

Feb 2025 test beam analysis

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Motivation

- Cross check of the test beam results independently
- Useful to identify the issue for next beam test

Reminder: Beam test

- RARiS positron beam line
 - Data taken at 100 (50) to 800 MeV range
- **Experimental Setup**
- Beam position monitor TI, T2
 - Pair of 2mm SciFi X-Y layer
 - TI:Z = 108.4 or 110.8 [mm]
 - T2: Z = 143.4 or 145.8 [mm]
- LYSO + APD DI
 - 8x8 = 64 bars (lcm*lcm)
 - DI: Z = -7.51 [mm]?
- PbWO + SiPM (Skip this report)
 - -5x5 = 25 bars (2cm*2cm)
 - Can be replaced by moving the stage



Data analysis flow



Contents

- Preparation
- Run Selection
- Pedestal Analysis
- Signal Analysis
- Results
 - -Linearity
 - -Energy Resolution

Data Synchronization and skimming

- Synchronize the three detectors based on the clock information

 - pcnt: Counter of slow clock, O(kHz)
 fcnt: Counter of fast clock, O(MHz)
 pfcnt: 1000000 pcnt + fcnt
- Select events where a common pfcnt is found across all three detectors
 - Penetrating events can be selected at this step
 - No ADC threshold is considered
- Reconstruct beam position from beam-monitor hits ۲
- Save information into a single rootfile per each run
- Repeats for all runs in different experimental setups
 - Threshold, beam position, HV etc (only 205 is used today) —

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Recorded beam position vs target channel

X [mm]	Y [mm]	Target ch
-20	-20	17
-20	-10	30
-20	0	33
-20	10	46
-20	20	54
- 0	-20	18
- 0	- 1 0	29
- 0	0	34
- 0	10	45
- 0	20	53
0	-20	19
0	- 1 0	28
0	0	35
0	10	44
0	20	53

X [mm]	Y [mm]	Target ch
10	-20	20
10	-10	27
10	0	34
10	10	43
10	20	51
20	-20	21
20	- 1 0	26
20	0	37
20	10	42
20	20	50

Taken from experimental note

Hit maps per beam position setting



Hit maps per beam position setting



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98_x10_y10

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Hit maps for 584 MeV & 796 MeV runs



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ADC distribution per position will be shown as reference. It may be redundant...

ch34

	34	45	53
	35	44	52
	36	43	51
Beam target ch			

- Only for 98 MeV, pedestal (offset?) value is slightly lower than the other beam energy
- Fit pedestal peak by Gaussian function
- Strange two peak at pos [0, 0]



ch35

	34	45	53
	35	44	52
	36	43	51
Beam target ch			

• Only for 98 MeV, pedestal (offset?) value is slightly lower than the other beam energy



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ch36

	34	45	53
	35	44	52
	36	43	51
Beam target ch			

• Only for 98 MeV, pedestal (offset?) value is slightly lower than the other beam energy



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	34	45	53
	35	44	52
	36	43	51
Beam target ch			





	34	45	53
	35	44	52
	36	43	51
Beam target ch			





	34	45	53
	35	44	52
	36	43	51
Beam target ch			





	34	45	53
	35	44	52
	36	43	51
Beam target ch			





	34	45	53
	35	44	52
	36	43	51
Beam target ch			





	34	45	53
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	36	43	51
Beam target ch			



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Pedestal values

- checked pedestal peak for all different run configurations for each energy and ch
 - Beam pos, threshold values
 - Fitted by function: y = a



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Signal peak determination steps

- I. Subtract fitted pedestal contribution from histogram
 - Use obtained offset values (Pedestal shifts**?), No clear peak**
- 2. Then, take mean values for each runs
- 3. make histogram of the 'mean-offset' values for each channel and energy
- 4. Plot relation between beam energy and mean of mean values
 - Obtain 'Energy Conversion factor' for each channel



Step3: ADC mean histograms



- Some runs occasionally show significantly deviated values
 → but in general, the results look stable
- The run to run variation is visible, but the cause is not yet understood

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Linearity (Mean_ADC vs beam energy)



OK for linearity (No saturation)

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RMS distributions

- RMS of Energy distribution for all runs (only main 9 channels are shown)
- RMS is stable against different run configurations



Energy resolution

- My analysis results
 - 50% energy resolution for the best case
 - Slightly worse than others
- Very far from requirements



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40%

Summary and prospects

- Performed test beam analysis independently
 - Good for cross check and identify issues for the next test beam
- Showed very tentative analysis results for test beam @ Feb 2025
- We analyzed LYSO+APD setup
 - Linearity: No significant problem found
 - Energy resolution: Slightly worse than others
 - Only IxI configuration
 - 50% even for the best case
 - Need to check analysis procedure again

Next

- See 3x3 (and 5x5) for LYSO
- See PbWO + SiPM data as well
- Cross-check are ongoing with my student (Kentaro Motohashi)

Plan for another test beam

- I. We have started designing an independent beam test setup using a Japanese budget
 - currently building a SciFi + MPPC (SiPM) hodoscope (materials are partially available)
 - $16ch \times 16ch \times 2 xy$ layers
 - An XZ moving stage is being prepared (the Z-axis is particularly challenging)
 - Started designing a system using Crystal+MPPC readout with a general-purpose SiPM readout ASIC (EASIROC)
 - 3x3 or 5x5 tower?
 - Purchase of Crystal scintillator? Need to discuss with Goto-san
 - investigating whether there are any MPPCs that are robust for saturation or how to improve against saturation

