2005 ALCPG & ILC Workshops – Snowmass, U.S.A.

Broader Impacts of the International Linear Collider

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The importance of Broader Impacts of Science in general and the ILC in particular are described. Additionally, a synopsis of education and outreach activities carried out as an integral part of the Snowmass ILC Workshop is provided.

1. INTRODUCTION

Large-scale scientific endeavors such as the International Linear Collider Project can have a lasting impact on education and outreach to our society. The ILC will provide a discovery platform for frontier physical science and it will also provide a discovery platform for broader impacts and social science.

1.1. Nature of the Opportunity

What is the nature of this opportunity? The extended time interval over which the accelerator and detector concepts are developed, the facilities are constructed, operation and data taking occur, and analyses and publications are prepared, provides significant opportunity to engage:

a. Participants with widely diverse skills and expertise.
b. Nontraditional and underrepresented groups.
c. A diverse set of communities providing the opportunity for interaction and collaboration.
d. The private sector.
e. In outreach to formal education (PK-14) settings, providing immersive and systemic research experiences in the classroom and in the research laboratories.
f. In outreach to informal education (for example, museum) settings.
g. In outreach to academic and laboratory settings, acquainting and involving researchers with improvements in teaching and mentoring.
h. In building expertise worldwide in accelerator science.

The international character of the laboratory and accelerator and detector collaborations can build and establish relationships and strengthen links on many levels with diverse communities worldwide.

1.2. Time Evolution vs. Education

There is an interesting comparison of the time evolution of the universe and the education of individuals. Consider the universe early in its history. The temperature was high. Forces were unified. Then as time evolved and the expansion occurred, the universe cooled. Various types of matter “froze out” and no longer interacted as before. Forces evolved with different strengths.

Now consider the education process for a young child. Early in schooling, all things are exciting. The energy level is high. Generally, boys and girls are equally engaged in the subjects of study. But as time evolves, attitudes and perceptions change, and interest in the study of science and math "cools." Then by middle school, certain students (often young women and those from underrepresented groups) "freeze out" from scientific study.

The analogy is thought provoking—the high-energy time in the education process for most students is when they are younger, not older. The high-energy physics that we pursue with passion is "cool" science—and we need to get this passion for science to younger students while their minds are still "hot."

1.3. Reaching Students

We have a technical reason to want to reach these young students, as can be seen from the timeline in Figure 1. It indicates the interval 2005-2015. One can imagine the ILC in operation for data taking in 2015, and key players at that time are graduate students and postdocs. The figure indicates that a graduate student (GS) in 2015 is actually a 7^{th} grader now.

2005					2010					2015				
7	8	9	10	11	12	UG				GS				

Figure 1. Education Timeline for a student who would be entering graduate school in 2015.

How do we reach students in middle school and convey the importance of science and technology to such a group? We can visit classes, invite tour groups to our labs and reach out with public lectures. But to be truly transformative, we need a more systemic approach. We need to engage the help of those people who daily are most closely associated with these children—teachers and family members.

Teachers at all levels, but particularly the middle school and intermediate level, need to be engaged immersively in the process of science. Most research and teaching faculty at universities are ill-equipped or simply not trained for this. So we need to engage practicing high school teachers, through established programs such as QuarkNet, NALTA, CROP, CHEPREO, Mariachi, ASPIRE, and others to help. After their own immersion in research, they can mentor teachers of younger students.

Additionally, we need to strengthen our involvement with informal education opportunities to engage students on field trips and the broader public, for example, in museum settings. Museums both large and small can be important vehicles to convey the message of forefront science. (An international accelerator museum might be a goal for ILC outreach.)

2. SNOWMASS 2005: EDUCATION AND OUTREACH PROGRAM

Within this basic context, the education and outreach program was designed to include three components: support for 20 young scientists and engineers to attend the workshop; two activities for 8 high school teachers, a dark matter workshop and a cosmic ray detector workshop and practicum; and several activities for the general public.

2.1. Formal Programs

The high school teachers who participated in the formal education programs included four from the Roaring Fork Valley who have been involved in SALTA, the Snowmass Area Large-Scale Time-coincidence Array, and four from QuarkNet centers in Texas, New York, California and Massachusetts. The dark matter workshop was led by H. Murayama who gave the content lecture and S. Fottrell who led the teachers through a classroom activity. The cosmic ray detector workshop was led by QuarkNet staff teacher, R. Peterson. He reviewed the hardware setup and gave teachers a chance to exercise the website using various analysis and publishing tools. The practicum involved the shower study on the Aspen Mall. Teachers set up four paddles in corners of a square tent with the computer in the center and ran a study for about six hours where members of the public could observe the action.

2.2. Informal Programs

Programs for the general public included public lectures, one held in conjunction with the Aspen Center for Physics, “$E=mc^2$: Opening Windows on the World,” Y. K. Kim, and ‘Seeing the Invisibles—Challenge to 21st Century Particle Physcis and Cosmology,” by H. Murayama. Two activities on the malls attracted passers-by into discussions with physicists and teachers. People browsed the Quantum Universe on the Snowmass Mall. Images from the popular Quantum Universe exhibit served as discussion starters. On the Aspen Mall teachers and physicists set up a cosmic ray shower study. Data was uploaded to the QuarkNet/Grid website where high school students have access to data from across the country. Finally, physicists and teachers put on a physics fiesta in Carbondale where many Latino families live. Hands-on activities challenged children and their parents to explore topics related to particle physics.

3. ILC EDUCATION AND OUTREACH OPPORTUNITIES

Due to an increased interest in supporting broader impacts activities, the ILC community has a unique opportunity to develop an education and outreach program along with the Global Design Effort. Physicists will need the expertise of formal and informal educators to develop a plan. Working together they can identify and prioritize audiences, activity and program formats, and existing and new resources. Examples of existing programs and resources include Research Experiences for Undergraduates and Research Experiences for Teachers and QuarkNet. It will take a commitment of real time and money: support from the top and involvement from the community. The challenge will be to take advantage of the international nature of the laboratory to meet the needs of education that are fundamentally local or national.

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