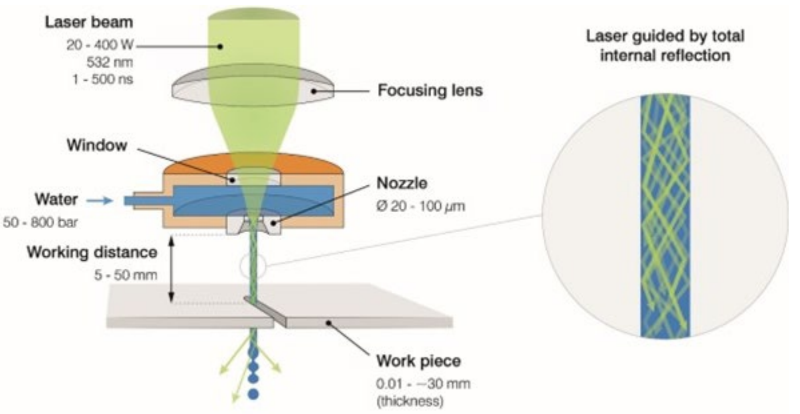
WATER JET GUIDED LASER
APPLICATION & IMPLEMENTATION



WATER JET GUIDED LASER CUTTING OF ELECTRICAL STEEL LAMINATIONS

The MTC worked with the University of Sheffield and the Advanced Manufacturing Research Centre (AMRC) to demonstrate the capability of a Synova LCS305 water jet guided laser for cutting of electrical steel laminations.

> Collaborating with the MTC, and the capability and expertise they bring, has been a real boost in helping us explore new methods for high-performance electrical machines.
>
> **Alexei Winter - Technical Lead for Electric Machines, AMRC**

THE CHALLENGE

- The state-of-the-art process for mass production of motor laminations is stamping. However, this method is unsuitable for laminations thinner than 0.2 mm due to deformation, and impractical for prototyping.
- Conventional laser cutting is already used for small batch production and processing thin laminations. However, thermal damage is unavoidable, and the total damage induced by the heat of the laser is akin to that induced using mechanical methods.
- Electrical discharge machining reduces fixture and tooling costs, enables easy design changes, and has minimal impact on the material's magnetic properties. However, cutting rates are slow making it uneconomical for anything except prototyping.

MTC'S SOLUTION

- The water jet guided laser (WJGL) was proposed as an alternative method for prototyping electrical steel laminations and cutting multiple stacked laminations. The continuous application of water ensures cooling, reducing the negative effects associated with laser heating, resulting in negligible thermal damage.
- A series of trials were performed using the MTC's Synova LCS305 WJGL system to cut individual 0.2 mm thick NO20-1200 laminations with a Suralac 9000 coating and stacked laminations.
- A detailed analysis of the cut quality and the impact on magnetic characteristics was performed.

THE OUTCOME

- Suitable process parameters were identified for WJGL cutting of 0.2 mm thick NO20-1200 laminations with a Suralac 9000 coating.
- Effective cutting speeds of 600 mm/min were obtained for cutting individual laminations.
- Analysis of cut quality found negligible cut taper, and minimal impact on the material's magnetic characteristics.
- Using the WJGL, a stack of 20 laminations (~4 mm total thickness) was cut to create a representative ¼ of a stator and yoke geometry.

BENEFITS TO THE CLIENT

- Enabled WJGL cutting of electrical steel laminations with minimal impact on magnetic properties.
- Improved quality of WJGL cutting for laminations compared to using conventional laser cutting.
- Improved productivity of WJGL cutting for laminations compared to using wire EDM.
- By demonstrating the WJGL as a viable solution for cutting electrical steel laminations, this indicates the potential this technology may have across the electrification sector.

> The desire for OEMS and Tier 1's to manufacture bespoke, in-house electric machines requires an agile supply chain which is cost-effective and able to rapidly prototype design iterations. The incumbent technologies of stamping and W-EDM for lamination cutting sit on opposite sides of the spectrum in terms of achievable design complexity, production rate, lead time, and cost. WJGL cutting offers a careful balance of these attributes for the purpose of low volume prototyping.
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> **Dan Walton - Technology Manager, MTC**

↓ Reduced impact on magnetic characteristics compared to conventional laser cutting

↑ Increased effective cutting rate by 60x for single laminations compared to EDM

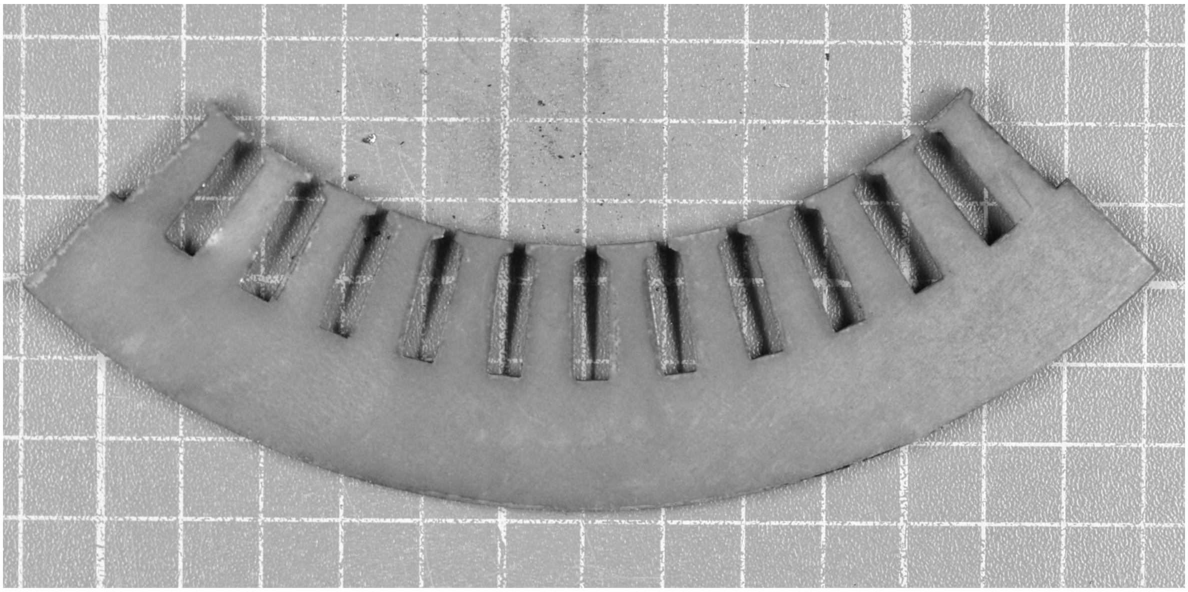

Figure 1: 4 mm thick stack consisting of 20 laminations, cut into ¼ of a stator and yoke geometry using the WJGL.

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