



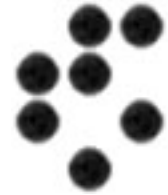
# Beam test of Burle 85011-501 64 channel MCP PMT

Peter Križan (for Andrej Gorišek and Samo  
Korpar)

*University of Ljubljana and J. Stefan Institute*



# Contents



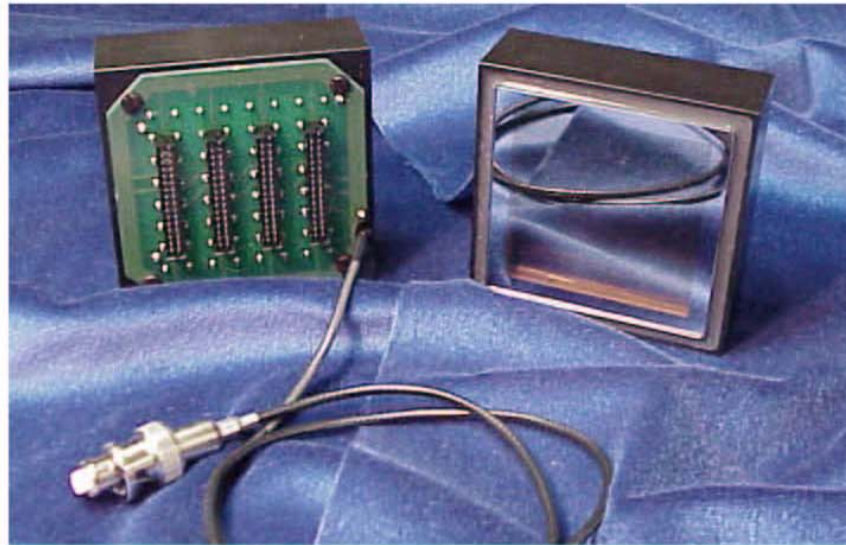
Burle 85011-501 MCP PMT

Test set-up

Beam test results

Further plans

The 85011 assembly is based on a new photomultiplier tube that uses microchannel plates (MCP) for electron multiplication, the PLANACON™. This 2" square head-on MCP-PMT is very low profile, less than one inch thick including the voltage divider network. The sixty-four anodes provide 6mm position resolution when used as a discrete pixel device. Improved resolution can be obtained using the charge-sharing technique with an alternate voltage divider network. The dual MCP multiplier provides excellent time response, good gain, and extremely high pulse linearity. Response uniformity over the full 2" square active area is exceptional, typically 1:1.5. The assembly comes with terminated anode and high voltage cables for ease of use.



Applications include specialized medical imaging, ring imaging Cherenkov counters, fluorescence microscopy, and high-speed applications such as LIDAR.

## GENERAL

Parameter		Value	Unit
Spectral Response		165 to 660	nm
Wavelength of Maximum Response		410	nm
Photocathode Material		Bialkali	--
Window	Material	Quartz	--
	Thickness	0.080	in
Multiplier	Structure	MCP (25µm pore, 40:1 L:D)	--
	Number of Stages	2	--
Anodes	Number	64 (8 x 8)	
	Size / Pitch	0.234 / 0.254	in
Voltage Divider Resistance		12	MΩ

## Maximum Ratings (Absolute Maximum Values)

Parameter		Value	Unit
Supply Voltage	Between Anode and Cathode	2400	Vdc
Average Anode Current, sum of all anodes		3	µA
Ambient Temperature		- 40 to + 70	C

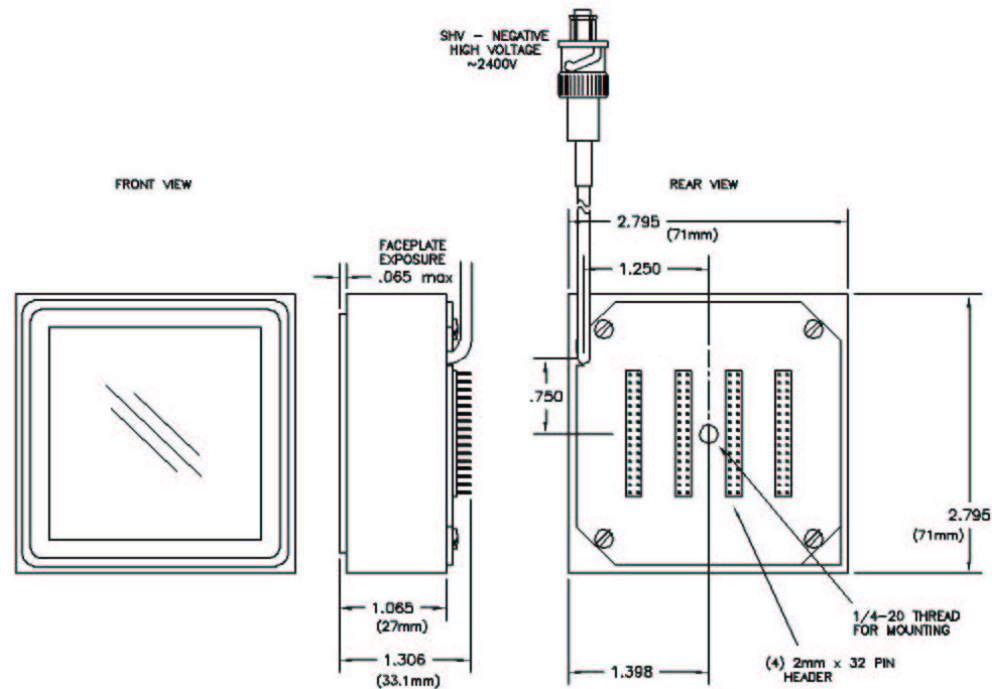
Parameter		Min.	Typ.	Max.	Unit
Cathode Sensitivity	Luminous	40	55	--	$\mu\text{A/Lm}$
	Blue (with CS-5-58 filter)	5.5	7.5	--	$\mu\text{A/lm-b}$
Anode Sensitivity	Luminous		35	--	A/lm
Modal Gain		$0.3 \times 10^6$	$0.6 \times 10^6$	--	--
Anode Dark Current, Sum of all pixels		--	0.5	5	nA
Time Response	Anode Pulse Rise Time	--	0.3	--	ns
	Anode Pulse Width (FWHM)	--	1.8	--	ns
Pulse Linearity at 5% Deviation		--	300	--	mA
Single Electron Response	Peak-to-Valley	--	2:1	--	
	Resolution (FWHM)	--	150	--	%
Anode Uniformity		--	1:1.25	1:1.5	
Pulse Height Resolution, 2" NaI(Tl) crystal, $^{137}\text{Cs}$ , 1700V (FWHM)		--	10.0	--	%

Note: Measured with the condition shown in Table 1 except where noted.

**Table 1 VOLTAGE DISTRIBUTION RATIO AND SUPPLY VOLTAGE ( -2300 Volts )**

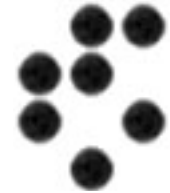
Electrodes	K	MCP <sub>in</sub>	MCP <sub>out</sub>	P
Ratio	1	10	1	

Supply Voltage : 1000Vdc,      K : Cathode      P : Anode





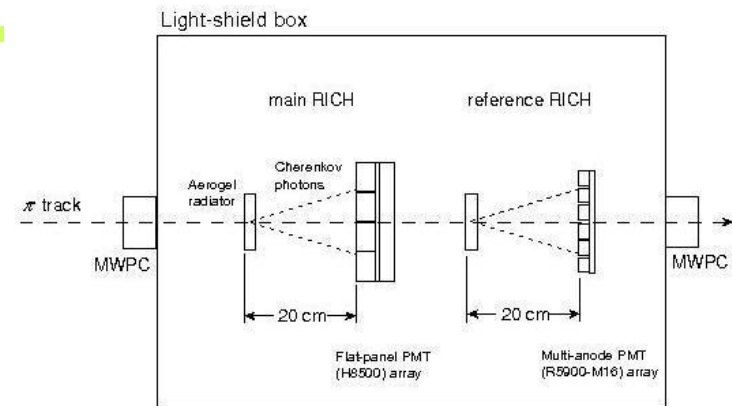
# Beam test set-up



Beam test Nov. 2002 set-up

RICH1: array of Hamamatsu H8500 (flat panel PMTs)

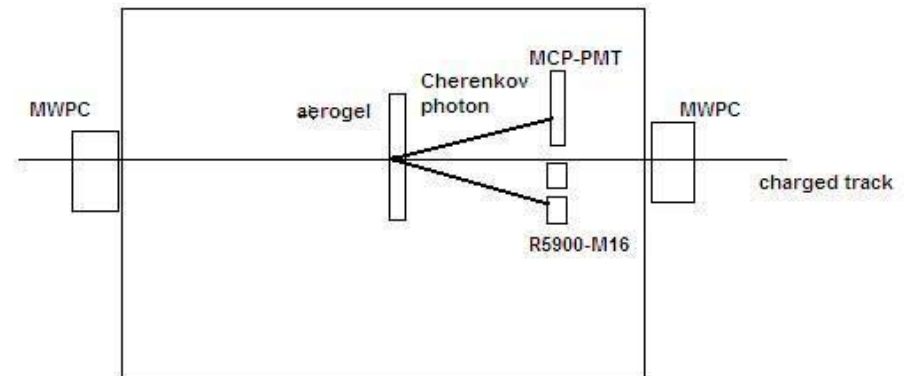
RICH2: reference, R5900-M16



Beam test March 2004:

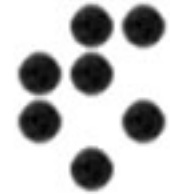
RICH1: same

RICH2: Burle 85011 MCP PMT (+Hamamatsu R5900-M16 as reference)





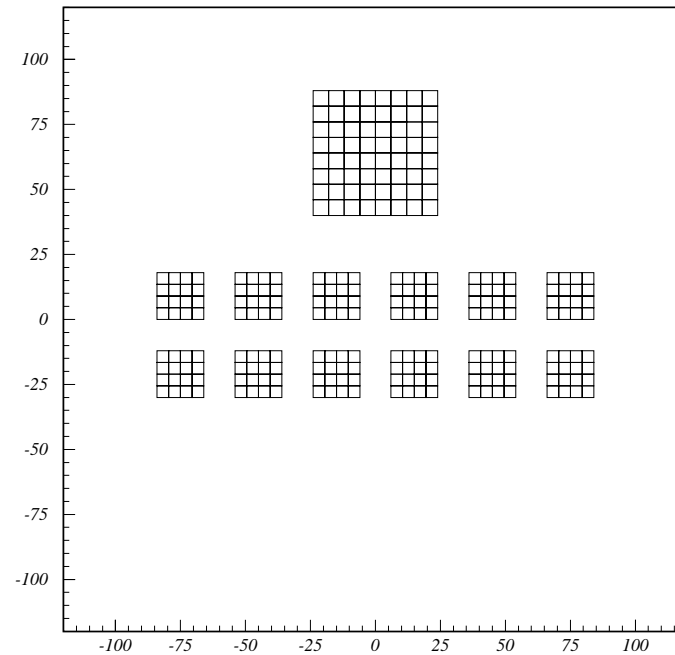
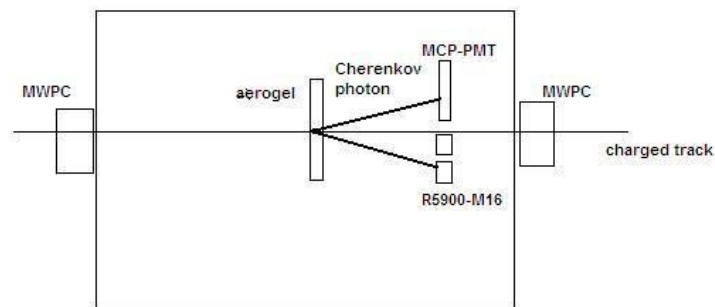
# Beam test set-up



RICH2:

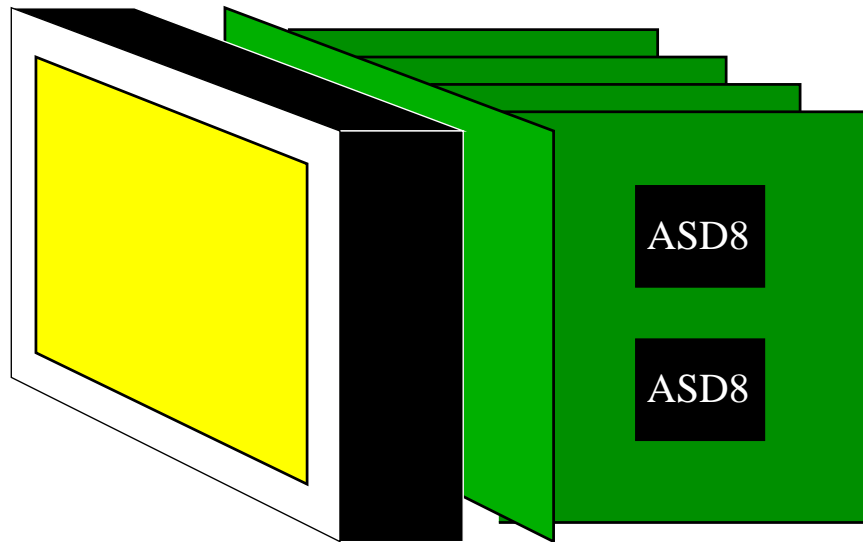
Burle 85011 MCP PMT

R5900-M16 as reference





# Beam test set-up: read-out



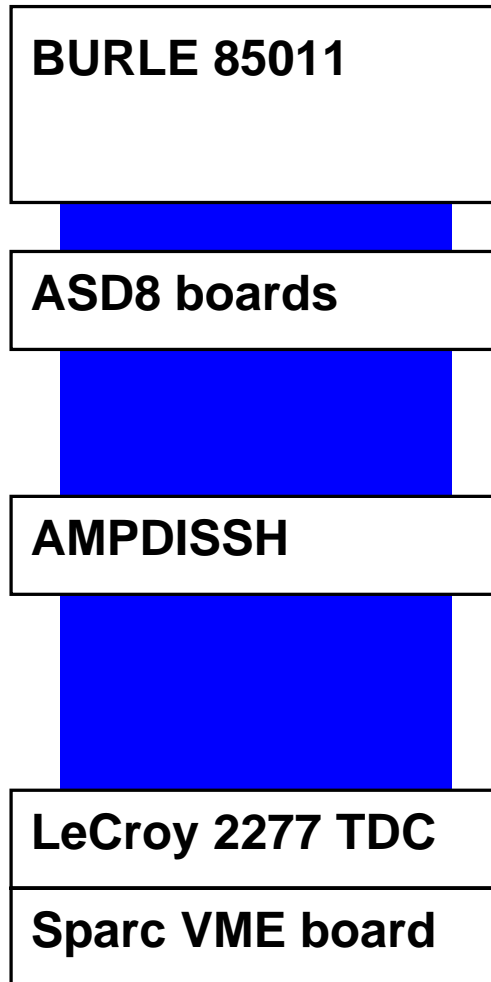
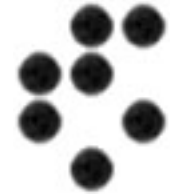
PMT with ASD08 boards, all inside the light tight box

Signals are lower than from R5900-M16 PMTs

- Need additional amplification
- Take the ASD08 amplifier, shaper and discriminator chip (same as in the HERA-B RICH)
- Feed the output signals to the read-out chain



# Beam test set-up: read-out

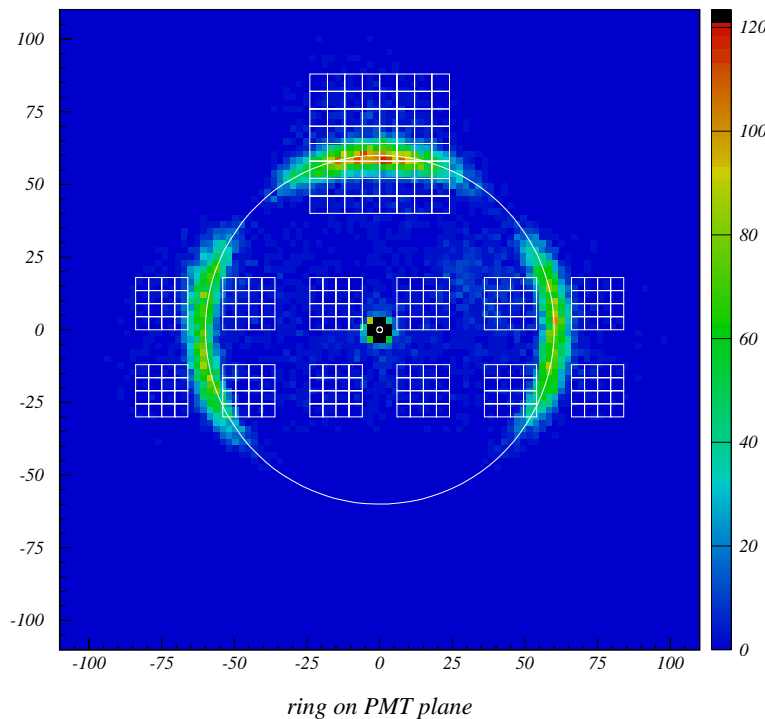
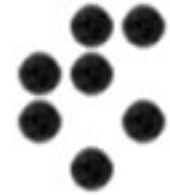


- Feed the output signals from the ASD08 amplifier to the usual PMT read-out chain (outside the light tight box)
- To the AMPDISSH boards, convert to the standard ECL logic signals





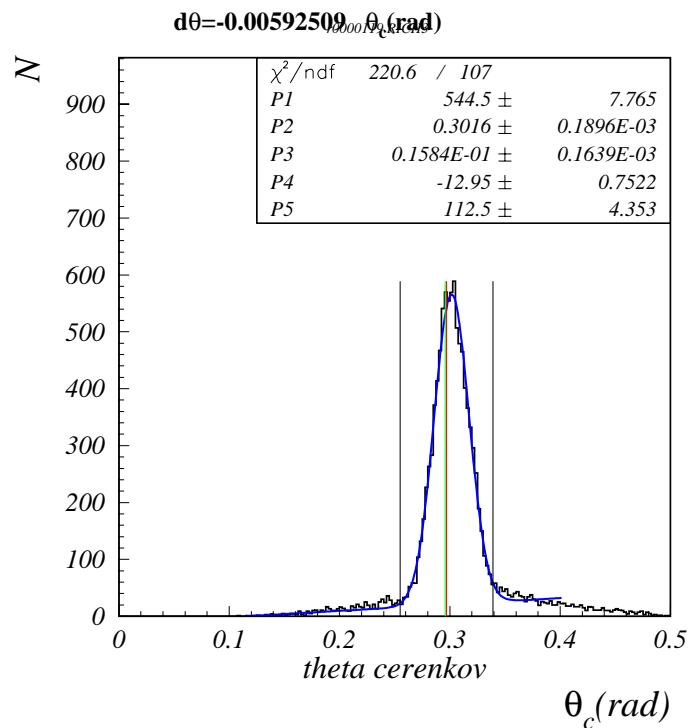
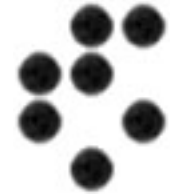
# Beam test results



Accumulated hits on  
both photon detectors  
- corrected for beam  
particle position and  
direction



# Resolution for single photons



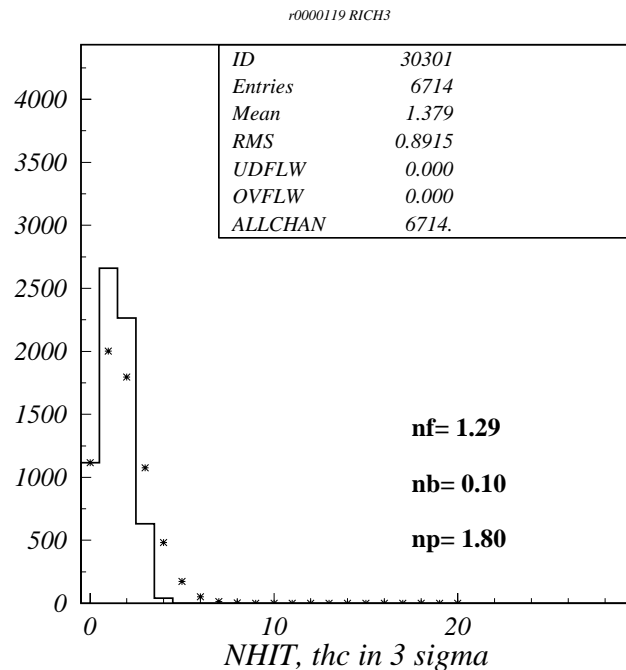
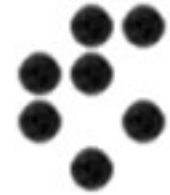
$\sigma = 15.3 \text{ mrad}$  in rough agreement with expectations

(R5900-M16 has 14.3 mrad for this particular run (4cm rad.) with slightly smaller pads, 4.5mm instead of 5.5mm)

- will come back to it



# Number of photons



$N=1.29$

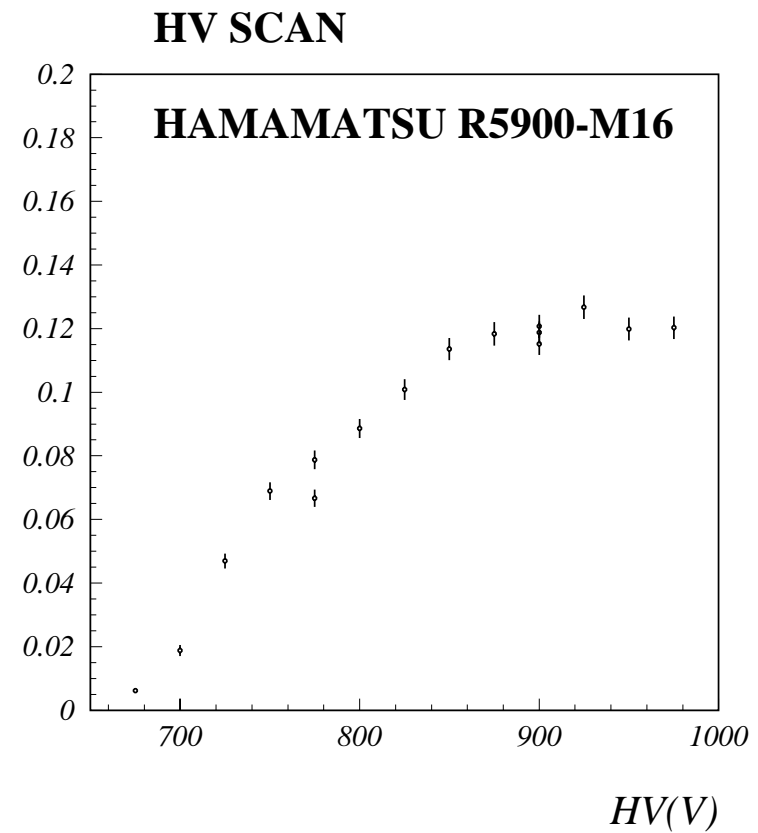
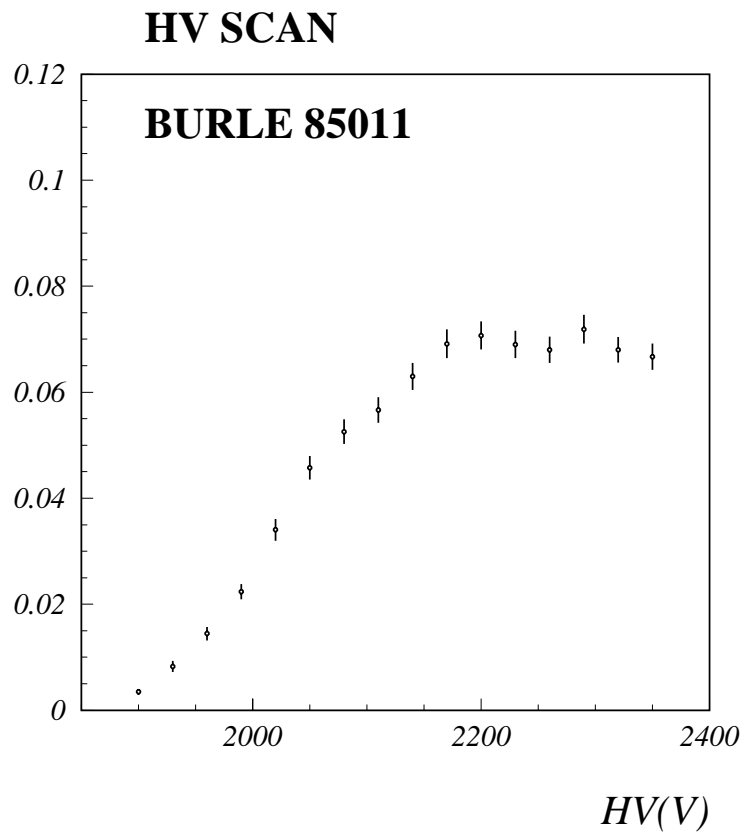
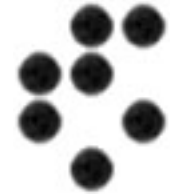
Extrapolate to full ring,  
full active area: 9.7

Extrapolate to full ring,  
real active area: 4.9

N.B. Numbers for the  
reference R5900-M16:  
16.2 and 5.8.

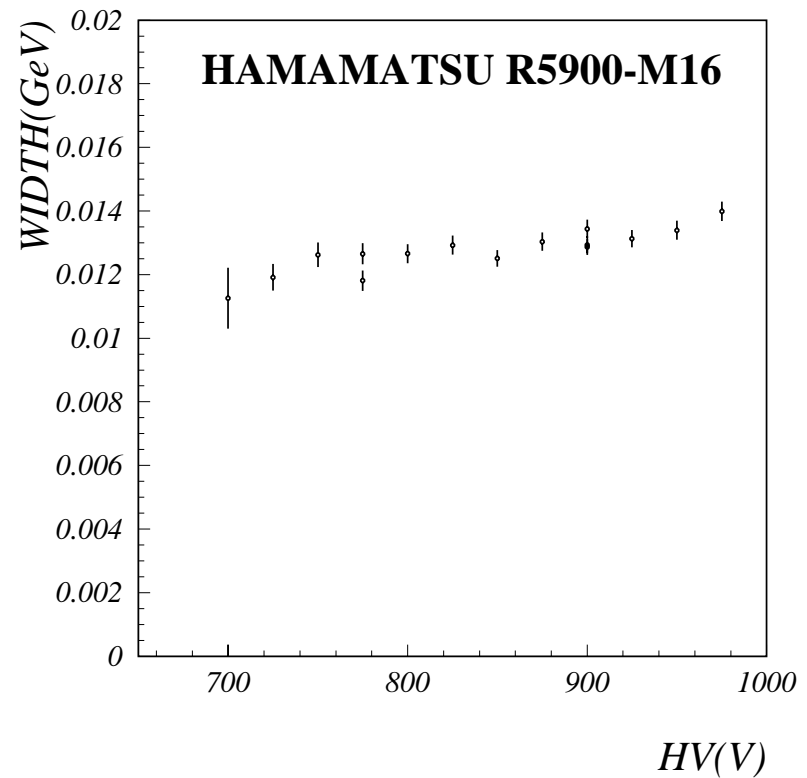
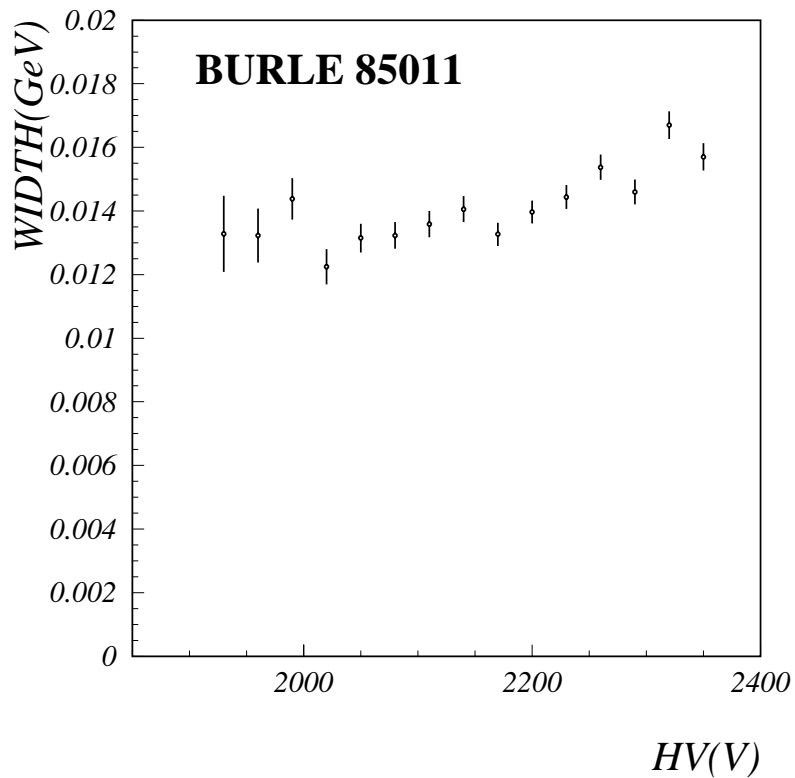
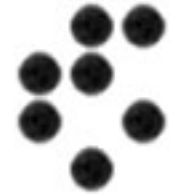


# HV scan: yield





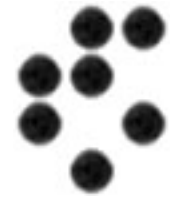
# HV scan: width



Width increases with HV: cross-talk?

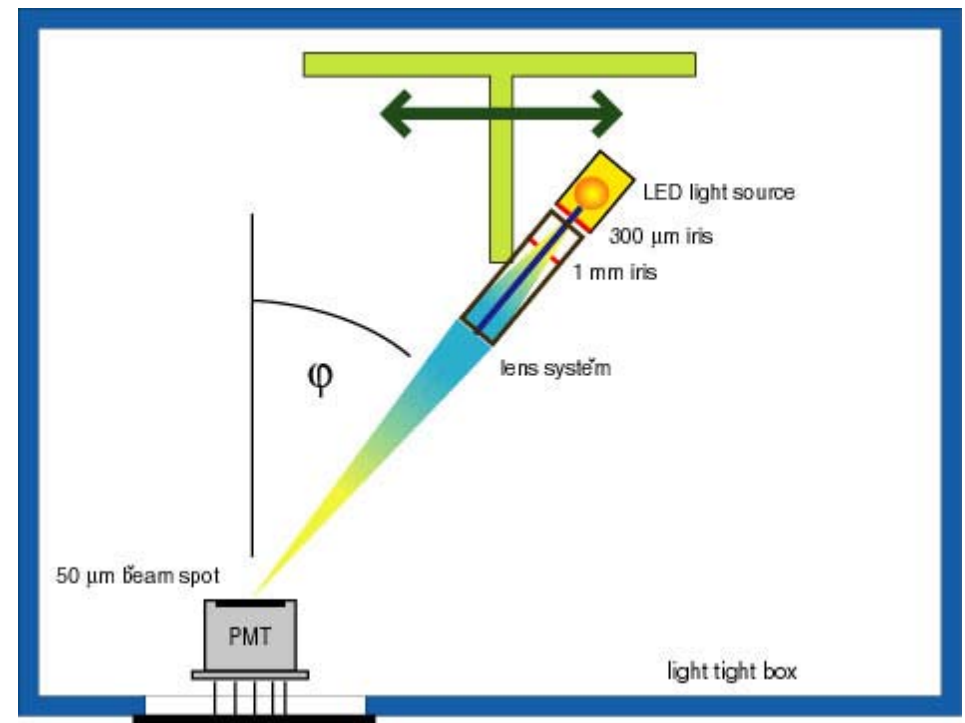


# Further tests - plans



Understand cross-talk,  
clustering

Study uniformity of the  
sensitivity over the  
surface



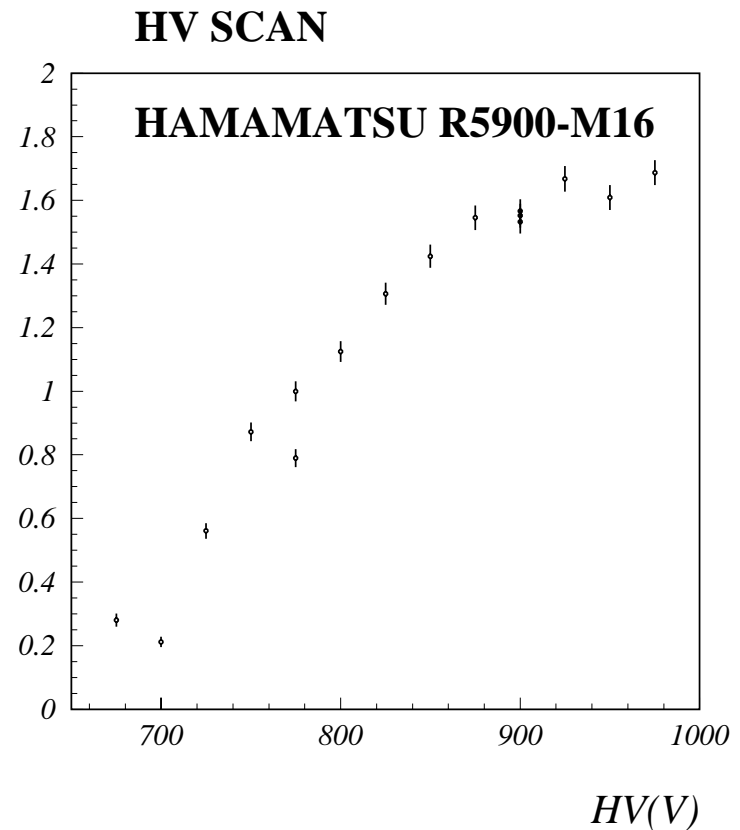
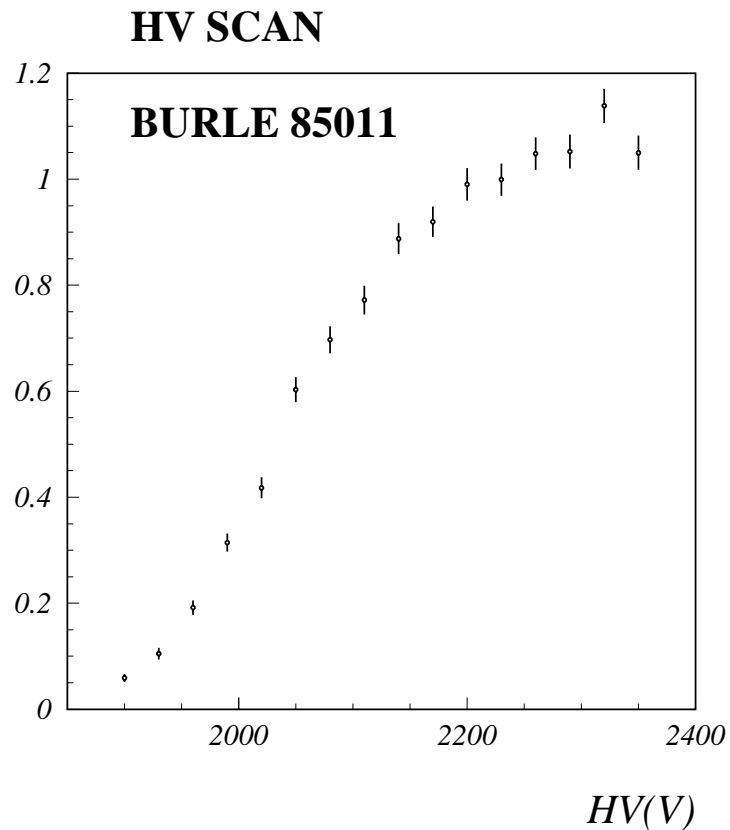
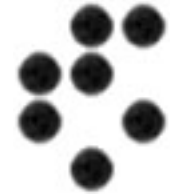


# Backup slides





# HV scan: yield from peak area



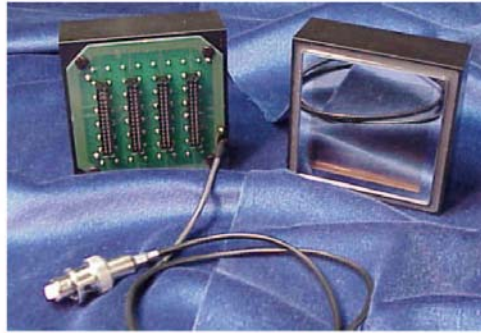


# BURLE

## PLANACON™ PHOTOMULTIPLIER TUBE ASSEMBLY 85011-501

TENTATIVE DATA  
November 2002

The 85011 assembly is based on a new photomultiplier tube that uses microchannel plates (MCP) for electron multiplication, the PLANACON™. This 2" square head-on MCP-PMT is very low profile, less than one inch thick including the voltage divider network. The sixty-four anodes provide 6mm position resolution when used as a discrete pixel device. Improved resolution can be obtained using the charge-sharing technique with an alternate voltage divider network. The dual MCP multiplier provides excellent time response, good gain, and extremely high pulse linearity. Response uniformity over the full 2" square active area is exceptional, typically 1:1.5. The assembly comes with terminated anode and high voltage cables for ease of use. Applications include specialized medical imaging, ring ima Cherenkov counters, fluorescence microscopy, and high-speed applications such as LIDAR.



### GENERAL

Parameter	Value	Unit
Spectral Response	165 to 660	nm
Wavelength of Maximum Response	410	nm
Photocathode Material	Bialkali	--
Window	Material	Quartz
	Thickness	0.080
Multiplier	Structure	MCP (25µm pore, 40:1 L:D)
	Number of Stages	2
Anodes	Number	64 (8 x 8)
	Size / Pitch	0.234 / 0.254
Voltage Divider Resistance	12	MΩ

### Maximum Ratings (Absolute Maximum Values)

Parameter	Value	Unit
Supply Voltage	Between Anode and Cathode	2400
Average Anode Current, sum of all anodes	3	µA
Ambient Temperature	- 40 to + 70	C

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83112-501 & 83112-502 / NOV 2002

# BURLE

## PHOTOMULTIPLIER TUBE 85011-501

### Characteristics (at 25 °C)

Parameter	Min.	Typ.	Max.	Unit
Cathode Sensitivity	Luminous	40	55	--
	Blue (with CS-5-58 filter)	5.5	7.5	--
Anode Sensitivity	Luminous	35	--	A/lm
Modal Gain	$0.3 \times 10^6$	$0.6 \times 10^6$	--	--
Anode Dark Current, Sum of all pixels	--	0.5	5	nA
Time Response	Anode Pulse Rise Time	--	0.3	ns
	Anode Pulse Width (FWHM)	--	1.8	ns
Pulse Linearity at 5% Deviation	--	300	--	mA
Single Electron Response	Peak-to-Valley	--	2:1	--
	Resolution (FWHM)	--	150	--
Anode Uniformity	--	1:1.25	1:1.5	--
Pulse Height Resolution, 2" NaI(Tl) crystal, <sup>137</sup> Cs, 1700V (FWHM)	--	10.0	--	%

Note: Measured with the condition shown in Table 1 except where noted.

Table 1 VOLTAGE DISTRIBUTION RATIO AND SUPPLY VOLTAGE (-2300 Volts)

Electrodes	K	MCP <sub>in</sub>	MCP <sub>out</sub>	P
Ratio	1	10	1	
Supply Voltage	1000Vdc, K: Cathode P: Anode			

