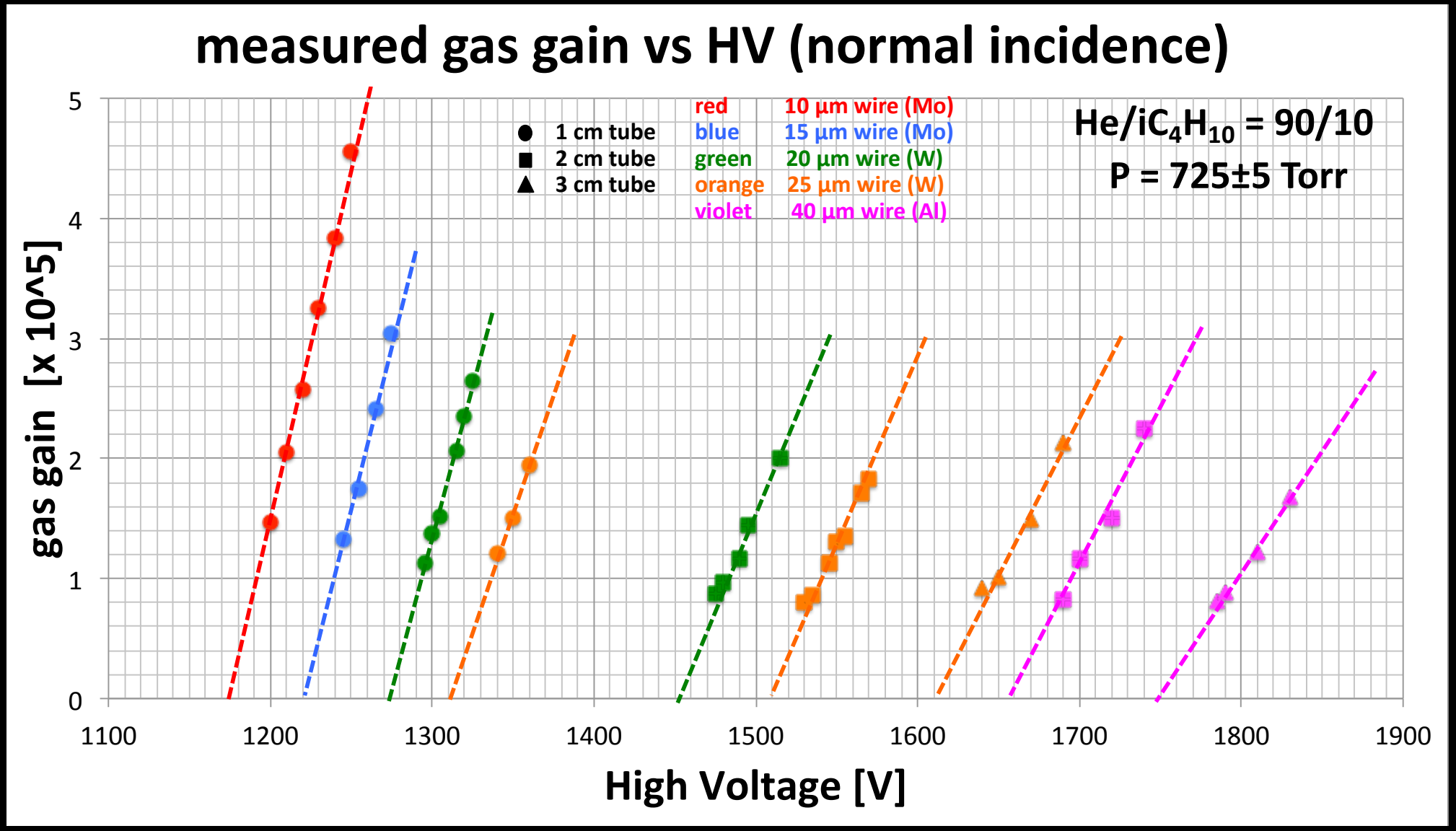
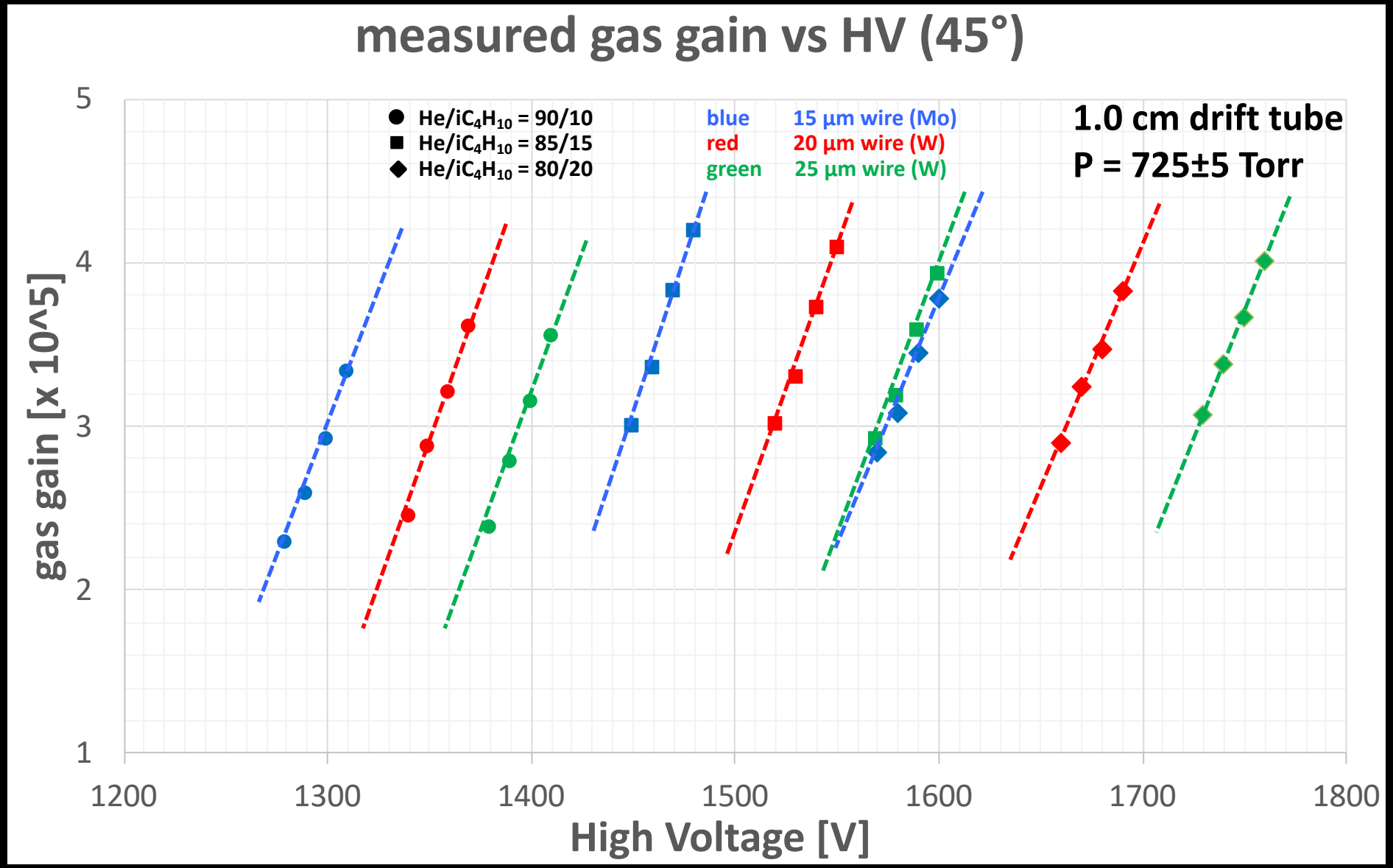
Analysis of the July 2022 beam test data

Brunella D’Anzi (INFN & University of Bari) for the Test Beam Crew

Gas Gain (TB November 2021)

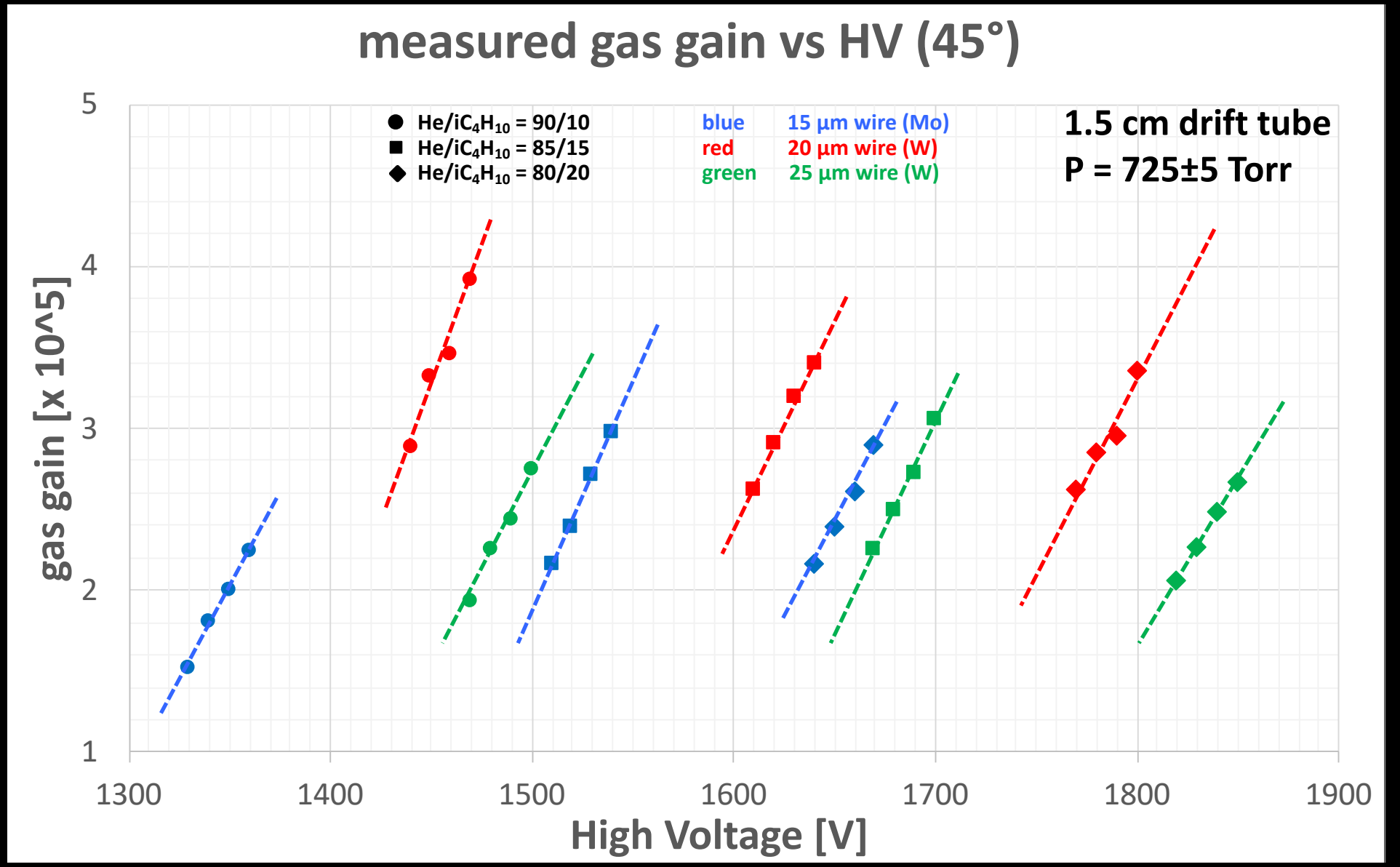


Gas Gain (TB July 2022)



The 25 micron wire He:IsoB 85/15 has the same gain of 15 micron wire He:IsoB 80/20!

Gas Gain (TB July 2022)

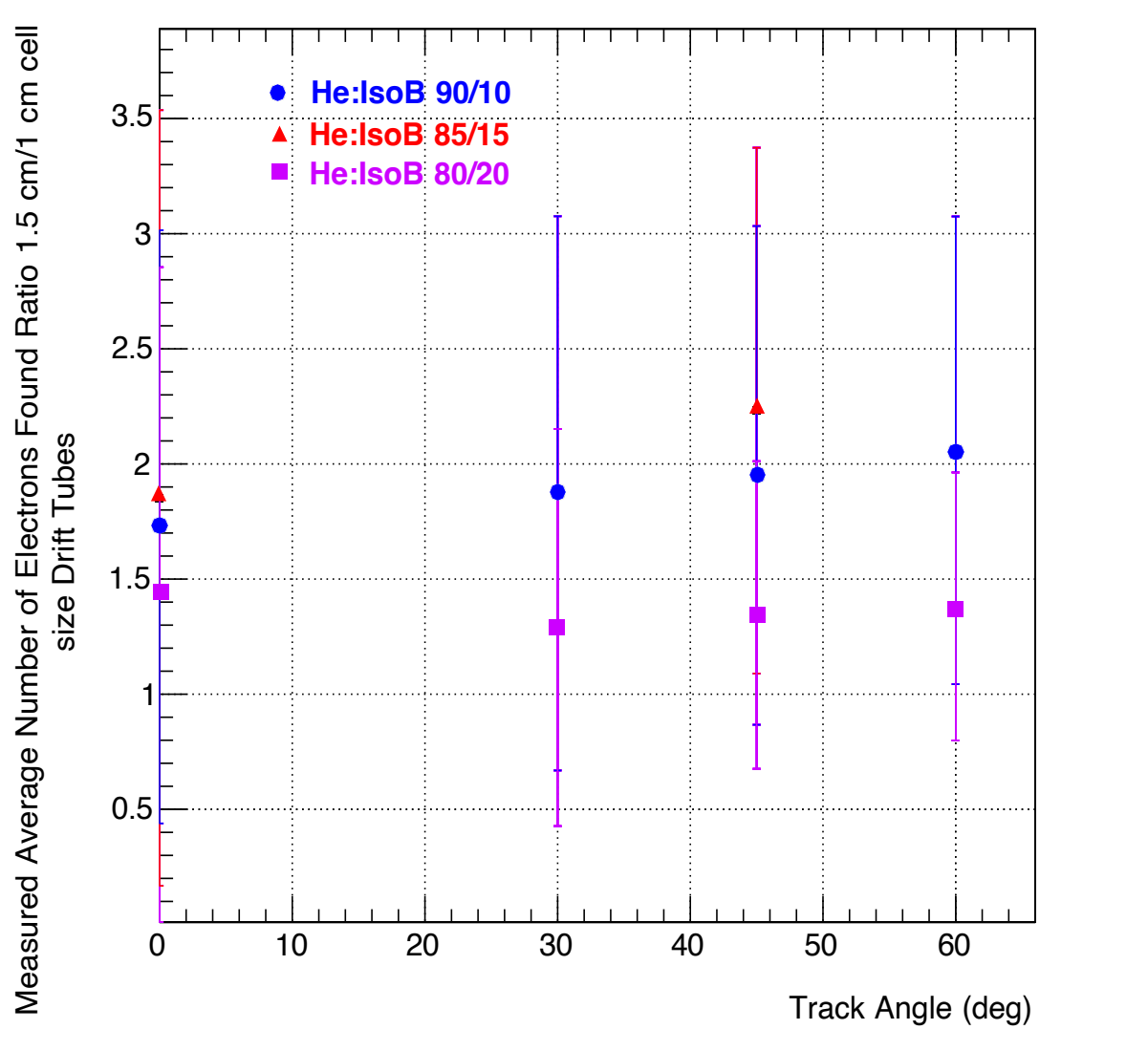


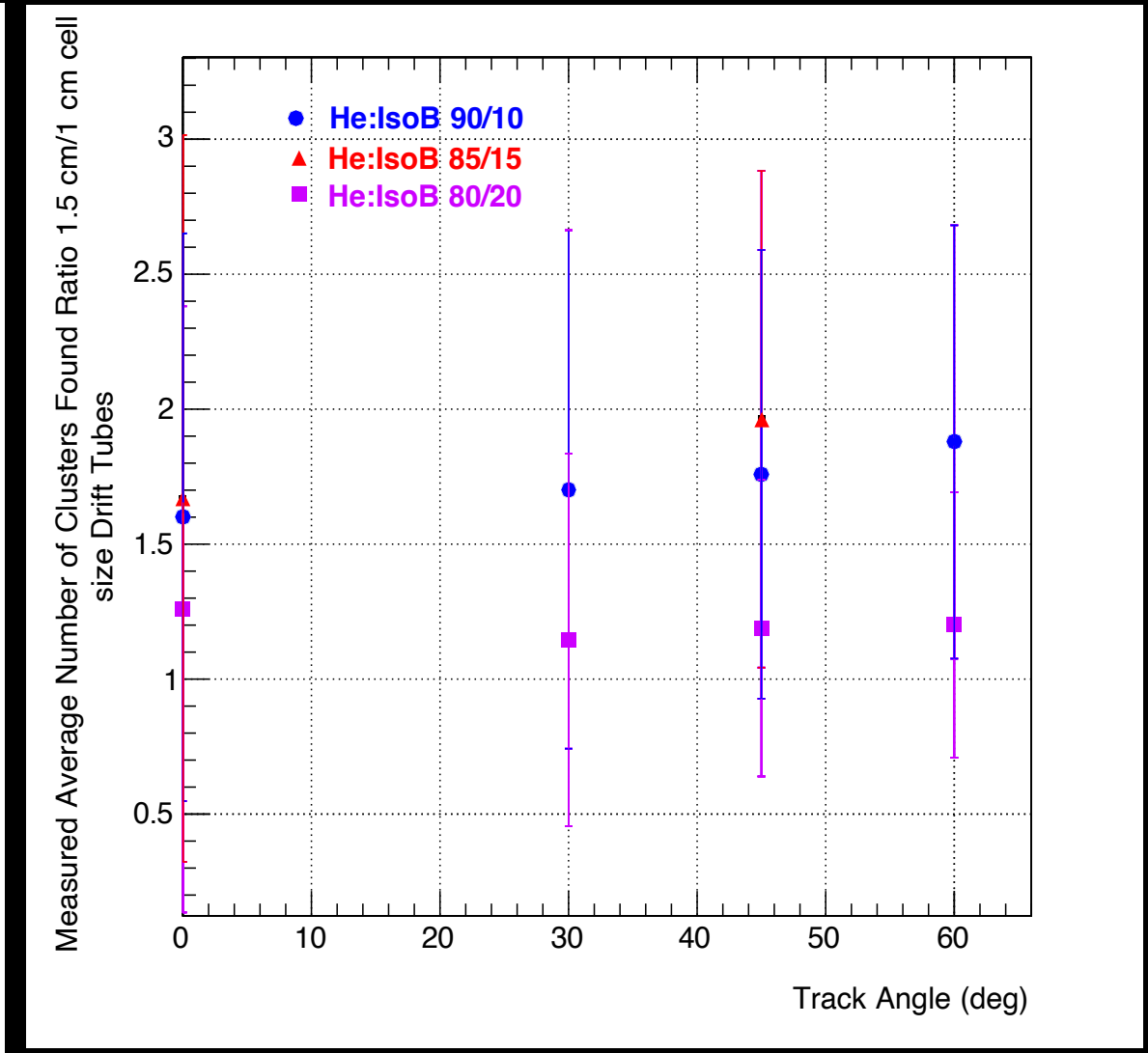
20 μm wire excluded from physical quantities mean computation

Ratios between 1.5cm/1cm wires

TB July 2022

(1,2/0,8)





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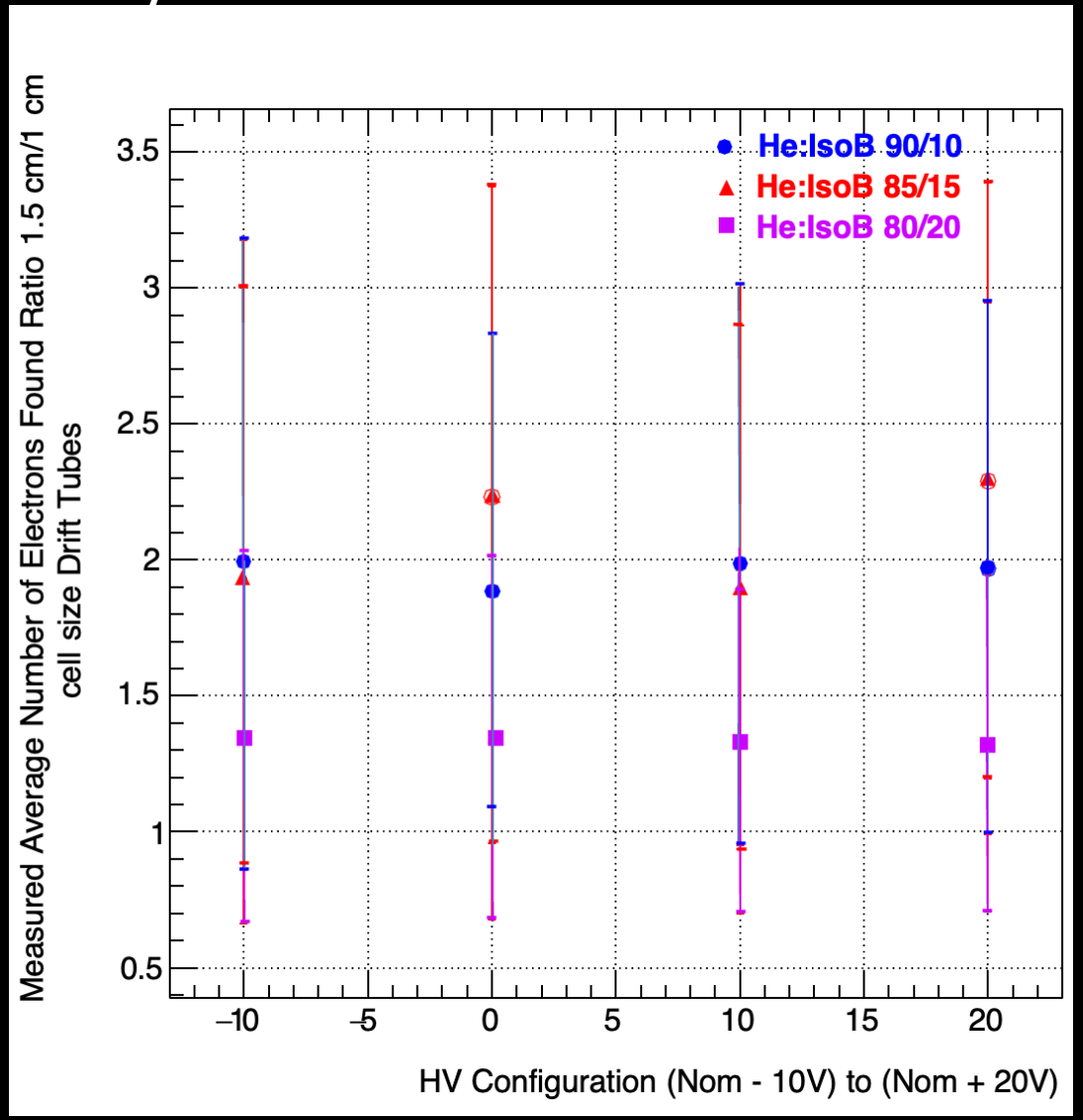
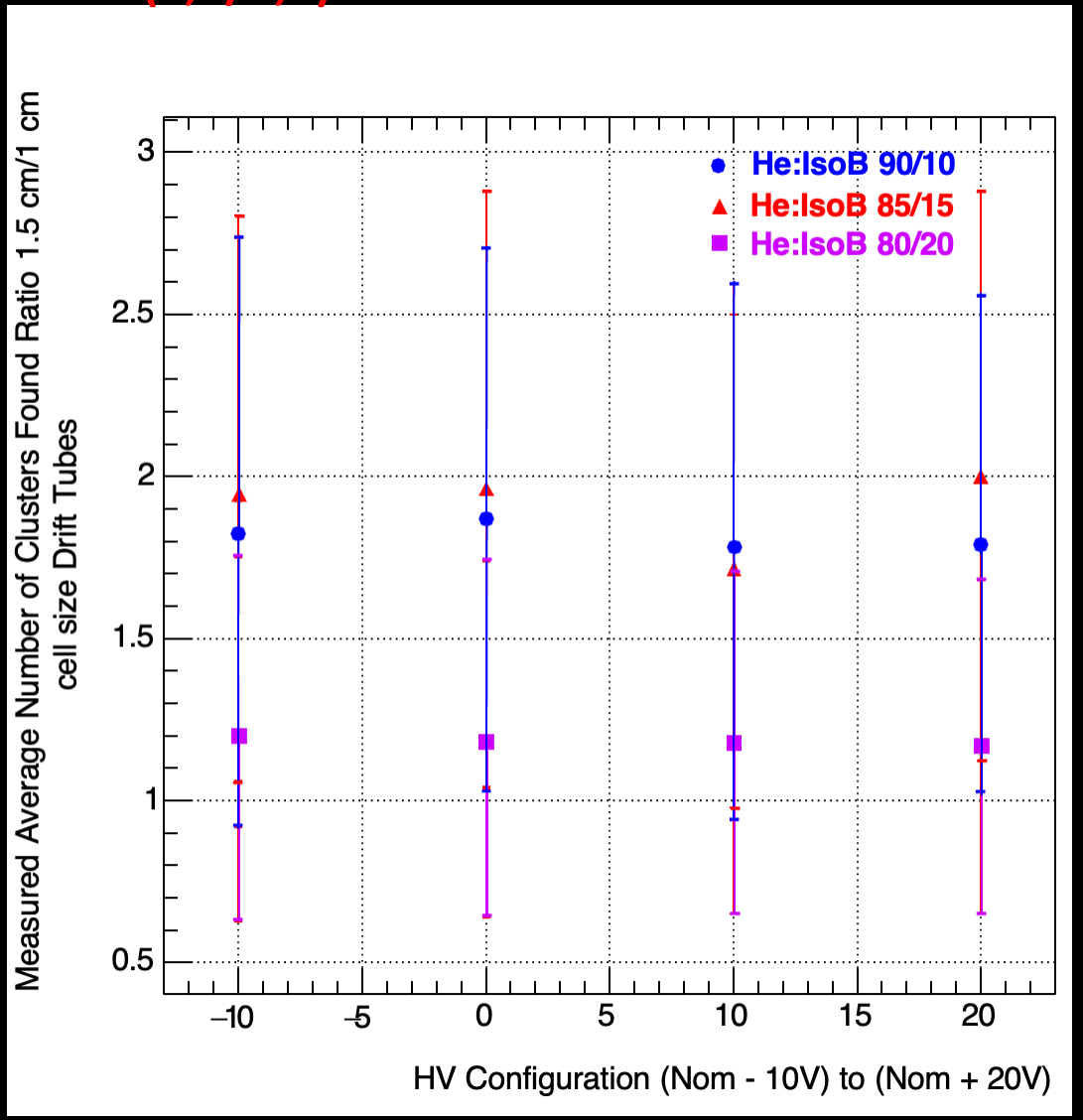


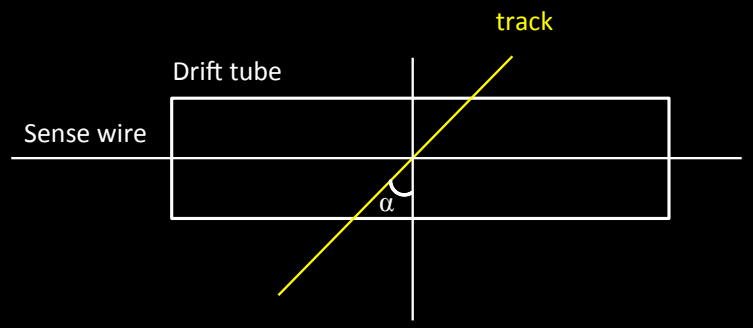
(1,2/0,8)



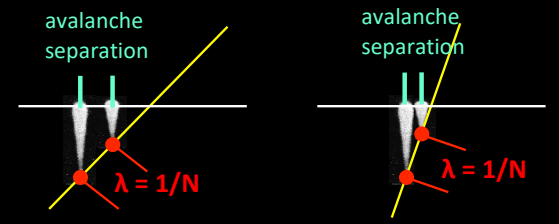
Reminder: Space Charge Effect

Space charge effect, at any given angle, results in reducing the effective gas gain (or, equivalently the average single electron pulse height) with respect to a configuration at a larger angle.

At 165 GeV/c, we expect **N ~ 16.5/cm → λ ~ 600 µm**.

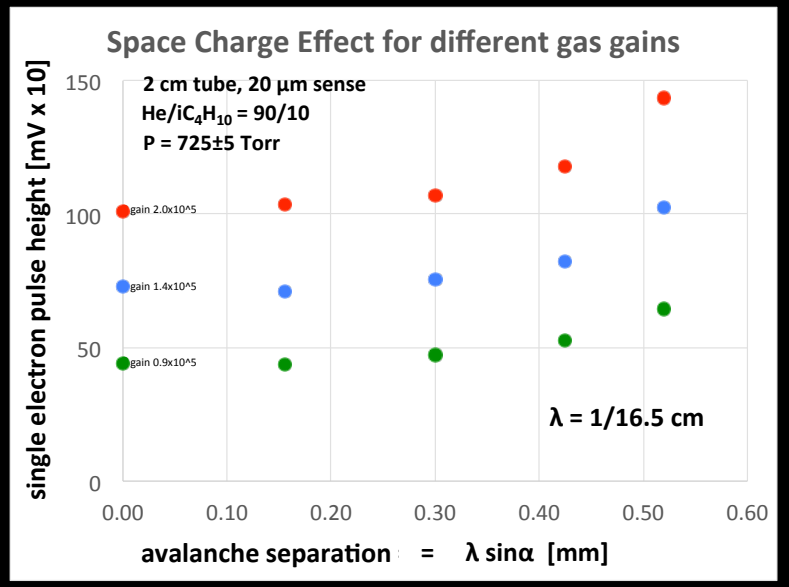


Study avalanche overlap as a function of the track angle

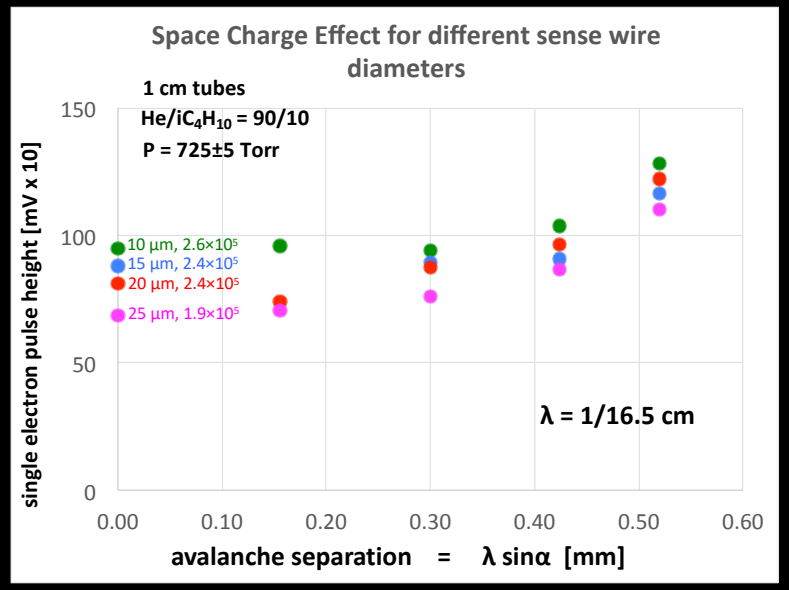


avalanche separation = λ sinα

TB November 2021



TB November 2021



Space charge effects, in this range of gas gain do not seem to depend on gas gain or, surprisingly enough, on sense wire diameter. The maximum **avalanche suppression**, for this gas mixture, amounts to

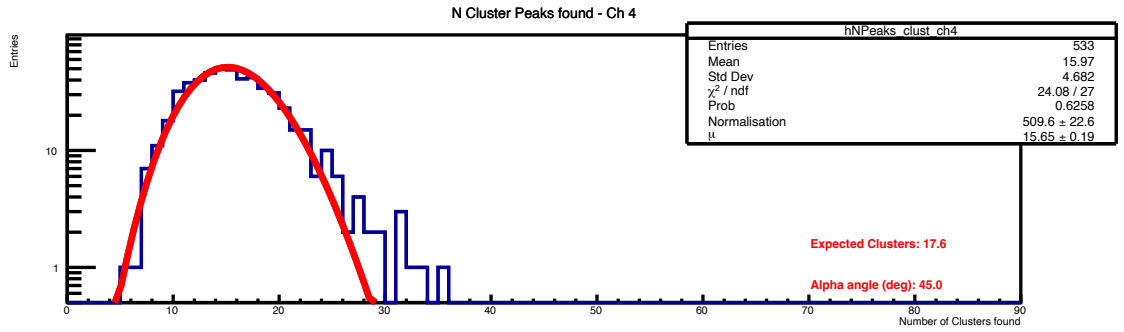
≈ 70%, at 0°.

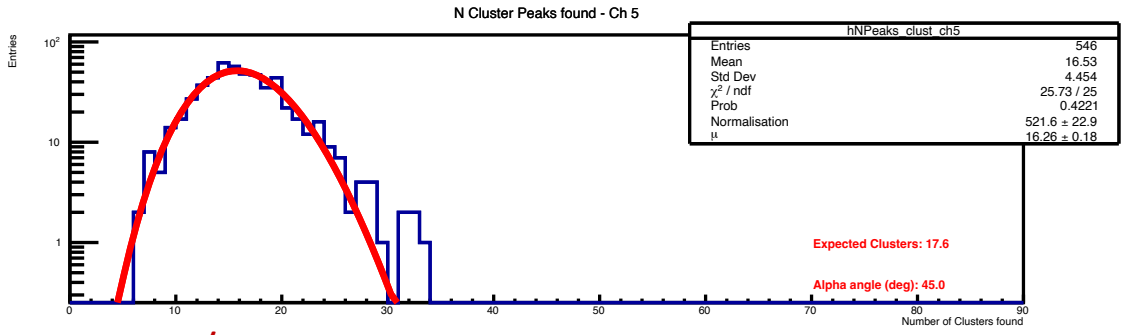
A naive model based on spherical avalanche gives, for this configuration, an **avalanche radius** of $r_{av} \approx 500\mu m$.

Number of Clusters (TB November 2021)

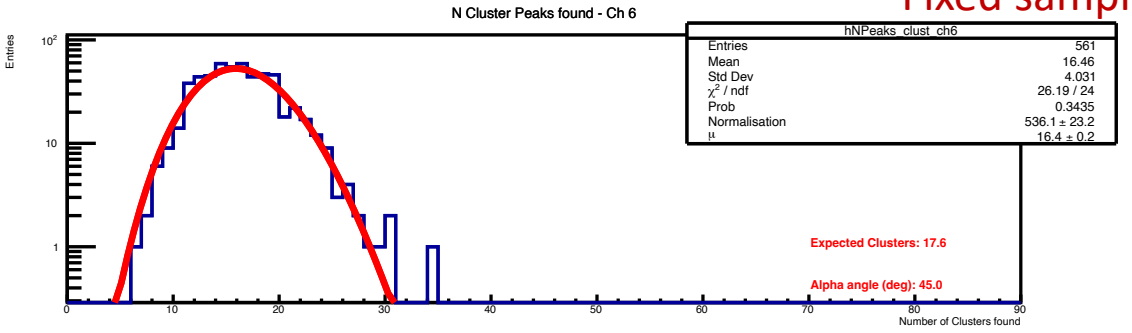
Run: run_94.root; Track angle: 45° ; Gas mixture: 90%He ; HV = +20

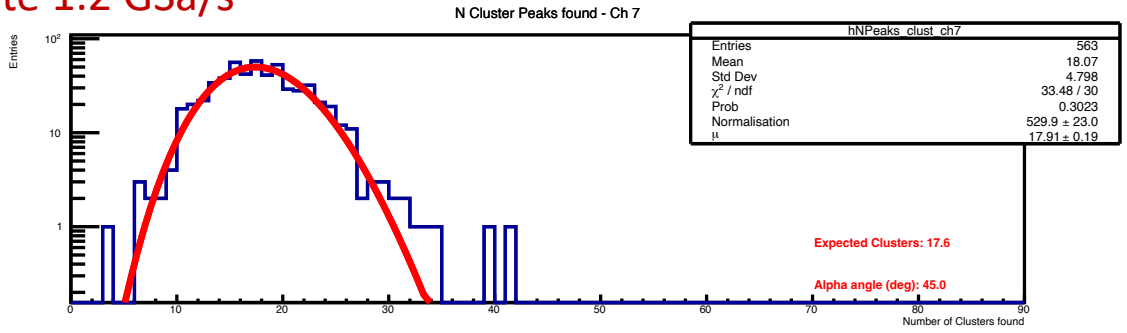
1 cm drift tubes

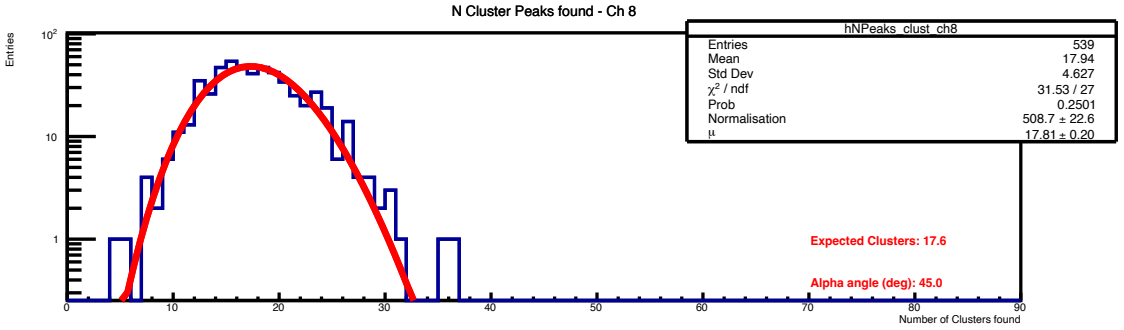


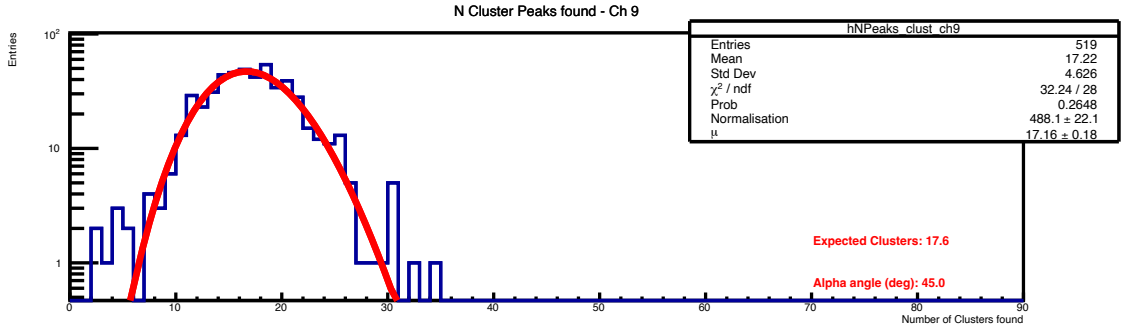


Fixed sampling rate 1.2 GSa/s





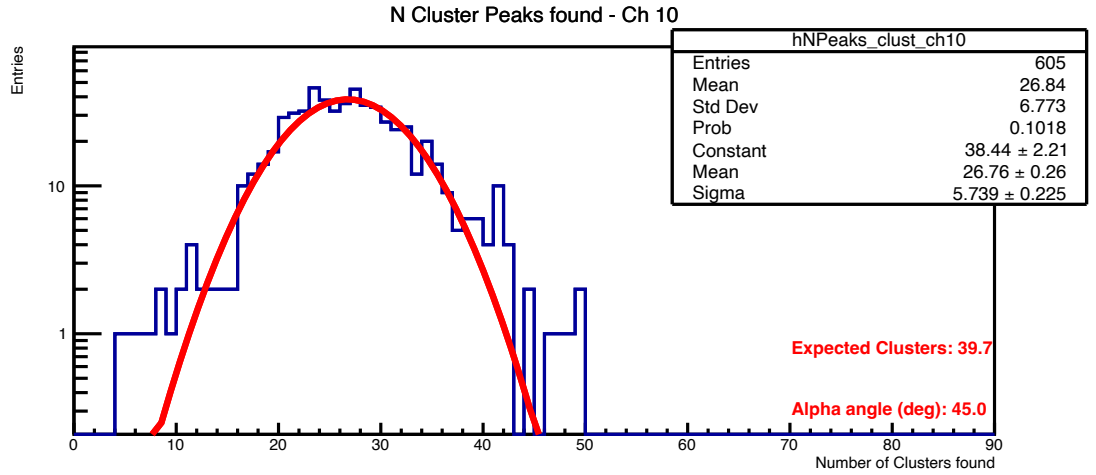


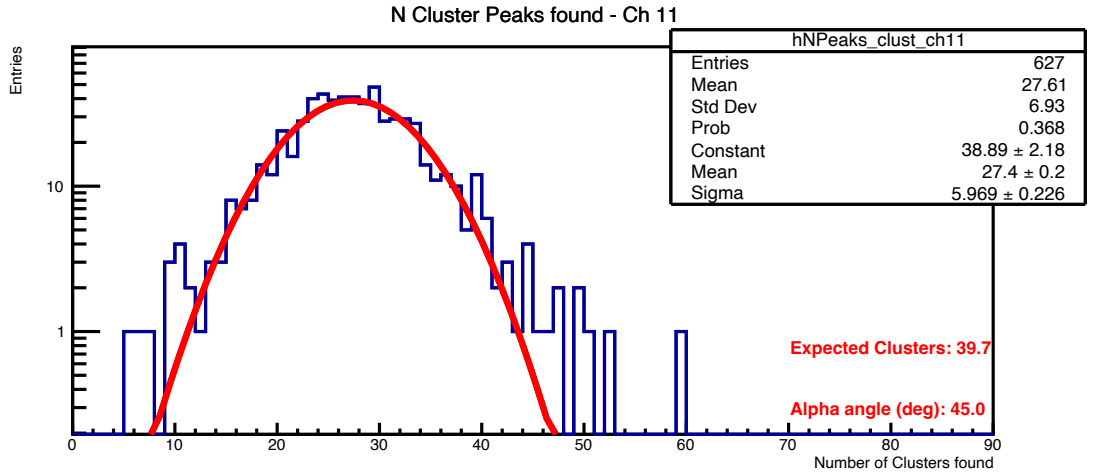


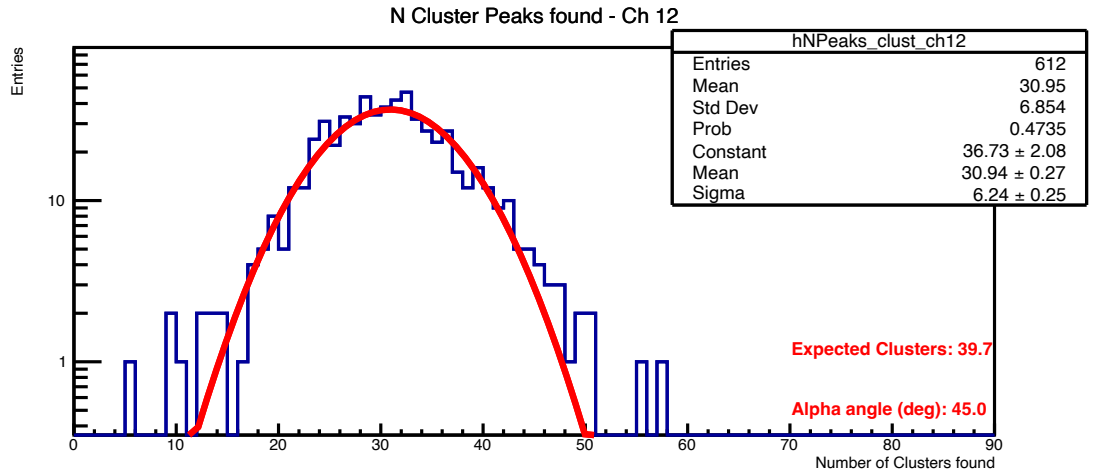
Number of Clusters (TB November 2021)

Run: run_94.root; Track angle: 45° ; Gas mixture: 90%He ; HV = +20

2 cm drift tubes







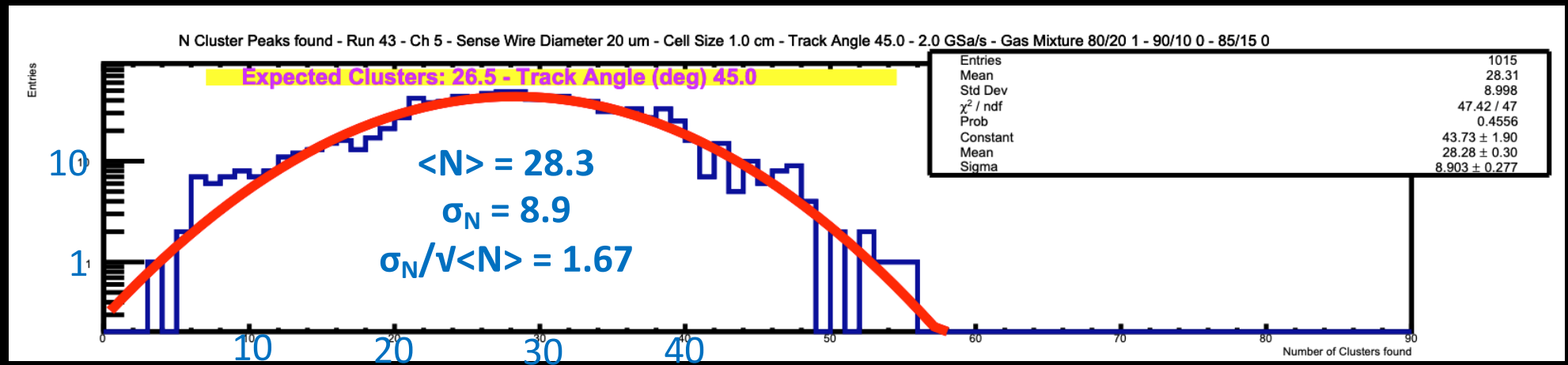
Fixed sampling rate 1.2 GSa/s

Underestimation due to under-counting of the electron peaks.

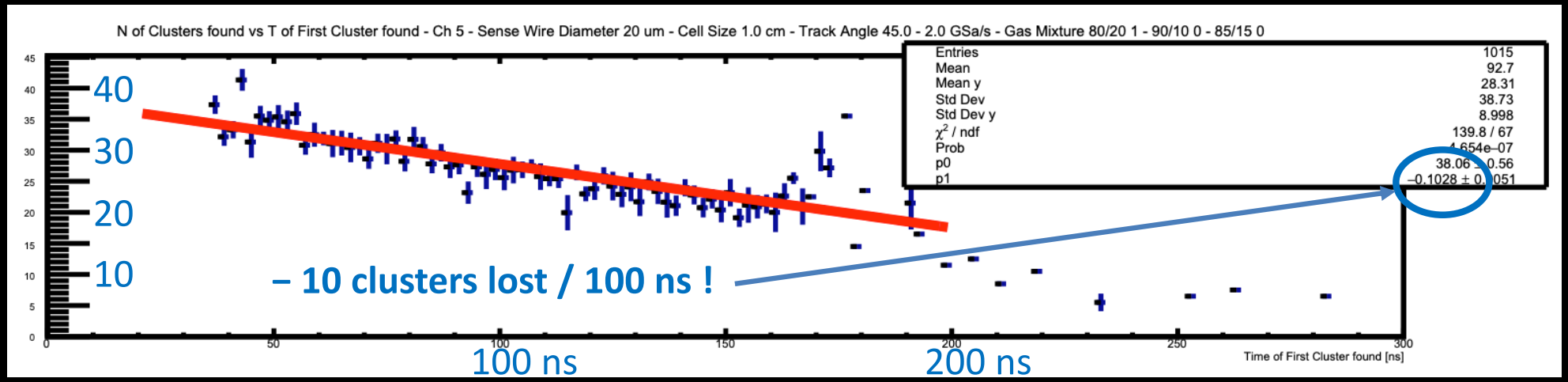
Recombination and Attachment Effects

TB July 2022

Number of clusters found



Number of clusters found vs cluster drift time

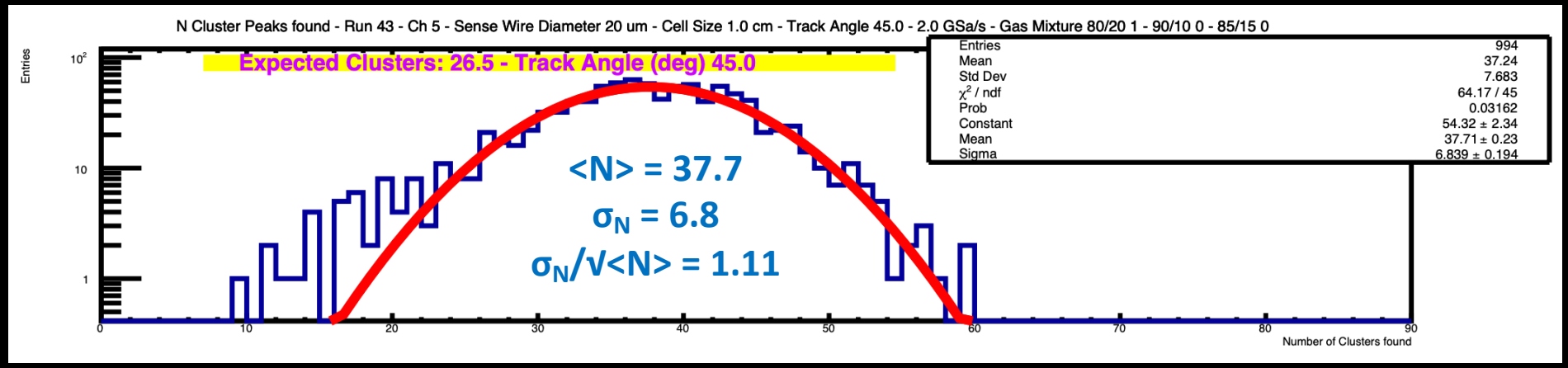


Combined action of recombination, electron attachment and E-field suppression due to space charge

Recombination and Attachment Effects

TB July 2022

Apply corrections to recuperate losses:



Obviously, the cuts on the derivative algorithm, which were optimized without considering the recombination and attachment effects, need to be reformulated.
Also, these corrections, for their nature, strongly depend on the drift length and, therefore, on the drift tube size and must be calculated for each different drift tube configuration.

This will be the goal of next task.

Conclusions

- Computation of Gas Gain for TB July 2022 datasets: the distribution is almost uniform for 1 cm wires while for 1.5cm much more attention should be paid .

- To be independent from theoretical assumptions and Gas Gain issues, the ratio between number of clusters (electrons) found in different configurations (gas mixtures, HV, angle, sampling rate) has been performed. The values measured are compatible within the error with the values expected, but there is still a margin of improvement.

- A solution to improve the clusters counting and retrieve the Poisson distribution expected is taking into account attachment and recombination effects as correction factors
  - Implemented for 1cm, while for 1.5cm still working in progress