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Aviation in Europe – Innovating for Growth

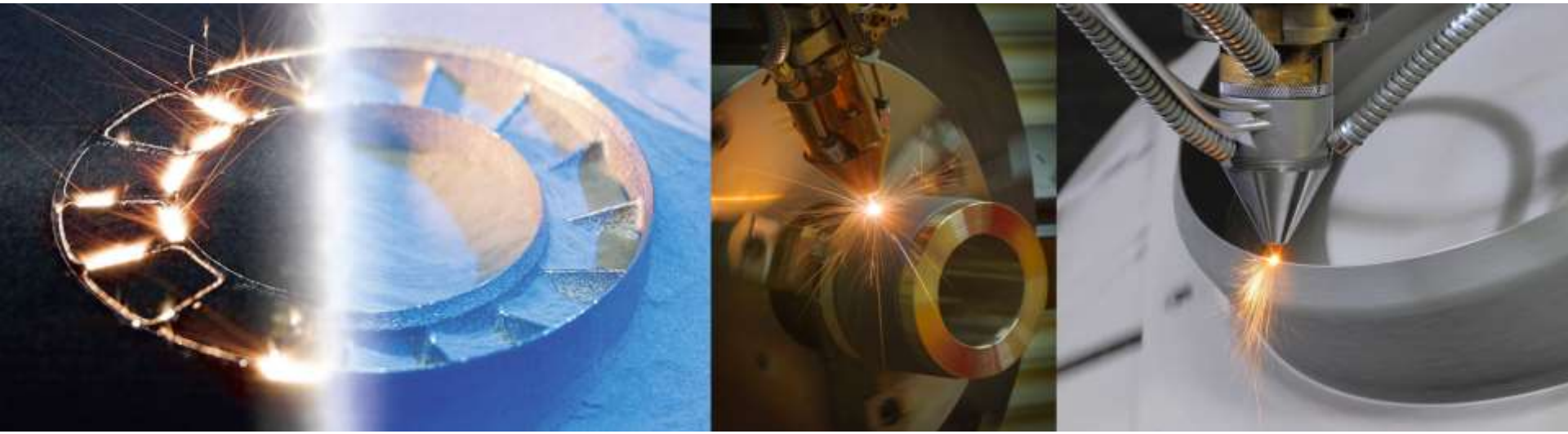
The 7th European Aeronautics Days

LONDON

20–23 OCTOBER 2015

MERLIN

Developments in the Additive Manufacture of Aero Engine Components



Carl Hauser, Principal Project Leader, TWI, UK.

and MERLIN Project manager

The Consortium

Rolls-Royce
WSK „PZL-Rzeszów" S.A.
GKN AEROSPACE
SAFRAN Turbomeca
MTU Aero Engines
ITP the power of talent
ARMINES
UNIVERSITY WEST
FREDERICK RESEARCH CENTER
LPW
BCT.
Fraunhofer ILT
TWI
LORTEK ik4 research alliance

" To reduce the environmental impact of air transport using Additive Manufacturing (AM) techniques in the manufacture of civil aero engine components "

Concept

- Develop AM techniques, at the level 1 stage, to allow environmental benefits including (reduction in life cycle emissions):
  - Near 100% material utilisation
  - No toxic chemical usage
  - No tooling costs
  - Reduce buy to fly ratios (reduction in waste)

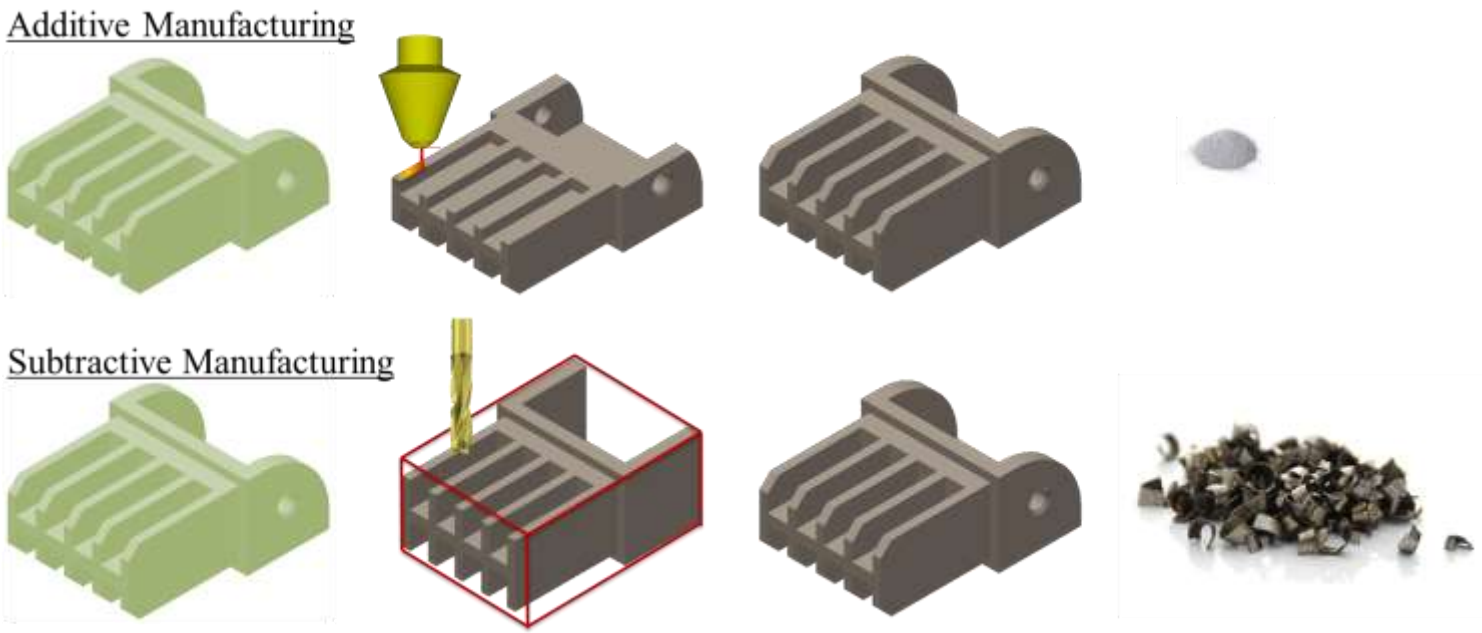
- In-service benefits from design optimisation underpinned by AM freedoms of manufacture:
  - Light-weighting for performance improvement
  - Reduced fuel consumption
  - Reduced emissions

" Improved performance of additive manufactured parts in a more productive, consistent, measurable, environmentally friendly and cost effective way "

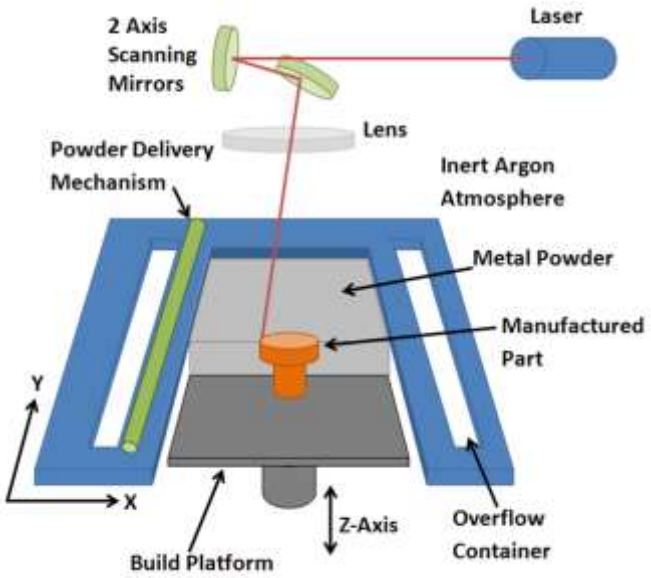
MERLIN Consortia 2011

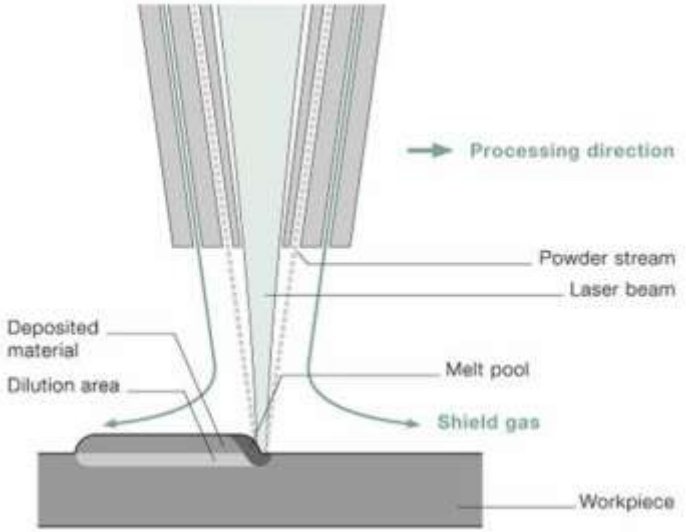
Additive Manufacturing

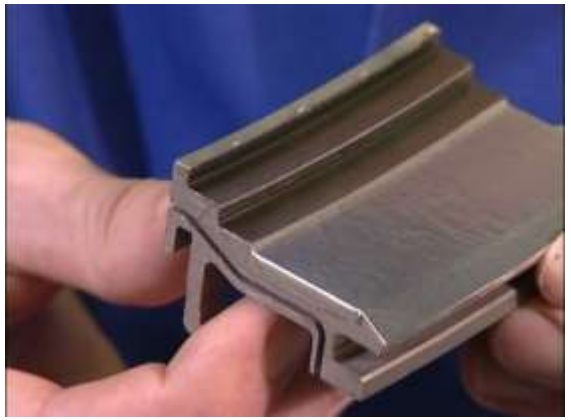
- The media use “3D Printing” as a synonym for all Additive Manufacturing activity.
- The process creates a part by adding material in layers rather than subtracting material from a billet.
- There are lots of individual processes which vary in their method of layer manufacturing



Selective Laser Melting and Laser Metal Deposition







Geometric Flexibility in Part Creation

Industry Pull

In 2011, the MERLIN consortia identified the following areas where a progression of the state-of-the art is needed to take full advantage of AM:

- High specification materials process development.
- Productivity increase.
- Part redesign and topology optimisation.
- Powder recycling validation.
- In-process NDT development.
- In-process geometrical validation.

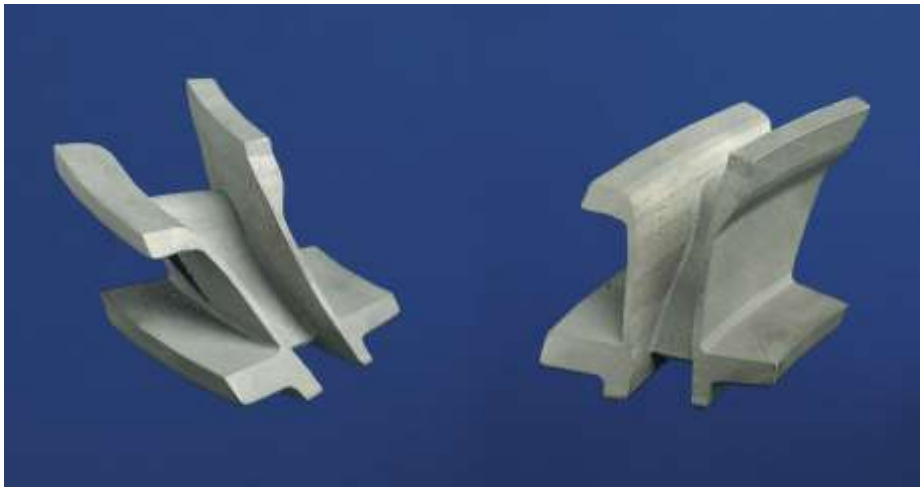
TWI

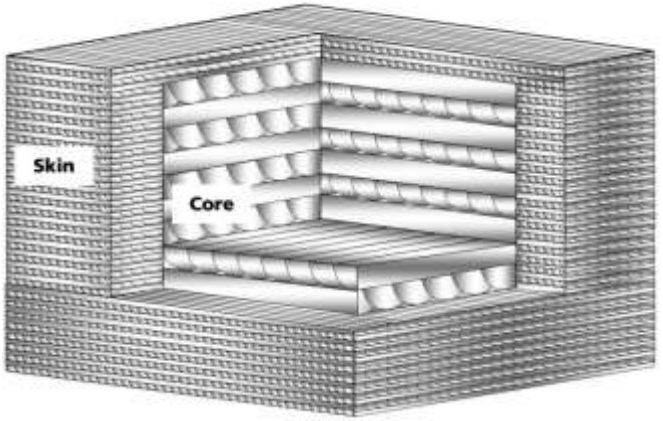
Case Study 1: Extension of Bade Root

Developed by Fraunhofer ILT and MTU Aero Engines

- Requirement is low weight and high strength
- Combination of two materials (1) LEK94 single crystal blade with an LMD deposited Inconel 718 root.
- It was not possible to weld LEK94 to an Inconel 718 component.
- Two approaches (1) LEK94-Inconel 718 interface and bulk Inconel 718 deposition.
- MERLIN successfully developed LMD methods to bond an Inconel 718 root to a LEK94 blade with a suitable bond and density for validation trials.

Case Study 2: SLM Productivity Increase



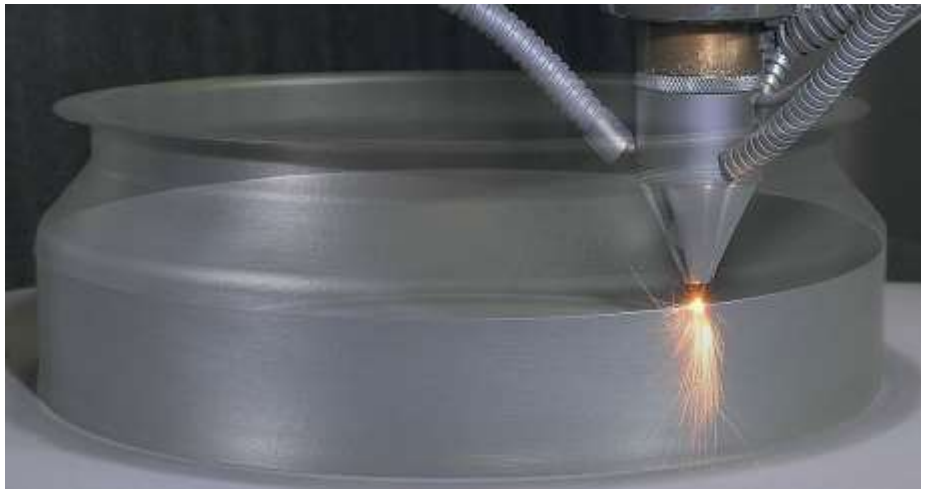


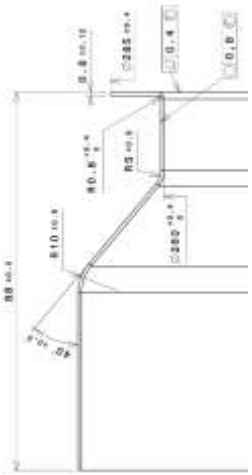
Developed by Fraunhofer ILT

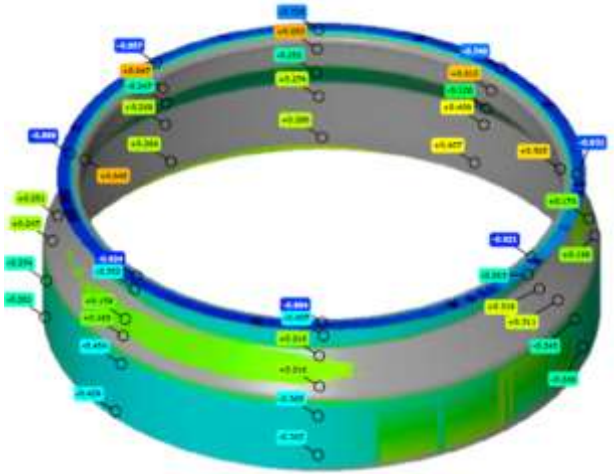
- An increase in productivity is required for SLM to be leveraged for production.
- ILT developed a skin/core scanning strategy using a high power (1KW) laser allowing large melt pools to be created in regions of lower geometric resolution.
- Through newly developed software tools, the component is sub-divided into a skin and core regions, allowing different processing parameters to be assigned.
- Process control must also ensure a defect free connection between skin and core.
- Inconel 718 component successfully built at x4 build rate increase using a single laser

TWI

Case Study 3: Net Shape Manufacture by LMD



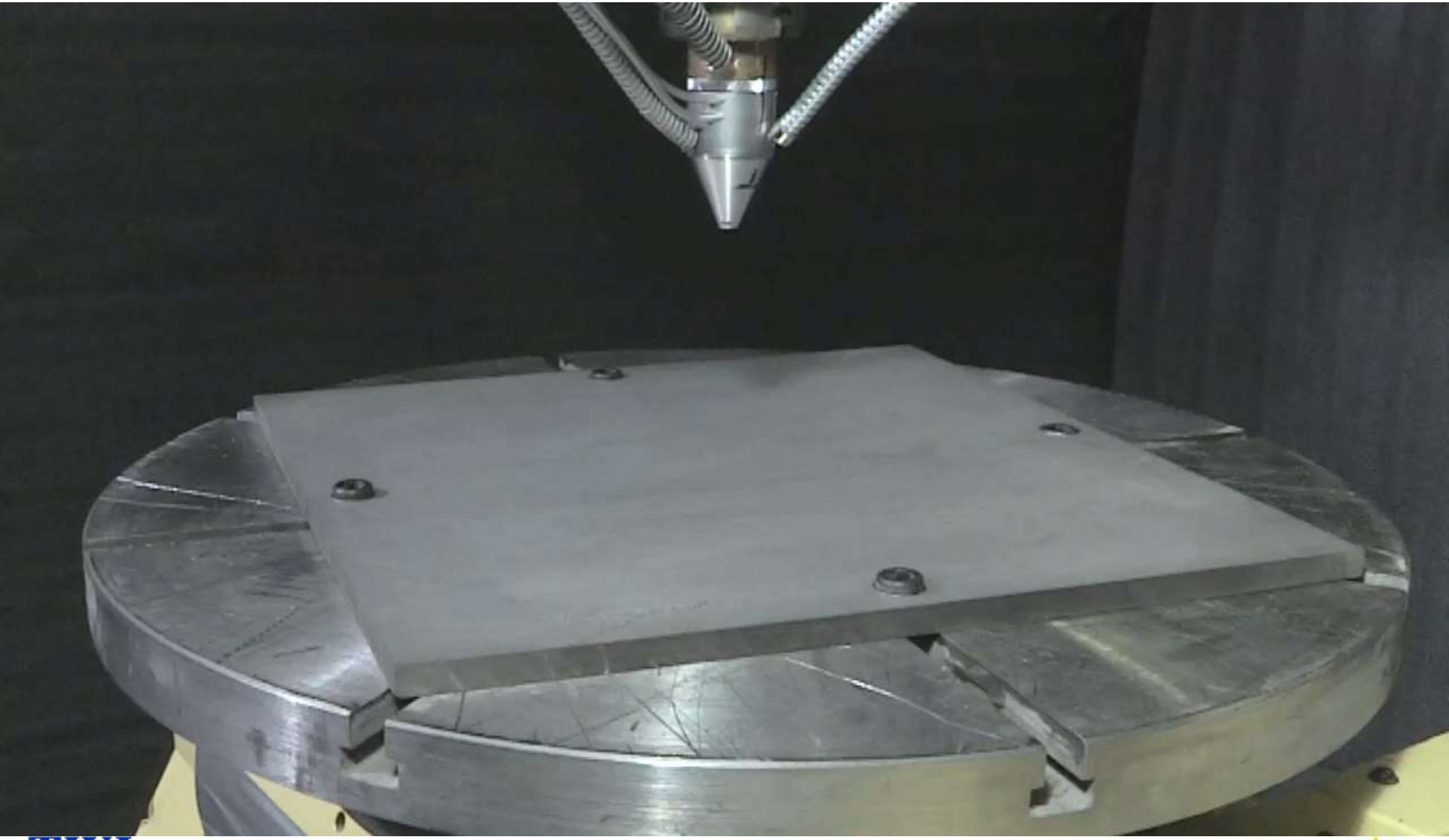




Developed by TWI

- TWI developed new methods for the net shape manufacture of thin walled casings using LMD.
- CAM-style software tools created at TWI maps a five-axis vector toolpath with deposition parameters to guide a three-axis coaxial LMD nozzle across a rotating and tilting substrate.
- Inconel 718 helicopter combustor casing was successful manufactured reducing lead time from several months to several hours and saved €50K tooling costs.
- 1.2Kg of powder material was used for manufacture and 400g was unused

Case Study 3: Net Shape Manufacture by LMD



Thankyou and Contact

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