



**CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY**

Name(s) James (Jiajun) Luo	Project Number S0711
Project Title Analysis of Physical Properties of Linear Accelerators	
Abstract Objectives/Goals One of the most interesting applications of magnetism is its ability to accelerate objects at tremendous speeds through the use of linear accelerators. In addition to applications in military fields, these launchers are the future of space travel and exploration. Also, the potential to launch projectiles at hypervelocity has been realized and these "guns" allow us a glimpse into the realm of relativistic effects. However, specific directions to amplify these guns must be taken first, as numerous research institutions have yet to discover the areas in which to improve these accelerators. Thus, the crux of my research lies in analyzing the interaction between the physical dimensions of these accelerators and the projectiles. Methods/Materials Experimentally, I designed and built several of these accelerators and tested their properties by experimentation. I analyzed the projectile-launcher relationship and the overall affect of projectile geometries on rail erosion and efficiency. Mathematically, I derived several equations modelling the energy and velocity of the projectile as it moved through the launchers and found limits to the performance of the Gauss Gun. Results It was found that the Gauss Gun can be amplified not through an increase of length, but rather by an increase in width. Furthermore, increased resistance in the coils demonstrates higher projectile velocity. The Rail Gun has infinite possible amplification in terms of length. Also, the use of different rail compositions alters performance. Carbon rails were found to be most efficient for larger-scale implementation, whereas aluminum and copper rails were best suited for small and medium-scale implementation. In addition, the shape of the launch opening is best designed towards the specific shape of the projectile to create better connectivity. Conclusions/Discussion Experimentally and mathematically, I explained methods to amplify the linear accelerators and also amplified themselves by using experimental means. Even moreso, I clarified the problems regarding these accelerators. Experimentally, the designs of the guns must be improved to a point where aerodynamic influence and travel efficiency are maximized. Future work will be done on the performance of the rails undergoing real-life erosion, including mathematics such as line-integration and maximum energy achievability.	
Summary Statement My project attempts to amplify and clarify amplification for Linear Accelerators.	
Help Received Sean Jung helped experiment; Used lab equipment at California State University Los Angeles under the supervision of Dr. Oscar Bernal.	