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A NEW INJECTOR (NPI) FOR NUCLEAR PHYSICS AT SLAC*

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Summary

A program of nuclear physics experiments has been approved at SLAC, and a new high average current injector is being added to the accelerator 650 meters upstream (Sector 25) of the accelerator output. The new injector (NPI) will produce beams in End Station A of up to 150 mA, 1.6 μsec, 180 pps at energies from 0.5 to 6 GeV. NPI will also have 1 nsec short pulse capability for electron injection into SSRL. Work on NPI started in October of 1983, and the first beam from the new injector is scheduled for the Fall of 1984.

Nuclear Physics at SLAC

Nuclear Physics at SLAC (NPAS) is a program of nuclear-structure physics based on an intense relatively low energy electron beam, and the electron-scattering facilities in End Station A of SLAC. The new injector as described below will be the heart of the nuclear-structure program at SLAC. This program was first proposed to the Department of Energy by a group of physicists from the American University, the University of Virginia, the Universitat Bonn, the Max-Planck Institut fur Kernphysik-Heidelberg, and Physikalisches Institut der Universat Heidelberg. Approval for construction and funding of 1.65 million dollars was obtained in October of 1983. Construction is in progress, all system components will be installed during the summer of 1984, and first test beams are expected in November. NPI should be available for experimental use in January of 1985.

It is worthwhile to enumerate some of the factors that dictated a downstream injector at SLAC. Nuclear physics experiments need high beam intensities at energies between 0.5 and 5 GEV. Beams from the Main Injector of SLAC can comfortably run only down to about 1.5 GeV, and at that level, they are severely limited in intensity by beam breakup. Beam breakup threshold for a 1.5 GeV, 1.6 μsec beam is only about 10 mA. Also, beam loading in the three kilometer accelerator structure causes the energy spectrum of the beam to be broad. Power consumption of the accelerator must also be considered in these days of short energy supply and high energy cost. It is not cost effective to operate three kilometers of linac when half a kilometer will do. By installing a second injector at the 5/6 point, low energy beams can be delivered with a beam breakup threshold of up to 150 mA with optimum focusing, beam loading is less so energy spectra can be better, and the new injector can be operated in conjunction with only 1/6 of the klystrons and electronic support so the power cost for NPI-only running is modest. There will be much down time when Stanford Linear Collider (SLC) construction is in progress, and during these times, the NPI injector will allow nuclear physics experiments to operate, and also the NPI short pulse capability will allow SSRL to fill with electrons and continue to do physics.

The NPI Injector

Figure 1 shows a block diagram of the NPI beamline. The injector is located on girder 25-1, and is installed in place of the last two accelerator sections on that girder. The beam source is a newly designed electron gun and pulser system described in a separate paper at this conference. The single gun is used for both long and short pulse operation, and has all solid state pulsers and fiber-optic controls.

In the gallery, there are two centers of NPI construction activity. At klystron 25-1, a new set of waveguide components is being installed to take care of injector section buncher and prebuncher power feeds. Beam transport power supplies and an rf monitoring and control system are installed at this location. Center for computer control is in the Sector 25 alcove. Here, a CAMAC based system ties into the new SLC computer control system. All controls including beam transport, timing, pulse generation, and monitoring are done through the computer control system. There are no local controls. Figure 2 shows a block diagram of this control system.

The injector layout in the housing is similar to that of the present Main Injector. The gun is mounted off-axis on the aisle side of the girder at main beam line level. Gun modulator electronics includes a new all solid state 0.01% regulation DC high voltage power supply capable of delivering 2 mA DC to 130 kV. All solid state pulsers are mounted in the housing on an open high voltage deck immediately adjacent to the gun high voltage terminal. A local radiation shielding wall protects the electronics from upstream beam scraped radiation sources. The 80 kV beam is transported onto the main accelerator axis via a series of thin lenses and an alpha magnet. Solenoidal focusing is employed in the main buncher and injector accelerator region. A set of optimally spaced over-the-accelerator quadrupoles is used to transport the beam through Sector 25, and the existing accelerator quads, or the new SLC quads will deliver the NPI beam to the switchyard.

NPI beam transport and timing electronics borrows heavily from the SLC accelerator improvement development work. The beam transport system operates with power supplies controlled by CAMAC based DAC's and ADC's. Klystron and beam timing are determined by elements of the new SLC timing system. This timing system is discussed in two other papers at this conference. With the introduction of a new beam generation and timing system, SLAC Beam Containment is undergoing restudy. A new set of Beam Containment electronics is being developed for NPI that works with, but is independent of the CAMAC based computer control system. Beam containment concepts developed here will be used in the Main Injector when that system is updated to SLC format.

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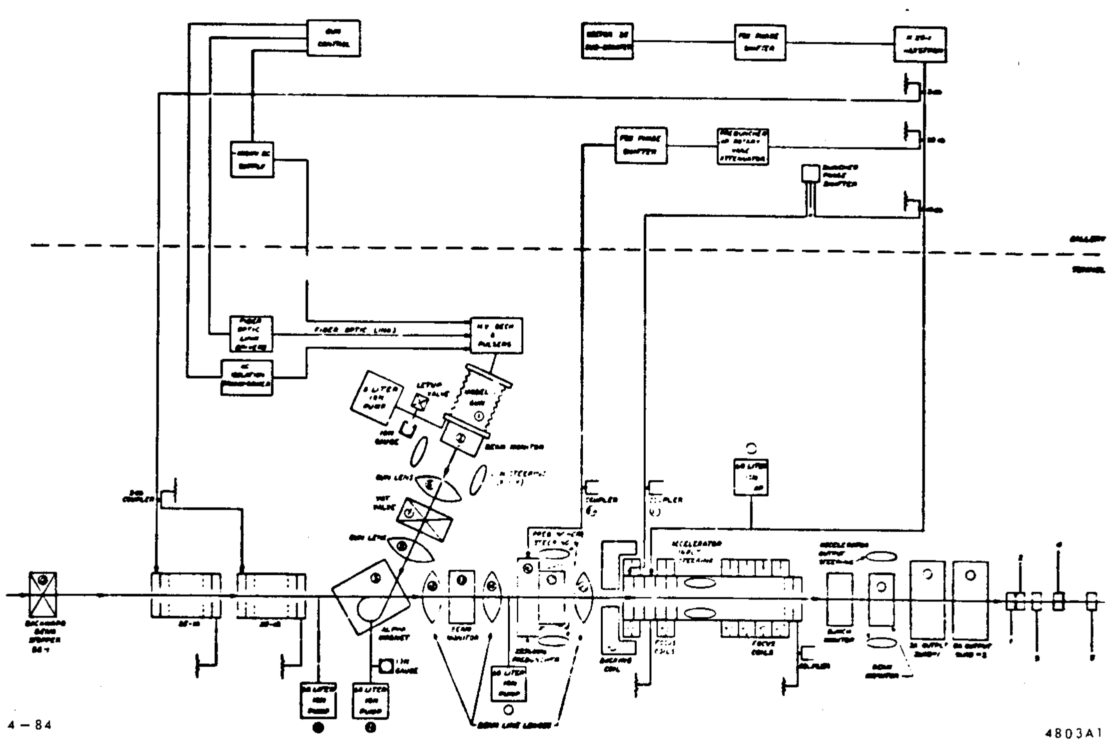

Fig. 1. Block diagram of the NPI beamline.

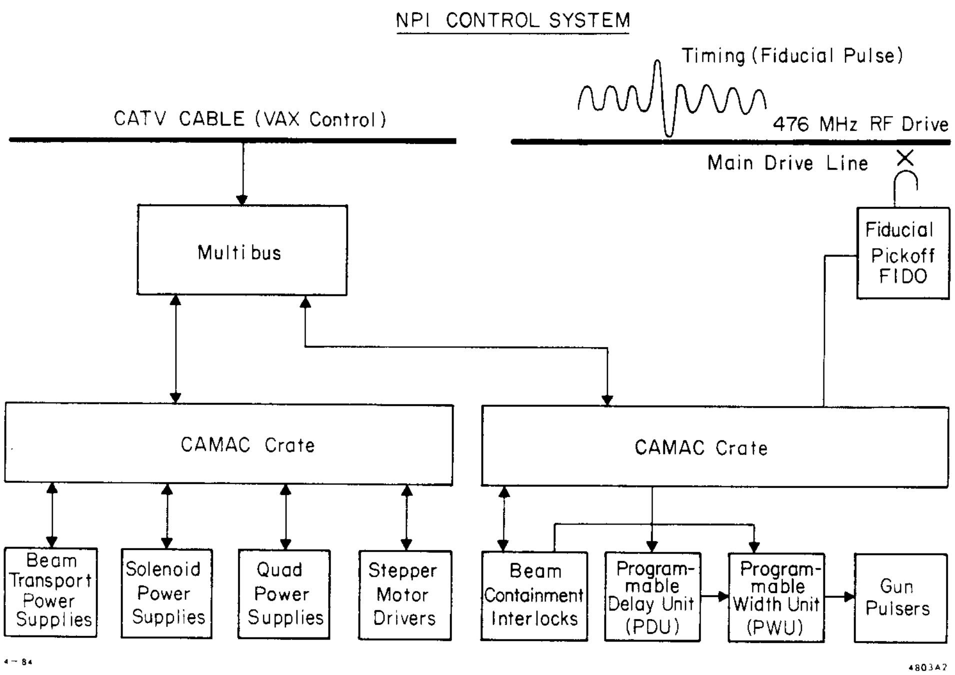

Fig. 2. Block diagram of control system.

Checkout and Operation

First rf processing of the new accelerator and waveguide components in the accelerator housing is scheduled to take place in late June of 1984. The beam transport line including gun will be in place by mid-August, and an 80 kV beam will be transported to the accelerator input. Full beam testing will await accelerator turn-on in October, but the computer based control system will be exercised during the early Fall, and new touch panels will be developed for NPI control. An NPI beam should appear in End Station A some time in December, and be ready to start physics experiments checkout in January of 1985.