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Memorandum

To: Members of the SPS Committee

From: CERN-Edinburgh-Mainz-Perugia-Pisa-Saclay-Siegen-Torino-Vienna Collaboration

Subject: Addendum to Proposal SPSC/P253

Since the open presentation to the SPSC and the subsequent constructive discussions with our referee our collaboration has continued to work on the final design of a detector to address a new precision measurement of ε'/ε in the kaon system.

1. Fast Calorimetry

We have studied as an alternate to the liquid Xenon calorimeter a calorimeter filled with liquid Krypton, but of otherwise equivalent construction, except for the difference in length required to contain an electromagnetic shower (1.20 m instead of 70 cm) .

An EGS Monte Carlo simulation of the resolution for the two liquids (including read-out electrode structures, lead converter and cryostat window) is shown in Fig. 1. Electronic noise is expected to be 30 and 37 MeV per photon, for LXe and LKr, respectively.

The transverse dimension of electromagnetic showers is expected to differ. The Molière radii are 4.1 cm and 4.7 cm respectively, which affects primarily the ability to recognise two close photons.

A Monte Carlo calculation of the $3\pi^\circ$ background to the $K_L \rightarrow 2\pi^\circ$ signal, taking into account the differences in energy resolution, space resolution and two photon separation gives the following results for the average background in a three K_S lifetime interval:

LXe	0.91×10^{-3}
LKr	1.15×10^{-3}
LAr/Pb (NA31)	3×10^{-3}

For comparison, the performance of a lead/liquid Argon sampling calorimeter like that used in the NA31 experiment is given.

Krypton is radioactive, and we expect ~100 mCi activity for the 7 m^3 of liquid required. The effect of this on the electronic noise is ~1 MeV per photon. Radiation safety should not be a problem, since the calorimeter and gas system is designed as an hermetic system.

The cost of 7 m^3 liquid Krypton is ~5 MSFr (using the current market price of 1 SFr ± 20% per litre of gas). According to several different manufactures contacted, this amount of Krypton is readily available.

In conclusion, a liquid Krypton calorimeter is almost as good in background rejection as a liquid Xenon, and the acceptance is similar. We propose therefore to consider liquid Krypton in place of the liquid Xenon.

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2. Hadron Calorimeter

We plan to reuse the existing NA31 hadron calorimeter. Demanding several GeV of energy deposition for events with two tracks will reject low energy $K_{2\pi}$ and K_{e3} decays and reduce the dead-time. The hadron calorimeter can help identify muons and will also be part of the muon veto system. To achieve a more uniform response the scintillator needs to be replaced. The estimated cost is 350 KSFr.

3. Additional Collaborators

Since submitting the proposal to the SPSC we have had serious discussions with several groups interested in joining the experiment, including a strong group from NIKHEF/Utrecht. It is probable that the collaboration will be further strengthened within the next few weeks.

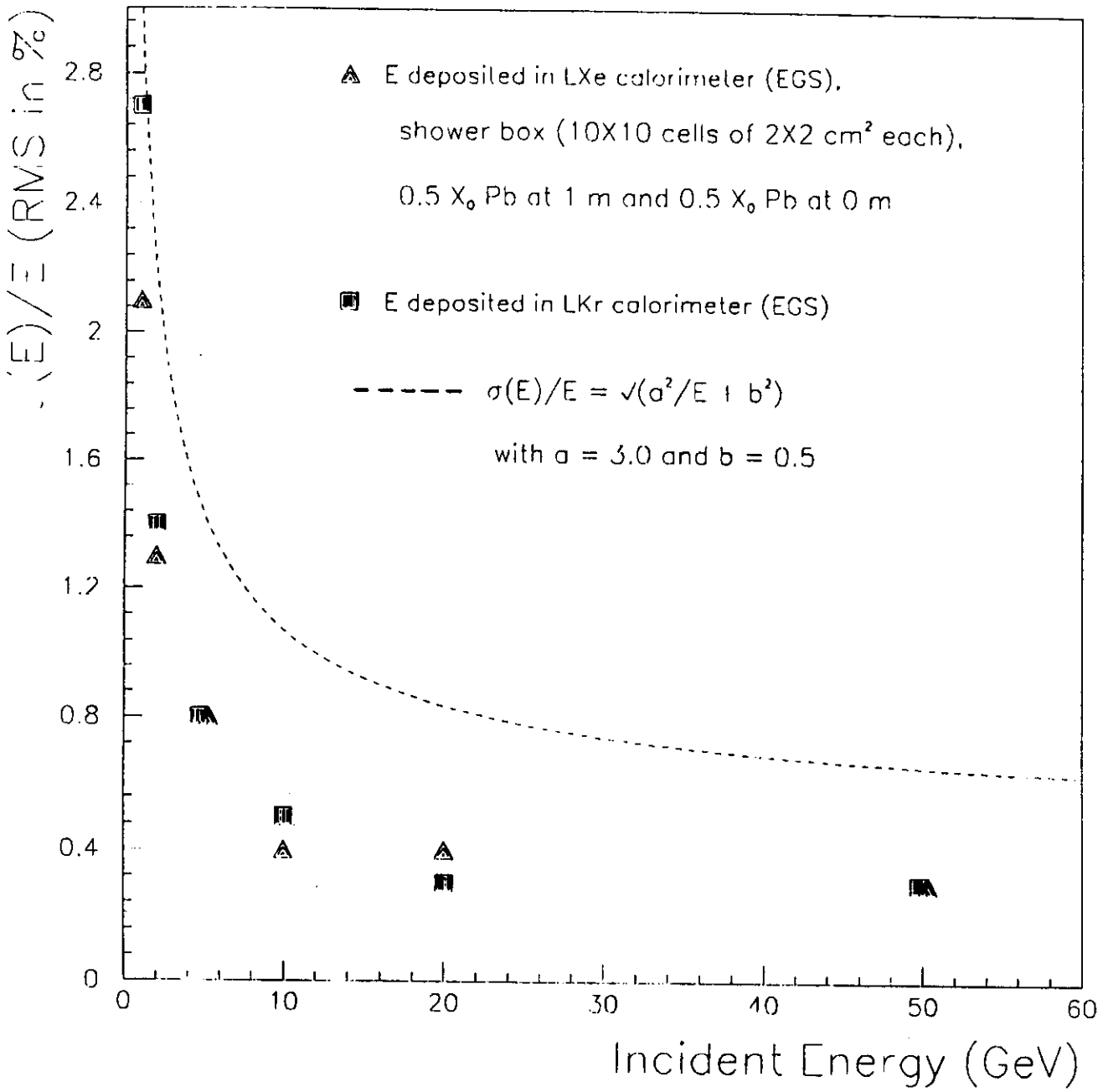
σ(E)/E (RMS in %)
2.8
2.4
2
1.6
1.2
0.8
0.4
0
0
10
20
30
40
50
60
Incident Energy (GeV)
E deposited in LXe calorimeter (EGS),
shower box (10X10 cells of 2X2 cm² each),
0.5 X₀ Pb at 1 m and 0.5 X₀ Pb at 0 m
E deposited in LKr calorimeter (EGS)
σ(E)/E = √(a²/E + b²)
with a = 3.0 and b = 0.5

Fig. 1