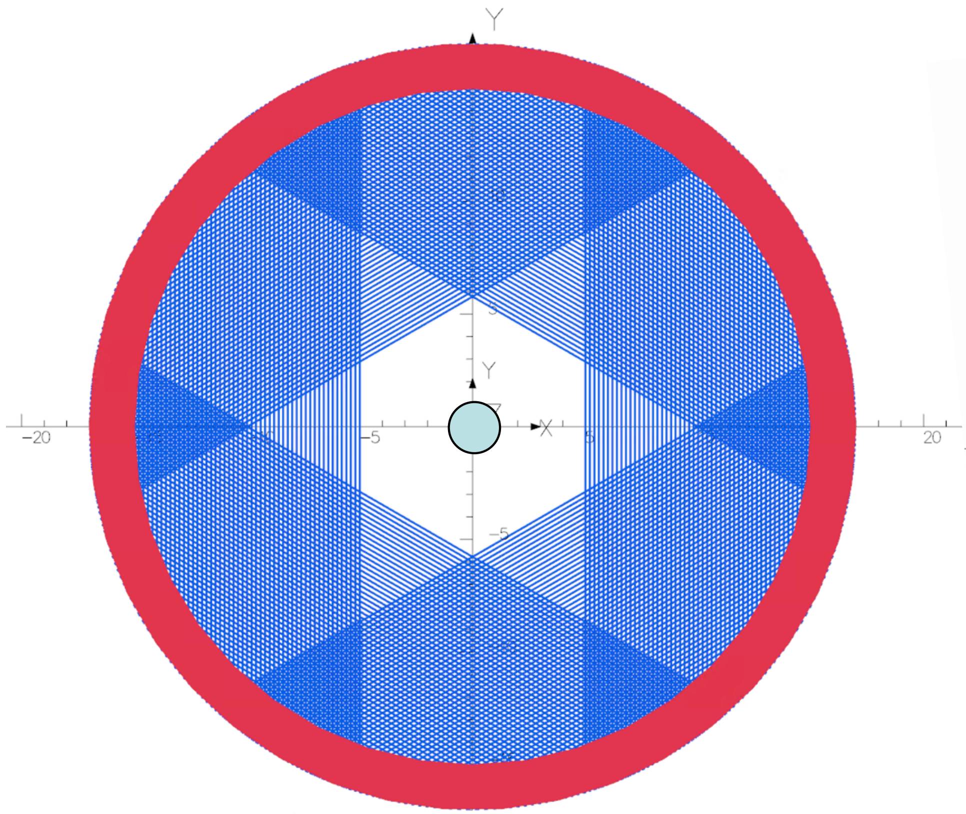
# Multi-Layer-Proportional Chamber for TDIS

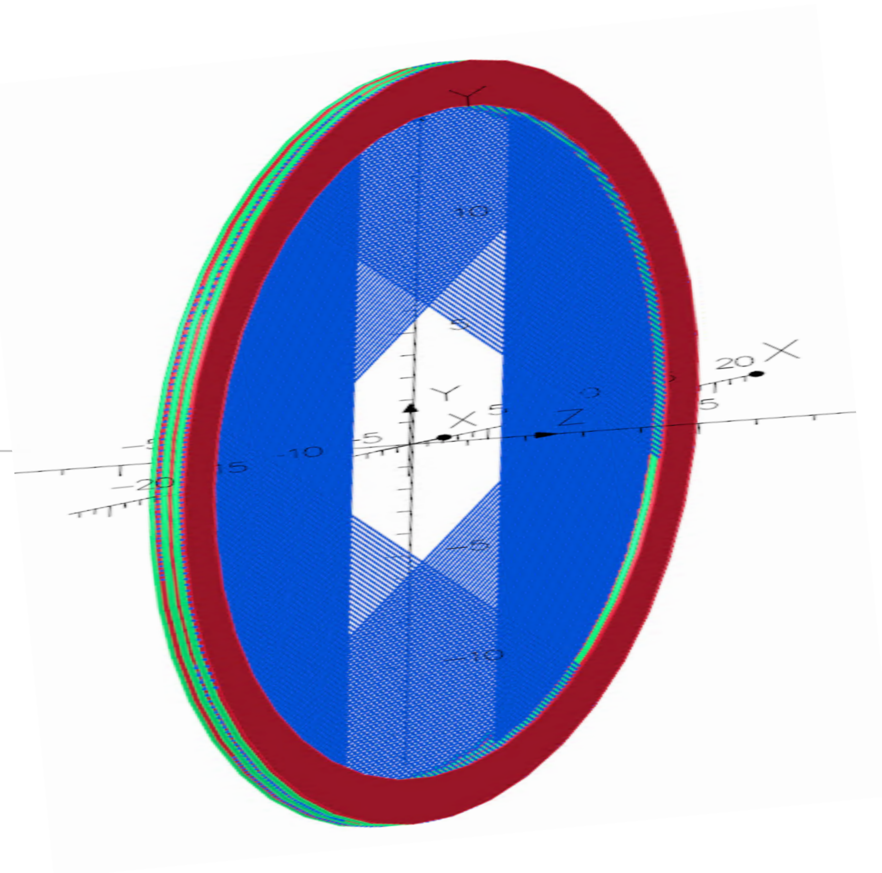
## Motivation and new suggestion

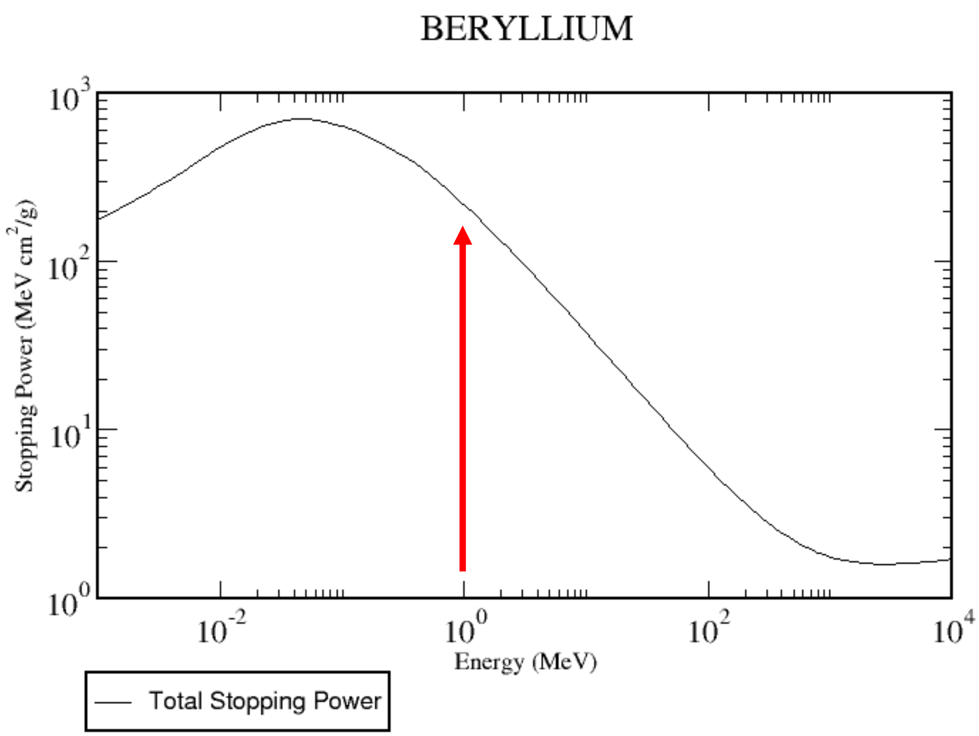
The chain finding efficiency vs track multiplicity for G4SBS tracks is shown in Fig. 16. A multiplicity of 2000 tracks per event corresponds to a singles rate of 1 GHz in the mTPC and has an efficiency of ~68% for useful tracks. A long track in Fig. 16 is a track that produces hits on 4 or more mTPC plane pads. A VIP track is from a proton that has the expected kinematics of a proton from the TDIS process. (i.e. $70 < p < 400$ MeV/c and $30° < \theta < 80°$). As seen from Fig. 16 the efficiency is not strongly rate dependent and the efficiency for VIP tracks is significantly better

After reading that mTPC needs to deal with 2000 tracks per event I come to different scheme of the detector - it is Multi-Layer-Proportional-Chamber, see attached views for three layers. The key is reduction of time per event by a factor of 25+. This will bring the number of tracks per event to < 80 which is much better. Coordinate resolution of 0.1 mm in drift time regime and 0.6 mm just from the wire spacing. The wires will be placed with spacing 2 mm which well developed for proportional chambers, so the drift distance is 1 mm. Wires are made of 10 um diameter golden Be. This gives 0.3-0.5% area with thickness which almost stops 1 MeV proton. Readout system will have 2x50x200 = 20k channels.
Ionization multi-layer chamber (MLIC) was recently made for medical application.

# Multi-Layer-Proportinal-Chamber for TDIS






| | Stopping Power (MeV cm²/g) | | | Range | | |
|---|---|---|---|---|---|---|
| MeV | Electronic | Nuclear | Total | CSDA (g/cm²) | Projected (g/cm²) | Detour Factor Projected / CSDA |
| 1.000E+00 | 2.168E+02 | 1.321E-01 | 2.169E+02 | 2.990E-03 | 2.971E-03 | 0.9937 |
| | | | | | 17 μm | |

# Time resolution and characteristic study of MWPC detectors with different Argon based gas

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**Abstract.** A set of small scale prototypes of Multi-Wire Proportional Chambers (MWPCs) has been fabricated for the study of various characteristics. The detectors have been operated with $Ar/CO_2$ gas mixture having 70:30 and 90:10 ratio. Detector characteristic like efficiency, gain and time resolution have been studied using radioactive sources.

**Keywords:** MWPC, gain, efficiency, time resolution

## 1 Introduction

The development of MWPC by Charpak [1] revolutionized the field of experimental nuclear and high energy physics. It found immense application in medical imaging also [2,3]. In VECC, Kolkata we have developed many small scale prototype of MWPC detector for the characteristic study in terms of its efficiency, gain and time resolution with various gas mixtures.

## 2 Experimental details and the test results

The MWPC detectors contains an anode wire plane in between two conducting planes named as drift plane and the readout plane. The distance of the anode plane is 3 mm from both the drift and readout plane. Anode wire diameter is 20 $\mu$m and wire spacing is 2.8 mm. Details about the detector are given in [4]. The detector is tested using Ar/$CO_2$ gas mixture having 70:30 and 90:10 ratio in flow mode at laboratory temperature and pressure.

### 2.1 Efficiency and gain

The efficiency of the detector is measured with $^{106}$Ru $\beta$-source using a 3-fold trigger setup made up with three scintillator detectors - two crossed scintillators above and one scintillator below the MWPC under study. The efficiency as a function of applied high voltage (HV) is shown in Fig. 1 for both gas mixtures. In the plateau region the efficiency is $\sim$94% in both cases.

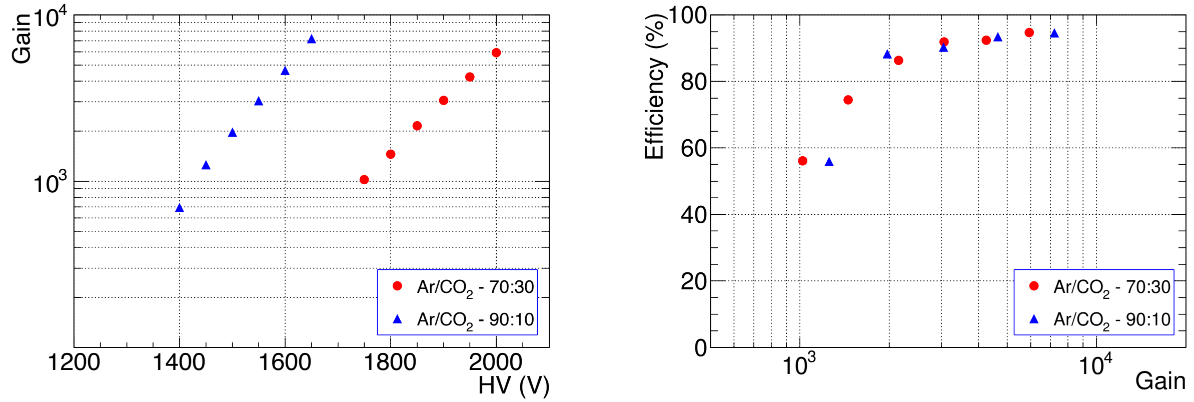


Fig. 3: (a) Gain variation as a function of HV in Ar/$CO_2$ 70:30 and 90:10 gas, (b) Efficiency as a function of gain variation.

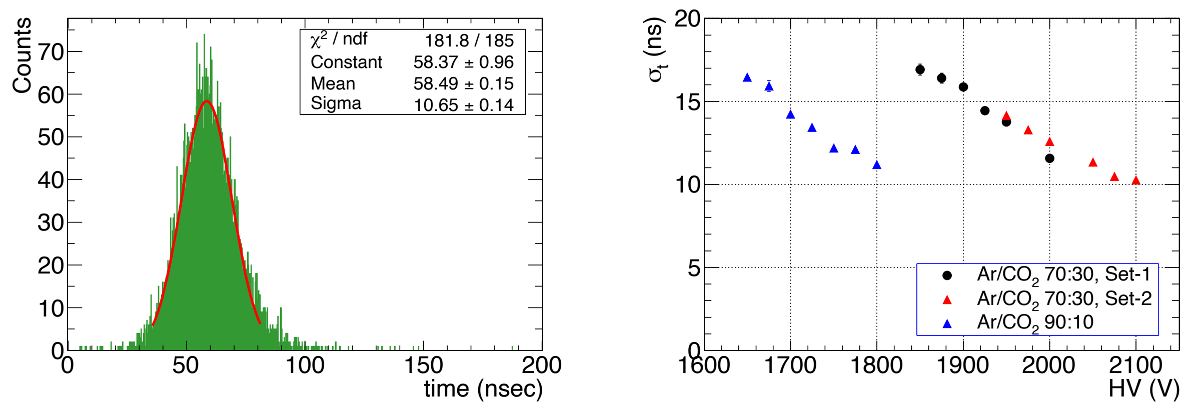


Fig. 4: (a) Time spectrum at 2075 V in Ar/$CO_2$ 70:30 gas, (b) $\sigma_t$ variation as a function of HV.

## 3 Summary

A number of small prototype MWPC detectors has been fabricated and operated with Ar/$CO_2$ 70:30 and 90:10 gas mixtures. The efficiency, charge fraction, gain, timing resolution have been measured using radioactive sources. A comparative study of gain and efficiency has also been performed. Gas gain approaching $10^4$ is achieved for both the gas mixtures. Time resolution of the detector is also measured with different gas mixtures at atmospheric pressure and $\sigma_t$ value of $\sim$10 ns is achieved.

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# PRINCIPLES OF OPERATION OF MULTIWIRE PROPORTIONAL AND DRIFT CHAMBERS

F. Sauli

Lectures given in the
Academic Training Programme of CERN
1975-1976

GENEVA
1977

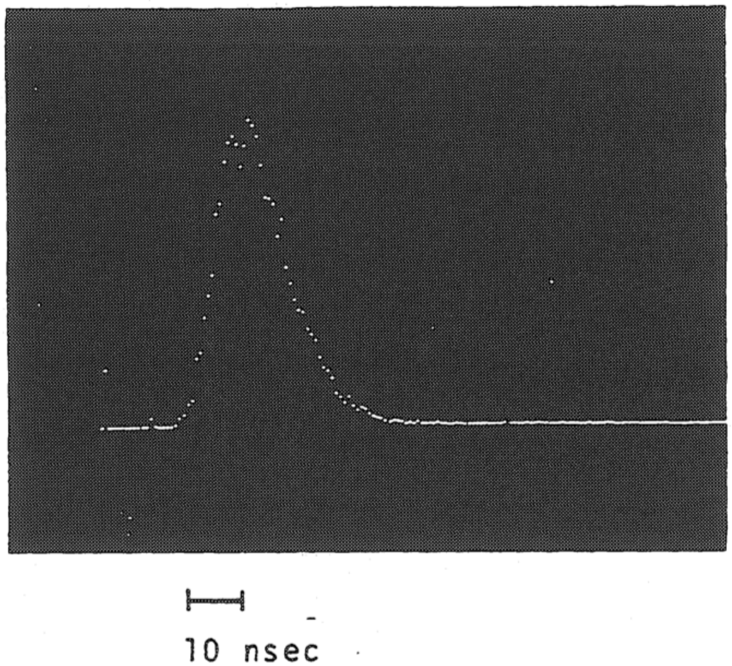



Fig. 67 Typical time distribution measurement in a chamber when all wires are connected together (total OR)

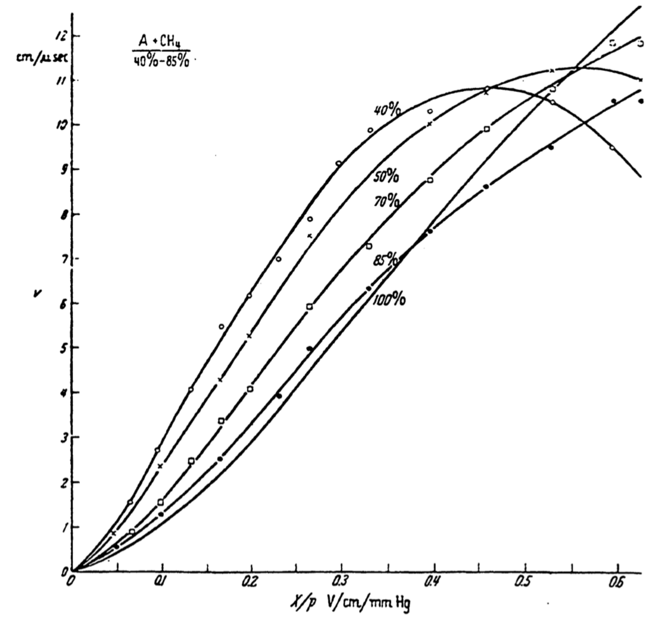



Fig. 28 Drift velocity of electrons in several argon-methane mixtures[12])

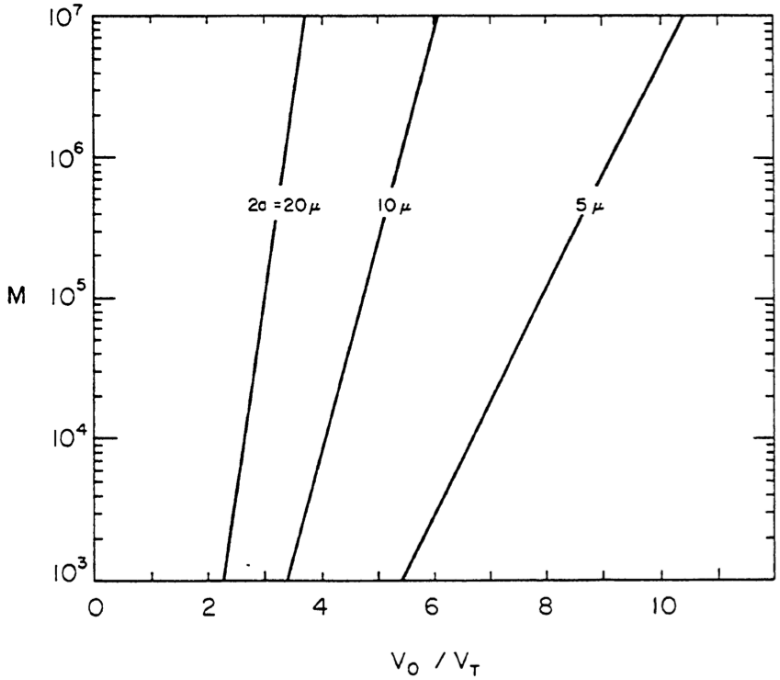
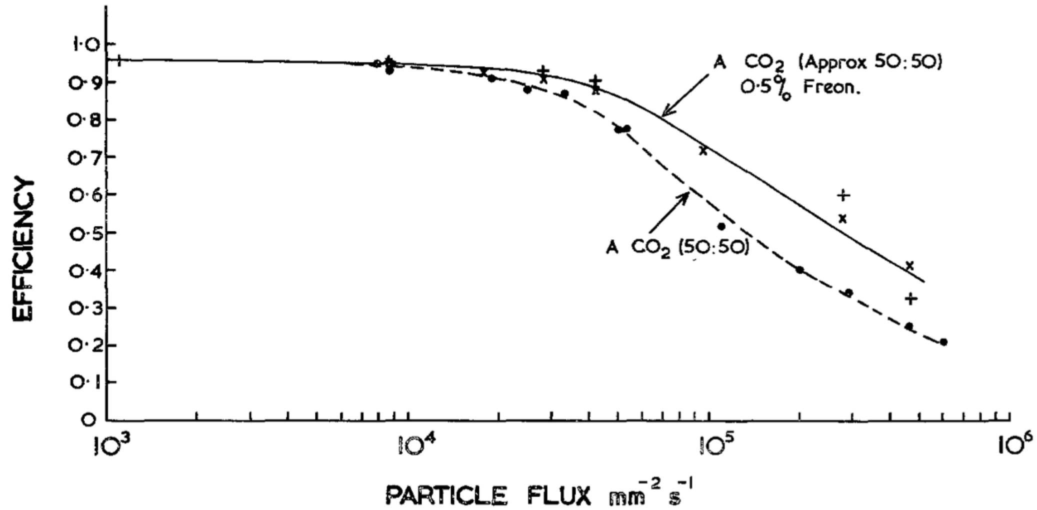



Fig. 59 Dependence of the multiplication factor on the operational voltage, relative to the threshold voltage, in a 2 mm spacing multiwire proportional chamber with several wire diameters [computed from expression (31)].



# Multi-Wire-Prop. Chamber in magnetic field

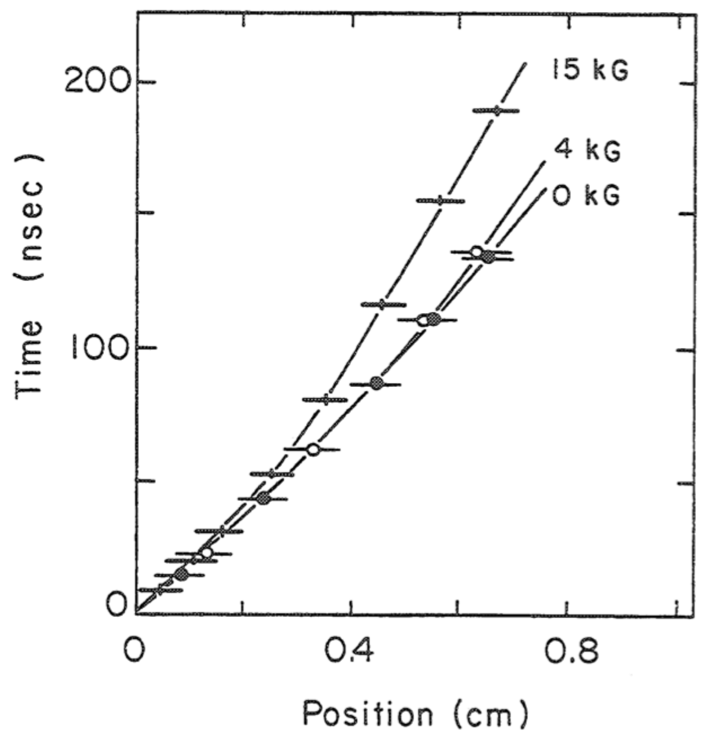



Fig. 97 Computed space-time relationship for normal tracks in the geometry of Fig. 96, at increasing values of the magnetic field[78])

# Multi-Wire-Proportional-Chamber

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A small fine-grain wire chamber was built and tested. The gas mixture of 60% $CF_4$ and 40% isobutane is very fast, and combined with the small drift spaces gave better than a 15 ns (full width at one-tenth maximum) collection time that will minimize wire occupancy. The chamber stability was greatly improved by increasing the operating pressure from the local atmosphere of 586 to 760 Torr. This chamber has shown what is needed to make fast ($< 25$ ns gates including trigger jitter), high rate ($3 \times 10^4$ mm$^{-2}$ s$^{-1}$), low mass ($3 \times 10^{-4}$ radiation lengths), 1-mm wire chambers work. Test results agree well with Monte Carlo predictions of the performance. The test results and Monte Carlo predictions will be used to design large cylindrical chambers for the MEGA experiment.