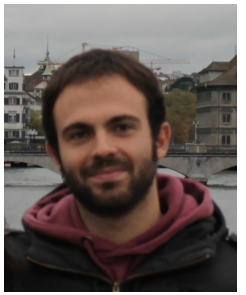
Ageing Tests for the MEG II drift chamber

MEG2 drift chamber will undergo a **very intense rate** of Michel positrons

⇒it is necessary to measure its robustness to ageing effects

$$I \simeq 10\,\mathrm{nA/cm} \xrightarrow[3\ \mathrm{DAQ\ years}]{} \sim 0.5\ \mathrm{C/cm}$$



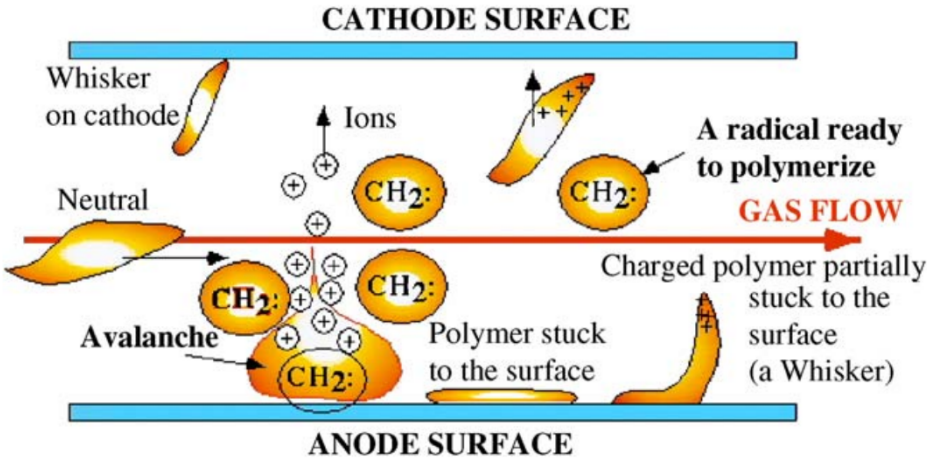
Presenter:
Marco Venturini

Drift chamber loss of performances

- **Gain loss**.
- Loss of response uniformity.
- **Electrical instability** and dark currents.
- Self-sustained discharges.

Ageing causes

- Gas molecules fragmentation (iC_4H_{10})
- **Free radicals** formation.
- Polymer **deposits** on wire surfaces.



Kadyk, Nucl.Instrum.Meth., A300:436-479, 1991
Niebuhr, Nucl.Instrum.Meth., A566:118-122, 2006

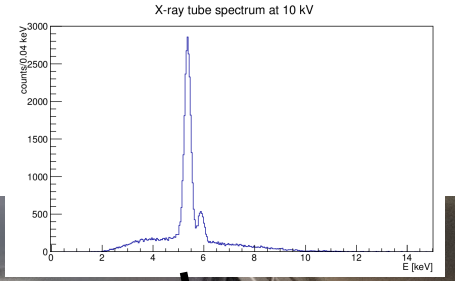
Ageing tests

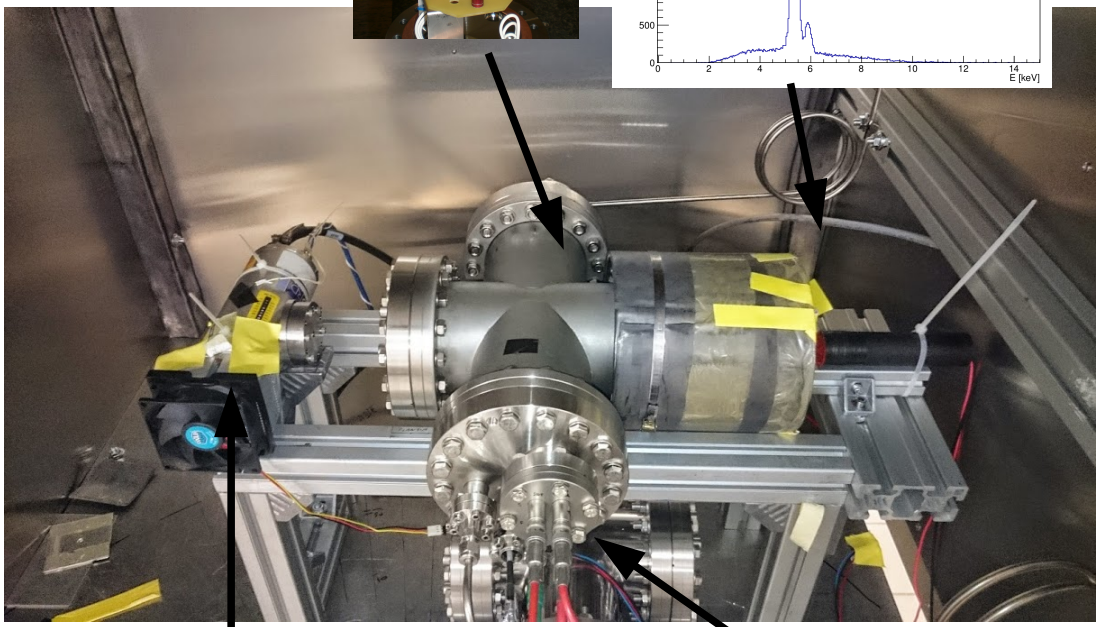
- Measurable quantity: gain loss
- **Accelerated** laboratory test with intense sources
- Gain monitored from anodic current

$$\mathcal{R} = -\frac{1}{G_0}\frac{\mathrm{d}\,G}{\mathrm{d}\,Q}\left(\frac{\%}{\mathrm{C/cm}}\right)$$

Test Chamber

X-ray tube

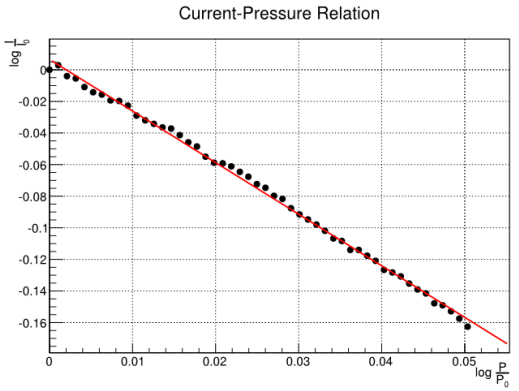




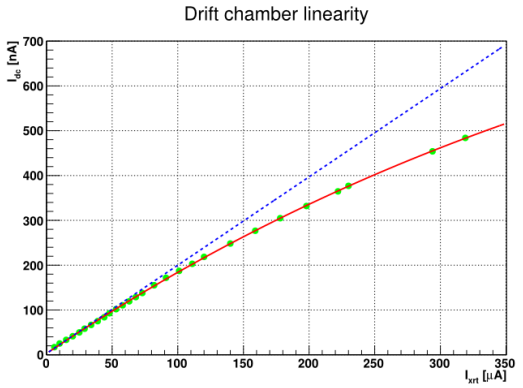
X-ray monitor

Readout to pAmmeter
Keithley 2635A

Gas gain varies with temperature and saturation, potentially mimicking ageing effects



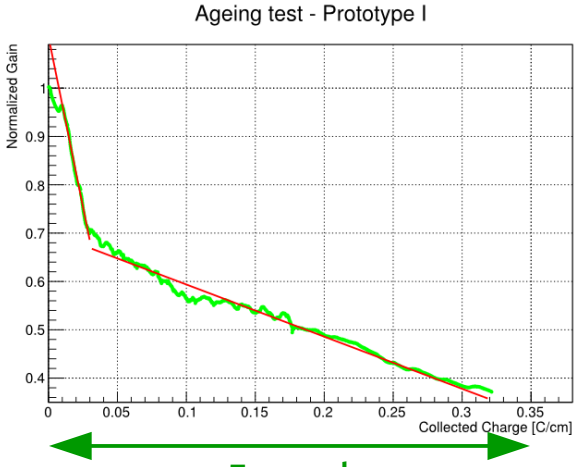
$$\left(\frac{G'}{G}\right) = \left(\frac{T'}{T}\right)_P^{\alpha} = \left(\frac{P'}{P}\right)_T^{-\alpha}$$



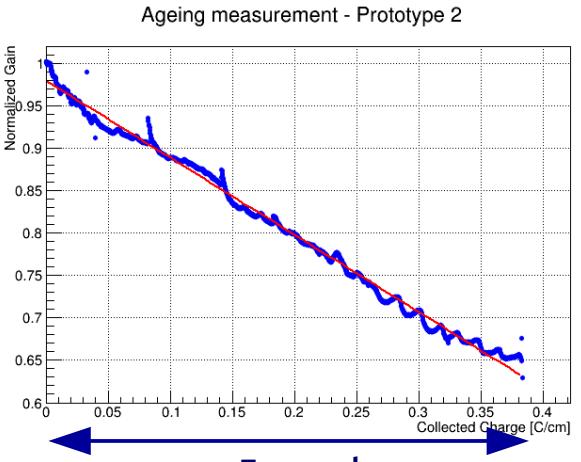
$$I = RG\,e^{-kRG}$$

Ageing test Results

Two tests were performed on single-cell prototypes.

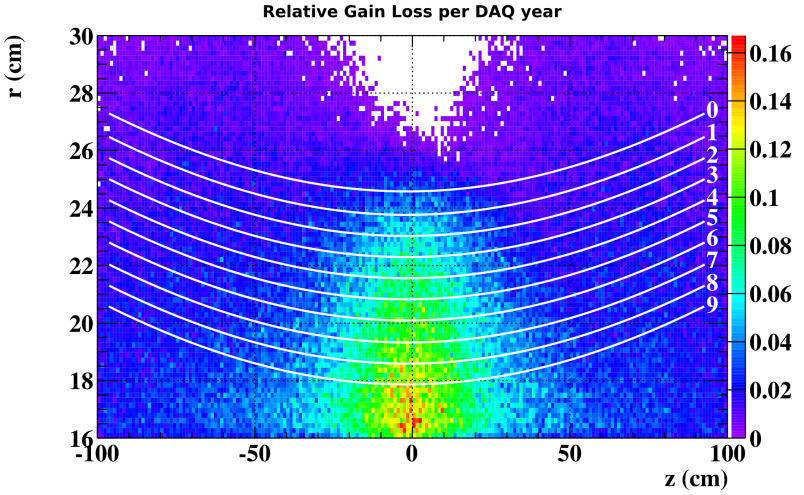


$$\mathcal{R} = 108 \pm 1\,\%/\,(\mathrm{C/cm})$$



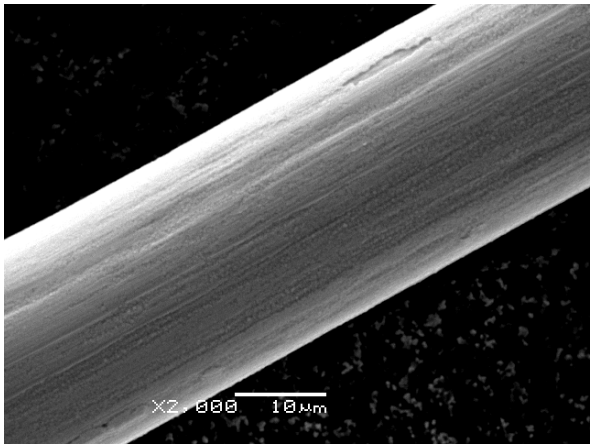
$$\mathcal{R} = 90.9 \pm 0.3\%/(\mathrm{C/cm})$$

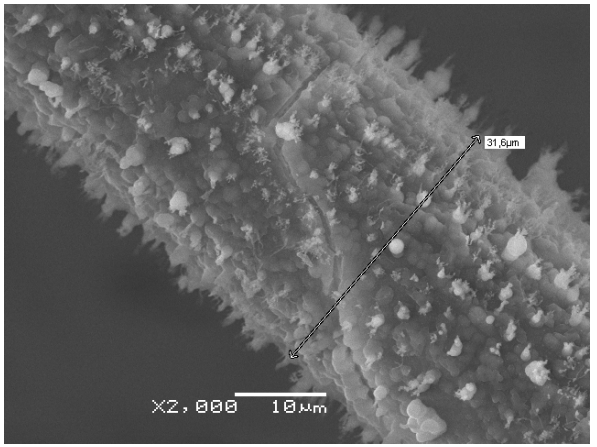
The measured ageing rates predict a **16% gain loss/year** in the hottest region of the chamber

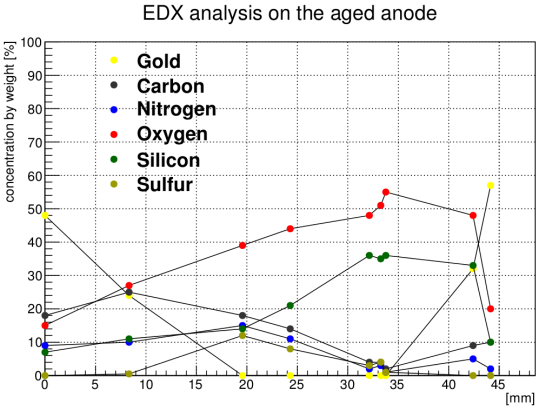


Microscopy of Aged Wires

Aged wires were analyzed at the SEM/EDX facilities @ INFN Lecce and Pisa

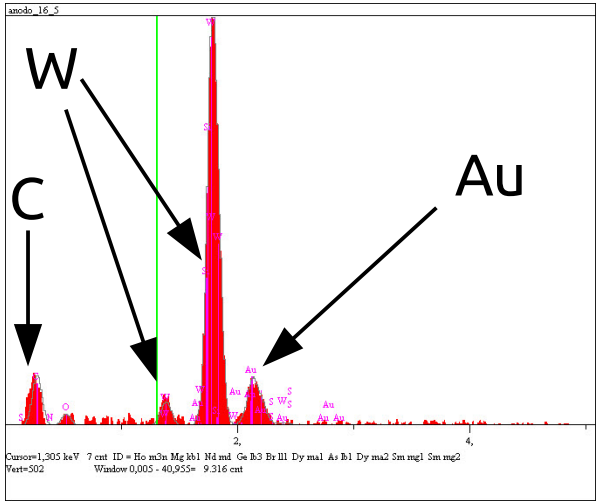






EDX analysis shows a coated area of ~3 cm.

Non irradiated area



Irradiated area