# High Energy & Nuclear Physics: Software [Homework]

## Computer Science and Physical Science Collide for the NuSteam Program

Gene Van Buren - Brookhaven National Laboratory - July 12, 2022

U.S. DEPARTMENT OF ENERGY
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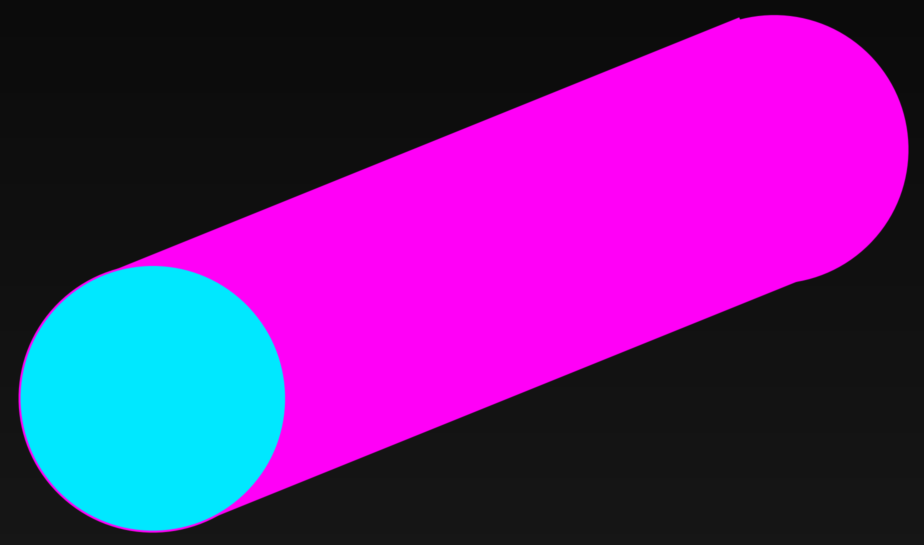
# Scintillating optical fibers (SciFis)

## Gene wants to build a detector

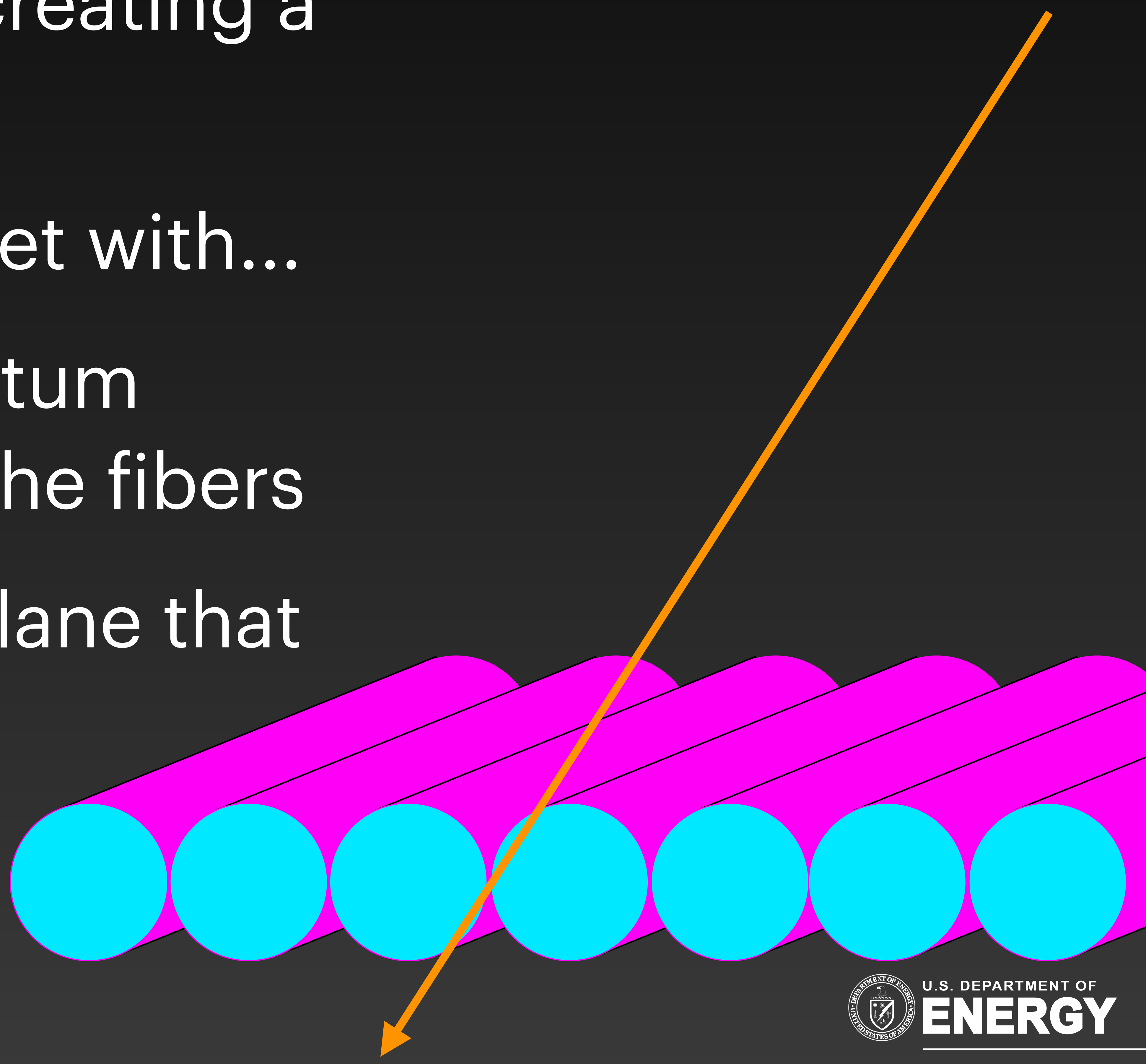


- The detector is composed of scintillating optical fibers
  - Scintillating: relativistically moving charged particles traversing the core material of the fiber generate light by exciting the atoms in that material
  - Optical fiber: light inside the fiber does not exit the sides, but bounces off the sheath and down the length of the fiber to its ends
- Each fiber is 1 mm wide (with a negligibly thin sheath around the core), 30 cm long, and is individually observed with a photo detector at one end (the other end is coated reflectively so that all internally generated light eventually goes out only the one end)

# SciFi Detector

## Gene wants to build a detector

- 300 fibers are laid side-by-side with no gaps, creating a sheet (layer) that is 30 cm x 30 cm
- Particles of interest will be incident on this sheet with...
  - No "dip" angle: particles will have no momentum component along the long axis direction of the fibers
  - Evenly distributed "crossing" angles: in the plane that slices the fibers into circles, tracks may be orthogonal to the sheet, or up to ±45° from orthogonal



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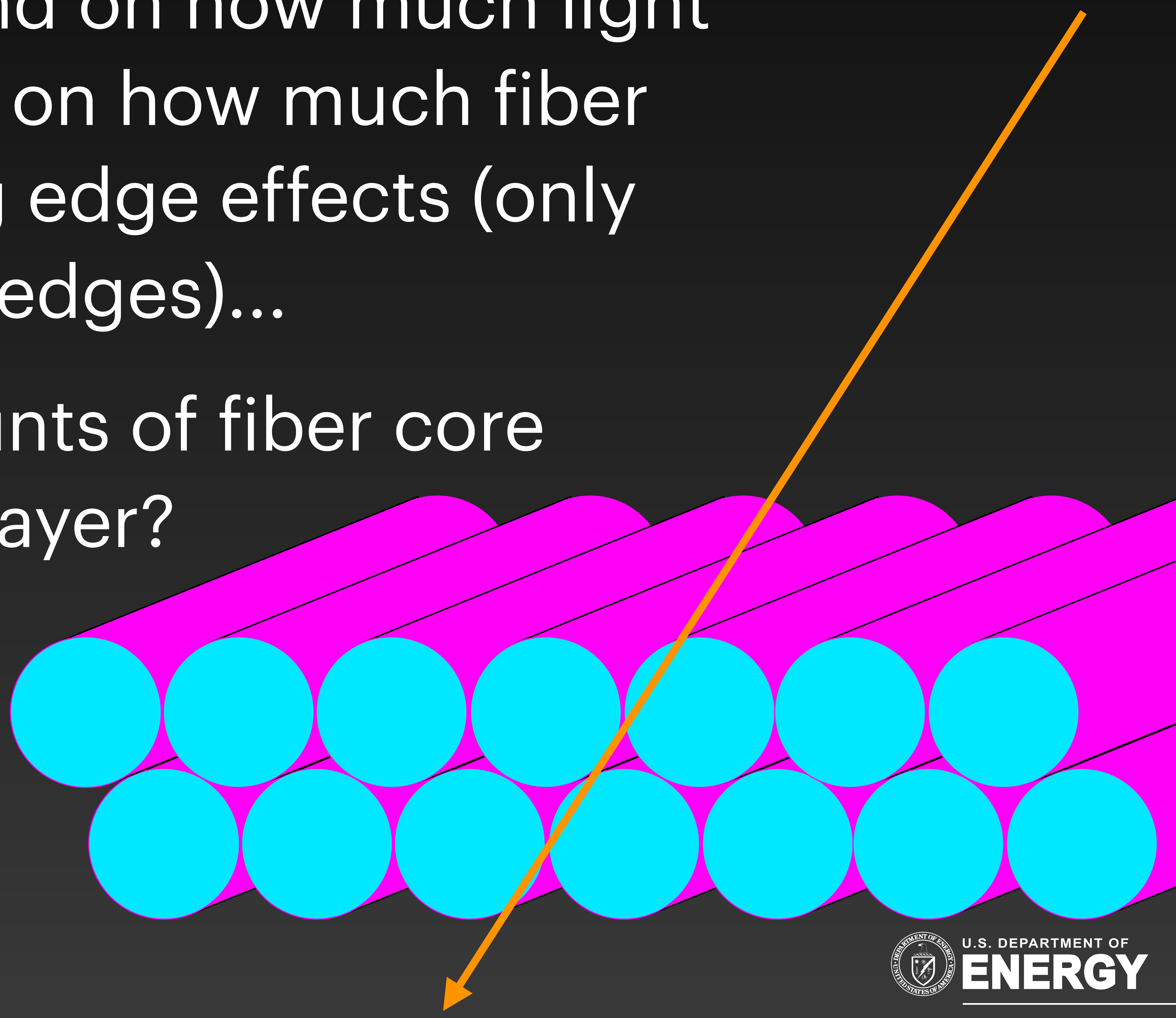
# SciFi Detector Performance

## Gene wants to build a detector

- Our detector performance is going to depend on how much light each particle produces, which is dependent on how much fiber core material the particles traverse. Ignoring edge effects (only interested in particles that aren't near sheet edges)...
- 1) What are the average and maximum amounts of fiber core material a particle may traverse for a single layer?
- 2) What are those numbers if two layers of fibers are stacked as shown?



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# Considerations

## Choices

- Can these numbers be determined analytically (calculus)?
- Can these numbers be determined through Monte Carlo simulation?
  - If so, for what quantities should dice be thrown?
- Which of the above methods would be more easily extended to...
  - Non-zero dip angles
  - More layers
  - Wider distributions of crossing angles
  - Curving charged particle tracks in a magnetic field