Pulling out all the Stops:

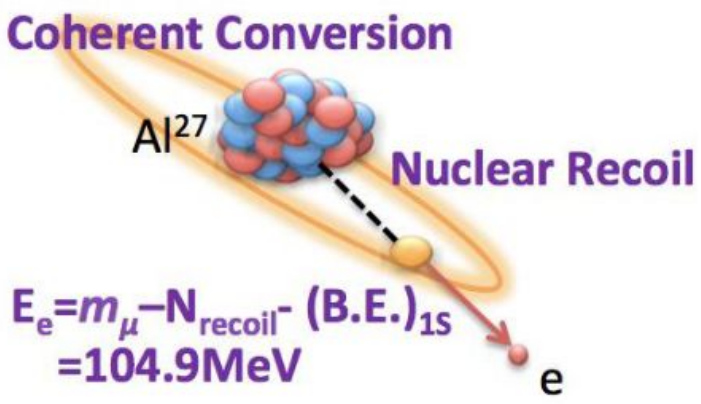
Measuring the normalisation of signal events in the Mu2e experiment

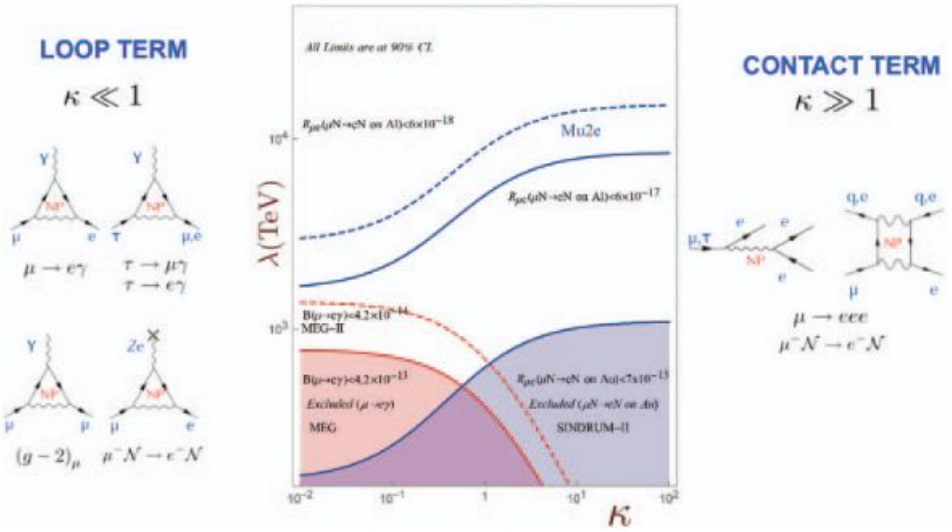
George Sweetmore

Muon4Future 2025

The University of Manchester

Mu2e experiment





Measure neutrinoless conversion from muon to electron in proximity of a nucleus

Highly suppressed in SM
Allows us to probe large range of BSM models

Target Sensitivity:

$$R_{\mu e} = \frac{\Gamma\left[\mu^- + A(Z,N) \to e^- + A(Z,N)\right]}{\Gamma\left[\mu^- + A(Z,N) \to \nu_\mu + A(Z-1,N+1)\right]} < 6.7 \times 10^{-17} (90\%\text{CL})$$

4 orders of magnitude better than current limits: SINDRUM II [W. Bertl et al., Eur. Phys. J. C 47, 337-346 (2006)]

Measure ratio between conversion events and stopped muons

Stopping Target Monitor

Target Sensitivity:

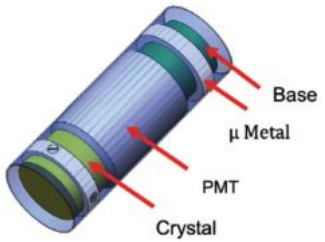
$$R_{\mu e} = \frac{\Gamma[\mu^- + A(Z,N) \to e^- + A(Z,N)]}{\Gamma[\mu^- + A(Z,N) \to \nu_\mu + A(Z-1,N+1)]} < 6.7 \times 10^{-17} (90\%\text{CL})$$

4 orders of magnitude better than current limits: SINDRUM II [W. Bertl et al., Eur. Phys. J. C 47, 337-346 (2006)]

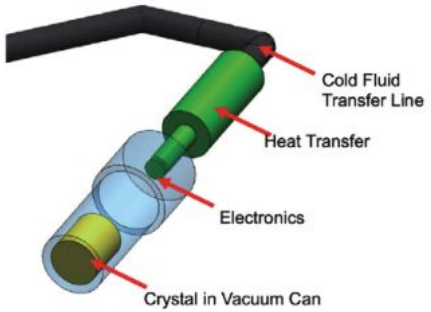
$3d \to 2p$ 62% of stops emit 66 keV	$2p \to 1s$ 62% of stops emit 347 keV	24.2% of stops DIO	
		37.8% of stops OMC	Emit 844 keV, 1809 keV X-rays or nothing
$2p \to 1s$ 18% of stops emit 347 keV	7% of stops DIO		
	11% of stops OMC	Emit 844 keV, 1809 keV X-rays or nothing	
stopped in: $1s$ 20% of stops	7.8% of stops DIO		
	12.2% of stops OMC	Emit 844 keV, 1809 keV X-rays or nothing	

Lower rates(<100kHz)
High resolution (~1keV for 1809keV)

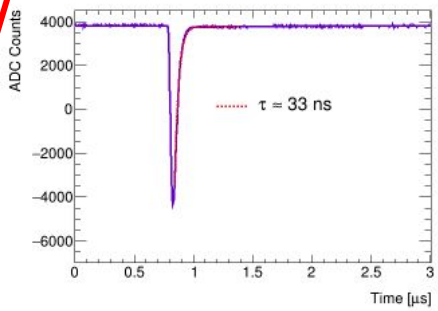
LaBr3

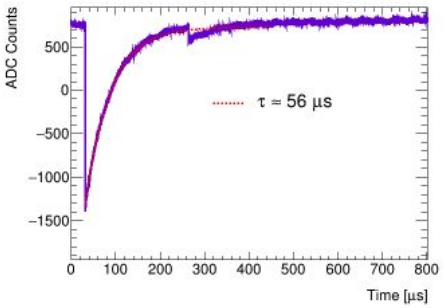


HPGe

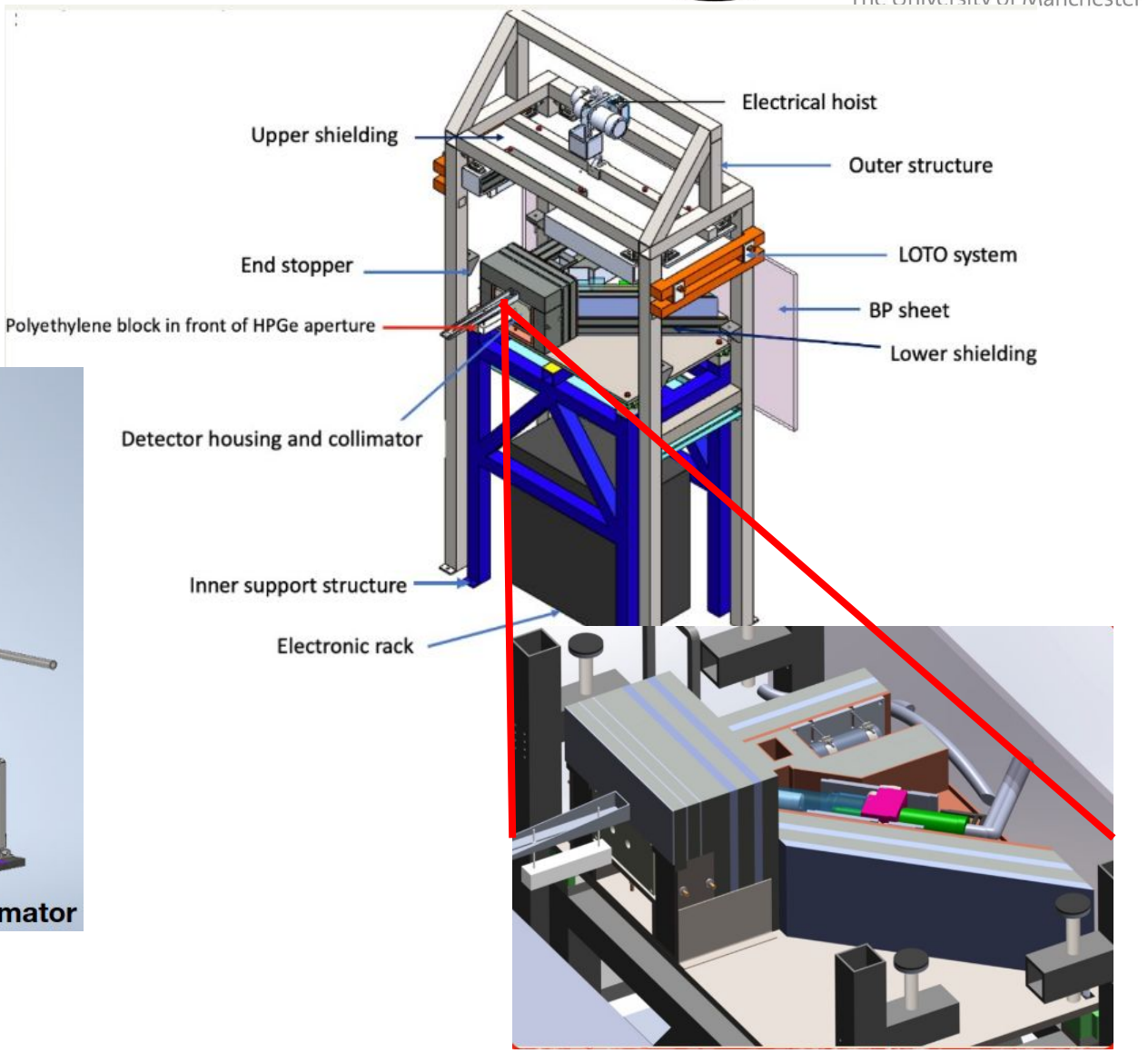


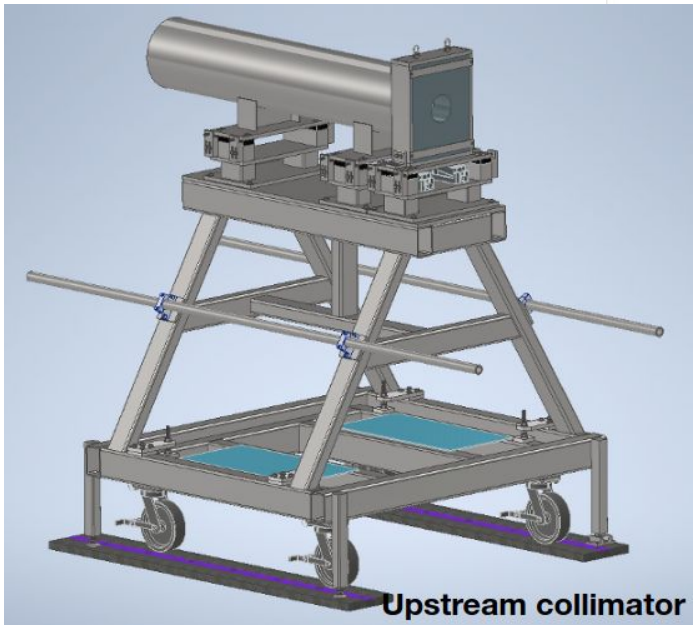
High rates(>100kHz)
Low resolution (~12keV for 1809keV)



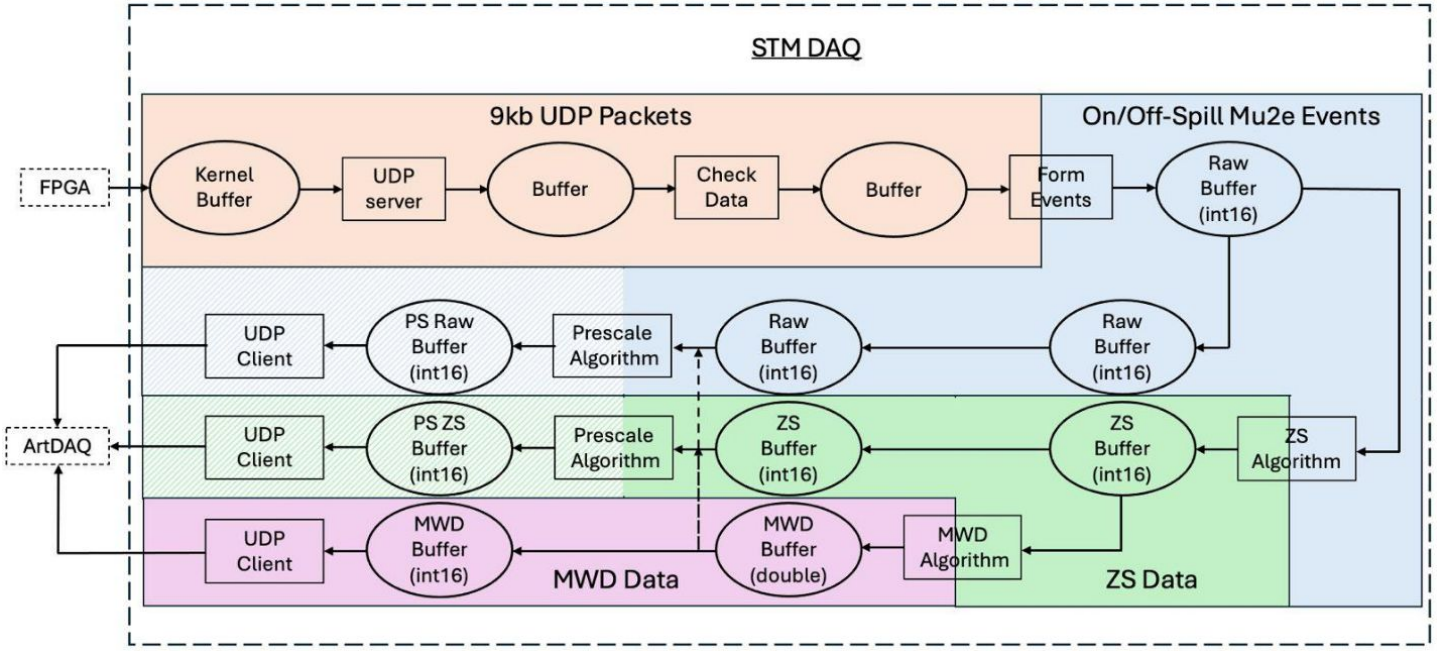


STM Infrastructure

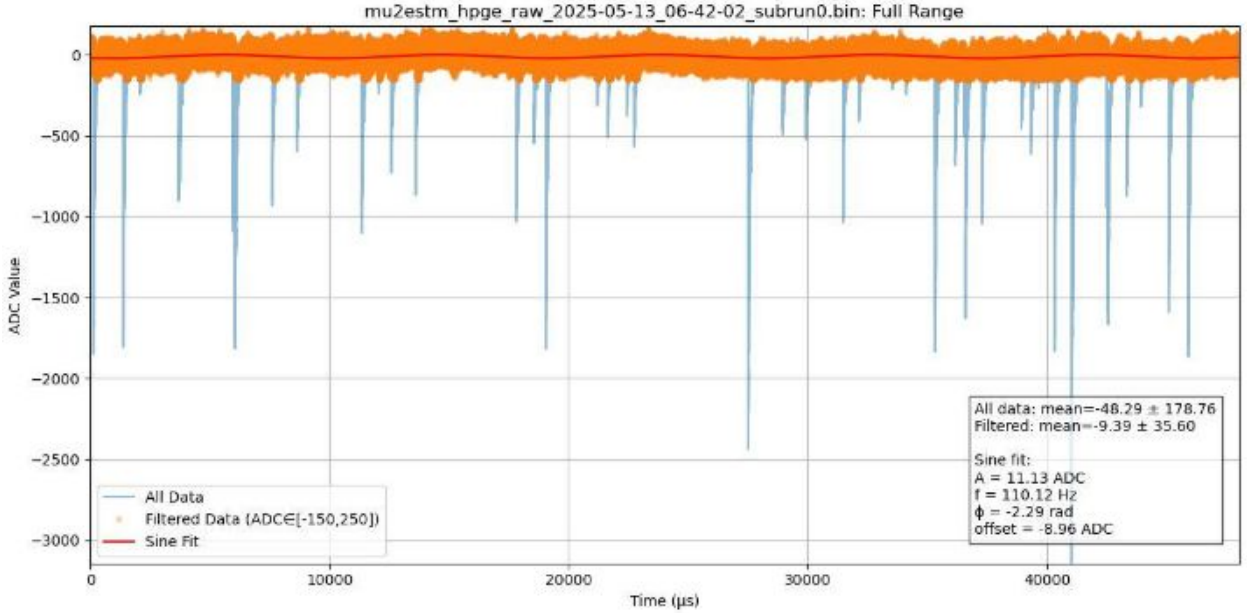


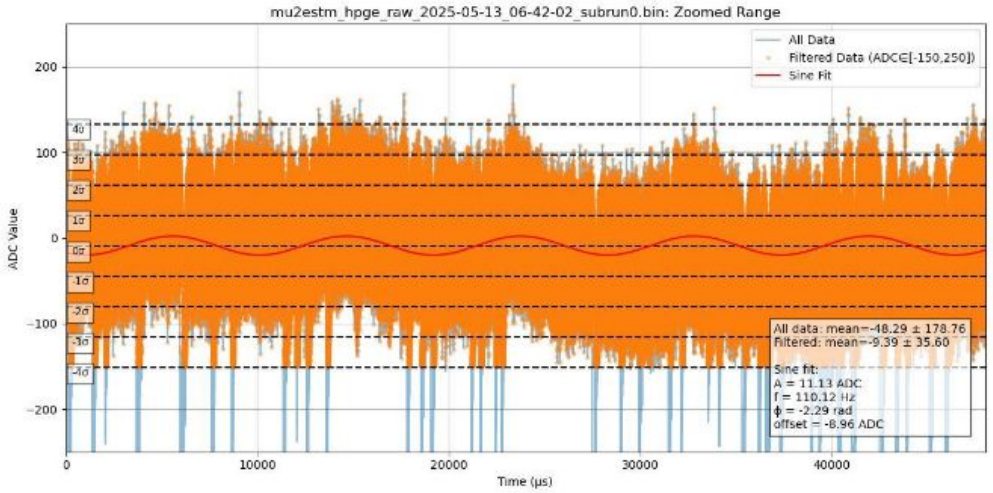


STM Data Acquisition (DAQ)



STM DQM


mu2estm_hpge_raw_2025-05-13_06-42-02_subrun0.bin: Full Range
ADC Value
Time (μs)
All Data
Filtered Data (ADC∈[-150,250])
Sine Fit
All data: mean=-48.29 ± 178.76
Filtered: mean=-9.39 ± 35.60
Sine fit:
A = 11.13 ADC
f = 110.12 Hz
ϕ = -2.29 rad
offset = -8.96 ADC


mu2estm_hpge_raw_2025-05-13_06-42-02_subrun0.bin: Zoomed Range
ADC Value
Time (μs)
All Data
Filtered Data (ADC∈[-150,250])
Sine Fit
All data: mean=-48.29 ± 178.76
Filtered: mean=-9.39 ± 35.60
Sine fit:
A = 11.13 ADC
f = 110.12 Hz
ϕ = -2.29 rad
offset = -8.96 ADC

Outlook: Status & Plans for first cosmic ray run

- STM Firmware is in a great state and ready to be implemented in coming weeks
- The STM DAQ is in a great state
- We can now run for O(10hrs)
- Online zero suppression is complete for LaBr3 and HPGe
- Timing studies performed in real time
- Have online DQM in standalone and OTSDAQ packages

TO DO:

- We need to push the data rates! where do we fall over?
- Ensure we understand cross sub-system timing
- Source testing of the detectors. What is our current achievable resolution for known energy peaks