MEGA, Technical Status and Simulations

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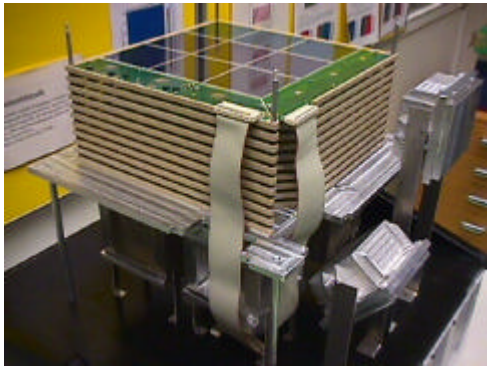
Further information is at: http//www.gamma.mpe-garching.mpg.de/MEGA/mega.html

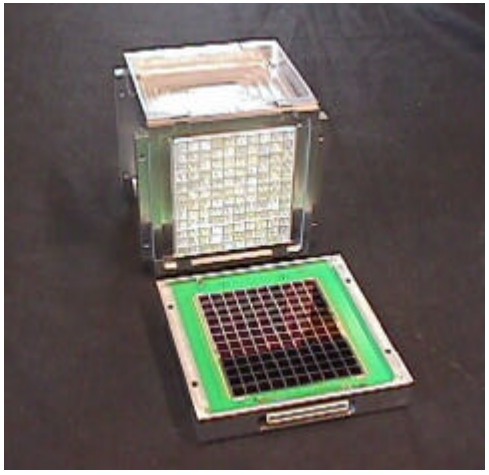
Overview of Prototype Detector Elements

- Doublesided Silicon Strip detectors
- Electron Tracking capability
- Self-triggering analog VLSI readout



D1

- Silicon Pad detectors
- Pixelized CsI crystal bars
- 2-D and 3-D detectors
- multiple interaction determination capability
- Self-triggering analog VLSI readout



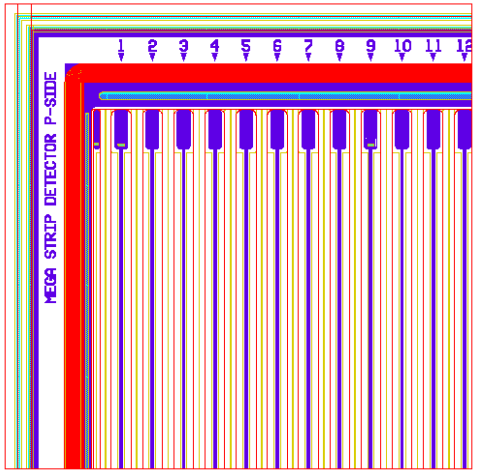
D2

Strip-detectors, technology

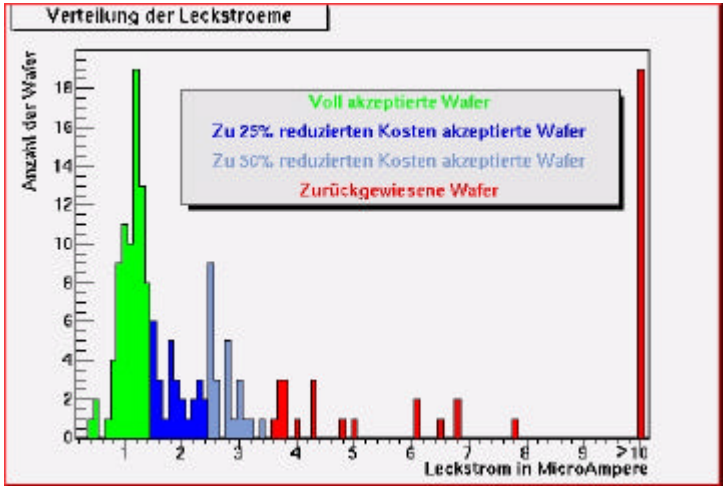
D1

- 6 x 6 cm doublesided, 128 strips, 0.47 mm pitch, 0.5 mm thickness
- Integrated AC-coupling and punch-through biasing, p-spray separation on n-side
- 110 Wafers accepted (<2 μA leakage, < 2 defect AC) out of >160 produced by EURISYS, France.

Strip layout p-side



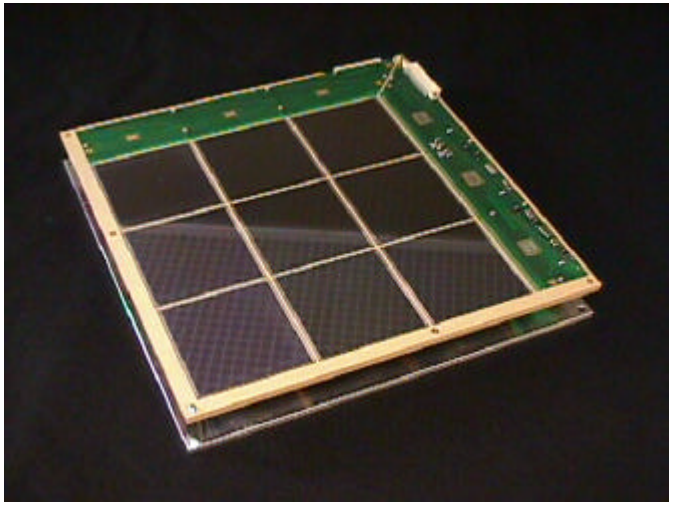
Leakage currents statistics



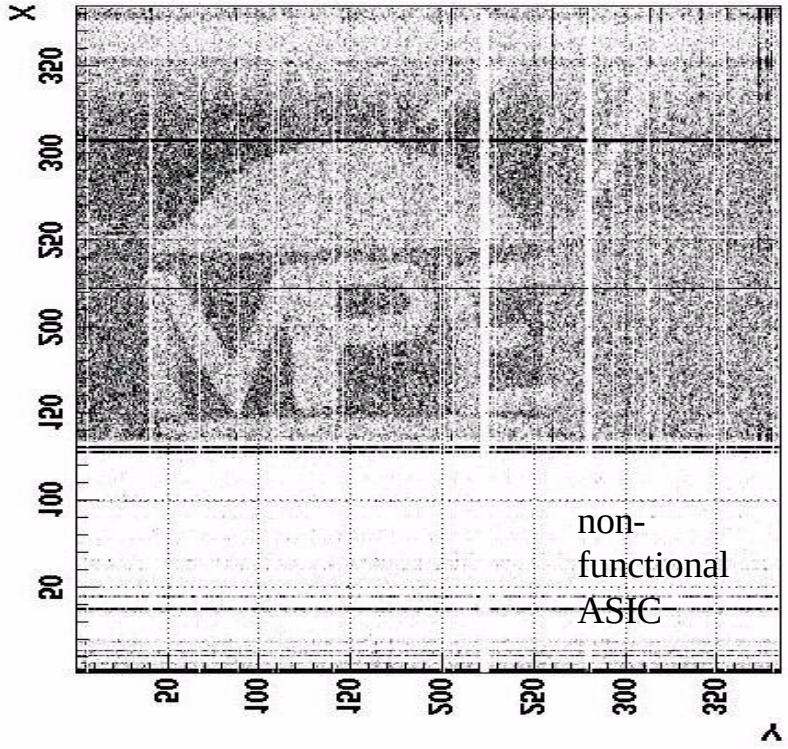
Strip-detectors, results from first layer

D1

- Expected noise value ~1200 e^-ENC (10 keV FWHM)
- Actual noise values 2500 e^-ENC (p-side) and 4000 e^- ENC (n-side).
- 5 more layers in preparation, 5 ready at Bonding Facility.
- Trigger threshold ~ 30 keV
- Rarely charge division between neighbouring strips.



Shadow mask illuminated with8 Ba^{133}

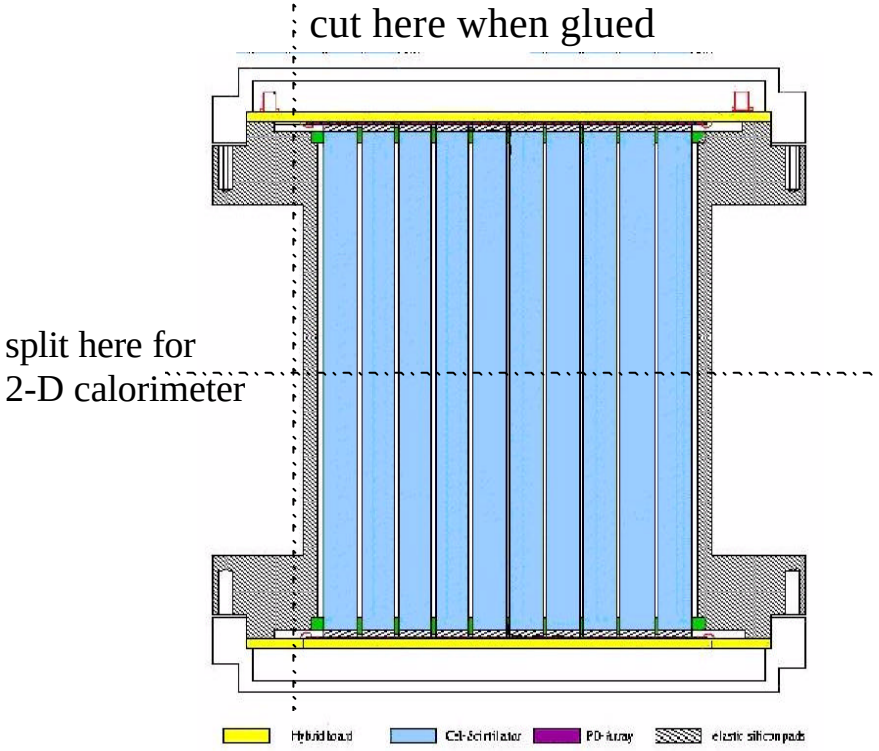


CsI Calorimeter, technology

D2

- Monolithic 10 x 12 PIN Diode Array with 5x5 mm^2 pixelsize produced by Hamamatsu.
- Low leakage current (20 nA) results in only 300 e^- ENC (2.3 keV FWHM).
- Readout electronics integrated on back of Hybrid.
- No measurable crosstalk between pads or crystals.

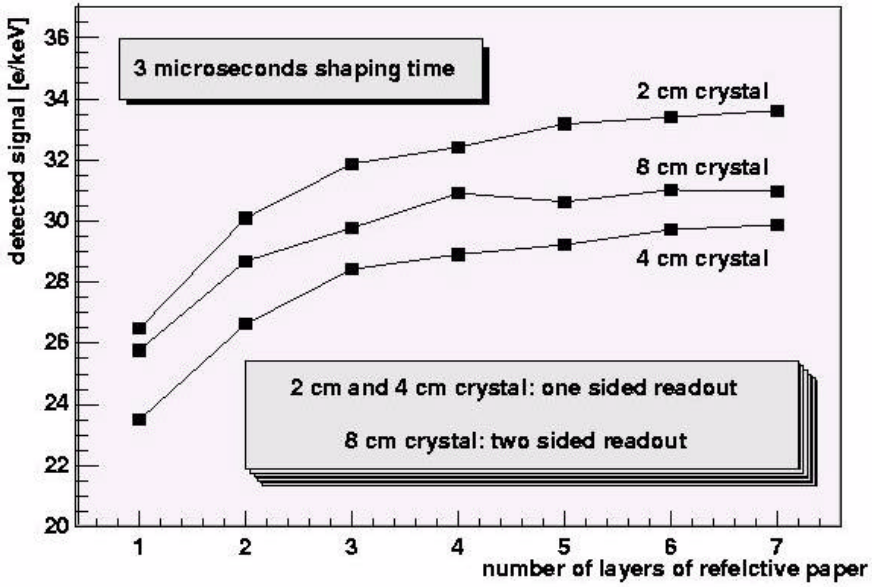
Assembly of CsI-arrays



Light Yield of CsI Bars **D2**

- CsI(Tl) crystals from Hilger Analytical, polished by hand and packed with Millipore paper 0.2 - 0.5 mm thickness.
- Coupling with white silicon grid filled with transparent silicon pads.
- Length of crystals: tradeoff between light yield, stopping power and paralaxe.
- Pixelsize: tradeoff between electronic noise and light yield.

Dependence of lightyield on paper thickness and crystal length.
The signal of the 8 cm crystal is the sum of both diodes.

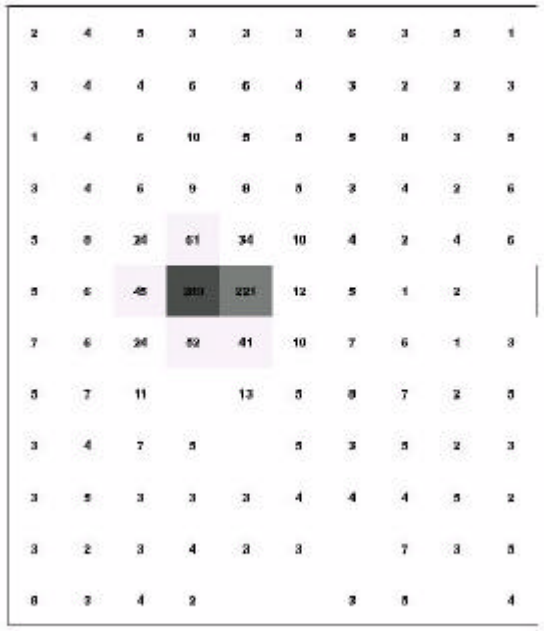


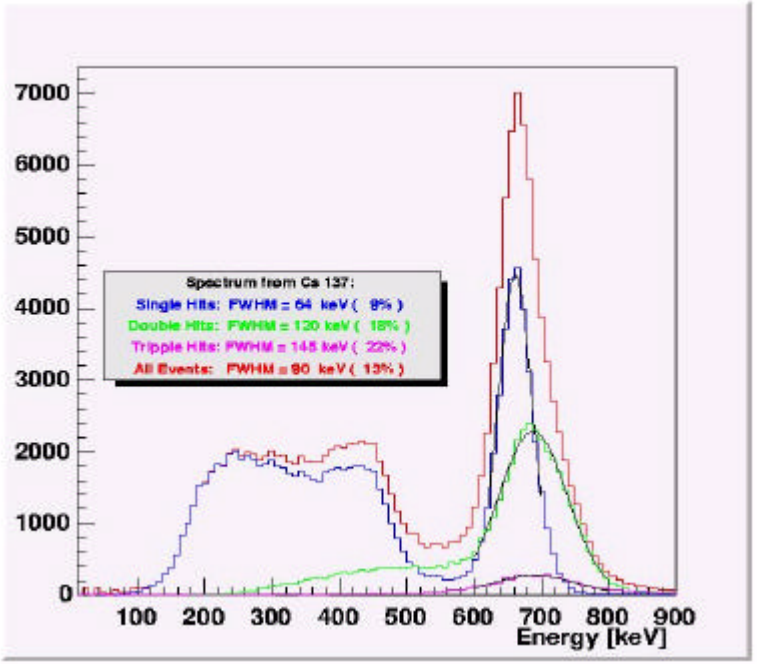
2-D Calorimeter

D2

collimated Cs^{137} source

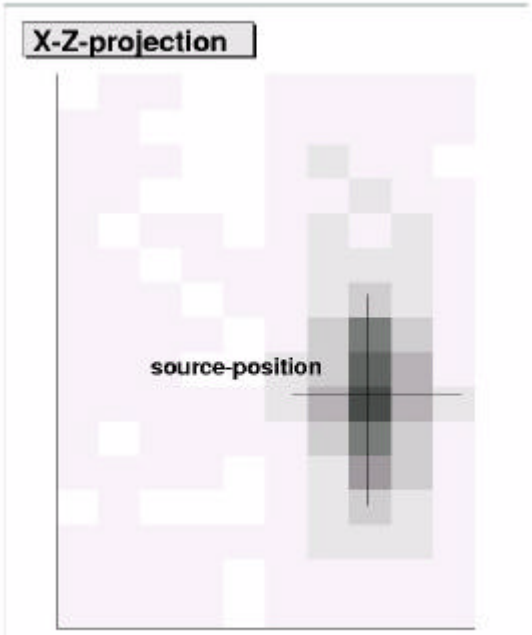
Energy resolution @ 662keV
varies between 6 and 10% FWHM





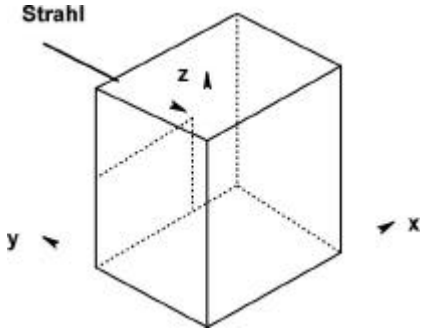
3-D Calorimeter

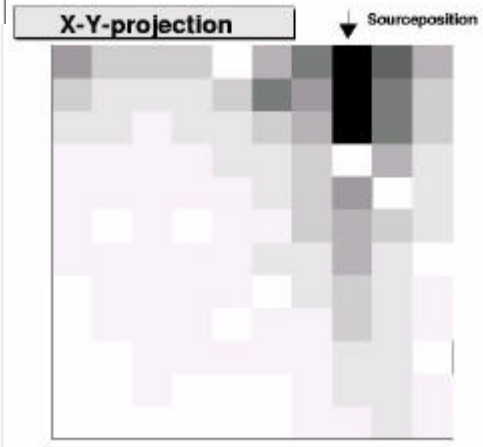
D2

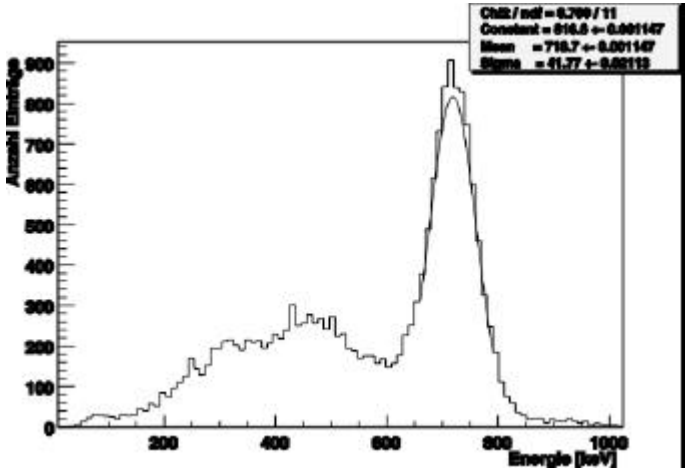


collimated Na^{22} source

Energy resolution
@ 662 keV: 14% FWHM



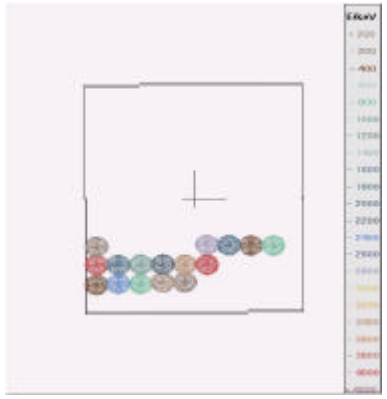


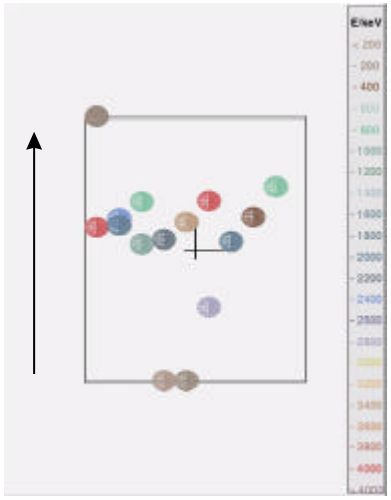


Self triggered μ – tracks

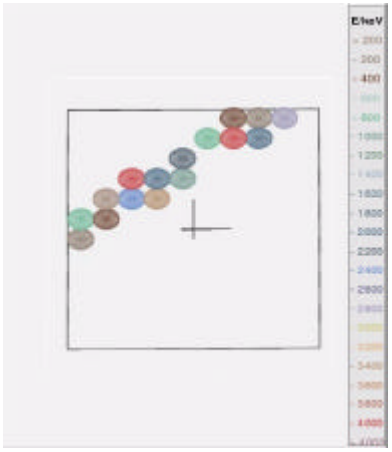
D2

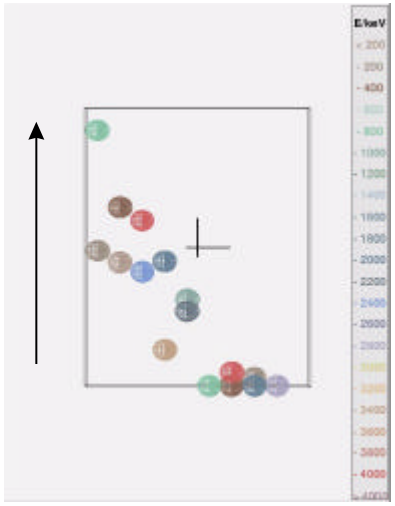
particle crosses perpendicular to the CsI-bars





particle enters through one of the diodearrays



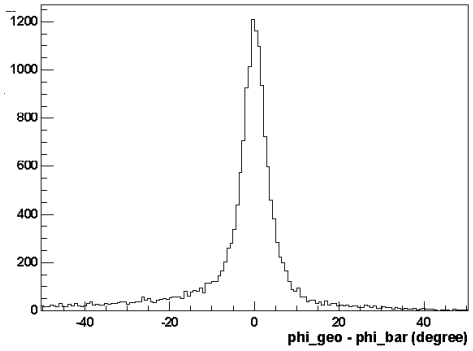


In this case there should be the possibility to discriminate charged particles from photons due to the extra charge created in the diode. T.b.d.

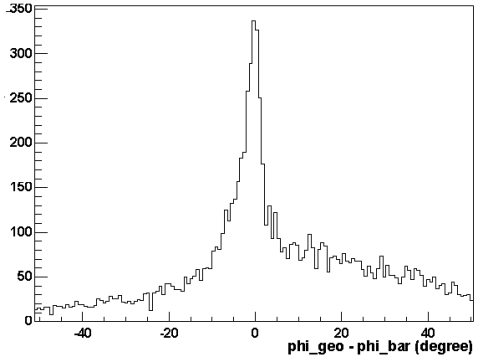
Simulations to Determine Angular Resolution Measure (ARM) and Scatter Plane Deviation (SPD) distributions

These Simulations were done for the Prototype Geometry.

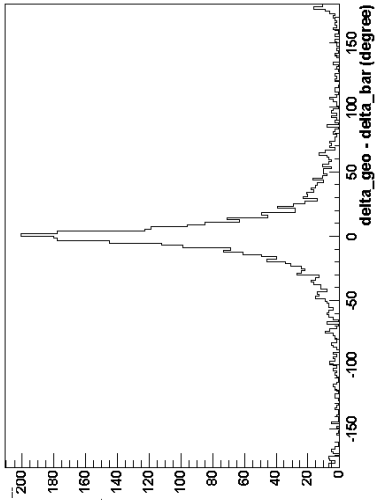
ARM at 500 keV



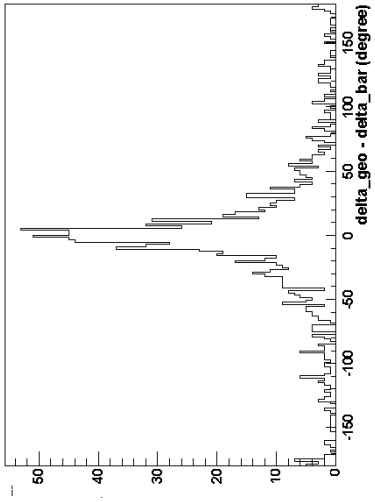
ARM at 3 MeV

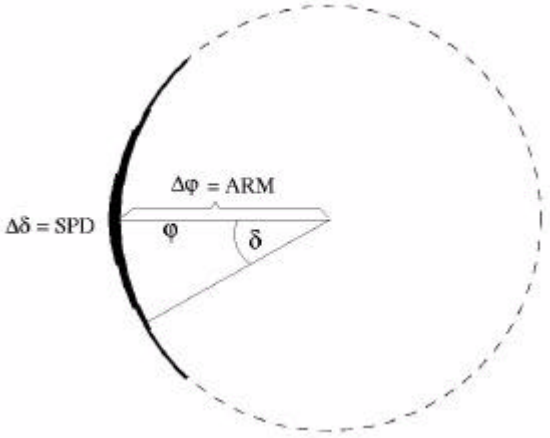


SPD at 3 MeV



SPD at 1MeV





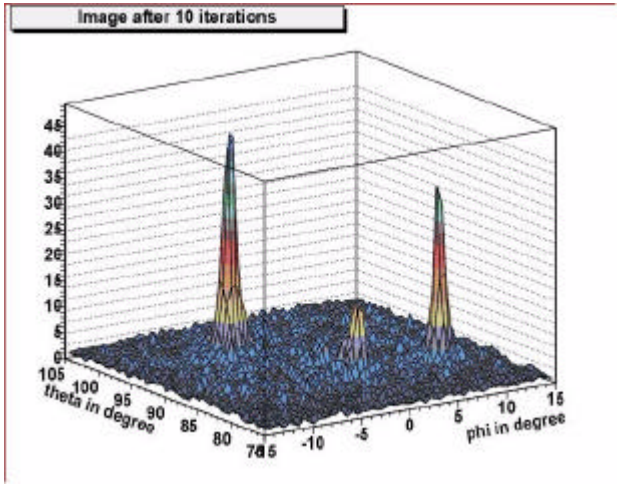
At high energies, ARM is dominated by loss effects.

Error Budget (from Simulation) for incident photons of 2 MeV

	Absolute error	ARM error
Position D1	0.5 mm No error in DoM assumed	0.24°
Energy D1	FWHM = 10 keV No error in DoM assumed	0.4°
Position D2	5 mm Pixel in x and y, FWHM 8 mm in z No error in Sequencing assumed.	1.2°
Energy D2	8 % FWHM @ 662 keV 5 % FWHM @ 1275 keV	1.6°

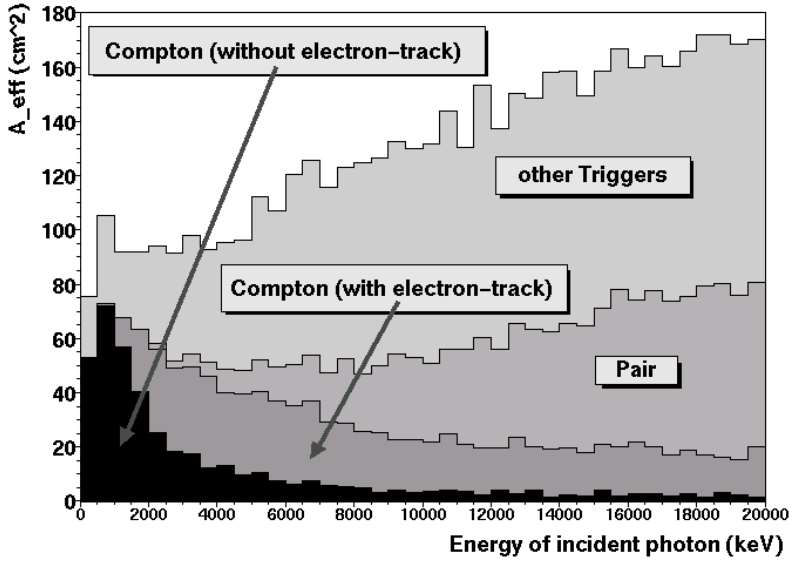
Sum is 2.4°

Listmode Likelihood image reconstruction can handle various event classes and additional information.



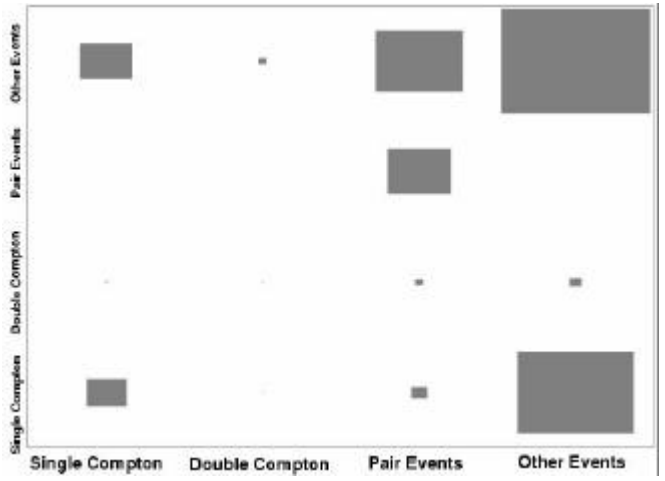
Event Classification

Probability for various interaction classes at normal incidence.



Result of crude event classification(first cut) for incident photons of energy 10 MeV.

recognized event



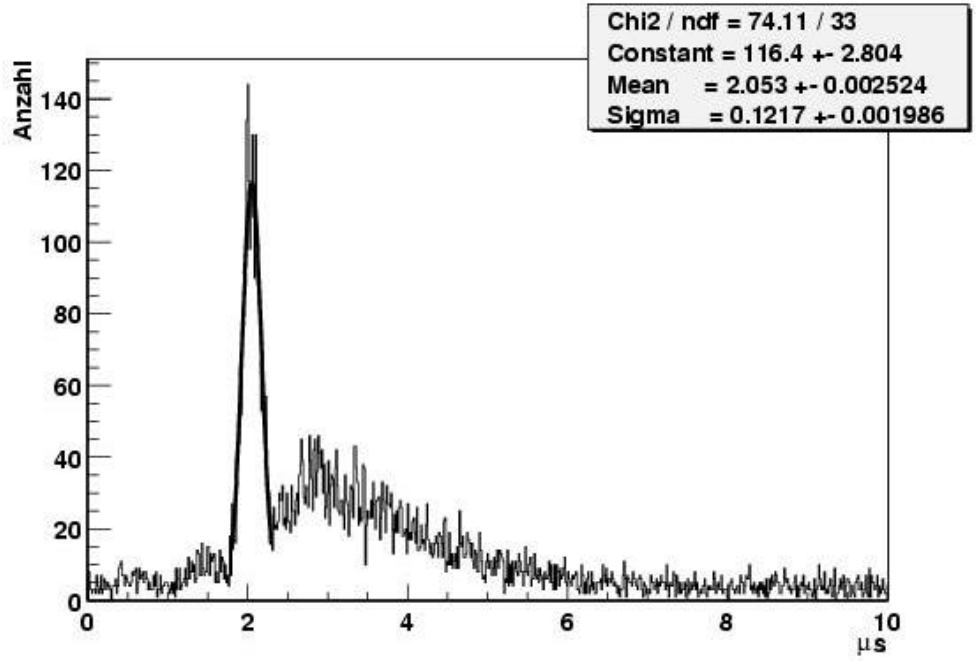
true event

=> Event classification is difficult and very important

Time Resolution

- Timeresolution is dominated by the timewalk of the simple level trigger.
- Coincidence window will effectively set an energy threshold.
- Other trigger methods are under investigation.

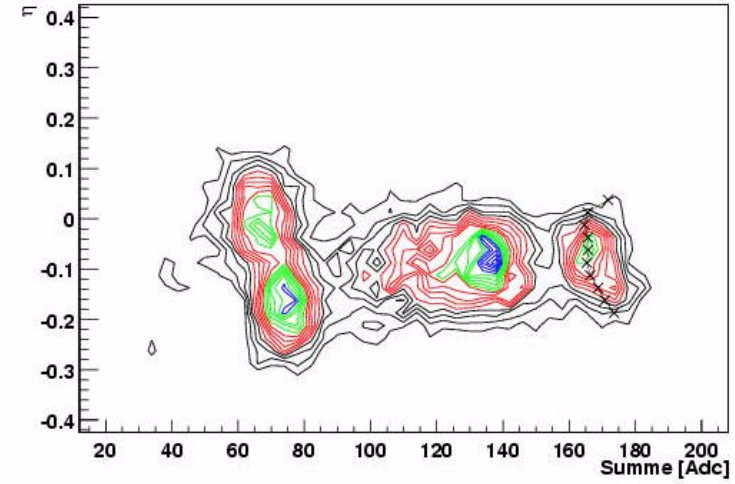
Delay of trigger signal from a D2-detector relative to a plastic scintillator (Na^{22} source).



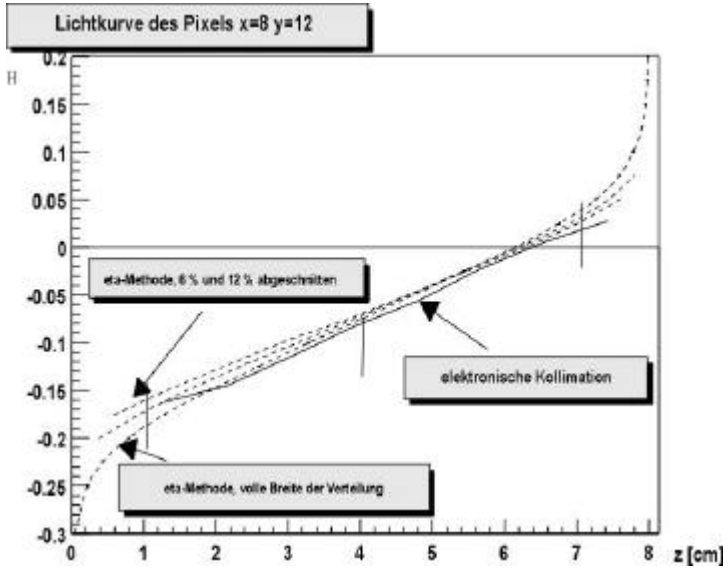
Calibration of lightcurves for 3-D Calorimeter **D2**

- The detector is homogenously flooded with a source.
- The measured distribution of Eta (relative Signal of the two diodes) is integrated to yield the lightcurve.
- Energy is calibrated for individual values of Eta.

Histogramm of Eta versus Sum for one CsI-bar. (Na^{22} source)

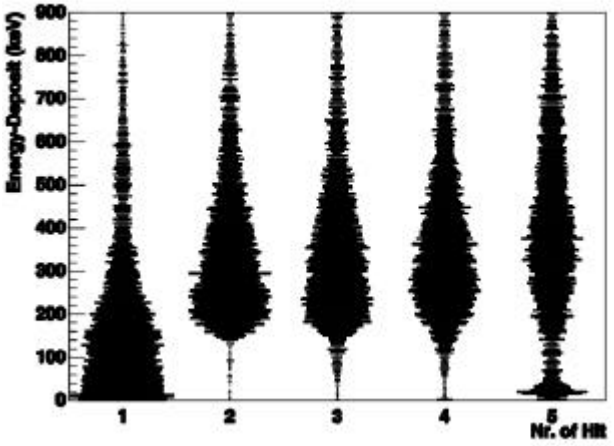


Comparison of thus determined lightcurve with those from mechanical and electronic collimation.

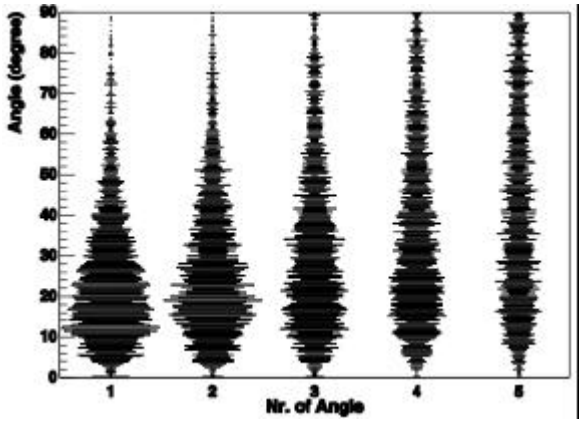


Direction of motion parameters (for 5 hit tracks)

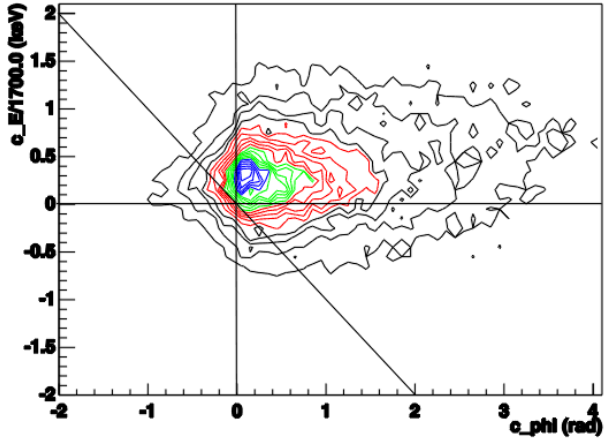
Energy loss distribution



Scatter angle distribution



Correlation coefficients



Number of correctly oriented tracks