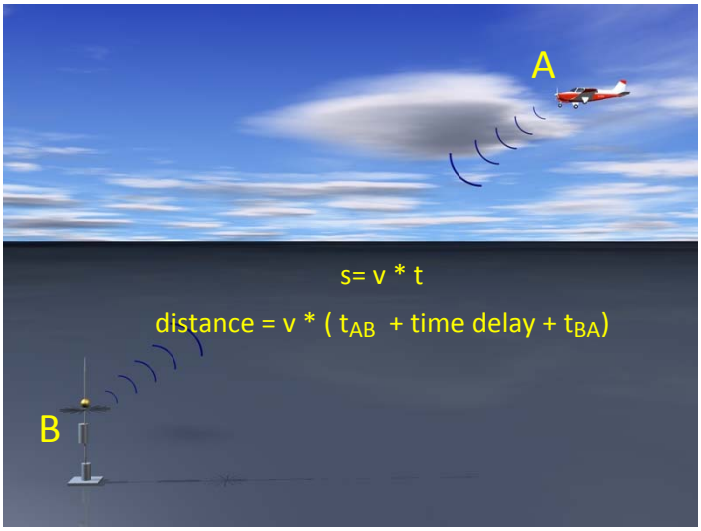
DME

Distance Measurement Equipment is a transponder-based radio navigation technology that measures distance by timing the propagation delay of VHF or UHF radio signals



The aircraft sends an interrogation signal with a series of pulses. These signals will take some time to reach the DME station (t_{AB}). When the ground station has locked onto the signal (time delay) it will send back a signal for confirmation (t_{BA}). The total time it took to send and receive the signals will be converted now by the DME equipment into a distance.

Note: Not all VOR's have DME !! and the DME station doesn't have to be at the same position as the VOR station !!

switch between NAV1 and NAV2 readings

the distance to the tuned DME station is 4.6 nm (slant range)

GS indication in knots (only useful when tracking the VOR)

Slant range

the Slant range is the line-of-sight distance between your aircraft and the ground station.

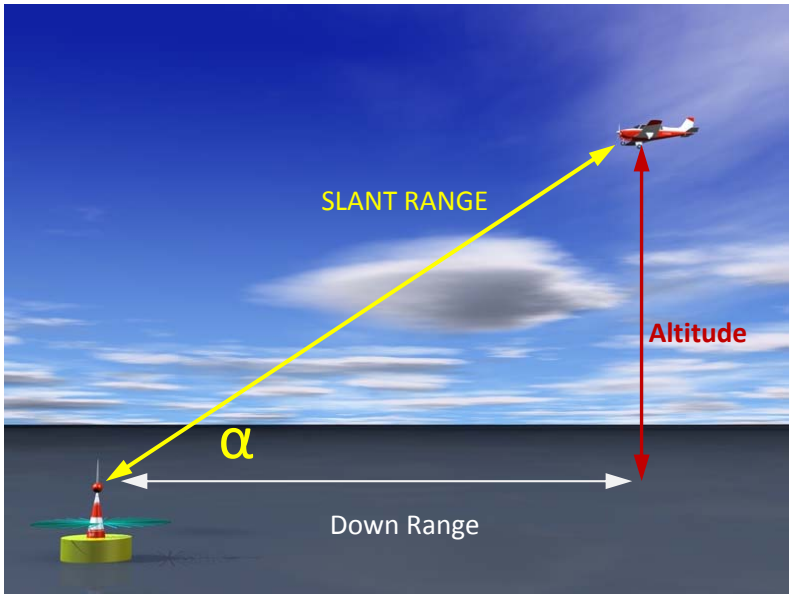


figure: 1

The Slant range indicates the straight horizontal distance when on the ground and at the same level as the ground station!

The Slant range indicates the altitude when exactly overhead the station.
For that reason...the basic DME equipment in small aircrafts is purely an indication and it will never read 0 unless you park your aircraft on top of the DME station ☺

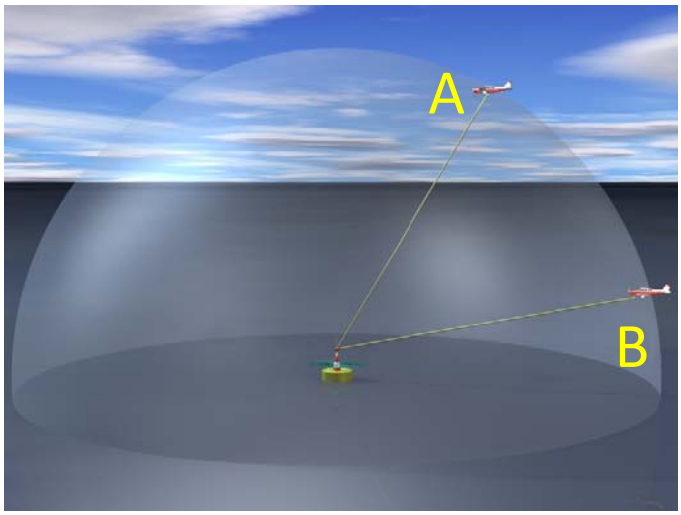


figure: 2

This situation clearly shows that both aircraft A and B have the same DME reading but it doesn't mean that they are about to hit each other

But how come big airliners read 0 DME when they overfly a VOR station??

well...as we have seen from figure nr 1, DME equipment gives you the slant range. If we know our altitude we could easily calculate with some math the DOWN RANGE (ground distance) according to:

downrange = slant range * cos α

but in reality it's not that easy because this equation only works if the earth is flat and no other effects will interfere with the transmission of the radio signals.

Have a look at the following situation:

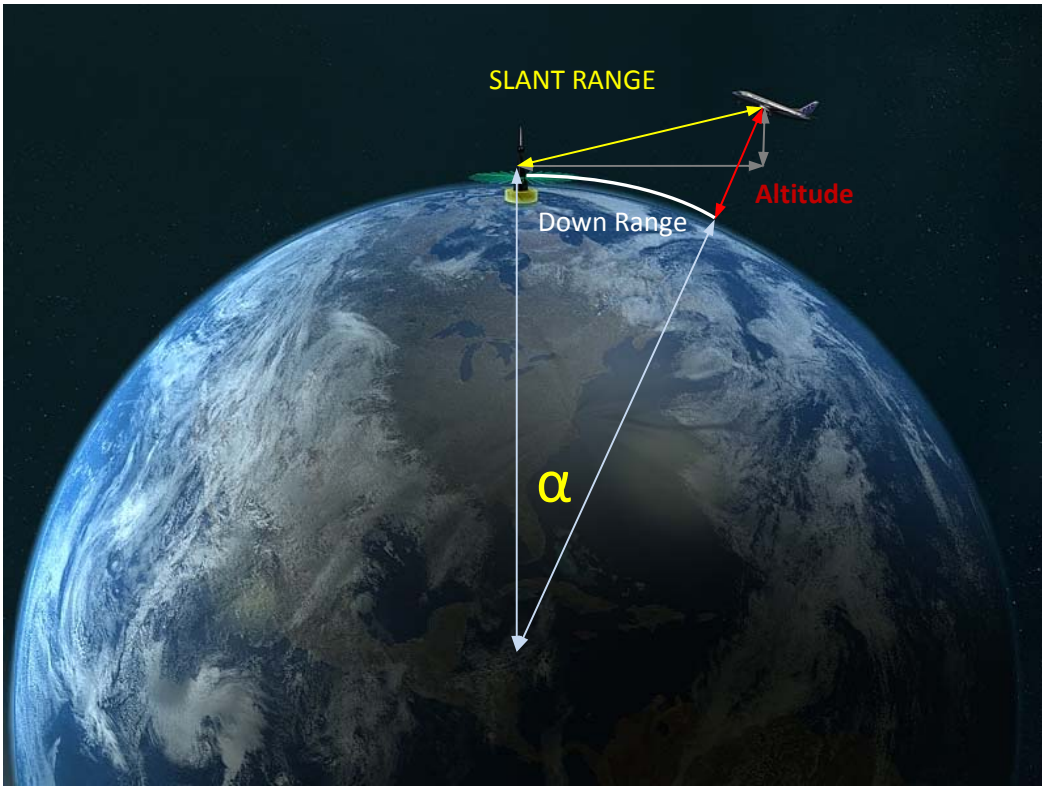


figure: 3

Aircraft flying at high altitude will have to deal with the earth's curvature. The downrange is no longer a straight line.

Other refraction effects like :

The transmitted wavelength of the radio signal
The barometric pressure
The air temperature
The atmospheric humidity
Coastal refractions
Mountain reflections etc...

requires very costly and highly complex equipment in order to calculate the GROUND distance. So ...for that reason....small aircrafts are equipped with simple DME instruments which will provide you a SLANT RANGE only.

Ground speed indication

Since your DME equipment measures the propagation time between your aircraft and the DME station it can calculate an estimated distance as well as an estimated groundspeed !
The interrogation signal is transmitted in fixed time intervals. Each time interval the distance is compared to the previous distance. With the difference in distance and the difference in time, the speed can now be calculated according to :

$$groundspeed = \frac{\delta\, distance}{\delta\, time}$$

figure: 4

Groundspeed indication of 74 knots

Remember:

1. The speed in your DME equipment is an indication only because your DME equipment measures the Slant range!
2. The Speed indication from your DME equipment will only make sense if you fly in a straight line to the station! (track a radial)
3. If you fly on a perfect circle around the DME station, the distance will remain the same and therefore your speed indication will be 0