Test beam with the Focusing DIRC prototype

(Log book: #2)
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To remind ourselves, we use this diagram in the following tests:

1. Quartz Start counter #1 (1kHz PiLas internal trigger rate):
a) Single electron mode per pad 0; all attenuators in.
- **Amplifier gain**: 100x.
- 2.4kV on MCP-PMT.
- **PiLas at 1kHz**, internal trigger, power 25.0%.
- Notice a baseline wiggle from PiLas diode firing about ~80ns after the signal. This wiggle is large enough to fire a discriminator. At 1kHz this comes after the end of our TDC range.

b) Remove 2 Mylar attenuators.
c) Remove 1 Mylar attenuators.
d) Remove 1 Mylar attenuators.
e) Remove 1 Mylar attenuators.
f) Go back to 17a, but remove 1 Mylar attenuators.

Josef’s analysis:

- The timing resolution of pads 01 and 10 is always worse than for pad 00 and 11.
- Shape of peak is also unusual, in case of pad 01 resolution with light intensity is getting worse.
- All data were put together and divided into slices from 13 to 200 counts wide.
- ADC table correction was applied.
- Although the single electron resolution has improved, the multiphoton resolution is now worse.

Investigate the noise sources in the ESA beam counters:

1. **Quartz start counter, pad 0, HV off**
   - PiLas on internal trigger
   - Look at the input side of the ADC 6dB attenuator, i.e., this is what Disc in front of TDC sees!!
   - Vary PiLas frequency and various variables possibly influencing the noise performance

<table>
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<th>Narrower sigma – new data (100x amplification)</th>
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<tr>
<td>0.00</td>
<td>120.00</td>
<td>160.00</td>
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<td>50.00</td>
<td>110.00</td>
<td>150.00</td>
</tr>
<tr>
<td>100.00</td>
<td>100.00</td>
<td>140.00</td>
</tr>
<tr>
<td>150.00</td>
<td>90.00</td>
<td>130.00</td>
</tr>
<tr>
<td>200.00</td>
<td>80.00</td>
<td>120.00</td>
</tr>
<tr>
<td>250.00</td>
<td>70.00</td>
<td>110.00</td>
</tr>
<tr>
<td>300.00</td>
<td>60.00</td>
<td>100.00</td>
</tr>
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   - Not clear at present why there is no improvement. Possibly a different noise level in the two different runs? In the first run, we had the external 10Hz trigger, in the second run we have 1kHz internal trigger. The timing delays changed vastly. In theory, it should be better in the second run as the ration of average signal level and the threshold increased. Will look at the noise level next.
Every so often we are getting a “paging noise”
2ns/div, 2mV/div, 1kHz, lid closed
Wooden pedestal, power from original outlet, Trigger the scope with the PiLas trigger

2. Russian MCP-PMT, HV off
- PiLas on internal trigger
- Look at the signal before the splitter
- Wooden pedestal, power from original outlet

5ms/div, 2mV/div, 1kHz, lid closed
5ns/div, 2mV/div, 1kHz, lid open
Trigger with a line trigger
No periodic structure!

- Restore PiLas to a nominal situation (no wooden pedestal, AC from an original outlet)

5ns/div, 2mV/div, 1kHz, lid open
No periodic structure!

- It looks like that the Quartz counter does need more work to get rid of the noise.
- The Russian tube seems to be picking up less, at least on the scope. No 60Hz noise.

Summary:
There are three sources of the noise in this particular MCP-PMT counter, if one looks at a 2mV scale (remember that the Disc threshold is only 11mV):
1. PiLas laser diode switching current makes a baseline disturbance in the Quartz Start #1 counter. I did not see it in the Russian MCP. This noise depends on the PiLas rate. I think that is the origin of the rate mystery.
2. We do have a 60Hz noise unfortunately in the Quartz Start #1 counter. I did not see it in the Russian MCP.
3. Every so often we do have a "paging" noise in the Quartz Start #1 counter in addition. I did not see it in the Russian MCP.

2. Russian MCP-PMT (#1448) (1kHz PiLas internal trigger rate):  
a) Go back to 17a, but remove 2 Mylar attenuators.
- 2.8kV on the Russian MCP-PMT. It seems to be very noisy. Cannot see a single photons; must increase the light intensity to set the timing, and then go back to the single photon mode.
- PiLas at 25.0%.
- The tube was very noisy initially; next day, it seem to be much better.
- A probability to get a hit is ~2%.

2ns/div, 50mV/div

b) Remove 2 more Mylar attenuators.  
- A probability to get a hit is ~30%.  
2ns/div, 100mV/div

c) Remove 2 more Mylar attenuators.  
- A probability to get a hit is 100%.  
2ns/div, 200mV/div

(1kHz PiLas internal trigger rate)  
a) Adjust the variable fiber attenuator on the Russian MCP to get it into the single photoelectron mode. MCP in slot 6 is also in the single photoelectron mode.
- 2.9kV on the Russian MCP-PMT, 2.4kV on the Burle MCP-PMT
- PiLas at 40.0% - necessary to get a decent enough rate in the slot 6.
- Change the attenuator after the splitter from 6dB to 14dB. The upper threshold is higher.

Russian MCP, 1ns/div, 10mV/div  
Burle MCP, Slot #6, 2ns/div, 100mV/div

Slot 6, Rows 0 and 1, raw data only, 1kHz, internal PiLas trigger:
Slot 6, Rows 2 and 3, raw data only, 1kHz, internal PiLas trigger:

Slot 6, Rows 4 and 5, raw data only, 1kHz, internal PiLas trigger:
Slot 6, Rows 6 and 7, raw data only, 1kHz, internal PiLas trigger:

Map of hits and distribution of multiple hits per trigger per entire MCP-PMT:

Map of peak positions a) raw data, b) with substracted 50 cnt (1.25 ns) delay between start of each TDC module:
b) Increase the light intensity in the fiber for the Russian MCP to get it into the multi-photon mode by adjusting the variable attenuator.

4. Calibration of MCP-PMT in slot 5 (1kHz PiLas internal trigger):

- 2.4kV on the Burle MCP-PMT
- PiLas at 40.0% - keep the rate the same as in the previous run (still single photon mode).
- Russian MCP HV is off.
- Slot 5 MCP-PMT is connected to CFD #9 & #10, and Philips TDCs.
- PiLas has 40% power.

Folder: /u2/juhe/endstationA/single_photons/2005-02-24_single_electrons_on_slot5_1kHz/raw_data_view/raw_data_view
(testrun_20050324_1053_1000000,testrun_20050324_1337_1000000,testrun_20050324_1609_1000000,testrun_20050324_1903_1000000,testrun_20050324_2150_1000000,testrun_20050325_0023_1000000,testrun_20050325_0310_1000000,testrun_20050325_0531_1000000,testrun_20050325_0808_1000000).

Slot 5, Rows 0 and 1, raw data only, 1kHz, internal PiLas trigger:
Slot 5, Rows 2 and 3, raw data only, 1kHz, internal PiLas trigger:

Slot 5, Rows 4 and 5, raw data only, 1kHz, internal PiLas trigger:
Slot 5, Rows 6 and 7, raw data only, 1kHz, internal PiLas trigger:

Map of hits and distribution of multiple hits per trigger per entire MCP-PMT:

Map of peak positions a) raw data, b) with subtracted 50 cnt (1.25 ns) delay between start of each TDC module:
5. **Russian MCP-PMT (#1448) (1kHz PiLas internal trigger):**
- **2.9kV** on the MCP-PMT
- PiLas at 40.0% - keep the rate the same as in the previous run (still single photon mode).
- Add **6dB** to the upper threshold, making it total of **20dB**. This means that the lower threshold is ~11mV and the upper threshold is ~260mV.
- Measure a noise rate of 5-10 counts/1µsec.
- Add a 1pF capacitor to the Elantek amplifier input and pulse it with a NIM pulse (50 Ohm terminated), which is derived from the Philips TDC start discriminator. The timing is adjusted so that the calibration pulse appears ~7ns after the single photoelectron pulse:

![A pulse before the splitter:](image)

### Diagram:
- Single electron pulses
- 2ns/div, 100mV/div
- Calibration pulse

6. **Hunting the origin of the oscillation problems in MaPMT in slot #2:**
- **Amplifier group #2** (was for a long time in the scanning setup). It was the 2-nd group made.
- Slot #2 has Hamamatsu MaPMT (the 2-nd version), which needs little adaptor cards. This arrangement was working OK in the scanning setup some time ago.
- Nominal Elantec amplifier, gain of 140x.
- Power all amplifiers in these slots: 2, 5, and 6.

#### a) The oscillation propagates to the entire system (origin is in the slot #2):
- No power in CFDs. However, all amplifier cables connected to CFDs.

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<th>Configuration</th>
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<td>Amp 1</td>
<td>MCP-PMT in slot 5</td>
</tr>
<tr>
<td>6</td>
<td>Amp 49</td>
<td>MCP-PMT in slot 6</td>
</tr>
</tbody>
</table>

- Remove power from amplifiers in slot 2 -> MCP-PMTs in slots 5 & 6 stop oscillating.

#### b) It does not depend on CFDs being powered:
- Power CFDs: 3&4 (slot 2), 6 (slot 3), 7 (slot 4), 9&10 (slot 5), 11&12 (slot 6).

#### c) Power just one amplifier card #1 in slot #2 -> it does not oscillate.
d) Power amplifier card #1 + #4 in slot #2 -> it does not oscillate.
e) Power amplifier card #1 + #2 + #4 in slot #2 -> it does oscillate.
f) Power amplifier card #1 + #3 + #4 in slot #2 -> it does oscillate.
g) Remove amplifier card #2 from slot #2 and power it -> it does not oscillate.
h) Move cables at the amplifier #2 card end -> can trigger oscillation.
i) Touch the adaptor card on the amplifier card #2 -> can trigger oscillation.
j) At this point Gholam comes and notices that one LEMO cable does not have the ground connected – take it to his lab.
k) Could reproduce the effect by (a) touching the adaptor card or cable end.
l) After soldering the cable: could still trigger the oscillation by touching the adaptor card or by twisting the board a bit !?!!?
m) Suddenly the oscillation stopped and we could not reproduce it. There must be some sort of fault inside the board or another cold solder joint. Will take another spare card to ESA.

n) Go back to ESA and place a spare card into a position of the card #2: it does oscillate.
o) So far, I was not able to remove the problem.
p) Place the amplifiers from slot #2 on a MCP-PMT in slot #1: it does oscillate.
q) Remove amplifier card #3: I can cause an oscillation by playing with the cables.
r) Cannot cause an oscillation by removing the LEMO cable from a LEMO female by ~1mm.
s) Cannot cause an oscillation by just hanging the LEMO cables without the termination.
t) Take amplifier to Gholam’s lab. He finds that two had problems (one has a disoldered ground at the amplifier card end. The other one had several cold solders and broken LEMO ground at far end. However, even after all this was fixed, the amplifiers oscillate in slot #2. Take away the adaptor card away and place the amplifiers on MCP-PMT in slot #1. It works!! So, the conclusion is that the adaptor board causes the oscillation. However, only in ESA. In the scanning setup or in the trailer, it was OK. Therefore, there is enough hostile environment in ESA (SPEAR is running, etc.), which drives the amplifiers to edge of oscillation. Any fault brings it over the edge.
u) Gholam demonstrates to me in his lab that if there is a broken LEMO cable, where the ground is completely separated from the LEMO end, it is OK as long as the LEMO male is not connected to its LEMO female. If one plugs such a cable in, the amplifier starts oscillating. Therefore, it is better not to plug such a cable in and leave it hanging.

w) There are many possible examples (a broken trace, a bad LEMO cable, a cold solder, unshielded power cables, …)

- A final point: we are a few feet away from the SPEAR RF cavities.
7. Quartz Start counter #1 (1kHz PiLas internal trigger rate):

- **Amplifier gain**: 10x. Reduce the amplifier gain because we had better results with it.
- **The logic of this change**: a long time ago we actually have run with a similar condition (we actually had 14dB), and got a better timing resolution for larger number of photoelectrons. The logic of this change is that the PiLas pickup and a 60Hz noise get reduced for smaller amplification. The new setting will worsen single photoelectron resolution, but it should improve the multiphoton resolution, which is what we want.
- 2.4kV on MCP-PMT.
- PiLas at 1kHz, internal trigger, power 25.0%.
- The LeCroy amplifier has a –30mV DC offset (?!?!?) in front of the discriminator before TDC. Add a 1µF capacitor to remove it. This is a new change!!

a) ADC input (after 6dB att.)
2ns/div, 2mV/div

b) TDC input (after splitter)
2ns/div, 5mV/div

- **Josef estimates about 200 photoelectrons per single PiLas trigger**

File: /u2/juhe/endstationA/ resolution vs intensity/2005-04-01_startCnt1_4_att_removed compared to SEM (testrun_20050330_1739_1000000, testrun_20050330_2028_1000000, testrun_20050330_2303_1000000, testrun_20050331_0155_1000000, testrun_20050331_0433_1000000, testrun_20050331_0706_1000000).

Josef’s analysis

Pad 00, left: ADC Corrected TDC spectrum, middle: raw ADC-TDC dependency, right: table corrected ADC-TDC dependency:
Mean and median spectra of all TDC pads:

- Throw away the adaptor card needed for MaPMT in slot 2. It cause troubles. The system is still sensitive, but at the end I managed to keep it working. Close the box. Do a simple EMI shielding (place a copper tape around the box edges).
- All 20 amplifier cards powered – no oscillation !!!
- Start running MaPMT in slot 2 without the special adaptor board.
- HV at -0.8kV.
- PiLas remains at 25% power and 1kHz internal trigger.

8. Quartz Start counter #1 & Russian MCP:

- Change the setup into an external PiLas trigger operation with a 10Hz MCC trigger.
- Quartz start counter 1: amplifier gain: 10x, 6dB in front of ADC, -2.4kV.
- Russian MCP: 100x Elantek amplifier gain, two thresholds 20dB apart, -2.9kV
- Will need a PiLas laser alignment with a fiber because the intensity is rather low. Cannot see anything in the prototype right now.

Mikhail’s analysis:

Reconstructed time $T_0$ (based on TDC1 and TDC2) – single pe mode:

Reconstructed time vs. Diff = TDC1 – TDC2:
Reconstructed time vs. Diff = TDC1 – TDC2 (in color):

A new change in the Quartz Start and Russian MCP counters:

[Diagram of the test beam setup with labels and connections]
9. ESA Philips TDC and SLAC TAC/ADC timing:  
J.V., 4.6.2005
- PiLas taken from the scanning setup to check the timing resolution.
- 120Hz external trigger from MCC.
- Splitter does not seem to work any longer. Drive the prototype directly from its fiber.
- MCC timing signals:
  a) **JV-1** (AB01-8-9): \( t_0 – 300.0 \text{ ns} \)
  b) **JV-2** (AB01-8-10): \( t_0 + 25.2 \text{ ns} \) (was changed from \( t_0 + 84.0 \text{ ns} \)); step: 8.4 ns
  c) **Note from Mike Woods:** They are active on Beamcode 18, which runs at 120Hz on timeslots 2 and 5. They had a conditional modifier, ~ten_hertz deact, which effectively fired them only at a 10Hz subset of the 120Hz beamcode 18 rate. To increase the rate today to 120Hz, I just removed the conditional modifiers. To restore to 10Hz, the modifiers can be activated again. One needs a SCIP password to change it.
- JV-1 drives PiLas, ADC gate, Start counter common start TDC, Philips TDC, and RESET
- JV-2 drives Common Stop on SLAC TAC (can be adjusted independently).
- PiLas at 25%, External NIM trigger level set at –0.2V.
- MaPMT at –0.8kV (detector slot 3, CFD 5 & 6).
- Markers: (a) CFD 7, ch. 1, ADC 7, (b) Philips TDC CAMAC slot 14, ch. 1
- **Start taking the calibration data with MaPMT in Slot 3.**

a) **Philips TDC:**
Top: Common TDC Start,  
Bottom: marker (via CFD7,ch.1),  
5ns/div, 500mV/div  
Scope trigger: Common TDC Start,  
Signal: marker (via CFD7,ch.1),  
1ns/div, 200mV/div

Top: Common TDC Start, Bottom: MaPMT pulses, Slot 3, CFD 5, pad 2,  
10ns/div, 500mV/div
b) SLAC TDC:
Top: TAC Common STOP,
Bottom: marker (via CFD7,ch.1),
20ns/div, 500mV/div

Top: TAC Common STOP,
Bottom: MaPMT pulses, Slot 3, CFD 5, pad 2,
20ns/div, 500mV/div

Top: TAC Common STOP,
Bottom: CFD RESET,
50ns/div, 500mV/div

Top: TAC Common STOP,
Bottom: CFD RESET,
20µs/div, 200mV/div

Top: ADC Stop,
Bottom: CFD RESET,
20µs/div, 200mV/div

- Slot 3 data with a new PiLas pulser, 120Hz rate from MCC.

(testrun_20050406_1733_1000000.dat, testrun_20050407_0945_1000000.dat)
10a. Russian MCP (S/N 1448):
- PiLas taken from the scanning setup to check the timing resolution.
- PiLas at 25% power.
- 120Hz external trigger from MCC.
- The fiber Splitter is out. Drive the MCP directly from its fiber. Use variable fiber attenuator.
- 2.9kV on the MCP.
- **20dB on the upper threshold**, i.e., the two thresholds are: \( V_1 \sim 11 \) and \( V_2 \sim 110 \text{mV} \).
- Pulse pictures taken at a point before the splitter:

![Pulse pictures taken at a point before the splitter.](image)

- It is clear that the extrapolation towards zero is (a) non-linear and (b) some pulses appear to be very complex in the very beginning, some appear to have undershoot.

Mikhail’s analysis:

**Reconstructed time** \( T_0 \) (based on TDC1 and TDC2) – single pe mode:

![Reconstructed time vs. Diff = TDC1 – TDC2](image)

**Reconstructed time vs. Diff = TDC1 – TDC2 (in color):**

![Reconstructed time vs. Diff = TDC1 – TDC2 (in color)](image)
10a. Russian MCP (S/N 1448):
- **Add 6dB to upper threshold** (total is 26dB), i.e., the two thresholds are: \( V_1 \sim 11 \) and \( V_2 \sim 220\text{mV} \).
- Add a calibration pulse again (~30ns after the single pe pulse from MCP).
- All else is the same as in previous case.

**Mikhail’s analysis:**

Reconstructed time \( T_0 \) (based on TDC1 and TDC2) – single pe mode:

Reconstructed time vs. Diff = TDC1 – TDC2:

Reconstructed time vs. Diff = TDC1 – TDC2 (in color):

The single pe peak (the 1-st one), the calibration peak (the 2-nd one), the noise level in between the two pulses, and a stability of the calibration peak:
11. **Slot 3 with Philips TDC:**
- MCC external trigger at 120Hz.
- 0.8kV on MaPMT in slot 3.
- All HV voltages on all detectors and LV on CFDs are running.

(testrun_20050412_1705_1000000.dat.gz, testrun_20050412_1924_1000000.dat.gz, testrun_20050412_2144_1000000.dat.gz,
testrun_20050413_0003_1000000.dat.gz, testrun_20050413_0223_1000000.dat.gz, testrun_20050413_0443_1000000.dat.gz,
testrun_20050413_0703_1000000.dat.gz, testrun_20050413_0922_1000000.dat)

12. **Slots 2, 3, and 5:**
- MCC external trigger at 120Hz.
- Slot 3 is connected also to Philips TDC.
- 0.8kV on MaPMT in slot 2.
- 0.8kV on MaPMT in slot 3.
- 2.4kV on MCP-PMT in slot 5.
- Slot 4 MCP-PMT is powered, but not read out.

- Slot 2, Pad 63, Calibration signal – looking for a possible late signal ~15 ns after a prompt signal.
  See no sign of the base line wiggles from PiLas:

5ns/div, 100mV/div

13. **Russian MCP (S/N 1448):**
- MCC external trigger at 120Hz.
- Single pe’ mode.
- 2.9kV on MCP-PMT.
- Use old Gholam CFD with 50mV threshold.
- Keep 10x10 amplification using Elantek amplifiers, add 12dB + 10x Philips amplifier.
- Get rid of the splitter – this gives a factor of 2x.
14. **Russian MCP (S/N 1448):**
- MCC external trigger at 120Hz.
- Single pe mode.
- **2.9kV on MCP-PMT.**
- Go back to the splitter.
- Keep 10x10 amplification using Elantek amplifiers + 6dB + 10x Philips amplifier.

15. **Russian MCP (S/N 1448):**
- MCC external trigger at 120Hz.
- Single pe mode.
- **2.7kV on MCP-PMT.**
- Keep 10x10 amplification using Elantek amplifiers +12dB+10x Philips amplifier

16. **Russian MCP (S/N 1448):**
- Find a sign of HV breakdown; it goes away below 2.4kV!!!!
- MCC external trigger at 120Hz.
- Single pe mode.
- **2.4kV on MCP-PMT.**
- Keep 10x10 amplification using Elantek amplifiers + 12dB + 10x Philips amplifier.
- Use splitter.
- **Reduce 26dB to 12dB in the upper threshold to take into account smaller pulses.**
Distribution of pads, which are read out by the Philips TDC:

**Cherenkov Ring Image in Detector plane**

- Each blue block represents a group of four pads, which are connected to Philips TDC (64 ch.).

**A view from the amplifier side:**

**Burle MCP-PMT in slot 4:**

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**Burle MCP-PMT in slot 5:**

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**Burle MCP-PMT in slot 6:**

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**Numbering in the scanning setup:**

![Image of scanning setup]
### Philips TDC connections:

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<th>CFD number</th>
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17. **Slots 2, 3, 4, 5 and 6, plus the Quartz Start counter:**

- MCC external trigger at 120Hz.
- Channels are connected to Philips TDC according to pattern above.
- SLAC ADCs are still off.
- 0.8kV on MaPMT in slots 2 & 3.
- 2.4kV on MCP-PMTs in slots 4 & 5 & 6.
- 2.4 kV on Quartz MCP-PMT.
- 2.4 kV on Russian MCP-PMT. However, it appears to be sick. Only calibration pulse is OK.
- Add 64ns to the ADC gate in Camac crate 2. Its width is 100ns (see a diagram on previous page).

2ns/div, 100mV/div, Slot 2, ch.17

2ns/div, 100mV/div, Slot 3, ch.17

2ns/div, 100mV/div, Slot 4, ch.17

2ns/div, 100mV/div, Slot 5, ch.17, lower rate

2ns/div, 100mV/div, Slot 6, ch.17, very low rate
17. Slots 2, 3, 4, 5 and 6, plus the Quartz Start counter:  
- MCC external trigger changed to 10Hz.
- Channels are connected to Philips TDC according to pattern above.
- SLAC ADCs are still off.
- 0.8kV on MaPMT in slots 2 & 3.
- 2.4kV on MCP-PMTs in slots 4 & 5 & 6.
- 2.4 kV on Quartz MCP-PMT.
- 2.3 kV on large scintillator MCP-PMT (however, no fiber is attached).
- Russian MCP-PMT is off (being repaired).
- Quantacon on large scintillator is on (however, no fiber is attached).
- Lead glass block PMT is on (however, no fiber is attached).

5/6/2005 9:14   Phillips TDC over all slots, 20% to 60%
File:/u2/juhe/endstationA/single_photons/2005-05-02_All_slots_with_Phillips_TDC/001_all_slots_with_Phillips_TDC.xml

- Improved analysis speed.
- Fit with a single Gaussian in a range between 20% (left side) and 60% (right side) of peak height.

TDC spectra and peak positions time dependencies:
18. **Slots 2, 3, 4, 5 and 6, plus the Quartz Start counter:**
- The same as above, but ground the detector and tie it to the ESA ground.

19. **Slots 2, 3, 4, 5 and 6, plus the Quartz Start counter:**
- Find that the timing has shifted compared to pages 19&20 from some reason.

**a) Philips TDC before timing change (to see a shift, compare to page 19):**
Bot: Common TDC Start (scope trig.),
Top: CFD output, CAMAC slot 17,ch.2),
10ns/div, 500mV/div

Bot: Common TDC Start (scope trig.),
Top: CFD output, marger from CFD 7, ch.1),
10ns/div, 500mV/div
b) Philips TDC after timing change (add 32ns to Philips TDC Start cable):
Bot: Common TDC Start (scope trig.),
Top: CFD output, CAMAC slot 17,ch.2,
10ns/div, 500mV/div

Bot: Common TDC Start (scope trig.),
Top: CFD output, CAMAC slot 141,ch.1)
10ns/div, 500mV/div

- Josef finds that the timing is now set incorrectly in the Philips TDC (too early). Go back to
the previous delays, i.e., remove 32 and 16ns from Philips TDC Start and SLAC TDC
Common Stop respectively.

c) SLAC TDC before timing change (to see a shift, compare to page 20):
Bot: Common TDC Start (scope trig.),
Top: CFD output, CAMAC slot 17,ch.2,
20ns/div, 500mV/div

Bot: Common TDC Start (scope trig.),
Top: CFD output, CAMAC slot 14,ch.1,
20ns/div, 500mV/div
20. **A new Russian MCP after a fix of the electrostatics (S/N 83):**

- **Information from Mikhail:**
  
  February, 17 2005 (BINP)
  
  MCP #83 test results

<table>
<thead>
<tr>
<th>Umcp</th>
<th>Upc-mcp</th>
<th>Fn, kHz</th>
<th>G, 10^6</th>
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<td>50</td>
<td>2.6</td>
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<td>1.04</td>
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<td>1800</td>
<td>400</td>
<td>5.0</td>
<td>--</td>
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<td>5.9</td>
<td>0.40</td>
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<td>6.4</td>
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<tr>
<td>2500</td>
<td>400</td>
<td>38.0</td>
<td>4.59</td>
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</tbody>
</table>

Umcp - voltage over MCPs (V),
Upc-mcp - voltage over photocathode-MCP gap (V)
Fn - frequency of noises, threshold of discriminator is about 10^5 electrons on anode
G - gain

- **The HV breakdown fixed; it was caused by a proximity of the ground in front of the photocathode, plus close wiring inside the housing among HV wires and anode wire.**
- MCC external trigger at 10Hz.
- Single pe’ mode.
- **2.5kV on MCP-PMT.**
- Add 16 ns to the calibration pulse delay to separate the signal from the calibration pulse.
- The upper threshold has 12dB. Both thresholds are 11mV.
- Keep 10x10 amplification using Elantek amplifiers + 12dB + 10x Philips amplifier.
- Use a new 3-way splitter (80:10:10). Unfortunately, the third fiber does not work. Had to switch other detectors off for this run.

- File: testrun_20050510_1259_1000000
Mikhail’s analysis:

21. A new Russian MCP (S/N 83), plus run the prototype: M.B., J.V., 5.11.2005
- Russian MCP has fix on the electrostatics (no ground in front of the photocathode).
- Reduce the electronics amplification on the Russian tube. Use 10x10 Elantek amplifier.
  Remove the 12dB attenuator and Philips 10x amplifier.
- MCC external trigger at 10Hz.
- Single pe mode.
- 2.5kV on MCP-PMT.
- The upper threshold has 12dB. Reduce 16 ns in the calibration pulse delay to 8ns.

Bottom: Scope trigger, Top: Russian MCP, 1ns/div, 50mV/div

- Files: testrun_20050511_1107_1000000 testrun_20050511_1553_1000000
Mikhail’s analysis:

Reconstructed time $T_0$ (based on TDC1 and TDC2) – single pe mode:

Reconstructed time vs. Diff = TDC1 – TDC2:

Reconstructed time vs. Diff = TDC1 – TDC2 (in color):

Josef’s analysis:

5/11/2005 12:59

Russian MCP stability test

File: /u2/juhe/endstationA/single_photons/2005-05-02_russMcp/time_dep_2 001_russMcp.xml
testrun_20050429_0125_1000000
testrun_20050429_0357_1000000
testrun_20050429_0631_1000000
testrun_20050429_0902_1000000
testrun_20050429_1136_1000000
testrun_20050429_1408_1000000
testrun_20050429_1640_1000000
testrun_20050429_1915_1000000
testrun_20050429_2148_1000000
testrun_20050430_0024_1000000
testrun_20050430_0257_1000000
testrun_20050430_0529_1000000
testrun_20050430_0801_1000000
testrun_20050430_1015_1000000
testrun_20050430_1307_1000000
testrun_20050430_1540_1000000
testrun_20050430_1812_1000000
testrun_20050430_2047_1000000
testrun_20050430_2318_1000000
testrun_20050501_0148_1000000
testrun_20050501_0419_1000000
testrun_20050501_0711_1000000
testrun_20050501_0940_1000000
testrun_20050501_1212_1000000
testrun_20050501_1445_1000000
testrun_20050501_1720_1000000
testrun_20050501_1952_1000000
testrun_20050501_2227_1000000
testrun_20050502_0102_1000000
testrun_20050502_0333_1000000
testrun_20050502_0603_1000000
testrun_20050502_0842_1000000.

Josef’s analysis:
22. A new Russian MCP (S/N 83), plus run the prototype:
- Fix a light leak (the noise rate is now 30kHz).
- 2.5kV on MCP-PMT.
- Add 16ns to Philips TDC Start on the prototype (just a comment).
- Reduce the PiLas noise (run the diode power cable three times back and forth).
- Add 32ns to Elantek output before splitter to go away from the PiLas noise.
- MCC external trigger at 10Hz.
- Single pe’ mode.
- CFD timing on the Russian MCP.

a) Nominal gain 100x, all else like before.

Bottom: Scope trigger, Top: Russian MCP, 1ns/div, 20mV/div

It appears that the pulse shape changes as a function of amplification
b) 100x + 6dB before splitter (total amplification: 50x)
c) 100x + 3dB before splitter.
d) 100x + 10x (Philips amp) + 17dB and change 32ns to 24ns.
e) 100x + 14dB before the splitter.
f) 100x + 6dB and go to Philips CFD with 25mV th.; place its output to Philips TDC, ch. 14.

- Files: testrun_20050512_1558_10000 - 10x10 xSPLITER, testrun_20050512_1617_10000 - 10x10(-6dB)xSPLITER, testrun_20050512_1638_10000 - 10x10(-3dB)xSPLITER, testrun_20050512_1704_10000 - 10x10(-17dB)x10xSPLITER, testrun_20050512_1727_10000 - 10x10(-14dB)xSPLITER

Mikhail’s analysis:

Sigma_vs_amplification:

Sigma_vs_threshold:

23. A new Russian MCP (S/N 83), plus run the prototype: M.B., J.V., 5.16.2005
- Go back to the double threshold timing.
- 2.5kV on MCP-PMT.
- 6dB in front of a splitter reduce 12dB in upper threshold to 6dB.
- Run with AC interlock on airflow for the first time.

- Investigate the PiLas noise.
- 2.5kV on MCP-PMT (may have been –2.4kV – see a comment in the next run).
- First take a run with PiLas off, HV on, calibration pulses on.
- Then play with various connection schemes:
  a) Effect of toroids: add them also on the +12V supply lines for Elantek (need them).
  b) Connect Elantek to the table ground (seems to be better).
  c) Disconnect ground to the table (does not seem to matter).
  d) Touch the steel PiLas box to ground (it is better not to connect)
  e) Tie the laser diode power cable to steel box (better).
  f) Run AC cord from a distant power plug (it is better).
- Add the CFD air-flow interlock into the protection scheme.
- Take some pictures before splitter.
25. **A new Russian MCP (S/N 83), plus run the prototype:**  
   - Set HV on the Russian MCP to –2.6kV.  
   - Take the run over the weekend. Initially the MCC had troubles with a PDU system and our initial trigger rate was sporadic; I found it OK, i.e. running at 10Hz, on Sunday morning. However, on Monday morning the power to the CFD & the prototype amplifier rack was shut down due to our protection system. It seems that the sensor in the tank does not work.  
   - Note: when power came on on Saturday, the MCP came to –2.4kV as if I had a wrong voltage in the previous run (I meant to run at –2.5kV).

26. **A new Russian MCP (S/N 83), plus run the prototype:**  
   - Set HV on the Russian MCP to –2.7kV.  
   - Take the protection on the amplifier flow off the interlock system.

27. **A new Russian MCP (S/N 83), plus run the prototype:**  
   - Set HV on the Russian MCP to –2.6kV.

28. **A new Russian MCP (S/N 83), plus run the prototype:**  
   - Set HV on the Russian MCP to –2.6kV.  
   - Put a Mylar sheet between ground and the MCP stand to improve the PiLas noise. The amplifier alone does not have a PiLas noise. It comes through MCP.
29. **A new Russian MCP (S/N 83), plus run the prototype:**

- Set HV on the Russian MCP to –2.6kV.
- Connect upper threshold branch to ADC (take 12dB out).
- Fix two dead channels in the prototype:
  1. Slot#6, switch TDC readout from Pad#23 to Pad#10.
  2. Slot#2, switch TDC readout from Pad#39 to Pad#40.

### Burle MCP-PMT in slot 6:

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### Hamamatsu MaPMT in slot 2:

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<td>22</td>
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</tbody>
</table>

30. **A new Russian MCP (S/N 83), plus run the prototype:**

- Set HV on the Russian MCP to –2.6kV.
- The Russian MCP is connected to ADC as in the previous run.
- Vary the intensity of light by removing Mylar absorbers.

31. **A new Russian MCP (S/N 83), plus run the prototype:**

- Set HV on the Russian MCP to –2.6kV.
- Go back to double threshold timing, which includes the calibration pulse.
- Vary the intensity of light by removing Mylar absorbers (all 3 out, 2 out and 3 in).
- Correlation of ADC and time for several runs with a number of attenuators removed (the correlation looks good thanks to a new MCP):

Mikhail’s analysis:

Josef’s analysis:

- The ADC correction does not seem to provide some magic improvement. Its main disadvantage is that one cannot run the electronics calibration pulse.
Status of hardware in ESA ~1 month before running:

1. Place CFD #2 into a slot for CFD#8. Connect it to Philips TDC channels. This completes the Philips TDC coverage of the prototype – see Josef presentation.

2. Finish a hook up of the signals for monitoring outside of ESA in bldg. 420:
   - Bot: JV-1, 50ns/div
   - Top: JV-2
   - Bot: JV-1, 50ns/div
   - Top: Slot 3, pad 1 marker
   - Bot: JV-1, 50ns/div
   - Top: Slot 3, Pad 23 real hits
   - Bot: JV-1, 50ns/div
   - Top: Qtz, Pad 1 disc. output
   - Bot: Common Stop, 50µs/div
   - Top: ADC_stop_in,
   - Bot: Common Stop, 50µs/div

3. One more comment about the problem we had in ESA gating system for the last few weeks. It turns out that the only way to prevent the TAC to start ramping from a random pulse is to have a very long Common Stop. In the scanning setup, where we run a 1kHz trigger rate or more, the gate generator can be adjusted to leave a gap between the leading edge and trailing edge of only a few microseconds, and it is stable in this mode. In the ESA, where we run 10Hz, the gate generator we are using is not able to do it, i.e., one needs to leave a gap to be ~200 microseconds. Any pushing of this gap to be smaller makes this particular gate generator unstable, i.e., it can "flip" into another mode where the gap is huge (millisecond). To be "alive" for such a long period means that we surely get a random pulse from a tube and TAC gets saturated. This is what happened accidentally a few weeks ago and that why Joe has always measured saturated values. Will have to watch.
5. Discover possible coherent effects when the prototype is flooded by a huge signal burst (many photons at the same time):

a) **3 Mylar absorbers out, Pilas at 25%, Slots 3 & 4 have 5-10 photoelectrons per pad**

Bot: Common Stop, 500mV/div:
Slot 6, Pad 1, 20ns/div, 100mV/div  
Slot 5, Pad 1, 20ns/div, 100mV/div  
Slot 4, Pad 1, 20ns/div, 100mV/div  
Slot 3, Pad 1, 20ns/div, 100mV/div  
Slot 2, Pad 1, 20ns/div, 100mV/div
b) 3 Mylar absorbers in, Pilas at 25\%, Slots 3 & 4 a “single” photoelectron mode per pad
(Bot: Common Stop, 500mV/div):

Slot 6, Pad 1, 20ns/div, 100mV/div

Slot 5, Pad 1, 20ns/div, 100mV/div

Slot 4, Pad 1, 20ns/div, 100mV/div

Slot 3, Pad 1, 20ns/div, 100mV/div

Slot 2, Pad 1, 20ns/div, 100mV/div

4) 4 Mylar absorbers in, Pilas at 25\%, Slots 3 & 4 have <1 photoelectrons per pad
(Bot: Common Stop, 500mV/div):

Slot 6, Pad 1, 20ns/div, 100mV/div

Slot 5, Pad 1, 20ns/div, 100mV/div
7. Unsolved problem at this point: Hodoscope readout; if we cannot make the TDC 3377 readout work, one has to connect them to the LeCroy ADC:

8. ADC readout – see Joe’s comments.

9. Generally speaking, if we are asked to run tomorrow, we can take decent data based on the present understanding of the system behavior.

32. **A new Russian MCP (S/N 83), plus run the prototype:**

- Set HV on the Russian MCP to ~2.6kV.
- 10Hz external trigger to PiLas.
- **Go back to double threshold timing on the Russian MCP, which allows a calibration pulse.**
  - Run #1: Remove 3 Mylar att. and increase the light amount 3-4 times in addition with a variable fiber attenuator in the Russian MCP. This run should give us ~40 photoelectrons. Double threshold timing.
  - Run #2: Remove 3 Mylar att. and increase the light amount ~5 times in addition with a variable fiber attenuator in the QUARTZ MCP. Run the Russian MCP with a 6dB in front of a splitter.
  - Run #3: Return to a single photon mode in both MCPs, i.e., add 3 Mylar att. and return the variable fiber att. to original positions. Add Philips 10x amplifier with a 20dB att. following to the Russian MCP. This is a condition I had in the trailer when I was getting good results with the Russian MCPs. **The idea is to saturate as much as possible, but return to the original noise level with the attenuators.** See if this will work, now that we have good MCP.
- **Electronics calibration signal:**

![Electronic calibration graphs](image)

Mikhail’s analysis:

- Electronics calibration signal:

- A PiLas signal with 26 photoelectrons reached the electronics resolution:

![Time resolution graphs](image)

- We seem to be limited by the electronics resolution at high pe-end, and by PiLas at low pe-end. Will try to lower the noise performance by getting the Ortec amplifier.
33. A new Russian MCP (S/N 83), plus run the prototype: J.V., J.S., 5.27.2005

- Joe tells me that we need to remove ~15-20ns from the Common stop for the ADC timing. Somehow, it has shifted after the grounding episode. Not 100% understood. Remove the LeCroy 621B discriminator to achieve this timing shift.

- Start doing some scope tests with the VME crate in ESA:

SYSCLK, 50ns/div, 2V/div
Single ADC in:

SYSCLK, 20ns/div, 2V/div
Single ADC in: All ADCs in:

SYSCLK, 20ns/div, 2V/div

DTACK, 1μs/div, 2V/div
Is NOT present on non-working ADC

A03, 1μs/div, 2V/div
Why is it so jittery?
Look again at the signals in bldg. 420 (signals with PiLas pulser, ext. trigger):

Bot: JV-1, 50ns/div  
Top: JV-2

Bot: JV-1, 50ns/div  
Top: Slot 3, pad 1 marker

Bot: JV-1, 50ns/div  
Top: Slot 3, Pad 23 real hits

Bot: JV-1, 50ns/div  
Top: Qtz, Pad 1 disc. Output

Bot: JV-1, 50ns/div  
Top: Russian MCP disc. output

Channels connected to 10 cables in bldg. 420 right now:
1. JV-1 in.
2. JV-2 in.
3. JV-1 out.
4. JV-2 out.
5. MCP in Slot 3, pad 1, timing marker.
6. MCP in Slot 3, pad 23, real hits.
7. Start counter #1, Quartz MCP, pad 1, disc output.
8. Russian MCP, disc output.
9. Quantacon PMT on the double rejection counter, anode signal.
10. Lead glass block PMT, disc output.

Connect the hodoscope to LeCroy 2249A ADCs in the following way:

ADC, slot 7, crate 2: x-direction, ADC ch. 0-11, hodoscope channels #1-12
ADC, slot 8, crate 2: x-direction, ADC ch. 0-3, hodoscope channels #13-16
ADC, slot 8, crate 2: y-direction, ADC ch. 4-11, hodoscope channels #1-8
ADC, slot 9, crate 2: y-direction, ADC ch. 0-7, hodoscope channels #9-16
ADC, slot 9 has a marker in the last channel #11.

The gate width is 140ns long, and its timing is set up so that we should read the beam-related hits correctly right away. Right now the hodoscope is running at -0.8kV. The PMT pulses go directly to ADC, i.e., bypassing the 10x amplifier. We should see random hits on a log scale, but mostly a pedestal.

I left a marker in the TDC 3377 system, in case that there will be a sudden discovery in making it work.
Bar alignment with a laser, set to be parallel to beam:
- Method:

a) The initial alignment:
Window #7 (~1.2” from bar end),
bar perpendicular to < 0.5mrad (< ~5mm/5meters):

Window #6 (~21.2” from bar end),
bar perpendicular to ~0.5mrads:

Window #5 (~81.2” from bar end),
bar perpendicular to ~0.5mrads:

b) Alignment on 6.2.2005:
Laser#1 distance from bar: 16’9” ~ 510.5 cm away

Bar still perpendicular to < 0.5mrad:
J. Va’vra’s logbook, Last update: 8.19.2005

Window #4 (~81.2” from bar end),

Bar perpendicular to ~1.0mrad:

Not measured

Window #3 (~81.2” from bar end), bar perpendicular to ~1mrad:

Bar perpendicular to <1.5mrad:
a) The initial alignment:

Window #1.

Not measured

Window #2.

Not measured

Overall results:

b) Alignment on 6.8.2005:

Laser#2 distance from bar: 17’1” = 520.7cm

Bar perpendicular to ~1.0mrad:
Update the beam design with the latest numbers:
- Add offsets for each beam hole position on the scale on the bar I-beam.
- Add position of the Russian MCP.
- Bob Reif’s drawing:
34. New high presission pulser to provide Common Stop:
- The precision digital delay/pulse generator DG535 is made by SRS (Stanford Research Systems) with the following specifications:
  a) Four independent delay outputs: A, B, C and D.
  b) NIM, TTL or ECL outputs.
  c) Output delays can be programmed from 0 to 1000sec.
  d) The jitter is $\sigma \sim 50\text{ps}$ for delays less than $100\mu\text{s}$, and worse for longer delays.
  e) Will use it with an external trigger from MCC (derived from JV-2).
- This pulser allows a very tight “live” window (250ns long) for the SLAC TAC.

Top: Slot 2, ch. 17, CFD 3, 100mV/div
Bot: Common Stop, 500mV/div, 50ns/div

Scope trigger: JV-2 pulse
Bot: Common Stop, 200mV/div, 1ns/div

Scope ext. trigger: Marker, Slot 2, ch.1, 20ns/div
Tot: Common Stop, 500mV/div, add 8ns cable
Bot: Slot 2, Pad 17, 200mV/div

Top: Common Stop, Dial 240, 250 and 280ns
Bot: Slot 2, Pad 17, 200mV/div

Is it adding an extra jitter?
Top: Slot 2, ch. 1, Marker, 200mV/div  
Bot: Common Stop, 500mV/div, 50ns/div

Top: TAC Reset, 500mV/div  
Bot: Common Stop, 500mV/div, 100ns/div

Top: ADC_stop_in, Bot: Common Stop  
(too narrow to be visible), 50µs/div

Pulse generator DG535, Dial 250ns

**DG535: Trailing edge is adjusted by a A-control, leading edge is adjusted by a B-control.**

Top: Common Stop, 500mV/div, 50ns/div  
Bot: Timing Marker in CFD 7, ch.1

- Nominally we run with 250ns “live” gate.
Timing sequence in the ESA test beam:
(IV-1 and IV-2 are MCC signals can be programmed in 8.4ns steps, rate 10-360Hz)

SLAC TDC (Common STOP timing):

-650 mV

~340 ns

0 mV

~100 μs

TAC RESET (NIM)
(~100 ns after the RESET)

TAC Common STOP

~250 ns

~50 ns (timing marker)

MCP raw pulses
(~50 ns before STOP typically)

ADC STOP_IN pulse, TTL
35. Add LEDs to the lead glass, Scintillator and fiber hodoscope:
- Red LEDs triggered by a TTL pulse for the scintillator and lead glass, and by a 10V pulse for the hodoscope. It was necessary to bring the LED close to hodoscope’s PMTs to get enough light. One gets a spray of a few photons per fiber typically. In these channels one should see pedestals. The Quantacon and lead glass has larger number of photons per pulse, so one will not see a pedestal. I drive these LEDs
from TTL pulses. Adjust attenuation on lead glass (a new value is 26dB) and Quantacon (a new value is 20dB). In addition add AC coupling for the Quantacon ADC.
- The Russian MCP and the quartz MCP have light from PiLas as before.
- Voltages:
  Russian MCP: -2.6kV,
  Quartz MCP: -2.4kV,
  Scintillator MCP: -2.3kV,
  Hodoscope MaPMT: -0.9kV,
  Quantacon and lead glass PMTs: -1.9kV (knob on the power supply).

Scintillator LED is next to Quantacon:

Lead glass block LED is at front:

Hodoscope window opened:

Lead glass block LED is at front:

Top: LED signal in Quantacon, 2mV/div
Bot: ADC gate, 200mV/div, 20ns/div

Top: LED signal in lead glass, 2mV/div
Bot: ADC gate, 200mV/div, 20ns/div
Top: Quantacon TDC stop, 500mV/div
Bot: TDC start, 200mV/div, 20ns/div

Top: Lead glass TDC stop, 500mV/div
Bot: TDC start, 200mV/div, 20ns/div

Bldg. 420 timing:
Top: Quantacon TDC stop, 500mV/div
Bot: JV-1, 500mV/div, 50ns/div

Top: Lead glass TDC stop, 500mV/div
Bot: JV-1, 500mV/div, 50ns/div

Beam-related electronics rack:
Trigger in the Test Beam

To Generate (in movable rack): COMMON STOP, TAC RESET and Russian MCP calib:

ADC_STOP_IN pulse (VME crate)

COMMON START for Philips TDC (CAMAC Crate #2) and CFD timing markers:
36. Attempt to understand the TDC calibration:
   a) Add 6.8 ns to Philips TDC START, add 8.3 ns to SLAC TDC Common STOP
   b) Remove Philips TDC START delay cable, leave the SLAC TDC delay cable in.
   c) Remove SLAC TDC START delay cable, leave the Philips TDC delay cable in.
   d) Remove 4 ns from Common STOP
   e) Remove 8 ns from Common STOP
   f) Add 8.3 ns from Common STOP
   g) Add 4 ns

37. Attempt to understand the TDC calibration:
   - Set 120 Hz on both AB01-8-9 (JV-1) and AB01-8-10 (JV-2) signals – done by Mike Woods.
   - Move timing markers so they are seen by both Philips TDC and SLAC TDC:
     a) CFD 3, Pad 22,
     b) CFD 4, Pad 43,
     c) CFD 5, pad 22,
     d) CFD 6, pad 43.
   - Set nominal timing delay to “0 ns” on Philips and “-8 ns” on SLAC TDCs.

38. Attempt to understand the TDC calibration:
   - 120 Hz trigger rate.
   - Timing markers in the Philips TDC and the SLAC TDC are still “aligned.”.
   - All detectors have voltages; all are in the single pe mode.
   - Philips TDC is at 0 nominal delay during all these runs.
   - Change the delay cable for the Philips CFD in JV-1 and JV-2 from 1 ns to 4 ns. The Philips manual recommends to set delay = rise_time + 1 ns. The MCC pulses JV-1 & JV-2 have huge risetime due to a very long cable delay, so it is difficult to set the Philips CFD right. I chose to try 4 ns. We probably will not see any benefit until we switch to the beam.
   - SLAC TDC calibration study:
     1. Start with -8 ns delay offset. Change "live" window from a nominal value of 250 ns to 200 ns by moving the leading edge (the trailing edge, which defines the Common STOP timing, remains unchanged).
2. Add 8.3 calibrated cable to Common STOP.
3. Change the "live" window from 200ns to 150ns by moving the leading edge.
4. Remove 8.3ns delay.
5. Remove TAC Reset.
6. Add 8.3ns delay.
7. Return the SLAC TDC to its nominal state, including the gate generator (250ns live time) and the cable delay (nominal zero).

- Josef tells me that based on the on-line study of markers, all runs yield 31.7 ps/count.

J.V., 6.27.2005

39. Change the PiLas timing:

- 120Hz trigger rate.
- Ever since we moved to ESA, I wondered what might be a reason why we cannot reproduce the timing resolutions, which were obtained in the trailer 233 with PiLas. Finally, I my have found the reason. Unfortunatelly, it required a BIG change. But I think we still have plenty of time to recover. The change is this:
  
  The JV-1 signal comes to a discriminator, which is driving all sorts of signals including the PiLas trigger. Because I run out of available outputs, I used a complementary NIM output signal to trigger PiLas. That is fine. The PiLas triggering was set to trigger on -0.2V and, on a negative-going slope. That de facto meant that we were triggering on the trailing edge of the discriminator's output. That is no good, as the width may have its own drift. Instead, we should have triggered on the positive-going edge.
  
  Unfortunatelly, to change this means that there are many consequences, and including possible errors. Anyway, I decided to do this. It was necessary to adjust delays in ADC gate, TDC common starts, TDC common stop, Russian MCP electronics calibration:

- Ever since we moved to ESA, I wondered what might be a reason why we cannot reproduce the
  ADC gate: remove 64+30+16ns
  Philips TDC Start in crate 2 (beam-related counters): remove 128ns
  Russian calib. Pulse: remove a large delay (?)
  ADC hodoscope gate: remove 32ns
  Philips TDC Start in crate 1 (prototype): remove (128-64)ns
  SLAC TDC Common Stop (gate generator DG 535): A signal delay: 250 -> 120ns, B=0ns

Timing shift due to PiLas triggering (either on the leading or trailing edge):

Top: PiGas trigger, 500mV/div
Bot: Qtz_MCP_1, 5mV/div, 100ns/div

Old
New

Bot: Qtz_MCP_1, 5mV/div, 20ns/div
PiLas trigger (do not see a large jitter on wrong edge on short time scale):
Scope trigger: JV-1 disc., 1ns/div
PiLas trig: neg.-going edge, 100mV/div

Scope trigger: JV-1 disc.
PiLas trig: pos.-going edge, 100mV/div

Russian MCP with a new way of triggering PiLas:
Scope trigger: JV-1 disc., 1ns/div
Russ_MCP: 50mV/div

Scope trigger: JV-1 disc., 1ns/div
Russ_MCP: 50mV/div

Consequence of the above change to the Common Stop & TAC Reset timing:
Top: TAC Common Stop, 50ns/div
Bot: TAC Reset

Top: TAC Common Stop, 20ns/div
Bot: Pad17, Slot5, 100mV/div

40. Confusion about the diff variable for Russian MCP:
- 120Hz trigger rate.
- Looking at Russian MCP data I got confused because a variable \( \text{diff} = t_2 - t_1 \) had values of about 10-12ns for the calibration data and only 2-6ns for the signal data. That is hard to believe as the calibration pulses are larger than the signal pulses and of about a similar risetime. Look at the scope this morning, and indeed, the diff is only about 3-6ns, and there are no pulses having \( \text{diff} = 10-12 \text{ns} \). So, we have a problem. Either we have a fantastic screw up in the data pointers, or
intermittent cable problem.

Scope trigger: Philips TDC Start, 2ns/div, 200mV/div
Top: Russ_MCP low th. Stop (ch. 12), Bot: Russ_MCP high th. Stop (ch.13)

Thinking about it and looking at above picture, it is possible to have diff=10-12ns. The single pe pulses are happening rarely (<5% of time). If they happen, the upper threshold may not fire because the pulse is small. In that case the lower threshold ch.12 TDC will stop with the single pe pulse, but the upper threshold will have the calibration pulse, so larger diff combination is possible.

**Russian MCP under the new timing conditions:**

Analysis by J.V., 6.28.2005

Data file: /u2/data/testrun_20050627_2036_1000000.root

**Single pe signal - Raw:**

**Single pe signal - Corrected:**

**Electronics calibration signal:**

**Single pe signal:**

σ ~ 29.5ps

σ\_narrow ~ 80ps
J.V., 6.28.2005

**Calibration of SLAC TDC with DG535 gate generator:**
B-delay = 0ns, 10ns steps using A-delay; CFDs: 3, 4, 5, 6 and 4 working ADCs.

<table>
<thead>
<tr>
<th>A-delay</th>
<th>Marker-Common Stop</th>
<th>ADC</th>
<th>ps/count</th>
</tr>
</thead>
<tbody>
<tr>
<td>180</td>
<td>120</td>
<td>3692</td>
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</tr>
<tr>
<td>170</td>
<td>110</td>
<td>3373</td>
<td>31.3</td>
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<tr>
<td>160</td>
<td>100</td>
<td>3056</td>
<td></td>
</tr>
<tr>
<td>150</td>
<td>90</td>
<td>2739</td>
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<tr>
<td>140</td>
<td>80</td>
<td>2421</td>
<td></td>
</tr>
<tr>
<td>130</td>
<td>70</td>
<td>2104</td>
<td>31.5</td>
</tr>
<tr>
<td>120</td>
<td>60</td>
<td>1785</td>
<td></td>
</tr>
<tr>
<td>110</td>
<td>50</td>
<td>1466</td>
<td>31.3</td>
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<tr>
<td>100</td>
<td>40</td>
<td>1148</td>
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<tr>
<td>90</td>
<td>30</td>
<td>829</td>
<td>31.3</td>
</tr>
<tr>
<td>80</td>
<td>20</td>
<td>507</td>
<td></td>
</tr>
<tr>
<td>70</td>
<td>10</td>
<td>172</td>
<td>29.9</td>
</tr>
</tbody>
</table>

Bot (scope trigger): Common Stop, 20ns/div
Top: Timing marker (CFD 11, pad 1)

- With Josef and Jose, we have done a calibration of SLAC TDC over its entire range, i.e., going in steps of 10ns from ADC value of 3692 to 507. For each step, we are getting (31.3 ± 0.1) ps/count, i.e., the calibration is a very good constant, but not 25ps/count. Clearly a challenge for Gholam to explain.

J.V., 6.29.2005

**Add a new ADC and TDC for the Quantacon and Lead glass PMTs:**
- Found working LeCroy ADC and TDC. That is an accomplishment by itself. The ADC has a 400ns long gate to be able to see the late LED signal, and TDC has a conversion factor of ~250ps/count. The beam should arrive considerable earlier than the LED signal, so we should measure it OK. Joe verified that both units work as far as DAQ.
- The new modules are intended for the Quantacon PMT and the lead glass only. The connections are as follows:
  - Quantacon: ADC, slot 11, crate 2, channel 0; TDC, slot 14, crate 2, ch. 0.
  - Lead glass: ADC, slot 11, crate 2, channel 1; TDC, slot 14, crate 2, ch. 1.
- The ADCs should have a signal for every trigger, so the pedestal is not visible at present. When the cable is off, the pedestal seems to be close to 60 according to Joe. In the beam most of the triggers will have no particle, so we should measure a true pedestal. The MCP in the scintillator
must remain in Philips TDC as it will provide a good start time, and therefore it is out of range of the LED signal.

**Do some timing checks (DG535 A-delay=180ns, B-delay=0ns):**

**Top:** Philips Start, cr. 2, slot 13, 50ns/div.
**Bot:** Quartz Start counter, pad 1

**Top:** Philips Start, cr. 1, slot 14, 10ns/div
**Bot:** CFD 3 output, Det slot 2, pad 19

**Top:** Common Stop, 50ns/div.
**Bot:** Amp. signal, det. slot 2, ch. 17

**Top:** Common Stop, 50ns/div.
**Bot:** marker to CFD 11, pad 1

**Scope trigger:** marker to CFD 11, pad 1.
**Bot:** A “good” common stop edge, 1ns/div

**Scope trigger:** marker to CFD 11, pad 1.
**Bot:** A “bad” common stop edge, 1ns/div
Top: Common stop
Bot: TAC Reset, 50ns/div

Look again at the signals in bldg. 420:
(signals with PiLas pulser, ext. trigger; these signals are independent of the setting in DG535)
Bot: JV-1, 50ns/div
Top: JV-2
Bot: JV-1, 50ns/div
Top: Slot 3, pad 1 marker
Bot: JV-1, 50ns/div
Top: Slot 3, Pad 23 real hits
Bot: JV-1, 50ns/div
Top: Qtz, Pad 1 disc. Output
Bot: JV-1, 50ns/div
Top: Russian MCP disc. Output
Bot: JV-1, 100ns/div
Top: Quantacon PMT with LED
Bot: JV-1, 100ns/div
Top: Lead glass PMT with LED
Calibration of SLAC TDC with DG535 gate generator:
B-delay = 0ns, 10ns steps using A-delay; CFDs: 7, 2, 9, 10 and the same 4 working ADCS.

<table>
<thead>
<tr>
<th>A-delay</th>
<th>Marker-Common Stop</th>
<th>ADC</th>
<th>ps/count</th>
</tr>
</thead>
<tbody>
<tr>
<td>180</td>
<td>110</td>
<td>3654</td>
<td></td>
</tr>
<tr>
<td>170</td>
<td>100</td>
<td>3336</td>
<td>31.4</td>
</tr>
<tr>
<td>160</td>
<td>90</td>
<td>3023</td>
<td>31.9</td>
</tr>
<tr>
<td>150</td>
<td>80</td>
<td>2708</td>
<td>31.7</td>
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<td>2393</td>
<td>31.7</td>
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<tr>
<td>130</td>
<td>60</td>
<td>2076</td>
<td>31.5</td>
</tr>
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<td>120</td>
<td>50</td>
<td>1760</td>
<td>31.6</td>
</tr>
<tr>
<td>110</td>
<td>40</td>
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<td>31.6</td>
</tr>
<tr>
<td>100</td>
<td>30</td>
<td>1128</td>
<td>31.6</td>
</tr>
<tr>
<td>90</td>
<td>20</td>
<td>813</td>
<td>31.7</td>
</tr>
<tr>
<td>80</td>
<td>10</td>
<td>495</td>
<td>31.4</td>
</tr>
<tr>
<td>70</td>
<td>0</td>
<td>173</td>
<td>31.1</td>
</tr>
</tbody>
</table>

Bot (scope trigger): Common Stop, 20ns/div, **A-delay: 160ns**
Top: Timing marker (at the CFD entrance; derived from a fanout module, compl. NIM)

Bot (scope trigger): Common Stop, 20ns/div, **A-delay: 140ns**
Top: MCP signals (at the CFD entrance)

Det. Slot 3, pad 17:

Det. Slot 4, Pad 17:
Top: Philips Start, cr. 2, slot 13, 50ns/div.
Bot: Quartz Start counter, pad 1

Bot: Russian MCP marker, no signal !?!?!

Top: Philips Start, cr. 1, slot 14, 10ns/div
Bot: Quartz Start counter, pad 1

Top: ADC gate, 50ns/div.
Bot: Quartz Start counter, pad 1, 5mV/div

Top: ADC gate, 20ns/div.
Bot: Quartz Start counter, pad 1, 5mV/div

Top: Common stop, 20ns/div.
Bot: CFD 5, pad 17, slot 3, 100mV/div

Top: Common stop, 50ns/div.
Bot: TAC reset
- Timing signals in bldg 420:

**MCC-related and PiLas-related signals:**

Bot: JV-1, 50ns/div  
Top: JV-2

Bot: JV-1, 50ns/div  
Top: Slot 3, pad 1 marker

Bot: JV-1, 50ns/div  
Top: Slot 3, Pad 33 real hits

Bot: JV-1, 50ns/div  
Top: Qtz, Pad 1 disc. Output

Bot: JV-1, 50ns/div  
Top: Russian MCP disc. Output

Bot: JV-1, 100ns/div  
Top: Quantacon PMT with LED

Bot: JV-1, 100ns/div  
Top: Lead glass PMT with LED
**Russian MCP died:**
- Sometimes on June 30 the pulse height diminished substantially.
- Do not see any pulses yesterday. See a permanent signal when triggering on the tube.
- After a day of rest, do see pulses after the tube gets HV:

<table>
<thead>
<tr>
<th>Trigger on the MCP</th>
<th>Trigger on JV-1</th>
<th>Trigger on JV-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>50mV/div, 20ns/div</td>
<td>10mV/div, 2ns/div</td>
<td>10mV/div, 2ns/div</td>
</tr>
<tr>
<td>Permanent signal</td>
<td>10min after switching HV</td>
<td>Immediately after switching HV</td>
</tr>
</tbody>
</table>

**Check Philips TDC timing as Josef tells me that the peak of the timing distribution is too close to the beginning (check the timing at the entrance to TDC):**

- Top: Philips Start, cr. 1, slot 14, 10ns/div.
- Bot: CFD 3 output, Det slot 2, pad 19

What we had up to this point:

- Added 12ns to Philips TDC START (see a picture on right).
### Philips TDC connections:

<table>
<thead>
<tr>
<th>Detector Slot</th>
<th>Amp. channels (pad number)</th>
<th>CFD number</th>
<th>LEMO cable label</th>
<th>Philips TDC CAMAC slot</th>
<th>TDC channel</th>
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<tbody>
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<td>9,10,11,12</td>
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<td>8-13,8-14,8-15,8-16</td>
<td>13</td>
<td>13,14,15,16</td>
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- Prototype connections to Philips TDC, amplifier groups and CFDs:

**A view from the amplifier side:**

Burle MCP-PMT in slot 4:

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<td>CFD #7</td>
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Burle MCP-PMT in slot 5:

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<tr>
<td></td>
<td></td>
<td></td>
<td>CFD #9</td>
</tr>
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</table>

- Each blue block represents a group of four pads, which are connected to Philips TDC (64 ch.).
Some small activity:
- Dress up power cables for CFDs.
- Connect Slot 3, Pad 35 to monitor the prototype in bldg.420 (previously, it was Slot 3, Pad 23).
- Move the Russian MCP to the lab. It does not work even if one disconnects the MCP from the support table. It takes ~30min before an onset of breakdown.
- Work out the correspondence between the focal plane position and angles – see next page.
Prototype optics:

- The prototype was designed to an angle of \(47.05^\circ\), which is derived from the fused silica refraction index and our most probable wavelength of \(\sim 410\text{nm}\).
- Near the most probable image, a small shift in a focal plane corresponds to an angular shift of \(\sim 3.455\text{ mrad/mm} \sim 0.198^\circ/\text{mm}\). Therefore, a pad resolution corresponds to \(\sigma = 6 \text{ mm}/\sqrt{12} \sim 1.73 \text{ mm} \sim 6 \text{ mrad}\). A pitch of 6 mm corresponds to 20.73 mrad.
- The angular resolution in this prototype, before any chromatic corrections are applied, is expected to be \(\sigma \sim 10\text{mrad}\), and therefore, the expected raw image width (+-3\(\sigma\)) is expected to be \(\sim 17\text{ mm}\) wide, i.e., about 3 pads. After the chromatic correction, we may reach a half of that.
- The picture shows a nominal design. However, during the cosmic ray run it was found necessary to move the detector plane down by 1.5 cm. That may or may not have been right move, as we will soon find out in the test beam.
- Picture shows also the fiber entry.
Reconstruction of $\theta_c$, $\alpha_x$, $\alpha_y$, $\cos \alpha$, $\cos \beta$, $\cos \gamma$, $L_{\text{path}}$, $t_{\text{propagation}}$:

- Geometry of the photon direction:

Each detector pixel determines these photon parameters:

$$\theta_c, \alpha_x, \alpha_y, \cos \alpha, \cos \beta, \cos \gamma, L_{\text{path}}, t_{\text{propagation}}, n_{\text{bounces}} - \text{assuming an average } \lambda.$$

$(t_{\text{propagation}} - t_{\text{measured}})$ can be used to correct $\theta_c$ to correct out the chromatic error.

a) $\alpha_x$, $\alpha_y$ angles:

$$\tan \alpha_y = Y/Z, \ Z = Y/\tan \alpha_y$$
$$\tan \alpha_x = X/Z, \ X = Z \tan \alpha_x$$

b) Cherenkov angle $\theta_c$:

$$\cos \theta_c = Y/P, \ P = Y/\cos \theta_c$$
$$\cos \theta_c = \tan \alpha_y/\sqrt{1 + \tan \alpha_x^2 + \tan \alpha_y^2}$$
c) Further relations in the coordinate system:

\[ \frac{L}{P} = \sin \theta_c \]
\[ \frac{X}{L} = \sin \alpha_x \]
\[ X = L \sin \alpha_x = P \sin \theta_c \sin \alpha_x \]
\[ Y = P \cos \theta_c \]
\[ Z = L \cos \alpha_x = P \sin \theta_c \cos \alpha_x \]
\[ \tan \alpha_y = \frac{Y}{Z} = \frac{Y}{X} \tan \alpha_x = \left( P \cos \theta_c / (P \sin \theta_c \sin \alpha_x) \right) \tan \alpha_x = 1 / (\tan \theta_c \cos \alpha_x) \]

for \( \alpha_x = 0 \): \( \tan \theta_c = Z/Y \) and \( \tan \alpha_y = Z/Y \Rightarrow \tan \theta_c = 1 / \tan \alpha_y \)

Therefore:
\[ \tan \alpha_y = \tan \alpha_y^0 / \cos \alpha_x \]

\[ \tan \alpha_y = \tan \alpha_y^0 / \cos \alpha_x \]

\[ \cos \beta = \cos \theta_c = k_y \]
\[ \cos \gamma = Z/P = Z/(Y/\cos \theta_c) = \cos \theta_c / \tan \alpha_y = k_z \]
\[ \cos \alpha = X/P = X/(Y/\cos \theta_c) = \cos \theta_c (X/Y) = \cos \theta_c (Z \tan \alpha_x)/(Z \tan \alpha_y) = \]
\[ = \cos \theta_c \tan \alpha_x / \tan \alpha_y = k_x \]
\[ (\cos \alpha)^2 + (\cos \beta)^2 + (\cos \gamma)^2 = (\cos \theta_c \tan \alpha_x / \tan \alpha_y)^2 + (\cos \theta_c)^2 + (\cos \theta_c / \tan \alpha_y)^2 = \]
\[ = (\cos \theta_c)^2 \left[ 1 + (\tan \alpha_x / \tan \alpha_y)^2 + (1 / \tan \alpha_y)^2 \right] = 1 \]

\[ \text{d) Direction cosines} \cos \alpha, \cos \beta, \cos \gamma: \]

\[ \cos \beta = \cos \theta_c = k_y \]
\[ \cos \gamma = Z/P = Z/(Y/\cos \theta_c) = \cos \theta_c / \tan \alpha_y = k_z \]
\[ \cos \alpha = X/P = X/(Y/\cos \theta_c) = \cos \theta_c (X/Y) = \cos \theta_c (Z \tan \alpha_x)/(Z \tan \alpha_y) = \]
\[ = \cos \theta_c \tan \alpha_x / \tan \alpha_y = k_x \]
\[ (\cos \alpha)^2 + (\cos \beta)^2 + (\cos \gamma)^2 = (\cos \theta_c \tan \alpha_x / \tan \alpha_y)^2 + (\cos \theta_c)^2 + (\cos \theta_c / \tan \alpha_y)^2 = \]
\[ = (\cos \theta_c)^2 \left[ 1 + (\tan \alpha_x / \tan \alpha_y)^2 + (1 / \tan \alpha_y)^2 \right] = 1 \]

\[ \text{d) Photon path lengths:} \]
\[ \text{Path}_1 \text{(directed photons)} = z_{\text{window}} \sqrt{(k_x / k_z)^2 + (k_y / k_z)^2 + 1} \]
\[ \text{Path}_2 \text{(reflected photons)} = (2*L_{\text{bar}} - z_{\text{window}}) \sqrt{(k_x / k_z)^2 + (k_y / k_z)^2 + 1} \]

\[ \text{e) Group velocity} v_{\text{group}}: \]
\[ v_{\text{group}} = c_0 / N_{\text{group}} = c_0 / [n_{\text{phase}} - \lambda * d(n_{\text{phase}})/d\lambda], \]

where \( N \) is the group index, \( n \) is the refraction index and \( c_0 \) is speed of light in free space.

At a wavelength of 420nm, which is close to an average wavelength of the wavelength acceptance in the Focusing DIRC if we use the Burle MCP (note: BaBar DIRC has a different acceptance!!), \( n_{\text{phase}} = 1.468094 \) and \( N_{\text{group}} = 1.506480 \). A variable \( dn_{\text{phase}}/d\lambda \) is determined by a numerical differentiation of the Melles-Griot data for the quartz refraction index.

\[ \text{f) Photon time-of-propagation (TOP)}: \]
\[ t_{\text{propagation}} = t_{\text{bar}} + t_{\text{detector box}} + t_{\text{various delay offsets}} \]
\[ t_{\text{bar}} \text{(directed photons)} = \text{Path}_1 \cdot N_{\text{group}} / c_0 \]
\[ t_{\text{bar}} \text{(reflected photons)} = \text{Path}_2 \cdot N_{\text{group}} / c_0 \]
\[dT(\text{two peaks}) = t_{\text{propagation}}(\text{peak}_1) - t_{\text{propagation}}(\text{peak}_2) =
= t_{\text{bar}}(\text{directed photons}) - t_{\text{bar}}(\text{reflected photons})\]

Note: Both \(t_{\text{detector box}}\) and \(t_{\text{various delay offsets}}\) variables cancel if we work with the same pad in terms of differences, i.e., using a variable \(dT(\text{two peaks})\).

g) Number of photon bounces in the bar:

\[n_{\text{bounces}} = n_x + n_y = \text{Path}/[\text{bar width} \ast \text{abs}(k_z / k_x)] + \text{Path}/[\text{bar height} \ast \text{abs}(k_z / k_y)]\]

h) Mirror radius:

A measured number, using an approximation \(1/f = 1/a + 1/x\), is \(f = 49.2\,\text{cm}\), which is close to expected \(48.5\,\text{cm}\), which is an official CRID number for barrel mirrors.
Reconstruction of $\theta_c$, $\alpha_x$, $\alpha_y$:

y-z view geometry ("x = 0" plane):

Procedure:
1. The focal plane is determined by choosing several incident particle directions.
2. Select $dy$-global = 0 in the center of the MCP in the slot 4.
3. Select $\alpha_y$ angles and for each determine the corresponding $dy$-global in the focal plane.

Result:

\[
\alpha_y = f(dy\text{-global})
\]

\[
y = 0.0003 \times dy\text{-global}^2 + 0.1868 \times dy\text{-global} + 42.95
\]
**x-z view geometry:**

**Procedure:**

1. Select $dx$-global = 0 in the center of the MCP in the slot 4.
2. Select $\alpha_x$ angles and for each determine the corresponding $dx$-global in the focal plane.

**Result:**

```
alpha-x=f(dx-global)
slope = f(dy-global)
```

---

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Measurement of the geometry:

- Thank god for this instrument… It removed a lot of confusion.

Checking dimensions with the coordinate machine

Portable coordinate measuring machine:

Geometry of the detector:

- Still finding mistakes…

Explanation of the error:

The prototype optics was designed assuming that the center of the detector in slot 4 is also in the center of the window. This is what I told Bob. However, Matt had to shift the window because of the difficulties to accommodate the flat gasket on the mirror side (it was too tight). This did not end up on my drawing defining the optics and as a result it was neglected. The error was partially corrected by shifting the detector plane down by 1.5 cm, which was done after the initial test in the cosmic ray setup. The additional correction was taken after the first beam test run when I shifted the pad readout towards the lower part of the MCP-PMTs (see pages 141-142).
## Nominal design - calculation for the beam in the bar position 1:

### 12.15.2005

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### Notes:
- Detailed calculations and assumptions for the stress analysis of the beam structure.
- All values are in SI units.

### Reference:
- J. Va’vra’s logbook, Last update: 8.19.2005
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<td>0.21</td>
<td>18.57</td>
<td>23.07</td>
</tr>
</tbody>
</table>

- Sl. no.: Sequential number
- Date: Date of the observation
- Position: Position of the observation
- Speed (knots): Speed recorded in knots
- Distance (nm): Distance covered in nautical miles
“Real” detector positions after the survey - Calculation for the beam in the bar position 1:

| Detector shift | 0.00 | 0.01 | 0.02 | 0.03 | 0.04 | 0.05 | 0.06 | 0.07 | 0.08 | 0.09 | 0.10 | 0.11 | 0.12 | 0.13 | 0.14 | 0.15 | 0.16 | 0.17 | 0.18 | 0.19 | 0.20 | 0.21 | 0.22 | 0.23 | 0.24 | 0.25 | 0.26 | 0.27 | 0.28 | 0.29 | 0.30 | 0.31 | 0.32 | 0.33 | 0.34 | 0.35 | 0.36 | 0.37 | 0.38 | 0.39 | 0.40 | 0.41 | 0.42 | 0.43 | 0.44 | 0.45 | 0.46 | 0.47 | 0.48 | 0.49 | 0.50 | 0.51 | 0.52 | 0.53 | 0.54 | 0.55 | 0.56 | 0.57 | 0.58 | 0.59 | 0.60 | 0.61 | 0.62 | 0.63 | 0.64 | 0.65 | 0.66 | 0.67 | 0.68 | 0.69 | 0.70 | 0.71 | 0.72 | 0.73 | 0.74 | 0.75 | 0.76 | 0.77 | 0.78 | 0.79 | 0.80 | 0.81 | 0.82 | 0.83 | 0.84 | 0.85 | 0.86 | 0.87 | 0.88 | 0.89 | 0.90 | 0.91 | 0.92 | 0.93 | 0.94 | 0.95 | 0.96 | 0.97 | 0.98 | 0.99 | 1.00 |
|--------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
- Still a discrepancy between by calculation and the MC calculation of Ivan.
- These spreadsheet have updated pad coordinates.
How well the spreadsheet calculation actually works?

- Calculate a difference between measured and calculated (up to a common constant)
- Pad 25, slot 4
- Window position 6
- Run 6 taken on 8.17.2005
- Use 23ps/count for a TDC calibration
The Russian MCP #83 fixed (?):
- It looks like I may have solved the problem. During the debugging the tube, we found that the photocathode cannot have either a direct ground in front of it, or even something, which will slowly charge up towards the ground. After a few tries with Mikhail, we decided to glue the fiber connector directly on the front insulating ring holding the MCP. Then we had a Kapton film joining the metal container and the fiber connector. At that time, to prevent a light leak, I have added a black insulating tape, which is unfortunately slightly conducting. We knew that and therefore we made sure that there is Kapton tape barrier between the black take and a direct ground. It was working for 3-4 weeks. However, we had an increase in temperature recently, and that was enough to increase the conductivity of these tapes, and, as a result, we returned to a breakdown situation.
  So, I got rid of the black tape, and replaced it with a black cloth. Under that condition the tube seems to behave OK. Before this change was implemented the gain would die in ~20 minutes.
- So, let’s watch it over the weekend. If it will run OK, I will switch it off until the run starts.

Bot: JV-1, 50ns/div
Top: Russian MCP disc. Output

J.V., 7.11.2005
- No, it is not fixed. It did not survive the weekend. The gain is gone. Will take it to the lab.
- Do two unsuccessful tries – in each case the gain goes away after a while:
  a) Remove also a Kapton tape,
  b) Cut the metallic container in half; leave just part with the connectors.
- Breake the MCP #83 accidentally when trying to take it apart.

J.V., 7.15.2005
- Select MCP 1448 as a new candidate for the test beam in ESA.
- Use the metallic container, but glue a ring for the fiber optics directly on the insulator.
- It seems to be sensitive to the single photons and has an acceptable noise rate.
- Replace BNC connector.
- Connect the Lucite radiator with a bit of optical grease.
- It looks good, some noise but not excessive at –2.5kV.
- Test it with the PiLas laser diode in the trailer and in the ESA setup. It seems to work OK:
1ns/div, 20mV/div, -2.5kV, 1kHz PiLas int. trigger

- Data file: /u2/data/testrun_20050718_0907_100000.root
- PiLas rate: 100Hz, external trigger, MCP at -2.5kV.

- This performance is very similar to that of MCP #83 (the electronics calibration is a bit worse).

Analysis by J.V., 7.19.2005

Electronics calibration signals:

\[ \sigma \approx 37.2\text{ps} \]
- Data file: /u2/data/testrun_20050627_2036_1000000.root
- PiLas rate: 120Hz, external trigger, MCP at –2.6kV.

**diff_vs_t0_linear_extrapolation (signal):**

- \( \sigma \approx 29.5\text{ps} \)
- \( \sigma_{\text{narrow}} \approx 78\text{ps} \)

**diff_vs_t0_linear_extrapolation (calibration):**

- \( \sigma \approx 29.5\text{ps} \)

**PiLas-generated single photons:**

**Electronics calibration signals:**
J.V., 7.19.2005

Last entry to ESA under the control access:
- Add AC coupling to lead glass and Quantacon PMTs. This moved a pedestal down for the Quantacon from ~840 counts to 27 counts as there was a small DC offset.
- Take a short run with 10Hz trigger rate to check the system.
- Take some pictures of relative timing of Philips and SLAC TDCs.
- Switch the PiLas laser diode and the LED pulsing off.

SLAC TDC: 20ns/div, 100mV/div
   Top: Common STOP
   Bot: CFD 3, ch.17

Philips TDC: 10ns/div, 100mV/div
   Top: Common START
   Bot: CFD 3, ch.17

J.V., 7.22.2005

The first beam in ESA – Run 1:
- Thanks to a great help of Mike Stanek, we finally had a beam. It took a long time and a lot of effort. First, during the day, Mike has found cables to bring signals from SEM wires on the Be target. This allowed him to center the primary electron beam on the Be target. He first set the magnet values according to the old GLAST setting, scaled to 10 GeV/c beam. However, that was not enough, still no signal. Then he lowered strength of quads and left dipoles at nominal values. He then increased intensity of electrons to ~1x10^10. Still nothing obvious, only occasionally a burst of pulses. I was interested to see where is the beginning of these bursts. It was ~1.9 µsec before a nominal t_0. Mike could not believe that we are that far away. Nevertheless, we decided to move the timing by that much. Finally, to make it precise, we adjusted it according to what was in my logbook based on the PiLas running. And that was it. We got a clear Cherenkov ring within 15 minutes of running.
- Mike Woods does not understand the 1.9 µsec time offset either. A stuck bit in a Camac module? A software error?
- We had 4 hours of good data taking, accumulated ~120k triggers. See several problems to fix. This is a shopping list:
  a) No TDC signal for the lead glass and Quantacon PMT on a large scintillator. I will put these signals into a Philips TDC where they used to be. They were moved to a LeCroy TDC because of the LED signal, which came too late.
  b) Hodoscope may harvest too much junk since we do not have a TDC to do a tight cut; we may have to tighten the ADC gate width.
c) The hodoscope hits seem to be offset to one side (near channel 1, which is closer to the mirror side of the bar). Is this dependent on the beam line tuning before the collimator? GLAST did some optimization like that.

d) Joe tells me that we have two channels swapped: Philips TDC 15, channel 16 and TDC 15, channel 15 (7-14 and 7-15). Will check.

e) JV-2 MCC pulse is suspected to disappear occasionally. This may cause a loss of pedestal in the SLAC ADCs. The problem was caught when the gated scaler in bldg 420 stop getting gated (since then, I switched to a logic based on the JV-1 signal). Since the JV-2 signal is used to produce the ADC_RESET pulse only, we can replace it easily with the JV-1 signal.

f) We seem to produce several peaks in the Quartz Start counter. Are we hitting not only target but also some flanges?

g) Observed rate of about 0.2 particles per pulse was achieved with an electron current of \(\sim 1 \times 10^{10}\) on the Be target and with an integration window set to integrate pulses for about 200ns after the very earliest one.

- **A monitoring setup available for the MCC operators:**

  SEM wires on the Be target to center the primary beam:  
  A scaler ratio of “Quartz counter/Linac pulses” and a scope display of the same pulses:

- **Signals during the run in the bldg 420:**

  Top: Quartz counter, pad 1, 50ns/div  
  Bot: JV-1 MCC pulse:  
  A ratio “Quartz counter, pad 1/ Linac pulses” Typically we had a value of 15-20%:
Top: Lead glass, 50ns/div
Bot: JV-1 MCC pulse:

Top: Quantacon on a scint., 50ns/div
Bot: JV-1 MCC pulse:

Joe and Josef busy with the data analysis:

The entire monitoring setup for MCC:

J.V., 7.25.2005

Do the following modifications in the ESA setup:

1. Reduce the ADC gate for the hodoscope finger from 150ns to 80ns. This should reduce the vacuum cleaning of the background we may be doing.
2. Replace JV-2 signal with JV-1 to generate the SLAC ADC ADC_STOP_IN pulse. It appeared to us that JV-2 sometimes disappears.
3. Change the HV PS for the Russian MCP. Set the voltage to -2.6kV. During 1 hour I was there it did not trip. Perhaps, it is a PS, which causes the problems.
4. Reset VME PS.
5. Move ADC signals from Quantacon and Lead glass PMTs to old ADC channels.
   Quantacon: ADC in slot 12, ch.4; Lead glass: ADC in slot 12, ch.5. The new ADC has smaller width, so we should be less sensitive to late garbage.
6. Move TDC signals from Quantacon and Lead glass PMTs to old Philips TDC channels.
   Quantacon: TDC in slot 13, ch.6; Lead glass: TDC in slot 13, ch.5.
7. Move some pads to improve a coverage of the Cherenkov signal near the wings:
   Det. Slot 6 - pad changes: 6->14, 21->29, 22->30, 35->43, 36->44.
8. Correct a mistake in previous wiring:
   Det. slot 4 - pads 41<->42.
8. Finally, open the door on the rack on the CFD side as it is warmer inside compared to
outside. Temperature on the amplifier exhaust is 30.1 degC.

9. Joe tells me that when the lead glass has a large pulse we see a shift in the timing marker delta function. This may be caused by some ground jump when a large pulse hits a splitter and half of it goes to a 11mV discriminator. Put an attenuator in front of a splitter as follows: AC coupling+20dB att.+splitter.

10. Take some pictures for the record:

Move some pads in slots 2, 5 & 6 to get better coverage of the Cherenkov ring:
Burle MCP-PMT in slot 4:

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Burle MCP-PMT in slot 5:

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### J. Va’vra’s logbook, Last update: 8.19.2005

#### Burle MCP-PMT in slot 6:

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#### Hamamatsu maPMT in slot 3:

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#### Hamamatsu MaPMT in slot 2:

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#### Numbering in the scanning setup:

![Relative efficiency MCP #2, 2kV, 20030425](image)
### Philips TDC connections:

**J.V., 7.25.2005**

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<th>Detector Slot</th>
<th>Amp. channels (pad number)</th>
<th>CFD number</th>
<th>LEMO cable label</th>
<th>Philips TDC CAMAC slot</th>
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</tbody>
</table>

* In red: recent changes, in blue: ch. 41 & 42 in slot 2 (CFD 4) are still confused and to be checked
Trigger in the Test Beam_b

To generate (in movable rack): COMMON STOP, TAC RESET and Russian MCP calib.

COMMON START for Philips TDC (CAMAC Crate #2) and CFD timing markers:
Some comments about the beam line A:  

J.V., 7.27.2005

- This area is not understood at the moment
- GLAST has worked on their beam for several days. We did it for 2-3 hours only with help from Mike Stanek and Roger Erickson.

- **Tune these quantities in the last run on Tuesday:**
  a) Q-10 & Q-11 quads (from some reason they are only a 1/4 of expected value)
  b) Horizontal trim coil T-28 (not much effect)
  c) SL-10 collimator (not much effect)
  d) C-37 horizontal & vertical collimator (we do see its effect in our hodoscope)

- **Plan for next major run:**
  a) With a tight C-37 collimator in the horizontal plane, try to adjust a horizontal corrector to center our spot on our hodoscope (already talked to Mike Stanek about it and he agrees that this is good thing to try). Vertically we seem to be centered and do see the effect of the horizontal C-37 collimator already.
  b) Check the polarity assignment for the beam line A magnets.
  c) Bring a primary beam partially into beam line A to check that everything is OK. They can monitor it very precisely. This requires approval of the safety committee and we have to make sure that we also would not be exposed to any background resulting from this.
  d) Provide a display of the hodoscope vertical and horizontal profiles to MCC (another TV ?)
List of other things to do:

- Understand the data from point of view of hardware errors
- Lead glass (may have too high voltage – looking into it).
- Start counters
- Will wait for the beam opportunity in the next week or so
- Right now we think we may get some beam for two days after August 12.