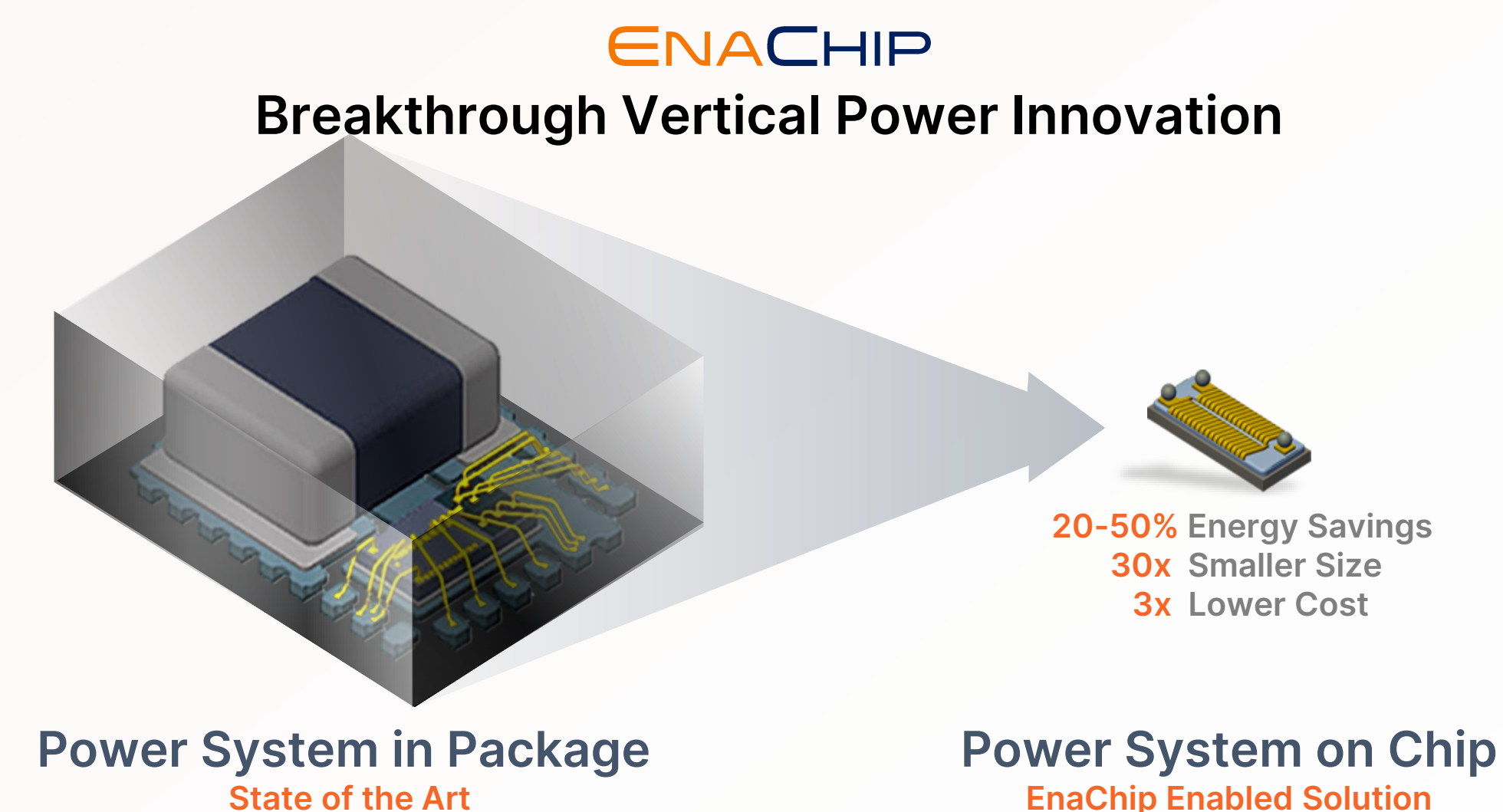
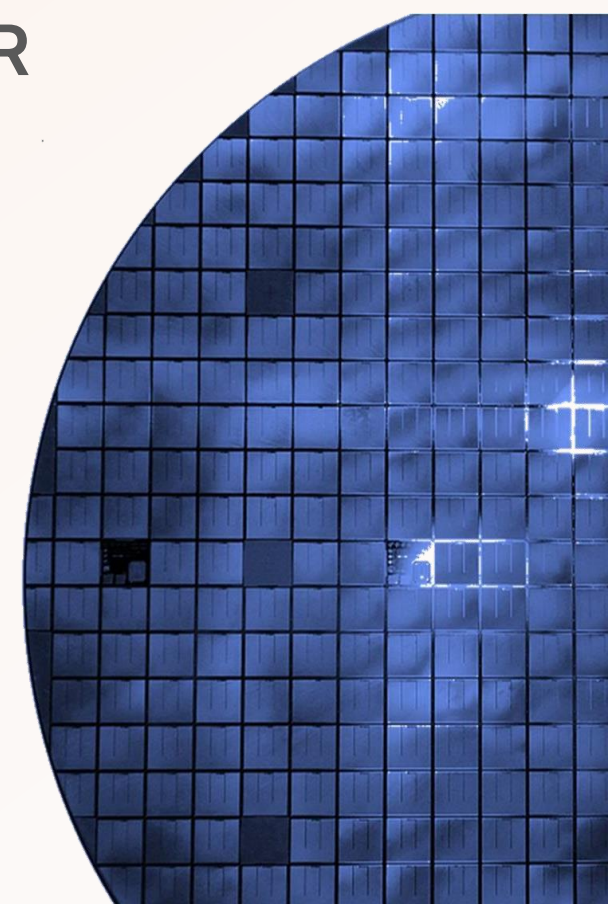


# One-Mask N-Layer Electroplated Cores for Wafer Level Magnetics

Kamyar Ahmadi, Mo Khodadadi, Matt Wilkowski, Trifon Liakopoulos

EnaChip Inc., New Jersey, United States

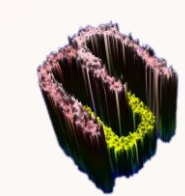
THE ROOT CAUSE of POWER  
INEFFICIENCIES



Method	Air Core 	Sputtered Core 	Electroplated Core 
Verdict	<ul style="list-style-type: none"><li>Easy to fabricate</li><li>Low power loss</li><li>Low inductance</li></ul>	<ul style="list-style-type: none"><li>High process control</li><li>Slow process</li><li>High capital</li></ul>	<ul style="list-style-type: none"><li>High process control</li><li>Fast and low cost *</li><li>Plated metallic films → small skin depth due to ↑ <math>\mu</math> and ↓ <math>\rho</math> **</li></ul>
Process Time			
Multi-layer Cost			
Performance			

\*(10-20x less than sputtering).

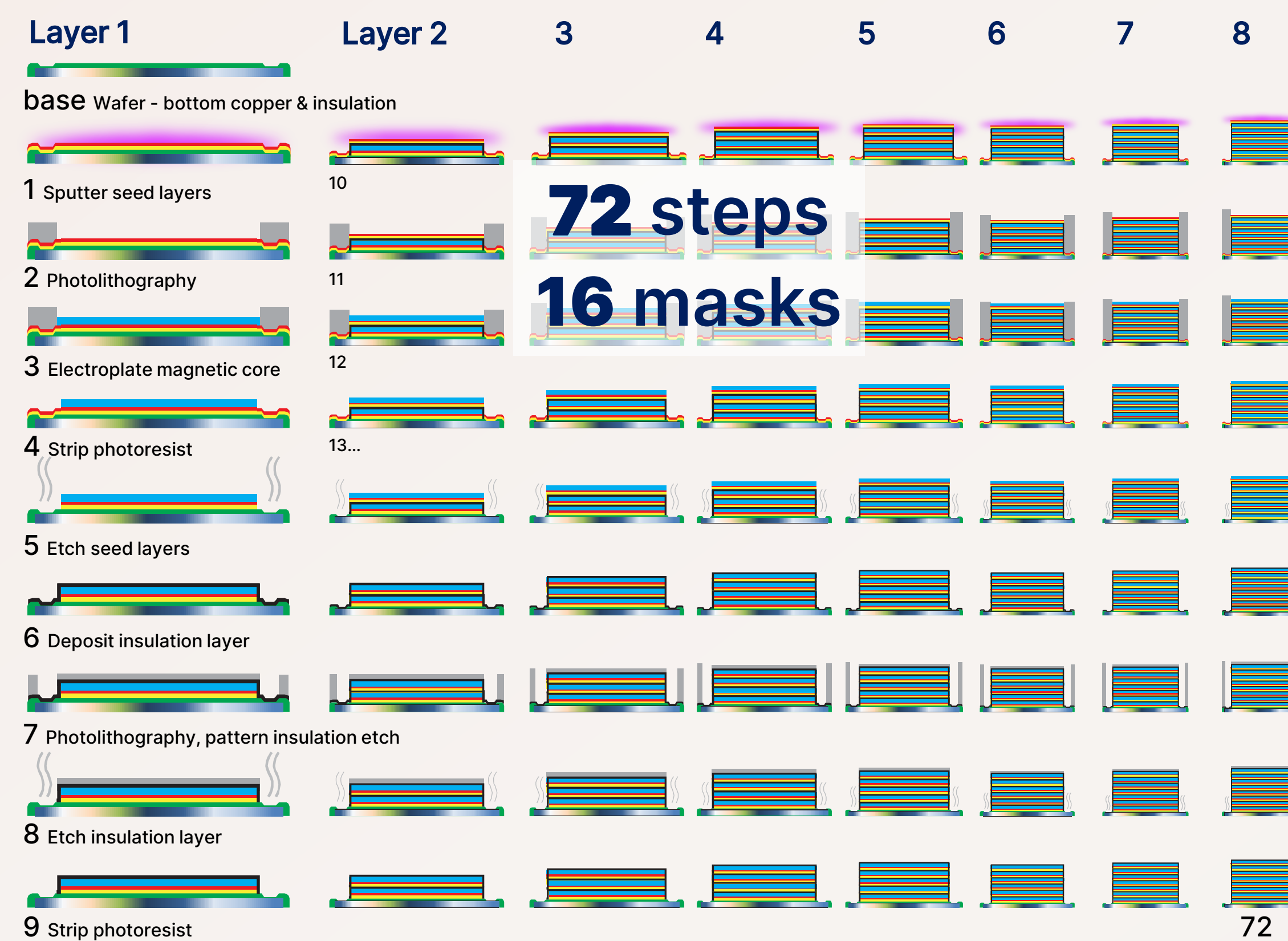
\*\* Multi-layer laminations needed for high currents > 1A



EnaChip addressed the shortcomings of electroplated based devices for cost-effective and high performance micro-magnetics.

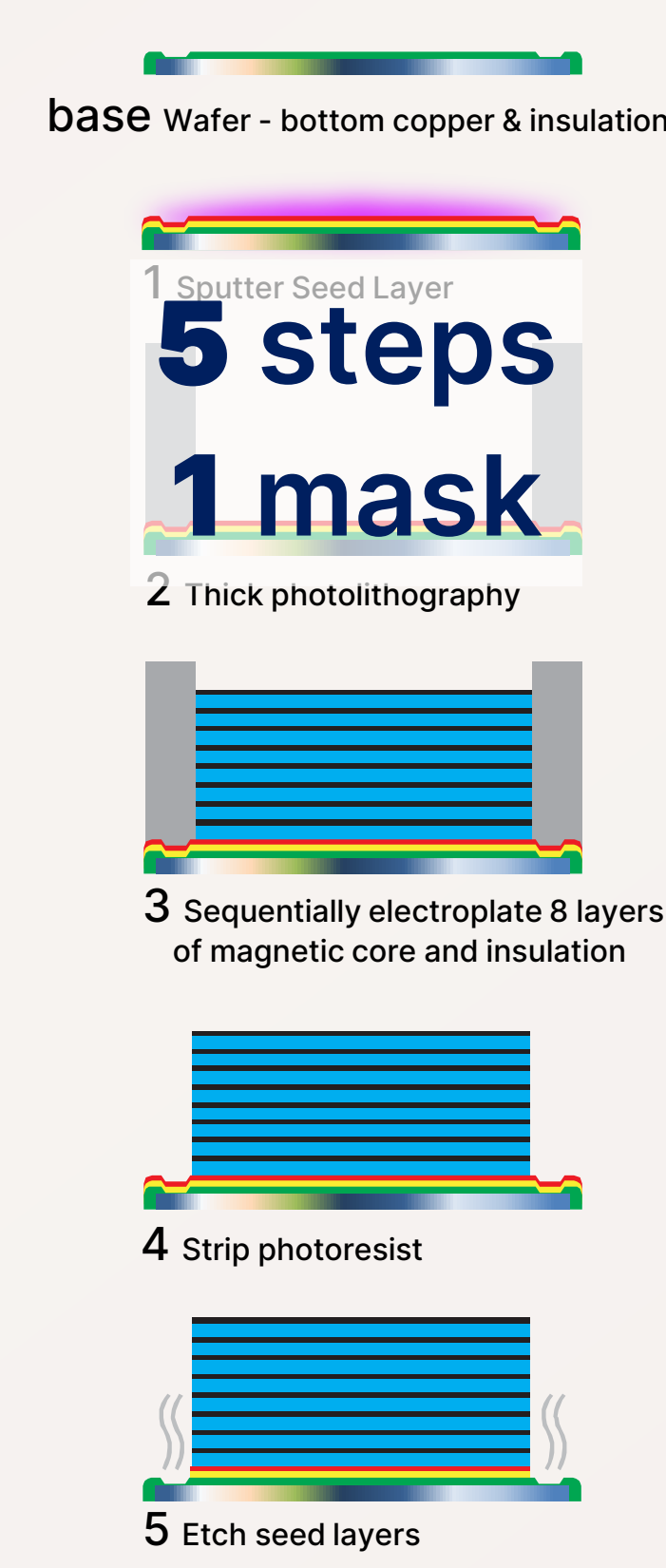
## Innovative multilayer lamination with revolutionary One-mask N-layer process

### Standard

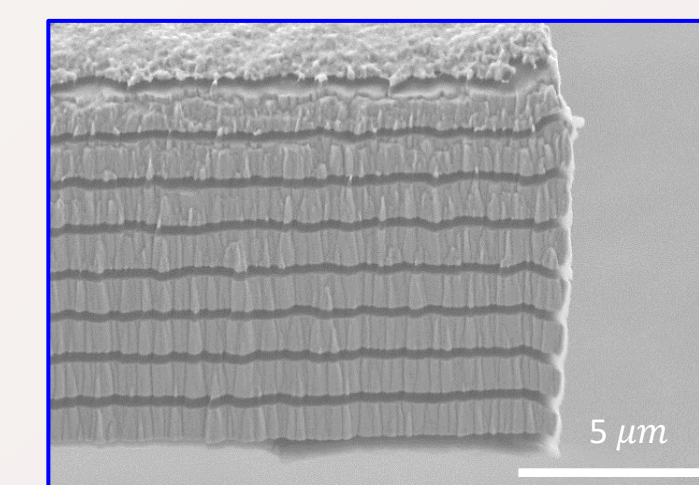
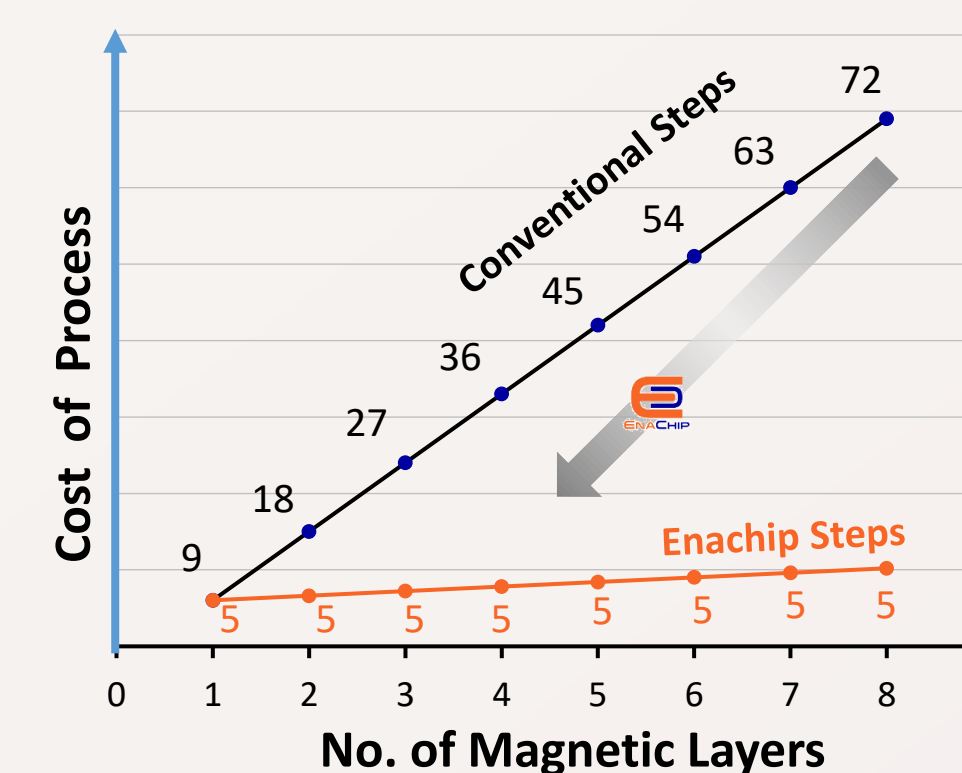


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### EnaChip



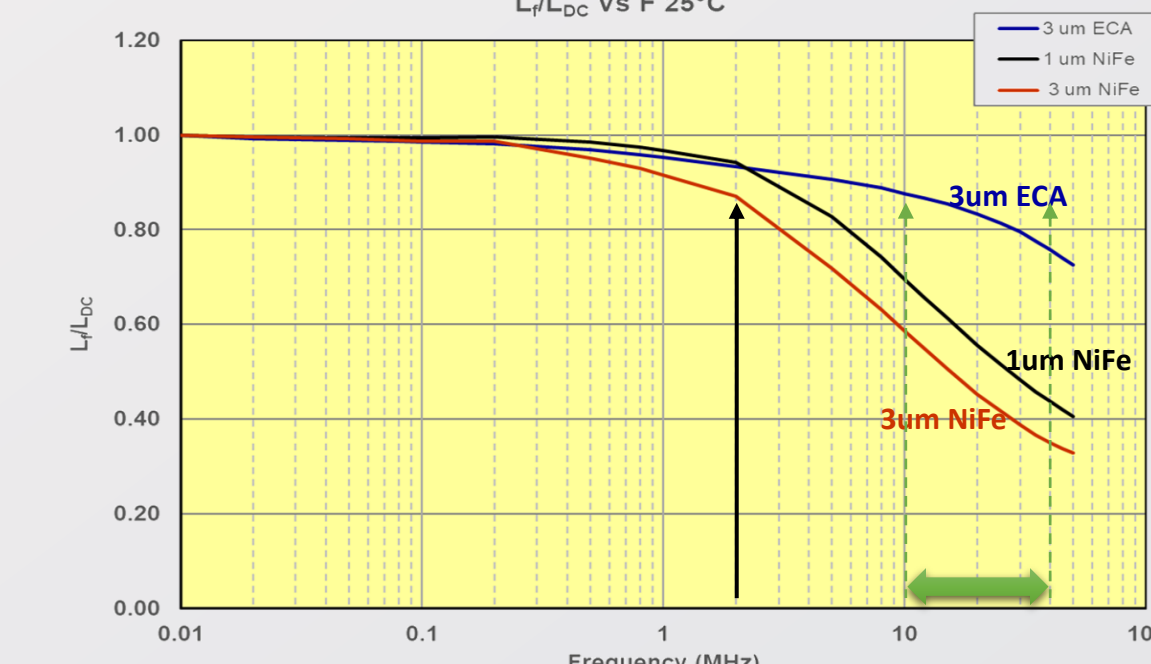
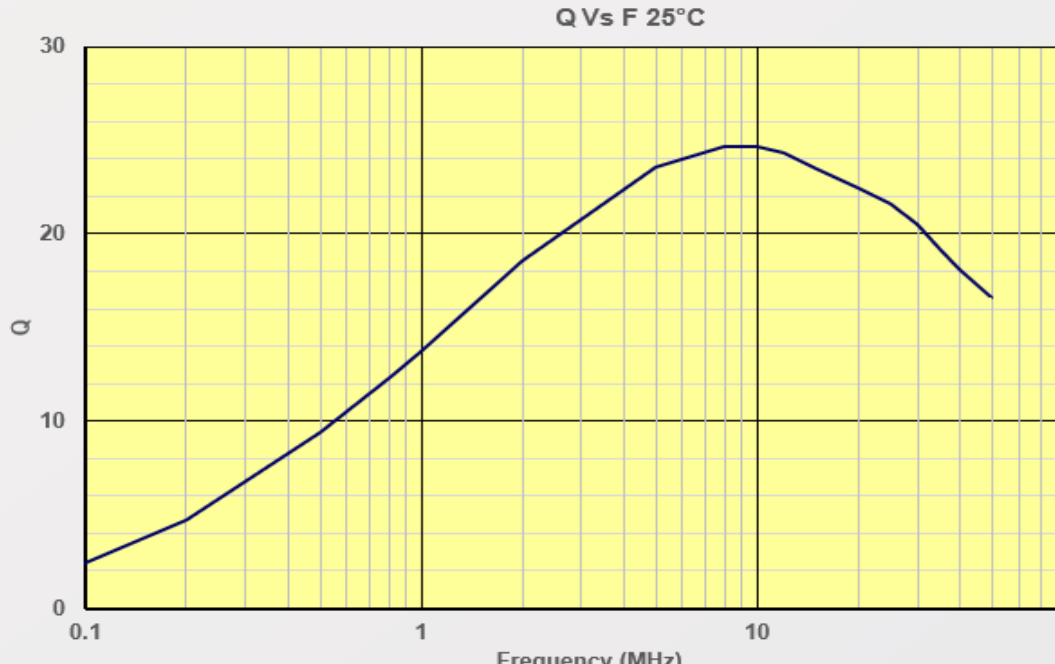
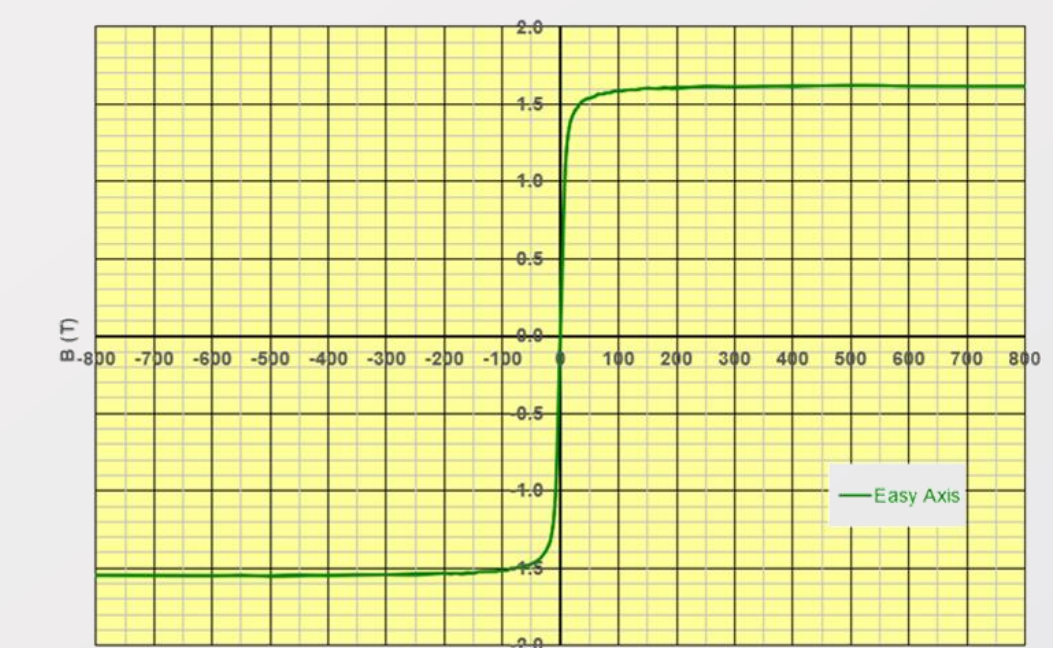
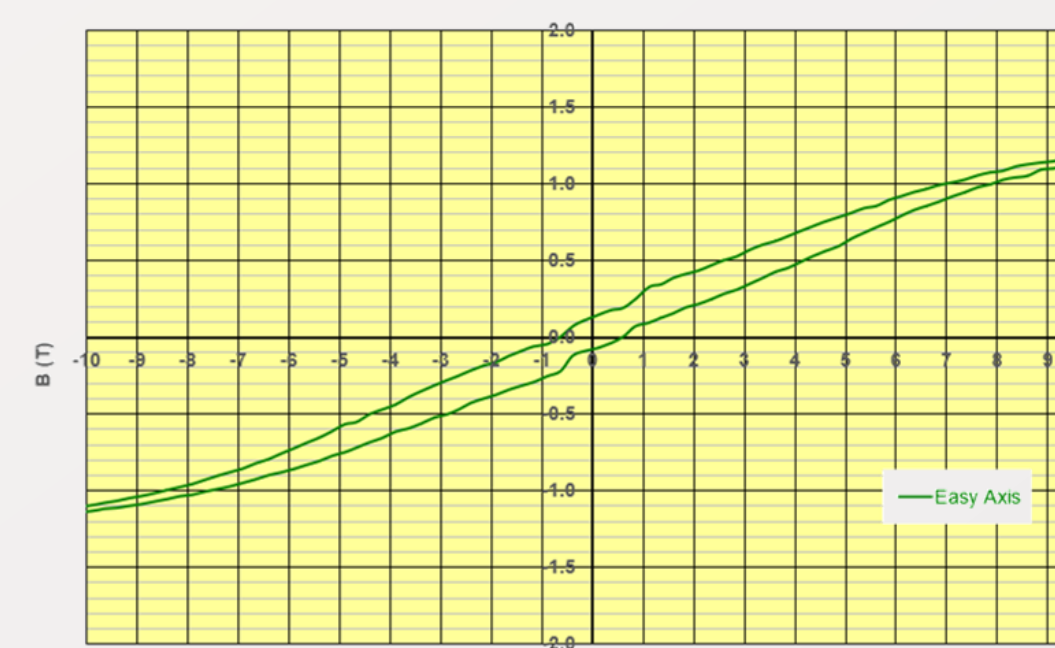
Lithography Steps for 8 Layer  
Magnetic Core  
Conventional: 72 steps  
EnaChip: 5 steps!  
→ 14x less steps  
→ Breakthrough cost reduction



## Proprietary high performance electroplated alloy

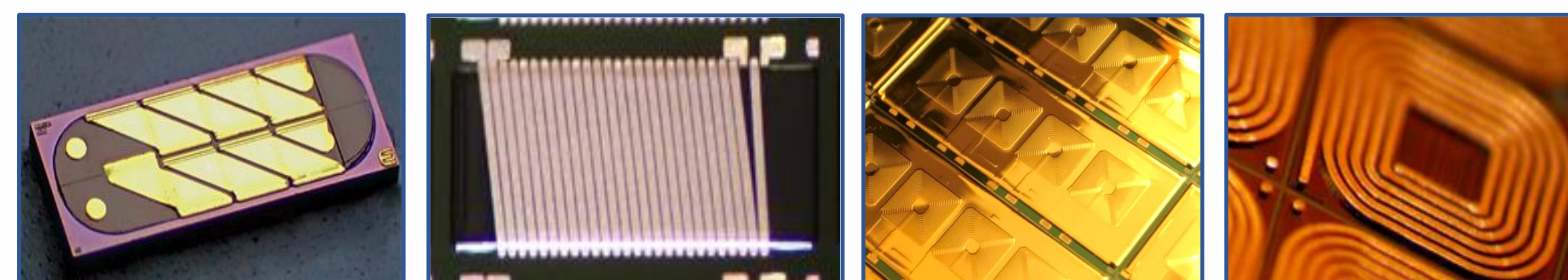
### EnaChip Alloy (ECA)

- Electroplated
  - Amorphous
  - Soft magnetic
  - $F_{sw}$  up to 30 MHz
  - $B_{SAT} > 1.6$  T
  - High resistivity\*
- Smaller solutions  
→ High power  
→ Thicker film → less layers



\* >3x resistivity of NiFe

## Advance integration & microfabrication



EnaChip technology transferable to volume manufacturing partner

## Applications

IVR  
Embedded Power  
Signal Conditioning  
Electromagnetic Actuation  
Magnetic Field Sensing  
Energy Harvesting

## Design Range

$$10 \text{ nH} \leq L \leq 200 \text{ nH}$$
$$10 \text{ A} \geq I_{DC} \geq 2 \text{ A}$$
$$1 \text{ m}\Omega \leq DCR \leq 20 \text{ m}\Omega$$

