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Advanced Materials - Industry Demands for Materials and New Types of Testing

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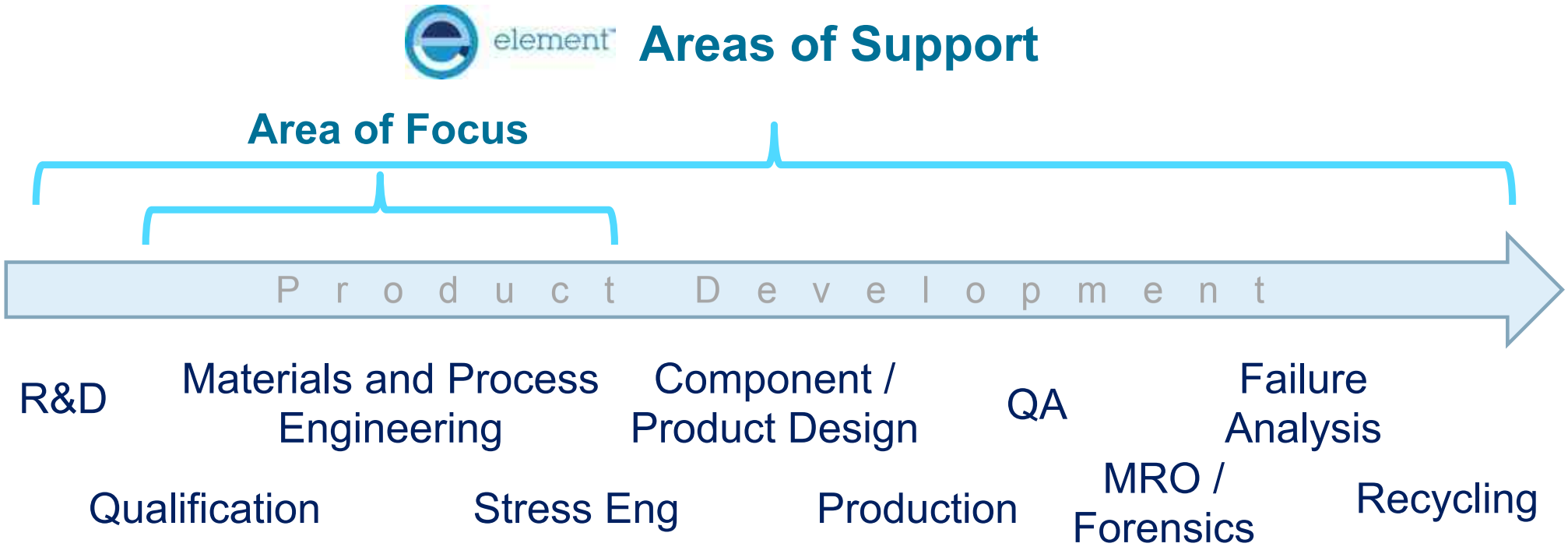
February 20, 2014

Advanced Materials, Testing Challenges



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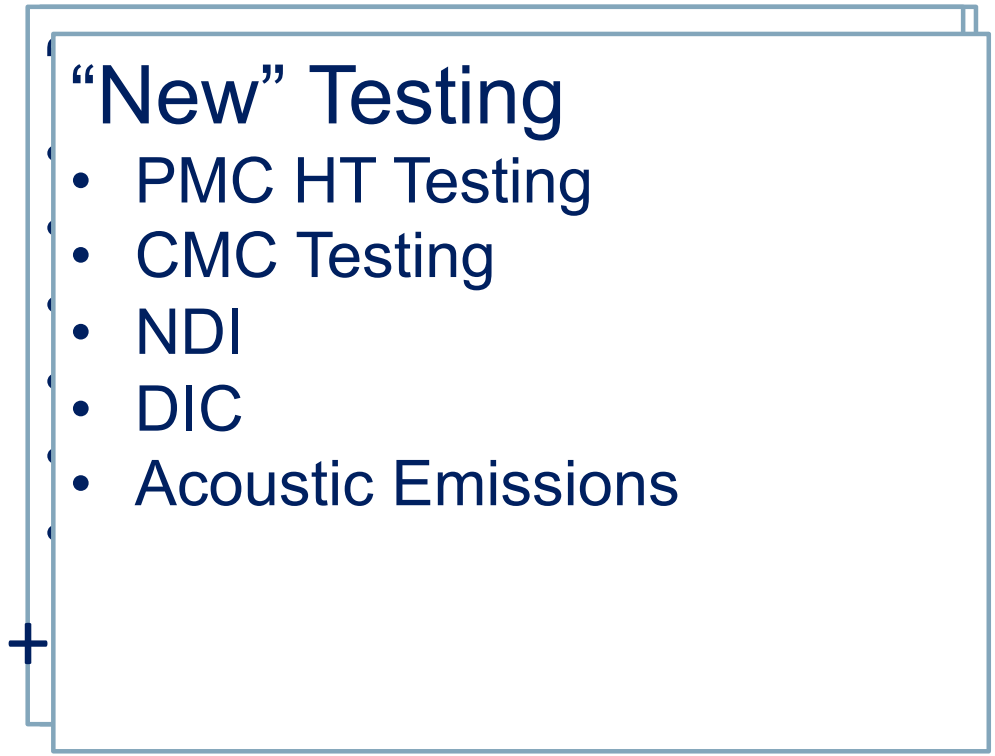

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Photos courtesy of MTS

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Advanced Materials, Testing Challenges

Illustration of Mech & Fatigue Test Capability / Capacity - 2012

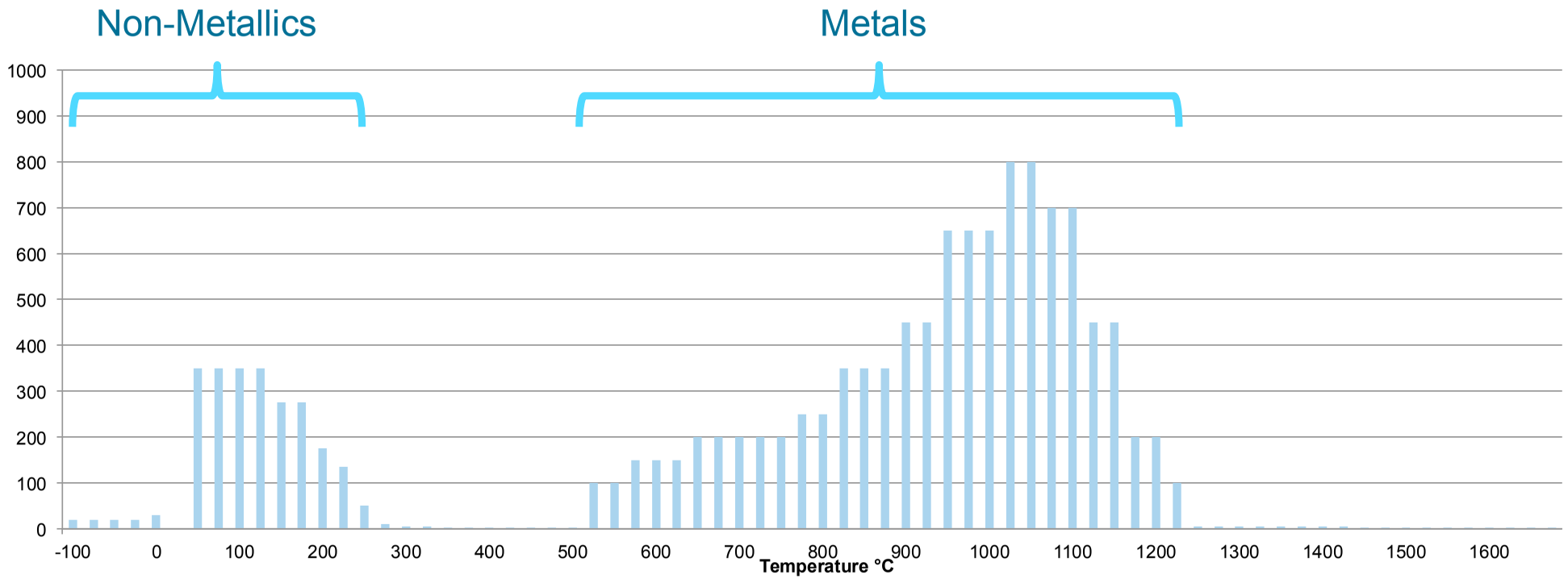

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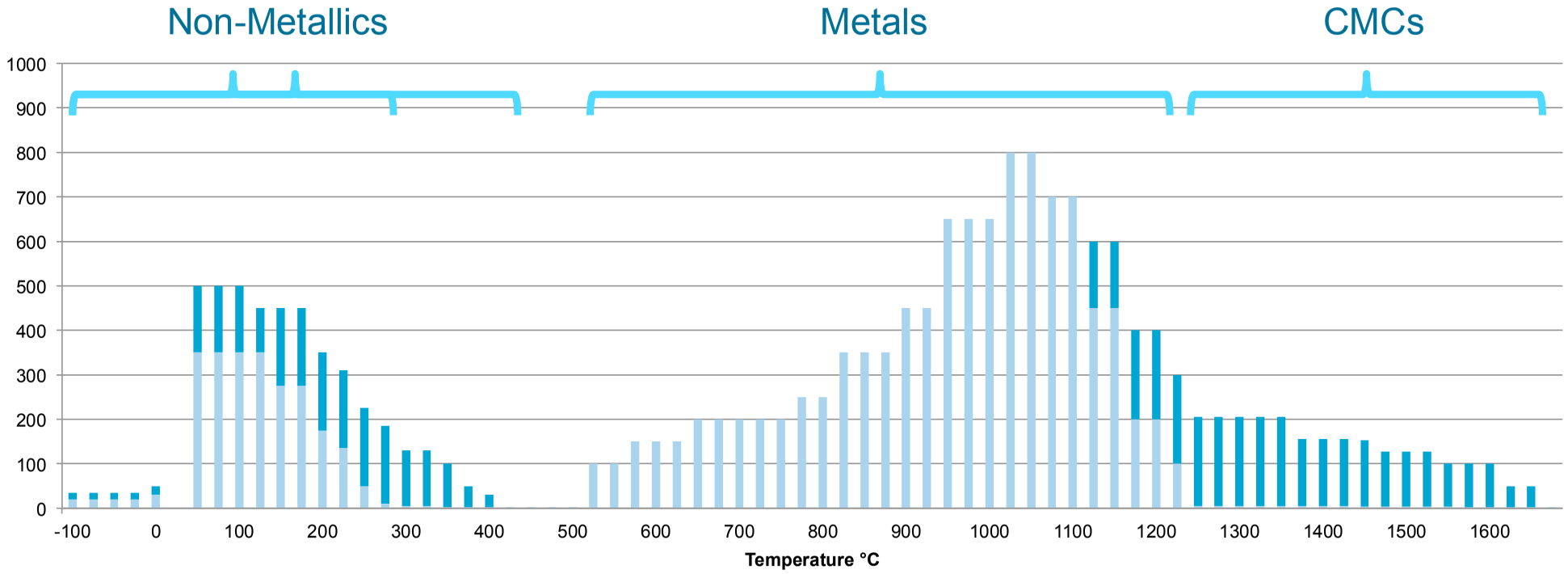
Illustration of Mech & Fatigue Test Capability / Capacity - Projected for 2015



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Major Challenges for PMC Testing of “New” Materials

- Temperatures up to 400°C
- Fixtures
- Durations
- New Methods for Tensile, Compression, Flex, Shear, Bearing and others

PMC Testing - Context

- Scalable – 30 to 60 frames
- Tensile, Compression, Flex, Shear, Cyclic, D&DT and Component
- Highly repeatable and efficient

PMC 400°C Temperature Challenge

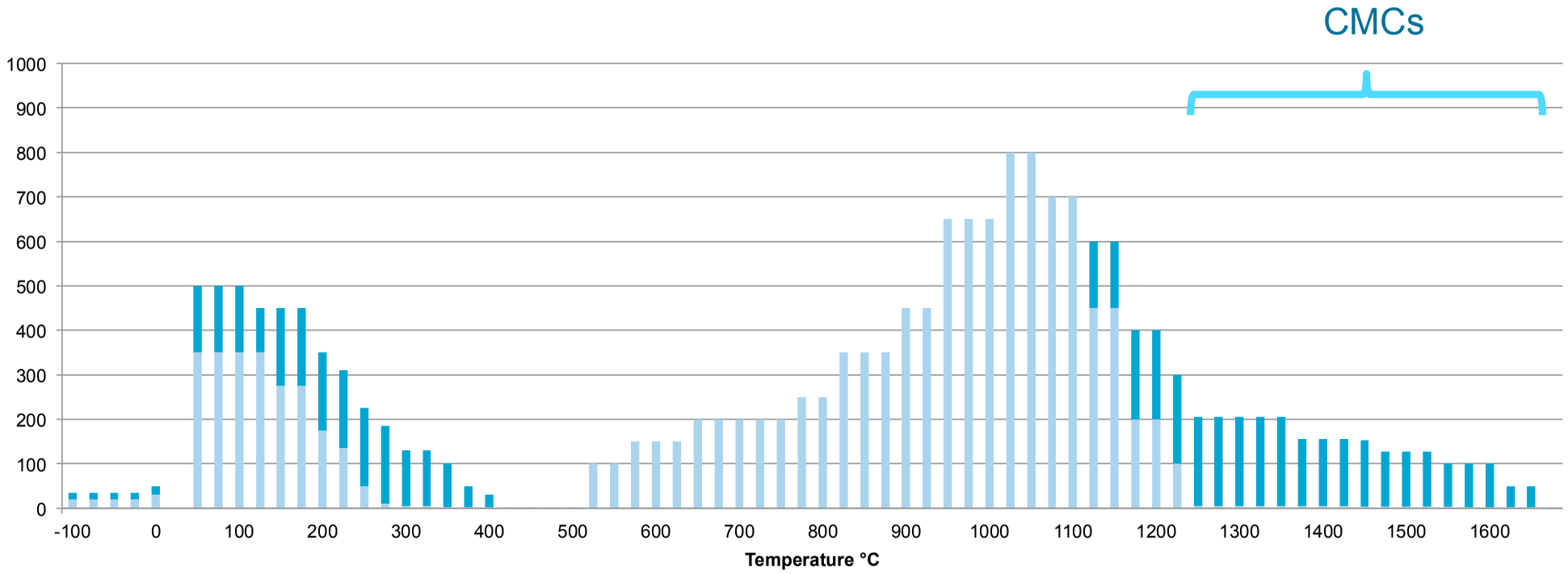
- Industry typically consists 250°C systems.
- Re-capitalization of infrastructure
- Re-think heating methods with consideration to other challenges: strain, fixtures and test durations

PMC 400°C Fixture / Test Duration Challenge

- Testing at 350°C can be 4X longer than at 200°C
- Re-think fixture's material and mass
- Localized heating where possible

Advanced Materials, Testing Challenges

Illustration of Mech & Fatigue Test Capability / Capacity - Projected for 2015



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Major Challenges for CMC Testing

- Temperature up to 1,650°C
- Strain Measurement
- Equipment Alignment.
- New Methods for Compression, Shear, Bearing, Flex and others

CMC Testing - Context

- Scalable – 40 to 70 frames
- Limited specimen size due to cost (flat)
- Tensile, Compression, Flex, Shear, Cyclic, D&DT and Component
- Highly repeatable and efficient
- Material handling restrictions

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CMC Temperature Challenges

- Furnace
- Measure and Control
- Grip
- Fixtures
- Instrumentation

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CMC Strain Measurement and Alignment Challenges

- Instrumentation Accuracy & Sensitivity

- Frame
- Gripping
- Fixtures

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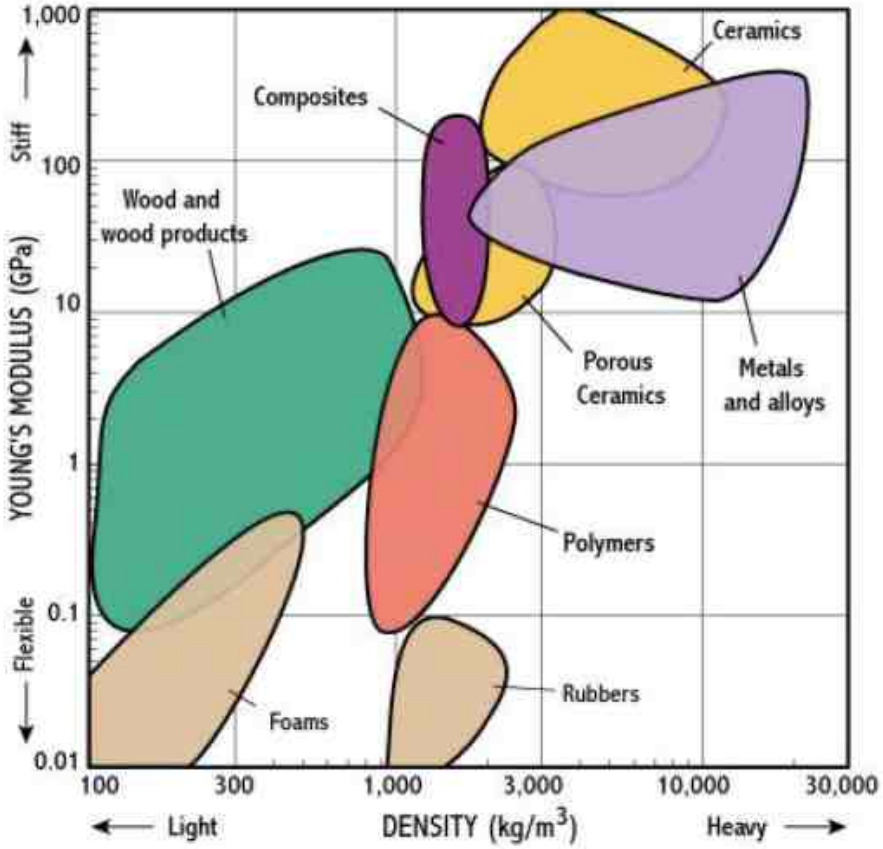
CMC Strain Measurement Challenges



Very high modulus (5X)

Strain measurements require 10X higher accuracy

Deformation measurement is near the limits of commercially available instrumentation

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CMC Strain Measurement Challenge

List of some items filtered out or shielded from strain signal:

- Test Frame Electrical
- Extensometer Electrical
- Hydraulic Pump
- Hydraulic Fluid Actuator
- Hydraulic Fluid Grips
- Cooling Water Grips
- Cooling Water Instrumentation
- Data Acquisition Electrical
- Transient Hydraulic Fluid Oscillations
- Transient Floor Vibrations
- Transient Electrical (lighting, etc)
- Air Temperature Fluctuations
- Air Humidity Fluctuations
- Drafts or Air Movements
- Electrical Power Fluctuations
- Ext. Water Bath Pump
- Ext. Water Bath controls

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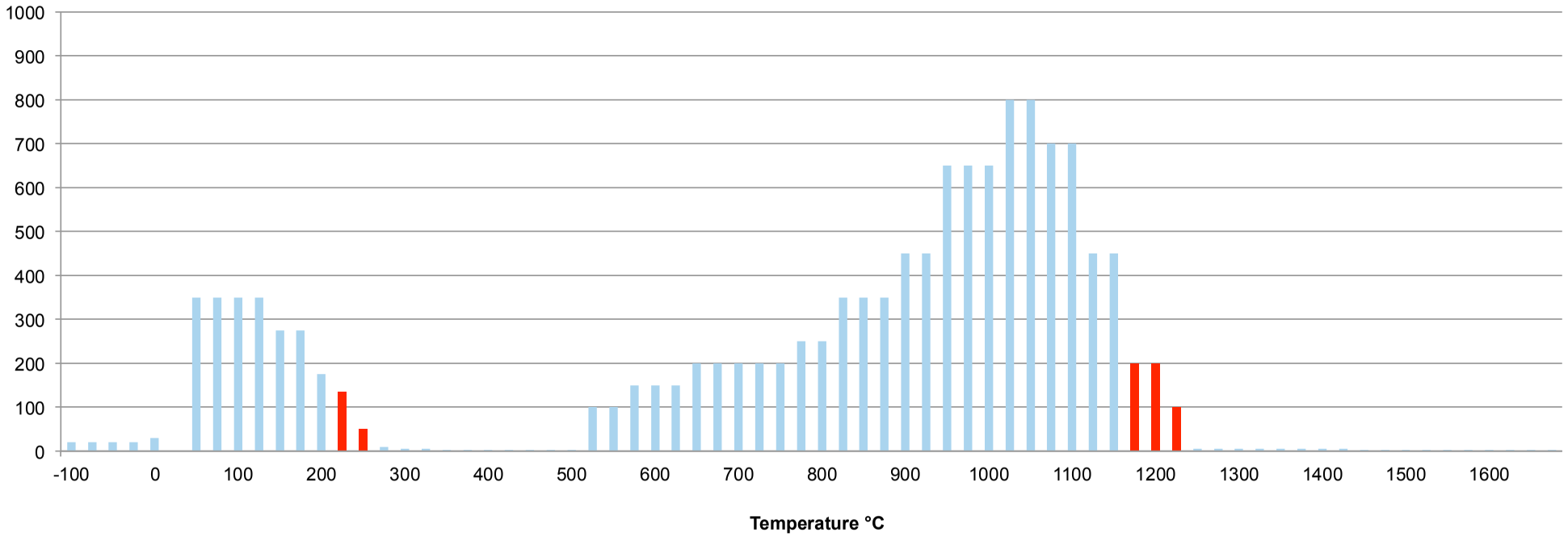
Illustration of Mech & Fatigue Test Capability / Capacity – Change from 1982 to 2012



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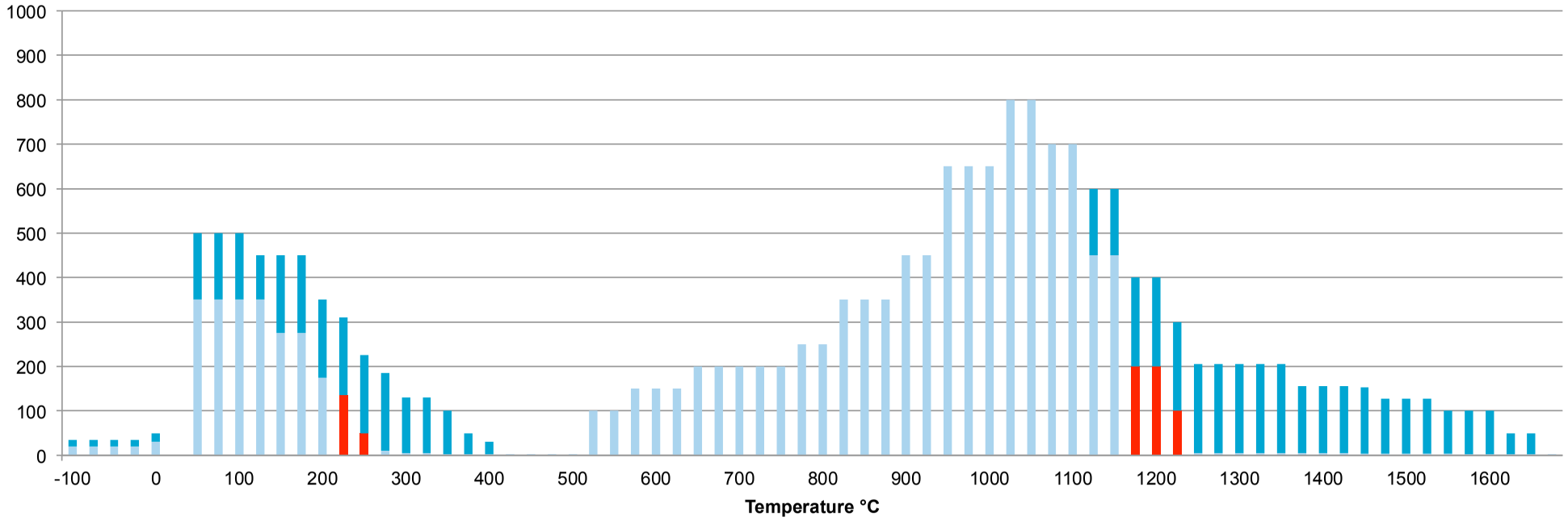
Advanced Materials, Testing Challenges

Illustration of Mech & Fatigue Test Capability / Capacity - Projected for 2015



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High Temperature PMC & CMC Implementation

Thank You