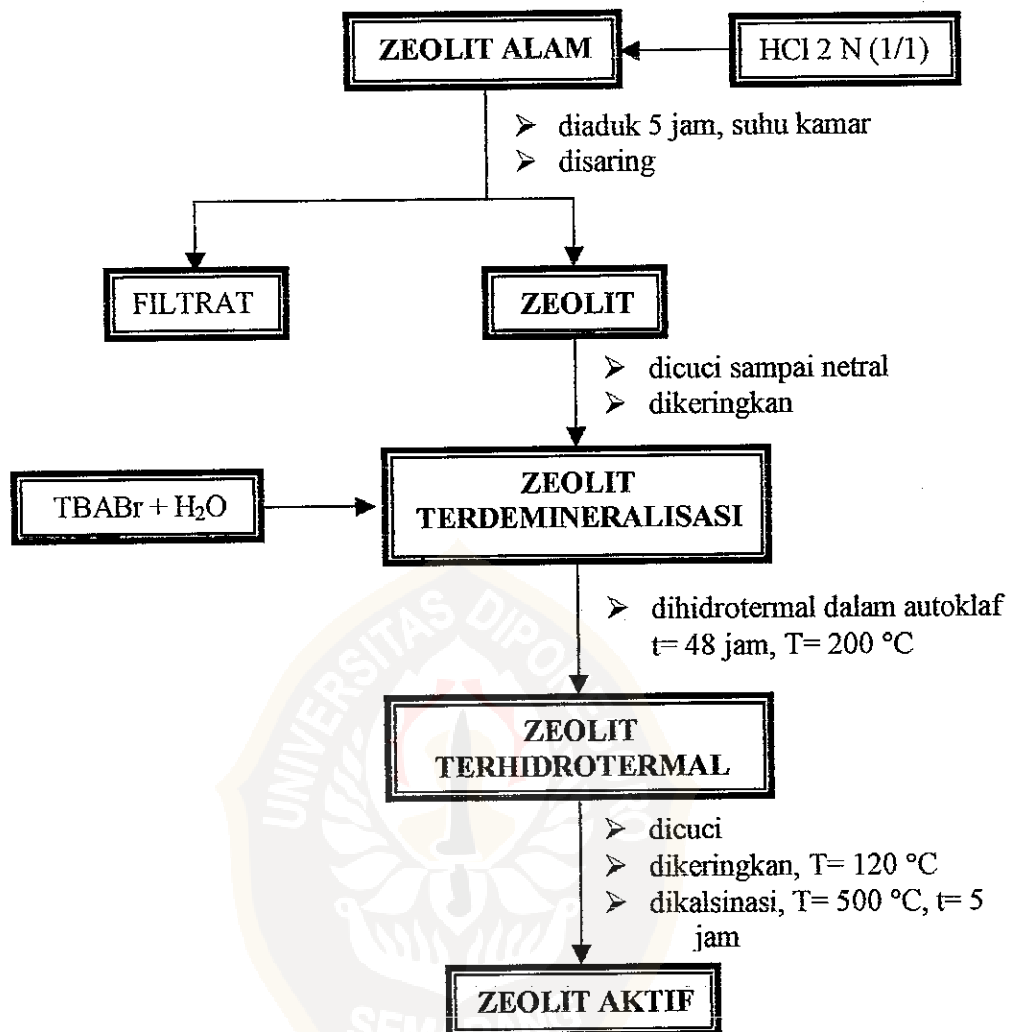
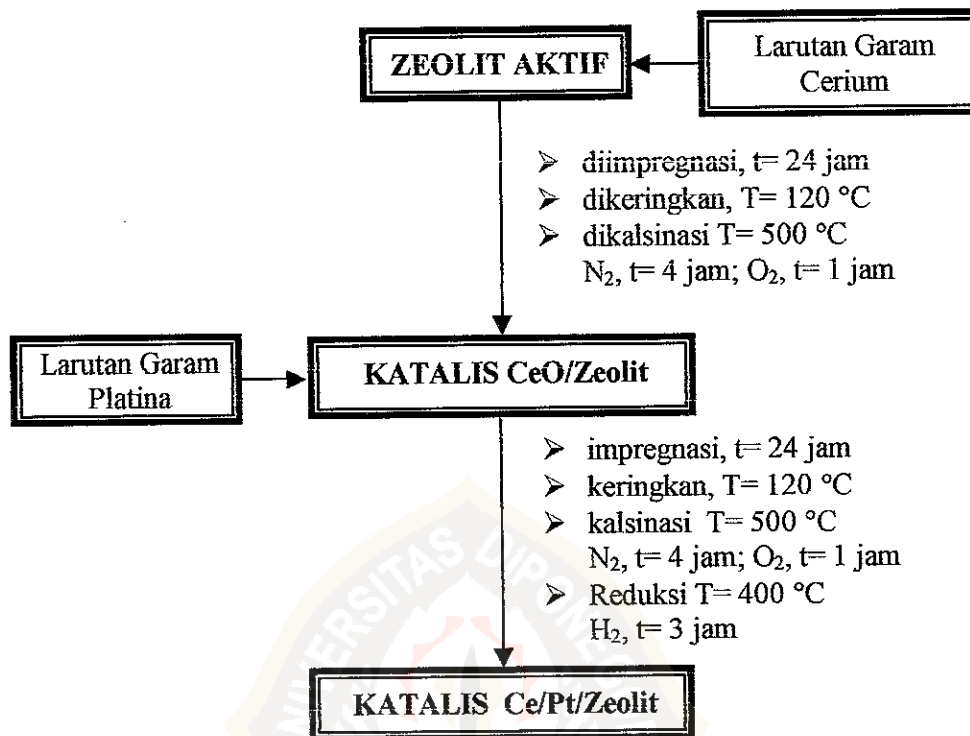


## Lampiran 1. Skema Preparasi Zeolit Alam



## Lampiran 2. Skema Kerja Preparasi Katalis

## 1. Preparasi I (Katalis Ce/Pt/Zeolit)



## 2. Preparasi II (Katalis Pt/CeZeolit)

Tahapan impregasi pertama: garam platina

Tabel Ringkasan Preparasi Katalis

Kondisi	Preparasi I	Preparasi II
Prosedur	Ce <sub>1</sub> -Pt (K 1.1) Ce <sub>2</sub> -Pt (K 1.2) Ce <sub>3</sub> -Pt (K 1.3)	Pt-Ce <sub>1</sub> (K 2.1) Pt-Ce <sub>2</sub> (K 2.2) Pt-Ce <sub>3</sub> (K 2.3)
Konsentrasi garam Pt (garam II)	0,1 %	0,1%
Konsentrasi garam Ce (garam I)	5 % 10 % 15 %	5 % 10 % 15 %

### Lampiran 3. Perhitungan Preparasi Bahan

#### 1. Perhitungan Preparasi HCl 2 M 500 mL

- HCl 37 %, Mr HCl = 36,64,  $\rho = 1,19$  gram/L

$$\begin{aligned} M_{\text{HCl}} &= \frac{\% \text{HCl} \times \rho}{\text{BM}_{\text{HCl}}} \times 1000 \text{ mL} \\ &= \frac{37\% \times 1,19}{36,64} \times 1000 \text{ mL} \\ &= 12,08 \text{ M} \end{aligned}$$

- $V_1 \cdot M_1 = V_2 \cdot M_2$

$$V_1 \cdot 12,08 \text{ M} = 500 \text{ mL} \cdot 2 \text{ M}$$

$$V_1 = 82,807 \text{ mL}$$

Sehingga banyaknya HCL 37 % yang dibutuhkan untuk membuat HCl 2

M 500 mL adalah 82,807 mL.

#### 2. Perhitungan Rasio Template yang digunakan

Kadar SiO<sub>2</sub> dalam zeolit awal : 62,18 %

- $\frac{R}{\text{SiO}_2} = 0,1$  ; Basis 1 gram mol SiO<sub>2</sub> = 0,6218 gram/60 gram.mol<sup>-1</sup>  
= 0,01 mol

$$R = 0,1 \times 0,001 \text{ mol}$$

- 1 gram R = 0,001 mol x 322,38 gram/mol  
= 0,32238 gram

- Untuk 200 gram zeolit, TBABr yang dibutuhkan adalah:  
= 200 x 0,32238  
= 64,476 gram

### 3. Perhitungan Preparasi Garam Promotor

- a. 5 % Ce = 5 gram zeolit dalam 100 gram zeolit  
 = 1 gram Ce dalam 20 gram zeolit

Berat garam  $\text{Ce}(\text{SO}_4)_2 \cdot 4\text{H}_2\text{O}$  yang dibutuhkan:

$$= \frac{\text{Berat Ce} \times \text{BM}_{\text{Ce}(\text{SO}_4)_2 \cdot 4\text{H}_2\text{O}}}{\text{BM}_{\text{Ce}}}$$

$$= \frac{1 \text{ gram} \times 404,306 \text{ gram/mol}}{140,12 \text{ gram/mol}}$$

$$= 2,8854 \text{ gram}$$

- b. 10 % Ce = 10 gram Ce dalam 100 gram zeolit  
 = 2 gram Ce dalam 20 gram zeolit

Berat garam  $\text{Ce}(\text{SO}_4)_2 \cdot 4\text{H}_2\text{O}$  yang dibutuhkan:

$$= \frac{\text{Berat Ce} \times \text{BM}_{\text{Ce}(\text{SO}_4)_2 \cdot 4\text{H}_2\text{O}}}{\text{BM}_{\text{Ce}}}$$

$$= \frac{2 \text{ gram} \times 404,306 \text{ gram/mol}}{140,12 \text{ gram/mol}}$$

$$= 5,7708 \text{ gram}$$

- c. 15 % Ce = 15 gram Ce dalam 100 gram zeolit  
 = 3 gram Ce dalam 20 gram zeolit

Berat garam  $\text{Ce}(\text{SO}_4)_2 \cdot 4\text{H}_2\text{O}$  yang dibutuhkan:

$$= \frac{\text{Berat Ce} \times \text{BM}_{\text{Ce}(\text{SO}_4)_2 \cdot 4\text{H}_2\text{O}}}{\text{BM}_{\text{Ce}}}$$

$$= \frac{3 \text{ gram} \times 404,306 \text{ gram/mol}}{140,12 \text{ gram/mol}}$$

$$= 8,6563 \text{ gram}$$

#### 4. Perhitungan Preparasi Garam Logam Aktif

- $\text{H}_2\text{PtCl}_6\cdot 6\text{H}_2\text{O}$  (37,7%) 1 gram diencerkan hingga 50 ml

$$37,7 \% \text{ Pt} = 0,377 \text{ gram Pt dalam } 50 \text{ mL}$$

$$1 \text{ mL} = \frac{377 \text{ mgram}}{50 \text{ mL}}$$

$$1 \text{ mL} = 7,54 \text{ gram}$$

- 0,1 % Pt dalam 20 gram zeolit = 20 mgram Pt dalam 20 gram zeolit

$$\text{Larutanyang dibutuhkan} = \frac{20}{7,54} \text{ mL} = 2,6525 \text{ mL}$$



Lampiran 4. Tabel Identifikasi Mineral Zeolit

**Komponen Mineral Zeolit Awal**

$2\theta$	$d$ (Å)	Intensitas (%)	Mineral
9,845	8,9770	46,2	Klinoptilolit
13,505	6,5512	24,0	Mordenit
22,305	3,9825	77,6	Klinoptilolit
19,660	4,5119	29,3	Mordenit
22,755	3,9048	27,5	Klinoptilolit
25,690	3,4649	100,0	Mordenit
26,655	3,3446	76,1	Quarsa
28,070	3,1763	35,4	Klinoptilolit
29,995	2,9767	18,3	Klinoptilolit
27,650	3,2236	62,9	Mordenit
30,920	2,8897	24,0	Mordenit

**Komponen Mineral Zeolit Aktif**

$2\theta$	$d$ (Å)	Intensitas (%)	Mineral
9,765	9,0504	42,4	Mordenit
13,425	6,5901	28,9	Mordenit
19,605	4,5245	28,9	Mordenit
22,285	3,9860	64,6	Mordenit
25,695	3,4643	100	Mordenit
26,285	3,3878	44,8	Mordenit
26,615	3,3466	47,5	Quarsa
27,655	3,2230	66,2	Mordenit
28,065	3,1769	71,5	Klinoptilolit
30,210	2,9560	18,3	Klinoptilolit

## Lampiran 5. Tabel Identifikasi Komponen Logam

**Komponen Logam Katalis**

Katalis	2 $\theta$	d (Å)	Intensitas (%)	Bentuk Logam
<b>K 1.1</b>	27,690	3,2189	70,1	Ce <sub>6</sub> O <sub>11</sub>
	32,030	2,7920	12,6	Ce <sub>6</sub> O <sub>11</sub>
	39,550	2,2767	5,6	Pt
	68,320	1,3718	97,1	Pt
	83,653	1,1539	2,2	Pt
<b>K 1.2</b>	27,750	3,212	70,9	Ce <sub>6</sub> O <sub>11</sub>
	32,125	2,7480	7,8	Ce <sub>6</sub> O <sub>11</sub>
	39,860	2,2597	1,9	Pt
	45,860	1,9775	100	Ce <sub>6</sub> O <sub>11</sub>
	45,980	1,9722	45,9	Pt
	68,225	1,3735	2,5	Pt
<b>K 1.3</b>	22,405	3,4437	100,0	Pt <sub>3</sub> O <sub>4</sub>
	27,740	3,2133	82,5	Ce <sub>6</sub> O <sub>11</sub>
	31,950	2,7988	13,5	Ce <sub>6</sub> O <sub>11</sub>
	35,900	2,4994	10,9	Pt <sub>3</sub> O <sub>4</sub>
	46,950	1,9337	4,5	Pt
	68,065	1,3763	3,4	Pt
	76,010	1,2510	37,8	Pt
<b>K 2.1</b>	26,340	3,3808	37,0	Ce <sub>2</sub> O <sub>3</sub>
	27,555	3,2344	37,8	Ce <sub>2</sub> O <sub>3</sub>
	35,8	2,5061	7,7	Pt <sub>3</sub> O <sub>4</sub>
	39,620	2,2729	6,7	Pt
	59,820	1,5448	100	Pt <sub>3</sub> O <sub>4</sub>
	81,515	1,1799	9,8	Pt
<b>K 2.2</b>	27,690	3,2269	20,0	Ce <sub>6</sub> O <sub>11</sub>
	29,981	3,1890	100,0	PtO <sub>2</sub>
	34,965	2,8765	7,6	Ce <sub>6</sub> O <sub>11</sub>
	58,795	1,6882	2,6	PtO <sub>2</sub>
<b>K 2.3</b>	22,915	3,9614	25,0	Pt <sub>3</sub> O <sub>4</sub>
	26,430	3,3695	30,3	PtO <sub>2</sub>
	27,695	3,2184	28,7	Ce <sub>6</sub> O <sub>11</sub>
	31,975	2,7967	14,3	Ce <sub>6</sub> O <sub>11</sub>
	46,750	1,9415	7,4	Ce <sub>6</sub> O <sub>11</sub>
	53,095	1,7235	3,2	PtO <sub>2</sub>
	68,065	1,3763	29,5	Pt
	84,815	1,1422	17,2	Pt

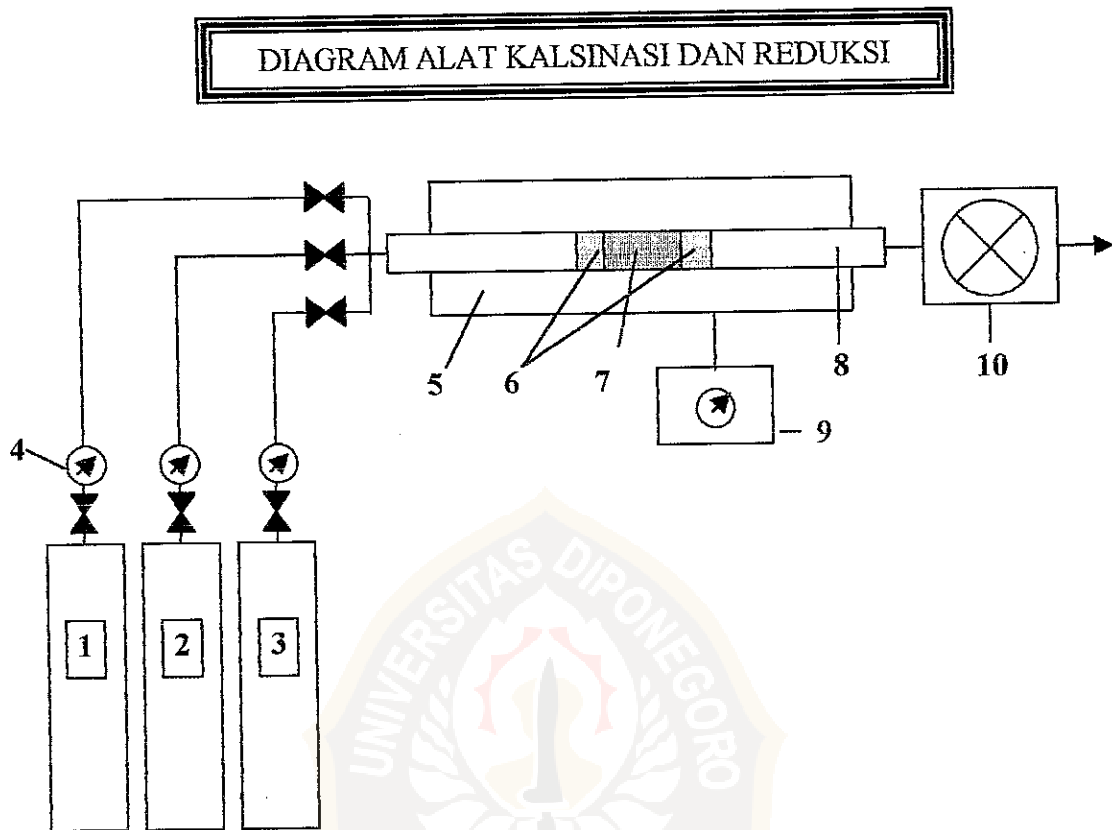
## Lampiran 6. Tabel Hasil Konversi Gas CO Katalis

Tabel Hasil Konversi Gas CO Katalis

Sampel	Suhu	% mol gas CO awal	% mol gas CO sisa	% Konversi CO
K <sub>1</sub>	300 °C	57,23	54,01	5,63
	500 °C	57,23	38,15	33,34
	700 °C	57,23	26,52	45,17
K <sub>2</sub>	300 °C	57,23	12,61	77,97
	500 °C	57,23	5,76	89,94
	700 °C	57,23	1,03	98,20
K <sub>3</sub>	300 °C	57,23	53,06	5,49
	500 °C	57,23	14,68	74,35
	700 °C	57,23	0,21	99,63
K <sub>4</sub>	300 °C	57,23	42,34	26,02
	500 °C	57,23	40,90	28,53
	700 °C	57,23	22,49	60,70
K <sub>5</sub>	300 °C	57,23	41,65	27,22
	500 °C	57,23	24,46	57,26
	700 °C	57,23	8,15	85,76
K <sub>6</sub>	300 °C	57,23	57,18	0,09
	500 °C	57,23	36,24	36,68
	700 °C	57,23	2,78	95,14



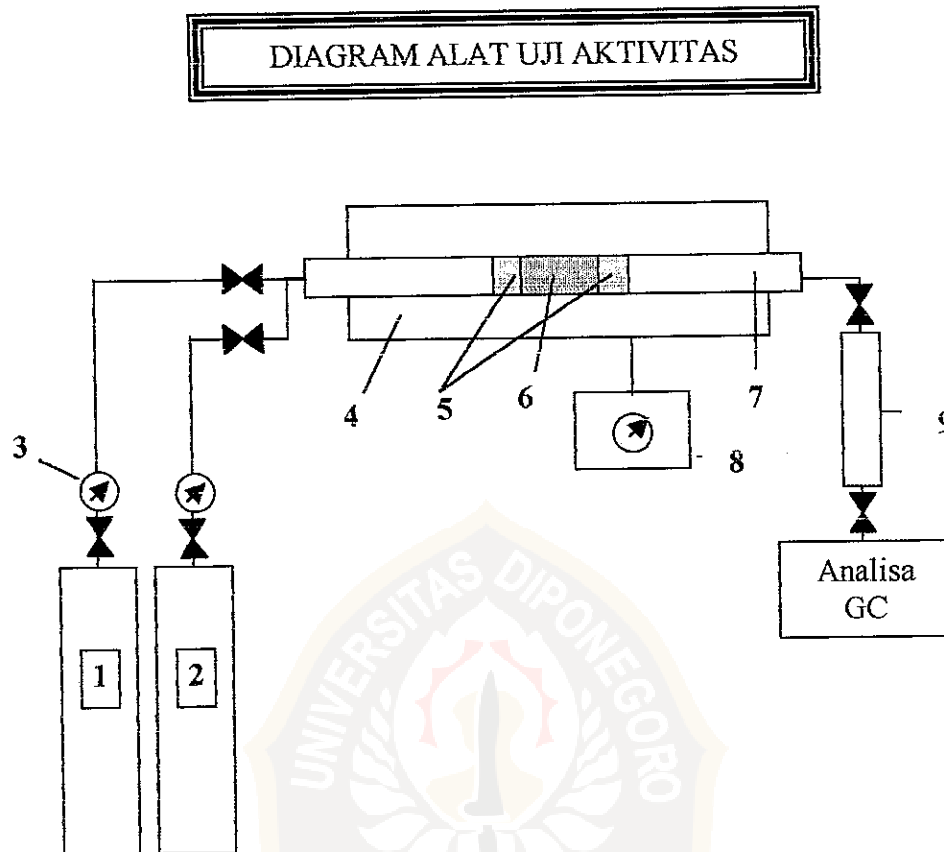
## Lampiran 7. Gambar Alat Kalsinasi dan Reduksi



## Keterangan :

1. Gas  $N_2$  (nitrogen)
2. udara tekan
3. Gas  $H_2$  (hidrogen)
4. Pengukur laju alir gas
5. Furnace Karl Kolb 40/5
6. Serat kaca
7. Sampel katalis
8. Tabung stainlesssteel 316
9. Pengatur suhu
10. Blower

## Lampiran 8. Gambar Alat Uji Aktivitas

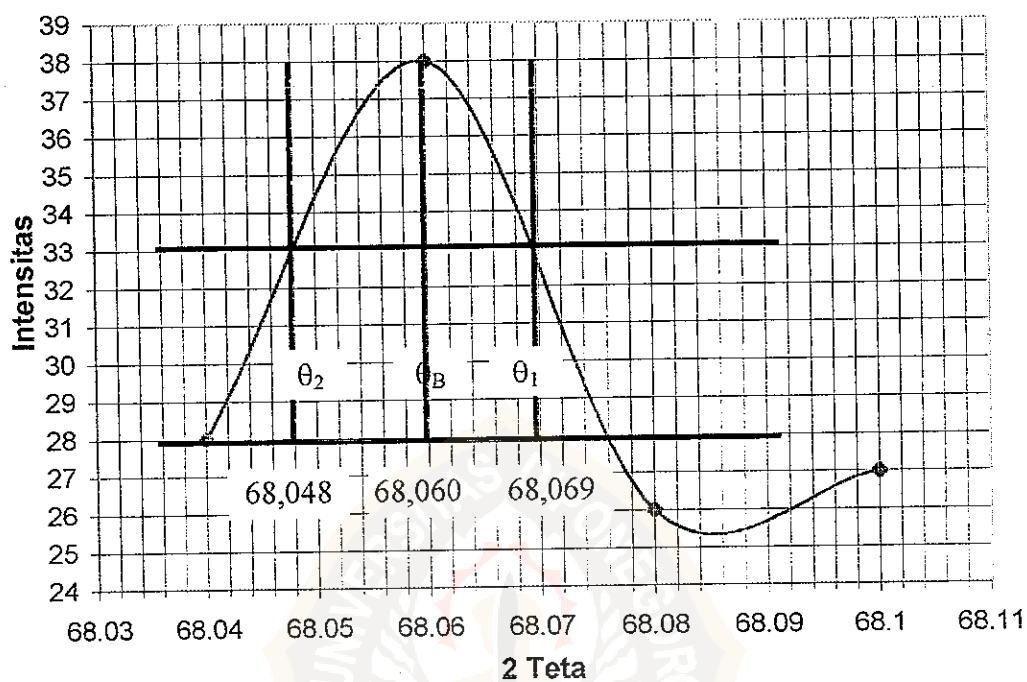


## Keterangan :

1. Gas CO (karbon monoksida)
2. Udara tekan
3. Pengukur laju alir gas
4. Furnace Karl Kolb 40/5
5. Serat kaca
6. Sampel katalis
7. Tabung stainlesssteel 316
8. Pengatur suhu
9. Penampung sampel gas buang

## Lampiran 9. Grafik Penentuan Ukuran Partikel K 2. 3

GRAFIK UKURAN PARTIKEL K 2.3



$$\blacksquare B = \frac{1}{2} (68,069^\circ - 68,048^\circ) \times \pi/180 = 1,8326 \cdot 10^{-4}$$

$$\blacksquare 2\theta = 68,060$$

$$\theta = 34,030$$

$$\blacksquare t = \frac{0,92 \times 1,54051}{B \times \cos \theta_B}$$

$$t = \frac{0,92 \times 1,54051}{1,8326 \cdot 10^{-4} \cos 34,030^\circ}$$

$$t = 9331,7677 \text{ \AA}$$

$$t = 933,1768 \text{ nm}$$

Sample identification: ZEOLITE AWAL (Zo)  
Data measured at: 11-sep-2000 20:31:00

Diffractometer type: PW1710 BASED  
Tube anode: Cu  
Generator tension [kV]: 35  
Generator current [mA]: 30  
Wavelength Alpha1 [Å]: 1.54060  
Wavelength Alpha2 [Å]: 1.54439  
Intensity ratio (alpha2/alpha1): 0.500  
Divergence slit: AUTOMATIC  
Irradiated length [mm]: 12  
Receiving slit: 0.2  
Spinner: ON  
Monochromator used: YES

Start angle [ $^{\circ}2\theta$ ]: 3.010  
End angle [ $^{\circ}2\theta$ ]: 59.950  
Step size [ $^{\circ}2\theta$ ]: 0.020  
Maximum intensity: 1246.090  
Time per step [s]: 1.250  
Type of scan: CONTINUOUS

Minimum peak tip width: 0.00  
Maximum peak tip width: 1.00  
Peak base width: 1.00  
Minimum significance: 1.00  
Number of peaks: 47

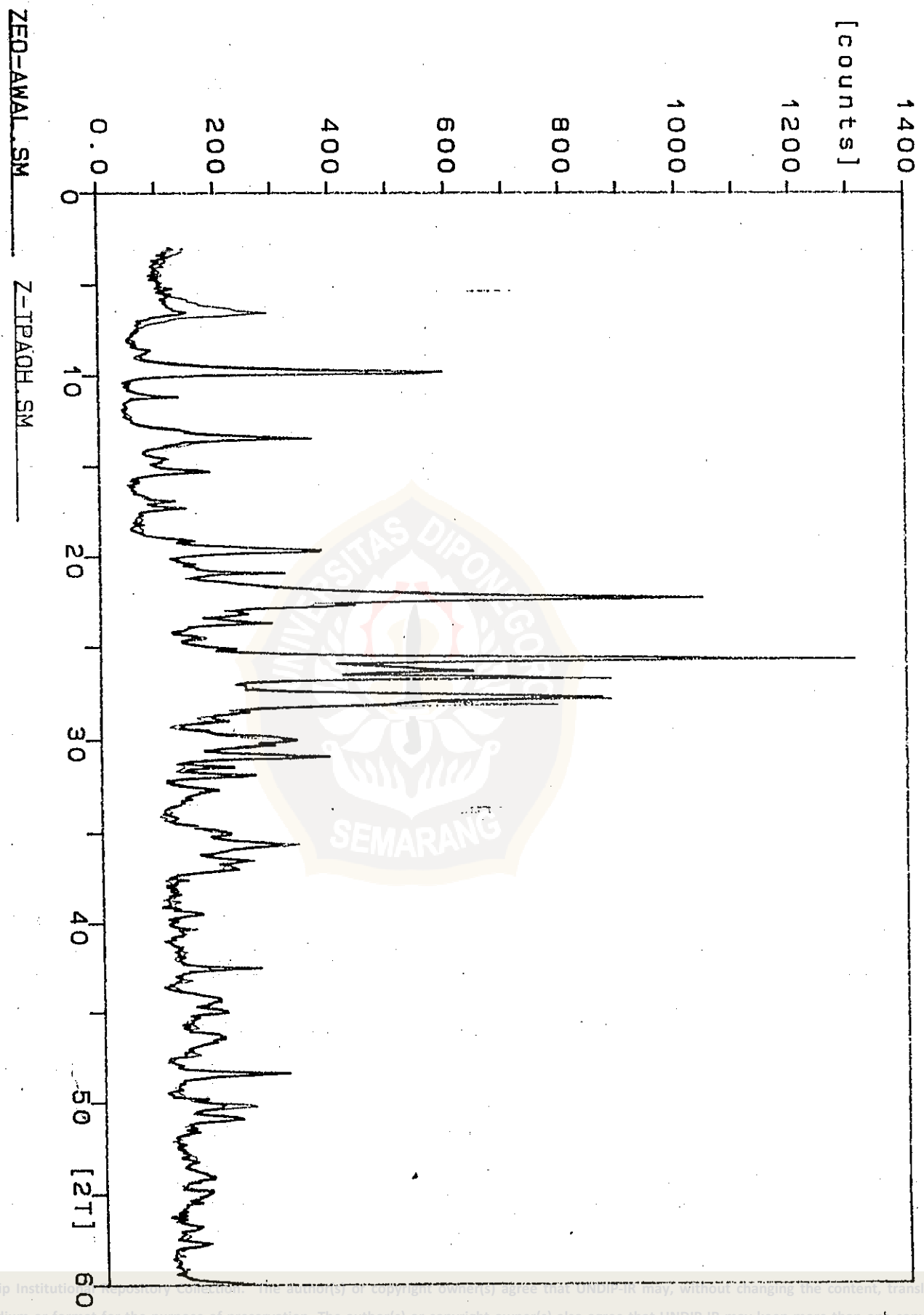
le θ]	d-value α1 [Å]	d-value α2 [Å]	Peak width [ $^{\circ}2\theta$ ]	Peak int [counts]	Back. int [counts]	Rel. int [%]	Signif.
35	13.5146	13.5478	0.160	64	86	5.1	1.29
25	10.1267	10.1516	0.240	35	52	2.8	1.16
45	8.9770	8.9991	0.100	576	49	46.2	1.34
85	7.9044	7.9238	0.120	98	45	7.9	2.35
05	6.5512	6.5674	0.080	299	61	24.0	1.77
20	6.0540	6.0689	0.240	52	62	4.2	1.29
65	5.7996	5.8139	0.200	123	62	9.9	2.97
30	5.2328	5.2457	0.120	76	59	6.1	2.78
35	5.1115	5.1241	0.100	92	59	7.4	1.14
60	4.6526	4.6640	0.160	92	66	7.4	1.05
60	4.5119	4.5230	0.080	365	67	29.3	1.02
90	4.2490	4.2594	0.120	228	72	18.3	3.10
05	3.9825	3.9923	0.160	967	77	77.6	4.24
55	3.9048	3.9144	0.120	342	81	27.5	1.76
95	3.7519	3.7612	0.100	204	85	16.4	1.08
60	3.6363	3.6452	0.200	79	88	6.4	1.11
75	3.5485	3.5572	0.120	139	90	11.2	1.19
90	3.4649	3.4734	0.180	1246	92	100.0	14.10
60	3.3910	3.3993	0.140	571	94	45.8	2.76
55	3.3416	3.3498	0.120	949	96	76.1	5.92

e	d-value a1 [Å]	d-value a2 [Å]	Peak width [°2θ]	Peak int [counts]	Back. int [counts]	Rel. int [%]	Signif.
0	3.2236	3.2315	0.100	784	100	62.9	1.55
0	3.1763	3.1841	0.160	441	102	35.4	1.52
10	3.0734	3.0810	0.160	108	106	8.7	1.15
5	2.9767	2.9840	0.360	228	110	18.3	6.13
0	2.9436	2.9509	0.120	182	112	14.6	1.18
0	2.8897	2.8968	0.060	299	114	24.0	1.59
10	2.8396	2.8466	0.120	106	117	8.5	2.33
15	2.7976	2.8045	0.160	146	117	11.7	3.50
0	2.7388	2.7456	0.160	76	125	6.1	1.52
15	2.5627	2.5690	0.400	96	121	7.7	1.62
0	2.5219	2.5281	0.280	193	123	15.5	3.38
10	2.4571	2.4632	0.160	125	125	10.1	1.66
30	2.4289	2.4349	0.120	114	125	9.2	1.67
10	2.2823	2.2879	0.060	112	112	9.0	1.54
50	2.2282	2.2337	0.320	26	114	2.1	2.72
0	2.1268	2.1320	0.080	199	128	16.0	2.61
15	2.0468	2.0518	0.480	74	123	5.9	2.89
25	2.0131	2.0181	0.240	83	130	6.6	1.93
30	1.9582	1.9630	0.480	62	142	5.0	3.34
25	1.8793	1.8839	0.120	180	114	14.4	2.29
20	1.8299	1.8344	0.080	55	119	4.4	1.01
25	1.8184	1.8229	0.200	104	121	8.3	1.10
25	1.7924	1.7968	0.280	98	137	7.9	4.28
20	1.6941	1.6983	0.280	35	142	2.8	1.01
30	1.6730	1.6771	0.120	55	144	4.4	1.72
15	1.6192	1.6231	0.240	44	123	3.5	1.31
10	1.5962	1.6001	0.200	58	121	4.6	1.24



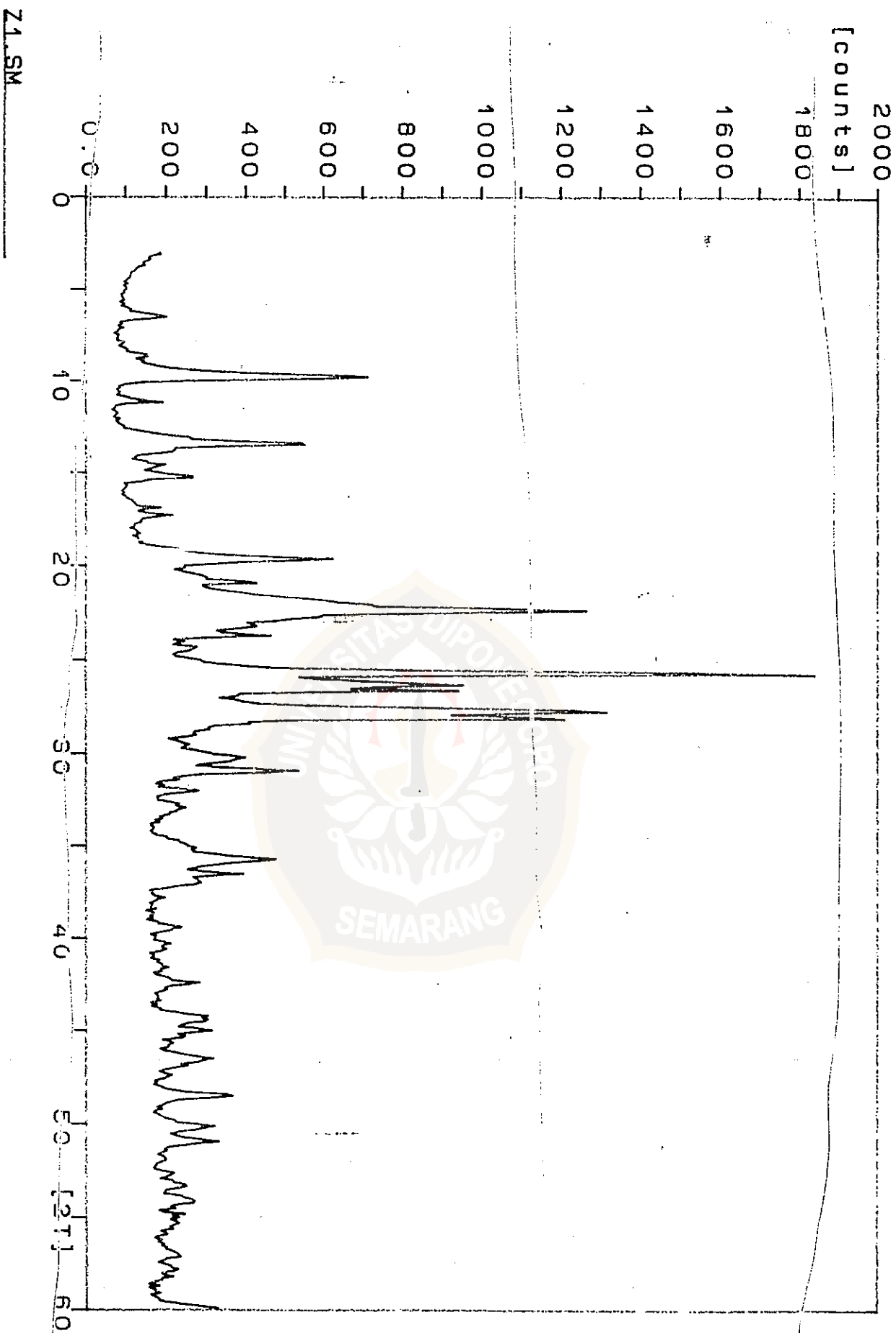
ZEOLITE AWAL vs ZEOLIT TPAOH (Z<sub>o</sub>)

11-sep-2000 23: 04



Z1

16-may-2001 20:27



Z1.SM

Sample identification: KP6 (K23)  
 Data measured at: 31-Jul-2001 12:40:00

Diffraction type: PW3710 BASED  
 Tube anode: Cu  
 Generator tension [kV]: 40  
 Generator current [mA]: 30  
 Wavelength Alpha1 [Å]: 1.54056  
 Wavelength Alpha2 [Å]: 1.54439  
 Intensity ratio (alpha2/alpha1): 0.500  
 Divergence slit: 1°  
 Receiving slit: 0.2  
 Monochromator used: NO

Start angle [°2θ]: 4.010  
 End angle [°2θ]: 89.970  
 Step size [°2θ]: 0.020  
 Maximum intensity: 196.0000  
 Time per step [s]: 0.250  
 Type of scan: CONTINUOUS

Minimum peak tip width: 0.00  
 Maximum peak tip width: 1.00  
 Peak base width: 2.00  
 Minimum significance: 0.75  
 Number of peaks: 25

hkl	d-value α1 [Å]	d-value α2 [Å]	Peak width [°2θ]	Peak int [counts]	Back. int [counts]	Rel. int [%]	Signif.
80	20.6281	20.6793	0.800	5	37	2.7	1.20
70	14.5484	14.5846	0.800	10	37	4.9	0.77
75	9.0409	9.0634	0.200	32	38	16.6	1.14
65	6.5222	6.5384	0.480	49	36	25.0	4.26
80	5.7564	5.7707	0.320	20	36	10.3	1.06
90	5.1841	5.1970	0.240	40	36	20.3	0.80
745	4.4926	4.5037	0.240	41	36	20.9	1.16
115	4.0524	4.0625	0.080	166	36	84.9	1.71
125	3.9614	3.9712	0.240	49	36	25.0	1.87
145	3.5387	3.5475	0.240	44	36	22.2	1.64
300	3.4503	3.4589	0.240	104	36	53.1	3.72
130	3.3695	3.3778	0.240	59	37	30.3	1.39
695	3.2184	3.2264	0.240	56	37	28.7	1.76
415	3.0340	3.0415	0.280	49	37	25.0	2.19
020	2.8806	2.8877	0.200	40	37	20.3	0.82
975	2.7967	2.8036	0.400	28	37	14.3	1.34
485	2.4607	2.4668	0.960	7	37	3.7	0.82
030	2.0116	2.0166	0.080	196	36	100.0	3.72
165	2.0059	2.0109	0.040	102	36	52.0	3.61
750	1.9415	1.9463	0.240	14	37	7.4	0.81
080	1.8908	1.8955	0.400	8	38	4.0	0.85
095	1.7235	1.7277	0.480	6	34	3.2	0.89



6.DI (K23)

31-Jul-2001 15:18

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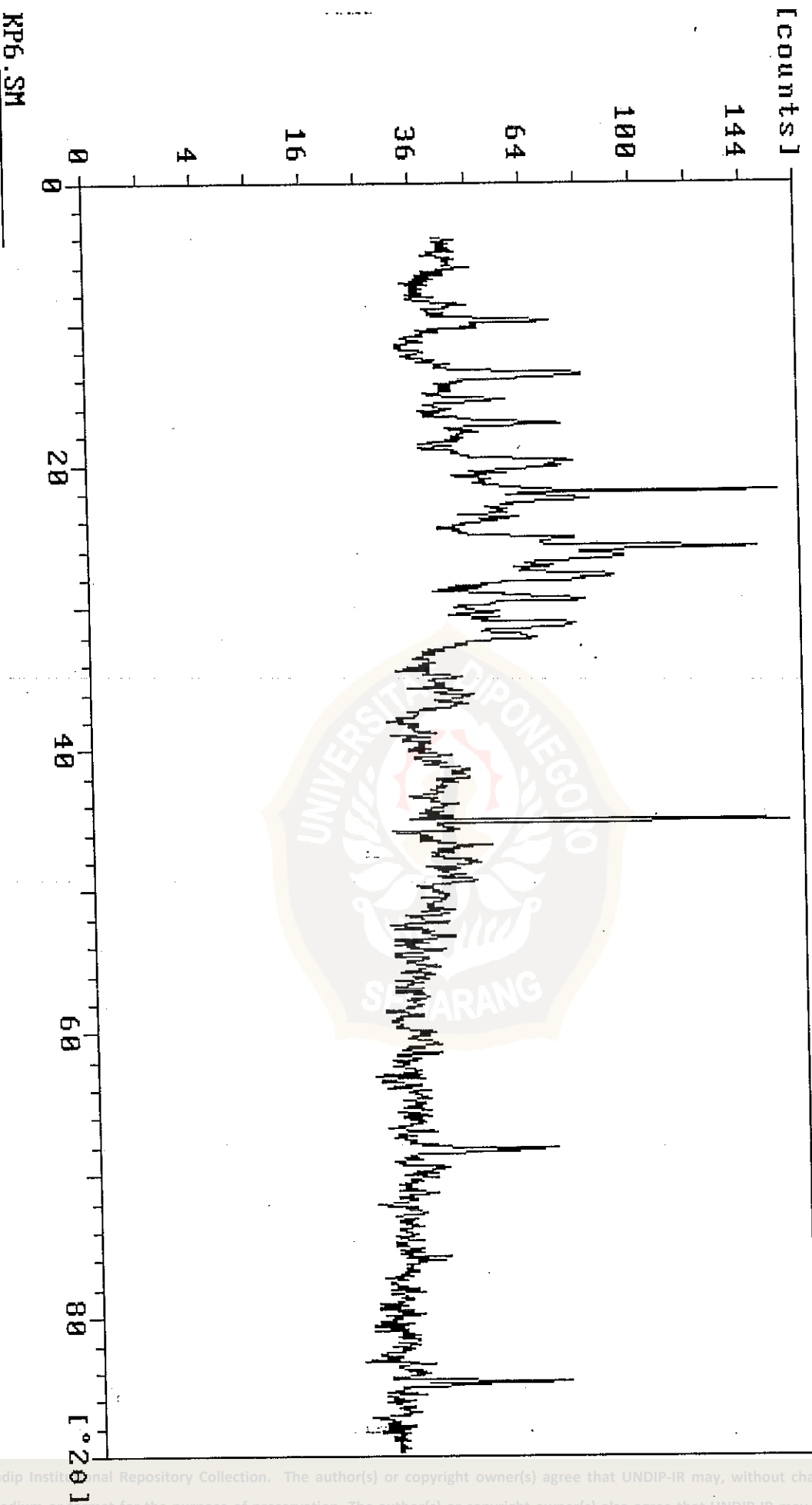
PC-APD, Diffraction software

d-value $\alpha_1$ [Å]	d-value $\alpha_2$ [Å]	Peak width [ $^{\circ}2\theta$ ]	Peak int [counts]	Back. int [counts]	Rel. int [%]	Signif.
1.3763	1.3797	0.080	58	31	29.5	0.98
1.1446	1.1475	0.120	52	29	26.4	1.18
1.1422	1.1450	0.060	34	29	17.2	1.05



Sample identification: KP6 (K2.3)

31-Jul-2001 15:17

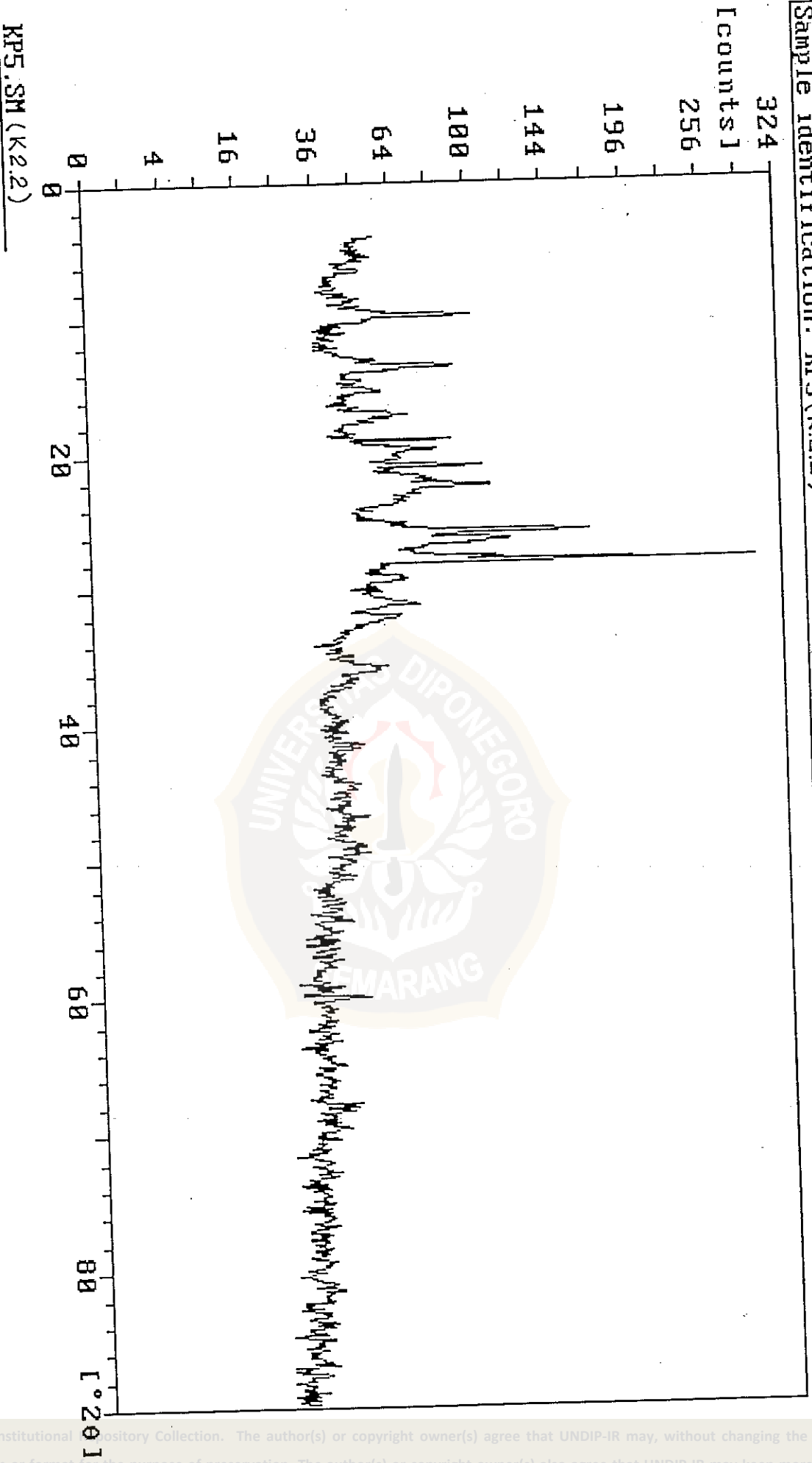


KP6.SM

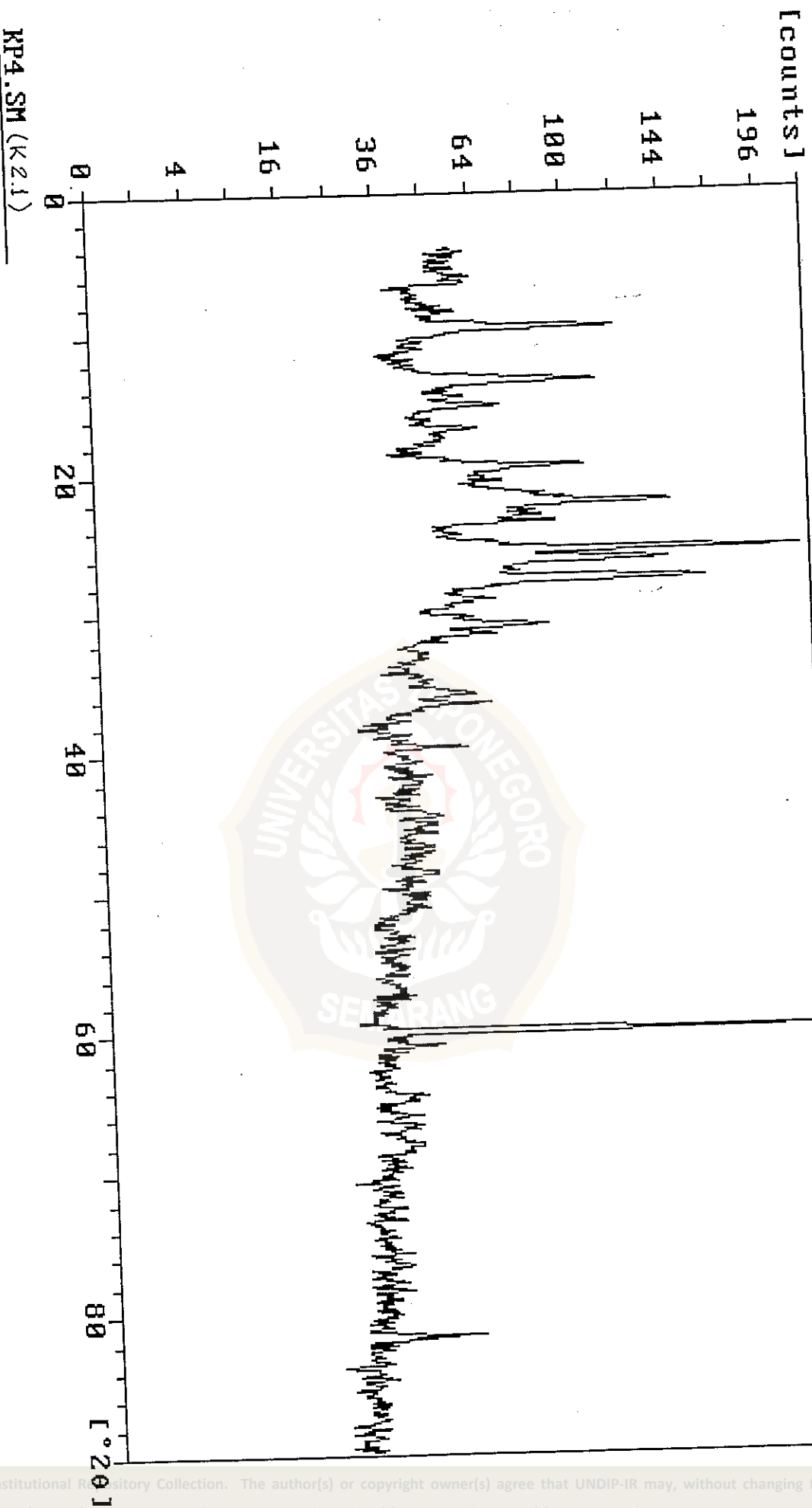
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Sample identification: KP5 (K.2.2)

31-Jul-2001 15:17

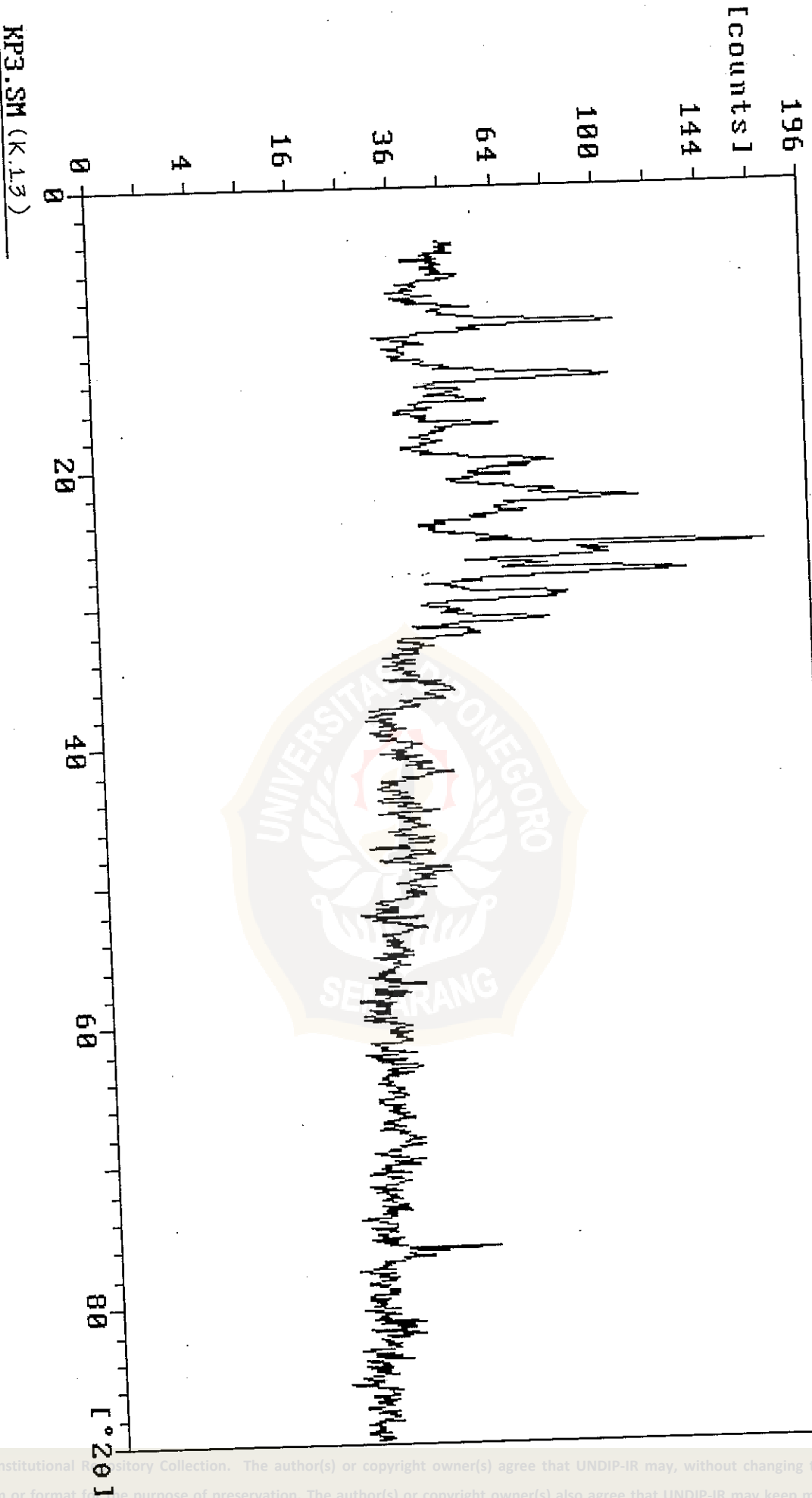


Sample identification: KP4 (K.2.1)



31-Jul-2001 15:17

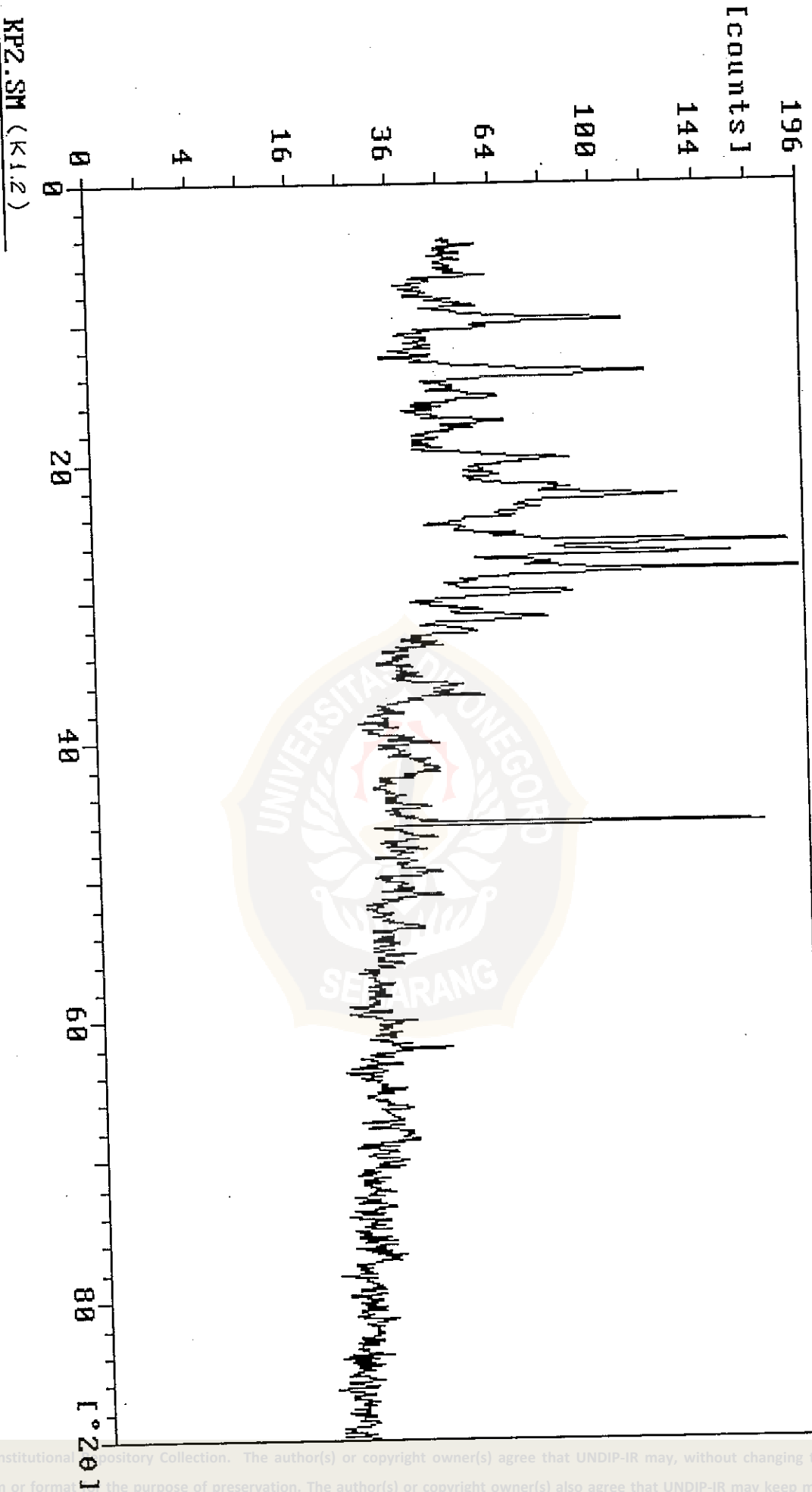
Sample identification: KP3 (K.13)



31-Jul-2001 15:16

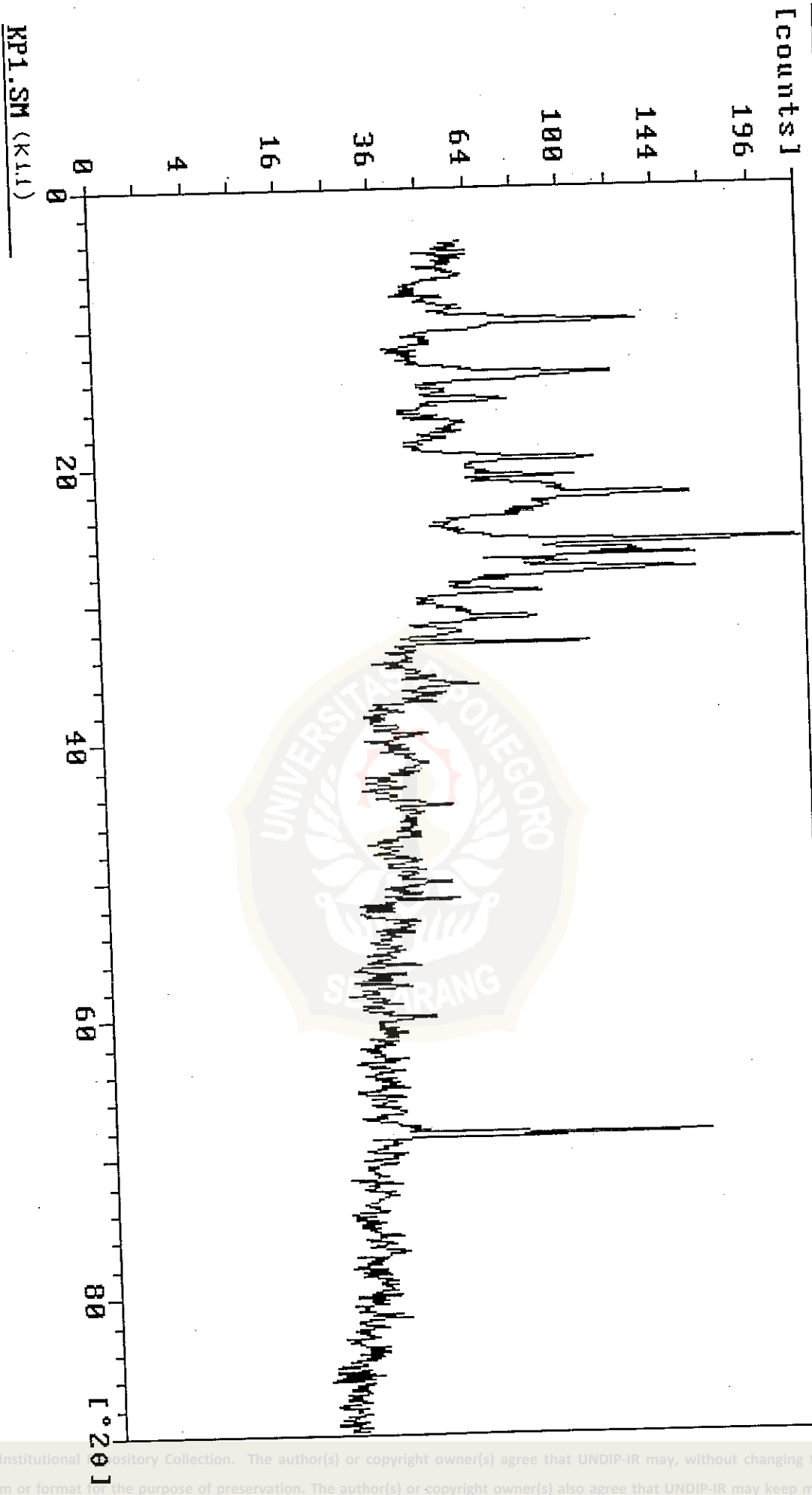
Sample identification: KP2 (K1.2)

31-Jul-2001 15:16



Sample identification: KP1 (K1.1)

31-Jul-2001 15:16

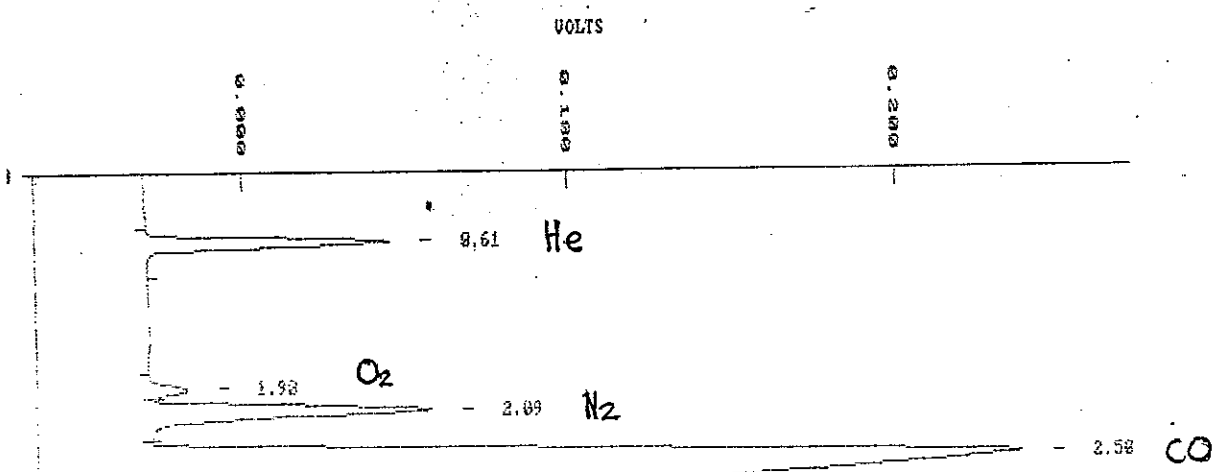


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*****
Date 02/08/01
:41 DELTA CHROMATOGRAPHY DATA SYSTEM - AREA PERCENT REPORT
*****
D :NATURALG
:CO-C02 2039
T : 1.000
ION : 1.000
INJECTION : 1 OF 1
CHROMATOGRAM FILE :KP6-300M (K.2.3)
CHROMATOGRAM SOURCE :ACQUIRE
*****

```

Run by Method :NATURALG on 02/08/01 at 7:57 am



COMP	COMPOUND	RETENTION TIME (MIN)	WIDTH (sec)	HEIGHT (mV)	AREA (mV.Sec)	AREA PERCENT
01	He	0.61	75.0000	411.64038	83.5837	100.00
02	O2	1.98	11.8000	70.22504	1.0668	
03	N2	2.09	87.0000	598.59180	7.0931	
04	CO	2.58	267.5000	5502.27537	83.5837	

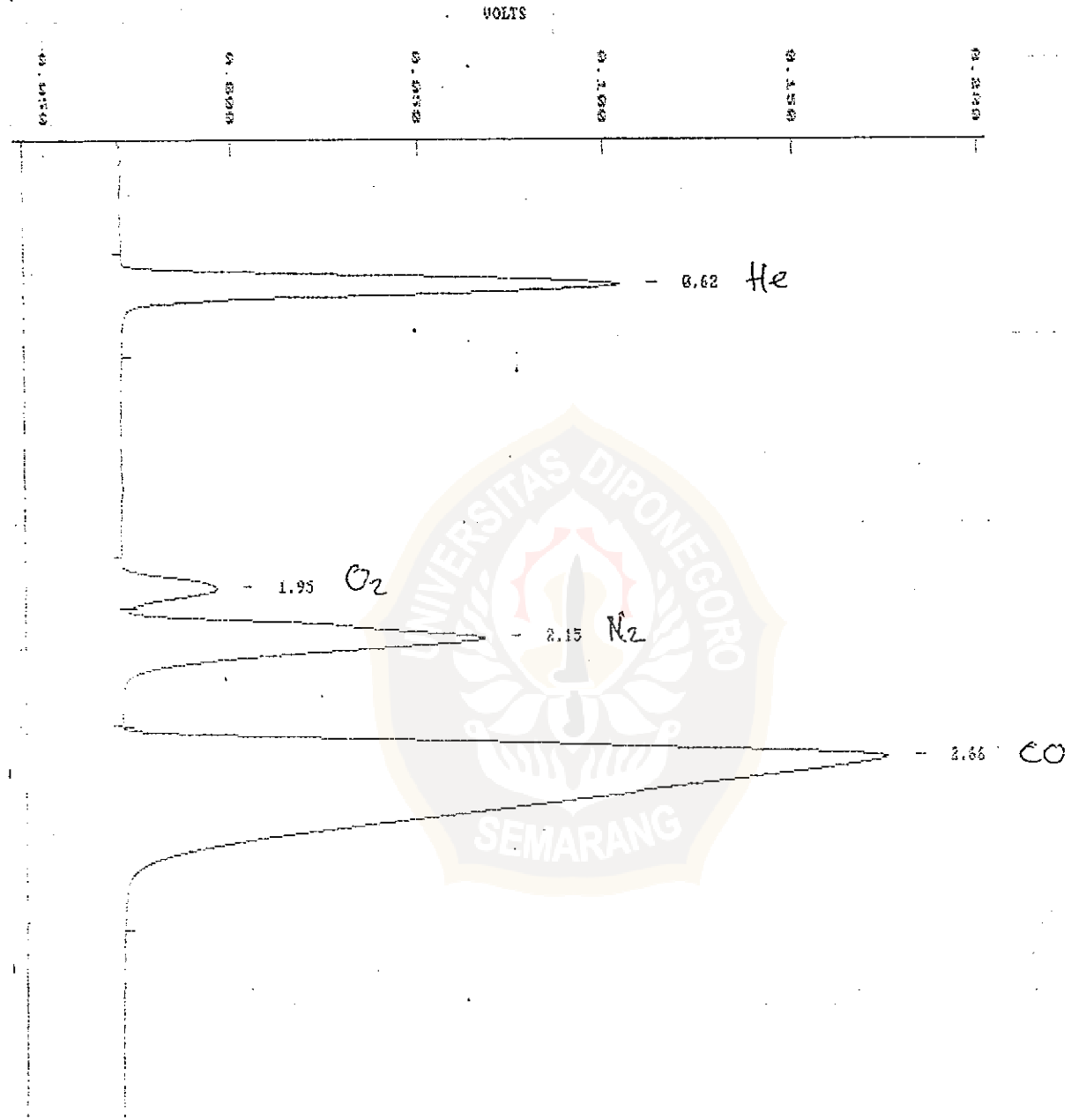


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*****
Date *
:35 DELTA CHROMATOGRAPHY DATA SYSTEM - AREA PERCENT REPORT 02/08/01 *
*****
) :NATURALG
:CO-CO2 2040 INJECTION : 1 OF 1
r : 1.000 CHROMATOGRAM FILE :KP6-500M (K.23)
IGN : 1.000 CHROMATOGRAM SOURCE :ACQUIRE
*****

```

d by Method :NATURALG on 02/08/01 at 8:12 am



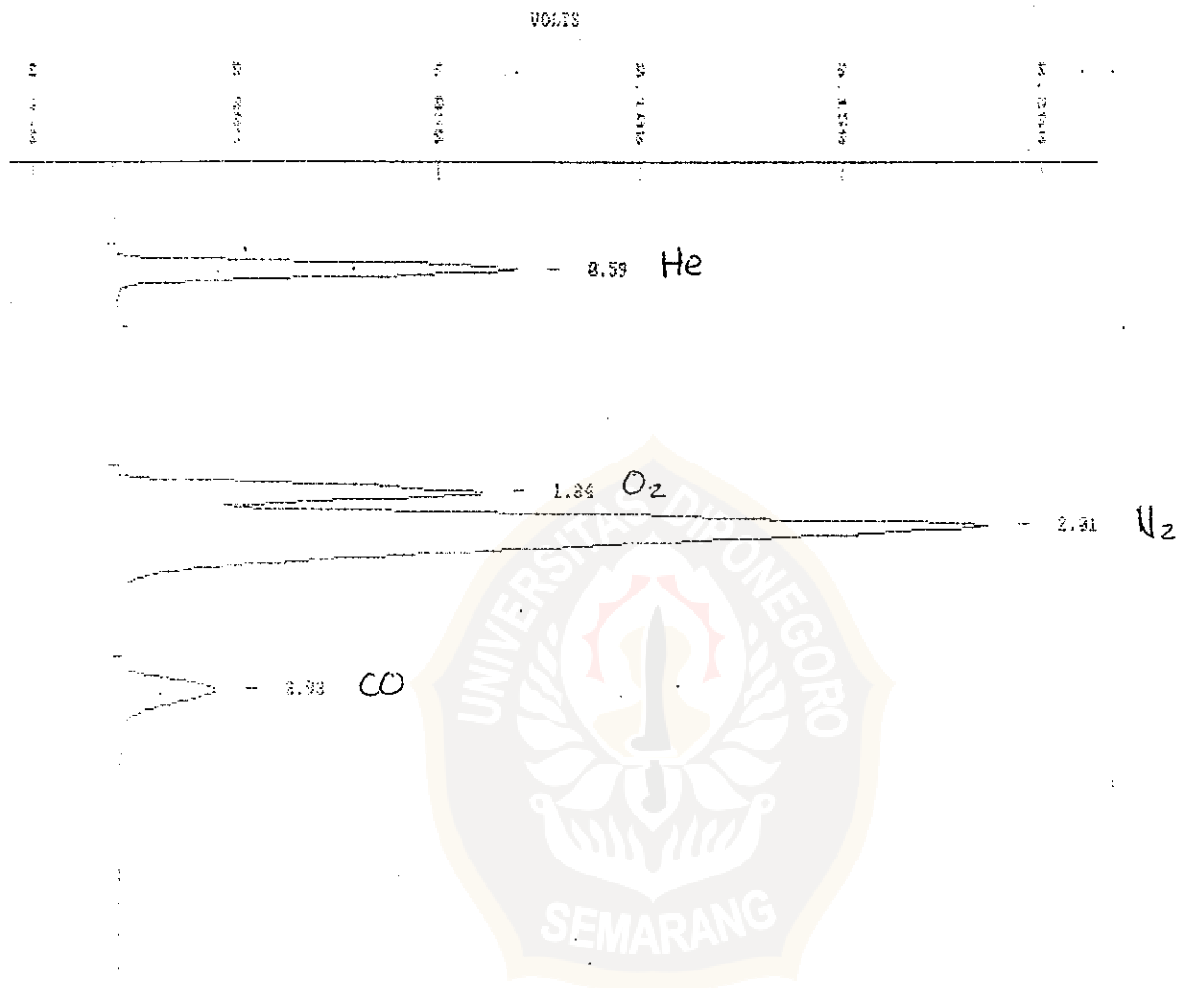
IMPT #	COMPOUND	RETENTION TIME (MIN)	WIDTH (sec)	HEIGHT (mV)	AREA (mV.Sec)	AREA PERCENT
				463.80	5158.55	100.0
TYPE	RET. TIME(min)	HEIGHT(volts)	AREA(volt.mins)	AREA %		
BB	0.625	134.0000	734.95392	14.2473		
BB	1.547	25.9000	154.41722	2.9934		
BB	2.147	97.8000	742.44849	14.3926		
BB	2.660	206.1000	3526.72754	68.3667		

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*****
Date *
14 DELTA CHROMATOGRAPHY DATA SYSTEM - AREA PERCENT REPORT 02/08/01 *
*****
:NATURALS *
:CO-CO2 2040 INJECTION : 1 OF 1 *
: 1.000 CHROMATOGRAM FILE : KP6-700M (K.2.3) *
IN : 1.000 CHROMATOGRAM SOURCE : ACQUIRE *
*****

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by Method :NATURALS on 02/08/01 at 8:46 am



RET. TIME (min)	RETENTION TIME (MIN)	WIDTH (sec)	HEIGHT (mV)	AREA (mV.Sec)	AREA PERCENT
0.592	0.592	99.3000	429.50	3822.28	100.0
1.817	1.817	218.9000	90.4000	534.20667	13.9761
2.311	2.311	231.9000	2526.20337	56.0916	3.7104