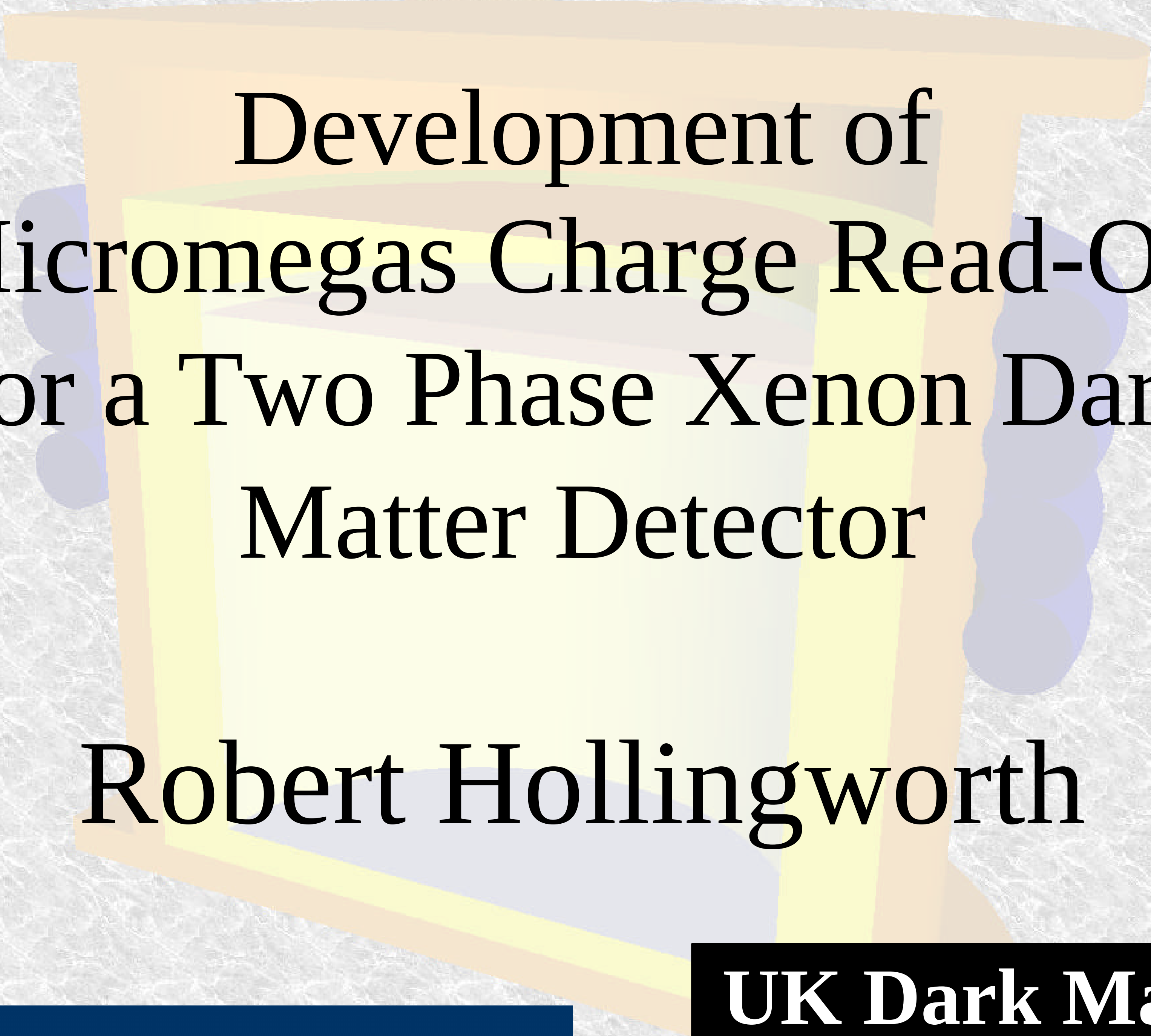

Development of Micromegas Charge Read-Out for a Two Phase Xenon Dark Matter Detector

Robert Hollingworth

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UK Dark Matter Collaboration

Overview

?Dark Matter Background

?Detector Design

?Gas Tests

?Results

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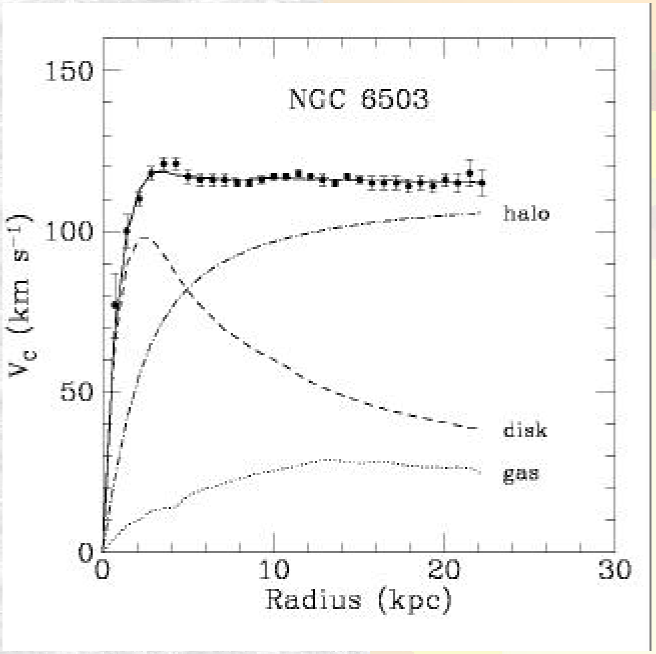
Evidence For Dark Matter?



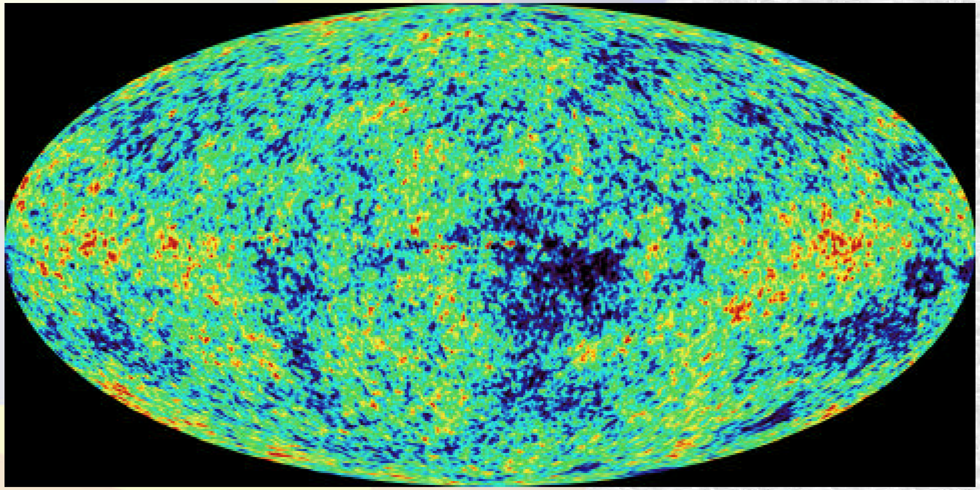
Initial evidence from galactic rotation curves, and the motion of matter on large scales.

Theory: $v \propto 1/\sqrt{r}$

Observed: v const with r.

Recently, WMAP has shown that 23% of the energy density of the universe is in the form of dark matter.

Image courtesy of the WMAP Science Team, http://lambda.gsfc.nasa.gov/product/map/



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WIMP Dark Matter

WIMP stands for: Weakly Interacting Massive Particle.

A promising WIMP candidate is the Lightest Supersymmetric Particle (LSP).

R-parity conserving Supersymmetry, predicts that the LSP will be stable and neutral.

These particles often have the correct mass and abundance to account for Dark Matter.

Direct searches look for predicted elastic scattering from atomic nuclei in detector materials.

Why Use Liquid Xenon?

Low energy threshold.

Heavy nucleus, good as spin independent scattering cross-section is proportional to A^2.

Isotopes with large spin-dependant enhancement factors, good for spin-dependent scattering cross-section.

High radio-purity, and easy to purify

Recoils produce scintillation light and ionisation, conventionally detected by Photo-Multiplier Tubes (PMTs).

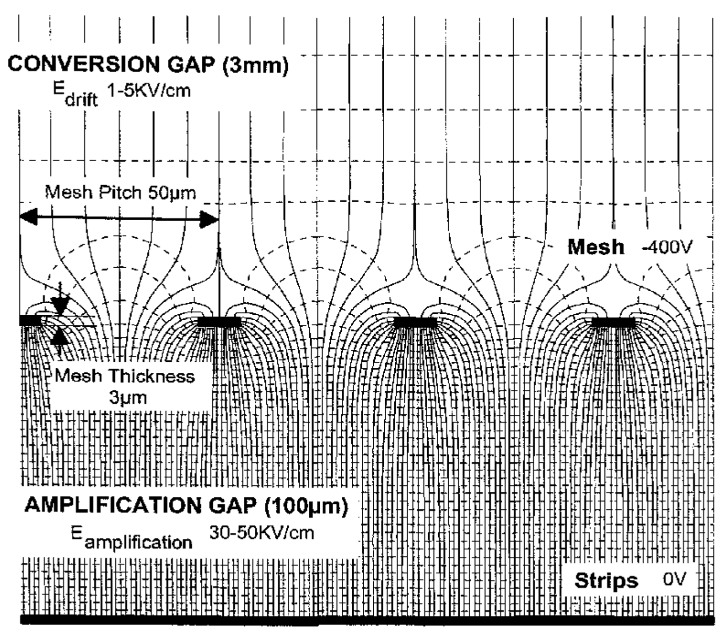
Why Charge Read-Out?

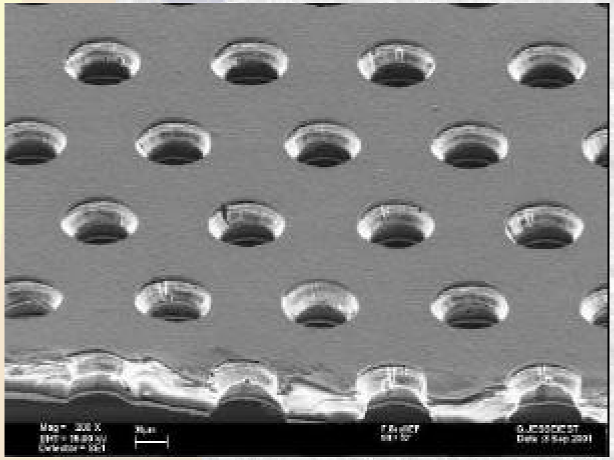
PMTs are bulky, can contain large amounts of radio-impurities, and are expensive.

Charge read-out devices are thin, and thus have low impurity levels, and are cheap.

Since the read-out takes up a small volume, the size of the apparatus that needs cooling is much less.

Charge read-out devices can also be used to cover large areas; making the electronics cheaper.





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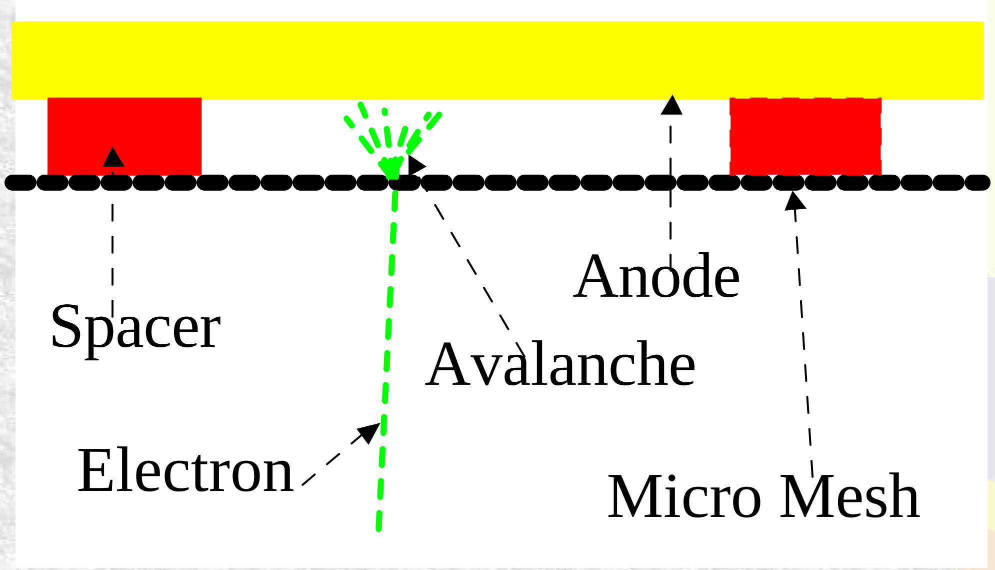
MICROMEGAS

Micromegas stands for : MICRO MEsh GAseous Structure.

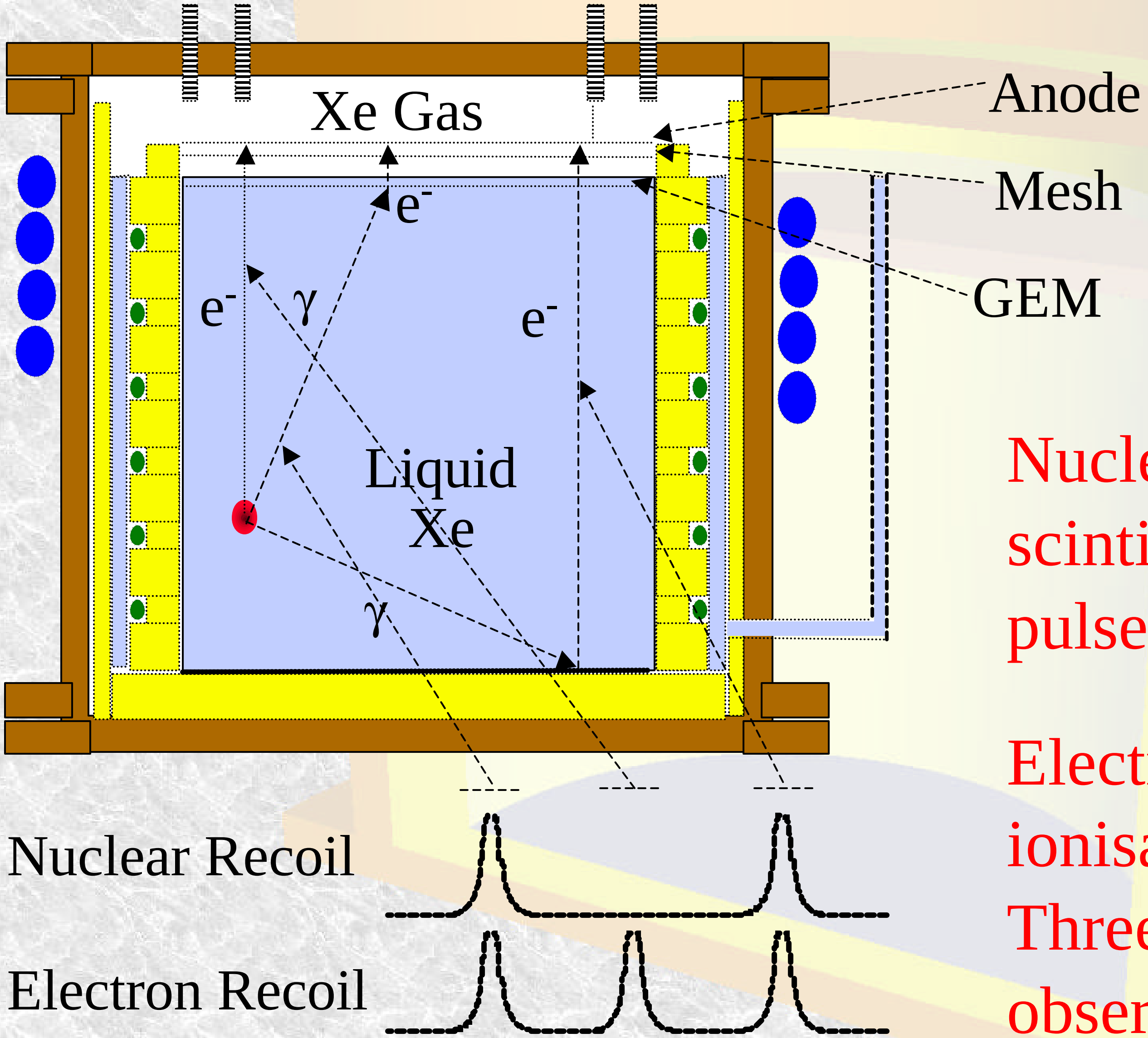
Developed by Giomataris et al.

Consists of a 5µm copper foil, with 25µm holes supported by 50µm high pillars every 2mm.



This system allows the production of high gain electron avalanches, in a small volume.

Detector Design



Rejection of electron recoil background events vital for DM detectors.

Nuclear recoils only cause scintillation. Two anode pulses observed.

Electron recoils cause ionisation and scintillation. Three anode pulses observed.

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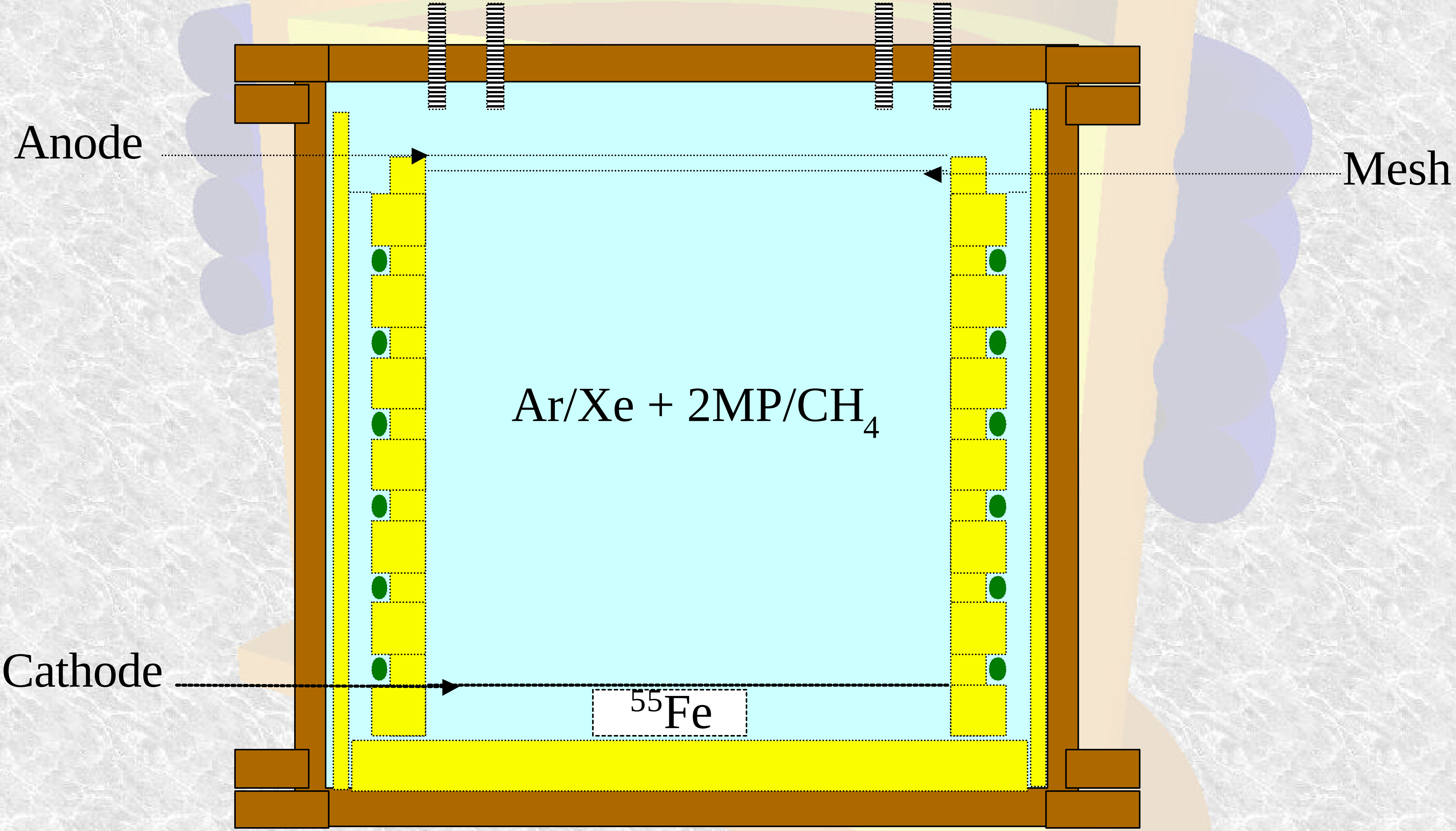
The Test Chamber



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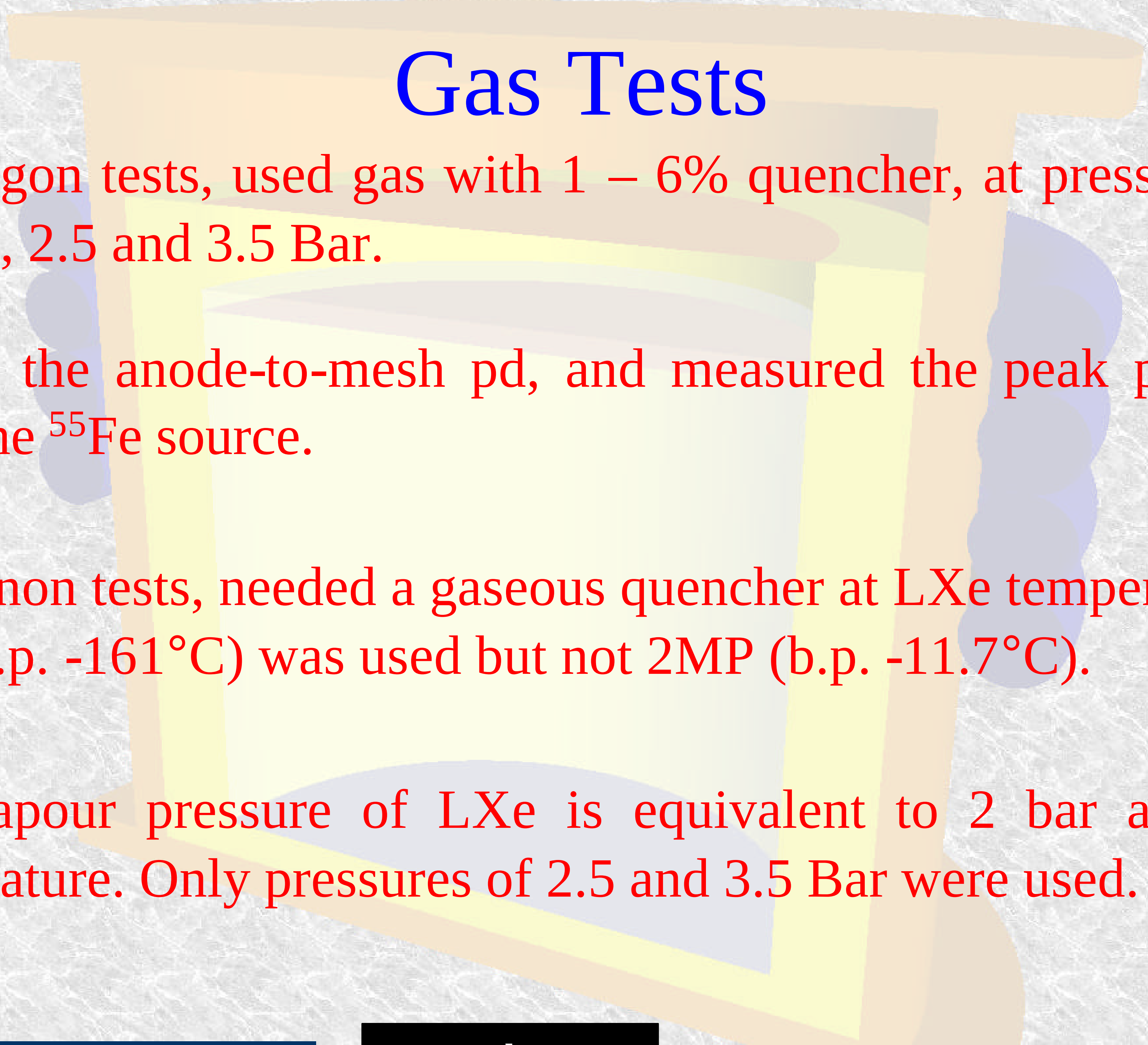
Gas Tests



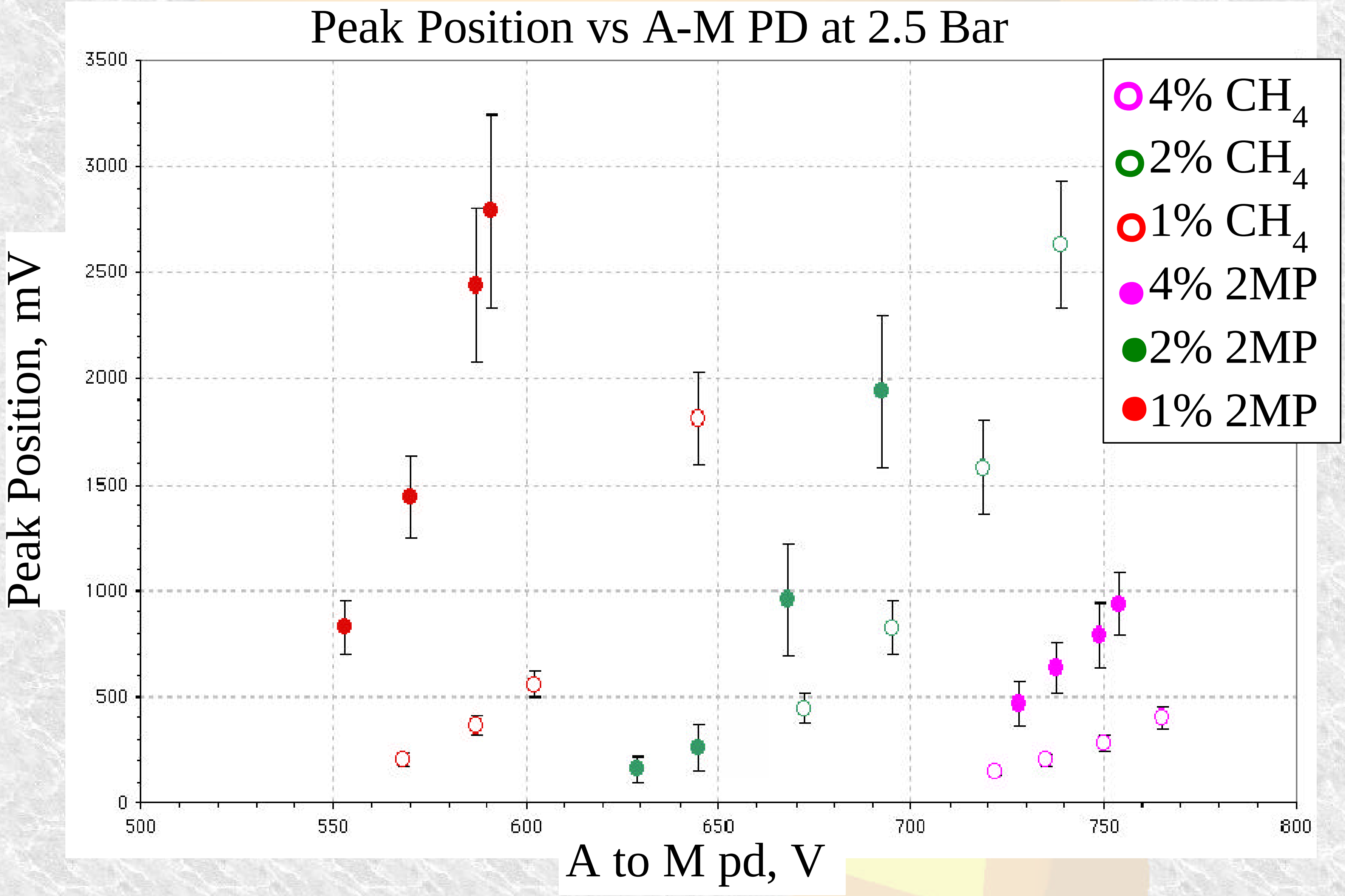
For Argon tests, used gas with 1 – 6% quencher, at pressures of 1, 1.75, 2.5 and 3.5 Bar.

Varied the anode-to-mesh pd, and measured the peak position from the ^{55}Fe source.

For Xenon tests, needed a gaseous quencher at LXe temperatures. CH_4 (b.p. -161°C) was used but not 2MP (b.p. -11.7°C).

The vapour pressure of LXe is equivalent to 2 bar at room temperature. Only pressures of 2.5 and 3.5 Bar were used.

Argon Results



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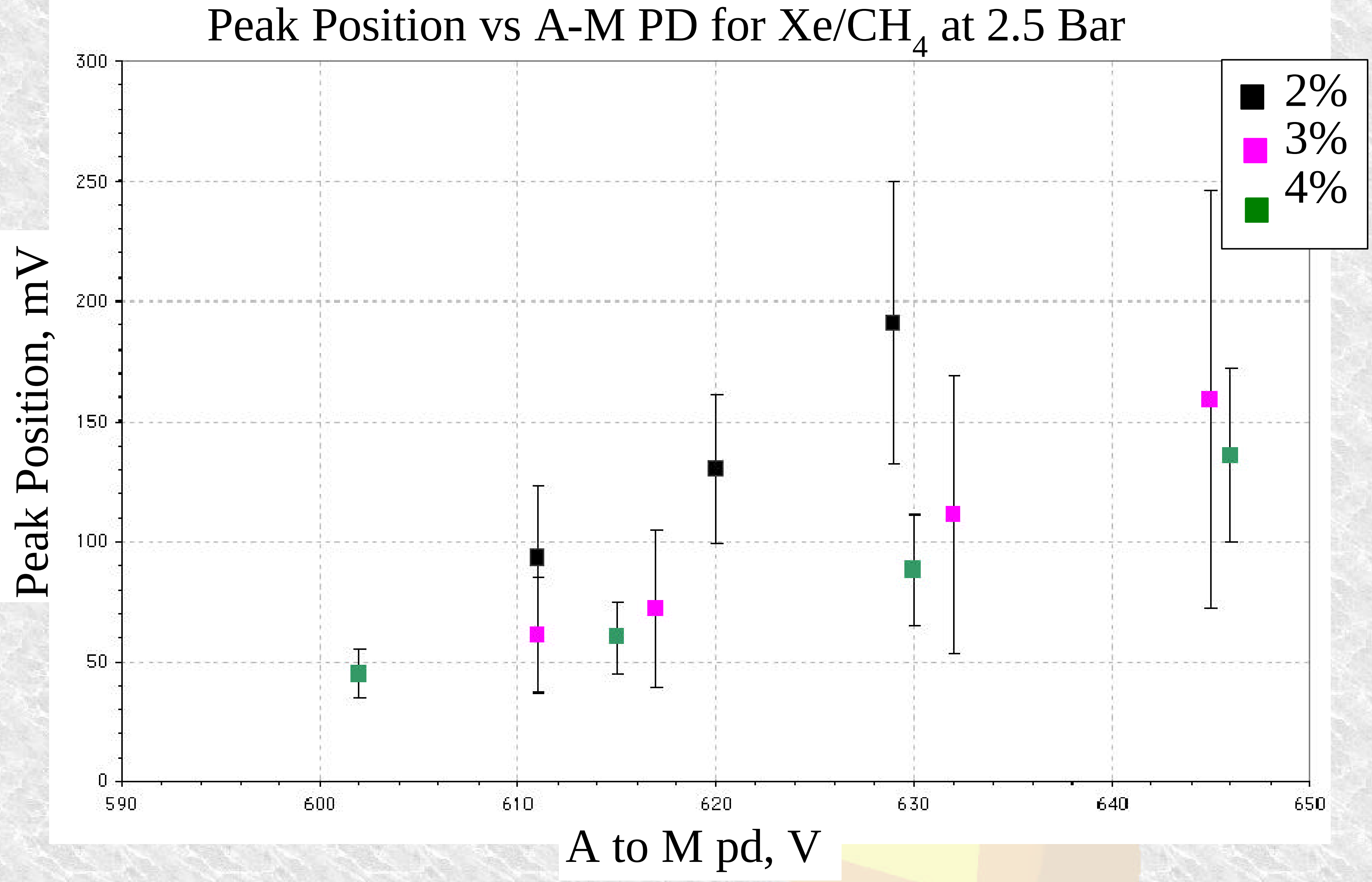
Xenon Results



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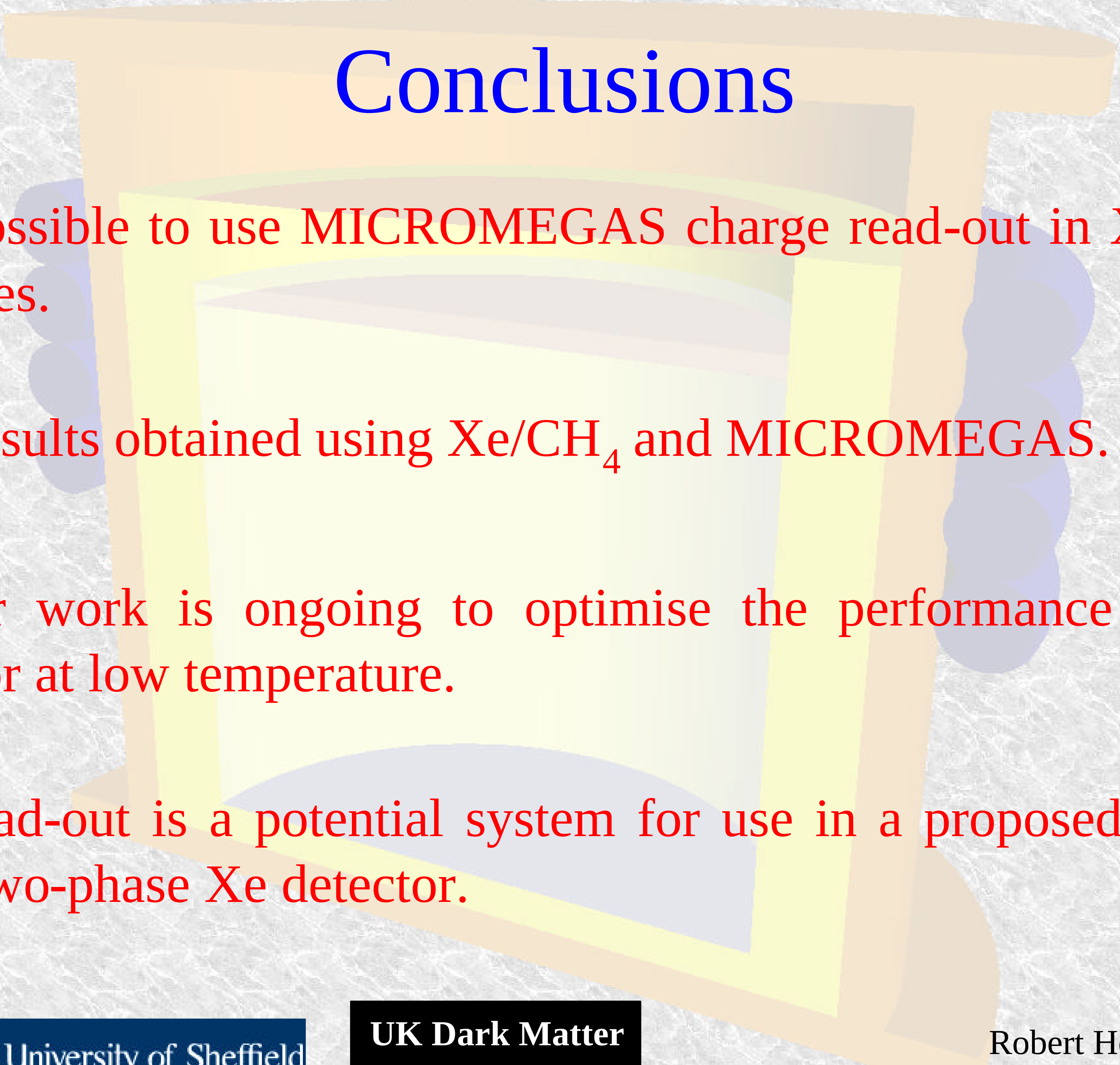
Conclusions



It is possible to use MICROMEGAS charge read-out in Xe/CH_4 mixtures.

First results obtained using Xe/CH_4 and MICROMEGAS.

Further work is ongoing to optimise the performance of the detector at low temperature.

The read-out is a potential system for use in a proposed tonne-scale two-phase Xe detector.