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Addendum 1 to Proposal P252

Proposal for a Light Universal Detector for the Study of Correlations between Photons and Charged Particles

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Contents

1 Changes to P252

Following the decisions of the SPSC of September 11 1990, we modify the proposal P252 as follows: The BGO detector is removed as a main part of the experimental system (see the layout in figure 1), but the physics program described in the proposal stays the same in its broad lines. Namely, we plan to measure:

1. the momenta of charged particles in a large phase space region using multi-step avalanche light chambers

2. the photon multiplicity in the forward hemisphere using a scintillator pads with CCD camera readout (Photon Multiplicity Detector)

3. π^0 and η production with an existing lead glass calorimeter

4. the forward and transverse energy flows using existing calorimeters

The physics aim is to observe and correlate different signatures for QGP formation in single events or in classes of events. Such signatures are:

- The source size from Bose-Einstein correlations in the central rapidity region (light chambers)

- A photon excess (direct photons) over those expected from the number of charged tracks and π^0's (PMD, lead glass and light chambers)

- A relation between the mean p_T of charged particles or π^0's and their density in the mid-rapidity region (light chambers and lead glass)
- In addition each event will be characterized globally by the impact parameter (zero degree calorimeter) and the transverse flow of energy (e. m. /hadronic calorimeter, lead glass and light chambers)

Although some of these signatures could be explained by other mechanisms than QGP formation, their simultanous occurence would be anambiguous.

The two new detectors are the light chambers and the scintillator pads. Their status:

2 Light chambers and magnet

The amplification of the chambers is limited by sparking. A main result of recent beam tests is that this limit is not changed in the heavy ions environment as compared to a "quiet" environment.

2.1 Resolution

An analysis of the beam test data shows a spot size (radius) of about 2.5mm for a minimum ionizing track perpendicular to the chamber, well compatible with the resolution of 1.5mm and the separation power of 10mm assumed in the proposal.

2.2 Efficiency

Light is produced for more than 99% of the tracks. Our present camera however is not sensitive enough and detects only 60–70% of the tracks. A more sensitive camera with two steps of image intensifiers instead of one is being ordered with a gain increase of a factor 20, which should be sufficient.

2.3 Magnet and tracking

It is feasible to modify the magnet (GOLIATH) to a gap size of 1.6 m, still with sufficient bending power. The field will be inhomogenous, but we do not require an homogenous field. Methods for efficient momentum reconstruction which are fast and use little memory exist for applications in such fields. See for example: Method for Efficient Magnetic Analysis in an Inhomogenous Field by C. Lechanoine, M. Martin and H. Wind. NIM 69(1969) 122.

3 Photon Multiplicity Detector

3.1 Configuration

The detector configuration as well as a pad detail are shown in figure 2. The overall dimensions are 1900 mm, 1700 mm, and 300 mm in depth.

3.2 Construction progress

Most of the material required for fabrication has reached India, including test electronics. Clean rooms will be ready at the end of October, WLS fiber testing equipment is ready and pad response testing equipment is in construction. Contract with a private firm for scintillator machining has been signed and job sharing responsabilities between the four Indian groups has been fixed.

A few pad-fiber assemblies have been made and tested. The response of one of them is shown in figure 3. We estimate that about 56 photon/MIP reach the CCD camera; this is about 2.5 times what was obtained from scintillating fibers for the UA2 system. We expect a signal corresponding to 10–100 MIP's per photon at energies larger than 200 MeV.

3.3 Simulation of the PMD response

1. Photon counting. Running the PMD in hadron-blind mode, that is with a threshold of two MIP's per pad, the number of hits varies linearly with the number of photons incident on the detector (Fig 4). With proper calibration the number of photons can be counted already with this simple method with an accuracy of about 5%.

2. Position measurement. A preliminary cluster finding algorithm using 9 pads has been tested: the reconstructed position of the photon is found to be accurate to 4 ± 2 mm, which is reasonably satisfactory.

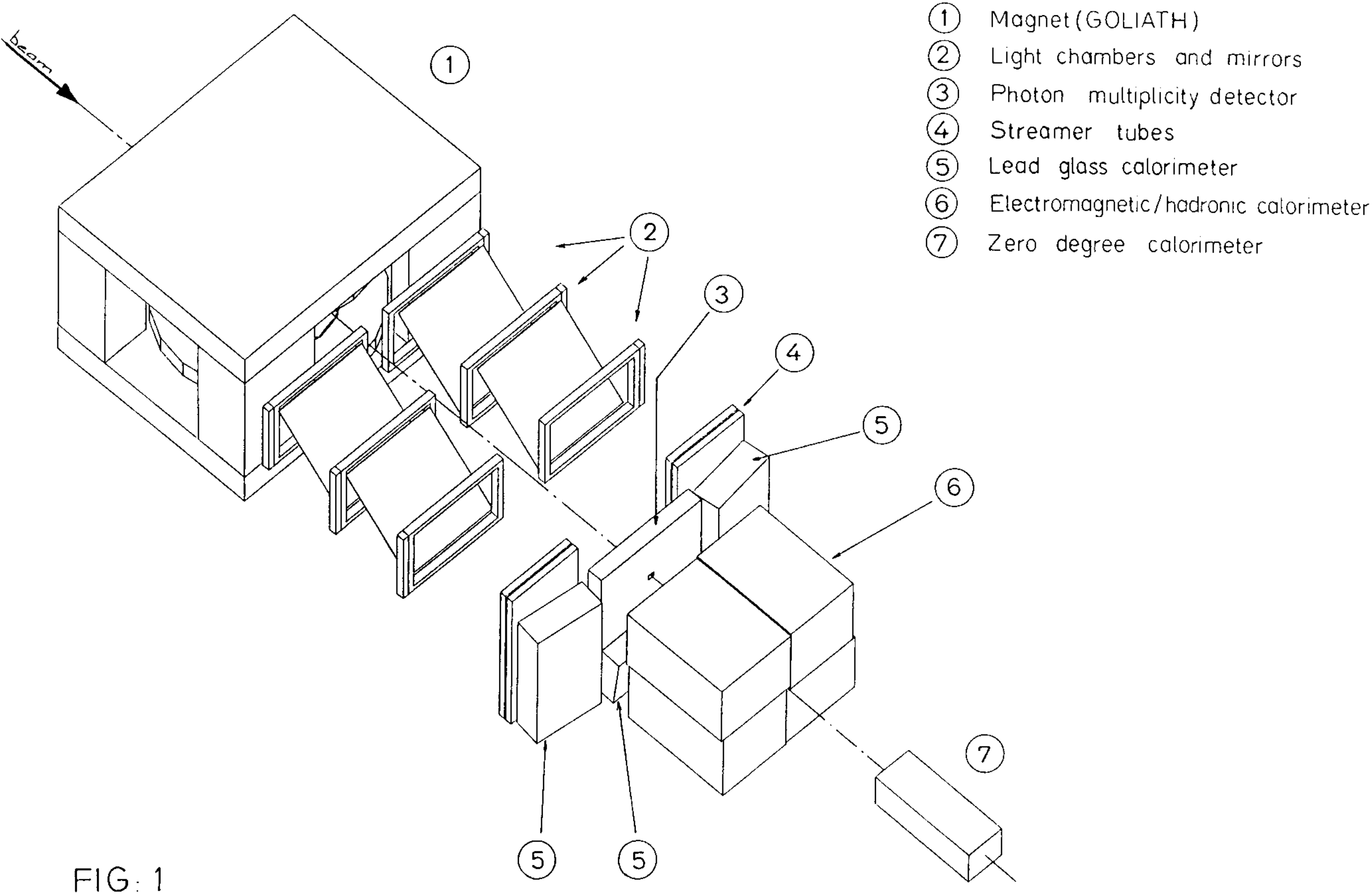
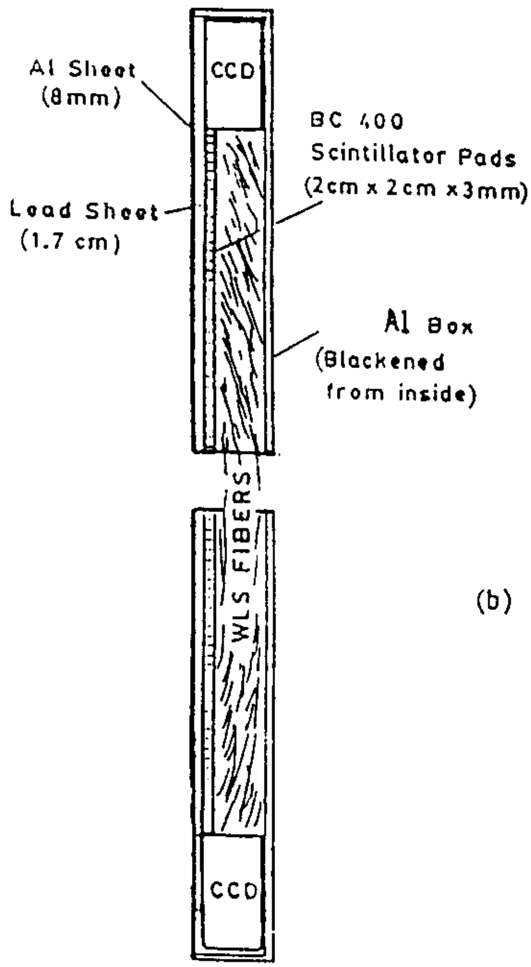
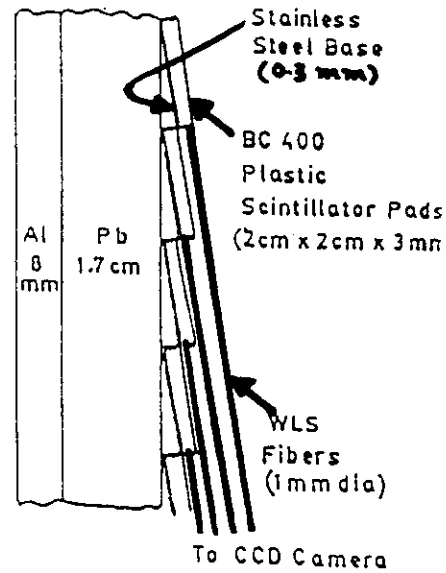

beam
1
2
3
4
5
6
7
5
5
1 Magnet (GOLIATH)
2 Light chambers and mirrors
3 Photon multiplicity detector
4 Streamer tubes
5 Lead glass calorimeter
6 Electromagnetic/hadronic calorimeter
7 Zero degree calorimeter

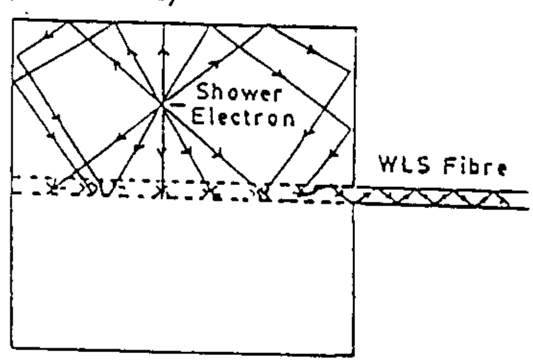
FIG. 1



(a) Side view of Photon
Multiplicity Detector
(1mm = 1cm)

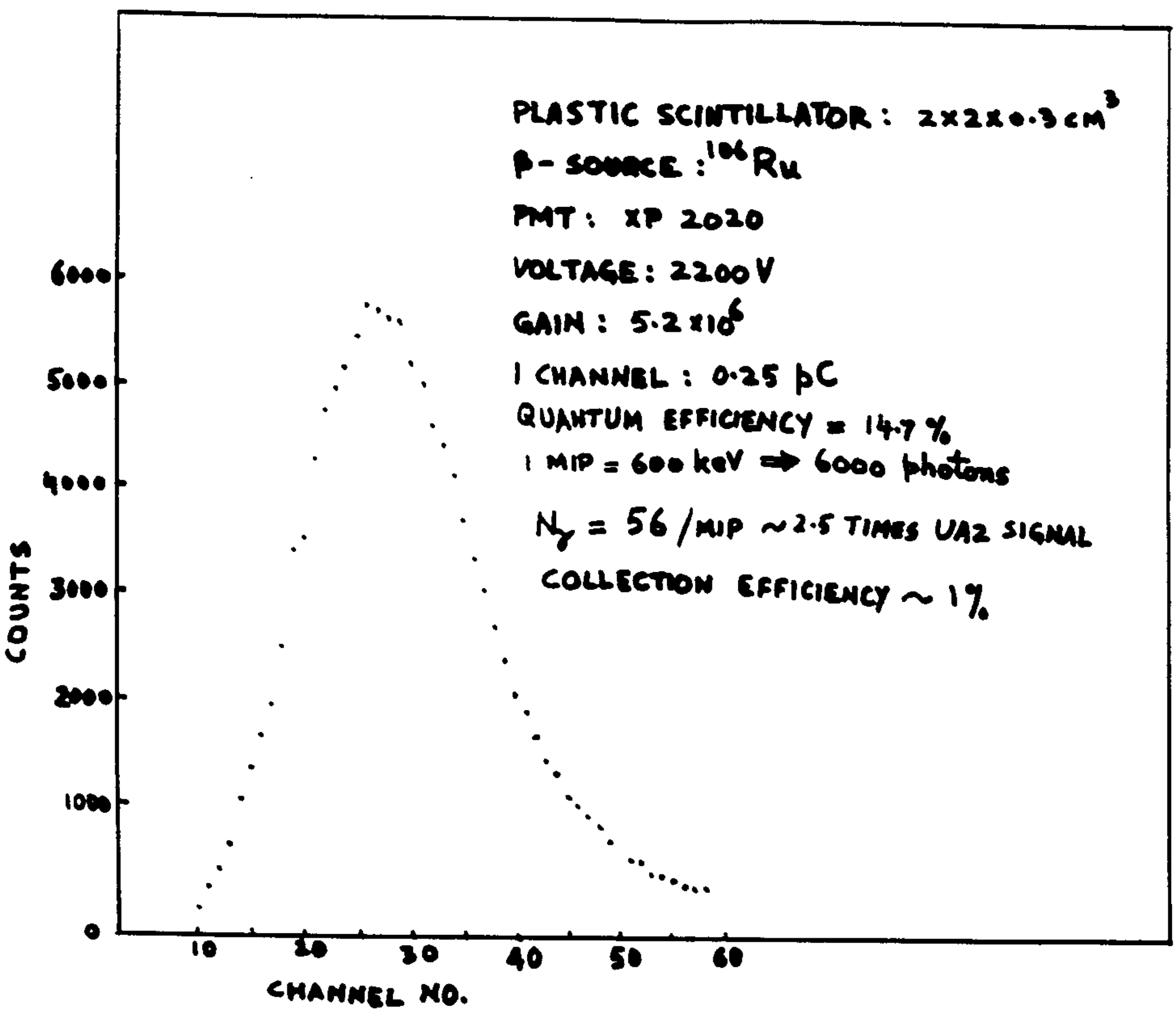


(b) Staircase Arrangement of Scintillator
Pads (Actual size)



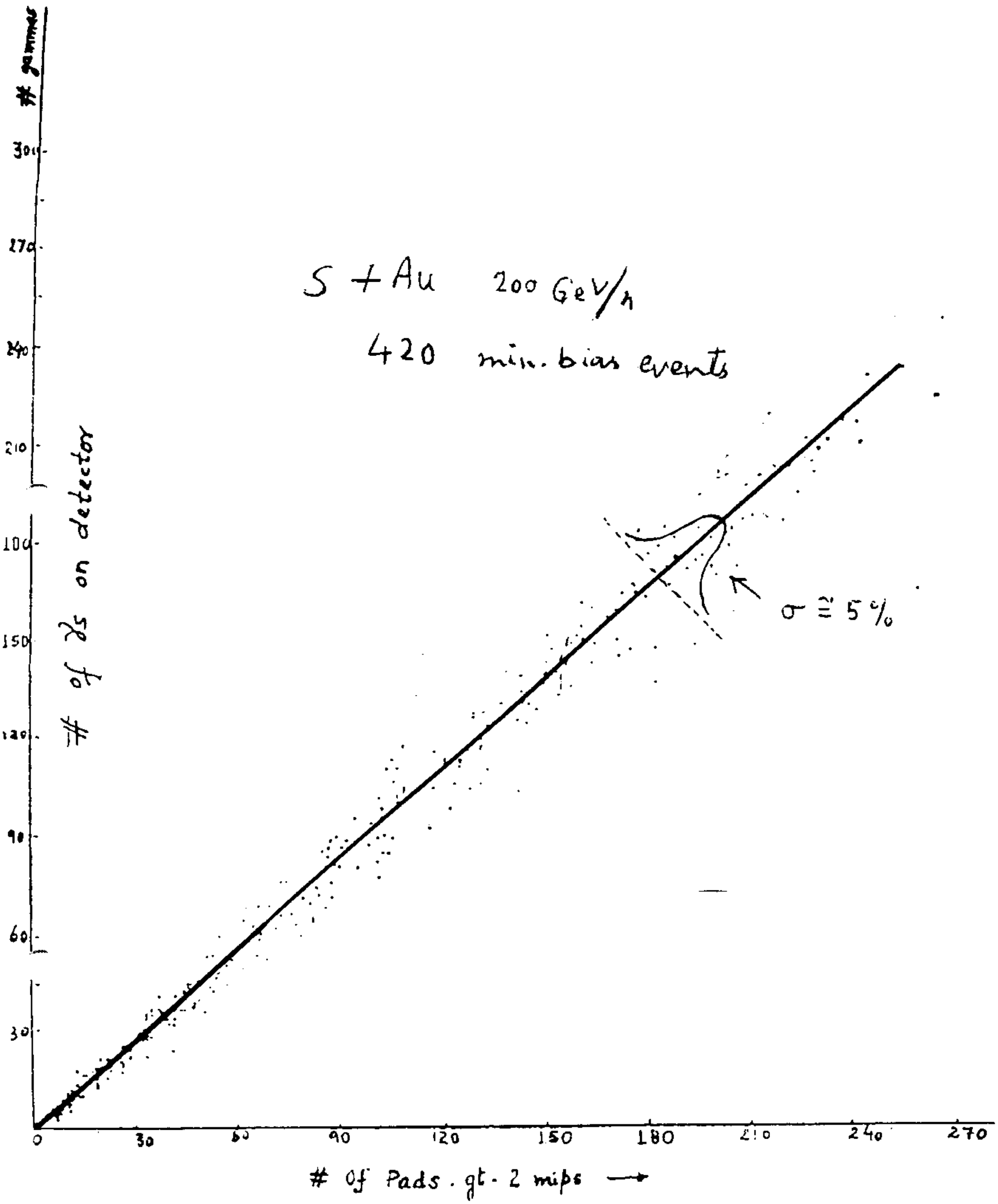
(c) BC 400 Scintillator Pad with WLS Fibre
Showing Light being Transfered to Fibre
(3 times the actual size)

Fig. 2



RESPONSE OF A PAD + FIBER ASSEMBLY

Fig. 3



S + Au 200 GeV/n
420 min. bias events
σ ≅ 5%
# of γs on detector
gammas
of Pads . gt . 2 mips →
0
30
60
90
120
150
180
210
240
270
300

Fig. 4