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# Particle physics

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PHYS 246 class 6

<https://lkwagner.github.io/IntroductionToComputationalPhysics/intro.html>

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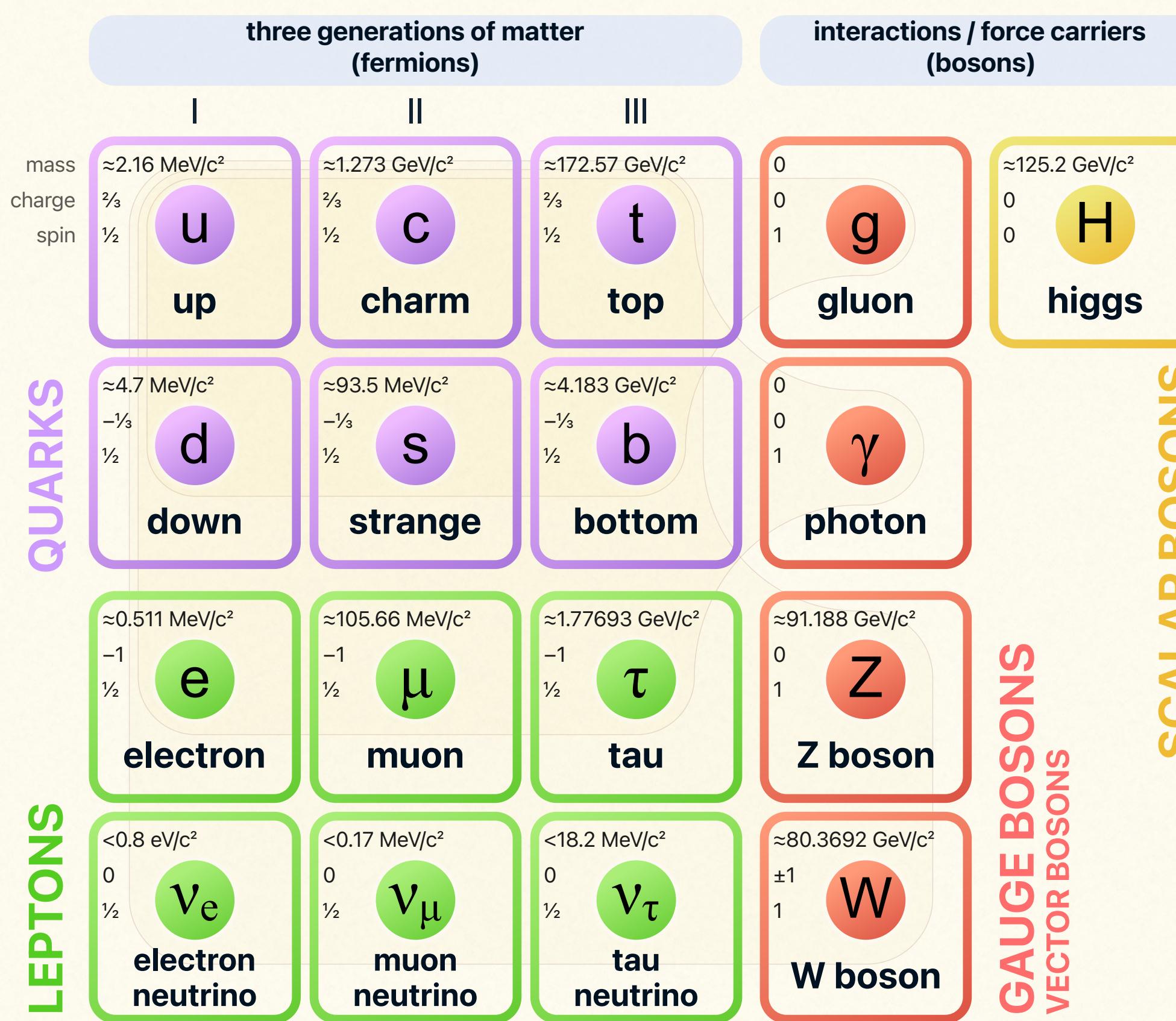
# Announcements/notes

- 'Chaos' is due tonight.
- I updated a few of the instructions (3d plots and clarified a couple variables) so grab the new version

```
from google.colab import drive  
drive.mount('/content/drive')  
!cp /content/drive/MyDrive/Colab\ Notebooks/Dynamics.ipynb ./  
!jupyter nbconvert --to HTML "Dynamics.ipynb"
```

# The physics reaction

## Standard Model of Elementary Particles



Meson: quark + antiquark.

Kaon:

strange quark + up/down quark

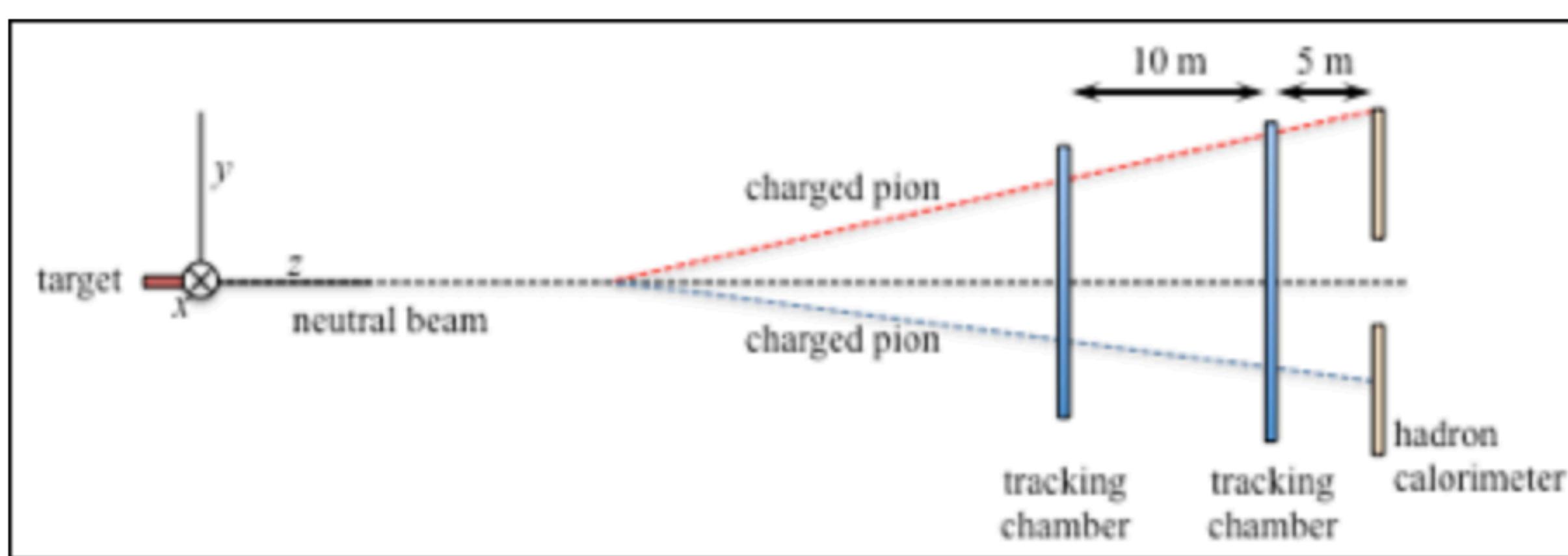
$K^0$ : down + anti-strange

Pion:

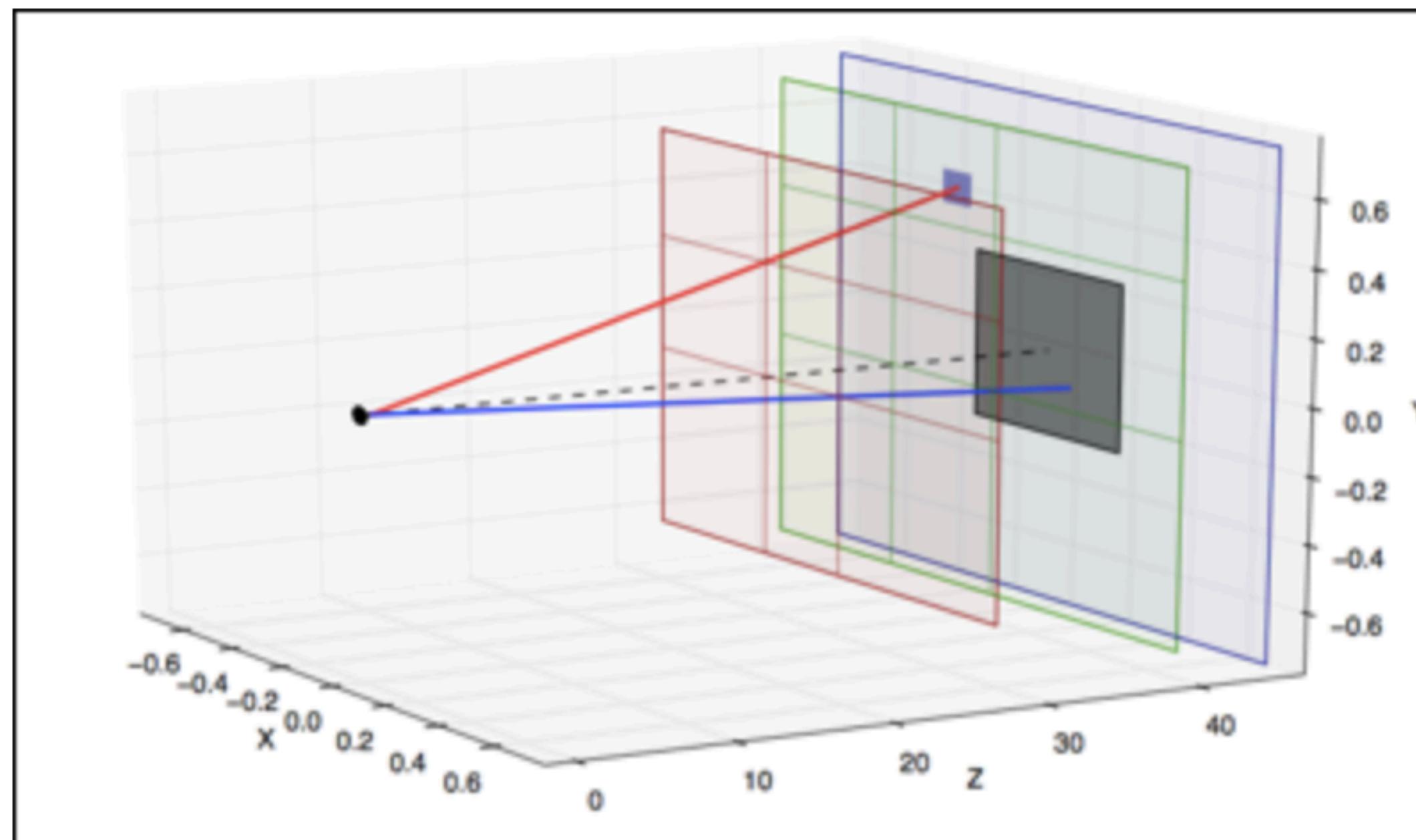
$\Pi^+$ : up + anti-down

$\Pi^-$ : down + anti-up

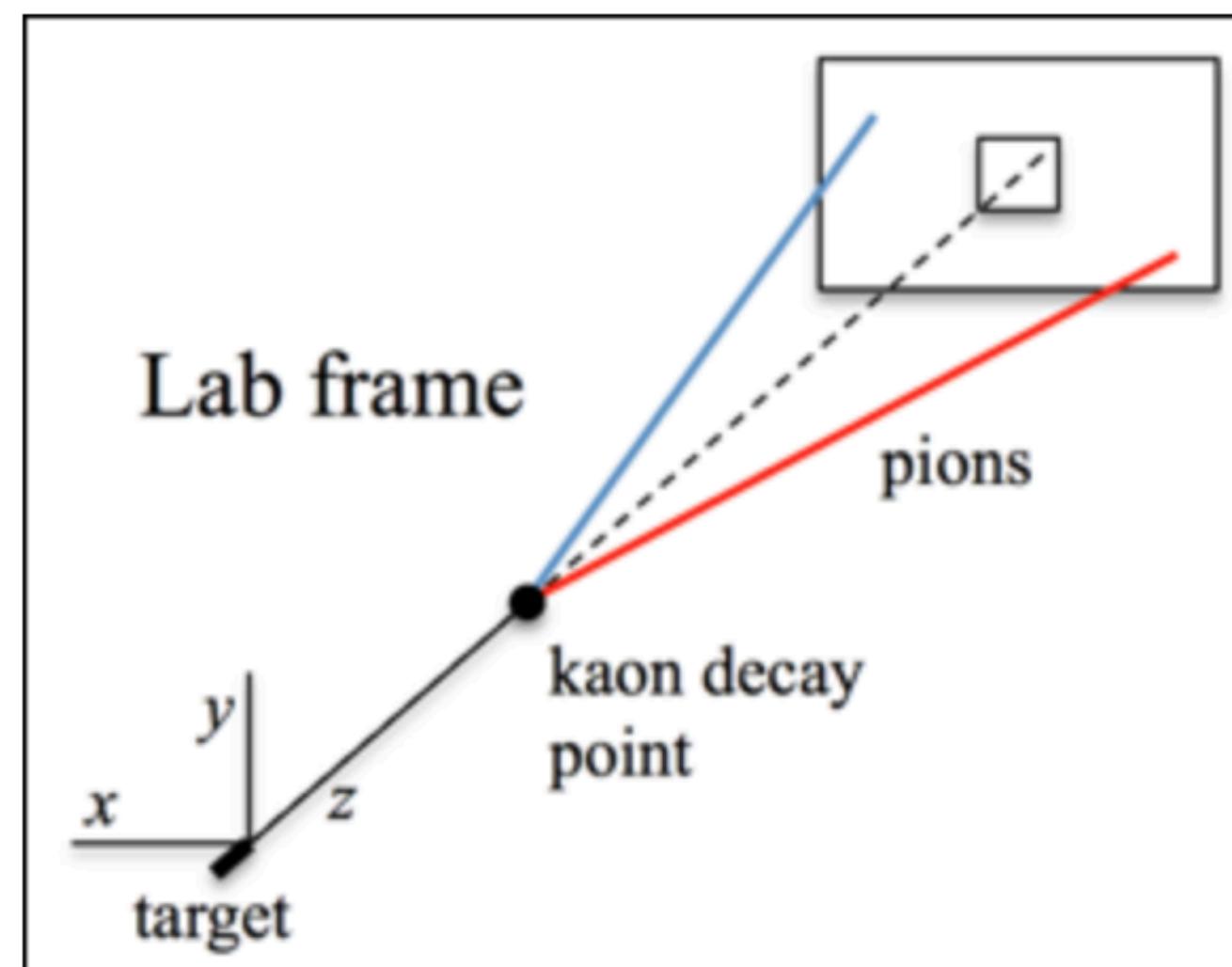
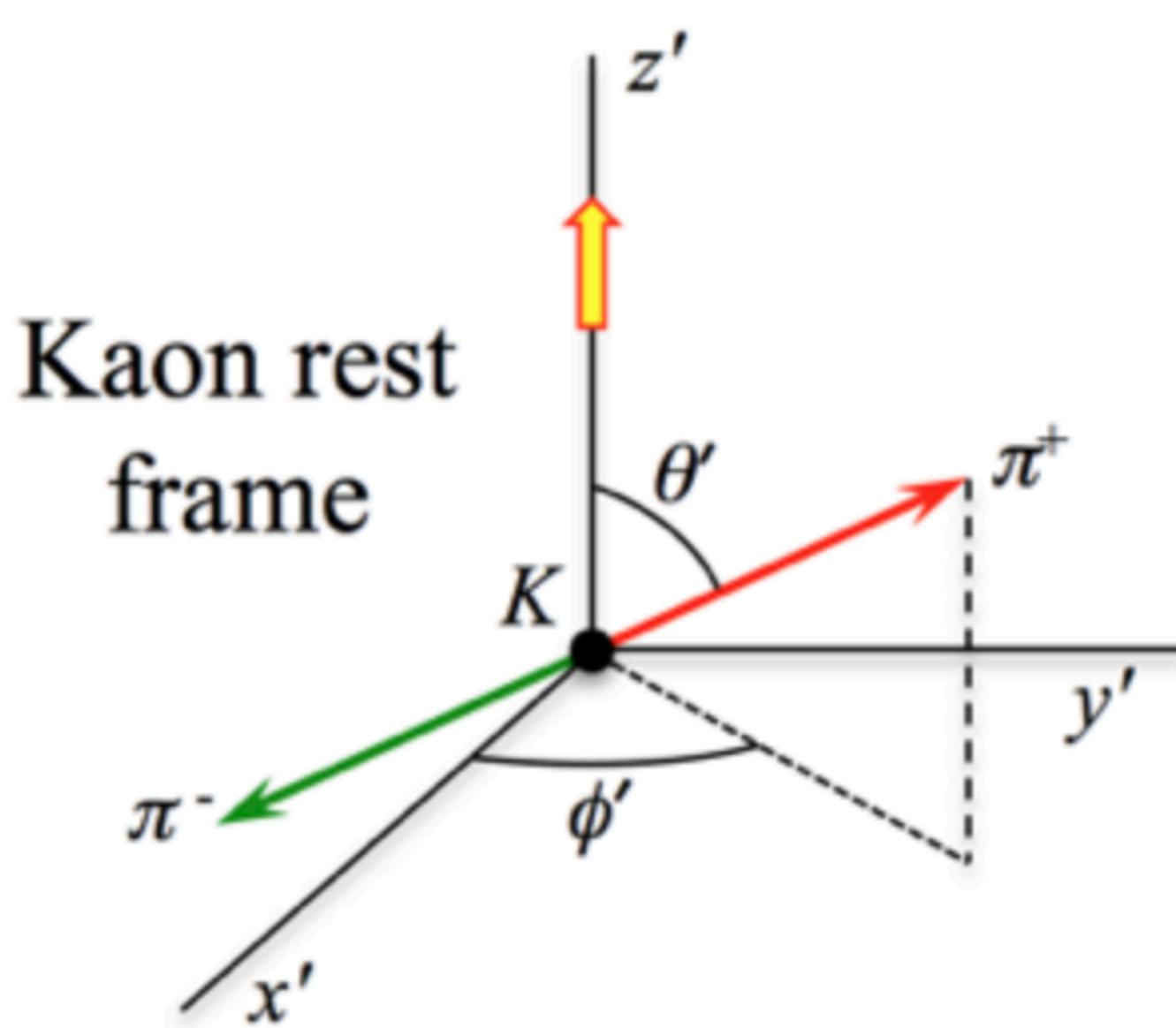
$\Pi^0$ : up + anti-up or down+anti-down



If you slam two heavy ions (like Au+Au) into each other, lots of particles



# Geometry

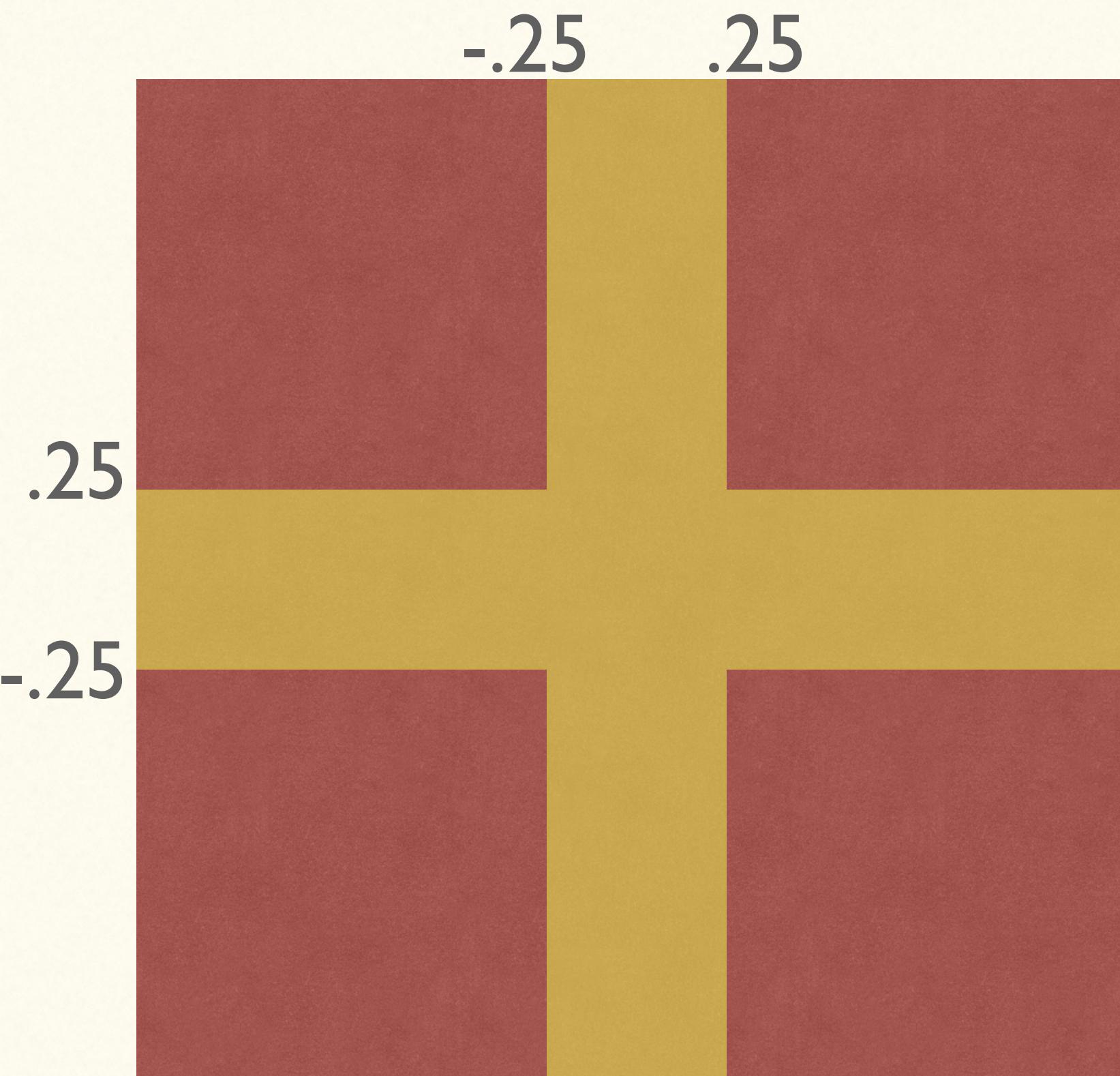


Everything is done in the lab frame

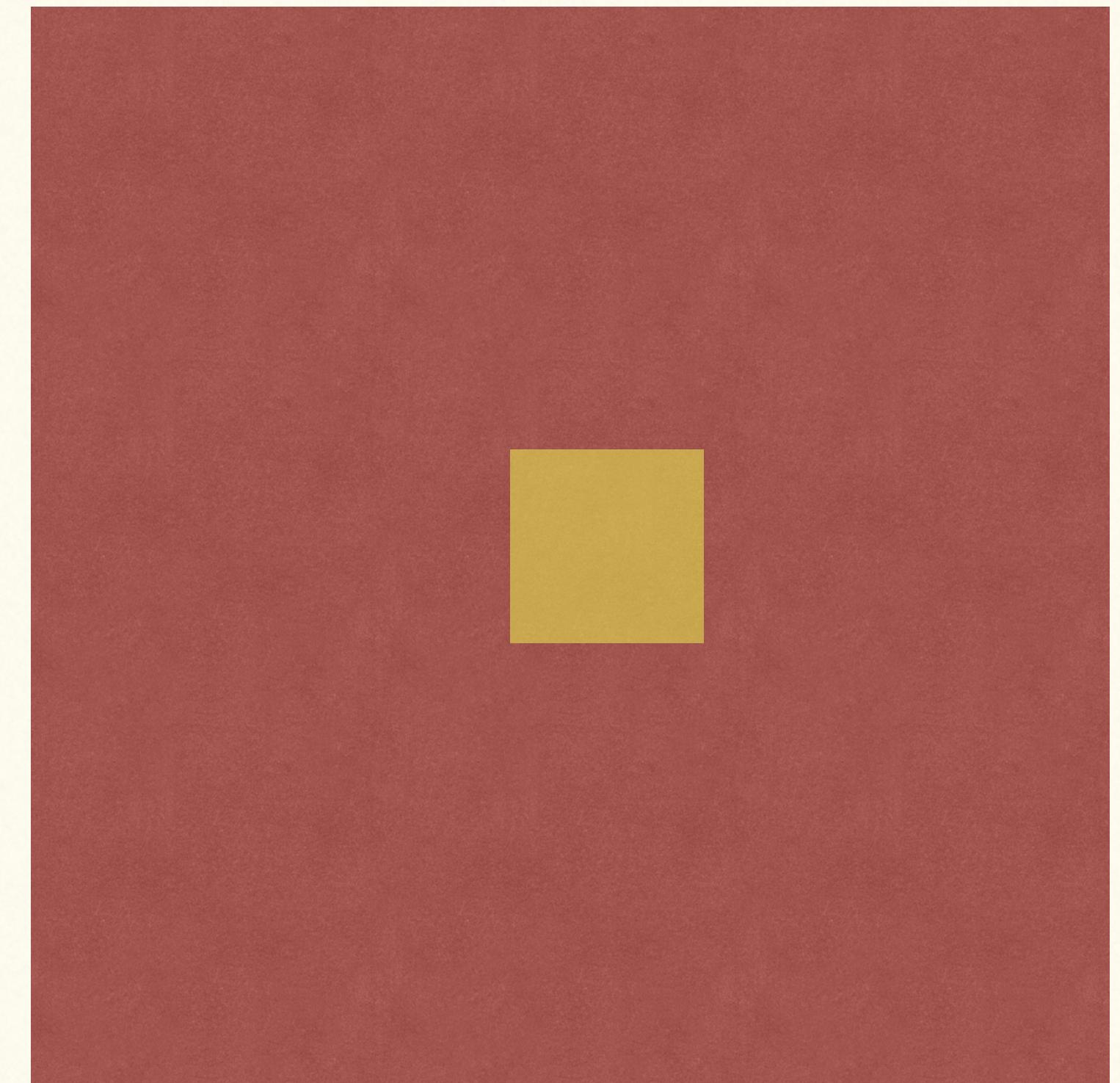
You can calculate the trajectory angle from the velocity only (no need for time or anything complicated!)

Then from the angle you can get the position of intersection.

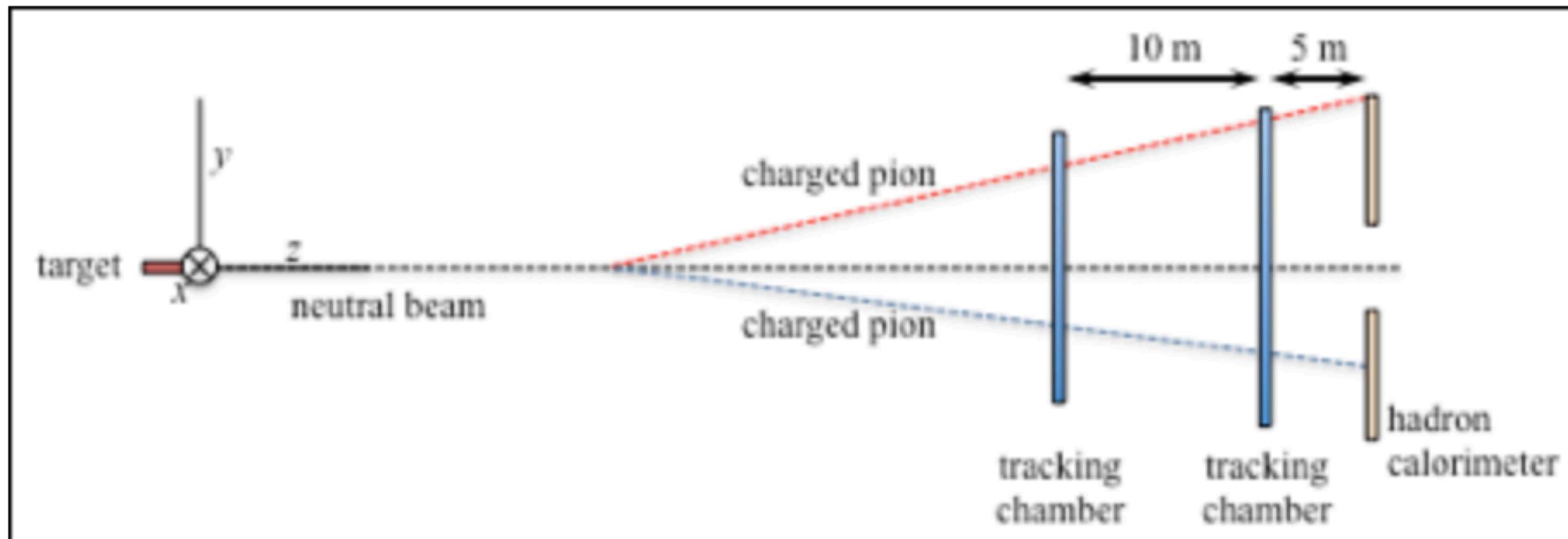
# Missing the hole



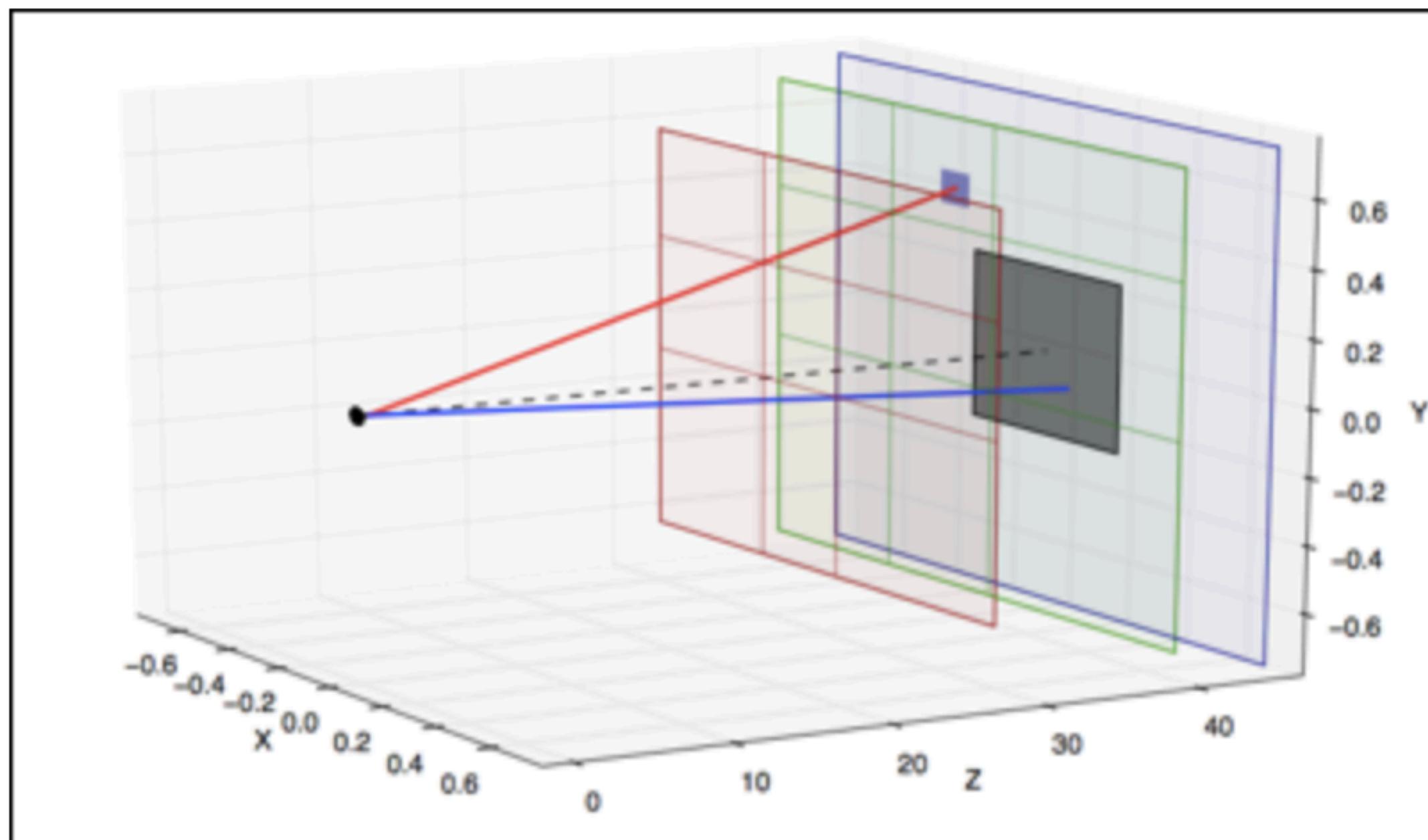
Which one does this describe?  
 $|x| \geq 0.25 \text{ AND } |y| \geq 0.25$



# Logic for what counts as a hit



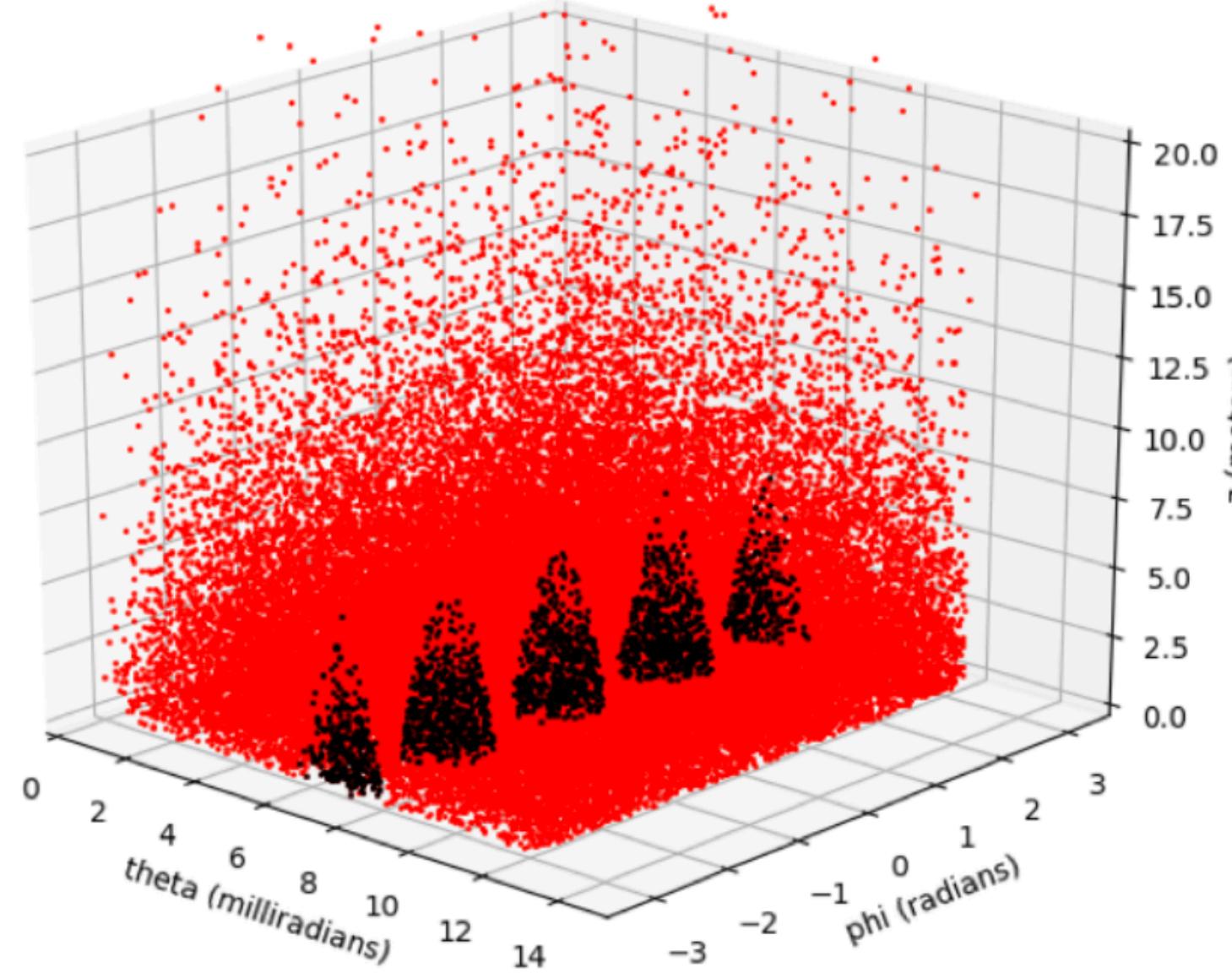
BOTH pions have to hit ALL THREE



# Discussion: why is the distribution in theta so small?

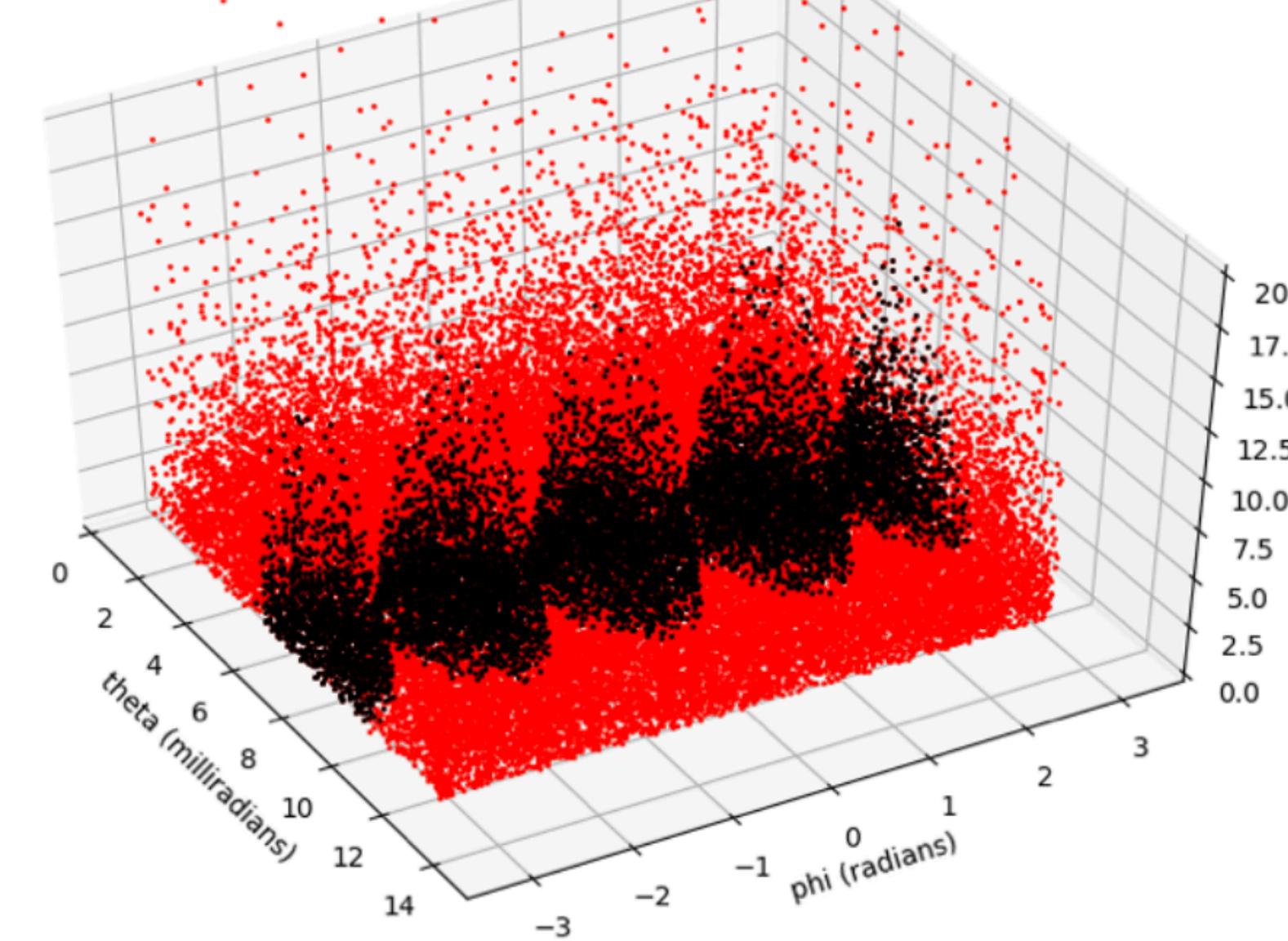
28 meters:

Kaon decay phase space: all decays (red); triggers (black)-- George Gollin



38 meters:

Kaon decay phase space: all decays (red); triggers (black)-- George Gollin



# Useful numpy functions

np.arctan2

x & y means element-wise AND

for example  $(x>2) \& (y<3)$  (parentheses are required for the compound expressions)

Functional programming styles can be helpful:

```
def function(x,y,z):  
    return u,v,w
```

- \* x,y,z are not changed by the function (immutable)
- \* There are no side effects inside the function (no global variables read in, no changes in x,y,z)
- \* The only effect of the function is to return u,v,w