

NW

Northern Waves



SweWIN

Swedish Wireless Innovation Network

Additive Manufacturing for Sustainable Microwave Systems

5th SweWIN Workshop

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CTO

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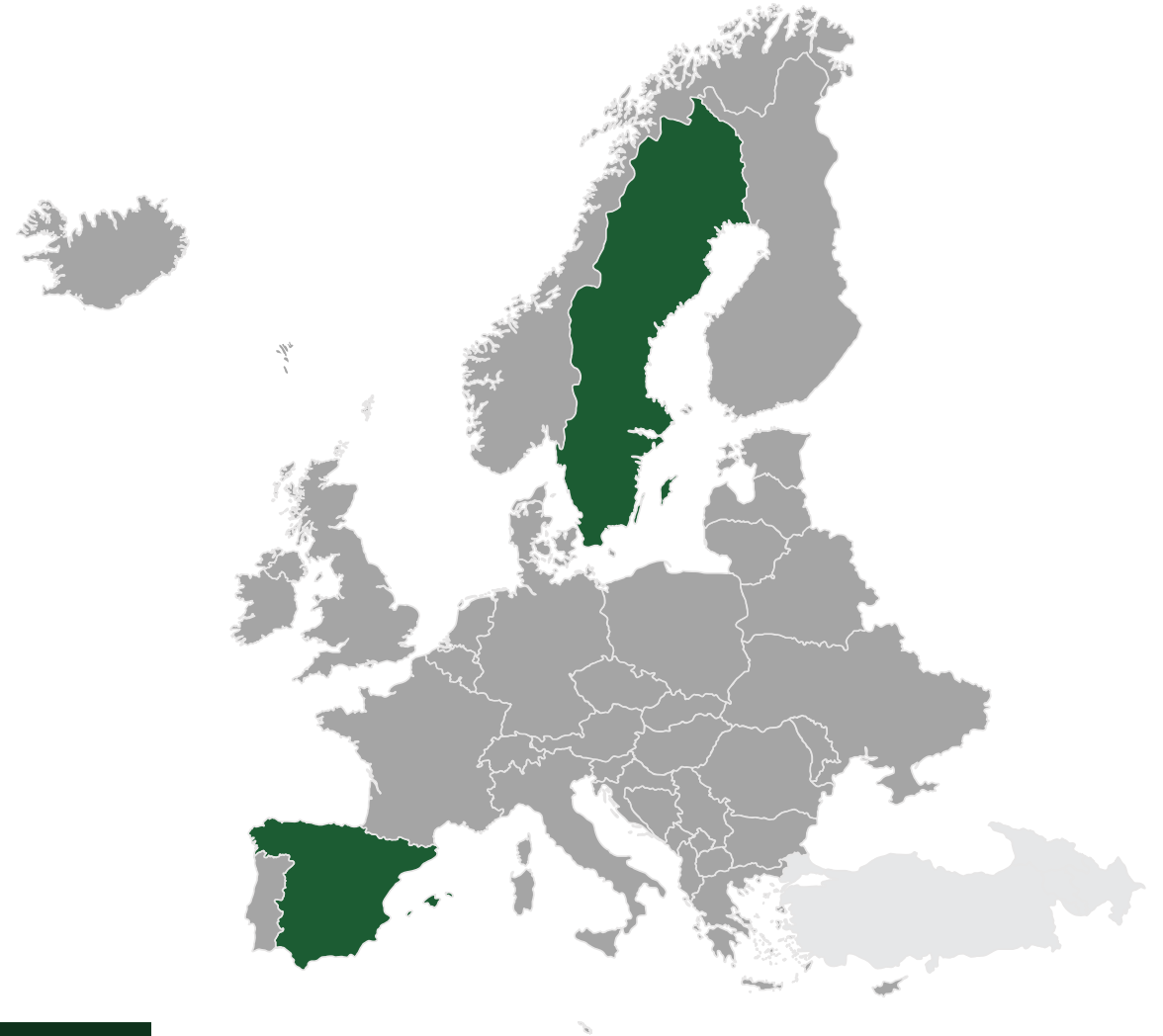
Northern Waves AB

Outline

- Introduction to Northern Waves
- Limitations of conventional manufacturing
- Additive manufacturing as a paradigm shift
- Case studies - Monolithic AM RF components
 - Geodesic Horn Antenna
 - X-Band Coaxial Filter
 - Horn Antenna Array
- Conclusions

Northern Waves

- Founded in 2023
- Transferring from PhD to industry
- Headquarters in Stockholm, Sweden
- Manufacturing facilities in Spain
 - Manufacturing, post-processing and mechanical testing
- Serving worldwide
- We are electromagnetic engineers that knows about additive manufacturing



Northern Waves

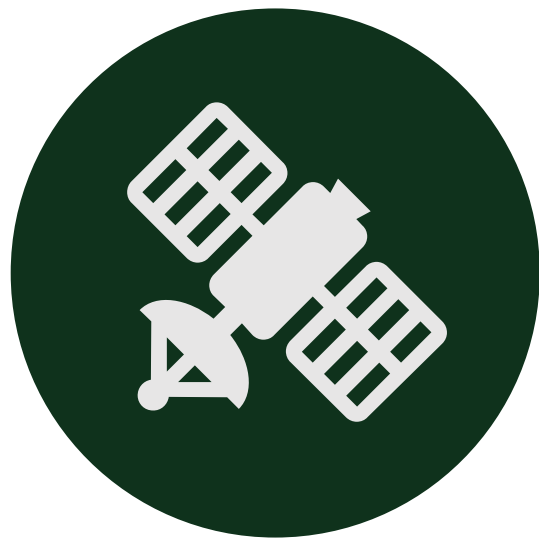
+60 clients
worldwide

+500 products
delivered

+8M SEK
revenue in 2025

Supported
by **ESA**

Northern Waves



Traditional Manufacturing

- **Why traditional manufacturing is not sustainable?**

- 1. Over-machining & material waste**

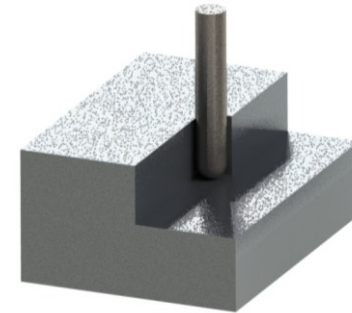
- Remove material from a solid block

- 2. Assembly-driven inefficiencies**

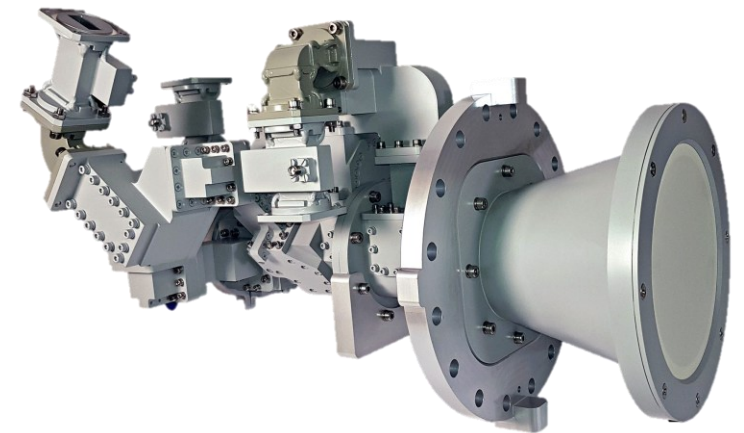
- Flanges, screws, misalignments
- Leakage → performance loss → inefficiency

- 3. Design constrained by manufacturing**

- Engineers design what can be built, not what should exist
- Heavier systems



CNC Milling representation



Source: Pasquali Microwave Systems

Additive Manufacturing

1. Monolithic integration

- One part instead of assemblies
- Less material, less risk

2. Design-for-Additive-Manufacturing (DfAM)

- More degrees of freedom
- Performance driven design
- Higher RF efficiency → less power consumption over lifetime

3. Manufacturing efficiency

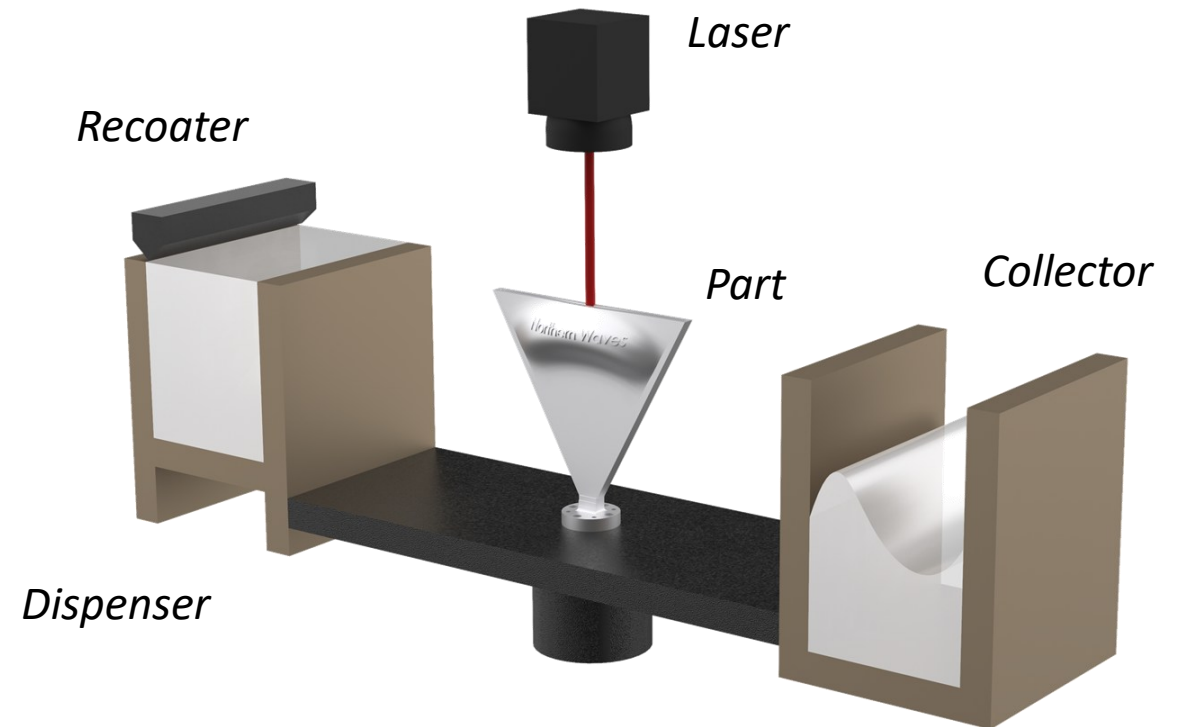
- Powder reuse
- Multiple parts in one built



Monolithic fully-metallic AM horn array. Northern Waves proprietary design.

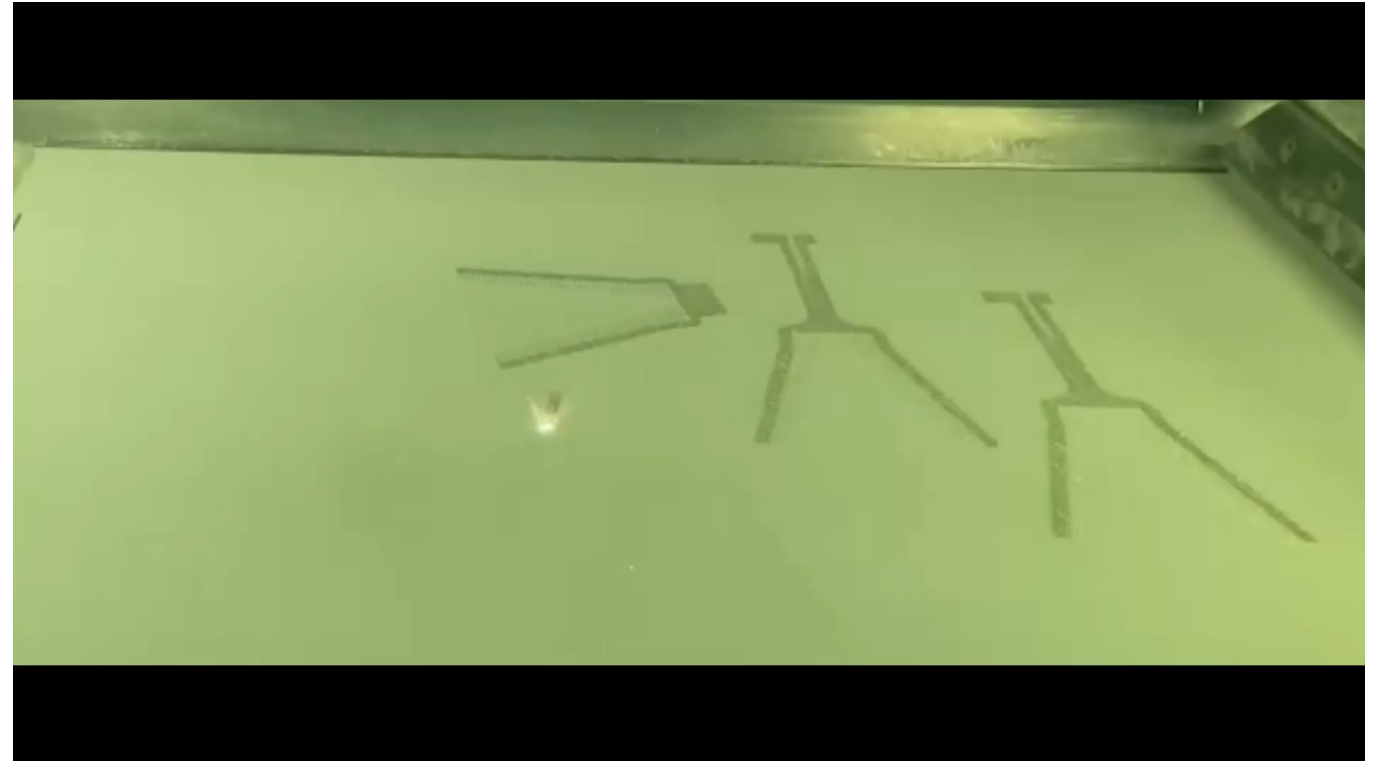
Laser Powder-Bed Fusion (LPBF)

- Metallic powdered materials are selectively consolidated by melting layer-by-layer together using a heat source, i.e. laser
- Materials:
 - AlSi10Mg
 - 316L – 17-4PH
 - Titanium
 - Inconel
- ✓ **Advantages:**
 - ✓ Speed
 - ✓ Cost-effective
 - ✓ Accuracy
 - ✓ Conformal shapes
 - ✓ Monolithic parts



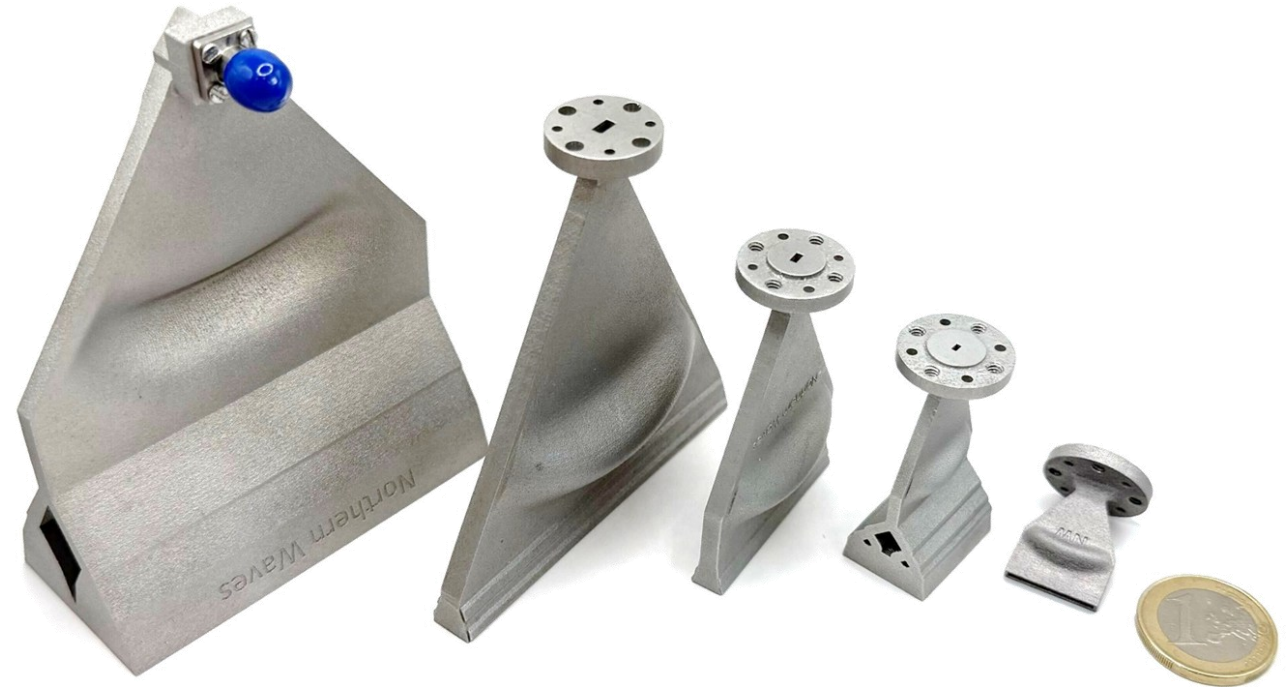
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 - Titanium
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- **Components from a few GHz up to 260 GHz**



AM Applied to Fully Metallic Components

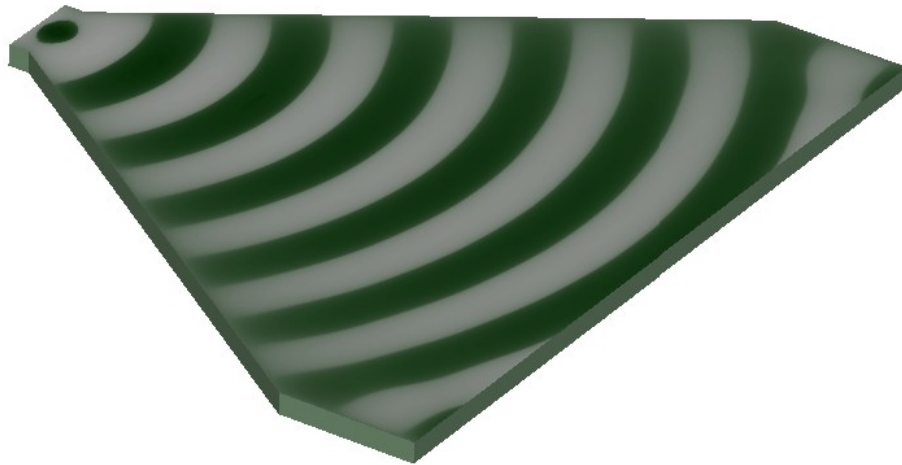
V-band Geodesic Horn Antennas



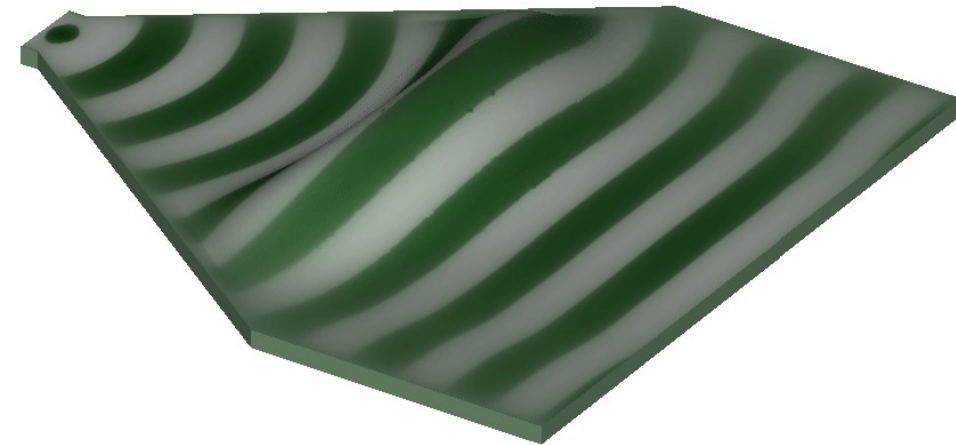
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Flat Horn



Geodesic Horn



- Delay the wave more in the center than in the extremes
 - Increase directivity

AM Applied to Fully Metallic Components

V-band Geodesic Horn Antennas



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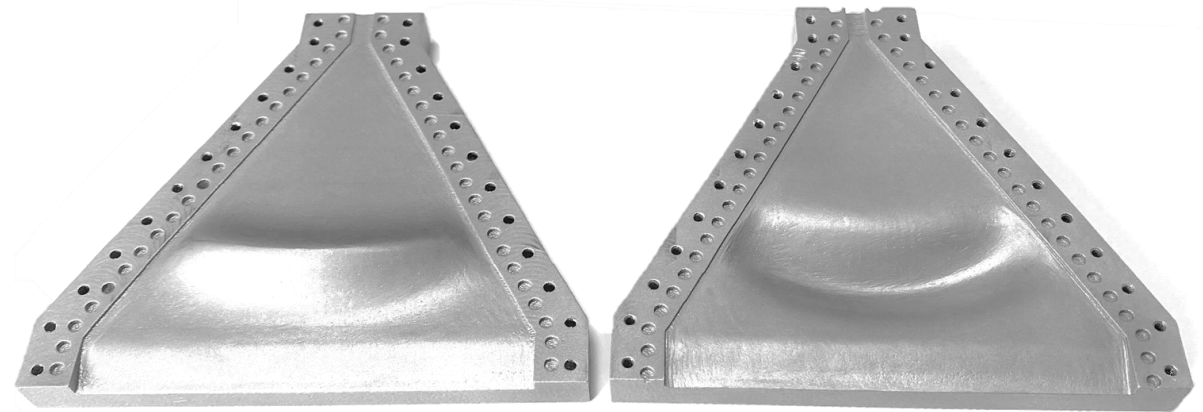
- Monolithic version

- LPBF
- Aluminum alloy AlSi10Mg
- Post-processing:
 - Sandblasting
 - Machining on flange



- Two-piece version

- LPBF
- Aluminum alloy AlSi10Mg
- Post-processing:
 - Polishing on the geodesic surface
 - Machining on EBGs contact surface and flange
 - M2 threading for assembly



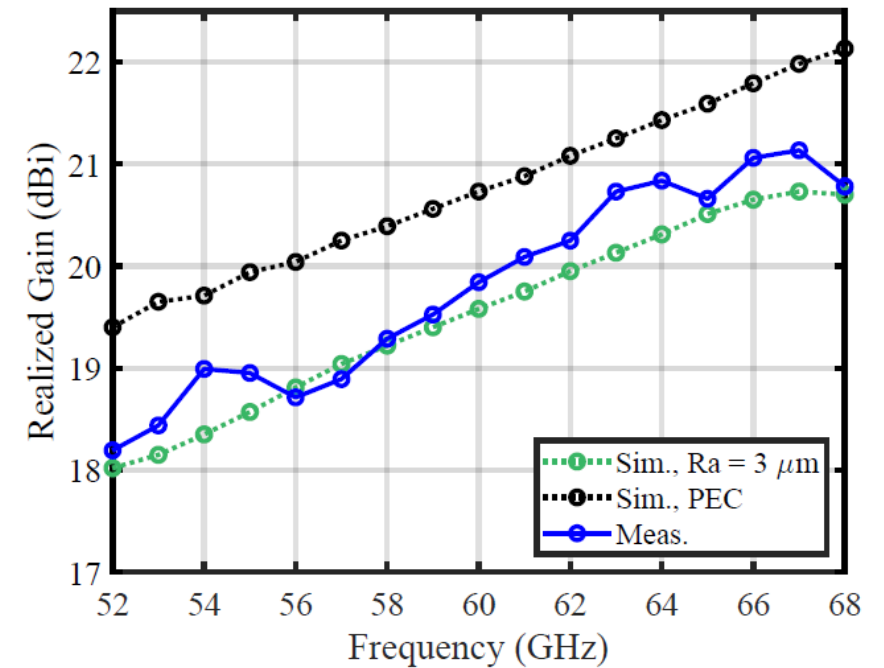
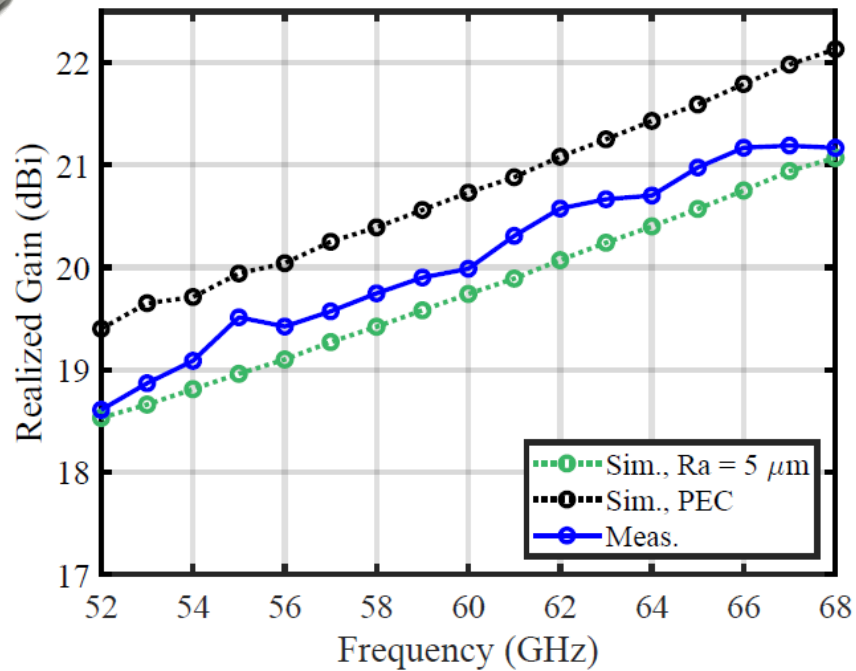
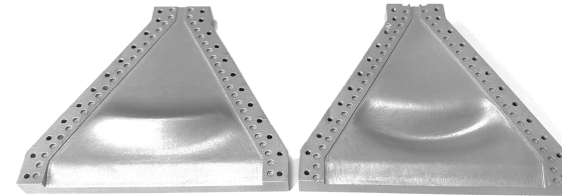
*M. Chen, J. Rico-Fernández, F. Mesa and O. Quevedo-Teruel, "Metal-Only Additive Manufacturing of V-Band Lightweight Waveguide and Horn Components," in *IEEE Trans. Microw. Theory Techn.*, Early Access, 2025

AM Applied to Fully Metallic Components

V-band Geodesic Horn Antennas



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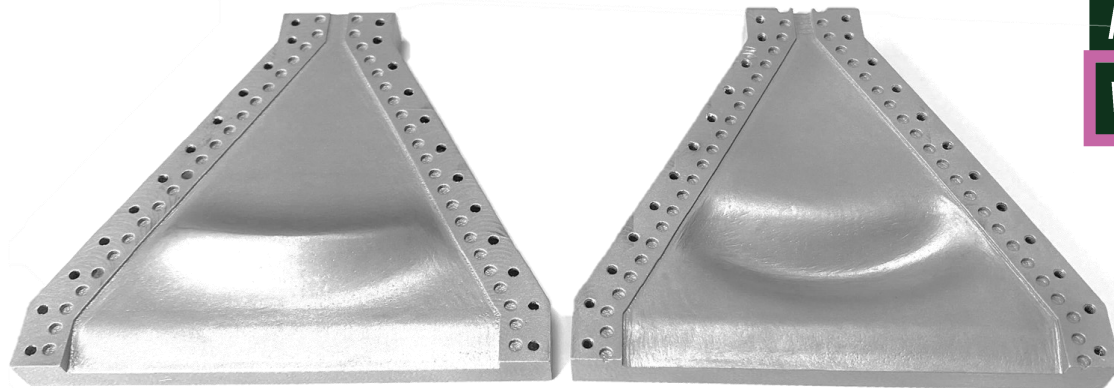
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V-band Geodesic Horn Antennas



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	Monolithic	Two-piece
<i>Freq. band (GHz)</i>	52 - 68	52 - 68
<i>Real. Gain (dBi)</i>	18.7 - 21.2	18.2 - 21.1
<i>SLL (dB)</i>	-23	-20
<i>Aperture eff. (%)</i>	51 - 57	45 - 57
<i>Radiation eff. (%)</i>	≥80	≥70
Weight (g)	32	198

84% weight reduction

*Screws not taken into account

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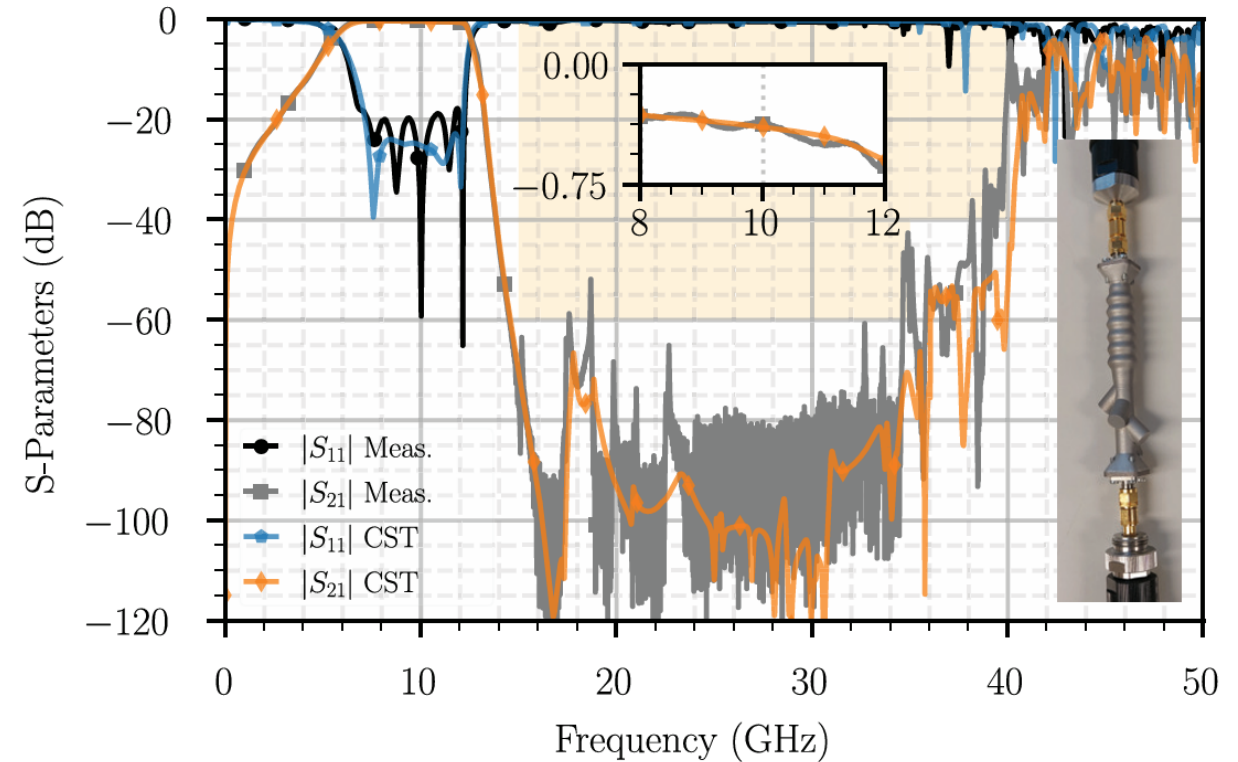
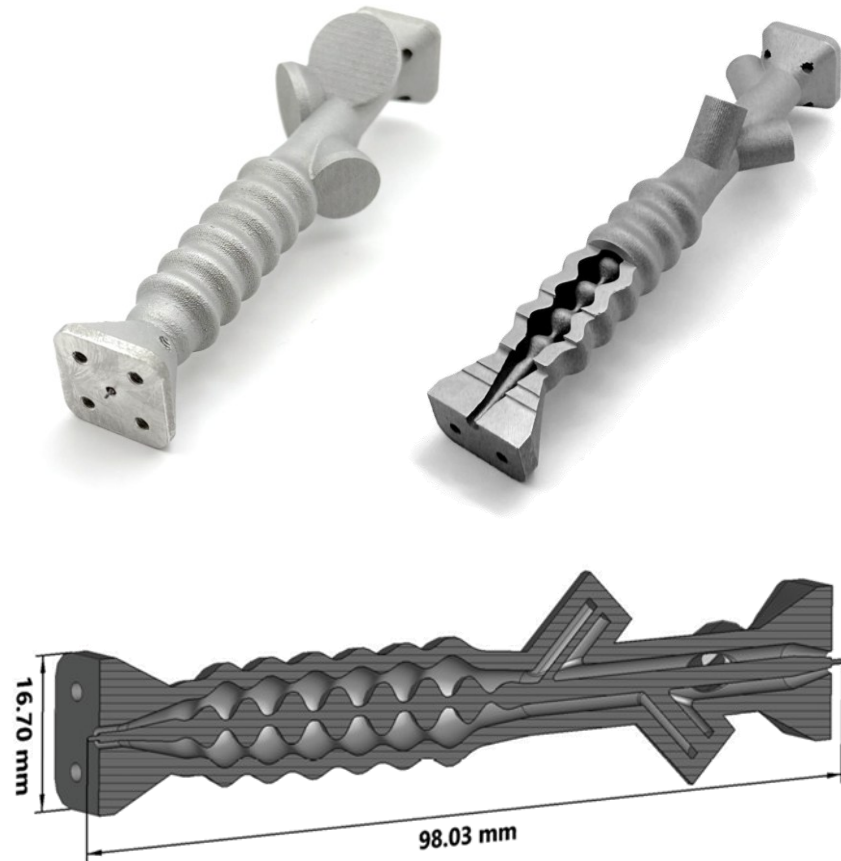
X-Band Filter



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European Space Agency



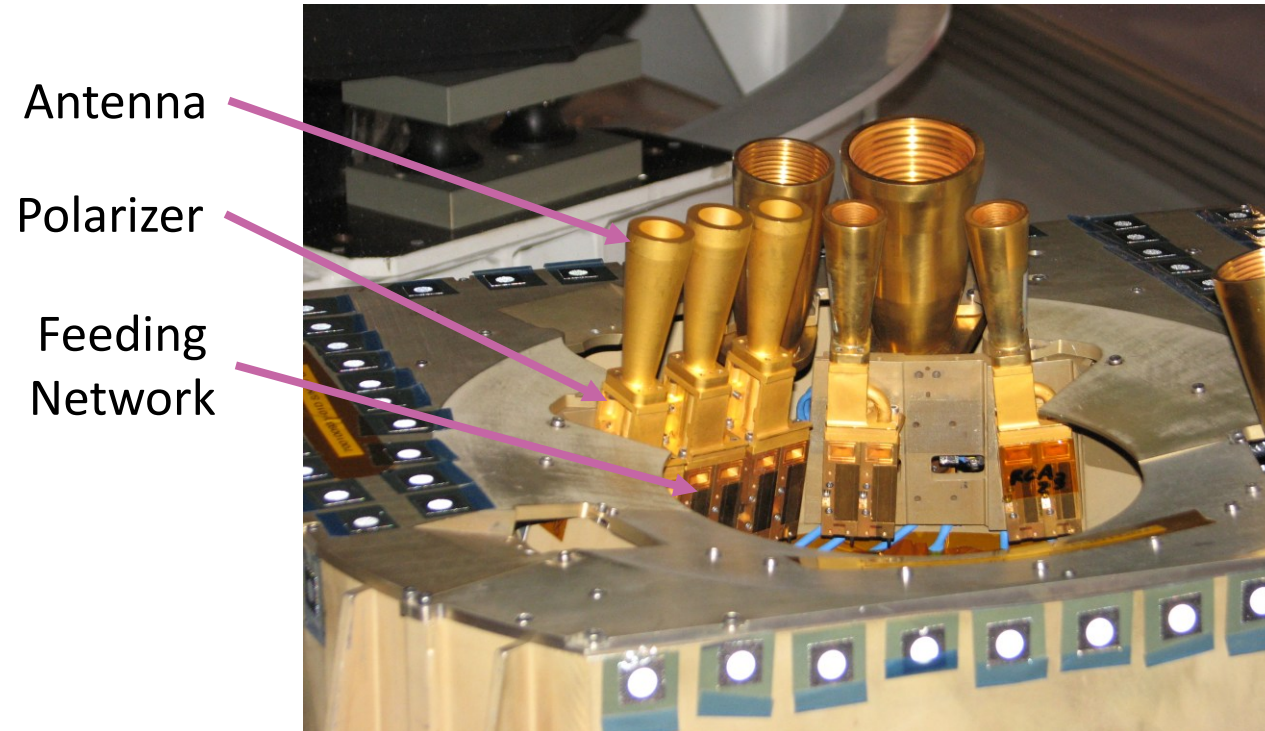
*Insertion losses = 0.37 dB
Attenuation in X-band 3.7 dB/m

M. Baranowski et al., "A 3-D-Printing-Oriented Coaxial-Line Filter With Wide Out-of-Band Rejection," in *IEEE Microwave and Wireless Technology Letters*, vol. 35, no. 9, pp. 1292-1295, Sept. 2025, doi: 10.1109/LMWT.2025.3578244.

AM Applied to Fully Metallic Components

Horn Antenna Array

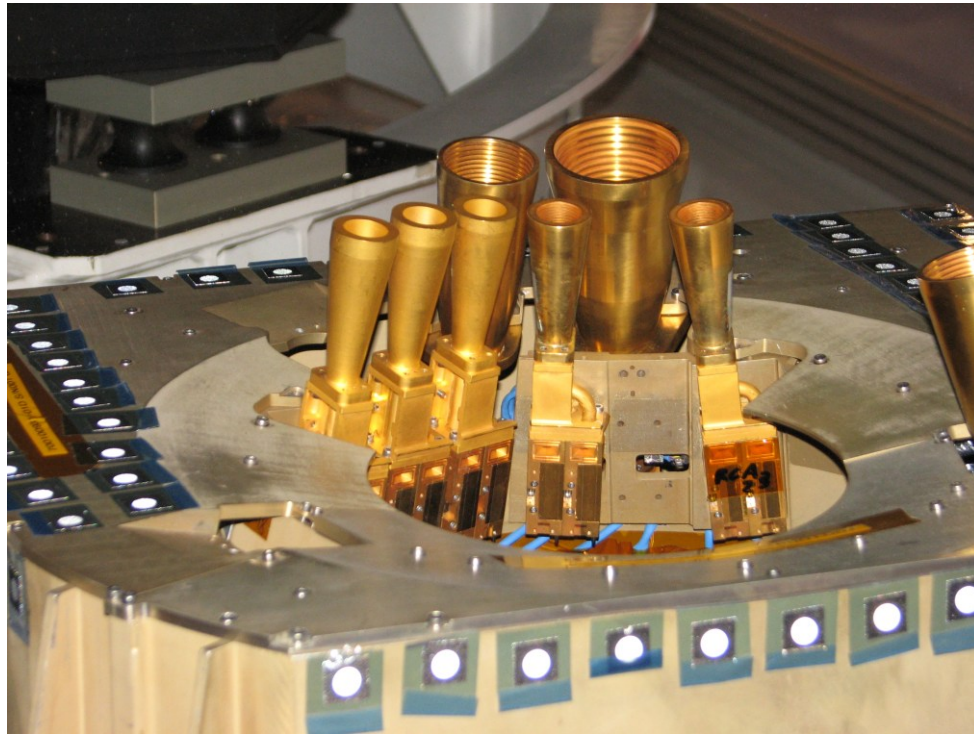
- Multiple part assembly
 - Misalignment
 - Leakage
 - Higher insertion loss
 - Lower efficiency
- Complex system
- Long lead times
 - Up to several months



Part of ESA satellite on board antenna.

AM Applied to Fully Metallic Components

Horn Antenna Array



Part of ESA satellite on board antenna.



Monolithic fully-metallic AM horn array. Northern Waves proprietary design.

AM Applied to Fully Metallic Components

Horn Antenna Array

- Monolithic piece
 - Antenna
 - Polarizer
 - Filter
 - PCB to waveguide transition
- Less complex
- Less material
- Lead time of a few weeks



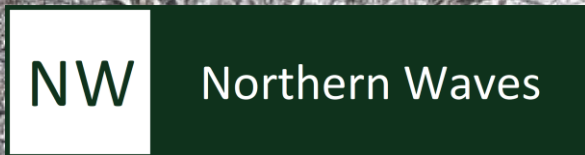
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Conclusion

- Sustainability in RF will not come from greener materials alone
- We must rethink how we design and manufacture at a system level
- Manufacturing defines performance
- Additive manufacturing
 - Removes interfaces
 - Unlocks efficiency
 - Lighter components
 - More reliable hardware
- At high frequencies AM becomes a necessity



Our aim is to turn the microwave designs in your mind into manufactured and tested parts.





THANK

YOU

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www.northern-waves.com

