DREAM Event Selection

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

University of Sussex

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Recap

- 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
- Measurements shown last time unstable wrt. run used for measurement
- Wanted to understand this dependence

Ancillary Selection: (plus 3 σ cut on beam profile)

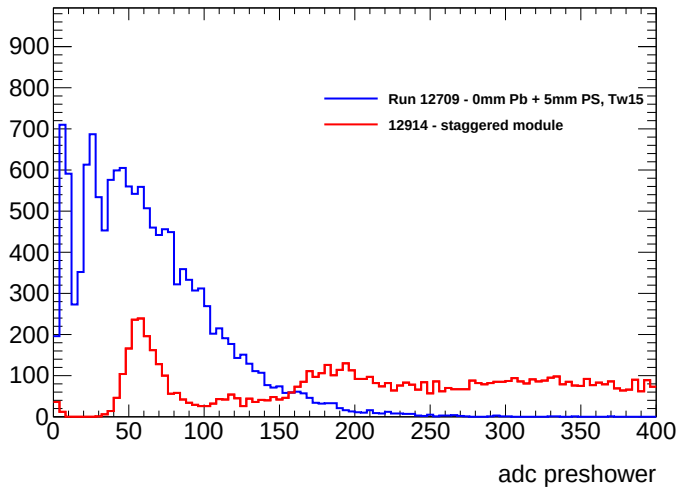
hadron category = "not electron or muon"

	preshower	muon ADC
electron	> 30	< 8
muon	< 20	> 10
hadron	< 20	< 5

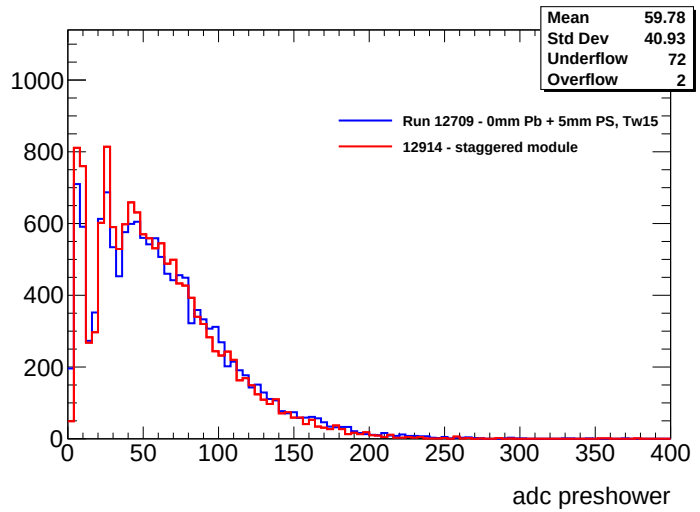
Preshower adc settings

- compare two electron runs: 12709 vs. 12914
- very different distributions for adc preshower (left-hand plot)
- expect that adc timing was changed between 12914 and previous run
- rescale adc preshower by 1/7.5 for run number $\geq$ 12914 for consistent cut (right-hand plot)

electron preshower adc



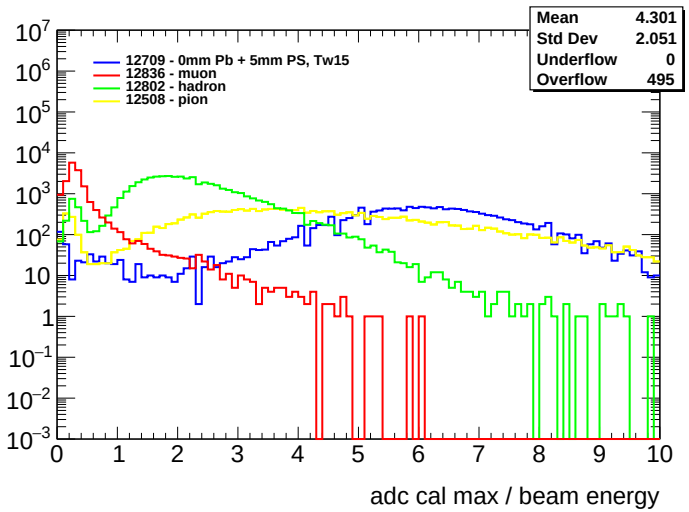
electron preshower adc - rescaled



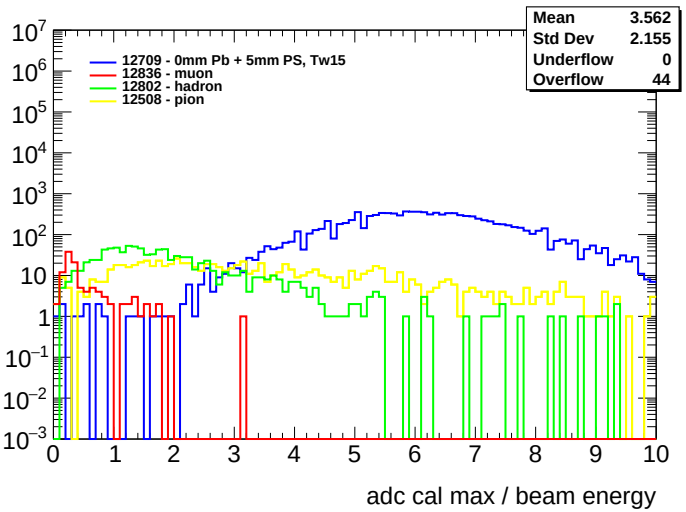
Calorimeter Selection

- compare electron, pion, hadron, muon run in RD52
- maximum adc counts in calorimeter normalised to beam energy
- clear muon peak at lower adc counts
- electrons tend to higher values

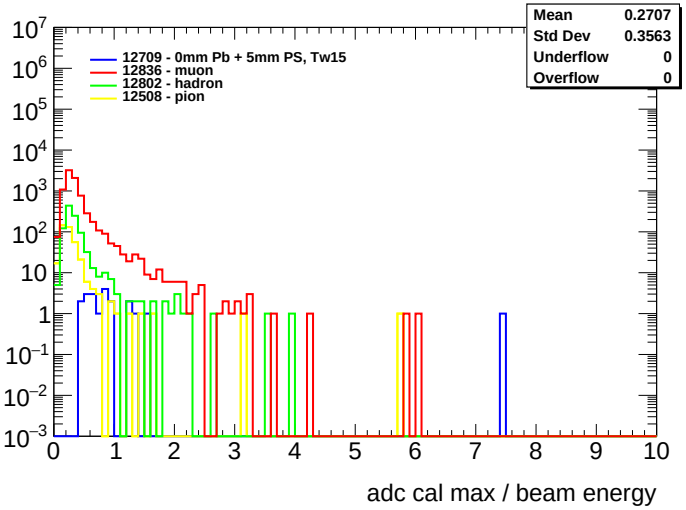
no cut



preshower adc > 30



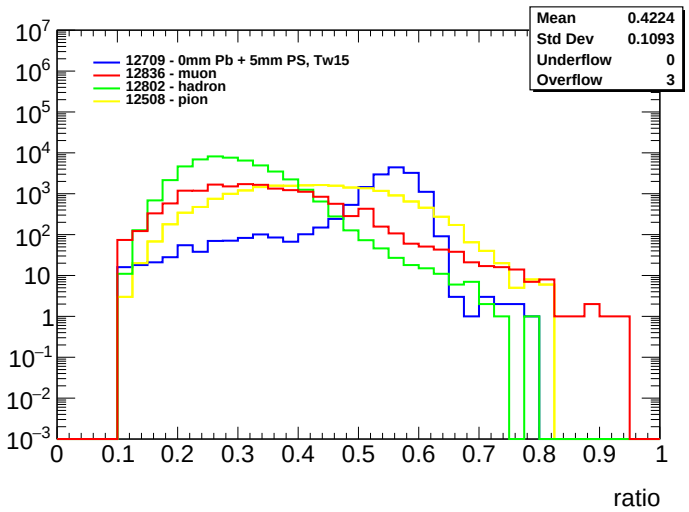
muon adc > 20



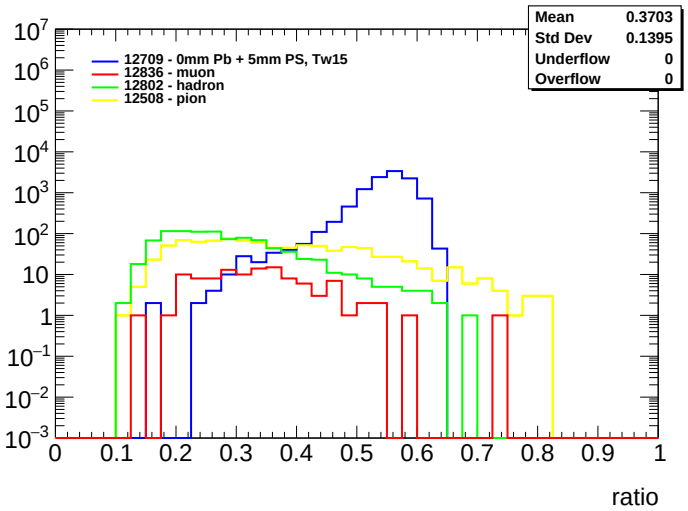
Calorimeter Selection

- compare electron, pion, hadron, muon run in RD52
- ratio of maximum calorimeter adc counts to sum of subleading ten
- good separation of electrons from other particles

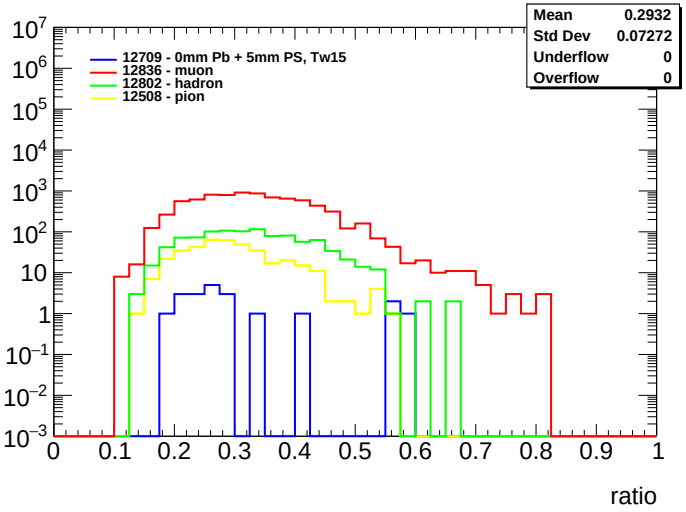
no cut



preshower adc > 30



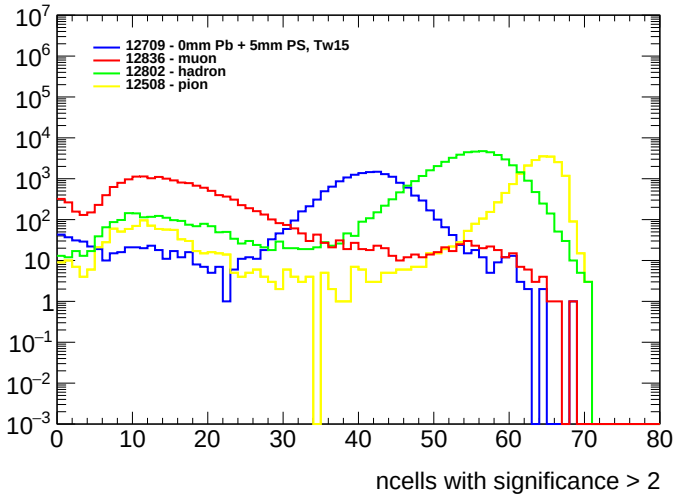
muon adc > 20



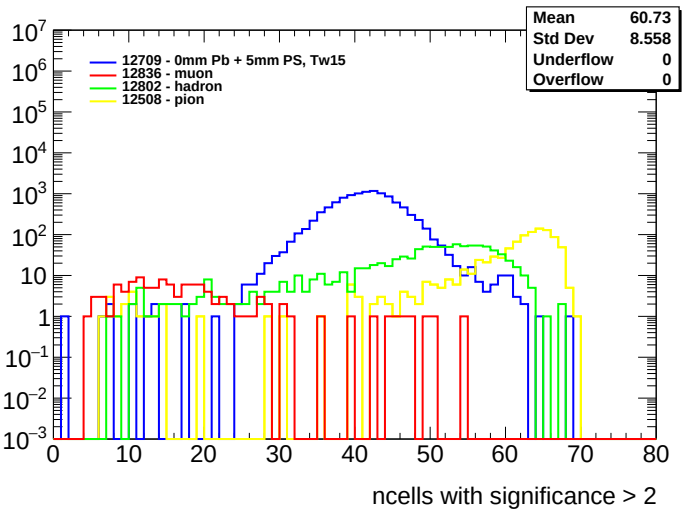
Calorimeter Selection

- compare electron, pion, hadron, muon run in RD52
- ncells with significance > 2
- additional separation between electrons and hadrons

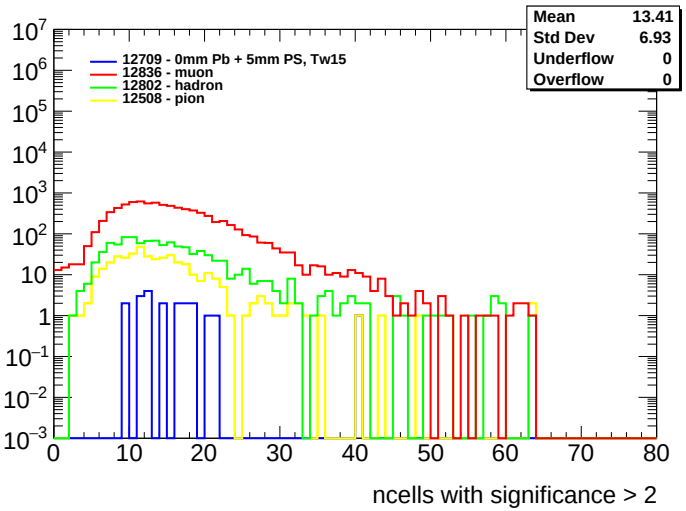
no cut



preshower adc > 30



muon adc > 20



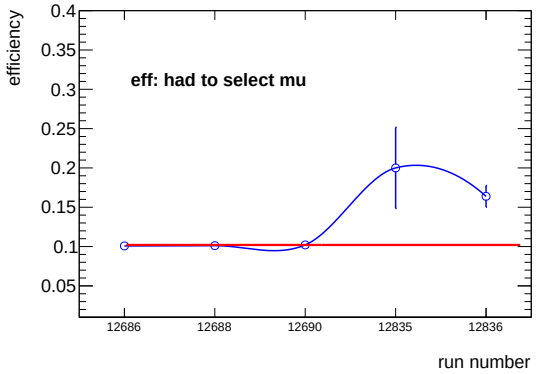
Efficiency Measurements

- apply tight calorimeter selections based on:
  - max calorimeter adc per beam energy
  - ratio of maximum calorimeter adc counts to subleading ten
  - number of cells with significance > 2
- selections are run dependent to reflect different conditions (eg. staggered module vs RD52)
- efficiency of X to select Y:
  - apply calorimeter selection for Y
  - measure efficiency for X to select Y by applying ancillary selection
- Measure efficiency in a collection of runs and check stability

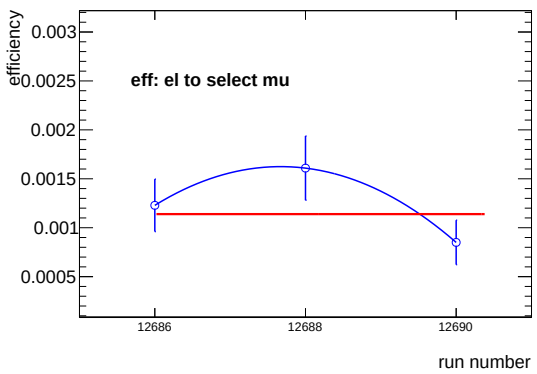
Muon efficiencies

- apply run dependent selection to obtain muon sample
- stable efficiency and fake rate for different runs
- high hadron fake rate

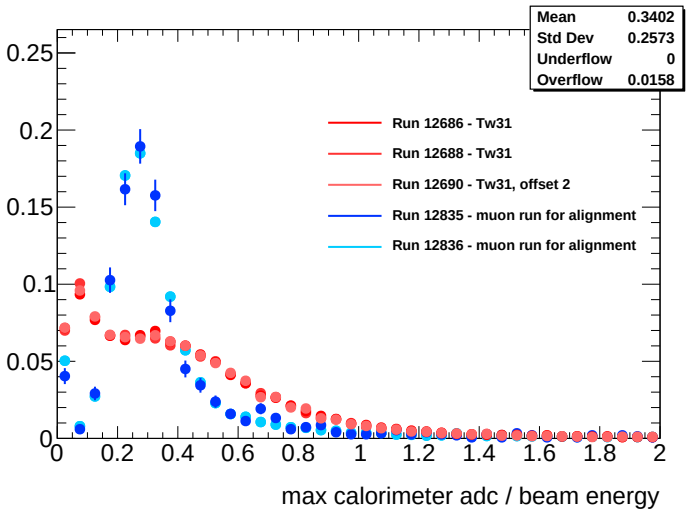
Hadron muon fake rate



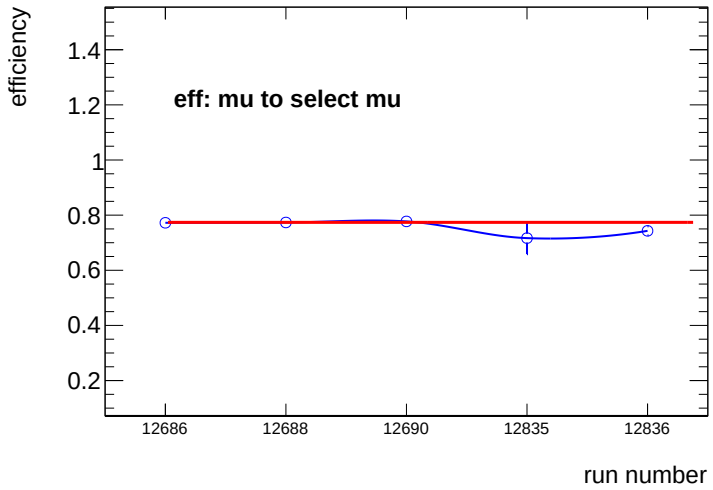
Electron muon fake rate



Muon runs



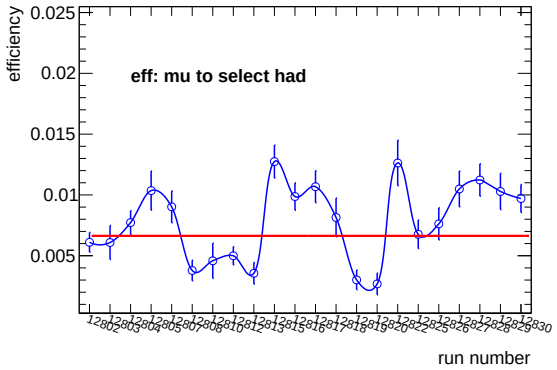
Muon ancillary selection efficiency



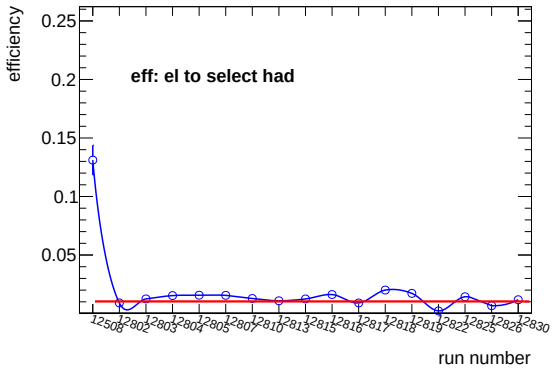
Hadron efficiencies

- measured in RD52 combined runs
- same calorimeter selection applied to obtain hadron sample
- efficiencies are roughly stable, jumpier than for muons

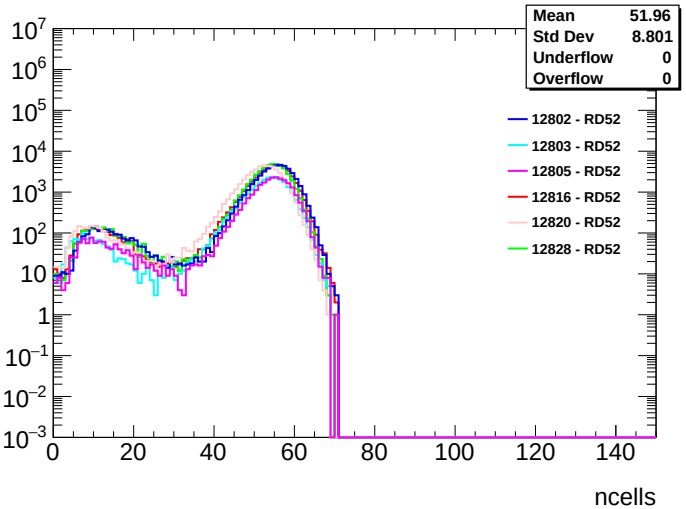
Muon hadron fake rate



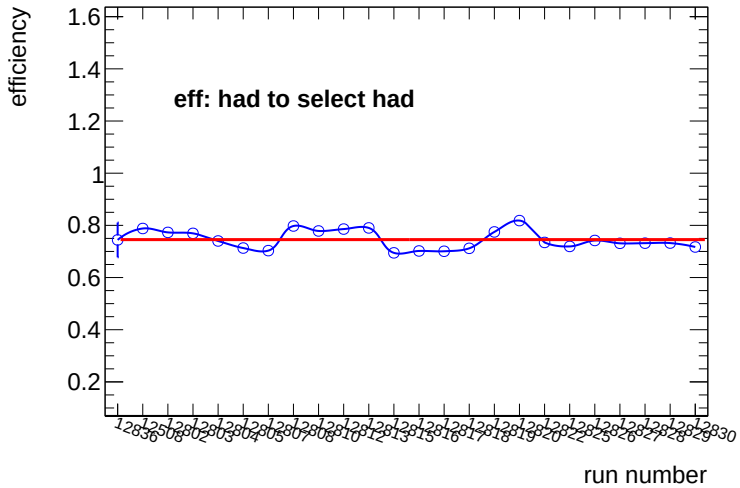
Electron hadron fake rate



Hadron runs - combined RD52



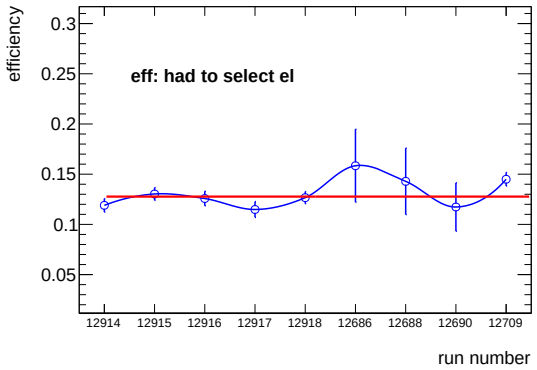
Hadron ancillary selection efficiency



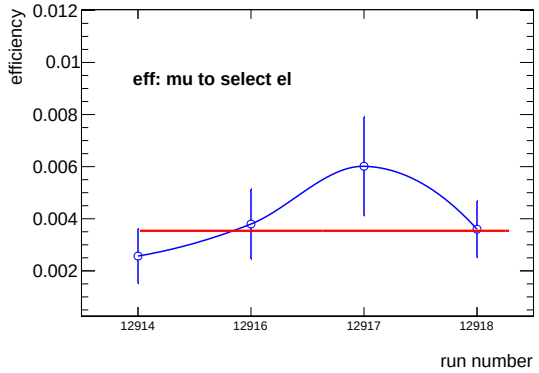
Electron efficiencies

- separate selection for RD52 and staggered module runs
- consistent measurements between the two collections of runs

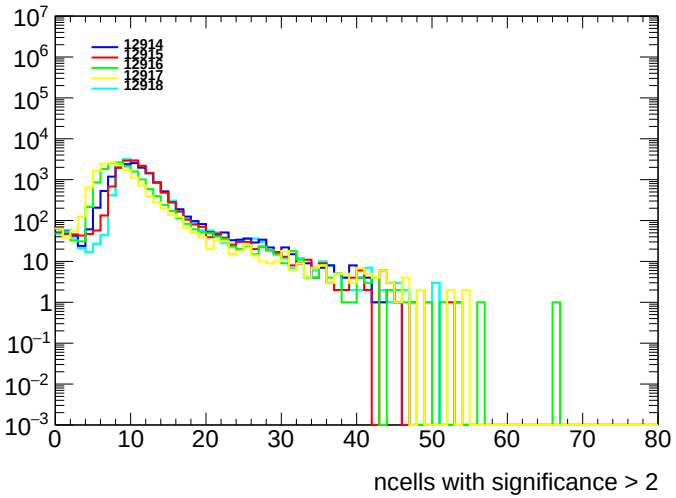
Hadron electron fake rate



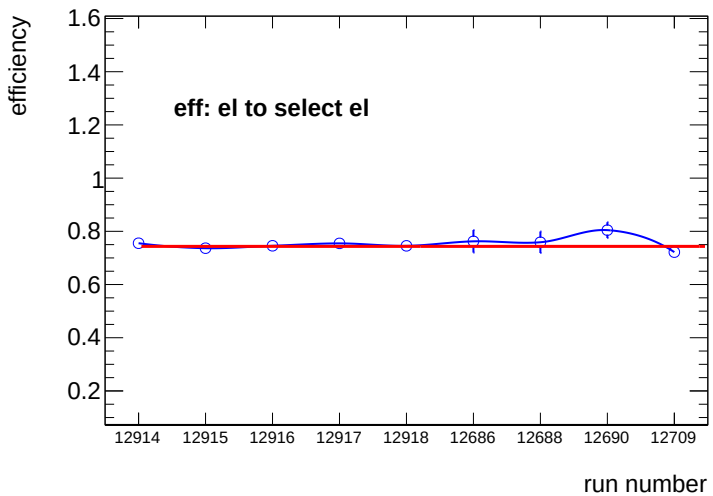
Muon electron fake rate



Electron runs - staggered module



Electron ancillary selection efficiency



Determination of beam compositions

- Total events from a run: $N = N_e + N_h + N_\mu$
- Event yield k_i for a given particle given approximately by:

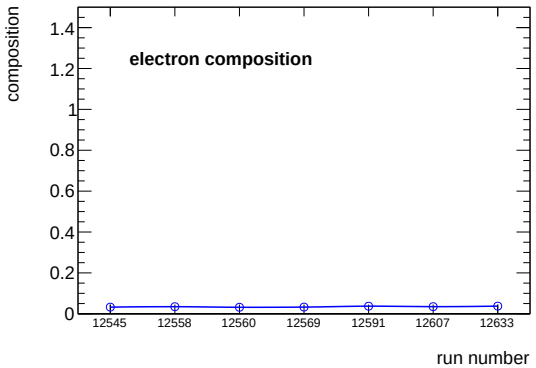
$$\begin{pmatrix} k_e \\ k_h \\ k_\mu \end{pmatrix} = \Lambda . \begin{pmatrix} N_e \\ N_h \\ N_\mu \end{pmatrix}; \qquad \Lambda = \begin{pmatrix} 0.743 & 0.010 & 0.001 \\ 0.128 & 0.745 & 0.102 \\ 0.004 & 0.007 & 0.774 \end{pmatrix}$$

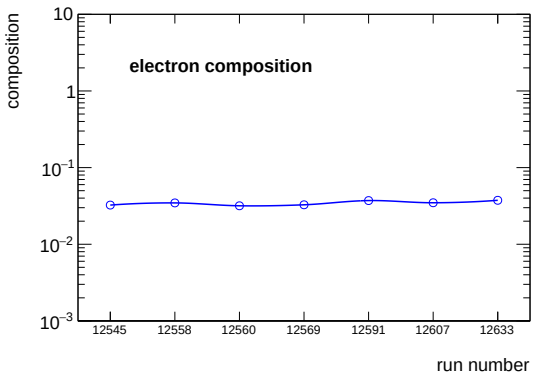
$$\vec{N} = \Lambda^{-1} . \vec{k}; \qquad \Lambda^{-1} = \begin{pmatrix} 1.348 & -0.019 & 0.000 \\ -0.231 & 1.346 & -0.177 \\ -0.004 & -0.011 & 1.294 \end{pmatrix}$$

Compositions in RD52 e/π 80 GeV runs

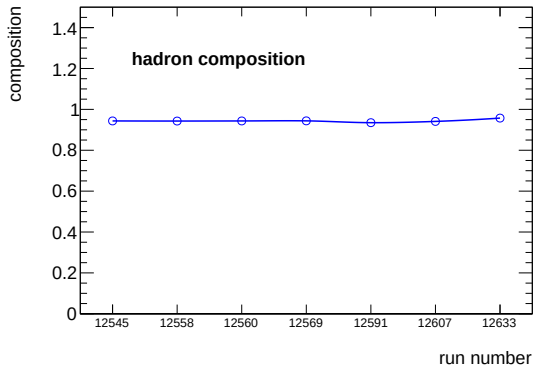
- selected runs
- plots show fraction of each particle category
- very stable composition for these runs
- very pure in hadrons

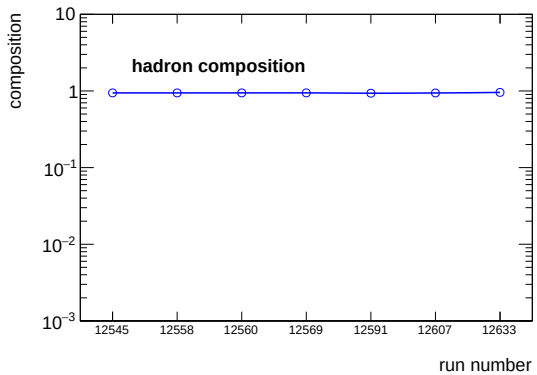
Electrons



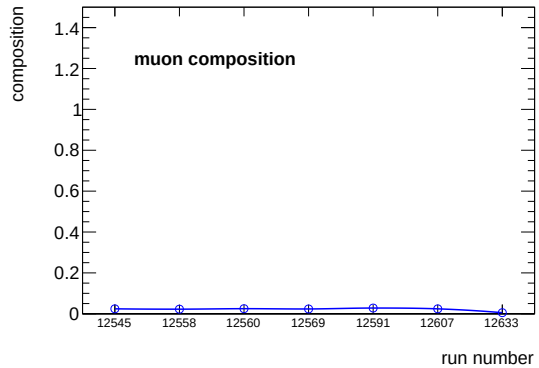


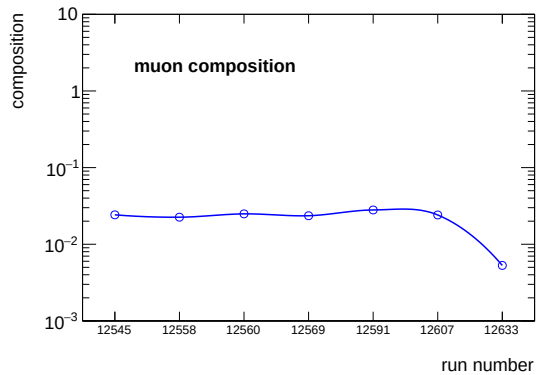
Hadrons





Muons

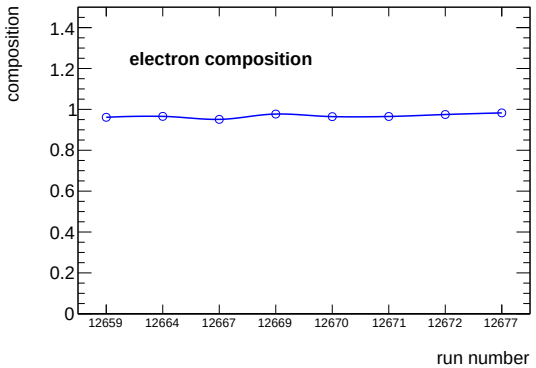


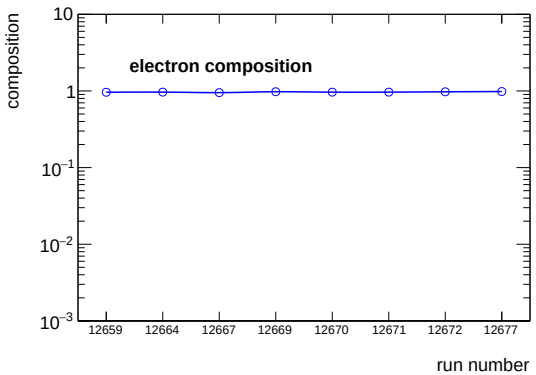


Compositions in RD52 e 20 GeV runs

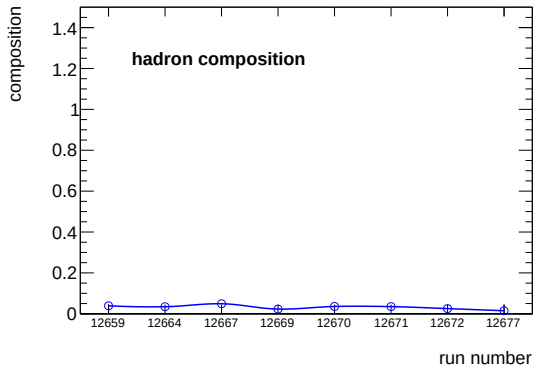
- plots show fraction of each particle category
- very stable composition for these runs
- very pure in electrons

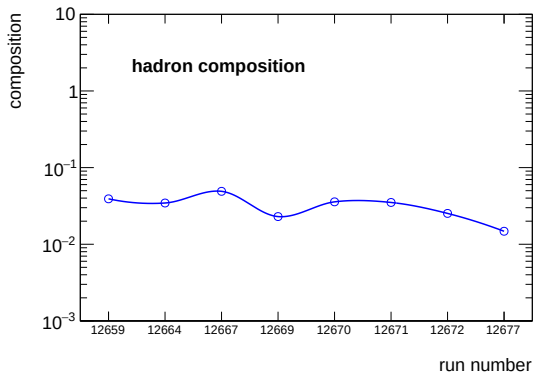
Electrons



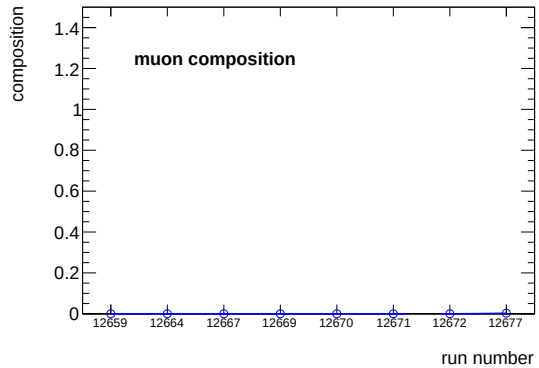


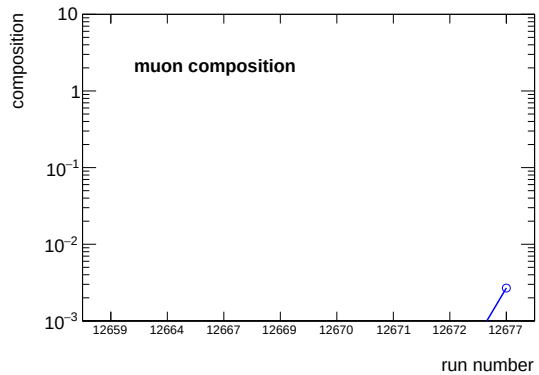
Hadrons





Muons

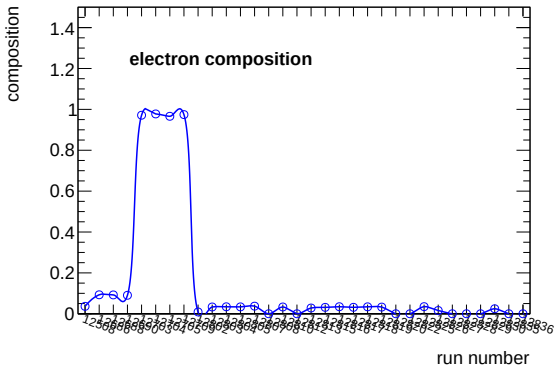


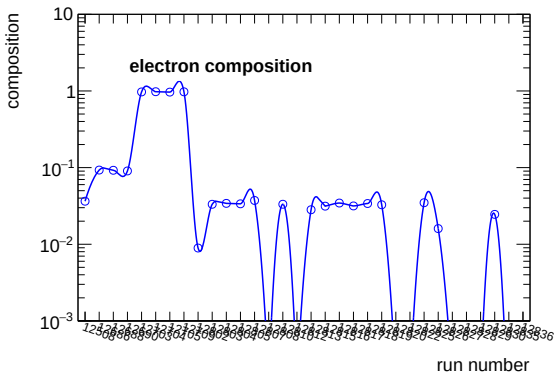


Compositions in RD52 combined runs

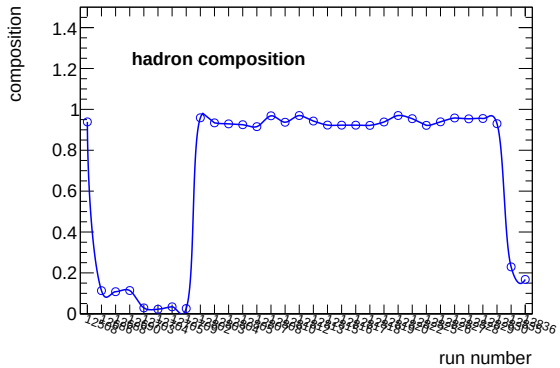
- plots show fraction of each particle category
- electron, hadron and muon runs can be clearly identified

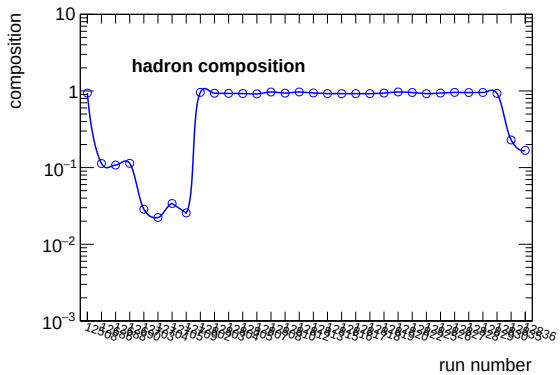
Electrons



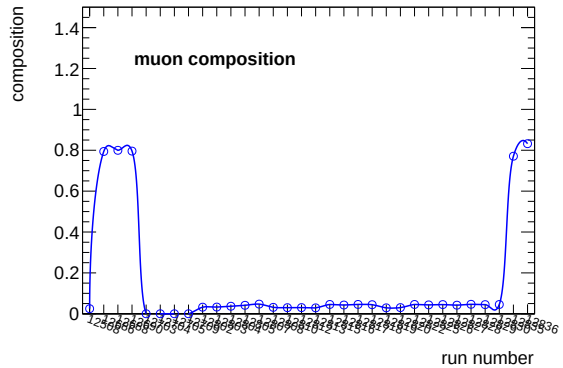


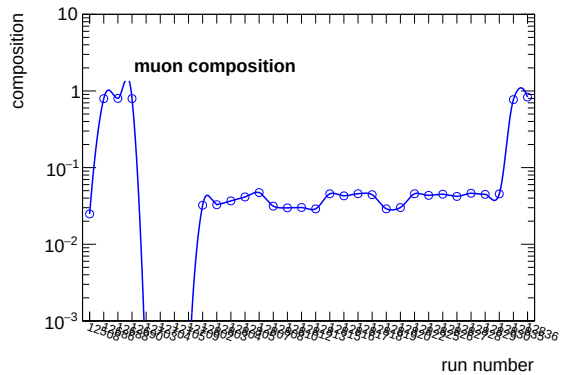
Hadrons





Muons

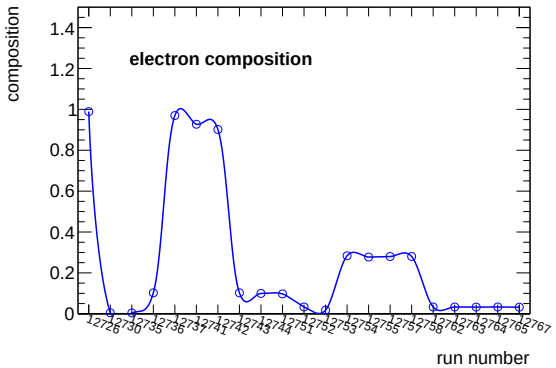


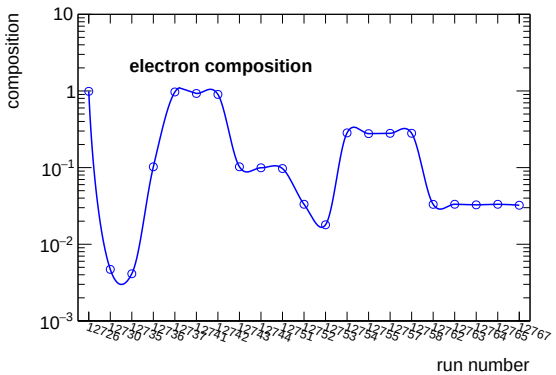


Compositions in SiPM runs

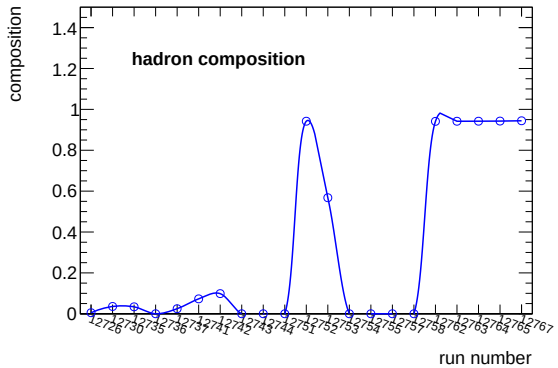
- selected runs
- plots show fraction of each particle category
- some "pion" runs appear to be mostly muons
  - eg. 12730, 12735

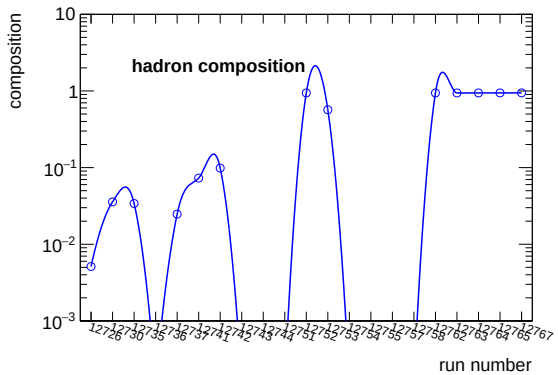
Electrons



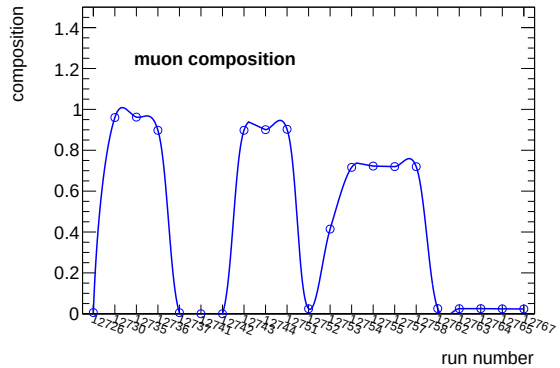


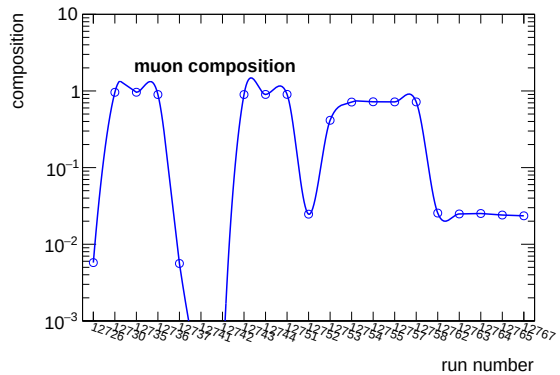
Hadrons





Muons

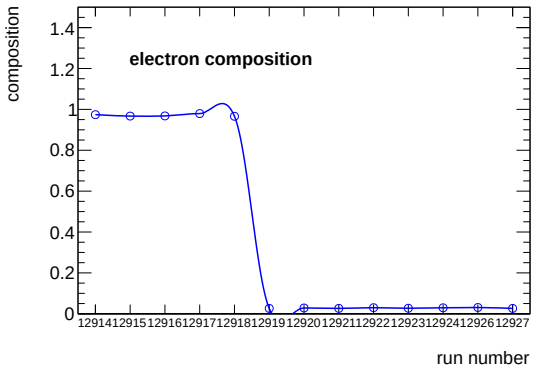


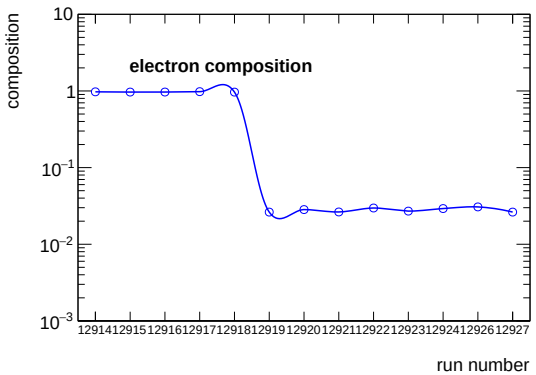


Compositions in staggered module runs

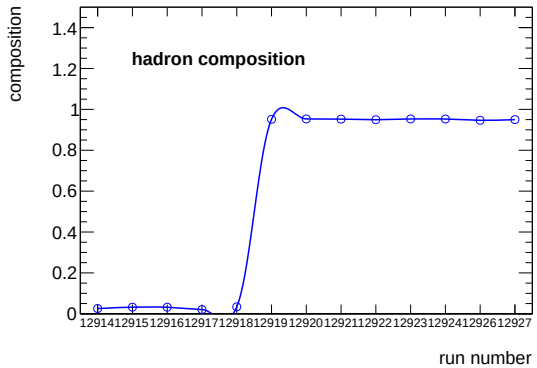
- plots show fraction of each particle category
- compositions agree with labelling in twiki, very pure

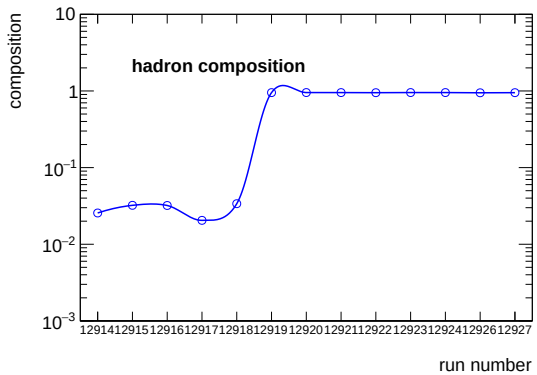
Electrons



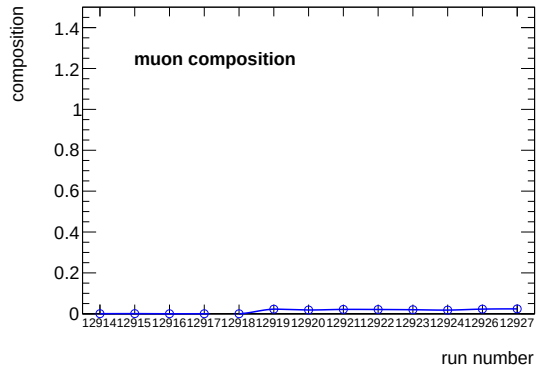


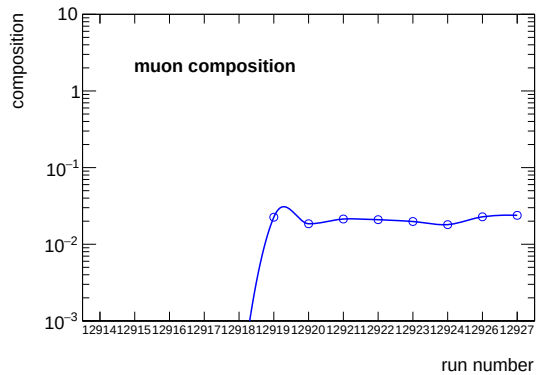
Hadrons





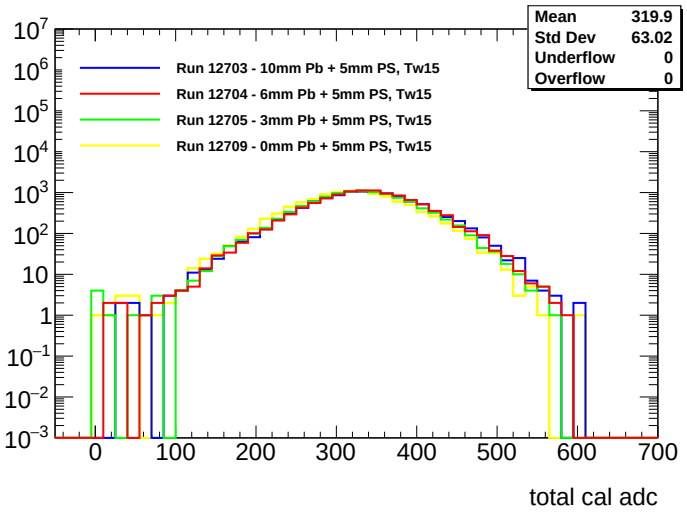
Muons

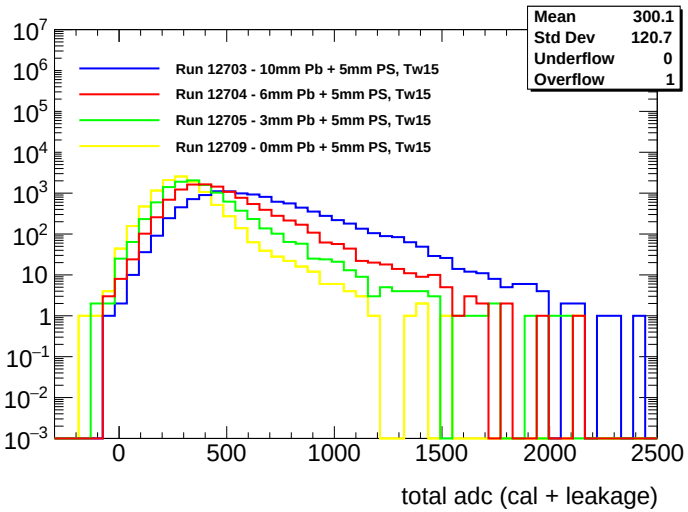


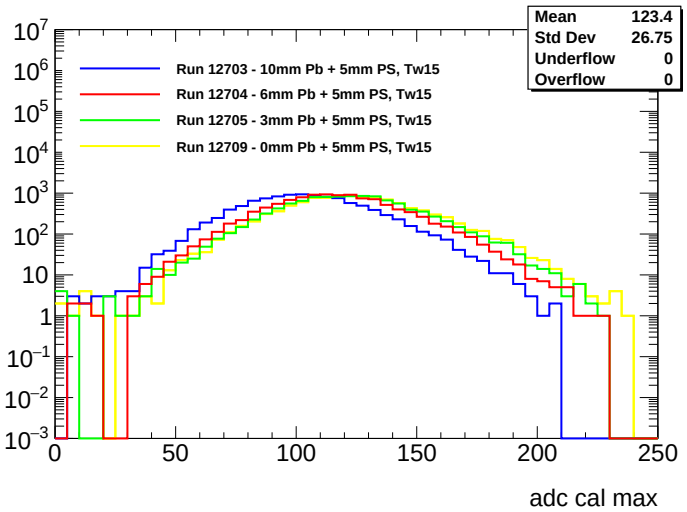


RD52 response to electron beams with Pb

- compare calorimeter response to electrons with 0,3,6,10 mm intervening lead
- similar distribution for total calorimeter adc (summing a lot of noise)
- larger response for less Pb
- higher leakage for more Pb







Conclusions

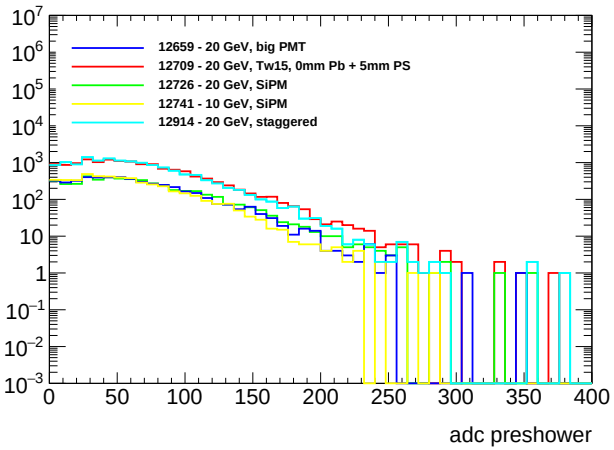
- efficiencies and compositions measured for all runs
  - consistent with twiki labelling except for some SiPM runs that appear to contain mostly muons
  - most runs look to have high purity particle category
- TODOs:
  - finish integrating into merging code
  - estimate uncertainties on compositions
  - add CEDAR to ancillary selection in runs where available (combined RD52 hadron run + staggered module runs)
    - should help to understand how much of the "hadron" category is genuinely a hadron
- many more plots for leakage, CEDAR, total adc, etc. included in backup

Backup

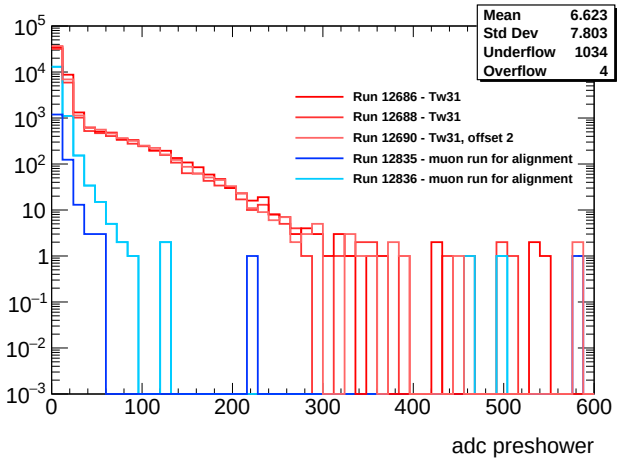
adc preshower plots - no cut

- edge at high adc counts for rescaled runs
- different distributions for electron rich runs vs. hadron tail

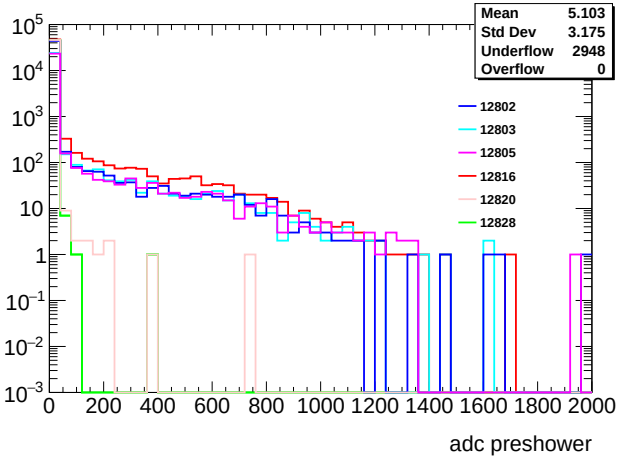
selected electron runs



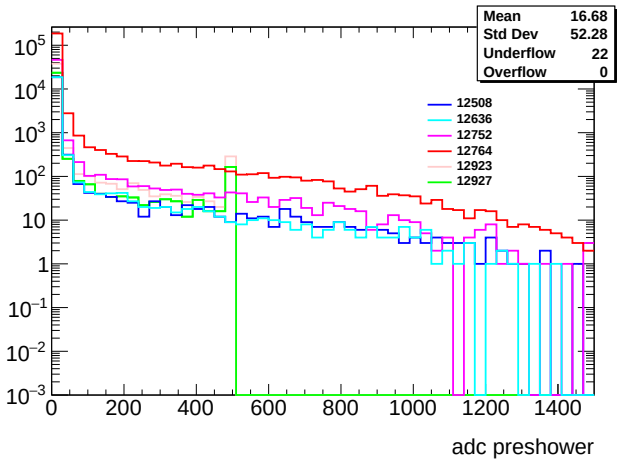
muon runs



selected hadron runs

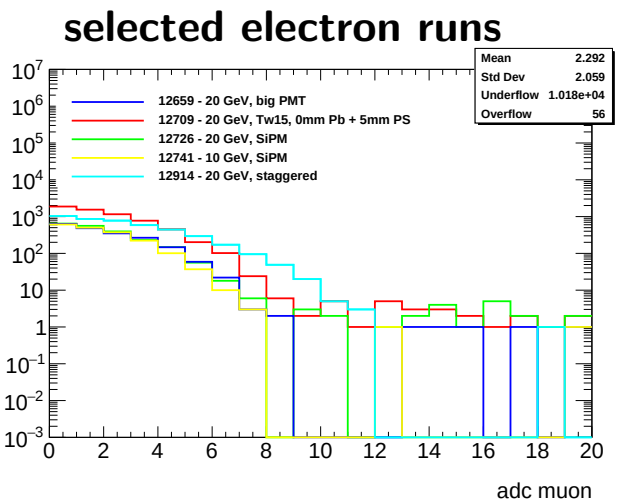


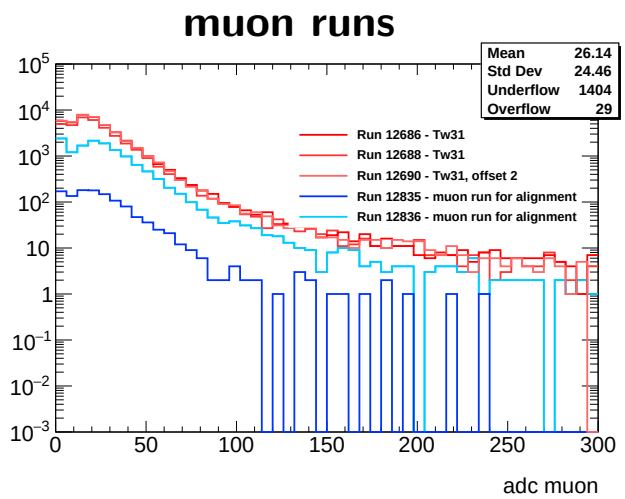
selected pion runs

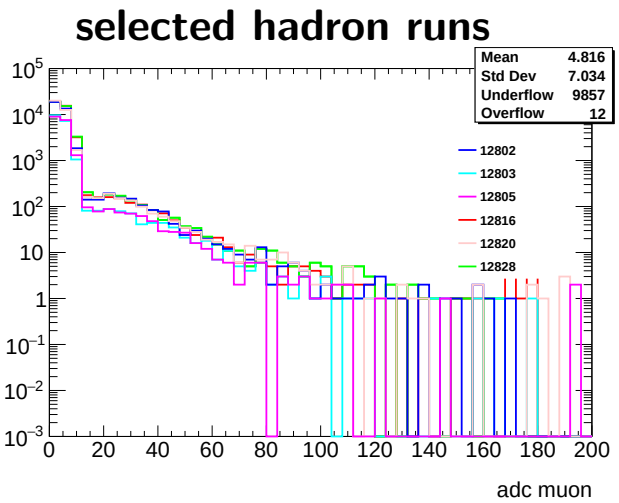


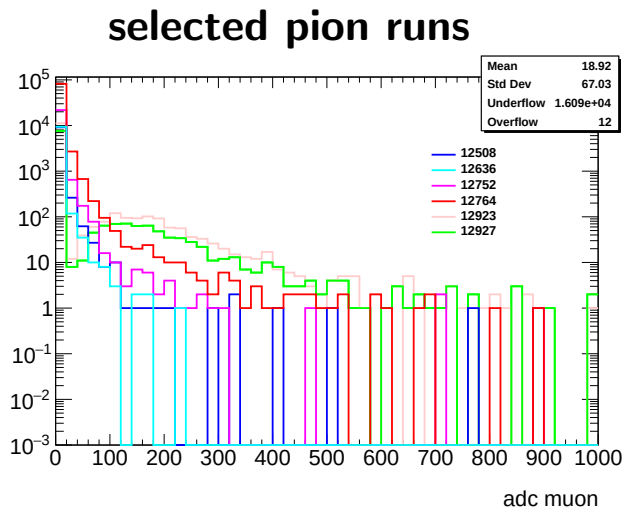
adc muon plots - no cut

- may be necessary to rescale muon adc in staggered module runs too
- electron runs have negligible muon content





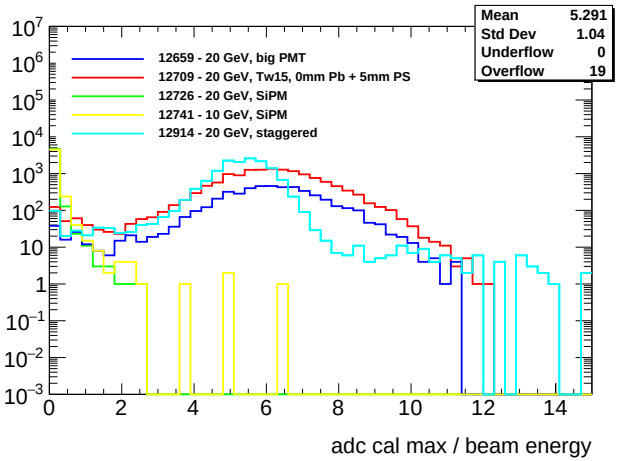




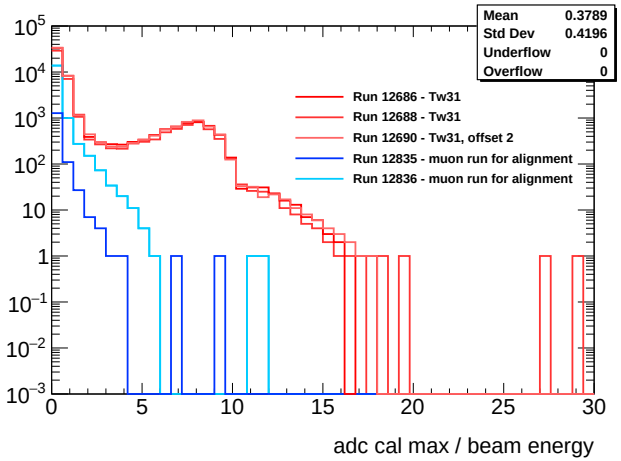
adc cal max plots - no cut

- may be necessary to rescale muon adc in staggered module runs too
- electron runs have negligible muon content

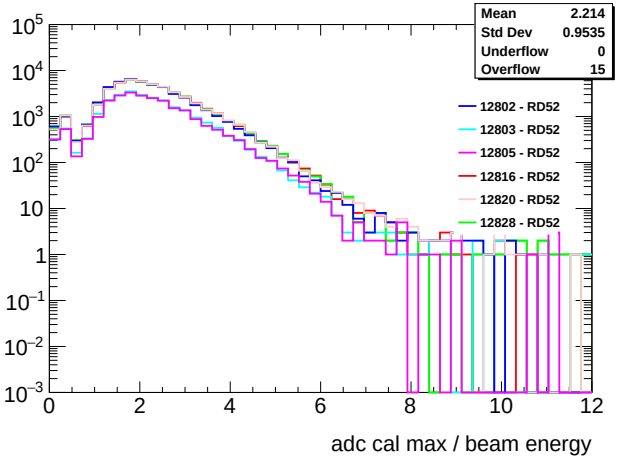
selected electron runs



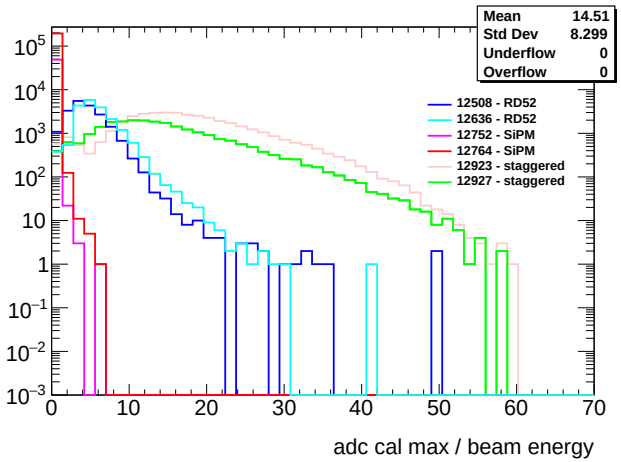
muon runs



selected hadron runs



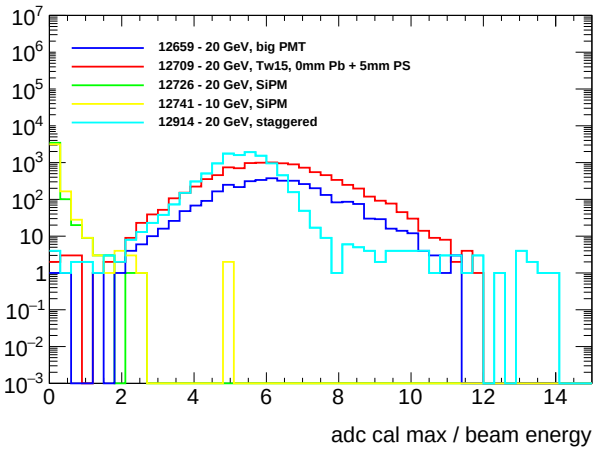
selected pion runs



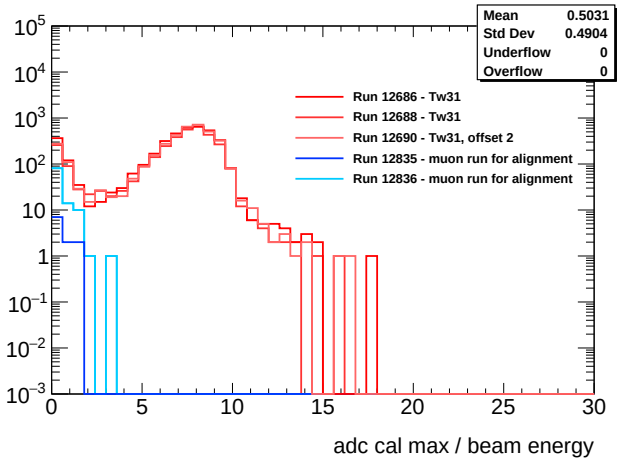
adc cal max plots - adc preshower > 30

- may be necessary to rescale muon adc in staggered module runs too
- electron runs have negligible muon content

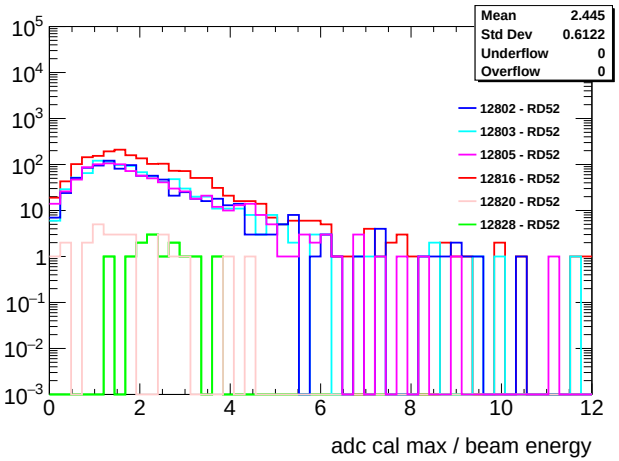
selected electron runs



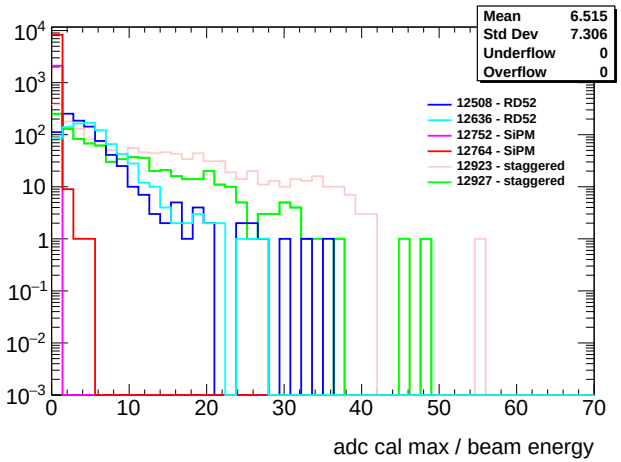
muon runs



selected hadron runs

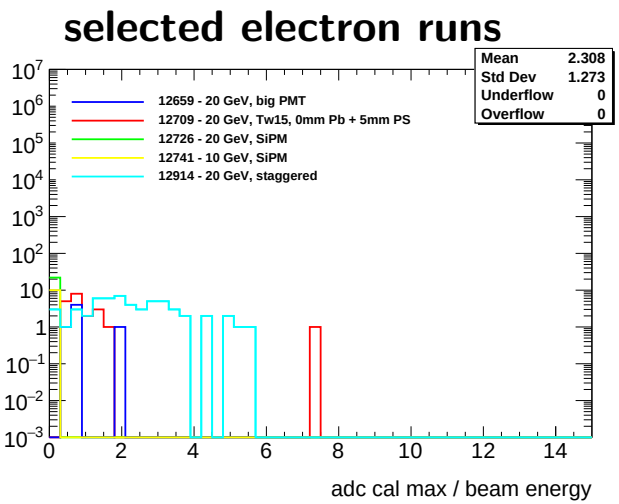


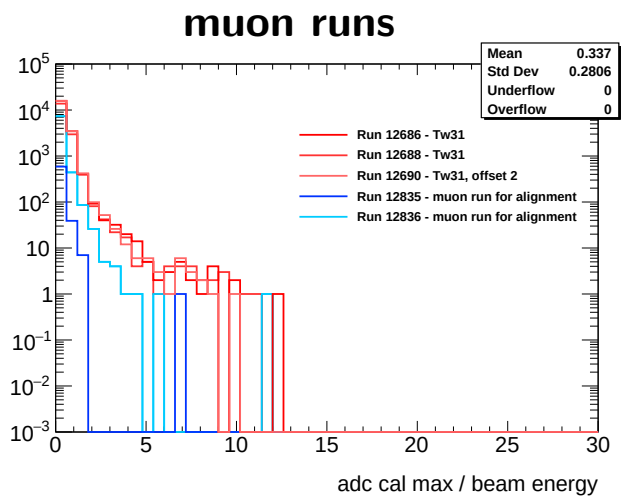
selected pion runs

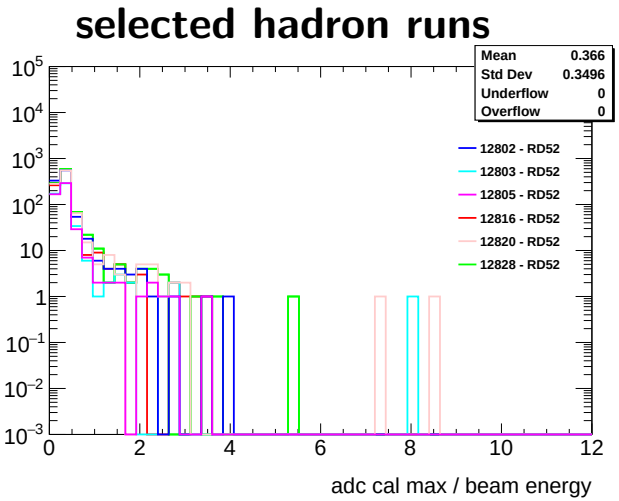


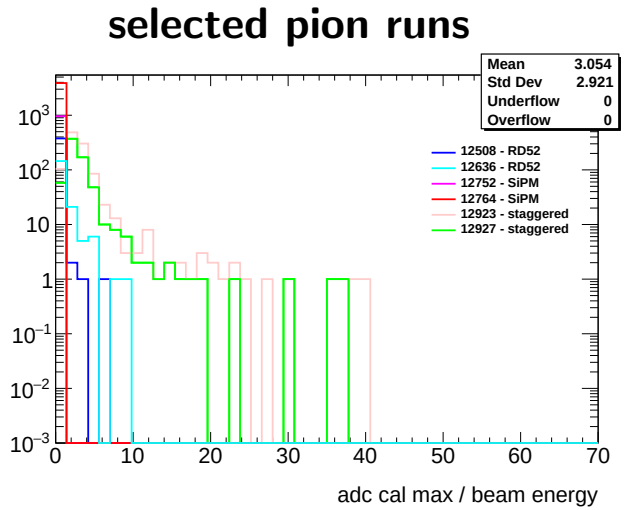
adc cal max plots - adc muon > 20

- may be necessary to rescale muon adc in staggered module runs too
- electron runs have negligible muon content





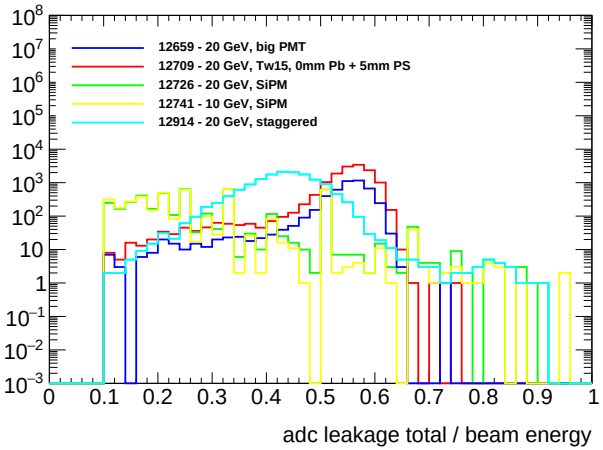




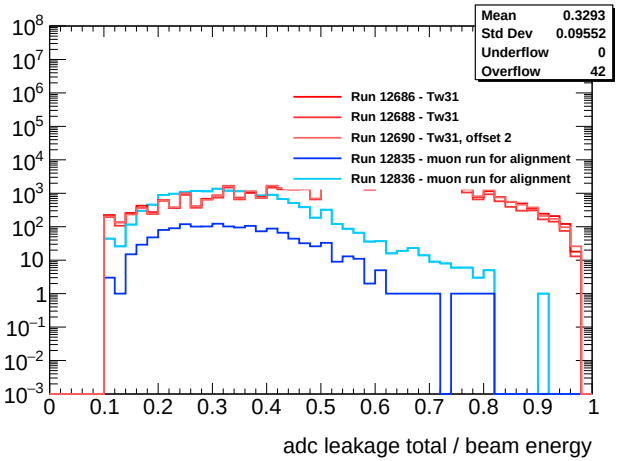
adc cal max ratio10 plots - no cut

- effect of the geometry of the module can be seen in the ratio variable

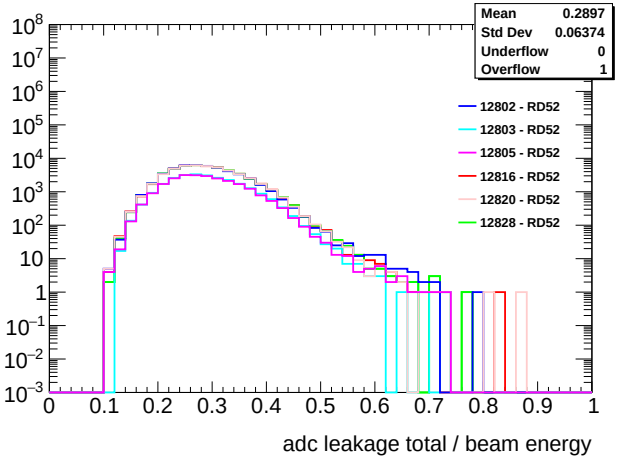
selected electron runs



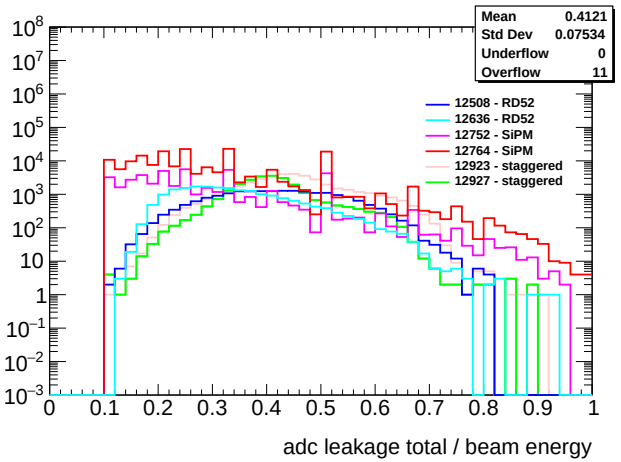
muon runs



selected hadron runs

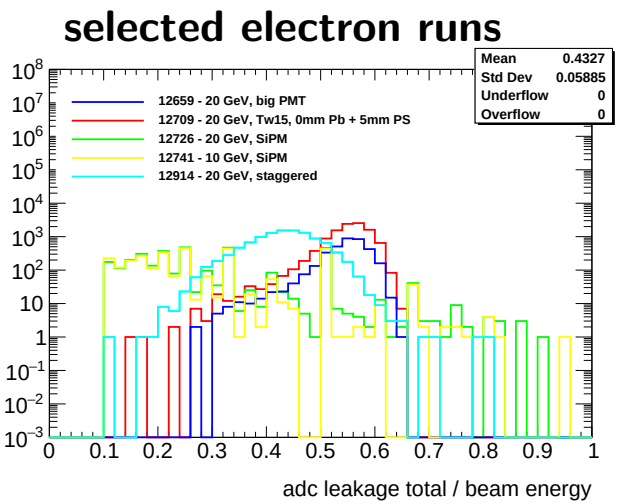


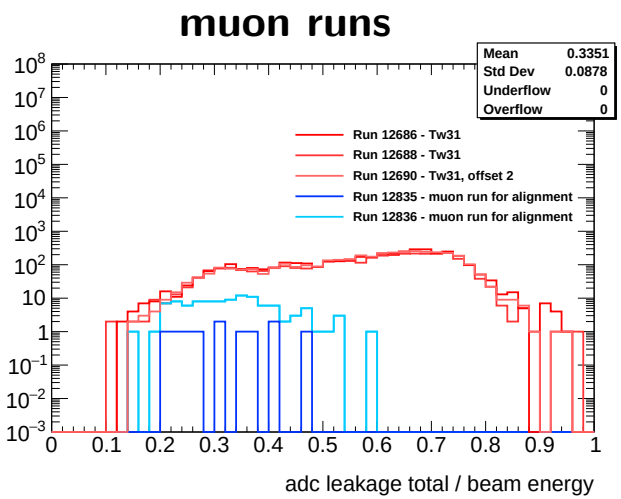
selected pion runs

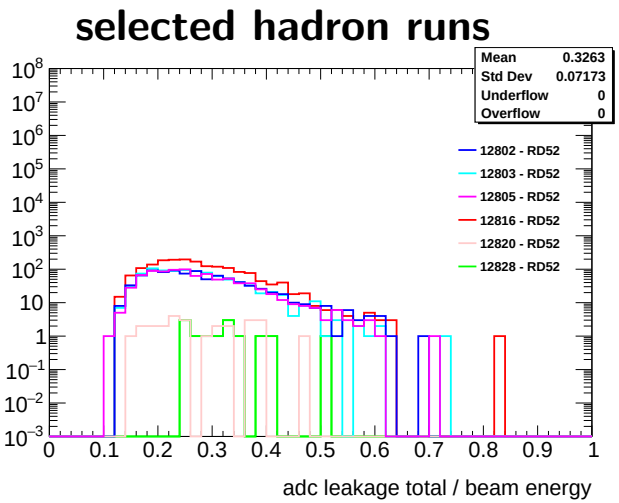


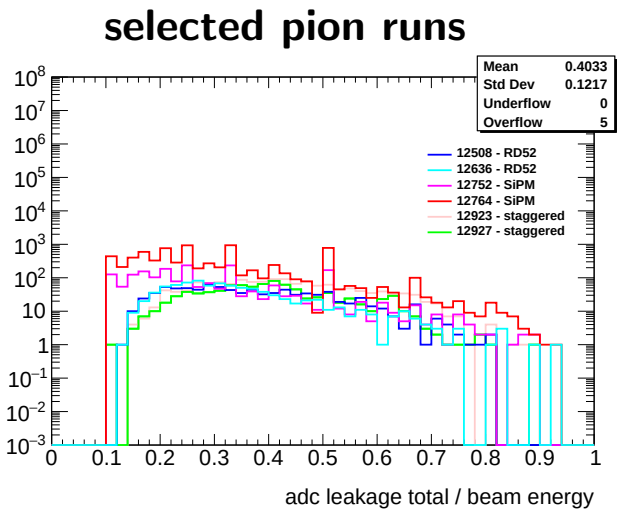
adc cal max ratio10 plots - adc preshower > 30

- effect of the geometry of the module can be seen in the ratio variable



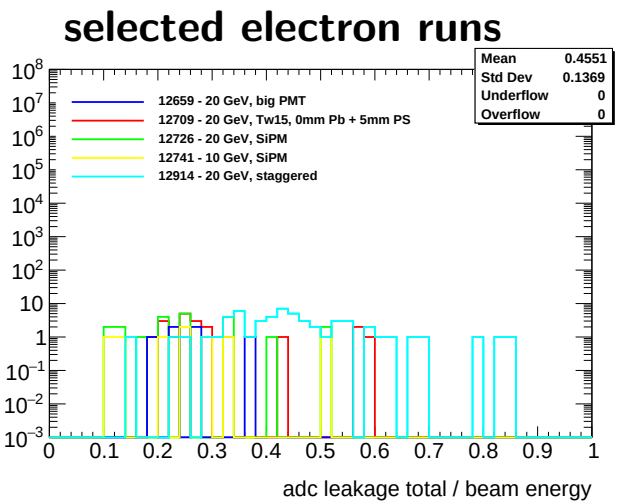


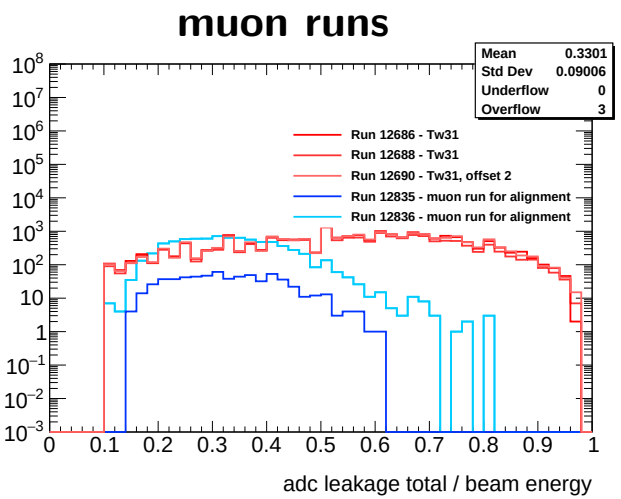


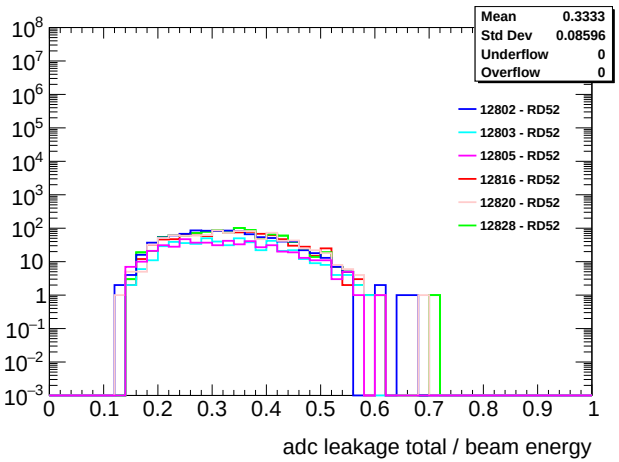


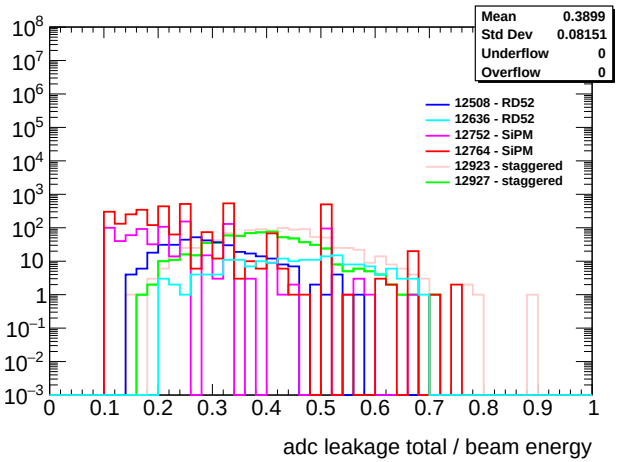
adc cal max ratio10 plots - adc muon > 20

- effect of the geometry of the module can be seen in the ratio variable





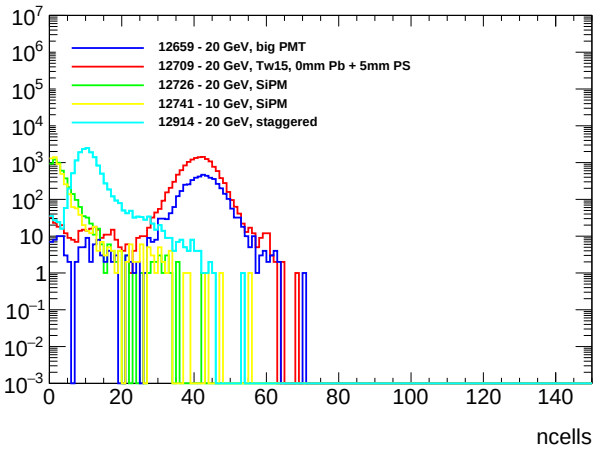




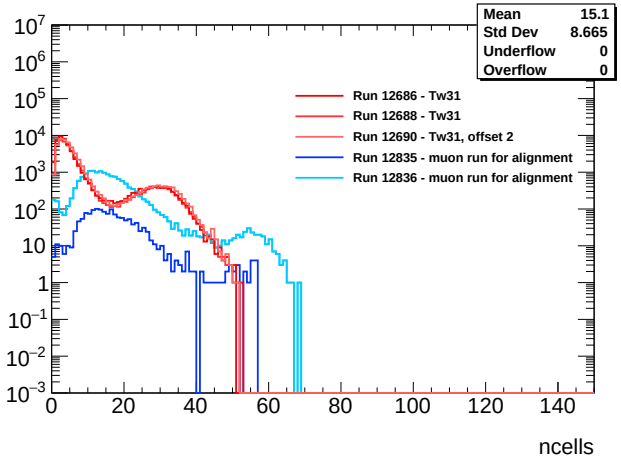
ncells plots - no cut

- added in run 12767

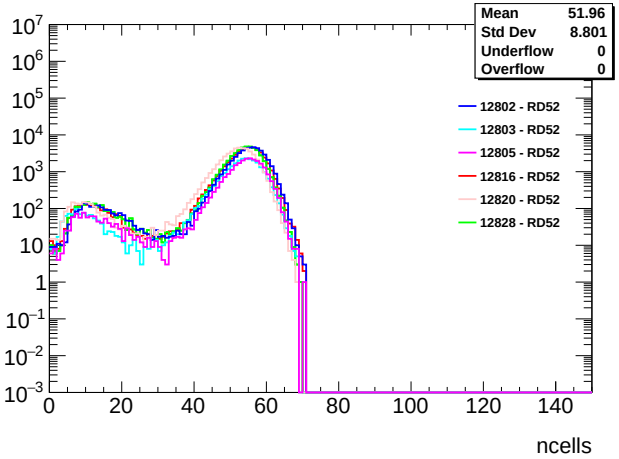
selected electron runs



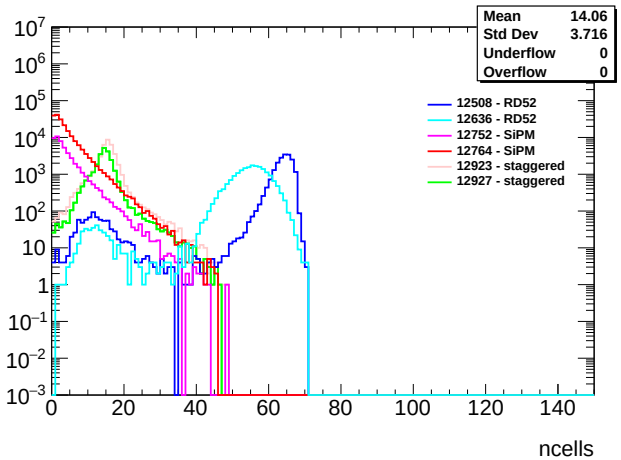
muon runs



selected hadron runs

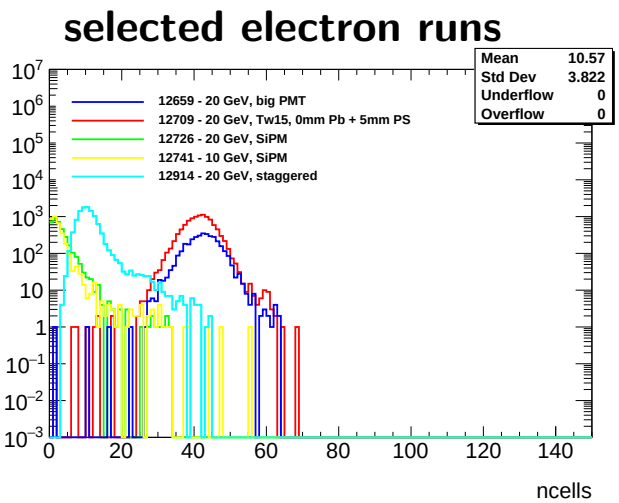


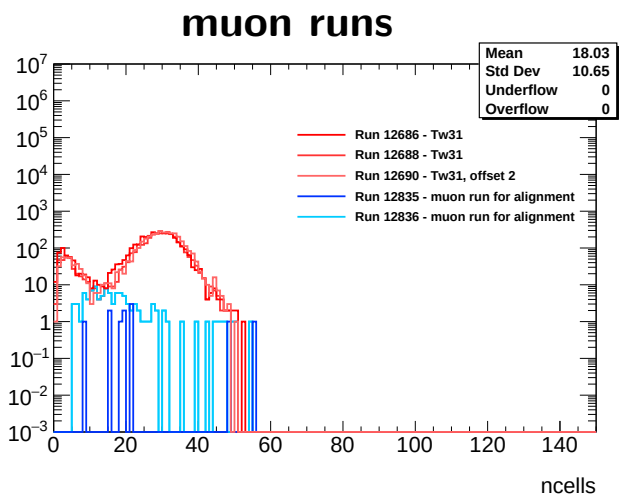
selected pion runs

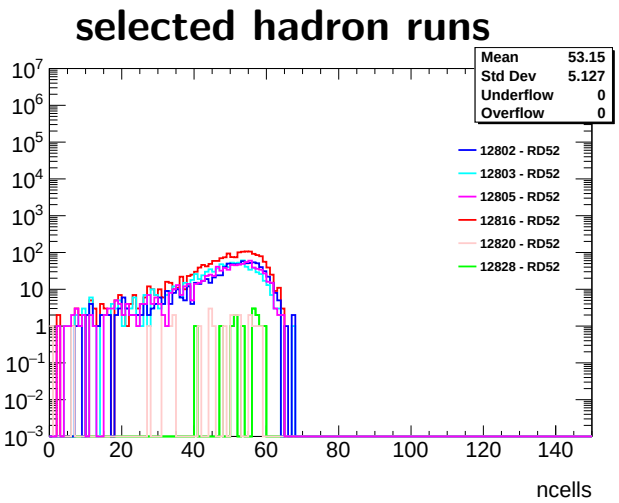


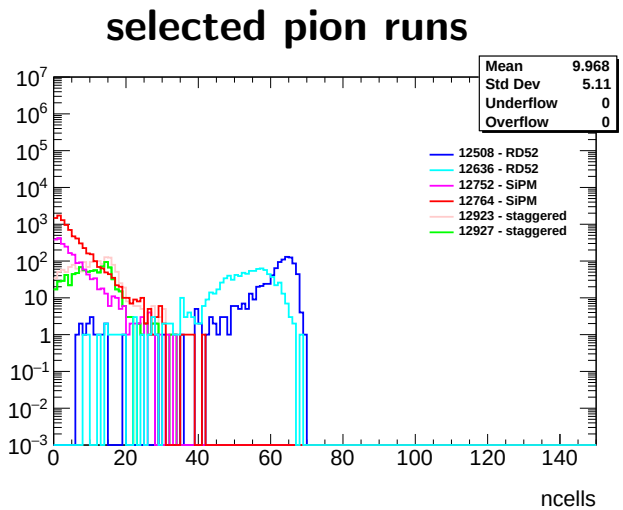
ncells plots - adc preshower > 30

- added in run 12767



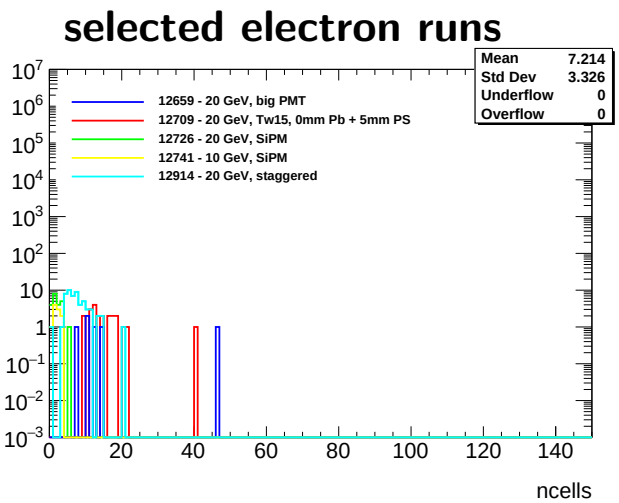


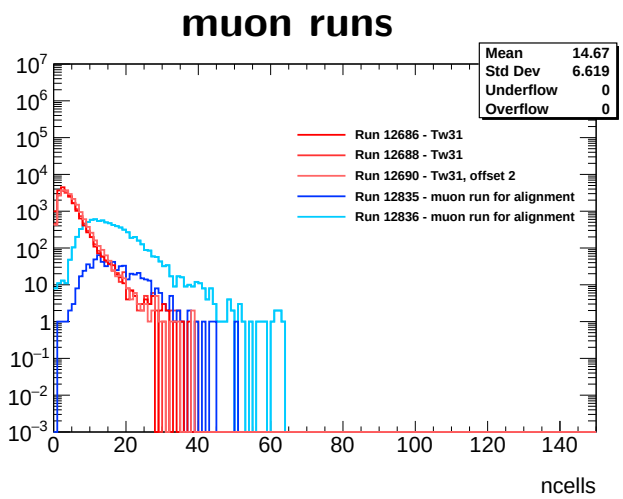


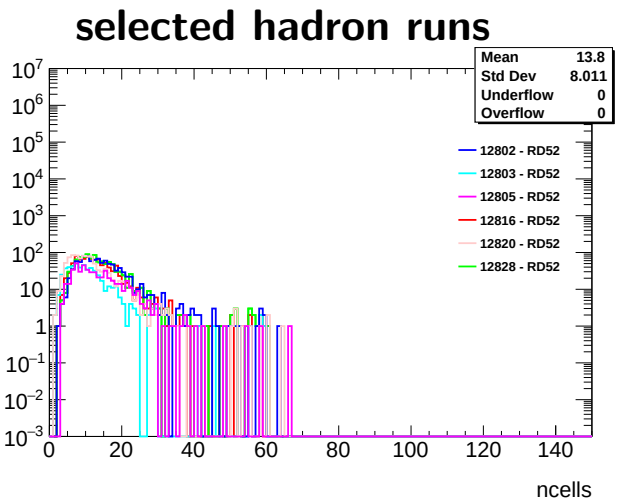


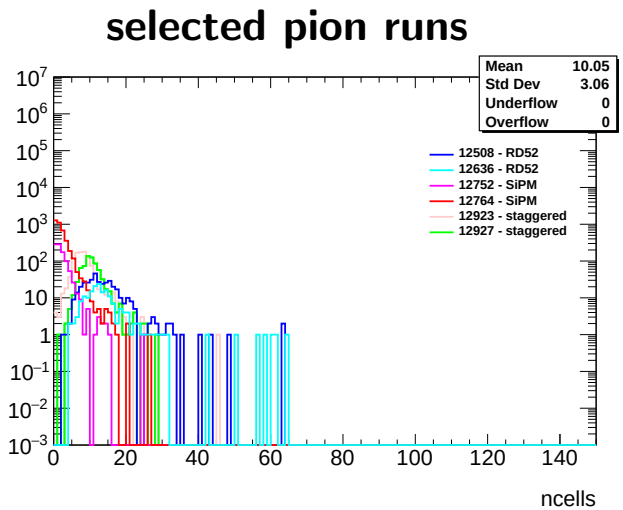
ncells plots - adc muon > 20

- added in run 12767





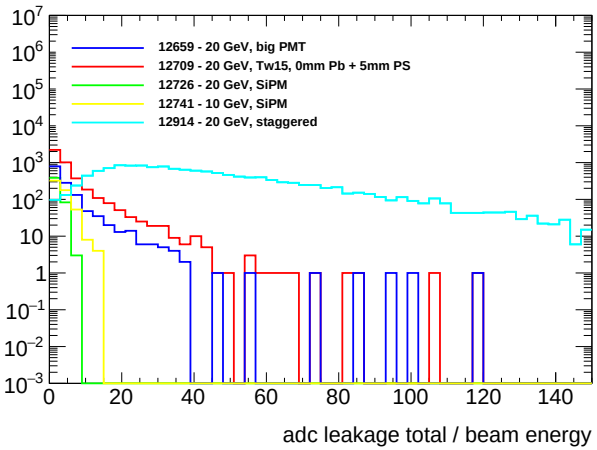




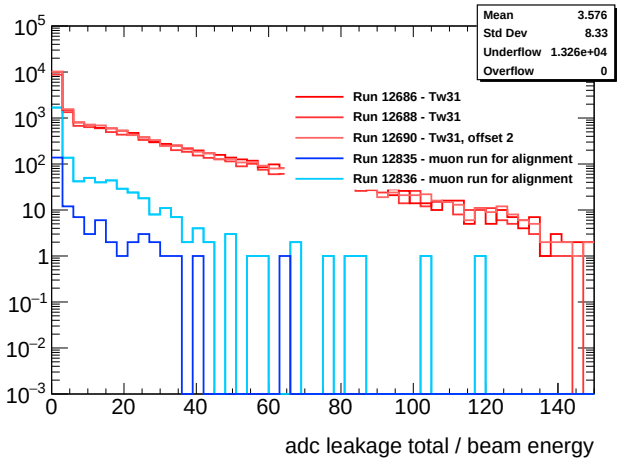
adc leak tot plots - no cut

- possibly all adc should be rescaled for staggered module runs
- greater leakage for runs aimed at Tw31, as expected

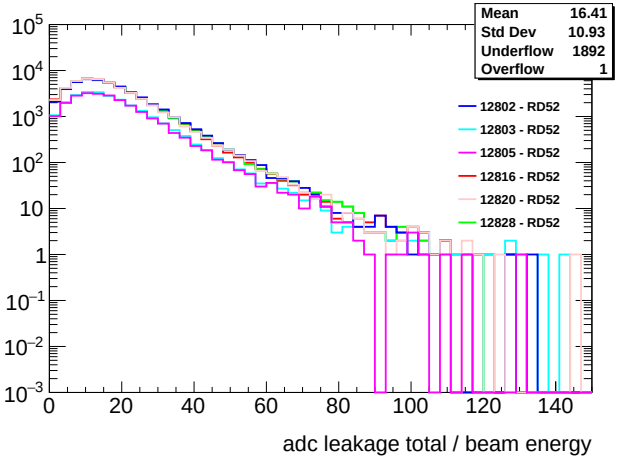
selected electron runs



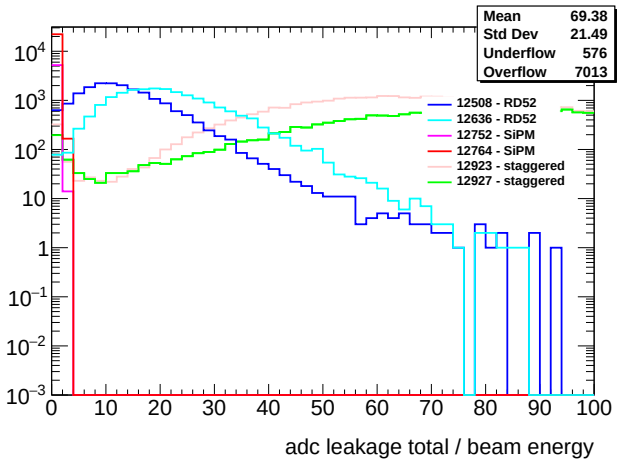
muon runs



selected hadron runs

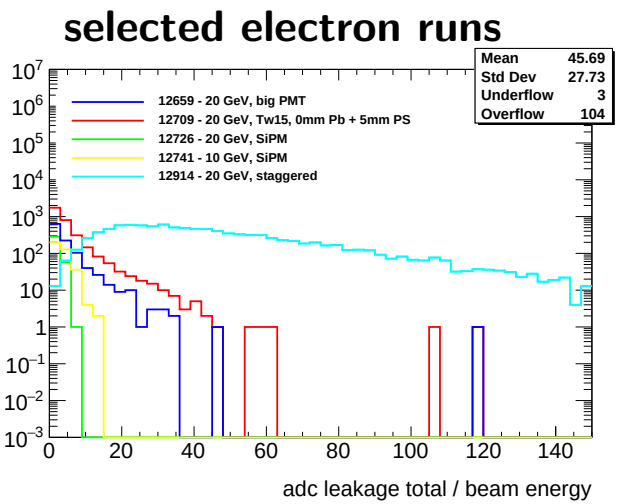


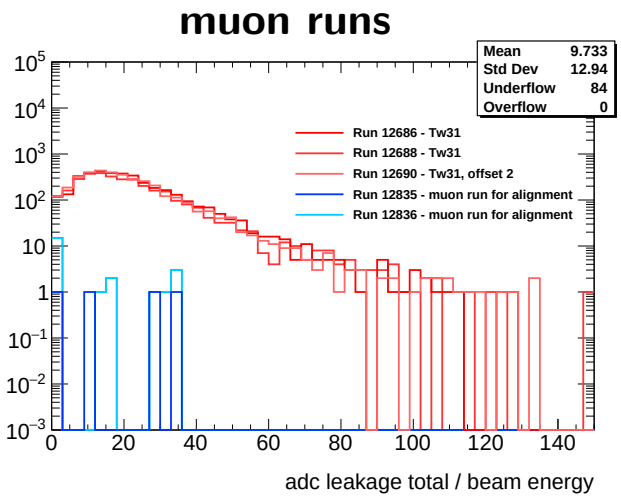
selected pion runs

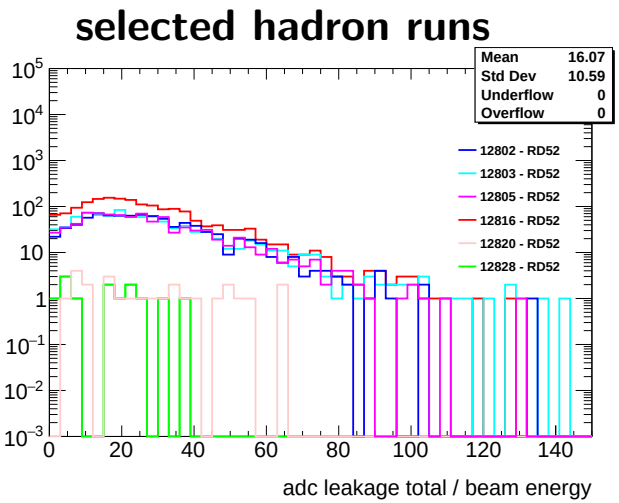


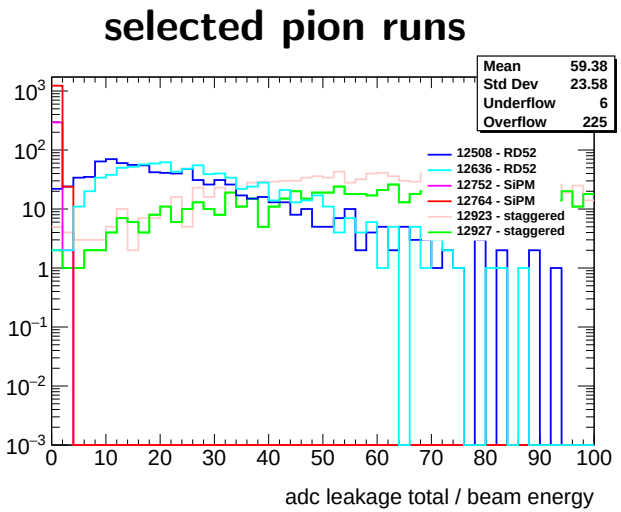
adc leak tot plots - adc preshower > 30

- possibly all adc should be rescaled for staggered module runs
- greater leakage for runs aimed at Tw31, as expected



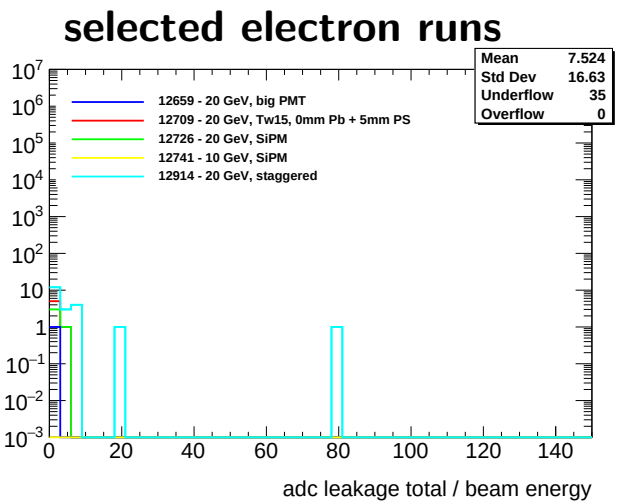


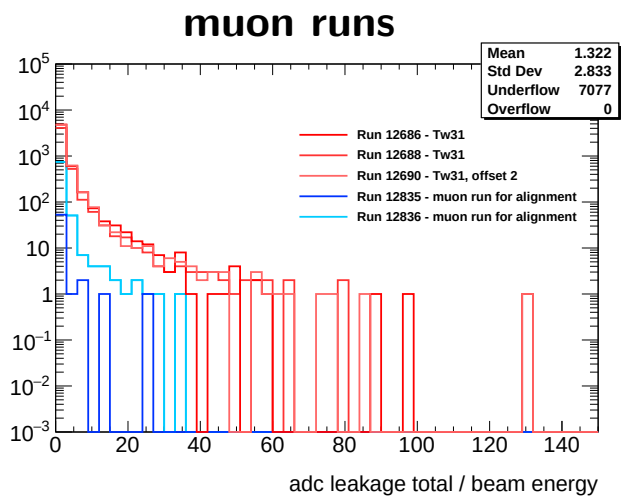


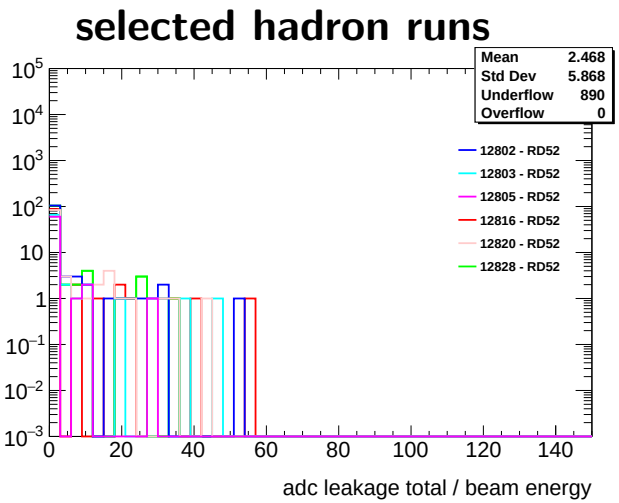


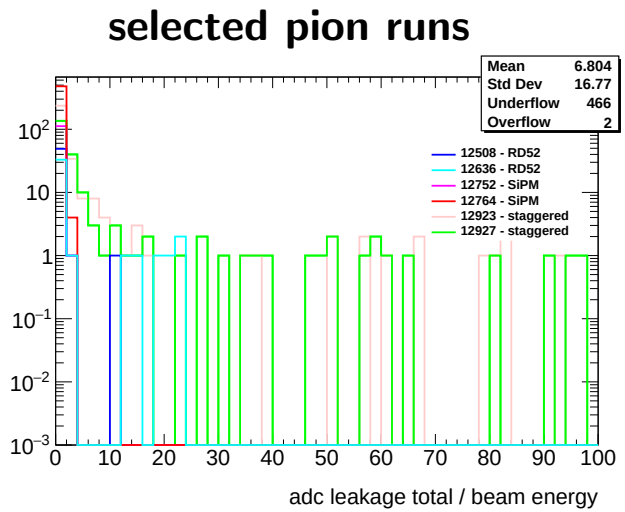
adc leak tot plots - adc muon > 20

- possibly all adc should be rescaled for staggered module runs
- greater leakage for runs aimed at Tw31, as expected





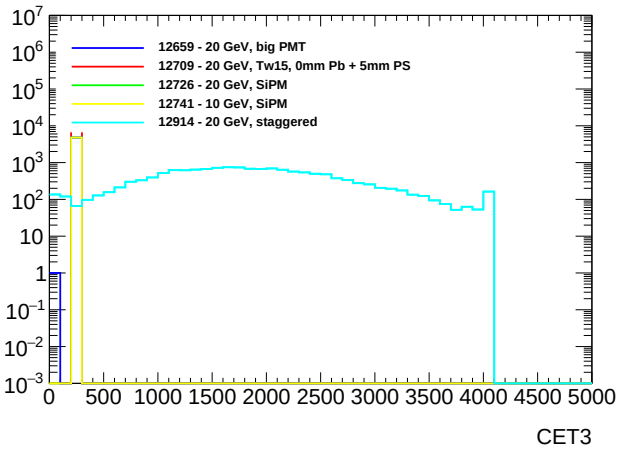




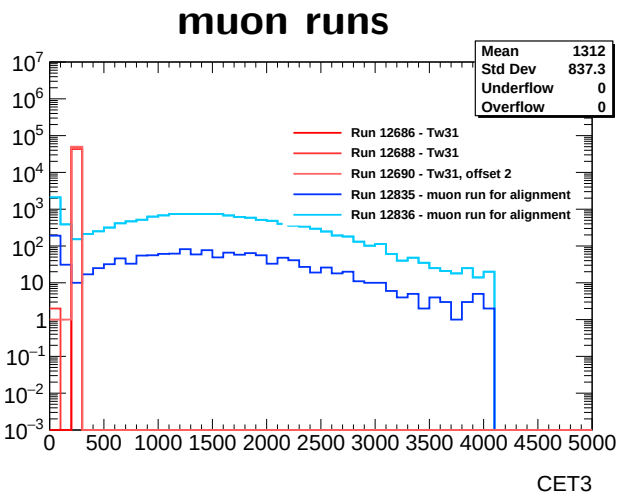
CET3 plots - no cut

- added in run 12767

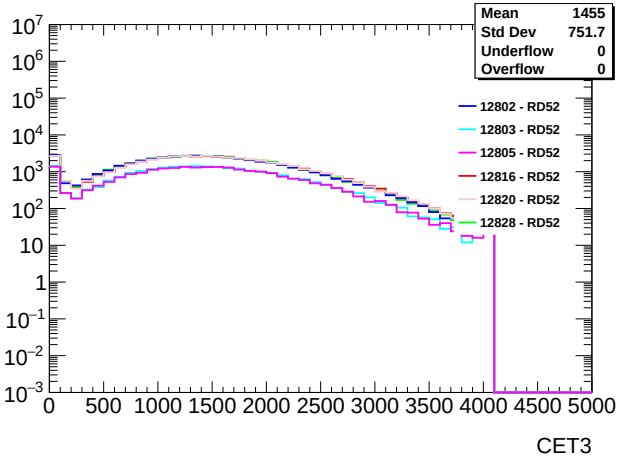
selected electron runs



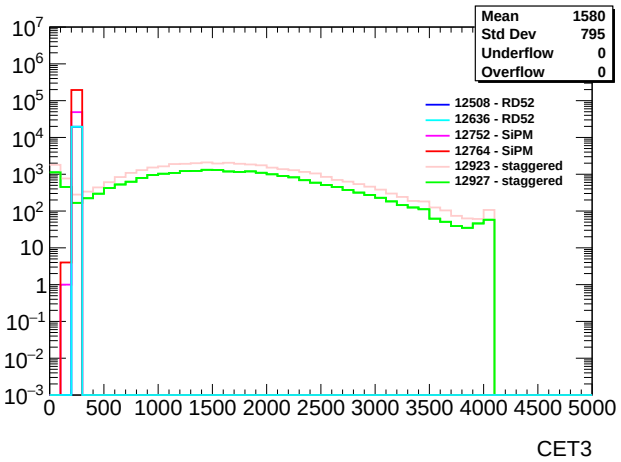
muon runs



selected hadron runs

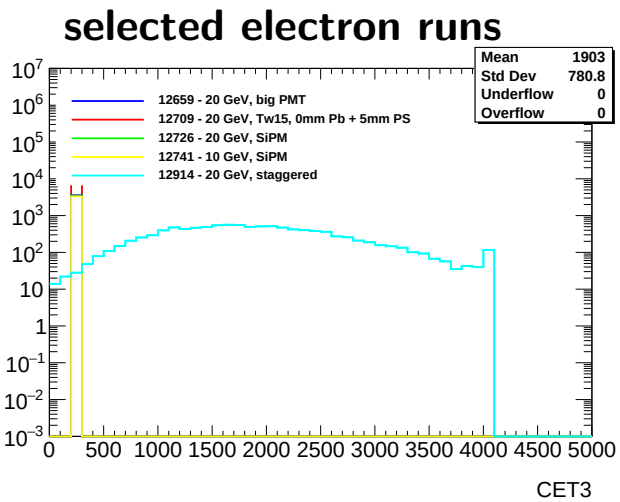


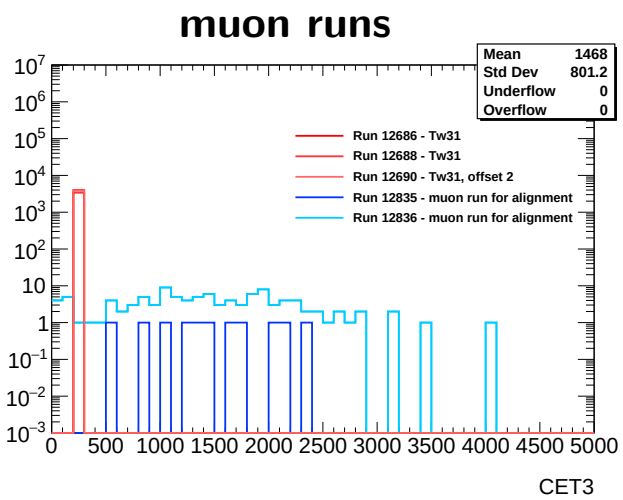
selected pion runs

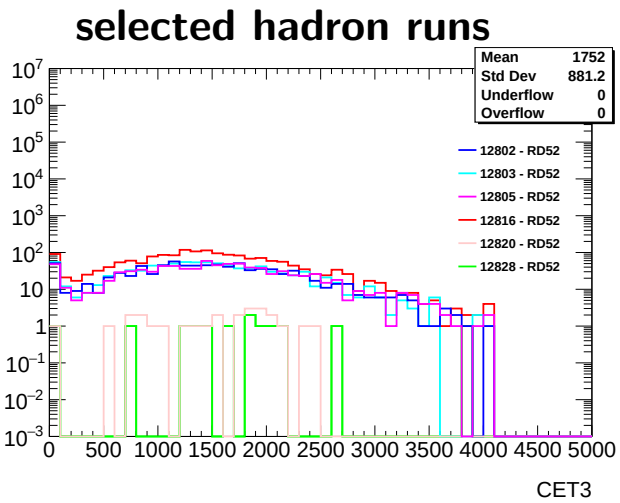


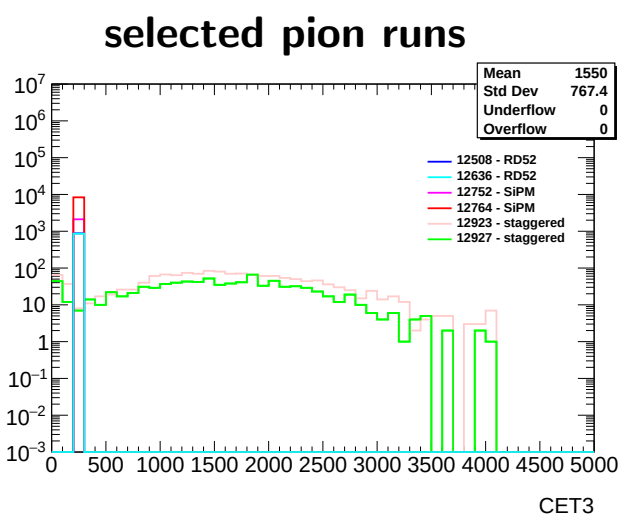
CET3 plots - adc preshower > 30

- added in run 12767



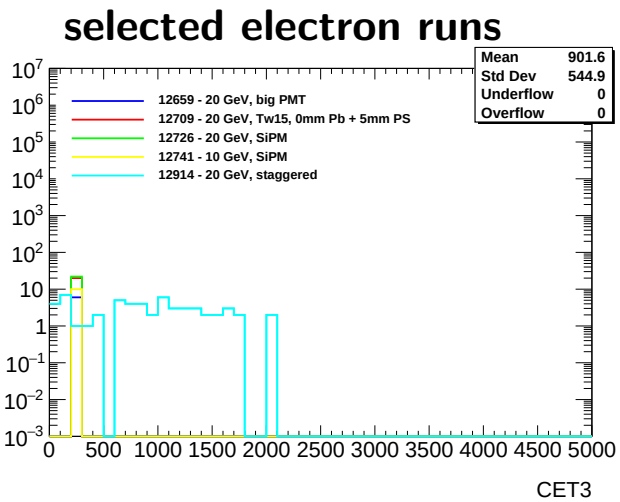


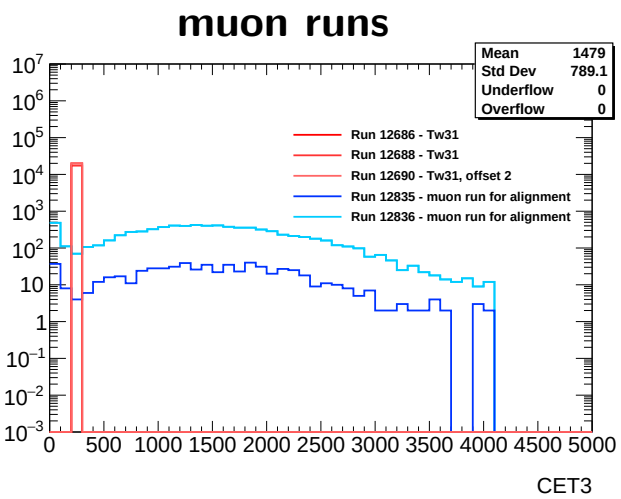


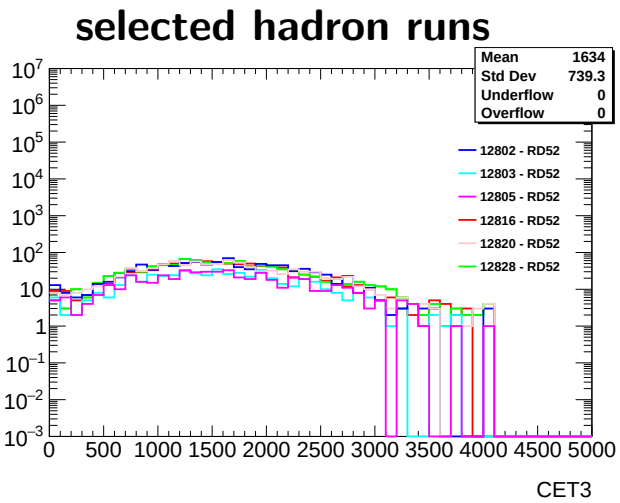


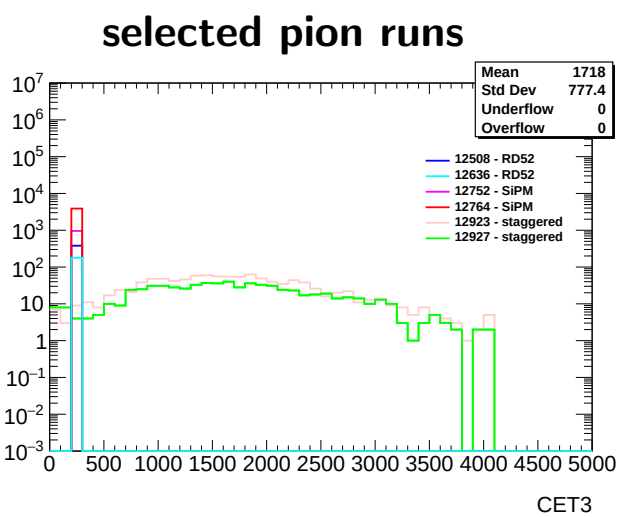
CET3 plots - adc muon $>$ 20

- added in run 12767



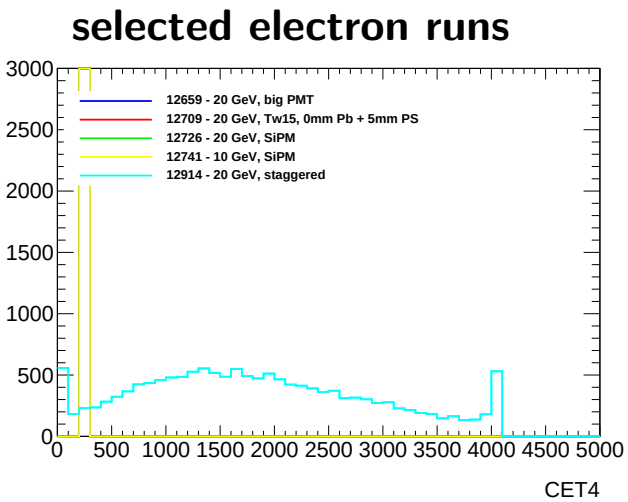


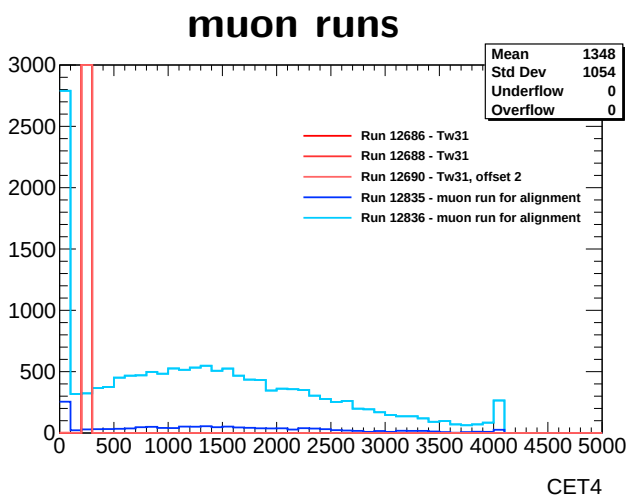


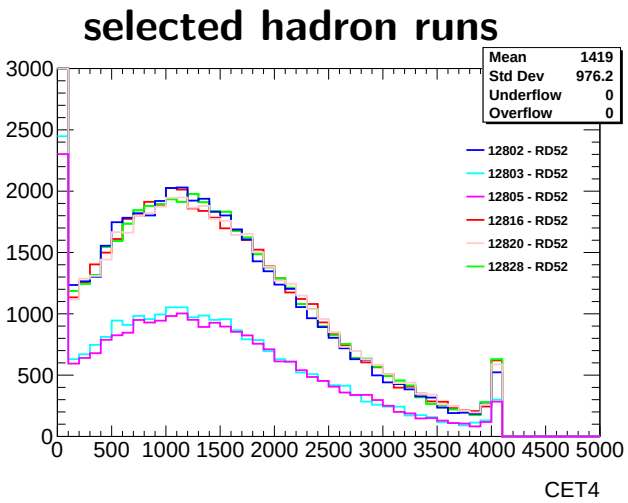


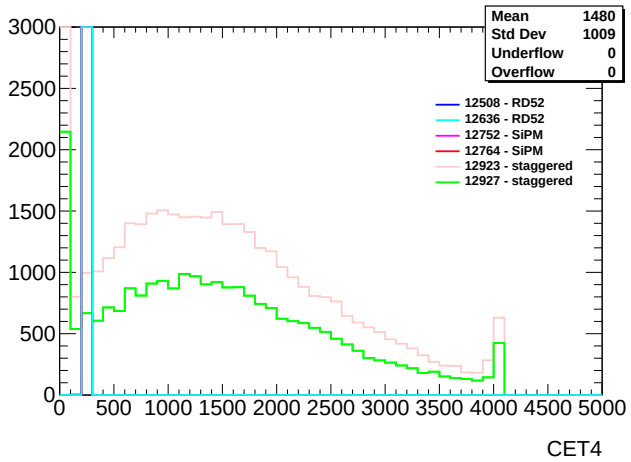
CET4 plots - no cut

- added in run 12767



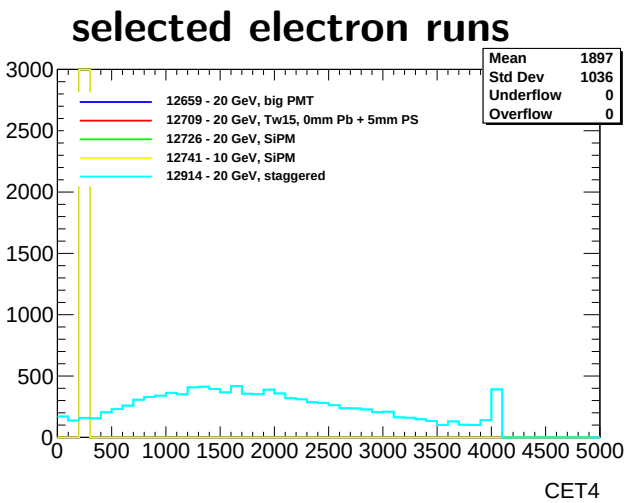


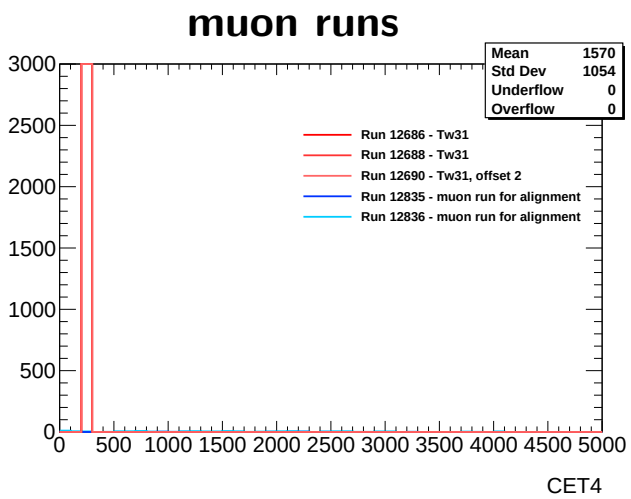


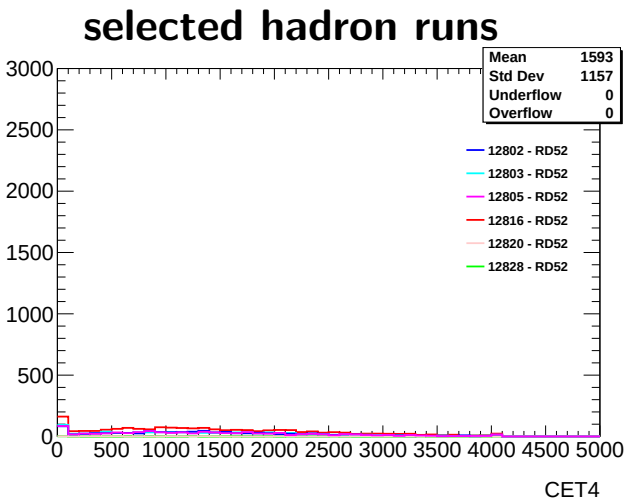


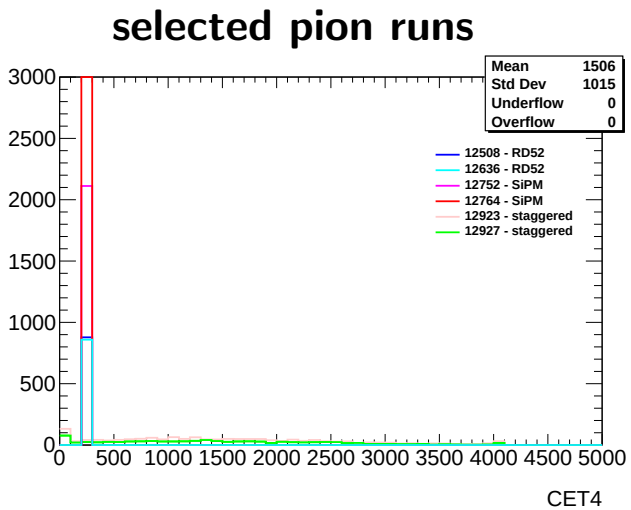
CET4 plots - adc preshower > 30

- added in run 12767









CET4 plots - adc muon $>$ 20

- added in run 12767