

Advancements and Operations for LHC Run-3 and Beyond

Guilherme Amadio, Maria Arsuaga Rios, Cedric Caffy, Gianmaria Del Monte, Abhishek Lekshmanan, Luca Mascetti, Andreas J. Peters, Elvin A. Sindrilaru, David Smith, Ioanna Vrachnaki

CERN IT Storage and Data Management – Physics Data Services



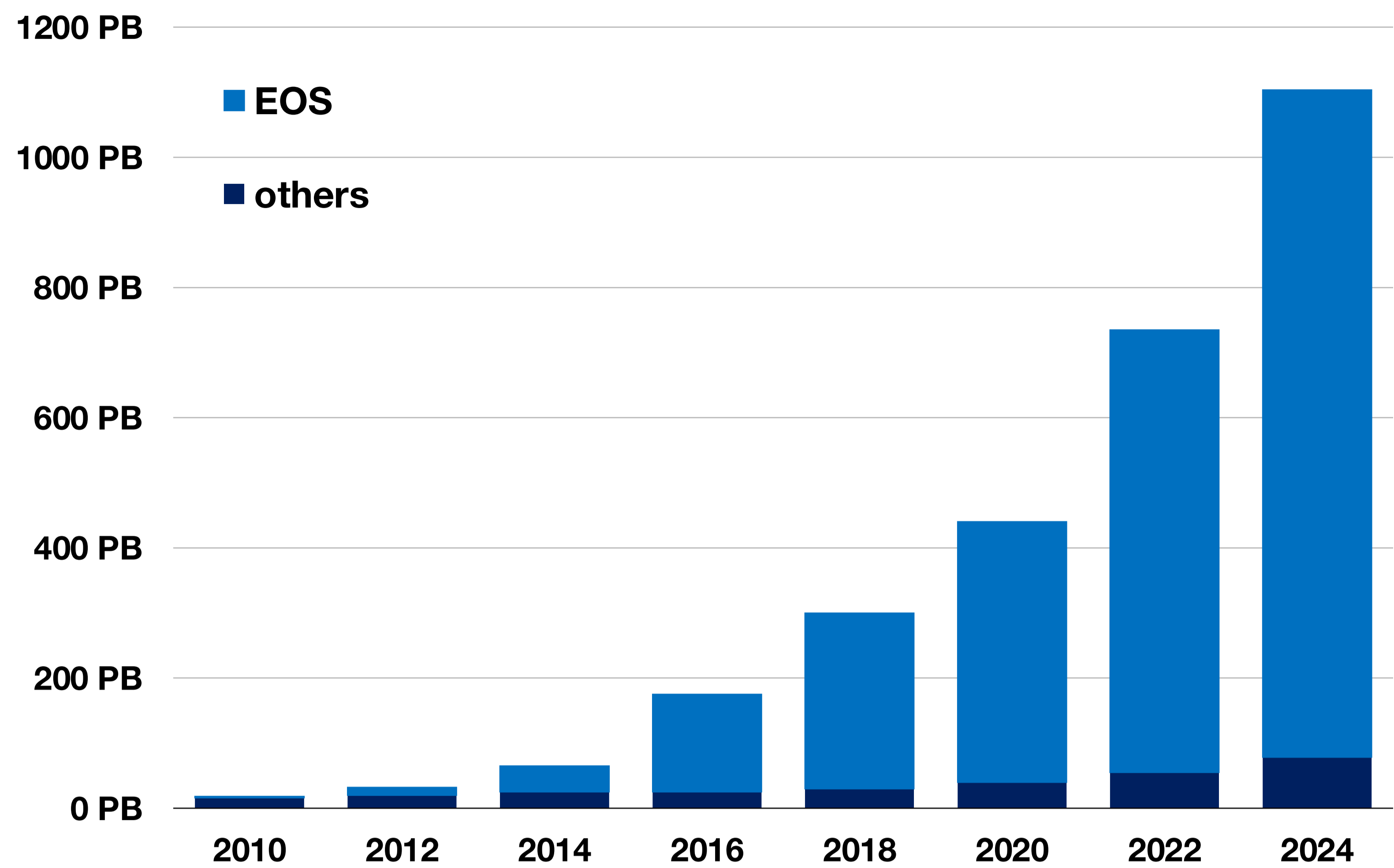
EOS Service for Physics

- Successful Storage Operations during 2024
 - Smooth LHC proton-proton data-taking
- Very good stability of the software with increasing challenging requirements

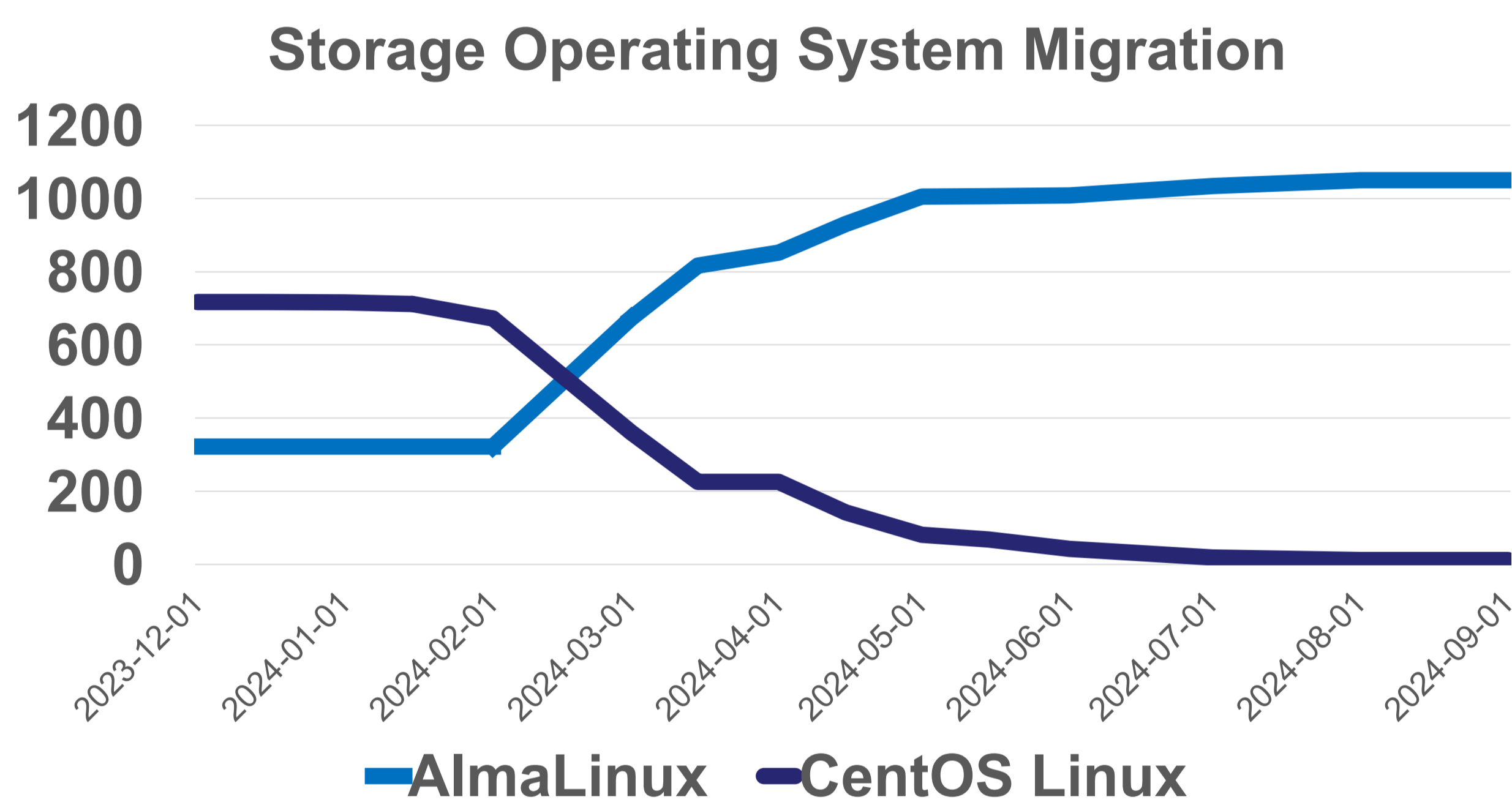
	Amount Files Read	Amount Bytes Read	Amount Files Written	Amount Bytes Written
2022	20.5 Bil	4.04 EB	4.63 Bil	586 PB
2023	21.6 Bil	5.33 EB	4.50 Bil	678 PB
2024	31.2 Bil	5.83 EB	5.25 Bil	918 PB

↑ 2024 is not yet a full year – HI Run is coming up

CERN IT - Operated Disk Storage Capacity

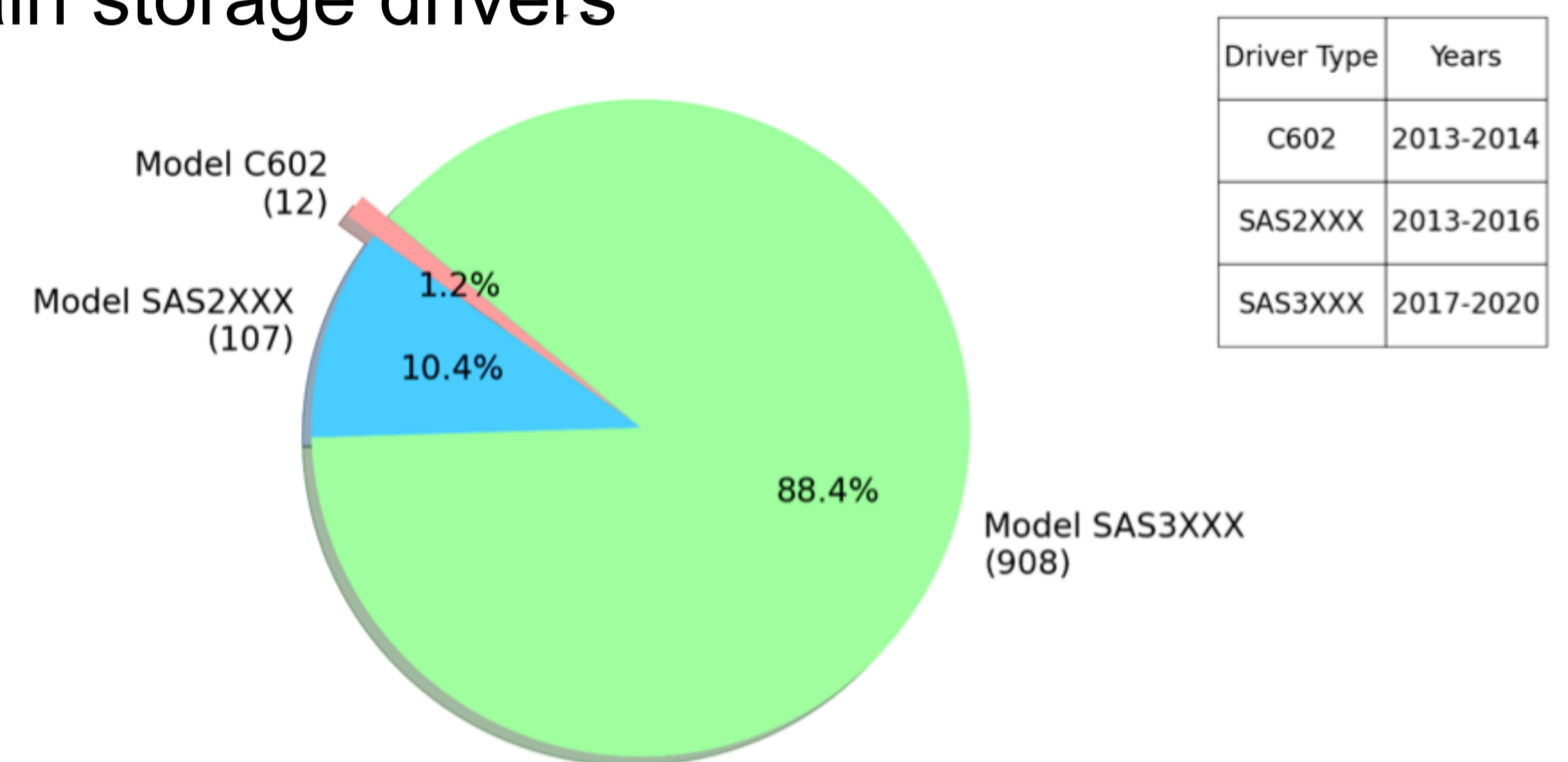


CentOS7 Migration to ALMA9



Storage Migration Key-facts

- 1100 Storage nodes to migrate
- More than 15 different hardware models
- 3 main storage drivers



EOS Quality Assurance

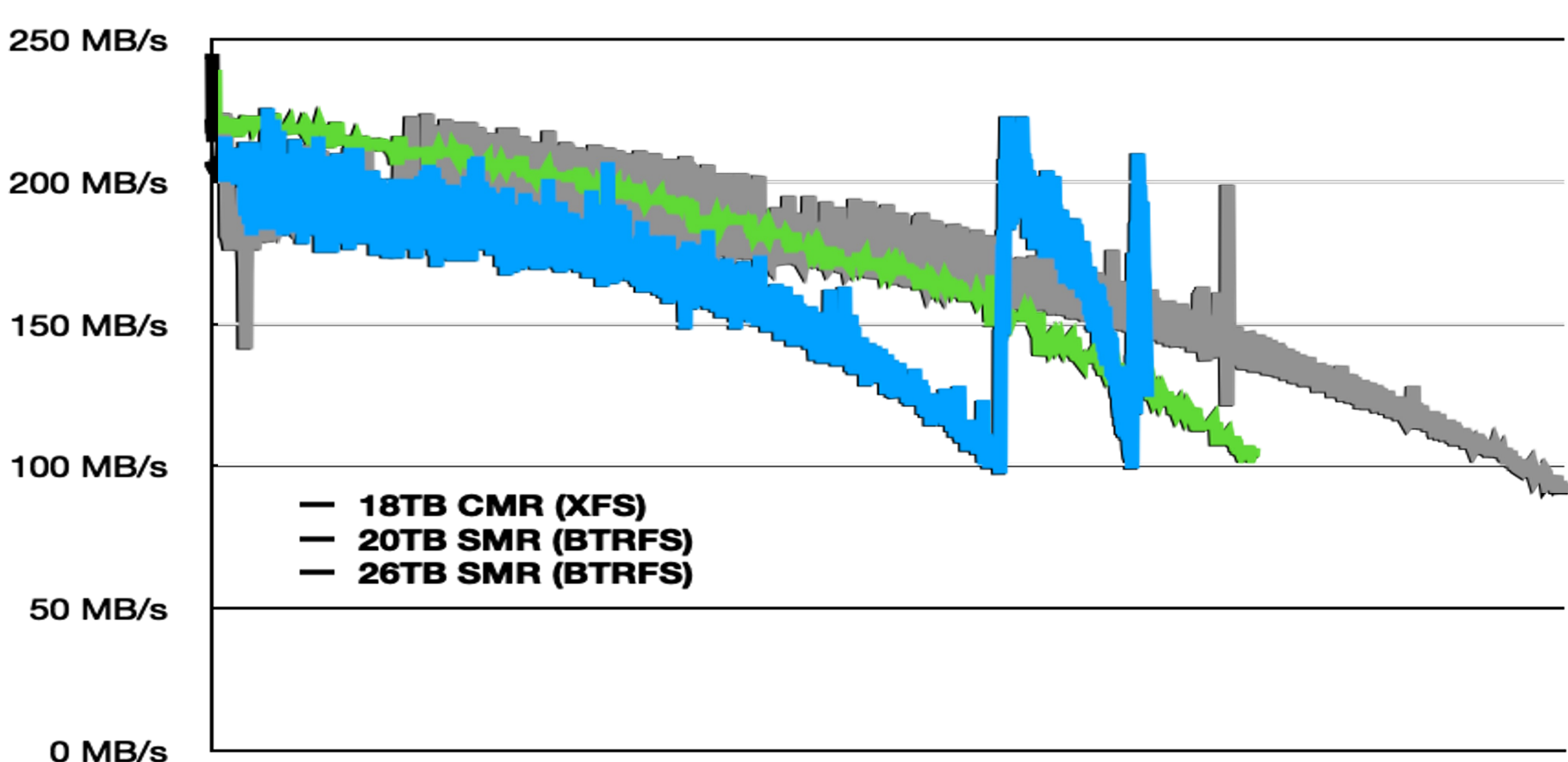
- Two main software branches
 - Stable
 - Feature
- Additional peer-code review
- Dedicated testing instance (pilot)
 - Continuous heavy access
 - Dedicated RNTuple scale tests

EOS File System Check - FSCK

- FSCK improvements for Erasure Coded (EC) Files
 - EC files are stored in blocks
 - Each block has a checksum
 - in addition to local check-summing FSCK now:
 - Handle over-replication
 - Handle full file checksum
 - Handle stripe validation
 - Full combination between stripes

Technology Evaluations

- Dedicated testing on future HDD technologies
 - Performance test of SMR disk
 - Planned for HAMR
- HDD Capacity roadmap aims at 50TB in 2030
 - No major drive performance improvements



Outlook towards Hi-Luminosity LHC

- The EOS service is successfully co-evolving and adapting to HL-LHC storage requirements
- The service had a well-defined R&D roadmap on storage technologies
- Current HDD trend will provide the necessary space, however not the necessary performance
- Actively investigating the role of SSDs

