

## BEAMLINE CERENKOV COUNTERS FOR E907

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It is planned to use two Cerenkov counters in the MCenter beamline to identify the incident particles to our experiment. The total length available for these counters is fixed by the geometry of the beam. Following is a proposal for allotting this space, configuring the counters and a scenario for utilizing them at the various momenta.

Of primary importance is the composition of the beam. Table 1 gives the fluxes expected at the experiment's target, corrected for decay, as determined by Raja for  $2.00E9$  Hz protons on the primary production target. The negative beam is always more than 90% pions, and the kaons and antiprotons are a small fraction. In the positive beam, pions are a major fraction up to 30 GeV/c and protons are above that. It would be ideal to tag each type of particle individually, but that would require three counters. It is best, in my experience, to tag the two minority particles. This is particularly true for negative beams and for the low and high momenta in positive beams. No counter is 100% efficient, so inferring a minority particle from the absence of the majority particle that may make up 90% of the beam introduces an unacceptably large error in the minority determination.

| mom. | p-bar | k-   | pi-   | total | %pbar | %k-  | %pi-   | p+     | k+    | pi+    | total  | %p+   | %k+  | %pi+  |
|------|-------|------|-------|-------|-------|------|--------|--------|-------|--------|--------|-------|------|-------|
| 5    | 1040  | 232  | 15508 | 16780 | 6.20  | 1.38 | 92.42  | 1532   | 328   | 24008  | 25868  | 5.92  | 1.27 | 92.81 |
| 15   | 2216  | 2459 | 52485 | 57159 | 3.88  | 4.30 | 91.82  | 16181  | 4436  | 71415  | 92032  | 17.58 | 4.82 | 77.60 |
| 25   | 1888  | 3361 | 59669 | 64917 | 2.91  | 5.18 | 91.92  | 52563  | 8591  | 112578 | 173732 | 30.26 | 4.94 | 64.80 |
| 30   | 1603  | 3401 | 58375 | 63379 | 2.53  | 5.37 | 92.10  | 81581  | 10434 | 127706 | 219721 | 37.13 | 4.75 | 58.12 |
| 40   | 1016  | 2887 | 51569 | 55472 | 1.83  | 5.20 | 92.96  | 166644 | 12942 | 139443 | 319029 | 52.23 | 4.06 | 43.71 |
| 50   | 531   | 1964 | 41146 | 43640 | 1.22  | 4.50 | 94.29  | 292889 | 13385 | 127885 | 434159 | 67.46 | 3.08 | 29.46 |
| 60   | 221   | 1080 | 29051 | 30352 | 0.73  | 3.56 | 95.71  | 459856 | 11917 | 100943 | 572717 | 80.29 | 2.08 | 17.63 |
| 70   | 70    | 471  | 17621 | 18161 | 0.39  | 2.59 | 97.03  | 652270 | 9193  | 68341  | 729804 | 89.38 | 1.26 | 9.36  |
| 80   | 15    | 153  | 8755  | 8923  | 0.17  | 1.71 | 98.12  | 829715 | 6024  | 38463  | 874202 | 94.91 | 0.69 | 4.40  |
| 90   | 2     | 32   | 3248  | 3282  | 0.06  | 0.98 | 98.96  | 917282 | 3163  | 16675  | 937121 | 97.88 | 0.34 | 1.78  |
| 100  | 0     | 3    | 726   | 729   | 0.00  | 0.41 | 99.59  | 809763 | 1148  | 4627   | 815537 | 99.29 | 0.14 | 0.57  |
| 110  | 0     | 0    | 49    | 49    | 0.00  | 0.00 | 100.00 | 428940 | 176   | 448    | 429563 | 99.85 | 0.04 | 0.10  |

TABLE 1: Particles Fluxes at Experiment

### COUNTER LENGTHS

It follows from the foregoing that we want to use the two counters in differential mode in most cases. Therefore we should share the length to give the same number of photons in each counter. The number of photons is proportional to the length of the counter times the square of the sine of the Cerenkov angle. The Cerenkov angle is determined by the hole size in the focal plane mirror, M2. As this is 5 mr in the first

counter and 7 mr in the second, it follows that the ratio of lengths is  $L1/L2 = 49/25$ . In the present beam design about 3.0 meters is available over the original design. This means that the length of the first counter, C1, would be 23.9 meters and the second counter, C2, be 12.2 meters. It turns out that this is about the length for C1 originally foreseen, and the extra 3.0 meters would be added entirely to C2.

Assuming the light collection efficiency to be 50% and the phototube conversion efficiency to be 30%, one expects 3.3 photoelectrons in each counter. With the ability to detect single photoelectrons, we expect maximum efficiencies of 96.3 % for both counters.

## **CERENKOV ANGLES AND GAS PRESSURES**

In the tables that follow, the Cerenkov angles are given for all particles when the angle of the particle being tagged is at the maximum angle that can get through the hole in the focal plane mirror, i.e. when the counter is used in the differential mode. The symbol ##### in place of the angle means the particle is below threshold. Since the largest angle accepted by either focal plane mirror is 30 mr., the anti-coincidence light in the differential mode extends from 5, or 7, to 30 mr.

The percentage of the tagged particles in the beam is given as a reminder.

Several gases were studied to obtain the necessary indices of refraction: helium, nitrogen, carbon dioxide and two fluorocarbons: C4F10 and C5F12. The pressures given are in pounds per square inch absolute (psia). The counters are intended for use below atmospheric pressure, so gases in the tables can only be used below 14.7 psia. Under the gases the symbol ##### means a pressure of 100 psia or more.

From the tables one sees that CO2 is not a big gain in pressure limitation over N2 and C5F12 is not, over C4F10. It is also seen that helium is only occasionally an improvement over nitrogen, especially if one notes the beam populations. It is proposed therefore to start out with nitrogen and C4F10 and consider using the others later when our backs are against the wall.

## **THE GAS SYSTEM**

In the past, Cerenkov counter pressure curves were taken to measure beam composition and determine operating points. This had the disadvantage of requiring a delay for the gas to come to equilibrium pressure after each addition of gas. The plan in MIPP is to take density curves. Knowing the real gas equation and the pressure and temperature at any moment, the density can be immediately calculated; one need only wait for acceptable temperature uniformity to take data. Terry Tope and his people have set up a test module to investigate this method and are awaiting the proper computing equipment.

|       |      |      | Set   |         |        |       |       | He    | N     | CO2   | C4F10 | C5F12 |
|-------|------|------|-------|---------|--------|-------|-------|-------|-------|-------|-------|-------|
| mass= |      |      | 0.49  |         | 0.14   | 0.494 | 0.938 | 3E-05 | 3E-04 | 5E-04 | 0.001 | 0.002 |
| mom.  | %k-  | %k+  | k(mr) | index-1 | pi(mr) | k(mr) | p(mr) | psia  | psia  | psia  | psia  | psia  |
| 5     | 1.38 | 1.27 | 5.00  | 0.00488 | 94.52  | 5.00  | ##### | ##### | ##### | ##### | 49.29 | 36.94 |
| 10    |      |      | 5.00  | 0.00123 | 47.58  | 5.00  | ##### | ##### | 66.21 | 40.20 | 12.44 | 9.32  |
| 15    | 4.30 | 4.82 | 5.00  | 0.00055 | 31.95  | 5.00  | ##### | ##### | 29.81 | 18.10 | 5.60  | 4.20  |
| 20    |      |      | 5.00  | 0.00032 | 24.19  | 5.00  | ##### | ##### | 17.06 | 10.36 | 3.21  | 2.40  |
| 25    | 5.18 | 4.94 | 5.00  | 0.00021 | 19.59  | 5.00  | ##### | 95.40 | 11.16 | 6.78  | 2.10  | 1.57  |
| 30    | 5.37 | 4.75 | 5.00  | 0.00015 | 16.56  | 5.00  | ##### | 68.01 | 7.96  | 4.83  | 1.50  | 1.12  |
| 40    | 5.20 | 4.06 | 5.00  | 8.9E-05 | 12.85  | 5.00  | ##### | 40.77 | 4.77  | 2.90  | 0.90  | 0.67  |
| 50    | 4.50 | 3.08 | 5.00  | 6.1E-05 | 10.71  | 5.00  | ##### | 28.16 | 3.30  | 2.00  | 0.62  | 0.46  |
| 60    | 3.56 | 2.08 | 5.00  | 4.6E-05 | 9.34   | 5.00  | ##### | 21.31 | 2.49  | 1.51  | 0.47  | 0.35  |
| 70    | 2.59 | 1.26 | 5.00  | 3.7E-05 | 8.41   | 5.00  | ##### | 17.18 | 2.01  | 1.22  | 0.38  | 0.28  |
| 80    | 1.71 | 0.69 | 5.00  | 3.2E-05 | 7.75   | 5.00  | ##### | 14.50 | 1.70  | 1.03  | 0.32  | 0.24  |
| 90    | 0.98 | 0.34 | 5.00  | 2.8E-05 | 7.26   | 5.00  | ##### | 12.67 | 1.48  | 0.90  | 0.28  | 0.21  |
| 100   | 0.41 | 0.14 | 5.00  | 2.5E-05 | 6.89   | 5.00  | ##### | 11.35 | 1.33  | 0.81  | 0.25  | 0.19  |
| 110   | 0.00 | 0.04 | 5.00  | 2.3E-05 | 6.60   | 5.00  | ##### | 10.38 | 1.21  | 0.74  | 0.23  | 0.17  |

TABLE 2: Angles and Gas Pressures for Kaons at 5 mr

|       |      |      |       |         |        |       |       | He    | N     | CO2   | C4F10 | C5F12 |
|-------|------|------|-------|---------|--------|-------|-------|-------|-------|-------|-------|-------|
| mass= |      |      | 0.49  |         | 0.14   | 0.494 | 0.938 | 3E-05 | 3E-04 | 5E-04 | 0.001 | 0.002 |
| mom.  | %k-  | %k+  | k(mr) | index-1 | pi(mr) | k(mr) | p(mr) | psia  | psia  | psia  | psia  | psia  |
| 5     | 1.38 | 1.27 | 7.00  | 0.00489 | 94.65  | 7.00  | ##### | ##### | ##### | ##### | 49.42 | 37.03 |
| 10    |      |      | 7.00  | 0.00124 | 47.83  | 7.00  | ##### | ##### | 66.85 | 40.59 | 12.56 | 9.41  |
| 15    | 4.30 | 4.82 | 7.00  | 0.00057 | 32.33  | 7.00  | ##### | ##### | 30.46 | 18.49 | 5.72  | 4.29  |
| 20    |      |      | 7.00  | 0.00033 | 24.69  | 7.00  | ##### | ##### | 17.71 | 10.75 | 3.33  | 2.49  |
| 25    | 5.18 | 4.94 | 7.00  | 0.00022 | 20.19  | 7.00  | ##### | ##### | 11.81 | 7.17  | 2.22  | 1.66  |
| 30    | 5.37 | 4.75 | 7.00  | 0.00016 | 17.27  | 7.00  | ##### | 73.53 | 8.60  | 5.22  | 1.62  | 1.21  |
| 40    | 5.20 | 4.06 | 7.00  | 0.0001  | 13.75  | 7.00  | ##### | 46.29 | 5.42  | 3.29  | 1.02  | 0.76  |
| 50    | 4.50 | 3.08 | 7.00  | 7.3E-05 | 11.78  | 7.00  | ##### | 33.68 | 3.94  | 2.39  | 0.74  | 0.56  |
| 60    | 3.56 | 2.08 | 7.00  | 5.8E-05 | 10.55  | 7.00  | ##### | 26.83 | 3.14  | 1.91  | 0.59  | 0.44  |
| 70    | 2.59 | 1.26 | 7.00  | 4.9E-05 | 9.73   | 7.00  | ##### | 22.70 | 2.66  | 1.61  | 0.50  | 0.37  |
| 80    | 1.71 | 0.69 | 7.00  | 4.4E-05 | 9.17   | 7.00  | ##### | 20.02 | 2.34  | 1.42  | 0.44  | 0.33  |
| 90    | 0.98 | 0.34 | 7.00  | 4E-05   | 8.76   | 7.00  | ##### | 18.18 | 2.13  | 1.29  | 0.40  | 0.30  |
| 100   | 0.41 | 0.14 | 7.00  | 3.7E-05 | 8.45   | 7.00  | ##### | 16.87 | 1.97  | 1.20  | 0.37  | 0.28  |
| 110   | 0.00 | 0.04 | 7.00  | 3.5E-05 | 8.22   | 7.00  | ##### | 15.90 | 1.86  | 1.13  | 0.35  | 0.26  |

TABLE 3: Angles and Gas Pressures for Kaons at 7 mr

|       |      |       | Set   |         |        |        |       | He    | N     | CO2   | C4F10  | C5F12  |
|-------|------|-------|-------|---------|--------|--------|-------|-------|-------|-------|--------|--------|
| mass= |      |       | 0.94  |         | 0.14   | 0.49   | 0.938 | 3E-05 | 3E-04 | 5E-04 | 0.001  | 0.002  |
| mom   | %p-  | %p+   | p(mr) | index-1 | pi(mr) | k(mr)  | p(mr) | psia  | psia  | psia  | psia   | psia   |
| 5     | 6.20 | 5.92  | 5.00  | 0.01747 | 183.48 | 157.57 | 5.00  | ##### | ##### | ##### | 176.62 | 132.36 |
| 10    |      |       | 5.00  | 0.0044  | 92.65  | 79.68  | 5.00  | ##### | ##### | ##### | 44.54  | 33.38  |
| 15    | 3.88 | 17.58 | 5.00  | 0.00197 | 61.98  | 53.35  | 5.00  | ##### | ##### | 64.26 | 19.89  | 14.91  |
| 20    |      |       | 5.00  | 0.00111 | 46.63  | 40.17  | 5.00  | ##### | 59.86 | 36.34 | 11.25  | 8.43   |
| 25    | 2.91 | 30.26 | 5.00  | 0.00072 | 37.43  | 32.29  | 5.00  | ##### | 38.56 | 23.41 | 7.25   | 5.43   |
| 30    | 2.53 | 37.13 | 5.00  | 0.0005  | 31.32  | 27.05  | 5.00  | ##### | 26.98 | 16.38 | 5.07   | 3.80   |
| 40    | 1.83 | 52.23 | 5.00  | 0.00029 | 23.72  | 20.56  | 5.00  | ##### | 15.47 | 9.39  | 2.91   | 2.18   |
| 50    | 1.22 | 67.46 | 5.00  | 0.00019 | 19.22  | 16.72  | 5.00  | 86.70 | 10.15 | 6.16  | 1.91   | 1.43   |
| 60    | 0.73 | 80.29 | 5.00  | 0.00013 | 16.25  | 14.21  | 5.00  | 61.97 | 7.25  | 4.40  | 1.36   | 1.02   |
| 70    | 0.39 | 89.38 | 5.00  | 0.0001  | 14.17  | 12.45  | 5.00  | 47.05 | 5.51  | 3.34  | 1.03   | 0.78   |
| 80    | 0.17 | 94.91 | 5.00  | 8.1E-05 | 12.63  | 11.16  | 5.00  | 37.37 | 4.37  | 2.66  | 0.82   | 0.62   |
| 90    | 0.06 | 97.88 | 5.00  | 6.7E-05 | 11.46  | 10.18  | 5.00  | 30.74 | 3.60  | 2.18  | 0.68   | 0.51   |
| 100   | 0.00 | 99.29 | 5.00  | 5.7E-05 | 10.54  | 9.42   | 5.00  | 25.99 | 3.04  | 1.85  | 0.57   | 0.43   |
| 110   | 0.00 | 99.85 | 5.00  | 4.9E-05 | 9.81   | 8.81   | 5.00  | 22.48 | 2.63  | 1.60  | 0.49   | 0.37   |

TABLE 4: Angles and Gas Pressures for Protons at 5 mr

|       |      |       |       |         |        |        |       | He    | N     | CO2   | C4F10 | C5F12  |
|-------|------|-------|-------|---------|--------|--------|-------|-------|-------|-------|-------|--------|
| mass= |      |       | 0.94  |         | 0.14   | 0.49   | 0.938 | 3E-05 | 3E-04 | 5E-04 | 0.001 | 0.002  |
| mom   | %p-  | %p+   | p(mr) | index-1 | pi(mr) | k(mr)  | p(mr) | psia  | psia  | psia  | psia  | psia   |
| 5     | 6.20 | 5.92  | 7.00  | 0.01748 | 183.55 | 157.65 | 7.00  | ##### | ##### | ##### | ##### | 132.46 |
| 10    |      |       | 7.00  | 0.00442 | 92.78  | 79.83  | 7.00  | ##### | ##### | ##### | 44.66 | 33.47  |
| 15    | 3.88 | 17.58 | 7.00  | 0.00198 | 62.17  | 53.57  | 7.00  | ##### | ##### | 64.65 | 20.01 | 15.00  |
| 20    |      |       | 7.00  | 0.00112 | 46.88  | 40.47  | 7.00  | ##### | 60.50 | 36.73 | 11.37 | 8.52   |
| 25    | 2.91 | 30.26 | 7.00  | 0.00073 | 37.75  | 32.66  | 7.00  | ##### | 39.20 | 23.80 | 7.37  | 5.52   |
| 30    | 2.53 | 37.13 | 7.00  | 0.00051 | 31.70  | 27.49  | 7.00  | ##### | 27.63 | 16.77 | 5.19  | 3.89   |
| 40    | 1.83 | 52.23 | 7.00  | 0.0003  | 24.23  | 21.14  | 7.00  | ##### | 16.12 | 9.79  | 3.03  | 2.27   |
| 50    | 1.22 | 67.46 | 7.00  | 0.0002  | 19.83  | 17.42  | 7.00  | 92.22 | 10.79 | 6.55  | 2.03  | 1.52   |
| 60    | 0.73 | 80.29 | 7.00  | 0.00015 | 16.97  | 15.03  | 7.00  | 67.49 | 7.90  | 4.79  | 1.48  | 1.11   |
| 70    | 0.39 | 89.38 | 7.00  | 0.00011 | 14.99  | 13.38  | 7.00  | 52.57 | 6.15  | 3.73  | 1.16  | 0.87   |
| 80    | 0.17 | 94.91 | 7.00  | 9.3E-05 | 13.55  | 12.18  | 7.00  | 42.89 | 5.02  | 3.05  | 0.94  | 0.71   |
| 90    | 0.06 | 97.88 | 7.00  | 7.9E-05 | 12.46  | 11.30  | 7.00  | 36.25 | 4.24  | 2.58  | 0.80  | 0.60   |
| 100   | 0.00 | 99.29 | 7.00  | 6.9E-05 | 11.62  | 10.61  | 7.00  | 31.51 | 3.69  | 2.24  | 0.69  | 0.52   |
| 110   | 0.00 | 99.85 | 7.00  | 6.1E-05 | 10.96  | 10.08  | 7.00  | 27.99 | 3.28  | 1.99  | 0.62  | 0.46   |

TABLE 5: Angles and Gas Pressures for Protons at 7 mr

|       |        |       | Set    |         |        |       |       | He    | N     | CO2   | C4F10 | C5F12 |
|-------|--------|-------|--------|---------|--------|-------|-------|-------|-------|-------|-------|-------|
| mass= |        |       | 0.14   |         | 0.14   | 0.49  | 0.938 | 3E-05 | 3E-04 | 5E-04 | 0.001 | 0.002 |
| mom   | %pi-   | %pi+  | pi(mr) | index-1 | pi(mr) | k(mr) | p(mr) | psia  | psia  | psia  | psia  | psia  |
| 5     | 92.42  | 92.81 | 5.00   | 0.0004  | 5.00   | ##### | ##### | ##### | 21.64 | 13.14 | 4.07  | 3.05  |
| 10    |        |       | 5.00   | 0.00011 | 5.00   | ##### | ##### | 50.55 | 5.92  | 3.59  | 1.11  | 0.83  |
| 15    | 91.82  | 77.60 | 5.00   | 5.6E-05 | 5.00   | ##### | ##### | 25.66 | 3.00  | 1.82  | 0.56  | 0.42  |
| 20    |        |       | 5.00   | 3.7E-05 | 5.00   | ##### | ##### | 16.95 | 1.98  | 1.20  | 0.37  | 0.28  |
| 25    | 91.92  | 64.80 | 5.00   | 2.8E-05 | 5.00   | ##### | ##### | 12.92 | 1.51  | 0.92  | 0.28  | 0.21  |
| 30    | 92.10  | 58.12 | 5.00   | 2.3E-05 | 5.00   | ##### | ##### | 10.73 | 1.26  | 0.76  | 0.24  | 0.18  |
| 40    | 92.96  | 43.71 | 5.00   | 1.9E-05 | 5.00   | ##### | ##### | 8.55  | 1.00  | 0.61  | 0.19  | 0.14  |
| 50    | 94.29  | 29.46 | 5.00   | 1.6E-05 | 5.00   | ##### | ##### | 7.54  | 0.88  | 0.54  | 0.17  | 0.12  |
| 60    | 95.71  | 17.63 | 5.00   | 1.5E-05 | 5.00   | ##### | ##### | 6.99  | 0.82  | 0.50  | 0.15  | 0.12  |
| 70    | 97.03  | 9.36  | 5.00   | 1.4E-05 | 5.00   | ##### | ##### | 6.66  | 0.78  | 0.47  | 0.15  | 0.11  |
| 80    | 98.12  | 4.40  | 5.00   | 1.4E-05 | 5.00   | ##### | ##### | 6.45  | 0.75  | 0.46  | 0.14  | 0.11  |
| 90    | 98.96  | 1.78  | 5.00   | 1.4E-05 | 5.00   | ##### | ##### | 6.30  | 0.74  | 0.45  | 0.14  | 0.10  |
| 100   | 99.59  | 0.57  | 5.00   | 1.3E-05 | 5.00   | 1.60  | ##### | 6.20  | 0.73  | 0.44  | 0.14  | 0.10  |
| 110   | 100.00 | 0.10  | 5.00   | 1.3E-05 | 5.00   | 2.54  | ##### | 6.12  | 0.72  | 0.43  | 0.13  | 0.10  |

TABLE 6: Angles and Gas Pressures for Pions at 5 mr

|       |        |       |        |         |        |       |       | He    | N     | CO2   | C4F10 | C5F12 |
|-------|--------|-------|--------|---------|--------|-------|-------|-------|-------|-------|-------|-------|
| mass= |        |       | 0.14   |         | 0.14   | 0.49  | 0.938 | 3E-05 | 3E-04 | 5E-04 | 0.001 | 0.002 |
| mom   |        |       | pi(mr) | index-1 | pi(mr) | k(mr) | p(mr) | psia  | psia  | psia  | psia  | psia  |
| 5     | 92.42  | 92.81 | 7.00   | 0.00041 | 7.00   | ##### | ##### | ##### | 22.29 | 13.53 | 4.19  | 3.14  |
| 10    |        |       | 7.00   | 0.00012 | 7.00   | ##### | ##### | 56.07 | 6.56  | 3.98  | 1.23  | 0.92  |
| 15    | 91.82  | 77.60 | 7.00   | 6.8E-05 | 7.00   | ##### | ##### | 31.18 | 3.65  | 2.22  | 0.69  | 0.51  |
| 20    |        |       | 7.00   | 4.9E-05 | 7.00   | ##### | ##### | 22.47 | 2.63  | 1.60  | 0.49  | 0.37  |
| 25    | 91.92  | 64.80 | 7.00   | 4E-05   | 7.00   | ##### | ##### | 18.43 | 2.16  | 1.31  | 0.41  | 0.30  |
| 30    | 92.10  | 58.12 | 7.00   | 3.5E-05 | 7.00   | ##### | ##### | 16.24 | 1.90  | 1.15  | 0.36  | 0.27  |
| 40    | 92.96  | 43.71 | 7.00   | 3.1E-05 | 7.00   | ##### | ##### | 14.07 | 1.65  | 1.00  | 0.31  | 0.23  |
| 50    | 94.29  | 29.46 | 7.00   | 2.8E-05 | 7.00   | ##### | ##### | 13.06 | 1.53  | 0.93  | 0.29  | 0.22  |
| 60    | 95.71  | 17.63 | 7.00   | 2.7E-05 | 7.00   | ##### | ##### | 12.51 | 1.46  | 0.89  | 0.28  | 0.21  |
| 70    | 97.03  | 9.36  | 7.00   | 2.6E-05 | 7.00   | 1.80  | ##### | 12.18 | 1.43  | 0.87  | 0.27  | 0.20  |
| 80    | 98.12  | 4.40  | 7.00   | 2.6E-05 | 7.00   | 3.74  | ##### | 11.97 | 1.40  | 0.85  | 0.26  | 0.20  |
| 90    | 98.96  | 1.78  | 7.00   | 2.6E-05 | 7.00   | 4.62  | ##### | 11.82 | 1.38  | 0.84  | 0.26  | 0.19  |
| 100   | 99.59  | 0.57  | 7.00   | 2.5E-05 | 7.00   | 5.16  | ##### | 11.71 | 1.37  | 0.83  | 0.26  | 0.19  |
| 110   | 100.00 | 0.10  | 7.00   | 2.5E-05 | 7.00   | 5.52  | ##### | 11.64 | 1.36  | 0.83  | 0.26  | 0.19  |

TABLE 7: Angles and Gas Pressures for Pions at 7 mr

## OPERATING SCENARIOS

From Tables 2 – 7 one first notices that at the lowest momentum (5 GeV/c), neither kaon nor proton can be positively tagged in the Cerenkov counters; the pressure required is too high with any gas. This will have to be done by time-of-flight measurement. At 10 and 15 GeV/c protons can still not be counted, but kaons can be in C4F10 and with either C1 (5 mr) or C2 (7 mr). I would propose doing this in C2 so that we do not have to change gases in going to 20 GeV/c where protons can be tagged in C2. Below 20 GeV/c C1 filled with nitrogen would count pions in either the differential or threshold mode depending on the cleanliness of the signal. At 20 GeV/c and above then, C1 filled with nitrogen would count kaons in the differential mode and C2 filled with C4F10 would count (anti)protons also in the differential mode. The rest of the beam would be pions. This would be true for all negative momenta and up to 30 or 40 GeV/c for positives. Above that C1 would count pions and C2, kaons with the majority protons always below threshold.

Various combinations of coincidences and anti-coincidences between the phototube channels can be used to give cleaner signals. For example, at 100 GeV and above kaons will be slightly above threshold in C1 when it is counting pions. C2 which would then be counting kaons would be put in anticoincidence with it. (Un)fortunately there will be very few kaons in this region and very few pions, in the positive beam, Table 1.

## EFFICIENCIES AND PURITIES

As noted above the maximum efficiency we can expect for these counters in differential mode is 96.3%. Efficiency and purity are negatively related. For example, cleanly separating kaons from more numerous pions requires increasing the index of refraction somewhat to prevent any pion light from getting through the hole in the focal plane mirror. This, of course, means that some kaon light in turn will hit the focal plane mirror and be sent to the anti channel, and that kaon will be lost.

Resolving power is determined by the angular spread of the Cerenkov light. Many factors contribute to this. In most cases the angular spread of the beam dominates. Fortunately in the new beam design this has been reduced to +/-0.3 mr. Other contributing factors are the momentum spread of the beam, multiple scattering, chromatic dispersion in the gas and temperature variation along the counter. Except for beam divergence and temperature variation these effects decrease with increasing momenta as does the angular separation of the Cerenkov light from different particles. At 100 GeV/c what few kaons are still present are 1.9 mr from the pions.

We can measure the efficiencies directly by setting the two counters to count the same particle, although this may not be of primary importance to us. Similarly we can measure the “purity” by using one counter to tag the particles the other counter is not set to tag and see how many “leak” through. This will require a little extra running time, as

the particle most likely to leak through will be the majority particle, which is not tagged but inferred during data taking. This is important to us. These calibrations are possible with the two counters having the same efficiency.

### **PRESENT STATUS**

Now that we have the final beam design, the extension tubes for the Cerenkov heads can be cut and welded. The interior of these will be cleaned and painted black. Outgasing of paint for this is now being tested. Jim Kilmer is awaiting parts to complete the motion systems for the primary mirrors. All mirrors have returned from cleaning and realuminizing. I have ordered new Hamamatsu R2256-02 photomultiplier tubes with bases and shields; a search for existing tubes was not successful. These are twelve stage, 2 inch, flat faced, end on, bialkali cathode, quartz window phototubes. As previously noted Terry Tope is awaiting computing equipment to test the "on-the-fly" gas density measuring system. Installation in MC7 can start after the time projection chamber is mounted on its table.