DATA RATE

EXPECTATIONS AT UII

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LHCb Upgrade II Tracking Workshop
7 March 2024

Baseline summary

SD	Throughput (Tbps)	DAQ links	Avg link rate (Gbps)
VeLo	64.0	5250	10.0
RICH	30.0	5700	5.3
UT	8.0	1900	4.2
MagnetStation	3.5	1400	2.5
MT (Pix)	63.0	7700	8.2
MT (SciFi)	40.0	4100	9.8
TORCH	28.5	4350	6.5
Calo	31.5	3400	9.2
Muon	21.0	2100	10.0
TOTAL	290.5	35900	

Vertex Locator

Scenario	Throughput (Tbps)	DAQ links	Avg link rate (Gbps)	Thput / lumi (Tbps·Hz/nb)
Baseline @ 15 Hz/ub	53	5248	10.0	4.3
Baseline @ 13 Hz/ub	46	4608	10.0	4.4
Baseline @ 10 Hz/ub	38	3840	10.0	4.7
Descoped @ 15 Hz/ub	50	4920	10.0	4.0
Descoped @ 13 Hz/ub	43	4320	10.0	4.1
Descoped @ 10 Hz/ub	36	3600	10.0	4.4

Upstream Tracker

Scenario	Throughput (Tbps)	DAQ links	Avg link rate (Gbps)	Thput / lumi (Tbps·Hz/nb)
Baseline @ 15 Hz/ub	8.0	1888	4.2	0.53
Baseline @ 13 Hz/ub	6.9	1680	4.1	0.53
Baseline @ 10 Hz/ub	5.3	1360	3.9	0.53
3 layers @ 15 Hz/ub	6.0	1416	4.2	0.40
3 layers @ 13 Hz/ub	5.2	1062	4.1	0.40
3 layers @ 10 Hz/ub	4.0	1020	3.9	0.40

Reduced coverage scenario: links reduced by 12%, but not throughput

Mighty Tracker (PixelI)

Scenario	Throughput (Tbps)	DAQ links	Avg link rate (Gbps)	Thput / lumi (Tbps·Hz/nb)
Baseline @ 15 Hz/ub	63	6312	10.0	4.2
Medium @ 13 Hz/ub	47	4692	10.0	3.6
Low @ 10 Hz/ub	36	3600	10.0	3.6

Throughput estimated assuming 100% link usage

30% data reduction expected at back-end output

Mighty Tracker (Fibre)

Scenario	Throughput (Tbps)	DAQ links	Avg link rate (Gbps)	Thput / lumi (Tbps·Hz/nb)
Baseline @ 15 Hz/ub	40	4096	10.0	2.7
Medium @ 13 Hz/ub	40	4096	10.0	3.1
Low @ 10 Hz/ub	37	3712	10.0	3.7

Throughput estimated assuming 100% link usage

80% data reduction expected at back-end output

Muon Tracker

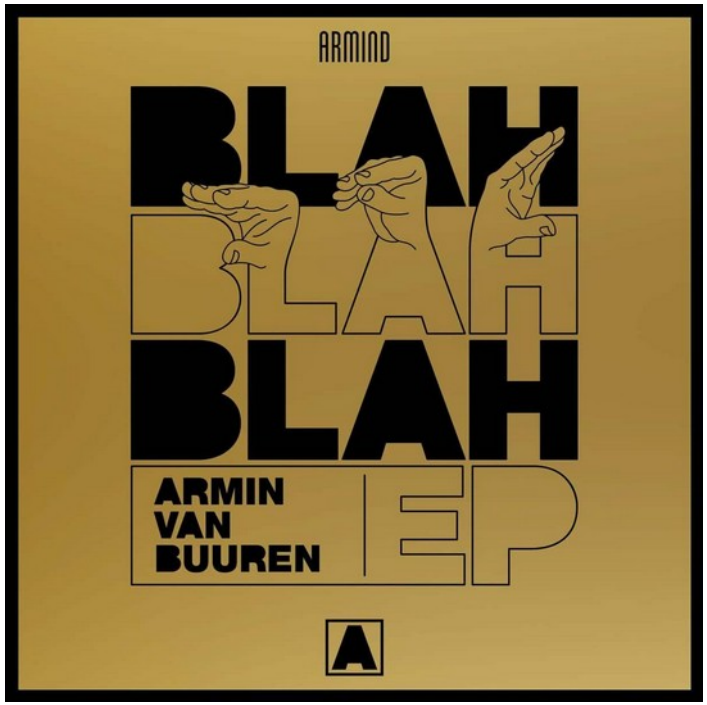
Scenario	Throughput (Tbps)	DAQ links	Avg link rate (Gbps)	Thput / lumi (Tbps·Hz/nb)
Baseline @ 15 Hz/ub	21	2112	10.0	1.4
Medium @ 13 Hz/ub	19	1944	10.0	1.5
Low @ 10 Hz/ub	17	1656	10.0	1.7

Throughput estimated assuming 100% link usage

Pontifications (1)

- Baseline totals are:
  - 36k links, 360 Tbps throughput
  - 4x links, 10x throughput vs. Run3
  - FTDR assumed 3x and 5x
- “Low” scenarios: numbers reduced by ~30%
- **But:** technological evolution in compute and networks continues relentlessly
  - 50 Tb/s single-ASIC switches available today!
  - 360 Tb/s will look tiny in 2032

→ No need to worry about over-optimising the front-ends



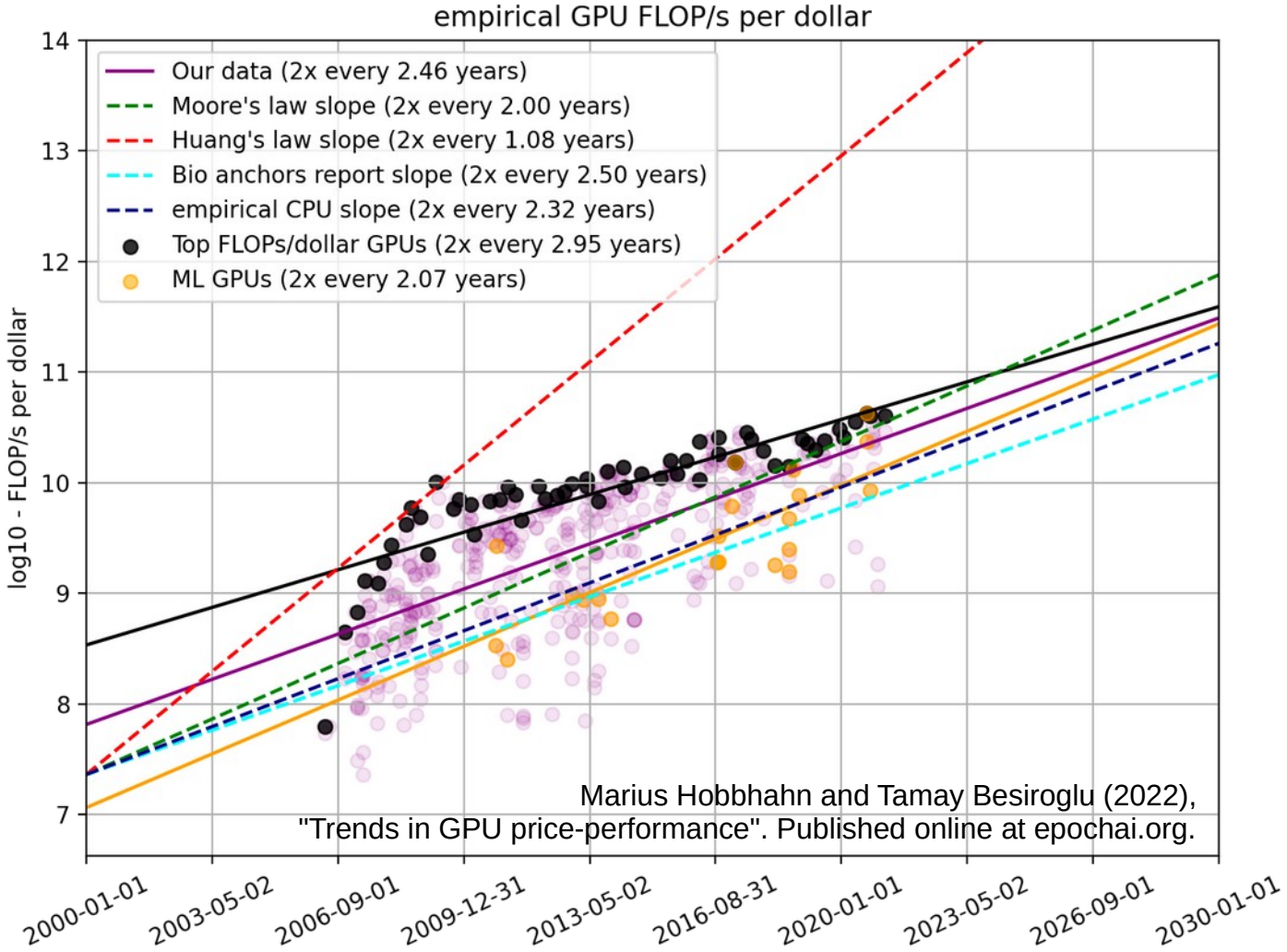
Pontifications (2)

- Because of geometry, some sub-detectors have:
  low link usage, or huge data reduction after back-end
- Others just assume 100% link usage for now
- Online system design depends essentially on:
  - Number of links
  - Back-end input throughput (shown in these tables)
  - Back-end output throughput Please give it some thought!
- These numbers can motivate R&D in different directions
  - A low-cost lpGBT “concentrator” for SDs with low link usage
  - A back-end / event builder with high input and lower output capacity

BACKUP

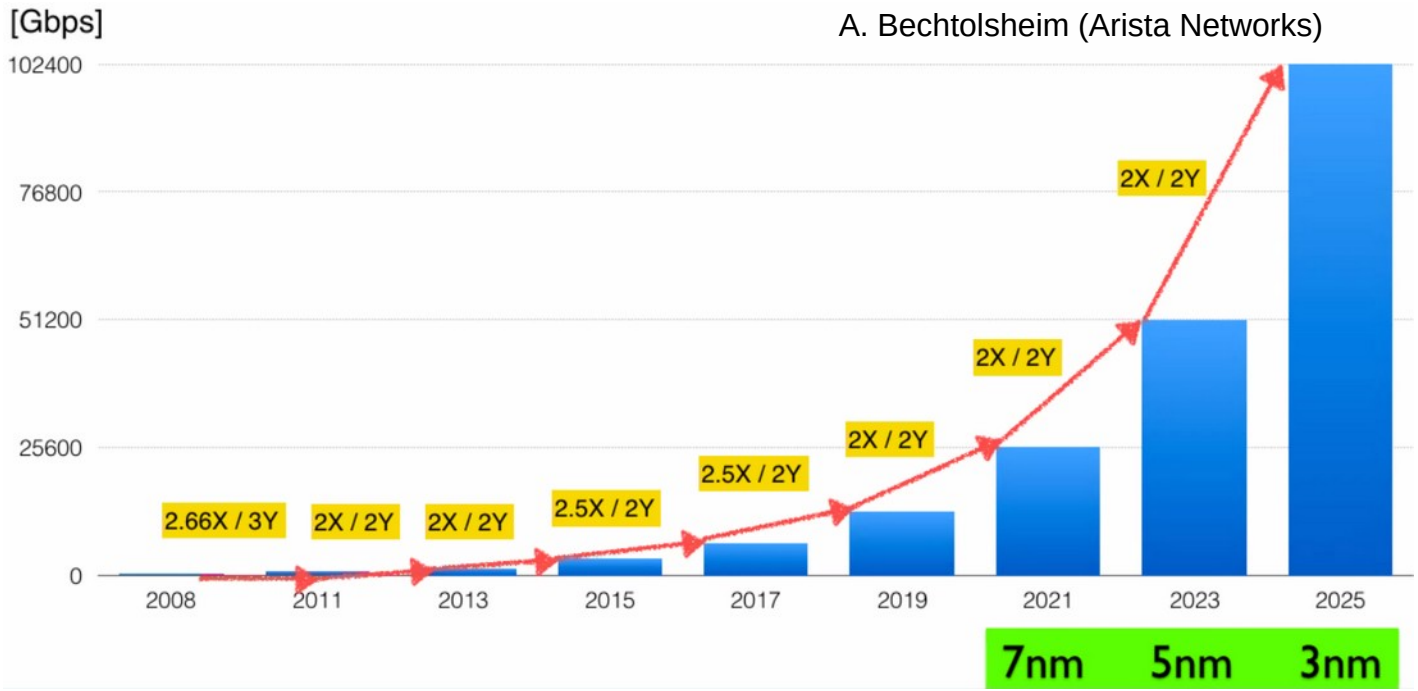
Compute

Reports of the death of Moore's Law have been greatly exaggerated



Network

- 50 Tb/s **single-ASIC switches** available today
- 100 Tb/s is around the corner
- Evolution driven by cloud and ML



- By 2032, our estimated requirement of 360 Tb/s will look minuscule
- Even if evolution stopped in 2025 we would be more than OK