CLAS-NOTE-90-001
30-January-1990

Report on the CLAS Collaboration Meeting

January 12-13, 1990

A meeting of the CLAS Collaboration was held at CEBAF Center on January 12-13, 1990. A list of the participants is attached to the end of this report.

The meeting started with a presentation by CEBAF's Scientific Director, Dirk Walecka, on the present situation of the experimental equipment after the recent discussions with DOE's Division of Nuclear Physics. DOE seems to be willing to consider funding the experimental equipment described CEBAF's Preconceptual Design Report. In contrast to previous thinking, DOE wants CEBAF to be responsible for distributing the money to the participating outside institutions. Unfortunately, DOE officials see no possibility to come up with the additional money by the beginning of 1994. This will require phasing equipment in some (or all) halls. The position of the CEBAF management is that all halls should be fully equipped by the end of 1995.

Christoph Leemann, the head of the CEBAF Accelerator Division, presented the start-up scenario for the accelerator (this is the same information that was given to the members of the PAC during PAC4a). The projected running time (beam to end stations) is

Calender year	Beam time (hours)	User multiplicity
1994	2000	1 (one hall at a time)
1995	4000	3 (3 halls, same energy)
1996	4500	3 (3 halls, different energies)

A matter of slight concern for Hall B is the range of beam currents that is presently thought to be easily available in 1994: 2 to 25 microamps. The lower limit is driven by pessimistic assumptions on the noise in the beam position monitoring system. The Accelerator Division will look into the possibility to provide lower currents already in the early phase of accelerator operation. Polarized beam should be available very early. However, determining and monitoring the polarization will be the task of the user.

An update of the End Station B equipment by Bernhard Mecking followed. The following points were discussed:

1. Data Acquisition Speed
Following PAC4a, there was concern about the fact that the beam time requested (45,000 hours) for what most people consider to be the initial round of experiments exceeds by a considerable factor the beam time that will be available from the accelerator in the initial period (e.g. the first three years). The CLAS system is a unique position to cope with this situation because experimental conditions are often so similar that the same data taking period can serve several experiments. Combining experiments will increase the overall scientific output of the facility and also solve some of the sociological problems caused by limited beam time. The extent to which data taking for different experiments can be combined will be limited by physics and quality considerations. The speed of the data acquisition system could also become a limiting factor. To reduce that possibility we will increase the data rate from 300/sec (as presented to PAC4a) to about 1500/sec (the data acquisition group says that their architecture allows for even higher speeds). This will require some rearrangement of the CLAS budget. Very likely, we will take money out of the trigger system which is presently more complex than required for the first round of experiments.

2. CDR Preparation
For the preparation of the Conceptual Design Report which will be due in April we will need more details on the following items (those items were not forgotten, we have already reserved a budget category in the Work Breakdown Structure):

Beam monitoring for electron and photon beams (position and intensity measurements, polarization measurements, Moller polarimeter)

Low power targets (hydrogen and deuterium cryo-targets for tagged photon experiments, pressurized gas targets for electron scattering experiments)

Scintillation counter hodoscope close to the target for tagged photon experiments (for triggering and particle ID).

Hall Crannell lead an extensive discussion of the CLAS Collaboration charter. After several modifications were made the final charter was unanimously accepted by those present. The members of the nominating committee for the position of the Chairman of the Coordinating Committee were determined by letting the (female) guard draw straws from a hat. The nominating committee consists of representatives of the following institutions:

University of New Hampshire
University of Massachusetts
University of Richmond

The nominating committee will come up with a list of candidates by March. The members of the collaboration will elect the Chairman in April.

The status of the preparation for PAC4b was discussed by the spokespersons for the proposals. It was decided to have a dry run for the Hall B presentations to PAC4b on March 17, 1990 at CEBAF. Please mark your calender.

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*   PAC4b DRY RUN   *
*   3/17/1990   *
*   *
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If you have any questions or suggestions concerning End Station B instrumentation, please don't hesitate to contact me.

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WORKING GROUP REPORTS

Drift Chamber Status Report

At the January 1990 CLAS meeting there were two talks to the collaboration regarding the status of the drift chamber construction project. The first, by Mac Mestayer, included a brief summary of the overall design, of results of work done in the past six months, of plans for the construction of the 'large' prototype, and of the current plans for the division of work between CEBAF and outside universities. The second, by Steve Dytman, focussed on the design of the Region 1 drift chambers. Both are summarized here.

The physics goals envisioned for the detector demand good resolution in determining the momentum vector of charged tracks. This, combined with the high B fields and long lever arms, puts a premium on reducing the amount of multiple scattering, and hence, material of the chambers. At the same time, only moderate spatial resolution of 200 micron per layer is required. For these reasons, we are designing chambers with a minimum of internal support, thin foils for gas bags, and aluminum field wires. The cell structure is hexagonal with each 20 micron gold-plated tungsten sense wire surrounded by six aluminum field wires of 140 micron diameter. There will be approximately 36,000 sense wires so a third design parameter is robustness of design. The chambers must be reliable.

Region 3 has received the most design work, so we will describe it first. The Region 3 chamber is envisioned to be a self-supporting chamber which can be lifted and installed without using an external frame. This rigidity is accomplished by a series of 5 spreader posts spaced along the inner face of the chamber and by a set of removable posts and a thin wall on the outer surface of the chamber body. We have chosen this design because it makes installation and construction easier and because the additional material does not adversely affect track reconstruction or resolution. The spreader posts are located immediately adjacent to and behind the more substantial posts which are necessary to hold the magnet coils in position; thus, they don't subtend any additional solid angle. The only adverse effect of the thin outer skin will be the introduction of additional material before the Cerenkov counter.

The drift cell configuration of both Region 3 and Region 2 will consist of 3 super-layers of 4 layers each in a hexagonal arrangement with wire orientation: normal, 6 degrees stereo and normal for the 3 super-layers. The Region 2 drift chamber will differ from that of Region 3 by having neither the posts at the inner face nor the thin skin at the outer face. Consequently, it will offer less material for the particle to traverse and thus reduce multiple scattering at a critical point in the particle trajectory, near the point of maximum sagitta. On the other hand, it will not be self-supporting. The chamber will be supported by attaching it to the cryostat walls via springs in order that cryostat movement not destroy the chamber. The chamber will be strung with removable spreader posts in place to offset the wire tension. At the time of installation into the magnet, the compressive load on these posts will be transferred to the locating springs and the posts removed.

For both Regions 2 and 3 we plan to construct the drift chamber end-plates out of a light and strong composite material, such as thin sheets of aluminum filled with an hexagonal-cell core. The wires will be affixed to insulating feed-throughs which penetrate the end-plates, using metal crimp pins which fit into the rear of the injection molded plastic feedthroughs. In order to hold constant tension on the wires, we will pre-tension the end-plates before stringing them. We are investigating various tooling methods to automate as much as possible the labor-intensive tasks of the stringing operation. The construction is being planned with mechanical tolerance and survey techniques in mind.

Region 1 Chambers

The Region 1 chamber design is less advanced than that of the other two regions. Steve Dytman reported on a number of possibilities, including an externally-supported open-cell design similar to that of Region 2, and another based upon wires located in individual cathode tubes, a straw chamber. The second idea is hampered by having a fair amount of material present and so has been dropped from consideration.

We originally considered a jet-cell arrangement for the Region 1 drift chamber for two reasons: tracks in Region 1 are approximately radial from the target, ideal for jet-cells which point back to the target, and jet-cells can be wider than they are thick, which is well suited for the small space available in Region 1 and ideal for minimizing absorption of background photons from the target. However, we rejected the jet-cell design because of a very serious flaw. Most tracks will pass through a single jet-cell. Thus, an out-of-time track segment will give a good chi**2 but will simply appear to be displaced in space by a small amount. This situation is avoided by a staggered-cell arrangement in which such an out-of-time track gives a poor chi**2. We are considering a hexagonal cell arrangement for Region 1 also.

The possible mechanical design for Region 1 is somewhat complicated. If we are to avoid spreader posts and their accompanying multiple scattering then the load of the wire tension must be borne by an external frame or perhaps by attaching one chamber to its neighbors into a single structure. Precise positioning could be provided by abutting the forward and backward ends of the chambers onto accurately machined rings, actually hexagonal in shape. One complication of attaching the six chambers into one unit is that they would probably capture the mini-toroid assembly. We need three-dimensional drawings or perhaps a physical model soon in order to visualize these geometrical obstructions and constraints.

Electronics, High Voltage, Low Voltage, Gas, Calibration

The past year has seen much progress in the electronics design for the drift chamber. We have bench-tested and calibrated a number of pre-amplifier boards, have produced designs for a translator board which adapts the varying hole pattern on the end-plate to a regular edge connector suitable for standard pre-amp boards, have procured the necessary electronics to instrument the large prototype and have made a variety of measurements and calculations regarding noise, power dissipation, signal shape, attenuation, etc. We have preliminary designs for the translator board, including the calibration circuitry, and for the pre-amp board. We still have only a rough sketch of the front-end board. For the large prototype tests in the spring and summer, we will use commercial TDC's and ADC's for the time and charge measurements.

We remind the reader of the requirements for the drift chamber amplifier:

1) a minimum ionizing track will release about 100 ions as it traverses 1 cm of Argon-Ethane

2) to achieve good spatial resolution, the electronics must be sensitive to the arrival of a single drifting electron,

3) at a gas gain of 10**4, this corresponds to 10**4 electrons, or about 2 fC of charge.

4) to achieve good time resolution, the rise-time of the amplifier must be faster than 5 ns

5) the two points above imply that a minimum input signal corresponds to 2 fC in about 10 ns, or 0.2 microAmp

6) for this minimum signal to cross a 10 mV threshold with 50 ohms impedance requires a gain of 1000.

The high voltage distribution system will be highly segmented in order to shut down as small a section of the chamber as possible in case of high voltage breakdowns or wire breakage. High voltage will be distributed to both sense and field wires. This distribution will be located on one end-plate of each chamber. The other end-plate will be occupied by the low voltage distribution system and the pre-amplifiers.

We plan a gas system which will recirculate, filter and monitor the gas. The most important element of the monitoring will be a small drift chamber in line with the gas flow which will provide a continual measure of the average pulse height and drift velocity of the gas. This in line chamber will measure tracks produced either by cosmics or perhaps by a collimated laser beam. We also plan to monitor the temperature, pressure and composition of the gas with dedicated instruments.

Large Prototype - Schedule and Progress Report

We have made substantial progress toward construction of a large drift chamber prototype. We have most of the mechanical components in hand for the drift chamber body and have made a schedule for the electronics components which dovetails nicely with the stringing timetable. We plan to have an operational chamber by May 1, 1990.

The large prototype will be a theta-section of the Region 3 drift chamber. It will have full length (3 meter) wires, end-plates at 60 degrees with respect to each other and realistically designed pre-amps mounted on the end-plate. There will be 144 sense wires arranged in three super-layers of four layers each; each layer being 12 wires across. We will test fabrication and stringing techniques, and, of course, the tracking studies will be realistic. There will be normal wires and wires with a 6 degrees stereo angle. We will study position resolution both perpendicular to and along the wire direction as well as tracking efficiency and dE/dx resolution. Prototype conditions which are different from actual chamber design include the following: no magnetic field, common start TDC's, and commercial post-amps, TDC's and ADC's.

One-Meter Prototype Results

We have measured the track resolution and efficiency of the 1-meter prototype chamber. The 1-meter prototype consists of some 44 sense wires and 100 field wires arranged in an hexagonal pattern, with a 1 cm spacing between sense wire and neighboring field wires. The 12 micron sense wires are held at ground potential while the 70 micron field wires are held at the proper negative potential (approx. 2450 V) to ensure proper chamber operation. The potentials are graded at the boundaries by the addition of 70 micron guard wires held at half the potential of the field wires. The chamber is filled with a gas mixture which is nominally 50 % Argon and 50 % Ethane at atmospheric pressure.

Scintillator paddles are located above and below the chamber at approximately mid-wire location. They provide the trigger for the system and the start signal for the TDC's. Eighteen of the sense wires are instrumented with a Signetics 5212 pre-amplifier, the output of which enters a discriminator with a nominal threshold of 10 mV. The discriminated signal is delayed and then provides a stop signal for a TDC channel. A start signal in the first TDC module provides a LAM which interrupts the data-taking MicroVax computer via a Kinetic Systems interface board.

We wrote a tracking program which took as input the 18 TDC channels and searched for a series of struck wires consistent with a straight line track expected for a penetrating cosmic ray. To convert the time signal from each TDC channel into a hit position we needed two calibrations: first, we calibrated each TDC channel to determine T0, the time channel corresponding to zero drift time (i.e. the case when the track was arbitrarily close to the wire) and, second, we used simulations and actual data to determine the relation between drift time and distance of closest approach of the track to a wire.

We found a single event display invaluable in understanding the chamber operation. We measured the inclusive time distribution for a single wire. The distribution extends up to times of about 280 ns; this maximum time corresponds to the transit time for ions drifting in from a track which just traversed the outer regions of the cell. Using the program, we can display the distance versus time scatterplot for those hit wires which were used in successful tracks. The distance of closest approach is calculated from the track parameters and the known wire position. The time variable is given by the TDC output with T0 subtracted. The drift velocity is approximately 50 micron per ns, with the drift velocity decreasing for distances greater than about 4 mm. We overplotted the drift velocity function used by the program; inspection revealed whether the function provided a good description of the data.

By excluding one layer from the fit we were able to determine the residual between expected and actual spatial position of the track through the layer and, hence, the resolution. After unfolding the expected tracks' resolution from each of these distributions, we conclude that the hit resolution per wire, averaged over the cell, is 155 micron (sigma).

For a given operating voltage and given amplifier gain, the resolution depends upon the discriminator voltage. Raising the discriminator threshold causes the TDC circuitry on a particular wire to sometimes fail to record the time of the first-arriving ion and thus to record an artificially longer drift time. This effect worsens the nominal resolution. By studying the resolution as a function of discriminator threshold we determined the amount of amplifier gain which we need.

In addition to studying the track resolution we have also investigated the efficiency of individual chamber layers in responding to the passage of a track through the active region. Our procedure was as follows: we excluded one layer from track-fitting and demanded that the program find a track which penetrated the layer in question. To insure that the track actually went through the layer we employed fiducial cuts which additionally required that the track be more than 600 microns from the edge boundaries of the layer. We then inquired whether there was at least one cell which fired in the layer. We measured this layer efficiency as a function of chamber operating voltage. The chamber reaches a layer efficiency exceeding 99 %, for a voltage of 2450 V or greater. Note that additional amplification or a lower discriminator threshold would have lowered this nominal chamber operating point. At 2450 V, a measure of the number of cells firing for which a track did not go through compared to the number of wires firing on a track is about 1 %.

Three-Meter Prototype Results

We have constructed a specialized prototype chamber which consists of seven hexagonal cells; six outer cells arranged about a central cell. The end-plates are canted at an angle of 60 degrees with respect to each other and the wires are about 2.5 m long. This prototype has served a variety of purposes. We first used it to test the accuracy of the wire placement scheme in which the insulating feedthroughs penetrate the endplate perpendicularly (at 90 degrees). To test the accuracy of wire placement, we chose one hole and its mate on the other side and repeatedly inserted feedthroughs, strung and crimped a wire, and then measured the position of the wire. We would then cut the wire and, using new feedthroughs, repeat the stringing and position measurement. A position deviation of 0.0015 inch (r.m.s.) was attributed to dimensional irregularities in the feedthroughs.

We also used the 3-m prototype to verify our calculations concerning the electrostatic stability of the wire locations. To minimize wire breakage, we plan to string the aluminum field wires at a tension corresponding to roughly half the yield stress of aluminum. In order to equalize the wire sag of sense and field wires, the sense wires will be strung at a quite low wire tension of approximately 17.5 g. Our calculations of the electrostatic instability at an assumed gas gain of 5*10**4 indicate that 17.5 g of tension is more than adequate to maintain stability (a safety factor of 7). Naturally, we would like to verify this experimentally.

The results above were for symmetric wire placement. At the super-layer boundaries there will be net forces tending to displace the outermost sense wires. We have chosen a guard-wire arrangement to neutralize these forces and, at the same time, to restore symmetry to the drift time isochrones. The 3-m chamber will also allow us to test our planned guard-wire scheme. Preliminary tests indicate that our proposed guard-wire scheme works well.

In addition to studies of wire placement and position, we've investigated the electronic properties of the long wire prototype. We first found that to reduce noise in the pre-amps it was necessary to ground the aluminized gas bag to the chamber end-plates. We then verified that the chamber operates successfully even if the high voltage is applied to the opposite end of the wires from the pre-amps. We studied the signal attenuation caused by the 3 m. long wires and found that dispersive effects caused a voltage attenuation of about a factor of 5 for signals far from the pre-amp compared to those nearby.

Division of Work

Drift Chamber - Division of labor

WHO	WHAT
U. of Richmond	materials testing gas calibration, monitoring
Electronic Engineers	post-amps, front-end boards

U. Mass.	components testing, CAD system, magnetic field dependence
CMU, Pitt	Region 1 design, prototype, construction
UNH	alternative gases

Report on the EGN Group Meeting
January 11-12, 1990

A meeting of the CLAS Electron-Gamma-Neutron Detector Group was held beginning the day before the CLAS collaboration. The following people participated in the meeting.

G. Adams (RPI), K. Beard (WM), V. Burkert (CEBAF), H. Funsten (WM), K. Giovanetti (JMU), D. Joyce (CEBAF), R. Marshall (UVa), R. Minehart (UVa), C. Riggs (partly, CEBAF), R. Sealock (UVa), P. Stoler (RPI), R. Welsh (WM), R. Winter (WM).

At the first day of the meeting the status of the design and construction of the various prototype detectors were presented and discussed. Also, preparations for the upcoming beam tests at Brookhaven National Laboratory were discussed and responsibilities assigned to the various institutions and individuals. At the second day, the status of the CLAS EGN detector designs, and the preparation of the Conceptual Design Report (due April 1990) were addressed.

A. Prototype detectors.

Three different prototype detectors are presently under construction.

(1) A lead/scintillator sandwich calorimeter prototype ("sandwich prototype") with stereo readout. The detector will have basically the same structure as the one described in the PCDR, but only 11 scintillator strips per layer instead of 30.

The total thickness will be 15 radiation length (r.l.), corresponding to a total of 39 layers of scintillator (13 in each view). The first 6 radiation length will be readout independently of the 9 radiation length in the rear.

(2) A lead/scintillating fiber calorimeter prototype ("scifi prototype") with dual (left-right, 1-coordinate) readout. The prototype detector will be composed of 2 separate modules each 15 r.l. deep, 120cm wide, and 9 cm high. The 2 modules will have a longitudinal segmentation into a front part of 6 r.l., and a rear part with 9 r.l.. The light will be readout at both ends, to allow a determination of the impact position.

(3) A threshold gas Cerenkov counter prototype. The prototype will have an optical mirror system which focusses the Cerenkov light to a light funnel system (basically a Winston cone), and to three 5" PMT's.

I. Sandwich prototype

Construction. All the major parts have been ordered, except for the mechanical support structure. The precise dimensions and tolerances of some of the mechanical parts can only be defined after we know more precisely how well the companies delivering the scintillator bars keep the specified tolerances. A large portion of the nearly 500 scintillator bars we ordered are in house, and the remaining pieces are scheduled for delivery by February, 15. The scintillators and wave shifter bars will be tested for light transmission at UVa. The prototype detector will be assembled at UVa. Larry Dennis will check whether the FSU machine shop(s) are equiped to allow machining of the mechanical parts at FSU.

Light guides. The light guides will be machined at WM and UVa.

PMT Bases. The PMT bases will be assembled at UVa and WM. Some financial support for undergraduate students may be needed.

Calibration. For monitoring the stability of the PMT's a laser driven optical fiber sytem will be used which may be installed inside the detector enclosure. The system will be put together at JMU. A nitrogen laser may be available at CEBAF. The absolute calibration (ADC channels -> energy deposited) can be done using minimum ionizing particles in the beam.

Readout electronics. Readout electronics (LeCroy FERA system), HV power supplies, data aqcuisition system, signal and HV cables are available for the 66 readout channels.

Data aquisition. UVa and GMU will look into the Q-system available at UVa, and develop the necessary software.

On-line and off-line analysis. Some routines written at CEBAF for the GEANT simulation can be used to do simple on-line analysis of the detector response in the test beam. CEBAF, WM, and GMU will be working on the on-line software.

II. Scifi prototype

The necessary parts for the construction have been ordered, including the scintillating fibers, lead, PMT's, PMT bases.

Mechanical construction. The lead/scifi modules will be constructed at UIC. If the fibers are delivered as scheduled (March, 1), the schedule for the prototype construction can be kept. WM will fabricate and test the light guides, and assemble the PMT's and bases. The final assembly of the complete detector prototype will be done at UIC.

Light guides. WM is working on air light guides with a 90 degree bend. They are also looking into other options.

Calibration. The laser/optical fiber system will presumably be used to monitor the PMT stability. As in the case of the sandwich prototype, miniumum ionizing particles can be used to for the absolute calibration.

On-line software. Data aqcuisition software will be done by GMU and WM. Yale will develop the software for the on-line analysis.

III. Threshold gas Cerenkov counter.

The Cerenkov counter prototype is under construction at RPI. There seems to be a good chance that the March 30 deadline can be kept, although there are still some problems related to the construction of the light collection system.

IV. Beam tests at Brookhaven National Laboratory.

Schedule and manpower. The BNL test beamline A2 can be used only until April 21. There will probably no test beam time available before late fall of 1990. So we should try hard to get the detectors ready by the end of March, which would leave us a period of 3 weeks for testing the detectors. Since we will have to share the test beam line with other users the effective beam time could be a lot less than 3 weeks.
There seems to be enough manpower available to allow us to run in 2 or 3 shifts over the full period of up to 3 weeks.

Beam line equipment. Steve Thornton (UVa) volunteered to see that the gas Cerenkov counters needed for electron/pion discrimination are in place, and the right radiator gas (presumably N_2 or/and CO_2) is available. UVa will also provide small scintillation counters for defining the exact beam position.

Data Acquisition and readout electronics. UVa will provide the Q system for data aqcuisition, and a total of 96 channels of readout electronics (ADC, TDC, Lecroy FERA system), HV channels, and cables, which is more than will be needed. There is also a certain amount of NIM electronics available.

Support platforms. There appear to be lifting table for 5000 lbs available at BNL which we can use for placing the detectors in the beamline.

B. CLAS EGN Detectors.

I. Requirements.

The various criteria for particle ID and energy and time resolution requirements were reviewed.

1. π^-/e^- discrimination.

There appears to be still some uncertainty as to the pion rejection necessary for the gas-Cerenkov-counter/calorimeter combination. H. Funsten will provide a table with the π^-/e^- ratio as a function of angle and momentum.

2. Energy and angle resolution for photons (and electrons).

The canonical $\delta E/E < 0.1/\mathrm{sqrt}(E(\mathrm{GeV}))$ and $\delta\theta < 10\mathrm{mrad}$ were derived by requiring a mass resolution for recontructed π^0 and η events of $\delta m/m < 0.20$ for momenta from 0.5 to 3.5GeV/c. This should be considered as an acceptable upper limit. Any improvement in energy and angle resolution would clearly be welcome.

3. Neutron detection efficiency.
The neutron detection efficiency should be of the order of 50% or higher.

4. Neutron/photon discrimination.
Discrimination between photons and neutrons will be based on time-of-flight measurements and on longitudinal and transverse energy deposition. A time resolution of $\delta T \simeq 1$ nsec is required for discriminating photons and neutrons for momenta up to $\simeq$ 3GeV/c. This eliminates detector designs based on streamer tubes and other gaseous detectors, and calls for a scintillator based design.

II. Design of the forward shower calorimeter.

The discussion focussed on the pro and cons of the alternative options of a design based on a 3-view readout ("stereo readout"), and a design with left-right readout along the y coordinate ("dual y readout"). In the dual readout option the calorimeter would be made of mudules, about 10cm high and with varying length. The advantage of such an arrangement would be that the shape of the calorimeter could follow the shape of the CLAS magnet coils and could be extended to large angles. In the stereo readout option the calorimeter would be planar and the design would have to be modified for large angle coverage. However, the capability of the dual readout option to resolve multiple hits in a single or in adjacent modules was questioned. A simple calculation shows that π° events with momenta of 2 or higher have a > 25% chance that the decay photons would hit the same or adjacent modules, respectively. It was not clear to what extend the physics would be compromised. With a 4 GeV electron beam pions with momenta above 3 GeV/c can be generated. With a 6 GeV beam pions with more than 3 GeV/c may be produced quite frequently. Obviously, this question needs to be adressed urgently, and in a quantitative manner.

III. Design of the large angle calorimeter.

For polar angles greater than 45 deg. pions are generated with momenta typically below 1.5 GeV/c. The calorimeter design for this angular region could be based on the dual readout system with probably much less impact on the physics than at smaller angles. Another option discussed was to modify the stereo concept to an y-z readout with additional readout at 45°. Another possibility is a y-z design with readout at both ends (dual y-z readout).

IV. Gas Cerenkov counters.

Monte Carlo simulation of the RPI design indicate that the 60cm gas volume presently forseen for the Cerenkov counters might be sufficient if the light extraction system works as assumed in the simulation. It is hoped that much information will be gained from the BNL test beams, in particular on the reliability of the simulatin code. Estimates about the probability of electron knock-on from material in front of the radiator gas (Freon 12) show that the amount of material must be kept below $\simeq 300\mathrm{mg/cm^2}$ to keep the knock-on probability for electrons (above threshold) below 0.5%. This has clear consequences for the design of the entrance windows and front mirror system, as well as for the design of the region 3 drift chambers.

C. CLAS EGN Memoranda of Understanding.

There was a discussion of the format for the EGN Memoranda of understanding. The group was under the impression that the EGN MOU would be specific to the EGN development. Kevin Giovanetti volunteered to work on development of a model that could be used as a guide by all EGN members.

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Time-of-Flight Working Group

The CLAS Time-of-Flight Working Group met Friday, Jan 12 to discuss several technical and planning issues. Attending were Bill Hersman, Dave Jenkins, Elton Smith, and Carey Stronach. Those present elected Bill Hersman as representative of the working group.

The light guide design and resulting tube placement was discussed. Short straight guides may degrade timing resolution but would facilitate fabrication. Curved guides from Notre Dame achieve performance of long straight guides.

Packaging would have to be examined with respect to the adjacent layers of chambers, the magnet supports, and the opposing sectors.

We determined that the discrimination scheme was inadequate. Either two discriminators (one low for timing, one high for threshold), or a constant fraction discriminator would be required. Pricing will be explored. The quality of the cabling required to maintain the timing quality should be determined. Automatic (software) setting of discriminator levels would be preferred. Discrimination in the tube base was discussed, but would require more cables, and decrease access and control of parameters.

Laser pulse distribution was discussed. Light division by passing the laser beam through opal glass has worked at NIKHEF. Two light injection points were suggested (center and off center) for timing, attenuation, and redundancy.

The need to support the scintillator across the length of the plastic to avoid flexing and crazing was identified. A blue seal box could both support the plastic and protect the counter.

Division of labor and responsibility was addressed. VPI (Jenkins) is able to build bases, and could test integrated tube/base assemblies. W&M (Welsh) is working on light guides. UNH (Hersman) and VSU (Stronach) plan to divide the responsibility for assembling the complete counters, with possible help from others. VPI will examine laser calibration. UNH plans to develop calibration and monitoring software. USC (Preedom) plans to develop a detector-wide integrated high voltage control system.

Software Working Group Report

I. Participants

For the first hour of the working group meetings the Data Acquisition and Software Working Groups meet jointly. In addition, some members of the CEBAF Data Acquisition Group attended the Software Working Group meeting.

Software Working Group

R. Whitney
B. Preedom
L. Dennis
B. Niczyporuk
G. Gilfoyle (Drift Chamber Group)
D. Joyce (Data Acquisition Group)
D. Doughty (Data Acquisition Group)
S. Zhou (Data Acquisition Group)

CEBAF Data Acquisition Group
C. Watson
D. Quarrie
E. Jastrzembski

II. Monte Carlo and Simulations

Elton Smith, Don Joyce, Bogdan Niczyporuk and Lee Crawford submitted written reports on some of their activities since July. Those reports are summarized below, the complete reports are available from LDENNIS@FSU.

FASTMC:

Elton Smith has been working on his FAST Monte Carlo program trying to incorporate many of the features users have requested. He intends to include these in the next version of FASTMC which he hopes to release Feb. 1. The added features include modifications to allow for a variable B field strength, the new geometry (90 degree coverage of Cerenkov and shower counter), output compatibility with PAW, a variable target position, and the approximate resolution for only 1, 2 and 3 DC superlayers .

CELEG:

Don Joyce has mostly been fixing miscellaneous bugs which have shown up in CELEG. The inclusion of vector meson production will not be done until a future release. In addition Don defined a common directory structure for CELEG, FASTMC and GEANT. This structure should make it easier for the installation of future updates.

GEANT:

In July 1989 a new version of CERNLIB, including GEANT (vers 3.13) was installed at CEBAF. M. Guckes embedded all accumulated modifications and changes for the CLAS into a new version of the CLAS PAM file (GLAS103.PAM). Bogdan Niczyporuk found numerous serious problems with the new version. He eventually was able to trace these problems to bugs in both GLAS103.PAM and to the GEANT routines GEANG and GINVOL. These bugs were fixed by Bogdan and Andy McPherson. The fixes along with the code for the cut tube geometry were sent to R. Brun for inclusion in GEANT (vers 3.14). R. Brun has indicated that the CUT TUBE geometry will become a part of standard CERN package. Such a change should eventually reduce the work required to use future CERN versions of GEANT. In addition to updating the CLAS version of GEANT, it was modified to include compatibility with PAW.

MISC:

Bogdan Niczyporuk has worked extensively on codes to simulate and perform a "Partial Wave Analysis of Pion Electroproduction Data" (see CEBAF-PR-089-040). In the process he produced several useful programs to calculate the acceptance of the CLAS as a function of Q**2, W, cos(theta) and phi, generate pion electroproduction data and perform partial wave analyses for these data.

Lee Crawford wrote a series of utility programs to merge LUND format files (such as those produced by CELEG and used as input by FASTMC). These programs merge two files, selecting events from the two files in user specified proportions, counts the number of events in a file, or extends a file by adding events which are identical to those in the input file, except they are rotated by a randomly selected phi angle. Lee also completed a program which converts HBOOK 1 and 2 dimensional histograms to into TOPDRAWER input files.

The CLAS software can still be obtained from Larry Dennis at FSU (Bitnet: LDENNIS@FSU), however, the new versions of the software will not be available until after Feb. 1. Those users who are not running PAW may want to continue using the old version of GEANT until after PAC 4b.

III. Update on Data Acquisition System

Chip Watson gave a talk on the current plans and recent activities of the CEBAF Data Acquisition Group. He presented a possible solution to the problem of obtaining approximately 2000 MIPS in the processor farm based on the Motorola HYPERmodule TP881V RISC multiprocessor board. Since the target costs of the processor farm is $100 K, this system is currently too expensive, but prices are expected to fall. There was some discussion of the possibility of needing faster computers in the processor farm and the likelihood that the fastest available systems support C, but not FORTRAN. Chip feels he must require that FORTRAN be available on the processor farm, even if we (Hall B) decide we can use C, since the other Halls will require FORTRAN. Chip also presented the results of simulations of the proposed Readout Controller and discussed preliminary designs for the switching network and trigger supervisor.

IV. Planned CEBAF Computing Environment

Roy Whitney presented an overview of the CEBAF computer system. Of particular interest to the collaboration are firstly, the planned connections of the CEBAF computer system to the Energy Sciences Network, SURAnet and the Virginia network and secondly, the planned offline processor farm at CEBAF and finally, the data storage system planned for CEBAF. The presence of a processor farm at CEBAF, coupled with a "multi-terabyte" disk/tape online data storage system will provide some of the computer resources need to analyze experimental data offline. However, offline analysis may be more computer intensive than online analysis and these facilities will be shared by all three halls, thus, additional computer and data storage systems will be needed.

There are two schemes by which these offline computer systems can be obtained. One, small processor farms can be spread out over many places. Or two, large processor farms can be spread out over a few places. The general consensus of those at the working group meeting was that the latter solution is the only workable solution with the expected power of the planned computer systems. Under this latter scheme, it is more likely that the needed computer resources are available to the collaboration through network access and it is more likely that the data needed for offline analysis is available at the location where it is needed. Using small farms at many places insures that no one group will have the resources needed to do their analysis on-site in a short time period and increases the likelihood that the resources that are available are underutilized.

IT IS CLEAR THAT HIGH QUALITY NETWORK CONNECTIONS TO CEBAF WILL BE A REQUIREMENT FOR EVERYONE WHO USES THE CLAS.

V. Online/Offline Software Design

Larry Dennis presented the some of the preliminary designs for the online and offline systems. The current plan is that Larry Dennis, Bogdan Niczyporuk, Don Joyce, Greg Riccardi, John Harris and Barry Preedom will attempt to finish a rough design by mid-February. Originally, this design was planned for completion in July 1990, but a number of people felt it was needed much sooner. The rough software design is meant to be a written starting point for discussions with members of the group. Input before Feb. 15 would be very welcome, so contact Larry Dennis at (904) 644-1804 if you have comments.

A number of items were discussed, including using DEC's CMS/MMS software packages on a VAX system located at FSU for the software library and supporting only VAXstations and DECstations as workstations.

VI. Tasks, Manpower, Funding and Schedules.

We had a general discussion of the tasks required for completion of the online and offline software. We are currently using a list of tasks prepared by Chip Watson as the list of programming tasks required. The list below gives updated estimates of the amount of time needed to complete these tasks (grouped in large general categories).

TASK	CLAS - FTE	TOTAL - FTE
System Design (including checking standards, code management, code integration)	5	8
Detector Component Software (detector control, calibrations, special purpose displays). Most to this effort must be supplied by the detector working groups.	17	17
Run Control	1	5
Online Analysis	5	8
Utility Routines (only those needed specifically by CLAS group)	2	2
Database (setup, optimization)	2	4
Event Reconstruction and Pattern Recognition	9	9
Off-line Analysis	9	12
Documentation	5	7
TOTAL	55	72

The above totals include only those activities directly related to software production. They do not include any of the time spent obtaining funding, equipment, personnel or any time spent training people.

The existing pre-MOU's include about 34 FTE's for work on software from people outside of those at CEBAF.

Within the software working group, none of the members have all the needed hardware to participate fully in the software development. The estimated needs are give below:

Workstations	(need about 5 more)	$45,000
Disk Drives	(need about 3 GBytes)	$18,000
Extra Memory for existing workstations		$10,000

Some of the needs at can be meet by the University (about $18K over three years), and existing federal funding (about $35 K over three years). However, some of these funds may be too late to do much good.

Triggering and Acquisition Working Group

The triggering and acquisition working group met Friday, January 12 to discuss the current status of the triggering and acquisition system design. Members present were:

Dave Doughty	CNC
Don Joyce	CEBAF
Chip Watson	CEBAF
Ed Jastrzembski	CEBAF
Dave Quarrie	CEBAF

During the first hour a joint meeting was held with the software working group at which Chip Watson reviewed the current architecture of the data acquisition system for the CLAS detector. Chip also presented the preliminary design of a trigger supervisor which the CEBAF in-house acquisition group is planning to develop for use by all three experimental halls. Ed Jastrzembski is planning to enter the schematics for the trigger supervisor into the P-CAD system.

After the software group had left, ramifications of Bernhard's proposal to upgrade the acquisition were discussed. It was concluded that no architectural changes to the acquisition system are needed to handle the increased data rate. To obtain higher data acquisition rates as early as possible, monetary resources will have to be allocated differently. For example, one would need to improve the data archiving capability, and possibly the online farm for monitoring. To provide funds for such items, fabrication of the third level trigger could be delayed, since it is not anticipated that tight trigger cuts implemented using LEVEL 3 would be used during the initial phase of operation. Trigger levels 1 and 2 are however still required for successful operation at the anticipated rates.

Dave Doughty presented the current status of the first level scintillator router design. The block diagram schematic for this design has undergone an internal design review. David and his student at CNC are proceeding to enter the detailed design into the P-CAD system. This job should be completed by April.

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