



# Readout System Enhancements for ATLAS ITk Project

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# Agenda

## Background

ATLAS & the Inner Detector  
HL-LHC & ITk

## Our Progress

s1

s2

## Acknowledgements

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# ATLAS & the Inner Detector



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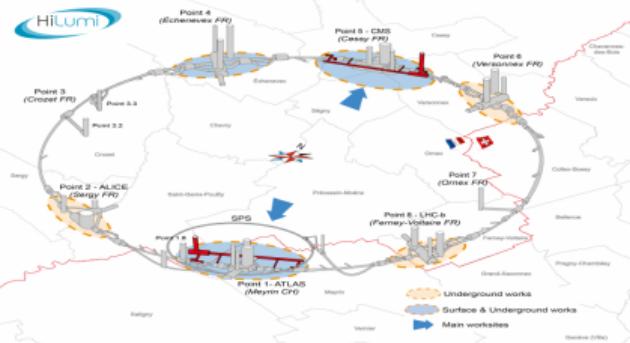
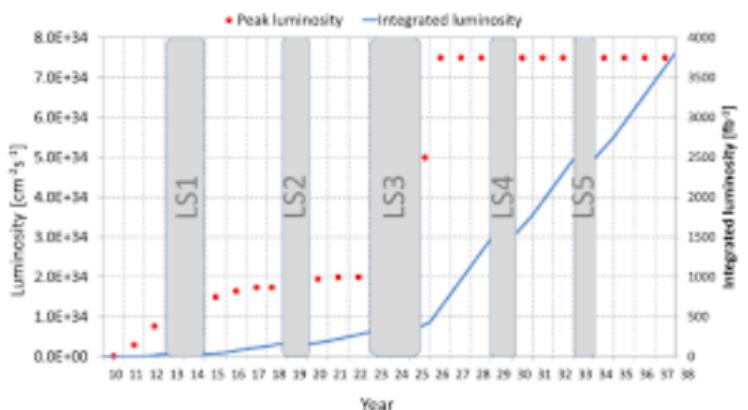
s2

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# High Luminosity LHC & ITk Upgrades

x10 increase in instantaneous luminosity!

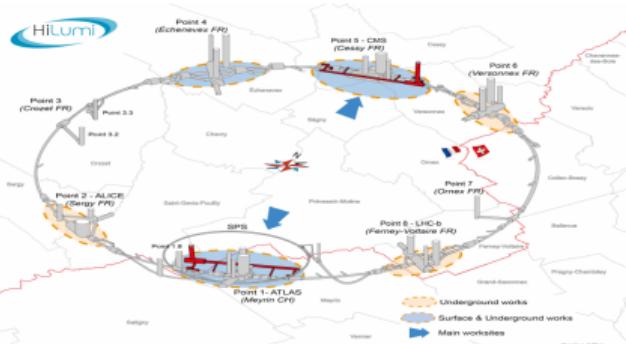
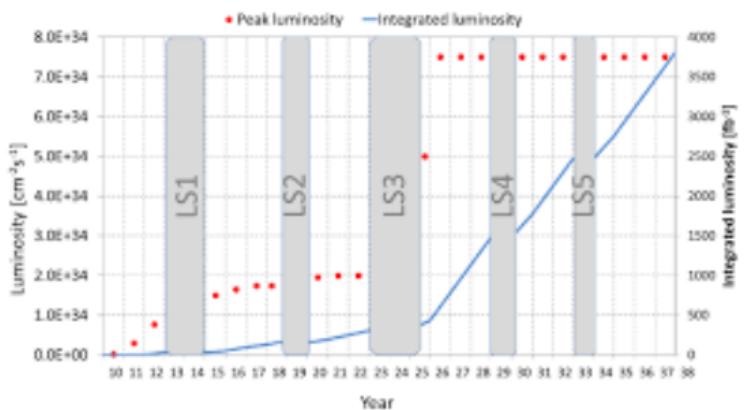
$$\blacktriangleright L = 1\text{e}73 \text{ fb}^{-1} \text{ s}^{-1} \rightarrow L = 1\text{e}74 \text{ fb}^{-1} \text{ s}^{-1}$$



# High Luminosity LHC & ITk Upgrades

x10 increase in instantaneous luminosity!

- $L = 1\text{e}73 \text{ fb}^{-1} \text{ s}^{-1} \rightarrow L = 1\text{e}74 \text{ fb}^{-1} \text{ s}^{-1}$
- More particles, more problems



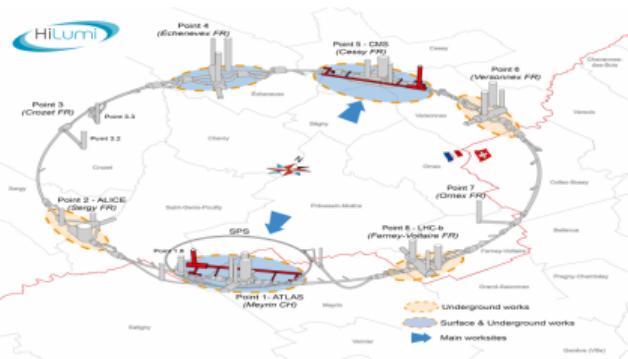
# High Luminosity LHC & ITk Upgrades

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The inner detector has insufficient:

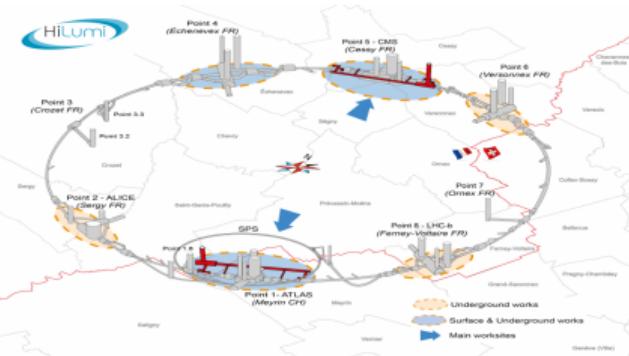
- radiation hardness
- granularity
- readout bandwidth
- trigger readout speed/storage



# High Luminosity LHC & ITk Upgrades

x10 increase in instantaneous luminosity!

- $L = 1\text{e}73 \text{ fb}^{-1} \text{ s}^{-1} \rightarrow L = 1\text{e}74 \text{ fb}^{-1} \text{ s}^{-1}$
  - **More particles, more problems**



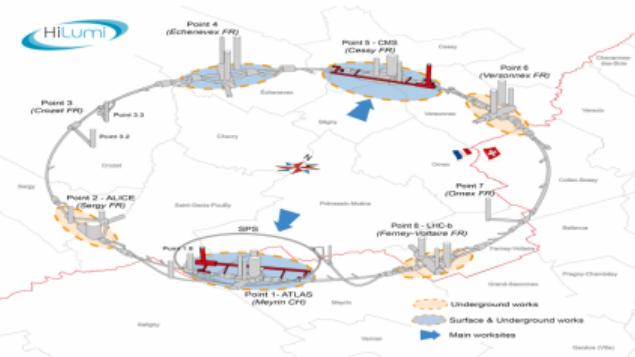
The inner detector has insufficient:

- radiation hardness: HL-LHC will deliver  $4000 \text{ fb}^{-1}$  fluence. ID PIX is designed for  $400 \text{ fb}^{-1}$ , ID SCT for  $700 \text{ fb}^{-1}$ , IBL for  $800 \text{ fb}^{-1}$

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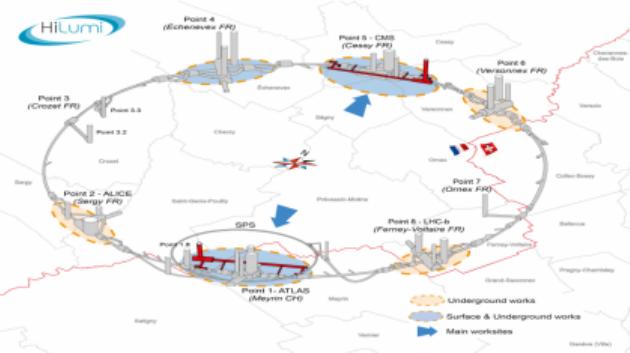
The inner detector has insufficient:

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

# High Luminosity LHC & ITk Upgrades

x10 increase in instantaneous luminosity!

- ▶  $L = 1\text{e}73 \text{ fb}^{-1} \text{ s}^{-1} \rightarrow L = 1\text{e}74 \text{ fb}^{-1} \text{ s}^{-1}$
- ▶ More particles, more problems



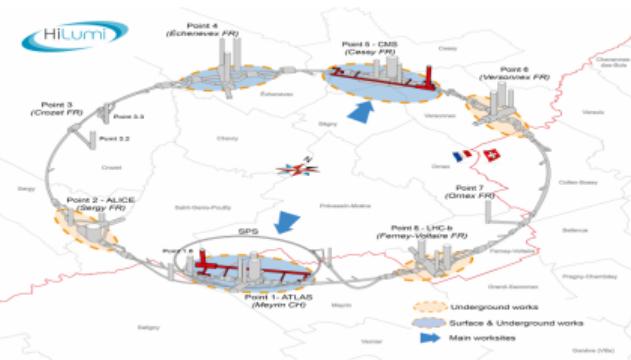
The inner detector has insufficient:

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

# High Luminosity LHC & ITk Upgrades

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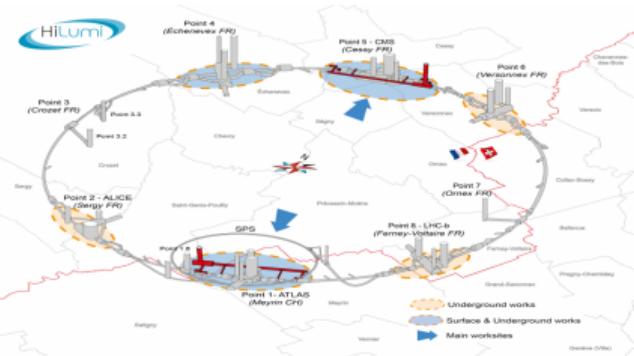
The inner detector has insufficient:

- trigger readout speed/storage: readout chain must accomodate much higher hardware (level 1) trigger rate

# High Luminosity LHC & ITk Upgrades

x10 increase in instantaneous luminosity!

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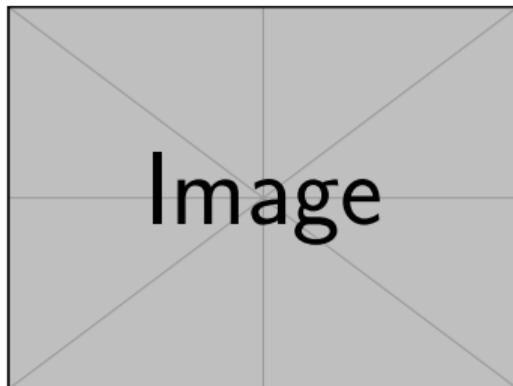
Goal of ITk:

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

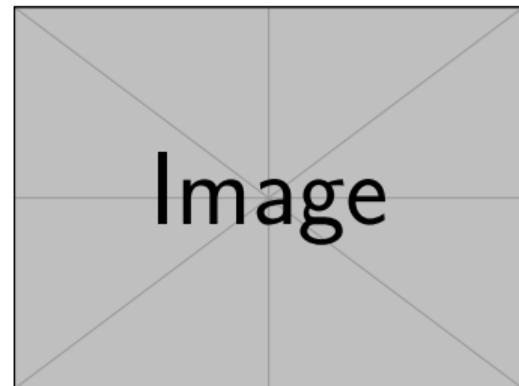
# ITk design

## ITk will have:

- ▶ Strip detector: 70M channels (6M currently)
- ▶ Pixel detector: 600M channels (80M currently)

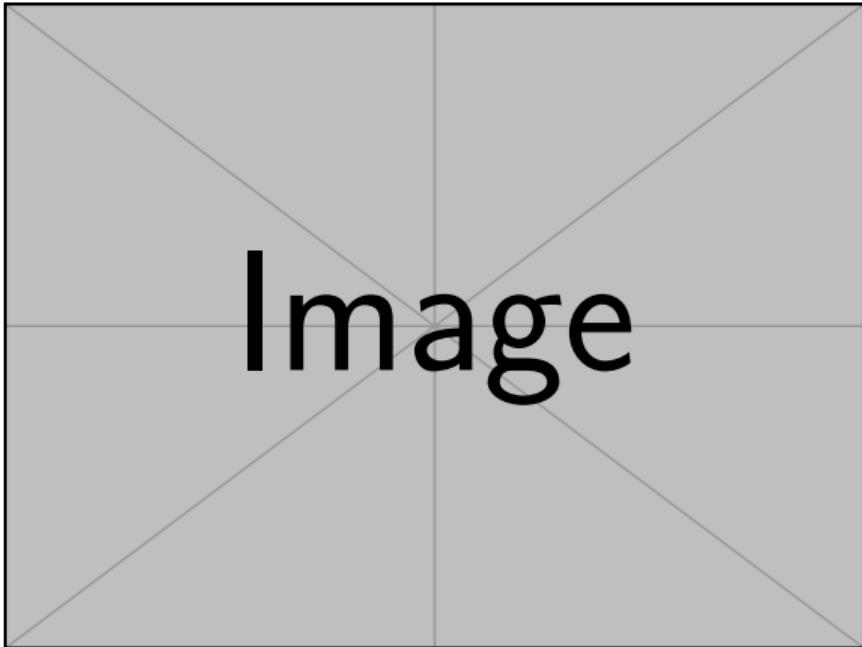


**Figure:** Design of ITk



**Figure:** ITk radiation length v.  $\eta$

# ITk Design: Strip Detector



- ▶ barrel staves
- ▶ endcap petals

# Strip Detector Readout



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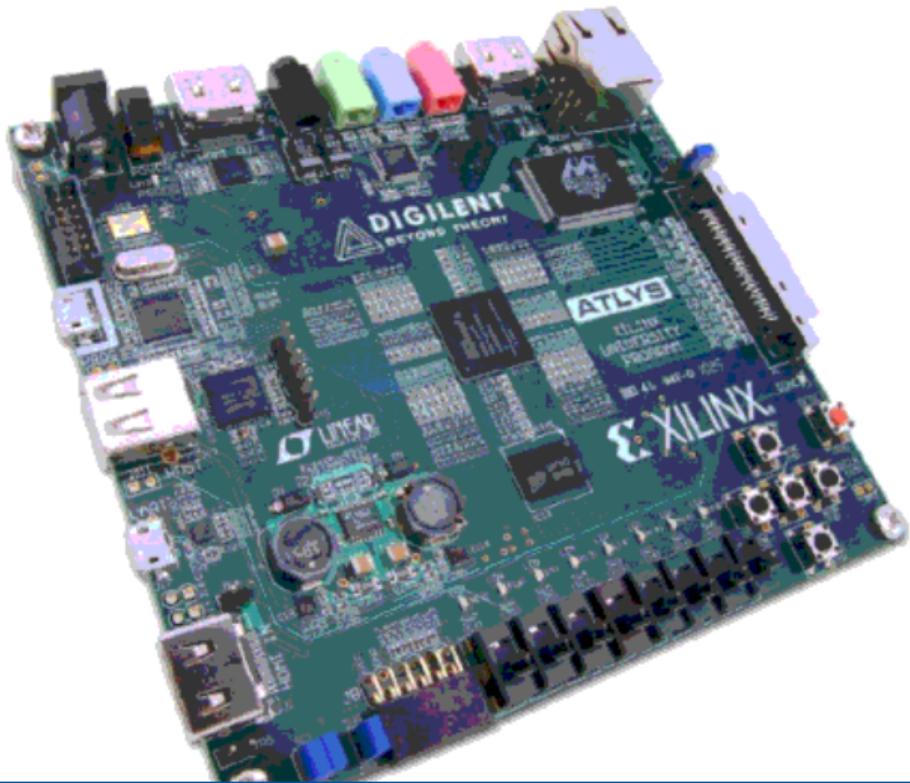
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# ATLYS Board



# Obstacles

fuck

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