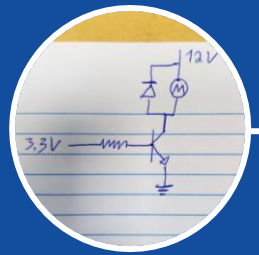
LABORATÓRIO DE INSTRUMENTAÇÃO
E FÍSICA EXPERIMENTAL DE PARTÍCULAS
partículas e tecnologia

SUMMER INTERNSHIP 2025

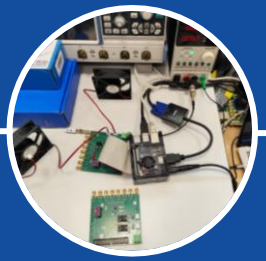
José Miguel

1.
PPS Cold Box

Environment Control Board



Proof of Concept

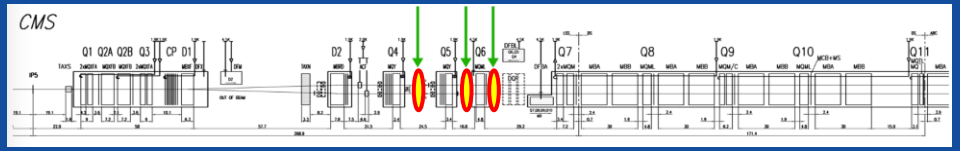


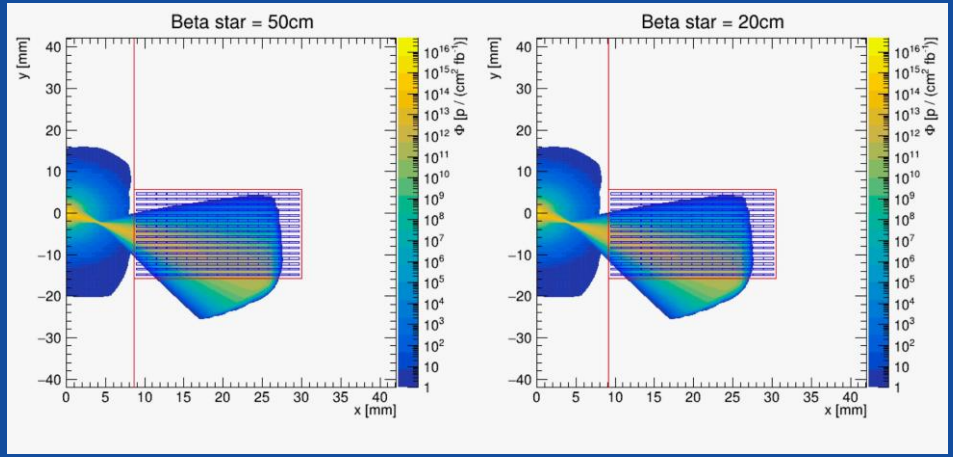
Prototyping

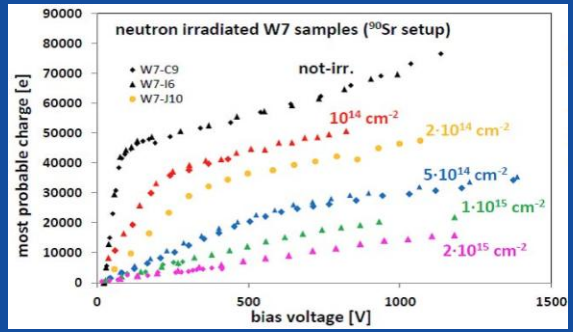
Execution

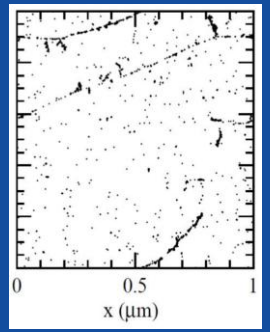
Intro: What is PPS and why do we need a cold box?

- Trackers and Precise Timing
  - High-Luminosity LHC
- Center Exclusive Production
  - Near-Beam Spectroscopy
  - Extreme Radiation intensity
- Non-uniformly irradiated detectors
  - Impacts of Radiation Damage need to be characterized



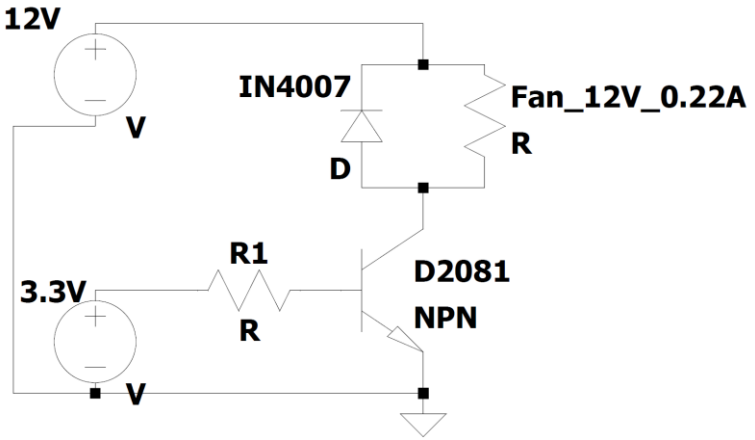


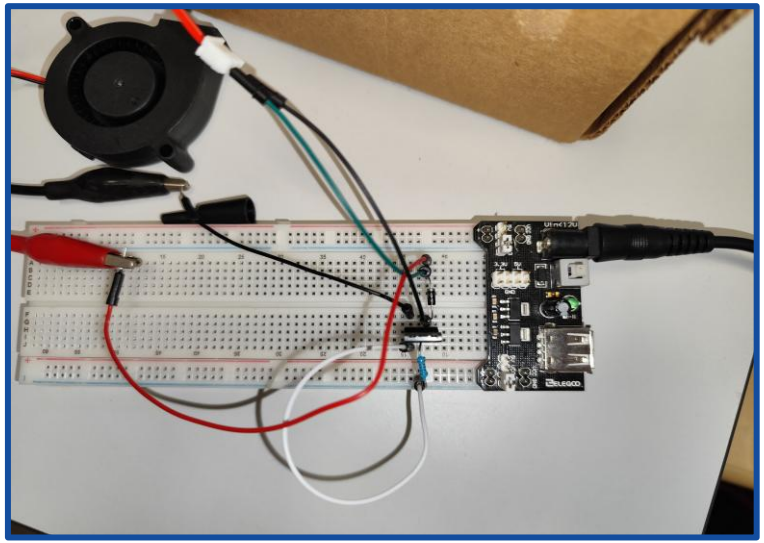




Proof of Concept

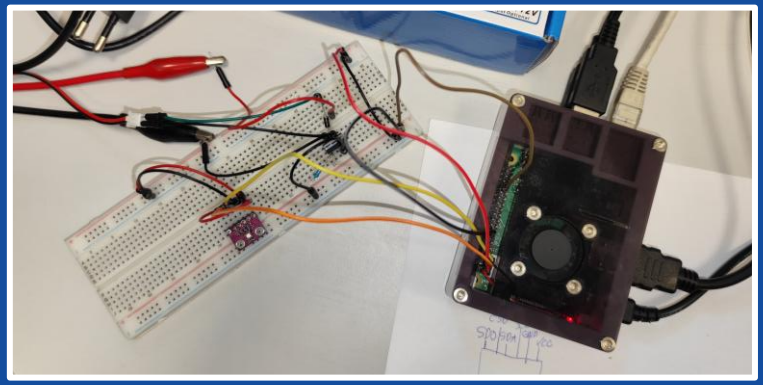
- Fan Control Circuit;
- Troubleshooting & Component Specifications;

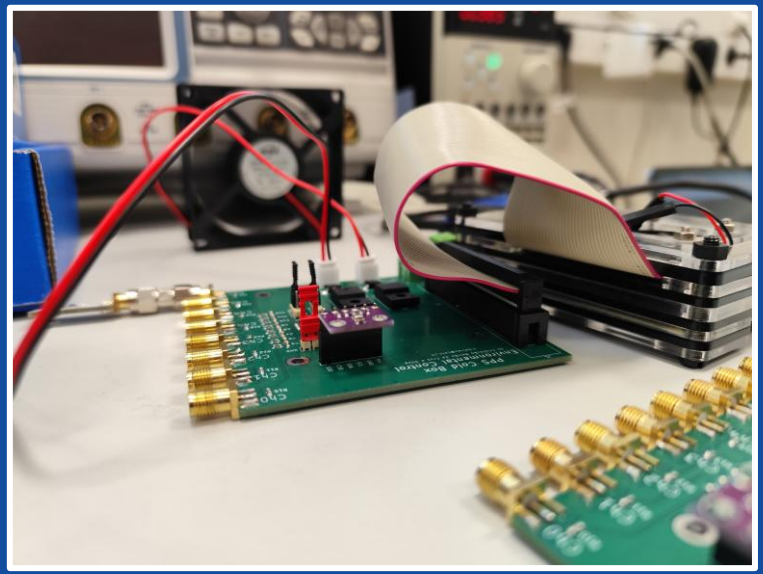




Prototyping

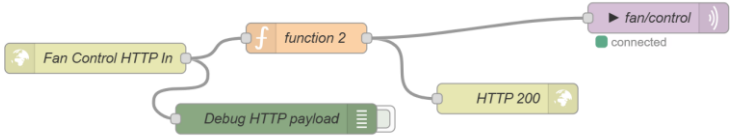
- PWM using Raspberry Pi
- BME280 Sensor
  - Temperature
  - Pressure
  - Humidity
- ADC & PT1000
  - Temperature





Prototyping

- MQTT-based server
- InfluxDB Database
- Visualization & Fan Control via Grafana



Final Iterations & Execution

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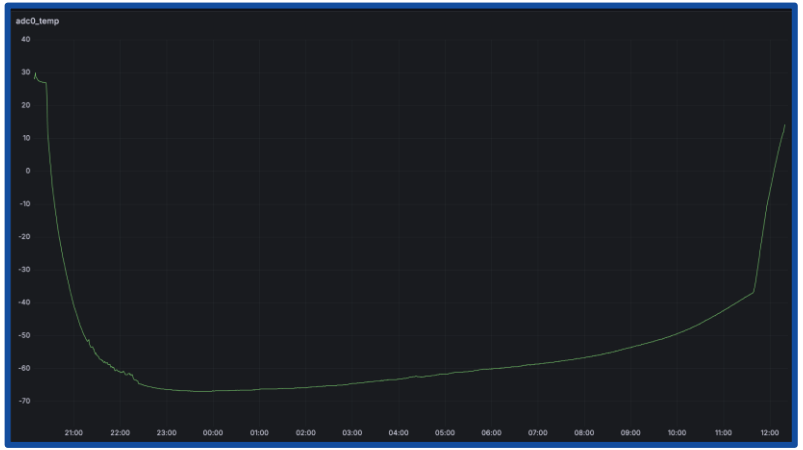
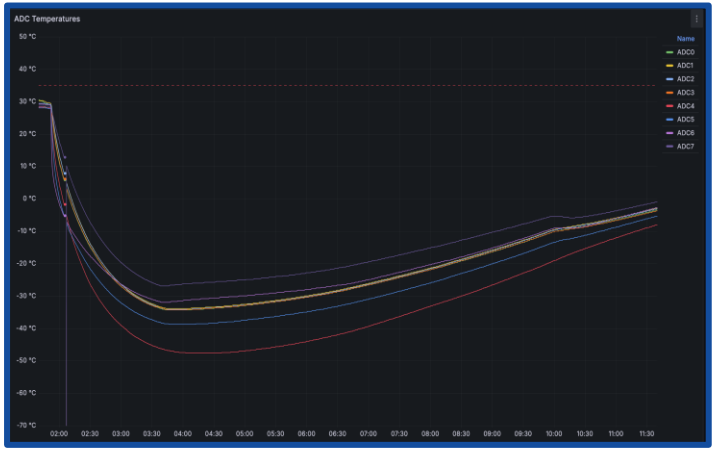
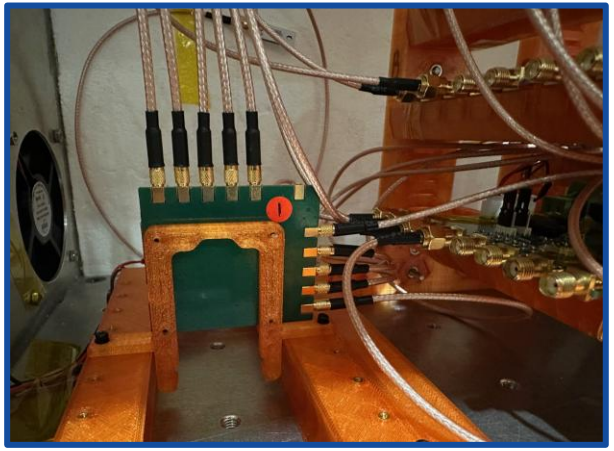




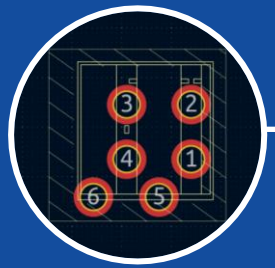


GitHub

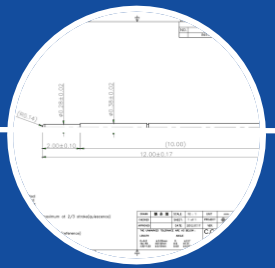
All code and setup instructions are available at:
https://github.com/JoseVM-2005/LIP

2. LGAD Caracterization

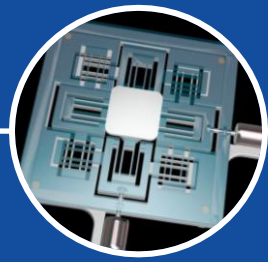
Circuit and Probing Apparatus



PCB



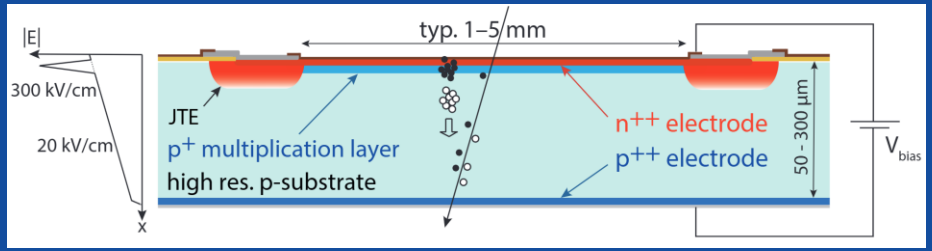
Probes

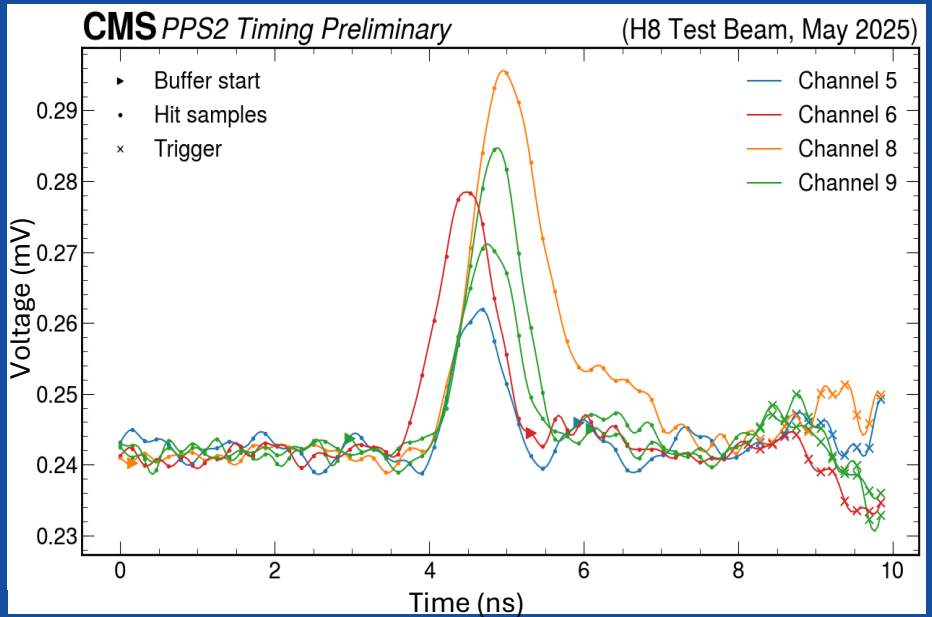


Positioning

Intro: What is an LGAD and why do we need to characterize them?

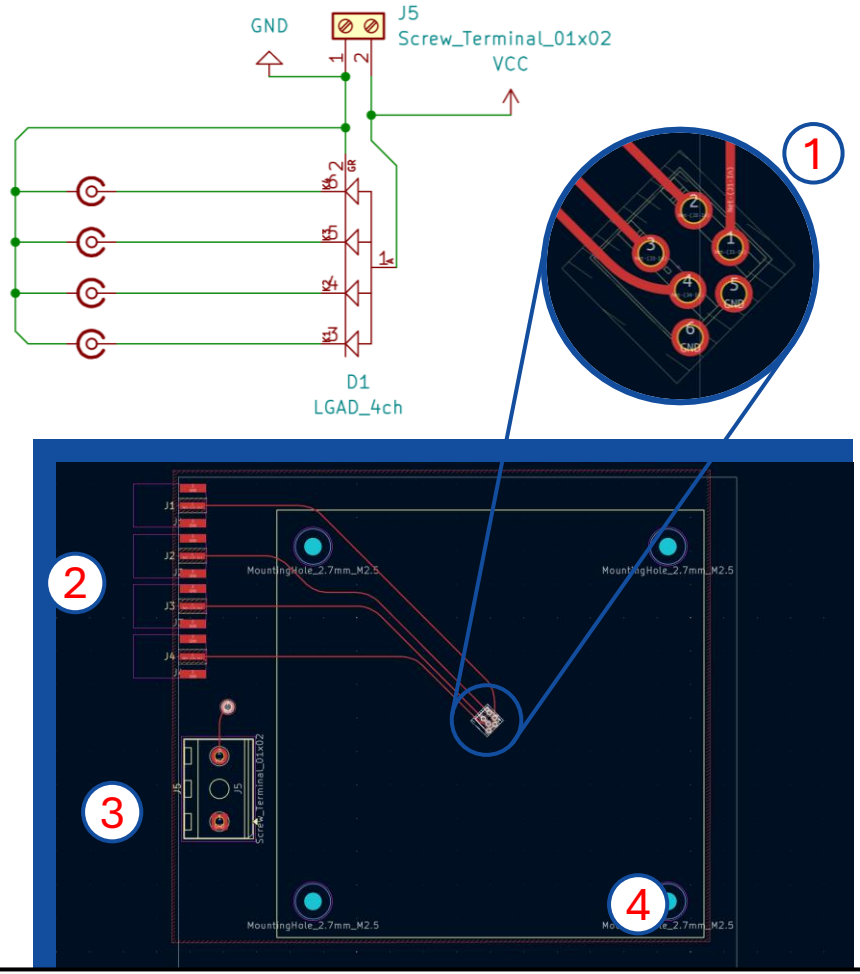
- Low Gain Avalanche Detector
  - Internally Amplified
  - High Signal-to-Noise Ratio
- High Slew Rate
  - Precision of ~50ps for PPS
  - Variations to be studied
- Customized Production
  - Tailor-made for PPS
  - Different versions to be studied





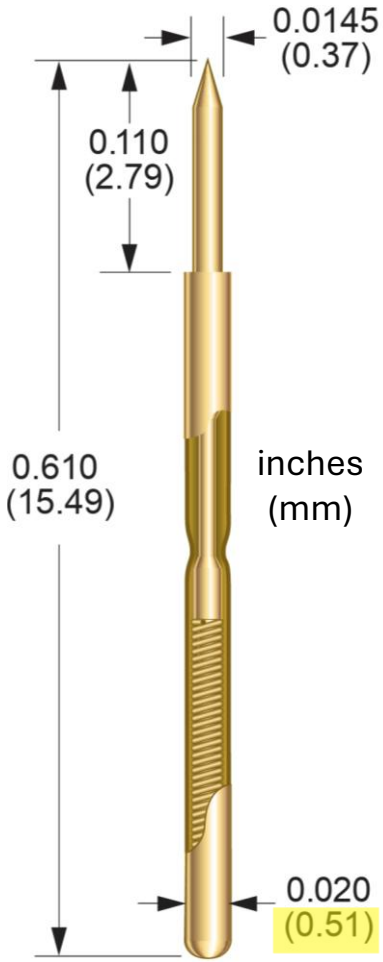
PCB Design

- Designed for a 2x2 LGAD Sensor [1]
- Edge connector [2]
  (represented by 4 co-axial terminals)
- High voltage input terminal [3]
- 4 mounting holes for the XY translation stage [4]



Spring Probes

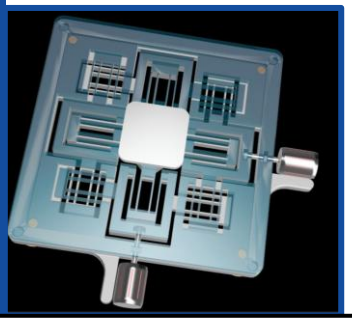
- Ensures reliable contact between the probe and the LGAD
- Rounded tip for increased contact area
- Slim profile for greater versatility

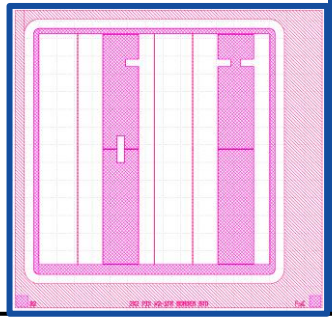


Probe Specifications	
Minimum Centers	0.039 (1.00)
Current Rating	Up to 3 Amps
Spring Force	1.30 oz (37 g) or 1.60 oz (45 g) @ 0.067 (1.70) travel
Preload Force	0.50 oz (14 g)
Typical Resistance	< 40 mΩ
Maximum Travel	0.100 (2.54)
Working Travel	0.067 (1.70)
Materials	
Barrel	Nickel/silver, preplated gold
Spring	Stainless steel or music wire, gold plated
Plunger	Beryllium copper, gold plated over nickel, or Duralloy™

Fine-tunning the LGAD's Position*

- 3D printed compliant XY translation stage mechanism
- Pitch of a couple millimeters (to be tested)
- Slim profile (1cm)





*See references

Next Steps

PCB Design
- Meet Impedance requirements;
- Component Selection.

Spring Probes
- Acquisition and testing.

Translation Stage
- Finish the design;
- Print and Test;
- Iterate!

Caracterization Circuit
- Design an Op-Amp-based circuit to measure the expected nano-amps current;

GOAL
Versatile equipment to obtain the IV and CV curves of the 2X2 LGAD's currently in production

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Thanks!

Any questions?

You can find me at: jose.valentim.miguel@tecnico.ulisboa.pt

References

[1] Kramberger, G., Baselga, M., Cindro, V., Fernández-Martínez, P., Flores, D., Galloway, Z., Gorisek, A., Greco, V., Hidalgo, S., Fadeyev, V., Mandić, I., Mikuz, M., Quirion, D., Pellegrini, G., Sadrozinski, H. F.-W., Studen, A., & Zavrtanik, M. (2015). Radiation effects in Low Gain Avalanche Detectors after hadron irradiations. *Journal of Instrumentation, 10*(07), P07006. https://doi.org/10.1088/1748-0221/10/07/P07006

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[3] Wim_v. (n.d.). *High precision XY stage (compliant mechanism)* [3D printed model]. MakerWorld. https://makerworld.com/en/models/1647459-high-precision-xy-stage-compliant-mechanism

[4] Zhu, J., Hao, G., Li, S., Yu, S., & Kong, X. (2021). *A mirror-symmetrical XY compliant parallel manipulator with improved performances without increasing the footprint* (DETC2021-69032). In **Proceedings of the ASME 2021 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference (IDETC-CIE2021)** (August 17–19, 2021, Virtual, Online). American Society of Mechanical Engineers. https://doi.org/10.1115/DETC2021-69032

Backup Slides: Characterization