
MAGLEV
AERO
Presents
The MagLev HyperDrive™

MagLev Aero Has Built an Exceptional Leadership Team With Deeply Relevant Experience

Ian Randall
Co-Founder
CEO

Rod Randall
Co-Founder
Chairman

Josh Elvander
SVP Engineering

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Chief Maglev Scientist

Raj Alur
VP Business Development

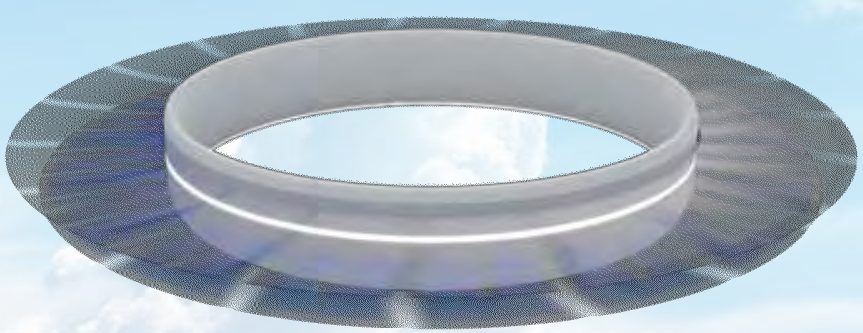
Stephen Lee
Fractional CFO

Kristen Bates
Head of HR

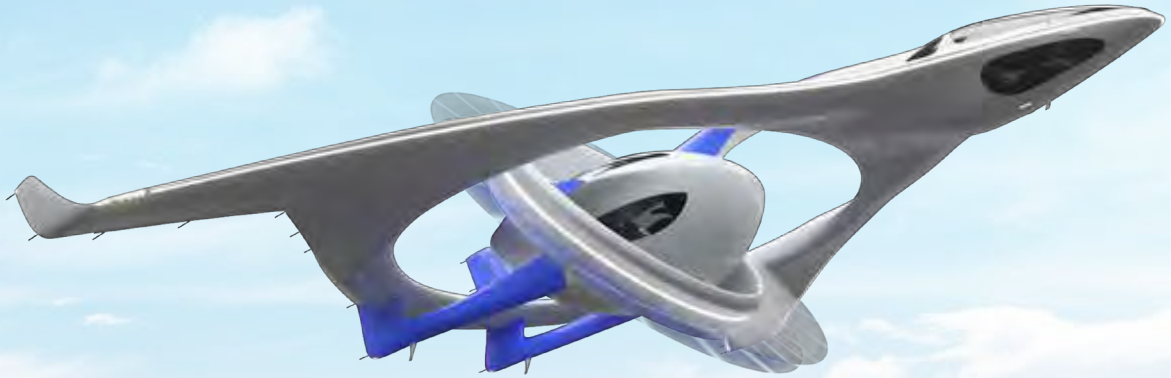
MAGLEV AERO

THE SKY IS THE LIMIT

MagLev Aero Unlocks the Potential for Clean Mass Market Urban Air Mobility



HyperDrive™ Breakthrough Propulsion



Example Aircraft Enabled By HyperDrive™

MagLev Aero is developing a breakthrough electric propulsion platform that will enable the Quietest, Highest-Performing, and Safest all-electric Zero Emissions eVTOL Passenger/Cargo aircraft to meet the mass market requirements for the emerging $1+ Trillion/year Urban Air Mobility Market

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The Market Opportunity For UAM Is Immense

Morgan Stanley Now Projects This Market To Grow to $9 Trillion Per Year By 2050

Morgan Stanley | RESEARCH

GLOBAL FOUNDATION

May 6, 2021 10:43 PM GMT

Urban Air Mobility

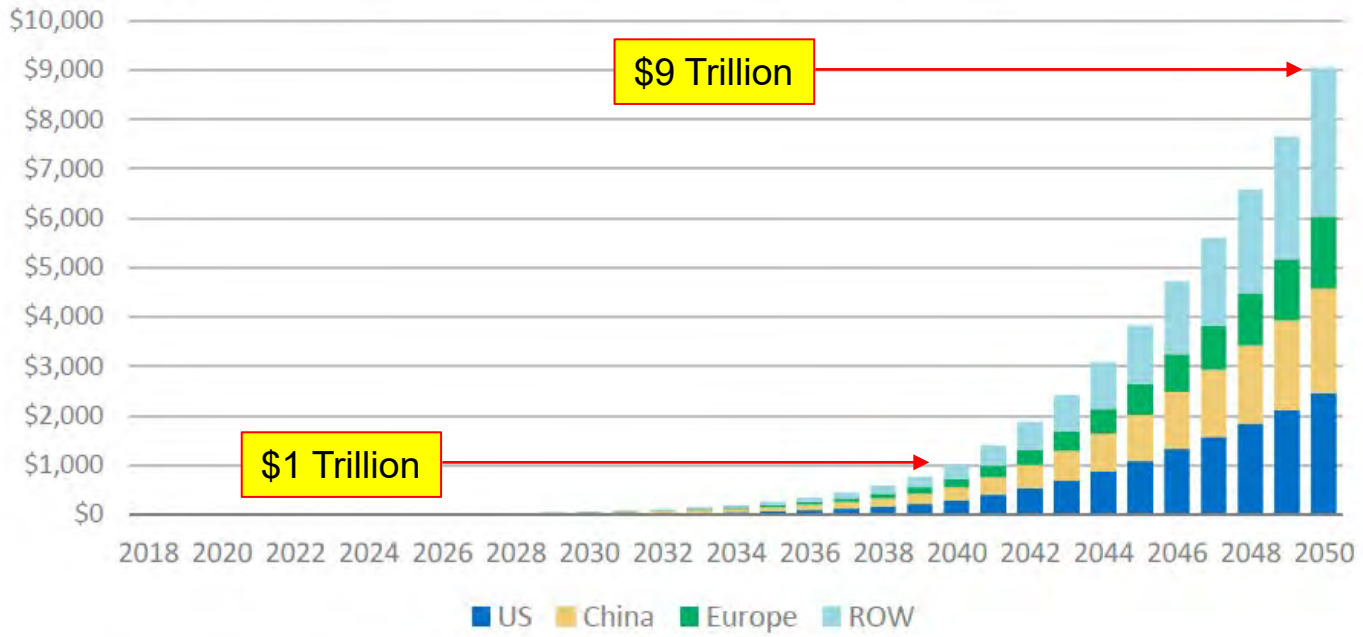
eVTOL/Urban Air Mobility TAM Update: A Slow Take-Off, But Sky's the Limit

The MS team decreases the Urban Air Mobility TAM base case to $1tn by 2040, but rolls out projections until 2050, when the TAM is projected to be $9tn. We don't think investors are prepared for the scope of this revolution. However, they must consider a host of regulatory factors that may slow adoption.

For analyst certification and other important disclosures, refer to the Disclosure Section, located at the end of this report.

Exhibit 10 :

UAM Global Total Addressable Market (Base Case)



Source: Morgan Stanley Research Estimates

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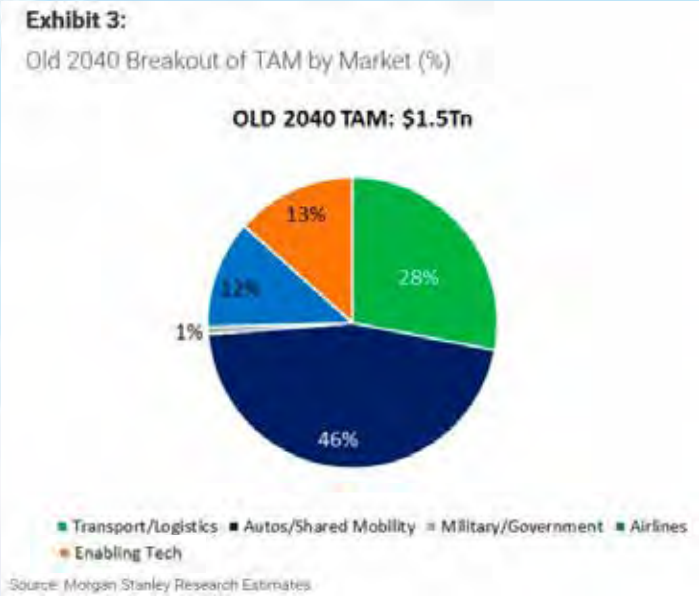
Morgan Stanley's updated projection shows the biggest opportunities are Cargo and Autos/Shared Mobility, which will require deep penetration into communities, which will require ultra-quiet operation.

Exhibit 3:

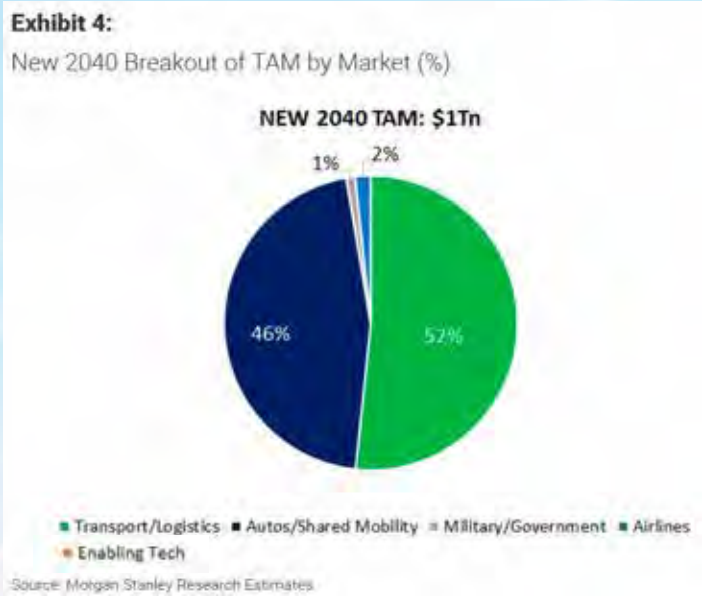
Old 2040 Breakout of TAM by Market (%)



Source: Morgan Stanley Research Estimates

Exhibit 4:

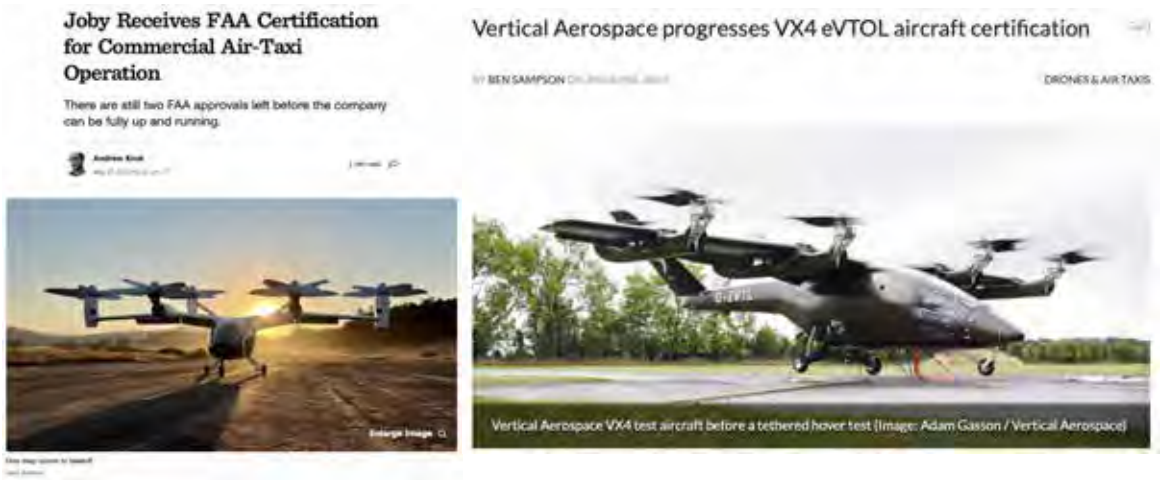
New 2040 Breakout of TAM by Market (%)



Source: Morgan Stanley Research Estimates

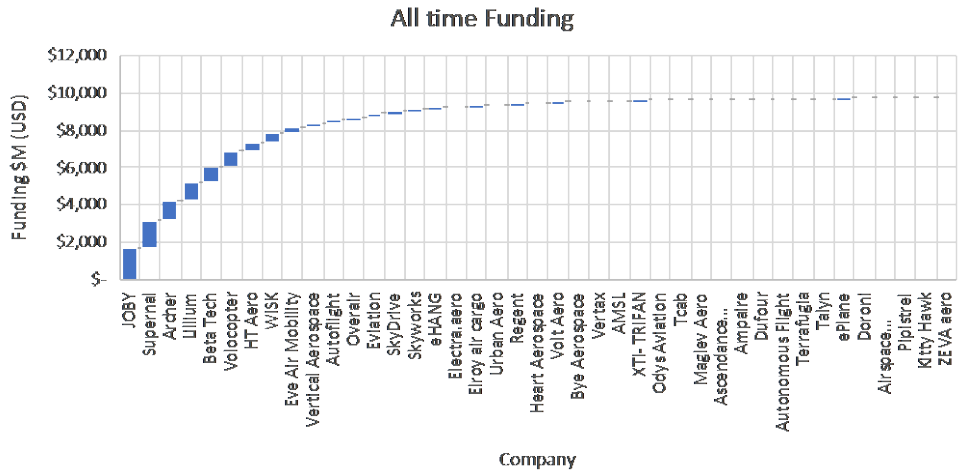
Tremendous Progress Has Been Made By UAM Industry Leaders Across Many Dimensions

eVTOL Certification Is Well Underway

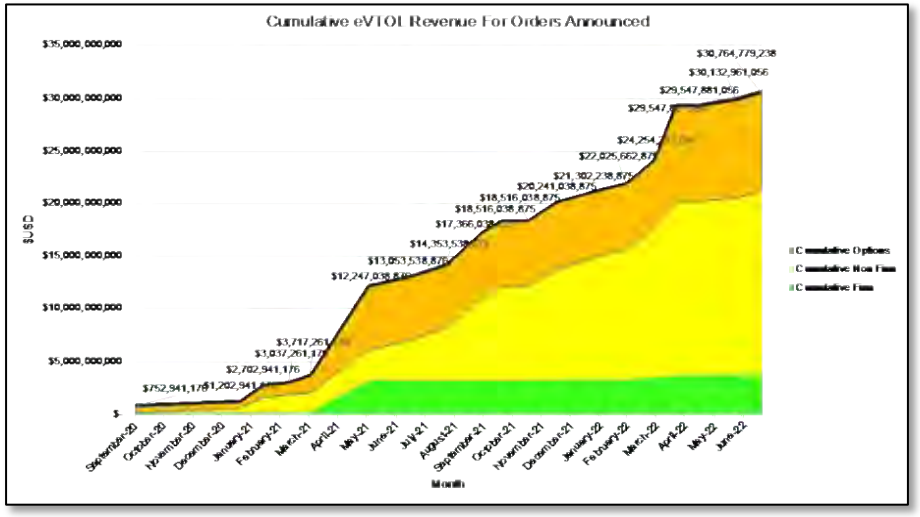


Automotive Scale Manufacturing Partnerships Have Begun

eVTOL Financings Now Total Over $10B In Funding



Pre-Orders Have Grown From $753M To Over $30.7B



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Early Solutions Meet the Requirements For Initial UAM Operations, But What Is Needed For Mass Market $1T+ Penetration?

Market Requirements For All Electric Battery eVTOLs

Key Criteria	Market Entry	Mass Market Adoption
Redundant Safety	$1x10^{-8}$ Table Stakes	$1x10^{-9}$ Or Better
Ultra Low Noise (Compared To Helicopters)	15dBA Quieter In Flyover Cruise	25dBA Quieter In Take-Off and Approach
Cruise Speed	150 MPH	300 MPH
Capacity	1 Pilot + 4 Passengers 1100 lbs	1 Pilot + 6 Pax + Bags 1400+ lbs
Consumer Appeal	Functional	Beautifully Inviting

Legend: Many Solutions Exist | A Few Solutions Exist | No Solutions Exist

MAGLEV AERO

While Noise Can Be Reduced In Cruise, Noise In Take-Offs And Landings Is Still Not Quiet Enough To Reach Mass Market Penetration

#NoiseMatters

UK Researchers Found eVTOL Propeller Noise Will Be Higher Than Expected

Forbes 2w ago

NASA study finds drone noise is more annoying than 'any ground vehicle'

Published Jul 18, 2017 | DL Cade

Share Tweet

A NASA study has confirmed what your ears have been telling you: people HATE drone noise. In fact, it was ranked more annoying than that of "any ground vehicle."

Read more at Engadget

Tags: drones, nasa, study

'Do it somewhere else': Glendale residents asking Walmart to stop drone delivery service

Some homeowners are upset as Walmart is testing large delivery drones, saying it sounds like helicopters flying directly above their houses.

By Sarah Robinson

Published: Jan. 6, 2023 at 7:19 PM EST

GLENDALE, AZ (3TV/CBS 5) -- People in a peaceful neighborhood off of 59th Avenue and Bell Road were in for a rude awakening when they say Walmart began testing their large delivery drones.

Residents say it sounded like a helicopter flying directly above their homes. "It sounds like a hornet's nest that's been kicked up," said Mike Baxter, who's lived in the neighborhood for five years.

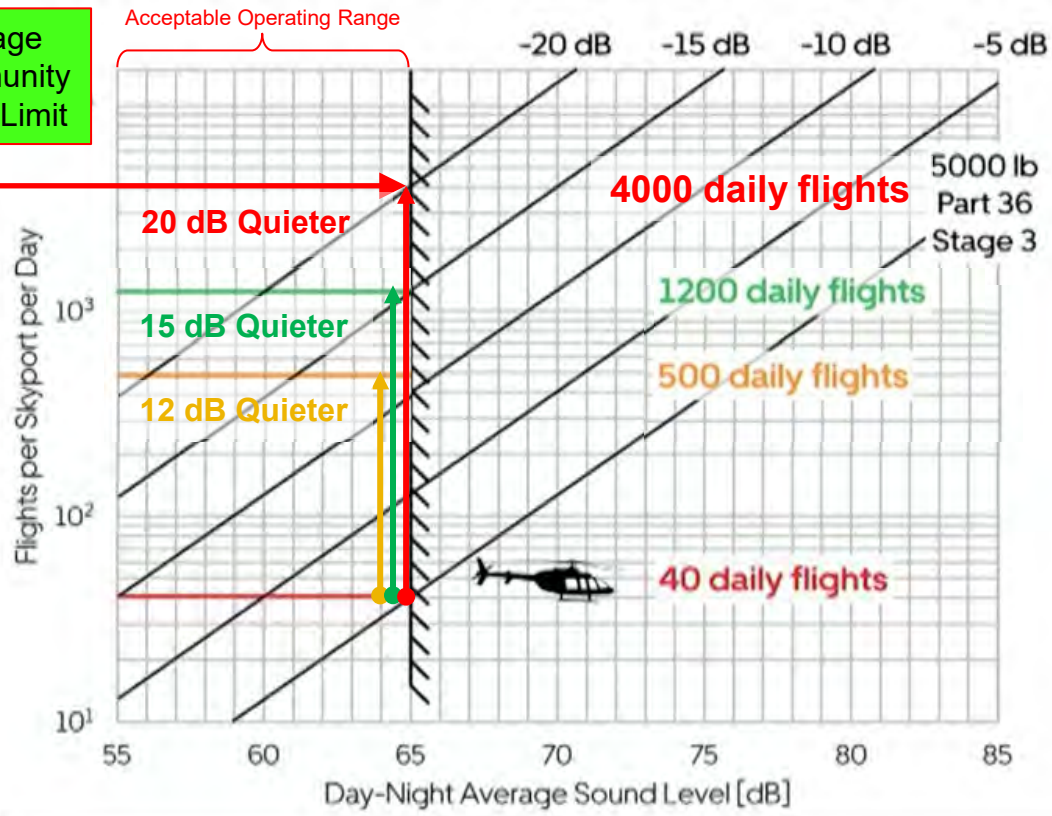
Day-Night Noise Level Limits Flights Per Day Per Region

Helicopters Are Limited to 40 Flights Per Day, MagLev Aero Can Expand This By 100x

Why does it matter?

Data-Driven Acoustic Goals

20+ dB Advantage Eliminates Community Acceptance as a Limit



Day-Night Noise Level

$$L_{dn} = 10\log_{10}\left[\frac{1}{86400}\left(\int_{0000}^{0700} 10^{[L_A(t)+10]/10}dt + \int_{0700}^{2200} 10^{[L_A(t)]/10}dt + \int_{2200}^{2400} 10^{[L_A(t)+10]/10}dt\right)\right]$$

Regulated By:

14 CFR Part 150
Appendix A
Sec. A150.101 Part B

65 DNL Acceptable for any community zoning region including:

Residential
Schools
Hospitals
Churches

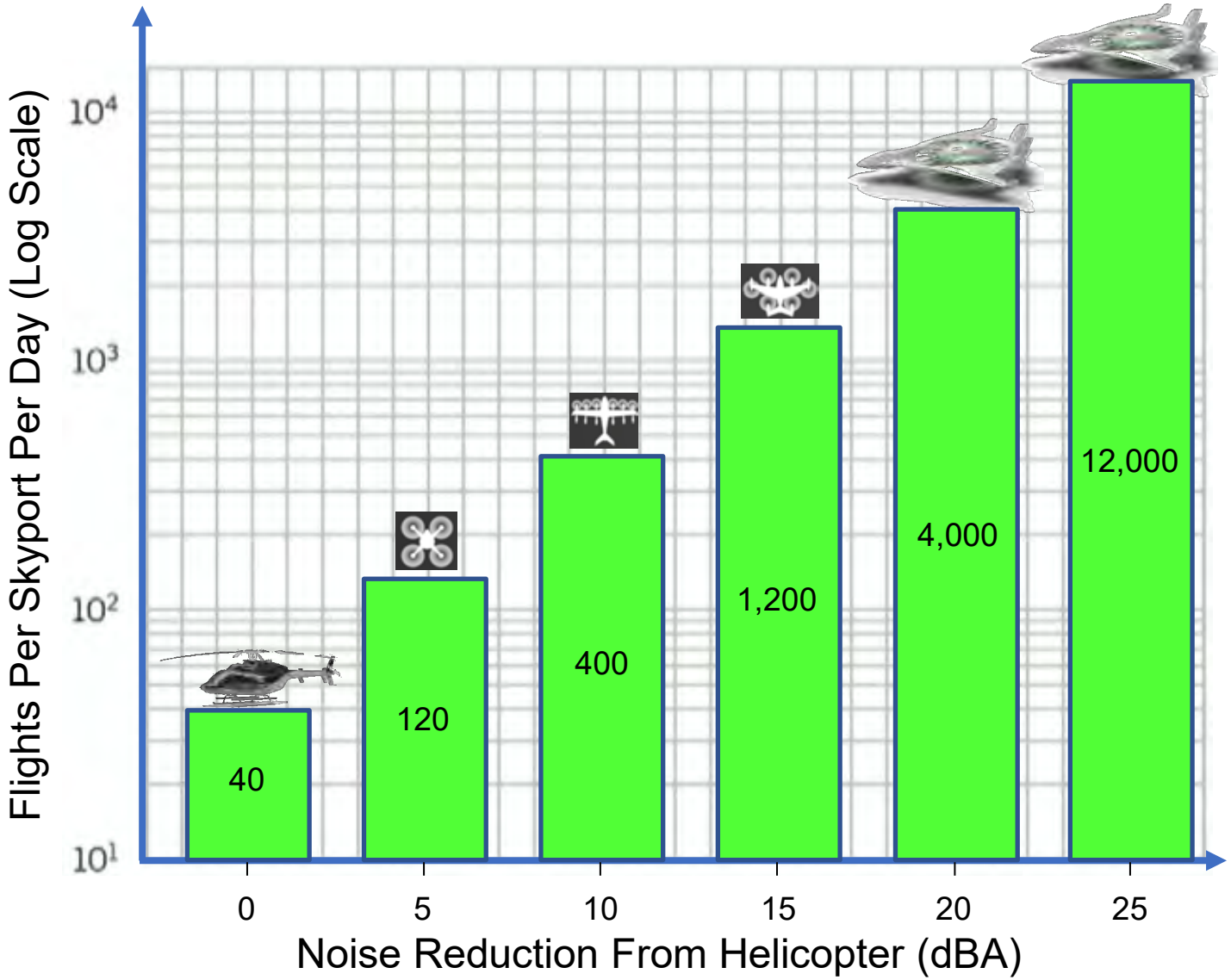
Uber

Source:
Rob McDonald
Uber Elevate 2019

The Bigger The Noise Reduction, The More Acceptable Flights Per Day

MagLev Aero's Ultra Quiet Target Enables More Flights, and Thus Revenue, Per Day

- Noise perception is nonlinear but looks linear on a log scale
- Helicopters are loud, limiting flights to 40 per day



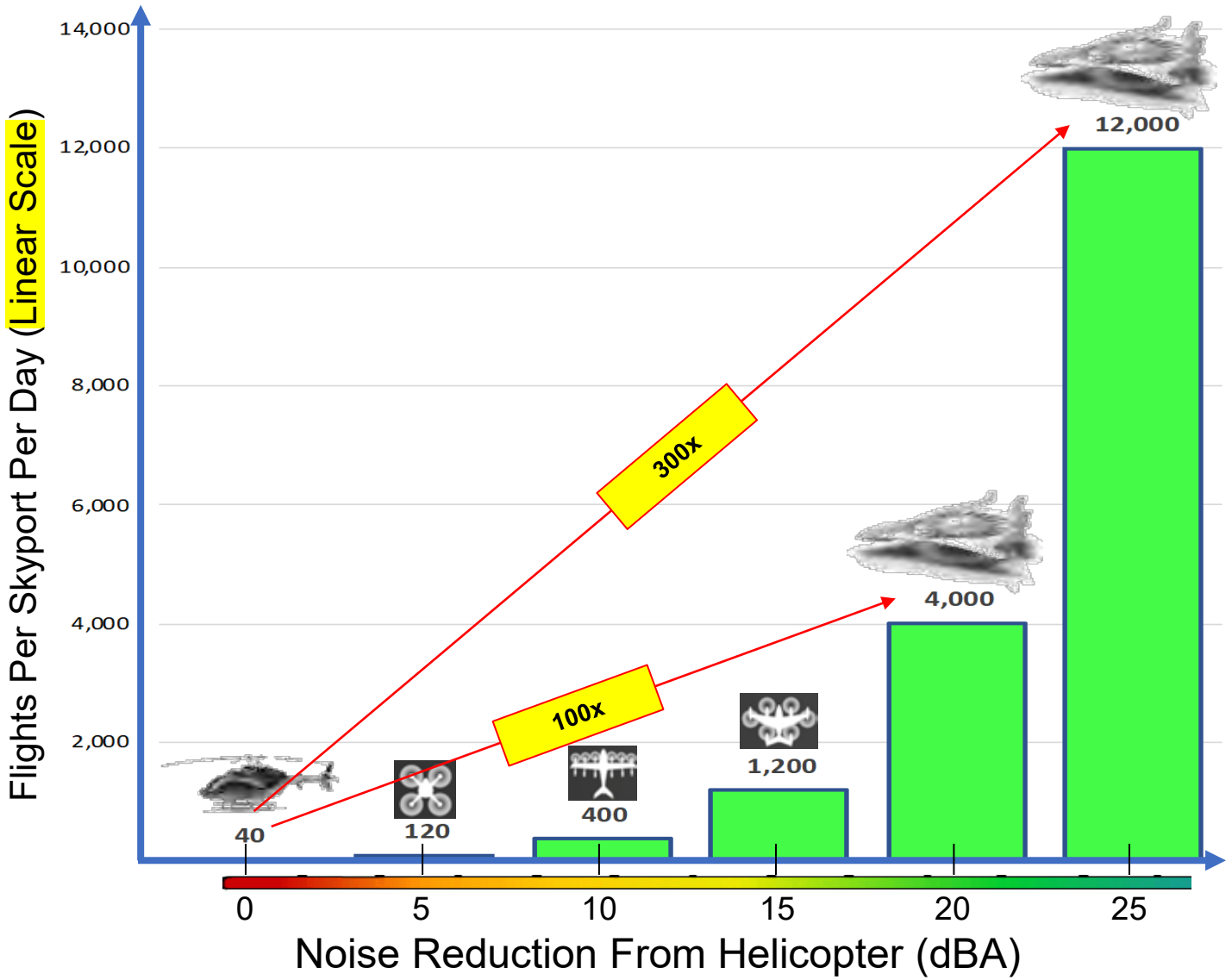
- The more the noise reduction from an eVTOL, the more flights per day that are acceptable to the community
- This is very nonlinear
- Quiet eVTOLs dramatically increase the revenue and market opportunity
- This is better seen on a linear scale

Why Is Noise So Important? Low Noise Enables Dramatic Market Expansion

MagLev Aero's Ultra-Quiet Target Enables 100x More Flights, and Thus Revenue, Per Day

How much does it matter?

- Different eVTOL designs may have dramatically different performance characteristics and revenue potential
  - Noise perception is nonlinear but looks linear on a log scale
  - Helicopters are loud, limiting flights to 40 per day



- The more the noise reduction from an eVTOL, the more flights per day that are acceptable to the community
- This looks linear on a log scale but is very nonlinear
- Quiet eVTOLs dramatically increase the revenue and market opportunity
- This is better seen on a linear scale

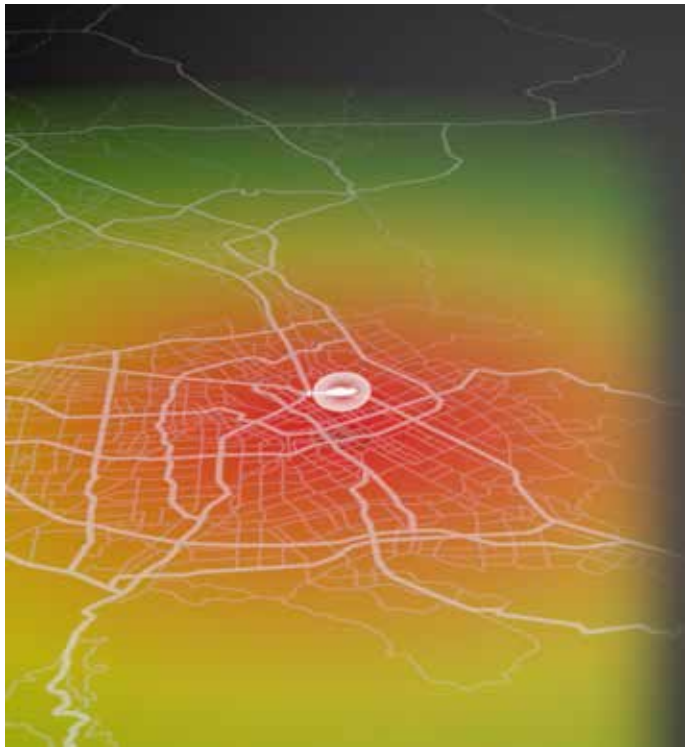
Source Data:
Rob McDonald
Uber Elevate 2019

MAGLEV AERO

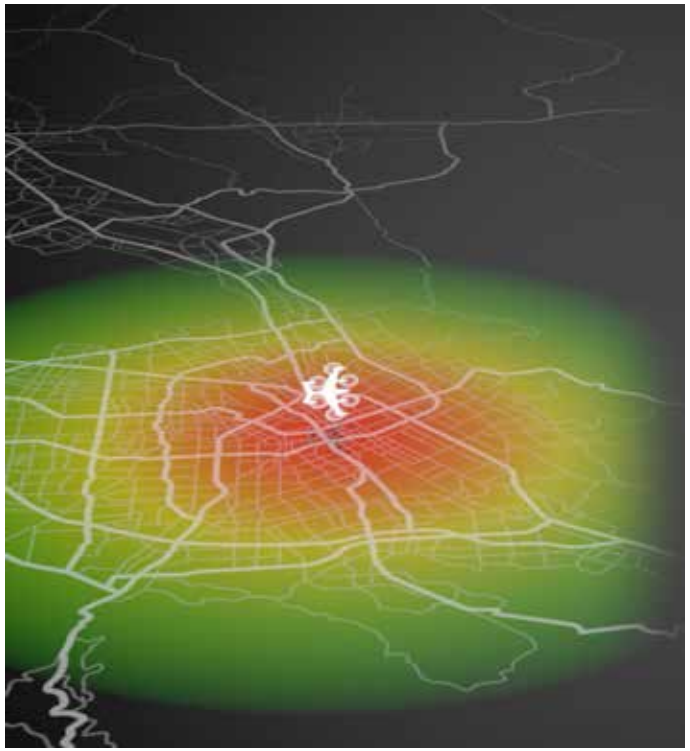
Noise Limits The Acceptance And Penetration Of Vertical Flight

Helicopters are Too Loud, Multi-Rotors Are Better, But Mass Market Adoption Needs A Solution

Why does it matter?



Helicopters are too loud



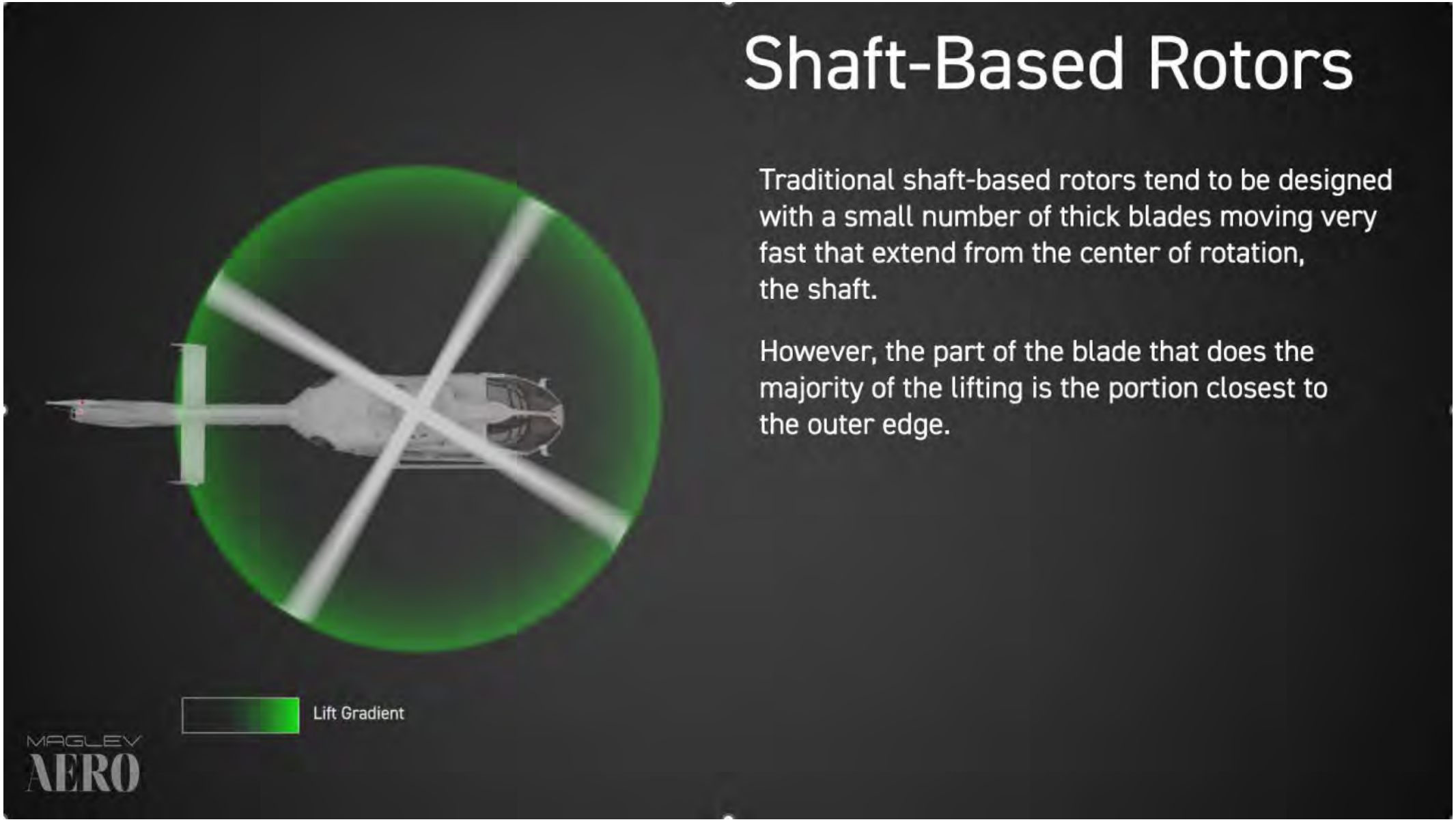
DEP Multi-Rotors are better

A much quieter solution is still needed

MagLev HyperDrive™ Can Have a Dramatically Lower Noise Profile Than Shaft-Based Helicopters and Multi-Rotors In Both Hover and Cruise

The Outboard Blade Spans Are Most Effective in Shaft-Based Rotors

But They Are Also the Most Loaded and the Loudest



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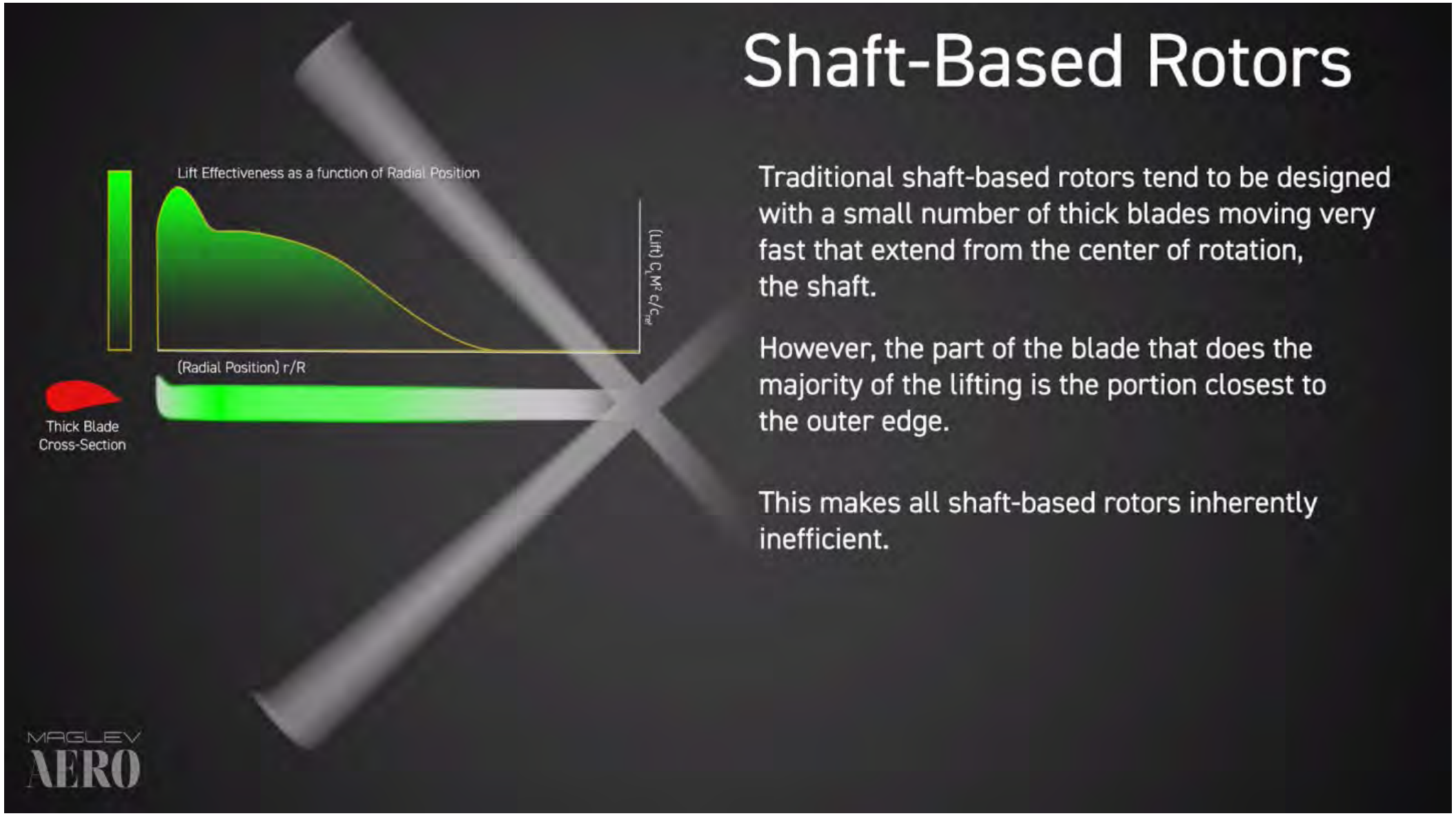

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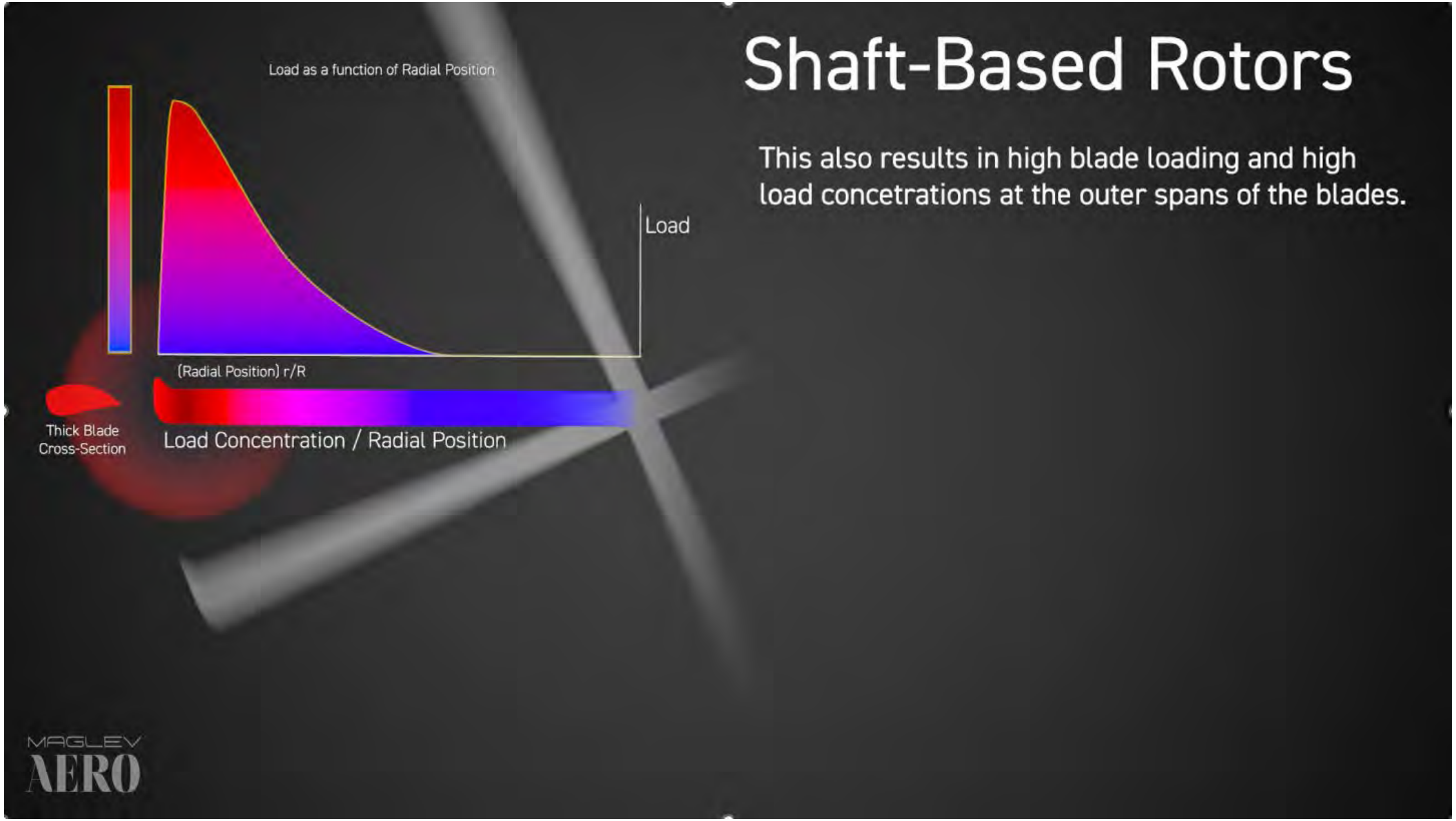

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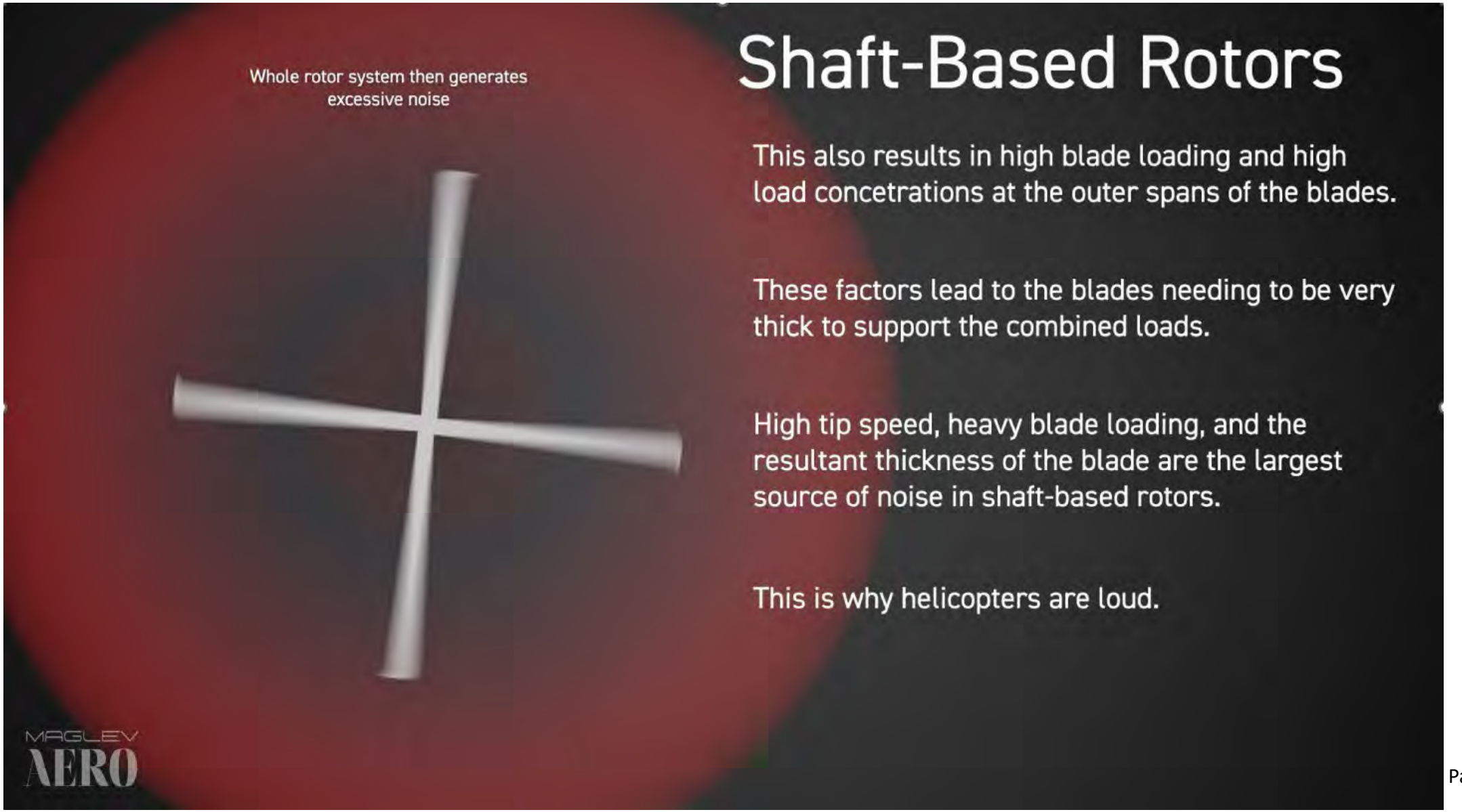
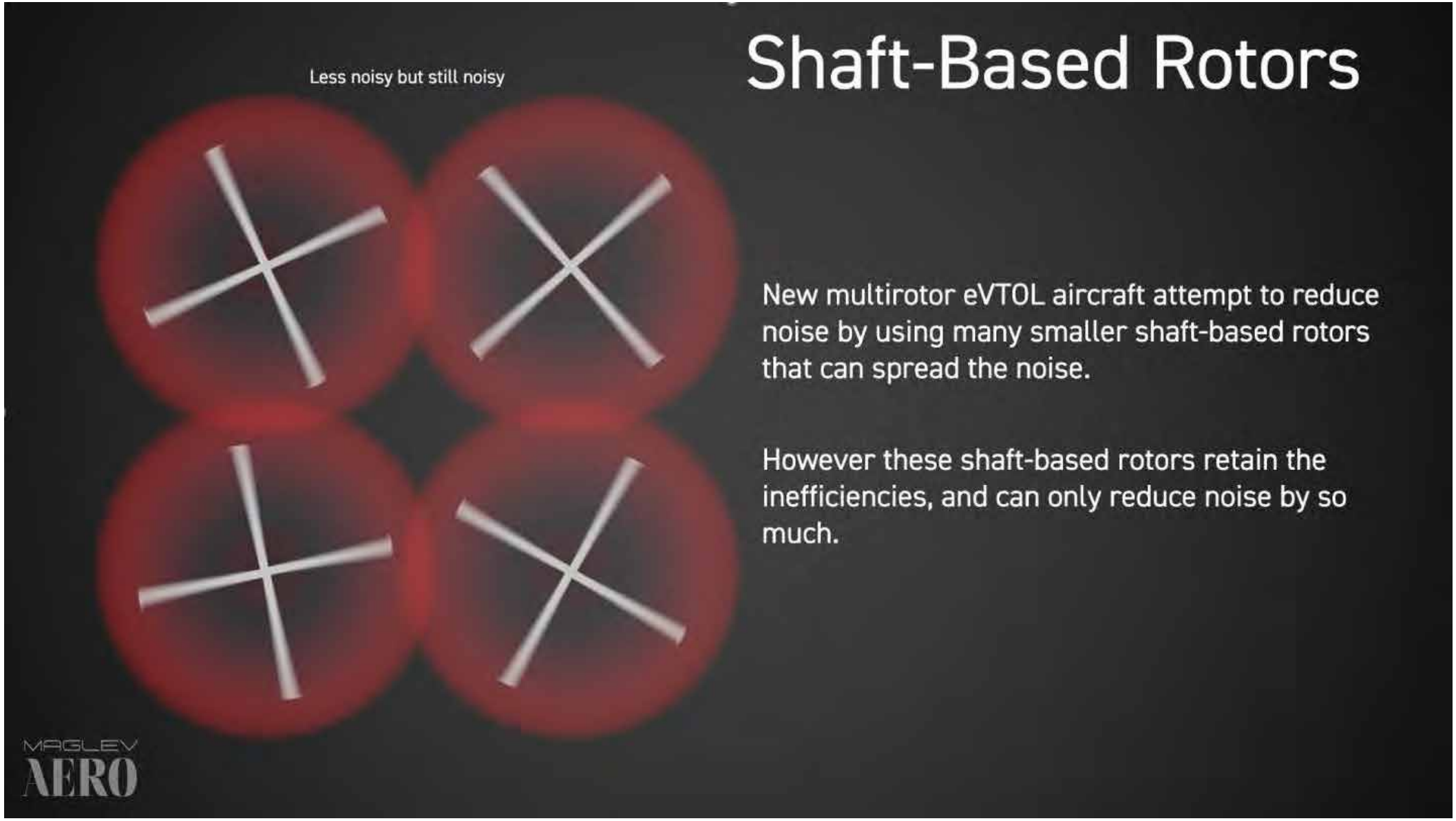


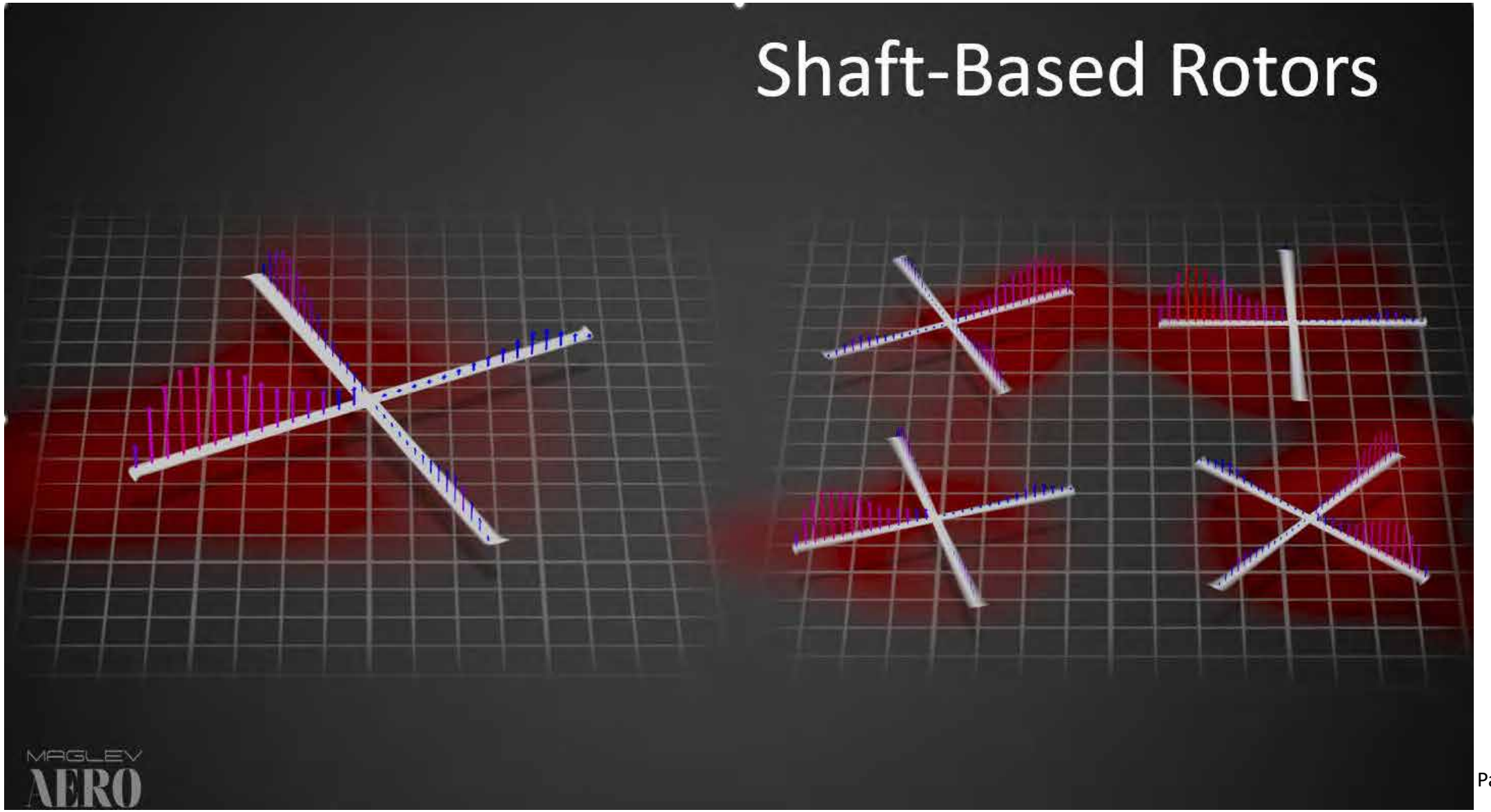
Multiple Smaller Rotors Can Be Quieter than Helicopter Rotors in Hover

However, Loading And Noise Are Similarly Concentrated In the Outboard Span



Unsteady Loading From Edgewise Flight Impacts Noise

Worse In Small, Fast Multiple-Rotor Systems Than Large, Slowed-Rotor Systems



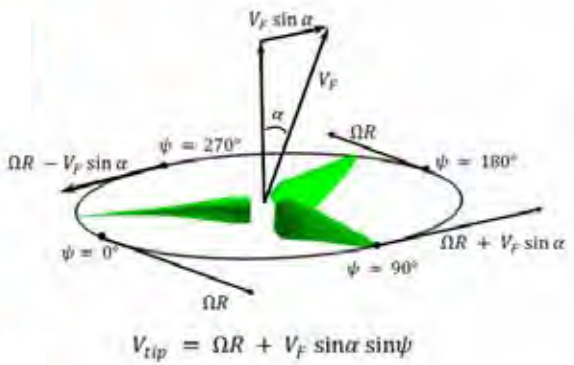
A Single Rotor Can be Significantly Quieter In Asymmetric Flows Than Multiple Rotors Due to Unsteady Loading

Original Slide Courtesy of PennState

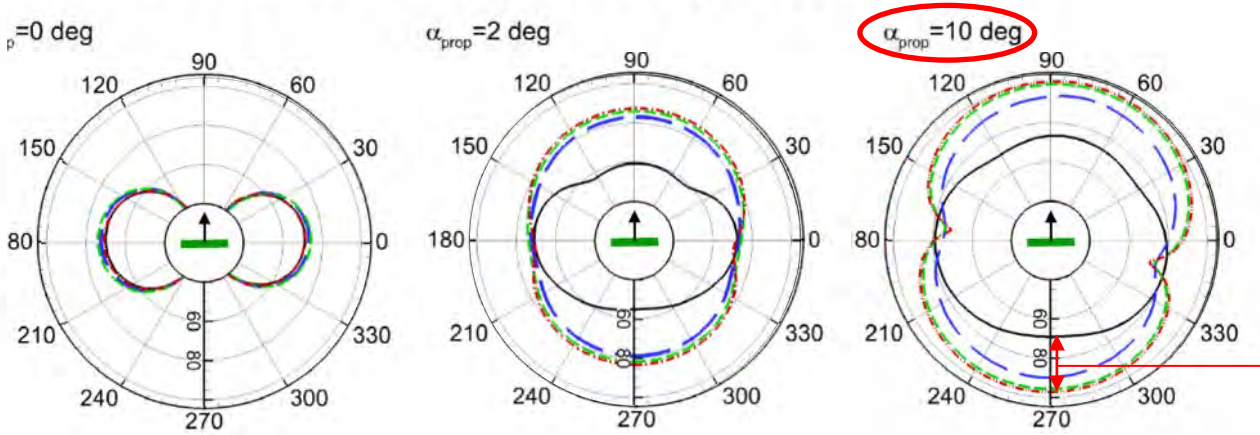
PennState

5. Effect of Multiple Propellers

In Hover



$$V_{tip} = \Omega R + V_F \sin\alpha \sin\psi$$



**Noise plots rotated for ease of viewing

X-Z Plane
(side view)

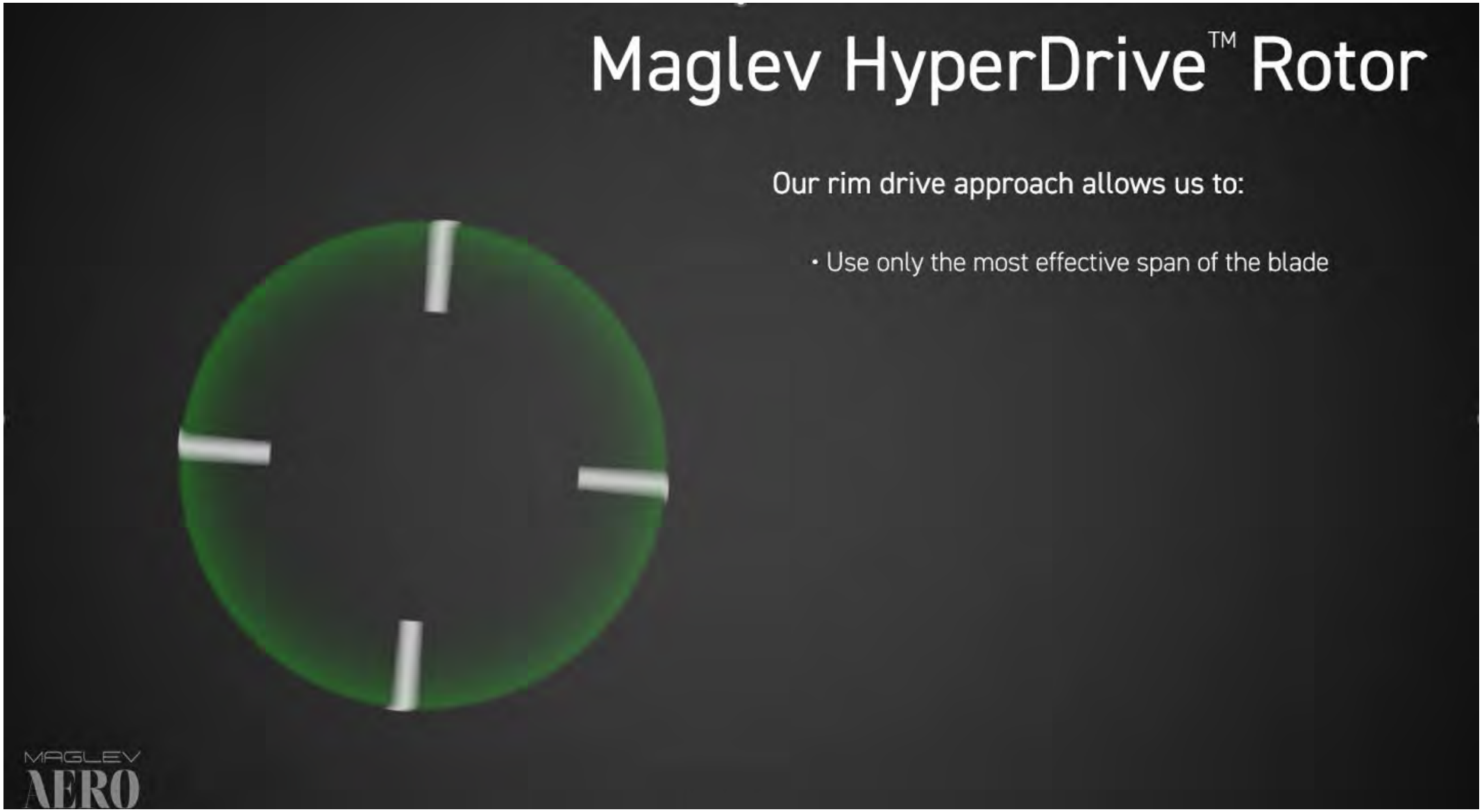
1 Prop
2 Props
4 Props
6 Props

M_{tip} = 0.4
X-Z plane

25-28 dB Less Unsteady Noise For Single Rotor In Tilted Flow

- When α_{prop} = 2°, the noise distributions are nearly the same
- The effect of unsteady loading is enormous, specifically at forward and aft directions
- The noise difference gets higher as the α_{prop} gets higher

A Larger Cutout Fan Can Support a Larger Number of Slower Moving, Lightly- and Uniformly-Loaded Blades for Fast, Efficient and Quiet Propulsion



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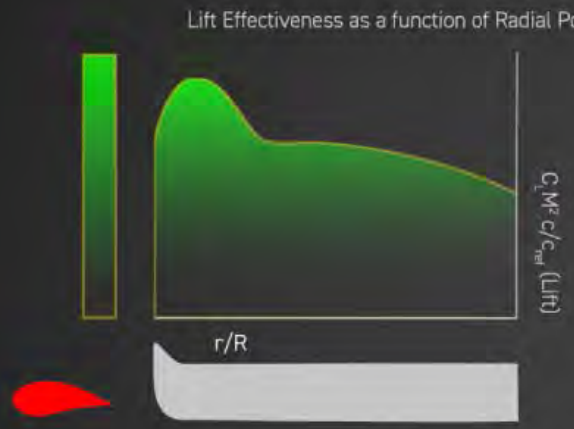
A Larger Cutout Fan Can Support a Larger Number of Slower Moving, Lightly- and Uniformly-Loaded Blades for Fast, Efficient and Quiet Propulsion

Maglev HyperDrive™ Rotor



Our rim drive approach allows us to:

- Use only the most effective span of the blade

MAGLEV AERO

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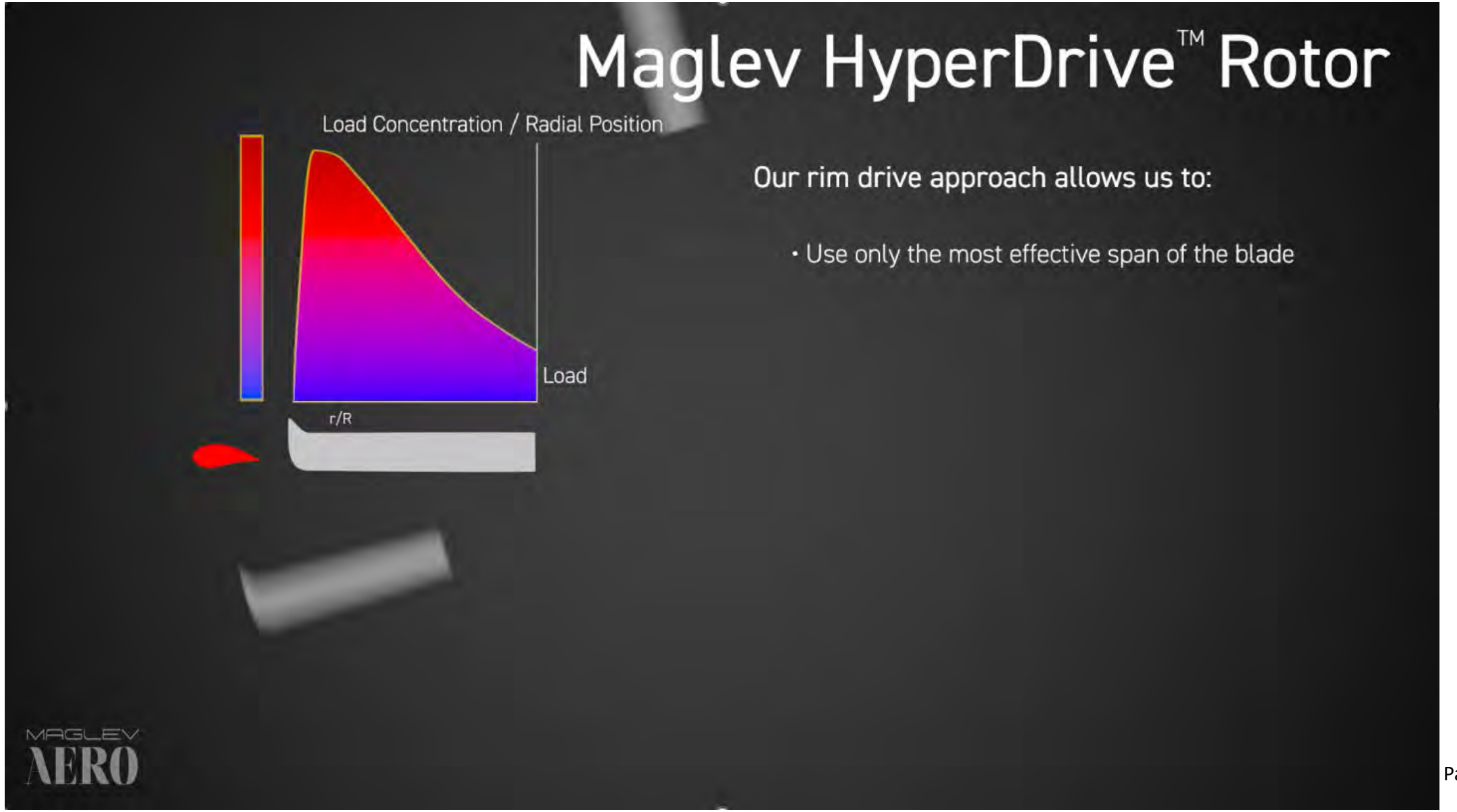

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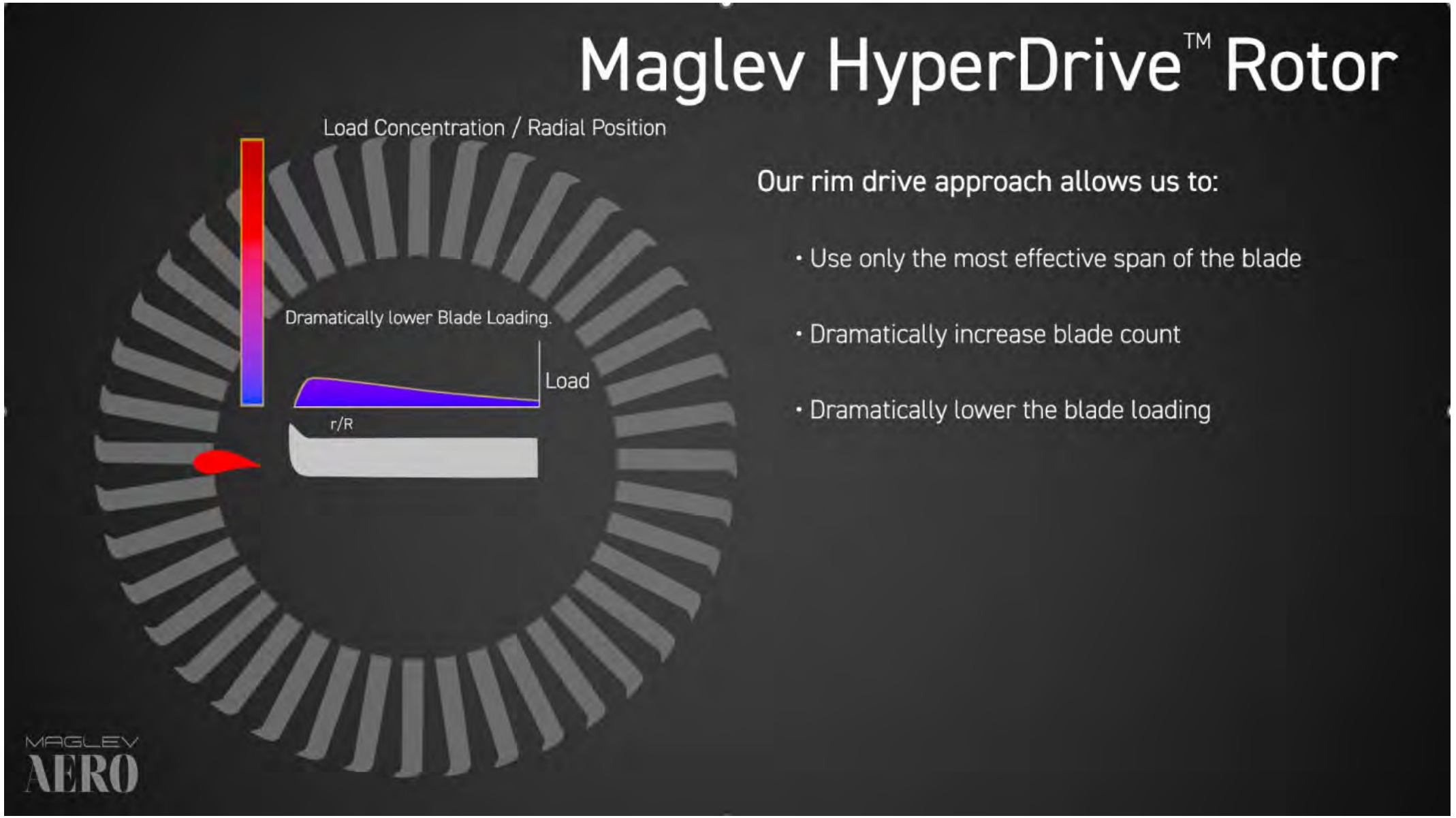

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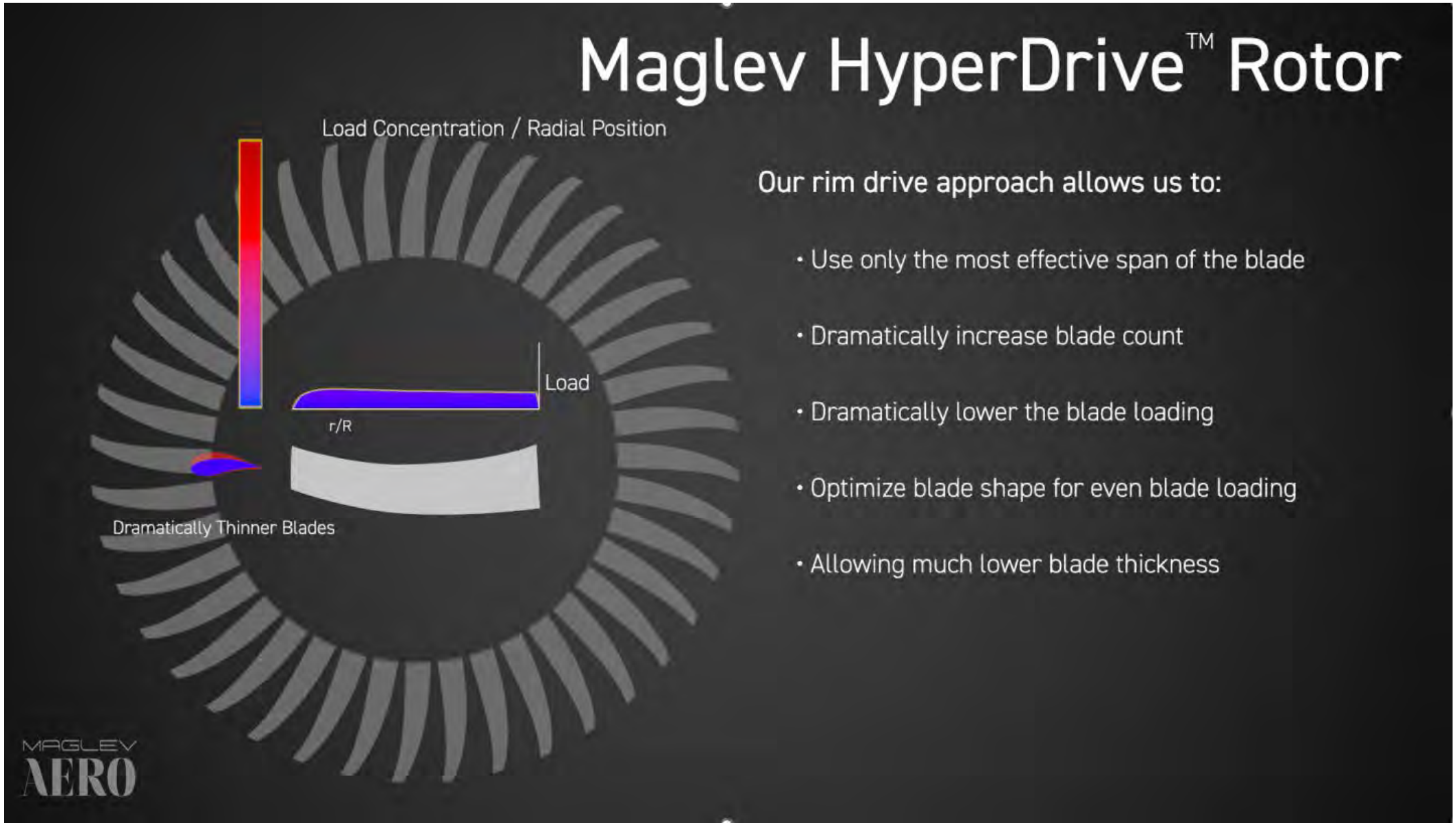

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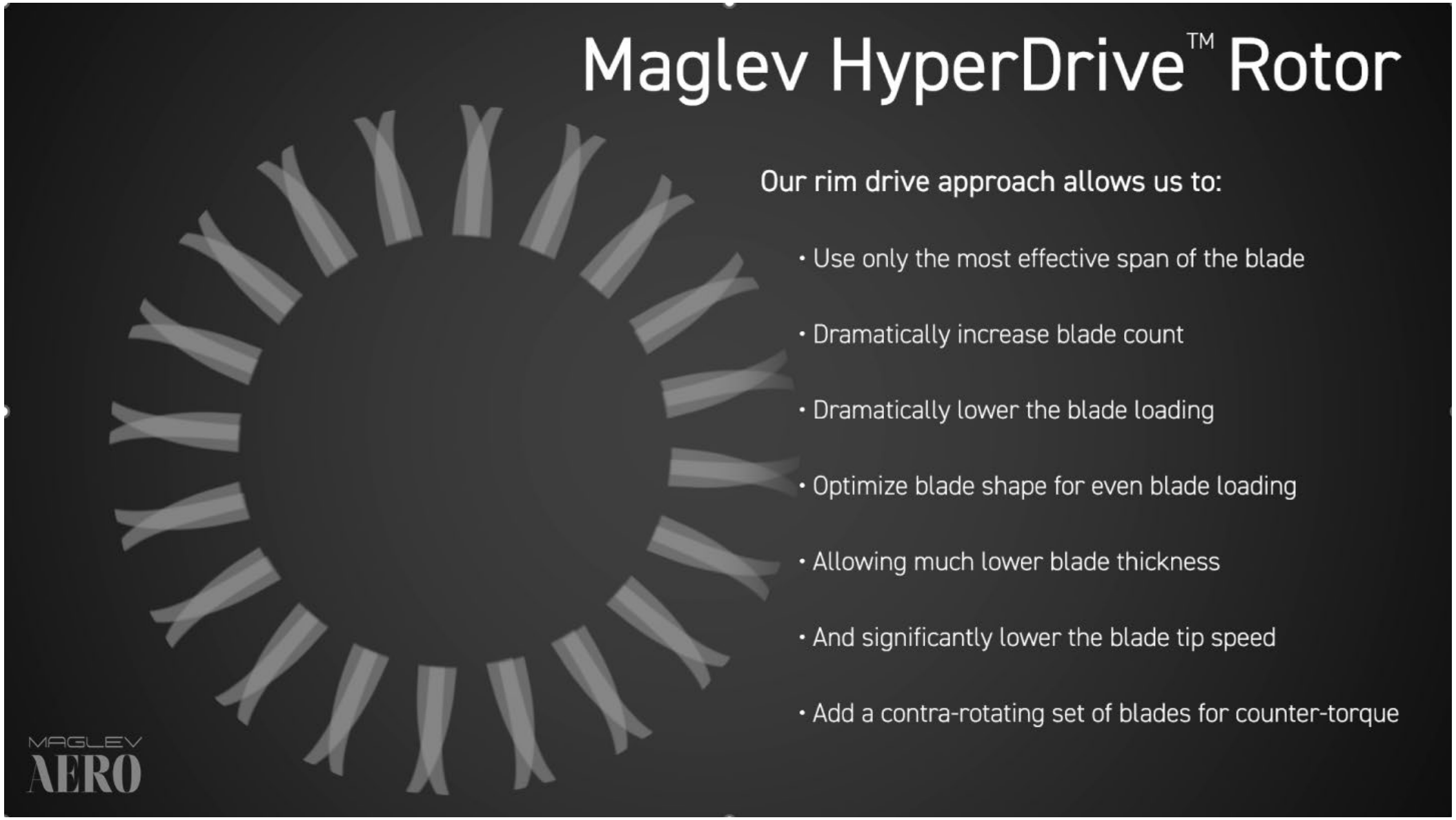

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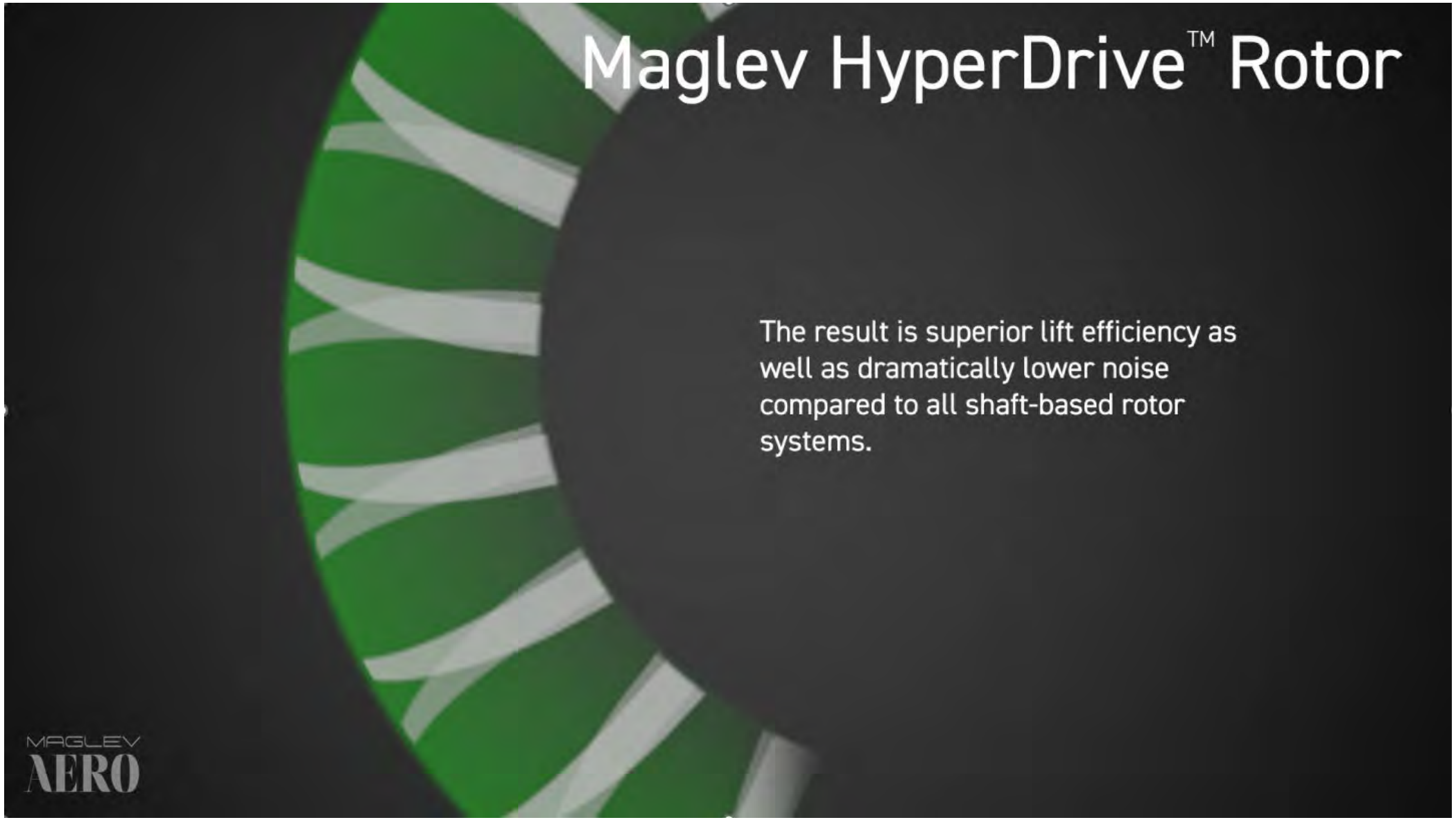


Maglev HyperDrive™ Can Enable Increased Efficiency at Slower Tip Speeds, Lighter Blade Loading and Lower Noise Levels

Maglev HyperDrive™

The contra-rotating MagLev HyperDrive™ system uniquely enables:

- Higher Hover Lift Efficiency
- Half the Blade Tip Speeds
- ~ Order of magnitude less Steady and Unsteady Blade Loading

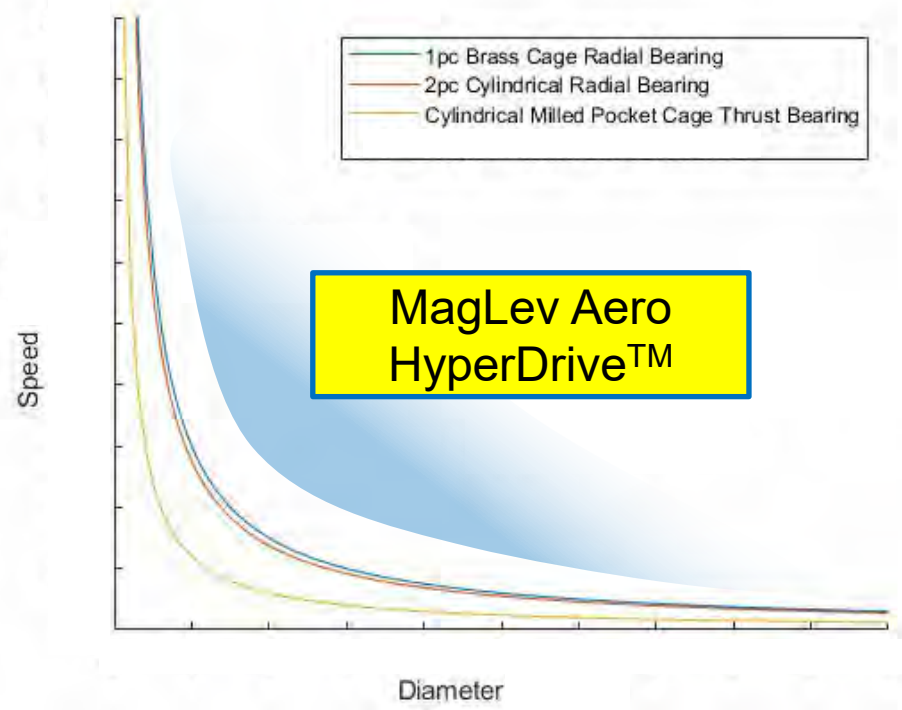
MagLev HyperDrive™ target is to enable eVTOLs to be up to 25+ dBA quieter in Take-Off and Landing than helicopters and up to 15+ dBA quieter than 1st generation multi-rotor eVTOL configurations

The HyperDrive™ cruise efficiency can also enable more than double the flight speed of helicopters

What Type of Bearing Could Support a Large-Diameter High-Speed Rotor?

- Traditional rolling bearings are too heavy, too wear-intensive and too expensive for high-speed large-diameter applications

Speed limit of Various Bearing Types as a function of Diameter

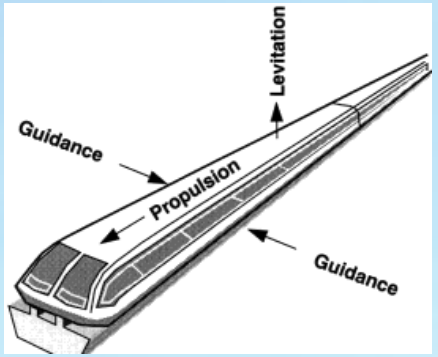


Large Diameter bearings are very heavy. This 10m bearing weighs **40 tons**.

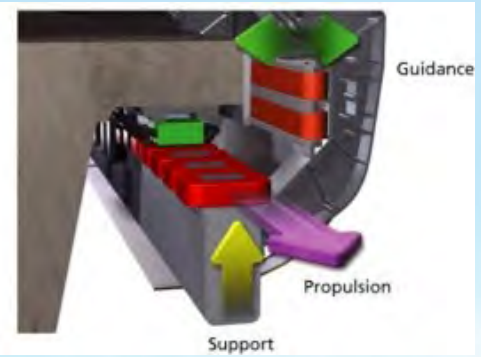
MagLev Aero Leverages the Advantages of Magnetic Levitation Train Technology in the Air

- **MagLev Train Attributes**
  - Zero Rolling Friction
  - Higher Speed*
  - More Energy Efficient*
  - Very Quiet Operation
  - 1/4 the power per Distance*
  - 1/5 the Maintenance Cost*
  - But: High Track Infrastructure Cost of 100s of miles

Japanese High Speed MagLev Train



The Forces of MagLev



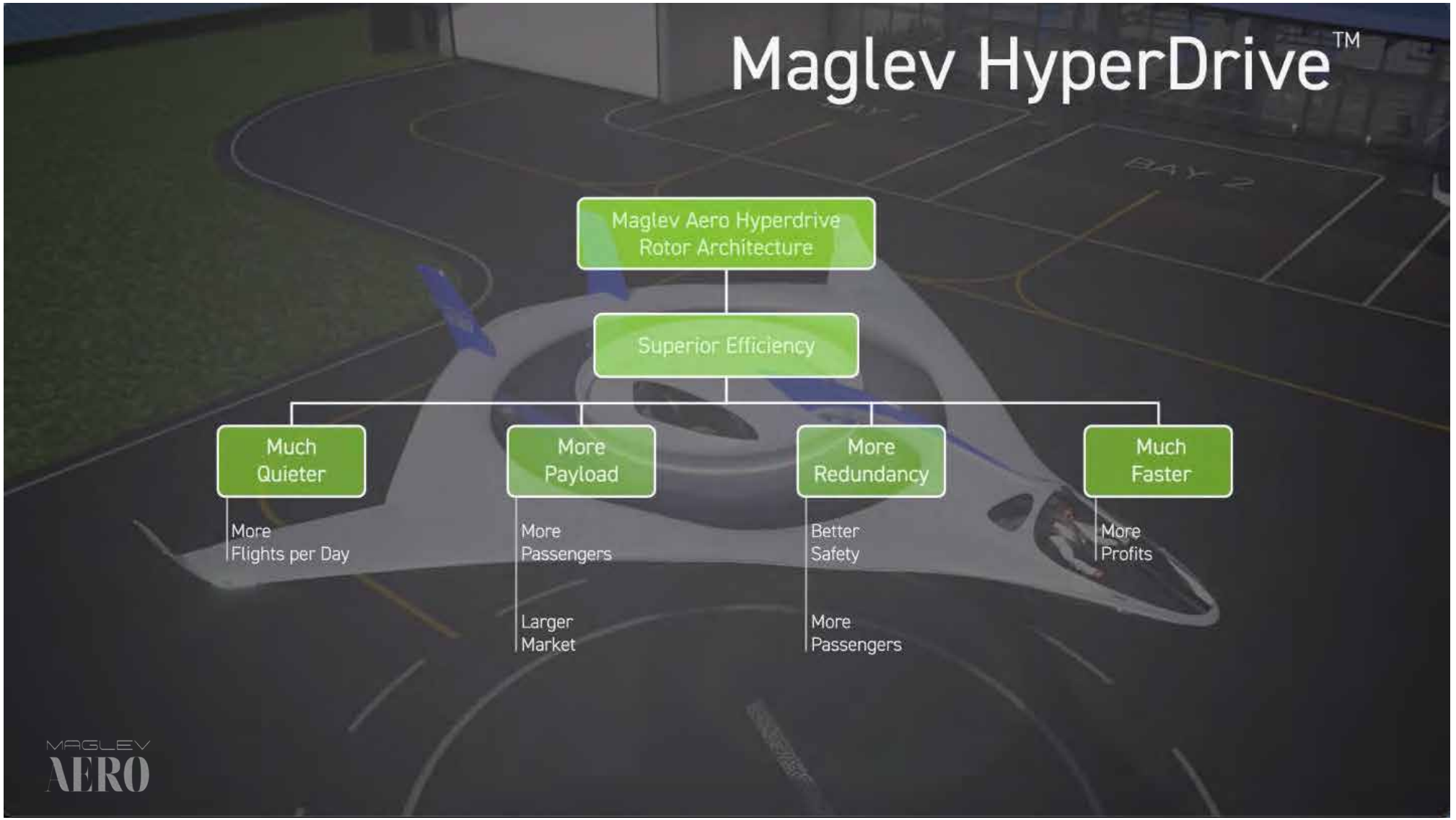
The Electro-Magnets and Guiderails of MagLev

- **MagLev Aero Leverages the Same Advantages without the Limitations**
  - Zero Mechanical/Transmission/Swashplate Friction
  - Dramatically lower noise than helicopters
  - More Energy Efficient
  - Greater Power Density
  - Smaller size per pound of payload
  - And: The track is contained within the vehicle and is only 10s of feet

* In comparison to comparable High-Speed Rail

Is The View Worth The Climb?

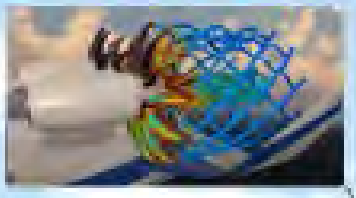
How are you different? Why does it matter? And how much does it matter?



This Has Never Been Doable Before and is Just Now Doable Due to a Confluence of Recent Technology Developments

Enabled By MagLev Aero's Breakthrough Innovation

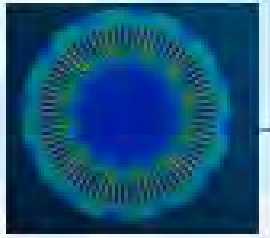
Cloud Scale
High Fidelity
Multi-Physics
Simulation for
CFD, EM, & FEA

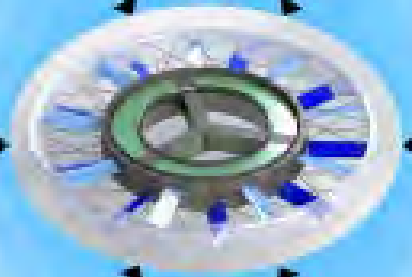


Metal 3D Printing
Additive Manufacturing
Generative Design

MagLev Aero
Breakthrough
Innovation

Advanced
High Energy
Magnetics
And Batteries





High Volume
Manufacturable
Advanced
High Strength Light
Weight Composites

Significant
IP Portfolio

Artificial Intelligence
Machine Learning
Control Systems

5G

Ultra Reliable Low Latency
Communications (URLLC)
Autonomous Navigation

MAGLEV AERO

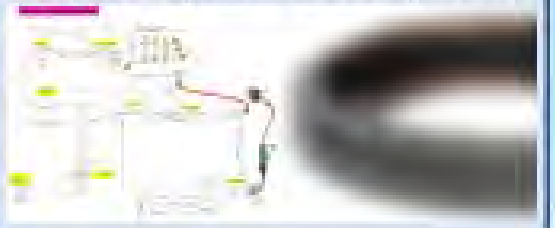
Crawl Walk Run Fly

Technology Maturation Follows a Proven Engineering Development Path

Requirements Definition

Empirical Correlation and Model Validation

Key Subsystem Development



Multi-Physics Modeling and Development

Subsystem Integration Tests

Propulsion Thrust Testing

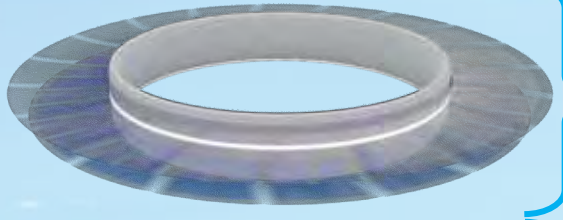
Flight Test System Development

MAGLEV AERO

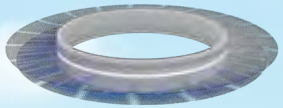
Crawl Walk Run Fly

Access Markets Without Waiting For Full-Scale Development

4 **Large 3600mm**

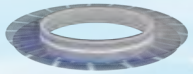


3 **Medium 1800mm**



Mosaic Certification Level
Two Person/Heavier Cargo

2 **Small 1200mm**



Light Sport Certification Level
Single Person/Heavy Cargo

1 ***Multi-Physics Validation***

Subscale Proof Of Concept
Technology Innovation

Mass Market TAM Expansion

Early Market Opportunity

Subscale Development Platform

Value Proposition

Now

Time

The MagLev Aero HyperDrive™ Propulsor Can Fulfill Diverse e-Aviation Needs

Many Sizes, Configurations, Payload Types, and Use Cases

Core Innovation

Size/Configuration

Payload Type

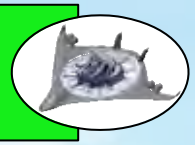
Markets/Use Cases

Market Size

MagLev Aero HyperDrive™ Propulsor

Small Wingless Ducted Rotor

Winged Ducted Lift Plus Cruise



Large Winged Tilt Rotor

People Payloads

Cargo Payloads

People Payloads

Cargo Payloads

UAM/Regional Freight/Logistics

UAM Air Taxi

Other Markets and Use Cases

- Military
- Medical
- Industrial
- Recreational
- Others…

Upside

AERO

Maglev Aero Is Backed By Insightful Venture Capital Investors