

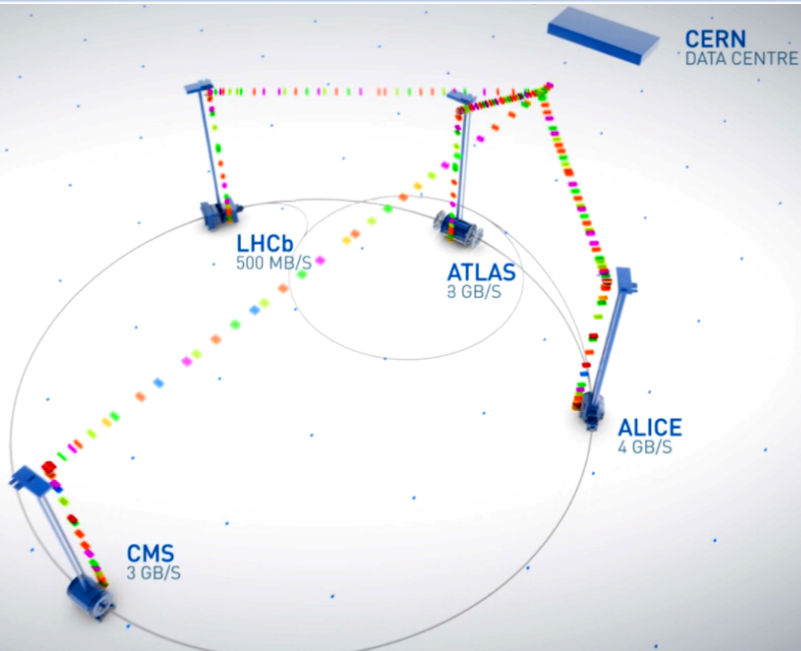
# CERN OPENDAYS

14-15/09/2019

- ▶ Explore the future with us
- ▶ Explorez le futur avec nous

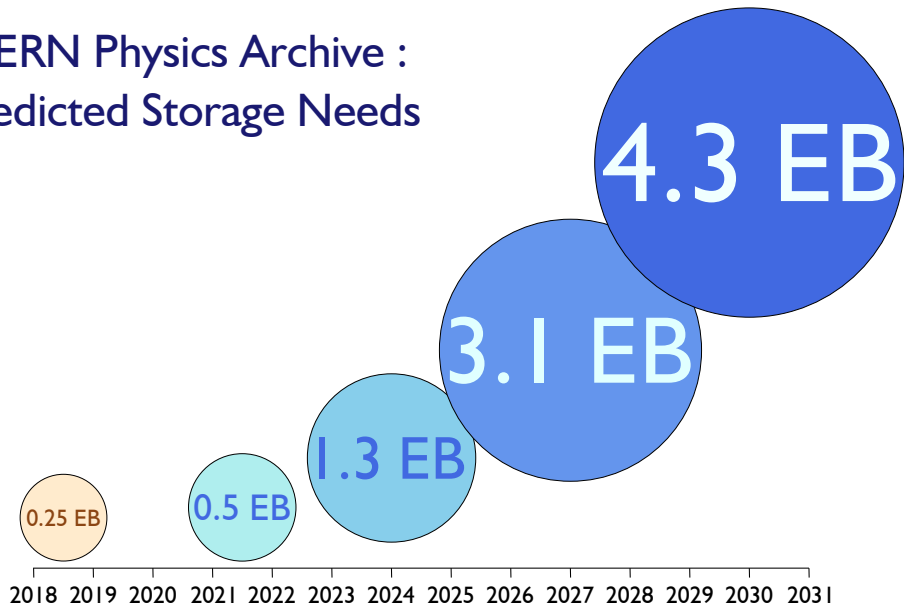
## Why Do We Still Use Tape At CERN?

# CERN needs to store a lot of data from the physics experiments



The amount of data is increasing exponentially

## CERN Physics Archive : Predicted Storage Needs



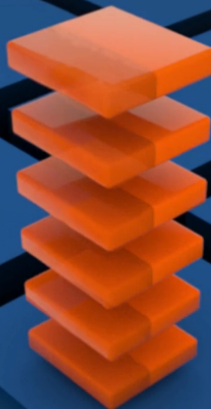
The custodial copy of the data is stored on tape



**TIER 0**

DATA CENTRE

Initial data reconstruction

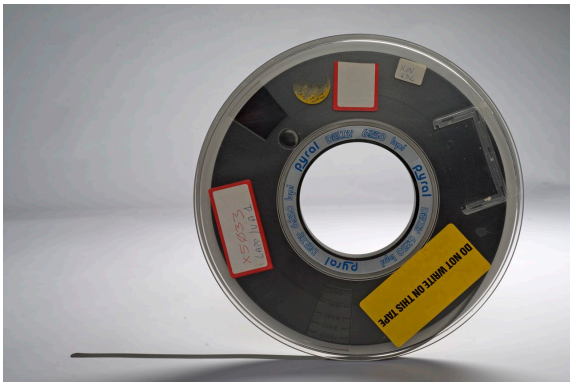


Copy to long-term  
tape storage

Isn't tape old-fashioned?



## In the Beginning : CERN Data Centre in the 1970s



140 MB 9-track tape (1974)



10 MB disk platter from CDC 7638 Disk Storage Subsystem (1974)

Today : Tape and disk have evolved in step

IBM TS1160 Tape Drive  
20 TB capacity



WD DC HC 530 Hard Drive  
14 TB capacity



## Comparing tape and disk

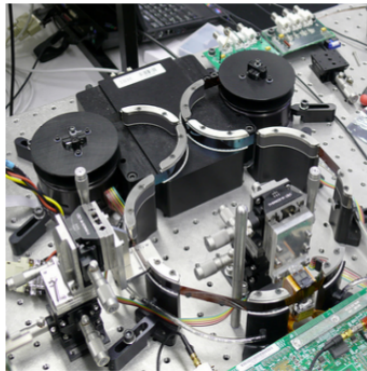
	Tape	Disk
Data transfer rate	400 Mb/s	200 Mb/s
Positioning type	<b>Fast Sequential Access</b>	<b>Fast Random Access</b>
Average positioning time	30 seconds (610 m @ 12 m/s)	5 milliseconds
Typical waiting time ("latency to first byte")	A few minutes	5–10 milliseconds

So why do we still use tape?



## Advantages of Tape : Reliability and Data Security

- Two heads are better than one :  
read after write verification
- No data loss if a drive fails
- Air-gap security
- Long media lifetime (30+ years)



## Advantages of Tape : Energy Efficiency

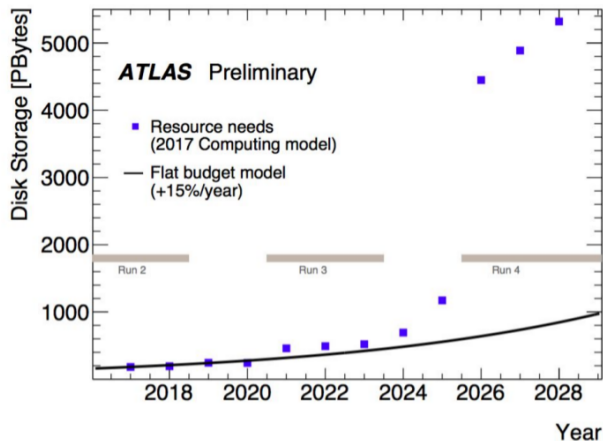
Hard disks are always on. They constantly consume power and generate heat.

- Expensive to run
- CERN Data Centre is at the limit of how much power and cooling it can deliver (3.5 MW)

Tape cartridges don't consume any power when they are not mounted in a drive.

- Tape capacity can be increased without requiring additional power

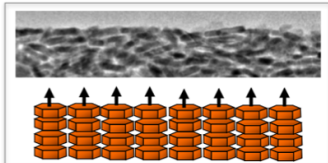
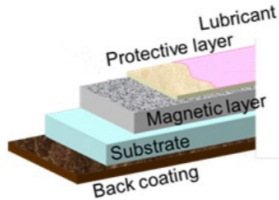
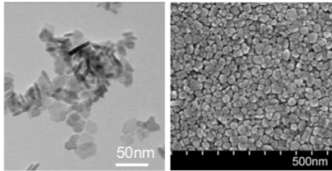
# Advantages of Tape : Cost!



## Storage budget

- Storage needs are increasing exponentially
- Budget is hardly increasing
- Tape storage is 3–5× cheaper than disk storage

# Advantages of Tape : Cost!



## Technology : new advanced materials

- Very fine magnetic particles
- Smooth surfaces with low friction
- 3D stacking of particles on tape surface

Disk technologies are pushing the limits of storage density. Tapes have plenty of room to improve capacity.

- The cost advantages of tape will increase over time

## Alternatives to Tape : Cloud

- “The Cloud is just someone else’s computers”
- Lobster Pot: Cheap to put data in, expensive to get it out



## Alternatives to Tape : Other Storage Technologies

- Solid-State Drives (SSD) : Still  $\approx 10\times$  more expensive than disk for the foreseeable future
- DNA, holographic, quartz crystal : promise high density and high reliability, but no sign of any products yet

# Data Storage at CERN : Disk and Tape together

	Disk	Tape
Use Case	Online : Data Analysis	Offline : Archival Storage
Drives	75 000 hard disks 15 000 SSDs	125 tape drives (in 6 libraries)
Media	—	30 000 tape cartridges
Storage Capacity	Nominal capacity 280 PB	Capacity 400 PB but can be easily extended  Currently $\approx$ 340 PB on tape (>600 million files)

## Conclusion

- Tape is the best currently-available technology for archival storage, in terms of reliability, stability over long periods of time and cost
- CERN is investing in tape as its primary archival storage medium for LHC Run-3 and Run-4



# Tape Libraries at CERN



Moving range of robot arms



Controller  
Drives  
Cartridges

Drives  
Cartridges

Cartridges



## Exit through the gift shop



