

23. The electric field is radially outward from the central wire. We want to find its magnitude in the region between the wire and the cylinder as a function of the distance r from the wire. Since the magnitude of the field at the cylinder wall is known, we take the Gaussian surface to coincide with the wall. Thus, the Gaussian surface is a cylinder with radius R and length L , coaxial with the wire. Only the charge on the wire is actually enclosed by the Gaussian surface; we denote it by q . The area of the Gaussian surface is $2\pi RL$, and the flux through it is $\Phi = 2\pi RLE$. We assume there is no flux through the ends of the cylinder, so this Φ is the total flux. Gauss' law yields $q = 2\pi\epsilon_0 RLE$. Thus,

$$q = 2\pi \left(8.85 \times 10^{-12} \frac{\text{C}^2}{\text{N} \cdot \text{m}^2} \right) (0.014 \text{ m})(0.16 \text{ m}) (2.9 \times 10^4 \text{ N/C}) = 3.6 \times 10^{-9} \text{ C} .$$