



## MODELING AND PREDICTING SCAN VECTORS IN SELECTIVE LASER MELTING

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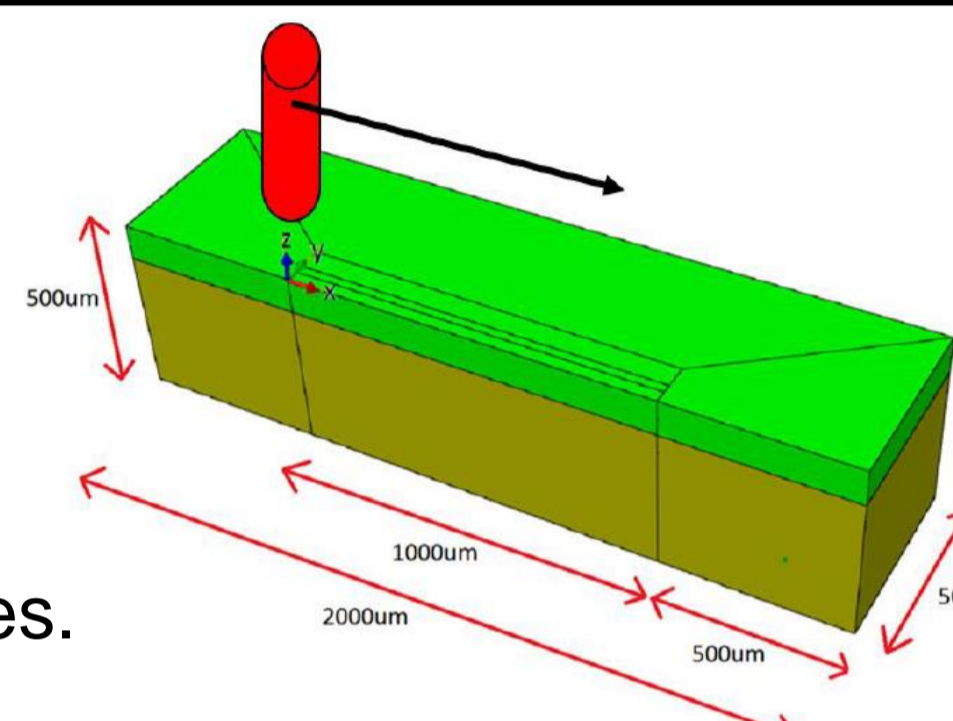
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### Introduction

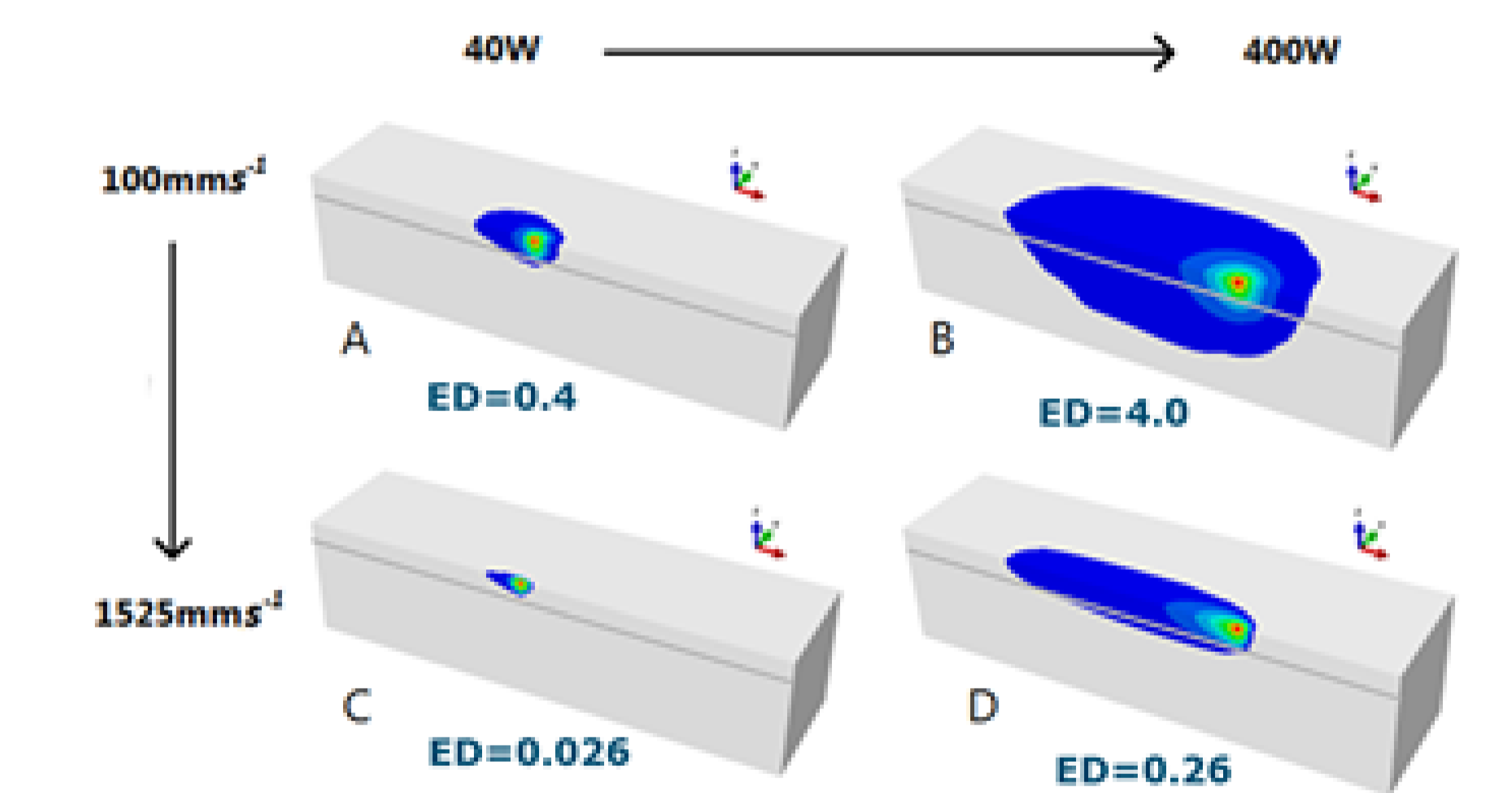
- ✓ Selective Laser Melting (SLM) build products by melting layers of metal powder successively.
- ✓ SLM is forecasted to partially replace conventional manufacturing for high-tech engineered products.
- ✓ But, good and reproducible part properties remain challenging.
- ✓ This depends strongly on the quality of single laser-melted tracks

### Process modeling

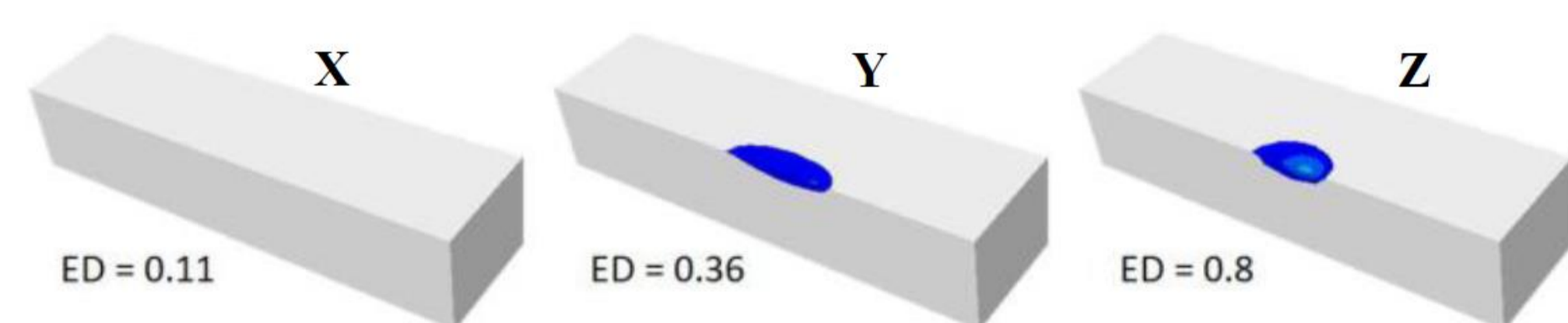
- ✓ Single scan vector model geometry (half symmetrical).
- ✓ Metal powder is modeled as a homogenized layer of opaque spheres.
- ✓ Radiative and convective heat losses are irrelevant compared to diffusion (through conduction).
- ✓ Thermal gradient driven mass flow is not considered.



### Simulation results



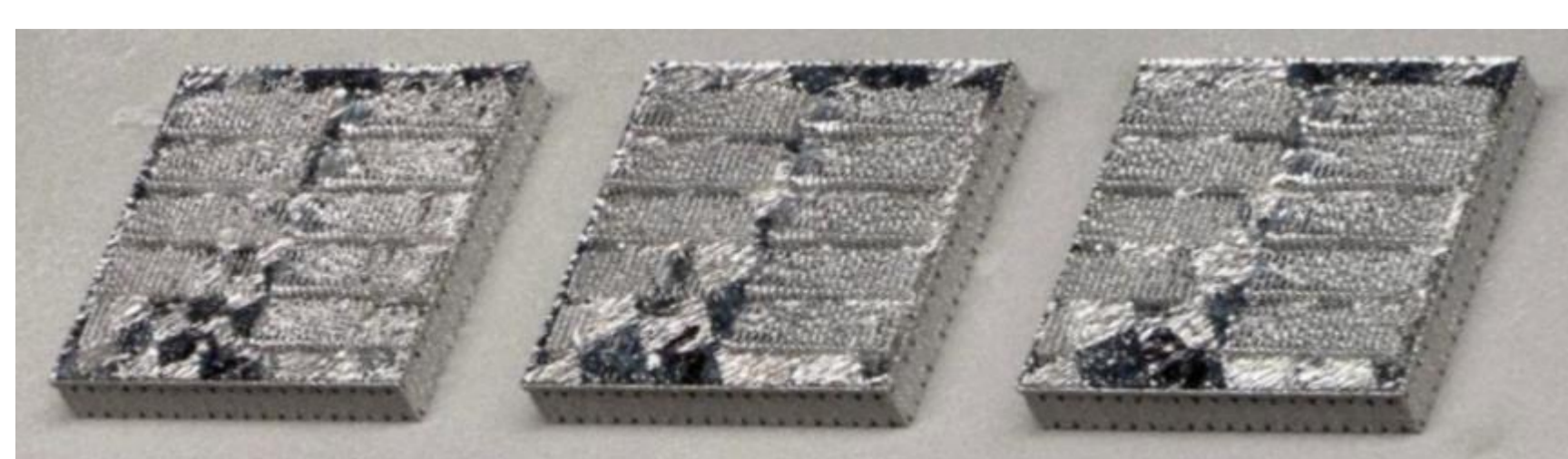
- ✓ Melt pool behavior at parameter extremes.
- ✓ Similar Energy Densities (ED) show similar melt pool depth and width, but the melt pool is longer for higher scan speeds.
- ✓ For proper attachment the melt pool should extend into the substrate.



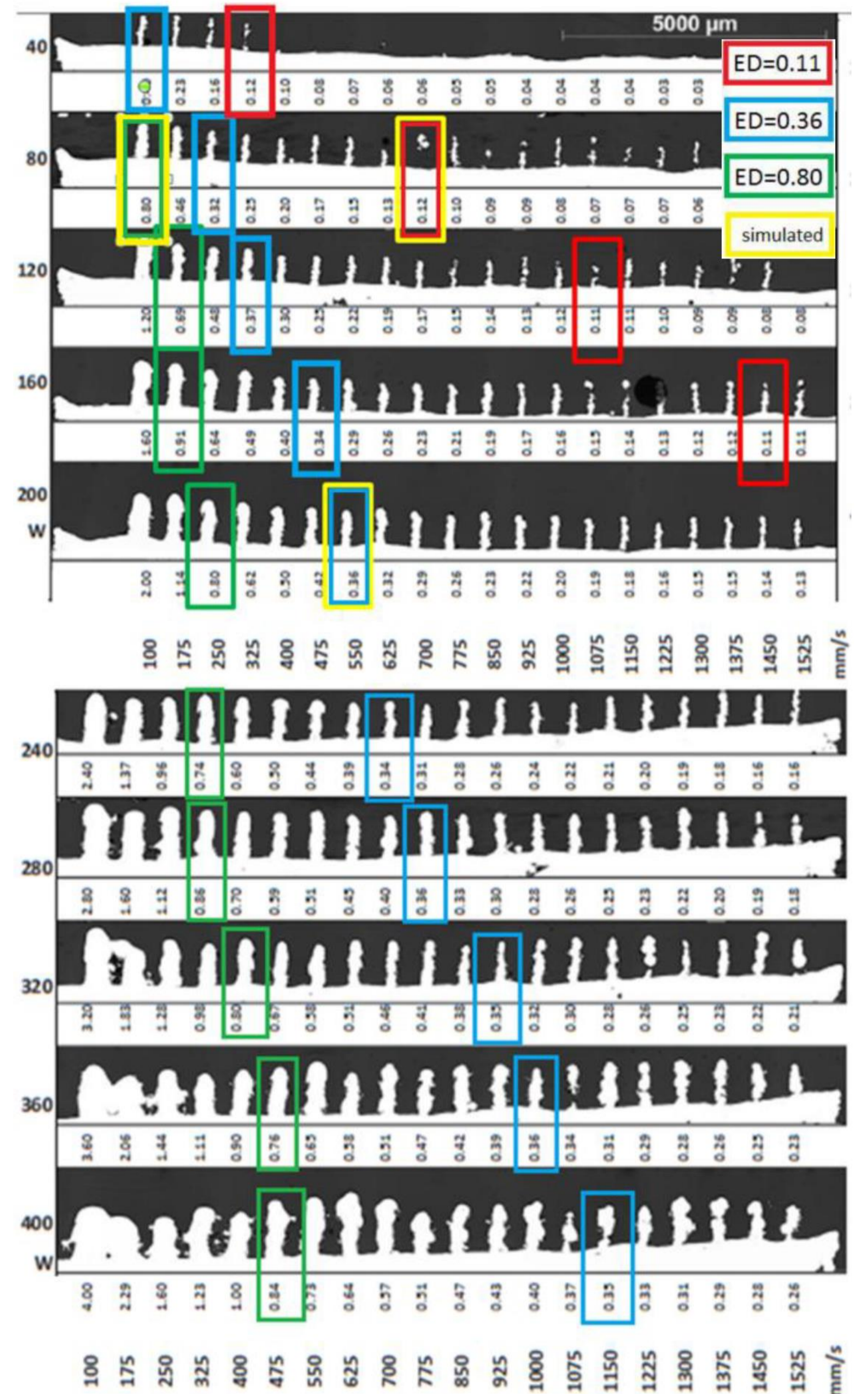
- ✓ Observing the remelted substrate.
- ✓ Remelted substrate width predicts track width.

### Experimental approach

- ✓ Printing test parts with varying process parameters using Ti6Al4V.

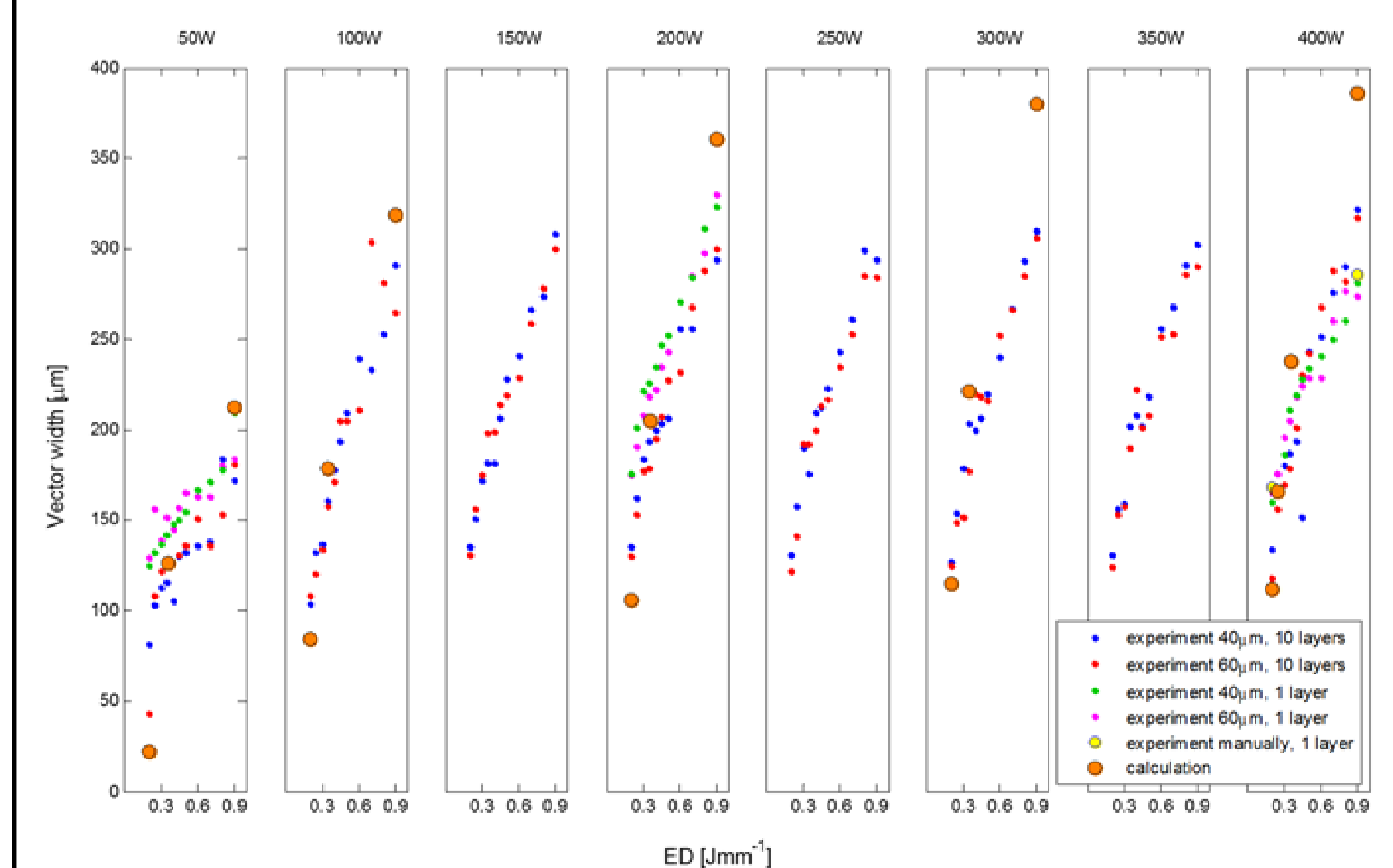


### Experimental results



- ✓ Ten-layer vectors are scanned with varying process parameters.
- ✓ Experiments were conducted on an SLM Solutions SLM280HL.
- ✓ Vector attachment and track width are observed from the resulting cross-sections.

### Conclusions



- ✓ Simulated and experimental results compare well.
- ✓ Numerical modeling can most accurately predict vector width for medium laser energy densities (commonly used in SLM).