Dr Ingo Ludtke

Head of Power Electronics, Compound Semiconductor Applications Catapult







COMPOUND SEMICONDUCTOR APPLICATIONS CATAPULT

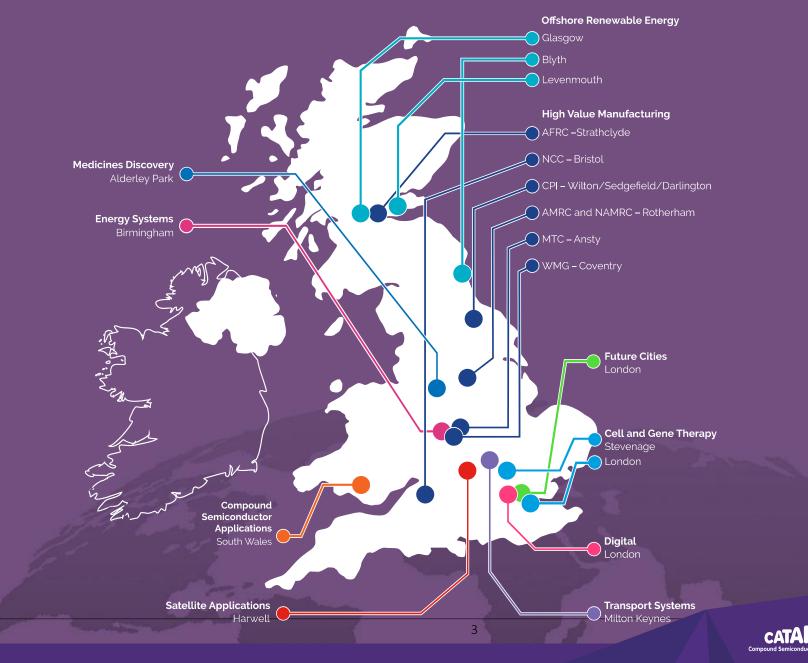
CPE – 4th July 2018

Dr Ingo Lüdtke Head of Power Electronics



Existing Catapults

Catapult Network – Fostering Innovation to Drive Economic Growth



We have identified the need for an independent centre of expertise that can join researchers and the compound semiconductor supply industry with those businesses that can gain the most from using compound semiconductors in systems and devices.

OUR VISION

the Catapult will generate economic growth by making the UK a global leader in developing and commercializing new applications for compound semiconductors

SKILLS

CHALLENGE

PROGRAMMES

Helping SMEs to

large companies

with access to

supply products to

global markets

Design studio and advanced expertise to create new products using compound semiconductors

EVALUATION MODULES

Allowing companies to develop prototypes using UK-sourced compound semiconductors

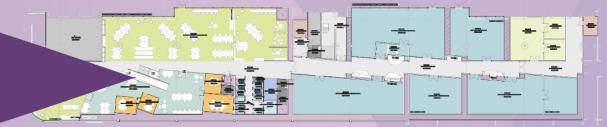
FACILITIES

Laboratories allowing companies to demonstrate market-readiness of new products



Strategy

- collaborative R&D facility
- design studio
- dedicated labs: power, RF, photonics & packaging



- EVM for power electronics, RF and photonics
- supporting services
- bespoke CR&D and commercial opportunities

• challenge-led programmes

- pre-competitive industry consortia
- dedicated project resource and secondments

New premises

design studio

- industry collaboration
- design expertise, simulation tools
- supply chain relationships
- reliability and failure analysis

class 10K advanced packaging lab

- materials characterisation
- precision engineering
- die preparation & hybrid integration





power electronics laboratory

- test & verification capability
- access to 0.5MW of power
- EMC screened

RF/microwave laboratory

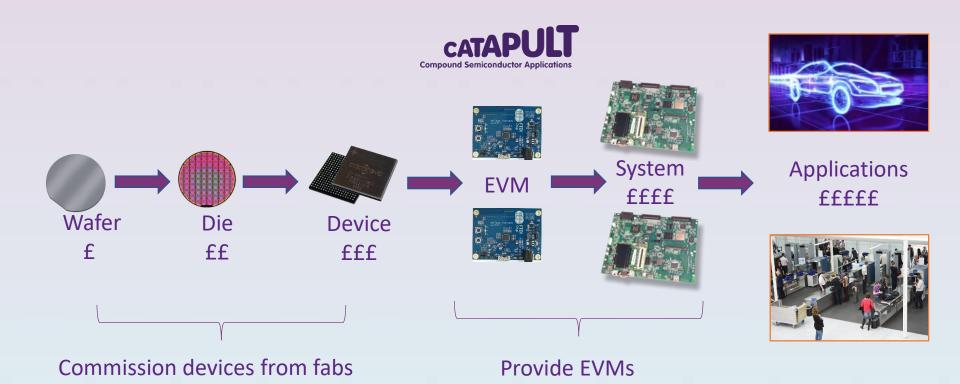
- device characterisation
- harsh environment analysis

photonics & sensors laboratory

- advanced metrology
- RF modulated photonics
- dark room

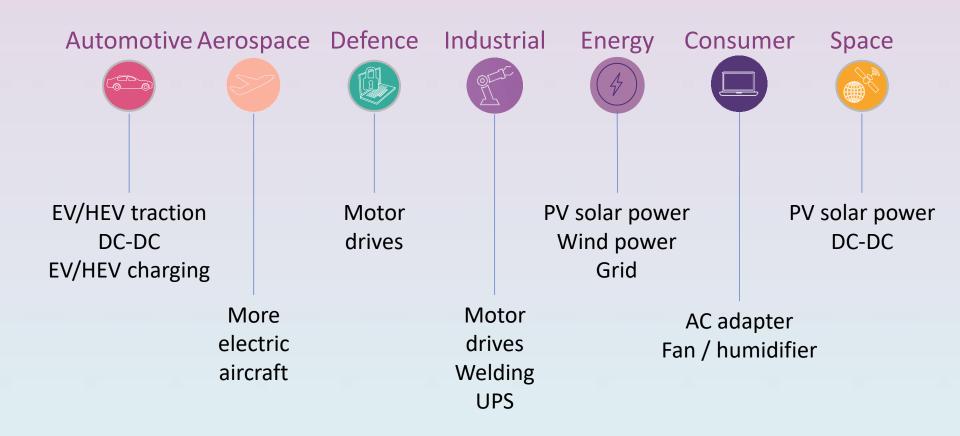


Evaluation modules (dev kits)



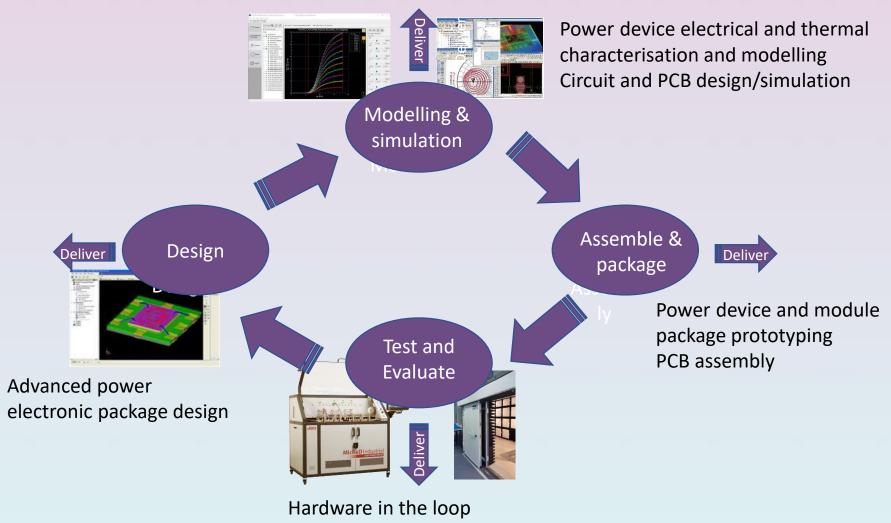


Power Electronics Key Markets





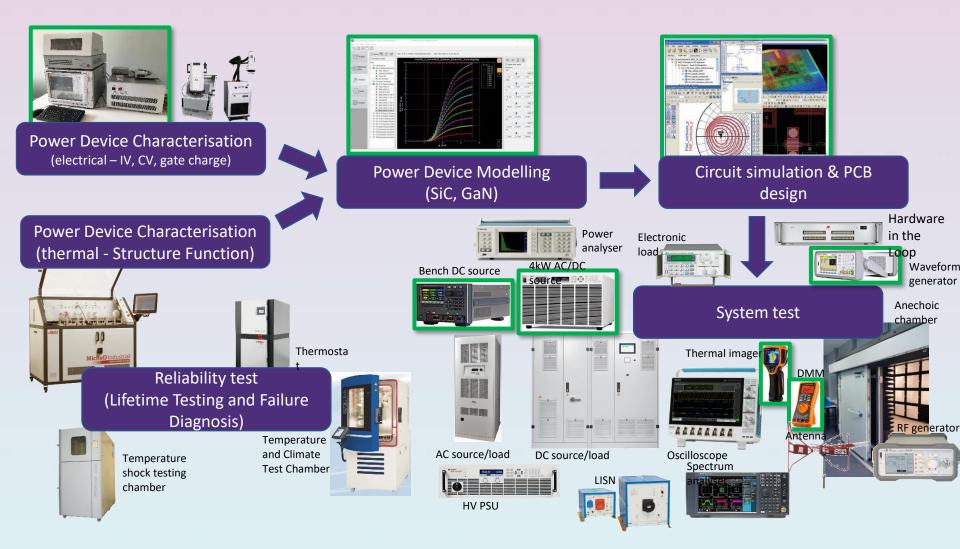
CSAC capability in power electronics



High power AC and DC sources and loads Reliability and EMC testing

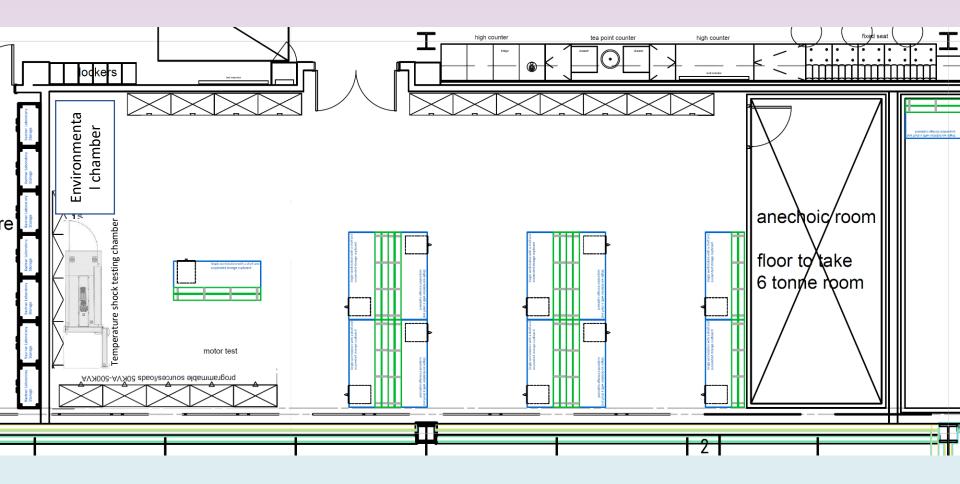


CSAC capability in power electronics



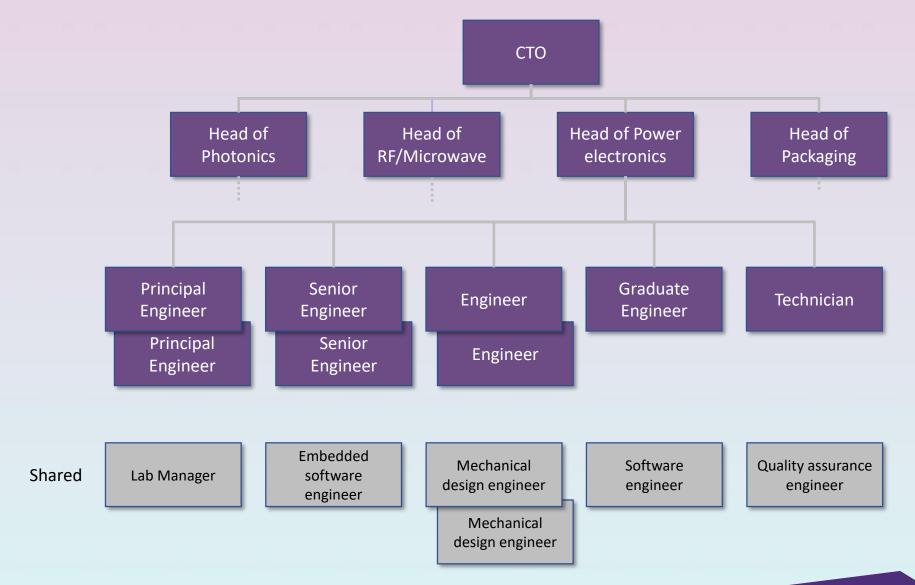


CSAC power electronics lab layout



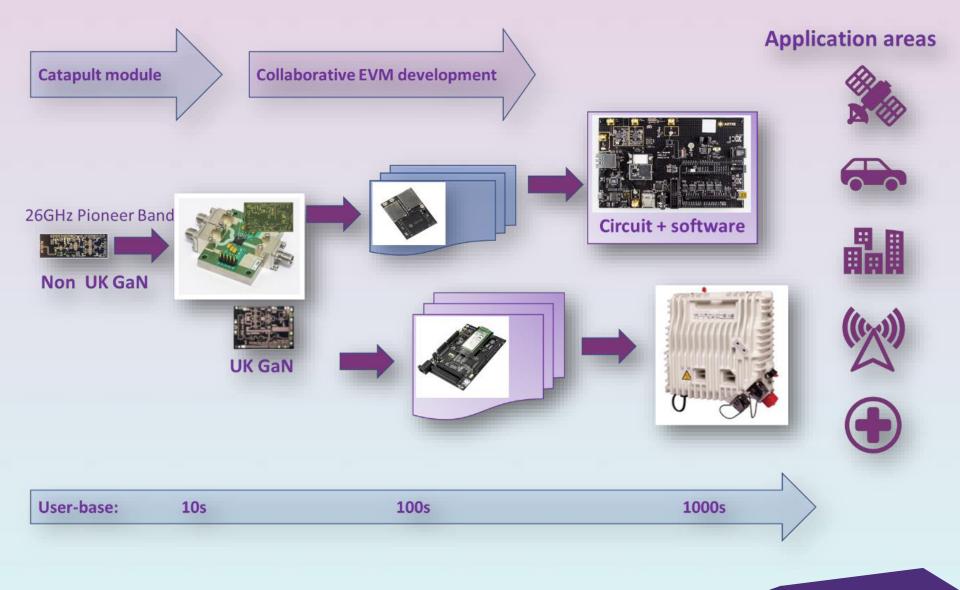


Building the team





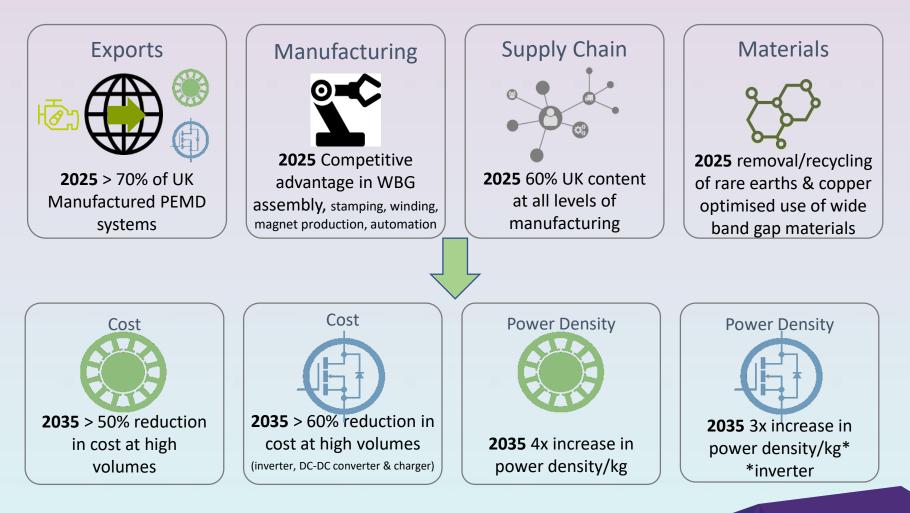
Example of what we're doing with RF





ISCF Wave 3 bid: Stephenson Challenge £96m

- driving the electrification revolution
- Proposal: Cross-Sectoral coordination of UK Power Electronics, Electric Machines and Drives (PEMD)
- *Objective: UK Manufacture of £5Billion more Motor Drives By 2025*



CATAPULT Compound Semiconductor Applications

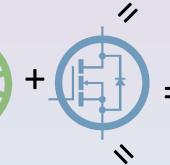
Stephenson Challenge - Driving future industries

Power Electronics, Motors & Drives (PEMD) are essential to next generation technologies:

- All UK cars to be zero carbon by 2040
- New aircraft to be more electric / hybridised to meet next phase emissions and noise legislation by 2040
- Renewables (Wind, Wave, Tidal) to form and increasing percentage of energy generation (80% CO2 reduction by 2050)
- High speed rail network to grow to reduce pressure on roads and decrease journey times

The Stephenson Challenge will ensure that our technology, industry and skills are in place to lead the world and create high value jobs, export and sustainability











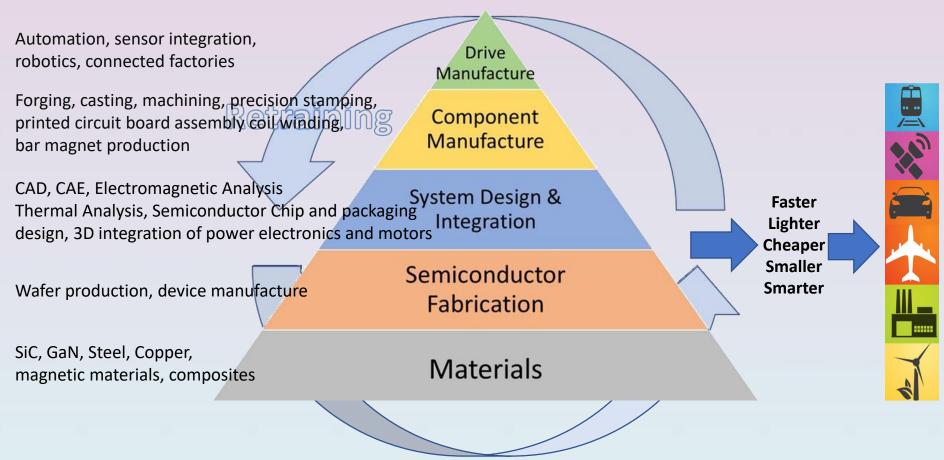
Stephenson Challenge - Market Opportunity

- Automotive Auto Council/APC Strategy Paper identified requirement for >2m next generation drives to underpin growth in electric vehicles and replace 2.5M engines produced in the UK as they are phased out
- **Aerospace** '100MW electrical energy on a plane' strategy driving the future of a £3.5 trillion export opportunity
- **Energy** Renewable energy is expected to grow at CAGR of 11.5%, PEMD is at the core of wind, tidal, wave and hydro-power system development. PEMD is also at the heart of high efficiency Solid State Transformer migration improving grid efficiency, the energy sector is expected to spend £60 billion on power electronics alone over the next 25 years
- Industrial Power Electronics UK white paper (over 100 UK companies across sectors) identified specific grand challenges in the kW and MW range
- ... other examples in Off-Highway, Rail, Marine, other sectors



Stephenson Challenge - Delivering Competitive Advantage

3 million motor drives worth > £5 billion p.a.



Five levels of the Supply Chain will be developed to deliver competitive advantage to UK manufacturers in key industrial sectors



Stephenson Challenge - Coverage

Building Blocks	Devices	Modules	Applications
Passives		<1kW conversion and control	Automotive
Materials	Low Voltage GaN	1-50kW conversion	Aerospace
Gate Control & Sensing	400V- 1kV GaN	and control	Rail Marine
Modelling & Simulation	<1.2kV SiC	50- 500kW Conversion and	Defence
Reliability & Lifetime	>1.2kV SiC	Control	Industrial
Multi-physics design	Hybrid	Grid and HV Voltages	Energy Consumer
Short Circuit Performance	Other WBGs	Uni and Bi-directional	Space
Packaging		DC-DC	Agri-Tech
Test & Measurement		Wireless Charging	



ISCF bid: Eyes of the autonomous future, £75m

- Prize
 - Reduce fatalities: 1700 per year on UK roads
 - Integrated transport system: £15Bn improved output
- Activities:
 - Components: Sources, Detectors, ROIC integration
 - Scale up: Pilot line for manufacturing
 - Deployment: Test bed and simulators
 - Regulatory framework development
- Support
 - 45 organisation supporting the bid
 - Automotive Council support



Trends

- UK automotive industry: £71.6bn
- UK manufactures 2.5m engines per year across 9 sites
- Conventional -> electric -> autonomous vehicles
- New infrastructure charging points
- £70bn infrastructure for UK 5G

Opportunities

- We have the capability to create supply chains in the UK
- This requires a step change in production and new manufacturing techniques
- Stephenson Challenge
- Eyes of the Autonomous Future



Questions

1. What EVMs would you like to see?

- Bidirectional (non) isolated dc-dc
- 3ph inverter
- Half bridge, H-bridge GaN 100W-300W
- Resonant dc-dc / wireless charging
- GaN HEMT SiC diode co-pack
- *PFC*

2. What core technologies should we promote/demonstrate?

- novel gate drivers
- novel heat spreaders
- novel packages

3. What should be our focus?

- power levels
- GaN vs SiC

4. How can we support your project?

- Characterise / model / simulation
- Power module design and assembly
- Converter test / reliability





Dr Ingo Lüdtke Head of Power Electronics Ingo.ludtke@csa.catapult.org.uk 07741 146 833

Compound Semiconductor Applications Catapult Ltd Regus House, Falcon Drive, Cardiff, CF10 4RU



Tel:	01633 373121
IEI.	010222/2151

Email: info@csa.catapult.org.uk

Twitter: @CSACatapult

Website: www.csa.catapult.org.uk

The CSA Catapult is a member of CS-Connected – the South Wales compound semiconductor cluster

www.csconnected.com

