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TEST OF BACKGROUND TO UA1 FROM THE UA6 GAS JET TARGET

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Test description

The most convenient position of the UA6 experiment in the SPS ring is in superperiod 5^-, about 130 m upstream of UA1. As can be seen from the schematic SPS layout of this region (Fig. 1), although the two experiments are rather close to each other they are separated by 6 SPS bending magnets (6×8 mrad). In order to better understand the additional background that the UA6 gas jet would produce for UA1 a simulation test was made on the 16th December, 1981.

The low beta configuration of the SPS machine was $\beta_h^* = 7$ m and $\beta_v^* = 3.5$ m in both LSS4 and LSS5. Intensities were $p_1 = 6.2 \times 10^{10}$, $p_2 = 5.8 \times 10^{10}$ and $\bar{p} = 4.5 \times 10^9$ from which a luminosity of about 5×10^{26} s^{-1} cm^{-2} can be assumed.

The UA6 gas jet was simulated by a pressure bump of nitrogen, centered on the possible position of the UA6 gas jet but, of course, not so well defined longitudinally. The pressure distribution along the beam line is illustrated in Fig. 2, and the strength of the pressure bump is referred to the pressure measured at its centre. The integrated thickness of the bump given in equivalent pressure x length (mbar cm) can be read from Fig. 3.

In the following report of the measurements made by UA1 using various systems of detectors all effects will be referred to this <u>nitrogen-pressure</u>.

UA6 have estimated[1)] that a pressure of 6×10^{-7} mbar in the present test is equivalent to the hydrogen gas jet foreseen to reach a luminosity of 10^{31} cm^{-2} s^{-1}, if the normalisation is done on the inelastic cross-sections. Lower values are reached when the normalisation is done on elastic rates, but we use here the pessimistic assumption given above.

In the test the nitrogen pressure was increased in six steps from the normal SPS vacuum of 7×10^{-10} mbar up to 5×10^{-6} mbar (see Table 1). At each step counting rates have been recorded by UA1 in various channels.

Unfortunately, a SPS proton cavity tripped just before the test started. This led to particle losses and consequently additional background at the underground experiments, which only slowly decayed during the period of the test.

In order to subtract this missleading effect from the background, seen by UA1, due to the pressure bump, rates measured by UA4 in LSS4 during the same period have been used.

Figure 4 shows UA4 rates recorded by two different monitors before the cavity tripped and during the time of the test thereafter[2)]. The increase of background rates due to the cavity trip is clearly seen followed by a linear decay of about 30 % per hour. However, no increase of UA4 counting rates due to the pressure bump near to LSS5 had been detected.

In Figures 5 to 8 different UA1 counting rates are plotted vs. the nitrogen pressure bump. The broken line presents a hand fit through measured data. The sudden increase and subsequent slow decrease of the rates due to the proton cavity trip is clearly visible as well as the effect due to the pressure bump, starting typically at pressure values between 10^{-8} and 10^{-7} mbar. Subtracting the cavity induced background by assuming that it decays in the same proportion as measured by UA4 (Fig. 4), leads to the full line (Figs 5 to 8), representing the real increase of UA1 counting rates due to the pressure bump. As expected the net effect is proportional to the bump pressure, see the dotted straight line in Figs 5 to 8.

A summary of results is given in Table 2, where UA1 rates before the pressure bump (and cavity trip) - UA6 "OFF" - are compared to rates at a pressure of 6×10^{-7} mbar - UA6 "ON" - (corrected for the cavity trip). The first effect listed is the total current drawn from the central detector. The second box gives rates induced by the protons and the antiprotons, respectively, and counted in the bouchon calorimeters. The third box contains signals measured with the SPS hodoscopes in three logical configurations, the latter, using a coincidence delayed by one machine revolution.

Comments on the results

We are not going to draw any conclusion here, it is not for us to do so, but a few interesting hints will be useful for those, who want to get an opinion on the problem.

1. At a first look the background created by UA6 is due to the proton bunches hitting the jet target shortly upstream of UA1. Our comment is that the relative importance of this background is going to drop by an order of magnitude, when higher luminosities will be reached with two times more protons and twenty times more antiprotons.
On the other hand a better background rejection might be needed for UA1 in the future, when they are going to look for rarer events.

2. But there are interesting indications in the present measurements that the background is mainly created by elastic scattering at small t . Using the measured values of Table 2, one can make the ratio :

$$\frac{\text{increased background due to } \bar{p}}{\text{increased background due to } p} = \frac{205 - 140}{1800 - 180} = 0.041,$$

and compare it to the beam intensities :

$$\frac{\bar{p}\text{ intensity}}{p\text{ intensity}} = \frac{4.5 \times 10^{9}}{6.2 \times 10^{10}} = 0.073.$$

The ratio of those ratios shows that the antiprotons are creating background to UA1 with an efficiency of 56 % compared to the protons. This is a striking result, since it suggests that UA6 located anywhere else in the machine would produce at least 56 % of the background it would produce if located in LSS5.

3. Since most of the background is produced by elastic scattering at low t the N_2 pressure equivalent to the H_2 gas jet is lower by an other factor 2 as shown in Ref. 1.

4. The number of accidentals computed from the p-gas and $\bar{p}$-gas rates is :

$$\frac{(\text{p-gas}) \times (\text{p-gas})}{\text{nb of bunch crossings in 10 s}} = \frac{230 \times 140}{444'000} = 0.07 \text{ (per 10 s)},$$

but the measured rate : SPS-random-tight = 6 (per 10 s), is two orders of magnitude larger, what can only be explained by a time correlation. Now neither the beam intensities nor the residual gas pressure can have a time structure. Hence, the actual background is not produced by the core of the beams, but by their far edges (at 20 σ) hitting the bottleneck of the vacuum chamber where a time structure can be induced by an infinitesimal coherent oscillation due to some power supply ripple.

5. One might therefore hope that the additional background due to the jet target <u>and</u> the beam-gas background of the rest of the machine will be cured by an adequate continuous scraping in LSS1, and a local shielding near the point of highest beta.

Acknowledgements

We wish to acknowledge the fruitful collaboration of K. Eggert, member of UA1, who was present during the test and participated later on in many discussions about the results shown here.

References

1. B. Jeanneret, UA6-SPS, Note 2 (8.1.1982)

2. J. Timmermans, Private Communication from UA4.

FIGURE CAPTIONS

Fig. 1 Layout in the SPS tunnel

Fig. 2 Pressure bump for the jet simulation

Fig. 3 Conversion diagram for pressure bump integrated thickness vs. pressure reading

Fig. 4 UA4 rates during the test

Fig. 5 UA1 proton gas rates

Fig. 6 UA1 antiproton gas rates

Fig. 7 SPS-tight-trigger rates

Fig. 8 SPS-tight-random rates.
These rates are obtained with a coincidence delayed over one SPS revolution.

TABLE 1

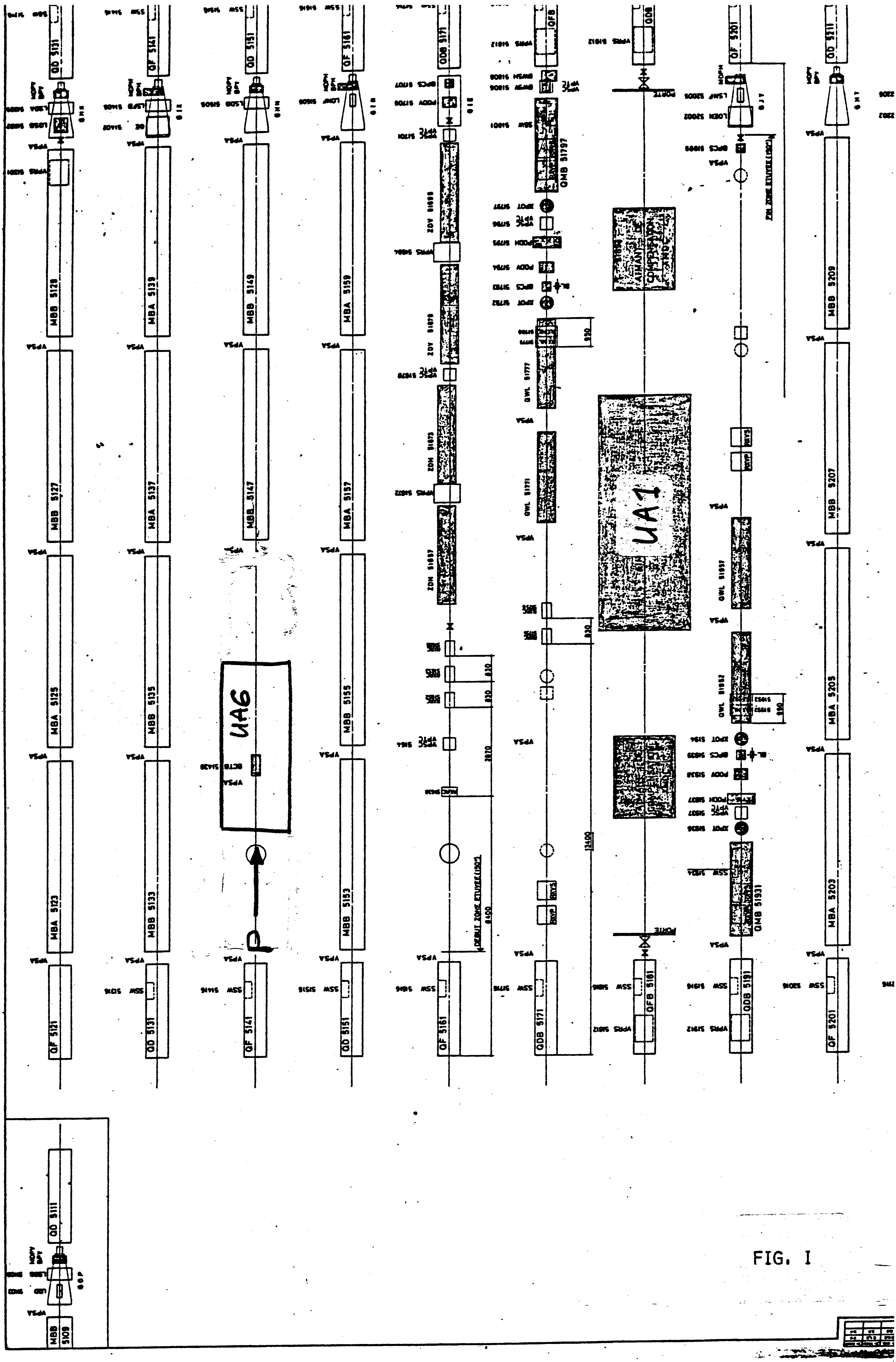
N_2 - Pressure Bump

Step	Time	Pressure (mbar)
0	23:00	7×10^{-10}
1	23:04	1.3×10^{-9}
2	23:10	3.0×10^{-9}
3	23:25	1.0×10^{-8}
4	23:45	1.1×10^{-7}
5	23:55	1.0×10^{-6}
6	0:05	5.0×10^{-6}

TABLE 2

Summary of UA1 Rates

Rate/10 s	UA6 "OFF" 7×10^{-10} mbar	UA6 "ON" 6×10^{-7} mbar	Increase Factor
Central detector current (μA)	17	23.5	1.4
p - gas	230	1800	7.8
$\bar{p}$ - gas	140	205	1.5
bouchon tight	257	517	2.0
SPS-loose-trigger	380	1900	5
SPS-tight-trigger	250	430	1.72
$\frac{\text{SPS-random-tight}}{\text{SPS-tight-trigger}}$	2.5 %	24 %	10



QD 5131
QF 5141
QD 5151
QF 5161
QDB 5171
QF 5201
QD 5211
MBB 5129
MBA 5139
MBB 5149
MBA 5159
MBB 5209
MBB 5127
MBA 5137
MBB 5147
MBA 5157
MBB 5207
MBA 5125
MBB 5135
MBB 5155
MBA 5205
MBA 5123
MBB 5133
MBB 5153
MBA 5203
QF 5121
QD 5131
QF 5141
QD 5151
QF 5161
QDB 5171
QFB 5181
QDB 5191
QF 5201
QMB 51797
QMB 51931
UA6
UA1
QD 5111
MBB 5109

FIG. I

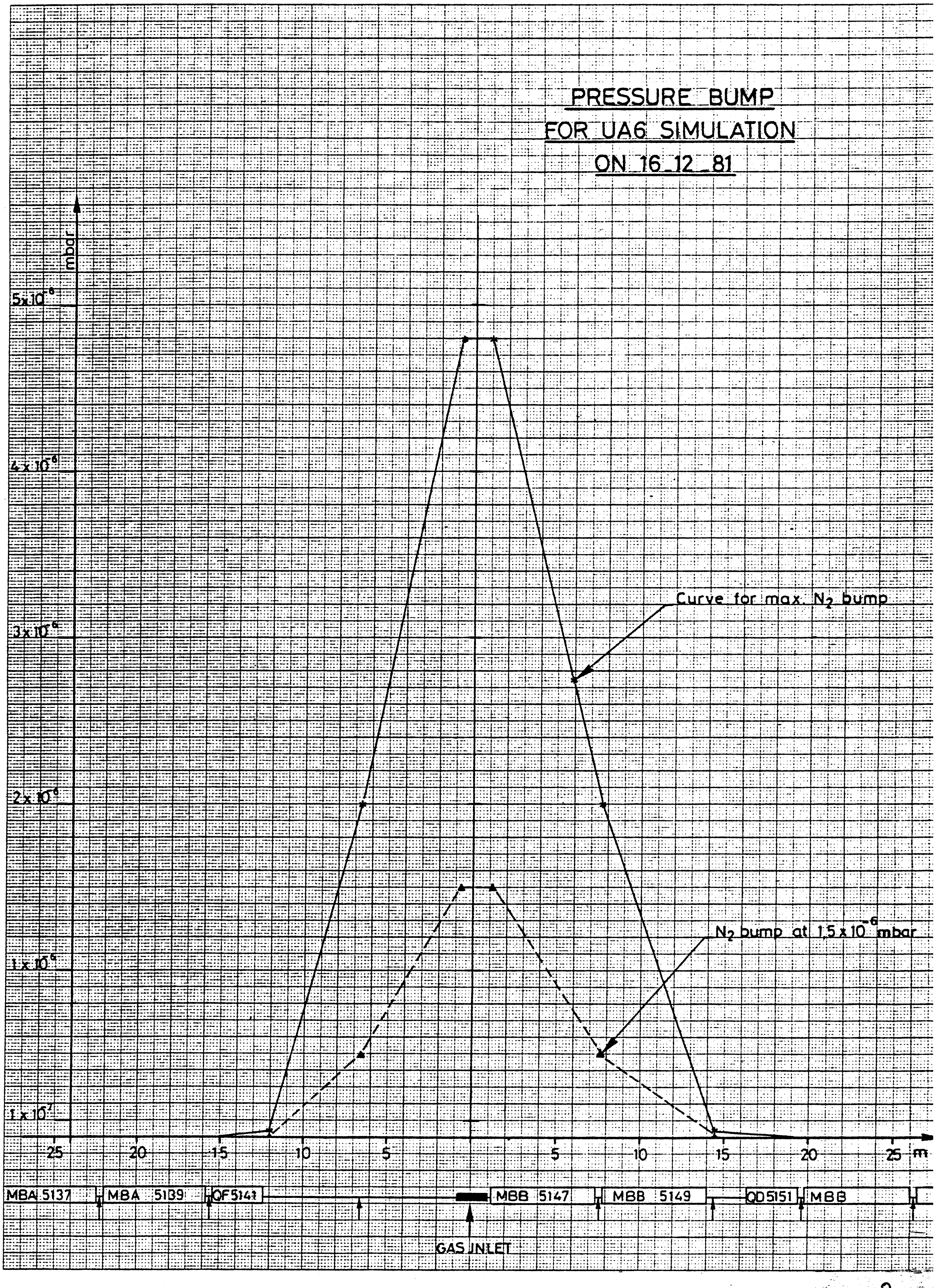

PRESSURE BUMP
FOR UA6 SIMULATION
ON 16-12-81
mbar
5x10⁻⁶
4x10⁻⁶
3x10⁻⁶
2x10⁻⁶
1x10⁻⁶
1x10⁻⁷
Curve for max. N2 bump
N2 bump at 1,5x10⁻⁶ mbar
25
20
15
10
5
5
10
15
20
25
m
MBA 5137
MBA 5139
QF5141
MBB 5147
MBB 5149
QD5151
MBB
GAS INLET

FIG. 2

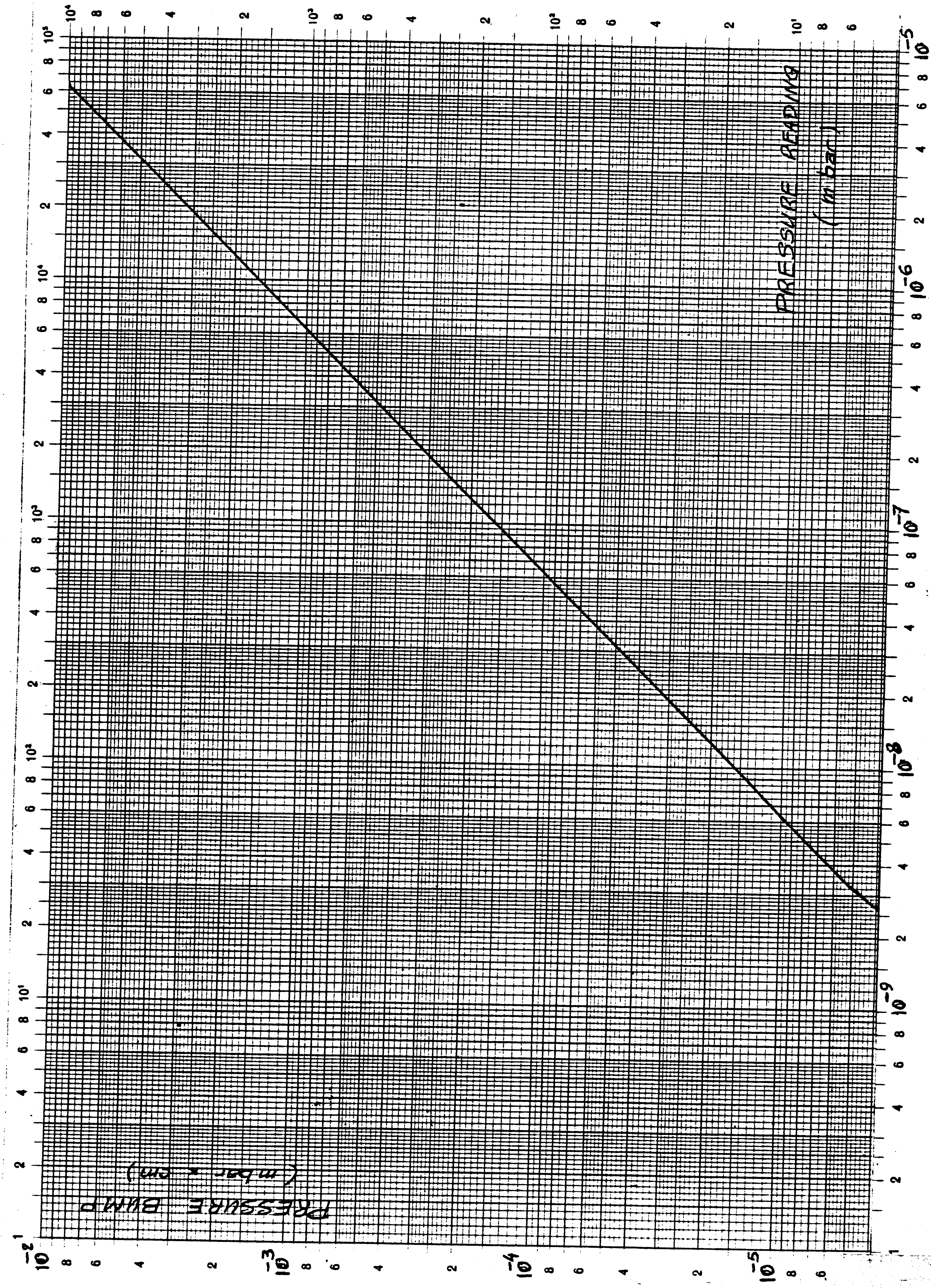


FIG. 3

UA4 - rates

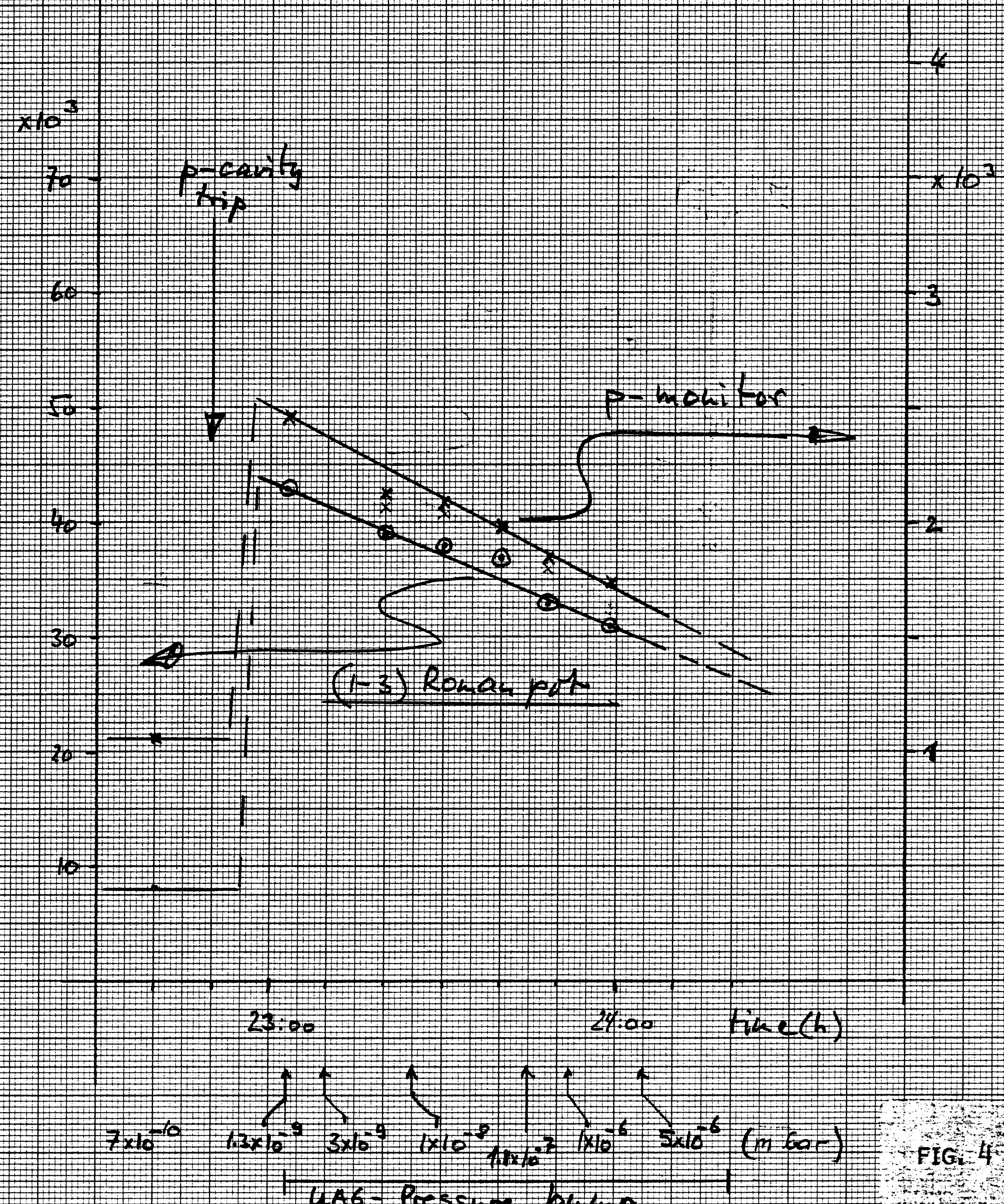


FIG. 4

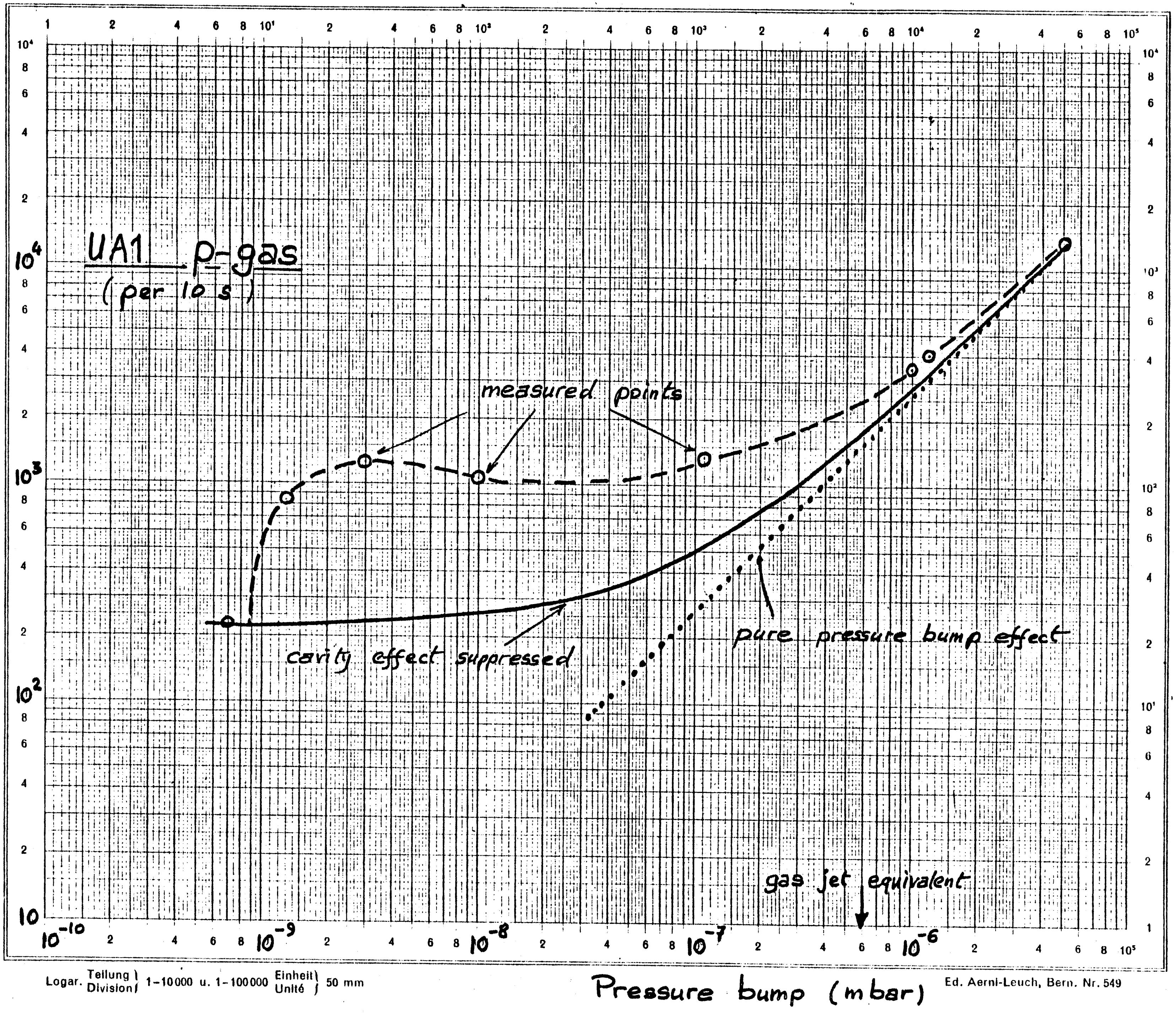
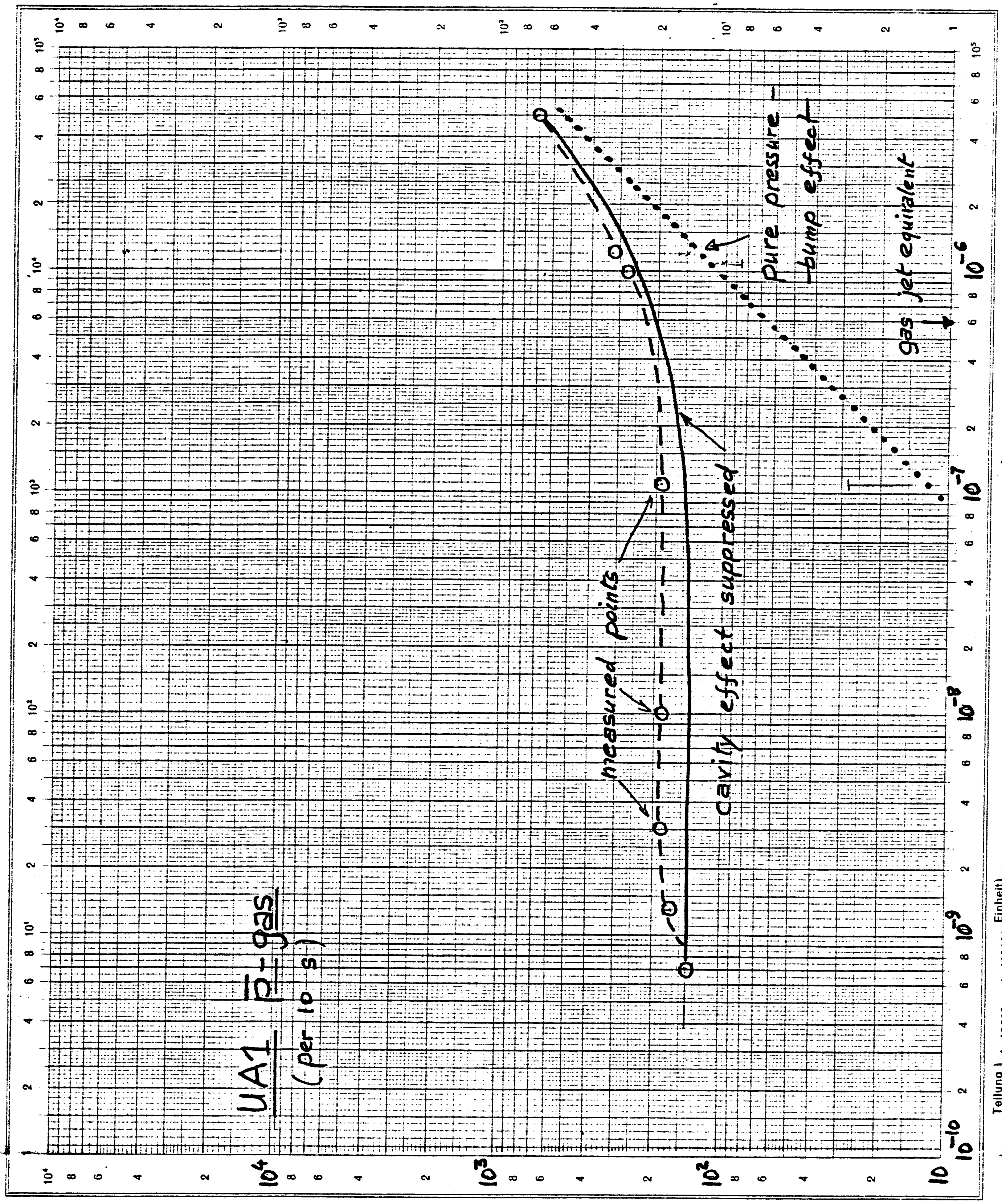

UA1 p-gas
(per 10 s)
measured points
cavity effect suppressed
pure pressure bump effect
gas jet equivalent
Pressure bump (mbar)
Logar. Teilung / Division 1-10000 u. 1-100000 Einheit / Unité 50 mm
Ed. Aerni-Leuch, Bern, Nr. 549

FIG. 5



UA1 p̄-gas
(per 10 s)
measured points
cavity effect suppressed
pure pressure bump effect
gas jet equivalent
Pressure bump (m bar)
10^-10
10^-9
10^-8
10^-7
10^-6
10
10^2
10^3
10^4
Ed. Aerni-Leuch, Bern. Nr. 549
Logar. Teilung / Division 1-10000 u. 1-100000 Einheit / Unité 50 mm

FIG. 6

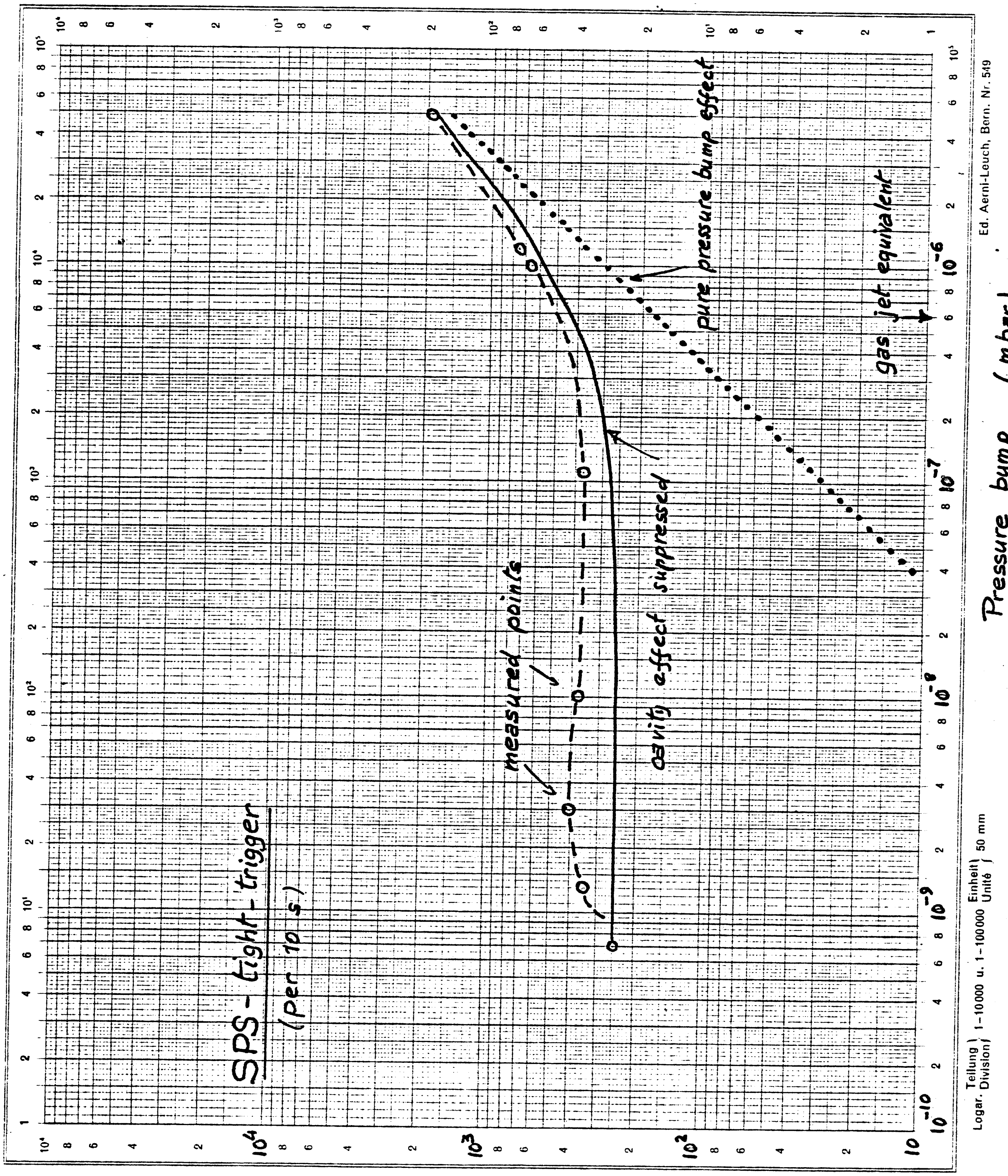
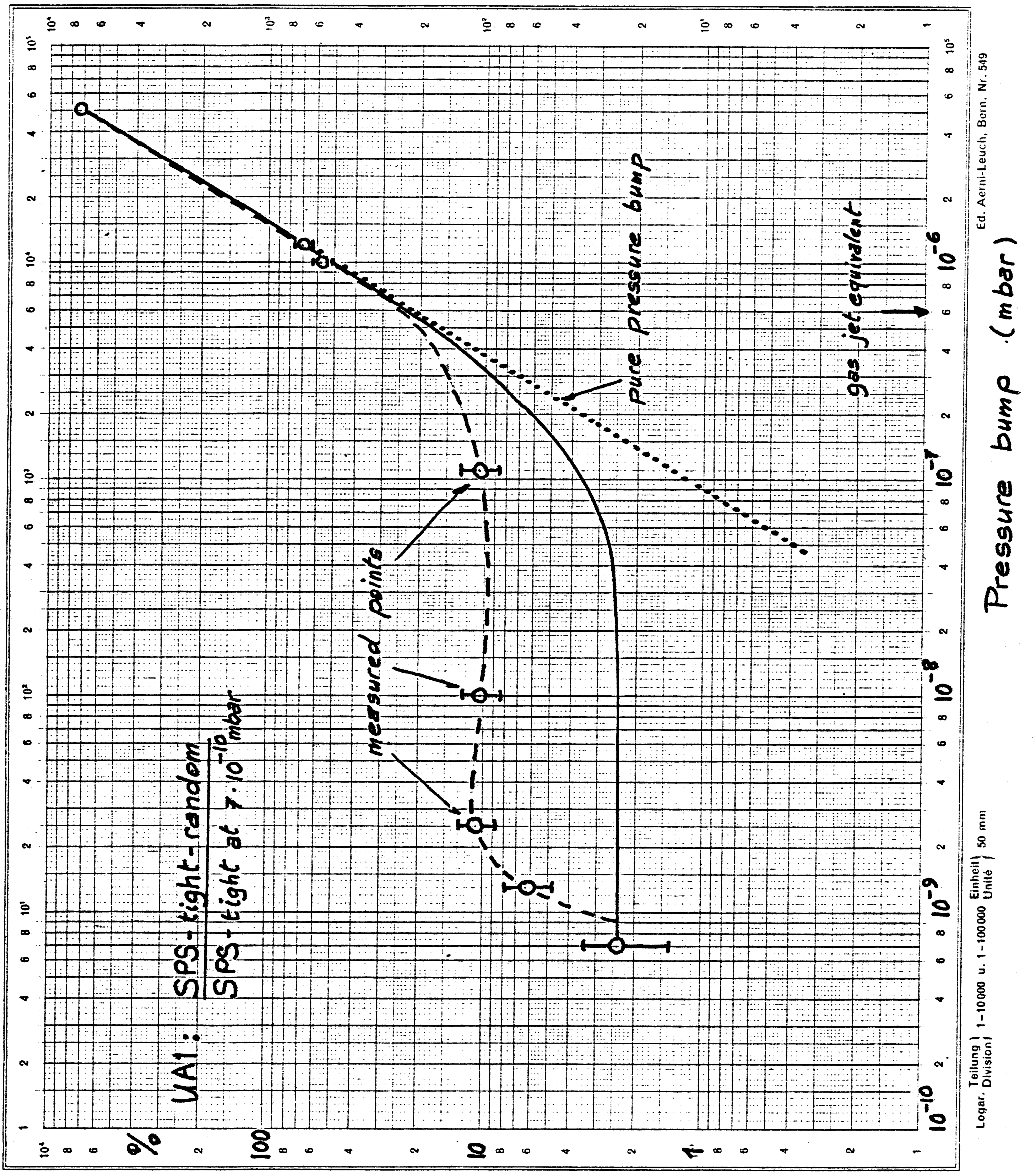

SPS - Light - trigger
(per 10 s)
measured points
cavity affect suppressed
pure pressure bump effect
gas jet equivalent
Pressure bump (mbar)
Ed. Aerni-Leuch, Bern. Nr. 549
Logar. Teilung / Division 1-10000 u. 1-100000 Einheit / Unité 50 mm

FIG. 7


UA1: SPS-tight-random / SPS-tight at 7·10⁻¹⁰ mbar
%
100
10
1
measured points
pure pressure bump
gas jet equivalent
Pressure bump (mbar)
10⁻¹⁰
10⁻⁹
10⁻⁸
10⁻⁷
10⁻⁶
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Logar. Teilung / Division 1-10000 u. 1-100000 Einheit / Unité 50 mm

FIG. 8