Hey, I'm Jason and I'm working for Prof. Ulmer. The main job I'm doing for Prof. Ulmer this summer is essentially trying to simulate photons collected from a distant galaxy cluster.

To give a little back story, a Japanese group used XMM-Newton, a telescope built by the European Space Agency, to measure the farthest galaxy cluster ever detected. Now I'm going to go into a bit of physics; they know this because they can measure the redshift, which is the "doppler effect," but for light. An object's z value is an indicator of the ratio between the wavelength of light that we observe and the wavelength that is emitted. Except that, redshift is measured sort of opposite from doppler effect. As you probably know, when an object emitting sound waves is moving toward you, its observed frequency gets higher, so there is a coefficient higher than 1. However, in redshift, the coefficient is higher than 1 when the object is moving AWAY from you. (Draw on board the two equations) You can see from the equations that when an object is moving away from you, its wavelengths go towards red, thus the term redshift.

There also exists a Hubble's Law that states that objects observed in deep space have proportional velocities and distances from the Earth, based on the observation of an expanding universe. A higher z value means the object is moving faster, therefore meaning the object is farther away because of Hubble's Law.

This galaxy cluster is worth studying because this is apparently the furthest RELAXED cluster ever detected which means that the galaxies are gravitationally bound and have already come together, and will not dissipate any more. Since it is almost 10 billion light years away and the galaxies themselves are measured to be around 2 billion years old, this is as early in the Universe's age this should happen.

What Mel wants to do is use Chandra, a telescope built by NASA, to look at this galaxy cluster to measure this paper's validity. The reason is that Chandra's spatial resolution is much better than XMM's resolution. Each side of Chandra's image is also 30 times smaller, 0.5 arcseconds versus XMM's 15 arcseconds, which means its area is 900 times smaller. This is very helpful because we will pick up much less background, which is photons coming in from sources that aren't what we are looking for.

The team that used XMM only detected 37 counts, or photons, total, which is as you might imagine, very few. But since the object is extremely faint and far away, it takes a very long time to detect just 37 counts. The team that used XMM took 50,000 seconds of measuring time, about 14 hours. However, since you actually get very little viewing time out of each day's 24 hours, it took them over two days to measure. Chandra takes even longer because of how each image is taken, so it will take about 10 times longer. 500 thousand seconds is a long time; it could mean weeks of telescope time.

We needed conclusive simulations to prove that you could measure a galaxy-cluster object using a reasonable amount of telescope time. So, what I am trying to do is use a Chandra simulator called MARX, as in Karl Marx, to simulate a few different light source scenarios. You can give MARX a source flux, exposure time, and other parameters, so I changed them to measure about 37 counts total, just like the XMM group. The three different scenarios to be simulated are: one, a point source, which is many photons concentrated in one spot. Two, a diffuse source, which corresponds to a model in which the photons density decreases as they are farther away from the center. Three, a half point half diffuse source, which means half the photons follow a point source model and the other half follow a diffuse model. One thing to note is that different models take different times to measure counts: point sources take less time to measure the same number of counts.

The more the actual galaxy cluster looks like a diffuse source, the better. We want as many counts following a diffuse model as possible, so our "borderline" for least diffuse source counts would be the half point half diffuse model. Because, every count that we collect coming from a point source is NOT coming from a diffuse source. By doing radial fits on the different simulation images, we would compare the simulations' fits to actual model curves. If we can meet the two conditions, that these simulations will have enough counts to match up reasonably to a diffuse galaxy cluster model and that we can measure it in a reasonable amount of time, then it will be a lot easier to get this much telescope time from Chandra.

Unfortunately, after running the simulations and creating the multiple images, I've gotten stuck at the radial fit step because of problems in Chandra's radial profile software, so currently I'm trying to get that fixed. I've been talking with the Chandra software team but until that gets fixed, I'm doing miscellaneous tasks for Mel.