combination of the four variables being optimized) and the right shows the output value of each iteration (the fact that it's decreasing means that the optimization is functioning as intended).

Week of 7-8-24

This week was a lot of diagnosing and improving on the work done the week prior; essentially, the information regarding positions, magnetic fields etc. of beamline components were obtained from a MADX program written to simulate the same beamline we're interested in. However, some issues ended up coming to light (checking Opal documentation and realizing that some quantities like design energy are given in MeV instead of GeV like in MADX, similar issues with the initial distribution of particles, etc.) that considerably improved the overall physical accuracy of the simulation. As well, it was found that the Opal emittance values (given in the .stat file output directly from the software after it runs an input file) is somewhat unreliable (several orders of magnitude too low) and doesn't give some crucial pieces of information (phase space distribution, from which the emittance can be calculated, for example). As such, it was decided that an external program which calculated the emittance based on other, better simulated parameters was necessary. It turned out that a program which does exactly this had been written prior by one of the graduate students in the accelerator group, and so we adapted it in various ways to be of use for the purposes of my project. It uses kernel density estimation (need to do some more research – appears to essentially draw boxes around data points of a specific magnitude or weight to find the total area encompassed by them) to calculate the emittance from an Opal output file. In general, it appears that this program functions as intended (good space charge effects visible, see fig. 6.1) but some adjustments may need to be made with regards to the minimum value of a datapoint for it to be enclosed.

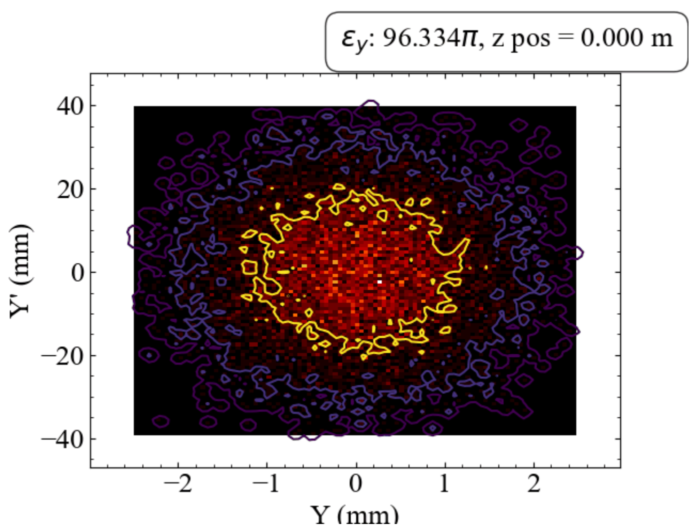

Fig 6.1: Animated .gif file that I generated from the Y-Y' phase space histograms generated by one of the simulations output by my optimization software. Each frame shows the emittance of the beamline at a variable z position (see the top right corner). The .gif was generated in order to investigate a strange increase in emittance at position z ~= 0.9 m down the beamline; in general, emittance should increase (and never decrease), but in this case it spikes aggressively

and then decreases immediately after (this is thought to be due to the emittance program trying to capture too many datapoints; the purple outline is still capturing data, just of an extremely low magnitude).

As well, new data was collected from the ion source this past Thursday which will be used for future analysis (essentially just a recollection of old data (see below); the old data experienced some information loss due to points of various “real” brightness being assigned a maximal brightness value (255)). Analysis on this data will be performed this coming week, and should be useful in determining the final course of action for optimizing the real emittance of the beamline.

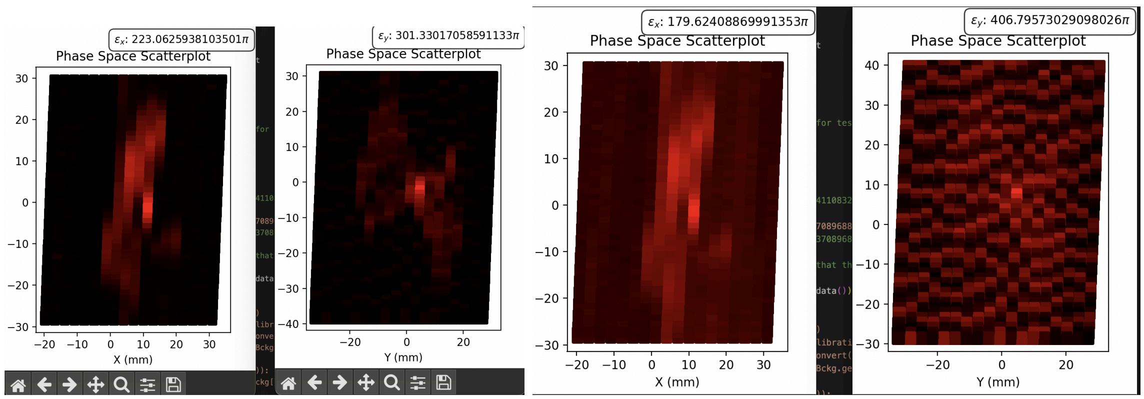

Fig. 6.2: Plots of emittance from the initial data collection last week that I presented in our weekly meeting (left plots with noise suppression, right without). In general, the difference in emittance value with and without noise suppression should not be so high, but the difference in this case (visually and numerically) was quite high and led to our discovery that there was a flaw in our data collection process.