# DOE Bipolar Plates Workshop

## Approach to Provide a Metallic Bipolar Plate Module to the Industry

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USCAR Southfield, Michigan
Feb. 14th 2017

Honesty & Integrity

Good Corporate Citizen

Open Communication

Continuous Improvement

# Dana Holding Corporation

- Founded in 1904
- Based in Maumee, Ohio
- 2015 sales: $6.060 billion
- 23,000 people
- Global operations and customers
  - More than 90 major facilities
  - 25 countries on six continents
  - Customers in 130 countries
- 16 R&D centers

# Dana Overview

## Dana Business Units

**Light Vehicle Driveline**

**41%**

**Commercial Vehicle Driveline**

**25%**

**Off-Highway Driveline**

**17%**

**Power Technologies**

**17%**

## Dana Core Technologies

**Driveline Technologies**

**Vehicle Driveline:**
Axles, driveshafts, transmissions, and tire management

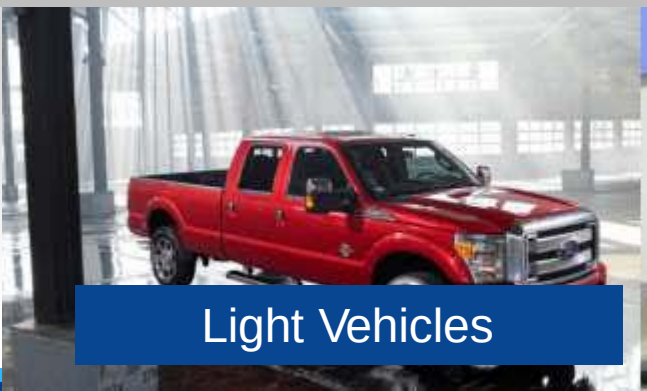
**Sealing Solutions**

**Vehicle Engine and Transmission:**
Gaskets and seals, transmission separator plates, plastic cam cover and oil pan modules, heat shields, and fuel cell plates

**Thermal Management**

**Vehicle Engine and Transmission:**
Transmission and engine oil cooling, battery and electronics cooling, charge air cooling, and exhaust-gas and heat recovery

## End Markets



Light Vehicles

Heavy Vehicles

Off-Highway

DANA VICTOR REINZ® Sealing Products

DANA LONG® Thermal Products

# Fuel Cells

Optimized product solutions meet new fuel-cell system requirements, including bipolar plates and high-performance thermal- and water-management components.

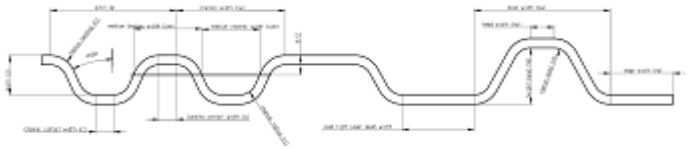
# metallic bipolar plate milestones at Dana :

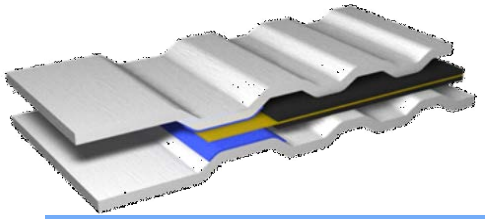
- 2001 Stamped first metallic bipolar plate
- 2002 Joint fist metallic bipolar plate
- 2003 Customer MBPP with seal
- 2004 First progressive die to MBPP
- 2005 Provide coated MBPP to customers
- 2007 First bead seal plate in customer hands
- 2009 Standardization of MBPP product
- 2012 Launch of Serial production of standardized MBPP
- 2014 Launched production using progressive dies

# Key elements for Industrialization

- Design for manufacturing
- Design to cost

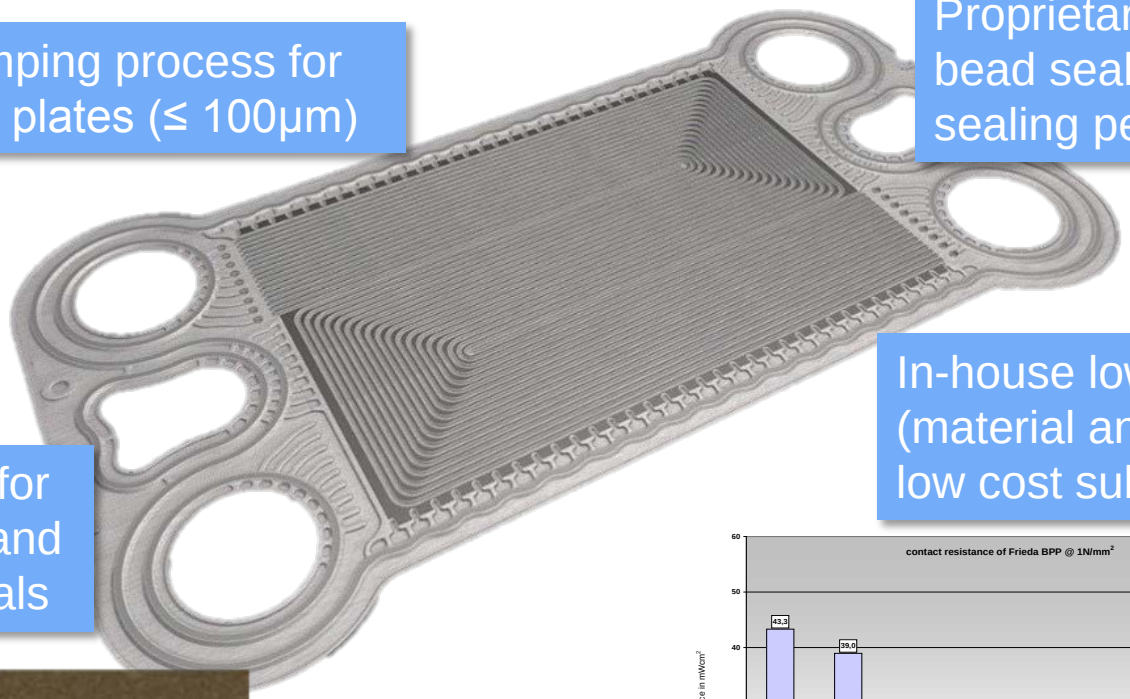
# DANA customizable
# Metallic Bipolar Plate module standard





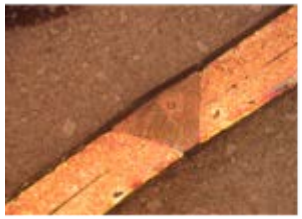
High speed stamping process for micro structured plates (≤ 100µm)

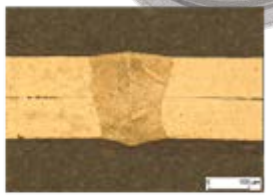
Proprietary, fully integrated bead seal with superior sealing performance

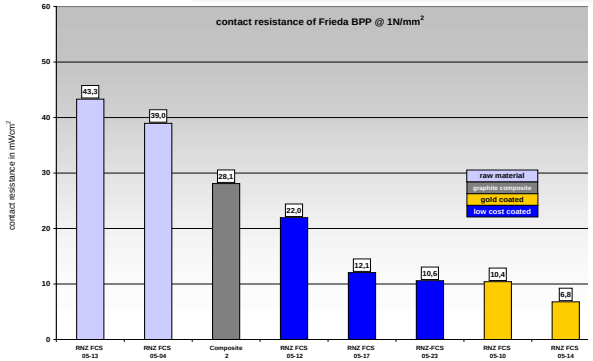


In-house low cost coating (material and process) on low cost substrates

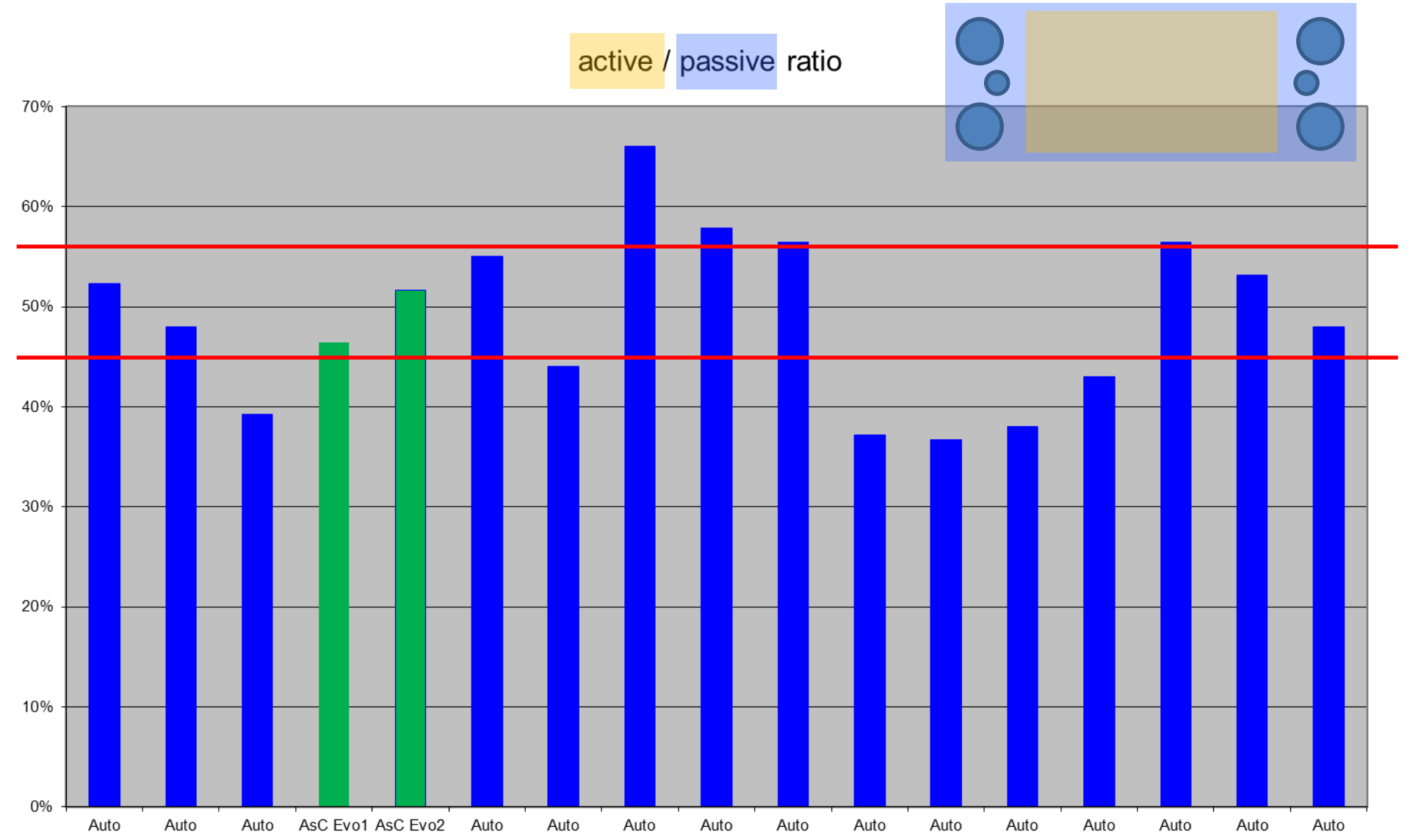
Joining process for micro channels and thin base materials



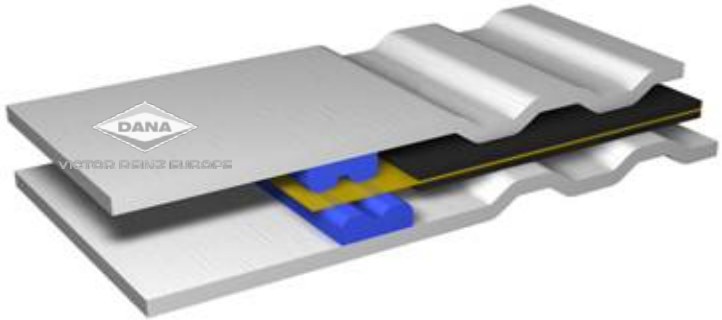


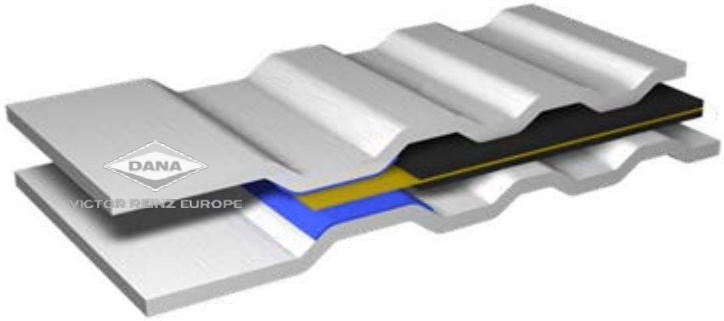


# Active to passive ratio in automotive applications



# Dana's Integrated Metallic Bead Seal

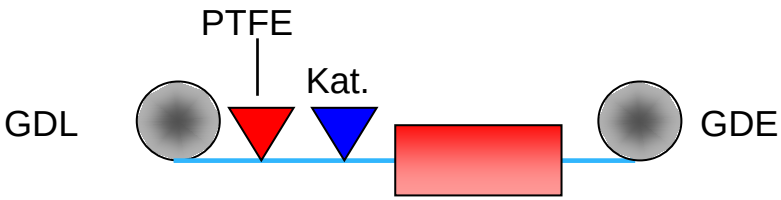


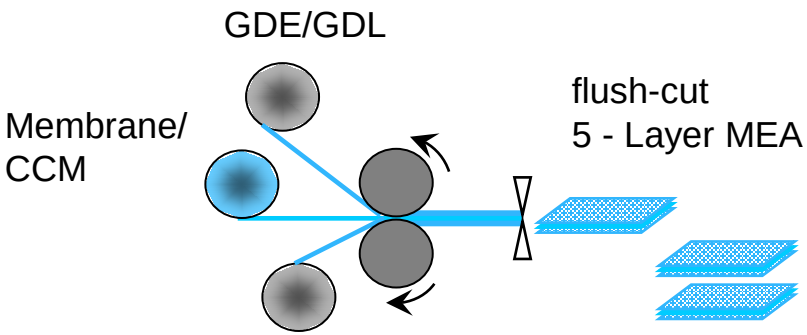

Benefits:

- Sealing is integrated part of the metallic bipolar plate module
- Simultaneous production process of the seal together with the bipolar plate
- Minor gas permeation, due metal
- Durable elasticity, minor creep
- Design flexibility – individual adjustment to plate, port geometry and soft goods
- Simplification of the port flow-field connection
- Simplification of the assembly process

# Sealing approach MEA with a injection molded gasket

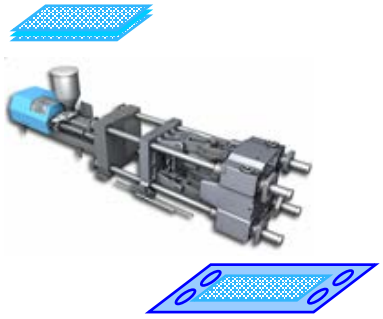



30 000 vehicles per year




Silicone/
rubber

*ca. 120°C*
*35-90 sec.*



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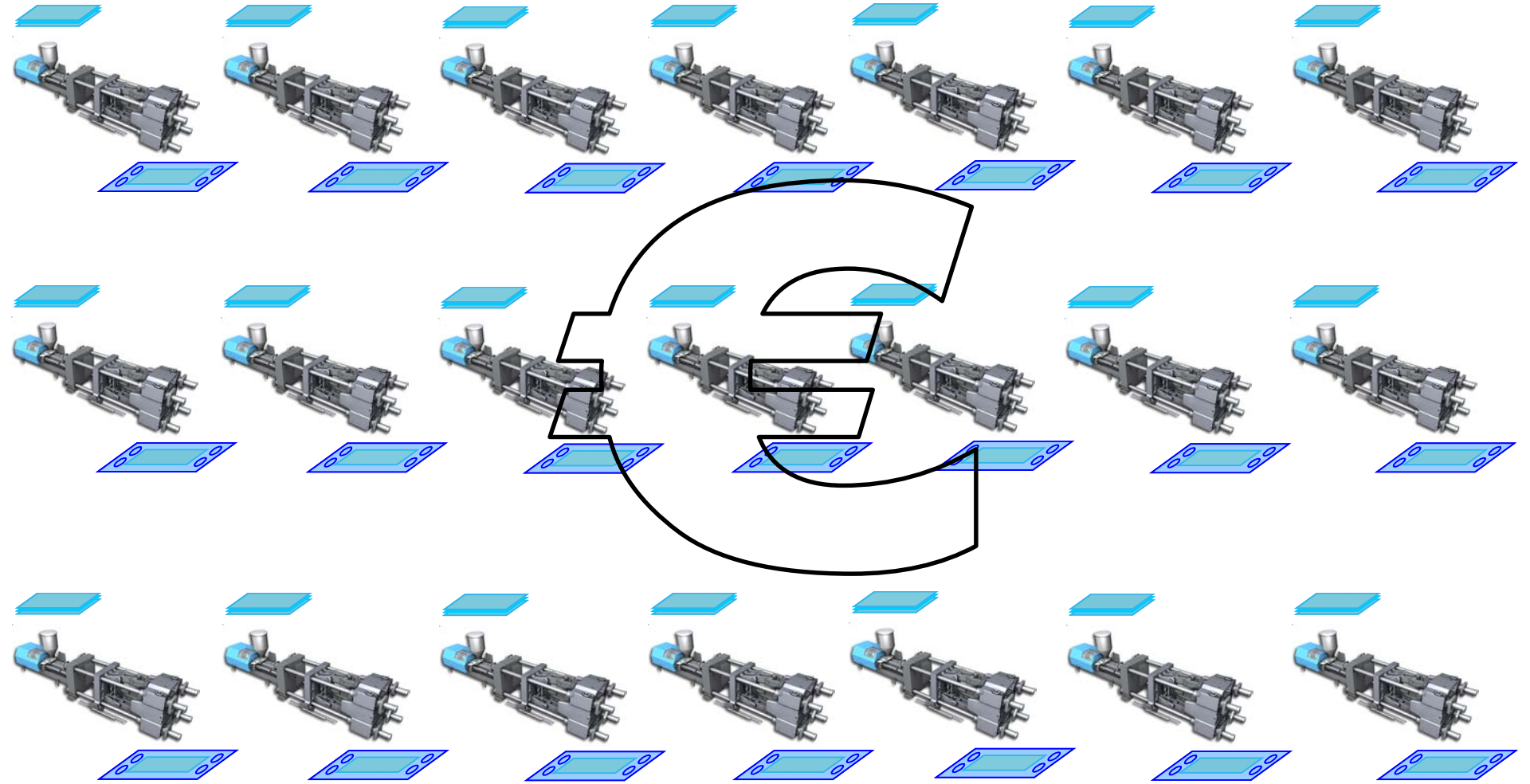
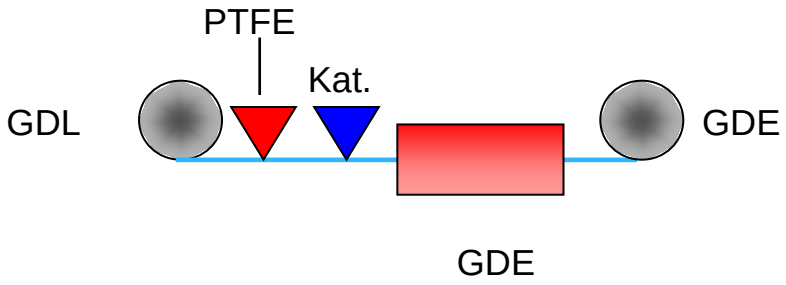
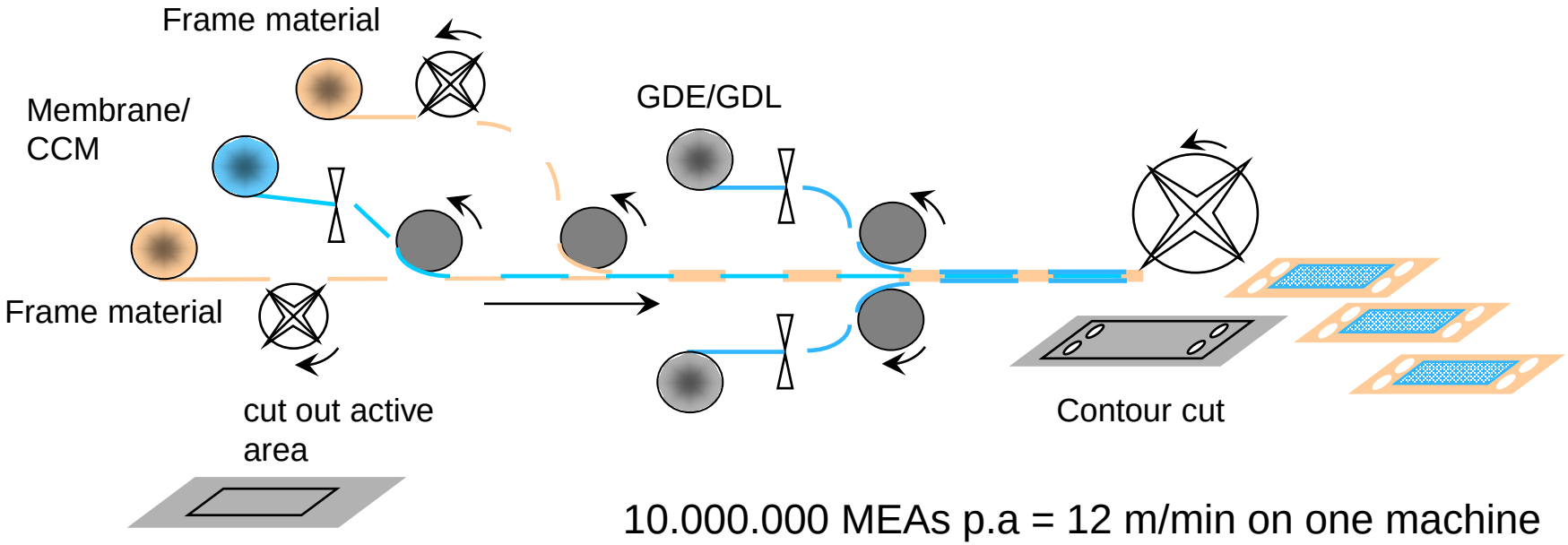
10.000.000 MEAs p.a (45 sec.) = 21 Injection molding cells

# 21 machines to mold seals to the MEA



# Laminated framed MEA for Dana's MBPP module

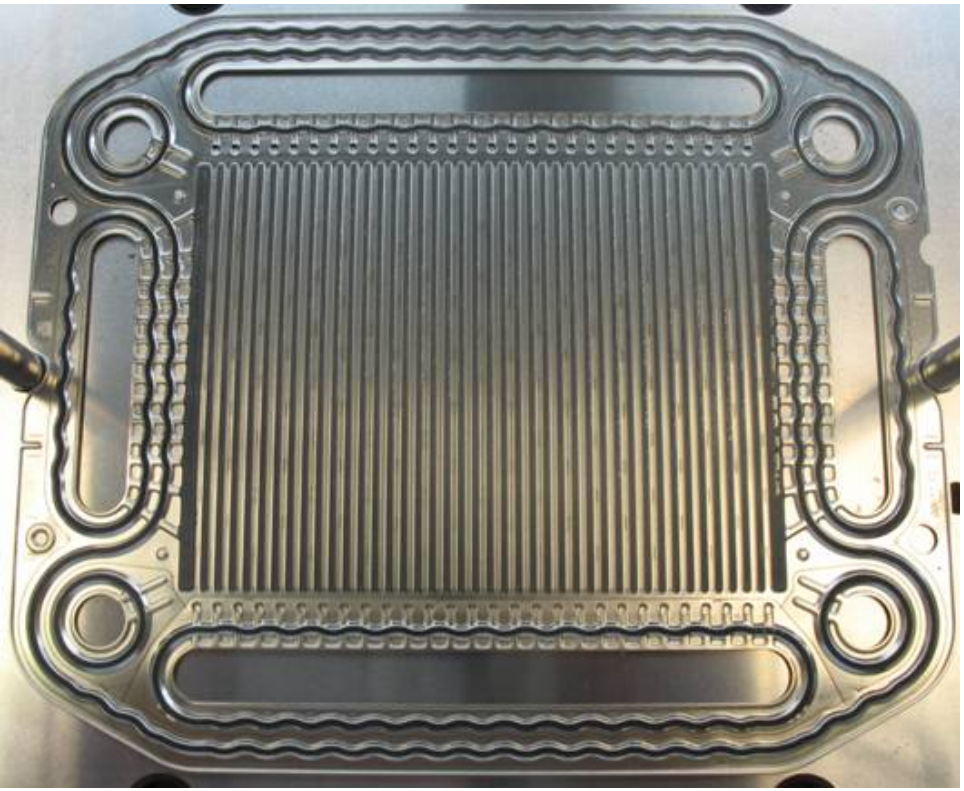


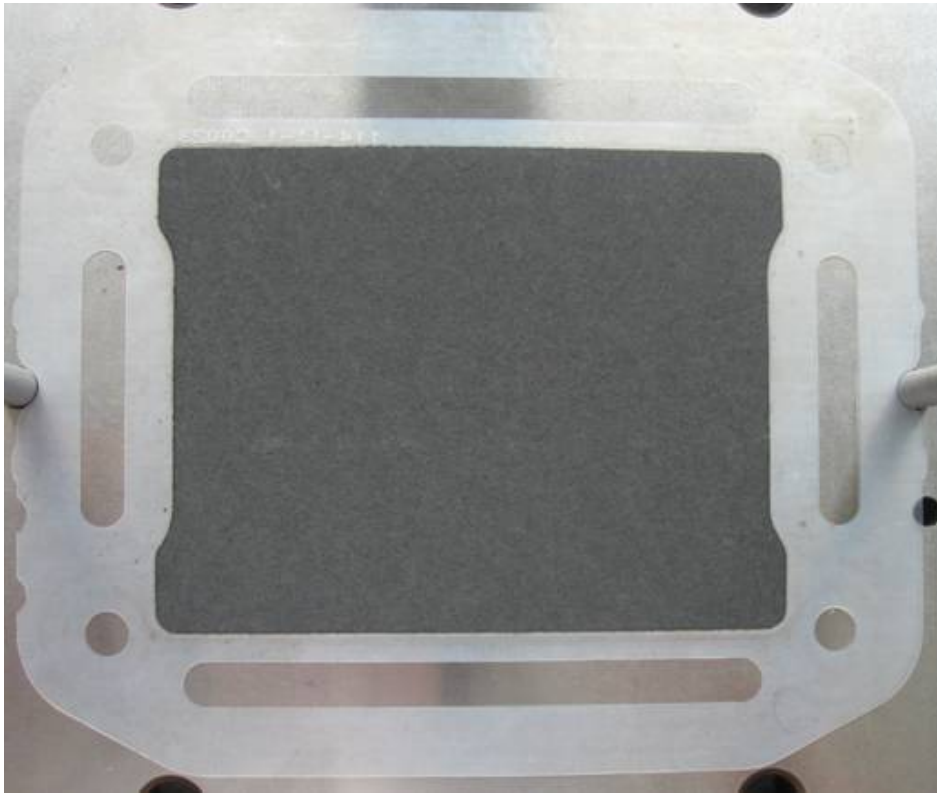

10.000.000 MEAs p.a = 12 m/min on one machine

# Component simplification by integration

Metallic bipolar plate module with integrated seal and low cost coating



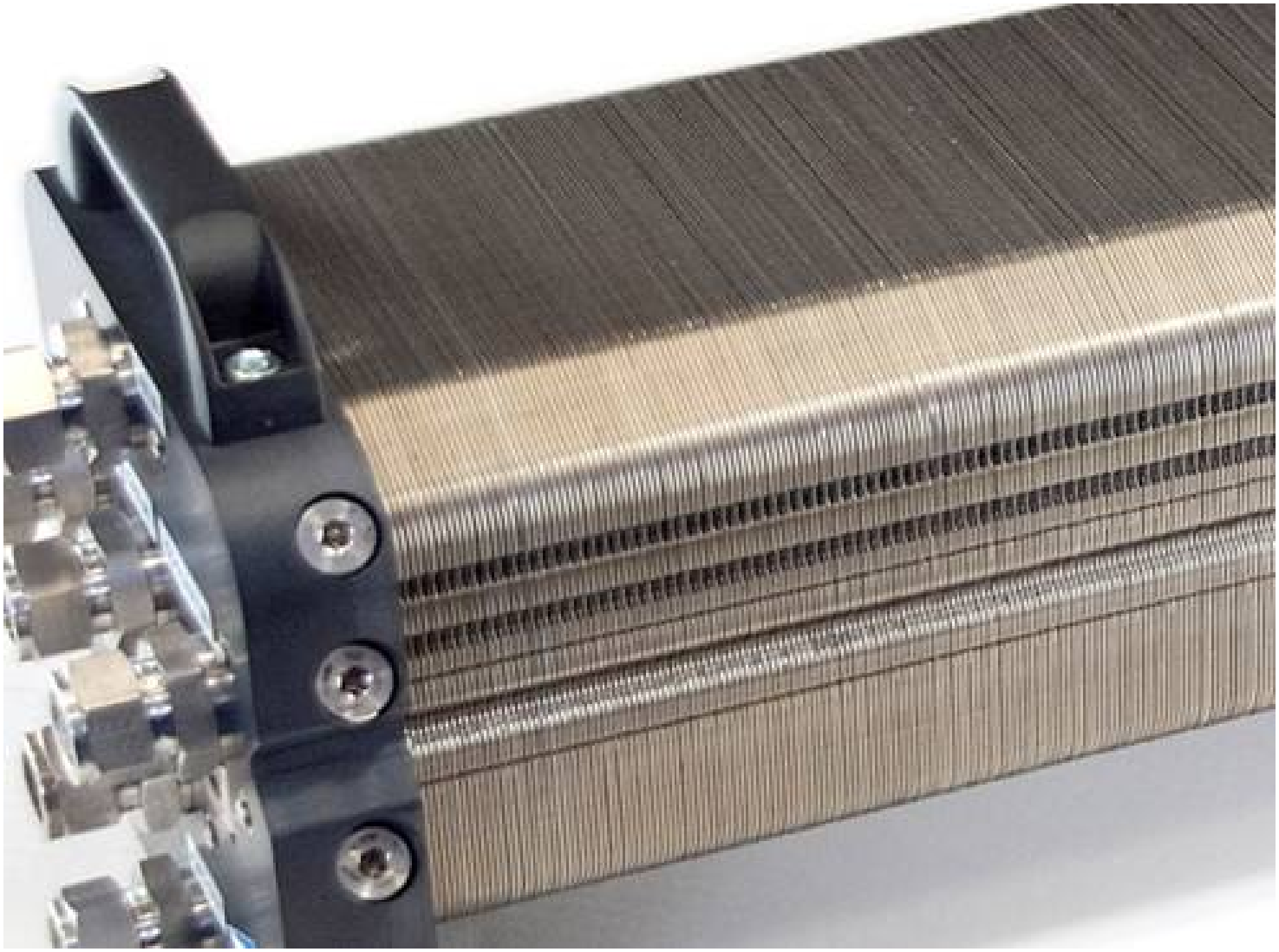
Integrated laminated MEA



# Assembly simplification

## Ideal pick an place structures

# Bead seal demonstrator „Eva XXL“



# Evolutionary steps of AutoStackCore MBPP


3D rendering by PowerCell

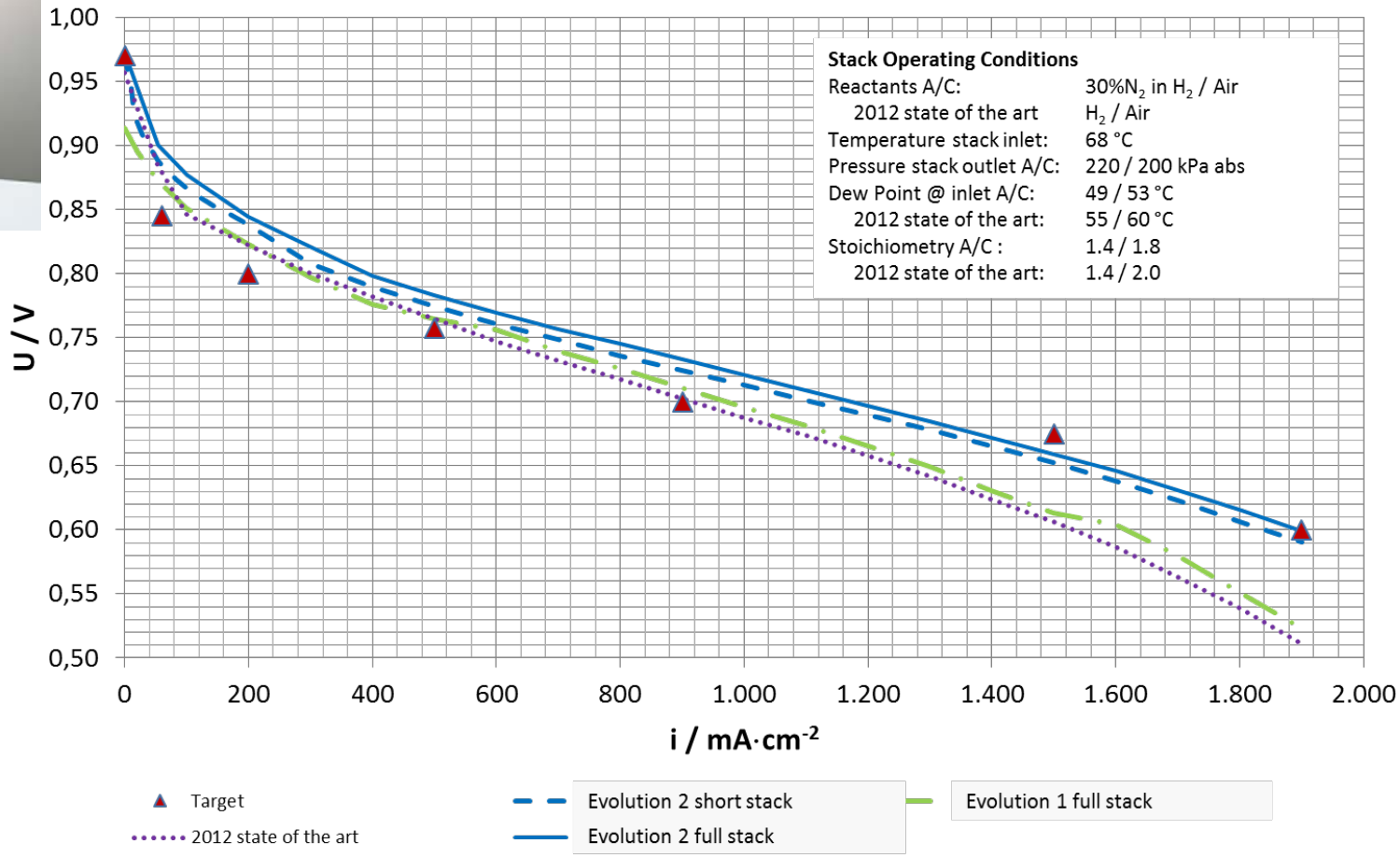
| | | Evolution 1 | Evolution 2 | changes |
|---|---|---|---|---|
| Active area | $cm^2$ | 300 | 300 | |
| Plate dimensions | mm x mm | 410 x 157.6 | 410 x 141.7 | - 10% |
| Active to passive ratio | | 46% | 52% | +6% |
| Cell pitch | mm | 1.2 | 1.0 | -16% |
| Nominal stack power | kW | 95 | 101 | +6% |
| Power density at stack level | kW/l | 2.8 | 3.5 | +12% |

published at AsC public stakeholder meeting 30th Jan. 2017

# Performance of AsC short and full size stacks


Evolution 1

Evolution 2



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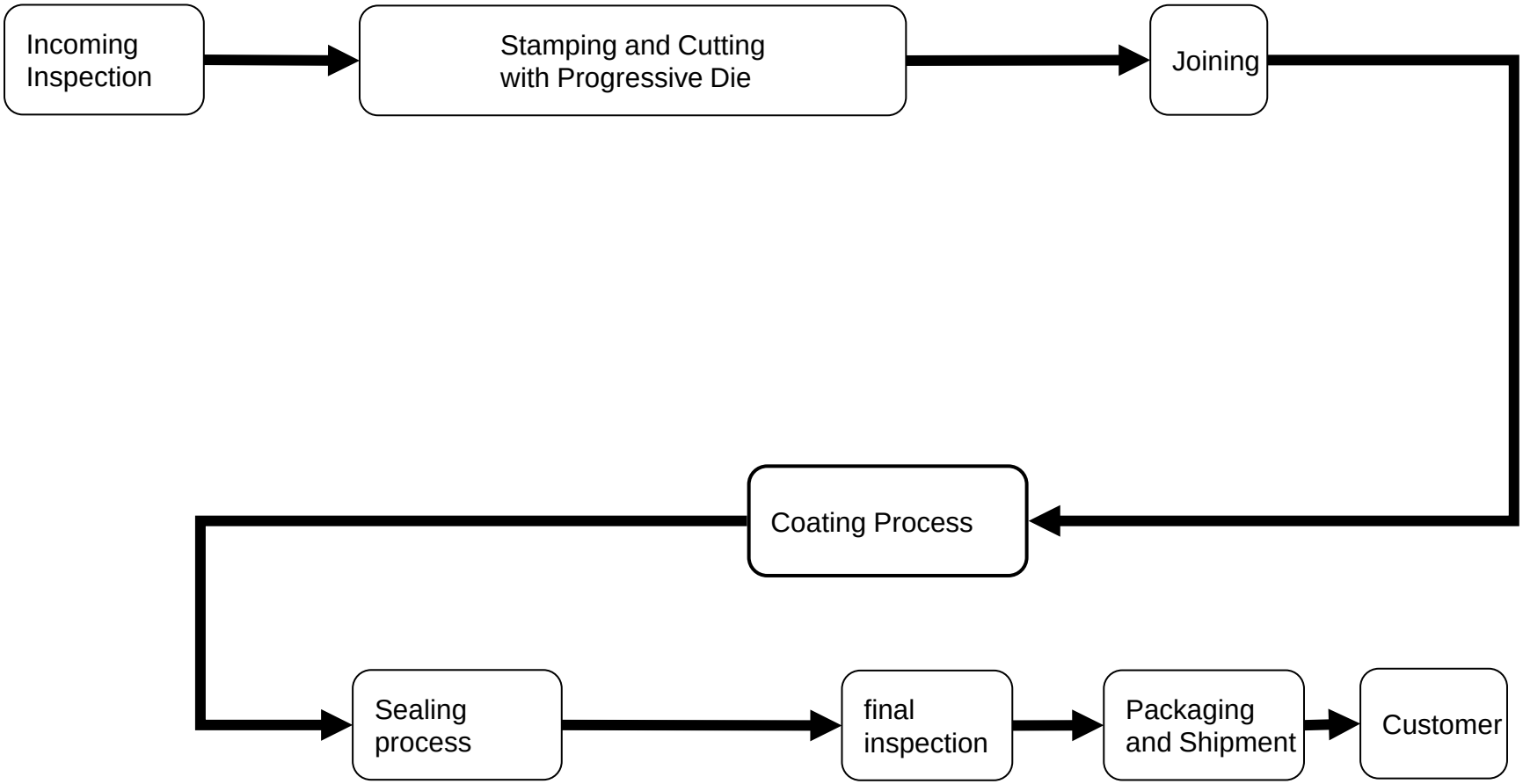
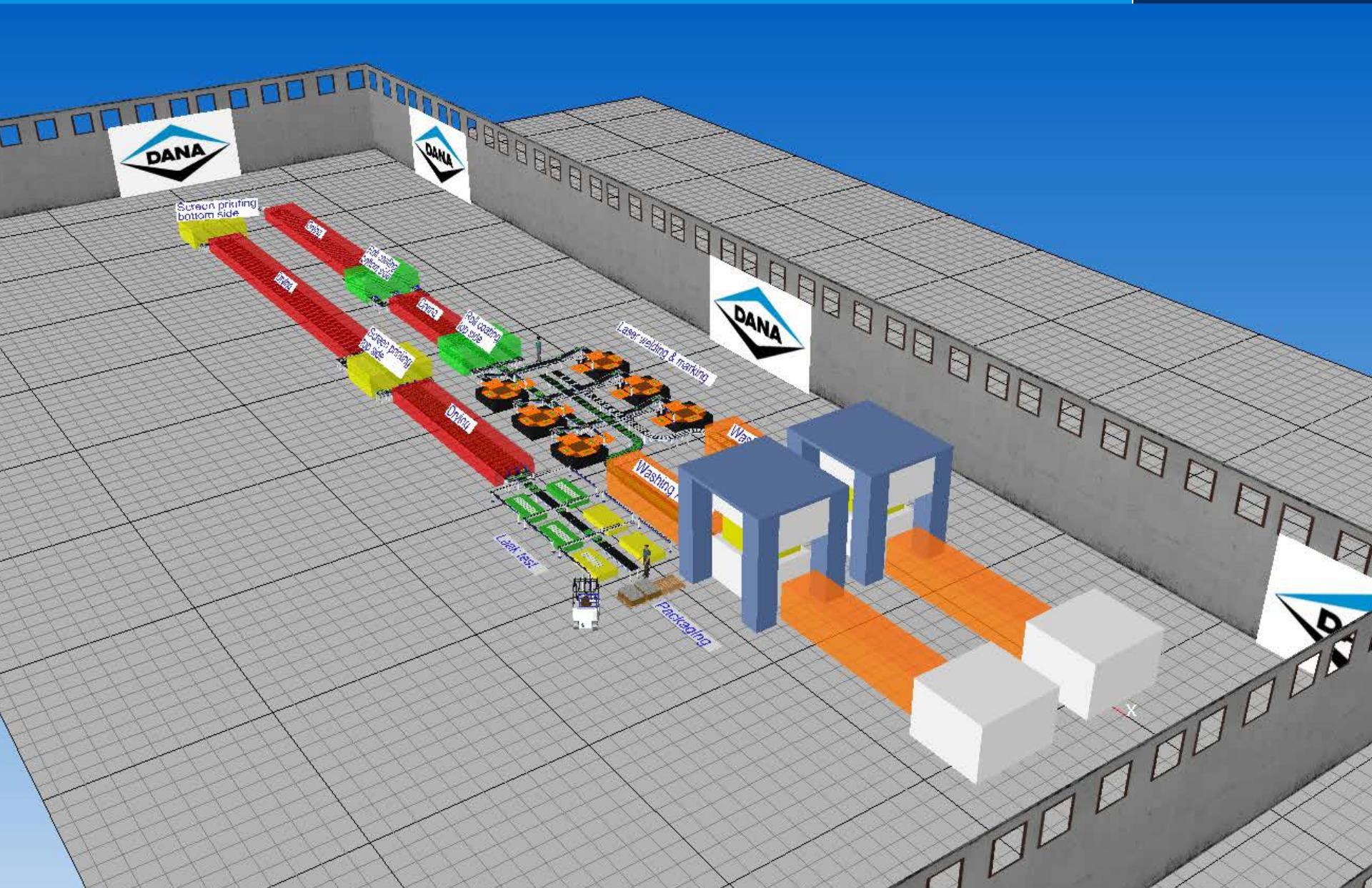
# DANA process flowchart to the standardized metallic bipolar plate module




DANA
Screen printing bottom side
Dryer
Laser welding & marking
Washing
Leak test
Packaging

# Thank you for your kind attention!

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