CALIBRATION OF BEAM CERENKOV COUNTERS

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Preliminaries:

Before curves can be taken, the DAQ must operate consistently, i.e. the 17 scalers involved must agree when recording T0 (=T00xT01) and when recording each of the 16 PMT combinations. This agreement should be to 1 part in 100,000 and preferably 1 in 1,000,000.

Parameters:

1. Beam momentum: we have chosen +40 GeV to give a reasonable number of each particle, i.e. 44% pions, 4% kaons and 52% protons according to Raja's table.
2. Index of refraction of the gas: Terry has combined pressure and temperature to give the density, i.e. index of refraction. We will use nitrogen for now.
3. Primary mirror alignment: C1 mirror is mounted on x and y gimbals driven by 2 separate motors. C2 mirror is driven by three motors at the corners of a triangular mounting plate. Care must be taken not to change the x alignment when adjusting the y, and vice versa.
4. PMT high voltage and delays.
5. Parallelism of the beam: tuning of the secondary beamline monitoring the tracks in the beam chambers. This is probably the limiting factor in mass resolution.

A Possible Scenario:

Using Scalers:

1. Take first curves, with other parameters set as they are now, to locate the pion, kaon and proton peaks and determine the backgrounds between the peaks from 0 to 22 psia. The shape of the background is needed to extrapolate under the peaks. Both counters to be done simultaneously but independently. This would be done manually, with one run per point every 5 minutes. Assuming 10,000 T0 per spill and 1 spill per minute, 45 points of 50K T0 takes 3.8 hours, assuming 100% efficiency of man and machine and no end effects. (A more realistic estimate might be 6 – 8 hours.)
2. Adjust PMT high voltages comparing peak and background rates. 80 points taking 3.3 hours.
3. Repeat 1.
4. Mirror alignment: set both counters on same peak and swing mirror in one counter at a time. 2x2x12=48 points taking 4 hours. This is a function of the secondary beam tune and would need to be repeated if there is a tune change.
5. Repeat 1.
6. Set both counters on same peak for each peak to measure efficiencies for each particle. 1 hour.

7. Measure feed through at peaks and troughs in one counter by setting other counter at other peaks and troughs. Needed for the confidence level of the tag. 2x6x5=60 points taking 5 hours
8. To ascertain the advantages of one counter assisting the other in tagging and rejecting, set one at a peak or trough and run full curve on other. Estimate 2x6x45 points = 45 hours.

Up to this point times are based on everything being done manually at 5 minutes per point with the present beam conditions and 100% efficiency; the total is 70 hours. Automation of the process combined with an increase in spill frequency, spill length and intensity will reduce these times, but we cannot exceed one point per spill. Automation will step the gas densities remotely, record all parameters and plot resulting curves. Mirror motion will probably continue to be done manually. With experience, we might be able to reduce the number of points needed.

Using Beam Chambers:

The above studies may well not provide the tagging confidence levels or efficiencies we desire. In the actual MIPP data runs we will have the beam chambers to select a more parallel beam. To repeat the calibrations above, a point with 50K triggers would require 125 spills at 400 triggers per spill (Andre). Thus the above times multiply by a factor of 25! And that assumes that all the incident particles triggered on are good (i.e. parallel) ones. So we clearly need to increase the number of triggers per hour with more frequent and longer spills; increased intensity won't help here.

Hopefully by the time we reach this point we will know enough about the counters to reduce the number of points to a more manageable level, but we at least need to repeat 1, 6 and 7 above (which totaled 10 hours). Without improvements to the spill this would therefore take at least a week at each momentum.