

Landesysteme



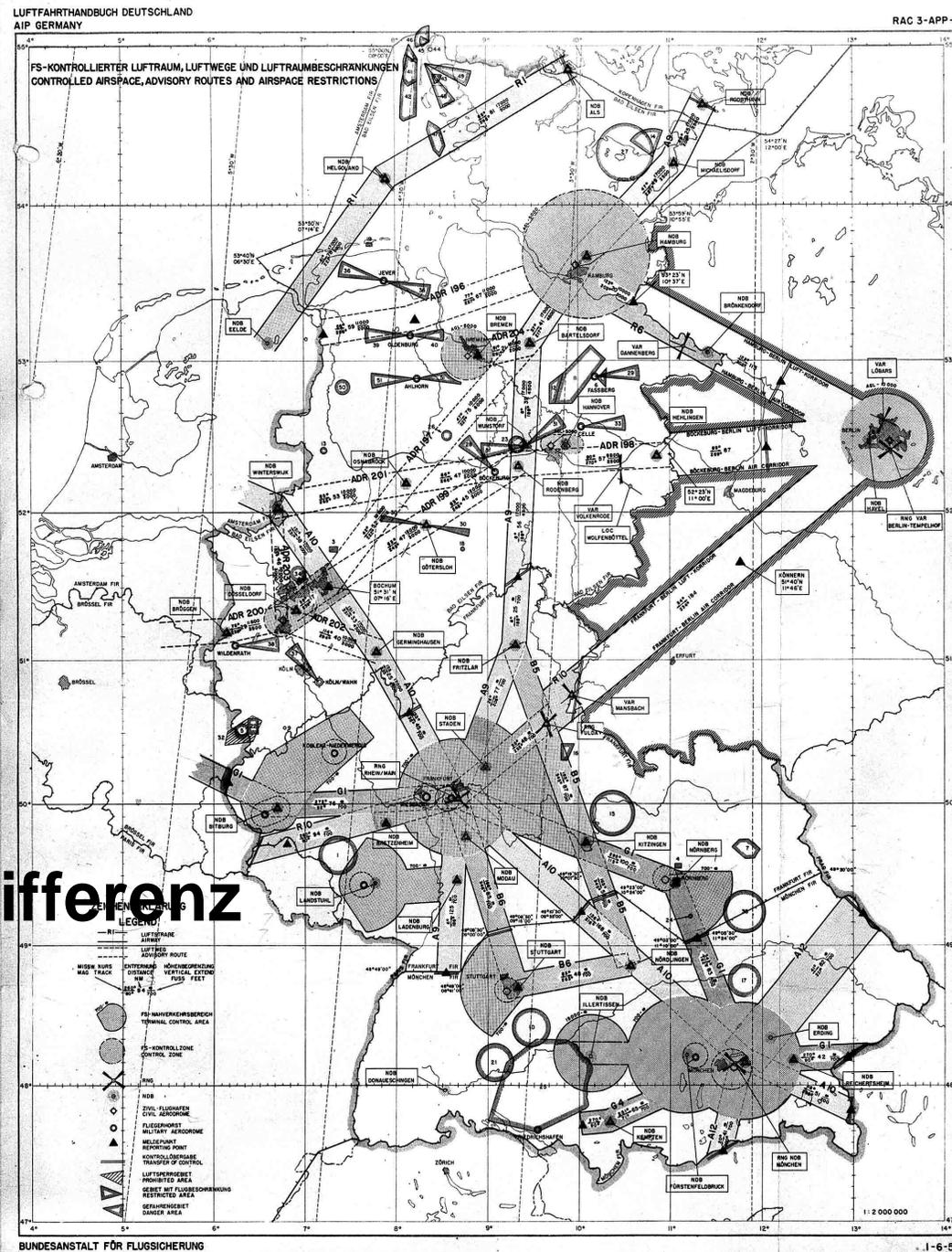
Werner Nüsseler
ehem. BFS / DFS
1966 - 2006

Land

N AVIGATION

Hf-Amplitude,
Hf-Phase,
Hf-Phasendifferenz
Nf-Amplitude,
Nf-Phase,
Nf-Phasendifferenz
Nf-Modulationsgrad-Differenz

Richtung
Entfernung
Höhe



Landesysteme



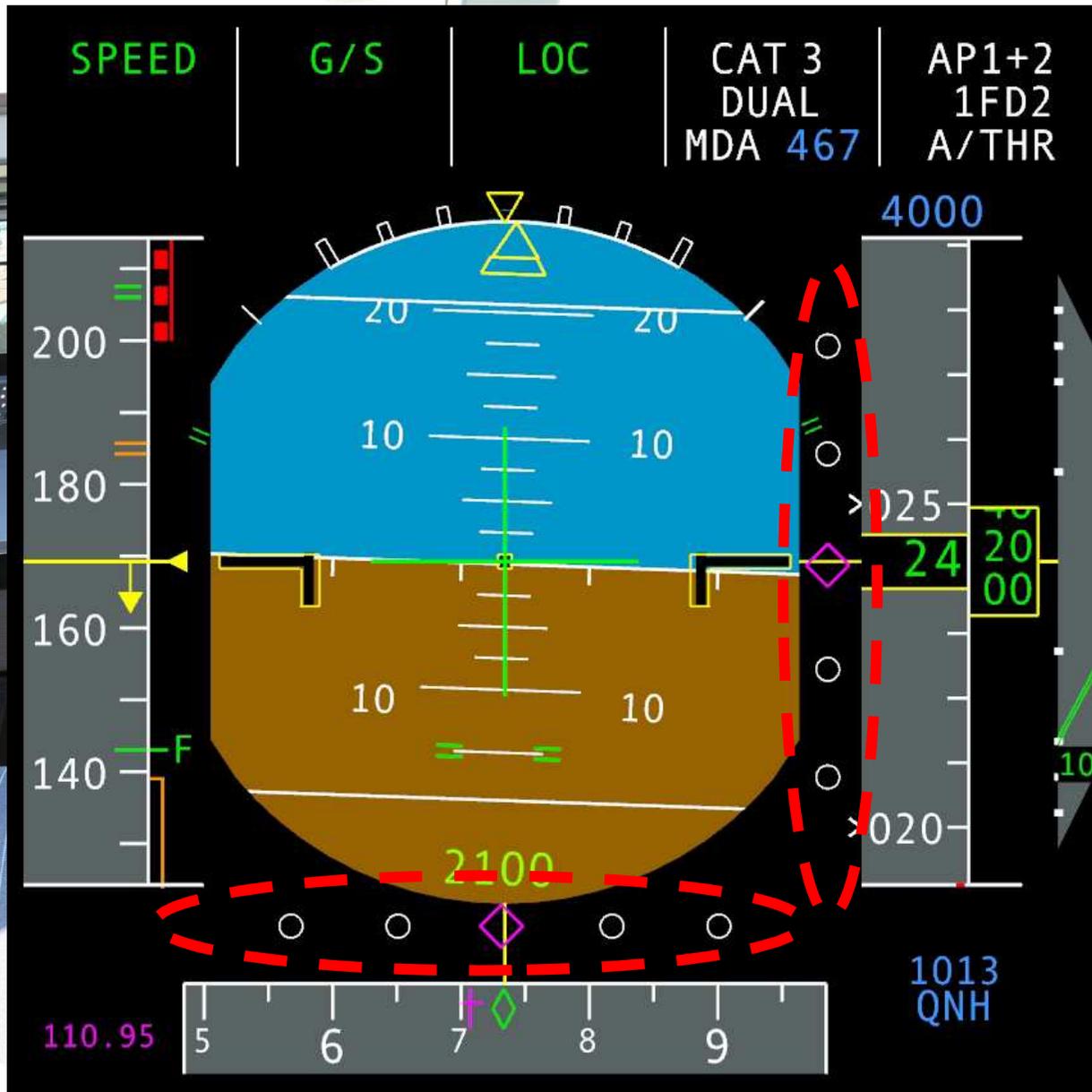
**Airbus
A 380**

Landesysteme



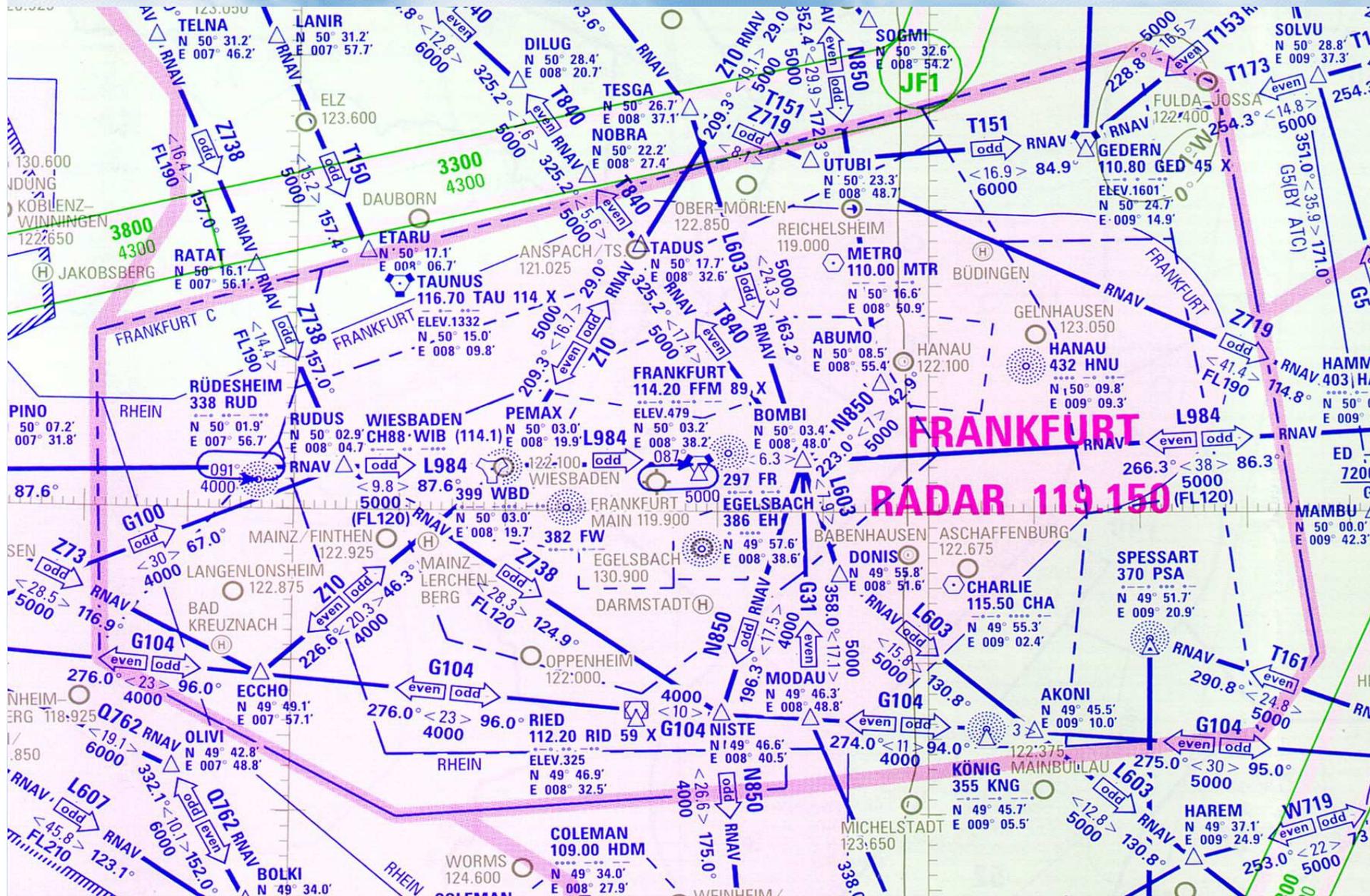
**Airbus
A 380**

Landesysteme

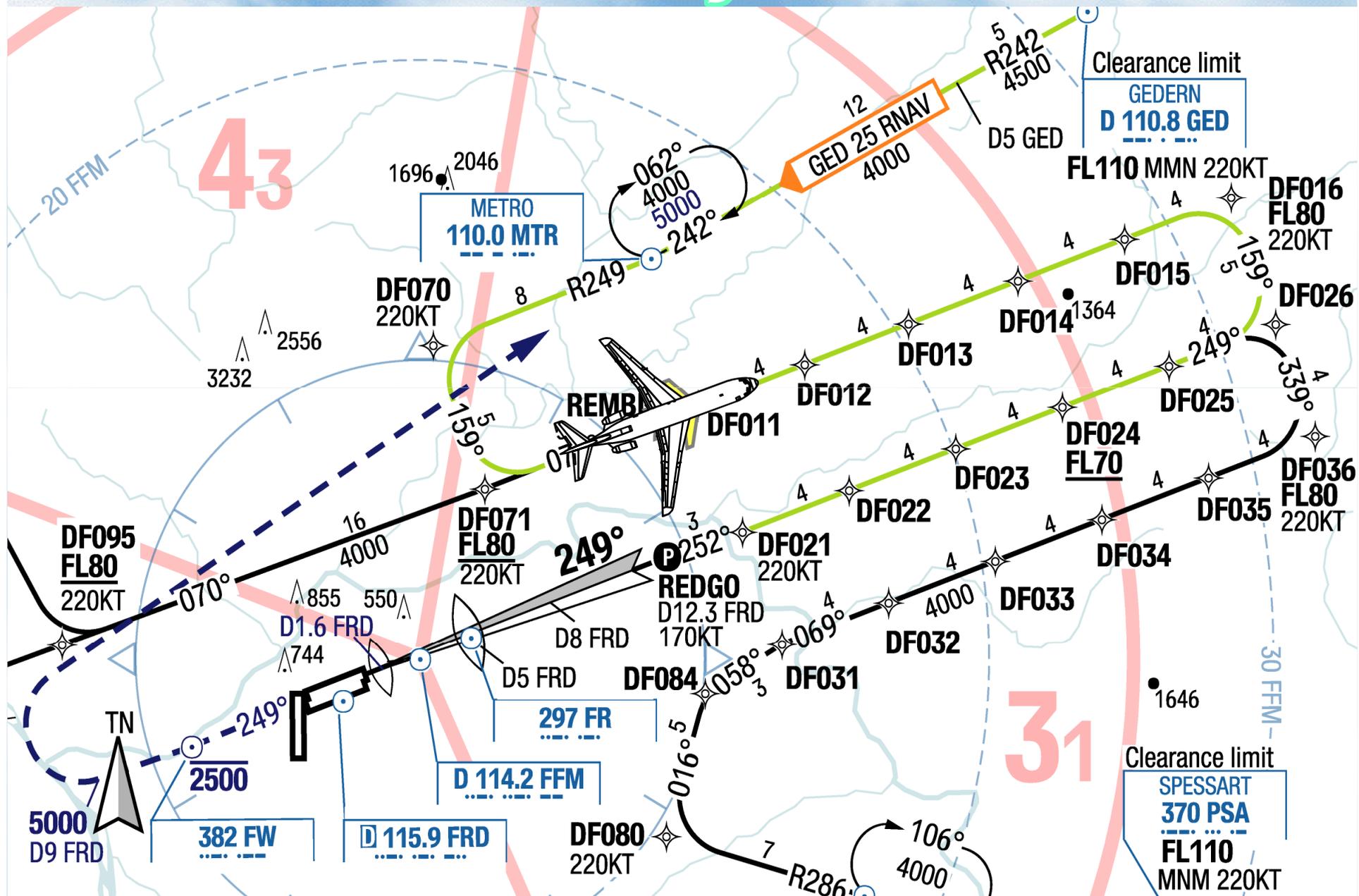


**Airbus
A 380**

Landesysteme



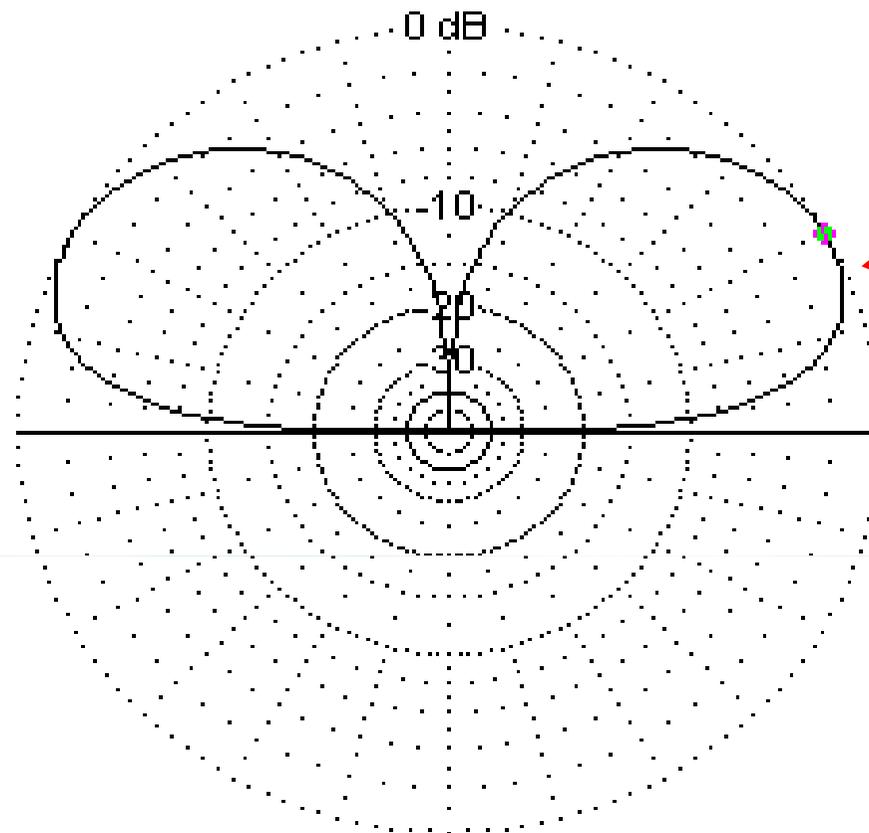
Landesysteme



Landesysteme

EZNEC

www.ez nec.com



**Linie
gleicher
Feldstärke**

30 MHz

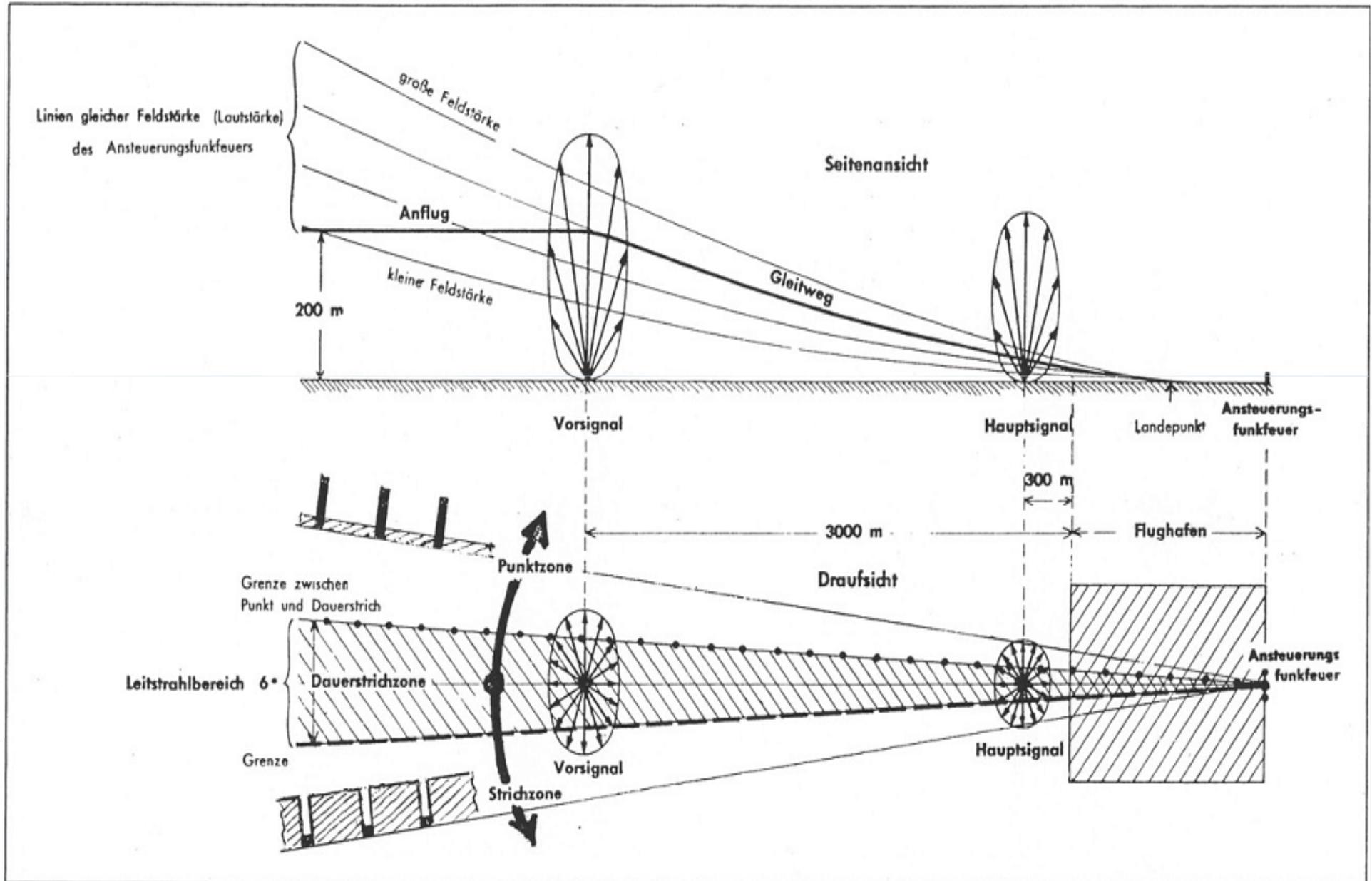
Elevation Plot
Azimuth Angle 0,0 deg.
Outer Ring -0,26dBi

Cursor Elev 29,0 deg.
Gain -0,26 dBi
0,0 dBmax

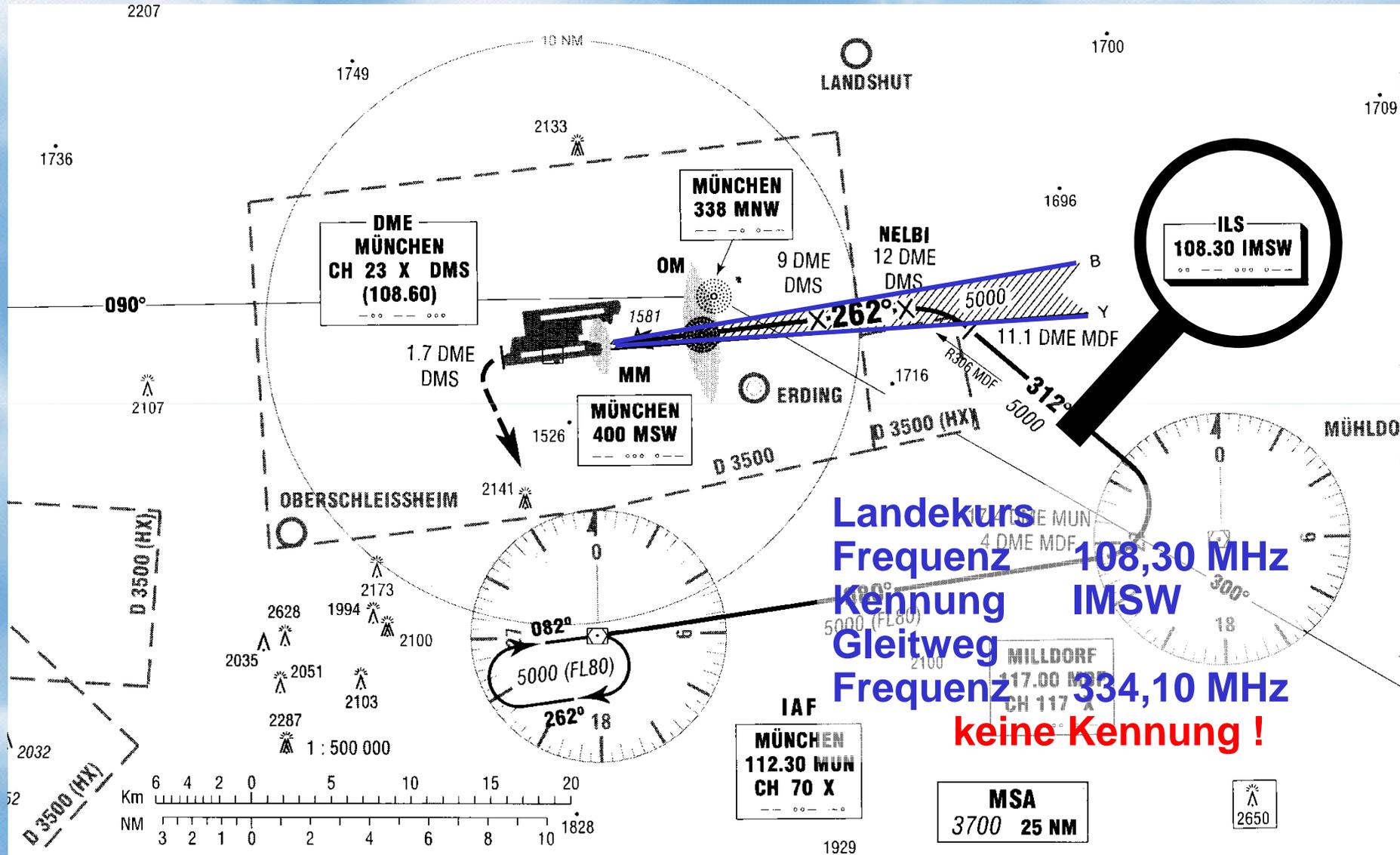
Slice Max Gain -0,26 dBi @ Elev Angle = 29,0 deg.
Beamwidth 46,3 deg.; -3dB @ 10,1, 56,4 deg.
Sidelobe Gain -0,26 dBi @ Elev Angle = 151,0 deg.
Front/Sidelobe 0,0 dB

5/2008 DL2JAS

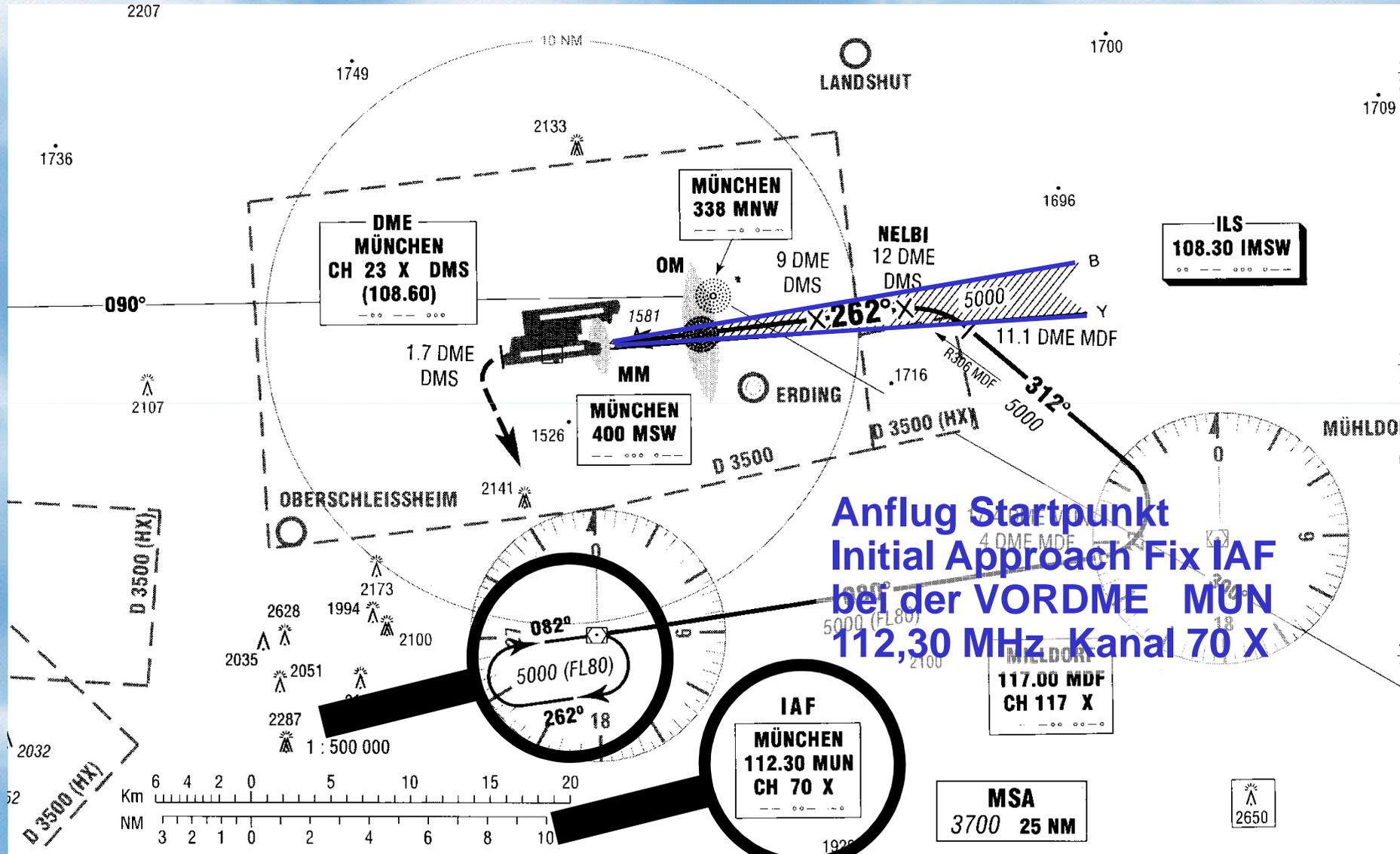
Landesysteme



Landesysteme

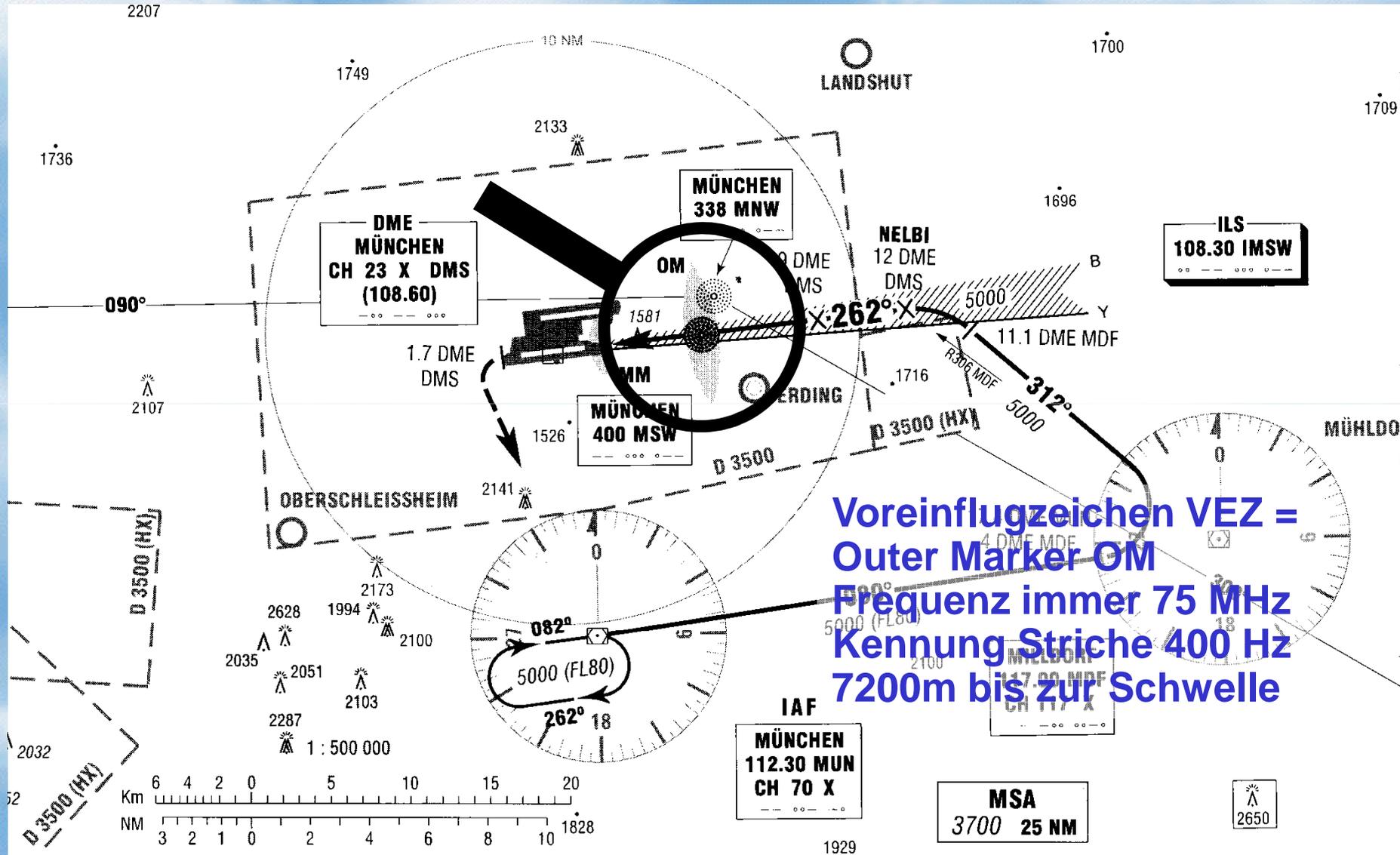


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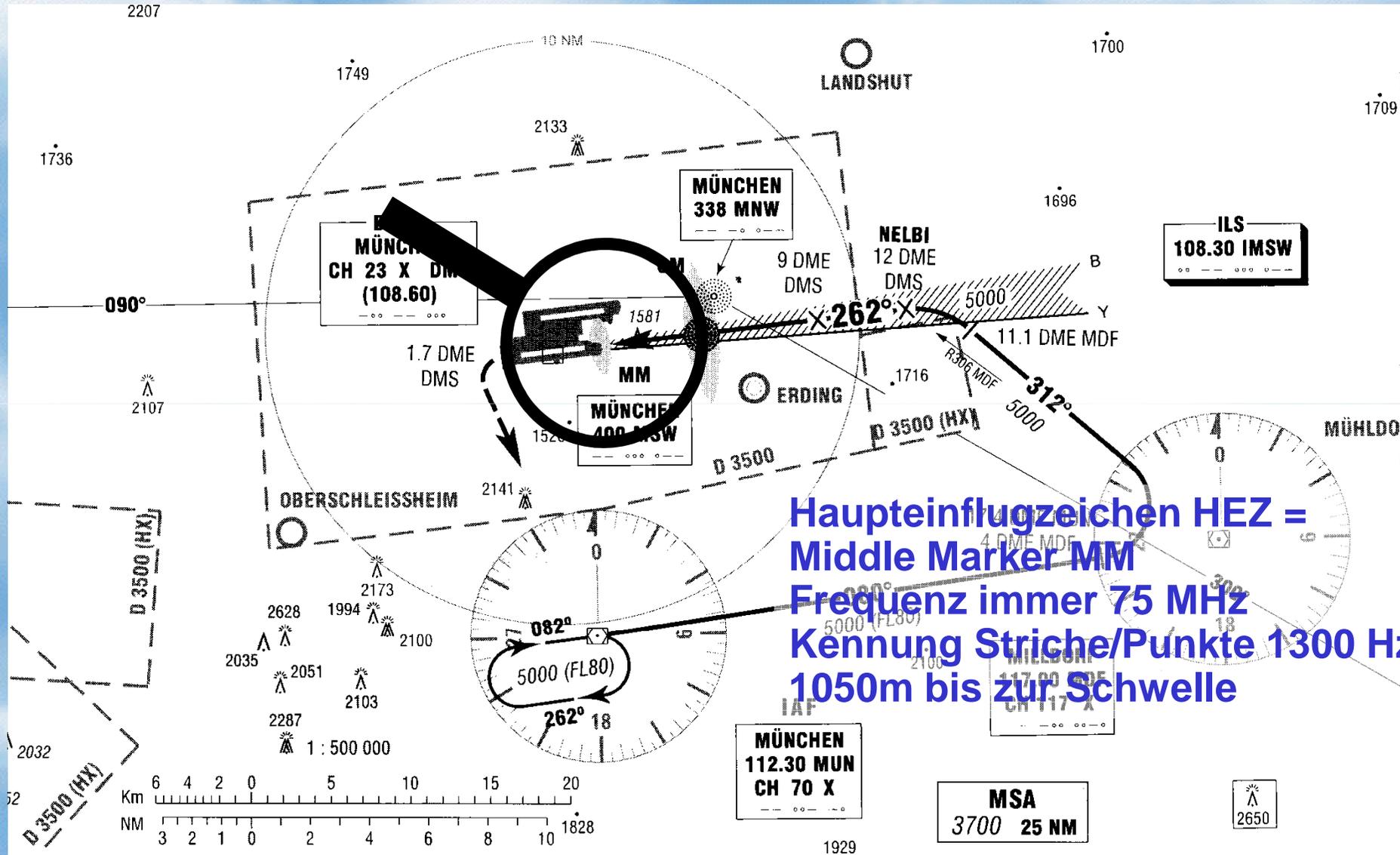
Anflug Startpunkt
Initial Approach Fix IAF
bei der VORDME MUN
112,30 MHz Kanal 70 X

Landesysteme



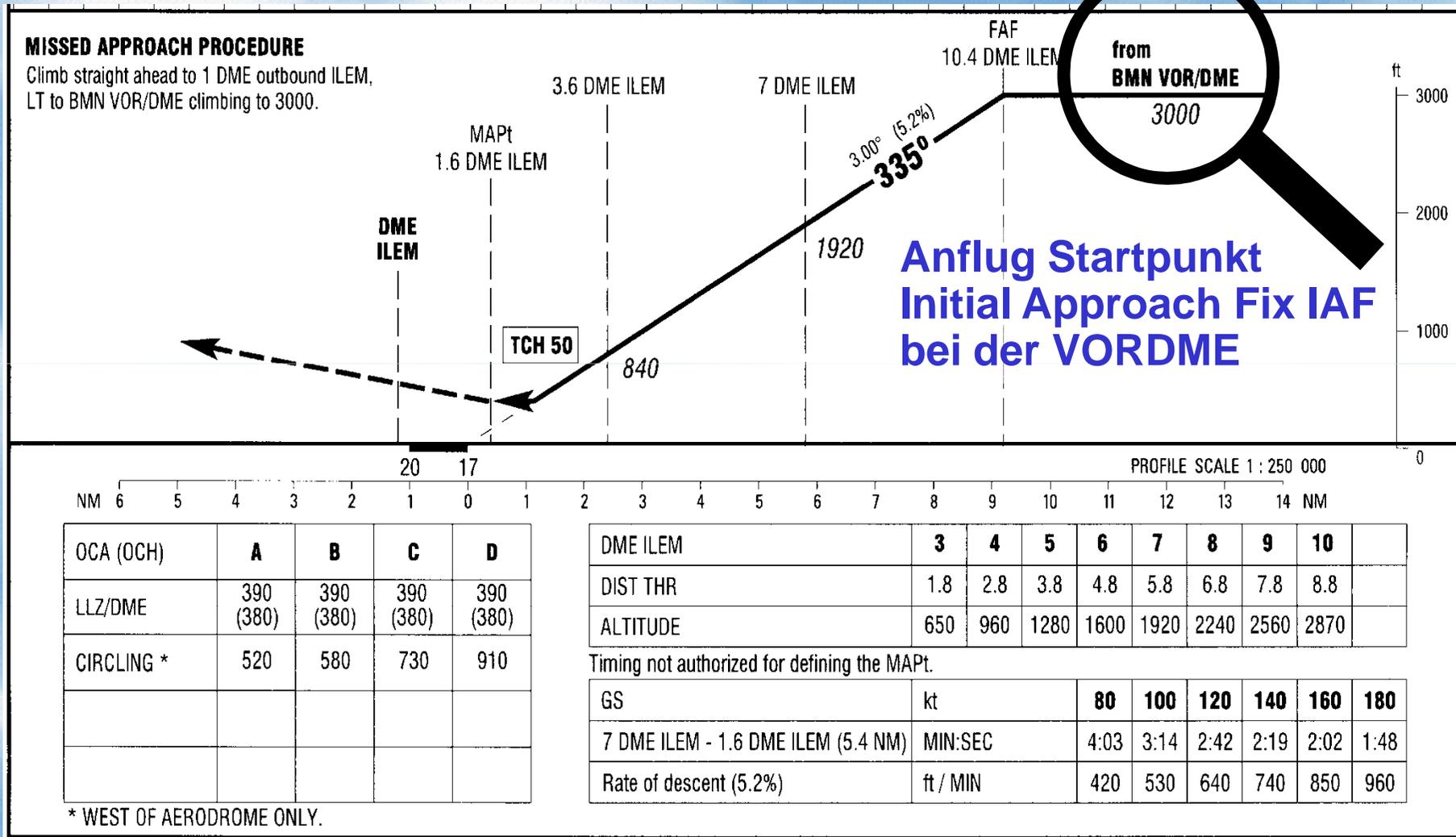
**Voreinflugszeichen VEZ =
Outer Marker OM
Frequenz immer 75 MHz
Kennung Striche 400 Hz
7200m bis zur Schwelle**

Landesysteme

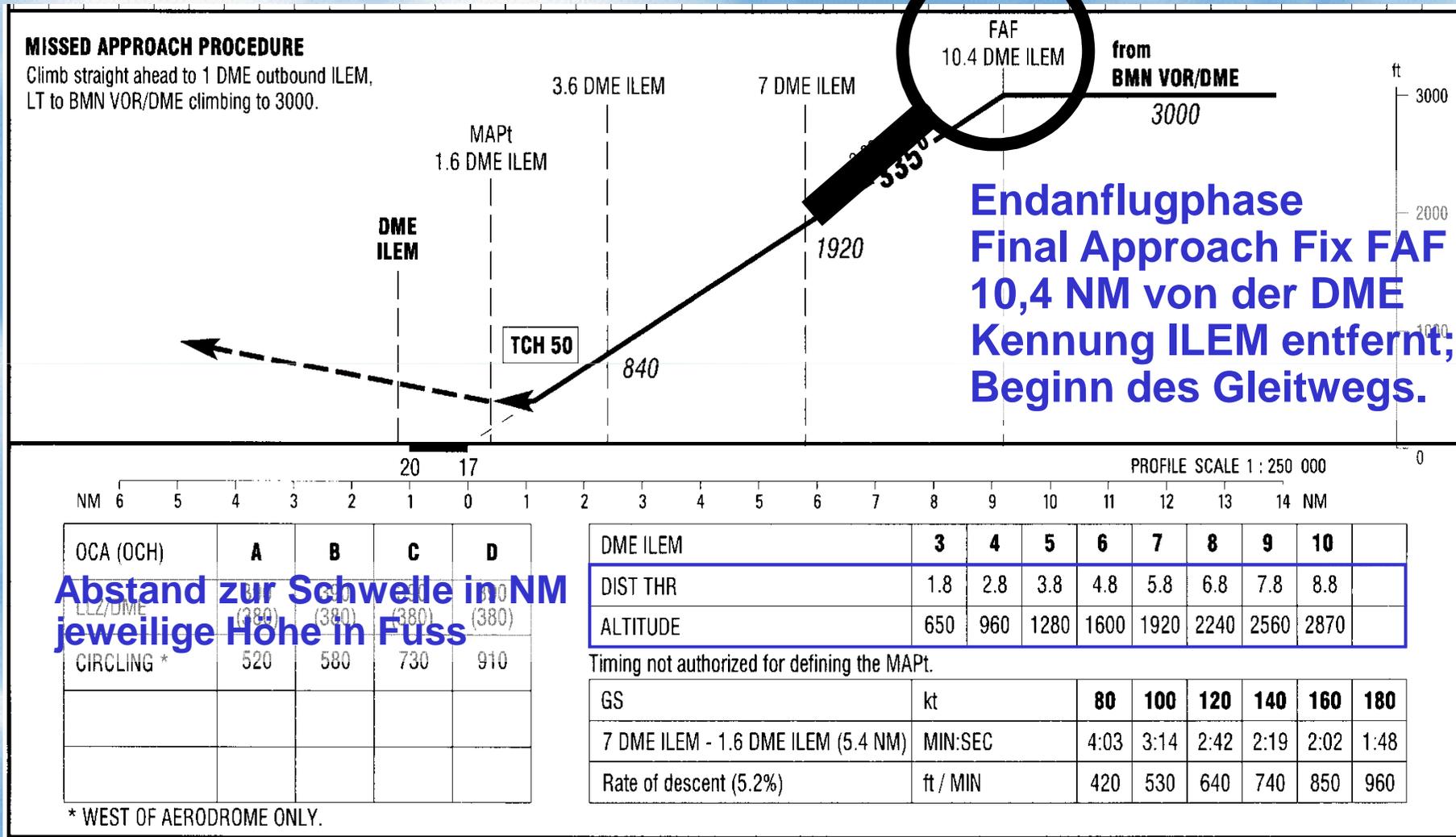


Haupteinflugzeichen HEZ =
Middle Marker MM
Frequenz immer 75 MHz
Kennung Striche/Punkte 1300 Hz
1050m bis zur Schwelle

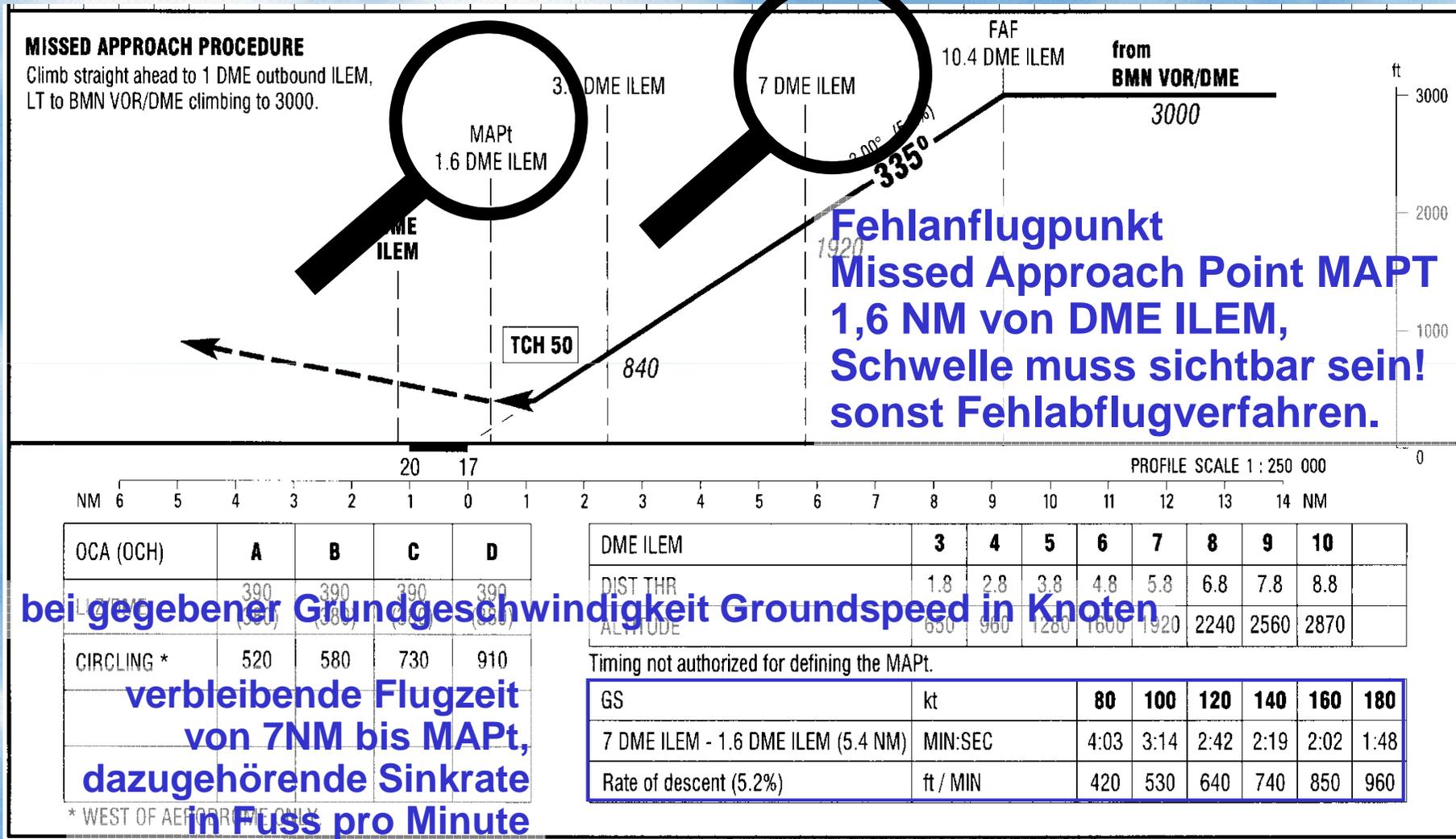
Landesysteme



Landesysteme



Landesysteme



bei gegebener Grundgeschwindigkeit Groundspeed in Knoten

OCA (OCH)	A	B	C	D
390 (390)	390 (390)	390 (390)	390 (390)	390 (390)
CIRCLING *	520	580	730	910

verbleibende Flugzeit von 7NM bis MAPt, dazugehörige Sinkrate in Fuss pro Minute

DME ILEM	3	4	5	6	7	8	9	10
DIST THR	1.8	2.8	3.8	4.8	5.8	6.8	7.8	8.8
ALTITUDE	650	960	1260	1600	1920	2240	2560	2870

Timing not authorized for defining the MAPt.

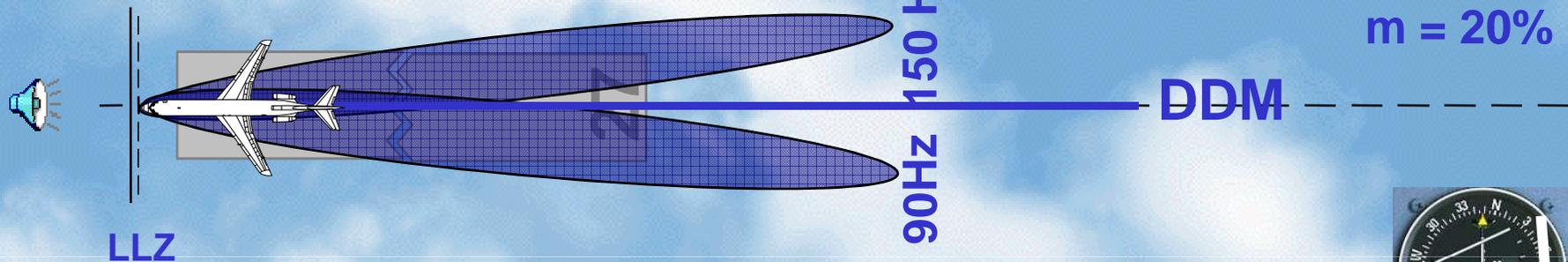
GS	kt	80	100	120	140	160	180
7 DME ILEM - 1.6 DME ILEM (5.4 NM)	MIN:SEC	4:03	3:14	2:42	2:19	2:02	1:48
Rate of descent (5.2%)	ft / MIN	420	530	640	740	850	960

* WEST OF AERODROME ONLY

Landesysteme



Landekursantennen am Bahnende erzeugen aufgefächertes Strahlungsdiagramm mit 90 Hz - und 150 Hz – AM $m = 20\%$

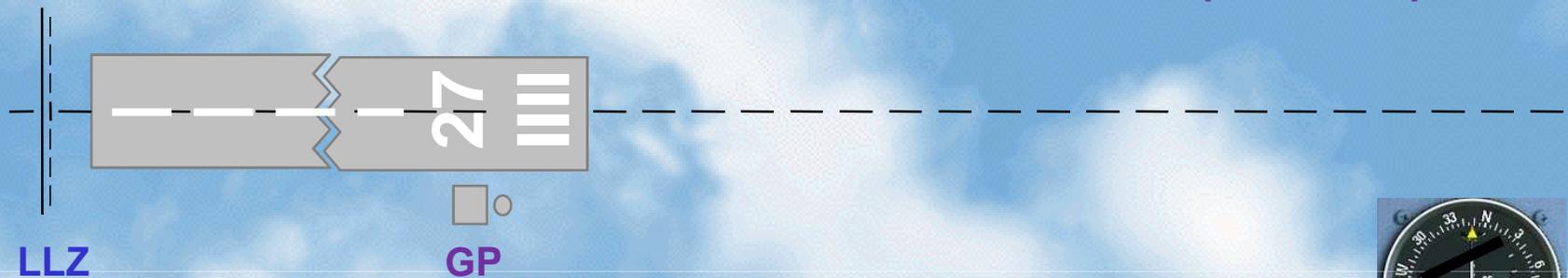


die steuern senkrechte Nadel im Kreuzzeiger-Instrument; durch Messung der Modulationsgrad-Differenz $DDM = 0$.

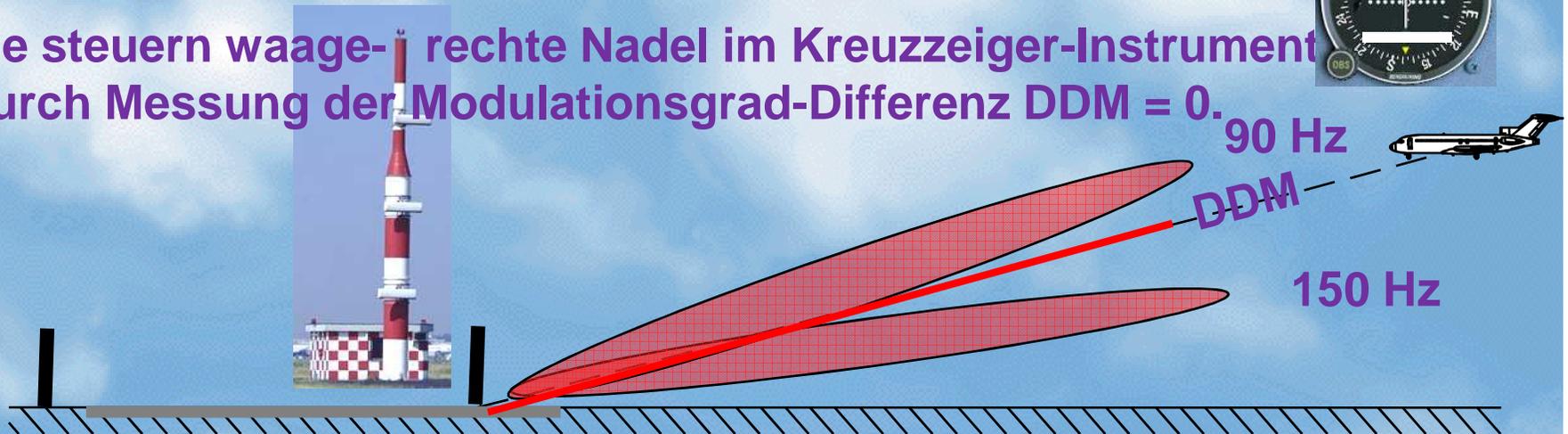


Landesysteme

Gleitwegantennen am Bahnanfang erzeugen aufgefächertes Strahlungsdiagramm mit 90 Hz - und 150 Hz – AM (m = 40%)

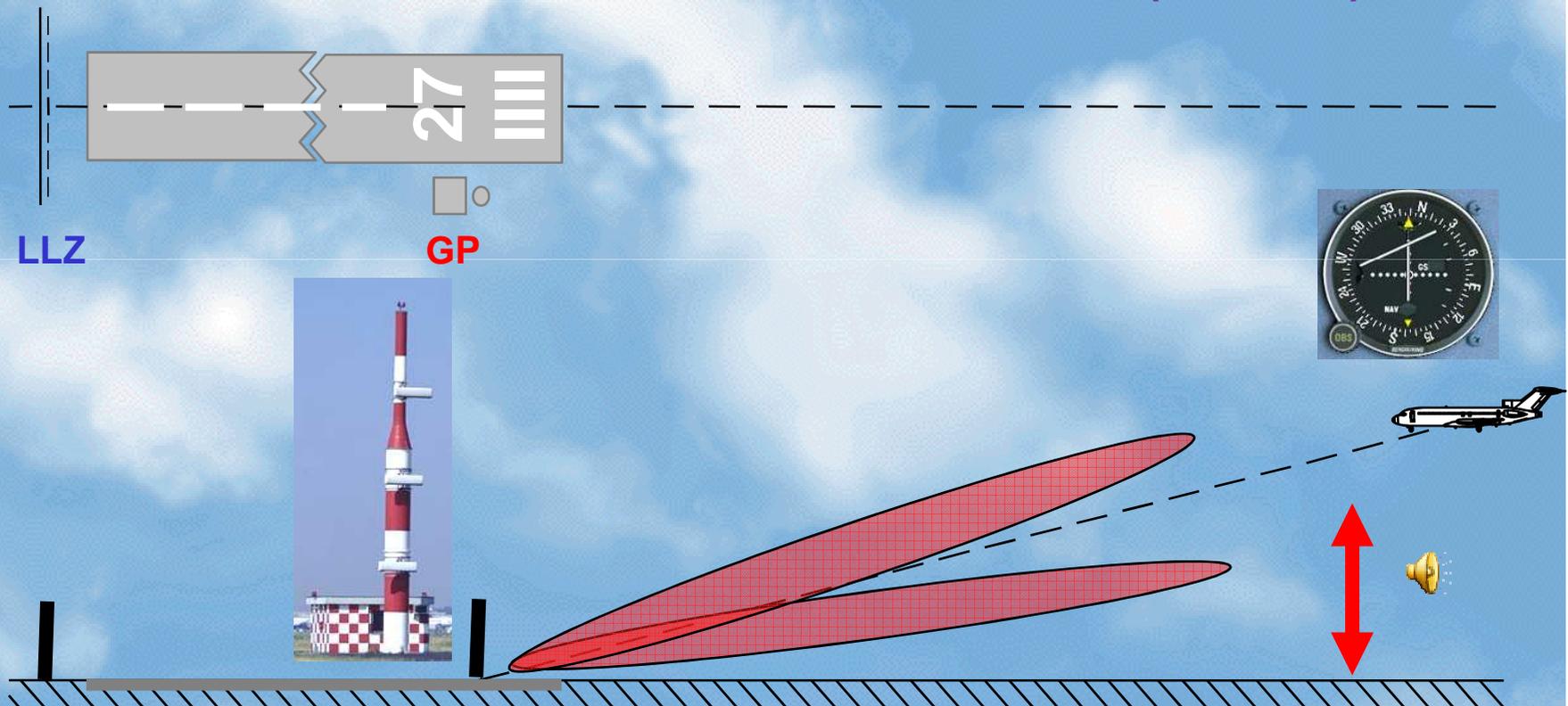


die steuern waag- rechte Nadel im Kreuzzeiger-Instrument durch Messung der Modulationsgrad-Differenz $DDM = 0$.



Landesysteme

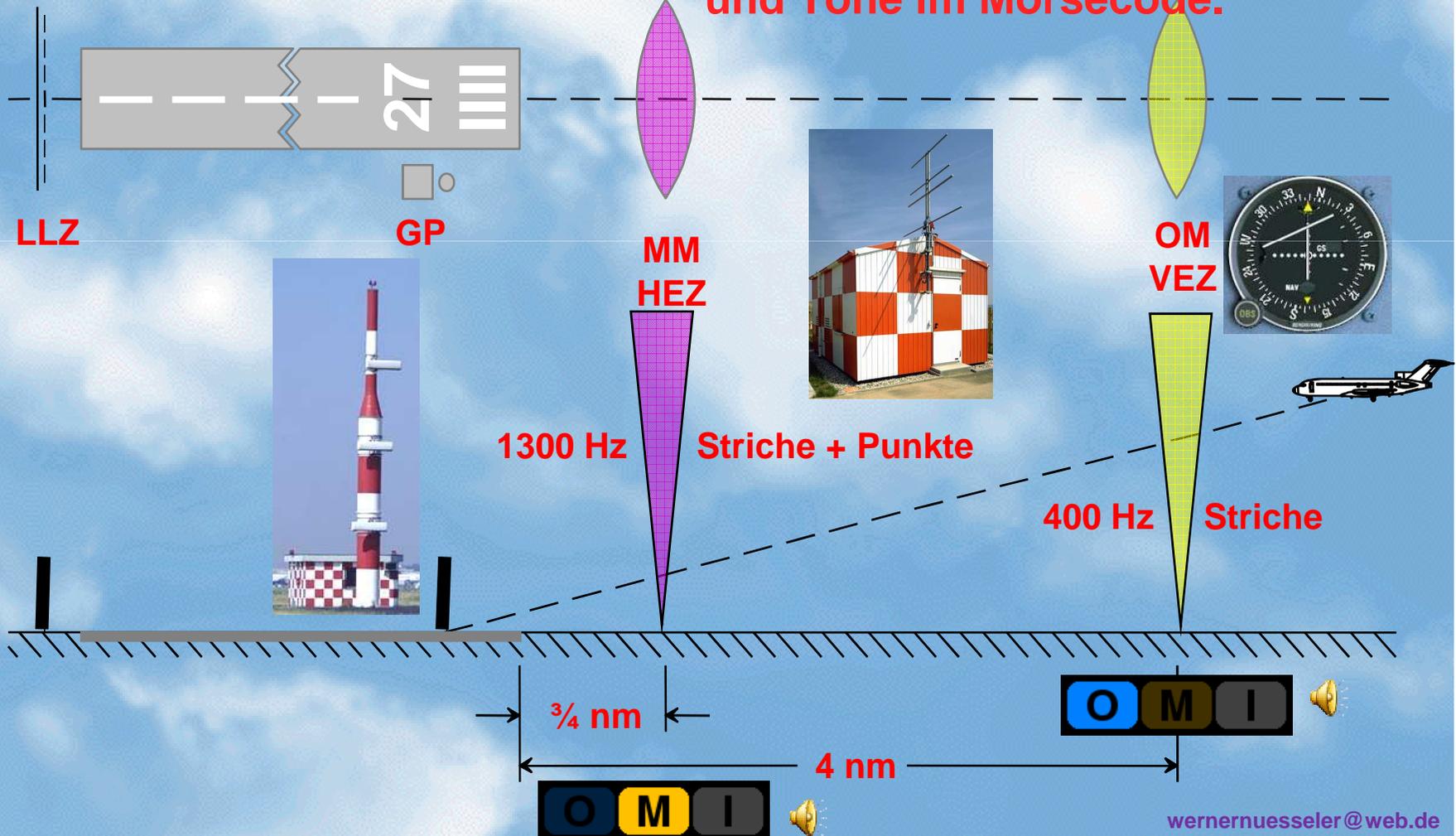
Gleitwegantennen am Bahnanfang erzeugen aufgefächertes Strahlungsdiagramm mit 90 Hz - und 150 Hz – AM (m = 40%)



ab MaPt erfolgt Höhen-Information in feet durch Laufzeitmessung
Bord-Boden-Bord mit akustischer Ansage

Landesysteme

Zwei Marker-Sender bilden Entfernungs-
marken in $\frac{3}{4}$ und 4 Nautischen Meilen,
angezeigt durch blinkende Lampen
und Töne im Morsecode.



Landesysteme

Status:	Primary ICAO standard non visual aid to final approach and landing
Frequency:	pairing ILS-LLZ,-GP, Marker and or DME(/TACAN), MLS (ICAO Annex 10)
ILS-LOC 1f	108.10-111.950MHz odd 100kHz 50kHz steps, signal may be comprised of 2 signals, closely spaced around the center-frequency (1f- and 2f- GP/LLZ signals interoperable).
2f	
ILS-GP 1f	328.6-335.4MHz, signal may be comprised of 2 signals, closely spaced around the center-frequency (1f- and 2f- GP/LLZ signals interoperable).
2f	

Function:	ICAO standard non visual aid to final approach and landing
ILS-LOC	course guidance to the runway centerline
ILS-GP	descent information down to decision height. projection angle 2° - 4° above hor. (norm. 3°).
DME paired to ILS	Provides slant-range between a DME-Interrogator and DME-Transponder
ILS-Marker -OM	
-MM	Rem.: DME may used instead
-IM	

Identification:		Tone	Speed
ILS-LOC	Morse Code max.4 letter, Voice possible	1020Hz 300-3000Hz	7WPM
ILS-GP	no Id		
(ILS/DME)	(Id from LOC)		
(MLS/DME)	(Id from LOC)		

LLZ: 108 ... 112 MHz a 100 kHz (ungerade)
GP: 328 ... 335 MHz

Landesysteme

Kanal	Landekurs	Gleitweg
01	110,300	335,000
02	109,900	333,800
03	109,500	332,600
04	110,100	334,400
05	109,700	333,200
06	109,300	332,000
07	109,100	331,400
08	110,900	330,800
09	110,700	330,200
10	110,500	329,600
11	108,100	334,700
12	108,300	334,100
13	108,500	329,900
14	108,700	330,500
15	108,900	329,300
16	111,100	331,700
17	111,300	332,300
18	111,500	332,900
19	111,700	333,500
20	111,900	331,500

Landesysteme

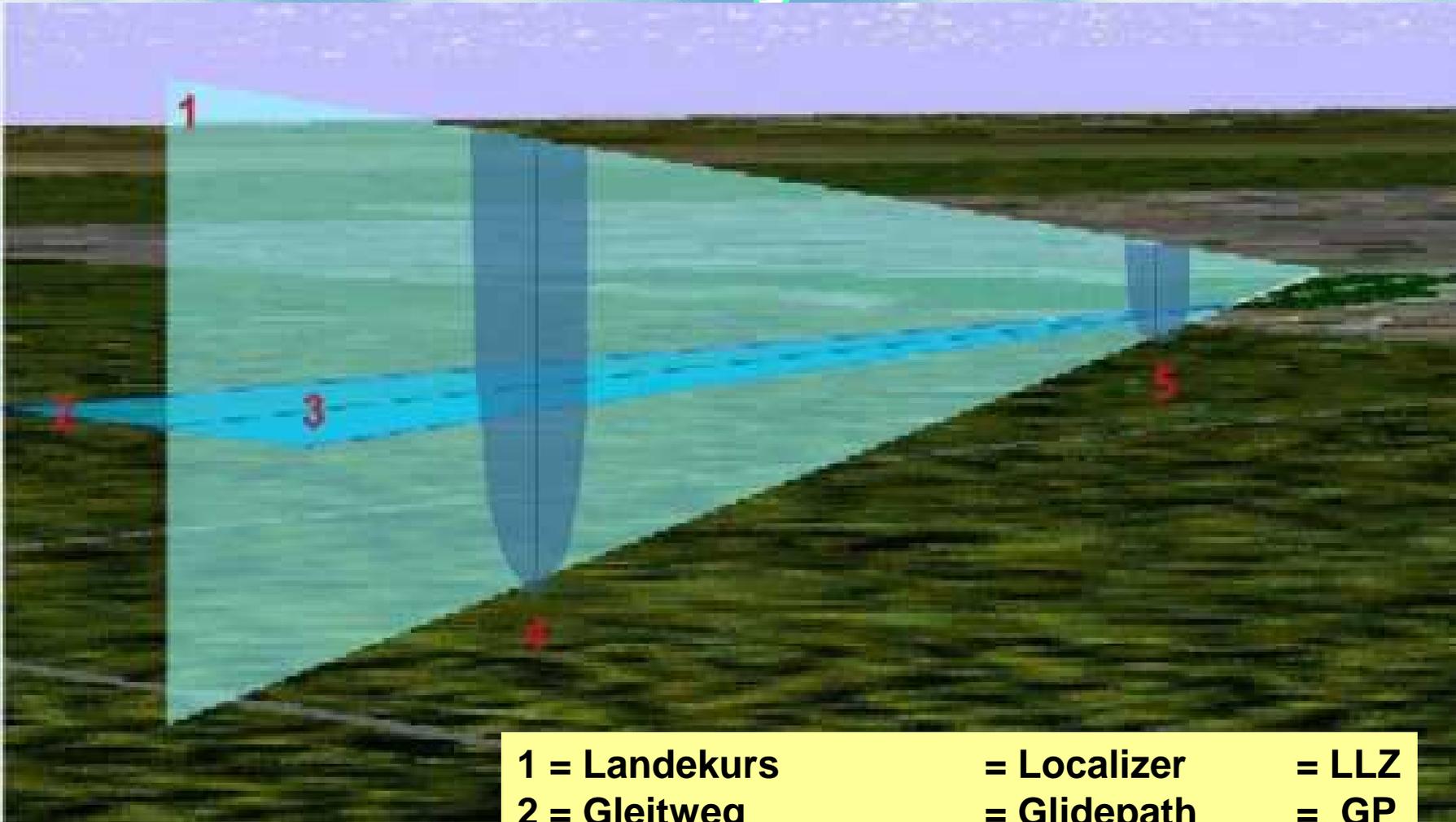
2. Marker 75.000 MHz

Status:	Primary ICAO standard navigation aid		
Frequency:	75MHz for all Markers		
ILS-Marker	pairing ILS-LLZ,-GP, Marker and or DME(/TACAN), MLS (ICAO Annex 10)		
Function:	ICAO Standard Navigation Aid.		
En route Marker	where required to mark a position on any air route.		
ILS-Marker -OM	indicates the distance from the threshold or a given position of the approaching aircraft.		
-MM	A suitably located DME may be an alternative to the use of marker beacons.		
-IM			
Coverage/DOC:	required field strength varies (ICAO Annex10)		
En route Marker			
ILS-Marker-IM	D=75-450m from threshold	h=150m ±50m above location	
-MM	D=1050m ±150m from threshold	h=300m±150m above location	
-OM	D=7.2km 3,5-6NM from threshold	h=600m±200m above location	
Identification:	Morse Code	Tone	Speed
En route Marker	sequence of 'dots and dashes'	3000Hz	6-10WPM
ILS-Marker-IM	'dots'	3000Hz	6dots/s
-MM	'dot and dash'	1300Hz	dots:6dotts/s, dashes: 2dashes/s
-OM	'dashes'	400Hz	2dashes/s

Band I

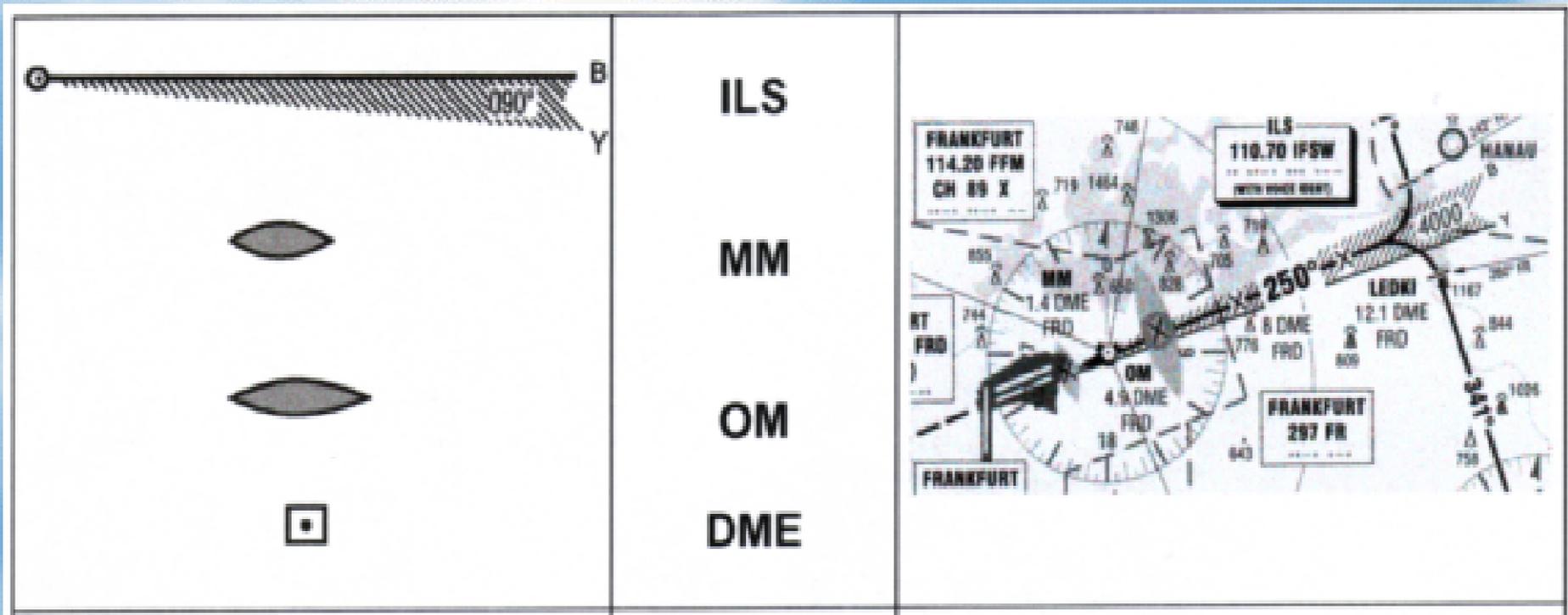
3.1.2.1 c) An Flugplätzen, die mit einem ILS ausgestattet sind, werden Voreinflugzeichen schrittweise durch DME-Festpunkte ersetzt.

Landesysteme



1 = Landekurs	= Localizer	= LLZ
2 = Gleitweg	= Glidepath	= GP
3 = Centerline	= Anfluggrundlinie	
4 = Voreinflugzeichen	= Outer Marker	= OM
5 = Haupteinflugzeichen	= Middle Marker	= MM

Landesysteme



Landesysteme

LLZ - Kursbildung

**Landekurs-
antennen**

Landekursebene



150 Hz-AM



90 Hz-AM

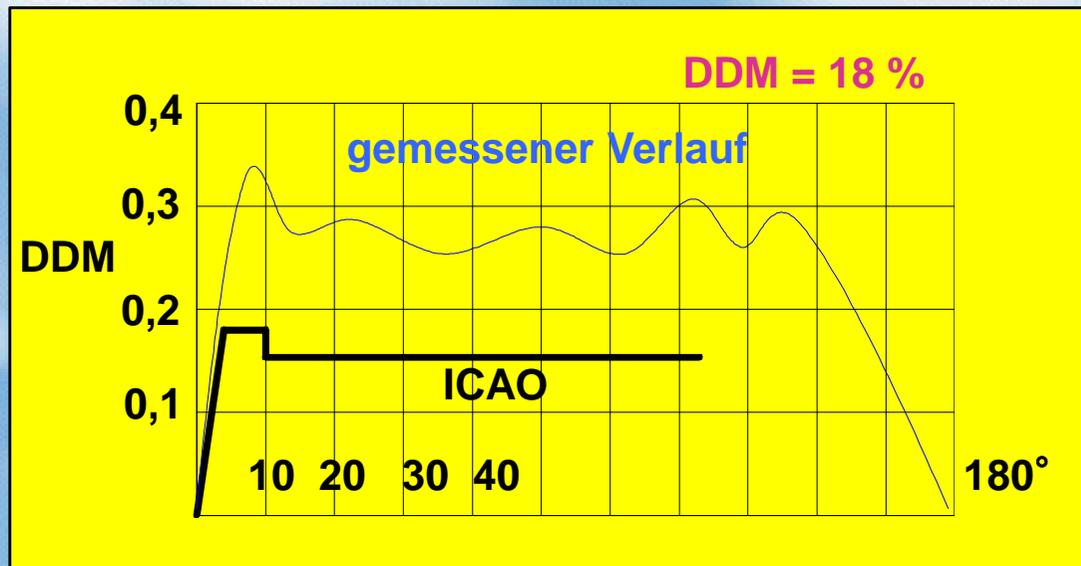


Landesysteme

LLZ - DDM - Verlauf

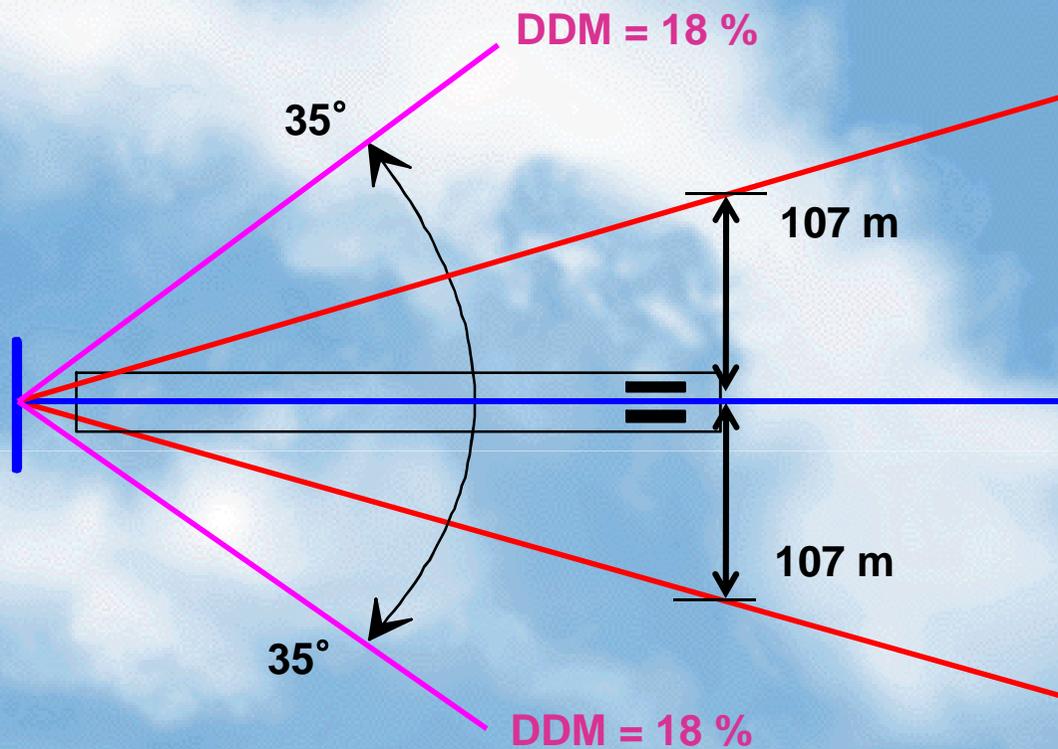


DDM = 0 %
 $m_{90} = m_{150}$



Landesysteme

LLZ - DDM - Verlauf



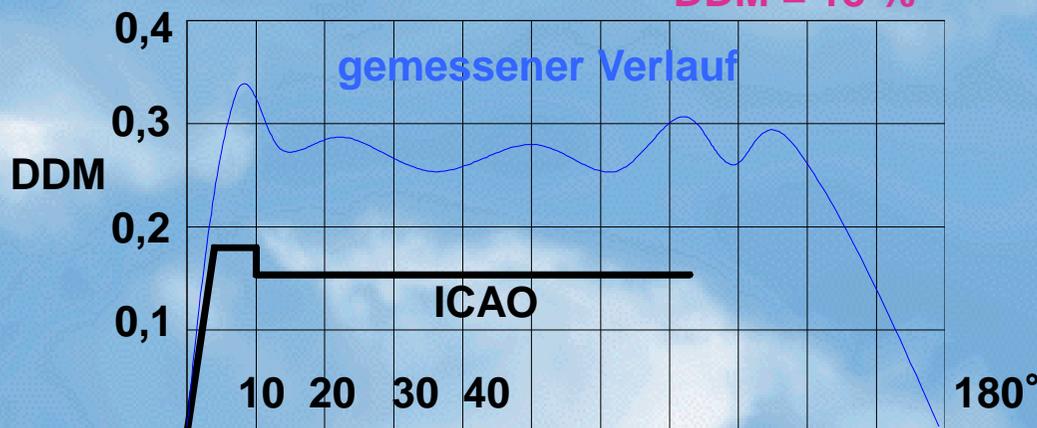
DDM = 15,5 %
5 Punkte links
-150 μA
 $m_{90} < m_{150}$



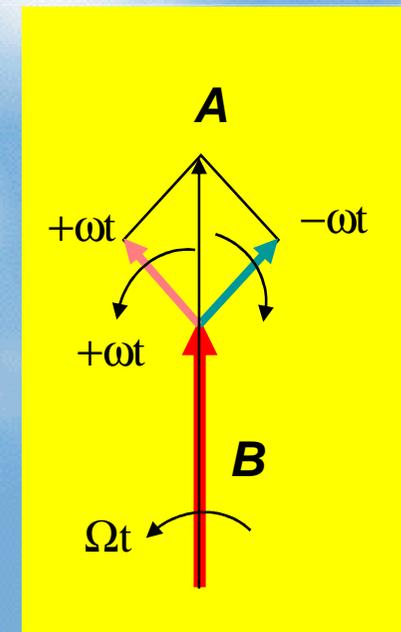
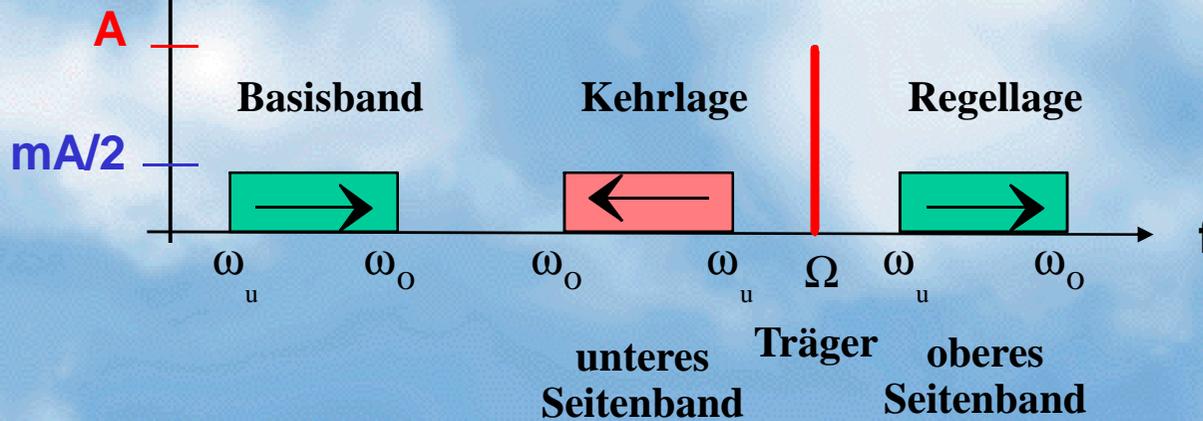
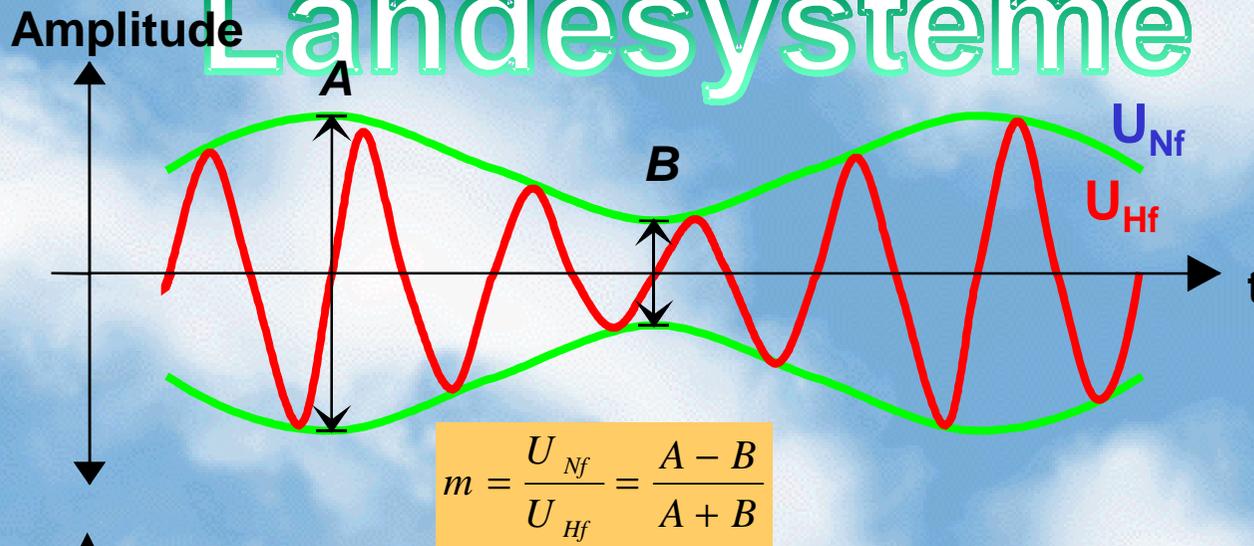
DDM = 0 %
 $m_{90} = m_{150}$



DDM = 15,5 %
5 Punkte rechts
+150 μA
 $m_{90} > m_{150}$



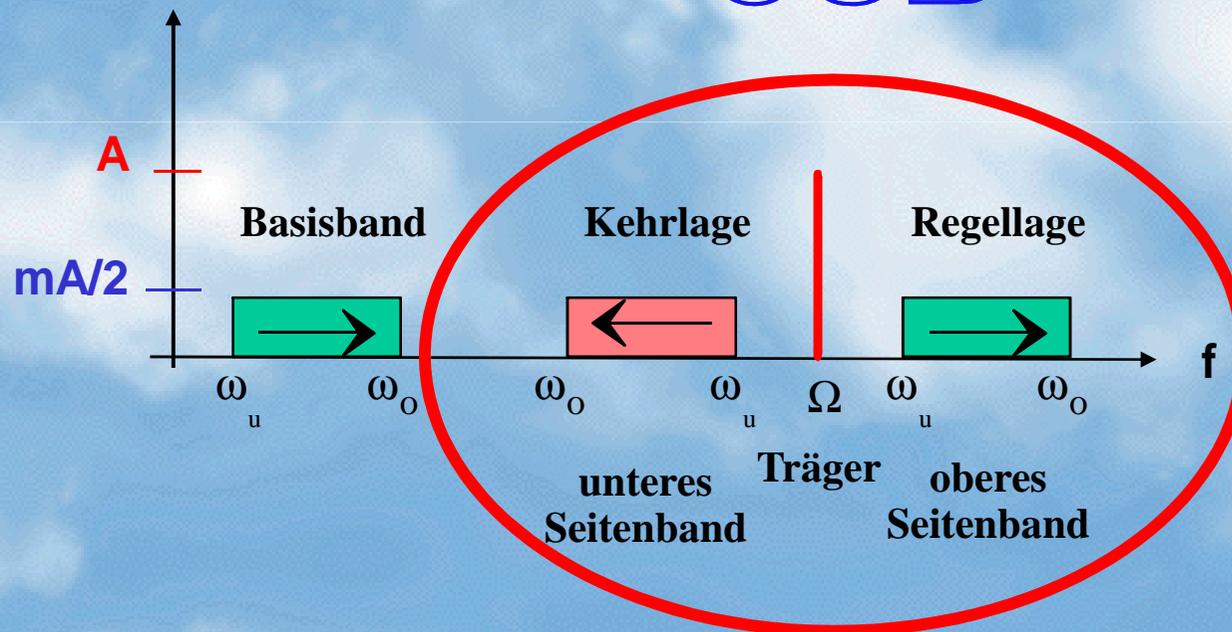
Landesysteme



Modulationsgrad

Landesysteme

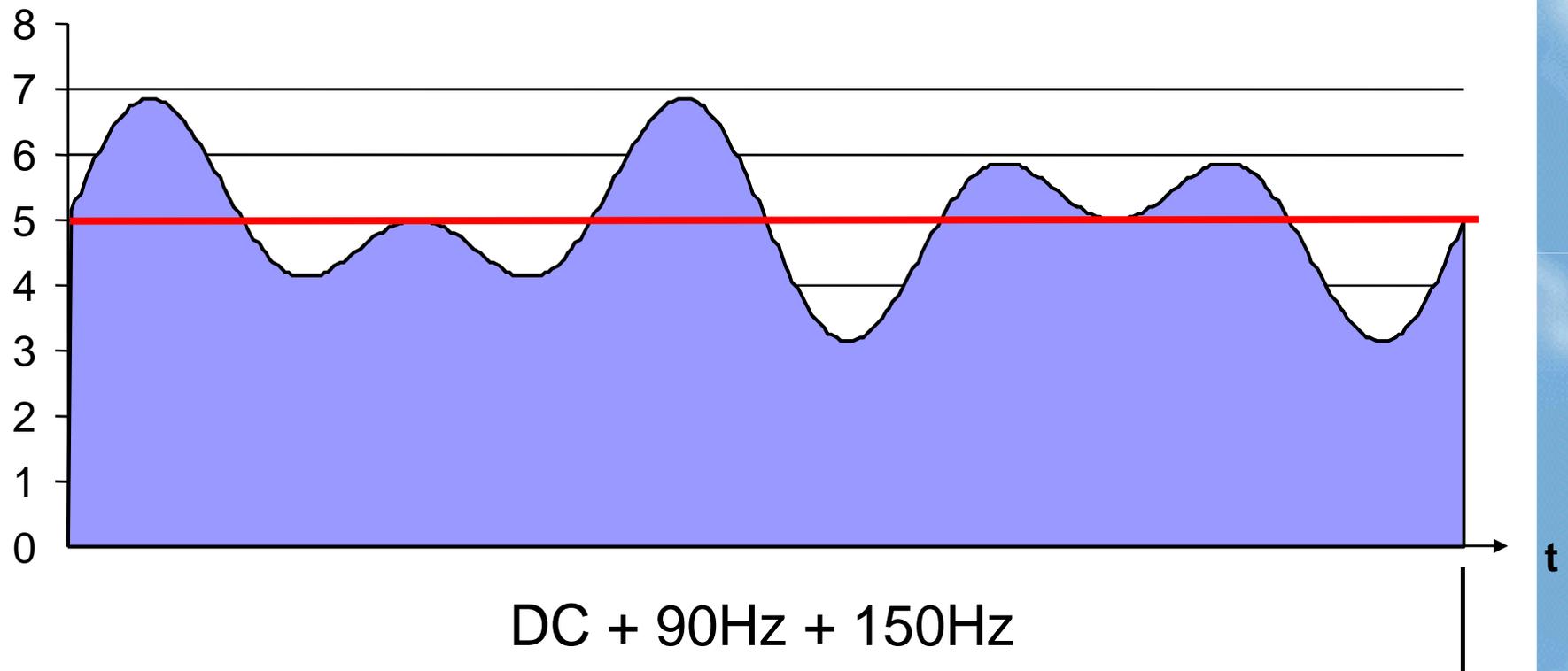
CSB



Modulationsgrad

Landesysteme

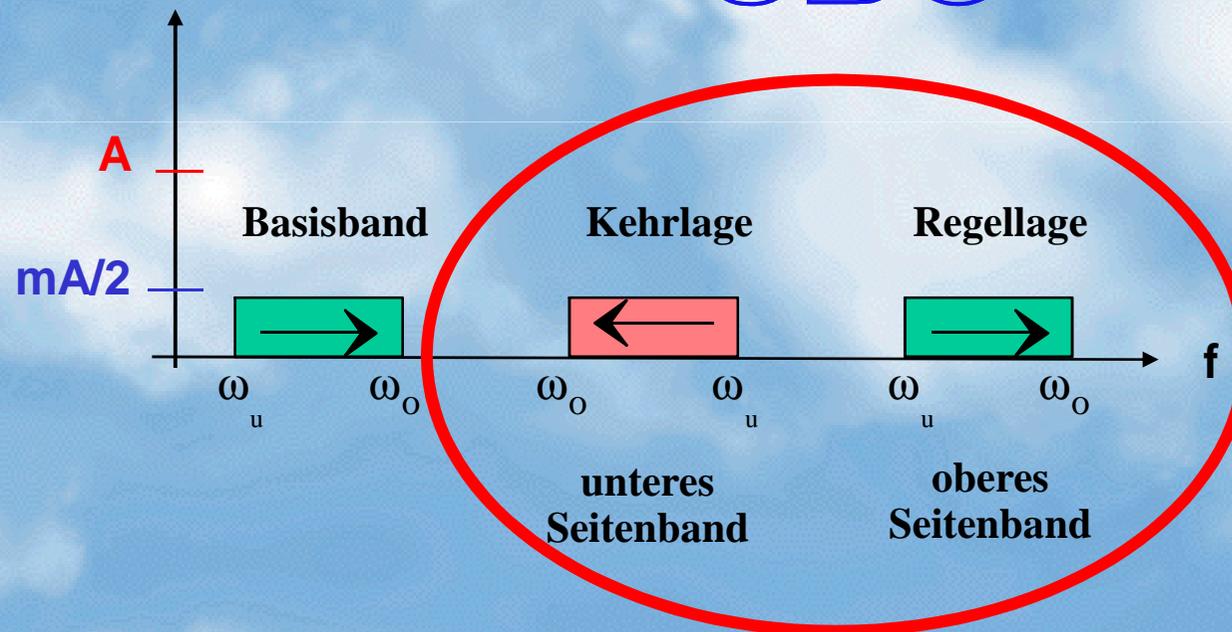
CSB-Modulationssignal



1/30 s

Landesysteme

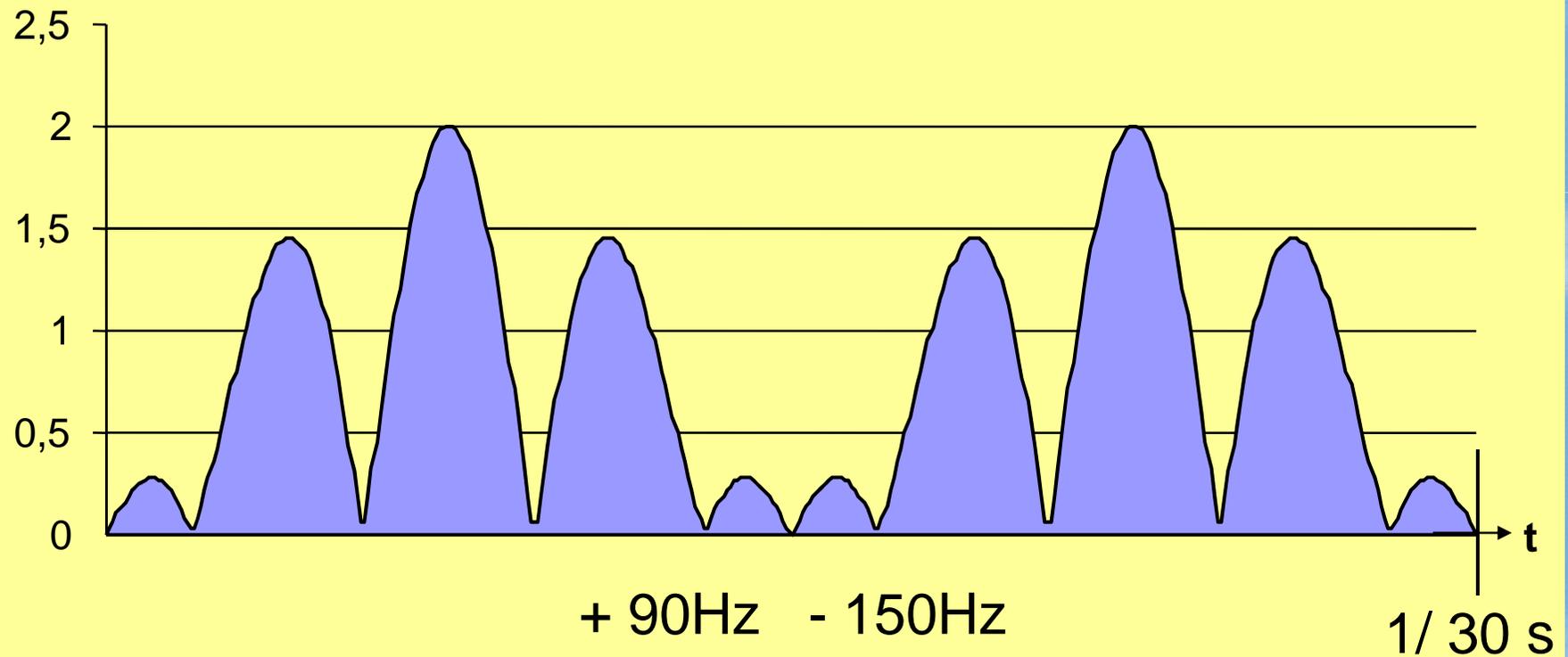
SBO



Modulationsgrad

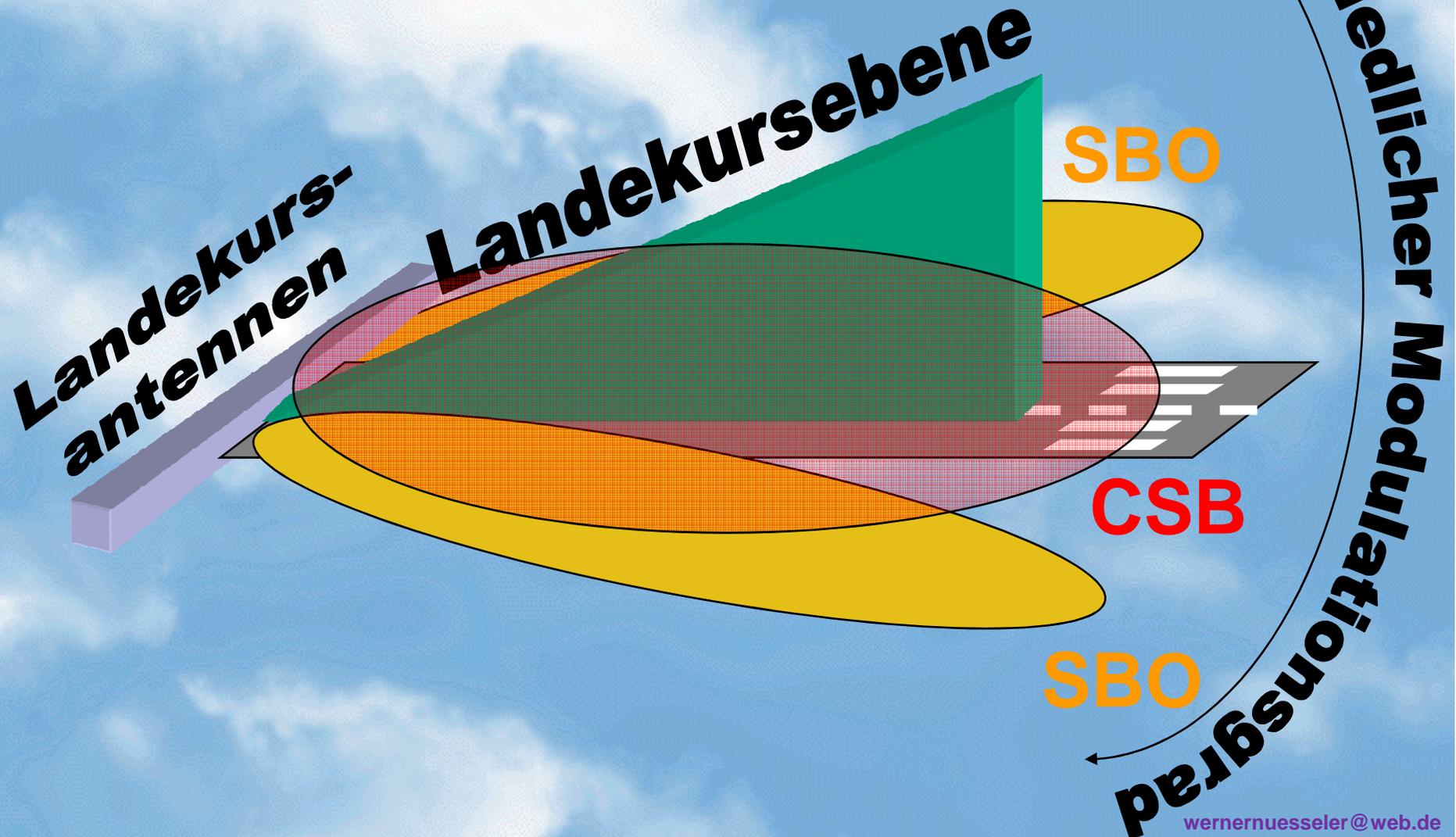
Landesysteme

SBO-Modulationssignal



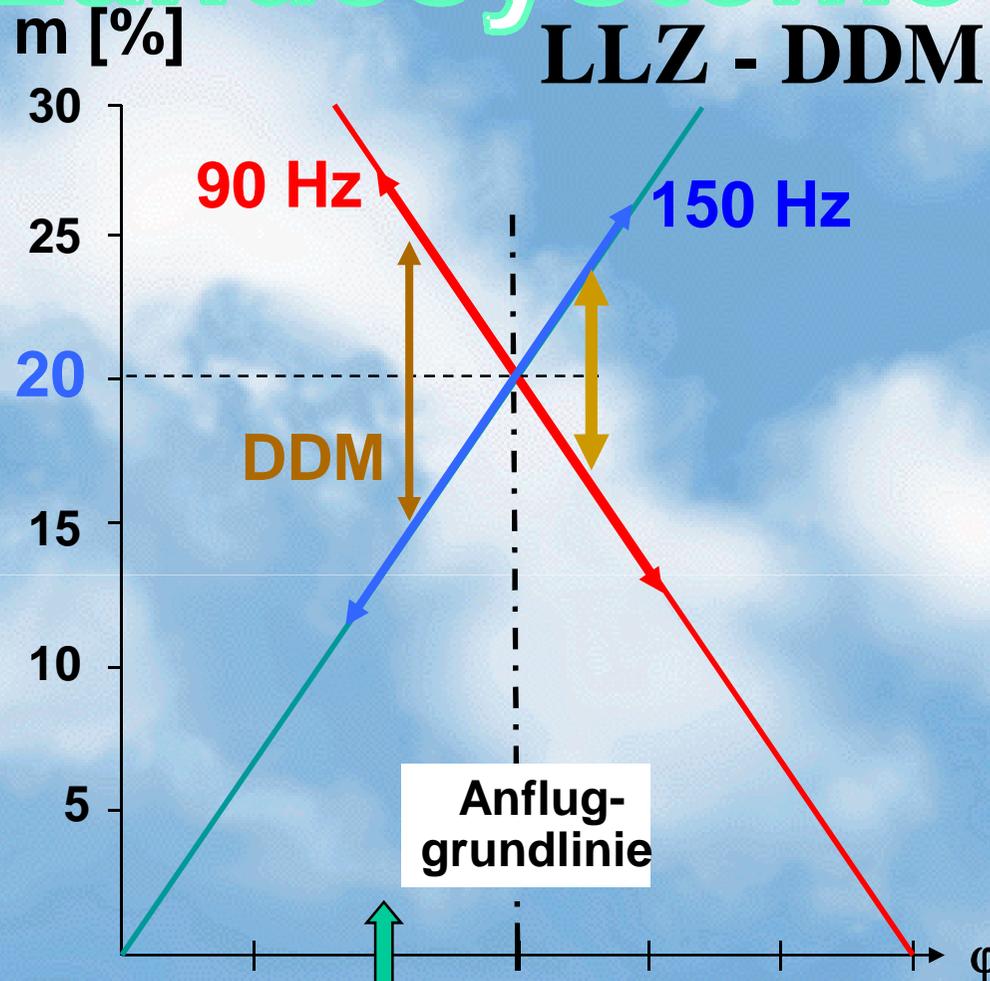
Landesysteme

LLZ - Kursbildung

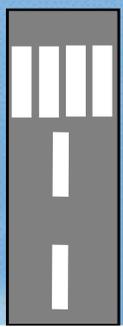


Landesysteme

LLZ - DDM - Verlauf

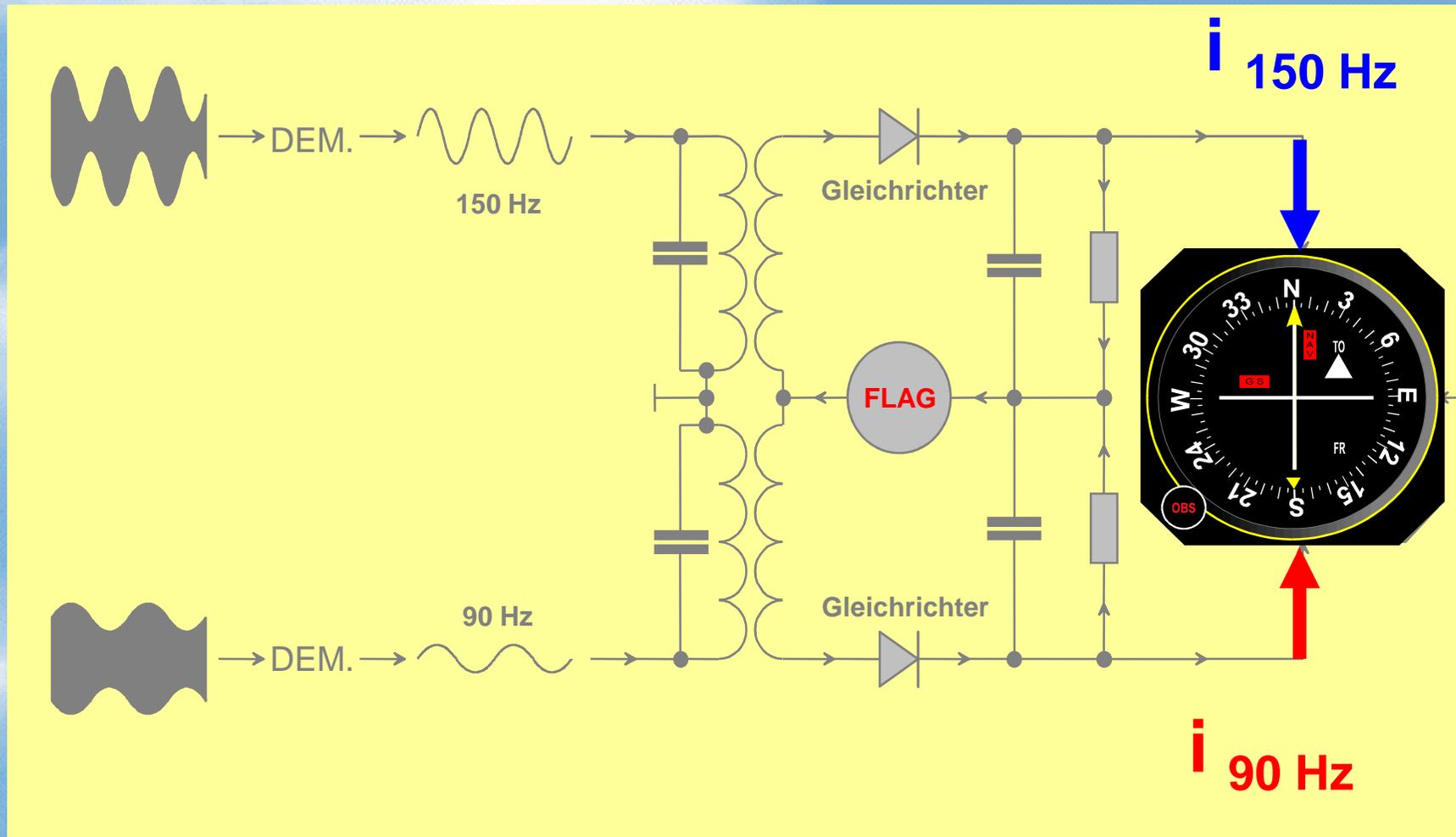


Anflug-
grundlinie



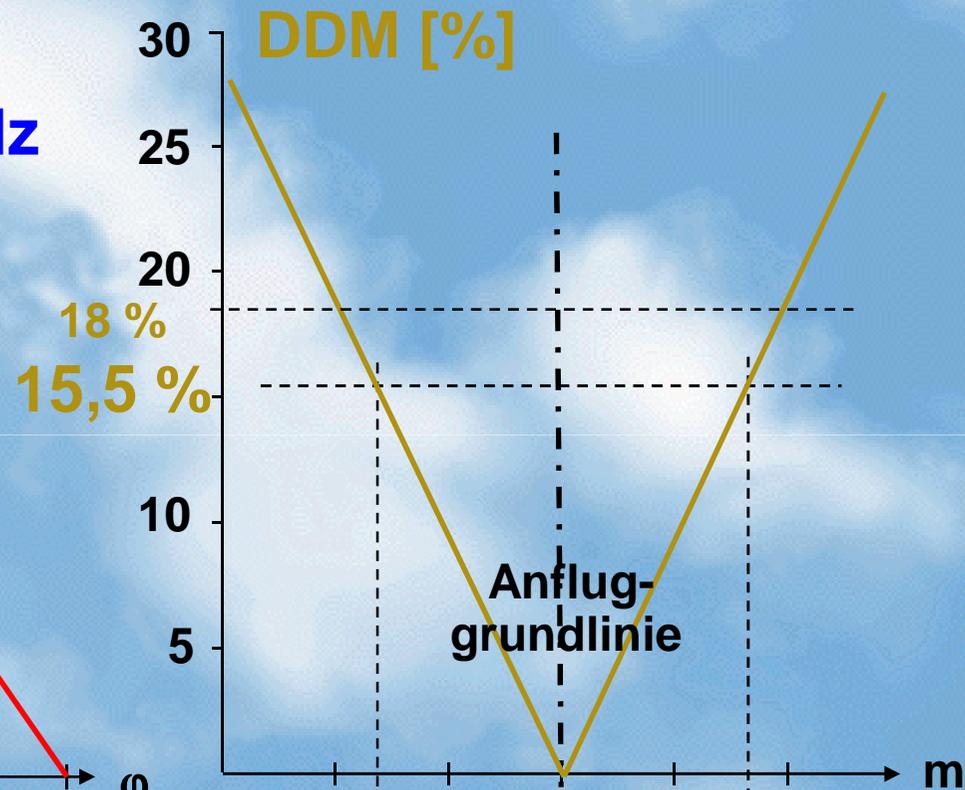
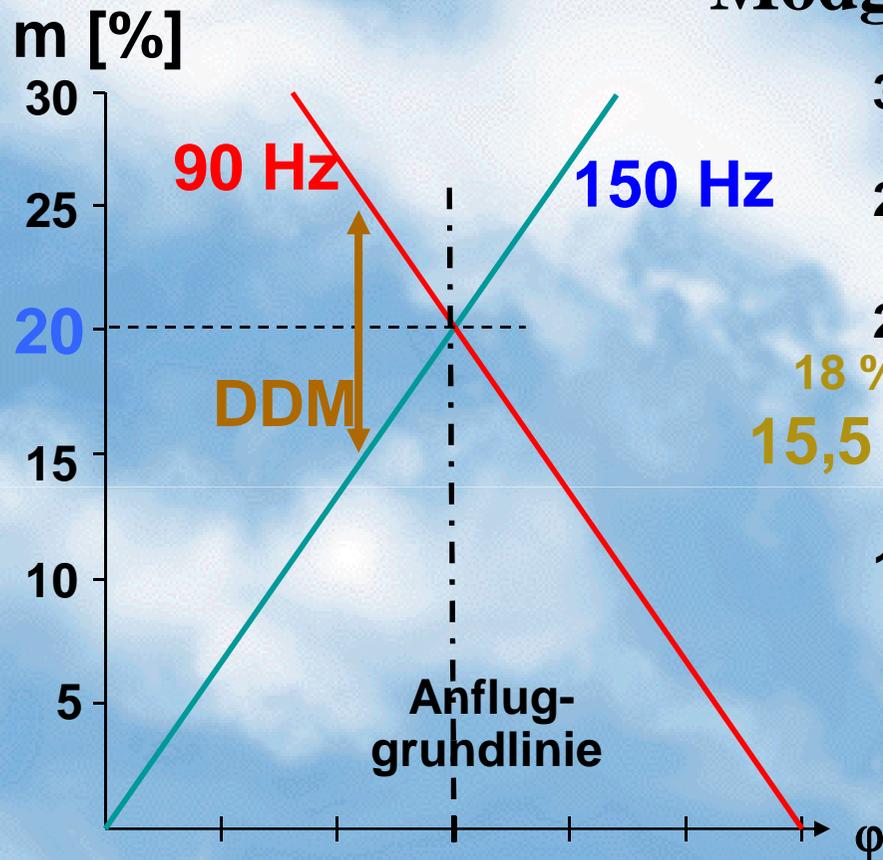
Landesysteme

Kreuzzeiger-Instrument



Landesysteme

Modgrad - und DDM - Verlauf



107m

0

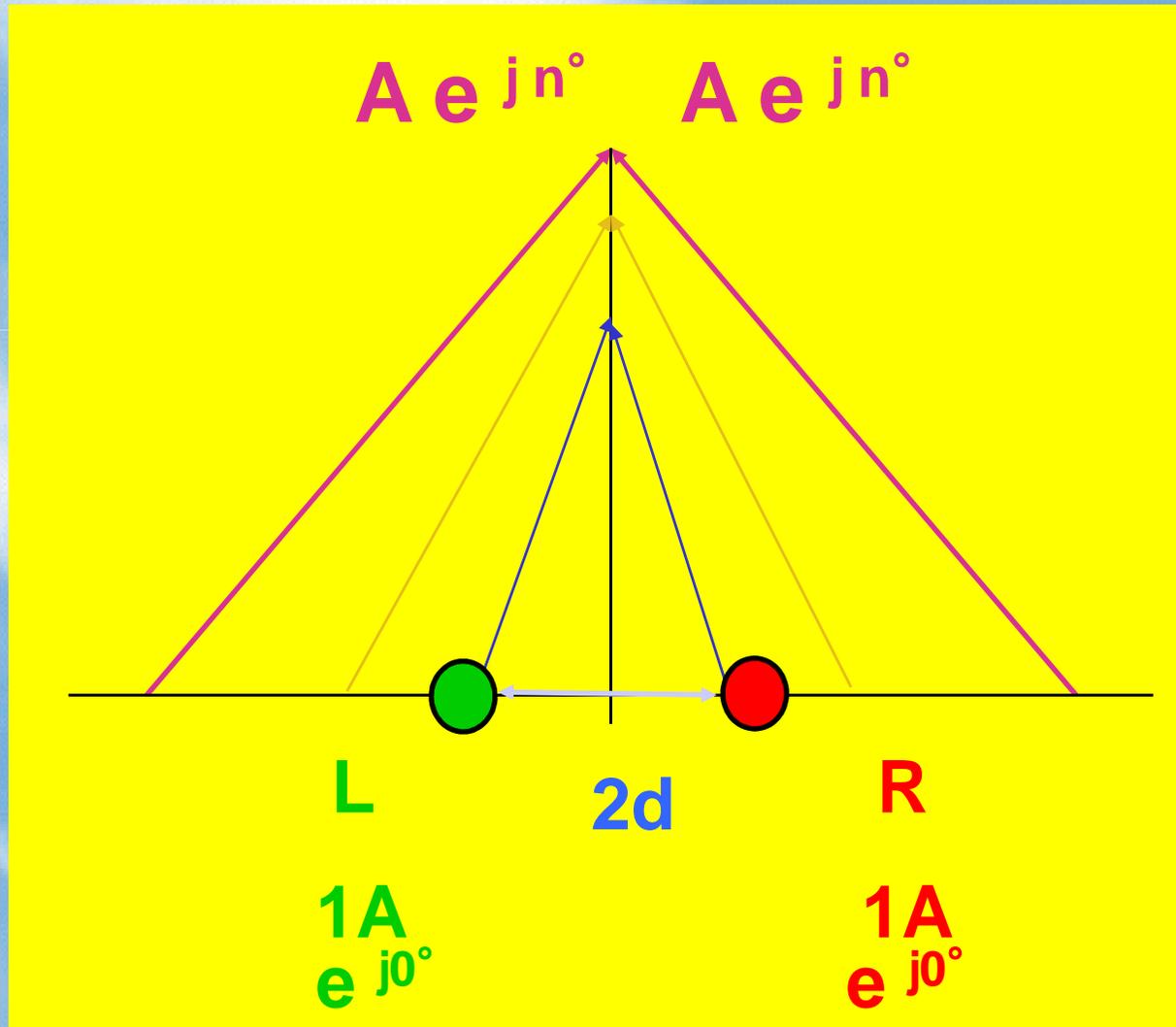
107m

Azimut



Landesysteme

Summenfeldstärke
Maximum



Landesysteme

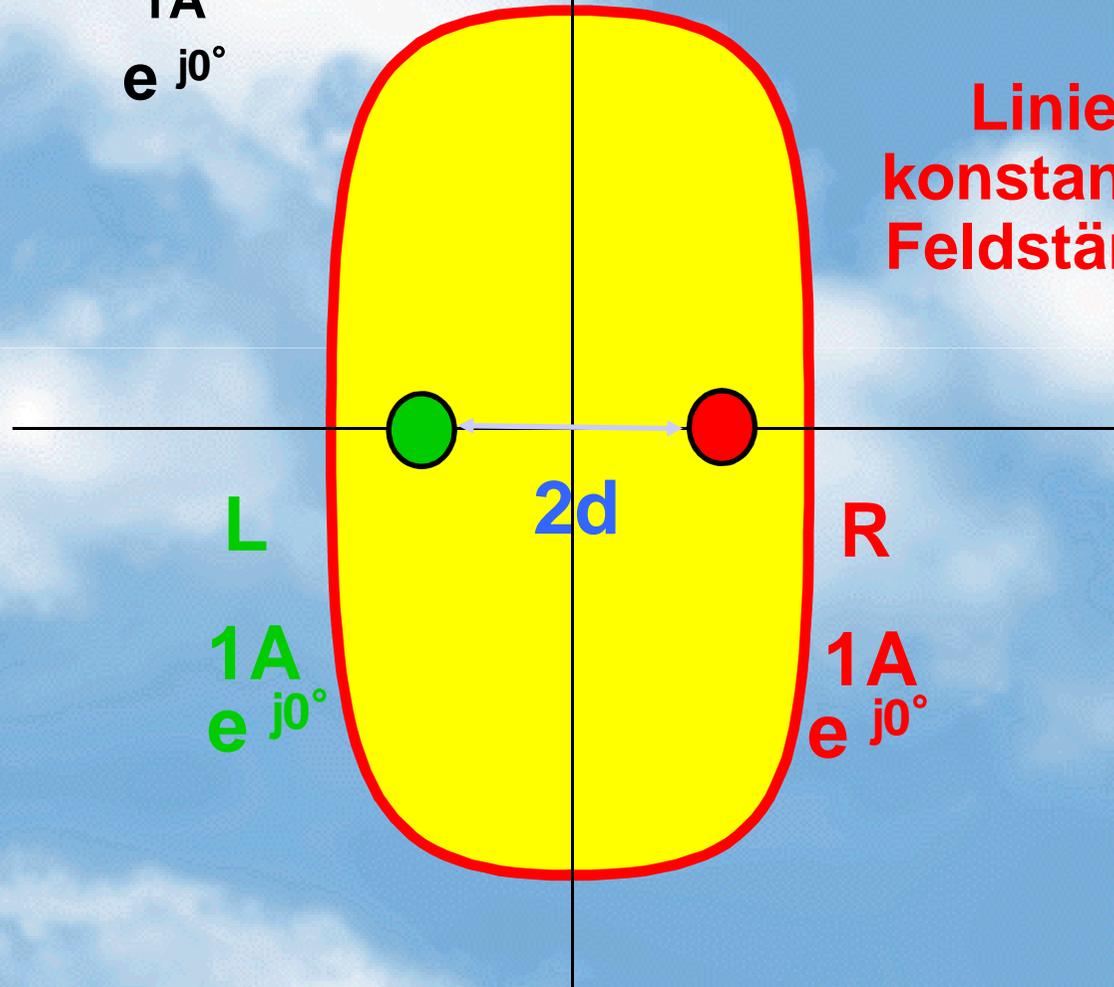
Summenfeldstärke



$$\frac{2d}{\lambda} = \frac{1}{4}$$

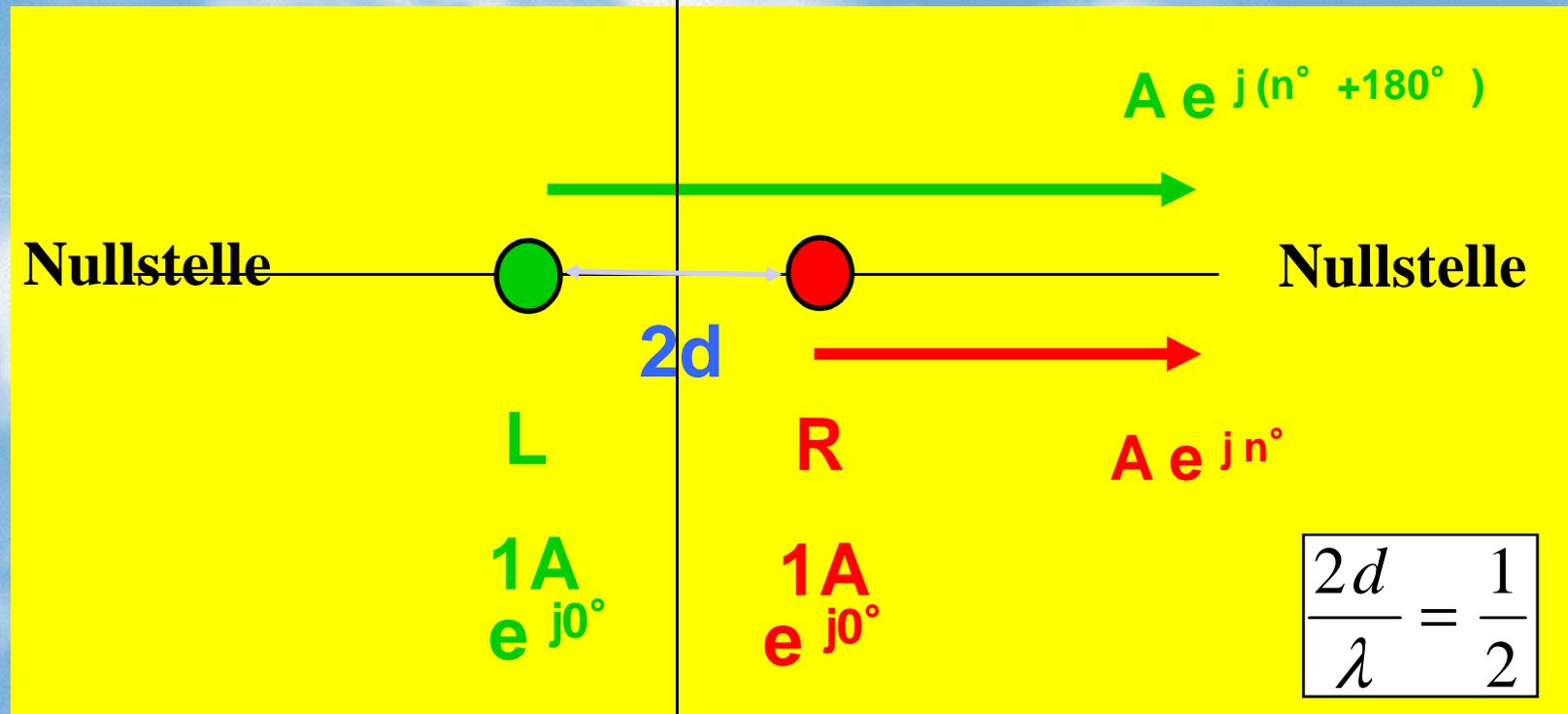
Maximum

Linie
konstanter
Feldstärke



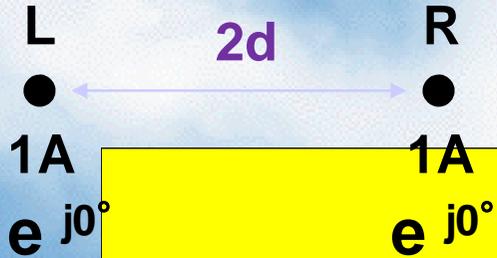
Landesysteme

Summenfeldstärke



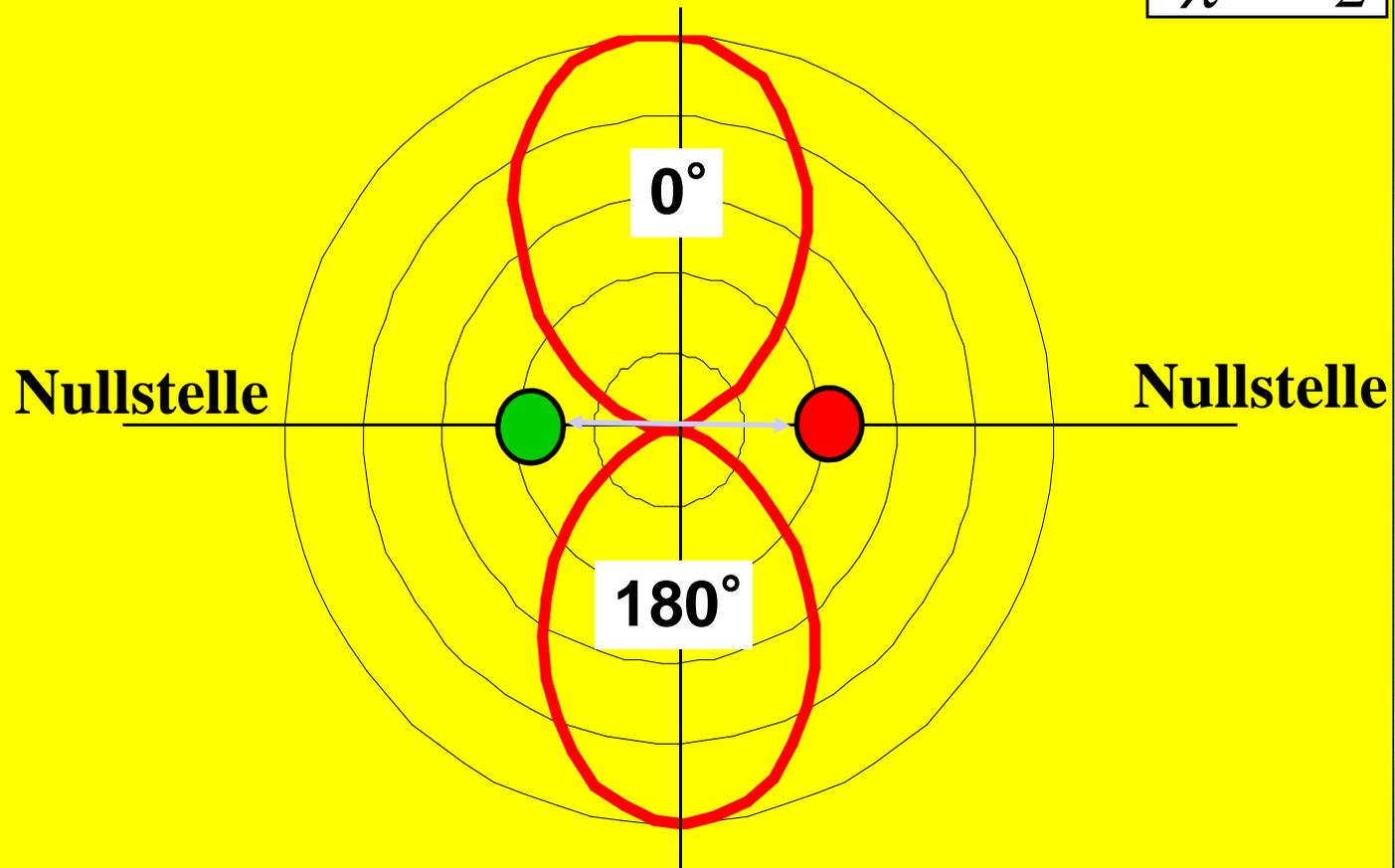
Landesysteme

Summenfeldstärke



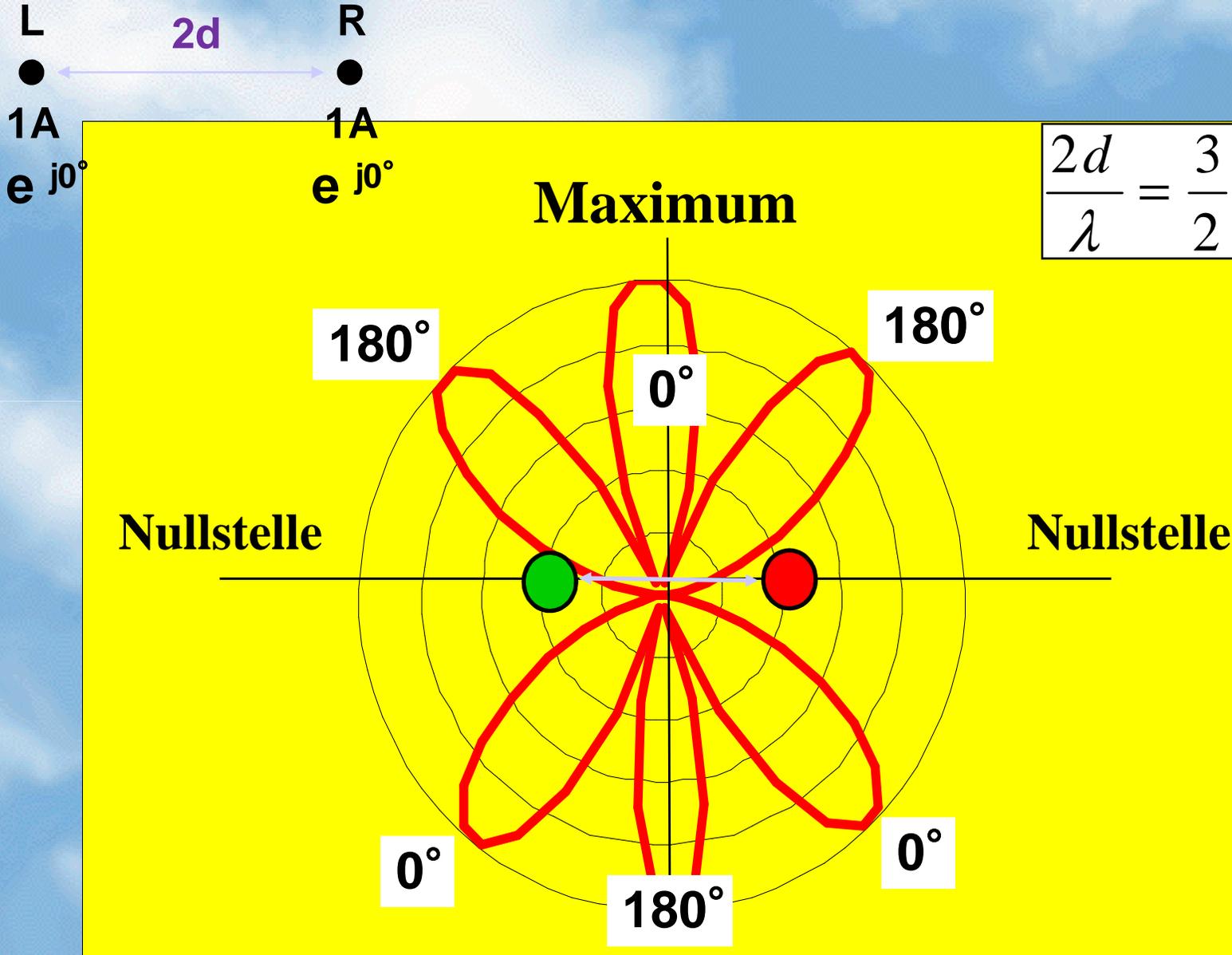
Maximum

$$\frac{2d}{\lambda} = \frac{1}{2}$$



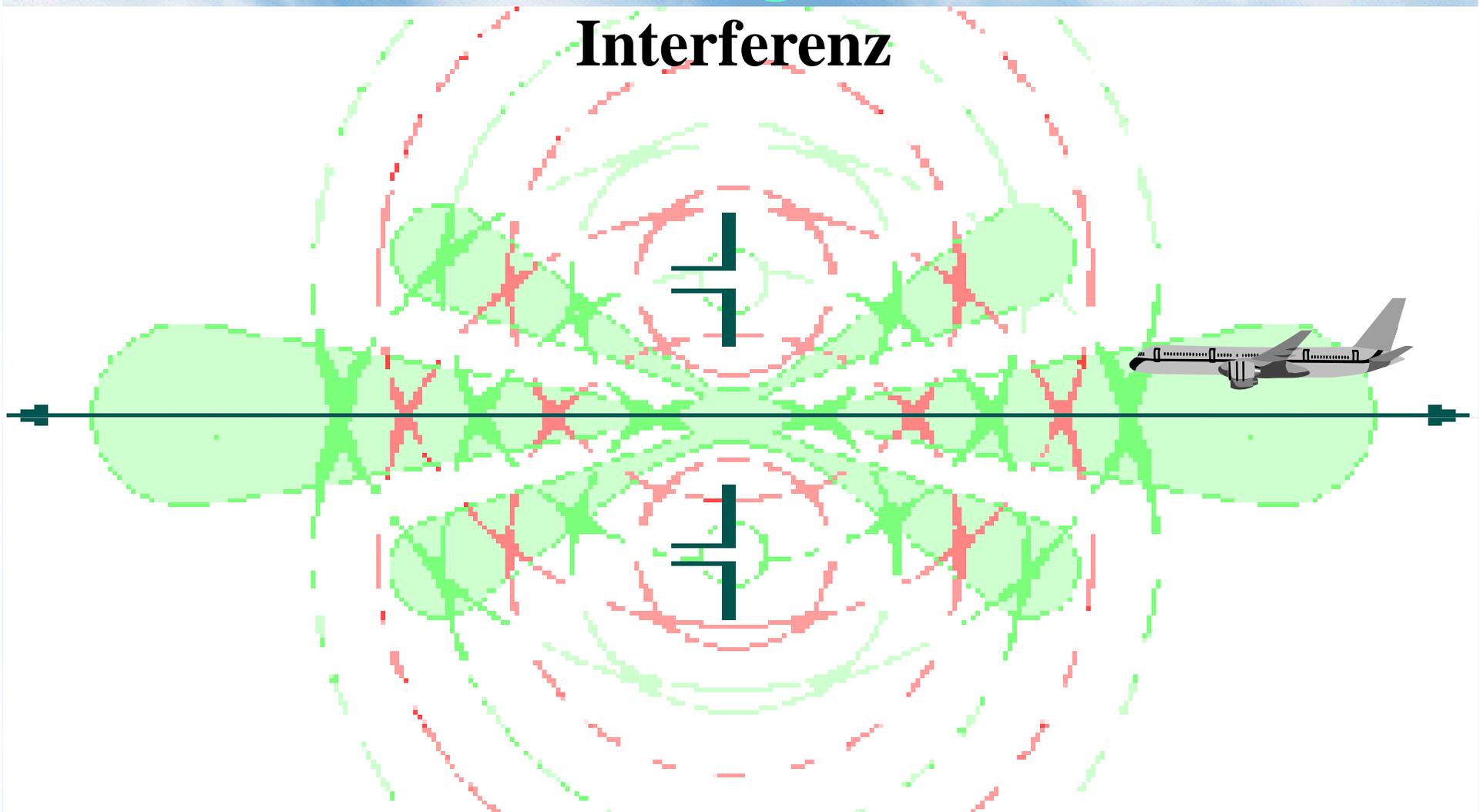
Landesysteme

Summenfeldstärke



Landesysteme

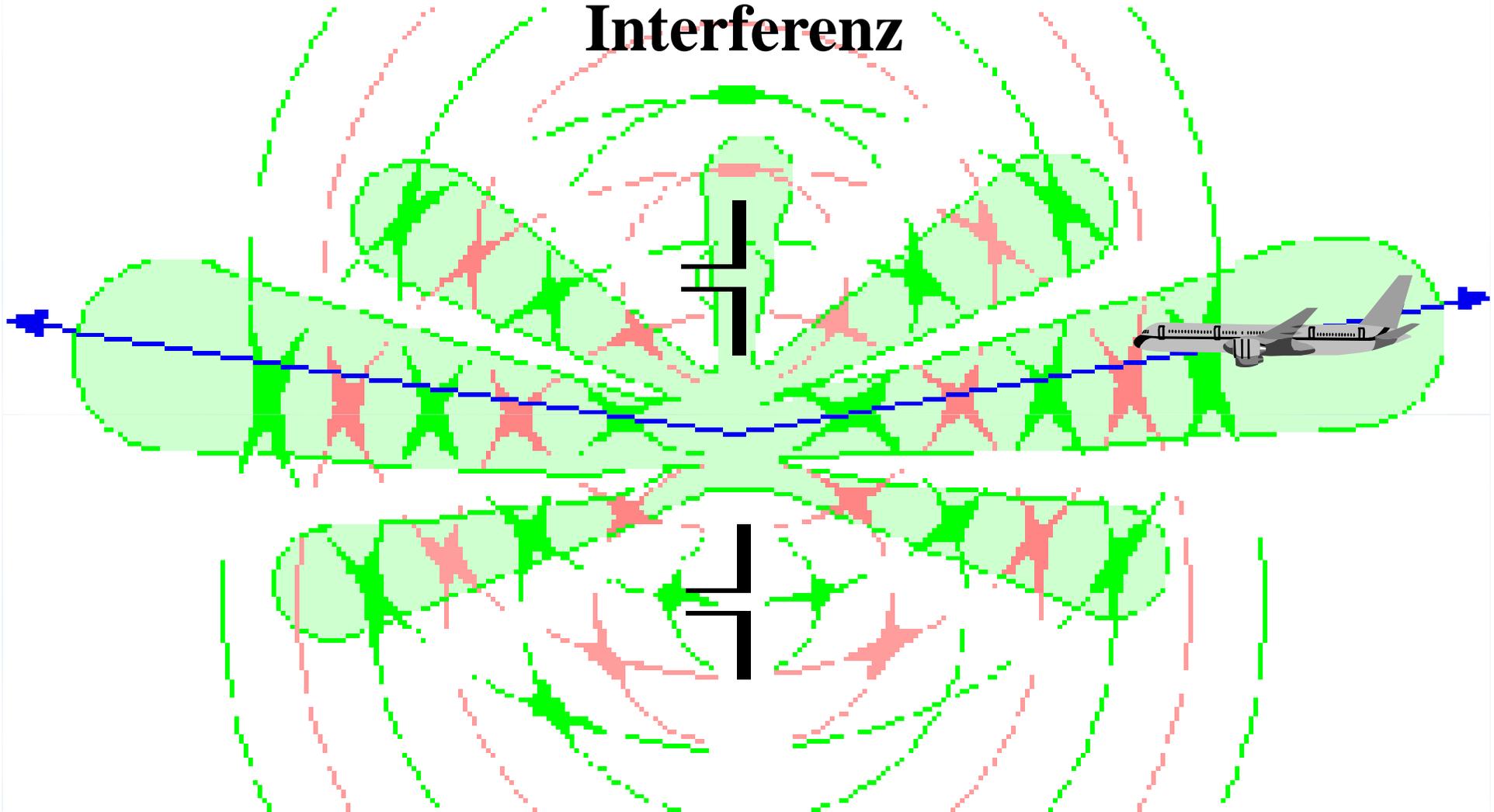
Interferenz



gleichphasige Speisung mit gleichen Amplituden

Landesysteme

Interferenz

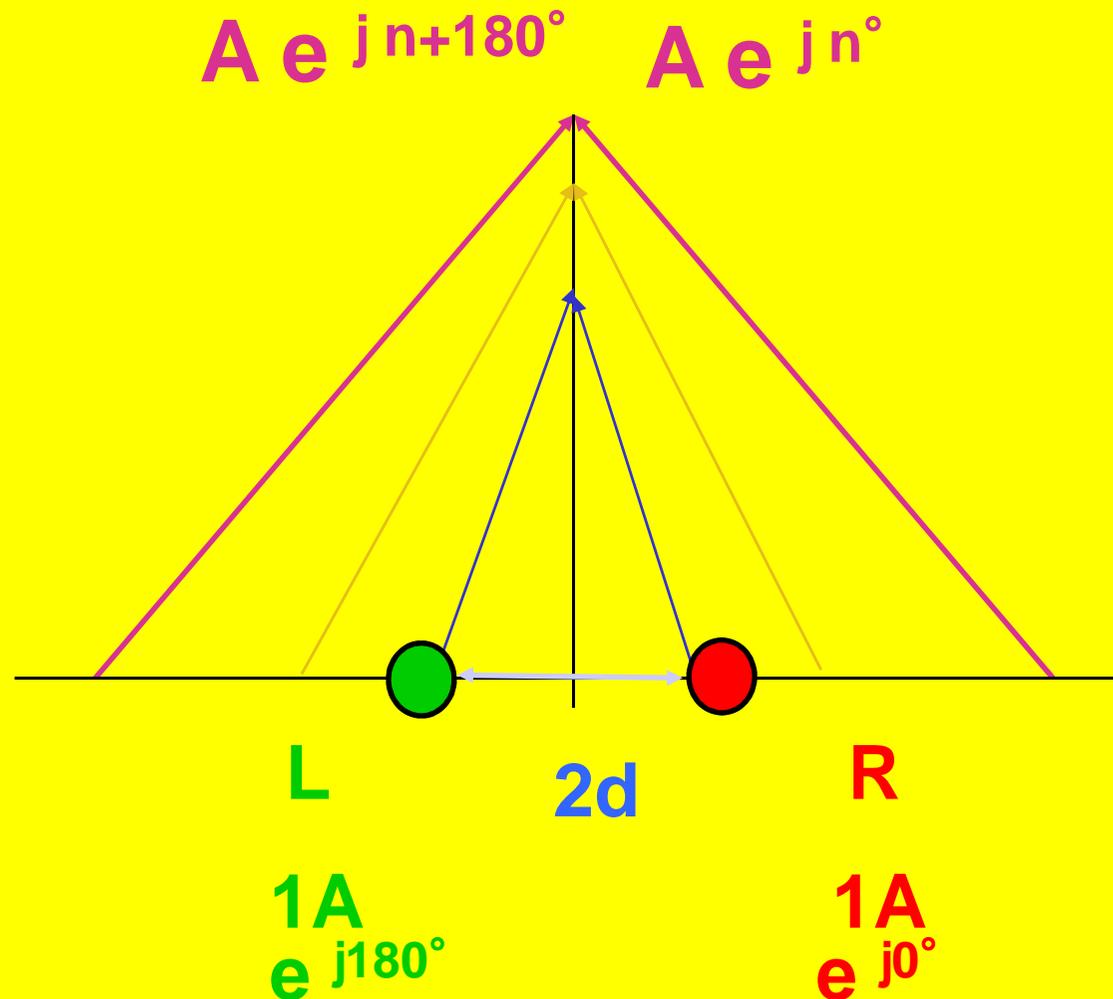


gleichphasige Speisung mit ungleichen Amplituden

Landesysteme

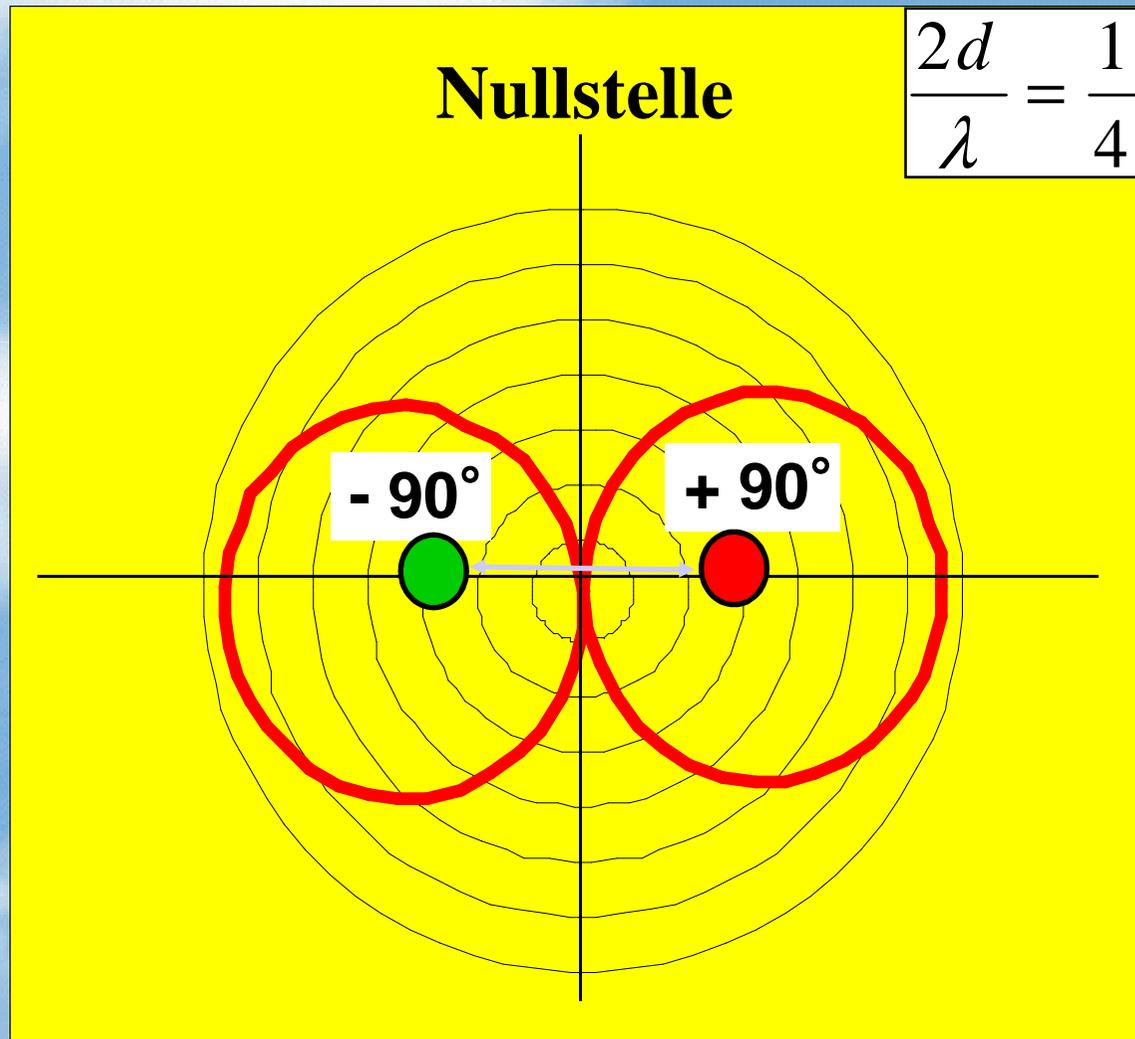
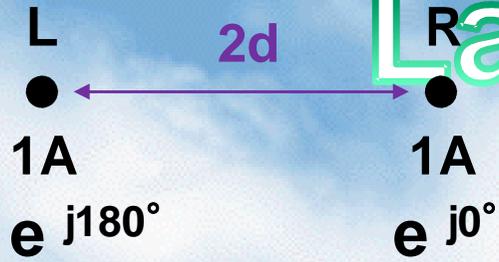
Summenfeldstärke

Nullstelle



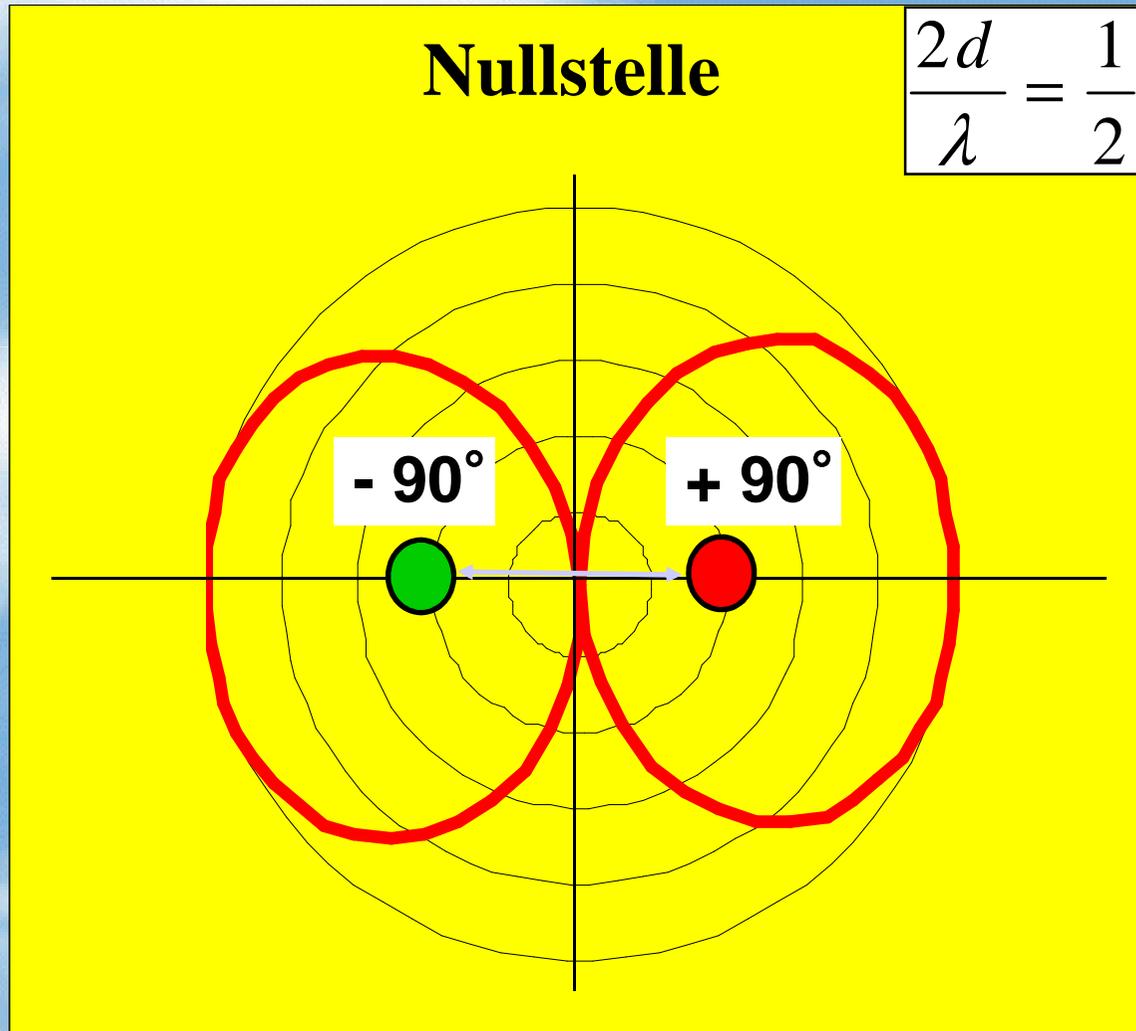
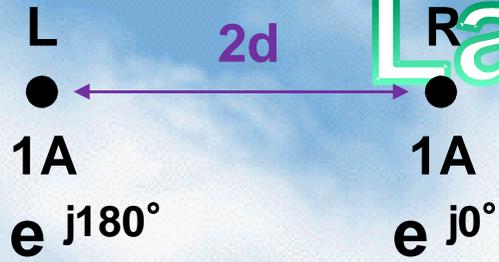
Landesysteme

Summenfeldstärke



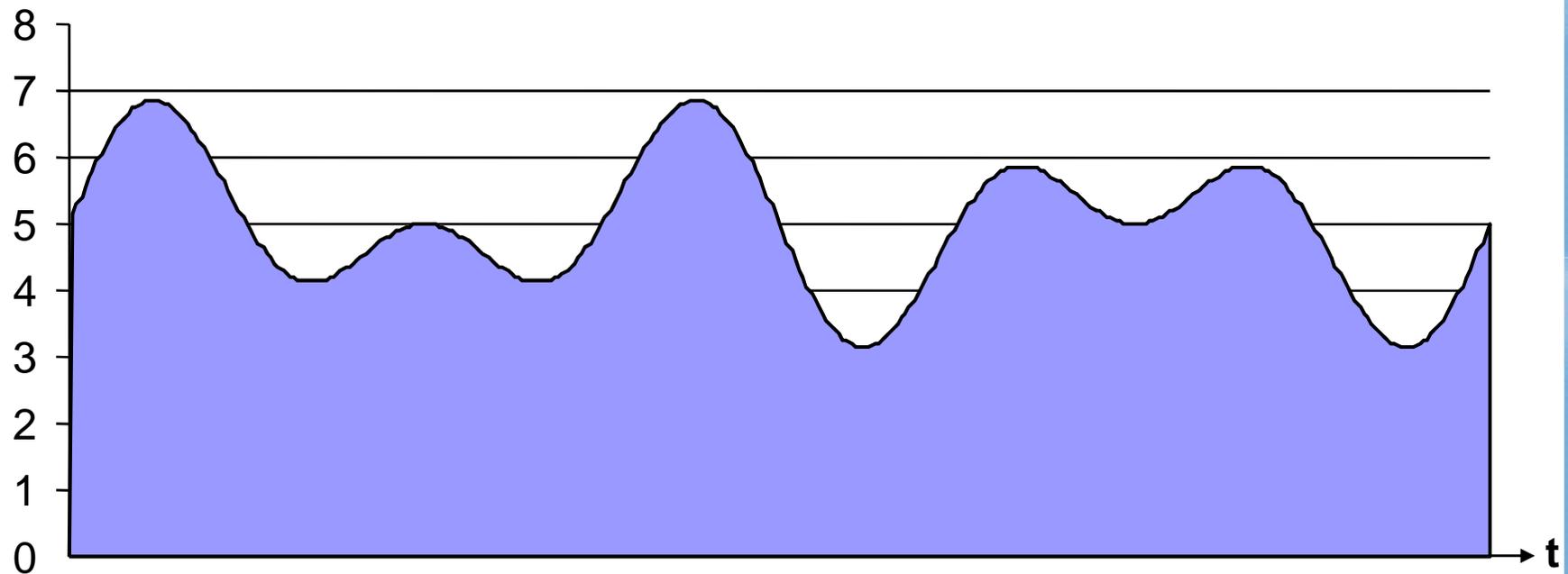
Landesysteme

Summenfeldstärke



Landesysteme

CSB-Modulationssignal

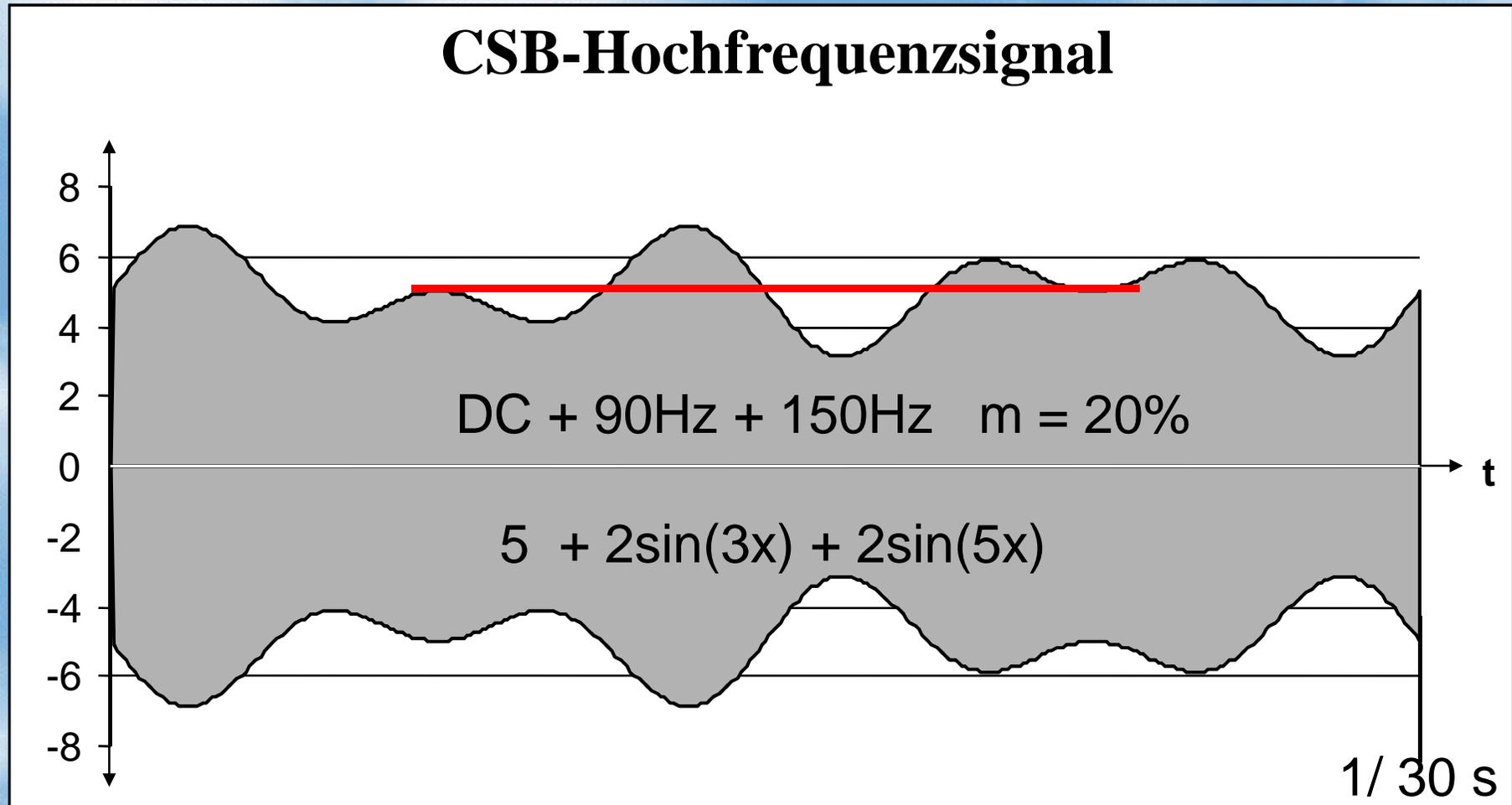


DC + 90Hz + 150Hz

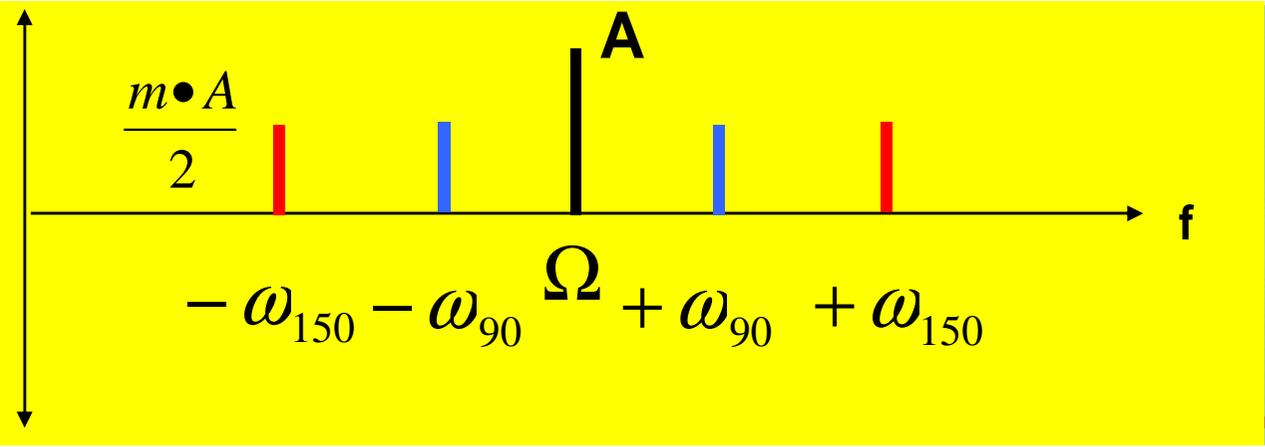
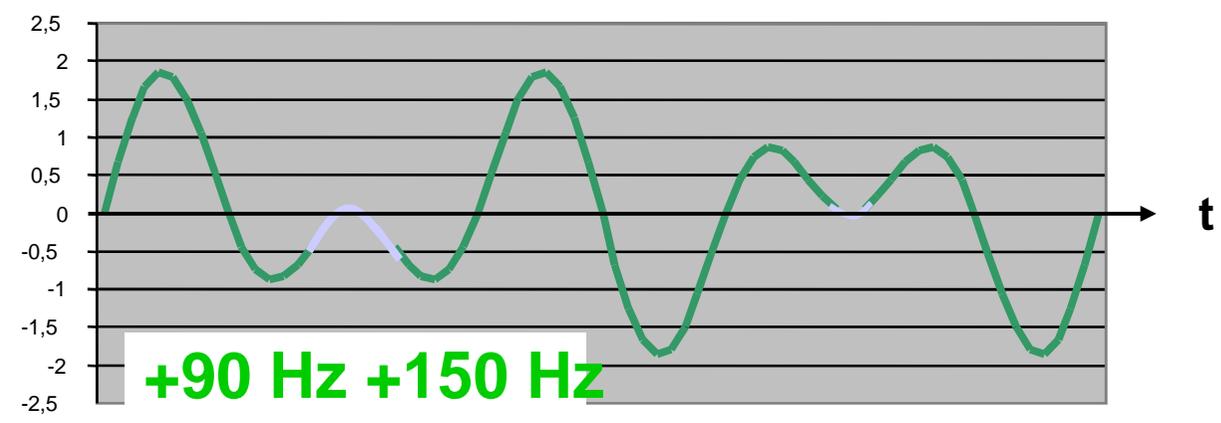
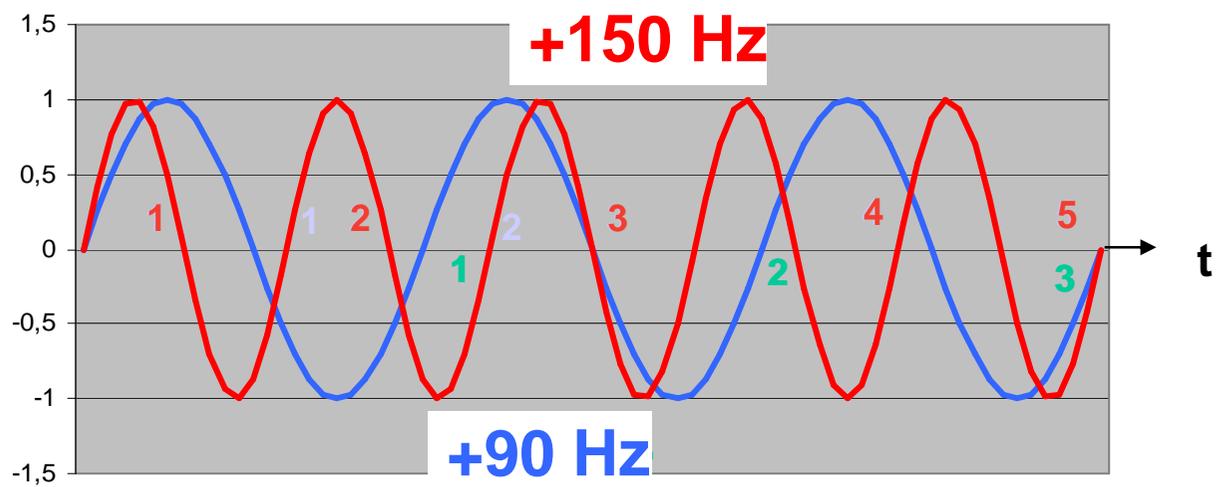
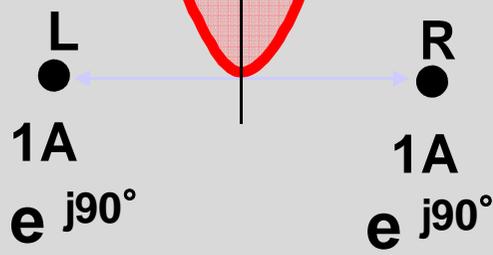
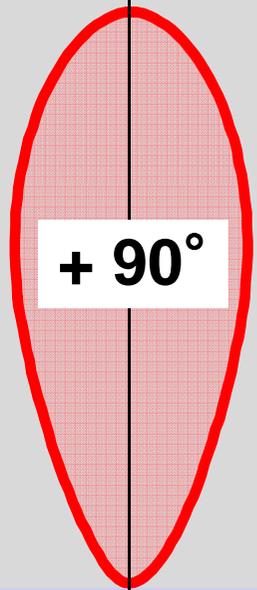
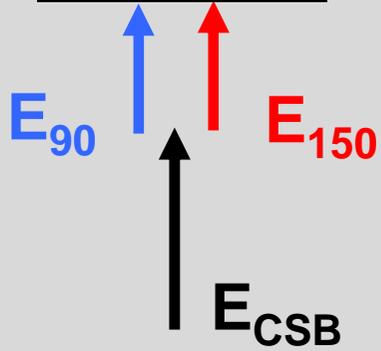
1/30 s

Landesysteme

CSB-Hochfrequenzsignal

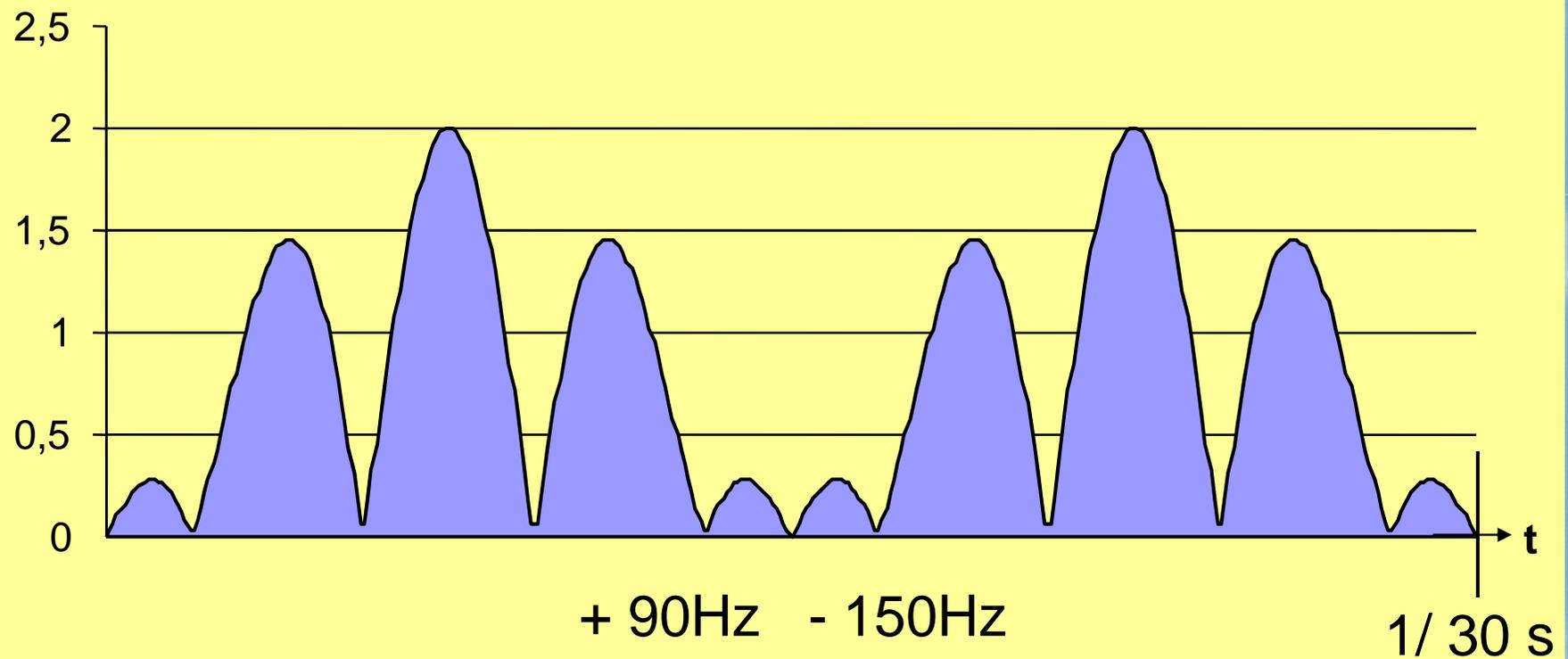


DDM = 0



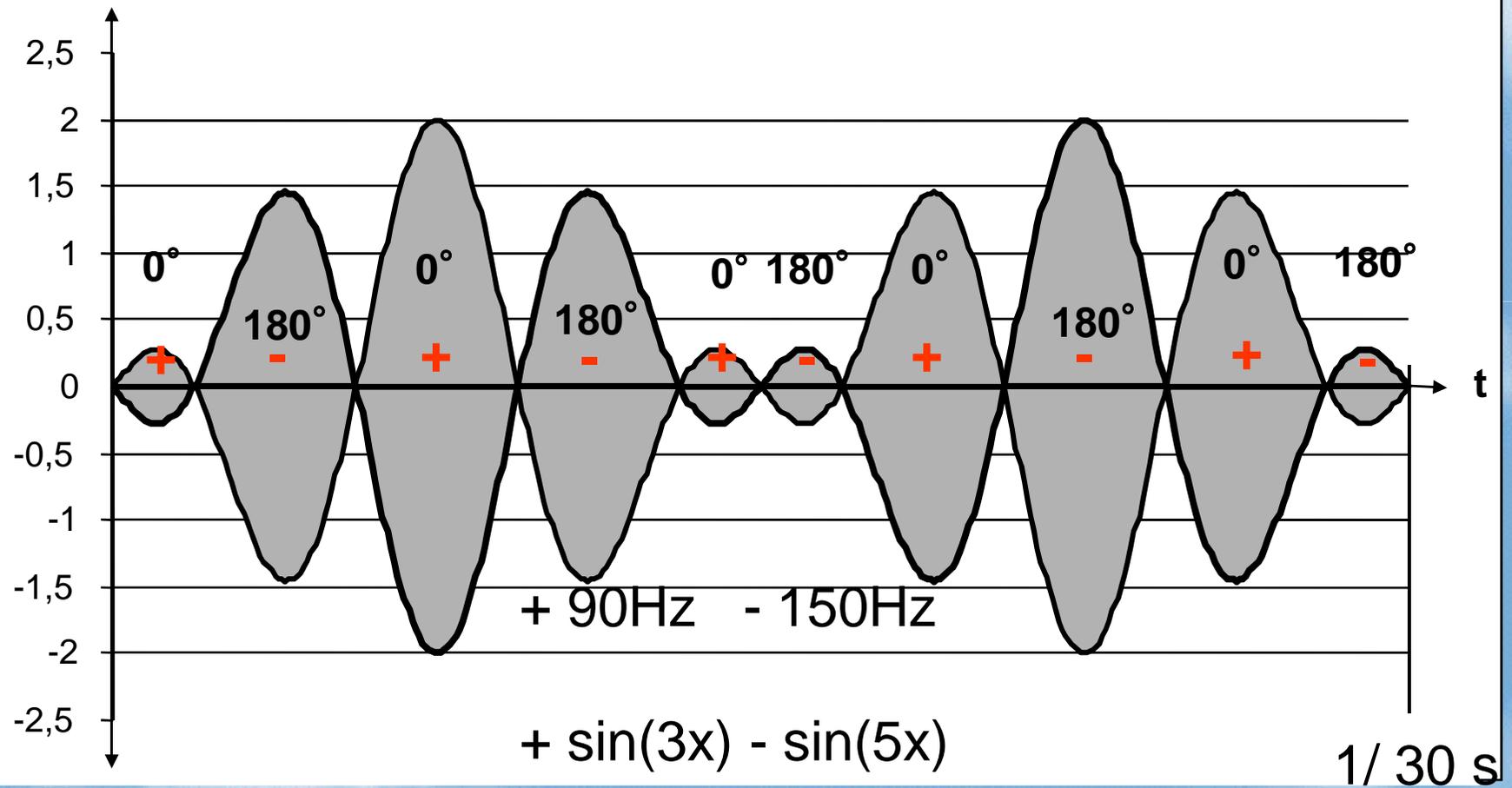
Landesysteme

SBO-Modulationssignal

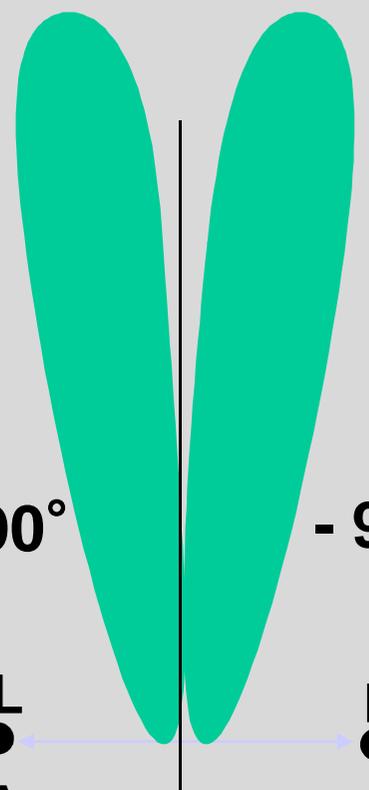


Landesysteme

SBO-Hochfrequenzsignal



E_{90}  E_{150} 

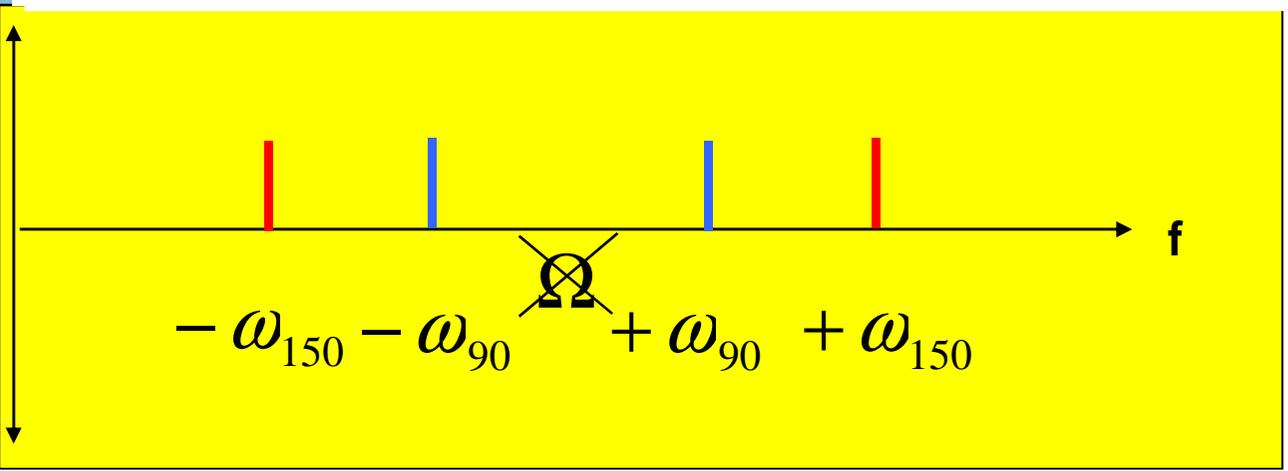
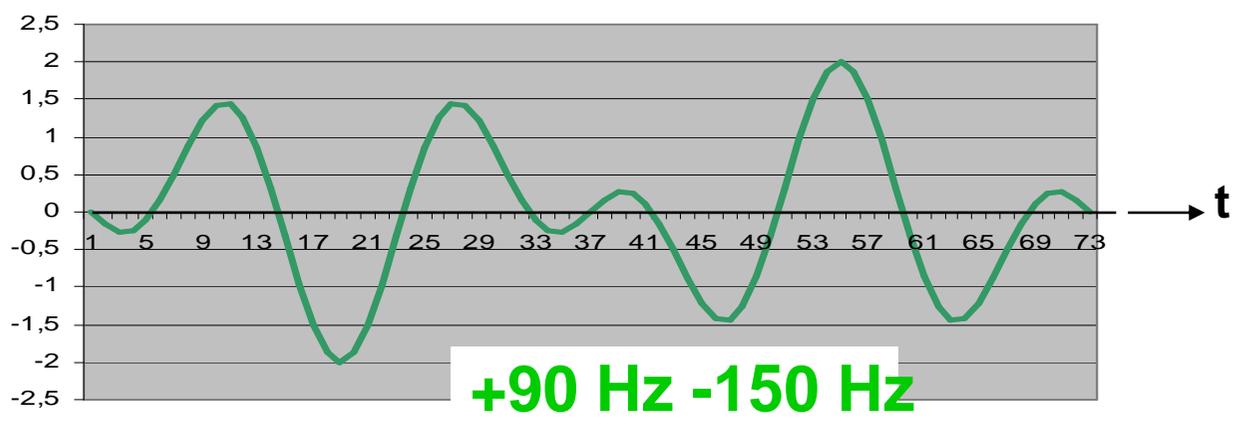
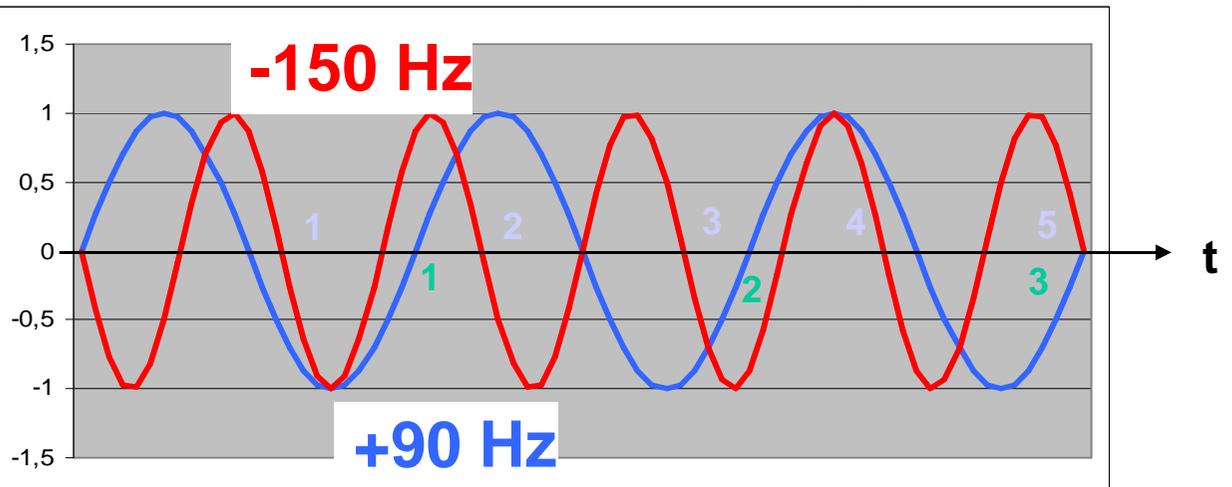


$+ 90^\circ$ $- 90^\circ$

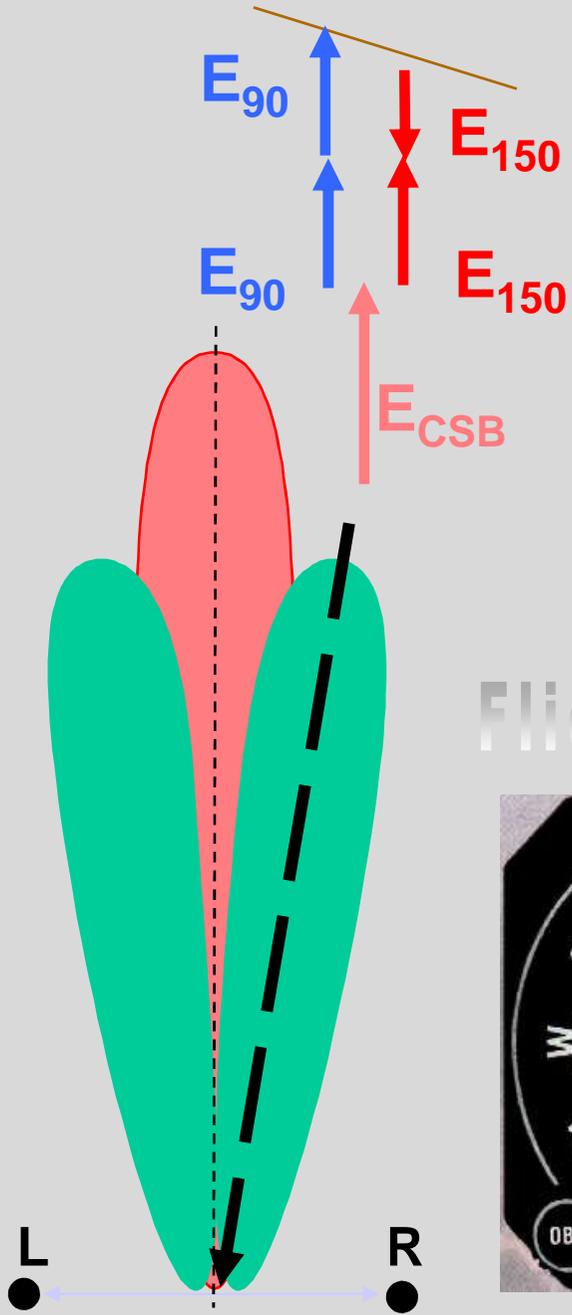
L R

$1A$ $1A$

e^{j0° e^{j180°



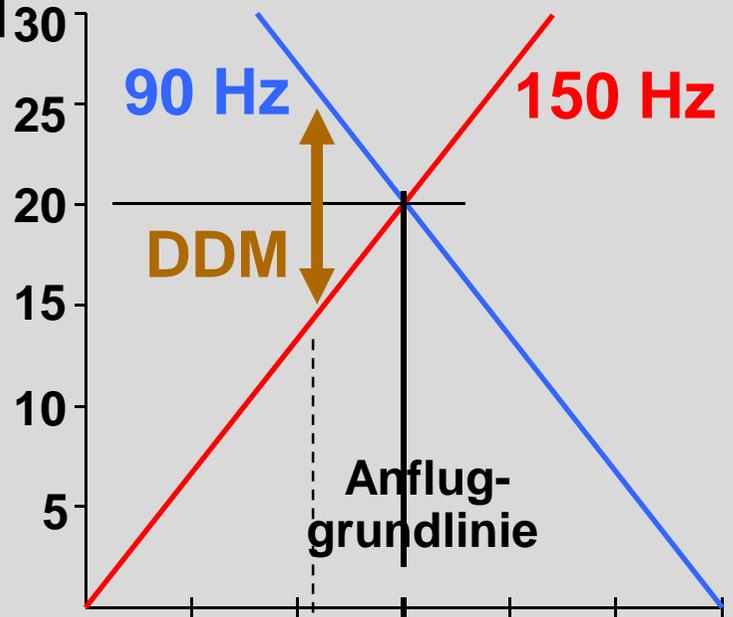
$DDM \neq 0$



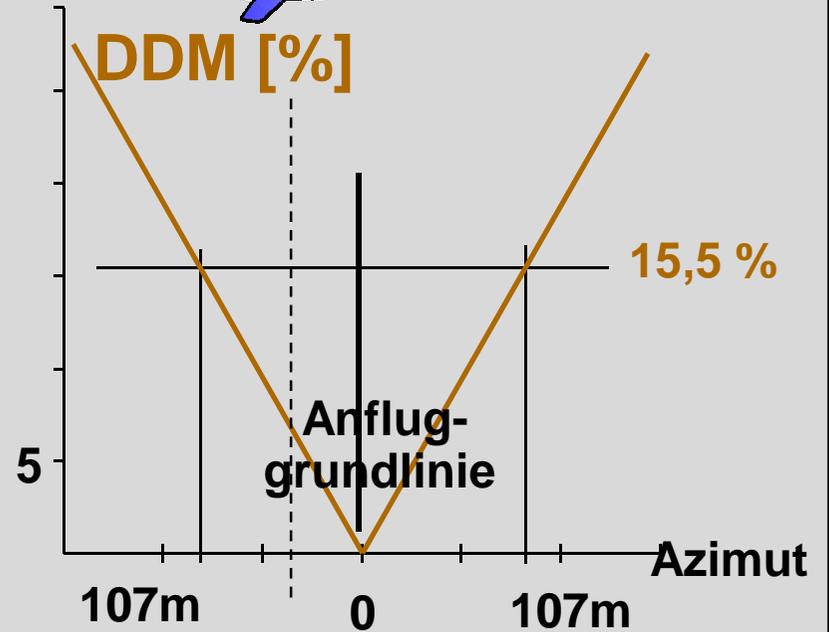
Fliege rechts!



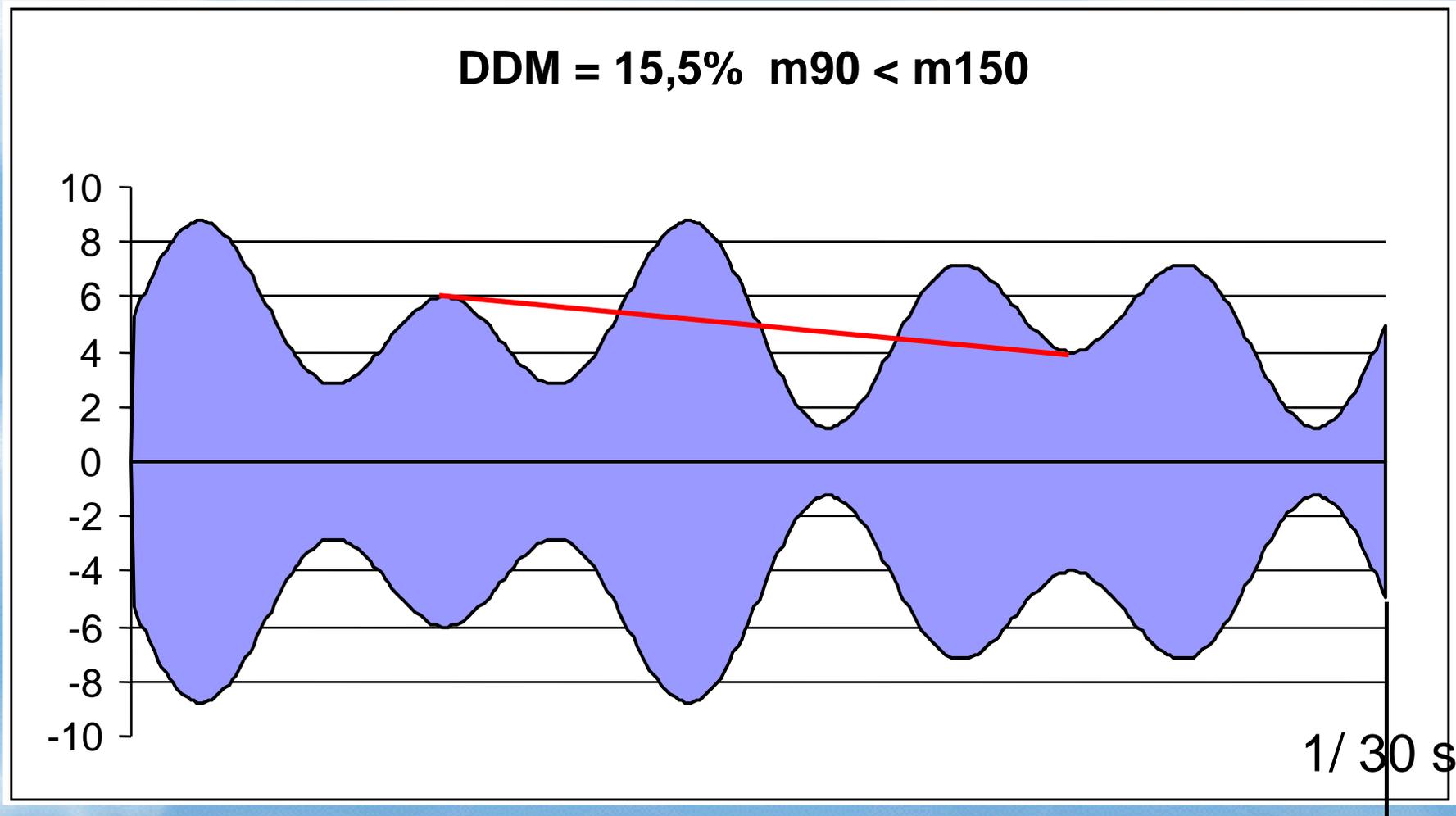
$m[\%]$



DDM [%]

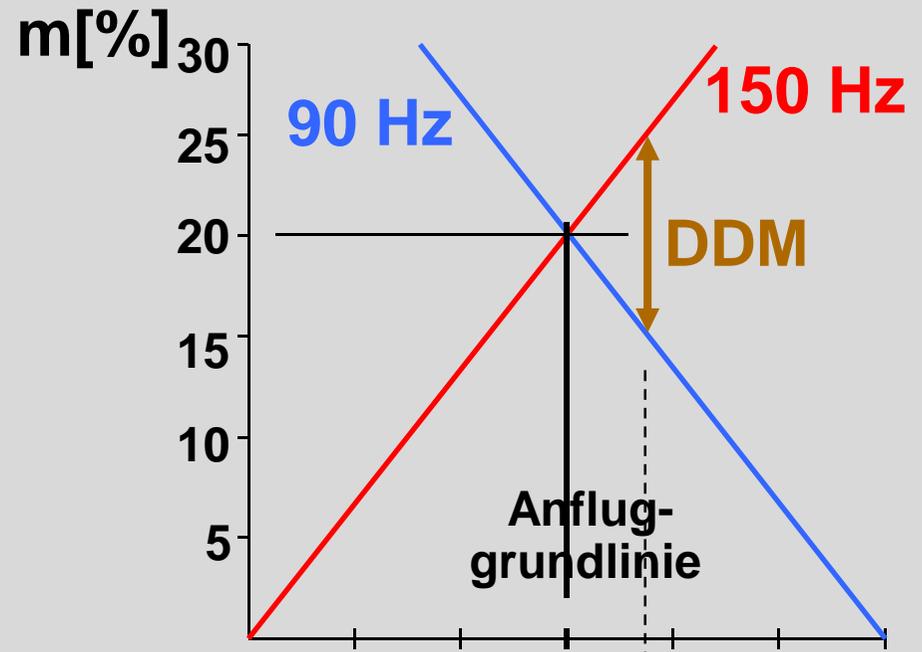
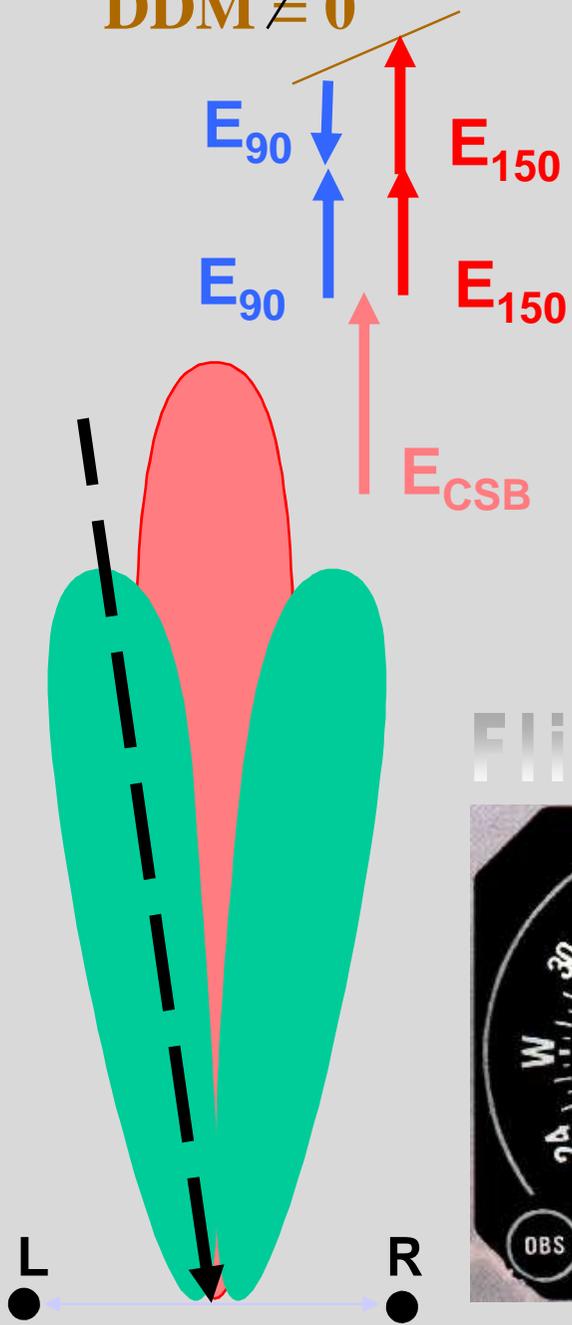


Landesysteme

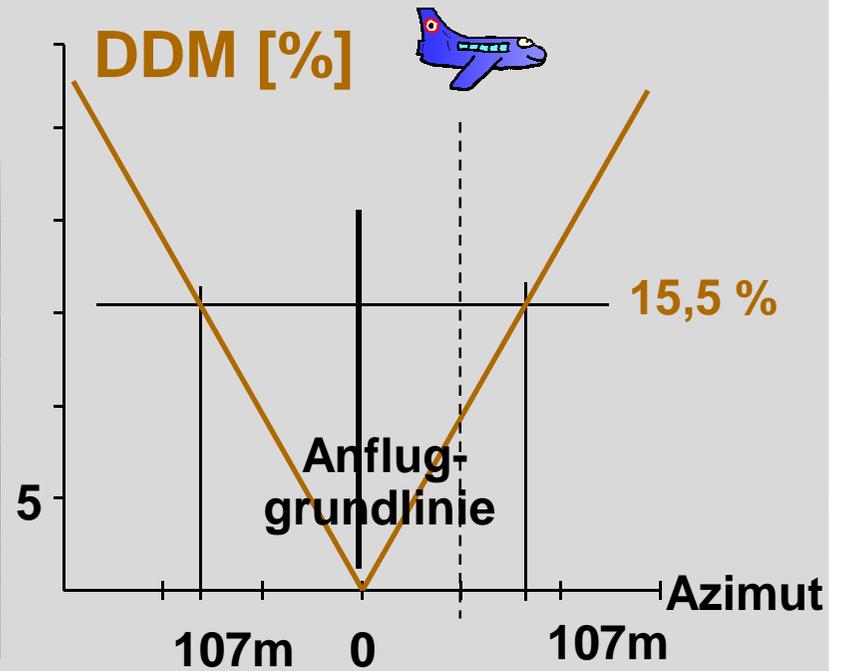


Gesamt-Modulations-Diagramm
am rechten Breitenpunkt

$DDM \neq 0$

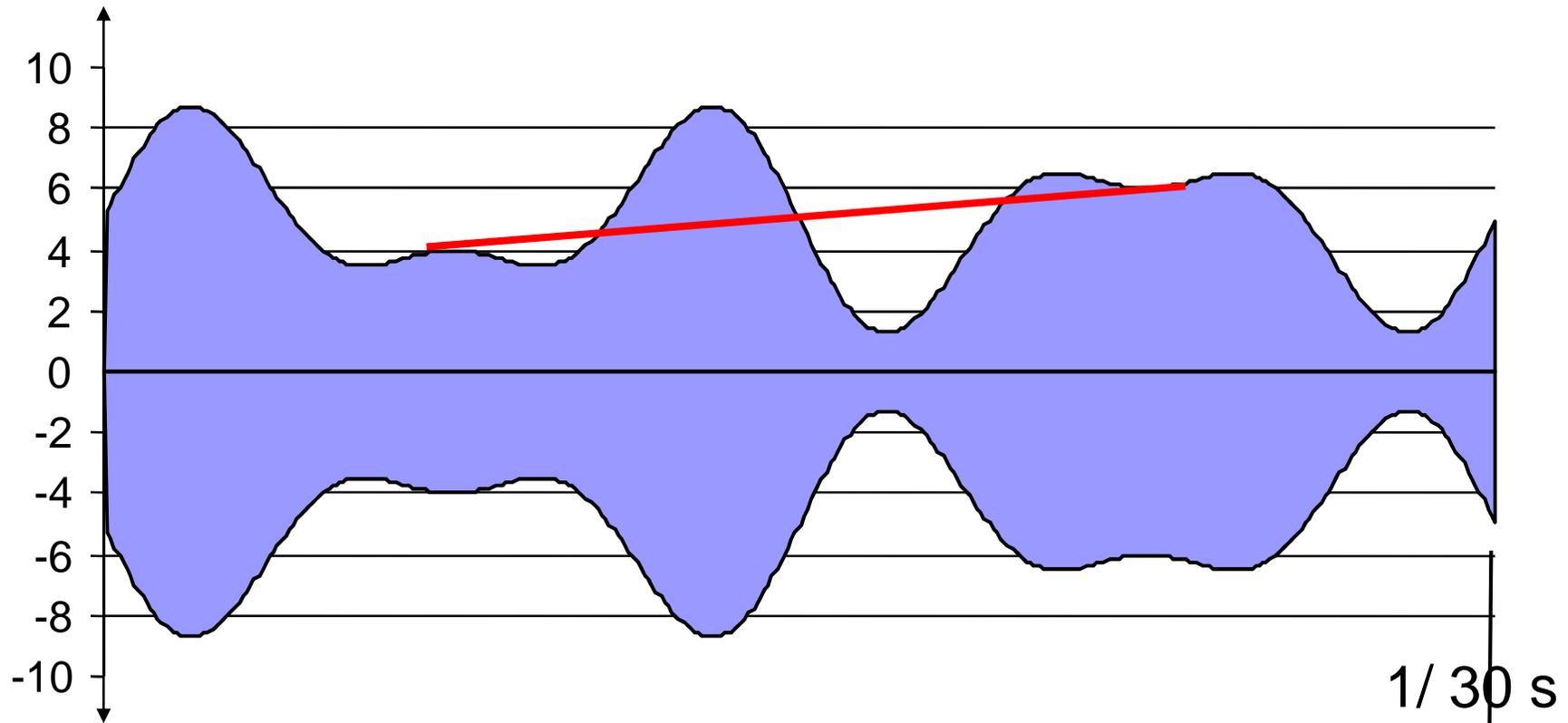


Fliege links!



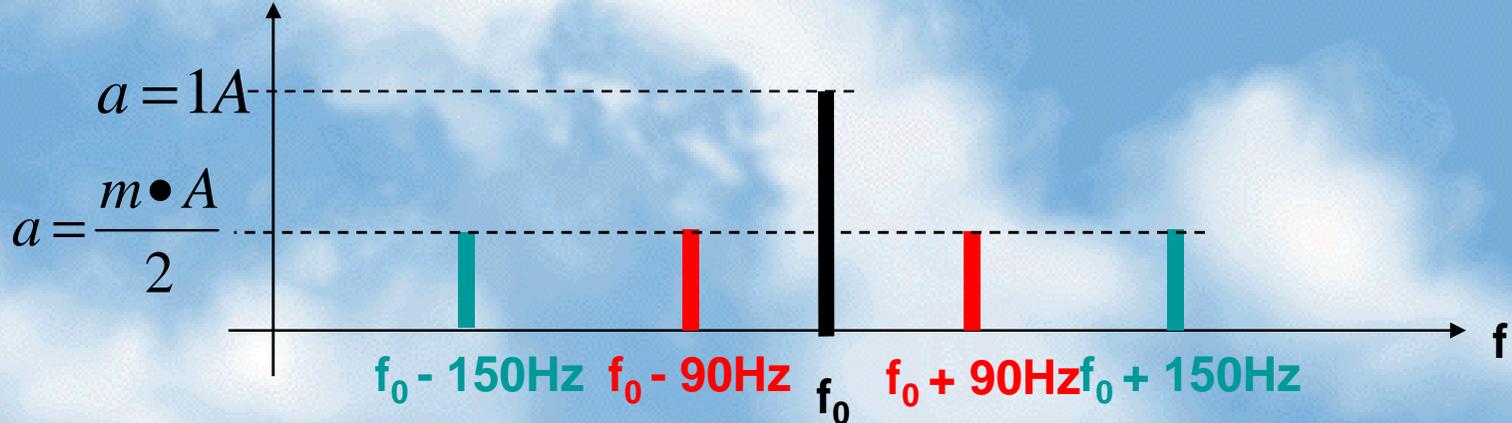
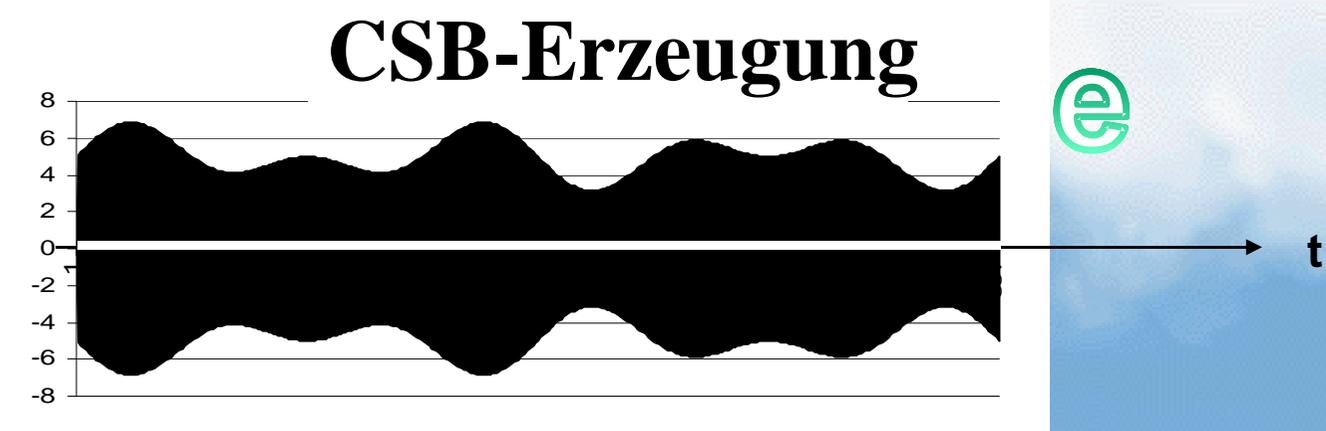
Landesysteme

DDM = 15,5% m90 > m150



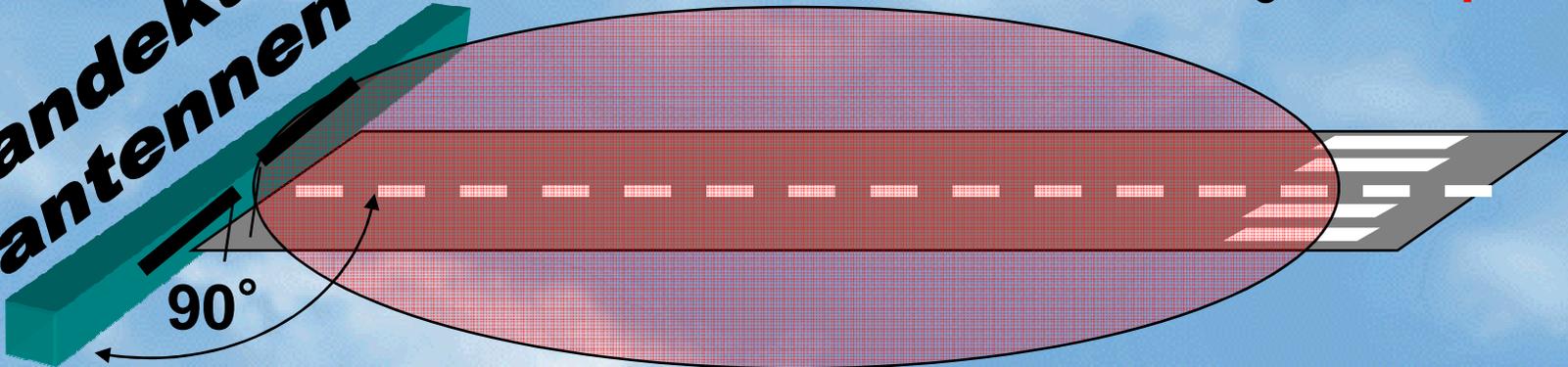
Gesamt-Modulations-Diagramm
am linken Breitenpunkt

CSB-Erzeugung



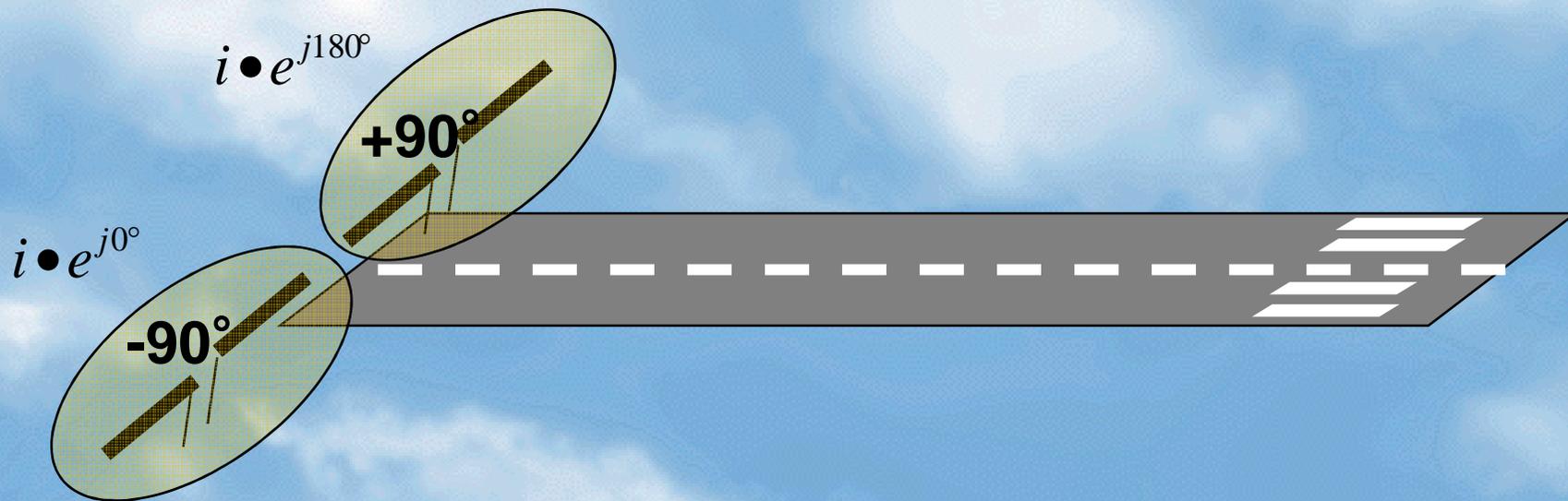
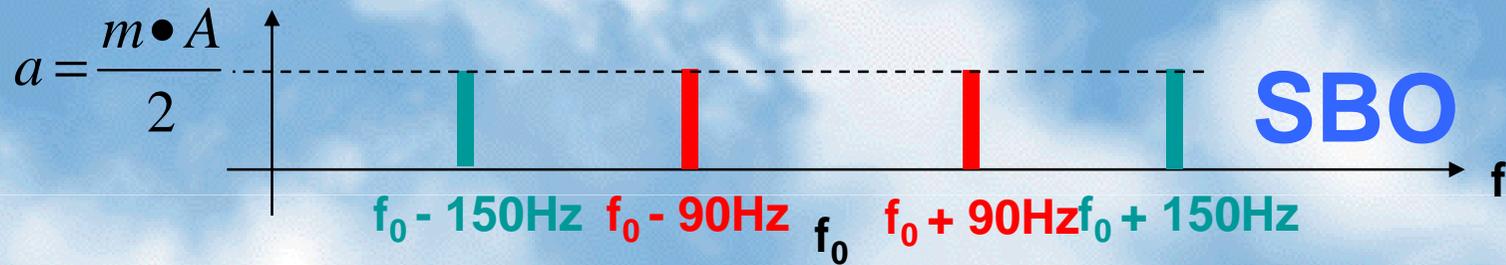
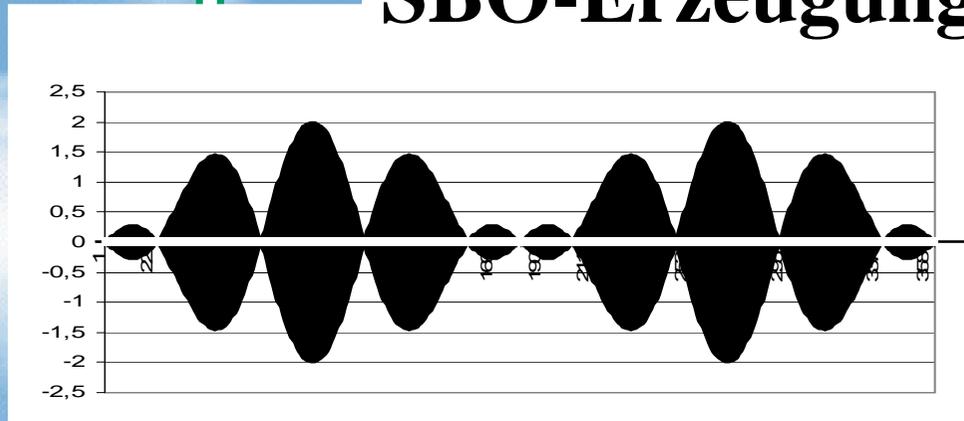
CSB: $f_0 + f_1 + f_2$

**Landekurs-
antennen**



SBO-Erzeugung

me



Landesysteme

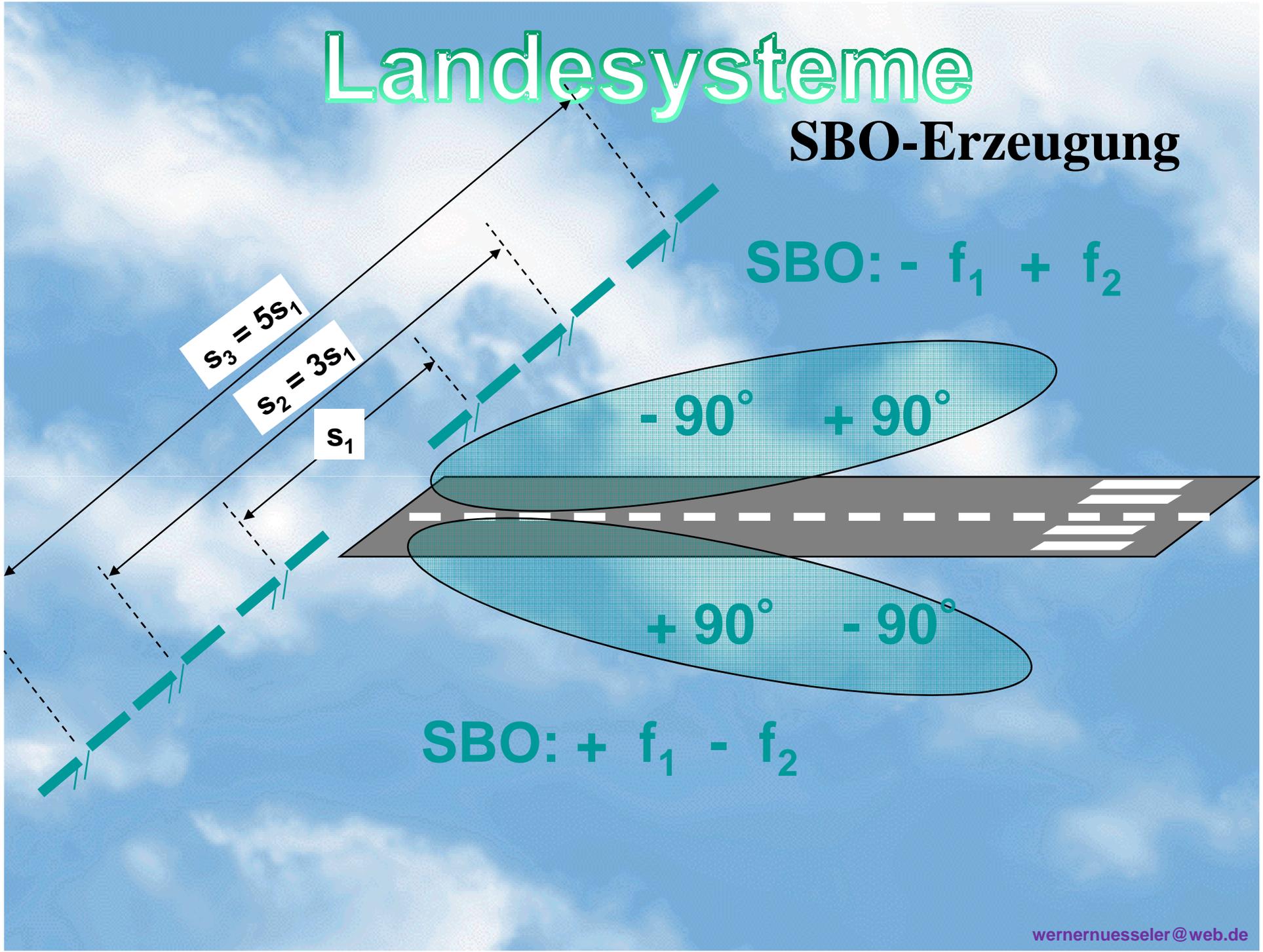
SBO-Erzeugung

$$\text{SBO: } - f_1 + f_2$$

$$- 90^\circ \quad + 90^\circ$$

$$+ 90^\circ \quad - 90^\circ$$

$$\text{SBO: } + f_1 - f_2$$



Landesysteme

Landekurs-Bildung

CSB: $f_0 + f_1 + f_2$

SBO: $- f_1 + f_2$

$i_{90} \cdot e^{j90^\circ} + i_{150} \cdot e^{j90^\circ}$

$- 90^\circ \quad + 90^\circ$

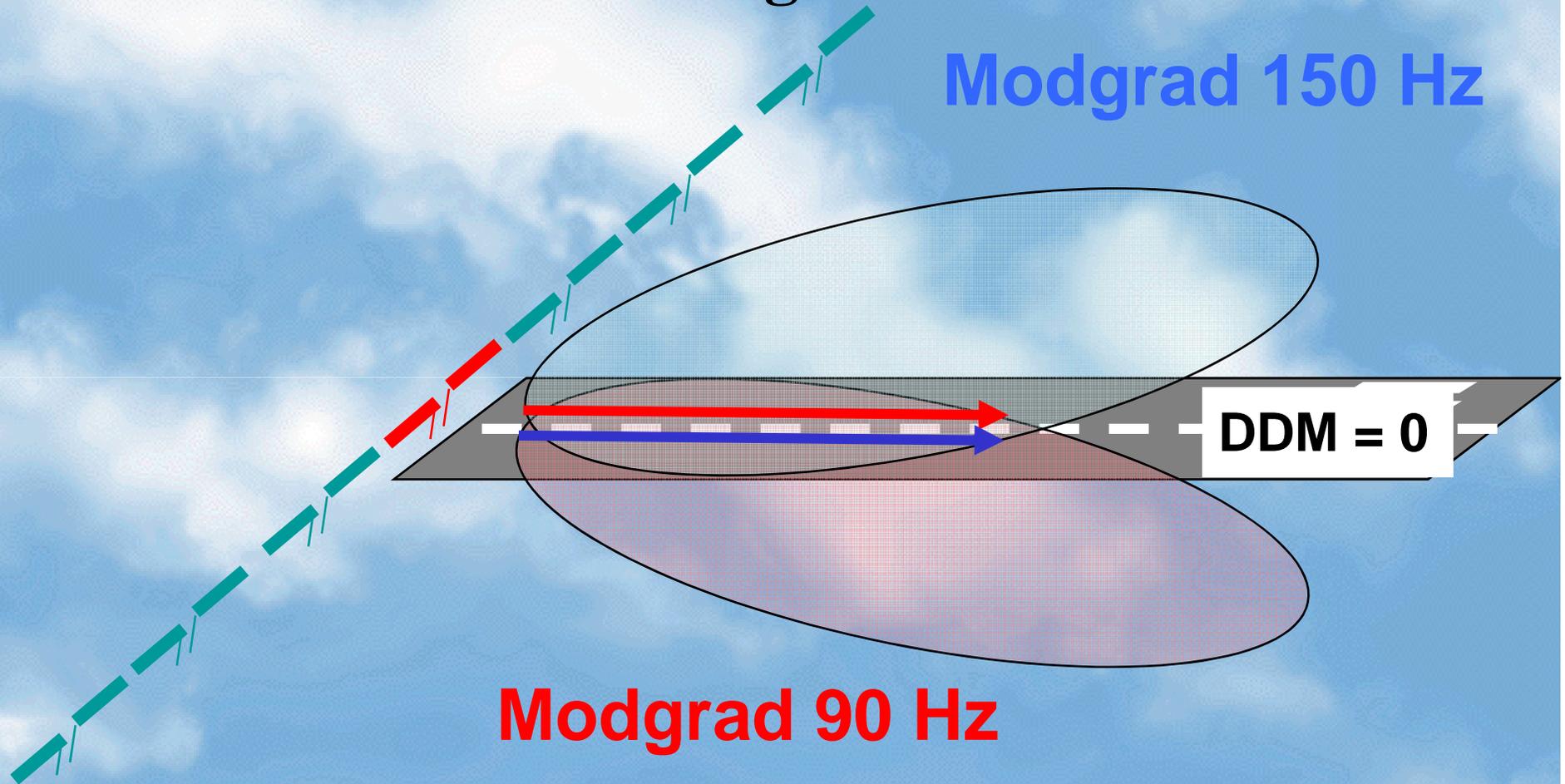
$+ 90^\circ \quad - 90^\circ$

SBO: $+ f_1 - f_2$

Landesysteme

Landekurs-Bildung

Modgrad 150 Hz



Landesysteme

Landekurs-Bildung

Modgrad 150 Hz

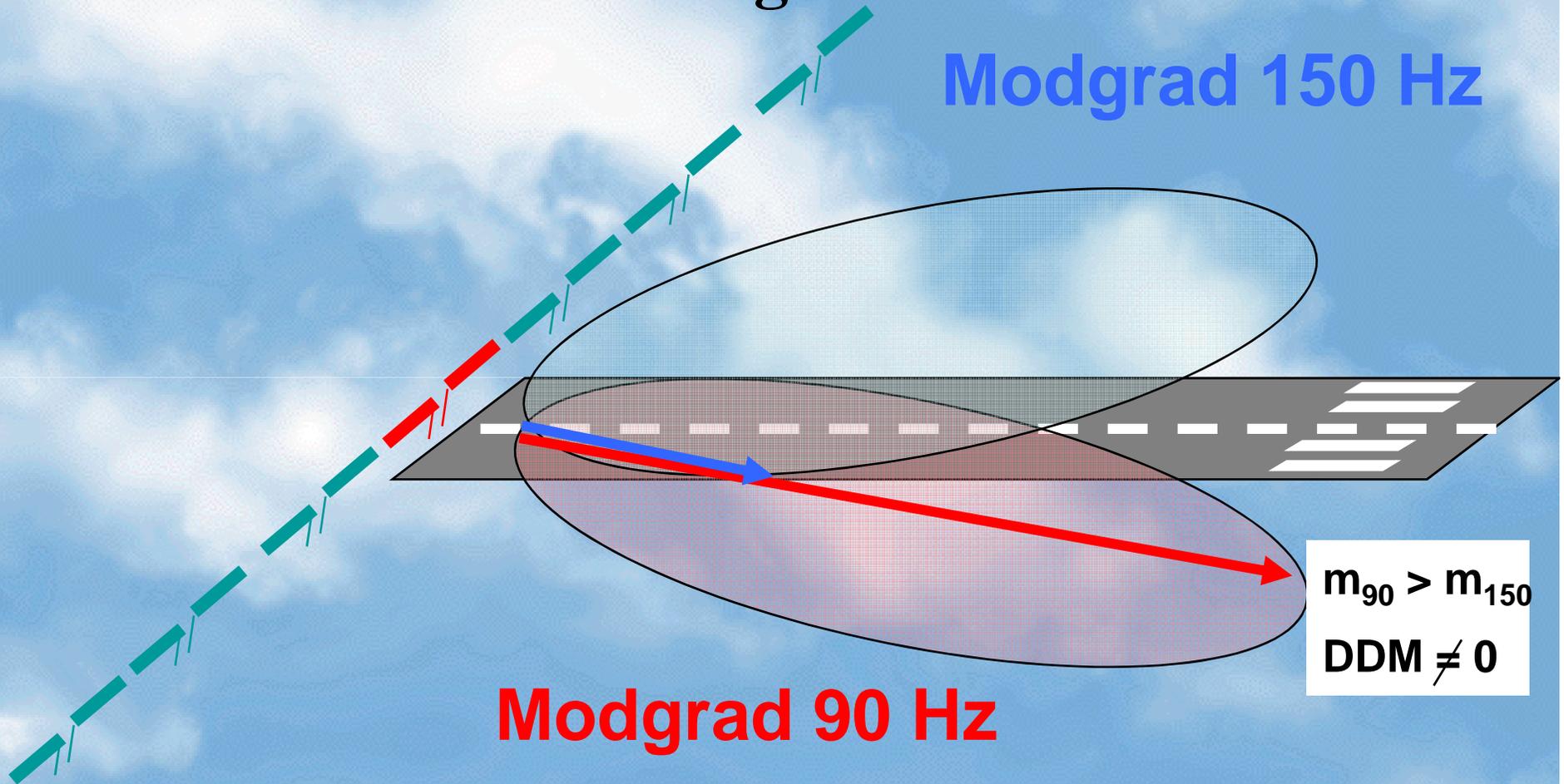
$$m_{150} > m_{90}$$
$$\text{DDM} \neq 0$$

Modgrad 90 Hz

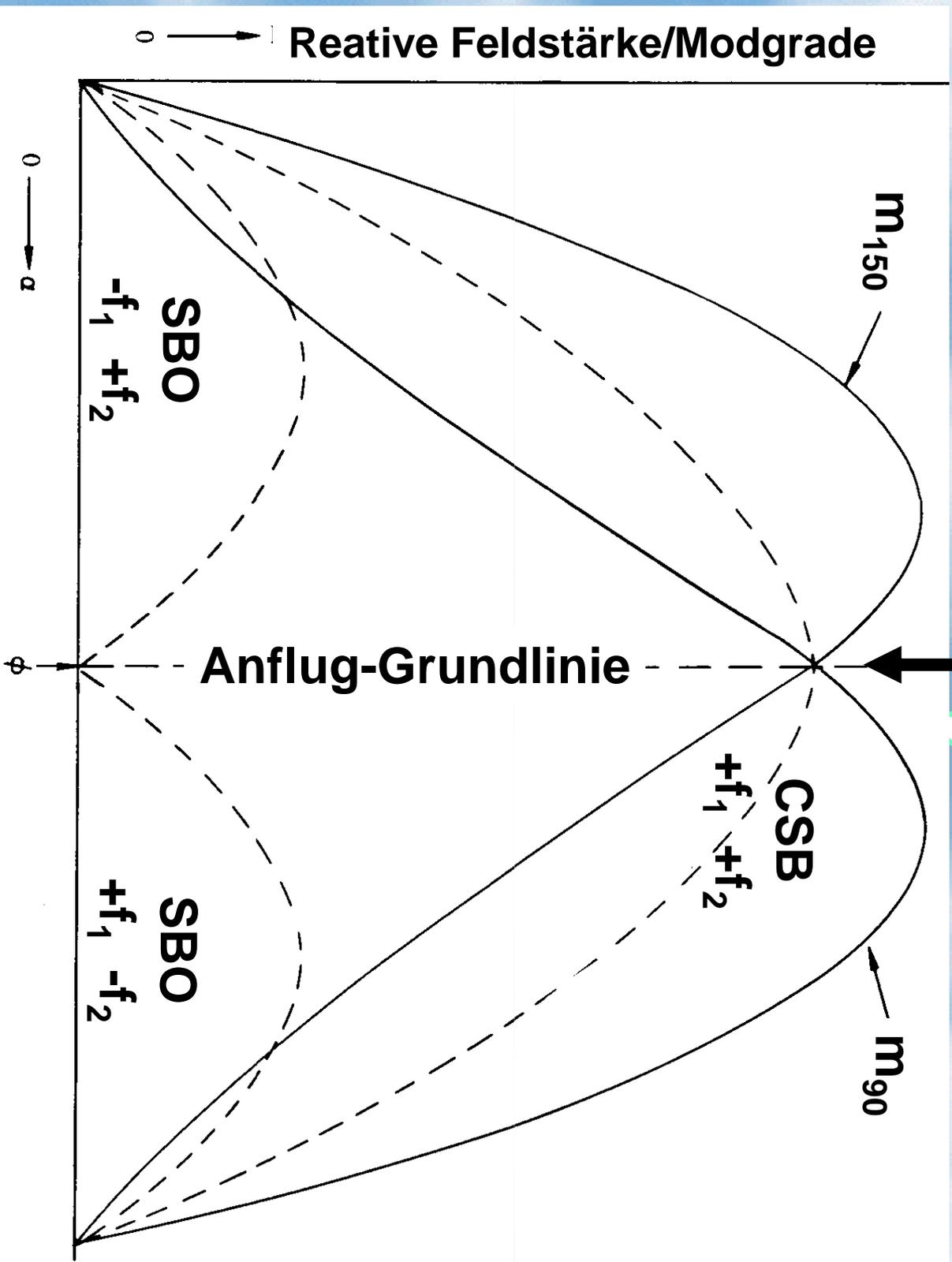
Landesysteme

Landekurs-Bildung

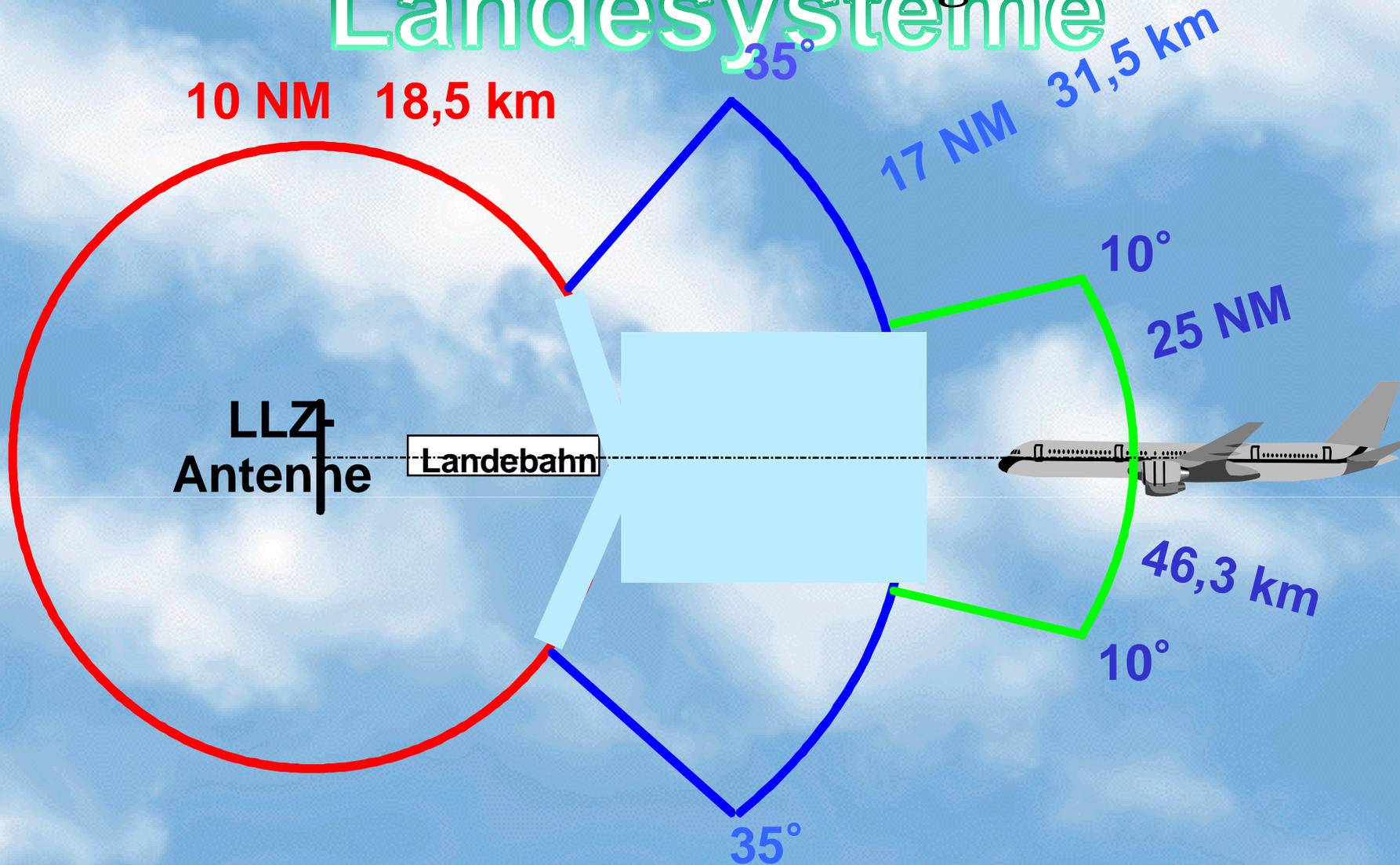
Modgrad 150 Hz



Landekurs-Bildung Landesysteme



LLZ - Bedeckung Landesysteme



Coverage/DOC:

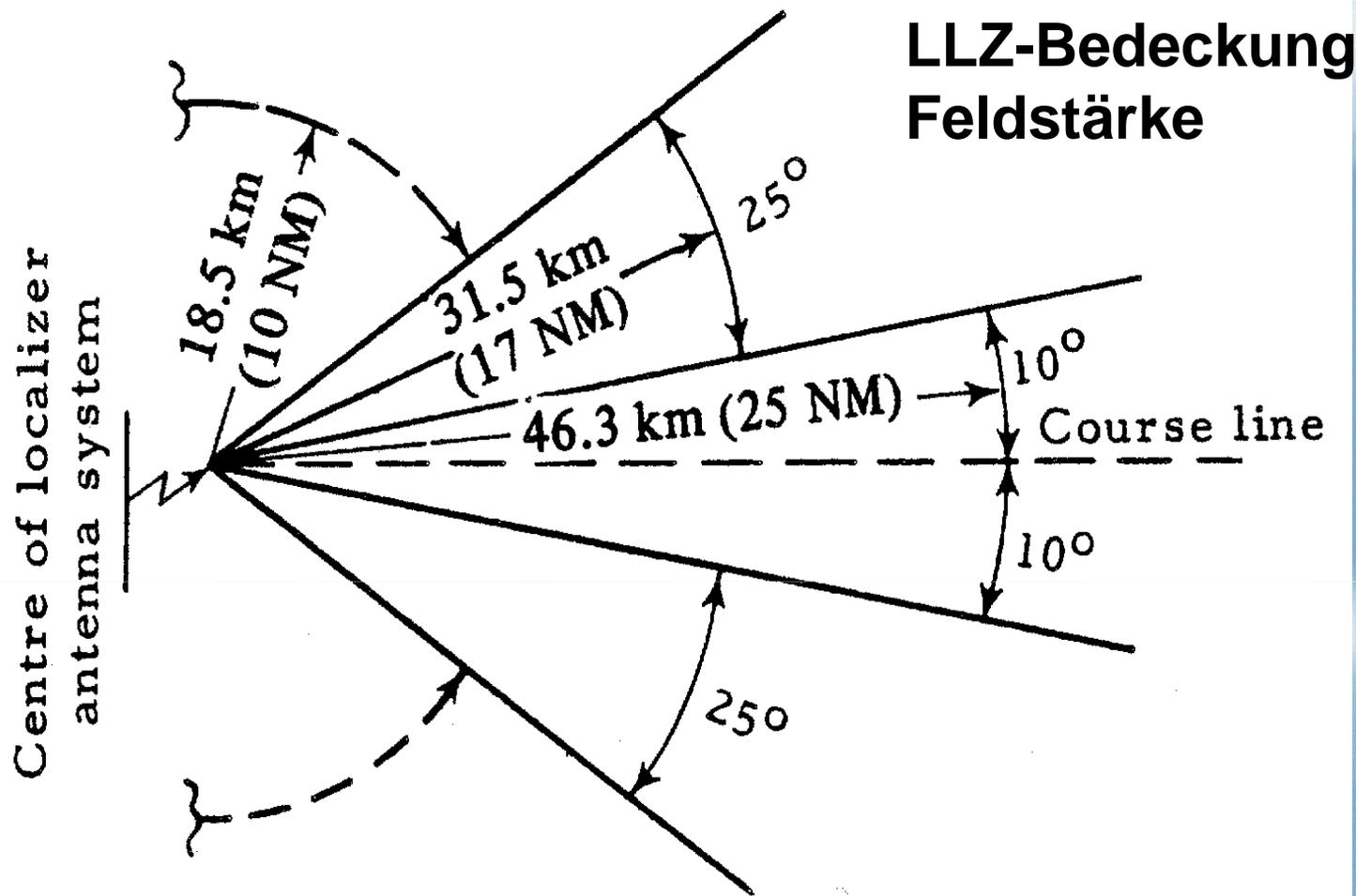
ILS-LOC

required field strength varies with category (ICAO Annex10)

25NM $\pm 10^\circ$ in front course line, within a height of 6,250 feet and for clearance,
17NM $\pm 35^\circ$ front course line.

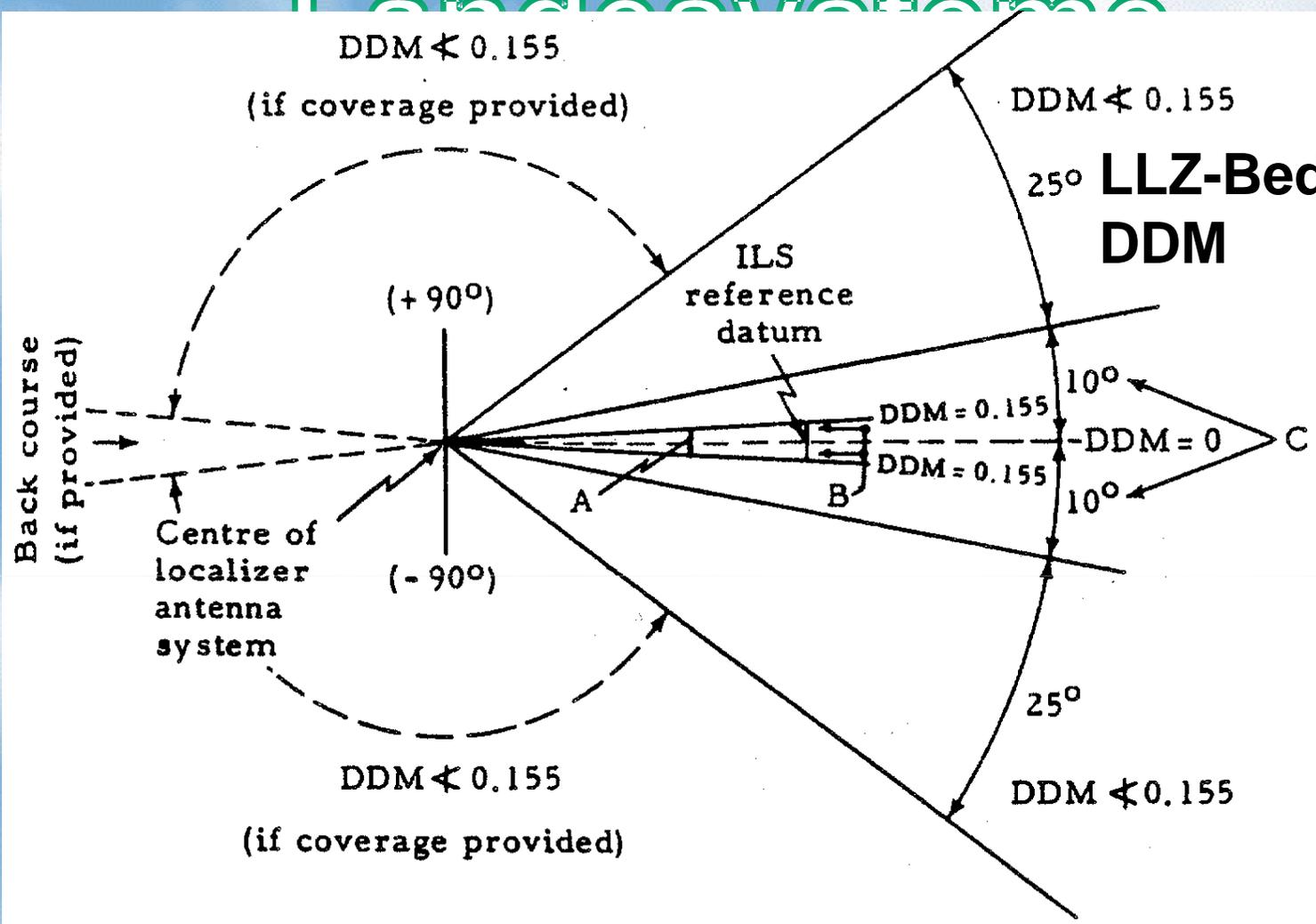
ILS-GP

≥ 10 NM $\pm 8^\circ$



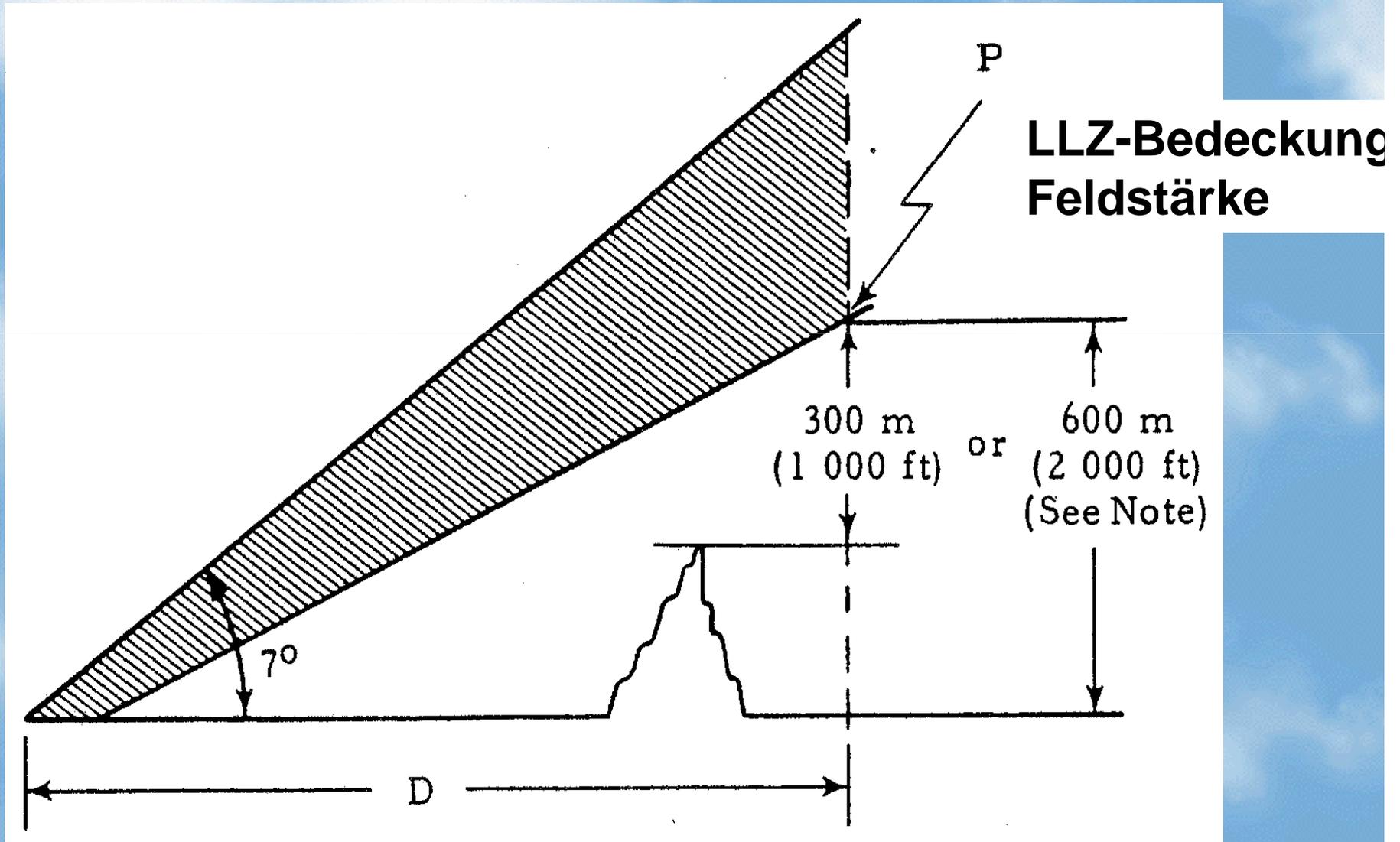
When topographical features dictate or operational requirements and alternative navigation facilities permit, the following coverage may be provided:

ILS Bedienung

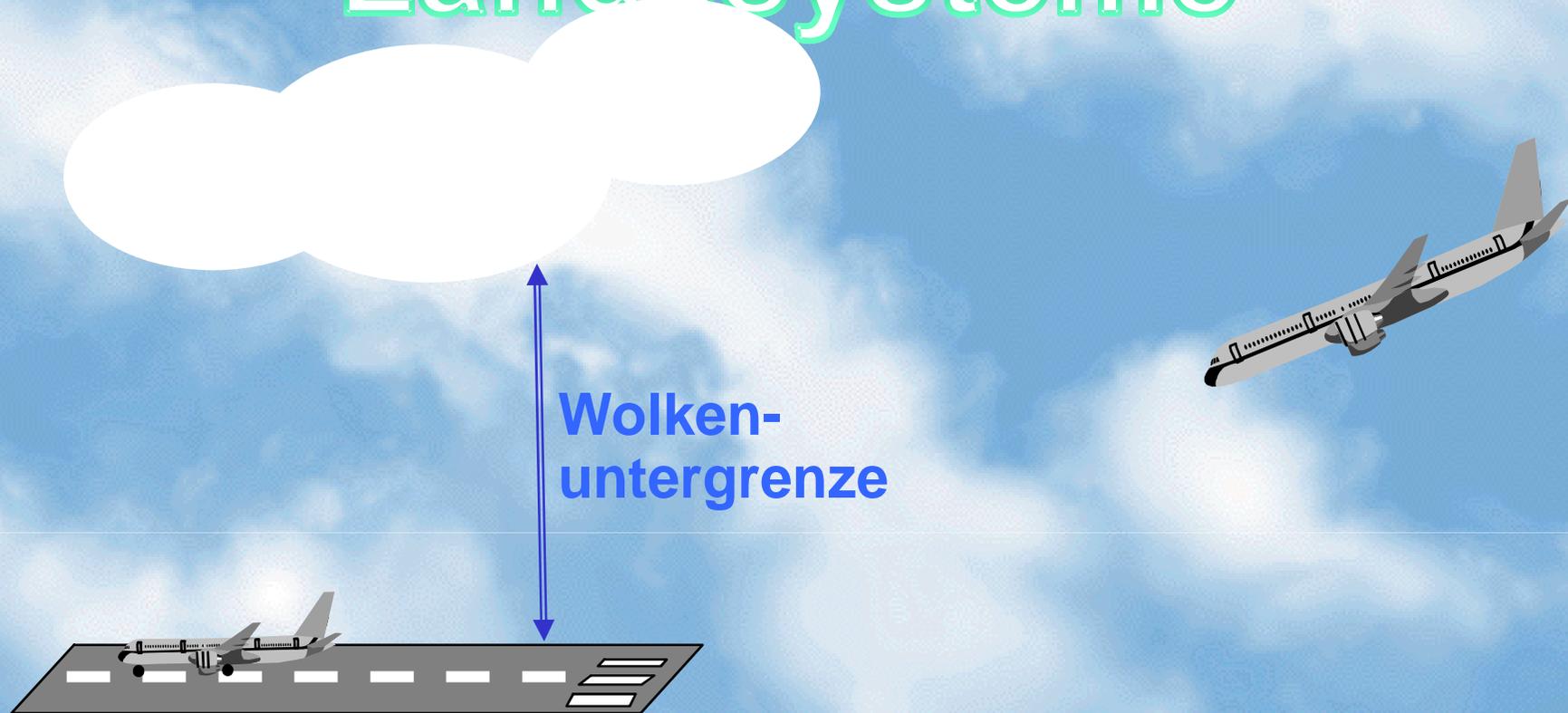


- A - Course sector ∇ 6 degrees
- B - Displacement sensitivity = 0.00145 DDM/metre (0.00044 DDM/foot) at the ILS reference datum
- C - DDM increases linearly from zero to value of 0.180, and then ∇ 0.180

Landesysteme

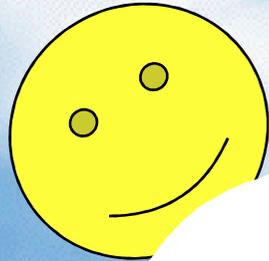


ILS - Betriebsstufen Landesysteme



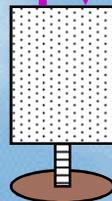
Wolkenuntergrenze ist die Höhe der als unterbrochen oder bedeckt gemeldeten untersten Wolken-
schicht oder einem anderen verdunkelnden Phänomen über der Erdoberfläche, die mehr als
die Hälfte des Himmels bedeckt (Bedeckungsgrad über 4/8) und unterhalb 6000 m Höhe liegt.
Die Höhe der Wolkenuntergrenze ist ein wichtiger Faktor bei der Entscheidung, ob Fliegen nach
Sichtflugregeln (VFR) möglich ist oder nicht. Gemessen wird die Wolkenuntergrenze mit
(mechanisch-optischen oder heute elektronischen) Wolkenhöhenmessern (Ceilometer).

ILS - Betriebsstufen Landesysteme



<i>Betriebsstufe</i>	<i>Wolkenuntergrenze</i>
I	> 60 m / 200 ft
II	60 - 30 m / 100 ft
III a	30 - 15 m
III b	< 15 m
III c	0

Ceilometer

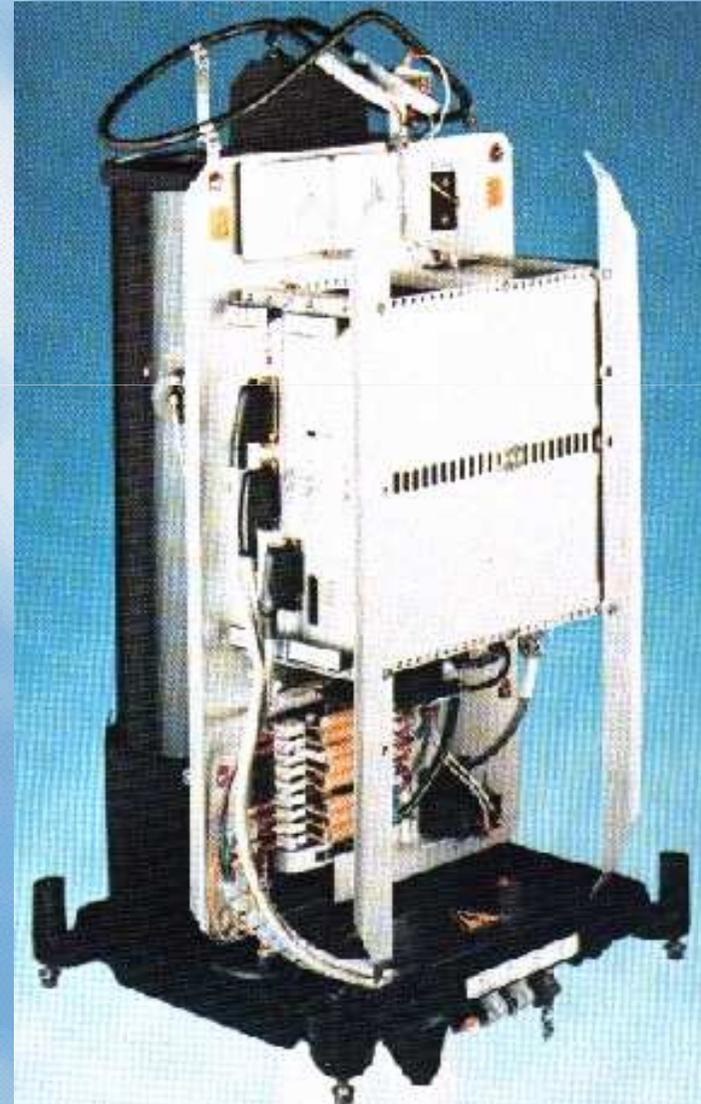


**Wolken-
untergrenze**



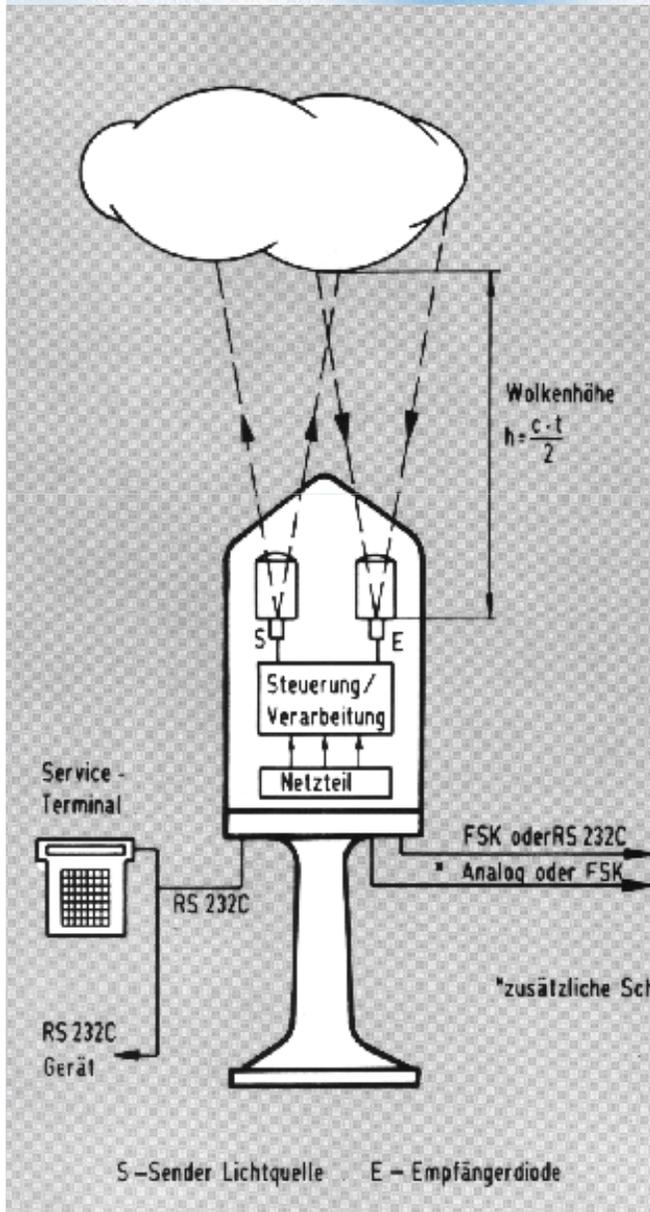
ILS - Betriebsstufen Landesysteme

Wolkenhöhenmessung
mit dem Ceilometer



ILS - Betriebsstufen Landesysteme

Wolkenhöhenmessung mit dem Ceilometer

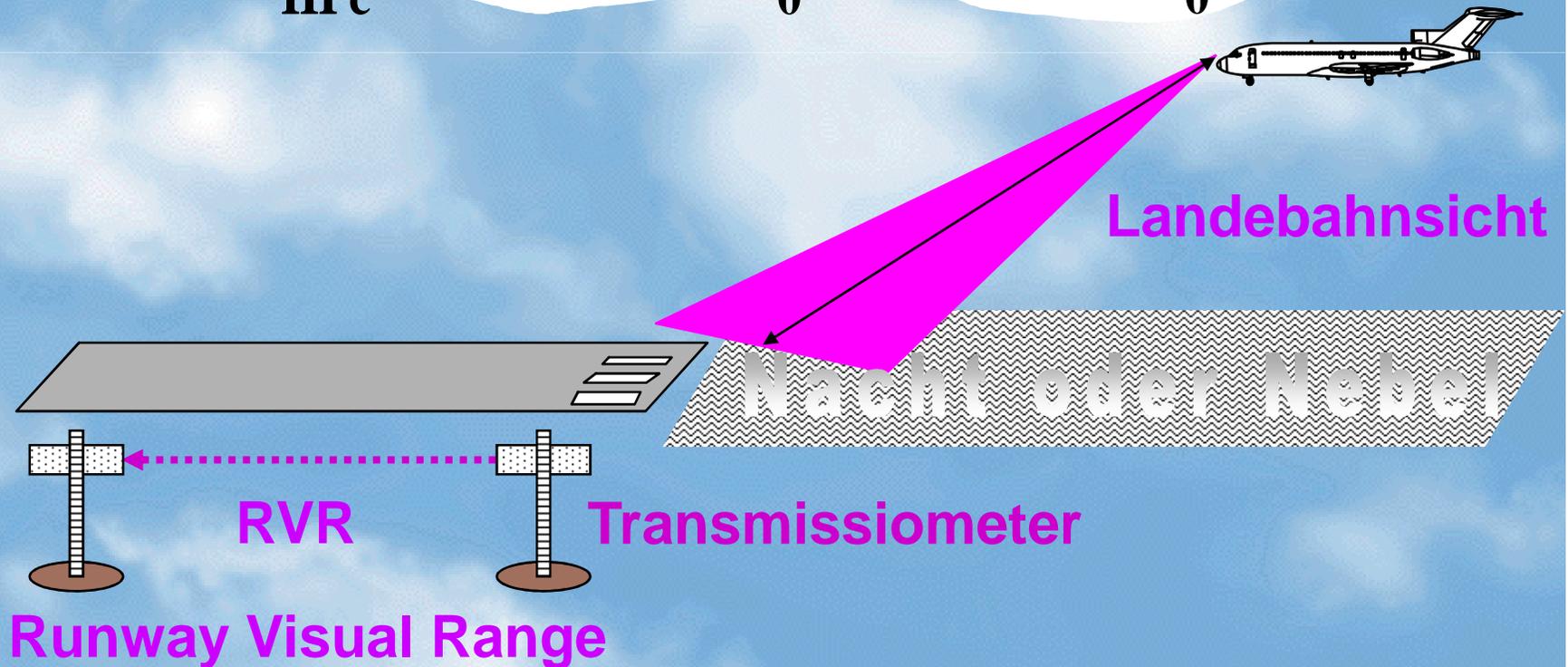


Sensor

Meßprinzip:	Laufzeit des Lichtes (LIDAR)
Meßbereich:	25 ft bis 3300 ft/5600 ft/12000 ft oder 8 m bis 1006 m/1707 m/3657 m
Höhenstufung:	25 ft, 50 ft, 100 ft und 200 ft abhängig von der Meßhöhe
Genauigkeit:	± eine Höhenstufe (besser als Empfehlung der ICAO)
Wiederholrate:	4 oder 2 Messungen pro Min.
Schnittstellen:	RS 232 C für Service und Sensortest RS 232 C für Rückstreu- und Instrumentdaten FSK-MODEM für Wolkendaten, Rückstreudaten, Sensor-Status, -Steuerung und -Kontrolle wahlweise: Schreiberschnittstelle od. zweites FSK-MODEM
Prozessor:	16/32 bit CMOS 68000 CPU
Lichtquelle:	Ga As-Laser
Lasersicherheit:	Entsprechend IEC 825/VDE 0837 Klasse 3 B
Lichtempfänger:	Si Fotodiode
Stromversorgung:	110 V, 120 V, 220 V oder 240 V AC +/- 10 %, 50 Hz oder 60 Hz 600 W einschl. Heizung und Gebläse
Temperaturbereich:	-40° C bis + 50° C
Gewicht:	42 kg

ILS - Betriebsstufen Landesysteme

<i>Betriebsstufe</i>	<i>Wolkenuntergrenze</i>	<i>Landebahnsicht</i>
I	> 60 m / 200 ft	> 550 m
II	60 - 30 m / 100 ft	> 300 m
III a	30 - 15 m	> 200 m
III b	< 15 m	200 - 75 m
III c	0	0

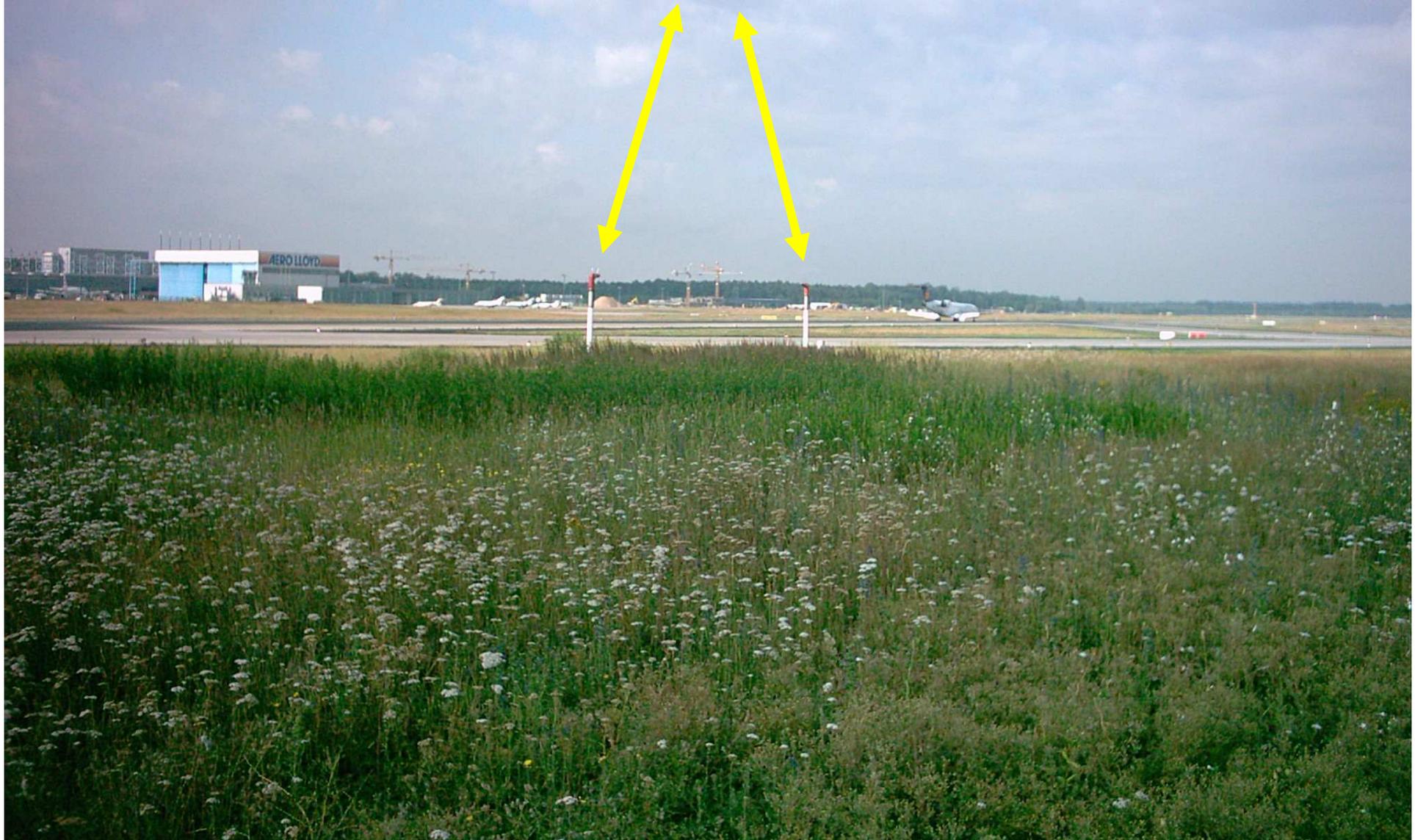


ILS - Betriebsstufen

systeme

**Sichtweitenmessung
Runway Visual Range RVR
mit dem Transmissiometer**

Runway Visual Range RVR-Messeinrichtung Transmissiometer

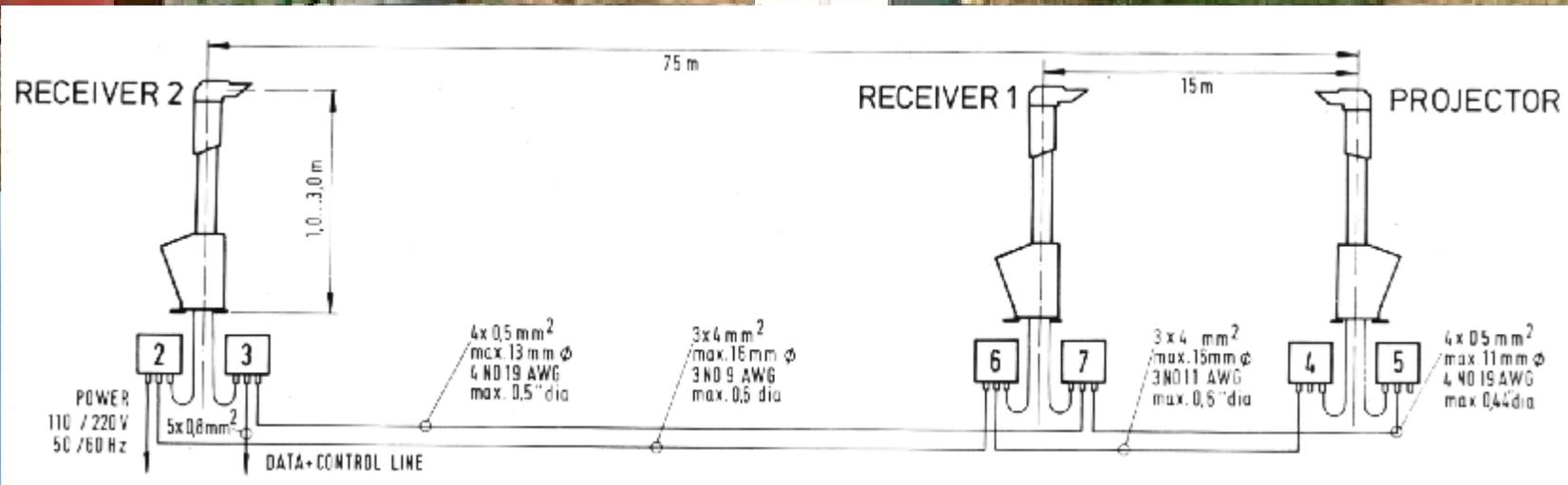


**Runway Visual Range RVR-Messeinrichtung
(Messung der Lufttrübung per Infrarot)
gefordert für CAT III - Anflüge**

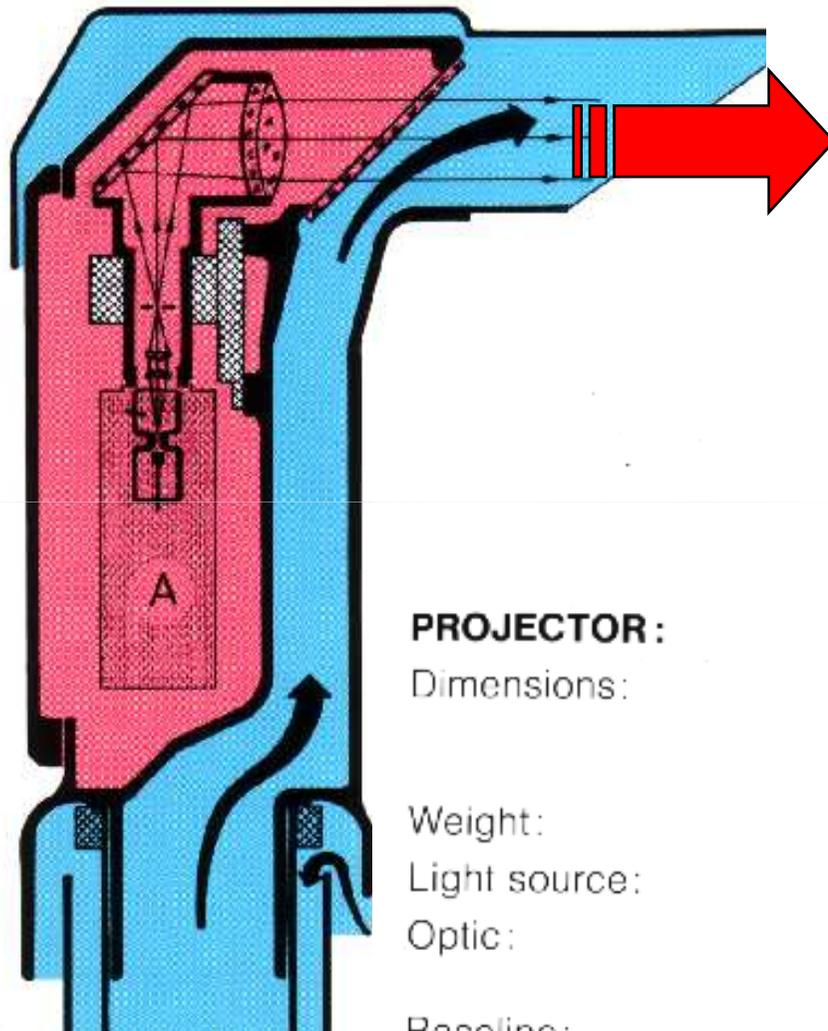


ILS - Betriebsstufen

**Sichtweitenmessung - Runway Visual Range RVR
mit dem Transmissiometer**



ILS - Betriebsstufen Landesysteme



PROJECTOR:

Dimensions:

Weight:

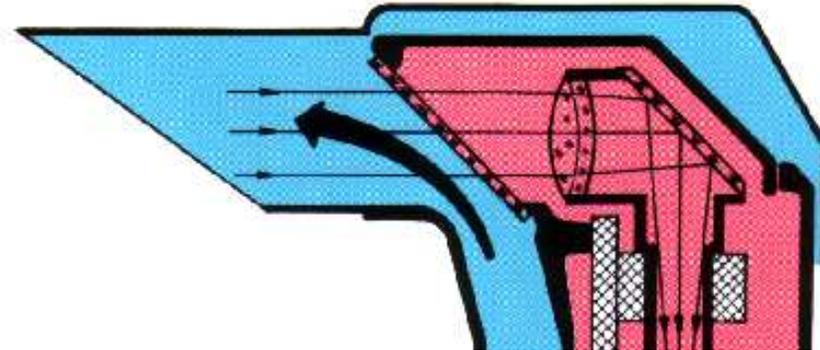
Light source:

Optic:

Baseline:

Power supply:

Power consumption:



Technical Data

SKOPOGRAPH II

Order No. 132/1100

Optical head H 435 × D 370 × W 140 mm

Stand 123 mm \varnothing various height 1 m to 3 m

Lower compartment H 450 × D 380 × W 320 mm

39 kg

Xenon flashlight with capillary guide tube

Achromat, Diameter 46 mm, Focus 120 mm,
Divergence 8 mrad

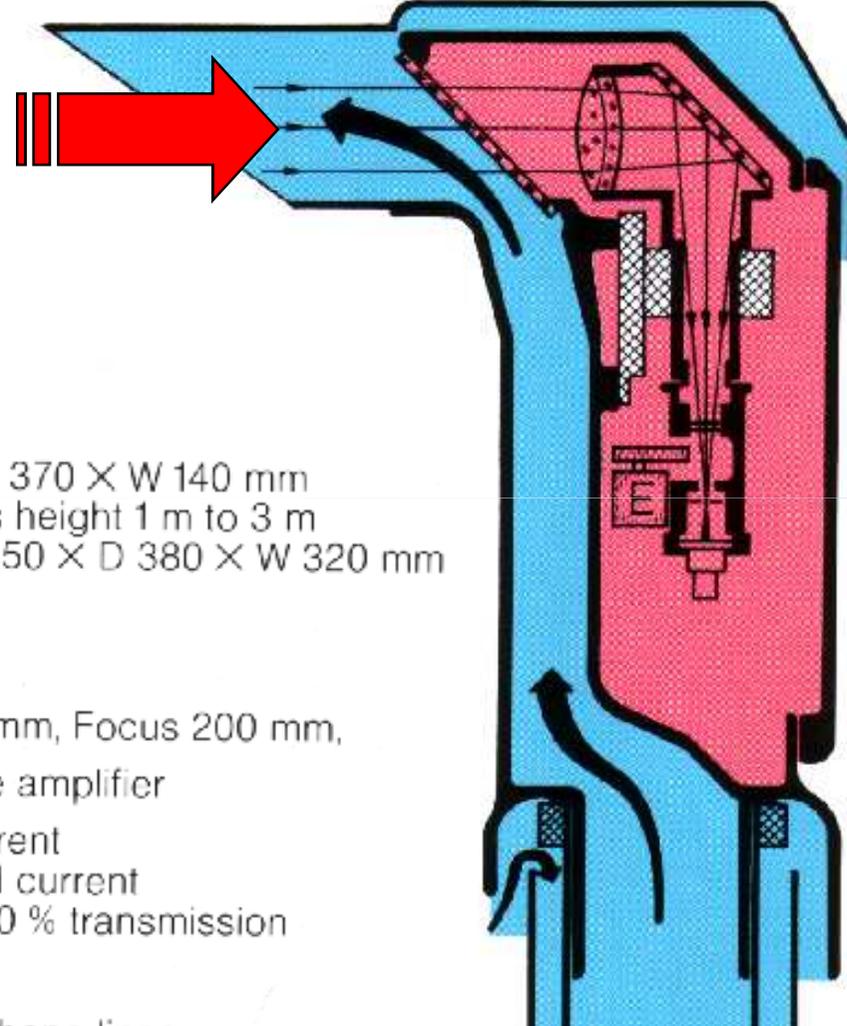
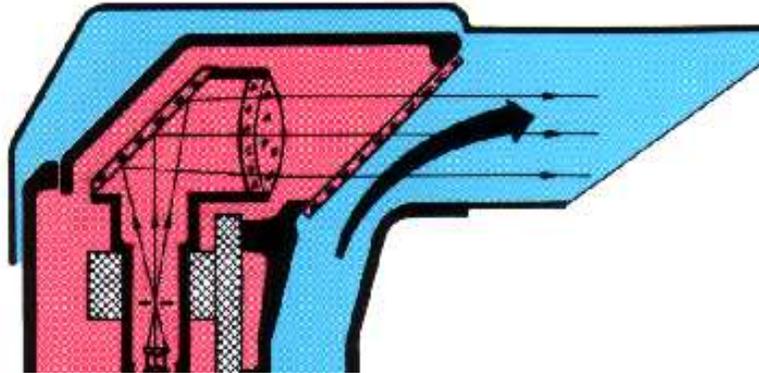
15 m to 75 m max.

220 or 110 V AC, 50 or 60 Hz

Electronics 10 W

Heaters 50 W

ILS - Betriebsstufen Landesysteme



RECEIVER:

Order No. 132/1200

Dimensions:

Optical head H 435 × D 370 × W 140 mm

Stand 123 mm \varnothing various height 1 m to 3 m

Lower compartment H 450 × D 380 × W 320 mm

Weight:

42 kg

Photo diode:

PIN 10 D

Optic:

Achromat, Diameter 46 mm, Focus 200 mm,

Receiver electronics:

Self compensating pulse amplifier

Analog output:

0...1 mA impressed current

or 4...20 mA impressed current

corresponding to 0...100 % transmission

Digital output:

RS 232 C ASCII

Data transmission:

10 km via standard telephone lines

Power supply:

220 or 110 V AC, 50 or 60 Hz

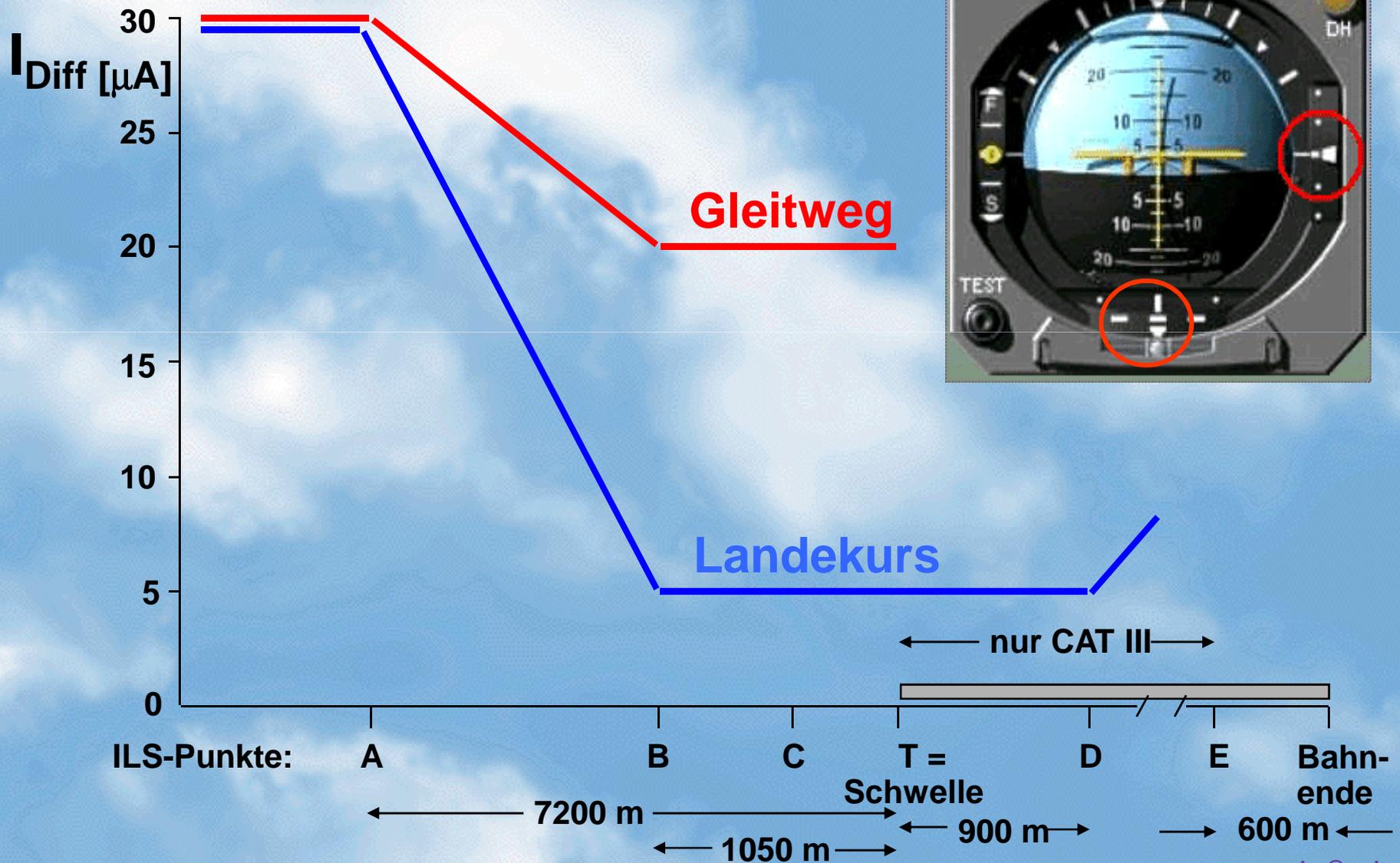
Power consumption:

Electronics 15 W

Heaters 125 W

Landesysteme

Kursstrukturen

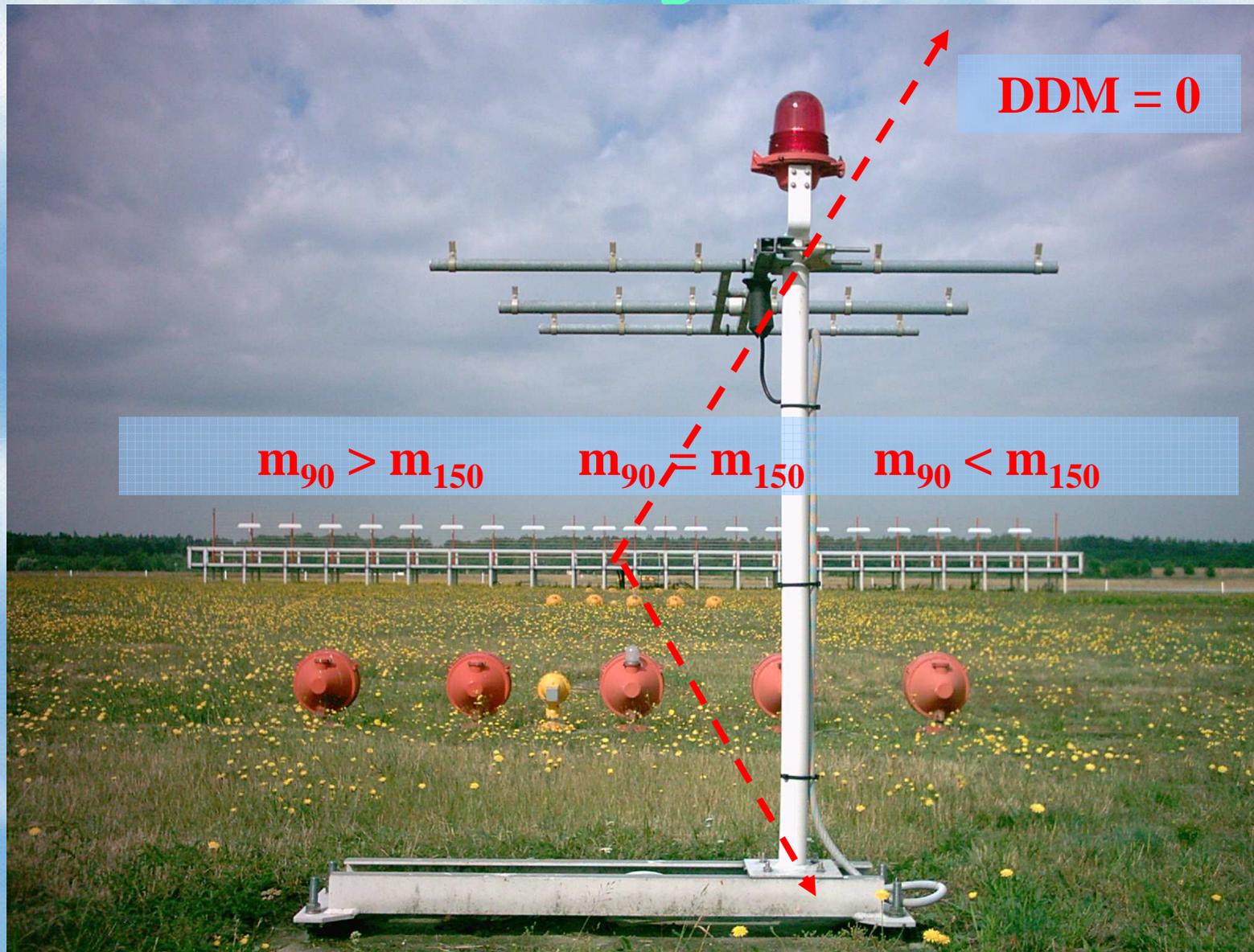


Kursstrukturen

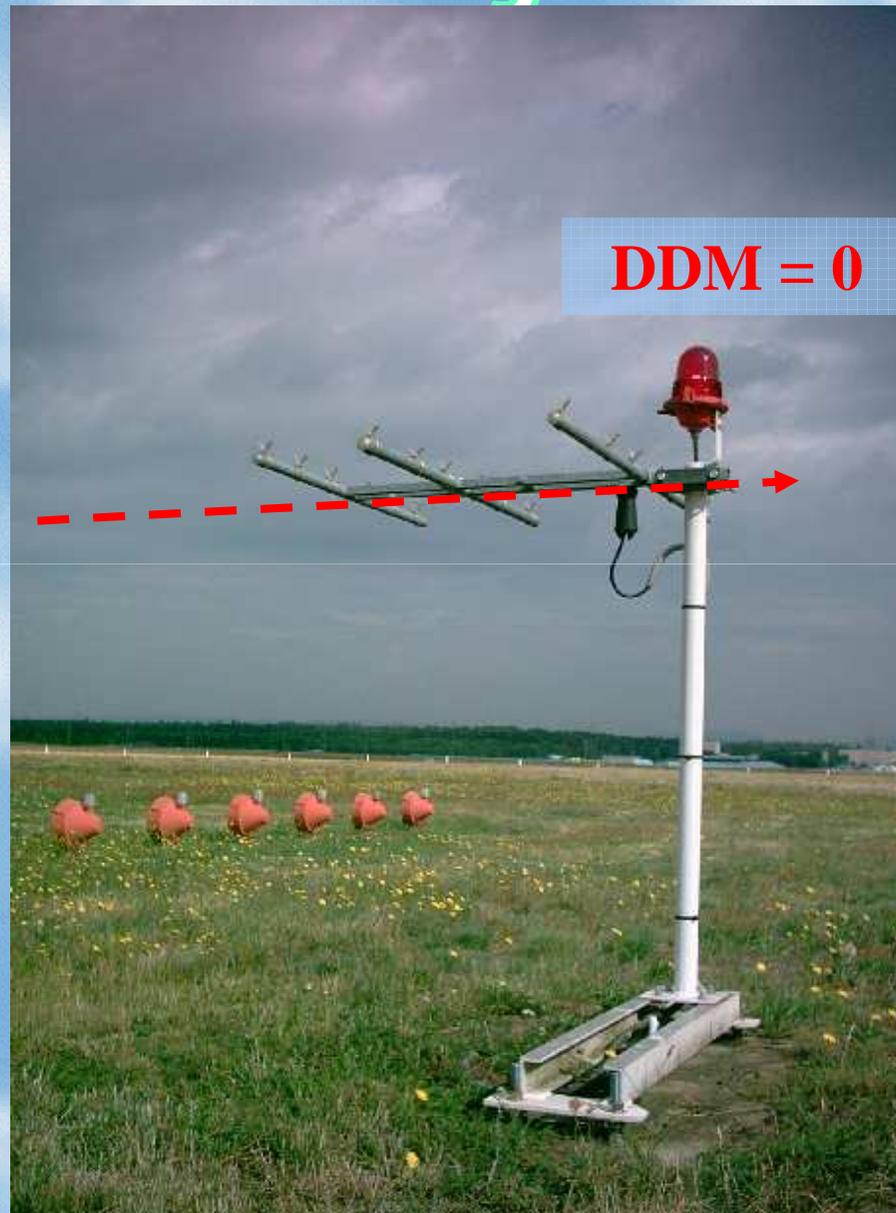
gemessen auf der Landebahn mit dem Messfahrzeug



Landesysteme



Landesysteme



Reflexionen Landesysteme

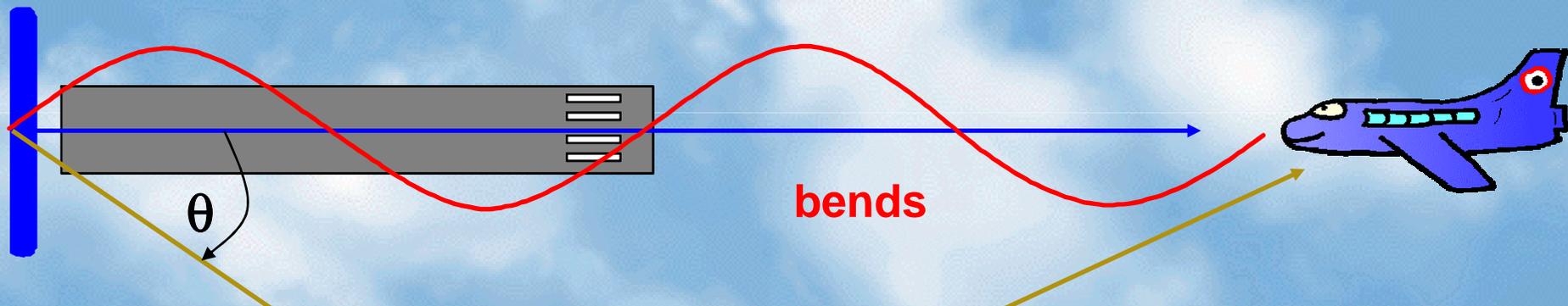
$$U_D = A_0 [1 + m_0 \cos \omega_{90} t + m_0 \cos \omega_{150} t] * \cos (\Omega t + \psi_D)$$



Reflexionen Landesysteme

$$U_D = A_0 [1 + m_0 \cos \omega_{90} t + m_0 \cos \omega_{150} t] * \cos (\Omega t + \psi_D)$$

$$\delta_{DDM} = (kA_\delta / A_0) * \sin (m_{90} - m_{150}) * \cos (\psi_D - \psi_R)$$



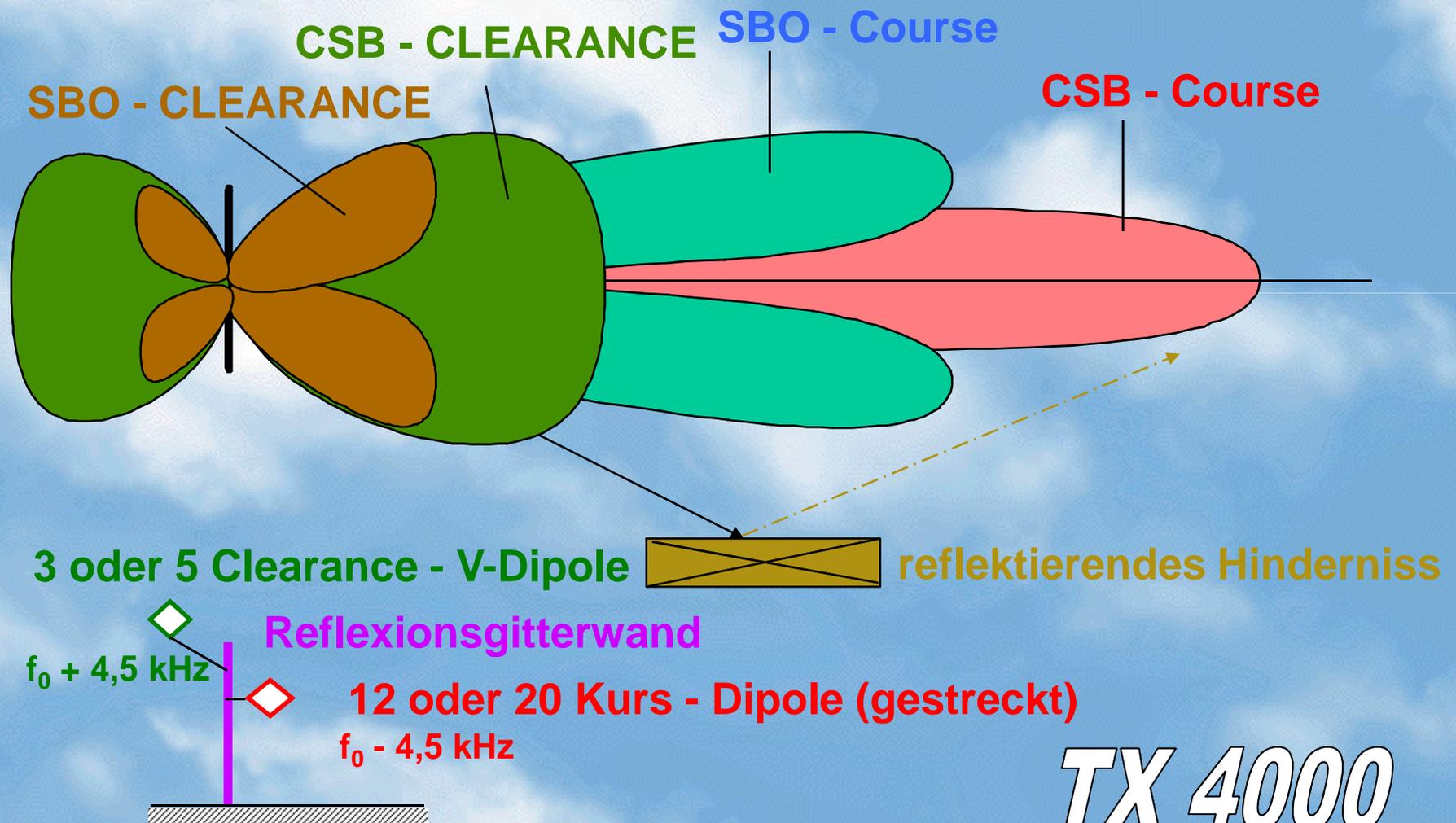
$$U_R = kA_\delta [1 + m_\delta \cos \omega_{90} t + m_\delta \cos \omega_{150} t] * \cos (\Omega t + \psi_R)$$

Reflektor

**Messantenne für bends-Erfassung
(LLZ-Kurslinie auf der Bahn)
Typ: V-Ring**



2F-Landekurs Landesysteme



TX 4000

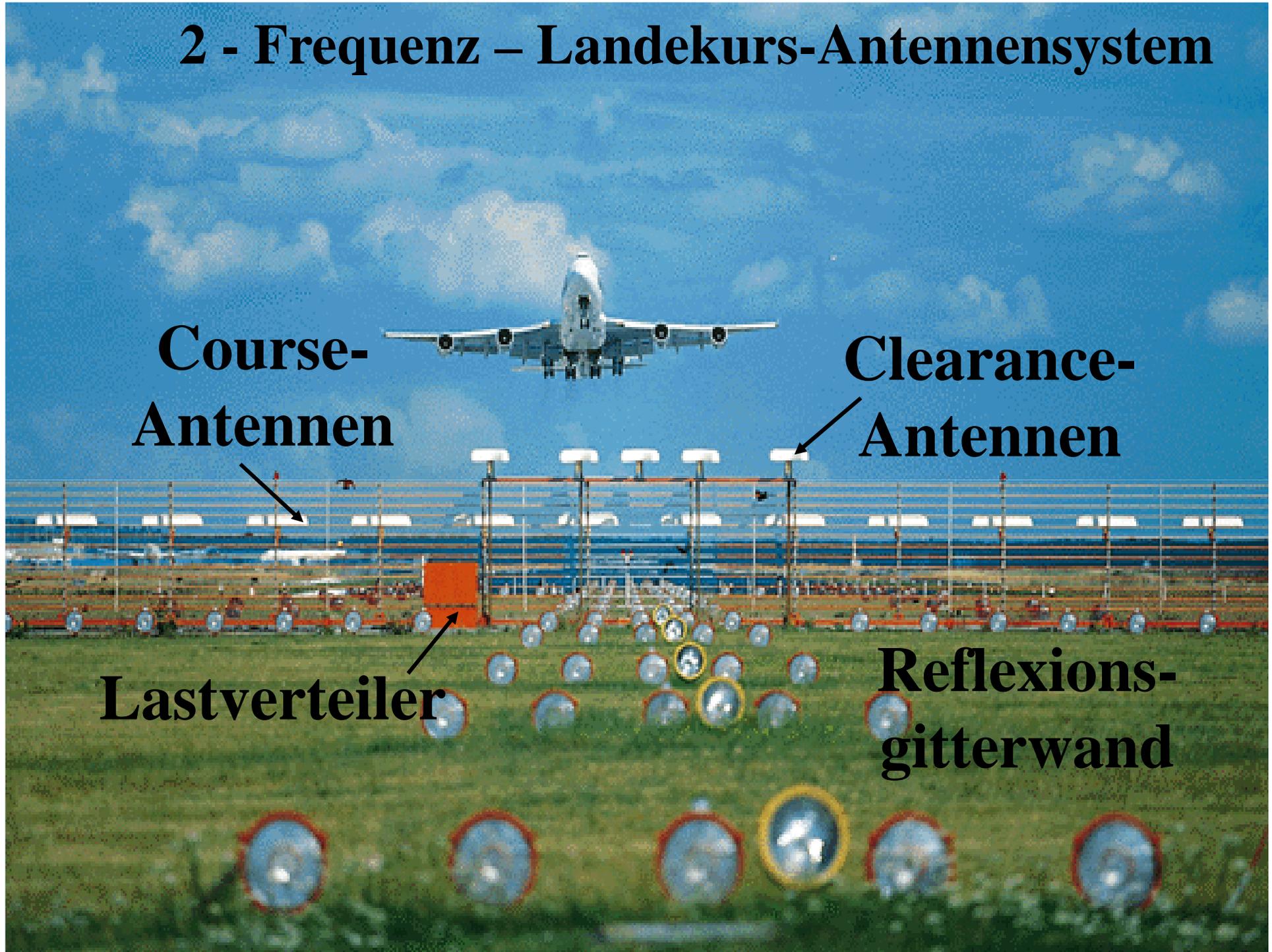
2 - Frequenz – Landekurs-Antennensystem

**Course-
Antennen**

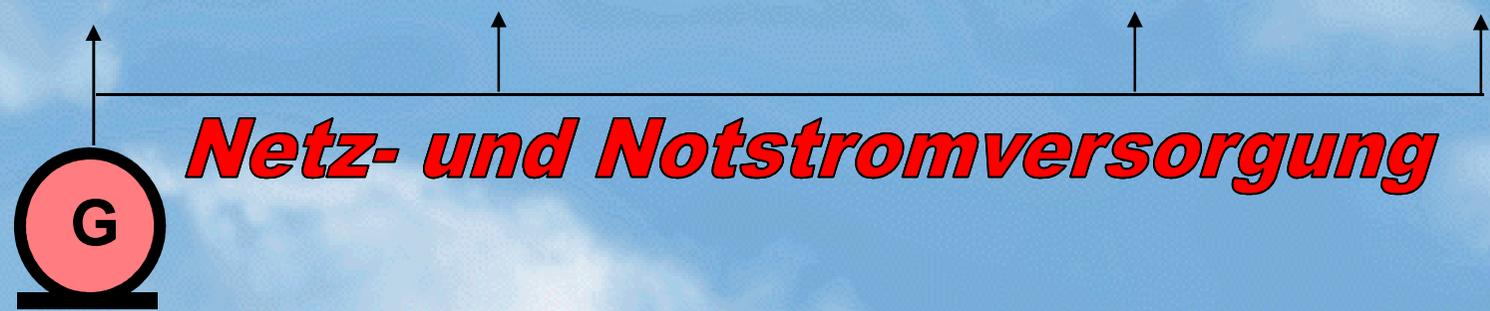
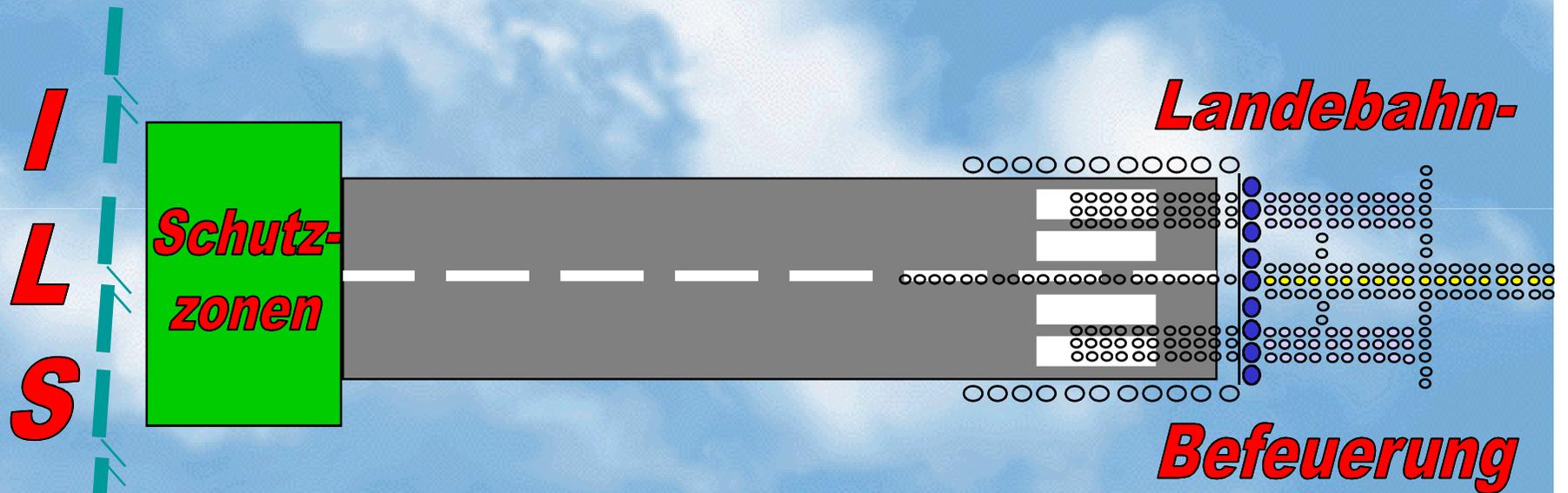
**Clearance-
Antennen**

Lastverteiler

**Reflexions-
gitterwand**

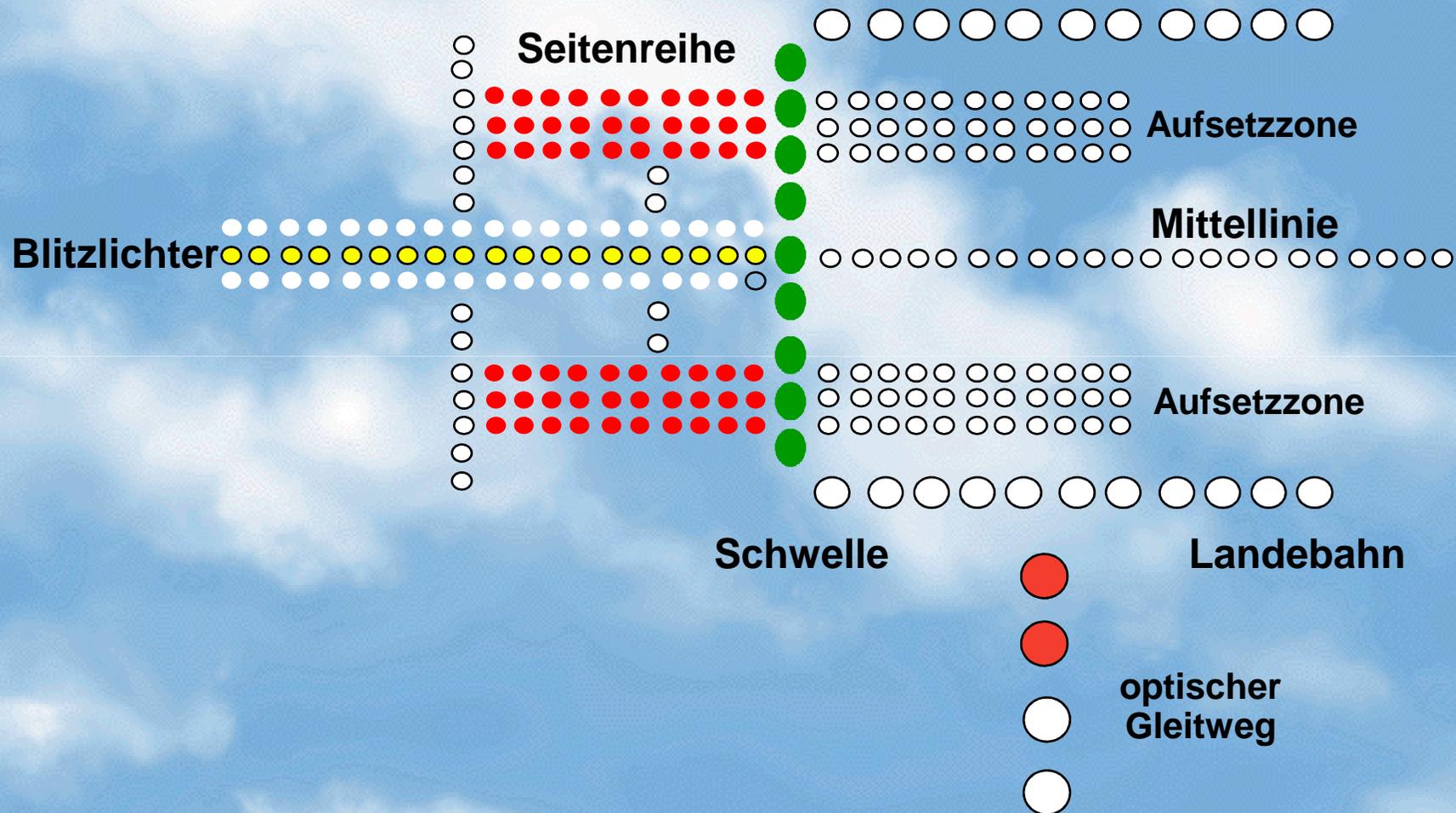


Allwetter-Flugbetrieb Landesysteme



Landesysteme

Landebahn-Befeuerung



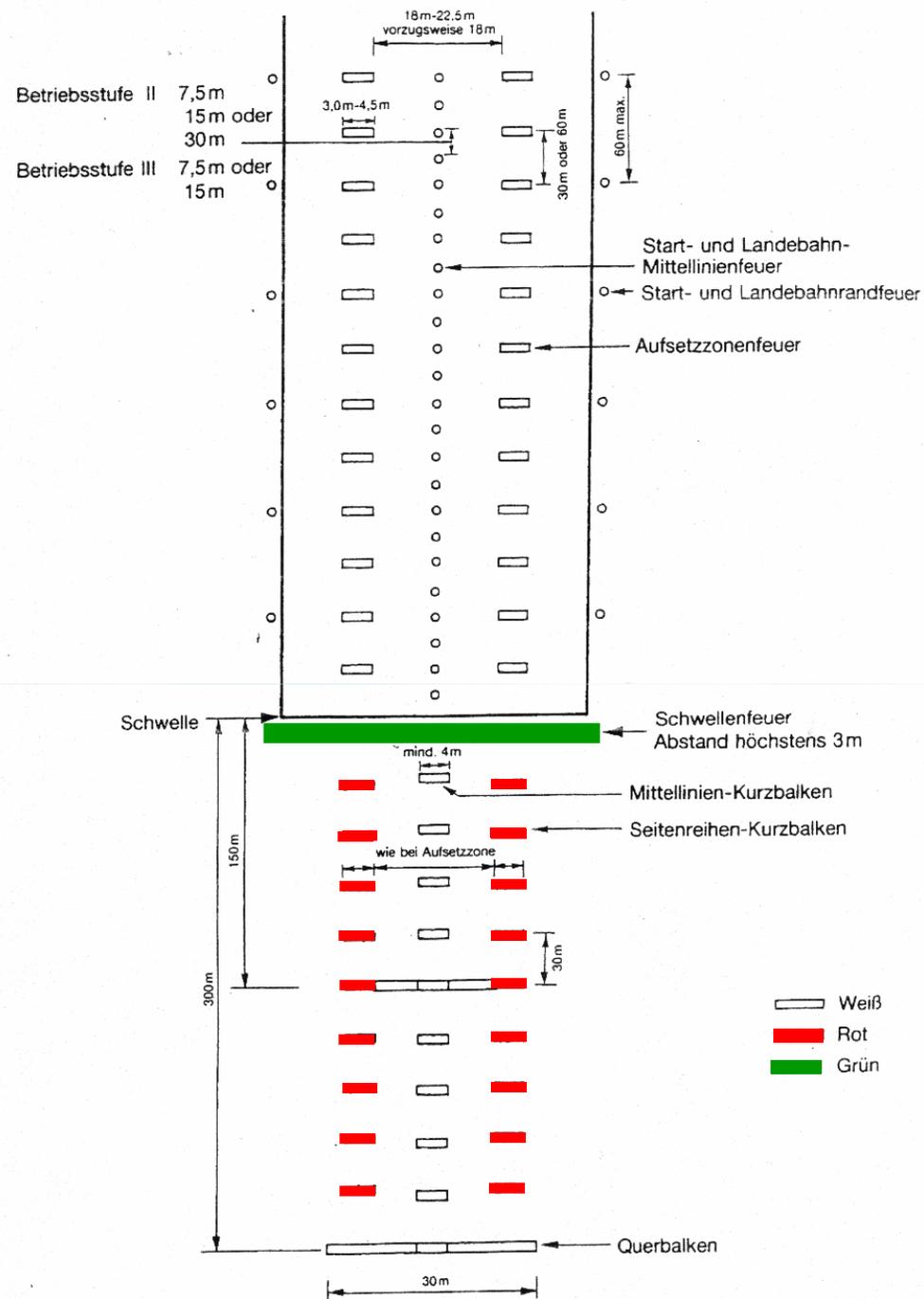
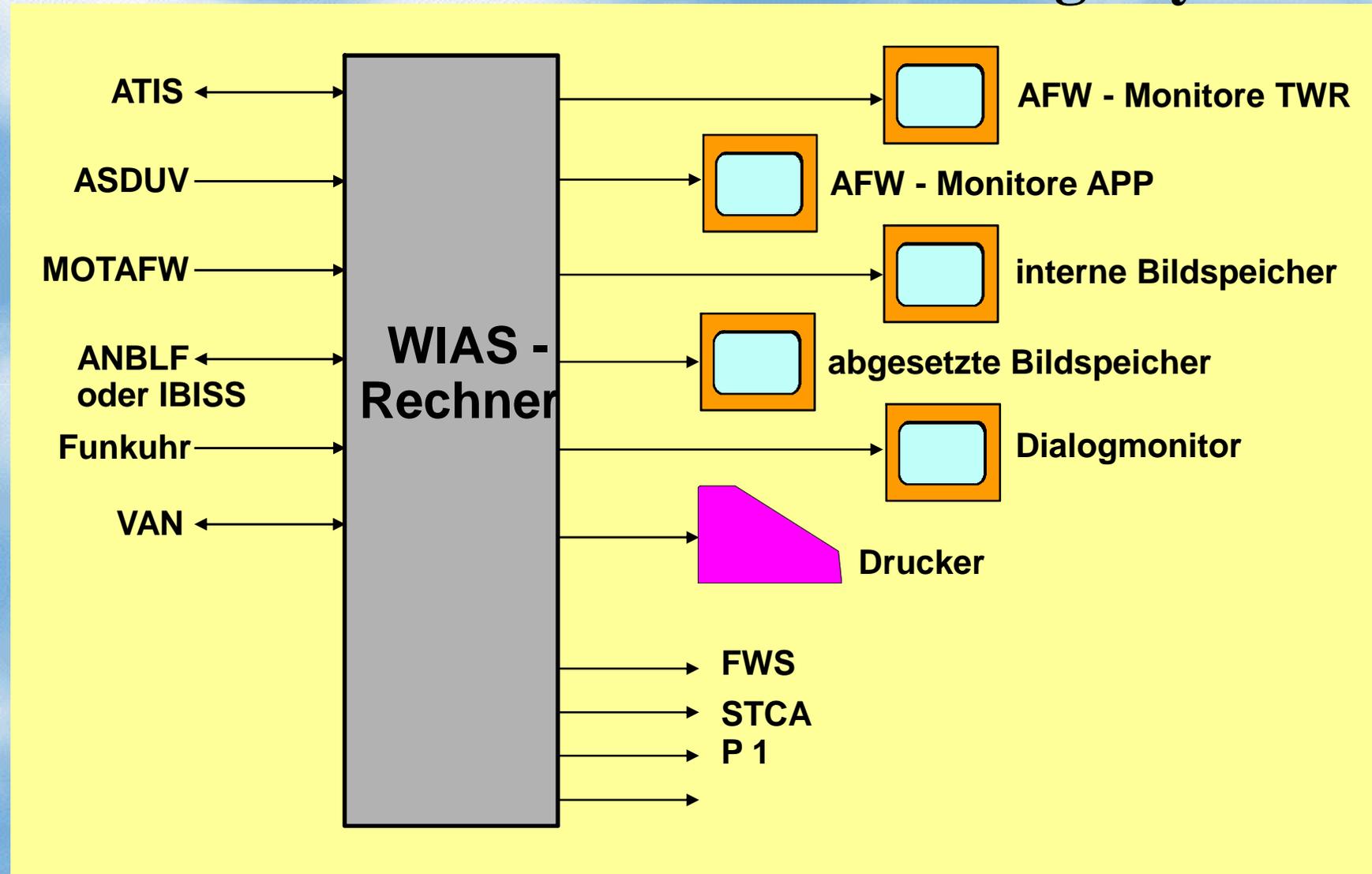


Abb. 6-7 Anflugbefeuerung für Landebahnen der Betriebsstufen II und III [70]

Landesysteme

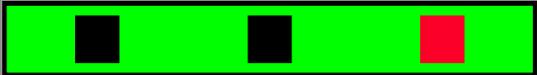
Wetter- und Informations-Anzeige System



WIAS AFW-Bild

Richtung Geschwindigkeit

b) →	C 300	3		280	4	A ←	c)
d) →	280-310	1-4	Tendenz	250-310	2-5	←	e)
f) →	18: - 2	3		07: - 3	2	25: 3 2	

RVR	↓	BA3	BA1	Good	Poor	Medium	←	h)
	18		RVR	F 250	E 300	D 500 ↓	←	i)
G 400		Poor	g)				25R ←	a)
				BS III				
H 350		Poor	BA2	30	34	36		
			RVR	C 200	B 250	A 400 ↑		
I 300		Good					25L ←	
			LZR	BS II weil kein LLZ-Reservesender				

k) →	998	QNH	UTC	153800	←	l)
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Landesysteme Gleitweg



Gleitweg



Landesysteme Gleitweg

Coverage/DOC:

ILS-LOC

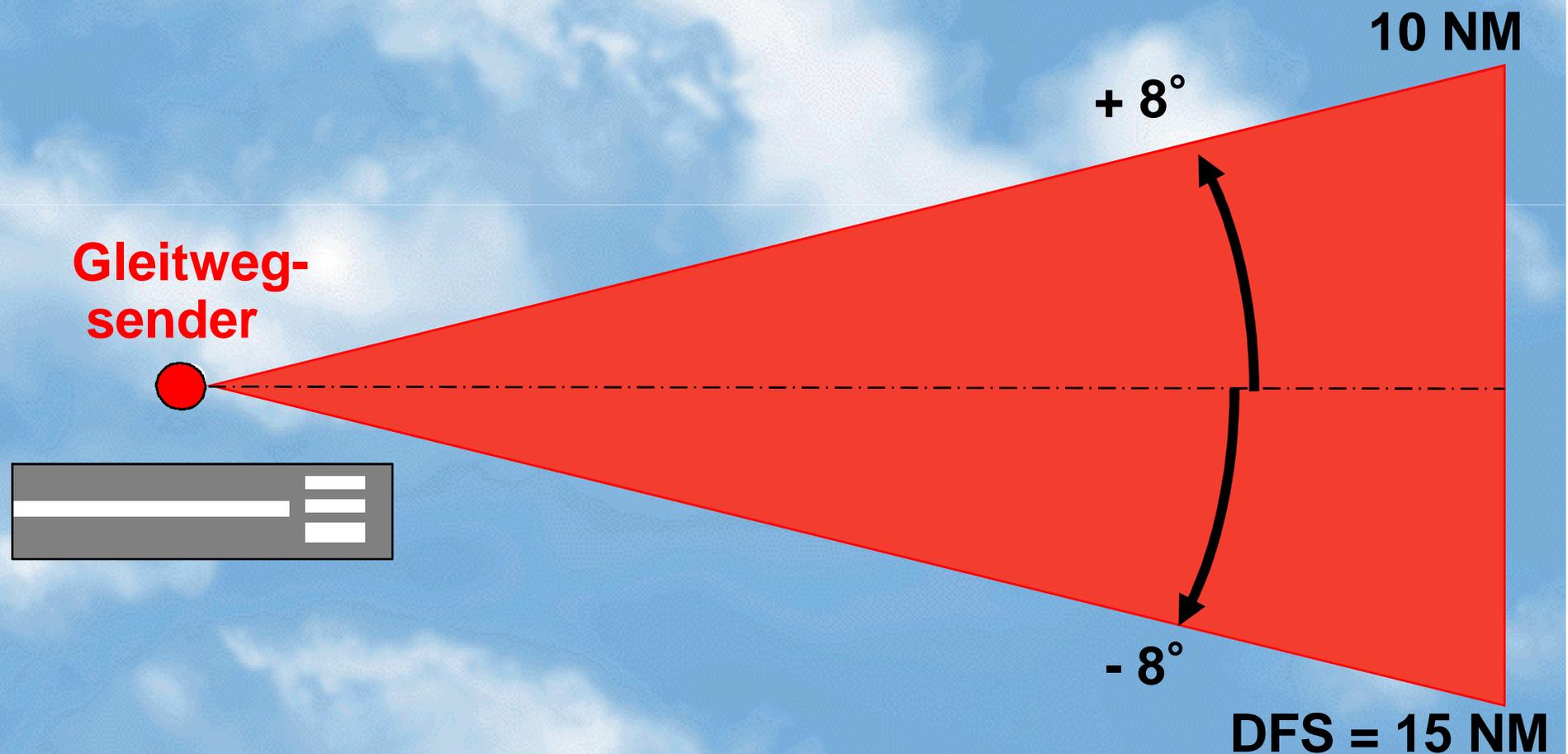
required field strength varies with category (ICAO Annex10)

25NM $\pm 10^\circ$ in front course line, within a height of 6,250 feet and for clearance,

17NM $\pm 35^\circ$ front course line.

ILS-GP

≥ 10 NM $\pm 8^\circ$



Landesysteme

DDM - Verlauf

DDM = 17,5 %
5 Punkte unten
- 150 μ A

Messbarer asymptotischer
Gleitweg zum Antennen-Fusspunkt



$m_{90} > m_{150}$



DDM = 0
 $m_{90} = m_{150}$

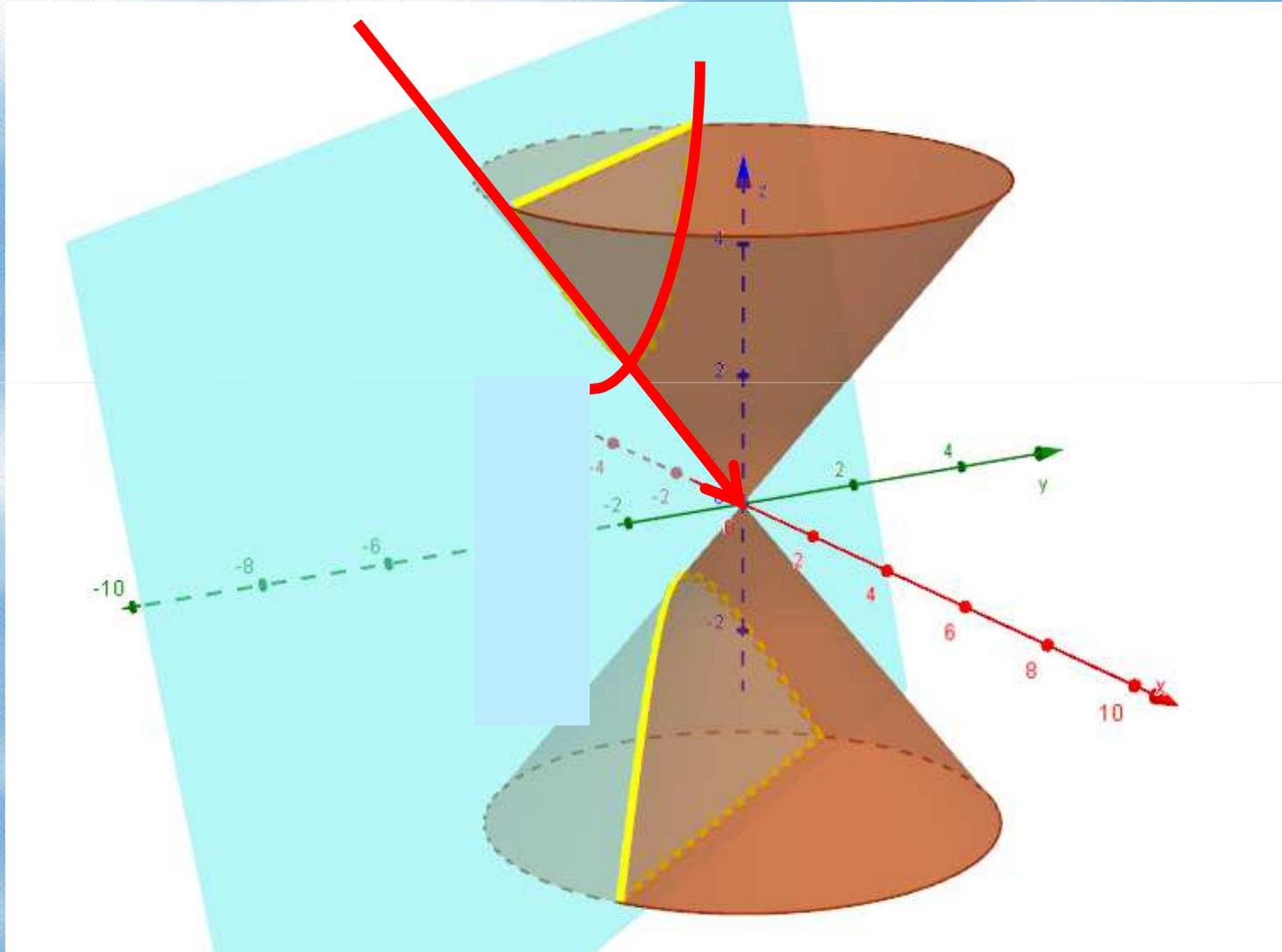


$m_{90} < m_{150}$

DDM = 17,5 %
5 Punkte oben
+ 150 μ A

Schwelle

Landesysteme **DDM - Verlauf**



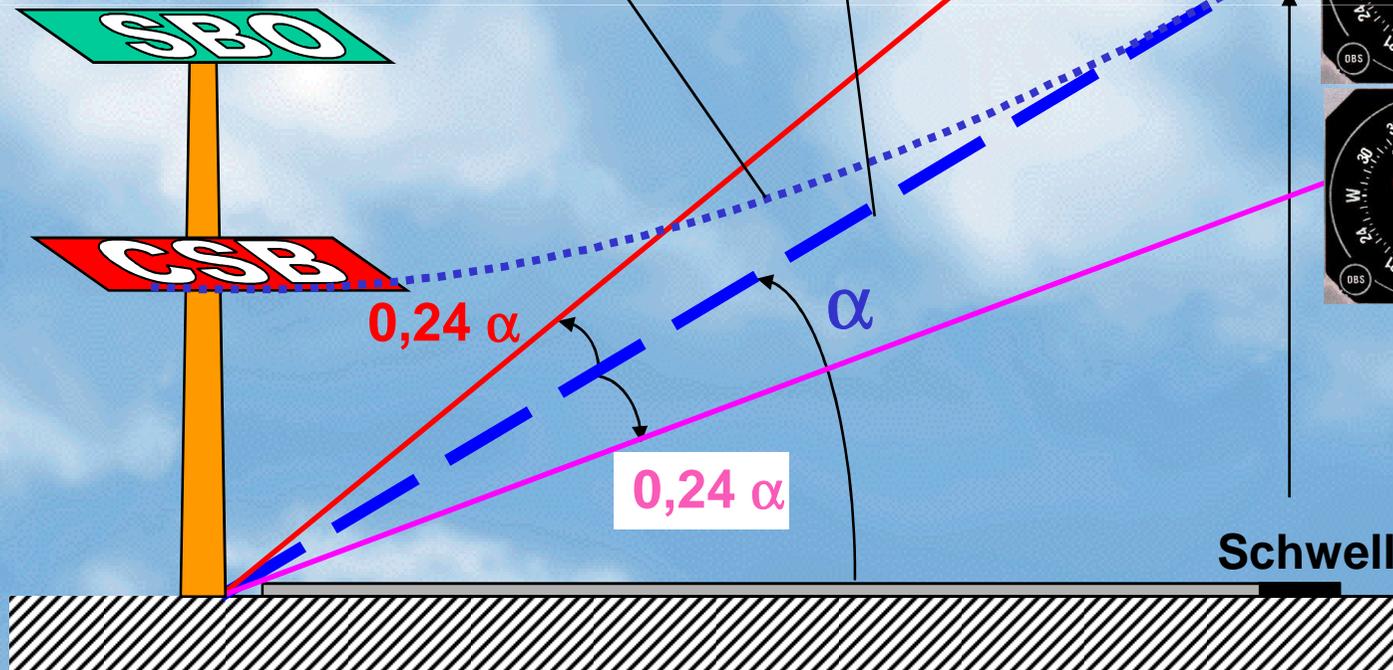
Landesysteme

DDM - Verlauf

DDM = 17,5 %
5 Punkte unten
- 150 μ A

Messbarer asymptotischer
Gleitweg zum Antennen-Fusspunkt

tatsächlicher hyperbolischer
Gleitweg über der Landebahn



$m_{90} > m_{150}$



DDM = 0
 $m_{90} = m_{150}$



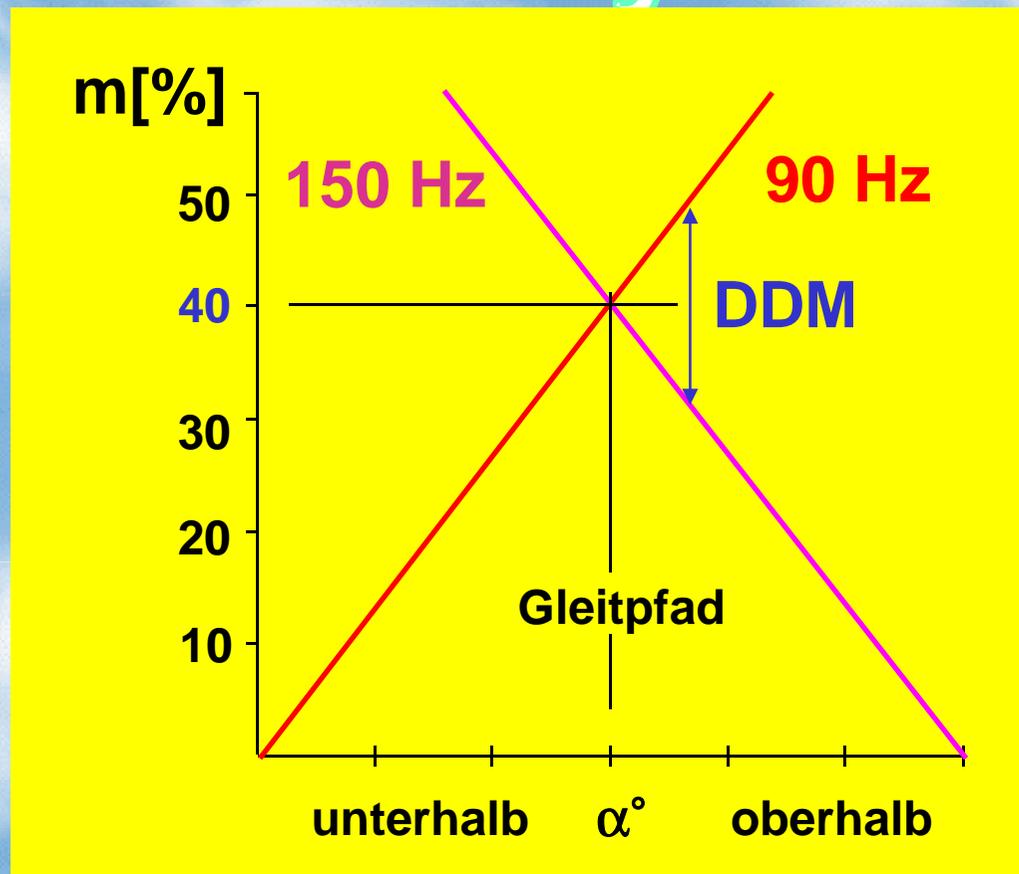
$m_{90} < m_{150}$

DDM = 17,5 %
5 Punkte oben
+ 150 μ A

Schwelle

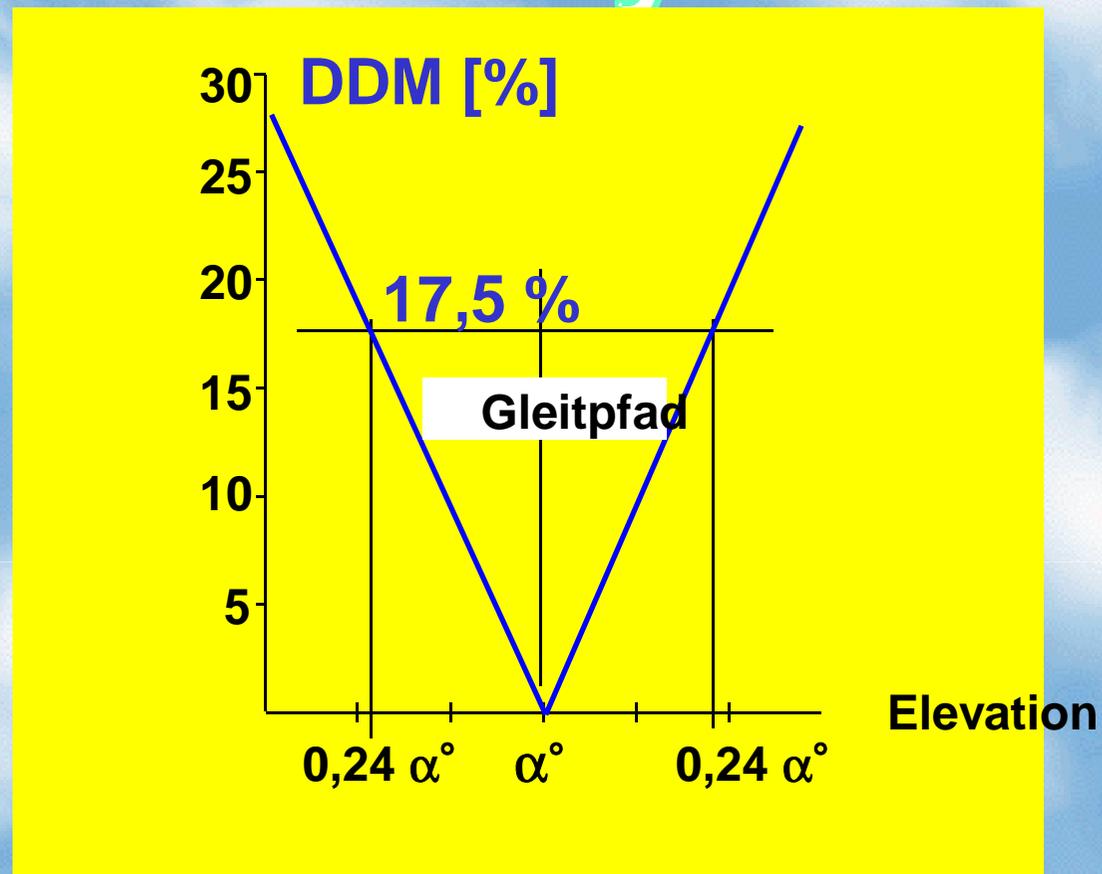
Landesysteme

Modgrad - Verlauf



Landesysteme

DDM - Verlauf



Landesysteme

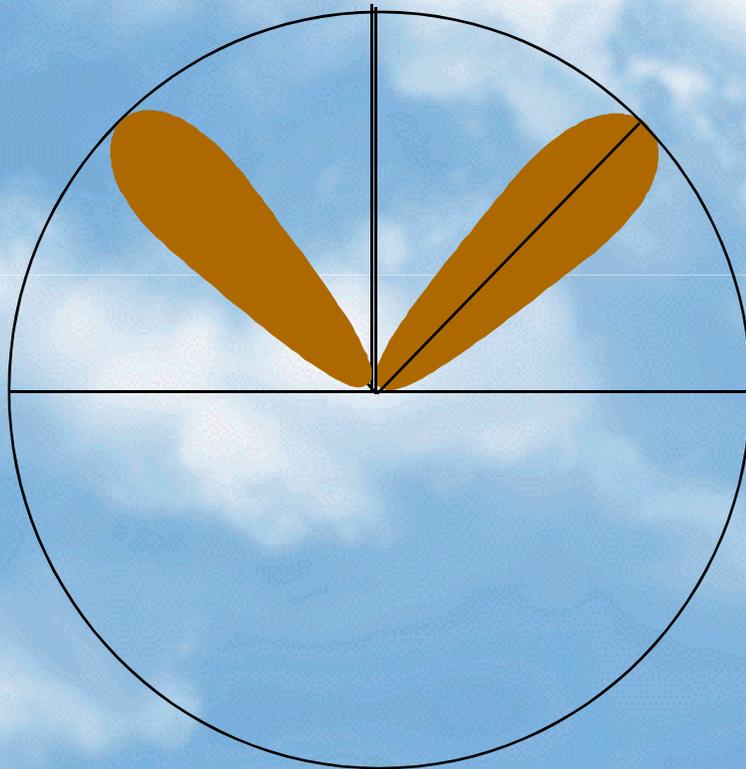
Punkte	μA	DDM	ΔGrad
0	0	0	0
1	30	0,035	0,144
2	60	0,07	0,288
3	90	0,105	0,432
4	120	0,140	0,576
5	150	0,175	0,720



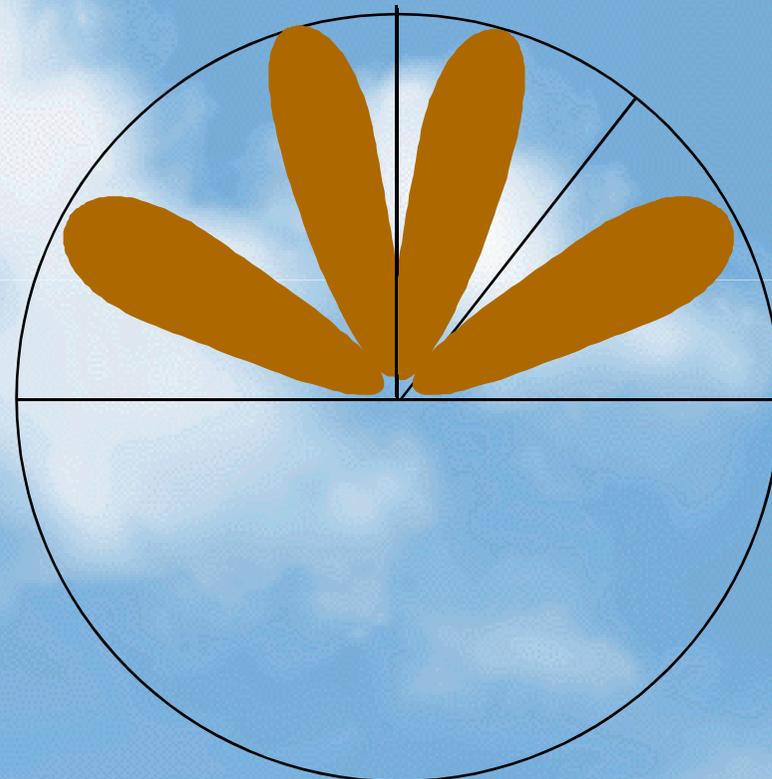
Landesysteme

Gleitweg - Bildung

$$h = \lambda/2$$



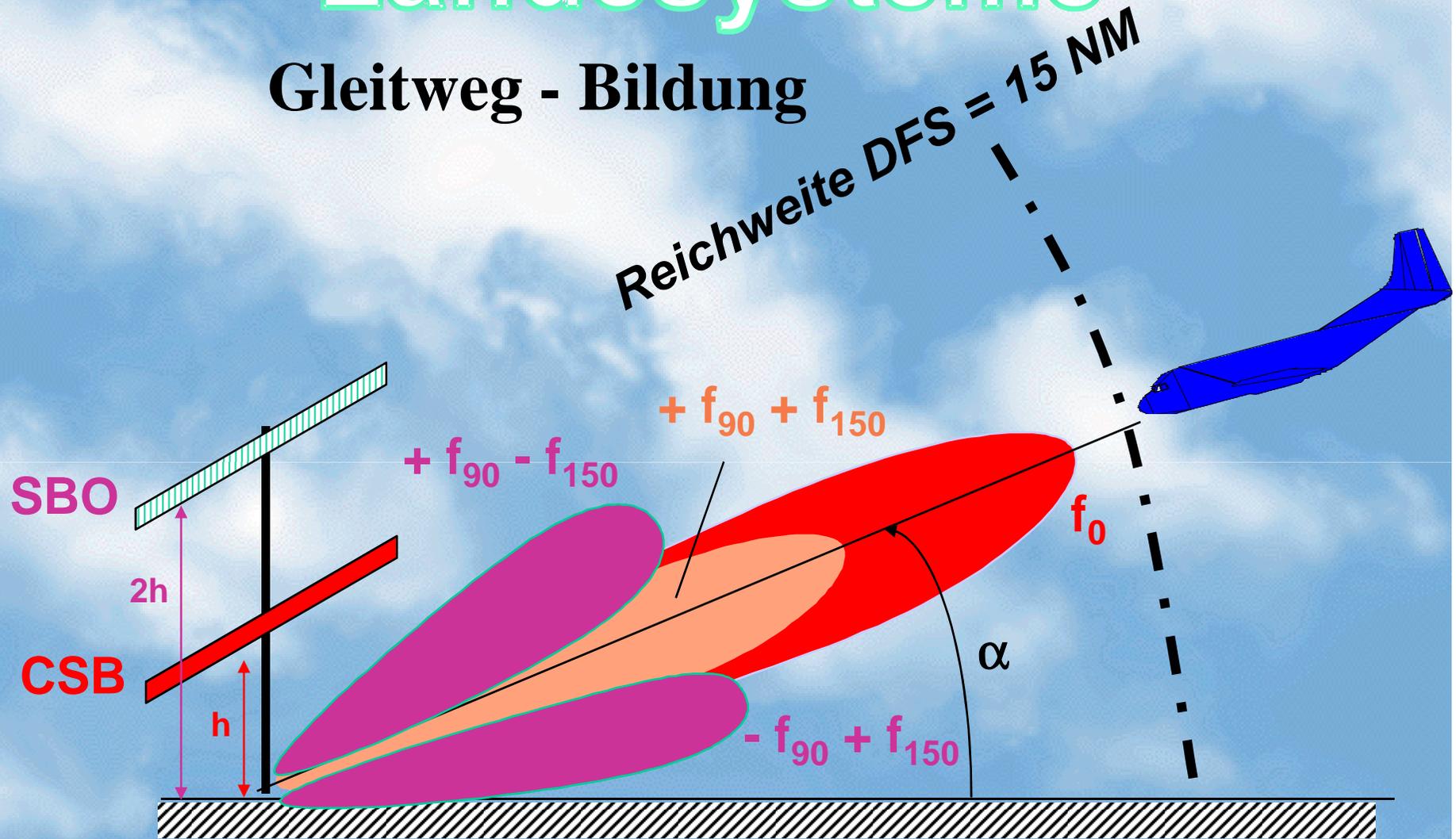
$$h = \lambda$$



Pro $\lambda/2$ – Höhe pro Quadrant eine Keule

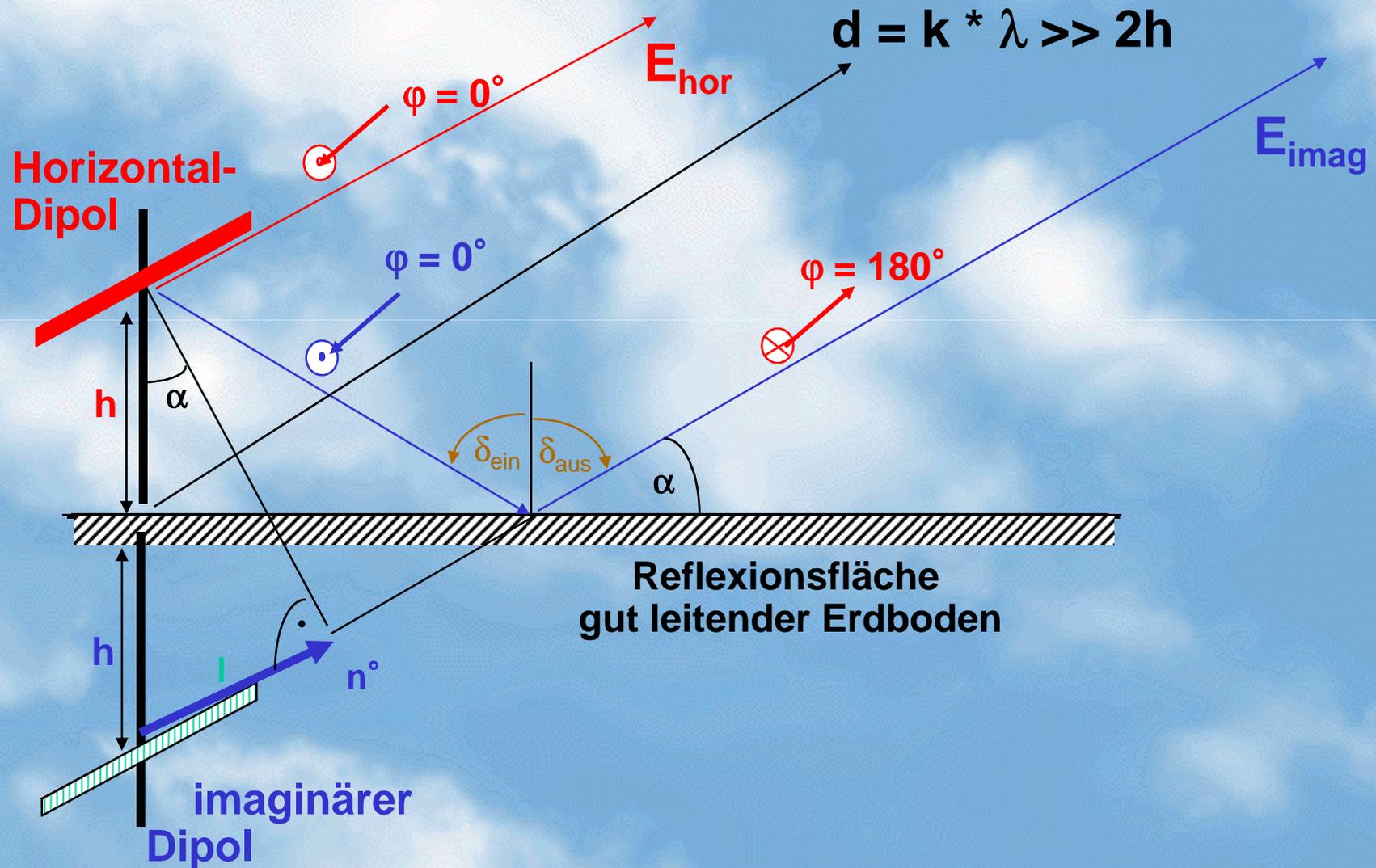
Landesysteme

Gleitweg - Bildung

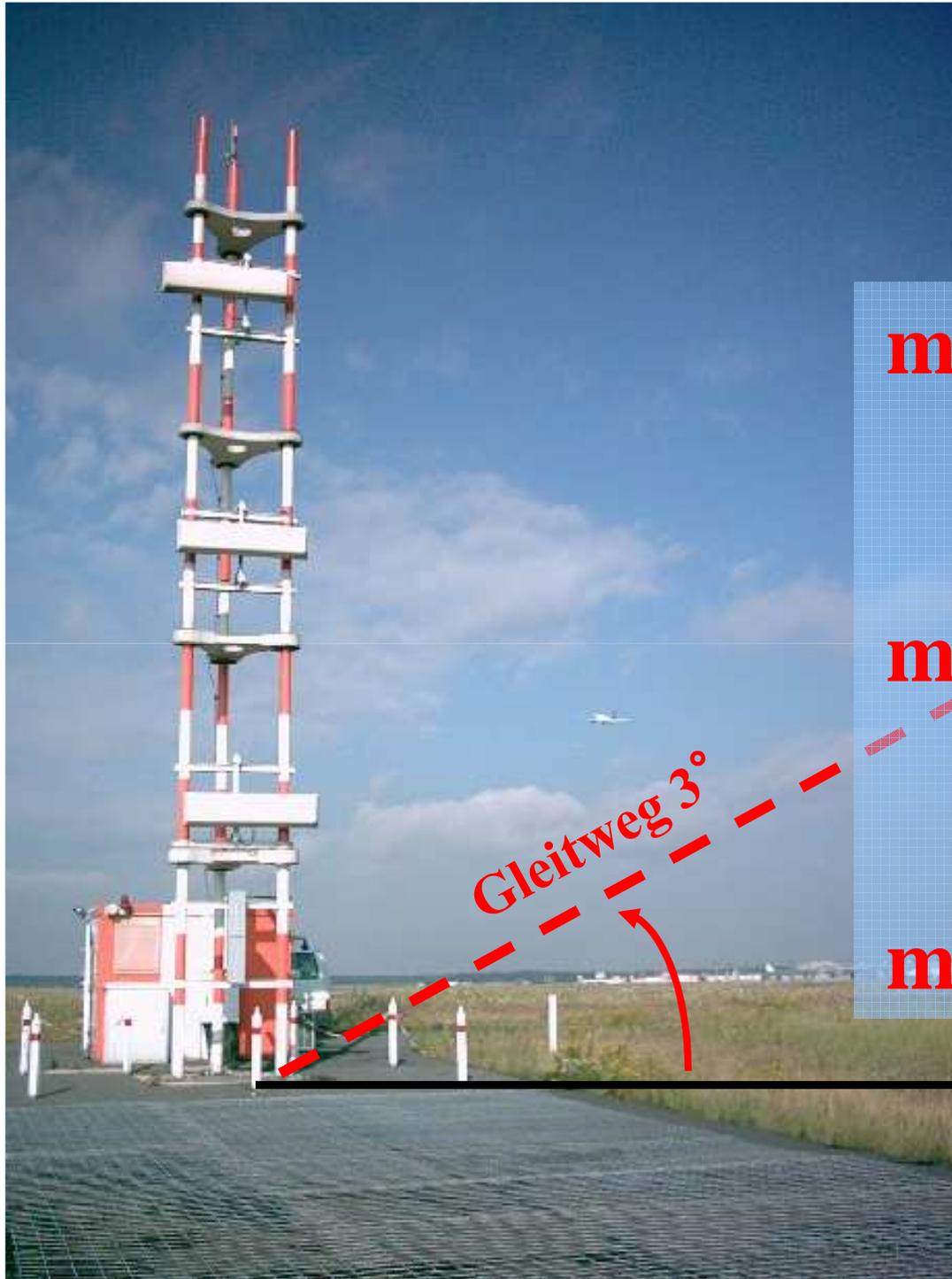


Landesysteme

Gleitweg - Bildung



steme



$$m_{90} > m_{150}$$

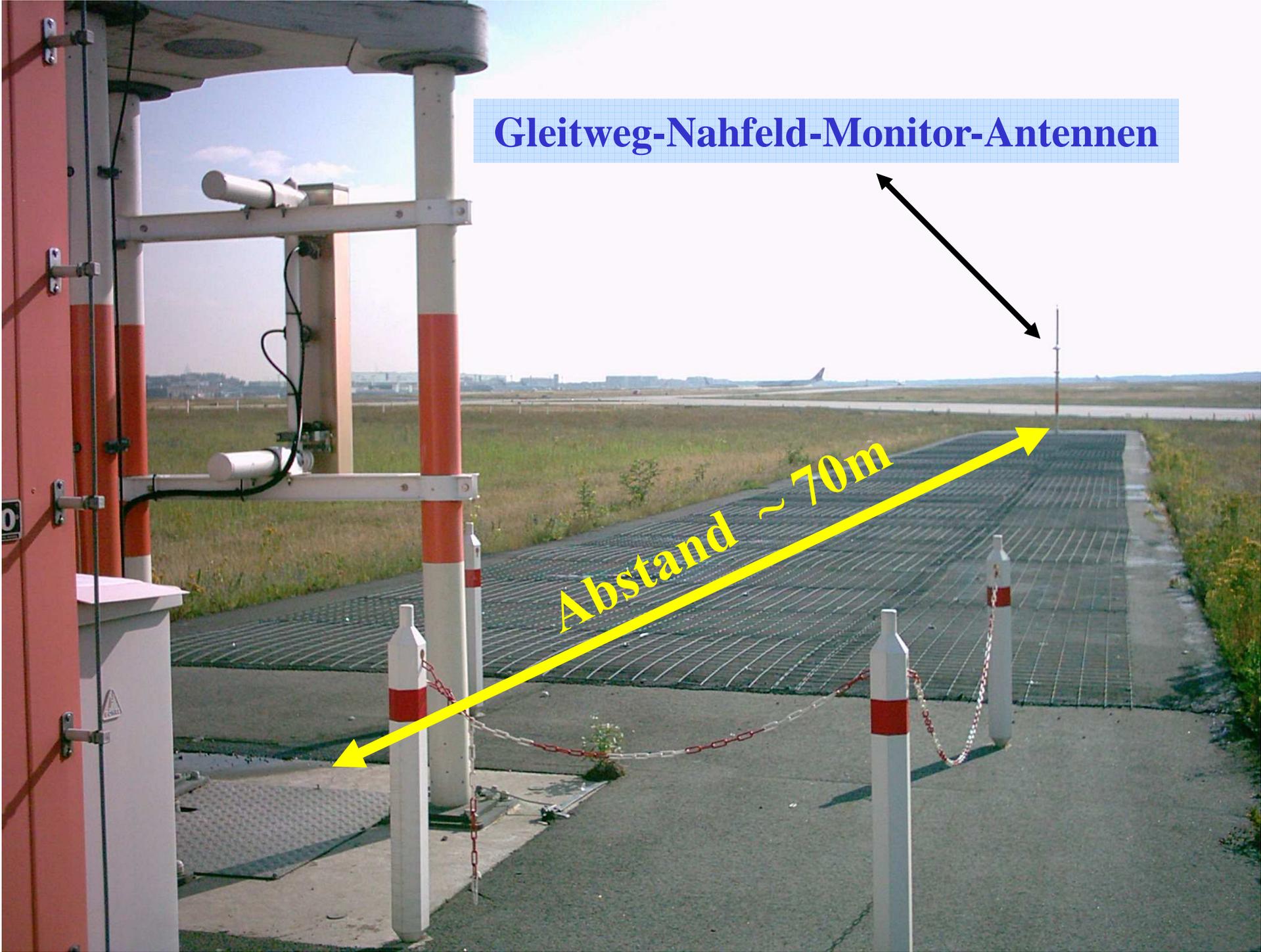
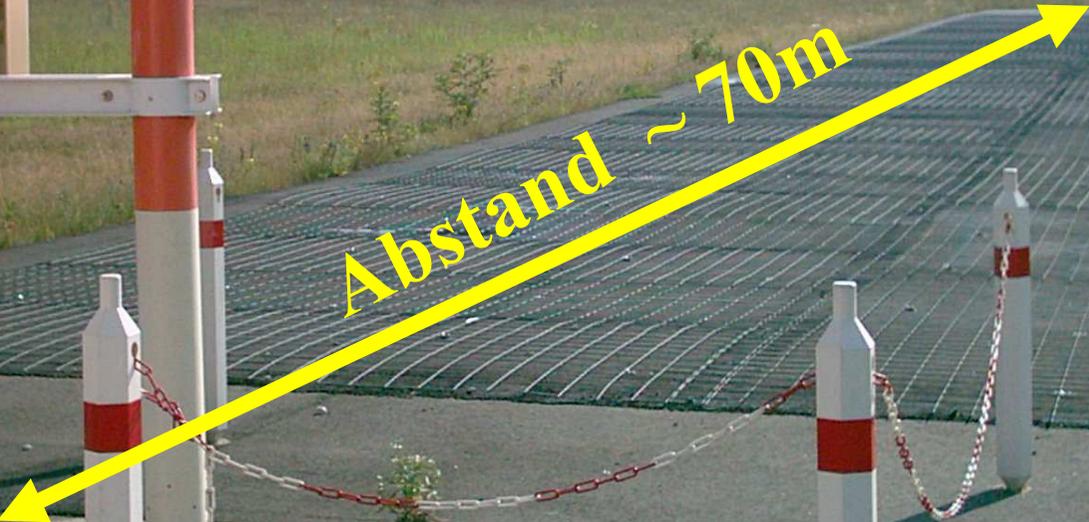
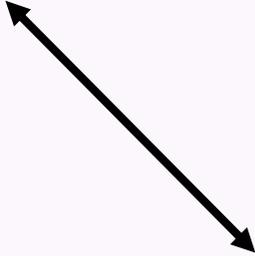
$$m_{90} = m_{150}$$

$$m_{90} < m_{150}$$

DDM = 0

Gleitweg 3°

Gleitweg-Nahfeld-Monitor-Antennen

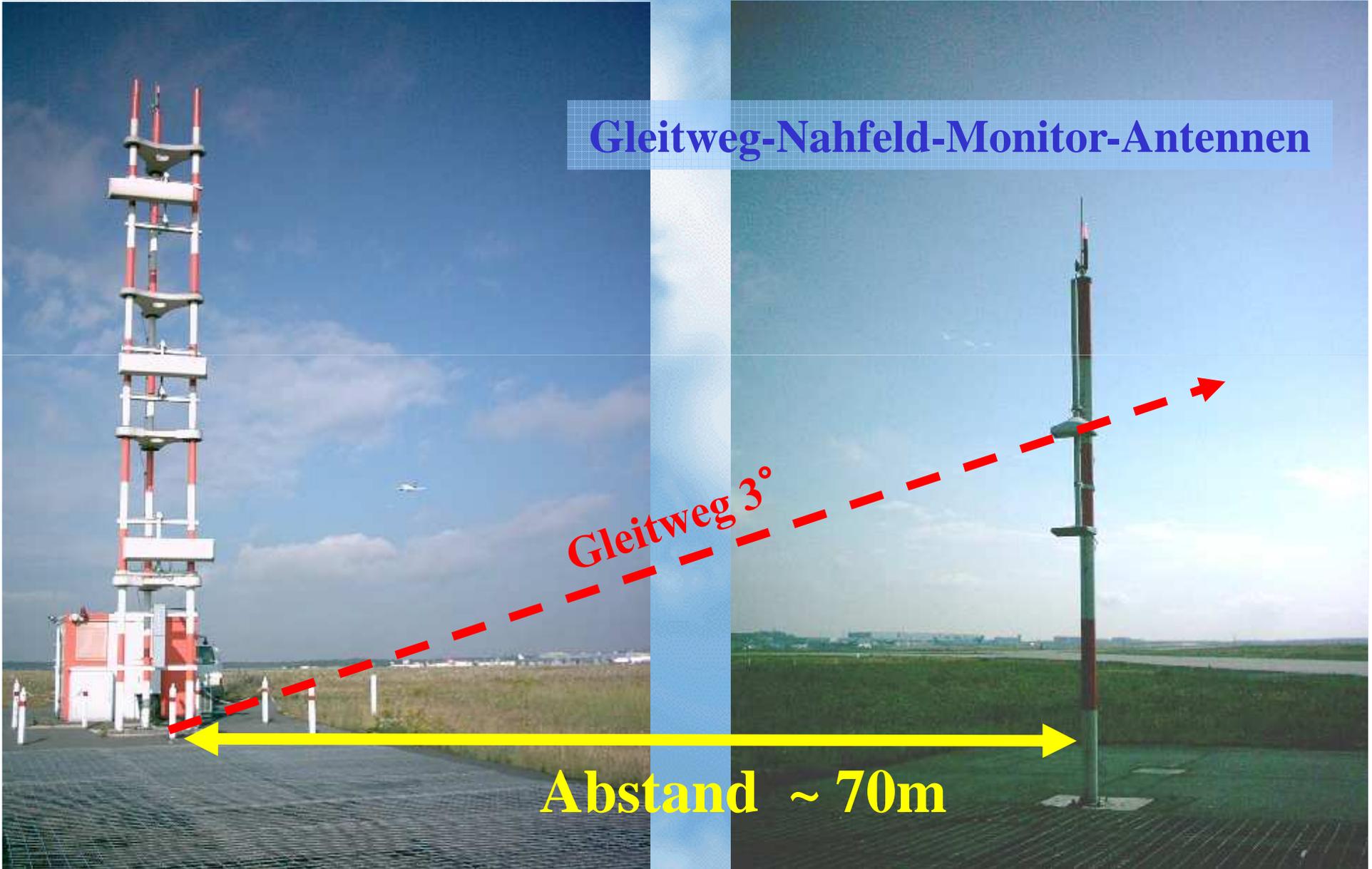


Landesysteme

Gleitweg-Nahfeld-Monitor-Antennen

Gleitweg 3°

Abstand $\sim 70\text{m}$

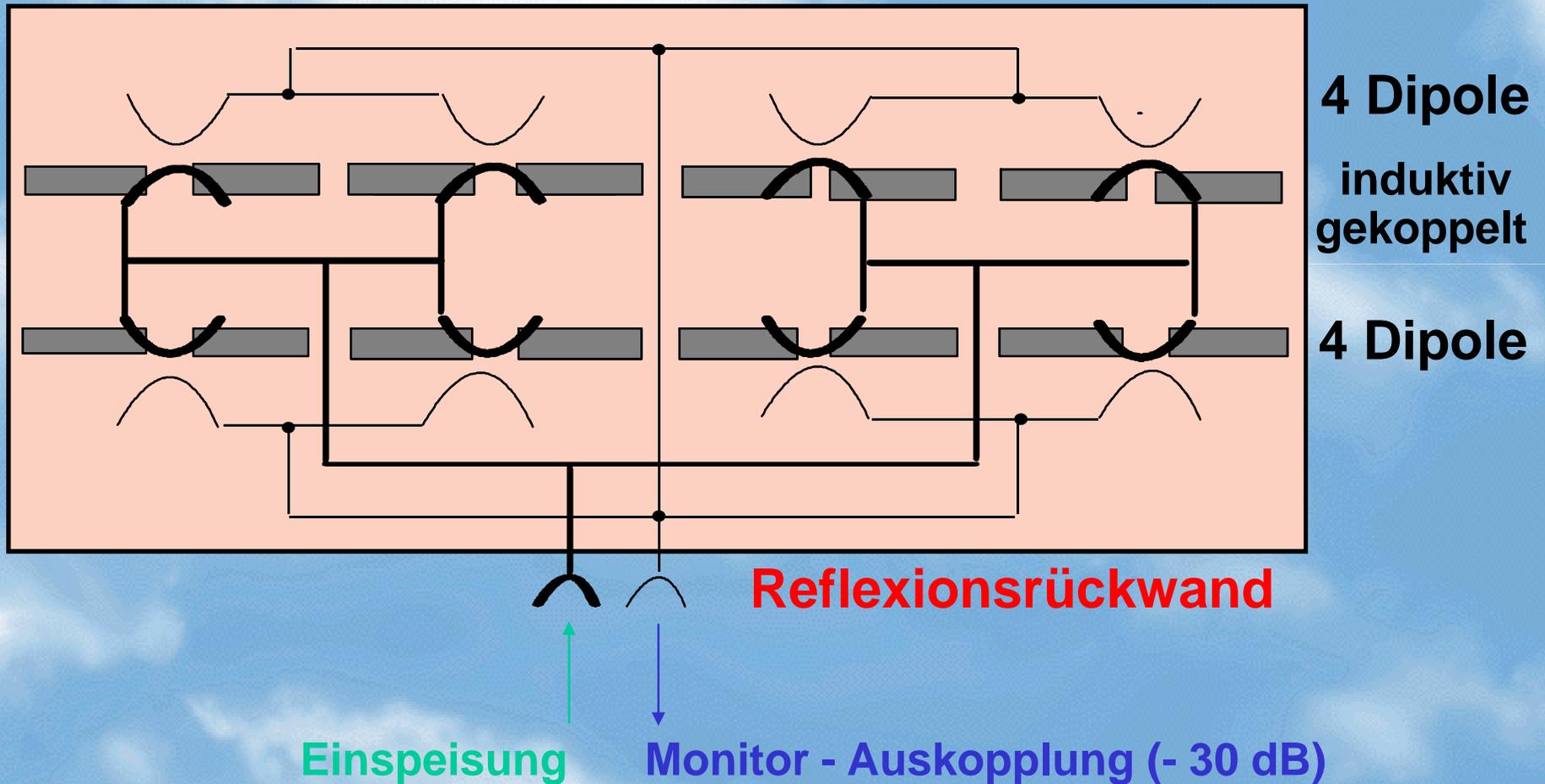




**geerdete Gleitweg-Reflexionsfläche
für stabile Monitor-Antennensignale
(Reflexionskoeffizient $k = \text{const.}$)**

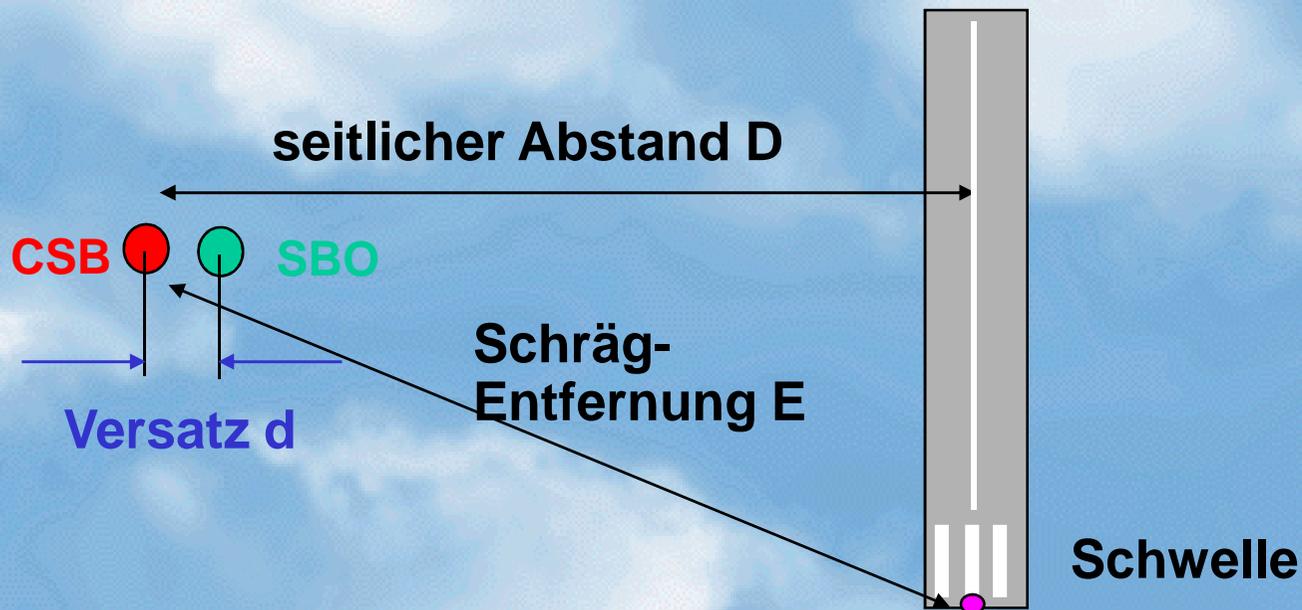
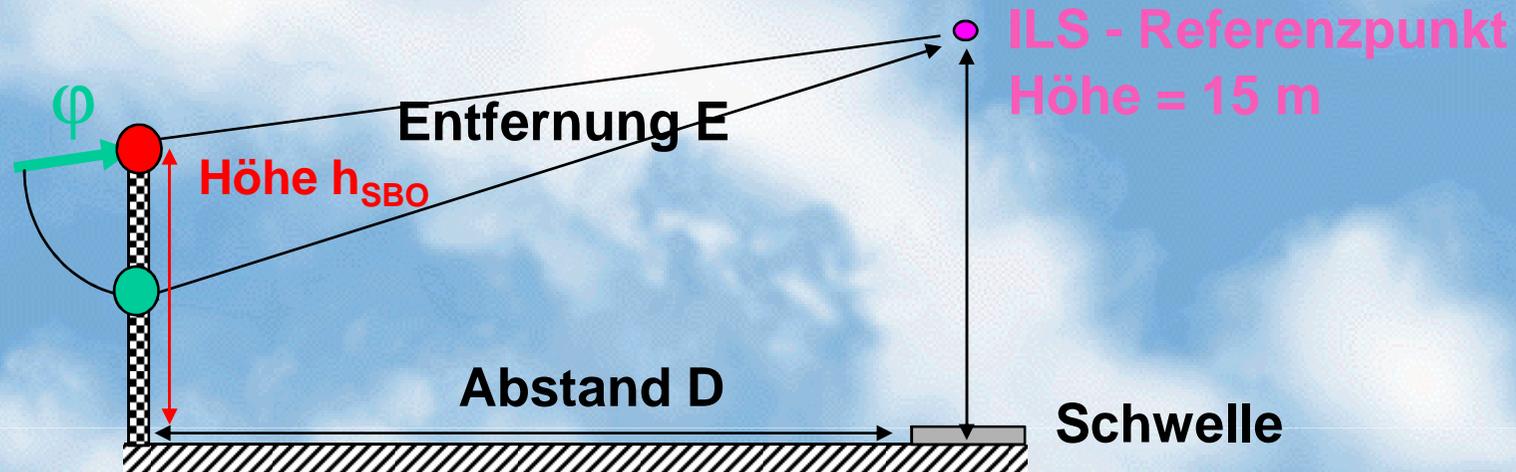
Landesysteme

Gleitweg - Dipolkombinationsantenne



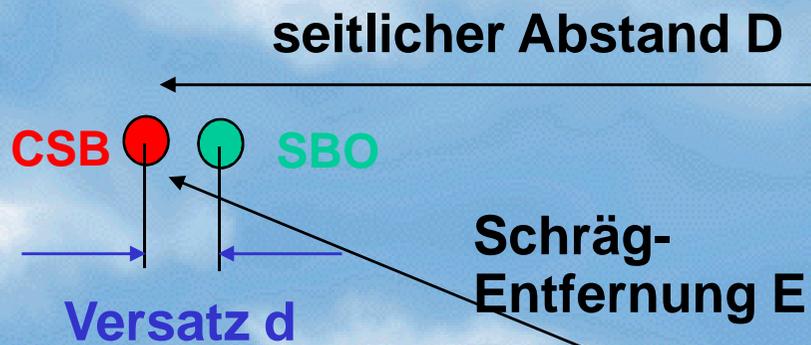
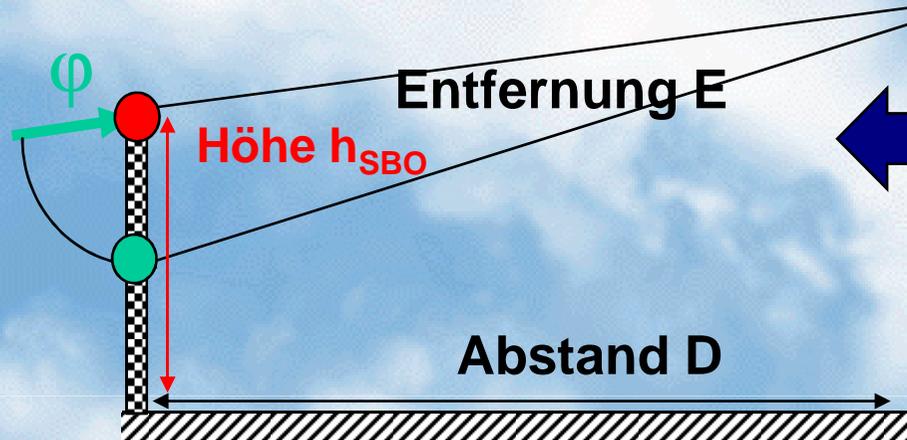
Landesysteme

Dipole - Anordnung



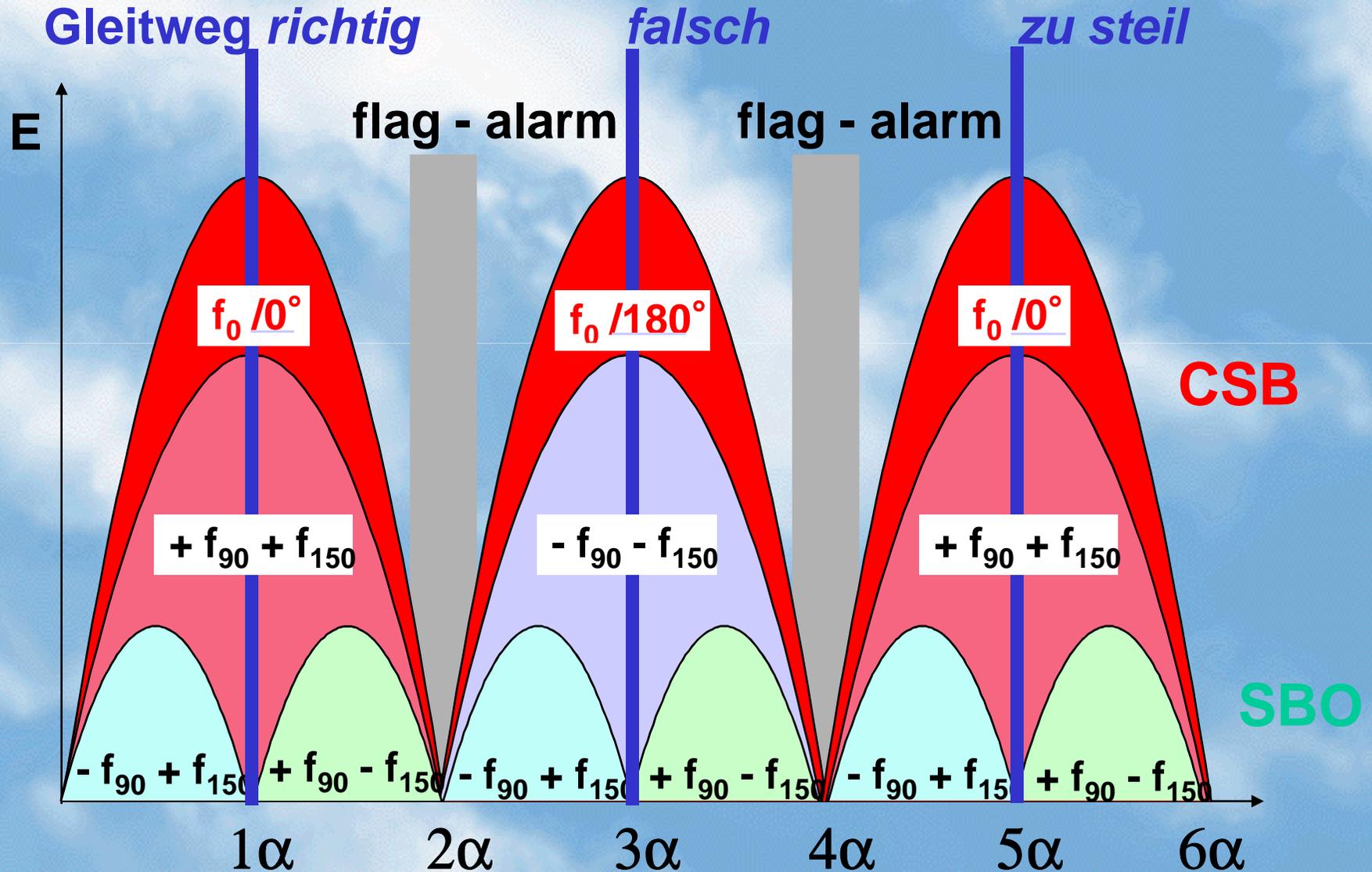
Landesysteme

Dipole - Anordnung

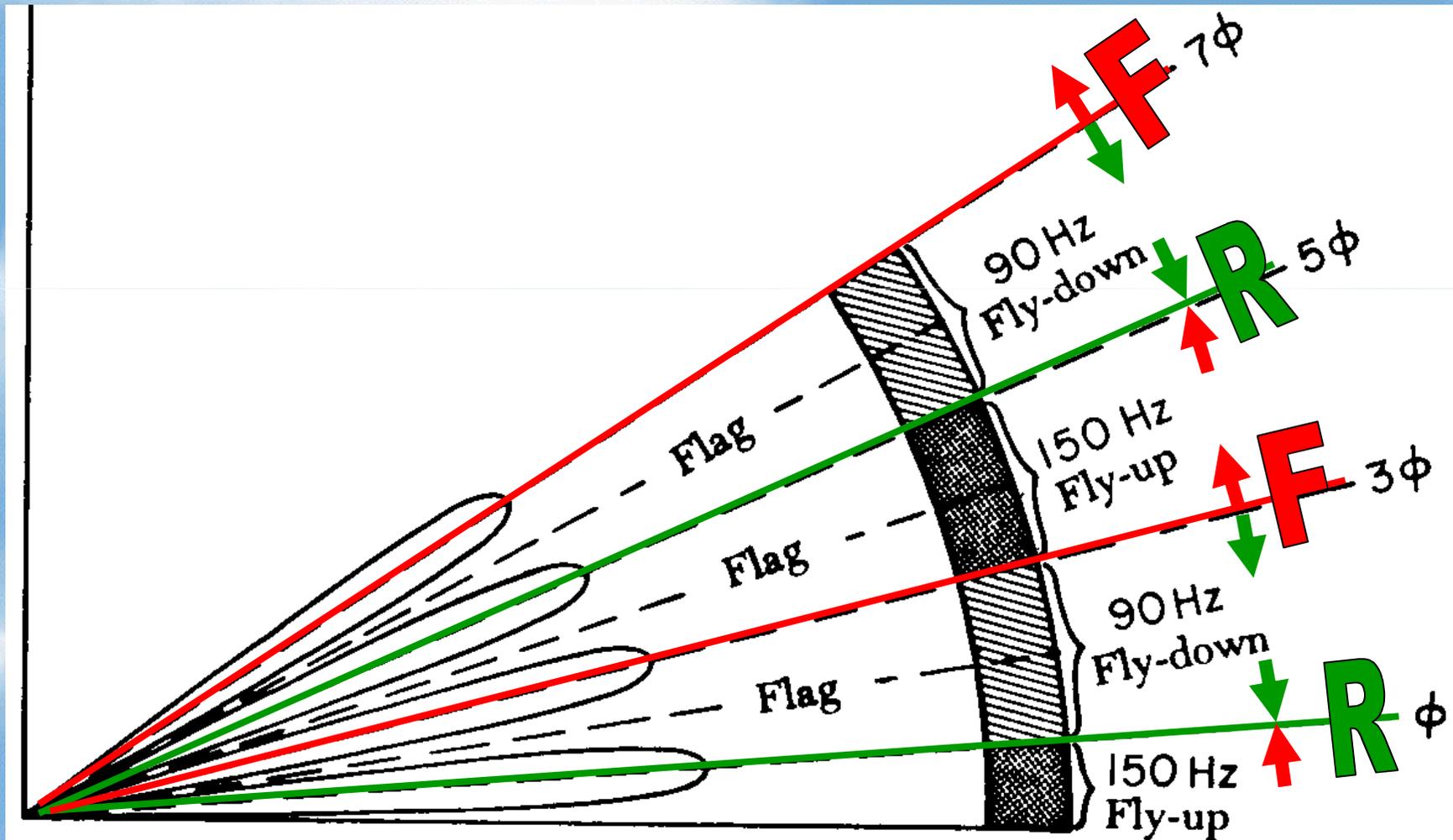


Landesysteme

Gleitwege-Bildung



Landesysteme





$$\Delta h \sim \Delta f$$



Landehöhenmesser

LRRA = Low Range Radio Altimeter

$$0 < H < 2500 \text{ ft}$$

FM-CW-Dopplerradar-Prinzip
mit dreieckförmiger Frequenzmodulation

$$f_s = 4,25 \text{ GHz}$$

$$\Delta f = 100 \text{ MHz (Hubfrequenz)}$$

Landesysteme

Optischer Gleitweg



Einflugzeichen - Sender



systeme

**VEZ / OM und HEZ / MM
mit gleichen Antennen**

Landesy

Einflugzeichen - Sender

**VEZ / OM oft
zusammen mit
einem NDB
als Locator**



NDB-Kennung, hier *LW*

· _ " ' _ _

