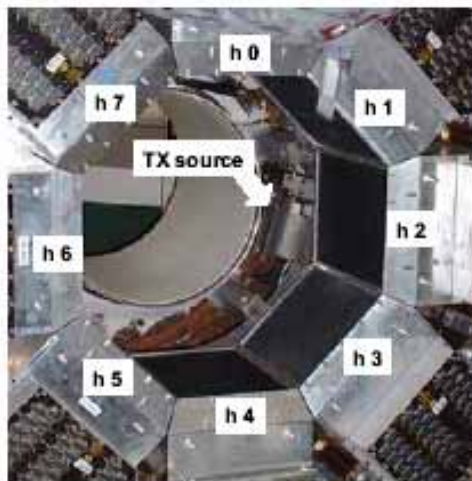


Chapter 8.8 Detector Setup

- Acquisition modes
- Emission Detector Setup
- Transmission Detector Setup
- Time Alignment

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To guarantee proper functioning of the of the tomograph, the signals from all 119,808 crystals must be mutually adjusted.

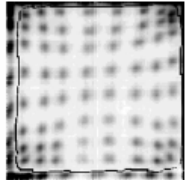
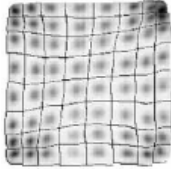
When?

- before putting the scanner into operation
- after replacement of PMTs or electronic components
- from time to time balance naturally occurring shifts of the PMT gains and the electronics

Acquisition Modes

- Position Profile Mode
- Shape Discrimination Mode
- Tube Energy Mode
- Crystal Energy Mode
- Runmode Image Mode
- Time Difference Mode

Position Profile Mode

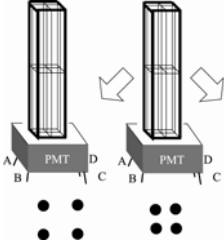

→


additional 'crystals' at the borders of the matrix

ignore

Why?

Some light is also transferred into the detector block of interest, so that the 'event' position shifted inwards.



Shaping Discrimination Mode

The ratio E_1/E_2 ? ?

The energy signal : $e(t)$ (integrated signal)

$$E_1(t_1) = 1 - e^{-t_1/\tau}$$

$$E_2(t_2) = 1 - e^{-t_2/\tau},$$

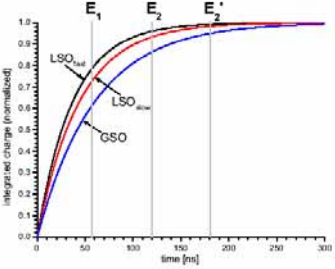


Figure 8.8: The integrated signal $e(t)$ is sampled at two time points $t_1=60$ ns and $t_2=120$ ns (or $t_2=180$ ns for the commercial HRRT). The ratio of the digitized values (E_1/E_2) is different for different scintillator materials (compare Figure 11.3).

Histograms of the E1/E2 for a LSO/GSO and for a LSO slow/LSO fast detector block

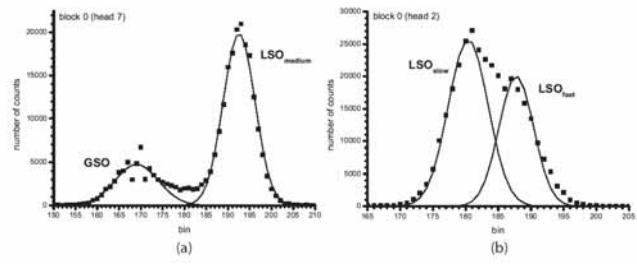
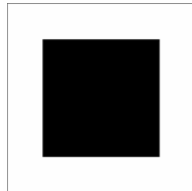
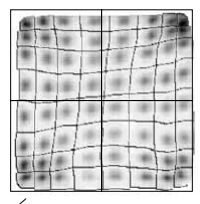


Figure 11.3: Pulse Shape Discrimination. (a) LSO/GSO detector head. (b) LSO/LSO detector head.

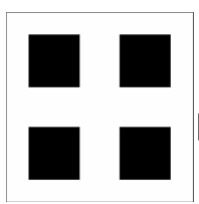


The ratio E1/E2 is histogrammed into a 256 array for each block.

Tube energy Mode



PMT

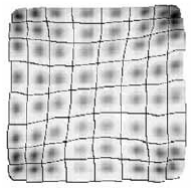


Detected by a single event

four PMT pulse height histograms



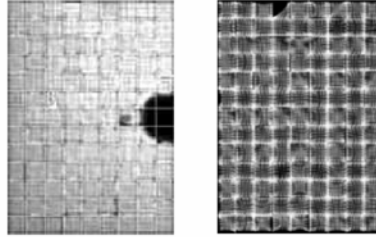
Crystal energy Mode



a 256 bins pulse height histogram

Runmode Image Mode

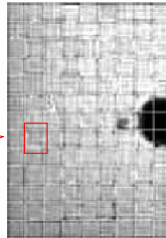
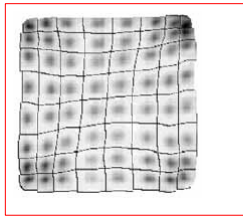
Daily Quality Check



(a)

(b)

Figure 13.3: (a) Runmode image of a detector head with a defective bleeder board. (b) Position profile image of a detector head with a defective analog card.



a 72×104 array

Time Difference Mode

The digitized signal from two single events occurring within the same 256ns sync window.



subtracted

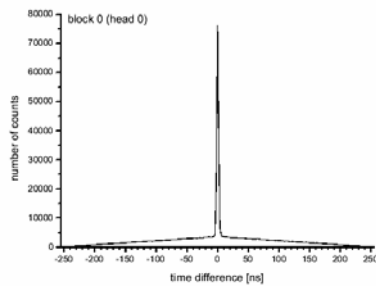


Figure 8.15: Time difference histogram for one block against all other blocks in coincidence measured with a rotation rod source at 100 mm radius.

Emission Detector Setup

- Offset Adjustment
- CFD Delay Adjustment
- Coarse Gain Adjustment
- Shape Discrimination Thresholds
- Fine Gain Adjustment
- Crystal Region Definition
- Crystal Energy Determination

Offset adjustment

$$X = (A + B + X_{offset}) / (A + B + C + D)$$

$$Y = (A + C + Y_{offset}) / (A + B + C + D).$$



desired bin

× fabrication tolerances

CFD delay adjustment

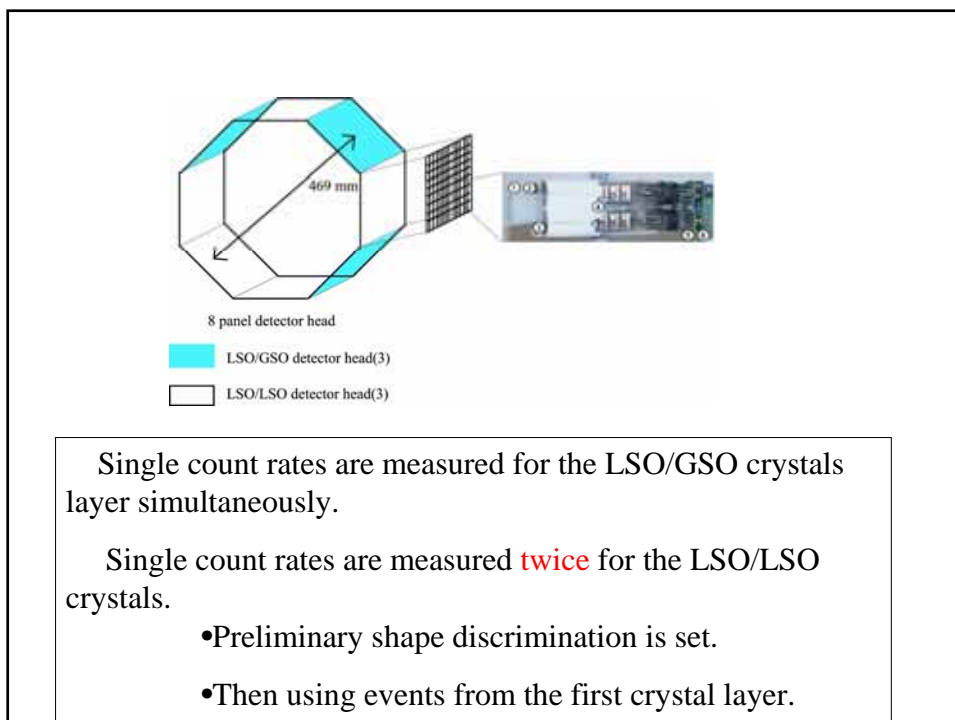
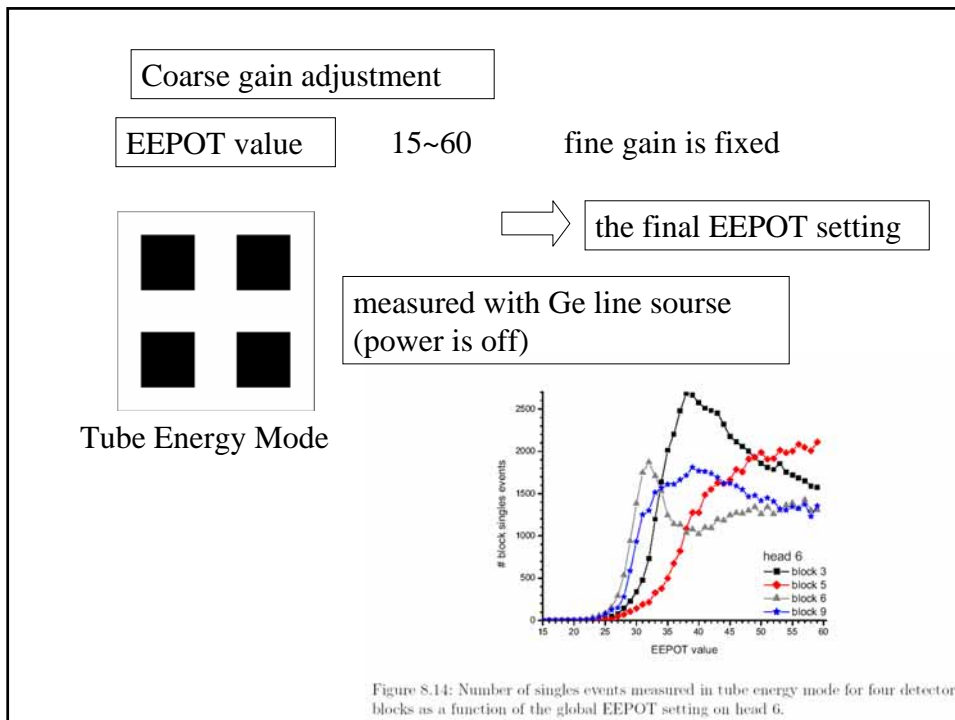
The CFD of the ASIC



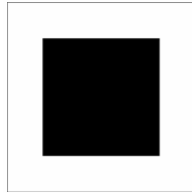
desired delay

test pulse

× fabrication tolerances



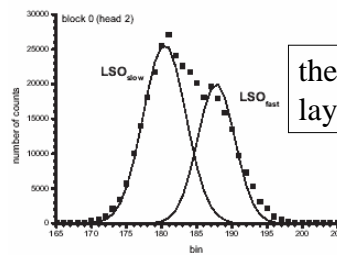
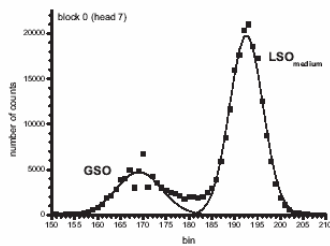
Shape Discrimination Thresholds



the shape discrimination values (SDVs)

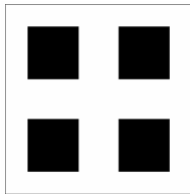
measured with Ge line source

Shape Discrimination Mode



the wrong crystal layer is minimal

Fine Gain Adjustment

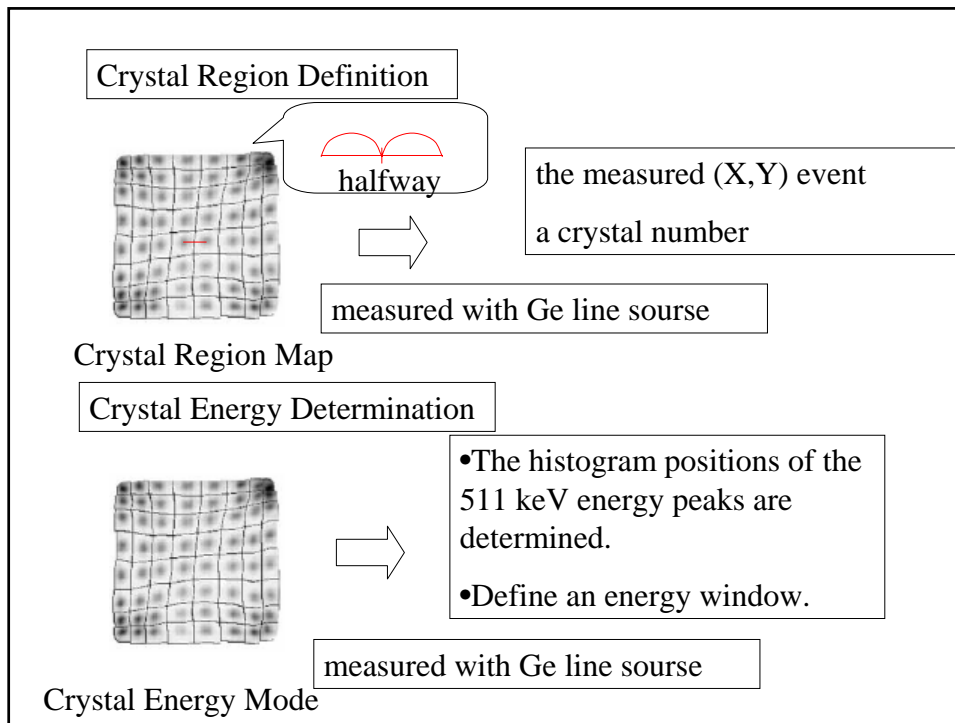


a desired position

measured with Ge line source

Tube Energy Mode

- The 511keV is shifted to a desired position.
(bin170 - LSO slow for the LSO/LSO detector head
bin190 – LSO medium for the LSO/GSO detector head)
- Regulate the amplifier gain inside the analog ASIC.
- If a peak position ± 5 bins around the desired peak position, the corresponding fine gain value is altered.



Transmission Detector setup

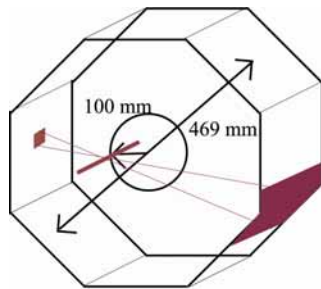
- The fine gain settings are lowered by the ratio 511/662.
- The electronics process with energy of **662keV** instead of 511keV.
- measured with ^{137}Cs point source

Time Alignment

Two single event, originating from the same e^+e^- annihilation in the center of FOV, are not necessarily detected simultaneously.



- Non-identical CFD circuits
- Individual path length of the photoelectrons within the PMT (transit time)
- Different signal path-length in the data cable



^{68}Ge line source

Time Difference Mode

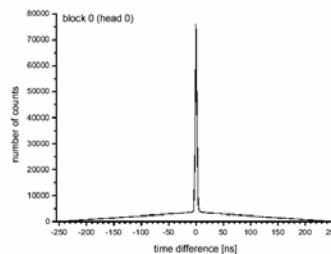


Figure 8.15: Time difference histogram for one block against all other blocks in coincidence measured with a rotation rod source at 100 mm radius.

- Time difference histogram are measured for each block in conjunction with all detector block in coincidence.
- The random are subtracted.
- The CFD delay altered to shift the peak toward the zero point.
- One already aligned head is used as reference.