DIS Parity Trigger and DAQ

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Here are my present thoughts on the PVDIS trigger and DAQ setup. This document will evolve over time as ideas emerge.

My present thinking is to try to use a "conventional" scaler counting DAQ for production mode, and supplement this by FADCs to study high-rate effects like pileup. Furthermore, it is supplemented by the standard HRS DAQ to confirm the logic using low-rate running.

It may well happen that the new FADCs satisfy our needs for a fast counting DAQ. At a minimum, they can be used (with high deadtime) to determine corrections for pileup by studying a fraction of the events at high rates. We will also need to measure deadtime; there are three schemes for measuring deadtime discussed below.

Fig 1 shows the detector arrangement. The Left HRS remains standard and the Right HRS shower is modified slightly to use only 4 columns by moving the stack over 7 cm. We need some analysis work to decide the following questions which have an impact on the trigger design:

- What is the X-Y beam envelope and are 4 columns on R-HRS sufficient to cover acceptance ? Is there a more economical arrangement ? Bogdan proposed to use one row of the thinner R-HRS preshower blocks for preshower on each HRS, but this might be too narrow (35 cm in Y). More blocks implies more electronics.
- Is the arrangement on the Left HRS with two "thick" layers adequate for PID ?
- Is the online sum of blocks adequate ? Or do we need a more complicated algorithm, e.g. using the AND of the sum with the ratio of preshower to shower, or perhaps a seperate cut on preshower ?

Assuming my guessed answers to the above, I have made a preliminary design of the final trigger for the experiment, see fig 2. We have 45 NIM summing modules ("sum8") leftover from the RCS experiment. Each one can be used to add the signals from up to 8 blocks. We will use these for the leadglass on each arm. The blocks are summed in regional segments. Note, it is not a good idea to sum the whole detector because there is too much noise (experience from RCS & G_N^E experiments). A local trigger is formed in each segment. The two paths through two discriminator widths are part of the plan to estimate the deadtime. One path has a narrow width and the other has a wide width. The discriminated logic levels from the leadglass are then put into an AND unit (PS 755) to form electron and pion triggers. The electron trigger is the AND of the leadglass, Cerenkov, and scintillator trigger. A pion requires a Scintillator trigger and the absence of leadglass and Cerenkov. To form this veto, the leadglass and Cerenkov are "or"d (PS 758) and fed to the veto of the PS 755. More elaborate triggers may be required, depending on the answers to the above questions.

It's a good idea to let the different trigger segments share leadglass blocks at their borders to provide good efficiency for showers that straddle the border. The present version of fig 1 shows the R-HRS not sharing blocks because by my count this would require more sum8 modules than we have. However, Bogdan thinks we should insist on overlaps. So we'll need to agree on a strategy for segmentation and find enough modules to do it.

The logical signal from each segment is then "OR"d to make the final triggers: A "wide" electron and a "wide" pion, as well as a a "narrow" electron and a "narrow" pion, where the width refers to the discriminator path. We will probably also split the Cerenkov and Scintillator triggers into narrow and wide paths, but this is not shown in fig 2. These resulting triggers are sent to a scaler gated by helicity; this is our "production mode DAQ" : simply count electrons and pions for each helicity. In addition the triggers are sent to the trigger supervisor to trigger the HRS DAQ for a test mode to verify the correctness of the trigger at low rates.

The summing modules have a ribbon cable output that goes to an HRS Fastbus ADC via existing delay lines. Thus each leadglass block will be read in the standard HRS DAQ. In addition we'll read Cerenkov and Scintillator detectors in ADCs and TDCs as is customary. Therefore, a complete event analysis is possible at low rates for diagnosis of the trigger.

TABLE I: **Trigger Modules for PVDIS including Spares**

Item	Units Needed	On Hand	To Purchase	Cost Ea.	Line Cost
FADC (8 chan/unit)	10	2	8	5k$	40k$
Sum8 (RCS summers)	42	45	0		0
L428 fanout	6	6	0	unavail.	0
PS706 discrim.	5	5	0	1.5k$	0
PS758 "or"	8	8	0	1.5k$	0
PS757 "or"	2	7	0	1.5k$	0
PS755 "and"	16	5	11	1.5k$	17k$
scalers	5	3	2	4k$	8k$
NIM crates	4	4	0	3k$	0
VME crates	2	2	0	4k$	0
VME cpu	2	2	0	5k$	0
TOTAL TO BUY				→	**65** k$

Each sum of leadglass blocks goes to a FADC. We may also send the sum of one segment of leadglass to a FADC and the analog Cerenkov sum (not shown in the figure). This information will help us evaluate the pileup corrections at high rates. However, in this scheme the FADC is *not* the "production mode DAQ". It just plays an auxiliary role of evaluating rate effects. Not many channels are needed, and commercial FADCs already on the market should suffice, though there may be good reasons for preferring the JLab FADC if it is available on time. The only thing that could force us to use the FADCs for production DAQ would be if the scaler DAQ is proved not to work. We will be able to find this out well in advance of the experiment in parasitic tests or in facility development.

Measuring the deadtime will be important because the correction to the asymmetry A_0 for deadtime δ is $A_0\ (1-\delta)$ and since the goal is to measure A_0 to 1% the deadtime must be small and known to $\ll$1%. The three schemes we are considering to measure deadtime are:

- The "wide" and "narrow" discriminator paths described above give an indication of electronic deadtime.
- Some sum8 modules will have spare inputs, into which we may plug a pulser (EDTM pulser that already feeds the scintillators).
- An LED pulsing system for each block of leadglass. The driving pulse can also go to the Cerenkov and Scintillator circuits. The LED system is being implemented by Eugene Chudakov and collaborators.

To provide information about whether the scaler counting DAQ will work, we can build a small-scale prototype DAQ, see fig 3. The idea is to make a cheap and easy test. This can be deployed in the one of the HRS in Fall 2006, to be decided. The test setup processes a few channels near the middle of the acceptance. The logic circuit should decide if the particles are electrons or pions, and these results are counted in scalers. The analog signals are sent to a FADC as well. The logic decisions (electron/pion) can be sent to the HRS DAQ as a flag, to confirm the logic using HRS. As in the final design there are different discriminator widths to estimate deadtime. We may propose facility development running conditions which have significant pion/electron mix if it doesn't happen parasitically.

Much of the electronics can be taken from the RCS & G_N^E experiments, including crates. Some will need to be purchased. I show in table I a list of modules, indicating how many are needed, whether they are on-hand or not, and the cost (relevant if they're not on-hand). Of course, this table will change as we finalize the trigger scheme. Bogdan and Albert have agreed to work on a detailed layout. Finding space for the new electronics will be difficult. But once we buy and deploy all the electronics, it can be tested in situ parasitically well in advance of PVDIS.

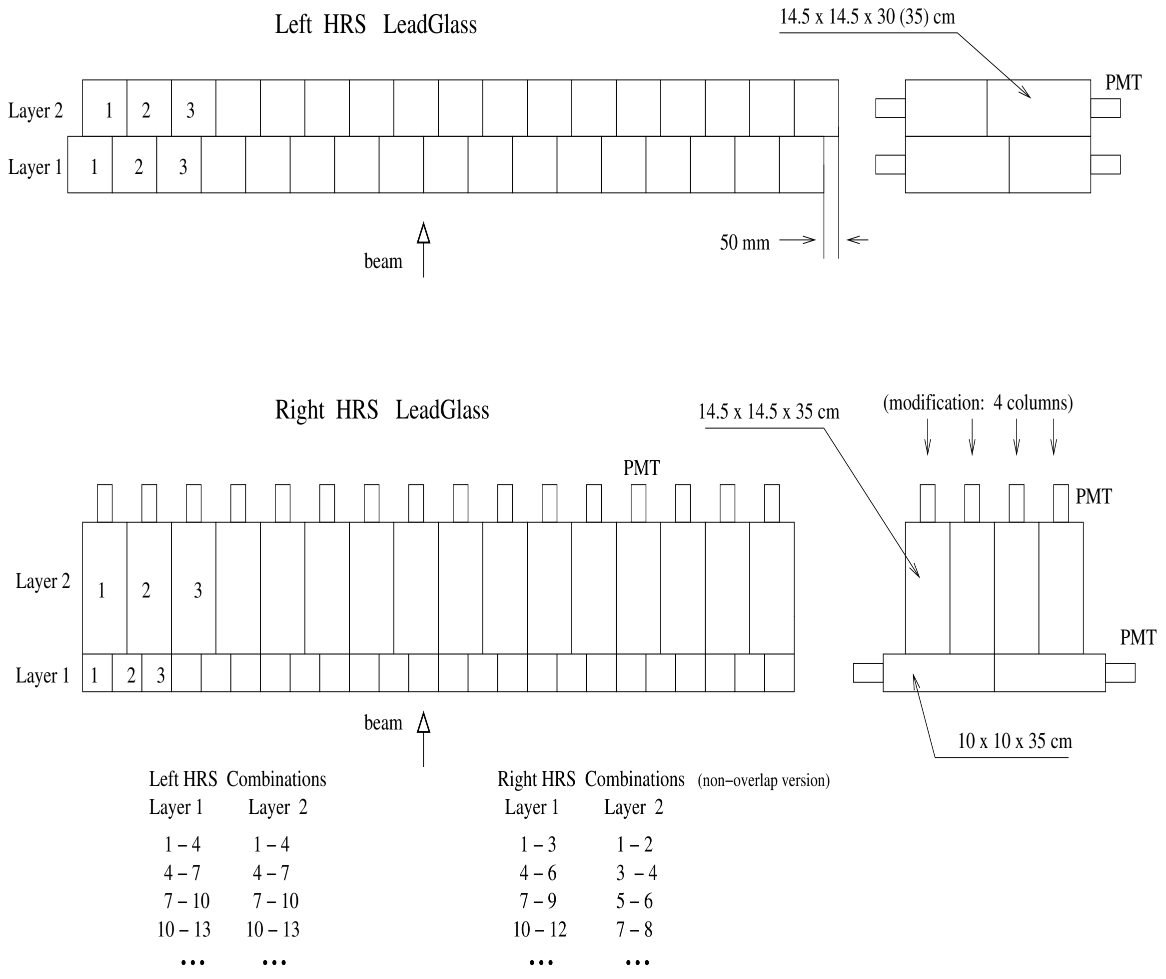

FIG. 1: Proposed layout of the leadglass detector for PVDIS. The scheme is unchanged on Left HRS. On Right HRS it is proposed to move the shower over by 7 cm and use only 4 columns.

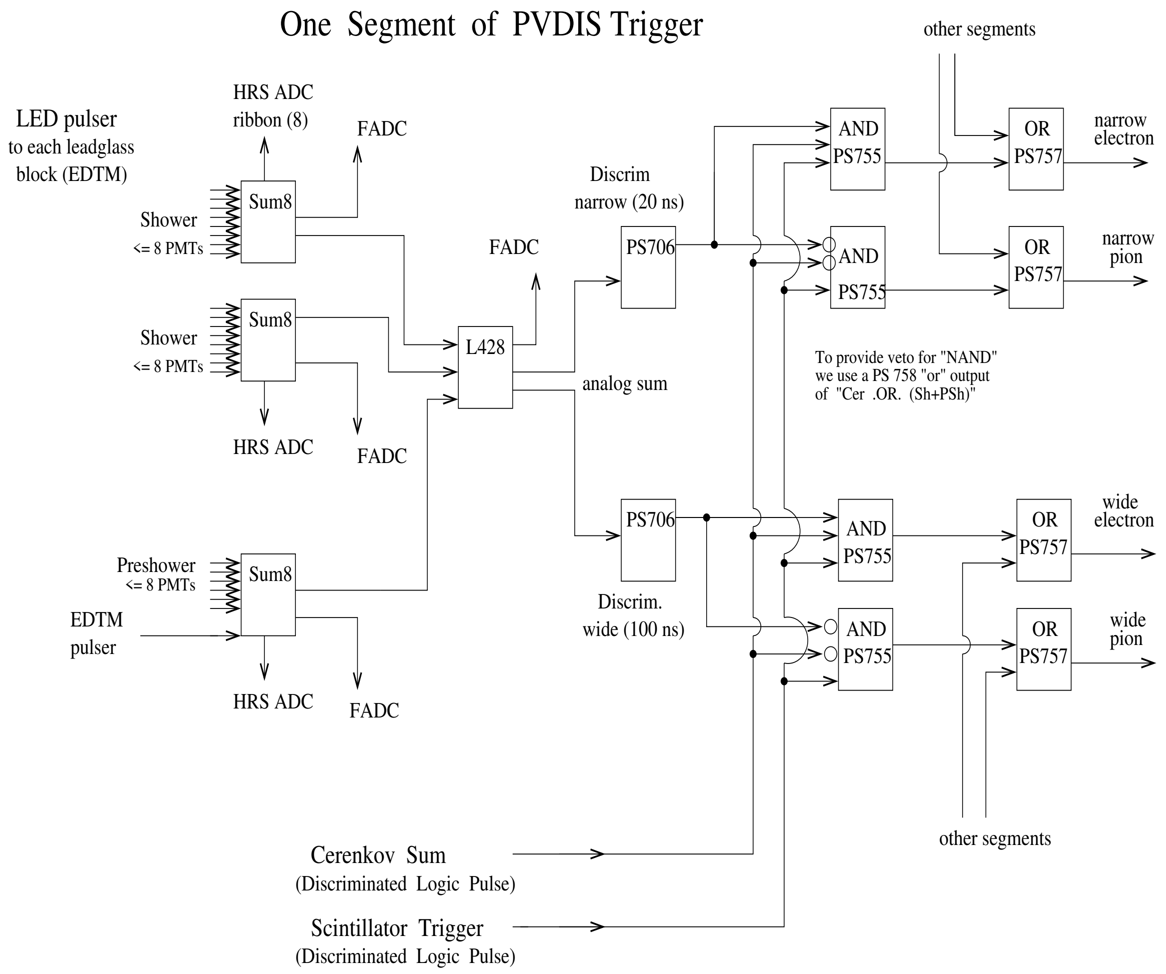

FIG. 2: Proposed trigger for PVDIS. The left portion shows one section of the trigger for either HRS. The 3 schemes for measuring deadtime is also shown and discussed in the text

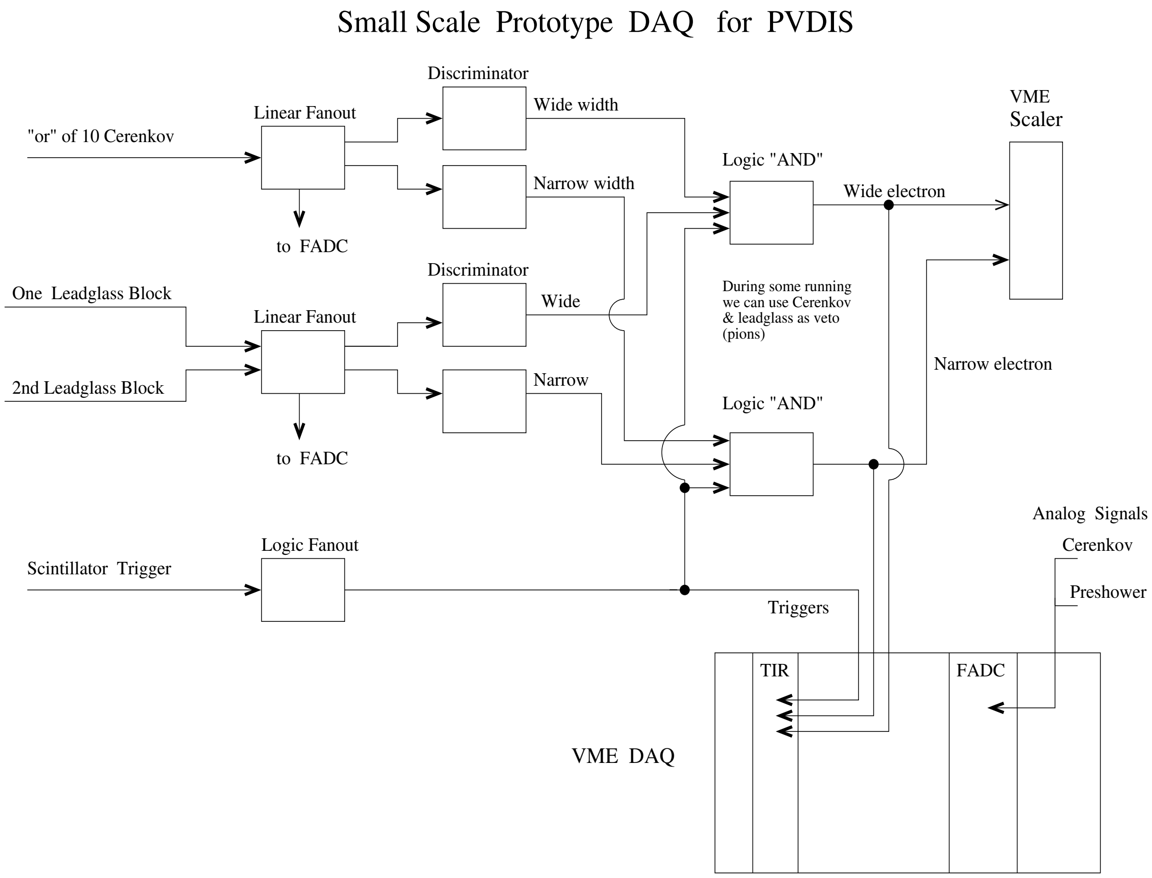

FIG. 3: Proposed test setup to test the feasibility of the scaler counting DAQ supplemented by FADCs.