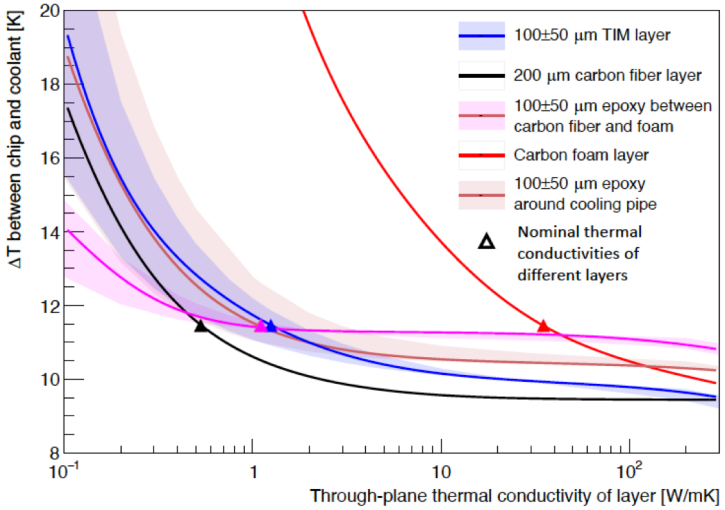
Composites Manufacturing & Simulation Center

Light-weight minimal mass tracking detectors: active & passive

- The need
- Current activities & Future R&D
- Conclusions



Andy Jung

Purdue team members: E. B. Vaca, S. Karmarkar and

UG students: Ben Pulver, Ian Holda, Morgan Shoop

BNL Seminar

My own biased view

PURDUE UNIVERSITY

June 18th, 2024

Detector "support mechanics"

Dual readout calorimetry w carbon fiber supports…

Drift chamber, e.g. using "CF" wire chambers…

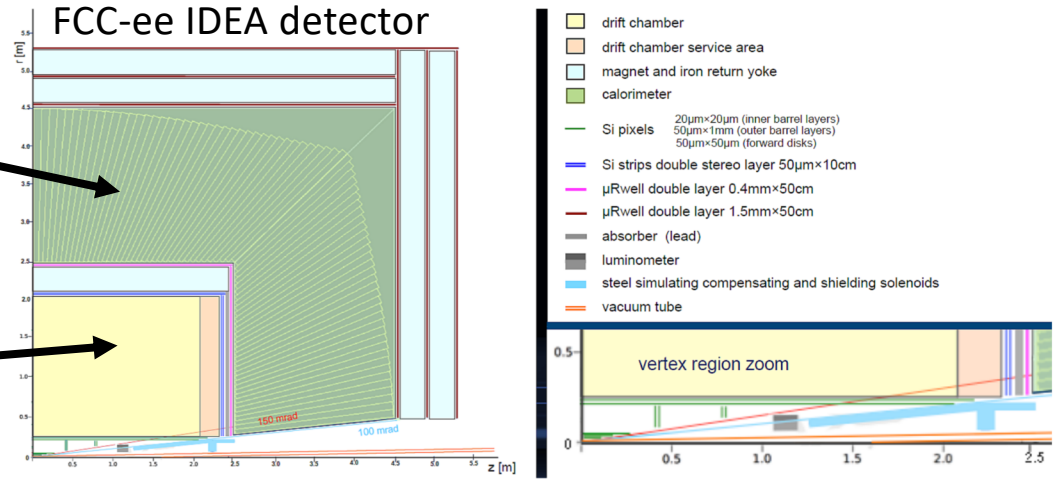


Figure 6: Cross section of the proposed layout for the IDEA detector concept.

→ Example of "large detector" but detector mechanics / services / cooling play a significant role in a detector's performance

→ **Highly relevant also to small experiments**

Exchange of ideas & progress across existing collaborations:

- **"CPAD RDC 10": R&D Collaboration for "Detector Mechanics R&D"**
- 9 others, so covers also your favorite topic's https://cpad-dpf.org
- Bridges nuclear, high energy physics but space applications / satellites too – broad field!
- Forum on tracking detector mechanics @Purdue: https://indico.cern.ch/e/ftdm24

Carbon Fiber wires @Purdue

- G. Charles et al. compared gold-plated tungsten wires to carbon wires for applications in multi-wire chambers
- This example: **factor 5 reduction** in material when moving from W+Al to C+Ag/Cu
- Supports is also a topic of interest
  - Volume separation

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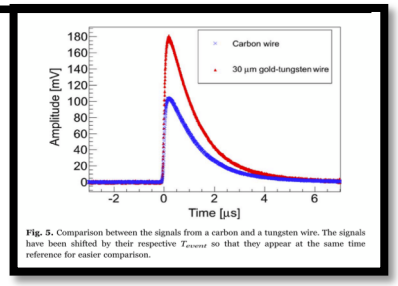


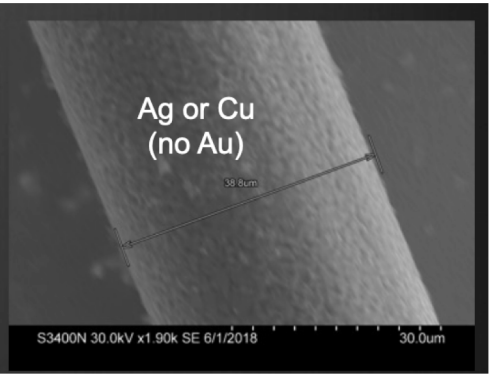
Fig. 5. Comparison between the signals from a carbon and a tungsten wire. The signals have been shifted by their respective $T_{reverse}$ so that they appear at the same time reference for easier comparison.

G. Charles et al.

Grancagnolo et al. (INFN)

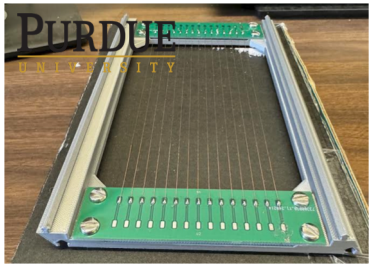
High-power impulse magnetron sputtering (HiPIMS)

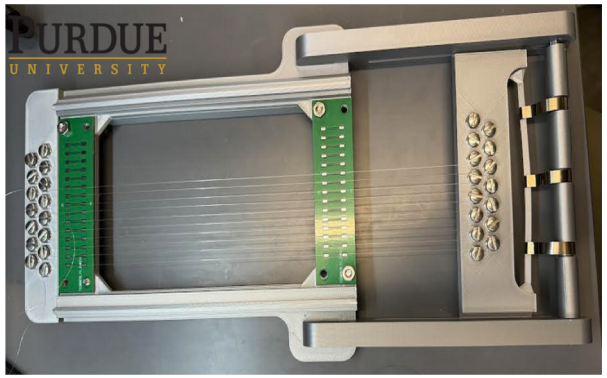
physical vapor deposition of thin films based on magnetron sputter deposition (extremely high power densities of the order of kW/cm^2 in short pulses of tens of µs at low duty cycle <10%)



A first bench-test setup @Purdue:

- Printed Circuit boards control the location of each wire
- Chamber is built in layers that can be stacked and offset for alternating sense and cathode wires
- Next steps: Sealed source & record data & spectra…stay tuned





Backup

Carbon Fiber wires

- G. Charles et al. compared gold-plated tungsten wires to carbon wires for applications in multi-wire chambers
- This example: **factor 5 reduction** in material when moving from W+Al to C+Ag/Cu
- Supports also a topic
- Volume separation

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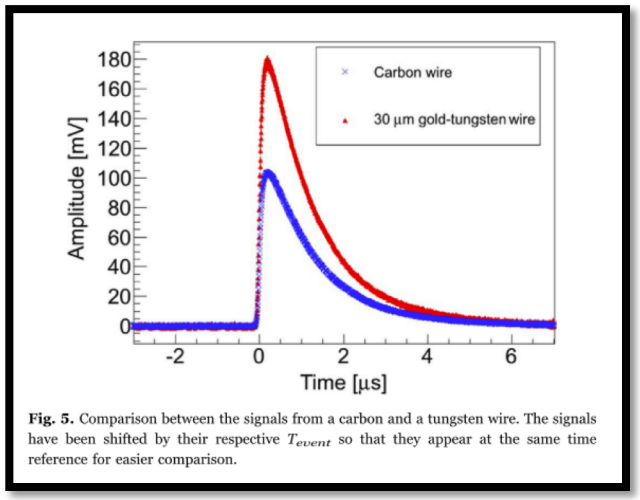
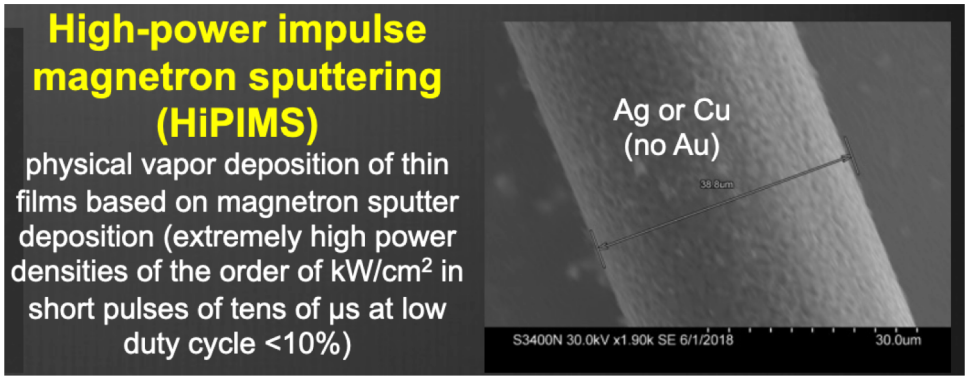
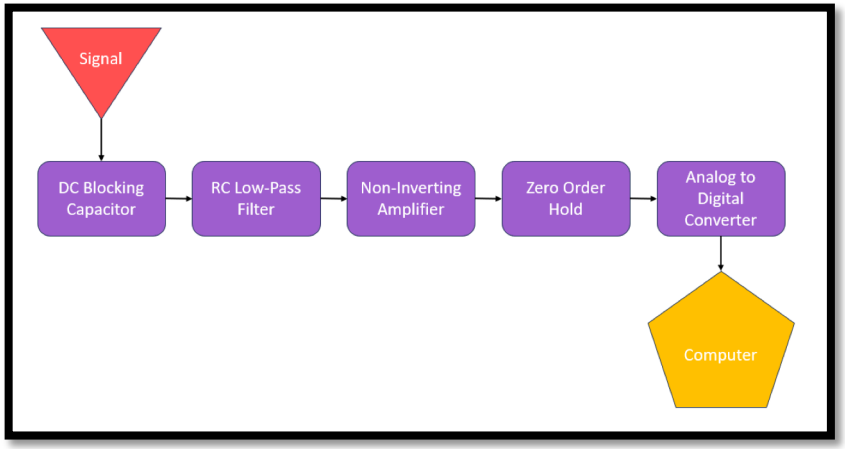


Fig. 5. Comparison between the signals from a carbon and a tungsten wire. The signals have been shifted by their respective T_{event} so that they appear at the same time reference for easier comparison.

G. Charles et al.

Grancagnolo et al. (INFN)





Small R&D activities @Purdue

- Purdue is using 30 um diameter Dexmat carbon sense wires
- Purdue benchmark is 25 um diameter tungsten wire from Midwest Tungsten
- Metal coating is a future project
  - Purdue has infrastructure
    - Atomic Layer Deposition (ALD)
    - Chemical Vapor Deposition (CVD)
    - Plasma Enhanced Chemical Vapor Deposition (PECVD)
    - High Density Plasma CVD (HDPCVD)
    - E-beam Evaporation DC/RF Sputtering multi-deposition (E-Beam Evaporation + Sputtering)
    - GaN Molecular Beam Epitaxy (MBE)
    - PVD Pulsed Laser Deposition (PLD)
    - Electrodeposition