CYGNO - Meeting

News

General schedule

Lab	Detector	Test	Oct-20	Nov-20	Dec-20	Jan-21	Feb-21	Mar-21
RM1	ORANGE	Hydrocarbon						
LNF	LEMOn	Luminescence/Saturation						
	LIME	Palazzi						
		KFC						
		Install Bandellas (if needed)						
		55Fe + AmBe + 137Cs						
		Migdal+Ar						
COIMBRA		Hydrocarbon						
GSSI	MANGO	Luminescence						
		GEM thickness						
		Fluoromethanes						
		AmBe/Ba						

LIME Internal box is back but we need copper bars and frames to install it;

LNF Cesidio is trying to fine a workaround workshop while we wait for the final ones;

Tests: New Saturation Measurements taken today, next week we hope to conclude luminesce studies;

Papers

Prepared for submission to JINST

First evidence of luminescence in a He/CF_4 gas mixture induced by non-ionizing electrons

E. Baracchini,[1,2] L. Benussi,[3] S. Bianco,[3] C. Capoccia,[3] M. Caponero,[3,4] G. Cavoto,[5,6] A. Cortez,[1,2] I. A. Costa,[5] E. Di Marco,[5] G. D'Imperio,[5] G. Dho,[1,2] F. Iacoangeli,[5] G. Maccarrone,[3] M. Marafini,[5,7] G. Mazzitelli,[3] A. Messina,[5,6] A. Orlandi,[3] E. Paoletti,[3] L. Passamonti,[3] F. Petrucci,[8,9] D. Piccolo,[3] D. Pierluigi,[3] D. Pinci,[5] F. Renga,[5] F. Rosatelli,[3] A. Russo,[3] G. Saviano,[3,10] and S. Tomassini[3]

[1] *Gran Sasso Science Institute, L'Aquila, I-67100, Italy*
[2] *Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali del Gran Sasso, Assergi, Italy*
[3] *Istituto Nazionale di Fisica Nucleare , Laboratori Nazionali di Frascati, I-00044, Italy*
[4] *ENEA Centro Ricerche Frascati, Frascati, Italy*
[5] *Istituto Nazionale di Fisica Nucleare, Sezione di Roma, I-00185, Italy*
[6] *Dipartimento di Fisica Sapienza Università di Roma, I-00185, Italy*
[7] *Museo Storico della Fisica e Centro Studi e Ricerche "Enrico Fermi", Piazza del Viminale 1, Roma, I-00184, Italy*
[8] *Dipartimento di Matematica e Fisica, Università Roma TRE, Roma, Italy*
[9] *Istituto Nazionale di Fisica Nucleare, Sezione di Roma TRE, Roma, Italy*
[10] *Dipartimento di Ingegneria Chimica, Materiali e Ambiente, Sapienza Univ*

E-mail: davide.pinci@roma1.infn.it

Abstract:

Optical readout of Gas Electron Multipliers (GEM) provides ve
and has been proposed for different applications in particle physics. In

ACCEPTED

Prepared for submission to JINST

A density-based clustering algorithm for the CYGNO data analysis

E. Baracchini,[a,b] L. Benussi,[c] S. Bianco,[c] C. Capoccia,[c] M. Caponero,[c,d] G. Cavoto,[e,f] A. Cortez,[e,b] I. A. Costa,[g] E. Di Marco,[c] G. D'Imperio,[c] G. Dho,[e,b] F. Iacoangeli,[c] G. Maccarrone,[c] M. Marafini,[e,h] G. Mazzitelli,[c] A. Messina,[e,f] R. A. Nobrega,[g] A. Orlandi,[c] E. Paoletti,[c] L. Passamonti,[c] F. Petrucci,[i,j] D. Piccolo,[c] D. Pierluigi,[c] D. Pinci[e] F. Renga,[e] F. Rosatelli,[c] A. Russo,[c] G. Saviano,[c,k] and S. Tomassini[c]

[a] *Gran Sasso Science Institute, L'Aquila, I-67100, Italy*
[b] *Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali del Gran Sasso, Assergi, Italy*
[c] *Istituto Nazionale di Fisica Nucleare , Laboratori Nazionali di Frascati, I-00044, Italy*
[d] *ENEA Centro Ricerche Frascati, Frascati, Italy*
[e] *Istituto Nazionale di Fisica Nucleare, Sezione di Roma, I-00185, Italy*
[f] *Dipartimento di Fisica Sapienza Università di Roma, I-00185, Italy*
[g] *Universidade Federal de Juiz de Fora, Juiz de Fora, Brasil*
[h] *Museo Storico della Fisica e Centro Studi e Ricerche "Enrico Fermi",*

Roma TRE, Roma, Italy
Roma TRE, Roma, Italy
Ambiente, Sapienza Università di Roma, Roma, Italy

working in combination with Gas Electron Multipli-
capable of detecting low energy events by capturing
ultiplication process by means of a high-resolution
ecently developed a TPC-Triple GEM detector cou-
CMOS sensor. For the image analysis, an algorithm
DBSCAN was implemented. In this paper a descrip-
m will be given, including test and validation of its
ed algorithm known as Nearest Neighbor Clustering
ersion of DBSCAN is capable of providing full sig-
resolution while improving the detector background

Prepared for submission to JINST

Stability and detection performance of a GEM-based Optical Readout TPC with He/CF_4 based gas mixtures

E. Baracchini,[a,b] L. Benussi,[c] S. Bianco,[c] C. Capoccia,[c] M. Caponero,[c,d] G. Cavoto,[e,f] A. Cortez,[e,b] I. A. Costa,[g] E. Di Marco,[c] G. D'Imperio,[c] G. Dho,[e,b] F. Iacoangeli,[c] G. Maccarrone,[c] M. Marafini,[e,h] G. Mazzitelli,[c] A. Messina,[e,f] R. A. Nobrega,[g] A. Orlandi,[c] E. Paoletti,[c] L. Passamonti,[c] F. Petrucci,[i,j] D. Piccolo,[c] D. Pierluigi,[c] D. Pinci,[e,l] F. Renga,[e] F. G. Saviano,[i,k] and S. Tomassini[c]

itute,

ica Nucleare,
l Gran Sasso, Assergi, Italy
ica Nucleare ,
Frascati, I-00044, Italy
Frascati, Frascati, Italy
ica Nucleare,
5, Italy
Sapienza Università di Roma, I-00185, Italy
- Juiz de Fora, Juiz de Fora, Brasil
ca e Centro Studi e Ricerche "Enrico Fermi",
oma, I-00184, Italy
atica e Fisica, Università Roma TRE, Roma, Italy
ica Nucleare, Sezione di Roma TRE, Roma, Italy
ria Chimica, Materiali e Ambiente, Sapienza Università di Roma, Roma, Italy

i@roma1.infn.it

rmance and long term stability of an optically readout Time Projection
iron amplification structure based on three Gas Electron Multipliers was
gas mixtures were used in two different proportions (60/40 and 70/30) in
th 7 litre sensitive volume. With electrical configurations providing very
n almost full detection efficiency in the whole detector volume was found
e a light yields almost 20% larger for the 60/40 was found. The electrostatic
onitoring voltages and currents for 25 days. The detector worked in very
on for the whole period. Anyway, in the presence of less CF_4, a larger
vents was clearly detected.

Identification of nuclear recoils in a gas TPC with optical readout

E Baracchini[1,2], L Benussi[3], S Bianco[3], C Capoccia[3], M Caponero[3,4], G Cavoto[5,6], A Cortez[1,2], I A. Costa[7], E Di Marco[5], G D'Imperio[5], G Dho[1,2], F Iacoangeli[5], G Maccarrone[3], M Marafini[5,8], G Mazzitelli[3], A Messina[5,6], R A. Nobrega[7], A Orlandi[3], E Paoletti[3], L Passamonti[3], F Petrucci[9,10], D Piccolo[3], D Pierluigi[3], D Pinci[5], F Renga[5], F Rosatelli[3], A Russo[3], G Saviano[3,11] and S Tomassini[3]

[1] Gran Sasso Science Institute, L'Aquila, I-67100, Italy
[2] Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali del Gran Sasso, Assergi, Italy
[3] Istituto Nazionale di Fisica Nucleare , Laboratori Nazionali di Frascati, I-00044, Italy
[4] ENEA Centro Ricerche Frascati, Frascati, Italy
[5] Istituto Nazionale di Fisica Nucleare, Sezione di Roma, I-00185, Italy
[6] Dipartimento di Fisica Sapienza Università di Roma, I-00185, Italy
[7] Universidade Federal de Juiz de Fora, Juiz de Fora, Brasil
[8] Museo Storico della Fisica e Centro Studi e Ricerche "Enrico Fermi", Piazza del Viminale 1, Roma, I-00184, Italy
[9] Dipartimento di Matematica e Fisica, Università Roma TRE, Roma, Italy
[10] Istituto Nazionale di Fisica Nucleare, Sezione di Roma TRE, Roma, Italy
[11] Dipartimento di Ingegneria Chimica, Materiali e Ambiente, Sapienza Università di Roma, Roma, Italy

E-mail: emanuele.di.marco@roma1.infn.it

May 2020

Abstract. The search for a novel technology able to detect and reconstruct nuclear recoil events in the keV energy range has become more and more important as long as vast regions of high mass WIMP-like Dark Matter candidate have been excluded. Gaseous Time Projection Chambers (TPC) with optical readout are very promising candidate combining the complete event information provided by the TPC technique to the high sensitivity and granularity of last generation scientific light sensors. A TPC with an amplification at the anode obtained with Gas Electron Multipliers (GEM) was tested at the Laboratori Nazionali di Frascati. Photons and neutrons from radioactive sources we employed to induce recoiling nuclei and el rons with kinetic energy in

A GEM-based Optically Readout Time Projection Chamber for charged particle tracking

V. C. Antochi,[1,a] G. Cavoto,[1,b] I. A. Costa,[1,c] E. Di Marco,[1] G. D'Imperio,[1] F. Iacoangeli,[1] M. Marafini,[1,d] A. Messina,[1,b] D. Pinci,[1] F. Renga,[1] C. Voena,[1] E. Baracchini,[2] A. Cortez,[2] G. Dho,[2,e] L. Benussi,[3] S. Bianco,[3] C. Capoccia,[3] M. Caponero,[3,f] G. Maccarrone,[3] G. Mazzitelli,[3] A. Orlandi,[3] E. Paoletti,[3] L. Passamonti,[3] D Piccolo,[3] D Pierluigi,[3] F. Rosatelli,[3] A. Russo,[3] G. Saviano,[3,g] S Tomassini,[3] R. A. Nobrega,[4] and F Petrucci[5,b]

[1] *Istituto Nazionale di Fisica Nucleare Sezione di Roma, I-00185, Italy*
[2] *Gran Sasso Science Institute L'Aquila, I-67100, Italy*
[3] *Istituto Nazionale di Fisica Nucleare Laboratori Nazionali di Frascati, I-00040, Italy*
[4] *Universidade Federal de Juiz de Fora, Juiz de Fora, MG, 36000-000, Brazil*
[5] *Dipartimento di Matematica e Fisica, Università Roma TRE, Roma, I-00146, Italy*

(Dated: 6 May 2020)

MOVED TO NIM-A

on the amplification of the ionization in Micro Pattern Gas Detector (MPGD) producing visible light collected by a sub-millimeter position resolution sCMOS (scientific CMOS) camera. This type of readout - in conjunction with a fast light detection - allows a 3D reconstruction of the tracks, a sensitivity to the track direction and a very promising particle identification capability useful to distinguish DM nuclear recoils from a γ-induced background.

Large Time Projection Chambers (TPC) have various applications in high energy physics and nuclear physics. These detectors are among the best in offering good charged particle energy resolution and to allow the identification of the particle's mass. This can be obtained along with a very good performance in tracking the particle's trajectory with competitive spatial resolution. The study of such a technology for ultra-rare events searches as the directional search of Dark Matter[1–3] (DM) and the detection of neutrinos coming from the Sun (SN)[4,5] is currently being pursued by several groups, which are part of the CYGNUS[6] international network[7],

A longer term project for tens of m^3 volume TPC requires the construction of 1 m^3 demonstrators. In this paper we describe the performance of a smaller 7 litres prototype (named LEMOn) in tracking ultra-relativistic electrons. LEMOn is based on Micro Pattern Gaseous Detectors (MPGD), namely a large triple Gas Electron Multiplier (GEM)[8], optically read-out by means of a low noise and high granularity sCMOS sensor[9,10],

Many smaller scale prototypes have been tested so far showing promising results to design the CYGNO 1 m^3 demonstrator to be constructed in 2020-2021 and to be hosted at the INFN National Laboratory of Gran Sasso (LNGS). In a later phase, a 30-100 m^3 detector is foreseen, as a brick of a world distributed observatory for DM and SN within the CYGNUS international network.

I. INTRODUCTION

The purpose of the current R&D phase is to asses the performance of a relatively large TPC based on the drift of the ionization electrons within a He-based gas mixture operated at atmospheric pressure and equipped with a high granularity and high sensitivity optical readout of GEMs. In this respect the test of the LEMOn prototype with ultra-relativistic electrons presented here is meant to study the capability of the optically readout TPC to detect and to reconstruct within the TPC drift region the positions of clusters with few ionization electrons each. The pattern of contiguous clusters represents the "track" of the ultra-relativistic electron trajectory and are exploited to identify it, demonstrating that LEMOn would also be an excellent beam monitoring device.

In absence of a reference time for the events, electron drift time can not be exploited to extract information about their depth inside the detector. In this paper, we study a method to measure the longitudinal position of an ionizing particle in the TPC drift volume based on the electron diffusion and there-

[a] Also at Dipartimento di Fisica Sapienza Università di Roma, I-00185, Italy now at Oskar Klein Centre, Department of Physics, Stockholm University, AlbaNova, Stockholm SE-10691, Sweden
[b] Also at Dipartimento di Fisica Sapienza Università di Roma, I-00185, Italy
[c] Also at Universidade Federal de Juiz de Fora, Juiz de Fora, MG, Brazil
[d] Also at Museo Storico della Fisica e Centro Studi e Ricerche "Enrico Fermi" Piazza del Viminale 1, Roma, I-00184, Italy
[e] Also at Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali del Gran Sasso, Assergi, I-67100, Italy
[f] Also at ENEA Centro Ricerche Frascati, Frascati, I-00044, Italy
[g] Also at Dipartimento di Ingegneria Chimica, Materiali e Ambiente, Sapienza Università di Roma, Roma, I-00185, Italy
[h] Also at Istituto Nazionale di Fisica Nucleare, Sezione di Roma TRE, Roma, I-00146, Italy

The CYGNO Experiment

PROPOSED FOR A SPECIAL ISSUE OF MDPI

[1] *Dipartimento di Fisica Sapienza Università di Roma, I-00185*
[2] *Universidade Federal de Juiz de Fora, Juiz de Fora, Br*
[3] *Museo Storico della Fisica e Centro Studi e Ricerche "Er Piazza del Viminale 1, Roma, I-00184, Ita*
[4] *Dipartimento di Matematica e Fisica, Università Rom*
[5] *Istituto Nazionale di Fisica Nucleare, Sezione di Ro*
[6] *Dipartimento di Ingegneria Chimica, Materiali e Ambient Roma, Italy*

Abstract

The search for a novel techno re-
coil events in the keVene ant as
long as vast regions of have been
excluded. Gaseou ical readout are
very promisin mation provided by
TPC tech ast generation scientific
light optical readout) is an exper-
ir he low mass region, exploiting
readout approach of multiple-GEM

Special Issue "Innovative Experimental Techniques for Direct Dark Matter Detection"

Saturation on GEM-3

Karolina Kmieć and Francesco Renga

INFN Sezione di Roma

April 21, 2020

1 Measurements of saturation

The saturation effect have been studied looking at the trends of the currents on GEM-2 and GEM-3 (I_2 and I_3, respectively) as a function of the high voltage applied on GEM-1 (HV_1). Changing HV_1 simulates indeed the effect on GEM-2 and GEM-3 of different energy deposits inside the chamber.

The chamber was exposed to a ^{55}Fe source and the current through the HV_4 bias circuit was measured. Since the bias circuit and the current readout introduce a 25 MΩ resistance in the supply line, and currents up to a few μA are observed in GEM-3, there can be a relevant voltage drop (up to several volts) from the power supply to the GEM. We compensated on the fly for this voltage drop by increasing the set voltage according to the drop predicted by

DRAFTING

ch-
in was
re ing
up from GEM-3 when it is on. GEM-2 is always kept at 460 V.

The measurements on GEM-3 have been always performed with a collimator in front of ^{55}Fe source, in order to not have an excessive current through the HV_3 bias circuit, that would have made unsafely large the necessary voltage compensation. Measurements on GEM-2 have been performed both with and without the collimator. In Fig. 1 we show the trends of I_2 versus HV_1. Since the measurements without collimator are affected by large relative errors, we will use the measurements without collimator in the following, but

Why don't we start writing a paper on signal simulations and comparison with experimental ones?