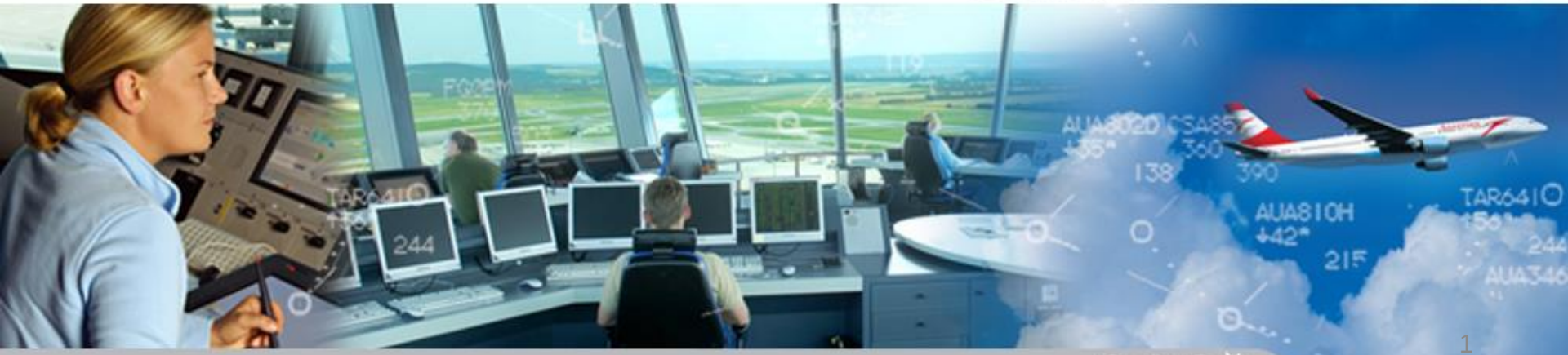
Performance based Navigation RNAV/RNP

Season Opener 2017

Dr. Daniel Schaad
Ilkka Laine
Andreas Kurtz

SICHERHEIT LIEGT IN DER LUFT



PBN
Performance based navigation

UL TL-2000 Sting

Cirrus SR22

UL 3Xtrim

Paradigmenwechsel

Aquila A210

C172

a. GNSS - SBAS

- GNSS Anbieter
- System SBAS / GBAS

GNSS
Global Satellite Navigation System

ENR 4.3 GLOBALES SATELLITENNAVIGATIONSSYSTEM (GNSS)

ENR 4.3 GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS)

GPS	1575.42 MHZ 1176.45 MHZ	Landesweit / Statewide	En-Route, Terminal und Anflug-Verfahren. Betreiber: U.S. Air Force / En-Route, terminal and approach procedures. Operated by: U.S. Air Force

GNSS
RNP Integrity by Augmentation

GBAS

Source: Honeywell

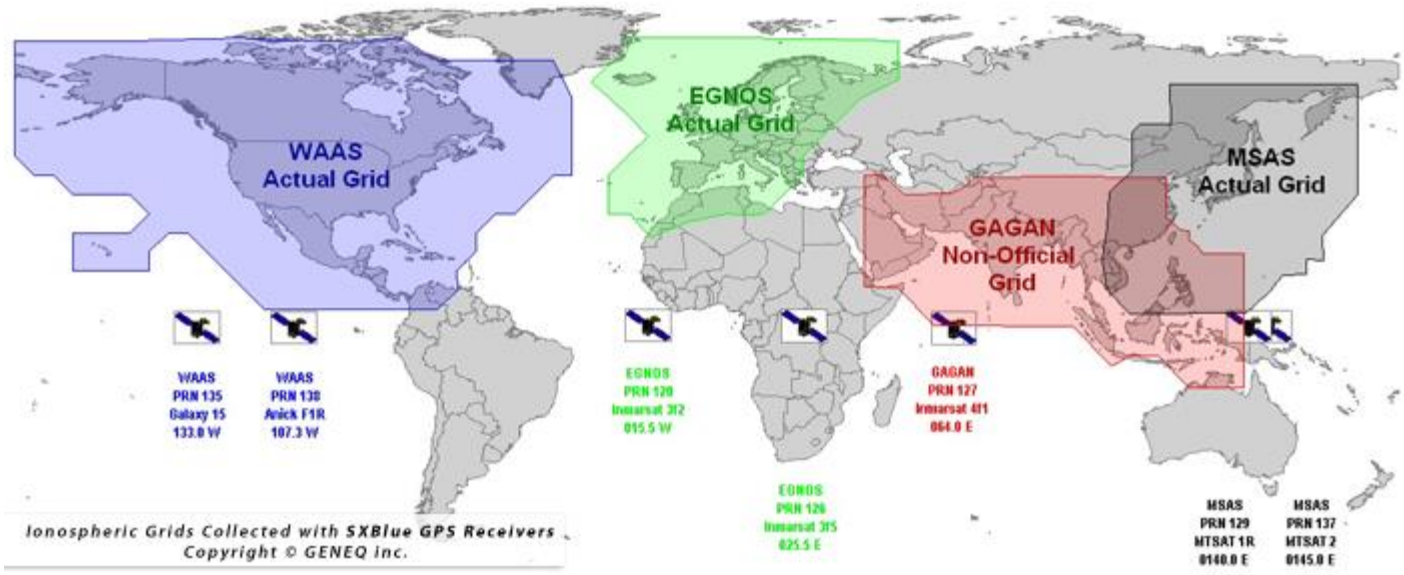
SBAS

Source: SES

ABAS

Source: Cirrus

Performance based navigation
SBAS



Europa:	EGNOS	European Geostationary Navigation overlay system
USA:	WAAS	Wide Area Augmentation System
Japan:	MSAS	Multi-Functional Satellite Augmentation System
Indien:	GAGAN	GPS and Geo Augmented Navigation

Space based Augmentation Systems SBAS

PBN
Performance basd navigation

~~RNP concept (« ICAO RNP manual)~~

PBN concept

Shift from sensor-based to performance-based navigation

ICAO Doc 9613

Fachjargon im Griff?

ICH HABE HEUTE FÜNF MINUTEN ÜBERLEGT, WAS ‚BRATHERING' HEISST... BIS MIR JEMAND GESAGT HAT, DASS ES EIN DEUTSCHES WORT IST!

ADF, NDB, VOR,
INS, Mode C,
IAF, MAPt, …

PBN, RNAV, B-RNAV, P-RNAV, RNP 5, VNAV,
GNSS, Baro-VNAV, LPV, LNAV+V, APV,
RAIM, DGPS, PBN/B2B3C3S2, …

WAAS, SBAS, EGNOS, LAAS, ABAS,
GBAS, ADS-B, ELS, EHS,
2D, 3D, Typ A, Typ B, LPV200, …

b. Basics

- Definitionen durch ICAO u. ECAC
- RNAV/RNP Kategorien
- *EASA Bestimmungen*

Performance based navigation RNAV/RNP

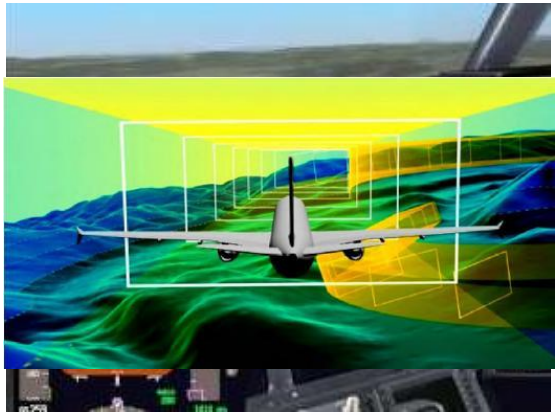
Definition des Luftraumes

Performance	Toleranz	ECAC		ICAO
En-Route	± 5 NM	B-RNAV	=	RNAV5
Terminal	± 1 NM	P-RNAV	≈	RNAV1

Final Approaches: zusätzlich zu klass. Anflügen

RNAV GNSS (RNP 0,3)

RNP (AR) hochpräzise bzw. mit Kurvenfluganteil nach FAF

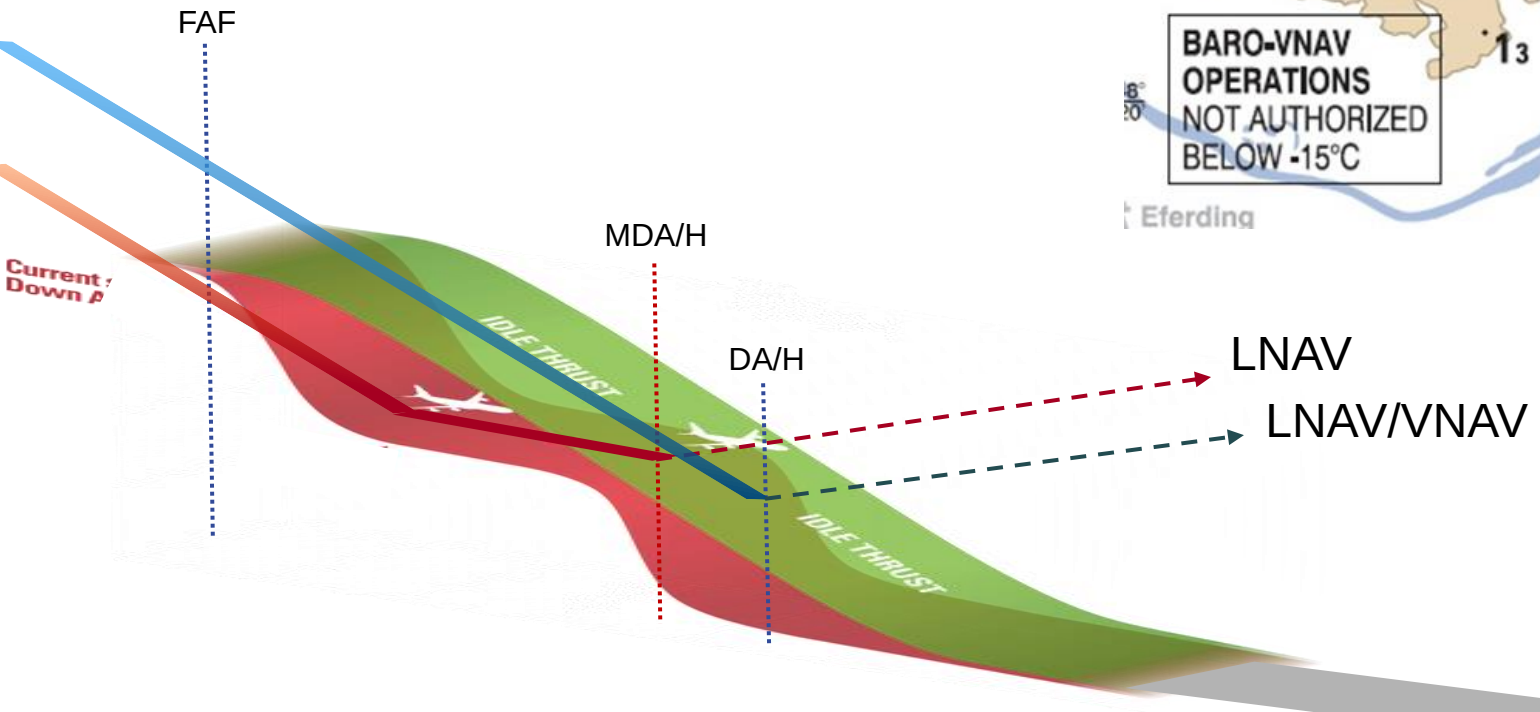


RNP *Required Navigation Performance*
AR *Authorization required*

Performance based navigation RNAV/RNP

Definition des Luftraumes

Performance based navigation
RNAV/RNP Approaches



OCA (OCH) IN FT	MA CLIMB GRADIENT	A	B	C	D
LNAV	2,5 %	1500 (420)			
LNAV/VNAV	2,5 %	1400 (320)			
LPV	2,5 %	1500 (420)	1500 (420)	1500 (420)	1500 (420)
	4 %	1350 (270)	1350 (270)	1350 (270)	1350 (270)

DIST In NM to RW35	5	4	3	2
ALTITUDE (HEIGHT)	2790 (1702)	2460 (1372)	2130 (1042)	1800 (712)

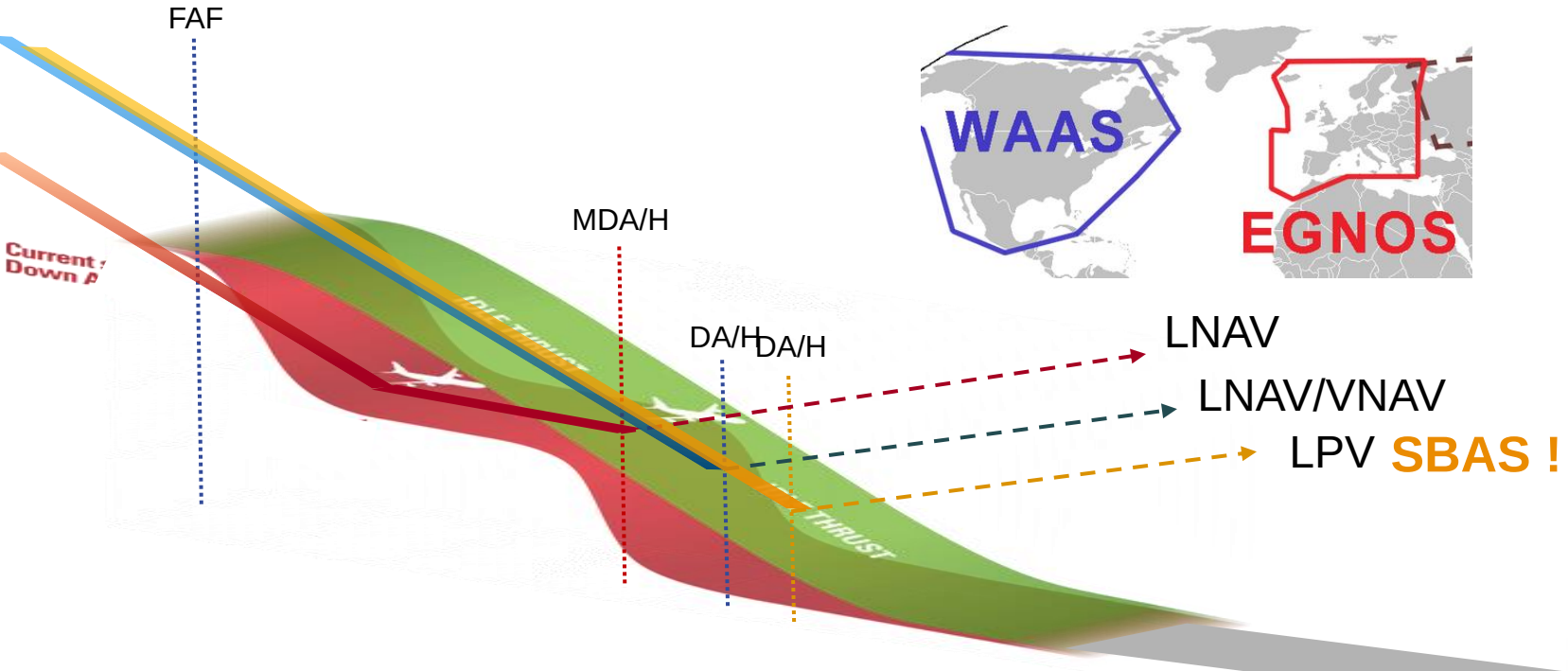
LNAV *lateral guidance navigation*

LNAV / VNAV *LNAV* with vertical guidance

LPV *Localiser performance with vertical guidance*

Performance based navigation
RNAV/RNP Approaches

Zulassung des Luftfahrzeuges



LNAV

LNAV/VNAV

LPV **SBAS !**

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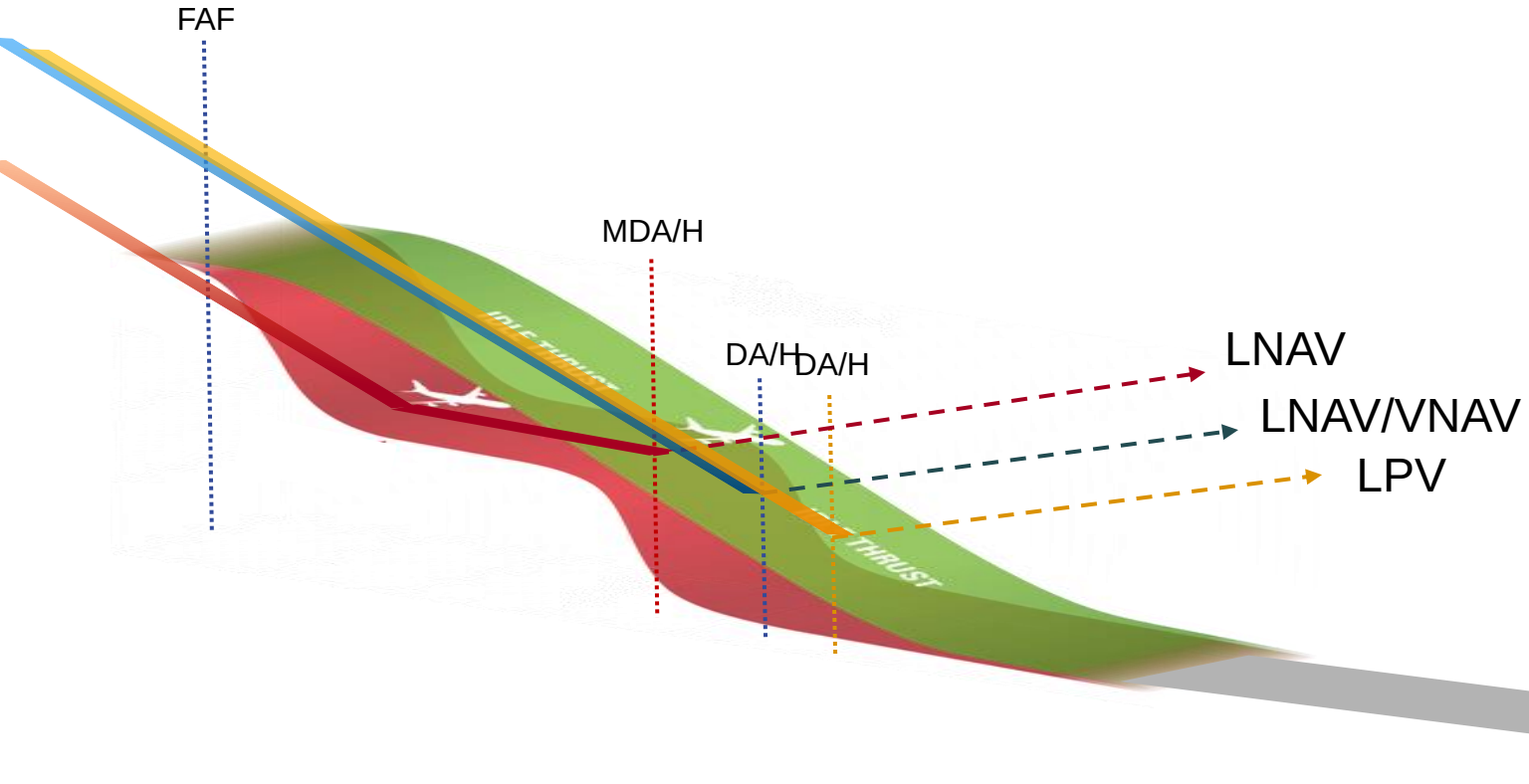
Performance based navigation
RNAV/RNP Approaches



APV
Ap*proaches with* ***v****ertical guidance*

LNAV	*lateral guidance navigation*
LNAV / VNAV	*LNAV* with vertical guidance
LPV	*Localiser performance with vertical guidance*

c. ICAO Classification

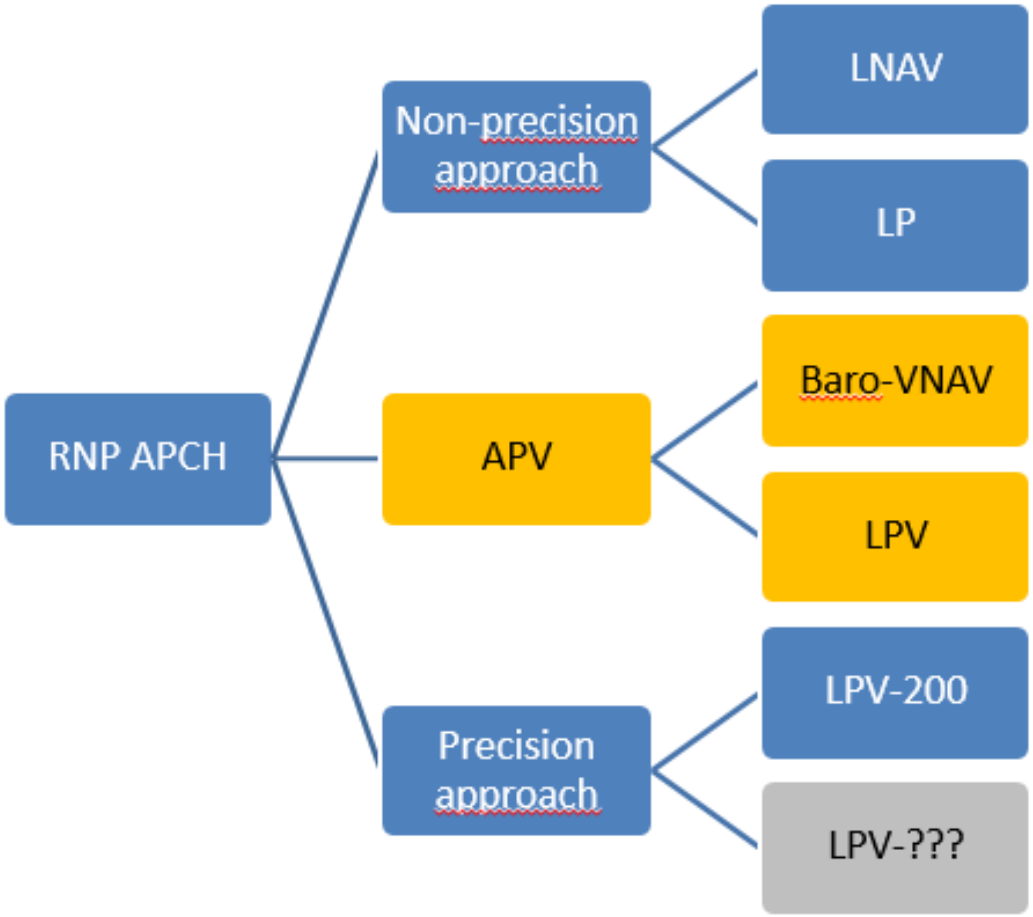
- Kategorien NPA - APV - PA
- Bezeichnungsänderungen
- *LPV 200*

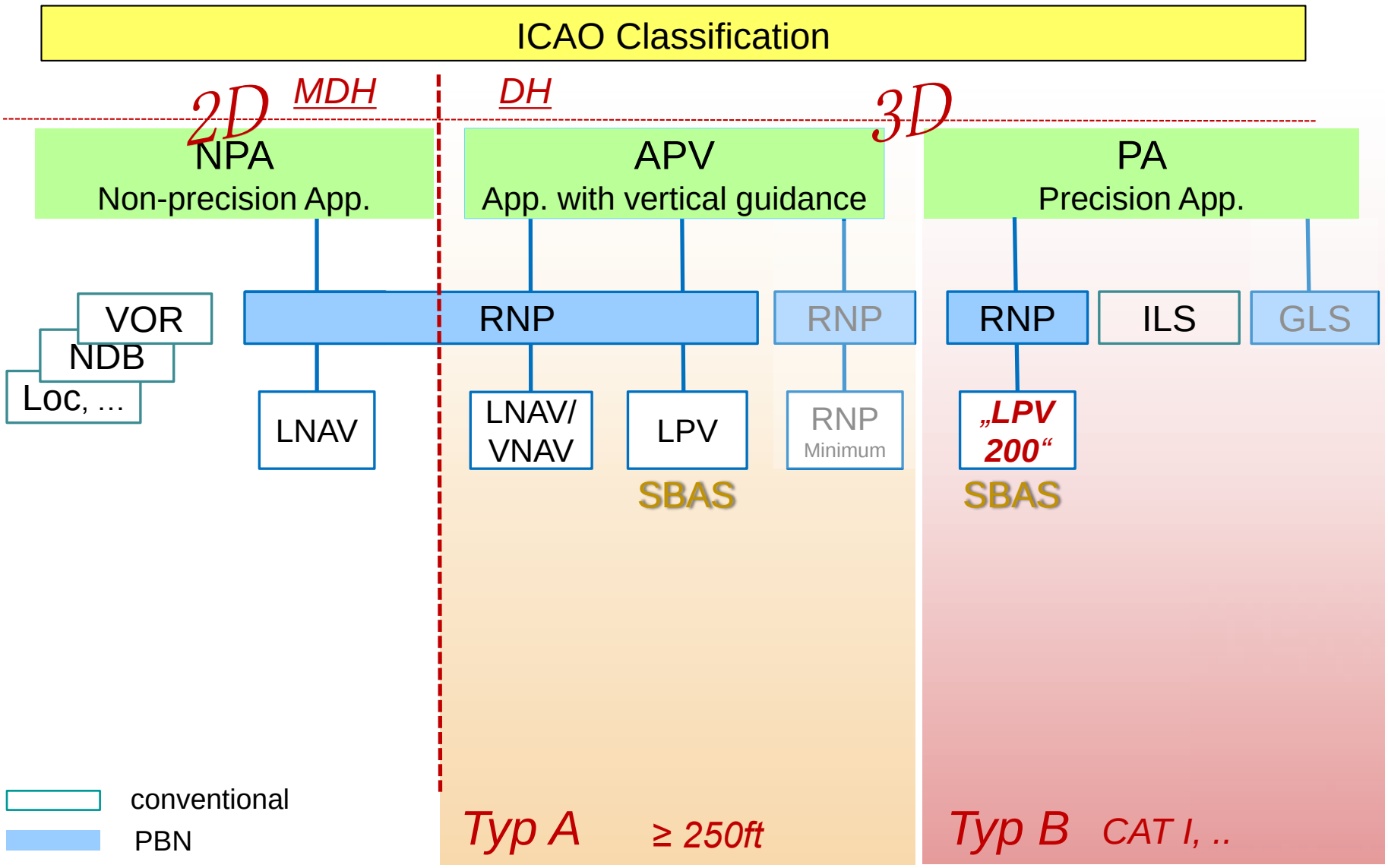
RNAV Specifications	
Oceanic/Remote	RNAV 10
En-route/ Terminal/Approach	RNAV 5, RNAV 2, RNAV 1

RNP* Specifications	
Oceanic/Remote	RNP 4
En-route/ Terminal/Approach	Basic RNP 1, RNP APCH, RNP (AR) APCH

Receiver **A**utonomous **I**ntegrity **M**onitoring

* Includes on-board navigation performance monitoring and alerting


RNP APCH
Non-precision approach
APV
Precision approach
LNAV
LP
Baro-VNAV
LPV
LPV-200
LPV-???


ICAO Classification
2D
MDH
DH
3D
NPA
Non-precision App.
APV
App. with vertical guidance
PA
Precision App.
VOR
NDB
Loc, ...
RNP
RNP
RNP
ILS
GLS
LNAV
LNAV/
VNAV
LPV
RNP
Minimum
„LPV
200“
SBAS
SBAS
conventional
PBN
Typ A
≥ 250ft
Typ B
CAT I, ..

ICAO Classification

2D

3D

NPA
Non-precision App.

APV
App. with vertical guidance

PA
Precision App.

VOR
NDB
Loc, …

RNP

LNAV

LNAV/
VNAV

LPV

SBAS

RNP

RNP
Minimum

RNP

ILS

GLS

„LPV 200“

SBAS

LOWL RWY08

OCA (OCH) IN FT	A	B	C	D / D_L
LNAV	1480 (510)			
LNAV/VNAV	1173 (195)	1186 (208)	1194 (216)	1204 (226)
LPV	1124 (146)	1136 (158)	1144 (166)	1155 (177)

In AUT: bei **neuen** LPV

OCH ≥ 250ft: LPV

OCH < 250ft: PA (LPV200, LPV *CAT I, ..)*

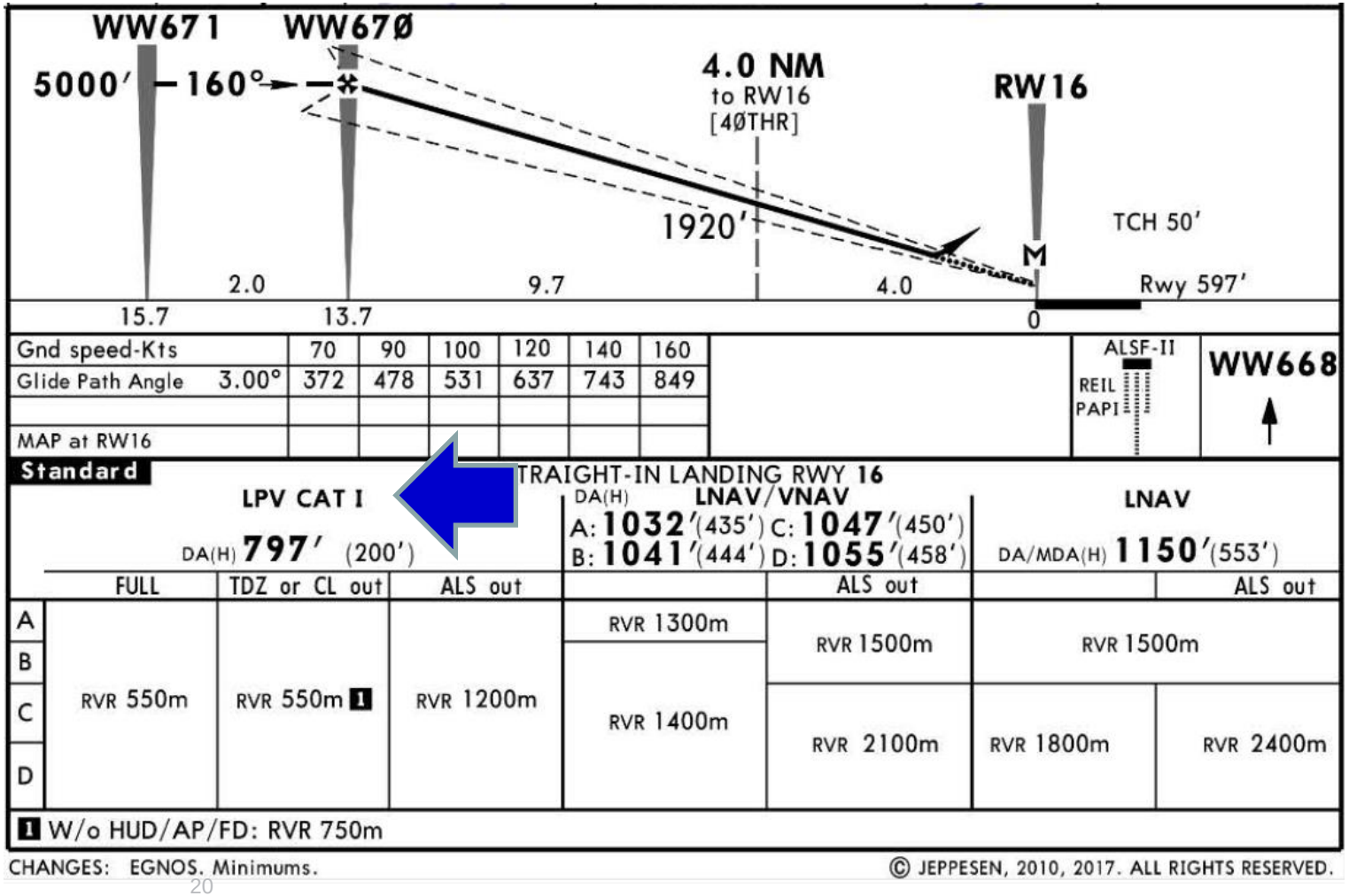
sonst Bemerkung „DH not below 250ft“

Typ A *≥ 250ft*

Typ B *CAT I, ..*

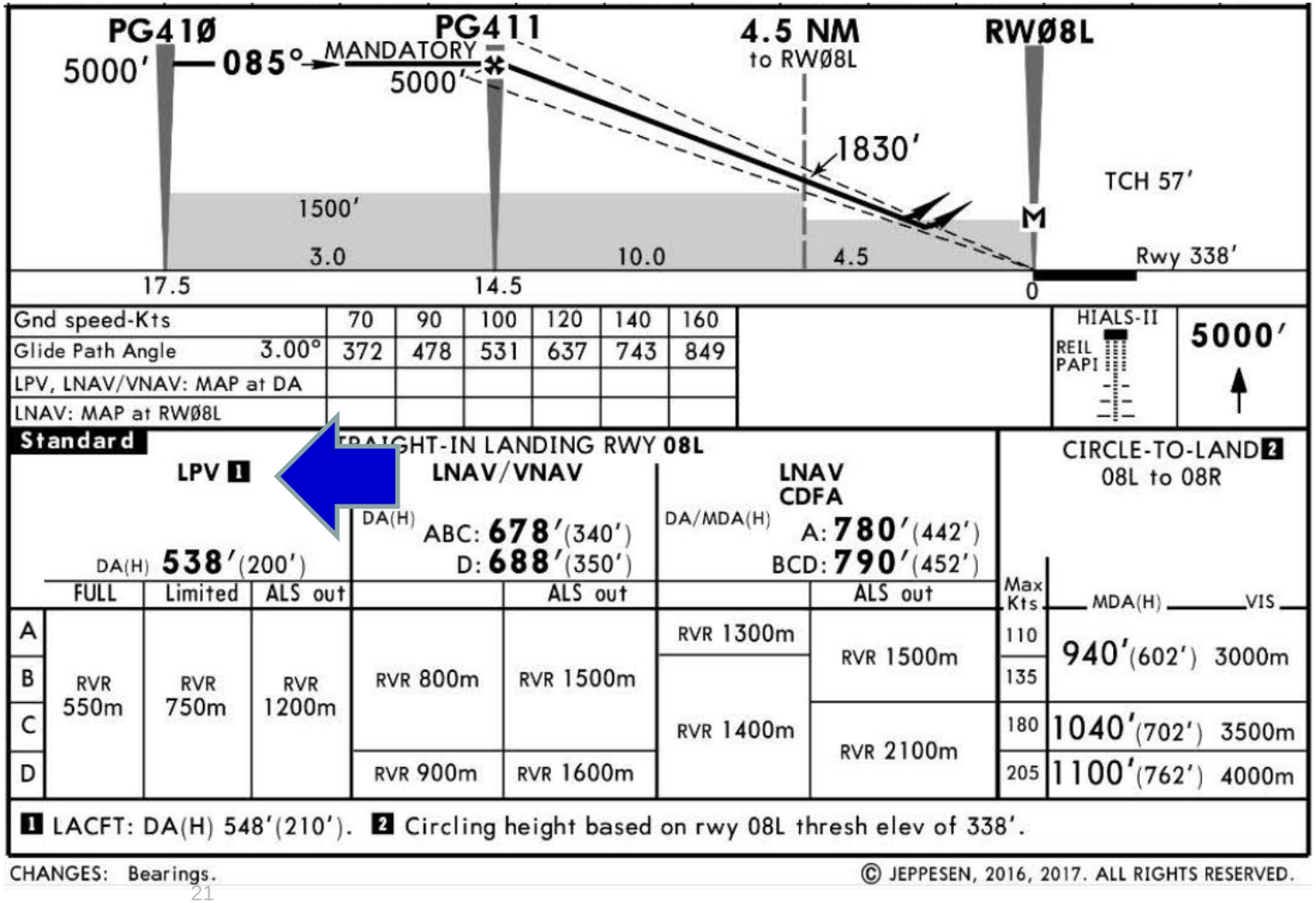
RNAV (GNSS) Approach Minima

- Beispiel „LPV-200“ LOWW (Jeppesen)

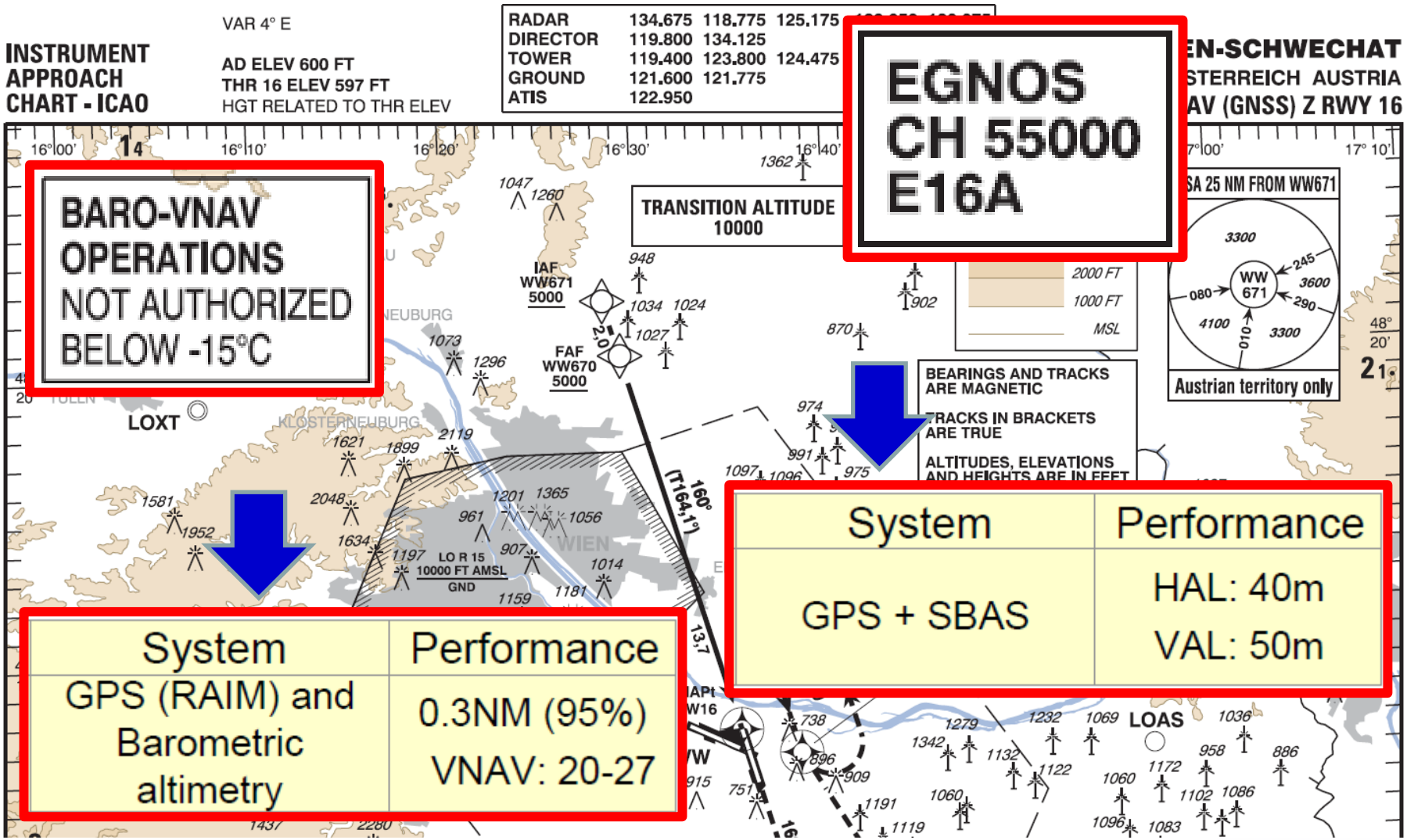


RNAV (GNSS) Approach Minima

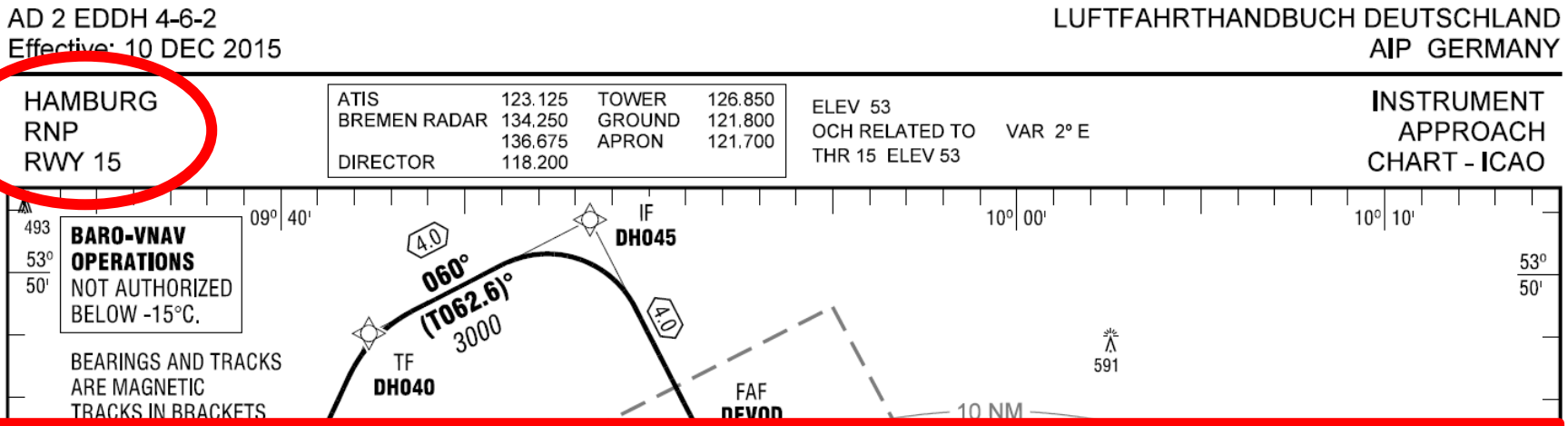
- Beispiel „LPV-200“ LFPG (Jeppesen)



RNAV (GNSS) Approach Minima



Charting Depiction (RNAV -> RNP)



Existing naming	*Interim naming*	*Final naming*
RNAV (GPS) RWY 23	$RNAV_{(GNSS)}$ RWY 23	RNP RWY 23
RNAV (GNSS) RWY 23	$RNAV_{(GNSS)}$ RWY 23	RNP RWY 23
RNAV (RNP) RWY 23	$RNAV_{(RNP)}$ RWY 23	RNP RWY 23 (AR)

d. Future Strategy

- Conventional Sensors
- RNAV/RNP Procedures
- Free Route Airspace

EGNOS SBAS Anflugverfahren (LPV)

- LPV:

  in LOWW, LOWL und LOWG

- LPV 200:

  LOWL RWY08

  LOWW RWY 11, RWY16, RWY34

  in Planung: LOWG RWY35, LOWW RWY29

- für LOWI ist ein LPV auf die Piste 26 geplant.
  Große Herausforderung aufgrund der Terrainsituation!
  Minimum in der Größenordnung vom Localizer Approach
  Sehr nützlich für GA community

Zukunft NDB & VOR

- NDB Planung im Laufen.
  max. Laufzeit ca. 10 Jahre

- **„One station per airport“** Policy
  (ILS werden dabei nicht hinzugezählt)

- das Ziel einer flächendeckenden DME-DME Infrastruktur wurde aufgrund der rapiden Entwicklungen auf Cockpitseite und der Kosten aufgegeben

- EASA: Änderungen im IFR Training