Microwave Landing Systems

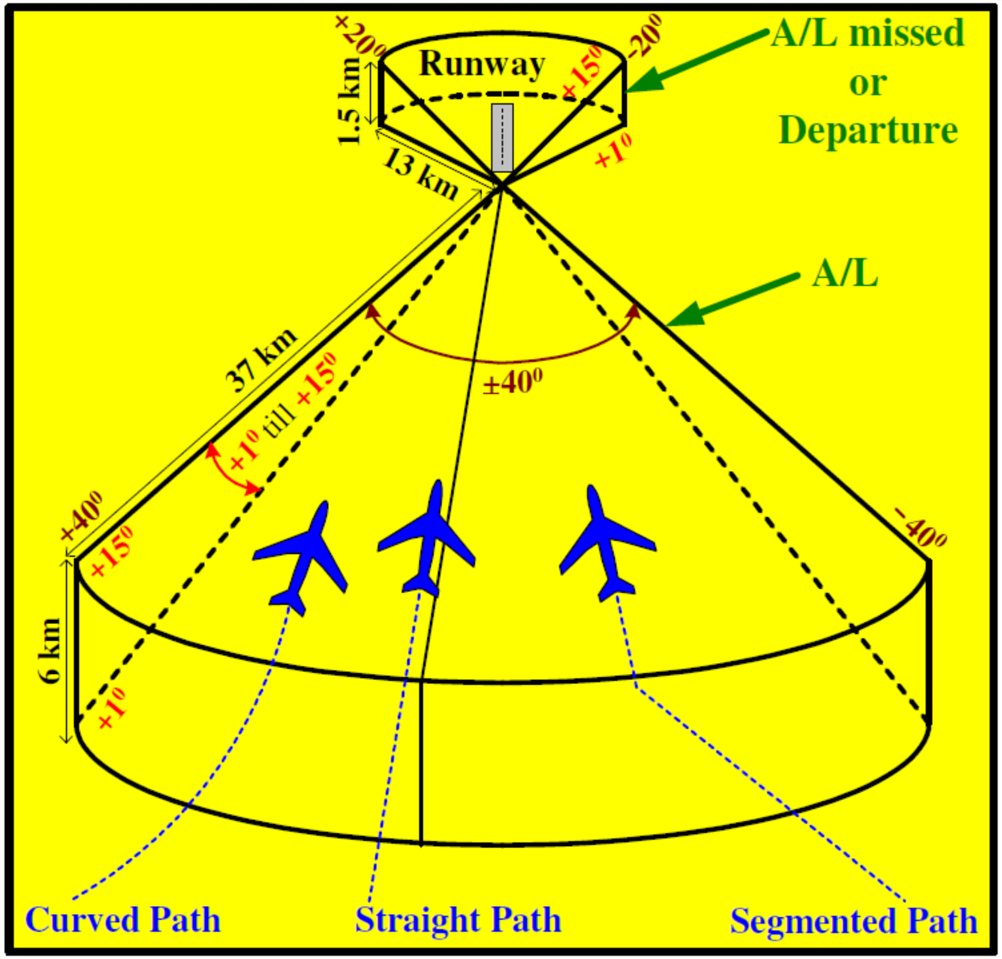
Principle:

Provides A/C guidance for curved or straight or segmented flight path landing. The main outputs obtained using MLS are bearing, slant distance, and ALT in the approach terminal area. Also it is important to mention the MLS system is exclusively used by MIL due to its flexibility in A/L as opposed to the CIV ILS.

- Usually a DME system (UHF) is integrated within the Azimuth-Tx (SHF), and hence the slant distance w.r.t. it is also available.

- Even though MLS is a MIL system, some EU countries, due to visibility conditions, have obtained license for commercial use to operate them as an alternative for ILS.

Microwave Landing Systems



MLS

INTRODUCTION

- The Microwave Landing System (MLS) was designed to replace ILS with an advanced precision approach system that would overcome the disadvantages of ILS and also provide greater flexibility to its users.
- However, there are few MLS installations in use at present and they are likely to co-exist with ILS for a long time.
- MLS is a precision approach and landing system that provides position information and various ground to air data.
- The position information is provided in a wide coverage sector and is determined by an azimuth angle measurement, an elevation measurement and a range measurement.

ILS DISADVANTAGES

ILS has the following disadvantages:

- There are only 40 channels available worldwide.
- The azimuth and glideslope beams are fixed and narrow. As a result, aircraft have to be sequenced and adequately separated which causes landing delays.
- There are no special procedures available for slower aircraft, helicopters, and Short Take Off and Landing (STOL) aircraft.
- ILS cannot be sited in hilly areas and it requires large expanses of flat, cleared land to minimize interference with the localizer and glideslope beams.
- Vehicles, taxying aircraft, low-flying aircraft and buildings have to be kept well away from the transmission sites to minimize localizer and glideslope course deviations (bending of the beams).

THE MLS SYSTEM

The Microwave Landing System (MLS) has the following features:

- There are 200 channels available worldwide.
- The azimuth coverage is at least ± 40° of the runway on-course line (QDM) and glideslopes from .9° to 20° can be selected.
- The usable range is 20-30 nm from the MLS site; 20nm in the UK.
- There is no problem with back-course transmissions; a secondary system is provided to give overshoot and departure guidance ± 20° of runway direction up to 15° in elevation to a range of 10 nm and a height of 10,000 ft.

THE MLS SYSTEM

The Microwave Landing System (MLS) has the following features:

- It operates in the SHF(Super High Freq.) band, 5031 - 5090 MHZ.
- This enables it to be sited in hilly areas without having to level the site.

- Course deviation errors (bending) of the localizer and glidepath caused by aircraft, vehicles and buildings are no longer a problem because the MLS scanning beam can be interrupted and therefore avoids the reflections.

THE MLS SYSTEM

The Microwave Landing System (MLS) has the following features:

- Because of its increased azimuth and elevation coverage aircraft can choose their own approaches. This will increase runway utilization and be beneficial to helicopters and STOL aircraft.

- The MLS has a built-in DME.

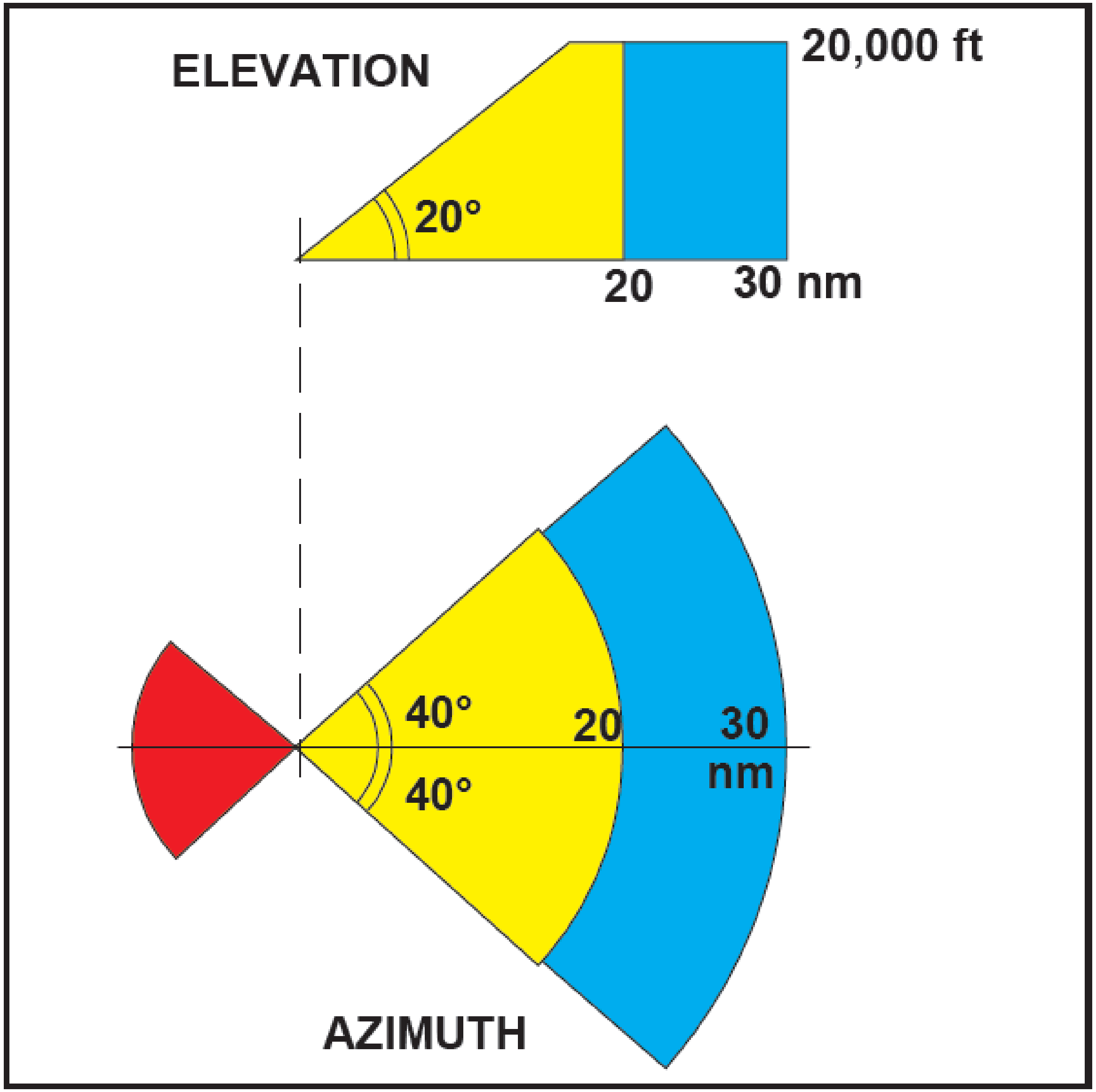
- MLS is compatible with conventional localiser and glidepath instruments, EFIS, auto- pilot systems and area navigation equipment.

- MLS gives positive automatic landing indications plus definite and continuous on/off flag indications for the localiser and glideslope needles.

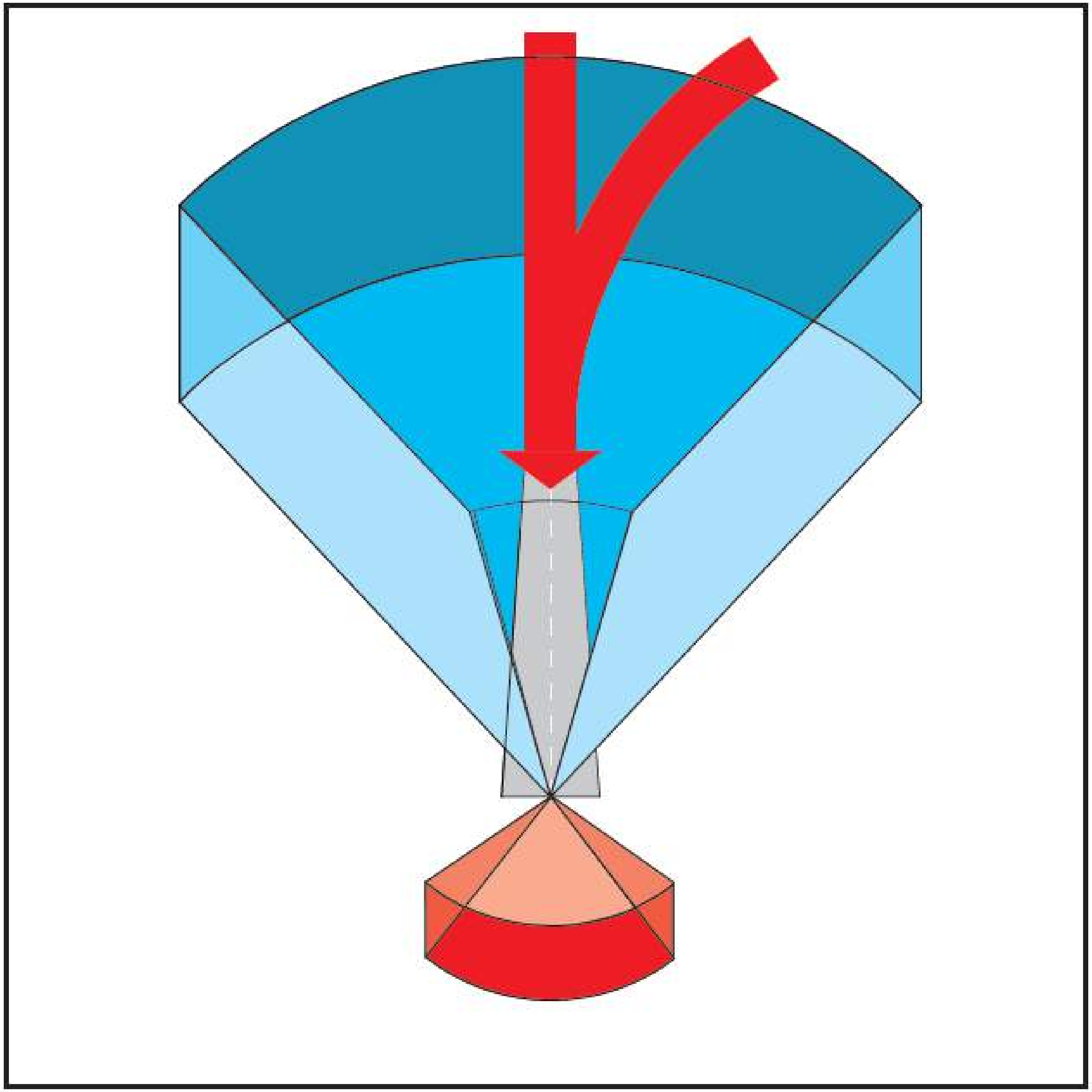
- The identification prefix for the MLS is an ‘M’ followed by two letters.

- The aim is for all MLS equipped aircraft to operate to CAT III criteria.

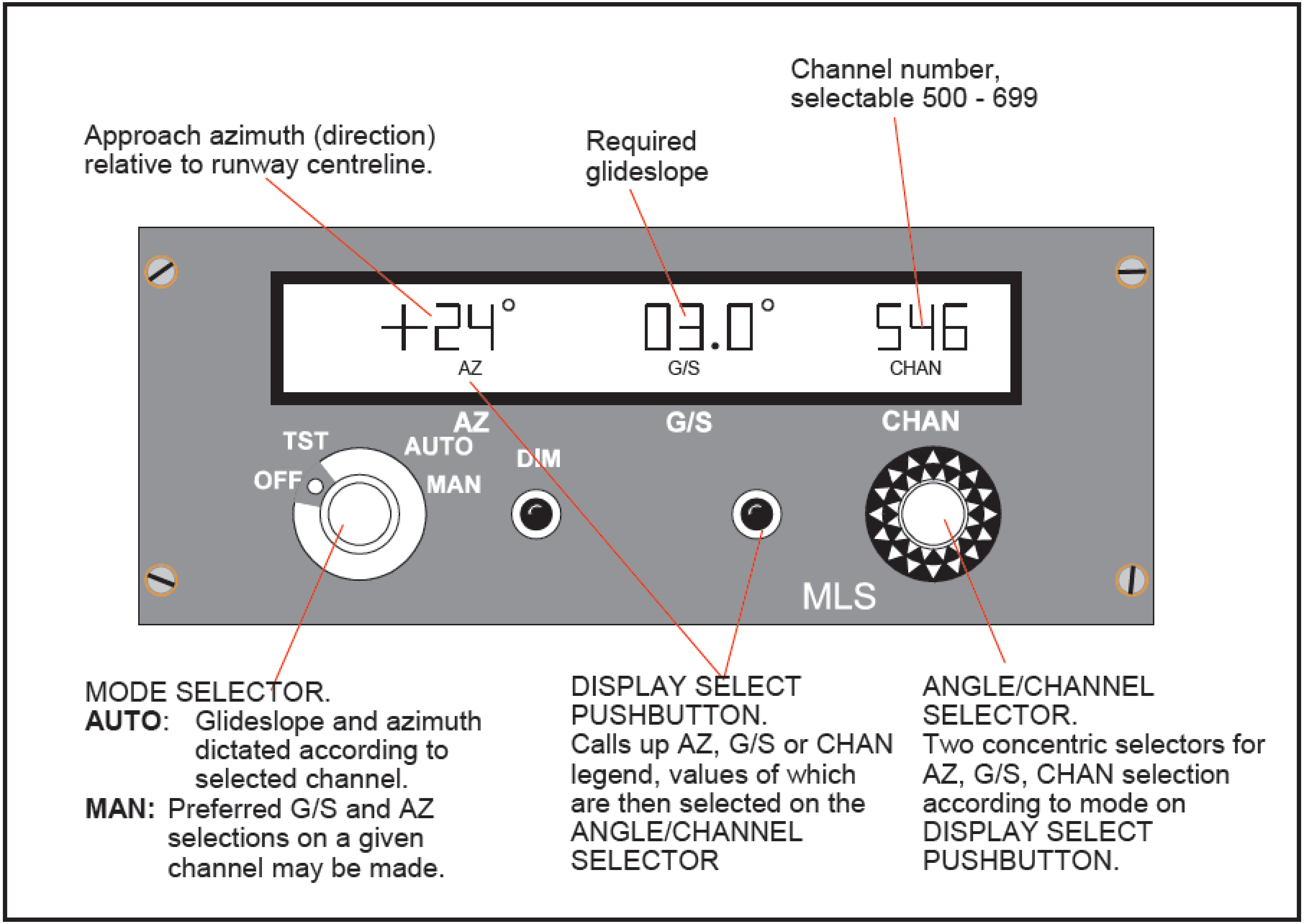
➢ Figures below show some of these features.



MLS coveraage



Approach coverage volume



Typical MLS flight deck control panel

PRINCIPLE OF OPERATION

MLS employs the principle of Time Division Multiplexing (TDM) *(see Figure 10.5)* whereby only one frequency is used on a channel but the transmissions from the various angle and data ground equipments are synchronised to assure interference free operations on the common radio frequency.

- **Azimuth location:-**

Time referenced scanning beam (TRSB) is utilised in azimuth and elevation as follows:

- The aircraft computes its azimuth position in relation to the runway centre-line by measuring the time interval in microseconds between the reception the ‘to’ and ‘fro’ scanning beams.

- The beam starts the ‘to’ sweep at one extremity of its total scan and travels at a uniform speed to the other extremity. It then starts its ‘fro’ scan back to its start position.

- **<u>Azimuth location:-</u>**

- The pilot can choose to fly the runway on-course line (QDM) or an approach path which he selects as a pre-determined number of degrees ± the runway direction. *(See Figure 10.4)*.

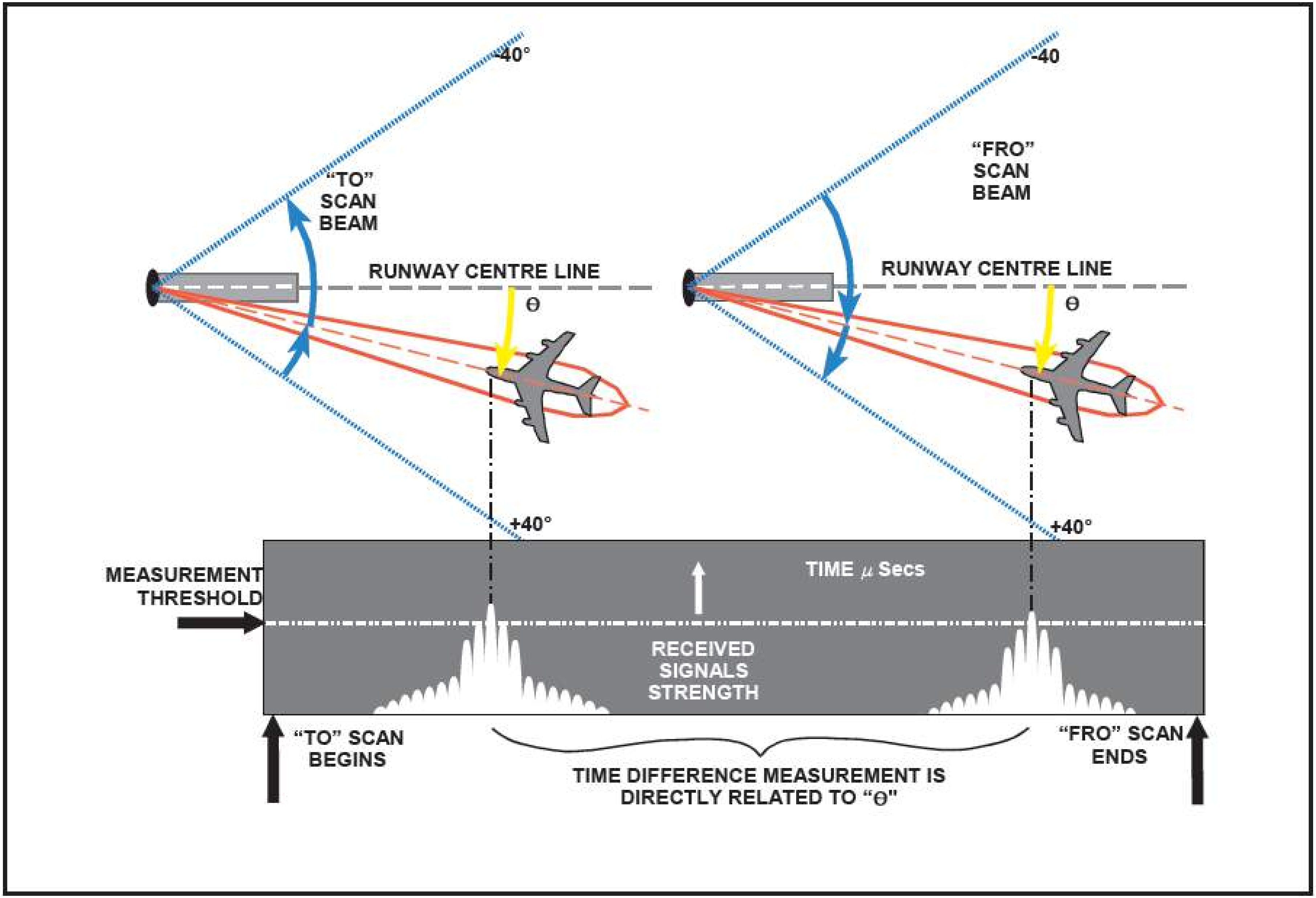
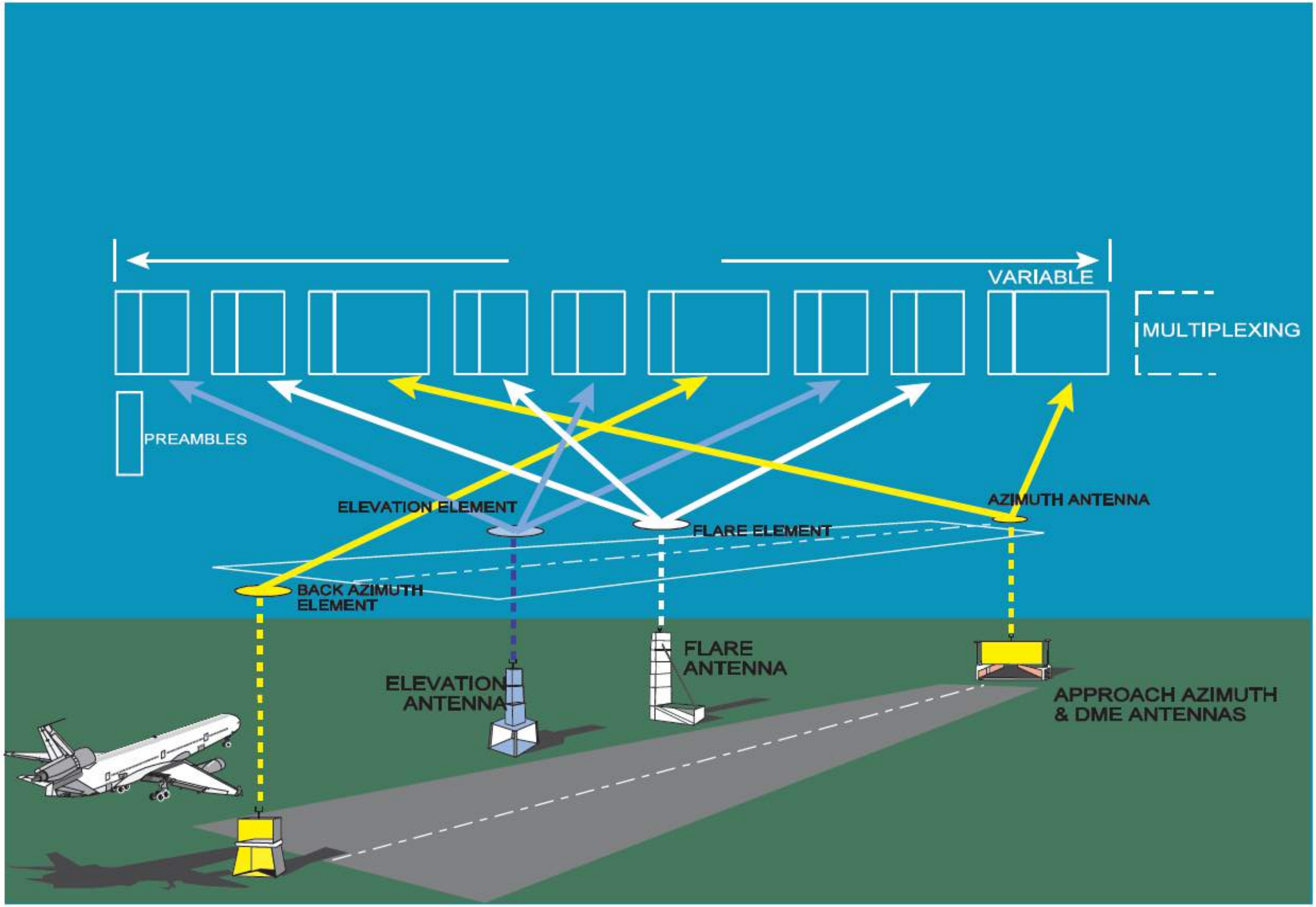

-40°
-40
"TO"
SCAN
BEAM
"FRO"
SCAN
BEAM
RUNWAY CENTRE LINE
RUNWAY CENTRE LINE
Θ
Θ
+40°
+40°
MEASUREMENT
THRESHOLD
TIME μ Secs
RECEIVED
SIGNALS
STRENGTH
"TO" SCAN
BEGINS
"FRO" SCAN
ENDS
TIME DIFFERENCE MEASUREMENT IS
DIRECTLY RELATED TO "Θ"

Figure 10.4



TRSB Component Site

- **Glideslope location** :-

- Another beam scans up and down at a uniform speed within its elevation limits.
- The aircraft's position in relation to its selected glideslope angle is thus calculated in the same manner by measuring the time difference between the reception of the pulses from the up and down sweep.
- The transmissions from the two beams and the transmissions from the other components of the MLS system are transmitted at different intervals i.e. it uses ' time multiplexing'.

➢ PRINCIPLE OF OPERATION

Other components of the system are:

- **Flare.** Although the standard has been developed to provide for flare elevation, this function is not intended for future implementation.

- **Back azimuth.** Gives overshoot and departure guidance ± 20° of runway direction up to 15° in elevation.

- **DME** Range along the MLS course is provided not by markers but by a DME. For Cat II and III approaches a precision DME (DME/P) that is accurate to within 100 feet must be available.

- Transmission of auxillary data. This consists of:
  - station identification
  - system condition
  - runway condition
  - weather information

AIRBORNE EQUIPMENT

The airborne equipment is designed to continuously display the position of the aircraft in relation to the preselected course and glide path along with distance information during approach as well as during departure.

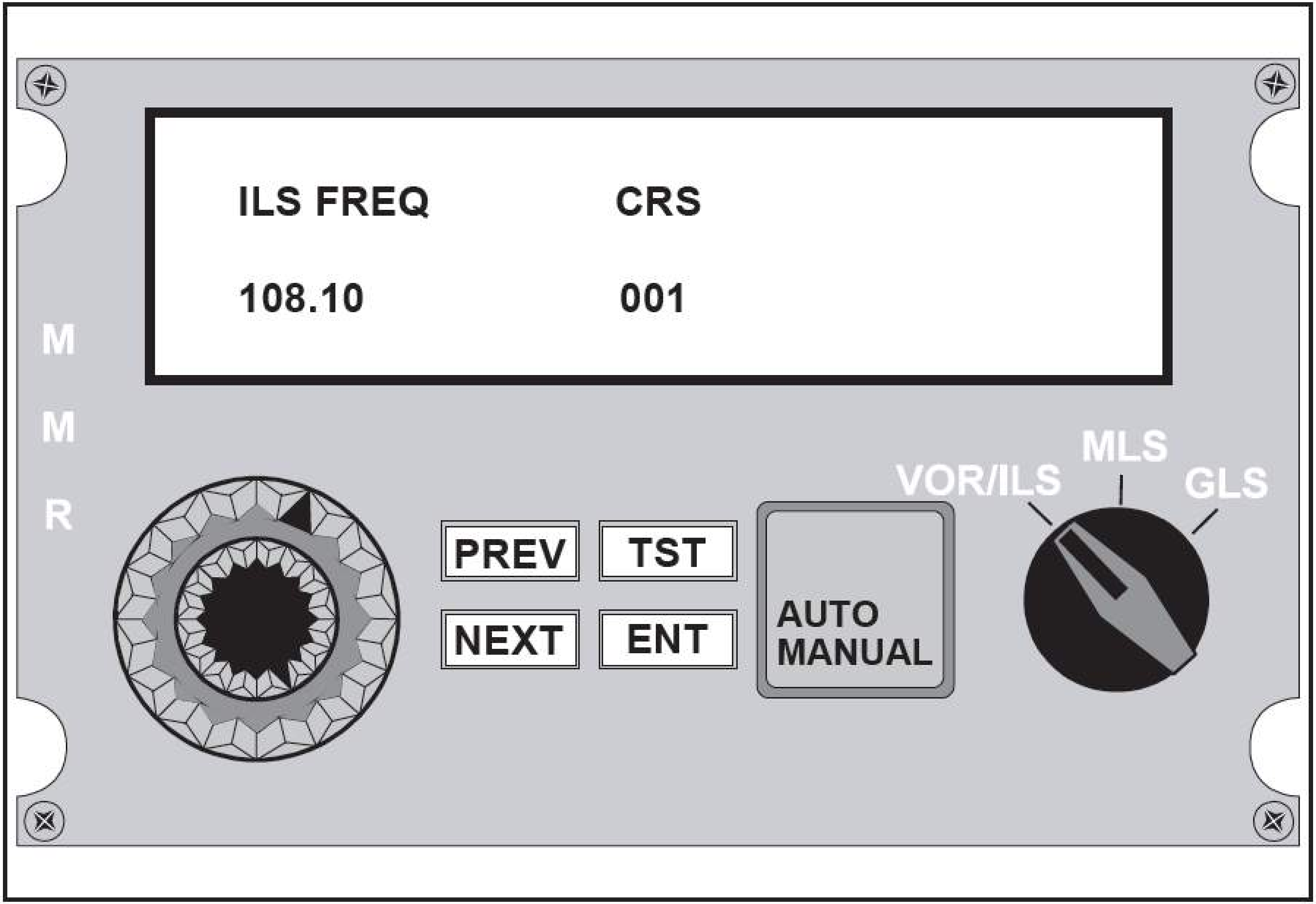
Display

The display consists of two cross bars similar to an ILS display except that the indications are given relative to the selective course.

It is possible to program the computer to give segmented approaches and curved approaches for which a DME-P must be installed on the ground.

Control Unit

In order to receive ILS, MLS and GPS transmissions, aircraft are equipped with multi-mode receivers and a combined control unit for ease of use by the flight crew. An example of such a control unit is shown at *Figure below.*



MRC Control Panel

On the GND:

1) Azimuth–Tx

- *Function:* *Provides bearing information.*
- *NAV:* *Horizontal Guidance.*
- *Quantity per runway*: *2*
- *Location:* *One is placed at the end of the runway, and the other one at the beginning.*
- *Frequency:* *SHF 5.031 – 5.0907 GHz*
- Number of Channels: *200*
- *Horizontal Range of Operation -37 km*
- *Deviation from Centerline -* ±*40 Deg [i.e. 80 Deg]*

- The one located at the end of the runway is used for approaching A/Cs, whereas the one located at the front of the runway is used for either missed approaches or for departure NAV.
- MLS horizontal guidance has a coverage area *20-times* that of ILS (*20* × *40 = 800*).

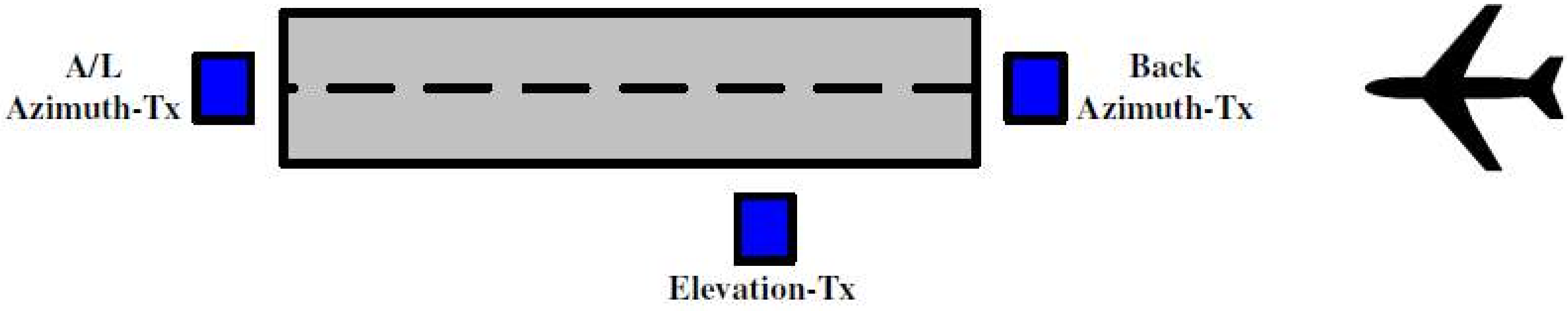
2) ***Elevation–Tx***

- *Function:* *Provides ALT information.*
- *NAV:* *Vertical Guidance.*
- *Quantity per runway:* *1*
- *Location:* *On the side of the runway.*
- *Frequency:* *SHF 5.031 – 5.0907 GHz*
- Number of Channels: *200*
- *Vertical Range of Operation* - *6 km*
- *Typical MLS Inclination* - *8 Degree*
- *Deviation from MLS -* *±7 Degree [i.e. 14 Degree]*

- Even though Azimuth and Elevation-Txs transmit at the same frequency, there is no critical signal interference among them due to timeshared operations.

- MLS vertical guidance has a coverage area *10-times* that of ILS ($10 \times 1.40 = 140$).

Microwave Landing Systems



Configuration of MLS GND systems

Microwave Landing Systems

Azimuth-Tx

Elevation-Tx

Azimuth and Elevation-Txs

Microwave Landing Systems

- **In the A/C:**

1) *Rx: MLS-Rx system.*
2) *Frequency: SHF*

3) *Primary outputs from MLS:*
   - Bearing / Slant Distance
   - ALT

4) *Secondary outputs from MLS:*
   - Meteorological info
   - Runway Status
   - Etc.

Microwave Landing Systems

- **Advantages:**

1) *Improved guidance accuracy with greater coverage area.*
2) *Provide flexible landing path NAV.*
3) *Offers guidance for missed approaches and departure NAV.*
4) *MLS has low sensitivity from weather conditions and airport GNS traffic as oppose to ILS.*
5) *MLS offers 200 frequency channels, 10-times more than ILS.*
6) *Low cost of installation and maintenance.*

- **Disadvantage:**

The use of MLS is not quite spread among CIV A/Cs.

- **Future:**

Similar to ILS, MLS is expected to be phased-out due to GPS and DGPS improved accuracy.

FREQUENCY	DESCRIPTION
30 GHz – 300 GHz	Extremely high frequency (EHF)
3 GHz – 30 GHz	Super high frequency (SHF)
300 MHz – 3 GHz	Ultrahigh frequency (UHF)
30 MHz – 300 MHz	Very high frequency (VHF)
3 MHz – 30 MHz	High frequency (HF)
300 kHz – 3 MHz	Medium frequency (MF)
30 kHz – 300 kHz	Low frequency (LF)
3 kHz – 30 kHz	Very low frequency (VLF)
300 Hz – 3 kHz	Voice frequency
up to 300 Hz	Extremely low frequency (ELF)

Thanks
Questions