Calculating a ship's course, speed, and position using data from the hydrophone

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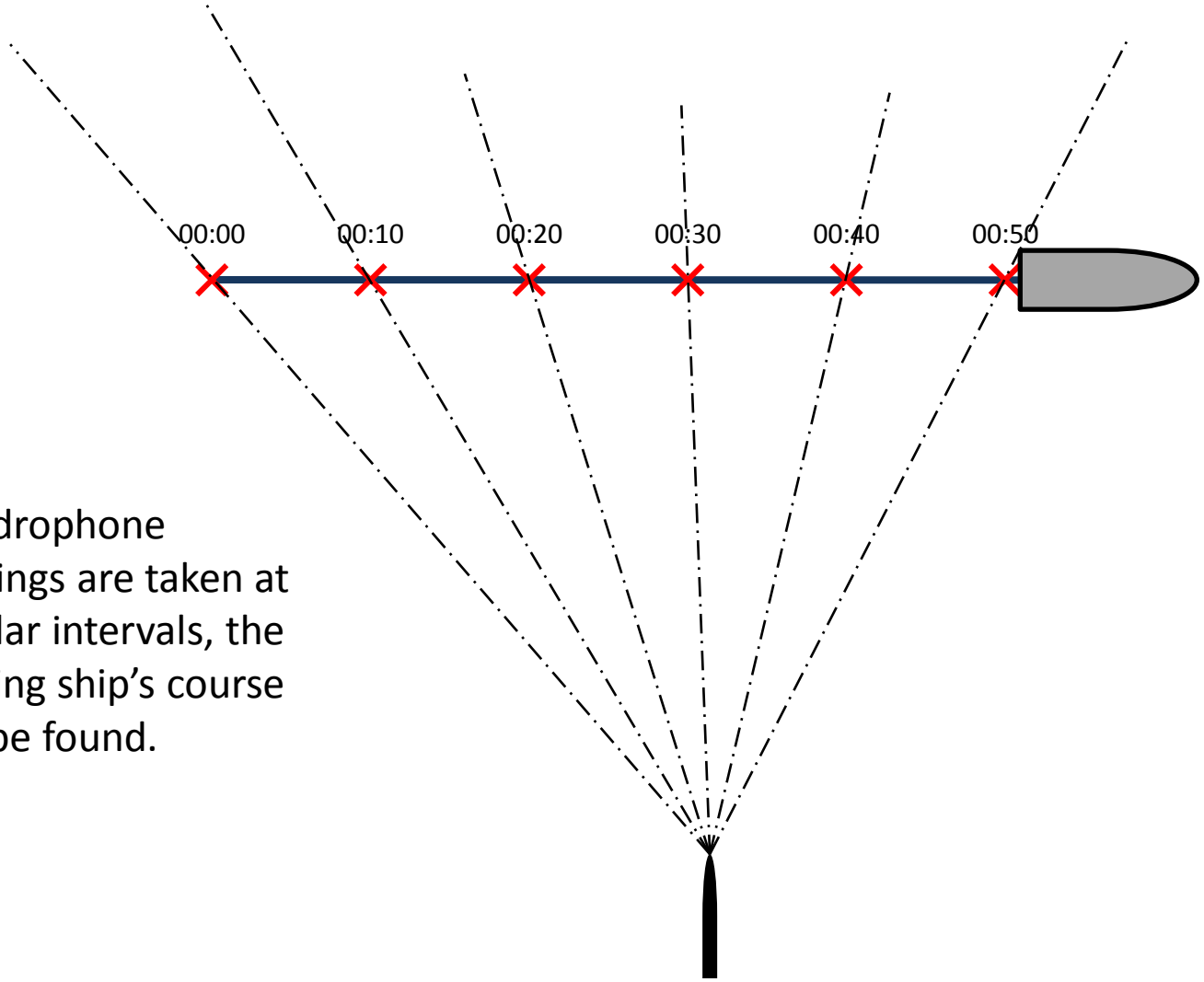
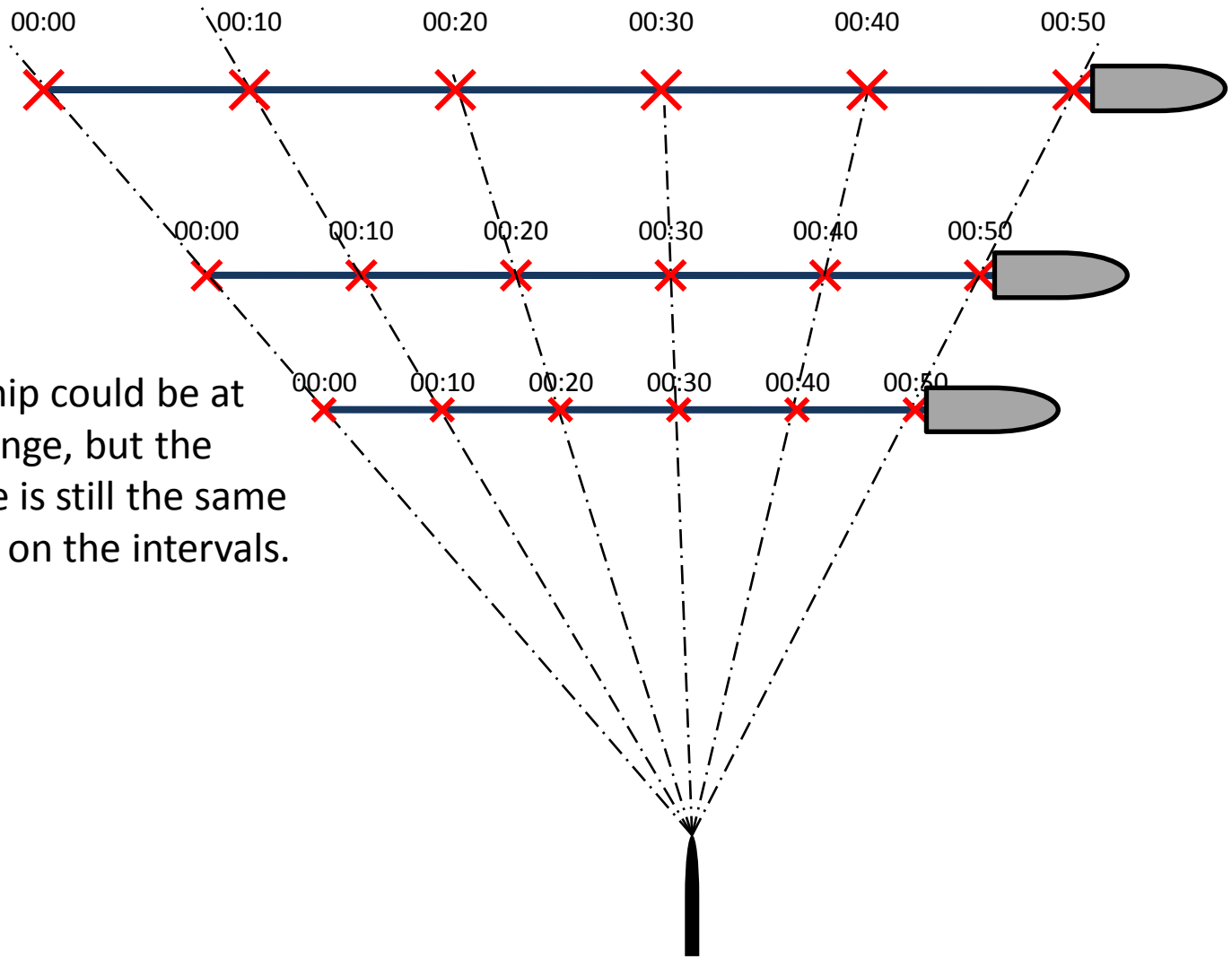
www.subsim.com

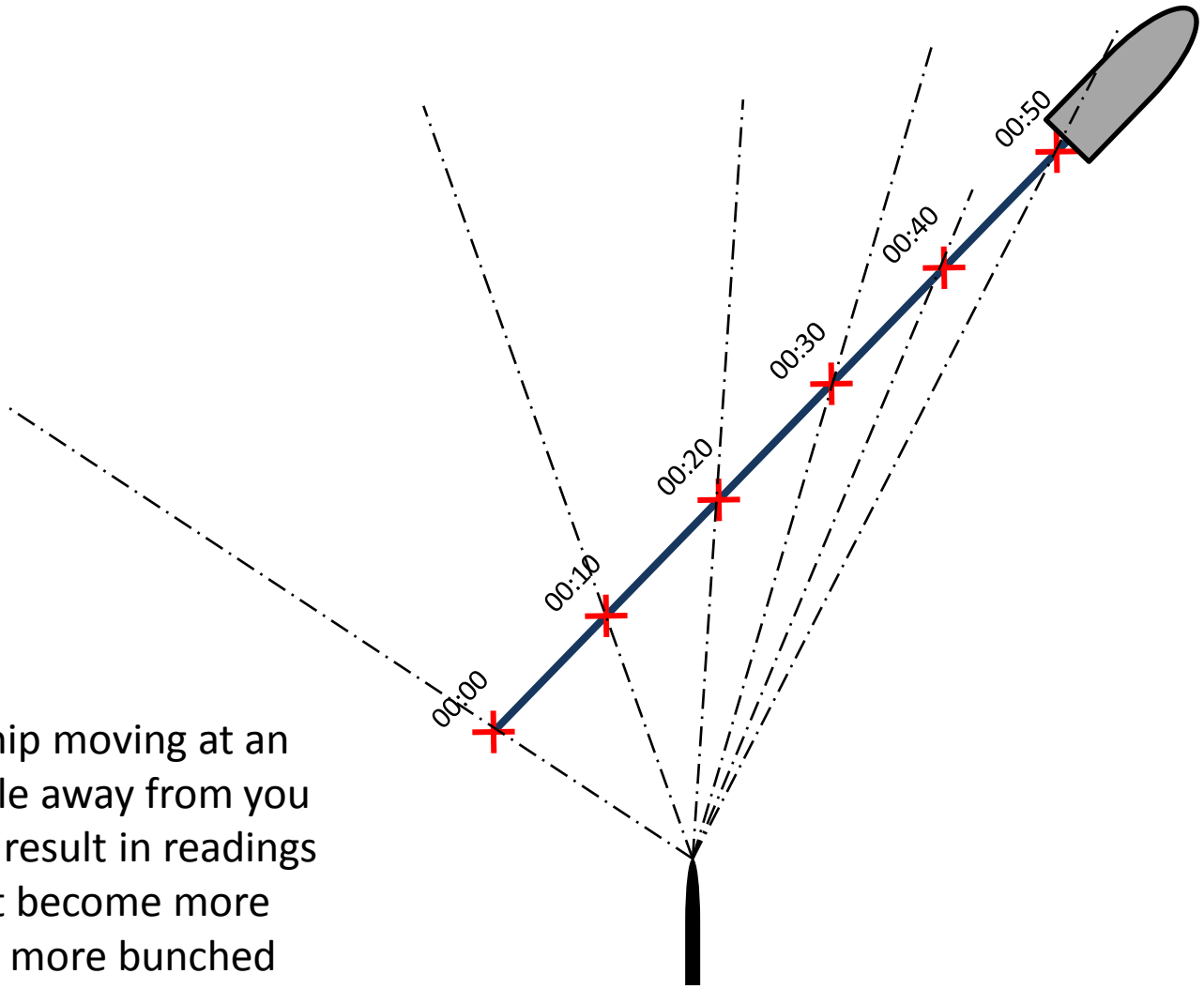
Assuming a constant speed and course, a ship will travel an equal distance during two equal time periods.



If hydrophone readings are taken at regular intervals, the passing ship's course can be found.

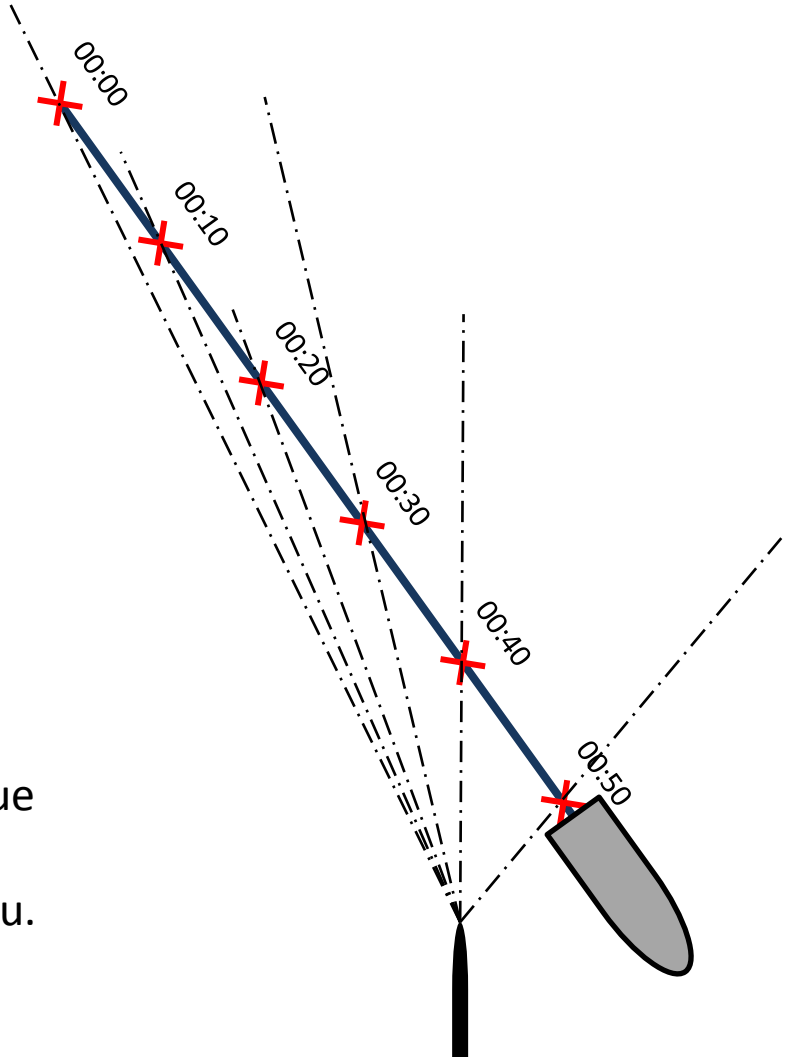


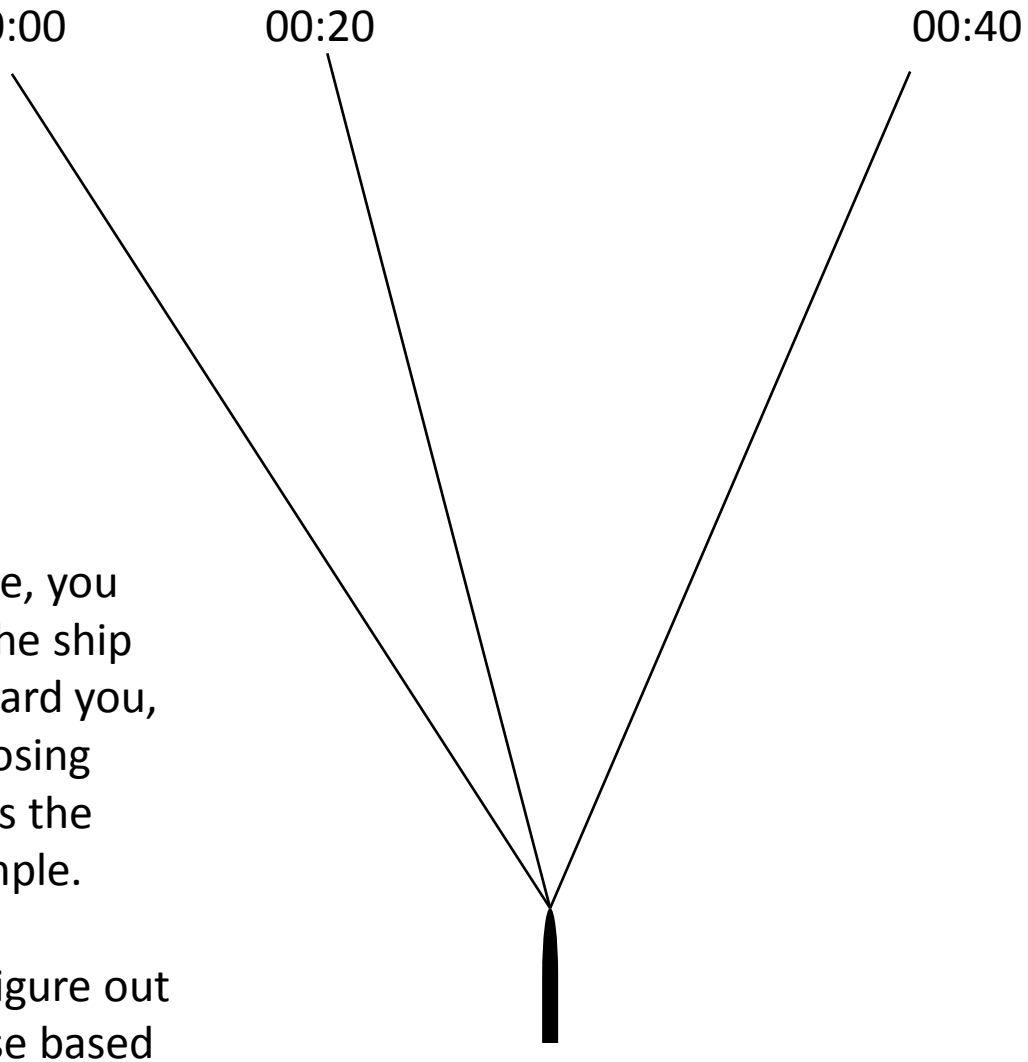
The ship could be at any range, but the course is still the same based on the intervals.



A ship moving at an angle away from you will result in readings that become more and more bunched up.

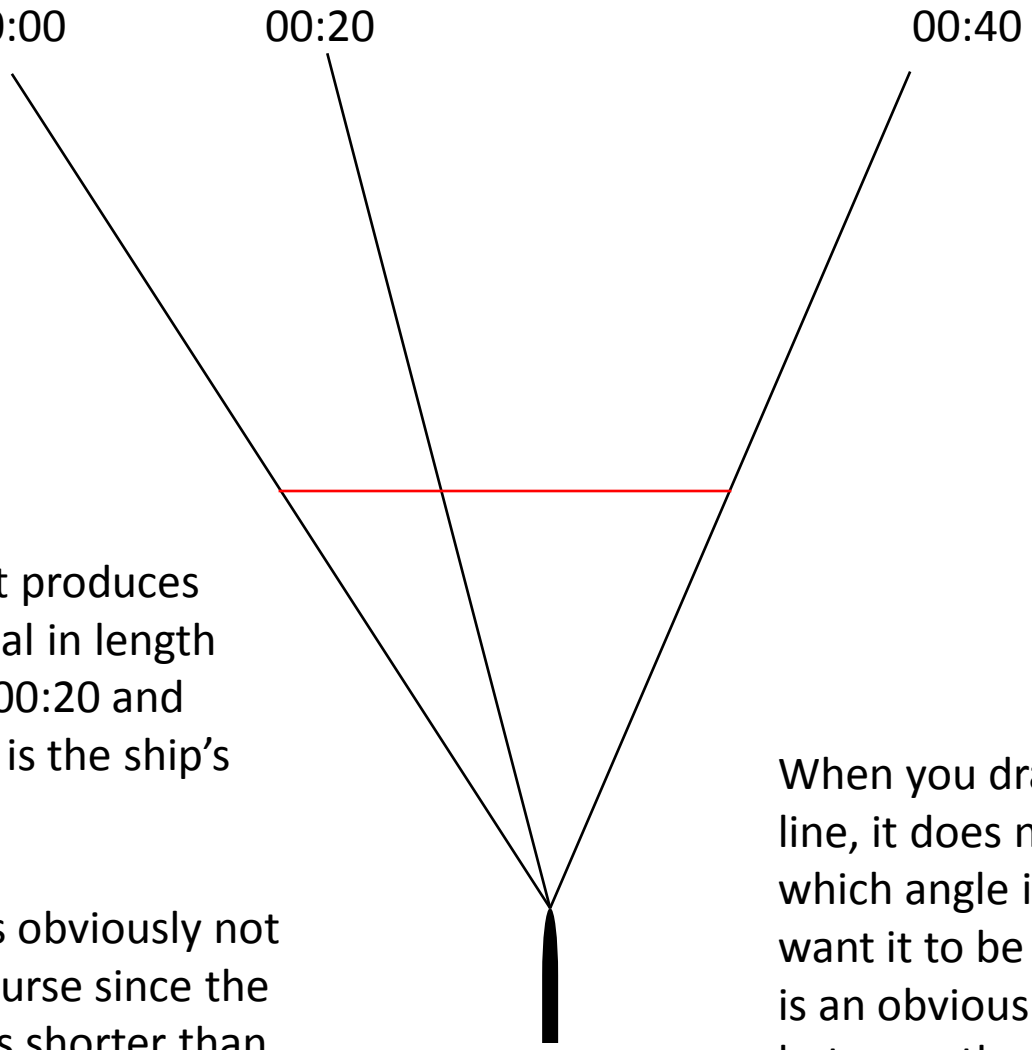
The opposite is true for a ship that is moving toward you.





In this example, you can see that the ship is moving toward you, though not closing quite as fast as the previous example.

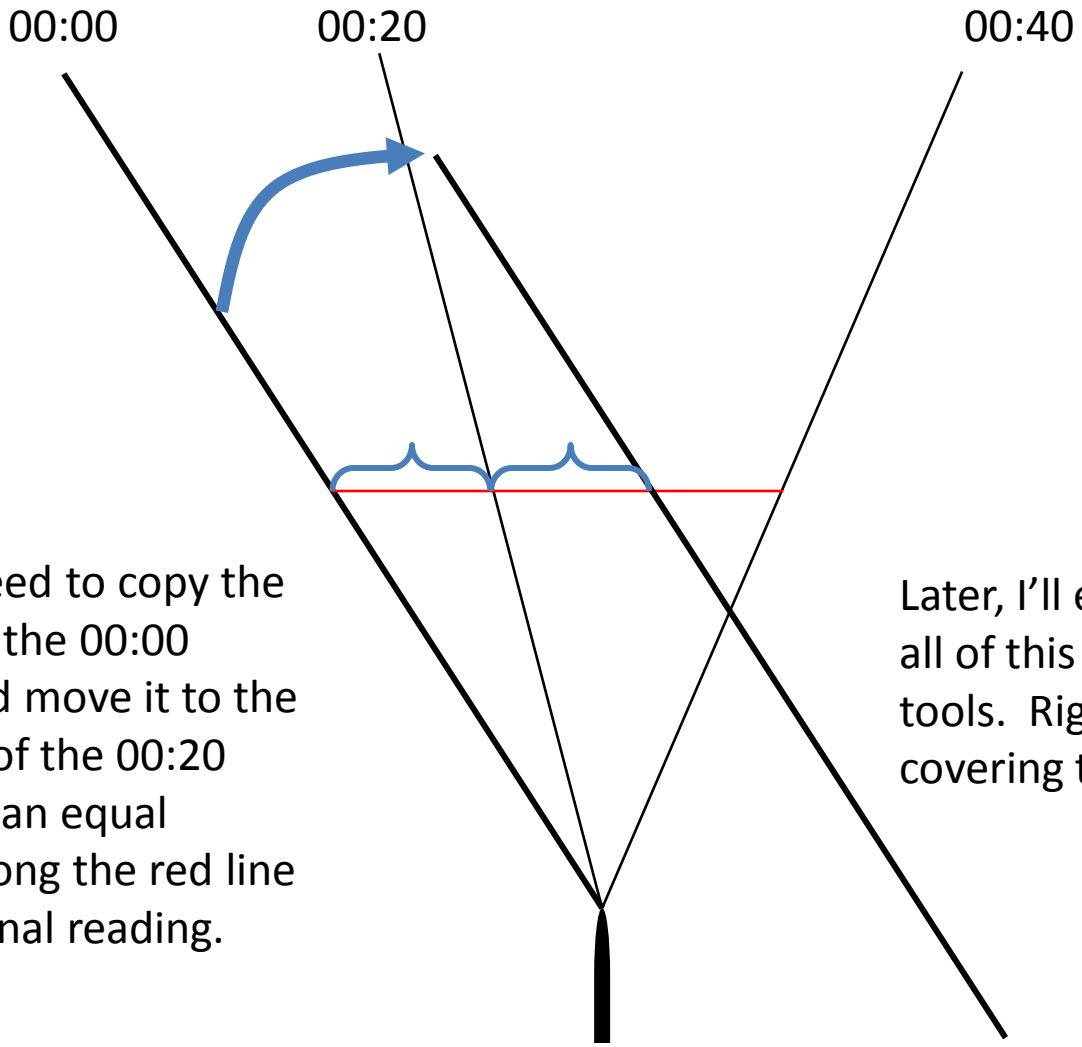
We will now figure out its exact course based on these readings.



The angle that produces segments equal in length from 00:00 – 00:20 and 00:20 – 00:40 is the ship's course.

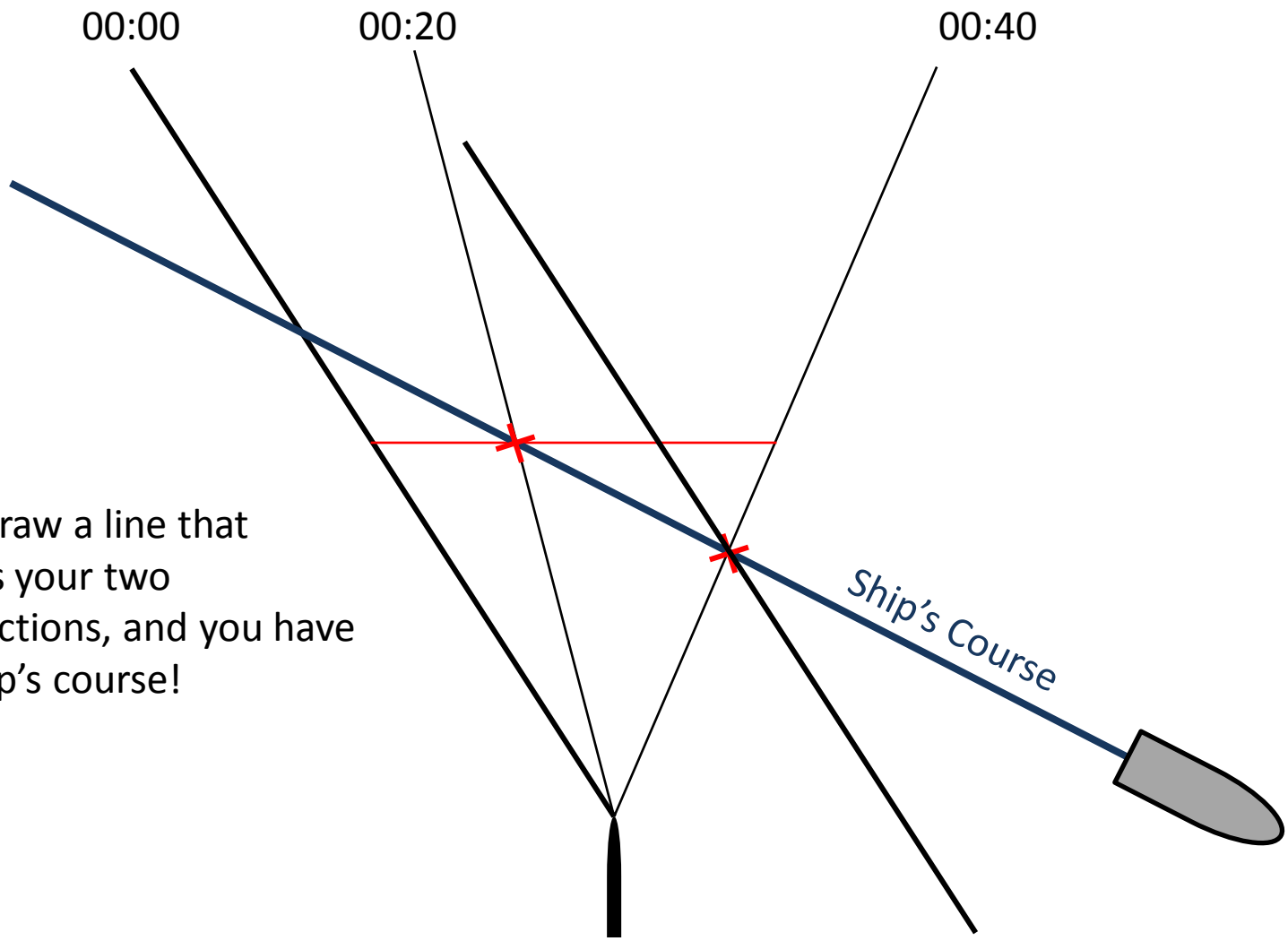
This red line is obviously not the correct course since the left segment is shorter than the right segment. But the red line will help us find the correct course.

When you draw this cross-line, it does not matter which angle it is at, but you want it to be such that there is an obvious difference between the two segments.

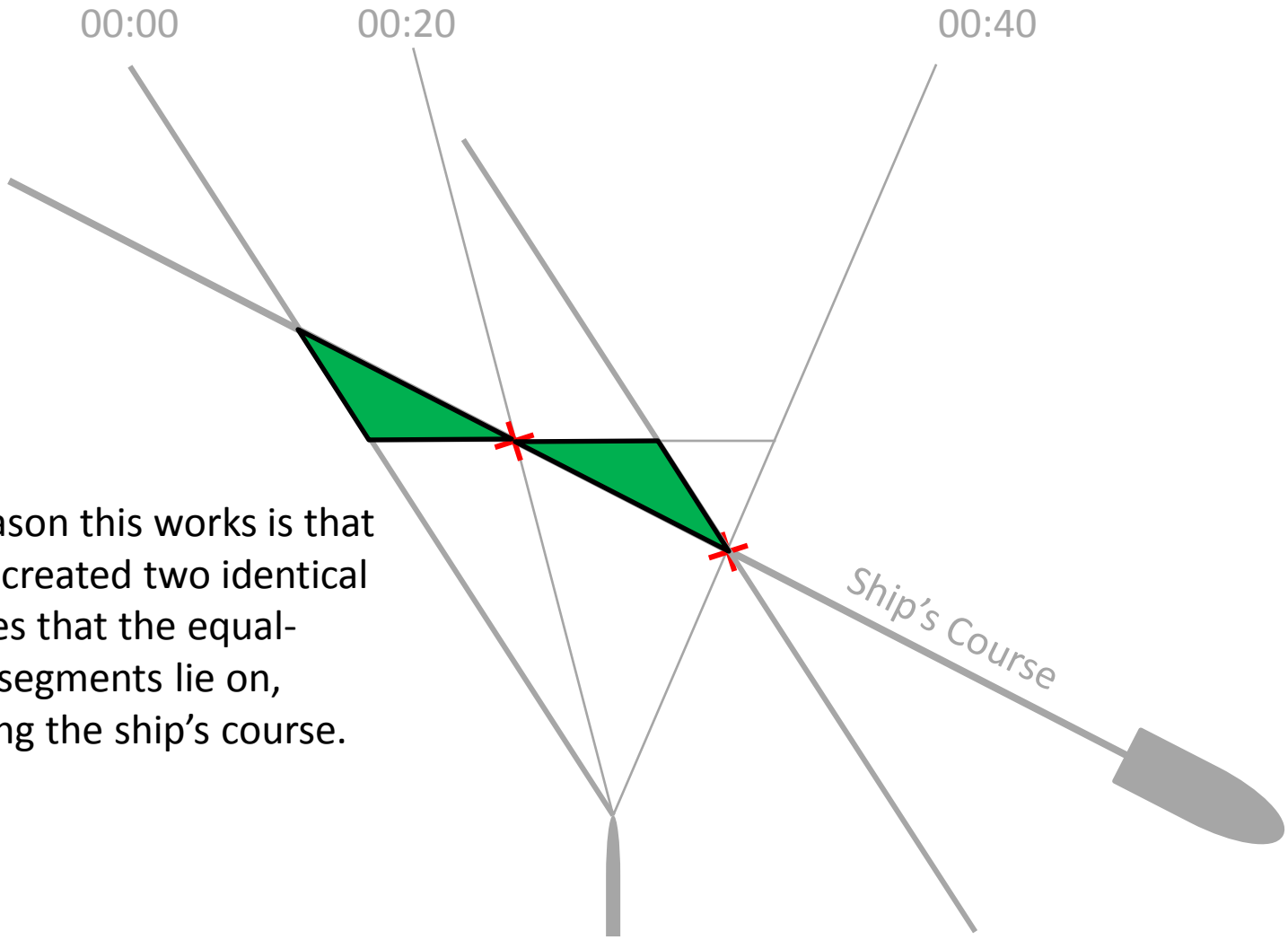


First, we need to copy the angle from the 00:00 reading and move it to the other side of the 00:20 reading, at an equal distance along the red line as the original reading.

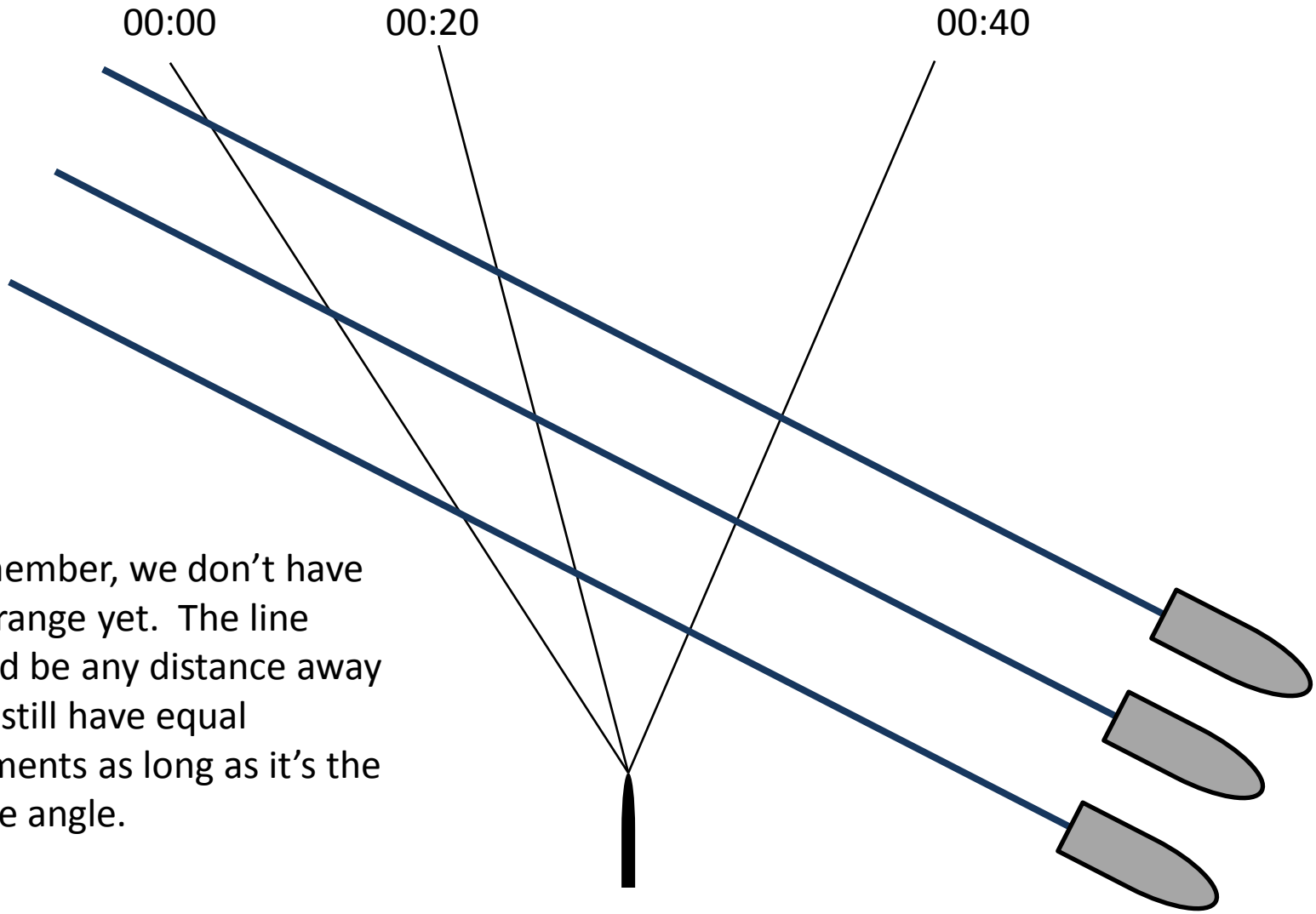
Later, I'll explain how to do all of this using the in-game tools. Right now we're just covering the concept.



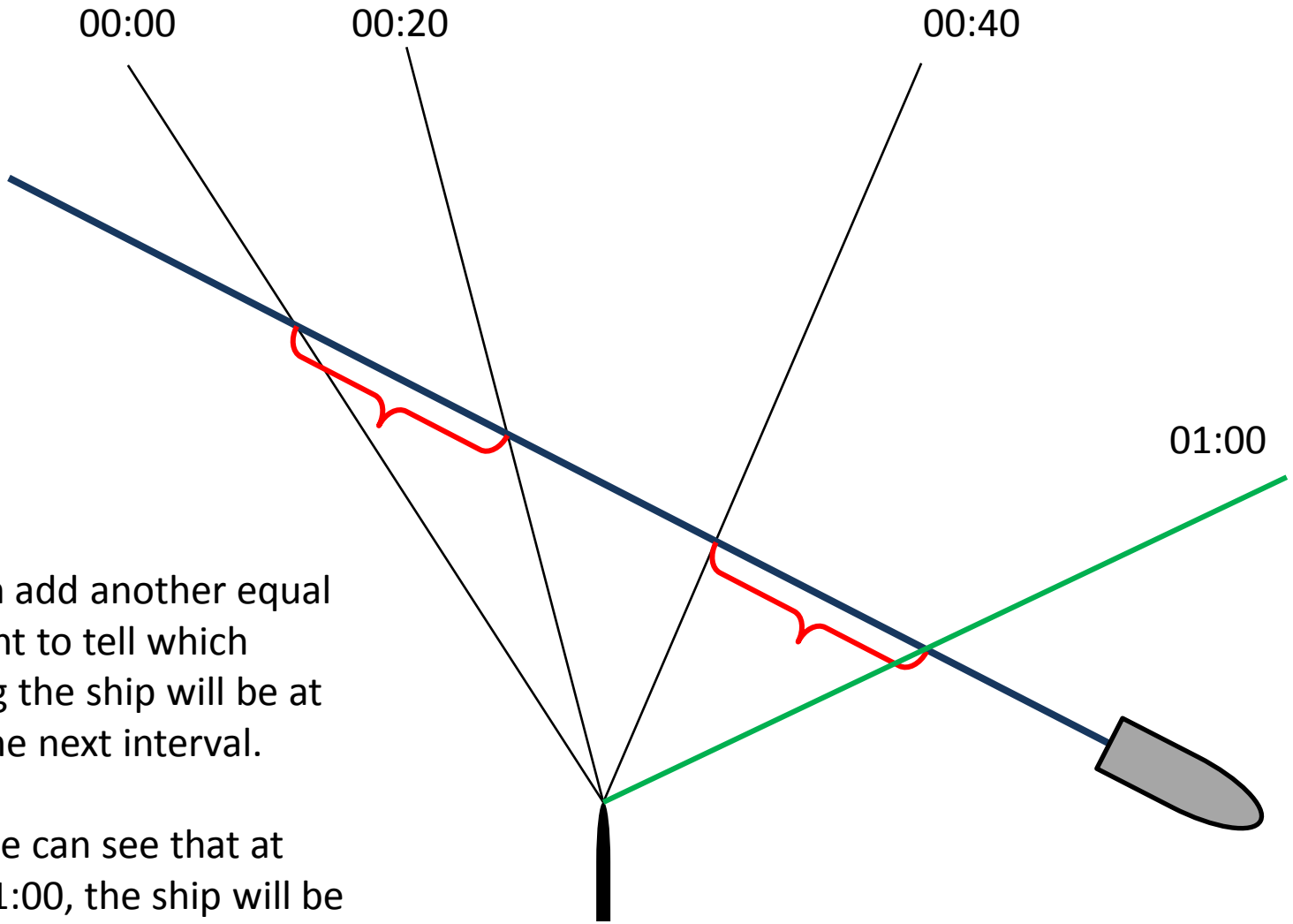
Now, draw a line that crosses your two intersections, and you have the ship's course!



The reason this works is that you've created two identical triangles that the equal-length segments lie on, revealing the ship's course.

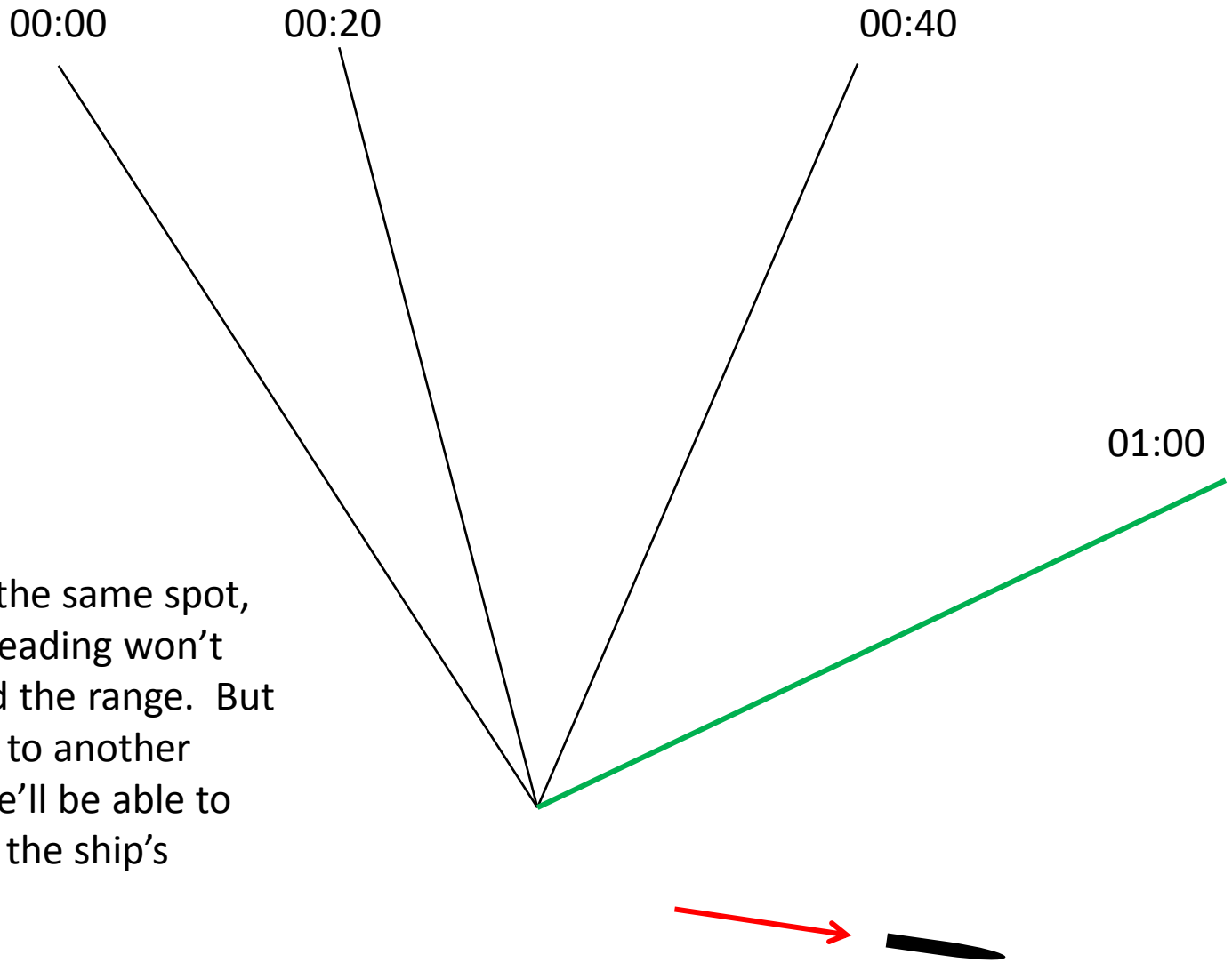


Remember, we don't have the range yet. The line could be any distance away and still have equal segments as long as it's the same angle.

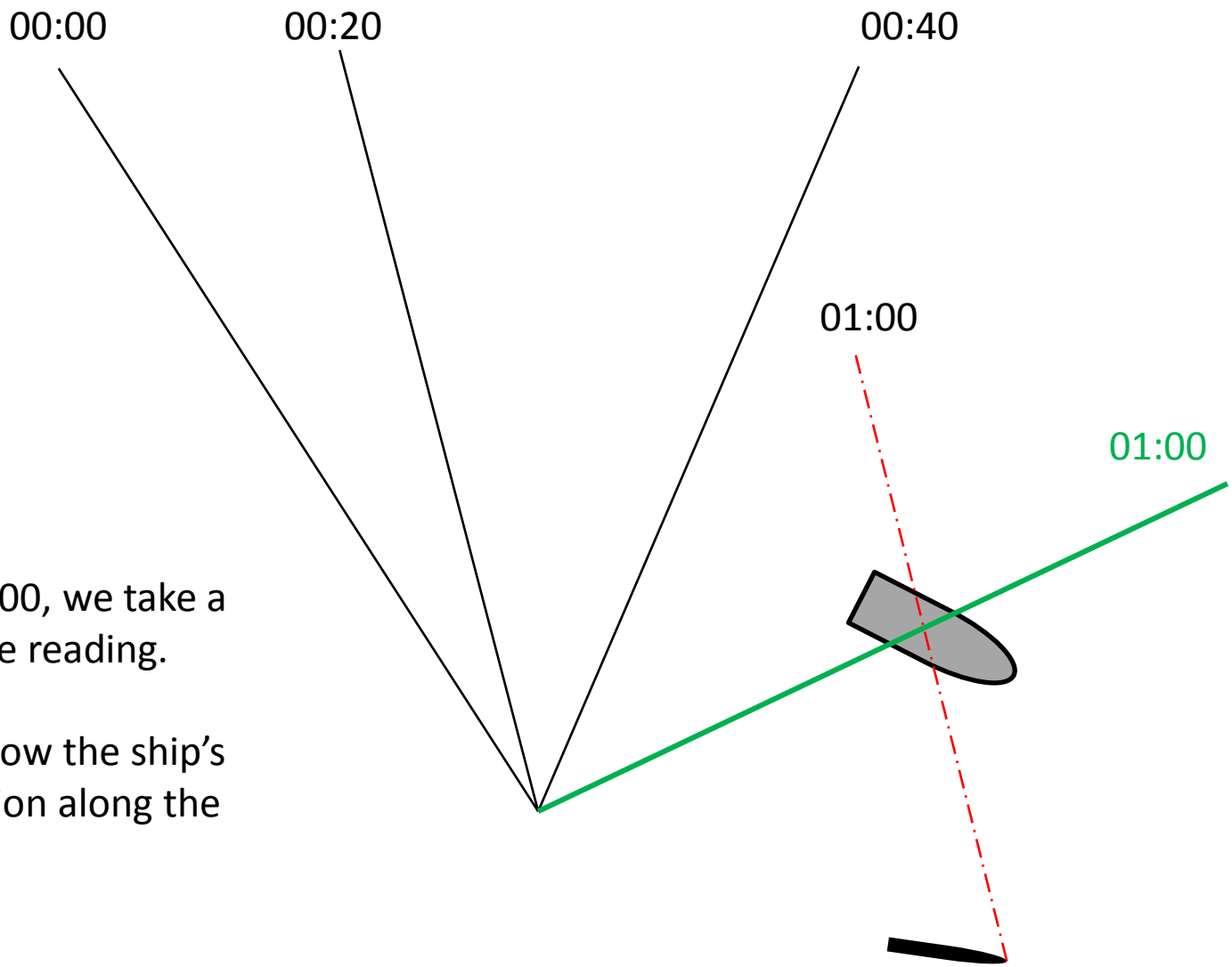


We can add another equal segment to tell which bearing the ship will be at after the next interval.

Here we can see that at time 01:00, the ship will be **somewhere** along the green line. We're going to figure out exactly where.

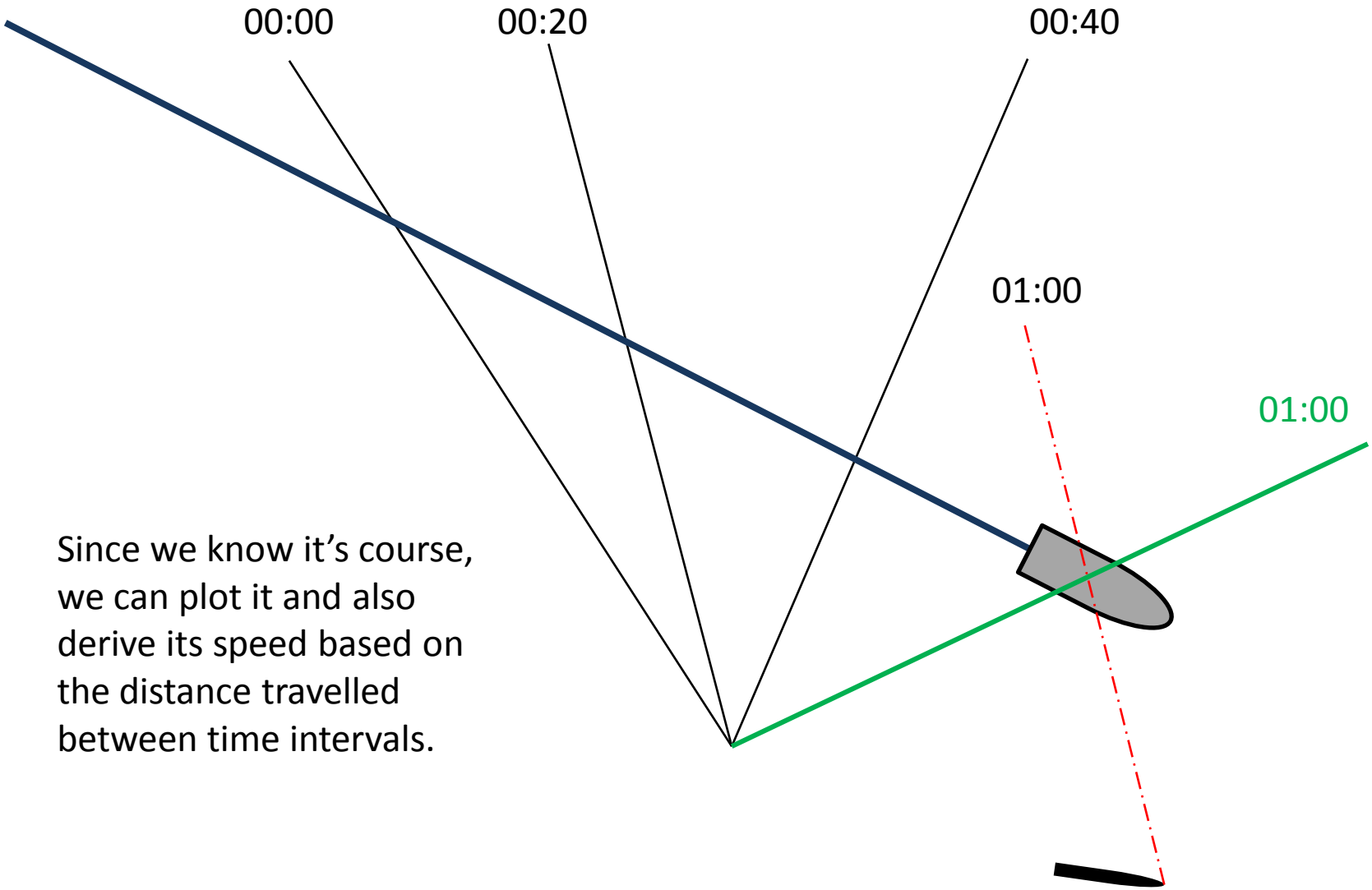


If we sit in the same spot, the 01:00 reading won't help us find the range. But if we move to another location, we'll be able to triangulate the ship's position.

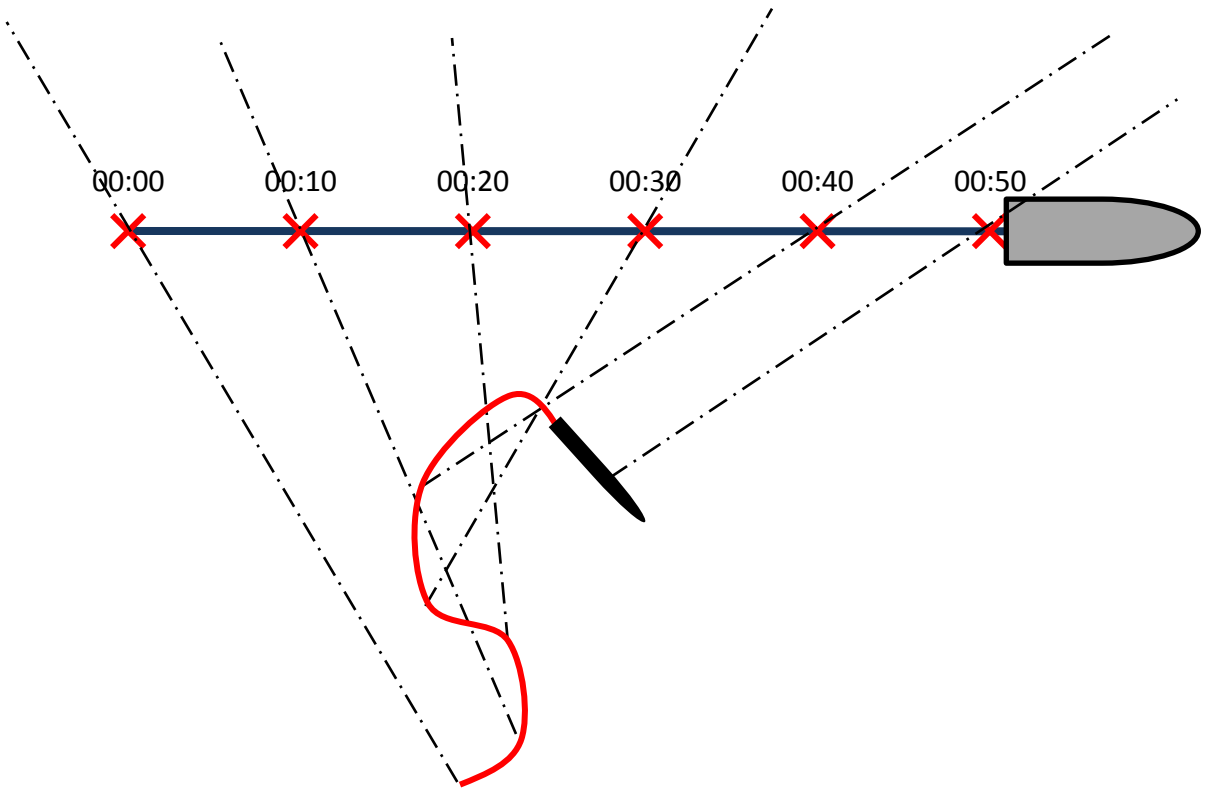


At time 01:00, we take a hydrophone reading.

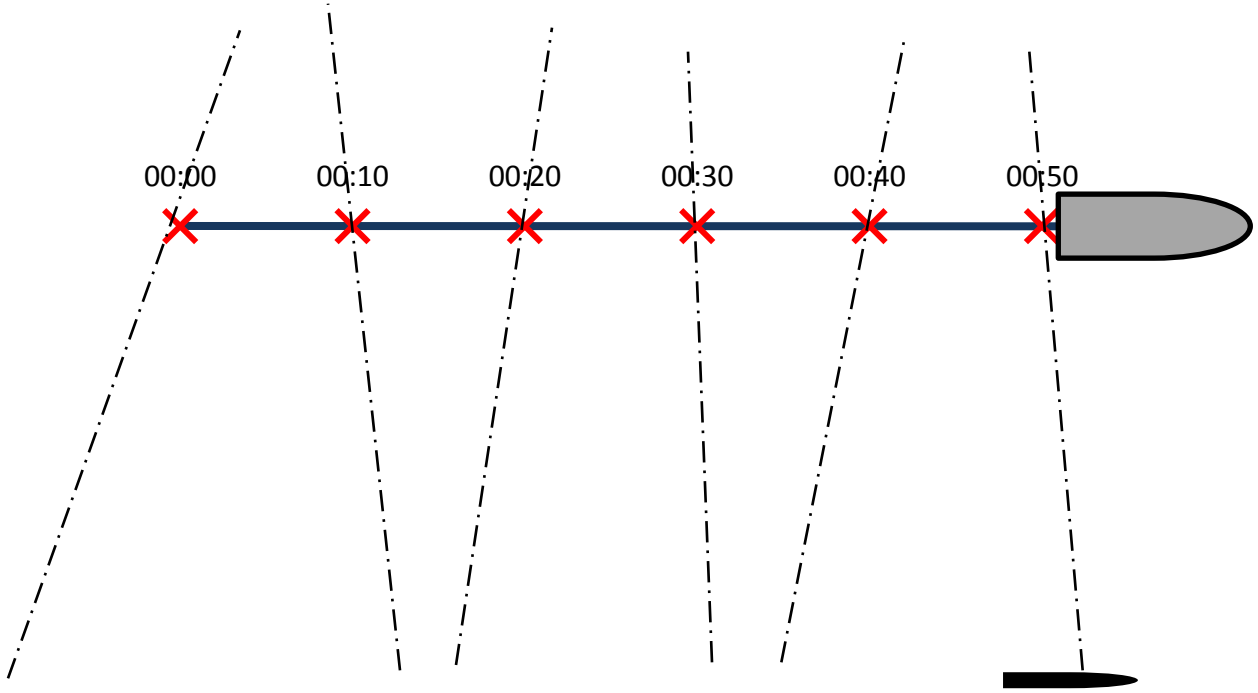
Now we know the ship's exact position along the green line.



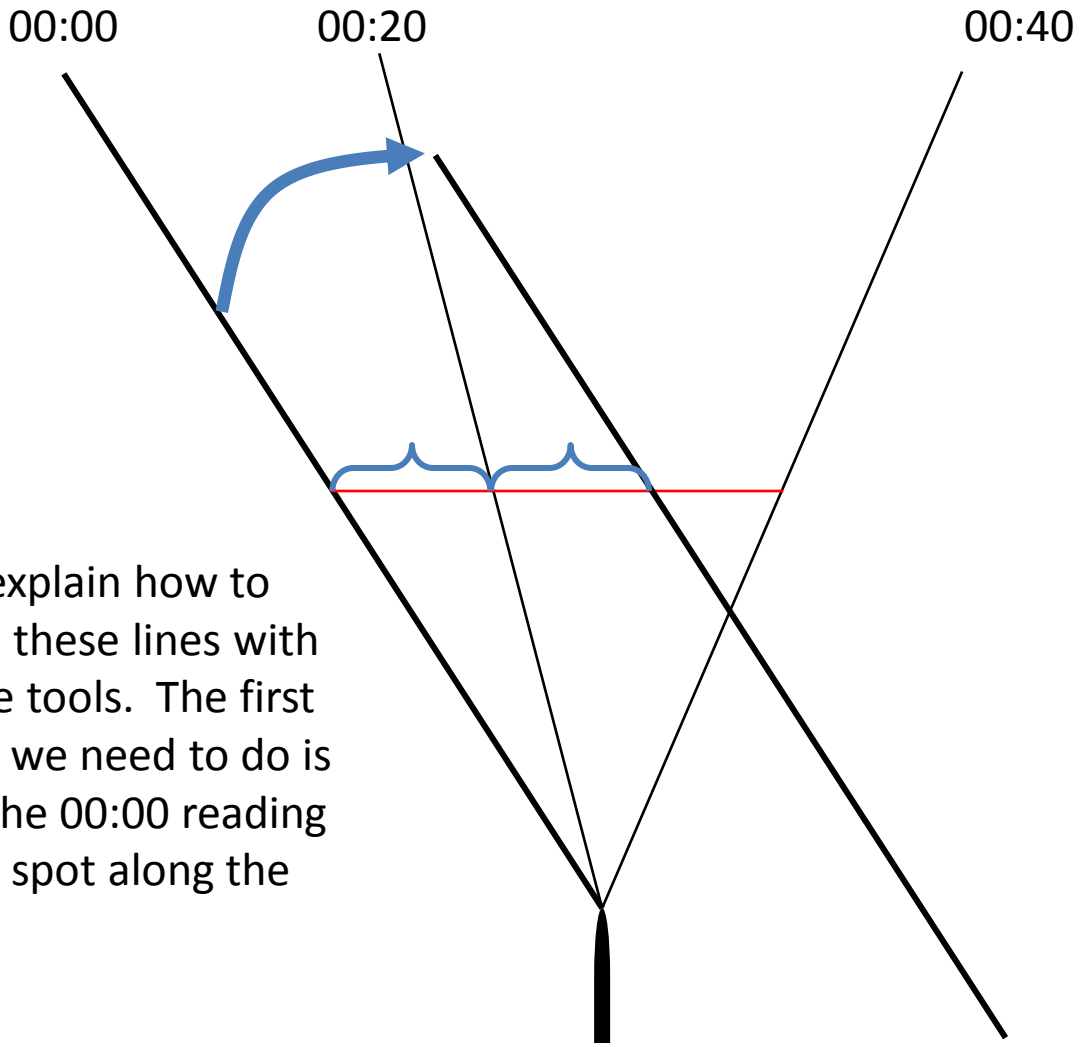
Since we know it's course, we can plot it and also derive its speed based on the distance travelled between time intervals.



You don’t have to be stationary for this method to work, but you do have to have a solid understanding of the principles I explained if you’re going to perform this while moving. The concept is the same though: find the line where the segments between readings are of equal length. Use the same methods as before to find this line.



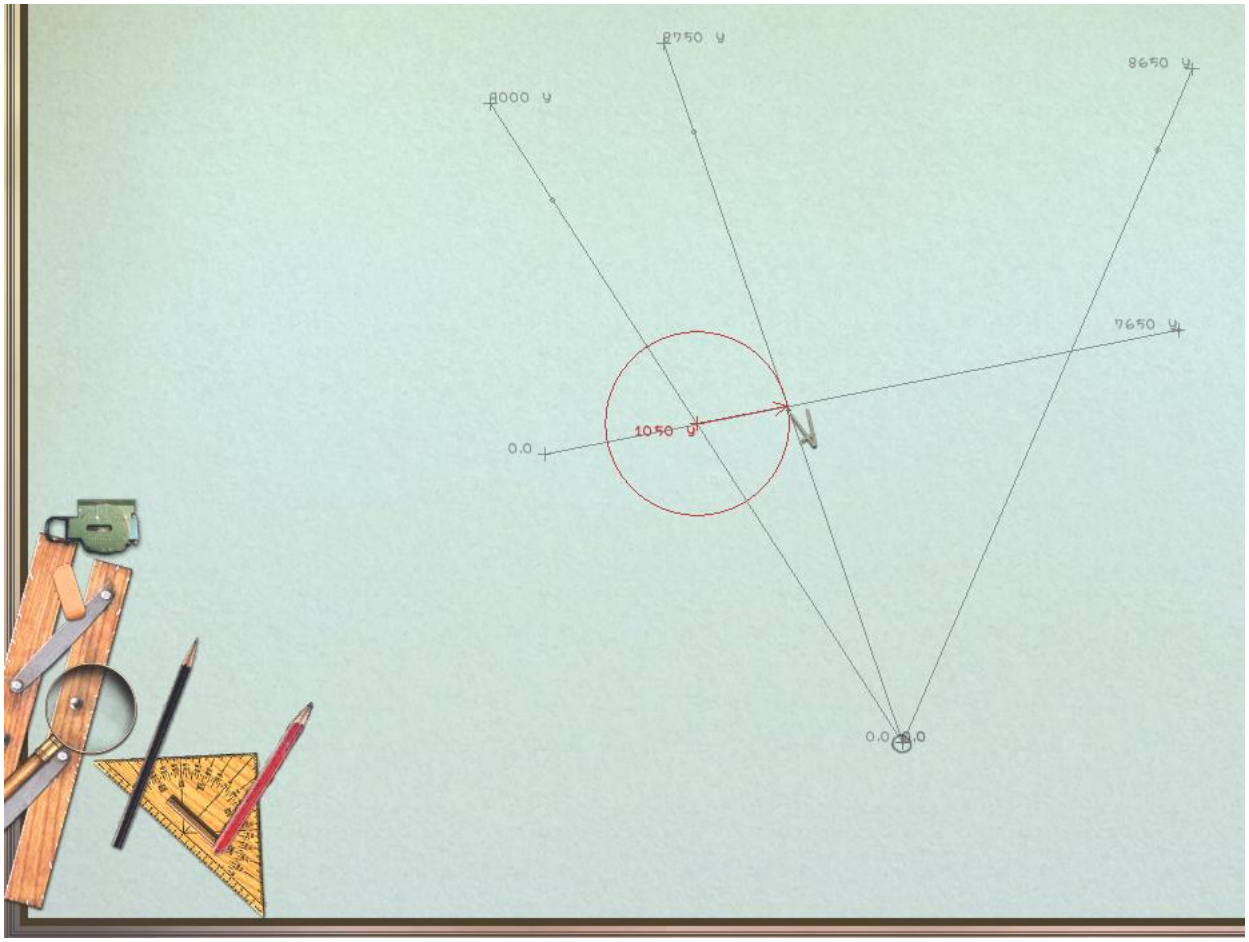
You can also try alternately speeding up and slowing down to triangulate the position and course. In this example, there is only one possible course and distance that will produce equal segments, and that is where the other ship is.



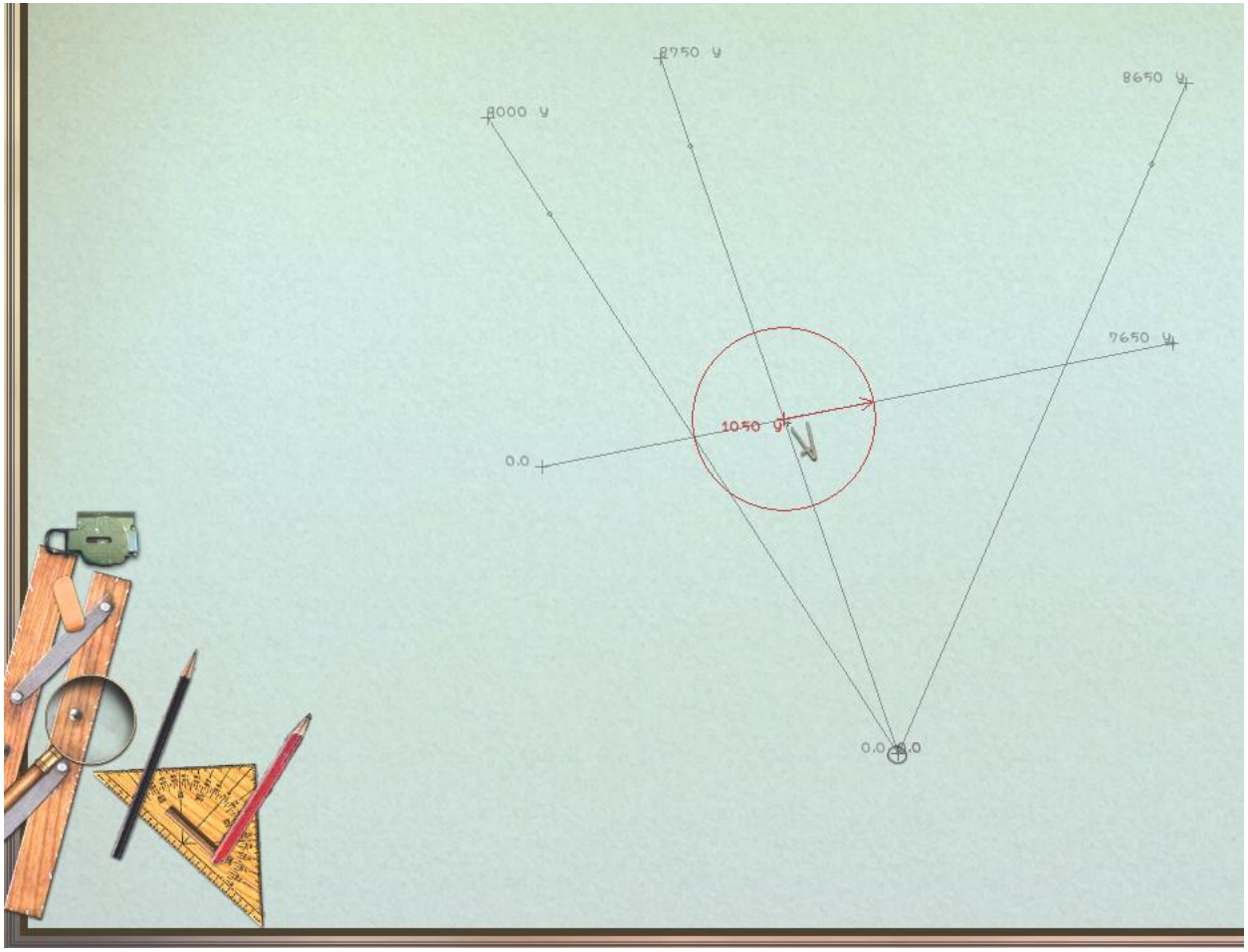
Now I will explain how to manipulate these lines with the in-game tools. The first tricky thing we need to do is transpose the 00:00 reading to the right spot along the red line.

The Compass is an excellent tool for transposing distances and angles because you can move it without altering it. You're not using the circle, but the arrow inside the circle.

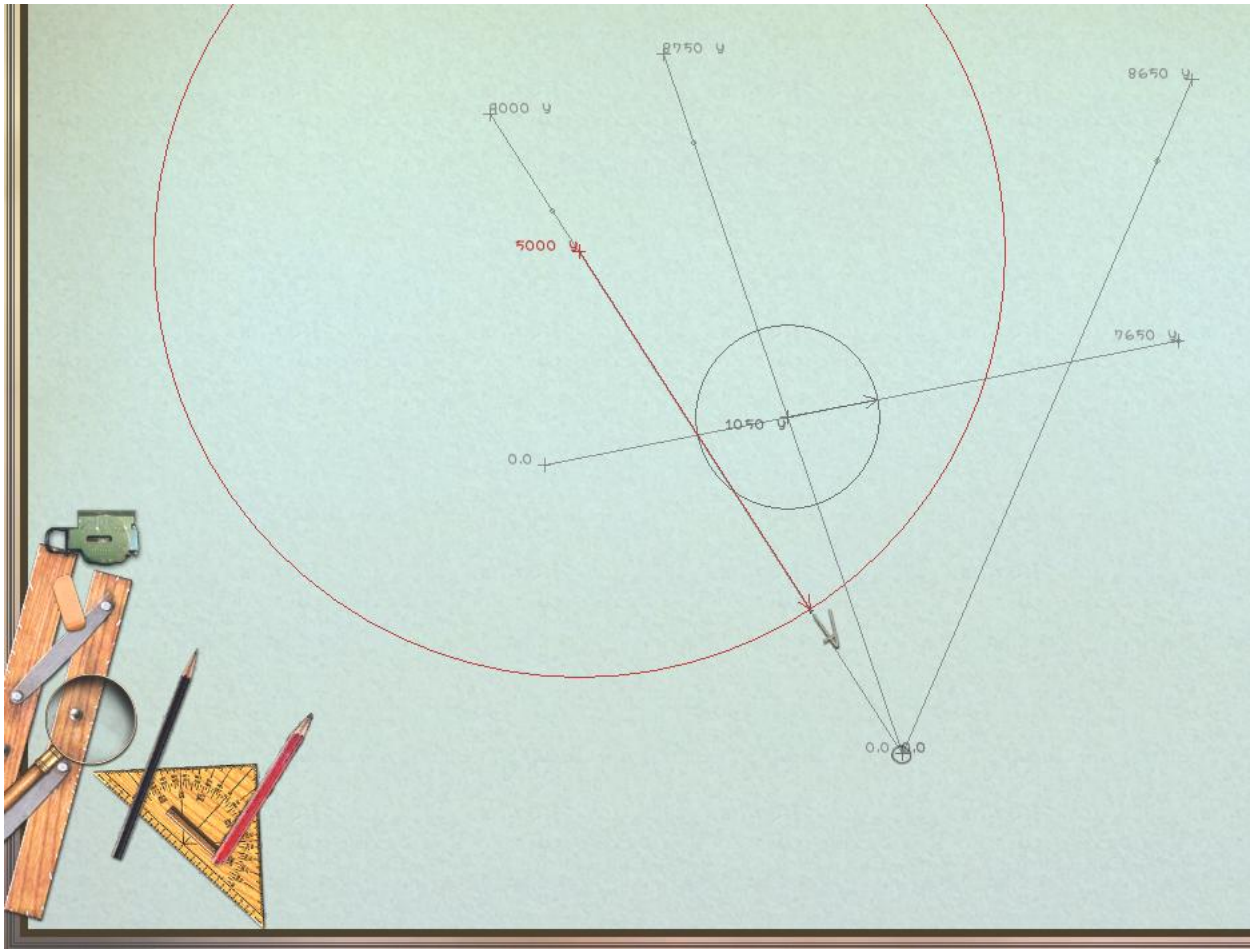
Start by drawing the distance you're going to have to match on the cross-line (red line on the example)



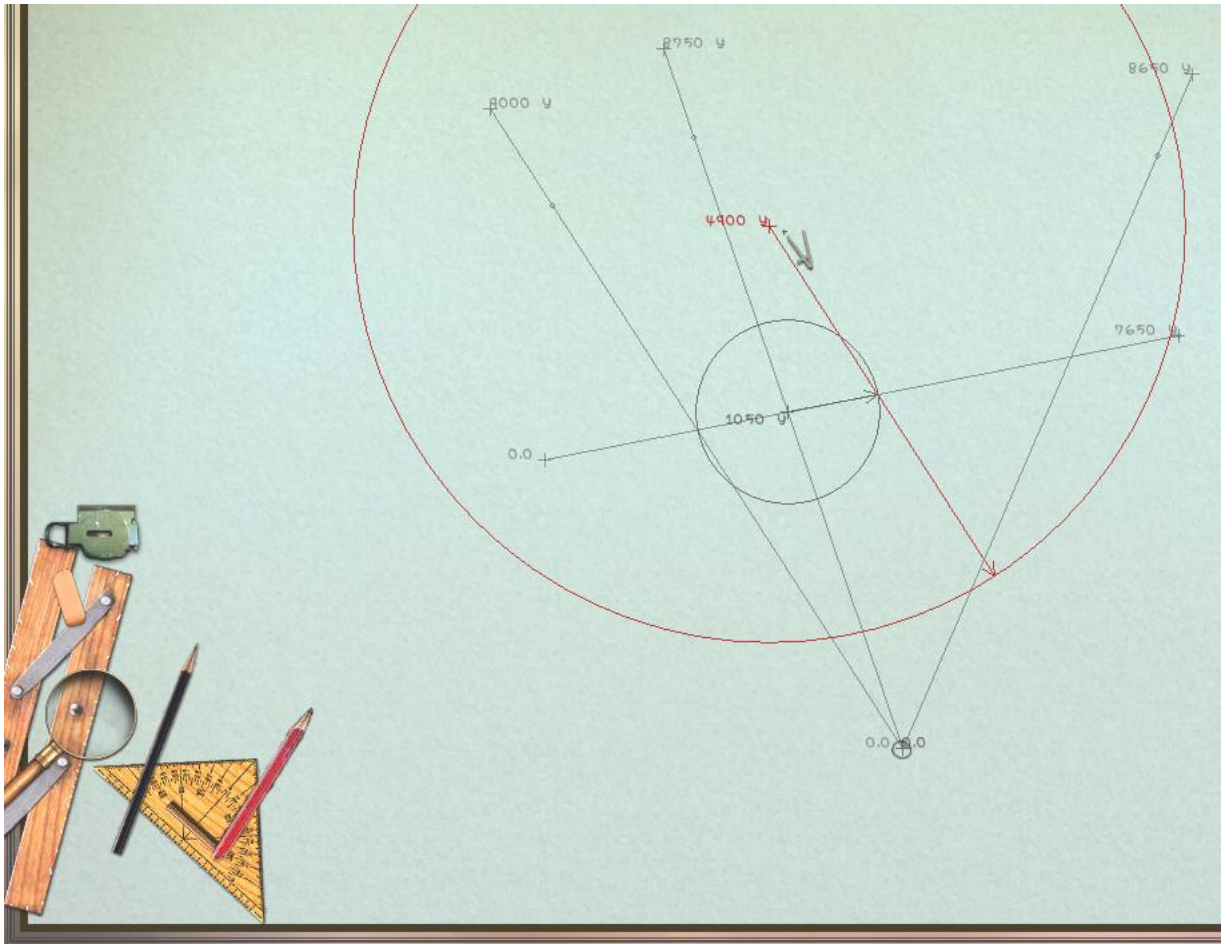
Now just drag the center of the circle over to the point where the 00:20 reading crosses the line. The end of the arrow will be your distance.



Next, we need to transpose the line from our 00:00 reading. Again, the compass is a great tool for this job.

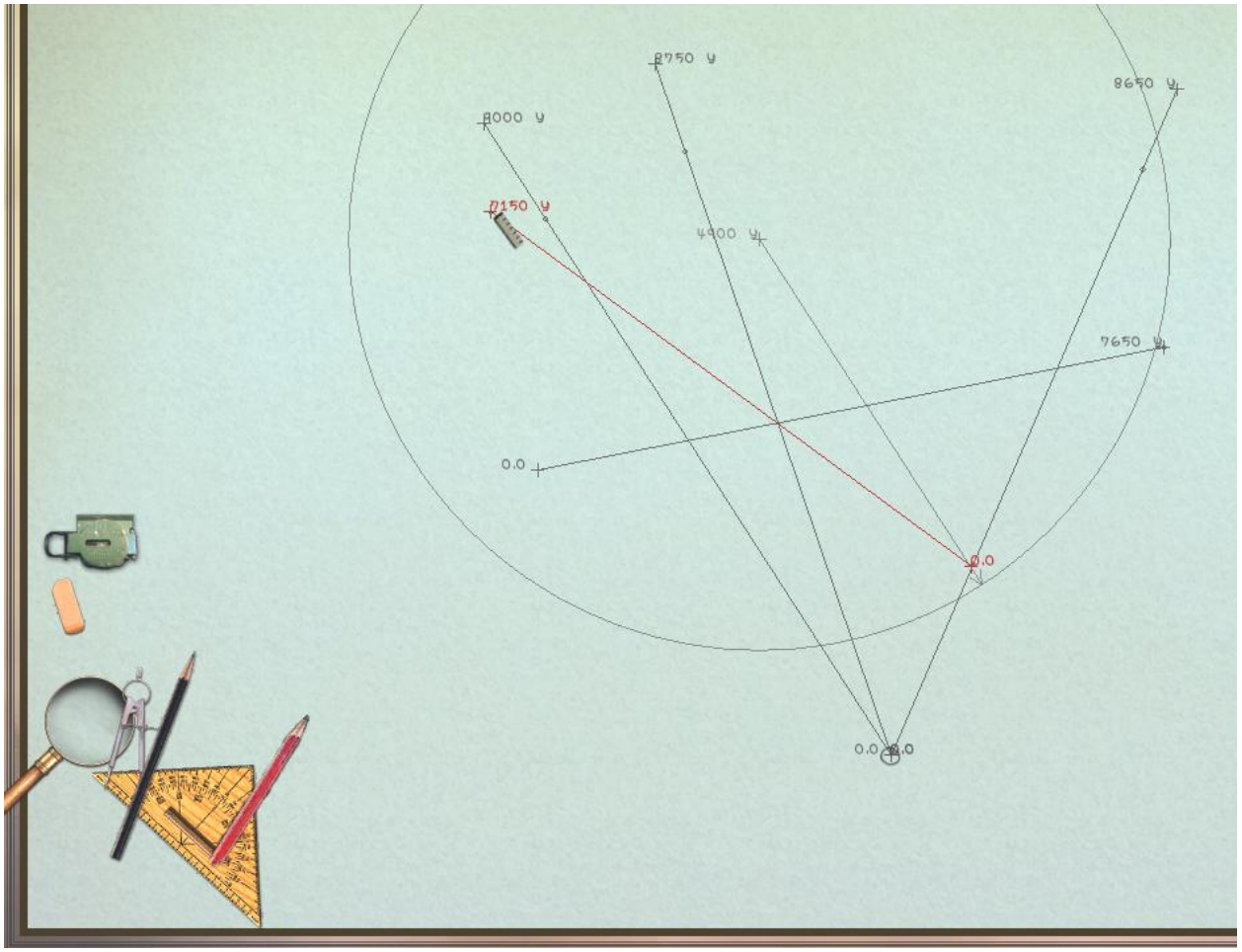


Now grab the center of this new circle and move it until the line touches the tip of the arrow on the small circle. Make sure the arrow on the large circle crosses the 00:40 reading.



Finally, draw a line that intersects the other lines as shown. This creates the two identical triangles, and draws the course of the other ship (shown in red here.) Notice I deleted the small circle to minimize clutter.

You can use the compass tool to transpose the distance and course to predict the 01:00 reading (green line on the example.)



Once you triangulate the other ship's position, you can use the compass tool again to trace the course and transpose it to the new position.