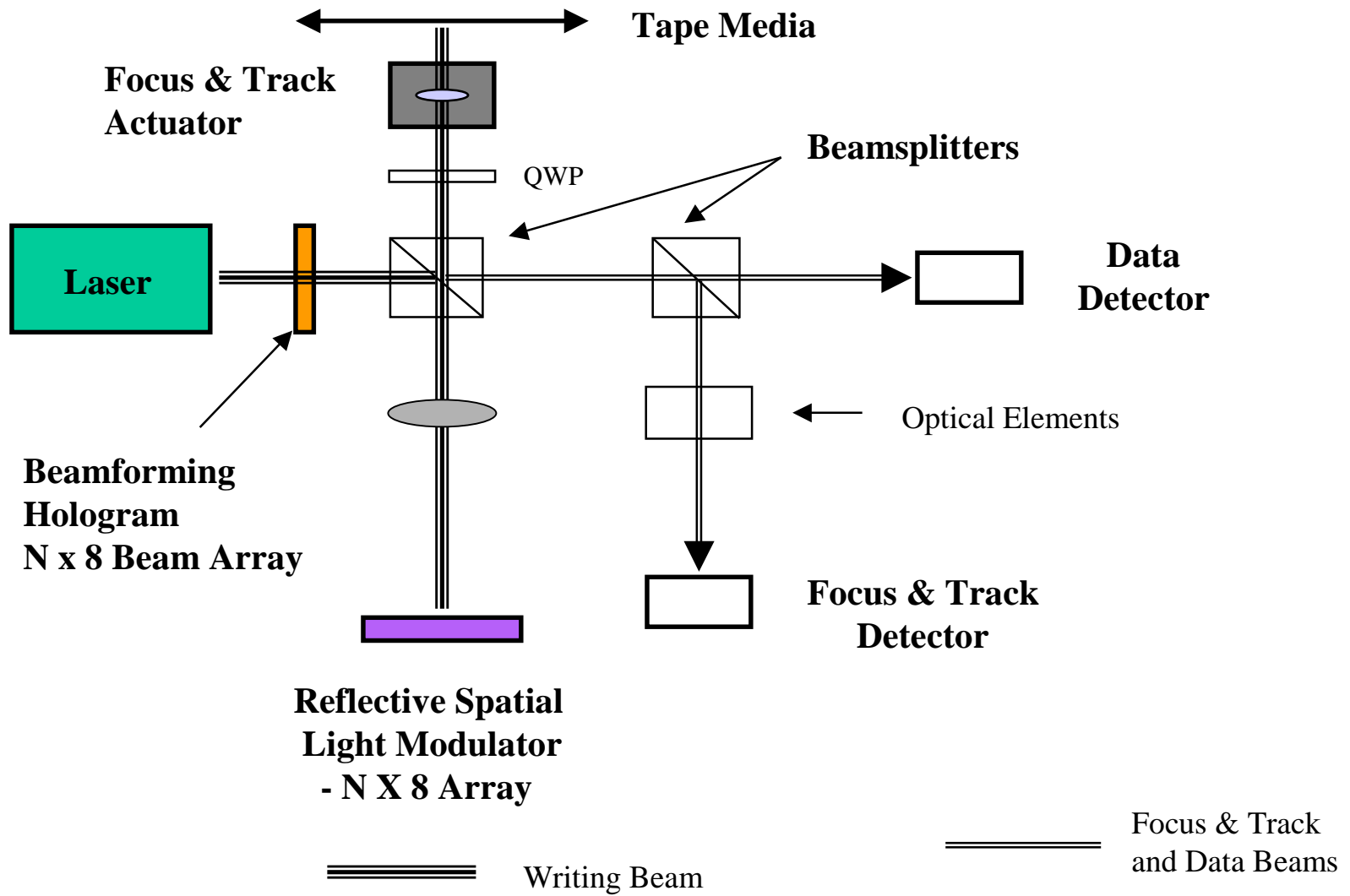


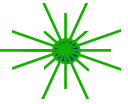
Basic Multi-beam System



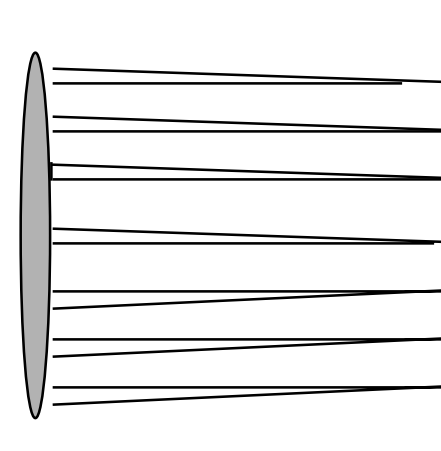
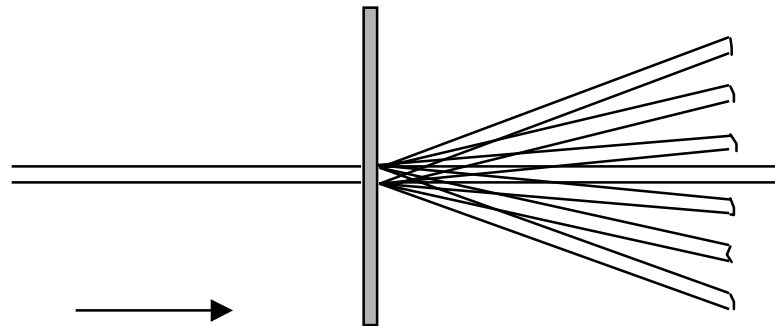


Optical Implementation





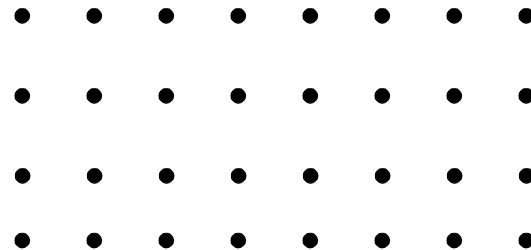
BEAMFORMING HOLOGRAM

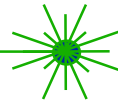


Single Collimated Beam Input,
Multiple Collimated Outputs.

All Beams Focus
In Same Plane

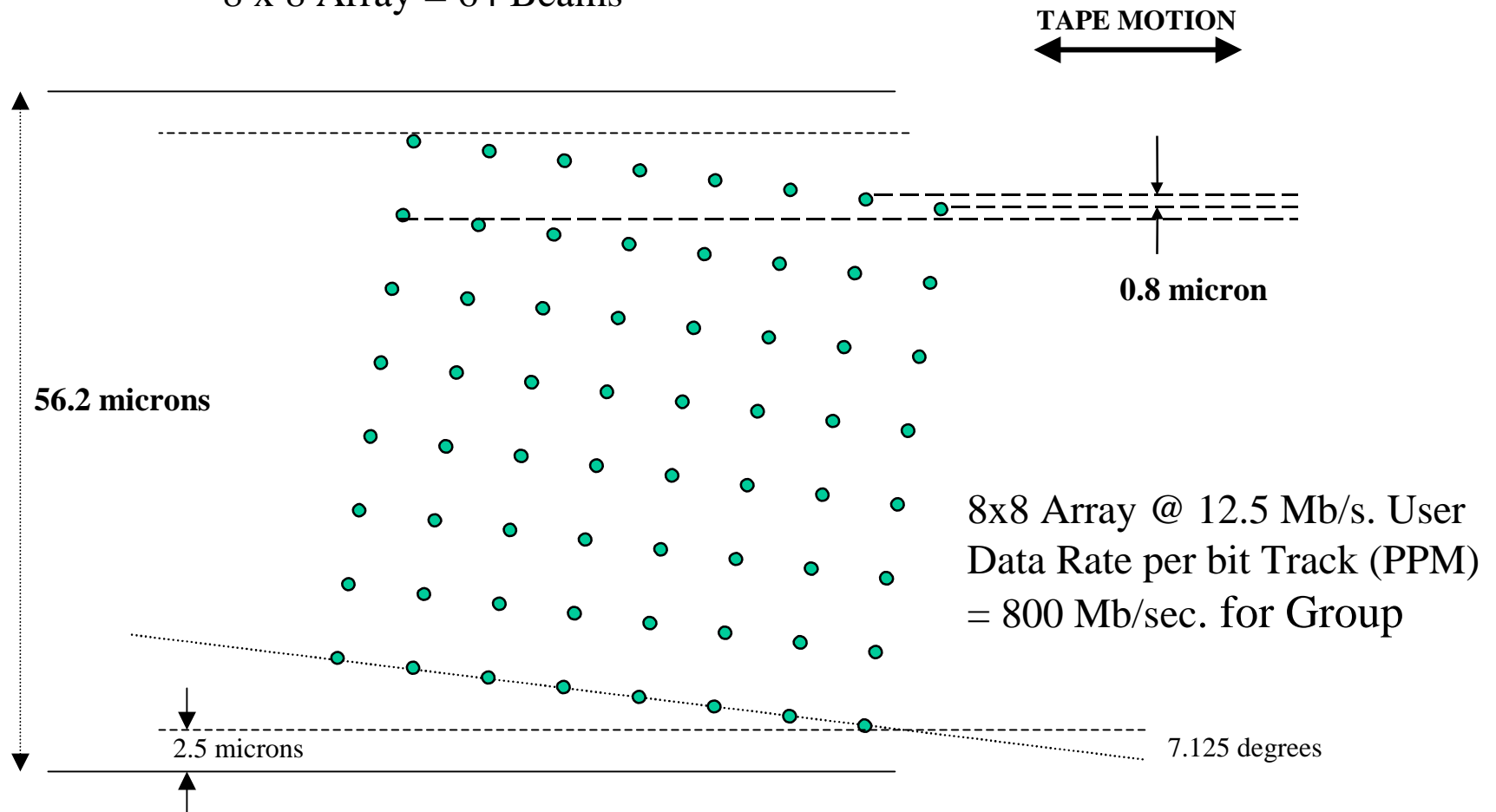
- All Beams Diffraction Limited
- Two Dimensional Fan
- $8 \times N$ Beams, e.g for $N = 4$

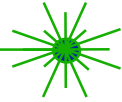




Beam Forming Pattern

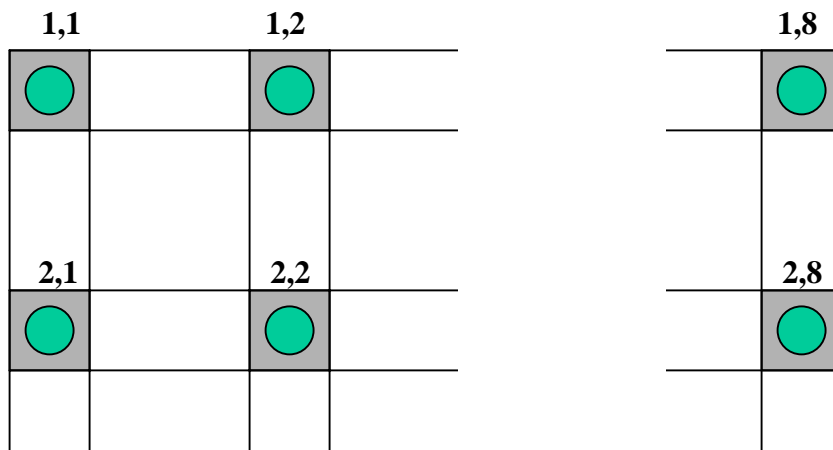
8 x 8 Array = 64 Beams



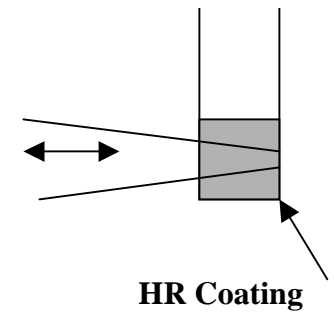
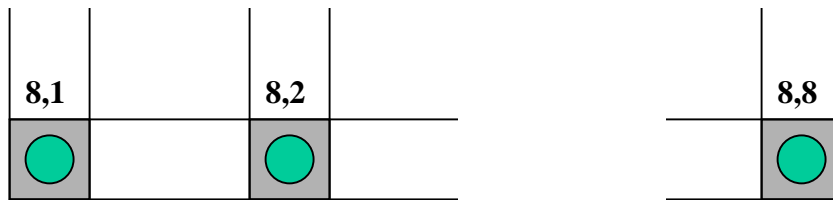
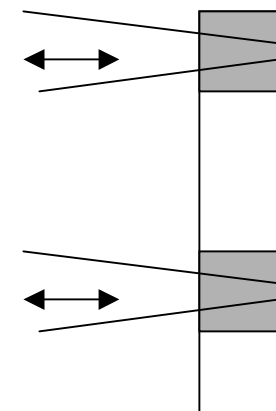


Modulator Pattern

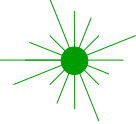
8 x 8 Array = 64 Beams



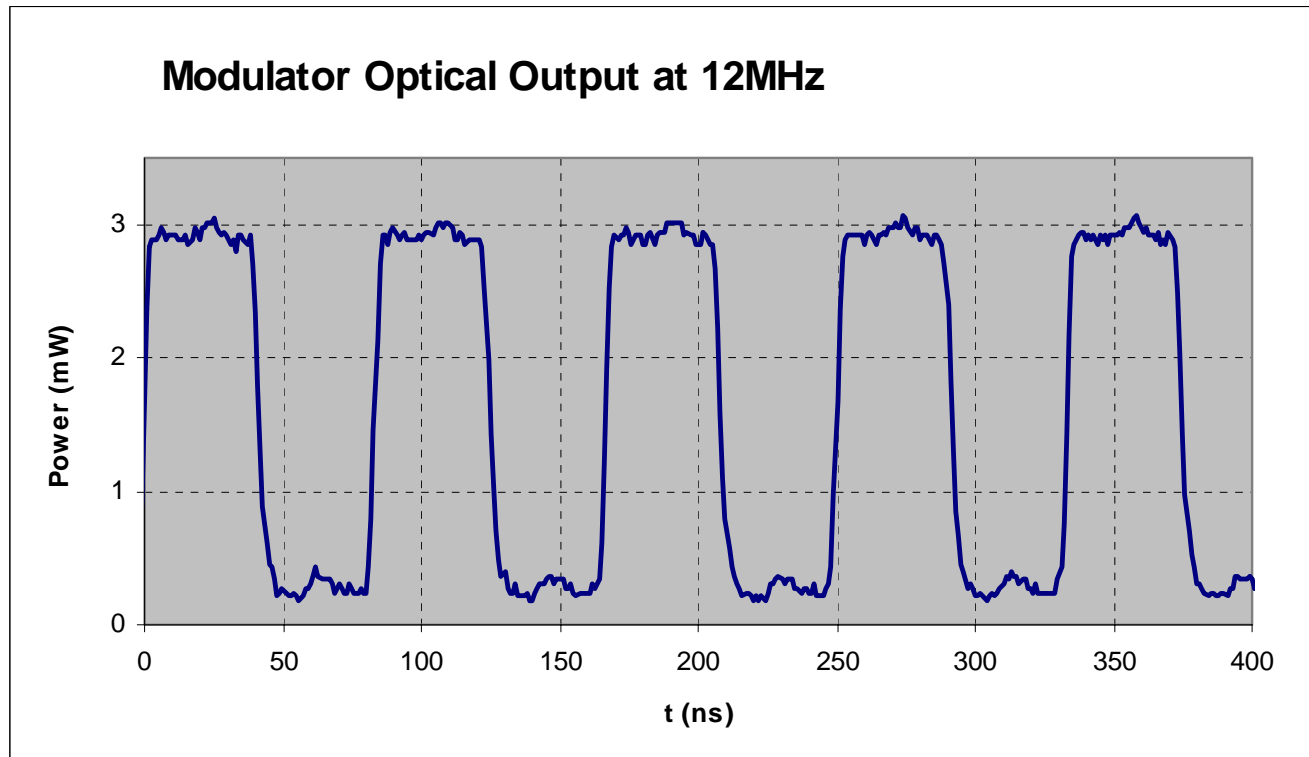
20%
80%



~ 2mm



LOTS Developed Array Modulator

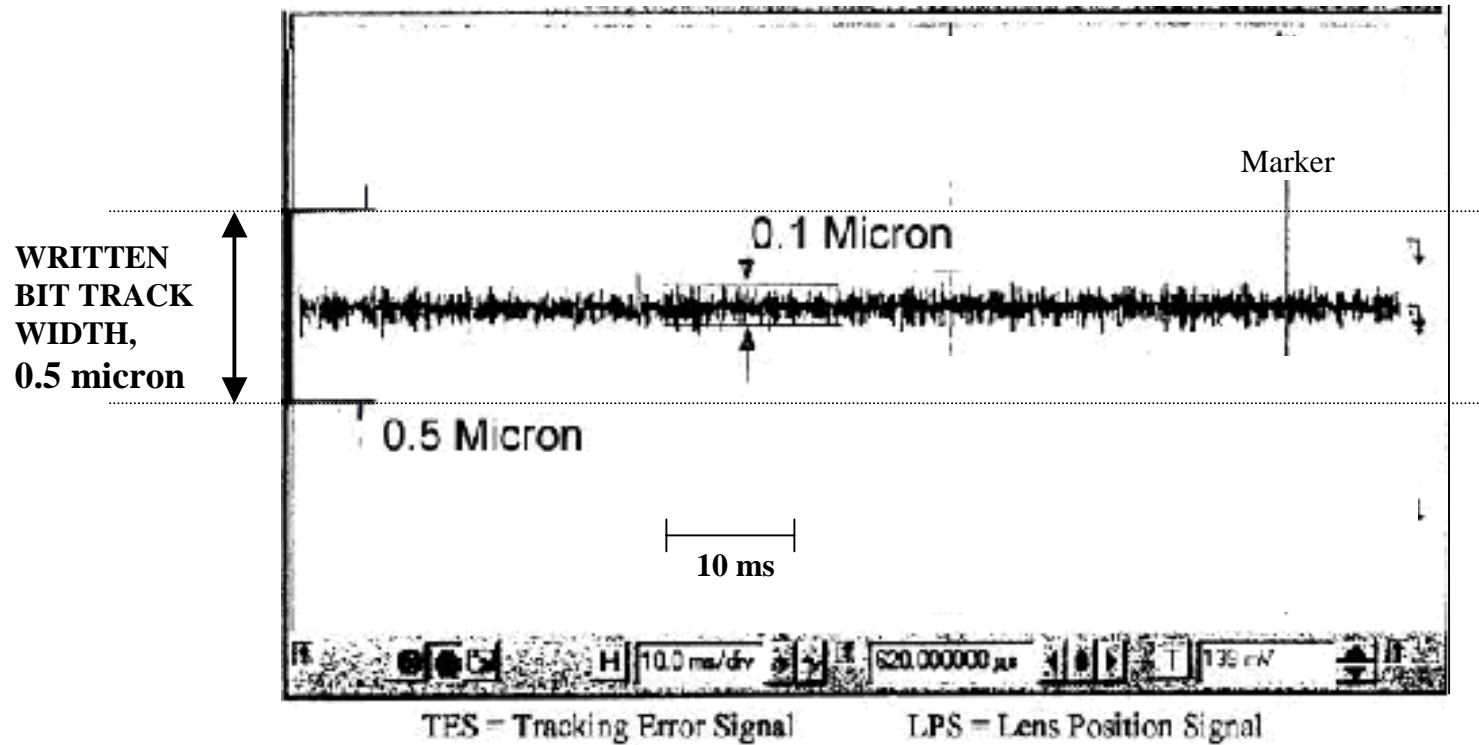


**Optical Modulation @ 12MHz allows writing PPM data at 16.7 Mbits/sec. per track,
e.g. 64 tracks = 1069 Mbits/sec. \Rightarrow 800 Mbit/sec. User Data Rate.**

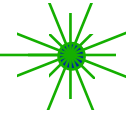


LOTS High Speed Tape Transport & Optical Servo System;

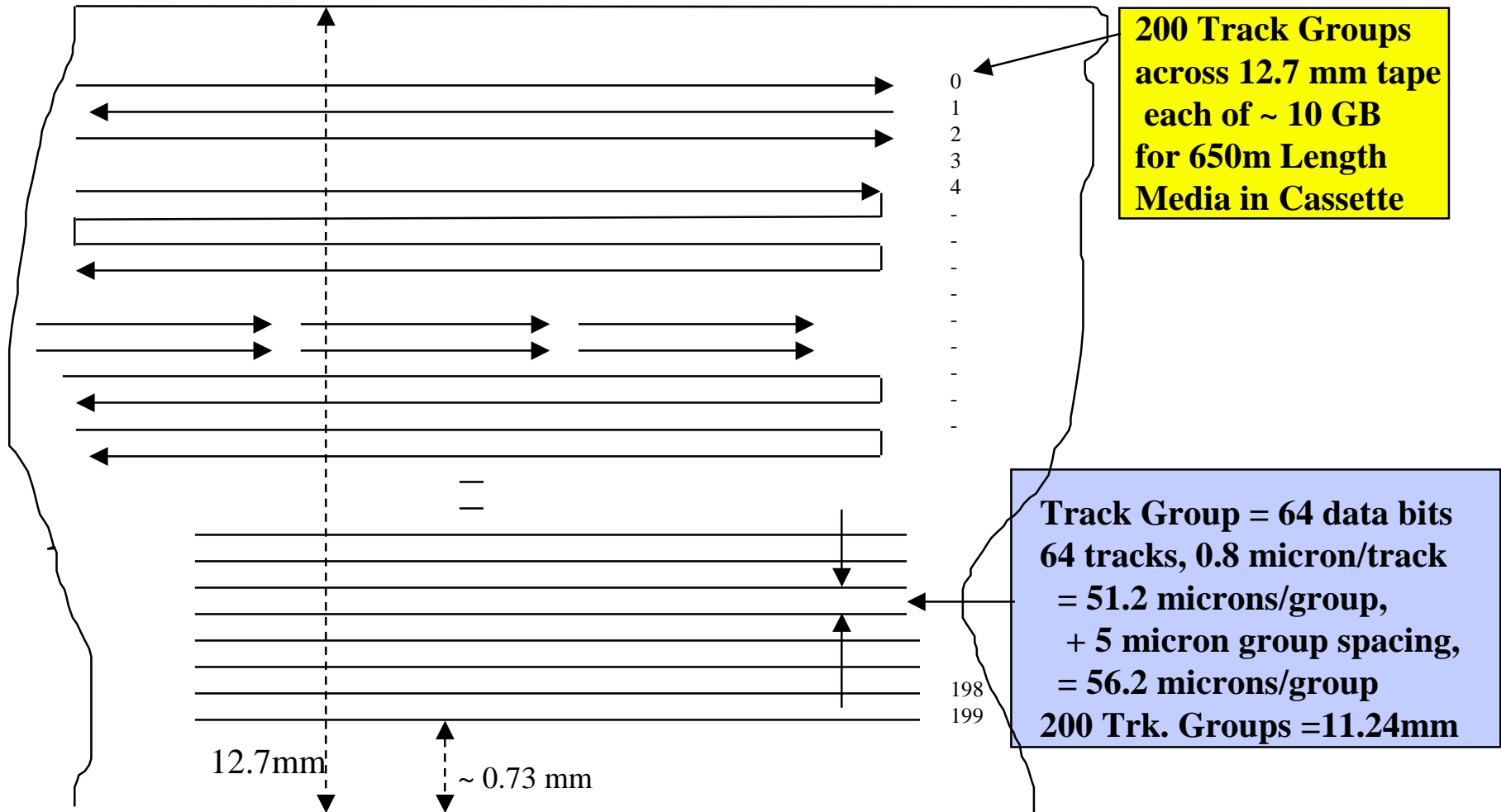
- Provides Sub-Micron Tracking at 10 m/Sec.



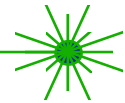
160T FORMAT



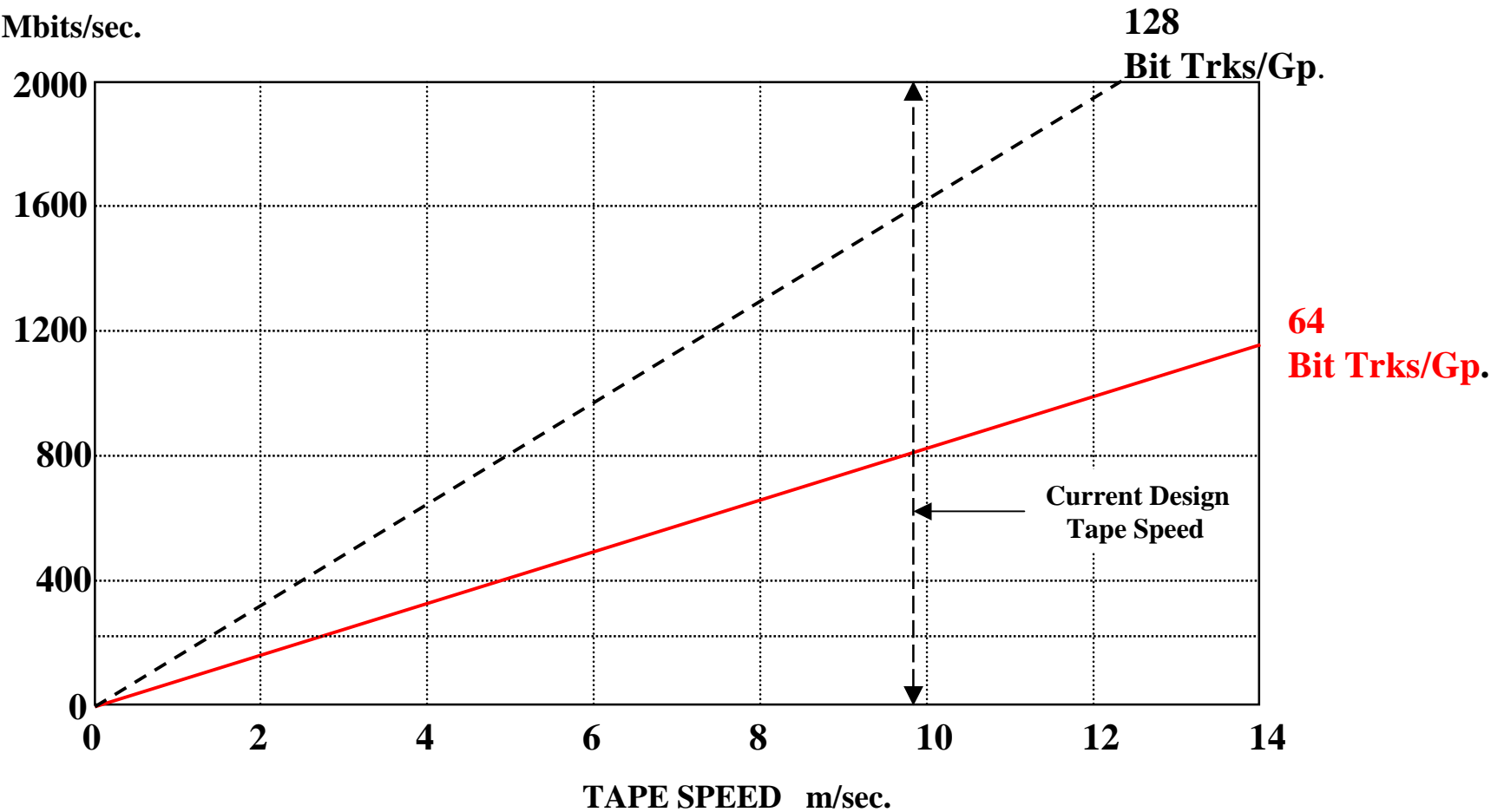
200 BOT, 64 data tracks/group, 10 GB each.
Bidirectional Serpentine



DATA RATES, PPM Encoding



User Data Rate
Mbits/sec.



Data Rate vs. No: Bit Tracks/Group & Tape Speed



DATA RATE GROWTH

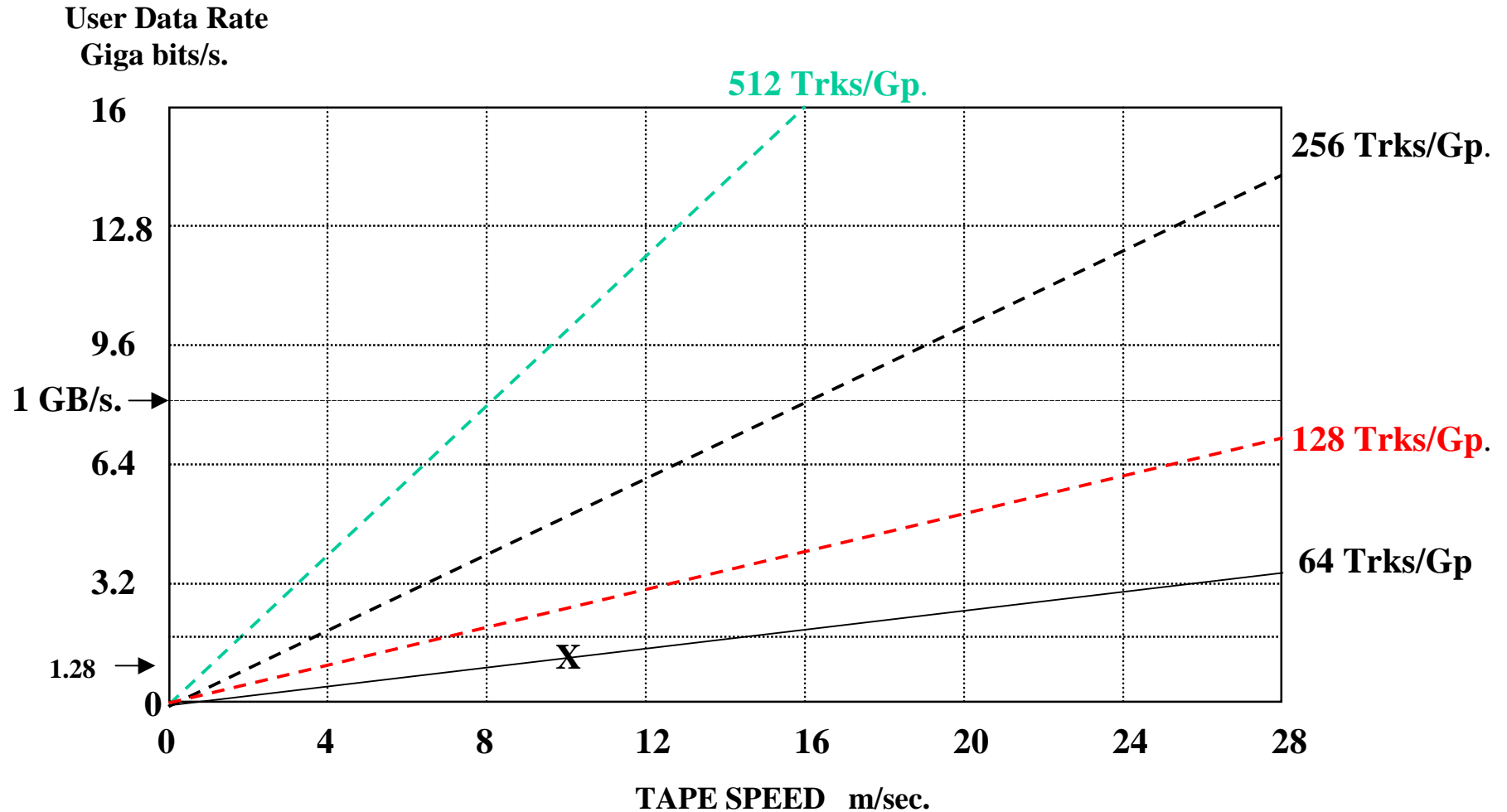
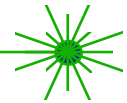
- **MAINTAIN BASIC FORMAT FOR COMPATIBILITY**

532 nm Laser & 0.8 Micron Track Spacing

- **Increase Bit Track Parallelism, Larger Group**
- **Increase Media Transport Speed**
- **Denser Encoding**

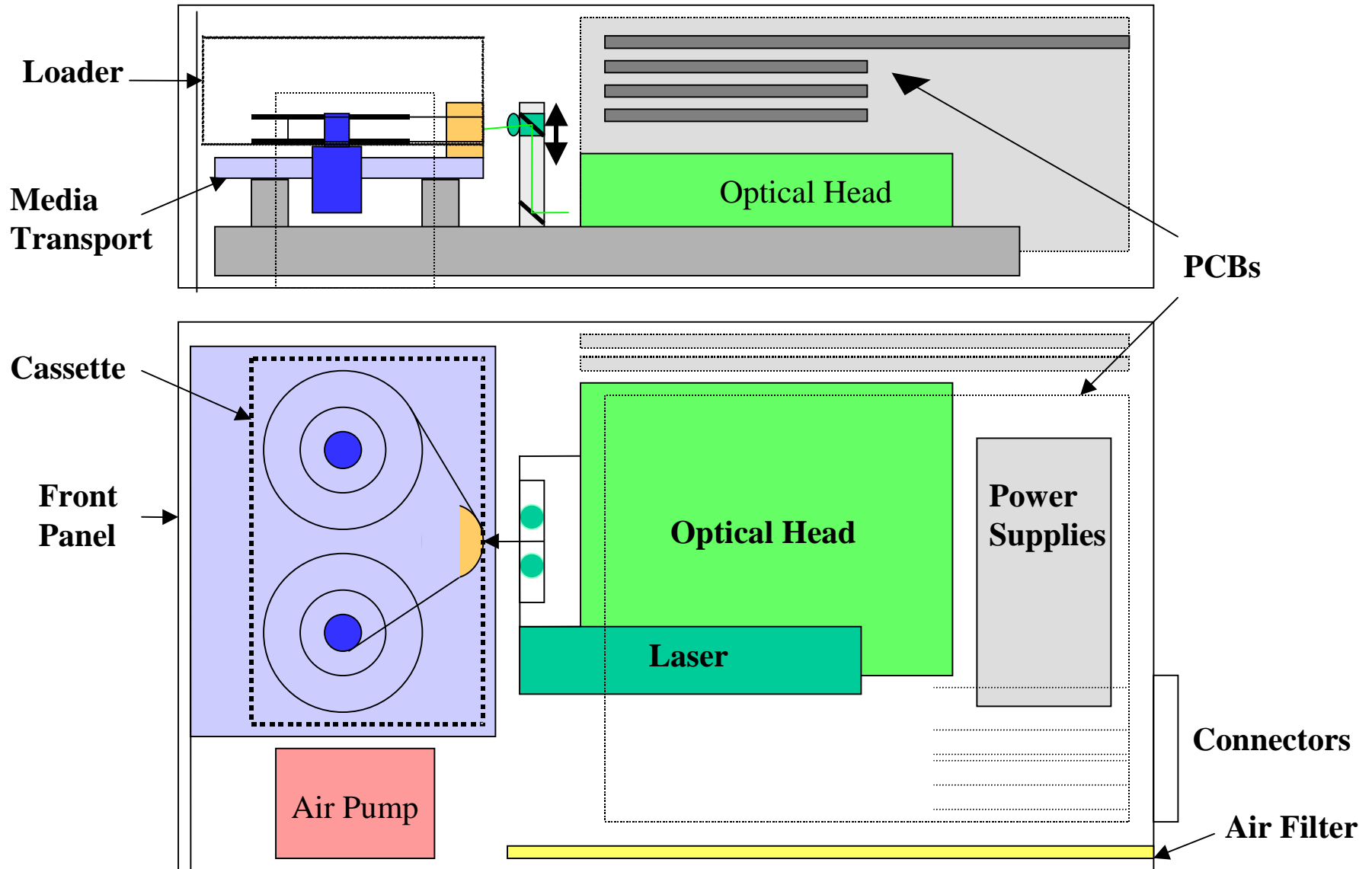
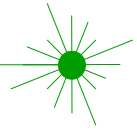
POTENTIAL DATA RATE - 1 GB/s. ?

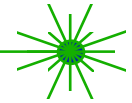
Using PWM & Higher Tape Speed



Data Rate vs. No: Bit Tracks/Group & Tape Speed

160T Configuration - 'DTF Cassette'

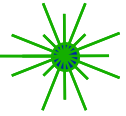




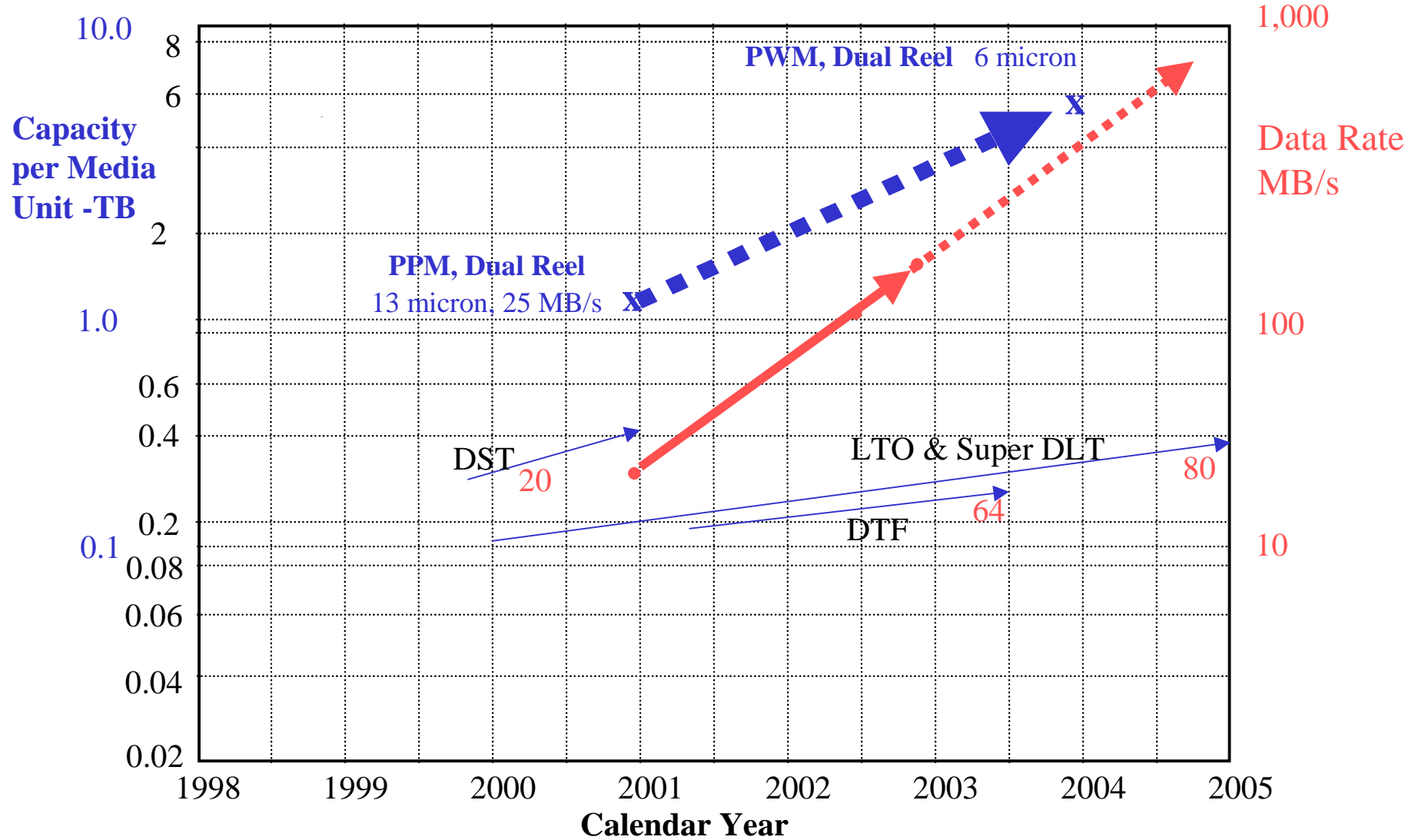
Media Parameters vs. Capacity

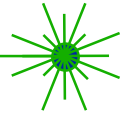
Media Package Size	'3480'			'DTF' (Center Park)		
Media Thickness - microns	13	9	6	13	9	6
Media Length - m	500	720	1080	650	940	1400
Capacity, PPM - TB	1.0	1.4	2.2	1.3	2.2	3.2
Capacity, PWM - TB	1.6	2.3	3.6	2.0	3.5	5.2
Capacity, PRML - TB	2.4	3.4	5.4	3.0	5.2	7.8
Time to EOT @15 m/s - s	33.3	48	72	21.6	32	47

PPM Access Rate = 30GB/s; PWM Access Rate = 48 GB/s



PROJECTED GROWTH





CONCLUSIONS

- **0.532 MICRON (GREEN) LASER & ASSUMING**
 - LARGE TRACK GROUPS > 128 TRACKS**
 - HIGH SPEED TAPE > 20 m/s**
 - THIN MEDIA BASE ~ 6 MICRONS**
 - **POTENTIALLY PROVIDES**
 - DATA RATES > 1GB/s**
 - CASSETTE CAPACITY > 5 TB**
-
- **BEYOND THIS, FAR IN THE FUTURE:**
 - 0.4 MICRON --- 1.33X DATA DATE & 1.75X CAPACITY**
 - PRML ----- 1.5X DATA RATE & 1.5 X CAPACITY**
 - **COMBINING ALL FACTORS, Data Rate > 2GB/s & Capacity > 10 TB**