

Looking for a new gas mixture for Picosec

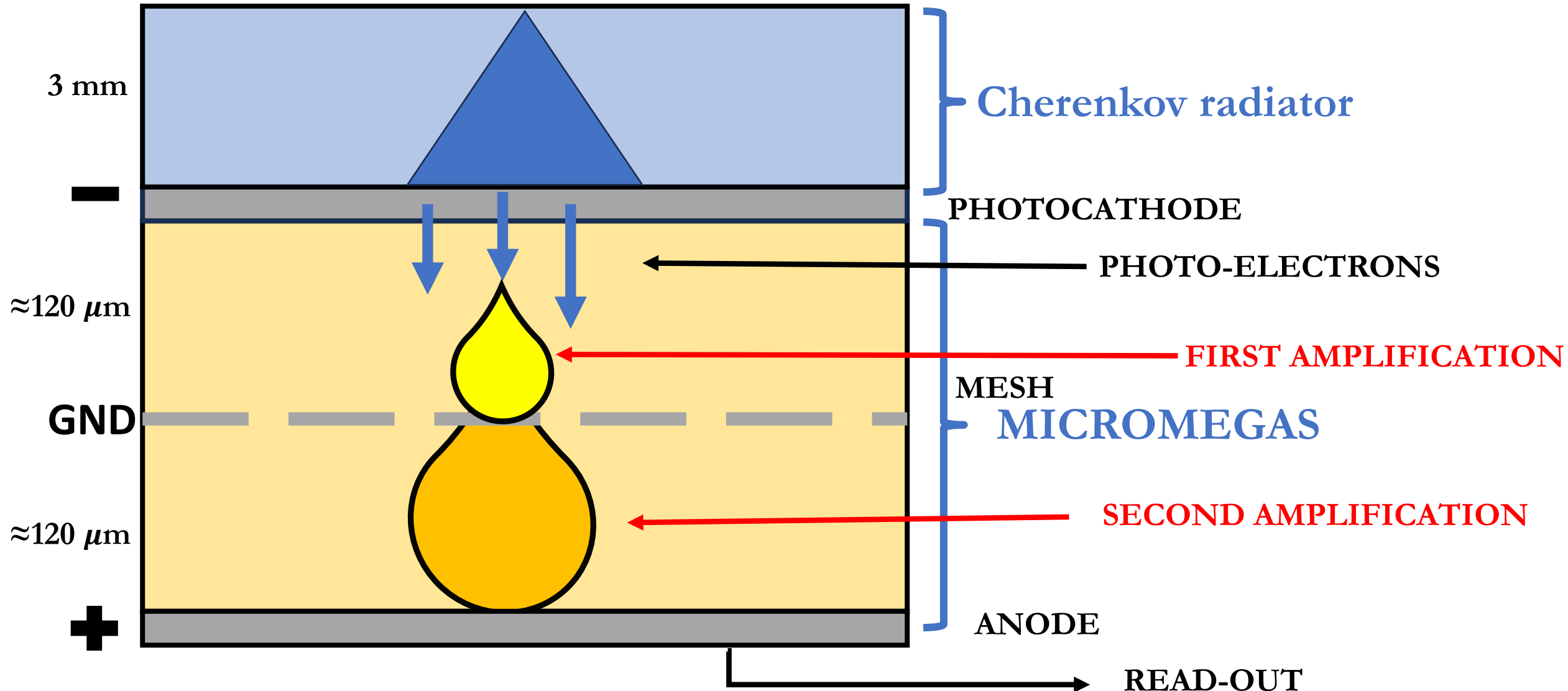
Matteo Brunoldi

For the Pavia team on behalf of the Picosec Collaboration

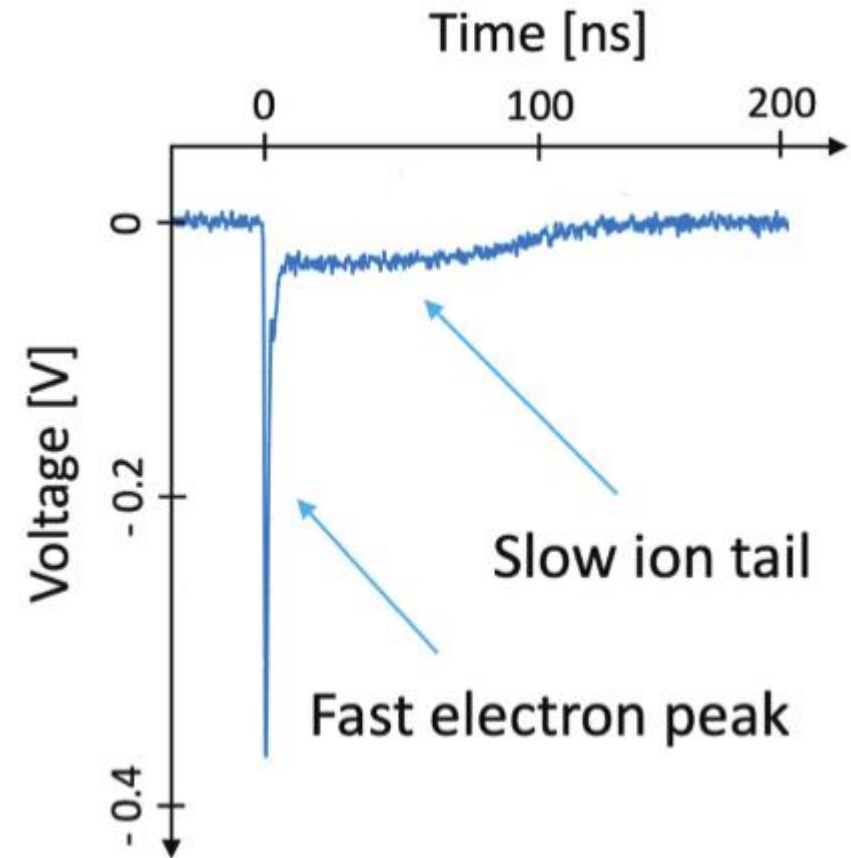
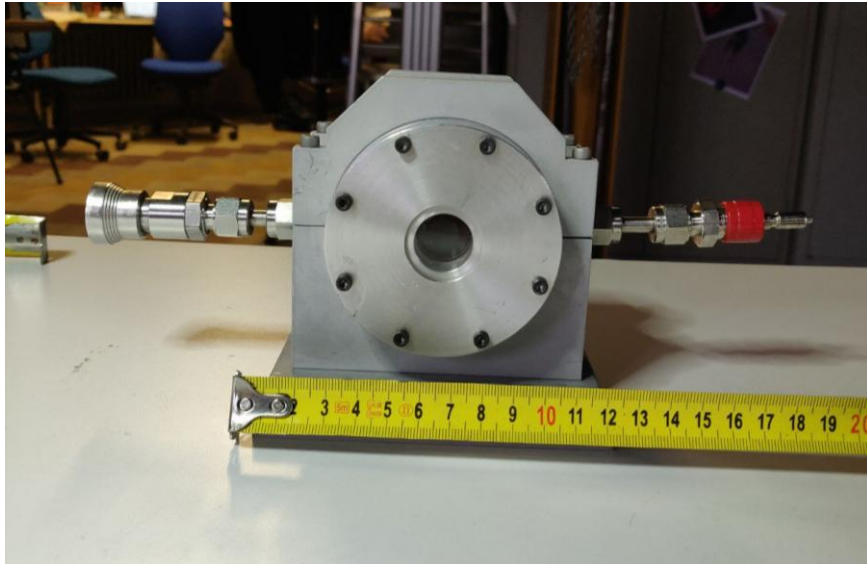
Picosec detector

Bortfeldt, J., et al. "PICOSEC: Charged particle timing at sub-25 picosecond precision with a Micromegas based detector." NIM A 903 (2018): 317-325.

link: <https://www.sciencedirect.com/science/article/pii/S0168900218305369>



Picosec detector used in Pavia

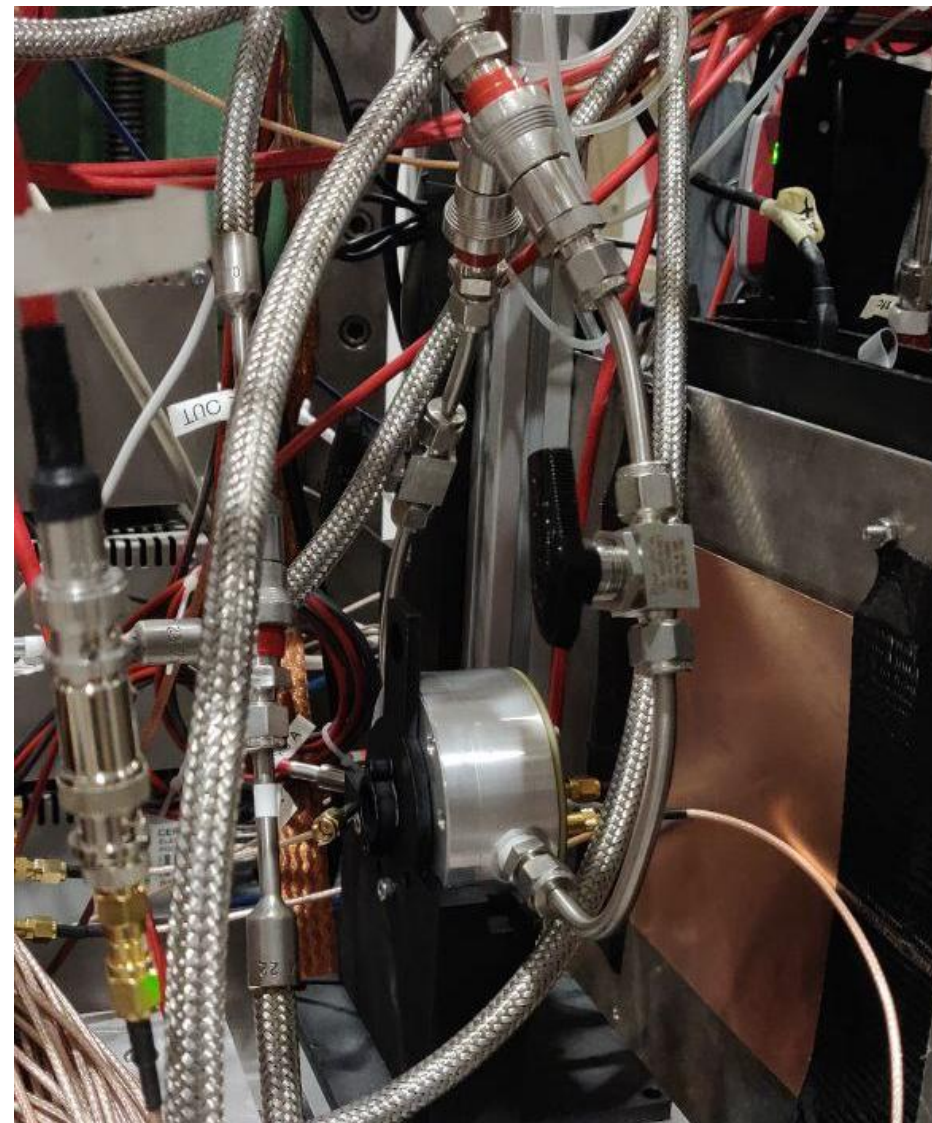
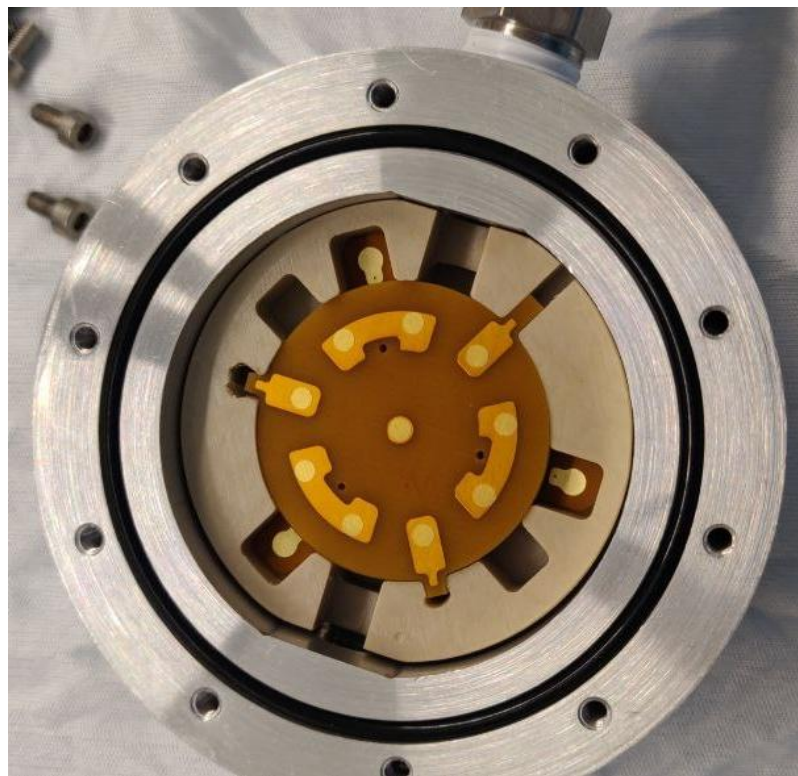
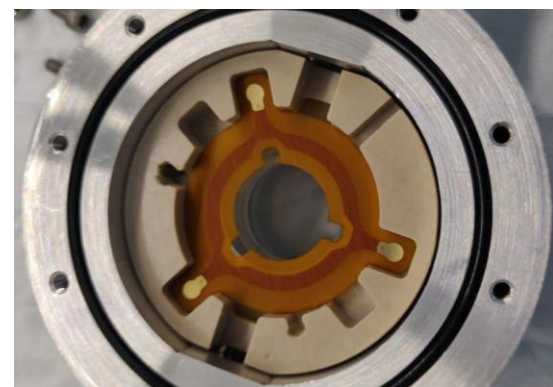
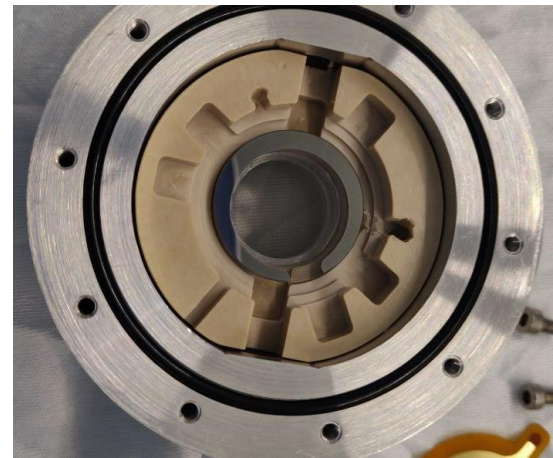


Papaevangelou, Thomas, et al. "Fast timing for high-rate environments with micromegas." EPJ Web of Conferences. Vol. 174. EDP Sciences, 2018.

Link: https://www.epj-conferences.org/articles/epjconf/pdf/2018/09/epjconf_mpgd2018_02002.pdf

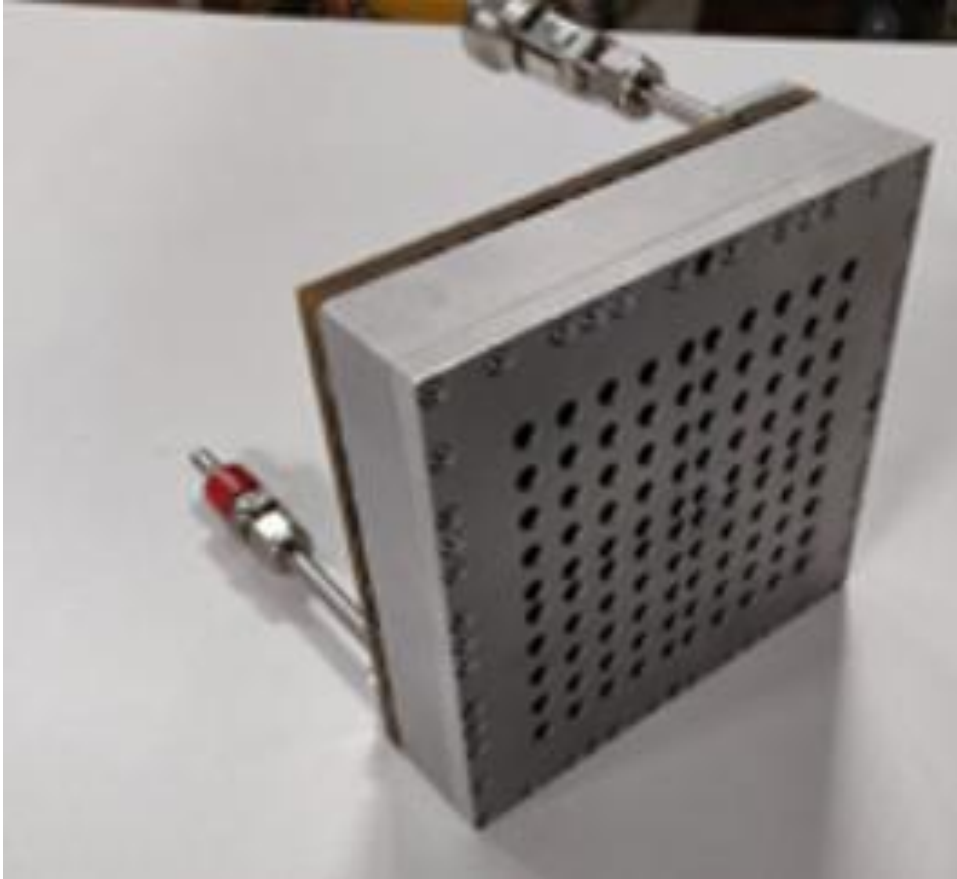
M. Lisowska et al. "Photocathode characterisation for robust PICOSEC Micromegasprecise-timing detectors", NIMA, 1072.170151(2025) <https://www.sciencedirect.com/science/article/pii/S0168900224010775?via%3Dihub>

Picosec detector used in Pavia



Utrobicic, A., et al. "Single channel PICOSEC Micromegas detector with improved time resolution."
NIM A 1072 (2025): 170127. Link: <https://doi.org/10.1016/j.nima.2024.170127>

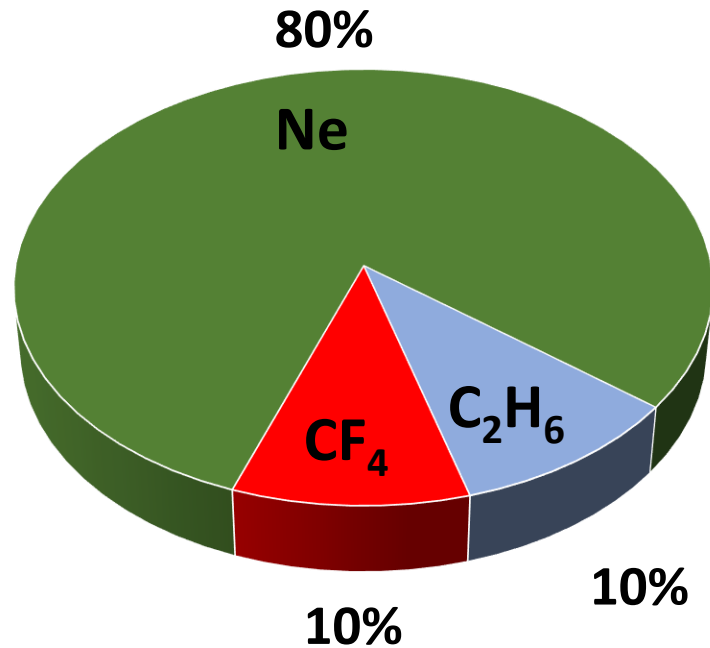
Picosec detector used in Pavia



10x10 cm² prototype for scalability studies

A. Utrobicic, et al., A large area 100-channel PICOSEC Micromegas detector with time resolution at the 20 ps level, JINST 18 (07) (2023) C07012.
Link: <https://iopscience.iop.org/article/10.1088/1748-0221/18/07/C07012>

Picosec gas mixture



Ne/C₂H₆/CF₄ 80/10/10
GWP ≈ 740

Neon (Ne)

Expensive

Ethane (C₂H₆)

Flammable

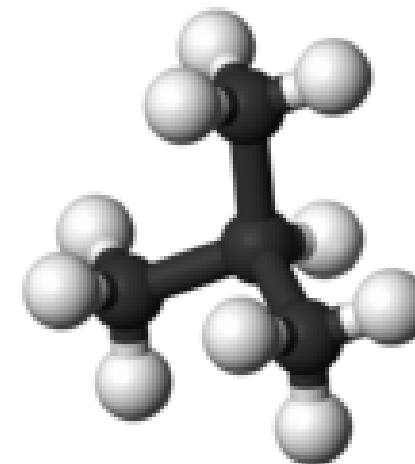
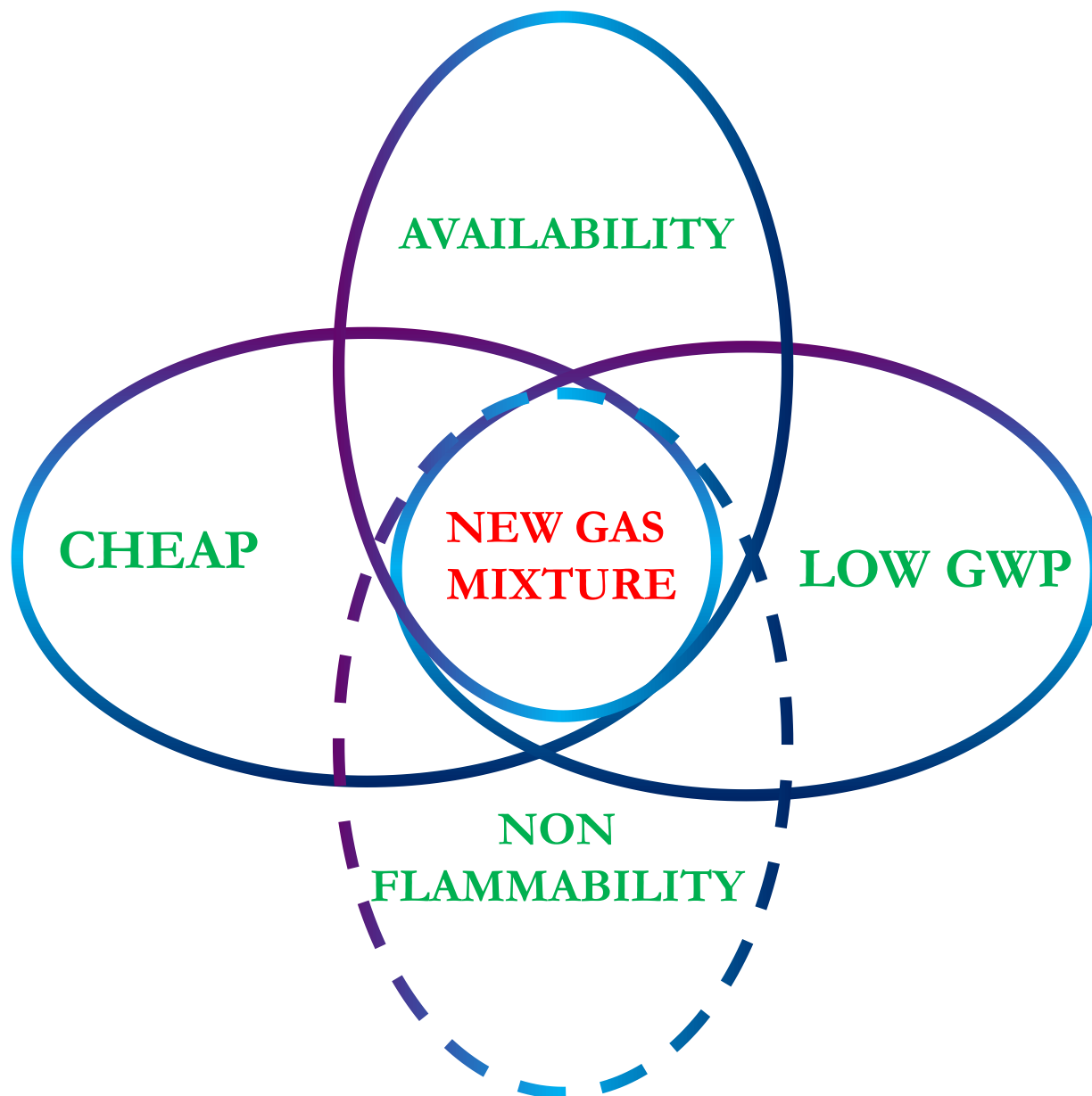
Tetrafluoromethane (CF₄)

Scarcity of supplies

Expensive

Very high Global Warming Potential (GWP)

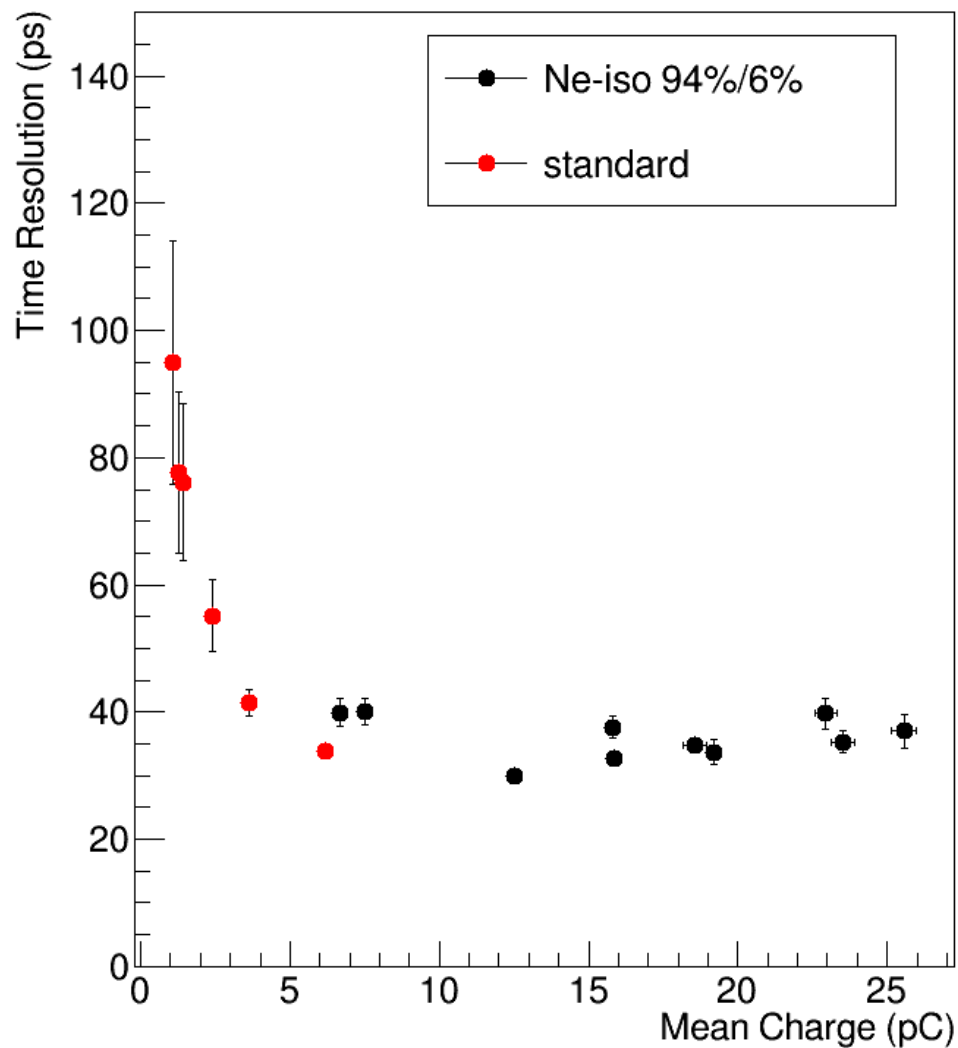
Look for new mixtures



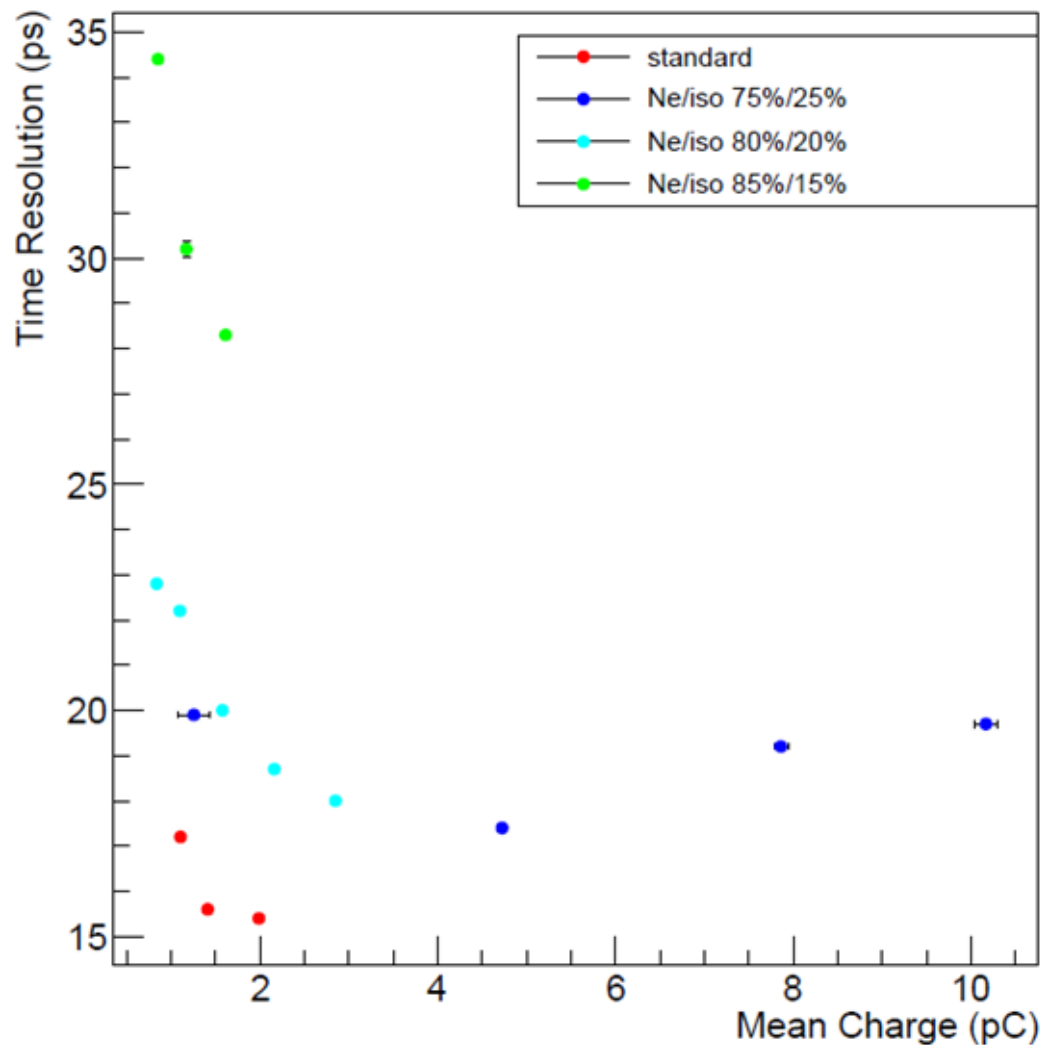
iC₄H₁₀
GWP 0.006

Previous results

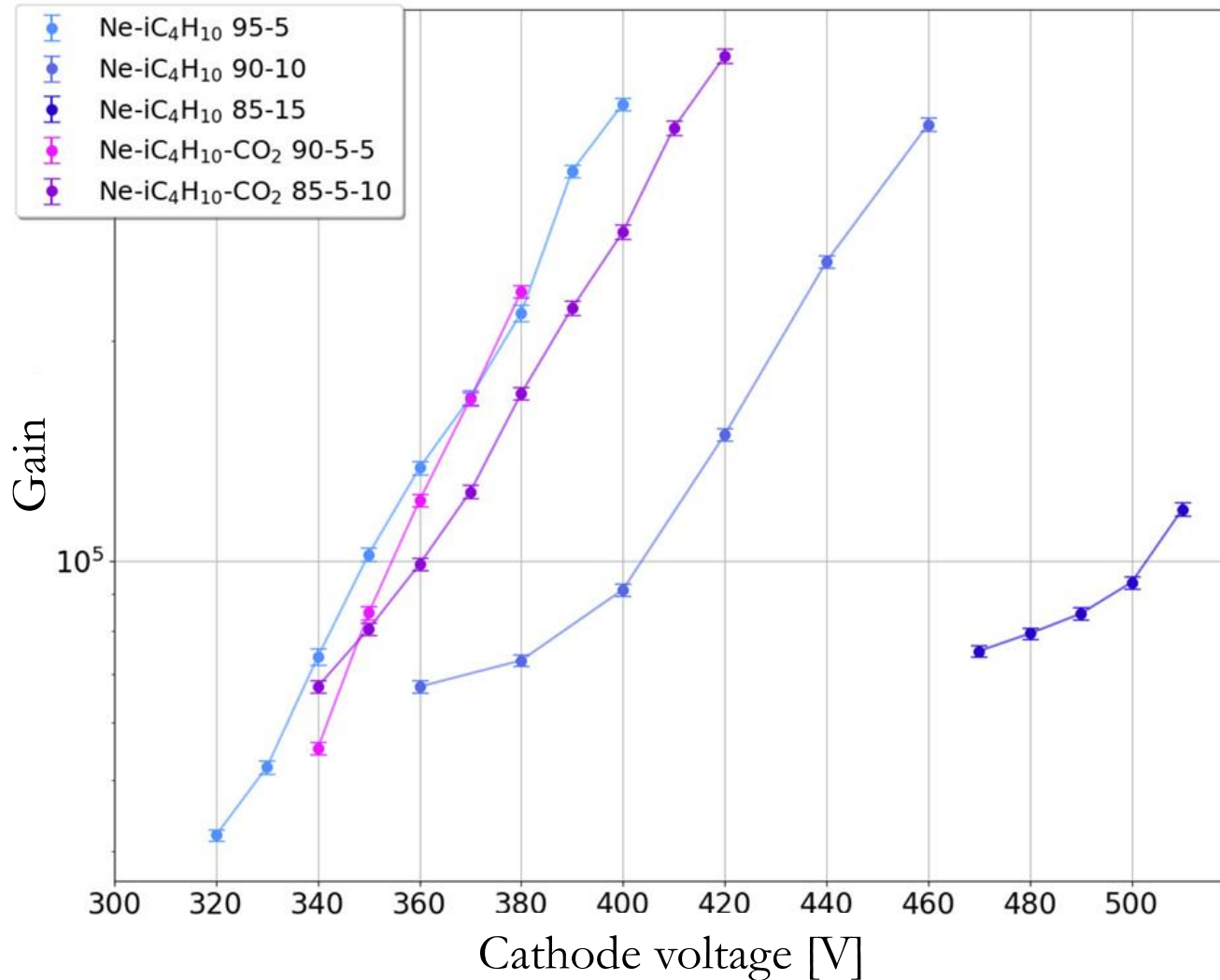
July 2023, Resistive MM, 82M Ω



April 2024, Non-resistive MM

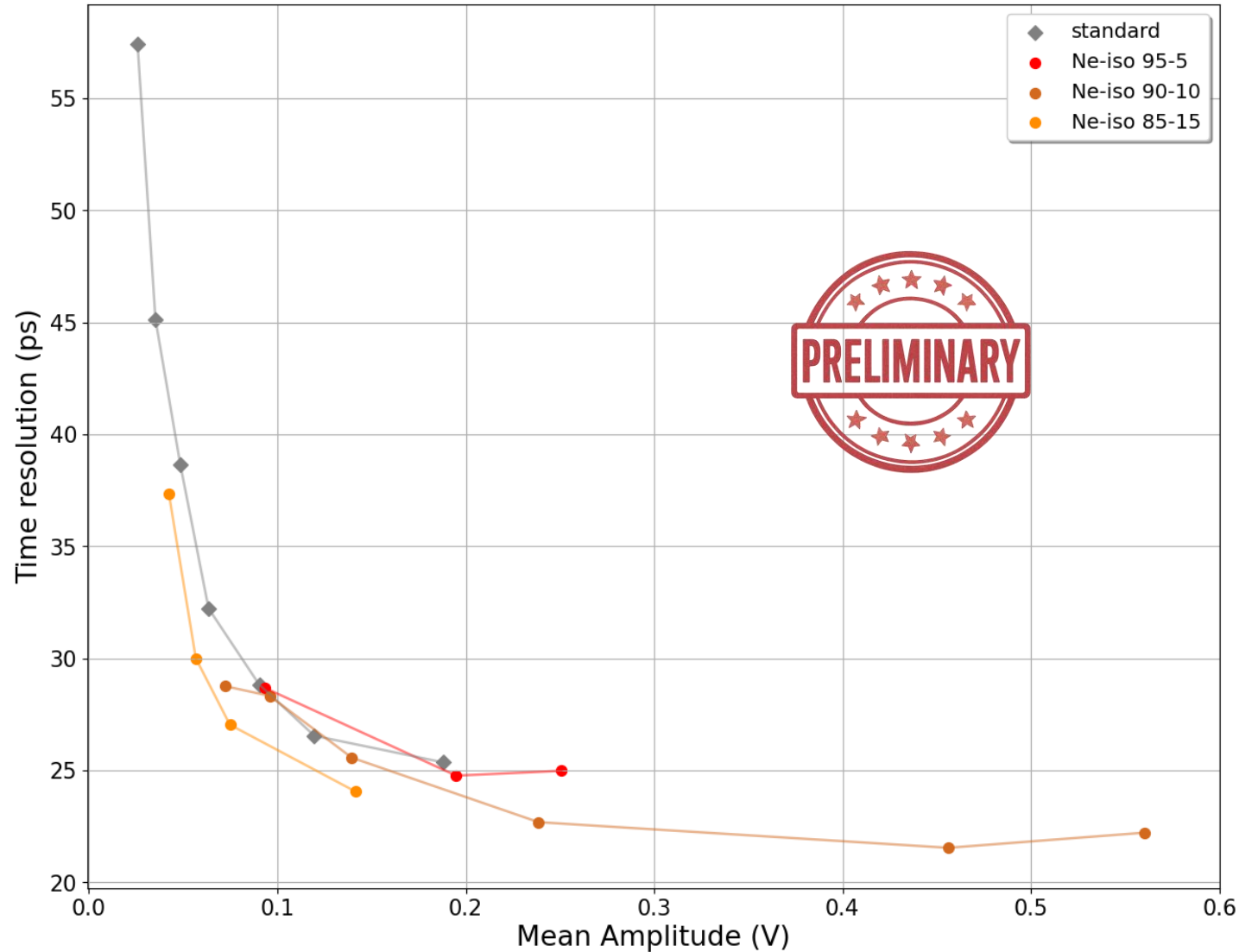


Gain results



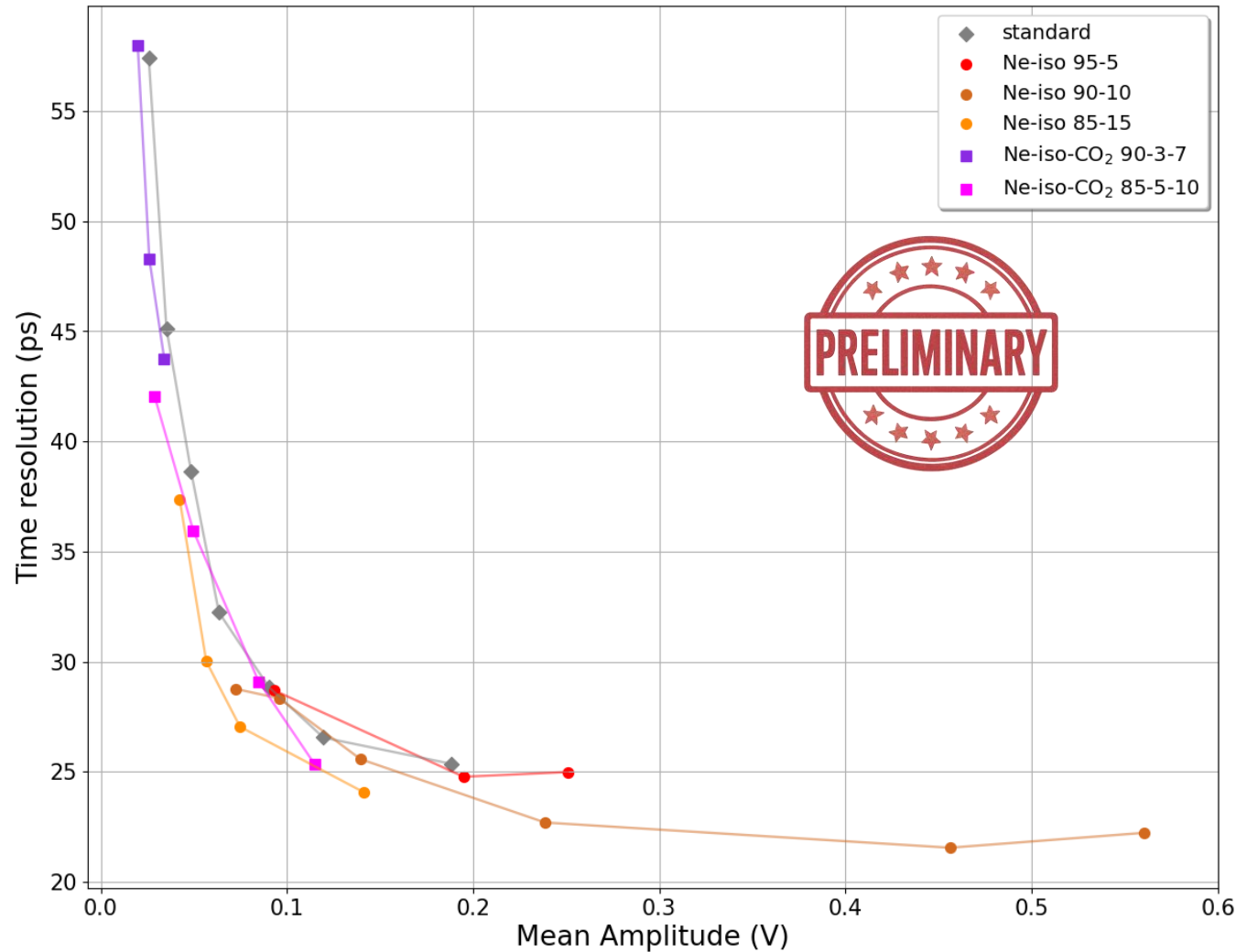
- Gain measurement to test different mixtures
- Similar results for the Ne – iso 95-5, 90-10 and Ne – iso – CO₂ 90-5-5 mixtures

Latest test beam results



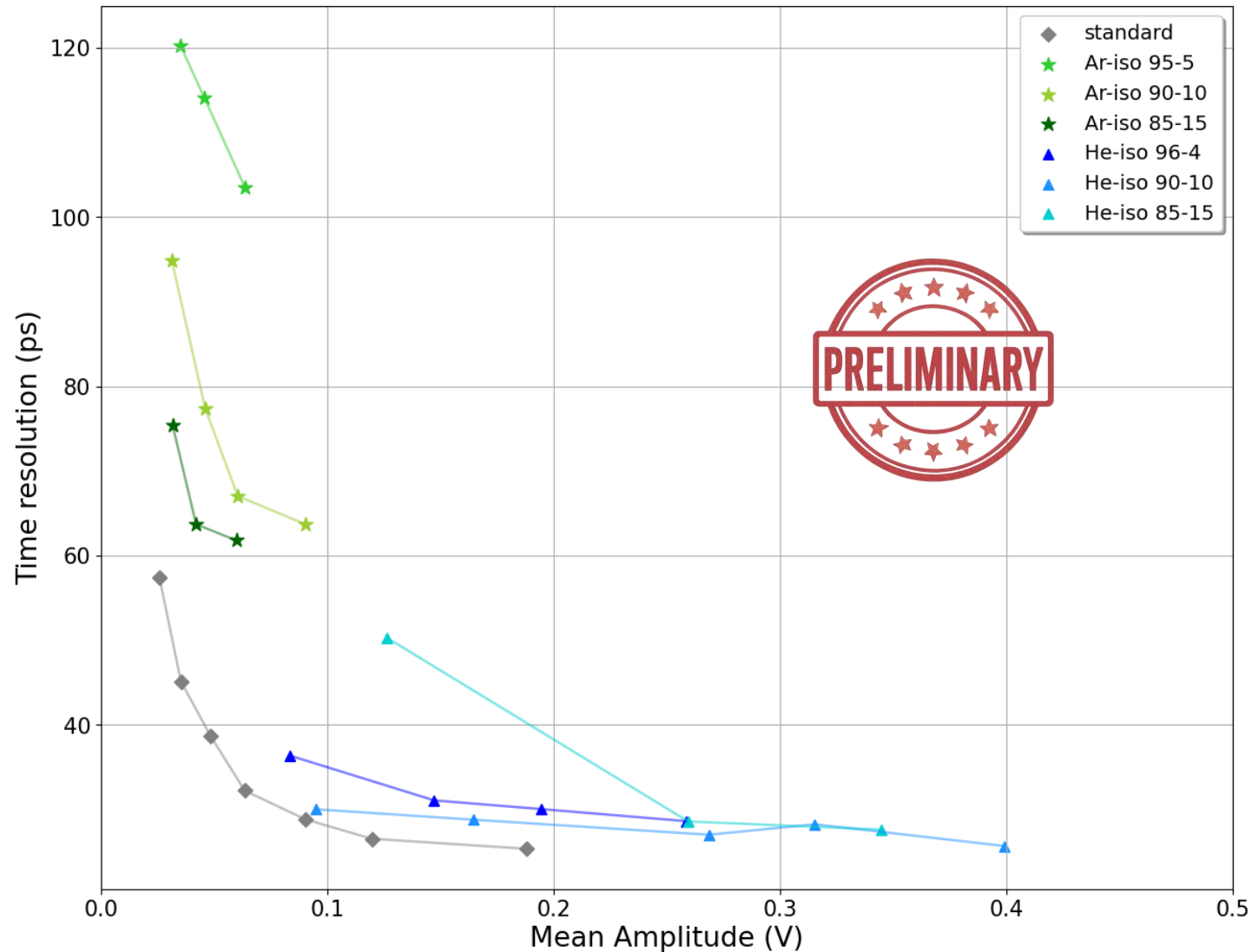
- Comparison standard mixture vs Ne-iso ones
- Comparable time resolution achieved with the new mixtures

Latest test beam results



- Comparison standard mixture vs Ne-iso ones
- Comparable time resolution achieved with the new mixtures
- Mixture with added CO₂
- The 2 mixture with CO₂ are non flammable

Latest test beam results



- Comparison standard mixture vs Ar based ones and He based ones
- Ar based mixtures show a worse time resolution
- He based mixture show a good time resolution (not as good as Ne)

Future perspectives and conclusions

- Test of new mixtures with ethane as a quencher
- «Ageing test» on isobutane mixture (looking for deposits)
- More tests on the Ne/Ar/He based mixture

- Ne-based mixtures confirmed to reach comparable time resolution to the standard one
- Ar- based mixtures has worse time resolution than Ne-based ones (but they are way cheaper)
- He-based mixtures show good time resolution (also costs are in the middle)