TRIUMF Experiment E614
Technical Note

Optimization of the Number of Sense Wires per Plane in the Dense Chamber Array

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Abstract

The number of sense wires per chamber in the dense array of 10 chambers at either end of the E614 spectrometer was optimized and found to be 48. This was the smallest number of wires required to add extra track points for small angle events and events in which the helix half-wavelength matches the spacing between chamber pairs in the sparse chamber array. This result assumes that the spacing between chamber pairs in the sparse array is 4.8 cm. If this spacing were increased to 6.8 cm, 60 wires per plane in the dense array would be required.

The 10 closely spaced drift chambers (dense array) at either end of the E614 spectrometer were included to provide a profile monitor of the incoming muon beam and to add extra track points to small-angle positron tracks. It is clear that the full 80 wires per plane used in the widely spaced drift chamber pairs (sparse array) are not necessary in this case. An optimum number was found when the positron helix wavelength was compared to the spacing between chamber pairs in the sparse array where the momentum and angle of the track are determined.

In the present design the spacing between pairs in the sparse array is 4.8 cm. Hence some positron tracks with wavelengths in the neighborhood of 9.6 cm will generate track points with nearly identical x (or y) coordinates throughout the sparse array, leading to a poorly determined momentum and angle. The helix wavelengths for which this is a problem occur roughly within the band

$$\frac{1.25\pi}{4.8cm} > k > \frac{0.75\pi}{4.8cm}. \tag{1}$$

As shown in Fig. 1 this band crosses a corner of the stated E614 acceptance, $10° < \theta < 60°$, $0.4 < x < 1.0$.

This defect can be corrected by adding extra track points from the dense array, but only if there are enough wires to contain the possible helix diameters when the wavelength is small ($k > 0.75\pi/4.8cm$). The number of wires per plane N_{wires} sufficient to contain a helix of diameter $2R_{max}$ is given by

$$N_{wires} = 2(2R_{max} + 2.0cm)/0.4cm \tag{2}$$

where 0.4 cm is the sense wire spacing and 2.0 cm is the likely maximum offset of the positron track origin from the z-axis due to the muon beam spot size at the target.

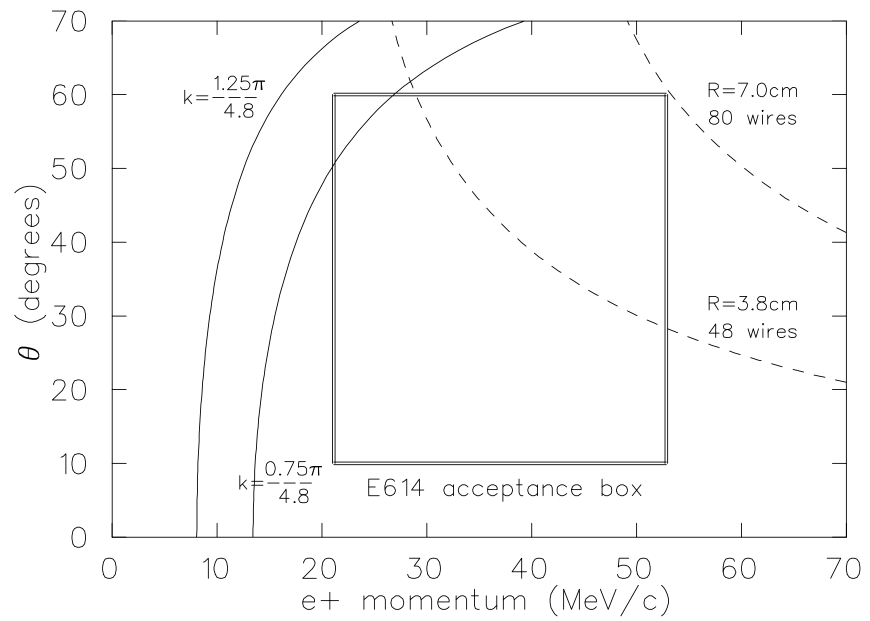

Figure 1: Acceptance coverage for a chamber-pair spacing of 4.8 cm. Solid lines: contours of helix wavenumber k as a function of positron momentum and angle. Dashed lines: contours of helix radius as a function of momentum and angle, with the number of wires per plane required to contain the helix diameter. Bold lines: acceptance region of E614 spectrometer.

In Fig. 1, the area beneath the dashed line represents all the momenta and angles for which the dense array adds a full 10 points (5 x and 5 y) to a track. The dashed line representing 80 wires per plane covers the entire spectrometer acceptance indicating that many of the wires in that case are redundant. The dashed line representing 48 wires per plane covers only part of the desired acceptance but enough to remedy the potential poor fits in the short wavelength corner. Coincidentally, considerations of wiring and packing of front-end electronics determined that more than 48 wires per plane in the dense array would be difficult [1]. Hence 48 wires per plane in the dense array was chosen for the final design.

This design decision has an impact on another question under consideration. It was shown that increasing the spacing between chamber pairs in the sparse array from 4.8 cm to 6.8 cm improved the angle and energy resolution significantly [2]. This would involve substituting 6.0 cm spacers for the 4.0 cm spacers which go between chamber pairs. The effect on the above wavenumber analysis is shown in Fig. 2.

Here the angle-energy region where poor fits would be likely has moved deeper into the E614 acceptance region. Assuming 48 wires per plane, part of the acceptance around 33 MeV/c and 55° is not covered by the dense chamber array. 60 wires per plane would be required. If that number is not possible then the increased spacing between chamber pairs in the sparse array should be avoided. It would however be possible to alternate 4 cm spacers with 6 cm spacers in the sparse array, which would entirely remove the problem of wavelength-spacing coincidence.

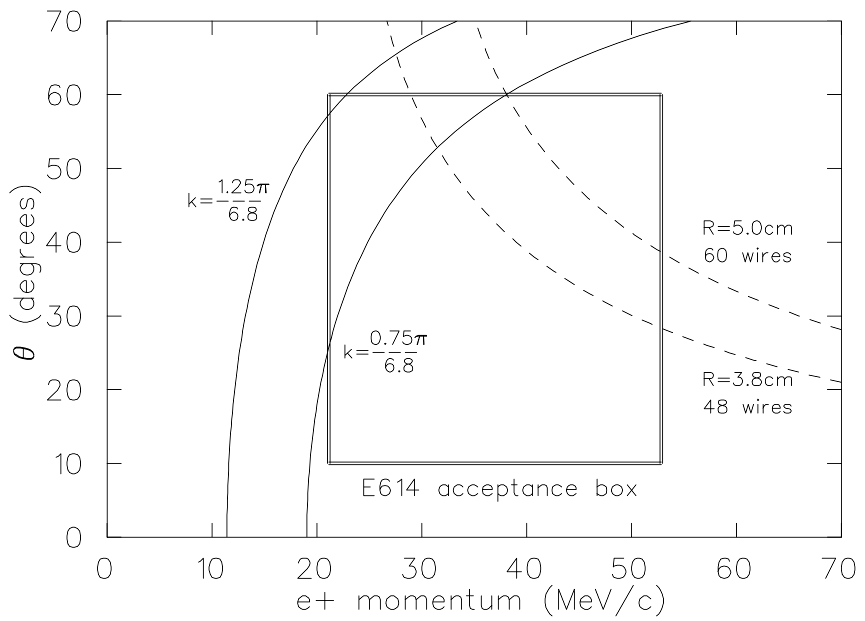

Figure 2: Acceptance coverage for a chamber-pair spacing of 6.8 cm. Solid lines: contours of helix wavenumber k. Dashed lines: contours of helix radius, with the number of wires per plane required to contain the helix diameter. Bold lines: acceptance region of E614 spectrometer.

References

[1] P. Amaudruz and G. Sheffer, private communication 1997.

[2] D.H. Wright, E614 Technical Note # 2, 1997.