# CF4 Scintillation and Aging

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## CF4 Scintillation

### ❑ CF4 Primary Scintillation

- ► **Produced by ionizing radiation**
- ► **Results were presented at Jornadas do LIP 2010 and published** [Ref. 1] [Ref.2]

### ❑ CF4 Secondary Scintillation

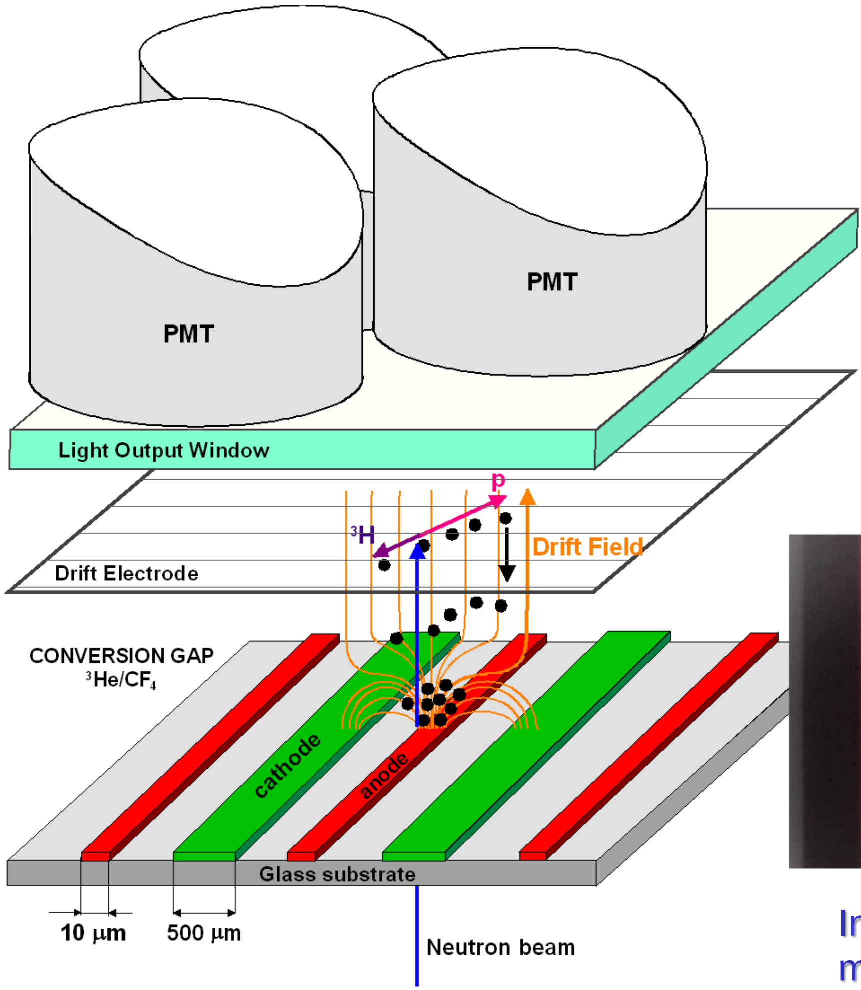
- ► Light emission associated to electron multiplication induced by a high electric field.
- ► In order to have a high electric field in a well-defined region of space micropattern structures can be used e.g. MSGCs, GEMs.


[Ref. 1] **Photon yield for ultraviolet and visible emission from CF4 excited with α-particles**
A. Morozov, M.M.F.R. Fraga, L. Pereira, L.M.S. Margato, S.T.G. Fetal, B. Guerard, G. Manzin, F.A.F. Fraga
Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms, Volume 268, Issue 9 (2010) 1456-1459.

[Ref. 2] **Effect of electric field on the primary scintillation from CF4**
A. Morozov, M.M.F.R. Fraga, L. Pereira, L.M.S. Margato, S.T.G. Fetal, B. Guerard, G. Manzin, F.A.F. Fraga
Nuclear Instruments and Methods in Physics Research Section A 628 (2011) 360-363.

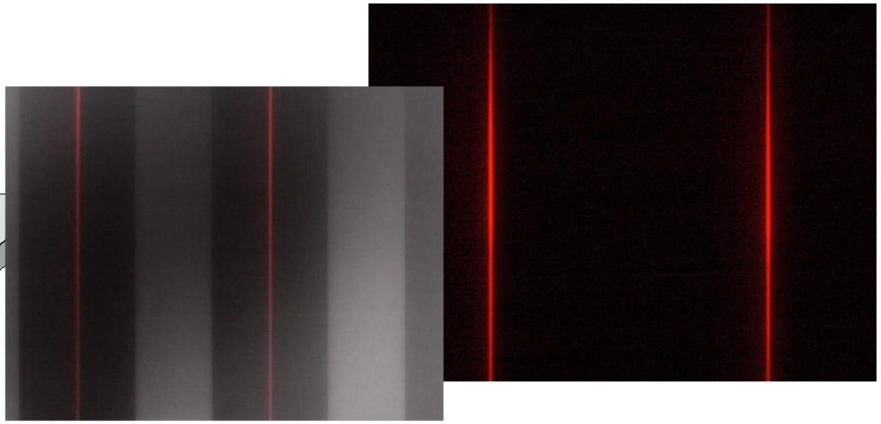
# CF4 Scintillation

## ❑ Secondary Scintillation




**For detector design it is critical to know:**

- Emission Spectra
- Light Yield
- Decay Time of the Emission
- Light Emission Stability



Images of the Sec. Scintillation from a microtrip (readout by a CCD)

# CF4 Scintillation

## ❑ Secondary Scintillation characterization

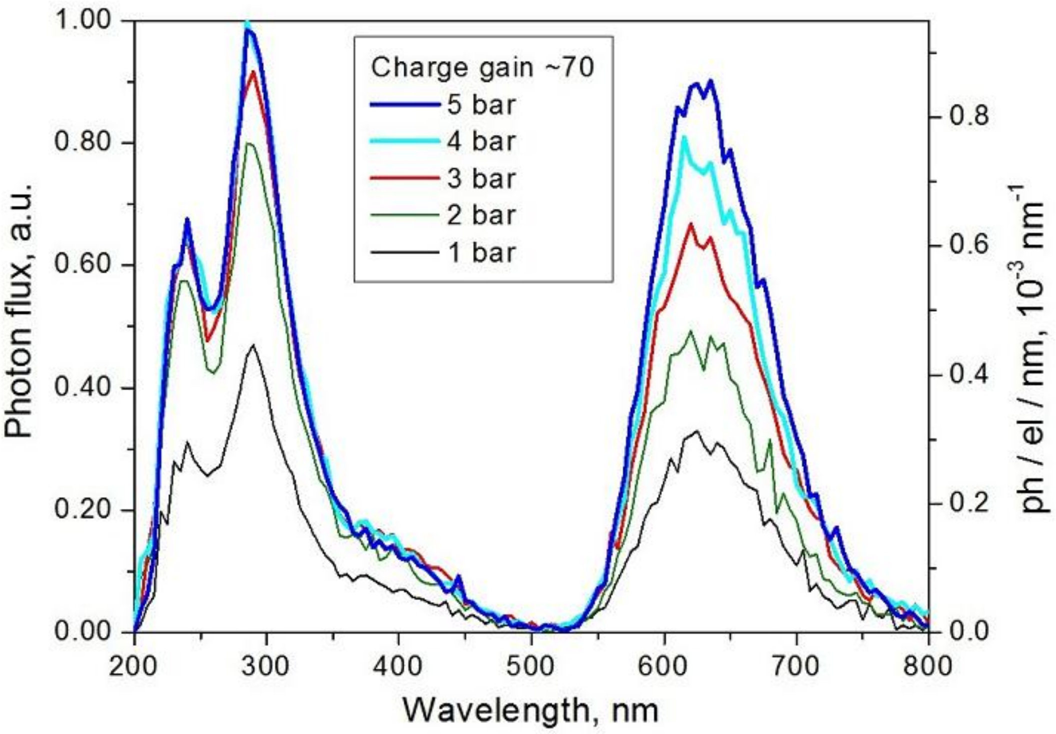
- ▶ Micropattern structures
  - – MSGC : 1 – 5 bar CF4
  - – GEM:  1 bar CF4
- ▶ Am-241 alpha source for $CF_4$ primary ionization
- ▶ Single photon counting using PMTs and Monochromator
- ▶ Absolutely calibrated light sources → PMTs and Monochromator response
- ▶ Charge
  - – MSGC: Anodes signals → Energy spectra, charge gain, trigger
  - – GEM: GEM lower electrode current → Charge gain

# CF4 Scintillation

**Secondary scintillation in CF4: emission spectra and photon yields for MSGC and GEM**
A Morozov, L M S Margato, M M F R Fraga, L Pereira and F A F Fraga
*JINST* 7 P02008, *doi:10.1088/1748-0221/7/02/P02008*

- **Secondary Scintillation characterization**
  - **Emission Spectra** (all corrections are applied)

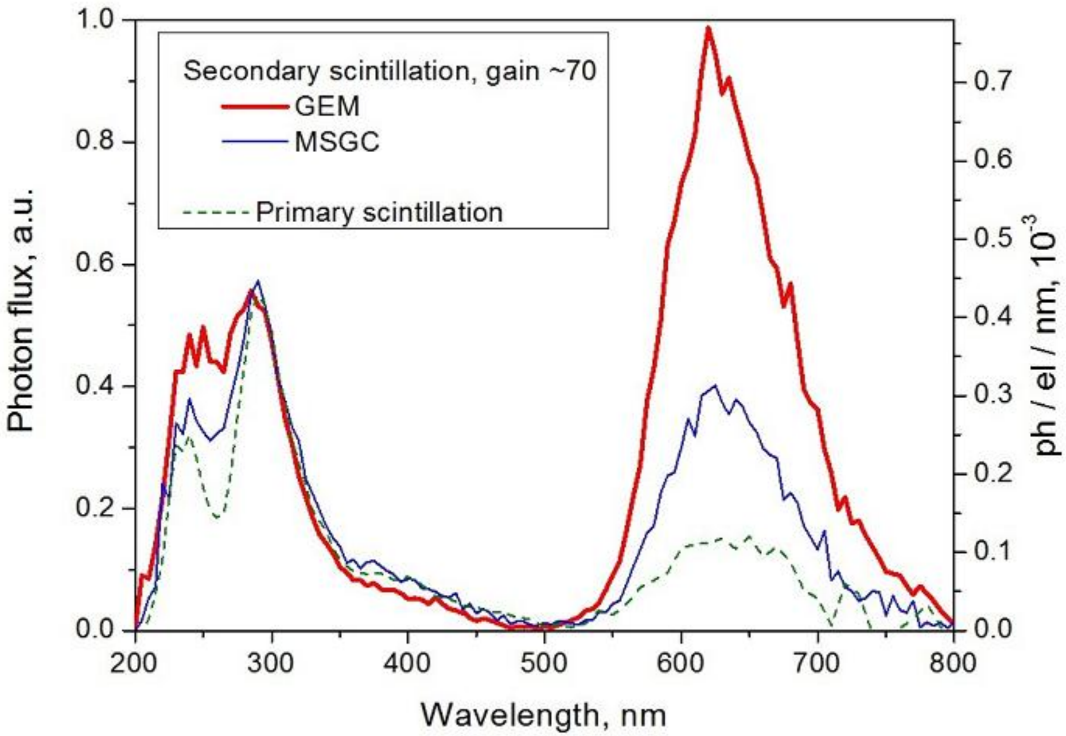
MSGC:
1- 5 bar CF4



# CF4 Scintillation

- **Secondary Scintillation characterization**
  - **Emission Spectra** (all corrections are applied)

GEM:
1bar CF4




GEM: spectra show an apparent increase in the intensity of the emission originating from excited molecules (and a minor decrease in the emission from ions)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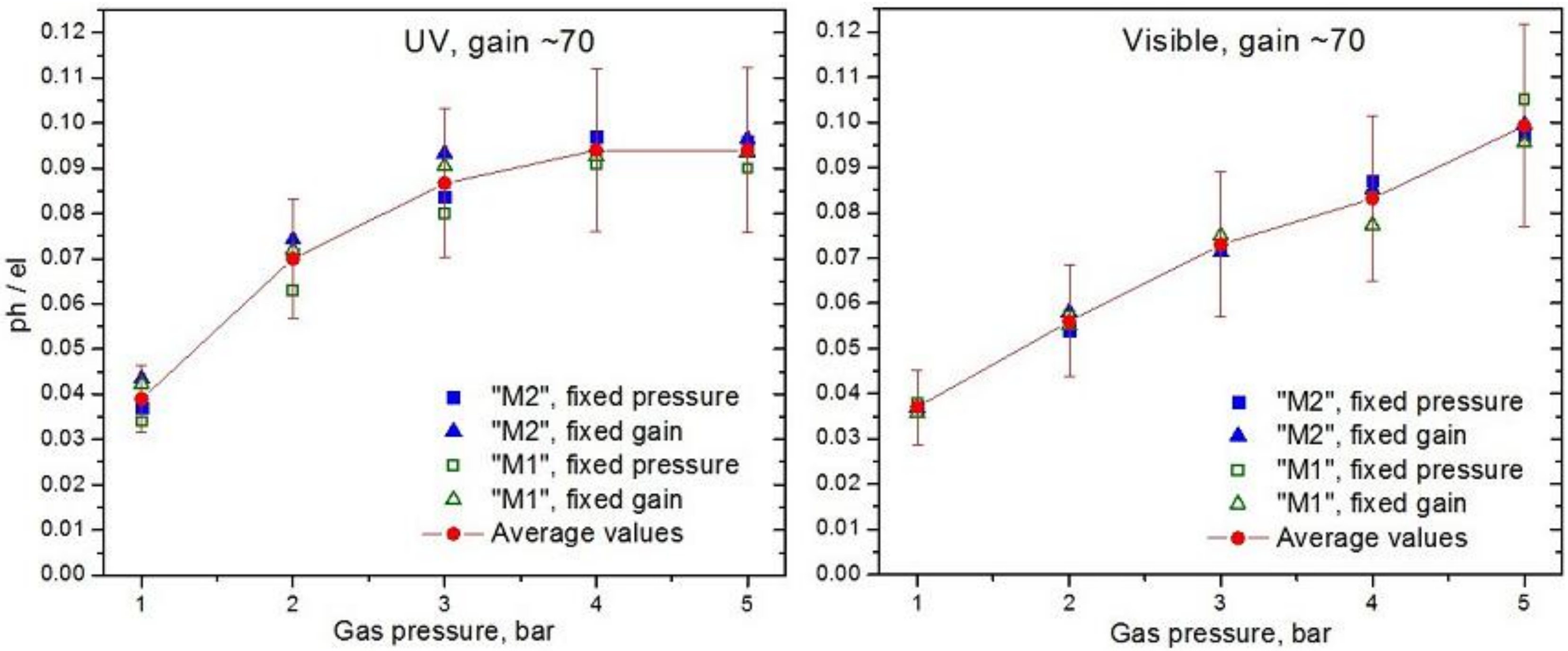
# CF4 Scintillation

❑ **Secondary Scintillation characterization**

➢ **Light Yield** (Ph / el ratios)




Ph/el ratio as a function of pressure for a fixed MSGC charge gain of ~70;
Two MSGCs (designated “M1” and “M2”) were used;

The average values of the ph/el ratios at each pressure are also shown with their full (statistical +systematic) uncertainties.

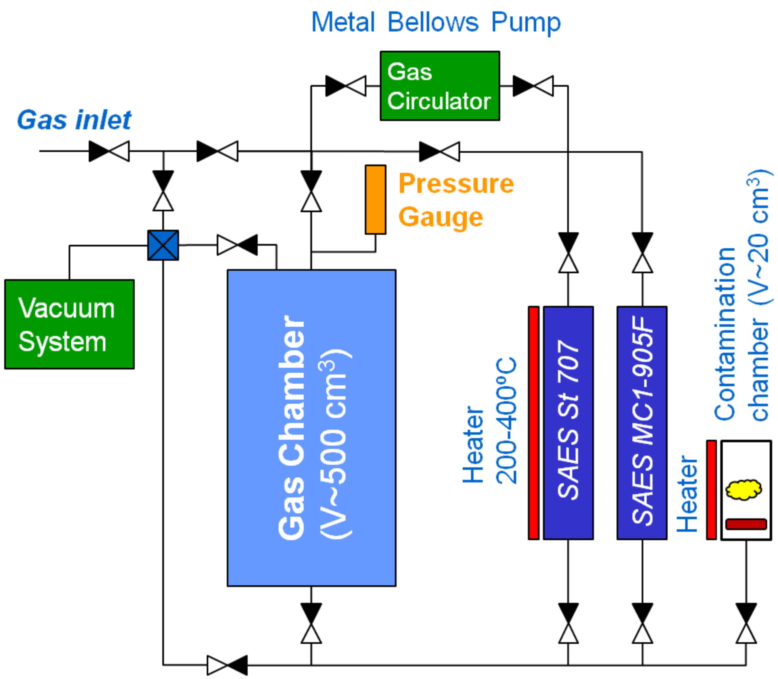
# CF4 Scintillation – Gas Aging studies

## Gas Purification System

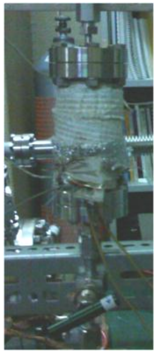
**Clean gas cell**

**Two Types of Purifiers**

- SAES St 707 getters (custom assembly)
- SAES MicroTorr MC1-905F

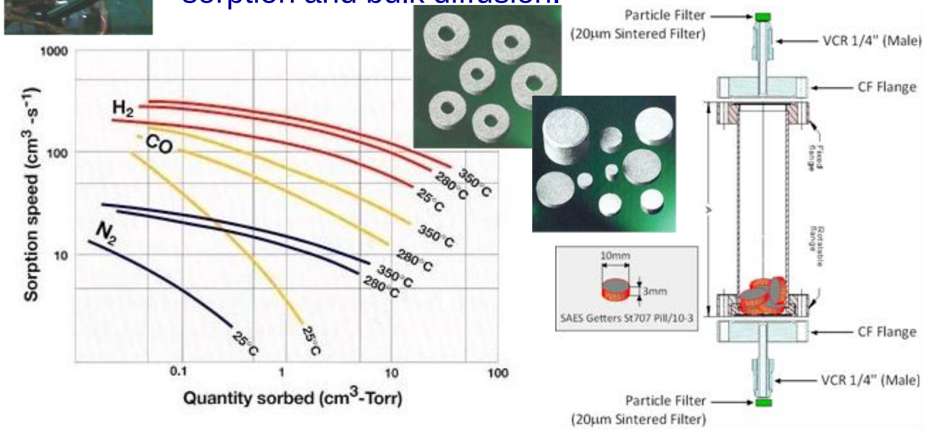



### Purifier SAES St 707 (Custom Assembly)



The St707 wide operating temperature range down to room temperature

Once the alloy is activated, reactive molecules such as $O_2$, $H_2O$, $N_2$, CO, $CO_2$ and $H_2$ are adsorbed via a three steps adsorption mechanism: surface dissociation, surface sorption and bulk diffusion.

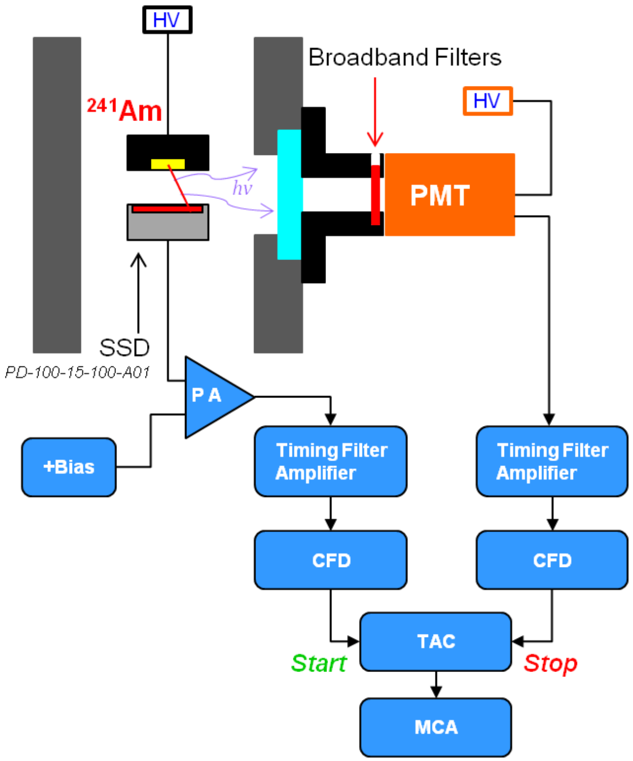



### Purifier SAES Microtorr MC1 – 905F

| Media | Gases Purified | Impurities Removed | Outlet Performance | Regenerable |
|---|---|---|---|---|
| 905 | $C_2F_6$, $C_2H_6$, $C_3F_8$, $C_3H_8$, $C_2F_4H_2$, $C_4F_8$, $C_4H_{10}$, $CCl_4$, $CF_4$, $CH_4$, $CHF_3$, $SF_6$ | $H_2O$, $O_2$, CO, $CO_2$, $H_2$, NMHC | < 1 ppb | YES |

# CF4 Scintillation – Gas Aging studies

## Experimental Setup




Time spectra was recorded by a start (Solid State Detector) and stop (PMT) technique

**Study performed in the UV (220-450nm) and Visible (450-800nm):**

An Am-241 alpha source was used for excitation

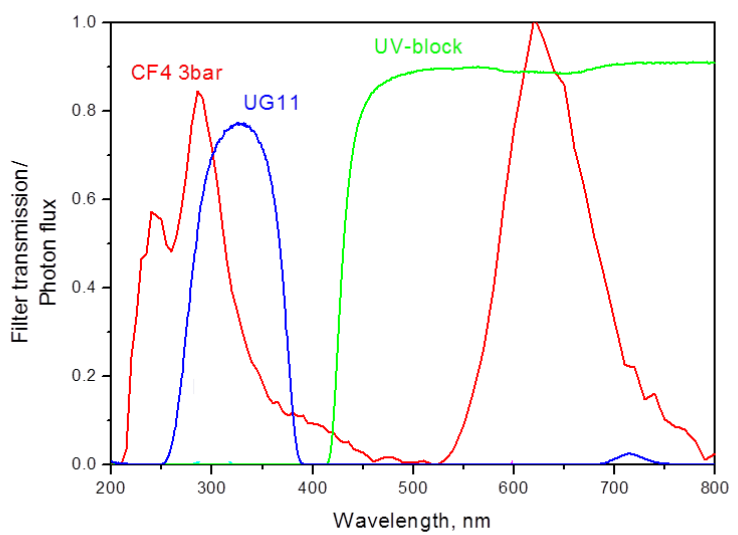
PMs were used in Single Photon Counting mode:

**UV (220-450nm)**

- PMT Photonis XP2020Q (HV=+2000V)
- Broadband Filter: Schott UG11

**Visible (450-800nm)**

- PMT Hamamatsu R1387 (HV=-1170V)
- UV-Block Filter: 450 nm cut-off



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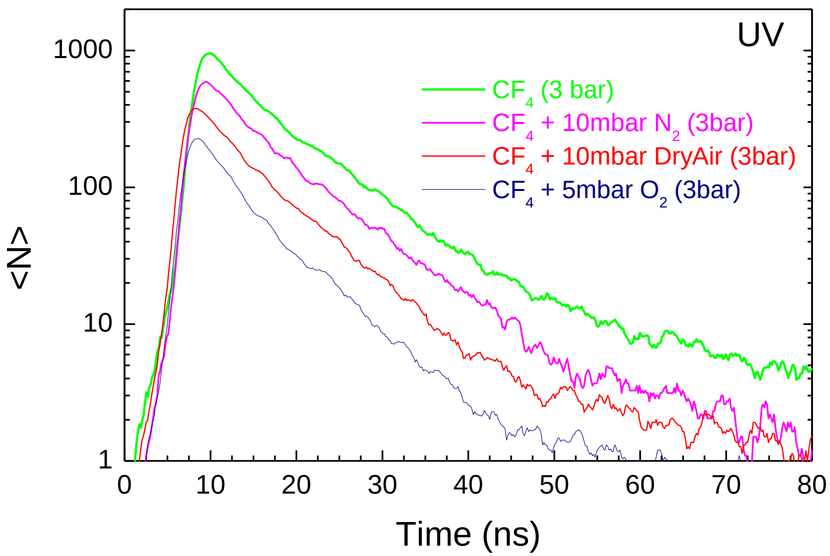
# CF4 Scintillation – Gas Aging studies

## Effect of small admixtures of N2, O2, Dry Air,  to CF4

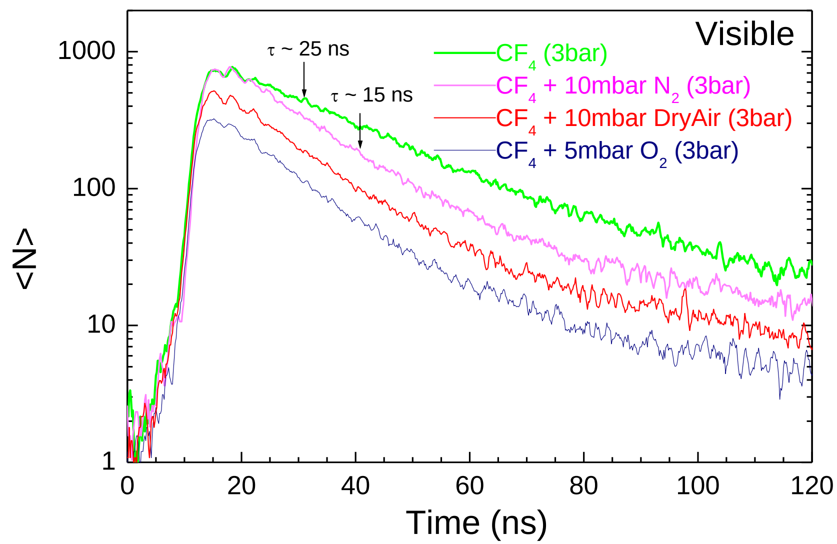
### Time spectra (Primary Scintillation)

### UV




Addition of N2, O2 and Dry Air seem to have a negligible effect in the Slope of the UV component

### Visible




Visible component is affected by N2, O2 and Dry Air admixtures (different decay times)



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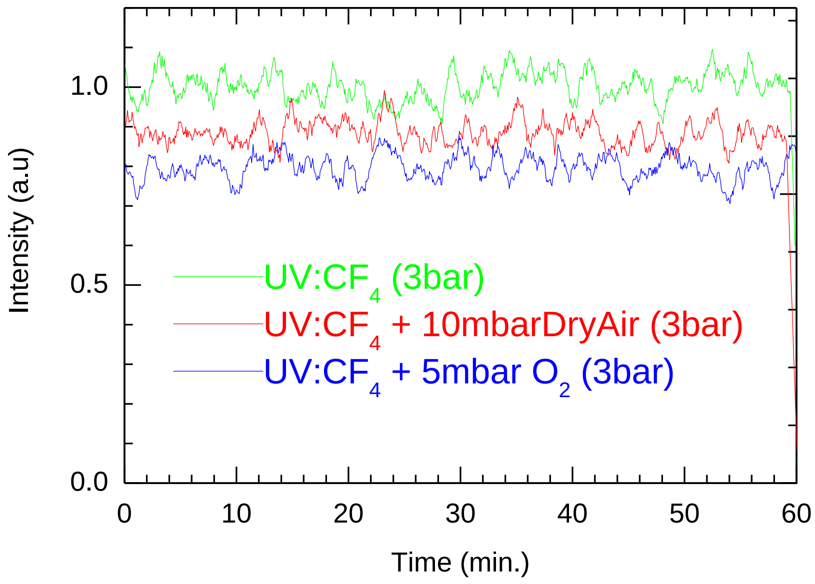
# CF4 Scintillation – Gas Aging studies

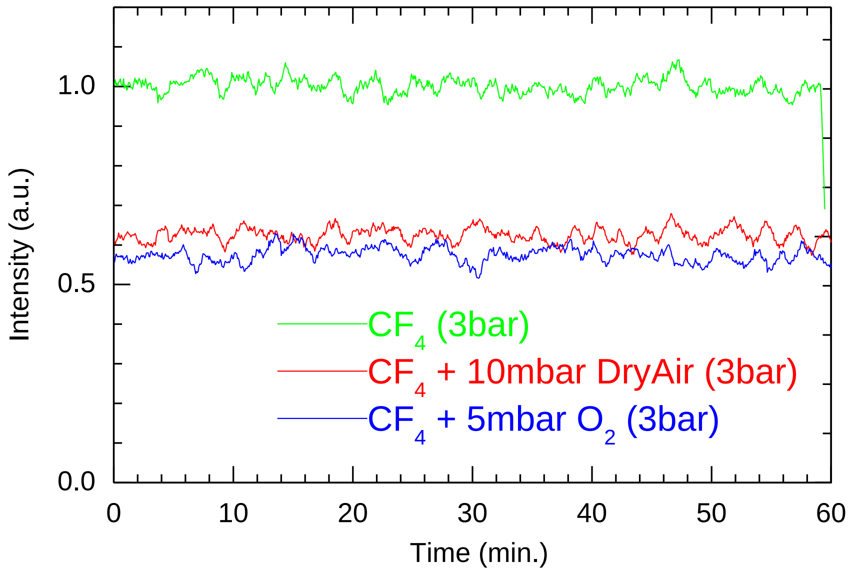
## Effect of small admixtures of N2, O2, Dry Air, to CF4

### Light output (relative intensity)

**UV**




**Visible**



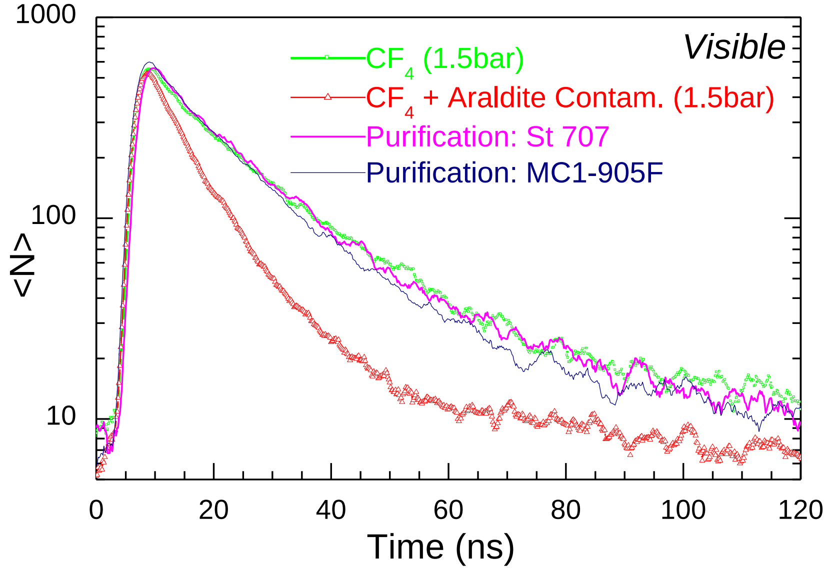
# Purification effect of the contaminated CF4

**Two examples: CF4 contaminated by Araldite (*); CF4 with an admixture of N2.**

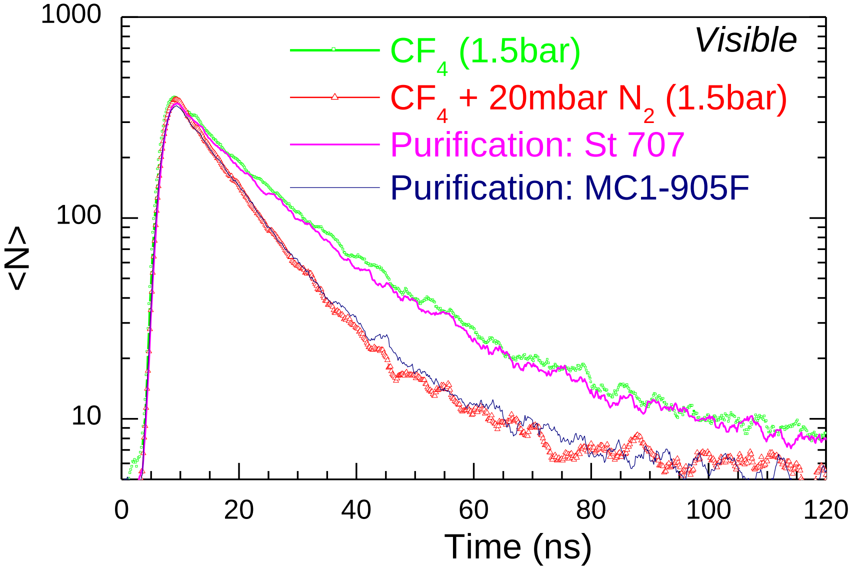
**(*) Araldite Rapid 2012**

## Time spectra (Visible component)

Contamination with Araldite




Admixture of N2




After purification recovery to pure CF4 conditions (both purifiers)

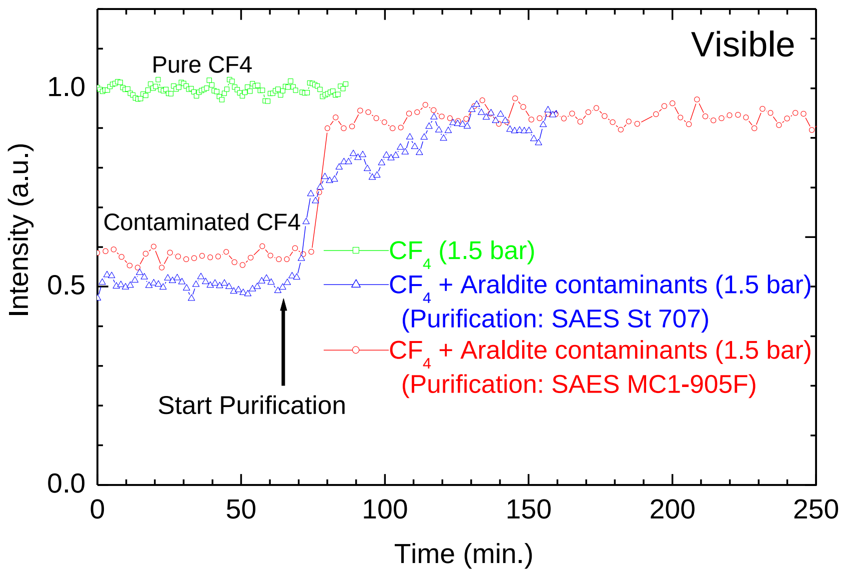
For **N2** admixtures **MC1** purifier **does not recover** to pure CF4 conditions

## Purification effect of the contaminated CF4

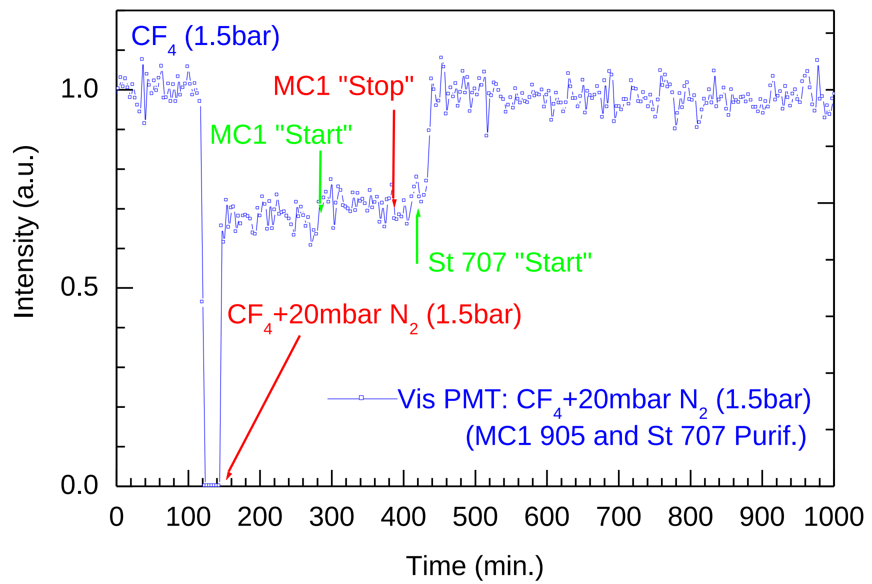
**Two examples: CF4 contaminated by Araldite; CF4 with an admixture of N2.**

### Light output (relative intensity)

Contamination with Araldite




Admixture of N2




**Effect of the gas contamination on CF4 primary and secondary scintillation**
L M S Margato, A Morozov, L Pereira, M M F R Fraga and F A F Fraga
Nuclear Instruments and Methods in Physics Research Section A (in press)
*http://dx.doi.org/10.1016/j.nima.2011.10.033*

# CF4 Scintillation – Gas Aging studies

- Emission Spectra and ph/el ratios of the Secondary Scintillation have been characterized:
  - ✓ Dependence on gain and pressure;
  - ✓ MSGC vs. GEM (1bar);
- Gas aging studies:
  - ✓ Was shown that a time resolved technique can be used to study CF4 contamination and purification;
  - ✓ The visible emission of primary scintillations is more sensitive to gas impurities than the UV emission;
  - ✓ Aging studies for CF4 Secondary Scintillation have also been performed;
  - ✓ The Purifiers SAES St 707 and MC1-905F show ability to recover contaminated CF4 to fresh filling conditions, but the MC1-905F doesn't remove N2

► **Study of the Decay Time of the CF4 Secondary Scintillation is being performed**

# Thank you for your attention

# Backup Slides

## CF4 Primary Scintillation: Time Spectra

### Typical effective lifetimes

Effective lifetimes measured in the absence of electric field are:
~**4 – 6** ns for the UV component
and
~**8 – 16** ns for the visible component

Both the visible and UV time spectra show no indications of any slow (effective lifetime on the order of 100ns and longer) decay components.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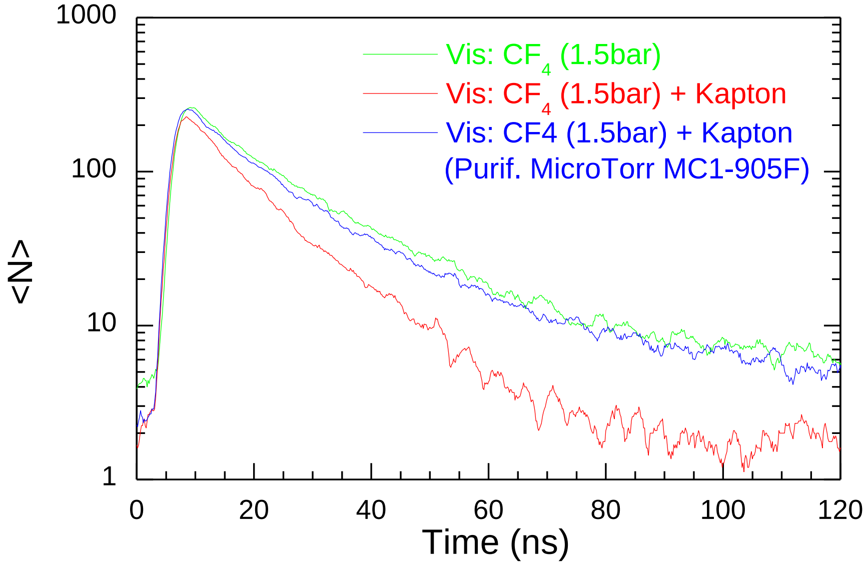
## Purification effect of the contaminated CF4

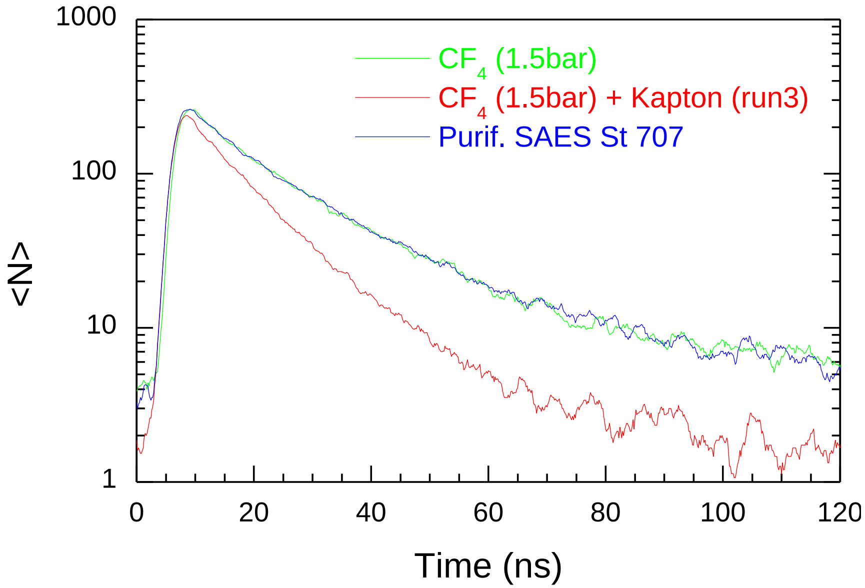
**CF4 contaminated by Kapton**

### Time spectra (Visible component)

**Purifier : SAES Micro Torr MC1 905**



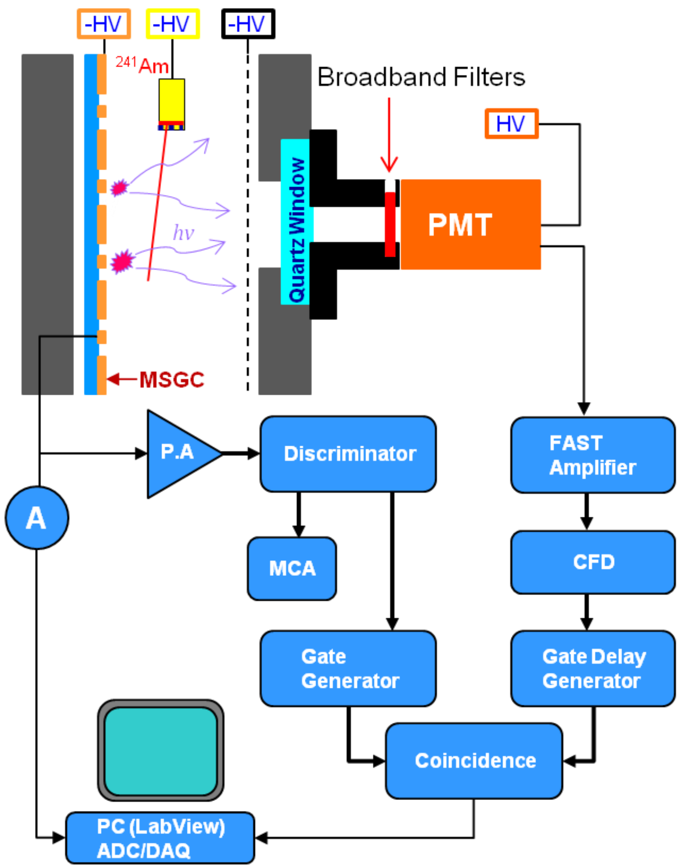

**Purifier: SAES St 707**

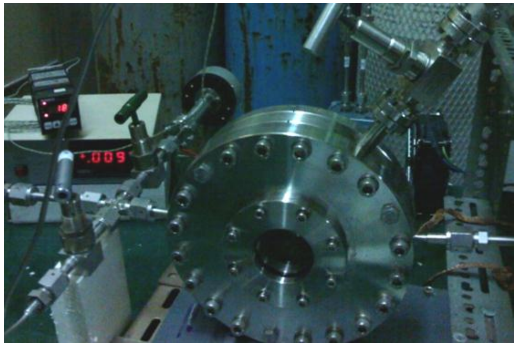



Kapton Contamination: After purification recovery to pure CF4 conditions (both purifiers)

# CF4 Scintillation – Gas Aging studies

## Secondary scintillation – Experimental Setup



**A MSGC plate (ILL6C) was used for electron multiplication and secondary light production**

**Anode current read by an electrometer (Keithley 602):**

- Used to monitor the MSGC charge gain

**Rate of coincidences between the charge and light signals:**

- Relative intensity of the secondary scintillation

**Ratio of the coincidence rate to the secondary current:**

- Secondary scintillation intensity corrected for the gain fluctuations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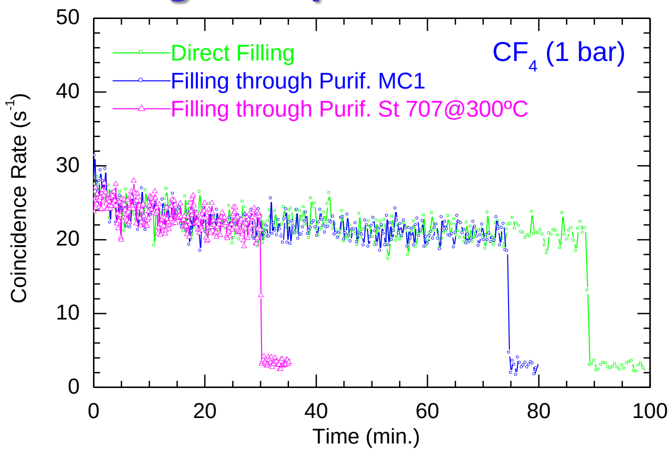
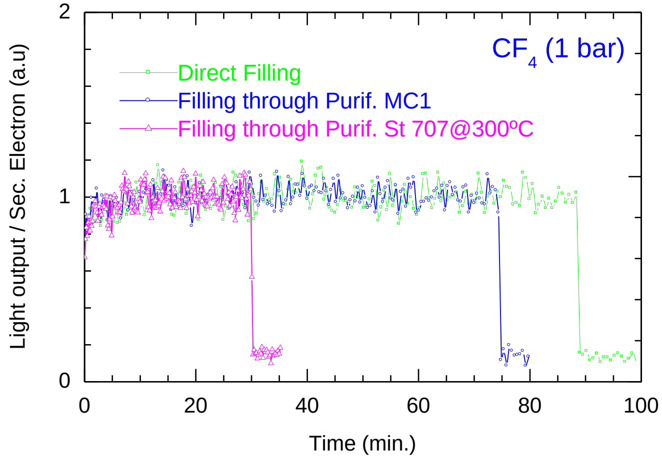
# CF4 Scintillation – Gas Aging studies

## Secondary Scintillation

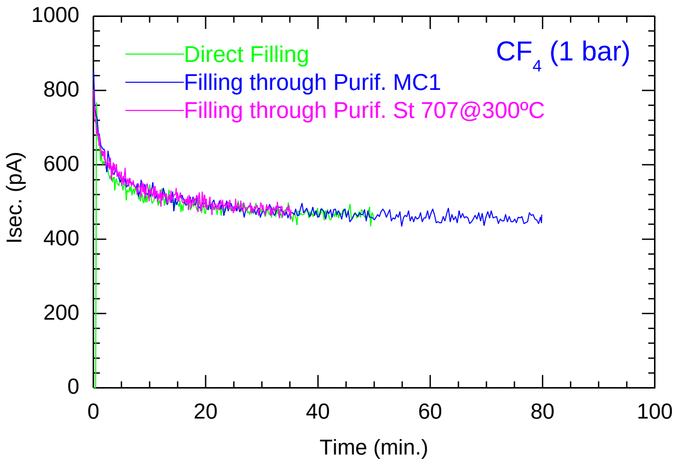
### Purification effect on CF4

**Light output**




**Anode current**




No significant difference in the emission intensity has been observed using these three filling conditions.