Analysis - Feature #1667

Ckov momentum scan from 28-29 March data

07 April 2015 14:00 - Bayes, Ryan

Status:	Closed	**Start date:**	07 April 2015
Priority:	Normal	**Due date:**	
Assignee:	Bayes, Ryan	**% Done:**	100%
Category:		**Estimated time:**	0.00 hour
Target version:			

Description

Part of the data collection of the 28th and 29th of March was a momentum scan using pion beams. The important runs are from 6268 to 6278 taken on Saturday evening and Sunday morning. A motivation for the momentum scan was to evaluate the behaviour of the CKOV as a function of momentum. As part of the physics shift (and at the suggestion of Paul Soler) I made a quick analysis of these data for this purpose. The results of this analysis may be used to refine the global particle identification.

The analysis (in the attached script "ckov_momentum_scan.py") selects muons, pions, and electrons from the beam using the time of flight between TOF0 and TOF1. The selections are tabulated here;

Beam momentum (@tgt)	run #	muon TOF range	pion TOF range	electron TOF range
300 MeV	6270 - 6271	28-29 ns	30-32 ns	25-27 ns
350 MeV	6274	27-28.3 ns	28.9-30 ns	25-27 ns
375 MeV	6275	27-28 ns	28.5-29.5 ns	25-26.7 ns
400 MeV	6276	26.7-27.8 ns	28-29 ns	26-26.7 ns
425 MeV	6278	26.5-27.5 ns	27.8-28.8 ns	26-26.5 ns

These selections were motivated by the inspection of the TOF distributions attached ("ckov_tof_distributions.pdf"). The particle momentum was calculated from the time of flight using p = m / sqrt((t/t_0)^2 - 1) where t_0 = D/c assuming D is the TOF0 to TOF1 distance from the exiting step IV drawings, or D=7862 mm (which should be updated when new surveys appear). For this distance t_0 is 26.02 ns which is consistent with the electron time of flight. A 1 ns (30 cm) difference in the time of flight can make a change of 36 MeV/c in this calculation so a better measure of the TOF positions will improve this measurement.

For each particle type at each CKOV, a 2 dimensional histogram is compiled for the number of CKOV photoelectrons against the momentum. The mean number of photo-electrons for the pions and muons are shown in the attached summary file ("ckov_scan_pvPE.eps"). The mean number of PEs from electrons was also calculated as 25 but not shown in the summary plot because the electron momentum can not be calculated from the time of flight. The figure of merit shows a clear threshold for the observation of muons in CKOVa at 260 MeV/c and a not so well defined threshold at 250 MeV/c for pions in CKOVb. This can be cleared up somewhat if run 6268 can be reconstructed (it was not in the grid reconstruction for an as yet unknown reason) as that beam line setting should fill in the region between 250 MeV/c and 280 MeV/c in the pion distribution. This is illustrated in the source 2d histograms also attached.

History

#1 - 07 April 2015 14:04 - Bayes, Ryan

Paul Soler has made the following comments via email;

> Dear Ryan, (cc all)
>
> Thank you for that. It is very impressive that you were able to get this done in such a quick time. Just to clarify, it seems that the software assumes a hardware calibration of 23 ADC/photoelectron. It would be useful to verify what is the final calibration for each of the CKOV PMTs using these CKOV HV settings is similar to this assumed value. The goal was to set them all at 25 ADC/PE but, in practice, these values could be somewhat different. Therefore, the PE numbers obtained might vary by ~10%, but I don't expect big changes.
>
> Just by looking at the plots, one can do a quick analysis by inspecting the threshold momenta.
>
> For CKOVa, the threshold for muons seems to be around 260 MeV/c. The threshold is achieved when np/E=1, therefore the refractive index obtained is:
> n=sqrt(260^2+105.7^2)/260=1.0795
> This would imply a pion momentum threshold of:

p=m/sqrt(n^2-1)=139.6/sqrt(1.0795^2-1)=343 MeV/c
It is hard to see where the threshold is for the pions in CKOVa, but it is somewhere around 330 MeV/c.

For CKOVb, the only threshold we see is the pion threshold around 250 MeV/c. Using the same argument then:
n=sqrt(250^2+139.6^2)/250=1.1453
Therefore, the muon threshold should be at
p=105.7/sqrt(1.1453^2-1)=189.3 meV/c

So, to see the muon curve for CKOVb, we would need extra CKOV runs at lower momenta.

This is all extremely preliminary due to the fact that it depends a bit on the TOF windows to select pure samples of muons and pions. In CKOVb there seems to be a change of slope in the muon curve at ~260 MeV/c. Maybe there is some pion contamination in this sample, but it is hard to tell.

Lucien, my understanding is that the nominal refractive index for CKOVa is 1.07 and of CKOVb is 1.12. This would imply that the actual refractive indices are a bit higher than designed. This could be because the aerogel could have absorbed some air and its density could have changed (and hence the refractive index increased). We observed this effect in the LHCb aerogels. Is the aerogel gas-tight? Could it be absorbing air and hence changing refractive index?

Thanks for the lovely plots Ryan.

Cheers, Paul

#2 - 13 April 2015 11:24 - Bayes, Ryan

- File ckov_scan_pvPE_v2.eps added

- File ckov_momentum_scan_v2.py added

I received an update on the TOF1 survey this morning. The results indicate that the centre of TOF1 was at z = 12922.10 mm in the hall coordinate system. Assuming that TOF0 has not changed position (z=5292 mm) this means that the TOF0 to TOF1 distance is 7630.1 mm or 262 mm smaller less than what I assumed before. This impacts the momenta calculated for the muons and pions in the above study very strongly. I have attached the updated ckov analysis script and summary plot with the corrected distance. The change in the time of flight distance lowers the muon threshold in CkovA by approximately 40 MeV/c to 220 MeV/c and brings the pion threshold in CkovB to be approximately in line with that value.

#3 - 26 June 2015 14:22 - Rogers, Chris

- Status changed from Open to Closed

- Assignee set to Bayes, Ryan

- % Done changed from 0 to 100

I think this analysis is closed. Let me know if that's a mistake...

Files

ckov_momentum_scan.py	12.8 KB	07 April 2015	Bayes, Ryan
ckov_tof_distributions.pdf	54.9 KB	07 April 2015	Bayes, Ryan
ckov_scan_pvPE.eps	16.5 KB	07 April 2015	Bayes, Ryan
ckov_scan_mu_pvPE.eps	214 KB	07 April 2015	Bayes, Ryan
ckov_scan_pi_pvPE.eps	128 KB	07 April 2015	Bayes, Ryan
ckov_scan_pvPE_v2.eps	14.2 KB	13 April 2015	Bayes, Ryan
ckov_momentum_scan_v2.py	12.9 KB	13 April 2015	Bayes, Ryan