**Activity 2-1 – August 29, 2016**

**Part 1 – Constructing the E-field**

Electrons and positrons are accelerated in the Cornell Linac in Wilson Lab. Charged particles are accelerated inside a long metal cylindrical pipe, which is 50m long and has a radius R = 6 cm. All the air is pumped out of this pipe, known as the “beam line.”

One afternoon, the beam line is struck by lightning, which gives it a uniform surface charge density σ. After the lightning strike, accelerator operators want to start accelerating particles in the beam line, but they are concerned that the charge density might affect the beam particles, causing them to crash into the wall of the pipe and burn a hole through it. Air and dirt would rush into the empty pipe causing months of expensive delay. You will investigate whether the surface charge of the beam line could affect the beam particles.

1. First, what is the infinitesimal area, d**A**, of a small patch on a cylindrical shell centered on the z-axis? Assuming you use this d**A** in a surface integral over a closed surface, give the vector direction of d**A**.

x

y

z



R

dA

1. What direction does the E-field point at all points in space? *Explain in detail* how you know. (i.e. simply stating symmetry is not enough: how does symmetry tell us this?)
2. Use Gauss’s Law to find the E-field at all points in space.
3. Does the charge σ on the beam line affect the particles being accelerated inside it? Could it affect the electronic equipment outside the tunnel?

You are given a long glass rod and a piece of silk. You rub the silk cloth along the length of the rod, but only on one side, until that side has a uniform surface charge distribution σ. Now you would like to calculate the electric field from the rod.

Top View

**+**

**+**

**+**

**+**

**+**

**+**

**+**

**+**

**+**

Does Gauss’ Law apply in this case? Can you use Gauss’ Law to calculate the electric field from the rod? If so, calculate it. If not, explain why not.