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SIMULATION STUDIES OF THE ELECTROMAGNETIC ENERGY RESOLUTION OF SCINTILLATING FIBRE CALORIMETER

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1. Introduction

Future high energy physics experiments at a new generation of hadron colliding beam accelerators will impose stringent requirements on particle calorimetry. Good energy and space resolution, fast response and high radiation resistance are required. Lead-scintillating fibre (SciFi) calorimeters are attractive candidates. Several experimental groups [1-6] have been carrying out research work in this field for the last few years.

In the present paper we analyse the effect of a variety of calorimeter parameters on the energy resolution of SciFi calorimeters using the Monte Carlo (MC) method. The parameters include the passive (absorber) to active (fibres) material volume ratio, fibre radius, reflectivity (light reflection coefficient at fibre end), transparency of fibres, and the tilt angle (i.e. the angle between the particle direction and the fibre axis).When possible we compare MC results with the existing experimental data.

We conclude by deriving an expression for the energy resolution as a function of the basic calorimeter structure parameters.

2. Simulated Setup

We simulated a calorimeter block of the volume 20 x 20 x 40 cm^3. To compare our results with experiment as well as to study the influence of energy leakage on energy resolution, results from a sub-block of smaller dimension was also extracted in some cases. The MC code is based on the GEANT 3.15 package [8]* . The passive material has been treated as a homogenous mixture of lead and epoxy glue. The kinetic energy cut-offs for both electrons and gammas have been taken 10 keV. Delta electrons over an energy threshold of 10 keV have been generated explicitly. Our simulations have been carried out for a broad set of input conditions, in some cases chosen in order to compare with existing experimental data, including:

- material volume ratios (lead: glue: fibre) of: 1: 0.17: 1, 1.8: 0.085: 1, 4: 0.0425: 1;
- tilt angle values of : 0.5°, 2°, 3°, 5°, 10°;
- fibre diameters of : 0.5 mm, 0.75 mm, 1.0 mm and 1.5 mm;
- other fibre characteristics such as the attenuation length and the reflectivity at the fibre end have also been treated.

The fibres were placed in a hexagonal matrix with each fibre equidistant to its six neighbours. The simulations were carried out for a square beam of 1 x 1 cm^2 of uniform illumination. To investigate the effect of the fibre spacing on the energy resolution a narrow beam (beam spot area comparable with fibre spacing) was used in some cases.

The energy resolution was analysed using the formula:

$$\frac{\sigma}{E} = \frac{a}{\sqrt{E}} \oplus b . \qquad (1)$$

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* We confronted the calculations based on GEANT 3.15 with those based on GEANT 3.16 and no substantial changes were noticed.

The stochastic (sampling) coefficient given by the square sum of two terms $a = \sqrt{a_1^2 + a_2^2}$ represents the combined effect of sampling (a_1) and photostatistics fluctuations (a_2). The coefficient b characterises non statistical effects that degrade the energy resolution such as non-uniformity in the fibre spacing, energy leakage, light attenuation in the fibre, etc. The operation $\oplus$ means that the stochastic ($a/\sqrt{E}$) and constant (b) terms are summed quadratically.

3. Simulation Results

3.1 Influence of Reflection and Attenuation Length

A detailed MC analysis of the SciFi calorimeter energy resolution dependence on fibre reflectivity and attenuation length was carried out for a sub-block of the volume 10 x 10 x 30 cm³ . This was done for absorber-to-fibres ratio of 4:1, fibre diameter of 1 mm, tilt angles of 0.5°, 2°, 3°, 5°, 10°, reflectivity values of 0%, 40%, 70%, 100% and attenuation lengths of ∞, 150 cm, 75 cm, 50 cm. The energy resolution was studied for the incident energies 1 , 5 , 10, 20 and 40 GeV. To simulate the reflectivity and light attenuation in fibres, the energy deposited in the fibres has been multiplied by the following empirically determined weight factor [1]

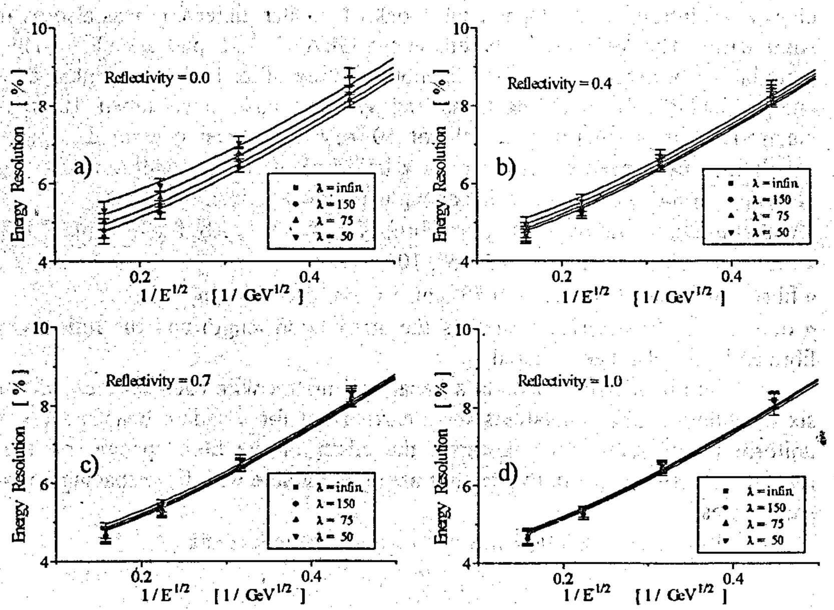

Fig.1. Energy resolution as a function of 1/√E for four values of attenuation length and reflectivity. (Tilt angle = 3°, Packing ratio (Absorber: Fibre) = 4: 1, Fibre diameter = 1 mm)

$$W = \exp(-\frac{l}{\lambda}) + r\exp(-\frac{2L - l}{\lambda}) \qquad (2)$$

where l is the distance from the place of energy deposit to the place of light collection, L is the fibre length, λ is the attenuation length and r is the reflectivity of the fibre end (away from the place of light collection).

The results of the simulation for a tilt angle of 3° are presented in Fig.1. From it can be figure out that the influence of the light attenuation is more significant for lower values of the reflectivity (Fig.1a, 1b). When the level of the reflectivity is more than 70% and the attenuation length is longer than the fibre length the energy resolution is practically the same for all cases. If the tilt angle is greater than ~1° the dependence of the stochastic term on reflectivity and light attenuation is weak.

The constant term in the formula (1) for the energy resolution as a function of the tilt angle for different values of reflectivity and attenuation length is plotted in Fig.2. From this figure we see that the constant term noticeably depends on the attenuation length at low levels of reflectivity (≤40%). At high values of reflectivity (≥70%) the effect of light attenuation is partially compensated (Fig.2c, 2d).

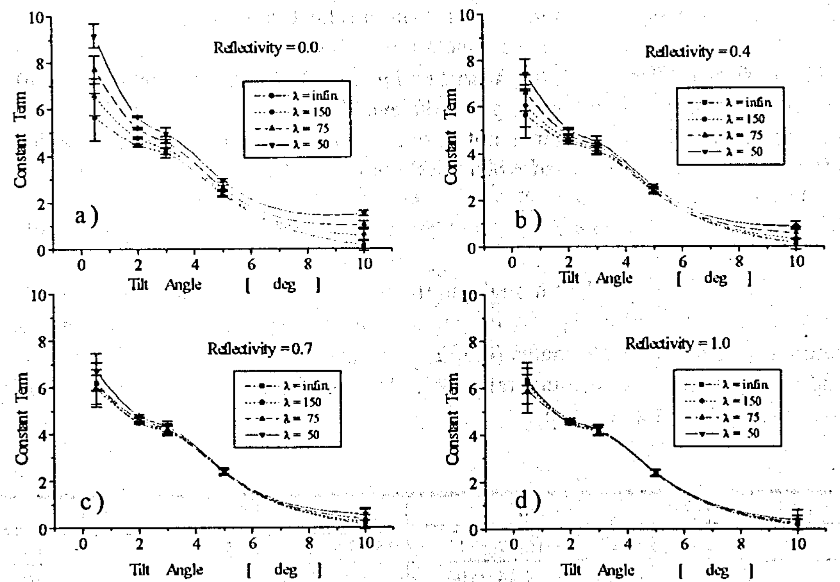

Fig.2. Constant term in the formula for the energy resolution as a function of the attenuation length and reflectivity. (Packing ratio (Absorber: Fibre) = 4: 1, Fibre diameter = 1 mm). The curves have been drawn only to guide the eye.

The dependence of the constant and stochastic terms on reflectivity for a tilt angle of 3° is shown in Fig.3. The stochastic term (Fig.3a) is practically independent of reflectivity and attenuation length at this and all others different tilt angles. The constant term (Fig.3b) shows a stronger dependence on reflectivity than the stochastic one, especially for short attenuation lengths.

We conclude that the dependence of the SciFi calorimeter energy resolution on reflectivity and attenuation length is weak at attenuation lengths greater than several (2-4) fibre lengths. At the shorter attenuation lengths the dependence is noticeable but influence only the constant term. At high values of reflectivity this effect is partially

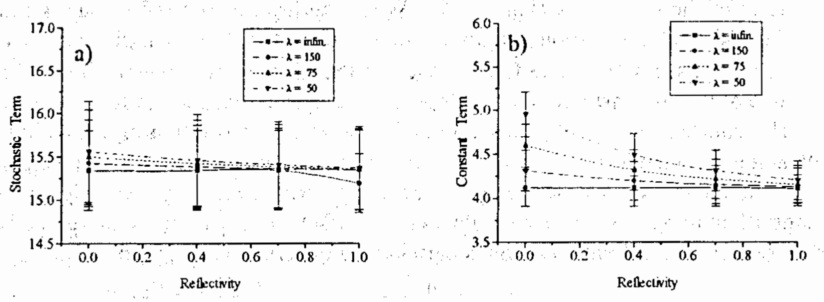

Fig.3. a) The stochastic term as a function of reflectivity.
b) The constant term as a function of reflectivity.
(Tilt angle = 3°, Packing ratio (Absorber: Fibre) = 4: 1, Fibre diameter = 1 mm) The curves have been drawn only to guide the eye.

compensated. This behaviour is not strongly dependent on the tilt angle although the effect is somewhat diminished when the tilt angle increases.

3.2 Influence of Tilt Angle

An influence of the tilt angle on the SciFi energy resolution was noticed early in SciFi calorimeter tests [2]. To investigate the tilt angle influence we simulated the setup at five different tilt angles (0.5, 2, 3, 5, and 10°) for the fibre diameter of 1 mm and absorber-to-fibre volume ratio 4:1. The results for the energy resolution are presented in Fig. 4 and Table 1.

tilt angle	0.5°	2.0°	3.0°	5.0°	10.0°
a	27.24±0.43	16.67±0.13	15.83±0.57	15.11±0.26	13.46±0.21
b	6.65±0.20	4.44±0.06	3.63±0.20	2.31±0.14	0.00±0.20
χ^2 / ndf	0.29	0.065	2.67	0.48	0.51

Table 1. Energy resolution coefficients *a* and *b* vs. the tilt angle at fibre-to-lead ratio 1:4 and fibre diameter of 1 mm.

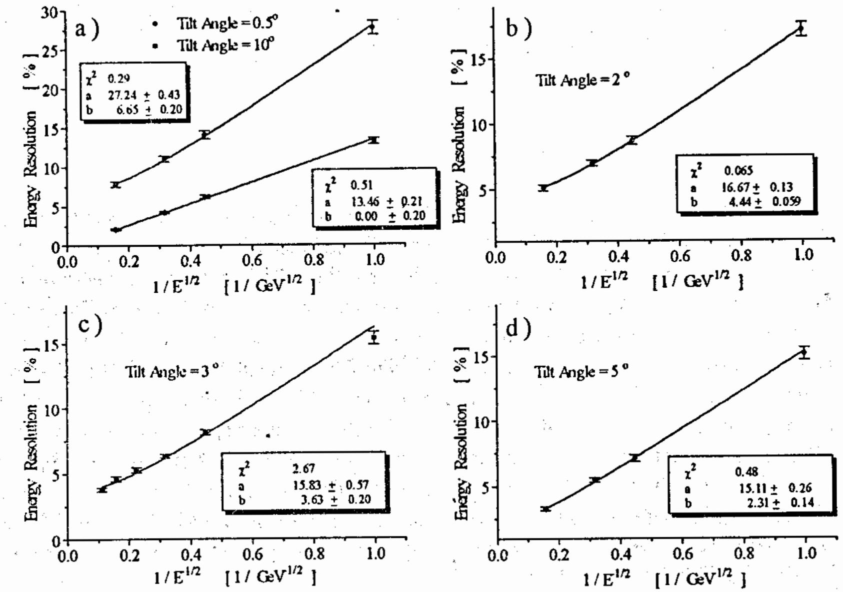

Fig.4. Energy resolution as a function of $1/\sqrt{E}$ for four different tilt angles.(Packing ratio (Absorber: Fibre) = 4: 1, Fibre diameter = 1 mm)

The strong influence of the tilt angle on the energy resolution is obvious from Fig. 4a, where the results for the tilt angles of 0.5° and 10° are compared. The stochastic and constant terms as a function of tilt angle are given in Fig. 5. The constant term

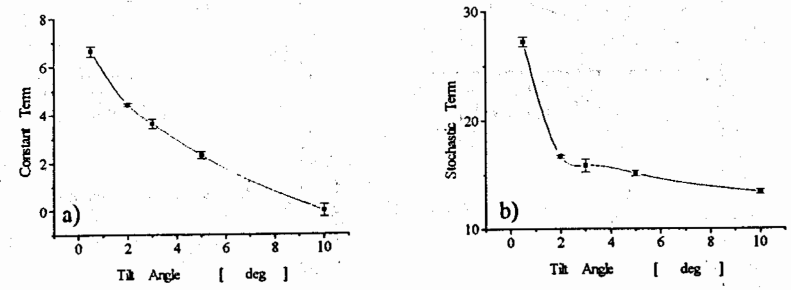

Fig.5. a) The constant term as a function of tilt angle.
b) The stochastic term as a function of tilt angle.
(Packing ratio (Absorber: Fibre) = 4: 1, Fibre diameter = 1 mm) The curves have been drawn only to guide the eye.

decreases almost linearly to zero at an angle of 10°. The stochastic term depends very weakly on the tilt angle until the tilt angle is less than ~2°. This term dramatically increases for small tilt angles because of the greater sampling fluctuation in these cases (see part 5).

3.3 Volume Material Ratio Influence

The results of simulations discussed so far were obtained for the calorimeter block very similar to a SPACAL SciFi calorimeter module which was built with a 4: 1 packing fraction in order to make it compensating [2]. To find the dependence of a SciFi calorimeter resolution on volume ratio we have simulated the SciFi calorimeter response for three absorber-to-fibre volume ratios: 1:1, 1.8:1 and 4:1. The dependence was investigated at a tilt angle of 3°. The simulation results presented in Fig. 6 show that this dependence is strong. The energy resolution is improving significantly when the ratio is changed from 4:1 to 1:1. In Fig.6, the energy resolution has also been plotted as a function of the sampling fraction, i.e. the ratio of the energy deposited in the active material (fibres) to the total energy. The dependence of the stochastic (Fig. 6b) and constant (Fig.6c) terms on the sampling fraction are also shown. The energy resolution as a function of the sampling fraction is plotted in Fig. 6d for 10 GeV incident particles.

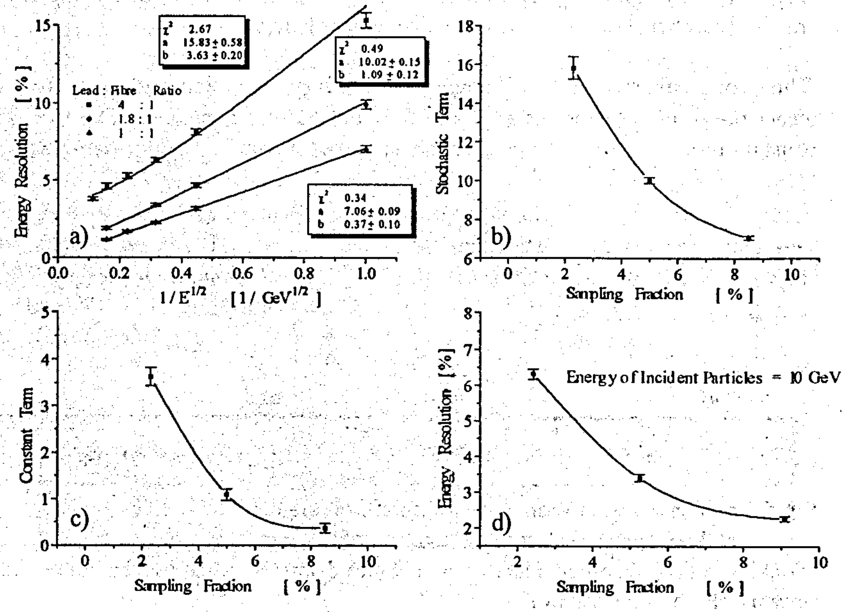

Fig.6. Effect of sampling fraction on energy resolution. (Tilt angle = 3°, Fibre diameter = 1 mm)

From the presented results it is clear that the energy resolution becomes better if the sampling fraction increases. The dependence is significantly strong for both the constant term and the stochastic one . A more detailed analysis of influence of the sampling fraction on energy resolution will be given in the next paragraphs.

3.4 Fibre Diameter Influence

A SciFi calorimeter response for a wide beam (global response) is built up of the local responses measured at different impact points (a detailed analysis of the relation between SciFi calorimeter global response distribution and its local one is made elsewhere [7]). If the structural non-uniformity of the SciFi calorimeter becomes large, its energy resolution degrades because of the greater response non-uniformity.

To reduce these fluctuations while keeping the absorber-to-fibre volume ratio constant, more fibres should be employed with the fibre diameters being reduced. We have investigated the SciFi calorimeter response with a volume material ratio of 4: 1 at different fibre diameters (0.5 mm, 0.75 mm, 1.0 mm, and 1.5 mm). Calculations were carried out for a set of incident energies: 5, 10, 20 50, and 100 GeV. In Fig. 7a, we compare the energy resolution for two diameters (0.5 mm and 1.0 mm) as a function of incident energy while in Fig 7b the energy resolution at 10 GeV is shown as a function of fibre diameter. The strong influence of the fibre diameter on energy resolution is evident. We see that a reduction of fibre diameter leads to a significant decrease of both the sampling fluctuations (stochastic term) and the structural non-uniformity (constant term).

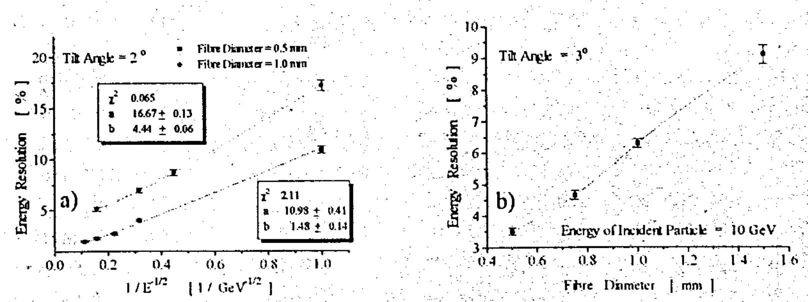

Fig.7. a) b) The energy resolution dependence on fibre diameter. (Packing ratio (Absorber: Fibre) = 4: 1

4: Comparisons with Experiments

Comparison of the simulated results with experiment is very important for judging of the predictions made on the basis of MC results . Hence, when possible, we have compared the results of our simulations with experimental data. In these simulations we have tried to take into account all nuances of the experiment being compared with.

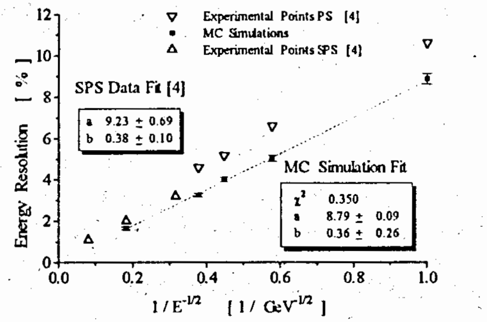

Fig.8. Experimental points [4] compared with our simulation results. (Tilt angle = 7.2°, Packing ratio (Absorber: Fibre) = 1.8: 1, fibre diameter = 1 mm)

We have simulated the calorimeter tests described in the paper of Dagoret et al. [4]. In their calorimeter the fibres of 0.5 mm diameter were used and lead was used as an absorber material. In that paper a significant difference between the energy resolution measured in the PS and SPS beams is reported. Both the experimental data and our simulated results are plotted in Fig.8. Note the discrepancy between the high energy SPS and the low energy PS data. The simulation is in good agreement with the experimental data measured in the SPS beam. In this case the resolution coefficients *a* and *b* for both the MC and experiment comply with each other in the limits of errors.

We have also compared our simulations with the results from the SPACAL collaboration [2] (Fig.9). Here the difference between the experimental and MC resolution is large, especially in the constant terms which differ significantly: 1.99 % (experiment) vs. 3.57% (MC). Although we are not positive of the source of the discrepancy, we believe it could be due to the "narrowness" of the beam used in the experiment. The reasons are as follows. The response of a scintillating fibre calorimeter strongly depends on the position of the incident electron impact point (i.e. how far from a fibre is the point of impact) particularly for high lead-to-fibre ratios and tilt angles less then 5°. This means that the measured energy resolution of such a calorimeter is sensitive to the beam diameter. Hence, one can expect the impact point to play an important role in the case of narrow beams (where the effective beam diameter is less then /or comparable with / the fibre-to-fibre distance).

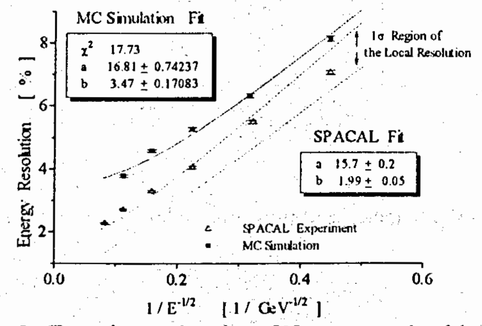

Fig.9. Experimental points [2] compared with our simulation results. (Tilt angle = 3°, Packing ratio (Absorber: Fibre) = 4: 1, fibre diameter = 1 mm)

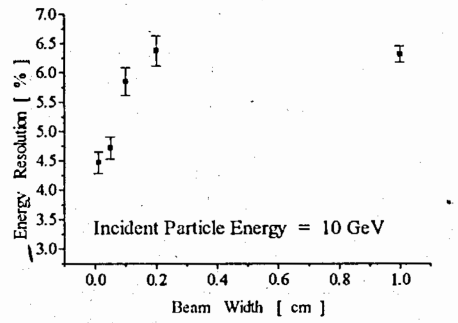

Fig.10. Energy resolution as a function of beam size. (Tilt angle = 3°, Packing ratio (Absorber: Fibre) = 4: 1, fibre diameter = 1 mm)

To understand the magnitude of the effect, the energy resolution dependence on the beam width has been investigated by MC simulations. We used a 10 GeV incident electron energy, a 4:1 lead-to-fibre volume ratio and a tilt angle of 3°. A square beam profile was used. The beam axis has been pointed to a point with the average local resolution (see below). Results are presented in Fig.10. The SPACAL collaboration has measured their energy resolution at 40 GeV for different impact positions [2]. They found oscillations in the energy resolution as the impact point scans across from fibre to fibre with the best resolution occurring when the beam is situated between the fibres. These oscillations neatly demonstrate the dependence of response on impact point seen by MC (and cannot be explained by e.g. the fibre-to-fibre response fluctuations). From our point of view the energy resolution is a global characteristics of calorimeter and therefore "the wide beam" should be used for finding it. Our explanation of the discrepancy is that the resolution reported by the SPACAL is a "local" one which could be caused by the effectively narrow beam used in their experiment. To demonstrate this we have simulated calorimeter local responses (the zero-width beam fixed at a certain point) at 100 different impact points for 5 and 40 GeV incident particles (electrons).The impact points have been chosen randomly over an area of 1 cm^2. At each point a set of events has been simulated (about 100 events per point) resulting, at last, in a local response distribution. As a result we have got 100 local response distributions at both incident energies. From these two sets of the local distributions we extracted the average responses and standard deviations and used them for calculation of the local resolutions at all impact points for the both incident energies. The mean value (m.v.) of local resolution (calculated from the set of local resolutions for different impact points) was 7.13% and 2.76% and corresponding standard deviation (s.d.) was 0.69% and 0.40% for the incident energies 5 and 40 GeV, respectively. It is interesting to compare the MC local resolution distribution at 40 GeV (m.v. = 2.76% and s.d. = 0.40%) with the resolution distribution measured by SPACAL (m.v.=3.85 %. and s.d.=0.43%). The average SPACAL resolution at 40 GeV (3.85%) is worse than the MC average local resolution (fixed zero-width beam) (2.76%) but is better than the MC resolution for wide beam (4.5%). That is why we think that the curve presented in the SPACAL paper is a resolution corresponding to the used narrow (effectively) beam. In this case the constant term is underestimated. More details can be found in [7].

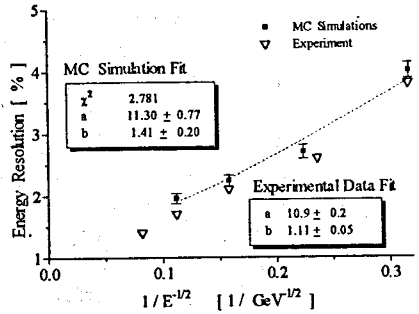

Fig.11. Experimental points [5] compared with our simulation results. (Tilt angle = 2°, (Absorber: Fibre) = 4: 1, fibre diameter = 0.5 mm)

We have also simulated a calorimeter block with the lead-to-fibre ratio 4:1 and fibre diameter 0.5 mm and compared it with the experimental results presented by Badier at al. [5]. In Fig.11 our MC data and the experimental ones are compared. A satisfactory agreement between the MC and experiment has been achieved. From this comparison we further see that the calorimeters using fibres with diameter *0.5 mm* have an acceptable constant term, i.e. an acceptable level of response non-uniformity also at the compensating absorber-to-fibres ratio 4:1.

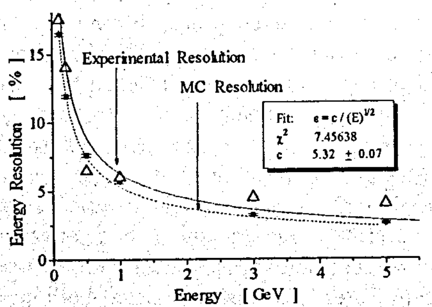

Fig.12. Experimental points [3] compared with our simulation results. (Tilt angle = 5.6°, Packing ratio (Fibre: Lead: Glue) = 50: 35: 15, fibre diameter = 1. mm)

To investigate calorimeters with a high sampling ratio, we have simulated a calorimeter similar to that used by Hertzog et al. [3]. In this case the fibre-to-lead-to-glue volume ratio was 50 : 35 : 15 and a tilt angle was 5.6°. From Fig.12 we can see a satisfactory agreement between our MC and the experiment. Some differences at higher energies could be caused by the energy leakage presented in the experimental calorimeter block because its depth was only 12.5 radiation lengths while in the MC we used twice as depth. The fit to the energy resolution [3] σ/E = 6.3% / √E and no constant term was considered in their paper.

5. A Simple Parametrization Formula for the Stochastic Term

We have analysed the dependence of the energy resolution on various SciFi calorimeter parameters. It was shown in the previous paragraph that the results of our simulations are generally in good agreement with experimental data. We now attempt

to derive an expression for the stochastic term as a function of the sampling fraction, fibre diameter and tilt angle.

Let us assume that a shower is initiated by an incident particle, with the tilt angle θ, in a calorimeter with the sampling fraction S_f and fibre diameter d. Assuming that in average a shower particle deposits an energy q_{eff} in fibre at one crossing, we can conceive the shower as

$$N = \frac{E}{q_{eff}} \qquad (3)$$

energy spots distributed in a calorimeter according a shower profile function. In such a way the calorimeter sampling fraction can be treated as a probability that the energy spot q_{eff} would be deposited in active medium. Hence, the number of spots deposited in active material is a binomial random variable but for small S_f (S_f<<1) and large N the binomial distribution goes to a Poisson one. Therefore for the average number of spots deposited in the fibres and its standard deviation we can write

$$N_s = S_f \cdot N = \frac{S_f}{q_{eff}} \cdot E \qquad (4),$$

and

$$\sigma_s = \sqrt{N_s} = \sqrt{\frac{S_f}{q_{eff}} \cdot E} \qquad (5).$$

Hence for the resolution we have (assuming the constant term is zero):

$$\varepsilon = \frac{\sigma_s}{N_s} = \sqrt{\frac{q_{eff}}{S_f}} \cdot \frac{1}{\sqrt{E}} \qquad (6).$$

It should be noted that at high sampling fractions the Poisson character of energy deposition distribution disappears and the standard deviation of binomial distribution $\sigma = \sqrt{N_s \cdot (1 - S_f)}$ should be used. In most conditions the sampling fraction is less than 10 % (the sampling fraction for volume fibre to lead ratio 1: 1 is approximately 10 %) and hence the Poisson approximation is sufficient.

From eq.6 it follows that the stochastic term coefficient a is given as a function of S_f and q_{eff} ($a = \sqrt{q_{eff}/S_f}$) with a dependence on the tilt angle and fibre diameter hidden in q_{eff}. As the quantity q_{eff} has been interpreted as an average energy loss of shower particle in fibre at one crossing we can express it as

$$q_{eff} = const \cdot \frac{d}{\sin \theta_{eff}} \qquad (7)$$

where d is the fibre diameter, and θ_{eff} is an effective angle between the particle direction and fibre axis.

To find a dependence of θ_{eff} on the tilt angle θ we have supposed that electromagnetic shower consists of two kinds of particles:

1) the shower core ones characterised by the effective angle $\theta_c \approx \theta$, and

2) the shower halo ones which are independent on the incident particle direction and their directions are isotropically distributed and thereby could be characterised by an average effective angle $\theta_h \approx \pi/2$.
Consequently, for the quantity q_{eff} this gives

$$q_{eff} = const \cdot d \cdot \left(\frac{w}{\sin\theta_c} + \frac{1-w}{\sin\theta_h} \right) \approx const \cdot d \cdot \left[w \cdot \left(\frac{1}{\sin\theta} - 1 \right) + 1 \right] \qquad (8)$$

where, d is the fibre diameter, w is the weight of the core shower particles, and θ is the incident particle tilt angle.
Finally, the stochastic term coefficient a reads

$$a = c \cdot \sqrt{\frac{d}{S_f}} \cdot \sqrt{w \cdot \left(\frac{1}{\sin\theta} - 1 \right) + 1} \qquad (9)$$

where, c and w are the calorimeter parameters to be found.

Note that the formula (9) has a natural minimum at $\theta = \pi/2$ when the incident particle direction is perpendicular to fibre axis. On the other hand the singularity at θ=0 is not principal as the expression (8) is clearly not valid for very small angles ($\sin\theta \leq d/L$, where L is the fibre length). The singularity could be removed by replacing $\sin\theta$ by $\sin(\theta + \theta_o)$ in (8) and (9), in which θ_o defines marginal ($\theta \to 0$) value of q_{eff}.

To fix the parametrization (9) we have fitted the simulated results presented in the previous paragraphs by means of MINUIT minimisation code [9] and have obtained the following values for the fitting parameters: $c = 17.2 \pm 1.0$ and $w = 0.04 \pm 0.01$.
Finally, the stochastic term coefficient a can be expressed as:

$$a = 17.2(\pm 1.0) \cdot \sqrt{\frac{d}{S_f}} \cdot \sqrt{0.04(\pm 0.01) \cdot \left(\frac{1}{\sin\theta} - 1 \right) + 1} \qquad (10)$$

A comparison between the stochastic term coefficients calculated by MC simulation and those calculated using the formula (10) is shown in Tab.2. Taking into account the comparison between the MC and experiment (see paragraph 4) as well as the comparison in Tab.2 one can conclude that the semiempirical formula (10) describes the SciFi calorimeter stochastic term coefficient as a function of the sampling fraction, fibre diameter and tilt angle fairly well.

From our point of view a parametrization similar to that given by (10) could be applied to any other sampling type of electromagnetic calorimeter and possibly also to hadron ones. It should be also noted that the similar results, as to the dependence of stochastic term on the sampling fraction and thickness of active layer, were obtained by R.Wigmans [10].

Conclusion

The energy resolution of electromagnetic SciFi calorimeter has been investigated for a variety of the calorimeter parameters (the sampling fraction, tilt angle, fibre diameter, attenuation length and reflectivity). The Monte Carlo results have been compared with experimental data. Good agreement between the Monte Carlo and experiment has been found. A simple semiempirical formula for estimation of the stochastic term coefficient as a function of sampling fraction, fibre diameter and tilt angle has been obtained.

a_{MC} [%(GeV)$^{0.5}$]	a_{model} [%(GeV)$^{0.5}$]	Tilt Angle [deg]	Sampling Fraction [%]	Fibre Diameter [mm]
4.25	3.99 ± 0.20	15°	9.09	0.50
5.59	5.30 ± 0.27	15°	5.25	0.50
6.54	6.13 ± 0.31	15°	3.83	0.50
7.15	6.79 ± 0.34	15°	3.21	0.50
7.71	7.71 ± 0.39	15°	2.76	0.50
8.21	8.32 ± 0.42	15°	2.43	0.50
5.20	4.56 ± 0.23	15°	9.09	0.75
6.84	6.36 ± 0.32	15°	5.25	0.75
8.01	7.66 ± 0.39	15°	3.83	0.75
8.75	8.54 ± 0.43	15°	3.21	0.75
9.44	9.15 ± 0.46	15°	2.76	0.75
10.06	10.17 ± 0.51	15°	2.43	0.75
6.01	5.25 ± 0.26	15°	9.09	1.00
7.90	7.77 ± 0.39	15°	5.25	1.00
9.25	8.82 ± 0.44	15°	3.83	1.00
10.11	10.32 ± 0.52	15°	3.21	1.00
10.90	11.33 ± 0.57	15°	2.76	1.00
11.61	12.01 ± 0.60	15°	2.43	1.00
14.85	15.80 ± 0.58	3°	2.30	1.00
10.06	10.02 ± 0.15	3°	5.01	1.00
7.72	7.06 ± 0.10	3°	8.50	1.00
11.60	10.98 ± 0.41	2°	2.30	0.50
16.41	16.70 ± 0.13	2°	2.30	1.00
13.47	15.11 ± 0.27	5°	2.30	1.00
12.34	13.42 ± 0.21	10°	2.30	1.00
26.63	27.40 ± 0.43	0.5°	2.30	1.00

Table 2. Comparison between the stochastic term coefficients calculated by MC simulation (a_{MC}) and those calculated using formula (10) (a_{model}).

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Изучение энергетического разрешения электромагнитного сцинтилляционно-волоконного калориметра методом моделирования

Используя программу Монте-Карло, основанную на пакете GEANT, исследовали энергетическое разрешение электромагнитного сцинтилляционно-волоконного калориметра как функцию отношения объемов пассивного (поглотитель) и активного (волокна) материалов, радиуса волокна, коэффициента преломления света на конце волокна, прозрачности волокна, а также угла наклона влетающей частицы. Полученные по программе Монте-Карло результаты сравнивались с имеющимися экспериментальными данными. Между экспериментальными данными и данными моделирования в большинстве случаев имелось хорошее соответствие. Найдена простая формула, описывающая стохастический член энергетического разрешения в виде функции основных параметров калориметра.

Работа выполнена в Лаборатории ядерных проблем ОИЯИ.

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Simulation Studies of the Electromagnetic Energy Resolution of Scintillating Fibre Calorimeter

Using a Monte Carlo code based on the GEANT package the energy resolution of a scintillating fibre calorimeter was investigated as a function of the volume ratio of passive (absorber) to active (fibres) material, fibre radius, light reflection coefficient at fibre end, fibre transparency, and incident particle tilt angle. The obtained MC results were confronted with the existing experimental data. Good agreement between the simulation and experiment was found in most cases. A simple formula describing the stochastic term of the energy resolution as a function of the calorimeter basic parameters has been found.

The investigation has been performed at the Laboratory of Nuclear Problems, JINR.

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