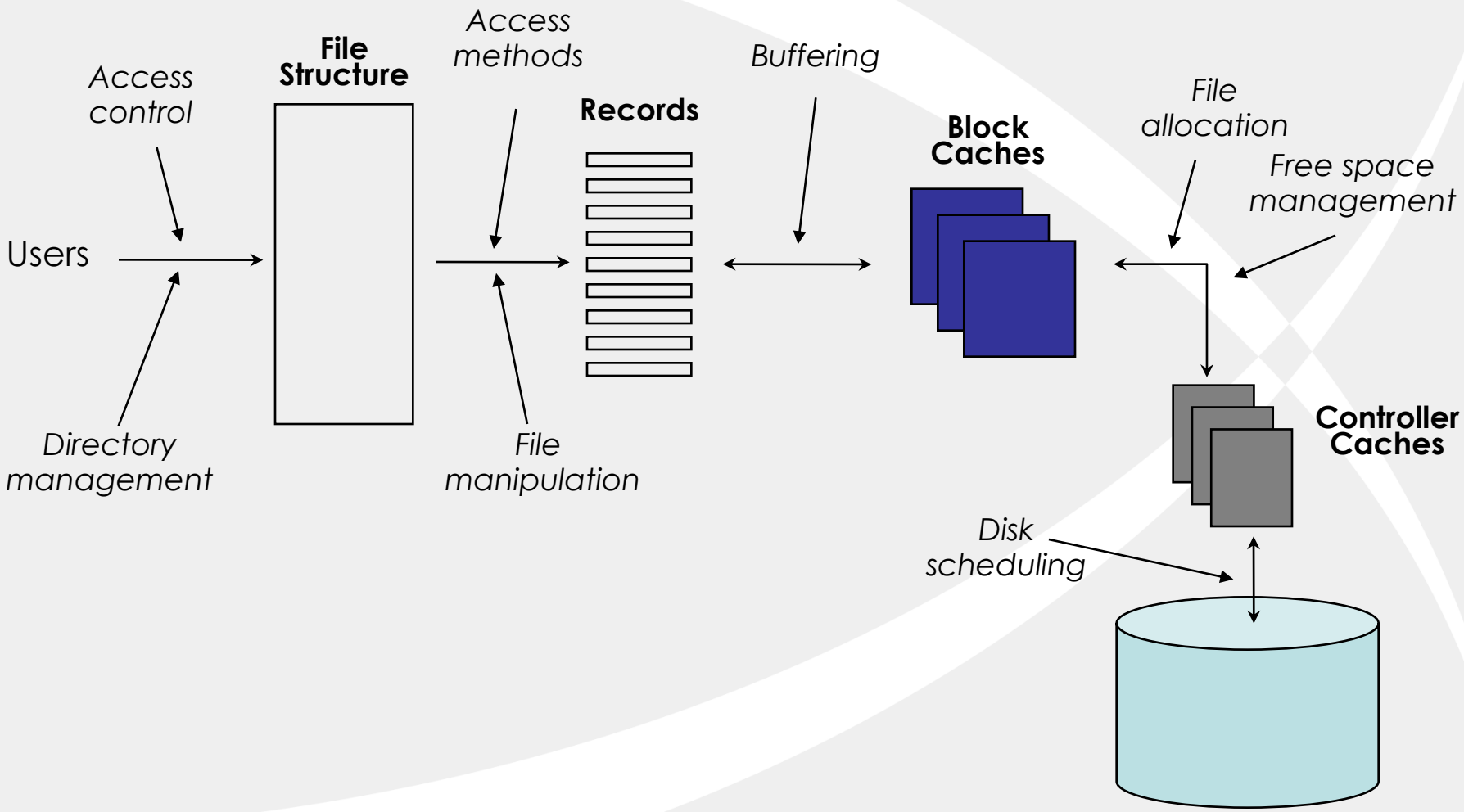
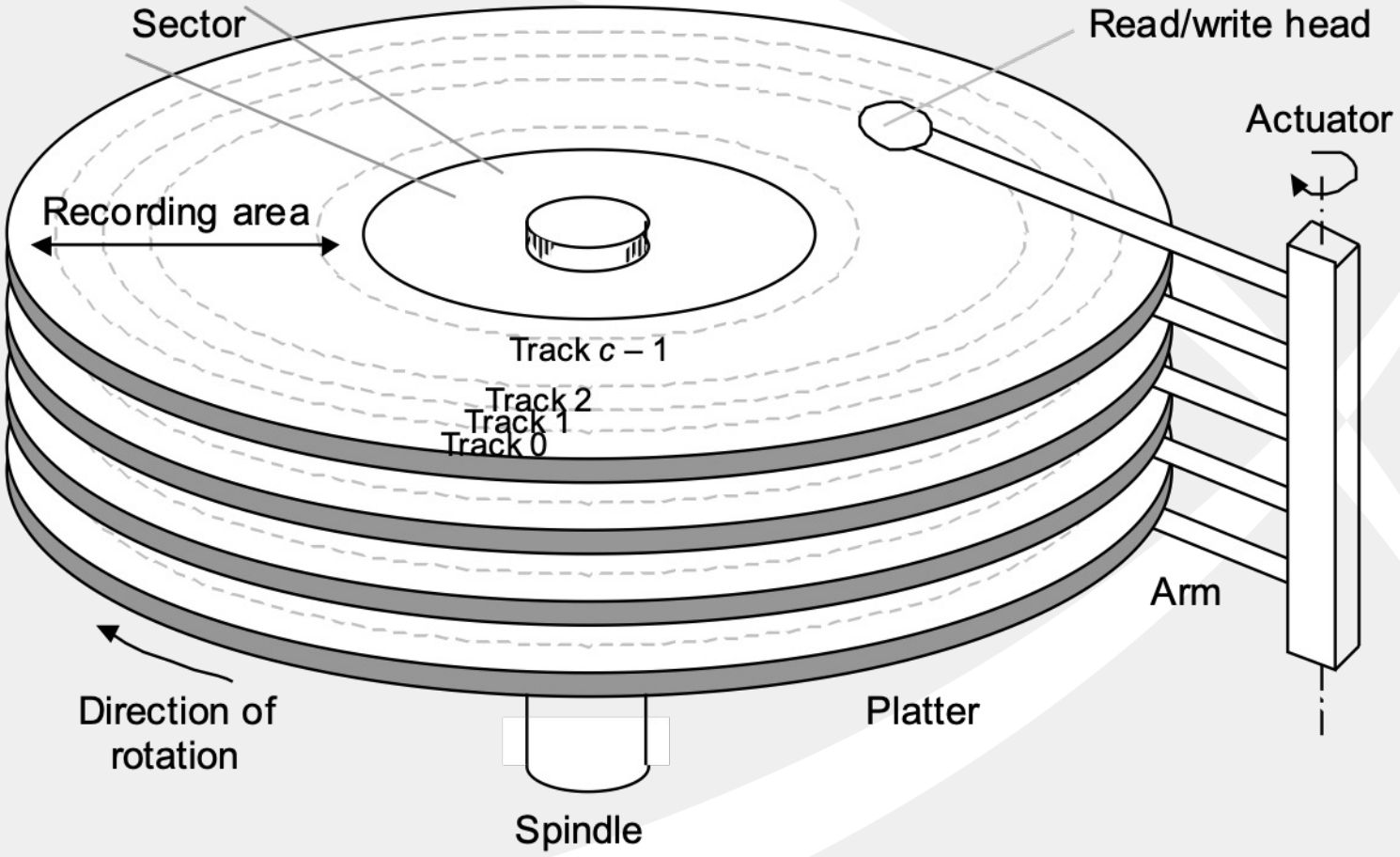
Secondary Storage System

Elements of storage a system

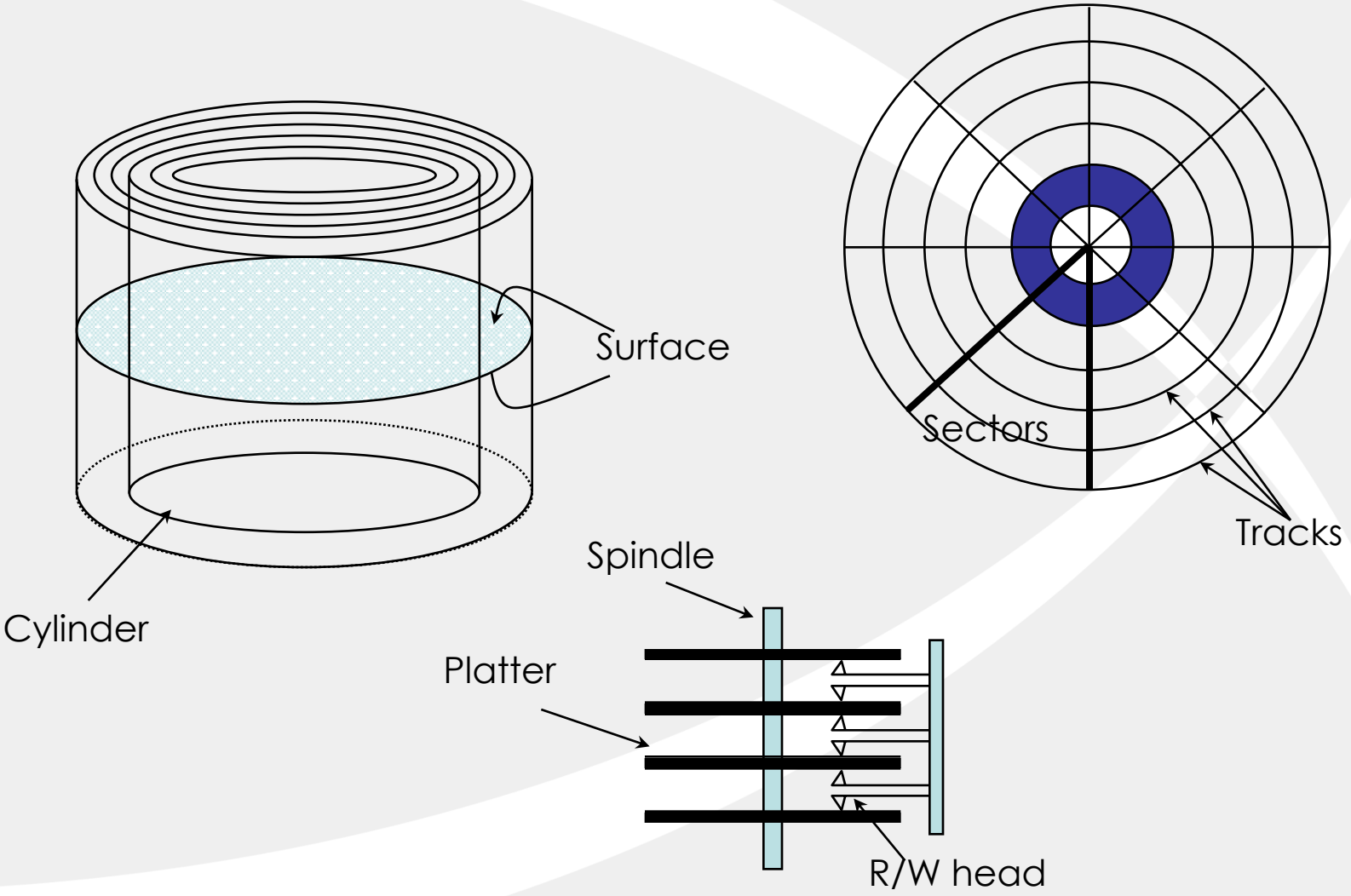


Disk Memory Basics

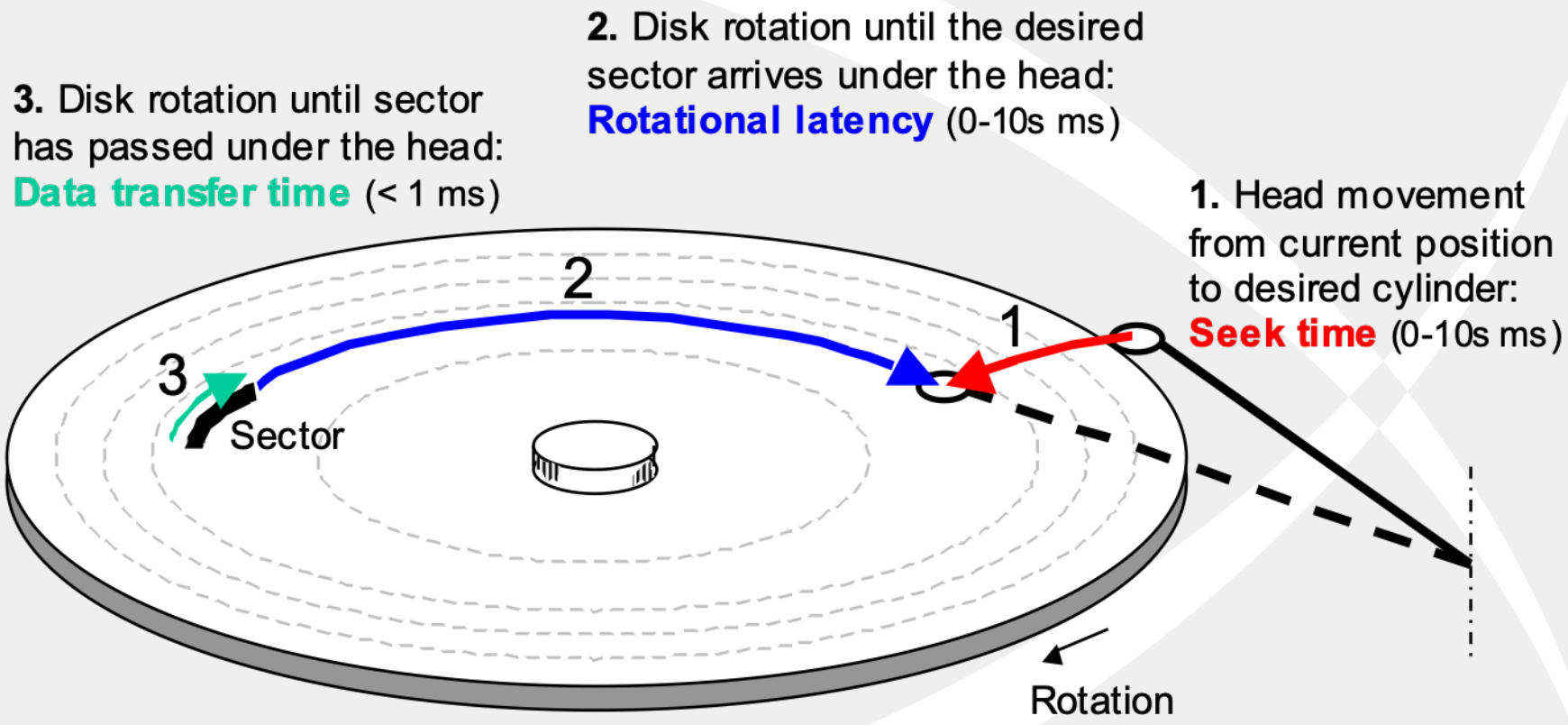


Disk memory elements and key terms.

Disk structure (another view)



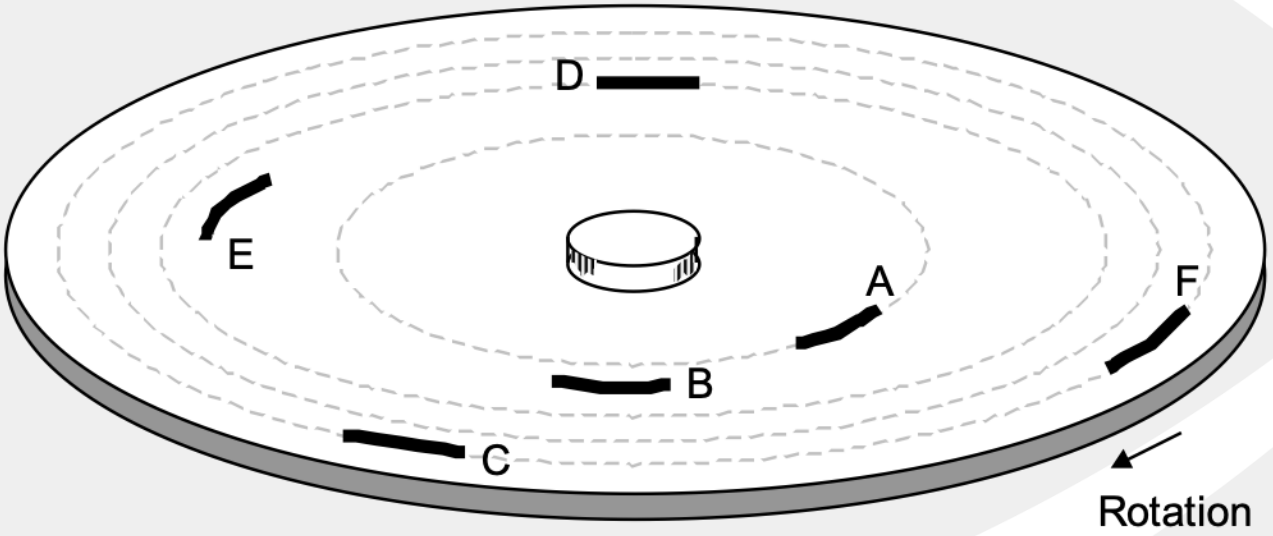
Access Time for a Disk



The three components of disk access time. Disks that spin faster have a shorter average and worst-case access time.

Disk Performance

Average rotational latency = 30 / rpm s = 30 000 / rpm ms



Arrival order of access requests:

A, B, C, D, E, F

Possible out-of-order reading:

C, F, D, E, B, A

Reducing average seek time and rotational latency by performing disk accesses out of order.

Disk Caching

Same idea as processor cache: bridge main-disk speed gap

Read/write an entire track with each disk access:
"Access one sector, get 100s free," hit rate around 90%
Disks listed in above table have buffers from 1/8 to 16 MB
Rotational latency eliminated; can start from any sector
Need back-up power so as not to lose changes in disk cache

Placement options for disk cache

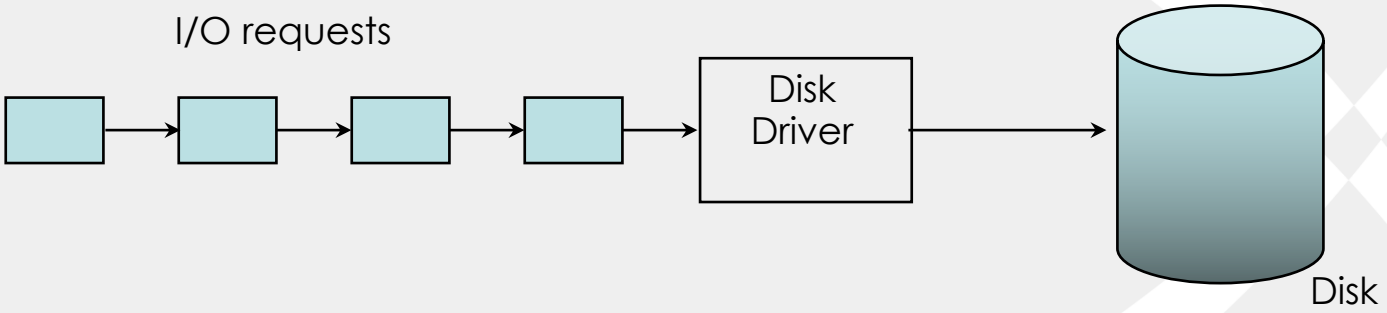
In the disk controller:
Suffers from bus and controller latencies even for a cache hit

Closer to the CPU:
Avoids latencies and allows for better utilization of space

Intermediate or multilevel solutions

Disk scheduling

- Scheduling problem: maximize the throughput with concurrent I/O requests from



- Strategy: minimize the time spent by disk seeking for data – maximizes the time spent reading/writing data

Disk scheduling strategies

- Commonly used strategies include:
  - *Random*
    - select from pool randomly
    - worst performer
    - sometimes useful as a benchmark for analysis and simulation
  - *First Come First Served (FCFS) or FIFO*
    - fairest of them all; no starvation; requests are honored in the order they are received
    - works well for few processes (principle of locality)
    - approaches to r*andom* as number of processes competing for the given disk increases

Disk scheduling strategies

- *Priority*
  - access to the disk is not actually controlled by the disk management software
  - based on processes' execution priority
  - designed to meet job throughput criteria and *not* to optimize the disk usage
- *Last In First Out (LIFO)*
  - service the most recently arriving request first
  - can be useful for processing sequential files
  - real danger of starvation; once a process falls behind it can be services only if the entire list ahead of it empties

Disk scheduling strategies

- Above algorithms have based disk scheduling decision on the requestor process
- Following algorithms use requested item, i.e. the requested disk address
  - *Shortest Service Time First (SSTF)*
    - select the item requiring the shortest seek time
    - no guarantee of improved average seek time in any particular circumstance but
    - in general better average seek time than FIFO
    - random tie breaker used, if needed, to decide in which direction to move

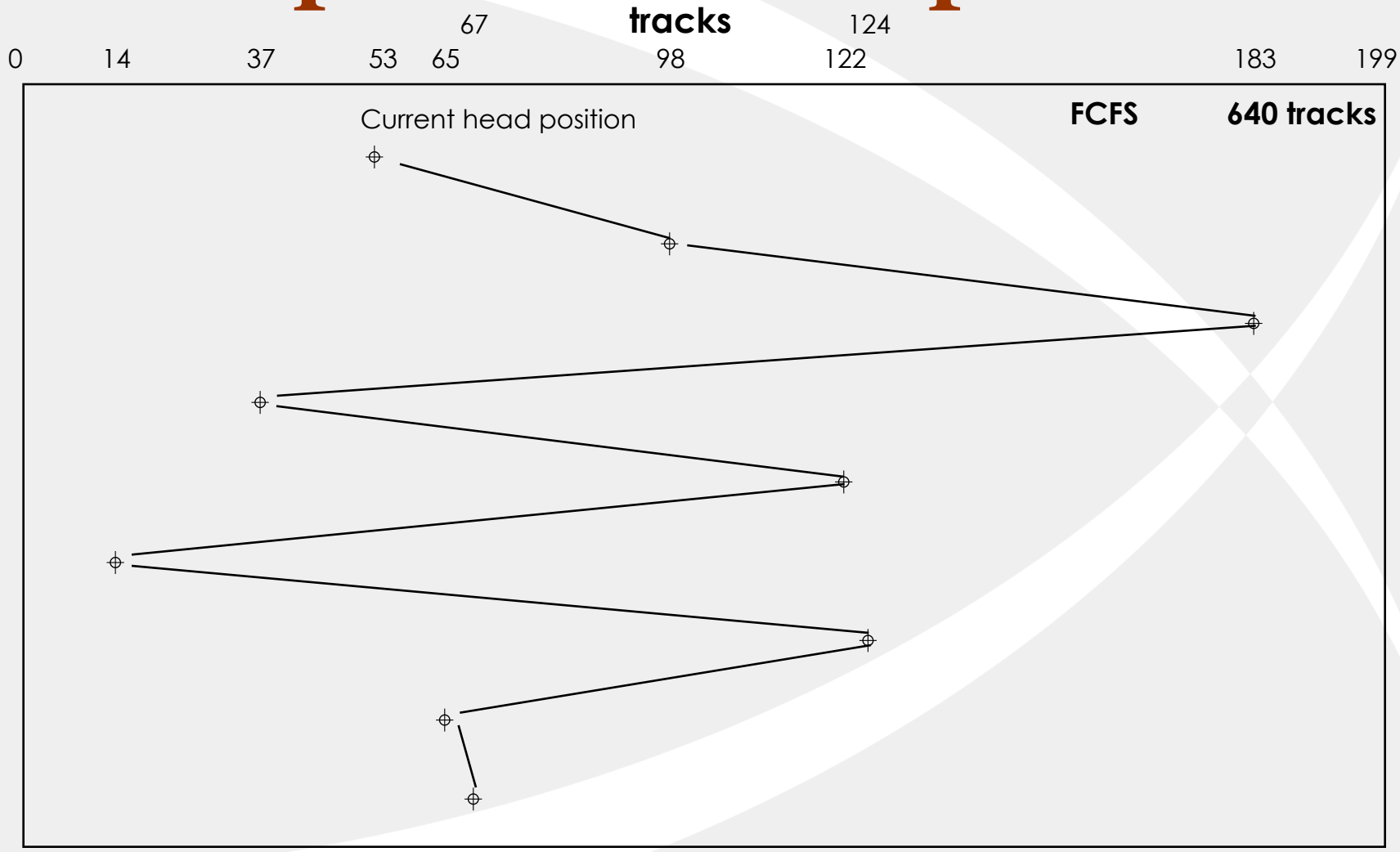
Disk scheduling strategies

- *SCAN*—back and forth over disk
  - heads move in only one direction until the last track is reached, then the direction is reversed
  - if the direction of the heads' travel is reversed once there are no more requests in that direction this method is called *LOOK*
  - no danger of starvation, but
  - biased **against** the most recently used area on the disk
    - Doesn't exploit locality as well as SSTF though or as LIFO
  - often similar to *SSTF*
- *C-SCAN*—circular SCAN or one way SCAN and fast return
  - scans in only one direction to the last track and then returns heads quickly to the beginning
  - reduces the maximum delay for new arrivals

Disk scheduling strategies

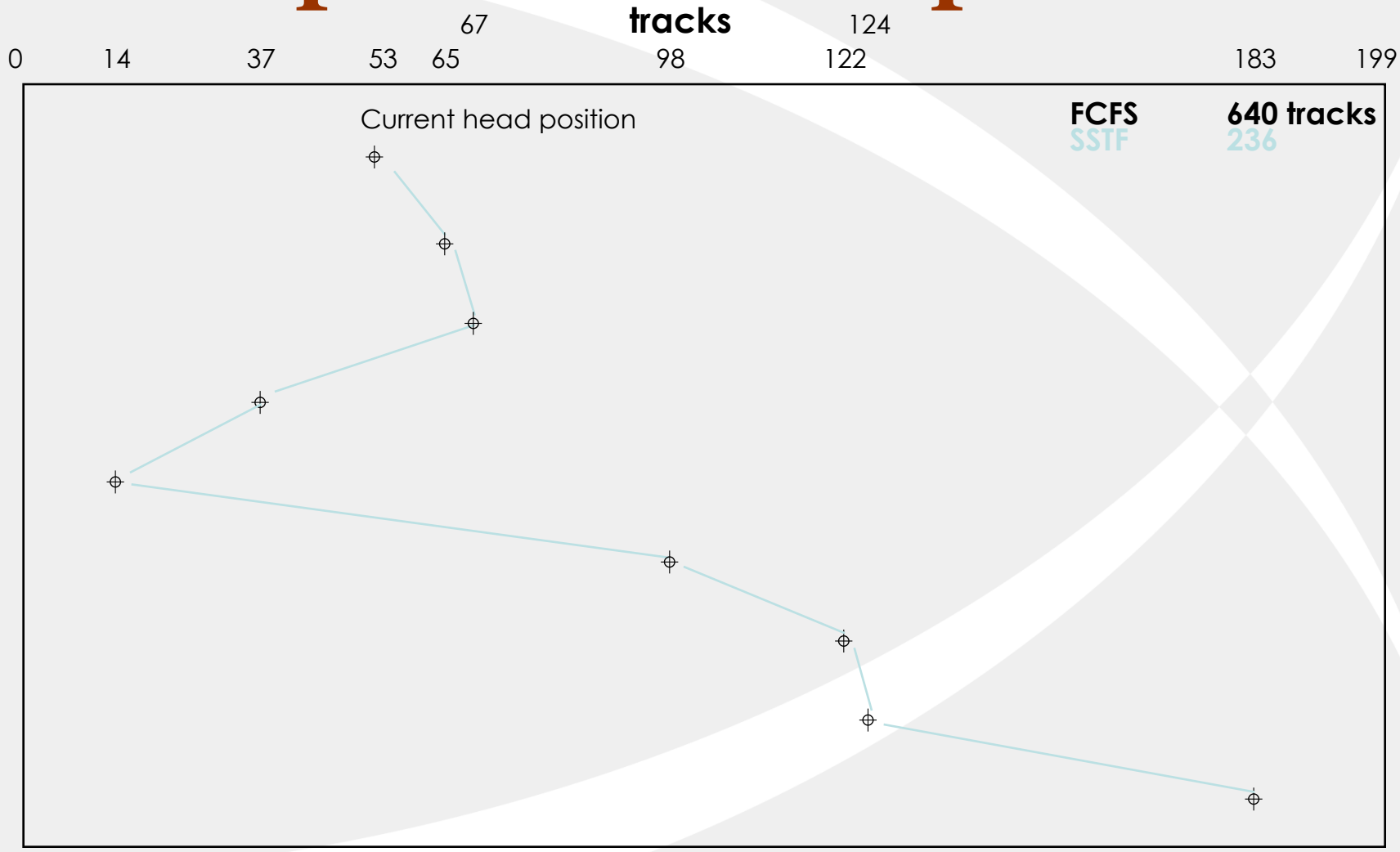
- *LOOK*—look for a request before moving in that direction
  - Heads move in only one direction until there are no more requests in that direction, then the direction is reversed.
- *C-LOOK*—circular LOOK
  - Scans in only one direction until there are no more requests in that direction and then returns heads quickly to the beginning

A comparative example—FCFS



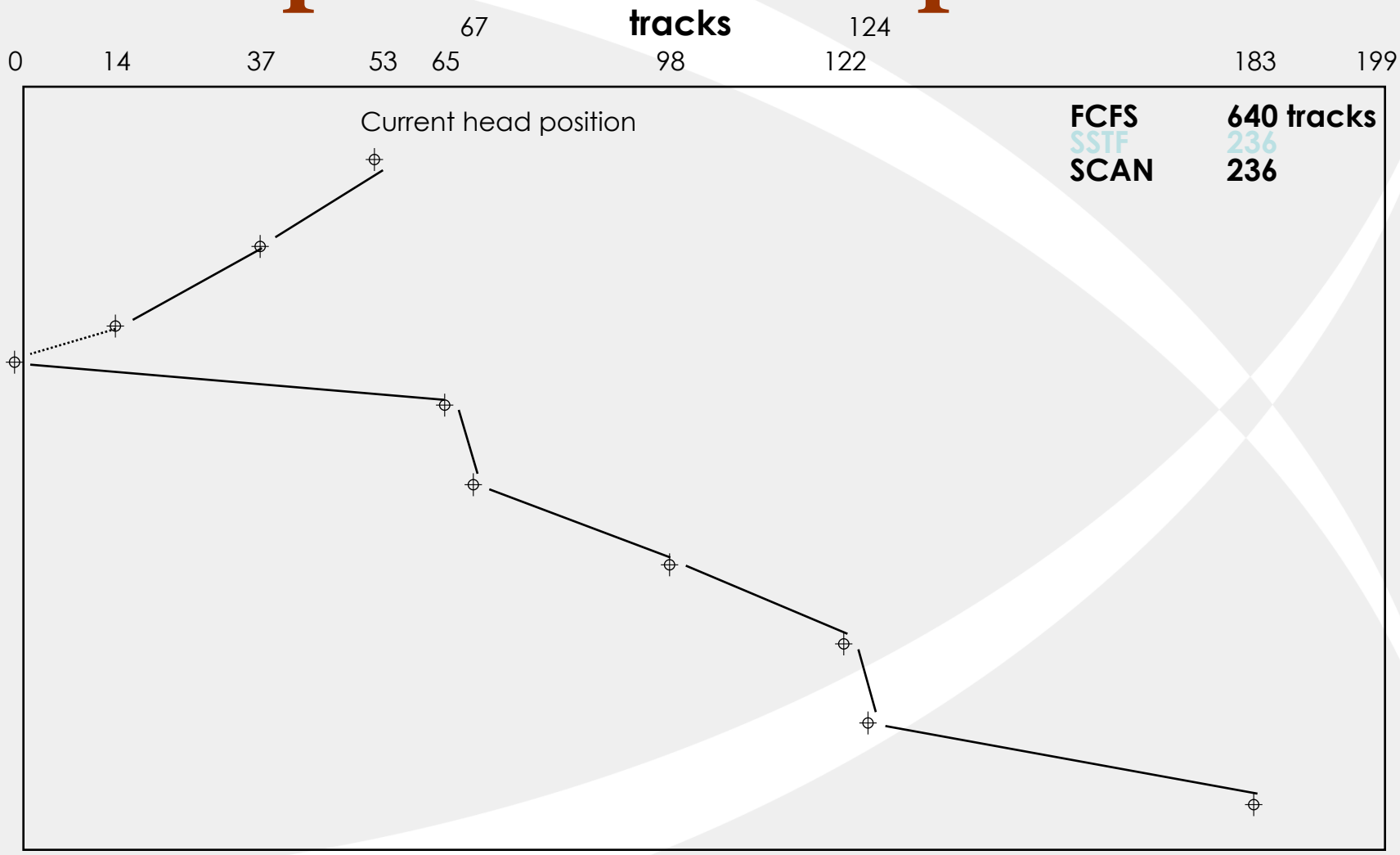
Request queue: 98, 183, 37, 122, 14, 124, 65, 67

A comparative example—SSTF



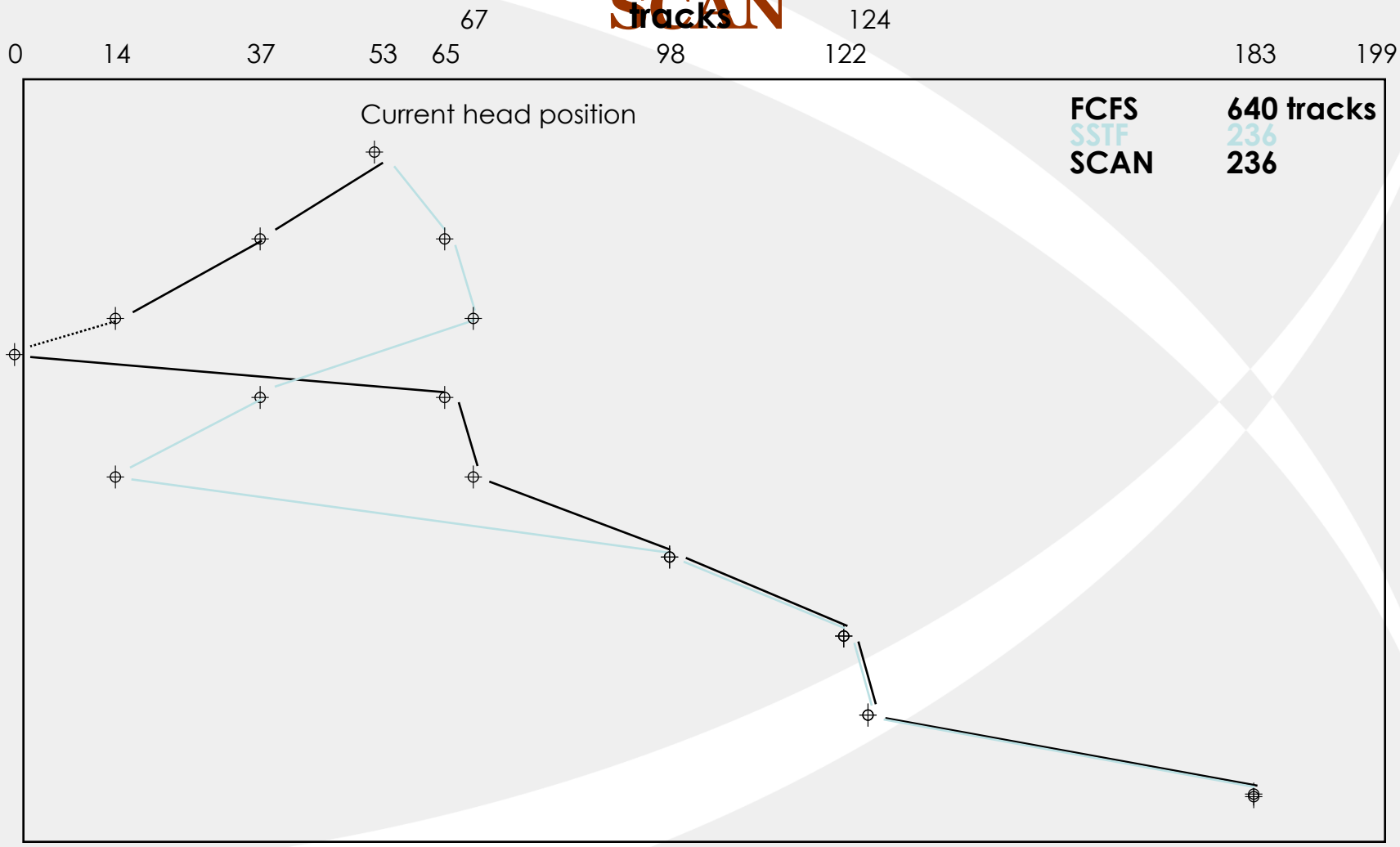
Request queue: 98, 183, 37, 122, 14, 124, 65, 67

A comparative example—SCAN



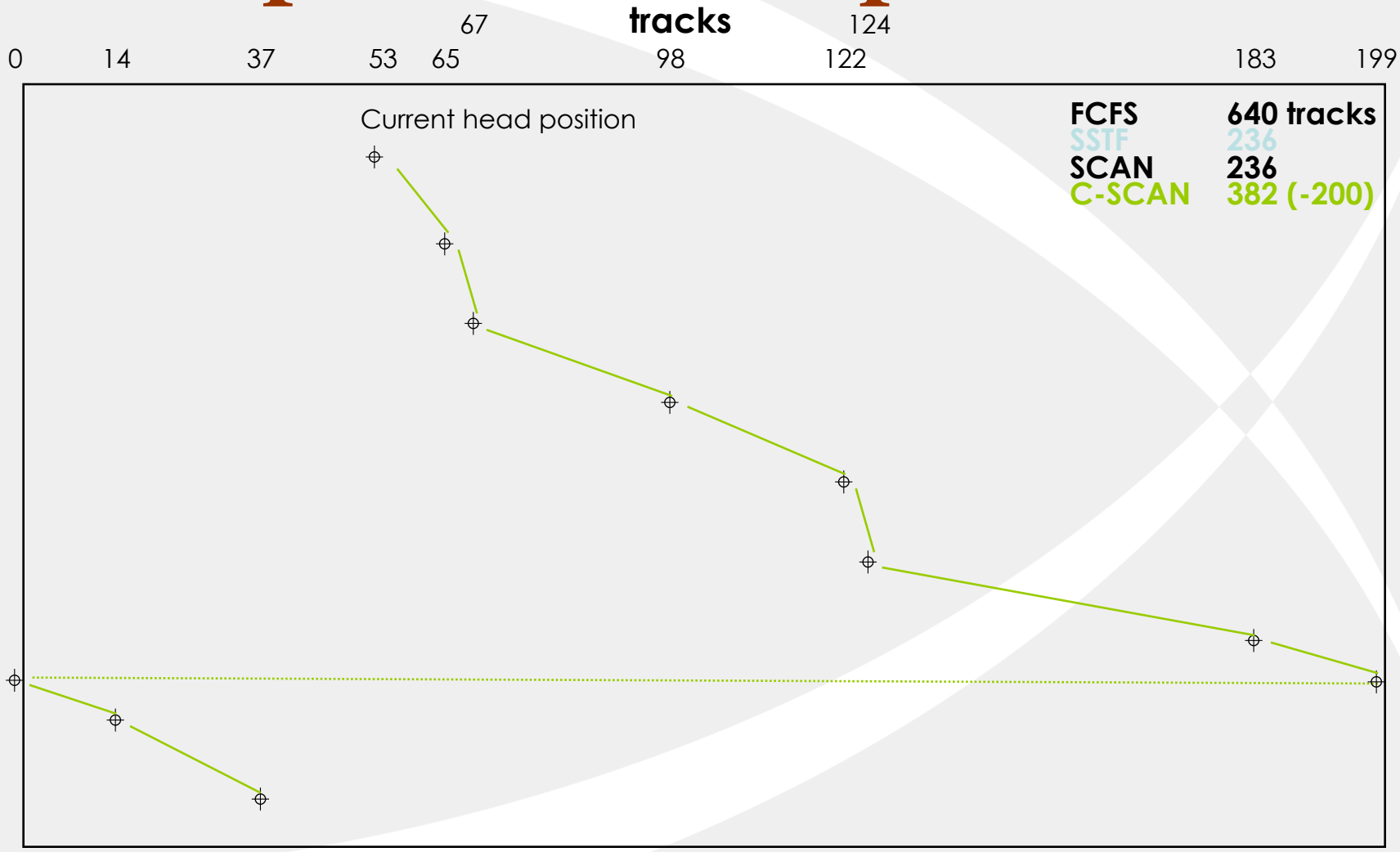
Request queue: 98, 183, 37, 122, 14, 124, 65, 67

A comparative example—SSTF vs SCAN



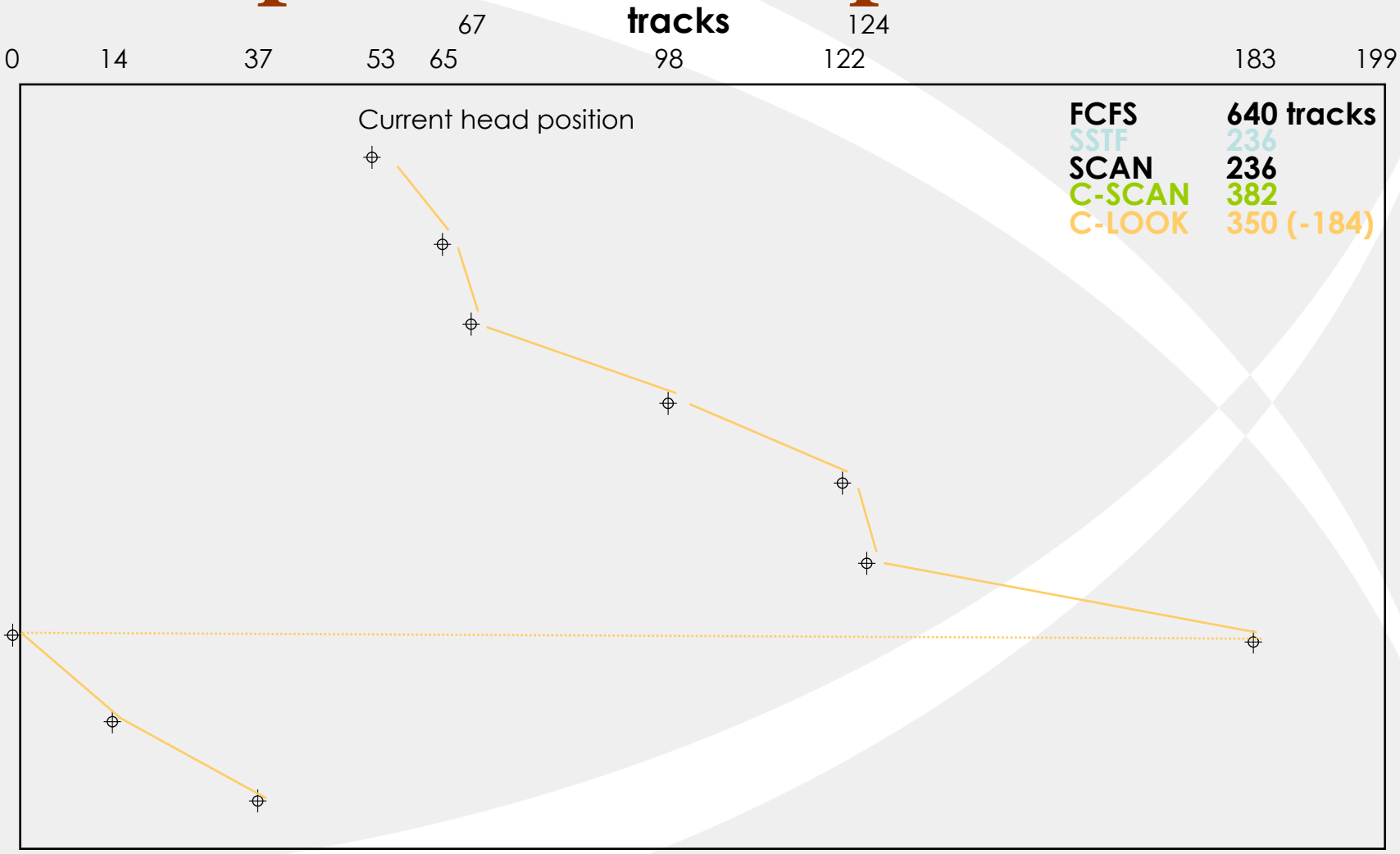
Request queue: 98, 183, 37, 122, 14, 124, 65, 67

A comparative example—C-SCAN



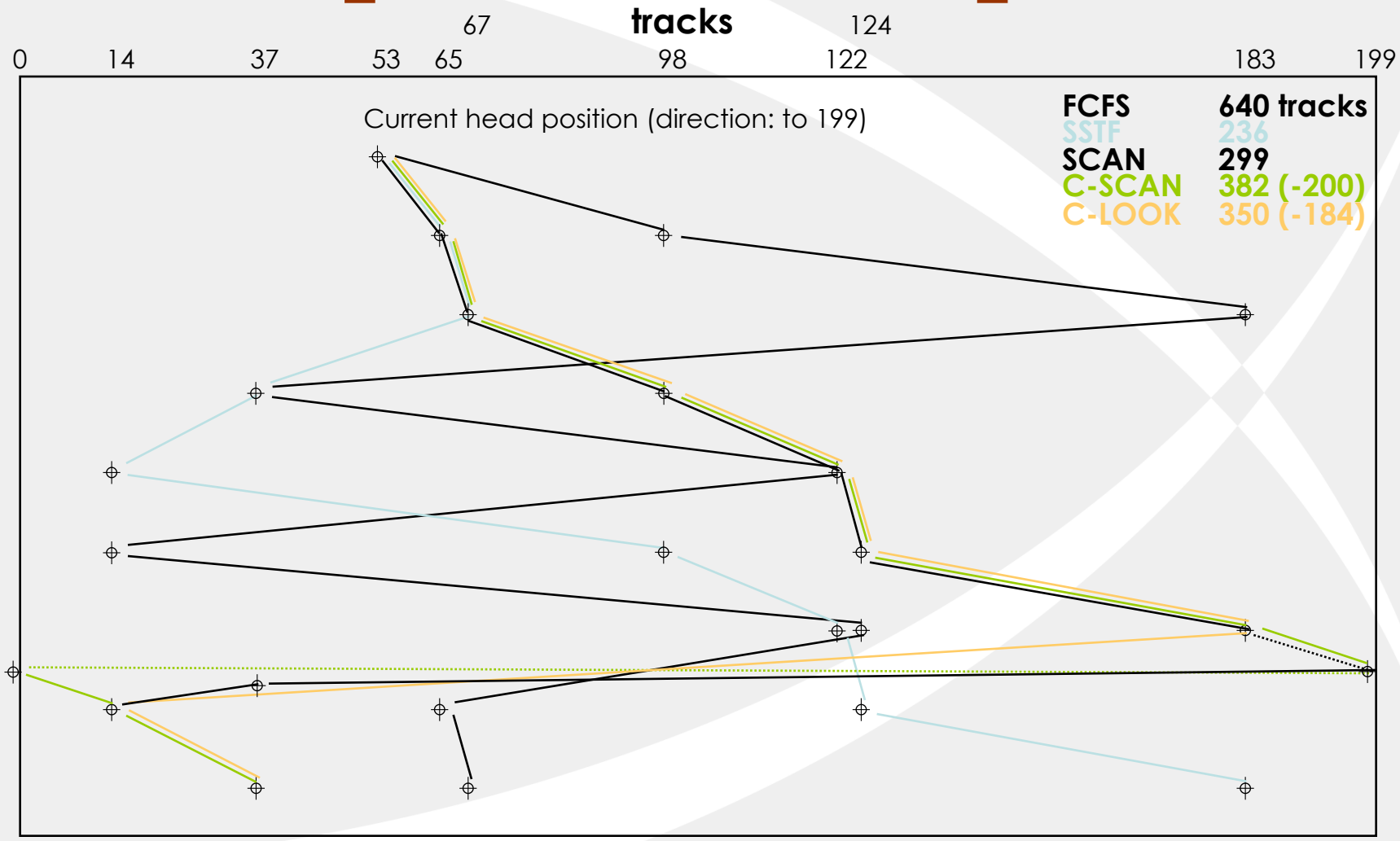
Request queue: 98, 183, 37, 122, 14, 124, 65, 67

A comparative example—C-LOOK



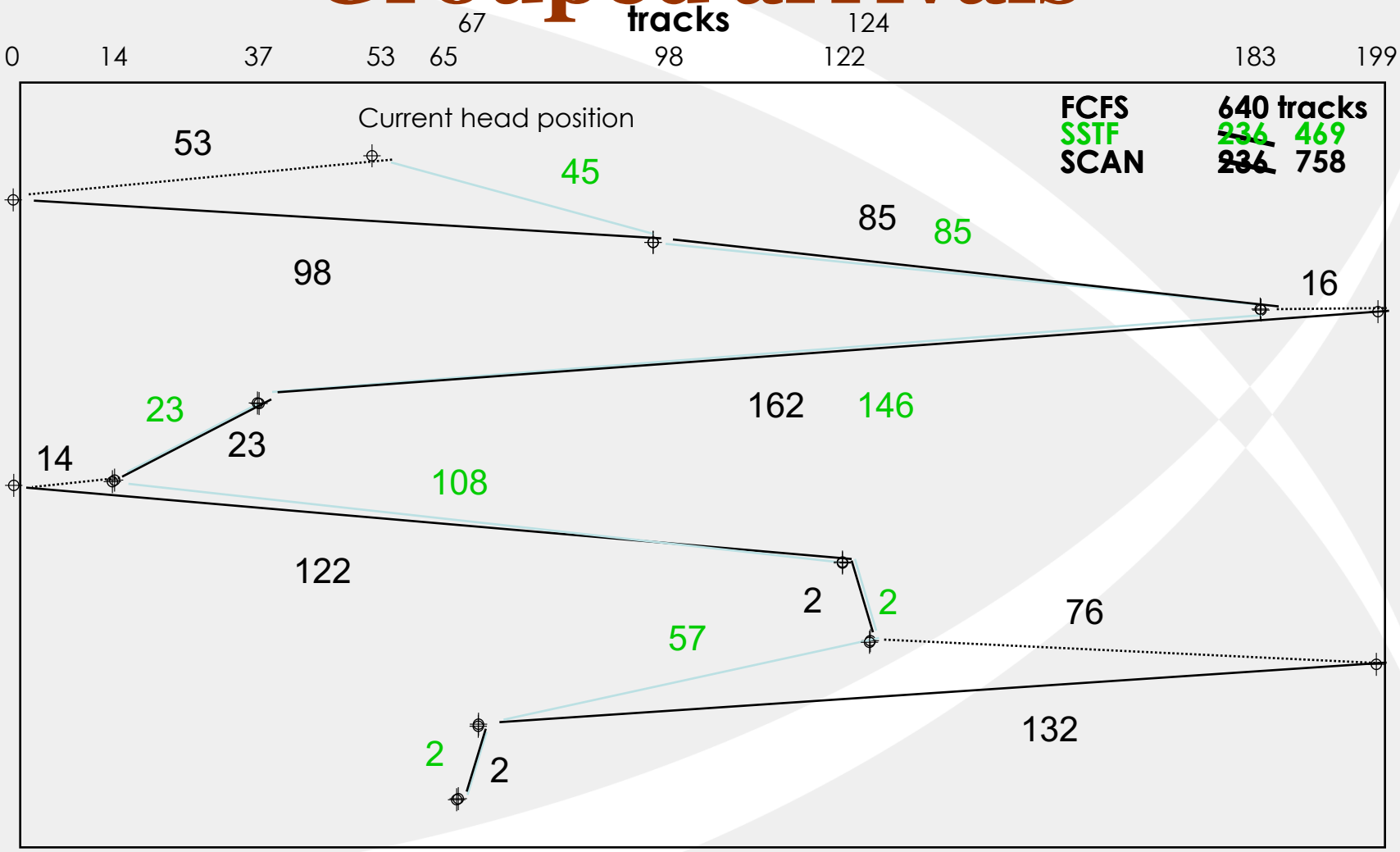
Request queue: 98, 183, 37, 122, 14, 124, 65, 67

A comparative example—All



Request queue: 98, 183, 37, 122, 14, 124, 65, 67

Grouped arrivals



Request queue: 98, 183, 37, 122, 14, 124, 65, 67
Arrivals: 98, 183; 37; 122, 14; 124, 65, 67