

# Heterogeneous Computing

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Reference: HEC for Heterogeneous Computing  
Date: 2015-06-08  
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Distribution: General

Attendees marked with \*

# Prodrive Technologies at a glance

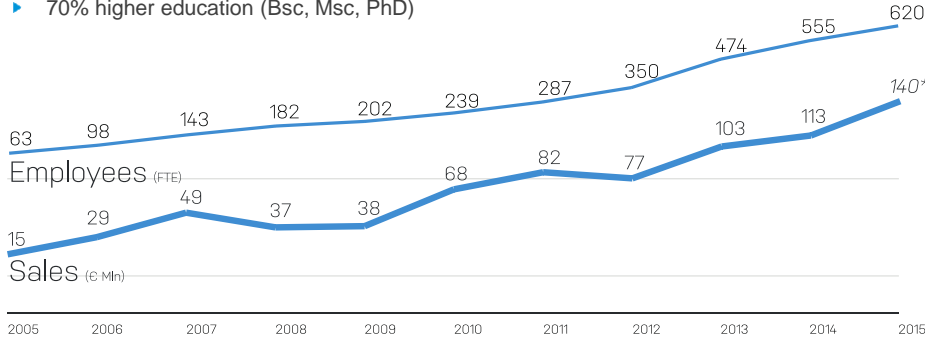


## One of the fastest growing privately owned technology companies in Europe

We focus on autonomous growth and a solid preservation of our company culture

## Current state

- ▶ 610 FTE of which 330 in development
- ▶ 70% higher education (Bsc, Msc, PhD)



\* Forecasted sales

## Core Business

- ▶ Design of electronics, software and mechanics
- ▶ Manufacturing
- ▶ Added value services

## Business model

- ▶ Ready-to-use products
- ▶ Technology solutions
- ▶ Manufacturing services



M



VE  
GIES



# A global reach

## Prodrive Technologies Netherlands (HQ)

- ▶ R&D
- ▶ Manufacturing
- ▶ Service
- ▶ Sales

## Prodrive USA

- ▶ Sales
- ▶ Manufacturing (Q4 2016)

## Prodrive Germany

- ▶ Sales

## Prodrive South-Korea

- ▶ Sales

## Prodrive China

- ▶ Sales
- ▶ Supply Chain
- ▶ Manufacturing
- ▶ Service

## Prodrive Israel

- ▶ Sales

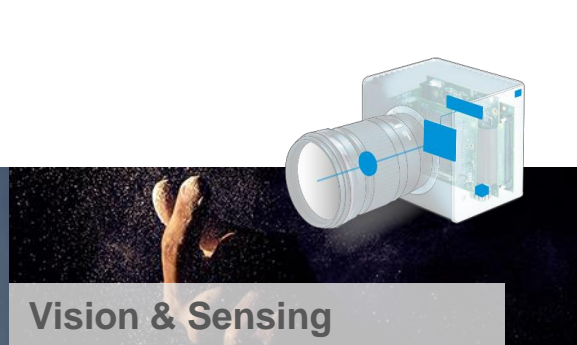
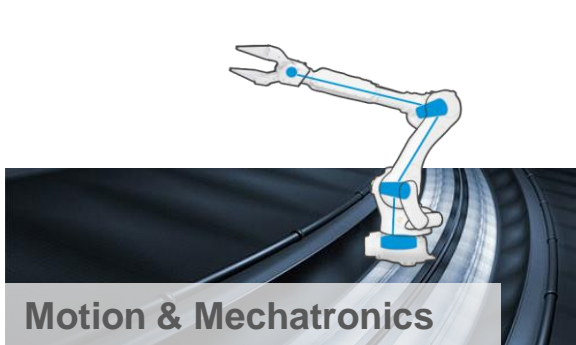
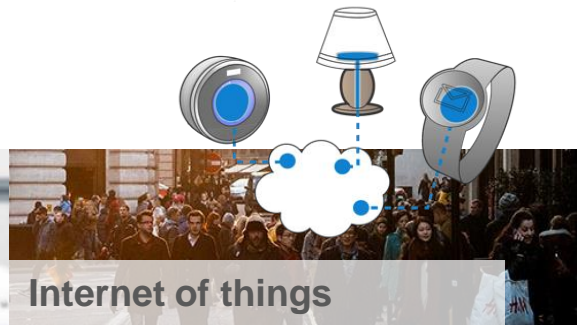
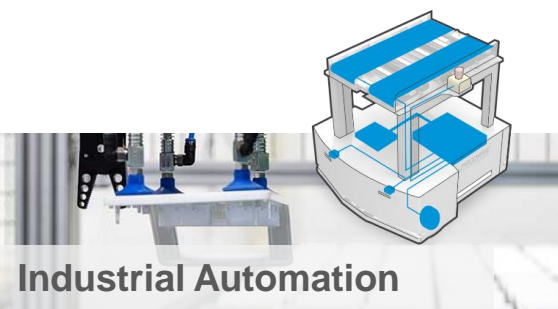
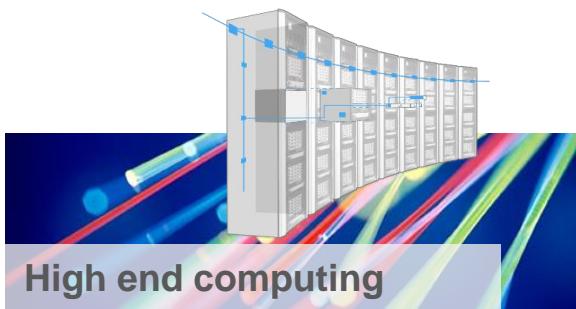
## Prodrive Hong Kong

- ▶ Sales

● Prodrive Technologies footprint to facilitate local demand



# Our technologies



# High-End Computing (HEC)

## HEC solutions

- ▶ Consist of a number of systems-on-chip with dedicated memory, interconnected by buses and/or packet switched networks
- ▶ May be heterogeneous
- ▶ May be scalable
- ▶ May be subjected to hard real-time constraints



## Innovation

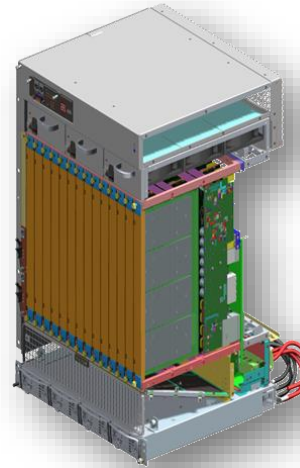
- ▶ Addressing the market's next needs
- ▶ Performance / \$
- ▶ Performance / Watt
- ▶ Performance / m3



# HEC examples

## Massively parallel high-end image processing

- ▶ Optical incoming data >160GB/s
- ▶ 2x ATCA shelf per cabinet
- ▶ RapidIO & 10/40GbE switching
- ▶ 576 ARM A15 MPCores
- ▶ 3456 C66x DSP CorePacs
- ▶ FPGA frame grabbing
- ▶ ±2 TB DDR memory
- ▶ Water cooling



# HEC examples

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## Wafer lithography

- ▶ 50kHz motion control loop; Going to 100kHz
  - ▶ 20us (10us) for processing and communication
- ▶ 14nm lithography, going to <10 nanometer
- ▶ RapidIO & 10/40GbE switching
- ▶ PowerPC processing
- ▶ FPGA synchronization and co-processing
- ▶ Intel x86 server, Host and co-processing
- ▶ 200kW power supply
- ▶ Multi-kW high-accuracy power amplifiers
  - ▶ RapidIO driven
- ▶ Water cooling





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## Heterogeneous Computing: building blocks

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# Intel Xeon processing

## Intel® Broadwell-DE® SoC

- 5<sup>th</sup> generation Xeon on 14nm process
  - ▶ 2.1x more efficient than 4<sup>th</sup> gen
- 10GbE Ethernet
- PCIe 3.0 x24 / PCIe 2.0 x8
- Optionally 2x 20Gbps Serial RapidIO

## Platform options

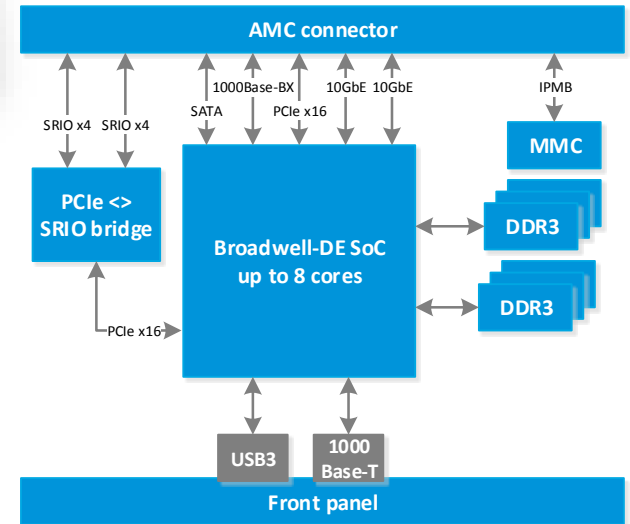
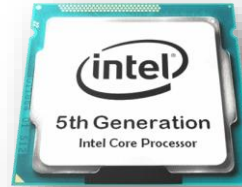
- Scalable 2, 4 or 8 cores (<20W ~ 45W)
- SATA 3.0 / USB 3.0
- 7 yr life/10 yr reliability with high Tcase

## Compliance

- PICMG AMC.0 R2.0
- PICMG AMC.2 R1.0
- PICMG AMC.4 R1.0
- PICMG MTCA.0 R1.0

## Applications

- Image processing
- Dense HPC
- Micro servers
- Storage

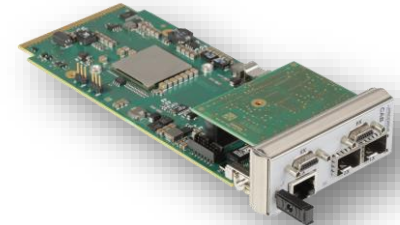


Status: Prototype 2015Q3

# 7-series FPGA platform



Feature	AMC-XZ7	AMC-XV7
<b>FPGA</b>	125K – 350K logic cells (Zynq-7000)	320K – 690K logic cells (Virtex-7)
<b>DDR FPGA</b>	Up to 8GB, 1600MT/s, ECC	Up to 16GB, 1600MT/s, ECC
<b>ARM</b>	2x ARM Cortex-A9	
<b>Interconnect support</b>	Serial RapidIO 2.1 Serial RapidIO 3.x prepared 10GBASE-KR 1000BASE-T	(Up to 20GBaud / port) (Up to 40GBaud / port) (Up to 10GBaud / port) (Up to 1GBaud / port)
<b>AMC connector ports</b>	1x Gigabit Ethernet 2x single lane Up to 1x quad lane	1x Gigabit Ethernet 1x 10Gb Ethernet Up to 2x quad lane
<b>Front panel ports</b>	1x RJ-45 2x SFP+	1x RJ-45 2x QSFP+
<b>Flash</b>	Up to 128MB NOR, 8GB eMMC	Up to 128MB NOR
<b>AMC width</b>	Single	
<b>AMC height</b>	Full-size, Mid-size	
<b>MMC</b>	Pigeon Point 1.5 based	
<b>Applicable standards</b>	PICMG AMC.0 R2.0 PICMG AMC.x R1.0	



# ARM+DSP platform



Feature	AMC-TK2	AMC-TK2-H2S
ARM core	4x A15 MPCore, 1.4GHz	
DDR ARM	Up to 2GB DDR3, 1333MT/s, ECC	
DSP core	8x C66x CorePac, 1.2GHz	24x C66x CorePac, 1.2GHz
DDR DSP	Up to 8GB DDR3, 1333MT/s, ECC	Up to 24GB DDR, 1333MT/s, ECC
Serial RapidIO	2.1 (up to 5Gbaud)	
SRIO to AMC connector	1x	3x
1GbE to AMC connector	1x 1000Base-BX	
10GbE to AMC connector	1x 10GBase-KR	
Ethernet to front panel	1x 1000Base-T	
RS232	1x CPU, 1x MMC	
Flash	64MB NOR	192MB NOR
AMC width	Single	
AMC height	Full-size	
MMC	Pigeon Point 1.5 based	
Applicable standards	PICMG AMC.0 R2.0 PICMG AMC.x R1.0	



# ATCA-TK2-6PU: *High density ARM+DSP*



6x processing units (PUs) in 1 ATCA blade

- 1 PU = AMC-TK2-H2S, without AMC mechanics
- 512MB DDR per ARM / DSP core; 84GB per blade

Connectivity

- Switched 10/40GbE (PUs, Zone-2, Zone-3)
- Switched Serial RapidIO Gen. 2 (PUs, Zone-3)
- Point-to-point PCIe Gen. 2 (PUs, Zone-3)
- 1GbE within PU
- 2x HyperLink (up to 40GBaud) within PU

Supports application specific RTM

- Switched RapidIO / Ethernet
- Point-to-point PCIe



Status: Prototype 2015Q1



# PowerPC platform

Feature	AMC-FP3-8548	AMC-FQP-4080	AMC-FQP-5020
PowerPC core	1x e500v2, 1.3GHz	8x e500mc, 1.5GHz	2x e5500, 2.1GHz
DDR	1GB DDR2, 533MT/s, ECC	Up to 16GB DDR3, 1333MT/s, ECC	
Serial RapidIO	1.2 (up to 3.125Gbaud)		1.3 (up to 5Gbaud)
SRIO to AMC connector	1x	2x	
1GbE to AMC connector	1x 1000Base-BX		
Ethernet to front panel	1x 1000Base-T		
SATA	No		2x 3Gbps
RS232	1x CPU, 1x MMC		
Flash	8MB NOR		
AMC width	Single		
AMC height	Full-height, Mid-height		
MMC	Pigeon Point 1.5 based		
Applicable standards	PICMG AMC.0 R1.0 PICMG AMC.2 R1.0 PICMG AMC.4 R1.0	PICMG AMC.0 R1.0 PICMG AMC.2 R1.0 PICMG AMC.4 R1.0 PICMG MTCA.0 R1.0	PICMG AMC.0 R1.0 PICMG AMC.2 R1.0 PICMG AMC.3 R1.0 PICMG AMC.4 R1.0 PICMG MTCA.0 R1.0



# ATX-KM-4M256: Quad MPPA-256 PCIe card



## Quad MPPA-256

- 4x KALRAY Multi-Purpose Processing Array
- Up to 16GB DDR3, 1600MT/s, ECC (SODIMM)
- Up to 256MB NOR flash



## Connectivity

- 10Gbps Network-on-Chip eXtension (NOCX)
- Switched PCIe Gen. 3 x16 (MPPA, PCIe connector)
- 2x FireFly system connectors
- 1/10/40Gb Ethernet
- Interlaken

ATX, PCIe x16



Status: Production 2015Q3

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# Enabling Heterogeneous Computing

*Switching, interconnects & infrastructure*

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# Introducing RapidIO

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- Bandwidth = like Ethernet
- Low switch latency = like PCIe
- Free topology = like Ethernet
- Low TCO (Gbps/\$, Gbps/W) = like PCIe
- Scales to 1000s of nodes = like Ethernet
- Protocol termination in hardware = like PCIe
- Guaranteed delivery = like PCIe
- Direct memory access, interrupts = like PCIe
- Messaging = like Ethernet
- Real-time characteristics = unheard of

# HPC2.0



## Datacenter and Compute Platform: 4 AMC-slot

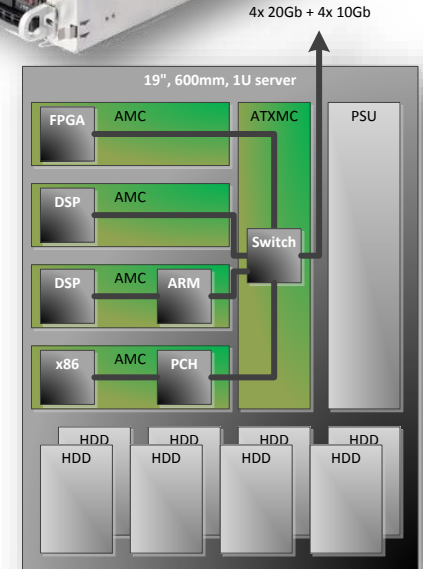
- Up to 4 AMCs
- 160Gbps RapidIO to AMCs; 80Gbps RapidIO to back
- 4x 10GbE to daughter cards
- Easily customizable



## Datacenter and Compute Platform: 8 AMC-slot

- Up to 8 AMCs
- Switched RapidIO Gen2 20Gbps per port
- Switched 10GbE/40GbE
- High performance density and heterogeneous computing in 1U

Wide Choice of cards: x86, ARM, DSP, FPGA, PowerPC, Manycore, GPU, Storage (SATA, NVMe)





# Top-of-Rack RapidIO switch



## 38-port, 19" Serial RapidIO Gen. 2 switch box

- 32 QSFP+ (20Gbps/port)
- 2 CXP (60Gbps/port)
- 2.4Tbps non-blocking bandwidth
- Integrated host controller
- 150W TDP (est.)
- 8x switched GbE



**Latency: 100ns-300ns**

**Power (est): <4W per port, <0.1W per Gbps**



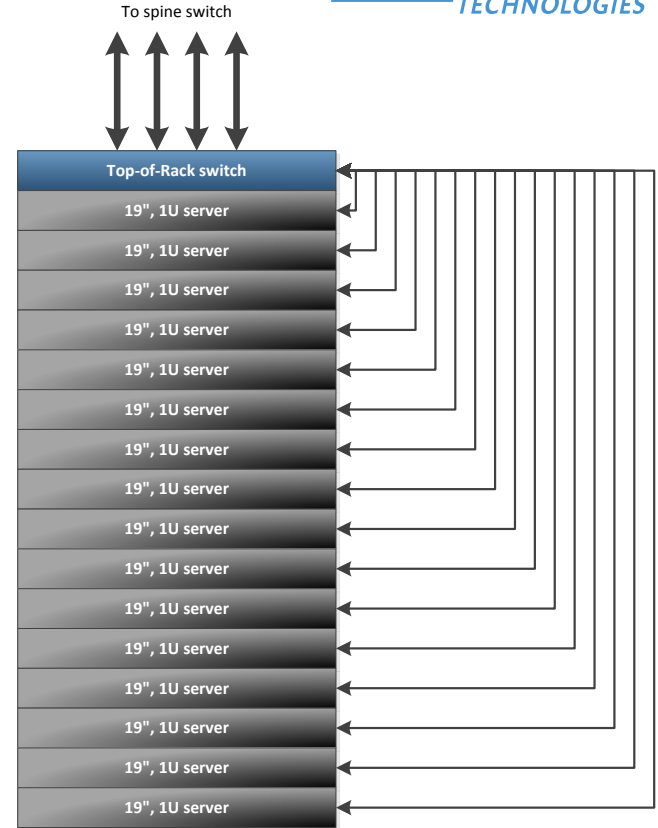
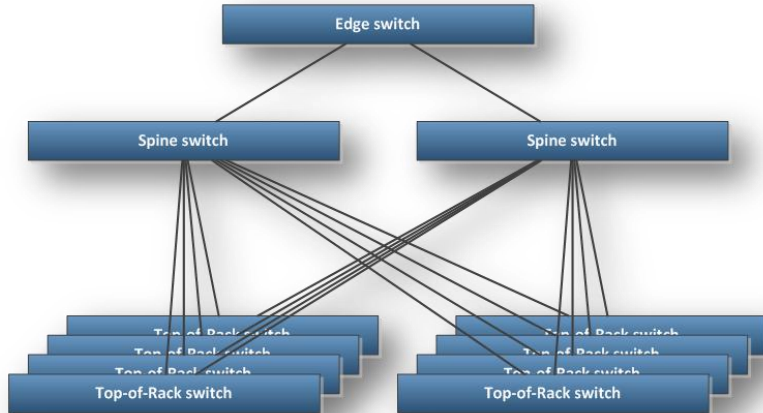
Status: Prototype 2015Q2

# Top-of-Rack RapidIO switch

En-masse aggregation of pizzas  
ToR switches for scale-out

- Within rack
- Between racks

Spine switches and edge switches



# Advanced TCA RapidIO switching

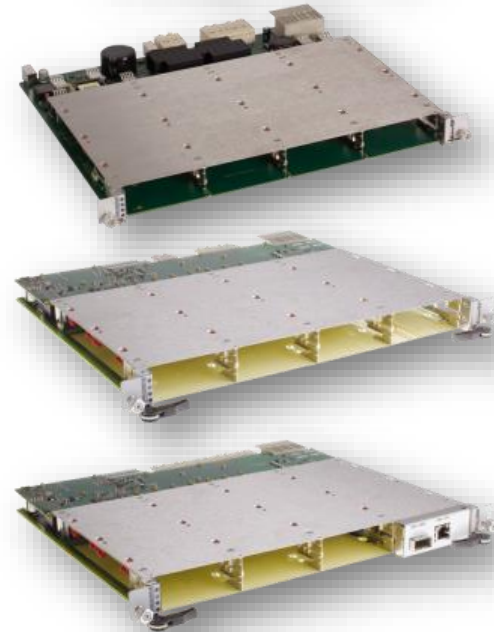
## ATCA RapidIO carrier & switch blades

- 3x or 4x full-size AMC support
- 320Gbps or 560Gbps non-blocking RapidIO gen2
  - ▶ 2x per AMC
  - ▶ 6x or 16x to backplane
- Gigabit Ethernet
  - ▶ 1x per AMC
  - ▶ 6x or 16x to backplane

## ATCA RapidIO carrier blade

- 4x full-height AMC support
- 160Gbps non-blocking RapidIO gen1
  - ▶ 2x per AMC
  - ▶ 4x to backplane
- Gigabit Ethernet
  - ▶ 1x per AMC
  - ▶ 5x to backplane

**RapidIO**



# Advanced TCA 10/40Gb Ethernet switching

## Ethernet ATCA carrier & switch blades

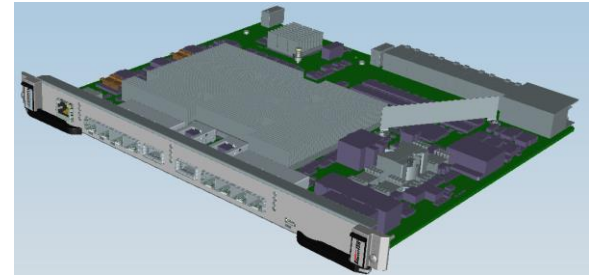
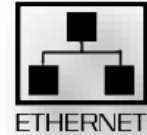
- Trident based, up to 640GbE non-blocking
- Up to 13x 10/40GBASE-KR to backplane
- Up to 13x 10/1000/1000BASE-T to backplane
- Up to 8x SFP+/2x QSFP+ cages on front panel

## Greyhound building block

- 1/10GbE 16-port switch with ARM
- Fit to integrate on existing products or standalone
- Up to Layer-3 switching (QoS / AVB / TSB)

## FPGA 10G UDP IP core

- Based on Xilinx 10GbE stack
- Forward Error Correction (FEC)



Status: Prototype 2015Q2

# Concluding

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- Heterogeneous Computing proven in mission critical solutions
- Focus on performance/W and performance/m3 is key
- RapidIO enables large scale heterogeneous computing, while not disabling Ethernet
- Next generation coming soon!

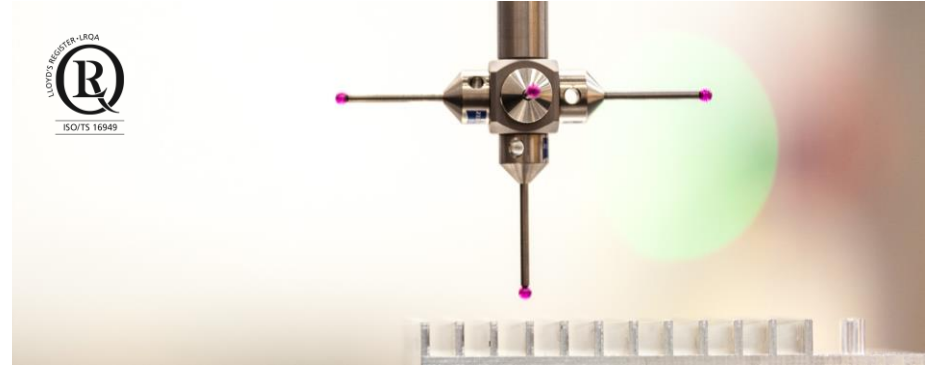


# Quality matters

## Continuous improvement



ISO 9001:2008	Quality management
ISO 13485:2012	Quality management – medical devices
ISO 14001:2004	Environmental management
OHSAS 18001:2008	Health and safety management
IECEE CB Scheme	Certified WMT laboratory
ISO/TS 16949:2009	Automotive quality management system
ISO/IEC17025:2005	Accreditation in progress



### Information Systems Roadmap

Building a world class information system that provides real time information to the entire organization (e.g. KPI's, SPC, Performance dashboards)

### Operations Roadmap

Continually reducing manual labor by robotics and automation (e.g. automatic guided vehicles, smart feeder carts, an automated warehouse)

### Management System Roadmap

Continually improve our quality, health, environmental and safety performance



Please contact us to explore if we can make your solution highly competitive

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