# Negative ionic drift

## *Free path of ionization electrons*

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Nikhef/Bonn LepCol meeting
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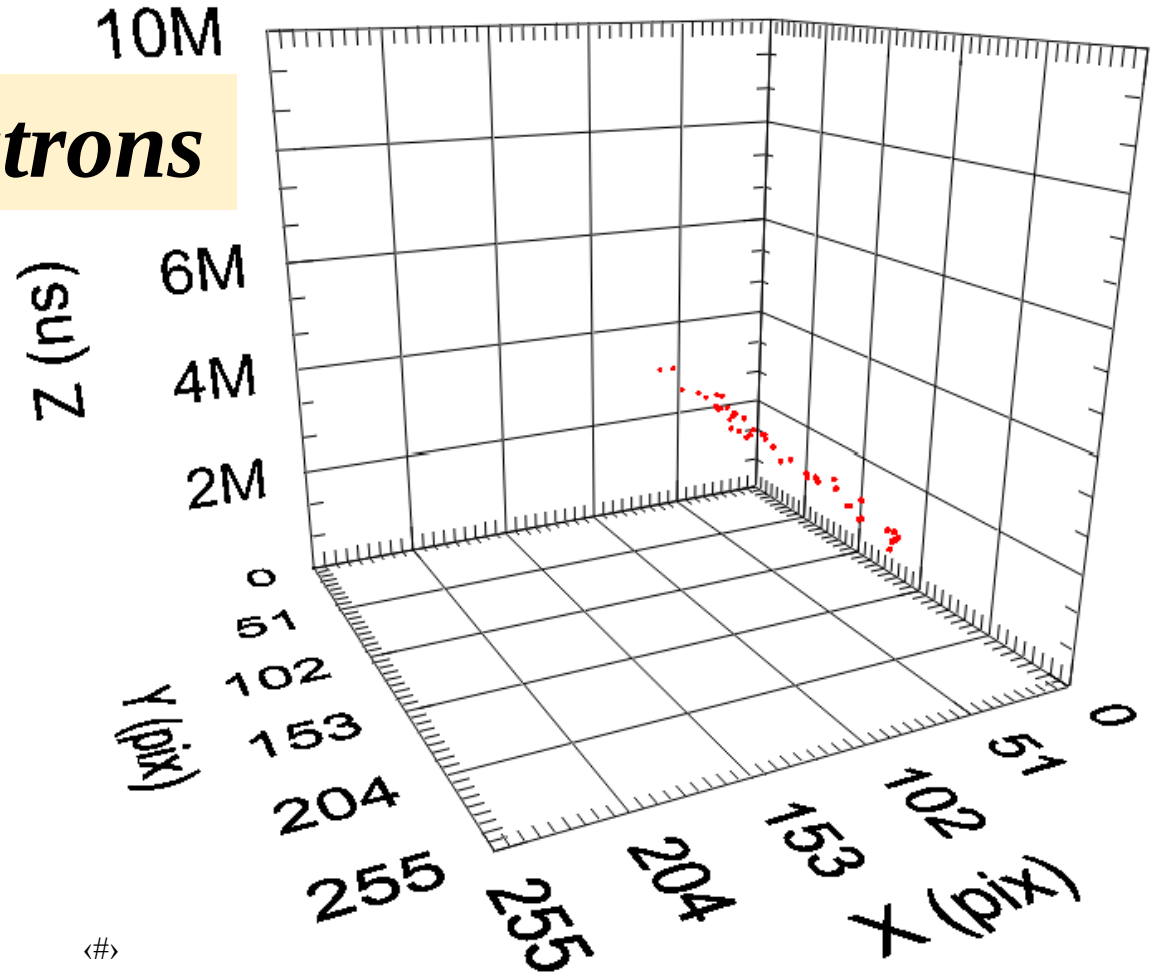
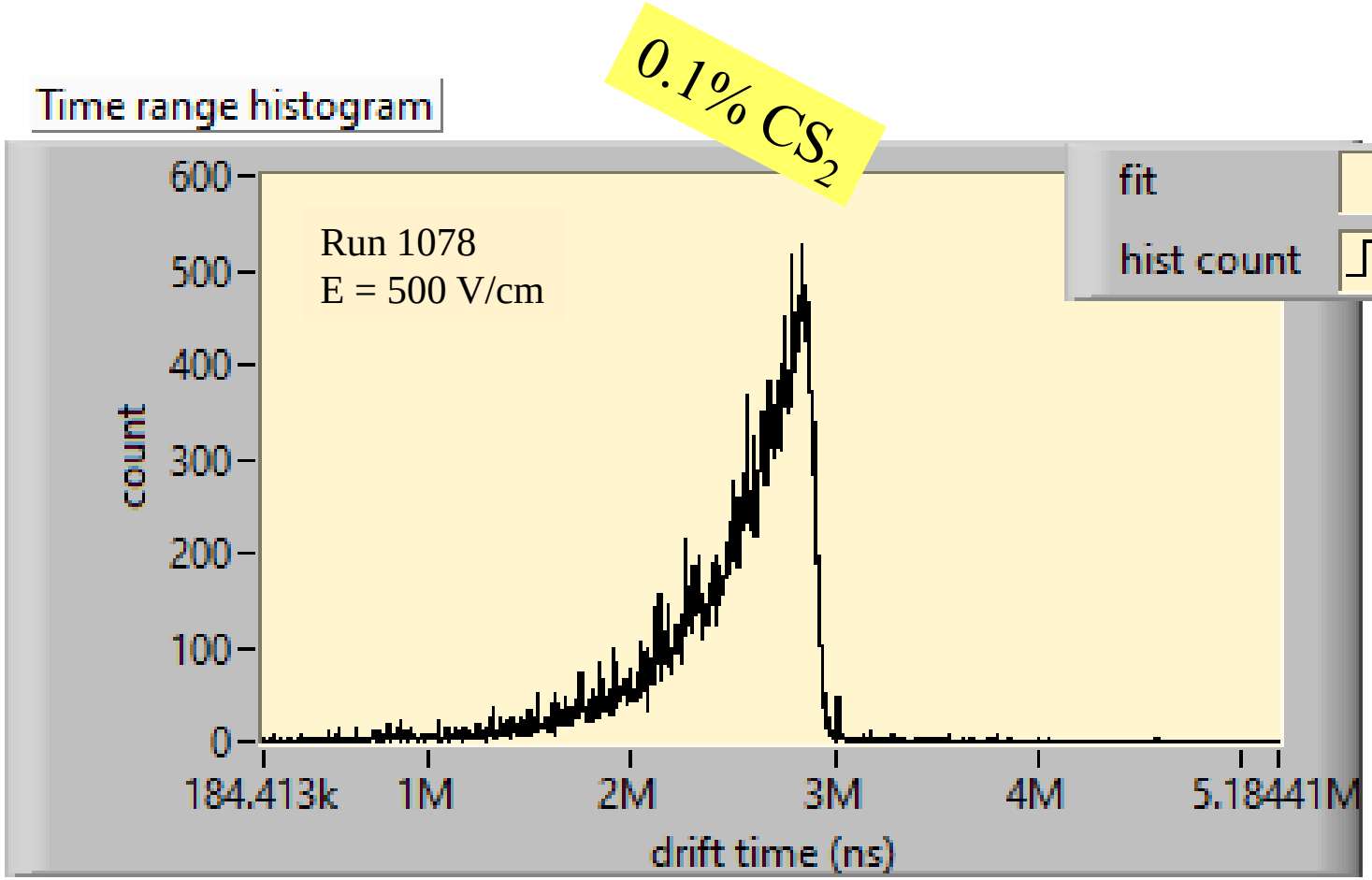


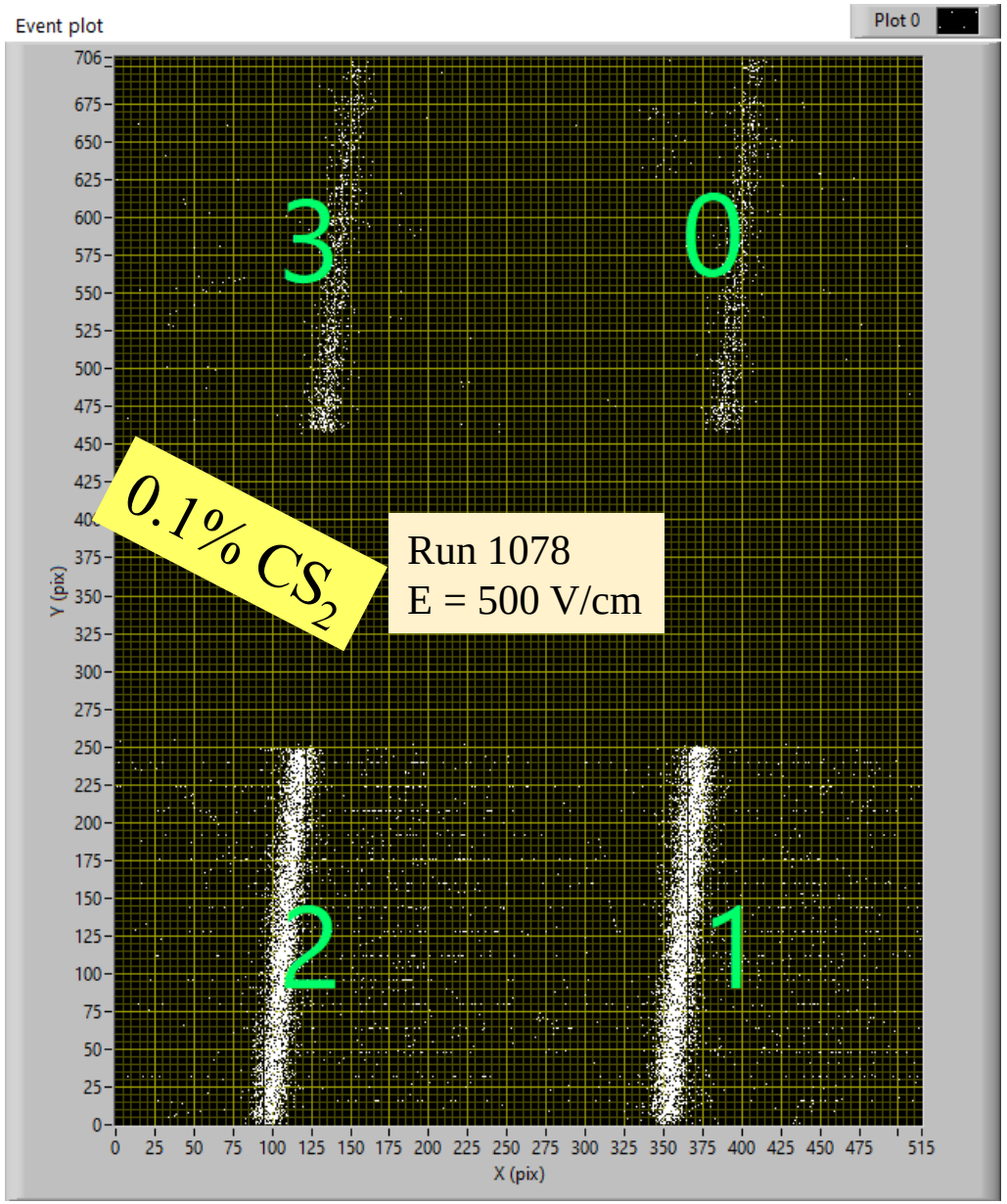
# Measuring the free electron path (λ) at low $CS_2$ concentration

- At low $CS_2$ concentration we see a tail of shorter drift times from electrons that are not captured immediately
- One may easily measure the mean free path of the ionization electrons by fitting the rising edge of the drift time peak
- Assuming the electrons have about a thermal energy, the life time in the $CS_2$ mixture would be constant
  - **=> λ is expected to be proportional to the drift velocity**



# Measurements of Kees at 26-3-2020

- Using the 8-quad testbox and the UV laserbeam
  - $Ar/iC_4H_{10}/CS_2$ 95/4.9/0.1
  - $V_{grid}$ -380 V
  - Z = 22.4 +/- 0.1 mm
- E = 150 – 500 V/cm in 8 steps
  - The measurement at 100 V/cm could not be used
- Measurements on two places
  - Chip 2
  - Chip 1
- ToT
  - ≈1050 ns chip 2 (ε = 90%)
  - ≈1300 ns chip 1 (ε = 95%)

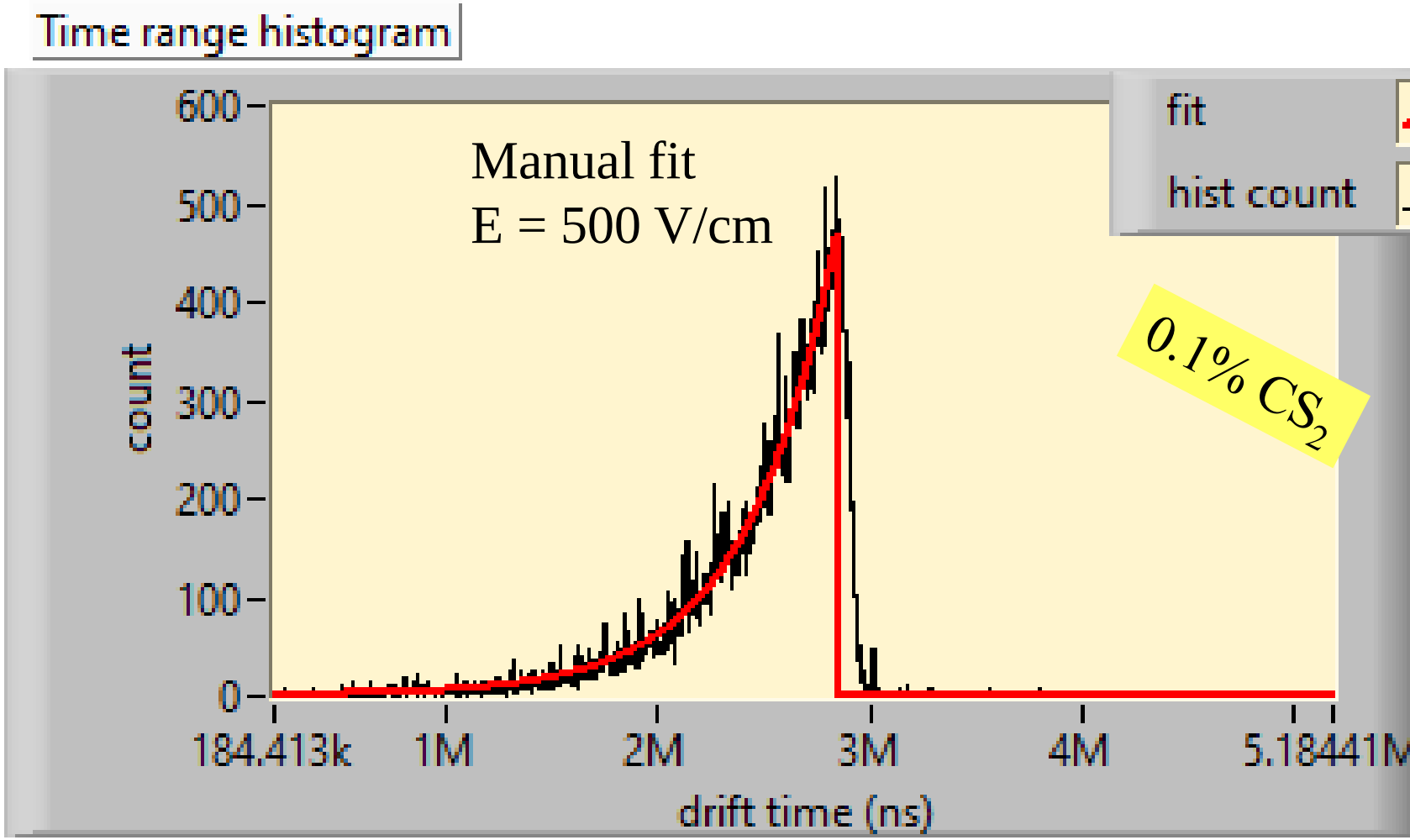


# Fitting the measured curve

- **Rising edge of curve fitted with:**

  **$\psi = C * \exp(x/\lambda)$ †**

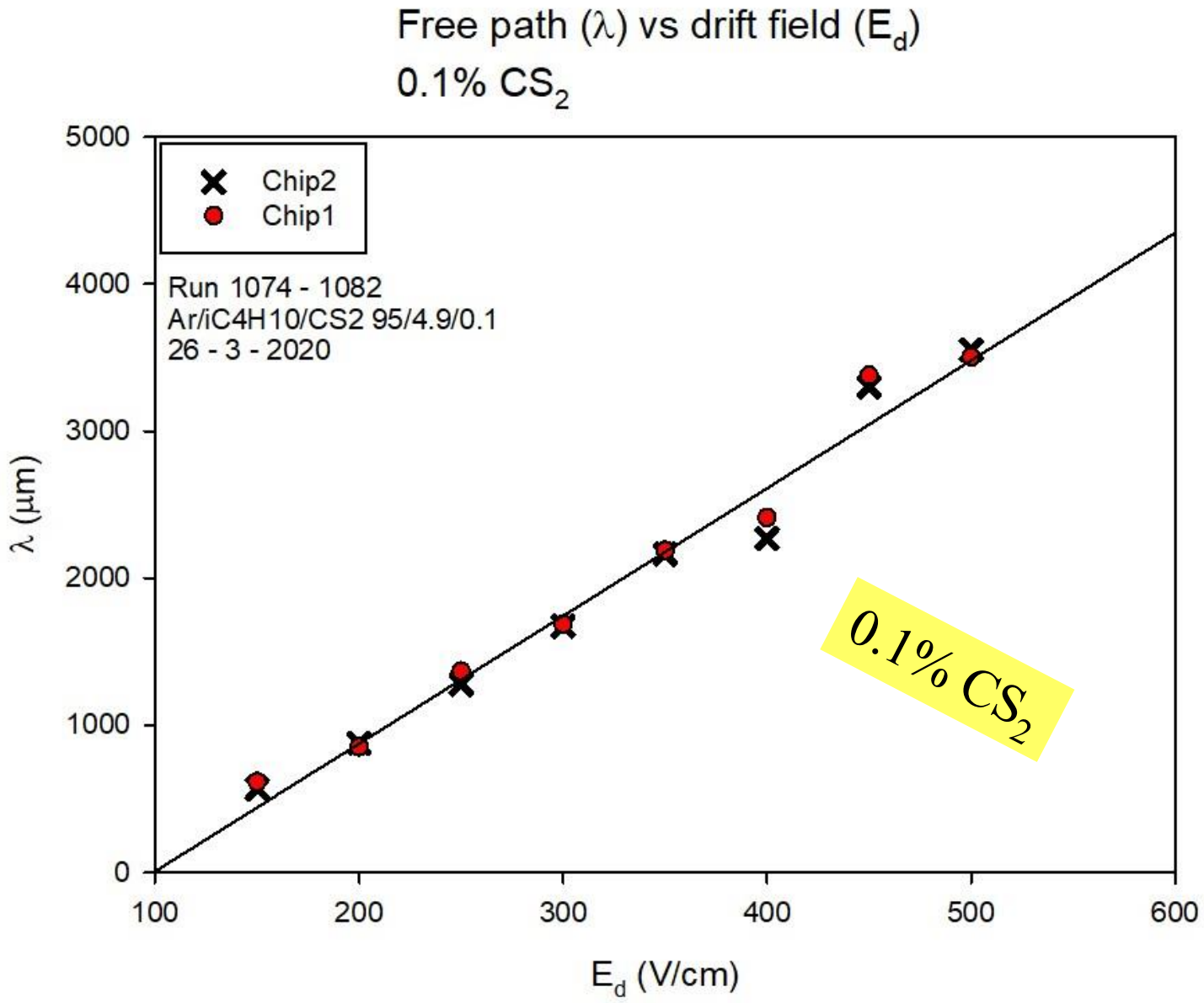
- Apart from E = 150 V/cm the free path slope is much wider than the Gaussian slope
- The drift time peak at 100 V/cm was completely Gaussian




†*N. Dongari, Y. Zhang and J. Reese, Molecular free path distribution in rarefied gases Journal of Applied Physics, 44(12):125502 · March 2011*

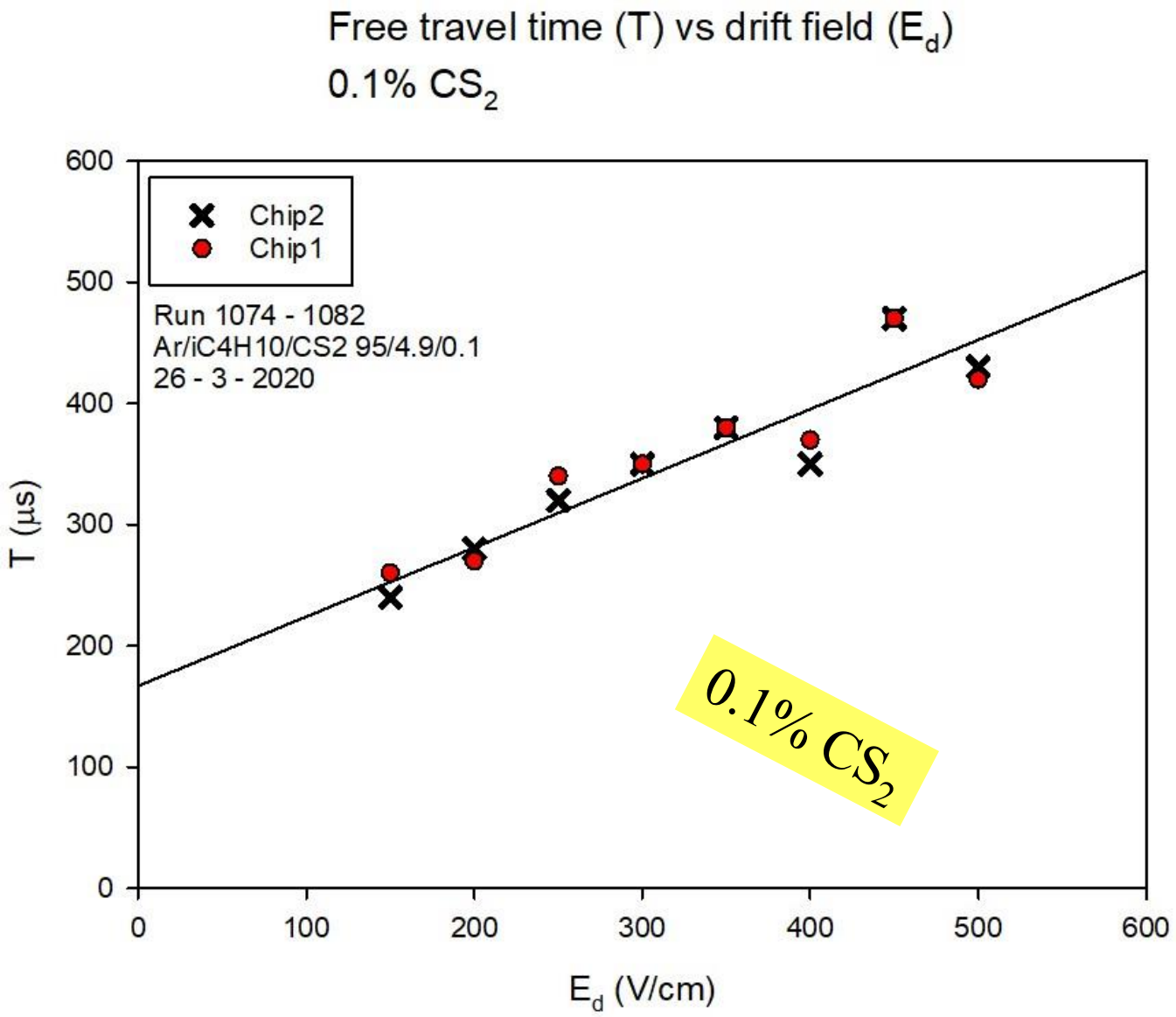
# Free electron path vs E

- Looks like a linear dependence on E
- But fitted straight line suggest $\lambda = 0$ at E = 100 V/cm
  - Not possible



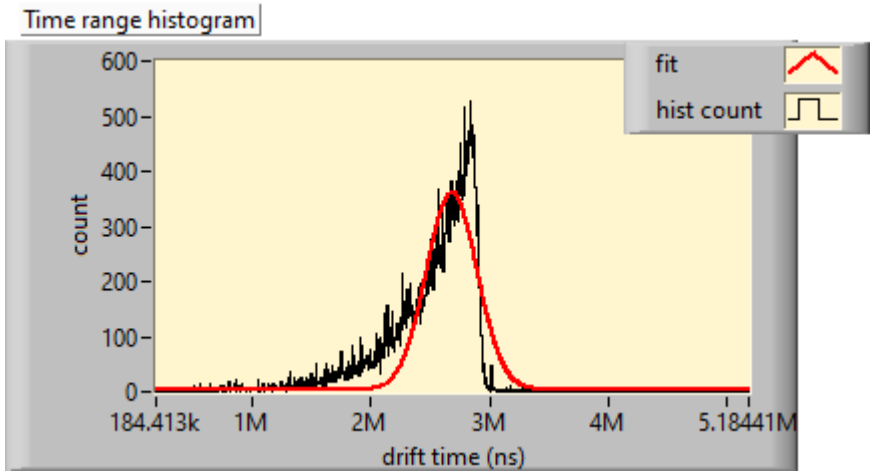
# Free electron stay vs E

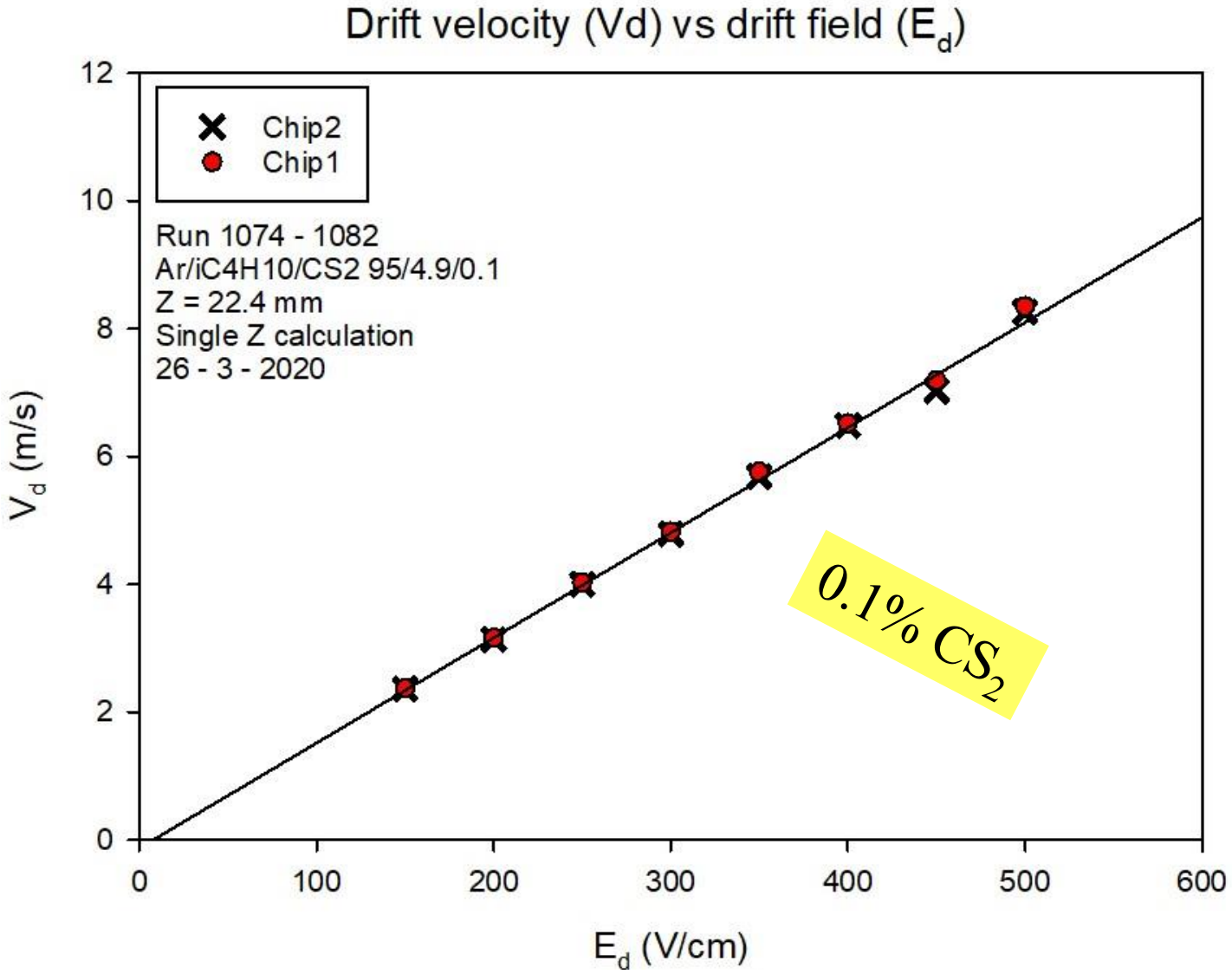
- Thermal electrons:
  - Expected to be independent from E
- Assuming more than thermal energy at higher fields
  - => more collisions per unit of time
  - => **shorter** stay at higher fields
- But **longer** stay observed at higher fields
- Obviously electrons with higher kinetic energy are less likely to be captured by a $CS_2$ molecule



# Drift velocity (single point) vs E

- Less accurate because of
  - single point calculation
  - Highly asymmetric drift time spectrum => bad Gaussian fit
- Values only used to calculate λ in μm

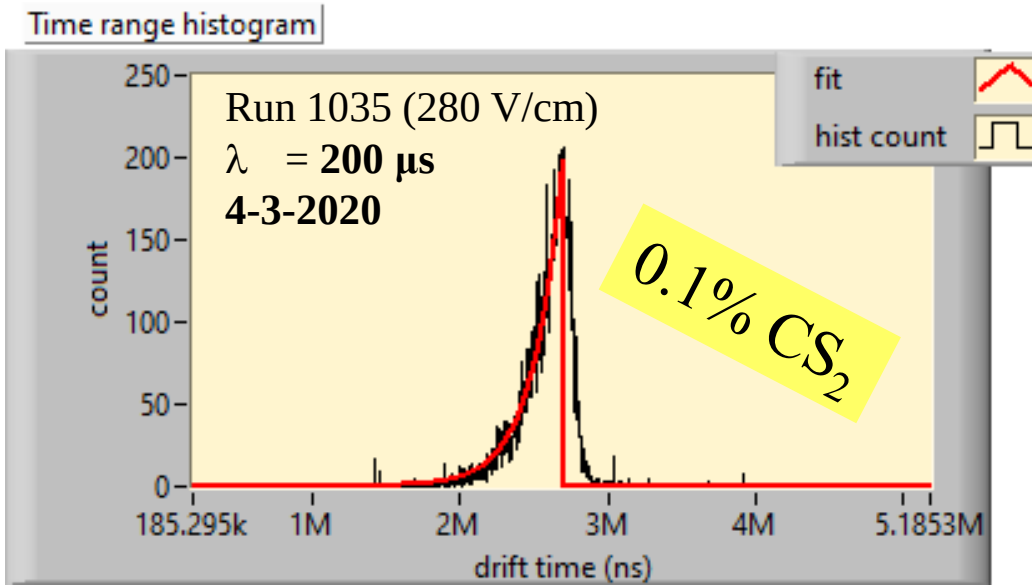


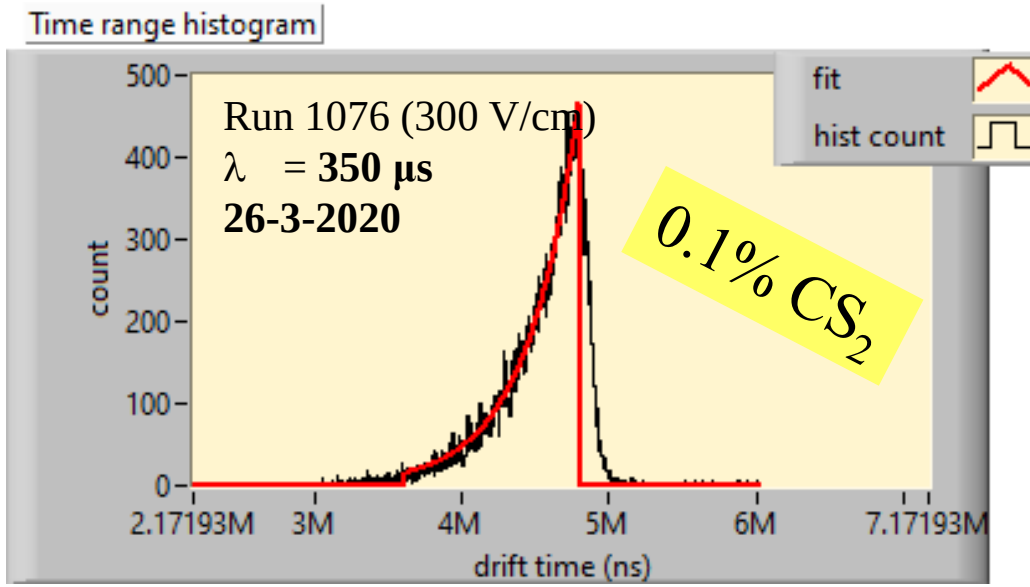



# No agreement with earlier measurement at 0.1% $CS_2$

- Reason unknown
- Same mixture bottle for both runs
- Rather short flush for the first measurement
  - 3 x the chamber volume
- Probably longer flush for the second measurement
  - 5 x the chamber volume?
- Maybe the gas in the bottle was not sufficiently mixed

- At present we don't have reliable data to check if λ is inversely proportional to the $CS_2$ concentration



# Conclusions on free path measurements

- Strong dependence of the mean free path of the electrons on the drift field
  - More than expected
- The electron energy significantly depends on the drift field for the applied $Ar/iC_4H_{10}$ mixture
  - => more collisions per unit of time at high drift fields
  - But longer stay of the ionization electron was measured at higher fields
- Obviously the ionization electron is less easy captured by a $CS_2$ molecule at higher kinetic energy

- Measured free path does not agree with an earlier measurement
- => we cannot check the dependence of the free path on the $CS_2$ concentration