CYGNO General Meeting

11/09/25

Summary of the Joint Meeting

- Before the summer we had a meeting to discuss main plans and topics for the collaboration activities: https://agenda.infn.it/event/47642/

- Minutes can be found here: https://docs.google.com/document/d/1OF6gugFuB_6Iz605qAQzUWh6dUqobk_2P0oil13NUx8/edit?usp=sharing

- Short summary in the next slides

Summary of the Joint Meeting

Advertising and Dissemination

- be more present in the DRD1 activities (meetings, workshops, test beams)
- have seminars in the other Universities and Laboratories
- Organise an Optical Readout Workshop?

Analysis

- RUN3, after September 2023, useful for ER studies with the Ba, Eu and Am sources;
- RUN5 useful for AmBe;
- RUN4 is our benchmark for background model (MC-Data comparison) and DM sensitivity studies;
- RUN5 useful for Neutron Flux and gain configuration studies;
- PMTs? Can we have association between spots and waveforms?

Summary of the Joint Meeting

Simulation

- Simulate and digitise:
  - Ba, Eu, Am and Kr sources
  - Ambe in RUN3;
  - RUN4 for background model and DM sensitivity studies;
  - RUN5 for AmBe and neutron flux;
- Produce a large sample of digitised data with different effective gains to reproduce response variations of RUN4 and RUN5 (Digi4 and Digi5): https://agenda.infn.it/event/48137/

Summary of the Joint Meeting

Test and R&D

- Study the saturation with oxyded GEM by acquiring the also the charge
- Measure the diffusion effect and z reconstruction from point spread function
- Gas system. Test to be done
  - Gas leakage in the different sub-sections;
  - Is the pump leaking or sucking air
  - Study the radon origin: bottles, filters, leakages

Summary of the Joint Meeting

CYGNO04

- We should plan the person power needed for the test, assembly and commissioning of the different CYGNO04 components;

- As soon as vessel and inner detector arrive (October) and up to “mission accomplished”, testing, assembling and commissioning CYGNO04, will have to be the main activities for the collaboration and we’ll have to be careful not to have any interferences;

Saturation paper

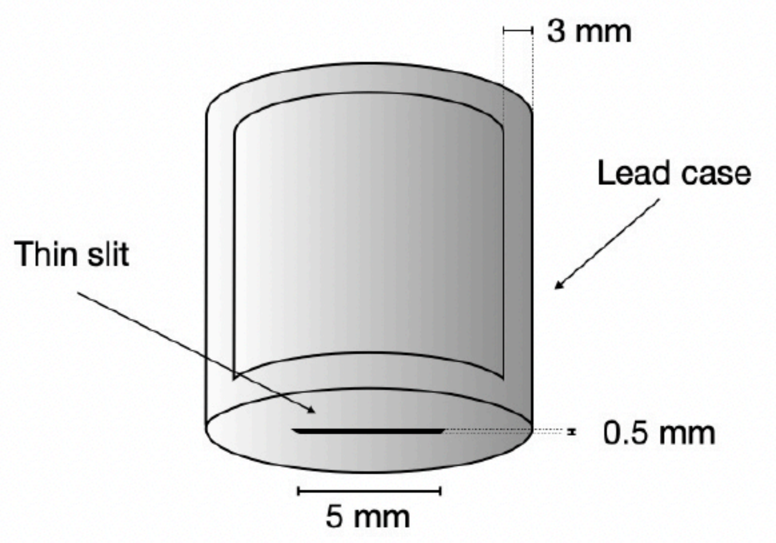
The Saturation paper had to be revised

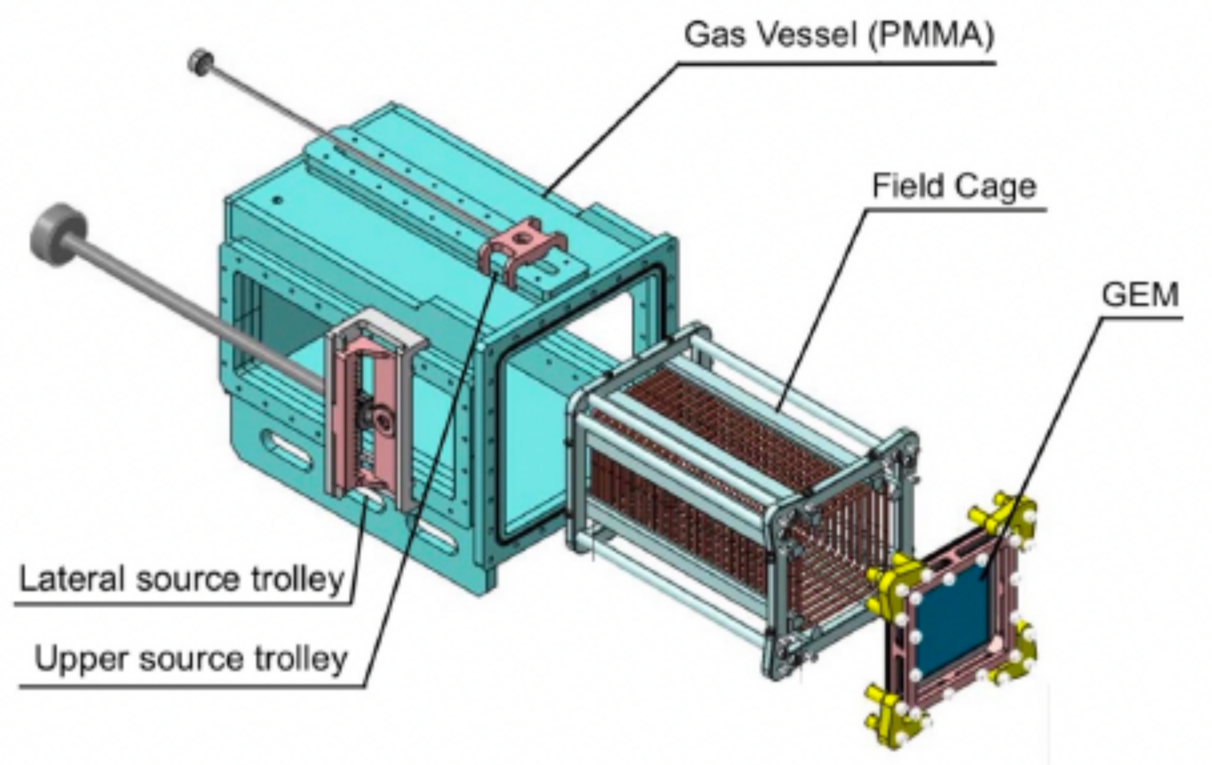
- Figures to describe source collimation and movement

- Explicit the dependence of Townsend coefficient on E and change equations accordingly

$$\alpha(E) = \tilde{\alpha} \cdot (E - E_{min})$$

where $\tilde{\alpha}$ has the dimension of the inverse of an electrical potential and E_{min} represents the minimum electric field needed to start a multiplication process. The Townsend equation, in presence of the screening effect of the ions during the multiplication process, would then become:





$$\frac{dn}{ds} = \tilde{\alpha} \cdot (E_{\text{GEM}}(1 - \beta n) - E_{min})n$$

By integrating this equation, inside the GEM channel:

$$\int_{n_{in}}^{n_{out}} \frac{dn}{(E_{\text{GEM}}(1 - \beta n) - E_{min})n} = \int_0^d \tilde{\alpha} ds \qquad (9)$$

we can obtain the formula to evaluate the gain of a GEM channel $G = n_{out}/n_{in}$ with a voltage drop V_{GEM}:

$$G = \frac{ce^{\tilde{\alpha} V_{\text{GEM}}}}{1 + \beta' n_{in}(ce^{\tilde{\alpha} V_{\text{GEM}}} - 1)}. \qquad (10)$$

where:

- $c = e^{-\tilde{\alpha} V_{min}}$ being $V_{min} = E_{min}/d$ the minimum potential drop to be applied to the GEM to have a multiplication in the channel;
- a new parameter β' is introduced $\beta' = (\beta V_{\text{GEM}})/(V_{\text{GEM}} - V_{min}) = r/(V_{\text{GEM}} - V_{min})$ which shows that the relevant electrical potential is the difference between V_{GEM} and V_{min}

Saturation paper

- take into account the GEM extraction and collection efficiencies

indicate with $\epsilon_i = \epsilon_i^{coll} \cdot \epsilon_i^{extr}$ the product of these efficiencies. Since electrons are not extracted from GEM_3, the relevant parameter in that case is $\epsilon_3 = \epsilon_3^{coll}$.

$$G_{tot} = \epsilon_1 G_1 \cdot \epsilon_2 G_2 \cdot \epsilon_3 G_3 = \quad (12)$$

$$= \epsilon \cdot \tilde{G}_1 \cdot \tilde{G}_1 \cdot G_3 = \quad (13)$$

$$= \frac{\epsilon G^3}{1 + \epsilon(p/\sigma^3(V_{\mathrm{GEM}} - V_{min})G^2(G-1)} \quad (14)$$

$$= \frac{G^3\sigma^3}{\sigma^3/\epsilon + (p/(V_{\mathrm{GEM}} - V_{min})G^2(G-1)} \quad (15)$$

where the parameter p accounts for r and k and $\epsilon = \epsilon_1 \cdot \epsilon_2 \cdot \epsilon_3$

The values of the parameters calculated from the fit are described below:

$\alpha = (2.05 \pm 0.02) \times 10^{-2}\mathrm{V}^{-1}$,
$c = (1.6 \pm 0.1) \times 10^{-2}$,
$p = (2.0 \pm 0.2) \times 10^4\ \mu\mathrm{m}^3\mathrm{V}$,
$\epsilon = 0.38 \pm 0.06$

The value of α obtained from this study is in reasonable agreement with results found in other experimental studies by CYGNO collaboration [46]. From c a value of $V_{min} = 200\pm\ 10\,\mathrm{V}$ can be determined that is in good agreement with literature values [13].

These parameters also allow for the evaluation of the no-saturated gains ($\tilde{G}$) for the tested V_{GEM} values:

$\tilde{G}(\mathrm{V_{GEM}} = 440\mathrm{V}) = 135 \pm 12$
$\tilde{G}(\mathrm{V_{GEM}} = 430\mathrm{V}) = 105 \pm 10$
$\tilde{G}(\mathrm{V_{GEM}} = 420\mathrm{V}) = 90 \pm 8$