Dr. Taiji Yamanouchi
Fermilab, MS-105
Batavia, IL 60510

August 14,1991

Dear Dr. Yamanouchi,

I am writing this letter in response to your request to supply you with more information regarding the test that we would like to do in an electron test beam at Fermilab. This test was described in my March 29, 1991 letter to you. In the following I will try to address one by one the questions listed under section 3.4 (Test Beam Requests) of the users manual.

a) Physicists and institutions involved in the study, and the names of the Spokesperson(s).

Please see attached list at the end of this letter.

b) Description of the detector to be studied and the purpose of the study.

The detector to be tested is an electromagnetic calorimeter. Its absorber is steel and the sampling medium is a noble gas (argon or xenon) at high pressure (up to 100 atms). The purpose of the study is to find the energy resolution function of this calorimeter and to check the linearity in its response. This type of calorimeter is, by nature, very radiation hard and it could be used especially in the forward region of the detectors that are now being planned for the high luminosity colliders like SSC, LHC and UNK. Our study is focused more on the development of a high pressure gas calorimeter for the forward region of the SDC detector.

This project is funded by the Texas National Research Laboratory Commission (Grant Number : RGFY9160).

c) Physical layout of the detector and associated equipment.

The calorimeter consists of ten high pressure cells. Each cell is made of two, one inch thick, steel plates. The diameter of the plates is 12 inches. The total calorimeter length is 20 inches and its weight is 640 pounds. It will rest on a table whose height can be adjusted so that the calorimeter can be centered on the beam. The preamplifiers will be mounted on the calorimeter.

d) Beam requirements, including an estimate of the beam time needed.

We need an electron beam with energies from 10 GeV to the highest possible energy. We need to trigger on electrons, therefore a Cerenkov counter is necessary. The rate should be no less than 100 electrons per second and we should be able to measure the momentum of each electron with an accuracy of about 1%. We estimate that we are going to need 96 hours (12 shifts) of beam time to complete the test.

e) Data Aquisition System and other electronics to be used, and computing needs.

We have bought our own data aquisition system (computer and electronics). There could be a problem with the transferring of the test beam magnetic spectrometer data to our DAQ.

We would like to request that a Tektronix 2465 oscilloscope be available to us for a total period of one month.

f) Financial arrangements

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g) Hazardous materials involved, if any.

There are no hazardous materials involved . We understand that, because the calorimeter contains gas at high pressure, special safety procedures will have to be worked out with the safety section.

h) Total occupancy duration in the experimental area.

We plan to spend some time tuning and debugging our detector with muons maybe in the downstream end of the test beam. Our total occupancy duration in the experimental area is expected to be about one month.

i) Other special conditions.

None.

We would appreciate to be given the opportunity to perform the test I outlined above. Thank you for your consideration.

Sincerely,

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Test Beam Request -- An Integrated Pixel Detector

Oct. 4, 1991

a). Physicists and institutions involved in the study; name of spokesperson

Physicists: Sherwood Parker (spokesperson)
Chris Kenney

University of Hawaii

Physicists (not absolutely certain; part time only on test run):
Carl Haber
Nicolas Produit

Lawrence Berkeley Lab

Electrical engineers: Walter Snoeys (graduate student)
Chye Huat Aw (graduate student)
James Plummer (Director, Integrated Circuits Lab)

Stanford University

b). Description of the detector, purpose of the study

The detector is a silicon chip in which the bottom, the bulk (which is depleted), and a set of small charge collection electrodes on top form an array of diode detectors. Surrounding the collection electrodes on all sides is an implanted region which serves as a CMOS well for the readout electronics, a focusing electrode which guides generated charge to the collection electrodes, and a Faraday cage which shields the drift field of the bulk from readout switching transients. Collected charge remains on a nearby low capacity MOS transistor gate, and controls the current to the edge of the chip during readout, providing ambiguity-free two dimensional information. In contrast with the 80 microvolt signal at the input of the Microplex chip in our Mark II vertex detector, the input signal on the pixel will be about 0.2 V. More detail is available in the enclosed draft of our Lepton-Photon Conference paper.

Detectors have been tested with 60 KeV X rays. We would like to use a high energy beam to test a string of detectors, measuring spatial resolution on the micron scale and time resolution on the nsec scale. In addition, if time is available, we would like to measure performance as we vary the well and back side voltages, and the response for tracks crossing at several angles to the long and short pixel directions.

c). Physical layout

Several test devices about 1 mm x 1 mm are located on a chip which is about 8 mm square, mounted in a 42 mm square pin grid array. A zero-insertion force socket 60 mm x 46 mm holds the pin grid array and in turn is held in a frame with two alignment surfaces that will be placed on a flat plate. (See Figure 1). While the internal alignment must be stable to about one micron, the chips need to be aligned only to about 0.1 mm to provide good overlap. The entire assembly needs only to be placed with a position error somewhat less than the beam size and direction spread. Because of the two-dimensional nature of the readout, the high-precision alignment required of strip detectors to make them parallel, is here unnecessary.

Six detectors will be placed in line; one will be adjustable in angle. (See Figure 2). Two 2 mm x 2 mm x 2 mm scintillators will be placed ahead of and two behind the pixel devices. Twisted pair lines from each device will go a short distance to driver - readout cards which will connect to long runs of twisted pair cables. We expect the equipment in or near the beam will occupy an area of about (1 ft. along the beam) x (2 ft. wide) x (8 in. high).

d). Beam requirements

1). Particle type: anything charged

2). Momentum: p > 100 GeV/c (p > 20 GeV/c with special thin mounts that minimize multiple Coulomb scattering). A moderate low energy component would be recognized as having larger errors in most all detectors simultaneously.

3). Beam area: anything greater than 1 mm x 1 mm.

4). Maximum beam rate: 10E8 / sq cm / spill: (1 track / gate) * (20 / 20E-6 gates/spill) * (100 sq mm / sq cm). (We can actually take higher rates, but might then use a shorter data collection gate than normal to keep multiple track rates down. Radiation damage levels are not known, but might come in on these unhardened chips at the 10 - 100 Krad level = 4E11 - 4E12 particles / sq cm. Thus at the highest rate, damage would be seen after 4,000 to 40,000 pulses, and we would probably prefer to move slightly off beam center.)

5). Minimum beam rate: no sharp limit, but 10E5 / sq cm / spill or more would be desirable. The GPIB link to our computer will handle about 400 events per spill. For fewer than about 1000 tracks per sq mm per spill, we will spend significant amounts of time waiting for events rather than reading them out.

6). Total beam: A few thousand good tracks through the detector and into the computer would make the run worthwhile. The triggering scintillators have 4 times the area of the pixel detectors. Imperfect alignment and false triggers would probably combine to reduce good tracks to perhaps 10% of the triggers. Thus we would need about 30,000 events into the computer. That might take about 75 pulses or about half of an average shift (assuming 1000 pulses per "good day" and about 2 calendar days per good day) if we are limited by our readout rate.

With that done, we would like to vary the angles of one detector through 5 positions in each plane, change gate timings, and vary well and backside voltages. These might total 20 - 30 data sets and take 10 - 15 shifts. All of this would probably need to be preceeded by a week or so of running for setup, debugging, and checkout of the electronics.

7). Accesses: If we can use the region in the new muon lab behind the spoiler, with the cart that is moved in and out of the beam with a rope, we should be able to do the entire test, installation included, with no need ever for accesses. Position accuracy needed would only be about 10% to 20% of the central beam spot size so that cart should be fine. The following paragraph describes what would be needed if we were in an area without a cart.

The planes are designed to be self aligning, and any one can be removed by loosening six nuts and unplugging one cable. Thus any access after the initial installation should take less than 5 minutes. That installation would mostly be spent stringing the cables and installing and aligning the support, since the detectors would be put in place as a preassembled package. The accesses to change the variable detector's angle would be the only planned ones.

e). Data acquisition system

We will bring custom driving and receiving cards, signal and DC power cables, power supplies, NIM bins, commercial waveform digitizers, a Tektronix 540 digital oscilloscope, a Tektronix 2465 analog oscilloscope, a SUN 3/60 computer, and some modular electronics for the scintillator trigger. We should be mostly self-contained, but would like a rack, two CAMAC crates, and AC power cables and distribution boxes. If necessary, we can also bring our own CAMAC crates.

f). Financial arrangements

We are supported by the Texas National Research Laboratory Commission through the University of Hawaii.

g). Hazardous materials

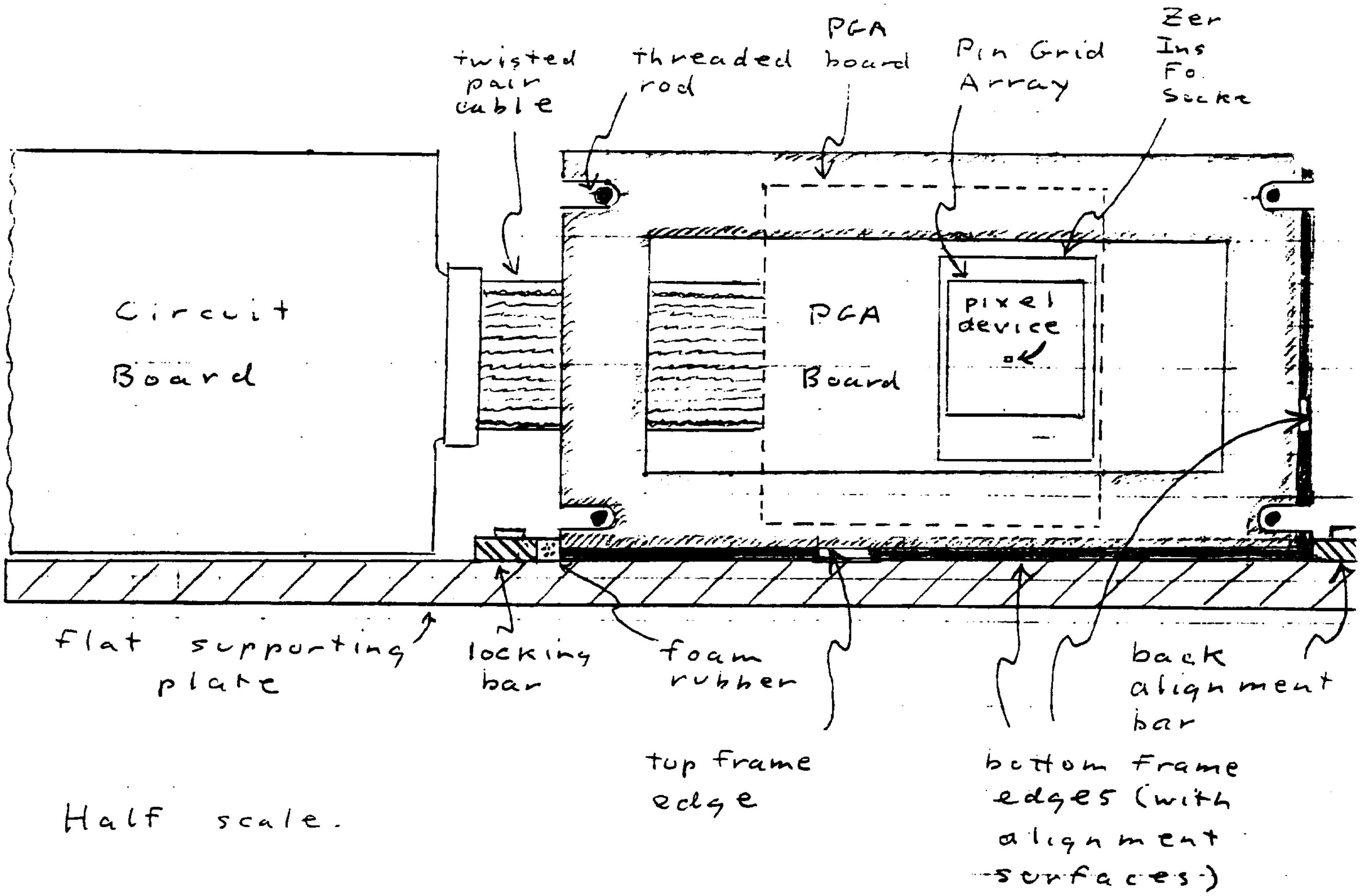
None.

h). Total occupancy duration

Routine setup and data collection should take about one to two weeks, assuming normal beam conditions. Since this is a completely new type of device that has never before been in a test beam, we would like to have available the maximum possible calender time. We have tried to make a setup which is fully compatible with all other users of the muon lab beyond using up about a foot of the beam line.

i). Other special conditions

None.



Half scale.

Figure 1 - Pixel Mounting

Plane perpendicular to beam.

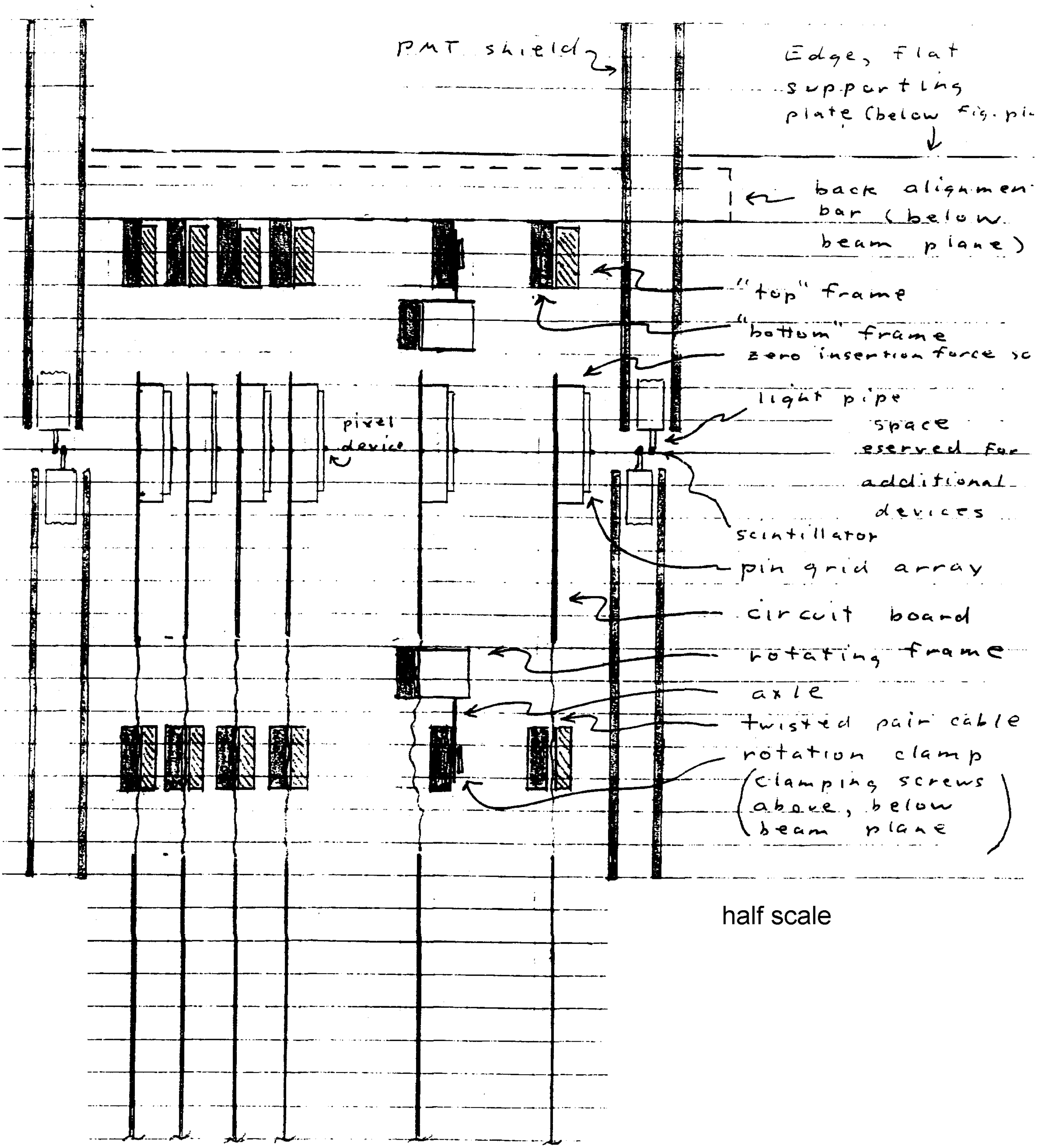


Figure 2 - Pixel Mounting
Top View
(beam plane section)