V. Rikalin explained the possibility of using a high power LED light source from Protvino to feed optical fibers and perform calibrations of various detectors in the experiment. The proposal was found particularly useful for the calibration of vertical and horizontal hodoscopes.

Although the Collaboration Board as such did not meet at this trigger workshop, a version of the Memorandum of Understanding was distributed by Max Ferro-Luzzi to the representatives of the institutes present. This version, after some minor modifications, was considered final and ready to be signed. It was also said that all groups must inform M. Ferro-Luzzi about agreement of authorised authorities of home institutes to sign this document or about corrections which must be done and only after agreement of all institutes the MoU may be signed.

Addendum

Test beam activities in 1997 as agreed at the workshop (compiled by M. Ferro-Luzzi)

Week number	Starting on	dE/dx	MSGC	VH	HH & muon ctr	DC	Pre-shower	Cherenk	SciFi
18	28 April	yes	yes	yes					
19	5 May	yes	yes	yes					
26	23 June				yes				yes
31	28 July					yes			yes
33	11 Aug.	yes				yes			yes
35	25 Aug.		yes	yes	yes		yes	yes	yes
36	4 Sept.	yes	yes	yes	yes		yes	yes	yes

òyesó means that the representatives of the group concerned expressed interest in using the beam to test the detectors they are responsible for.

that the presence of the various detectors could be revised on Aug. 3 according to the results of the previous tests.

The distribution finally approved was the following

Test runs of 1997

	Dates	Tested detectors
1.	28.04 - 11.05	dE/dX, MSGC, VH, pre-shower
2.	23.06 - 29.06	SciFi, HH
3.	28.07 - 03.08	DC, SciFi
4.	11.08 - 17.08	DC, SciFi, dE/dX
5.	25.08 - 07.09	MSGC, SciFi, dE/dX, VH, HH, Preshower, Cherenkov

It was also agreed that M. Ferro-Luzzi should be informed with sufficient advance of the material needed by the groups from the electronics pool.

IV) Other subjects

L. Nemenov brought up the following points for discussion and information:

1) experimental area and setup
2) HV supply
3) cables
4) monitoring of proton and secondary beams
5) detector calibration with light sources
6) MoU
7) dates of next meeting

L. Nemenov and A. Kuptsov will prepare a memo to be submitted to the PS division including electric power supply and front-end electronics requirements, and also installation of gas racks for DC and MSGC. Special conditions related to the latter should be specified to him as soon as possible. A small crane will be requested for the detectors downstream of the magnet. It was said that there was no need for it for those detectors sitting upstream. The temperature in the experimental area should be stabilized between 18 and 25 degrees Celsius, according to the DC requirements. The requirements of the MSGC detector should be specified. An estimation of the total power dissipation has to be carried out, specially for the front-end electronics.

A proposal was described by **L. Nemenov** of an experimental setup for a precision monitoring of the position stability of the secondary beam, including a collimator, several counters with lead absorbers and a certain coincidence logic. The device aims at gamma detection from ^{o} decays, having expected rates lower than 10^6 Hz. It was agreed that this could be the responsibility for a new group joining the collaboration.

sub-events

3- It would be nice, if as in the case of FERA and DC data, the T4 number would be written in the high 11 bits of every 32 bit data word

4- the transfer rate of data to this unit (or the transfer time) must be close to the one of the FERA bus

5- if the data will be transferred in this unit on the previous level trigger signal, then the unit must discard the data if RESET signal from T4 will arrive.

S. Trusov proposed also that every detector group will prepare within 2 months the detailed scheme of electronics readout including all the details (front-end units, ADC, TDC, delays, cable lengths) so that the DAQ group can combine these schemes into a global scheme for the experiment. This is important for the understanding of what and how much different electronics units the collaboration needs to have, and how they fit into the trigger and DAQ schemes, and what kind of software must be developed for the readout and control of the apparatus.

Some points were clarified during the discussion. As we intend to use different triggers for $^{+-}$, e^+e^- in the same run we need the input register keeping the trigger type for each event. We may also have "calibration" events formed by light sources on the detectors. The read-out of the calibration events must be provided in the pause between spills.

It is planned to read the CAMAC and VME units of other types only once per spill. For example, scalers counting the detector loading rate, live time and dead time of the set-up, units for monitoring tasks, and so on.

Some discussion took place about the limitation of 2000 sub-events per spill, and its implications on the total amount of data stored after one year of data taking, if it is reached. This limitation comes from the size of LeCroy 1190 memory units, and it will not really be reached.

The workshop approved the DAQ scheme including requirements to the electronics and detector groups were committed to prepare the detailed electronics readout scheme and send it to the DAQ coordinator (S. Trusov) within two months, so that the global scheme can be prepared and discussed in the next collaboration meeting.

III) Test runs in 1997

M. Ferro-Luzzi reviewed the schedule of the allotted beam periods for DIRAC testing during 1997. Some discussion took place on which detectors were to take data in each period. M. Ferro-Luzzi mentioned that, provided there was the possibility for the Cherenkov prototype to be ready in August, it was much safer to include it in the period no. 4, having still the possibility to repeat the test in period no. 5. In any case, it was agreed

ation with INFN will be clear, aiming at the solution with commercial electronics.

K. Kuroda and F. Takeutchi: with the proposed JINR electronics the module could not be tested during this summer test-beam, whereas we can hope to get LeCroy TDCs at this time to test the performance of the read-out.

After some discussion (C. Guaraldo, K. Kuroda, A. Penzo, M. Ferro-Luzzi) the following consensus was reached:

- it looks reasonable to use commercial electronics
- it is not possible to order TDC chips for SFD now (before June 1997)
- the problem should be re-discussed in September, when financial situation with INFN groups will be more clear. In case the request is approved, A. Penzo may contribute half of the required sum (40 K$), M. Ferro-Luzzi may pay 20 K$; the remaining 20K$ are still be found.
- negotiations with LeCroy company must be done to get possible discount in the module prices

DAQ electronics

S. Trusov reminded in his report the general scheme of DAQ. The digitization of the physical data must be started on arrival of the second level trigger signal (since the trigger scheme was not fixed yet, it is possible that level 3 trigger may be used for this aim). If the third or fourth level trigger processor will generate RESET signal then the data must be discarded. Upon arrival of the fourth level trigger signal, the data must be transferred in the VME buffer memory (LeCroy 1990). It is decided to use FERA ADC and TDC as they provide the maximum data transfer rate, minimum digitization and reset time. The dedicated readout system of drift chambers will transfer data in the VME buffer memory over 32 bit ECL bus compatible with FERA protocol.

In order to be able to distinguish the different events the FERA bus will put the data in the sub-event formatter unit (developed by V. Karpukhin). This unit contains the scaler which counts the T4 signal, writes the counted value on the high 11 bits of 16 bit word and combines this word with every data word transferred over FERA bus or obtained from DC electronics, forming the 32 bit word acceptable for the VME buffer memory. It allows to distinguish the data of the different events and perform the event building in the next stages.

It is possible also to use dedicated VME units with a buffer memory of 2000 sub-events size for some detectors. These VME units must satisfy the following requirements:

1- Each sub-event must contain the number of the T4 signal (i.e. the event label) which caused the storage of this sub-event

2- There must be the marks which allow to distinguish the data of different

3) Pre-shower Results were presented by **M. Petcu** on e/end electronics. Results on the degradation of pulse-height at rates in the Mhz range were shown.

4) Muon-counters **V. Rykalin** reported the IHEP design for HV divider of the R1828 P.M. showing results of PM signal at 5V, 500 Ω stable up to $2x10^6$ per burst. CFD and ADC will be used. If high resolution is needed, then 2 layers can be installed instead of one, and mean timers will be added.

II) Readout electronics and DAQ electronics requirements

Drift chambers and SFD

V. Karpukhin presented a block-diagram of the electronics designed in JINR to perform the read-out of drift chambers. The electronics consisted of 3 parts: front-end 16 channels multi-hit TDC, bus drivers and read-out controller. This solution was accepted and generally approved. The multi-hit TDC can be used also for the read-out of SFD. Some modifications are needed for the input part of the module to handle the ECL logic input signals. The printed board should be redesigned, and the internal NIM bus should be replaced by a FERA bus. The general scheme was explained by V. Karpukhin. The required time for production of TDC modules was 7 months (3 month PCB design, 4 months production). The JINR group stated that this work could be done only at the cost of postponing the production of the trigger 4 level processor until the end of 1998, which is also under responsibility of V. Karpukhin. An alternative to this scheme was also considered, on the basis of using 16 units of commercial LeCroy TDC modules of 32 input channels.

L. Nemenov showed a transparency indicating the cost of each of the two solutions:

- estimation of JINR-made SFD TDC readout: 48,000 US dollars (using LeCroy TDC chips)

- standard LeCroy TDC module solution: 80,000 US dollars (1996 price list of LeCroy). However, if an order is placed before June 1997 the price will be reduced.

Several opinions were expressed: S. Trusov, A. Kulikov: the JINR solution looks preferable due to its lower cost and because data formats are the same in SFD and drift chambers. Also the data transfer is estimated to be 2-3 times faster than for the commercial unit.

A question was raised to A. Penzo on whether the purchase of LeCroy electronics could be made before June in order to benefit from the price reduction. He said that only in September the money for SFD electronics would be received, if approved by INFN.

B. Adeva expressed worry on the possibility that the production of trigger 4 processor could be delayed after the startup of the experiment, being such an essential part, and proposed to re-discuss the issue of SFD electronics in September, when the financial situ-

more version of cooperation of the dE/dx and SciFi detectors was suggested by I.Manuilov. Some discussion was around a problem of dead space in the dE/dx detector. There were made some conclusions. Concerning the second level trigger itself, the participants were not ready yet to choose the mode of combining the dE/dx and SciFi detectors. Further work is needed to make well-grounded decision. It became clear also that the presented first level trigger scheme and the electronics of the ionization detector are incompatible. It was decided to search for a way to modify the first level trigger scheme to provide acceptable conditions for the dE/dx detector electronics.

B. Adeva presented the results of the Santiago group simulations made for the development of the third level trigger scheme. He confirmed the Santiago group responsibility for T3 at all stages (programming, purchase, installation). He informed that they agree with the method of realization of the T3 scheme suggested by Dubna group at the previous meeting and that they are going to explore the possibility of implementing Delta x = V1(i) - V2(k) selection even at earlier (T1) stage.

V. Karpukhin reported about the fourth level trigger scheme which deals with track information from wires of the drift chambers. The scheme was not changed compared with presented in the DIRAC Proposal. The practical realization of the T4 processor will begin at the completion of the work on testing and production of the readout hardware.

Session of 18 February 1997

I) Aspects of front-end electronics related to trigger

1) Hodoscopes **B. Adeva** mentioned that for vertical and horizontal hodoscopes the front-end electronics consisted of CFD and precision Mean Timers. Commercial modules exist from CAEN (C208 for CFD and C561 for MT) that meet the requirements, and this is considered the default option. A message has been received in Santiago from J.Buytaert in the electronics pool saying that they have urged CAEN to redesign their C561 as a VME board. They have produced a prototype PCB and they are debugging it. If this module is produced and the electronics pool makes it available for rent, this is the way to go. The CAMAC CFD+MT Ralex from Julich is still kept as an option. A final decision will be made in May, after the first test-beam period.

2) Cherenkov detectors **A. Lanaro** reported that discriminators (possibly constant fraction) and ADCs will be used. VME crates and controllers are needed, and the question has to be asked to the electronics pool whether they can be rented. L. Nemenov made the recommendation that the same lines should be followed by Cherenkov detector and hodoscopes, concerning front-end electronics.

MINUTES

Session of 17 February 1997

The first level trigger section included two brief reports. In the first one **A. Kulikov** presented the updated scheme of the first level trigger. A new dedicated module for more flexible selection using the coplanarity criterion was implemented into the scheme as well as other modifications done.

In the second communication **V. Karpukhin** reported about the structure and schematics of this dedicated module which is in the development stage in JINR. The updated first level trigger scheme followed the previously reported (July 1996 DIRAC collaboration meeting) ideology, where the data from the two spectrometer arms and from the upstream detectors (dE/dx, SciFi) were processed in parallel and the combined decision of the dE/dx and SciFi detectors accompanied by the first level trigger produced the second level trigger signal. But M.Ferro-Luzzi argued that the electronics of the dE/dx detector cannot work at a rate larger than 100 kHz and so demands gating by the first level trigger. The discussion was postponed till the presentation of the reports on detectors involved into the second level trigger.

There were three reports on the second level trigger. **F. Takeutchi** on the basis of his simulations presented four versions of combining the data from dE/dx and SciFi detectors to provide as high as possible and uniform efficiency (uniform by the distance between two tracks) while keeping a high rejection power. No absolute preference has been done to some of these versions.

M. Ferro-Luzzi reported about the possible trigger scheme for the dE/dx detector on the base of commercially available modules with addition of a dedicated circuit developed at CERN. The results of the tests of ADC with this circuit (fast integrator) using a radioactive source and a real size detector element promise a good separation of single and double ionization events within 50 ns integration time. The integrator needs gating and provides good separation at rates not larger than 100 kHz.

C. Detraz in his short talk added to this report the description of a mechanical construction of the ionization detector which is finally completed.

J. Buytaert in his report described the principle of operation of the fast integrator and the technical details of its realization.

An extensive discussion of the first and second level triggers took place. It was mentioned that gating of the dE/dx electronics by the first level trigger will add almost 100 ns delay in all ADC and TDC channels in the frame of the considered T1 scheme. The redesigned T1 scheme could decrease this additional delay to several tens nanoseconds. One

II. Read-out electronics and DAQ electronics requirements.
1. Read-out electronics for SciFi detector
- V.Karpukhin, 15 min.
2. Discussion, sharing of responsibilities, formal approval 30 min.
3. DAQ
- S. Trusov, 15 min.
4. Discussion, formal approval - 30 min.

Lunch.

18 February, Tuesday, 15:00

I. Test runs of 1997.
1. The PS time sharing for the detector tests.
2. CERN pool electronics for the test runs.

II. All other subjects.

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AGENDA

17 February, Monday, 9:00

Bld. 60 room 6-002 (main building)

I. Introduction. - L.Nemenov, 10 min.

II. First level trigger.

1. Update of the first level trigger scheme. - A.Kulikov, 10 min.
2. A first level trigger processor - V.Karpukhin, 10 min.
3. Discussion - 30 min.
4. Formal approval, preliminary

Coffee break

III. Second level trigger

1. Trigger logic with SciFi and dE/dx- F. Takeutchi, 60 min.
2. Electronics of the ionization detector.
   M. Ferro-Luzzi, 60 min
   Jan Buytaert, 30 min
3. Discussion including the co-operation of SciFi and ionization detector electronics.
4. Status of the dE/dx hodoscope construction
   - C. Detraz, 30 min
5. Formal approval, preliminary

Lunch

17 February, Monday, 15:00

I. Third level trigger.

1. Santiago presentation of trigger simulation
   - B.Adeva, 20 min
2. Discussion.
3. Formal approval and assignment of responsibility

Coffee break

II. Fourth level trigger.

1. Status report.
   - V.Karpukhin, 10 min.
2. Discussion
3. Formal approval

18 February, Tuesday, 9:00
Bld. 40 SS D-01 (new building)

I. Aspects of front-end electronics related to trigger.

1. Discussion on the front-end electronics of hodoscopes, Cherenkov, pre-shower and muon detectors 60 min.

Coffee break

DIRAC note 97-07
10 April 1997

DIRAC Workshop on Electronics and Trigger held at CERN on 17- 18 February, 1997

Disclaimer

These minutes are based on texts prepared by **B. Adeva**, **A. Kulikov** and **S. Trusov**.

M. Ferro-Luzzi is only accountable for modifying text formats, re-assembling them, correcting misprints and mispellings, preparing the Addendum and enclosing copies of the printed manuscripts and transparencies that have been handed to him.