July 14, 2000
Wayne Faszer
File:e614n8.wpd

Travelling Microscope

A travelling microscope is used to inspect the e614 drift chamber anode planes after stringing to check the accuracy of wire stringing. If for some reason a wire position is sufficiently out of tolerance, the wire can be removed and replaced. The map of wire positions produced with this travelling microscope is entered into the E614 data base where it may be used for chamber calibration. Both ends of each wire plane are inspected, since any given wire could be out of position at either end. This proceedure only measures the position of a wire relative to it's neighbors, and only at one end. That is because the travelling microscope is essentially a one dimensional device, with only one axis of travel. Therefore it cannot provide information about the positions of the two ends of a wire relative to each other. That would require two axes of travel. Thus the information provided by this device is necessary for constructing chambers that operate properly, but it is not sufficient for doing the experiment. For the experiment, three dimensional information about the position of the wires relative to some chamber coordinate system is desired. Unfortunately the three dimensional information must be obtained by some other calibration means. If the orientation of a plane is found by some other means, the maps of wire positions at each end could probably be used to then map the positions of the wires on the plane.

The travelling microscope consists of two zoom lenses and video cameras mounted on a precision linear bearing and rail, attached to a digital readout system. The video cameras travel orthogonal to the wire direction. The cameras sight on the wires and provide a magnified image of about 100 times on video monitors. Each camera has it's own monitor and there is a graticule on the monitor screen. One camera points down at the wires and the other camera points at a 45 degree angle down to the same focal point. Data taking consists of lining up the image of a wire with the graticule for the vertical camera and recording the position on the digital readout. Next the image of the wire is lined up with the graticule for the camera pointing at the 45 degree angle, and that position is recorded. The x position of the wire in the plane is therefore read out directly, while the z position of the wire in the plane is given by the difference between the two readings. The base of the microscope consists of a tooling steel plate that has been precision ground to a tolerance of ±5 μm. The rail and bearing is a ultra-precision grade THK rail with an overall straightness tolerance of ±2 μm over the length of the rail. The digital readout is an Acurite glass scale with a resolution of 1 μm and an accuracy of ±2 μm over all, traceable to the national bureau of standards.

A straight line fit is then done for wire position as a function of wire number. The slope of the line corresponds to the wire spacing and the residuals of the wire positions correspond to the errors of the wire positions relative to their ideal positions in the plane.

Specifications

Specifications to follow after this device has been calibrated. A prototype of this unit, constructed with less precise components was used for some initial chamber surveys. The prototyle achieved an accuracy of $\pm 10\ \mu m$ with a possible cumulative error of .0001 mm per mm. It is expected that the final unit will be about a factor of 5 better.