4.2.11 Target Hall Crane Camera System

4.2.11.1 Target hall crane camera system overview

The purpose of the NuMI target hall crane camera system is twofold. First, to safely operate the crane from a remote location not within line-of-sight of the crane or load. Secondly, to allow precision placement and picks of crane loads. This is to be accomplished using ten miniature video cameras located on the crane with the video signals transmitted wirelessly to receivers at the upstream end of the target hall. These signals will be hard wired to the crane remote operating station in the target hall passageway where they will be displayed on four good resolution video monitors. The crane motion will be controlled using the vendor supplied IR remote controls. The goal is to position the crane and load to within 0.5 inch along the beam direction (x) and transverse to the beam direction (y).

4.2.11.2 Algorithm for precision location of the crane

The travel of the crane in the x direction is from 8 to 211 feet from the upstream face of the target hall. The travel of the crane trolley in the y direction is about 18 feet approximately centered on the proton beam line. A special high contrast scale with one inch graticule spacing is fixed to the crane rail for the full x range and viewed by a video camera (C1) fixed to the crane bridge. The x position is determined by viewing the location of a pointer (fixed to the crane bridge) in the field of the scale. Tests at MI-8 indicate that a resolution of better than 0.5 inch can be achieved. A similar technique is used for the y direction where the scale is attached to the crane bridge and the video camera (C2) and pointer are attached to the crane trolley.

4.2.11.3 Algorithm for location of the crane hook

The crane design specification allows the hook to drop essentially vertically, i.e. with fixed x,y position. However the hook can be remotely controlled to rotate in the horizontal plane. A video camera (C3) is mounted on the bridge trolley to monitor the angular orientation of the hook relative to a scale located on the hook system.

4.2.11.4 Algorithm for safe motion of the crane

Since the crane will not normally be within the line of sight of the operator it is necessary to provide a general view of the region around the crane. A view of the general areas upstream and downstream of the bridge position will be given by video cameras (C4 and C5) mounted on the crane bridge. These cameras leave a blind spot below the bridge. Two video cameras (C6 and C7) will be mounted on the bridge one at each end and will view the area below the crane. As will be seen below in section F, these cameras may require remote control of tilt, zoom and focus.

4.2.11.5 Viewing the crane hook area

The crane hook can be used to lift loads directly, or to attach to special lifting fixtures to lift T-Blocks or Horn/Target Modules. These functions require a good view of the hook area. A video camera (C8) will be mounted on the bridge trolley to monitor the hook area. This camera may require remote control of the tilt, zoom and focus.

4.2.11.6 High quality view of H-Block covers, etc.

To remove and install the H-Blocks, T-Blocks, Modules, etc. it is necessary to have a high-resolution view of the lifting regions, alignment indicators and general view of the top area of the subject unit as well as the area of the slot in which the unit is installed. Video cameras C6, C7 and C8 can provide most of these functions since they can be remotely controlled for tilt, zoom and focus. To see the alignment indicators for installing the T-Blocks, two additional video camera (C9 and C10) will be installed either on a special outrigger attached to the T-Block lifting fixture, or directly on the bridge.

4.2.11.7 Video transmission from the crane to the remote crane operations area.

To minimize cables in the target hall it is proposed to use a wireless video transmission system. For quality and noise reduction the 2.4 GHz non-license frequency band is used. The ten video cameras on the bridge will be connected to four video transmitters each operating at a different frequency within the 2.4 GHz band. Eight signals in two sets of four signals each will be combined using two quad processors. These two video transmitters will send signals that can be viewed on two monitors each displaying in real time four signals, one in each quadrant of the monitor screen. The remaining two signals will be transmitted individually.

The outputs of the four transmitters are combined using an impedance matched power combiner and transmitted using a high gain reflective grid antenna with 8-degree beam width. The antenna is mounted on the upstream side of the bridge and focused horizontally pointing to the upstream wall of the target hall. The receiving antenna is identical in design, mounted on the upstream target hall wall focused horizontally but displaced 5 feet below the axis of the transmitting antenna. This arrangement gives a received signal strength with is somewhat uniform (within a factor of 10) over the range in x of the crane bridge.

The received signal is power divided into four video receivers with frequencies matched to the four video transmitters. The output of the four receivers will be hard wired to four good resolution monitors in the remote crane operations area. For improved resolution the complete video systems should be a color system.

4.2.11.8 Noise in the video system

The main sources of noise in the video system are from (1) radiation from the buss bar sliders which provide power to the bridge and trolley and (2) video signals reflected from the walls of the target hall and arriving at the receiver antenna out of phase with the direct signals. Using very focused transmitting and receiving antennas can minimize both of these sources of noise. In addition the transmitting antenna must be on the opposite end of the bridge from the crane exposed buss system. It may also be necessary to place electrostatic shielding around the buss scraper area. The extent of these noise problems can be tested using the crane in MI-8. An undesirable backup would be to use either an optical fiber or RF cables festooned from the bridge to the remote crane operation area.

4.2.11.9 Power for cameras and transmitters

The video cameras and transmitters use 12-volt power. It is proposed to take 110-volt AC power from the bridge power system to operate a single well-regulated and filtered 12-volt power supply. A festooned system will connect power and video signal cables between the crane bridge and the trolley.