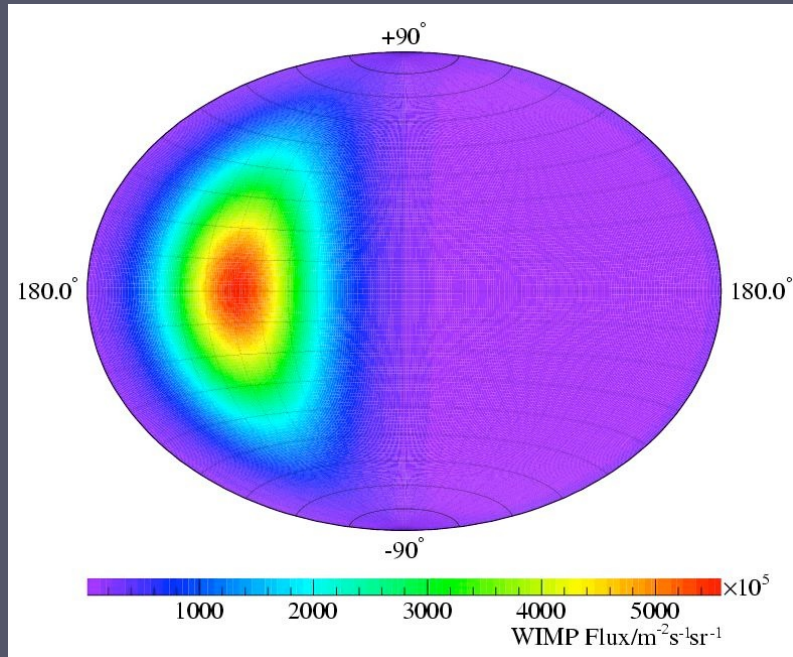


CYGNUS - Sheffield update



- R&D relevant to CYGNUS
- Recent and planned work

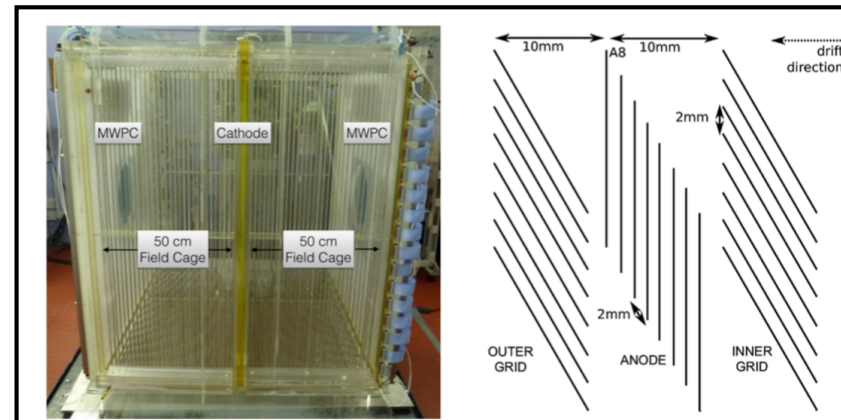
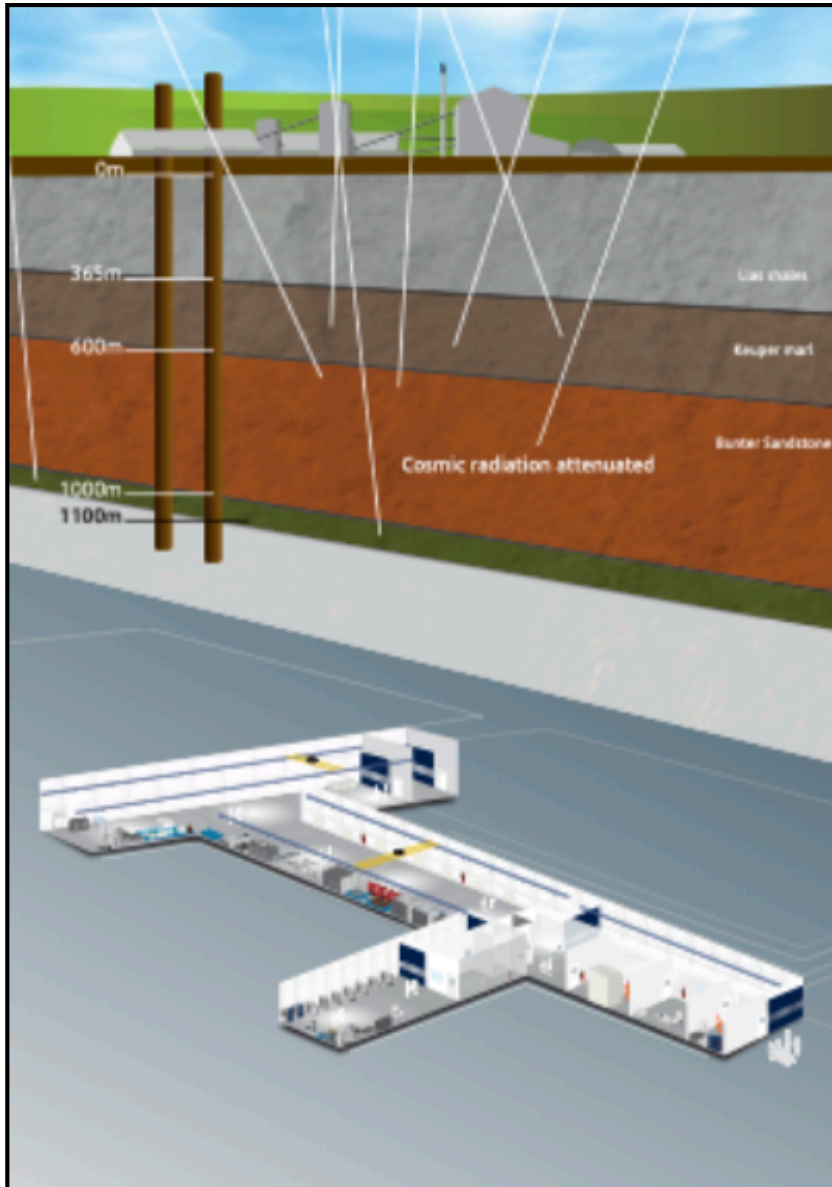
Neil Spooner, University of Sheffield

Group: *Callum Eldridge*, Anthony Ezeribe, Trevor Gamble, **Rob Gregorio**, *Warren Lynch (now York)*, **Ali McClean**, Andrew Scarff



Boulby

DRIFT still operational at Boulby, facilities can be used



DRIFT (at Boulby) Analysis

data analysis using BDT (Warren Lynch)

Journal of Cosmology and Astroparticle Physics 2021(07):014

Improved Sensitivity of the DRIFT-II-d Directional Dark Matter Experiment using Machine Learning

[J.B.R. Battat](#), [C. Eldridge](#), [A.C. Ezeribe](#), [O.P. Gaunt](#), [J.-L. Gauvreau](#), [R.R. Marcelo Gregorio](#), [E.K.K. Habich](#), [K.E. Hall](#), [J.L. Harton](#), [I. Ingabire](#), [R. Lafler](#), [D. Loomba](#), [W.A. Lynch](#), [S.M. Paling](#), [A.Y. Pan](#), [A. Scarff](#), [F.G. Schuckman II](#), [D.P. Snowden-Ifft](#), [N.J.C. Spooner](#), [C. Toth](#), [A.A. Xu](#)

feasibility of improved sensitivity with directional BDT analysis

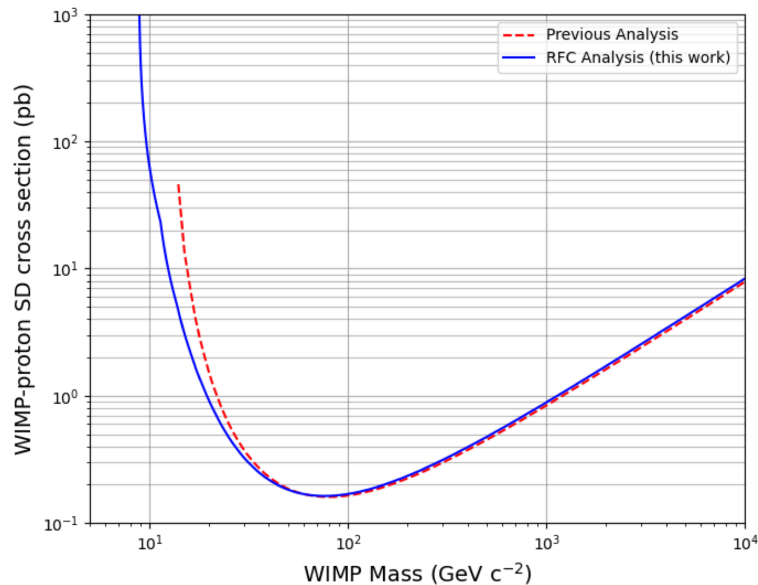


Figure 9. Projected DRIFT-II-d SD WIMP exclusion limits for the previous [5] and RFC analyses, calculated for a hypothetical 100 day exposure using the analysis efficiencies from Figure 7 and the methods and parameters described by ref. [21] and ref. [22].

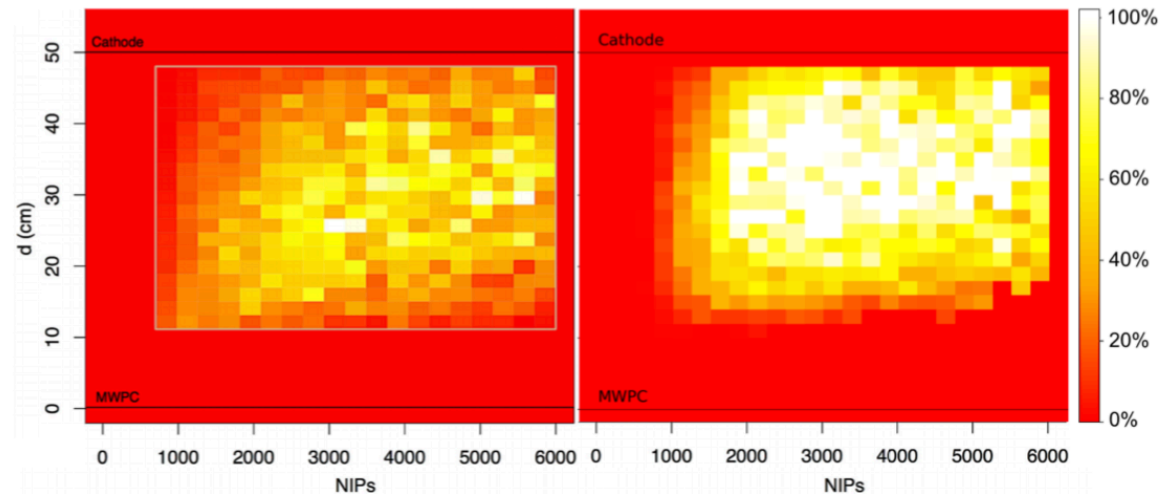
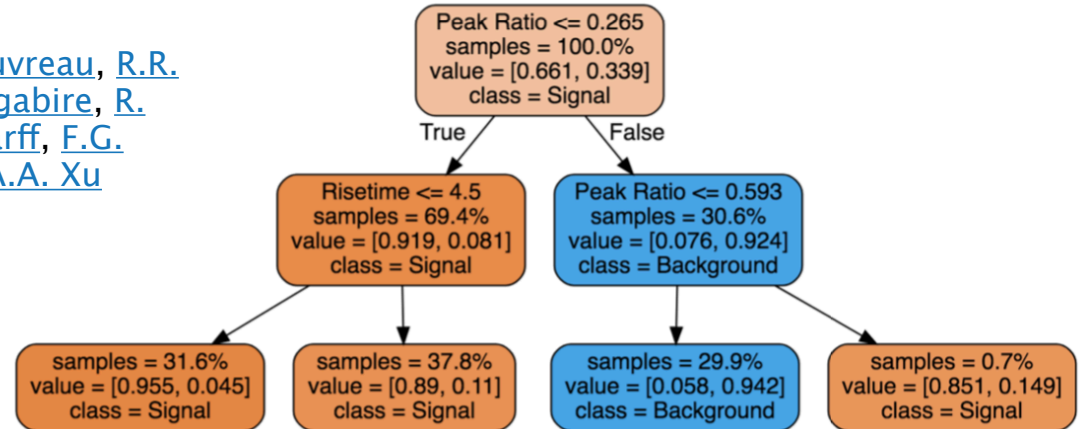


Figure 6: Efficiency maps for the previous (left) and RFC analysis (right). White = 100%, red = 0%. The image on the left was taken from [4].

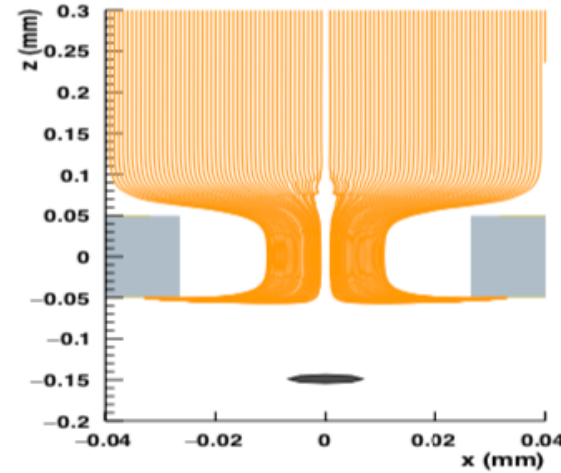
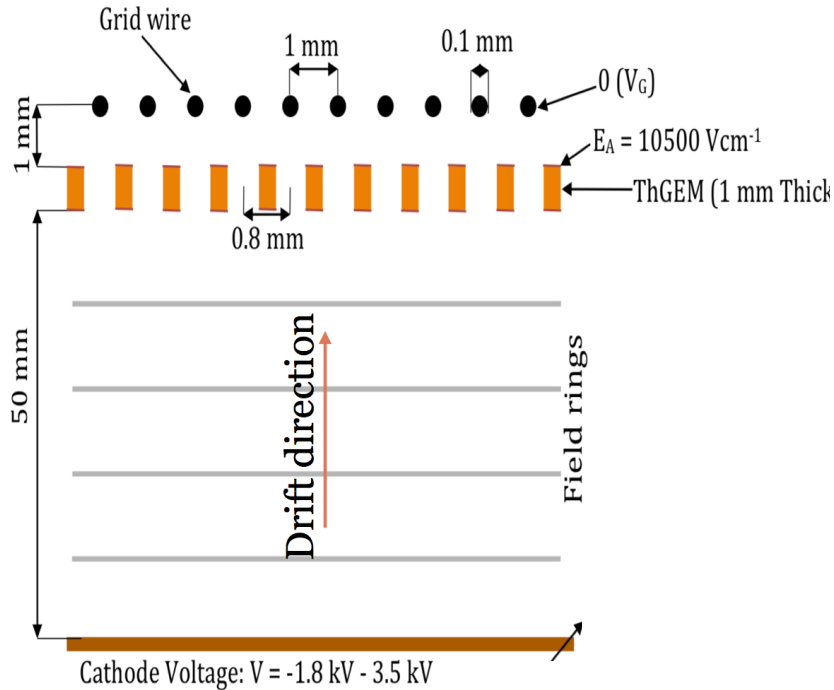
GEM-Wire 2D-HT hybrid Readout

Hybrid wire readouts (Anthony Ezeribe)

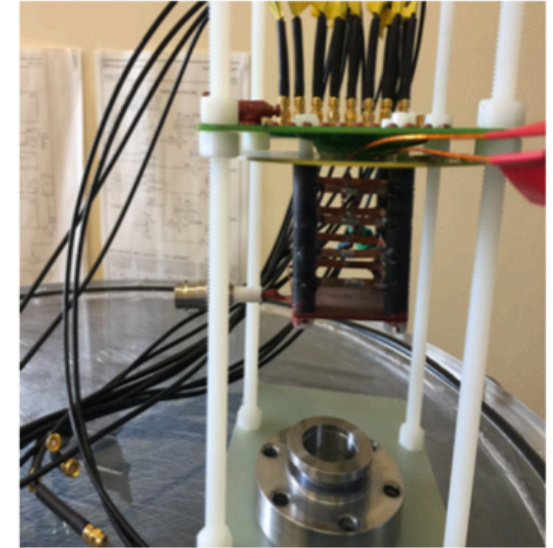
Nucl. Instrum. Meth. A 987 (2021) 164847

Demonstration of ThGEM-multiwire hybrid charge readout for directional dark matter searches

- [A.C. Ezeribe](#)(Sheffield U.), [C. Eldridge](#)(Sheffield U.), [W. Lynch](#)(Sheffield U.), [R.R. Marcelo Gregorio](#)(Sheffield U.), [A. Scarff](#)(Sheffield U.)

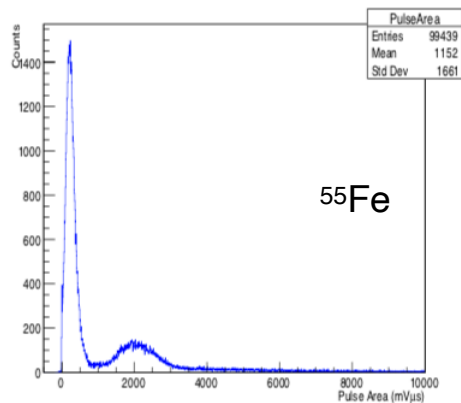


Electric field lines.

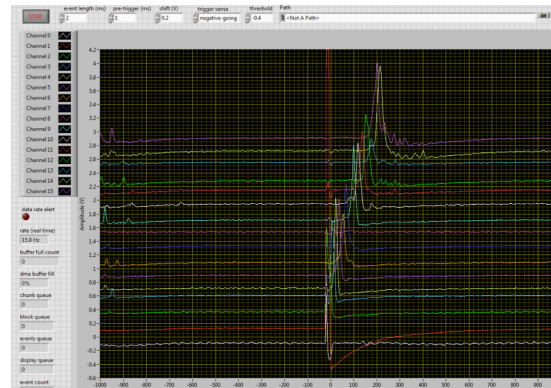


Pictorial view of the detector.

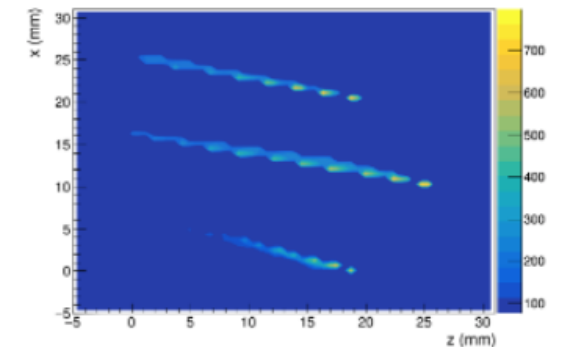
Alpha tracks in 50 Torr SF₆ -ve ion drift, readout by wires (no gain) with ThGEM providing gain stage



Data spectrum from the Fe55 run.

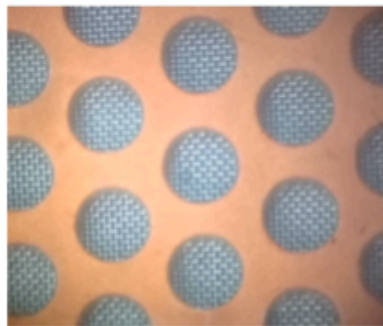
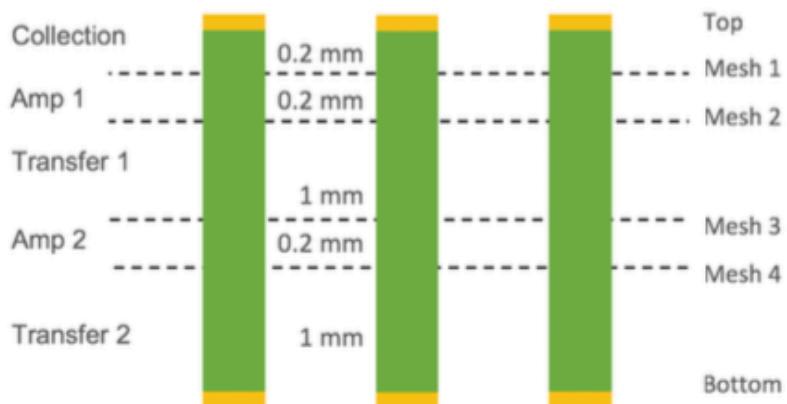


Reconstructed alphas



Micromegas with MM-ThGEM Gain

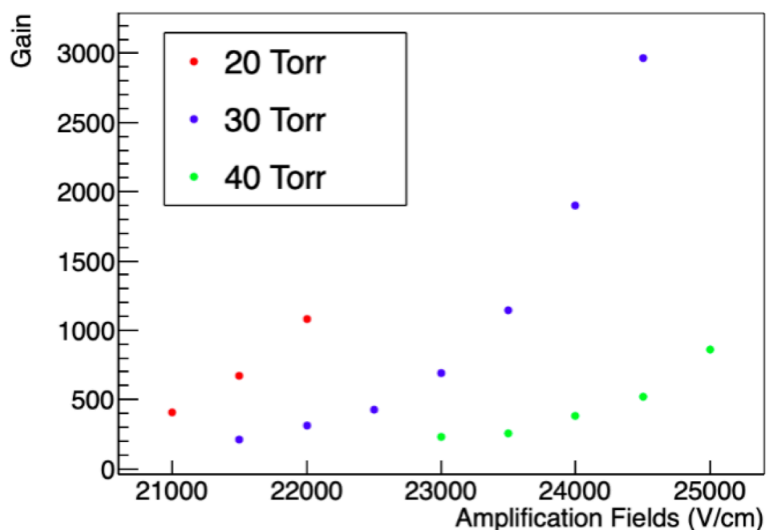
Improving gain with SF₆ and mixtures (Ali McLean, Callum Eldridge)



(a) Cross-section of the MMThGEM detector with the field names (left), plane names (right) and the gap widths (centre-left) above

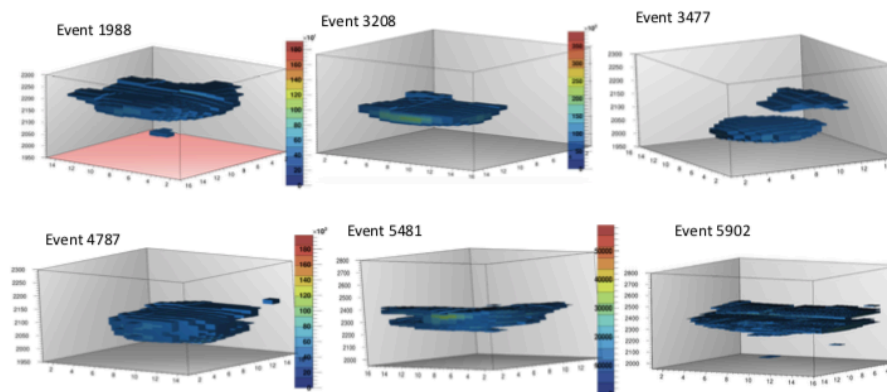
(b) Picture of the MM-ThGEM holes from

MM-ThGEM Operation in SF₆



Micromegas ⁵⁵Fe tracks

Fe⁵⁵



CF₄ : SF₆
39.0 : 1.8 Torr 20200229T172918

Pressure (Torr)	A (cm ⁻¹ Torr ⁻¹)	B (V cm ⁻¹ Torr ⁻¹)	λ (μm)	I _e (eV)
20	201 ± 10	3500 ± 50	2.49 ± 0.12	17.4 ± 0.9
30	176.5 ± 15	2666 ± 66	1.89 ± 0.16	15.1 ± 1.3
40	89.0 ± 30	1909 ± 120	2.81 ± 0.95	21.4 ± 7.4

Gas Recirculation and Radon Scrub

Enabling safe and low background SF₆ operation (Rob Gregorio)

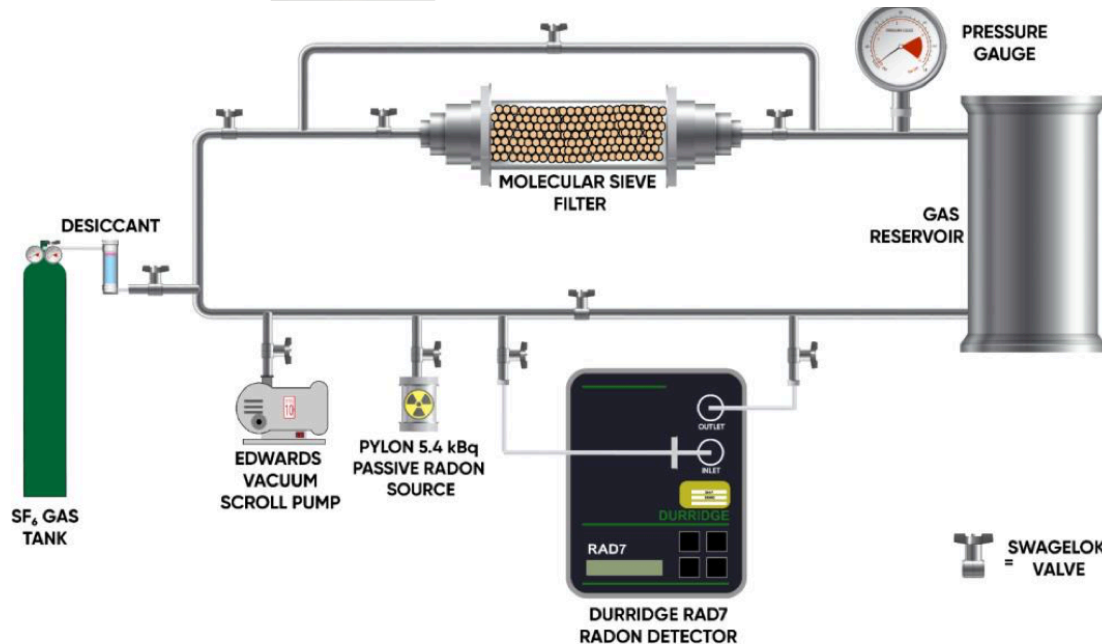
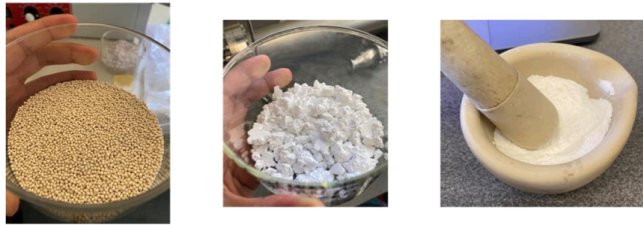
Collaboration with Kobe and CYGNO

JINST 16(06): (2020) P06024

Test of low radioactive molecular sieves for radon filtration in SF₆ gas-based rare-event physics experiments

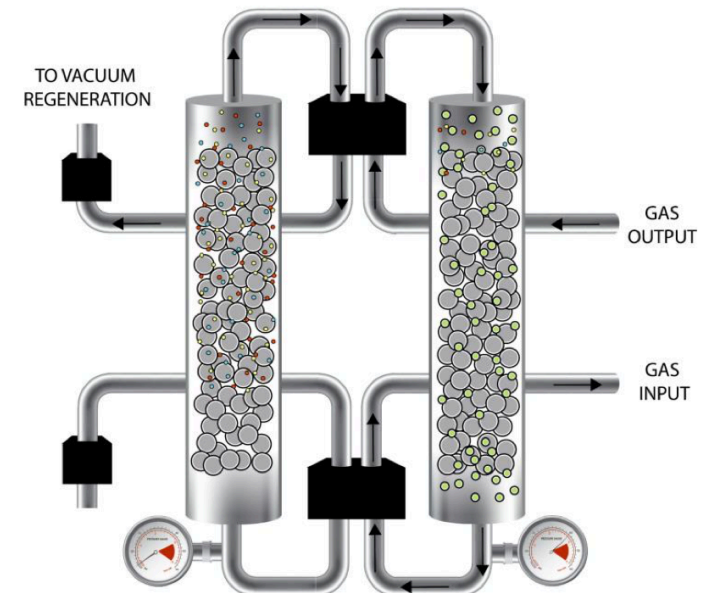
[R.R. Marcelo Gregorio](#)(Sheffield U.), [N.J.C. Spooner](#)(Sheffield U.), [J. Berry](#)(Sheffield U.), [A.C. Ezeribe](#)(Sheffield U.), [K. Miuchi](#)(Kobe U.) et al.

New low background molecular sieves



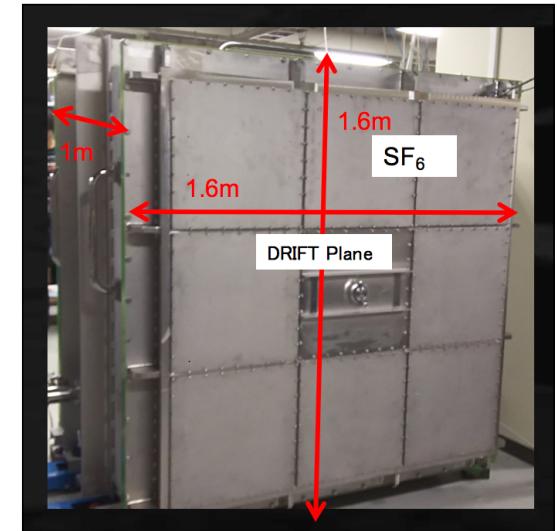
Recirculation using

Vacuum Swing Adsorption (VSA)

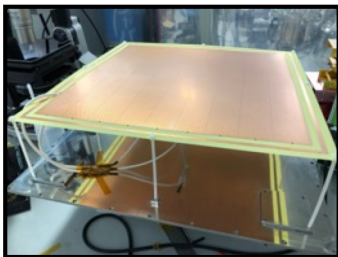
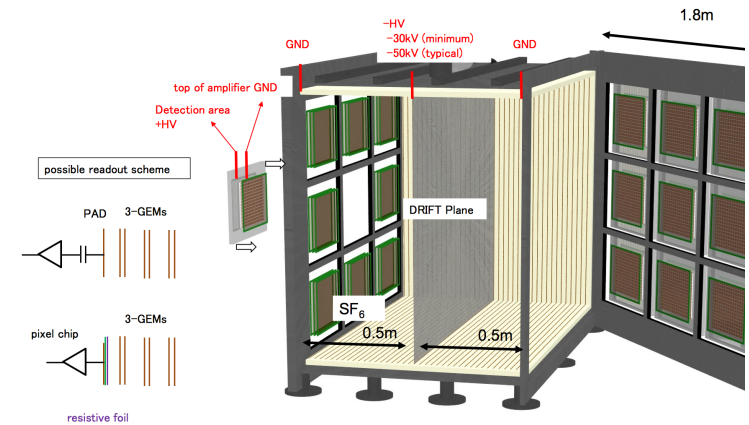


Near-term Plans

- MM-ThGEM and micromegas with He mixtures, improved designs
- Test of SRS, LTARS (Kobe) and Cremat electronics
Collaboration with Hawaii and Kobe
Hope to operate in Kobe vessel
- New low radon MS (paper in prep.)
- Demonstration of SF₆ gas recirculation system in lab
Hope to operate at Boulby at 1 m³ scale
- Continue work on detector simulations (Geant4, Ansys etc)
- Continue work on scale-up designs and tests

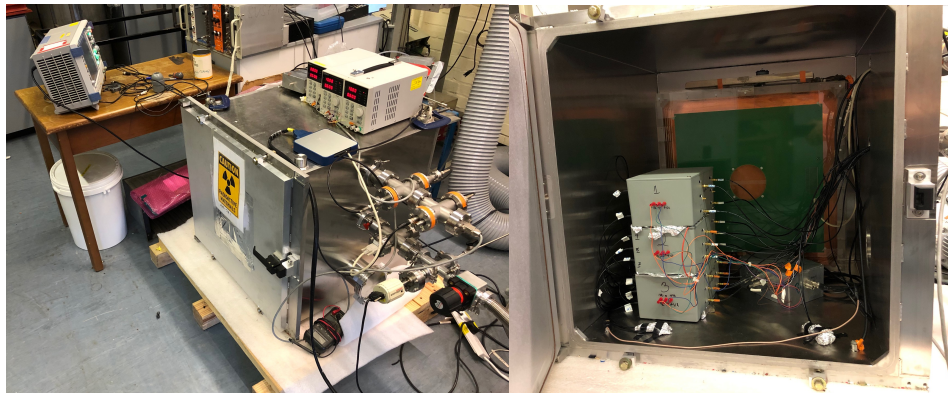


Kobe vessel

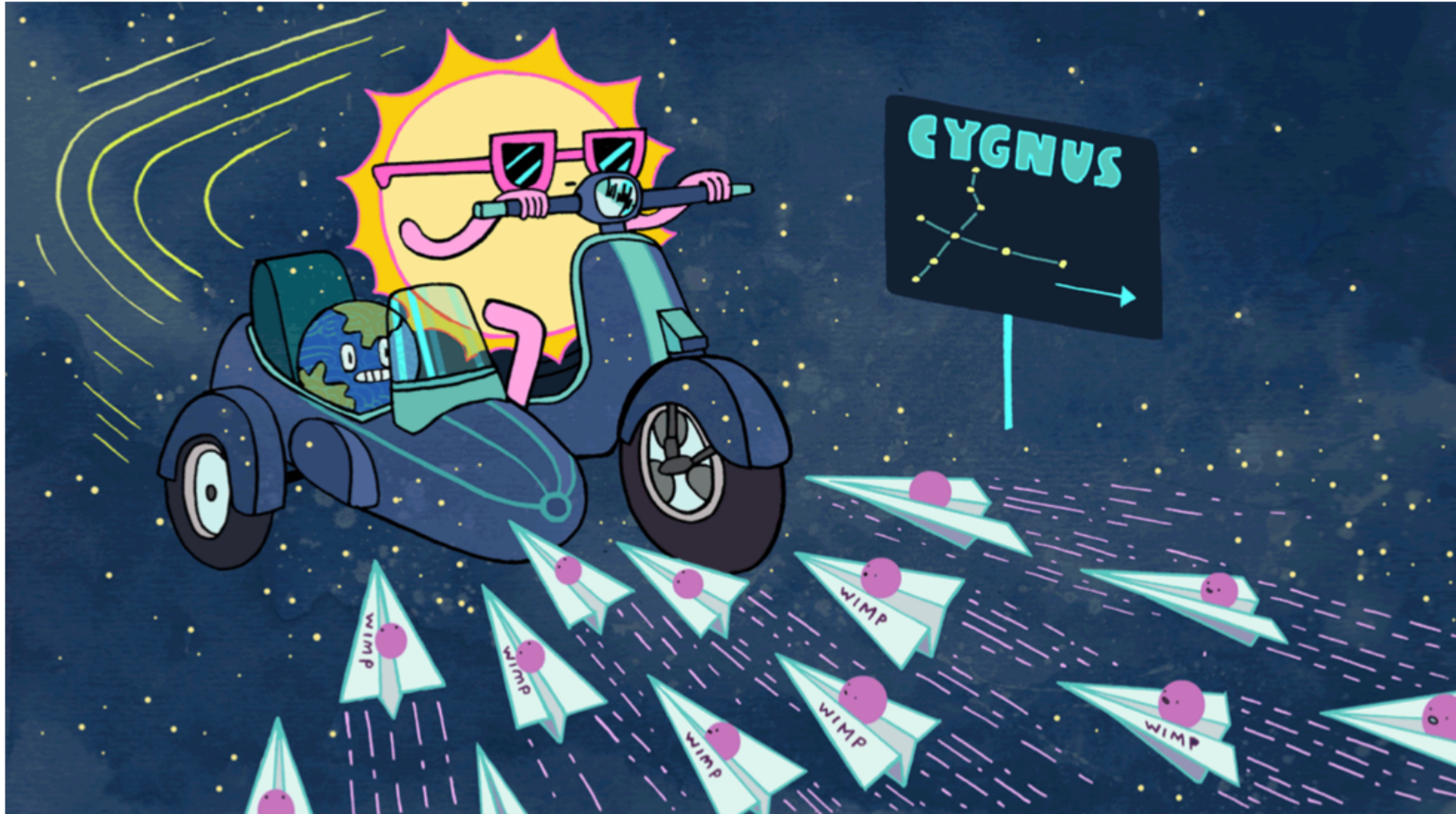


Sheffield vessel

ThGEM prototypes



Conclusions...



<http://www.symmetrymagazine.org/article/wimps-in-the-dark-matter-wind>