New Readout Schemes

ArgonCube Collaboration Meeting

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Introduction

- Several new readout schemes proposed
- Some just alterations of existing ones
- Some completely new
- Some require new technologies
- Some create a need for new readout electronics

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Motivation

- Sensing wires did a great job in smaller detectors
- BUT they have many drawbacks:
    - Prone to microphonics
    - Only projections of X and Y (or U,V,W)
    - Induce ambiguities in reconstruction
    - Mechanically demanding (like a piano)
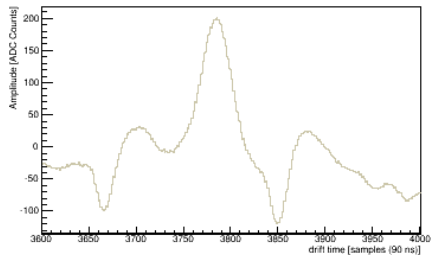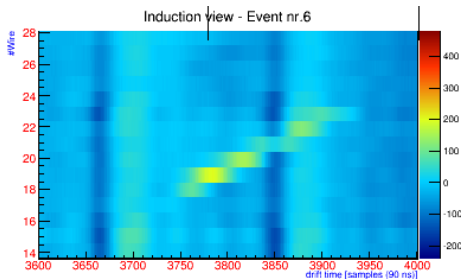   - Problems increase with detector size

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Pixels

- Copper pads on FR4 (standard PCB)
- Connected to back through vias
- LARASIC preamp directly on back
- Size comparable to wire pitch

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# Pixel prototype
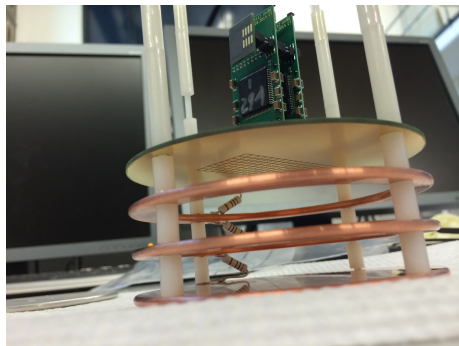
First pixel event

Pixels

- Proof of concept
- $+$ No ambiguities
- $+$ Standard PCB technology
- $+$ Rugged
- $-$ Increase of number of readout channels by a magnitude of one or two
- $-$ Need for new type of readout electronics

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Copper on Kapton

- Simply put: Charge sharing wire plane on PCB
- Bottom plane: standard copper tracks on FR4
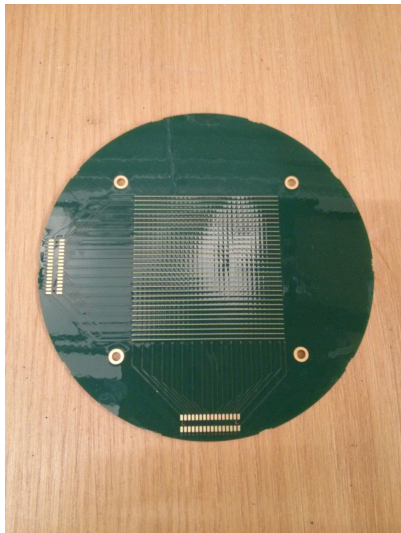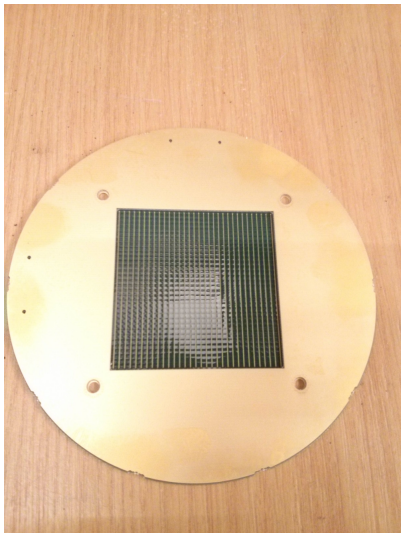- Top plane: copper tracks on Kapton tracks on top of first plane
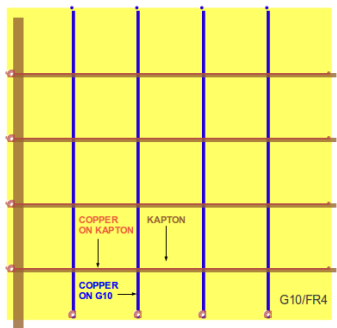
Our prototype

- Slightly changed layout
- Copper tracks on both sides of a flex PCB (50 µm)
- Plane on the back works in induction mode
- Easier to manufacture
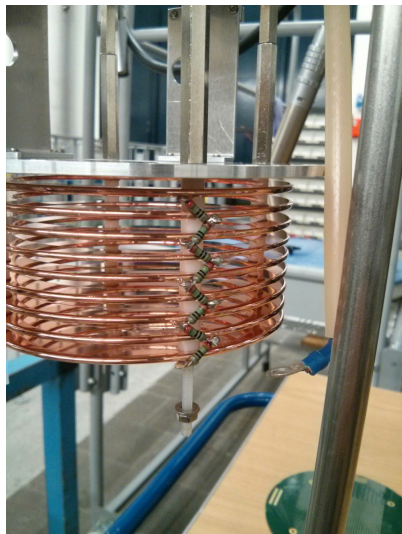- Using LARASIC preamps
- Not yet tested

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Copper on Kapton prototype

"Wire" plane

Copper on Kapton prototype
TPC

Copper on Kapton

- Test will follow shortly
- + Rugged
- + Same number of readout channels as standard wires
- + Connectorless interfacing to electronics possible
- - Projection ambiguities
- - Advanced technology

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Multiplexing

- Pixelized readouts have an extreme number of readout channels
- Signal feedthroughs only accommodate a limited number
- $\Rightarrow$ Multiplexing
    - Genetic
    - Digital
    - Region of interest (ROI)

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Genetic multiplexing

- Multiplexing erases information
- $\Rightarrow$ Find redundant information
- Strip detector: Tracks often hit two strips simultaneously
- What if we connect multiple strips to one readout channel such that no neighbouring strips are connected to the same readout channel?
- $\Rightarrow$ $\binom{n}{2} = \frac{n(n-1)}{2} + 1$ strips for n readout channels
- Handshake problem: number of unique pairs among n people

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Genetic multiplexing

- Passing particle hits two strips
- Strips activate unique combination of two readout channels
- Demultiplex readout channel pairs
- $\Rightarrow$ Position on detector

particule

2
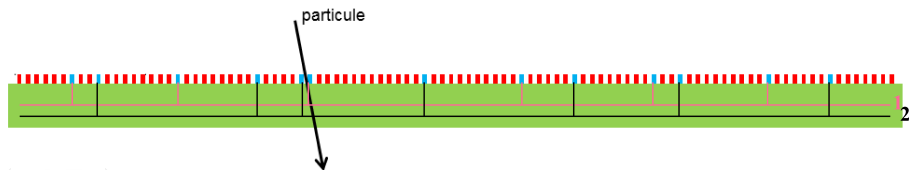
Genetic multiplexing

+ Reduce number of readout channels by $\frac{n(n-1)}{2n} \approx \frac{n}{2}$

⇒ Number of readout channels for n^2 pixel plane: $2n$ = same as for wire plane

- New ambiguities

- Very complex in 2D

- Lower SNR due to higher capacitance of combined strips/pixels

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Smart token zero suppression
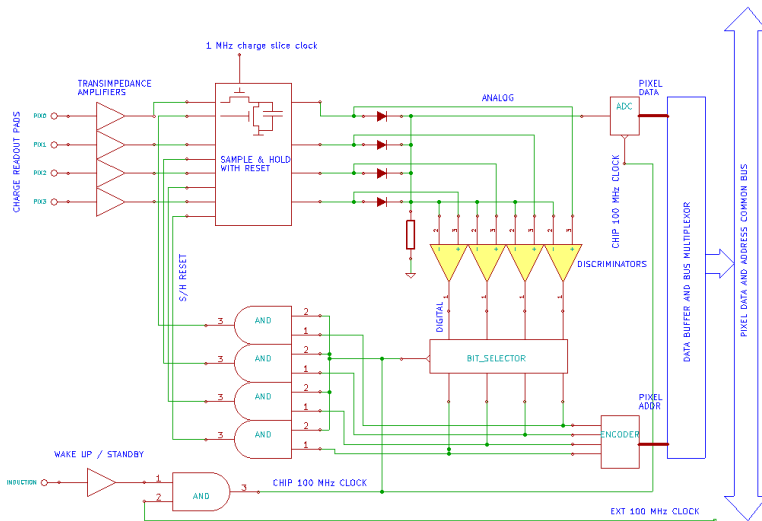
Region of interest (ROI)

- Cu induction grid around pixels
- Wake up preamps and ADCs
- Multiplex digital signals of ROIs
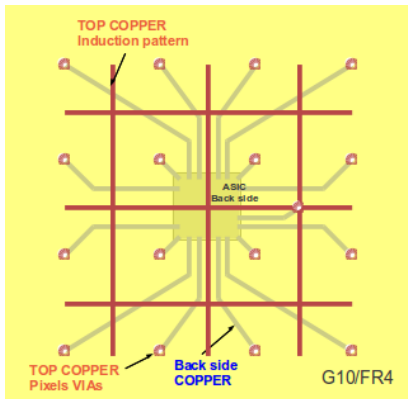
Other things to be done

- Copper on Kapton test (very soon)
- Test BNLs new cold ADC
- ROI
- Scale up for module in the dewar in Grosslabor

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Conclusions

- Proof of concept of pixels
- Need to develop accompanying electronics
- Copper on Kapton could be an economic solution
- Can CERN manufacture Kapton tracks?
- Despite the challenges, both are viable alternatives to wires

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References

- S. Procureur; Genetic Multiplexing; RD51, 05/07/2013