


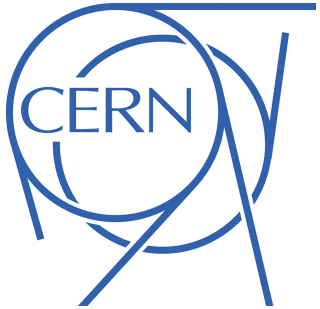

Measuring Single Event Upsets in the ATLAS Inner Tracker

Noah Lupu-Gladstein

April 9th, 2015

High Luminosity (HL) LHC and ATLAS

- “A highly performant tracker underpins the entire ATLAS physics program”[1]
- “The much harsher radiation and occupancy conditions of the HL-LHC necessitates a complete replacement of the present ID” (Inner Detector)[1]

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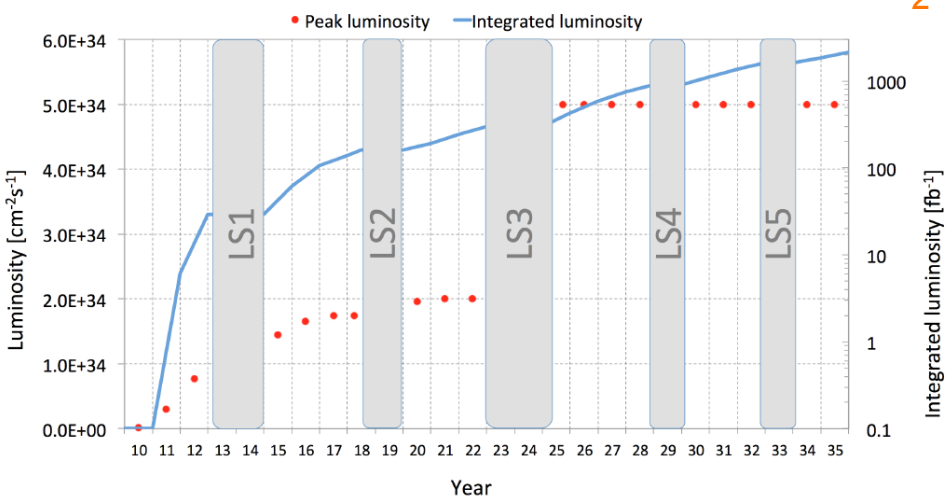
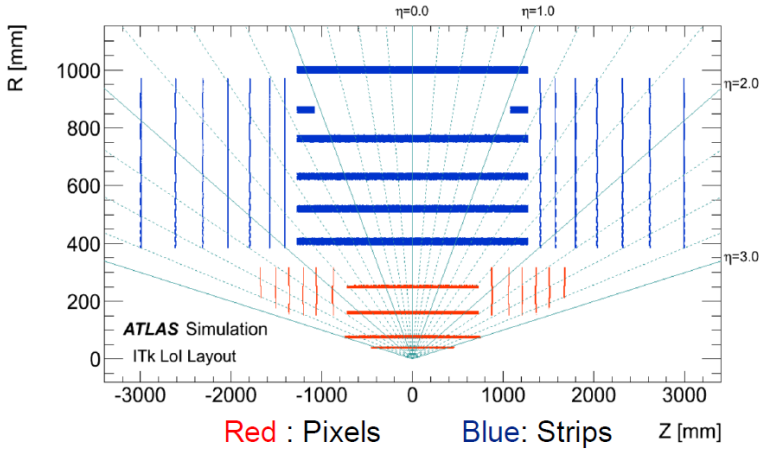
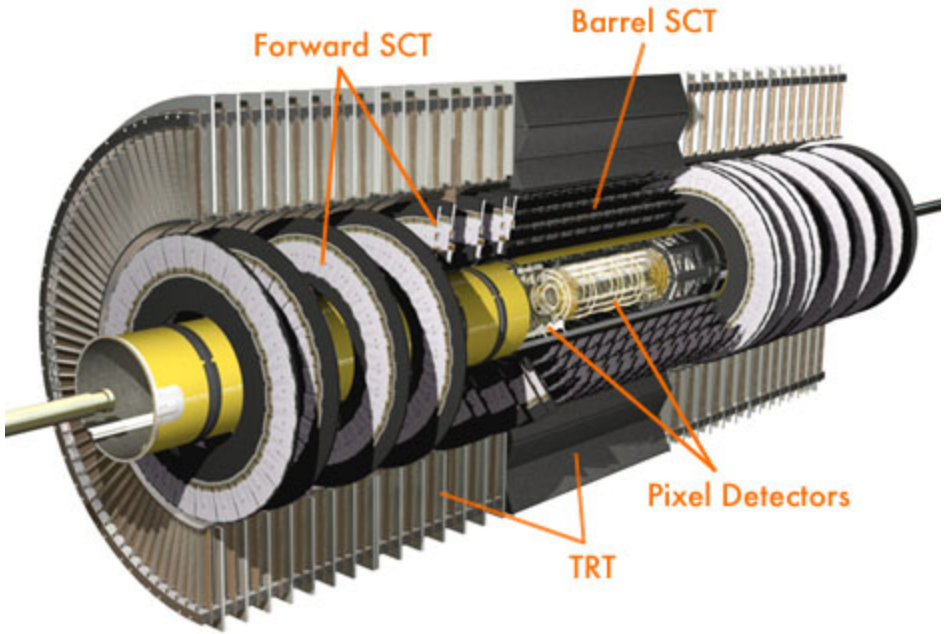


1. ATLAS Letter of Intent Phase-II Upgrade
2. LHC Commissioning. http://lhc-commissioning.web.cern.ch/lhc-commissioning/schedule/LHC-schedule-update.pdf

The ATLAS Inner Detector

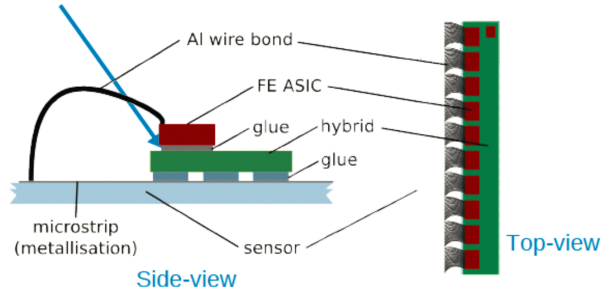
- SCT = SemiConducting Tracker
- Use Silicon to detect charged particles





Strip Detector Design

3 >Glue and wire bonds



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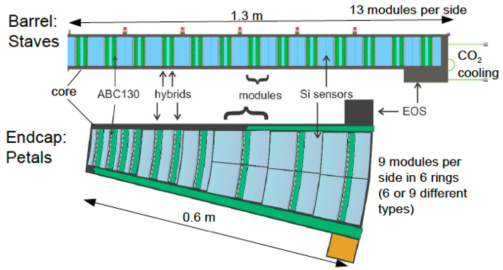
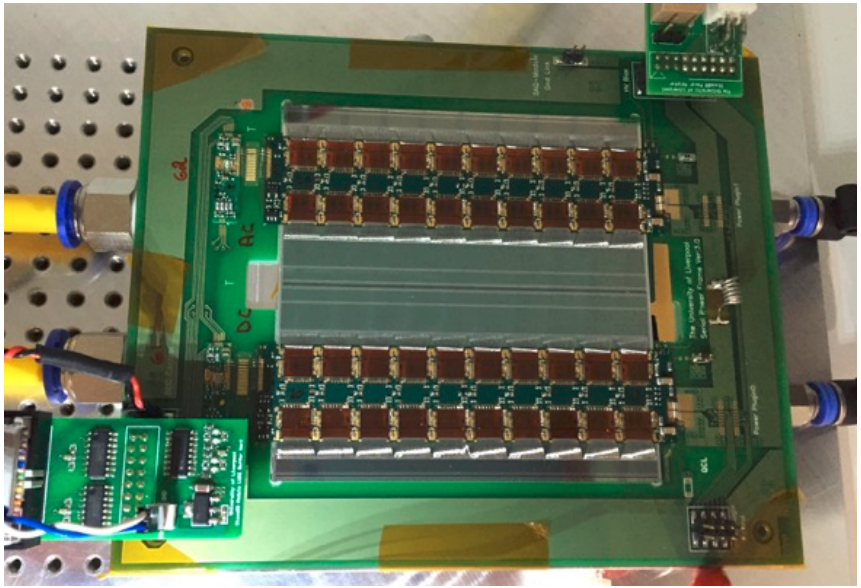


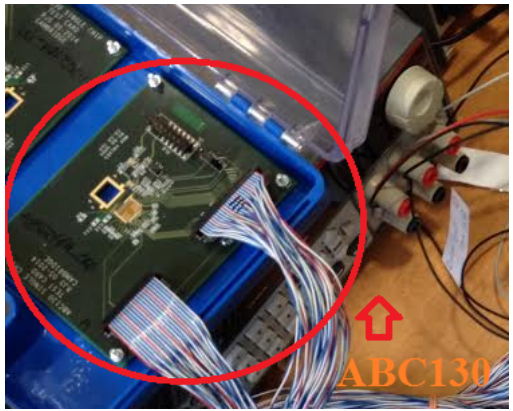


3. FRAIS-Workshop “From Silicon Sensor to Full Detector System”. Richard Teuscher. https://indico.cern.ch/event/382226/contribution/1/material/slides/0.pdf

The ABC130

Higher luminosity means:

- More pileup
- More radiation damage



The ABC130 significantly differs from the ABCn and predecessors. [4]
The main changes are listed below:

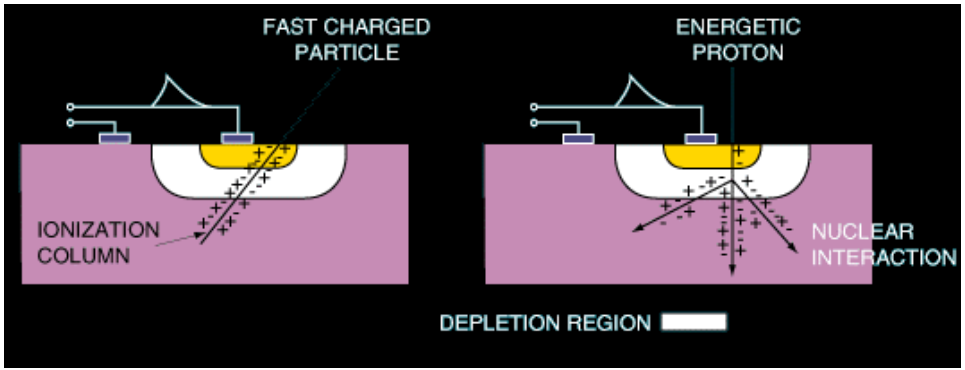
- 130nm CMOS technology
- 1.3V external power supply
- Three Trigger types, L0, R3 and L1 control the data flow.
- Fixed Length data structure with multiple data types.
- Xon / Xoff flow control between chips.
- Readout clock up to 160Mbits/sec.
- Readout mode compatible with an external Hybrid Controller Chip, HCC
- Bonding pads arrangement, chip size fitting to the hybrid prototype
- SEU errors handling
- I/O and register scan through JTAG
- Fast cluster finder logic

4. ABC130 Specifications. https://indico.cern.ch/event/227566/material/0/0.pdf

Single Event Effects (SEE)

- High-energy charged particle interferes with device operation

- Single Event Latchup (SEL)
- Single Event Burnout (SEB)
- Single Event Upset (SEU)



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5. Single Event Effects. http://holbert.faculty.asu.edu/eee560/see.html

The ABC130 and SEUs

- SEUs are “soft” errors
- Harder to detect during operation
- ABC130 uses register triplication

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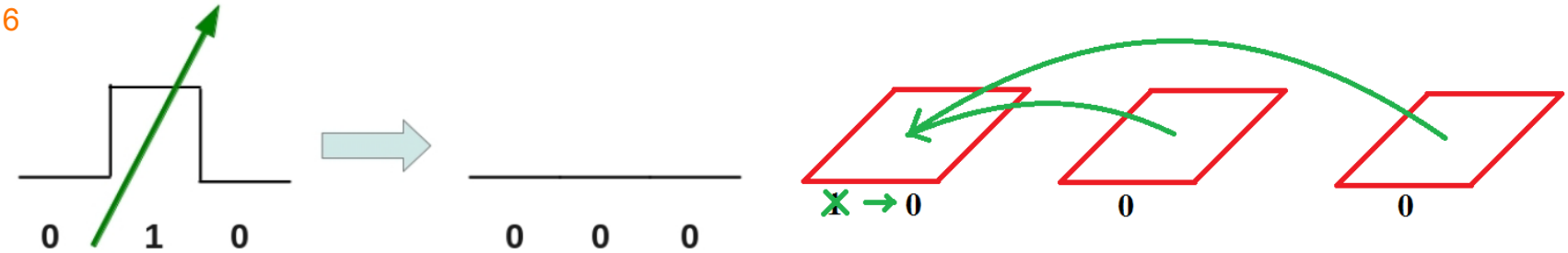


6. DAQ for SEU Studies on ABC130 chips. Richard Teuscher, Kyle Cormier, Noah Lupu-Gladstein, Luigi Vigani, et al. https://indico.cern.ch/event/361445/session/18/contribution/32/material/slides/0.pdf

Experimental Goals

Report an approximate measurement of SEU cross section and validate triplication correction

Dependent Variable:

- SEU cross section

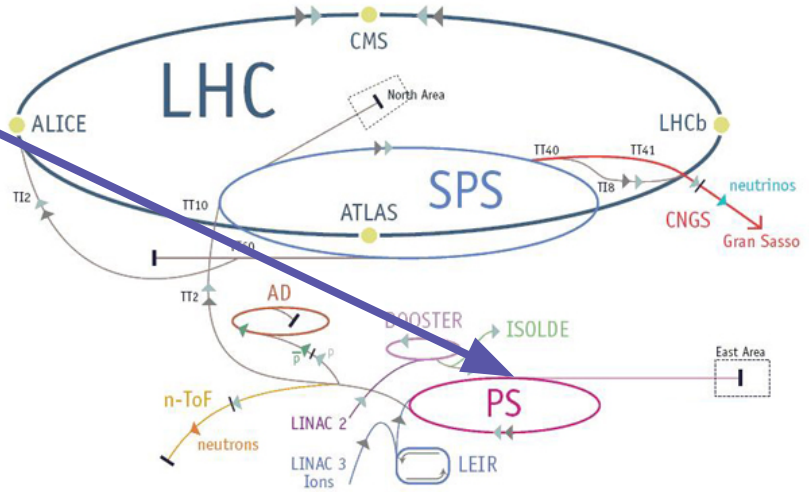
Independent Variables:

- Fluence
- Current consumption
- Other Diagnostics

Test Beam

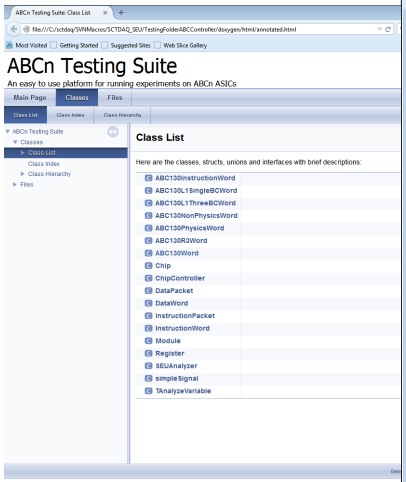
Cern High energy AcceleRator Mixed field facility (CHARM):

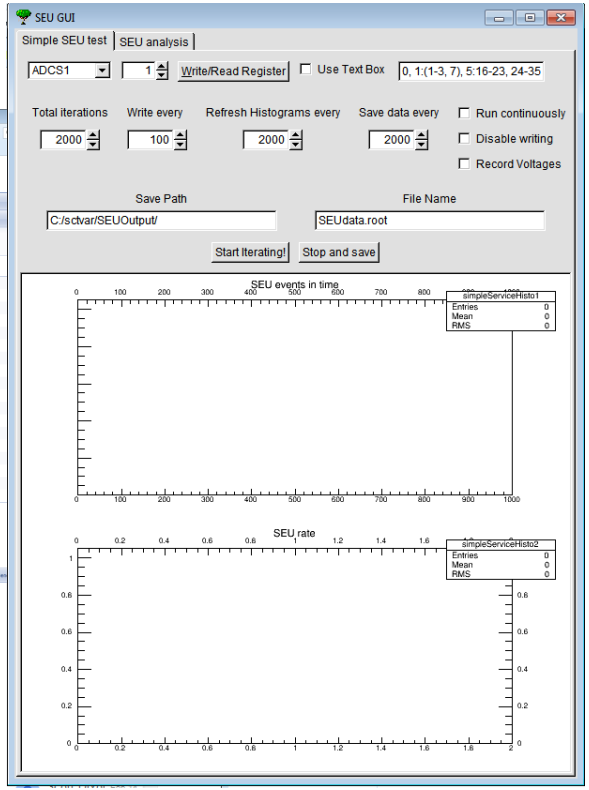
- 24 GeV/c protons
- One spill every ~300ms
- 2 x 10^9 protons/cm^2/spill
- $O(10^{14})$ per cm^2 a week[6]

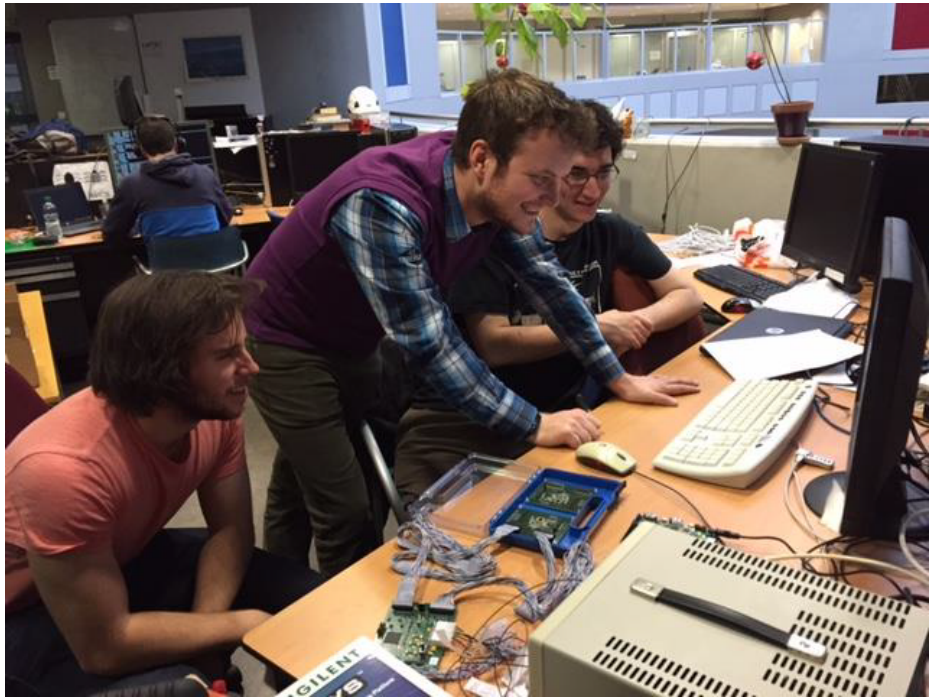


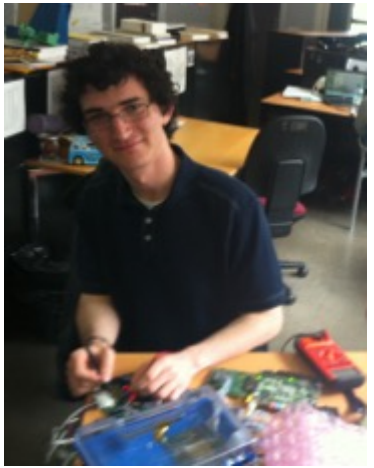
Software

- Write and read registers continuously
- Inject “physics” data
- Record Diagnostics (eg: *temp, I, V*)
- Catch SEU Flags
- Analyze Data
- User-friendly
- Integrate with existing software









Thank you!