E-6

ISR-OP/FL/svw

22nd September, 1980

ISR PERFORMANCE REPORT

MD, Run 1147, 7.8.80, 26.6 GeV/c, Solenoid + Steel low-β ON

Intersection 1, luminosity calibration over the diamond position

1. Aim

The physicists in this intersection were trying to find their luminosity monitor calibration constant dependence over the horizontal position of the interaction diamond. In parallel the same calibration was made with the I-1 standard monitor.

2. Standard monitor set-up

Two 40 x 40 cm^2 scintillators are fixed at the top of the first downstream main magnet for each ring. This special configuration was chosen to correspond with the installation of the steel low-β insertion in order to avoid the screening effect of scattered particles by quadrupoles.

3. Monitor calibration constant calculation σ

$$\sigma = \frac{(\text{Beam-Beam})_{\text{max.}}}{\text{Luminosity}}$$

$$L = 0.1 \frac{I_1 \times I_2}{h_{eff}}$$

$$\text{with } h_{eff} = \frac{\int \rho_1(z)dz \int \rho_2(z)dz}{\int \rho_1(z)\rho_2(z)dz} = \frac{\text{curve area}}{BB_{\text{max.}}}$$

obtained from vertical beam steering.

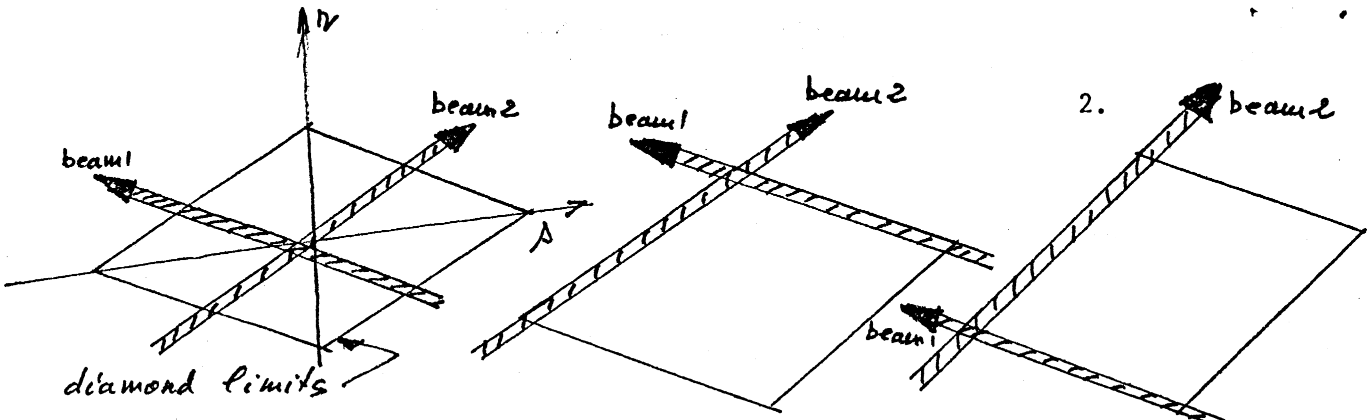
The aim was to obtain :

$\sigma = f(r,s)$

for different measurements achieved with small stacks at different radial positions.

4. Data

3 sets of measurements were performed with the following beam positions:



Beam position 1 — Beam position 2 — Beam position 3

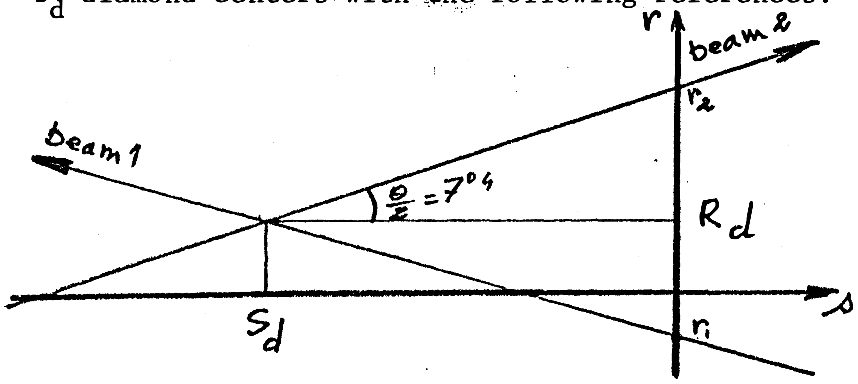
Figures 1_1, 1_2, 2_1, 2_2 and 3_1, 3_2 give the beam profiles and radial positions. Taking beam positions 1 as a reference (centered stacks), beam positions 2 give a radial dependence and beam positions 3 give a longitudinal dependence.

Figures 4, 5 and 6 show the curves obtained from beam steering for positions 1, 2 and 3 respectively.

Table I gives the results of gaussian fits of the curves and calculations of h_{eff}, σ and L.

5. Results

Taking the radial beam centers, we can calculate the radial R_d and longitudinal S_d diamond centers with the following references.



$$R_d = \frac{r_1+r_2}{2}$$

$$S_d = \frac{r_1-R_d}{tg\ \theta/2}$$

Beam Positions	Beam position centers (mm)	Radial diamond center (mm)	Longitudinal diamond center (mm)	Monitor constants σ ($\mu b^{-1}s^{-1}$)
1	+ 2, + 1	1.5	3.8	3.09
2	+34, +37	35.5	-11.5	2.9
3	-17, +36	9.5	-204.	2.8

6. Errors for monitor constant determination

The statistical errors taking into account the gaussian fit can be evaluated to be ±1%. The systematic errors due to radial dependence of vertical bumps with ELSA line used in the experiment are, however, more important. These measurements have been taken by K. Potter (see P.R. 26.2.76) and a fit of the results gives :

$$\frac{\Delta z}{z}\left[\%\right] = 1.7 \times 10^{-3}\, r^2 + 8.2\times10^{-2} r\,(\mathrm{mm})$$

where $\frac{\Delta z}{z}$ is the vertical bump error in % versus the radial position r in mm. Thus the vertical bumps can be estimated as +5% too large for outer stacks and -1% too small for inner stacks when compared to centered stacks for which the bumps are considered to be correct.

We have :

$$\sigma_{mon} = \frac{BB_{max}}{L_{max}} = \frac{BB_{max} \cdot h_{eff}}{0.1\ I_1 \cdot I_2}$$

and $h_{eff} = \sqrt{2\pi}\,\sqrt{\sigma_1^2 + \sigma_2^2}$ where σ_1 and σ_2 are the r.m.s. of vertical beam densities.

We obtain :

$$(1)\quad \frac{\Delta\sigma_{mon}}{\sigma_{mon}} = \frac{\Delta h_{eff}}{h_{eff}} = \tfrac{1}{2}\,\frac{\Delta\sigma_1}{\sigma_1} + \tfrac{1}{2}\,\frac{\Delta\sigma_2}{\sigma_2}$$

Assuming for a gaussian that $\frac{\Delta\sigma}{\sigma} = \frac{\Delta z}{z}$, we obtained from (1) the systematic error for σ's and the following results for the 3 stack positions.

Beam positions	$\frac{\Delta\sigma_1}{\sigma_1}$	$\frac{\Delta\sigma_2}{\sigma_2}$	$\frac{\Delta\sigma_{mon}}{\sigma_{mon}}$	σ_{mon} measured ($\mu b^{-1}s^{-1}$)	σ_{mon} "true" ($\mu b^{-1}s^{-1}$)	Variation $\frac{\sigma-\sigma_{pos.1}}{\sigma_{pos.1}}$
1	0	0	0	3.09	3.09 ± .03	0
2	.05	.05	.05	2.9	3.04 ± .03	-.016 ± .015
3	-.01	.05	.02	2.8	2.86 ± .03	-.074 ± .015

7. Conclusions

For the standard monitor in I1 the monitor constant calibration is independent of the radial stack position. This is in agreement with the previous measurements and mainly due to the fact that the detectors are placed above the beams, symetrically to their vertical planes. Longitudinally, the dependence can reach 7%; the reason for this is not understood at the moment.

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cc : ISR Coordinator - L. Camilleri
H.J. Besch/EP (experiment R110)

Fits of curves and calculations –

1 – **stack positions 1** [+10, −6] [+8, −6] mm

I1 = 3.51 Amps ; I2 = 3.51 Amps.

```
OPTIMUM POSITION =    -0.661 MM
MAXIMUM BEAM-BEAM=     2.6
EFFECTIVE HEIGHT =     1.480 MM
MONITOR CONSTANT =     3.092 MICROBARN
QUALITY OF FIT   =     25.8
Luminosity       =     .83 µb-1s-1
```

2 – **stack positions 2** [+42, +26] [+44, +30] mm.

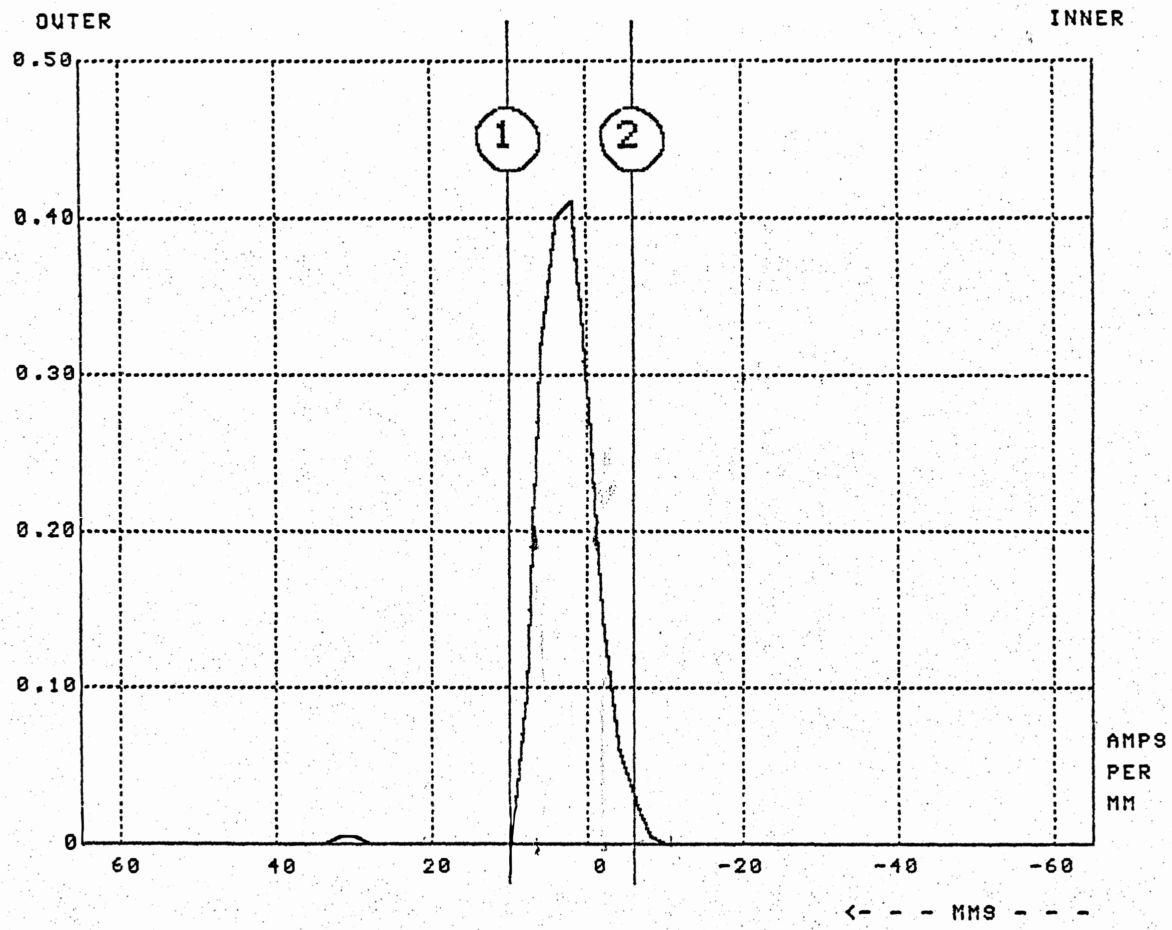
```
**********************************************************************************I
 RUN: 1147                    LUMINOSITY MEASUREMENT                              I
 E1= 26.0000 GEV/C  E2= 26.0000 GEV/C                                   SFM ON   I
 I1=  3.5464 AMPS   I2=  3.0824 AMPS   INITIAL                                    I
 I1=  3.5448 AMPS   I2=  3.0824 AMPS   FINAL                                      I
**********************************************************************************I
 INT I HEFF  I OPT POS       I MON      I  MAX      I LUM     I EL PT I NO I FQ   I
     I       I  R1      R2   I CONS     I  BB       I         I       I PT I      I
==================================================================================I
     I  MM   I  MM      MM   I MUB      I C/S       I  (*)    I       I    I      I
**********************************************************************************I
                          STANDARD MONITORS                                       I
**********************************************************************************I
  1  I 1.498 I  0.05 -0.05  I      2.9 I       2.1 I  0.74  I -1.20 I 10 I   31 I
**********************************************************************************I
(*)=MUB-1SEC-1
```

– **stack positions 3** [−8, −26] [+44, +28] mm.

```
**********************************************************************************I
 RUN: 1147                    LUMINOSITY MEASUREMENT                              I
 E1= 26.0000 GEV/C  E2= 26.0000 GEV/C                                   SFM ON   I
 I1=  3.6336 AMPS   I2=  3.4760 AMPS   INITIAL                                    I
 I1=  3.6336 AMPS   I2=  3.4760 AMPS   FINAL                                      I
**********************************************************************************I
 INT I HEFF  I OPT POS       I MON      I  MAX      I LUM     I EL PT I NO I FQ   I
     I       I  R1      R2   I CONS     I  BB       I         I       I PT I      I
==================================================================================I
     I  MM   I  MM      MM   I MUB      I C/S       I  (*)    I       I    I      I
**********************************************************************************I
                          STANDARD MONITORS                                       I
**********************************************************************************I
  1  I 1.615 I -0.06  0.06  I      2.8 I       2.2 I  0.79  I -1.60 I 10 I   12 I
**********************************************************************************I
()=MUD-1SEC-1
```

– Table I –

R	FILE	TIME	DATE	RUN	WC	I	P	WIDTH	RMS	COFG
1	DENS	22H40M46S	80-08-07	1147	LB	3.514	26.59	23.50	6.40	2.55



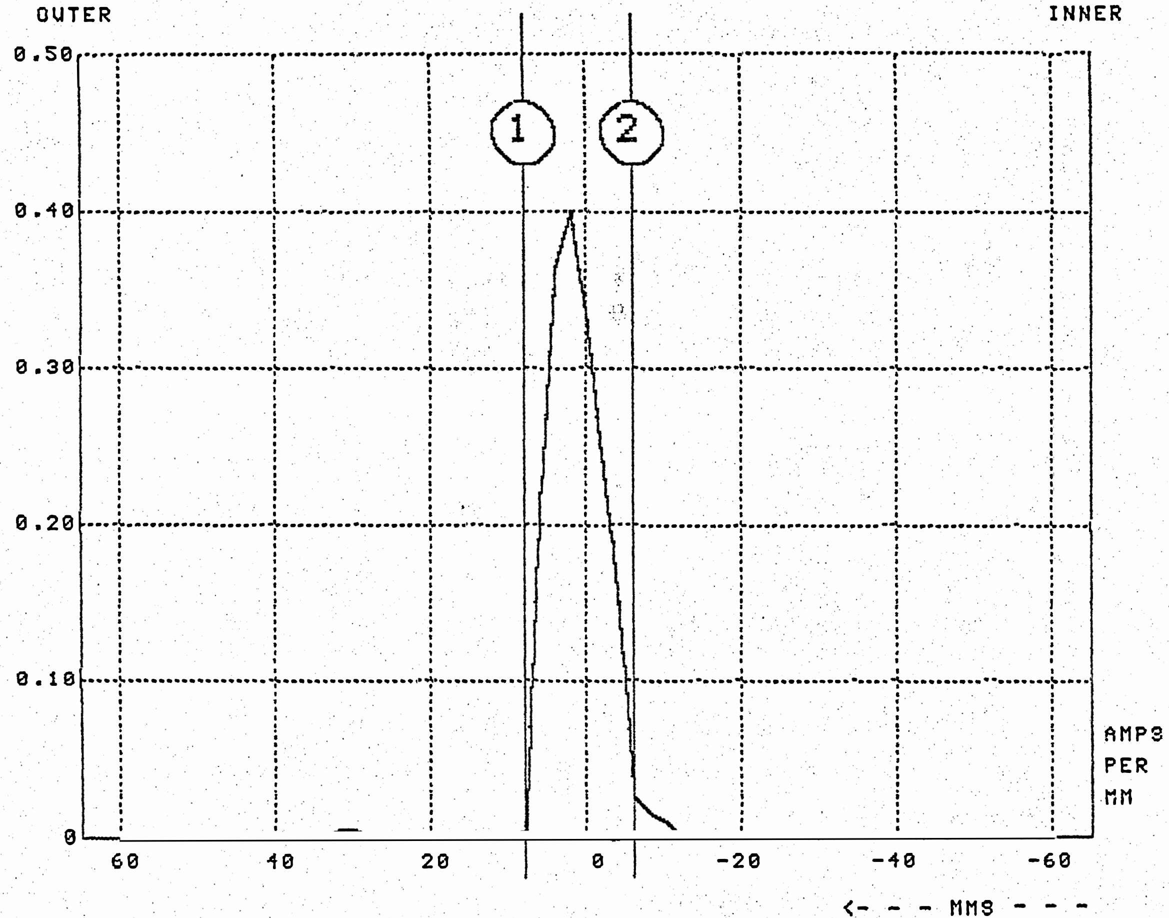
N	MMS	A/MM	P
1	10	0.000	26.739
2	-6	0.029	26.507

MMS MMS I

fig 11

Centred shock

R	FILE	TIME	DATE	RUN	WC	I	P	WIDTH	RMS	COFG
2	DENS	22H18M41S	80-08-07	1147	LB	3.511	26.59	21.11	6.49	1.39



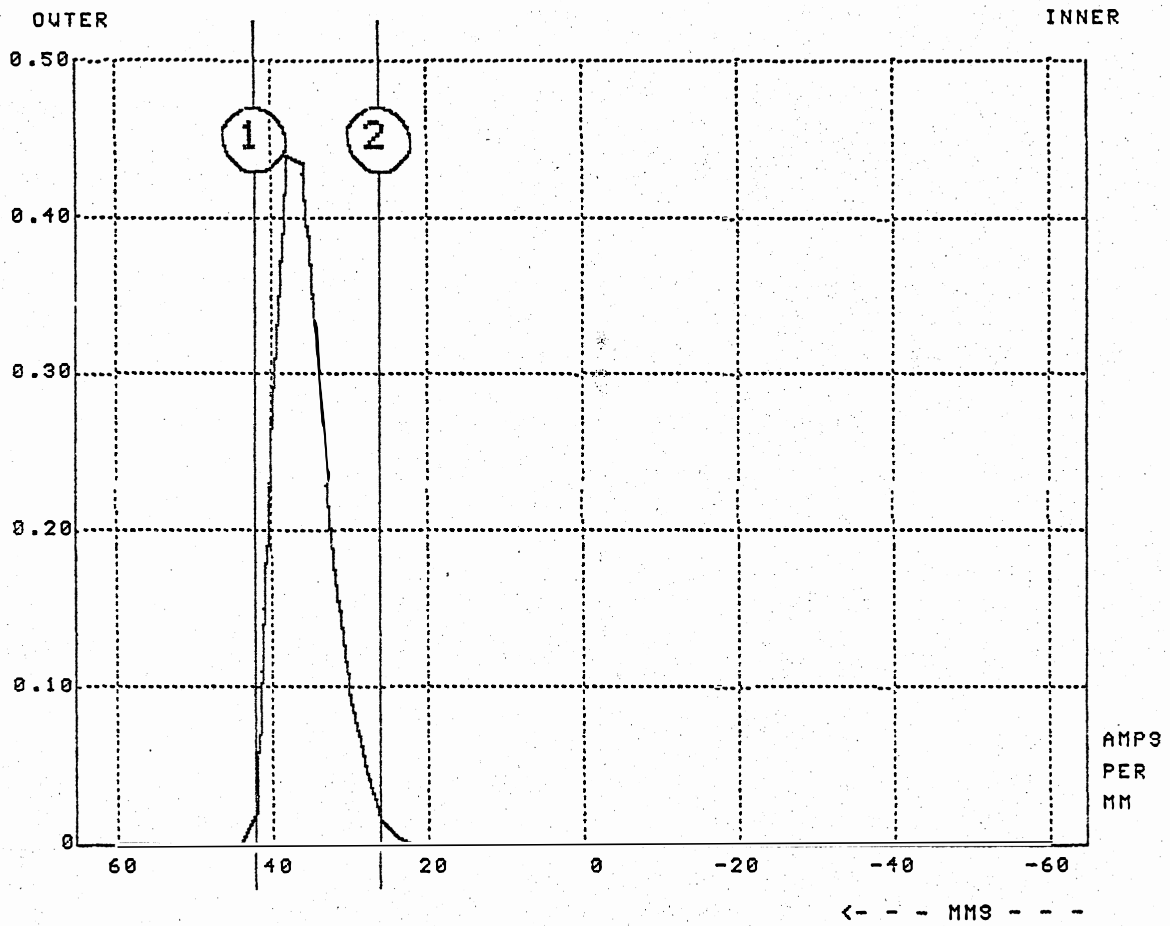
N	MMS	A/MM	P
1	8	0.006	26.706
2	-6	0.023	26.503

MMS MMS I

Fig 1/2

outer Heck

R	FILE	TIME	DATE	RUN	WC	I	P	WIDTH	RMS	COFG
1	DENS	23H50M10S	80-08-07	1147	LB	3.546	26.59	21.00	6.43	35.73

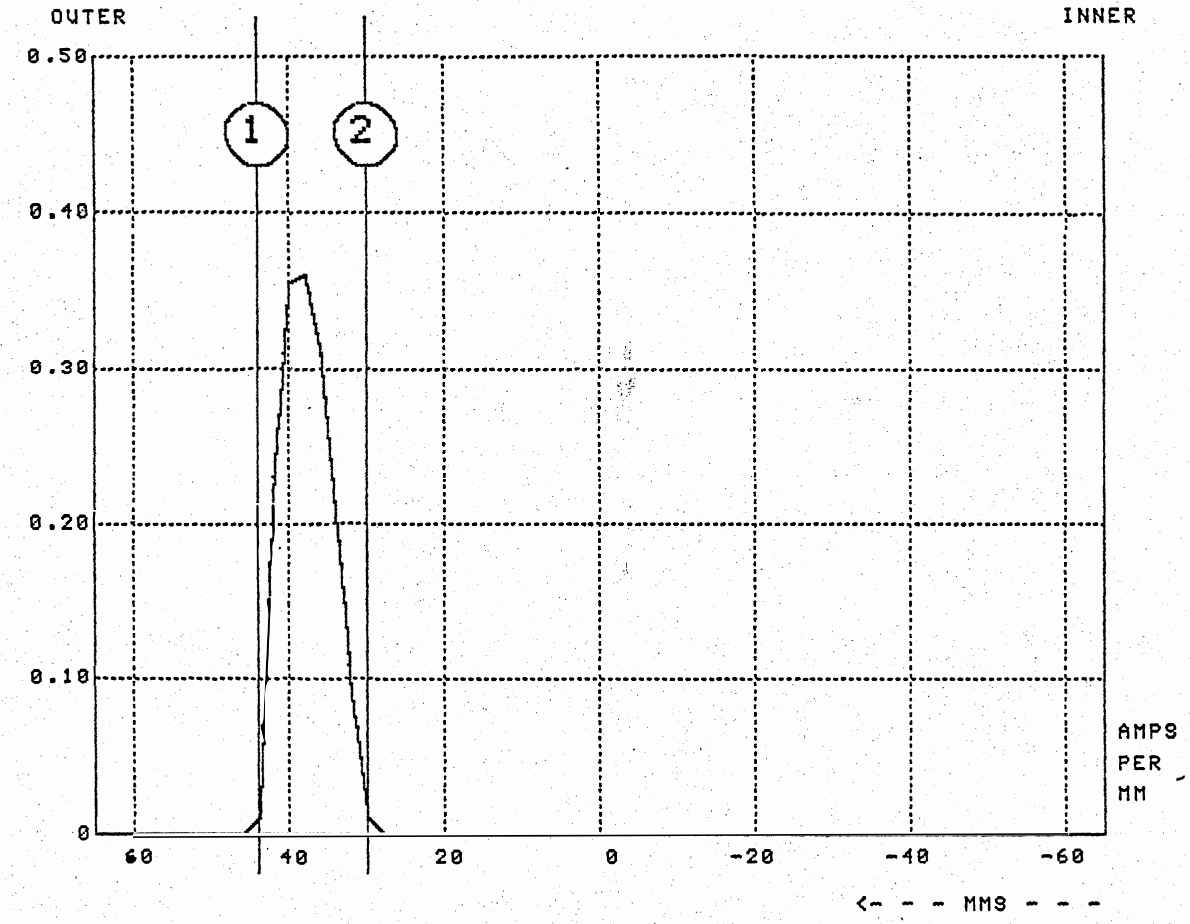


N	MMS	A/MM	P
1	42	0.020	27.205
2	26	0.015	26.972

MMS MMS I

fig 21

R FILE	TIME	DATE	RUN	WC	I	P	WIDTH	RMS	COFG
2 DENS	23H49M12S	80-08-07	1147	LB	3.082	26.59	16.24	5.71	37.65



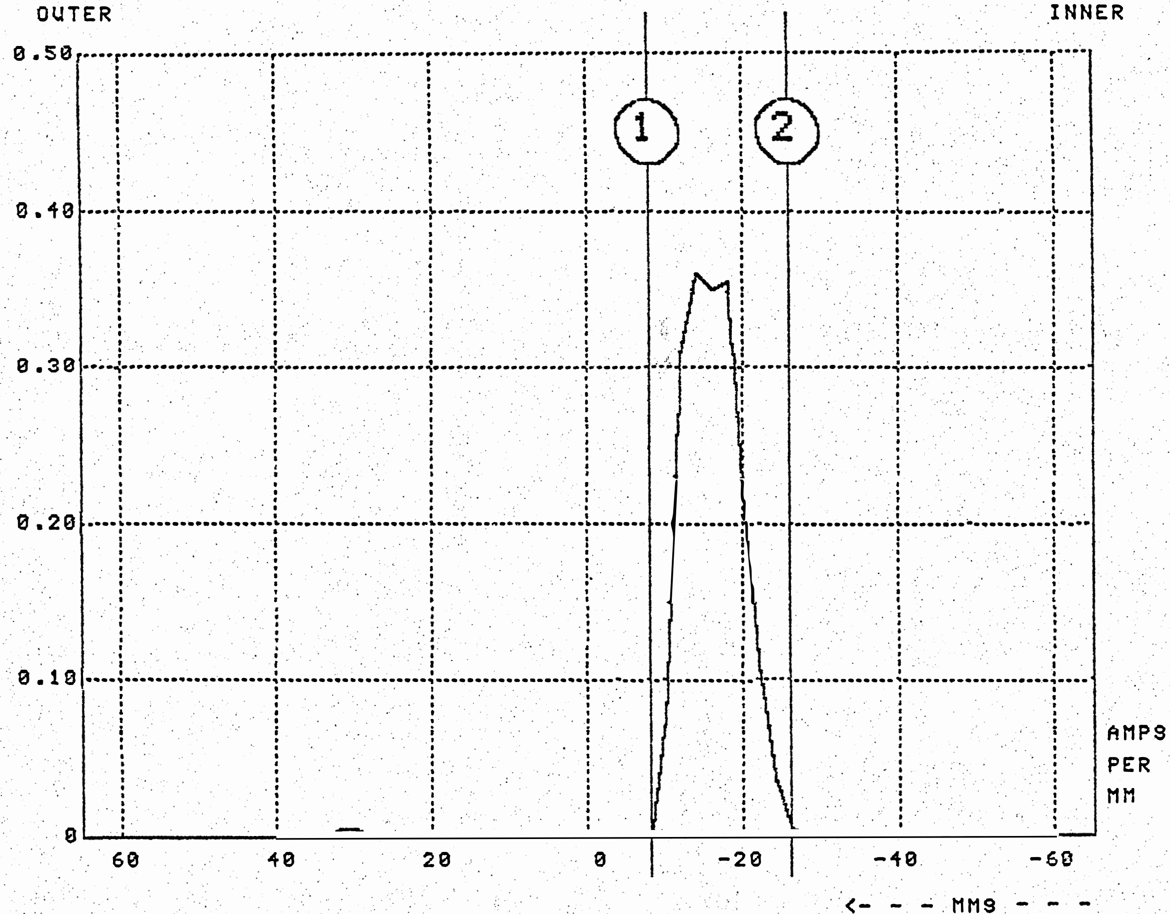
N	MMS	A/MM	P
1	44	0.008	27.227
2	30	0.011	27.025

MMS MMS I

fig 22

2. inner stack (bottom)

R	FILE	TIME	DATE	RUN	WC	I	P	WIDTH	RMS	COFG
1	DENS	00H59M27S	80-08-08	1147	LB	3.634	26.59	19.58	6.66	-16.21



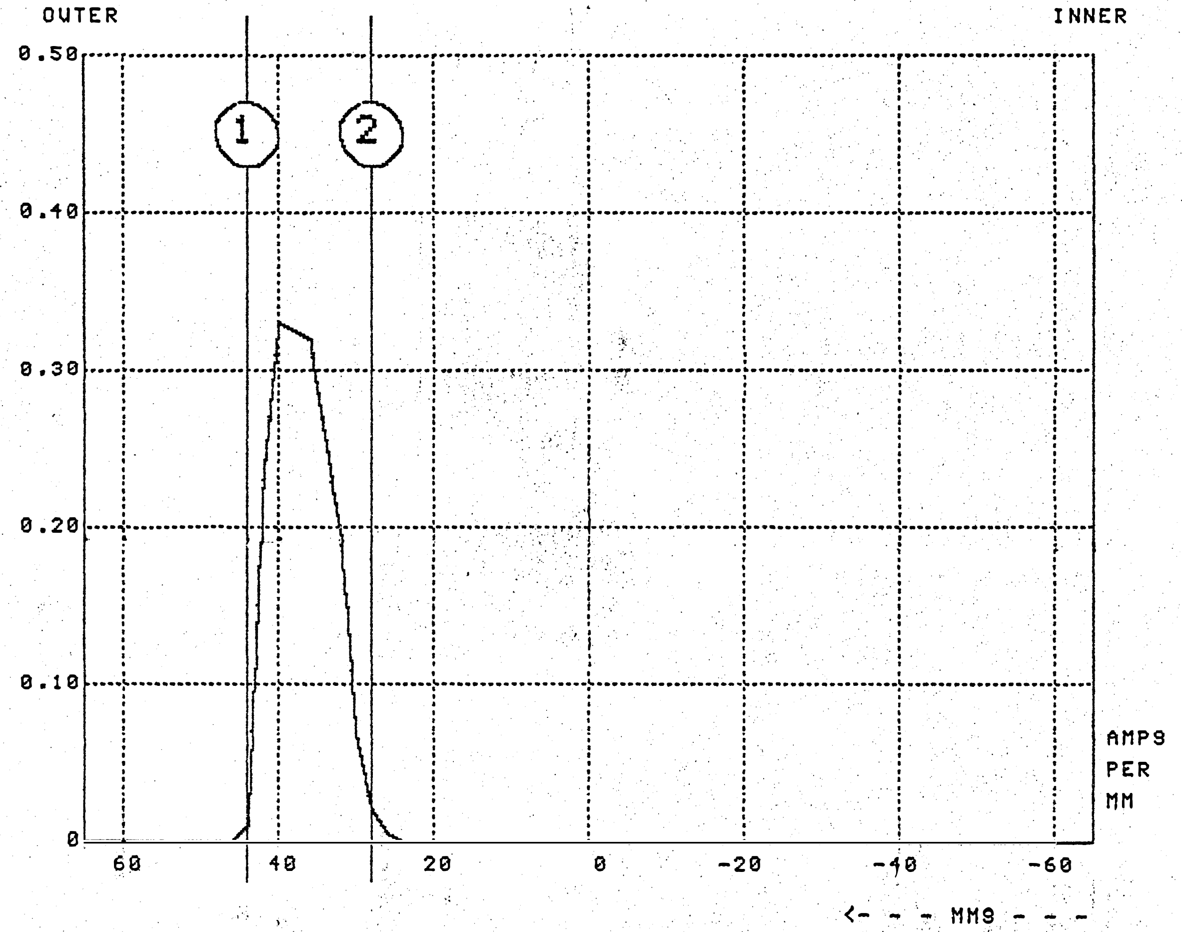
N	MMS	A/MM	P
1	-8	0.000	26.478
2	-26	0.005	26.216

MMS MMS I

fig 37

L. outer stack (top)

R	FILE	TIME	DATE	RUN	WC	I	P	WIDTH	RMS	COFG
2	DENS	01H00M45S	80-08-08	1147	LB	3.476	26.59	21.39	7.04	36.74



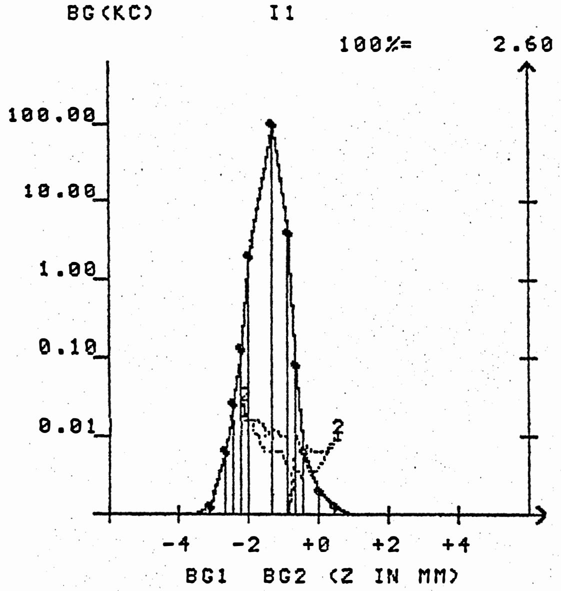
N	MMS	A/MM	P	MMS	MMS	I
1	44	0.010	27.227			
2	28	0.018	26.995			

fig 32

--- LUMINOSITY CURVE ---

RUN 1147   MOMENTUM RING1: 26.000 GEV/C   RING2: 26.000 GEV/C
STANDARD MONITORS

1st stacks centered.



No fit from Luma.

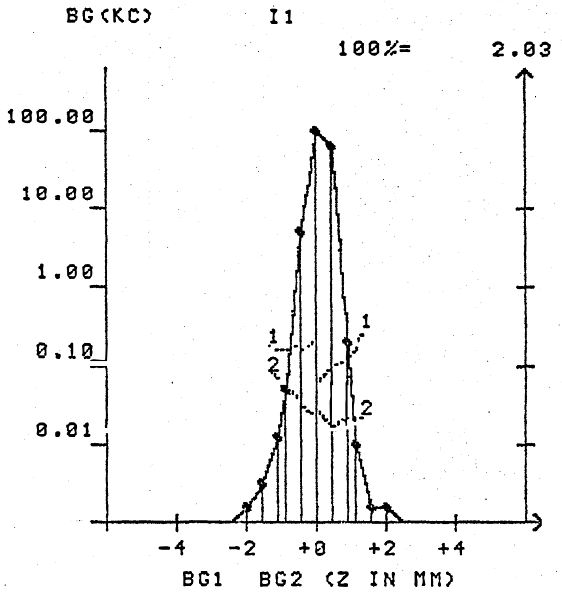
– Fig 4 –

2nd stack

--- LUMINOSITY CURVE ---

RUN 1147   MOMENTUM RING1: 26.000 GEV/C   RING2: 26.000 GEV/C
STANDARD MONITORS

outer stacks centred

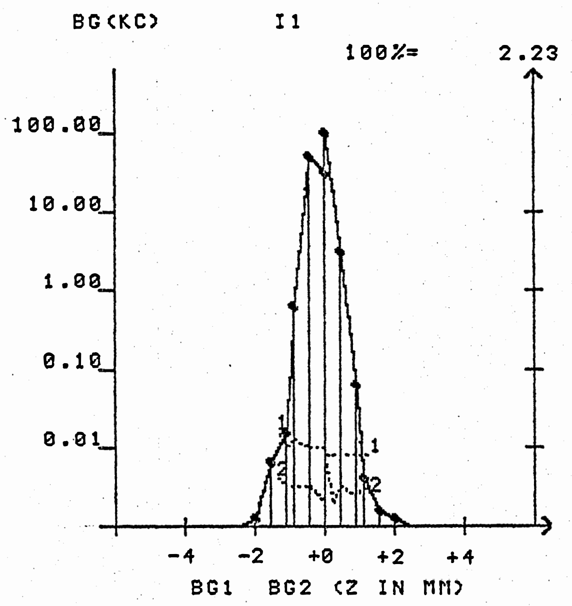


- fig 5 -

K1 bottom K2 top

--- LUMINOSITY CURVE ---

RUN 1147 MOMENTUM RING1: 26.000 GEV/C RING2: 26.000 GEV/C
STANDARD MONITORS



- fig 6 -