



FUEL CELLS AND HYDROGEN
JOINT UNDERTAKING

INSPIRE

**Integration of Novel Stack
Components for Performance,
Improved Durability and Lower Cost**



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Programme Review Days 2019

Brussels, 19-20 November 2019

PROJECT OVERVIEW



- Call year: 2015
- Call topic: FCH-01.1-2015 Low cost and durable PEMFCs for transport applications
- Project dates: 01/05/2016 – 31/10/2019
- % stage of implementation 01/11/2019: 100 %
- Total project budget: 6,877,870 €
- FCH JU max. contribution: 6,877,870 €
- Other financial contribution: [0 €]
- Partners: JM, BMW, DANA, SGL, CNRS Montpellier, TUM, TUB, IMTEK, VTT, Pretexo



PROJECT SUMMARY

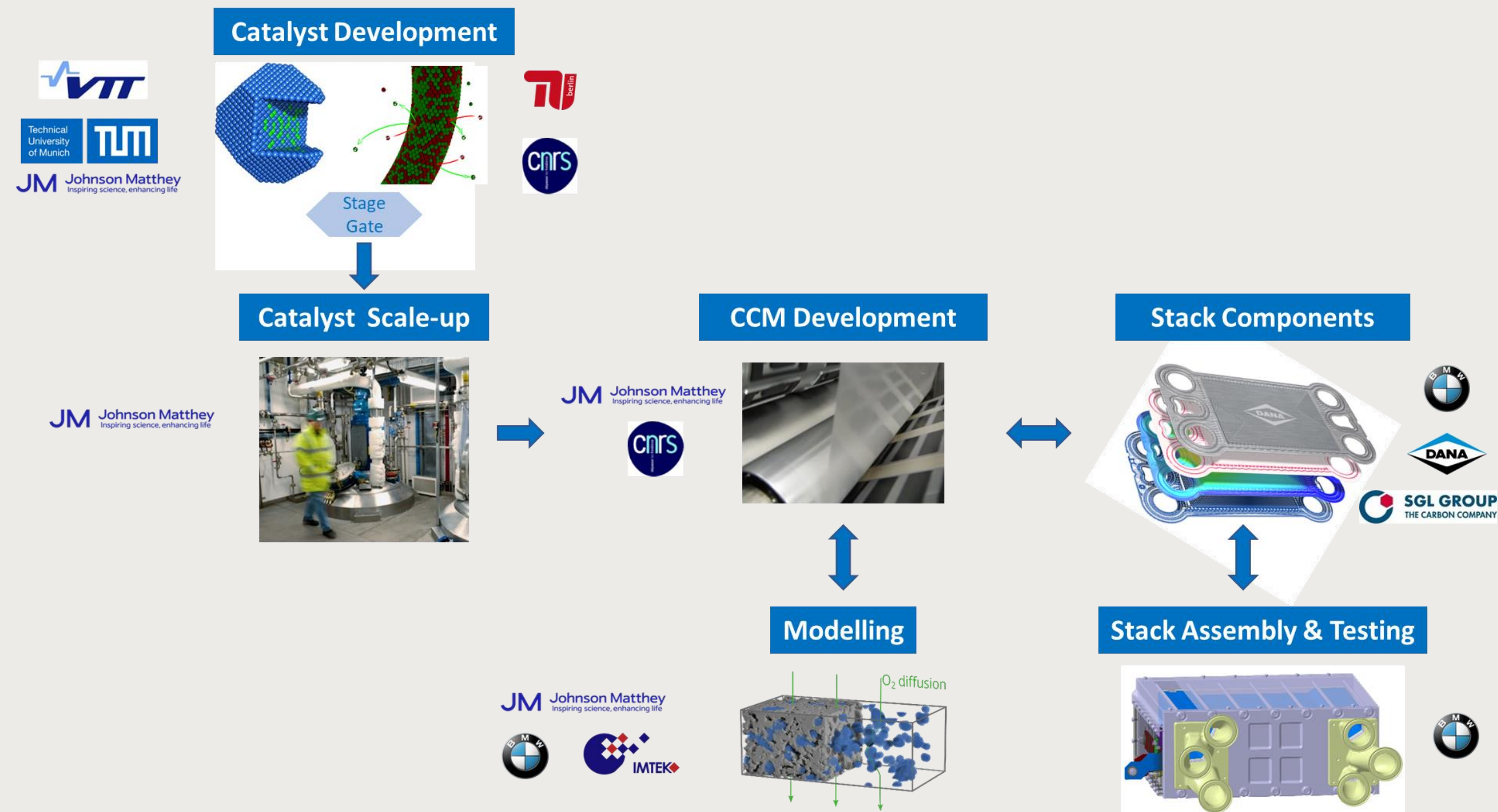


- **INSPIRE:** Integration of Novel Stack Components for Performance, Improved Durability and Lower Cost
- **Key objectives:**
 - Beginning of life (BOL) power density of **1.5 W/cm² at 0.6 V**
 - 6,000 hours operation with less than 10% power degradation
 - Stack production cost below 50 €/kW for 50,000 units per annum
- Global positioning vs international state-of the art
 - **Stack power density >4.8 kW/L** at 170 kW peak power vs. Mirai 3.1 kW/L, AutoStack-CORE 4.1 kW/L (all including housing)

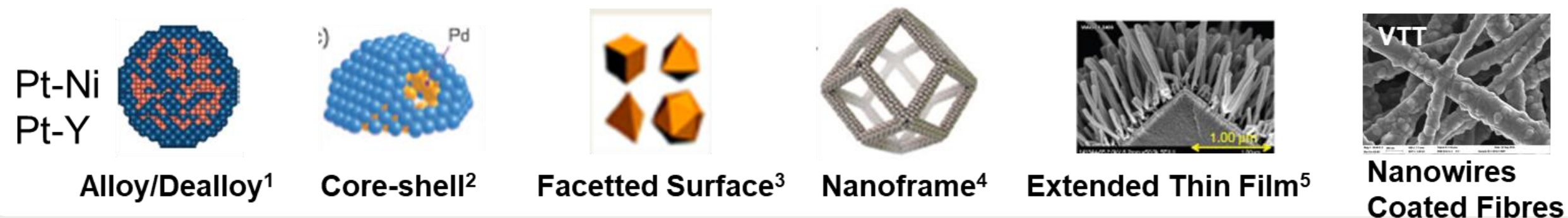


PROJECT SUMMARY – TECHNICAL APPROACH AND ACHIEVEMENTS

- INSPIRE has developed and integrated advanced and critical PEMFC stack components into fuel cells for **large-scale automotive fuel cell commercialisation** in an industrially-relevant environment at TRL6.



PROJECT PROGRESS/ACTIONS – Catalyst Development



Achievement to-date

0.2 A/mg Pt

0.44 A/mg Pt

0.6 A/mg Pt

25%

50%

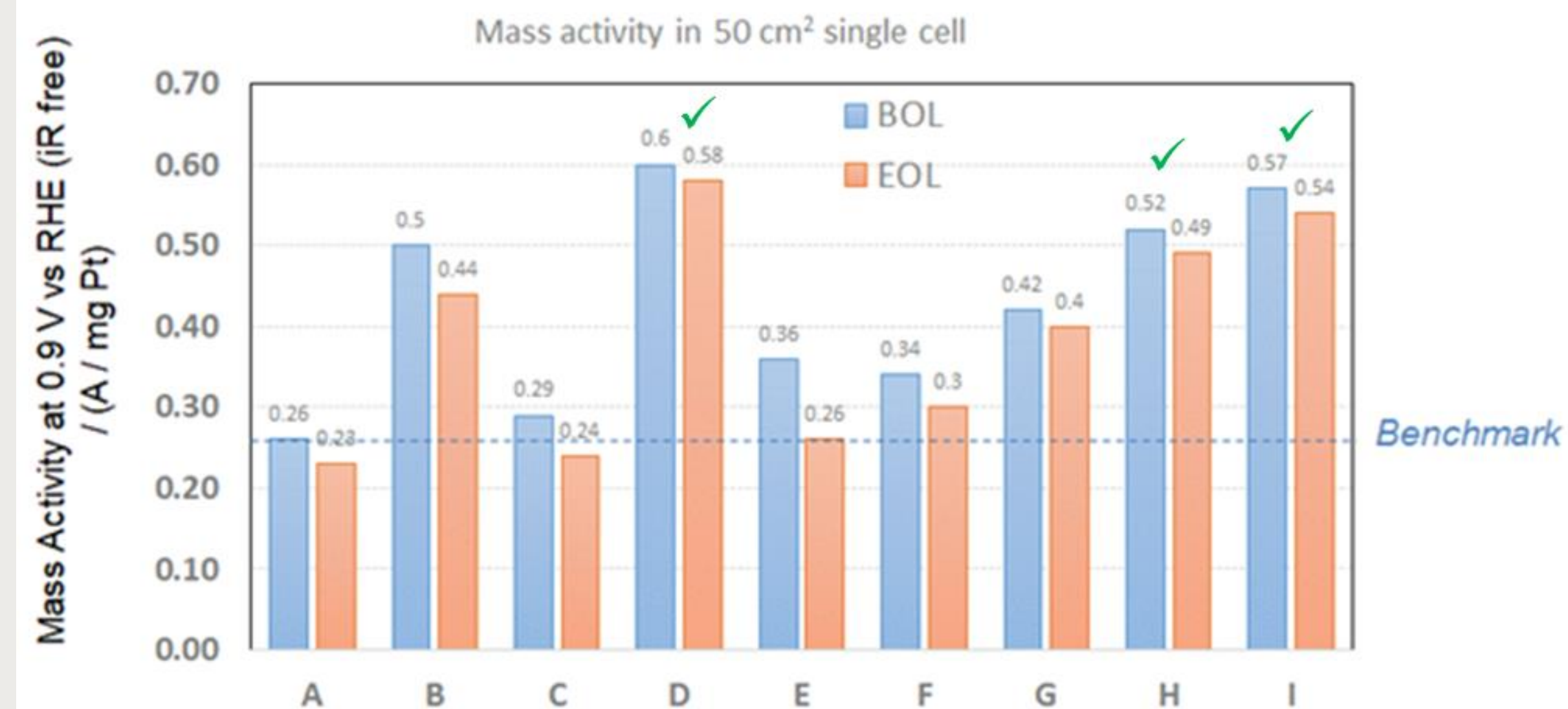
75%

Targets:

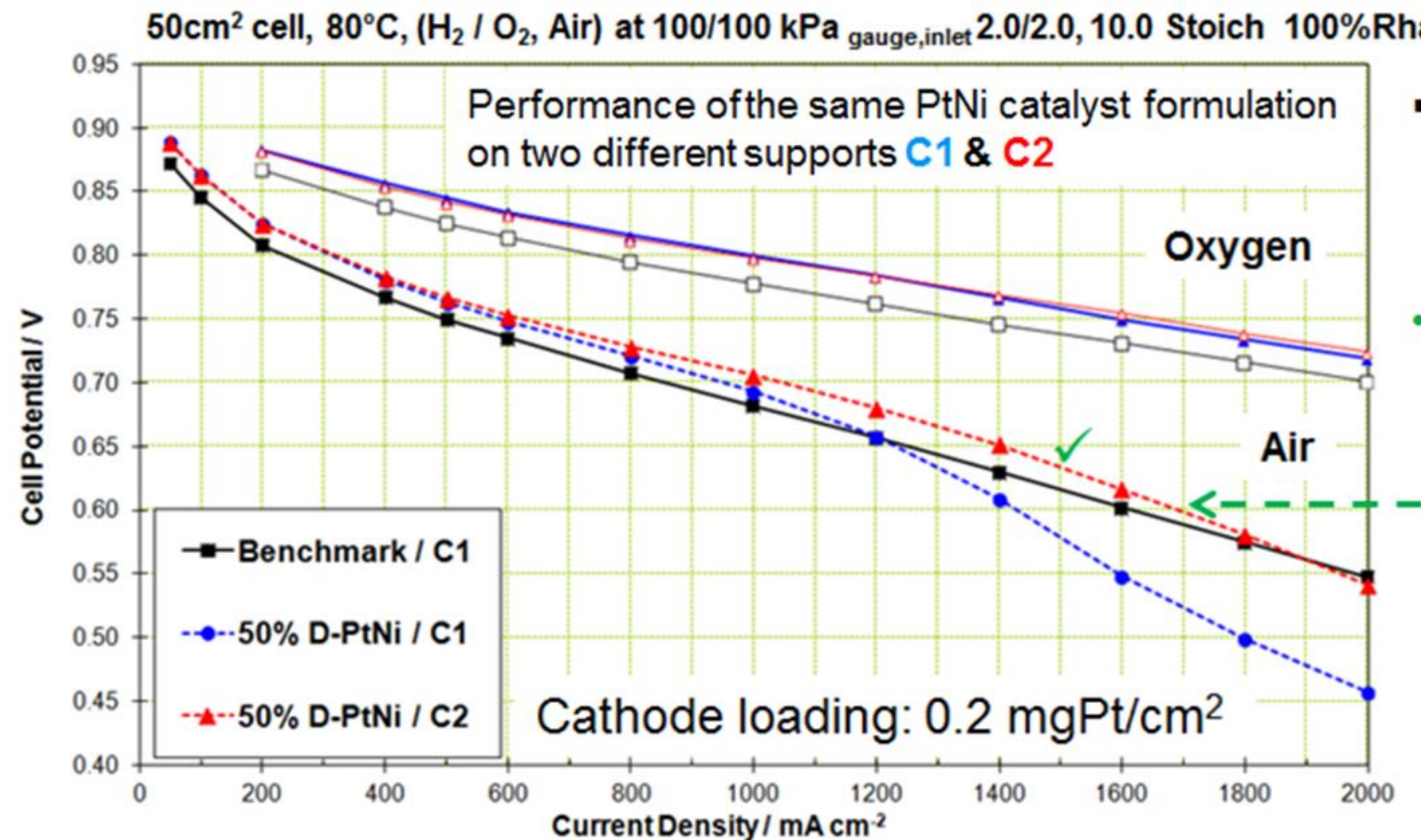
- Mass activity of 0.6 A/mg Pt
- Power density within 10% of that of SoA at 1.5 A/cm²
- Catalyst scale-up to kg batches
- SoA 2016: 0.44 A/mg Pt at lab scale
- MAWP mass activity target for 2020 of 0.6 A/mg Pt

Achievement:

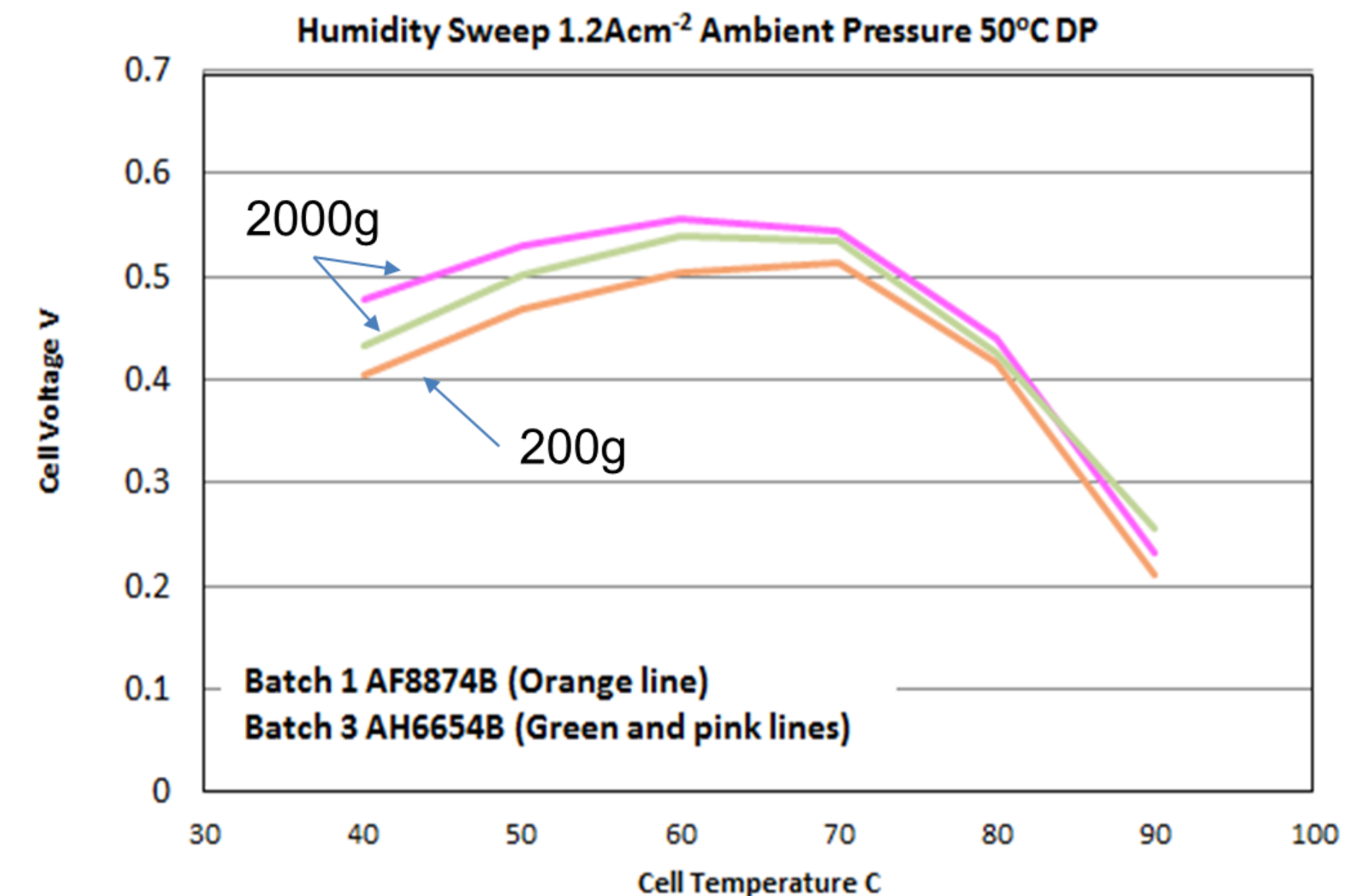
- INSPIRE achieved 0.6 A/mg Pt by project end



PROJECT PROGRESS/ACTIONS – INSPIRE Catalyst Scale-Up



- Performance under oxygen is insensitive to the carbon support type **C1** & **C2** (in this hardware)
- H₂/Air performance within 10% benchmark at 1.5 A/cm² with PtNi / C2 (Catalyst F)



Two 2 kg catalyst batches were manufactured with MEA performance higher than lab-scale baseline

PROJECT PROGRESS/ACTIONS – Stack Power Density



Achievement to-date

1.12 W/cm²

1.2 W/cm²

1.5 W/cm²

25%

50%

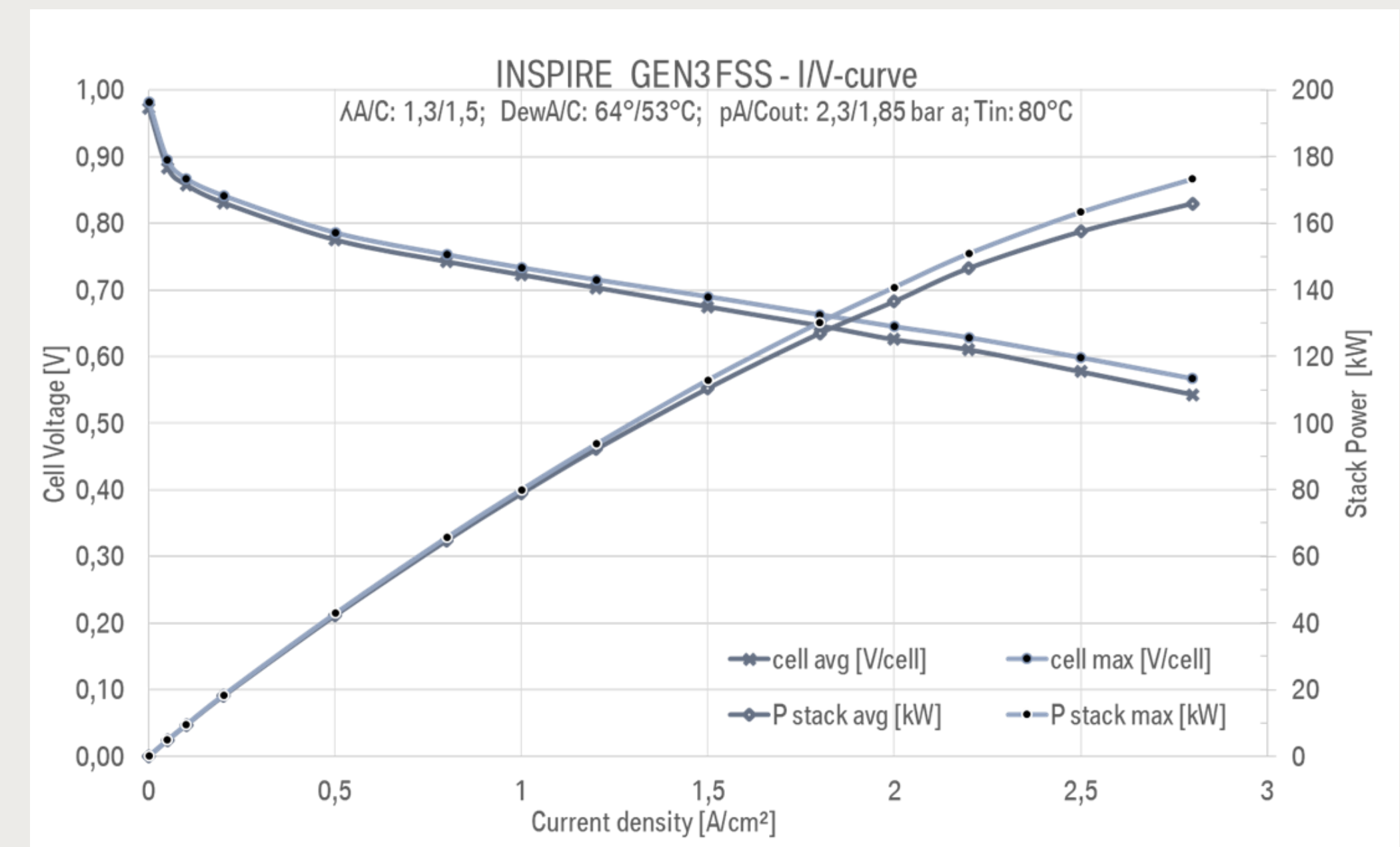
75%

Targets:

- INSPIRE single cell power density target 1.5 W/cm²
- SoA 2016* 1.0 W/cm²
- MAWP power density target for 2020 1.5 W/cm²

Achievement:

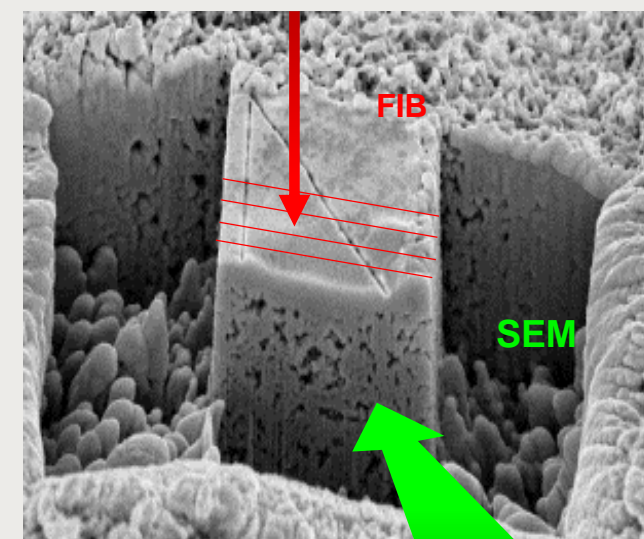
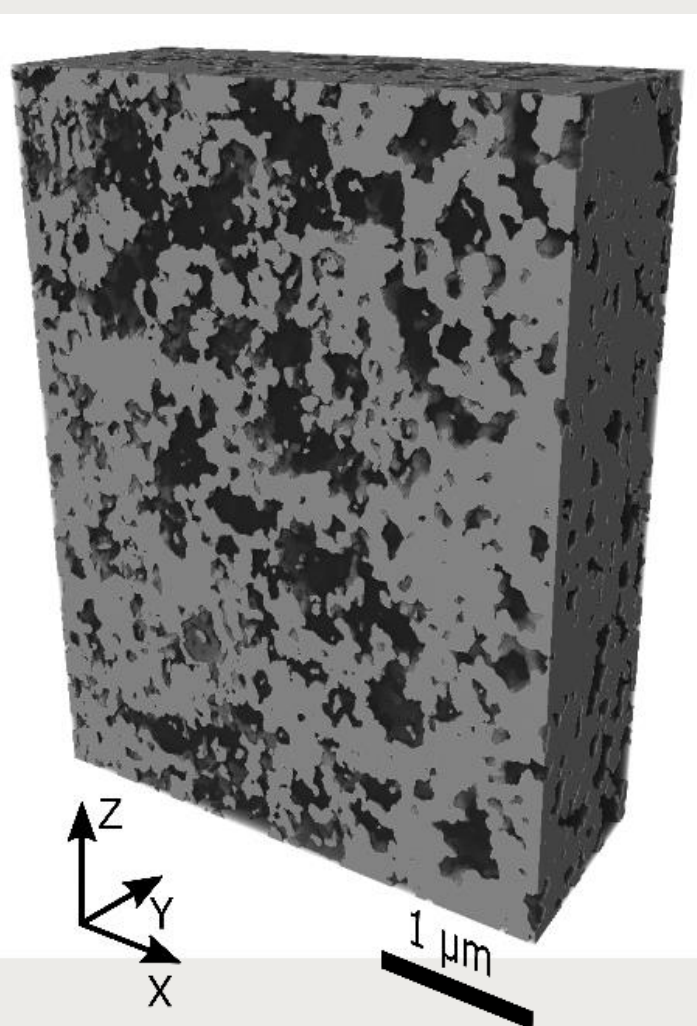
- **INSPIRE achieved 1.5 W/cm² at 0.6 V at M42**



PROJECT PROGRESS/ACTIONS – INSPIRE MEA Degradation Modelling



FIB tomography



Tomography

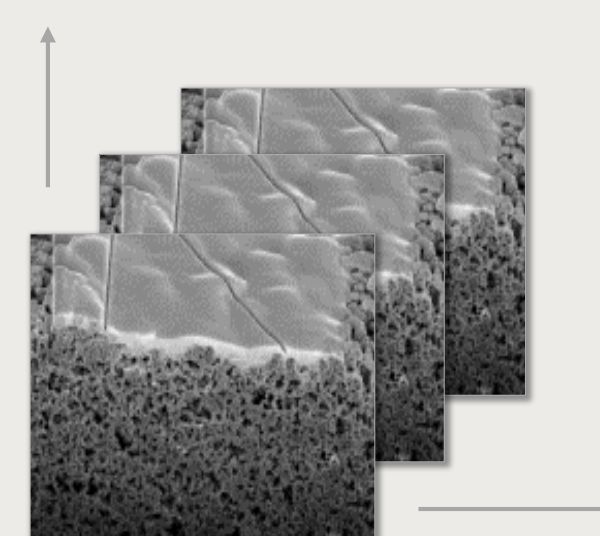
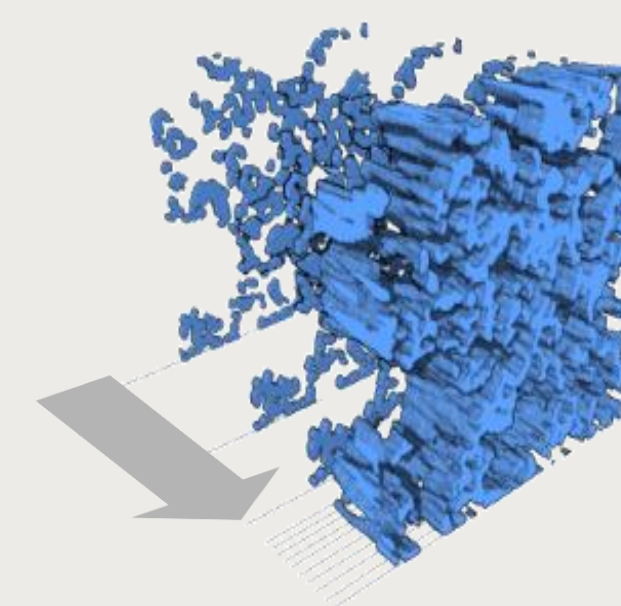
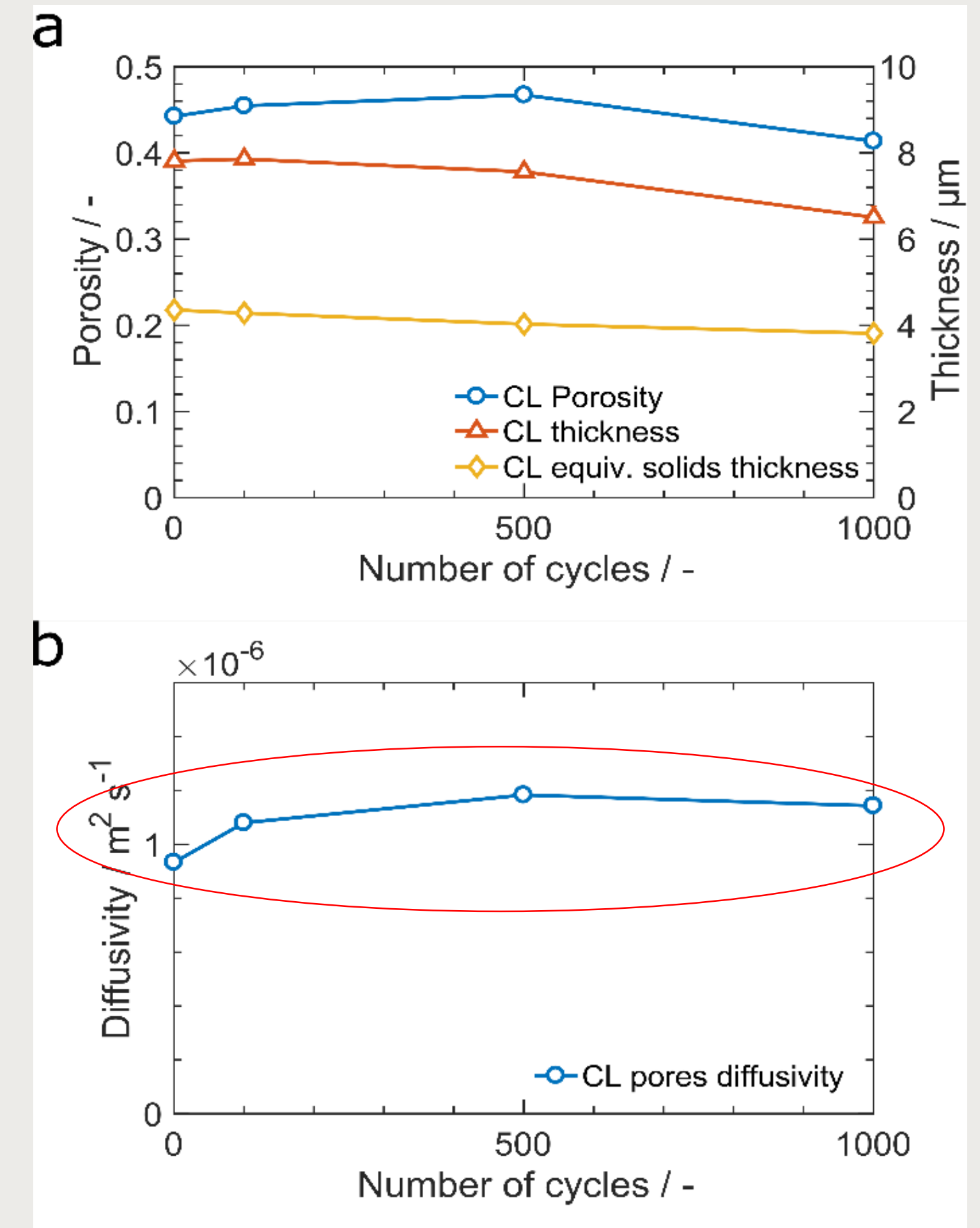


Image series



3D reconstruction

- Pore space diffusivity remains constant
- Not the reason for increased Mass Transport Resistance



PROJECT PROGRESS/ACTIONS – Design, Manufacture and Test

Two New Stack Designs



Achievement to-date

GEN 1.0



25%

50%

75%

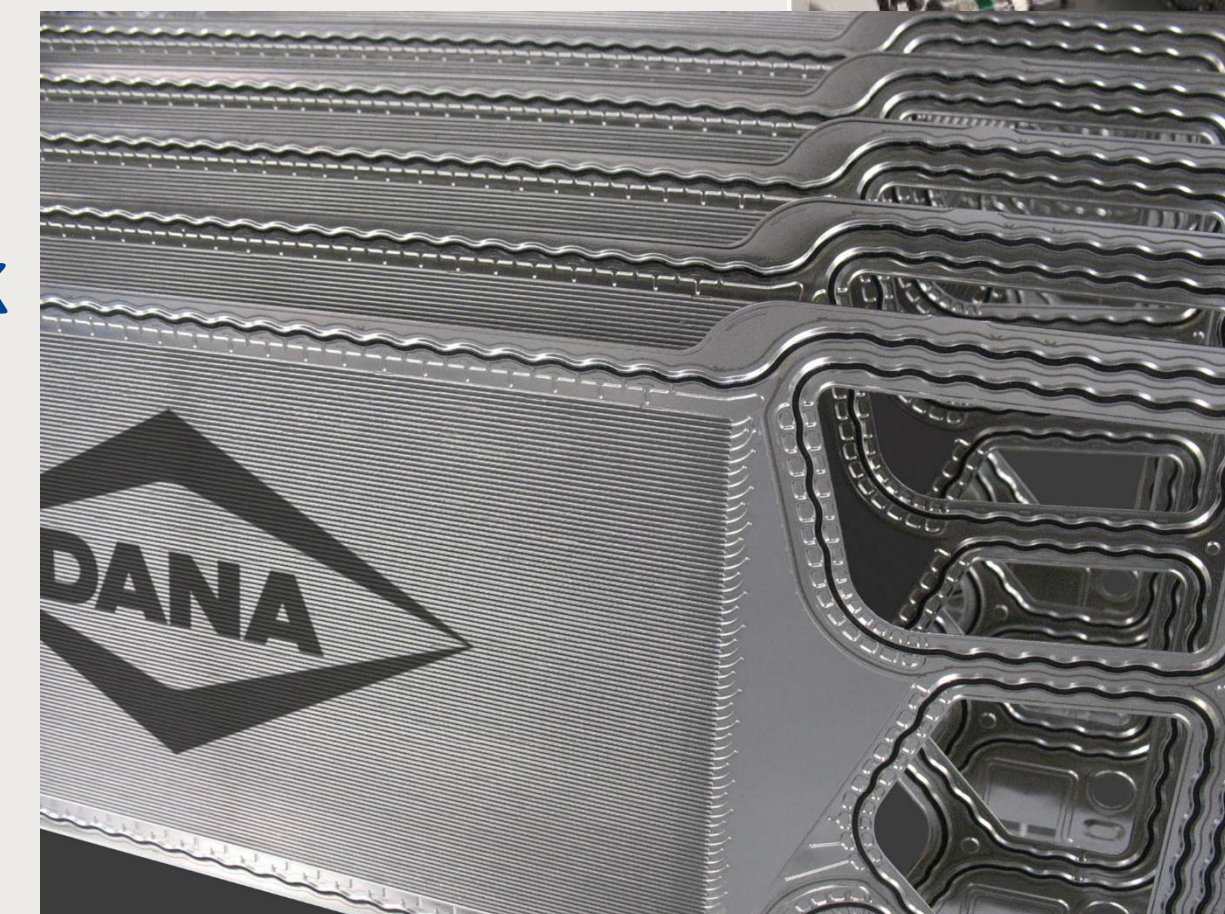
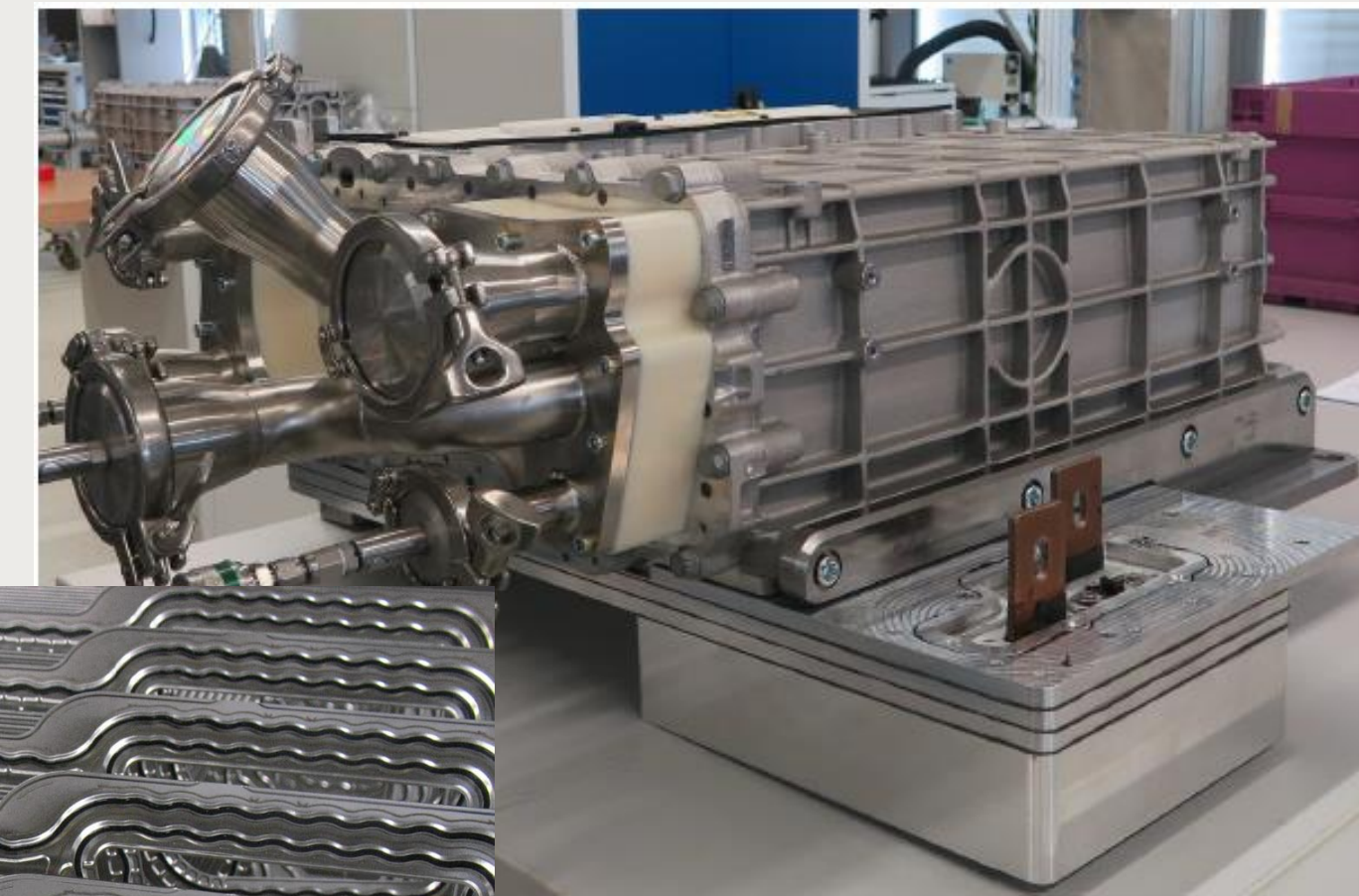
GEN 3.0
5.7 kW/L

Targets:

- INSPIRE stack power density target 1.5 W/cm^2 @ 0.6V with new stack designs
- SoA: Mirai 3.1 kW/L , AutoStack-CORE 4.1 kW/L

Achievements:

- Stack power density of 1.5 W/cm^2 achieved at 170 kW peak
- Cell pack only: 5.7 kW/l ; 4.2 kW/kg
- Stack including case and housing: 4.8 kW/l ; 3 kW/kg



Risks and Challenges



Project has been successfully completed on 31st of October 2019

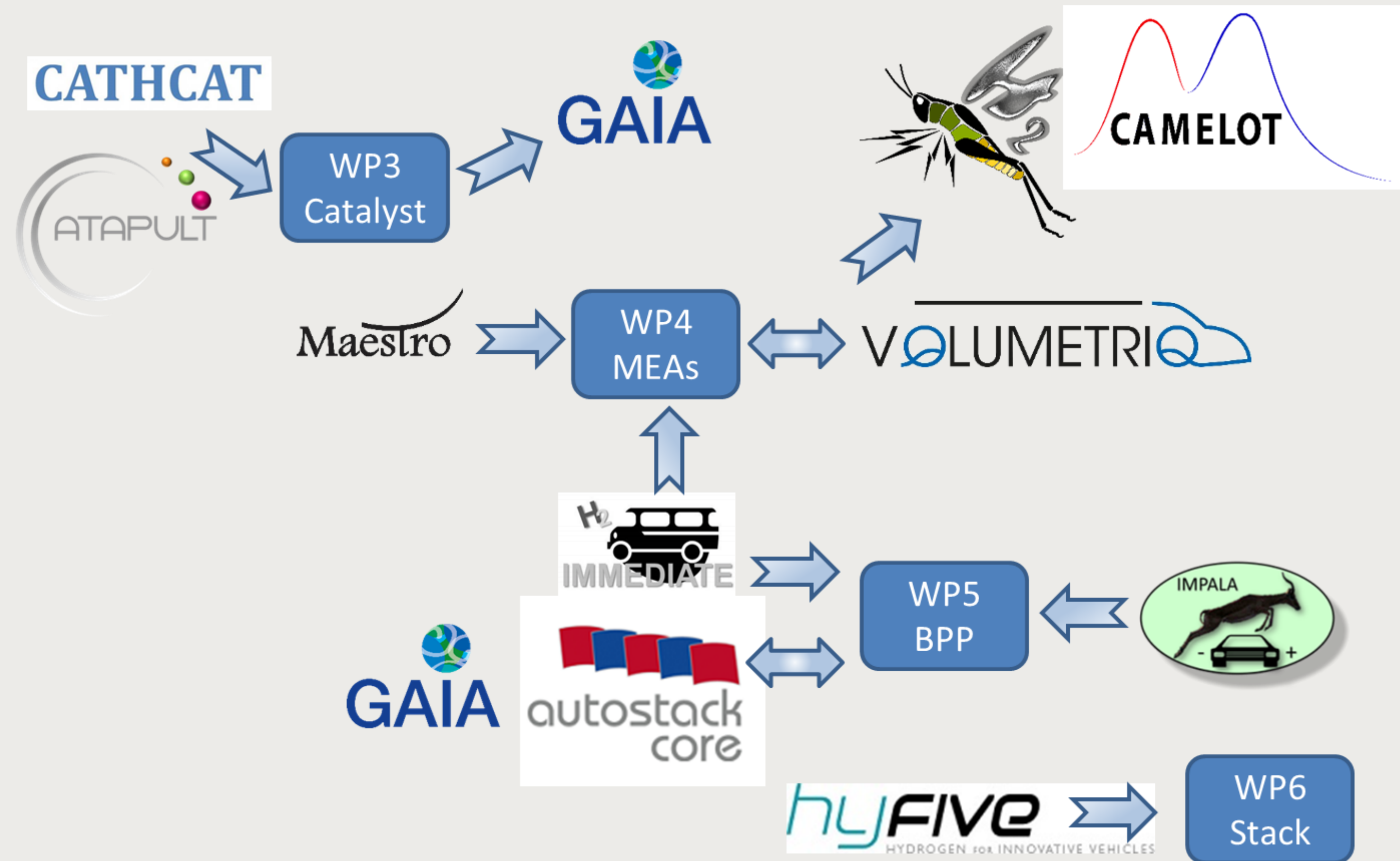
A 6-month extension was required to the original (36-month) project timeline to enable a better feedback loop between both stack designs and complete the required testing



Communications Activities



- 24 conference presentations (invited, oral & poster)
- 7 publications accepted, plus 2 further publications submitted
- Full integration with other FCH JU projects
- 1 technical information-sharing workshop with 10 FCH JU projects represented
- 3 blogs
- 1 STEM outreach activity with 400 primary and secondary school children involved
- Website <http://www.inspire-fuelcell.eu/>
- Flyers and newsletters



 @INSPIREFuelCell



Exploitation Plan/Expected Impact



Exploitation

- Samples of scaled-up catalyst at 2 kg scale now sent to customers – JMFC
- New gas diffusion substrate developed in INSPIRE now released as a commercial product – SGL 22BB
- Bipolar plate process moved to TRL6
- BMW to exploit the results from INSPIRE for their automotive development programme



Impact

- EU fuel cell supply chain strengthened and advanced, including catalyst, MEA, GDL, BPP and stack
- Common stack platform and protocols in use at JMFC, DANA and BMW. Platform will continue to support FCH JU projects GAIA, CRESCENDO and CAMELOT. INSPIRE GEN 1.0 samples also provided to ID-FAST for baseline
- Membrane, MEA and catalyst output from project being pursued further within GAIA



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The INSPIRE team thank you for your attention!



Be inspired, be inspiring



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