Cornell University
Laboratory for Elementary-Particle Physics

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SR CCS 2011

Summer Research for Community College Students – 2011

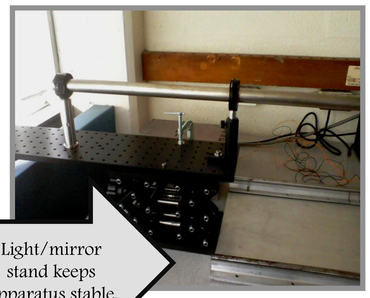
Automating the Optical Inspection System

Current System

Part of the System for the ILC (International Linear Collider)

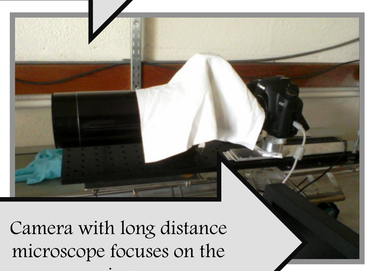
Why is cavity inspection important?

In order to achieve higher energy gradients for particle accelerators, cavities have to be defect-free. By inspecting cavities, imperfections such as pits and bumps can be located and removed via mechanical polishing or chemical treatment. Cavities are expensive and RF measurements are time consuming and costly, so in order to increase performance, optical inspection is a must.

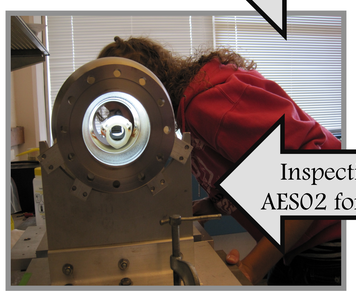


Light/mirror stand keeps apparatus stable.

Light/mirror illuminates cavity surface, revealing imperfections.



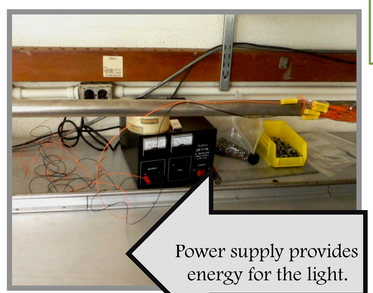
Camera with long distance microscope focuses on the mirror.



Inspecting AES02 for pits.

How to Inspect a Cavity

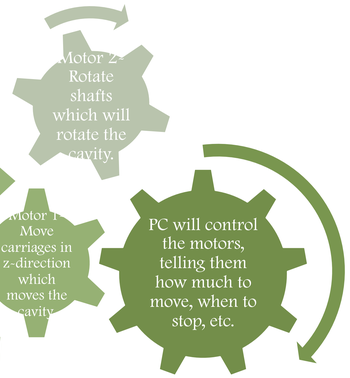
There is some equipment needed in order to inspect a cavity. The current system consists of the following (shown below): an apparatus consisting of a light source and a mirror, a stand for the apparatus, a power supply to provide electricity for the light, a stand to stabilize a cavity, a camera with a long distance microscope attached to it, and a PC. A cavity is placed on its stand and rolled until an image appears on the PC. The long distance microscope is adjusted, and an image is taken. Any images revealing a defect are recorded and looked at more carefully.

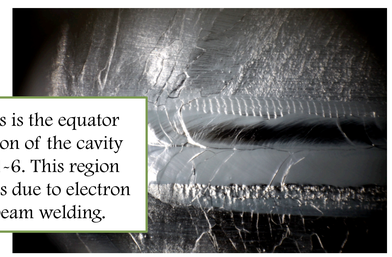


Power supply provides energy for the light.

How the New System Will Work

Goals for the New System:
- Efficiency– decrease time spent to inspect a cavity
- Reliability– decreasing human error
- Usability– making the system easy to use





This is the equator region of the cavity LR1-6. This region forms due to electron beam welding.

This is the equator region of AES02. This cavity has smaller grains than LR1-6.

This is another image of LR1-6. This cavity has large grains creating a smoother surface.

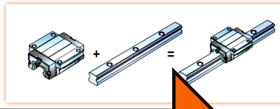
Here are some images taken by the current optical inspection system. There is some blurriness present due to vibrations form the light/mirror apparatus.

Why do we need a new system?

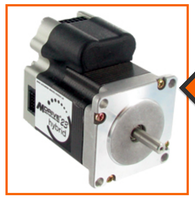
Manual optical inspection takes a lot of time and is subject to human error. The entire inside of a cavity looks very similar, so it's hard to tell if you are photographing a different area or the same one. By programming a motor to move a precise amount, one is less likely to miss a section.

System for the ILC

New and Improved System



Carriages will allow for smooth movement along the rails.

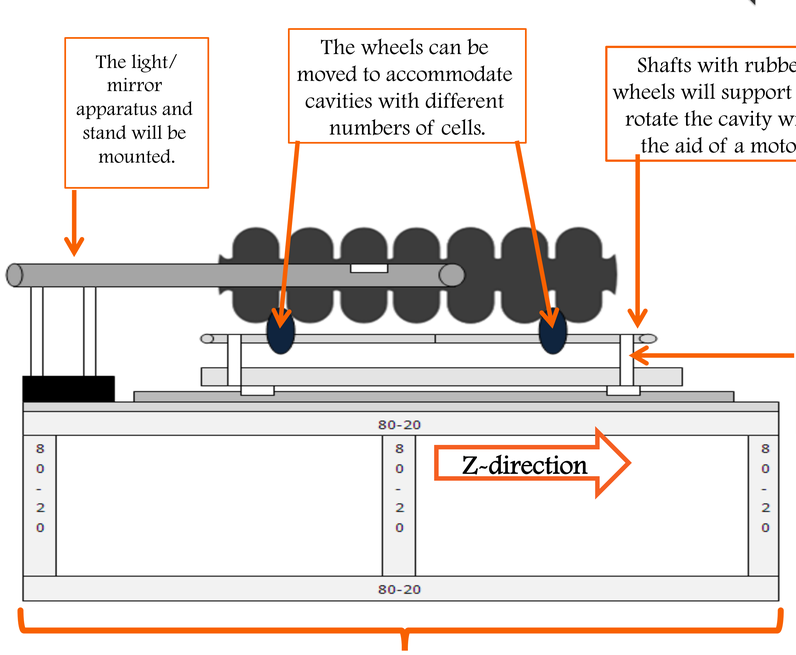


Hybrid Stepper Motors allow for smooth movement.

The light/ mirror apparatus and stand will be mounted.

The wheels can be moved to accommodate cavities with different numbers of cells.

Shafts with rubber wheels will support and rotate the cavity with the aid of a motor.



Shafts will be mounted onto a stand resting on two carriages, and this whole set-up will glide along profile rail guides in the z-direction.

This is the set-up envisioned based on the system at Fermilab. A frame will be made using 80-20– a rigid structure. On top of the frame, a sheet of 1" thick aluminum will serve as a mounting surface that damps vibration. Two stepper motors will be responsible for moving the set-up resting on the carriages and rotating the shafts. The motors will be computer controlled. This will allow for quicker optical inspections.

Cross-Section View of 80-20

LEPP, the Cornell University Laboratory for Elementary-Particle Physics, has joined with CHESS to become the Cornell Laboratory for Accelerator-based Sciences and Education (CLASSE). LEPP's primary source of support is the National Science Foundation.
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