CERN

Readout Chain Testing for ATLAS ITk Strip Detector

Kyle Beyer, kyle.beyer@cern.ch
Dylan Hatch, dylan.brown.hatch@cern.ch
Mentors: Richard Teuscher & Olivier Arnaez

11 Oct 2018

Agenda

Background
- ATLAS & the Inner Detector
- HL-LHC & ITk
- ITk Design and Readout

Lab Testing of Hybrid Chips
- Testing Setup
- Progress & Goals

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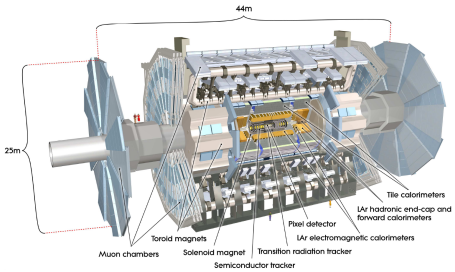
ATLAS & the Inner Detector

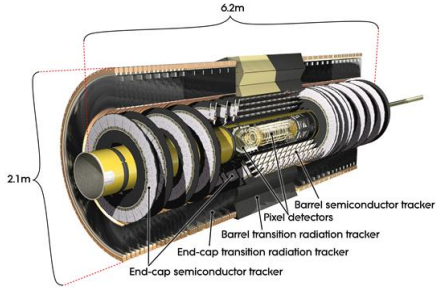
ATLAS Detector

- Inner Detector
- Calorimeters
- Muon Spectrometer

Inner Detector

- Pixel Detector (PIX)
- Semiconductor Tracker (SCT)
- Transition Radiation Tracker (TRT)





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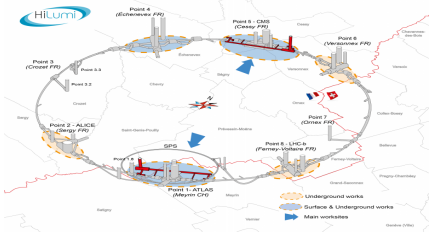
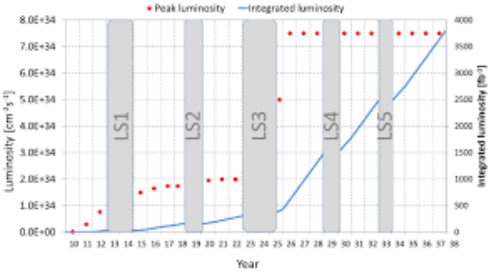
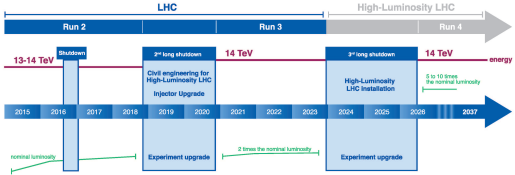
High Luminosity LHC & ITk Upgrades

3x increase in instantaneous luminosity!

- L =2e73 fb^{-1} s^{-1} $\rightarrow$ L = 7e73 fb^{-1} s^{-1}



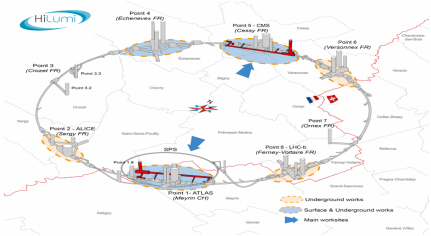


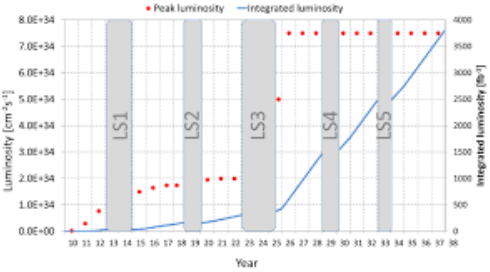


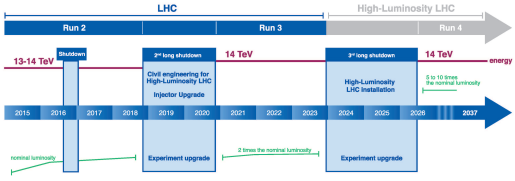
High Luminosity LHC & ITk Upgrades

3x increase in instantaneous luminosity!

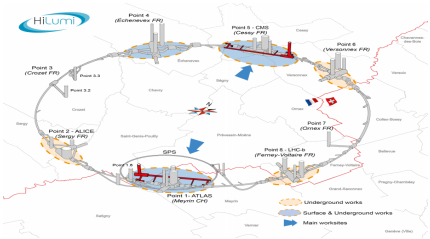
- $L = 2\text{e}73\ \text{fb}^{-1}\ \text{s}^{-1} \rightarrow L = 7\text{e}73\ \text{fb}^{-1}\ \text{s}^{-1}$
- **More particles, more problems**







High Luminosity LHC & ITk Upgrades



$3x$ increase in instantaneous luminosity!

- $L = 2\mathrm{e}73\ \mathrm{fb}^{-1}\ \mathrm{s}^{-1} \rightarrow L = 7\mathrm{e}73\ \mathrm{fb}^{-1}\ \mathrm{s}^{-1}$

The inner detector has insufficient:

- radiation hardness
- granularity
- readout bandwidth
- trigger readout

High Luminosity LHC & ITk Upgrades

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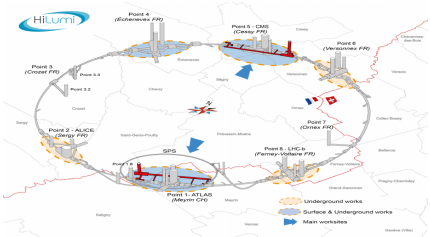

The inner detector has insufficient:

- radiation hardness: HL-LHC will deliver 4000 fb^{-1} integrated luminosity, ID PIX is designed for 400 fb^{-1}, ID SCT for 700 fb^{-1}, IBL for 800 fb^{-1}

High Luminosity LHC & ITk Upgrades

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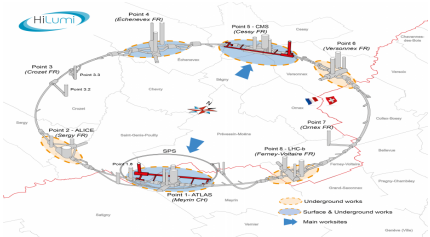

The inner detector has insufficient:

- granularity: Increasing fluence means higher granularity is needed to maintain performance; compensate for instrinsic dead time

High Luminosity LHC & ITk Upgrades

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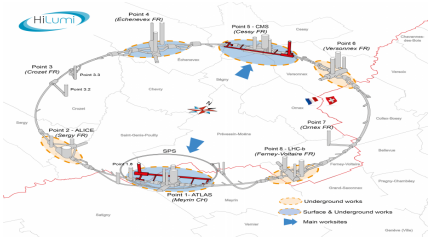


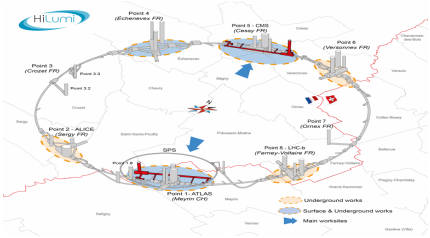
The inner detector has insufficient:

- readout bandwidth: HL-LHC will roughly quadruple ID designed bandwidth saturation

High Luminosity LHC & ITk Upgrades

$x10$ increase in instantaneous luminosity!

- $L = 1e73\ \text{fb}^{-1}\ \text{s}^{-1} \rightarrow L = 1e74\ \text{fb}^{-1}\ \text{s}^{-1}$
- **More particles, more problems**



The inner detector has insufficient:

- trigger readout: readout chain must accomadate much higher hardware (level 1) trigger rate, and ideally include tracking info

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$x10$ increase in instantaneous luminosity!

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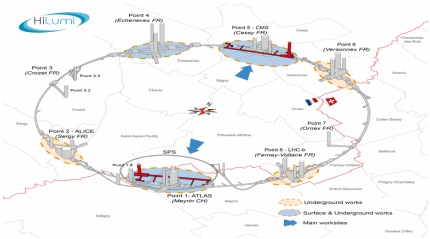

Goal of ITk:

Same or better performance than ID in harsh environment of HL-LHC

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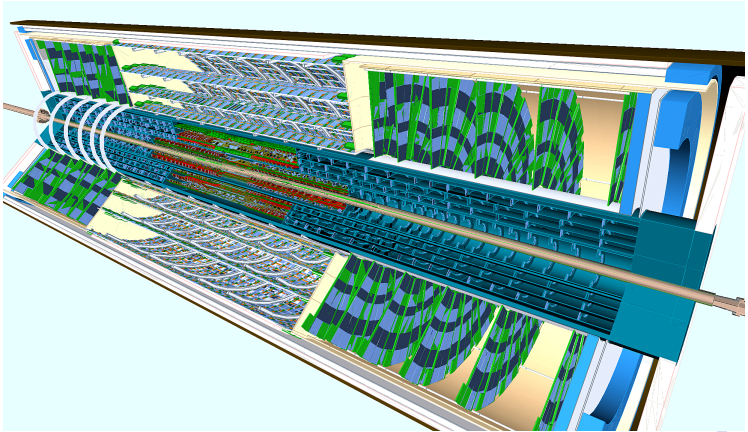
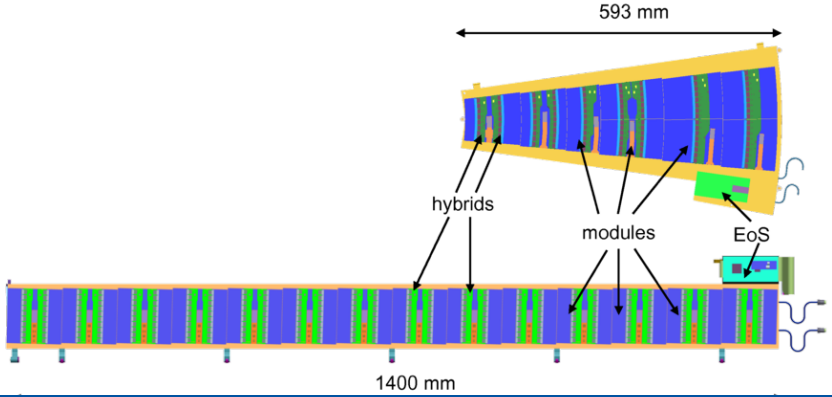
ITk design

- Pixel detector: 600M channels (80M in PIX): 5 barrel layers, encap system
- Strip detector: 70M channels (6M in SCT): 4 barrel layers, 6 EC rings



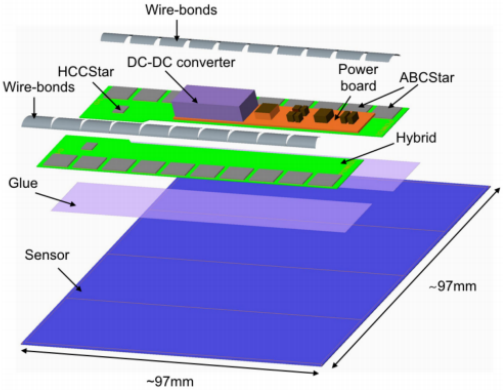
ITk Strip Detector

- Stave/petal: structure, cooling, power, electrical, etc.
- Module: silicon sensor + ASIC + readout hybrid + power board
- Hybrid: Flexible PCB with Hybrid Controller Chip (HCC) to interface w/ ASIC



ITk Strip Detector Readout

- sensor $\rightarrow$ front-end ASIC for signal amplification shaping, & discrimination
- 10-12 ABC ASICs per hybrid; each ASIC reads out 256 ch
- Hybrid Controller Chip interfaces the stave/petal service bus & front-end ASICs



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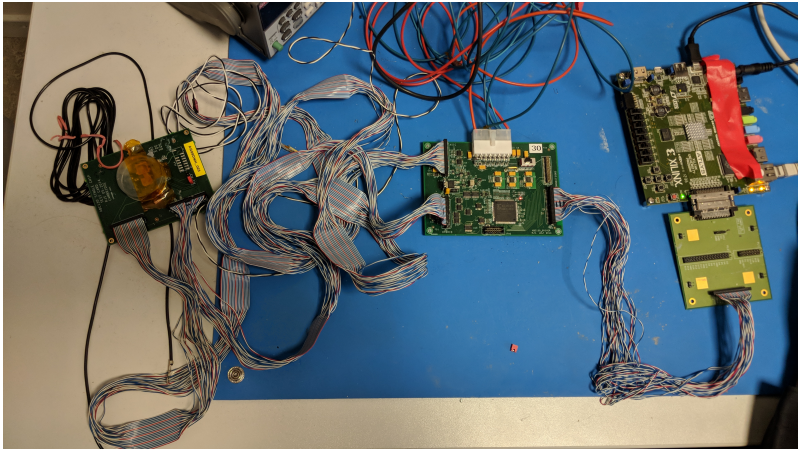
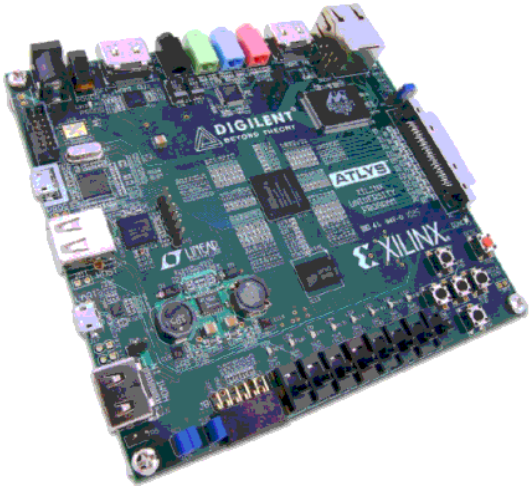
Current DAQ Readout Chain



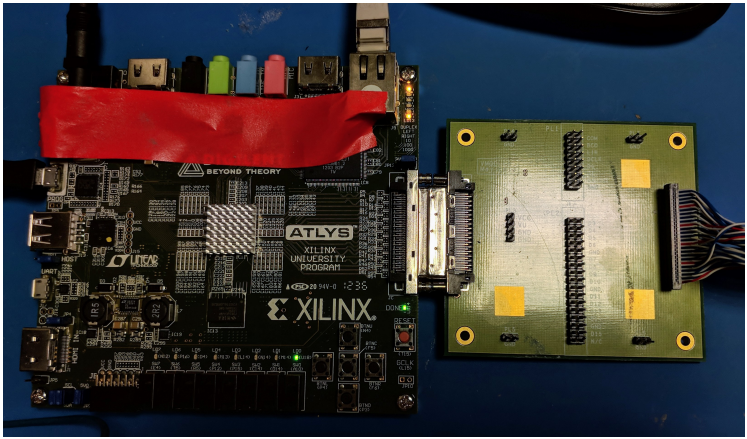
A look at the fully assembled readout chain, ending in the ABC130 prototype test board.

ATLYS Board



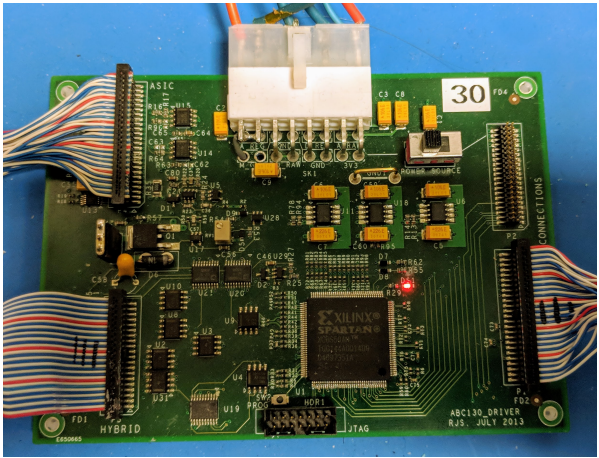
ATLYS is a low cost, widely available board that supports single chip, hybrid, and module tests.

Interface Connection



The ATLYS board is connected to to its interface board, VMOD-IB.

Driver Board



Orientation of the power, ABC130, and ATLYS connections.

ABC130 Single Chip Test Card

Test card, with connection to the driver board.

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Progress & Obstacles

Progress

- Preliminary tests with ITSDAQ software
- Able to run correct versions of NI-VISA, NI-DAQMX Base, and NI-488.2 and communicate with devices

Obstacles

- We accidentally lost a configuration and register assignment file on a formatted Windows SSD.
- We have a segmentation violation in the GUI of the ITSDAQ software.
- NI-VISA instrument control software doesn't recognize our power supplies

Goals

- Get ITSDAQ working
- Solve NI-VISA issues and run HV controller through ITSDAQ
- Integrate FELIX chip (optical, rad-hardened comm protocol drivers) into readout chain

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We would like to acknowledge the University of Michigan Department of Physics, specifically Jean Krisch, Tom Schwarz, and Steven Goldfarb. We would also like to acknowledge the support of the Lounsbery foundation.

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