Scattering cross-sections and detector simulation

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High precision detectors :

Drift , tpcs, Mwpc

Low precision detectors:

RPC , streamer, geiger

- High precision detectors:
- Drift velocity +- 0.5%
- diffusion +- 2%
- townsend coeficients +-3%
- lorentz angle +- 1 degree
- data base satisfies above constraints

mixtures of Ar, He,Ne,Kr and Xe

molecular gases :

N2,CO2, CH4,CO,DME,CF4,H2,D2,O2

- slightly reduced accuracy on :
- TMA,C2H6,C3H8,C4H10,C3H6,NH3,N2O,TMA,H2O,
- Alcohols,SF6,O3,GeH4,BF3,NO,Methylal,C2H4
- Fluorocarbons: C2F6,C3F8,CHF3,R134a soon:HFO

- Low precision detectors:
- drift velocity +- 5%
- diffusion +- 10%
- townsend gain +-4%
- attachment +-4%
- lorentz angle +- 5 degree

- Rpc simulation requirements satisfied by the lower precision .
- The main parameters required are the gain and attachment (see Regler and Veenhof)
- the cross-sections sets also allow for the calculation of the primary Cluster size and spacing for the incident particle using degrade
- There are also important non-equilibrium effects in RPCs that are automatically taken into account by using Garfield++ and the magboltz database.

Interest in Hydro Fluorocarbons for reduced global warming:

2006 :

created R134a (C2H2F4) x-section file

derived from C2F6 (2002)

2010 :

updated R134a file with better mixture data

2021:

updating C3F8(2002) then use for HFO

- Updates planned:
- 2021 (May) C3F8
- 2021 summer HFO
- 2021 autumn C2F6 then R134a
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Analysis improvements for Fluorocarbons :

A) 3 body attachment now includes the critical density dependence of the attachment x-section

scaled by : $1/((Nc/N)+1)$

this now replaces the N dependence of the 3body x-sections..

B) Using dipole screened coulomb angular distribution for the vibrational scattering rather than Capitelli-Longo algorithm.

- Requirements for standard measurements:
- Hydrofluorocarbons: good purity 99%
- Mixture data with Helium and Argon :
- 90/10, 95/5 and 99/1
- ratio must be accurately measured to 1% of the smaller component :
- ie 99/1 requires 1 be to +- 0.01

Temperature and pressure to better than 1KPa and 2 degrees C.

water and nitrogen measured to +- 50 ppm.

townsend as function of pressure (very important)

- Additional measurements required:
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- Electron scattering experiments :
- locate the attachment resonance energies.
- Measure ionisation x-sections
- BEB ionisation model can be used but not accurate to better than 10%..

- Conclusion:
- possible to create x-section sets for the hydrofluorocarbons adequate to use in RPC simulation but not accurate enough for precision simulation of other detector stuctures.
- experimental measurements required are
- accurate mixture data with argon and helium
- pressure dependent townsend measurements
- A recent report on the CO update is attached to this talk and discusses some techniques used in the derivation of x-sections.