Presenting Physics:
Produce Pretty Pictures

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16/12/25

Humans are bad with abstract data

Sure, we can get something like Python to tell us about a data structure, but it probably doesn't help that much on its own

Compare these two: obviously they aren't the same, but can you say any more?

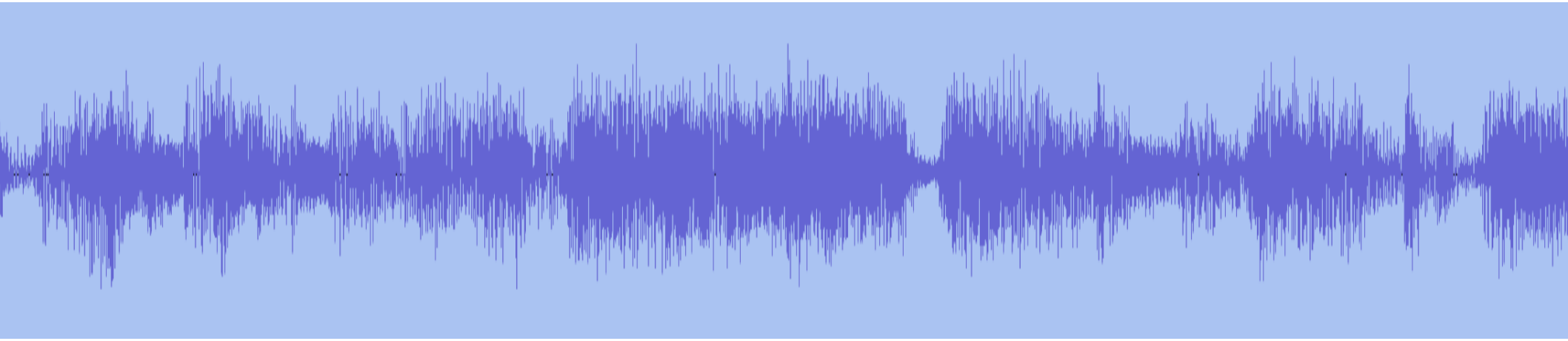
```
(44100, array([[    0,     0],
       [    0,     0],
       [    0,     0],
       ...,
       [14721, 15839],
       [13252, 15569],
       [11643, 14254]], shape=(6562339, 2), dtype=int16))
```

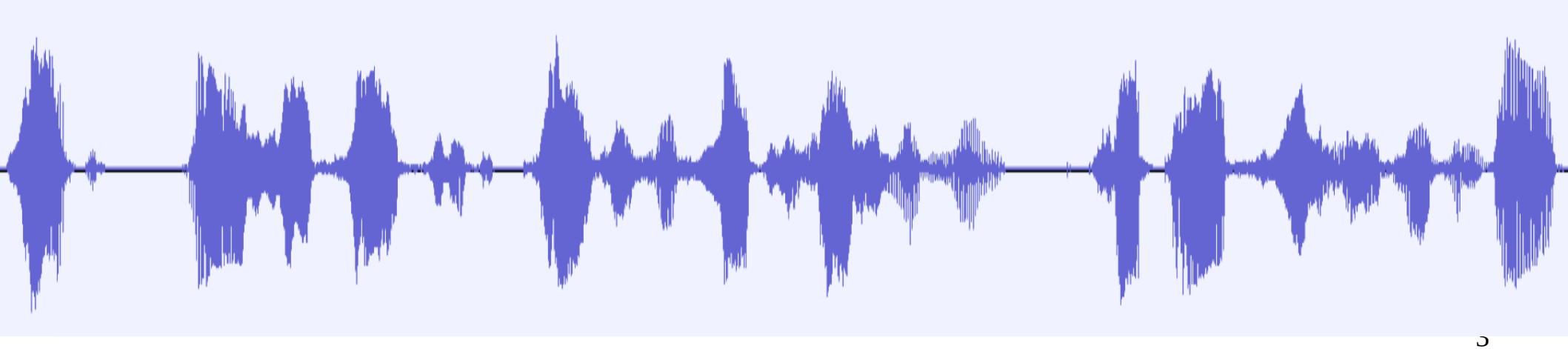
```
(44100, array([[  0,   0],
       [  0,   0],
       [  0,   0],
       ...,
       [ 54, 105],
       [ 53,  84],
       [ 22,  89]], shape=(47695728, 2), dtype=int16))
```

So we make graphs

Alright, we're physicists, let's throw it on a plot. Obviously it's a long sequence of numbers, so let's just see how they change with time

Compare these two: did this help at all? Maybe we can guess a little more

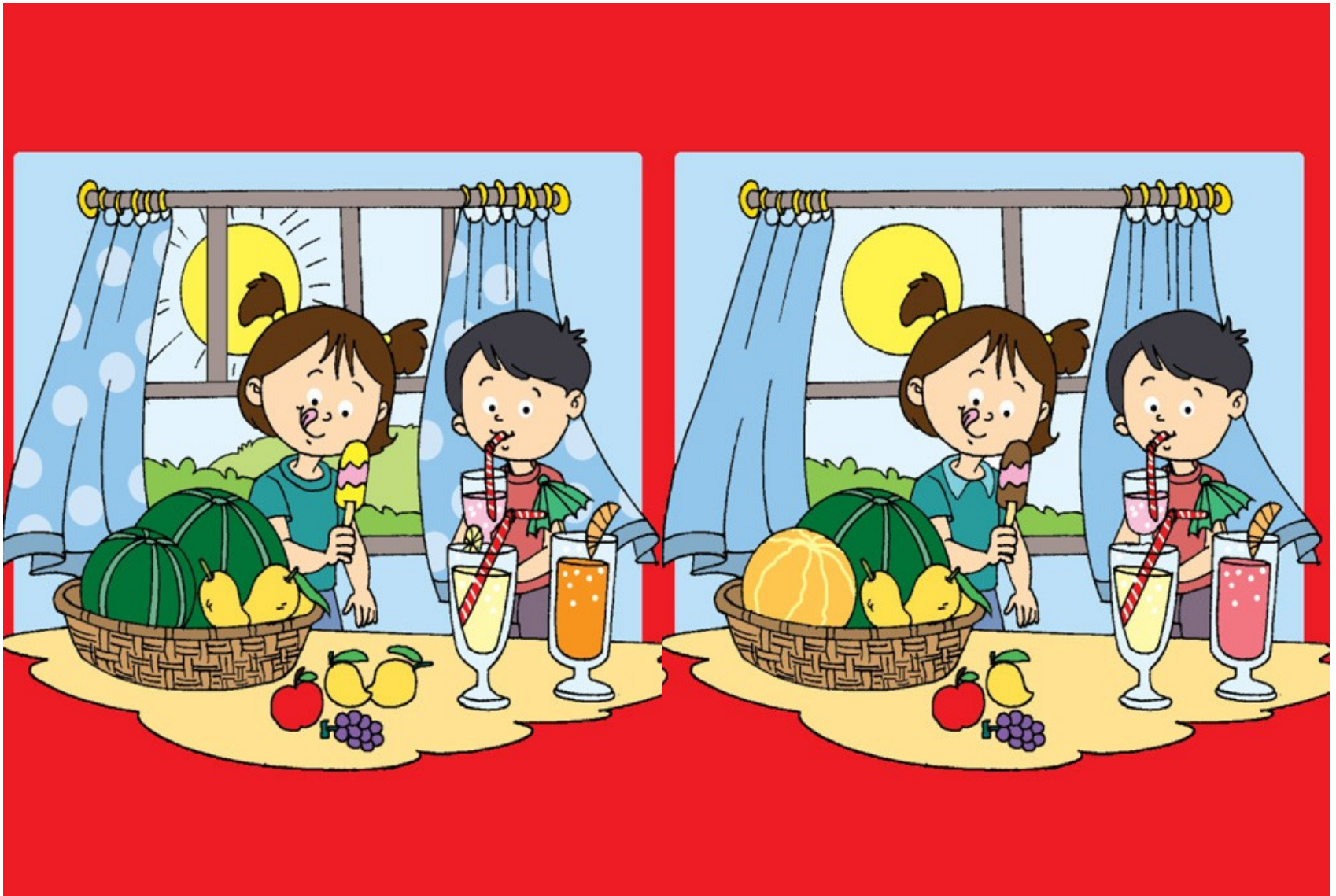




We can do better

Most of our perception has a time-like dimension (c.f. the audio example before) and we can use that

It works even in presentations!



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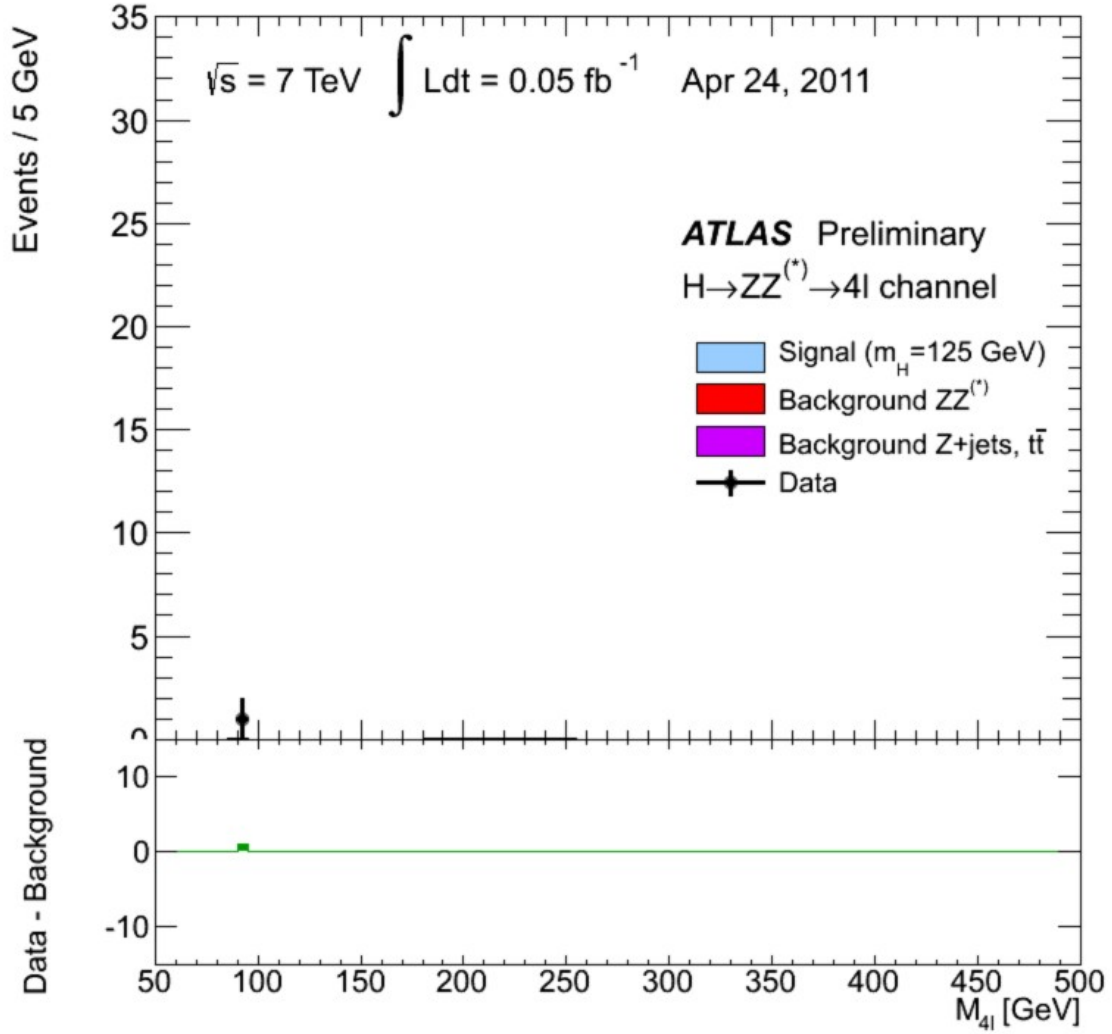
It even works with graphs

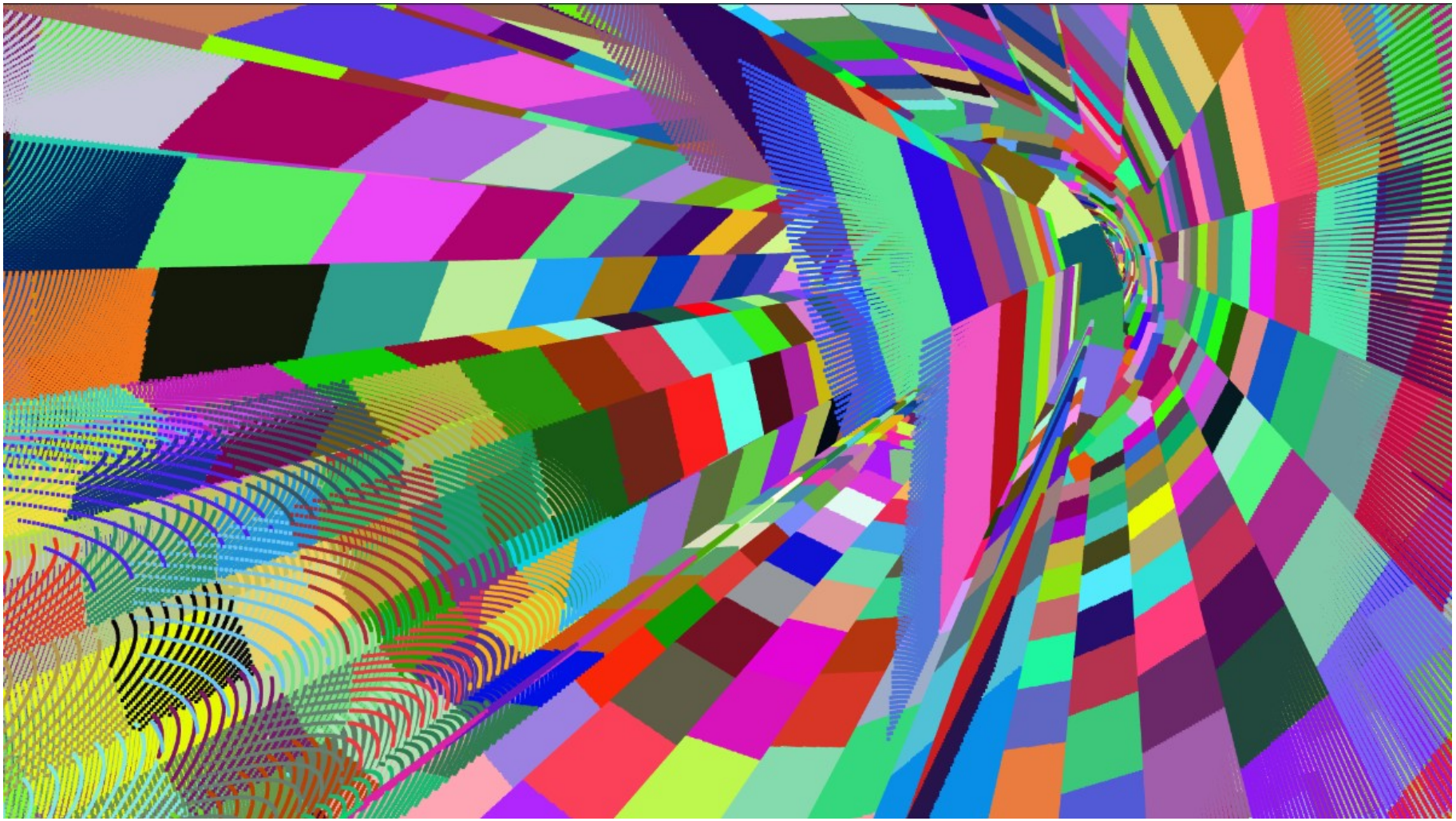
I'll often scroll through a lot of similar graphs very quickly, just looking for changes or outliers – often you can use a standard image viewer

Even ATLAS understands that you can improve on BORING ROOT PLOT



3D perception

Sure, we have binocular vision that gives us a sense of depth. But we also gain information about 3D spaces through time-varying effects like parallax (as well as effects like perspective within a single image)



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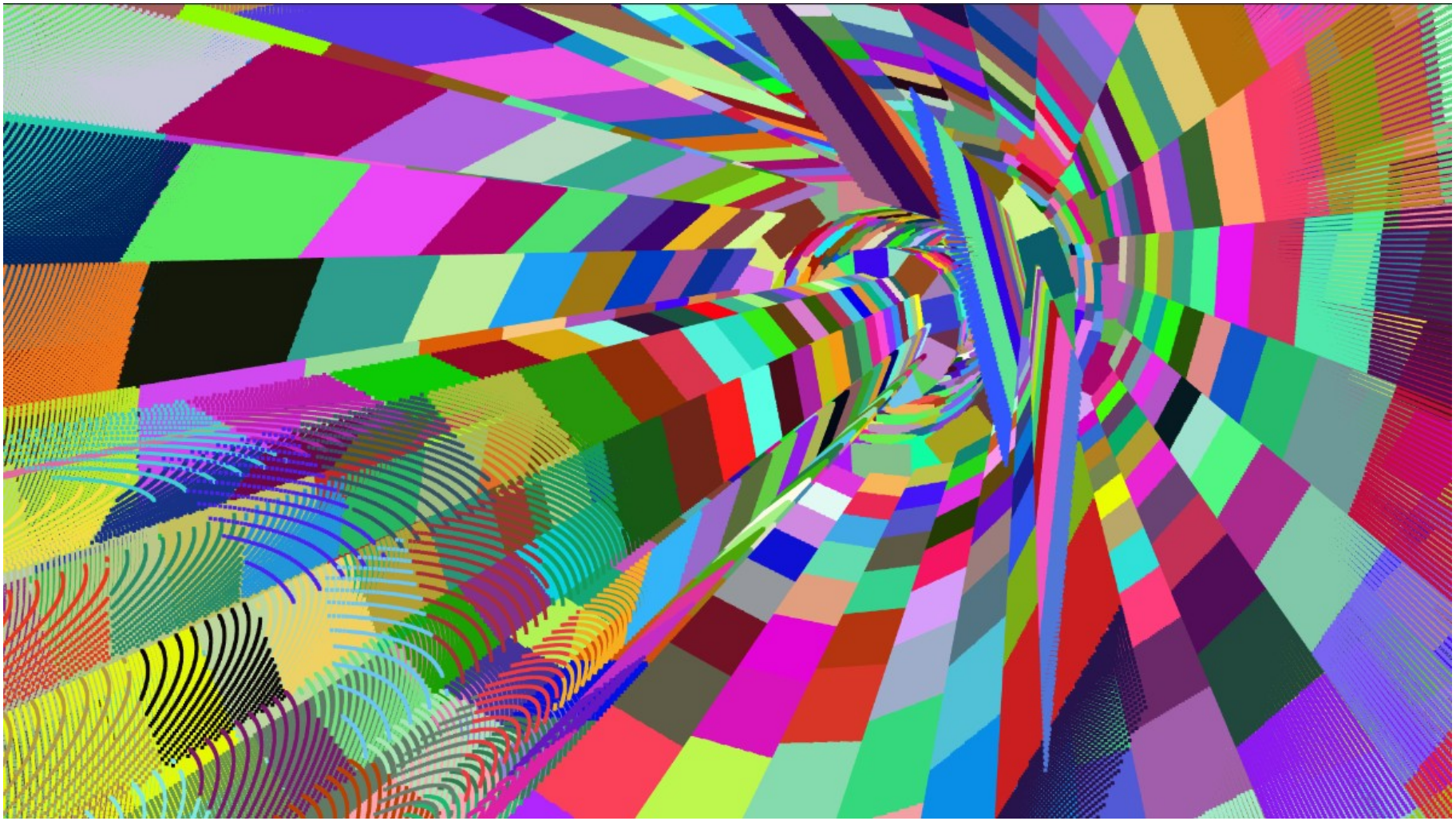

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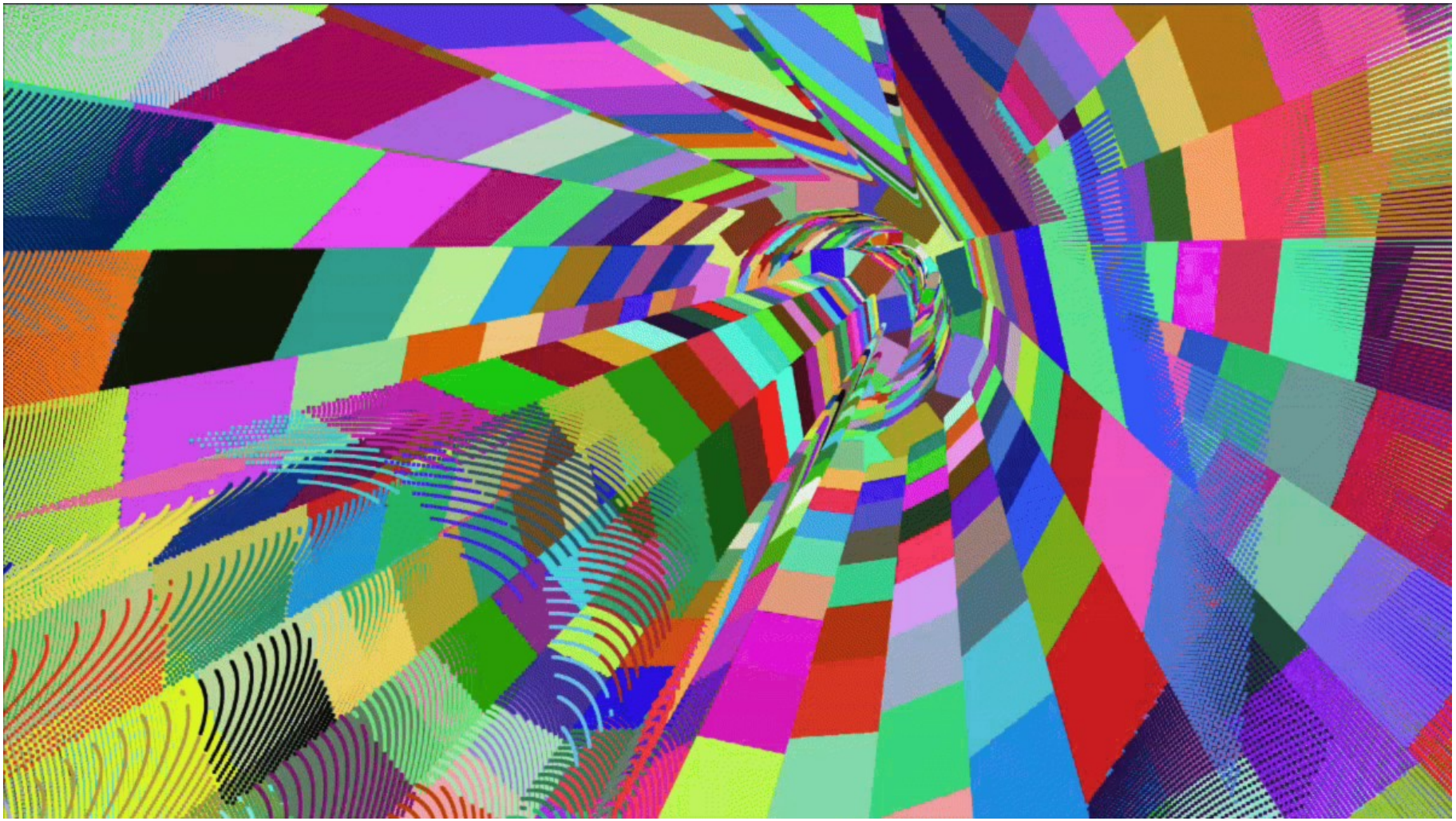
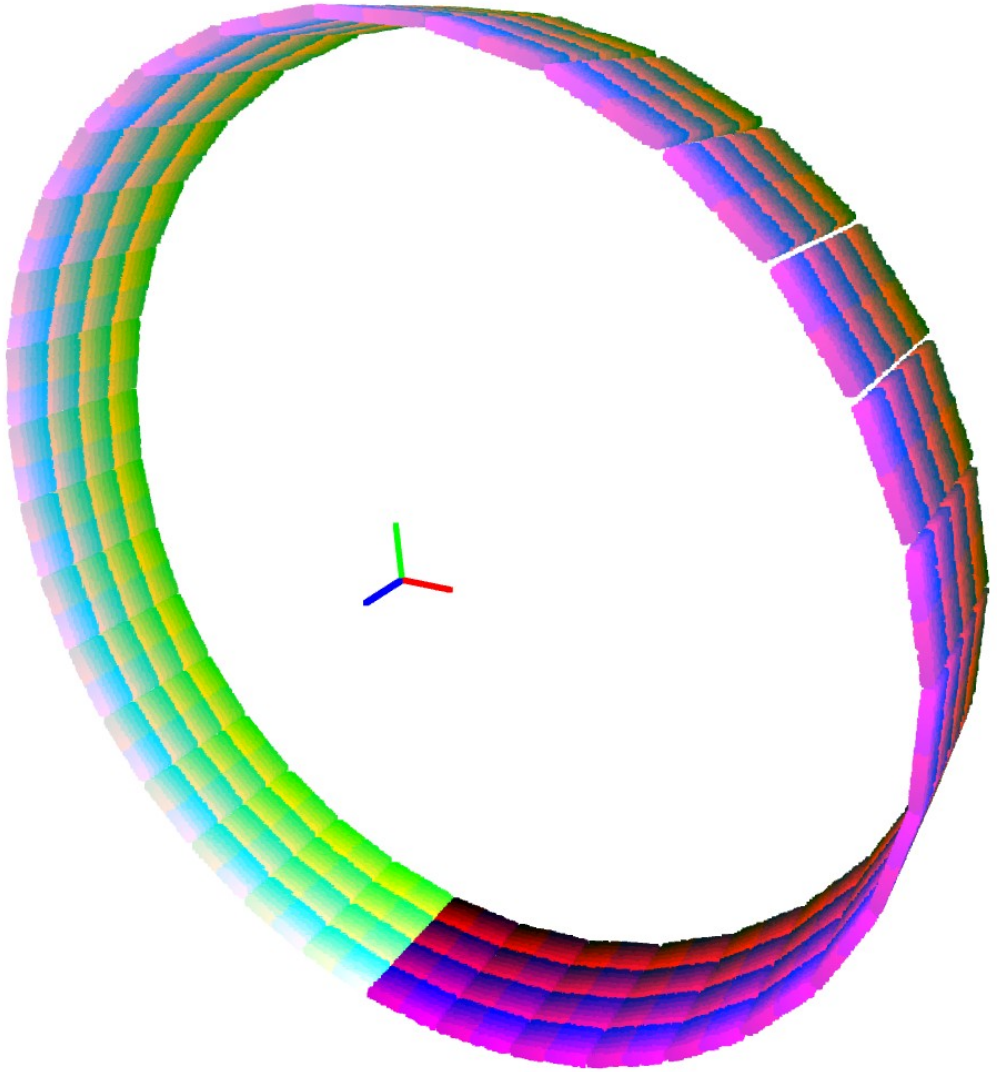


Colours are nice

Often we just choose colours to distinguish A from B, like different lines on a graph – in the previous image each module has a random colour assigned

However, we can encode actual information in RGB values – each is effectively an independent plotting dimension

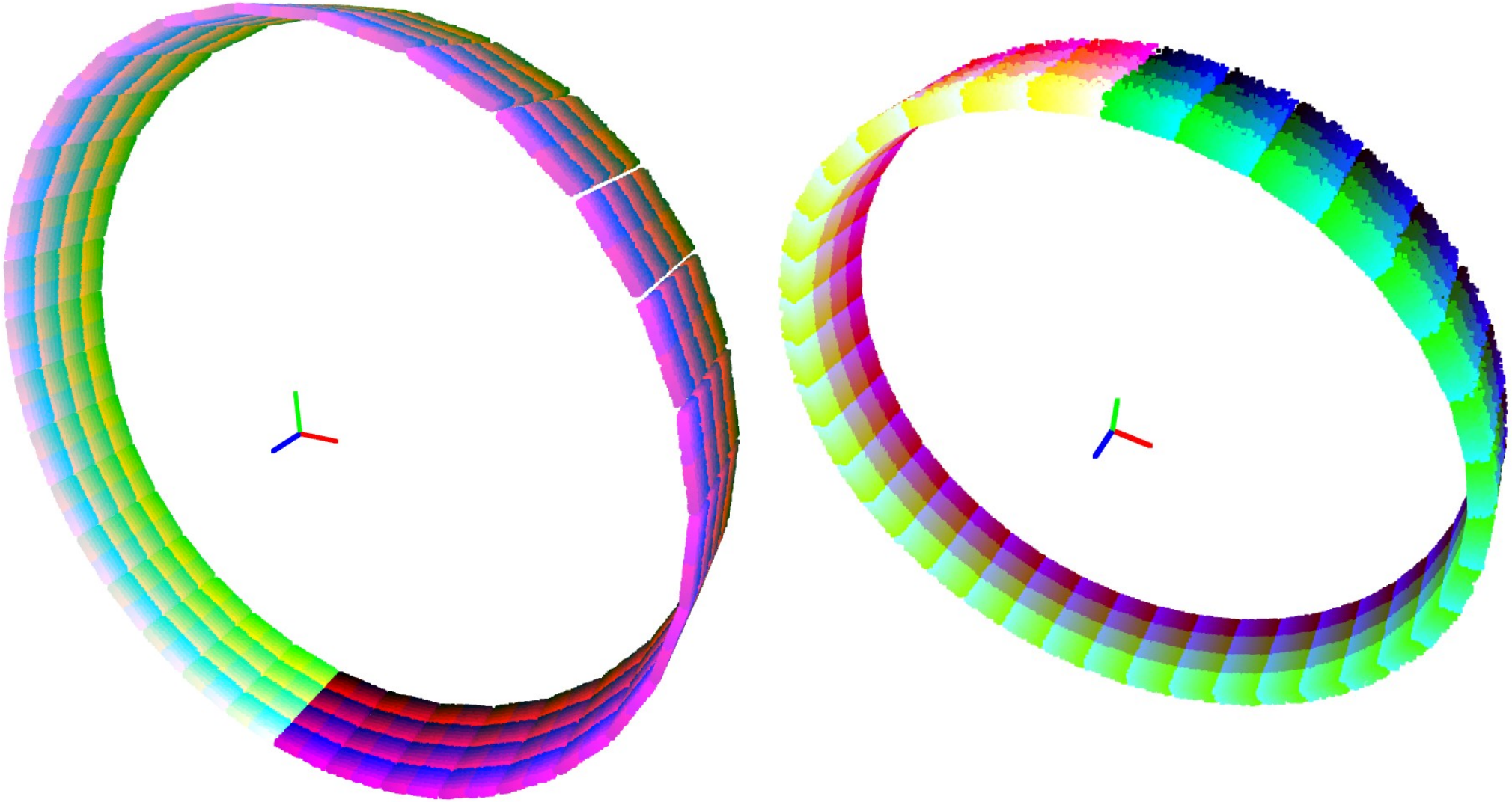


Here I'm encoding three custom spatial indices for identifying scintillator crystals within a PET scanner, but that's not important

Fuzzy comparison

On the left I have my example detector, on the right I have a detector that needs to have the same layout convention, even though it's a different shape

Just look at the colour patterns!



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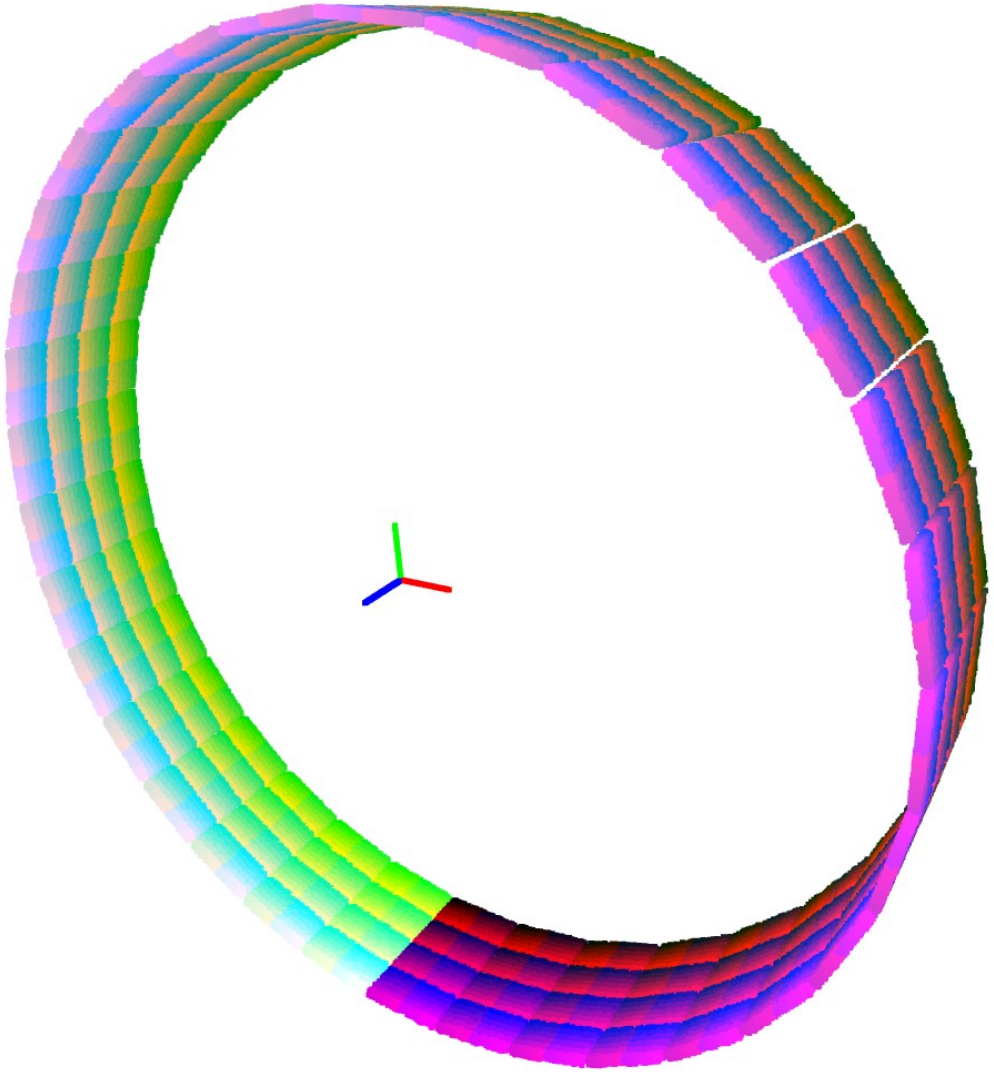

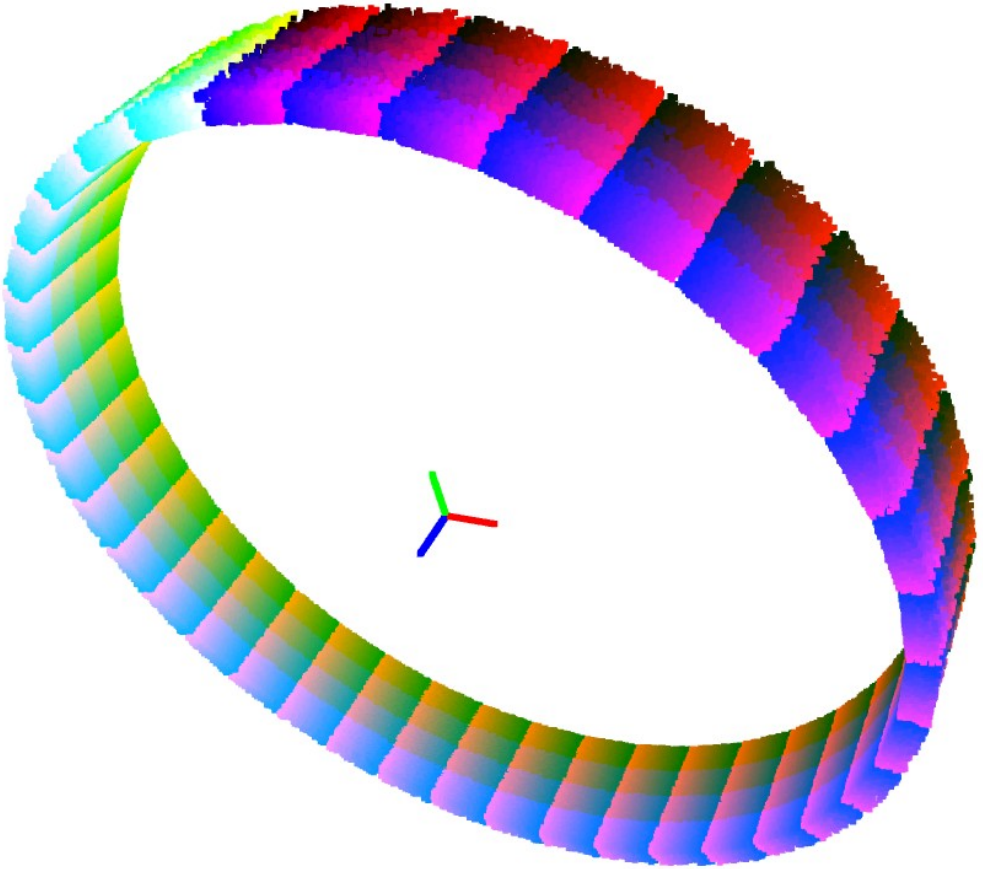

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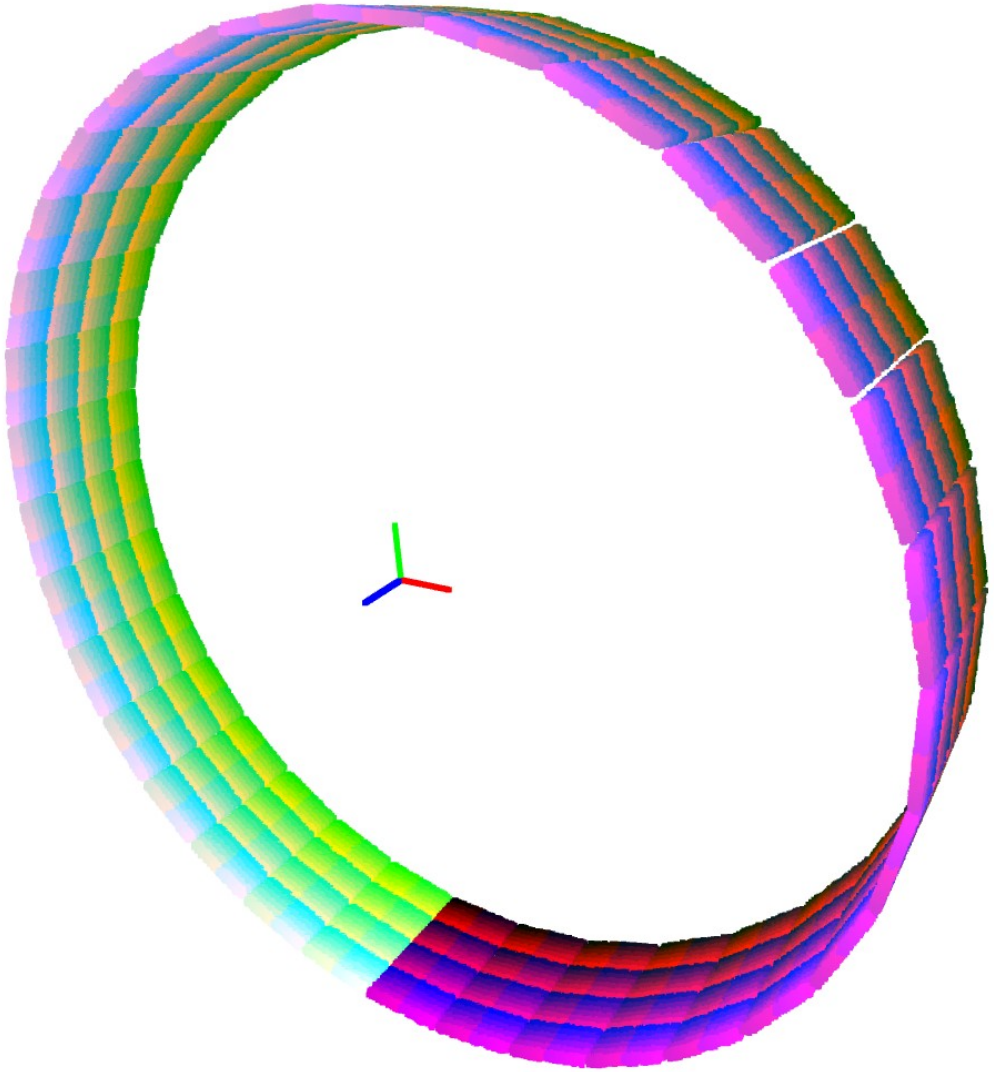
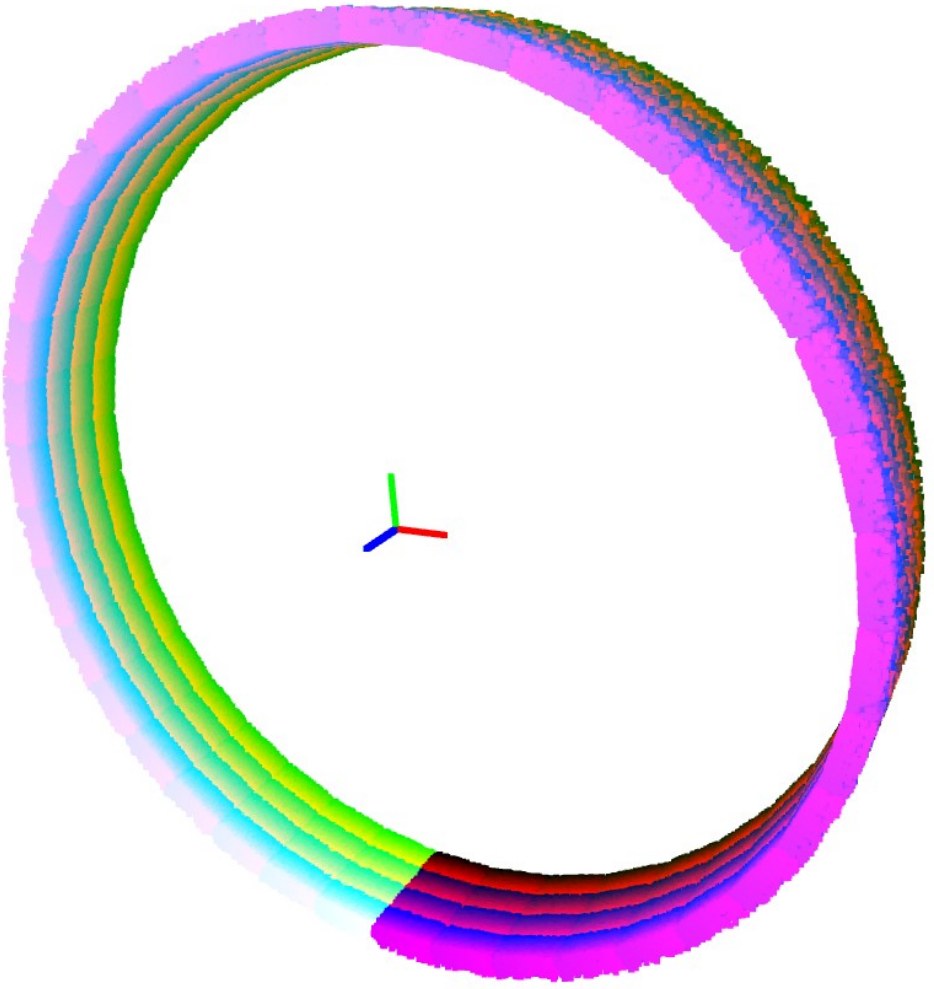
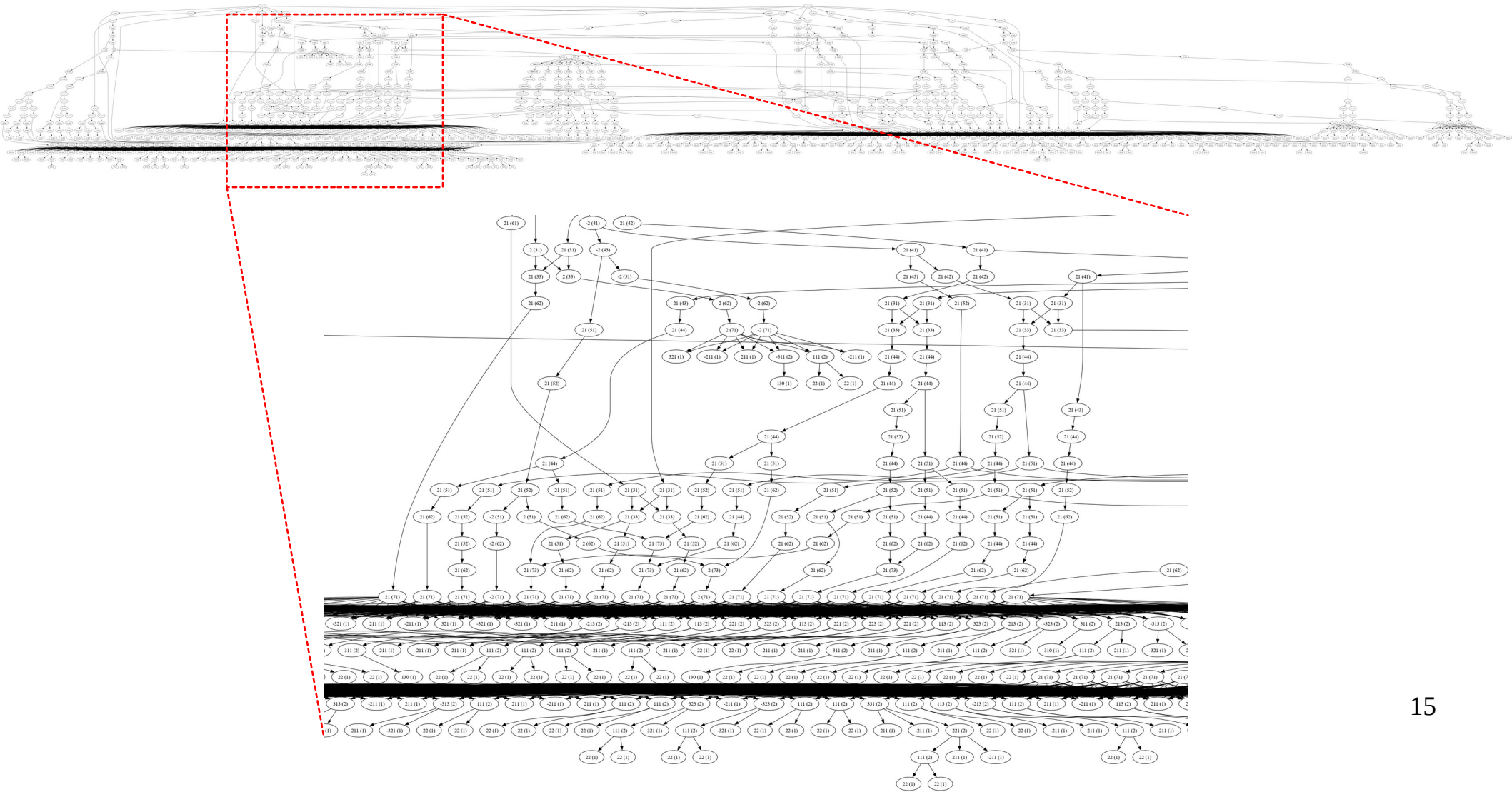




I don’t know what it means, so make a picture

I was trying to understand some exotic MC file – I didn’t understand what the decay was doing, so I just graphed the whole ancestry tree for all particles

Hmm, too messy to read



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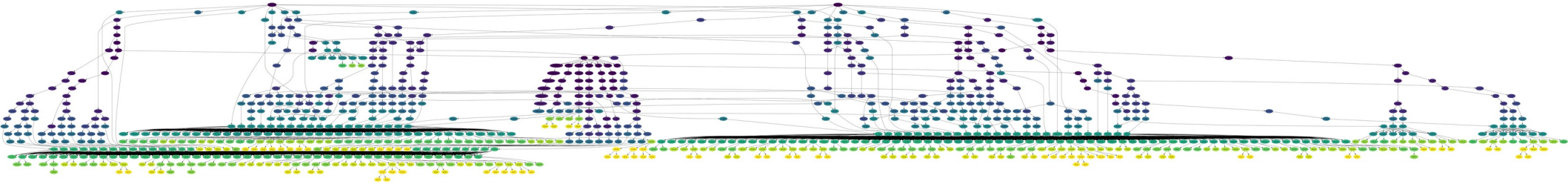
Just choose whatever extra data you have and make colours with it



Does this tell me anything?

Nah, not really. I just get a vague sense that the brighter colours are near the bottom

(Again it’s not actually important, but I’m using the MC particle “barcode” property and the widely-used “viridis” palette from MatPlotLib)

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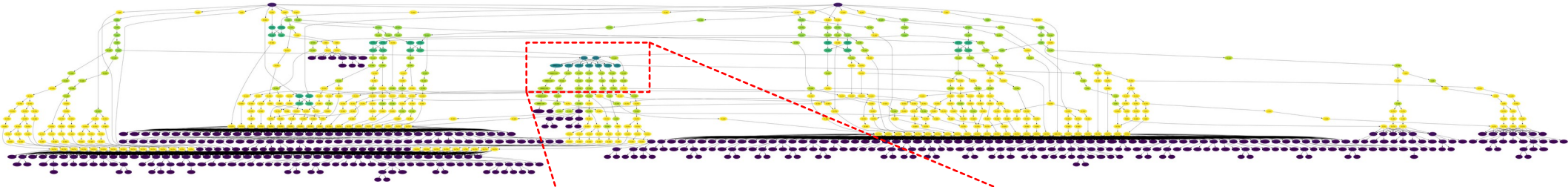
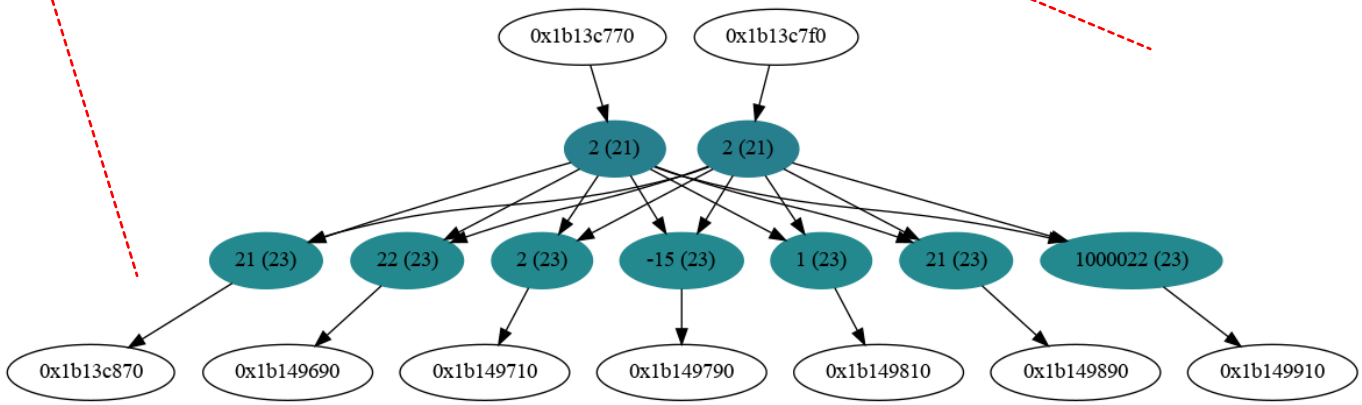
Try a different colour variable!

(MC “status”)



Much more promising!

Now I can see that there’s something special about this bit in the middle



Now that I have an interesting variable I can select the corresponding nodes and see what they do: I printed the PDG ID and see those up quarks (2)
- this is the hard scatter, the interesting bit

Don’t do it for me, do it for you

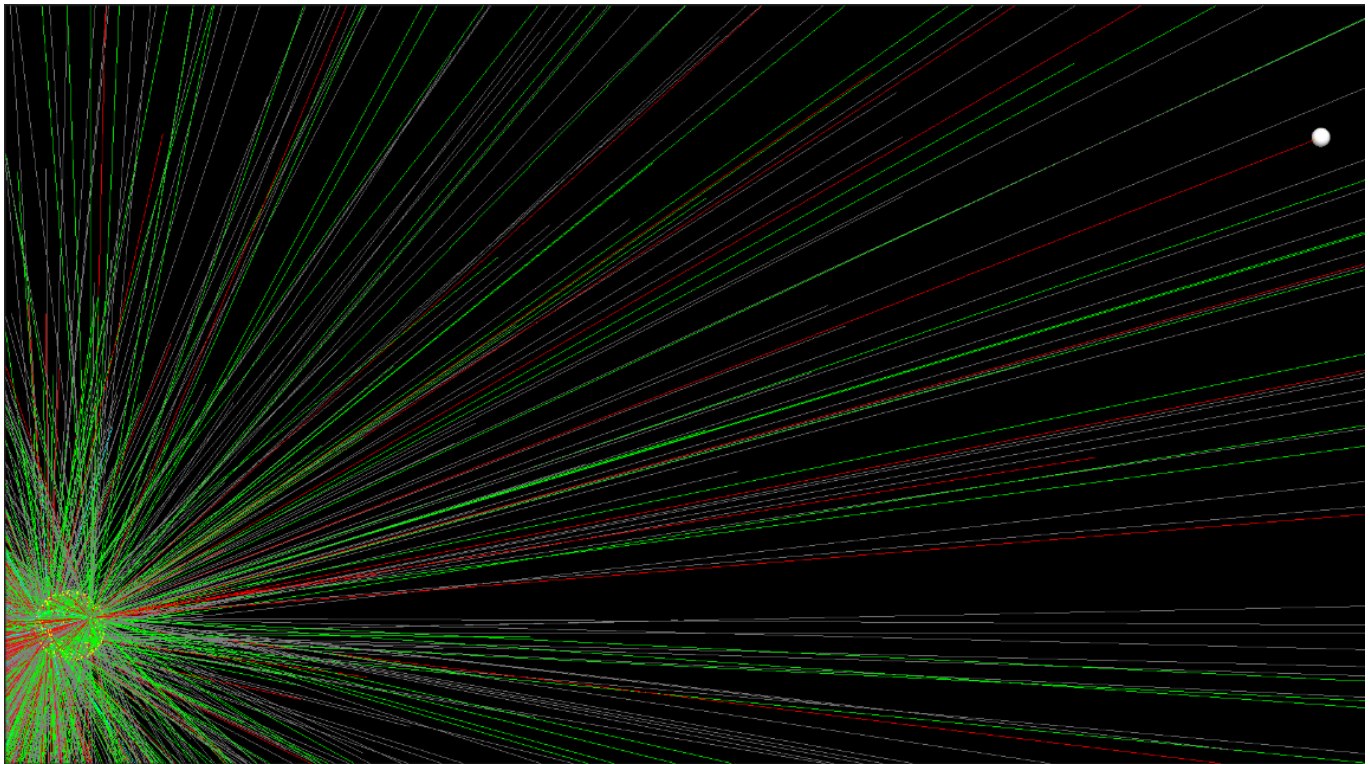
The main thing I use this kind of visualisation for is debugging

I’m not trying to show these pictures to someone else, I’m making them to help myself understand

Of course, they can be good to show in presentations, but the point is that you should make them first, to help you work, rather than as a final output

Don’t just squint at something in TBrowser and think “eh, it looks about right”

Take the time to make nice images as part of your workflow



BACKUP