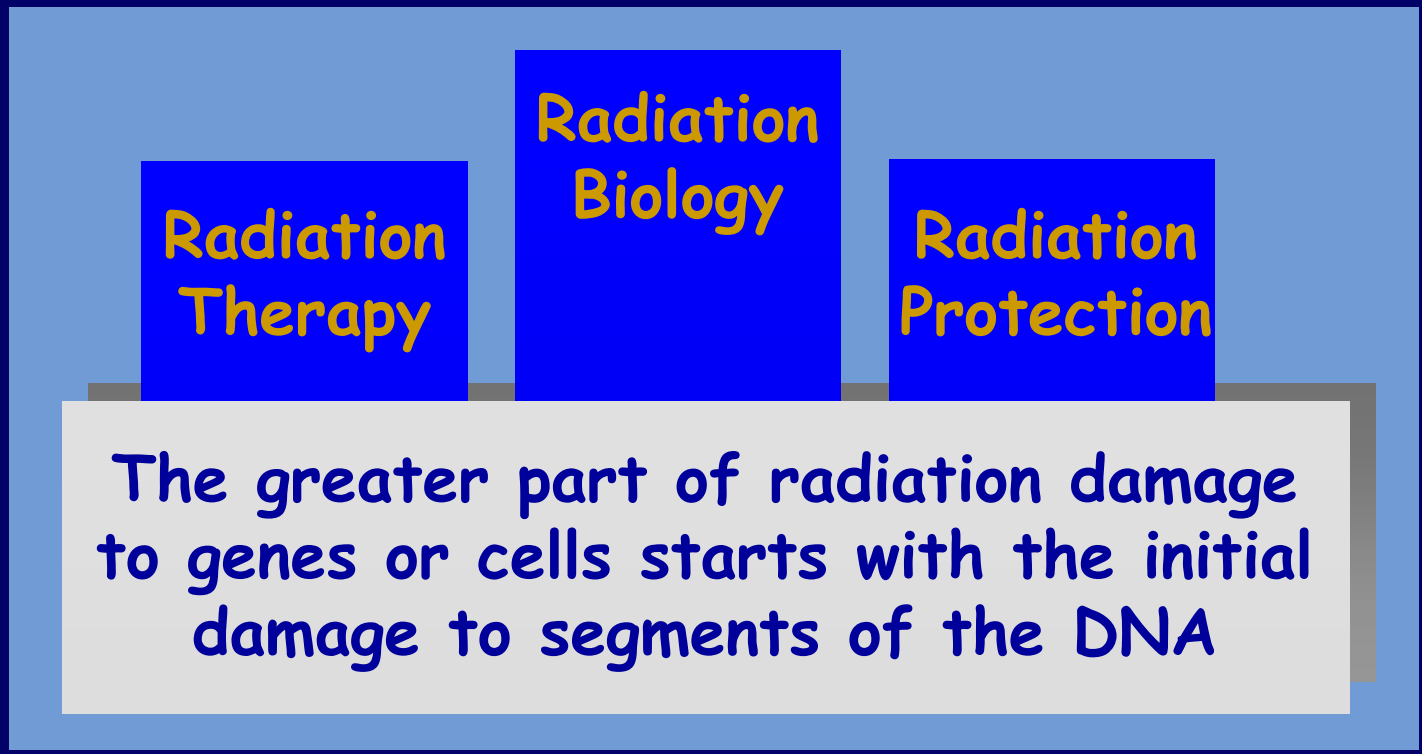
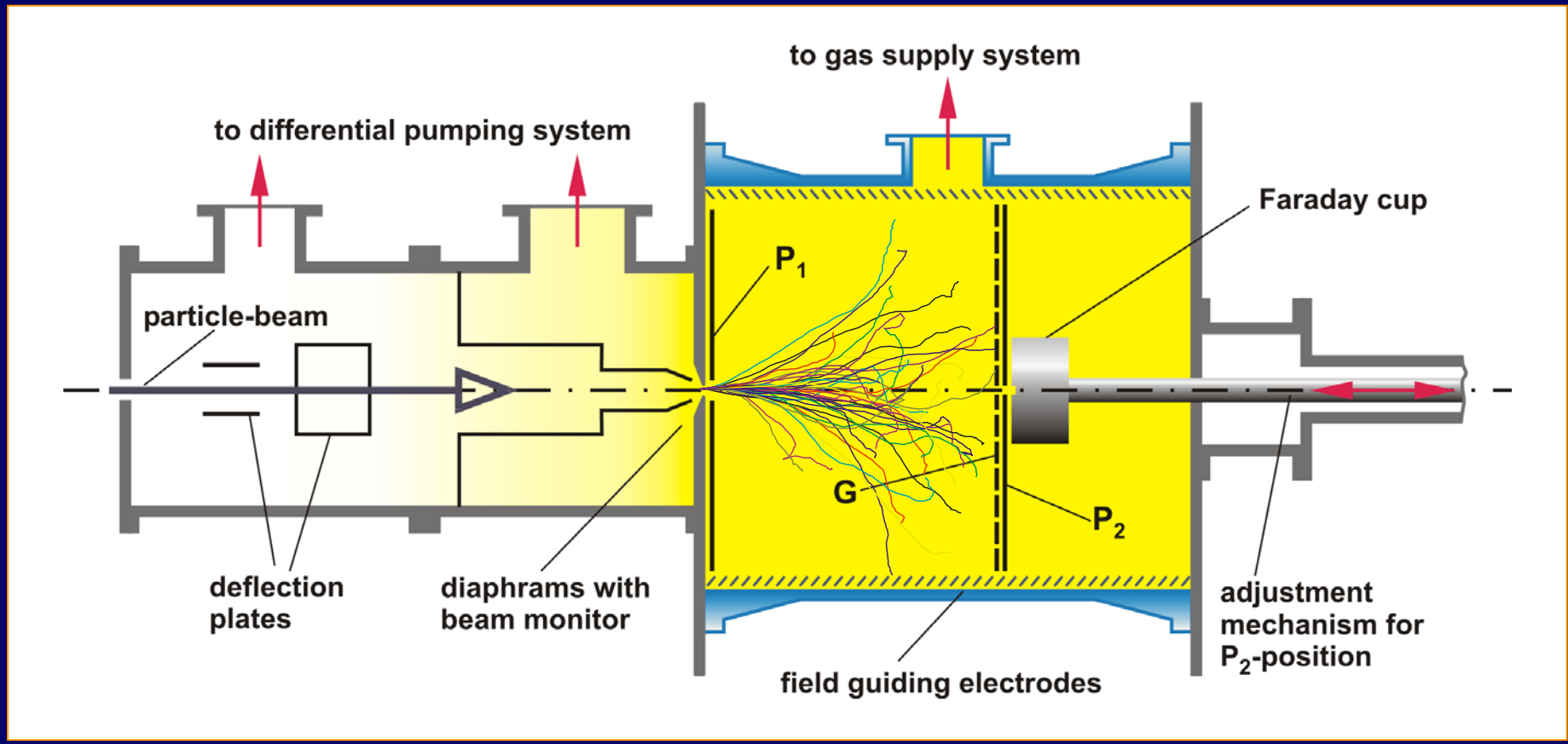
Tracks of Charged Particles and Their Characteristic Quantities in Gases



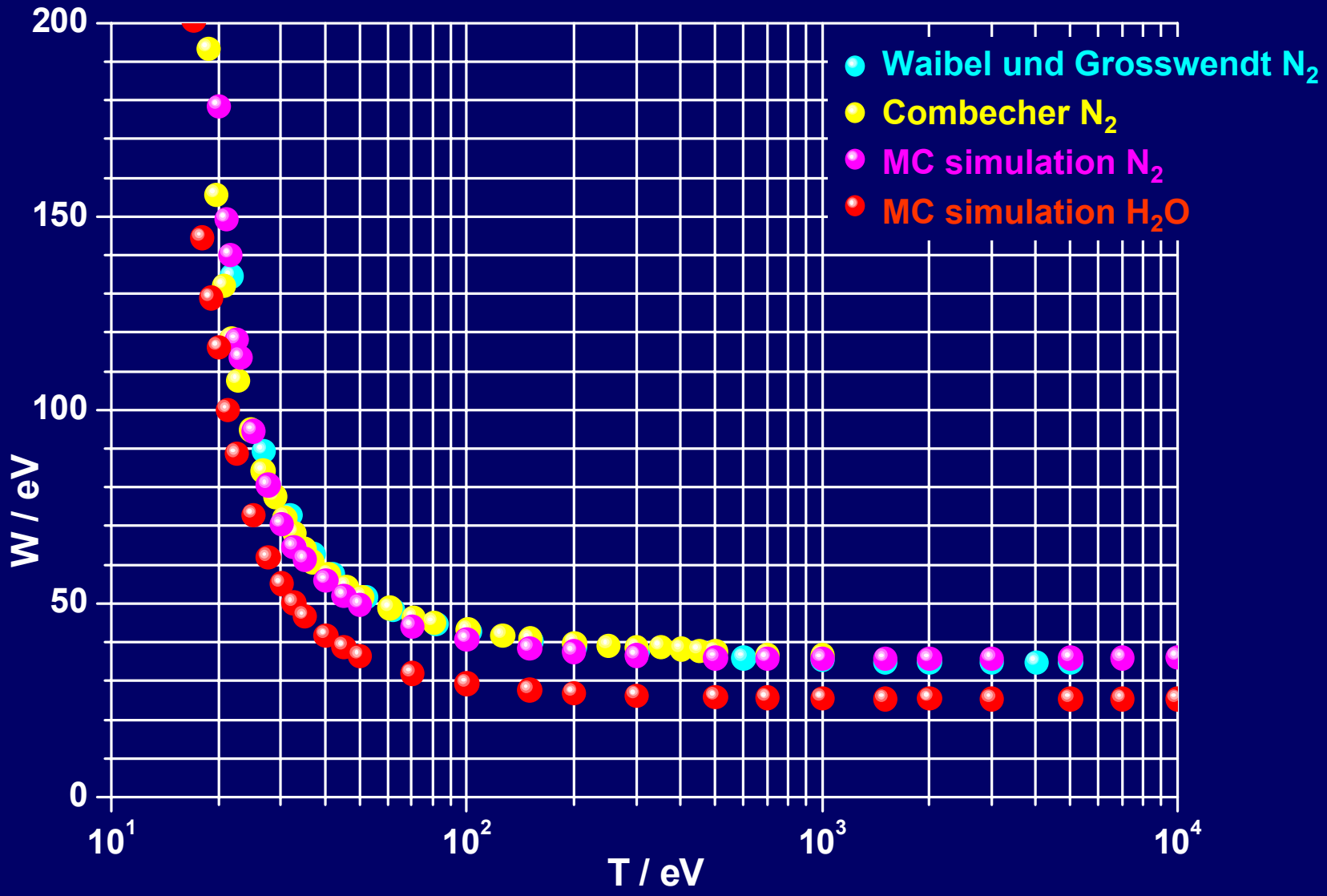
Traditional Practice: Radiation damage is described by macroscopic quantities like LET and absorbed dose

Bernd Grosswendt, Physikalisch-Technische Bundesanstalt, Bundesallee 100, D-38116 Braunschweig, Germany

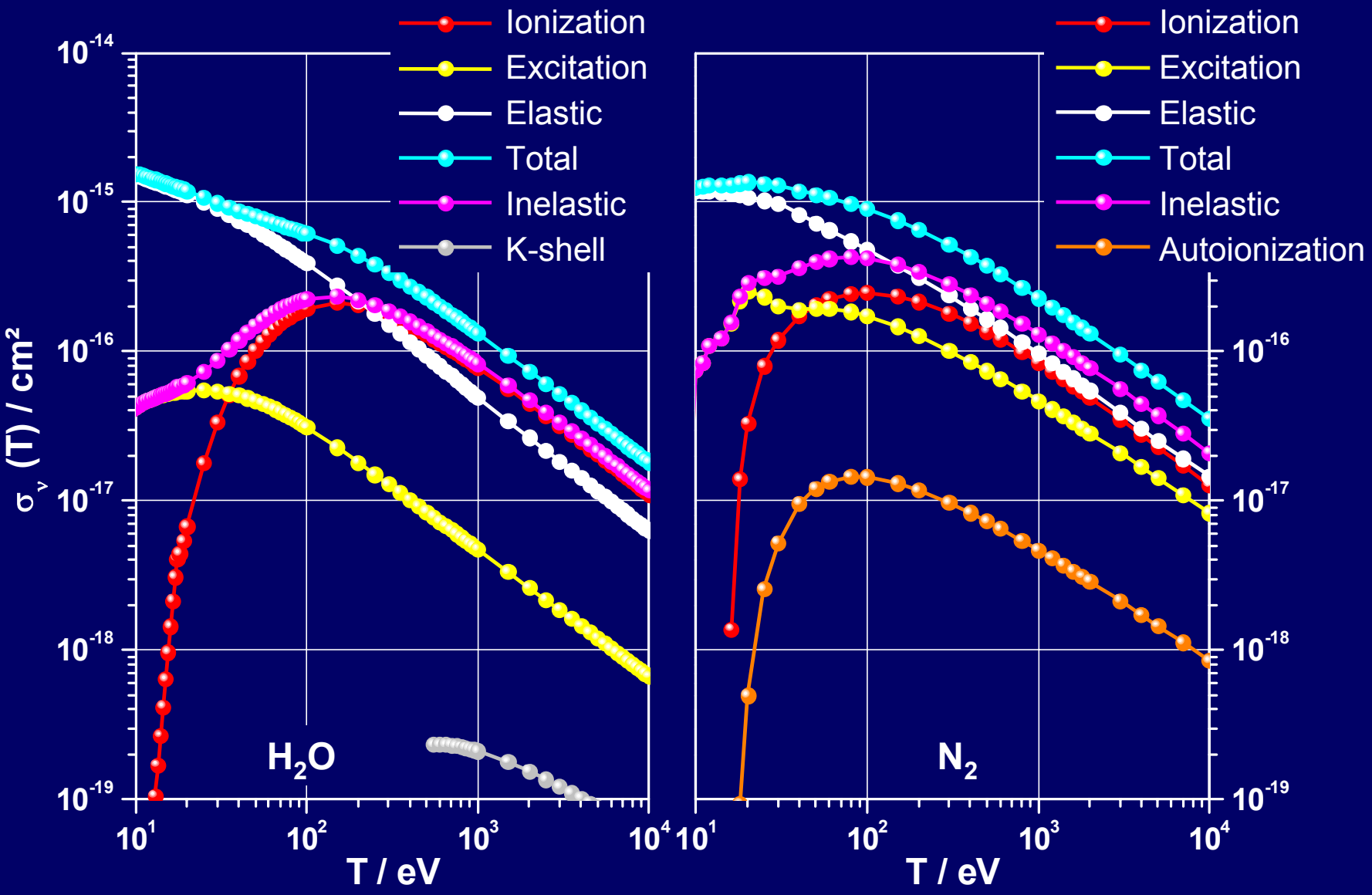
Electron Degradation in Gases: Measurement of W-values or Ionization Ranges



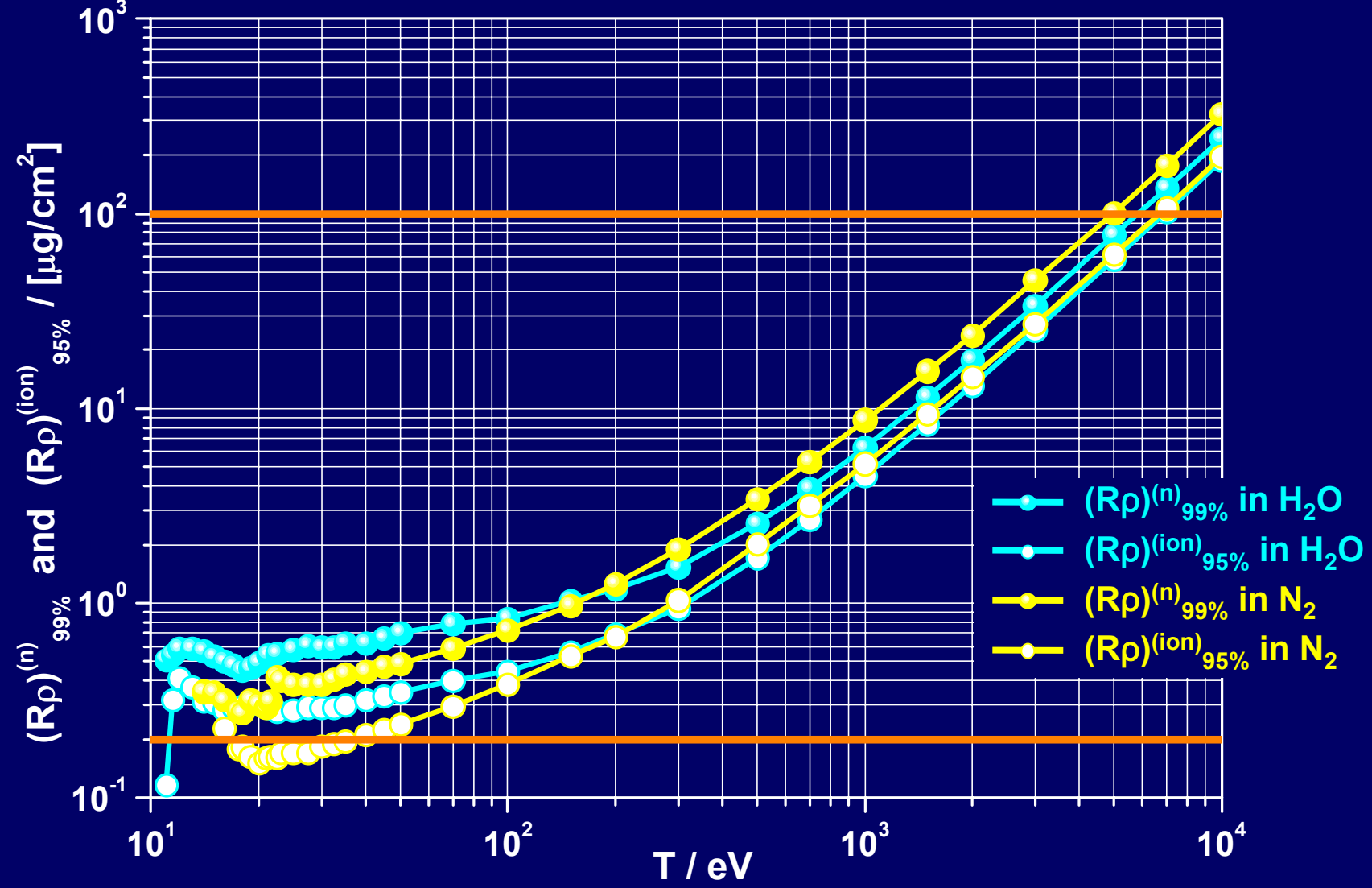
W-value of Electrons in Liquid Water and Molecular Nitrogen



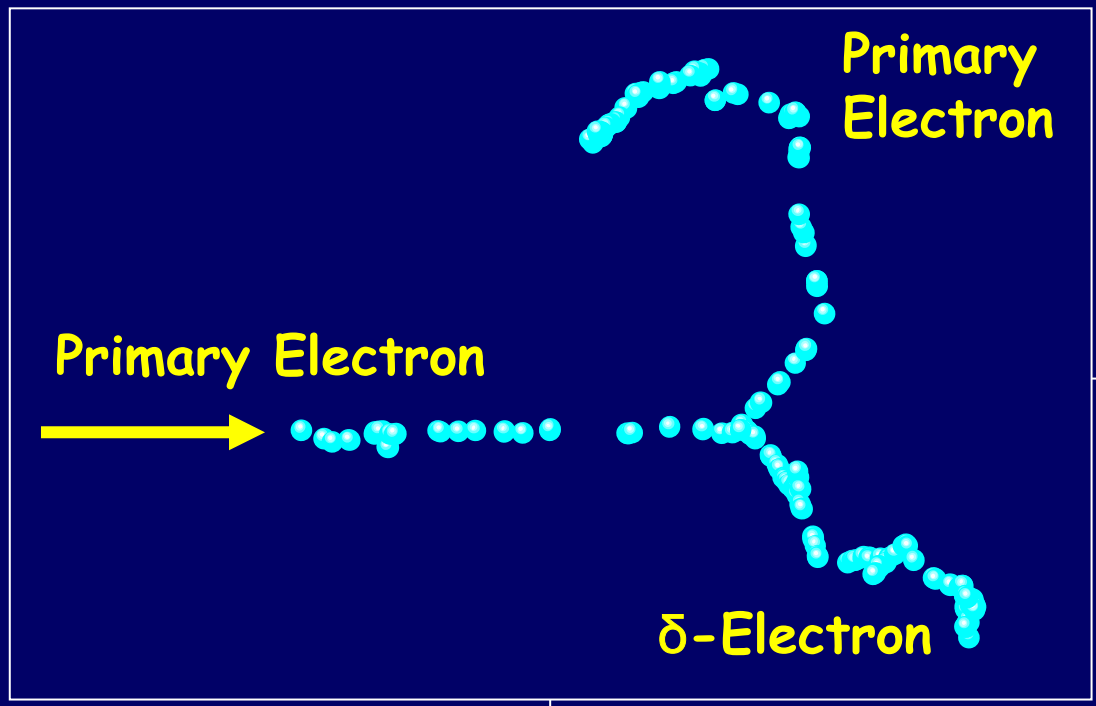
A Selection of Electron Cross Sections of Liquid Water and Molecular Nitrogen

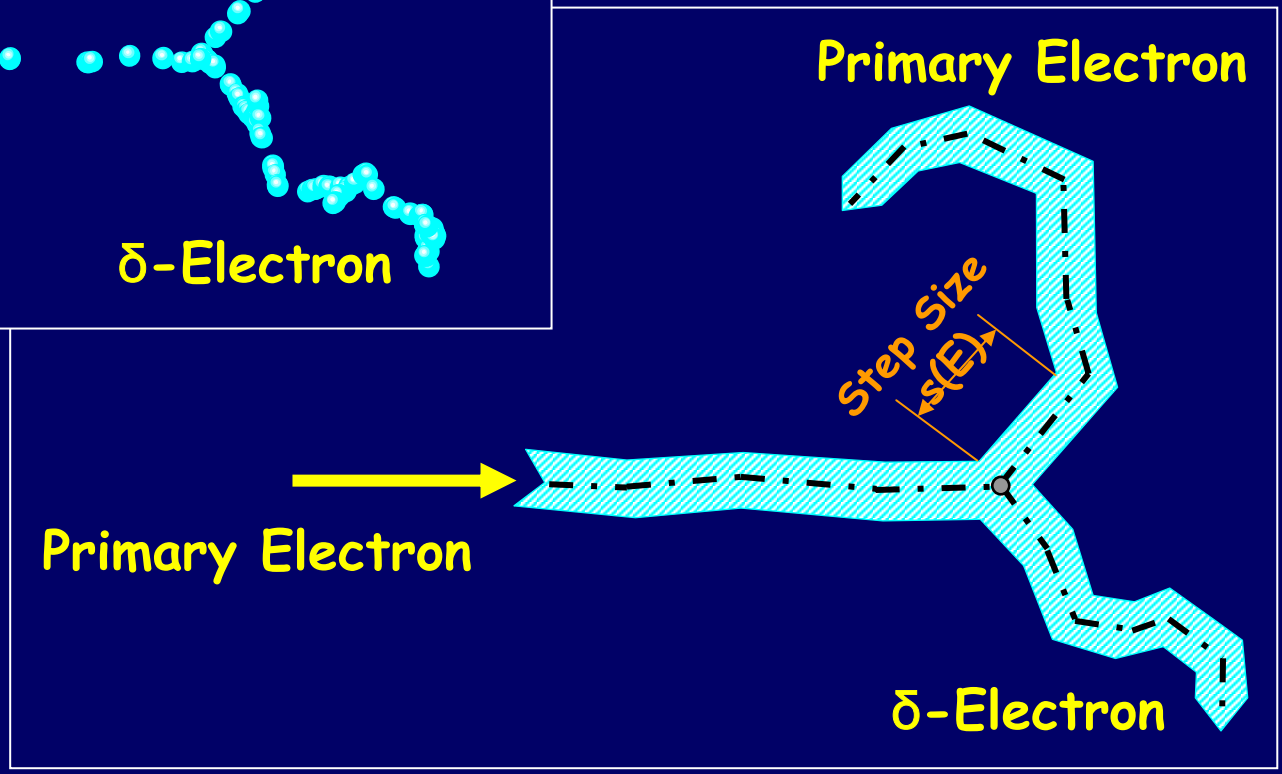


Electron Mass Ranges in Liquid Water or Molecular Nitrogen



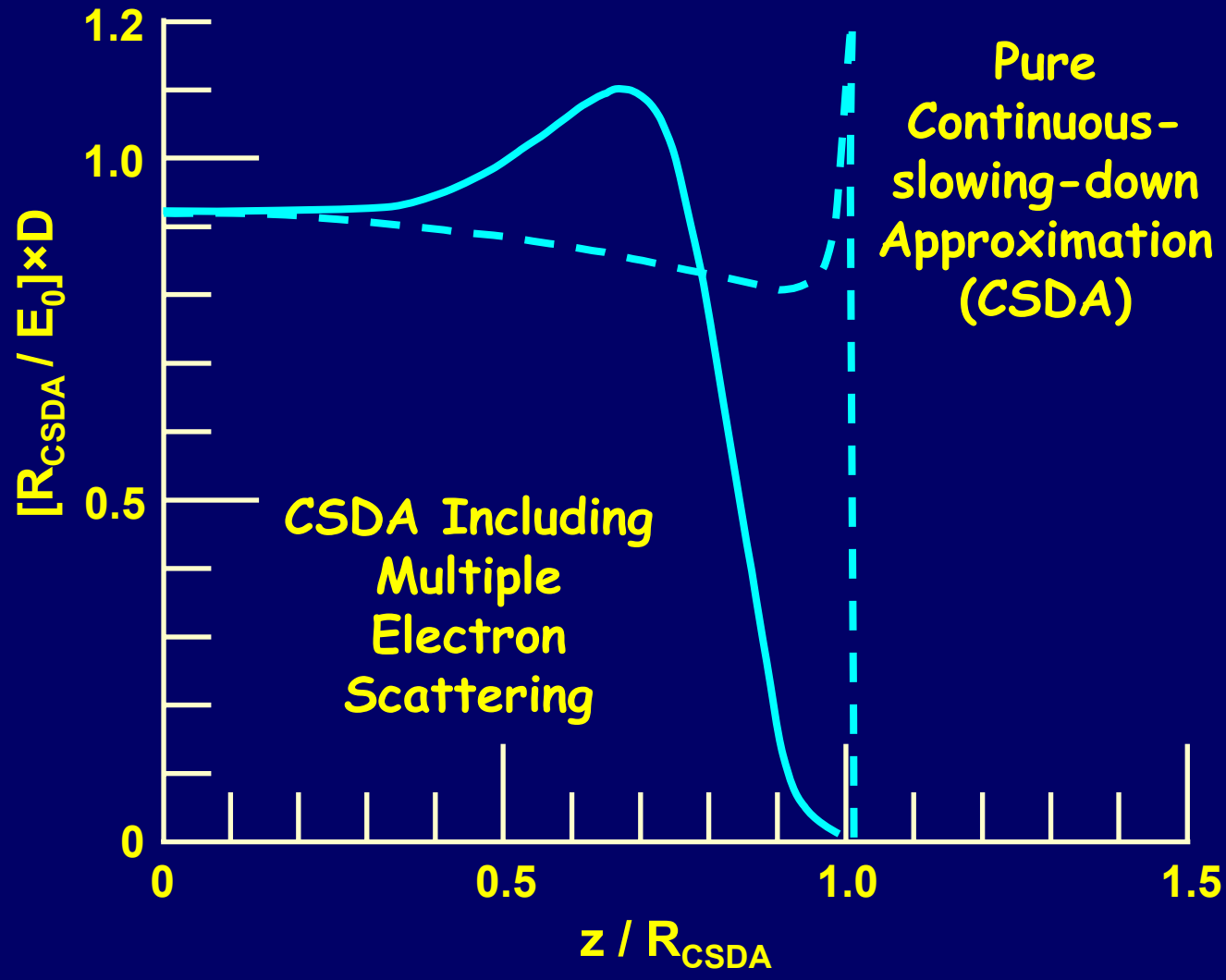
The Traditional Model of Particle Tracks Based on Condensed Histories



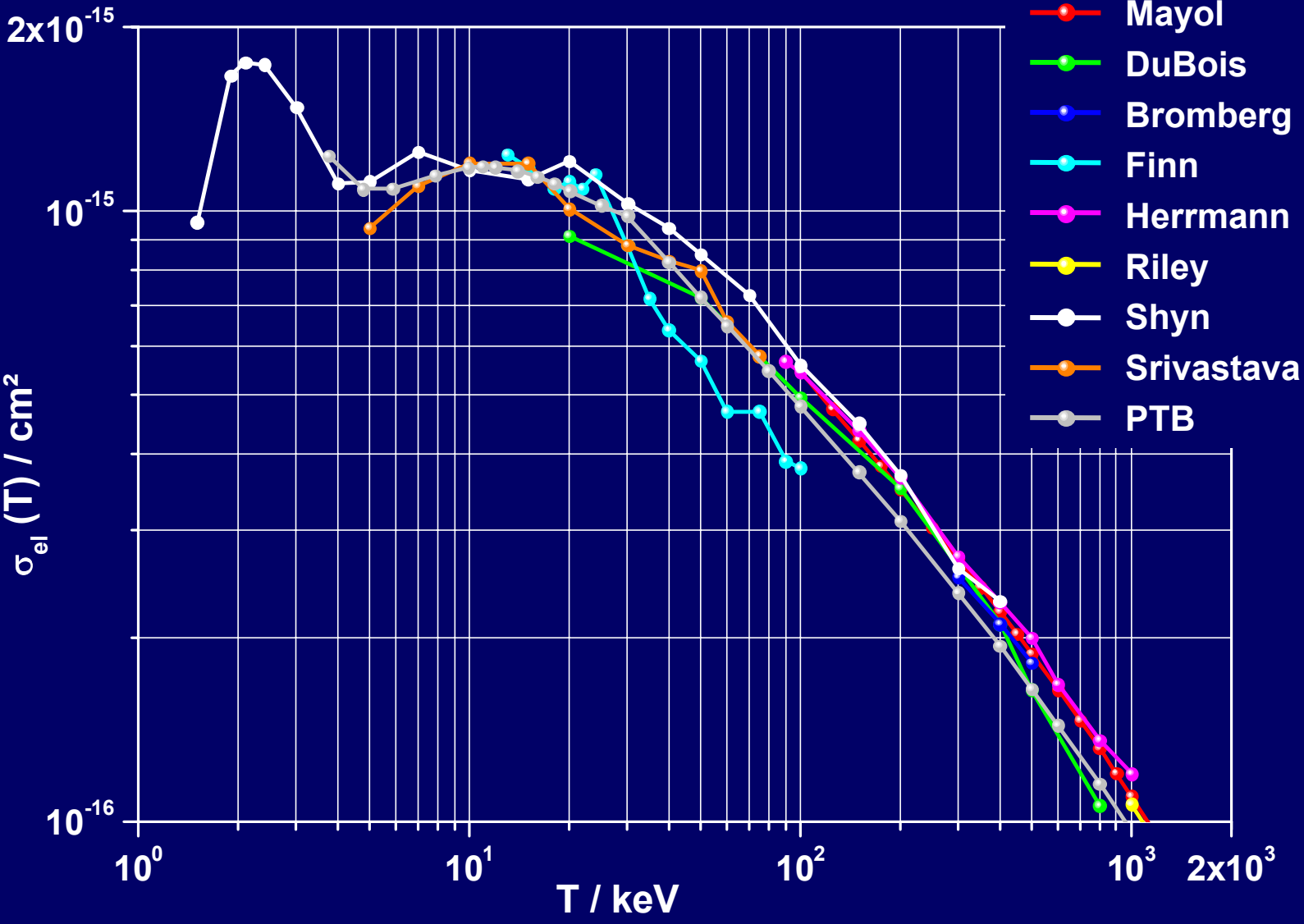


The Stochastics of Electron Energy Degradations

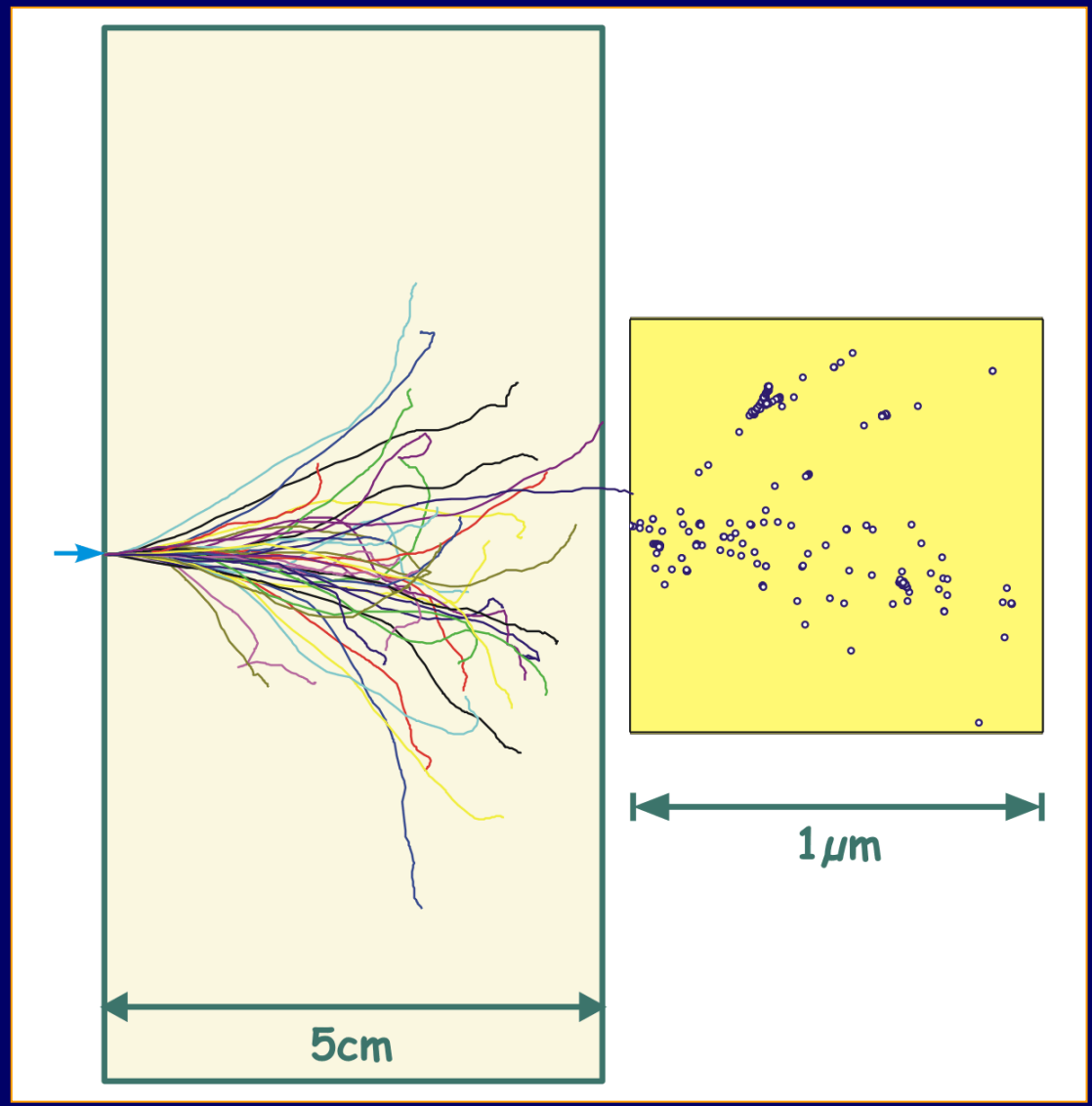
The Influence of Angular Scattering on Depth-Dose Distributions



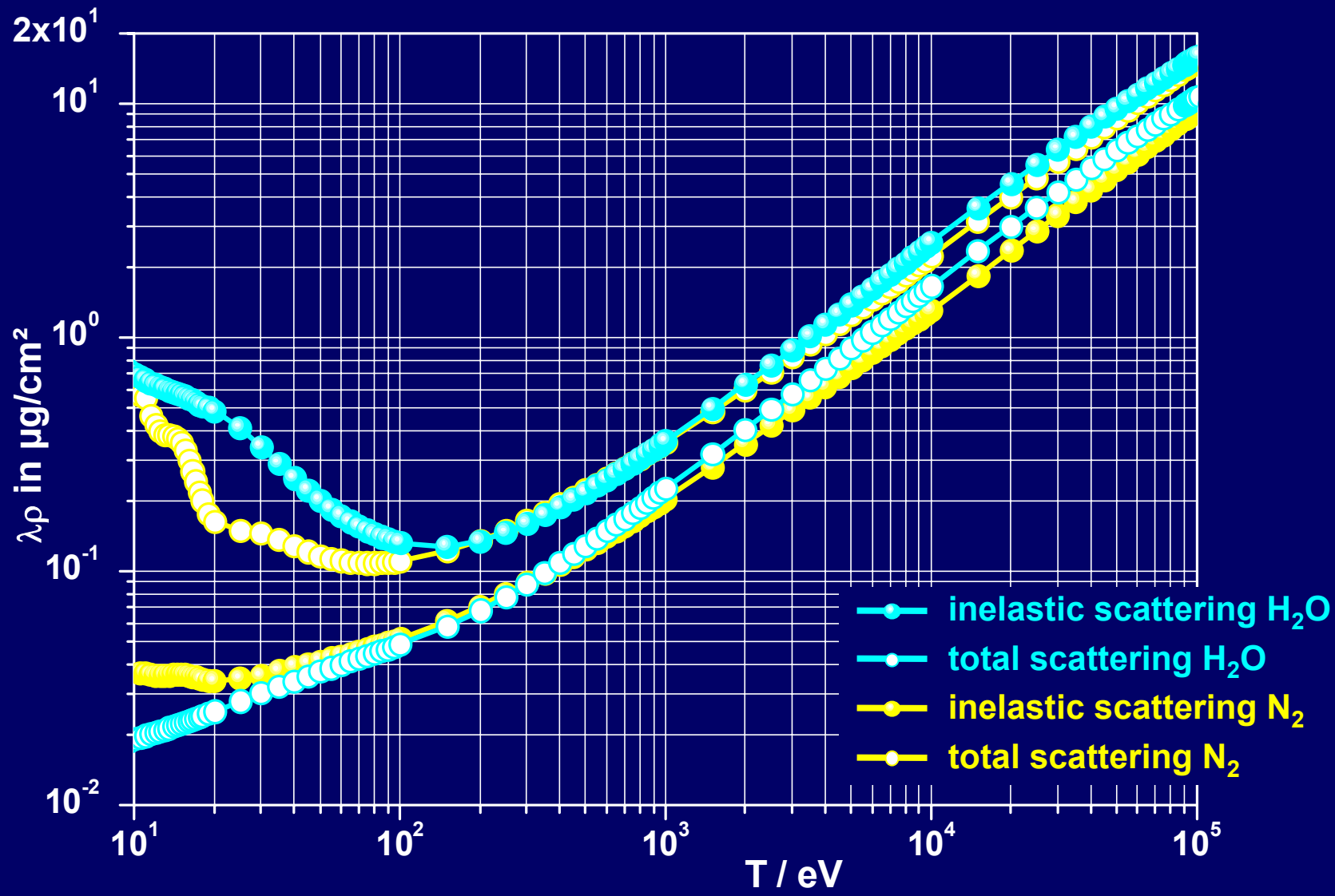
Elastic Cross Section of Molecular Nitrogen for Electrons



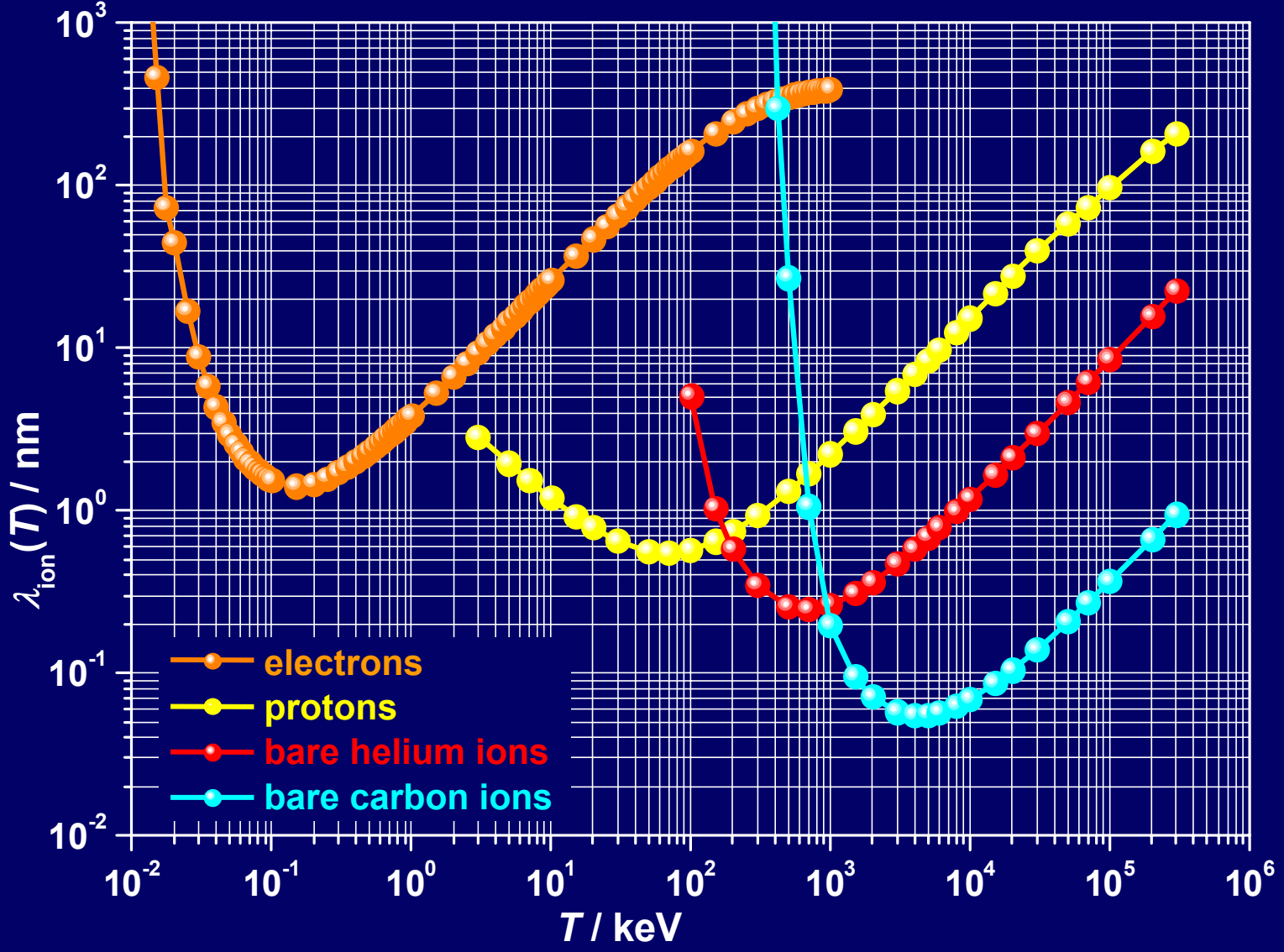
Macroscopic and Microscopic Aspects of Electron Tracks



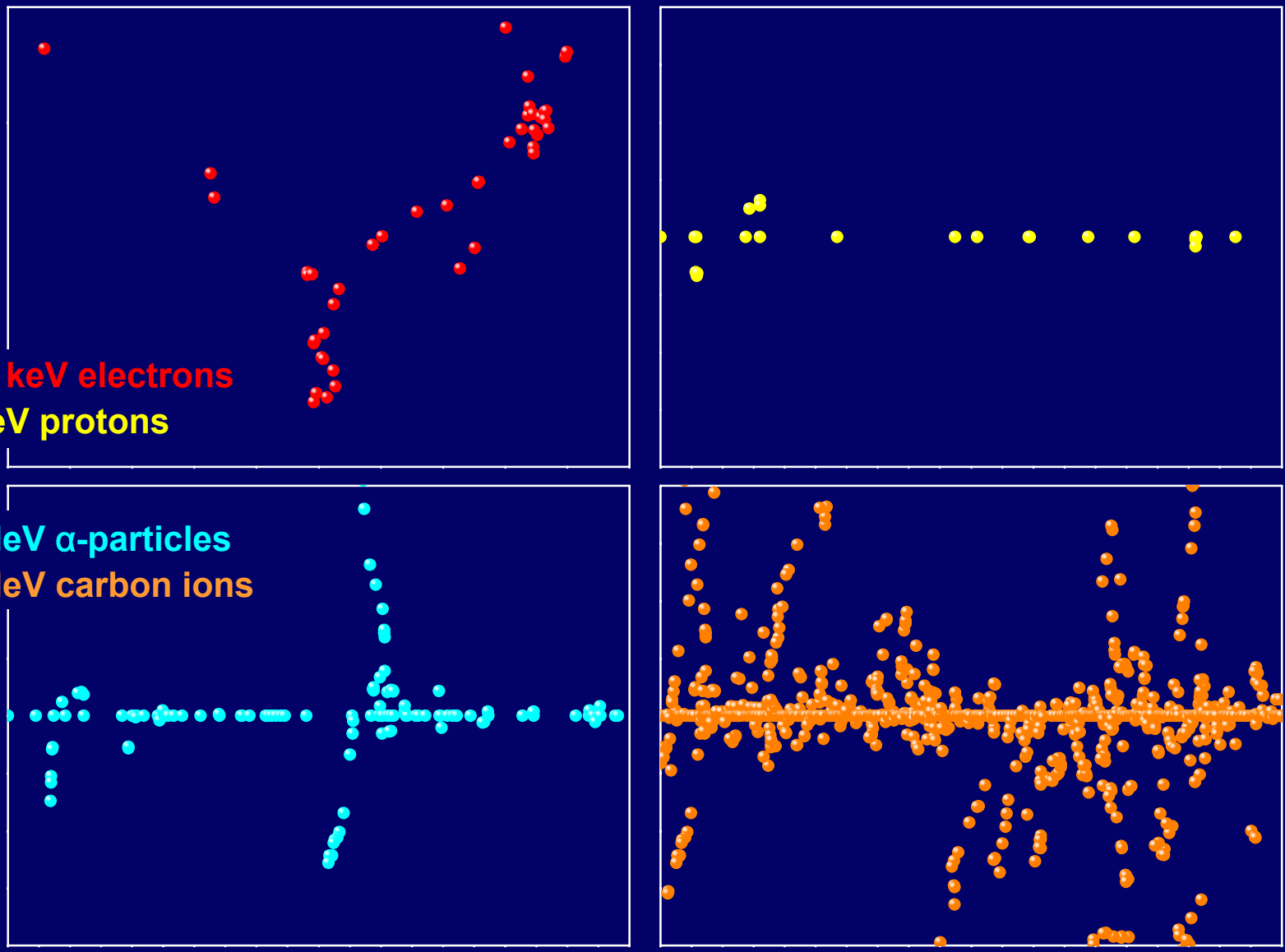
Mean Free Path Lengths of Electrons in Liquid Water or Molecular Nitrogen



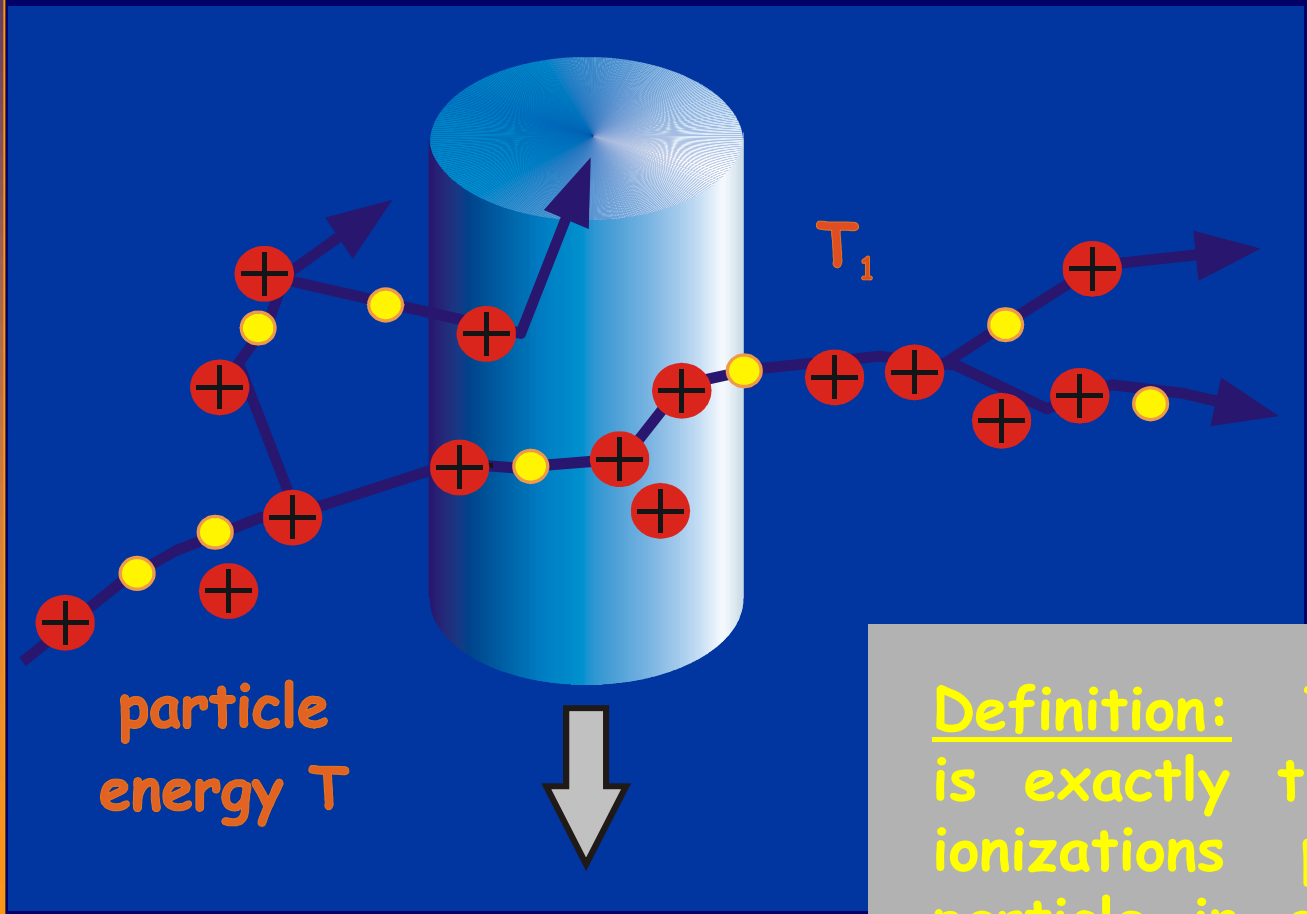
Mean Free Ionization Path Lengths of Charged Particles in Liquid Water



Track Segments, 100 nm in Length, in Liquid Water

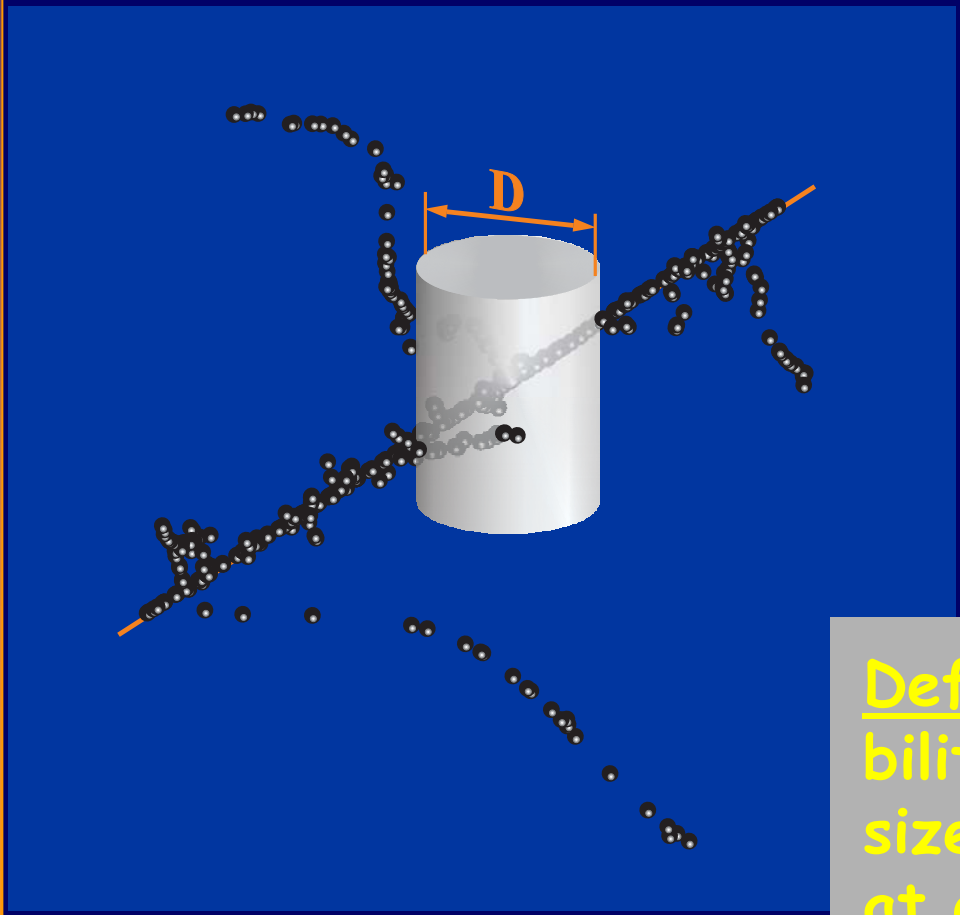


General Aspect of Ionization Cluster-size Formation (De Nardo et al. (2002))



Definition: The cluster size is exactly the number ν of ionizations produced by a particle in a specified piece of matter

General Aspect of Ionization Cluster-size Formation

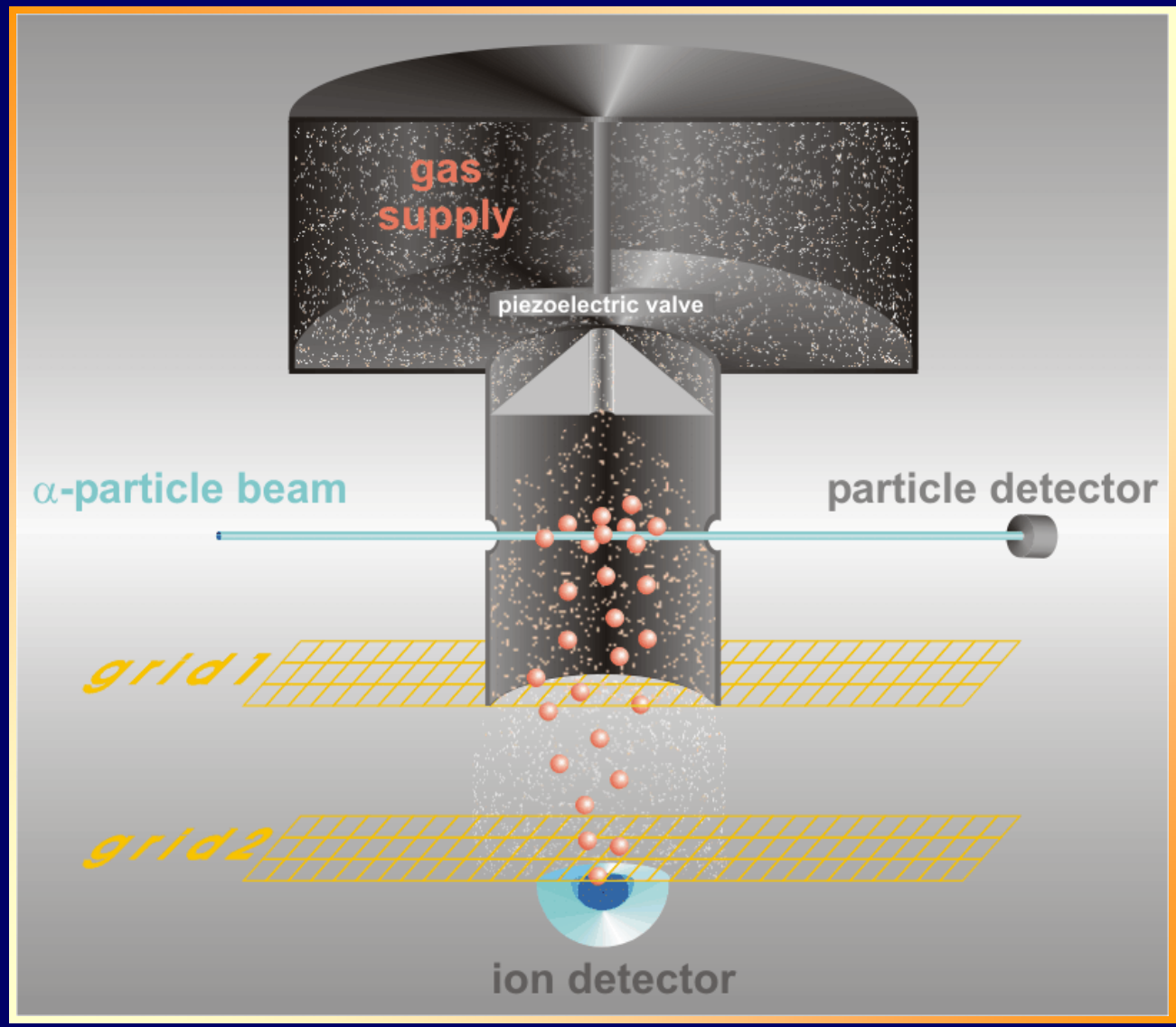


The mean cluster size is given by the first moment:

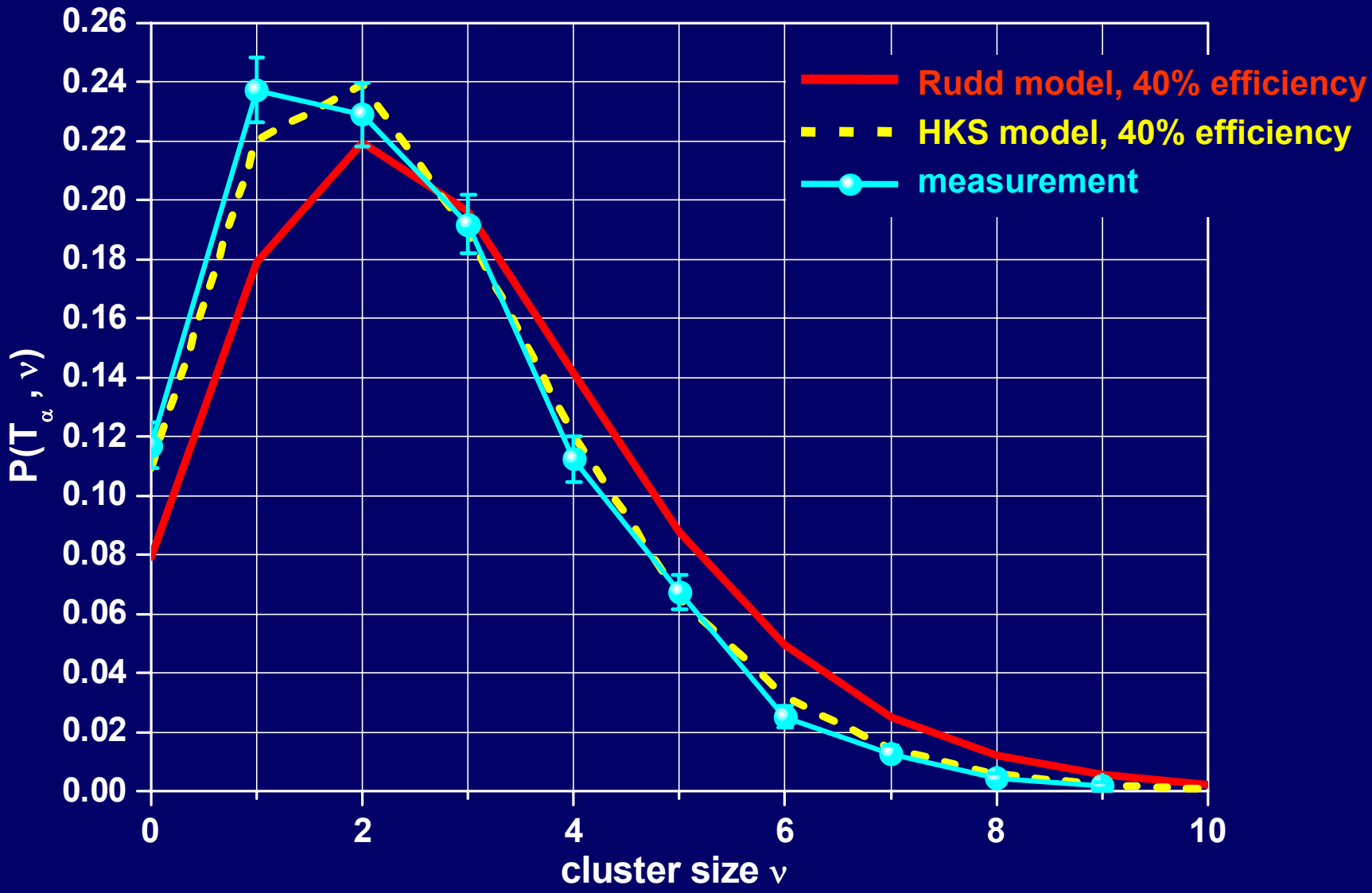
$$M_1(T) \approx L_{travel} / \lambda_{ion}(T)$$

Definition: $P_\nu(T)$ is the probability that exactly the cluster size ν is produced by a particle at energy T in a specified piece of matter.

The Jet Counter of Pszona et al. (2000)

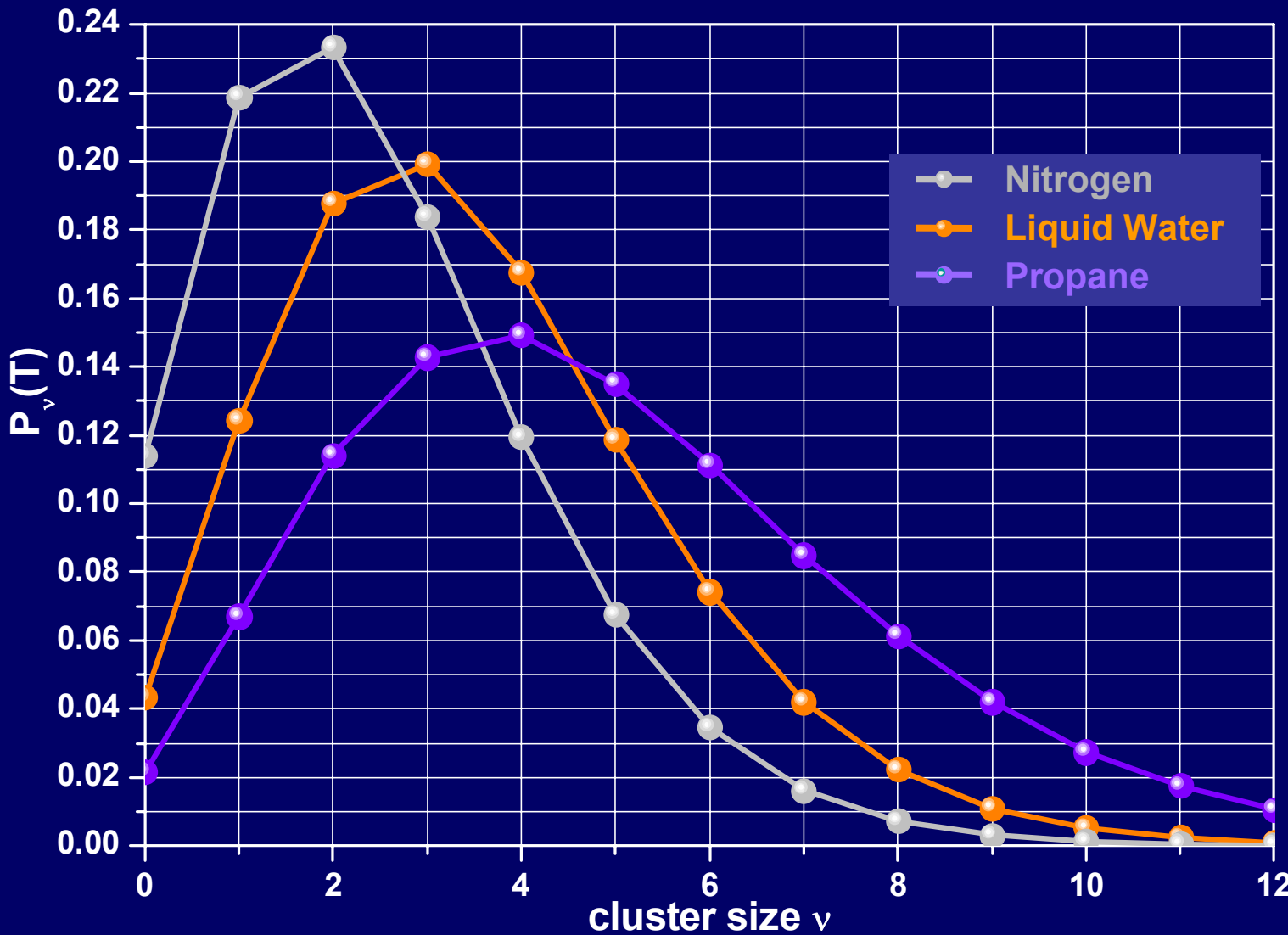


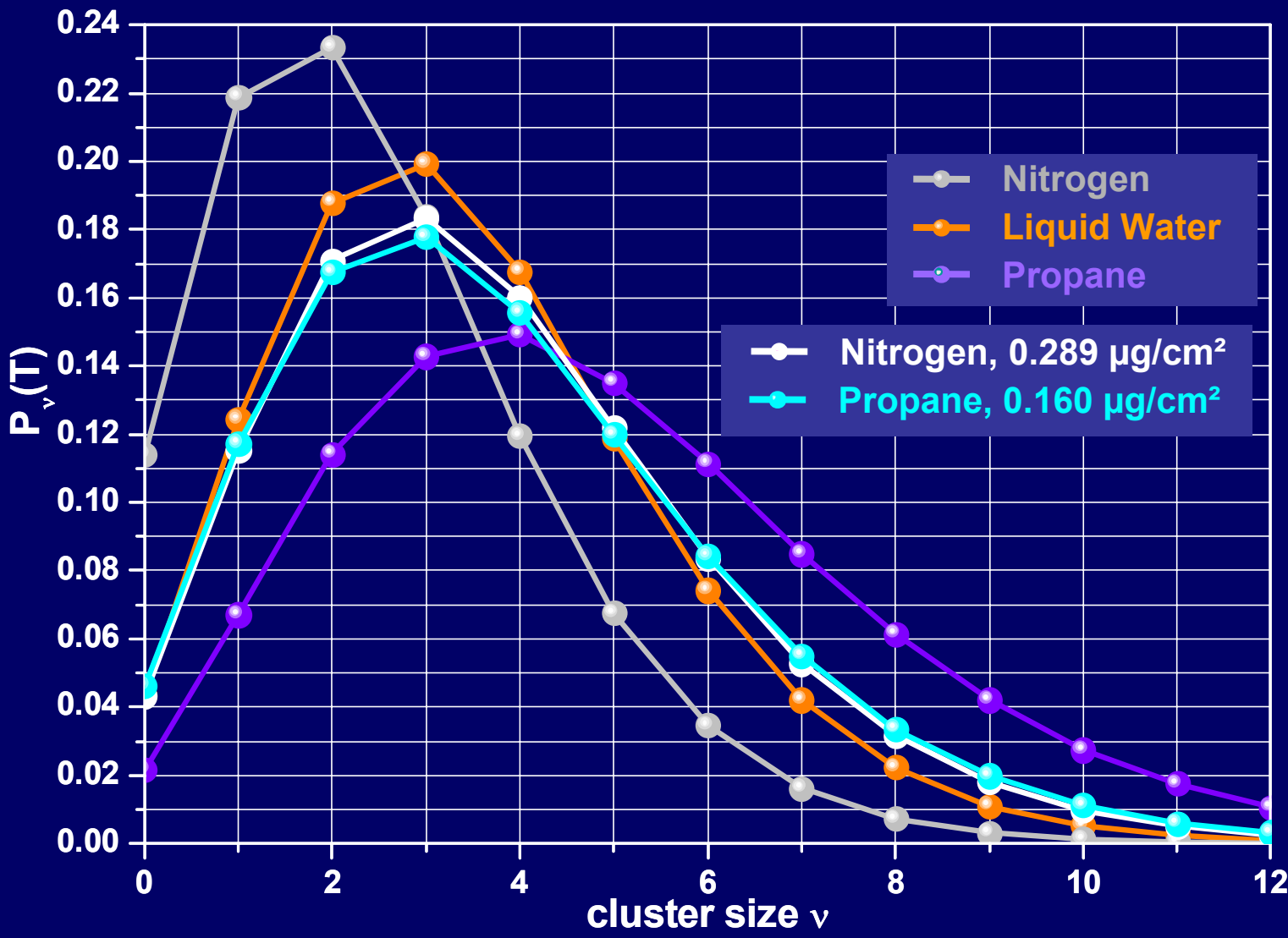
Ionization Cluster-size Distributions of 4.6 MeV α-Particles in Nitrogen



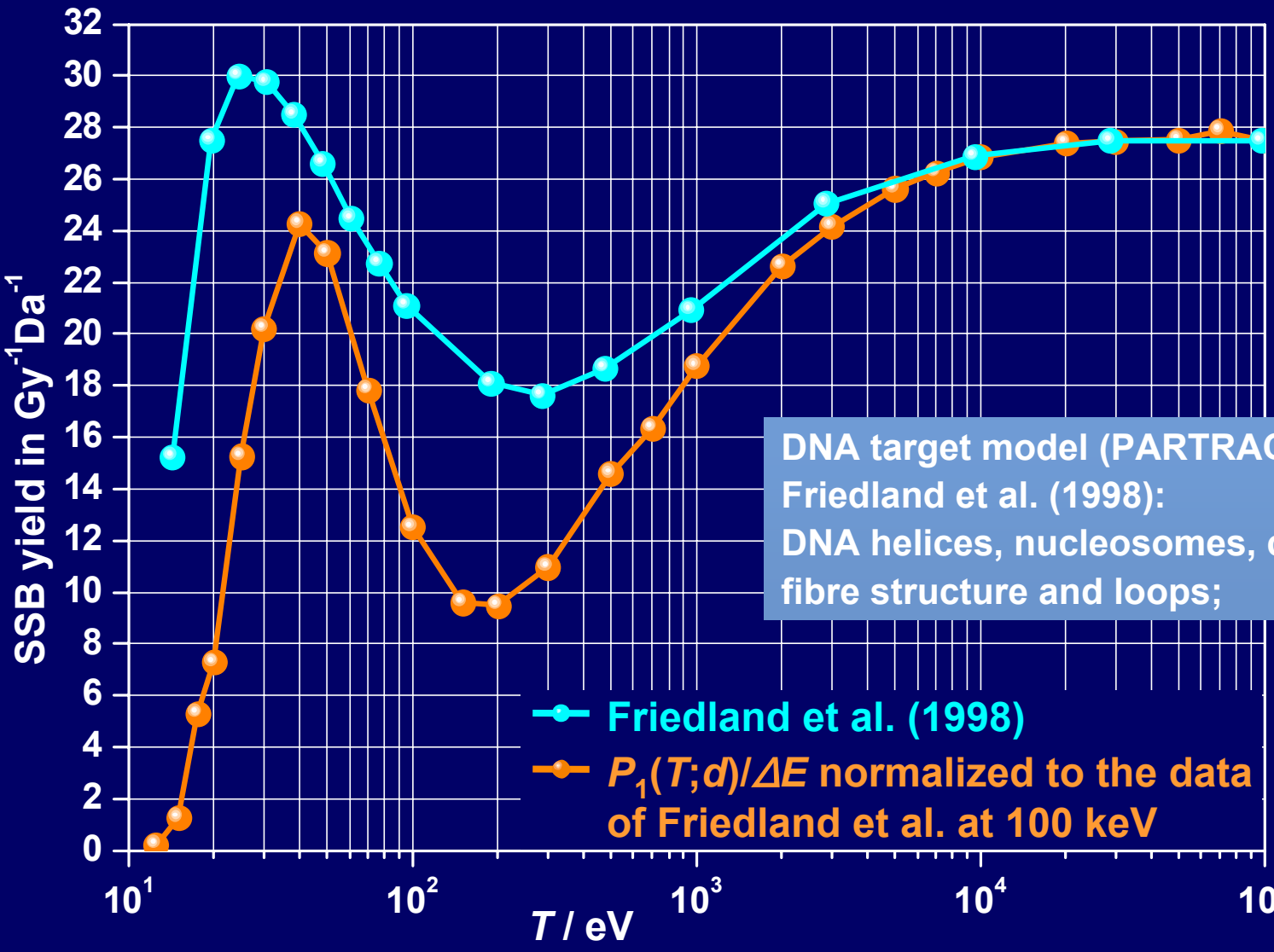
Ionization Cluster-size Distributions of 4.6 MeV α-Particles in Cylindrical Volumes:

► liquid water with D = 2nm, compared with nitrogen and propane for (Dρ) = 0.2 μg/cm²



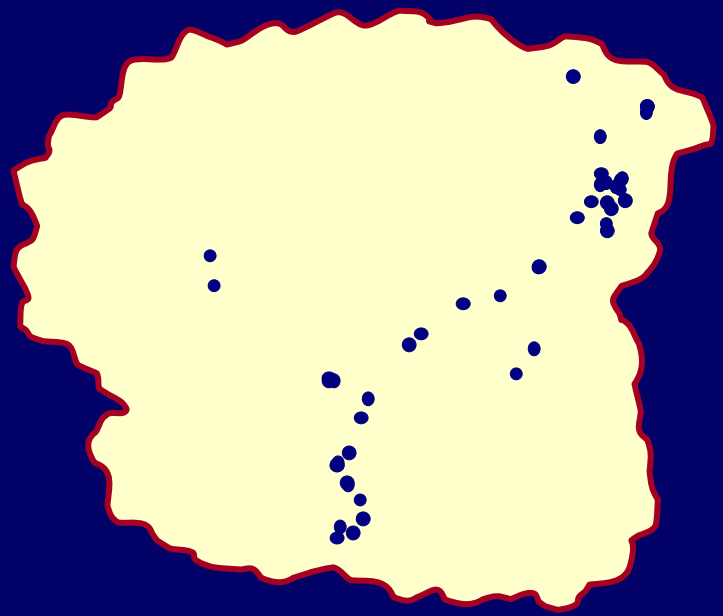

0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
P_ν(T)
0
2
4
6
8
10
12
cluster size ν
Nitrogen
Liquid Water
Propane
Nitrogen, 0.289 µg/cm²
Propane, 0.160 µg/cm²

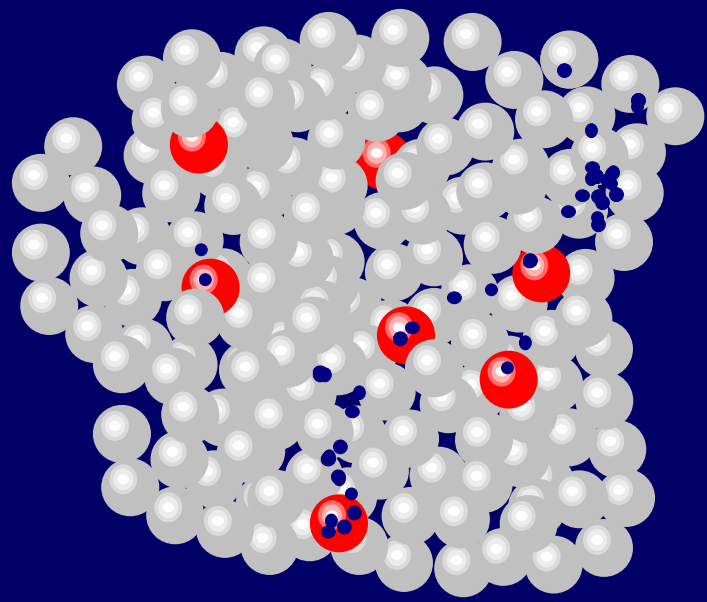
Yield of Single Strand Breaks as a Function of Electron Energy



DNA target model (PARTRAC), Friedland et al. (1998):
DNA helices, nucleosomes, chromatin fibre structure and loops;

Tracks of Charged Particles and Their Characteristic Quantities in Gases





Macroscopic Targets:

- W-value
- stopping power
- particle range
- absorbed dose

Nanometric Targets:

- interaction cross sections
- stochastics of primary interactions
- fluence