JADE Computer Note 88

How to Handle Lead Glass Clusters in Calculating the Visible Energy E_{vis}

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To calculate E_{vis} a summation is done over the momenta of the charged tracks and the energies of the lead glass clusters.

$$E_{vis} = \sum_i p_i + \sum_j E_j$$

In MCREDU, the routine which applies the cuts in E_{vis} and the momentum balance p_{bal}, the index j runs over all clusters in the 'LGCL' bank, neutral or charged [1]. In this case the mean value of E_{vis}/E_{cm} becomes nearly 1. This gives one the impression that the full amount of energy released in an e^+e^- annihilation is detected. You can imagine that this cannot be true because of particles escaping through holes in our detector or leaving the detector without any interaction like ν's or K^0_L's. Some people subtract 300...350 MeV for each charged track that is connected to a lead glass cluster. This is of course insufficient in cases where an electron hits the lead glass or a hadronic interaction takes place.

In this JADE note I present a method which handles these cases more adequately. Charged tracks with $p > 0.2\ GeV/c$ are extrapolated into the lead glass and the energies of the hit blocks are summed up. If this energy is lower than p, these blocks are deleted in the 'ALGN' bank. If the energy is bigger than p, an energy equal to p is subtracted from the energy of the hit blocks. After this is done for all charged tracks, the lead glass analysis is repeated for the modified 'ALGN' bank. The results are stored in the banks 'ALGN',2 and 'LGCL',2. The original banks 'ALGN',1 and 'LGCL',1 are restored.

An example is shown in Fig. 1. The upper part shows the standard rolled out view of the lead glass. Numbers inside the blocks give the energy in MeV. The lower part shows the same view after modification of the 'ALGN' bank. Blocks hit by T3, T4, T6, T7, T11 and T20 are deleted. Some energy is subtracted from the blocks hit by T8 and T9.

Some checks are done. In Monte Carlo events it was checked whether neutral particles (γ, n, K^0_L) are lost because the blocks where they deposited their energy are deleted. Nearly all neutral particles are found unless there is a close overlap with a charged particle.

The total lead glass energy after modification E_2 (taken from 'LGCL',2) is compared to the expected lead glass energy E_e. All neutral particles (γ, n, K^0) which encounter the lead glass

[1] If a lead glass cluster is connected to one or more charged tracks it is called a charged one.

are considered, this means if they satisfy $|cos\,\vartheta| \leq 0.8$ or $0.87 \leq |cos\,\vartheta| \leq 0.93$.

$$E_e = \sum E_\gamma + \sum E_n + \sum E_k$$

E_γ is taken from the 'VECT' banks. Problems arise for neutrons and $K^0\,'s$, because it is not known, how much energy they deposited in the lead glass. So the energies in the blocks hit by a neutron or a K^0 are taken. This may be too big in some cases, where the cluster of a neutron or a K^0 overlaps with a cluster of a photon or a charged track. In Fig. 2a E_2 (full line) and E_1 (total cluster energy from 'LGCL',1 bank, dotted line) are compared to E_e (dashed line). Mean values and widths of the distributions are listed in table 1. Perfect agreement is found between E_2 and E_e, whereas E_1 is much bigger than E_e. Energy deposited by charged tracks in the lead glass accounts for this difference. Fig. 2b and 2c show a comparison between Monte Carlo ($E_{cm} = 34\,GeV$) and data ($E_{cm} = 34\,GeV$ from 1981) for E_2 and E_1 respectively. The results for E_{vis}/E_{cm} are plotted in Fig. 3. You have to distinguish between the three quantities $E^{(1)}_{vis}/E_{cm}$, $E^{(2)}_{vis}/E_{cm}$ and $E^{(3)}_{vis}/E_{cm}$. For $E^{(1)}_{vis}/E_{cm}$ and $E^{(2)}_{vis}/E_{cm}$ cluster energies are taken from the 'LGCL',1 bank and the 'LGCL',2 bank respectively. In the case of $E^{(3)}_{vis}/E_{cm}$ cluster energies are taken from the 'LGCL',1 bank, but 300 MeV are subtracted for each charged track connected to a cluster. The fact that E_1 is much bigger than E_2 is reflected in $E^{(1)}_{vis}/E_{cm}$ and $E^{(2)}_{vis}/E_{cm}$. $E^{(3)}_{vis}/E_{cm}$ is about halfway between. Again in Fig. 3b and 3c a comparison between Monte Carlo and data is shown.

Deleting the lead glass energy caused by charged tracks affects not only the visible energy but other quantities as well, for instance thrust, sphericity, or the axes of these quantities. As an example I have studied the influence on the transverse mass which is defined as

$$M_T = \frac{E_{cm}}{E_{vis}} \sum_i |p^{out}_{\perp\,i}|$$

Numbers can be found in table 1.

1981 and 1982 data with 'ALGN',2 and 'LGCL',2 banks are available on tapes F11HEL.ELSEL.TPM... . The entire list can be found in my catalog. TPM... corresponds to the list in computer note 83 where you can find RUN numbers and beam energies. Monte Carlos are available as well. Input were our standard MC data sets F11BET.MHTP34.LND52.MUMLGCBP.A01 - A08. Events after applying MCREDU are on my tapes F11HEL.ELSEL32.A01 - A08.

Results from 'ALGN',2 and 'LGCL',2 can be obtained in a graphics session in the view RU with command RES after deletion of 'ALGN',1 and/or 'LGCL',1 bank(s).

The program is on my library F11HEL.TEPOS(PBENPH). No LOAD version exists. It is possible to improve almist everything. Suggestions are welcome.

Table 1

	Monte Carlo		Data	
	mean	rms	mean	rms
$E_1\ (GeV)$	13.7	4.5	14.2	4.3
$E_2\ (GeV)$	8.1	4.4	8.6	4.3
$E_e\ (GeV)$	7.7	4.3		
$E^{(1)}_{vis}/E_{cm}$	0.94	0.19	0.94	0.20
$E^{(2)}_{vis}/E_{cm}$	0.78	0.15	0.77	0.16
$E^{(3)}_{vis}/E_{cm}$	0.86	0.18	0.85	0.19
$M^{(1)}_T$	4.36	1.63	4.22	1.70
$M^{(2)}_T$	3.81	1.41	3.71	1.49
$M^{(3)}_T$	3.68	1.37	3.60	1.43

Figure captions

Fig. 1: (a) Rolled out view of the lead glass
(b) The same after modification of the 'ALGN' bank

Fig. 2: (a) The lead glass energies E_1 (dotted line), E_2 (full line) and E_e (dashed line) for Monte Carlo events
(b) Comparison between Monte Carlo (full line) and data (dashed line) for E_2
(c) The same for E_1

Fig. 3: (a) $E^{(1)}_{vis}/E_{cm}$ (dashed line), $E^{(2)}_{vis}/E_{cm}$ (full line) and $E^{(3)}_{vis}/E_{cm}$ (dotted line) for Monte Carlo events
(b) Comparison between Monte Carlo (full line) and data (dashed line) for $E^{(2)}_{vis}/E_{cm}$
(c) The same for $E^{(1)}_{vis}/E_{cm}$

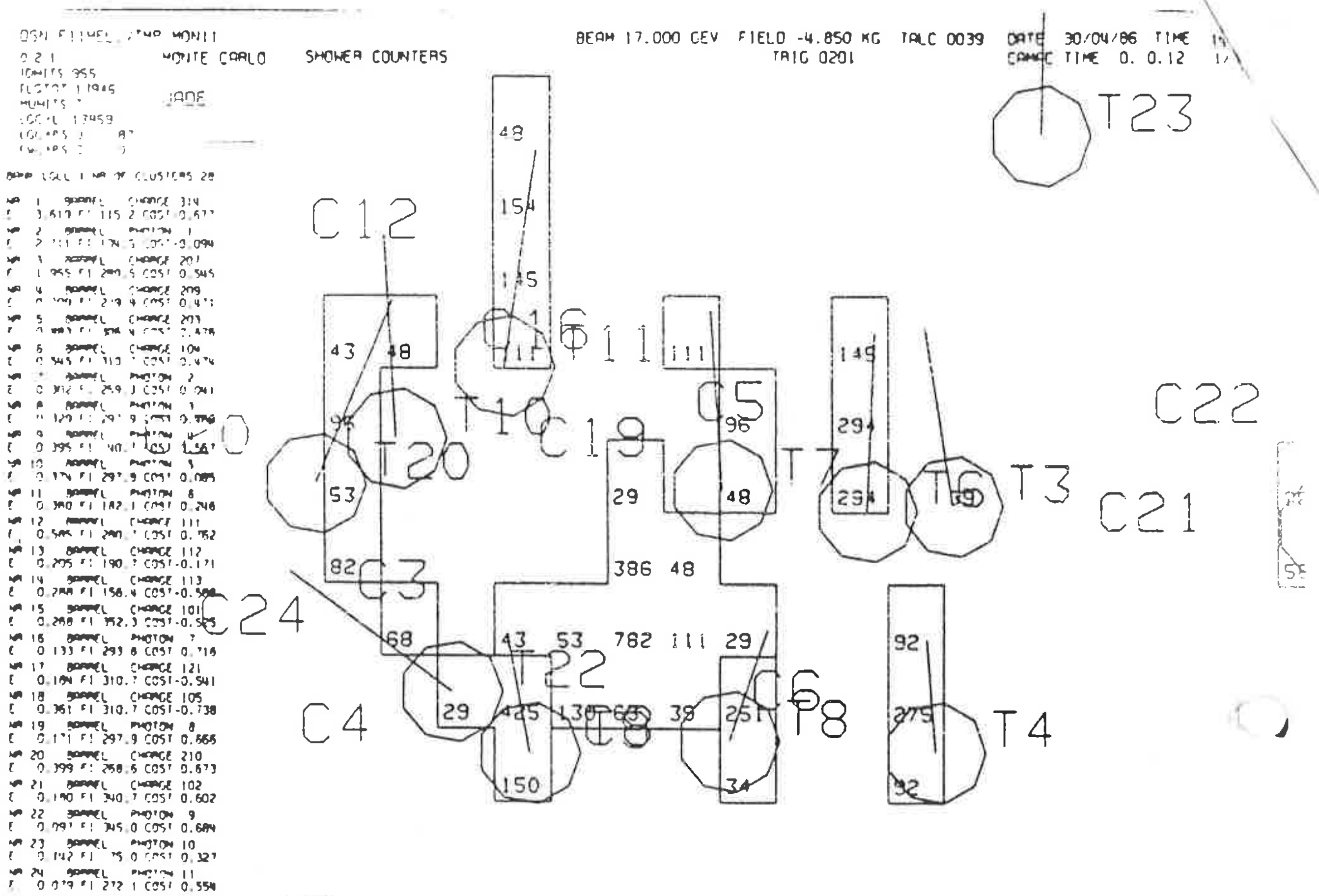

Fig. 1a

TOTAL CLUSTER ENERGY 15.313 PHOTON ENERGY 5.377 NR OF PHOTONS 13

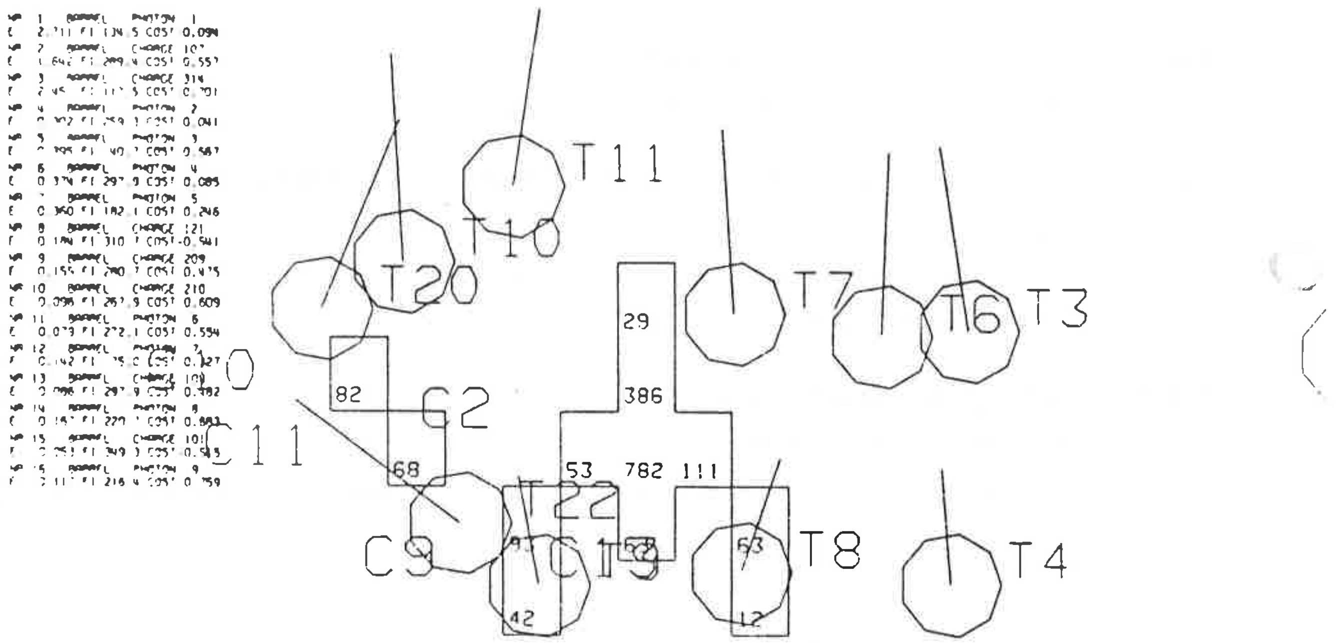

Fig. 1 b

TOTAL CLUSTER ENERGY 9.320 PHOTON ENERGY 4.848 NR OF PHOTONS 9

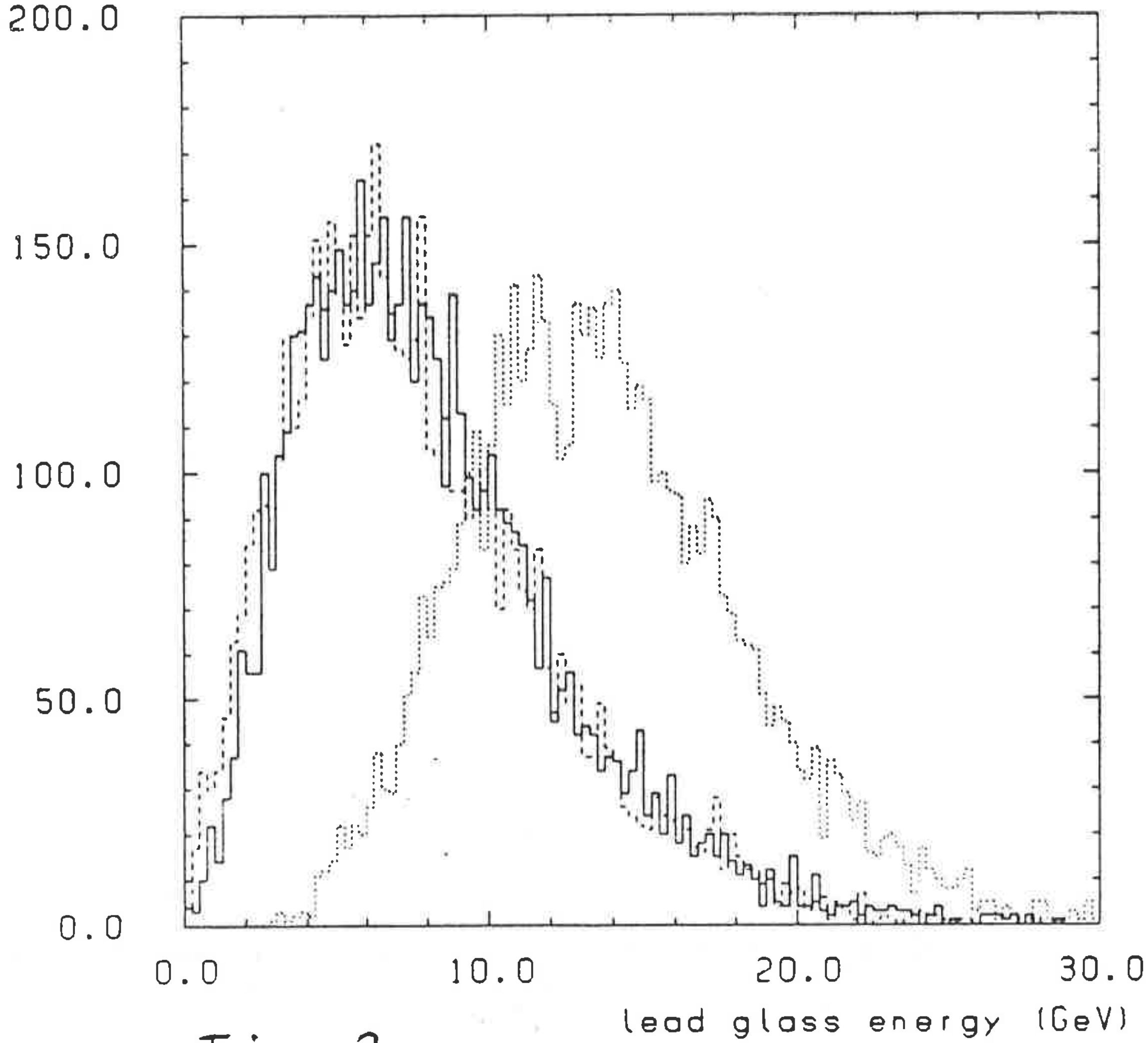

Fig. 2a

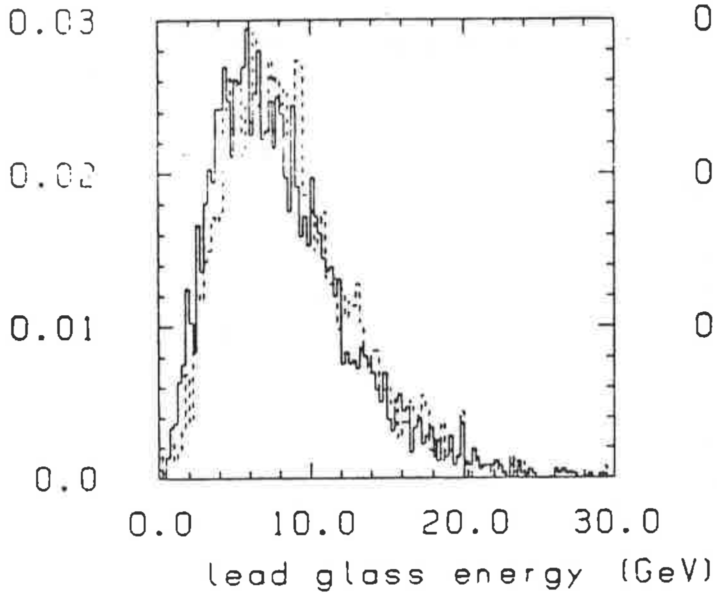

Fig. 2b

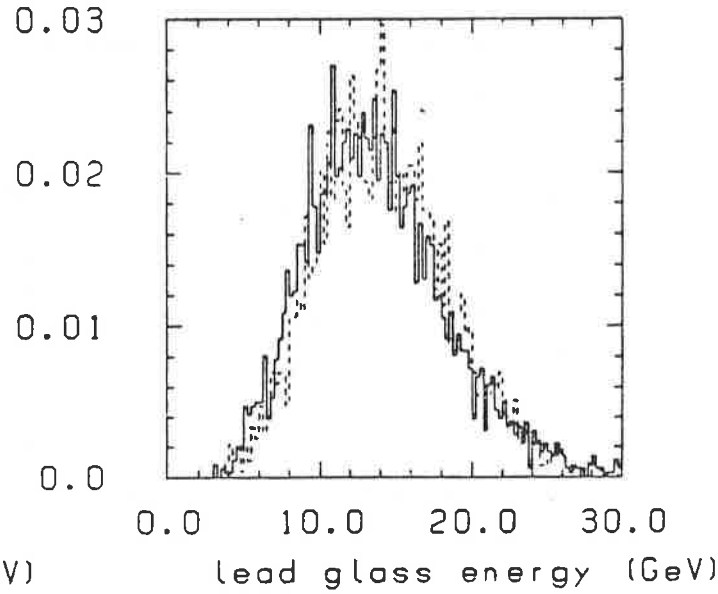

Fig. 2c

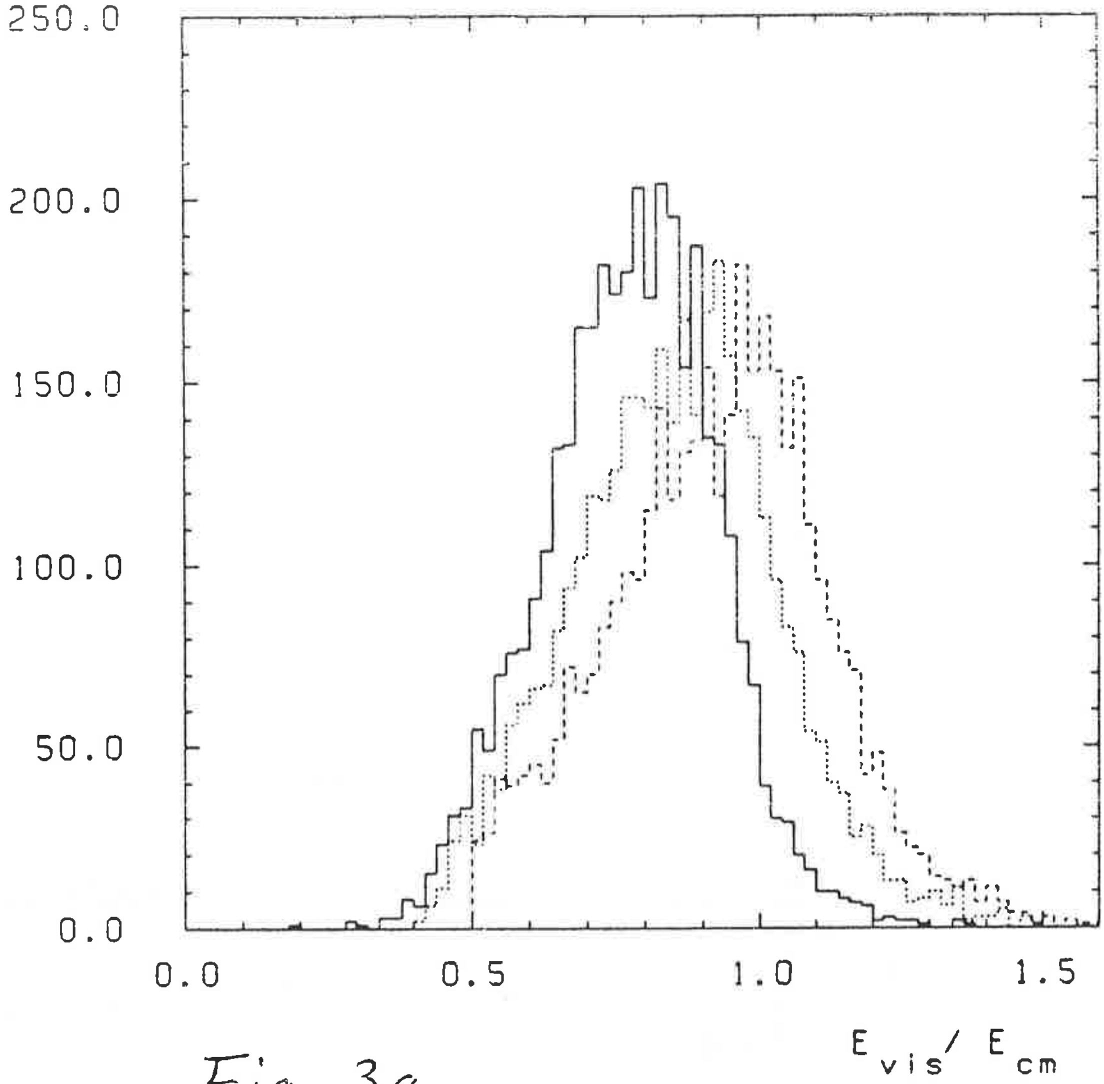

Fig. 3a

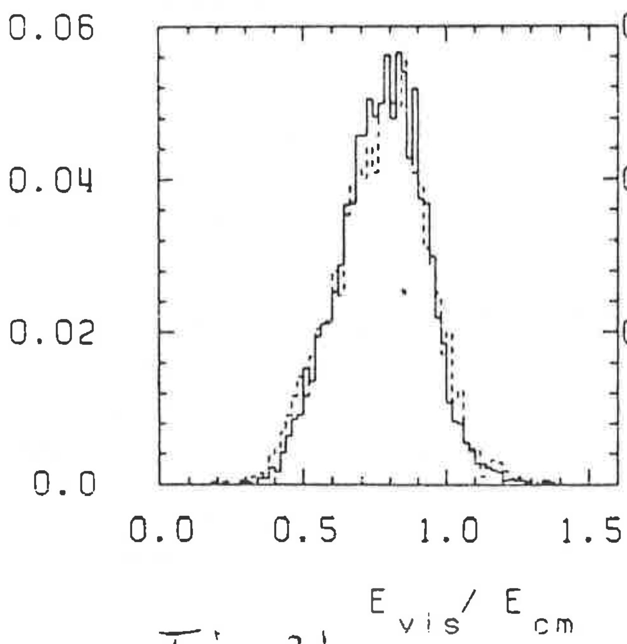

Fig. 3b

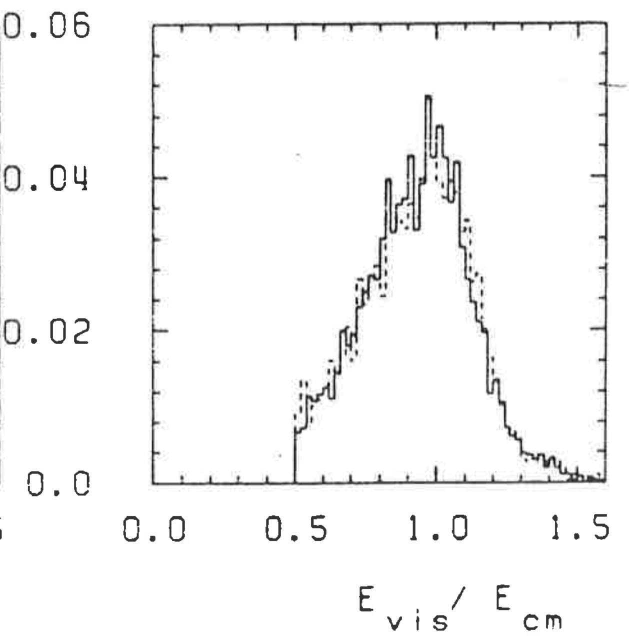

Fig. 3c