Intelligent Trackers Slam

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Magical Materials

- Bulk materials have definite properties: Young's modulus, thermal expansion coefficient etc

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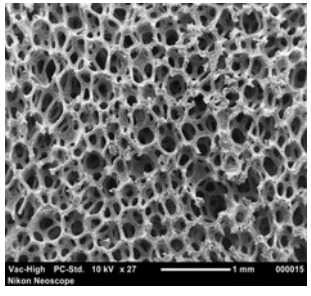
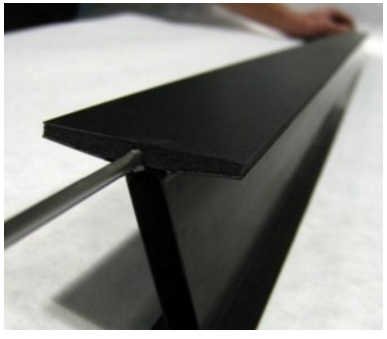
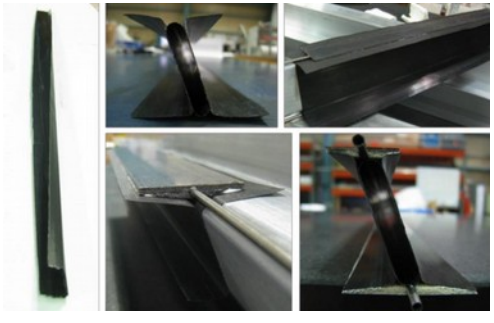
- What if you want properties that no bulk material has, for example low mass but high thermal conductivity and zero thermal expansion?
- Composites (eg. Carbon fiber laminates) allow engineering “any” combination of desired properties by integrating dissimilar elements
- (Mechanical supports for silicon detectors are all C composites today)







Magical Detectors?

- Materials used for detectors have bulk properties that allow collection of small signals produced by charged particles

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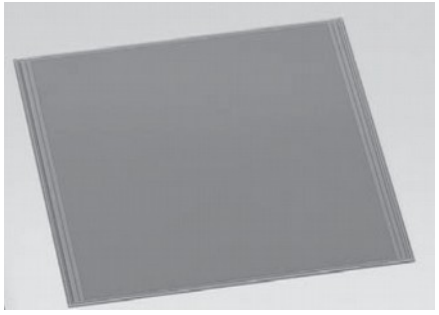
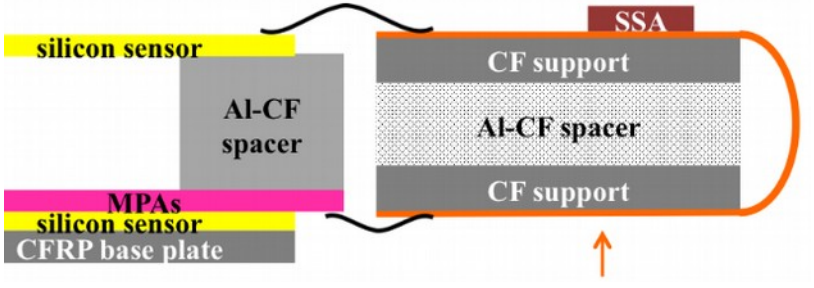
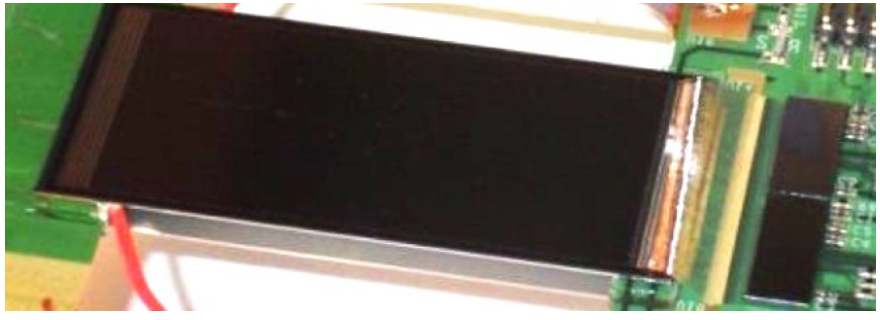


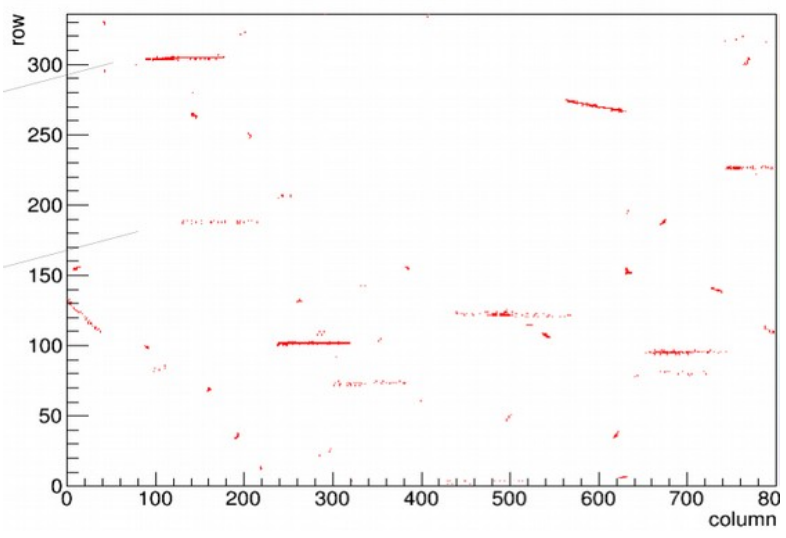
- What if you want properties that no bulk sensor has, for example modulated signals depending on origin of the detected particles
- Can this be achieved with “microscopic complexity” in analogy to composite materials?





Direction Sensitivity 1

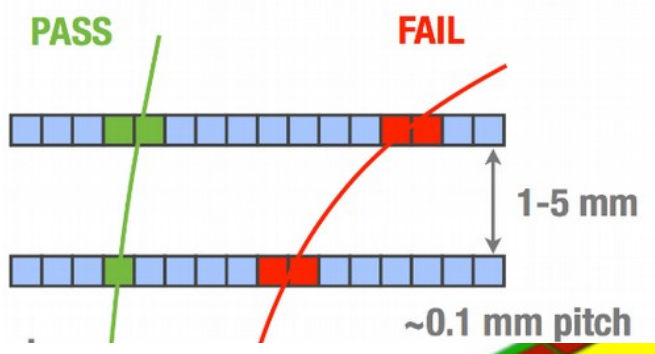
- Long clusters plainly show the particle direction when we look at them
- A chip can do the same with digital processing

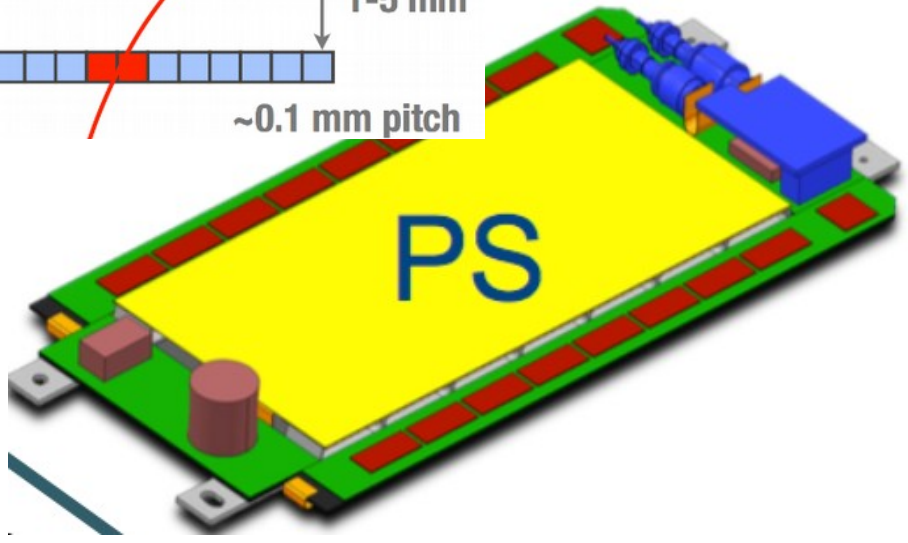


- What could one do with this information?
- Example: count particles coming from a certain point
  - Counting could be done for all collisions at the 40 MHz HL-LHC rate, even though we are not able to read out at this rate in ATLAS/CMS (data volume too high).
  - But chip can simply count internally and report the count
  - This would give high precision luminosity measurements

Direction Sensitivity 2

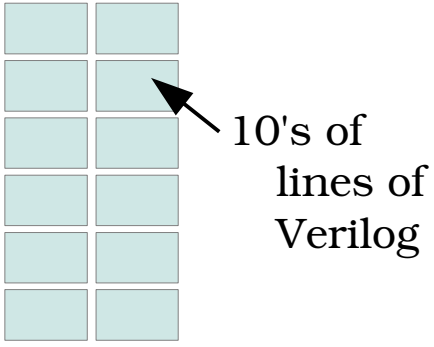
- Can provide external inputs to a pixel chip, for the chip to correlate with its hits internally
- These external inputs can be signals from a near-by strip detector
- Correlations define a direction with needing a shallow incidence angle

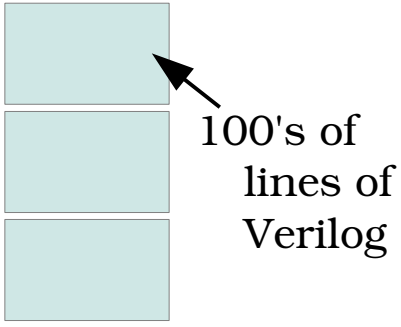


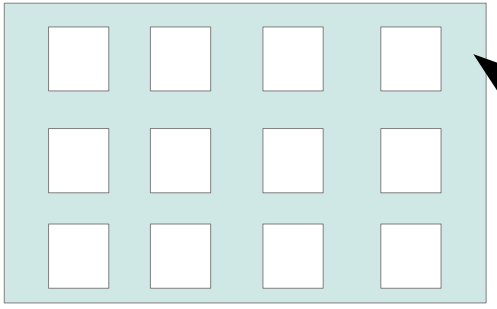


- Filtered data volume is low enough that it can be read out for every bunch crossing
- Can then use these per-filtered vectors to enhance electron and muon triggers

More Processing in Readout Chips







Traditional Design

* Make 1 pixel
* Step & Repeat identical copies

More Recently

* Make few-pixel region
* Step & Repeat identical copies

New Approach

* Synthesize a "core" containing a large number of pixels (256 in FE65_P2)
* Different digital environment around every pixel! Pixels not "identical"!
* Does it work? Ask next year

A Digital Core with Analog Islands

No digital step-and-repeat