Optical Drives
Compact Disk

Last updated 2/15/24

Optical Disks - CD

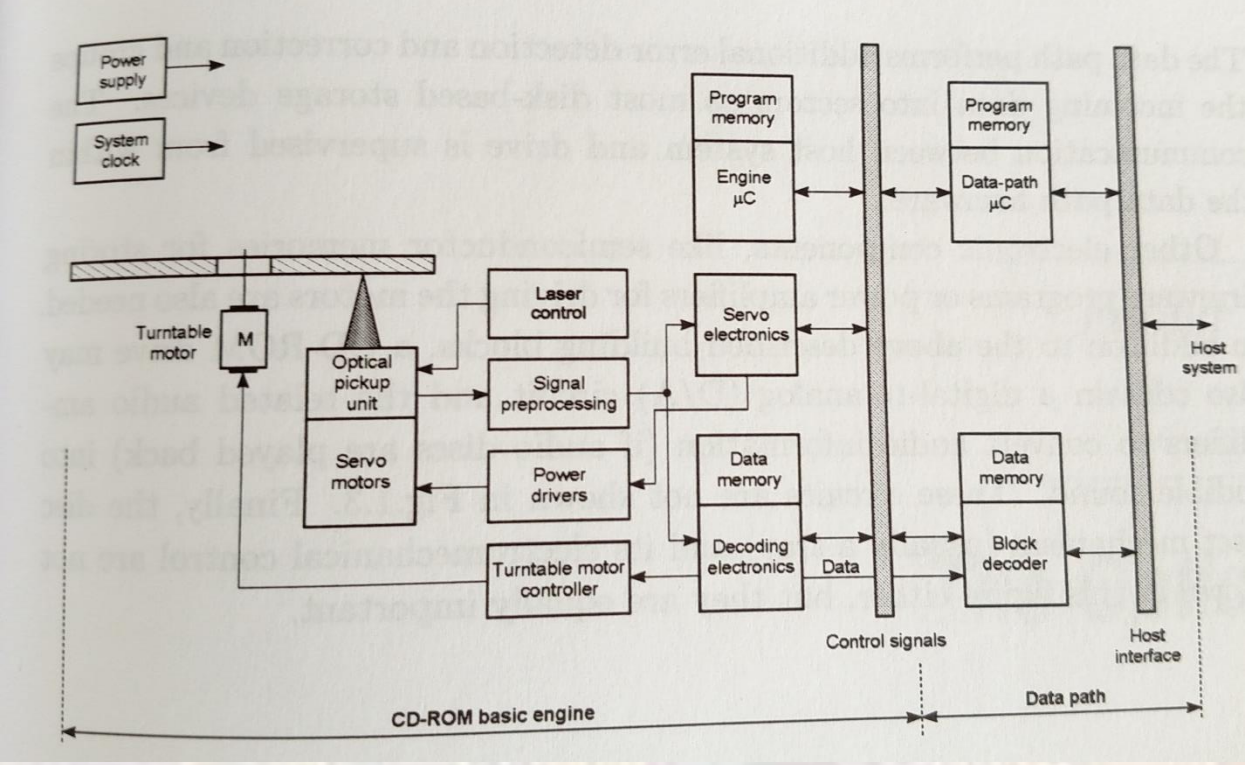
- Overview
  - CD - Compact Disk
  - Originally developed to replace LPs
    - Late 70's
    - Audio
    - Smaller
    - Longer life – no wear damage
    - Manufactured

Optical Disks - CD

- Overview
  - Multiple variations
    - CD-DA – Digital Audio
    - CD-ROM – Read only
    - CD-R – Write once
    - CD-RW – Write many

Optical Disks - CD

- Overview
  - Functional block diagram - Read



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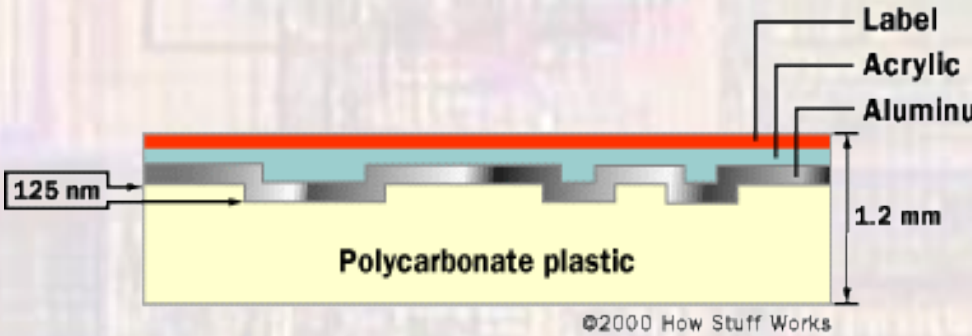
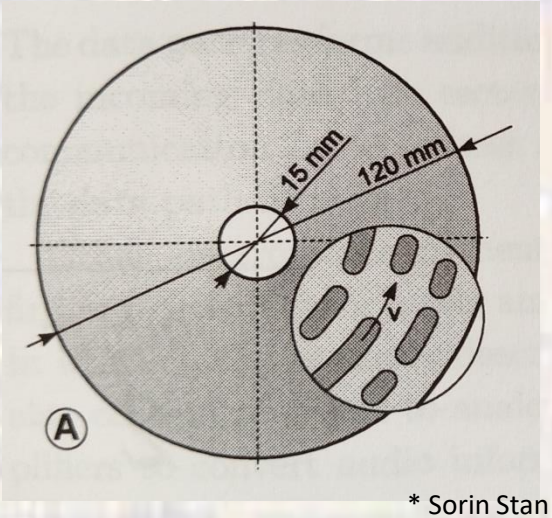
Optical Disks - CD

- Mechanical



  - CD-DA and CD-ROM
    - Data is pressed onto the disk
    - Spiral tracks – 1.5um to 1.7um centers
    - Pits and Lands (everything not a pit)
      - Pits – 0.6um wide
      - Pits – 0.9um – 3.3um long



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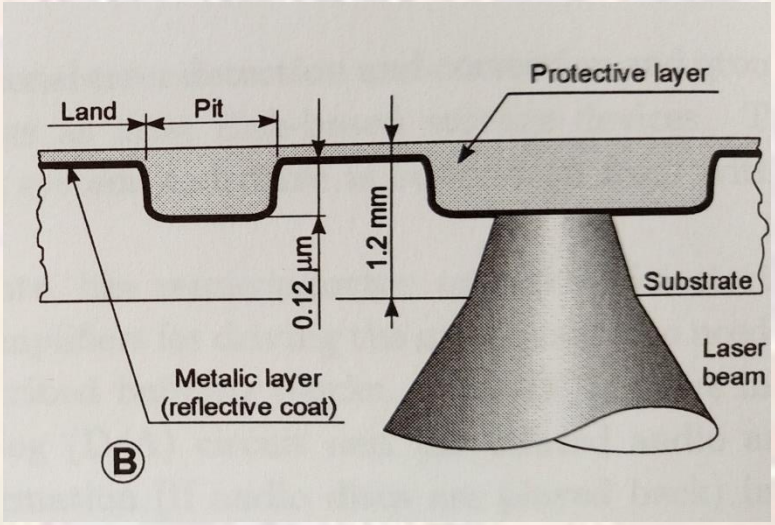

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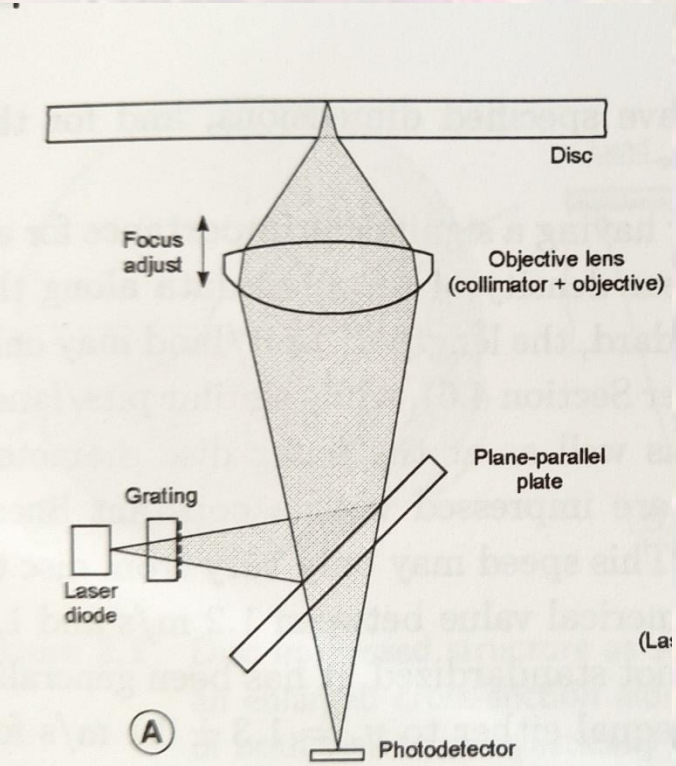
Optical Disks - CD

- Mechanical
  - Simplified Optics
    - 780nm laser
    - 3mW output
    - Split into 3 beams
    - Reflects off CD and back onto a multi sensor detector
    - The pits are designed to cause a quarter wavelength destructive interference → low reflected signal



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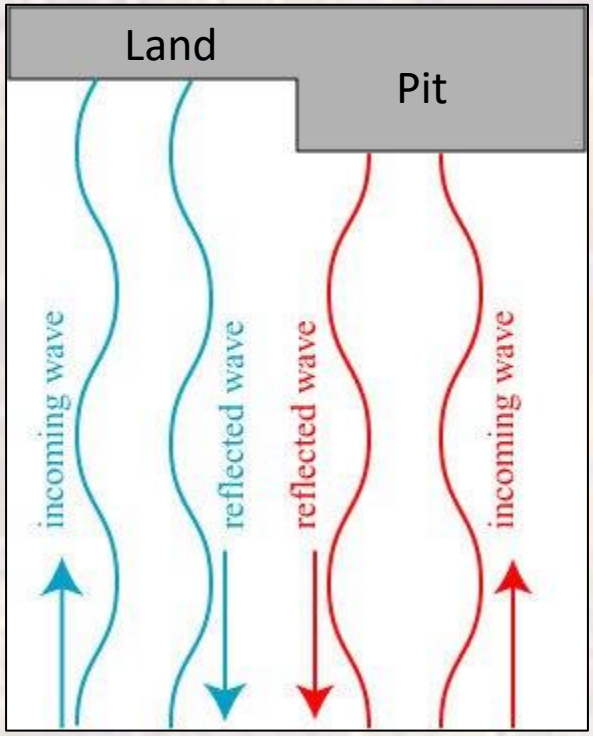
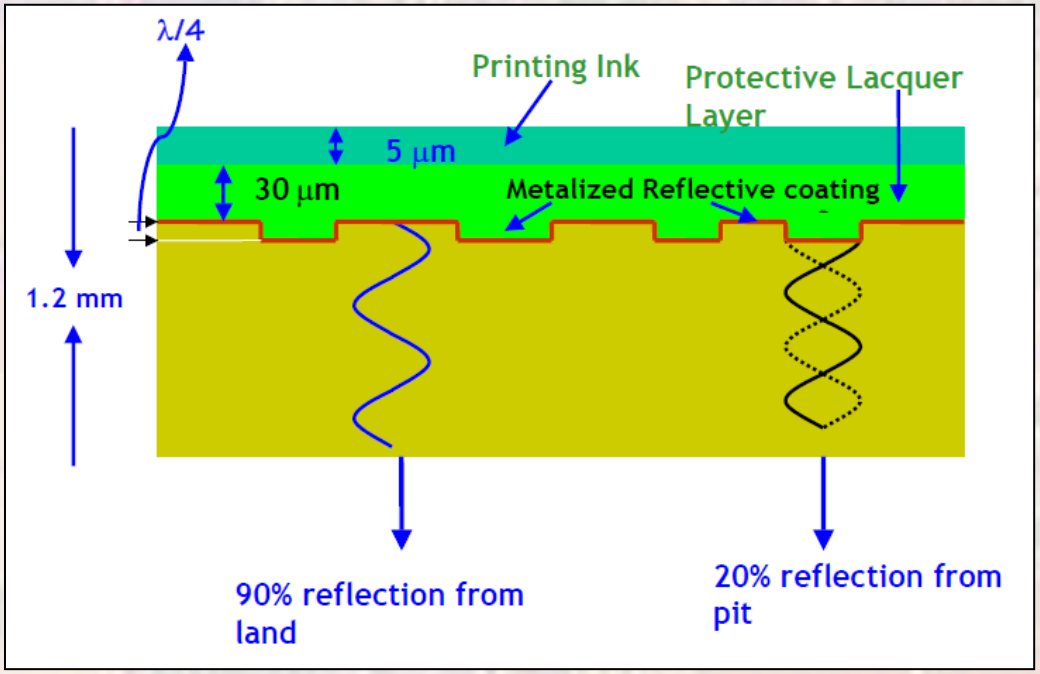
Optical Disks - CD

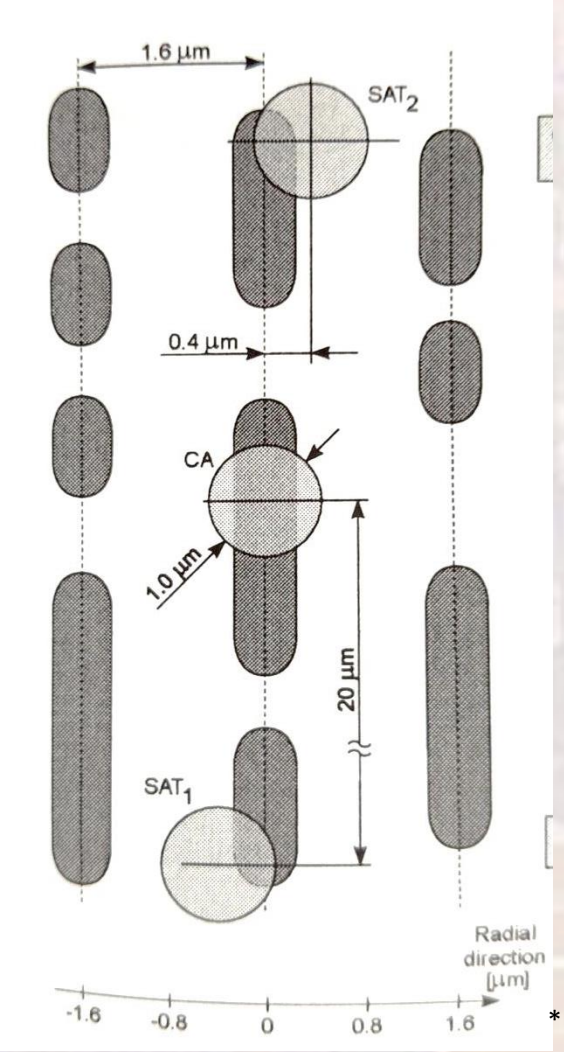
- Mechanical
  - Interference





Optical Disks - CD

- Mechanical
  - 3 beam configuration
    - 1 central beam – data
    - 2 radial beams – tracking



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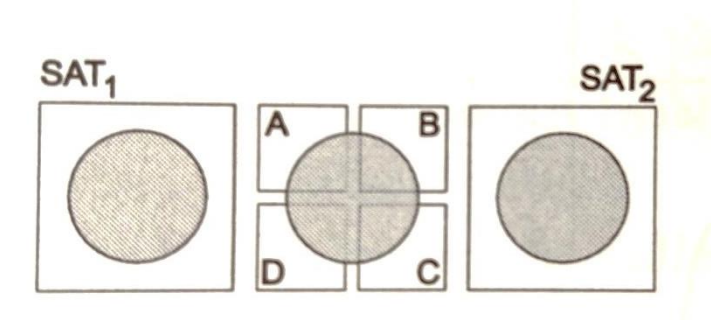
Optical Disks - CD

- Mechanical
  - 3 beam detector
    - Astigmatic focus detection
      - Central spot signal = Fn(A,B,C,D)
    - Twin spot radial detection



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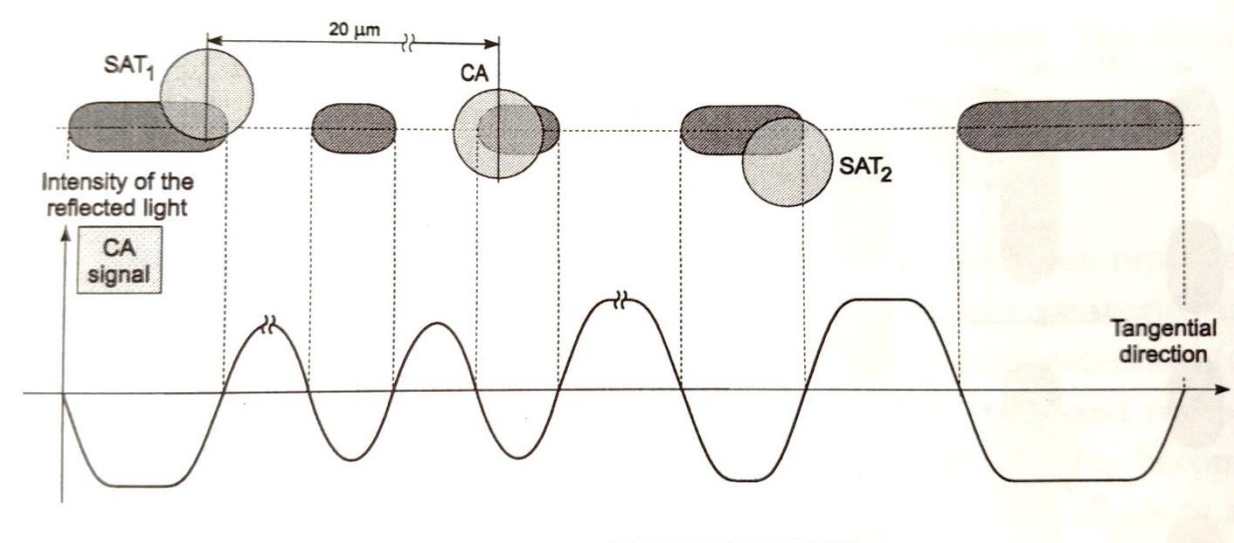

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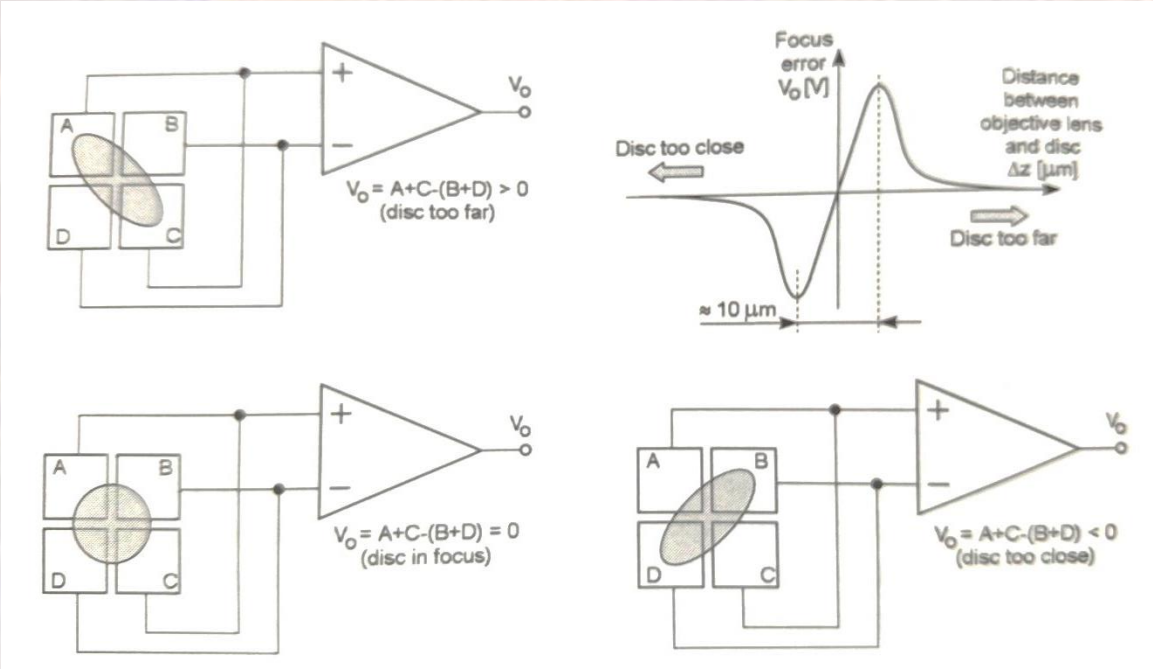
Optical Disks - CD

- Mechanical
  - Astigmatic focus detection
    - Astigmatism intentionally introduced into the optics (rotation of focus)



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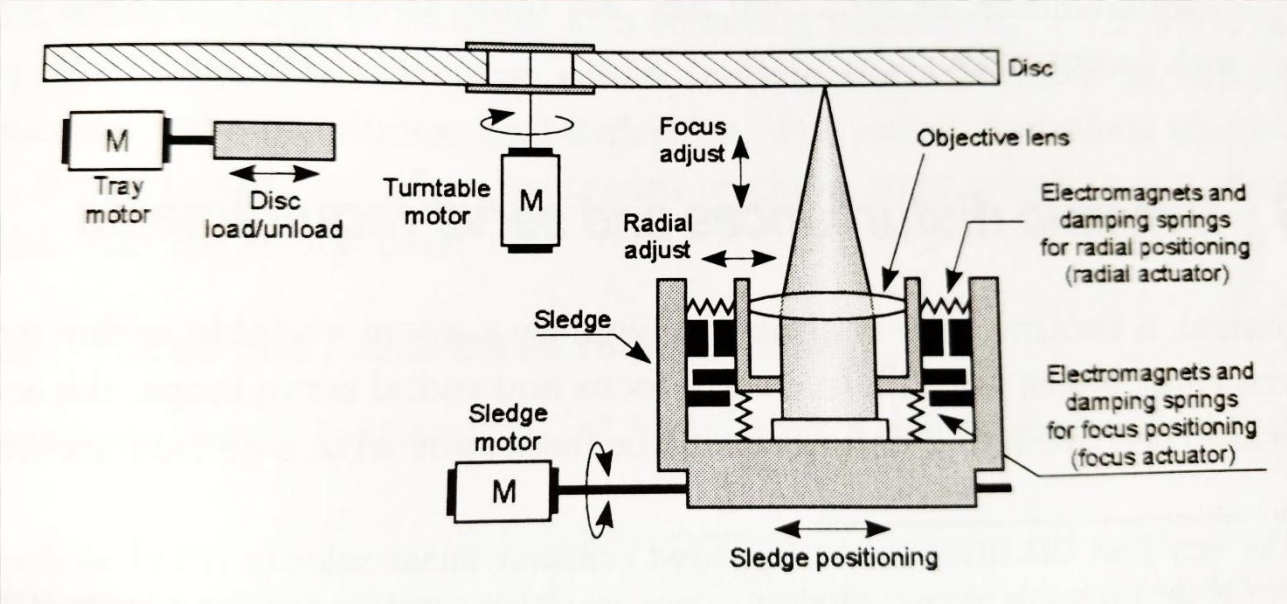
Optical Disks - CD

- Mechanical
  - Laser/Detector actuators
    - Electromagnetic focus and fine positioning control
    - Sledge motor for course (tracking) radial control
    - Servo-loop control



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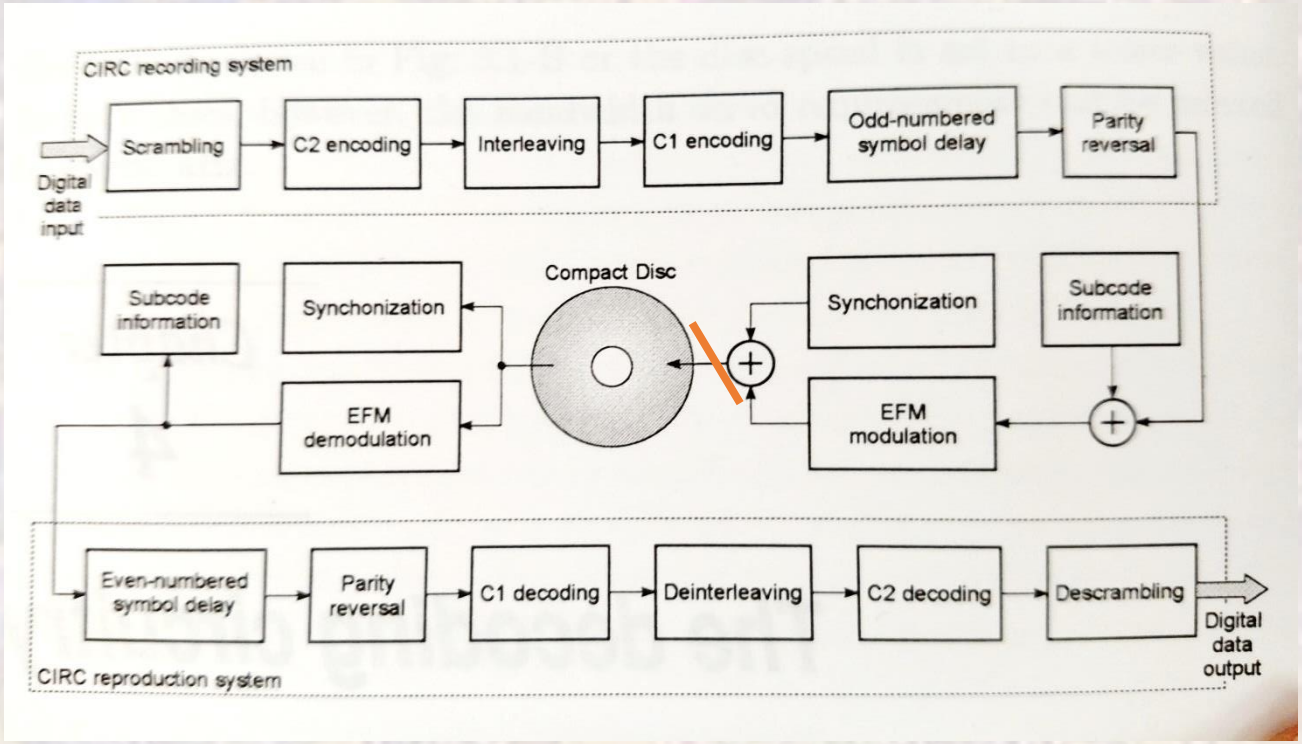
Optical Disks - CD

- Data Channel



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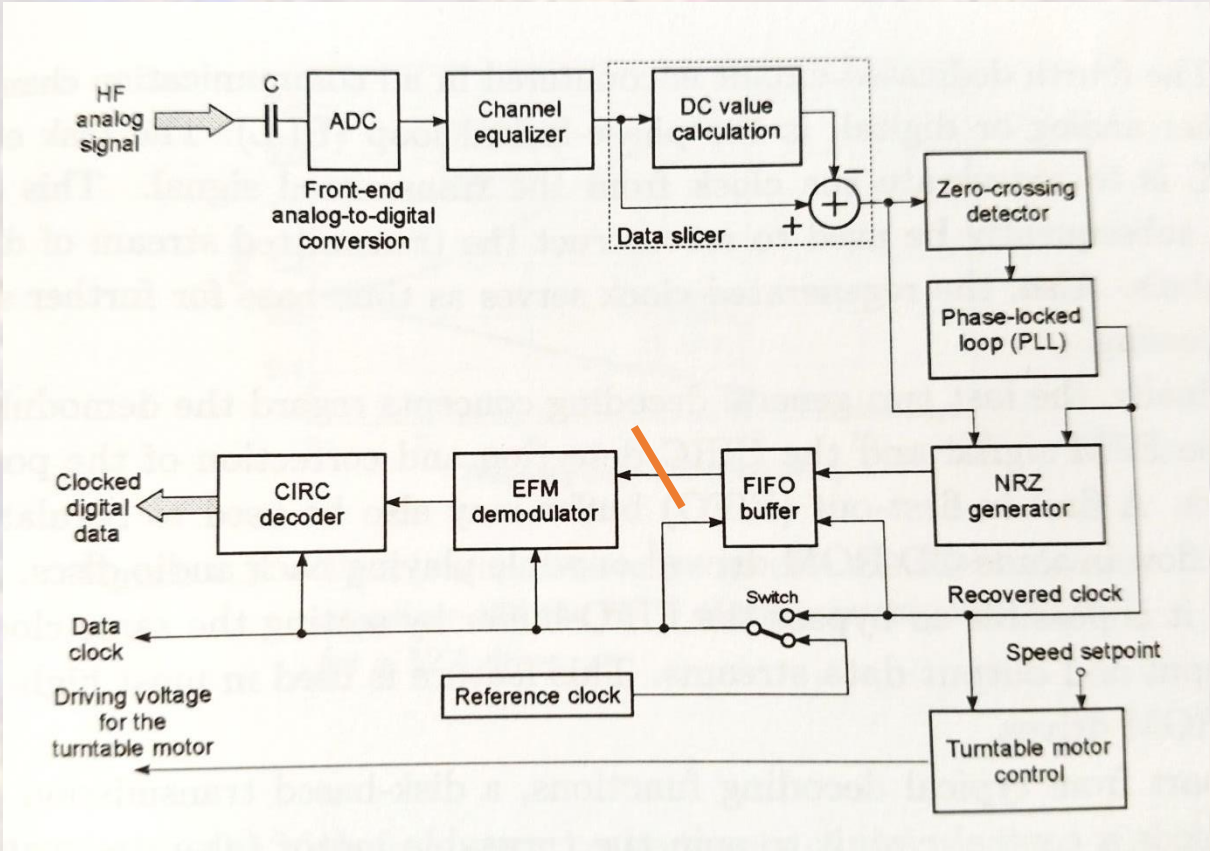
Optical Disks - CD

- Data Channel - Read



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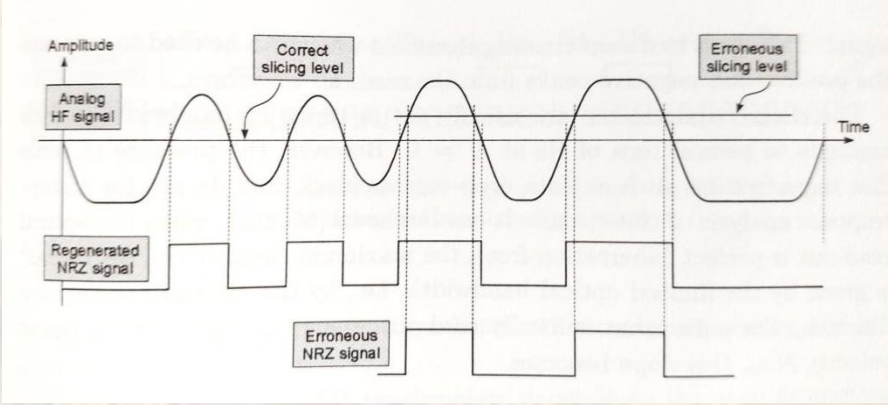
Optical Disks - CD

- Data Channel - Read
  - ADC
    - Early conversion to digital
    - ??? Resolution
    - ??? Input resolution
  - Channel Equalizer
    - Shapes the signal due to optical distortion
    - High Pass characteristic
    - Variable – to support CAV operation (constant angular velocity)

Optical Disks - CD

- Data Channel - Read
  - Data Slicer
    - Determine a level to consider as the transition level from 0 to 1
    - Signal from the laser is AC coupled
    - Calculate the DC level of the signal
  - Zero Crossing Detector
    - Create a digital signal associated with the locations the signal crosses the slicing level



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Optical Disks - CD

- Data Channel - Read
  - Clock Recovery
    - PLL based
    - Aided by modulation scheme
  - NRZ Generator
    - Detects the changes and no-changes in the digital stream
    - No-change → 0
    - Change → 1
  - FIFO
    - Buffer to control output stream
    - When full – stop reading

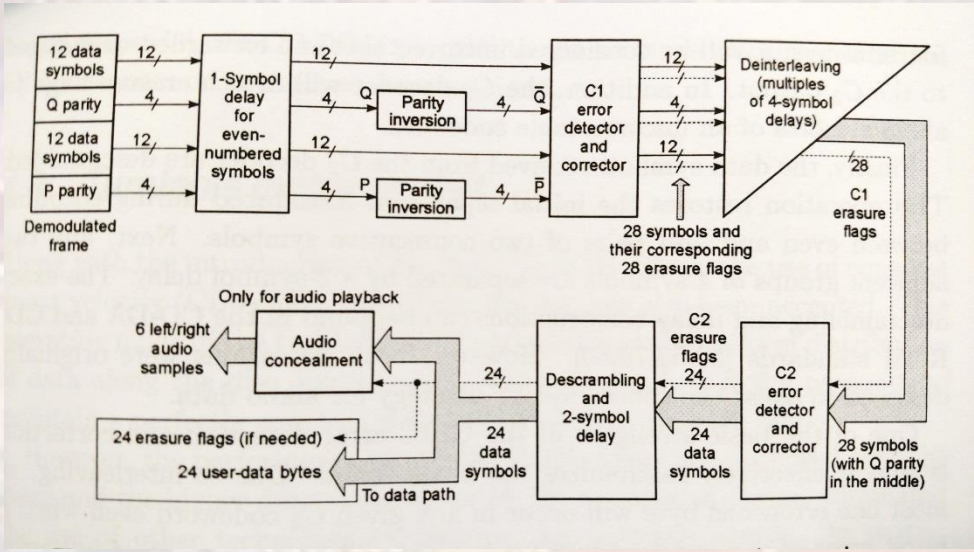
Optical Disks - CD

- Data Channel - Read
  - EFM Demodulator
    - Eight to Fourteen Modulation
    - RLL Code (2,10)
      - 8 bit data → 14 bit symbol
      - Shortest pit/land = 0.3um x 3
      - Longest pit/land = 0.3um x 11
    - 3 merging bits are placed between each 14 bit symbol
      - Removed by the demodulator

Optical Disks - CD

- Data Channel - Read

  - CIRC
    - Cross Interleaved Reed-Solomon Code
    - Error Detection and Correction
    - Linear Block Codes
      - C1 – 24 data + 4 parity (from C2) bytes
      - C2 – 24 data bytes
    - Parity
      - 2 sets of 4 bytes
      - one set for each C1/C2



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Optical Disks - CD

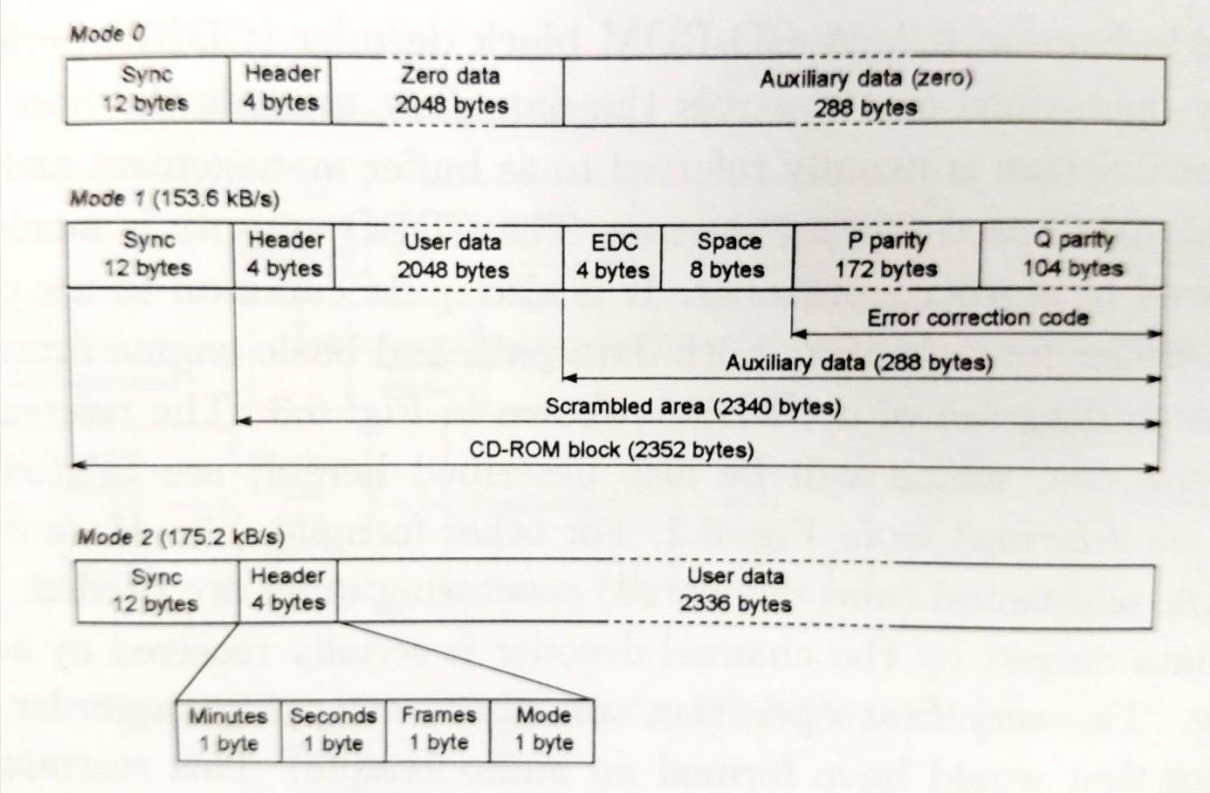
- Data Channel - Read
  - Subcode
    - Contains additional information
      - Audio vs data
      - Music title
      - Marks data blocks on a CD-ROM
      - Position on the disk
    - 8 logical subcode channels (P-W)
    - 1 byte in every frame
    - Combines bytes from 98 consecutive frames

Optical Disks - CD

- Audio - Framing
  - 24 bytes of user data
    - 2x12
  - 8 Bytes of CIRC
    - 2 x 4
  - 1 Subcode Symbol
    → 33 Bytes
  - EFM Coding
    - 8 → 14
    - 3 merging bits
      → 17 bits / byte
      → 561 channel bits
  - 27 sync bits → 588 bits / frame

Optical Disks - CD

- ROM - Framing
  - 3 modes



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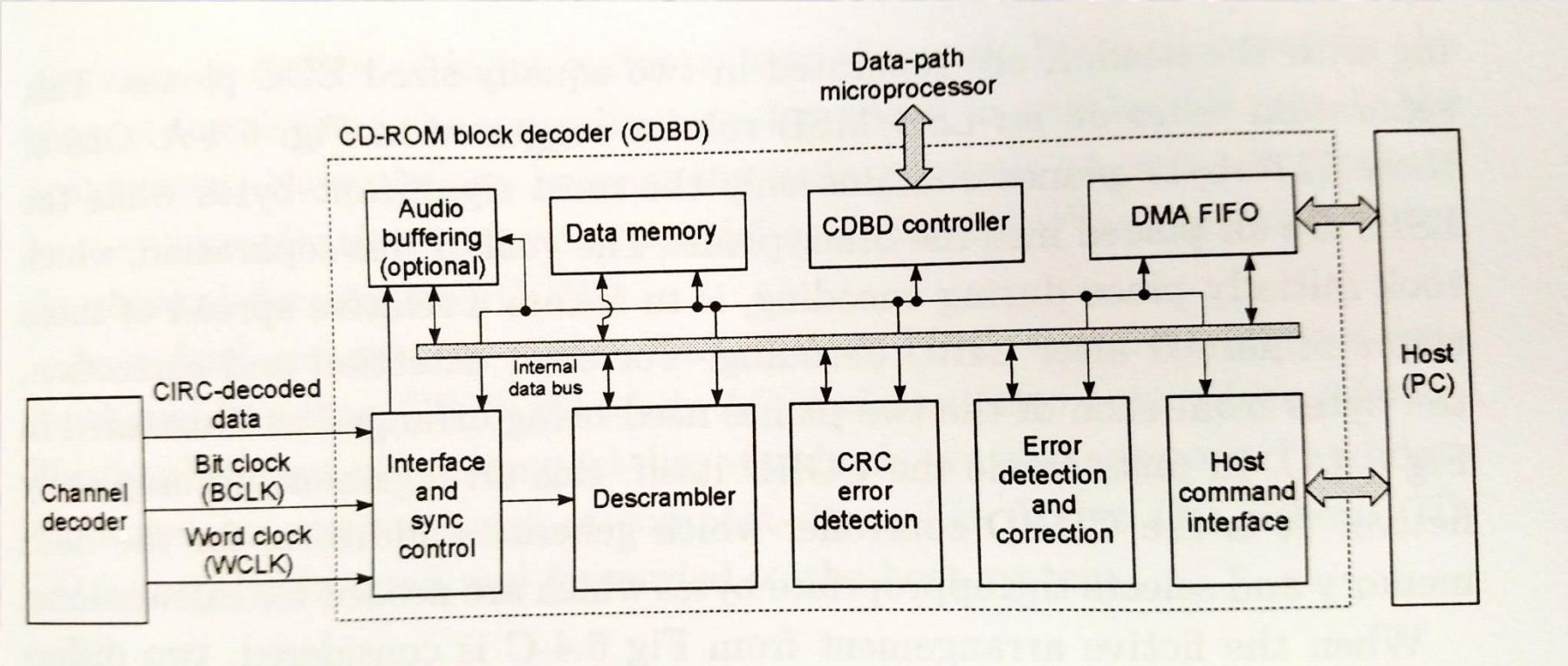
Optical Disks - CD

- Data ROM – additional processing



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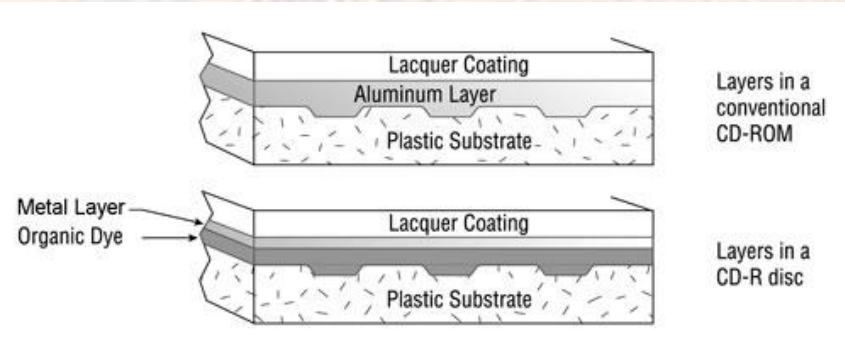
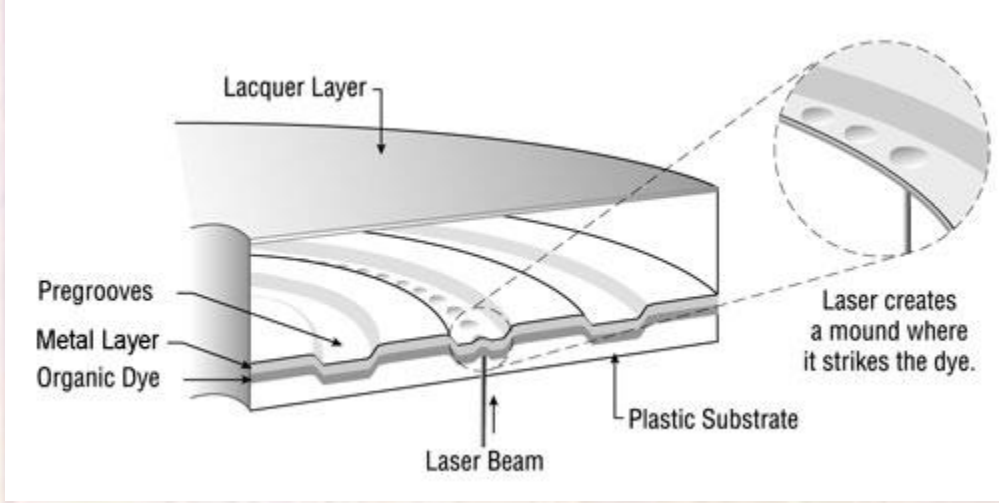
Optical Disks - CD

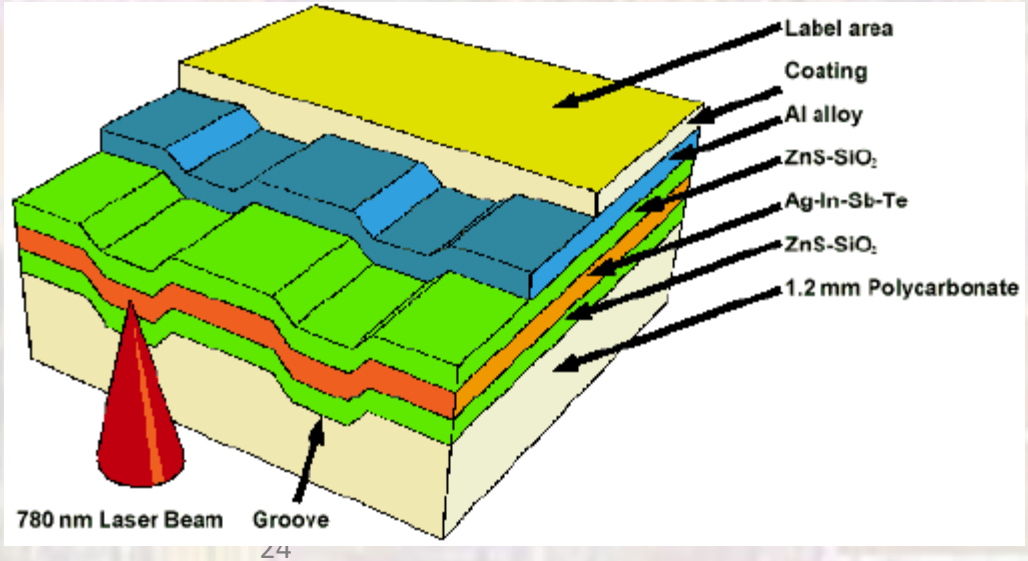
- R
  - Write once
    - Higher power laser for writing
    - Pre-grooved
    - Laser modifies the Dye layer (normally transparent)
      - Changes it to opaque – looks like a pit
      - Causes expansion in the polycarbonate – looks like a pit





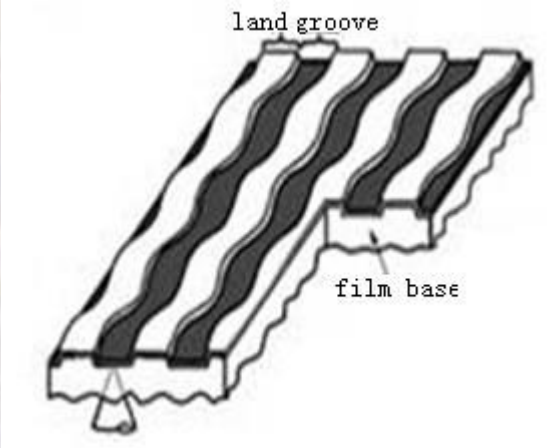
Optical Disks - CD

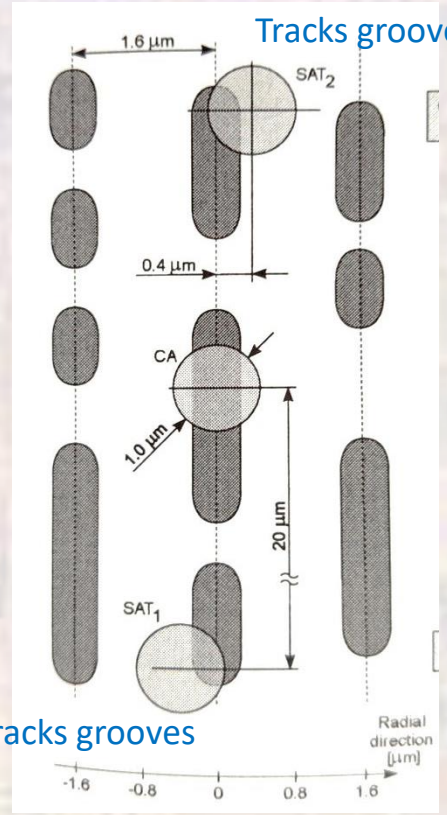
- RW
  - Read/Write
    - Higher power laser for writing
    - Pre-grooved – used for tracking
    - Laser modifies the Phase Change material
      - Highest power changes it to amorphous - opaque
      - Medium power changes it to crystalline - transparent



Optical Disks - CD

- R and RW
  - Pre-groove Wobble
    - ATIP – Absolute Time In Pre-groove
    - Pre groove has a 140.6Kz wobble
    - Used for tracking, time reference





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