



Mountain Engineering II, Inc.

A roller guide for a high performance tape path

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New Tape Path Challenges

- Tape speeds are increasing
- Tapes are getting thinner
- Contamination is more critical because of higher recording densities
- Requirement for higher stability (PRML)
- Tape drives are getting smaller
- Reduced cost



Increased Tape speeds

- ◆ 3480 2m/s
- ◆ DLT ~4m/s
- ◆ LTO >6 m/s

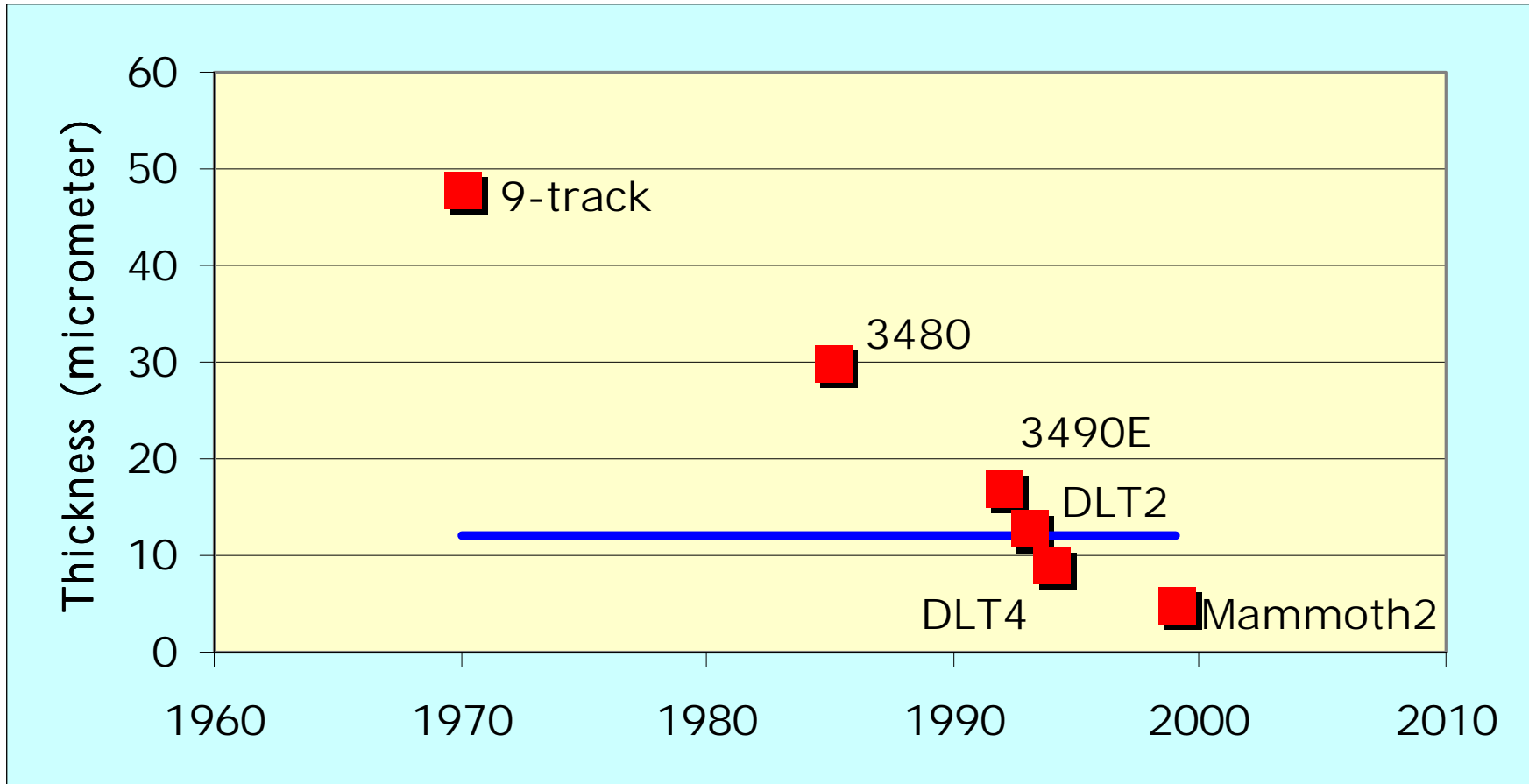


Tapes are getting thinner

- ◆ 9-track 48 μm
- ◆ 3480 30 μm
- ◆ 3490E 17 μm
- ◆ DLT2 13 μm
- ◆ DLT4 9 μm
- ◆ AIT-1 7 μm
- ◆ Mammoth2 5 μm

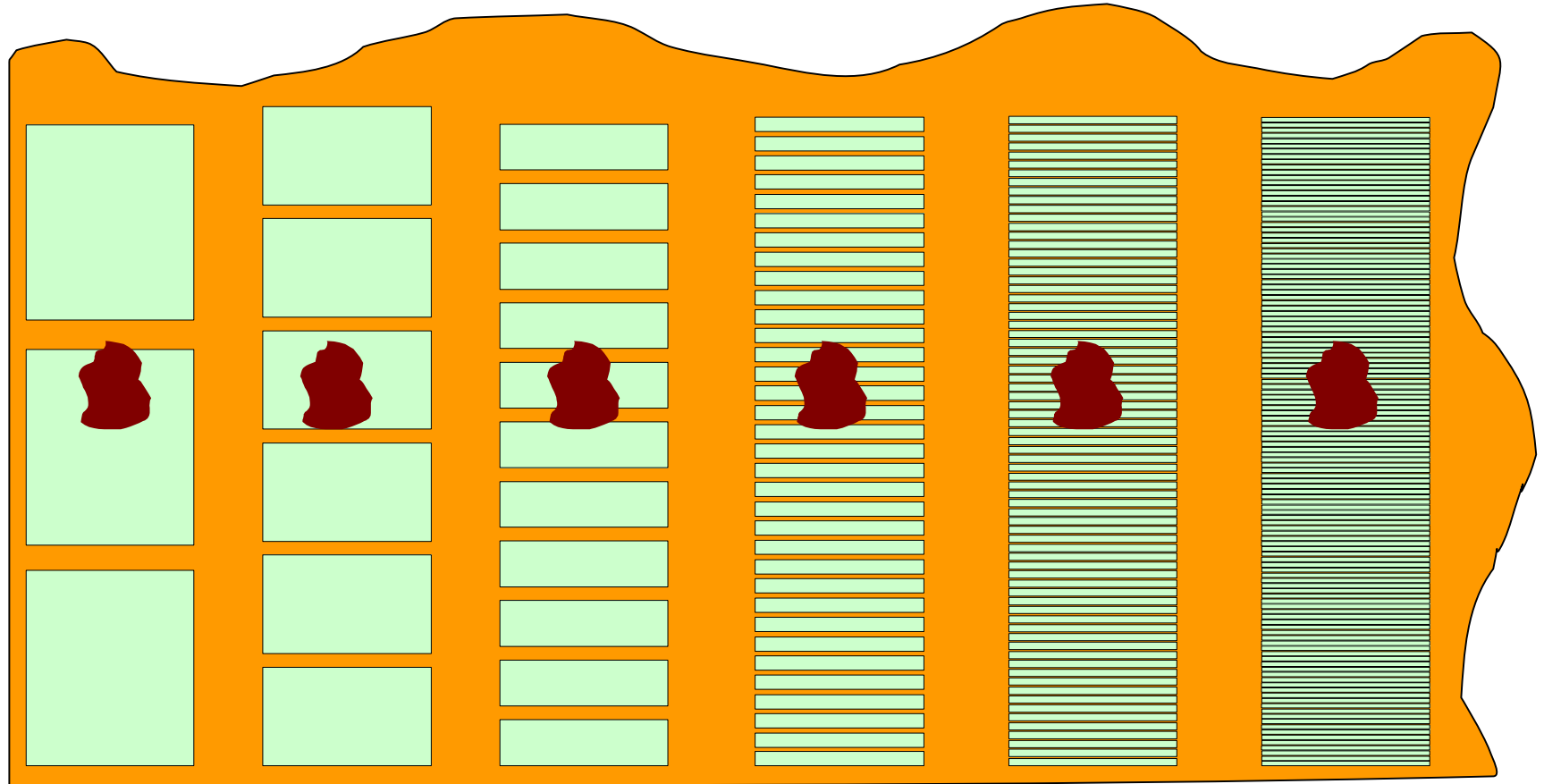


Thinner Tape





Contamination is critical



9-track

18-track

36-track

128-track

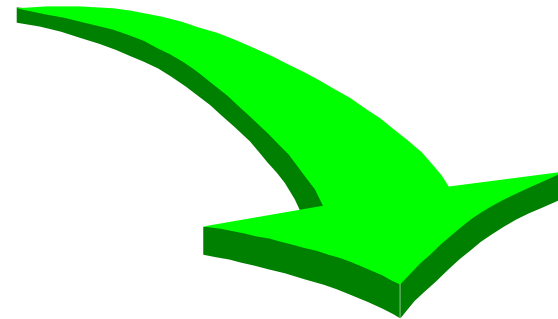
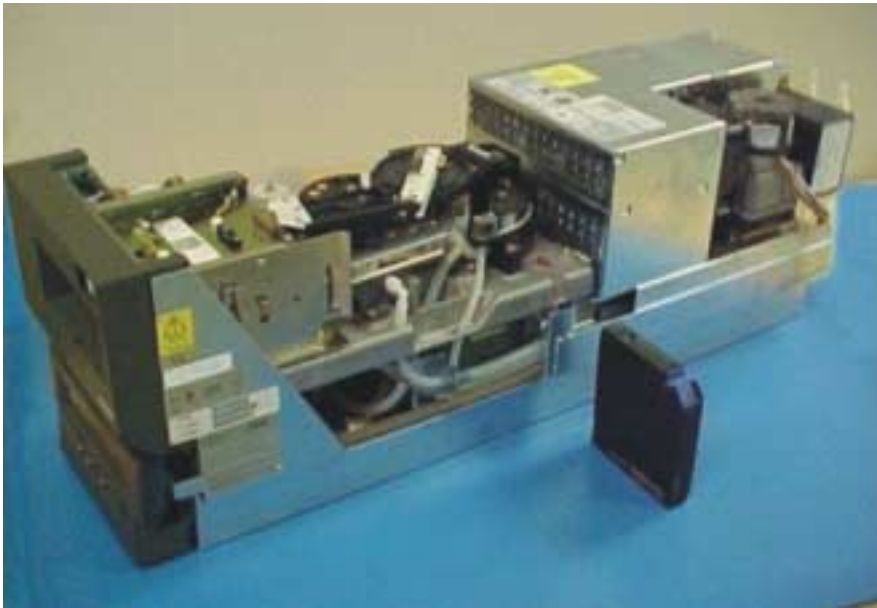
208-track

384-track



Smaller tape drives

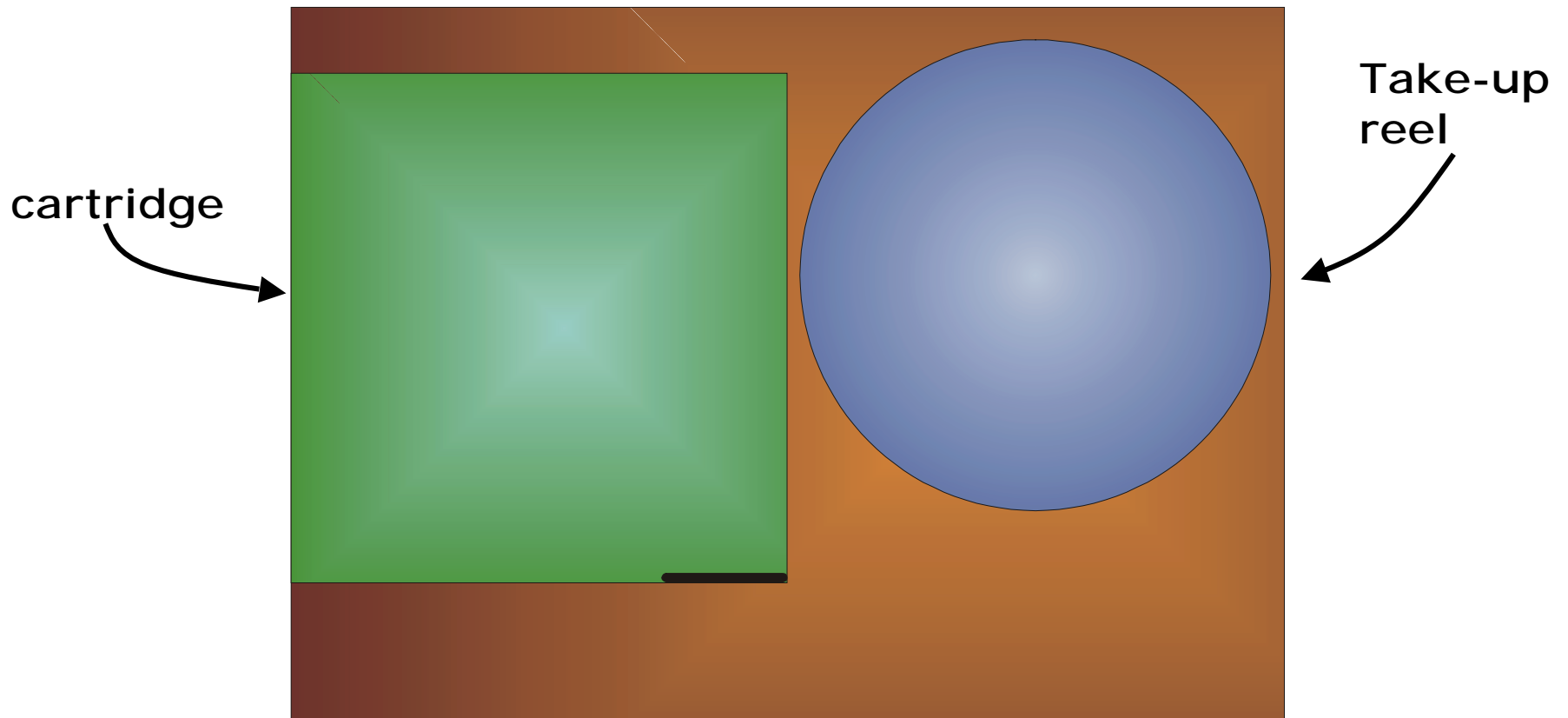
- Newer tape drives are 5¼ inch form factor or smaller





Smaller tape drives

5¼ inch form factor drive





Guiding tape

- Guiding means leading tape from the supply to the take-up hub
- Does not mean controlling the tape-head alignment (tape tracking)
- Three technologies
 - ◆ Hydrostatic air bearings
 - ◆ Hydrodynamic bearings
 - ◆ Rollers



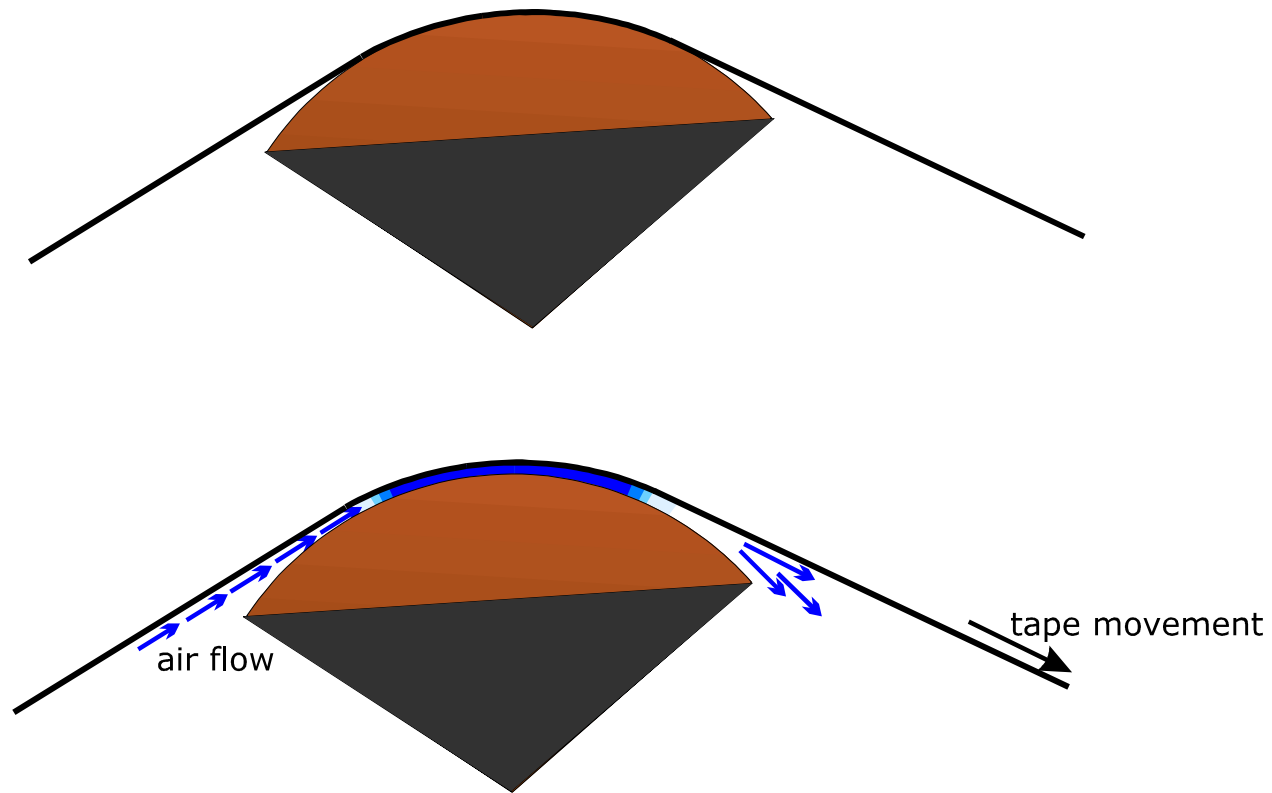
Hydrostatic air bearings

- Use compressed air to separate tape from a bearing
- Require pumps and filters
- Used for over 40 years in tape drives
- Are bulky and expensive
- Are the dinosaurs of tape path technologies
- Low flow air bearings for specialty applications



Hydrodynamic bearings

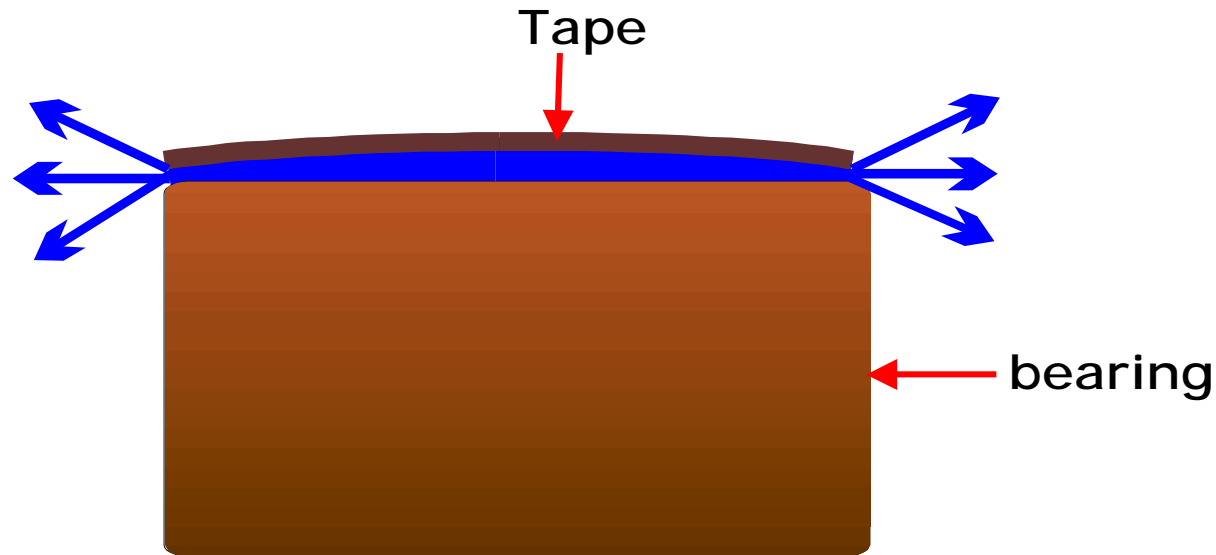
- Air film is generated by the movement of the tape





Hydrodynamic bearings

- Limited flying length
- Middle of tape flies higher than edges

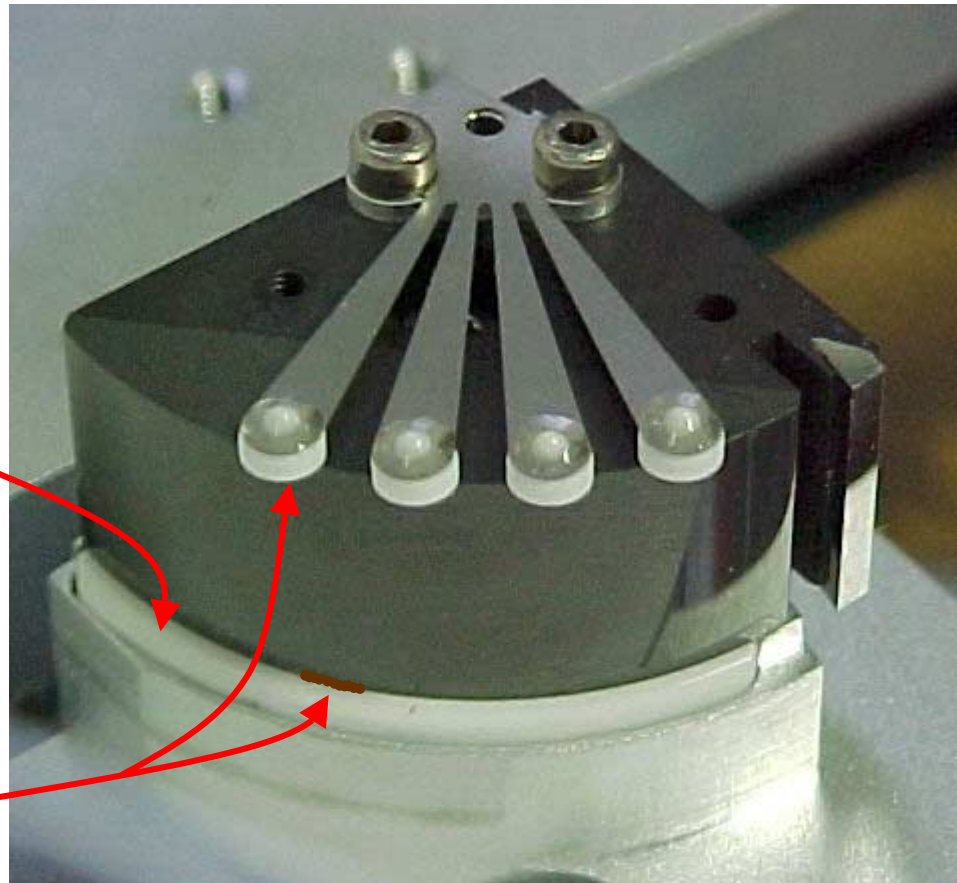




Hydrodynamic bearings

reference edge

debris





Hydrodynamic bearings

- Tape is in contact with bearing at low speed during start and stop operations
 - ◆ 'Stickage' can be a problem
 - ◆ Wear can be a problem
 - ◆ Tape tracking: springs contacting tape edge
 - ◆ Edge damage possible
 - ◆ Contamination of tape path
- Surface finish is critical



Hydrodynamic bearings

- Have been used for many years
- Successful if used correctly
- Suitable for high tape speeds
- No limitation of tape acceleration



Rollers

- Very little tape wear
- Debris trends to be moved away from the roller
- No stickage problem
- Roller mass dampens tape path
 - ◆ Dampened tape path is desirable
 - Higher recording densities
 - New recording technologies (PRML)



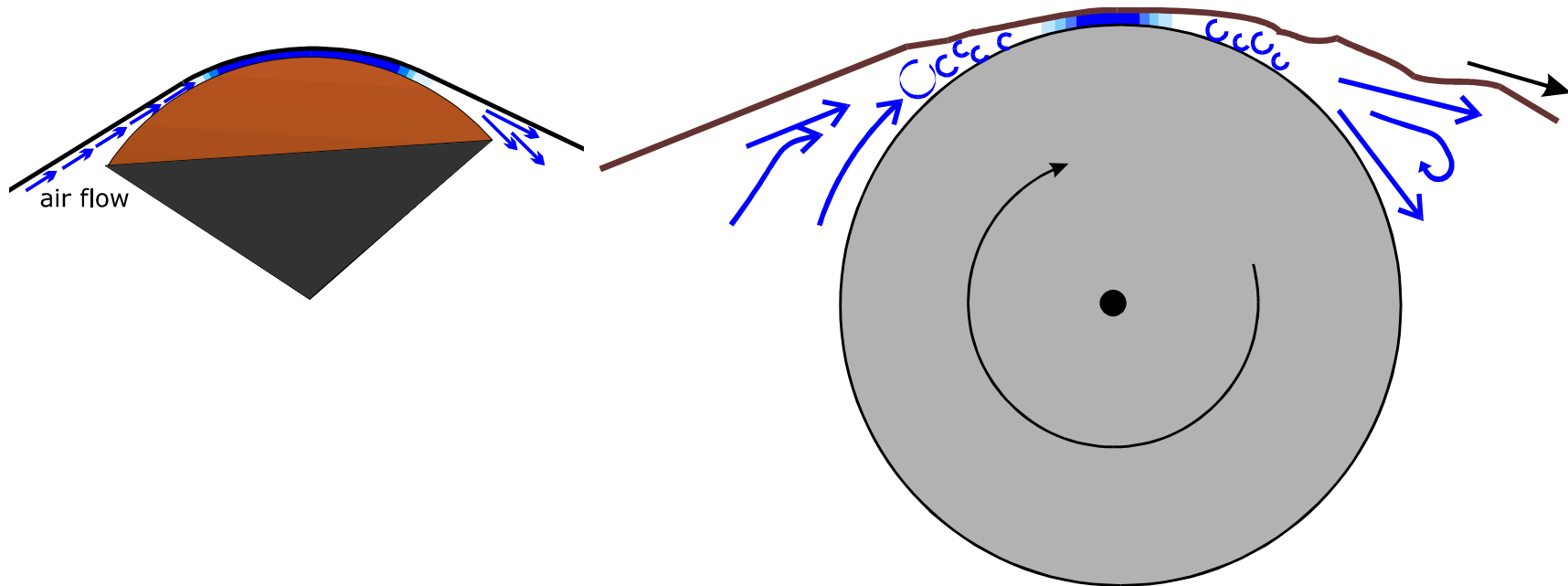
Rollers

- Problems
 - ◆ Eccentricity
 - ◆ Barber poling - perpendicularity
 - ◆ Bearing vibrations
 - ◆ Acceleration of rollers may limit tape acceleration
 - ◆ Tape can fly over rollers
- Used in slower applications



Tape flies over rollers

- Rollers are terrible hydrodynamic bearings
 - ◆ Tape movements not stable





Tape flies over rollers

- Rollers are terrible hydrodynamic bearings
 - ◆ Wear during stop operation
 - ◆ Loss of dampening effect
 - ◆ Possible loss of tracking
 - ◆ Problem if tach attached to roller
- Most advantages rollers have are eliminated when tape flies
- Additional problems



When does tape fly?

- Parameters for flying
 - ◆ Tape speed
 - ◆ Wrap angle
 - ◆ Tape tension
 - ◆ Roller surface

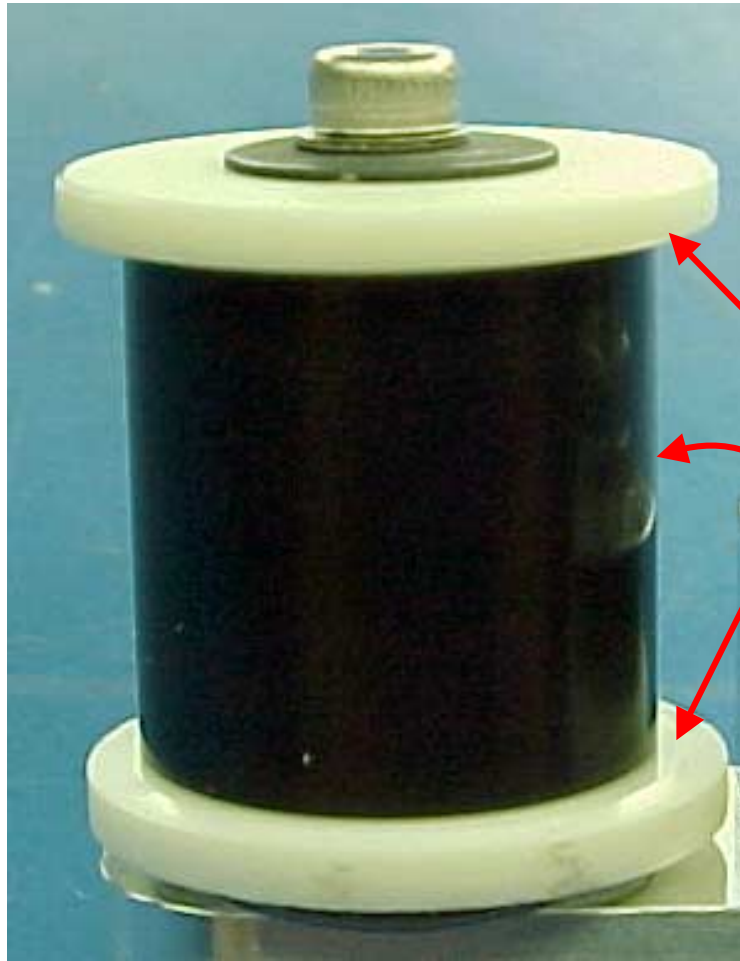


Test of 3 rollers

- Rollers with 3 surfaces
 - ◆ solid surface
 - ◆ grooves
 - ◆ MEII roller
- Variable speed
 - ◆ 1 m/s - 12 m/s
- Variable wrap angle
 - ◆ 10 degree - 120 degree
- Constant tension (1N)



Solid surface roller

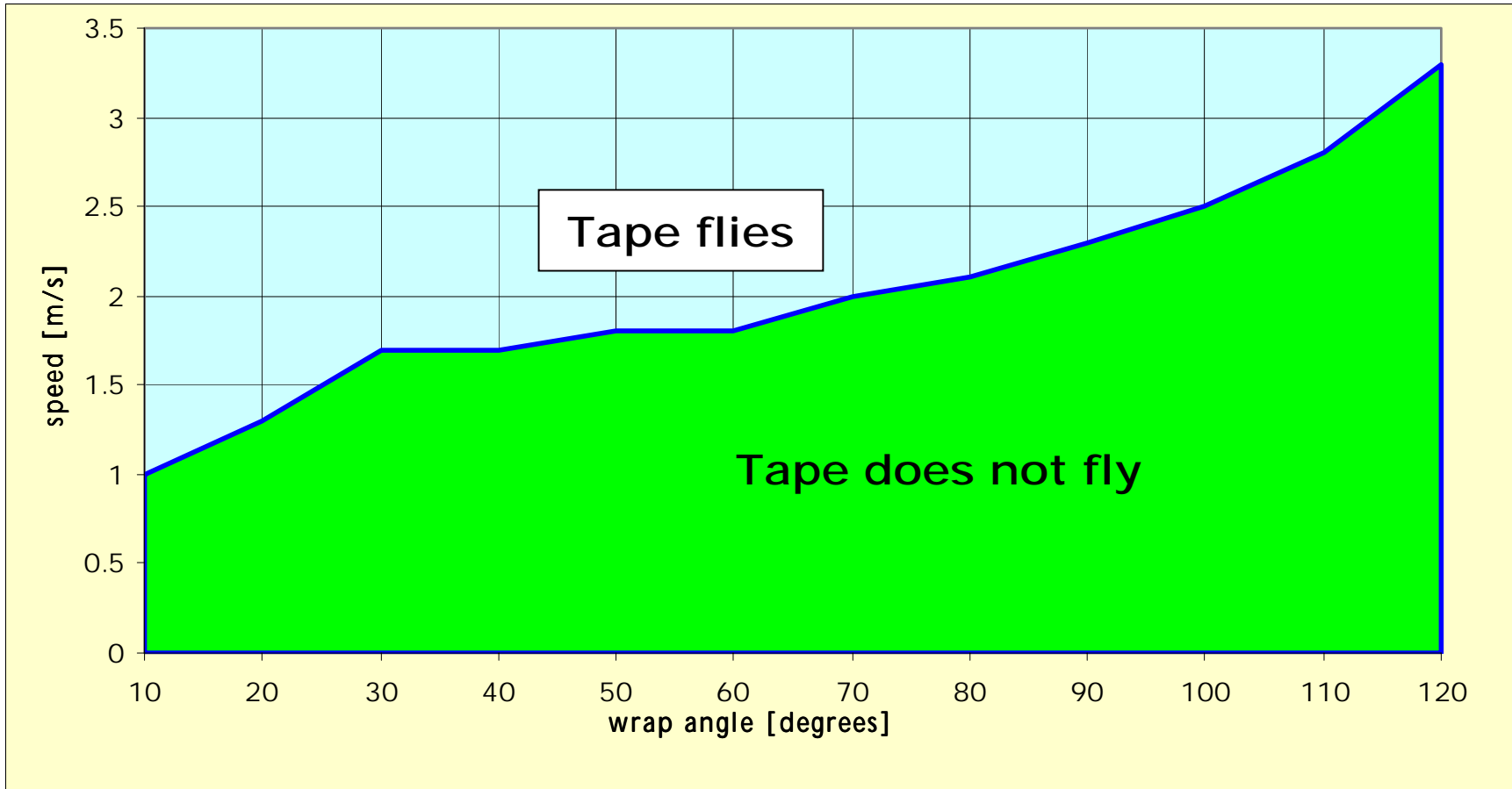


Fixed flanges

Solid surface

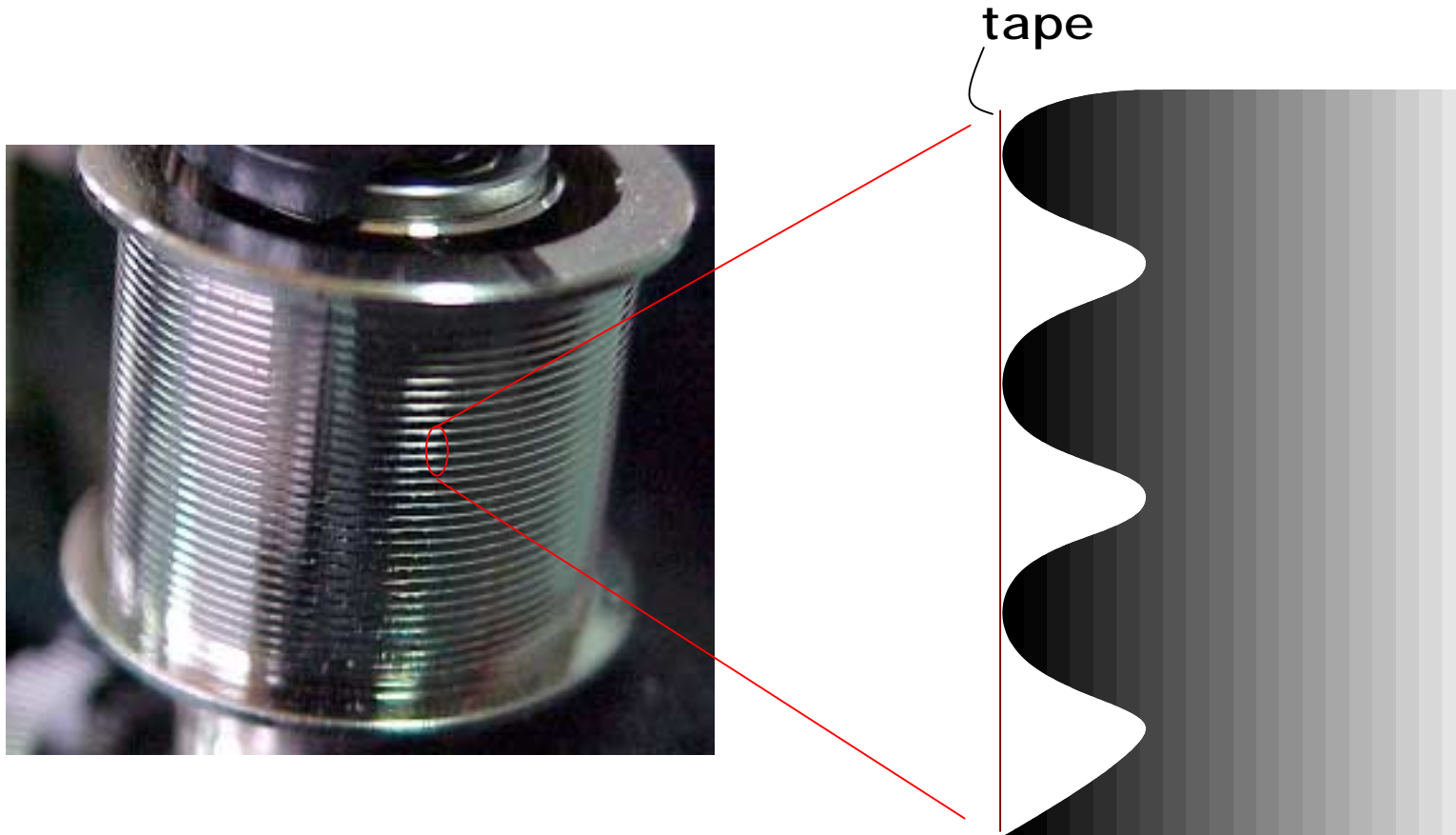


Solid surface roller



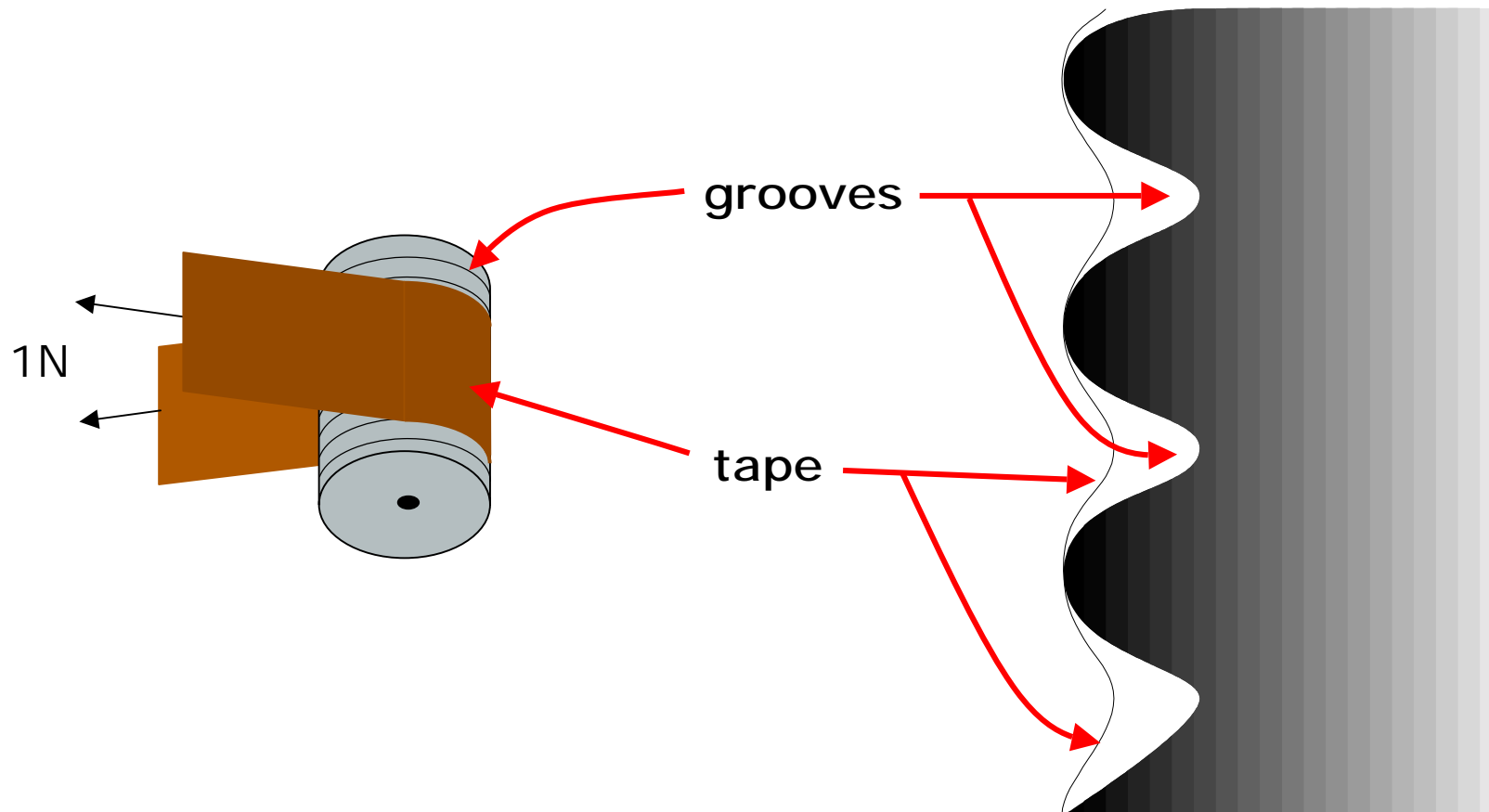


Rollers with grooves





Tape deformed by grooves

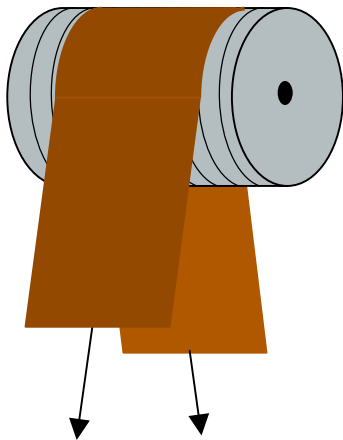




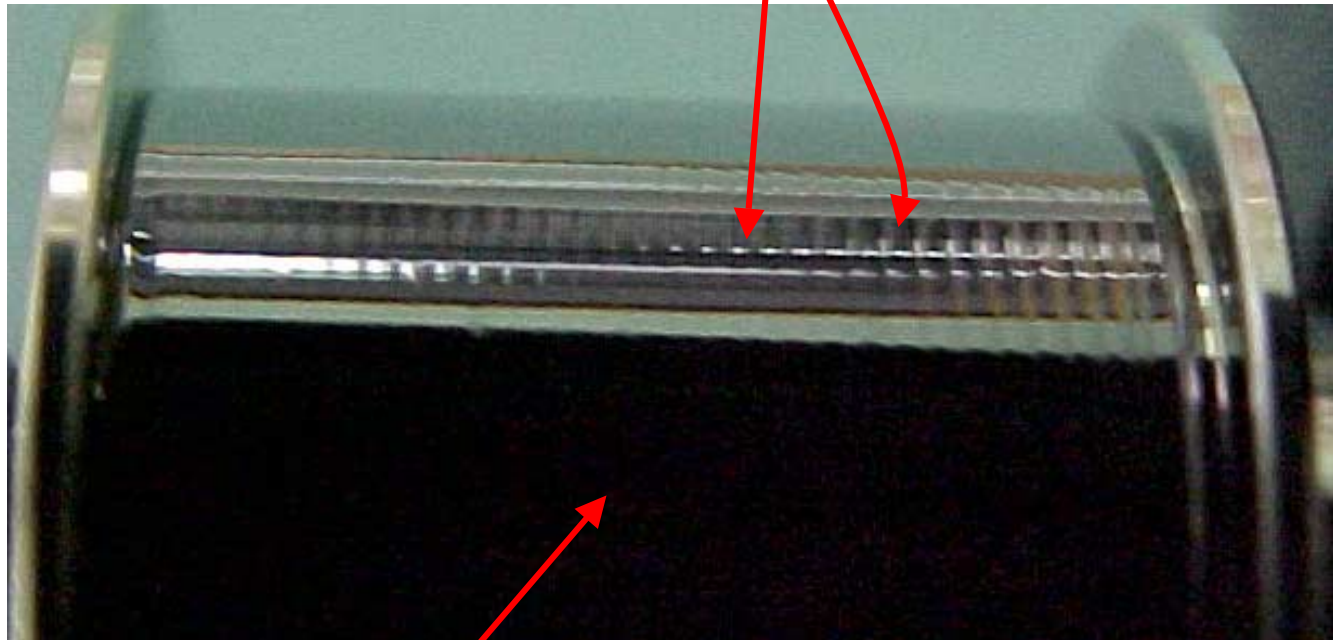
Tape deformed by grooves



view



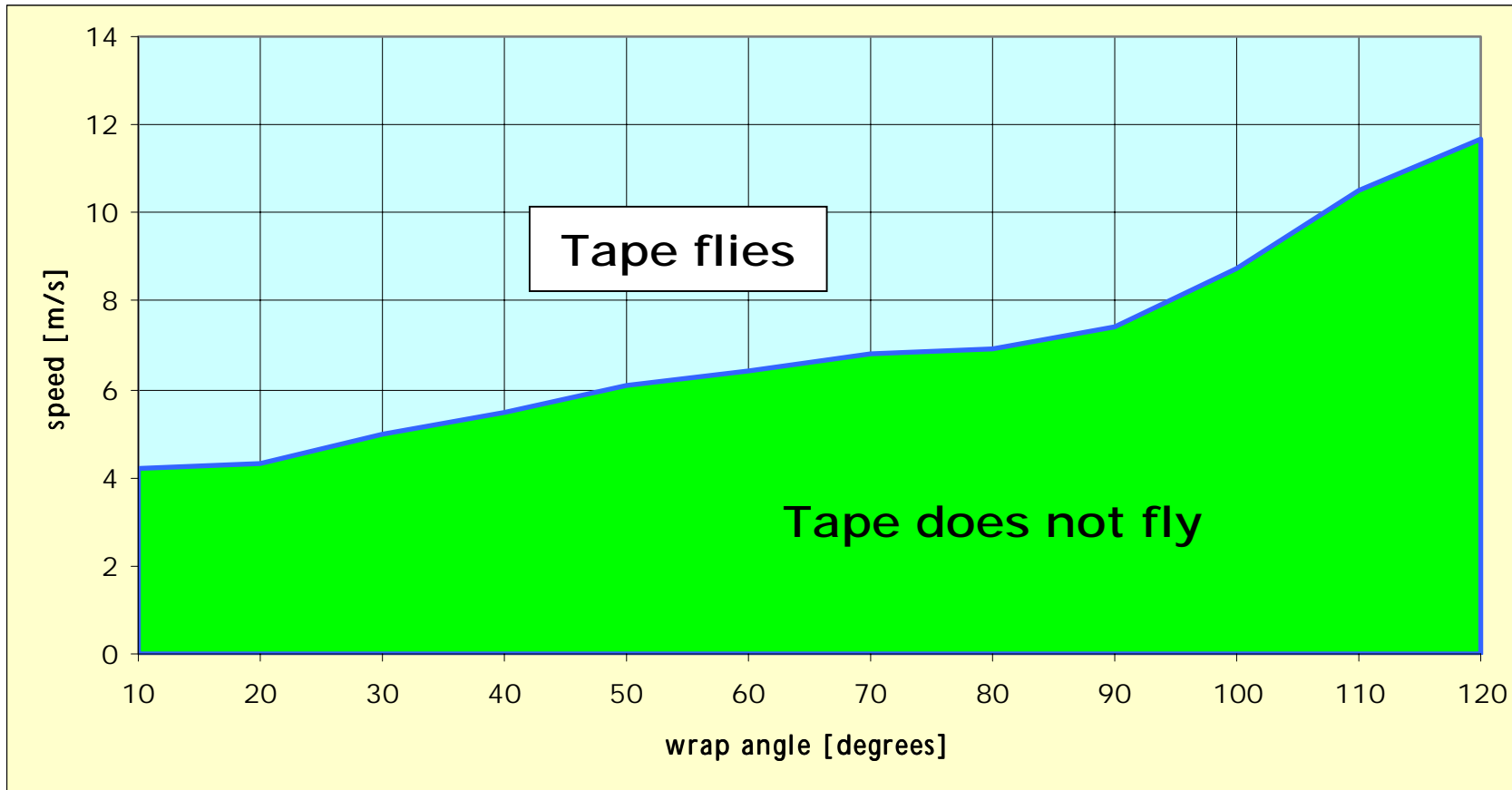
grooves



tape

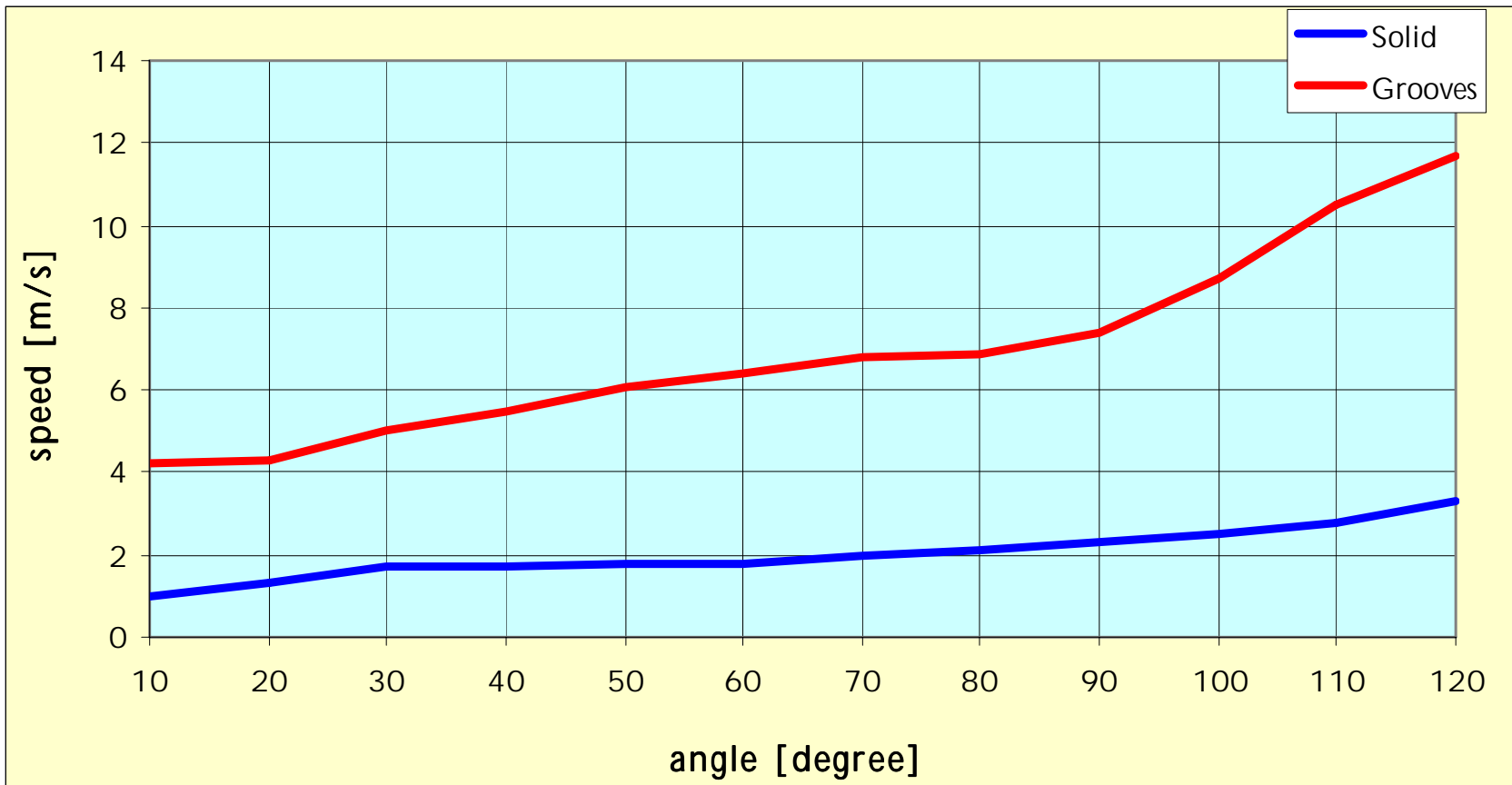


Roller with grooves





Comparison solid v. grooves





Roller with grooves



- Prevents flying at higher speed
- Deforms tape
 - ◆ Problem especially with thinner tape
- Introduces lateral bias depending on tape direction



MEII high speed roller

- Surface does not cause tape damage
- No lateral bias
- Superior flying characteristics compared to roller with grooves



Porous roller

■ Roller spool is porous

◆ Ceramic

- more rigid than plastic
- thinner spool wall
- should be conductive for ESD

◆ Plastic

- molded/extruded
- lowest cost
- suitable for high volume

◆ Metal

- sintered metal
- conductive

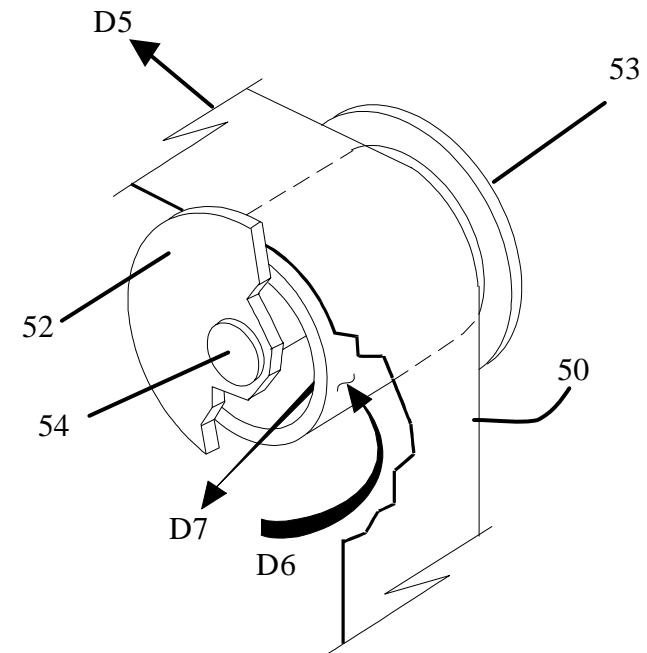


FIG 6

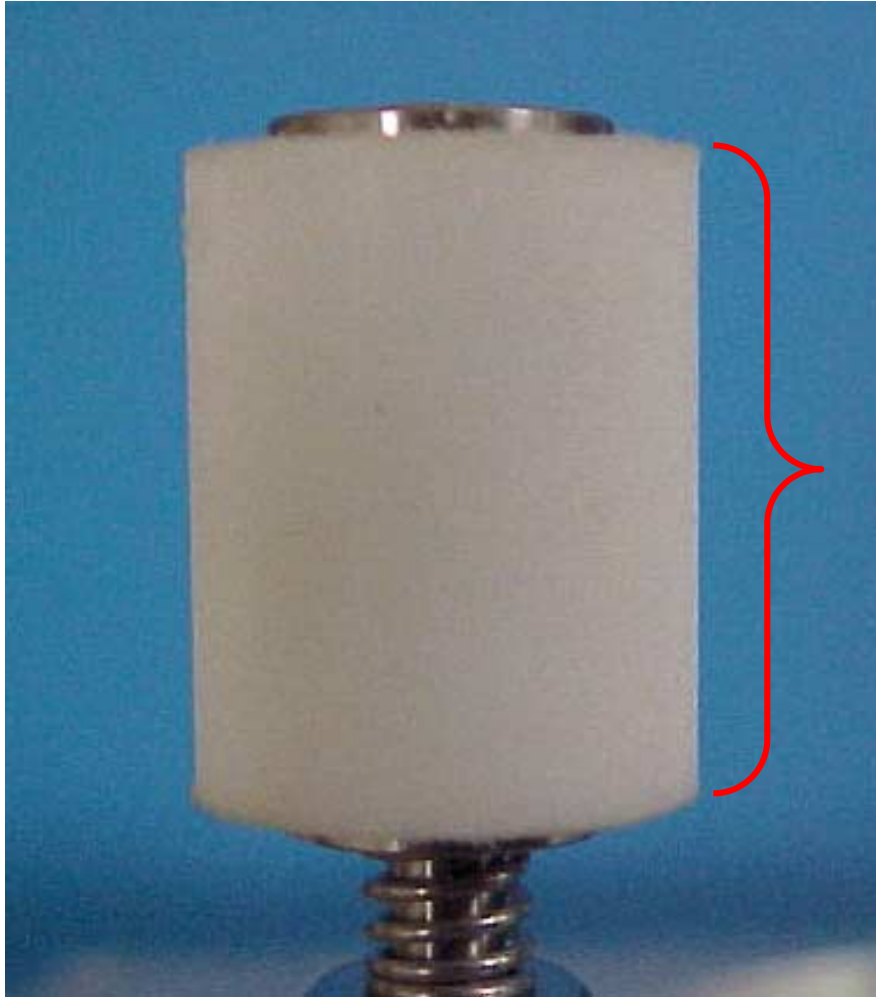


Porosity

- Requirement
 - ◆ Sufficient air flow to prevent air film
 - ◆ Sufficient surface to support tape
- Pore size
 - ◆ 50 μm - 250 μm (average diameter)
- Pore density
 - ◆ 40% - 60% open



Porous roller



Porous surface



Porous roller surface



Porous plastic, ~150 μm pore size, 50% open

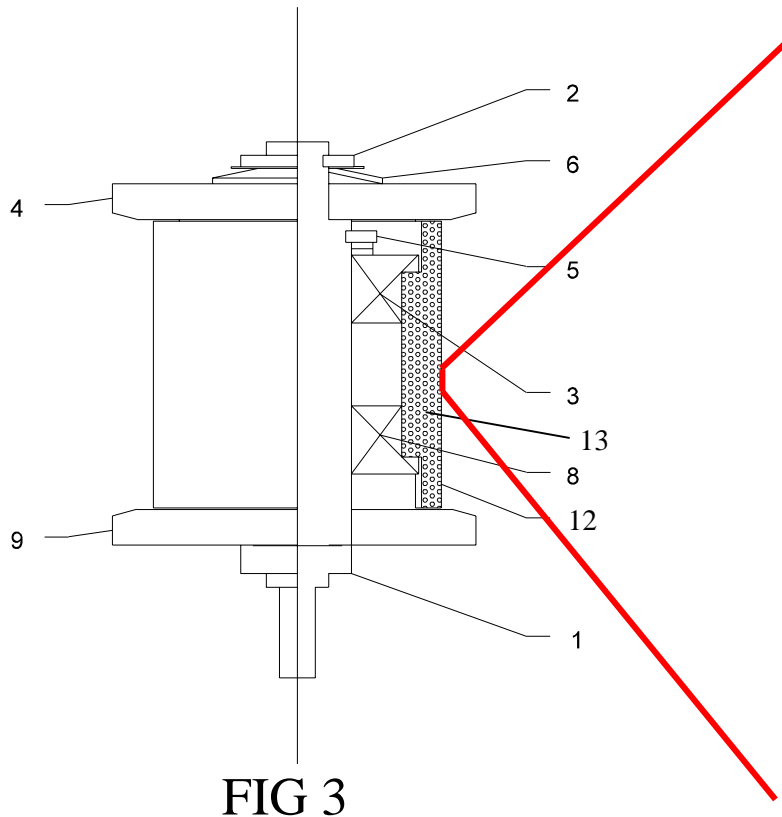
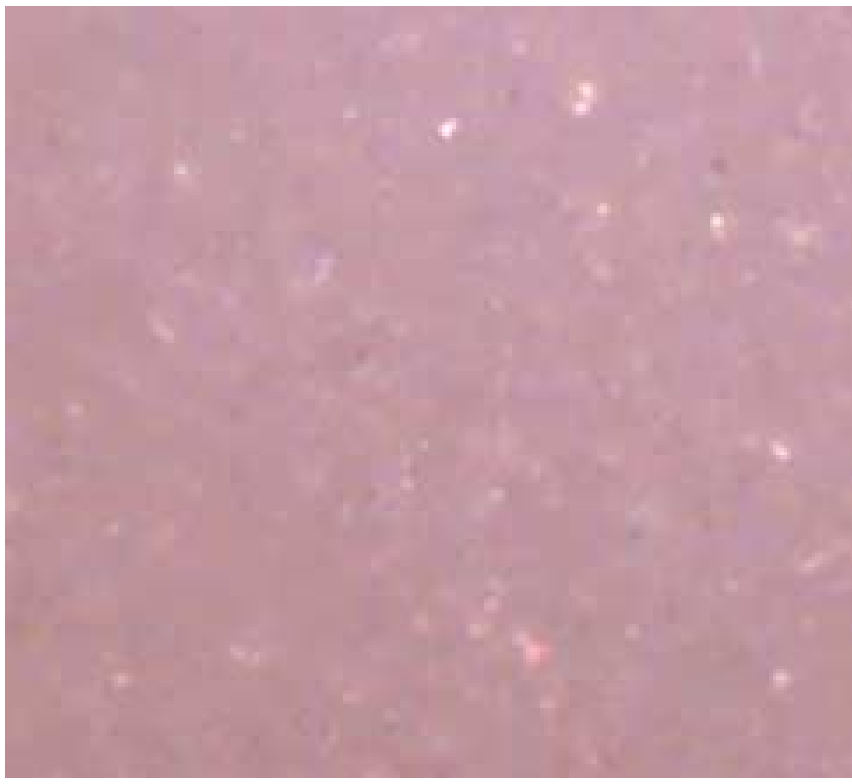


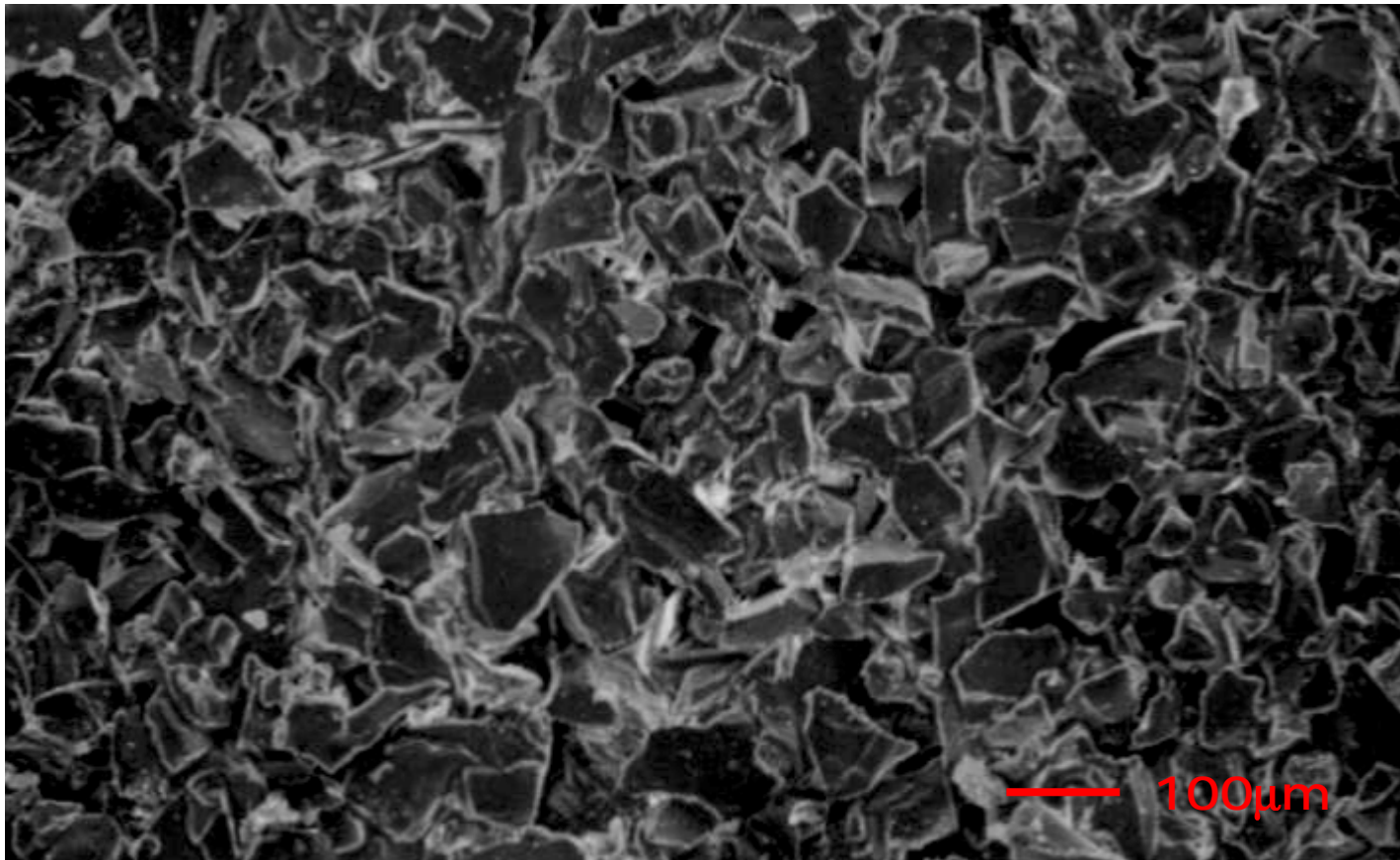
FIG 3



200 x magnification



Porous ceramic surface



Porous ceramic

37% open

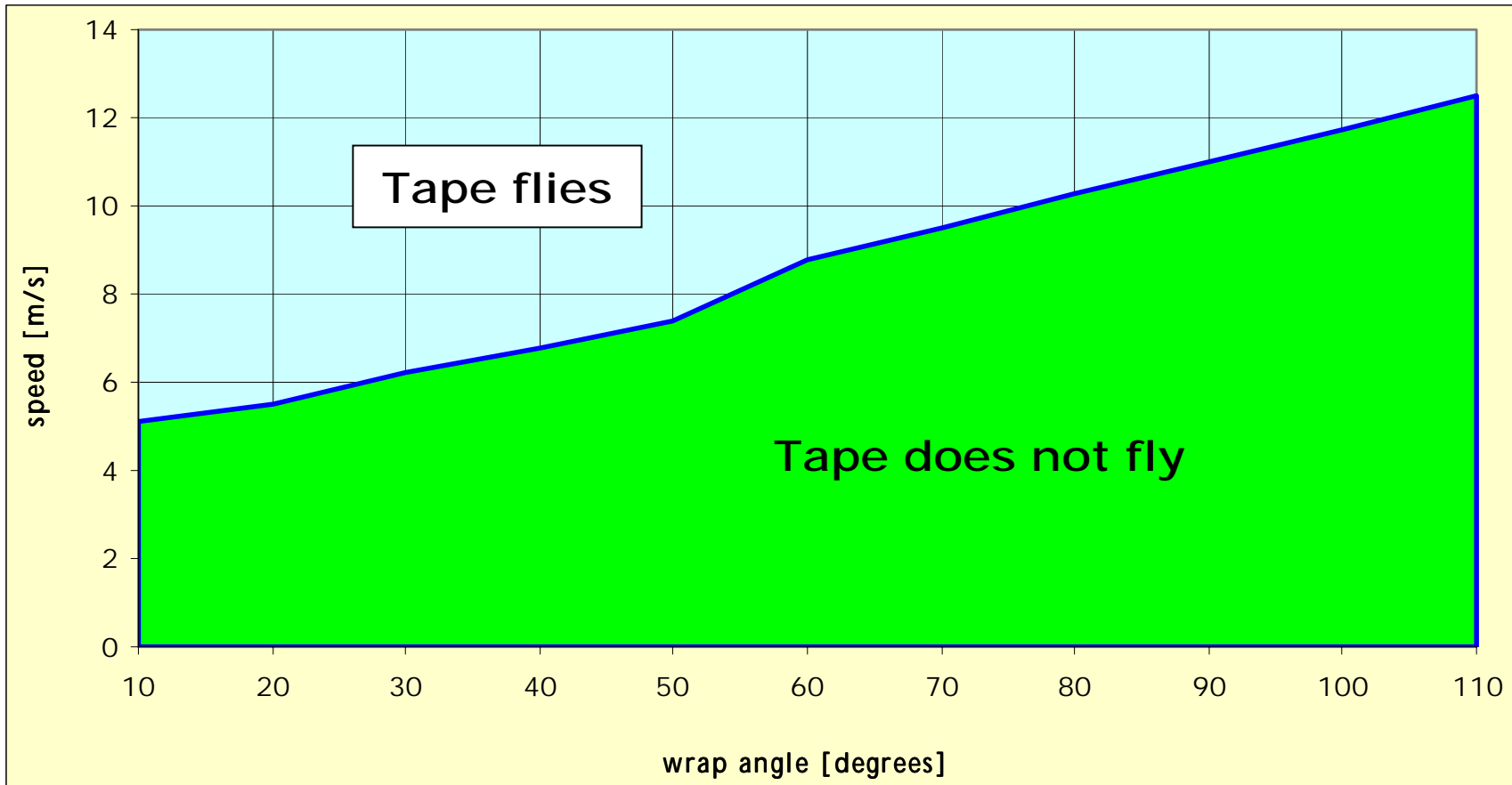
20µm pore size



Porous roller

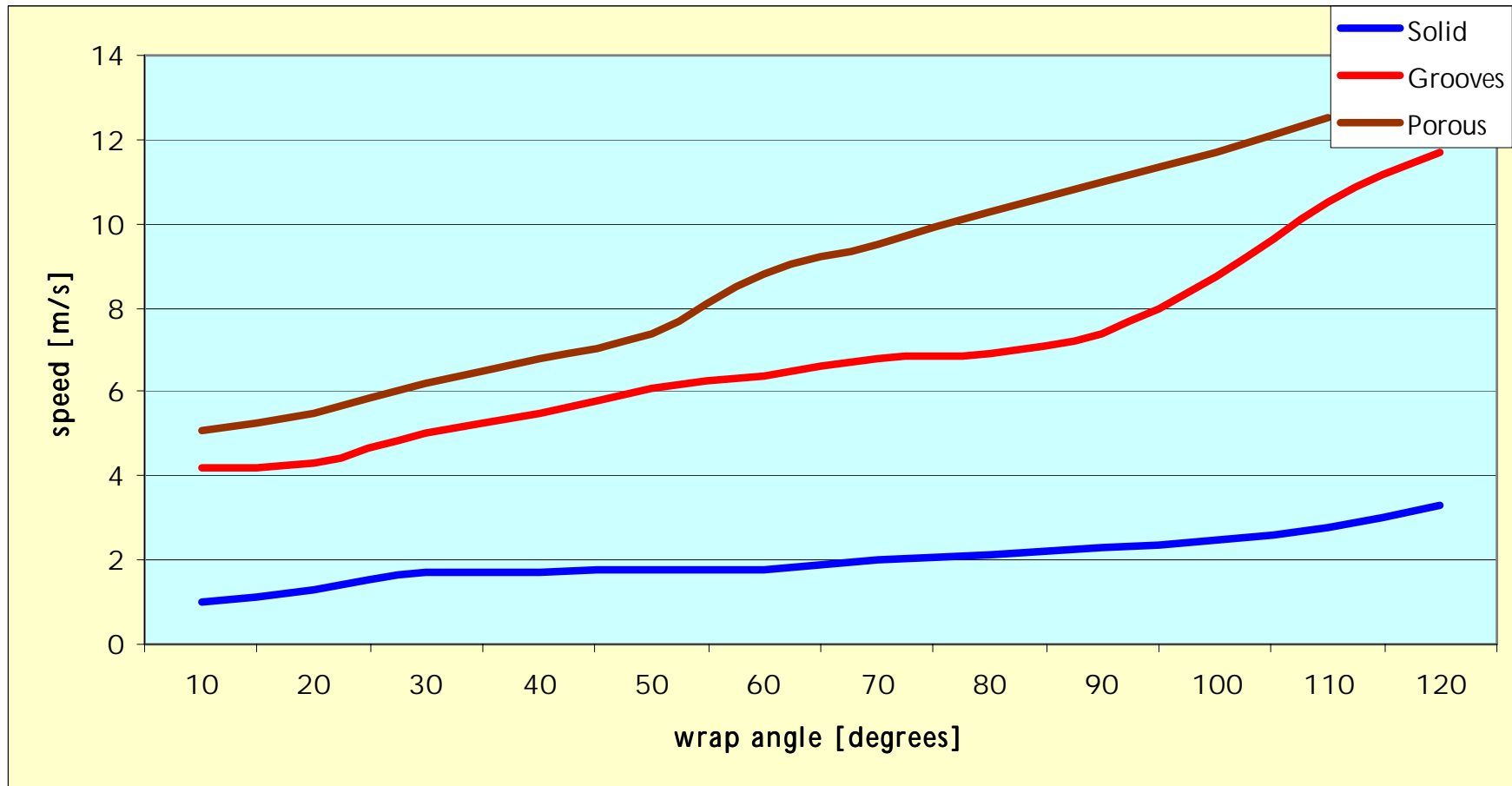


Porous plastic, $\sim 150 \mu\text{m}$ pore size, 50% open





Comparison solid v. grooves v. porous





Roller comparison

- Roller solid surface
 - ◆ suitable for low speed application
- Roller with grooves
 - ◆ suitable for higher speed
 - ◆ tape damage is of serious concern
 - ◆ expensive
- MEII Porous roller
 - ◆ suitable for very high speed
 - ◆ does not damage tape
 - ◆ low cost



MEII porous roller



- Technology is adaptable
 - ◆ fixed, spinning or no flanges
 - ◆ diameter of roller
 - ◆ conductivity of roller
 - ◆ mass of spool
- Samples are available
- Manufacturing
 - ◆ by established roller manufacturers in cooperation with MEII and user



Meeting the challenge

- Improvements in several areas required for future tape drives
- Tape path requires innovation to keep up with developments in other areas
- MEII roller is suitable for high tape speed and for thin tape
- MEII technology helps to build the tape path of the future