Experiments and measurements taken between 14.07. and 05.10.2003

(please look also in the sketchbook)

For the measurements 1- 5 a CVI stepping motor was used to move the light source across the PMT. Furthermore for these experiments the setup was as follows: A plug with soldered LEMO-cables were connected to the pins at the PMT. From there the LEMO cables went out of the light tight box into a fast amplifier (amplification ~ 200x). The next device was a delay for 63.5 ns. That was caused by the choice to use a trigger for the measurements (the dynode signal in all cases). After getting a signal from the dynode there was a time window from 1 ?ms? to collect all the signals from the channels for one event. For the dynode signal a discriminator was used to cut off noise. After the delay track the signals of the channel were plugged into an ADC for readout.
In all cases a blue LED was used as a light source, focussed through a microscope (focus = 30 microns) with currents as mentioned in the experiments. High voltage for the PMT was U = -1000V.

1. Shape and structure of the M64 PMT

description: The first important information of the PMT was to get to know the structure with the aim to create a coordinate system to put the light source precisely at certain positions.

accomplishment: Eight points were measured at the outer shape of the PMT, eight points at the outer border of the effective area and eight points at the first inner wires, i.e. between the rows of tubes 1 & 2 in x and y direction. Afterwards also four points between rows of tubes 2 & 3 (= channels rows 1 & 2) were measured. Points were measured by looking through the microscope and guessing a certain position in the middle of the view field, i.e.mistakes in positions supposed to be +\- 10 steps, except the last four points (+\- 3 steps).

date:18.07.2003
program used: c:\home\korpar\cvi\premik\scan.prj

files for analysis:---

results: See also at sketchbook. One step of the stepping motor (also called pixel) has the length of 12.68 microns. The outer rows of tubes are smaller in y direction (calculated x = 225 steps, y = 152 steps) than the inner tubes and the outer but one were a little bit smaller as well. Thats why the points (2,2), (2,14) and (14,2) (explanation follows) were chosen for creating the coordinate system.

explanation coordinate system: The coordinate system is based on the wires easily seen through the microscope which divides the PMT into tubes (not channels). According to the motion of the stepping motor the origin was set in the "upper left corner while looking into the box". That means x and y axes expand from 0 to 16. Positions are always given by these coordinates (with X and Y as dummies in the following text), because the coordinates created by the stepping motor are changing whenever the PMT was lifted or the like.

2.Cross talk measurement (8 channels)

description: To have an estimate of how much of cross talk appeares for that PMT, the light source was focussed on a certain posion and all eight channels are measured.

Measurement a) and b) are identically except of the chosen treshold of the discriminator.

accomplishment: Because only one connector was available, a maximum of eight channel could be measured. The channels between $12 < X < 16$ & $0 < Y < 8$ were chosen (For drawings please have a look in the sketchbook). Because of noise the light source was set at a certain position and then the motor was switched off. The measured points are:

a) & b) a "cross" in channel 6 (when start to count with 1) to get the dependence of the position within a channel ,

i.e. (12,3),(12.5,3),(13,2),(13,2.5),(13,3),(13,3.5),(13,4),(13.5,3),(14,3)

and b) in the middle of each ogf the eight channels to get the dependence of the channels, i.e. (13,1),(13,5),(13,7),(15,1),(15,3),(15,5),(15,7).

date: a) 21.-22.07.2003, b) 23.-25.07.2003
program used: C:\home\stefan\pcivme_camac\tdc.prj
time measured: 2000s
current LED: 0.5 mA
focus: photo cathode
data stored: D:\data\scaler\morz\measurement1\talk X-Y_file0.hbook = a)
D:\data\scaler\morz\measurement2\tlk X-Y_file0.hbook = b)

files used for analysis: a) not analysed
b) crtX-Y.kumac for getting the histograms of the signals
sigX-Y.eps pictures of the histograms
cutX-Y.kumac to decide where to cut off the background at the light source signal
cutX-Y.eps pictures of that cut off
ctX-Y.kumac to get the histograms of cross talk while cutting the noise at the light source channel
ctX-Y.eps histograms of crosstalk

results: see ctX-Y.eps

problems: - measurement a) was stopped because of a to high treshold
- channel 5 was not working properly, the signal could still be seen, but with a lower amplification (ca. factor 4 smaller), problem later discovered as a bad connection at the connector or the soldered cables

3. Cross talk measurement (9 channels)

description: Because there was a second connector available, it was now possible to measure 16 channels at once = one quarter of the PMT, otherwise analogous to the previous experiment

accomplishment: One row of the new connector was wrong soldered (signal and ground was mixed up), so in fact only 12 channels were available. The used ADC has only 12 plugs with plug 11 not well working, thats why a square of 9 channels (plus dynode signal) was chosen to be measured: $10 < x < 16$ and $2 < y < 8$. The light source was located at 3 different kind of positions: a) two "crosses" on channel 5 (for the mapping please look in the sketchbook),

i.e. (12,4),(12,5),(12,6),(12.5,4.5),(12.5,5),(12.5,5.5),(13,4),(13,4.5),(13,5),(13,5.5),(13,6),(13.5,4.5),(13.5,5),(13.5,5.5),(14,4),(14,5),(14,6),

b) the middle of each of the nine channels to get a cross talk dependence of the channels, i.e. (11,3),(11,5),(11,7),(13,3),(13,7),(15,3),(15,5),(15,7),
and c) in the middle of each other channel, i.e. every combination of odd numbers you can imagine.

date: 29.-31.07.2003
program used: C:\home\stefan\pcivme_camac\tdc.prj
time measured: 1000s
current LED: 0.5 mA
focus: photo cathode
data stored: D:\data\scaler\morz\measurement3\sqrX-Y_file0.hbook

files used for analysis: a) not analised
b) crtX-Y.kumac for getting the histograms of the signals
crtX-Y.eps pictures of the histograms
cutX-Y.kumac to decide where to cut off the background at the light source signal
cutX-Y.eps pictures of that cut off
crtX-Ya.kumac to get the histograms of signals while cutting the noise at the light source channel
crtX-Ya.eps pictures of the histograms
ctX-Y.kumac to get the histograms of cross talk while cutting the noise at the light source channel
ctX-Y.eps histograms of crosstalk
ctX-Ya.kumac to get the histograms of cross talk while cutting the noise at the light source channel and on the other signals as well
ctX-Ya.eps histograms of real estimate of crosstalk with numbers of entries
legoX-Y.eps lego plot of ctX-Ya.eps
boxX-Y.eps box plot of ctX-Ya.eps
c) not analysed

results: see ctX-Ya.eps, cross talk less than 1% after cutting off background on all channels

problems: none

4. Intermezzo Multi Channel Plate

description: As another possible detector a Multi Channel Plate was discussed, so it was though to continue the measurements with that device. And the first measurement is of course the characteristics.

accomplishment: The Multi Channel Plate has a maximum high voltage of U = 2400 V. So a characteristic from 1900 < U < 2400 V in steps of 20 V was measured. The measurement was a beginning estimate, so only the count rate was used. The position of the light source was also located by count rate and channel 4 was used to count.

date: 04.08.2003
current LED: 5.0 mA
data stored: sketch book

problem: the characteristic doesn't reach the plateau, its still increasing at U = 2400 V

results: Thoughts about a pre-amplifier came up, but the decision to continue with the PMT was made.

5. Incident Angle dependence of cross talk

description: It is expected that you have the largest amount of cross talk, appearing as "shadows" from the channel where the light source is located, when the incoming photon are not perpendicular to the surface of the detector. That's why a measurement with an incident angle was created .

accomplishment: The microscope, i.e. the incoming light, was set in an angle of 40 degrees to the perpendicular position. Because it is difficult to see the focus through the microscope in that case, the location of the light source was detected by the count rates of channels. In the first measurement a) the points where the light source was located, was insufficent, so the measurement was repeated b). In total nine points of light source were measured (from the middle of channel 5 to the middle of channel 2): Point 1 = (13,3), (13.25,3),(13.5,3),(13.75,3),(14,3),(14.25,3),(14.5,3),(14.75,3), Point 9 = (15,3)

date:
program used: C:\home\stefan\pcivme_camac\tdc.prj
time measured: 1000s
current LED: 0.5 mA
focus: roughly on the photo cathode
data stored: D:\data\scaler\morz\measurement4\angleP_file0.hbook = a)
D:\data\scaler\morz\measurement4\anglP_file0.hbook = b)
(where P stand for point number)

files used for analysis: a) & b) not analised

results: ---

problems: finding the absolut position at the PMT, locate light source by count rate not sufficient

6. 2D table

The CVI stepping motor produces too much noise, so another possibility to move the light source was thought about: the Unidrive 6000 2D table. The software for controlling the table was complitely inplemented in the appearance (i.e. panel and the like) of the CVI motor, i.e. while using the control panel, there is no difference to recognise. The steps of the 2D table are set to micrometers and the usable range is from -50,000 < axes 1 & 2 < 50,000, i.e. 10 cm each axes. The table has to be reset everytime it is initialised (usually automaticly done by the written programs) and because of the still produced noise, the table switches off the motor after changing position. Even then there is some noise, so the better isolated LEMO-cables have to be used. Due to the larger height of the table the micoscope had to be set a little bit higher, so in the following measurement of angular dependence the position of the light source changes (and has to be readjusted) with the incident angle.

position control panel: C:\home\stefan\unidrive0\unidrive6000.prj

In all the following measurements the Unidrive 2D table was used for moving the PMT.
(Warning: In the program of the position control panel the function for absolut and relative position are mixed up, but at the panel as well. So everything works properly!)

7. Incident angle dependence scan

description: With the 2D table the structure of measurements changed. Now it was possible to control the steps by programs, so software controlled long time measurements became available. Also the second connector was working properly, i.e. 16 channels = one quarter of the PMT could measured.

accomplishment: The microscope was adjusted by screws with the incident angle of 0, 15, 30 and 45 degrees to the perpendicular position. The setup was as follows: The signals, coming from the channels of the connector, are amplified (factor ~ 200x) by a fast amplifier. Afterwards the signal, i.e. hits, are counted by a camac. That means only count rate and no pulse height distribition are measured.

The PMT was moved with a step size of 100 microns/step and all 16 was measured.

date: 28.08.-02.09.2003
program used: C:\home\andrejg\H8500 surfscan\surf.prj
time measured: 300 ms/point, 12h 21min in total
current LED: 5.0 mA
focus: photo cathode
data stored: D:\data\scaler\morz\measurement5\data\scan_100mu_3.dat = 0 degrees
angle_15_wi.dat =15 degrees
angle_30_wi_2.dat =30 degrees
angle_45_wi.dat =45 degrees

files used for analysis: D:\data\scaler\morz\measurement5\data_kumac\
get.kumac software setup
anglech3.kumac comparison of the crosstalk due to the incident angle by the example of channel 3
anglech3lin.eps 2D histograms of that with a linear color scale in z direction
anglech3log.eps 2D histograms of that with a logarithmic color scale in z direction
(examples for channel 10 and 16 exist as well)

results: as expected, the relative crosstalk increases with the incident angle of the light and appeares as "shadows"

problems: a lot of breakdowns or slowdowns of the computer, so some tries were needed before a measurement succeded

8.Dependence of focus of the light source

description: Because in the previous measurement the structure of the PMT couldn't be seen as clearly as expected, it was decided to determine the dependance of the "resolution" of the PMT from the focus. The focus of the light source at the PMT is roughly 30 microns in diameter.

accomplishment: For that purpose six almost equidistant points of focus were chosen, where point 2 was focused on the dynodes (abbr.: dy), point 3 on the photo cathode (abbr.: wi) and point 6 on the suurface of the glass (abbr.: gl). The other points are the points in between. A region crossing 4 channels was measured to have the possiblity of having a stepsize of 50 microns (each axes) a) measurement within reasonable time. A

second measurement was started with a stepsize of 200 microns in x- and 25 microns in y- direction b)

date: 25.08.-28.08.2003
program used: C:\home\andrejg\H8500 surfscan\surf.prj
time measured: 300 ms/point,
current LED: 5.0 mA
focus: photo cathode
data stored: D:\data\scaler\morz\measurement5\data\focus_abbr_P.dat = a)
D:\data\scaler\morz\measurement5\data\strips_abbr_P.dat = b)
with abbr = abbreviation (example gl) and P number of point

files used for analysis:

results: In measurement a) no denpendance of the focus could be seen, so measurement b) with a smaller stepsize than the focus was intended. But even there the dependance of the focus couldn't be detected.

problems: a lot of breakdowns or slowdowns of the computer, so some tries were needed before a measurement succeded

9. Uniformity and cross talk scan

description: Only 16 channels can be detected at once. But it is very important to know, whether the whole PMT work uniformly.

accomplishment: That's why a scan of all 16 channels was started and the two connectors where plugged in the four quarters of the PMT. The measurement hasn't finished yet.

date: 02.09.- 09.2003
program used: C:\home\andrejg\H8500 surfscan\surf.prj
time measured: 300 ms/point,
current LED: 5.0 mA
focus: photo cathode
data stored: D:\data\scaler\morz\measurement5\data\scan_100mu_3.dat (upper right part)
D:\data\scaler\morz\measurement5\data\100mu_lowleft_hv.dat (lower left part)

files used for analysis: ???

results: ???

problems: a lot of breakdowns or slowdowns of the computer, so some tries were needed before a measurement succeded