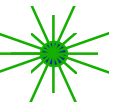# HIGH DATA RATE
OPTICAL TAPE RECORDING

W.S. Oakley
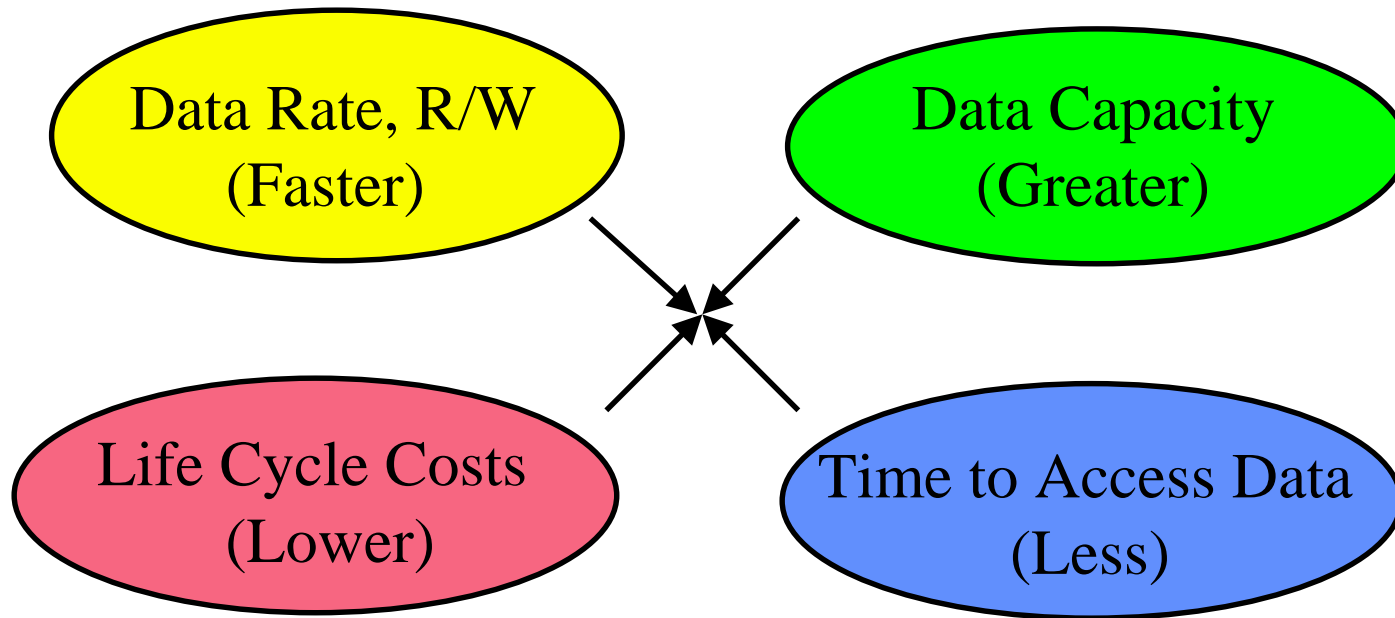
LOTS TECHNOLOGY, Inc.

20 April 2001
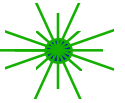
1274 Geneva Drive
Sunnyvale
CA 94089
Ph: (408) 747-1111 x66
Fax: (408) 747-0245
e-mail: william.oakley@lotstech.com

1

NEED: SIGNIFICANTLY IMPROVED PERFORMANCE

Data Rate, R/W
(Faster)

Data Capacity
(Greater)

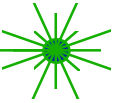Life Cycle Costs
(Lower)

Time to Access Data
(Less)

- Standards
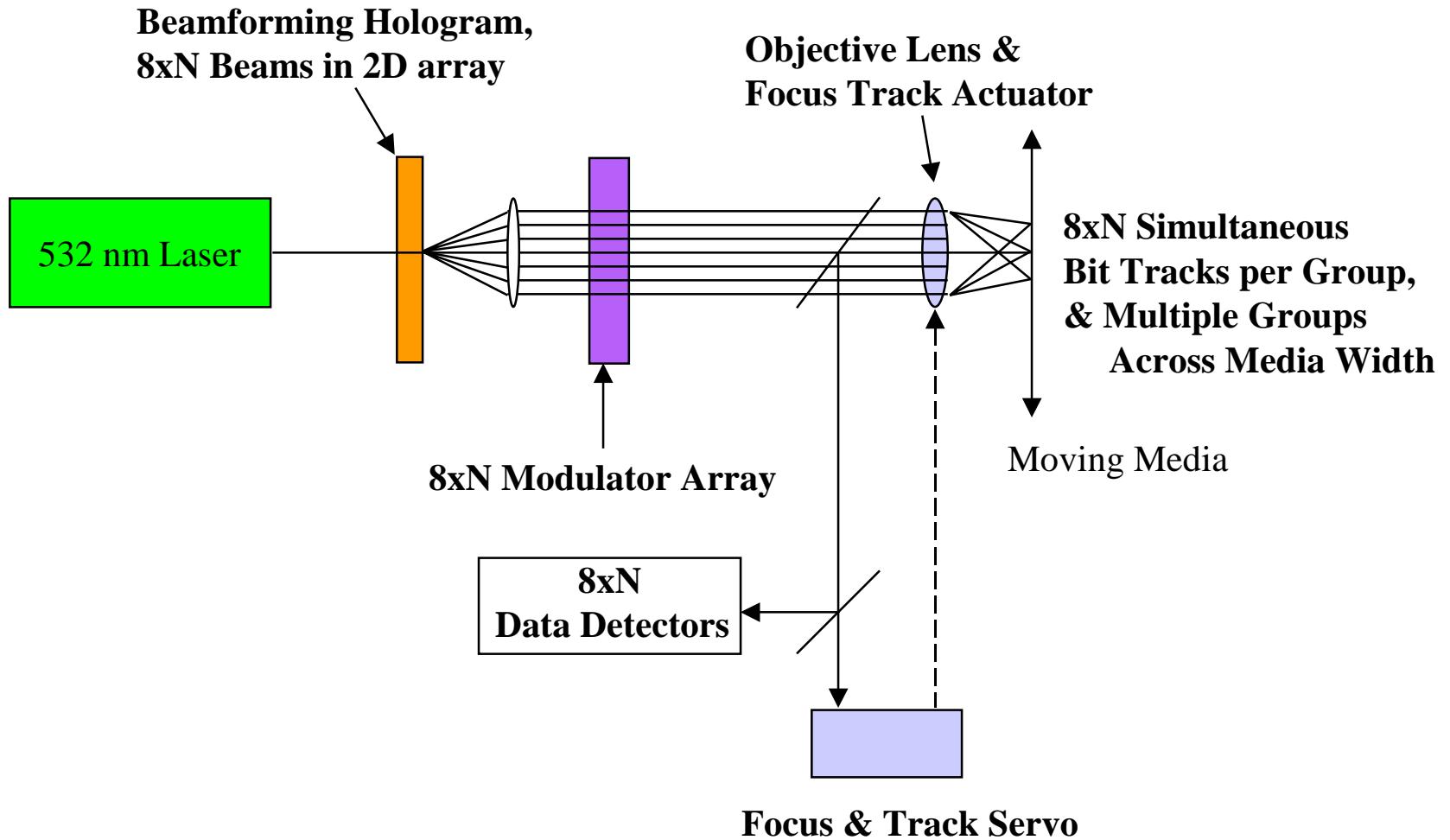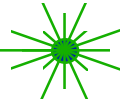- Reliability
- Technology Stability

OPTICAL TAPE MEETS THE NEED

- **High Data Rates** **> 100 MB/sec.**

  Multiple Parallel Bit Tracks & Fast Tape Speed

  (16 to 80 Bit Tracks; Write & Read @ 11.5 m/sec.)

- **High Data Capacity** **1 Terabyte per Cassette / Cartridge**

  User Data, Native (Uncompressed)

- **Fast Data Access** **15 Sec. Avg. 1st Access Within 1 TB**

  34 GB/sec., Due to High Data Density & Fast Tape
  (1.7 GigaBytes of Data per meter & 20 m/sec.)

- **High Reliability** **Non -Contact Recording**

  No Head Wear, Very Low Media Wear

- **Low System Costs**

  Much Higher Capacity/Media Unit

  = Less Media, Smaller Robots, 90% Less Volume

- **Media Archival** **Now > 100 year**
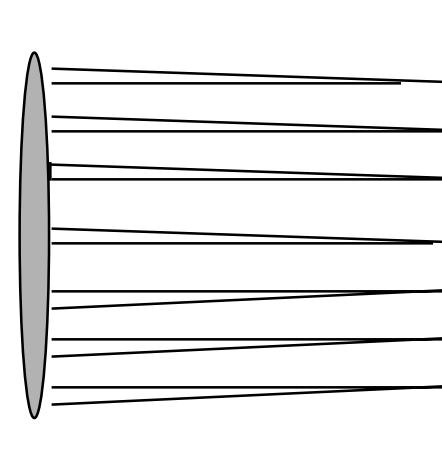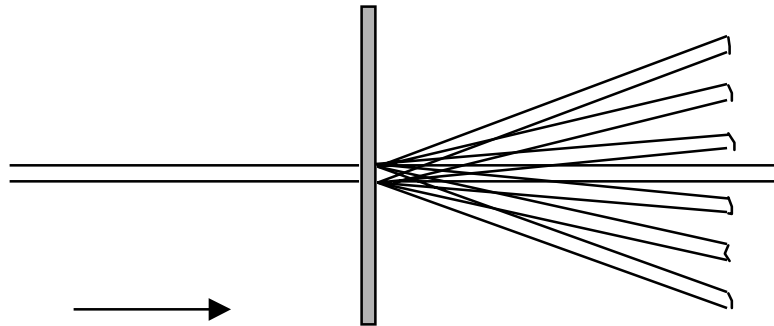
  Reusable Media Soon

LOTS Multi-beam Concept

**Beamforming Hologram,
8xN Beams in 2D array**

**Objective Lens &
Focus Track Actuator**

532 nm Laser

**8xN Simultaneous
Bit Tracks per Group,
& Multiple Groups
Across Media Width**

Moving Media

8xN Modulator Array

**8xN
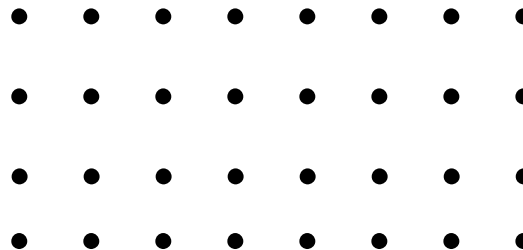Data Detectors**

Focus & Track Servo
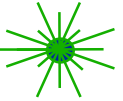
4

BEAMFORMING HOLOGRAM

Single Collimated Beam Input,
Multiple Collimated Outputs.

All Beams In Same Focal Plane

- All Beams Diffraction Limited
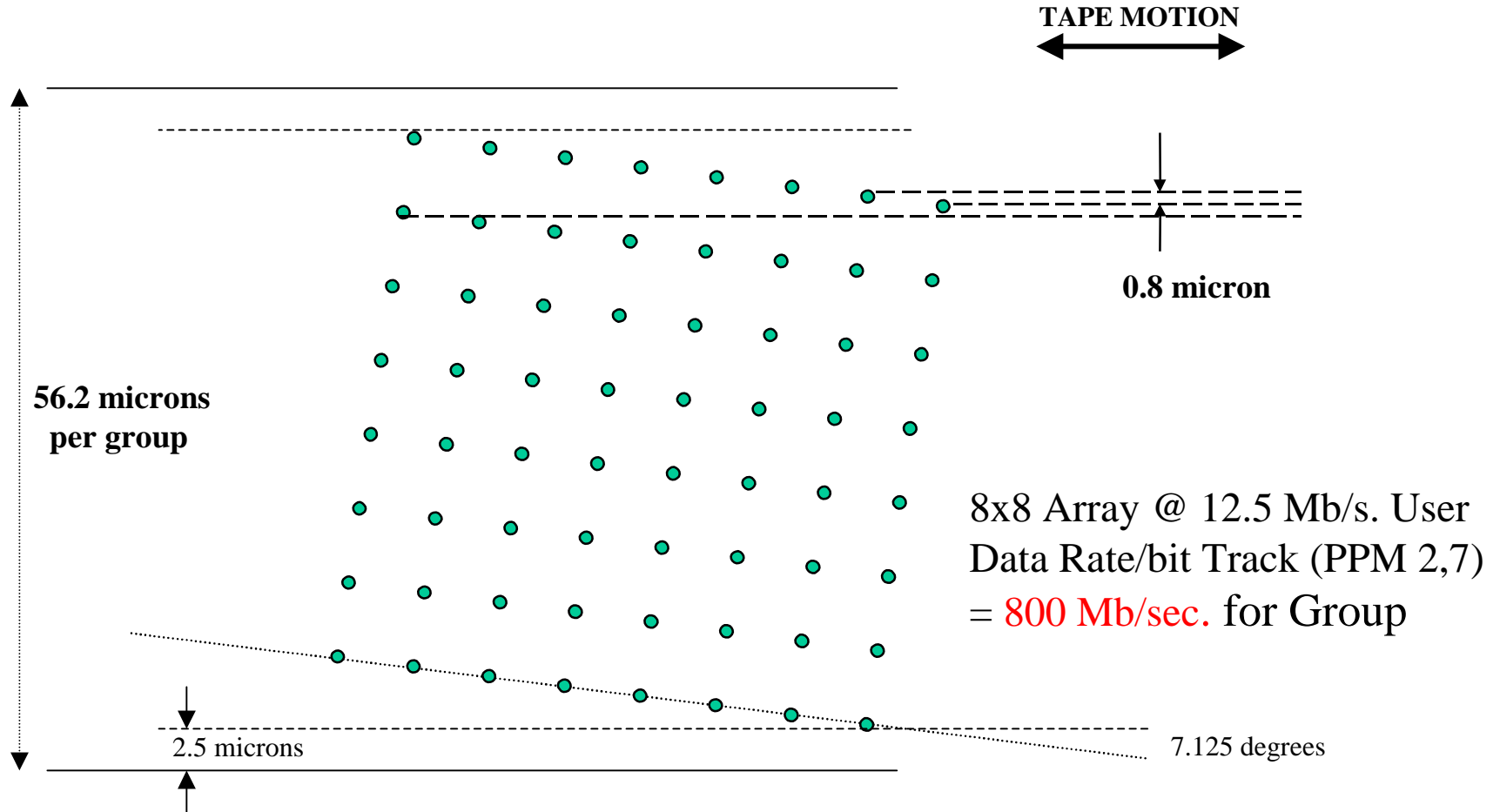- Two Dimensional Array
- 8xN Beams, e.g for N = 4 $\longrightarrow$

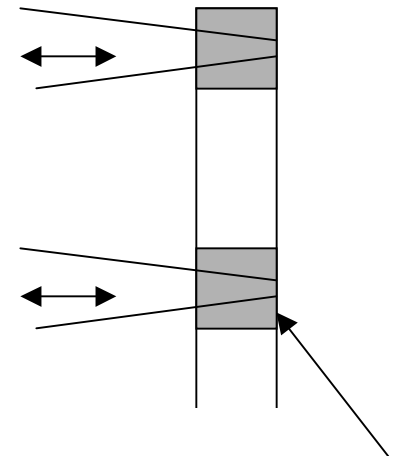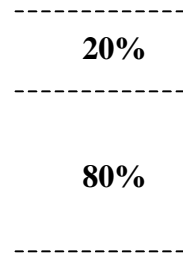**Relative Beam Locations Fixed**

Beam Forming Pattern

8 x 8 Array = 64 Beams

TAPE MOTION

56.2 microns per group

0.8 micron

8x8 Array @ 12.5 Mb/s. User Data Rate/bit Track (PPM 2,7) = 800 Mb/sec. for Group

2.5 microns

7.125 degrees

Modulator Geometry

8 x 8 Array = 64 Beams

1,1   **1,2**   **1,8**

20%

80%

2,1   **2,2**   **2,8**

8,1   **8,2**   **8,8**

~ 2mm
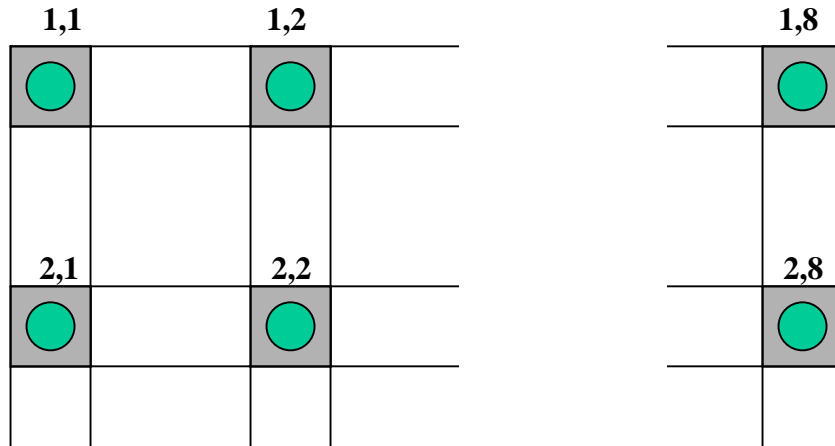
HR Coating

Side View

LOTS TECHNOLOGY
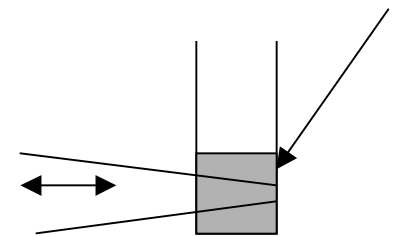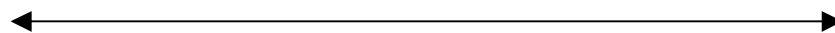
Array Modulator Response

Modulator Optical Output at 12MHz
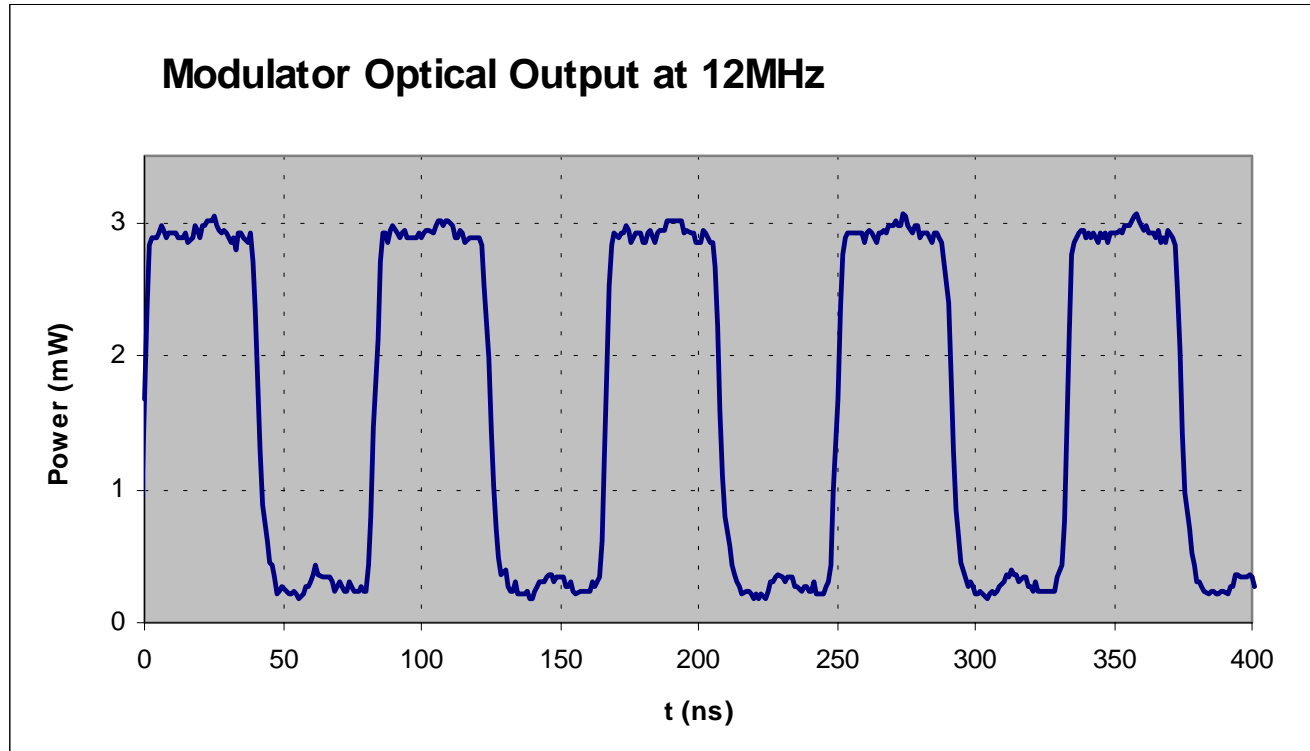
Optical Modulation @ 12MHz provides PPM data at 16.7 Mbits/sec. per track, e.g. 64 tracks = 1069 Mbits/sec. ⇨ 800 Mbit/sec. User Data Rate (34% O.H.)

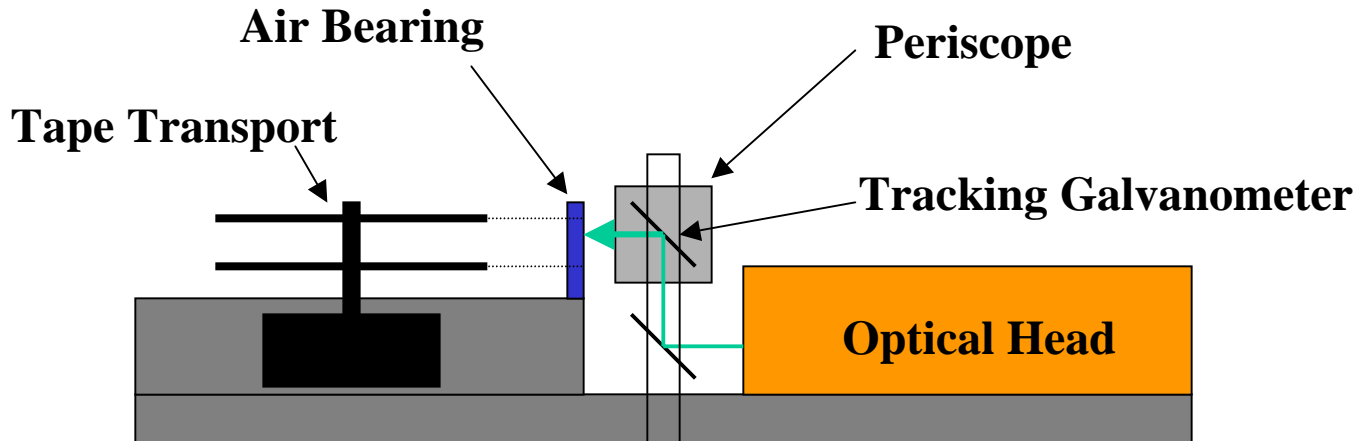# SYSTEM CONFIGURATION

Air Bearing

Periscope

Tape Transport

Tracking Galvanometer

Optical Head
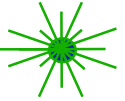
- **Track Group Selection by Periscope**

- **Tracking by Mirror Galvanometer**

Non Contact Write & Read

Optical Beams

Plan View

Air Bearing
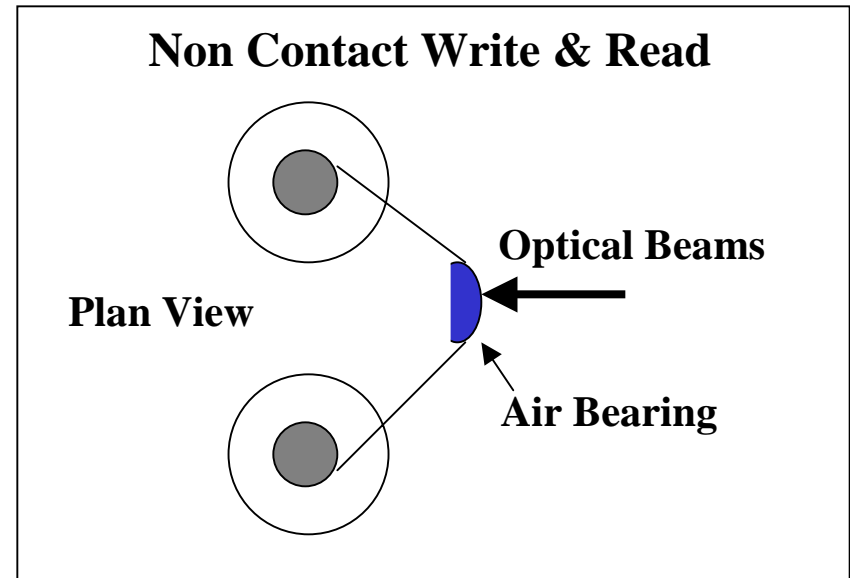
LOTS High Speed Tape Transport
& Optical Servo System

- Provides Sub-Micron Tracking
 Peak to Peak Tracking Error = ± 0.050 Microns
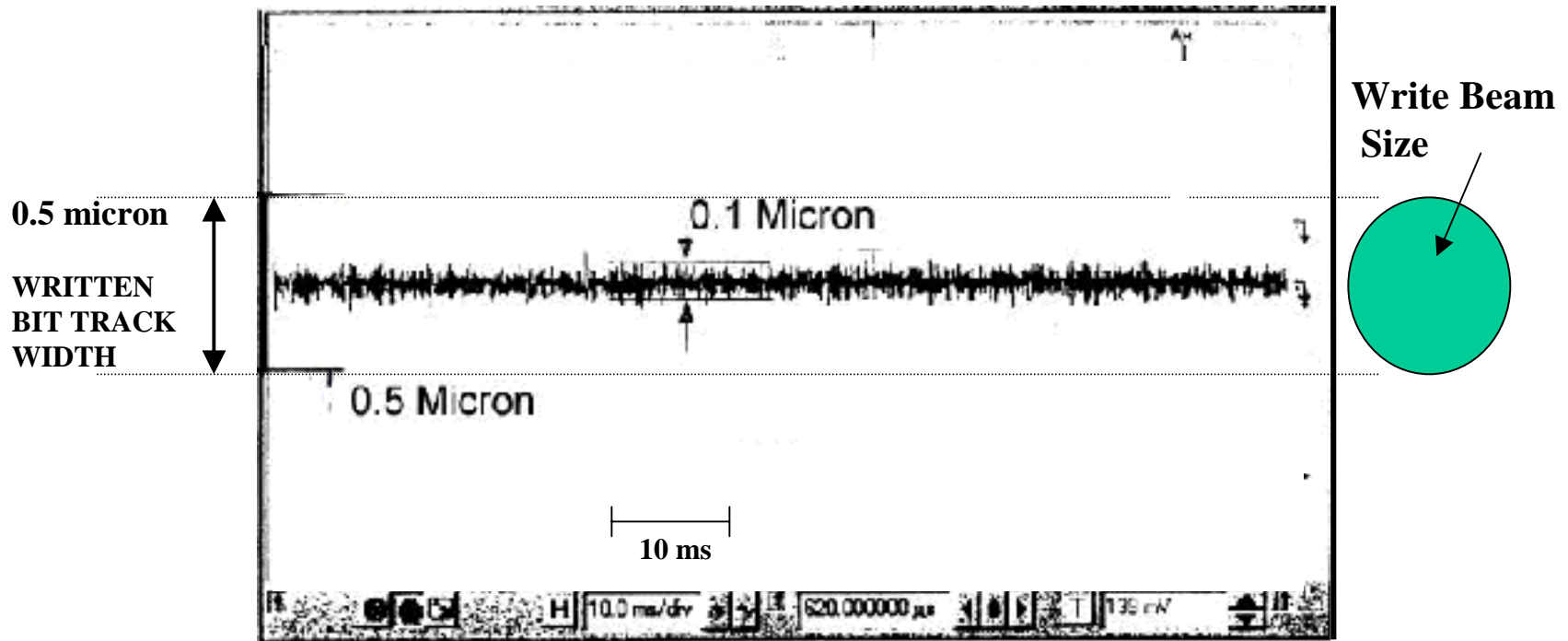
BASIC DRIVE FEATURES

25 -100+ MB/sec. Data Rates

1 TeraByte User Capacity

600m of 13 Micron Thick Media

0.8 micron Track Spacing

PPM(2,7) encoding

20 m/sec. Access Tape Speed = 33.3 GB/sec.

No Head Wear & Essentially No Media Wear

Bi-Directional Serpentine Write/Read @ 11.5 m/sec.

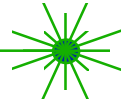**~ 15,000 Bit Tracks across 12.7mm Media Width**

DATA TRACK CONFIGURATIONS

16 data Tracks + Servo = 25 MB/s.
  x 800 Track Groups

or

64 data Tracks +Servo = 100 MB/s.
  x 200 Track Groups

Media Parameters vs. Capacity

'3480' or 'DTF'	April 2001	Future	Access Rate GB/s.
Media Thickness - microns	13	7	
Media Length - m	600	1100	
Capacity, PPM(2,7) - TB	1.1	2.0	33*
Capacity, PWM - TB	1.75	3.2	53
Capacity, PRML - TB	2.5	4.5	80
Time to EOT @ 20 m/s - s	30	55	

*   15 sec. Avg. to 1st Access in 1 TB, 10 sec. Avg. to Next Access in 1 TB

CURRENT PRODUCT STATUS

- **Engineering Prototypes Operating**
    - **Commercial Quality Recording**
    - **Acceptable SNR & BER**
    - **Reliable Tracking**
    - **Satisfactory Wear Characteristics, Media & Drive**
    - **Product Design in Progress**

- **NO Product Schedule Due to Funding Limitations**