



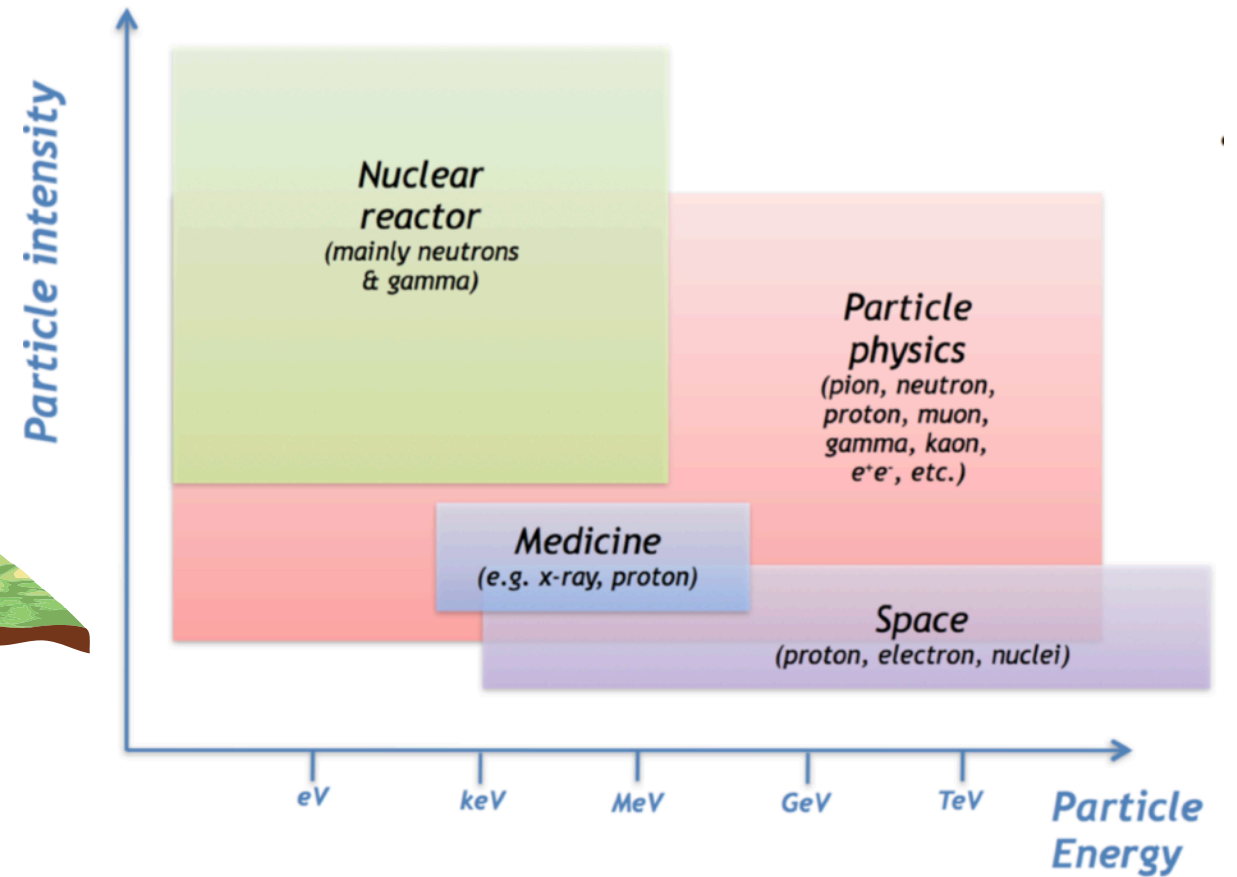
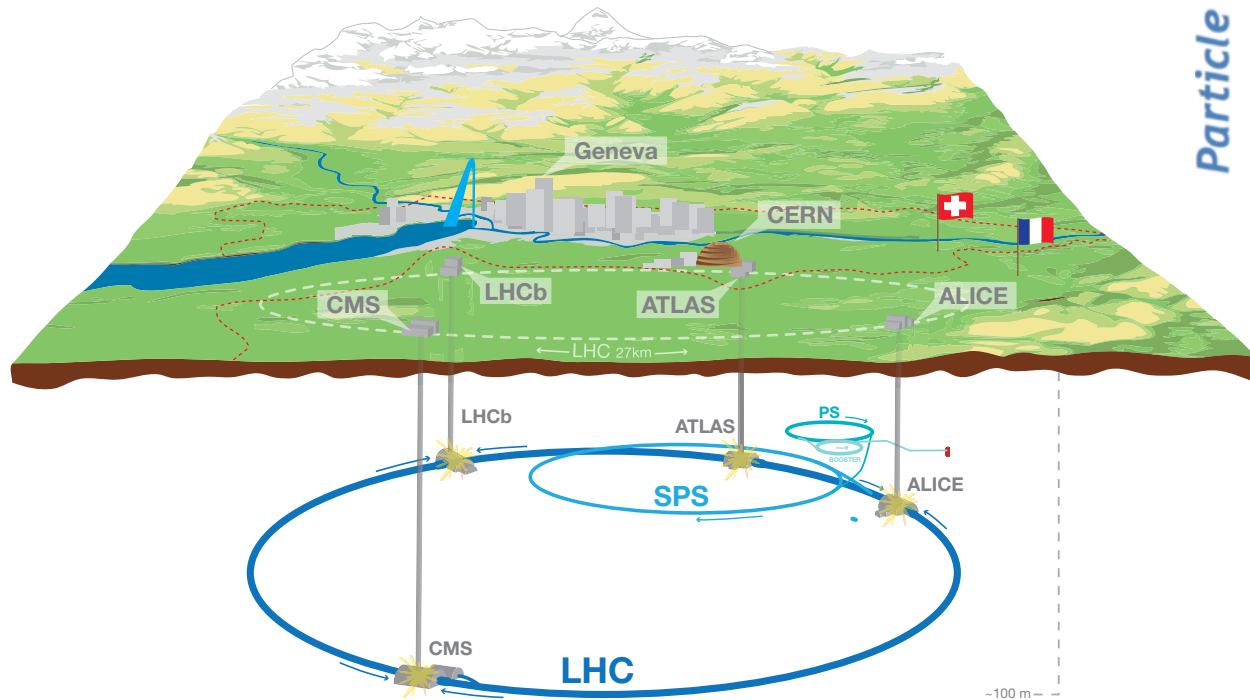
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Industry Links

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LHC Particle physics environment



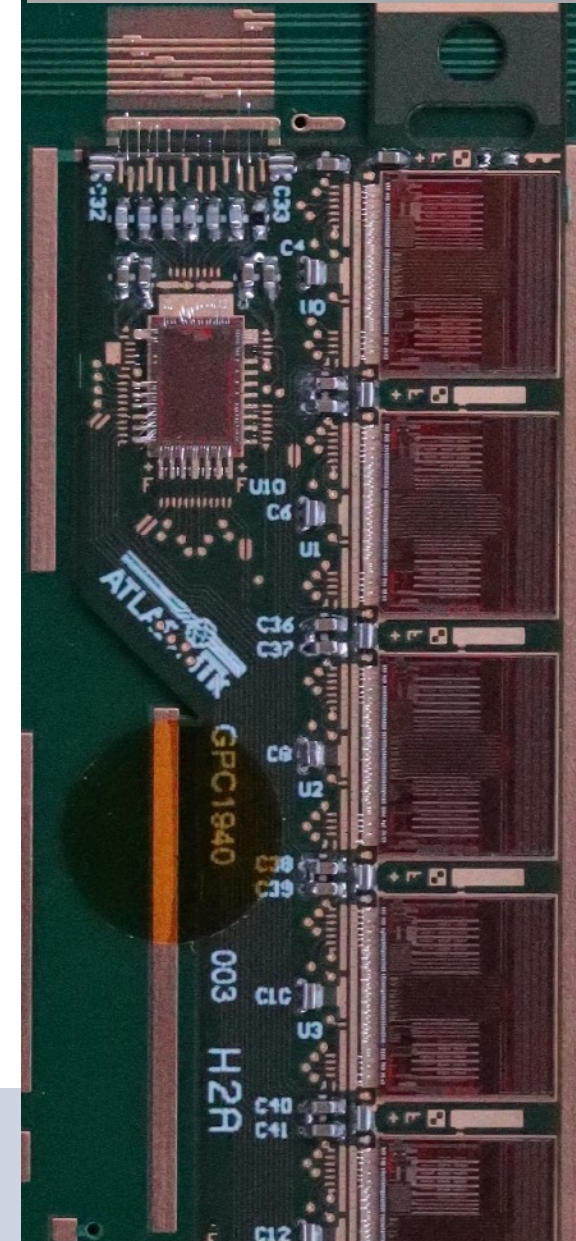
Industry Links

- **The Large Hadron Collider (LHC) requires novel solutions to unique problems**
- **Many off the shelf components will work well**
- **For some parts need to study radiation damage effects to qualify proposed solutions**
- **Some problems needed a lot of academic research to understand, but often required industry to ramp up for “production” of bespoke instruments**
- **We learn from and rely on industry experts to co-create solutions new where necessary**
- **Industry is an unsung hero of the LHC story**

Industry Links: supply chain

- The UK has an excellent manufacturing base covering heavy industry and high-tech components
- Examples include: Ability to source components and materials from around the world and
 - Assemble key parts, such as ceramic electrical brakes in cooling systems for detectors
 - Manufacture PCBs to required specifications, addressing global supply issues of 'qualified' parts
 - Manufacture tooling required for system builds
- Retail sector giants like RS and Farnell are also key to manage just in time assembly

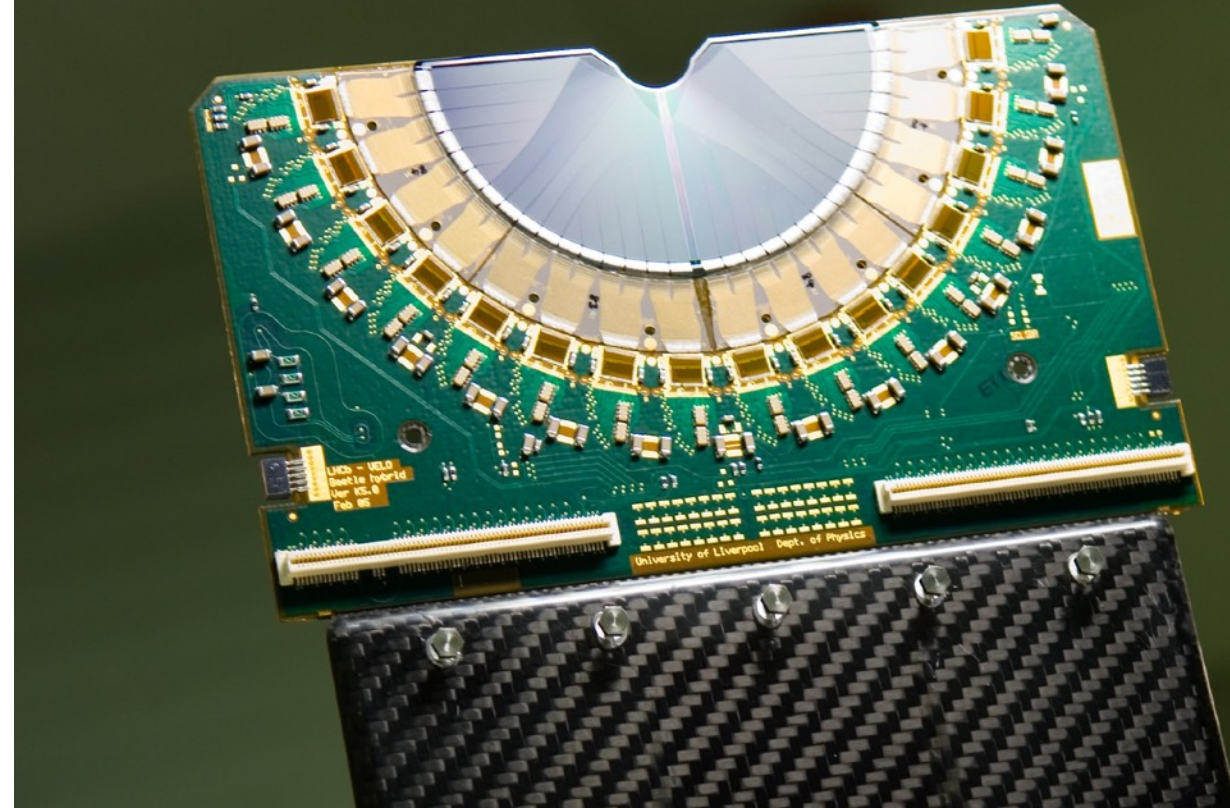
Example: ATLAS upgrade strip barrel hybrid: manufactured by Graphic Plc., populated by Garner Osborne



Industry Links: Co-creation of solutions

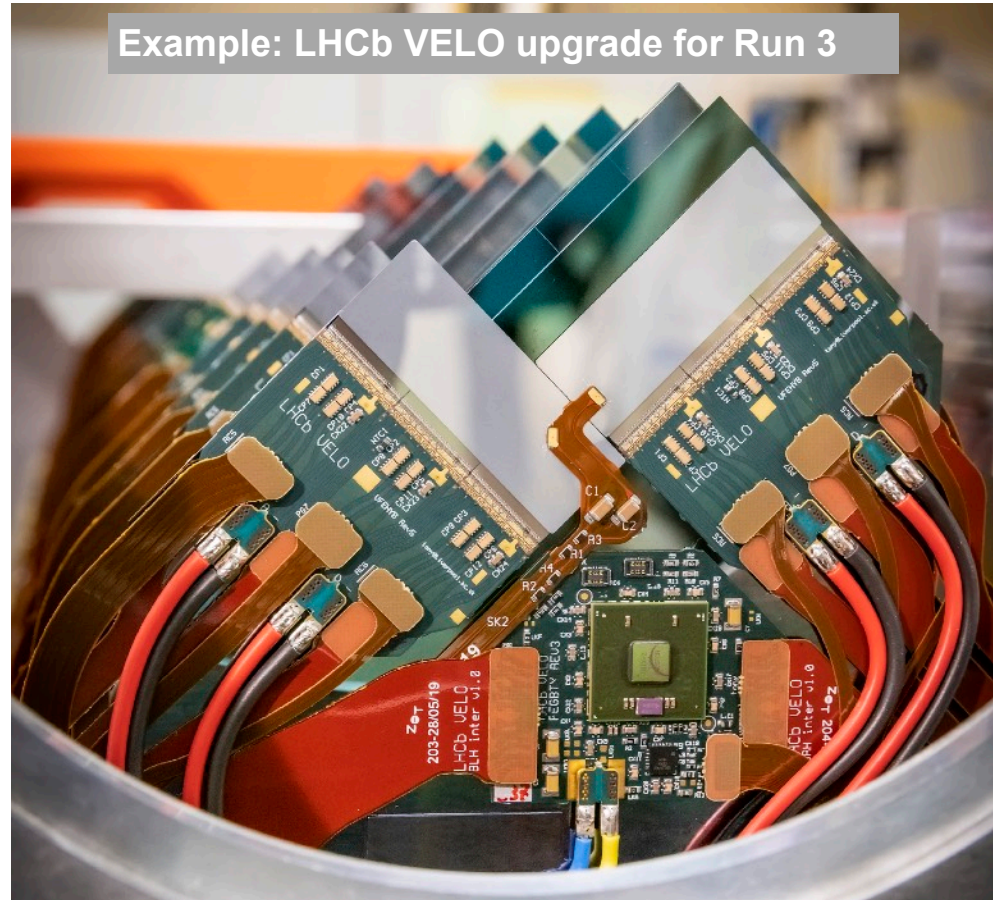
- **SME's are a vital part of the LHC team**
- **Knowledge of cost-effective fabrication methods**
- **Ability to scale up production**
- **Flexibility to try something different**
- **Essential for success**

Example: LHCb VELO - silicon sensors manufactured by Micron Semiconductor Ltd. who worked closely with UK academic groups to develop suitable components for this instrument.



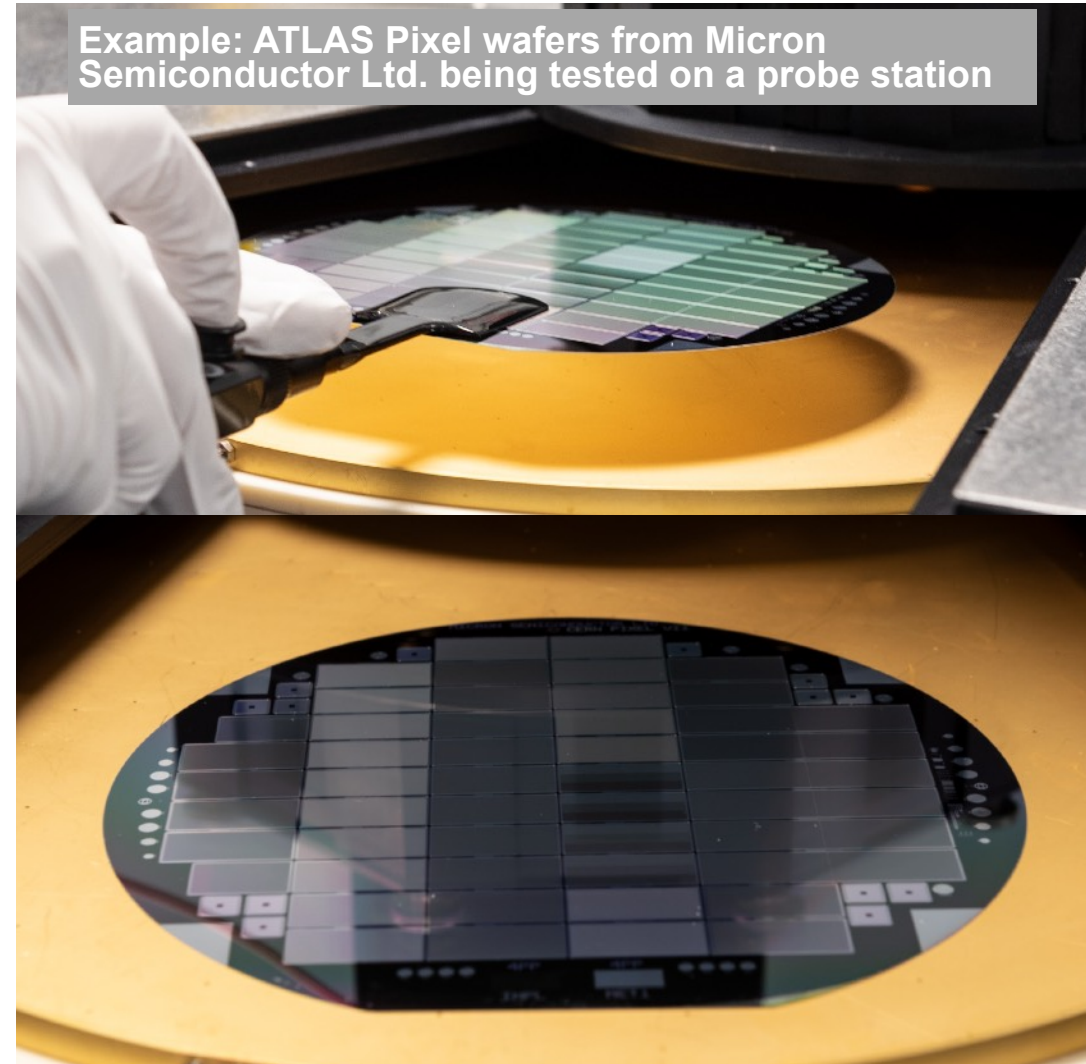
Industry Links: Co-creation of solutions

- SME's are a vital part of the LHC team
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Industry Links: Co-creation of solutions

- **SME's are a vital part of the LHC team**
- **Knowledge of cost-effective fabrication methods**
- **Ability to scale up production**
- **Flexibility to try something different**
- **Essential for success**
- **Other LHC experiments have similar examples**



Industry Links: Long standing partnerships

- The UK's GRIDPP benefits from competitive pricing from industry leaders such as Dell and Viglen
- These are vital for our scientific results and design of detector upgrades
- Other tech companies such as NVIDIA have played significant roles with LHC academics holding industry fellowships
- An army of companies provide equipment, training, and maintenance for universities and laboratories.
- These are all essential components of the UK's LHC academic community

Example: Lord Sugar opening an upgraded PC farm at QMUL



Example: Clean room used for sensor testing for the ATLAS upgrade programme

Industry Links: ... once the LHC is built

- Big science enhances technical capabilities of academia and industry
- Can lead developing new solutions for real world problems and industry-academia networks fuel the next generation of instrument construction
- The community is working with Micron and EEV to developing LGAD technology for future accelerators

pa PRECISION ACOUSTICS
Innovate UK
 Radiation resilient ultrasonic transducers

Designed for ambient temperature inspection and NDT applications in high radiation environments, Precision Acoustics' RRUUS transducers have been tested up to a cumulative Gamma dose of 9.5 MGy with almost no change in performance up to doses of 2 MGy.

Transducers are available from 5-20 MHz and incorporate a 20 ms delay line as standard. Additional radiation shielding and/or delay line lengths can be supplied by request to allow greater radiation exposure or to allow probes to be fitted into existing systems with specific size requirements for sensors.

HotSense™ monitoring in the nuclear environment
 for Wall Thickness and Gas Void measurements

1. Scope of this Technical Note

Ultrasonic testing (UT) transducers are used in the nuclear non-destructive testing (NDT) industry for various applications including wall thickness integrity monitoring and gas void locating and sizing. Traditionally, these measurements are made manually by inspectors who must physically hold the UT transducer onto the measurement location, often in hazardous environments including ionising radiation, high temperatures and working at height or in confined spaces. Installed, fixed point, UT transducers can be used with other automated remote monitoring systems or with cables which extend to safe zones. Fixed UT transducers promote a safer and more efficient maintenance program with the following key areas of benefit:

1. **Increase safety** by reducing exposure of employees to hazardous environments
2. **Minimise the dose** of radiation staff incur when performing their duties by reducing the time spent at the location
3. **Reducing the total time** required to collect measurements by removing the challenges of restricted access i.e. no need for rope access or scaffolding

Radiation endurance of commercially available UT sensors/transducers is limited to cumulative doses of only 1 to 2 MGy, even for models branded as radiation resistant. Severe operational difficulties can occur due to unexpected UT transducer failure and resource waste (replacement is both time consuming and expensive). Additionally, to successfully monitor whilst the plant is in service, requires resilience to high operating temperatures (up to 350 °C).

The IoniX HotSense™ ultrasonic transducer platform is designed for operation in these extreme environments, with continuous operation viable up to 380 °C and beyond. Previous testing for the radiation resilience of the low MPZ piezoelectric material alone, demonstrated no significant degradation upon a cumulative gamma dose of 8 MGy.

Hence, the suitability of the HotSense™ transducers for monitoring in nuclear environments is shown, with exposure to both gamma and neutron ^{240}Pu α neutron fluxes.



Summary

- Industry is vital to support our big science goals:
 - An essential part of the research ecosystem
 - Augment the expertise of university and national laboratory facilities
 - Expert in cost effective fabrication - valuable knowledge feeding in from their customer base to the scientific community
 - Ability to create something “new” and translate tech from R&D to production line

Also see the Technopolis report “[Evaluation of the Benefits that the UK has derived from CERN](#)”