

SEB Extraction Study I - Calibrations of the Ring Loss Monitor (RLM) and the Secondary Emission Chamber (SEC) by Changing the Electrostatic Septum Position and Skew (H2OUS/DS)

E. Bleser

December 1986

Collider Accelerator Department
Brookhaven National Laboratory

U.S. Department of Energy

USDOE Office of Science (SC)

Notice: This technical note has been authored by employees of Brookhaven Science Associates, LLC under Contract No. DE-AC02-76CH00016 with the U.S. Department of Energy. The publisher by accepting the technical note for publication acknowledges that the United States Government retains a non-exclusive, paid-up, irrevocable, world-wide license to publish or reproduce the published form of this technical note, or allow others to do so, for United States Government purposes.

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or any third party's use or the results of such use of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

1/27/87

Number 219

AGS Studies Report

Date(s) December 17, 1986 Time(s) 0800 - 1600
Experimenter(s) E. Bleser, J.W. Glenn, M. Tanaka, R. Thern
Reported by M. Tanaka
Subject SEB Extraction Study I - Calibrations of the Ring
Loss Monitor (RLM) and the Secondary Emission
Chamber (SEC) by Changing the Electrostatic Septum
Position and Skew (H2OUS/DS)

I. Introduction

As the AGS beam intensity has been steadily increasing, a further improvement in SEB extraction efficiency is seriously under consideration in order to keep the activation of sensitive machine components during extraction as low as possible. In 1979 an electrostatic wire septum was installed at H20, resulting in an increase of the SEB extraction efficiency from 85% to 97%.

Since it is difficult to measure the absolute extraction efficiency, which is close to 100%, with high accuracy, the beam loss, i.e., the extraction inefficiency, is measured instead.¹ The purpose of this study is to measure the extraction inefficiency with the present H20 septum calibrating the RLM against the SEC.

II. SEC Sensitivity on the Beam Position

The beam spot (0.6 cm ϕ) on the CE011 flag was moved horizontally from the edge to edge (2.5 cm) by changing the F10 ejector current (F10FN) to check the so-called radiation induced aging effect. During the movement, the SEC response normalized to the circulating beam intensity (CBM), SEC/CBM, stayed constant at 8.14 ± 0.06 , showing no aging effect within an accuracy of $\pm 0.8\%$ level (Figure 1).

III. RLM/CBM vs SEC/CBM

To study the RLM response against the SEC reading, the beam loss during extraction was varied by changing H2OUS and/or H20DS. Results are summarized in the following figures:

A.(1) $CBM = 4.2 \times 10^{12}$ ppp

Figure 2a: SEC, RLM.../CBM vs H2OUS with H2ODS = 2043
(mils)*

Figure 2b: RLM/CBM vs SEC/CBM

*There was a minimum hardware limit of H2OUS = 1725.

(2) $CBM = 2.4 \times 10^{12}$ ppp

Figure 3a and 3b: the same except CBM*

*When learning that H2OLS (H2O loss monitor) was not functioning properly, CBM was reduced to protect the H2O septum from possible radiation damages.

- As H2OUS moves back and forth, SEC/CBM exhibits the so-called backlash effects as much as 10 counts (mils).
- Somehow the curves of RLM/CBM vs SEC/CBM display a substantial amount of hysteresis, which cannot be explained simply by the backlash effects.
- SEC/CBM dropped by 15% when CBM changed from 4.2 to 2.4×10^{12} ppp while RLM, F105L.../CBM did not show any strong CBM dependence.

It is not expected that there is any strong beam intensity dependence since SEC, RLM... are normalized to CBM.

- During this data taking, the CBM reading varied to to 18% pulse by pulse, indicating that the machine was not stabilized enough. In the figures, 5 to 10 pulse-average values are plotted to eliminate pulse-to-pulse variations.

B. The following data was taken when the beam intensity was rather stable with $CBM = (2.6 + 0.1) \times 10^{12}$ ppp.

Fig. 4a: SEC,RLM.../CBM vs H2ODS with H2OUS = 1773

Fig. 4b: RLM/CBM vs SEC/CBM

Fig. 5a: SEC,RLM.../CBM vs H2ODS with H2ODS = 1725

Fig. 5b: RLM/CBM vs SEC/CBM

Since the amount of hysteresis had been reduced significantly with the more stable beam, Fig. 4b and 5b are combined. Ignoring the hysteresis, a linear fit to the data gives $RLM/CBM = 13 - 1.9 \times SEC/CBM$, which yields a SEC calibration of 6.8 counts/ 10^{10} protons and a RLM calibration for beam loss to be 13 counts/ 10^{10} protons. At the optimum position of $H2OUS = 1725$ and $H2ODS = 2043$, the extraction (in)efficiency is estimated to be approximately 96(4)%.

IV. Spiral Pitch at H20

Fig. 6a shows SEC, RLM and $H2OLS/CBM$ as a function of $H2ODS$ with $H2OUS$ adjusted to minimize the $H2OLS$ at each point as shown in Fig. 6. From the figure, the spiral pitch or beam width can be measured to be 0.56 cm (0.22") as the distance between the dip in RLM around $H2ODS = 2040$ and the fall-off in $H2OLS$ near $H2ODS = 2260$.

Fig. 6a: SEC, RLM, $H2OLS$ vs $H2ODS$ with the optimum $H2OUS$ position which minimizes $H2OLS$ at each $H2ODS$ setting.

Fig. 6b: $H2OUS$ vs $H2ODS$

V. Conclusions

We attempted to calibrate the SEC and RLM, which have been used to measure the SEB extraction efficiency, by moving the H20 septum position and skew. The data indicate that at the optimum H20 position the extraction efficiency is in the vicinity of 96% and the spiral pitch at H20 is 0.56 cm, consistent with the previous measurements.²

However, it is unclear at this point to what extent the measured calibration factors are accurate and reliable because the data exhibit a strong beam intensity dependence, a large amount of hysteresis, pulse-to-pulse variations, and day-to-day variations without any change of the SEB parameters.

We later learned that the CBM timing trigger was set at 100 ms to T_0 , i.e., before the transition. For extraction efficiency measurements the XCBM (post transition CBM) with a timing trigger just before the extraction (780 ms) is a proper parameter. the use of XCBM has reduced pulse-to-pulse variations of $SEC/XCBM$ as shown in Fig. 7a and Fig. 7b. $CBM(100) \approx 1.1 \times XCBM(780)$.

For the next SEB extraction study, we plan to investigate the SEC and RLM responses on the beam intensity (XCBM), rather than playing with other SEB parameters like the F5 septum position and skew.

VI. References

1. J.W. Glenn and H. Weisberg, AGS Div. Tech. Note No. 133 (1977).
2. H. Weisberg and J.W. Glenn, Nucl. Inst. & Methods 169, 319 (1980).

mvh
TANAKA/STUDY

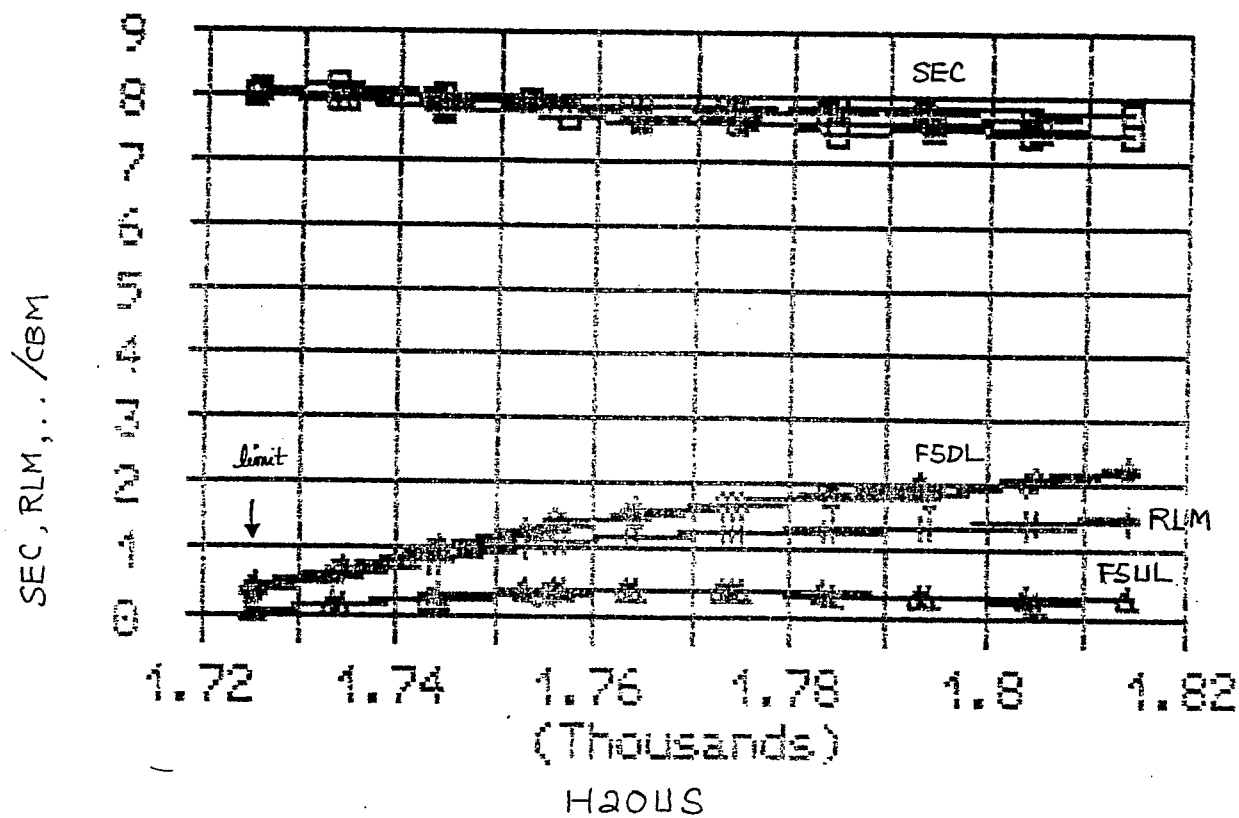


Fig. 2.a

$$CBM = 4.2 \times 10^{12} \text{ PPP}$$

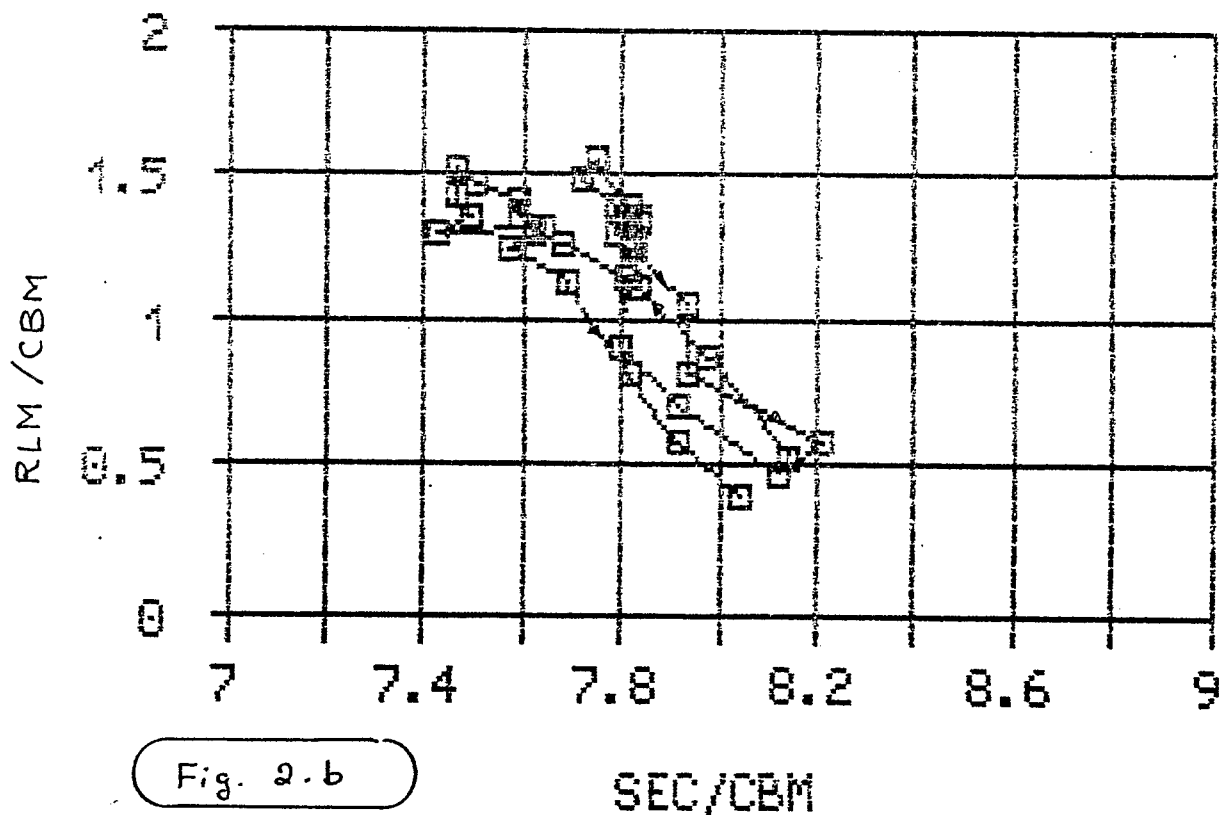
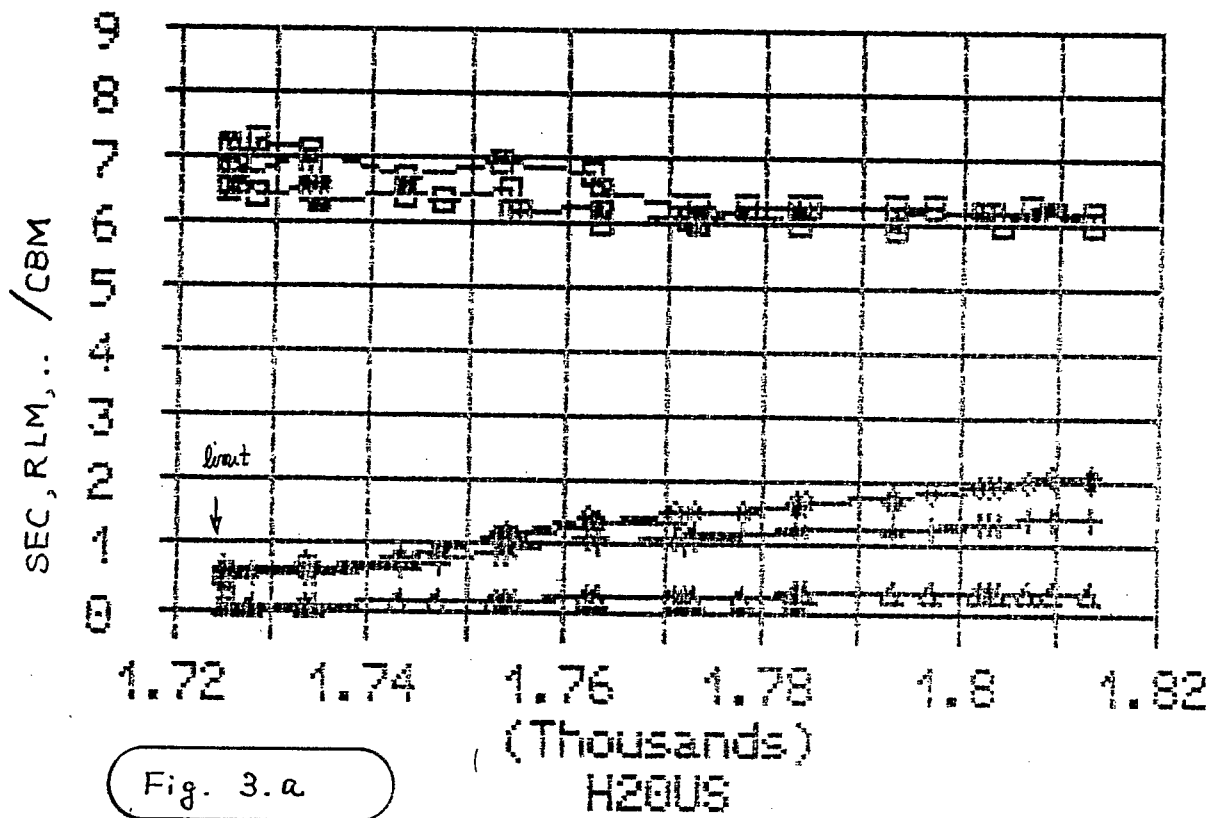
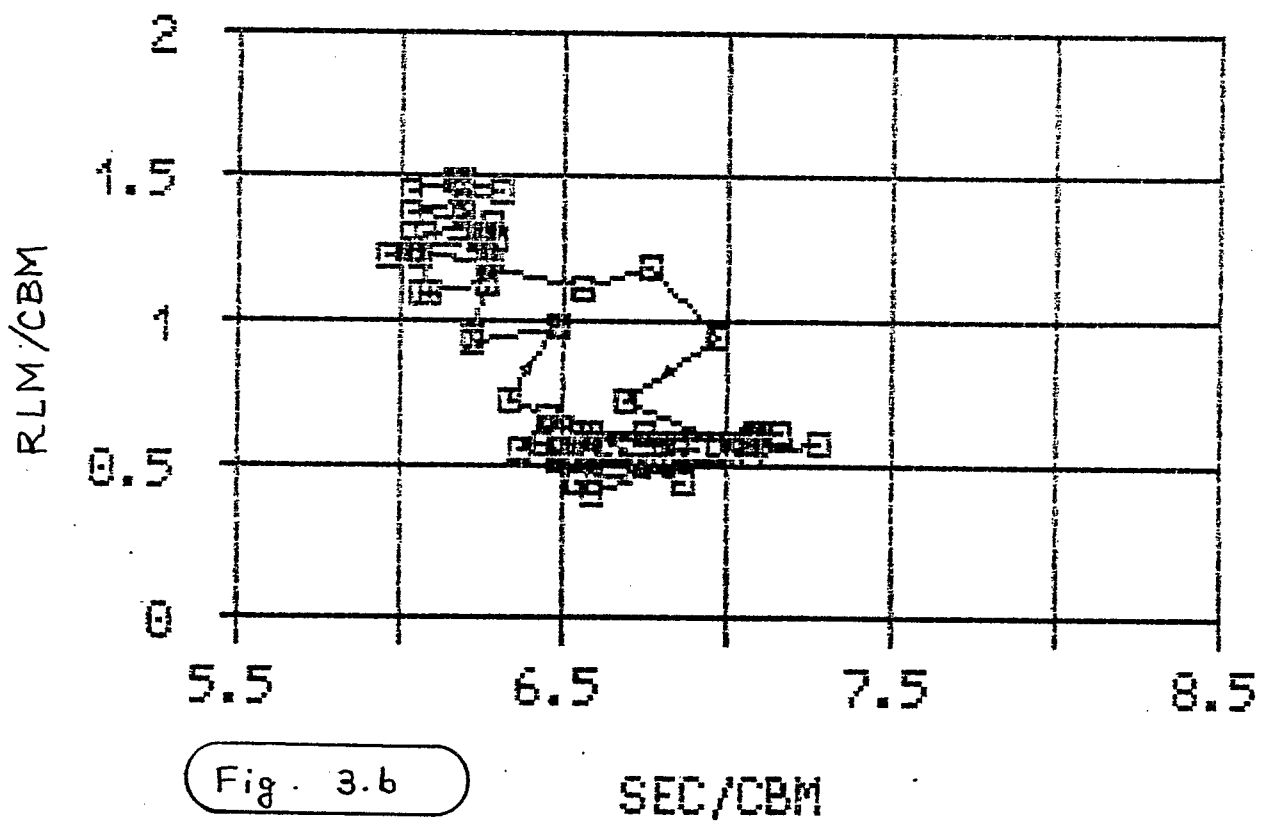


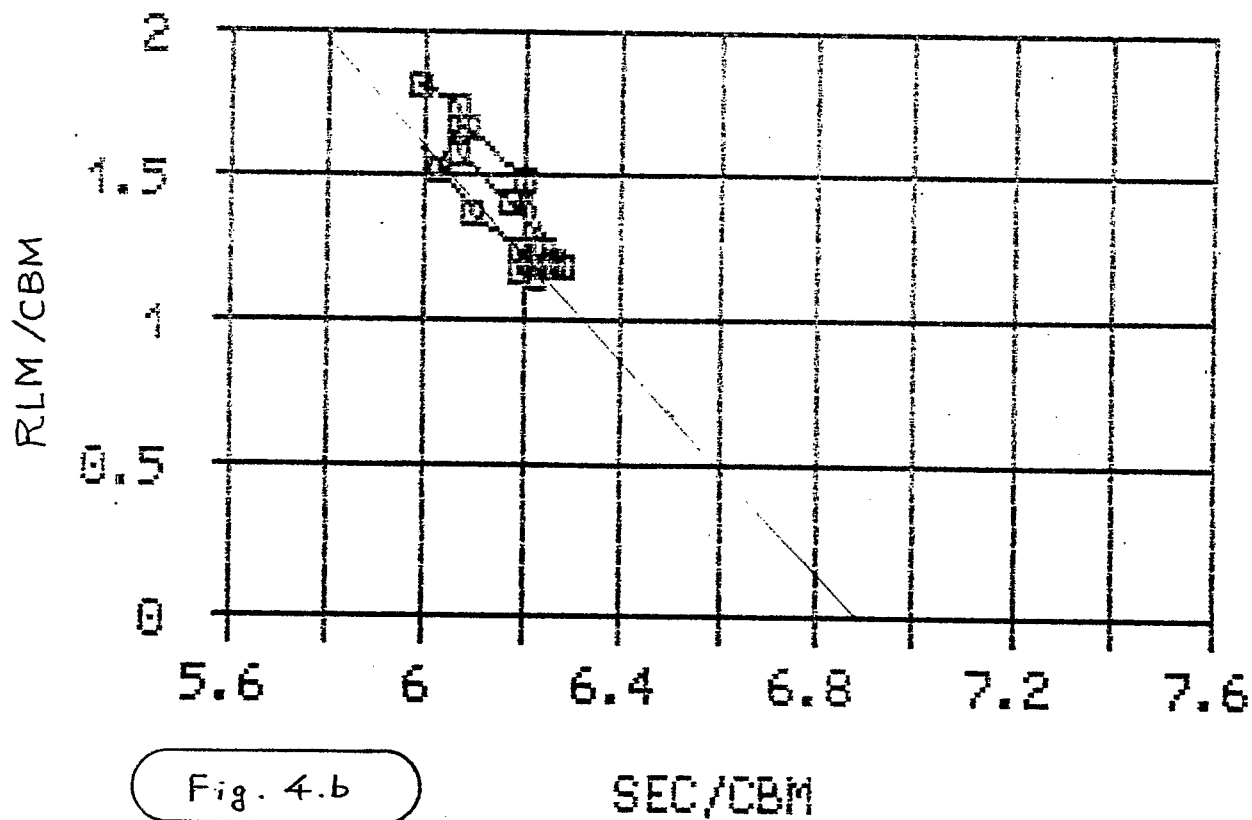
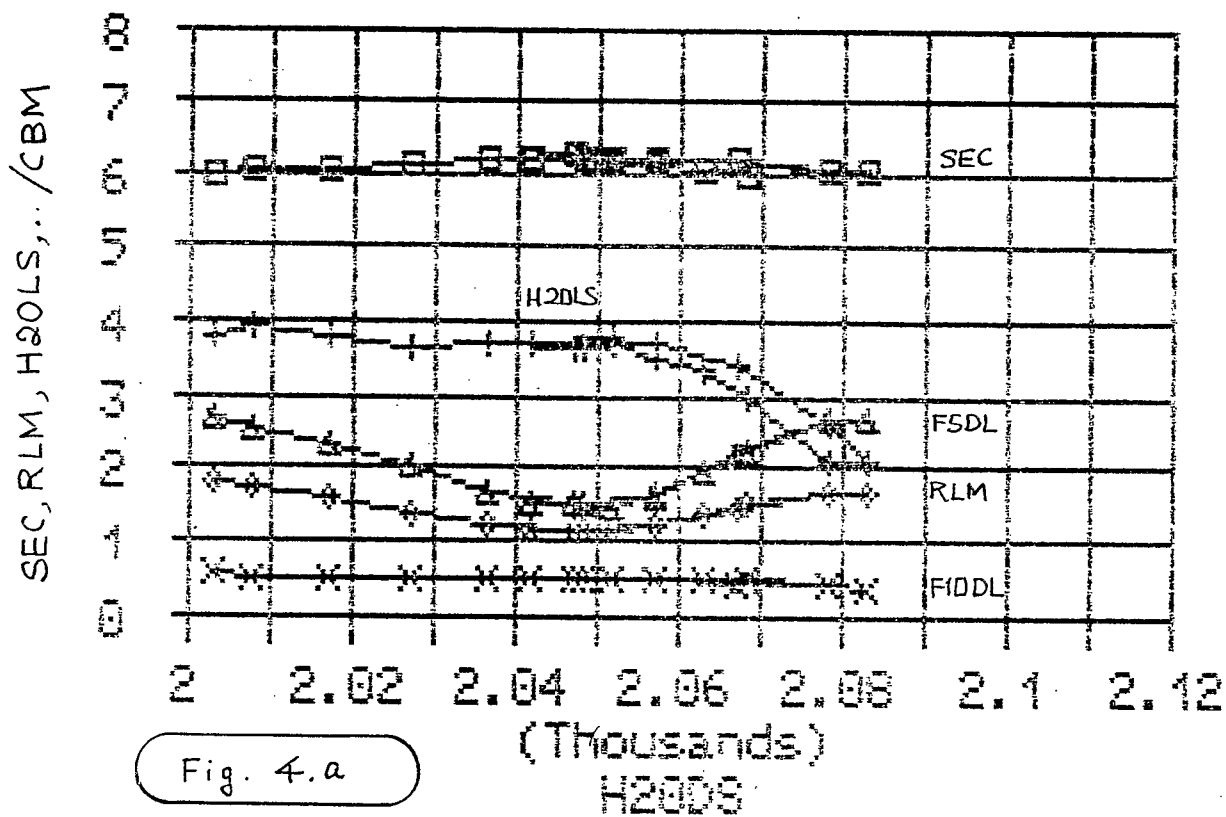
Fig. 2.b



$$CBM = 2.4 \times 10^{12} \text{ gpp}$$



at H2OUS=1773



at H2OUS=1725

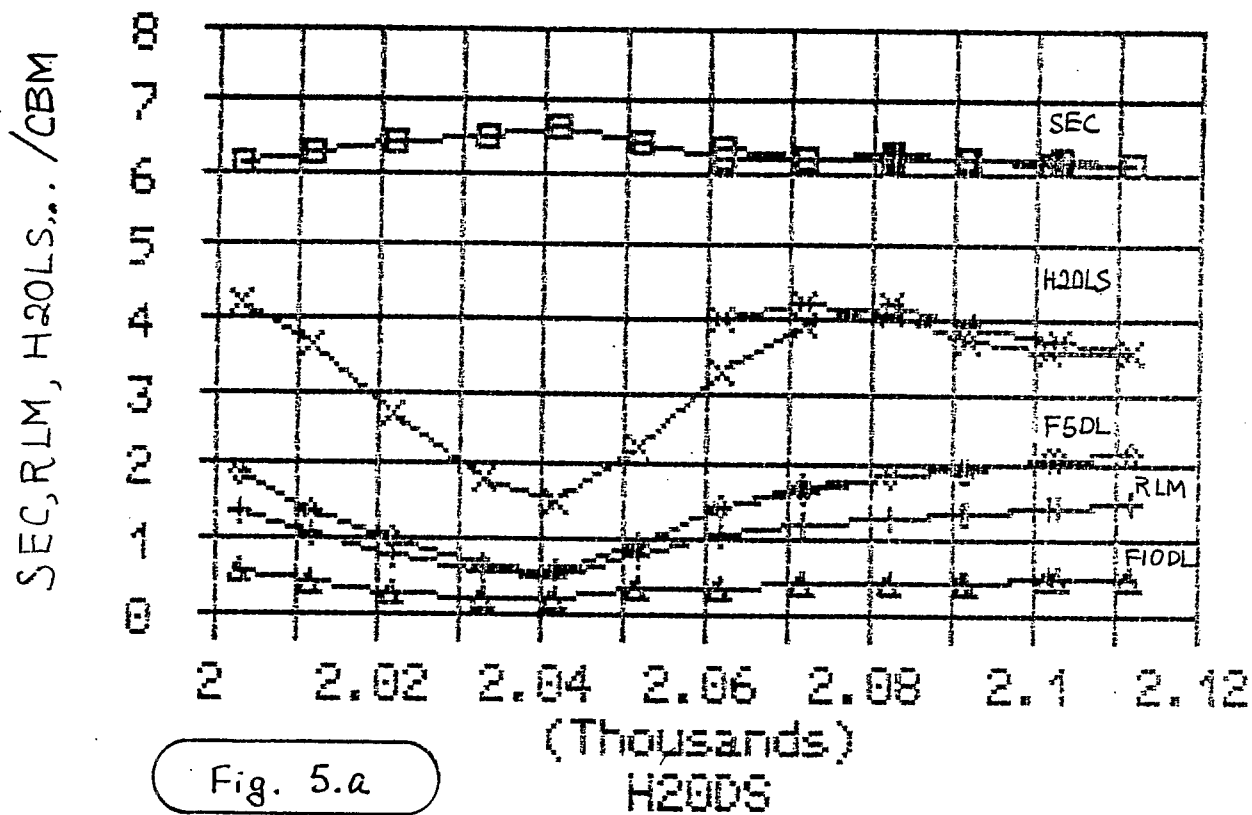


Fig. 5.a

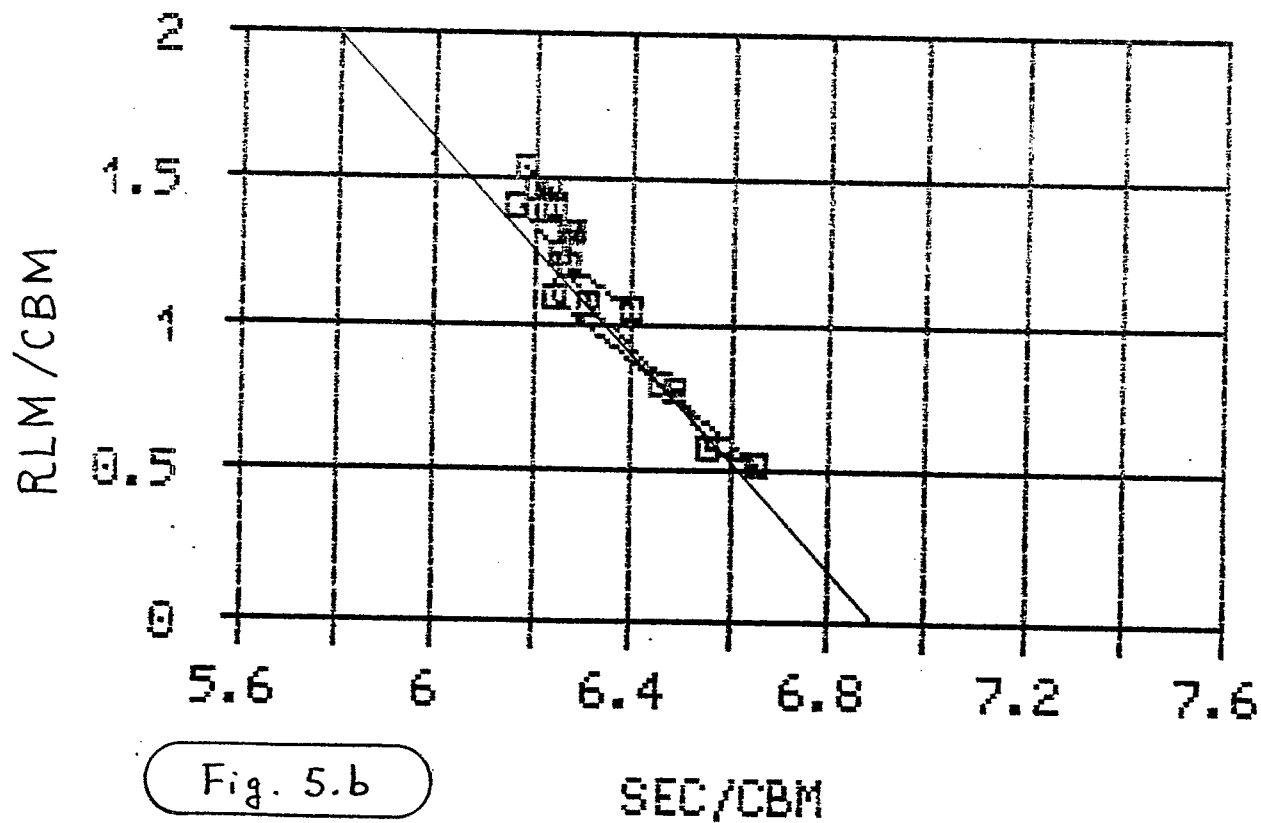
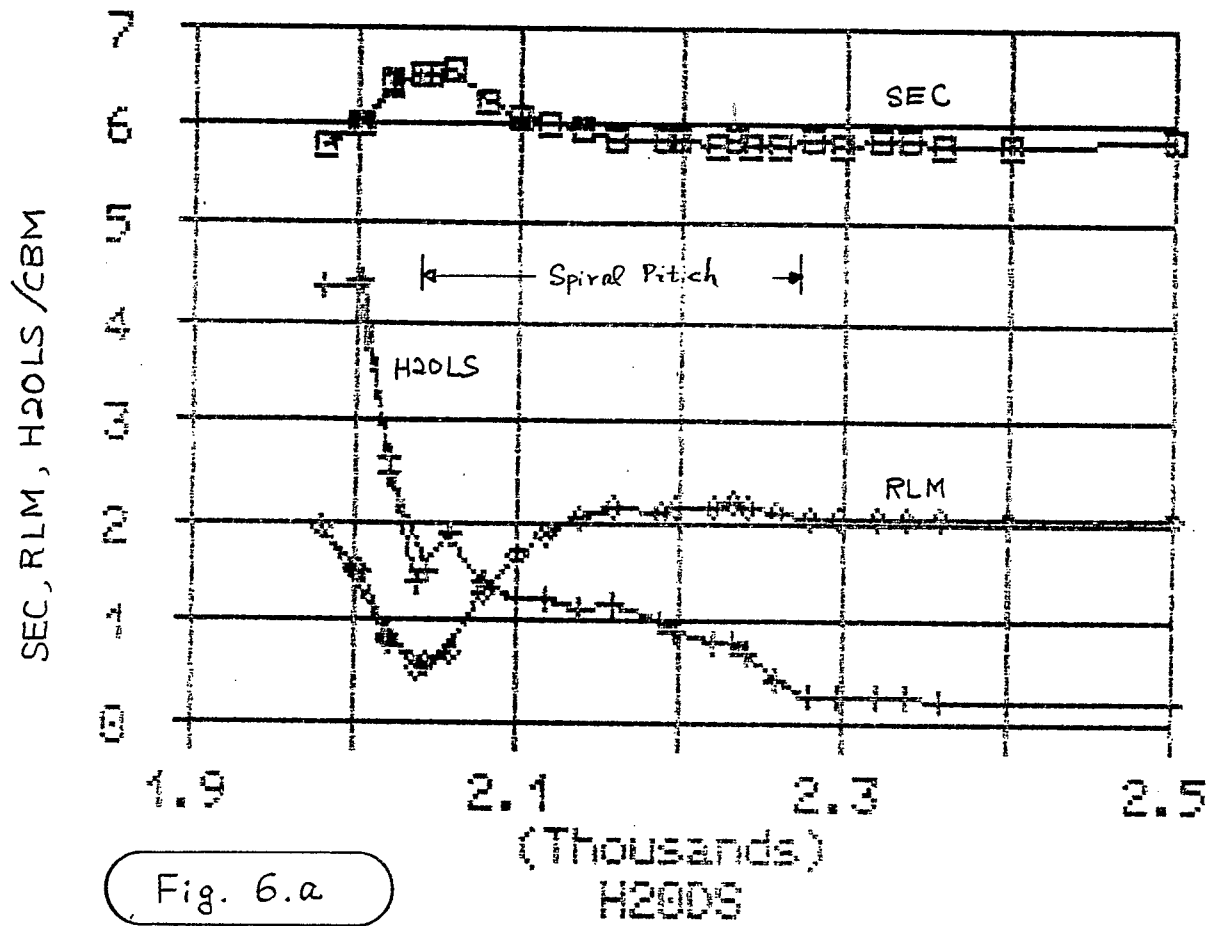
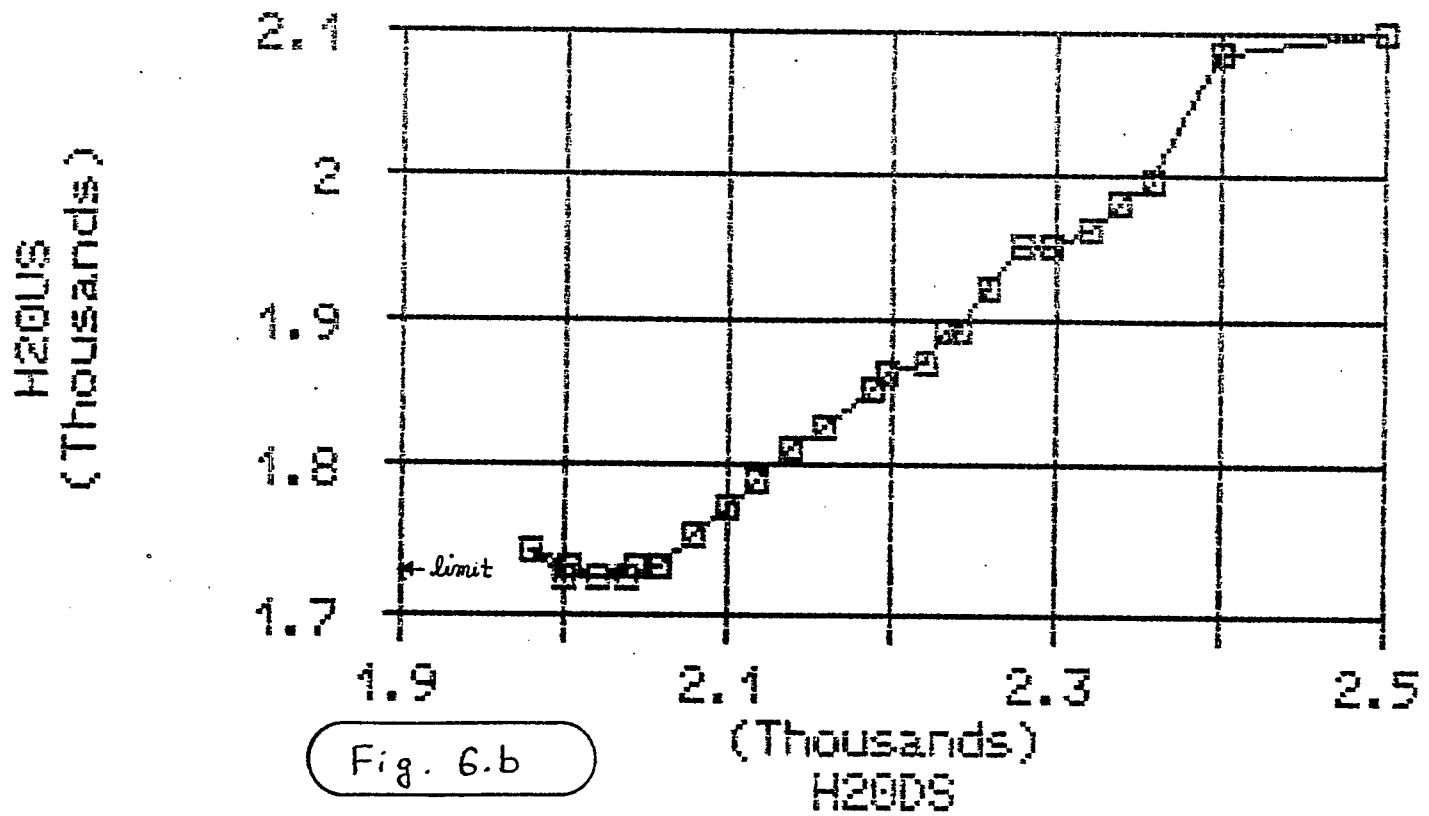


Fig. 5.b



with minimum H20LS



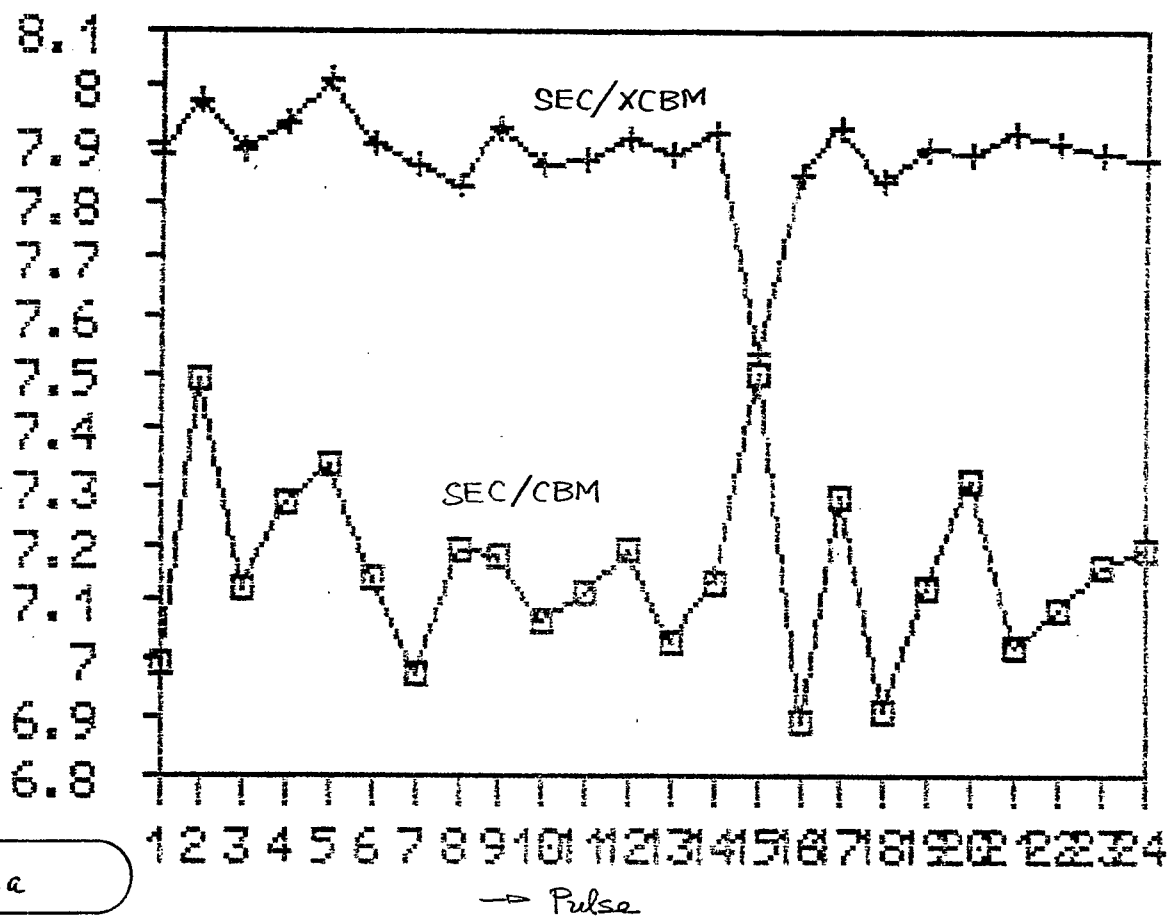


Fig. 7.a

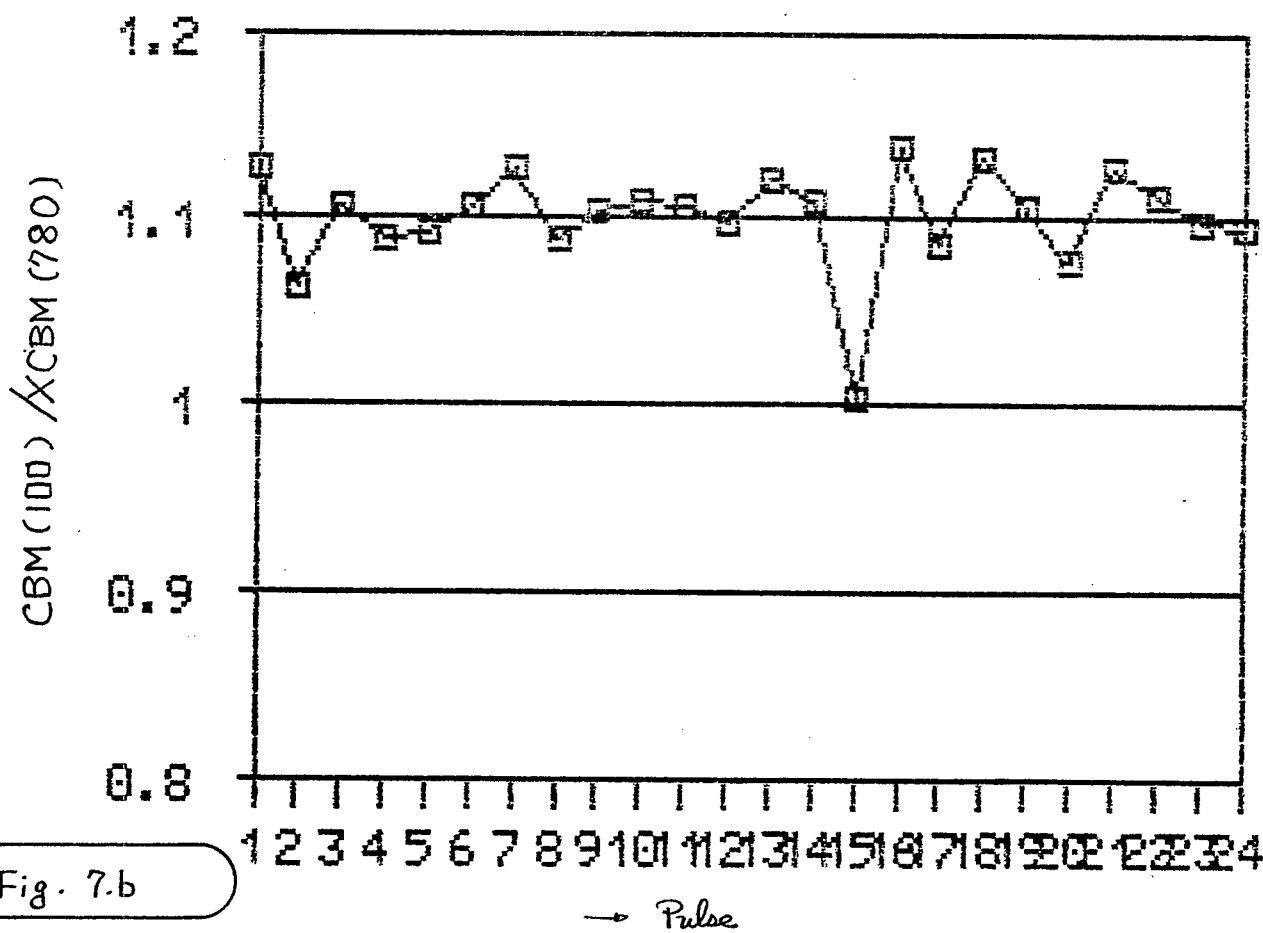


Fig. 7.b