Höhenruder-Messung

C_R

0,4
0,3
0,2
0,1
-0,3
-0,4
-0,6

-2 2 4 6 8 10 12 14 16 20 22 $\alpha_g°$

C_{mR}

0,1
-0,1
-0,2

-2 2 4 6 8 10 12 14 16 22 $\alpha_g°$

$C_R, C_{mR} = f(\alpha_g°, \eta°)$

$\eta_T = 0°$

——— glattes Ruder mit Strahl $f = 300\ sec^{-1}$

– – – – glattes Ruder ohne Strahl $f = 0$

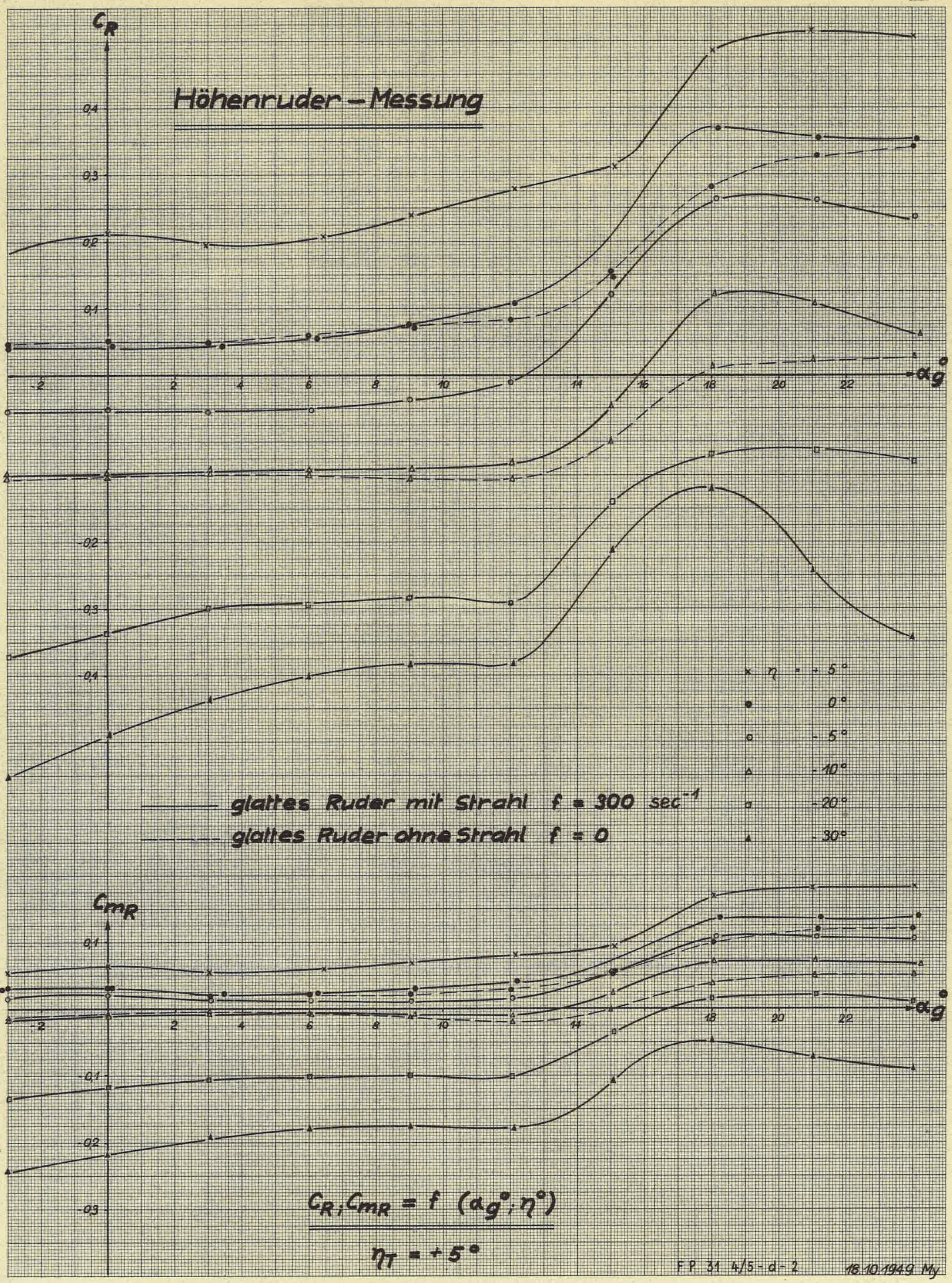
—·—·— Störkante an Höhenruder + Trimmklappe mit Strahl $f = 300\ sec^{-1}$

× η = + 5°
● 0°
○ - 5°
△ - 10°
□ - 20°
▲ - 30°

FP 31 4/5 - d - 1

18.10.1949 My

Höhenruder – Messung

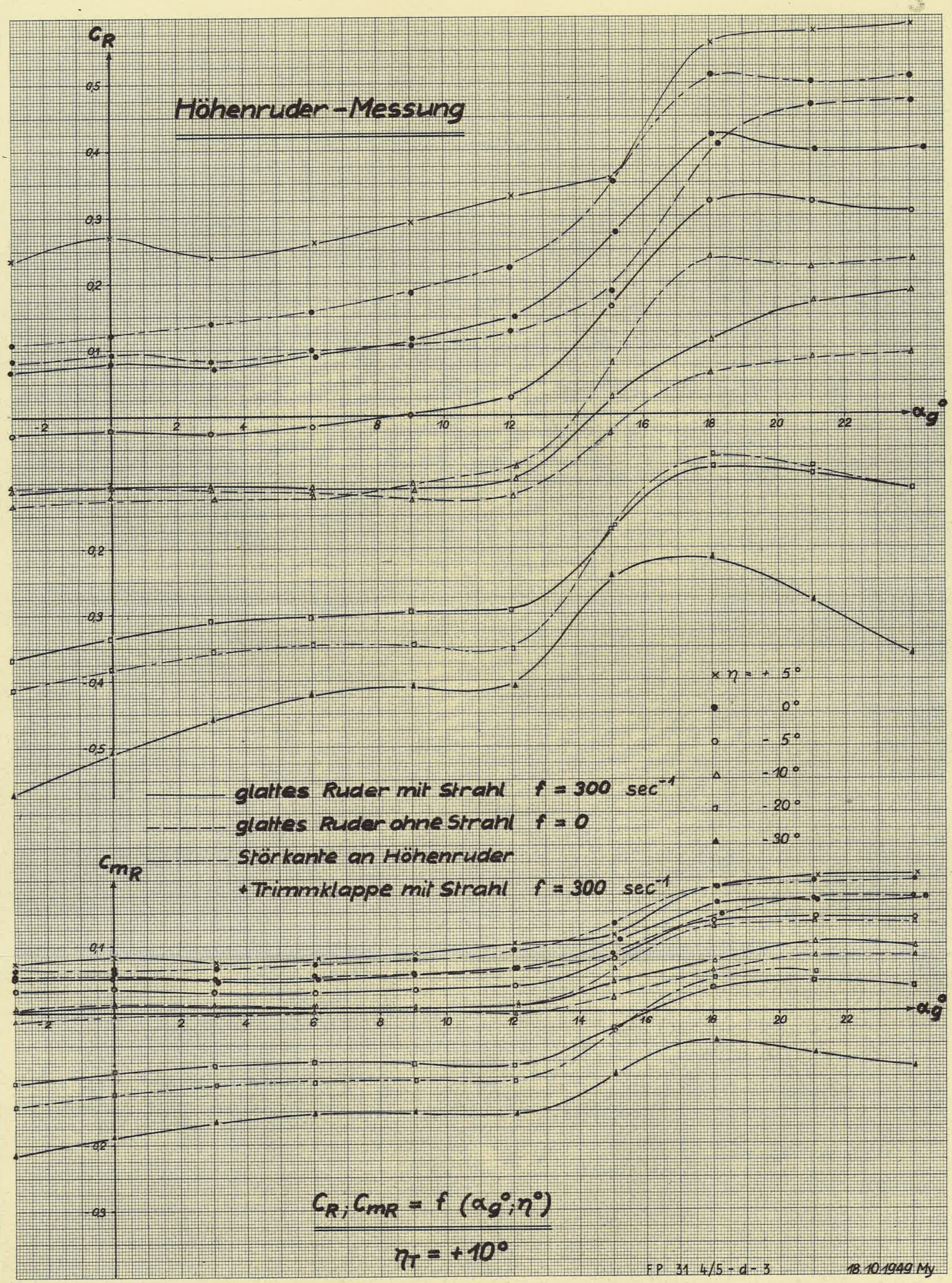


$c_R ; c_{mR} = f\ (\alpha_g° ; \eta°)$

$\eta_T = + 5°$

FP 31 4/5 - d - 2 16.10.1949 My

Höhenruder-Messung

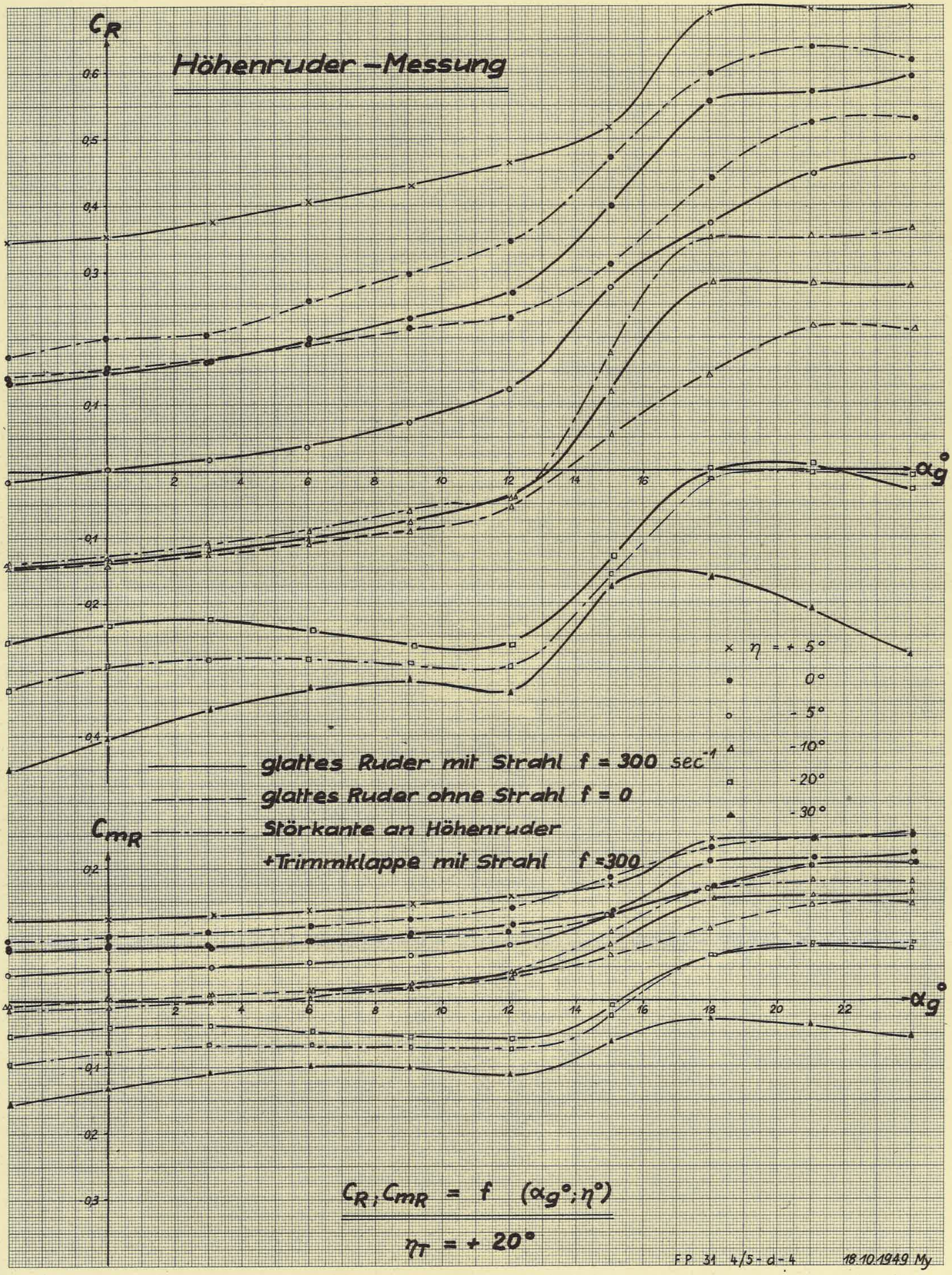


$$c_R ; c_{mR} = f(\alpha_g°; \eta°)$$

$$\eta_T = +10°$$

FP 31 4/5 - d - 3 18.10.1949 My

Höhenruder – Messung



$$c_R ; c_{mR} = f\ (\alpha_g°; \eta°)$$

$$\eta_T = + 20°$$

FP 31 4/5-d-4 18.10.1949 My

Höhenruder - Messung

C_R

0,7
0,6
0,5
0,3
0,2
0,1
-0,1
-0,2
-0,3

-2 2 4 6 8 12 14 16 18 20 22 $\alpha_g°$

C_{mR}

0,1
-0,2
-0,3

-2 2 4 6 8 10 12 14 16 22 $\alpha_g°$

—— glattes Ruder mit Strahl $f = 300\ sec^{-1}$

– – – glattes Ruder ohne Strahl $f = 0$

× $\eta = +5°$ ▲ $\eta = -10°$

● $0°$ ▫ $-20°$

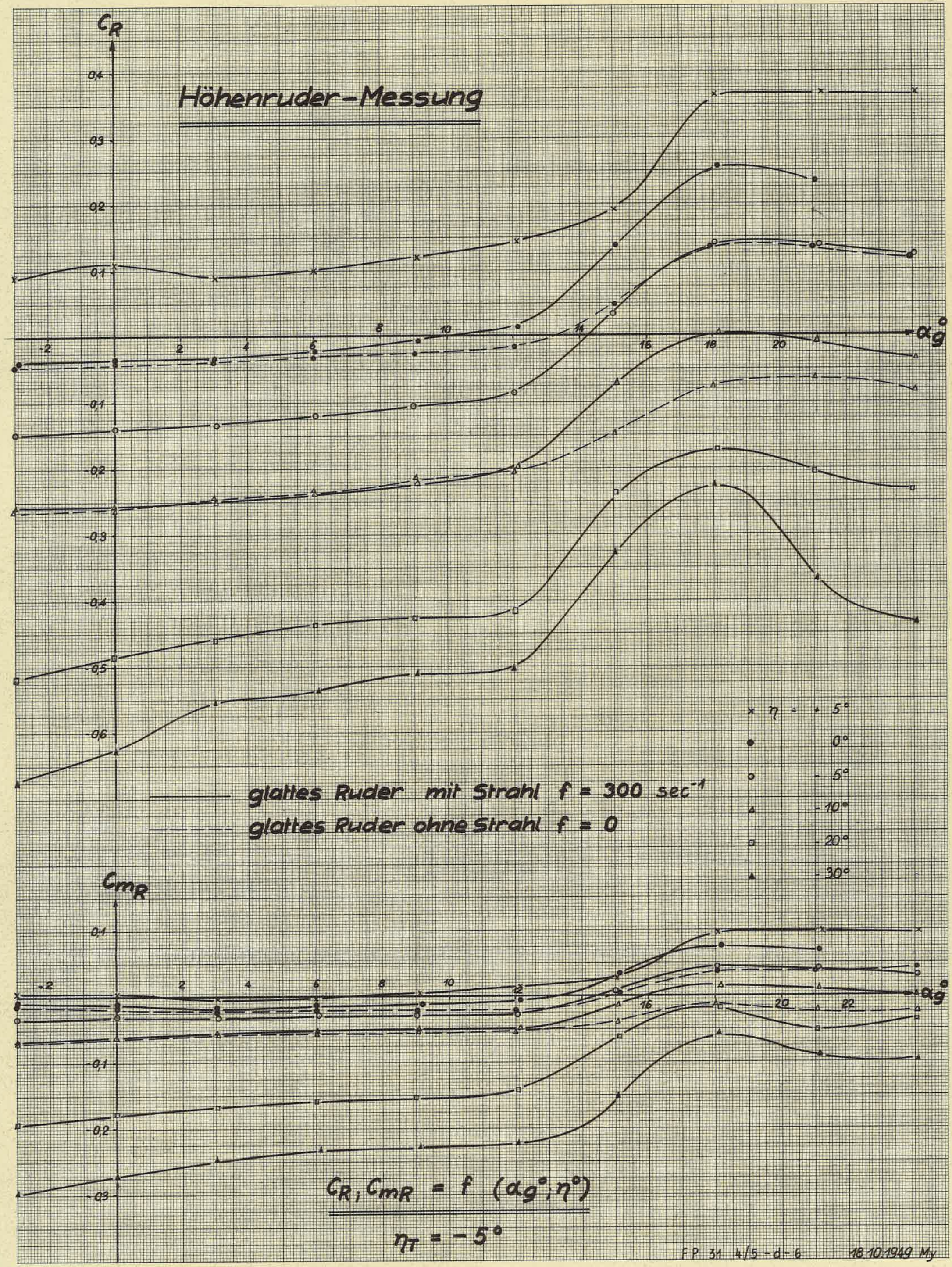
○ $-5°$ ▲ $-30°$

$C_R; C_{mR} = f(\alpha_g°; \eta°)$

$\eta_T = +30°$

FP 31 4/5 - a - 5 18.10.1949 My

Höhenruder-Messung

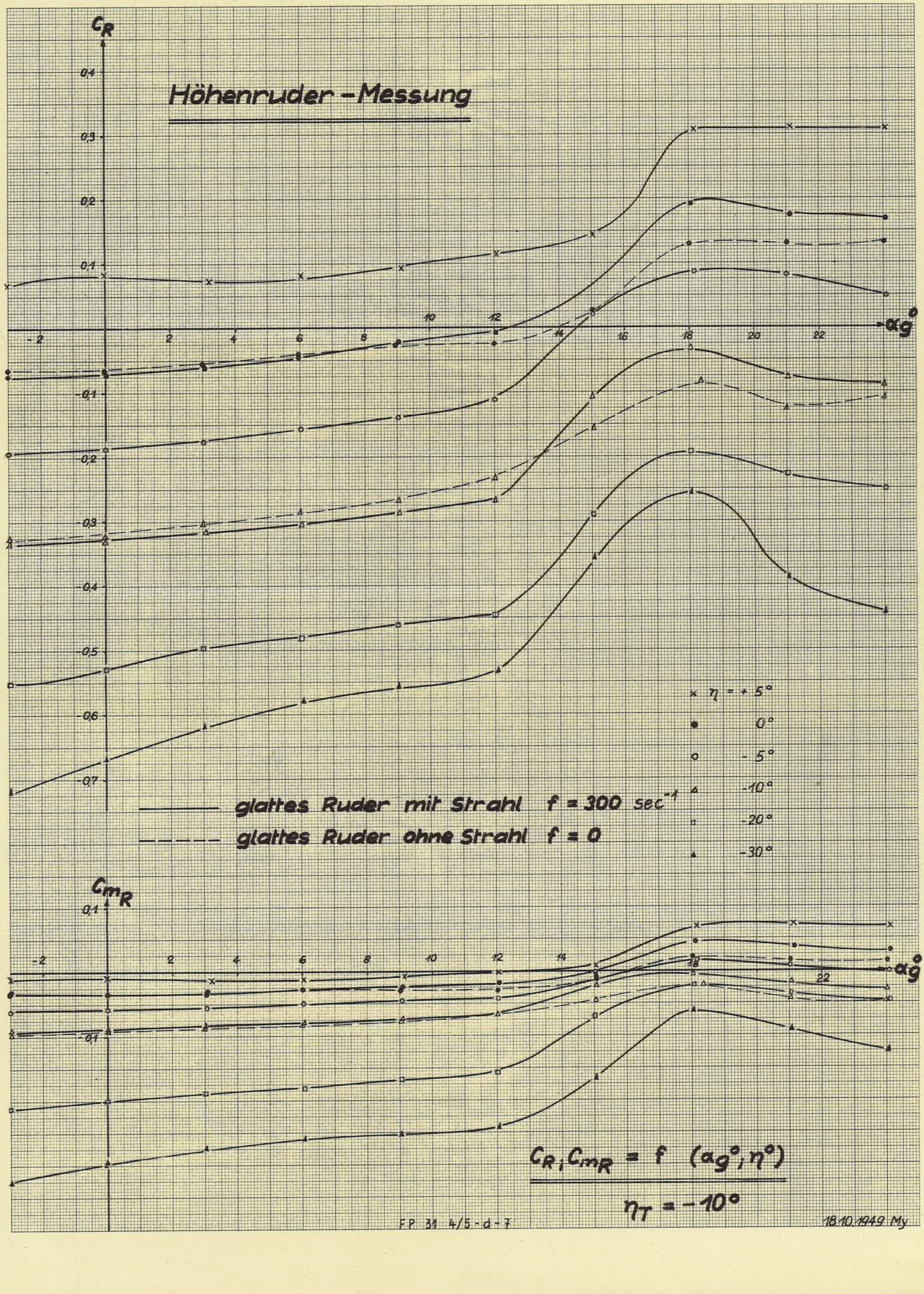


$c_R ; c_{mR} = f\ (\alpha_g° ; \eta°)$

$\eta_T = -5°$

FP 31 4/5 - d - 6 18.10.1949 My

Höhenruder - Messung



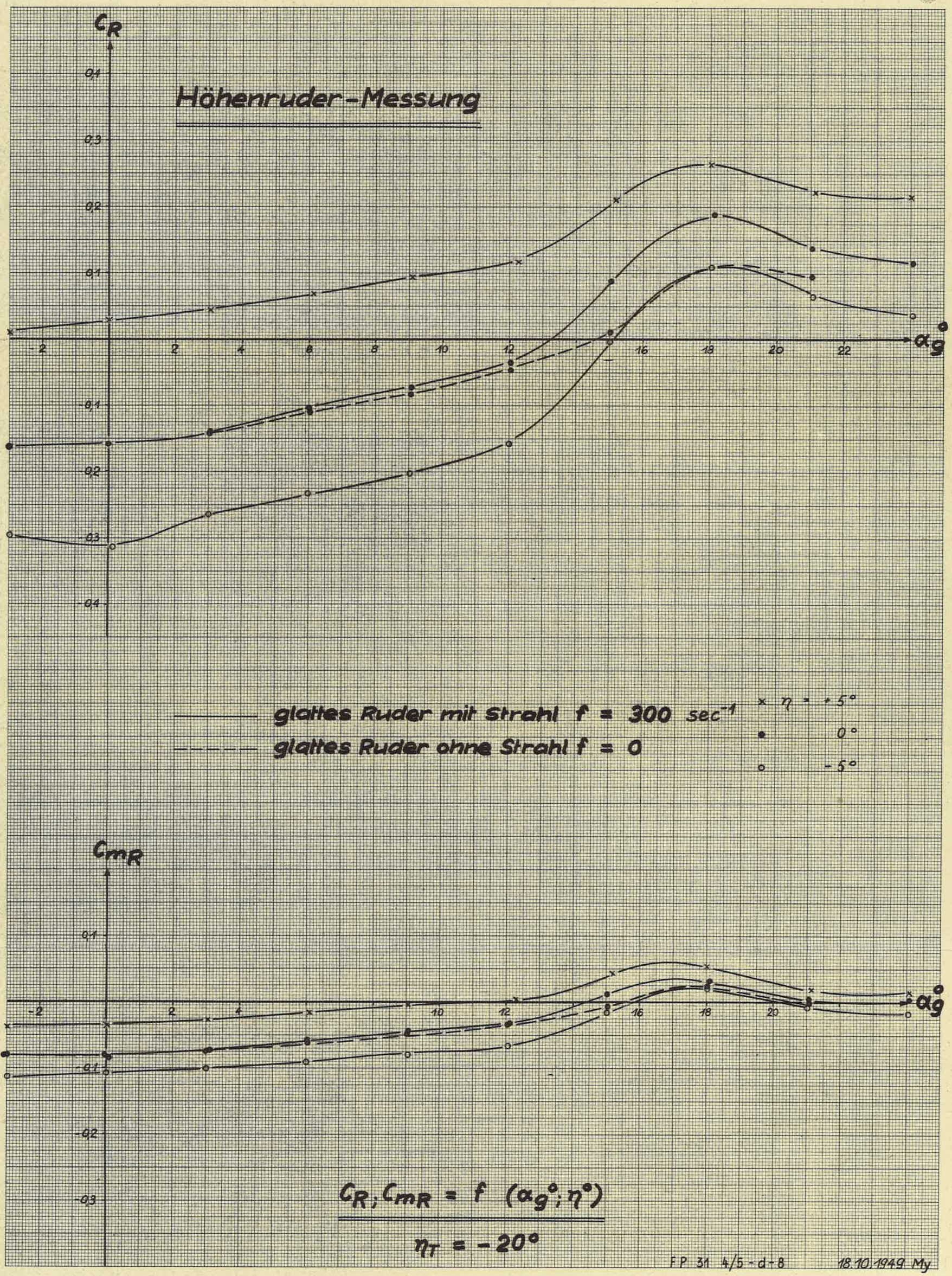
$c_R ; c_{m_R} = f\ (\alpha_g^0 ; \eta^0)$

$\eta_T = -10°$

FP 31 4/5 - d - 7

18.10.1949 My

Höhenruder-Messung

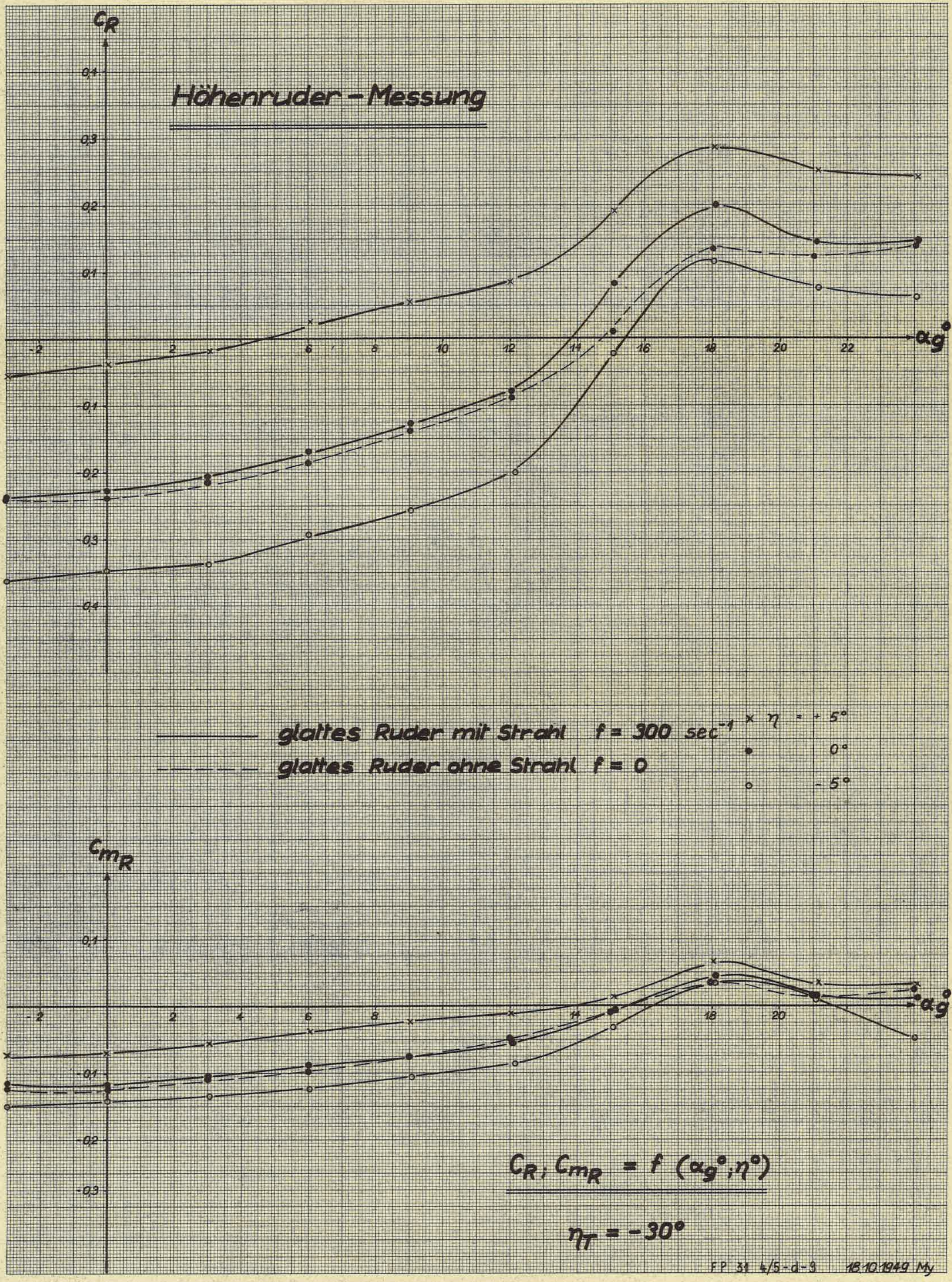


$$c_R ; c_{mR} = f\ (\alpha_g° ; \eta°)$$

$$\eta_T = -20°$$

FP 31 4/5 - d - 8 18.10.1949 My

Höhenruder - Messung



$c_R ; c_{m_R} = f(\alpha_g° ; \eta°)$

$\eta_T = -30°$

FP 31 4/5-d-9 18.10.1949 My

Höhenruder - Messung

y/l_R

● = 1,32

1,0

0,8

0,6

0,4

0,2

-0,2

● = -1,54

● = -2,23

-2 2 4 6 8 10 12 16 18 20 22 $\alpha_g°$

glattes Ruder mit Strahl $f = 300\ sec^{-1}$

× η = + 5°
● 0°
○ - 5°
△ - 10°
□ - 20°
▲ - 30°

x/l_R

● = 2,30

0,8

0,6

0,2

-0,2

-0,4

● = -8,25

● = 1,01

-2 2 4 6 8 10 12 14 16 18 20 22 $\alpha_g°$

$y/l_R;\ x/l_R = f(\alpha_g°; \eta°)$

$\eta_T = 0°$

Höhenruder – Messung

y/l_R

$\alpha_g°$

$\Delta = -5{,}34$

glattes Ruder mit Strahl $f = 300\ sec^{-1}$

× η = + 5°
● 0°
○ - 5°
▲ - 10°
□ - 20°
▲ - 30°

x/l_R

$\Delta = -1{,}21$

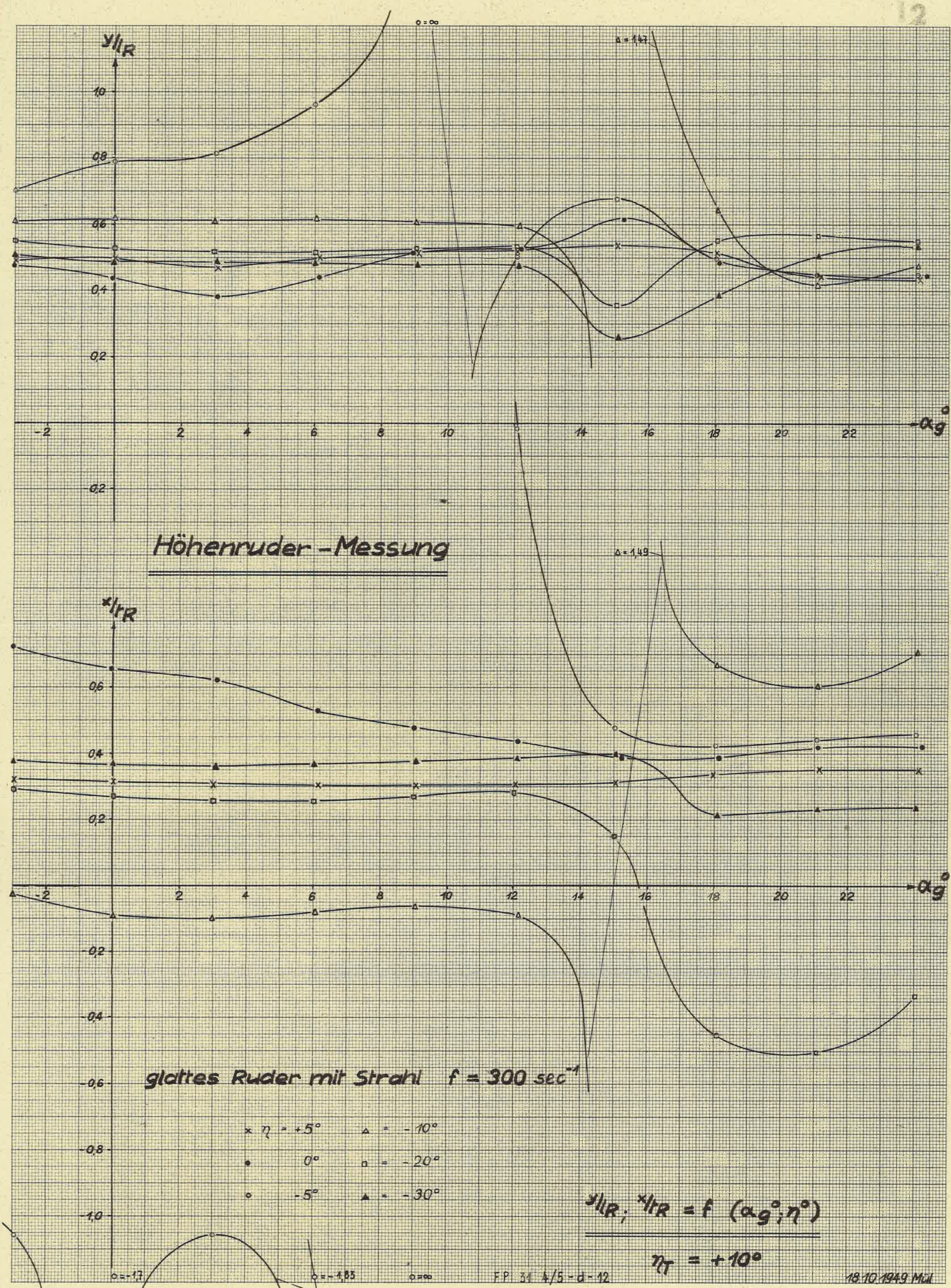
$\Delta = -4{,}36$

$y/l_R;\ x/l_R = f(\alpha g°; \eta°)$

$\eta_T = +5°$

FP 31 4/5 - a - 11 18.10.1949 Mül

Höhenruder-Messung



glattes Ruder mit Strahl $f = 300\ sec^{-1}$

× $\eta = +5^\circ$ △ $= -10^\circ$

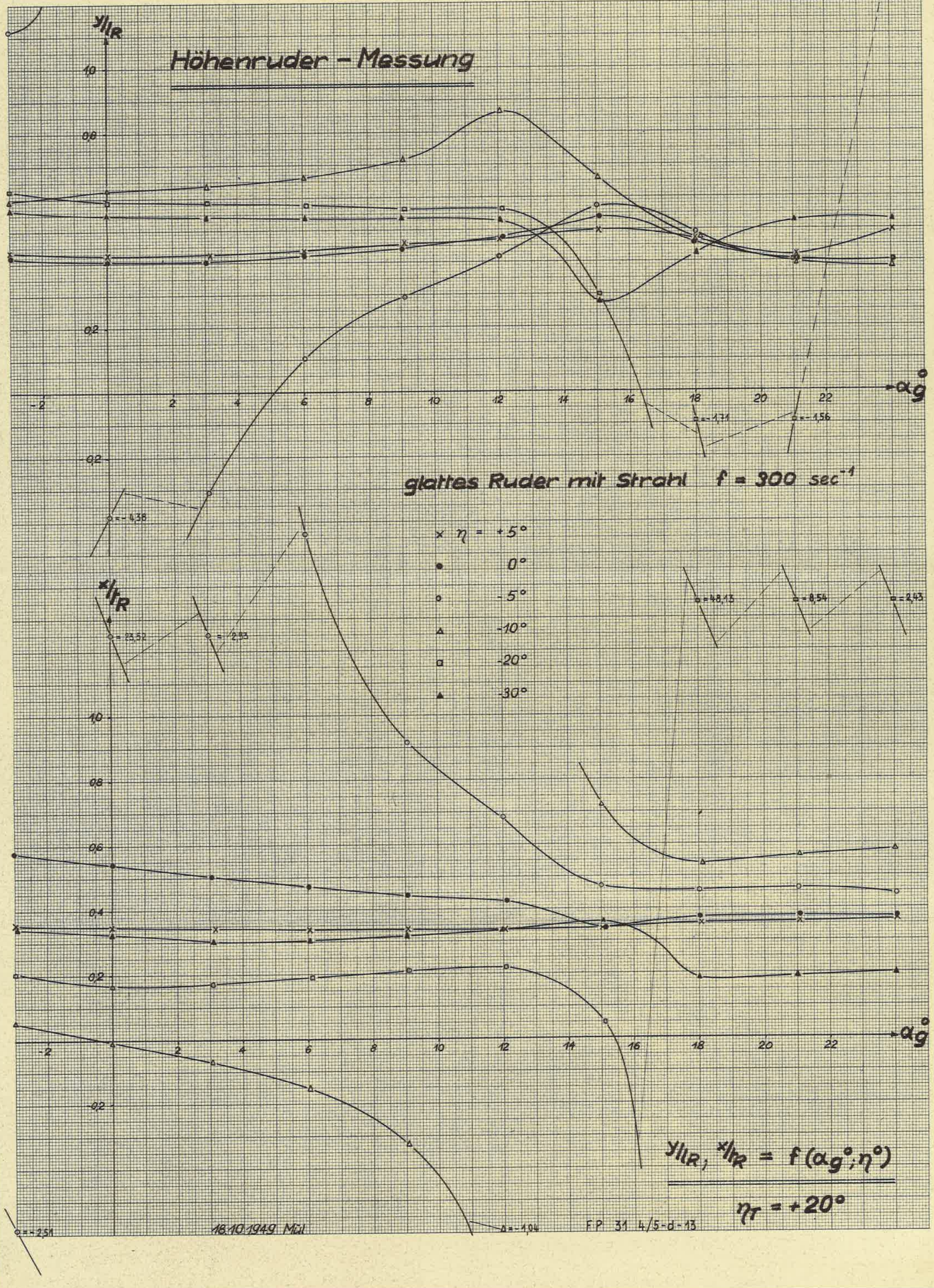
• 0° □ $= -20^\circ$

○ -5° ▲ $= -30^\circ$

$y/l_R;\ x/l_R = f\ (\alpha_g^\circ; \eta^\circ)$

$\eta_T = +10^\circ$

Höhenruder - Messung



glattes Ruder mit Strahl $f = 300\ sec^{-1}$

× η = +5°
● 0°
○ -5°
△ -10°
□ -20°
▲ -30°

y/l_R, $x/l_R = f(\alpha_g^\circ; \eta^\circ)$

$\eta_T = +20°$

Höhenruder - Messung

glattes Ruder mit Strahl $f = 300\ sec^{-1}$

y_{l_R}

1,0
0,8
0,6
0,2

Δ = - 2,31

Δ = 8,31

x_{l_R}

0,8
0,6
0,4
0,2
-0,2
-0,4
-0,6

Δ = - 1,02

-2 2 4 6 8 10 12 14 16 18 20 22 $\alpha_g°$

× η = +5°
● 0°
○ -5°
△ -10°
□ -20°
▲ -30°

$y_{l_R}, x_{l_R} = f(\alpha_g°; \eta°)$

$\eta_T = +30°$

FP 31 4/5 - d - 14 18.10.1949 Mül

Höhenruder-Messung

y/l_R

$\Phi = 1{,}70$

$\Delta = 7{,}3$

$\Delta = -1{,}48$

$\alpha g°$

glattes Ruder mit Strahl $f = 300\ sec^{-1}$

x/l_R

$\Delta = 5{,}1$

$\Phi = 1{,}98$

$\Delta = -1{,}6$

× η = + 5°
● 0°
○ - 5°
△ - 10°
□ - 20°
▲ - 30°

$y/l_R;\ x/l_R = f\ (\alpha g°; \eta°)$

$\eta_T = -5°$

FP 31 4/5 - a - 15 18.10.1949 Mül

Höhenruder – Messung

y/t_R

1,0
0,8
0,6
0,4
0,2
-0,2

-2 2 4 6 8 10 12 14 16 18 20 22 $-\alpha_g°$

= 2,64
= 1,59
= - 1,51

glattes Ruder mit Strahl $f = 300\ sec^{-1}$

× η = + 5°
● 0°
○ - 5°
△ -10°
□ -20°
▲ -30°

x/t_R

0,8
0,6
0,4
0,2
-0,2
-0,4

-2 2 4 6 8 10 14 18 20 22 $-\alpha_g°$

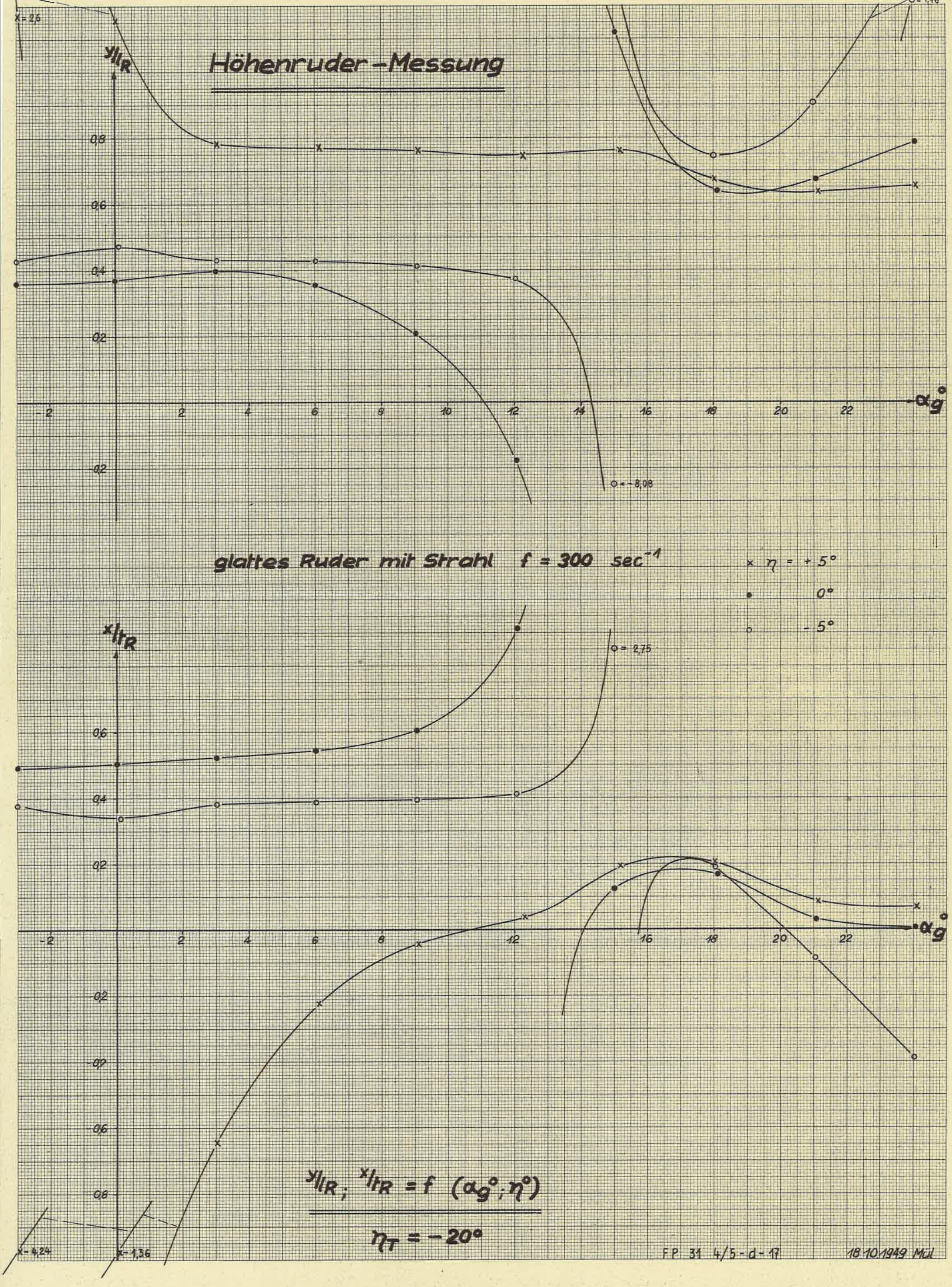
= 2,64

y/t_R; x/t_R = f ($\alpha_g°$; $\eta°$)

η_T = - 10°

FP 31 4/5 - d - 16 18.10.1949 Mül

Höhenruder-Messung



glattes Ruder mit Strahl $f = 300\ sec^{-1}$

× $\eta = +5°$
• $0°$
○ $-5°$

$$y/l_R;\ x/l_R = f\ (\alpha_g°; \eta°)$$

$$\eta_T = -20°$$

FP 31 4/5-d-17 18.10.1949 Mül

Höhenruder-Messung

glattes Ruder mit Strahl $f = 300$ sec^{-1}

× η = + 5°
● 0°
○ − 5°

y/l_R

x/l_R

$\alpha_g°$

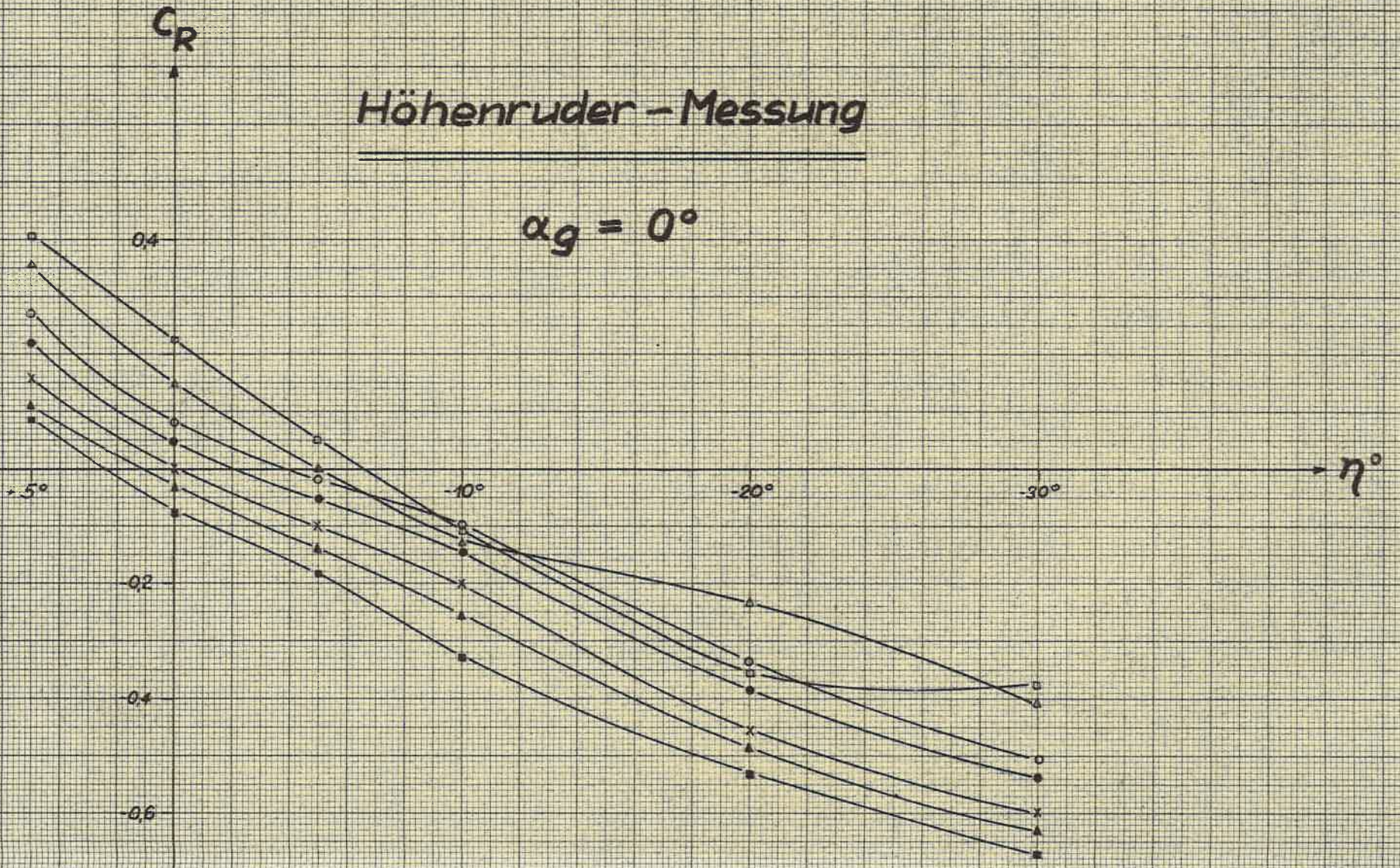
$y/l_R;\ x/l_R = f\ (\alpha_g°; \eta°)$

$\eta_T = -30°$

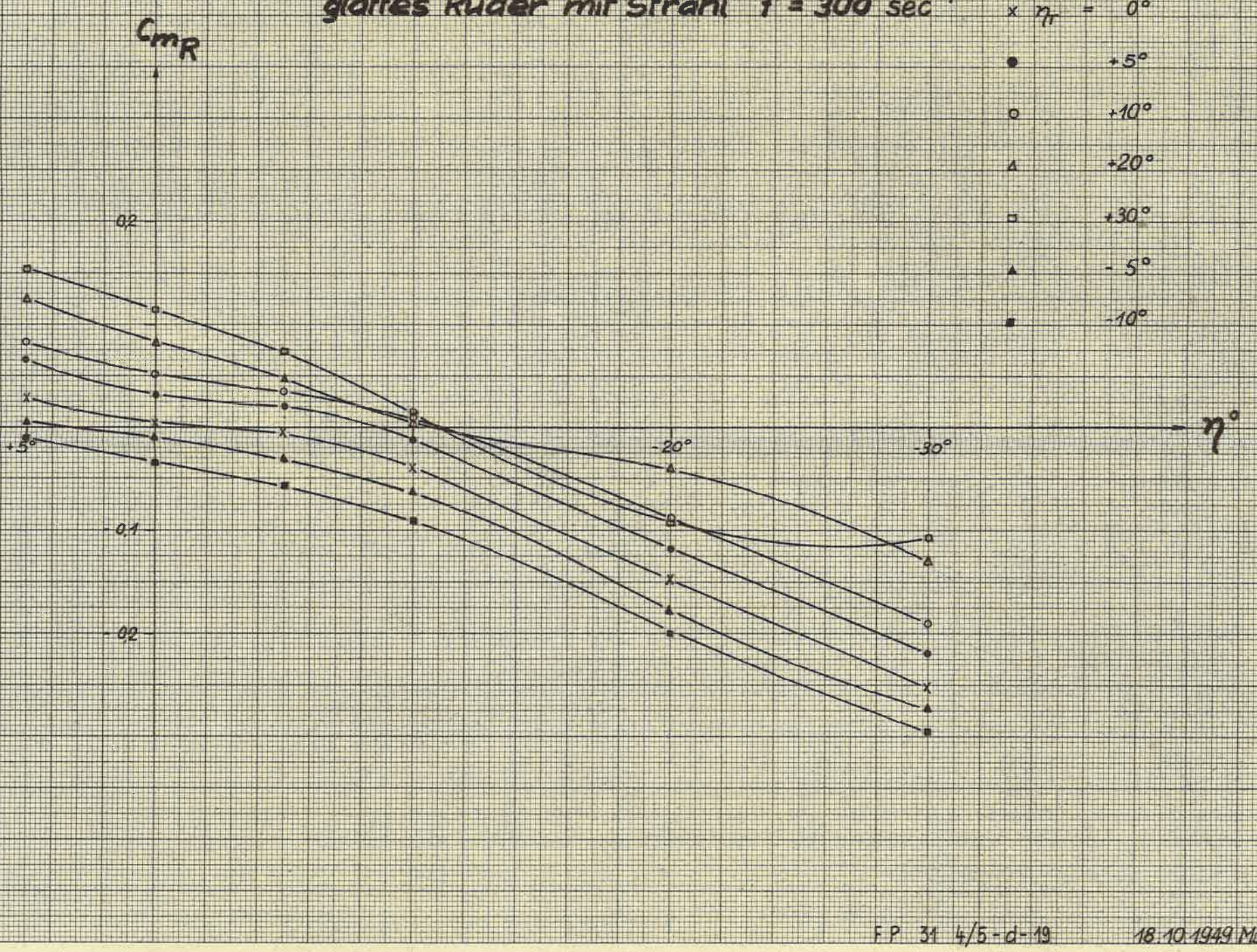
FP 31 4/5-d-18 18.10.1949 Mül

Höhenruder – Messung

$\alpha_g = 0°$



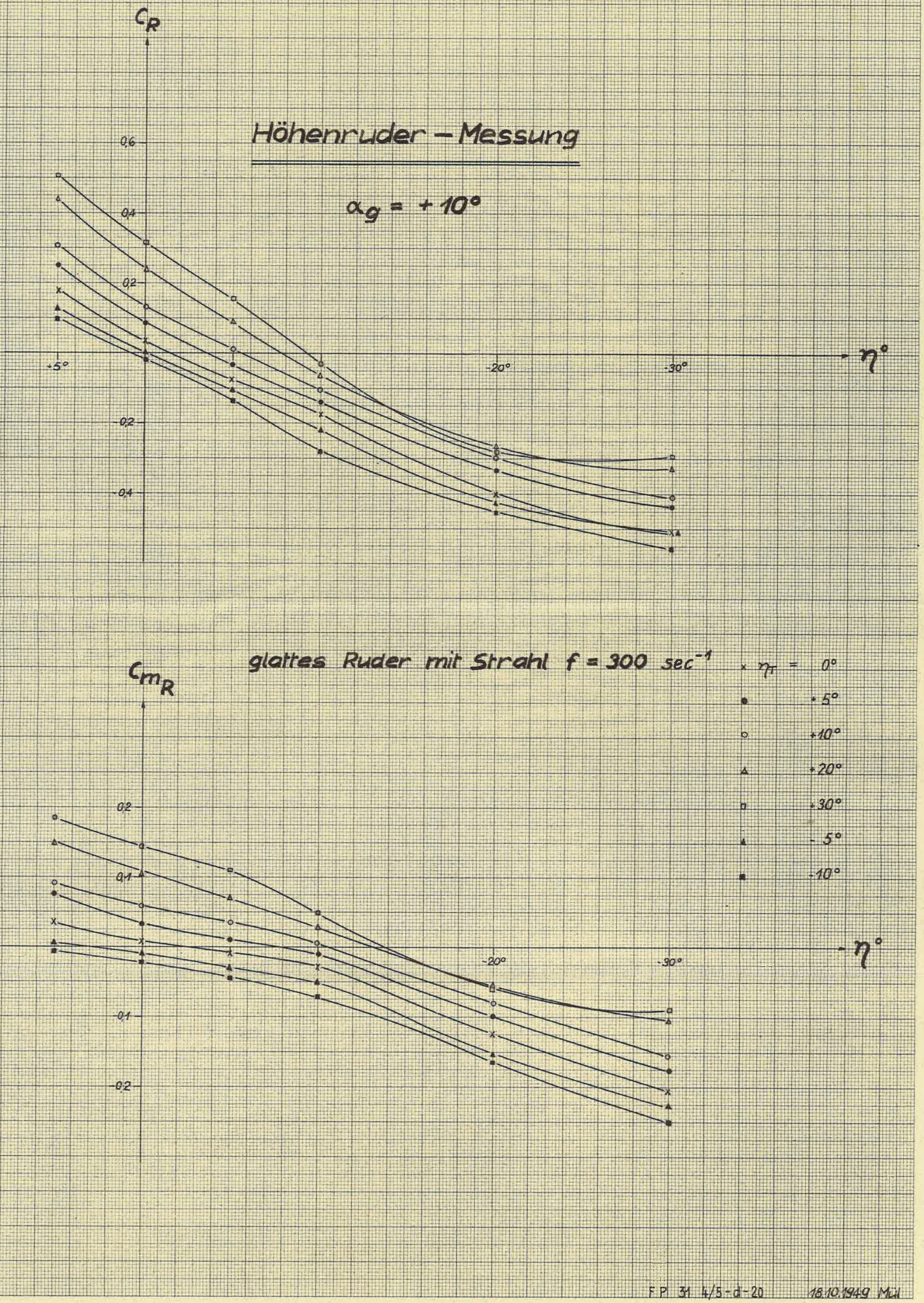
glattes Ruder mit Strahl $f = 300\ sec^{-1}$



× η_T = 0°
● +5°
○ +10°
△ +20°
□ +30°
▲ -5°
■ -10°

Höhenruder – Messung

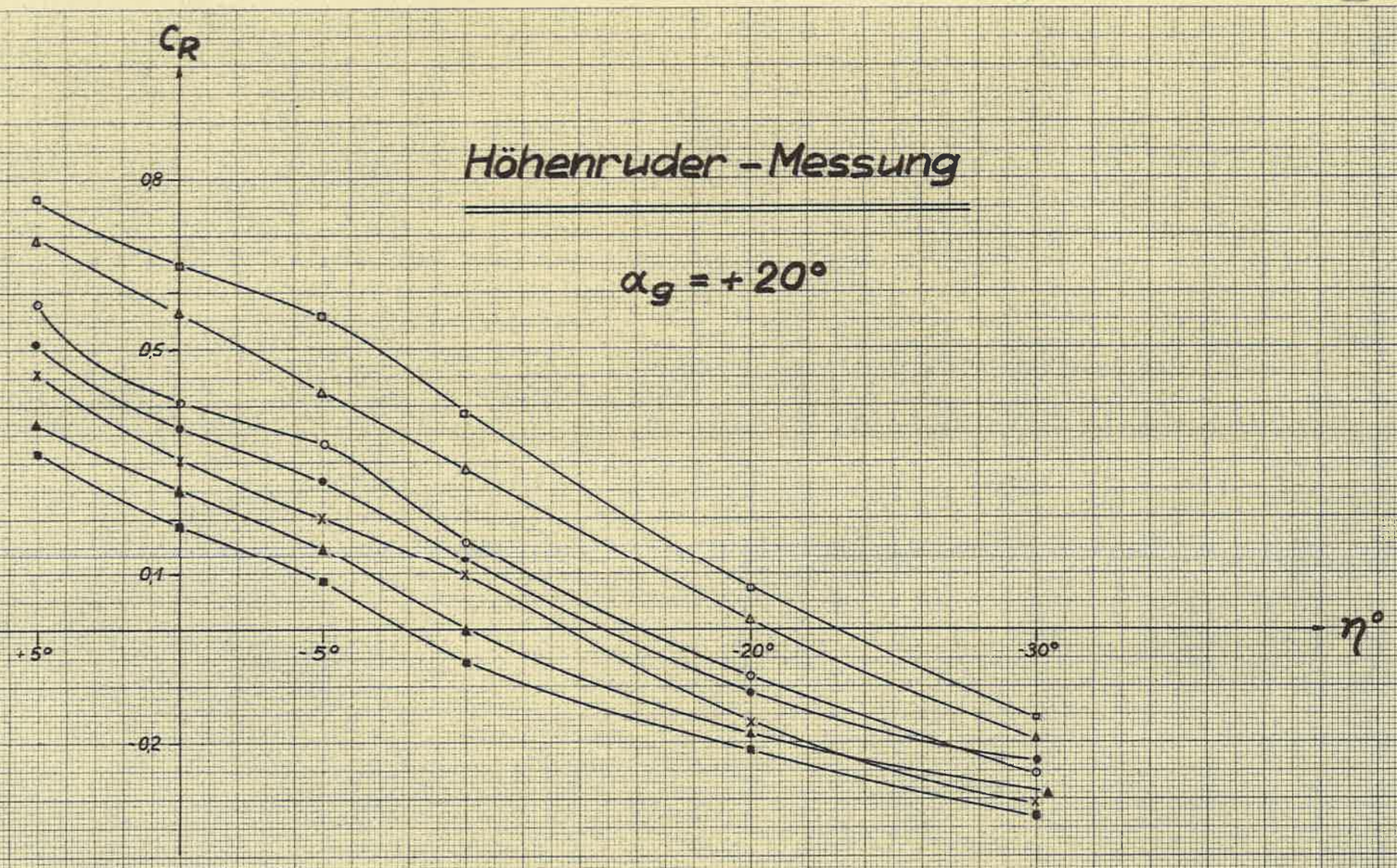
$\alpha_g = +10°$



glattes Ruder mit Strahl $f = 300\ sec^{-1}$

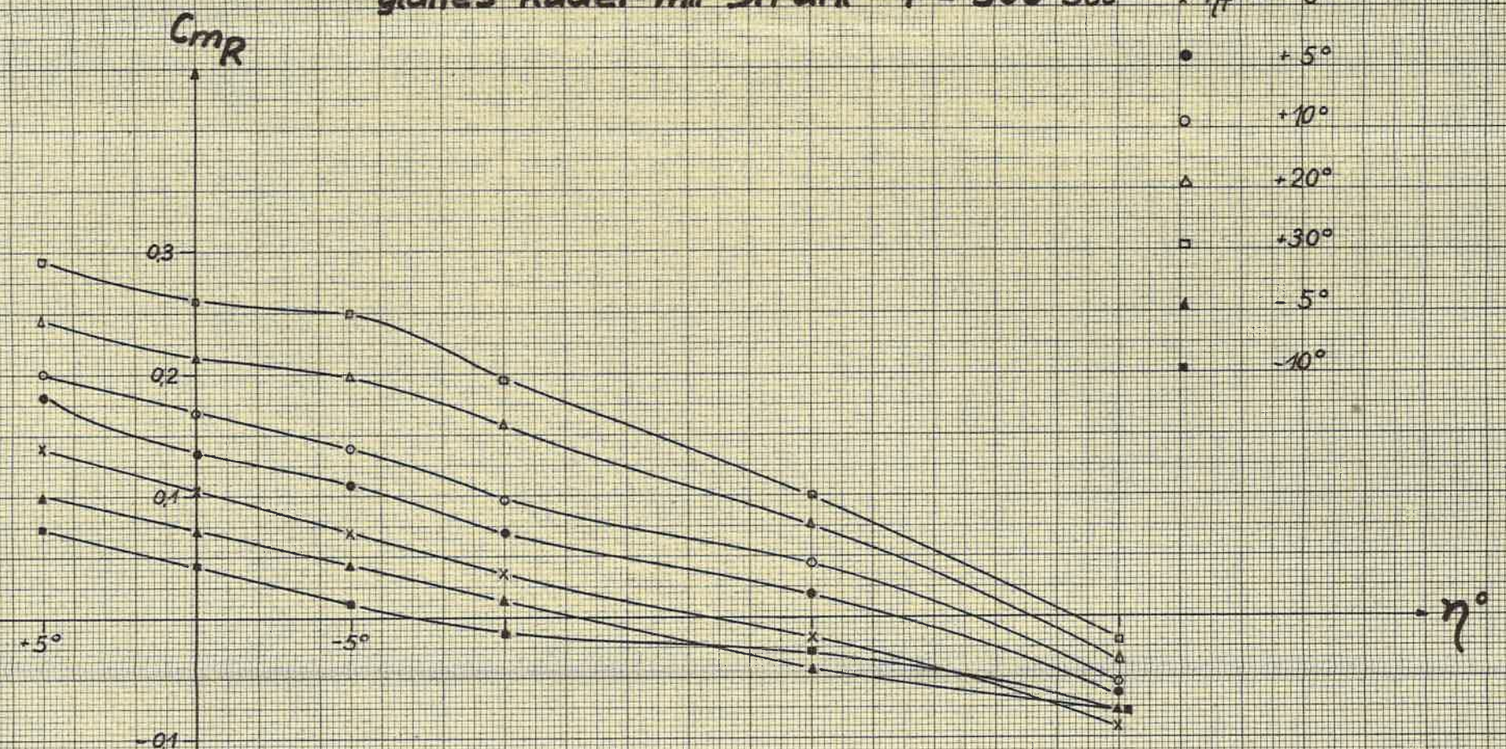
Höhenruder - Messung

$\alpha_g = +20°$



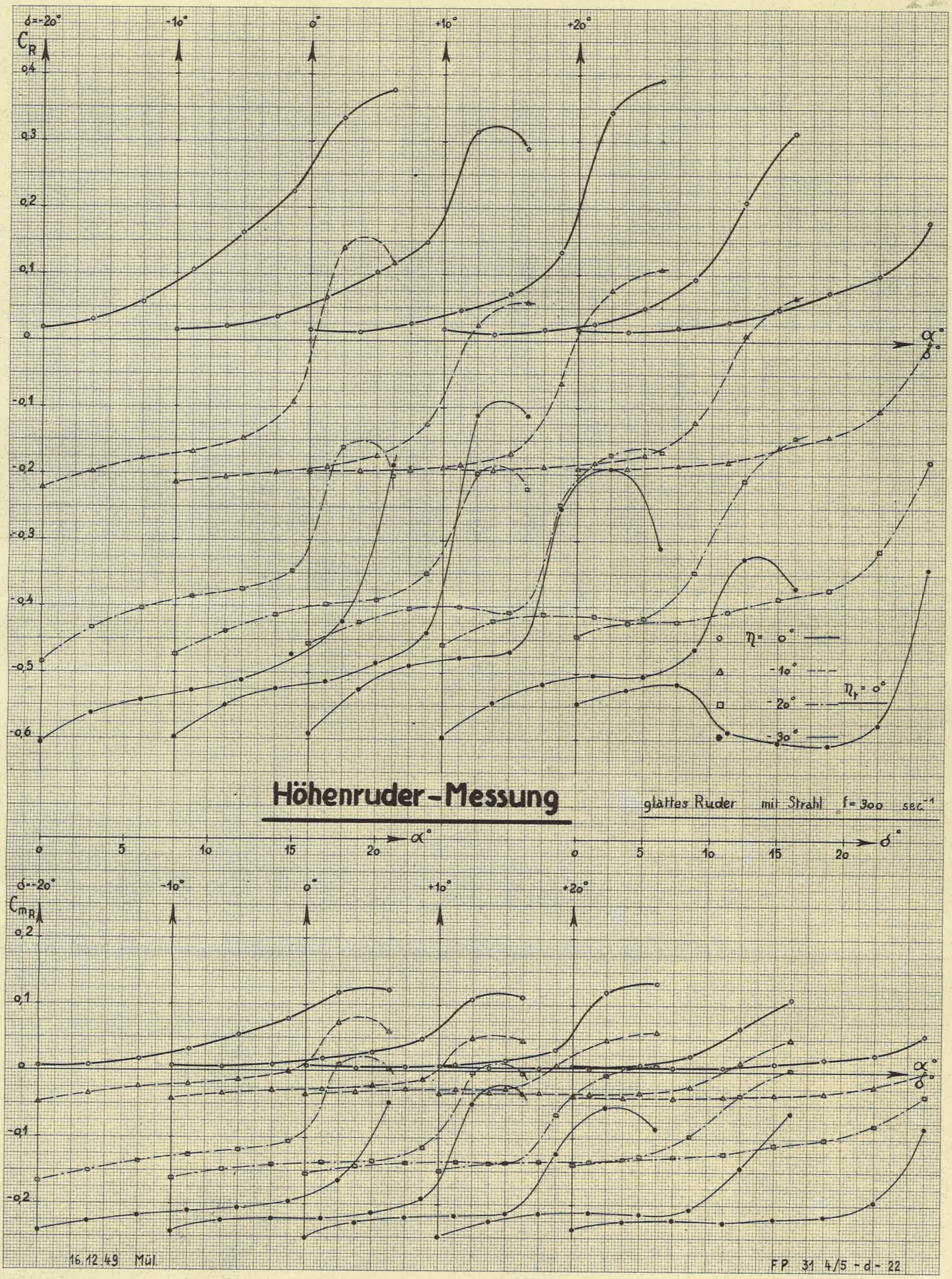
glattes Ruder mit Strahl $f = 300\ sec^{-1}$

× η_T = 0°
● +5°
○ +10°
△ +20°
□ +30°
▲ -5°
■ -10°



Höhenruder-Messung

glattes Ruder mit Strahl $f = 300\ sec^{-1}$



16.12.49 Mül.

Höhenruder-Messung

glattes Ruder ohne Strahl

C_R — $\delta = -20°$, $-10°$, $0°$, $+10°$, $+20°$ — $\alpha°$

η = 0°, 10°, −20°, −30°

$\eta_T = 0°$

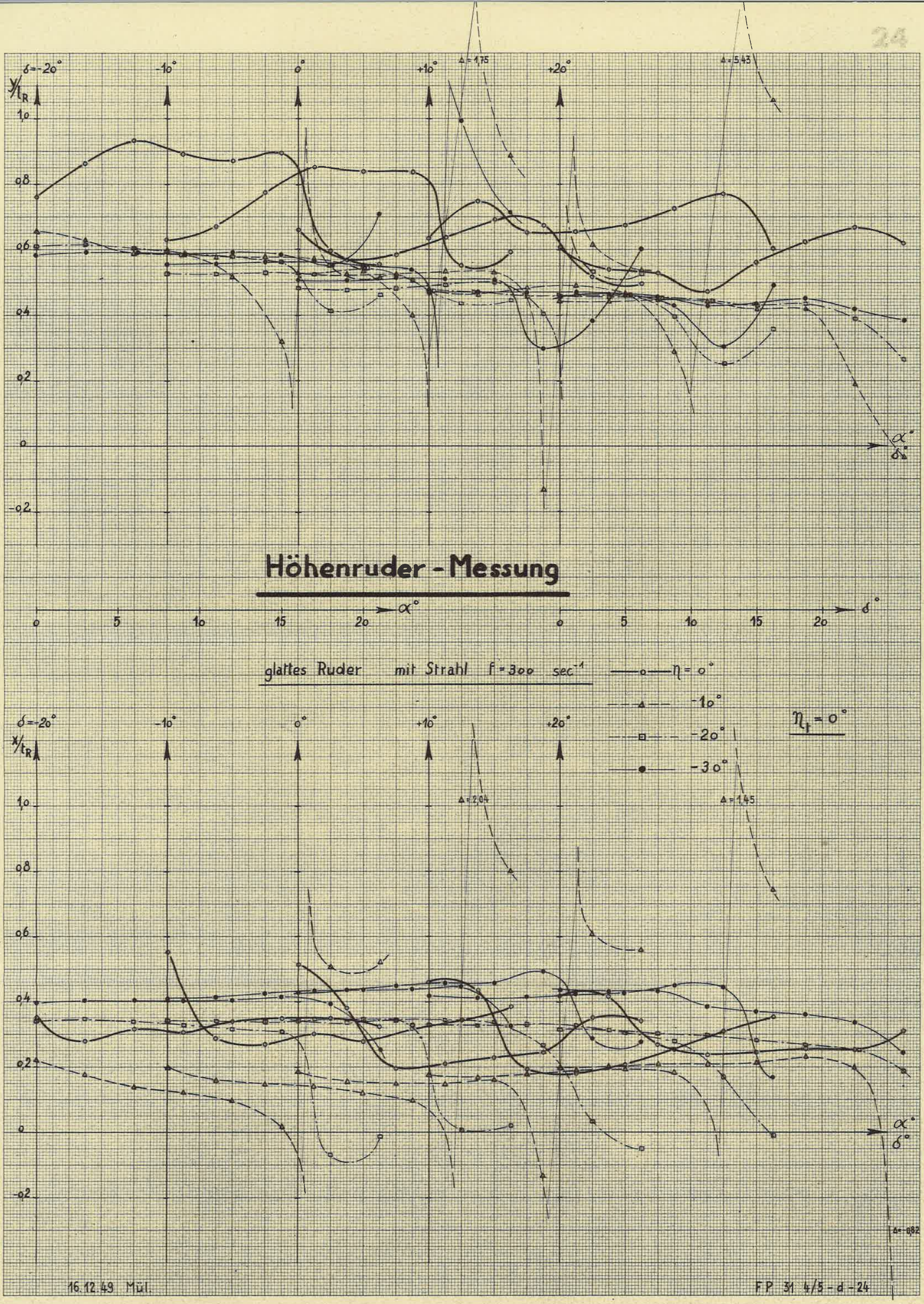
C_{m_R} — $\delta = -20°$, $-10°$, $0°$, $+10°$, $+20°$ — $\alpha°$, $\delta°$

16.12.1949 My

FP 31 4/5 – d – 23

Höhenruder - Messung

glattes Ruder mit Strahl f = 300 sec^{-1}



16.12.49 Mül.

FP 31 4/5 - d - 24

Höhenruder-Messung

glattes Ruder ohne Strahl

o $\eta = 0°$
△ $-10°$
□ $-20°$
● $-30°$

$\eta_r = 0°$

$\delta = -20°$ $-10°$ $0°$ $+10°$ $+20°$

y/t_R 1,0 0,8 0,6 0,4 0,2 0 -0,2

$\alpha°$ / $\delta°$

0 5 10 15 20

△ = 18 = 2,190

△ −0,516 △ −2,387 △ −1,036

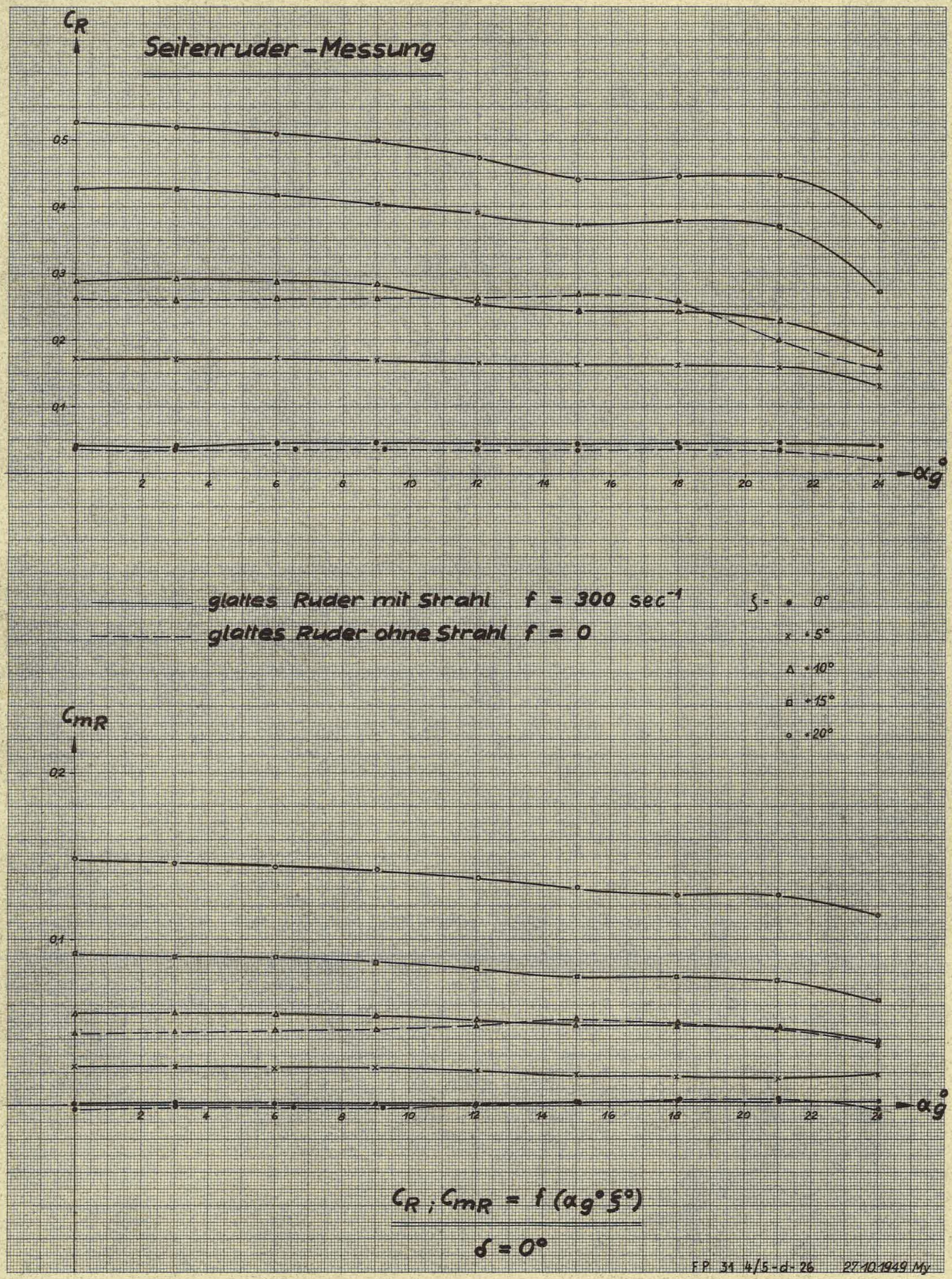
x/t_R 1,0 0,8 0,6 0,4 0,2 0 -0,2

△ −0,561 △ −0,622 △ −2,137 △ −1,867

16.12.1949 My

FP 31 4/5 – d – 25

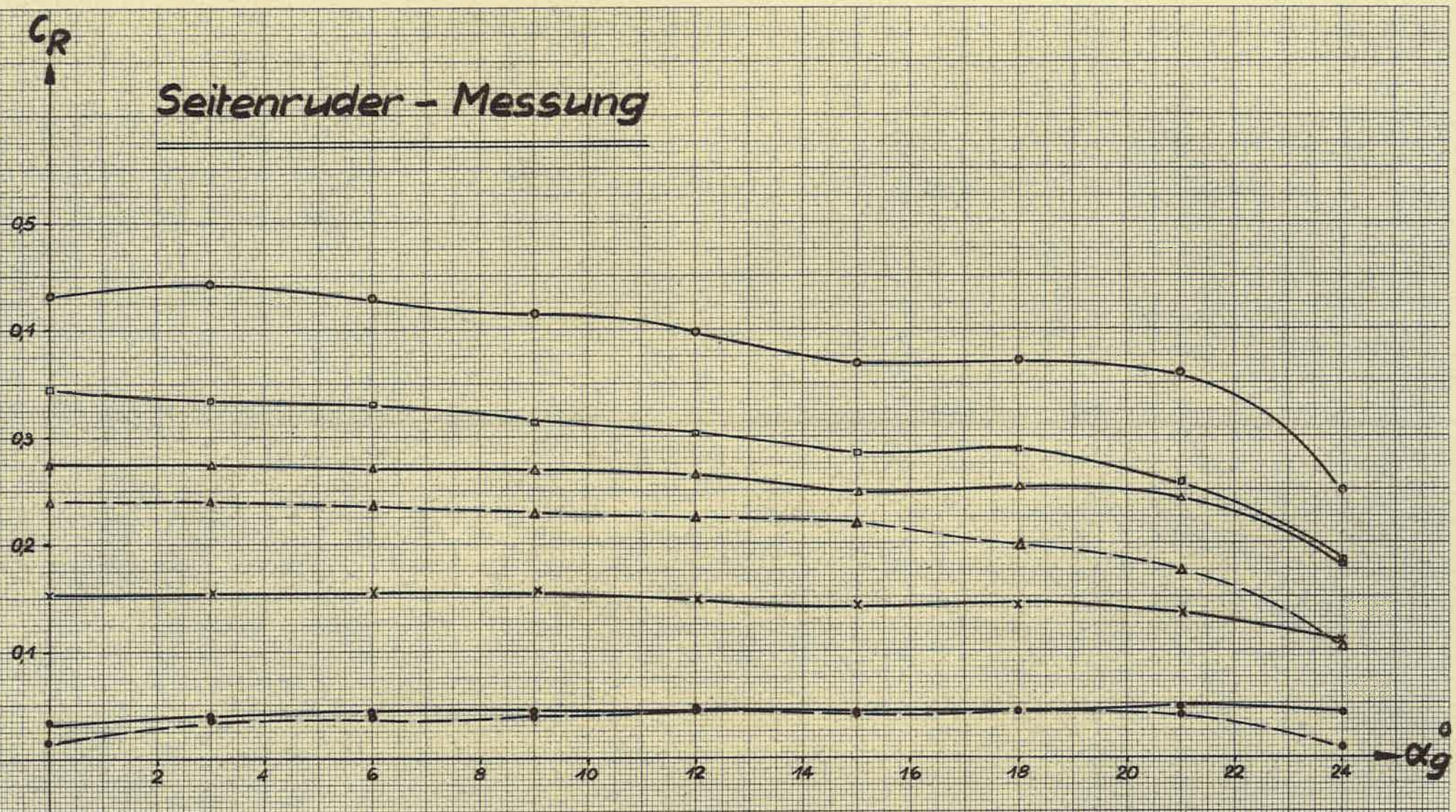
Seitenruder-Messung



$C_R ; C_{mR} = f(\alpha_g° \delta°)$

$\delta = 0°$

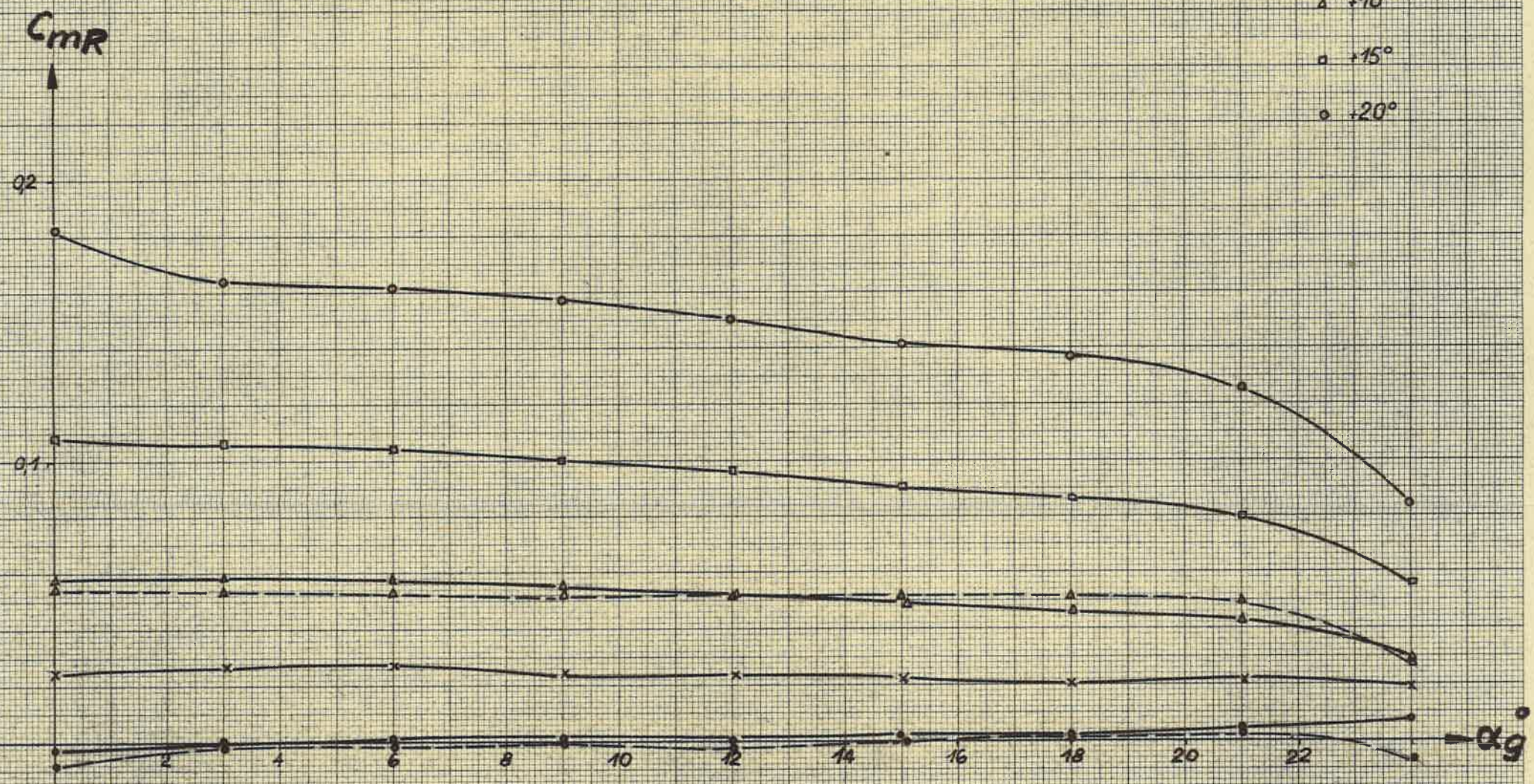
Seitenruder - Messung



——— glattes Ruder mit Strahl $f = 300\ sec^{-1}$

– – – – – glattes Ruder ohne Strahl $f = 0$

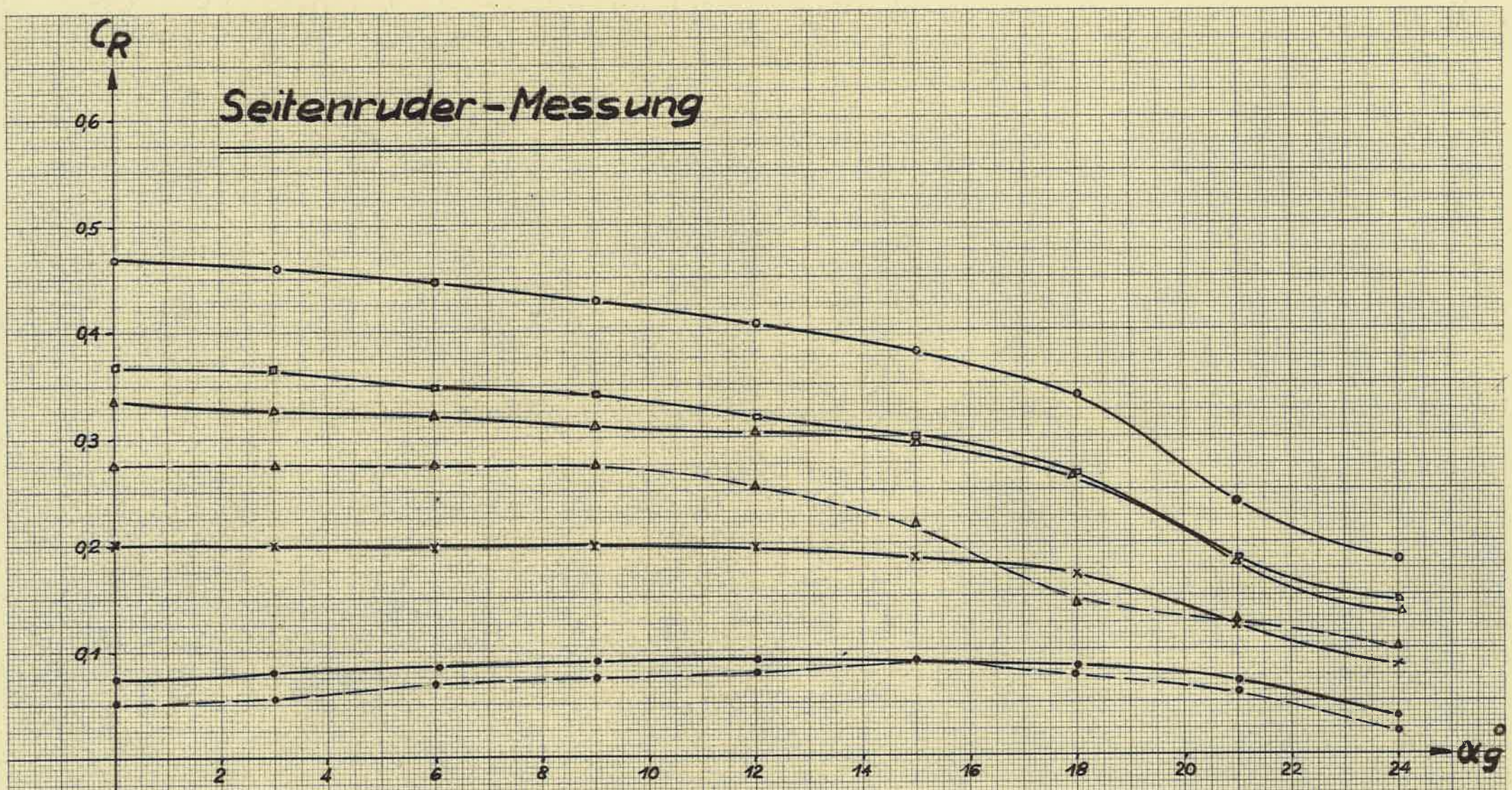
ζ = ● 0°
x +5°
△ +10°
□ +15°
○ +20°



$c_R ; c_{mR} = f(\alpha_g°; \delta°)$

$\delta = +5°$

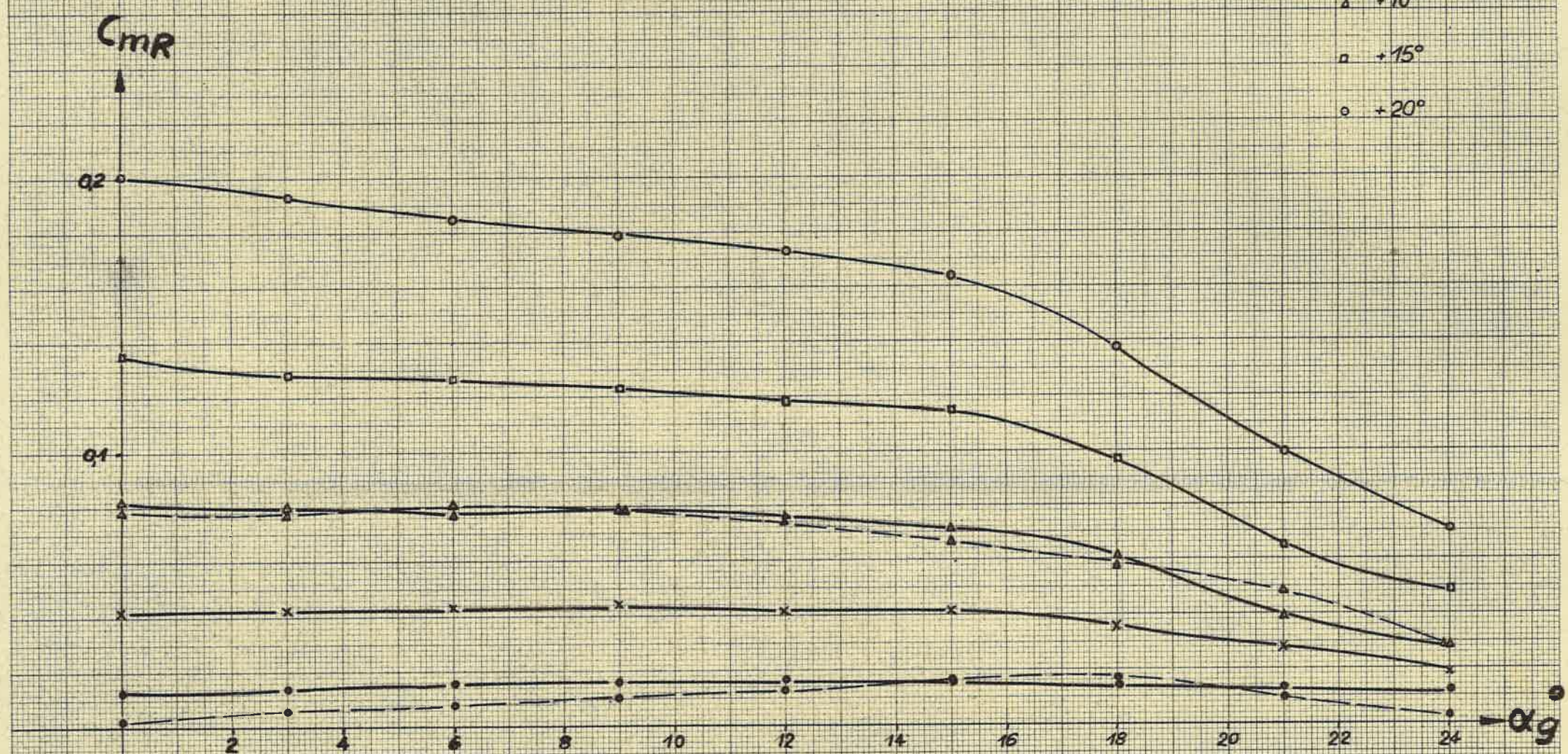
Seitenruder-Messung



——— glattes Ruder mit Strahl $f = 300\ sec^{-1}$

– – – – glattes Ruder ohne Strahl $f = 0$

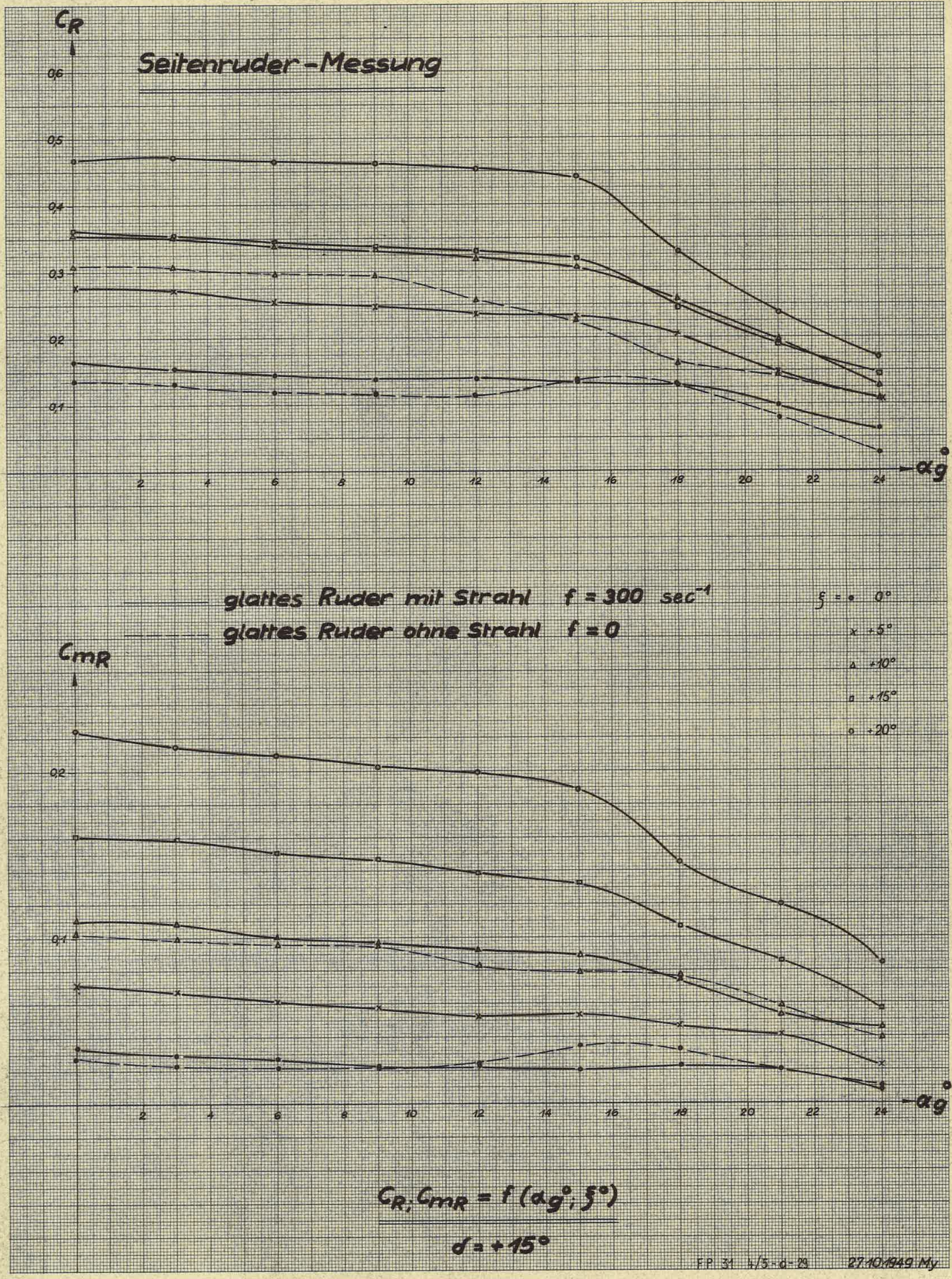
ζ = • 0°
× +5°
△ +10°
□ +15°
○ +20°



$C_R ; C_{mR} = f(\alpha_g°; \zeta°)$

$\delta = +10°$

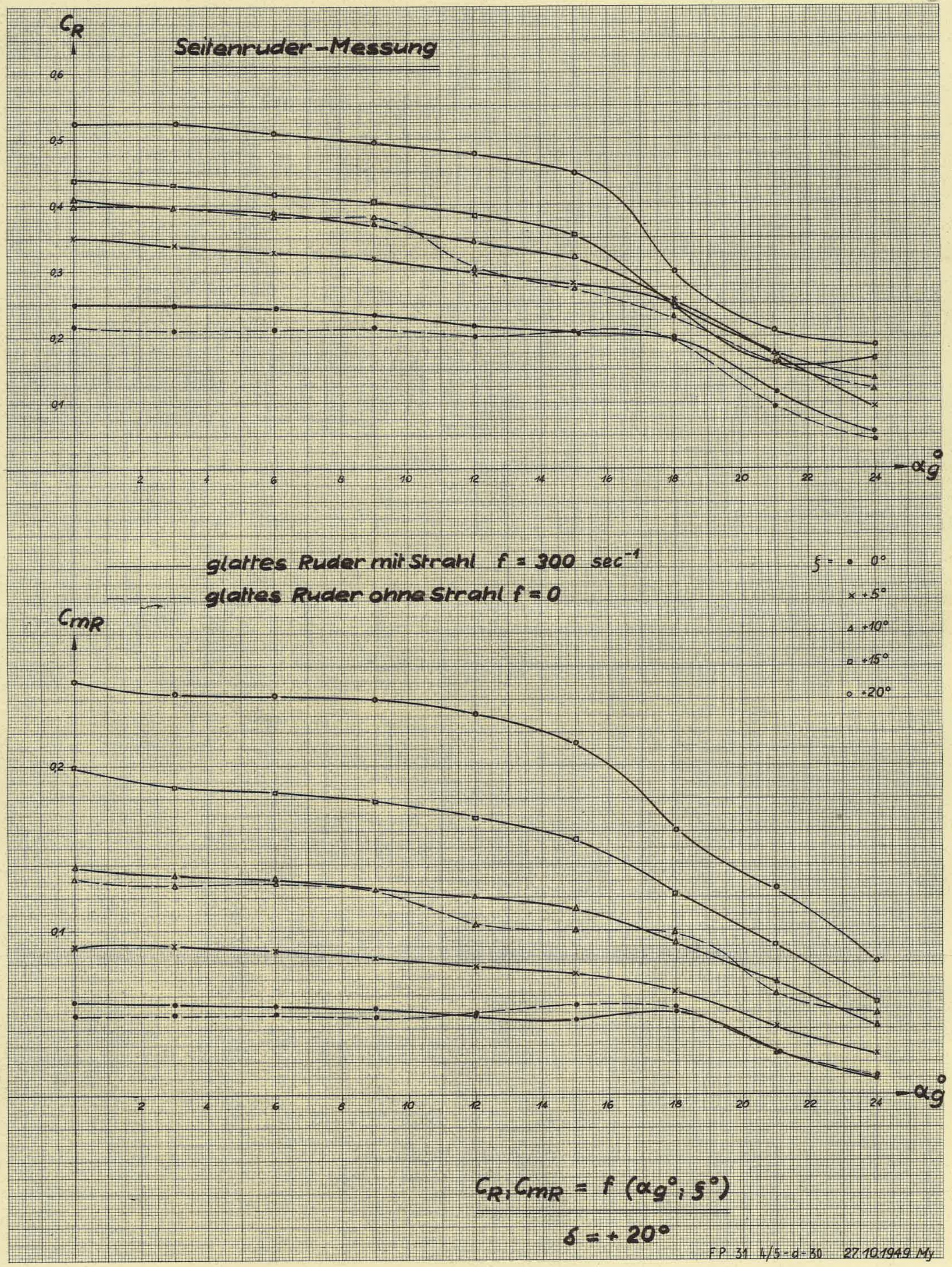
Seitenruder-Messung



$c_R; c_{mR} = f(\alpha_g°; \zeta°)$

$d = +15°$

Seitenruder-Messung

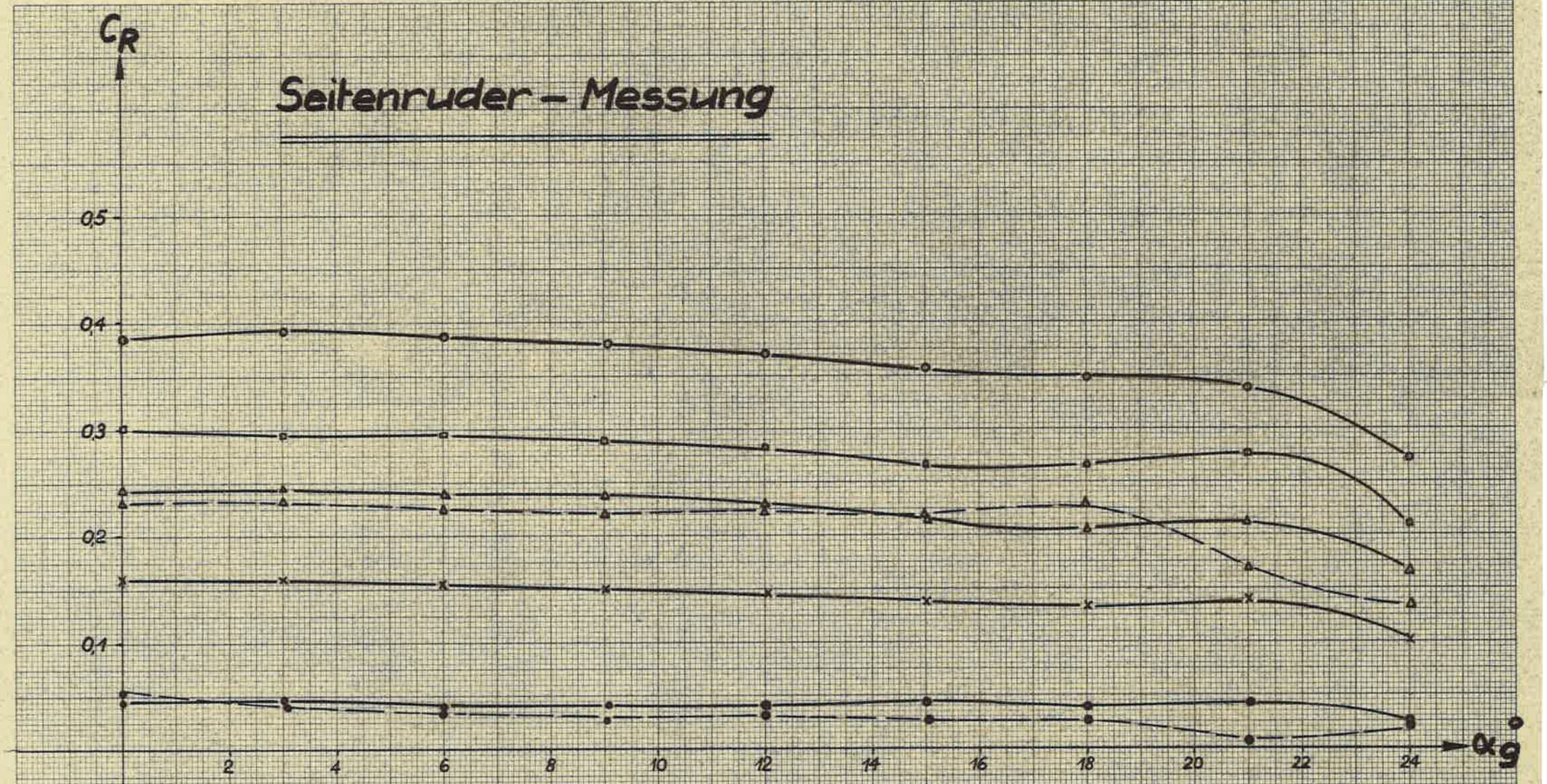


$C_R ; C_{mR} = f(\alpha_g° ; \zeta°)$

$\delta = +20°$

FP 31 4/5-d-30 27.10.1949 My

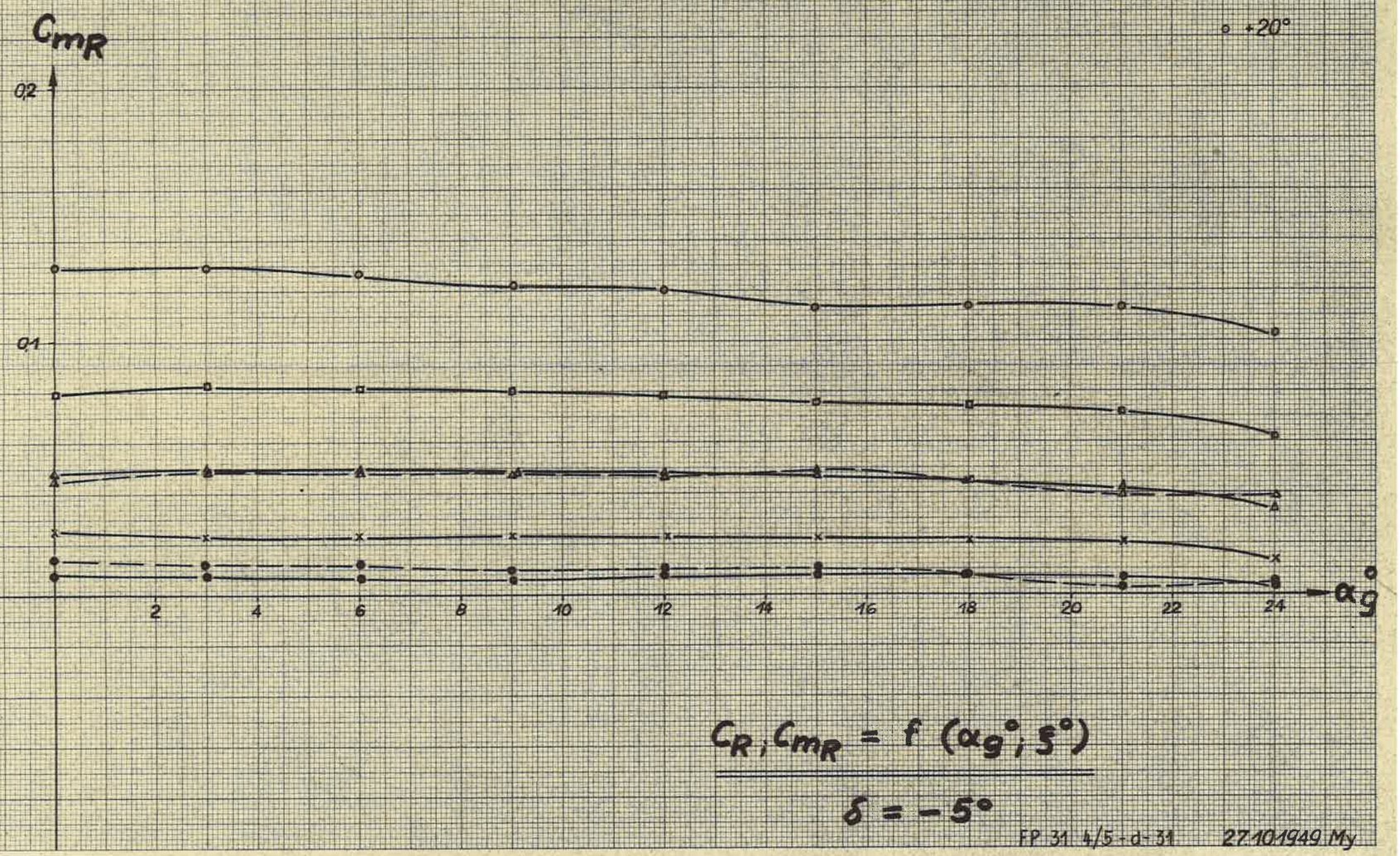
Seitenruder – Messung



——— glattes Ruder mit Strahl $f = 300\ sec^{-1}$

– – – – – glattes Ruder ohne Strahl $f = 0$

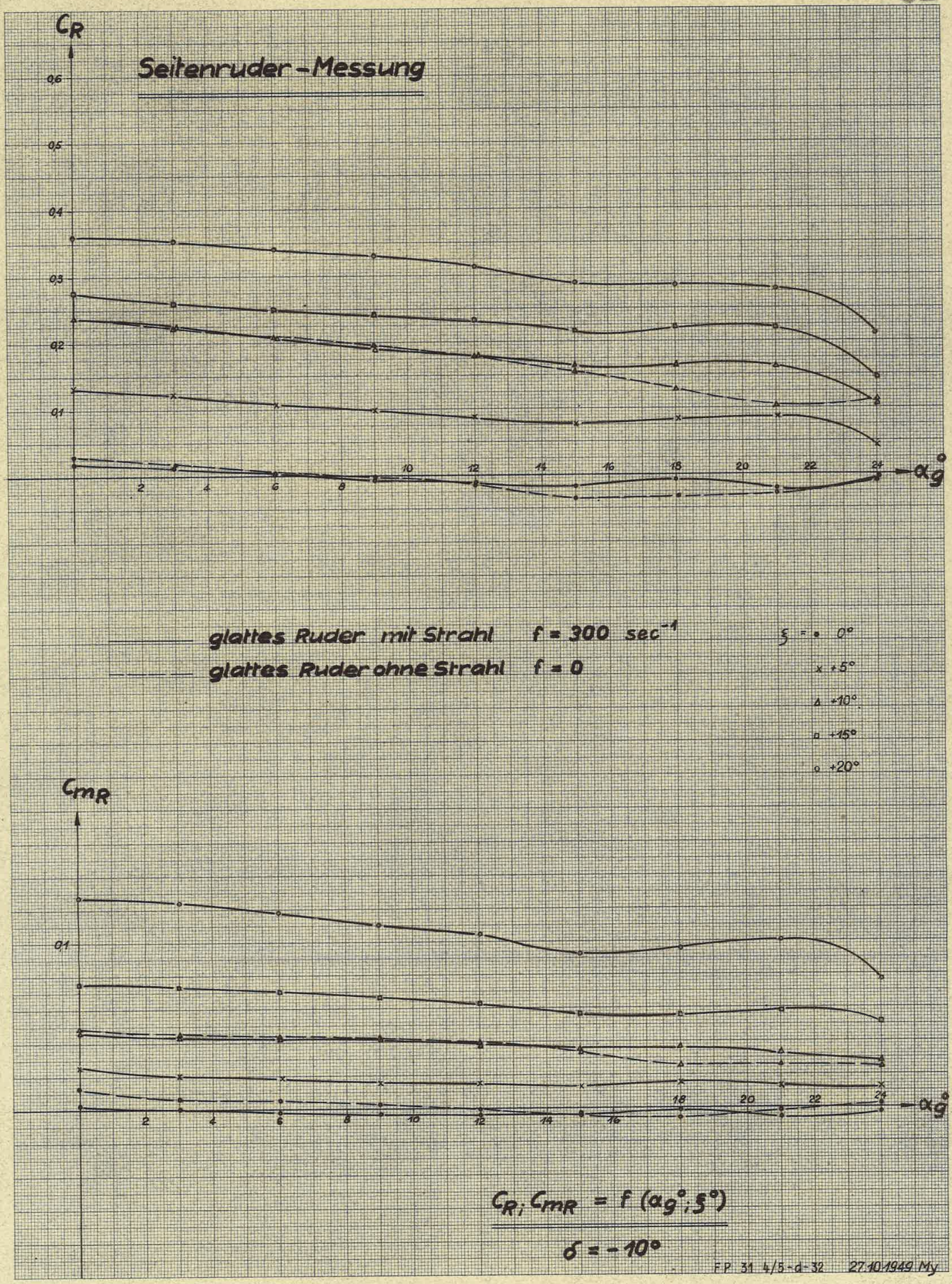
ζ = • 0°
× +5°
△ +10°
□ +15°
○ +20°



$C_R ; C_{mR} = f(\alpha_g°; \zeta°)$

$\delta = -5°$

Seitenruder-Messung



——— glattes Ruder mit Strahl f = 300 sec^{-1}

– – – – glattes Ruder ohne Strahl f = 0

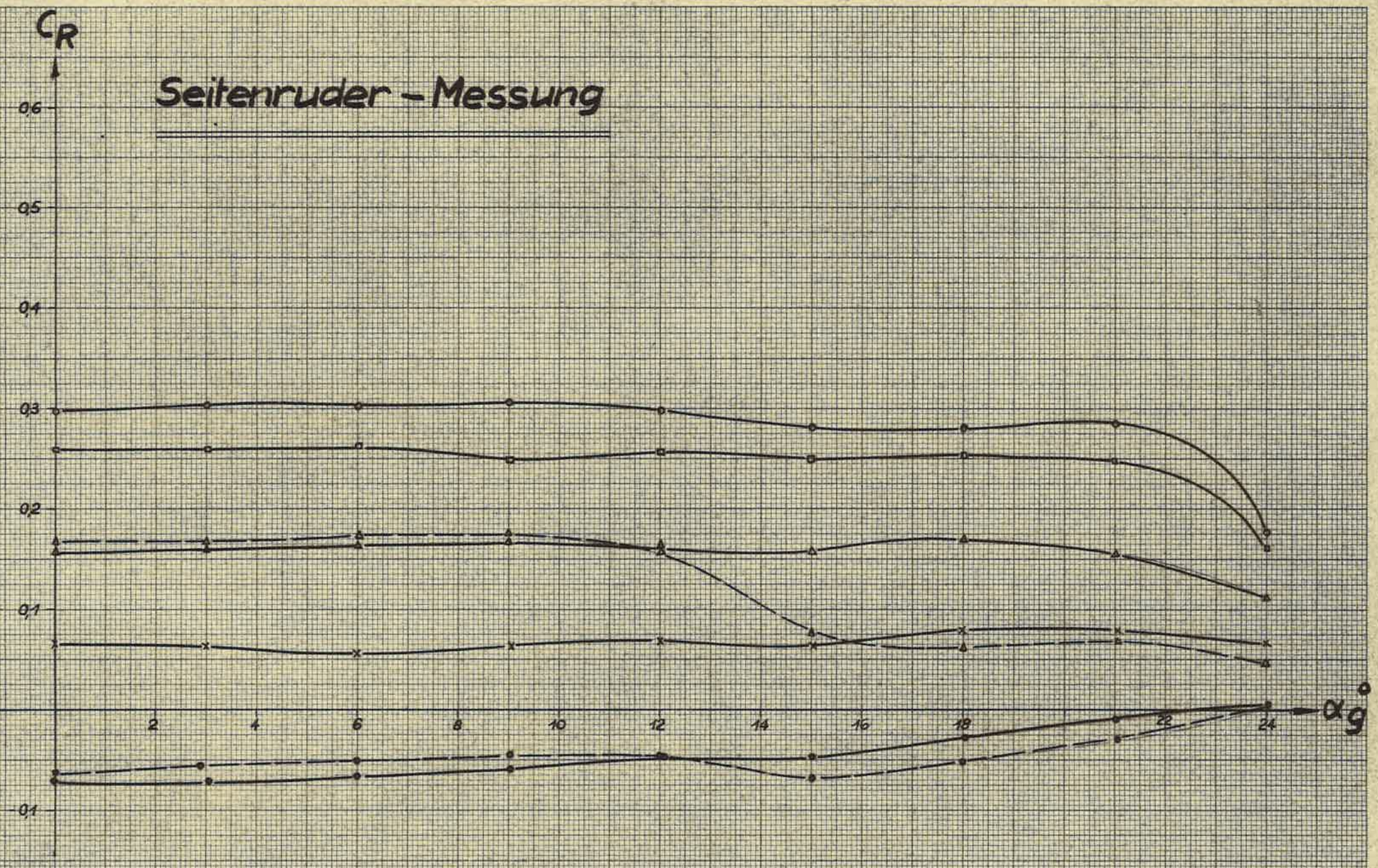
ζ = • 0°
x +5°
Δ +10°
□ +15°
○ +20°

$C_R ; C_{mR} = f(\alpha_g°; \zeta°)$

$\delta = -10°$

FP 31 4/5-d-32 27.10.1949 My

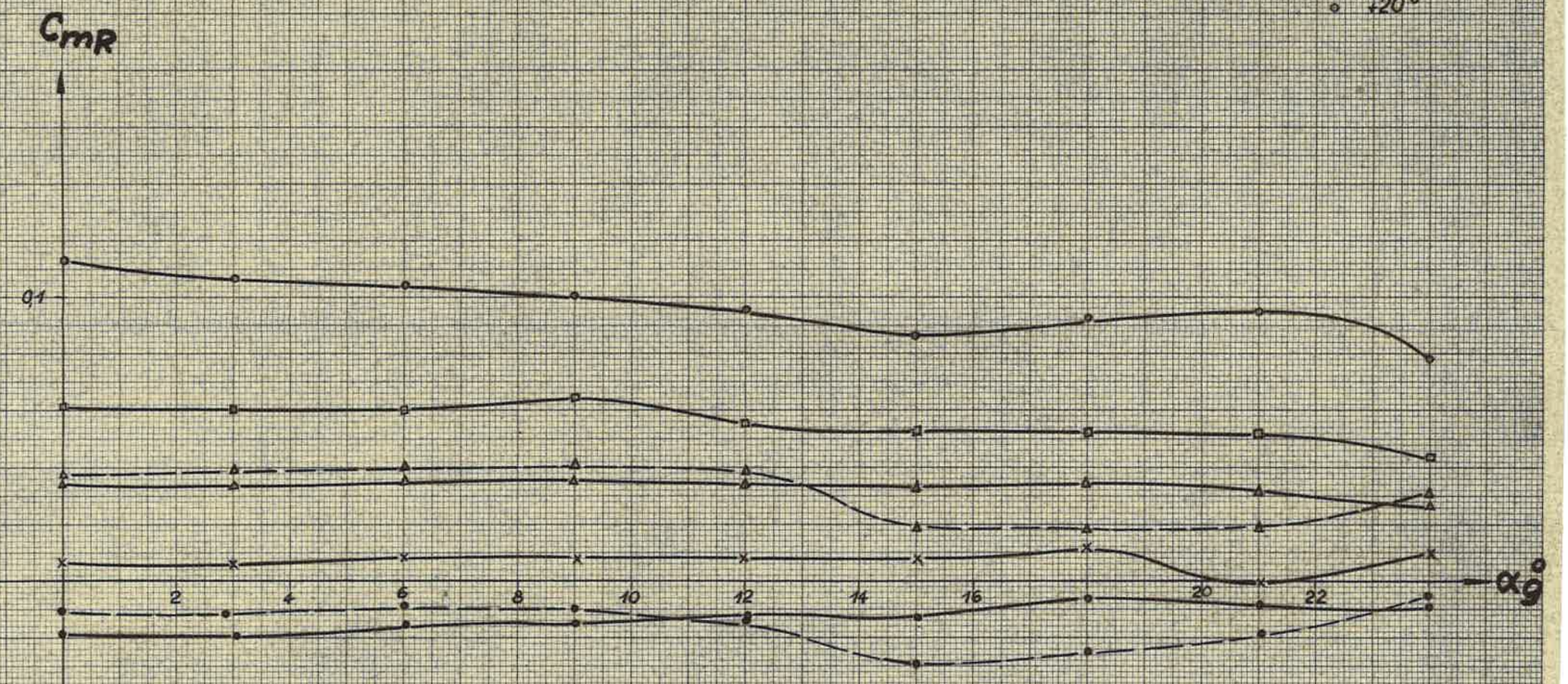
Seitenruder – Messung



——— glattes Ruder mit Strahl $f = 300\ sec^{-1}$

– – – – – glattes Ruder ohne Strahl $f = 0$

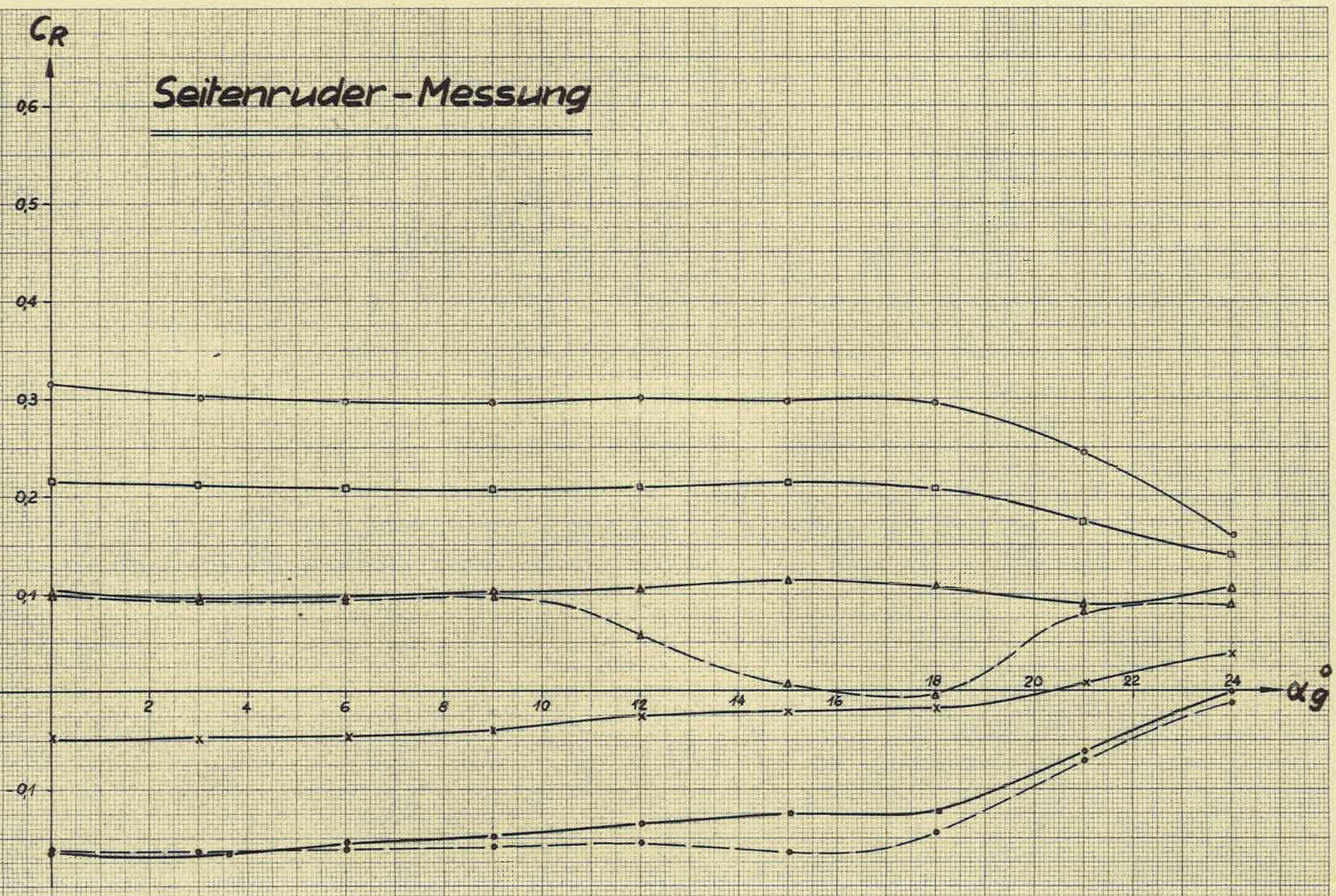
ζ = • 0°
× +5°
△ +10°
□ +15°
○ +20°



$C_R ; C_{mR} = f(\alpha_g° ; \zeta°)$

$\delta = -15°$

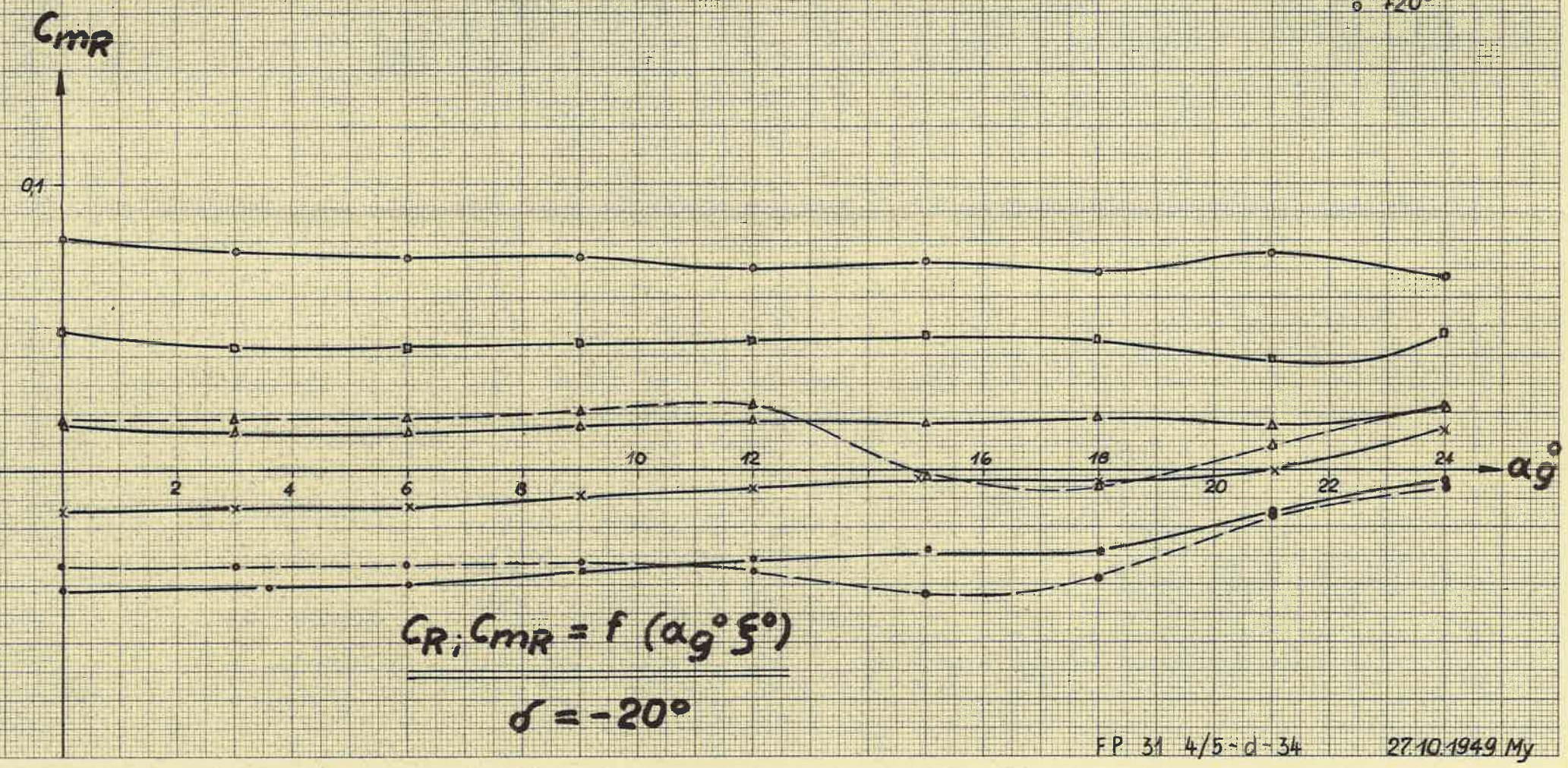
Seitenruder-Messung



——— glattes Ruder mit Strahl $f = 300\ sec^{-1}$

– – – – – glattes Ruder ohne Strahl $f = 0$

ζ = • 0°
× + 5°
△ + 10°
□ + 15°
○ + 20°

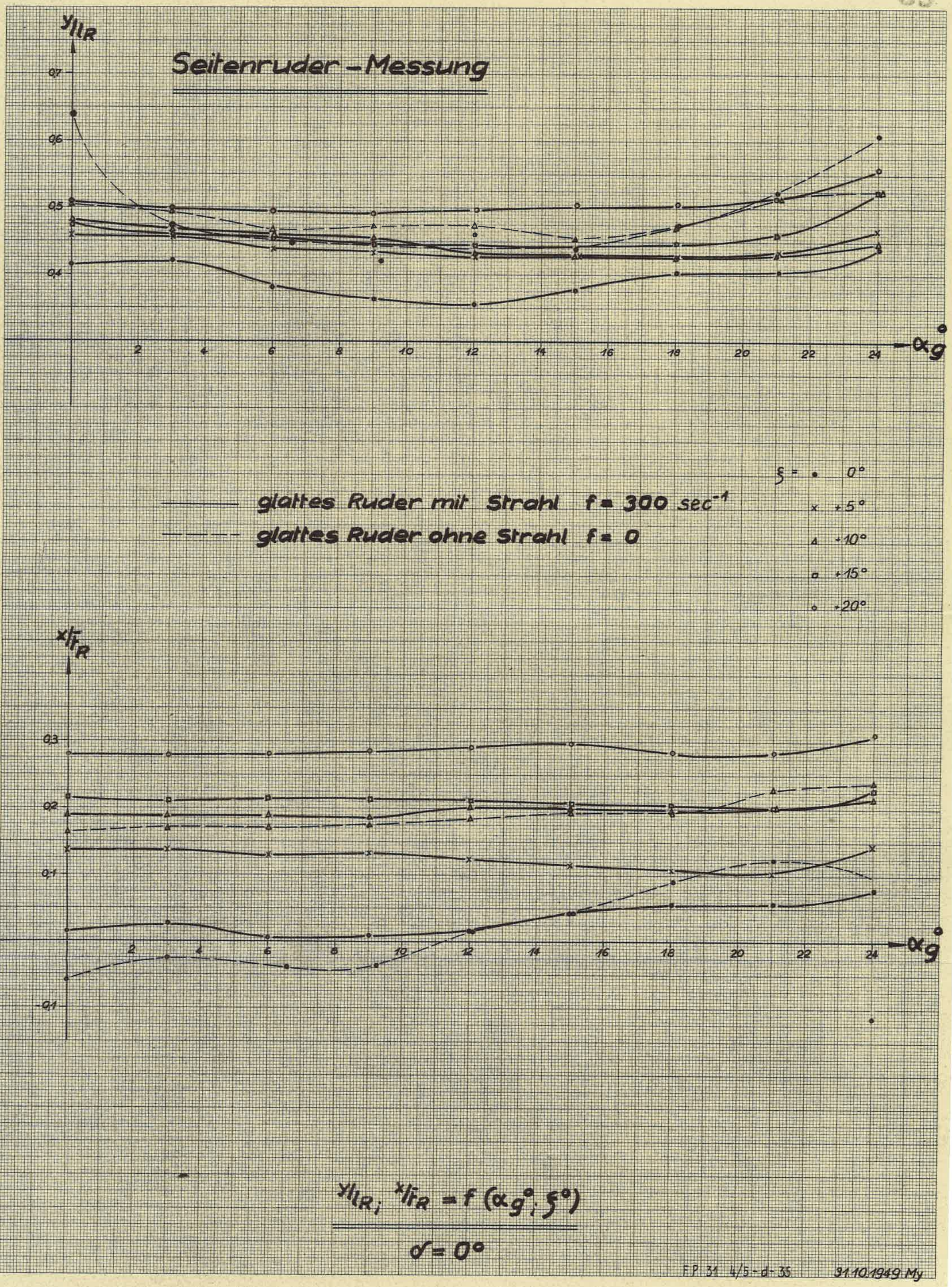


$C_R ; C_{mR} = f(\alpha_g° \zeta°)$

$\sigma = -20°$

FP 31 4/5-d-34 27.10.1949 My

Seitenruder - Messung



——— glattes Ruder mit Strahl $f = 300\ sec^{-1}$

– – – – glattes Ruder ohne Strahl $f = 0$

ζ = • 0°
× +5°
△ +10°
□ +15°
○ +20°

$$y_{l_R};\ x_{f_R} = f(\alpha_g°; \zeta°)$$

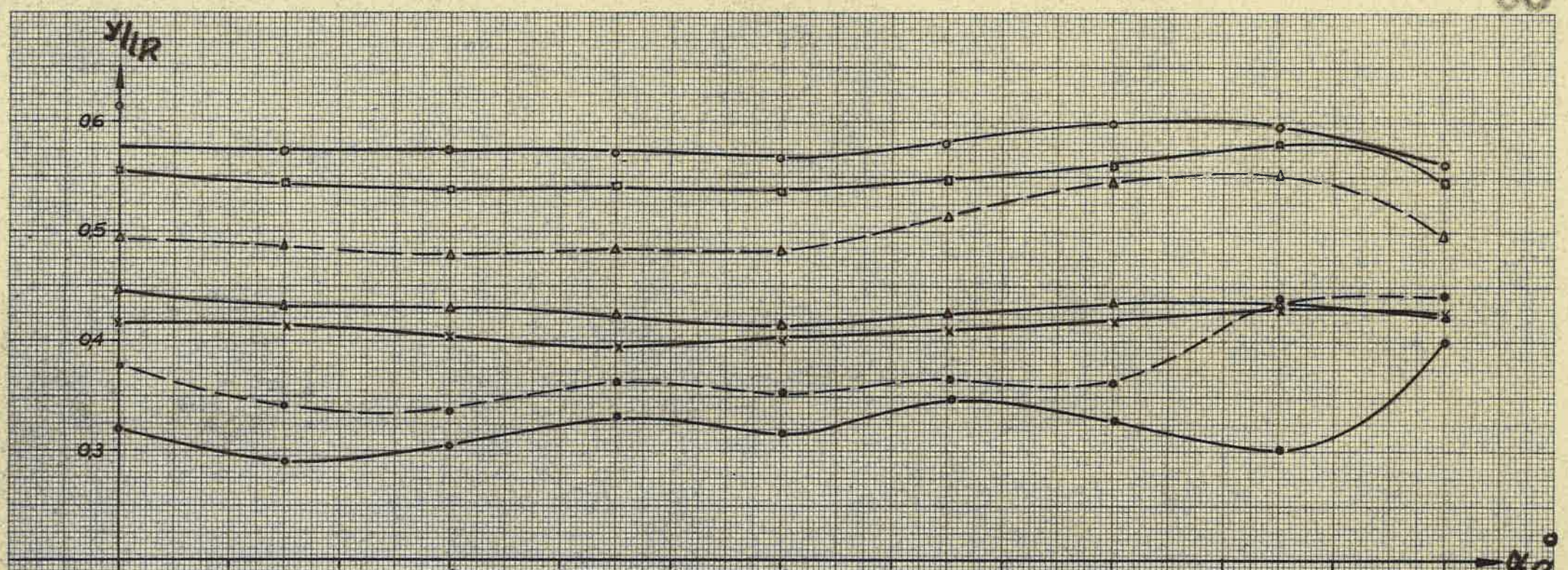
$$\sigma = 0°$$

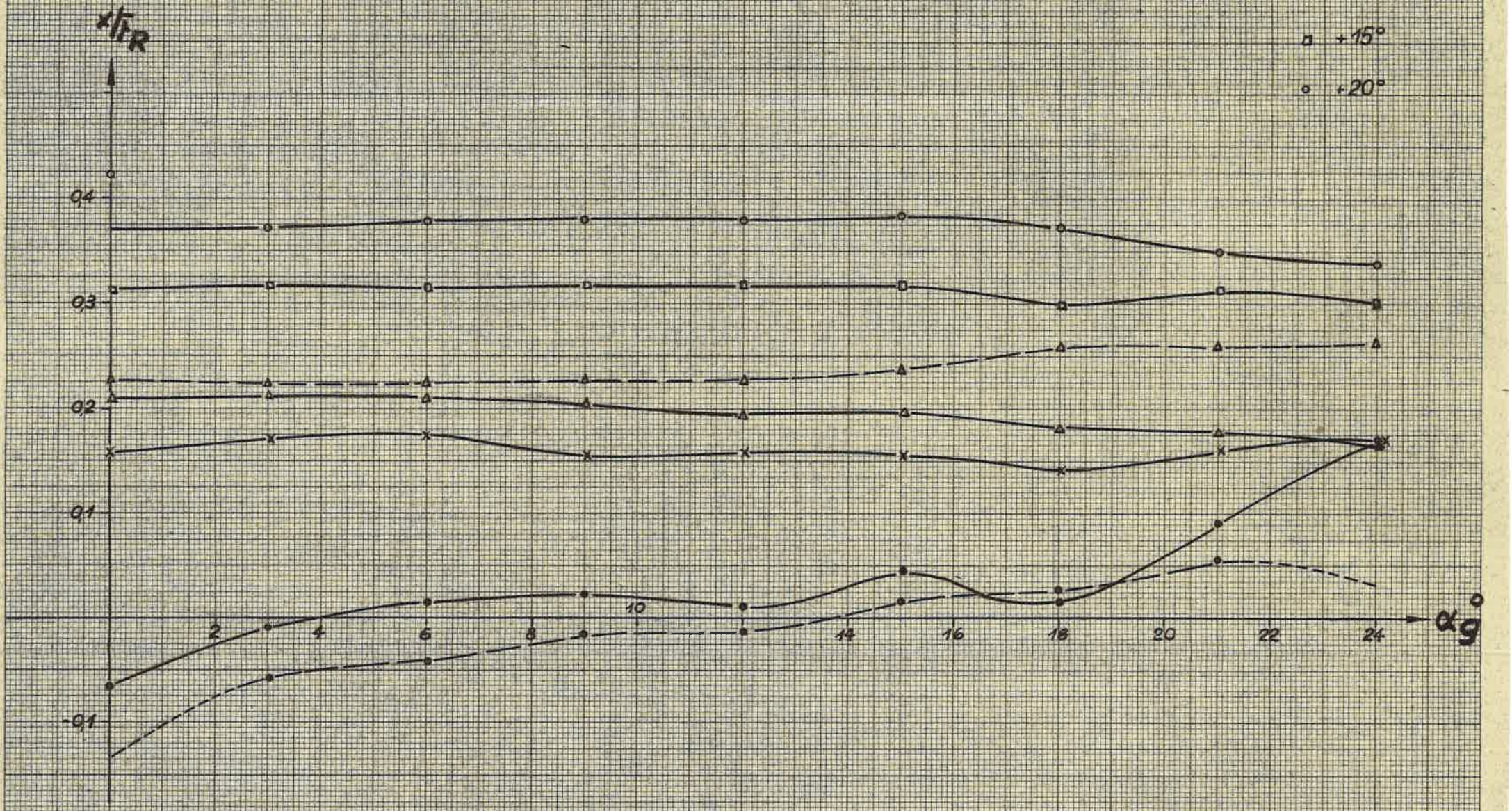
Seitenruder - Messung

——— glattes Ruder mit Strahl $f = 300\ sec^{-1}$

– – – – – glattes Ruder ohne Strahl $f = 0$

ζ = • 0°
× +5°
△ +10°
□ +15°
○ +20°





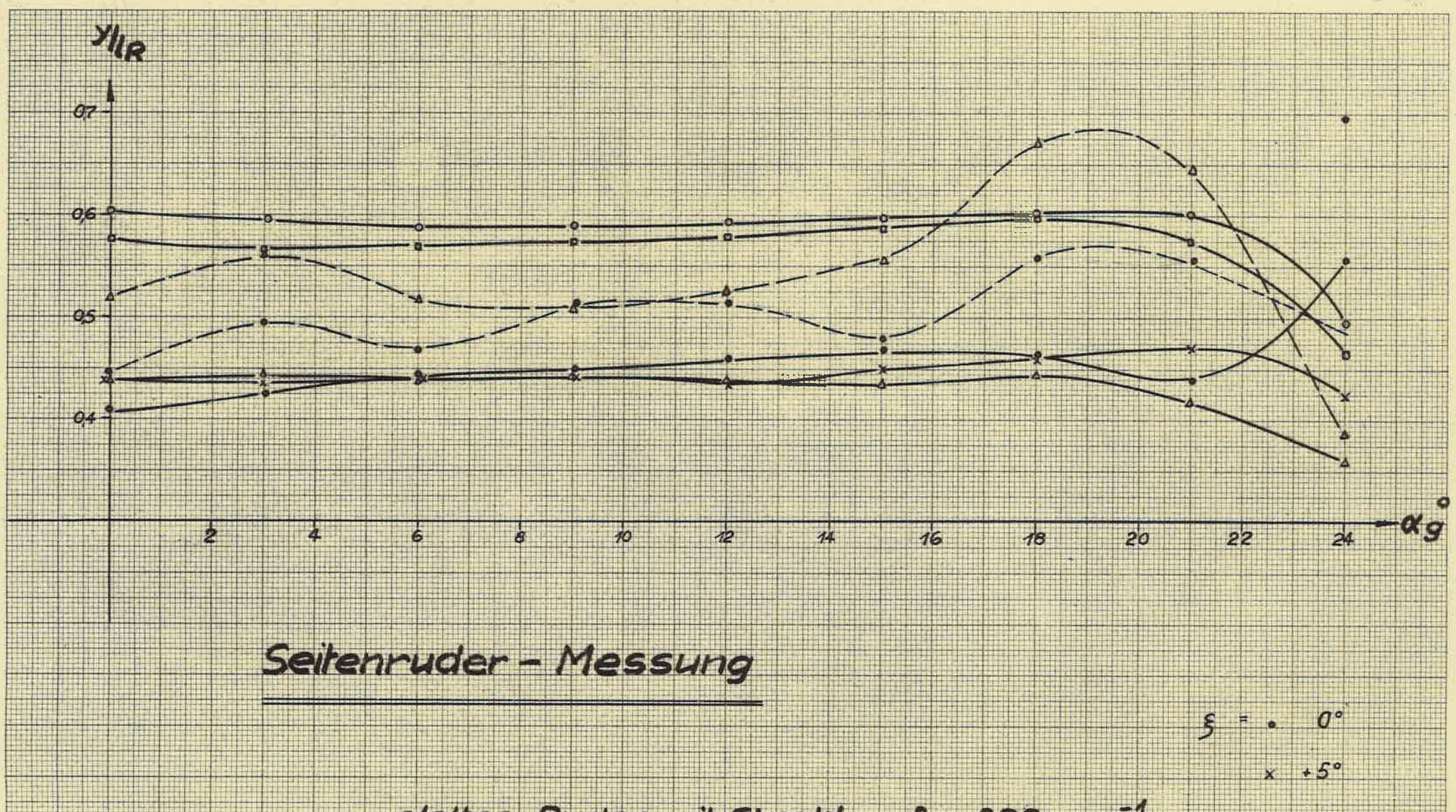
$$y/l_R\ ;\ x/t_R = f(\alpha_g°\ ;\ \zeta°)$$

$$\sigma = +5°$$

31.10.1949 My

FP 31 4/5-d-36

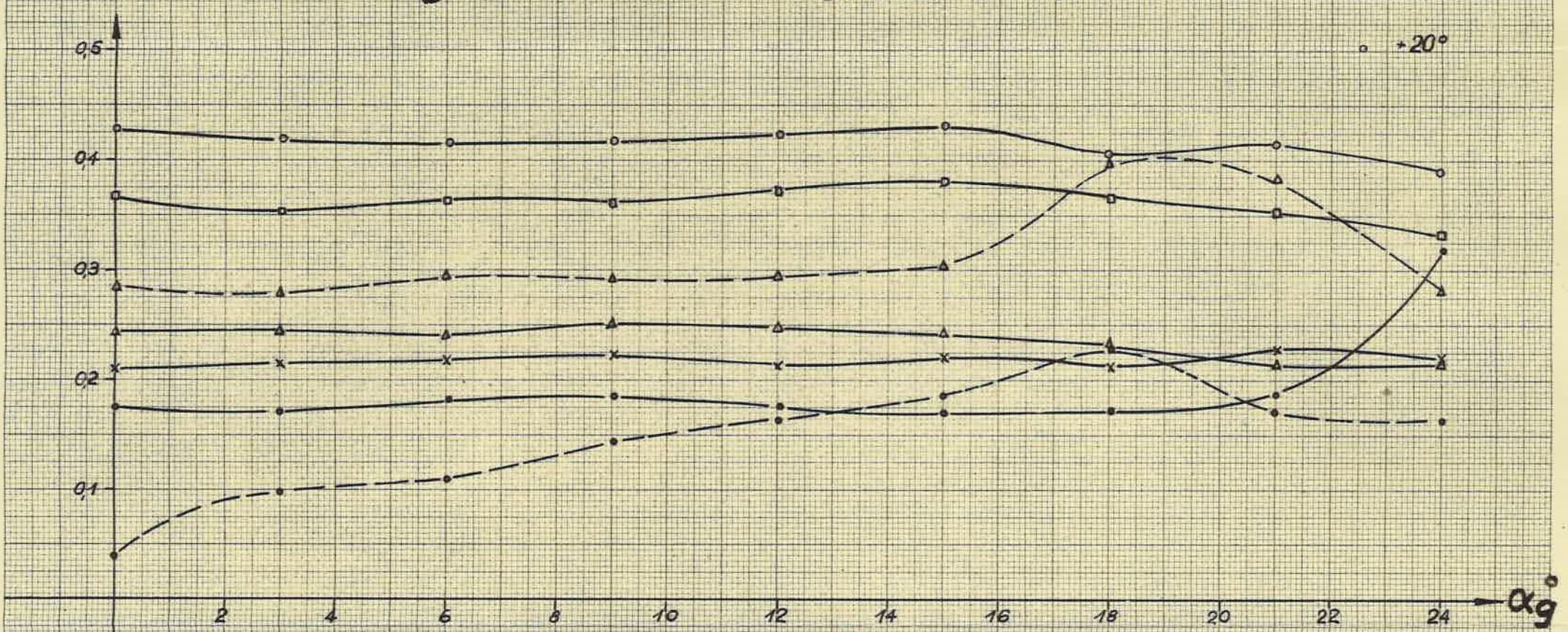
• = -0,654



Seitenruder - Messung

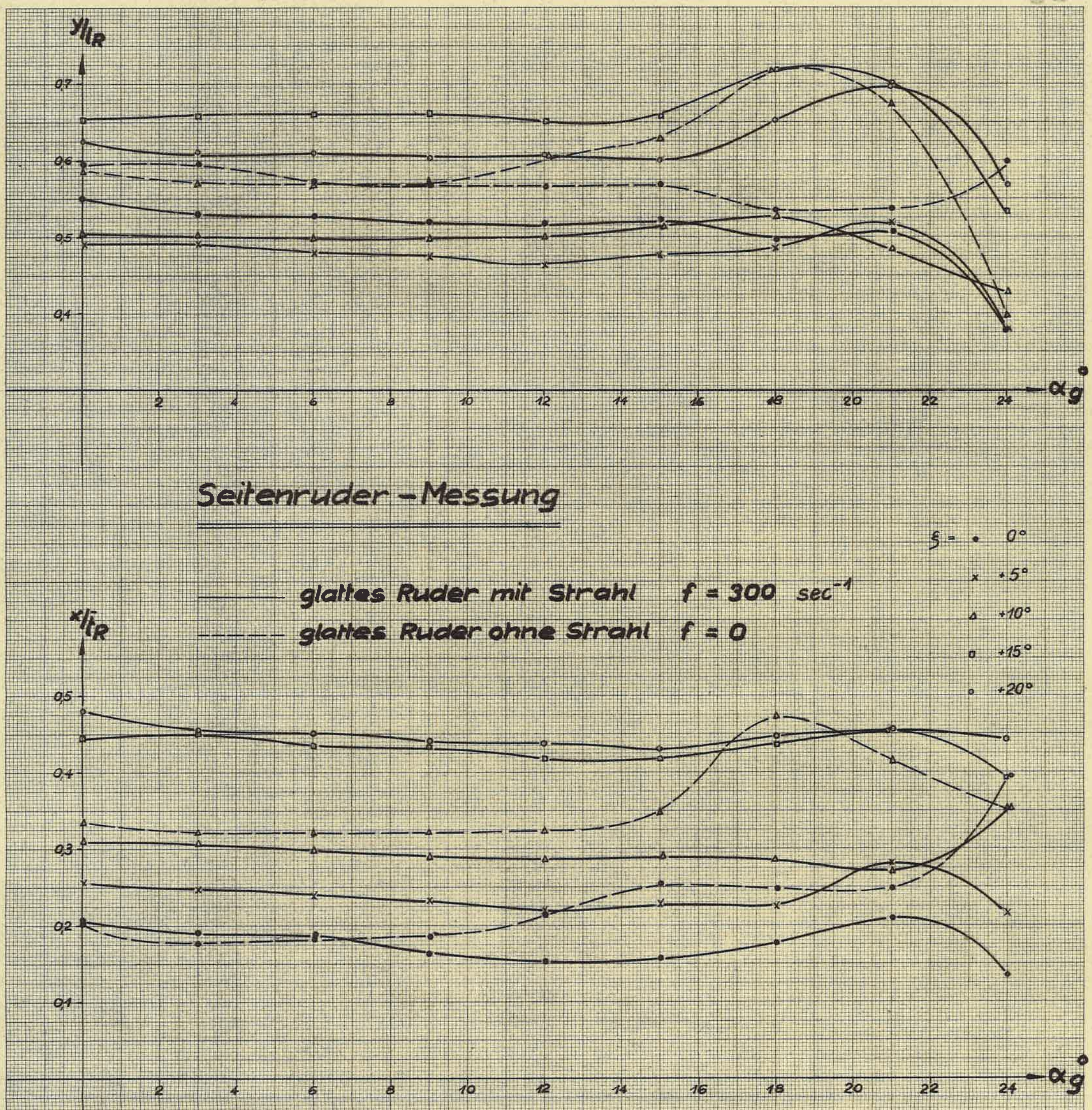
ζ = • 0°
× ±5°
△ ±10°
□ ±15°
○ ±20°

——— glattes Ruder mit Strahl f = 300 sec^{-1}
– – – – glattes Ruder ohne Strahl f = 0



$$\frac{y_{IIR};\ ^{x}/_{t_R} = f(\alpha_g°; 5°)}{\delta = +10°}$$

FP 31 4/5-d-37 31.10.1949 My



$y/l_R ; x/l_R = f(\alpha_g°; \zeta°)$

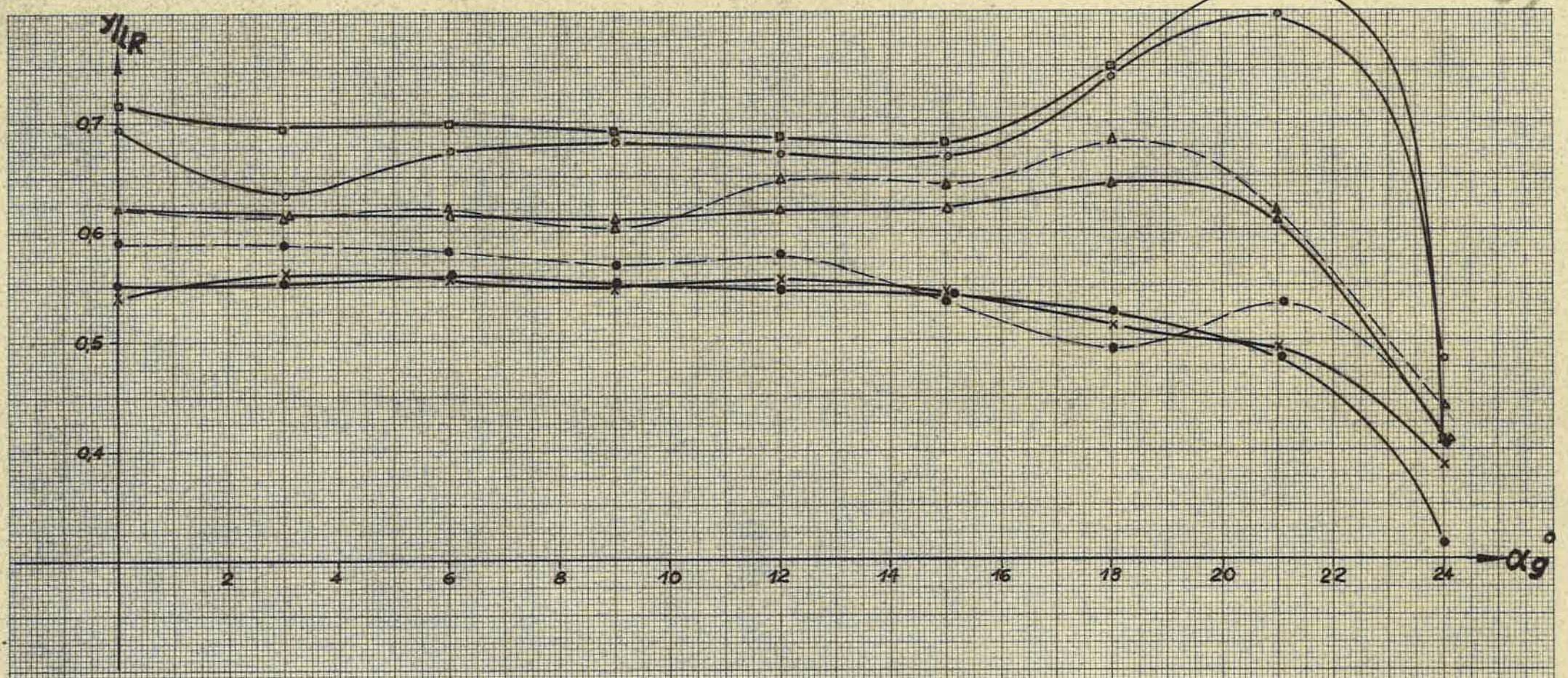
$\delta = +15°$

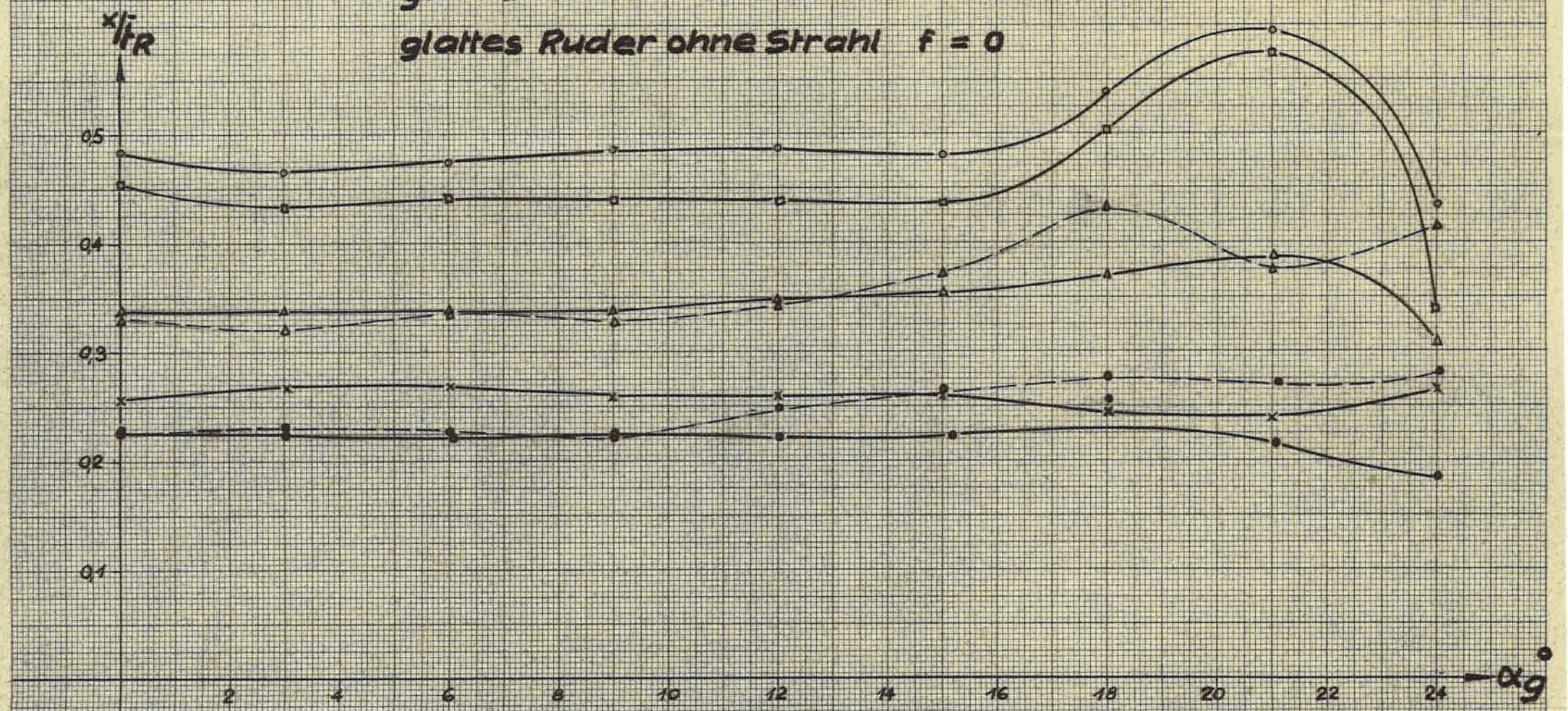
FP 31 4/5 - d - 38 31.10.1949 My

Seitenruder-Messung

glattes Ruder mit Strahl $f = 300\ sec^{-1}$

glattes Ruder ohne Strahl $f = 0$





ζ = ● 0°

× +5°

△ +10°

□ +15°

○ +20°

$y/l_R;\ x/l_R = f(\alpha_g°; \zeta°)$

$\delta = +20°$

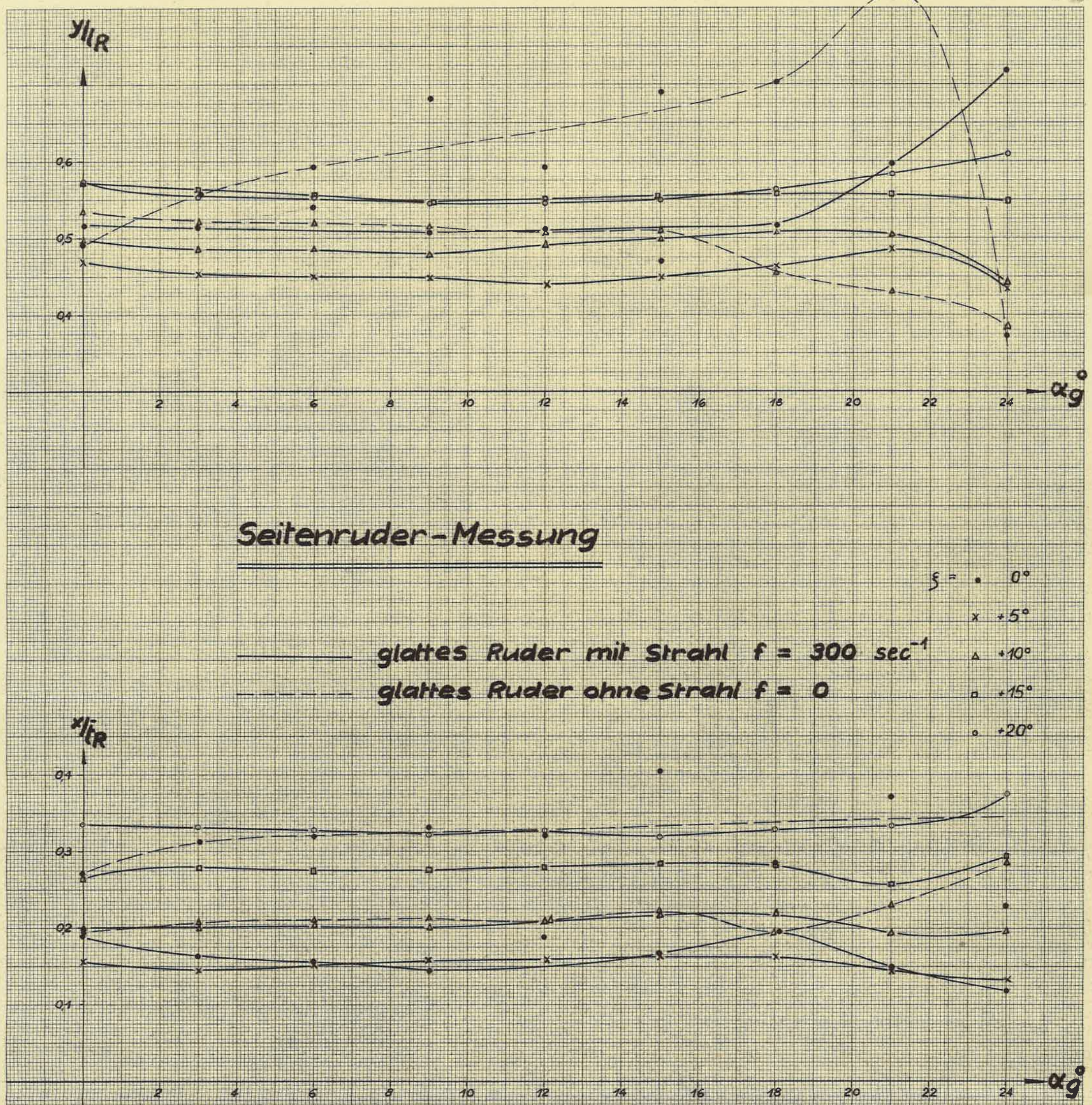
FP 31 4/5-d-39 31.10.1949 My

Seitenruder-Messung

ζ = • 0°
x +5°
△ +10°
□ +15°
○ +20°

——— glattes Ruder mit Strahl f = 300 sec^{-1}

– – – – – glattes Ruder ohne Strahl f = 0



$y_{l_R}; x_{l_R} = f(\alpha_g°; \zeta°)$

$\sigma = -5°$

Seitenruder-Messung

y/l_R

$\varphi = 1{,}766$

$\varphi = 0{,}750$

0,5 — 0,4 — 0,3 — 0,2 — 0,1

2 4 6 8 10 12 14 16 18 20 22 24 $-\alpha_g°$

x/l_R

$\varphi = 1{,}260$

$\varphi = -0{,}285$

$\varphi = -1{,}120$

0,4 — 0,3 — 0,2 — 0,1 — 0,1 — 0,2 — 0,3 — 0,4

2 4 6 8 10 12 14 16 18 20 22 24 $-\alpha_g°$

——— glattes Ruder mit Strahl $f = 300\ sec^{-1}$

– – – – glattes Ruder ohne Strahl $f = 0$

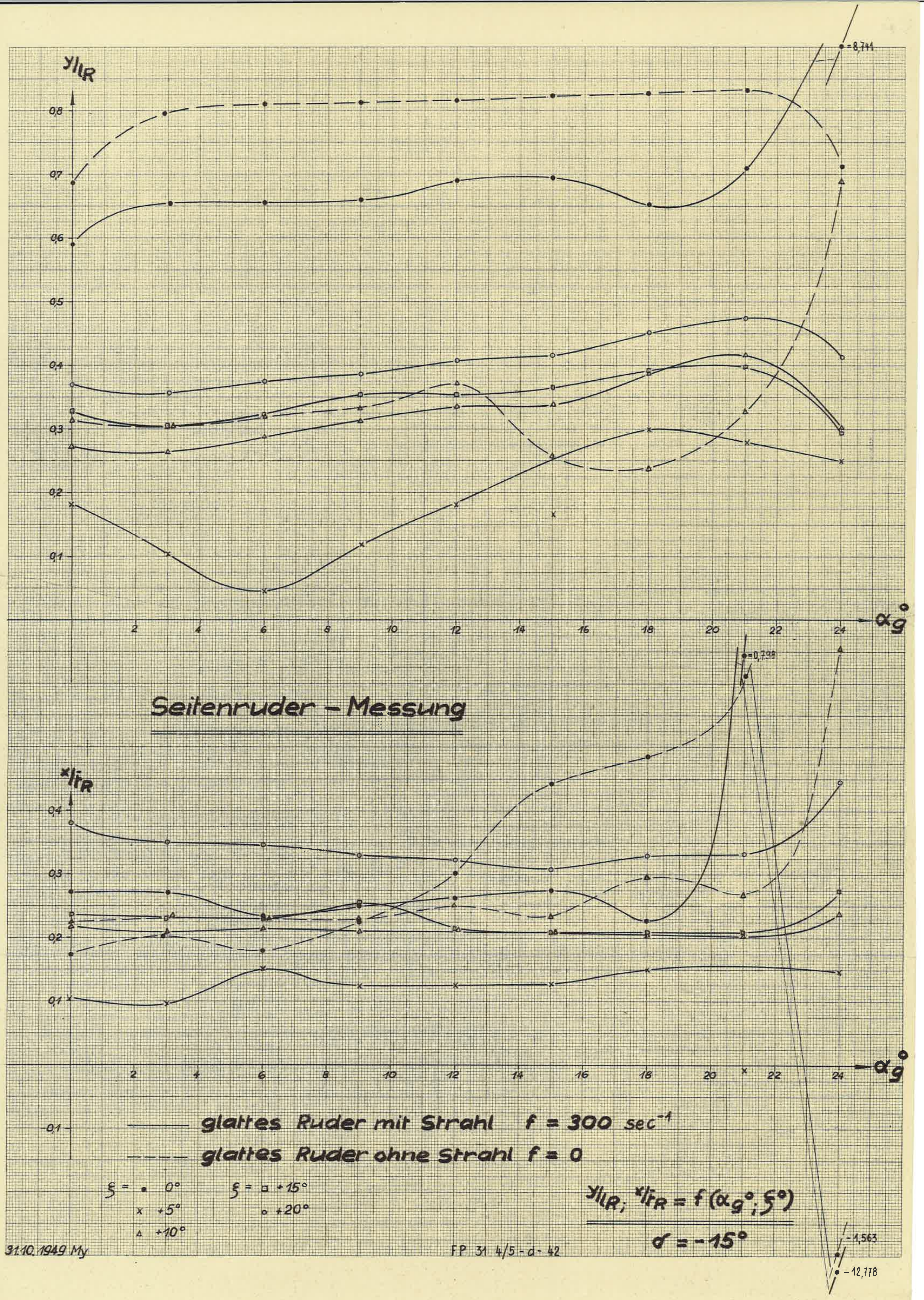
ζ = • 0° ○ +15°

× +5° ○ +20°

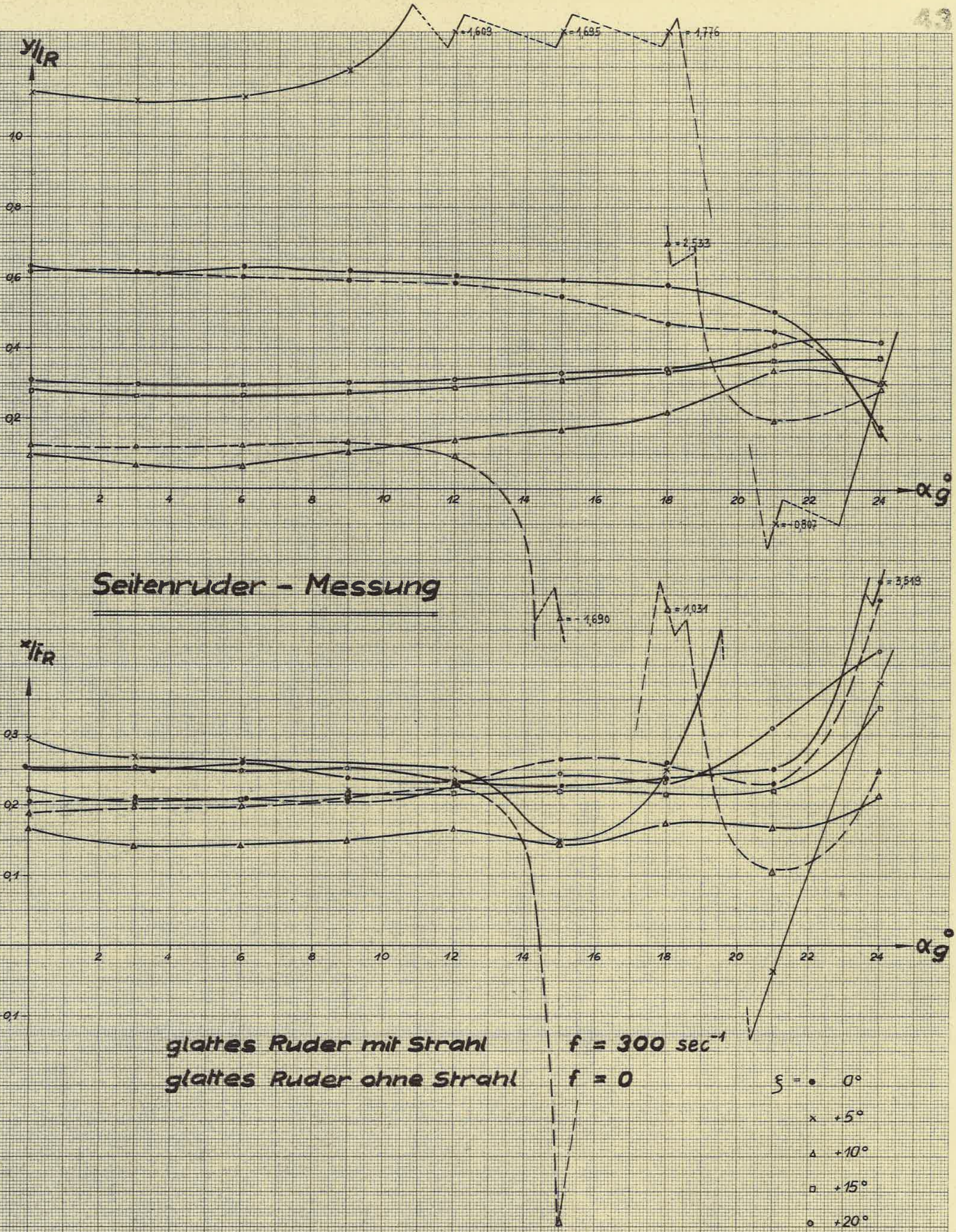
△ +10°

$y/l_R;\ x/l_R = f(\alpha_g°; \zeta°)$

$\delta = -10°$


y/l_R
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
= 8,741
Seitenruder – Messung
x/t_R
= 0,798
−0,1
2 4 6 8 10 12 14 16 18 20 22 24
α_g°
glattes Ruder mit Strahl f = 300 sec⁻¹
glattes Ruder ohne Strahl f = 0
ξ = ● 0°
× +5°
△ +10°
ξ = □ +15°
○ +20°
y/l_R; x/t_R = f (α_g°; ξ°)
σ = −15°
−1,563
−12,778
31.10.1949 My
FP 31 4/5-d-42

Seitenruder - Messung



glattes Ruder mit Strahl

glattes Ruder ohne Strahl

$$\frac{y/l_R;\ x/l_R = f(\alpha_g^\circ; \xi^\circ)}{\sigma = -20^\circ}$$

FP 31 4/5-d-43 31.10.1949 My

Seitenruder-Messung

$\alpha_g° = 0°$

c_R

0,6 0,5 0,4 0,3 0,2 0,1 −0,1

$\delta°$ −20 −15 −10 −5 +5 +10 +15 +20 $\delta°$

——— glattes Ruder mit Strahl f = 300 sec^{-1}

– – – – glattes Ruder ohne Strahl f = 0

c_{m_R}

0,2 0,1 −0,1

$\delta°$ −20 −15 −10 −5 +5 +10 +15 +20 $\delta°$

ζ = • 0°

× + 5°

△ + 10°

□ + 15°

○ + 20°

FP 31 4/5 - d - 44 31.10.1949 My

Seitenruder-Messung

$\alpha_g° = +10°$

c_R

0,6
0,5
0,4
0,3
0,2
0,1
-0,1

-20 -15 -10 -5 +5 +10 +15 +20

$\alpha°$

——— glattes Ruder mit Strahl f=300 sec^{-1}

– – – – – glattes Ruder ohne Strahl f=0

c_{m_R}

-0,2
-0,1
-0,1

-20 -15 -10 -5 +5 +10 +15 +20

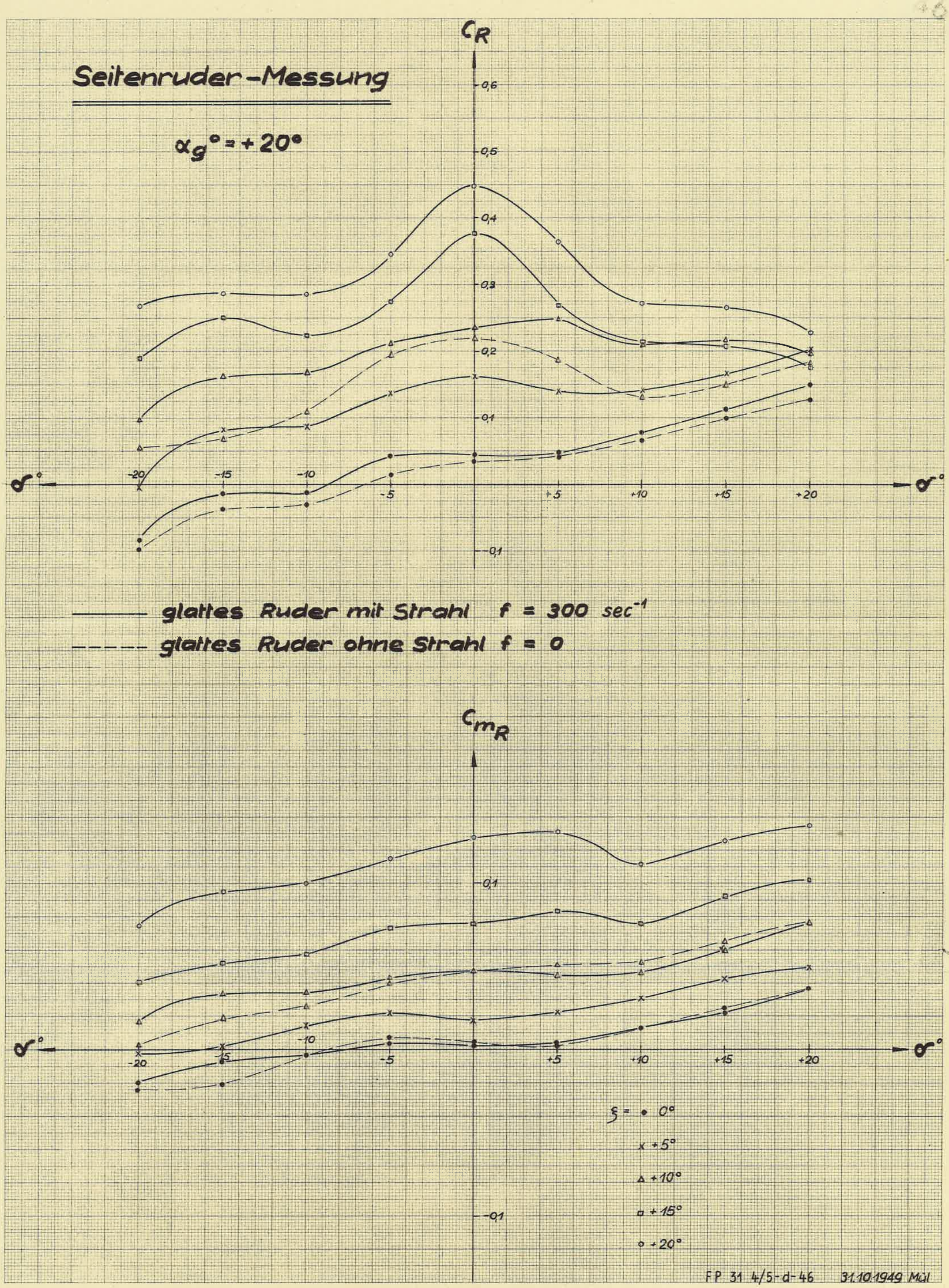
$\alpha°$

ζ = • 0°
x +5°
△ +10°
□ +15°
○ +20°

FP 31 4/5-d-45 31.10.1949 My

Seitenruder-Messung

$\alpha_g° = +20°$



——— glattes Ruder mit Strahl $f = 300\ sec^{-1}$

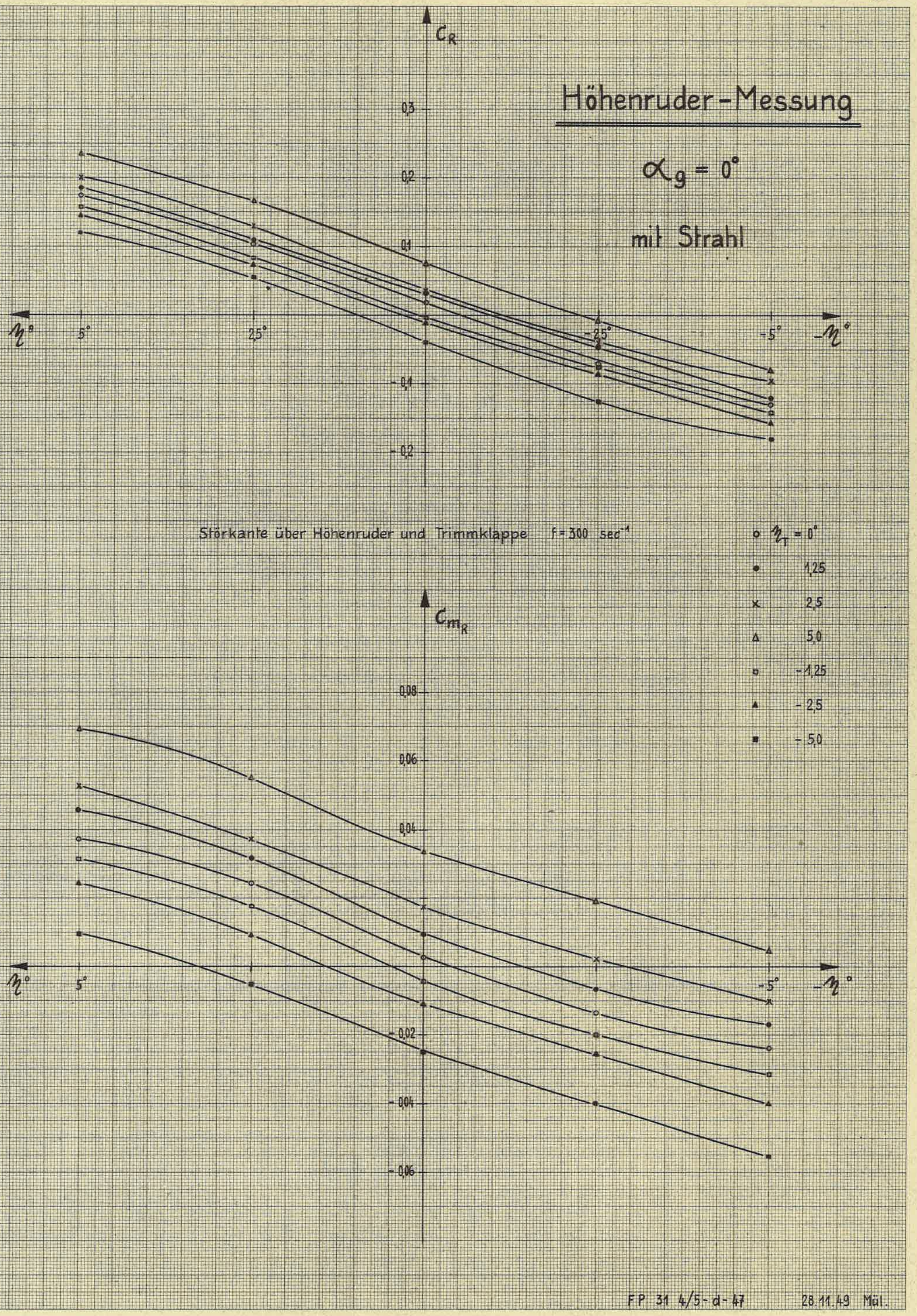
– – – – – glattes Ruder ohne Strahl $f = 0$

FP 31 4/5-d-46 31.10.1949 Mül

Höhenruder-Messung

$\alpha_g = 0°$

mit Strahl



Störkante über Höhenruder und Trimmklappe $f = 300\ sec^{-1}$

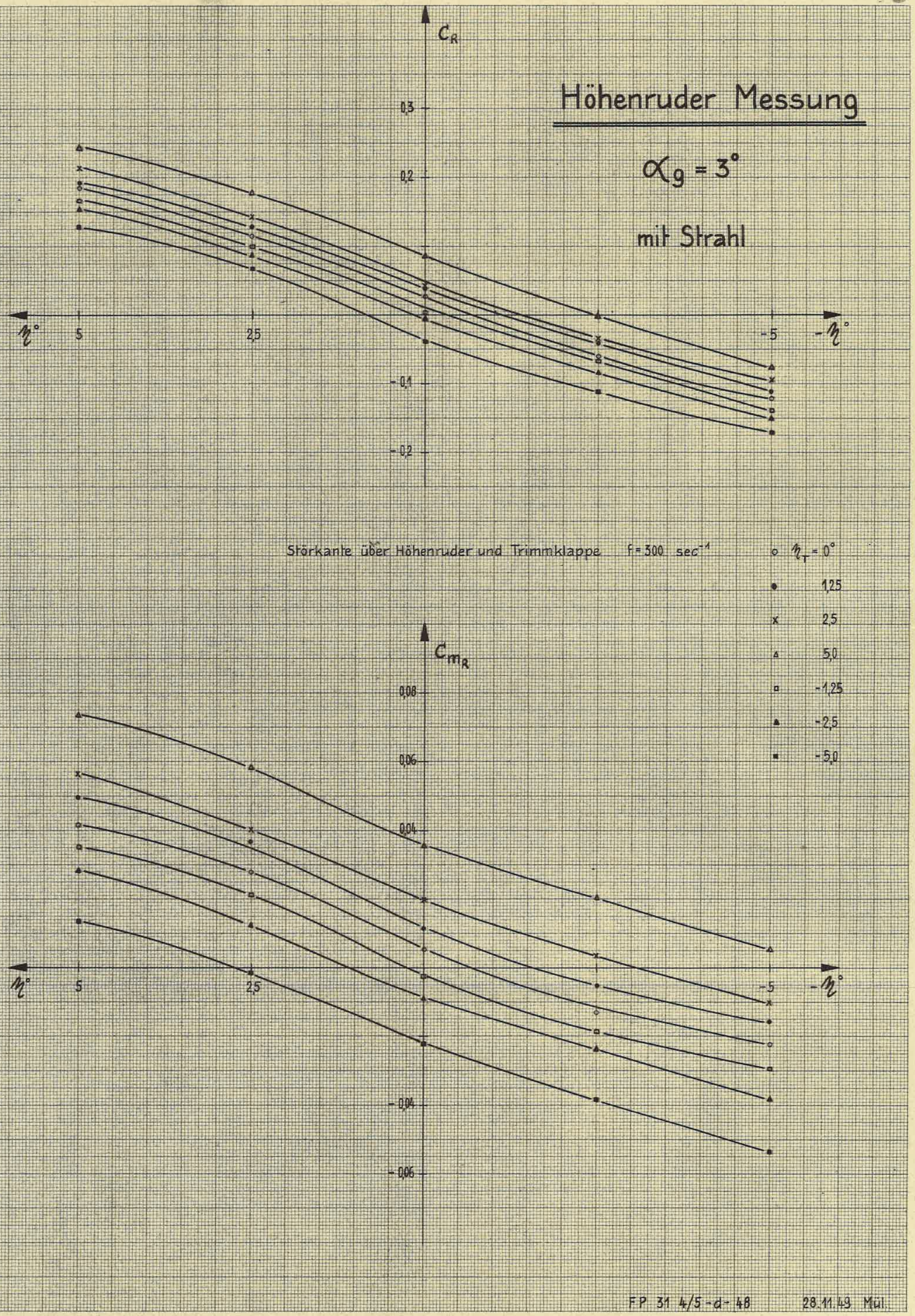
- ○ $\eta_T = 0°$
- ● 1,25
- × 2,5
- △ 5,0
- □ - 1,25
- ▲ - 2,5
- ■ - 5,0

FP 31 4/5-d-47 28.11.49 Mül.

Höhenruder Messung

$\alpha_g = 3°$

mit Strahl



Störkante über Höhenruder und Trimmklappe f = 300 sec^{-1}

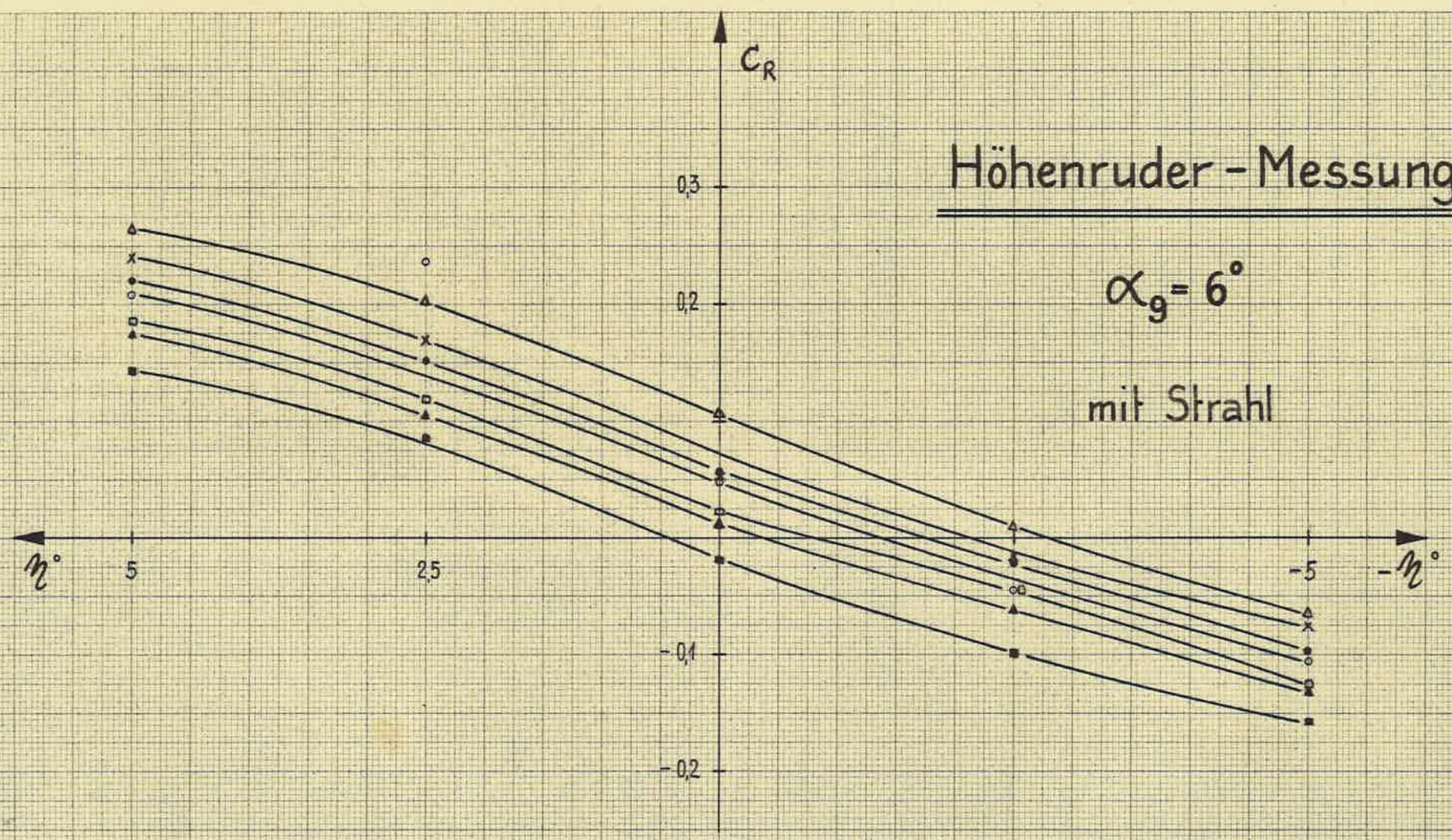
- ○ $\eta_T = 0°$
- ● 1,25
- x 2,5
- △ 5,0
- □ -1,25
- ▲ -2,5
- ■ -5,0

FP 31 4/5 - d - 48 28.11.49 Mül.

Höhenruder-Messung

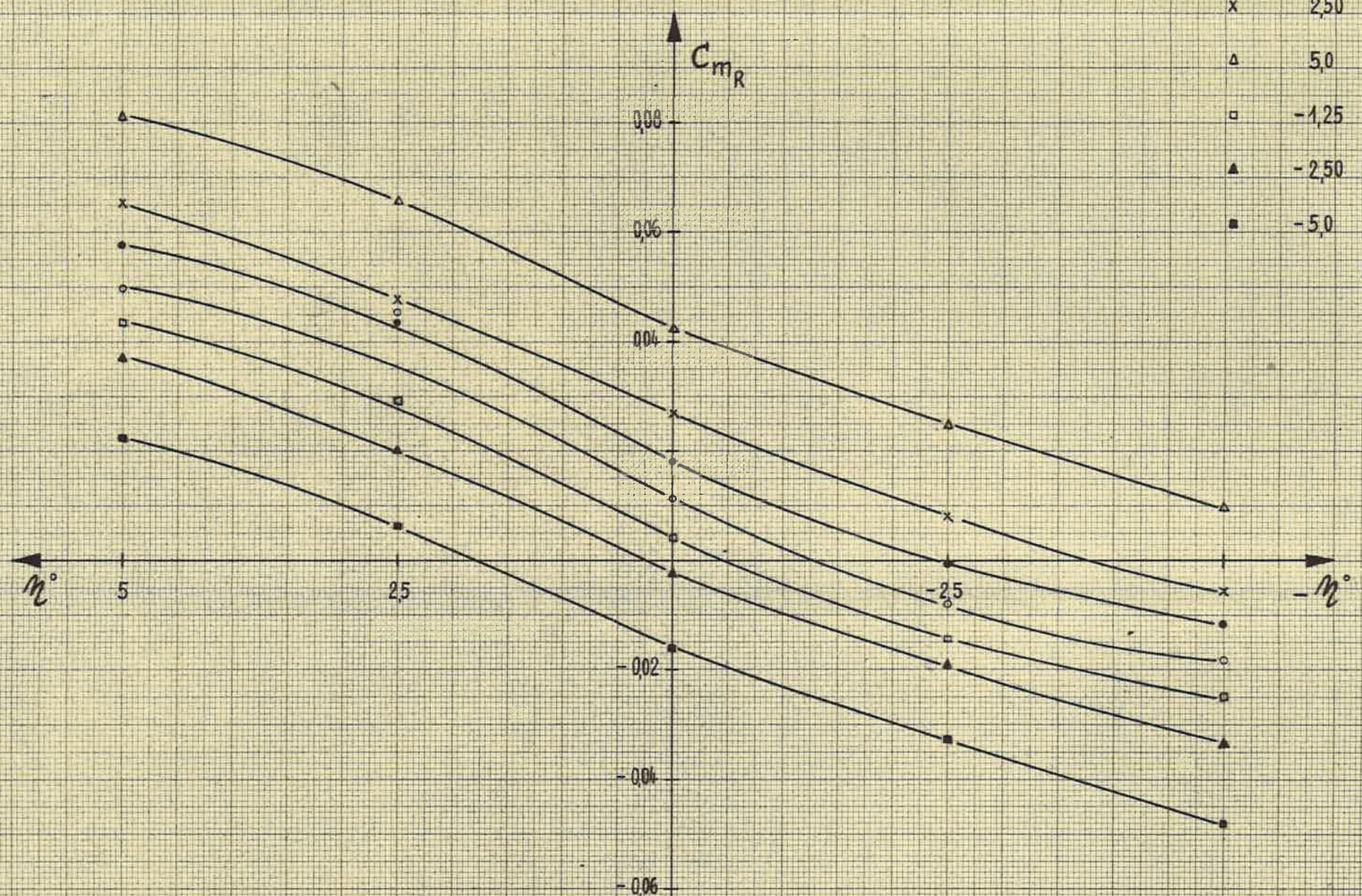
$\alpha_g = 6°$

mit Strahl

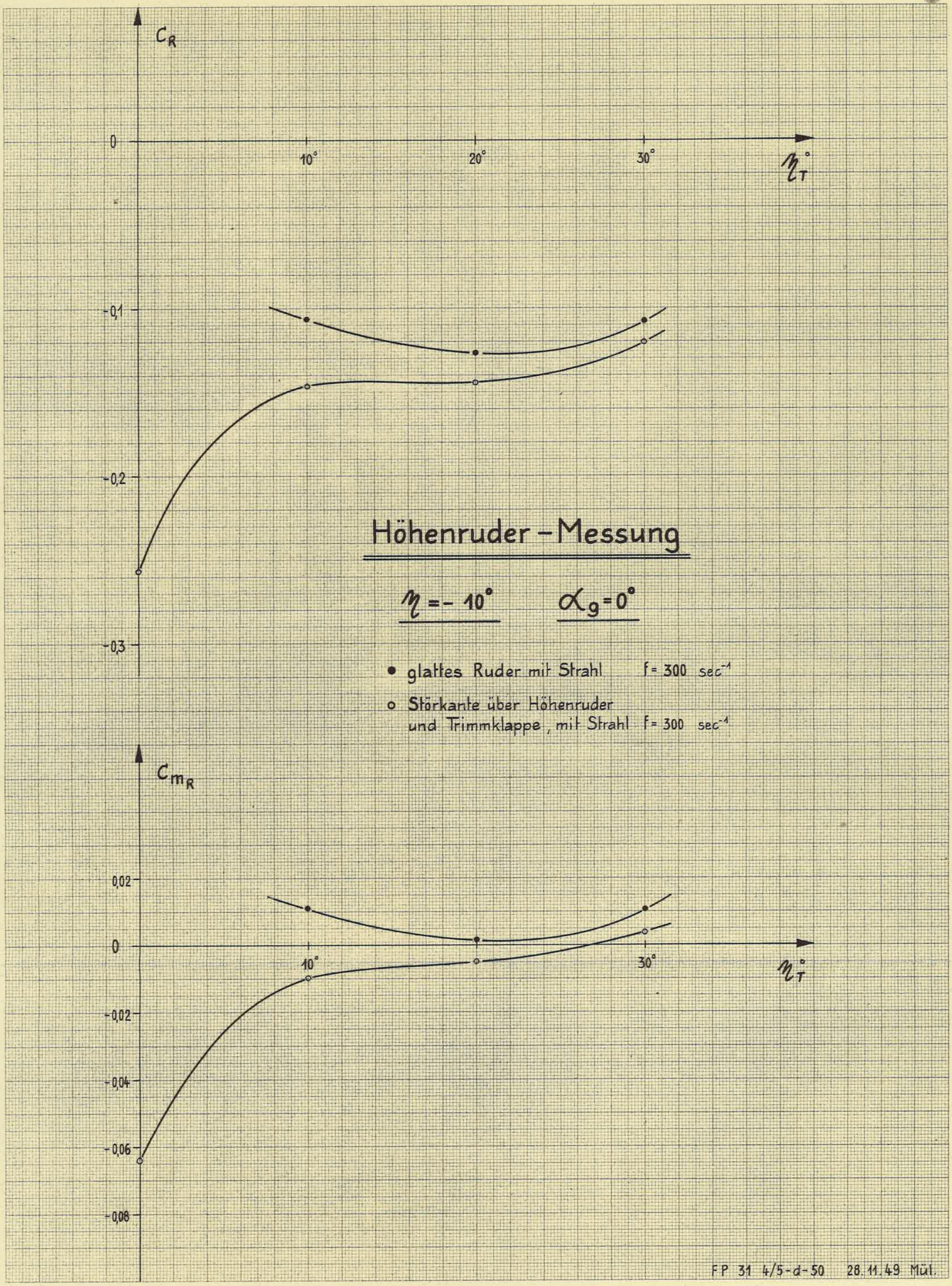


Störkante über Höhenruder und Trimmklappe f=300 sec^{-1}

- o $\eta_T = 0°$
- • 1,25
- x 2,50
- Δ 5,0
- □ -1,25
- ▲ -2,50
- ■ -5,0



FP 31 4/5-d-49 28.11.49 Mül



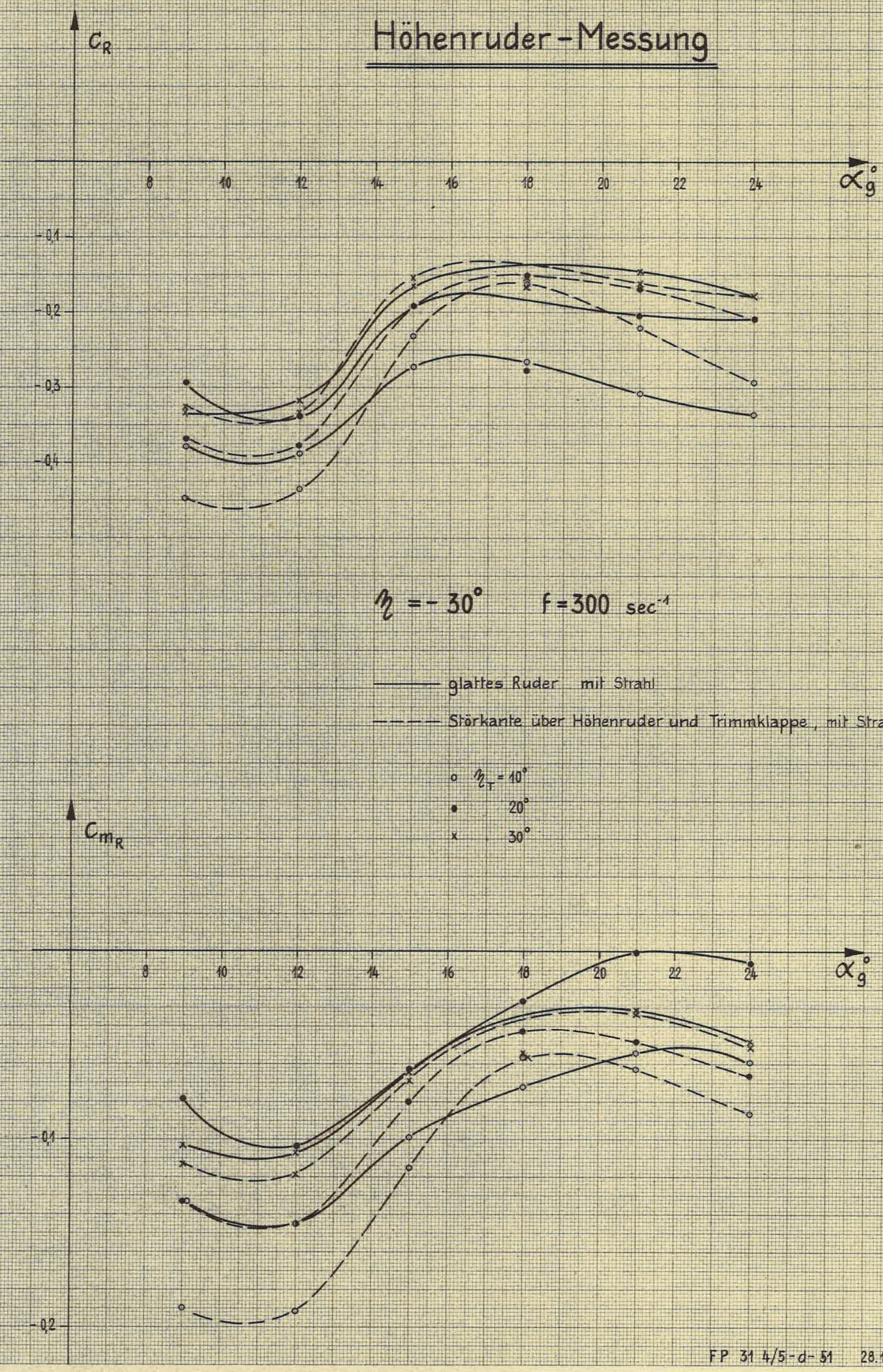
Höhenruder-Messung

$\eta = -10°$ $\alpha_g = 0°$

- glattes Ruder mit Strahl $f = 300\ sec^{-1}$
- Störkante über Höhenruder und Trimmklappe, mit Strahl $f = 300\ sec^{-1}$

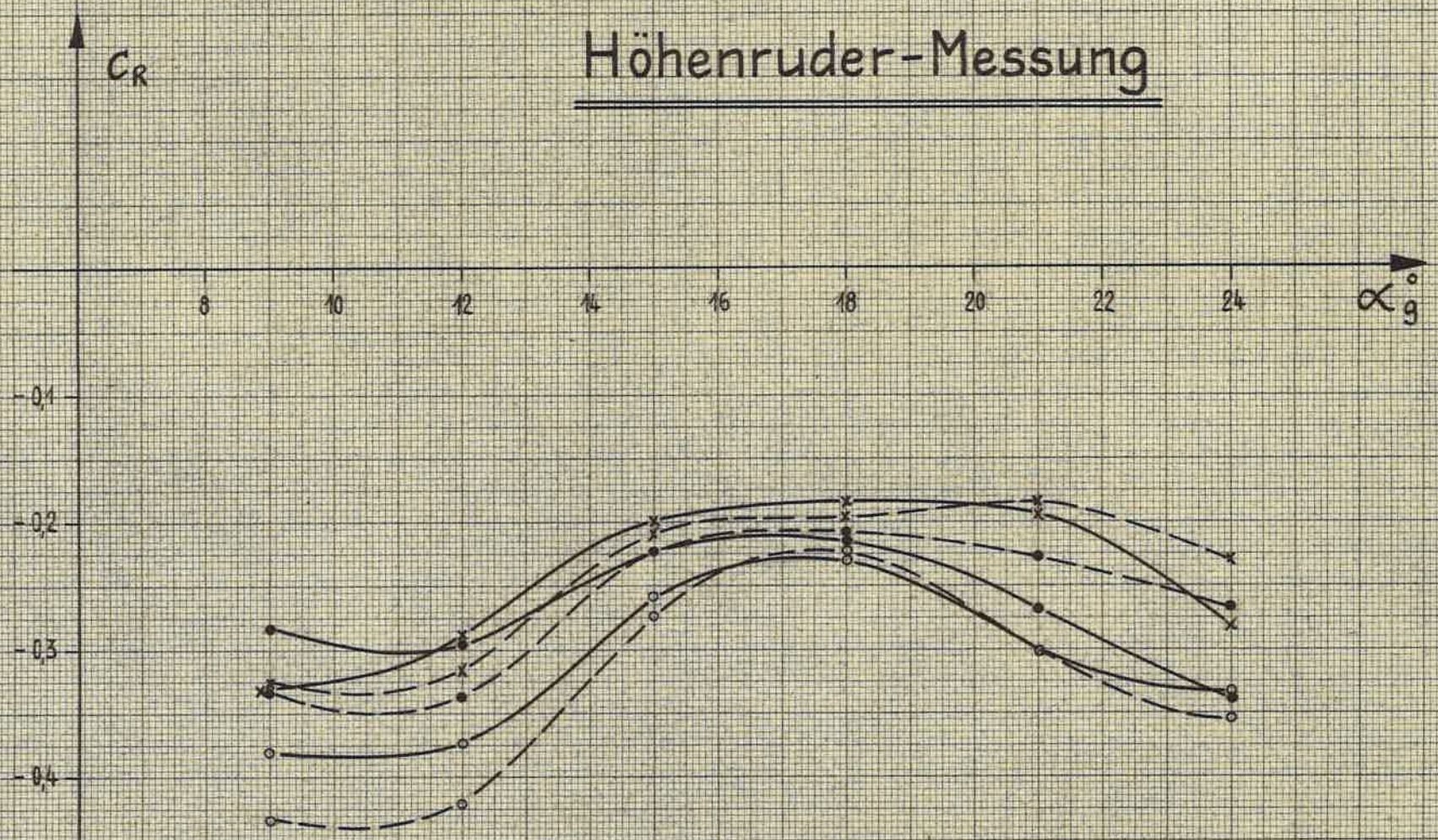
FP 31 4/5-d-50 28.11.49 Mül.

Höhenruder-Messung



FP 31 4/5-d-51 28.11.49 Mül.

Höhenruder-Messung



$\eta = -30°$ F = 0

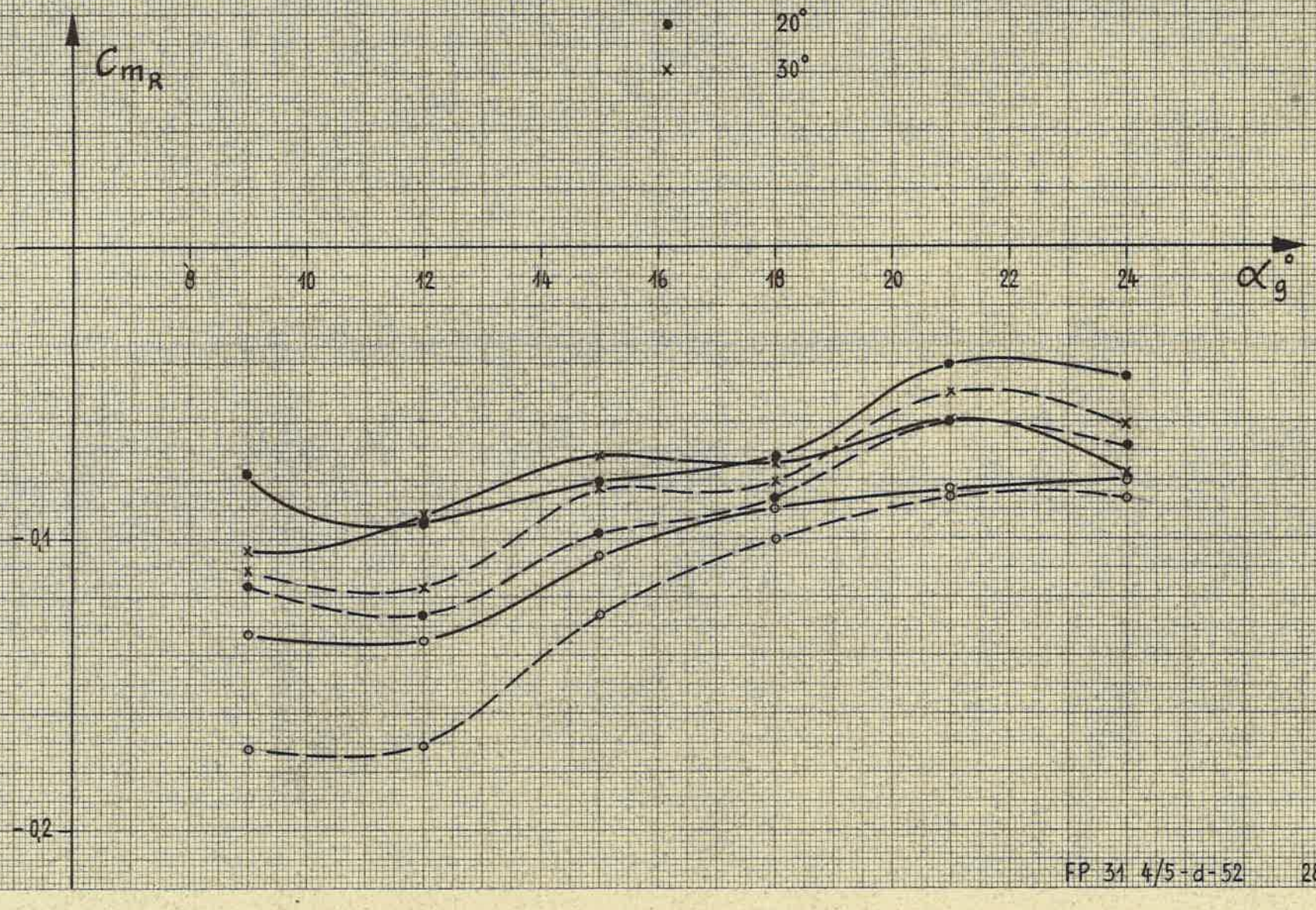
——— glattes Ruder ohne Strahl

– – – – Störkante über Höhenruder und Trimmklappe, ohne Strahl

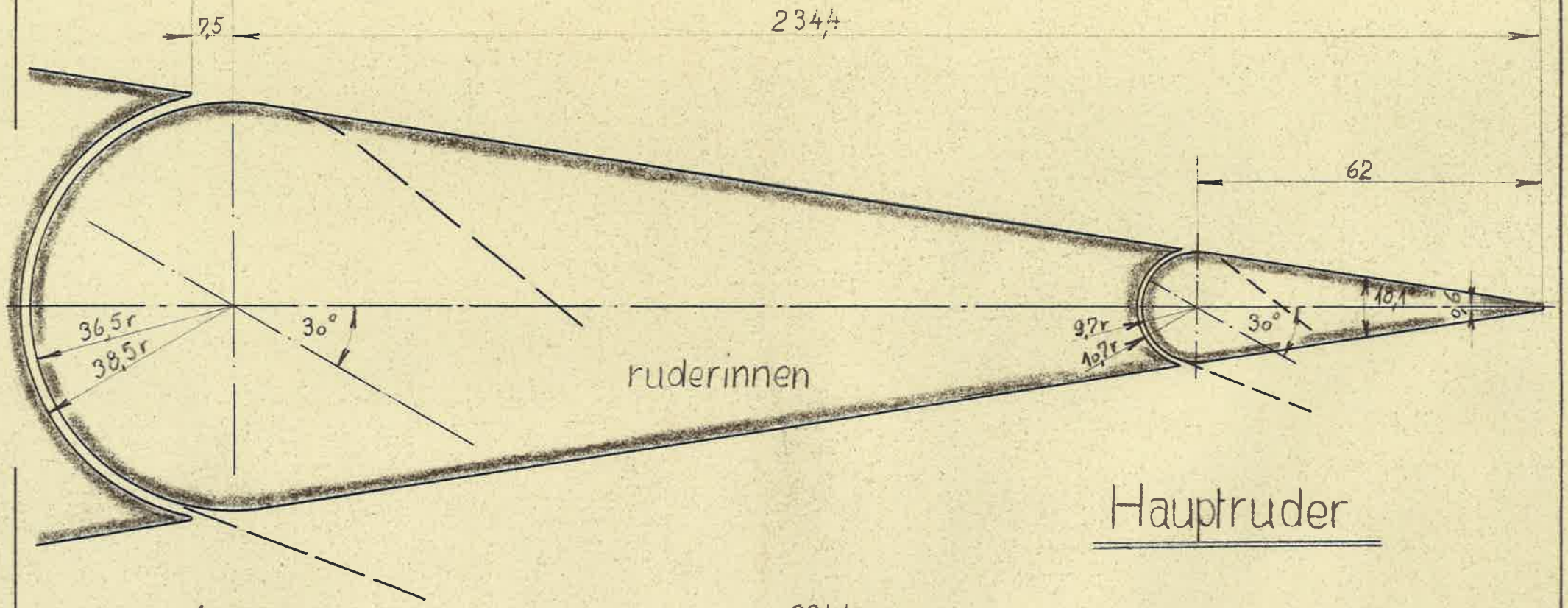
○ η_T = 10°

• 20°

× 30°



FP 31 4/5-d-52 28.11.49 Mül.


7,5
234,4
62
36,5r
38,5r
30°
ruderinnen
9,7r
10,7r
30°
18,1
10
9
Hauptruder
10
234,4
28r
30r
30°
ruderaussen
15,2
3
2
20
6
178,3
25°
28
23r
20°
ruderinnen
14,8
6
5
Seitenruder
10
5
106
25°
14,9
11,5r
20°
12,1
8
7
ruderaussen
Profilschnitte der Ruder
Modell N-20 1:3,2
M = 1:1
FP 31 4/5 - d' - 53

	Datum	Vis.
Messg.		
Ausw.		

B = _____ mm Hg

Grosser Windkanal

geschlossene Messstrecke

F_R = 0,2007 m²
t_R = 0,2344 m
ℓ_R = 0,8563 m

$M_I = -2,739 \cdot \Delta z_1 \cdot 10^{-3}$
$M_{II} = 2,568 \cdot \Delta z_2 \cdot 10^{-3}$
$M_{III} = 0,9451 \cdot \Delta z_3 \cdot 10^{-3}$

ℓ_1 = -0,024 m
ℓ_2 = +0,028 m
ℓ_3 = +0,043 m

c = +0,0653 m
d = 0,7963 m

Höhen - Rudermessung

η = _____
ζ = _____
f = _____

Protokoll Nr. _____

ϑ	α_K	δ	p_K	Δz_1	Δz_2	Δz_3	M_1	M_2	M_3	$Q_1=Q_2$	Q_3	R	M	ℓ	y	c_R	c_m	$\frac{\ell}{t_R}$	$\frac{y}{\ell_R}$
°C	°	°					m kg	m kg	m kg	kg	kg	kg	m kg	m	m				

$Q_1 = Q_2 = \frac{M_2 - M_1}{\ell_2 - \ell_1} = \frac{M_2 - M_1}{0,052}$

$Q_3 = \frac{M_3}{\ell_3} = 23,256 \cdot M_3$

$R = Q_1 + Q_3$

$M = M_2 - Q_1 \cdot \ell_2 = M_2 - Q_1 \cdot 0,028$

$\ell = \frac{M}{R}$

$y = \frac{Q_3}{R} \cdot d = (Q_3/R) \cdot 0,796$

$c_R = \frac{R}{p_K \cdot \varepsilon \cdot F_R} = \frac{R}{p_K \cdot \varepsilon} \cdot 4,9826$

$c_{m_R} = \frac{M}{p_K \cdot \varepsilon \cdot F_R \cdot t_R} = \frac{M}{p_K \cdot \varepsilon} \cdot 21,2567$

$y/\ell_R = \frac{1}{\ell_R} \cdot (y + c) = 1,1678 \cdot (y + 0,0653)$

ε =

$\bar{p}_K \cdot \varepsilon$ =

	Datum	Vis.
Messg.		
Ausw.		

Grosser Windkanal

geschlossene Messstrecke

Höhen - Rudermessung

B = ______ mm Hg

F_R = 0,2007 m² M_I = −2,739 · $\Delta z_1 \cdot 10^{-3}$ ℓ_1 = −0,024 m   c = +0,0653 m

t_R = 0,2344 m M_{II} = 2,568 · $\Delta z_2 \cdot 10^{-3}$ ℓ_2 = +0,028 m   d = 0,7963 m

ℓ_R = 0,8563 m M_{III} = 0,9451 · $\Delta z_3 \cdot 10^{-3}$ ℓ_3 = +0,043 m

η = ______

ξ = ______

f = ______

Protokoll Nr. ______

ϑ	α_K	δ	p_K	Δz_1	Δz_2	Δz_3	M_1	M_2	M_3	$Q_1 = Q_2$	Q_3	R	M	ℓ	y	c_R	c_m	$\frac{\ell}{t_R}$	$\frac{y}{\ell_R}$	
°C	°	°					m kg	m kg	m kg	kg	kg	kg	m kg	m	m					

$Q_1 = Q_2 = \frac{M_2 - M_1}{\ell_2 - \ell_1} = \frac{M_2 - M_1}{0,052}$

$Q_3 = \frac{M_3}{\ell_3} = 23,256 \cdot M_3$

$R = Q_1 + Q_3$

$M = M_2 - Q_1 \cdot \ell_2 = M_2 - Q_1 \cdot 0,028$

$\ell = \frac{M}{R}$

$y = \frac{Q_3}{R} \cdot d = (Q_3/R) \cdot 0,796$

$c_R = \frac{R}{p_K \cdot \varepsilon \cdot F_R} = \frac{R}{p_K \cdot \varepsilon} \cdot 4,9826$

$c_{m_R} = \frac{M}{p_K \cdot \varepsilon \cdot F_R \cdot t_R} = \frac{M}{p_K \cdot \varepsilon} \cdot 21,2567$

$y/\ell_R = \frac{1}{\ell_R} \cdot (y + c) = 1,1678 \cdot (y + 0,0653)$

ε =

$\bar{p}_K \cdot \varepsilon$ =