

Focusing DIRC prototype

(T-469 test)

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Technicians who built it: M. McCulloch, B. Reif

Special thanks to:

Engineering help: T. Thurston and A. Scholz

EFD help to setup the beam line: C. Hast, J. Weisand, and their techs

Alignment: C. LeCocq and her crew.

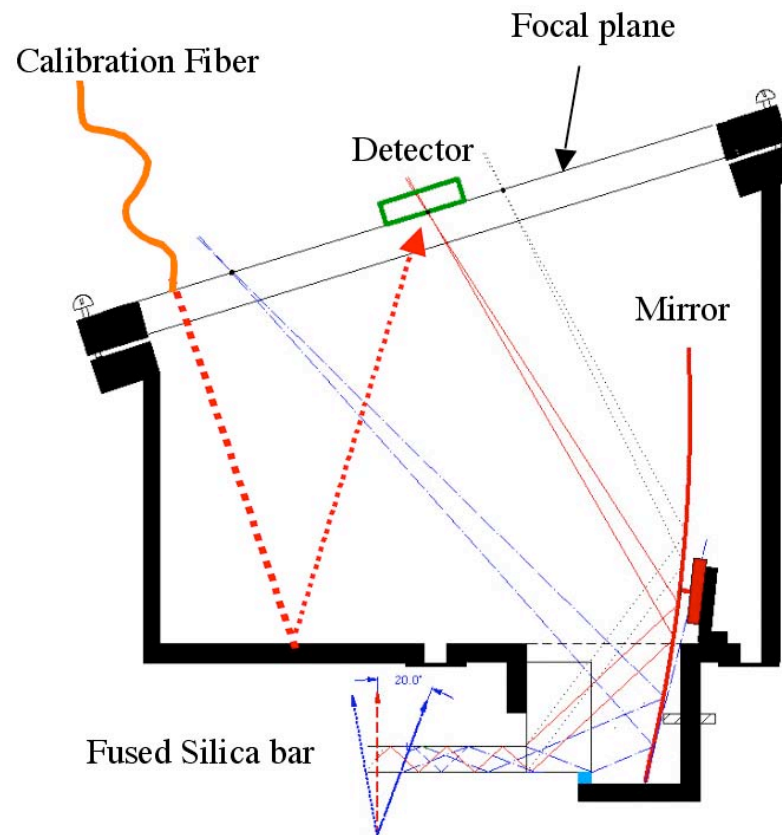
MCC help: M. Stanek, R. Erickson, and MCC operators running our beam

Advice about running in ESA: R. Arnold, P. Bosted

Motivation

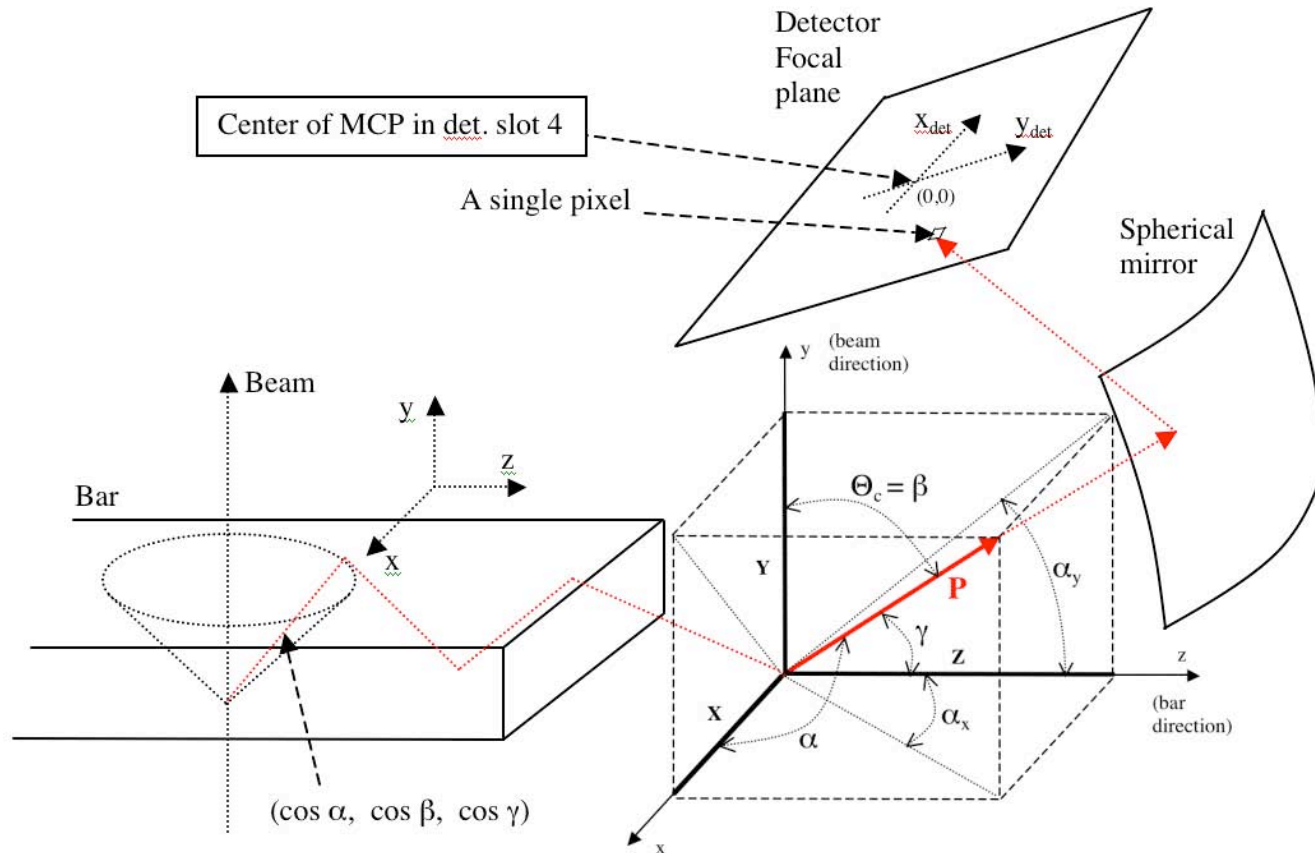
- DIRC is a very successful particle identifying detector.
- One can measure its success by a fact that the Japanese are trying to come up with it also for their Super B-factory. They are choosing to measure **x & Time-of-Propagation (TOP time)** for each Cherenkov photon.
- We thought that we should be in a position to propose DIRC upgrade for Super B-factory, which would be capable of taking higher rates, be less sensitive to background and be able to correct the chromatic error contribution to the Cherenkov angle. We are choosing to measure **x, y and the TOP time** for each photon. We believe that this a better way to do it in a high background.

Optics of the prototype



- Spherical mirror corrects quartz bar thickness
- Oil filling makes it affordable; a final device would be made out of solid quartz.

Focusing DIRC principle



- **Each detector pixel determines these photon parameters:**
 θ_c , α_x , α_y , $\cos \alpha$, $\cos \beta$, $\cos \gamma$, L_{path} , $t_{propagation}$, $n_{bounces}$ – for average λ .

A beautiful aspect of DIRC - predictivity of the photon propagation in the bar, if everything is right...

Detector slot #1 - detector plane shifted down by 1.5cm based on the common ray telescope scan
 (baric 100; pad using the bars, gap between pads: 8mm; F=0.514685714 Meters, full range: 520mm
 Center of the local coordinate system is at center of MCP; in case of Slot #1, it is also a center of the overall system)

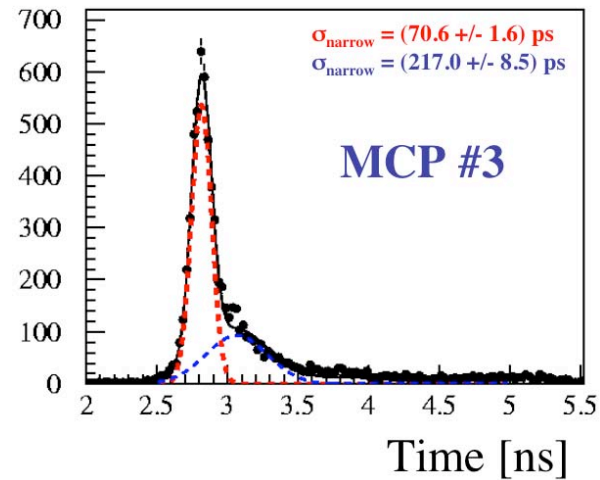
Pad number (cm)	z (cm)	z_start (cm)	z_end (cm)	theta_c (deg)	L_path1 (cm)	n_bounces1	t_path1 (ns)	L_path2 (cm)	n_bounces2	t_path2 (ns)	dT (ns)	
1	0	-15	-22	22	-22	80.447	43	4.028	913.58	489	45.75	41.722
2	0	-15	-16.4208	-22	-16.4208	80.447	43	4.028	913.58	489	45.75	41.722
3	0	-15	-10.8416	-22	-10.8416	80.447	43	4.028	913.58	489	45.75	41.722
4	0	-15	-5.2624	-22	-5.2624	80.447	43	4.028	913.58	489	45.75	41.722
5	0	-15	0.3168	-22	0.3168	80.447	43	4.028	913.58	489	45.75	41.722
6	0	-15	5.896	-22	5.896	80.447	43	4.028	913.58	489	45.75	41.722
7	0	-15	11.4752	-22	11.4752	80.447	43	4.028	913.58	489	45.75	41.722
8	0	-15	17.0544	-22	17.0544	80.447	43	4.028	913.58	489	45.75	41.722
9	0	-15	22.6336	-22	22.6336	80.447	43	4.028	913.58	489	45.75	41.722
10	0	-15	28.2128	-22	28.2128	80.447	43	4.028	913.58	489	45.75	41.722
11	0	-15	33.792	-22	33.792	80.447	43	4.028	913.58	489	45.75	41.722
12	0	-15	39.3712	-22	39.3712	80.447	43	4.028	913.58	489	45.75	41.722
13	0	-15	44.9504	-22	44.9504	80.447	43	4.028	913.58	489	45.75	41.722
14	0	-15	50.5296	-22	50.5296	80.447	43	4.028	913.58	489	45.75	41.722
15	0	-15	56.1088	-22	56.1088	80.447	43	4.028	913.58	489	45.75	41.722
16	0	-15	61.688	-22	61.688	80.447	43	4.028	913.58	489	45.75	41.722
17	0	-15	67.2672	-22	67.2672	80.447	43	4.028	913.58	489	45.75	41.722
18	0	-15	72.8464	-22	72.8464	80.447	43	4.028	913.58	489	45.75	41.722
19	0	-15	78.4256	-22	78.4256	80.447	43	4.028	913.58	489	45.75	41.722
20	0	-15	84.0048	-22	84.0048	80.447	43	4.028	913.58	489	45.75	41.722
21	0	-15	89.584	-22	89.584	80.447	43	4.028	913.58	489	45.75	41.722
22	0	-15	95.1632	-22	95.1632	80.447	43	4.028	913.58	489	45.75	41.722
23	0	-15	100.7424	-22	100.7424	80.447	43	4.028	913.58	489	45.75	41.722
24	0	-15	106.3216	-22	106.3216	80.447	43	4.028	913.58	489	45.75	41.722
25	0	-15	111.9008	-22	111.9008	80.447	43	4.028	913.58	489	45.75	41.722
26	0	-15	117.48	-22	117.48	80.447	43	4.028	913.58	489	45.75	41.722
27	0	-15	123.0592	-22	123.0592	80.447	43	4.028	913.58	489	45.75	41.722
28	0	-15	128.6384	-22	128.6384	80.447	43	4.028	913.58	489	45.75	41.722
29	0	-15	134.2176	-22	134.2176	80.447	43	4.028	913.58	489	45.75	41.722
30	0	-15	139.7968	-22	139.7968	80.447	43	4.028	913.58	489	45.75	41.722
31	0	-15	145.376	-22	145.376	80.447	43	4.028	913.58	489	45.75	41.722
32	0	-15	150.9552	-22	150.9552	80.447	43	4.028	913.58	489	45.75	41.722
33	0	-15	156.5344	-22	156.5344	80.447	43	4.028	913.58	489	45.75	41.722
34	0	-15	162.1136	-22	162.1136	80.447	43	4.028	913.58	489	45.75	41.722
35	0	-15	167.6928	-22	167.6928	80.447	43	4.028	913.58	489	45.75	41.722
36	0	-15	173.272	-22	173.272	80.447	43	4.028	913.58	489	45.75	41.722
37	0	-15	178.8512	-22	178.8512	80.447	43	4.028	913.58	489	45.75	41.722
38	0	-15	184.4304	-22	184.4304	80.447	43	4.028	913.58	489	45.75	41.722
39	0	-15	190.0096	-22	190.0096	80.447	43	4.028	913.58	489	45.75	41.722
40	0	-15	195.5888	-22	195.5888	80.447	43	4.028	913.58	489	45.75	41.722
41	0	-15	201.168	-22	201.168	80.447	43	4.028	913.58	489	45.75	41.722
42	0	-15	206.7472	-22	206.7472	80.447	43	4.028	913.58	489	45.75	41.722
43	0	-15	212.3264	-22	212.3264	80.447	43	4.028	913.58	489	45.75	41.722
44	0	-15	217.9056	-22	217.9056	80.447	43	4.028	913.58	489	45.75	41.722
45	0	-15	223.4848	-22	223.4848	80.447	43	4.028	913.58	489	45.75	41.722
46	0	-15	229.064	-22	229.064	80.447	43	4.028	913.58	489	45.75	41.722
47	0	-15	234.6432	-22	234.6432	80.447	43	4.028	913.58	489	45.75	41.722
48	0	-15	240.2224	-22	240.2224	80.447	43	4.028	913.58	489	45.75	41.722
49	0	-15	245.8016	-22	245.8016	80.447	43	4.028	913.58	489	45.75	41.722
50	0	-15	251.3808	-22	251.3808	80.447	43	4.028	913.58	489	45.75	41.722
51	0	-15	256.96	-22	256.96	80.447	43	4.028	913.58	489	45.75	41.722
52	0	-15	262.5392	-22	262.5392	80.447	43	4.028	913.58	489	45.75	41.722
53	0	-15	268.1184	-22	268.1184	80.447	43	4.028	913.58	489	45.75	41.722
54	0	-15	273.6976	-22	273.6976	80.447	43	4.028	913.58	489	45.75	41.722
55	0	-15	279.2768	-22	279.2768	80.447	43	4.028	913.58	489	45.75	41.722
56	0	-15	284.856	-22	284.856	80.447	43	4.028	913.58	489	45.75	41.722
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59	0	-15	301.5936	-22	301.5936	80.447	43	4.028	913.58	489	45.75	41.722
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61	0	-15	312.752	-22	312.752	80.447	43	4.028	913.58	489	45.75	41.722
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63	0	-15	323.9104	-22	323.9104	80.447	43	4.028	913.58	489	45.75	41.722
64	0	-15	329.4896	-22	329.4896	80.447	43	4.028	913.58	489	45.75	41.722
65	0	-15	335.0688	-22	335.0688	80.447	43	4.028	913.58	489	45.75	41.722
66	0	-15	340.648	-22	340.648	80.447	43	4.028	913.58	489	45.75	41.722
67	0	-15	346.2272	-22	346.2272	80.447	43	4.028	913.58	489	45.75	41.722
68	0	-15	351.8064	-22	351.8064	80.447	43	4.028	913.58	489	45.75	41.722
69	0	-15	357.3856	-22	357.3856	80.447	43	4.028	913.58	489	45.75	41.722
70	0	-15	362.9648	-22	362.9648	80.447	43	4.028	913.58	489	45.75	41.722
71	0	-15	368.544	-22	368.544	80.447	43	4.028	913.58	489	45.75	41.722
72	0	-15	374.1232	-22	374.1232	80.447	43	4.028	913.58	489	45.75	41.722
73	0	-15	379.7024	-22	379.7024	80.447	43	4.028	913.58	489	45.75	41.722
74	0	-15	385.2816	-22	385.2816	80.447	43	4.028	913.58	489	45.75	41.722
75	0	-15	390.8608	-22	390.8608	80.447	43	4.028	913.58	489	45.75	41.722
76	0	-15	396.44	-22	396.44	80.447	43	4.028	913.58	489	45.75	41.722
77	0	-15	402.0192	-22	402.0192	80.447	43	4.028	913.58	489	45.75	41.722
78	0	-15	407.5984	-22	407.5984	80.447	43	4.028	913.58	489	45.75	41.722
79	0	-15	413.1776	-22	413.1776	80.447	43	4.028	913.58	489	45.75	41.722
80	0	-15	418.7568	-22	418.7568	80.447	43	4.028	913.58	489	45.75	41.722
81	0	-15	424.336	-22	424.336	80.447	43	4.028	913.58	489	45.75	41.722
82	0	-15	429.9152	-22	429.9152	80.447	43	4.028	913.58	489	45.75	41.722
83	0	-15	435.4944	-22	435.4944	80.447	43	4.028	913.58	489	45.75	41.722
84	0	-15	441.0736	-22	441.0736	80.447	43	4.028	913.58	489	45.75	41.722
85	0	-15	446.6528	-22	446.6528	80.447	43	4.028	913.58	489	45.75	41.722
86	0	-15	452.232	-22	452.232	80.447	43	4.028	913.58	489	45.75	41.722
87	0	-15	457.8112	-22	457.8112	80.447	43	4.028	913.58	489	45.75	41.722
88	0	-15	463.3904	-22	463.3904	80.447	43	4.028	913.58	489	45.75	41.722
89	0	-15	468.9696	-22	468.9696	80.447	43	4.028	913.58	489	45.75	41.722
90	0	-15	474.5488	-22	474.5488	80.447	43	4.028	913.58	489	45.75	41.722
91	0	-15	480.128	-22	480.128	80.447	43	4.028	913.58	489	45.75	41.722
92	0	-15	485.7072	-22	485.7072	80.447	43	4.028	913.58	489	45.75	41.722
93	0	-15	491.2864	-22	491.2864	80.447	43	4.028	913.58	489	45.75	41.722
94	0	-15	496.8656	-22	496.8656	80.447	43	4.028	913.58	489	45.75	41.722
95	0	-15	502.4448	-22	502.4448	80.447	43	4.028	913.58	489	45.75	41.722
96	0	-15	508.024	-22	508.024	80.447	43	4.028	913.58	489	45.75	41.722
97	0	-15	513.6032	-22	513.6032	80.4						

Photon detectors in this test: $\sigma \sim 70\text{-}140\text{ps}$

Burle MCP PMT (64 pixels):



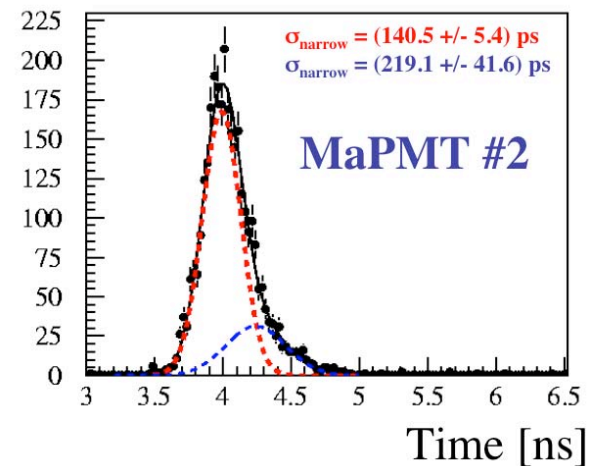
Burle 85011-501 MCP-PMT:



Hamamatsu MaPMT (64 pixels):

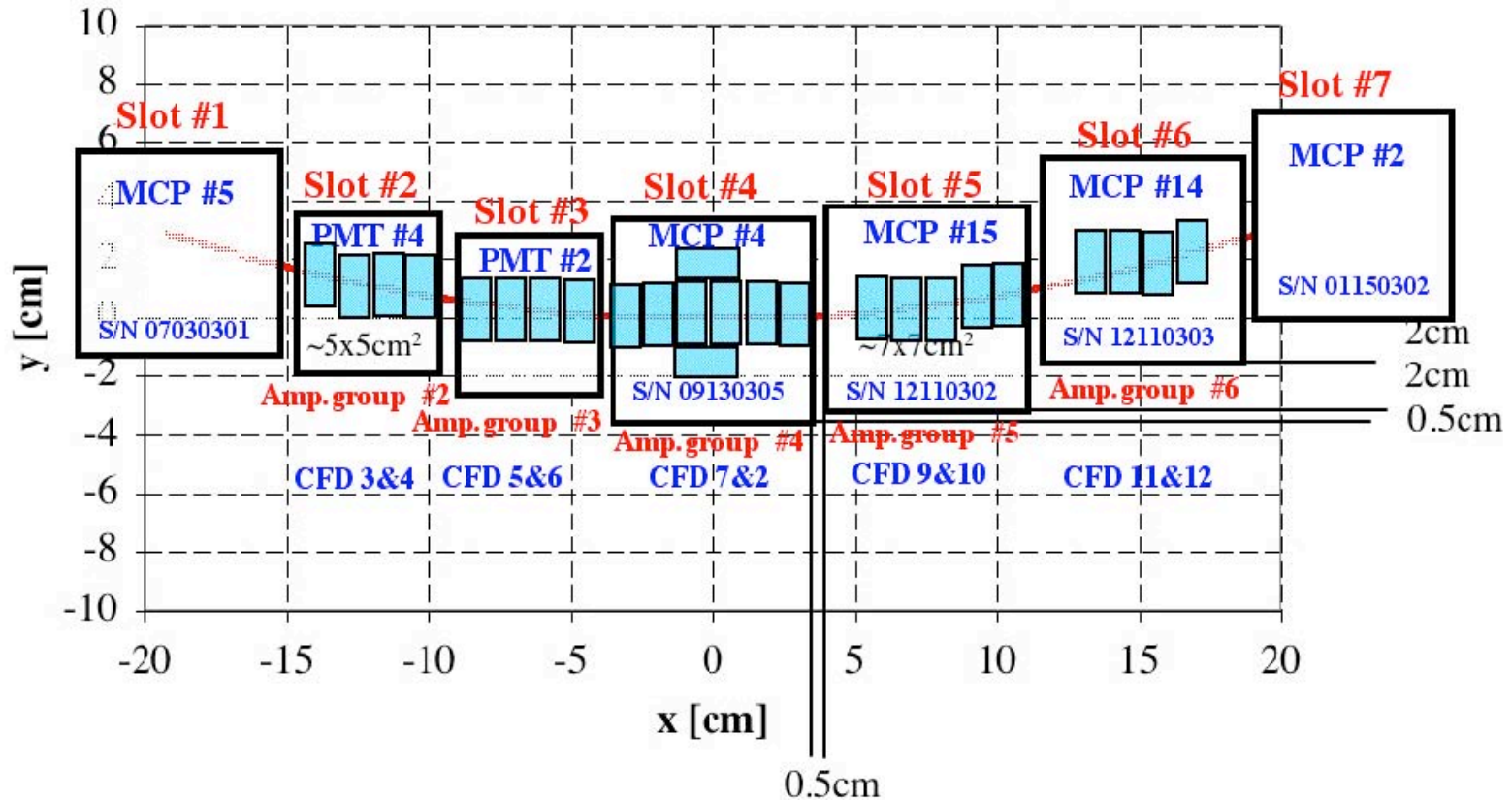


Hamamatsu Flat Panel H8500 PMT:



Distribution of detectors on the prototype

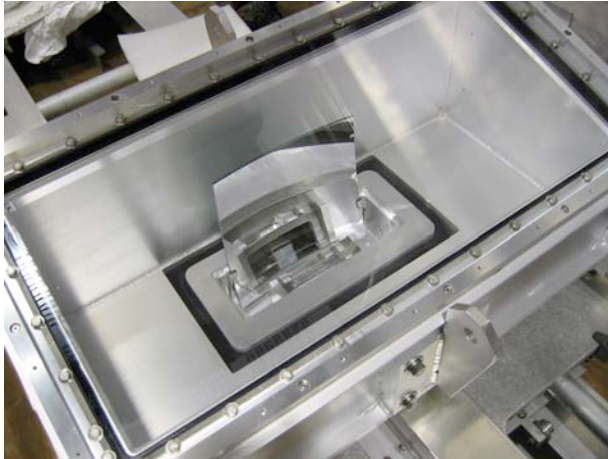
Cherenkov Ring Image in Detector plane



- 2 Hamamatsu MaPMTs
- 3 Burle MCPs

Detector setup in ESA

Mirror and oil-filled detector box:

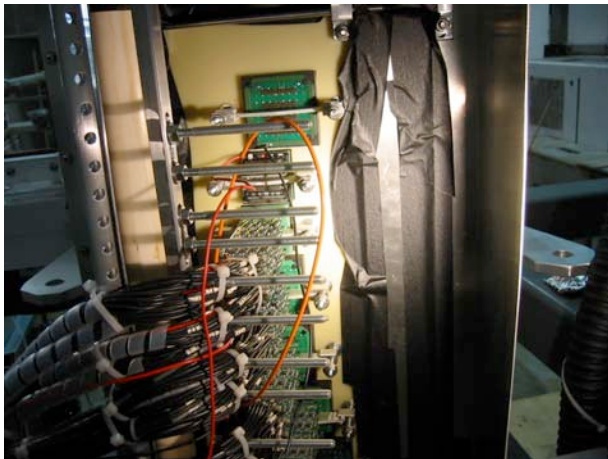


Start counters, lead glass:



Orient the MCPs to minimize the timing dependency on the beam position

Electronics:



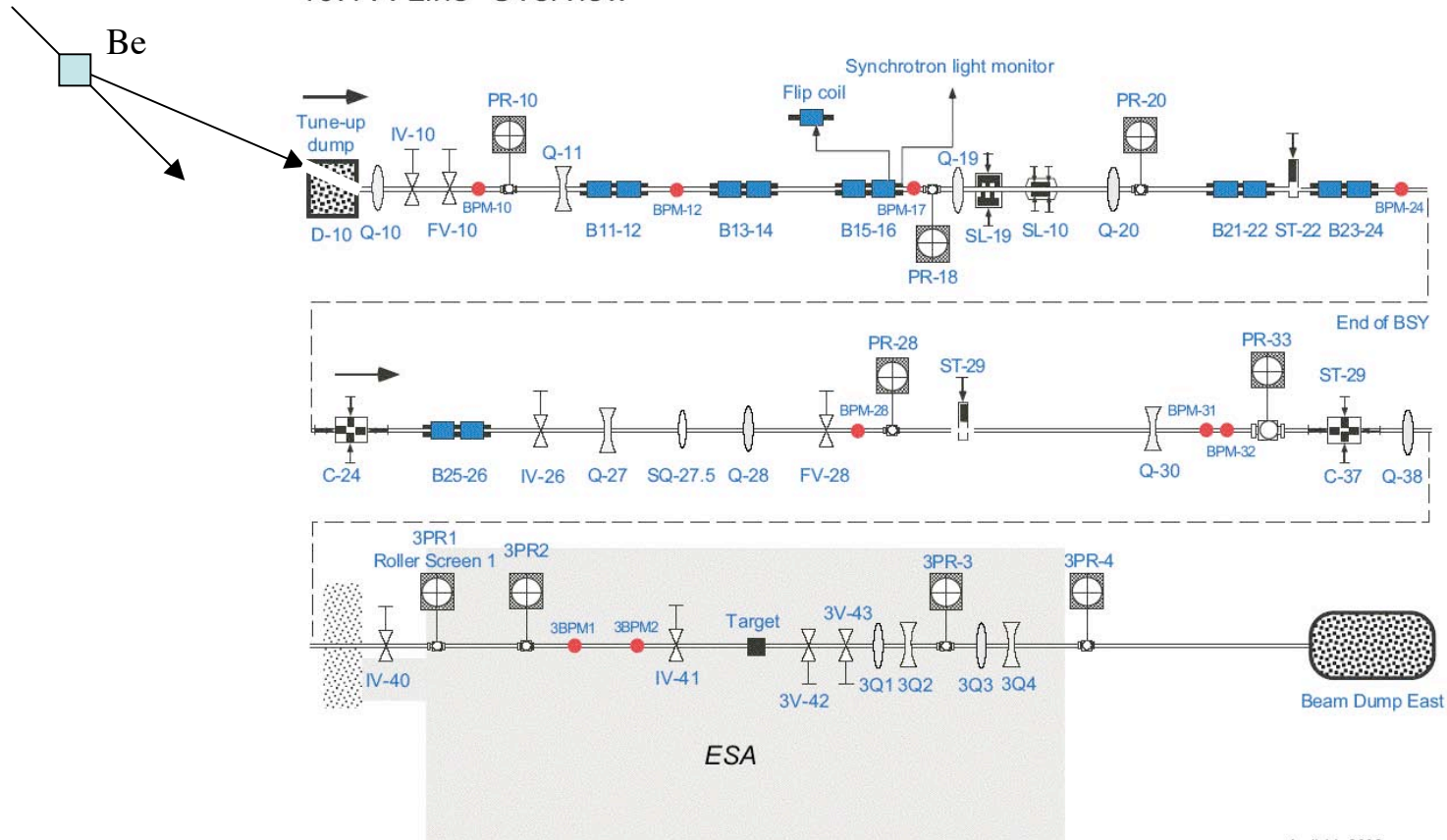
Movable bar support, hodoscope:



Moving the bar worked very well

Beam line A

10.1 A-Line Overview

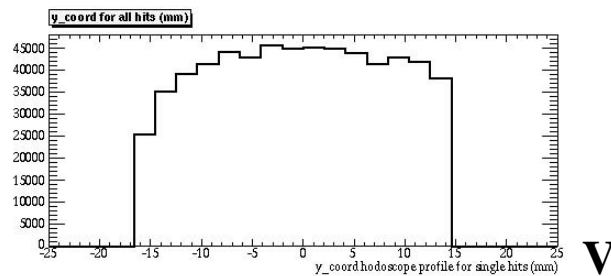


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 10.1, Page 1 of 1

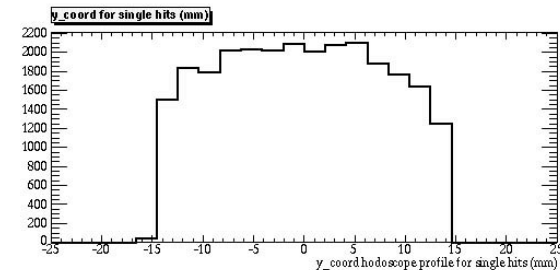
- Q10 & Q11 had to run at a very low current, otherwise we would get nothing. Mike Stanek found a solution to “detune” all other quads compared to nominal values. As a result, we had a “beam pipe filler” beam entering the collimator.

Beam profile in the fiber hodoscope

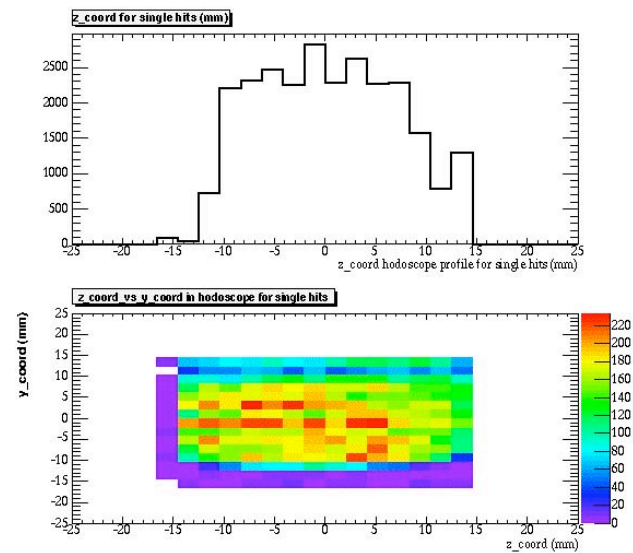
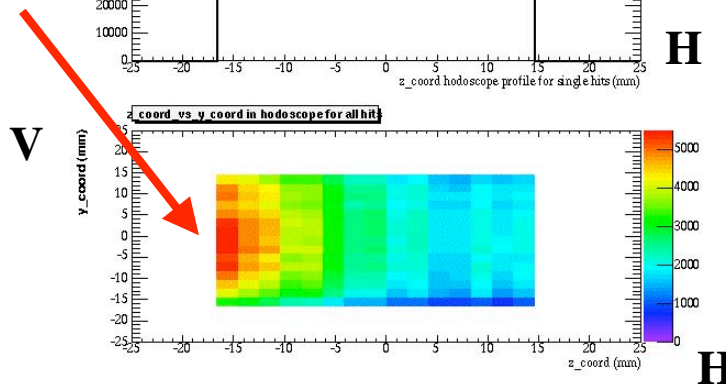
All triggers:



Single hodoscope hits only:



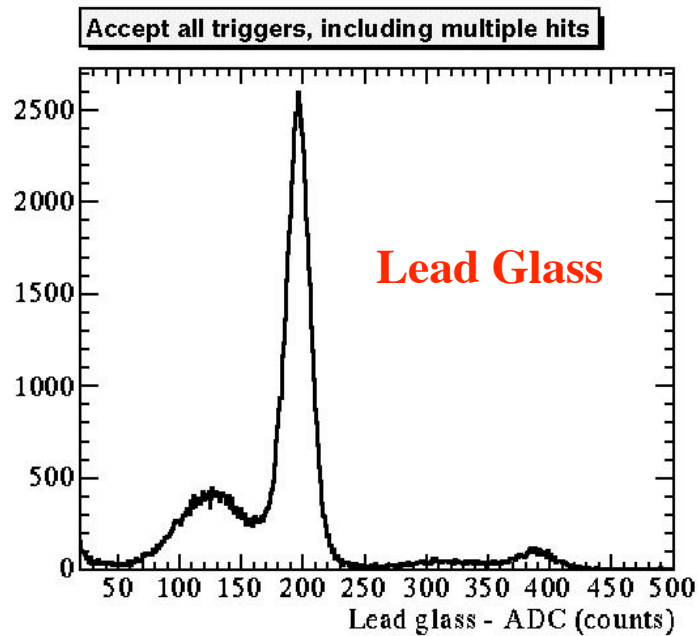
Hot spot
dominated
by multiple
hit events



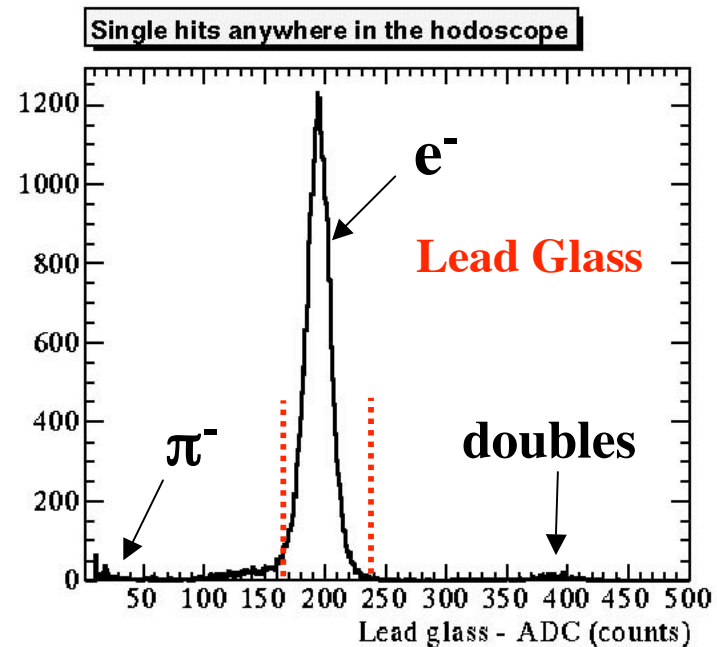
- The big blob on left side dominated by multiple hits (showers). Demanding the single hits in the hodoscope cleaned up the distribution.

For the negative polarity: mostly electrons

All triggers:



Single hodoscope hits only:

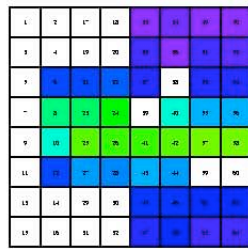


- P. Bosted guess: should get mostly electrons when selecting the negative polarity in beam line A with a Be target. We confirm that.
- **A definition of a “good” event: single hit in hodoscope and tight correct energy in the lead glass ($160 < \text{ADC} < 240$) - this cleans up our events nicely.**

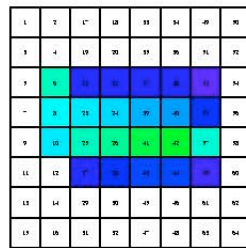
Cherenkov ring in x & y plane

Joe's picture:

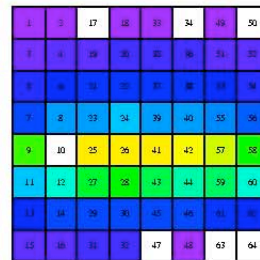
Focusing DIRC Prototype Occupancy Run 6, August 17, 2005



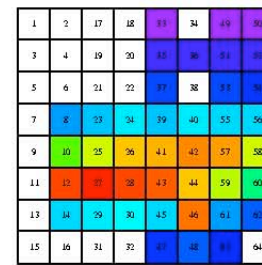
Slot 2
Hamamatsu
CFD 3 CFD 4



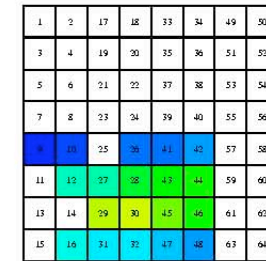
Slot 3
Hamamatsu
CFD 5 CFD 6



Slot 4
Burle
CFD 7 CFD 8



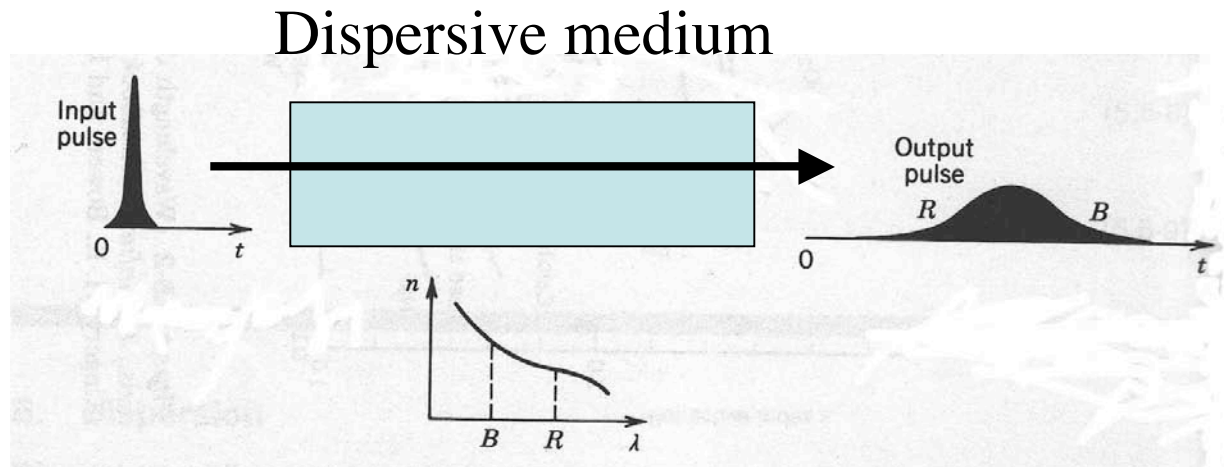
Slot 5
Burle
CFD 9 CFD 10



Slot 6
Burle
CFD 11 CFD 12

- A clear image, but that is not what we are after. In this test, we are mainly interested in the time domain.
- Not all pixels instrumented, only those around the ring.

Chromatic broadening of a light impulse

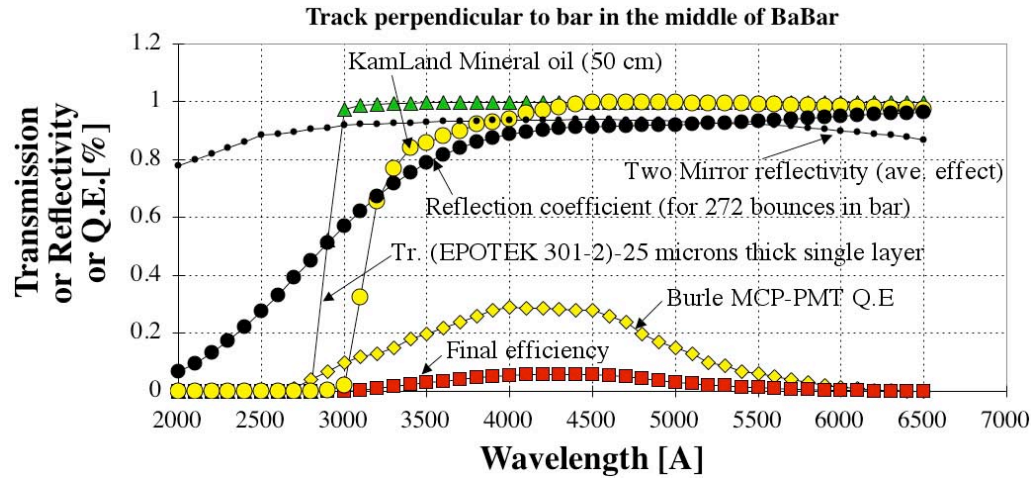


$$dt = -L \lambda \, d\lambda / c_0 * d^2n/d\lambda^2$$

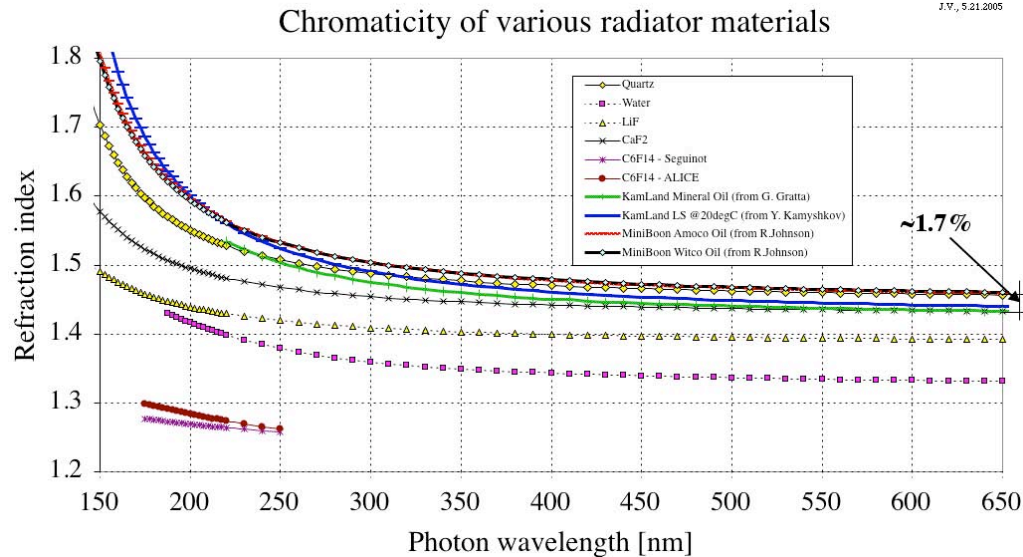
dt is pulse dispersion, fiber length L , wavelength bandwidth $d\lambda$, refractive index $n(\lambda)$

- Well known effect in the fiber industry
- DIRC behaves the same way.

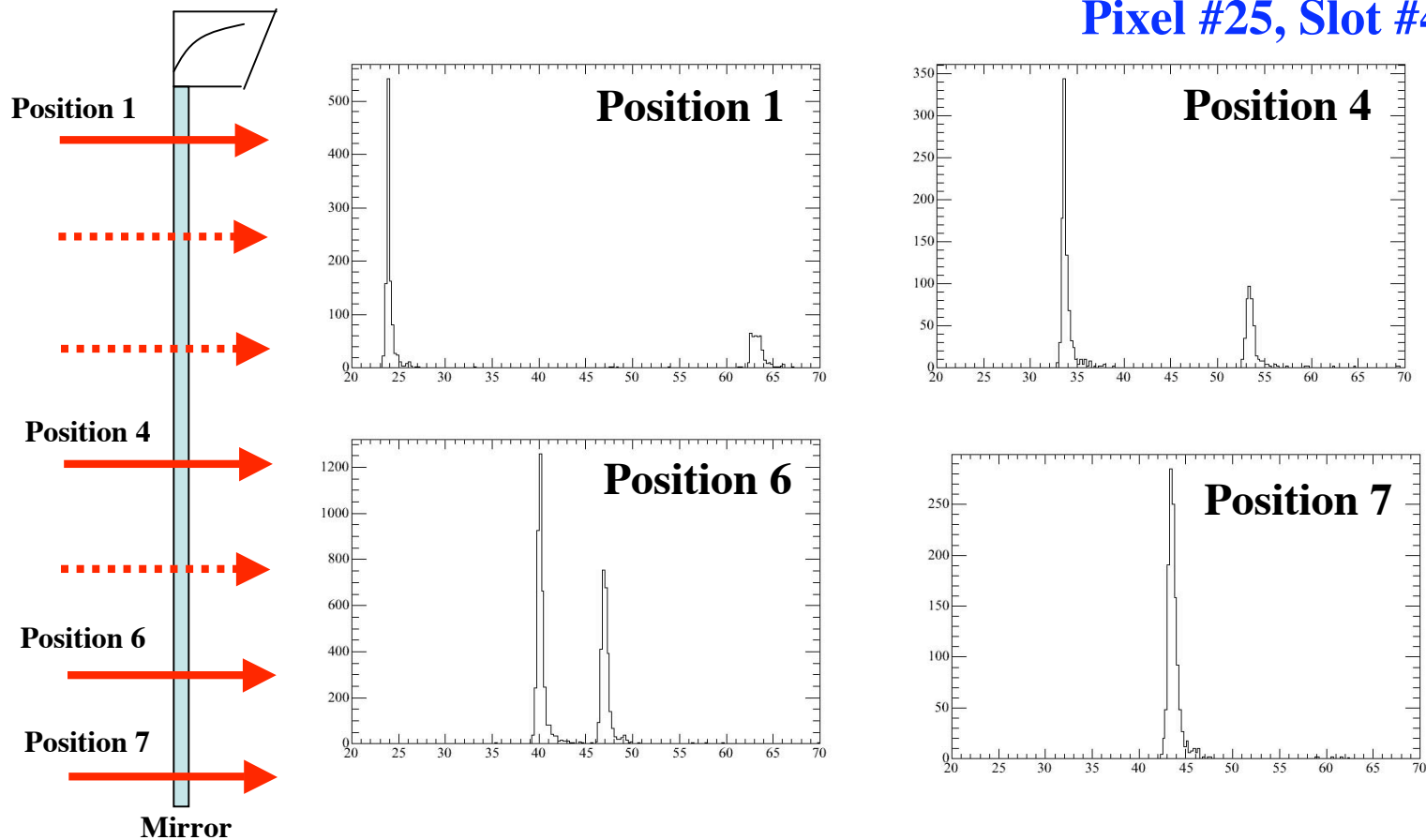
Focusing DIRC chromaticity



- Burle QE curve has a peak a bit higher than that of the DIRC PMT.
- $d\lambda \sim 300 \text{ nm}$
- Assume an average wavelength of $\sim 430 \text{ nm}$
- Some uncertainty in the oil refraction index ($< 1.7\%$).

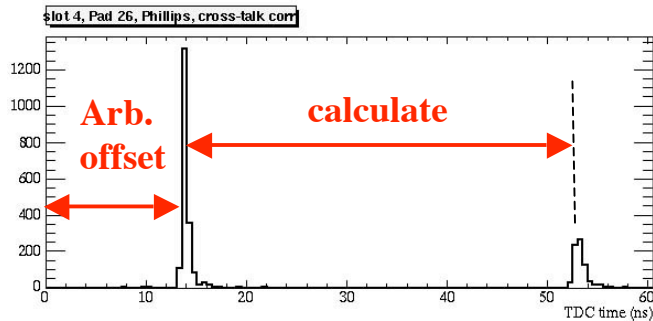


The Cherenkov ring in the time domain

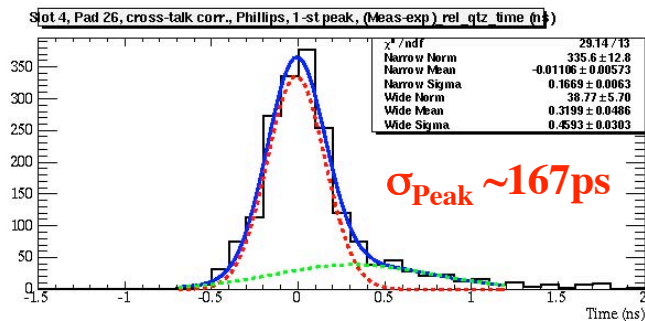


- Two peaks correspond to forward and backward going part of the Cherenkov ring (the backward part is reflected by a mirror back)

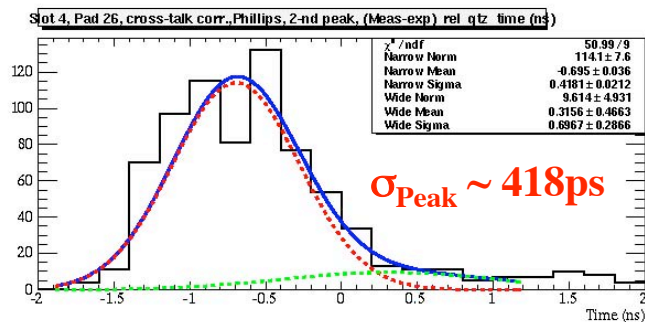
Chromatic growth in pixel #26, slot 4, Run7, position 1 (Burle MCP)



1-st peak:



2-nd peak:

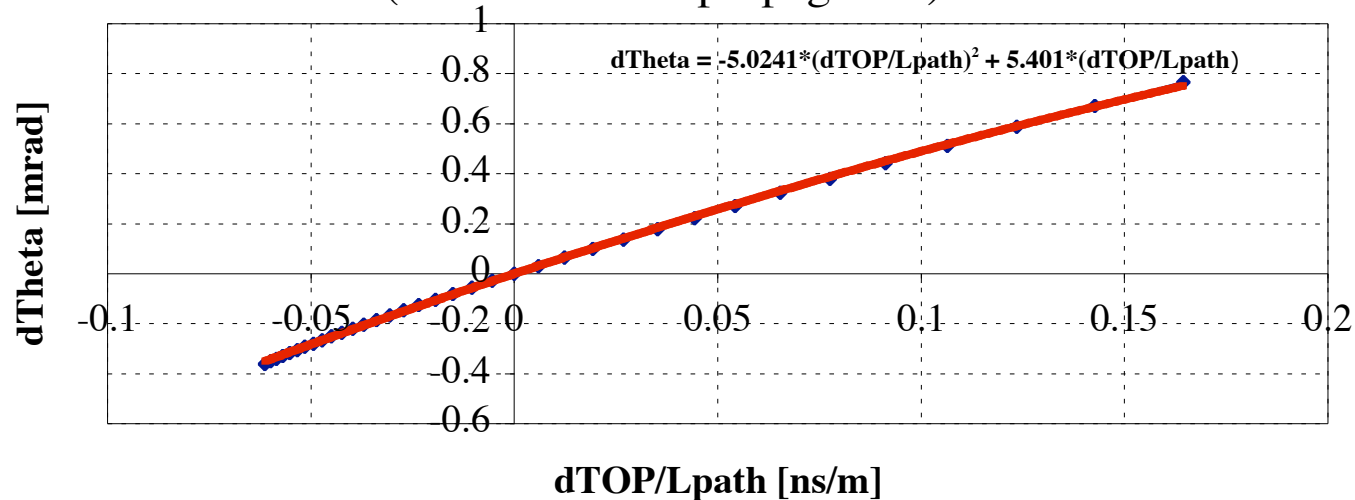


- The largest chromatic effect is in the position 1
- Peak 1 was first adjusted with Joe's constants based on the PiLas calibration. Then it was adjusted arbitrarily adjusted to zero by a constant $C_{\text{pad26,slot4,run7}}$.
- Peak 2 was adjusted using the calculated offse using my spreadsheet, and assuming a TDC calibration of 23 ps/count.
- The 2-nd peak does not come to zero. It is off by $\sim .65\text{ns}$ at present.
- Corrected for the MCP cross-talk and for time drift using the Start counter 1.
- Assume that the detector plane is shifted down by 1.5cm in this analysis.

Chromatic correction

J.V., 8.20.2005

$d\theta = f(dTOP/Lpath)$ for 10GeV/c e⁻
(TOP = time-of-propagation)

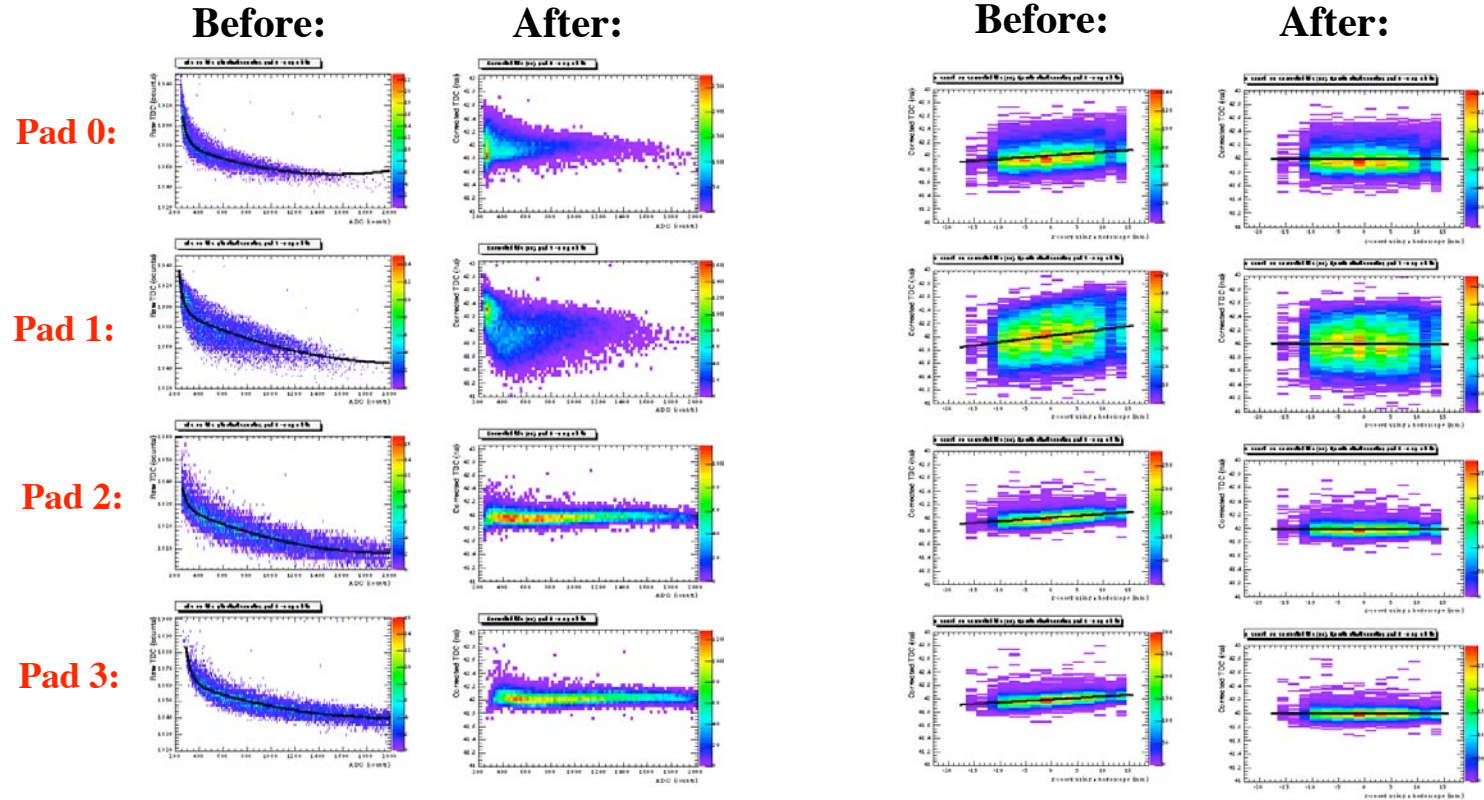


- An average photon with a color of $\sim 430\text{nm}$ arrives at 0 ns offset, and the Cherenkov angle is not corrected.
- A photon of different color, arrives either early or late. We can calculate its total photon path length, measure dTOP, and then determine $d\theta_c$ according to the above graph (one way to do it).
- **Doing this correction, and doing several other upgrades in future, the future Focusing DIRC could reach the π/K PID limit of 5-6 GeV/c.**

Start counter 1 - Quartz counter MCP

ADC correction:

Z- position correction:

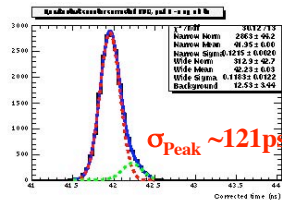


- MCP pads 3 & 4 see much more light. Will use only those for the time definition.

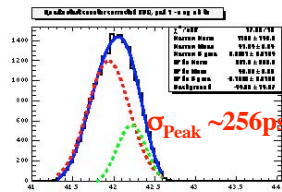
Start counter 1 - Quartz counter MCP

Individual pads:

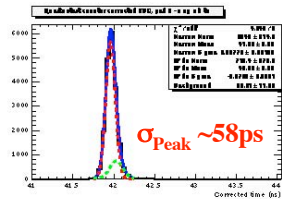
Pad 0:



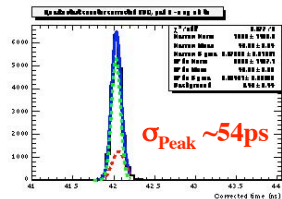
Pad 1:



Pad 2:

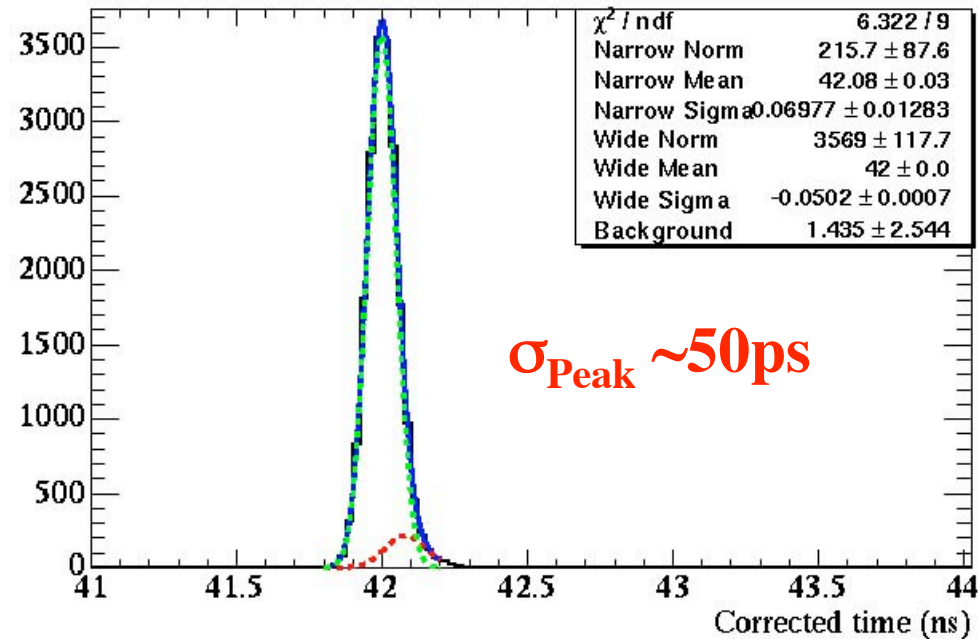


Pad 3:



Average of 2 pads (3 & 4):

Quartz start counter c1 orrected TDC, ave of 2 pads - single hits



- Excellent resolution. Time drifts due to temperature effects are not yet corrected out, so further improvements possible.

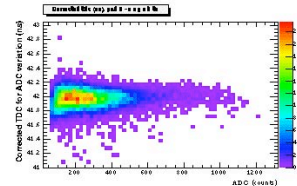
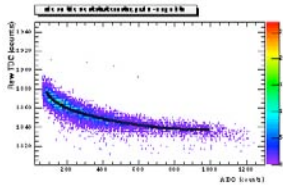
Start counter 2 - Scintillator counter MCP

ADC correction:

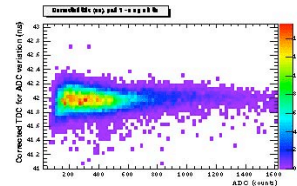
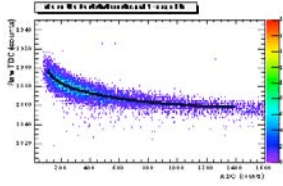
Before:

After:

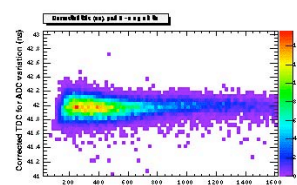
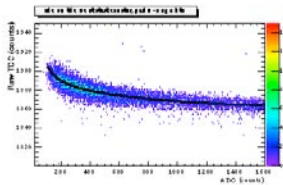
Pad 0:



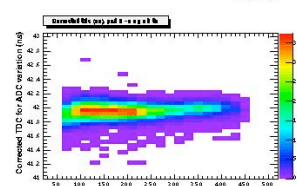
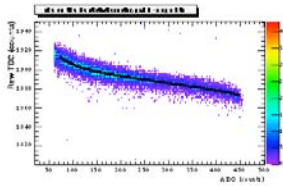
Pad 1:



Pad 2:



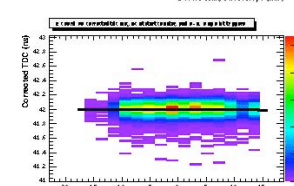
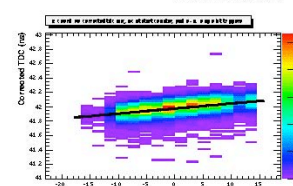
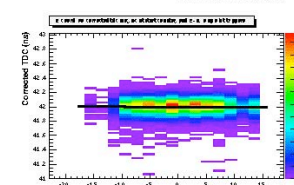
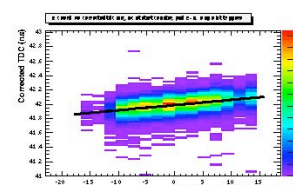
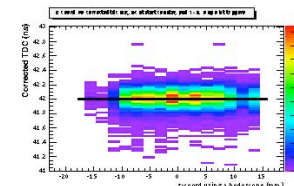
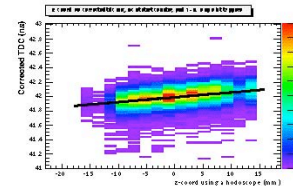
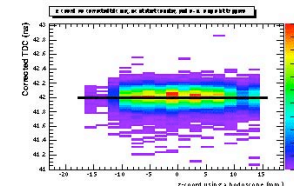
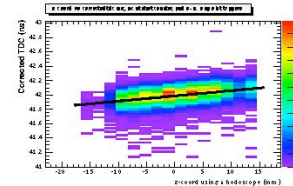
Pad 3:



Z- position correction:

Before:

After:

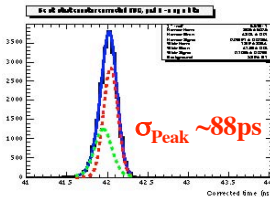


- All MCP pads are OK.

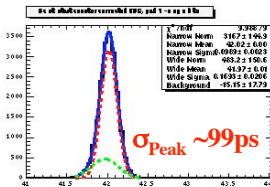
Start counter 2 - Scintillator counter MCP

Individual pads:

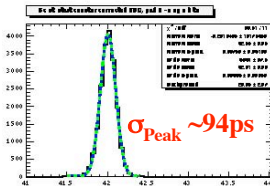
Pad 0:



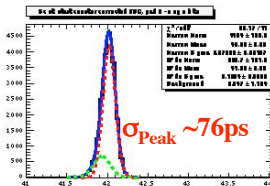
Pad 1:



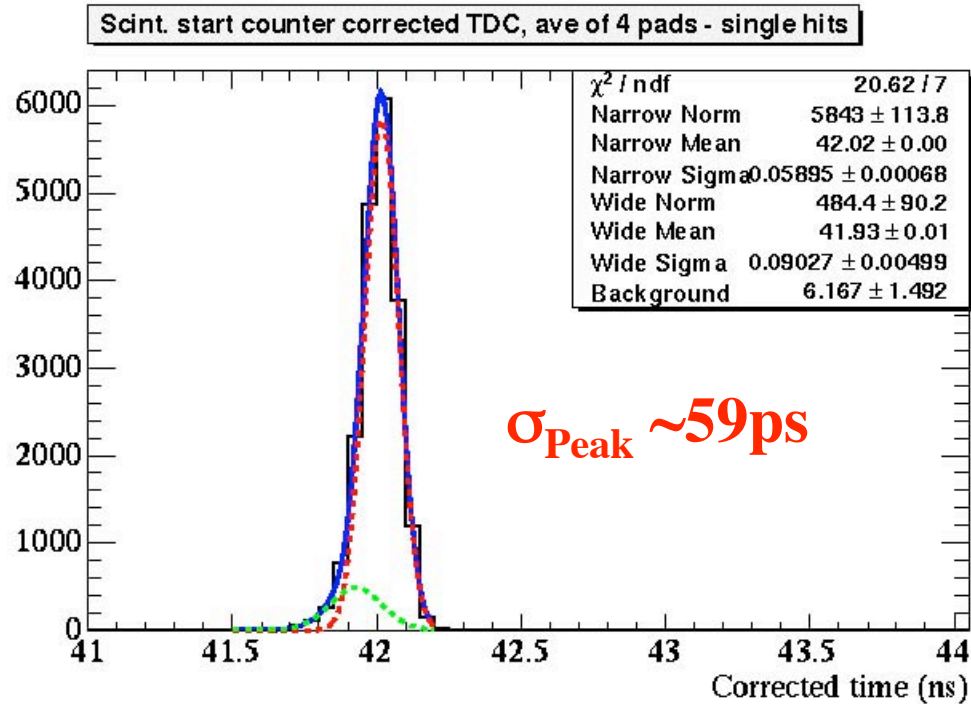
Pad 2:



Pad 3:



Average of all pads:

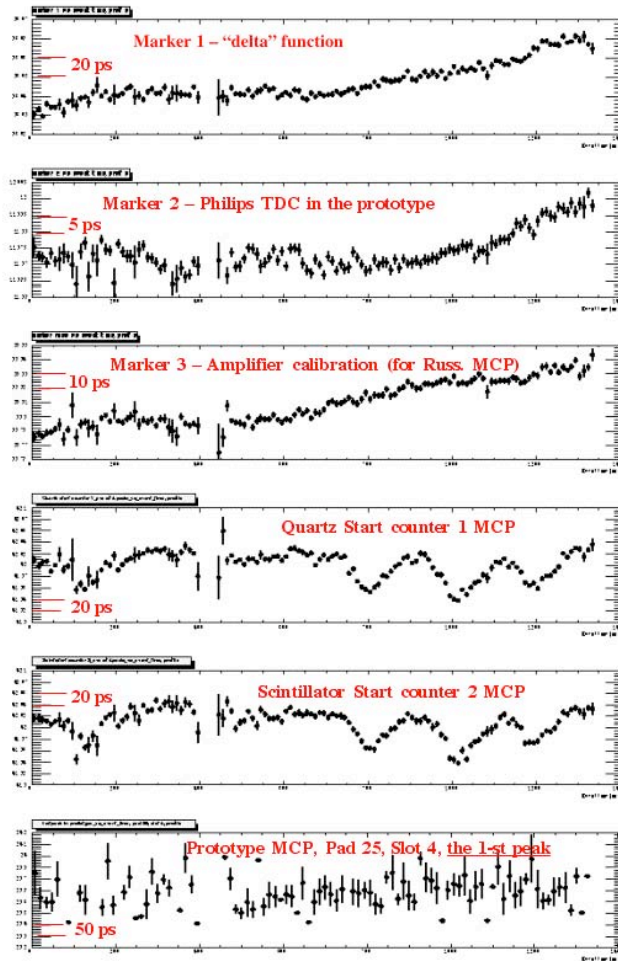


- Excellent resolution. Time drifts due to temperature effects are not yet corrected out, so further improvements possible.

The timing stability and TDC calibration is very critical for this type of detector

Run 7, Position 1 – Stability as a function of time over ~22 hours:

Time
Drift [ns]

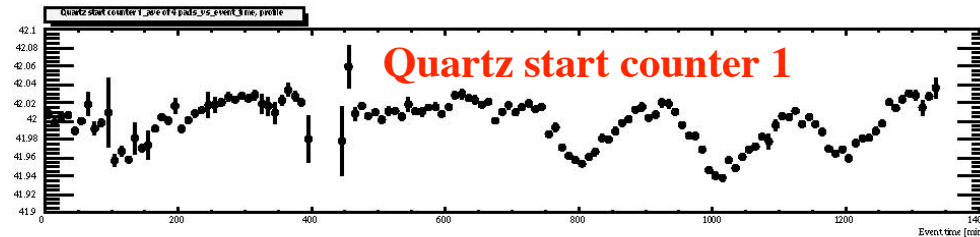


Elapsed time [min]

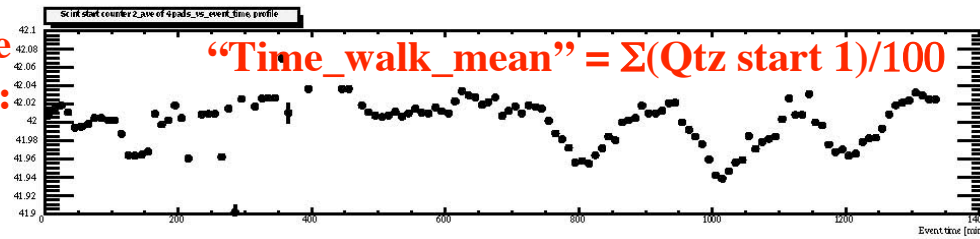
- To keep track of the timing drifts between the MCC start signal and the beam, we have two precise beam start counters (can probably achieve better than $\sigma < 50\text{ps}$).
- To keep track of timing drifts within the electronics system, we have altogether 7 timing markers, which can be used to correct the system drifts (can easily achieve $\sigma < 5\text{-}10\text{ps}$).
- Understanding of the TDC calibration and its stability using a PiLas laser diode is very important.

Correction using the Start counter 1

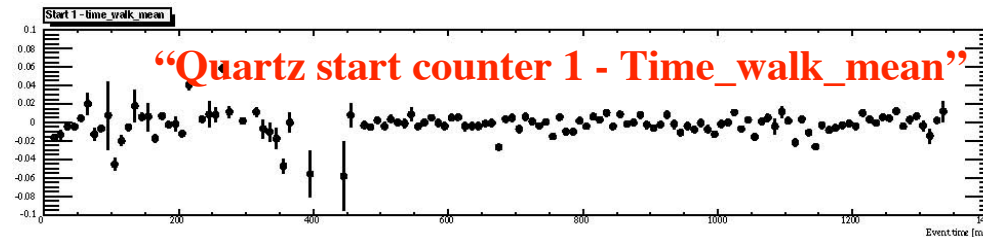
Profile of
Quartz Start
counter 1:



Correction reference
“Time_walk_mean”:



Difference:



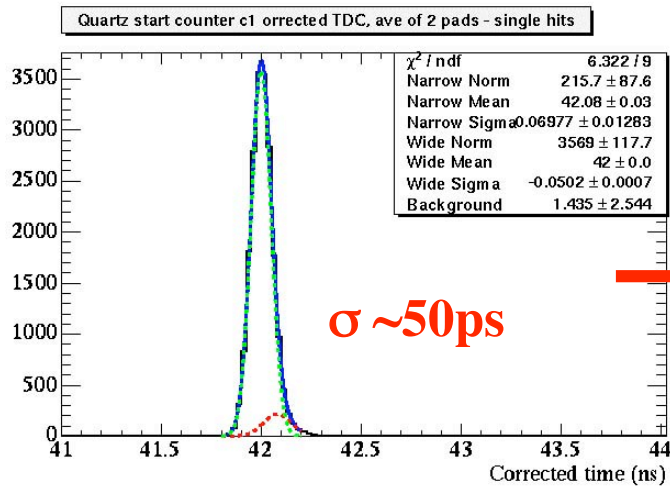
Elapsed time [min]

- The correction reference “Time_walk_mean” is doing the same thing as the profile of the Quartz start counter 1. It is created by averaging over the previous 100 measurements of “good hits” in the Quartz start counter 1.

Scintillator Start counter 1 corrected by the Quartz Start counter 1 (averages over 100 events).

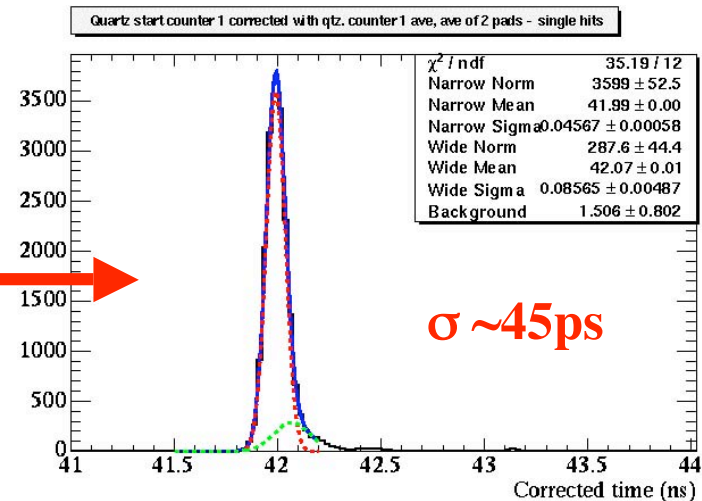
Start 1, average of all pads:

(Start TDC with the MCC signal, which is derived from the Linac RF)



Start 1, average of all pads:

(Correct the MCC signal with the Quartz Start 1 counter; averages over 100 events)

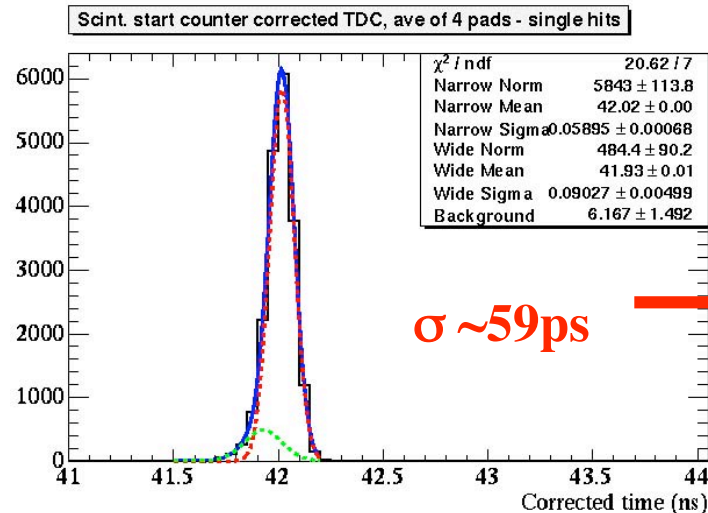


- It helps a bit.

Scintillator Start counter 2 corrected by the Quartz Start counter 1 (averages over 100 events).

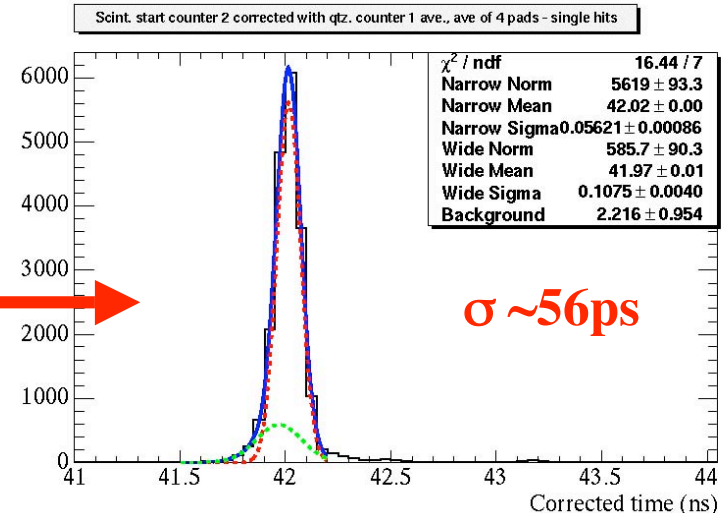
Start 2, average of all pads:

(Start TDC with the MCC signal, which is derived from the Linac RF)



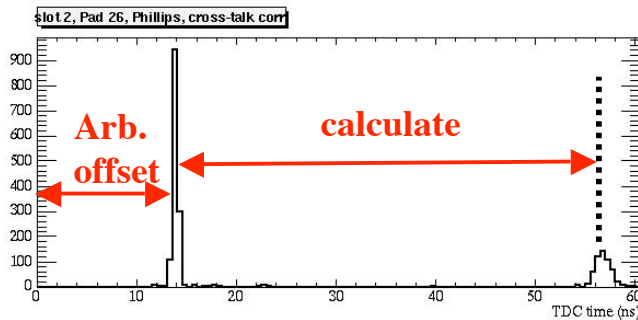
Start 2, average of all pads:

(Correct the MCC signal with the Quartz Start 1 counter; averages over 100 events)

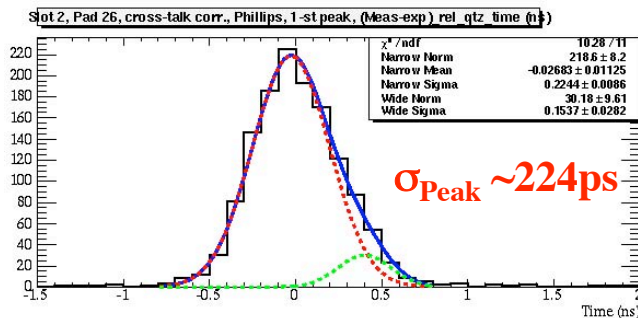


- It helps only a little bit. This may mean that the resolution of the counter is comparable to a size of the correction.

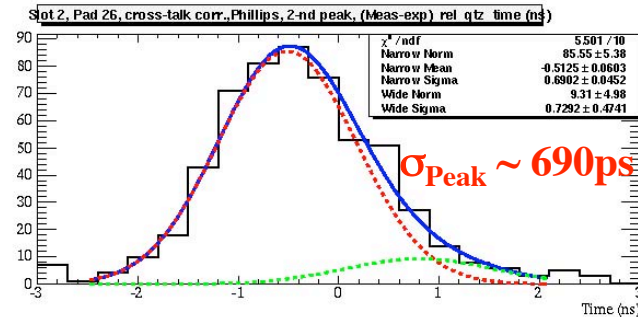
Chromatic growth in pixel #26, slot 2, Run7, position 1 (Hamamatsu MaPMT)



1-st peak:

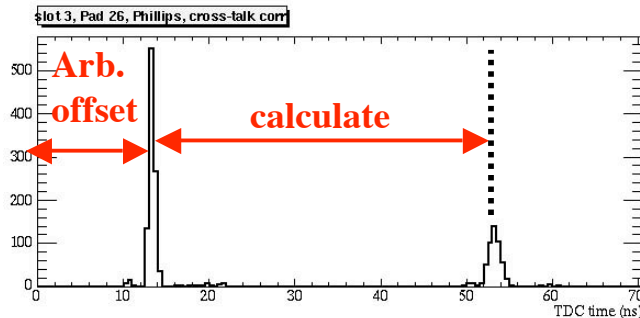


2-nd peak:

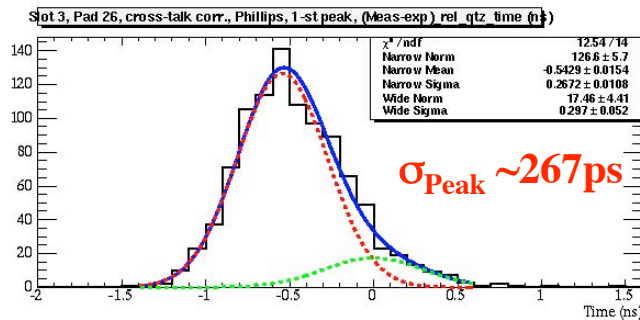


- Hamamatsu MaPMT does not have as large tail as the Burle MCP, but it is good enough to correct the chromatic error
- Peak 1 was first adjusted with Joe's constants based on the PiLas calibration. Then it was arbitrarily adjusted to zero by a constant $C_{\text{pad26,slot4,run7}}$
- Peak 2 was adjusted using the calculated offset, and assuming a TDC calibration of 23 ps/count.
- The 2-nd peak does not come to zero. It is off by ~ 0.51 ns at present.
- Corrected for the MCP cross-talk and for time drift using the Start counter 1.
- Assume that the detector plane is shifted down by 1.5cm in this analysis.

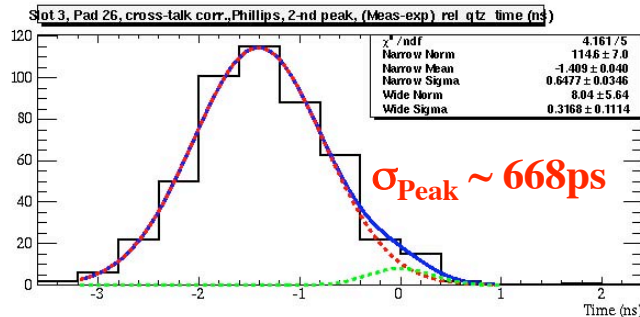
Chromatic growth in pixel #26, slot 3, Run7, position 1 (Hamamatsu MaPMT)



1-st peak:

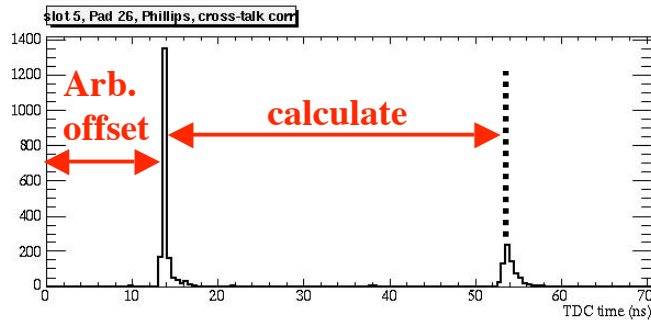


2-nd peak:

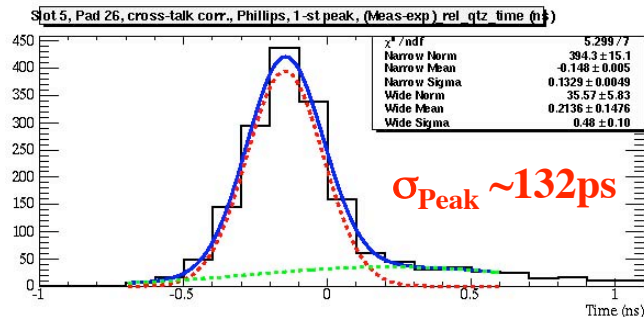


- Hamamatsu MaPMT does not have as large tail as the Burle MCP, but it is good enough to correct the chromatic error
- Peak 1 was first adjusted with Joe's constants based on the PiLas calibration. Then it was arbitrarily adjusted to zero by a constant $C_{\text{pad26,slot4,run7}}$
- Peak 2 was adjusted using the calculated offset, and assuming a TDC calibration of 23 ps/count.
- The 1-st peak does not come to zero. It is off by $\sim 0.54 \text{ ns}$ at present. The 2-nd peak is off by 1.4 ns.
- Corrected for the MCP cross-talk and for time drift using the Start counter 1.
- Assume that the detector plane is shifted down by 1.5 cm in this analysis.

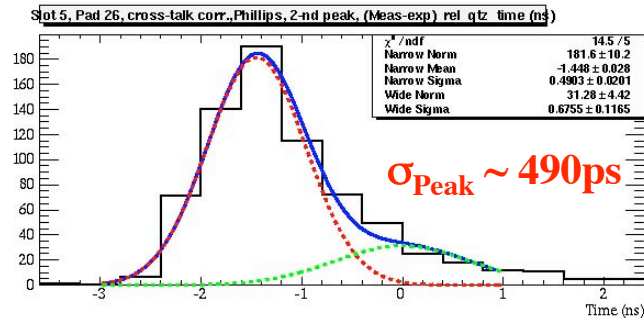
Chromatic growth in pixel #26, slot 5, Run7, position 1 (Burle MCP)



1-st peak:

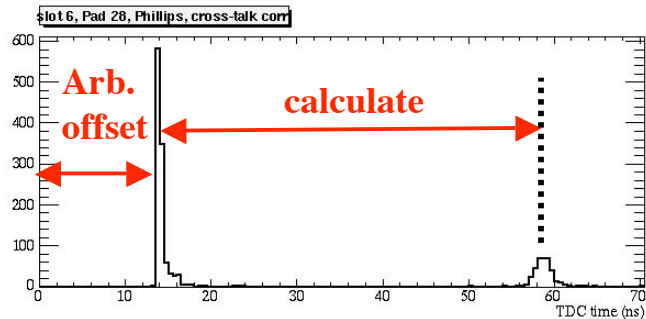


2-nd peak:

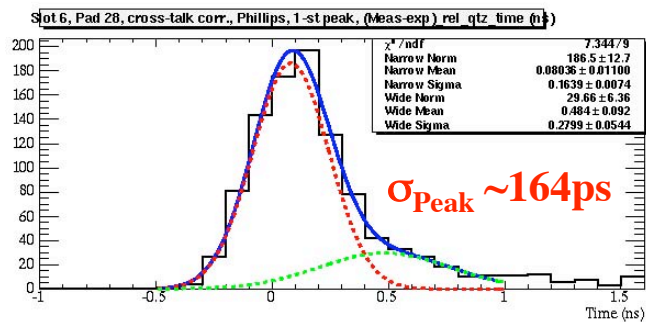


- Hamamatsu MaPMT does not have as large tail as the Burle MCP, but it is good enough to correct the chromatic error
- Peak 1 was first adjusted with Joe's constants based on the PiLas calibration. Then it was arbitrarily adjusted to zero by a constant $C_{\text{pad26,slot4,run7}}$
- Peak 2 was adjusted using the calculated offset, and assuming a TDC calibration of 23 ps/count.
- The 1-st peak does not come to zero. It is off by $\sim 0.15\text{ns}$ at present. The 2-nd peak is off by 1.5ns.
- Corrected for the MCP cross-talk and for time drift using the Start counter 1.
- Assume that the detector plane is shifted down by 1.5cm in this analysis.

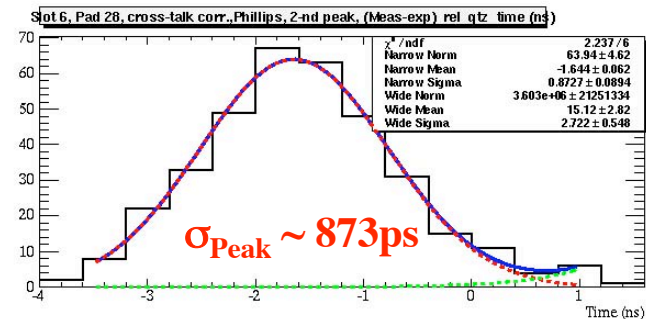
Chromatic growth in pixel #28, slot 6, Run7, position 1 (Burle MCP)



1-st peak:



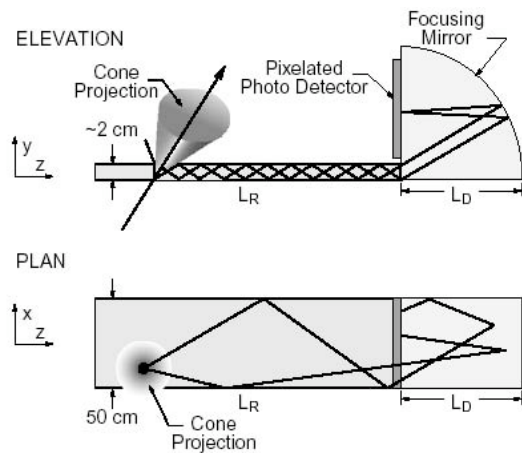
2-nd peak:



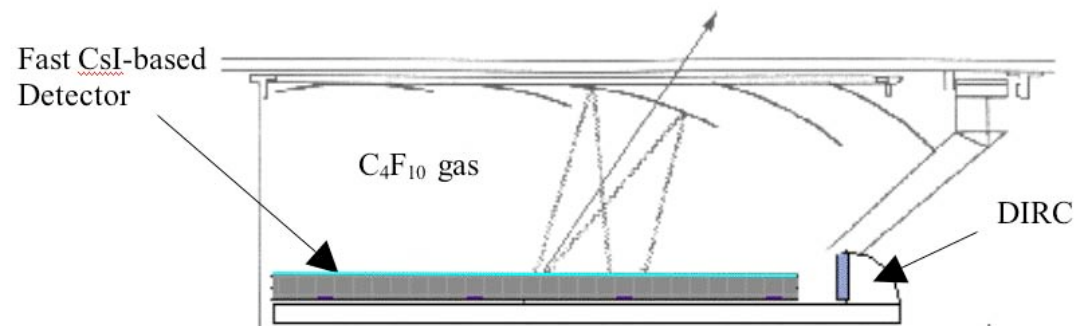
- Hamamatsu MaPMT does not have as large tail as the Burle MCP, but it is good enough to correct the chromatic error
- Peak 1 was first adjusted with Joe's constants based on the PiLas calibration. Then it was arbitrarily adjusted to zero by a constant $C_{\text{pad26,slot4,run7}}$
- Peak 2 was adjusted using the calculated offset, and assuming a TDC calibration of 23 ps/count.
- The 1-st peak does not come to zero. It is off by $\sim 0.08\text{ns}$ at present. The 2-nd peak is off by 1.6ns.
- Corrected for the MCP cross-talk and for time drift using the Start counter 1.
- Assume that the detector plane is shifted down by 1.5cm in this analysis.

What are possible applications ?

Super B-factory (?):



ILC (?):

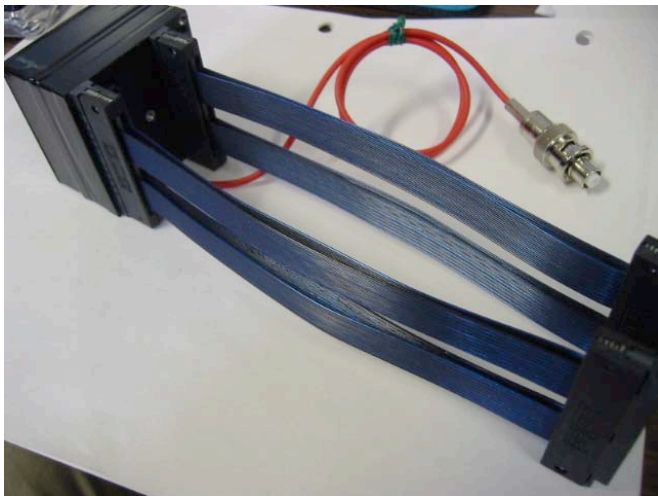
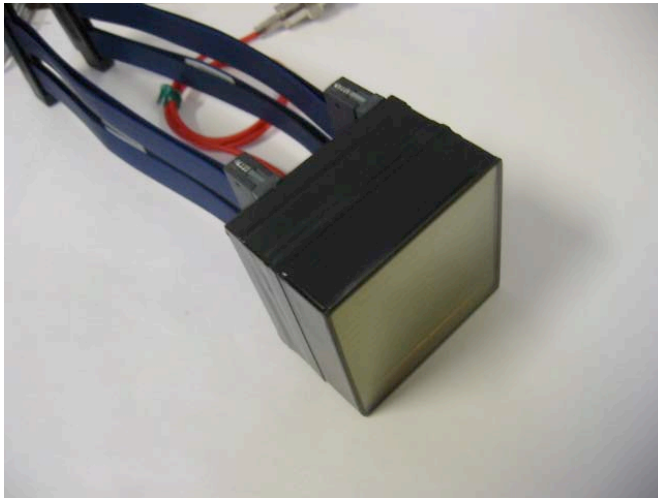


- Or, just simply publish it.
- **This is the first time ever that a Cherenkov ring imaging detector attempts to correct the chromatic error.**

Plan for the next 6 months

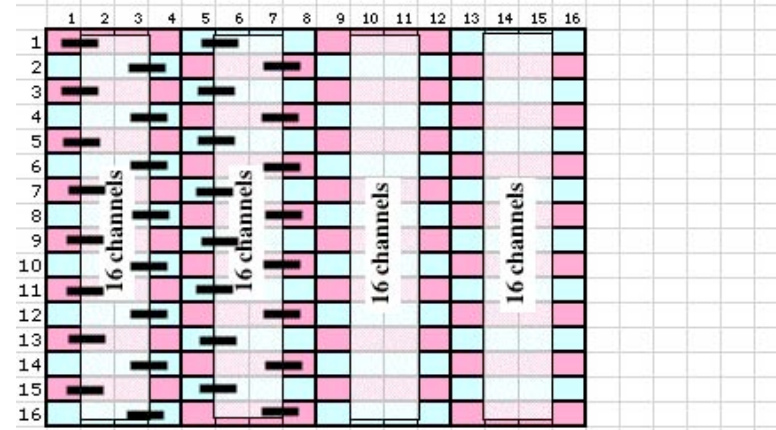
- Mike Woods is planning to run in November and we have to move the hodoscope, beam telescope and the prototype (not the table though).
- We will have three new devices, one is a 1024-pixel Burle MCP, two are small margin 64-pixel Burle MCPs, and one 256-pixel Hamamatsu MaPMT.
- We have one 4-pixel Burle MCP with 10 micron holes, which will be used in tests in the magnetic field. This tube is only on a loan and have to return it by the end of the year.

New 256-pixel Hamamatsu MaPMT H-9500



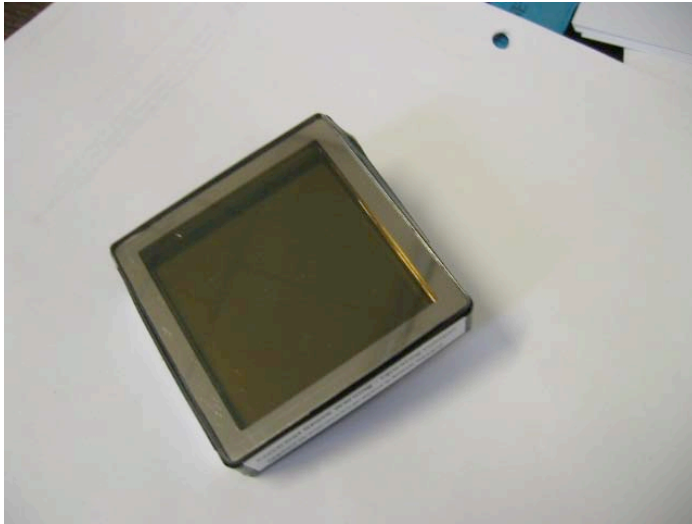
A proposal how to connect pads:

256-pad Hamamatsu MaPMT --> make it a 64-pad device

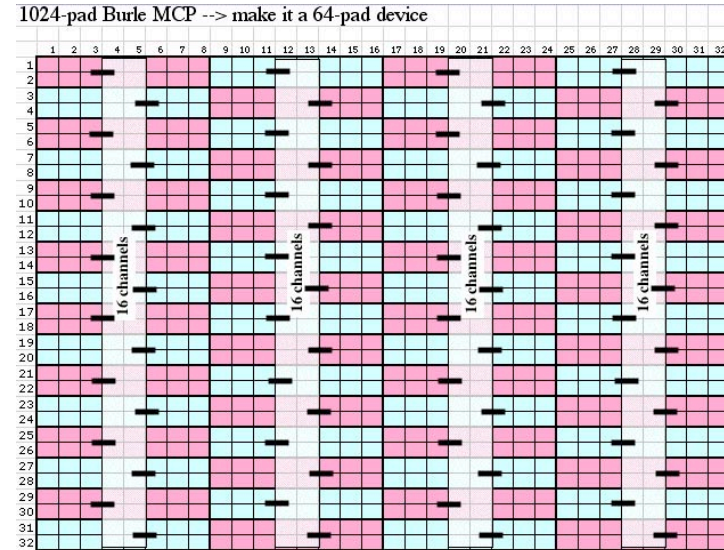


- 256 pixels (16 x 16 pattern).
- Pixel size: 2.8 mm x 2.8 mm, with a pitch of 3.04 mm.
- Very neat connections

New 1024-pixel Burle MCP 85021-600



A proposal how to connect pads:



- 1024 pixels (32 x 32 pattern)
- Pixel size: it looks to like $\sim 1/16''$ x $\sim 1/16''$, which is $\sim 1.59\text{mm}$ x 1.59mm (need to verify with Burle).