

DIRC commissioning and data analysis

GlueX collaboration meeting

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GlueX DIRC team



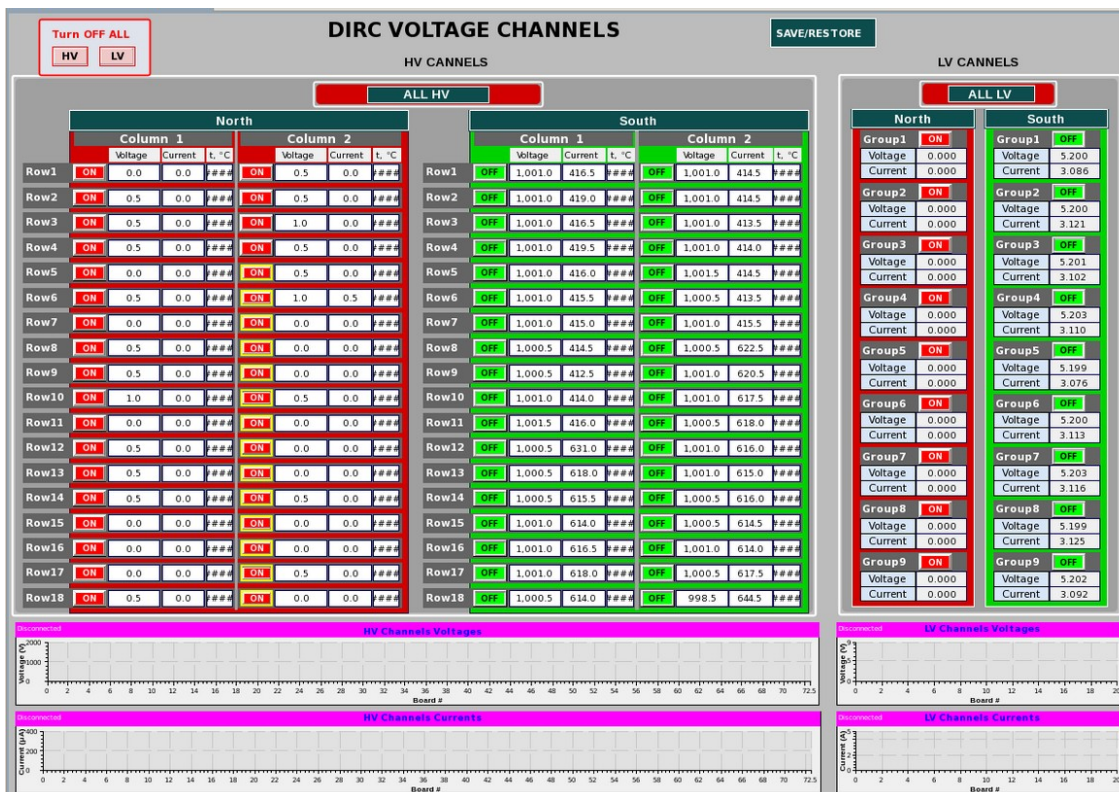
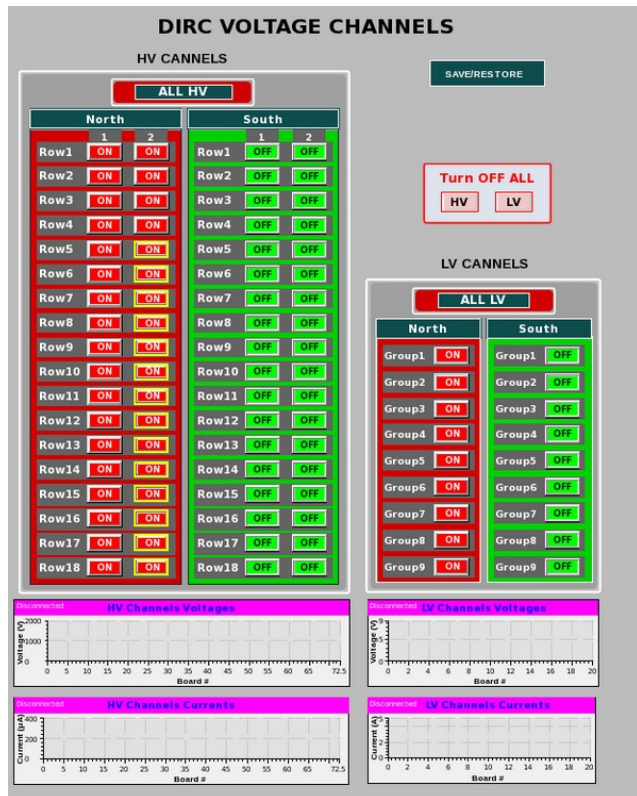
Commissioning Goals

- Integrate DIRC readout with general Hall D DAQ and online/offline monitoring
- Confirm cabling through HV/mask checks with LED system
- Calibrate per-pixel timing offset of MAPMTs using LED system
- Implement reconstruction algorithm and compare data/MC:
 - photon multiplicity
 - Cherenkov angle resolution
- Determine geometric alignment parameters (position and angle offsets) for optical components

EPICS Integration

Low/high voltage control:

by Hovanes, Vanik, Nick



EPICS Integration

by Hovanes, Vanik, Nick

DIRC environment control:

DIRC ENVIRONMENT

North OpticalBox Interlocks

Environment Variables	Interlock	Limit Setpoint	Limit Readback	Interlock Override
Temp 0.00 °C	<input checked="" type="checkbox"/>	25	25.00	Bypass OFF Bypass ON
Humidity 0.00 %	<input checked="" type="checkbox"/>	0	0.00	Bypass OFF Bypass ON
Light Sensor 0.02 V	<input checked="" type="checkbox"/>	0.1	0.10	Bypass OFF Bypass ON
Hall Light Sensor 0.017 V	<input checked="" type="checkbox"/>	0.1	0.10	Bypass OFF Bypass ON
Airflow Switch	<input checked="" type="checkbox"/>			
Cover Switch	<input checked="" type="checkbox"/>			
Leak Detector	<input checked="" type="checkbox"/>			
N2 Flow 0.00 sl/hr				

South OpticalBox Interlocks

Environment Variables	Interlock	Limit Setpoint	Limit Readback	Interlock Override
Temp 20.54 °C	<input checked="" type="checkbox"/>	23	23.00	Bypass OFF Bypass ON
Humidity 21.99 %	<input checked="" type="checkbox"/>	60	60.00	Bypass OFF Bypass ON
Light Sensor 0.03 V	<input checked="" type="checkbox"/>	0.1	0.10	Bypass OFF Bypass ON
Hall Light Sensor 0.017 V	<input checked="" type="checkbox"/>	0.1	0.10	Bypass OFF Bypass ON
Airflow Switch	<input checked="" type="checkbox"/>			
Cover Switch	<input checked="" type="checkbox"/>			
Leak Detector	<input checked="" type="checkbox"/>			
N2 Flow 15.12 sl/hr				

North BarBox

BarBox Top N2 Flow	2.76	sl/hr
BarBox Top N2 Pressure	0.52	H2O in
BarBox Bot N2 Flow	2.76	sl/hr
BarBox Bot N2 Pressure	0.52	H2O in
BarBox Manifold Pressure	1.54	H2O in

Water Skid

Water Flow	2.01	G/m
Water Temp	72.81	°F
Pump Enable	<input checked="" type="checkbox"/>	ON OFF
Alarm Status	<input checked="" type="checkbox"/>	

South BarBox

BarBox Top N2 Flow	1.39	sl/hr
BarBox Top N2 Pressure	0.39	H2O in
BarBox Bot N2 Flow	1.40	sl/hr
BarBox Bot N2 Pressure	0.25	H2O in
BarBox Manifold Pressure	1.54	H2O in

LED pulser control:

RESET **DIRC LED PULSER CONTROL** Pulser Status: WHITE

Color & status	Start/Stop pulsing	Pulse width Readback	Pulse width Setpoint	Frequency Readback	Frequency Setpoint	Number of pulses Readback	Number of pulses Setpoint	Cont. Mode ON/OFF
WHITE <input checked="" type="checkbox"/>	STOP	100 ns	100	5.000 KHz	5,000	CONTINUOUS	-1	OFF <input checked="" type="checkbox"/>
TRIG <input checked="" type="checkbox"/>		100 ns	100	5.000 KHz	5,000	CONTINUOUS	-1	

OUTPUT "MOR" CONTROL

MOR width Readback	MOR width Setpoint	MOR delay Readback	MOR delay Setpoint
100 ns	100	0 ns	0

DIRC LED VOLTAGE CONTROL

Channel Name	Voltage Readback	Voltage Setpoint	Setpoint Readback	ON / OFF	Channel Status	Current Readback	Extra Screens
BIAS	12.410	12.4	12.400	<input checked="" type="checkbox"/>	On	0.097	Advanced Settings
LV 5V	5.002	5	5.000	<input checked="" type="checkbox"/>	On	0.035	Advanced Settings
LV 12V	12.026	12	12.000	<input checked="" type="checkbox"/>	On	0.190	Advanced Settings

FCAL Master Or Control

EPICS Integration

by Hovanes, Vanik, Nick

DIRC scalers per pmt/channel:

DIRC Scalers (Sums)

		North					
		Column 1			Column 2		
Row		1-1	1-2	1-3	1-1	1-2	1-3
Row1		0	0	0	0	0	0
Row2		2-1	2-2	2-3	2-1	2-2	2-3
		0	0	0	0	0	0
Row3		3-1	3-2	3-3	3-1	3-2	3-3
		0	0	0	0	0	0
Row4		4-1	4-2	4-3	4-1	4-2	4-3
		0	0	0	0	0	0
Row5		5-1	5-2	5-3	5-1	5-2	5-3
		0	0	0	0	0	0
Row6		6-1	6-2	6-3	6-1	6-2	6-3
		0	0	0	0	0	0
Row7		7-1	7-2	7-3	7-1	7-2	7-3
		0	0	0	0	0	0
Row8		8-1	8-2	8-3	8-1	8-2	8-3
		0	0	0	0	0	0
Row9		9-1	9-2	9-3	9-1	9-2	9-3
		0	0	0	0	0	0
Row10		10-1	10-2	10-3	10-1	10-2	10-3
		0	0	0	0	0	0
Row11		11-1	11-2	11-3	11-1	11-2	11-3
		0	0	0	0	0	0
Row12		12-1	12-2	12-3	12-1	12-2	12-3
		0	0	0	0	0	0
Row13		13-1	13-2	13-3	13-1	13-2	13-3
		0	0	0	0	0	0
Row14		14-1	14-2	14-3	14-1	14-2	14-3
		0	0	0	0	0	0
Row15		15-1	15-2	15-3	15-1	15-2	15-3
		0	0	0	0	0	0
Row16		16-1	16-2	16-3	16-1	16-2	16-3
		0	0	0	0	0	0
Row17		17-1	17-2	17-3	17-1	17-2	17-3
		0	0	0	0	0	0
Row18		18-1	18-2	18-3	18-1	18-2	18-3
		0	0	0	0	0	0
Total North		Column 1			Column 2		
		0			0		

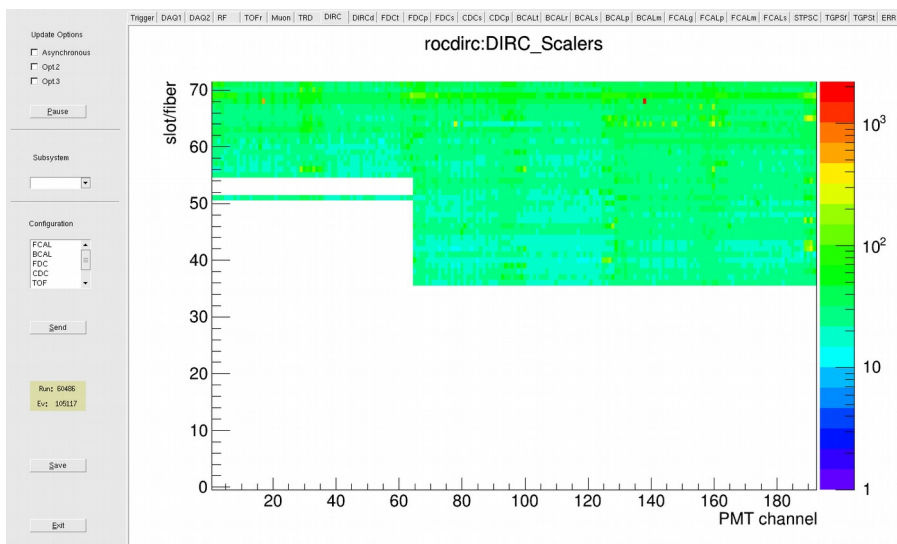
		South					
		Column 1			Column 2		
Row		1-1	1-2	1-3	1-1	1-2	1-3
Row1		0	2,295	2,510	2,219	1,911	0
Row2		2-1	2-2	2-3	2-1	2-2	2-3
		0	5,586	7,053	6,788	4,218	0
Row3		3-1	3-2	3-3	3-1	3-2	3-3
		0	10,982	17,761	20,108	13,631	0
Row4		4-1	4-2	4-3	4-1	4-2	4-3
		0	10,300	16,371	20,033	14,529	0
Row5		5-1	5-2	5-3	5-1	5-2	5-3
		0	4,740	6,749	5,956	3,703	0
Row6		6-1	6-2	6-3	6-1	6-2	6-3
		0	2,841	3,144	3,143	2,504	0
Row7		7-1	7-2	7-3	7-1	7-2	7-3
		0	2,874	2,982	2,952	2,822	0
Row8		8-1	8-2	8-3	8-1	8-2	8-3
		0	3,577	4,905	7,140	4,286	3,509
Row9		9-1	9-2	9-3	9-1	9-2	9-3
		0	7,637	13,031	20,572	11,101	3,990
Row10		10-1	10-2	10-3	10-1	10-2	10-3
		0	7,412	17,212	14,785	9,167	3,896
Row11		11-1	11-2	11-3	11-1	11-2	11-3
		0	4,062	5,986	4,728	3,353	2,900
Row12		12-1	12-2	12-3	12-1	12-2	12-3
		5,017	2,992	7,371	3,743	2,811	2,427
Row13		13-1	13-2	13-3	13-1	13-2	13-3
		2,731	2,938	3,418	21,692	12,836	3,160
Row14		14-1	14-2	14-3	14-1	14-2	14-3
		3,336	4,343	7,379	7,820	4,402	3,009
Row15		15-1	15-2	15-3	15-1	15-2	15-3
		3,653	7,032	9,174	12,714	9,439	4,158
Row16		16-1	16-2	16-3	16-1	16-2	16-3
		4,569	7,548	11,205	17,493	10,254	6,260
Row17		17-1	17-2	17-3	17-1	17-2	17-3
		4,741	5,356	6,470	5,779	4,554	3,565
Row18		18-1	18-2	18-3	18-1	18-2	18-3
		4,129	5,504	5,625	3,845	3,753	3,644
Total South		Column 1			Column 2		
		274,527			341,302		

		South							
		Column 2				Row 7:1			
Row		1	2	3	4	5	6	7	8
53		50	52	52	58	60	61	66	
9		10	11	12	13	14	15	16	
46		43	43	44	44	49	55	56	
17		18	19	20	21	22	23	24	
47		44	41	42	44	46	51	58	
25		26	27	28	29	30	31	32	
45		40	40	42	44	44	49	57	
33		34	35	36	37	38	39	40	
47		40	39	49	43	41	46	53	
41		42	43	44	45	46	47	48	
40		37	38	41	39	44	45	52	
49		50	51	52	53	54	55	56	
44		39	38	40	62	43	42	49	
57		58	59	60	61	62	63	64	
39		36	38	40	40	41	46	57	

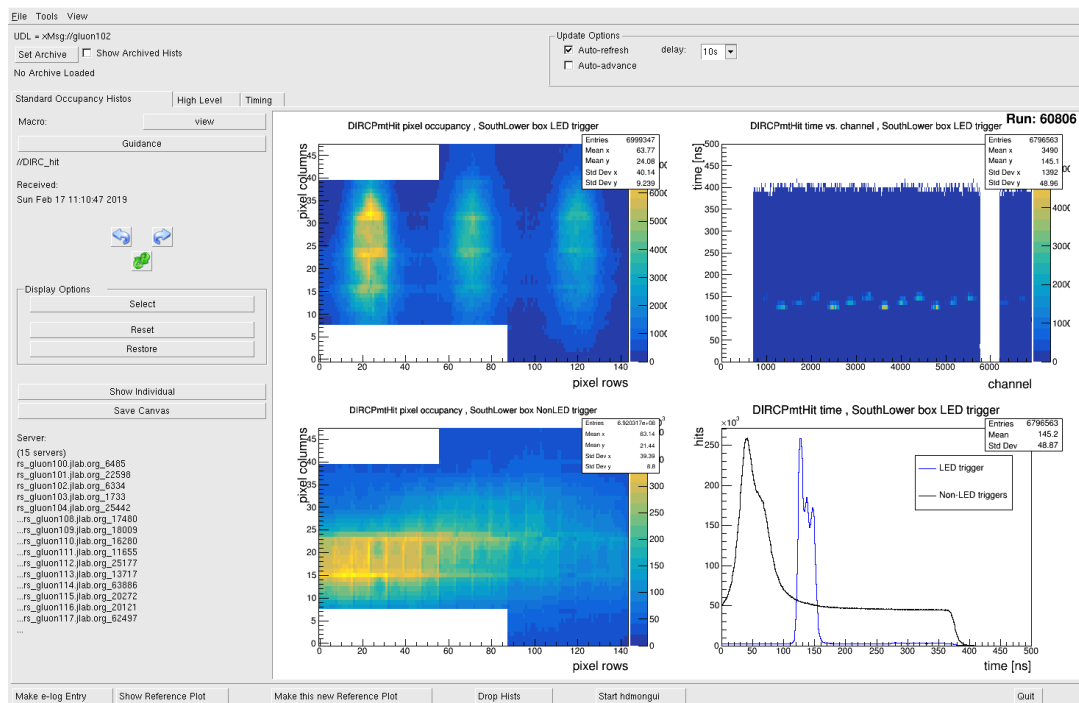
Monitoring Tools

by Sergey

DIRC scaleres:



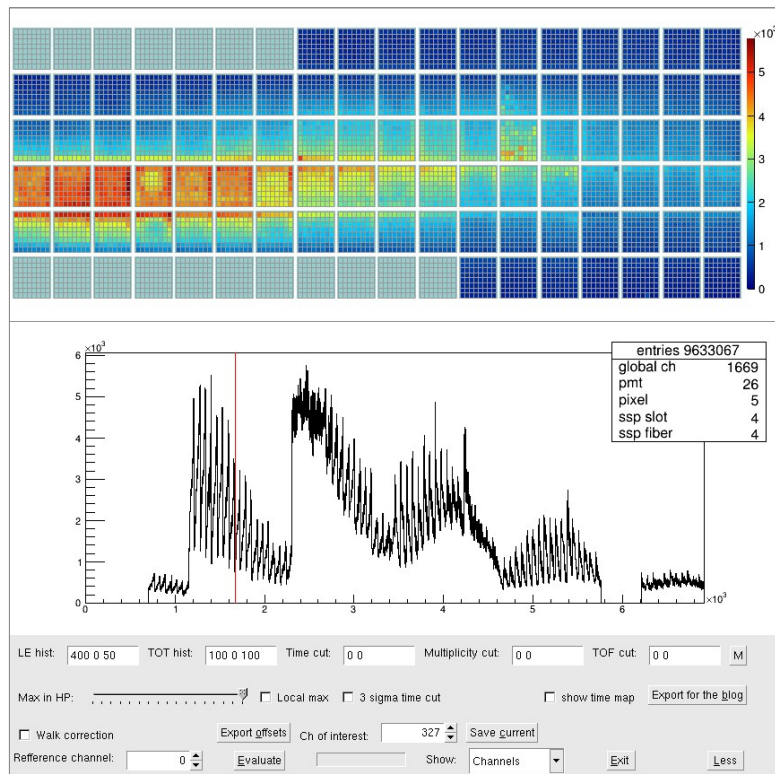
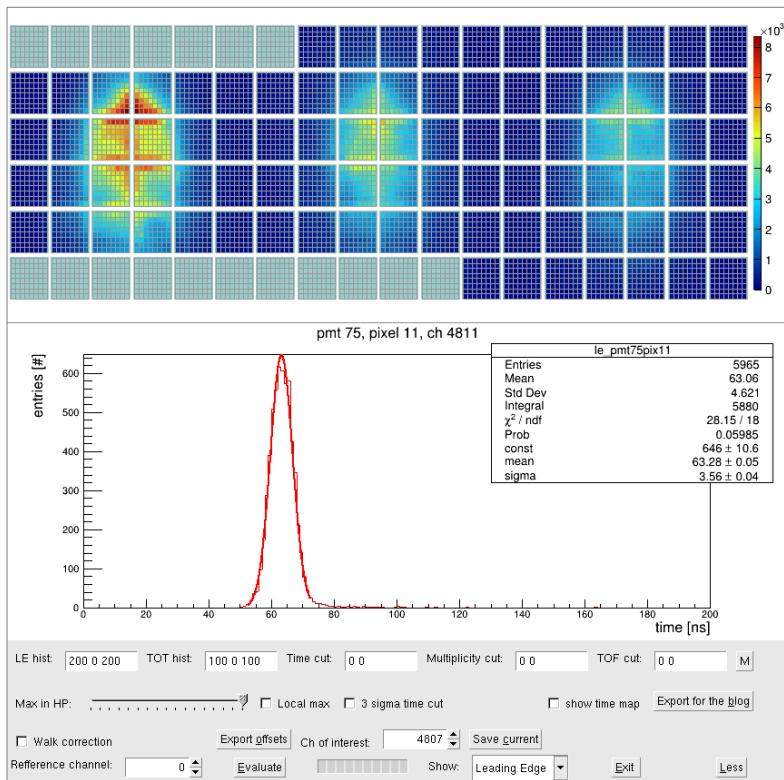
RootSpy:



by David

Monitoring Tools

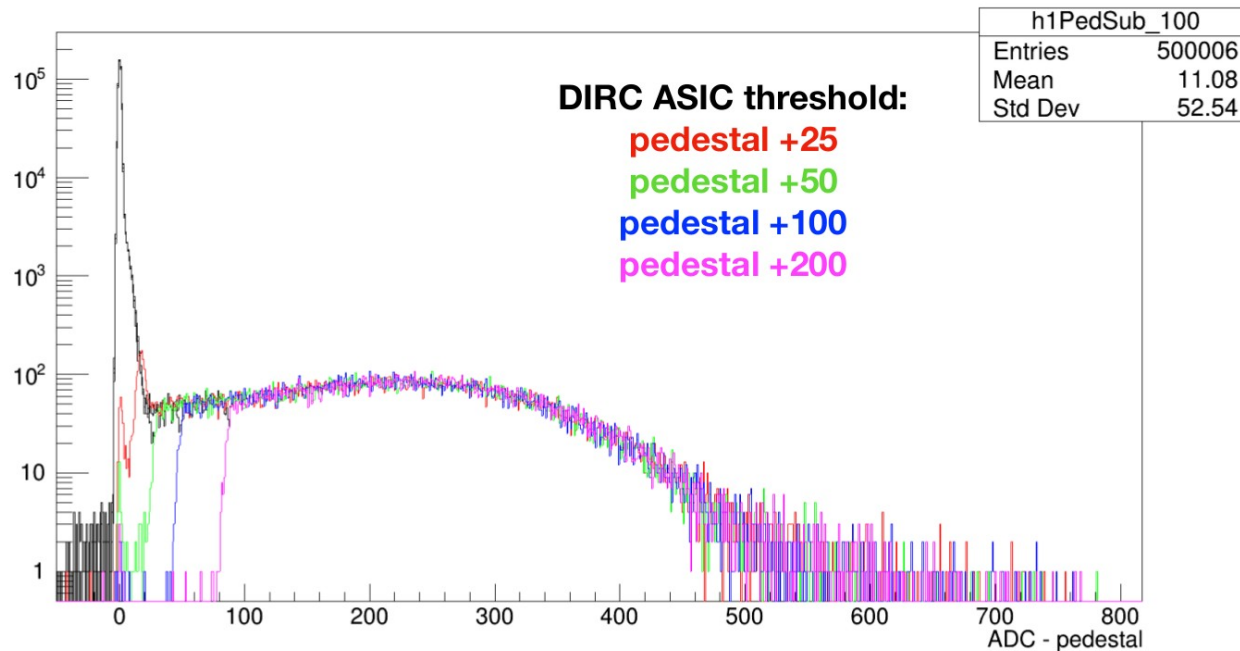
gdisplay:



Laser calibration data

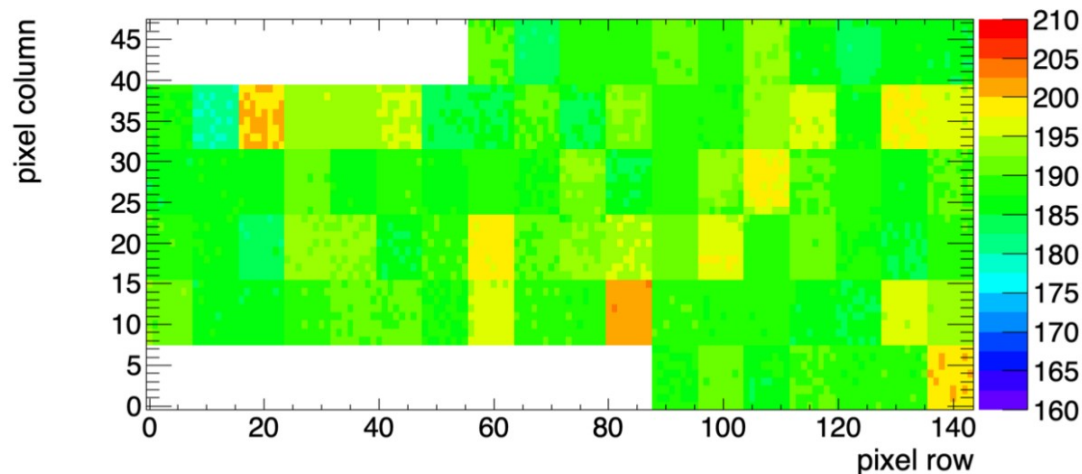
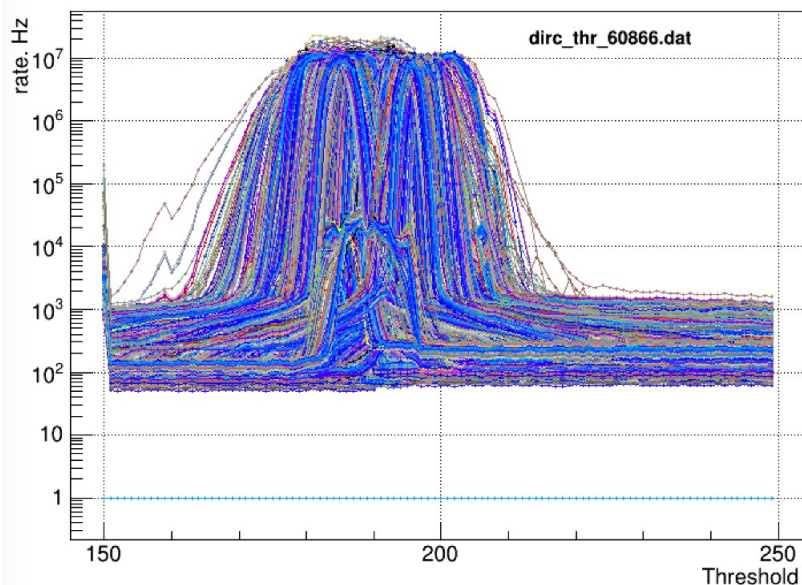
- Per-pixel gains determined from single PE peak fits
- Studying efficiency dependence on threshold in both laser test data and beam data to optimize for production running

Andrew Hurley, W&M

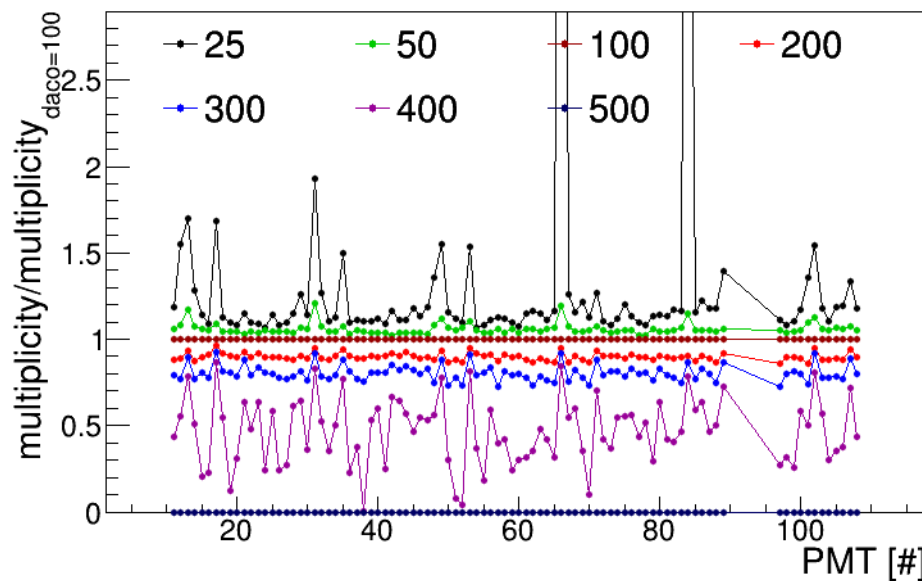
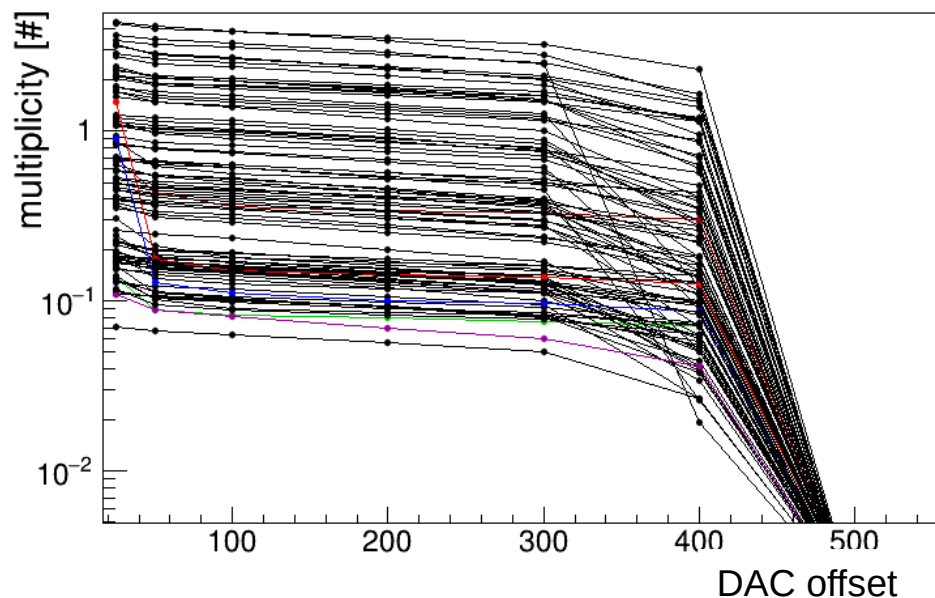


Threshold scans & Pedestal Map

- Sergey wrote program to scan DAC thresholds and save scaler rate for every pixel (part of “daily” DIRC tasks)
- Take centroid of this scan to set pedestal and threshold for each PMT/ASIC
- Pedestals mostly driven by ASIC, so they are common across pixels in a given PMT as seen in threshold scan data
- Single threshold set for each PMT/ASIC is sufficient



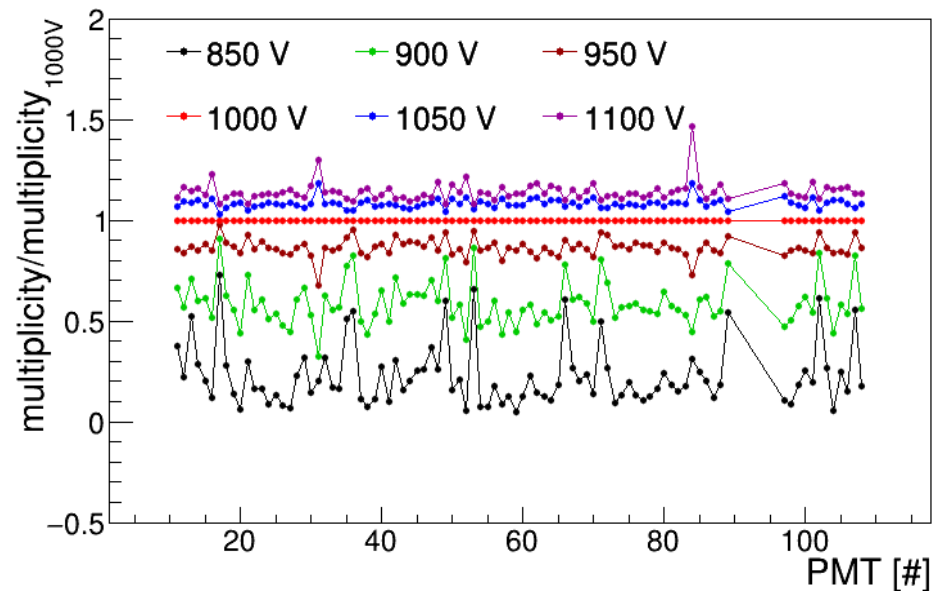
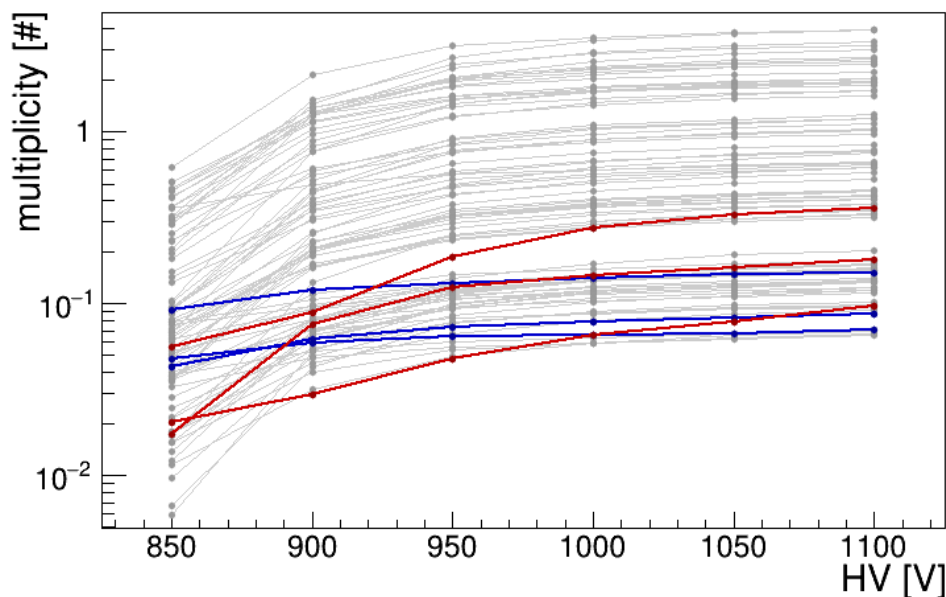
Detected LED multiplicity per PMT



offset 100 was used for most of the data; 1B triggers were collected @ 50, 200

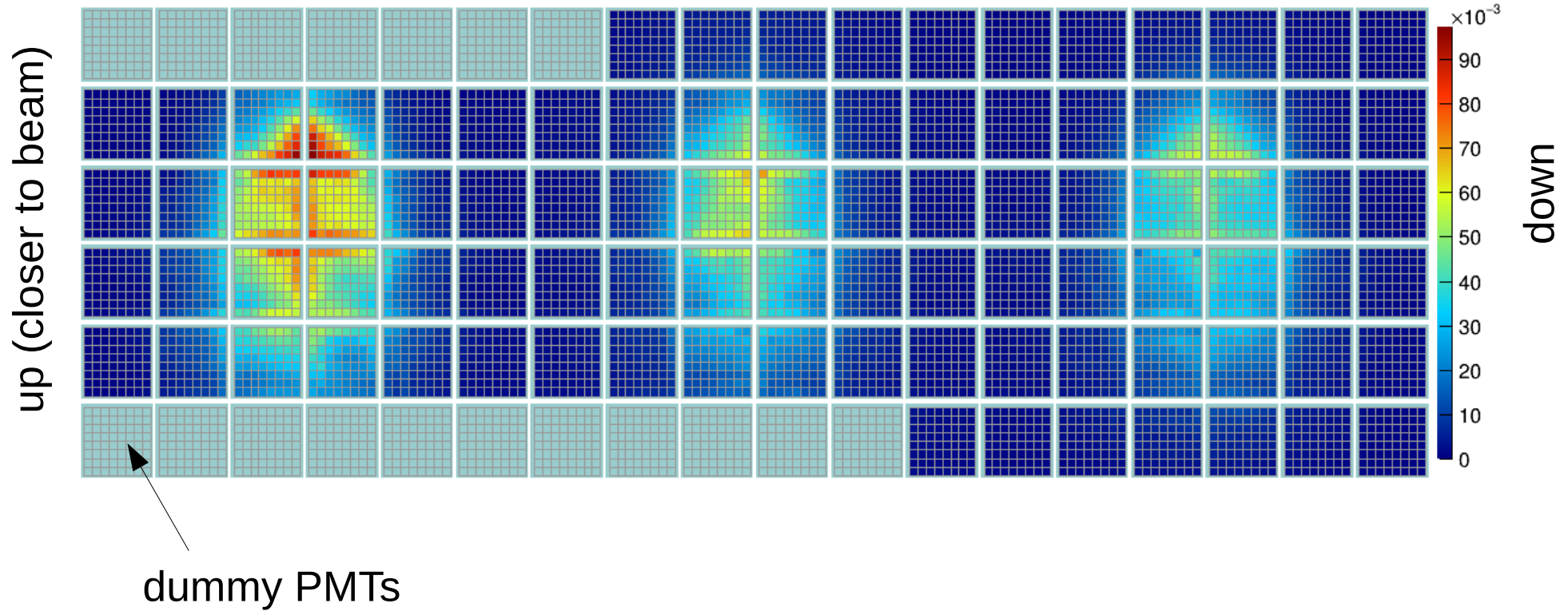
HV scan

Relative multiplicity as a function of the PMT number and HV value:



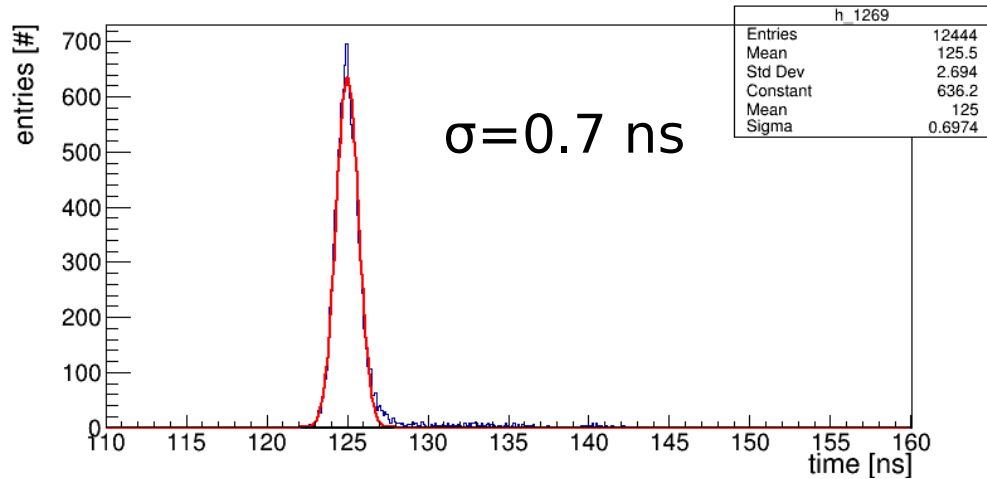
1000 V was used for most of the data

LED Hit Pattern

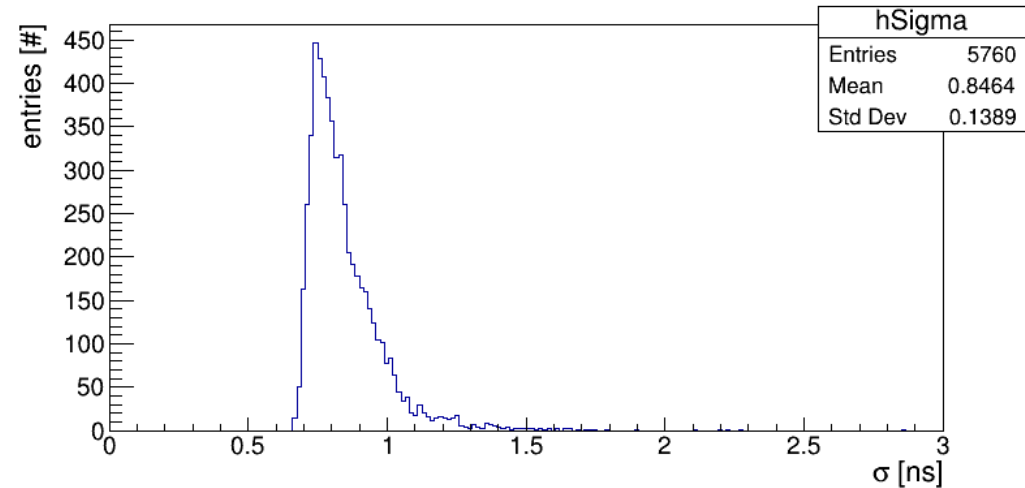


Time resolution from LED data

Example of time distribution for ch 1269:

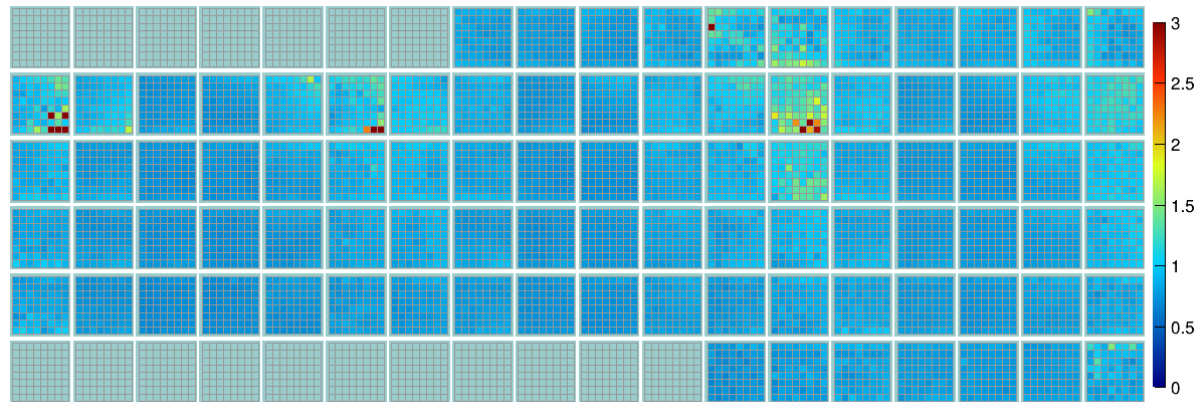


Resolution per channel after walk correction:

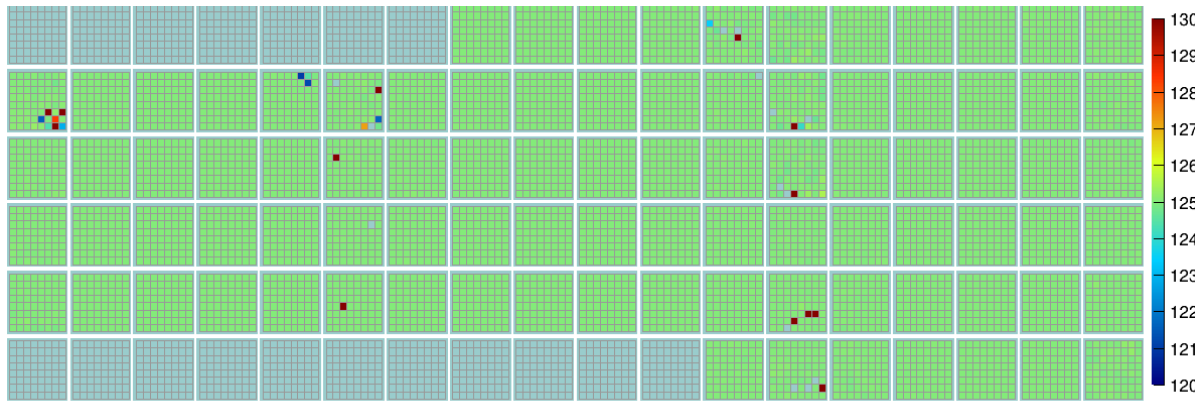


➔ mean resolution 0.8 ns

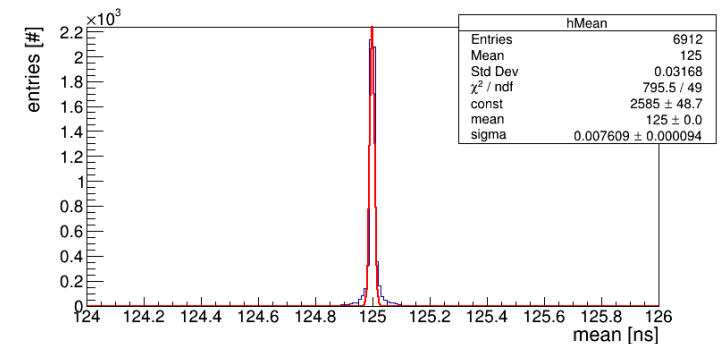
Time resolution from LED data



Time resolution [ns]

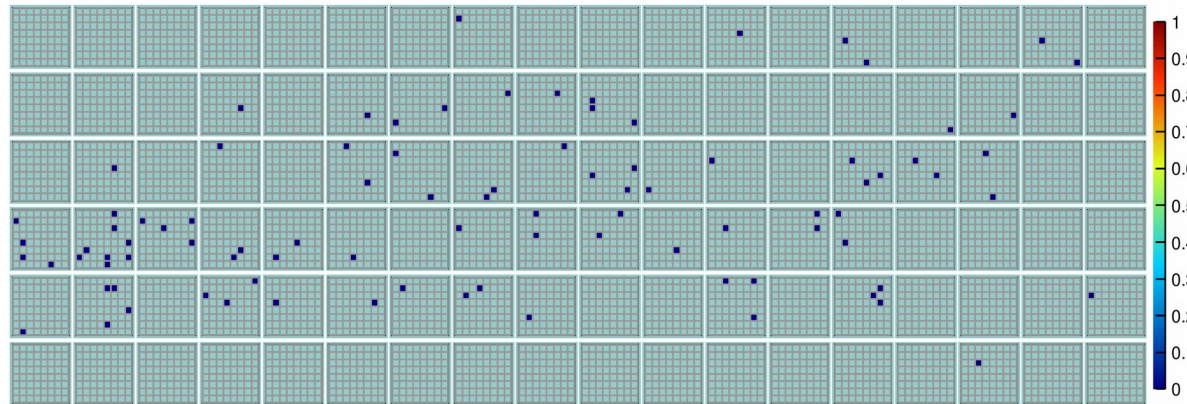


Time offsets [ns]



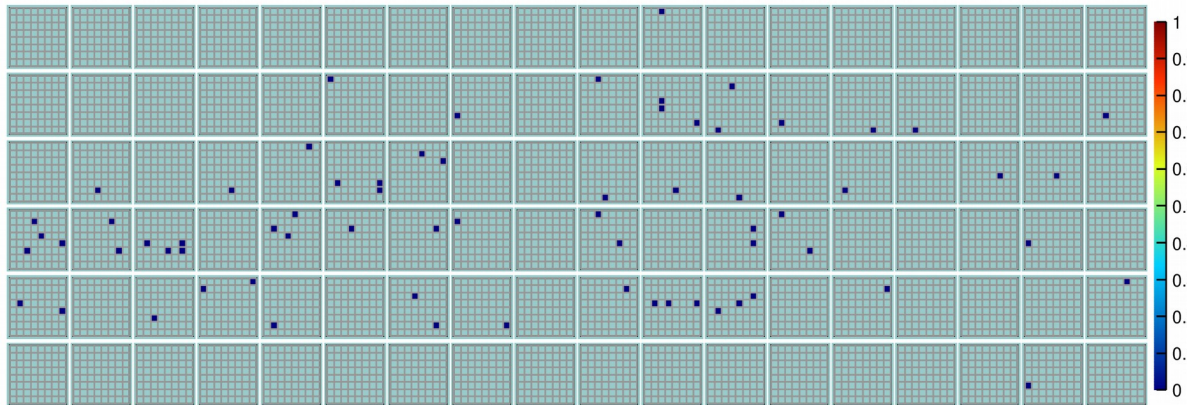
➔ Good start time alignment

Single Event Hit Patterns



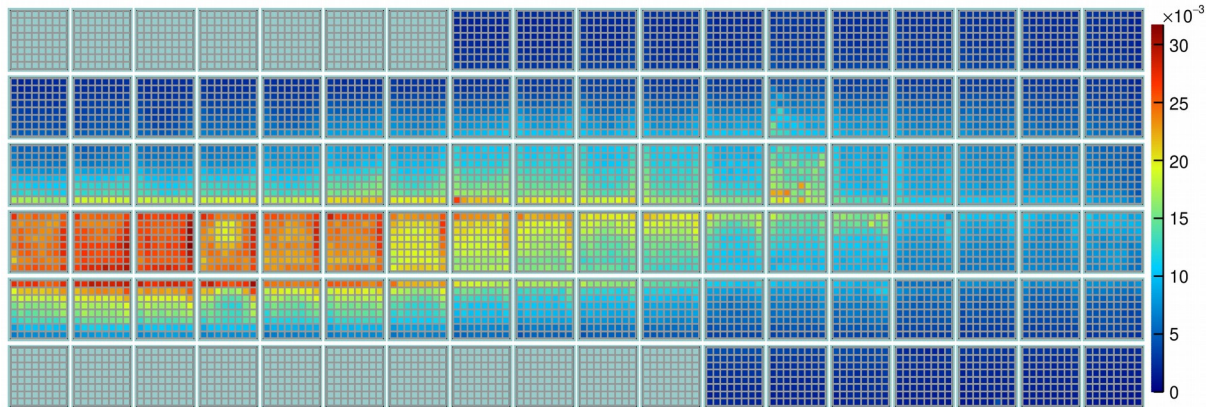
beam data, PID based on
reconstructed ρ, ϕ events

pion

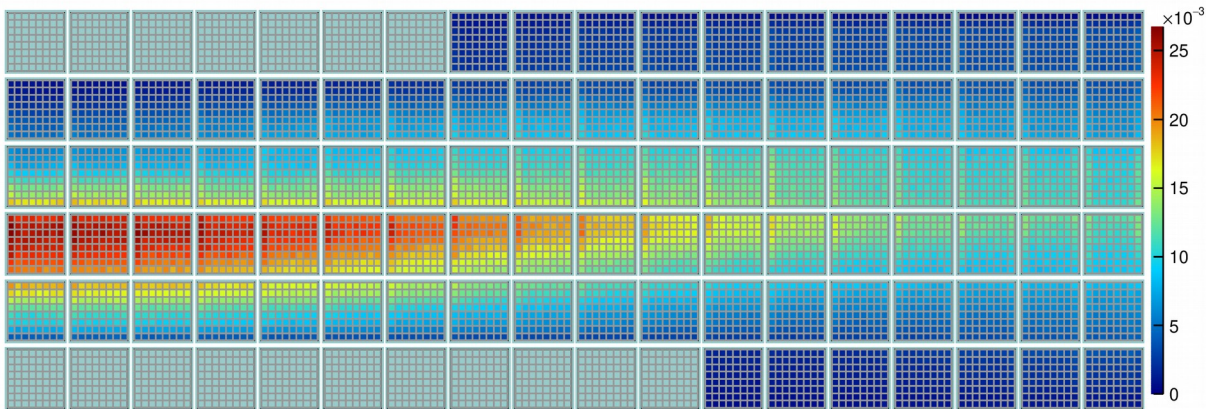


kaon

Hit Pattern Accumulated for All Angles



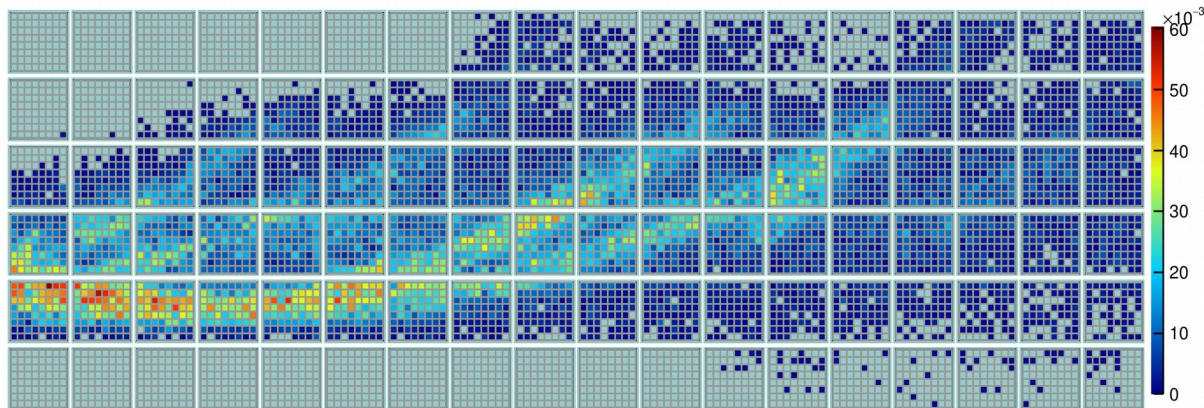
beam data



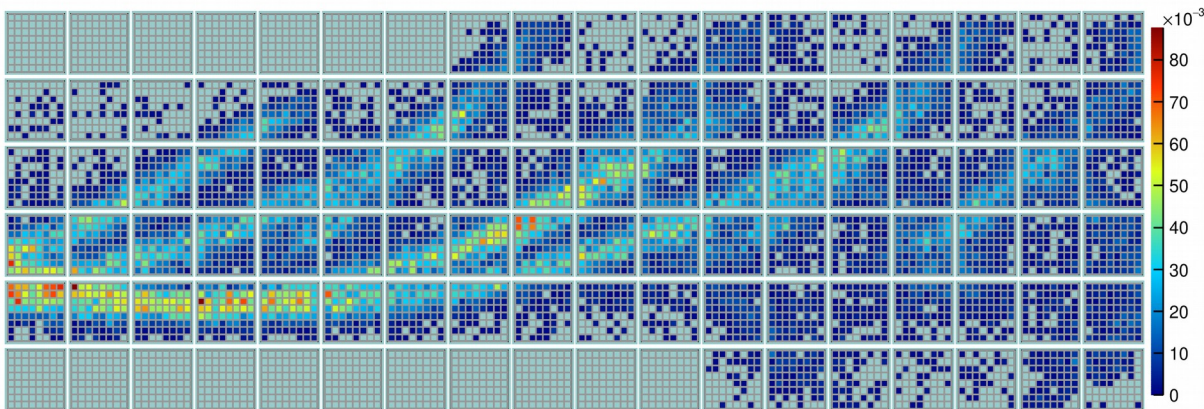
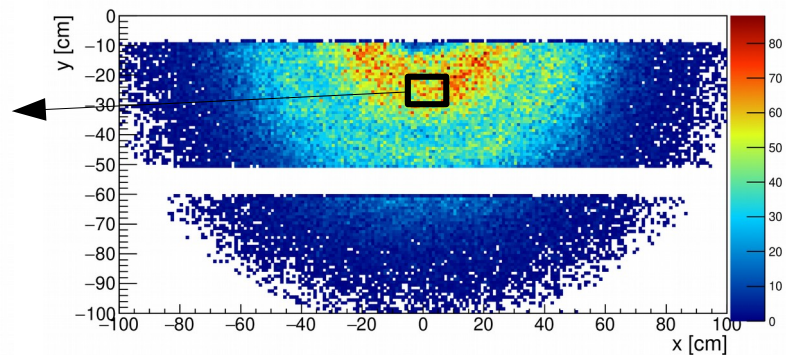
geant4

Hit Pattern

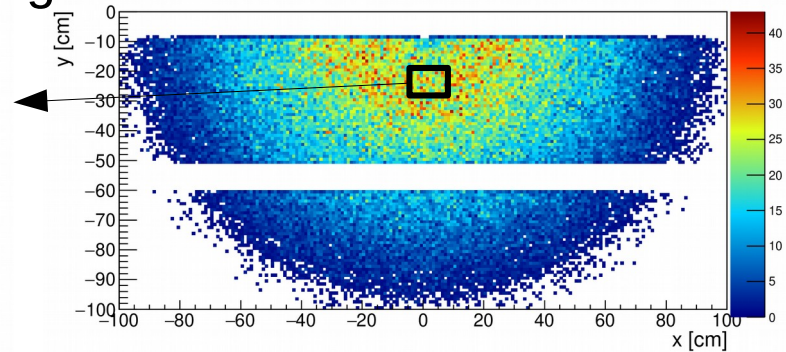
[3.8,4.2] GeV/c pions from beam



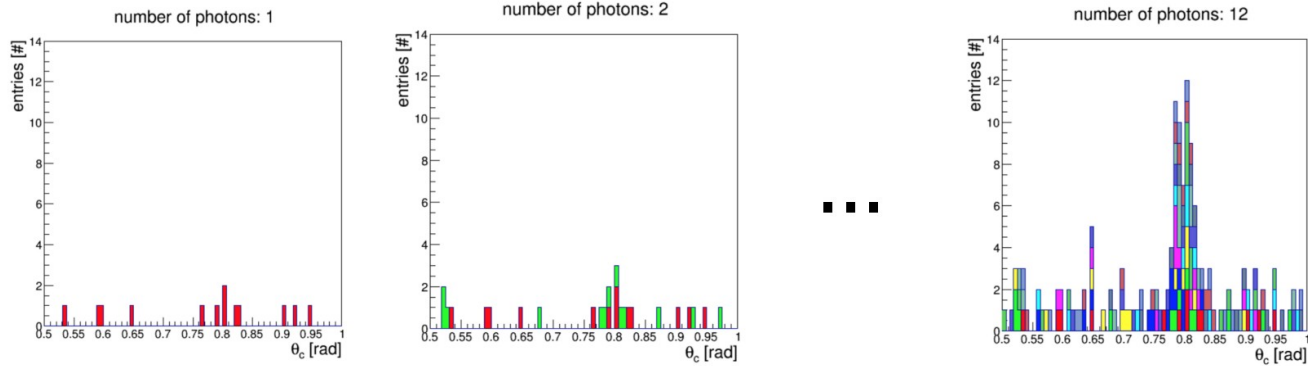
Hit positions on the radiator wall:



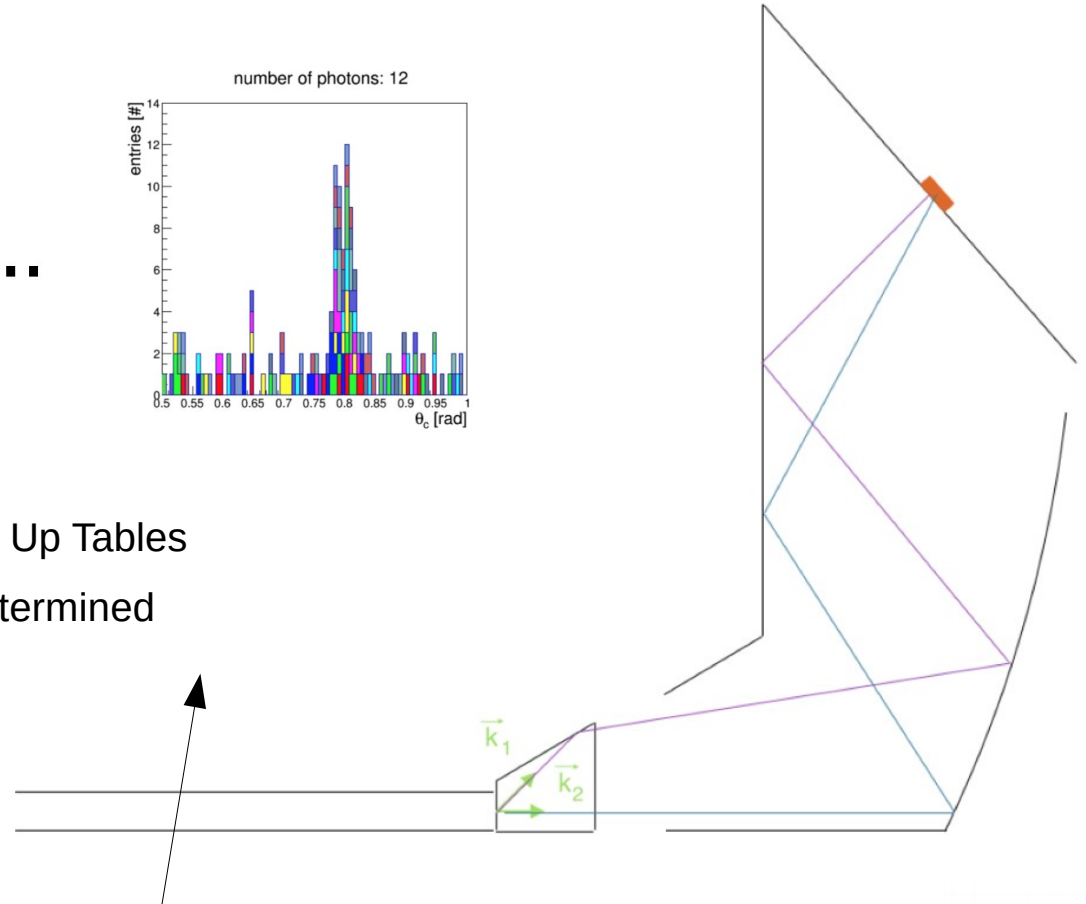
geant4



Geometrical Reconstruction

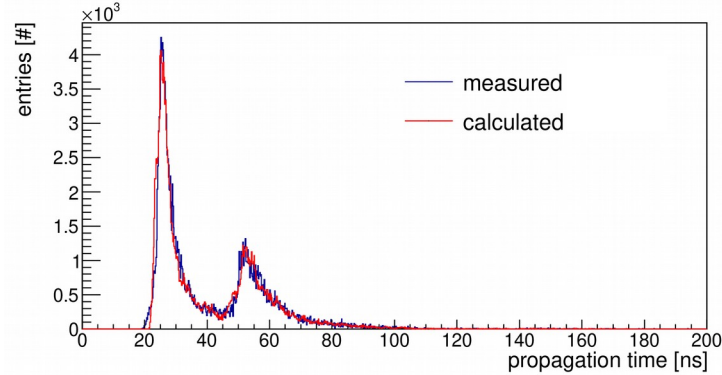


- Geometrical algorithm determine θ_c using Look Up Tables
- PID performed by unbind likelihood fit of the determined θ_c to different mass hypothesis

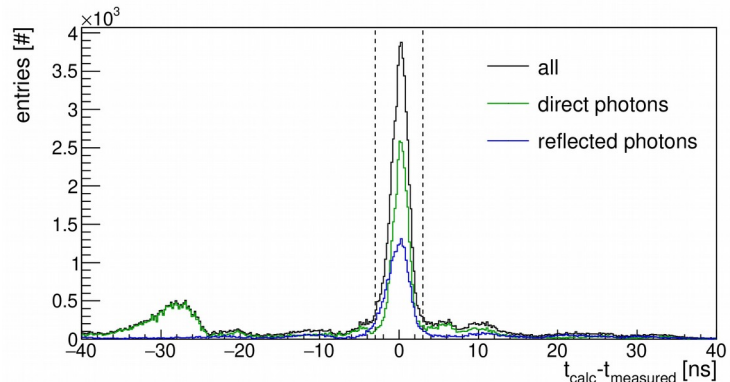
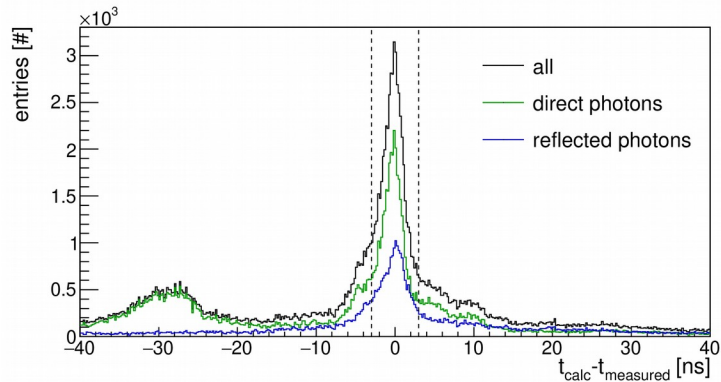
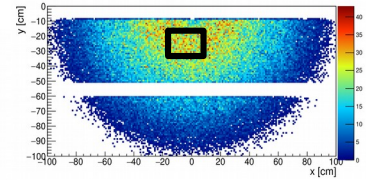
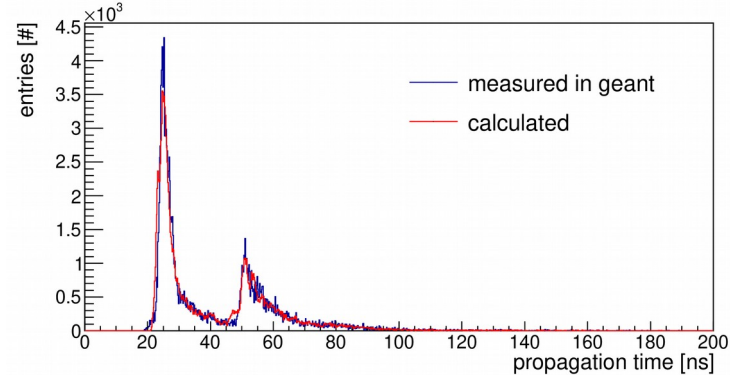


Geometrical Reconstruction

propagation time: beam data



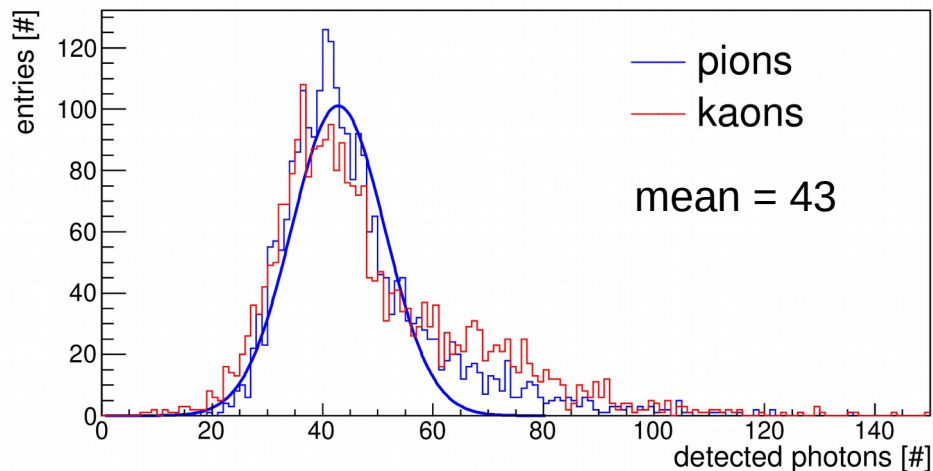
geant4 simulation:



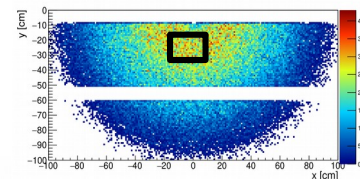
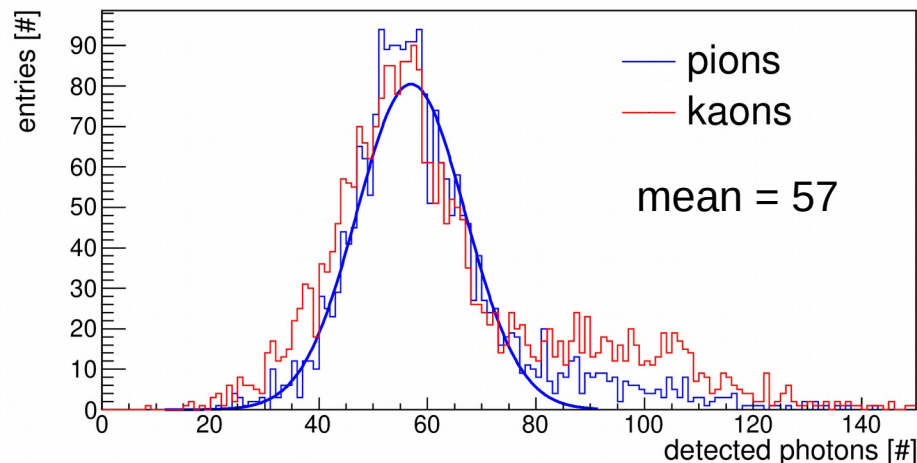
Reconstructed Photon Yield

pions and kaons @ [3.8,4.2] GeV/c:

beam data



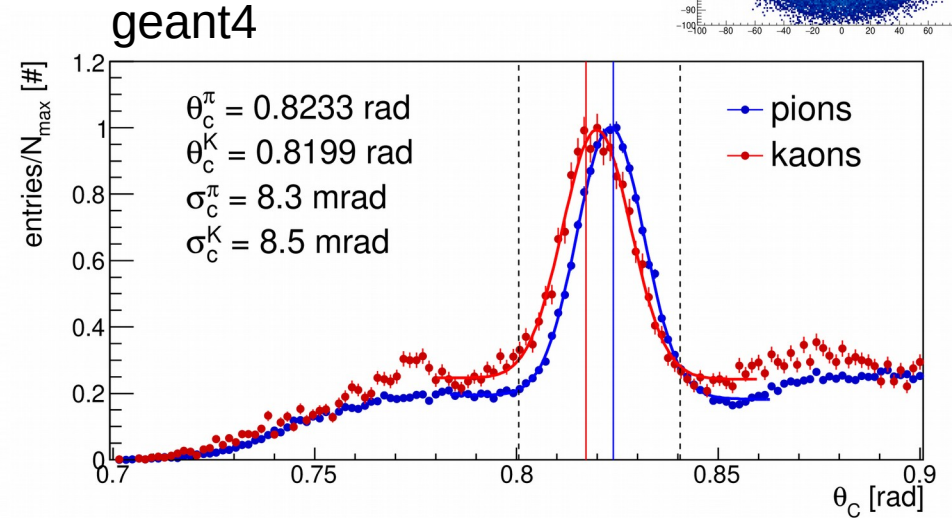
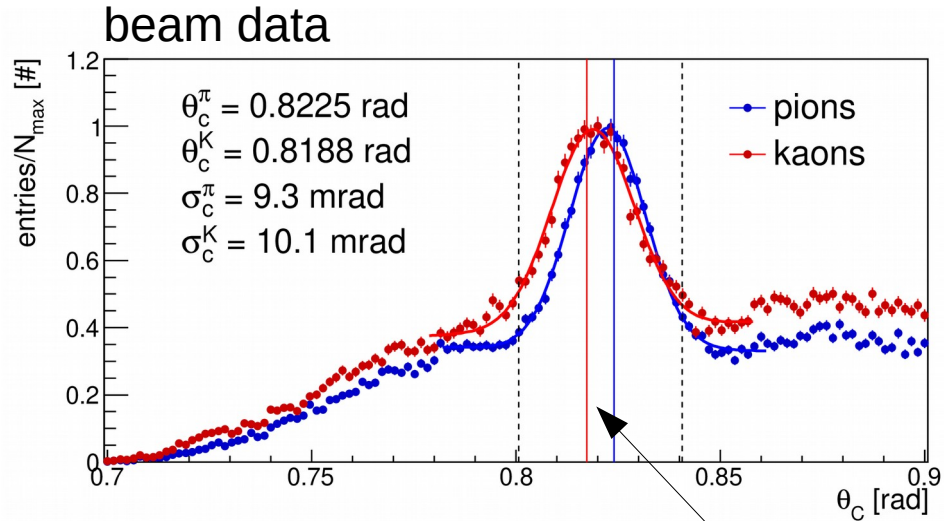
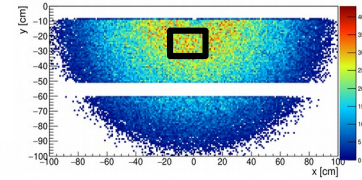
geant4 simulation:



high photon yield but still some discrepancy with simulations

Geometrical Reconstruction

Reconstructed Cherenkov angle for pions and kaons @ [3.8,4.2] GeV/c:



expected θ_c for pions and kaons



obtained SPR 9-10 mrad

Summary

- DIRC readout was implemented into Hall D DAQ and online/offline monitoring
- Optimal gain and threshold for PMT's pixels were determined and used to collect ~10B triggers at various beam and detector conditions
- Sub nanosecond timing resolution was obtained
- Geometrical reconstruction algorithm (Look Up Table) was implemented into GlueX software and successfully used to reconstruct first data
- Demonstrated initial performance of the DIRC in terms of the photon yield and SPR
- Good agreement between beam data and geant4 simulations



Successful commissioning of the DIRC

Outlook

- Evaluation of the performance over all available phase space
- Geometric alignment using FastDIRC
- Per PMT/pixel θ_c correction
- Comparisons of beam intensity dependence and threshold dependence of the reconstruction

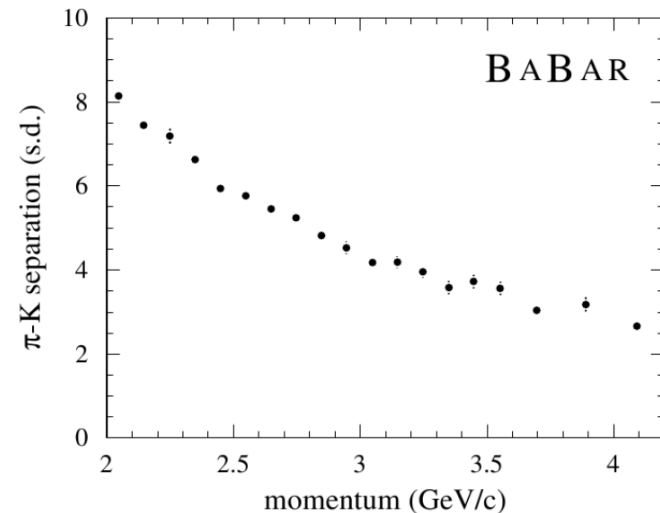
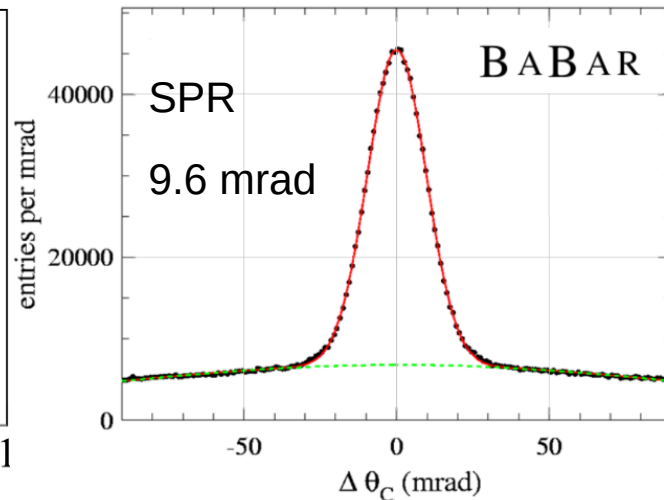
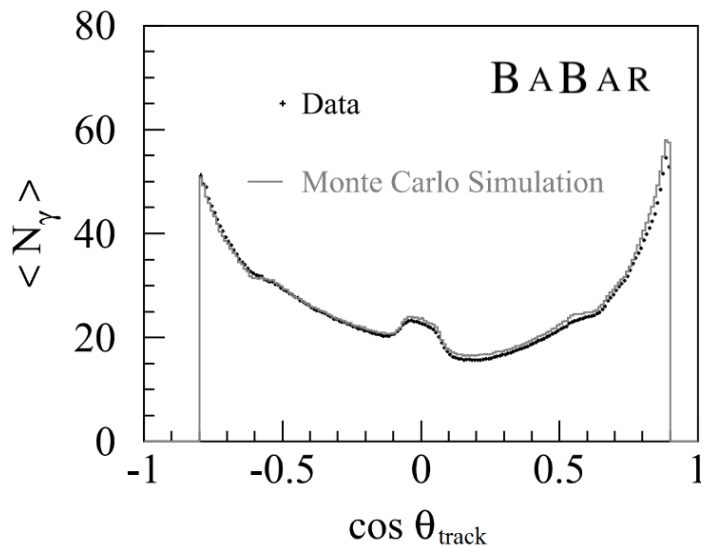
Outlook

- Evaluation of the performance over all available phase space
- Geometric alignment using FastDIRC
- Per PMT/pixel θ_c correction
- Comparisons of beam intensity dependence and threshold dependence of the reconstruction

Thank you for the attention

Expected Performance

Based on BaBar results:



=> 3 s.d. π /K separation up to 4 GeV/c (2.4 mrad Cherenkov track resolution)