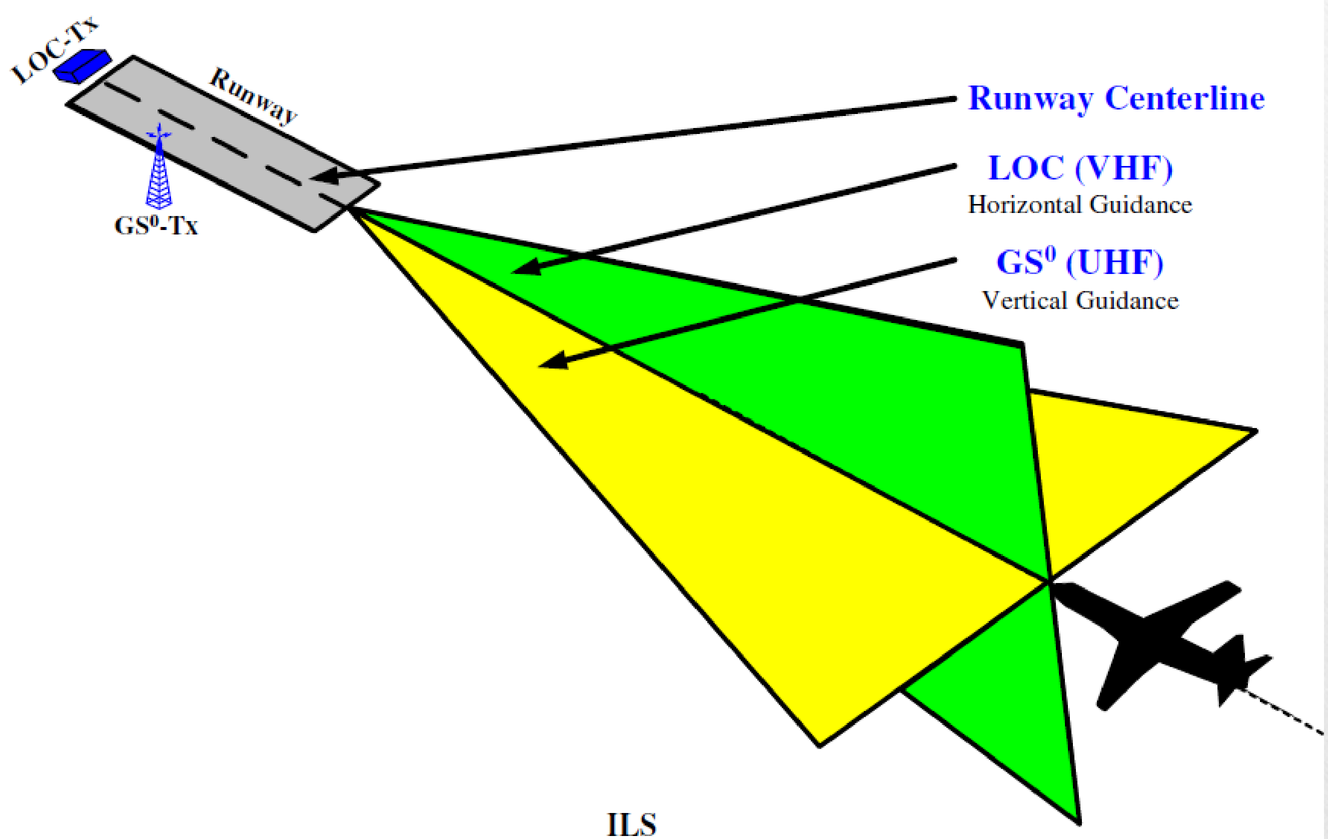
Landing Systems

- Mechanics of Landing,
- Automatic Landing Systems,
- Instruments Landing Systems,
- Microwave Landing Systems,
- Satellites Landing Systems,
- Carrier Landing Systems

Instrumented Landing Systems



ILS

Instrumented Landing Systems

Principle:

Provides A/C guidance for a straight flight path landing. ILS is used in IFR precision approach A/Cs from FAF until TDP.

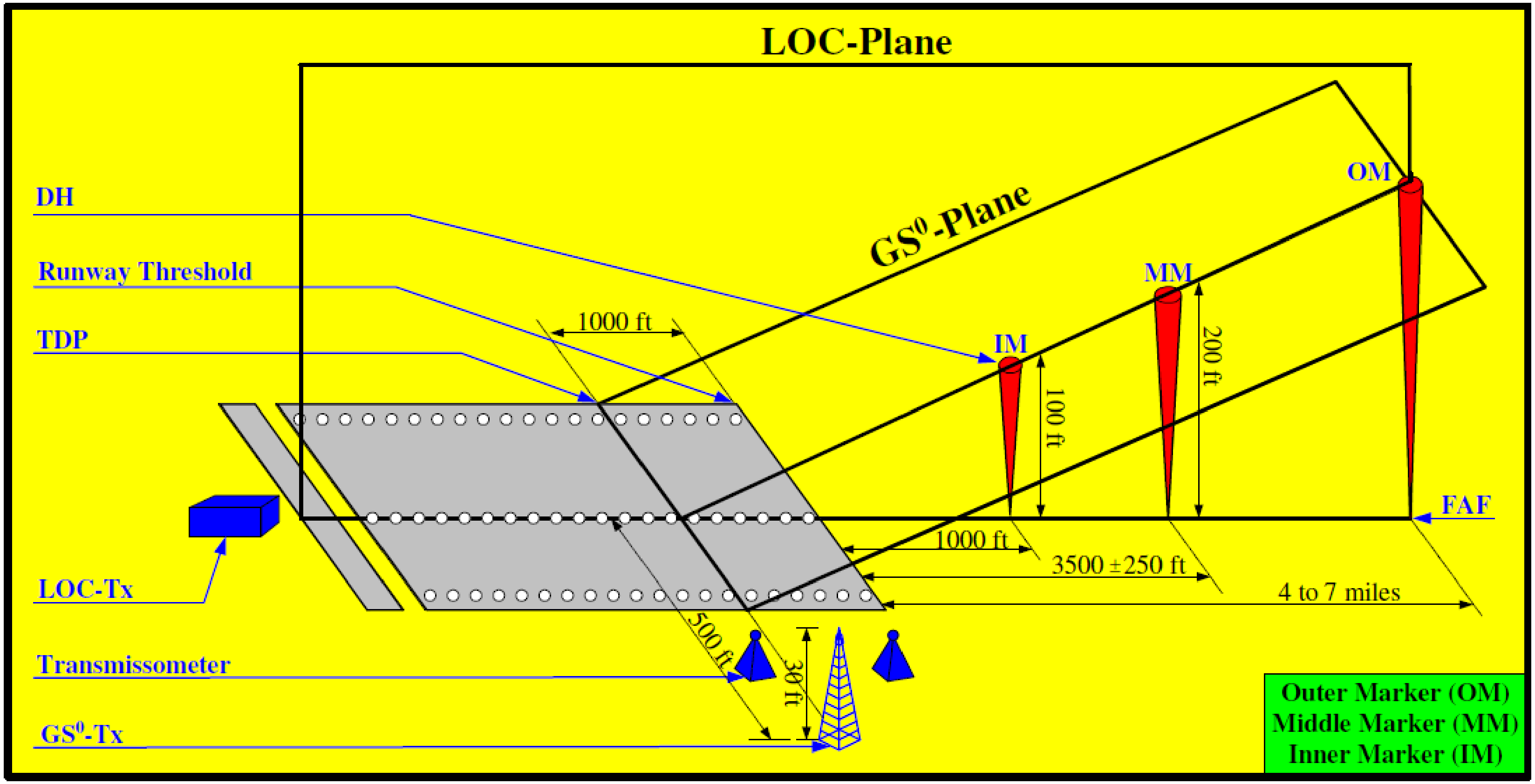
As for insuring an ideal landing, the system is based on the intersection of the runway centerline, the Localizer (LOC) beam, and the GS degree beam.

Instruments Landing Systems

Basic elements of the ILS system and their brief description:-
The ILS system consists of four subsystems:

- VHF localizer transmitter
- UHF glide slope transmitter
- marker beacons
- approach lighting system

On Ground



ILS CAT-II runway

Transmissometer

- Transmissometer providing Runway Visual Range information

- A **transmissometer** is an instrument for measuring the extinction coefficient of the atmosphere, and for the determination of visual range.

- It operates by sending a narrow, collimated beam of energy (usually a laser) through the propagation medium.

- A narrow field of view receiver at the designated measurement distance determines how much energy is arriving at the detector, and determines the path transmission and/or extinction coefficient.

- Atmospheric extinction is wavelength dependent phenomenon, but the most common wavelength in use for transmissometers is 550 nm, which is right in the middle of the visible waveband, and allows a good approximation of visual range.

- Transmissometers are sometimes referred to as telephotometers, transmittance meters, or hazemeters.

- The term transmissometer is also used by oceanographers and limnologists to refer to a device for measuring the optical properties of natural water.

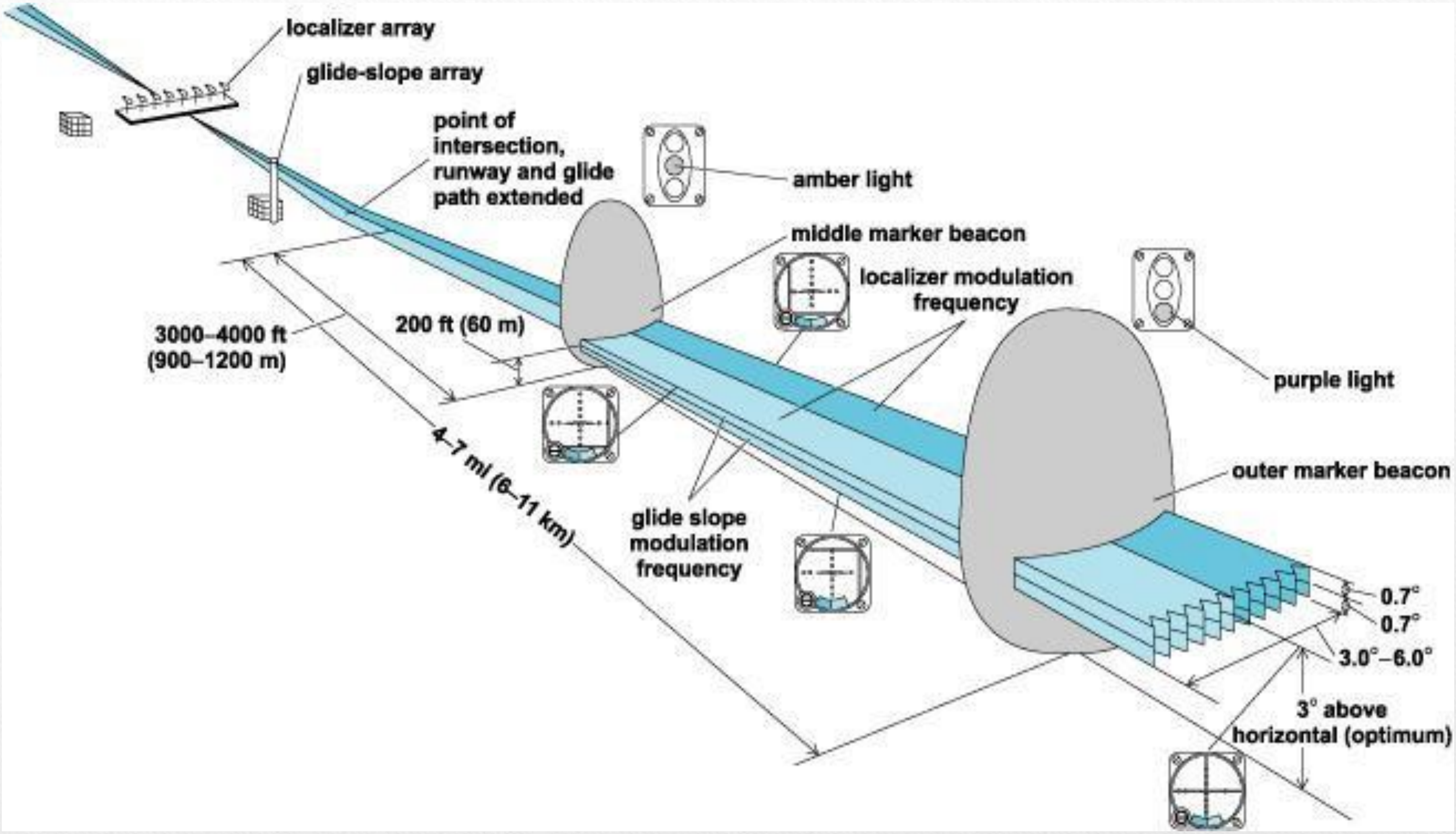
- In this context, a transmissometer measures the transmittance or attenuation of incident radiation from a light source with a select wavelength, often 660 nm, through a defined cell volume.

Localizer

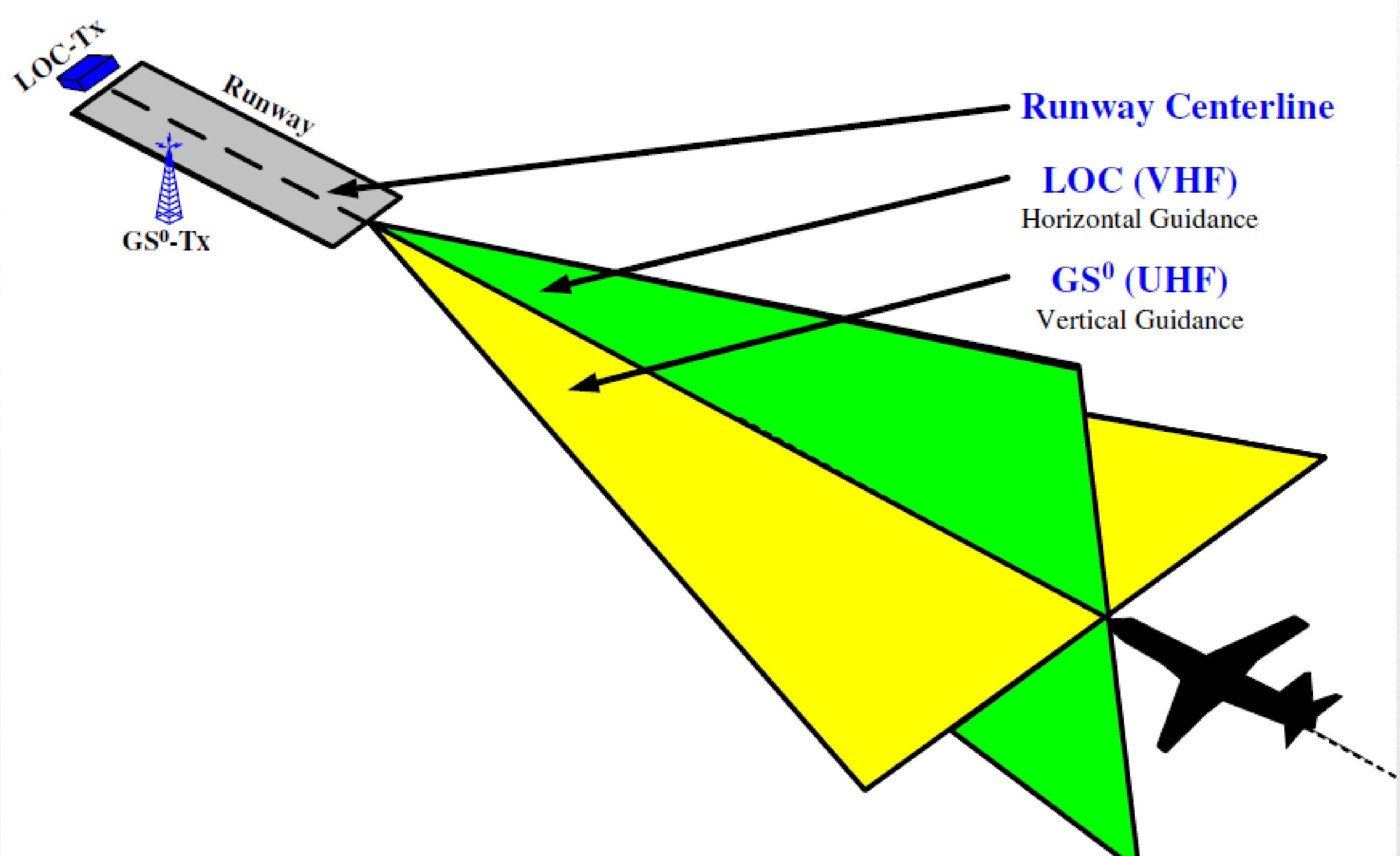
- A **localizer (LOC)** is one of the components of an Instrument Landing System (ILS), and it provides runway centerline guidance to aircraft.
- In some cases, a course projected by localizer is at an angle to the runway (usually due to obstructions around the airport).
- It is then called a Localizer Type Directional Aid (LDA).
- Localizers also exist in stand-alone instrument approach installations and are not always part of an ILS.
- The localizer is placed about 1,000 feet from the far end of the approached runway.
- Its useful volume extends to 18 NM for the path up to 10 degrees either side of the course.

Localizer as component of an ILS (KMEZ Runway 27, Mena, Arkansas).

- For an angle of 35 degrees either side of the course the useful volume of the localizer extends up to 10 NM.
- Horizontal guidance gets more accurate the closer you fly to the localizer station.
- Localizer approaches have their specific weather minimums found on approach plates.

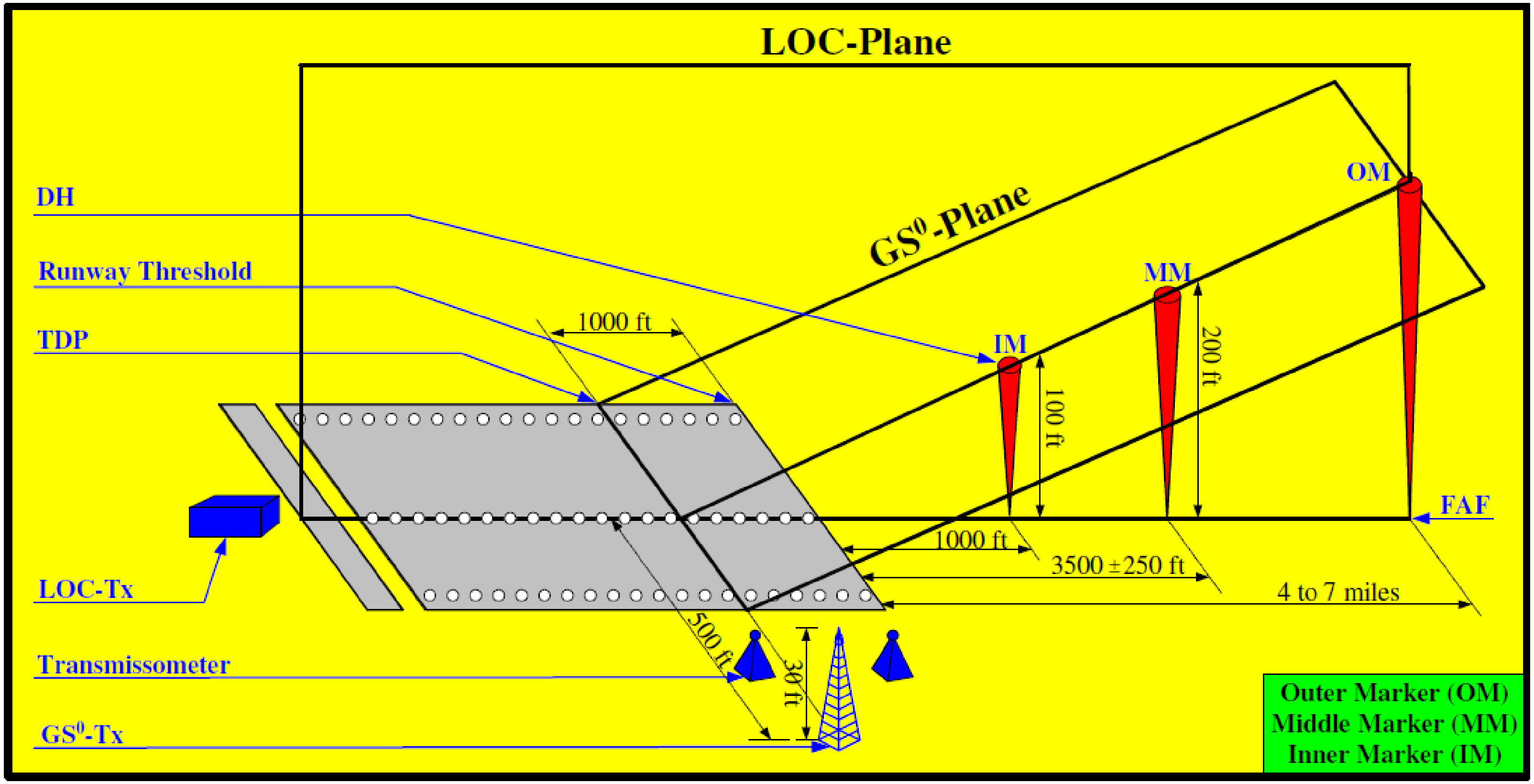


The description and placement of the individual parts of the ILS system


LOC-Tx
Runway
GS0-Tx
Runway Centerline
LOC (VHF)
Horizontal Guidance
GS0 (UHF)
Vertical Guidance

ILS

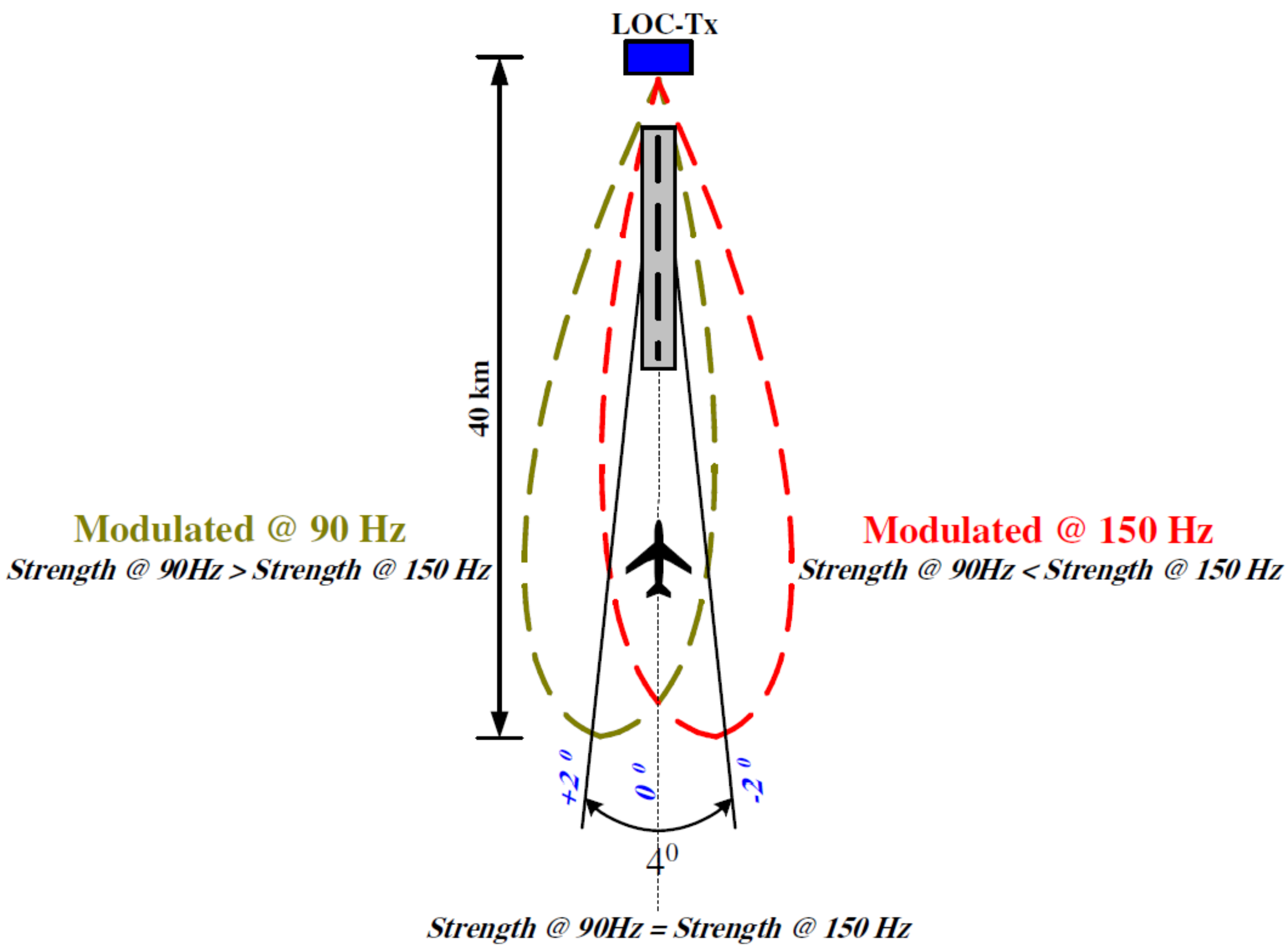
On Ground



ILS CAT-II runway

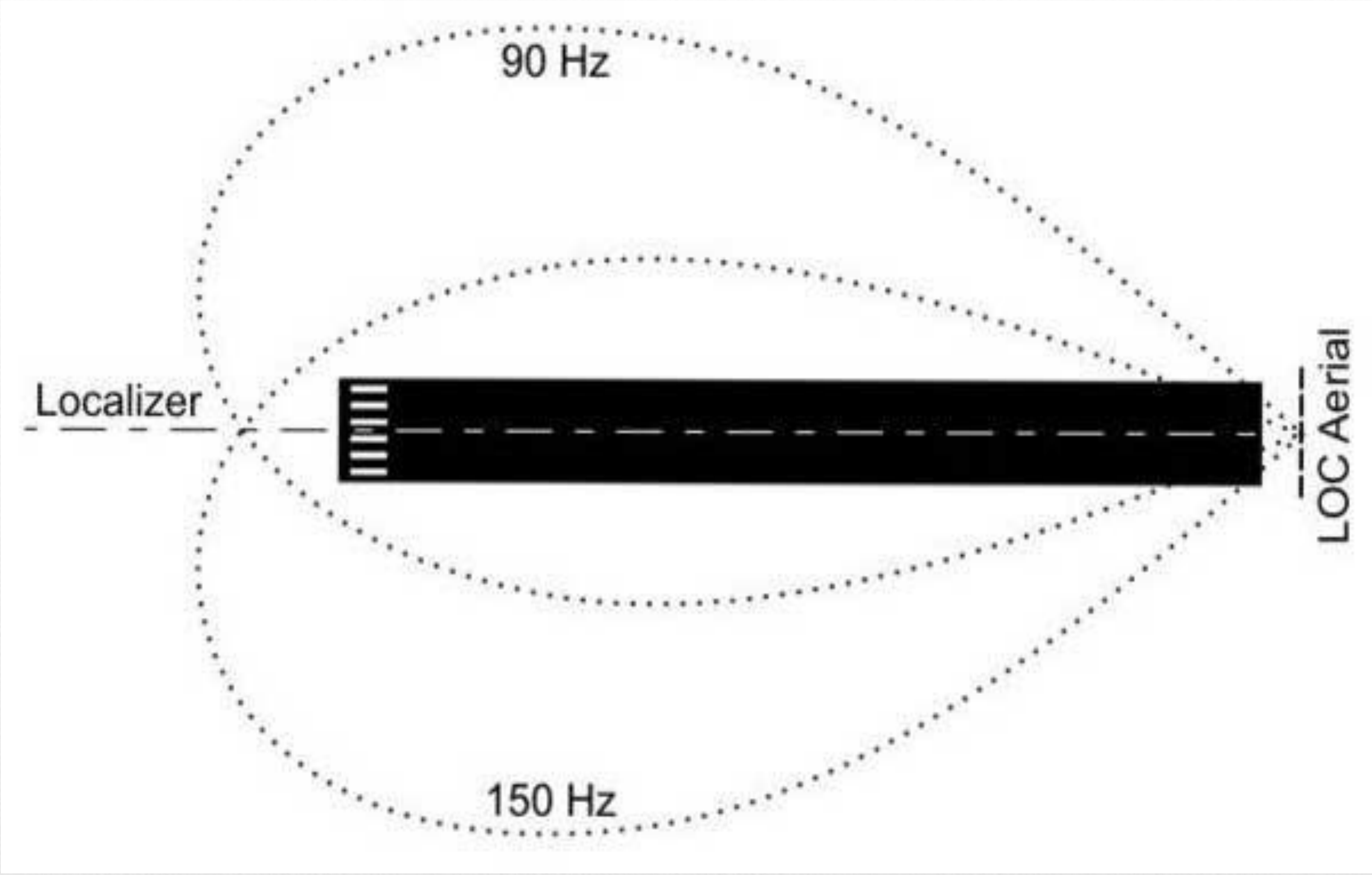
1) ***LOC–Tx***

- *Function: Provides alignment with runway centerline.*
- *NAV: Horizontal Guidance.*
- *Quantity per runway: 1*
- *Location: At the end of the runway.*
- *Frequency: VHF ≈ 108 – 112 MHz*
  - Number of Channels: *20*
- *Horizontal Range of Operation ≈ 40 km*
- *Deviation from Centerline* $\approx \pm 2^0$ *[i.e.* 4^0*]*


LOC-Tx
40 km
Modulated @ 90 Hz
Strength @ 90Hz > Strength @ 150 Hz
Modulated @ 150 Hz
Strength @ 90Hz < Strength @ 150 Hz
+2 0
0 0
-2 0
4 0
Strength @ 90Hz = Strength @ 150 Hz

ILS-LOC

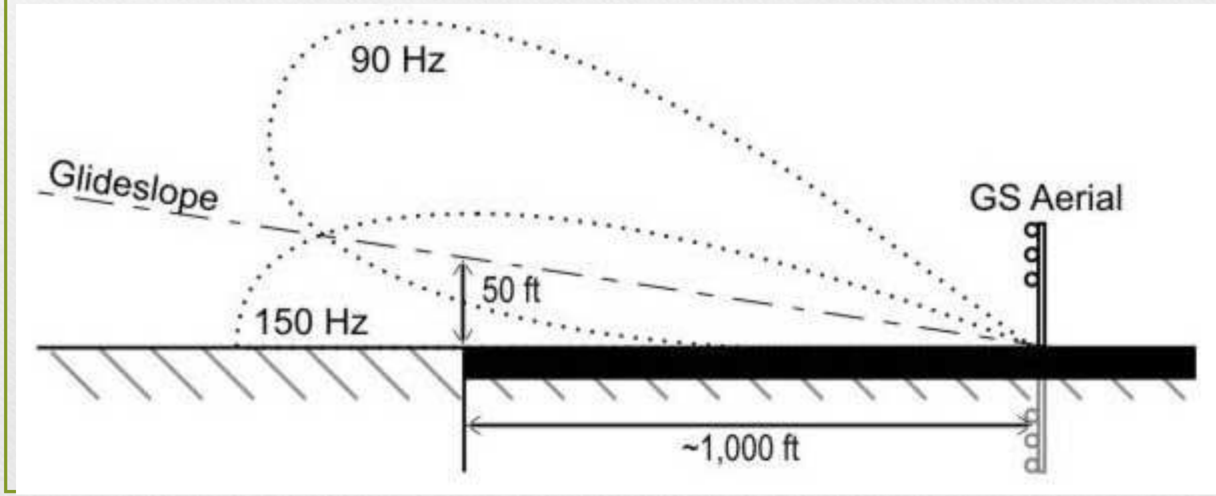
Radiation pattern of the localizer's VHF transmitter



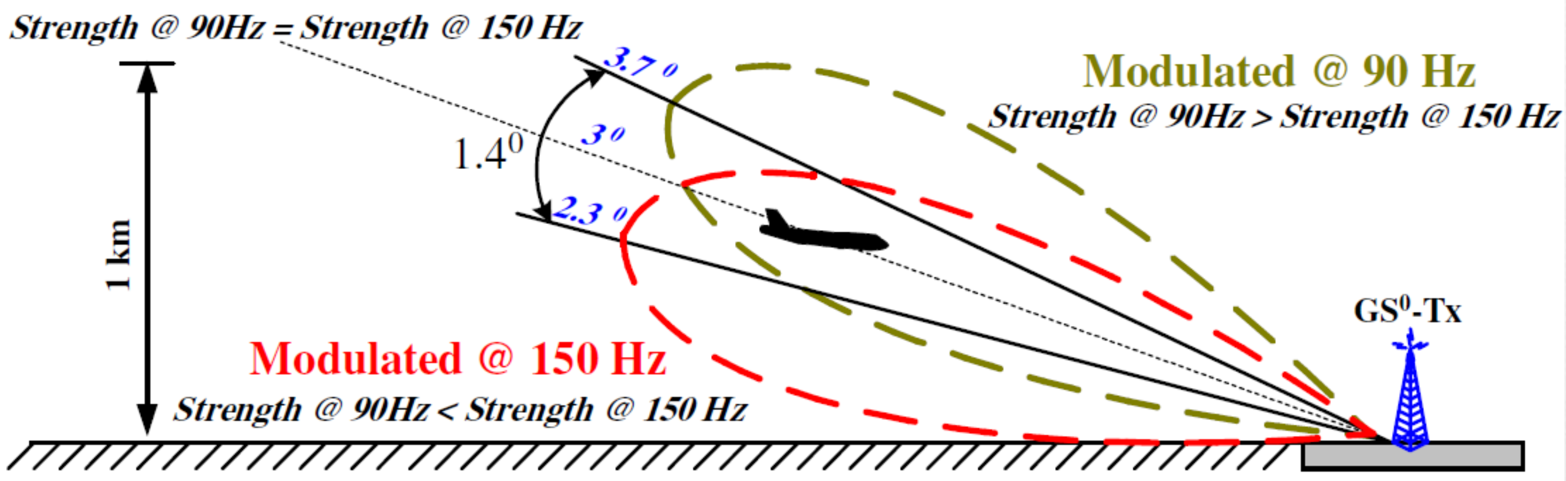
2) GS^0–Tx

- *Function: Provides fix descent rate.*
- *NAV: Vertical Guidance.*
- *Quantity per runway: 1*
- *Location: On the side of the runway.*
- *Frequency: UHF ≈ 329 – 335 MHz*
  - Number of Channels: *20*
- *Vertical Range of Operation ≈ 1 km*
- *Typical GS^0 Inclination ≈ 3^0*
- *Deviation from GS^0 ≈ $\pm 0.7^0$ [i.e. 1.4^0]*

✓ UHF descent beacon draws a glide slope in the area



✓ The radiation pattern of the UKV descent beacon forming the glide slope



Strength @ 90Hz = Strength @ 150 Hz
3.7°
3°
1.4°
2.3°
1 km
Modulated @ 90 Hz
Strength @ 90Hz > Strength @ 150 Hz
GS⁰-Tx
Modulated @ 150 Hz
Strength @ 90Hz < Strength @ 150 Hz

ILS-GS⁰

3) *MB–Tx*[84]

- *Function: Provides indication to crew that the A/C is in a specific location.*
- *NAV: Horizontal Guidance.*
- *Quantity per runway: 2 or 3* [85]
- *Location: Prior to runway along its centerline.*
- *Frequency: VHF ≈ 75 MHz*

LOC-Tx

GS^0-Tx

MB-Tx

LOC, GS^0, and MB-Txs

4) ***Transmissometer:*** *System used to measure the transmission of light through the atmosphere in order to determine visibility, and hence RVR.*

- *Function: System used to measure the transmission of light through the atmosphere in order to determine visibility, and hence RVR.*
- *Quantity per runway: 2*
- *Location: On the side of the runway.*
- *Range of Operation ≈ 10 km*
- *The system is able to identify 7 different types of pricipitation:*
  - Drizzle (i.e. gentle rain) || Rain
  - Frizzing Drizzle || Freezing Rain
  - Mixed Rain & Snow
  - Snow || Ice pellets

Transmissometer

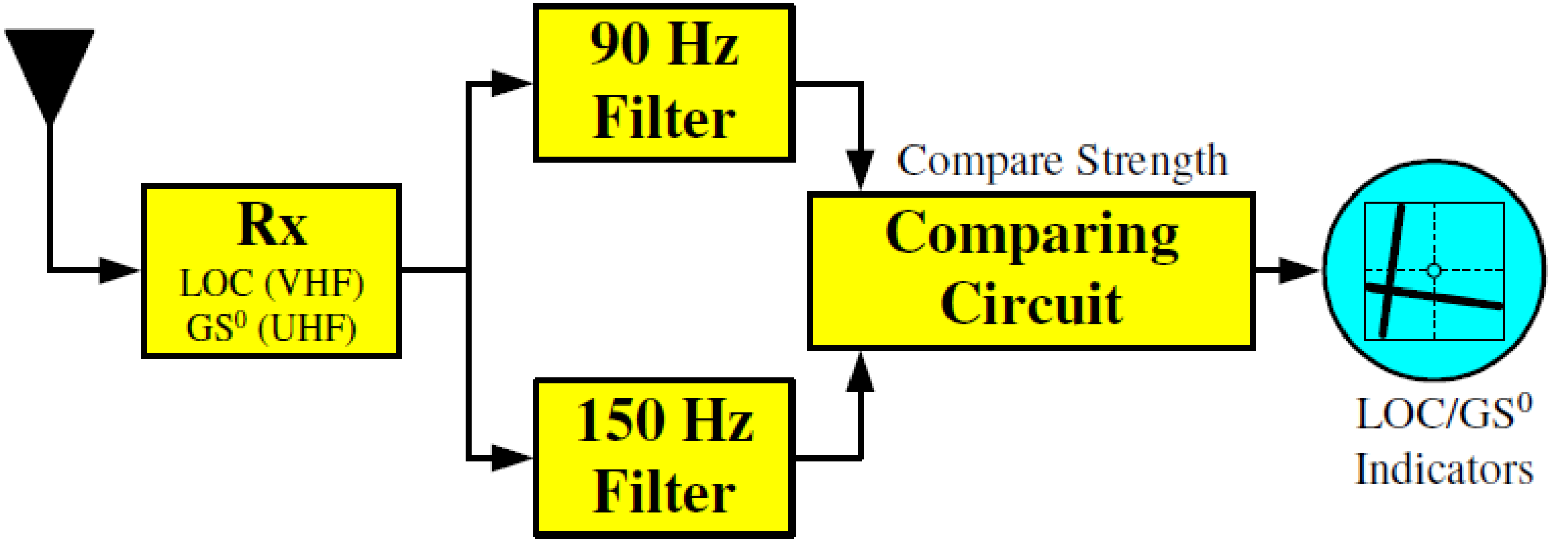
Onboard equipment

In the A/C:

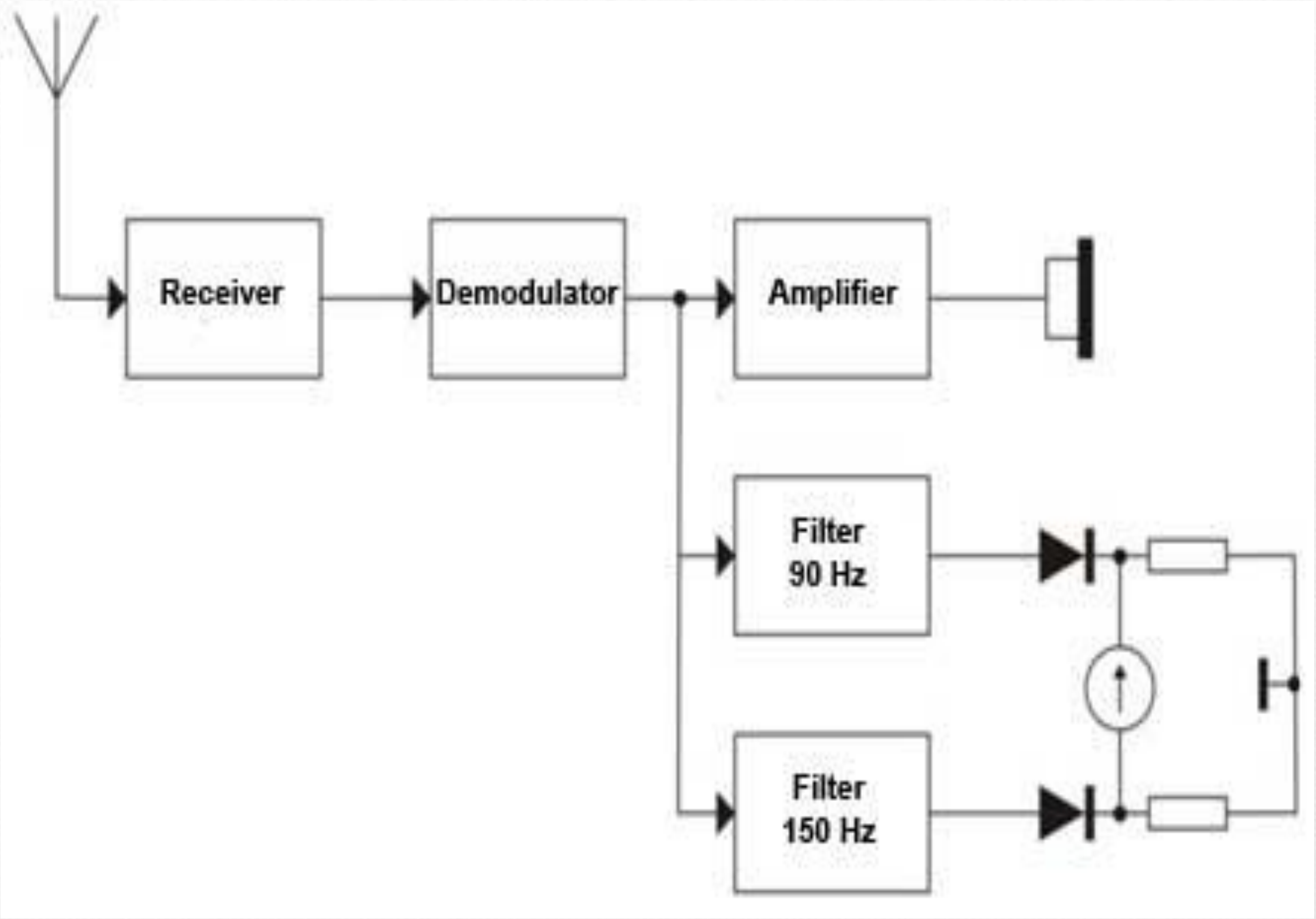
1) ***LOC/GS^0–Rx or HSI–System***[86]

- *Frequency:*
  - VHF: *LOC*
  - UHF: *GS^0*

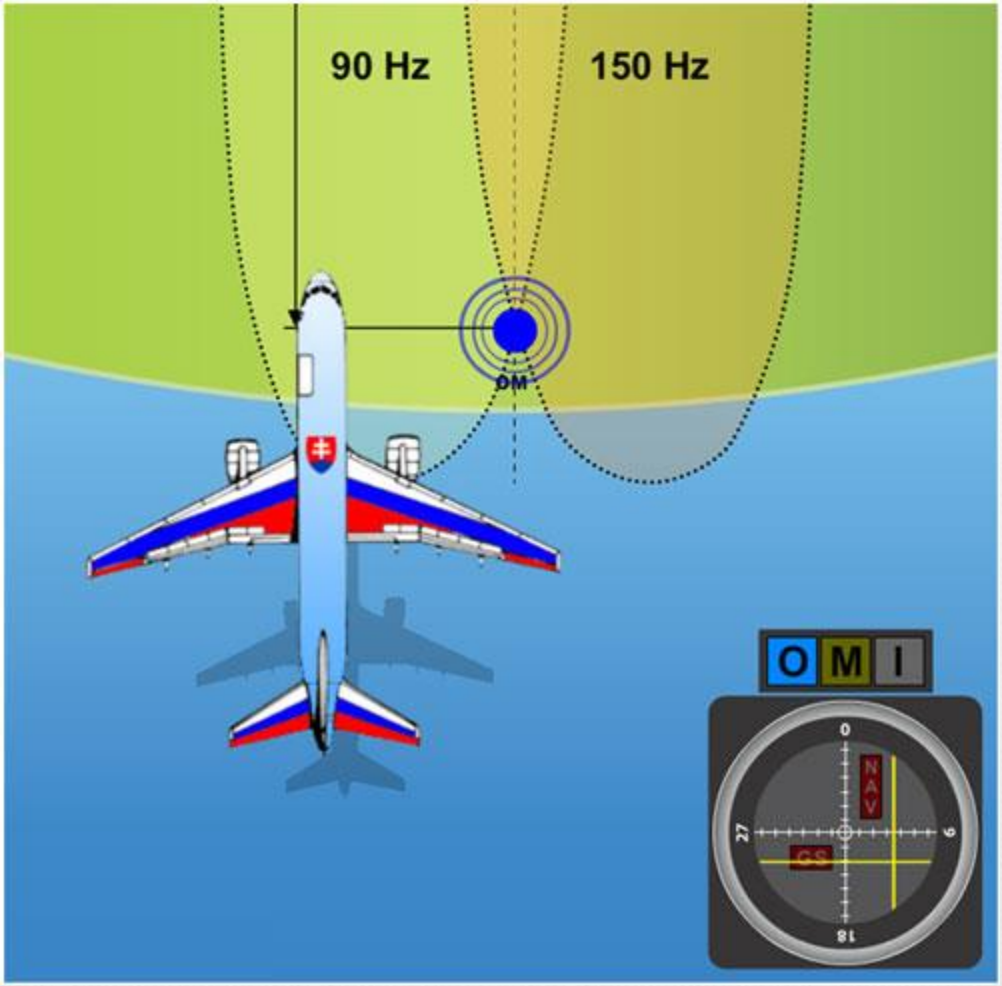
- *Rx compares the strength of the 90 and 150 Hz modulated signals for both LOC and GS^0, and outputs the actual A/C position w.r.t. ideal centered path.*



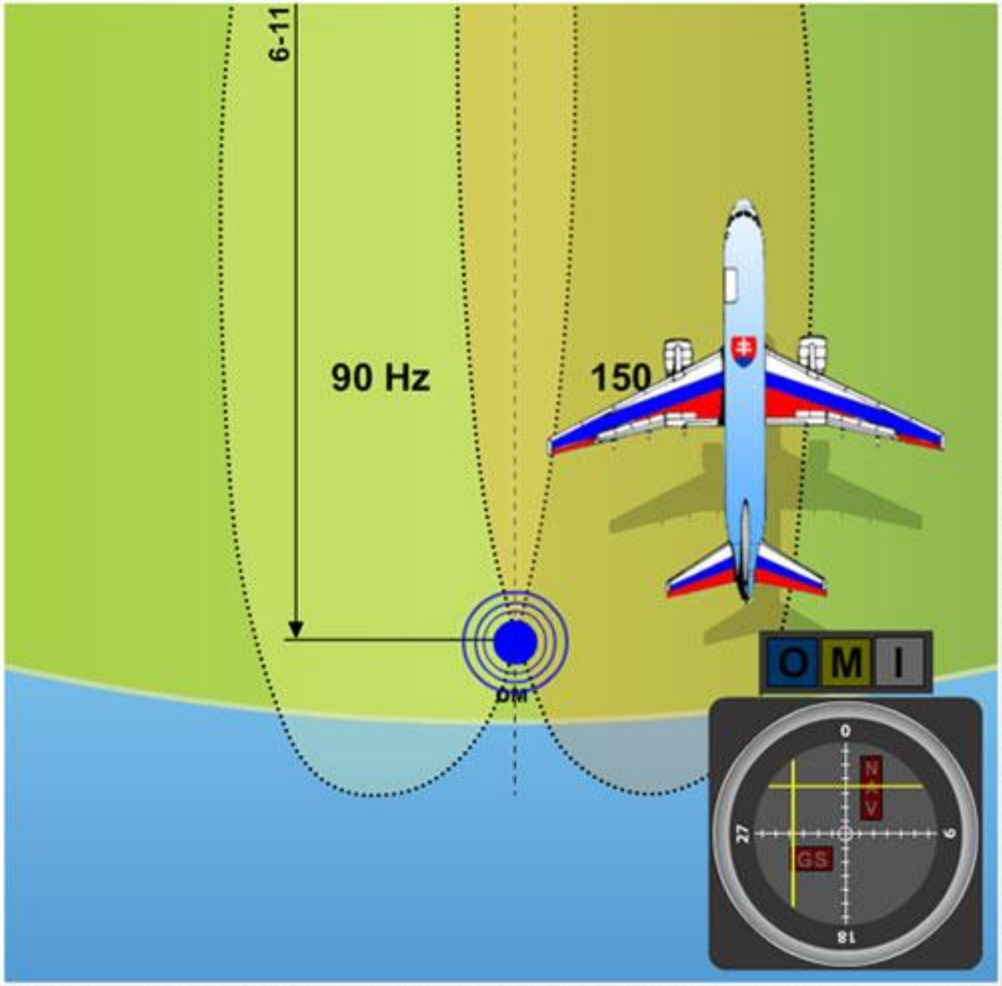
LOC/GS^0-Rx



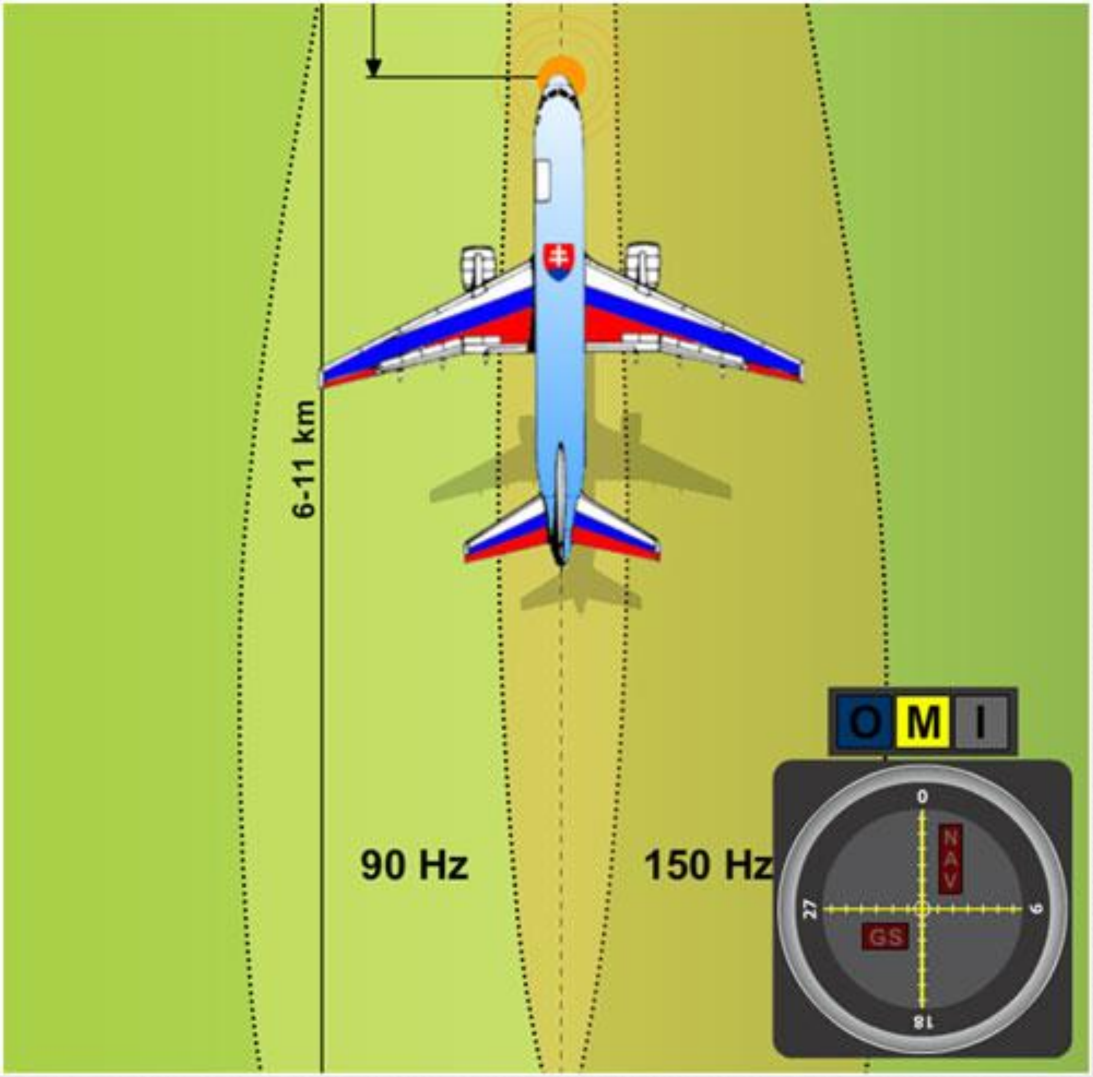
Block scheme of the onboard course beacon‘s signal receiver



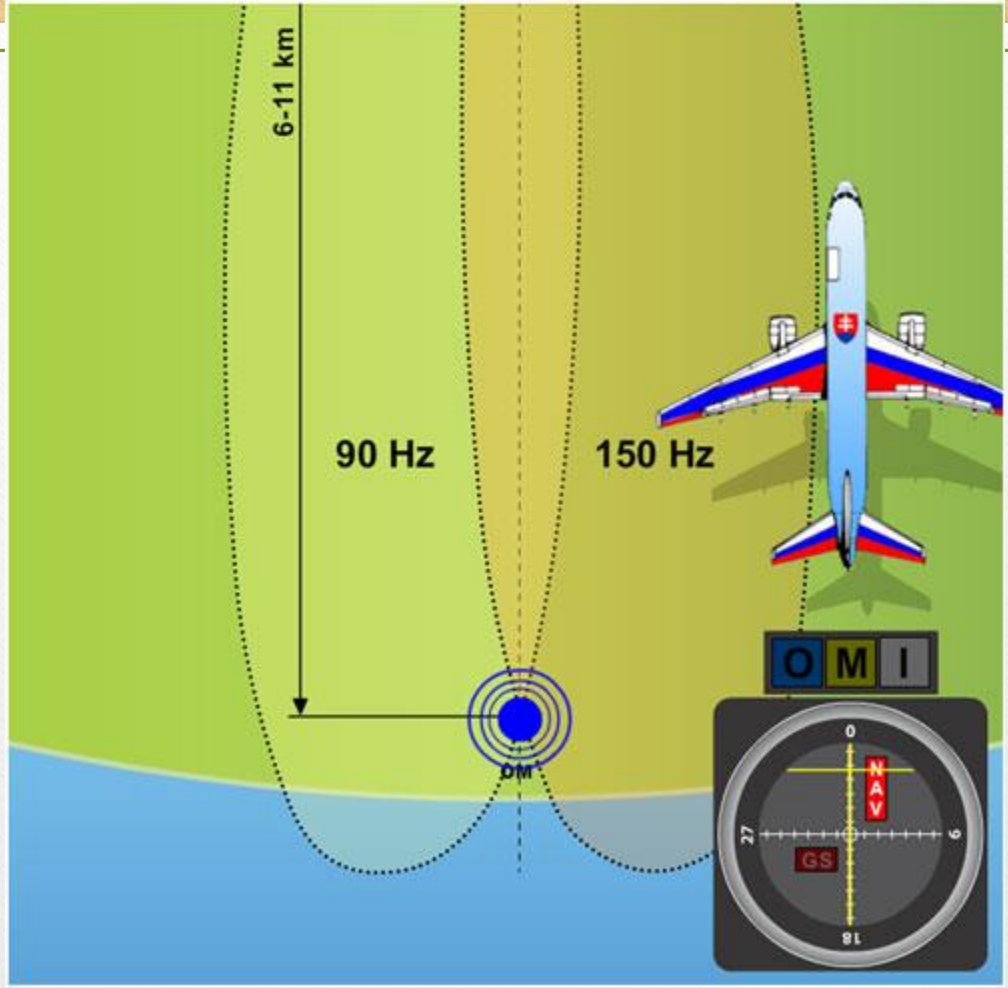
A plane flying approximately along the axis of approach,
however partially turned away to the left



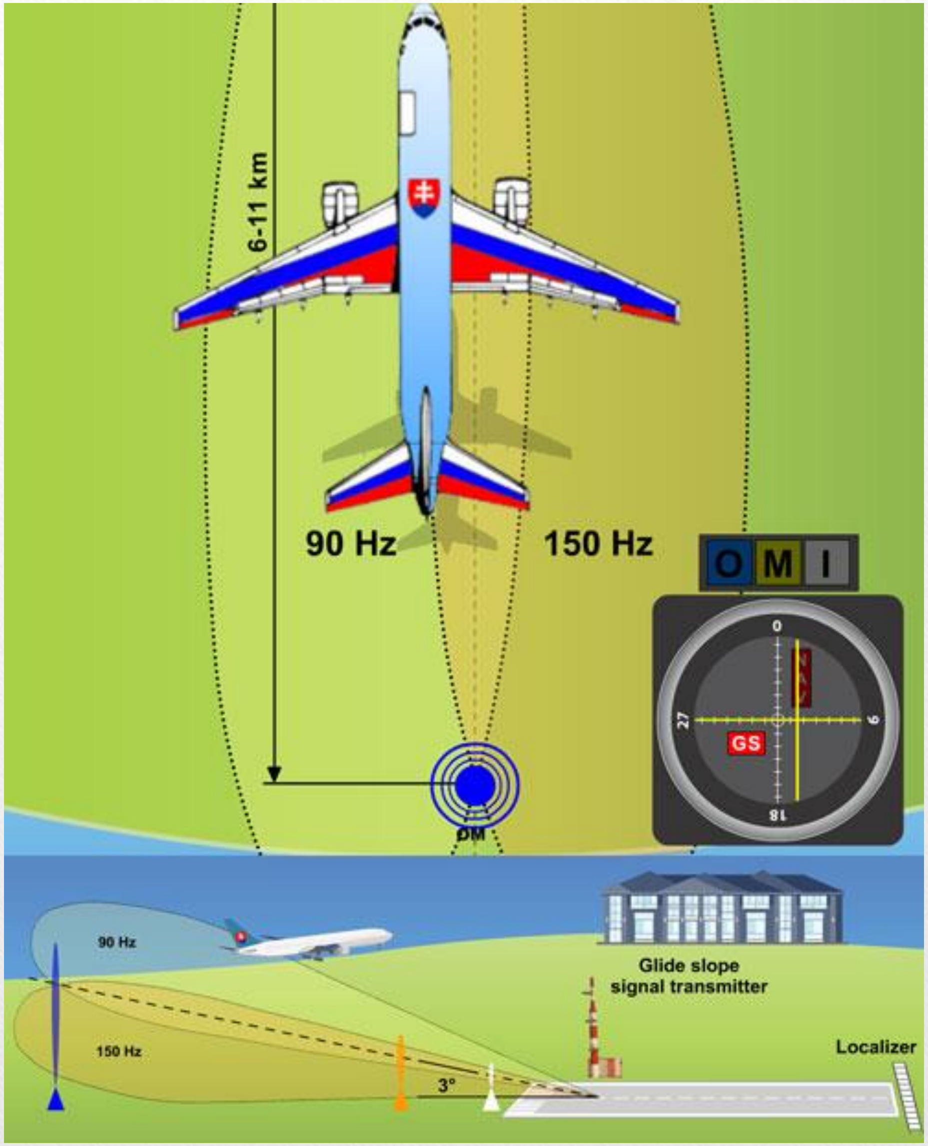
A plane flying nearly in the approach axis slighlty leaned out to the right



A plane flying exactly in the axis of approach

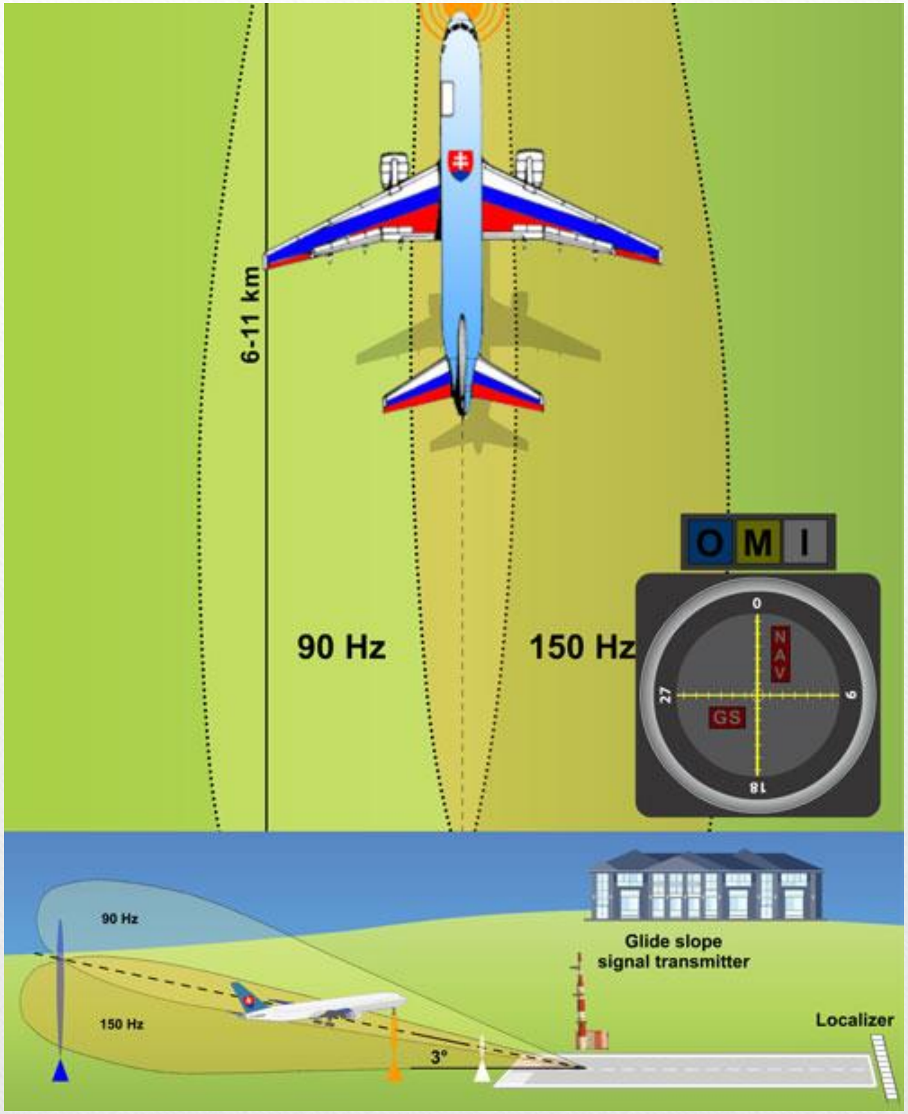


A plane situated out of reach of the VKV course beacon's signal

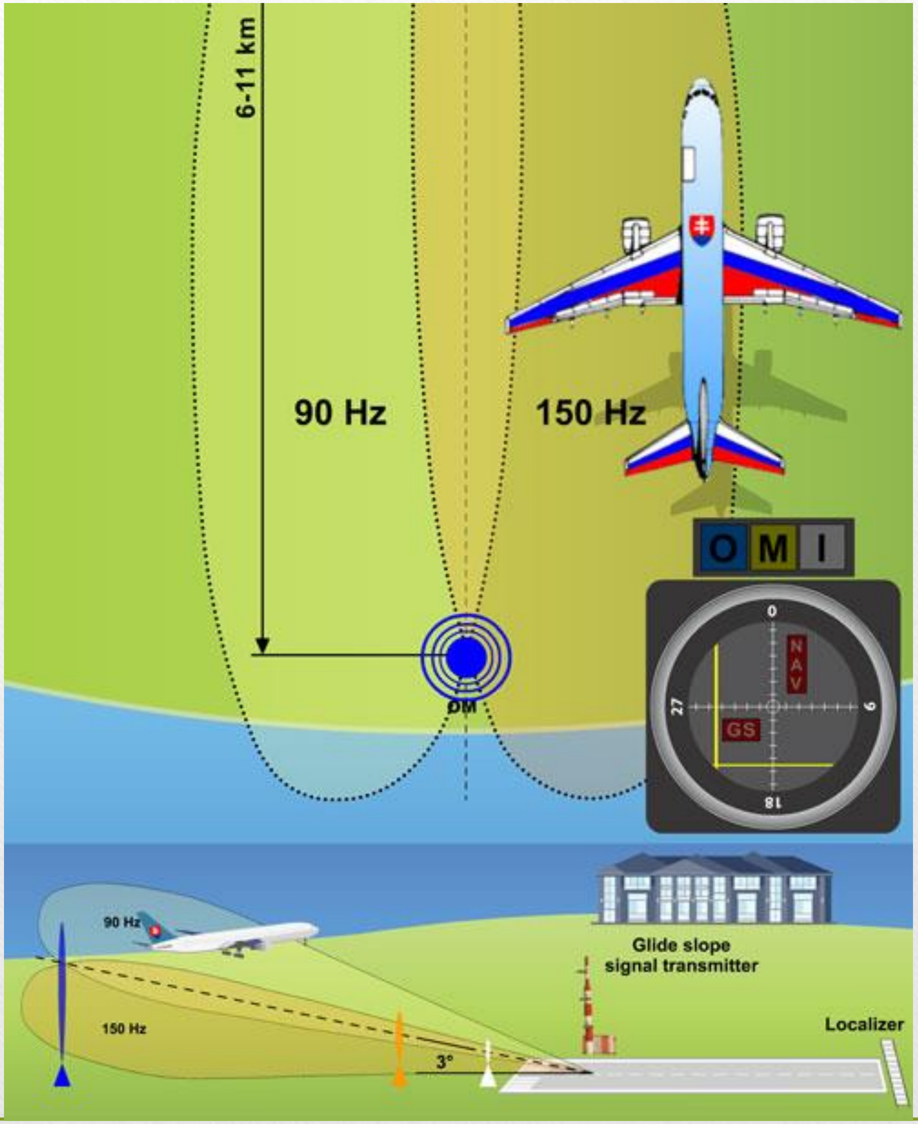


An example of the displayed GS pointer notifying a diversion from the glide slope, a too weak received signal, or an obstacle on the way

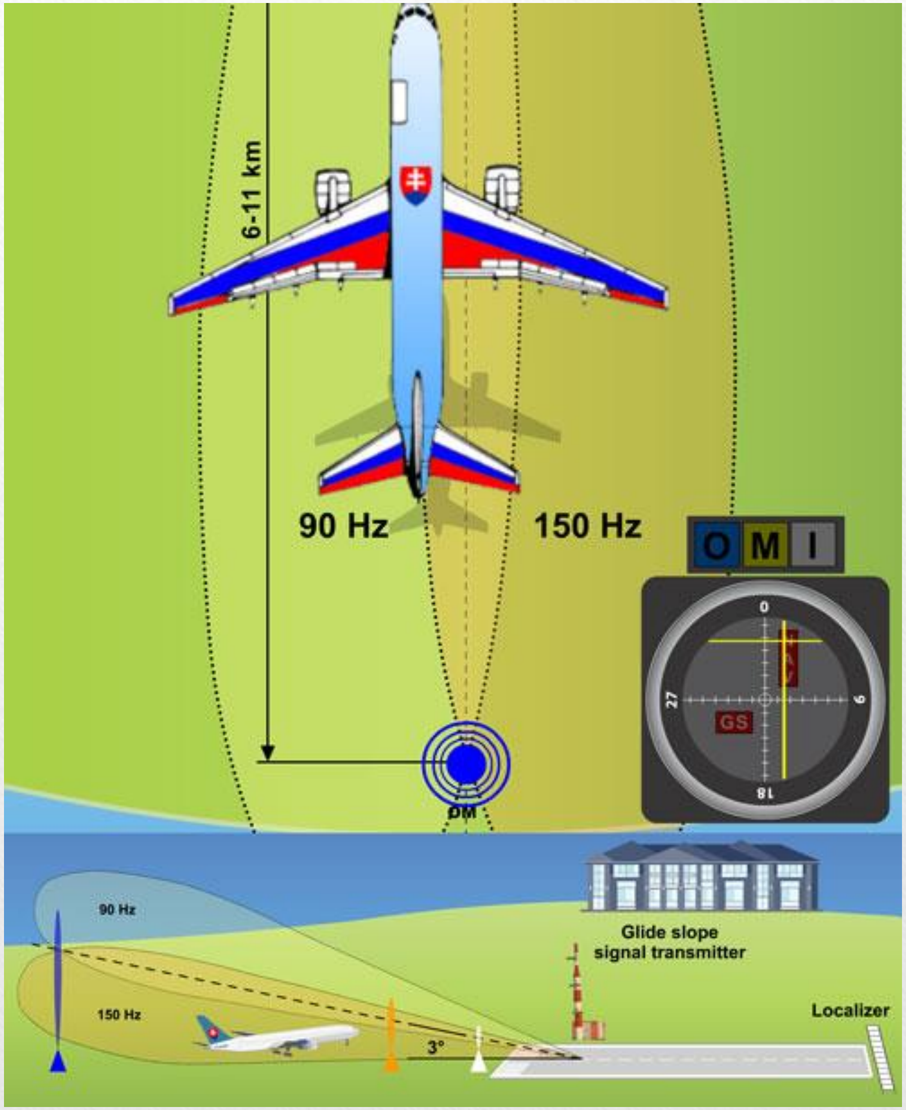
Both pointers in the middle – the aircraft is located in the point of intersection of the course and descent plane.



A case when the aircraft is located right of the runway's axis
and too high over the glide slope

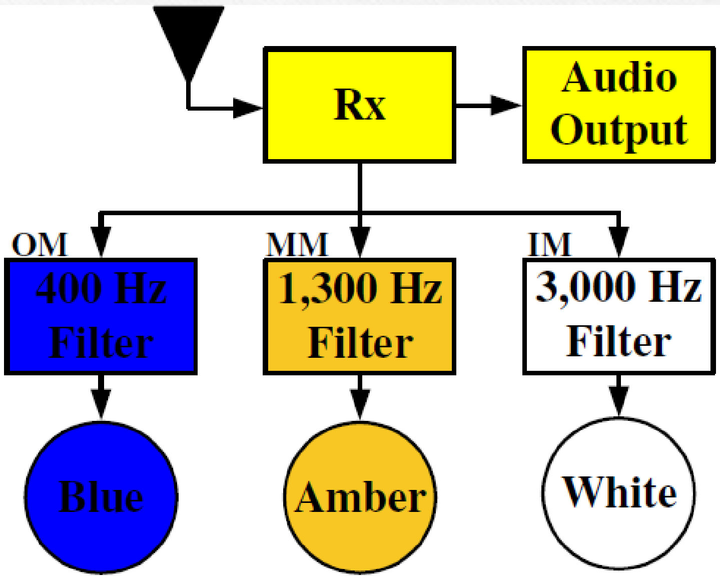


A case when the aircraft is located left of the runway's axis and too low under the glide slope



2) *MB–Rx*

- *Frequency: VHF*
- *Rx detected the signal sent by the GND MB-Tx and alerts the A/C crew audibly and visually.*



MB	Audible Alerts		Visual Alerts
	Tone Freq	Morse Code	Color
OM	400 Hz	Continuous: ▬	Blue
MM	1,300 Hz	Alternate: ● & ▬	Amber
IM	3,000 Hz	Continuous: ●	White

MB-Rx and its alerts ***left:[K3-29] right:[K6-28]***

Marker beacons

For the purpose of discontinuous addition of navigation data with the value of a momentary distance from the aircraft to the runway’s threshold, the following marker beacons are used:

The outer position marker (blue).

The middle marker (yellow).

The inner marker (white).

Outer Marker (OM)

- The outer marker is located 3.5-6 NM (5.556-11.112 km) from the runway's threshold.
- Its beam intersects the glide slope's ray at an altitude of approximately 1400 ft (426.72 m) above the runway.
- It also roughly marks the point at which an aircraft enters the glide slope under normal circumstances, and represents the beginning of the final part of the landing approach.
- The signal is modulated at a frequency of 400 Hz, made up by a Morse code – a group of two dots per second.
- On the aircraft, the signal is received by a 75 MHz marker receiver. The pilot hears a tone from the loudspeaker or headphones and a blue indicative bulb lights up.
- Anywhere an outer marker cannot be placed due to the terrain, a DME unit can be used as a part of the ILS to secure the right fixation on the localizer.
- In some ILS installations the outer marker is substituted by a Non Directional Beacon (NDB).

Middle Marker (MM)

- The middle marker is used to mark the point of transition from an approach by instruments to a visual one.

- It's located about 0.5-0.8 NM (926-1482 m) from the runway's threshold.

- When flying over it, the aircraft is at an altitude of 200-250 ft (60.96-76.2) above it.

- The audio signal is made up of two dashes or six dots per second. The frequency of the identification tone is 1300 Hz.

- Passing over the middle marker is visually indicated by a bulb of an amber (yellow) colour . It was removed in some countries, e.g. in Canada.

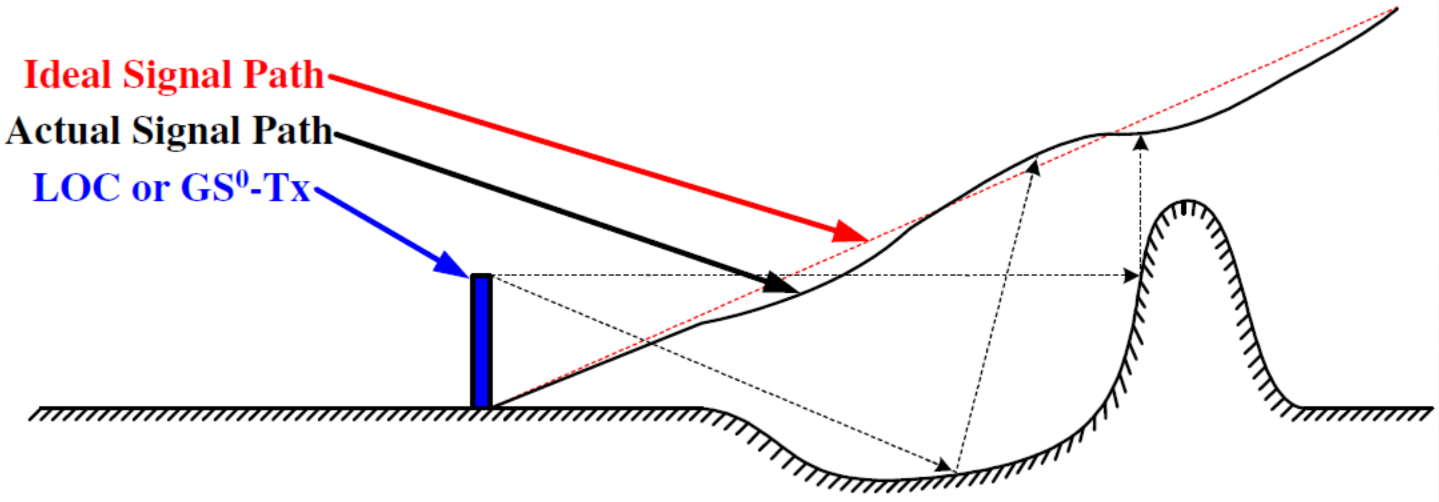
Inner Marker (IM)

- The inner marker emits an AM wave with a modulated frequency of 3000 Hz.

- The identification signal has a pattern of series of dots, in frequency of six dots per second.

- The beacon is located 60m in front of the runway's threshold.

- The inner marker has to be used for systems of the II. and III. category.



Terrain effect in ILS

- **Advantage:** ILS is a powerful system available for landing guidance.
- **Disadvantages:**

    1) *LOC and GS^0 signals suffer from bending due to site and terrain effect.*

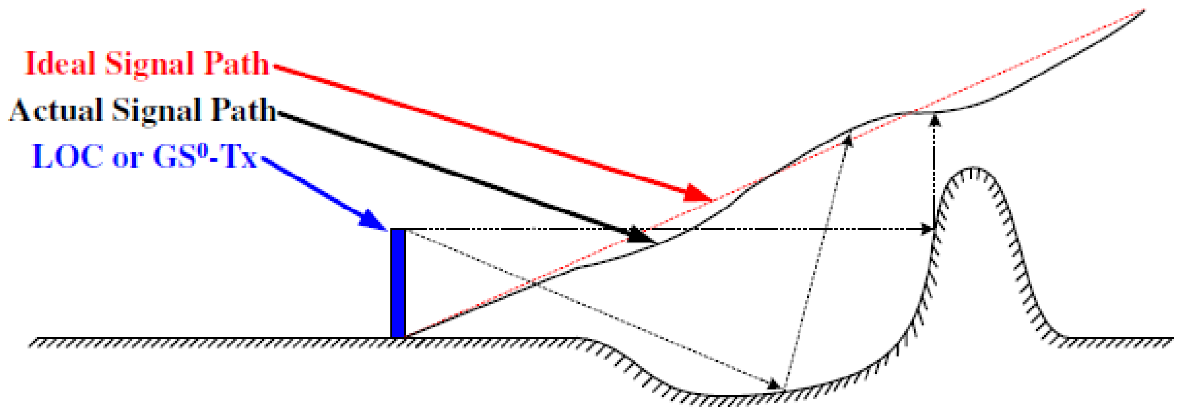


Figure-7.15 Terrain effect in ILS ***[K3-30]***

    2) *GS^0 signals are highly sensitive w.r.t. LOC; and therefore, they are also affected by:*
        - Snow
        - Airport GND moisture
        - Airport GND vehicle movement

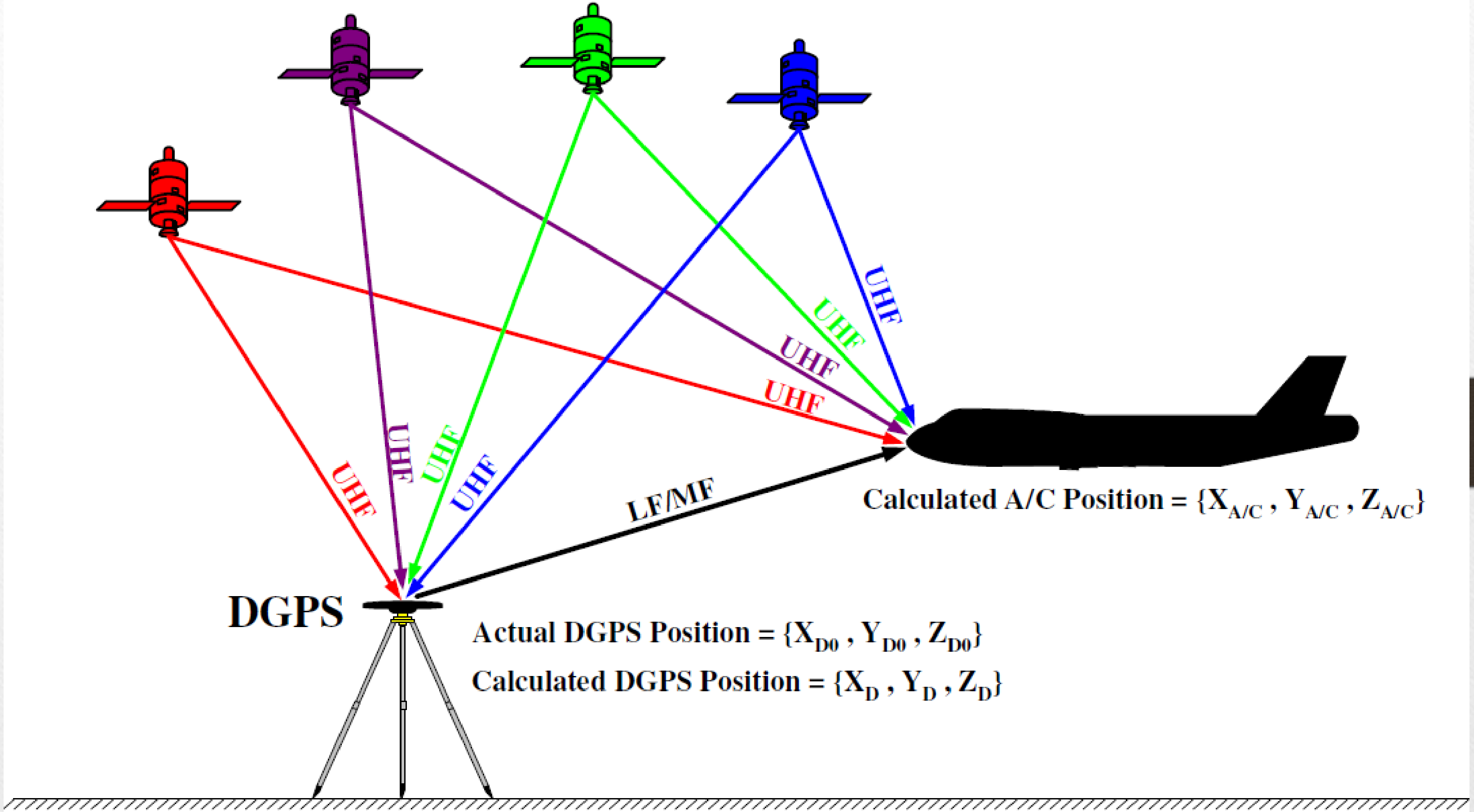
    3) *The path used for landing in ILS cannot be flexible; it must remain straight at all times.*

    4) *Only 20 frequency channels are available for LOC and GS^0 use.*

    5) *High cost of installation and maintenance.*

- **Future:** ILS is expected activity until *2010* in most A/Cs and airports; following that, it will remain available as a backup system in case an unexpected malfunction occurs to GPS and/or DGPS.

Satellites Landing Systems



DGPS used to correct A/C position fix

Thanks

Questions