

Combination of Remote Laser Welding and 2D Gantry Systems for High Volume Battery Production

Holger Schlüter



BLACKBIRD
ROBOTERSYSTEME

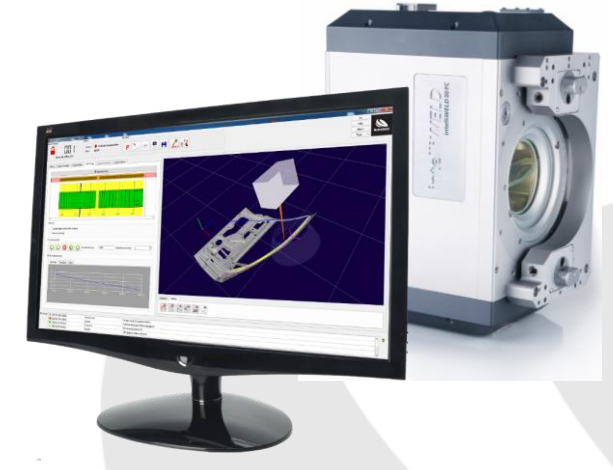
Outline



- **Introduction to Blackbird Robotics**
- Laser welding for the e-mobility
- On-the-fly welding with linear stages
- Outlook



- **Leading supplier** for pre-integrated remote laser welding scanner systems
- **Proven experience** in the development of user-friendly and powerful software tools for industrial use.
- **Perfectly fitted** system solutions to the needs of our customers



TecInvest Holding AG



- ✓ **Foundation:** 2008 in Munich
- ✓ **Systems installed:** 500 and counting
- ✓ **Employees:** 35



- ✓ **Foundation:** 1990
- ✓ **Annual systems:** 40.000
- ✓ **Employees:** 500



- ✓ **Foundation:** 1989
- ✓ **Annual systems:** 10.000
- ✓ **Employees:** 30



Introduction

Blackbird Locations



Blackbird Robotersysteme GmbH

Garching, Munich (Headquarters)

Laboratory, Research & Development, Sales & Service



Blackbird Robotics Co., Ltd.

Shanghai (Subsidiary)

Laboratory, Spare Parts, Sales & Service

Our sales & service partner :



ScanControlUnit (SCU)

- ✓ Electrical cabinet
- ✓ Connects all components
- ✓ Individually built
- ✓ Various fieldbus & safety options
- ✓ Service convenience

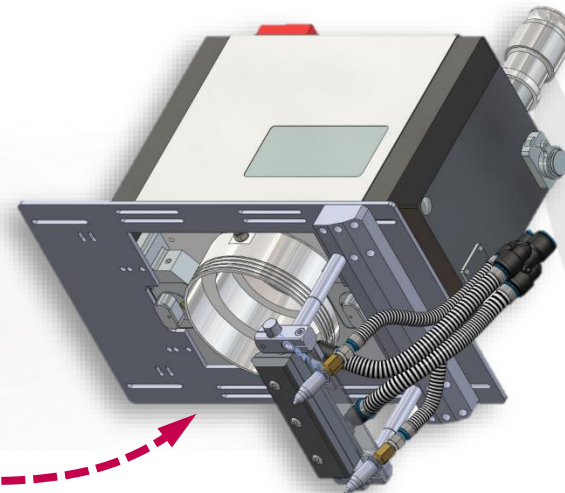


RobotSyncUnit (RSU)

- ✓ User software
- ✓ **Most intuitive** programming on the market
- ✓ Configuration of **all process parameters**
- ✓ Scene visualization during programming
- ✓ Seamless integration of all **Blackbird packages**

2D- / 3D-Scanner

- ✓ High quality SCANLAB products
- ✓ Customizable
- ✓ Reliable and efficient
- ✓ Future-proof



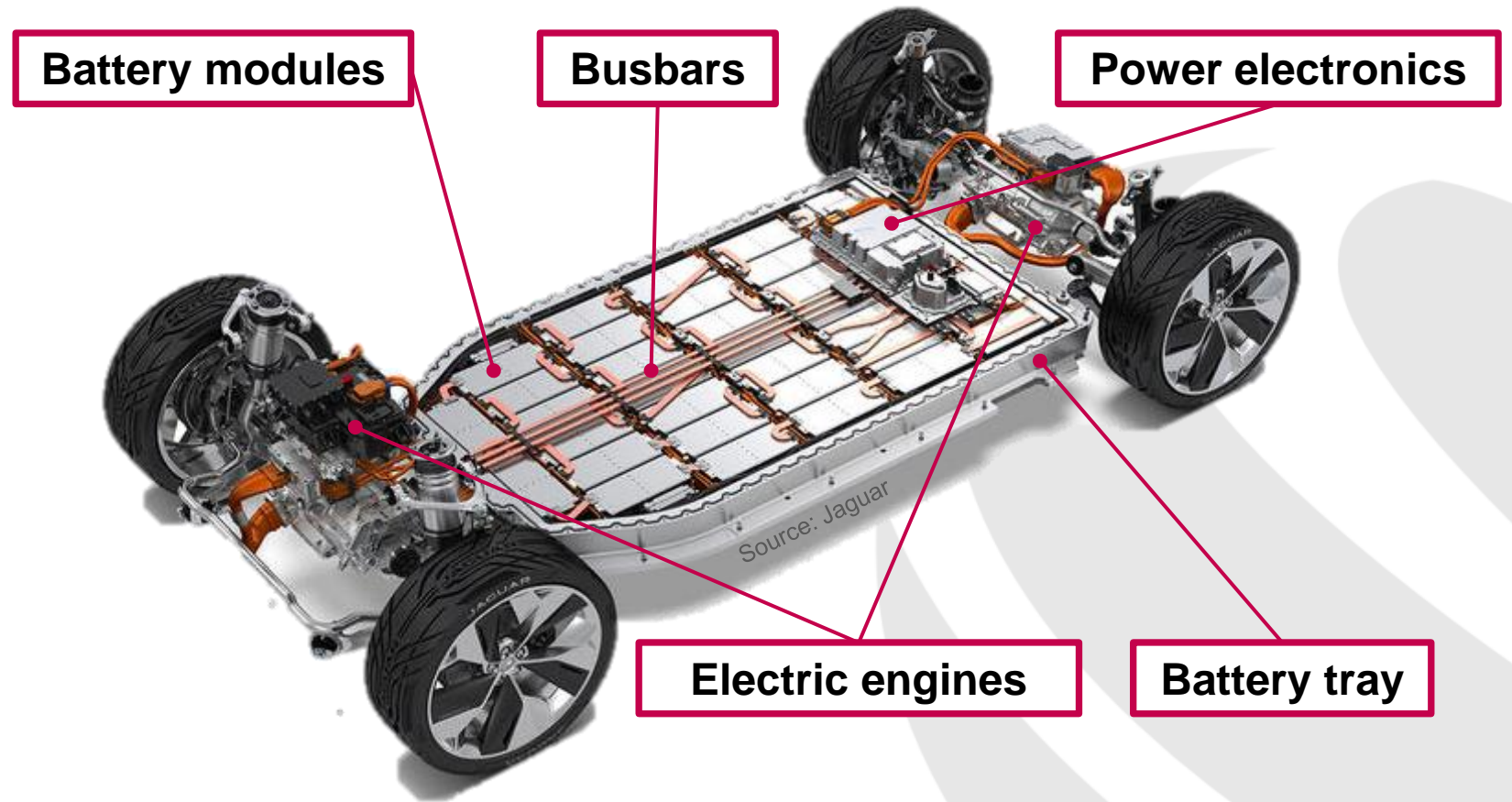
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Laser welding for the e-mobility

Laser welding applications



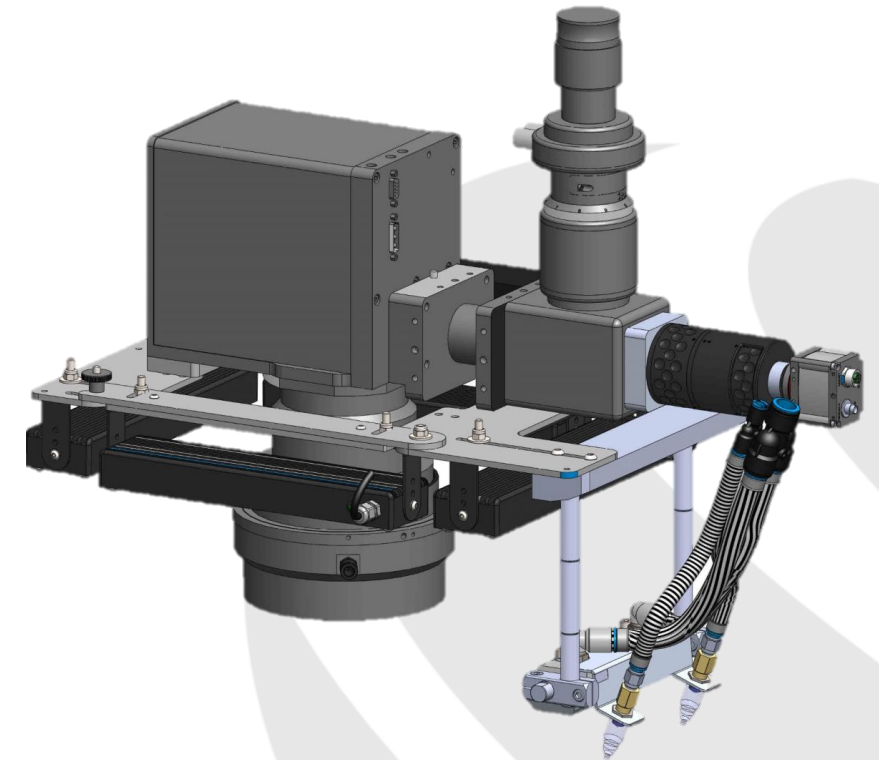
Further applications

- ✓ Battery foil cutting
- ✓ Prismatic cells
- ✓ Pouch cells
- ✓ Cylindrical cells
- ✓ Fuel cell components
- ✓ Connector plugs

- Laser beam properties:
 - Small multi-mode fibers (50 μm) vs. single-mode
 - Ring-mode lasers
- Two-dimensional processing:
 - Most workpieces offer planar weld geometries
- Automatization:
 - Image-based part detection
- High duty-cycle requirements:
 - Maximize laser processing speed
 - Reduce all non-value-adding tasks

- 2D F-Theta scanning optics:
 - Different collimation lengths for different numerical apertures (NA)
 - Planar processing
- How to change the focal plane?
- F-Theta influence on SM lasers?
- Is the scan field large enough?

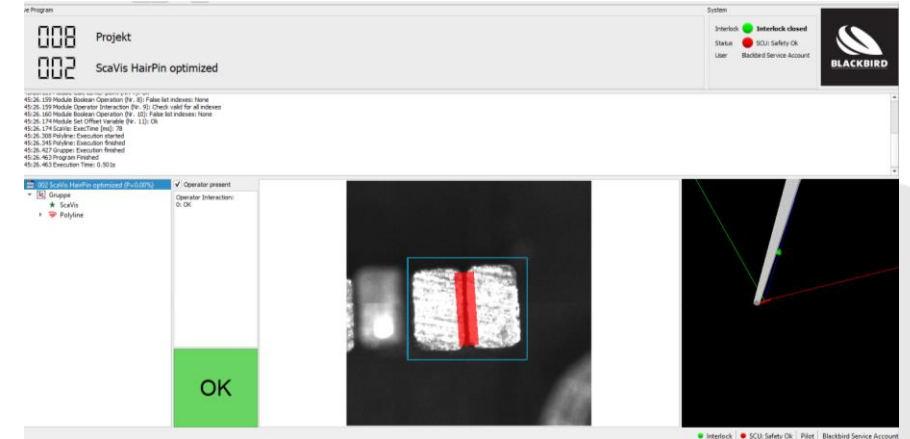
→ **3D (single-mode) pre-focus scanner**



SCANLAB intelliSCAN with ScaVis vision system from Blackbird.

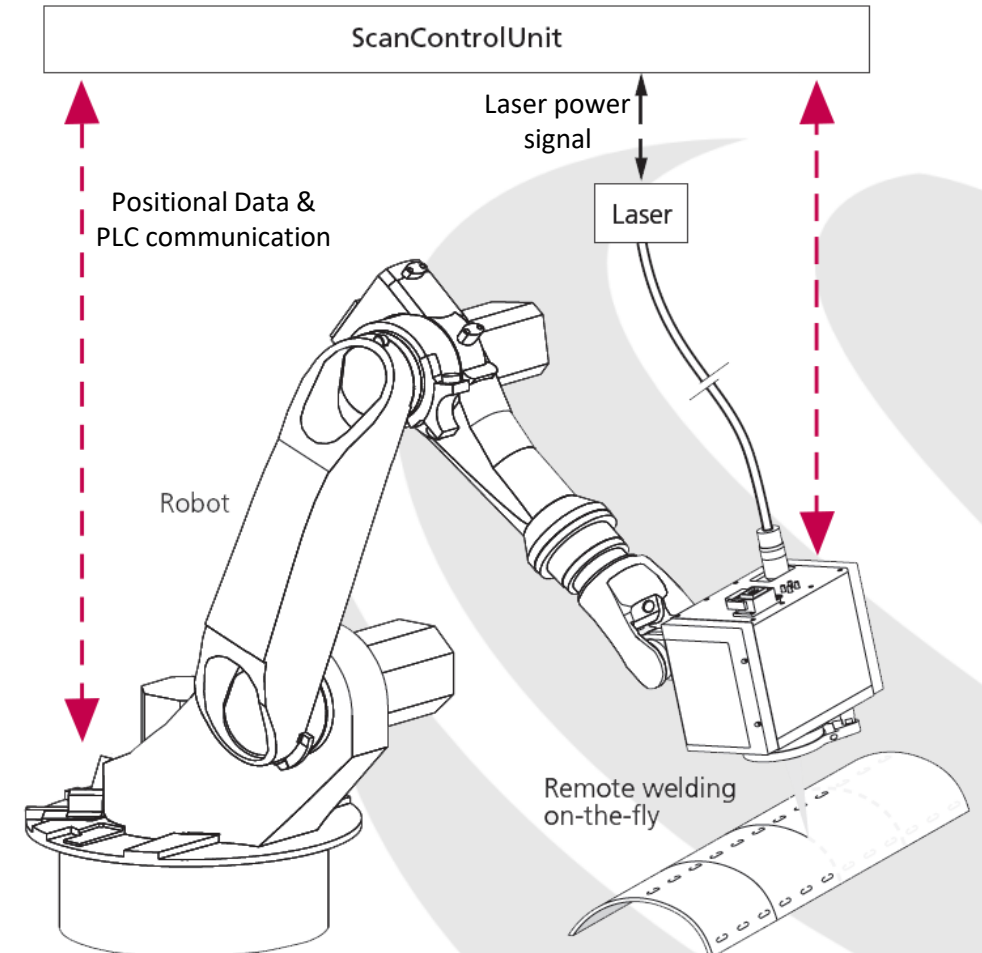
- Camera system:
 - Coaxial part detection
 - 2D scan path adjustment
- How to use cameras in on-the-fly applications?
- Focus shift:
 - Varies in function of laser power
 - Aggravated by use cover glasses
- How to adapt the welding program?

→ **External 3D seam alignment**



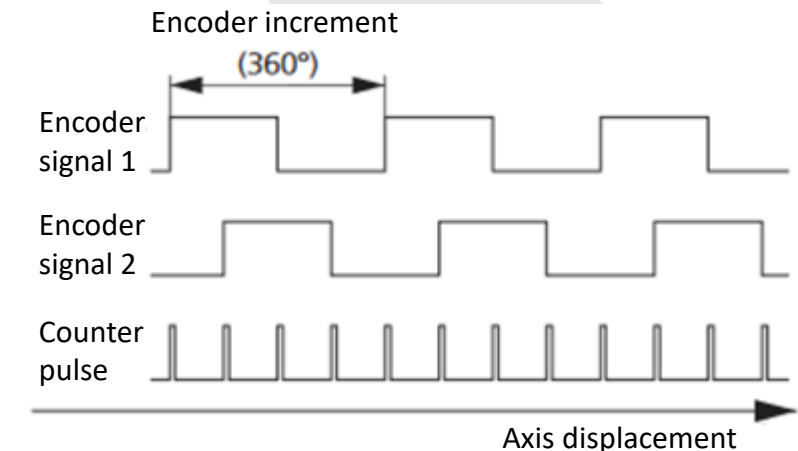
- On-the-fly processing:
 - Synchronized movement between scanning device and robot.
 - Allows for high duty-cycle
 - Six degrees of freedom (6DOF)
- Why investing in a 6-axis robot for just processing 2D-parts?
- How to downsize the overall setup?

→ On-the-fly for 1D/2D linear stages



Necessary system improvements

- 3D (single-mode) pre-focusing scanner
 - intelliWELD PR 1:1,84 – 1:6
- RTX: 1D/2D linear stages for on-the-fly remote laser welding
 - High compatibility by using standardized interface (incremental encoder on RS422)
- External 2D offset for welding shapes
 - Input of offsets by third party systems
- External offset for focal plane
 - E.g. provided by regular caustic measurements



Outline



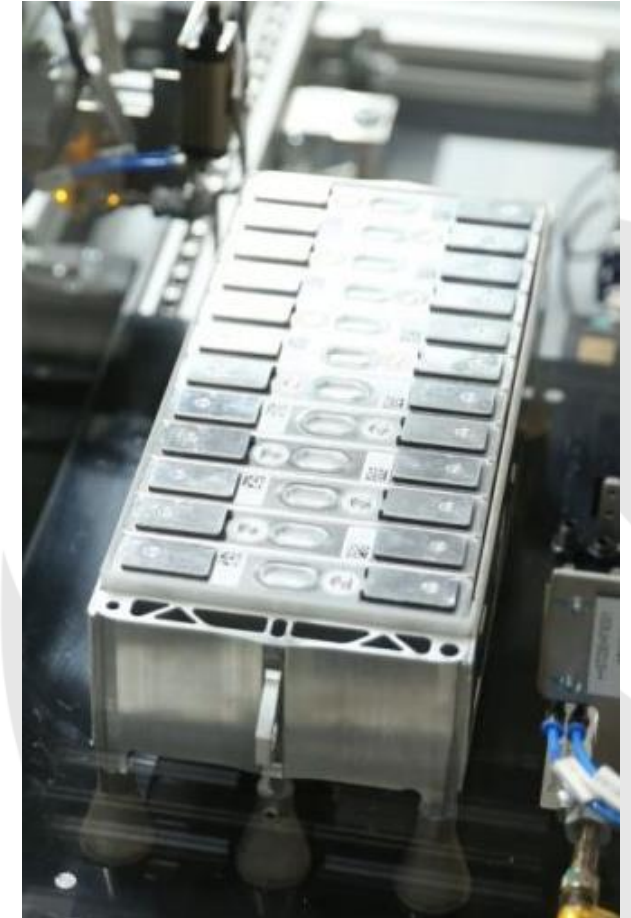
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On-the-fly welding with linear stages

Battery application example



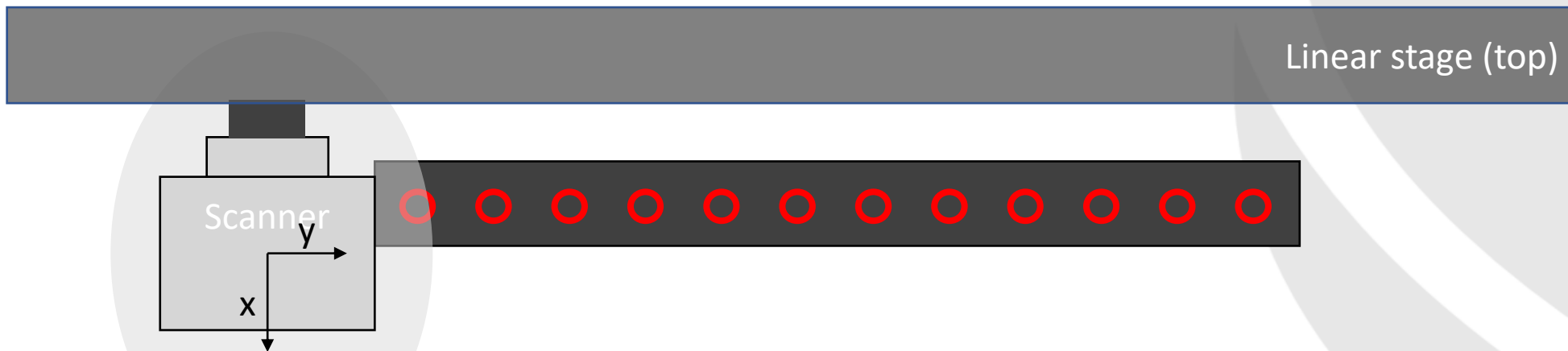
- Three laser applications are identified and well understood in the field of battery manufacturing:
 - Cap-Can welding
 - Busbar to battery terminal
 - Battery modules
- Considering the amount of batteries produced, an improved cycle time is mandatory to sustain a positive business case.



Source: BMW

On-the-fly welding with linear stages

Static welding



On-the-fly welding with linear stages

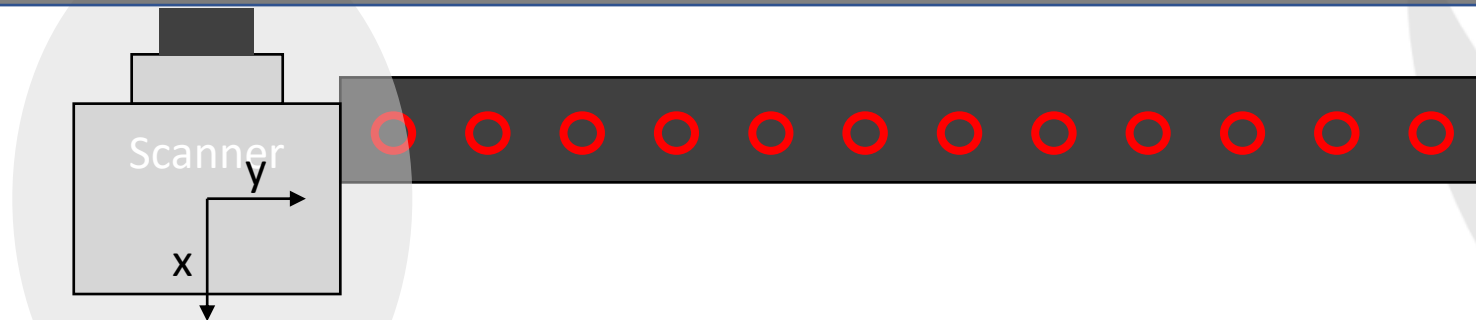
Static mode disadvantages



- But: the lack of on-the-fly capability leads to undesirable laser-off times between adjacent groups of seams.
- Additionally, by using a larger scan field, some physical aspects need to be considered for the scan field's edges:
 - Variation of the angle of incidence
 - Elliptical spot geometry
- Both drawbacks can be eliminated by implementing the on-the-fly capability for 1D/2D linear stages.

On-the-fly welding with linear stages

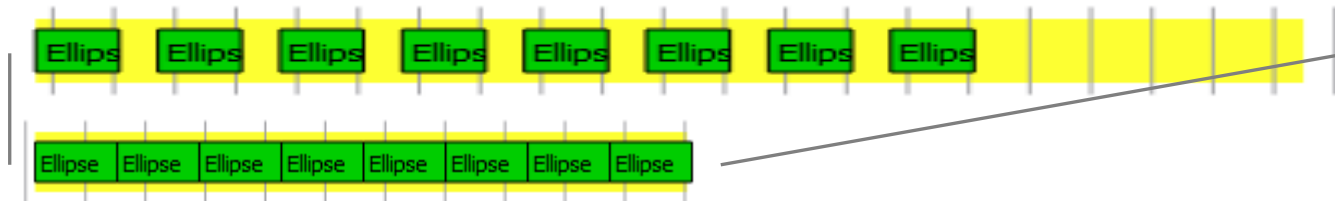
On-the-fly welding



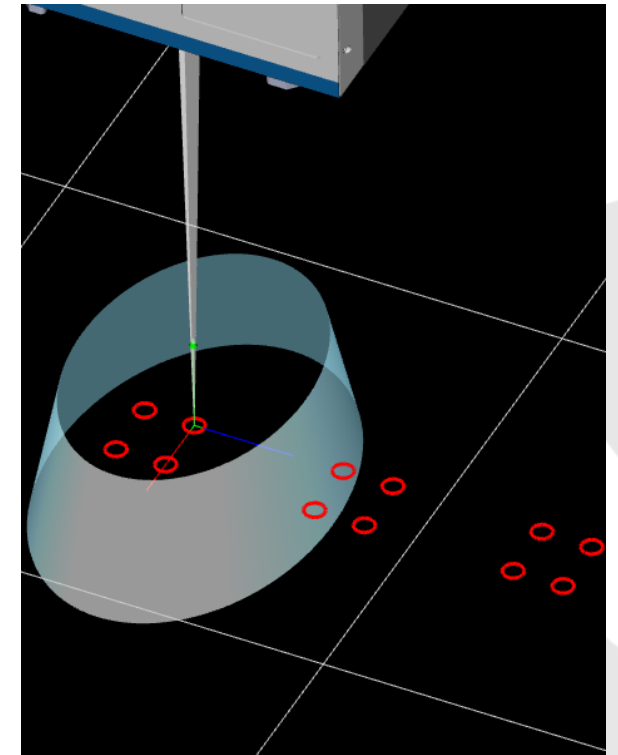
On-the-fly welding with linear stages

On-the-fly mode advantages

- The pre-recording of the axis' velocity permits to increase it until no laser-off time is identified in the process:

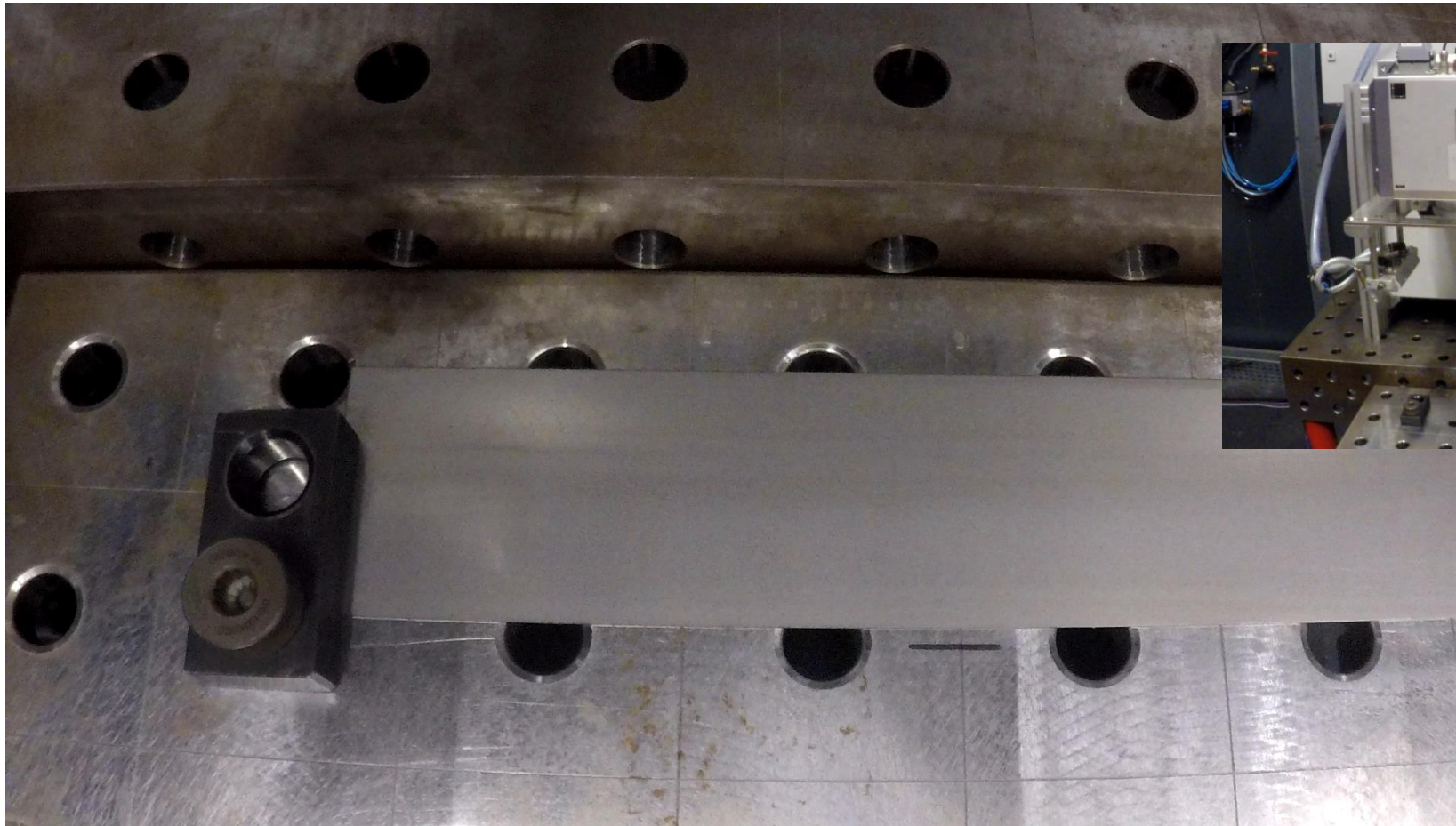


- By adding a second, perpendicular axis and by prolongating both, scan fields in the size of several sqm or beyond are achieved.



Preview of multiple seams outside of the field of view of the scanner.

On-the-fly welding with linear stages RTX demonstration

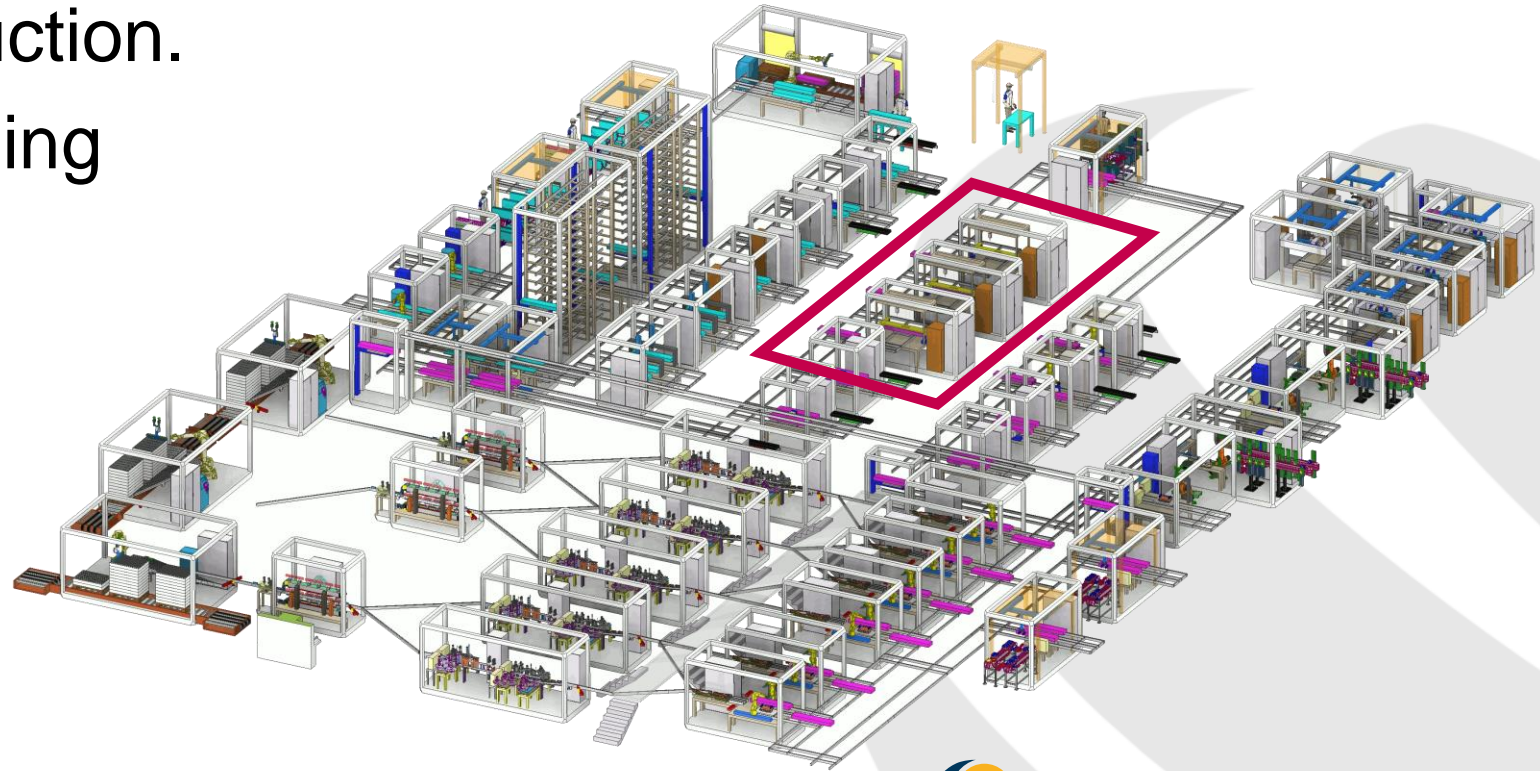


On-the-fly welding with linear stages

RTX application example

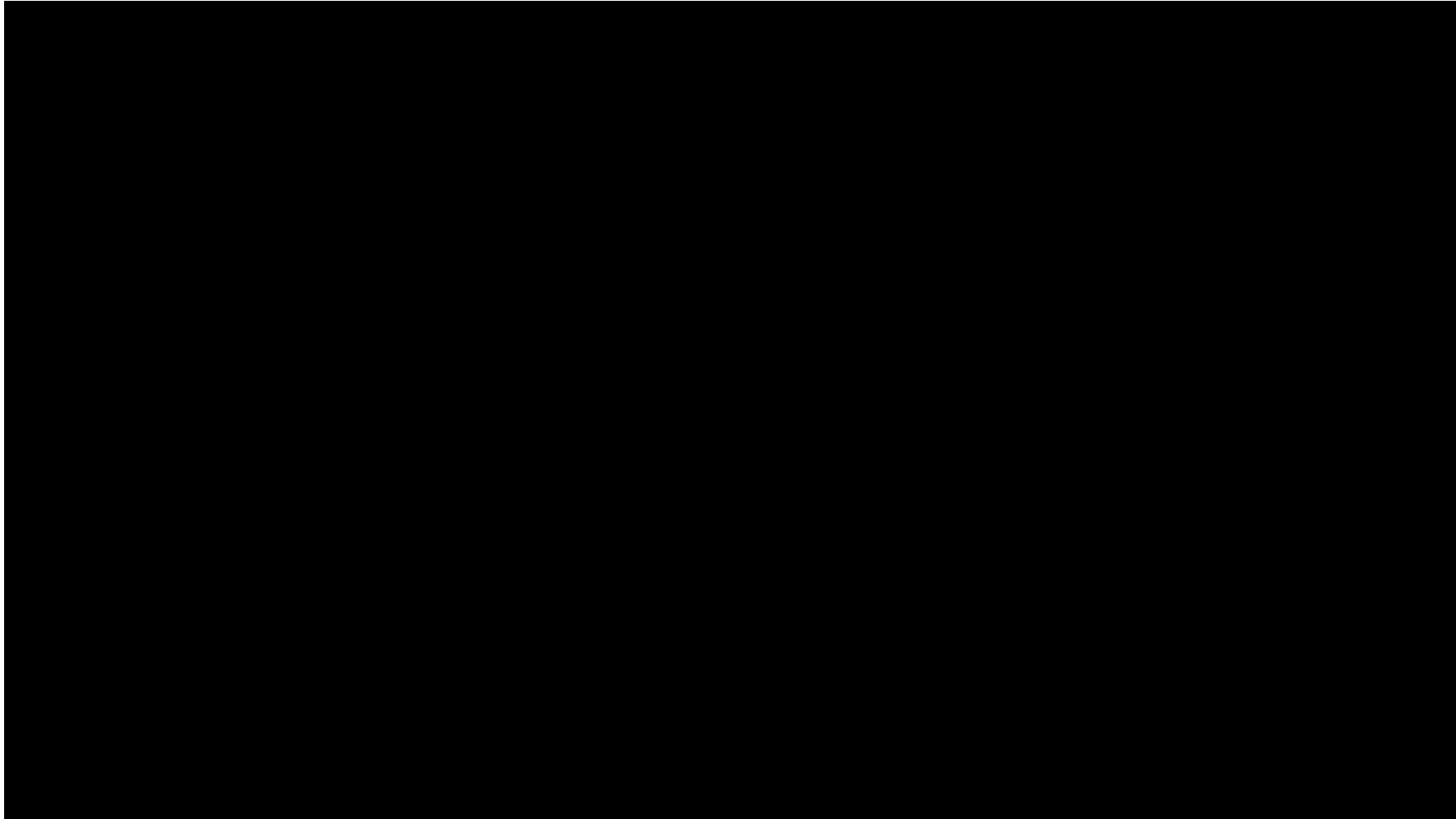


- Industrial application in a plant for battery production.
- Up to three laser welding cells with RTX.
- The line is designed for 100k units/year and can be upgraded to 250k and 1m units/year.



On-the-fly welding with linear stages

RTX application example



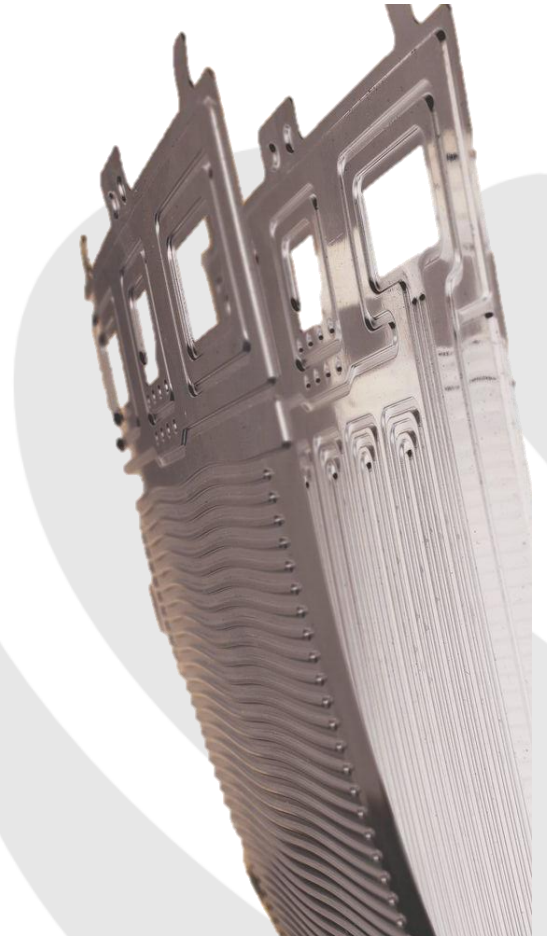
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Outlook

- The combination of 3D-scanners, single-mode laser sources and linear stages offers a versatile setup for e-mobility applications.
- The current range of battery applications may be joined by the production of:
 - Bipolar plates for fuel cells
 - Remote laser cutting of battery foils
- The ScanControlUnit can provide a multitude of process data for Smart Manufacturing – but the business cases need to be identified.



Source: Fraunhofer ILT



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