

The logo for Cailabs features the word "cailabs" in a bold, lowercase, sans-serif font. The text is white and is set against a dark background. Behind the text is a large, glowing light effect that transitions from a bright cyan at the top to a deep purple at the bottom, creating a lens flare or bokeh effect.

**cailabs**

SHAPING THE LIGHT

# Tailored Beam-shaping Solutions for E-mobility based on Multi-Plane Light Conversion Technology



24-25 October 2023. Stuttgart, Germany

EPIC Meeting on Laser Applications along Battery Manufacturing Process at ARENA2036



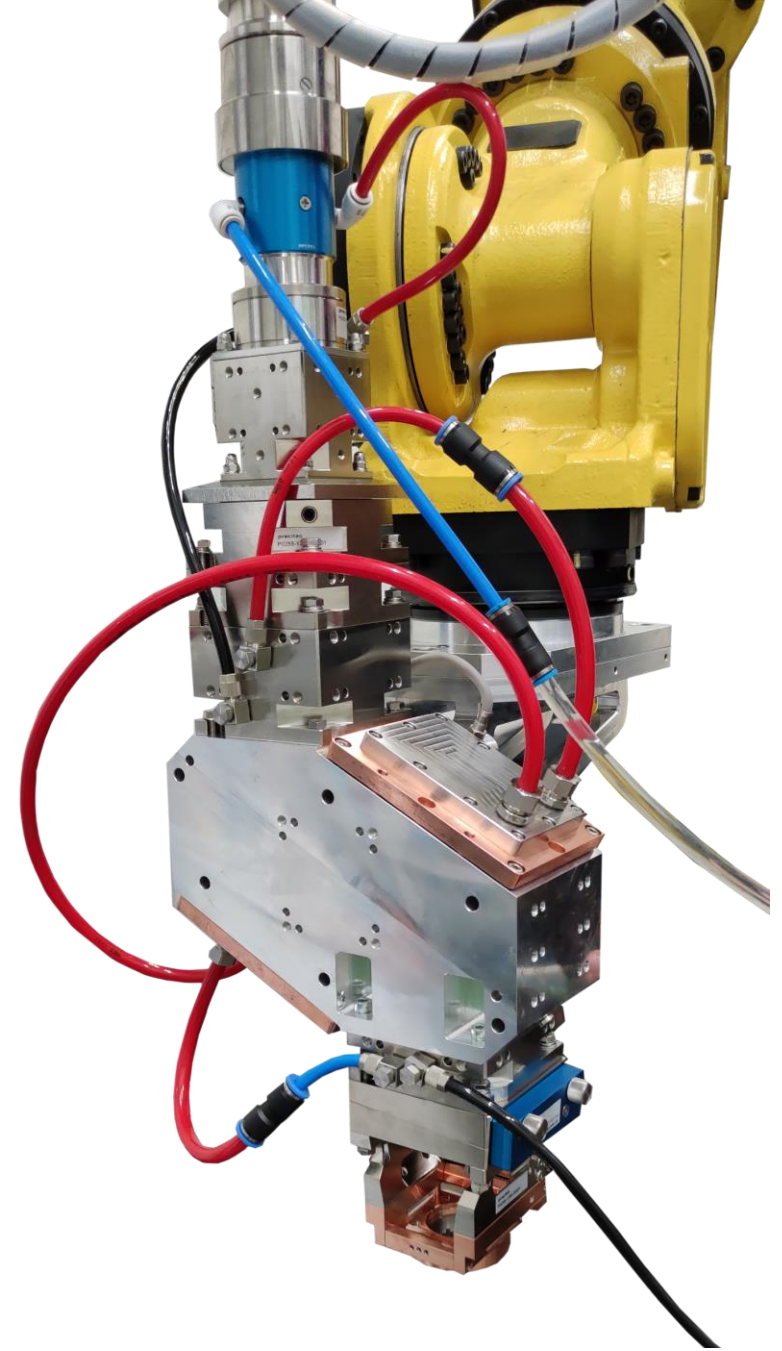
**Gwenn PALLIER – Product Line Manager**



# CANUNDA

BY CAILABS

- **Cailabs' solution to the copper welding challenge in e-mobility**
- Process results
- Deep-dive on solution benefits
- Cailabs in a few words
- Take away message





# Copper Laser Beam Welding is still an open challenge of e-mobility

High quality copper welding is critical for e-mobility for

- Good conductivity (limited pores)
- No short circuit (no projections)

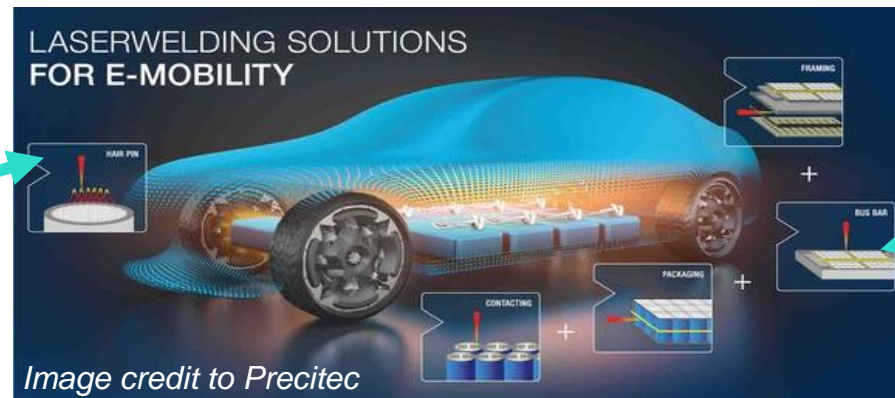
Yet **fundamental physics** makes copper welding challenging

- Very low absorption at 1 $\mu$ m in solid Copper leads to difficult weld initiation
- High heat conductivity leads to instable weld

Cailabs provides solutions for **busbars and hairpins** welding, turning a challenging process into a **forgiving one**.



*Hairpins*



*Image credit to Precitec*



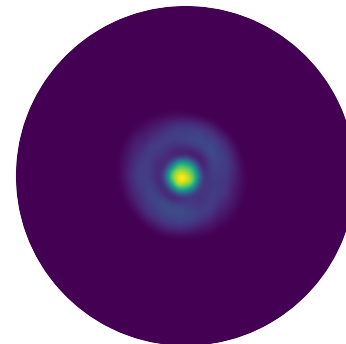
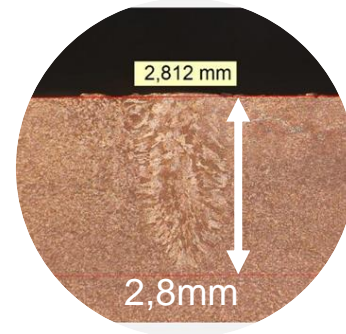
*Busbars*

# Cailabs e-mobility laser head enables cost reduction, more robust processes and quality improvement

**Up to 3x cost reduction** thanks to compatibility with all laser brands

**More robust process** thanks to large process window (1,5x) and extended Depth Of Field (4x), reducing preparation time, scrap rate and increasing reproductibility

**Quality improvement** thanks to easy tailoring to each specific application requirement (scanner integration, optimal & dynamic shape, add-ons, footprint...)

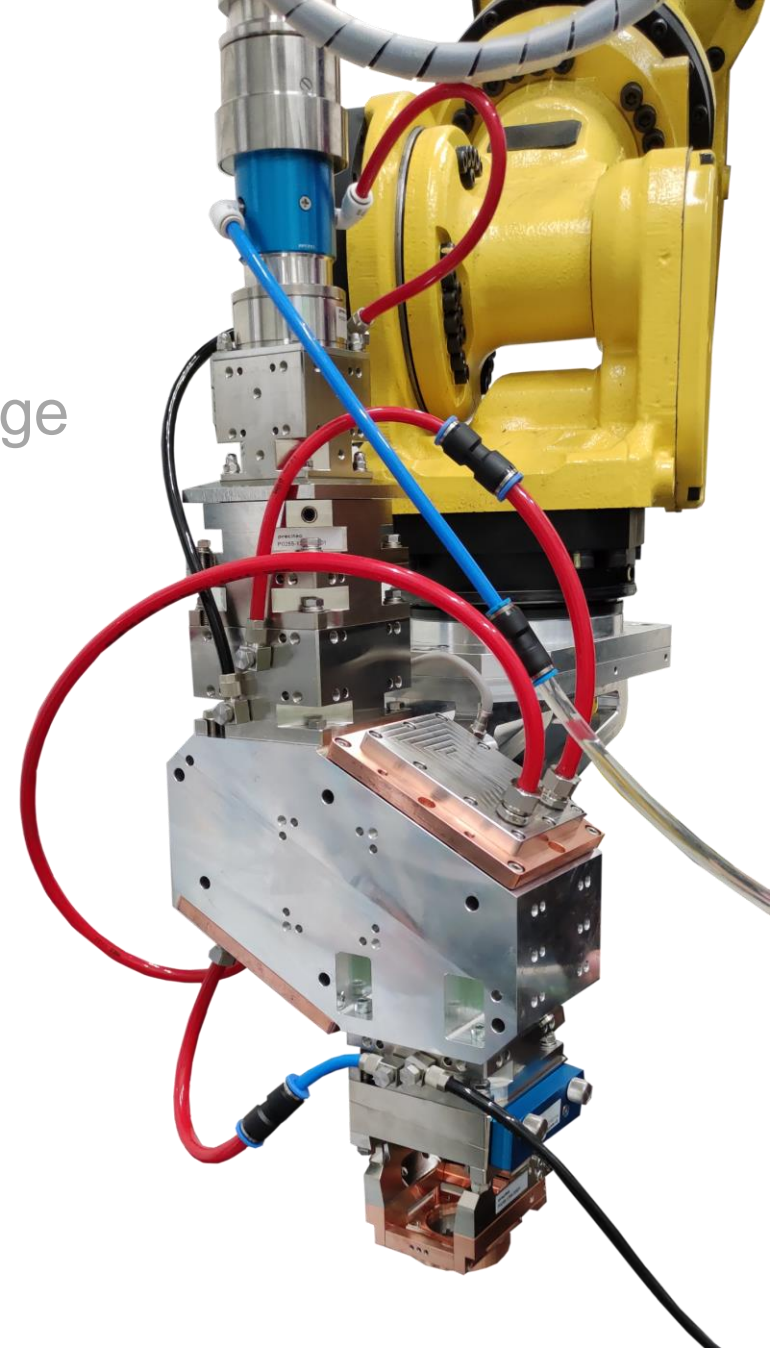


**1/3** cost of  
the total  
solution

**x 1,5**  
process  
window

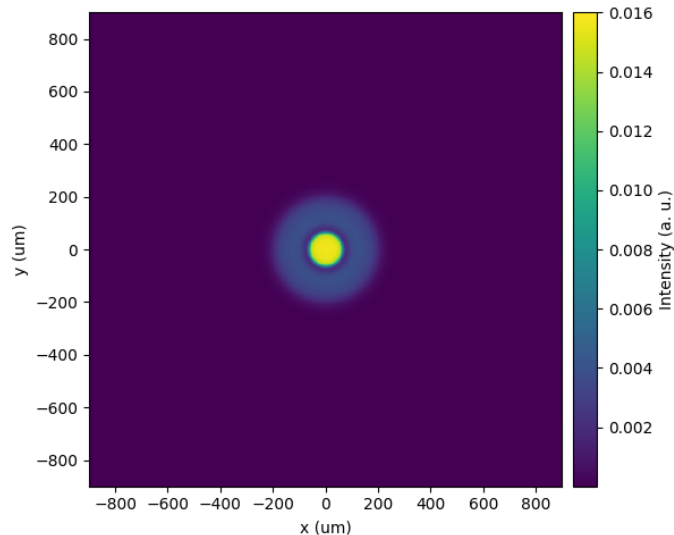
**x 4** Depth  
Of Field

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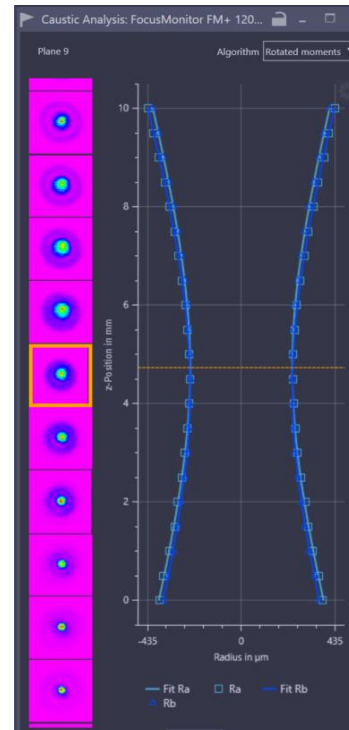


# An intense dot to initiate, a ring to reduce the thermal gradient Process results in Copper

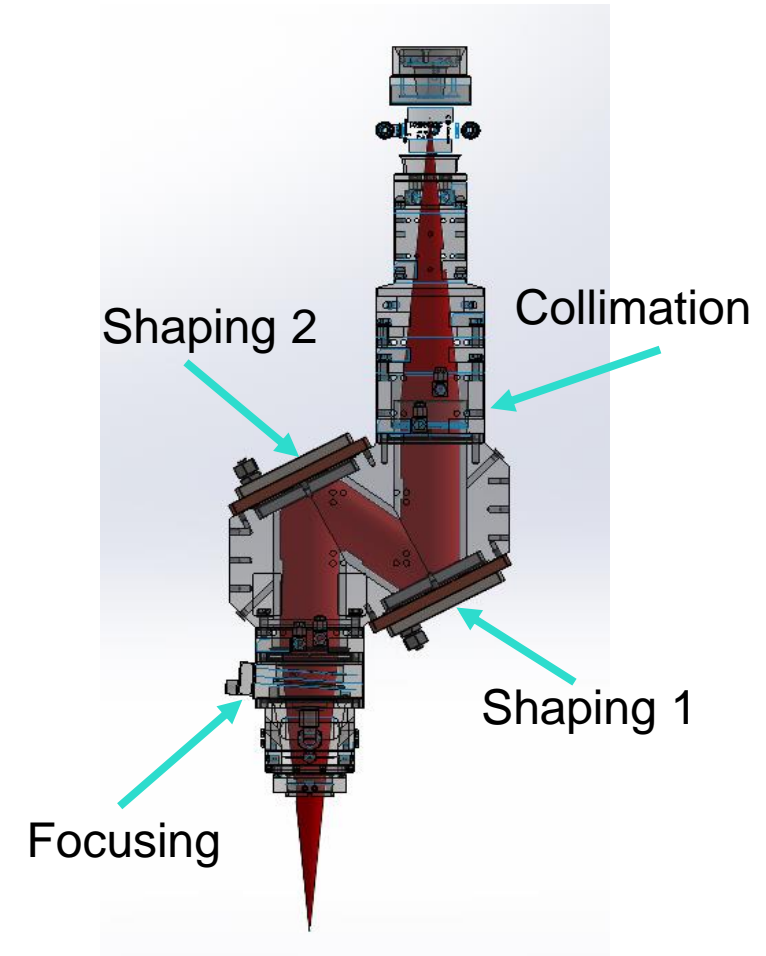
Different configurations were tested by switching the shaping mirrors and/or focusing lenses.



Theoretical profile : the O-Dot shape



PRIMES measurement



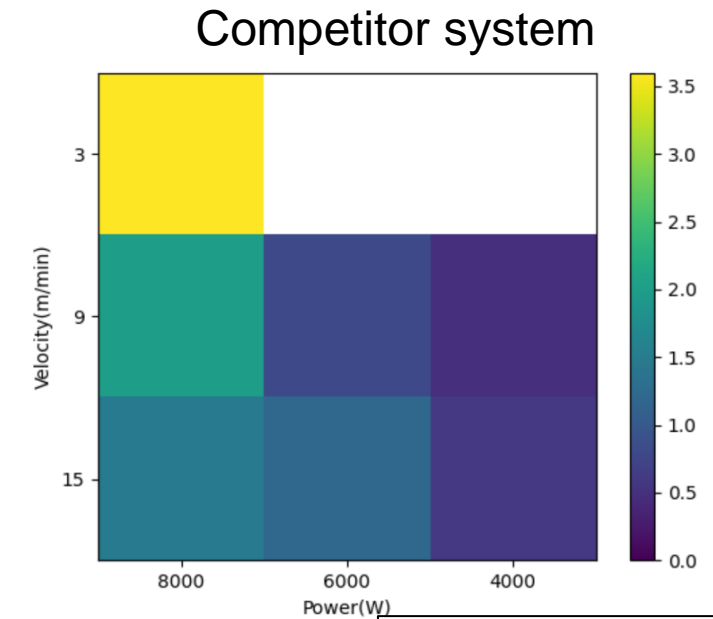
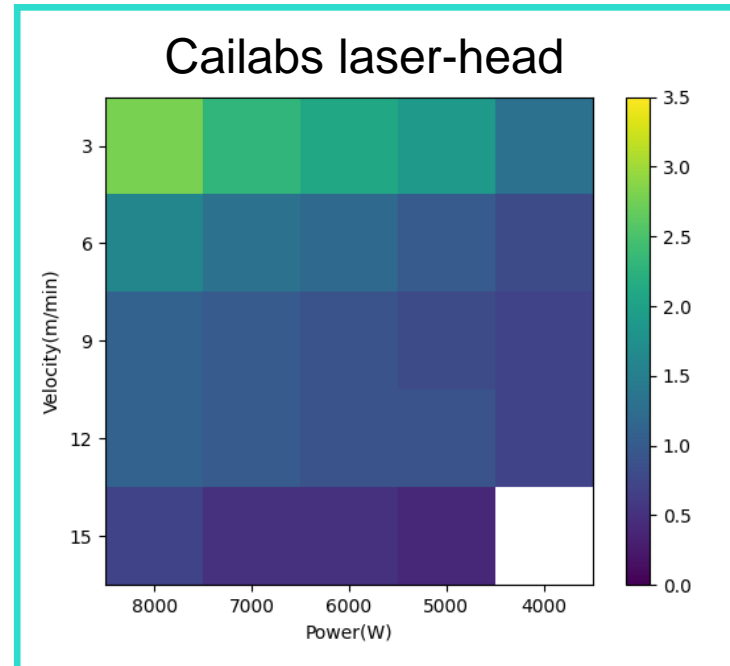
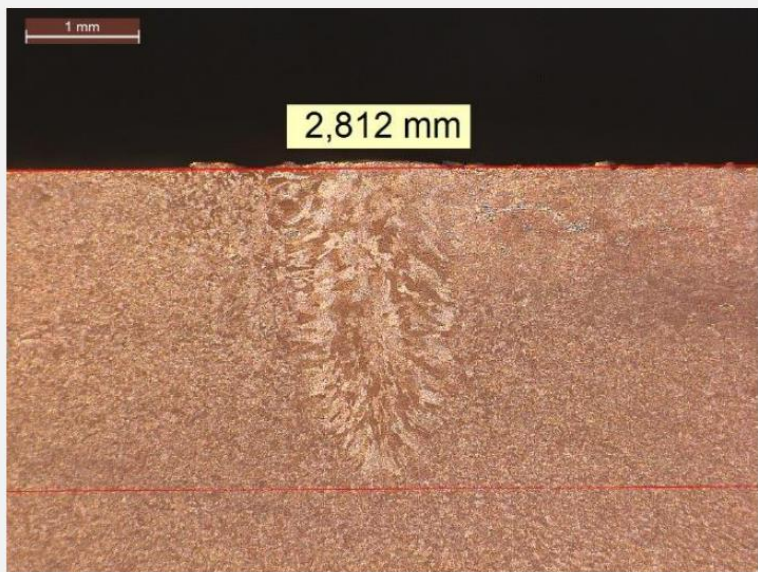
Laser-head principle



# Compliant weld at lower speed than competitor

## Process results in Copper

Process windows : welding speed vs power vs penetration depth (color)



**Legend :**  
*X axis power (4kW to 8kW)*  
*Y axis velocity (3 to 15m/min)*  
*Colorcode penetration depth (mm)*  
*No color : weld not compliant*

- x1,5 larger process window with Cailabs system
- Better performance of Cailabs system at lower speeds

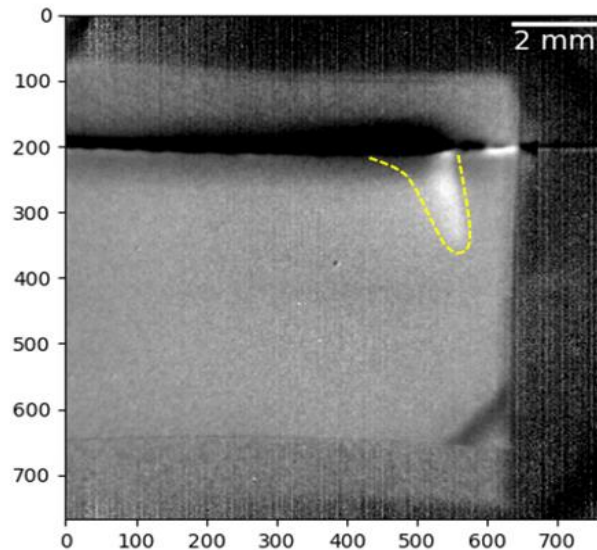


# Stable melt pool during the weld Process results in Copper

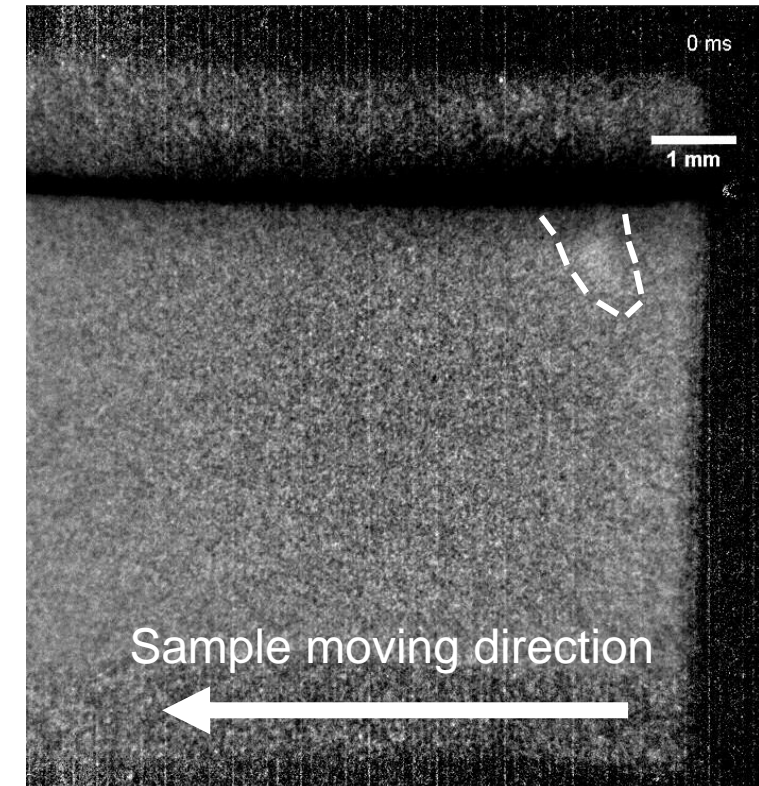
Live X-Ray analysis conclusions :

- **Stable capillary length** over the whole welding time
- No visible pores and ejected material during welding

*Averaged image of the live X-ray video:*



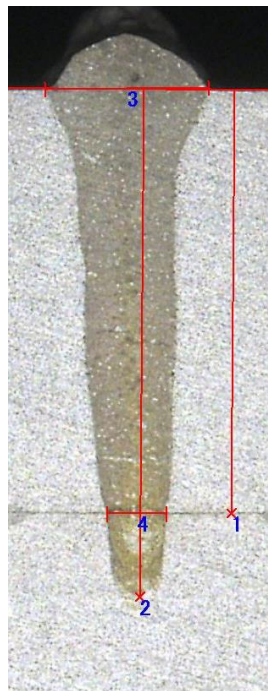
*Cailabs beam-shaper  
15m/min - 8kW*



# Welding speed x3.3 compared to wobbling

## Process result in Aluminum

Welding of **Aluminum** through a **large Field of View Precitec ScanMaster** system with a **Raycus laser**. Welding speed : 20m/min @ 3kW

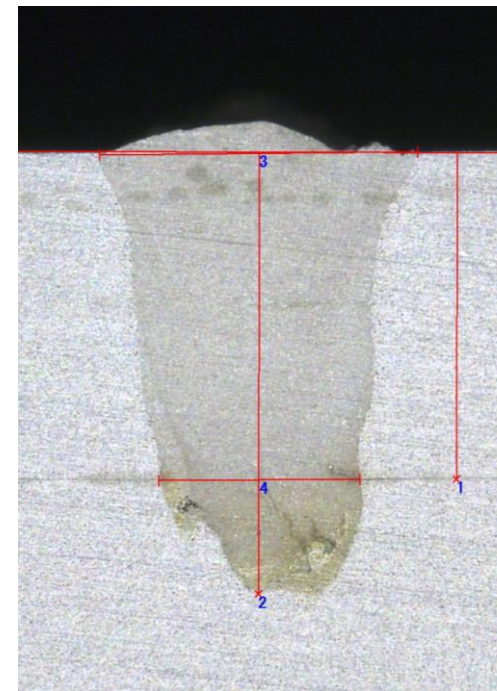


Welding without wobbling  
20m/min @ 3kW

Nr.	Messung	Ergebnis
1	Senkr.Ln	1911.62 um
2	Senkr.Ln	2292.13 um
3	2 Punkte	735.85 um
4	2 Punkte	266.88 um

Anz.

X-Y	Msg
X	
Y	
D	



Welding with wobbling  
6m/min @ 3kW

Nr.	Messung	Ergebnis
1	Senkr.Ln	1916.34 um
2	Senkr.Ln	2594.79 um
3	2 Punkte	1868.22 um
4	2 Punkte	1181.90 um

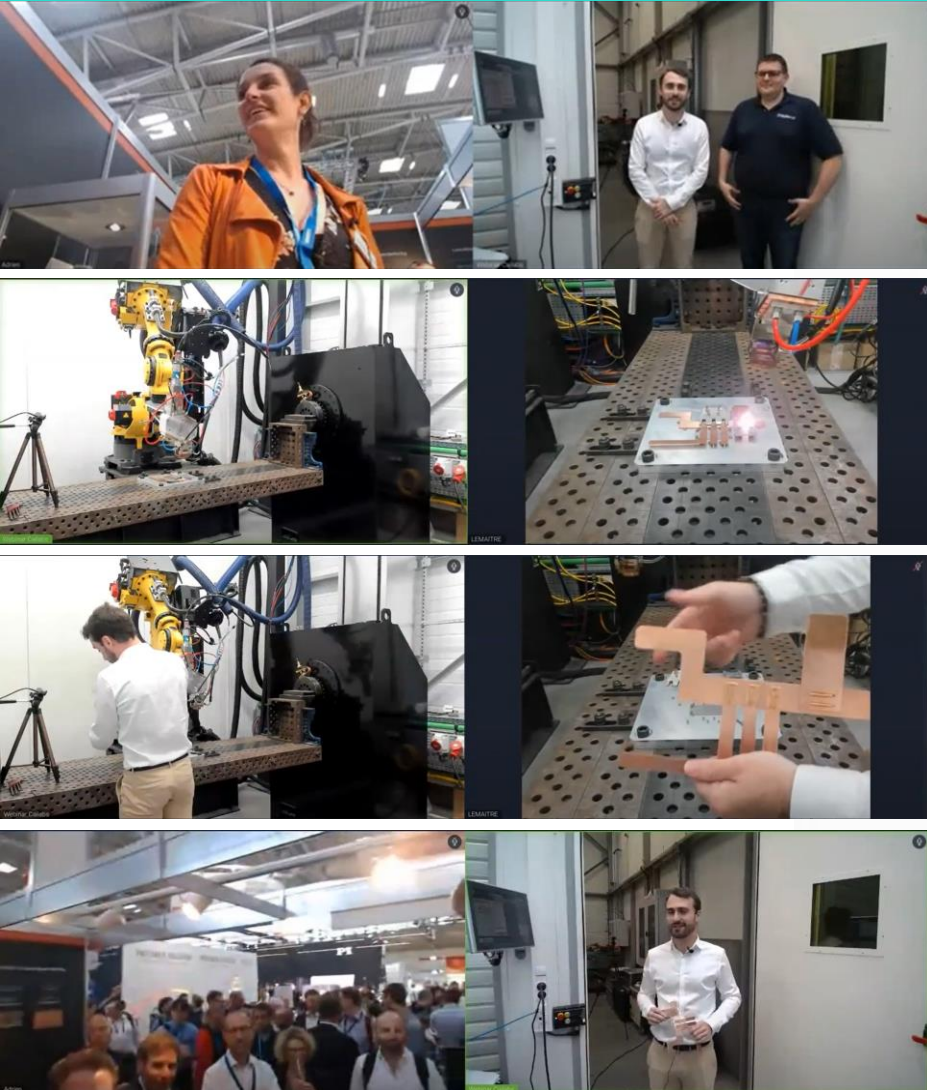
Anz.

X-Y	Msg
X	
Y	
D	

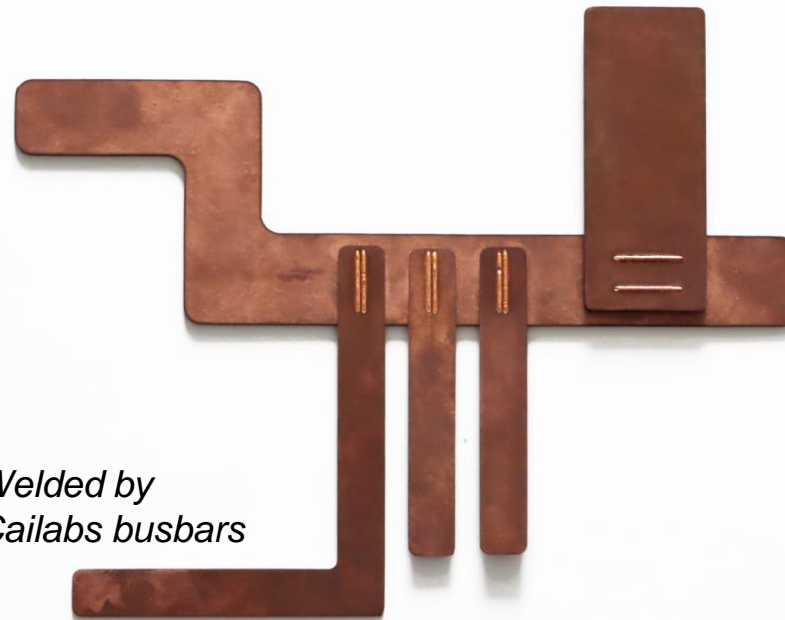


# Reproducible processes

## Process result on real parts – Busbar

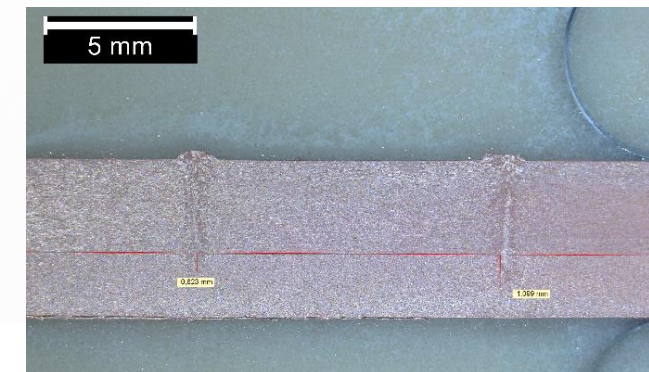


Live busbars Welding demonstration during **Laser World of Photonics** trade show showing the stability and reliability of the process - <https://www.youtube.com/watch?v=su4SDLWJYNk>



*Welded by  
Cailabs busbars*

- Copper ETP
- 3 mm over 2 mm
- 5 m/min @ 8kW
- Compliant with std 13919-2
- Penetration: 1mm in lower part
- Bond Thickness: 0.8mm

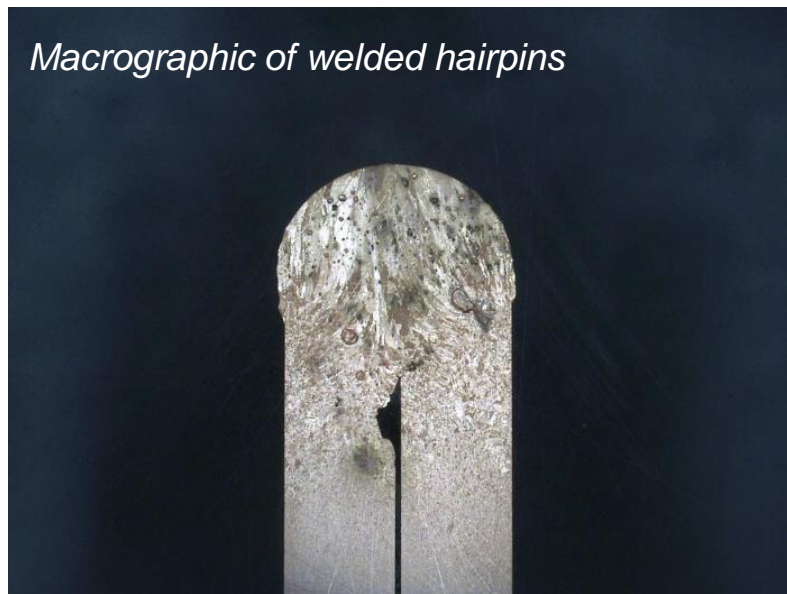


# Copper LBW process results - Real e-mobility parts welding

## Process result on real parts – Hairpins

Welding of **hairpins** through a **large Field of View Precitec ScanMaster system with a Raycus laser 6kW**

Welding speed : 10m/min – 3 circles 1.5mm diameter



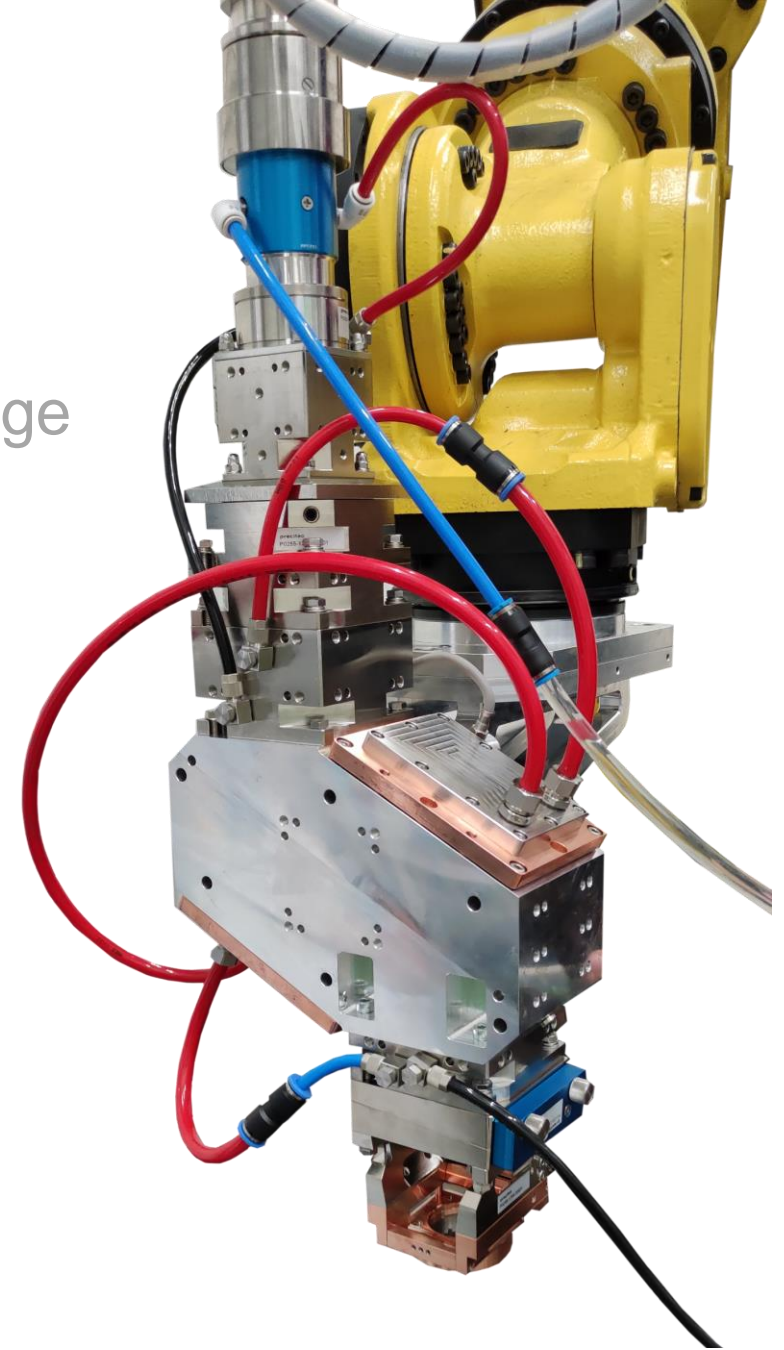




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# A solution compatible with all industrial environments

## Compatibility with all laser brands ...

*Example* : successfull tests with a Raycus 6kW fiber laser



**... to adapt to existing platform and to enable more competitive global solutions (total price /3)**

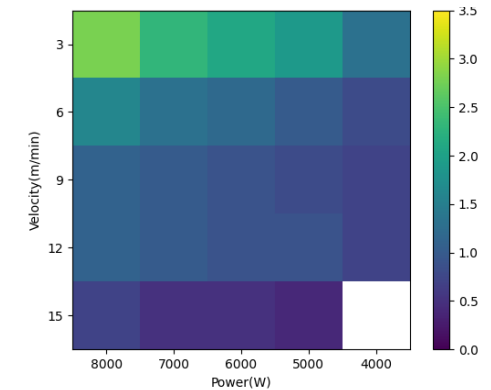
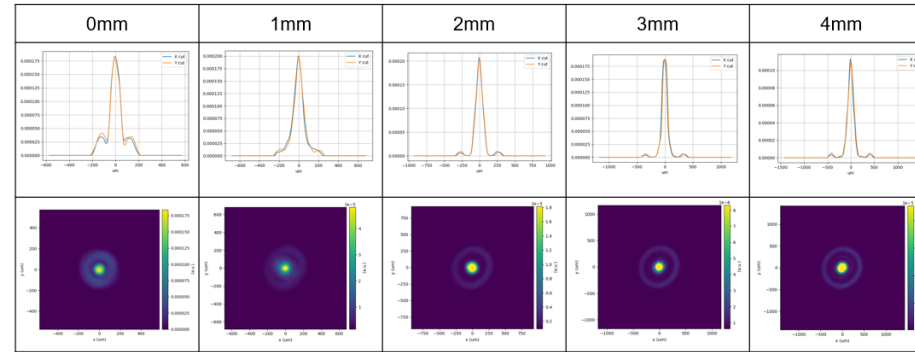
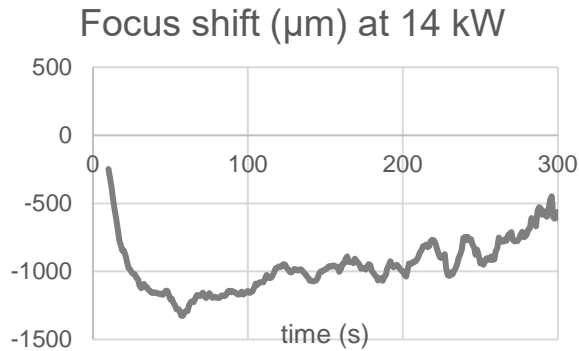
## Compatibility with small/large fields scanners ...

*Example* : successfull tests with Precitec ScanMaster system



**... to weld all type of parts including hairpins at high speed**

# A robust design turning a challenging process into a forgiving one



## High power management...

- Up to 24kW
- /10 focus shift

... to fasten the process and to keep it stable

## Extended Depth of Field...

- Preserved shape over > 8mm
- Preserved performance over the Field Of View of scanner

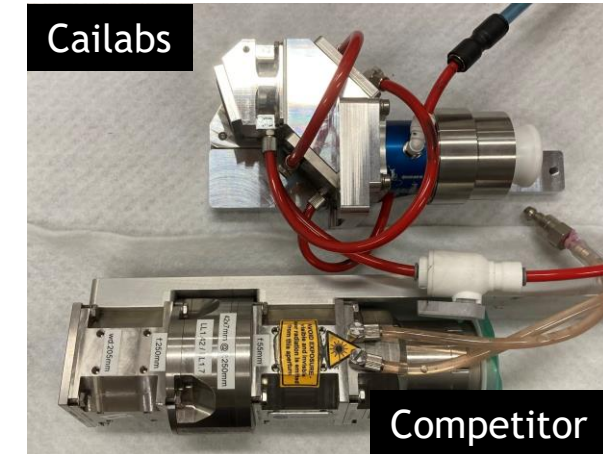
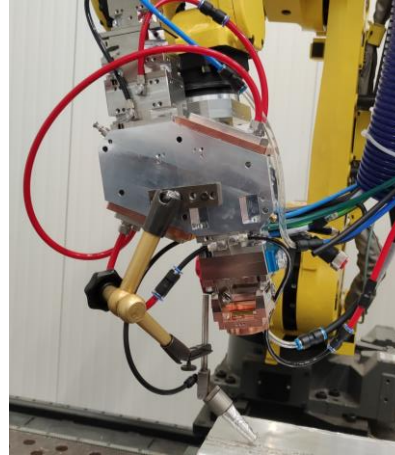
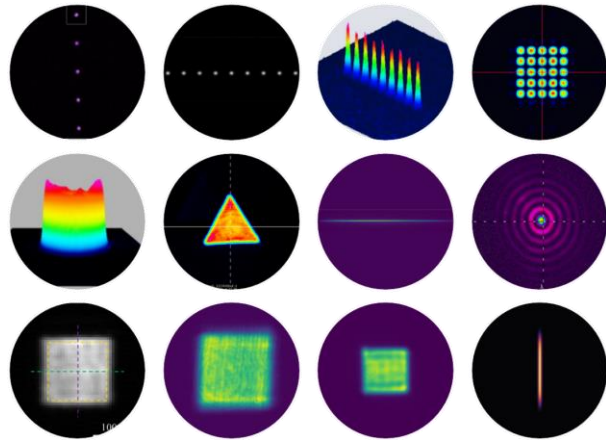
... to reduce the preparation time and to lower the scrap rate

## Large process window ...

- Compliant quality (pores & spatters) at all speed & power
- Good penetration depth

... to reduce the process optimization time and to increase the reproducibility

# A solution flexible enough to be customized to each specific application



## Flexibility of the shape,

- Flexible dimensions (ring and dot dimension adjusted independently...)
- Flexible shape (4 spots...)

## Flexibility of the add-ons,

- Process add-ons : gaz...
- Monitoring add-ons : high-speed camera...
- Safety add-ons : photodiode...

## Flexibility of the footprint ...

- Compact solution
- Customized to fit the machine environment

**... to tailor and to optimize the solution to each application and customer's exact need**

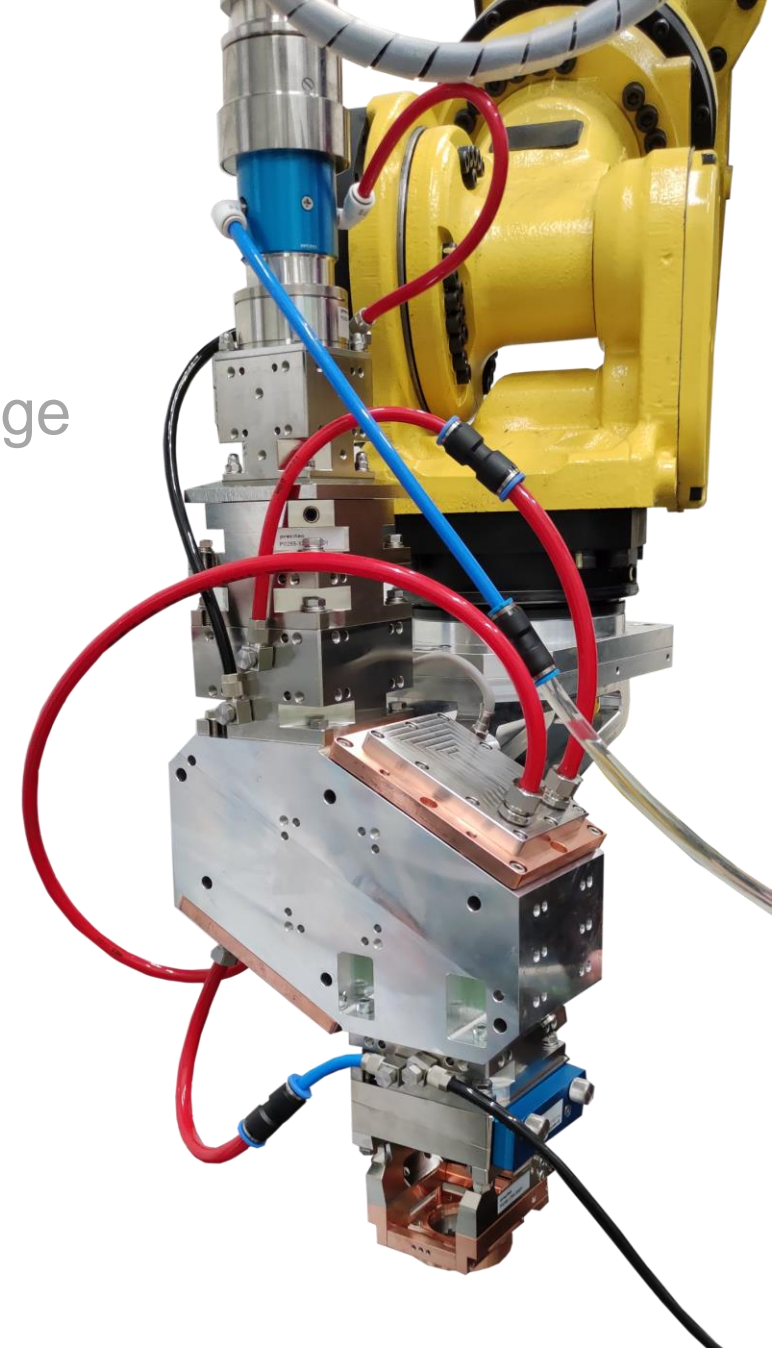




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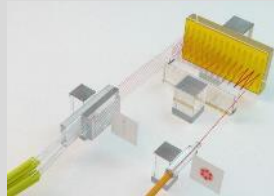
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# Cailabs – A deeptech expert in beam-shaping

MPLC tech  
spin-off from  
University



- MPLC tech derived from decades of quantum optics at **Kastler Brossel Lab**
- New class of beam transforms based on sequence of **spatial phase profiles**
- **Passive with no intrinsic loss and no moving parts**

And turned into  
innovative  
products



**CANUNDA**  
BY CAILABS

3D print faster and  
laser-weld copper  
for car batteries



**AROONA**  
BY CAILABS

Save on local  
networks upgrades,  
both cash & CO<sub>2</sub>



**PROTEUS**  
BY CAILABS

Explore new  
possibilities for the  
future of fiber  
networks



**TILBA**  
BY CAILABS

Deliver high-capacity  
FSOC even through  
the atmosphere



**CUSTOM**

Confidential &  
emerging solutions

Cailabs  
today



Created in  
**2013**



**20+** patent  
families

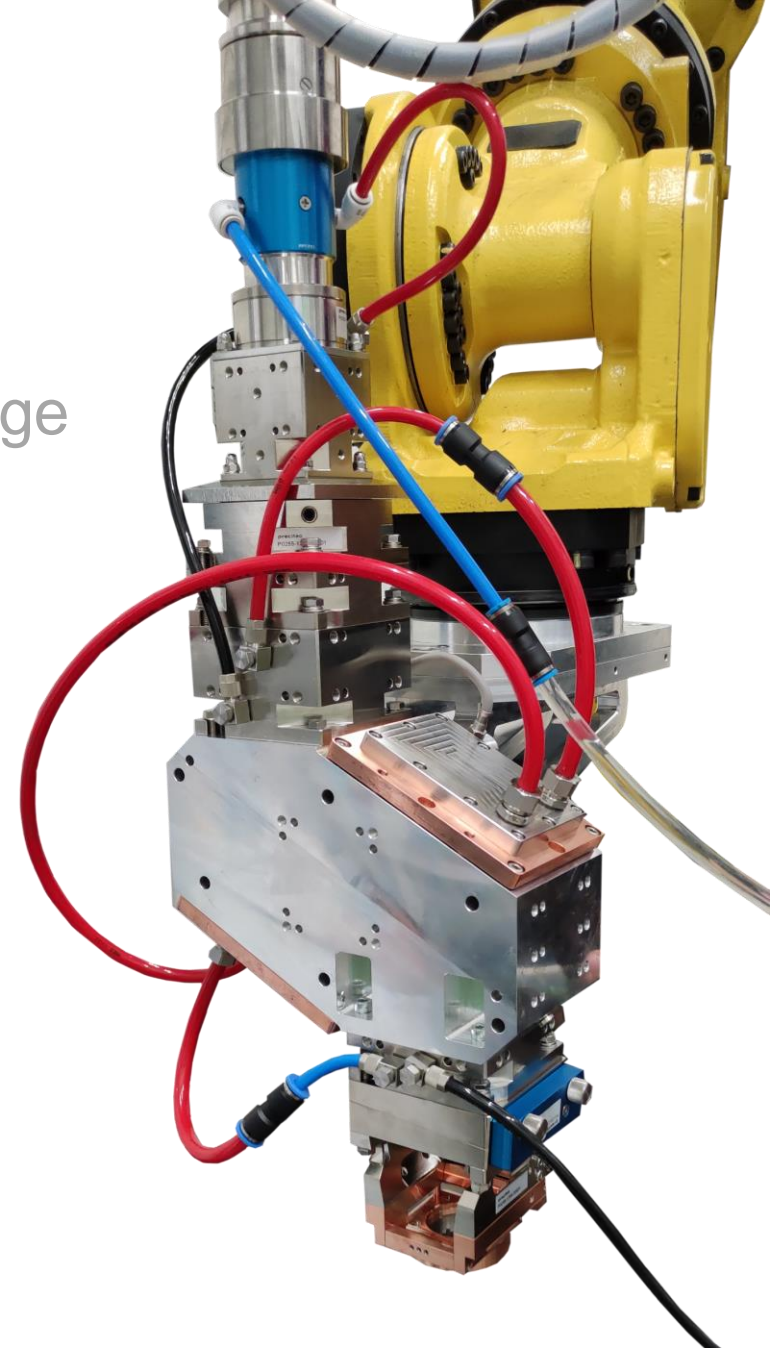


**90+**  
employees

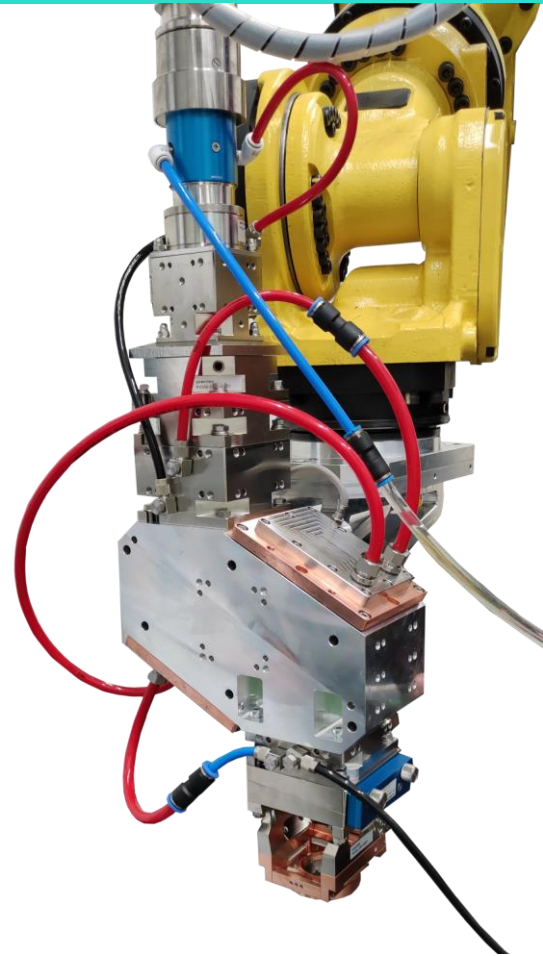


**43 M€**  
raised

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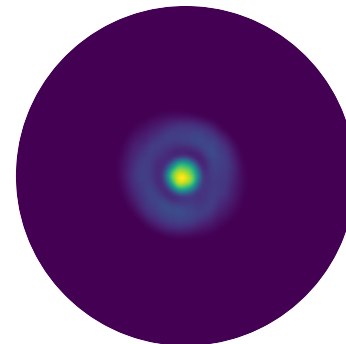
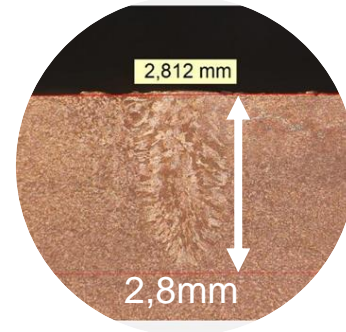
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**1/3** cost of  
the total  
solution

**x 1,5**  
process  
window

**x 4** Depth  
Of Field



# The EPIC questions : What can I do for the others ? What can the others do for me ?



We can **enhance your laser processes** and find **the optimal solution** for your application.

Our main focuses currently : **additive manufacturing** (especially LPBF), **laser welding** (especially e-mobility applications), and **micro-processing**

**We always look for partners :**

- **Sales**
  - OEM / integrators to adress end-users together
  - Connexions to less accessible markets (China, US...)
- **Process development**
  - Give me your challenges !
  - Collaborate to help us with process development – Currently on e-mobility we work or will work soon with Institut Maupertuis, IREPA, Fraunhofer ILT, IFSW, TUM, BLZ
- **R&D projects** : Horizon Europe etc.



**Thank you for your attention**

**[Gwenn@cailabs.com](mailto:Gwenn@cailabs.com)**