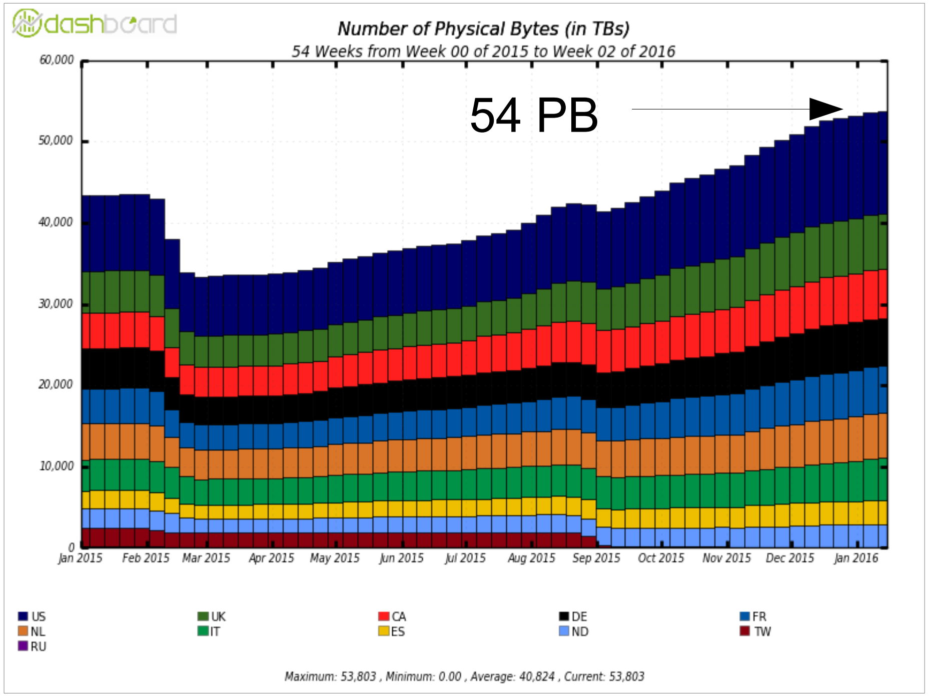
Tape operations & experience

R. Tafirout, TRIUMF

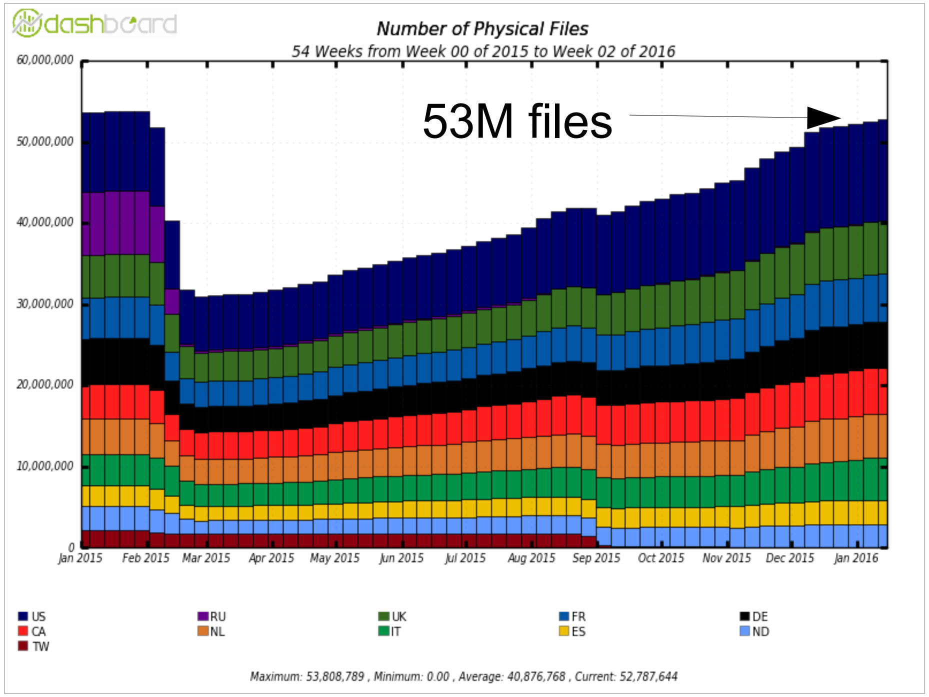
with contributions from Tier-1s:

BNL (David Yu)
CCIN2P3 (Emmanouil Vamvakopoulos)
CNAF (Vladimir Sapunenko)
KIT (Xavier Mol)
NDGF (Ulf Tigerstedt)
PIC (Josep Flix, Esther Accion, Aresh Vedaee)
RAL (Brian Davies)
SARA (Onno Zweers)
TRIUMF (Simon Liu, Yun-Ha Shin)

Overall Tape Activities (ADC)

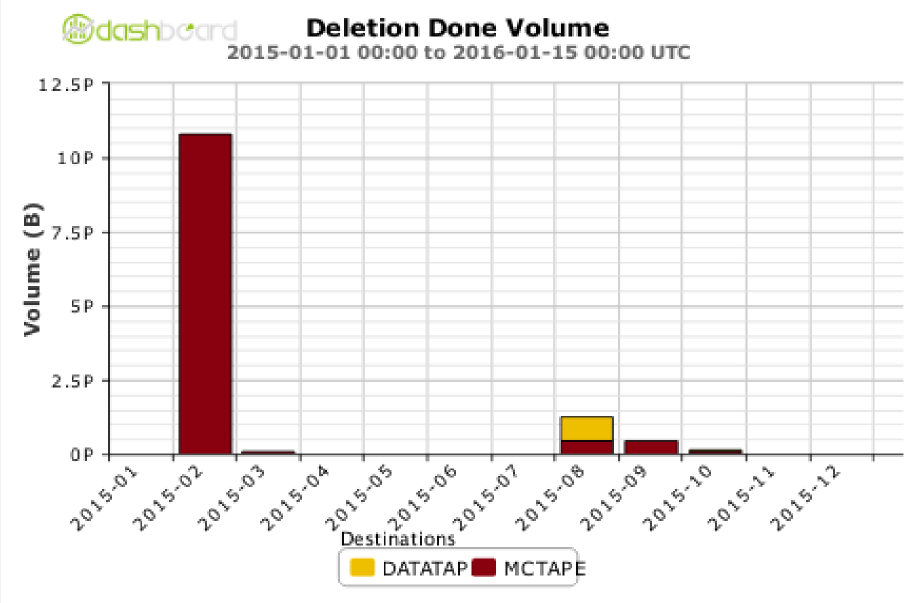


54 PB

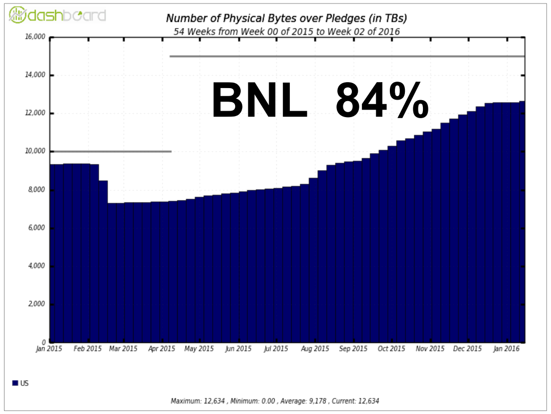


53M files

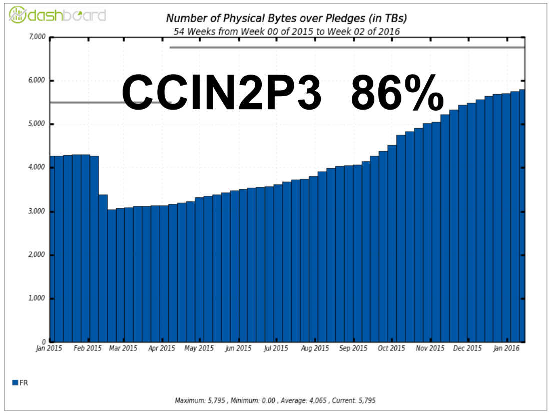
- Massive deletion campaign in February
- ASGC (TW) decommissioned, no data hosted since ~September
- No tape activity at NRC-KI (RU)
- Includes grouptape (SUSY + TOP) at CNAF, NDGF, SARA, TRIUMF.



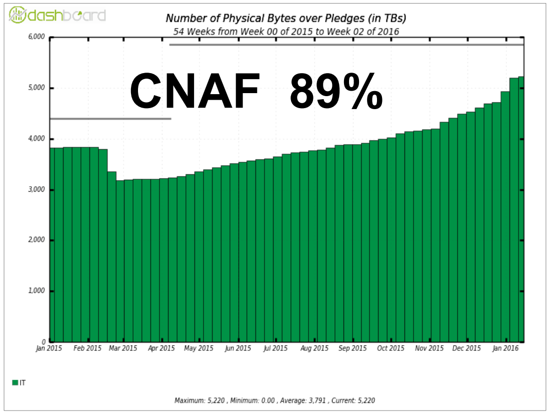
Tape Usage versus Pledged



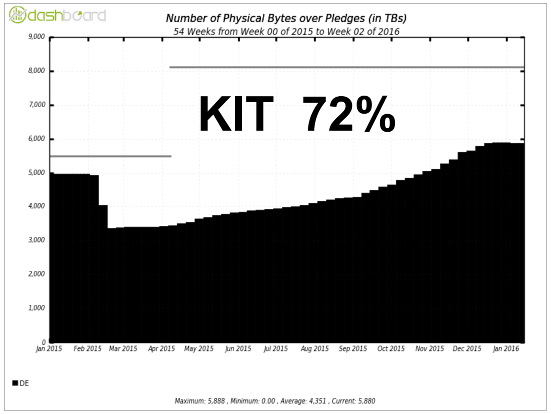
BNL 84%



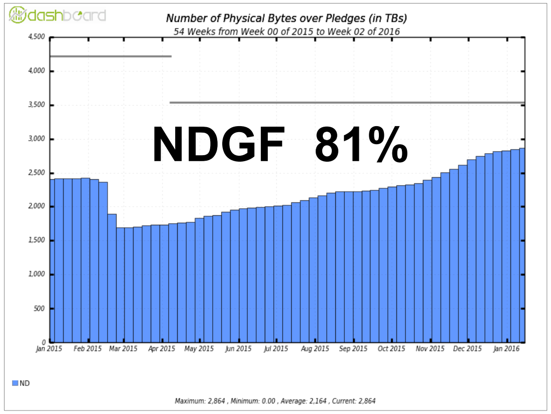
CCIN2P3 86%



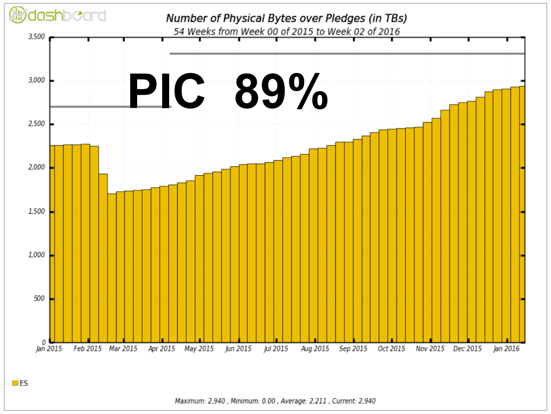
CNAF 89%



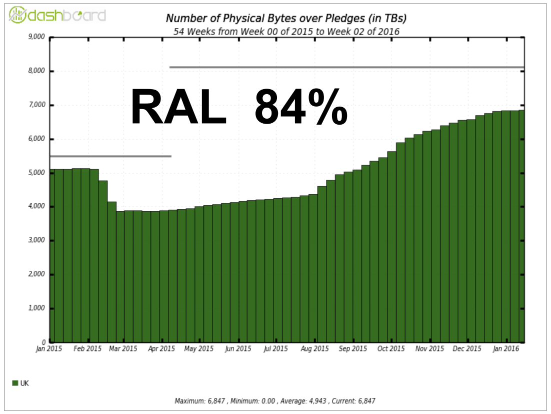
KIT 72%



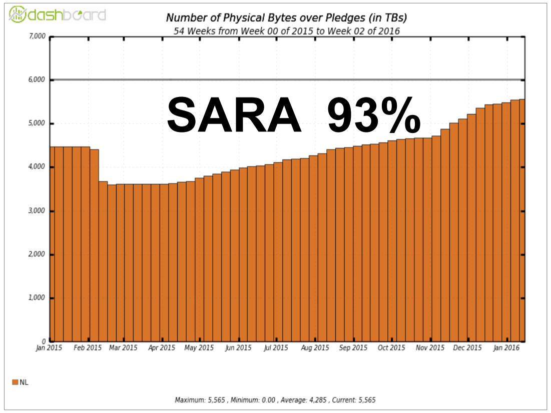
NDGF 81%



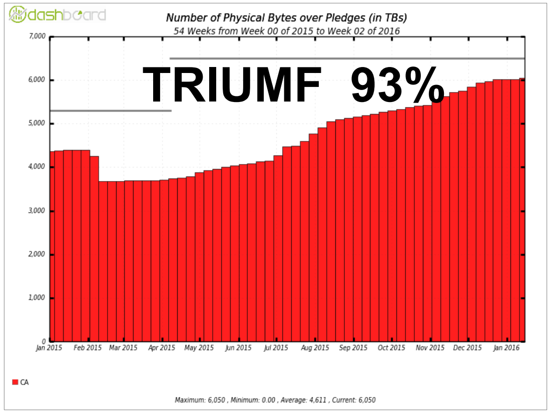
PIC 89%



RAL 84%



SARA 93%



TRIUMF 93%

Tape Systems Specs

	MoU share (%)	Library	Software	Drives	Disk buffer
BNL	23	4 x SL8500	HPSS	30xLTO4 , 23xLTO6	209 TB
CCIN2P3	10	4 x SL8500	HPSS	T10K: 28xB,22xC,43xD	120 TB
CNAF	9	1 x SL8500	TSM	T10K: 17xD	~220 TB (dynamic)
KIT	13	Multiple / mixed	TSM + ERMM	mix of LTO and T10K	350 TB
NDGF	5	4 sites / 3 countries	TSM	-	~160 TB
PIC	5	1 x SL8500	Enstore	14xLTO4, 4xLTO5 , 8xT10KC, 5xT10KD	60 TB
RAL	13	1 x SL8500	Castor	14 x T10KC	360 TB
SARA	9	2 x SL8500	DMF	T10K: 16xB, 8xC, 13xD	84 TB
TRIUMF	10	1 x TS3500	Tapeguy	14 x LTO5 , 10 LTO6	400 TB

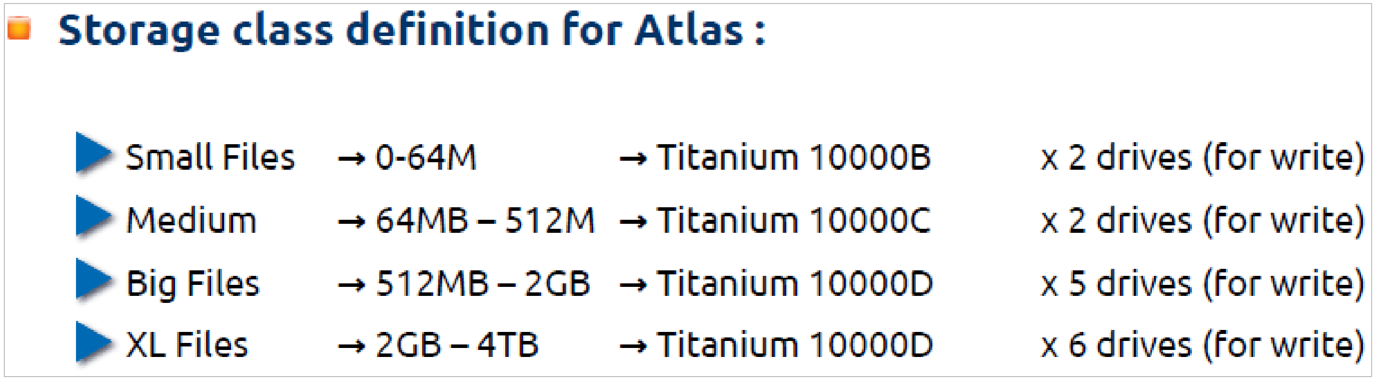
- BNL & TRIUMF: ATLAS only
- Disk buffer: includes W + R.

Drive & Media specs (native):
LTO-4,5,6 (R/W) = 120 , 140, 160 MB/s
LTO-4,5,6 (capacity) = 0.8, 1.5, 2.5 TB
T10K B,C,D (R/W) = 120, 240, 250 MB/s
T10K B,C,D (capacity)= 1, 5, 8.5 TB

Tier-1's serving multiple VO's (I)

Drive access rules for sharing, prioritization & scheduling:

- **CCIN2P3:**



Storage class definition for Atlas :

▶ Small Files	→ 0-64M	→ Titanium 10000B	x 2 drives (for write)
▶ Medium	→ 64MB – 512M	→ Titanium 10000C	x 2 drives (for write)
▶ Big Files	→ 512MB – 2GB	→ Titanium 10000D	x 5 drives (for write)
▶ XL Files	→ 2GB – 4TB	→ Titanium 10000D	x 6 drives (for write)

- **CNAF:**

  - 8 drives maximum (4 for writing & 4 for recalls), with a global overbooking factor taking into account all VO's.

- **KIT:**

  - at most 10 drives (6 for writing & 4 for recalls), adjusted often for backlogs depending on other VO's activities. Disk reading buffer for ATLAS dedicated (150 TB).
  - tape resources are shared: first-come-first-serve, no way to guarantee a certain number of drives per VO.

Tier-1's serving multiple VO's (II)

Drive access rules for sharing, prioritization & scheduling:

- **NDGF:**
  - no detailed info about drives
  - 4 different sites / 3 countries: each site has one pool for reading and one for writing per VO; each pool size 8-30 TB.

- **PIC:**
  - each VO assigned to a specific tape technology
  - T10KC used for ATLAS with a dedicated disk buffer of 60 TB.
  - each VO can use up to 2 drives per tape family.
  - for reading all drives can be used but system does some balancing.

- **RAL:**
  - 1 T10KC dedicated to ATLAS, the remaining 12 drives shared with LHCb (which has also 1 dedicated drive); no weighting (first come first served)

- **SARA:**
  - Two libraries : T10KC used for ATLAS and up to 5 drives per library.

Site issues & concerns (I)

- **BNL**: small files is the biggest issue (dragging system performance down), need to watch out for work done near tape library (dust control); unscheduled system maintenance handled carefully to minimize downtime.
- **CCIN2P3:** incident in October (448 TB received in 7 days, ~776 MB/), write buffers filled up; issue fixed by increasing # of drives for migration to tape; system can handle now ~1.2 GB/s)
- **CNAF**: small files slowing down migration and recalls, any file aggregation possible ?. One tape damaged in January 2015, 12 files lost.
- **KIT**: bad file size distribution (5.7 M files registered with average size of 1 GB ± 1.1 GB standard deviation); writing small files to tape not necessarily an issue, but recalls are very slow.

- issue about tape families: “ATLAS doesn't make use of different tape families” ... “data sets are spread wildly over tape cartridges”.

*(*needs clarification/discussion with ADC...)*

- **NDGF**: have not had any problems with ATLAS. Access through ARC and aCT (more controlled I/O access).

Site issues & concerns (II)

- **PIC**: no problems observed related to scalability. Tape family via GGUS?
  - usual patterns problems - not observed or affected the site
  - Currently suffering from some tape media integrity for T10KD technology, in contact with Oracle (media taken out of production); files will need a recovery procedure (details to be communicated to ADC asap).

- **RAL:** issues with tape recall policy/algorithm (initially set at 500 files or 32 GB; 32 GB was not working due to timeout; changed to 10 files.
  - Policy to improve drive performance leads to latency: recalls only triggered after 10GB/10files/1hr ; migration only triggered after 100GB/500 files/2hrs (per tape pool).
  - some files are being recalled many times increasing load and churn rate.
  - bringonline request : what lifetime should be aimed for disk buffer ?
  - disk buffer current bottle neck: new hardware being added.
  - being able to control FTS transfers to tape to improve WAN.

- **SARA**: broken pool in Jan. '15 / data loss; lots of SRM timeout issues since dCache upgrade in March, issue is now understood.

- **TRIUMF**: no major issues, some minor issues with library; some 10G card issues with HSM pools (cards replaced recently). Lots of 1 file datasets:
  - Various issues with SUSY group migration (very bursty), FTS damping ?
  - lots of SUSY datasets: 105k vs 50k (datatape + mctape).

Planned & Tentative System upgrades

- **BNL**: migration to LTO-7 generation, no schedule yet
- **CCIN2P3**: TBD
- **CNAF**: move HSM servers from FC8 to FC16 (February); disk storage system replacement & data migration to new storage (February).
- **KIT**: migration to HPSS as tape management software
- **NDGF**: Not known at the moment
- **PIC**: getting T10KD in production again, finish migration from LTO-4, Enstore upgrade in conjunction with a dCache upgrade.
- **RAL**: move to T10KD media; SRM upgrade & SL6; Castor upgrade to 2.1.15; investigating disk cache with CEPH pool; merging Castor instances into one for WLCG experiments; mainly following CERN's advice.
- **SARA**: **major downtime in the fall (moving to another data centre), careful planning with ADC a must / potential data loss at stake**.
- **TRIUMF**: readiness for 2016 pledges / media replacement for 2000 LTO-4 to LTO-6 (migration ongoing); upgrade of 8 LTO-5 to LTO-6 (in February). Tape system software upgrade for various improvements and bug fixes.

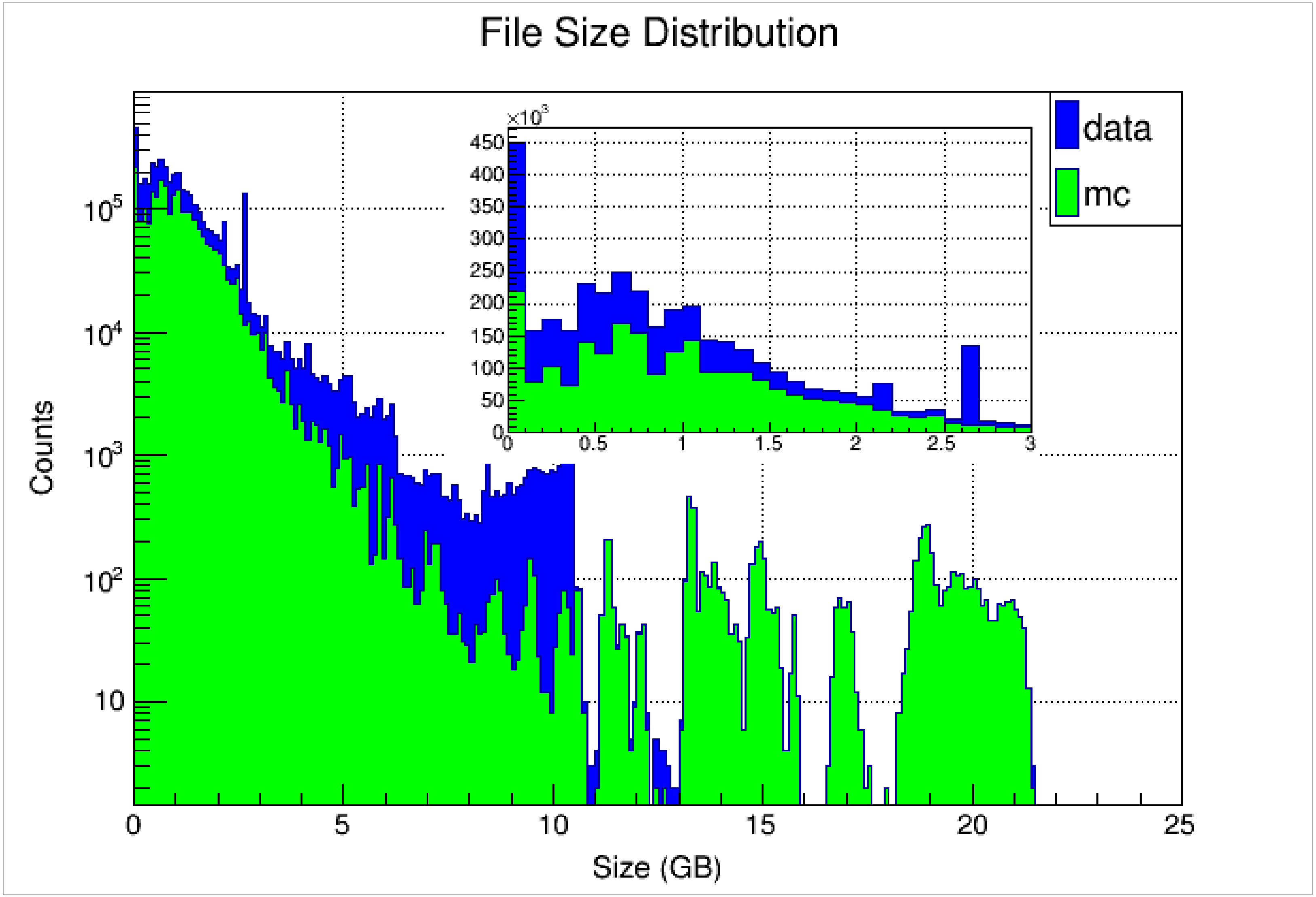
Other aspects for discussion

- **Various sites have their own monitoring, metrics, etc.**
  - ATLAS tape activity is well monitored and tracked at the sites.
- **Can sites handle more ATLAS activity ?**
  - Based on the information received, it looks like most Tier-1 sites have no major issue beside what was discussed in earlier slides.
  - With both ADC and sites tweaks or tuning, more activity could be handled in principle; drives capacity seems to indicate there is more room.
  - Bringonline / tape recalls strategy
- **How is file deletion handled and tape space reclaimed ?**
  - It is not clear to me which Tier-1 sites have already reclaimed the deleted space; perhaps done automatically (only asked a few), and what strategy will be adopted.
  - Unless space is needed urgently, this is in principle handled automatically when doing media migration / technology refresh.

EXTRA MATERIAL
(monitoring & stats plots)

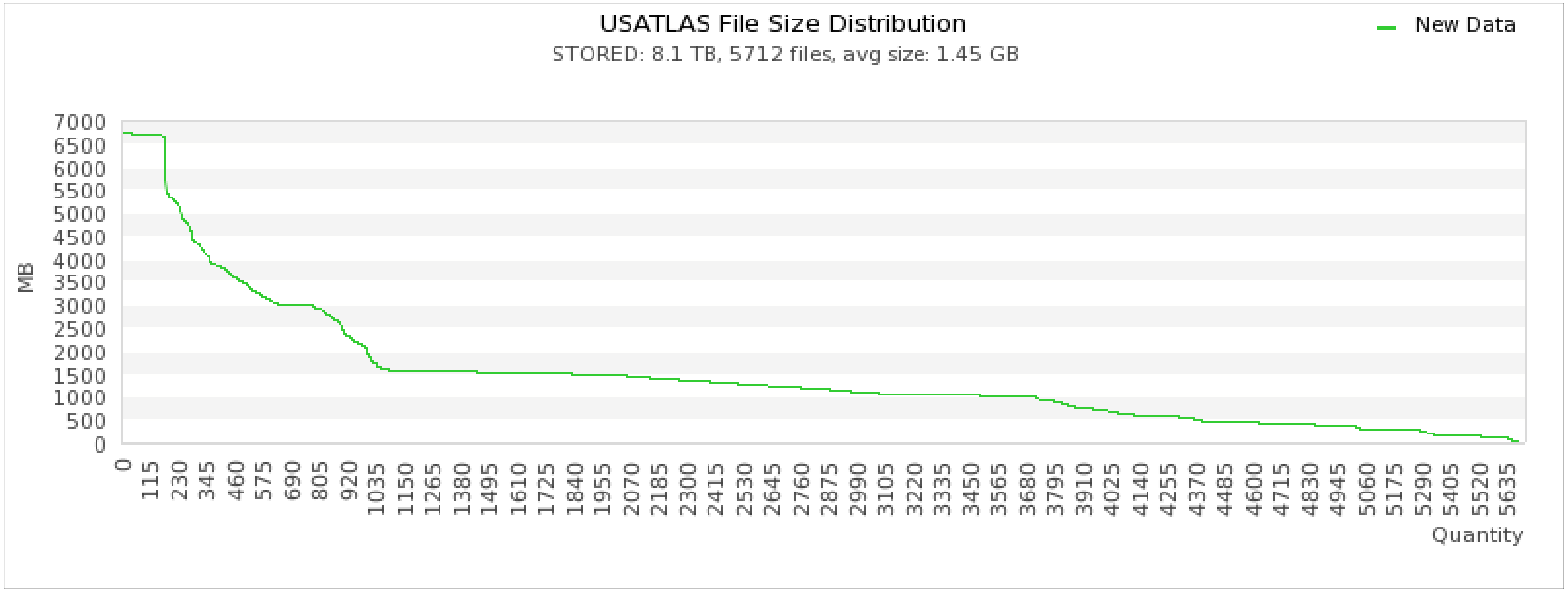
(a small sample from all received material...)

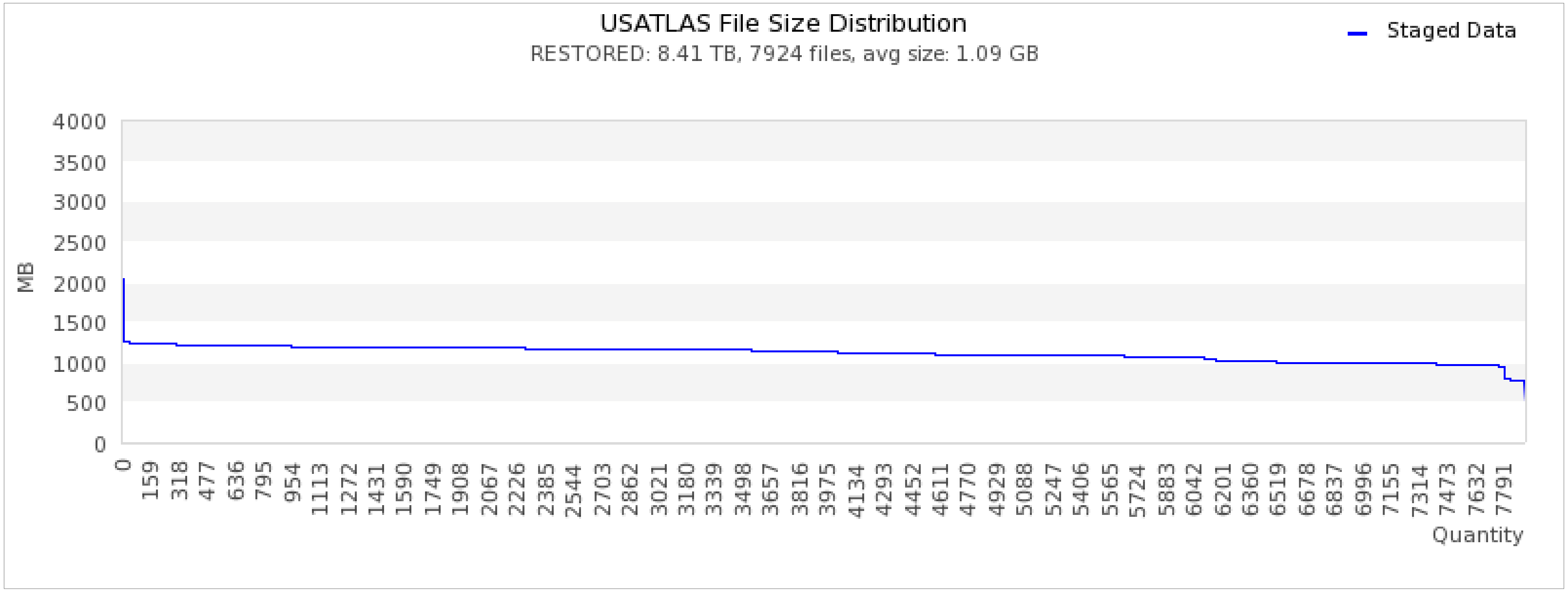
File size distribution @ TRIUMF



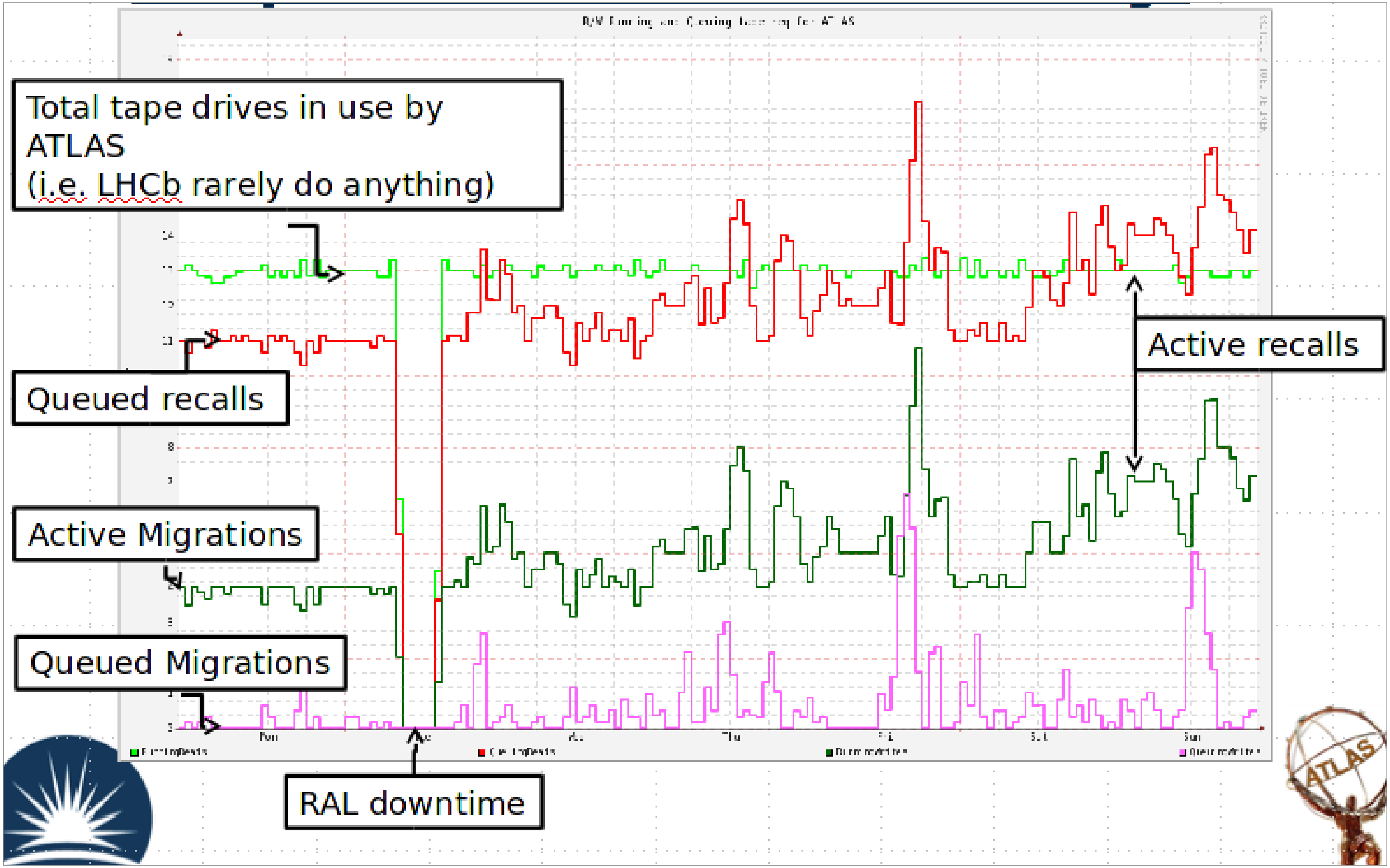
File size distribution @ BNL

- 24 hours activity sampling for stored and staged data:





Tape activity monitoring (RAL)



Total tape drives in use by ATLAS
(i.e. LHCb rarely do anything)

Queued recalls

Active Migrations

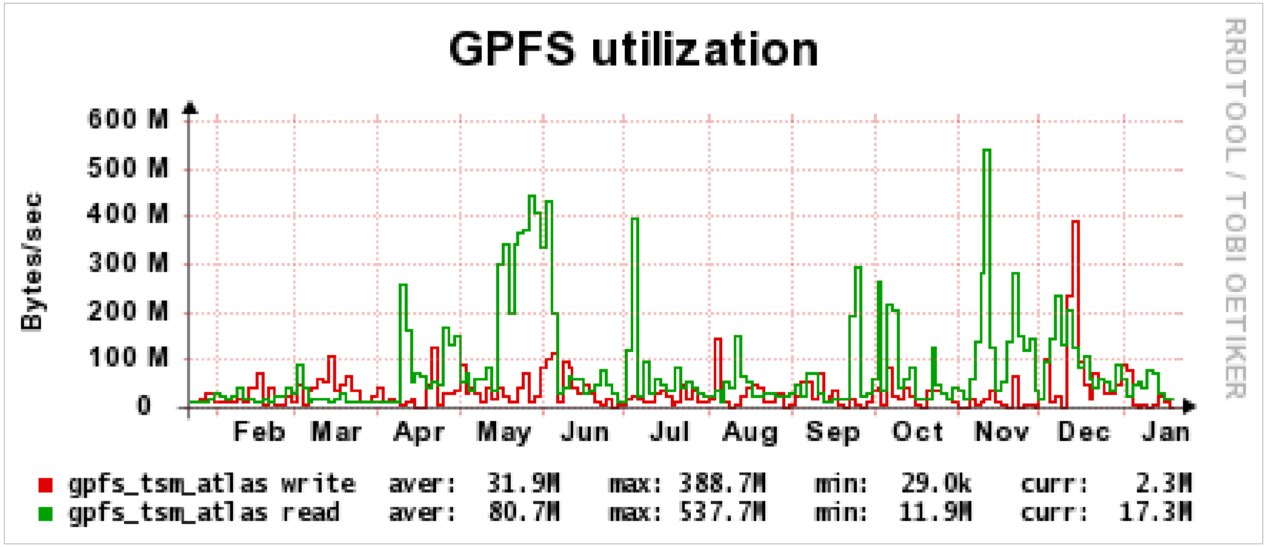
Queued Migrations

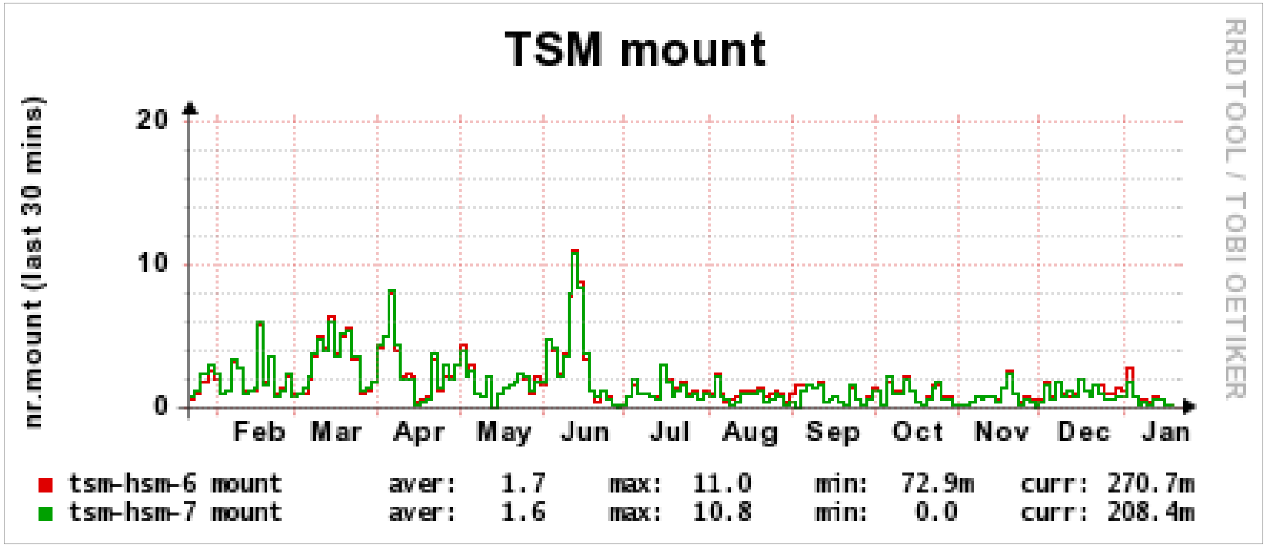
Active recalls

RAL downtime

Tape activity monitoring (CNAF)

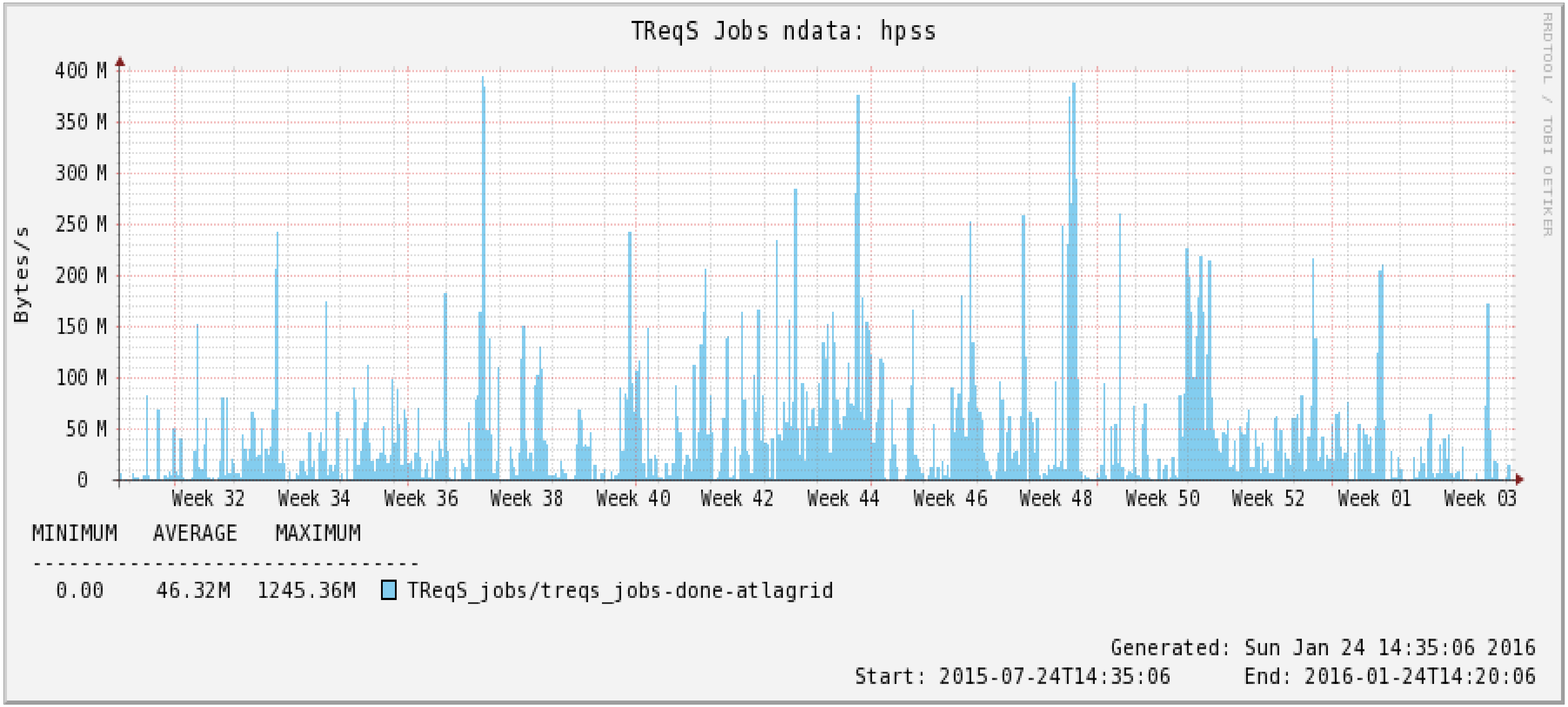
- Read & Write throughput & tape mounts





Tape activity monitoring (CCIN2P3)

Stage-in throughput (last 6 months)



Max at 1.2 GB/sec
Average media mount time ~ 1-2 minutes

Tape activity monitoring (KIT)

- Average number of files recalled per tape mount: tape families, grouping issues.

ATLAS vs. GridKa tape **worst case**

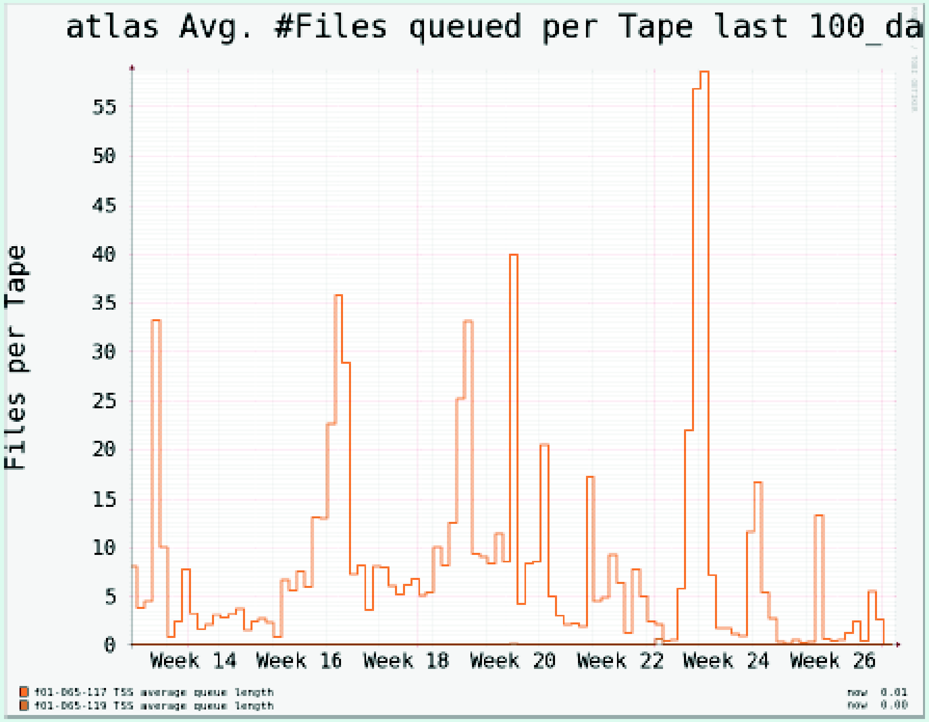
- ∼600MB average file size

⇝ 2500 files fit on one LTO-5 tape

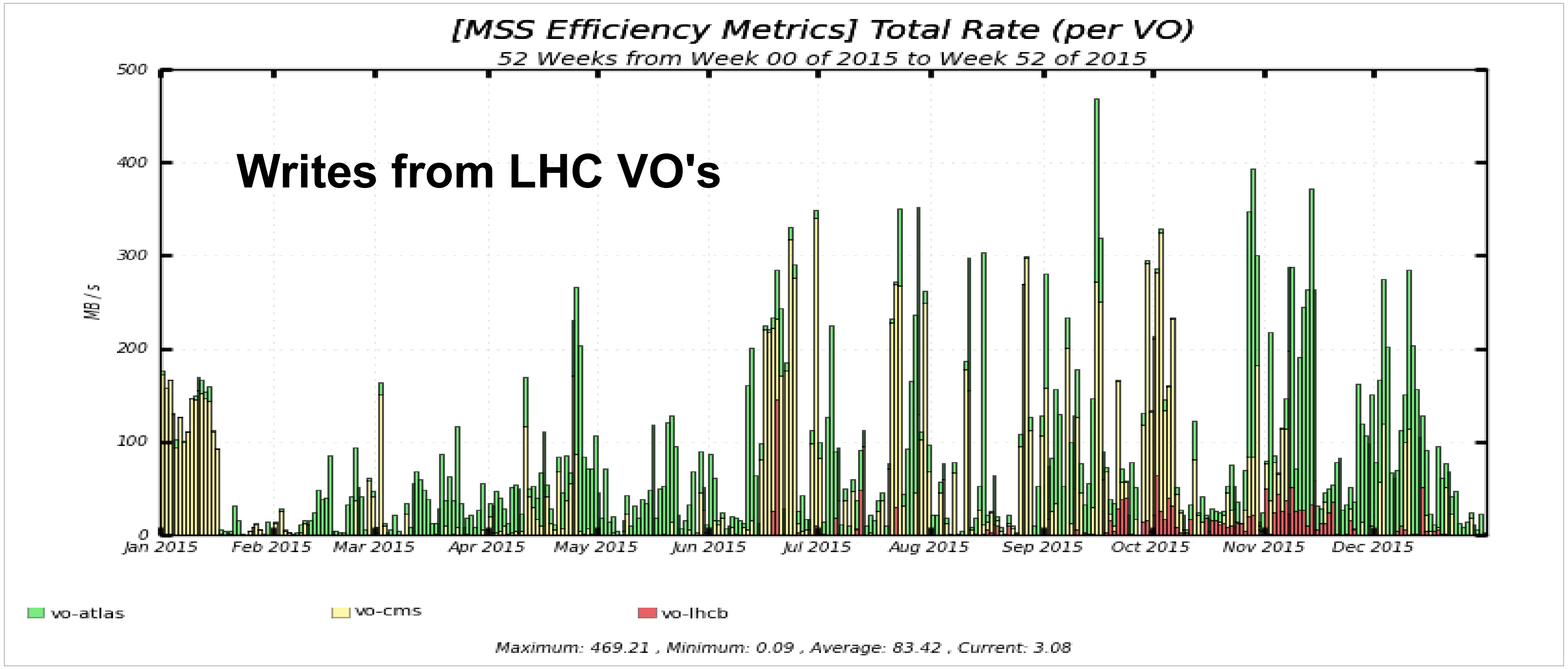
- ≤10 files queued per tape on average recall
- every second wrap a file ⇝ 90s winding to reach a file
- **+4s** to read 600MB + fraction to mount tape
  ≈ 100s total read time/file

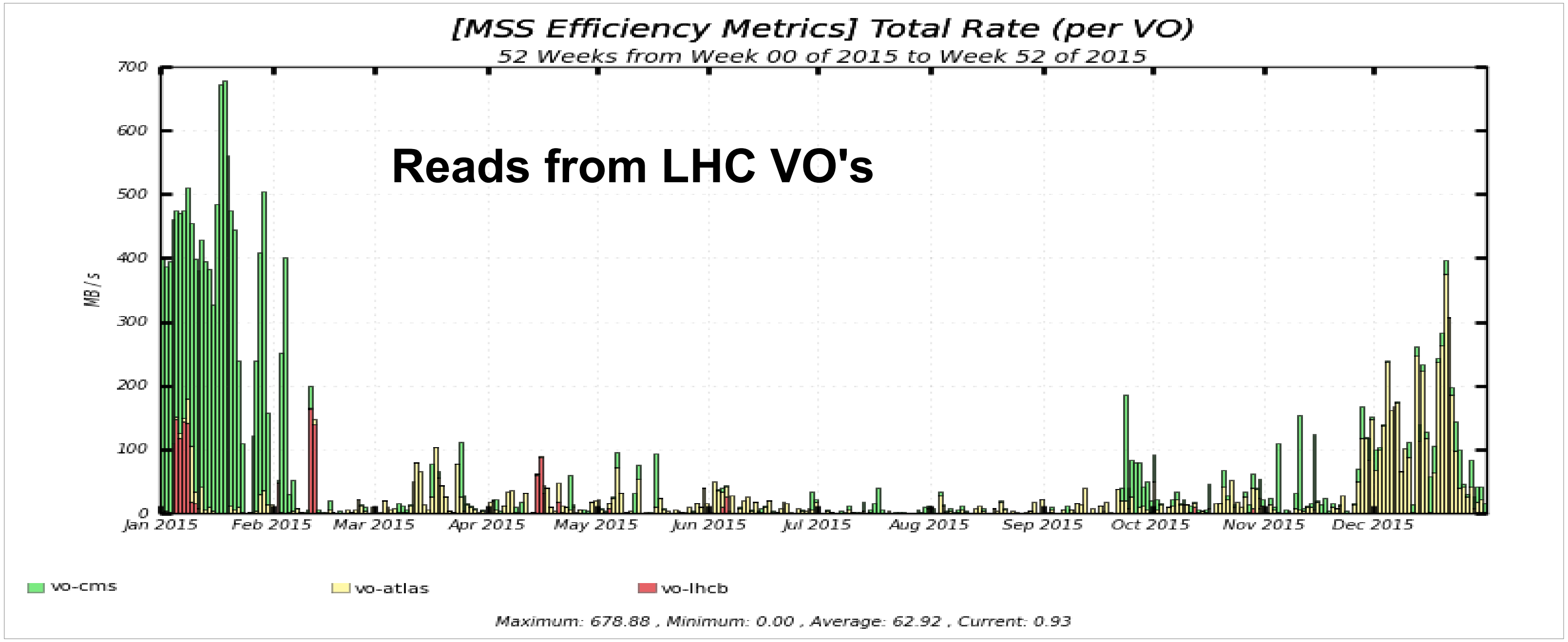
≈ 6MB/s throughput in the worst case

files queued per tape



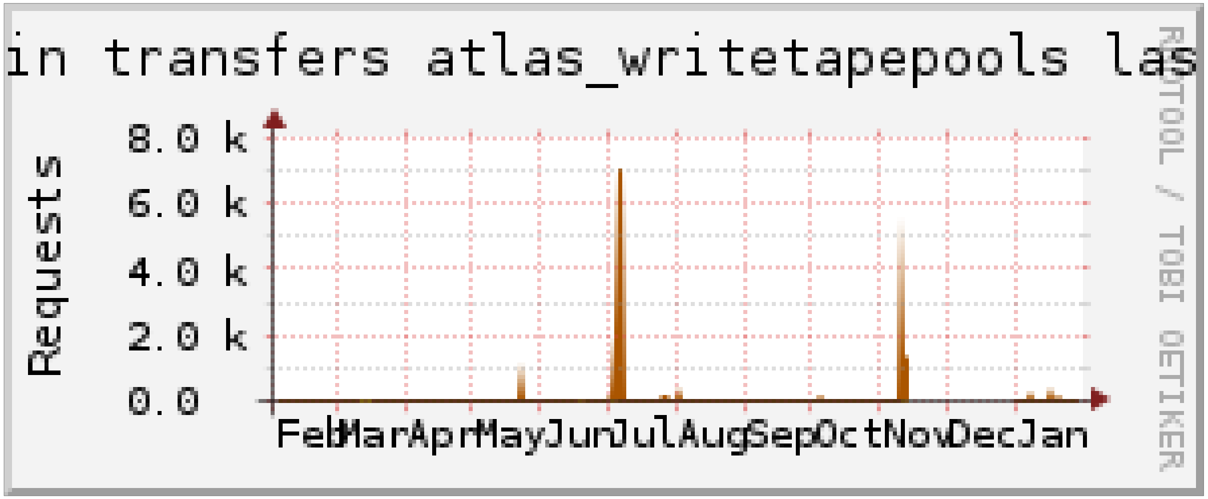
Tape activity monitoring (PIC)





Tape activity monitoring (SARA)

- Write and read pool requests for the last year (see http://web.grid.sara.nl/dcache.php?r=year)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Requests
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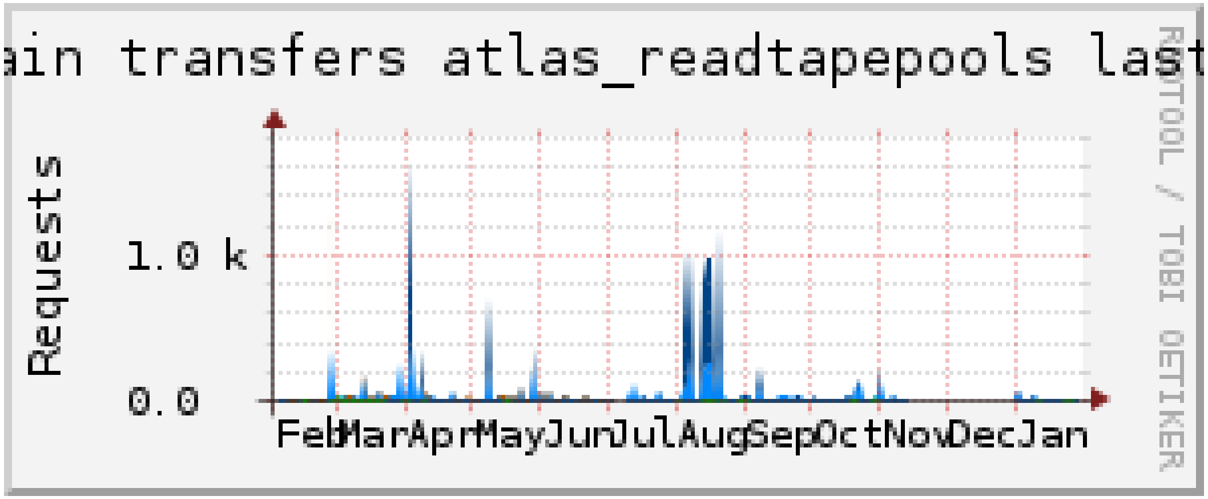
RRDTOOL / TOBI OETIKER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