OCP E1.S THERMAL METHODOLOGY PROPOSAL – IMPEDANCE BASED –FORM FACTOR WIDTH COMPARISON RESULTS

Intel

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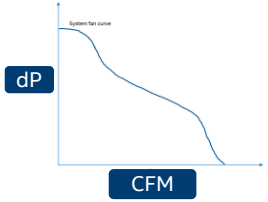
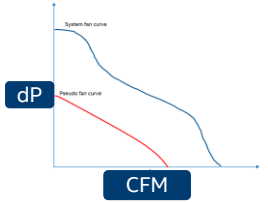
Methodology “Strawman”

True operating point – based on ISO Fan Curve and SSD Impedance

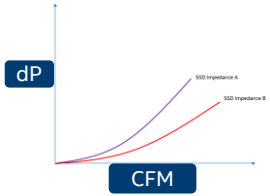
Existing Platform Fan Curve



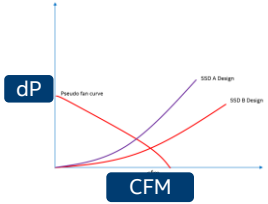
Fan Curve **Derated** Pseudo Fan Curve



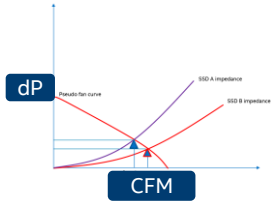
SSD Design – Impedance Curves



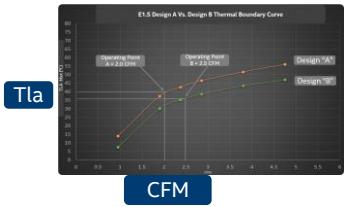
Pseudo Fan Curve Intersects SSD Impedance Curve



True operating point of SSD’s



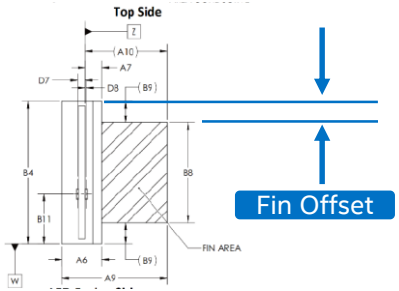
True Thermal Capability (Operating points)



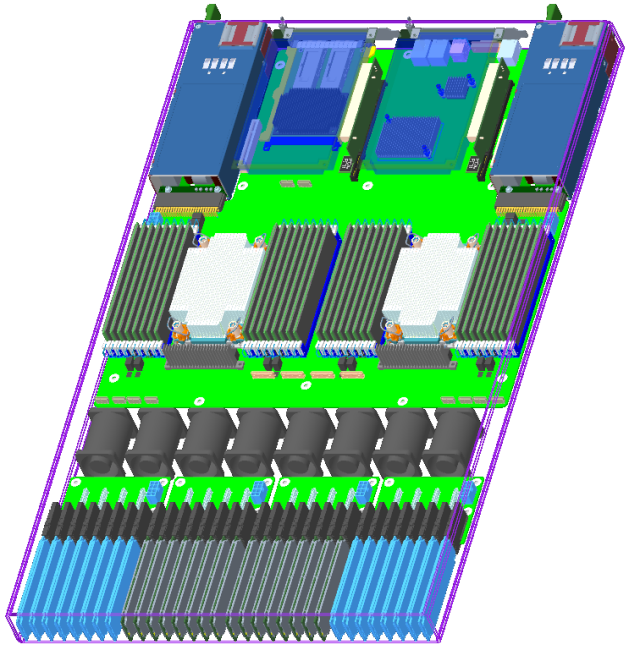
Form Factor Estimate Basis

- **Width Comparison Basis**

	Width	Pitch	Fin Offset	Fin Thk / Gap	PWR	# drives System
A	9.5	12.5	n/a	n/a	20.5	32
C	15	17	5	1 / 1.9	20.5	24
D	25	26	5	1/1.9	20.5	16

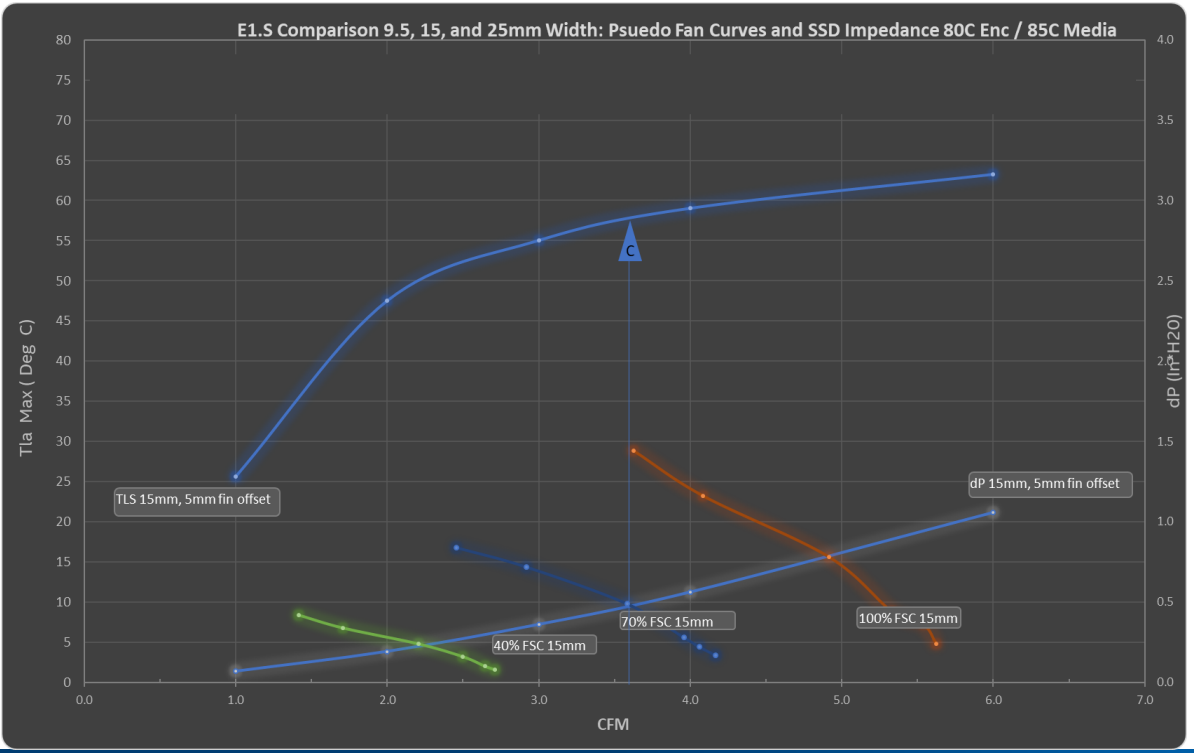


Intel Platform used for Fan Curve and SSD Integration Basis



32 E1.S @ 9.5mm

TLA vs Flowrate and dP, Example for 15mm Width E1.S

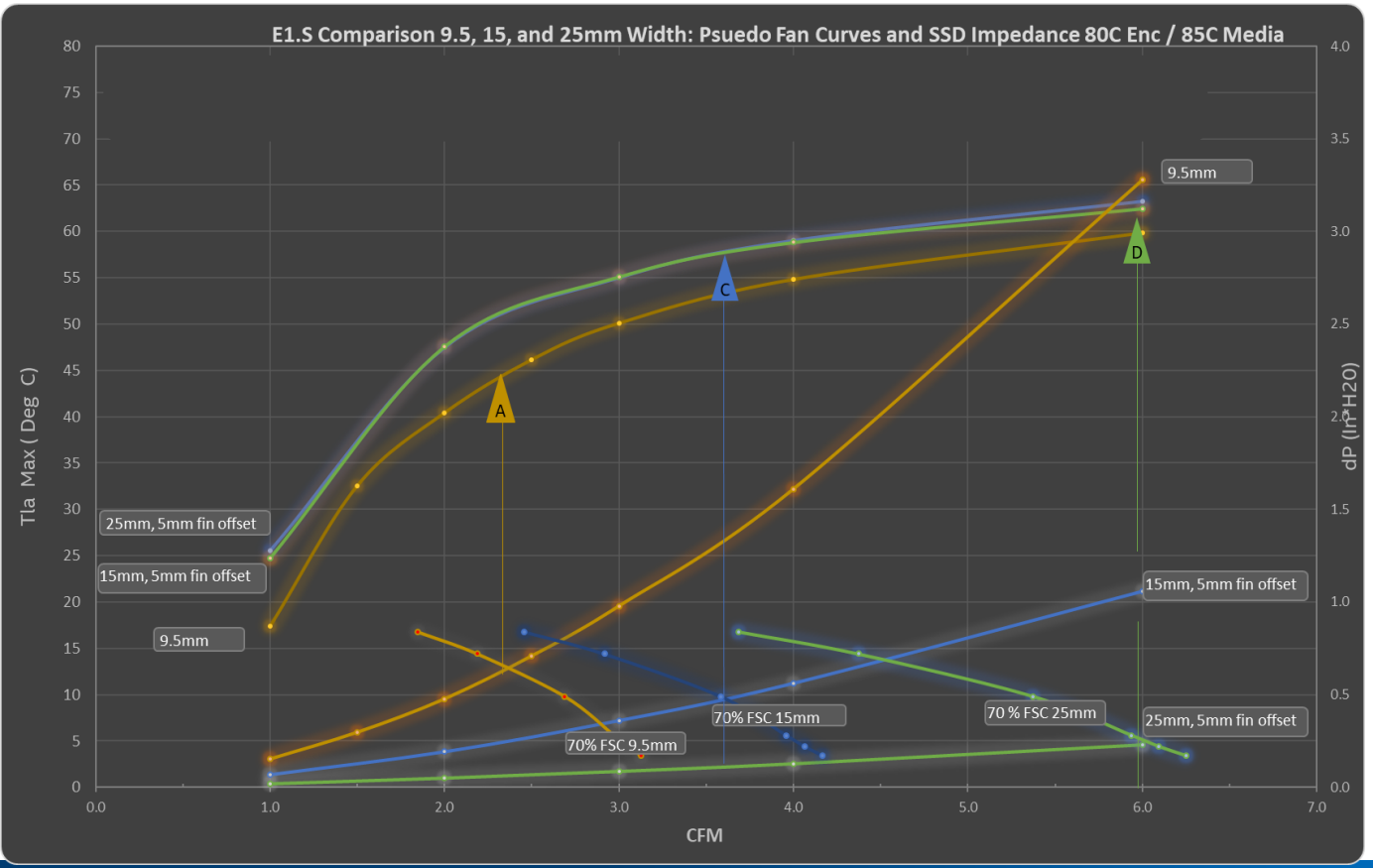


- **Intersection** of fan curve and SSD impedance curve is actual operating point.
- Showing 15mm at a **3.6CFM for a 70% FSC Curve**

  Varies with **each platforms** fan curve
- AT 3.6CFM the drive supports a **Tla** (Temperature local ambient) of ~57.
  - Tla is temperature local ambient (aka "inlet temperature".

	Width mm	Fin Thk / Gap	SSD CFM	dP (in*H20)	Tla
C	15	1 / 1.9	3.6	0.5	57

What does all this mean? @ 80C Enc / 85C Media



Trend: Increasing width achieves better system airflow, higher Tla, naturally achieves higher flow on the fan curve.

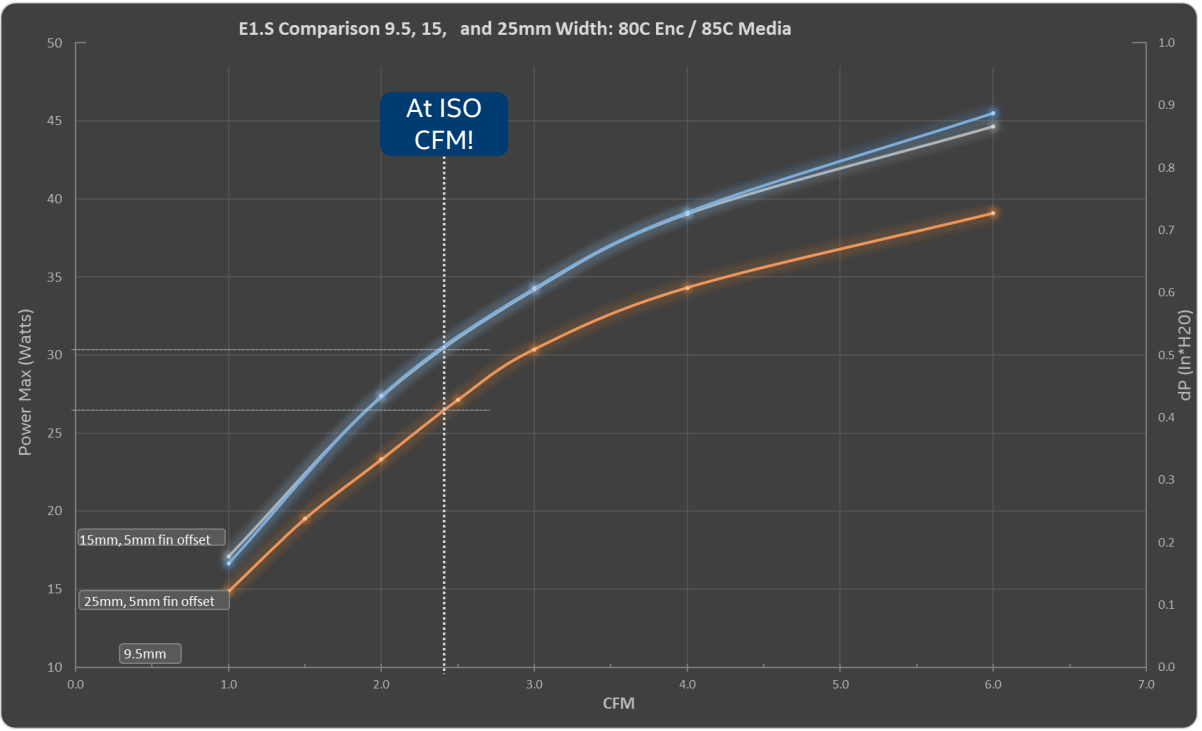
How Do they Compare: 80C Enclosure at 85C Media,@ fixed 20W SSD PWR

	Width	Fin Offset	SSDs / Platform	Fin Thk / Gap	CFM/SSD	Tla	dP SSD (in-H2O)	Platform CFM	PWR/SSD*	Total SSD PWR	Air T-rise
A	9.5	n/a	32	n/a	2.4	45	.62	76.8	20	640	16.3
C	15	5	24	1 / 1.9	3.6	57	.5	86.4	20	480	10.8
D	25	5	16	1/1.9	6.0	62	.24	96	20	320	6.5

Platform Thermal Benefit at ISO SSD Power:

- Increasing width achieves better system airflow
- Supporting Tla increases as a function of width
- Lower Air T-rise and lower impact on CPU, etc.

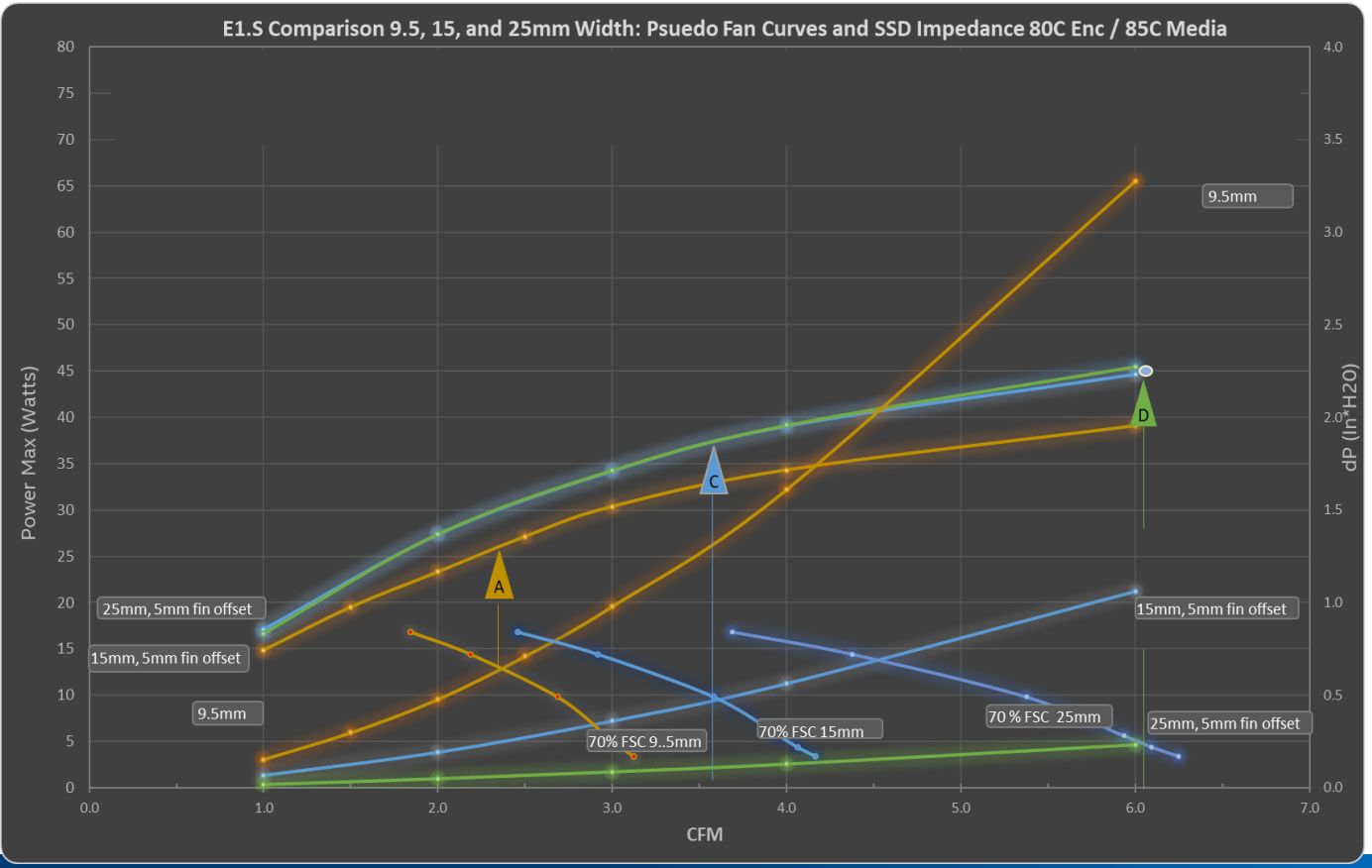
Estimated Power Capability at 80C Enc / 85C Media



- Power vs. CFM
- Approximated power - extrapolated
- An iso CFM view
- Shows 15mm and 25mm look equal!
- See next slide for True difference

- Benefit increases when we look at actual operating differentials wrt fan curves

Estimated Power Capability at 80C Enc / 85C Media (context of true operating point for a respective fan curve)



- Larger width **DOES NOT** require more CFM.
- It has the **advantage** of **operating at > CFM** under that **same** platform conditions.

Power Comparison : 80C Enclosure at 85C Media allowing airflow through SSD to scale to the fan curve

	Width	Fin Offset	SSDs / Platform	Fin Thk / Gap	CFM/SSD	Tla	dP SSD (in-H2O)	Platform CFM	Max PWR/SSD*	Total SSD PWR	Air T-rise
A	9.5	n/a	32	n/a	2.4	35	.62	76.8	25	800	20.3
C	15	5	24	1 / 1.9	3.6	35	.5	86.4	35	840	19
D	25	5	16	1/1.9	6.0	35	.24	96	45	720	14.6

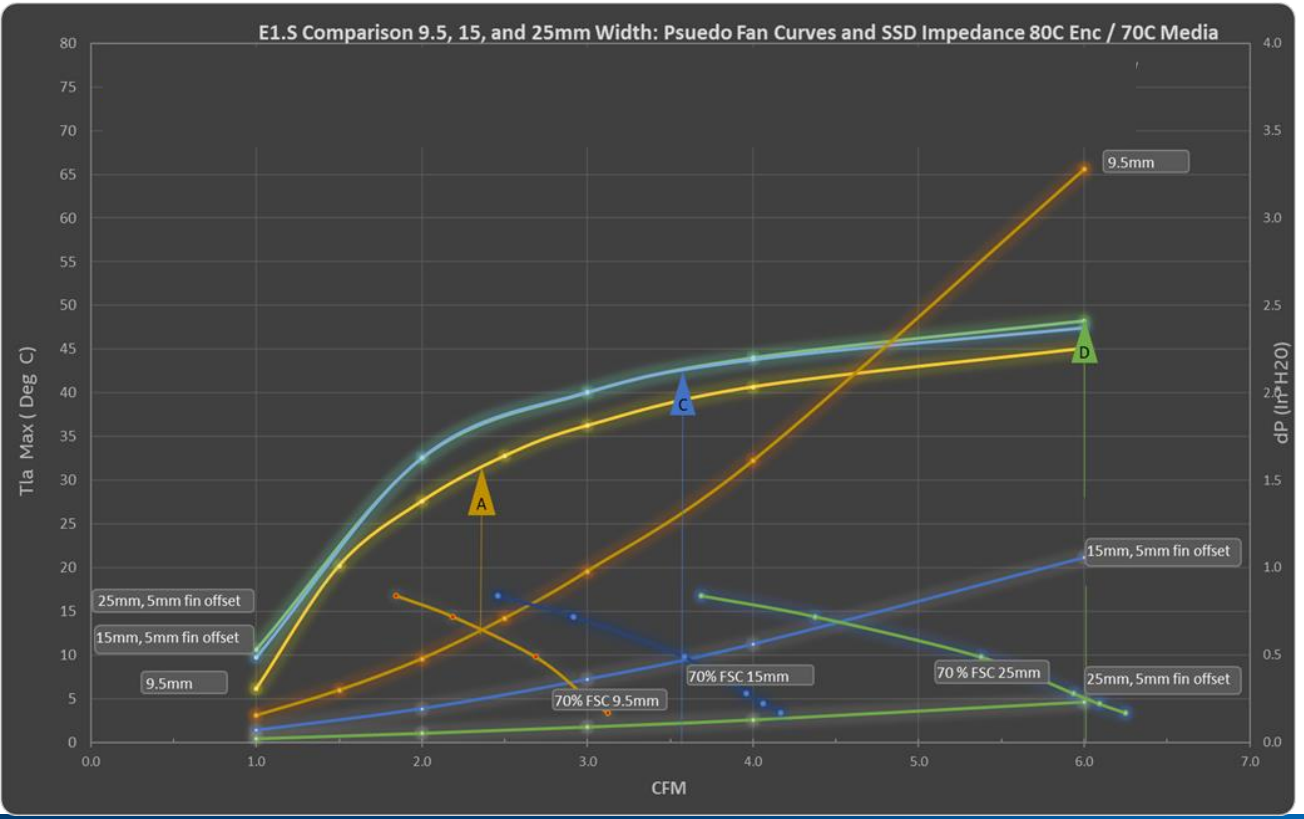
* Allowable power at operation CFM relative to Fan Curve @ 80C enclosure and 85C Media temp limit

- **9.5mm**
  - Great 1U capacity – 32 SSDs
  - Cross Modular with 25mm
- **15mm**
  - Great 1U total power – 840W
  - Good 1U capacity – 24 SSD
- **25mm**
  - Lowest impedance – down stream thermal advantage
  - Best SSD power capability (45)
  - Best SSD thermal advantage

Conclusions

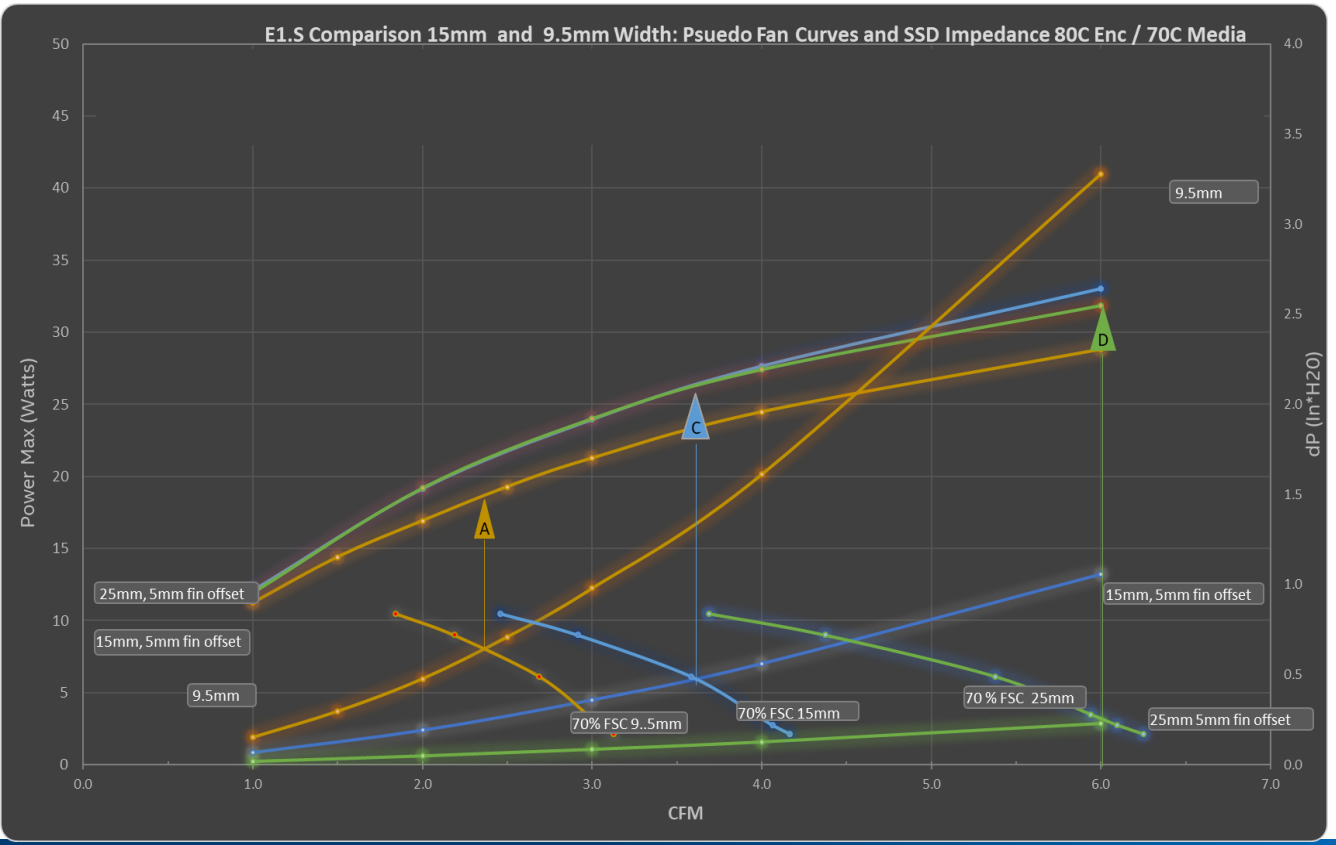
- As Width increases a thermal advantage is present to SSD and platform but at the cost of drive density.
  - **9.5mm** provides the best drive density but least power capability.
  - **15mm** provides **better power than 9.5mm** for SSD, and **higher system flowrate** realizing a lower Air T-rise than 9.5mm **at ISO power.** May achieve higher Air-Trise at 15mm **"Max SDD PWR"** scenarios.
  - **25mm** provides highest SSD PWR, the lowest impedance and lowest Air temp to downstream components, but limited drive density.
- Systems will have different fan curves and design based on impedance curves of SSD.
  - SSD manufactures to provide thermal metrics combined with impedance curves.

Tla at True Operating point @ 70C Media



	Width mm	Fin Offset	Fin Thk / Gap	SSD CFM	Tla	Plat-form CFM
A	9.5	n/a	n/a	2.4	32	76.8
C	15	5	1 / 1.9	3.6	42	86.4
D	25	5	1/1.9	6.0	47	96

Estimated Power Capability at 80C Enc / 70C Media



- PWR Reduced at 70C Media
- Trend is still present – capability in 15/25mm