LAMPIRAN

LAMPIRAN 1 Pengolahan Data Hasil Pengujian Impak Material Komposit

% Volume	l	d	A (mm2)	Energi impak (Em) (Joule)	Kekuatan Impak (Joule / m2)	Kekuatan Impak (Kilo Joule / m2)
15	12.15	9.2	111.78	2.4	21,470.75	21.47
	11.5	9.5	109.25	2.5	22,883.30	22.88
	12.4	8.5	105.4	2.5	23,719.17	23.72
	12.15	9.5	115.425	2.5	21,659.09	21.66
20	12.15	11	137.5	12	87,272.73	87.27
	13.4	10.5	140.7	8	56,858.56	56.86
	13	10.75	139.75	10	71,556.35	71.56
			-			
25	12.2	10.45	127.49	2.3	18,040.63	18.04
	12.2	10.25	125.05	8	63,974.41	63.97
	11.4	11	125.4	6	47,846.89	47.85
	11.4	10.09	124.26	4	32,190.57	32.19
30	12.15	12	145.8	6	41,152.26	41.15
	12	10	120	5.8	48,333.33	48.33
	12.75	11.75	159.8	6.3	39,424.28	39.42
			163.2	6.2	37,990.20	37.99
35	12.25	11	134.75	10	74,211.50	74.21
	12.27	12	152.4	12.5	82,021.00	82.02
	11	12	132	12	90,909.09	90.91
	12.5	11	137.5	10	72,727.27	72.73

Keterangan L : lebar spesimen
d : tebal di bawah takik
A: Luas di bawah takik

Penghitungan kekuatan Impak

$$I_r = \frac{E_m}{A} \qquad \textbf{(3.1)}$$

Keterangan:

I_r : Impat Resistance (J/m^2) A : Luas Penampang (m^2)

E_m : Energi impak pengukuran

LAMPIRAN 2 Pengolahah Data Hasil Pengujian Tekuk Material Komposit

2.1 Data Kekuatan Flexural

% Volume	d (mm)	L (mm)	b (m)	Beban (kg)	P (Newton)	Flexural strength (Mpa, N/mm^2))	XFs
15	3.5	56	25	26	254.8	69.888	1123.5
	3.5	56	25	26	254.8	69.888	
	3.5	56	25	28	274.4	75.264	
20	3.5	56	25	28	274.4	75.264	1605.1
	3.5	56	25	32	313.6	86.016	
	3.5	56	25	26	254.8	69.888	
25	4	64	25	38	372.4	89.376	2086.6
	4	64	25	38	372.4	89.376	
	4	64	25	32	313.6	75.264	
30	4	64	25	46	450.8	108.192	2434.3
	4	64	25	41	401.8	96.432	
	4	64	25	46	450.8	108.192	
35	4	64	25	62	607.6	145.824	3089.7
	4	64	25	42	411.6	98.784	
	4	64	25	55	539	129.36	

Perhitungan berdasarkan

$$\sigma_f = \frac{3PL}{2bd^2} \qquad \textbf{(3.4)}$$

Keterangan:

σ_f : Flexural strength (MPa) b : lebar spesimen (mm)

L : Support span (mm) d : tebal spesimen (mm)

P : Beban yang diberikan saat pengujian (N)

2.2 Plotting beban tekuk berdasarkan kurva hasil pengujian

% Volume	Load (Kg) on Depth Deformation of testing beam							
	0	1.25	2.5	3.75	5	6.25	7.5	8.75
15	0	4	8	12	15	19	24	26
	0	6	8	12	15	18	20	24
	0	4	8	11	15	18	21	12
20	0	4	8	12	15	19	24	6
	0	6	12	16	21	25	29	4
	0	6	12	18	23	15	12	4
25	0	8	16	22	28	32	36	16
	0	10	16	23	29	22	34	8
	0	8	14	20	22	28	20	8
30	0	8	16	26	33	44	16	10
	0	10	20	28	35	32	12	10
	0	8	16	24	30	32	40	10
35	0	12	24	36	45	54	62	20
	0	4	18	28	36	44	44	24
	0	12	22	30	38	44	50	24

Dari Lampiran 2.1 dan 2.2 dihitung berdasarkan persamaan 3.4 dan 3.5 maka akan didapat tabel tegangan regangan material komposit rami – poliester.

$$\sigma_f = \frac{3PL}{2bd^2} \qquad \textbf{(3.4)}$$

Keterangan:

σ_f : Flexural strength (MPa) b : lebar spesimen (mm)

L : Support span (mm) d : tebal spesimen (mm)

P : Beban yang diberikan saat pengujian (N)

$$\varepsilon_f = \frac{6Dd}{L^2} \qquad \textbf{(3.5)}$$

Keterangan : ε_f : Flexural strain (regangan)

D : Nilai deformasi maksimum pada span tengah.

2.3 Tabel Tegangan pada titik tegangan tertentu

% Volume	Nilai Tegangan pada titik regangan tertentu						
	0.008371	0.016741	0.025112	0.033482	0.045201	0.050223	0.055246
15	10.75	21.50	32.26	40.32	51.07	64.51	69.89
	16.13	21.50	32.26	40.32	48.38	53.76	64.51
	10.75	21.50	29.57	40.32	48.38	56.45	32.26
20	10.75	21.50	32.26	40.32	51.07	64.51	16.13
	16.13	32.26	43.01	56.45	67.20	77.95	10.75
	16.13	32.26	48.38	61.82	40.32	32.26	10.75
25	21.50	43.01	59.14	75.26	86.02	96.77	43.01
	26.88	43.01	61.82	77.95	59.14	91.39	21.50
	21.50	37.63	53.76	59.14	75.26	53.76	21.50
30	18.82	37.63	61.15	77.62	103.49	37.63	23.52
	23.52	47.04	65.86	82.32	75.26	28.22	23.52
	18.82	37.63	56.45	70.56	75.26	94.08	23.52
35	28.22	56.45	84.67	105.84	127.01	145.82	47.04
	9.41	42.34	65.86	84.67	103.49	103.49	56.45
	28.22	51.74	70.56	89.38	103.49	117.60	56.45

Setiap nilai dari tegangan pada titik regangan tertentu pada masing – masing fraksi volum dirata – ratakan sehingga mendapatkan hasil :

2.4 Tabel Stress strain flexural Rata – rata untuk setiap fraksi volum

% Volume	Nilai Tegangan pada Regangan tertentu (MPa)						
	0.008	0.017	0.025	0.033	0.045	0.050	0.055
15%	12.54	21.50	31.36	40.32	49.28	58.24	55.55
20%	14.34	28.67	41.22	52.86	52.86	58.24	37.63
25%	23.30	41.22	58.24	70.78	73.47	80.64	19.71
30%	20.38	40.77	61.15	76.83	84.67	60.93	12.54
35%	21.95	50.18	73.70	93.30	111.33	122.30	21.50

Tabel inilah yang menjadi data acuan untuk membuat grafik stress strain seperti tertera pada BAB V gambar 5.5

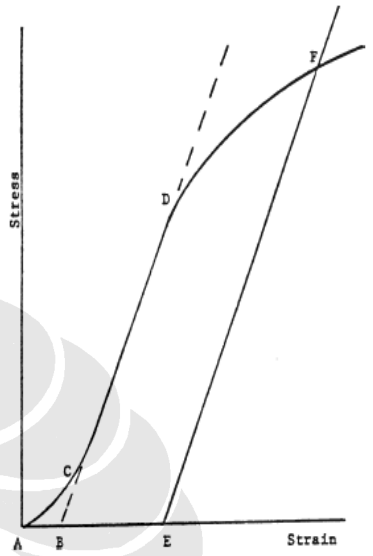
2.5 Penentuan elastic modulus flexural

Pada tabel 2.3 telah diketahui nilai tegangan pada setiap regangan. Untuk modulus elastisitas kita harus menentukan terlebih dahulu daerah lurus pada grafik stress dan strain. Dengan prinsip dibawah ini (ASTM D790)

A1.1 In a typical stress-strain curve (see Fig. A1.1) there is a toe region, *AC*, that does not represent a property of the material. It is an artifact caused by a takeup of slack and alignment or seating of the specimen. In order to obtain correct values of such parameters as modulus, strain, and offset yield point, this artifact must be compensated for to give the corrected zero point on the strain or extension axis.

A1.2 In the case of a material exhibiting a region of Hookean (linear) behavior (see Fig. A1.1), a continuation of the linear *(CD)* region of the curve is constructed through the zero-stress axis. This intersection *(B)* is the corrected zero-strain point from which all extensions or strains must be measured, including the yield offset *(BE)*, if applicable. The elastic modulus can be determined by dividing the stress at any point along the Line *CD* (or its extension) by the strain at the same point (measured from Point *B*, defined as zero-strain).

A1.3 In the case of a material that does not exhibit any linear region (see Fig. A1.2), the same kind of toe correction of the zero-strain point can be made by constructing a tangent to the maximum slope at the inflection Point *H'*. This is extended to intersect the strain axis at Point *B'*, the corrected zero-strain



NOTE—Some chart recorders plot the mirror image of this graph.

FIG. A1.1 Material with Hookean Region

Berdasakan A1.2 ditentukan daerah regangan yang akan dijadikan patokan untuk menentukan nilai flexural adalah pada saat regangan 2.5 % dan B = pada saat regangan 0.8 %, dari sini kita bisa menghitung nilai m yang akan digunakan pada persamaan :

$$E_B = \frac{L^3 m}{4bd^3} \qquad \textbf{(3.6)}$$

Keterangan :

E_B : Modulus elastisitas Tekuk (Mpa) d : Tebal spesimen

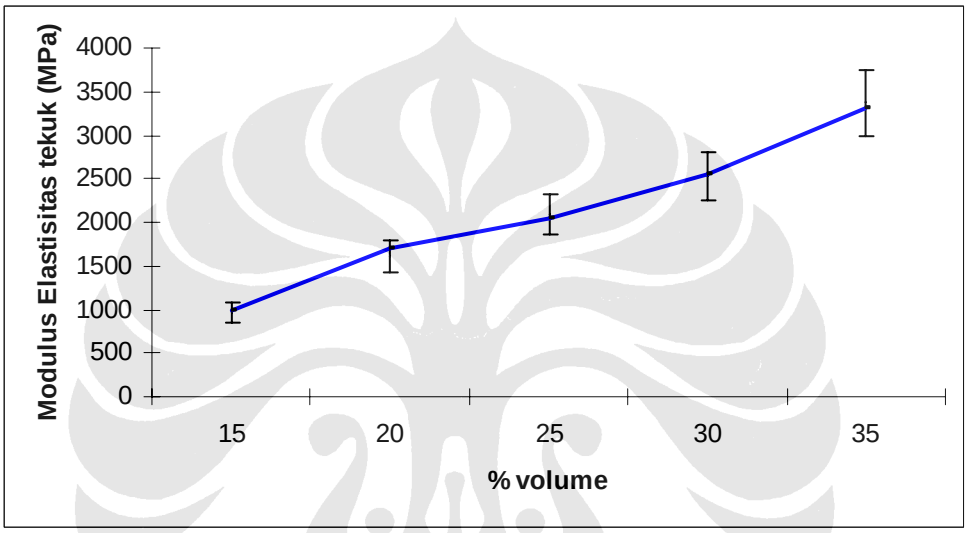
L : Support span (mm) b : Lebar spesimen

m : kemiringan kurva tegangan-regangan

Akhirnya didapat nilai modulus elastisitas rata – rata untuk tiap fraksi volum penambahan seperti pada tabel dibawah :

Tabel nilai Modulus elastisitas tekuk material komposit rami poliester.

	Besar modulus pada masing – masing frraksi volum				
	15	20	25	30	35
Sample 1	1284.051	1284.051	2247.089	2527.975	3370.634
Sample 2	963.0382	1605.064	2086.583	2527.975	3370.634
Sample 3	1123.545	1926.076	2150	2247.089	2900



Grafik modulus Elastisitas tekuk material komposit rami – Poliester

LAMPIRAN 3 Pengolahan Data hasil Pengujian Tekuk Material Komposit

3.1 Tabel Kekuatan tekan material komposit

% **Volume**	T (mm)	W (mm)	PC (Kg)	FC (Newton)	σ_c (MPa)	Xc (MPa)
15	6.3	12.7	376	3684.8	46.05424	44.24114
	6.4	12.7	316	3096.8	38.10039	
	6.8	12.7	428	4194.4	48.56878	
20	7.8	12.7	425	4165	42.04523	44.61328
	8	12.7	485	4753	46.7815	
	7.8	12.7	455	4459	45.01312	
25	6.5	12.7	355	3479	42.14416	45.38965
	6.5	12.7	370	3626	43.92489	
	6.7	12.7	435	4263	50.09989	
30	8	12.7	840	8232	81.02362	78.53718
	7.5	12.7	715	7007	73.5643	
	8	12.7	840	8232	81.02362	
35	10.1	12.7	1120	10976	85.5695	80.21646
	10.3	12.7	1040	10192	77.91453	
	10.2	12.7	1020	9996	77.16535	

Keterangan w : lebar specimen, T =tebal spesimen, sedangkan panjang spesimen sama semuanya yaitu 70 mm.

Nilai σ_c didapatkan dari persamaan dibawah ini

$$\sigma_c = \frac{F_c}{A} \qquad \textbf{(3.2)}$$

Keterangan :

σ_c : Compressive strength (MPa)

Fc : Beban Tekan (Newton)

A : Luas penampang terkecil specimen (mm^2)

Sedangkan Strain bisa didapatkan dengan persamaan

$$\varepsilon = \frac{l_i - l_0}{l_0} = \frac{\Delta l}{l_0} \qquad \textbf{(3.3)}$$

Keterangan: ε : Regangan (mm/mm) l_o : Panjang awal (mm)

l_i : Deformasi(mm) Δl : Pertambahan panjang (mm)

3.2 Plotting beban tekan berdasarkan kurva hasil pengujian

% Volume	Load (Kg) on Deformation of testing beam							
	0.5	1	1.5	2	2.5	3	3.5	4
15	40	87	240	320	380	320	255	51
	44	120	240	302	382	316	269	87
	40	120	240	340	420	360	300	100
20	100	200	210	390	425	300	150	100
	100	180	310	410	460	480	320	230
	70	120	210	320	410	460	320	200
25	70	120	220	330	360	320	200	100
	80	150	260	370	350	290	230	170
	60	150	300	400	430	300	190	130
30	50	180	300	560	800	840	550	400
	60	100	360	570	600	300	210	160
	80	250	400	700	840	600	480	450
35	80	180	400	660	600	1060	1120	700
	160	540	840	1000	1040	800	700	600
	100	300	500	700	900	1000	800	450

Untuk menghitung strain dan stress digunakan persamaan **3.3.** dan **3.2** diatas sehingga didapat tabel tegangan regangan tekan dibawah ini :

3.3 Tabel nilai tegangan dan regangan pada berdasarkan plotting hasil pengujian tekan

% Volume	Nilai Tegangan pada regangan tertentu							
	0.00714	0.01429	0.02143	0.02857	0.03571	0.04286	0.05000	0.05714
15	4.7	10.3	28.5	38.0	45.1	38.0	30.3	6.1
	5.2	14.2	28.5	35.9	45.3	37.5	31.9	10.3
	4.7	14.2	28.5	40.4	49.9	42.7	35.6	11.9
20	11.9	23.7	24.9	46.3	50.5	35.6	17.8	11.9
	11.9	21.4	36.8	48.7	54.6	57.0	38.0	27.3
	8.3	14.2	24.9	38.0	48.7	54.6	38.0	23.7
25	8.3	14.2	26.1	39.2	42.7	38.0	23.7	11.9
	9.5	17.8	30.9	43.9	41.6	34.4	27.3	20.2
	7.1	17.8	35.6	47.5	51.0	35.6	22.6	15.4
30	5.9	21.4	35.6	66.5	95.0	99.7	65.3	47.5
	7.1	11.9	42.7	67.7	71.2	35.6	24.9	19.0
	9.5	29.7	47.5	83.1	99.7	71.2	57.0	53.4
35	9.5	21.4	47.5	78.4	71.2	125.8	133.0	83.1
	19.0	64.1	99.7	118.7	123.5	95.0	83.1	71.2
	11.9	35.6	59.4	83.1	106.8	118.7	95.0	53.4

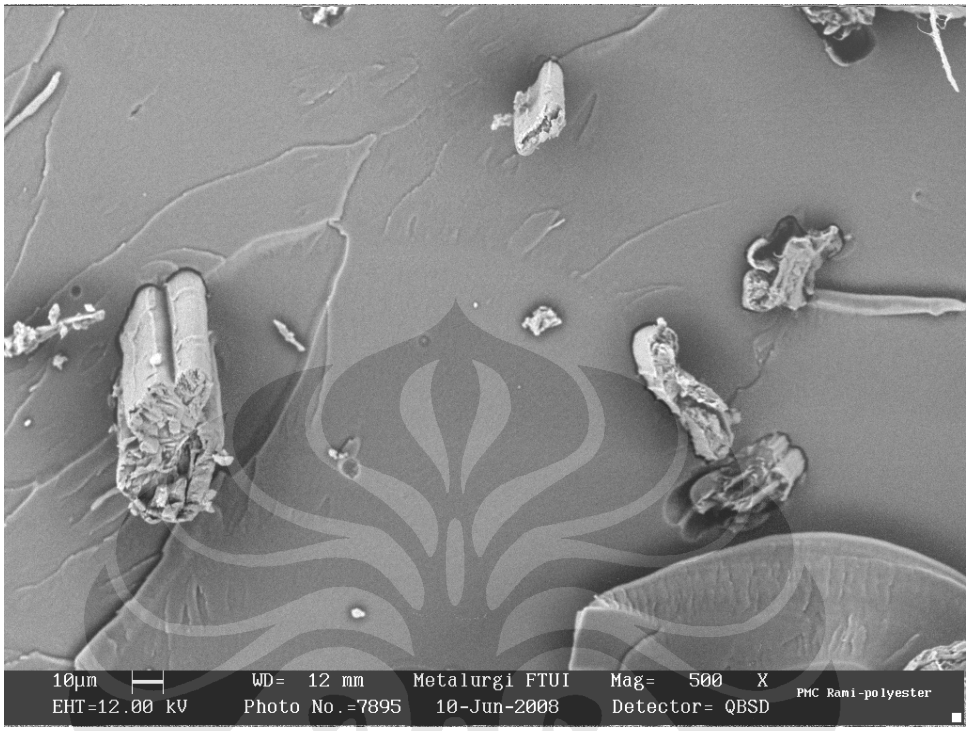
Setiap nilai dari tegangan pada titik regangan tertentu pada masing – masing fraksi volum dirata – ratakan sehingga mendapatkan hasil :

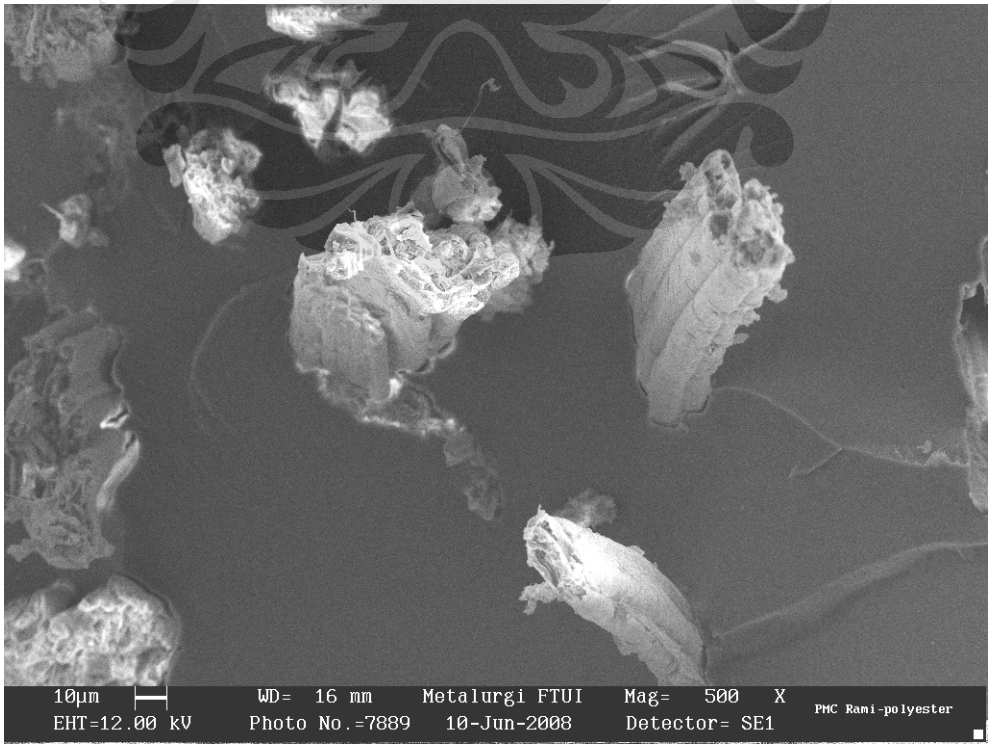
3.4 Tabel Stress strain tekan Rata – rata untuk setiap fraksi volum

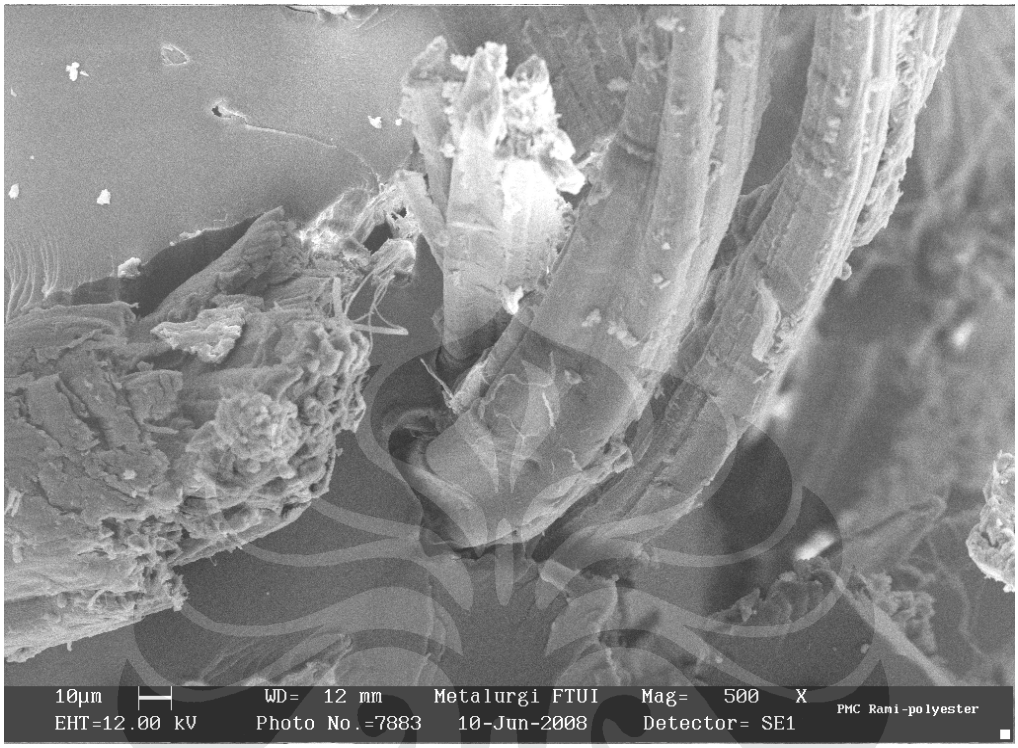
% Volume	Nilai Tegangan pada Regangan tertentu (MPa)						
	0	0.007	0.014	0.021	0.029	0.036	0.043
15%	0	4.91	12.94	28.49	38.07	46.77	39.41
20%	0	10.68	19.79	28.89	44.32	51.25	49.07
25%	0	8.31	16.62	30.87	43.53	45.11	36.01
30%	0	7.52	20.97	41.95	72.42	88.64	68.86
35%	0	13.45	40.36	68.86	93.39	100.51	113.18

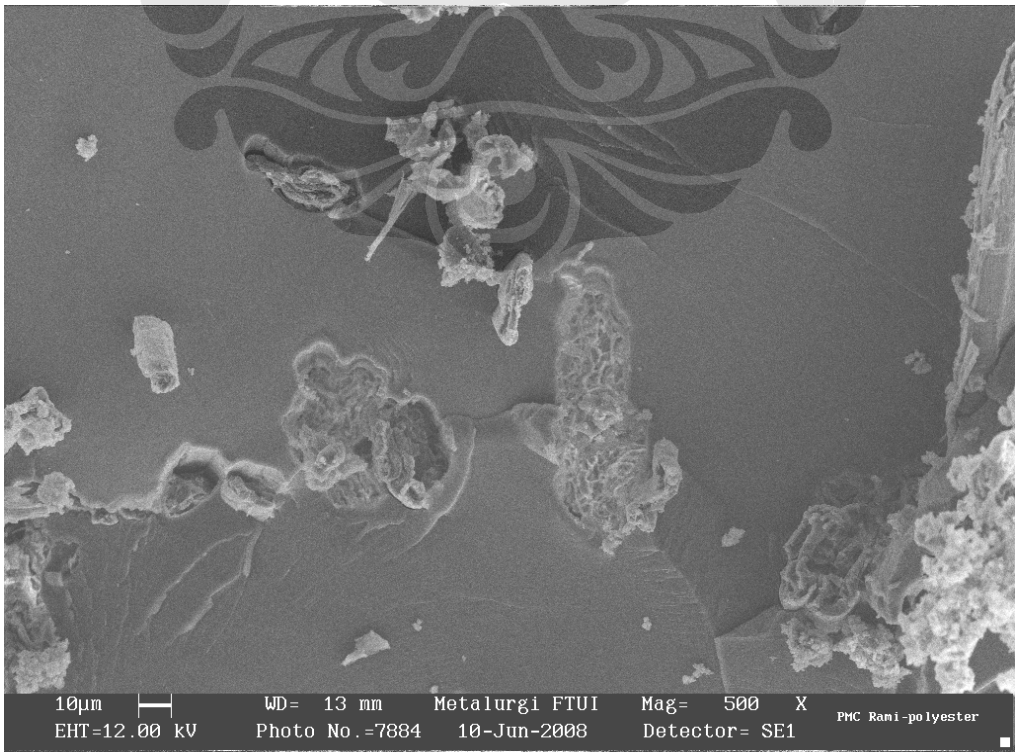
LAMPIRAN 4 Data Hasil Struktur Mikro Dengan SEM Dan EDS

4.1 Data hasil Sturktur mikro menggunakan SEM

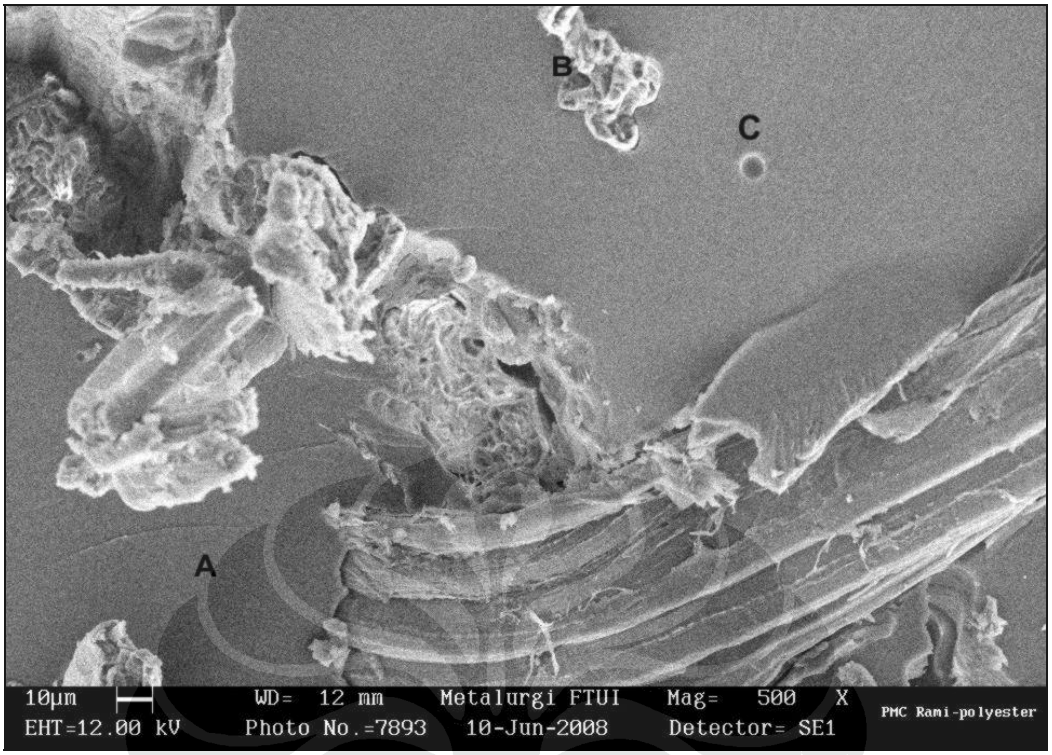




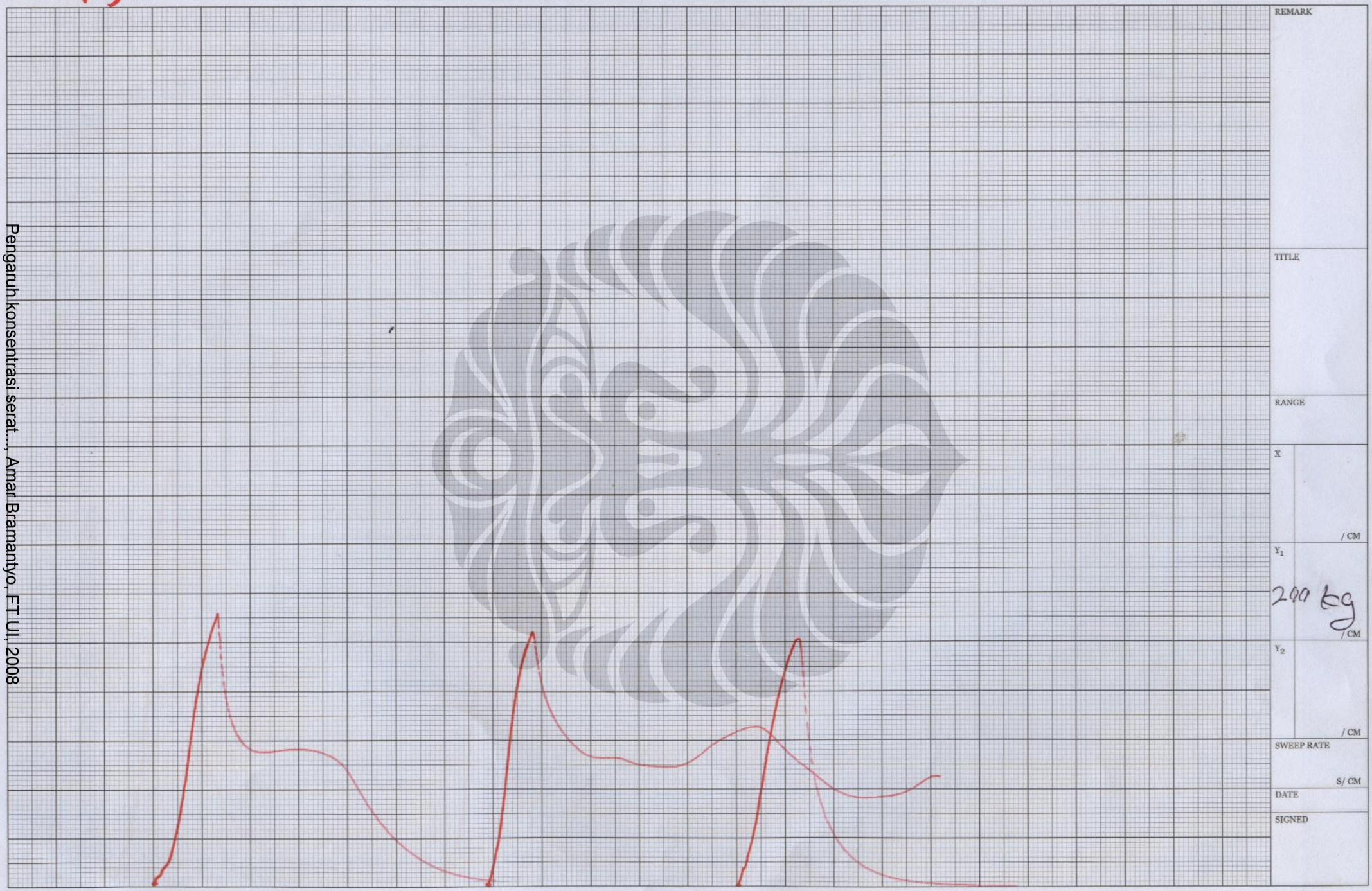




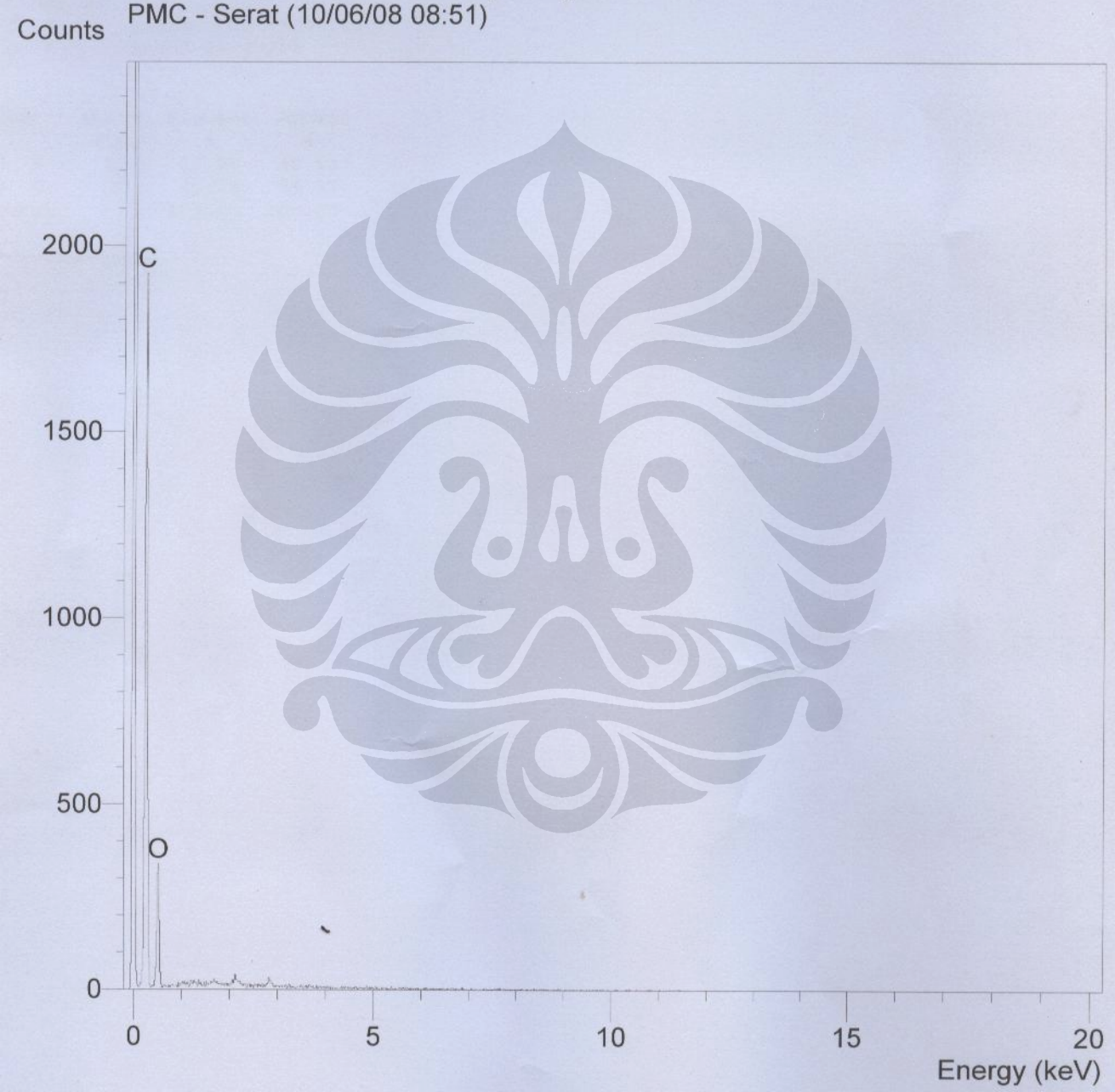
4.2 Data pengamatan struktur mikro dengan EDS



TS



Operator : jaya
Client : Dept. Metalurgi dan Material Universitas Indonesia
Job : Energy Dispersive X-Ray Analysis
PMC - Serat (10/06/08 08:51)



SEMQuant results. Listed at 08:53:48 on 10/06/08
Operator: jaya
Client: Dept. Metalurgi dan Material Universitas Indonesia
Job: Energy Dispersive X-Ray Analysis
Spectrum label: PMC - Serat

System resolution = 59 eV

Quantitative method: ZAF (3 iterations).
Analysed all elements and normalised results.

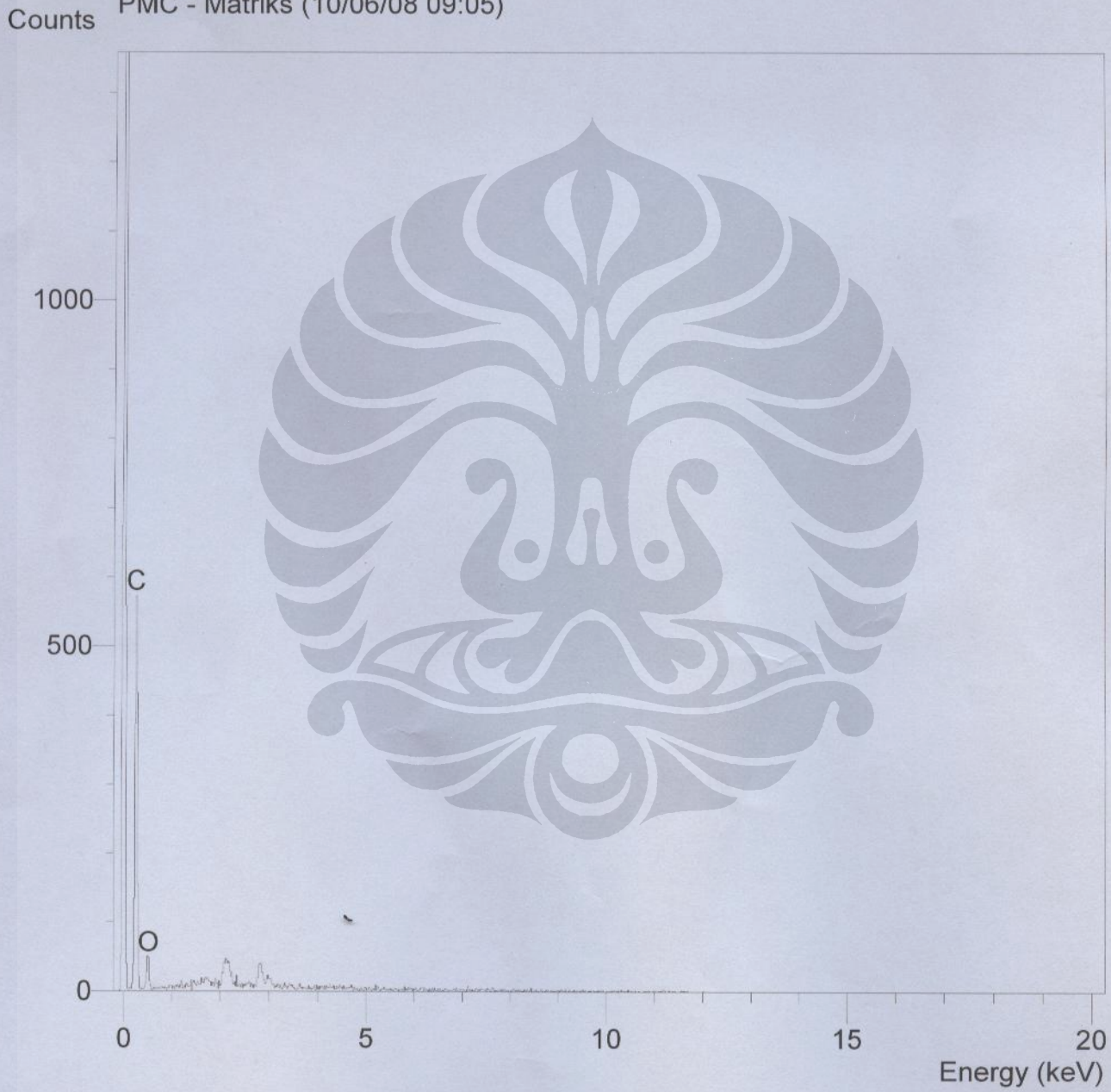
2 peaks possibly omitted: 2.14, 2.84 keV

Standards :
C K Carbon Low 13/09/06
O K AL2O3 22/03/06

Elmt	Spect. Type	Element %	Atomic %
C K	ED	33.94	40.63
O K	ED	66.06	59.37
Total		100.00	100.00

* = <2 Sigma

Operator : jaya
Client : Dept. Metalurgi dan Material Universitas Indonesia
Job : Energy Dispersive X-Ray Analysis
PMC - Matriks (10/06/08 09:05)



SEMQuant results. Listed at 09:06:50 on 10/06/08
Operator: jaya
Client: Dept. Metalurgi dan Material Universitas Indonesia
Job: Energy Dispersive X-Ray Analysis
Spectrum label: PMC - Matriks

System resolution = 59 eV

Quantitative method: ZAF (2 iterations).
Analysed all elements and normalised results.

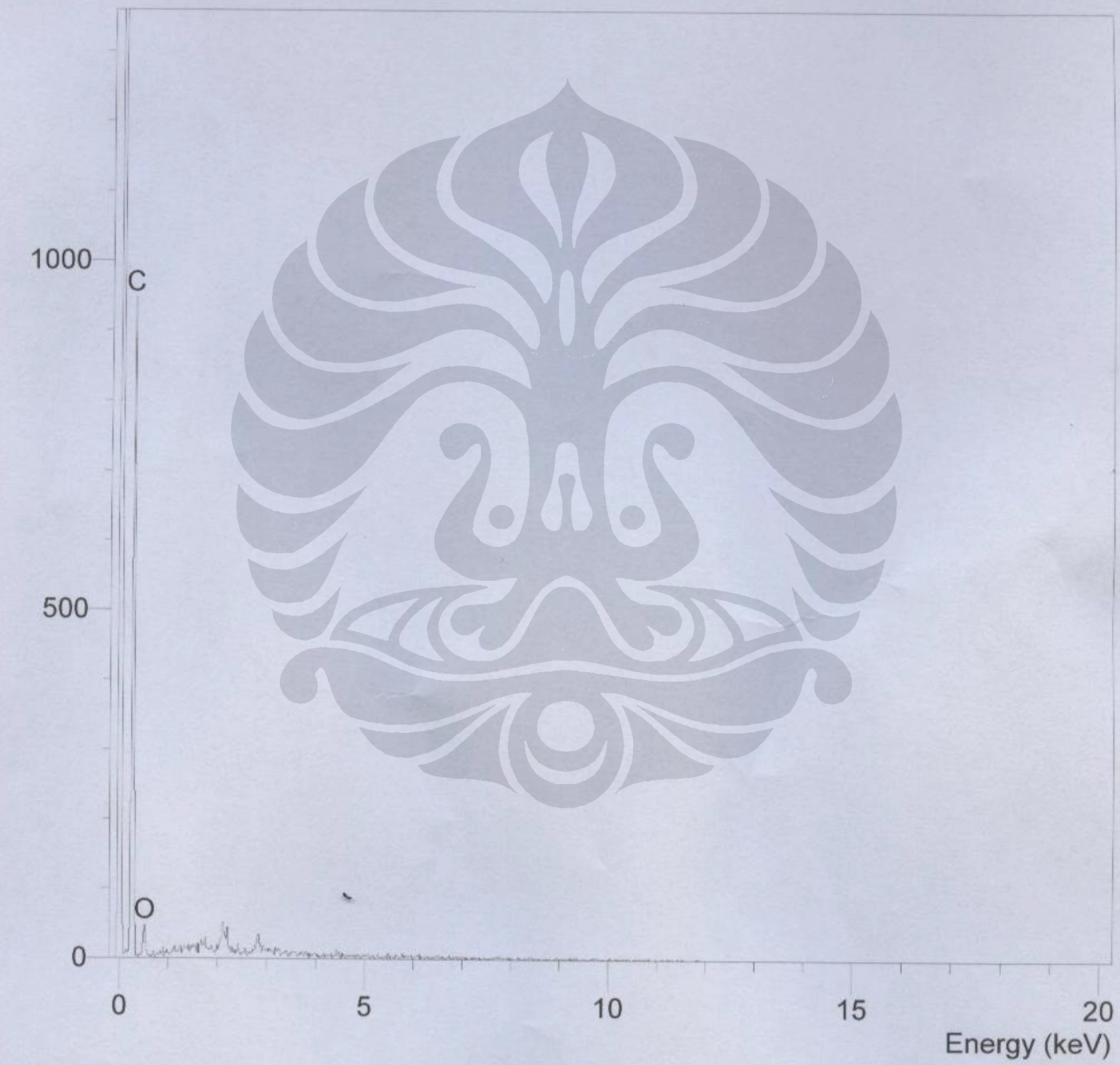
2 peaks possibly omitted: 2.14, 2.82 keV

Standards :
C K Carbon Low 13/09/06
O K AL2O3 22/03/06

Elmt	Spect. Type	Element %	Atomic %
C K	ED	46.58	53.73
O K	ED	53.42	46.27
Total		100.00	100.00

* = <2 Sigma

Operator : jaya
Client : Dept. Metalurgi dan Material Universitas Indonesia
Job : Energy Dispersive X-Ray Analysis
PMC - Spot (10/06/08 09:07)



SEMQuant results. Listed at 09:08:46 on 10/06/08
Operator: jaya
Client: Dept. Metalurgi dan Material Universitas Indonesia
Job: Energy Dispersive X-Ray Analysis
Spectrum label: PMC - Spot

System resolution = 59 eV

Quantitative method: ZAF (2 iterations).
Analysed all elements and normalised results.

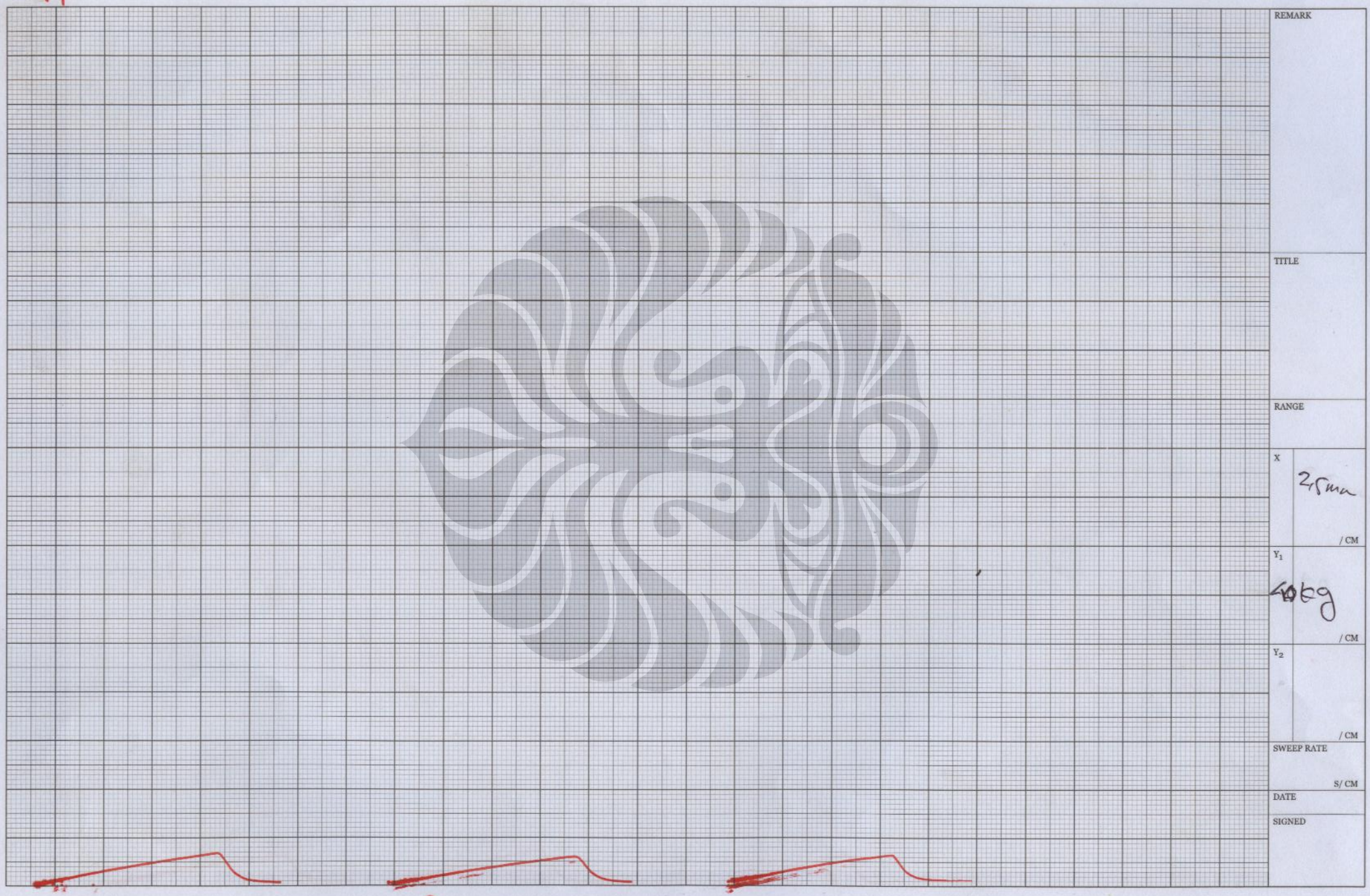
3 peaks possibly omitted: 1.72, 2.14, 2.82 keV

Standards :
C K Carbon Low 13/09/06
O K AL2O3 22/03/06

Elmt	Spect. Type	Element %	Atomic %
C K	ED	54.91	61.87
O K	ED	45.09	38.13
Total		100.00	100.00

* = <2 Sigma

F1



REMARK

TITLE

RANGE

X 2,5 mm / CM

Y_1 40 kg / CM

Y_2 / CM

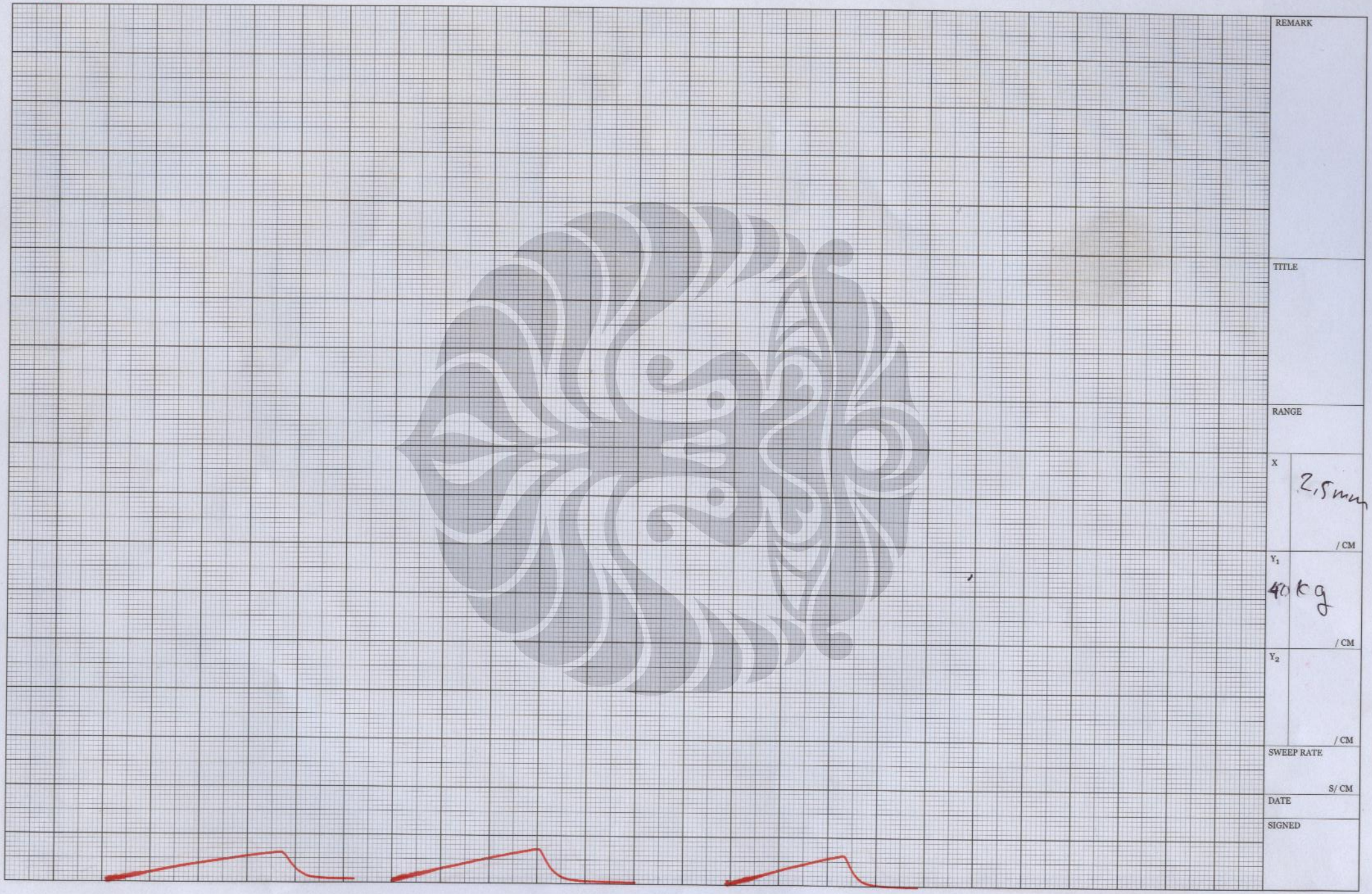
SWEEP RATE S/ CM

DATE

SIGNED

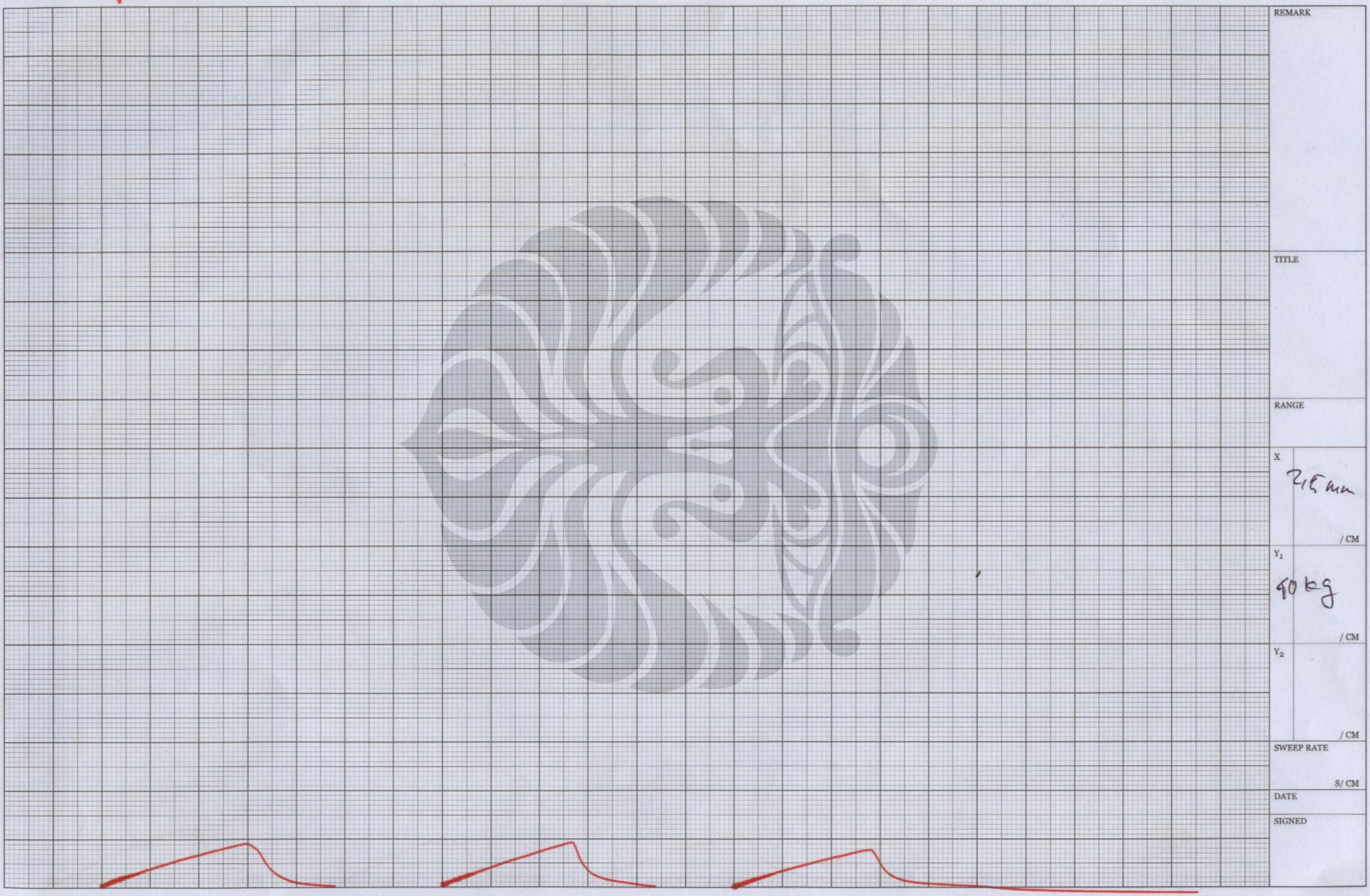
F2

2



REMARK	
TITLE	
RANGE	
X	2,5 mm / CM
Y_1	40 kg / CM
Y_2	/ CM
SWEEP RATE	S/ CM
DATE	
SIGNED	

F1 ₵3



REMARK

TITLE

RANGE

X
2,5 mm
/ CM

Y_1
40 kg
/ CM

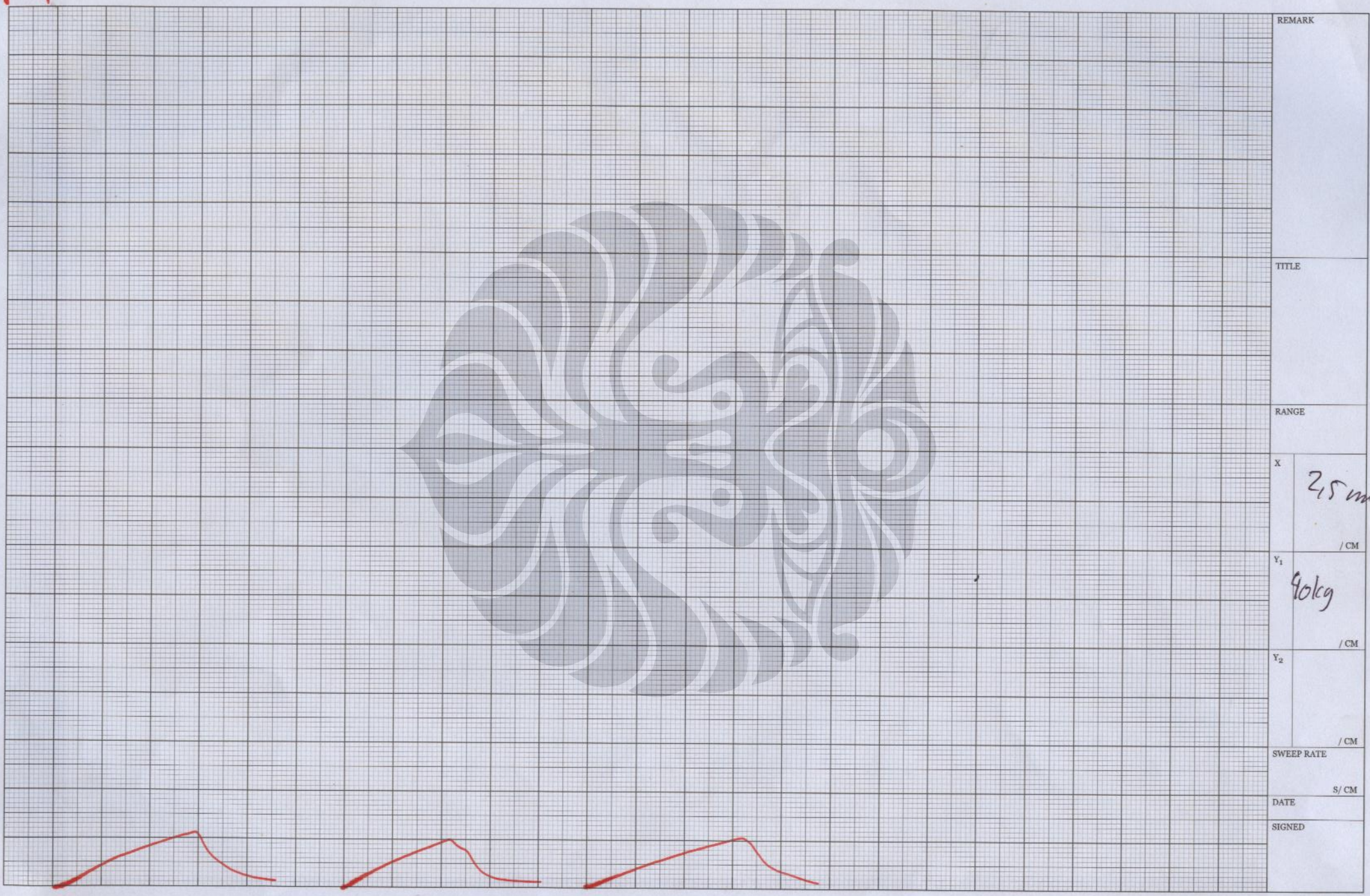
Y_2
/ CM

SWEEP RATE
S/ CM

DATE

SIGNED

F4



REMARK

TITLE

RANGE

X 2,5 mm / CM

Y_1 40kg / CM

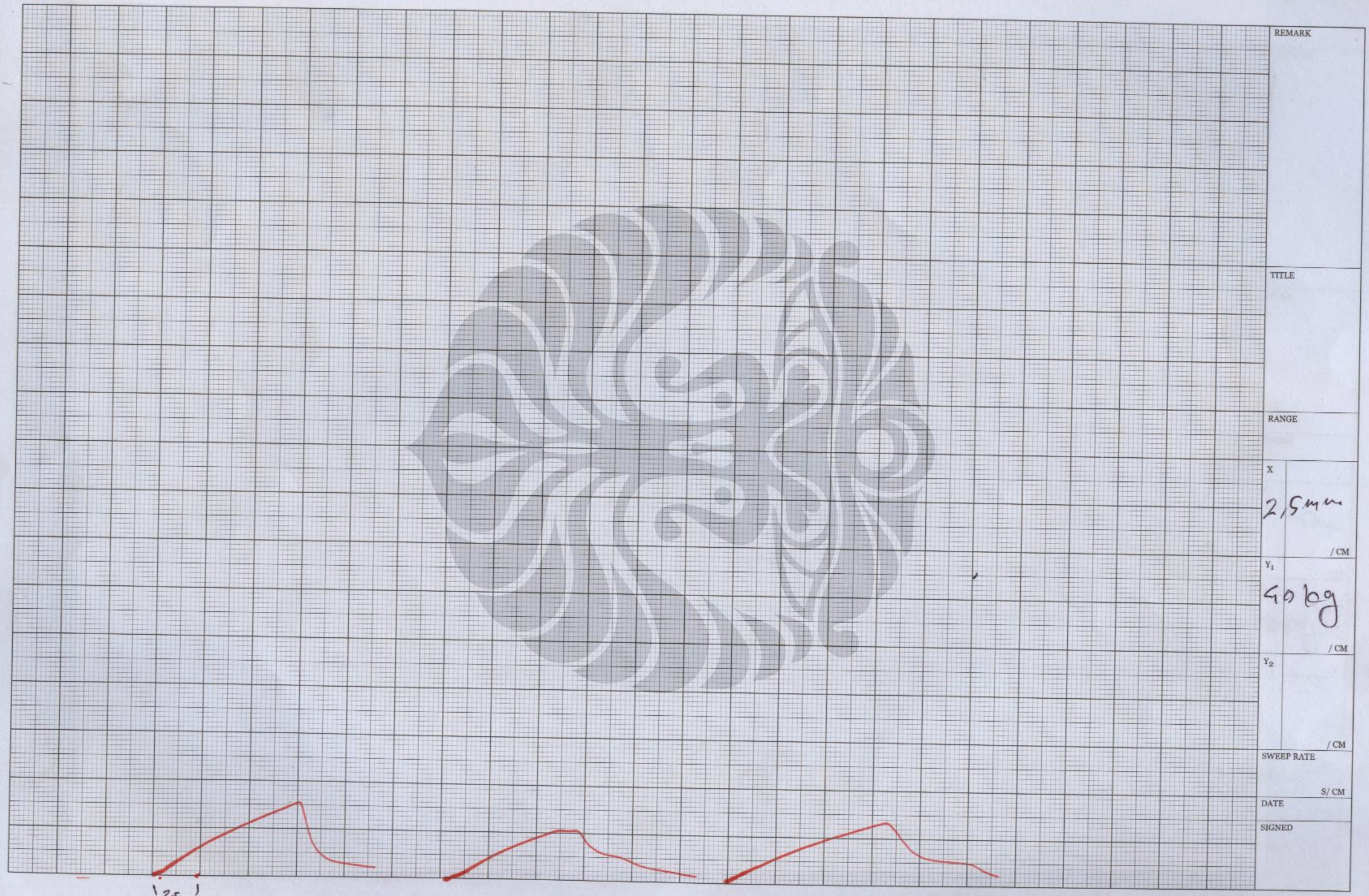
Y_2 / CM

SWEEP RATE S/ CM

DATE

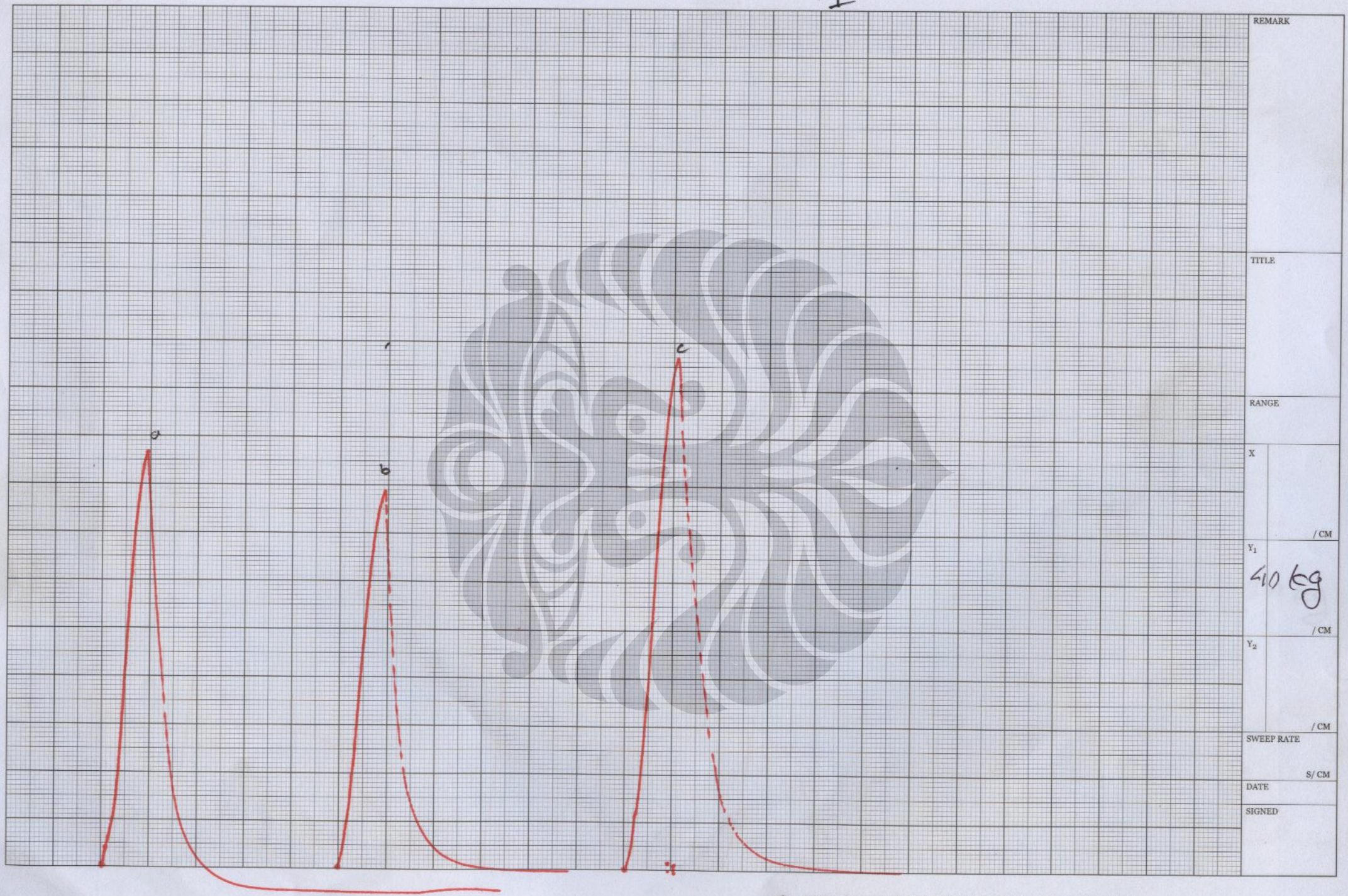
SIGNED

F5



T1

T1



REMARK

TITLE

RANGE

X / CM

Y_1 40 kg / CM

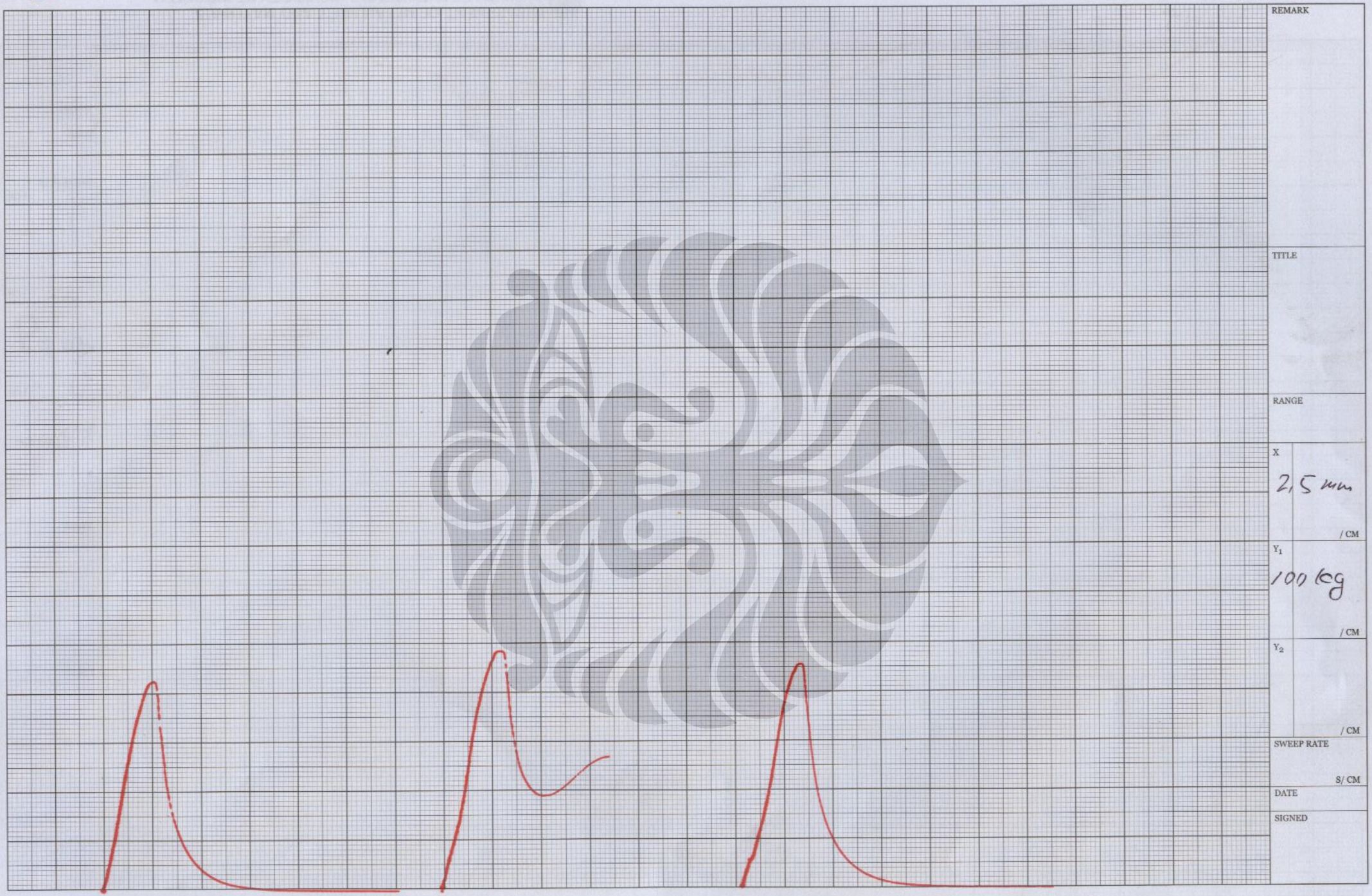
Y_2 / CM

SWEEP RATE S/ CM

DATE

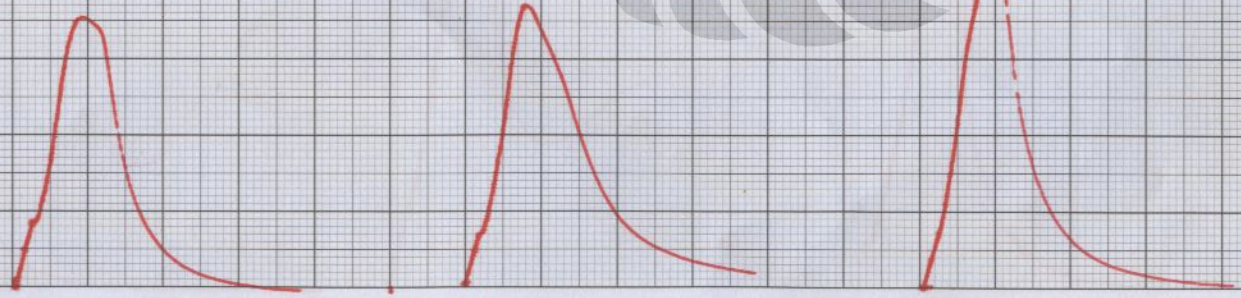
SIGNED

T2



REMARK	
TITLE	
RANGE	
X	2,5 mm / CM
Y_1	100 kg / CM
Y_2	/ CM
SWEEP RATE	S/ CM
DATE	
SIGNED	

T3



REMARK

TITLE

RANGE

X / CM

Y_1 100 kg / CM

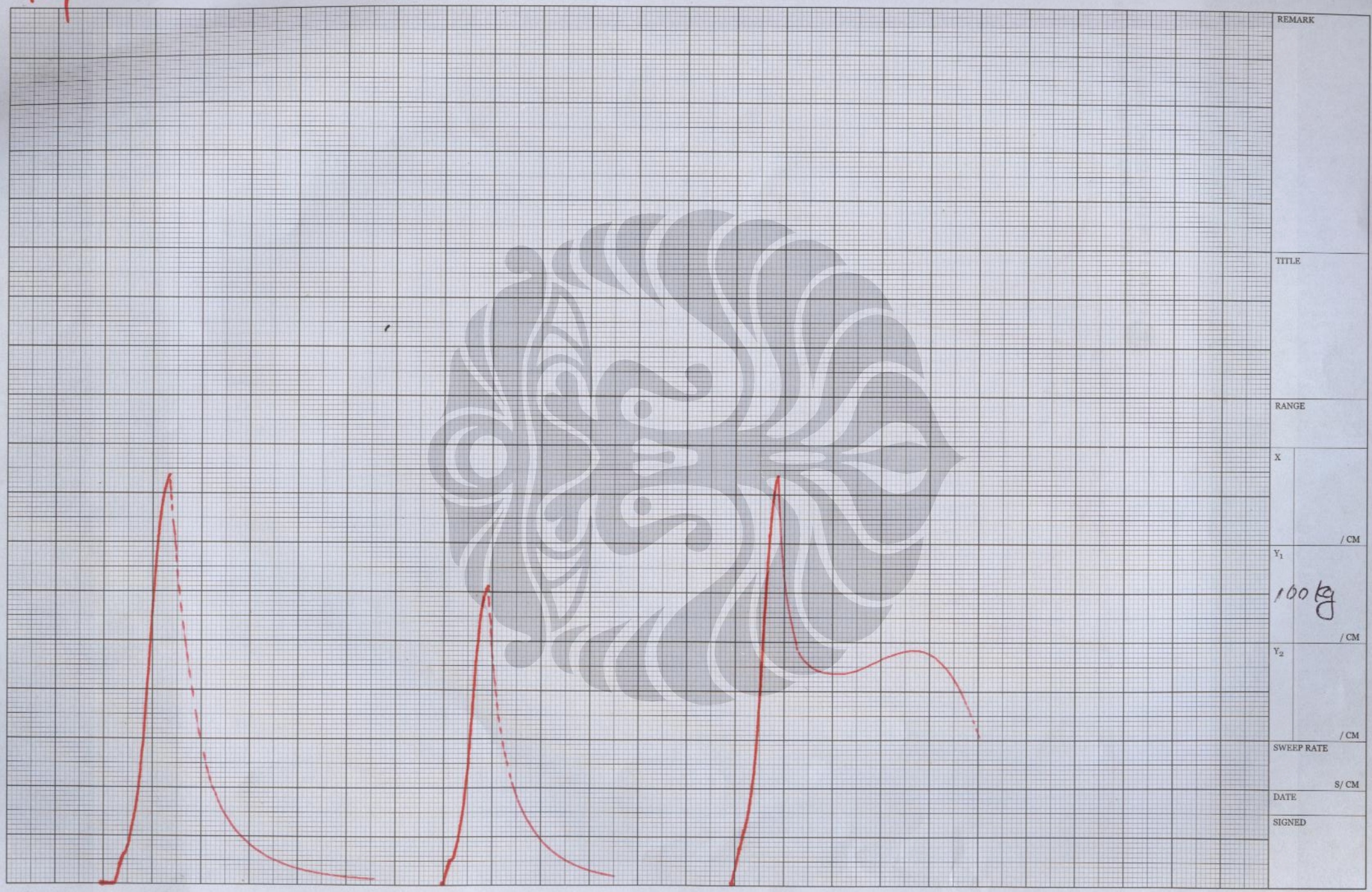
Y_2 / CM

SWEEP RATE S/ CM

DATE

SIGNED

T4



REMARK

TITLE

RANGE

X / CM

Y_1 100 kg / CM

Y_2 / CM

SWEEP RATE S/ CM

DATE

SIGNED