DREAM Event Selection

Tom Coates, **Samuel Jones**,
Fabrizio Salvatore, Iacopo Vivarelli

University of Sussex

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University of Sussex

Event Selection

- Design two independent event selections based on:
  - Calorimeter deposits
  - Ancillary detectors
- Total events from a run: $N = N_e + N_h + N_\mu$
- Event yield k_i for a given particle given approximately by:

$$\begin{pmatrix} k_e \\ k_h \\ k_\mu \end{pmatrix} = \Lambda . \begin{pmatrix} N_e \\ N_h \\ N_\mu \end{pmatrix} ; \qquad \Lambda = \begin{pmatrix} \epsilon_e & f_e^h & f_e^\mu \\ f_h^e & \epsilon_h & f_h^\mu \\ f_\mu^e & f_\mu^h & \epsilon_\mu \end{pmatrix}$$

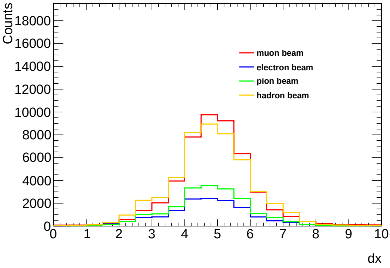
- By measuring the elements of Λ we can relate the ks and Ns for ancillary selections
  - Measure ancillary selection efficiencies using tight calorimeter selections

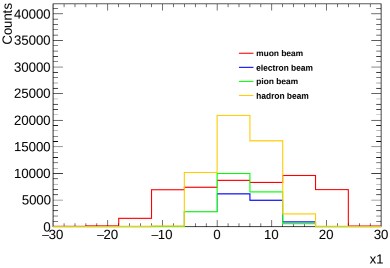
Runs used in this study:

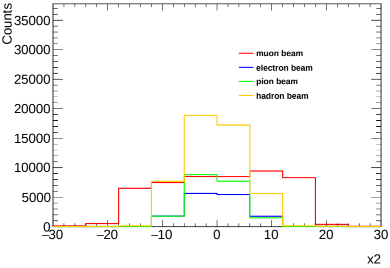
Composition	Run No.	Energy	Note
Electron	12709	20	Veto In, Cal in Tw15, 0 mm Pb + 5mm PS
Pion (secondary beam)	12508	80	-
Muon	12686	40	No Veto, Cal in Tw31
Hadron	12802	60	-

Beam position

- No selection applied in plots
- Muon beam broader than other compositions
- Δx approximately Gaussian
- $\sim$ 5mm offset between x_1 and x_2
  - Calibrate position by mean position over a run

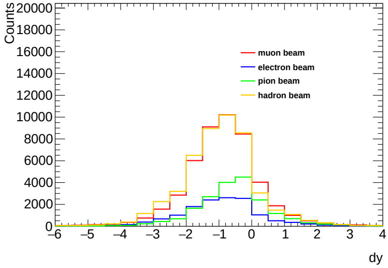


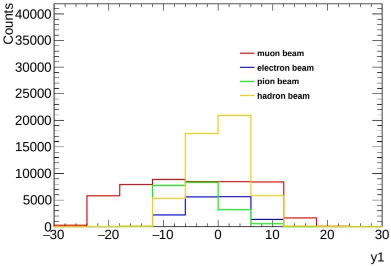


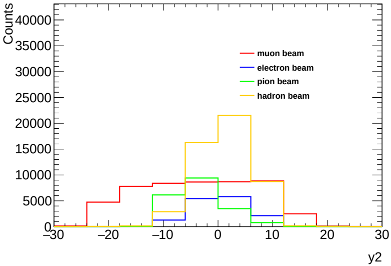


Beam position

- No selection applied in plots
- Muon beam broader than other compositions
- Δy approximately Gaussian
- Offset is run dependent
  - Calibrate position by mean position over a run

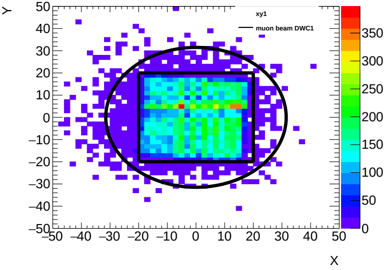


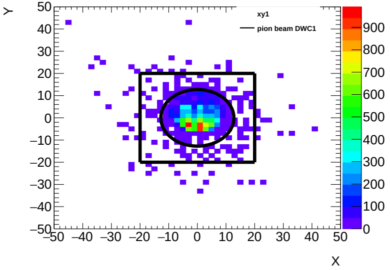


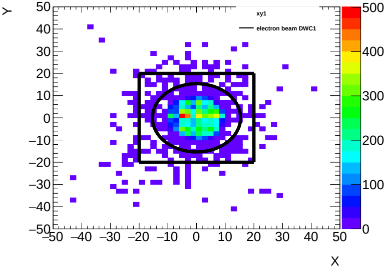


Beam position

- Using calibrated x and y positions to plot beam profile
- Remove outliers from average beam position: $\mu \pm 3\sigma$
- Muon beam is fairly evenly distributed
  - Remove events that lie outside apparent limits
- TODO: Use to track $\Delta\theta$ from beam angle



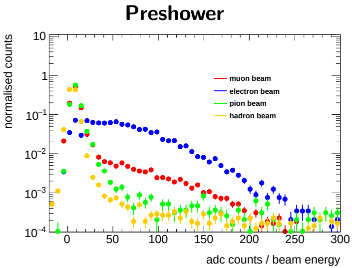


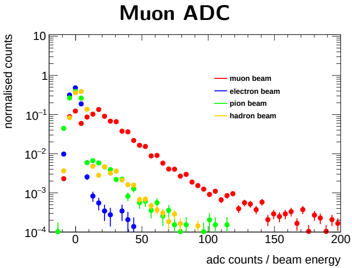


Ancillary Selection

- Beam outliers removed in plots
- Mean pedestal for run is subtracted
- Suggest the following selections:

	preshower	muon ADC
electron	> 20	< 8
muon	< 20	> 10
pion	< 20	< 5

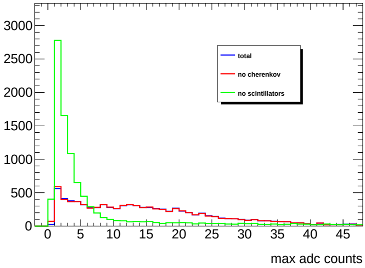




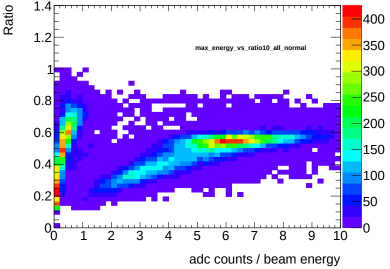
Calorimeter Selection

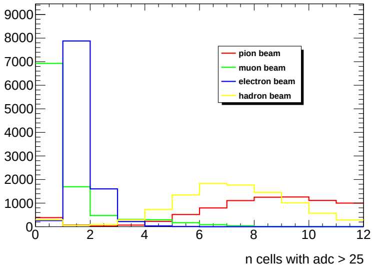
- Beam outliers removed
- Mean pedestal for run is subtracted
- Small response to muons - almost no energy deposited in cherenkov
- Energy ratio & shower shape variables distorted for muons
- $N_{\text{cells}} > 25 = 0$ very pure for muons

Muon Beam



Ratio $R = Q_{\textbf{max}} / \sum_{10} Q_{\textbf{max}}$

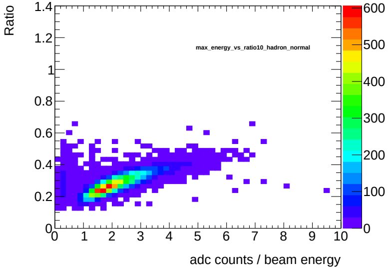


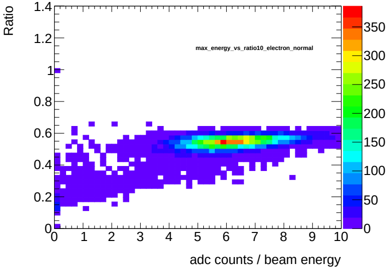


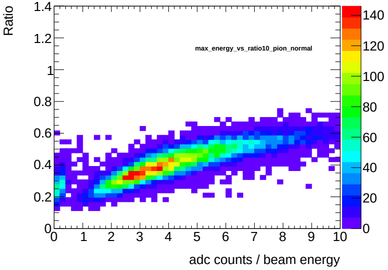
Calorimeter Selection

- Apply tight selection to obtain high purity samples - to be used for ancillary efficiency estimate
- Divide electrons and hadrons using maximum energy and ratio

	max adc / E_{beam}	$N_{\text{cells}} > 25$	R
electron	> 5	$2 - 5$	$0.55 - 0.6$
muon	$(0, 1)$	$0 - 1$	-
pion	$(2, 4)$	> 4	$0.0 - 0.4$



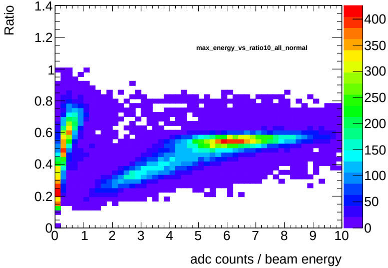




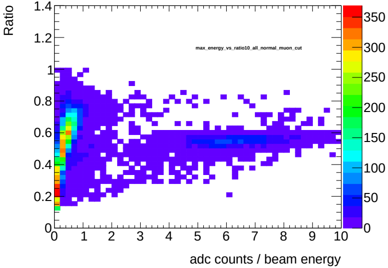
calorimeter selection + ancillary selection

- Compare distributions before and after applying muon adc cut

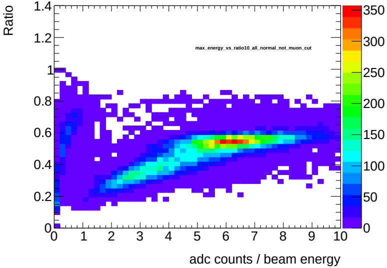
no cut



applying muon cut



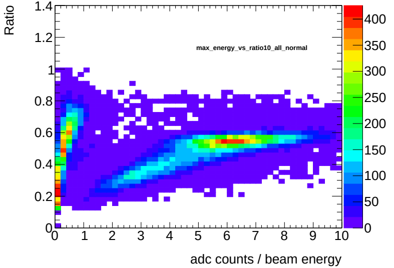
applying anti-muon cut



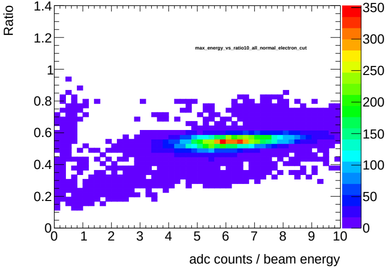
calorimeter selection + ancillary selection

- Compare distributions before and after applying preshower cut

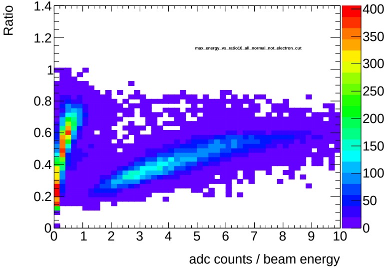
no cut



applying preshower cut



applying anti-preshower cut



Determination of Λ

- To measure ϵ_i, apply ith calorimeter selection to beam of composition i to obtain high purity sample
  - Then apply ancillary selection to measure the efficiency
  - The fake rate f_j^i is then the jth selection applied to the same sample

$$\Lambda = \begin{pmatrix} \epsilon_e & f_e^h & f_e^\mu \\ f_h^e & \epsilon_h & f_h^\mu \\ f_\mu^e & f_\mu^h & \epsilon_\mu \end{pmatrix}$$

Determination of Λ - results

$$\Lambda = \begin{pmatrix} 0.858 & 0.090 & 0.012 \\ 0.140 & 0.877 & 0.151 \\ 0.002 & 0.033 & 0.803 \end{pmatrix}$$

Determination of Λ - results (varying beams)

80 GeV pion beam $\rightarrow$ 60 GeV hadron beam
40 GeV muon beam $\rightarrow$ 60 GeV muon beam

$$\Lambda = \begin{pmatrix} 0.745 & 0.000 & 0.005 \\ 0.245 & 0.788 & 0.233 \\ 0.000 & 0.034 & 0.700 \end{pmatrix}$$

Conclusions

- Designed a selection based on ancillary detectors - to be finalised
- Determined efficiencies and fake rates from calorimeter selection
- TODOs:
    - Unstable when varying beam energies - need to investigate
    - Estimate uncertainties on Λ matrix, beam compositions
    - Add tracking, $\Delta\phi$, deviation from beam angle
    - Implement the final selection in the merging code

Backup