ATLAS Upgrade and Related Topics

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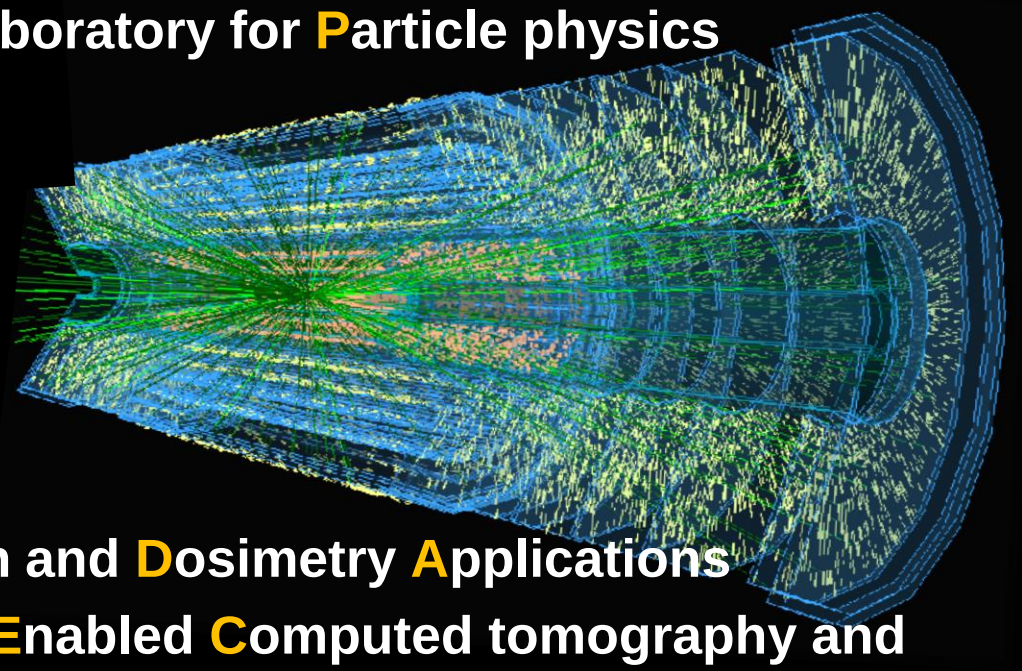
+ Steve Worm (since Monday)

UNIVERSITY OF BIRMINGHAM

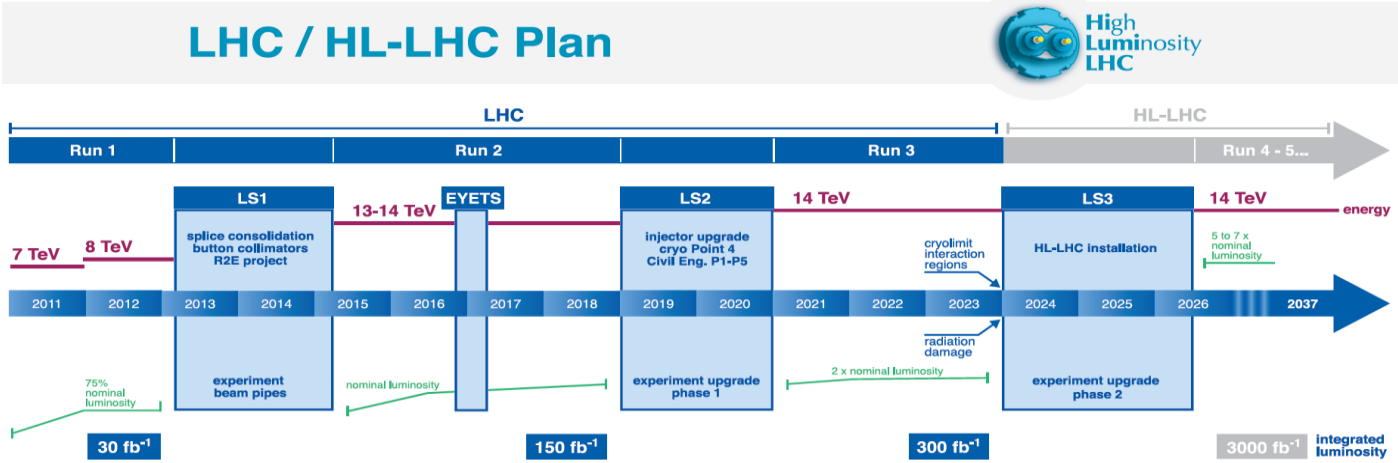
30/09/15

- International Context
- UK Programme and Birmingham Roles
- Birmingham Instrumentation Laboratory for Particle physics and Applications (BILPA)
- Hybrid and Module Assembly
- DAQ R/O and Testing
- ATLAS Irradiations
- Beyond ATLAS Upgrade: FCC
- Proton Radiotherapy Verification and Dosimetry Applications
- Son of PRaVDA, Single Particle Enabled Computed tomography and dose Tracking Radiotherapy Equipment (SPECTRE)



International Context

- **Formal approval High Luminosity LHC (HL-LHC) by CERN Council (17/6/16) along with CERN Medium Term Plan, building on European Strategy for Particle Physics (adopted by Council in May 2013) and US Particle Physics Project Prioritisation Panel (2014: "first high priority large-scale project").**



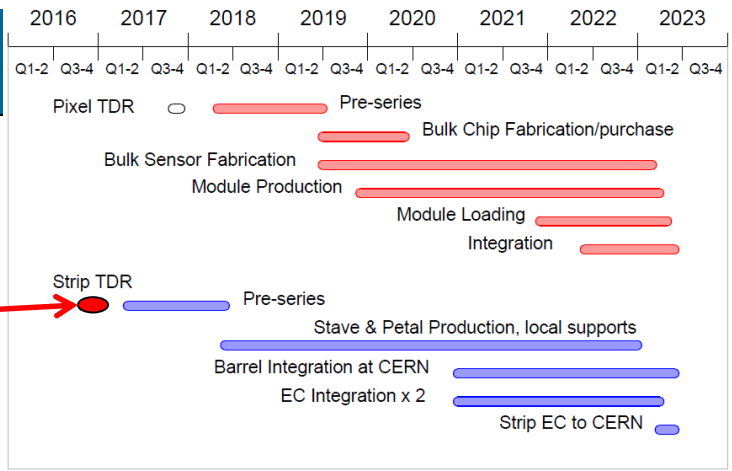
- **Next update for European Strategy expected 2019 (*cf* target for FCC studies).**

- **ATLAS Scoping Document (https://cds.cern.ch/record/2055248?ln=en) approved by Resource Review Board with recommendation to proceed based on funding between Reference and Middle level**

Scoping Scenarios		
Reference (275 MCHF)	Middle (235 MCHF)	Low (200 MCHF)

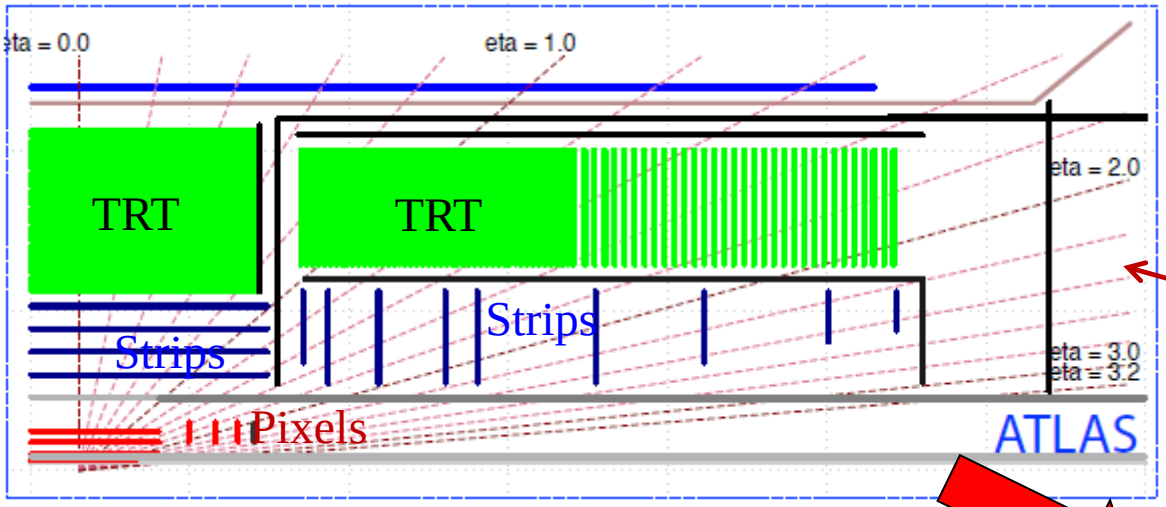
- **Phase 2 Technical Design Reports expected mostly expected by LHCC in 2017 with first TDR (ITk strips) due by end of this year (at 322 out of ~500 pages).**

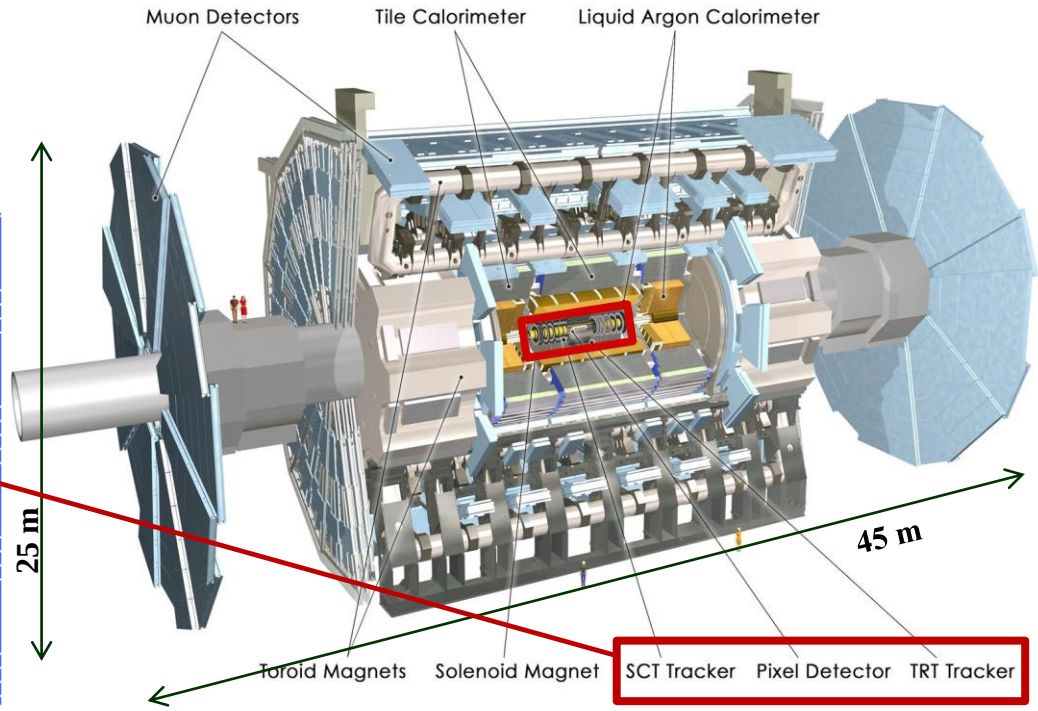
(LG writing electronics section, PA one of 5 editors)

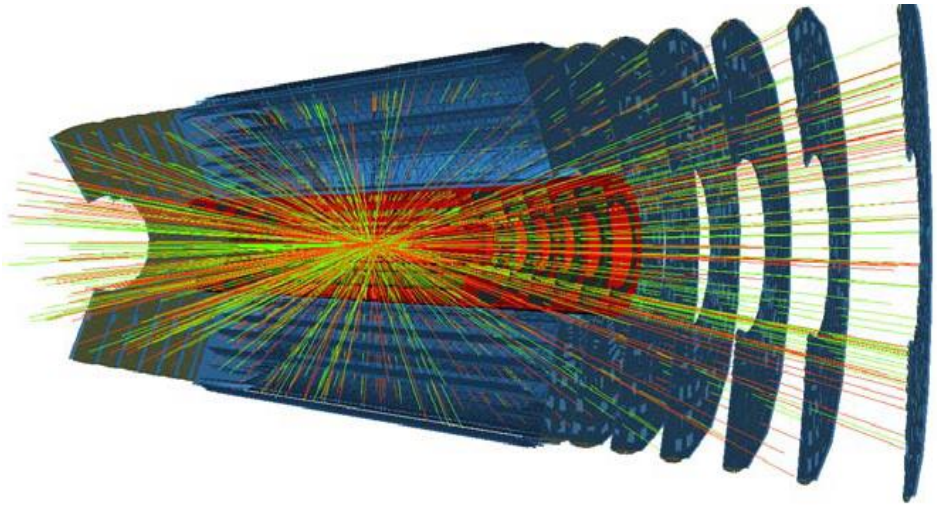


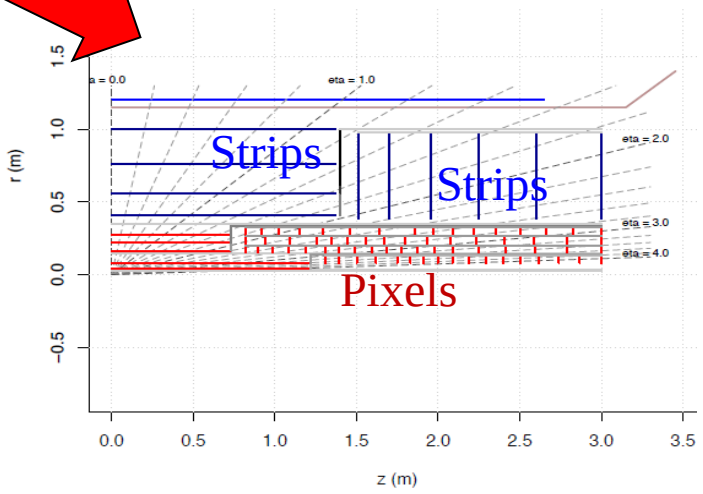
ATLAS Tracker Upgrade

- HL-LHC: 10× LHC integrated luminosity, 7.5× LHC nominal instantaneous luminosity
  - ➢ 10× radiation levels, data volumes and data rates
  - ➢ 7.5× hit densities (pile-up) per beam crossing
  - → Need major upgrades and new tracker
  - → Opportunity for tracking in Level-1 trigger









- Pixel area ~15m^2 (= 10,000 pixel modules)
- Silicon strip area ~165m^2 →100m^2 barrel strips (= 11,000 barrel modules)
- With spares means of order 14,000 needed to be split 50:50 UK:USA

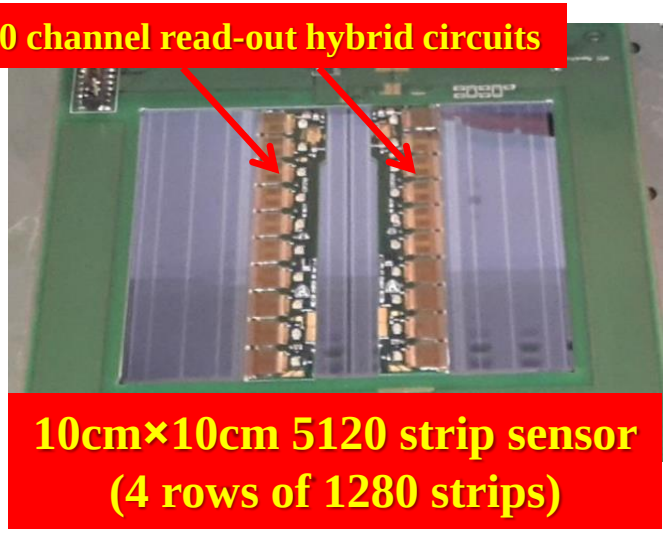
ATLAS Tracker Upgrade

- LG is the International Strip ASIC Co-Coordinator and PA is on the Upgrade TDAQ Architecture/Readout Sub-committee (and both busy with TDR)
- Birmingham R&D has focussed on glue studies, assembly techniques, development of strip module read-out and Quality Assurance
- For the UK in the construction phase of the strip modules we will contribute specifically to three task areas outlined below.
- **Work Package 1 Strip Module Production**

TASK	Description	Institutes	SY
1.3	Hybrid Assembly and QC	Birmingham, Liverpool, Sheffield, Warwick	8.6
1.4	Module Assembly and QC	Cambridge, Birmingham, Glasgow, Liverpool, RAL, Sheffield, Warwick	62.3

- **Work Package 9 Systems and Irradiation Support**

TASK	Description	Institutes	SY
9.6	Irradiation Programme	Birmingham, Lancaster, Liverpool	8.6



- Key to these activities both for completion of the R&D phase and for production are the facilities of **B**irmingham **I**nstrumentation **L**aboratory for **P**article physics and **A**pplications (BILPA) into which our assembly and DAQ equipment have now been moved.

Birmingham Instrumentation Laboratory for Particle physics and Applications

BILPA

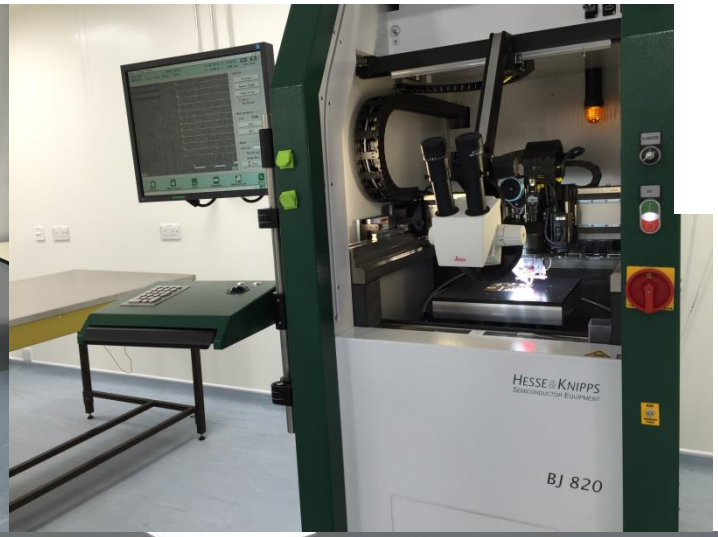
- **180m² of new and reconditioned cleanroom laboratory space for both ITk strip module production and R&D on novel radiation-hard detector development**

Hesse & Knipps BondJet 820 automatic wire bonder (ISO-5)

OGP SmartScope CNC 500 Coordinate Measuring Machine (ISO-5)

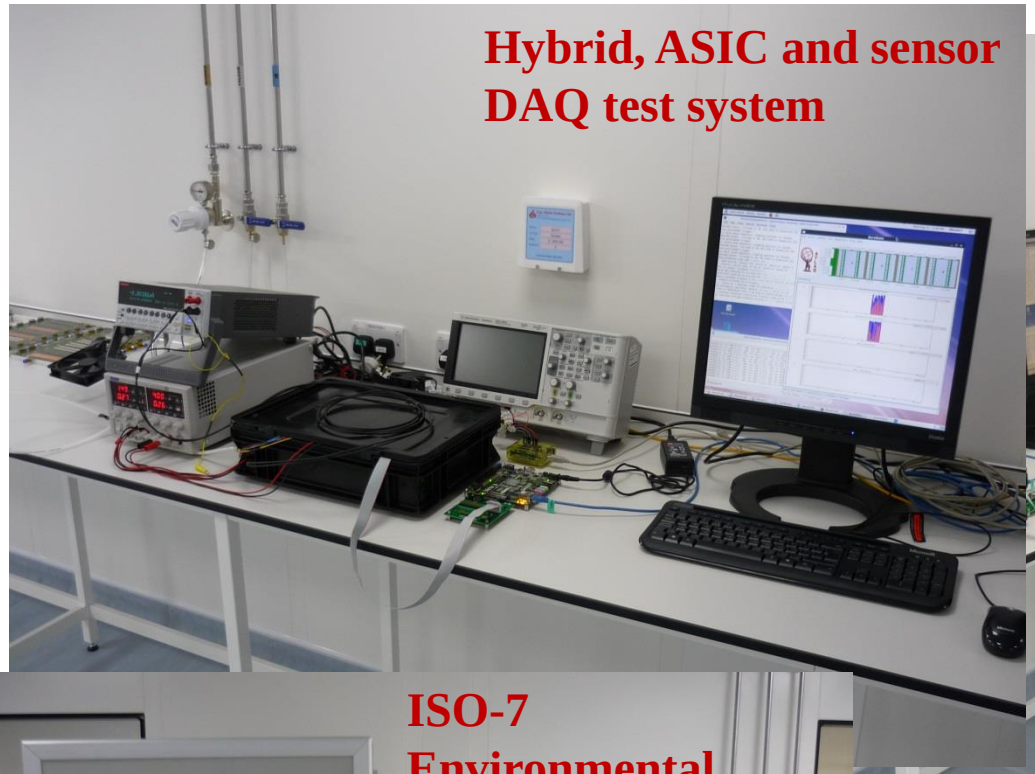
Hybrid and Module Assembly (ISO-5)

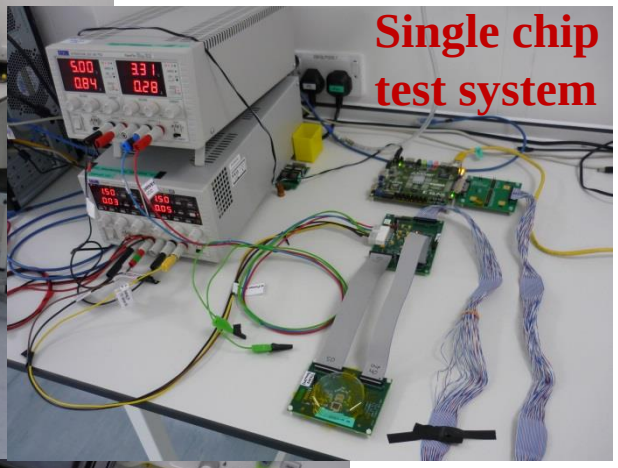
BILPA

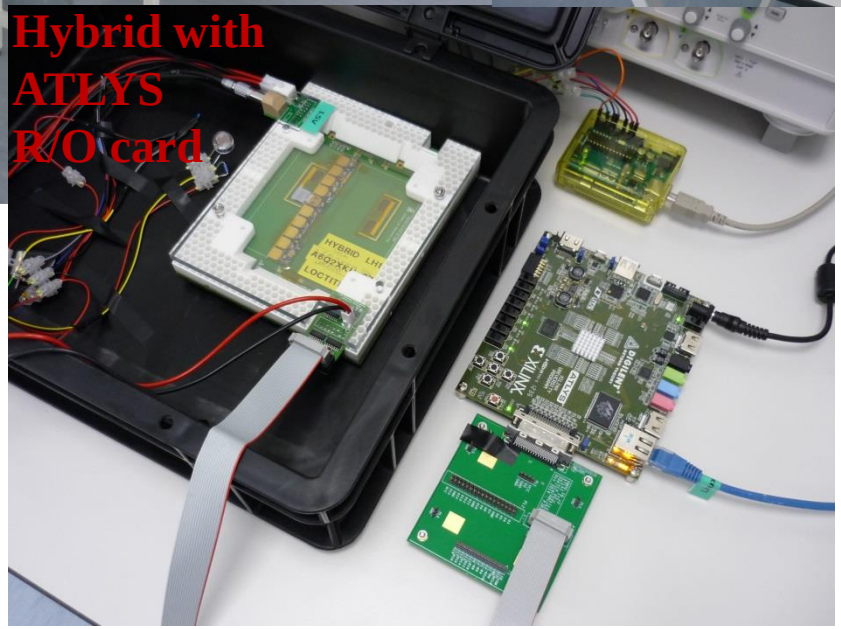


DAQ, Read-out and Testing (ISO-7)

BILPA

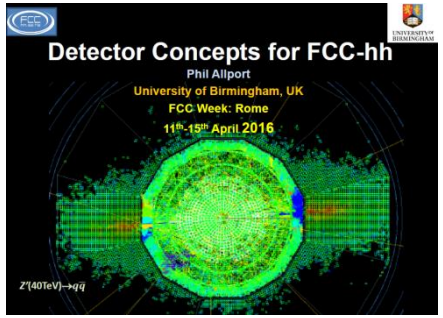


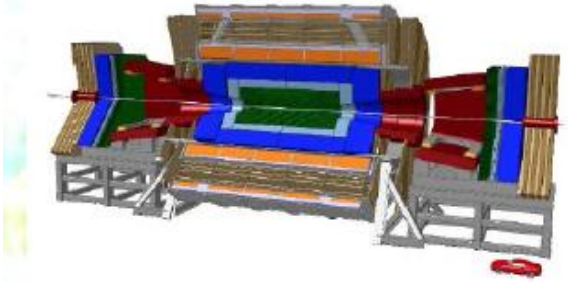




Irradiations for HL-LHC and Future Colliders (ILC, FCC, EIC, LHeC, …)

- Birmingham R&D on irradiating ATLAS components including electronics and sensors (*see talk by LG*).
- Irradiations as AIDA 2020 Transnational Access Facility (*see talk by LG*).
- R&D on **M**onolithic **A**ctive **P**ixel **S**ensors (MAPS) in High Voltage HV-CMOS or High Resistivity HR-CMOS sensors (*talk by LG*).
- Rad-hard MAPS R&D for *possible* use in ATLAS upgrade tracker (pixel outer layers?) but development time for HL-LHC very aggressive in terms of schedule.
- Huge potential for future facilities both in terms of fast, narrow charge collection (**ILC, EIC, LHeC**) and radiation tolerance (**FCC-hh**) with potential for costs as low as standard CMOS chips (> cm^2/\$) making up to $10^4 m^2$ possible in future.

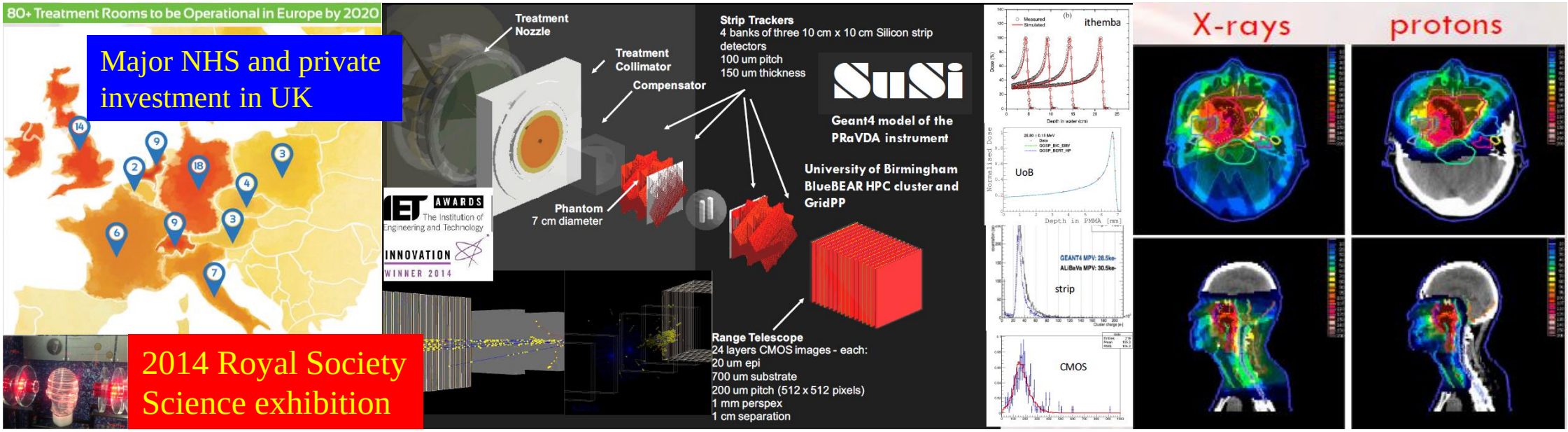




- Also promises applications where radiation can be an issue for more standard CMOS sensors (eg radiotherapy esp **hadron therapy**).

Proton Radiotherapy Verification and Dosimetry Applications

- Stopping protons (or ions) give lower doses to non-target tissue
- Strip sensors for proton tracking and energy measurement through stopping distance (Perspex-silicon range telescope)



- Range telescope strip modules largely assembled, wire-bonded and tested at Birmingham
- Full system test and radiation studies also at Birmingham MC40

(Son of PRaVDA, Single Particle Enabled Computed tomography and dose Tracking Radiotherapy Equipment)