Atlas Drift Tube ageing test

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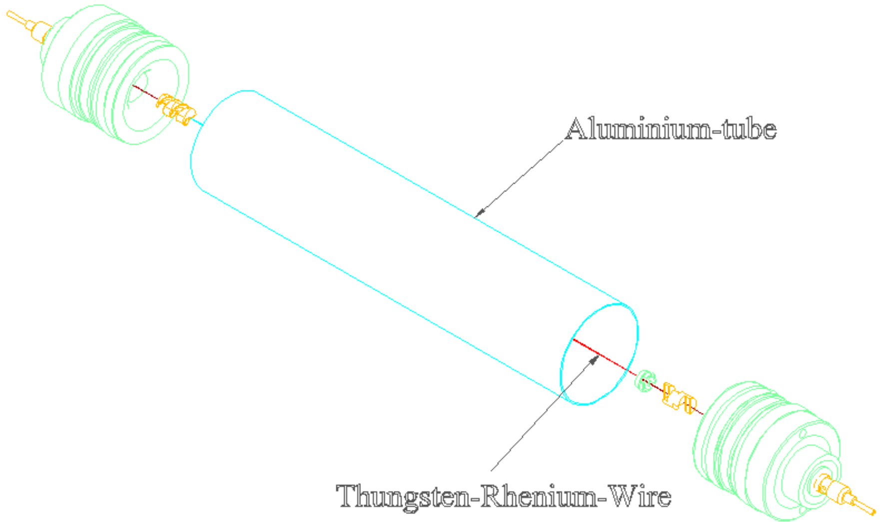

- Goal of Drift Tube ageing test
- Setup
- Ageing as function of total charge [mC/cm] ?
- Influence on the choice of gas for ATLAS
- Conclusion

Goal of Drift Tube ageing tests

Drift Tubes for the precision chambers of the Atlas Muon Spectrometer

Single Tubes

- Number : 380000
- Length : up to 6m

DT Operating Point

- Gas gain: **$2*10^4$**
- High resolution: **80?m**

Rates :

high γ and n Background

⇒Countrates up to **300Hz/cm** over **10 years** of operation

⇒

Goal :

Lifetime > **0,6 C/cm**

(with **security** factor **5**)

⇓

$Ar\text{-}CO_2$ 93-7 „Baseline Gas"

$Ar\text{-}CH_4\text{-}N_2\text{-}CO_2$ 94-3-2-1 „R&D Gas"

Parameters influencing ageing

- Parameters to optimize ageing performance of detector
- **Parameters of ageing tests (needed for extrapolation, I will focus my talk on this point)**

Optimization of Ageing-Performance

- Cathode/Anode coating
- Cathode/Anode cleanliness
- Gas mixture
- Gas additives
- Gas flow
- Gas purity
-

red=tested in Freiburg

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How to make an ageing test?

An ageing test should be made in a **short time** on **laboratory scale** and **be reliable**!

Possibilities to accelerate ageing tests:

increased **gas gain** and **irradiation rate**

to study dependence on

- **Irradiation length**
- **High-Voltage**
- **Irradiation Rate**
- Primary Ionisation

Can we conclude anything from the collected total charge [mC/cm] ?

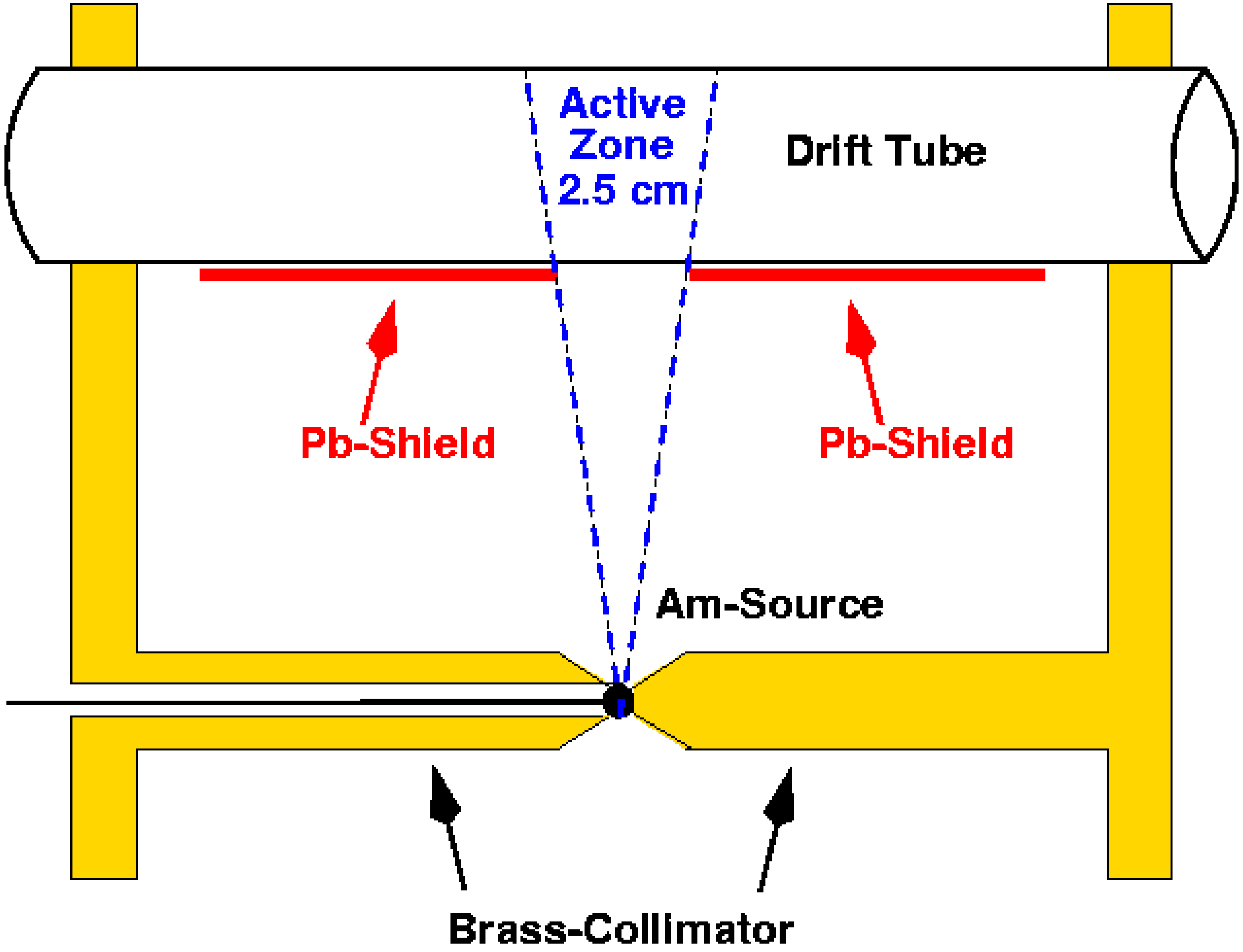
Experimental discrepancies

using $Ar\text{-}CH_4\text{-}N_2\text{-}CO_2$

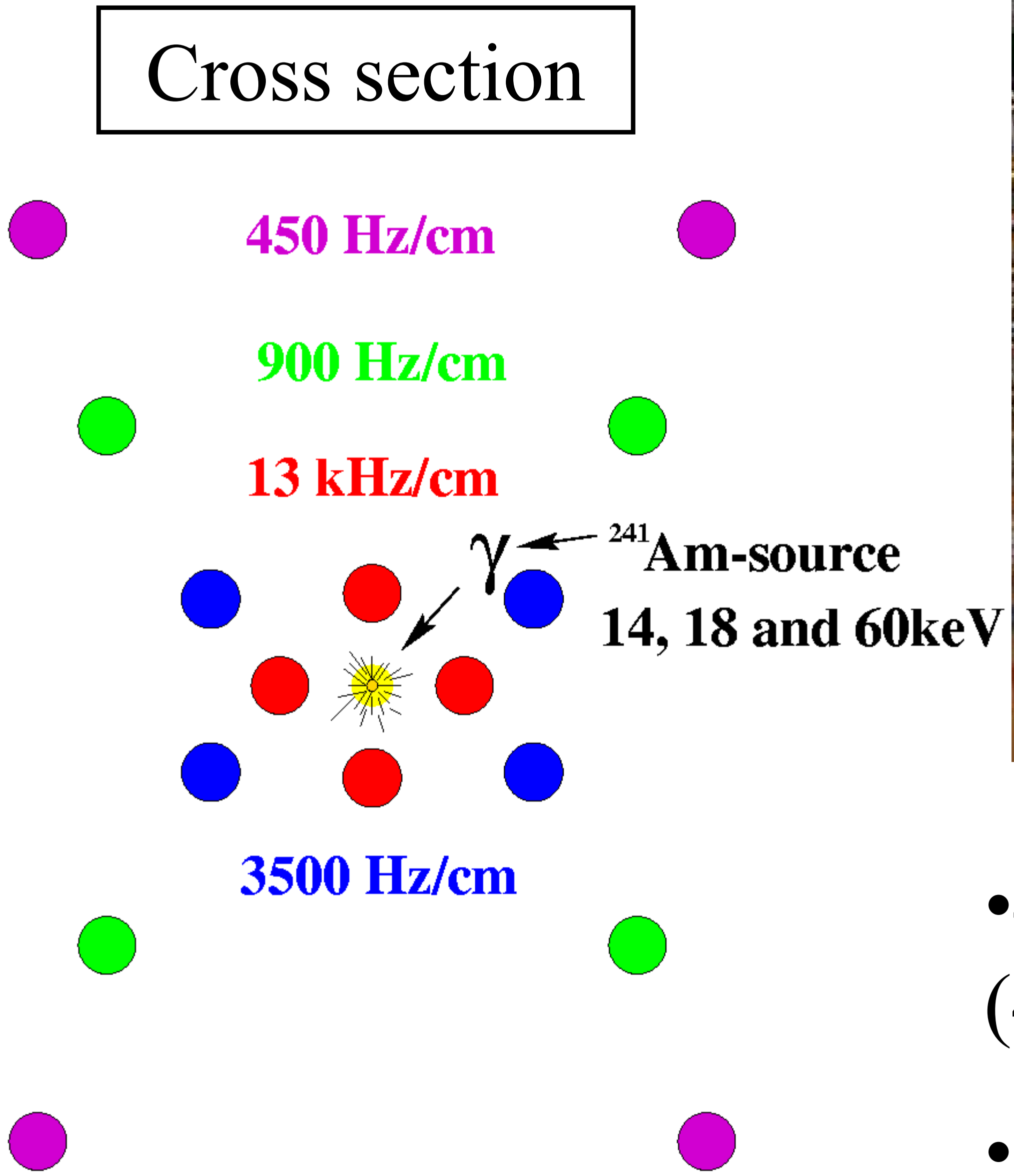
Setup	Freiburg 1998	CERN X5-GIF 1998
	No ageing up to **3000 mC/cm**	All (48) tubes **inefficient** after **80 mC/cm**
Tube cleanliness	higher	lower
HV	**3350 Volt**	**3400 Volt**
Irradiation zone	**2.5 cm**	**340 cm**
Irradiation rate	**0.5 – 13kHz/cm**	**1.8 kHz/cm**
Gas flow/ Volume exchange time	2 – 240 hours	2,5 hours
Gas system	all parallel	each 3 serial
Photon energy	14, 18 and 60 keV	660 keV

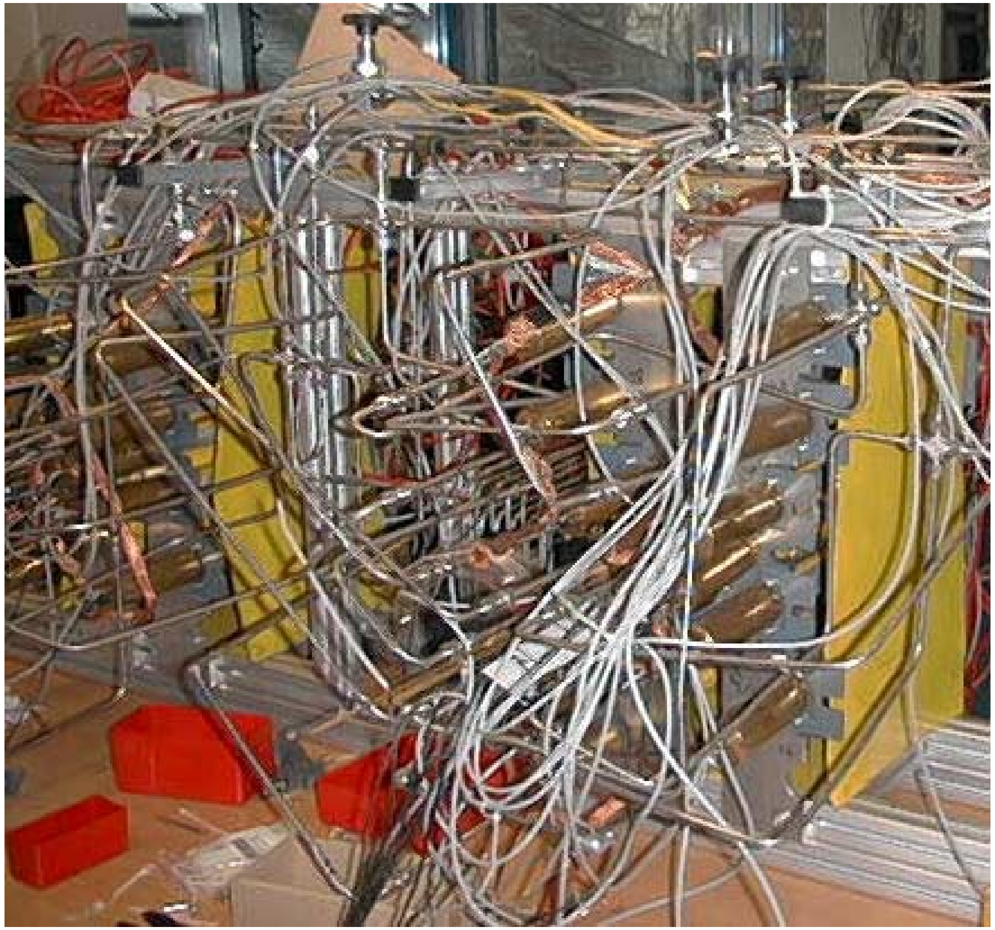
Cathode cleanliness and gas flow alone could not explain the different results

Freiburg “Ageing Setup”



- 1995 Start of ageing tests
- Active zone (irradiation zone) 1.5 to 8 cm
- Total length of the tube: 30cm





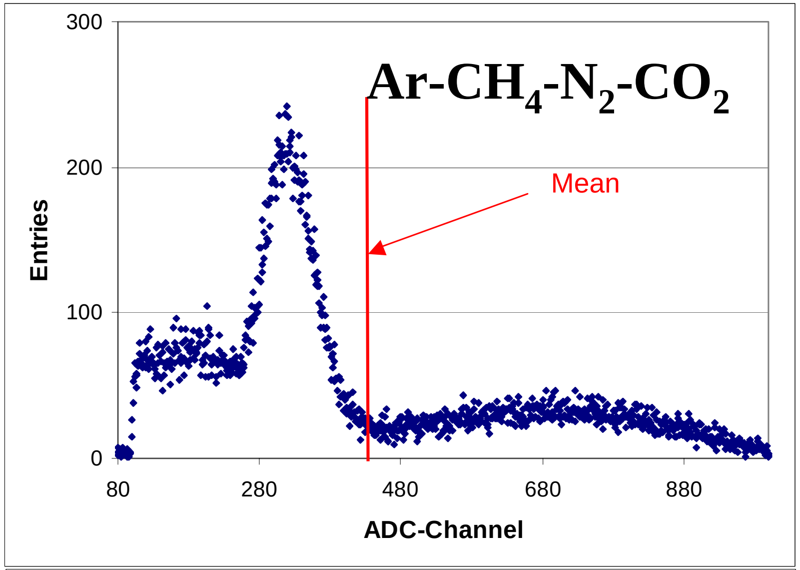
- 4 different irradiation rates (4 distances)
- 5 Setups ⇨ 80 individual tubes

4 ways to measure the drift tube efficiency

***1.) Current* (every 30min)**

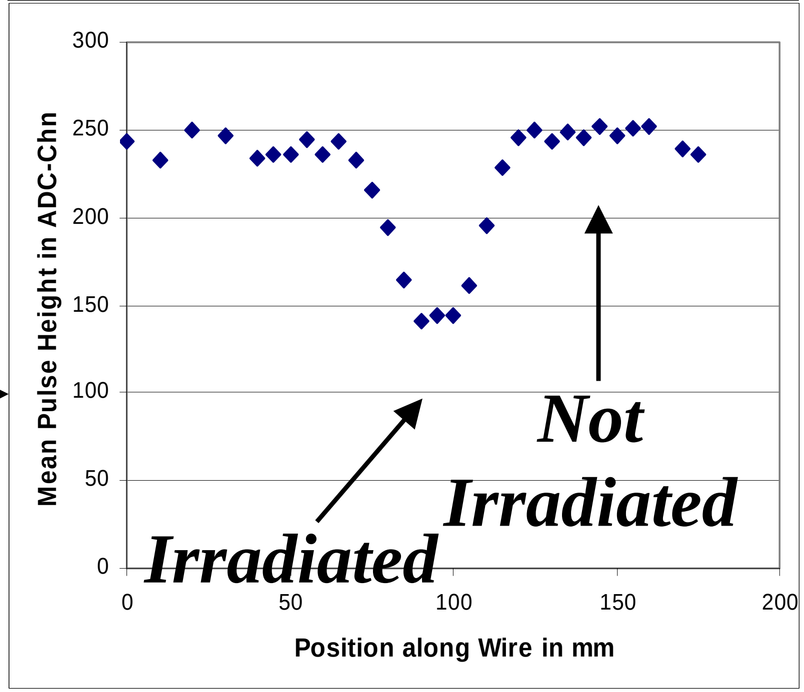
***2.) Count Rate* (every 30min)**

***3.) Mean Pulse Height* (every 3days)**



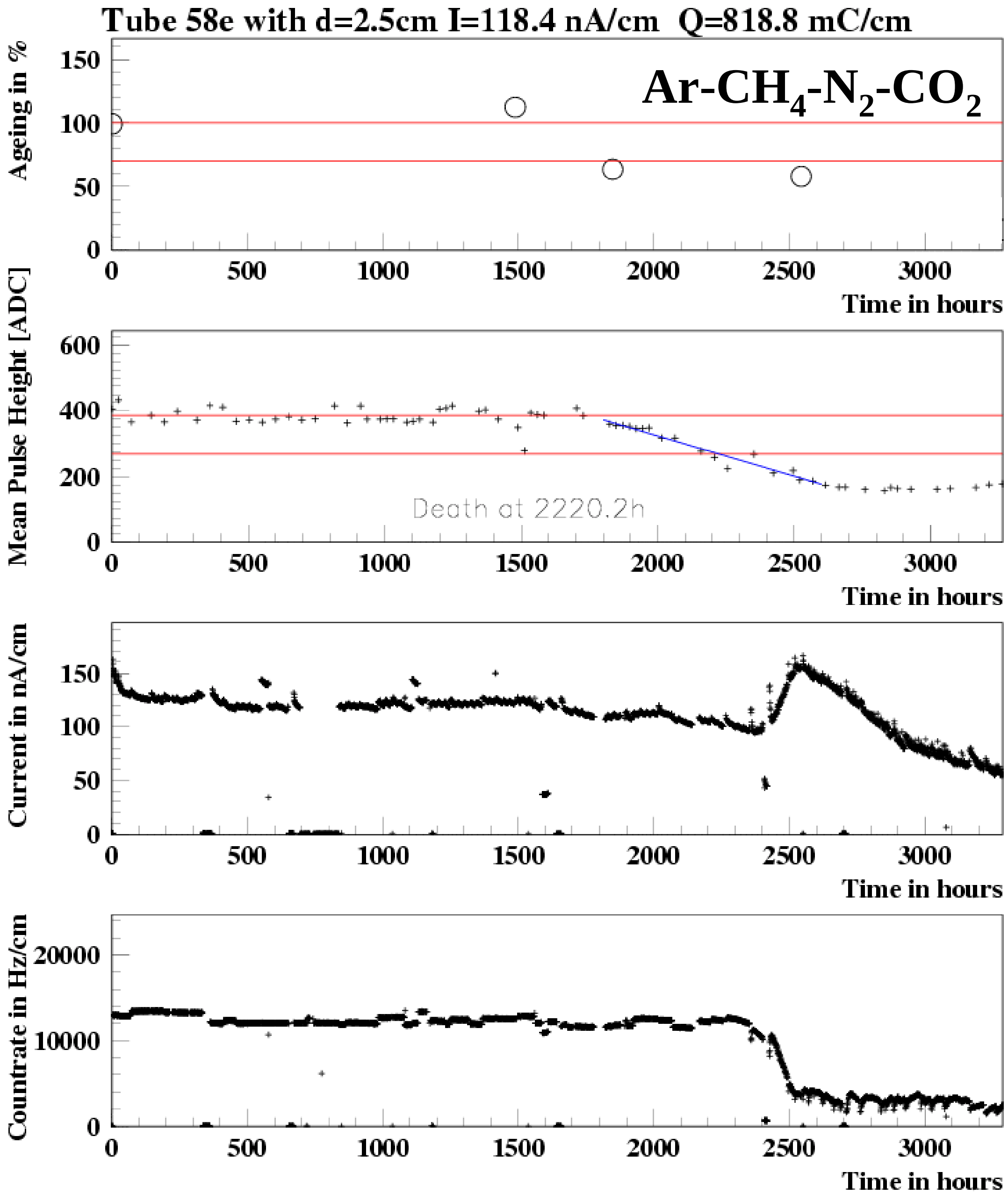
***4.) Ageing* (4 times in a MDT-operation time)**

$$ageing := \frac{ADC\,(\text{irradiated zone})}{ADC\,(\text{Not Irradiated zone})}$$



Independent of electronics, gas mixture, high voltage

Example of an inefficient Tube

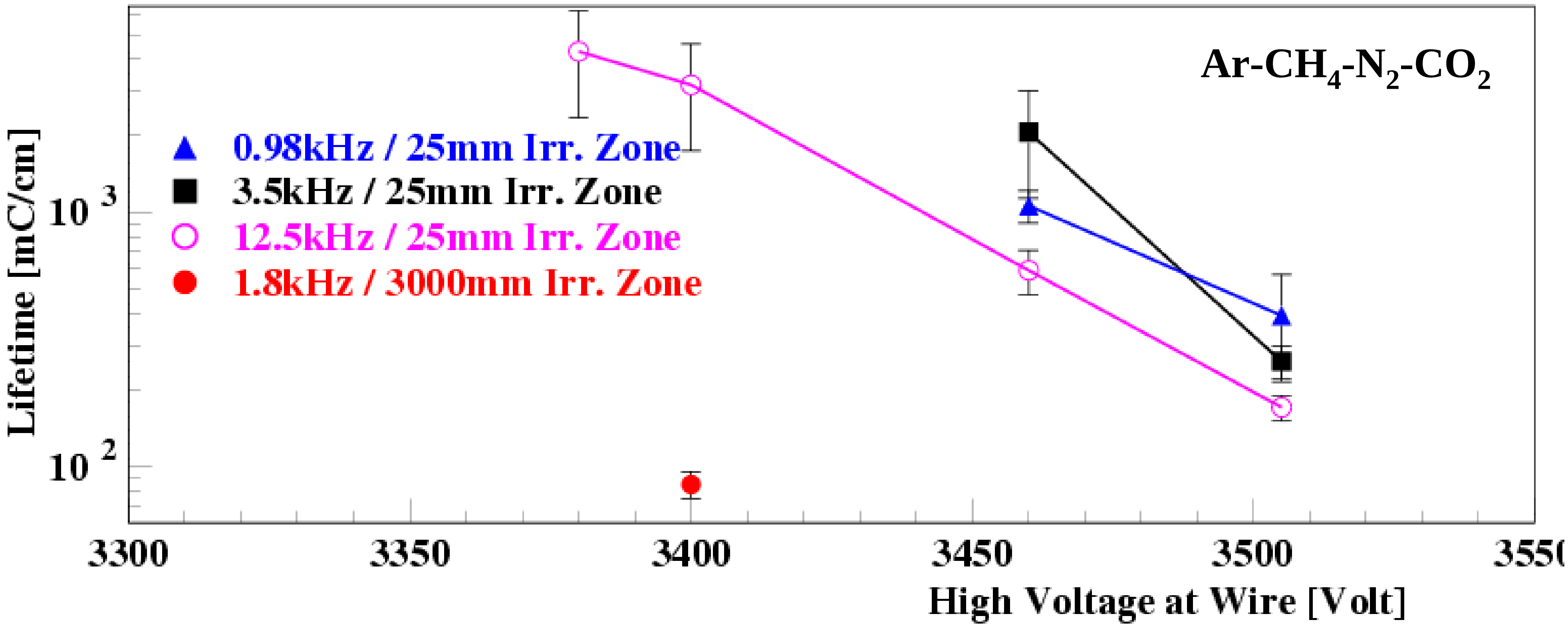


Tube is defined
to be inefficient if:
- ***Mean Pulse Height < 70%***

then we find always :
- ***Ageing-Ratio < 70%***

Typical :
- ***Onset of Malter-Effect after death***
- ***Drop of Count Rate***

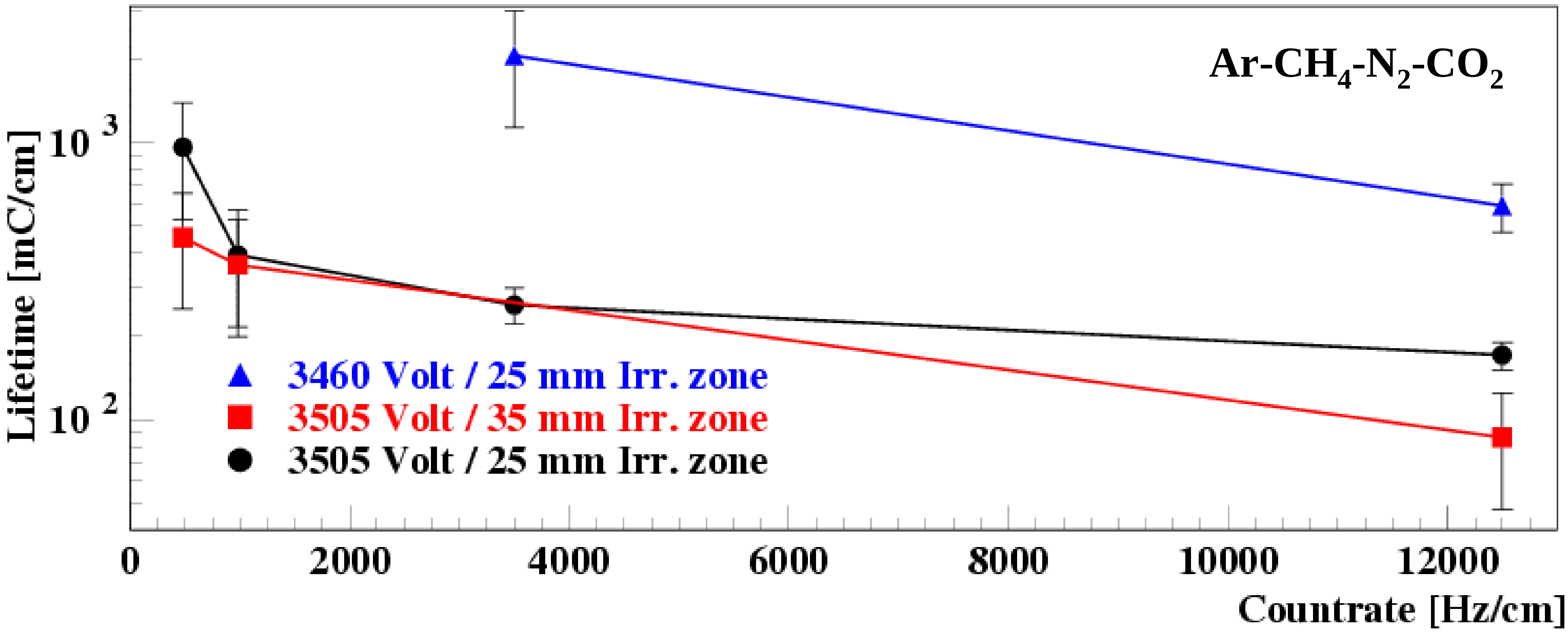
Ageing dependence on High Voltage



Lifetime = Total Charge/Length up to 70%-Level of pulse height
Equal Colors = identical parameters **except Voltage**

Strong HV-Dependence of Lifetime

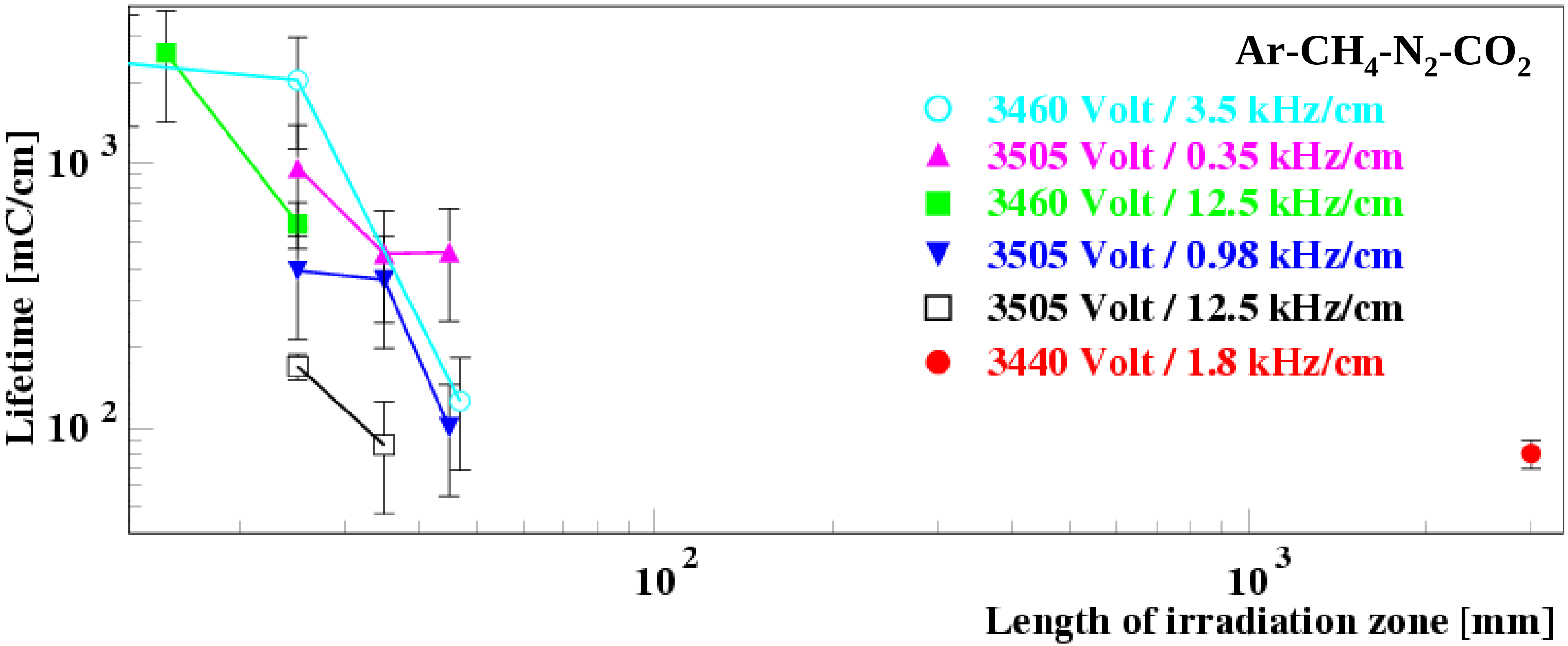
Ageing dependence on irradiation rate



Lifetime = Total Charge/Length up to 70%-Level of pulse height
Equal Colors = identical parameters except **irradiation rate**

Strong rate-dependence of Lifetime

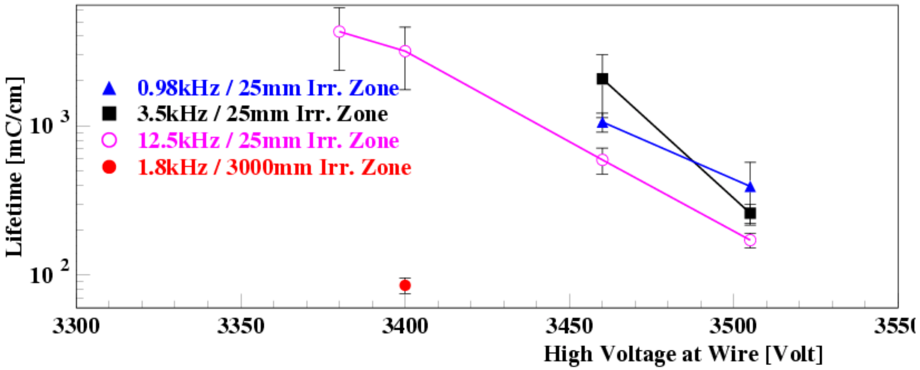
Ageing dependence on irradiation zone

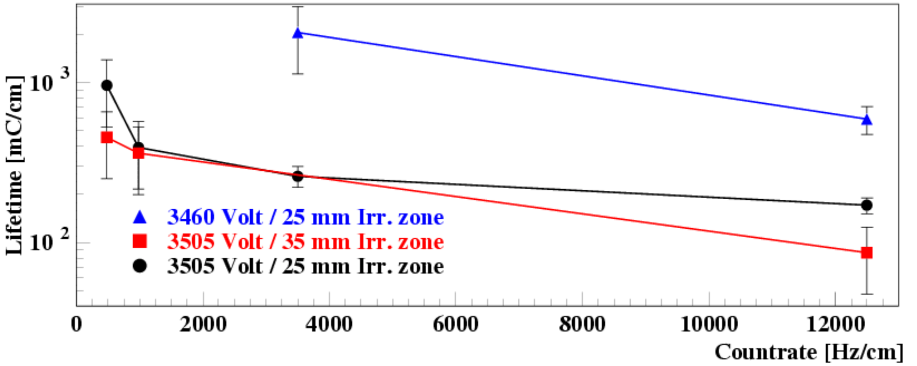


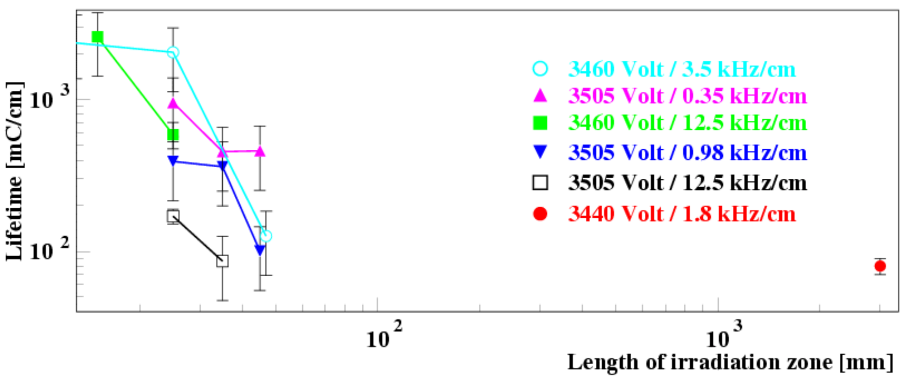
Lifetime = Total Charge/Length up to 70%-Level of pulse height
Equal Colors = identical parameters except **irradiation zone**

⇒ **Strong length of irradiation zone dependence** of Lifetime

Dependences of lifetime in Ar-CH_4-N_2-CO_2







Strong **dependence** of the lifetime on **HV, irradiation rate** and **irradiation zone**

Extrapolation to Atlas-Operating Point (**600cm, 300Hz/cm, 3130V**) not possible

"safe ageing test": full length, higher rate & HV ⇨ ***X5***

Is this behaviour independent from gas-mixture **?**

Interpretation of the ageing dependences

Irradiation in gas mixtures with hydro-carbons can produce ageing

Polymerisation on the wire reduces the gas gain (experimental result)

Does ageing depend on chemical concentration?

(That is up to now an unchecked idea)

Chemical concentration increases:

- with higher HV
- along direction of gas flow
- with higher irradiation rate
- with longer irradiation zone
- in serial gas systems with position in the series

Dependence of lifetime in Ar-CO_2 93-7

=0

(no sign of ageing)

Ar-CO_2 (93-7) :

- Number: 21 Tubes
- HV: 3400V, 3500V
  (HV_{ATLAS}=3080 Volt)
- Irradiation Zone: 2,5 – 8 cm
- Source: ^{241}Am (60 keV)
- Rate: 0,8–12,5 kHz/cm

⇒100% efficient after 1,3 C/cm (avr.)
⇒ one tube 4,8 C/cm

Ar-CO_2 (90-10) :

- Number: 47 Tubes
- HV: 3400V, 3440V
- Irradiation Zone: 3,4 m
- Source: ^{137}Cs (660 keV)
- Rate: 1,8 kHz/cm

⇒ 100% efficient after 0,6 C/cm

However

Drift tubes in a safe gas like Ar-$C0_2$ can age if there are small quantities of impurities in the tube

We have seen ageing in Ar-CO_2, when the tube is sealed with Araldit

(Contact surface << $1 mm^2$)

(Araldit AW106, HV 953)

Conclusion

•Ageing has a strong dependence on **HV**, **irradiation rate** and **length of irradiation zone**

•To make an usefull ageing test, you have to study the dependence on these parameters

a safe test in Ar-CH_4-N_2-CO_2:
full length, higher rate and higher HV

•A safe gas for the Atlas Muon Drift tubes is Ar-CO_2 93-7