CF4, measurements and calculations

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Available data

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Gas multiplication process in mixtures based on Ar, CO_2, CF_4

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Available online 17 November 2006

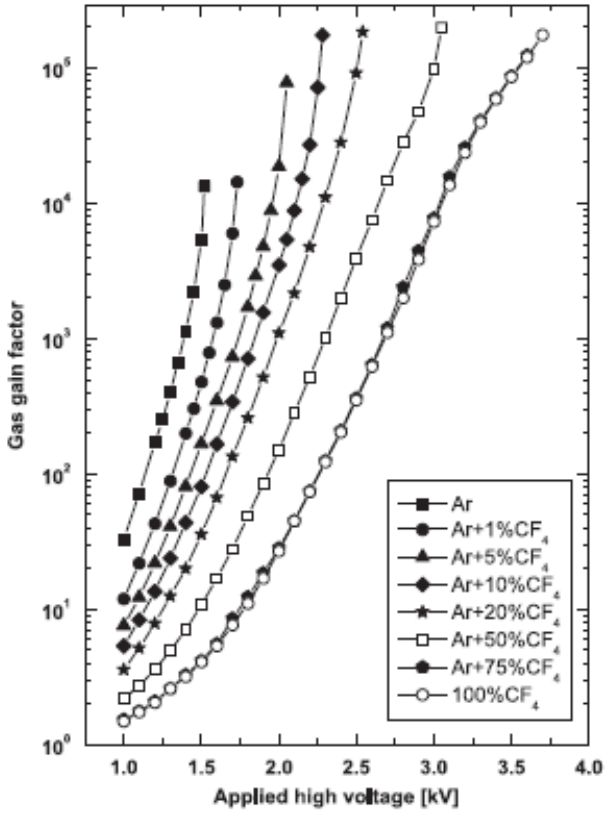


Fig. 1. Gas gain as the function of applied high voltage for Ar + CF_4 mixtures.

Single wire chamber

- r_a = 25 µm, r_c = 0.9 cm

Gas

- 1000 hPa pressure, 20 °C temperature

Gain

- Order of 10^5

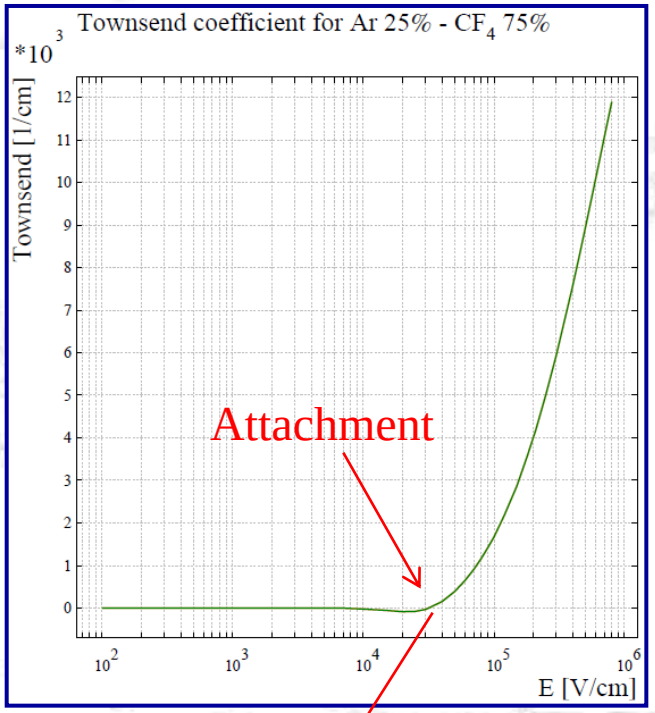
Error on gain

- < 10%

Calculation Method

- Effective Townsend coefficient (attachments included) calculated by Magboltz 9.0.1 version [S.F. Biagi, *NIM A* **421** (1999) 234–240]

$$G = \exp \int_{\text{tube}}^{\text{anode}} \mathrm{d}r\, \alpha(E(r))$$



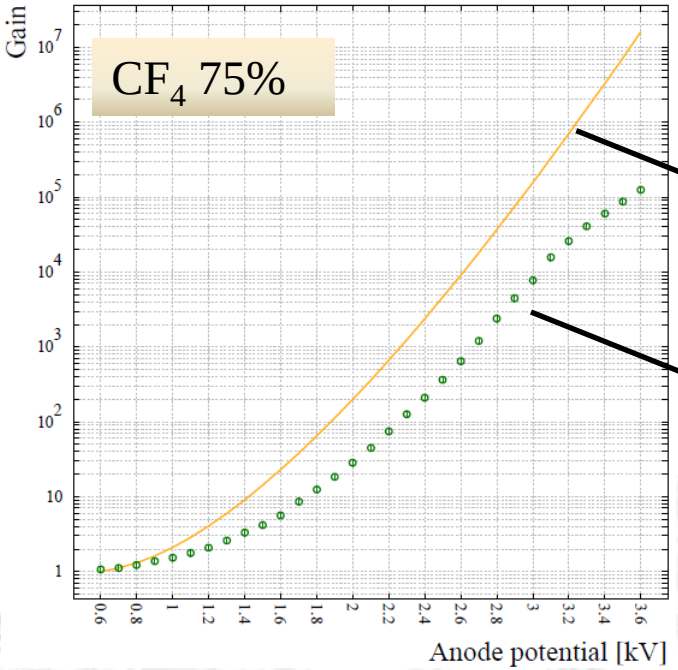
- Ionisations: Ar 15.76 eV, CF_4 15.90 eV
- Ar – CF_4 is **NOT** a Penning mixture
- Dissociative excitation of CF_4 at 12.56 eV

Photon feedback

- Unabsorbed fotons from Ar,
- secondary avalanches, at high gain,
- over exponential increases on semi -log gain plots
- almost uncorrelated, free parameter.

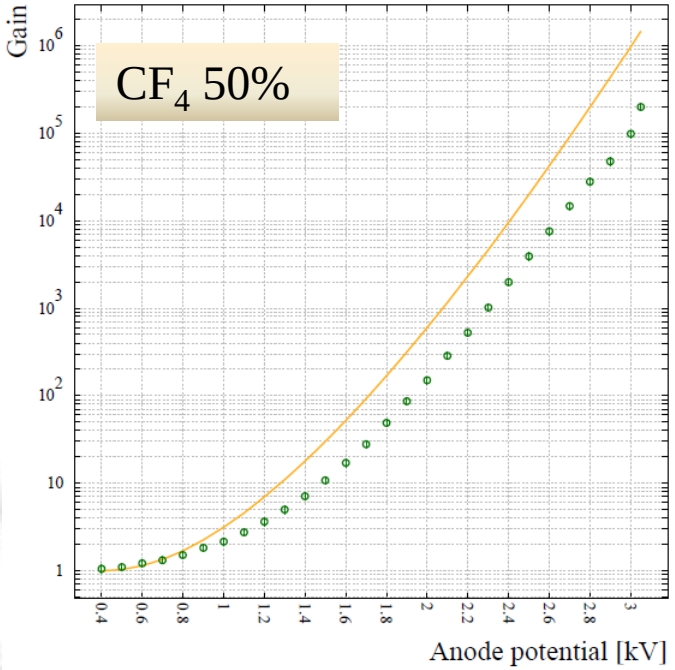
$$G := G/(1-\beta G)$$

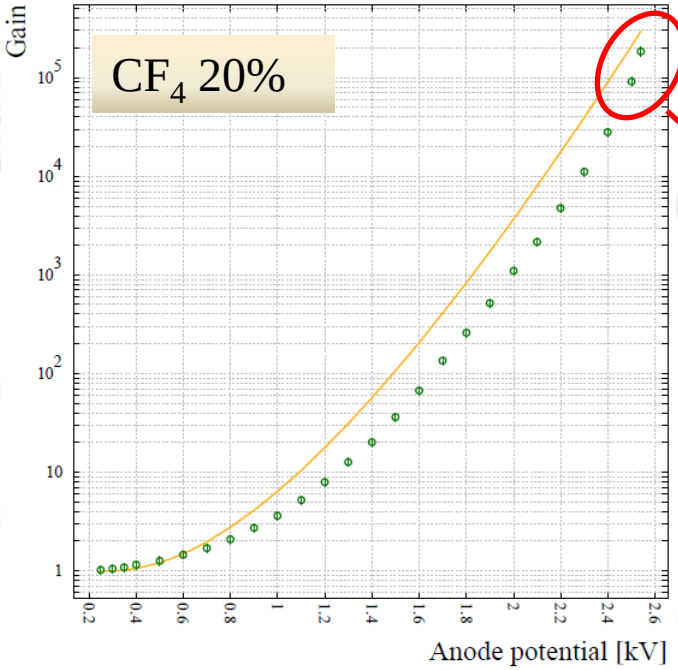
Fits I



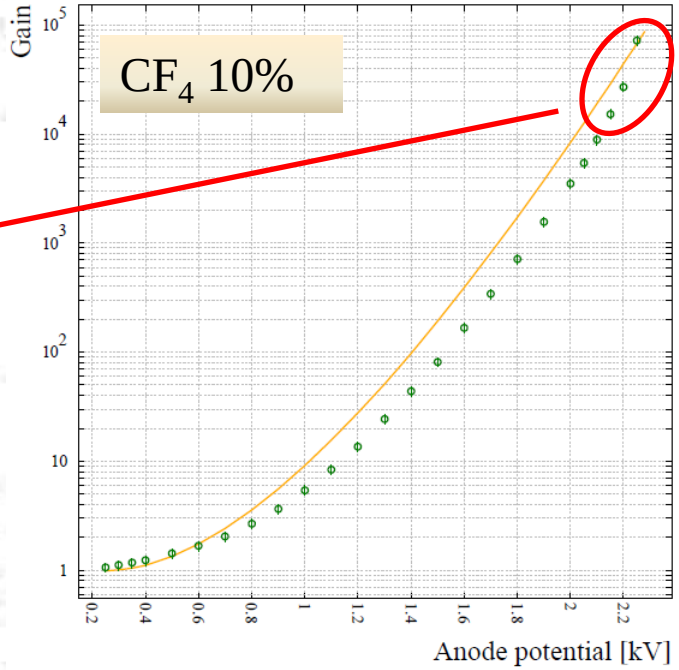
Calculation

Experiment





Photon feedback



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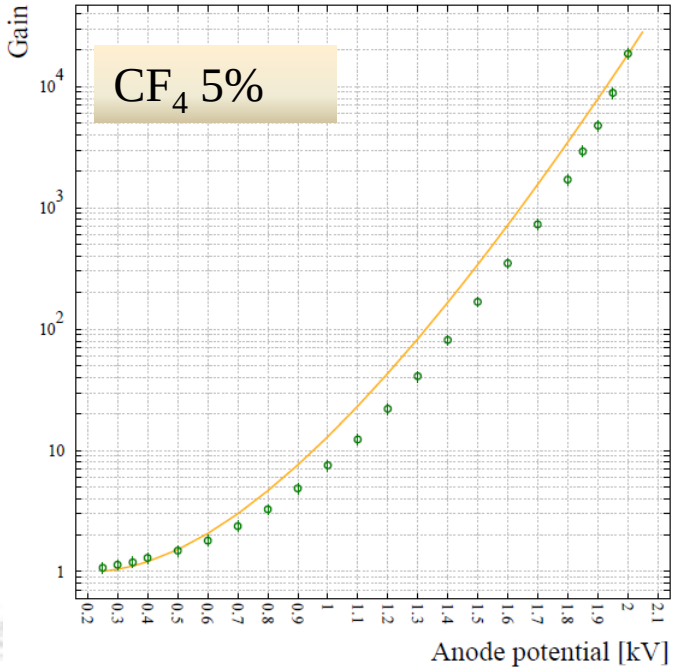
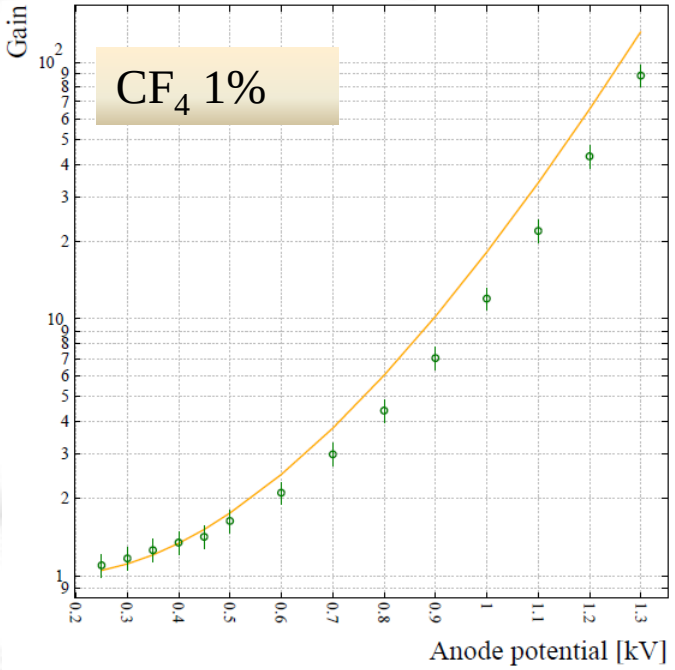
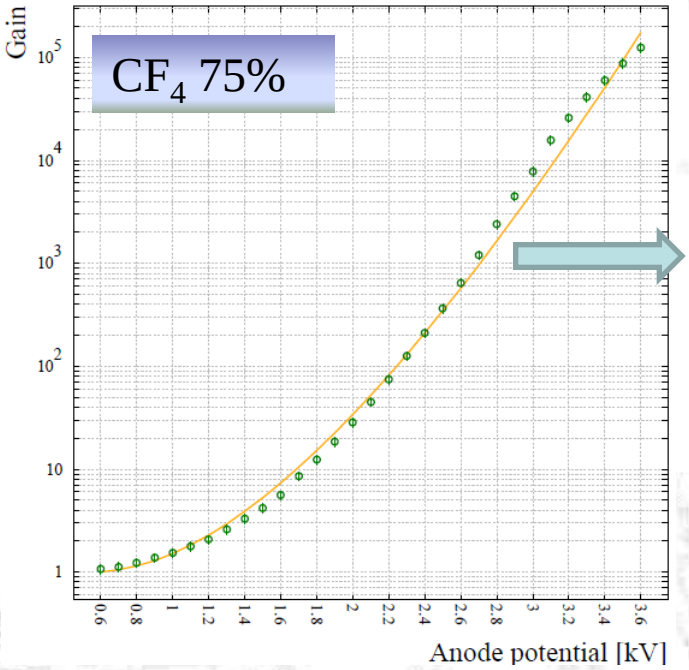


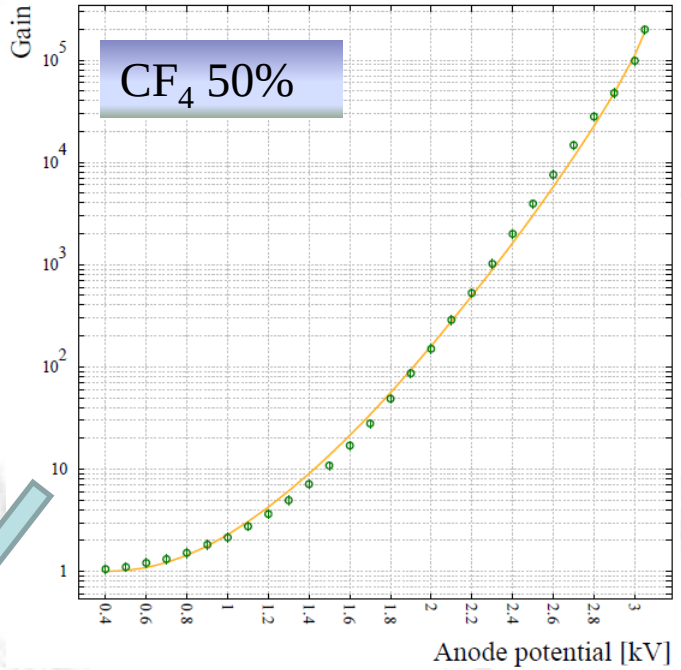


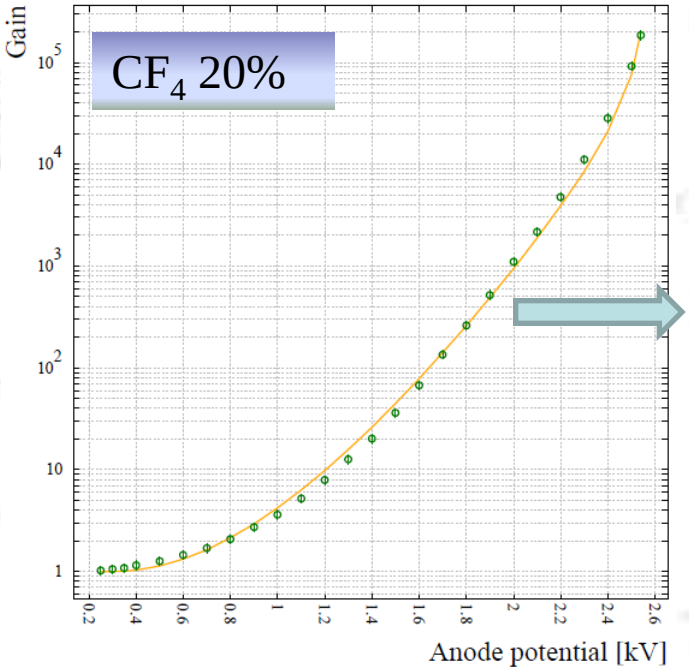
- Why the calculations are bigger than the experimental data **???**
  - Attachments could have an effect but not at high fields
- Should include the photon feedback terms **!!!**
  - Not possible to get an agreement if only take into account feedback **!!!**
- Could gain scaling factors play the major role **???**
  - No, we have already tried **!!!**
- **Other explanations , ideas ???, welcome !!!**

Fits II

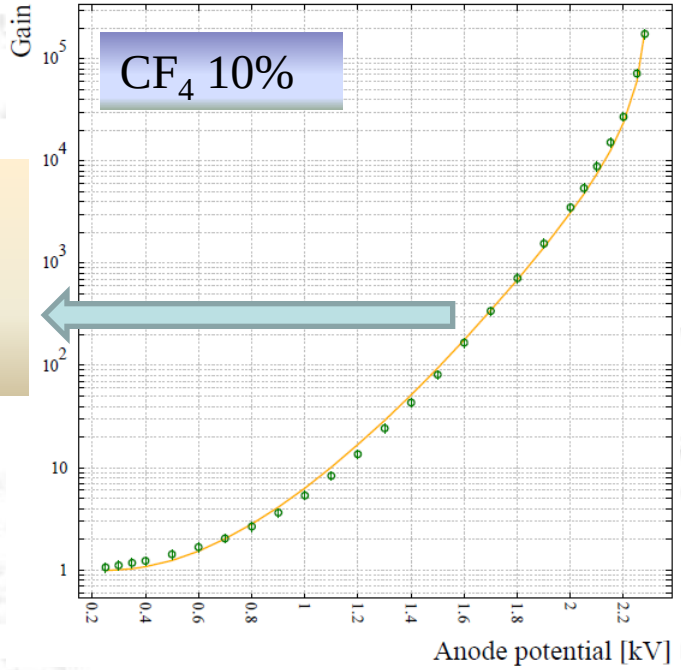


- Dissociative excitation of CF_4

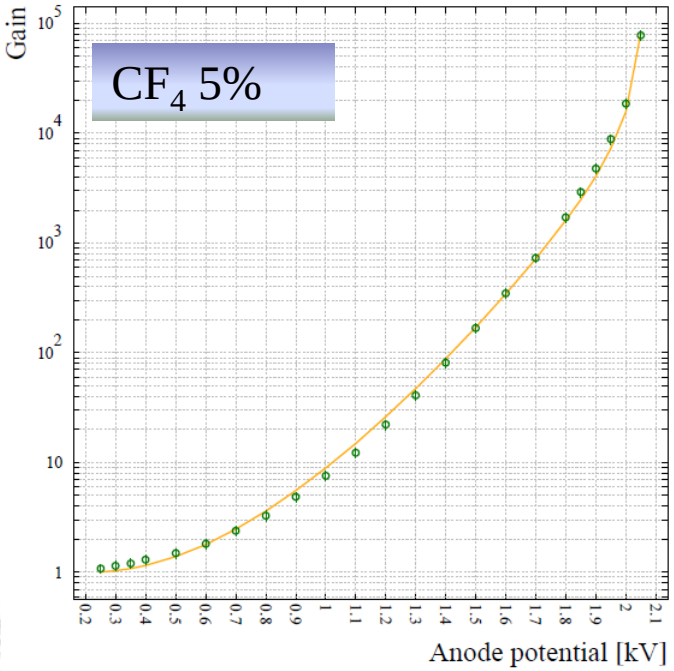


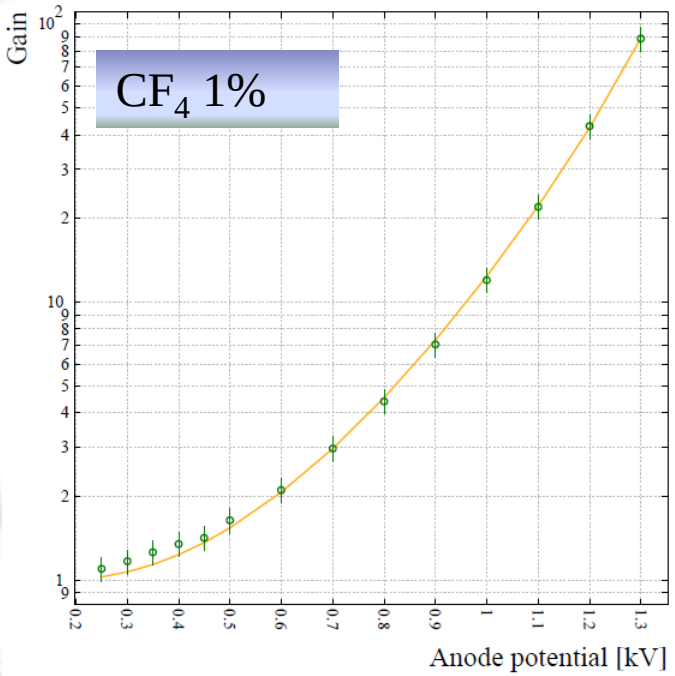


- Dissociative excitation of CF_4
- Feedback parameter



Fits II





- Almost perfectly fine agreements by using Dissociative excitation of CF_4 and Feedback parameter
- No need to use gain scaling factors
- **But,** too early to be sure about Dissociative excitation parameters (see the table on the next page)
- Magboltz CF_4 ionisation cross sections could probably be too high **???**
  - Should be checked **!!!**

Dissociative excitation & Feedback parameters

Mixture	Diss. Parameter	Error	Beta	Error
Ar 25% - CF_4 75%	**-0.245**	0.433E-02	not used	-----
Ar 50% - CF_4 50%	**-0.242**	0.709E-02	0.344E-05	0.110E-05
Ar 80% - CF_4 20%	**-0.484**	0.189E-01	0.186E-04	0.200E-05
Ar 90% - CF_4 10%	**-0.681**	0.305E-01	0.375E-04	0.255E-05
Ar 95% - CF_4 5%	**-1.104**	0.515E-01	0.932E-04	0.594E-05
Ar 99% - CF_4 1%	**-4.475**	0.320E+00	0.281E-02	0.104E-02

- Increase with Argon concentration
- **But,** improbable to have **> -1** dissociative excitation parameter

Summary

- Ionisation and dissociative excitation (may be attachment) cross sections of CF_4 in Magboltz should be checked carefully
  - Ionisation checked 1 year ago, seem correct **!!!**
- Seems no need to use gain scaling factors
- But feedback parameters are essential to reproduce the experimental data (except Ar 25% - CF_4 75% mixture)

NEXT:

- It will be possible to handle triple mixtures of CF_4 with more confidence ($Ar - CO_2 - CF_4$)
- Understanding of CF_4 may also be important for ALICE TPC gas mixtures (Ne 90% – CF_4 10%)

Thanks & ???