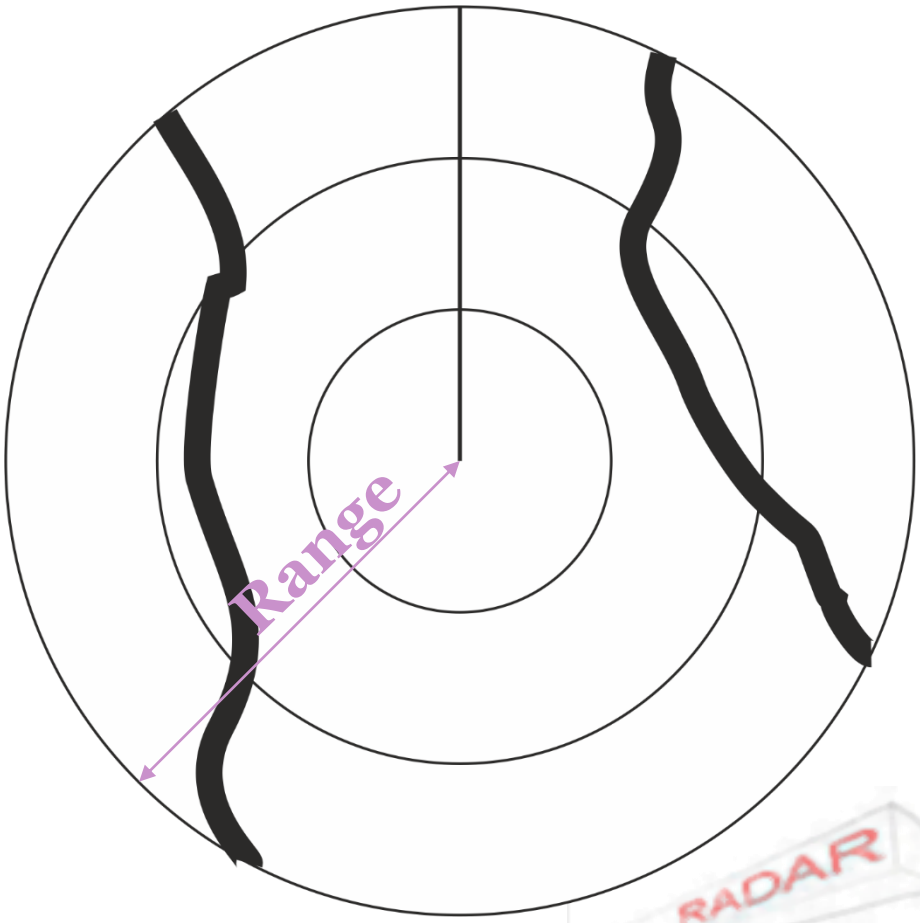
Radiolocation 3

Orientation and presentation of radar picture, interpretation of echoes movement

Range scale

- Range scale (Range) is the radius length of the operational area when is centered, expressed in Nm



Range scales according to IMO

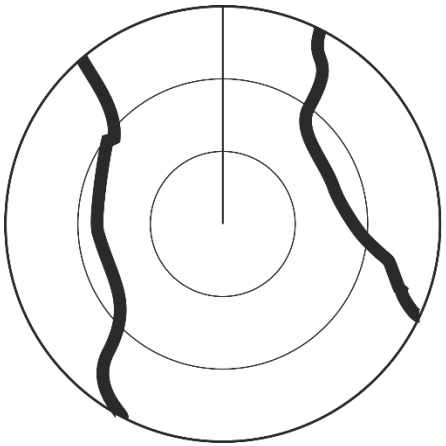
- Marine navigational radars use standardized range scales of observation. The following observation ranges are required in accordance with the requirements of the IMO resolutions [IMO, 2004]:

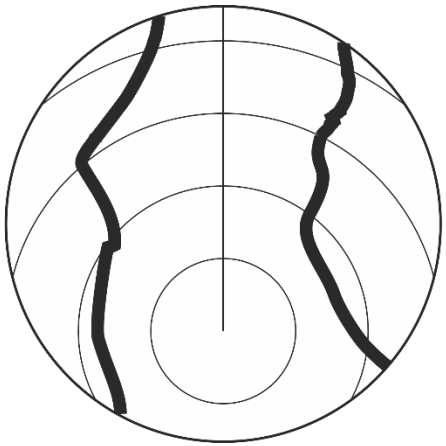
0.25	Nm,	3	Nm,
0.5	Nm,	6	Nm,
0.75	Nm,	12	Nm,
1.5	Nm,	24	Nm.

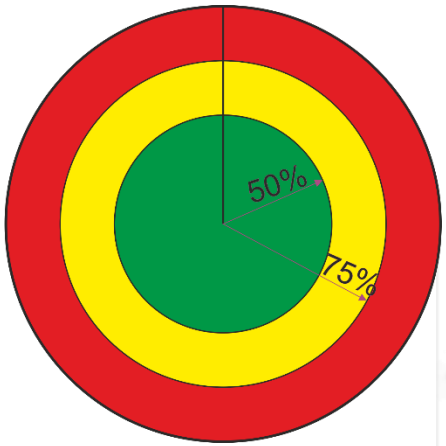
The resolution also permits additional ranges of observation, both smaller than 0.25 Nm and larger than 24 Nm.

Off-centering

- Do not identify the currently selected observation range with the maximum distance of detected echo. In marine radars, it is possible to off-center (decentralize) the radar image by moving the antenna position into chosen direction.
- Off-center – up to at least 50% not more then 75%

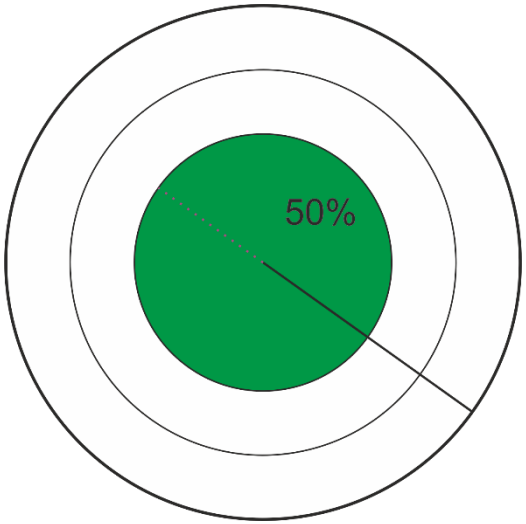






Off-centering

- A facility for automatically positioning own ship for the maximum view ahead may be provided.
- In True Motion, the selected antenna position should automatically reset up to a 50% radius to a location giving the maximum view along own ship's course. Provision for an early reset of selected antenna position should be provided.



Selection of the range scale

- The general rule is to choose such a range scale, for the given conditions, which will ensure:
  - The best radar discrimination,
  - The best radar measurement accuracy,
    - The accuracy of radar measurements (distance and bearing) depends, among other things, on the distance between the object and the radar, as well as on the relative distance of the echo from the center of the display operational area.
  - to take, early enough, an anti-collision maneuver.
    - COLREG, rules 5, 6, 7 (observation, sefe speed, risk of collision)

The orientation and presentation

- The orientation of the radar image determines the reference direction when measuring horizontal angles (true bearings or relative bearings).
- The presentation determines the manner of presenting the movement of the own ship and other objects.
- The combination of orientation and presentation have a fundamental importance in determining the parameters of echo motion and anti-collision plots.

Trails

- Tracks displayed by the radar echoes of targets in the form of an afterglow. Trails may be true or relative.
- Variable length (time) target trails should be provided, with an indication of trail time and mode. It should be possible to select true or relative trails from a reset condition for all true motion display modes
- The trails should be distinguishable from targets.
- Trails should be maintained and should be available for presentation within 2 scans or equivalent, following:
  - the reduction or increase of one range scale;
  - the offset and reset of the radar picture position; and
  - a change between true and relative trails.

Vectors

- True vector: Vector representing the predicted true motion of a target, showing course and speed with reference to the ground.

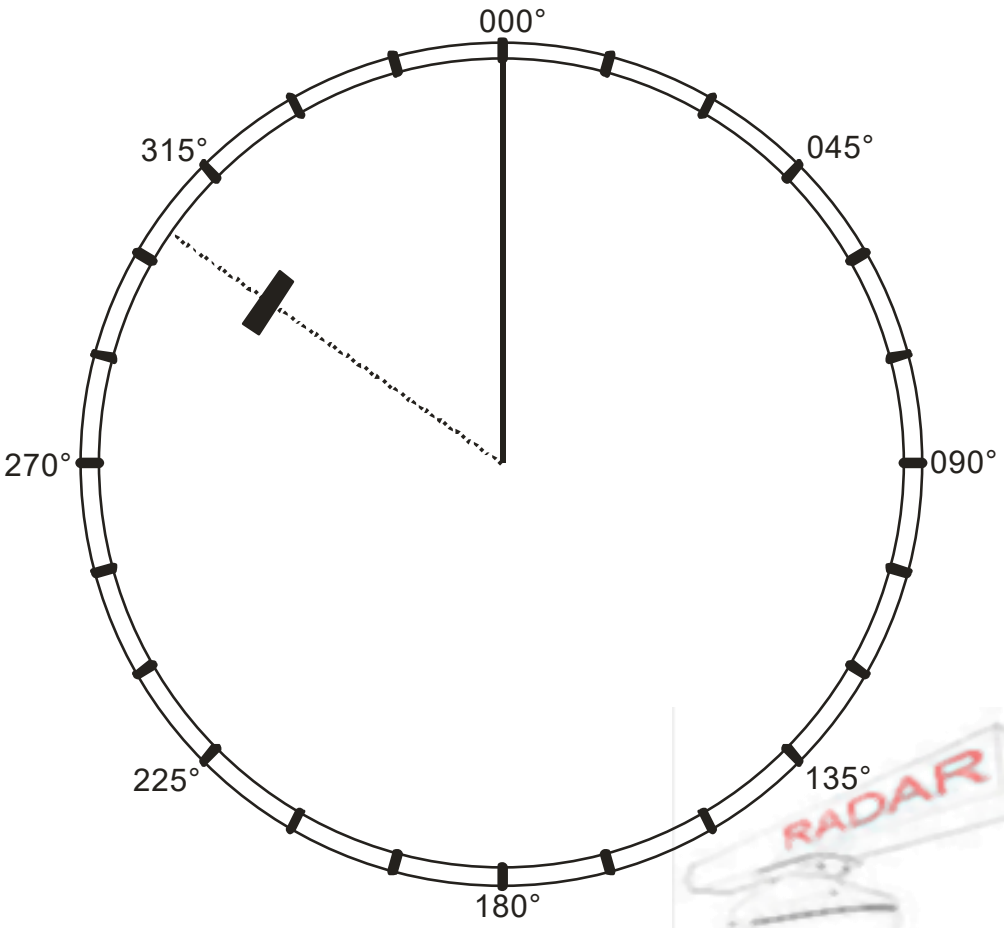
- Relative vector: Predicted movement of a target relative to own ship's motion.

Display orientation

- The following types of radar image orientation can be distinguished (picture orientation):
  - H-up - head up,
  - N-up - north up,
  - C-up - course up

Head-up

- An unstabilized presentation in which own ship's heading is uppermost on the presentation (000°)
- relative courses can be determined using radar's measurement facilities
- True bearing can be calculated by adding the true course.



Head-up, advantages

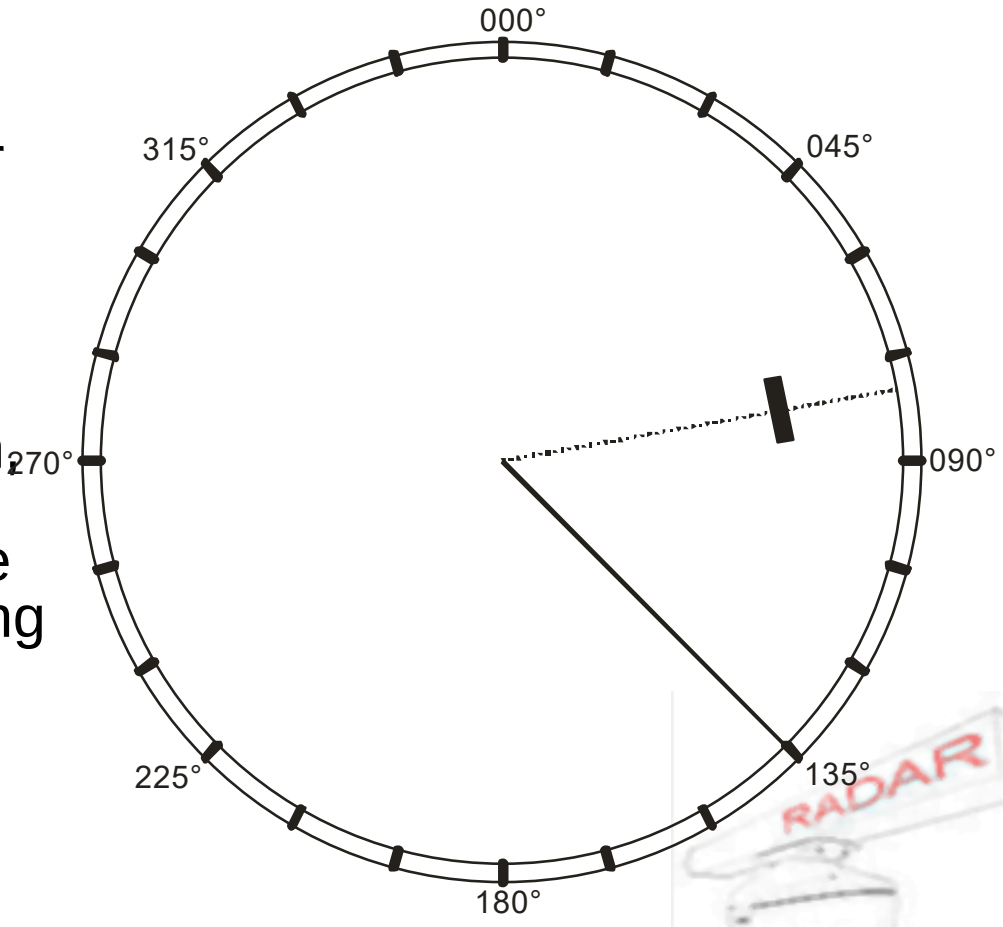
- The advantages of this orientation are undoubtedly the similarity of the situation surrounding the ship with its projection on the radar screen.
- It is very easy to identify the directions observed on the screen with the surroundings.
- Most oftenit is used in narrow passages and port approaches.

Head-up, disadvantages

- The disadvantages include difficulties in accurately determining the relative bearings because the entire radar image will rotate due to the "yaw" about the correct course or due to changing of the course.
- The vessel's course alternations will also affect the angular dimensions of the radar echoes and the trails generated by them.

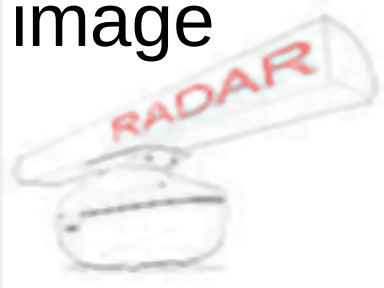
North-up

- an azimuth stabilized presentation
  which uses the gyro input (or equivalent) and north is uppermost on the presentation.
- 000° on the outer bearing scale indicates the true north, while the position of the heading line is in accordance with the current ship's heading (true course)
- directions determined using radar measurement markers are true bearings



North-up, zalety

- The advantages of this orientation include the lack of blurring echoes and trails due to the yaw or due to the changing course of the own vessel.
- In this case, a course alternation causes the position change of the heading line only and not the whole image (head-up).
- Using this orientation, the observer can easily identify the echo by comparing the radar image with the navigational map.

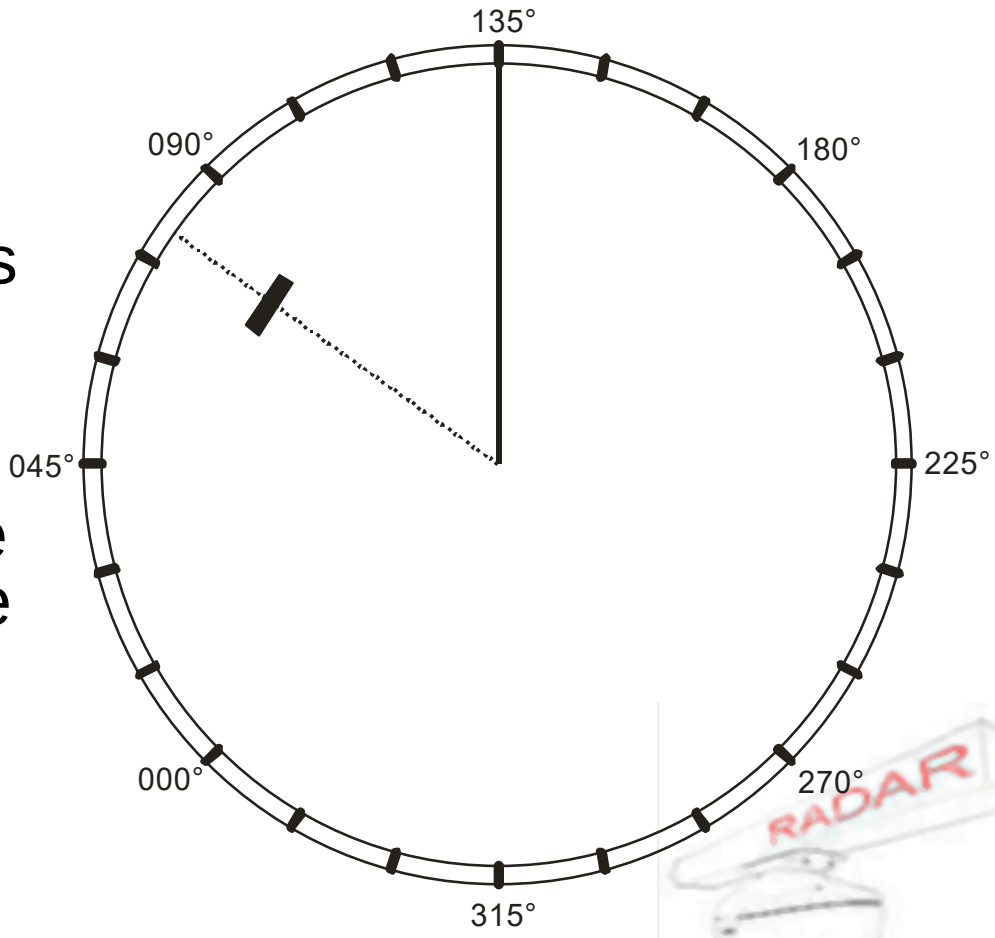


North-up, disadvantages

- The disadvantage of this orientation is that it is not as natural as the head-up one.
  The navigation in narrow passages and approaches could be more difficult, especially if the true courses are close to 180°.
  Therefore, the North-up orientation should be used in open waters.

Course-up

- an azimuth stabilized presentation which uses the gyro input or equivalent and the ship's course is uppermost on the presentation at the time of selection.
- The vertical heading line indicates the true course on the external scale
- The read directions are true bearings



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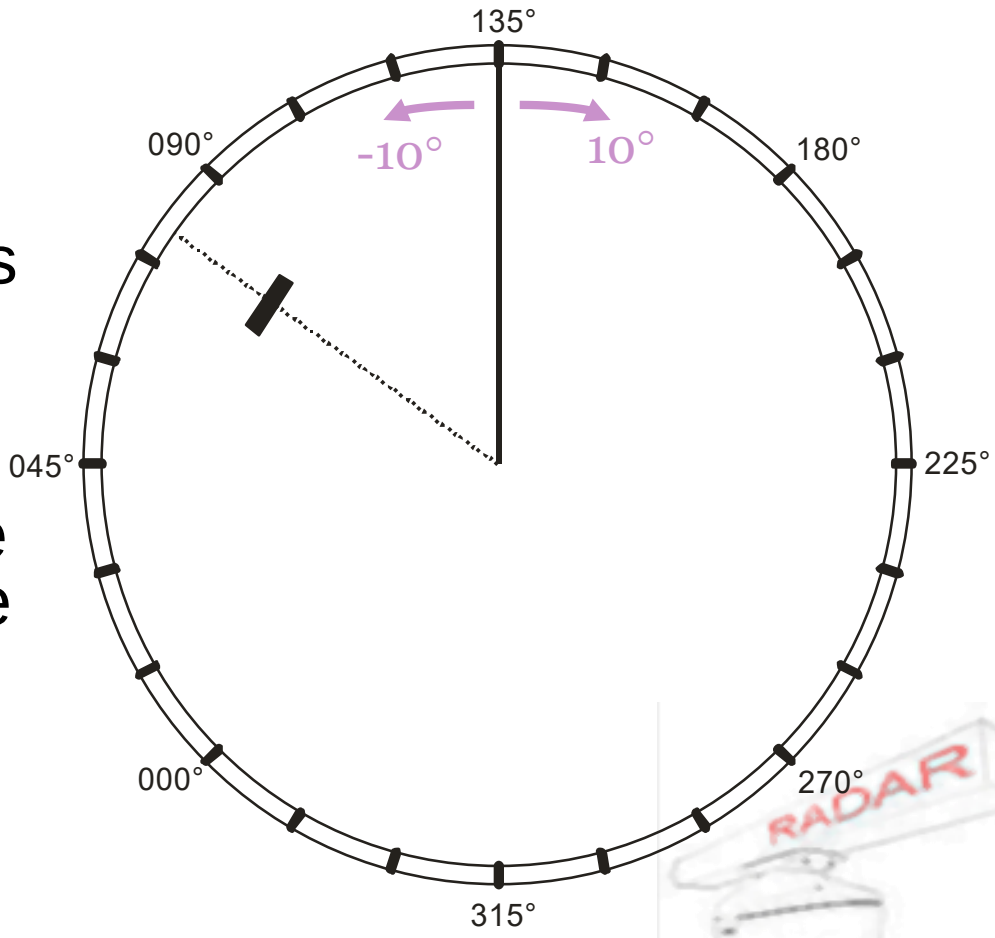

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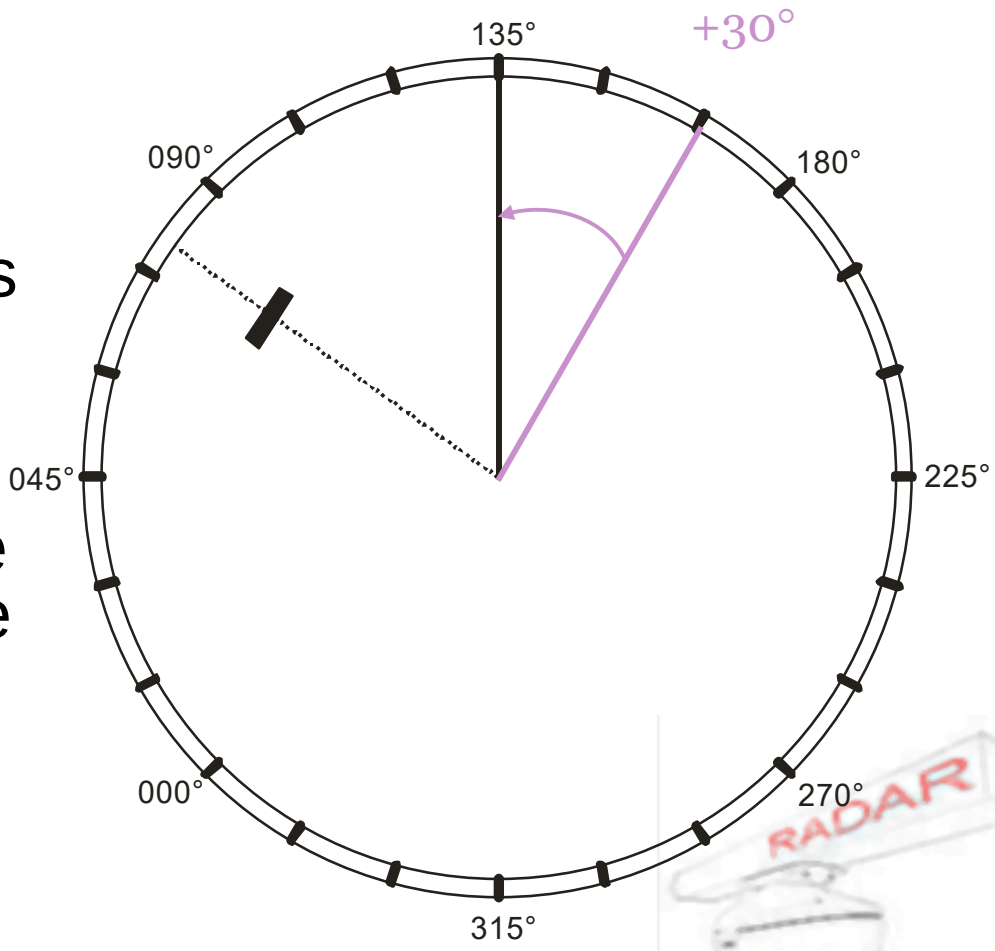


Course-up, advantages

- It is similar to head up orientation, but without the echo blur caused by yaw or course alternation. Only the heading line is rotated (in some radars, after changing the course, the position of the heading line has to be reset).
- An additional advantage of this orientation with respect to the head up is the ability to obtain a true bearing directly from the radar indicator without the need to add the true course.

Motion presentations

- The following types of motion presentations are distinguished (picture presentation):
  - RM - relative motion,
  - TM - true motion,
  - CD - centered display or constant display.

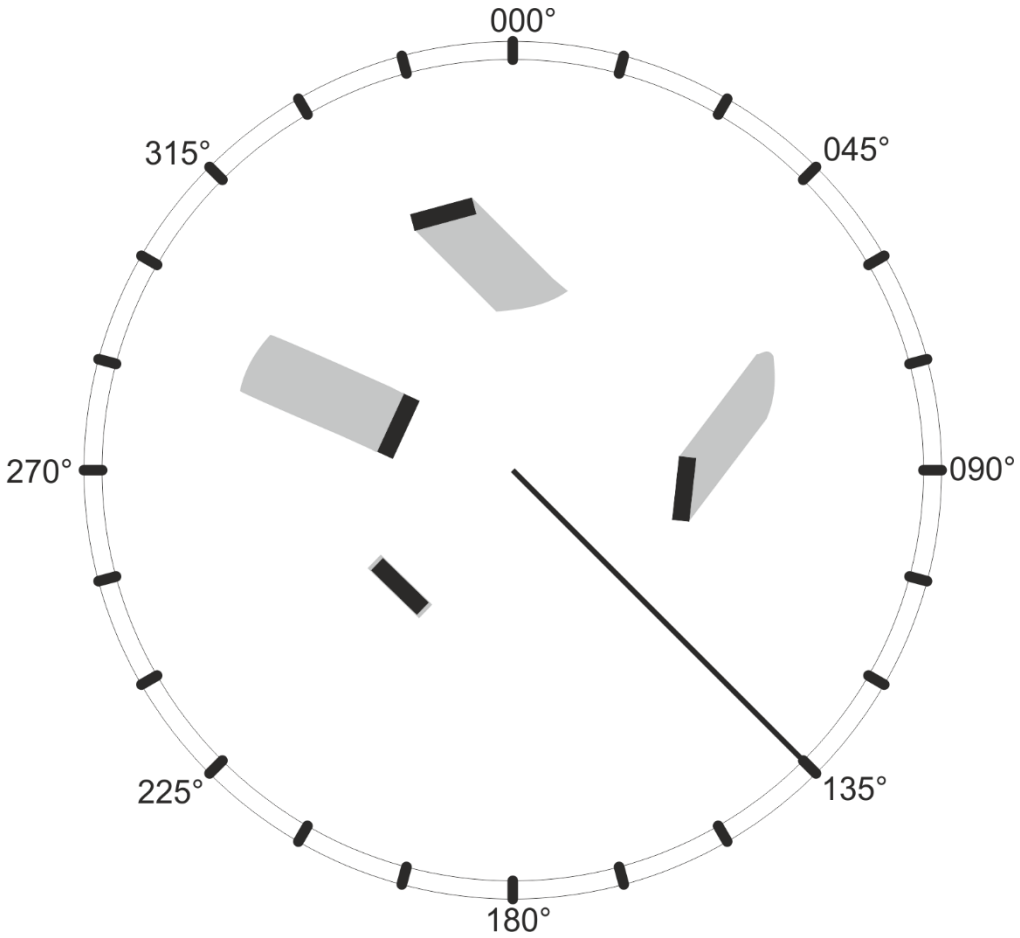
Relative motion presentation

- The position of the observer on the radar picture is constant whereas the echoes from the objects move on the screen with the relative courses and relative velocities that arise as a result of the movement of the own ship and targets
- In relation to a fixed object, its echo will move on the radar screen with the velocity equal to the speed of the own ship and the opposite course (rotated 180°) to the own course.
- on the other hands, the bearing and distance to the echo of an object moving at the same speed and course as the own ship are constant.

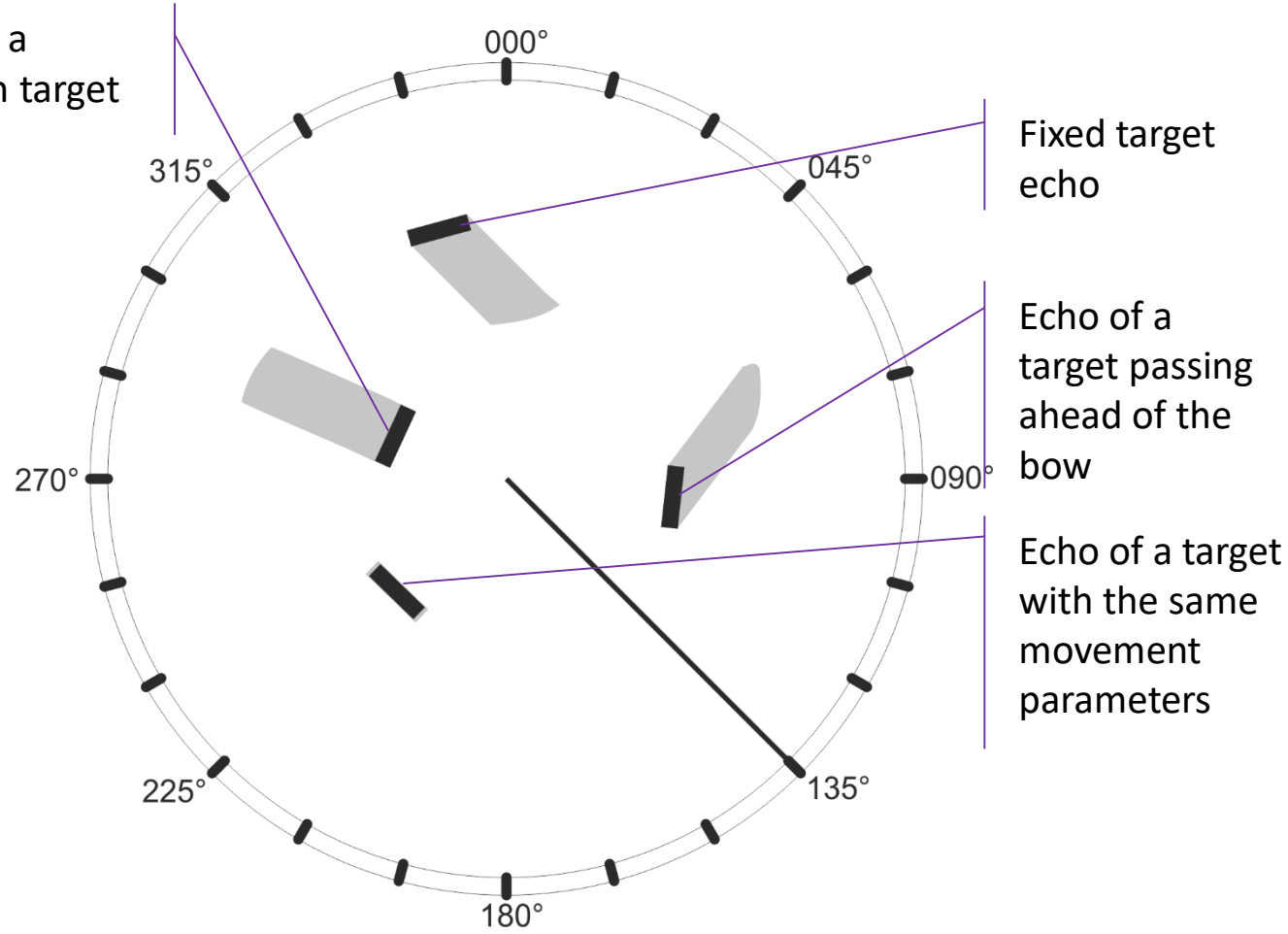
Relative motion presentation

- The trails of the fixed object will be equal to the speed of the own ship but directed according to the opposite course
- The echo of the object moving with identical motion parameters as the observer's ship will be presented without trails.
- Echo of an collision object: the distance to it will decrease, and the straight line being an extension of the trails will pass through the position of the observer.
- Without the use of a radar plot or the use of the ARPA device function, real object motion parameters can not be determined: COG and SOG.
- On the other hand it's easy to determine CPA and TCPA using typical measurement markers and trails.

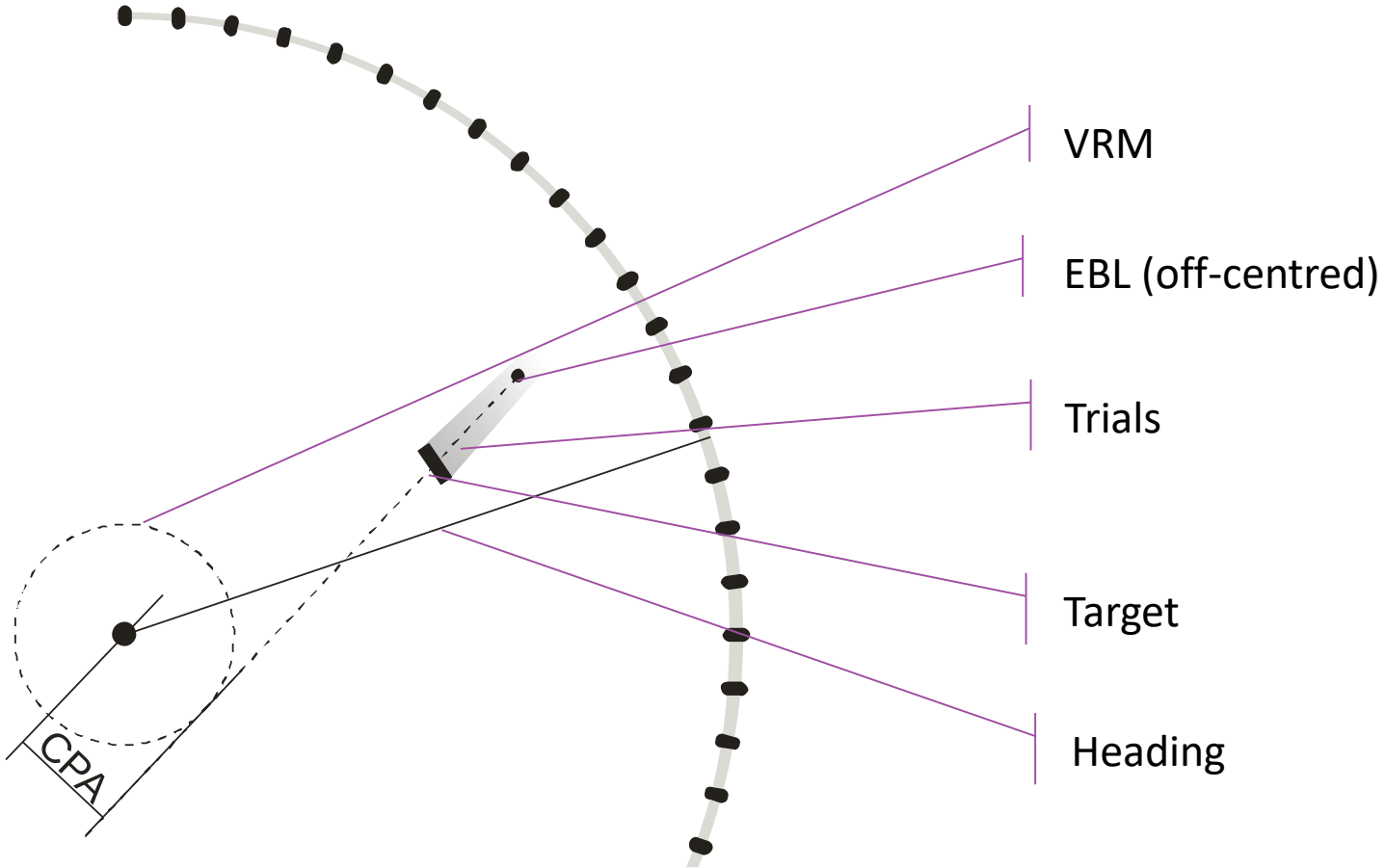
Relative motion presentation



Relative motion presentation



CPA TCPA by VRM and EBL



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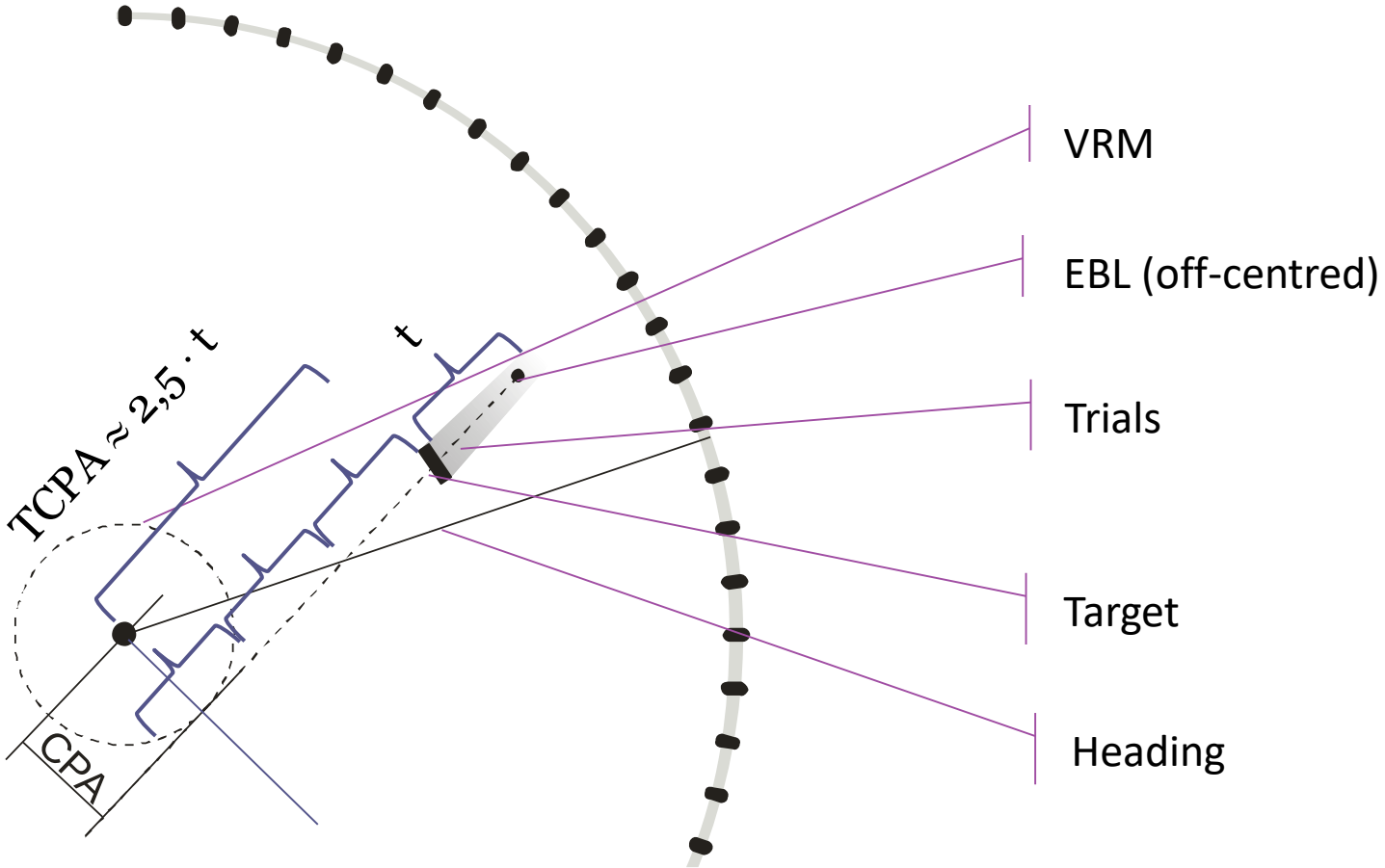
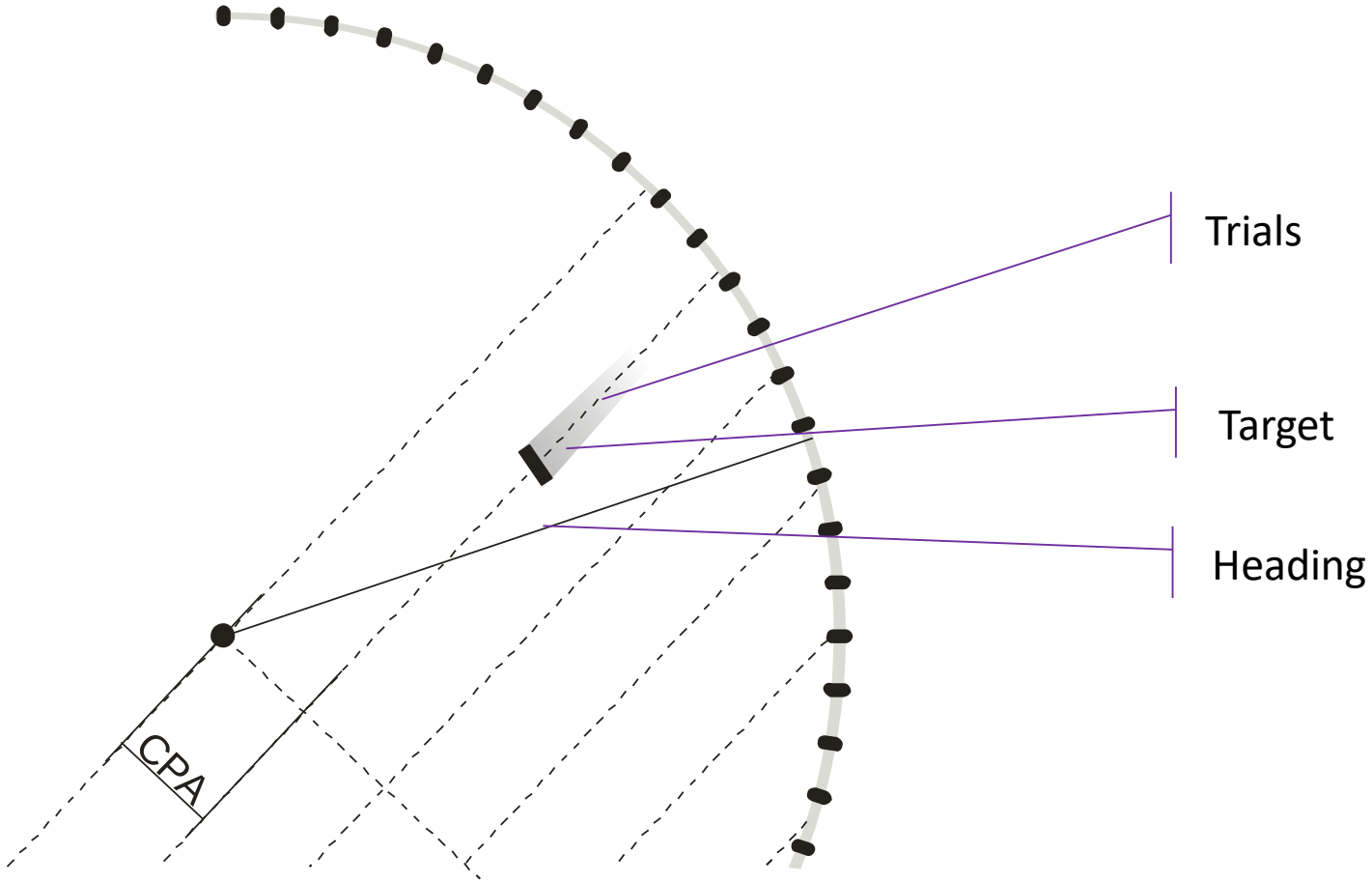
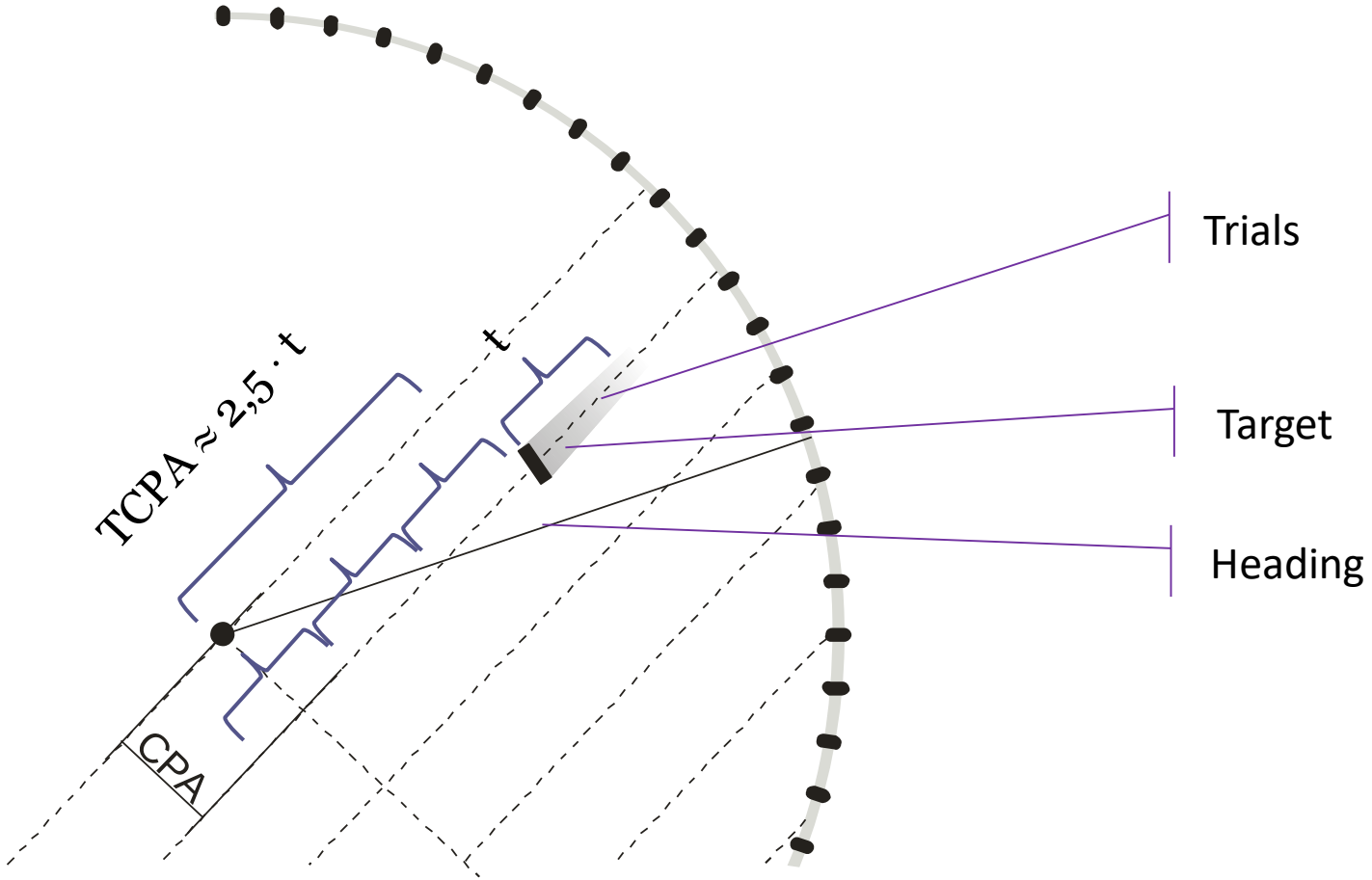


CPA TCPA by PI



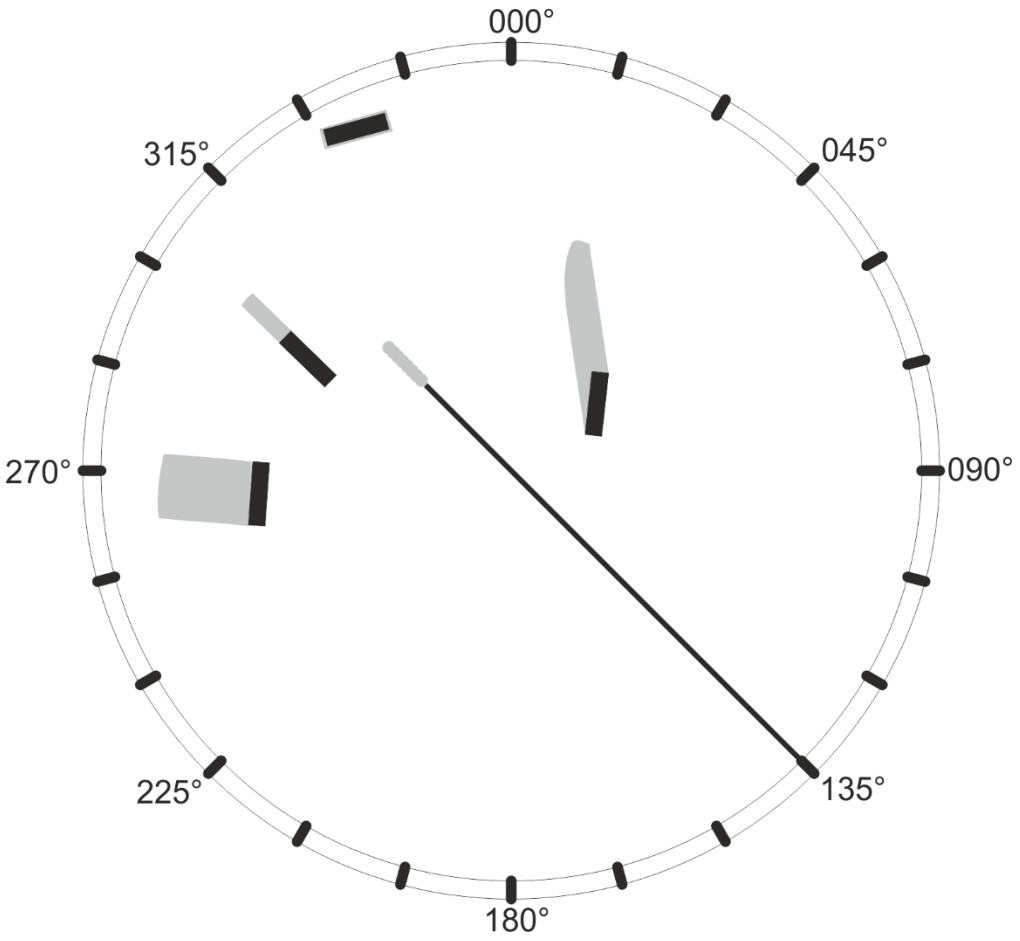
CPA TCPA by PI



True motion presentation

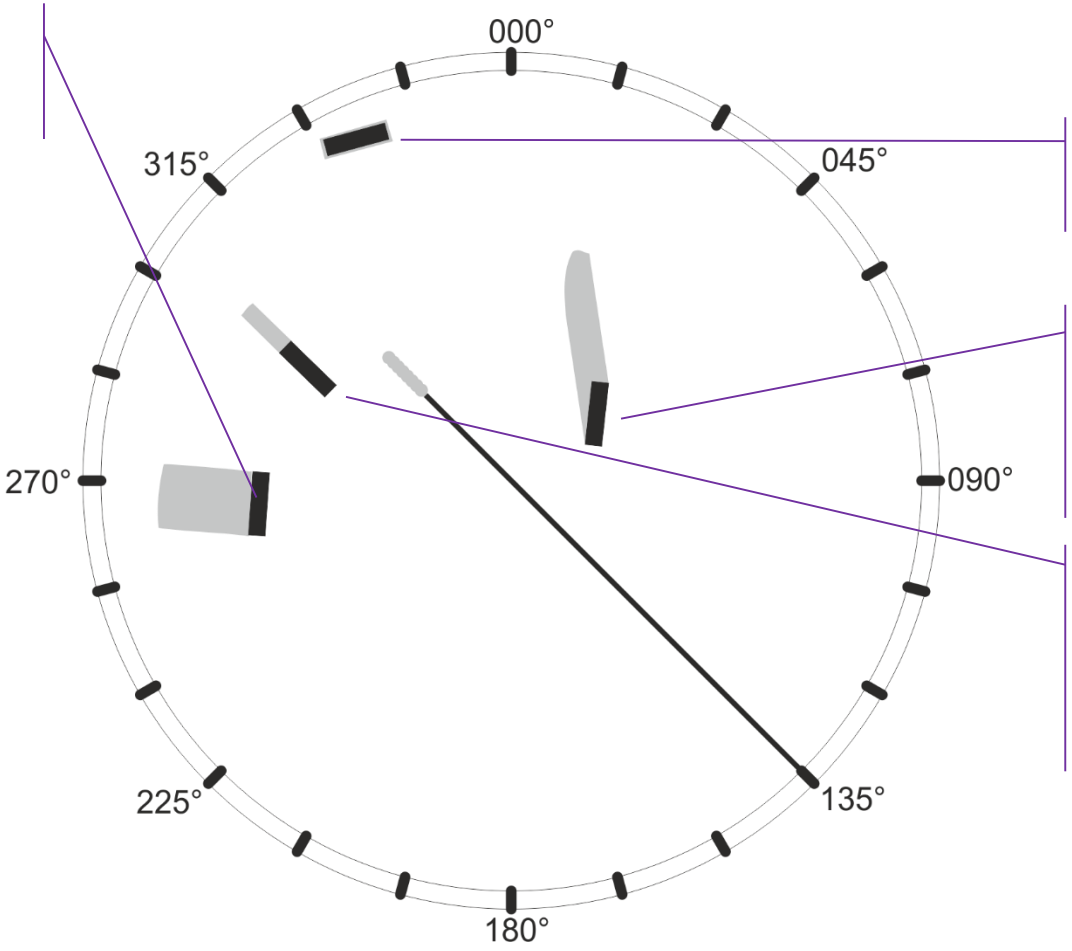
- All echoes of the detected objects, including the observer's (antenna) position, move on the radar screen according to their movement parameters, which results in the radar image being natural.
- It is very easy to recognize echoes from solid objects because they do not have any trails. This is very useful when the observer is sailing along the shore. Echo from the land then does not blur (doesn't generate a glow), which significantly affects the readability of the radar image.
- You can easily identify echoes from the buoys or from anchored ships, which facilitates navigation on the approach to ports, locks, anchorages, etc.

True motion presentation



True motion presentation

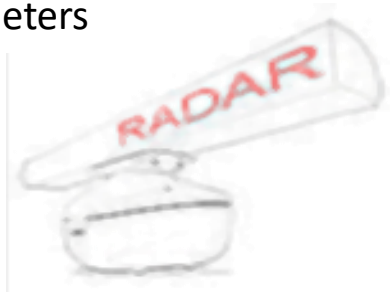
Echo of a collision target



Fixed target echo

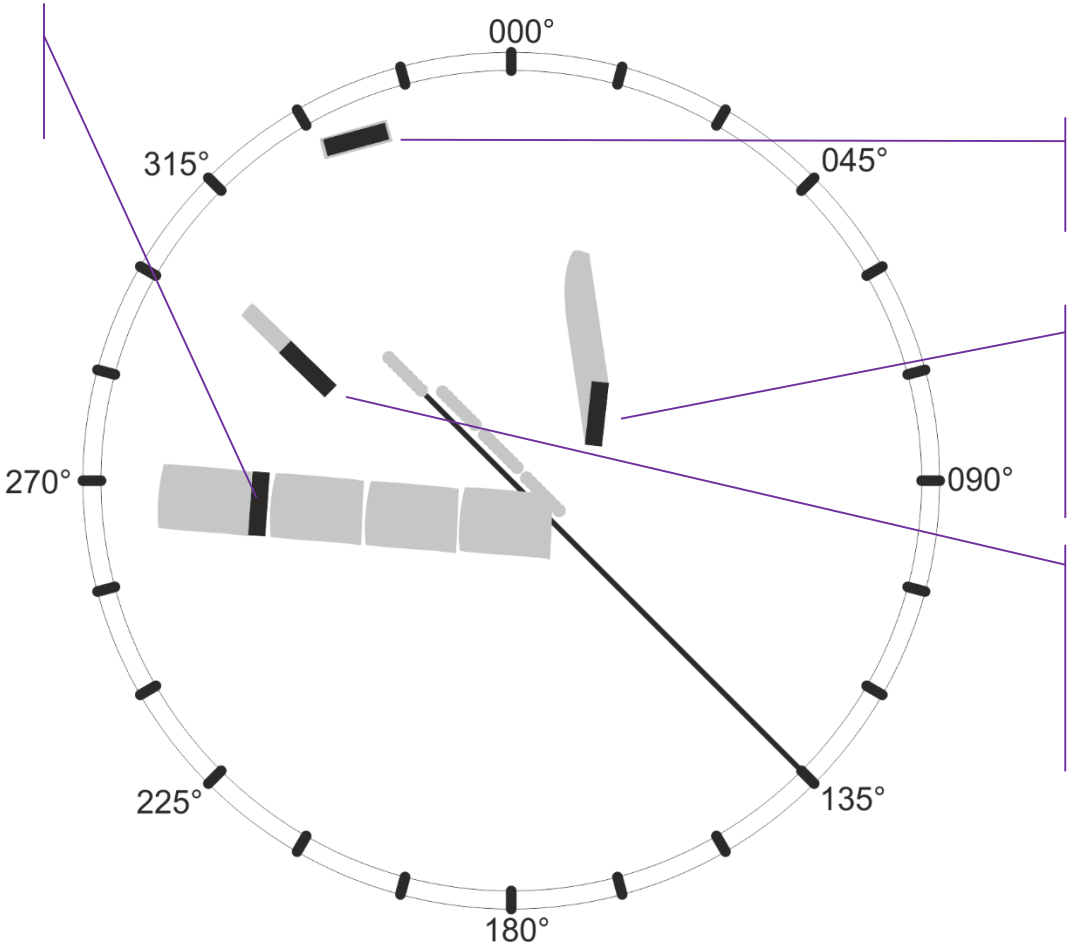
Echo of a target passing ahead of the bow

Echo of a target with the same movement parameters



True motion presentation

Echo of a collision target



Fixed target echo

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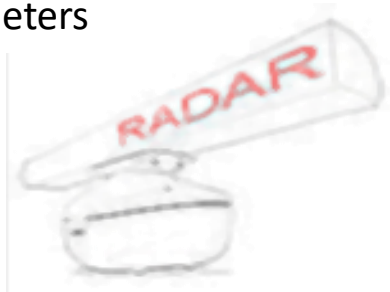
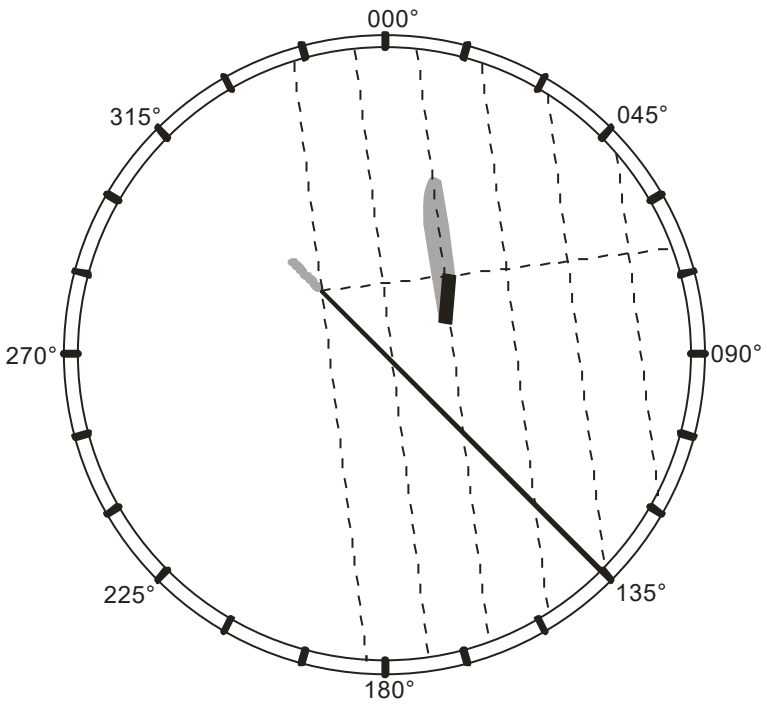
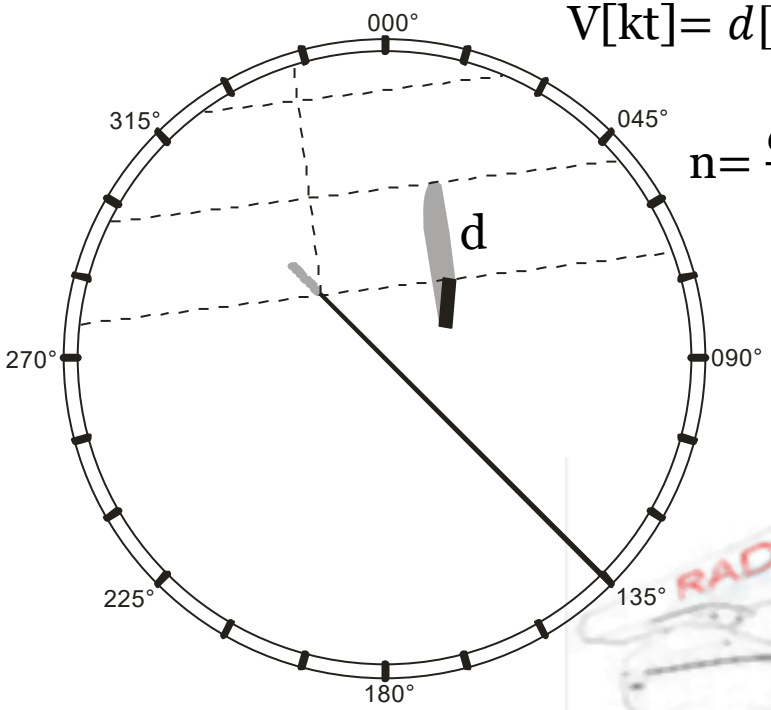


True motion presentation

- Based on the trails, you can determine targets' movement parameters; Parallel Index lines (PI).



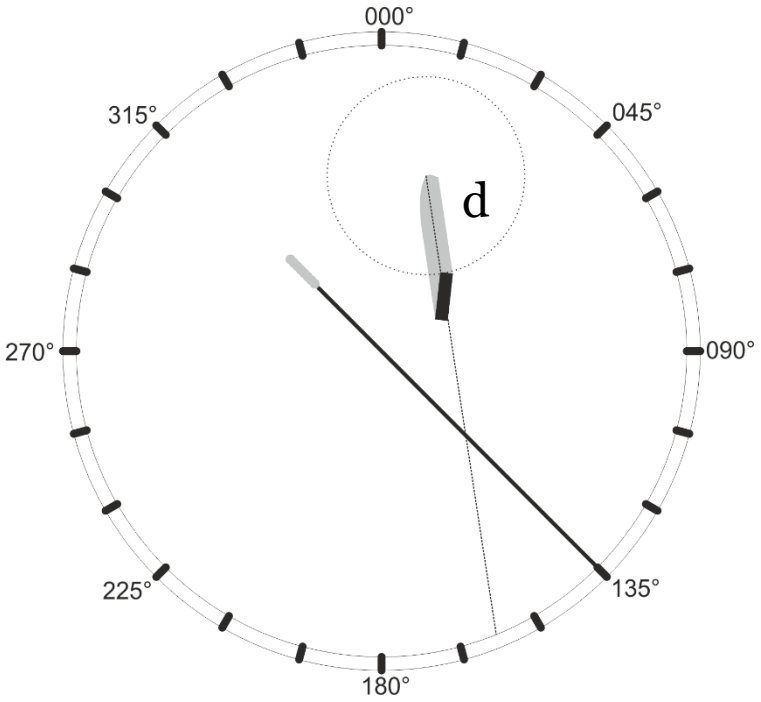


$$V[kt] = d[Nm] \quad n$$

$$n = \frac{60\ [min]}{t\ [min]}$$

True motion presentation

- Based on the trails, you can determine targets' movement parameters; EBL + VRM



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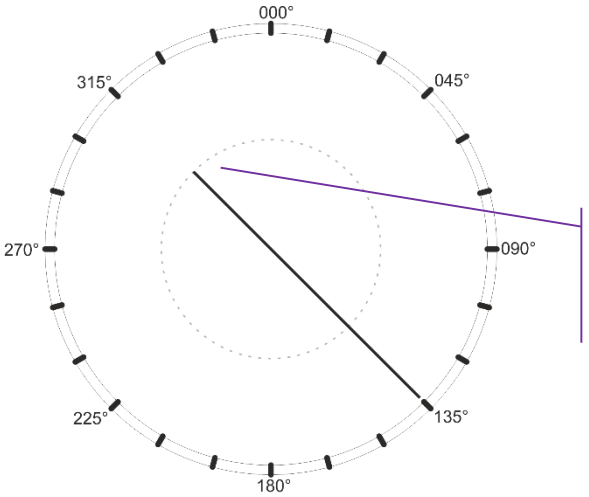
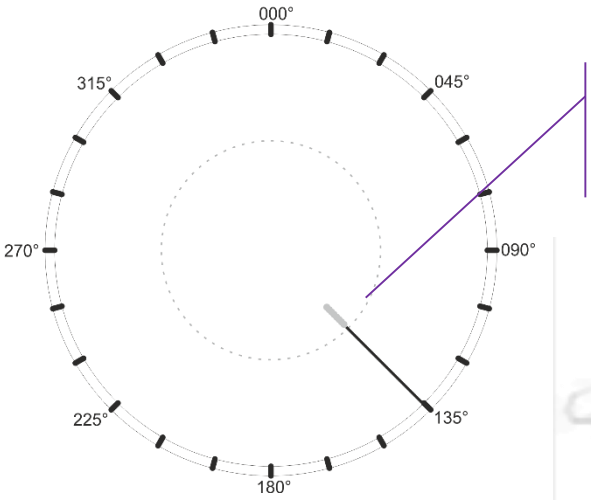
$$V[kt] = d[Nm] \quad n$$

$$n = \frac{60\ [min]}{t\ [min]}$$

True motion presentation

- The disadvantage of this motion presentation is the periodic reduction of the radar picture area ahead of the bow.
- The antenna position should automatically reset up to a 50% radius to a location giving the maximum view along own ship's course.
- Provision for an early reset of selected antenna position should be provided



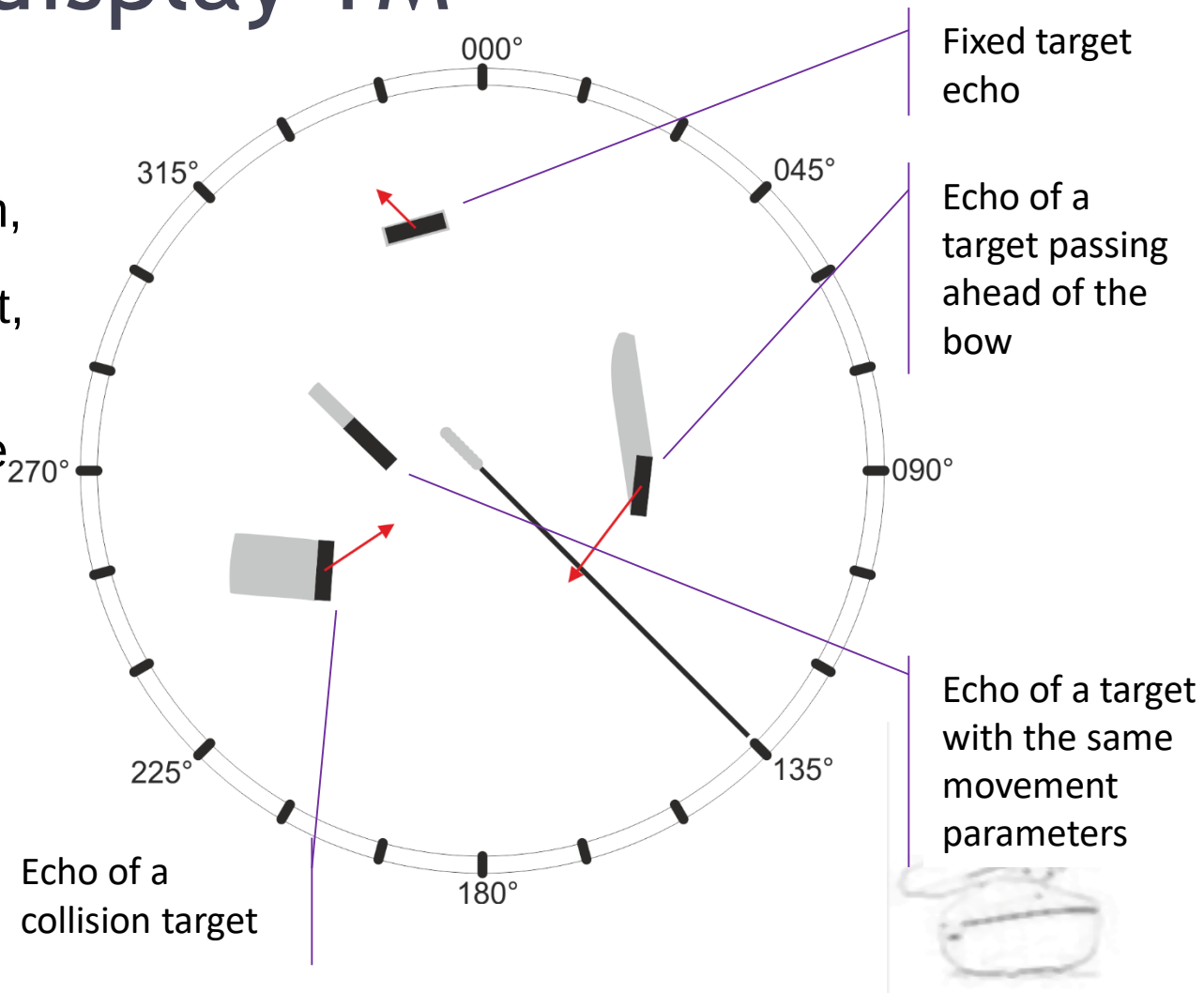


True motion presentation

- In the case of TM presentation, it is necessary to enter the parameters of the movement of the own vessel.
- You can do this manually by entering relevant data from time to time or automatically providing the necessary data via the NMEA protocol.

Constant display TM

- In the constant display true motion, as in relative motion, the position of the observer is constant, the echoes on the screen move in accordance with the relative motion (relative speed and relative course).
- On the other hand, the artificially generated trails corresponds to the true motion



The choice of orientation and motion presentation

Depends on:

- on the type of navigation (navigation on an open water or on a constrained water area),
- traffic intensity
- operator own preferences

Display mode of radar picture

- According to IMO Res. MSC 192:
  - A True Motion display mode should be provided.
  - The automatic reset of own ship may be initiated by its position on the display, or time related, or both.
  - Where the reset is selected to occur at least on every scan or equivalent, this should be equivalent to True Motion with a fixed origin (in practice equivalent to the previous relative motion mode)

Display mode of radar picture

- According to IMO Res. MSC 192:
  - North Up and Course Up orientation modes should be provided.
  - Head Up may be provided when the display mode is equivalent to True Motion with a fixed origin (in practice equivalent to the previous relative motion Head Up mode).

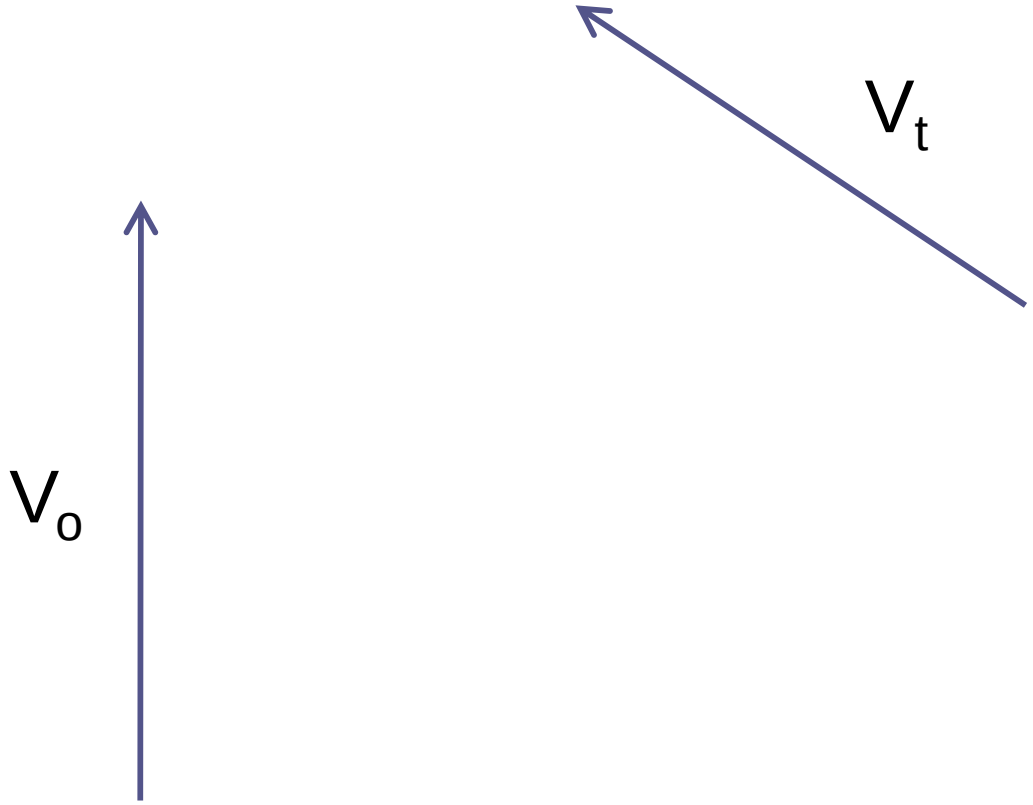
Relative motion with head up

- True Motion with a fixed origin + head up + relative trails
- It is only possible combination without information about own vessel's movement parameters ("stand alone")

True motion modes

- True motion + course up + trails (true / relative)
- True motion + north up + trails (true / relative)

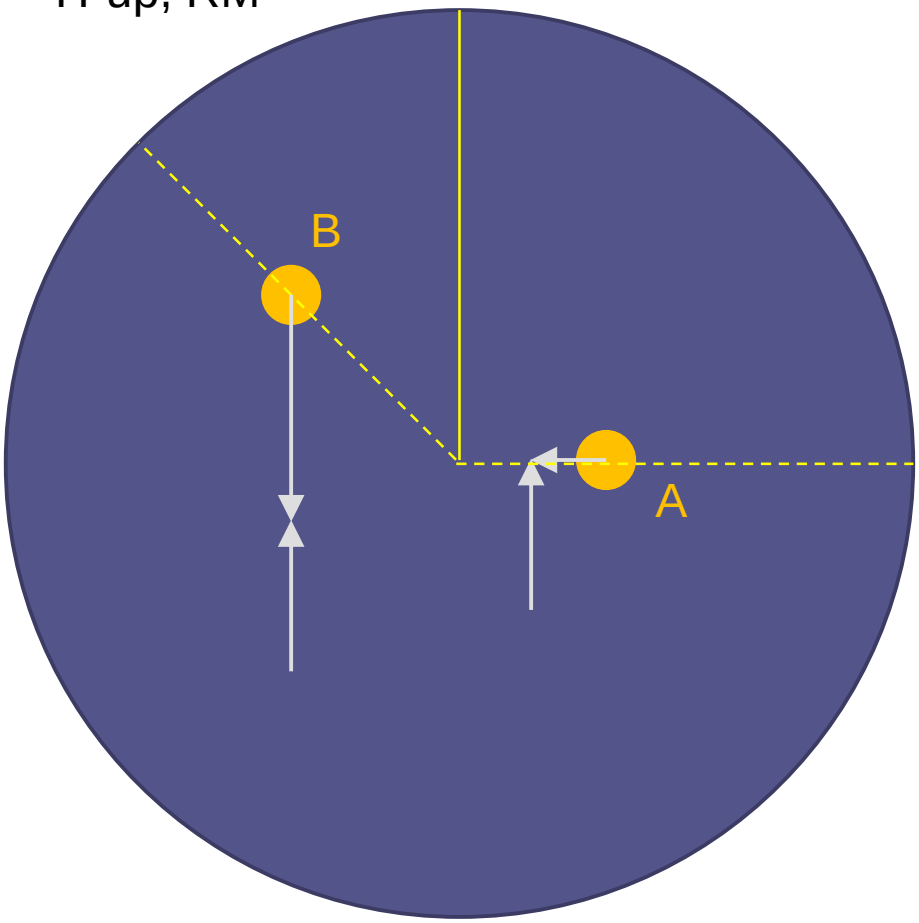
Addition of vectors



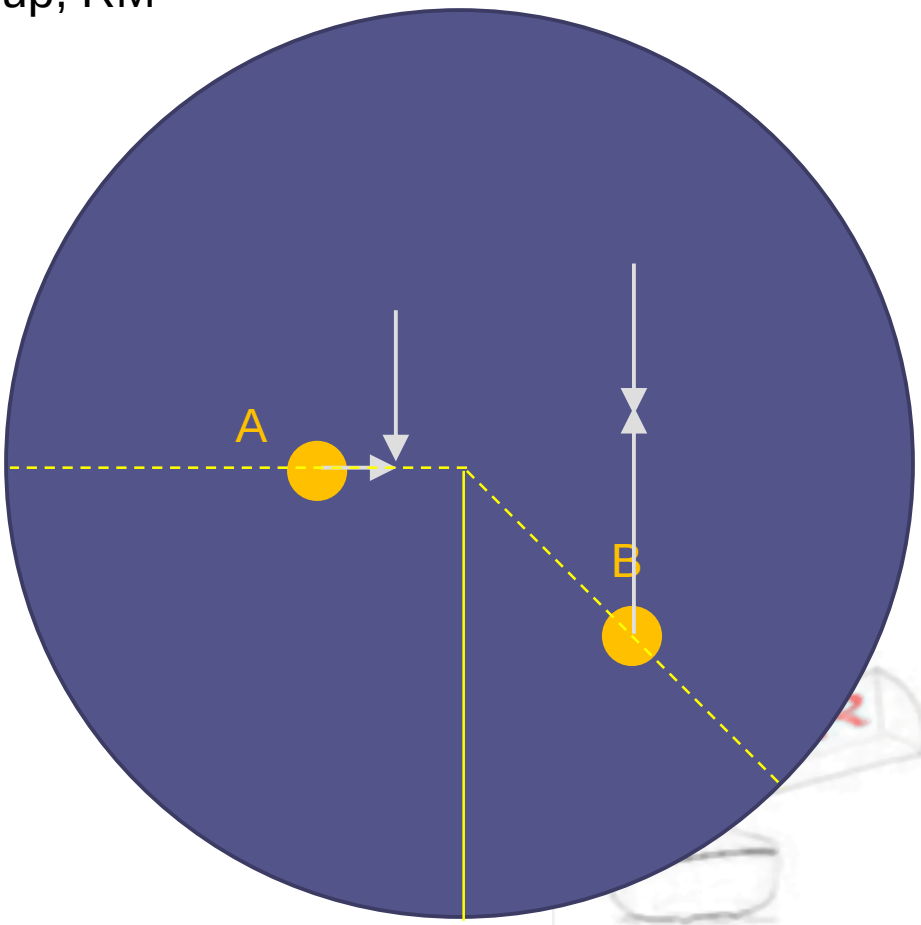
Example

- O: Ct = 180°, v = 12 kt
- A: Br = 90°, d = 2 Nm, Ct = 90°, v = 6 kt
- B: Bt = 135°, d = 3 Nm, Ct = 000°, v = 18 kt
- t=0 min, t'=10min

H-up, RM



N-up, RM



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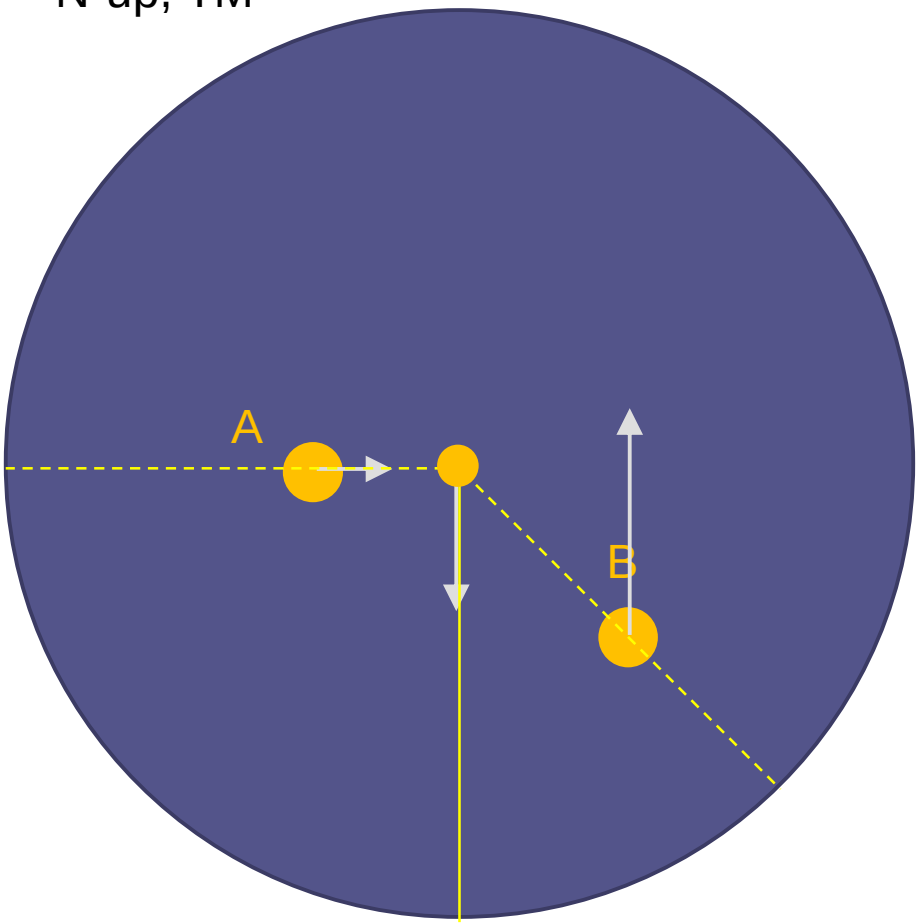
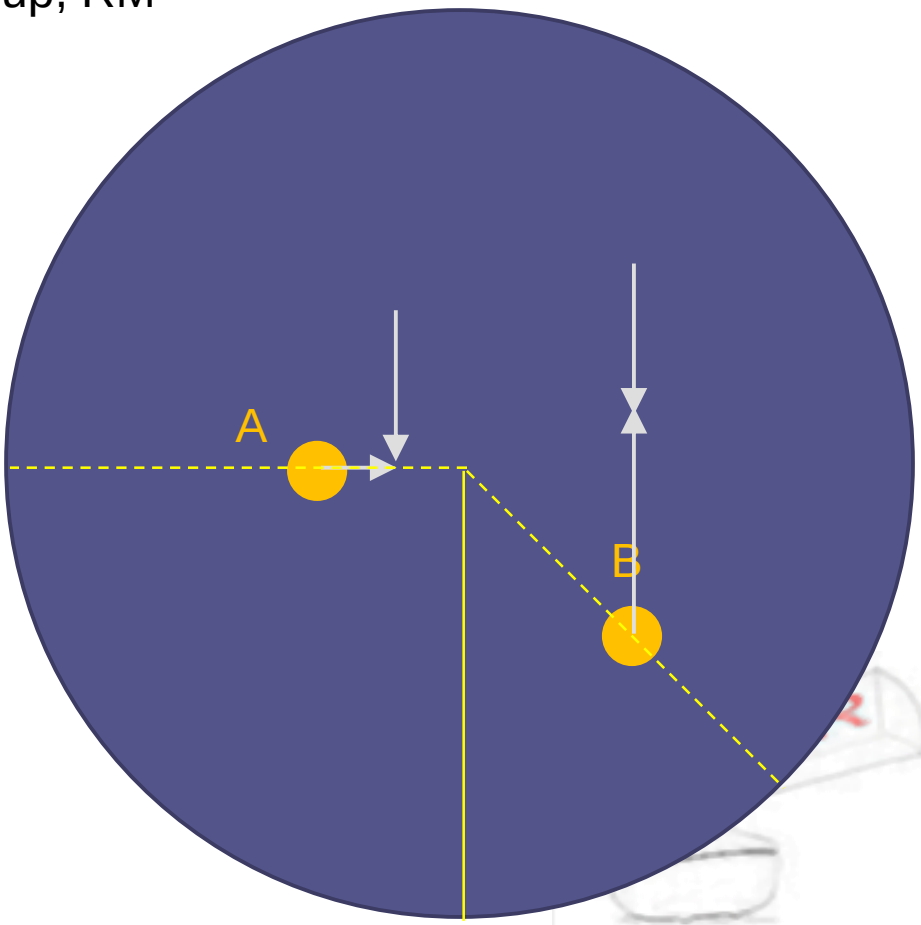
N-up, TM



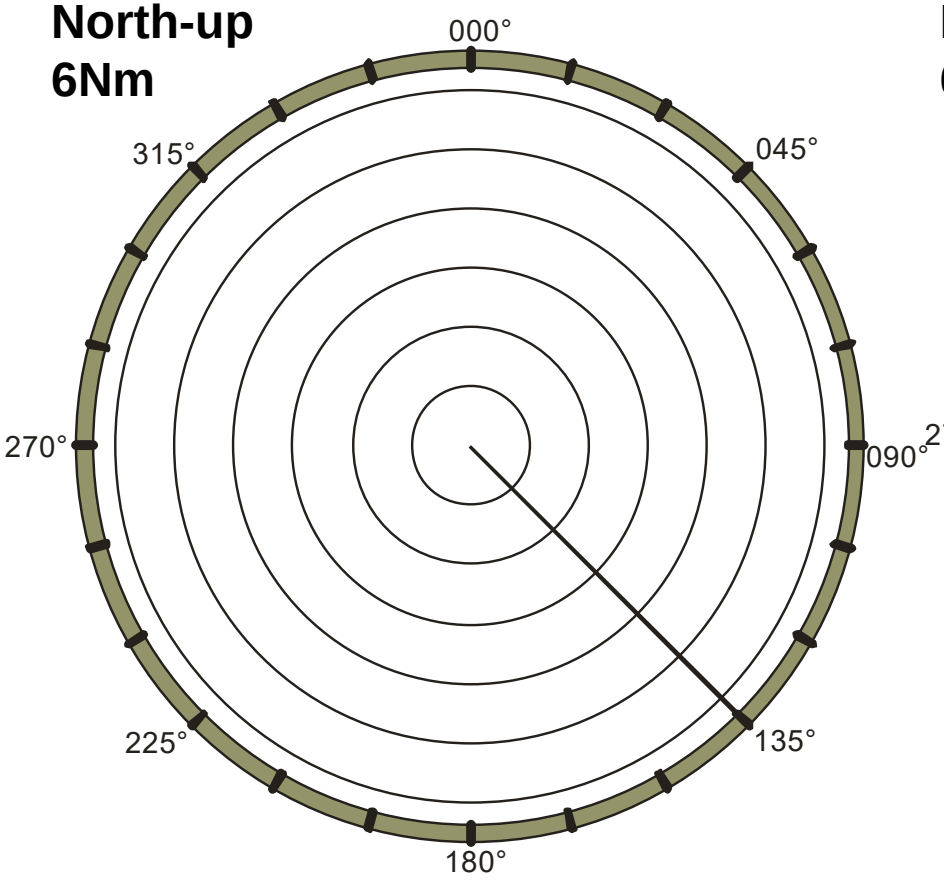
N-up, RM



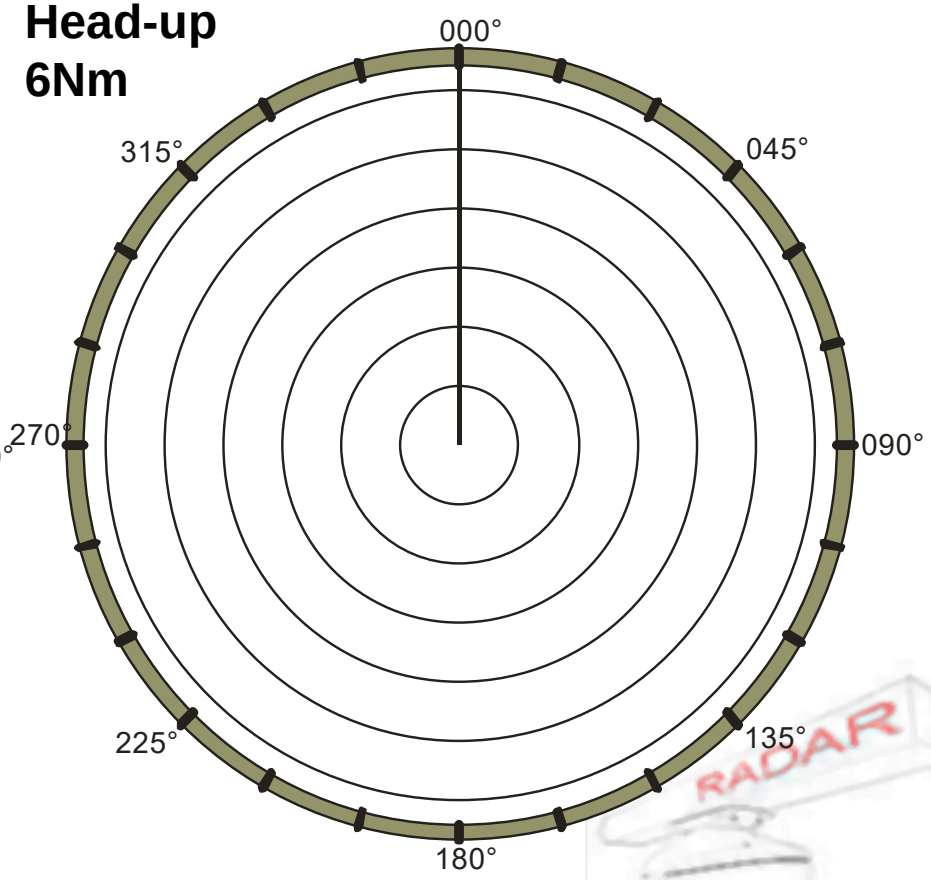
Example:

a) Bt = 030°, d = 5Mm
b) Br = 330°, d = 4Mm
c) Bt = 180°, d = 3Mm
d) Br = 060°, d = 2Mm

North-up
6Nm



Head-up
6Nm



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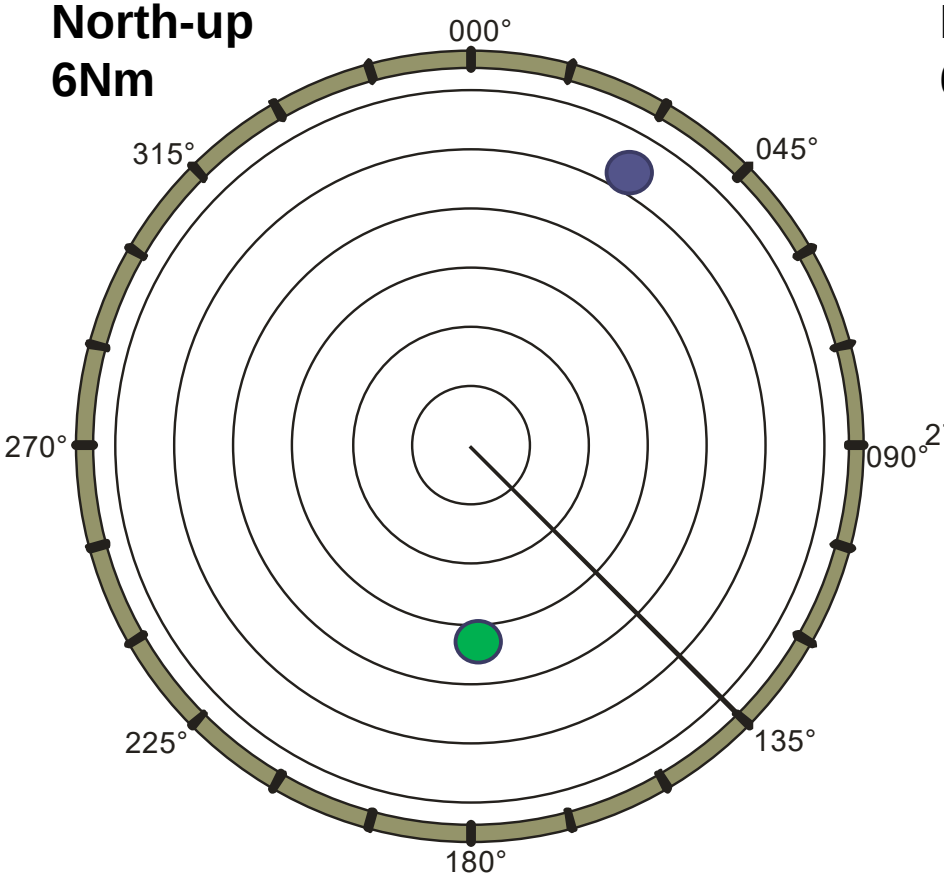
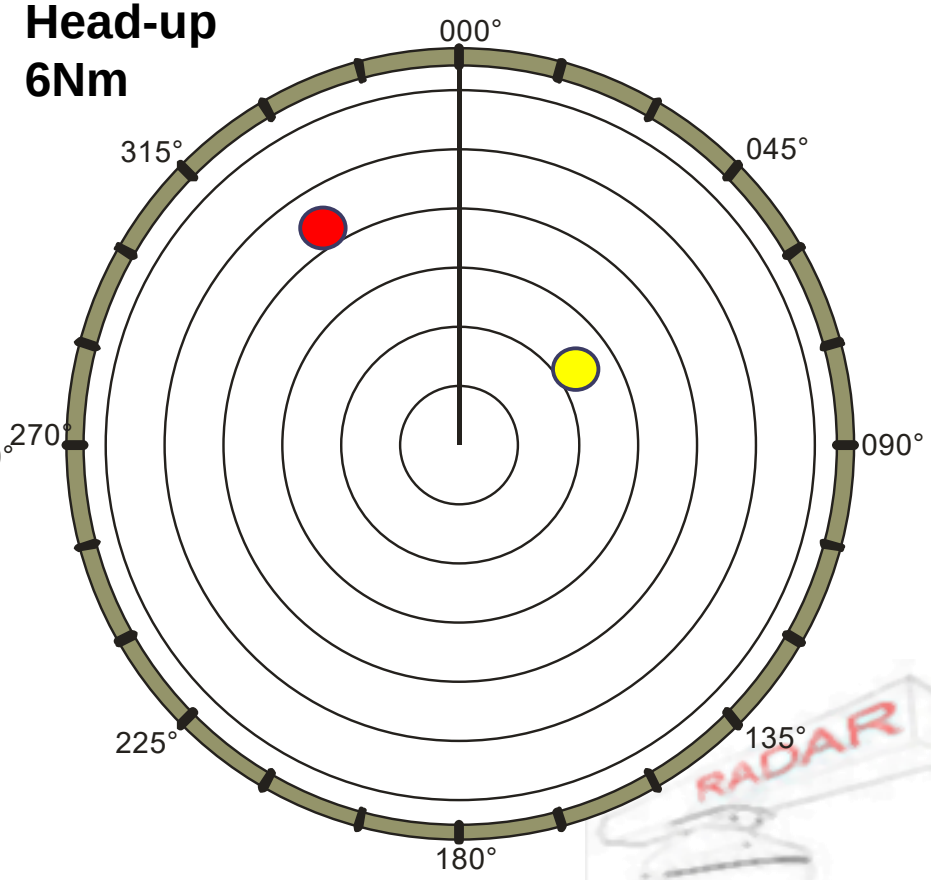
North-up
6Nm



Head-up
6Nm



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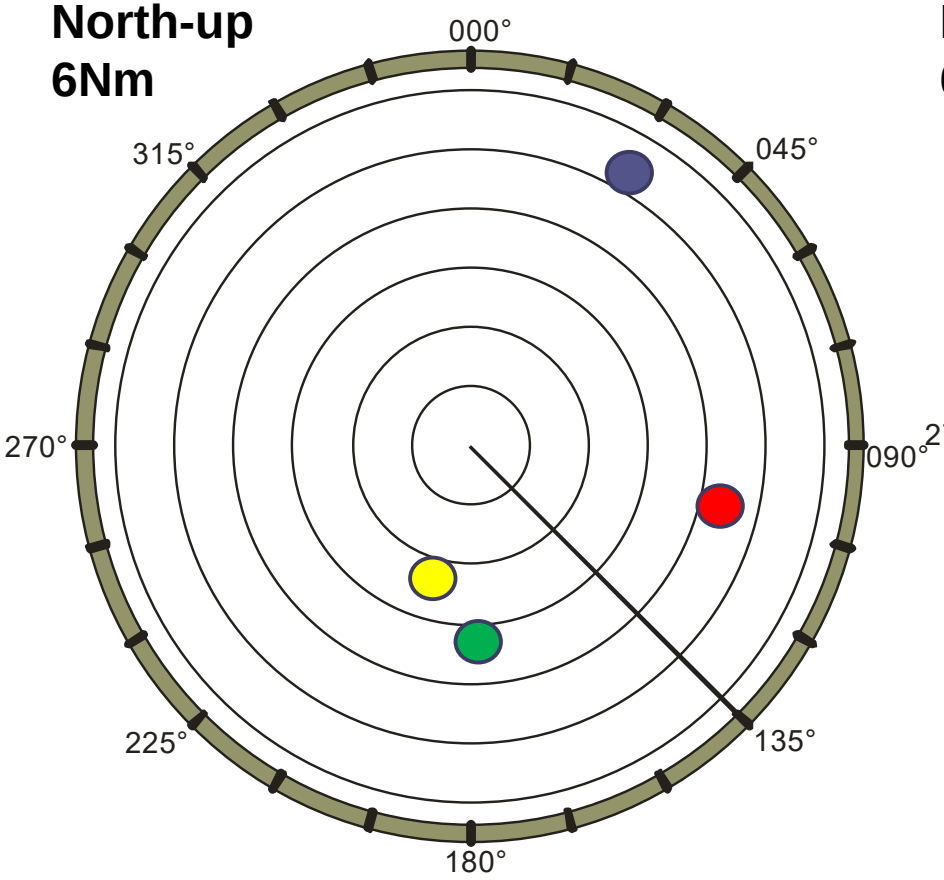
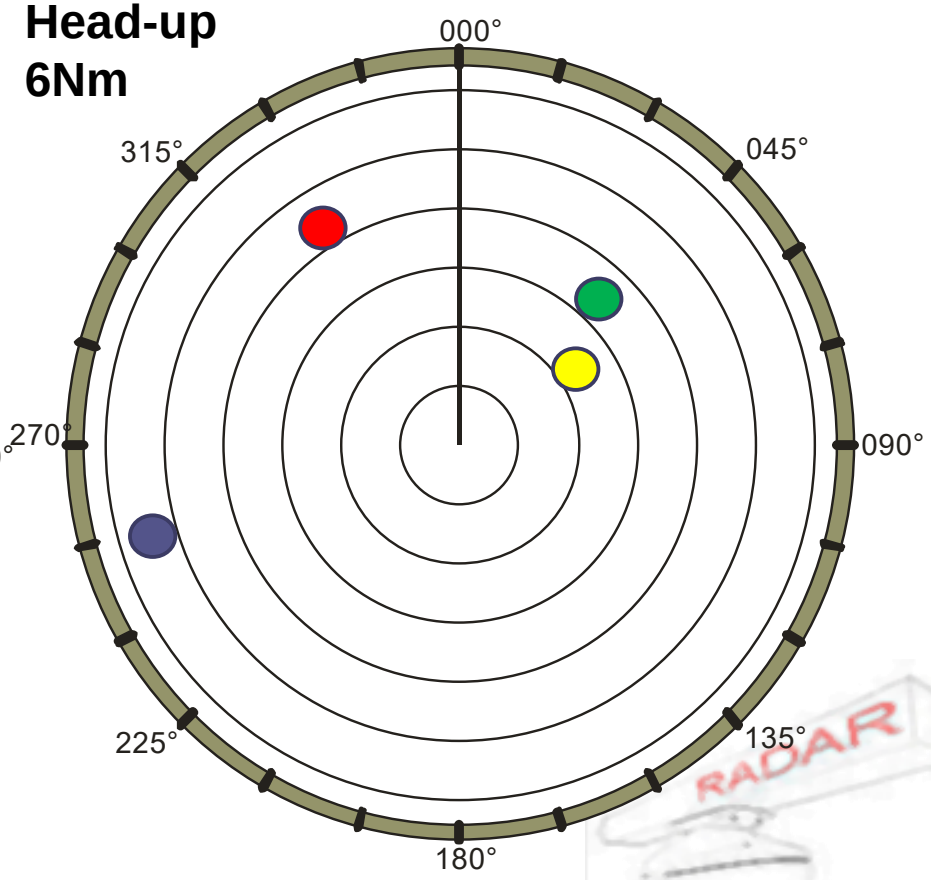


Head-up
6Nm



The end