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Searching for a Betatron Tune Working Point for the Proposed Electron-Ion Collider at Jefferson Laboratory SCOTT ALTON, MSU/ODU/JLab, REU AT ODU TEAM — The mechanics of relativistic particles in storage rings are well understood. The particles oscillate around the intended orbit in the transverse X and Y directions–called the betatron oscillations. The number of oscillations per orbit is known as the betatron tune. If the betatron tune is an integer or a special resonance value, the oscillations will build in amplitude due to constructive interference and the beam will become less focused. This becomes complicated in the proposed ELectron-Ion Collider at Thomas Jefferson National Accelerator Facility (ELIC). The ELIC will be similar to a storage ring except that there will be beams of particles in both directions through each other several times every turn around the ring. When the beams pass through one another, they give each other a "kick" which alters the betatron tune often causing it to become one of the resonance values and degrading the beam quality and luminosity, which is a measure of the number of collisions per turn around the ring. This narrows down the range of betatron tunes that are available to operate the collider with a well focused beam. The purpose of this research was to find a betatron tune working point, or a set of betatron tunes in both transverse directions, which optimize the luminosity for both beams. A tune map shows which areas of the tune space are far from resonance values. The tune map was used to choose some betatron tune working points far from resonance. The region that was used was near half integer, because there was a large space on the tune map that was far from the regions of resonance. Simulations were run that broke down the collider rings into a series of linear maps around the ring and elementary forces at the point where the two beams interact. The goal was to find a betatron tune point where the beams stayed focused after many turns. An effort was made to separate the different tunes to find out how each one affected the luminosity but due to the highly nonlinear nature of the forces involved, this was ineffective. A stable working point has been found in the half integer region of the tune map. The point maintained about 65% of its peak luminosity after 30000 turns. This compares well with some of the best working points that have been found which top out at around 70% of the peak luminosity. It was found that there are certainly stable working points in the half integer region, and more points should be explored in this promising region of values. With a good working point, it will be possible to build a high luminosity collider allowing new experiments involving quantum chromo dynamics.

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