PS/OP/NOTE 90-13
PS/AR/NOTE 90-12
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THE NEW CLEARING SYSTEM FOR THE AA

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1 INTRODUCTION:

To be able to understand better the ion-induced instability problems seen in the AA, a new ion-current monitoring system has been developed.

The new system consists of 44 "pico-ammeters", which supplies each clearing-electrode with its individual clearing-voltage, and on the same time measures the ion-current floating from the electrode. All currents, together with the transverse emittances and stack-intensity, are digitized and stored in a micro-processor (Smacc).

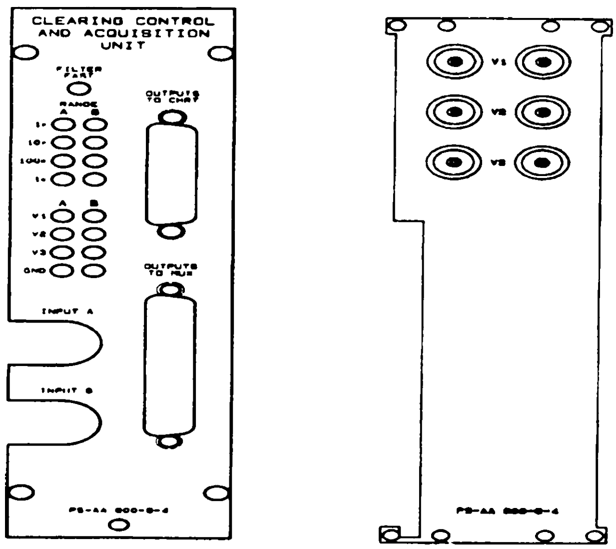
The system gives the possibility of both real-time-monitoring (last hour), and monitoring of the last 24 hours "statistics", of both clearing-currents, emittances stack intensity, and stacking-rate.

This note describes in general the system hardware, software and the operational aspect.

2 THE HARDWARE:

a)Pico-ammeter:

The "pico-ammeter module" (see fig. 1), consists of two individual pico-ammeters, with individual control and acquisition. They measure currents in four different ranges : 1pA, 10pA, 100pA and 1nA full scale with an accuracy within 1 % of full scale. Each pico-ammeter is auto-ranging and gives the range on a 2-bit form. A schematic diagram of one "channel" of the module is seen on fig. 2.



1a: Frontpanel　　　　1b: Backpanel

FIG 1. : Pico-ammeter module

On the backside of the module there are 3 high tension inputs, "V1", "V2" and "V3", which together with ground can be selected as clearing potential for the specific electrode, connected to the input of the pico-ammeter. The preamplifier, which is directly connected to the input terminals is measuring in a "floating mode ", meaning that the ion-currents are measured on the same potential as the clearing-electrode. In other words it is the preamplifier that supplies the tension, which is on the electrode.

Due to the high tension on the input terminal, care must be taken to avoid leakage currents in any cable between the electrode and the pico-ammeter. To deal with this, all connections on the input side are triaxial. An example of a triaxial configuration is seen on fig 3.

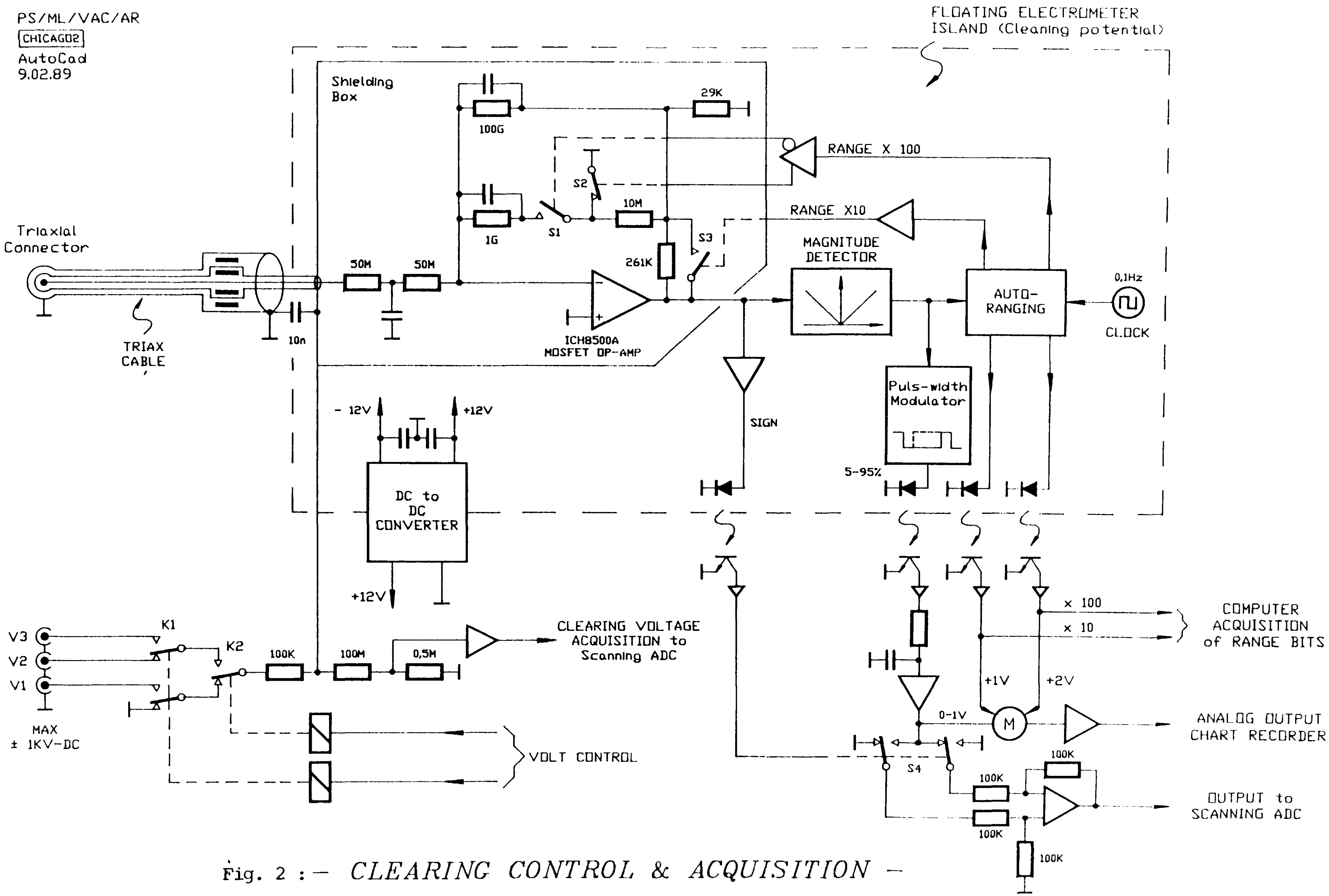


Fig. 2 :— *CLEARING CONTROL & ACQUISITION* —

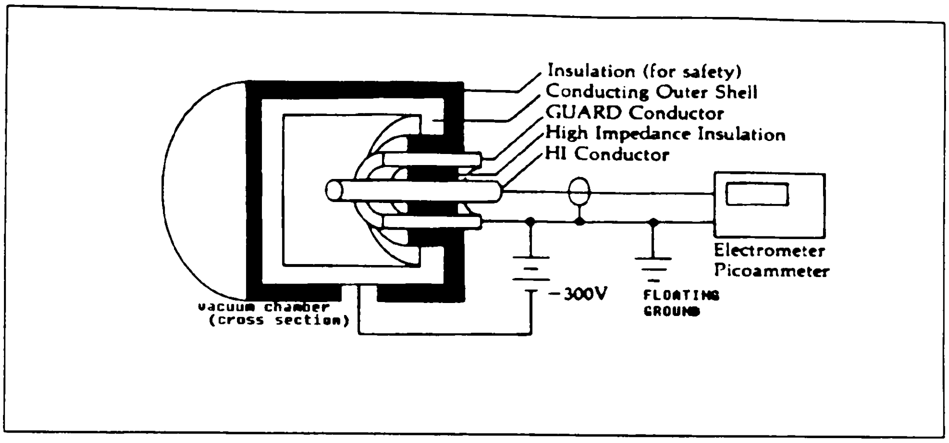


FIG. 3: Guarding high voltage sources.

The guard conductor is on the same potential as the input pin (floating ground), and the only voltage difference between the input pins will be the offset voltage of the input amplifier. The leakage in the cable, feedthrough, and connectors are therefore reduced by 5-6 orders of magnitude. The outer screen must be on "real ground" for safety.

The pico-ammeters (cca) are mounted in 4 cim-crates (see fig 4) around the ring (see fig. 6) each one containing 6 modules = 12 pico-ammeters, together with 1 single-transceiver for range acquisition and voltage control.

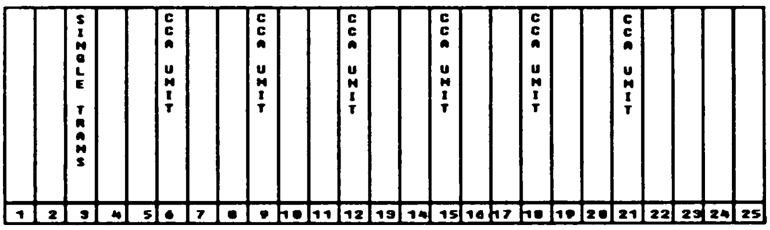


FIG. 4 CIM-CRATE

Each pico-ammeter has two analog outputs, one for chart recorder (semi-logarithmic), and one for computer acquisition (camac modules). Allchart-recorder outputs are "picked up" in an analog bus, and transferred to a J-010 in the ACR, where they are accessible on a patch panel (see fig 6). Here are also located the 3 (2 for the moment) Hewlett Packard High Tension power supplies that generates the clearing voltages "V1", "V2" and "V3". The analog-signals for computer acquisition are, on a similar way transferred to camac- crate #50, located beside the ACR (eguipment room).

ATTENTION: Due to security reasons the 3 cables connected to the high tension power supplies MUST be connected to ground during shutdowns.

A special box equipped with ground connectors and a pad-lock is located just below the power supplies. When re-connecting the cables to the power supplies, it is important to connect V1 (left) to powercable (red) nb: 241791and V2 (right) to cable nb: 214792, to assure correct operation of the voltage control.

b) Camac :

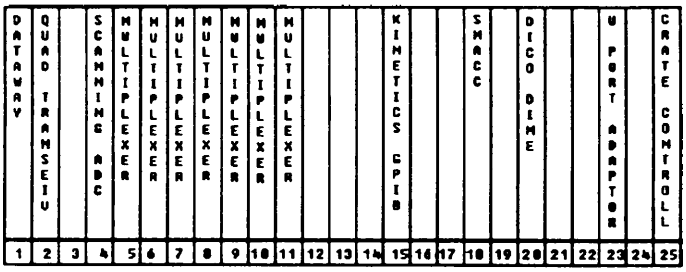


FIG.5:CAMAC CRATE 50,LOOP 2

All ion-currents and the 2 transverse emittances are acquired by one scanning-ADC", together with 7 multiplexers.

One "quad-transceiver", together with the 4 single-transceivers, are used for voltage control plus range acquisition.

The " Kinetics GPIB " module is used by the "stacking statistics program", running in parallel with "ion-current measurement program". It reads the AA-beam transformer.

The SMACC contains all the software modules for real-time acquisition, and for interfaces with the AA-Nord.

c) Emittances :

The real-time measurement of the transverse emittances is acquiring data from 2 HP spectrum-analyzers located in the ACR Ra J-021. Each spectrum-analyzer is tuned to a specific sideband giving, via a filter, an output proportional to the emittance. These 2 outputs are read by the scanning ADC, and via a calibration (done by the operator) displayed on the screen as Pi-mm.mrad, see fig 11. It is important that the 2 spectrum-analyzers are correct tuned, drift can occur and therefore an adjustment must be done, but this is rather rare.

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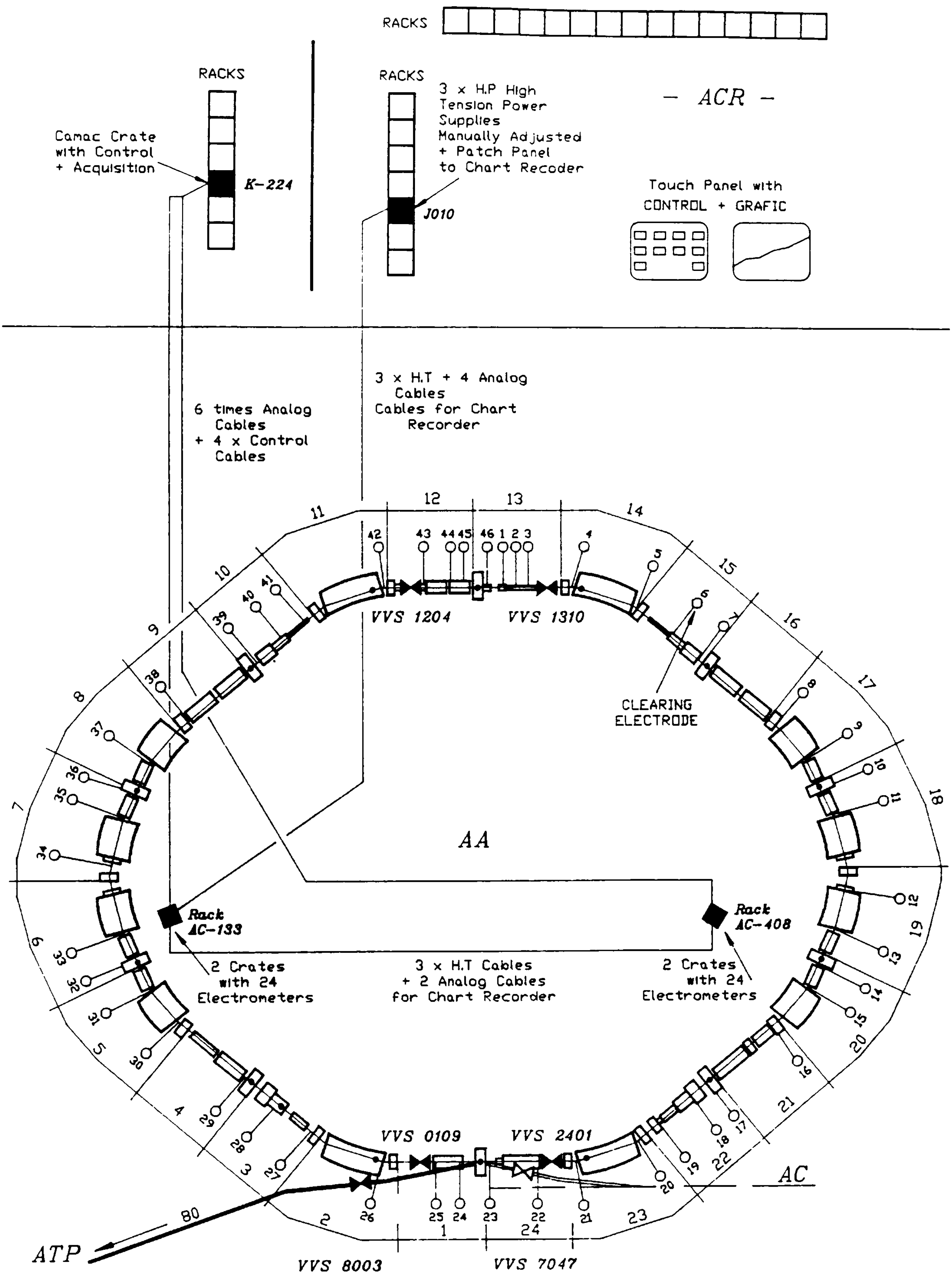
Fig. 6 :— *AA CLEARING SYSTEM* —



3 THE SOFTWARE :

The software which is running on the SMACC is developed on the Vax Priam Ultrix-system, and is written in Pascal. It consists of 2 major modules: "Stacking statistics" and "Read currents"

The "Stacking statistics" program acquires the AA-beam current transformer , and the AC injection transformers, 9012 9053 (not yet), and generates an image of stacking performance (see fig. 17 and 18), including " stacking rate/ shot " and "stacking rate / hour ". It also gives injection efficiency (not yet), if this is selected.

The " read currents " program generates an image of up to 4 different ion-currents plus the 2 transverse emittances (see fig 17). The emittances are measured by acquiring the total power in horizontal and vertical sidebands by means of the fixed tuned spectrum analyzers mentioned earlier with 100Khz bandwidth, and normalising with the stack intensity. It is also possible to select an image of all the different clearing voltages around the ring. These potentials are shown in a histogram in the bottom right corner of the screen. A futher possibility is to deselect the ion-current measurements, leaving only the emittances, displayed with a better resolution (see fig. 18).

Due to lack of space on the monitor, it was not possible to have both injection-transformers and clearing-voltages displayed at the same time. A software control has been installed to switch between these 2 images in the lower right corner of the monitor, (see fig 17 and 18).

To control the monitor and clearing voltages, some communication software has been developed as well, using the AA-touch panel as interface and "remote procedure calls" for data transfer.

If by any reason the program stops a reload (restart) can be done, on the AA touch panel under Trunc select "Controls", "Reload Smacc" and enter 2 (Smacc 2) on the Newburry terminal.

4 OPERATION :

Control of display and clearing voltages, can be done on an AAC-console, enter under "VACUUM"; "AA-VACUUM", and then "NEW-CLEARING", the page seen on fig. 7 occurs.

"VOLT CONTROL" : If this button is pressed, the choice between "single electrode" control, or "all electrodes" (see fig 8) is optained.

"SINGLE ELECTRODE" : The number of the electrode wanted to be controlled (see fig 9) should be entered. Values between 1 and 48 is accepted. If eg. 14 is entered, select between "V1", "V2", "V3" and "GND" (see fig 10). When this is done the appropriate electrode will be set to the selected potential. Note V3 is not yet installed.

"ALL ELECTRODES" : The same as above, but here all electrodes will be set to the selected clearing voltage.

"DISP CONTROL": This call a program that permits to control the real time display (see fig 11).

"Trace 1", "Trace 2", "Trace 3", "Trace 4": As mentioned before, the system gives the possibility to survey up to 4 different clearing electrode currents at the time, trace 1 to trace 4. If eg. "Trace 1" is pressed, fig. 9 will be displayed. Here the number of the electrode that one wants to observe, must be entered, if "0" is entered the trace is disabled.

"CALIBRATE EMITTANCES": Gives the possibility to enter the transverse emittances on the Newbury terminal.

"TOGGLE-BEAM-TRA / CL-VOLT": Will shift the display from monitoring "Injection transformers" (no data yet) to monitoring of 'Clearing voltages" around the ring, (see fig. 17, 18)

"CHANGE CLEARING SWEEPTIME": See fig. 12. For different modes of operation, stacking, machine development, etc., it is possible to change the speed of the clearing current acquisition. There is a choice of 4 different sweeptimes : "6 min" = 1 measurement each second; "12 min" = each 2. second; "60 min"= each 10. second; "120 min" = each 20. second. When the sweeptime is changed, all traces are erased, and monitoring restarts from the beginning.

"TOGGLE CLEARING CURRENTS / ONLY EMITTANCES : Gives the possibility to deselect ion currents on the display. The transverse emittances are then displayed with a much better resolution (fig. 18).

"CLEARING STATISTICS": Due to lack of memory space it is not possible to store 24 hours of data on the SMACC. Therefore a program, running on the SMACC, has been developed to calculate average values for each minute independent of the sweeptime. The average values are stored in an array which is readable by the AA-NORD computer. On the Nord a "scheduled program", reads this buffer each 15. minute and stores the data on hard disk for 24 hours. If "clearing statistics" is pressed, fig. 13 is displayed.

"PLOT LAST 24 HOURS": Will plot the last 24 hours of clearing-currents, emittances and stack intensity. This plot gives a resolution of "1 pixel per 3 minute" on the timebase.

"PLOT LAST 8 HOURS": Same as above, but with a timebase resolution of "1 pixel per minute".

"PLOT -16 HOURS - -8 HOURS" : Same as above but with different time-interval.

"PLOT -24 HOURS - -16 HOURS" : Same as above but with different time-interval.

After one of the above buttons is pressed fig. 14 occurs. After selection of the clearing currents wanted to be observed, a plot of the 3 currents, together with stack-intensity and transverse emittances, occurs on the color monitor (see fig. 15). It is also possible to select a plot of "only" emittances, stack-intensity and stacking-rate. An example of this plot is seen on fig. 16.

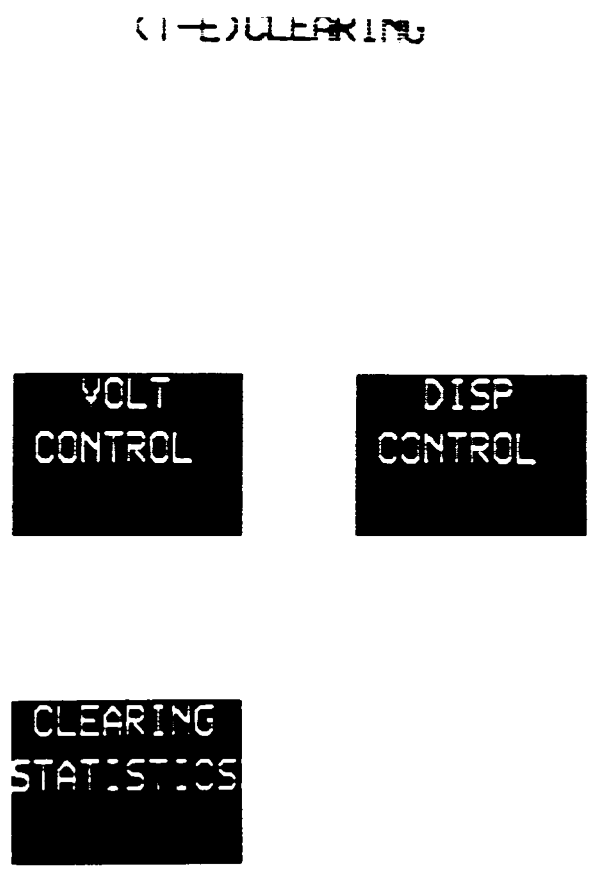


Fig. 7 Vacuum "AA-Vacuum" - "New clearing"

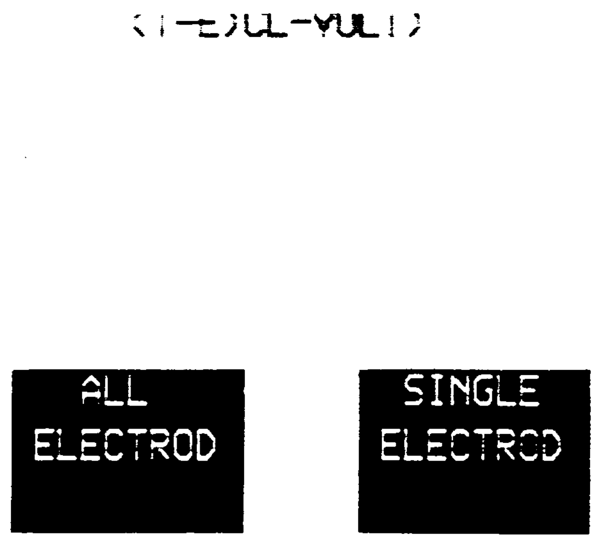


Fig. 8 : This page appears after pushing "voltage control"

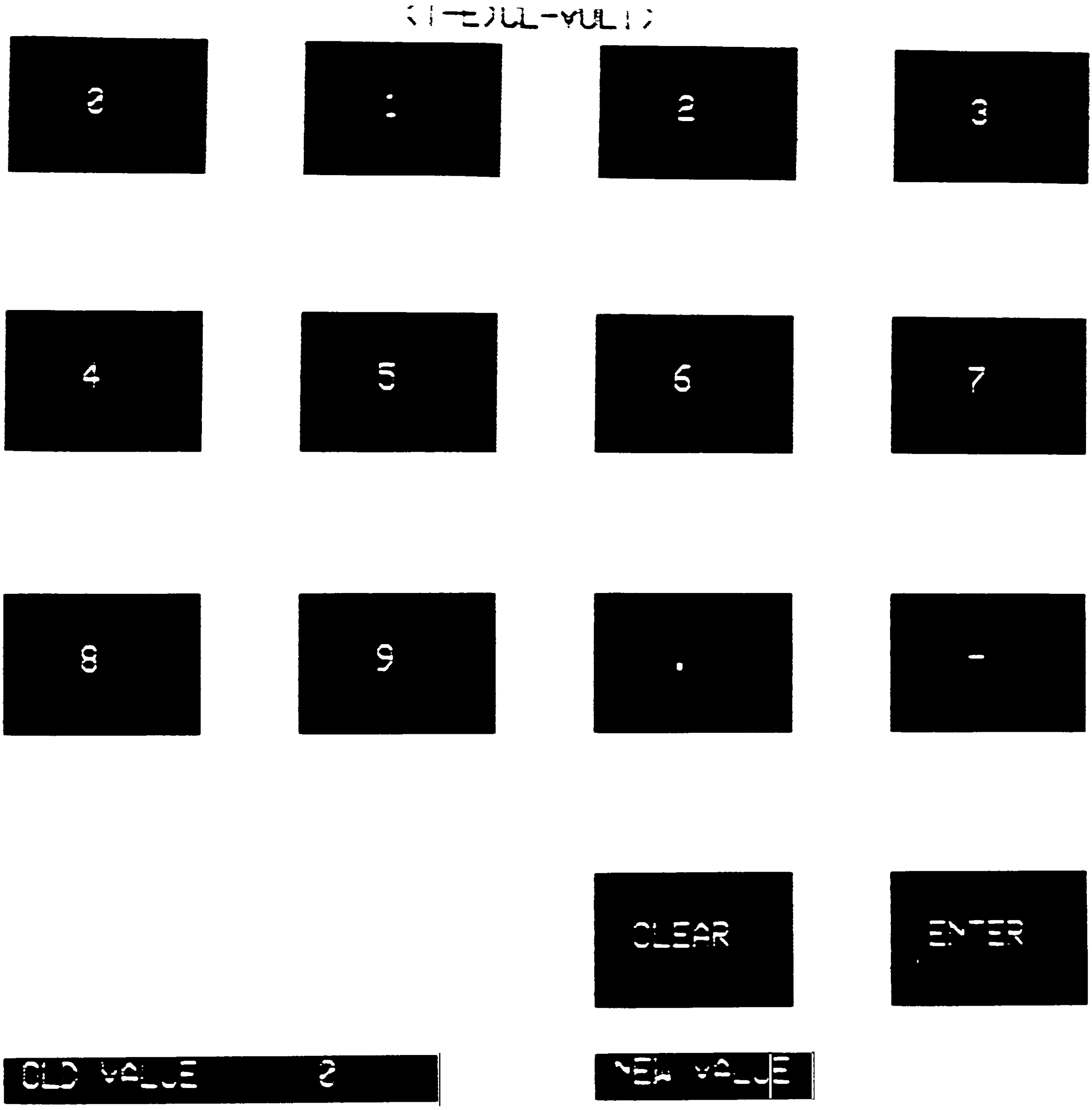


Fig. 9 : This page appears after pushing "single electrod" On Fig. 8, or after pushing i.e. "Trace 1" on Fig. 11.

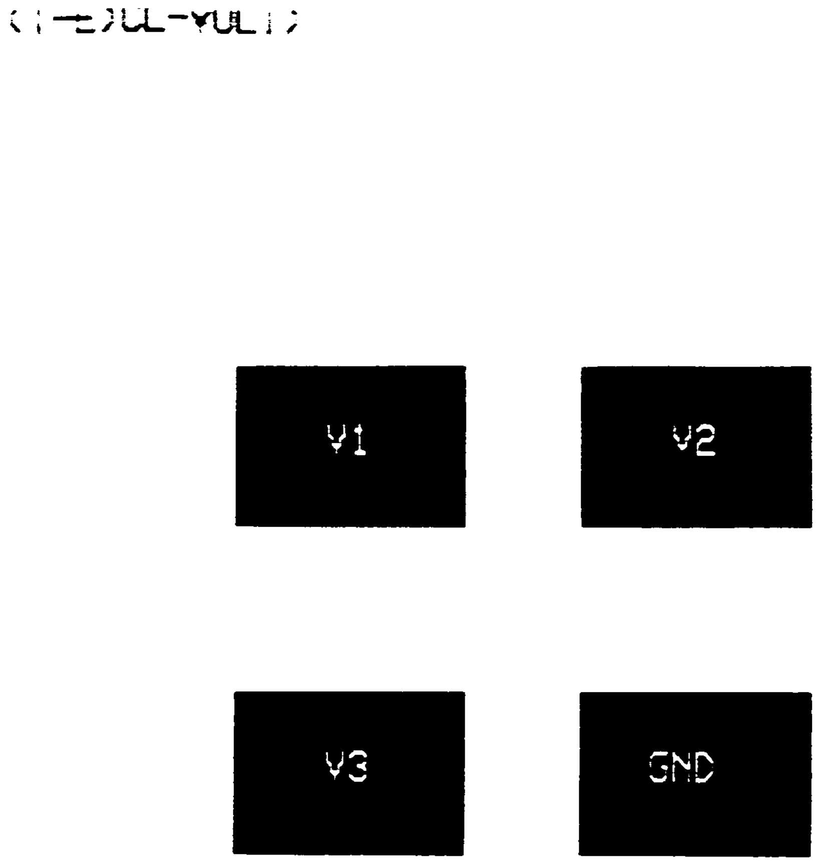


Fig. 10 : This page appears after either pushing "all electrodes" or entering the number of electrode under "single electrode"

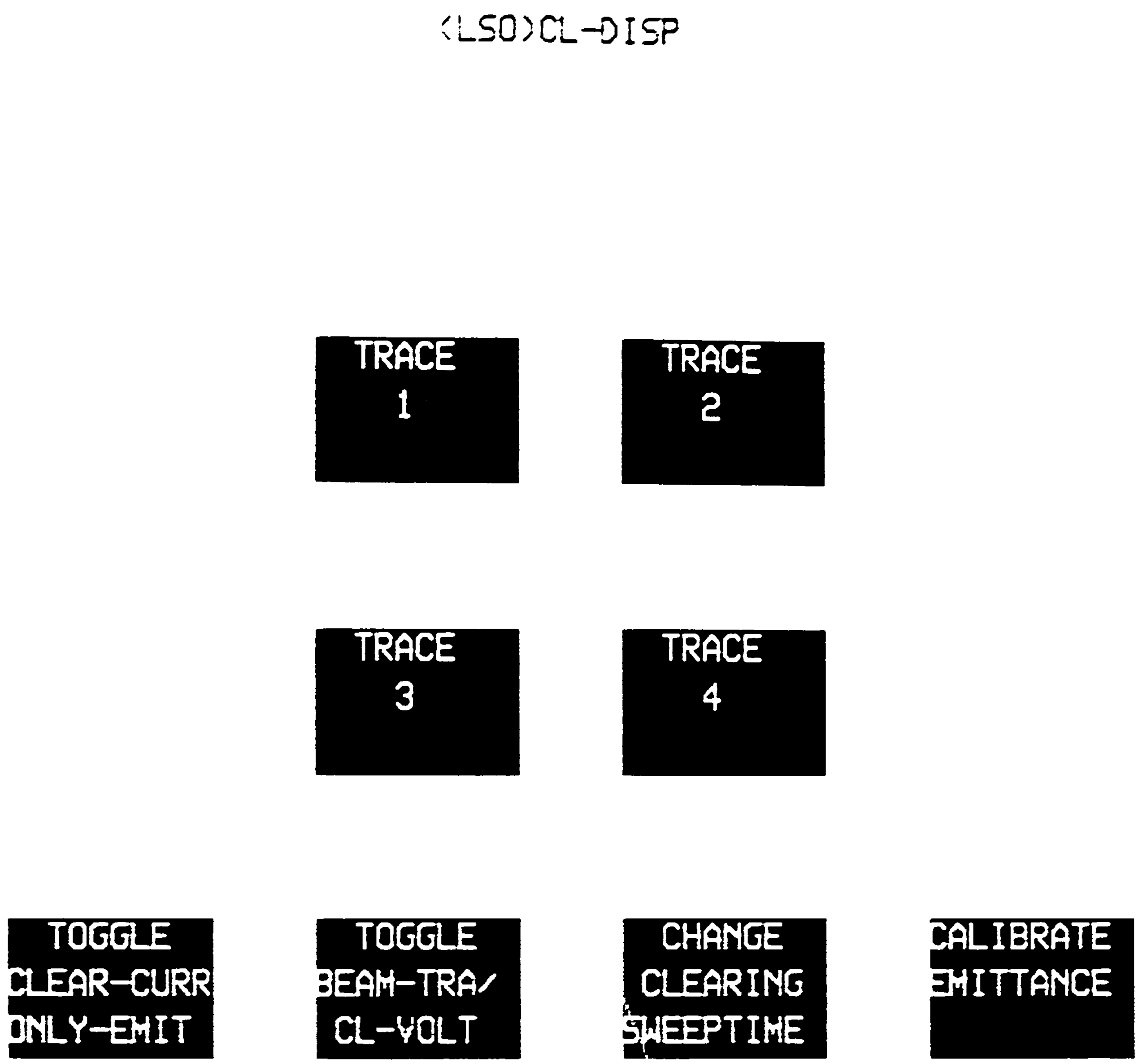


Fig. 11: This page appears pushing "disp-control" on Figure 7.

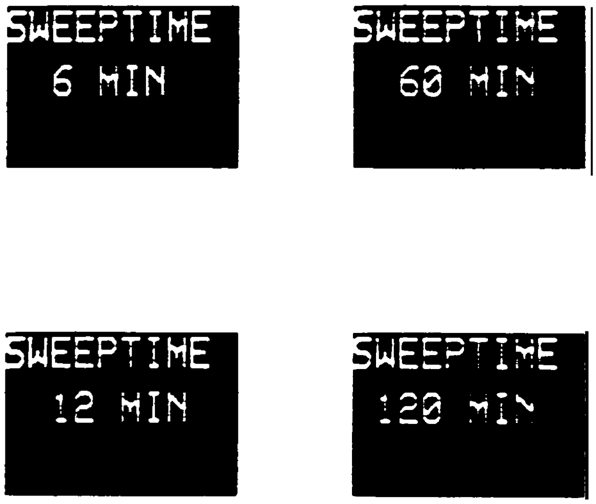


Fig. 12 : This page appears after pushing "change clearing sweeptime"

<LSO>CL-HIST

PLOT
LAST
24 HOURS

PLOT
LAST
8 HOURS

PLOT
-16 HOURS-
-8 HOURS

PLOT
-24 HOURS-
-16 HOURS

Fig. 13 : This page appears pushing "clearing statistics" on Fig. 7.

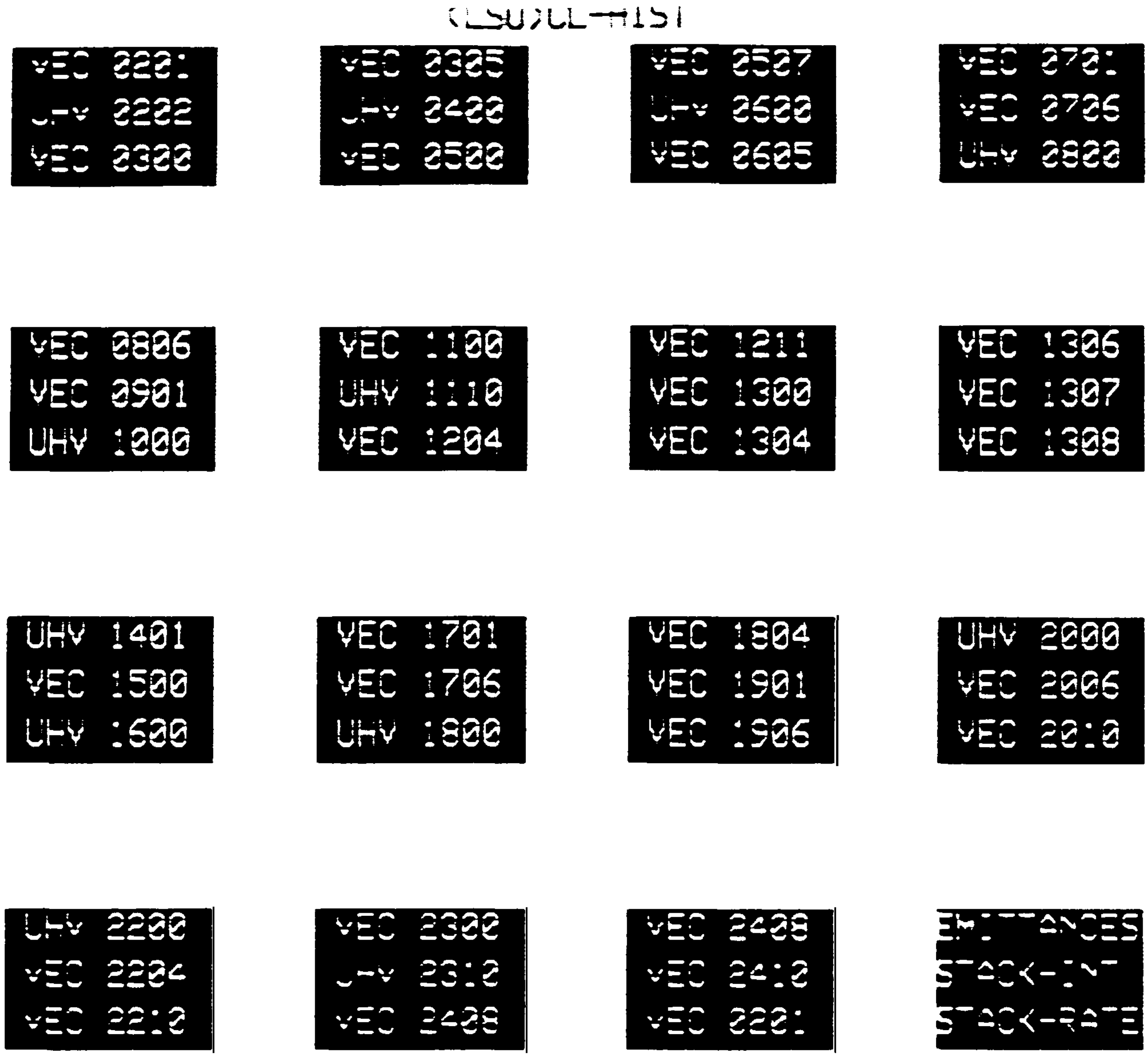


Fig. 14 : This page appears after pushing one of the buttons seen on Fig. 13

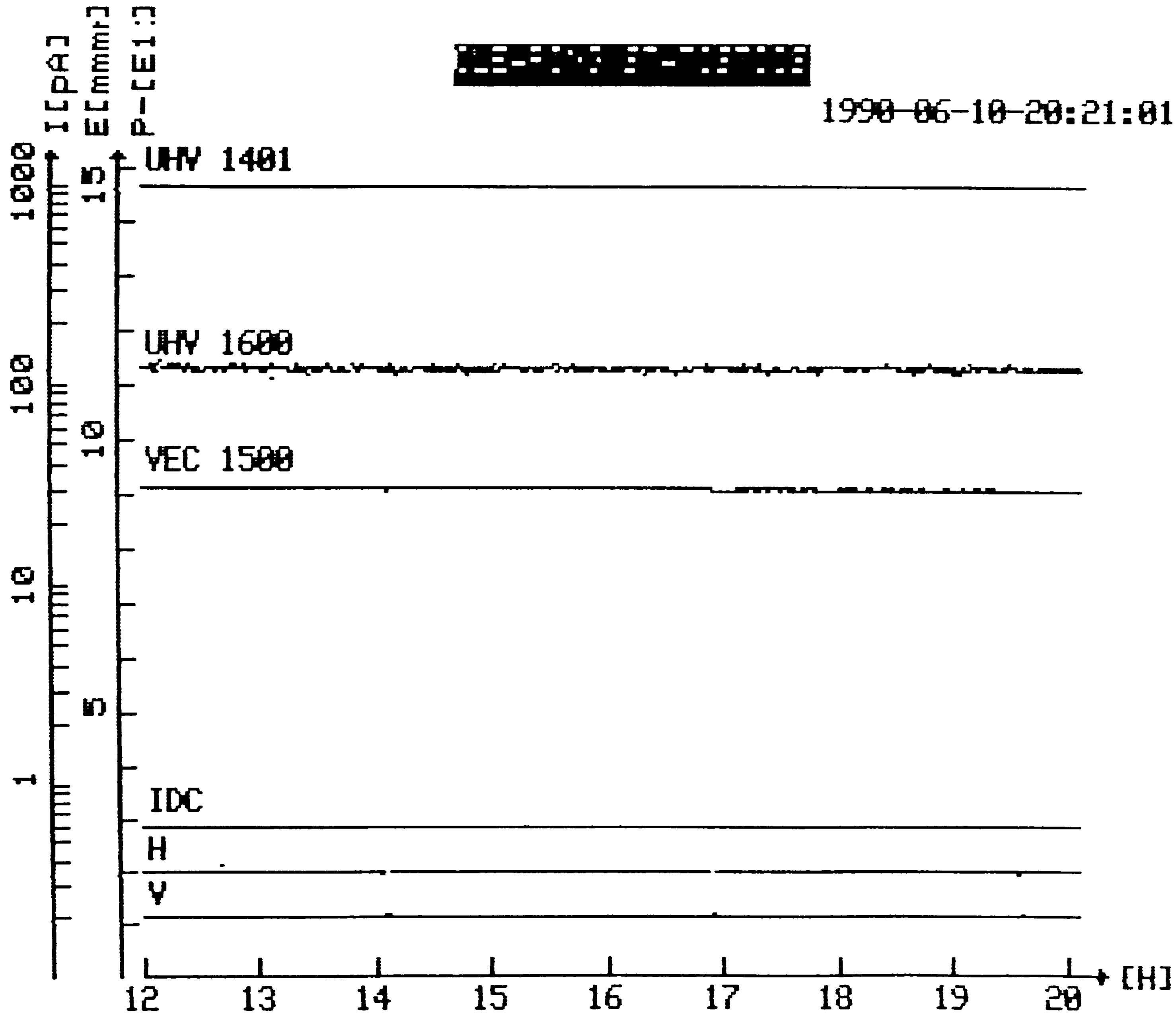


Fig. 15 : This plot appears on the color screen when pushing one of the clearing electrode buttons on Fig. 14.

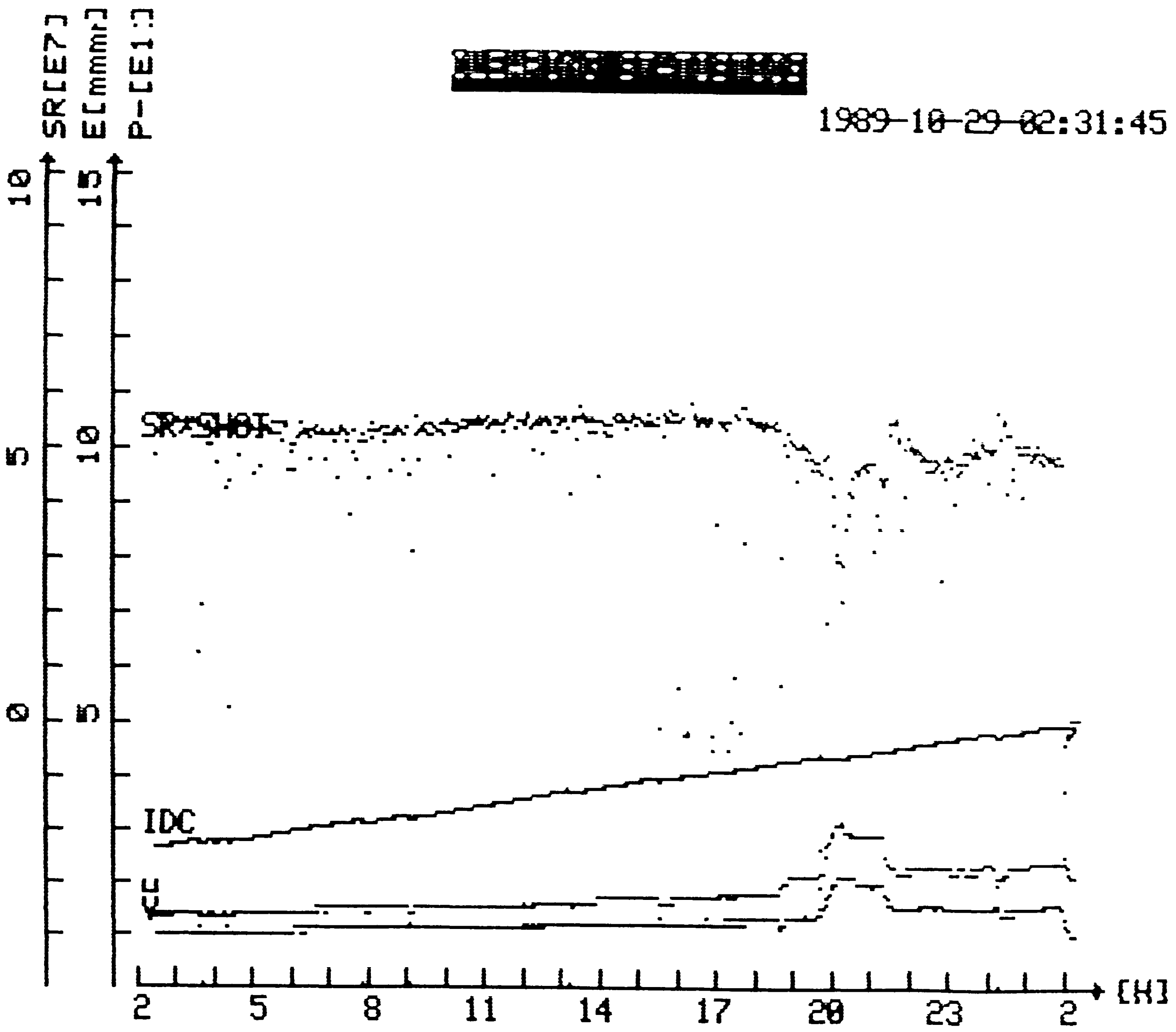


Fig. 16 : This plot appears on the color screen after pushing the "emittances - stack Inj - Stack rate" button, on Fig. 14.

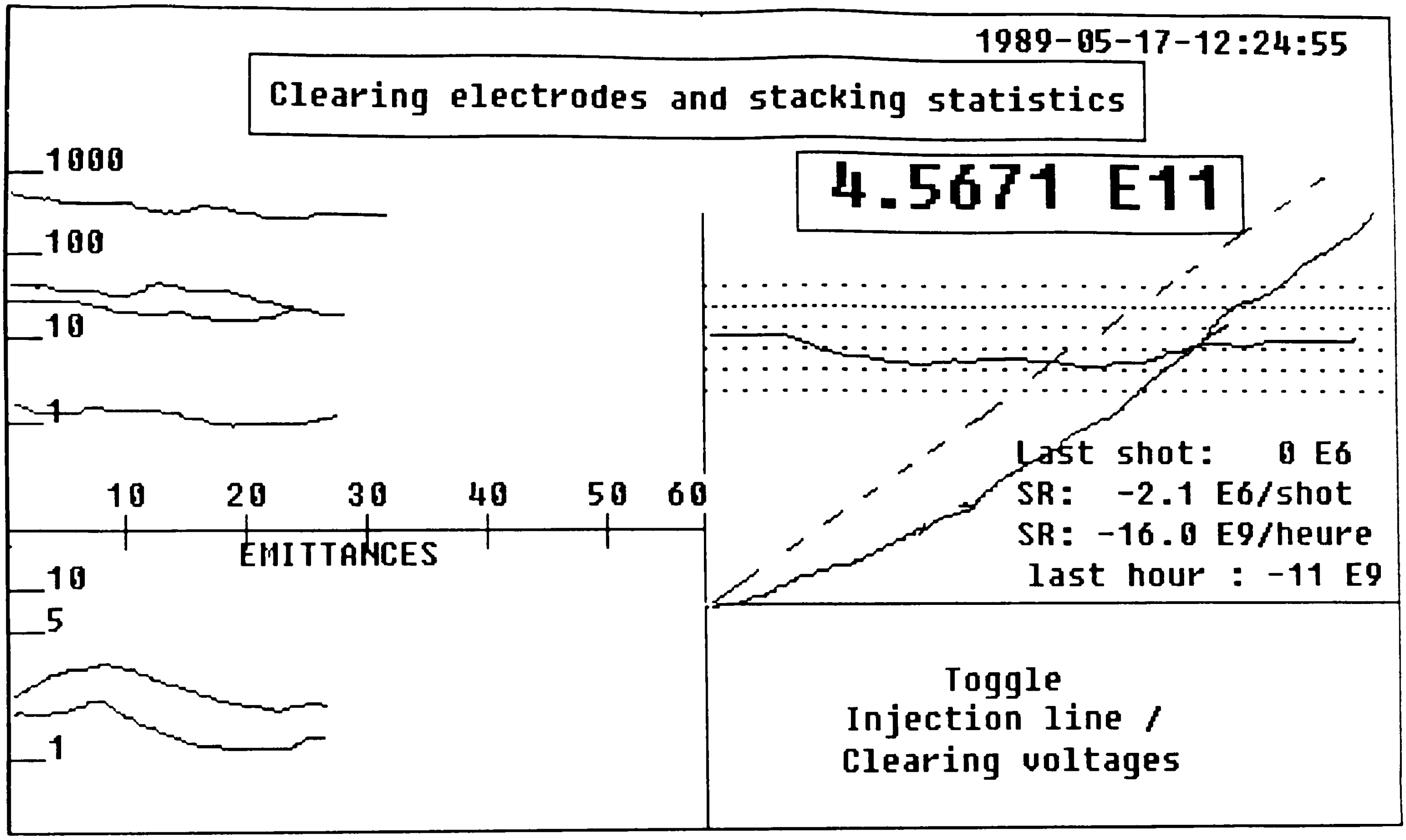


Fig. 17 : Real time display with stacking statistics, ion currents, emittances and clearing voltages/injection transformers.

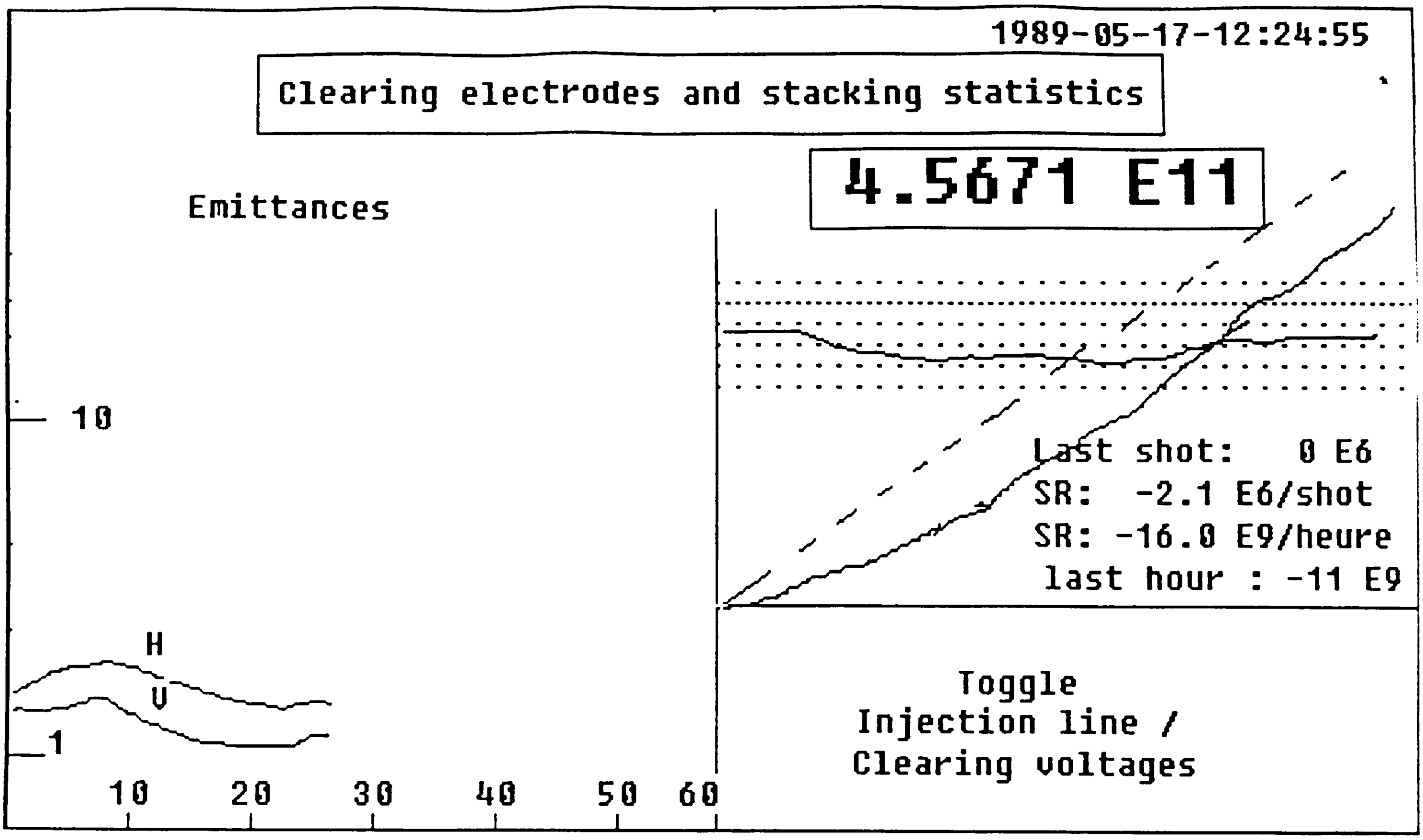


Fig. 18 : Real time display with ion currents deselected, leaving the left part of the screen for the emittance measurements.

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