Efficiency Study

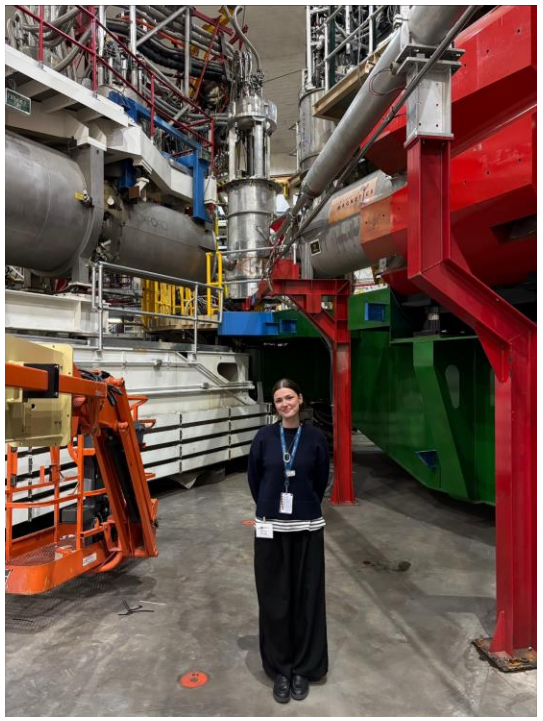
Tracking and detector efficiencies to correct effective charges

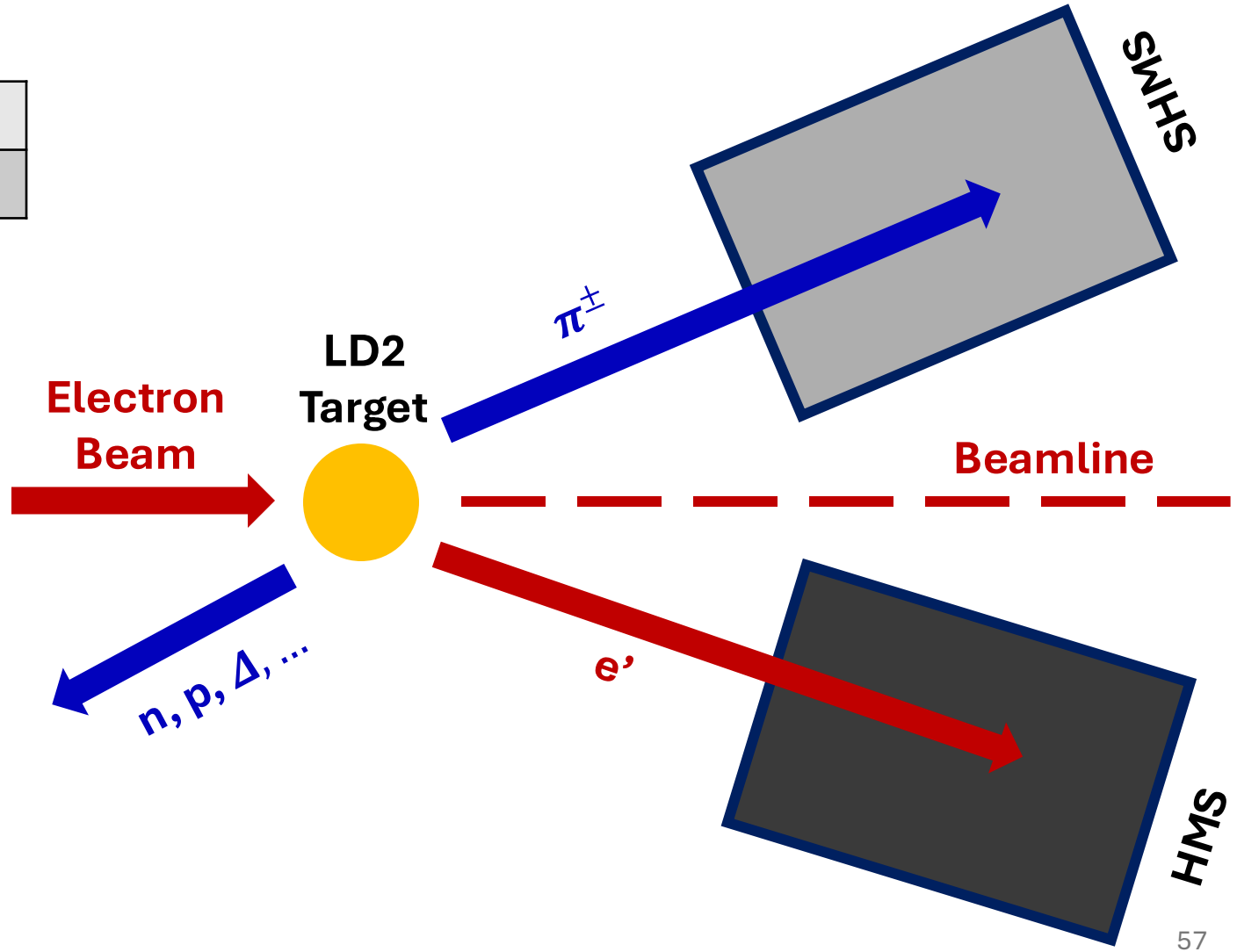
01/05/26

PionLT Experiment - $p(e, e'\pi^+)$n

Settings reminder:

E_{beam}	Q^2	W	$-t_{min}$	x_B	ε
6.40	1.60	3.08	0.03	0.17	0.27





Why is efficiency important?

Efficiencies (ϵ) are an essential part of an LT-separation because of **error amplification** in the systematic uncertainties.

To achieve the pion electroproduction cross section, the **normalised yield** must first be found. This is defined as

$$Y_{exp} = \frac{N}{Q_{eff}}$$

Where N is the total number of normalised events that pass event selection/PID, and Q_{eff} is the **effective charge** defined by

$$Q_{eff} = Q_{tot} \cdot \epsilon_{tot}$$

Where Q_{tot} is the cumulative charge at the target and ϵ_{tot} is the overall efficiency. The experimental yield must be corrected for the **tracking** and **detector** efficiencies to then compare it to the Monte Carlo simulation yield (next stage of analysis)

Tracking efficiency

Tracking efficiency accounts for the loss due to bad track reconstruction of charged particles (e^- and π^+):

$$\epsilon_{track} = \frac{N_{did,track}}{N_{should,track}}$$

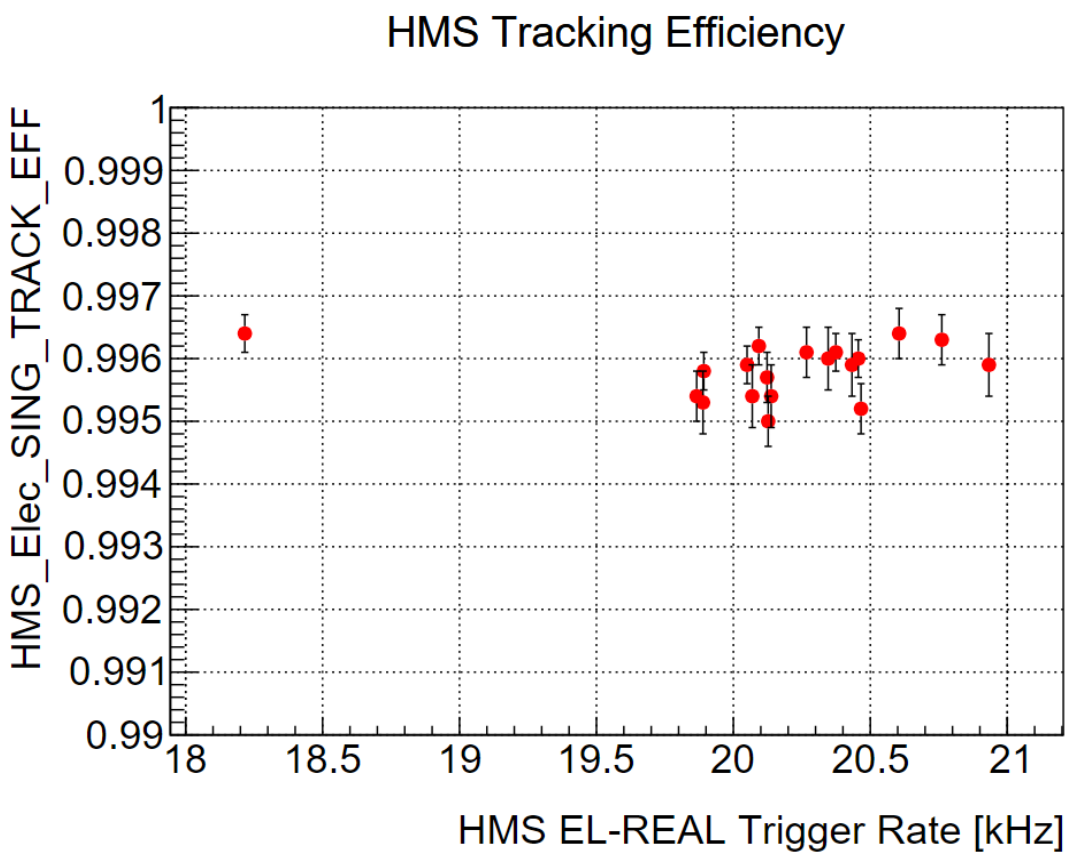
Where $N_{did,track}$ = number of events with at least one track

$N_{should,track}$ = number of events expected to have a track after acceptance + PID cuts

- "Should" is defined from all the other detectors and is the best available experimental approx. for truth.
- A track must fire 5/6 of the DC wire planes.
- Derived from hit information from the HMS and SHMS **DC** and **hodoscope** individually.
- Plotting ϵ_{track} over all runs allows the efficiency to be investigated over time.

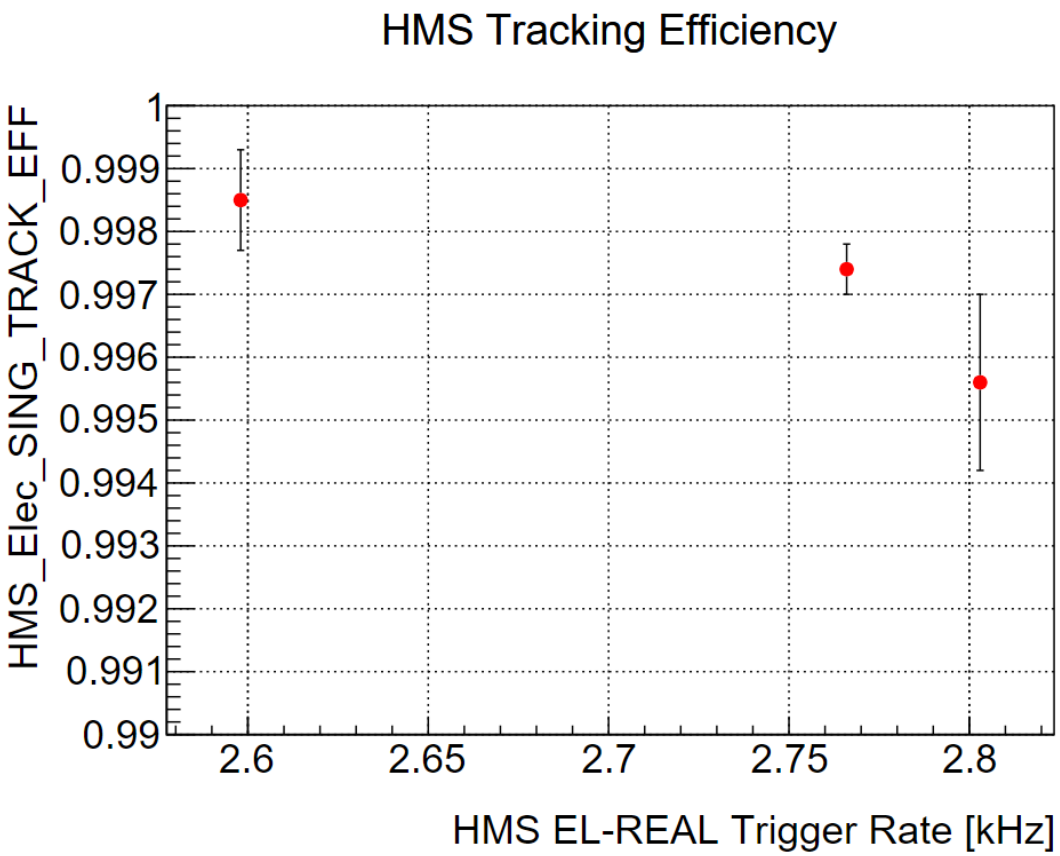
Tracking efficiency - HMS

Production



0.995811 +/- 9.35599e-05

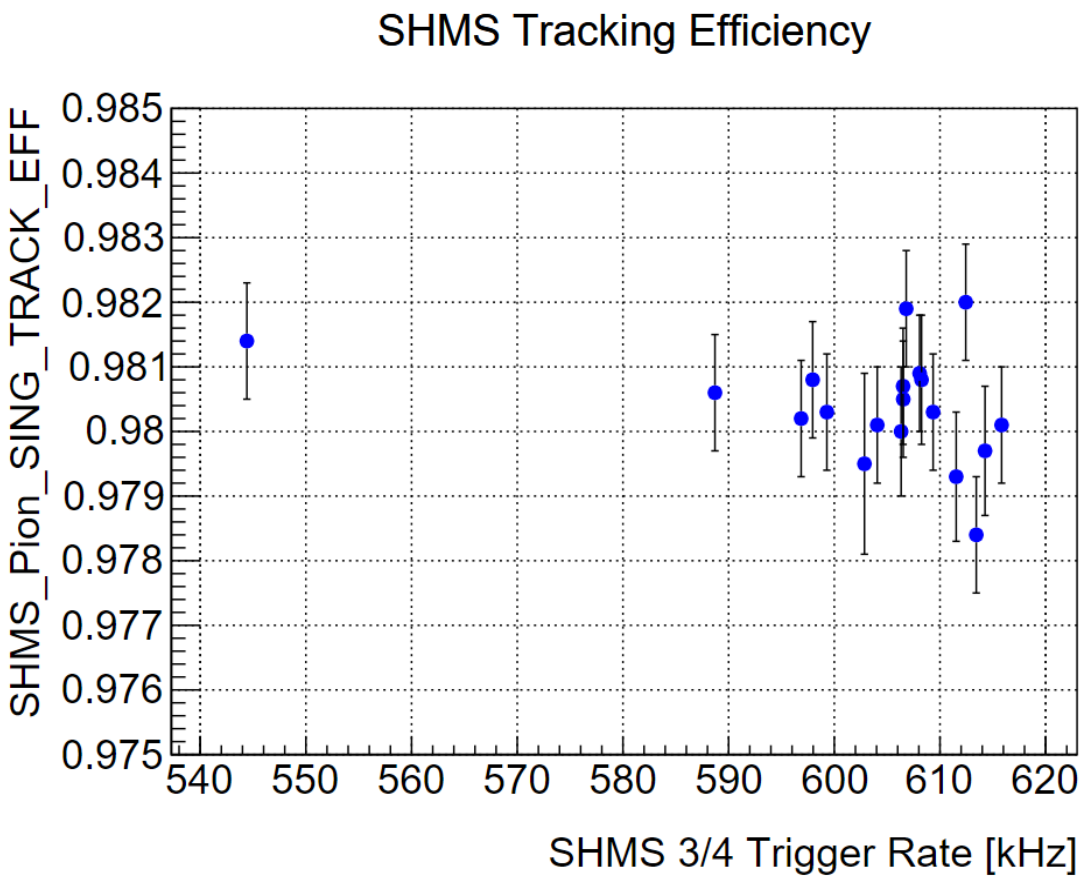
Dummy



0.997167 +/- 0.000553775

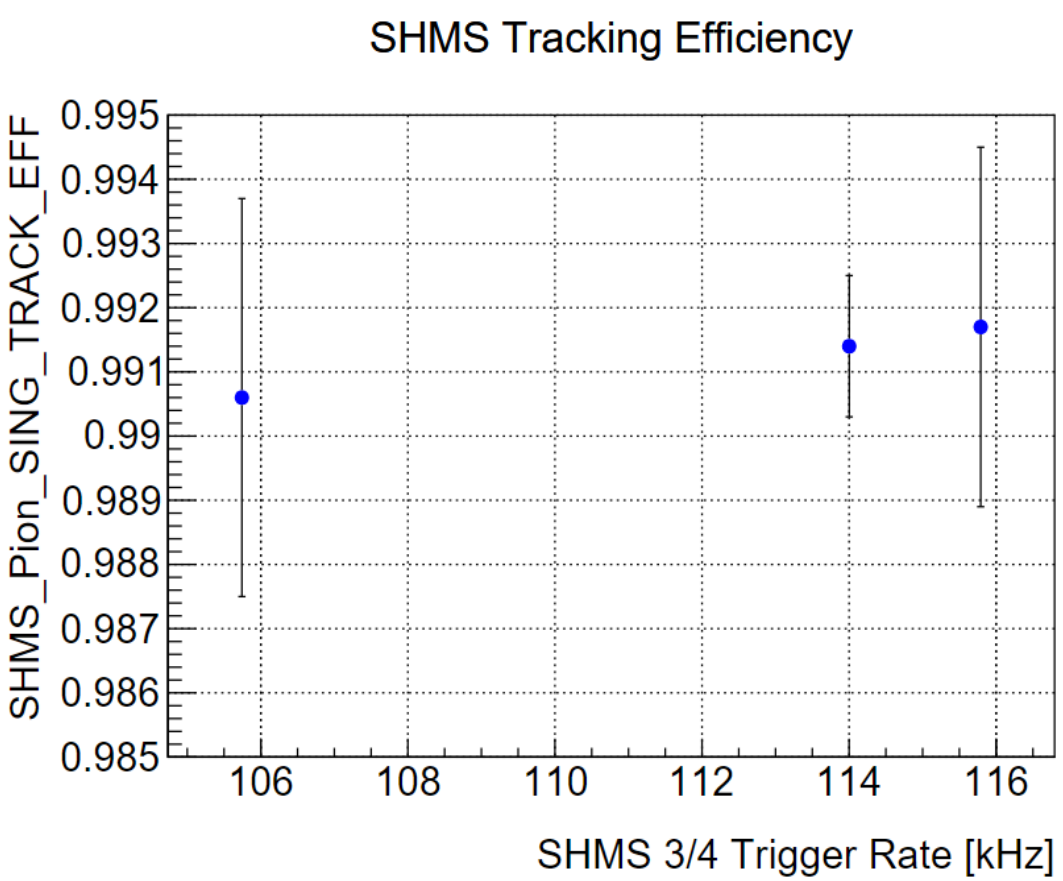
Tracking efficiency - SHMS

Production



0.980395 +/- 0.000218912

Dummy



0.991233 +/- 0.00143991

Tracking efficiency

Tracking for HMS is in general more efficient than in SHMS. This is due to the trigger rate being a factor of 10 greater in the SHMS.

Higher rates just means more accidentals, pile up and multiple track confusion.

In dummy target, there are far fewer usable pion tracks – that is why the error is so large on the data points.

Production

Efficiency	HMS	SHMS
Tracking	0.996 +/- 9.36e-05	0.980 +/- 0.000219

Dummy

Efficiency	HMS	SHMS
Tracking	0.997 +/- 0.000554	0.991 +/- 0.00144

Detector efficiency

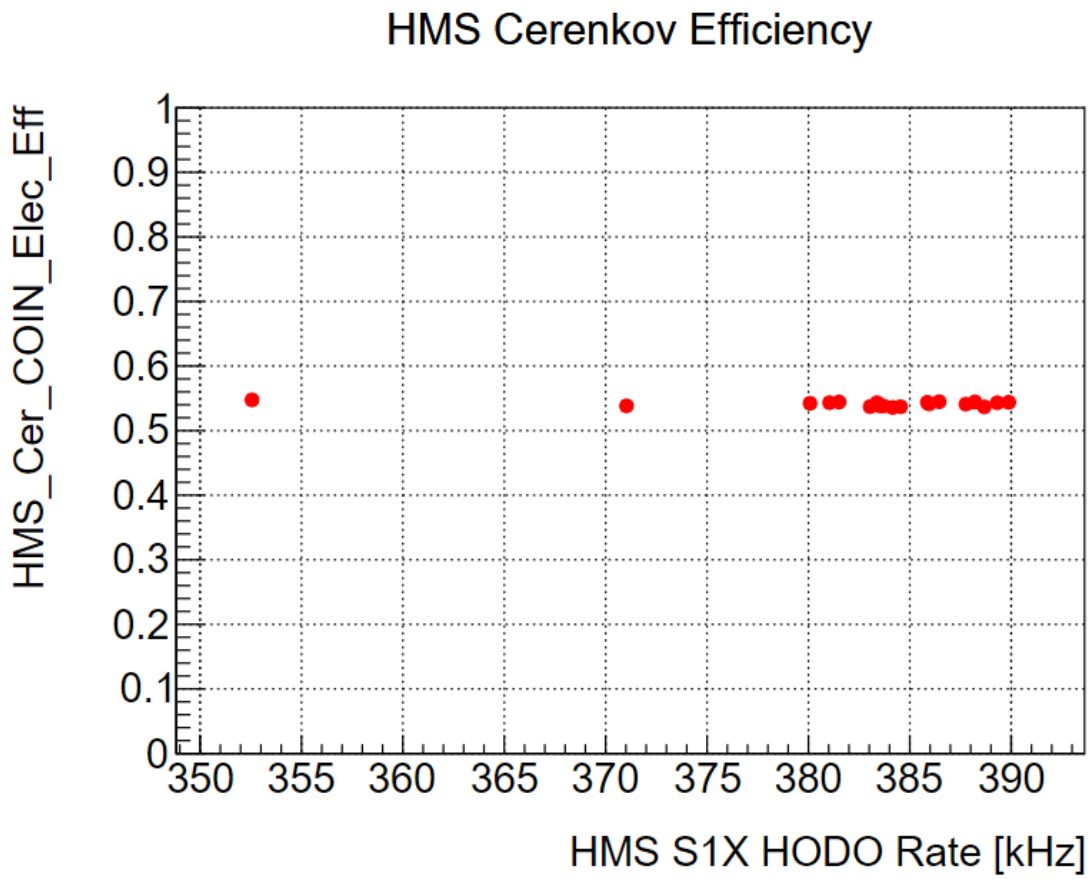
$$\epsilon_{det} = \frac{N_{did,det}}{N_{should,det}}$$

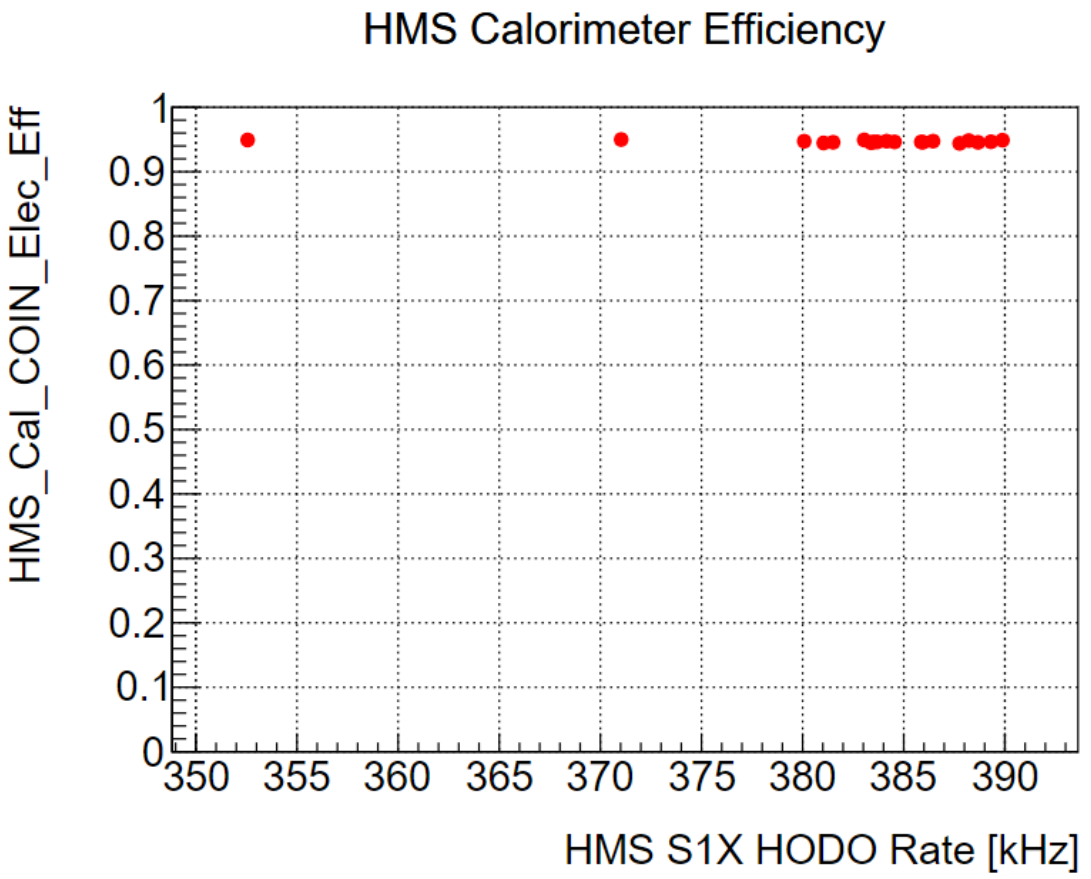
Where $N_{did,det}$ = number of events after ALL acceptance + PID cuts

$N_{should,det}$ = number of events after acceptance + PID cuts EXCEPT detector under study

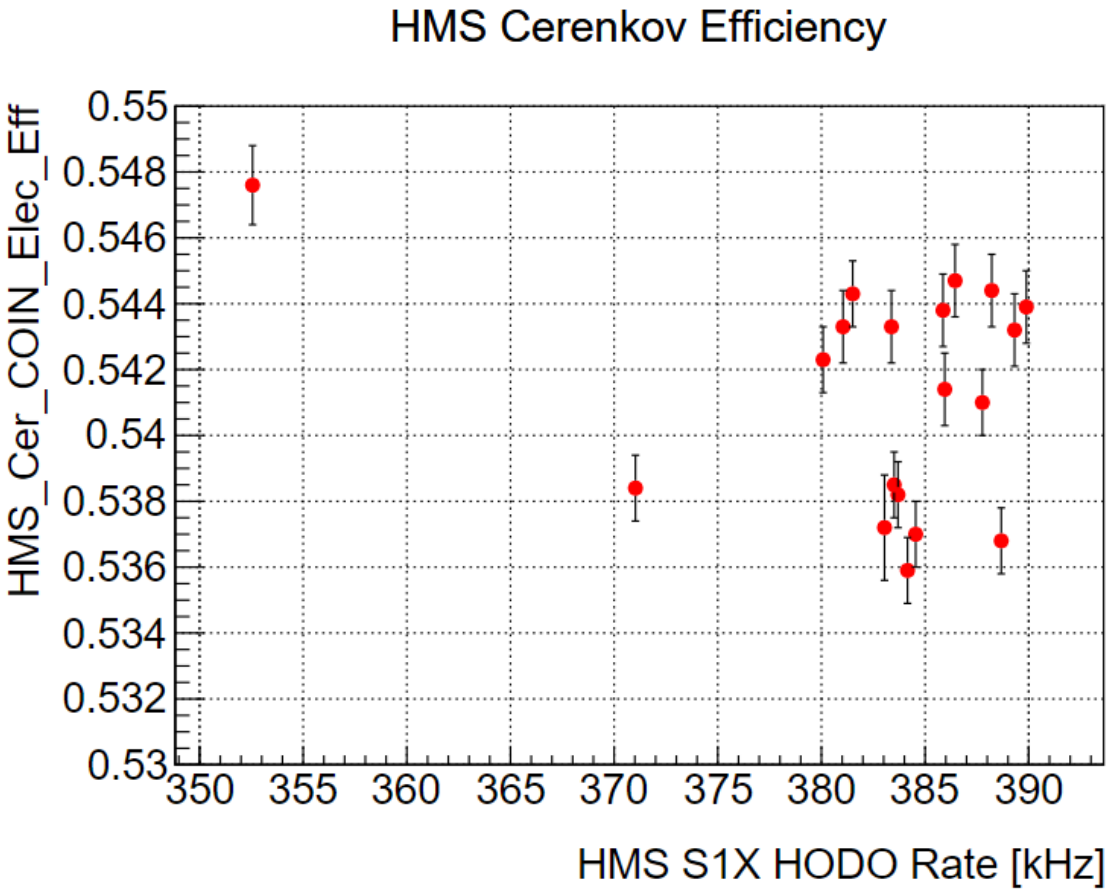
- Efficiency plotted per run in the LD2+ group for this setting. Can also display as per ¾ trigger rate (also in the report file)

HMS Detector Efficiencies

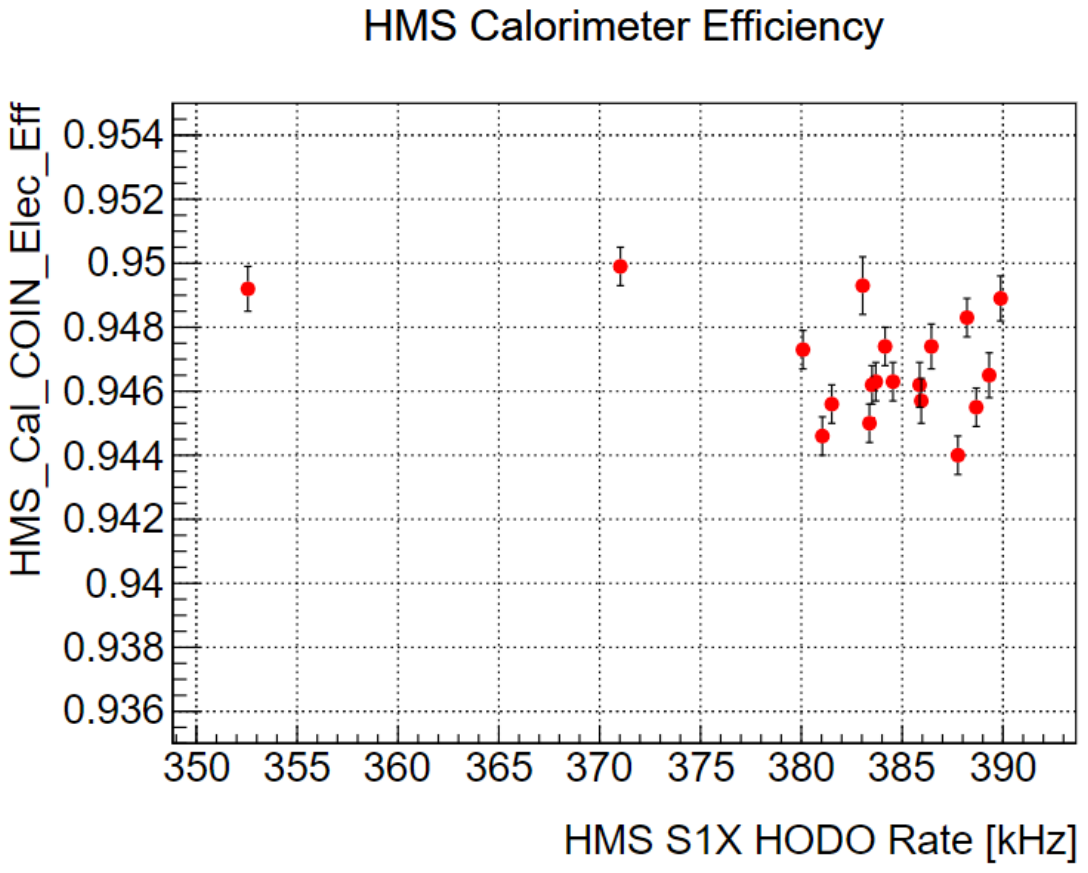




HMS Detector Efficiencies - zoomed

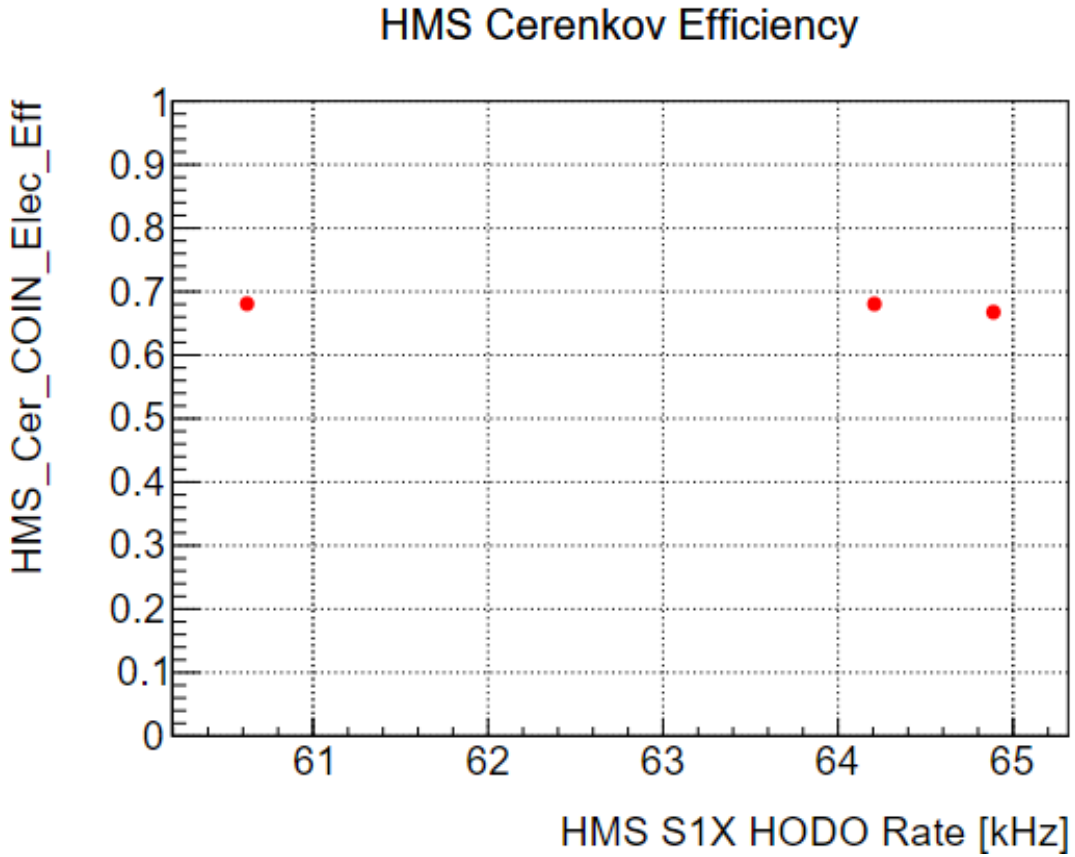


0.541326 +/- 0.00025065

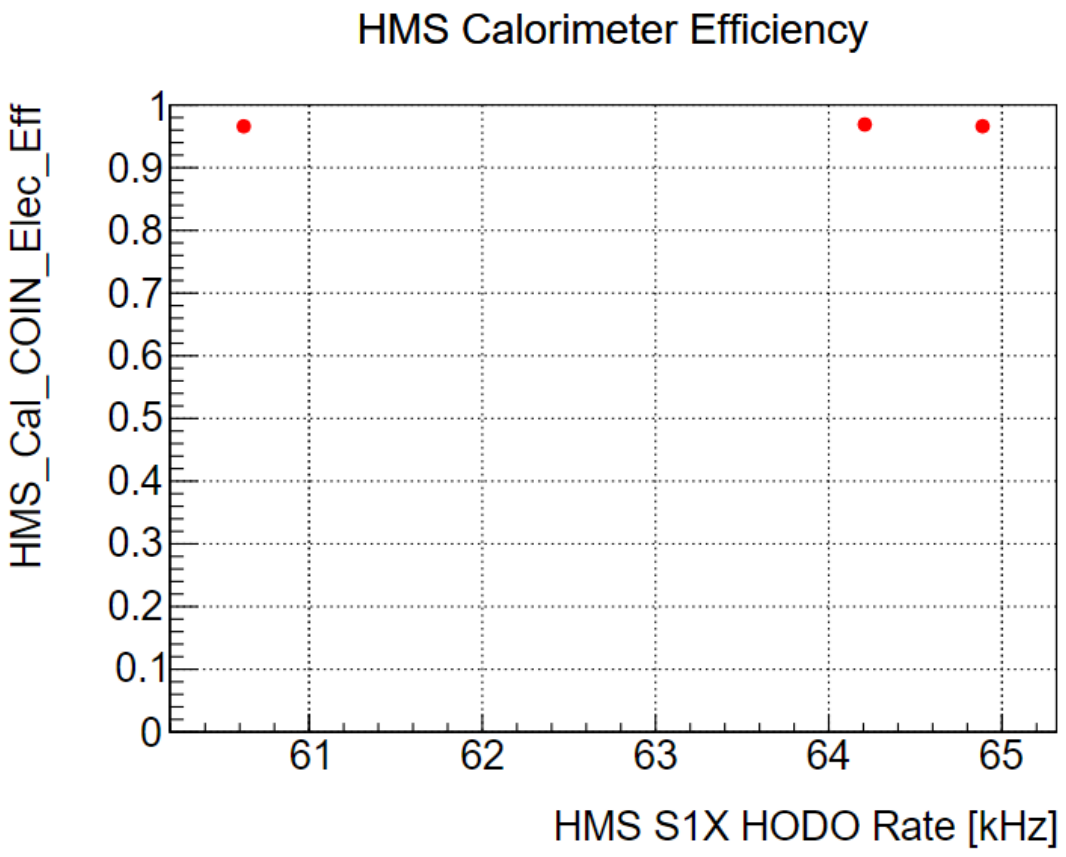


0.946821 +/- 0.000149514

HMS Detector Efficiencies - dummy



0.6763 +/- 0.00470945

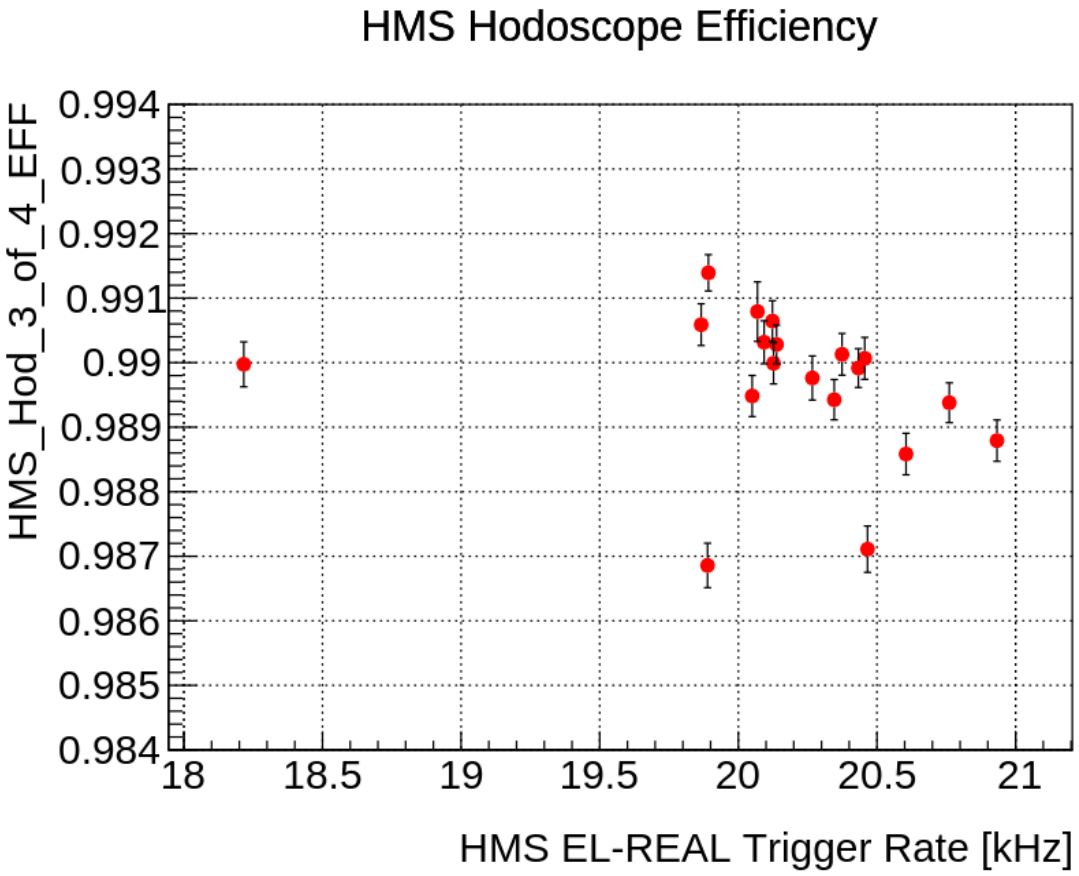


0.967 +/- 0.00218937

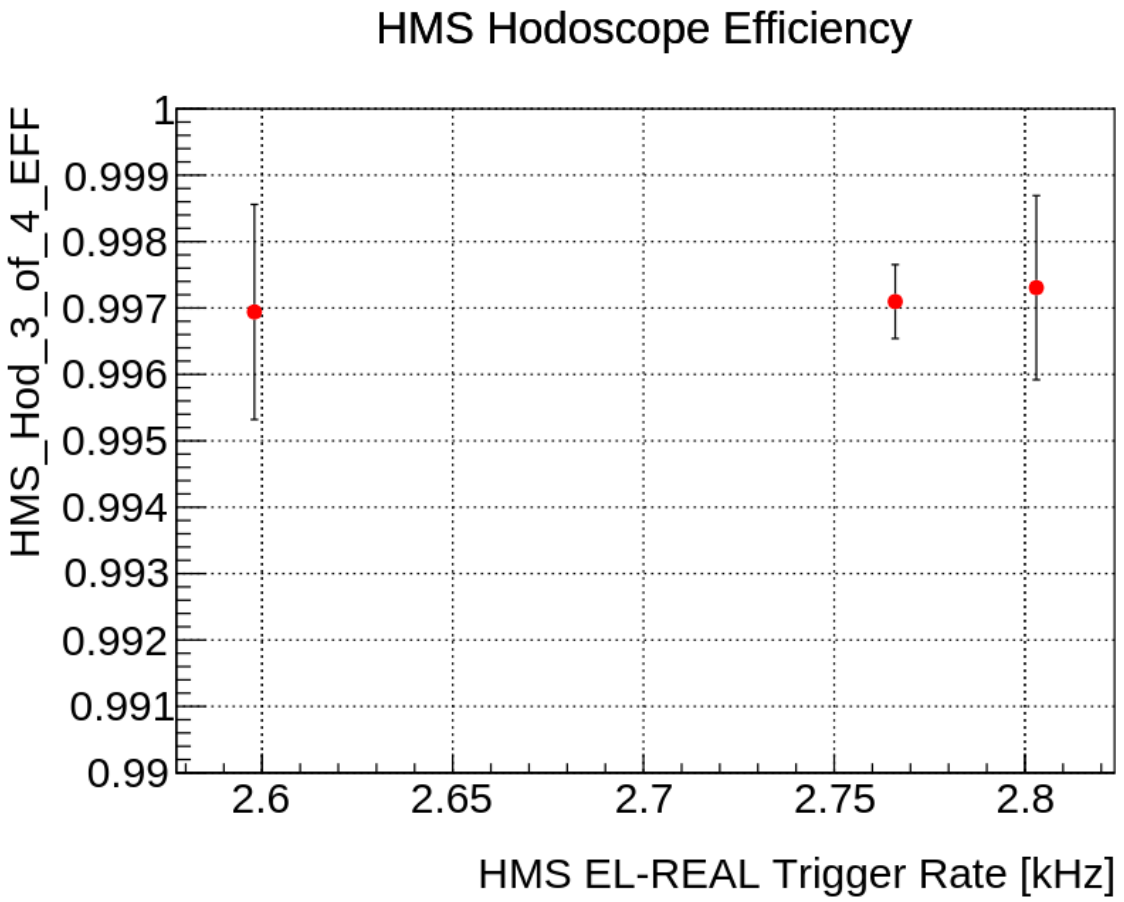
HMS Hodoscope Efficiency

University of Glasgow

Production



Dummy



Normalisation factors

Normalization Factors	Comments
Charge	Calculated run-by-run
HMS & SHMS Tracking Efficiencies	> 98%
Live Time Correction	>98%
HMS Cerenkov Efficiency	>99%
HMS Calorimeter Efficiency	>99%
SHMS Aerogel Efficiency	>98%
HMS & SHMS Hodoscope Efficiency	>98%
RF Efficiency	>99%
Boiling Correction Factor	Calculated run-by-run
Coin Blocking Correction	Calculated run-by-run
Pion Absorption Correction	~97%

Normalisation Factors	Comments
Charge	Calculated run-by-run
HMS & SHMS Tracking Efficiencies	>98%
Live Time Correction	
HMS Cherenkov Efficiency	>55% ?????
HMS Calorimeter Efficiency	>97%
SHMS Aerogel Efficiency	
HMS & SHMS Hodoscope Efficiency	>99% (so far just HMS)
RF Efficiency	
Boiling Correction Factor	
Coin Blocking Correction	
Pion Absorption Correction	