Name: ____________________ Date: ________________


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# Semi Automatic TMA Walkthrough

# Tutorial 7

# Contents

# 7 Semi-Automatic TMA Walkthrough

Semi Automatic Track Construction (SATC) was developed in response to the challenges of handling and solving multi-leg target tracks using **Debrief**'s manual TMA algorithms. SATC provides an automated means of obtaining an optimal solution based upon disparate "packages" of analyst knowledge, measured data, and logical/geometric deductions (collectively these are called “contributions”). This tutorial looks at:

- Single Leg TMA Solution
- Multi Leg TMA Solution

## 7.1 Single Leg TMA Solution

The first tutorial in this set will involve an engagement where there is just a single leg of target data. Here we follow 5 steps:

- Loading a Simple Scenario
- Creating a Scenario
- Generating a Solution
- Converting the Solution to a Track

### 7.1.1 Loading a Simple Scenario

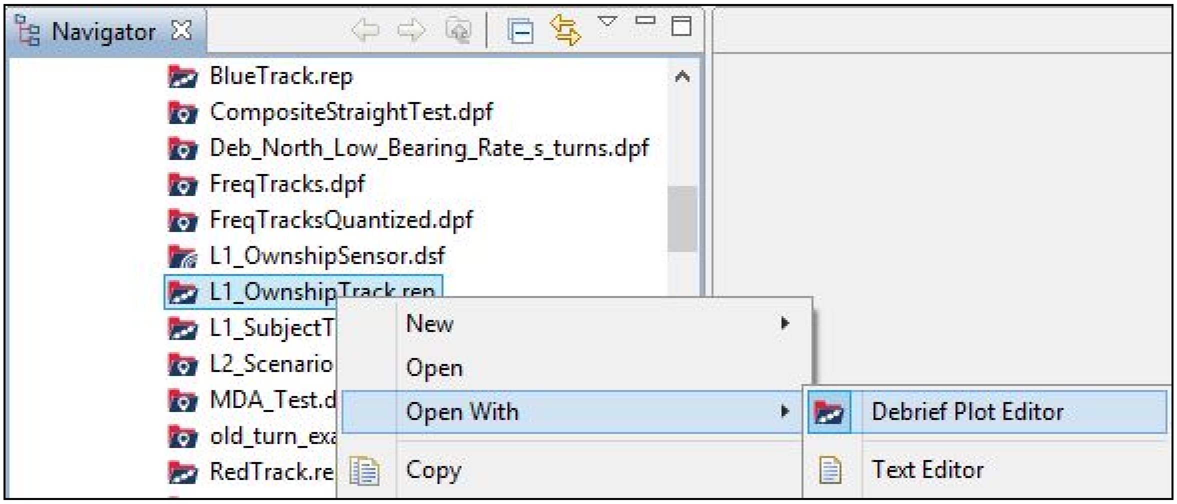
**Note**:Before you begin this section, you should know how to generate a project and generate links to existing data.

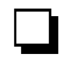
To produce target solutions we must load some ownship data. We’ll do that now.

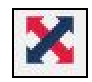
**Find SATC Subfolder and Load Ownship Track**

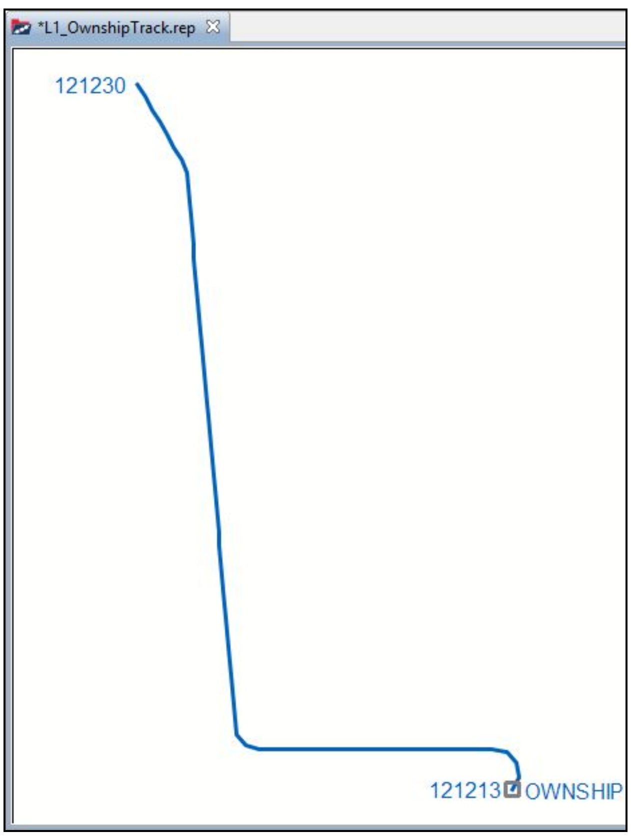
In the **Navigator** view:

1. Open the **SATC** sub-folder and either drag the **“L1_OwnshipTrack.rep”** file into the **Debrief** plot area or right click and select **Open With > Debrief Plot Editor**. ❏




2. In the **Select track mode** dialog, select **Over the Ground (OTG)** mode. 

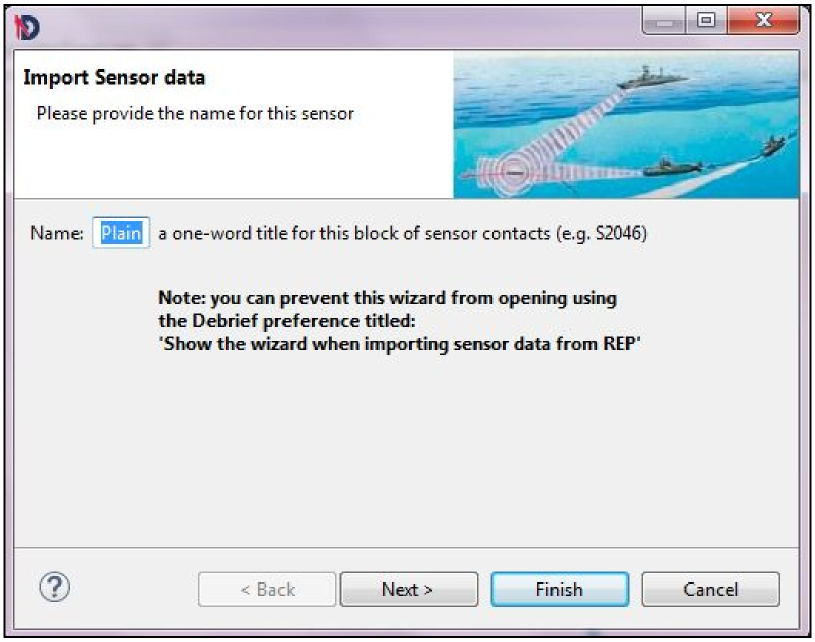
You will now see the blue ownship track in your Plot Editor. Click **Fit to window** button  to view the entire plot.



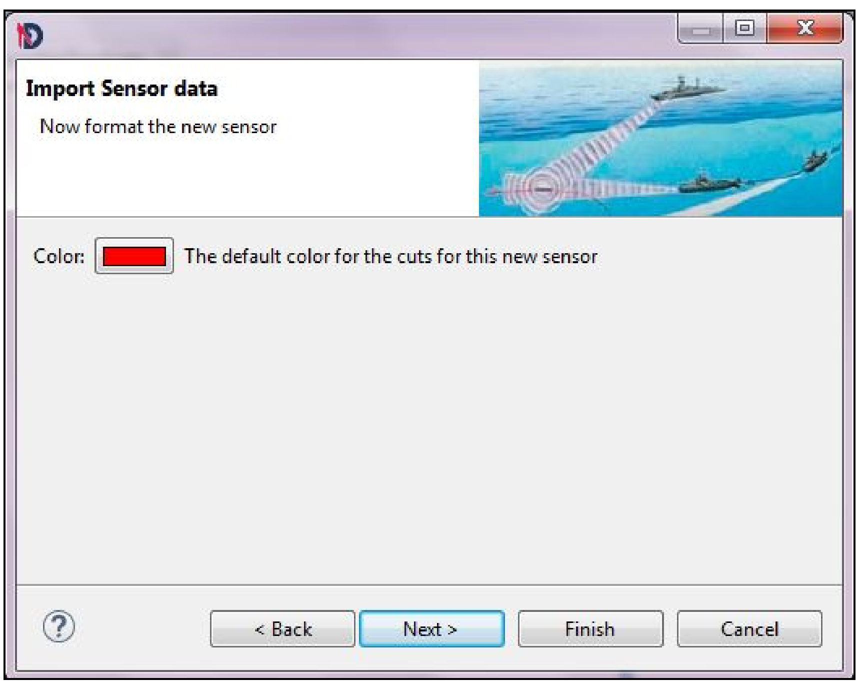

**Load Ownship Sensor Data**

Next, we will load the ownship sensor data (this is the sonar data):

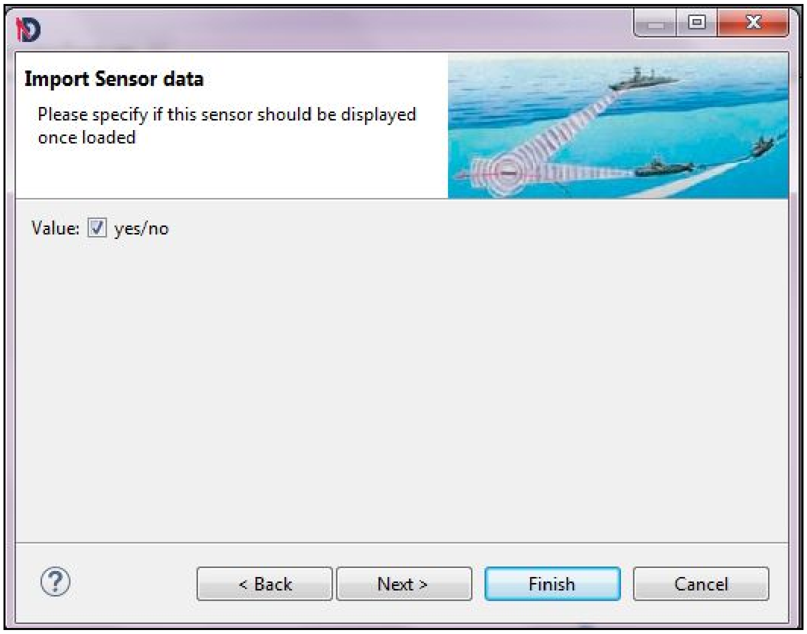
1. Drag and drop the **"L1_OwnshipSensor.dsf"** file onto the plot, the **Import Sensor Wizard** will display.



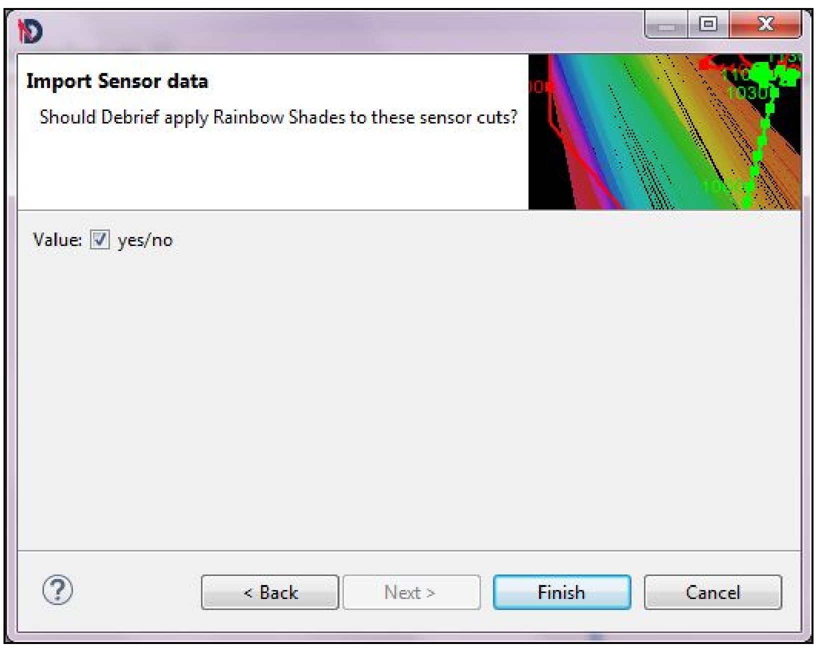

2. You can leave this **sensor contact name** as **Plain**. Click **Next**.



3. Choose a **color** for the sensor data, then click **Next**. ❑

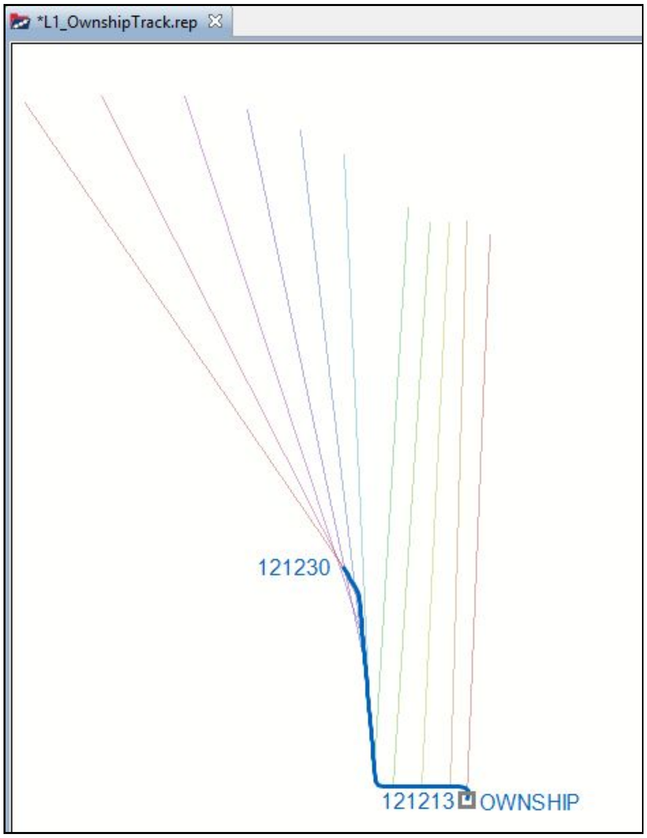



4. Select the **value** check box so that the sensor data will be visible, then click **Next**. ❑




5. In the **Rainbow shades** dialog, select the check box to shade the sensor cuts in a range of colors. Click **Finish**. ❑

The dialog box will close and the fan of ownship bearing data (sonar data) will be seen radiating north-west and north from the ownship track.




If you don't see this, then repeat the above steps (making sure you've loaded the correct files).

Now we've loaded our data and we can now create a scenario.

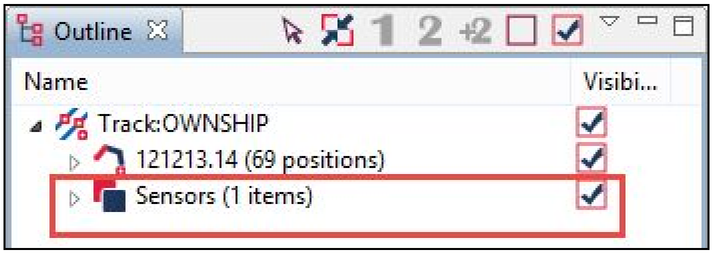
## 7.1.2 Creating a Scenario

**Debrief** uses the term ***scenario*** to describe the combination of data that is collated in order for SATC to produce an optimal 'solution'. Let's create our first scenario now.

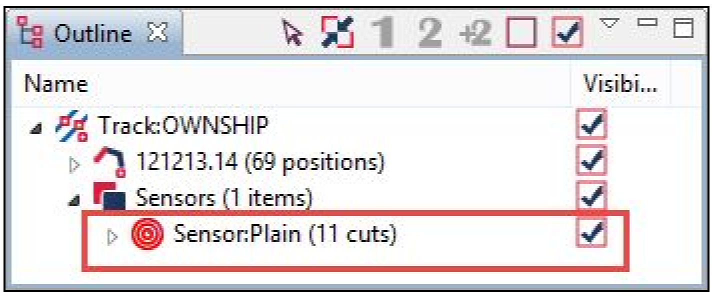
### 7.1.2.1 Creating a Scenario Based on Cuts

We will use all of the ownship sensor data to create our scenario:

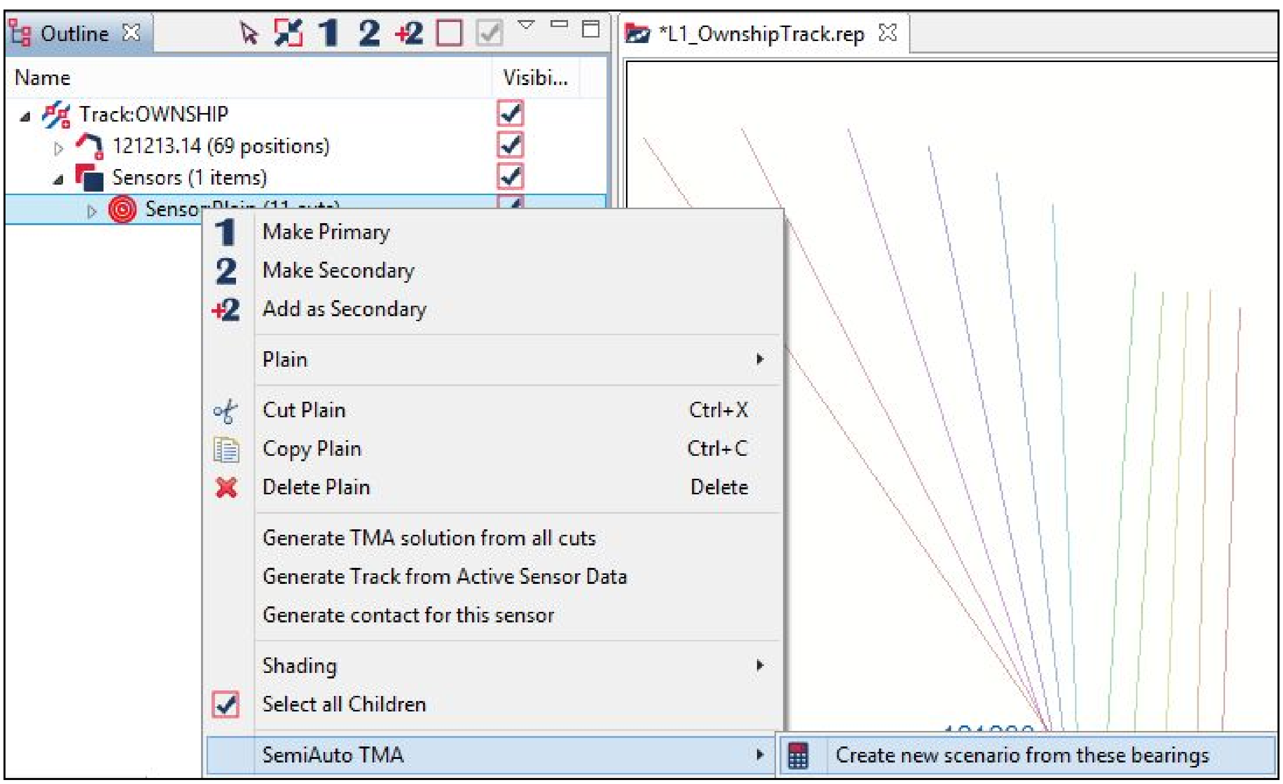
1. Open the **Outline** view. ❑
2. Open **Track:OWNSHIP**. ❑




3. The ownship track has a **Sensors (1 items)** object, open this and you will see the single block of sensor data, titled **Sensor:Plain (11 cuts)**.

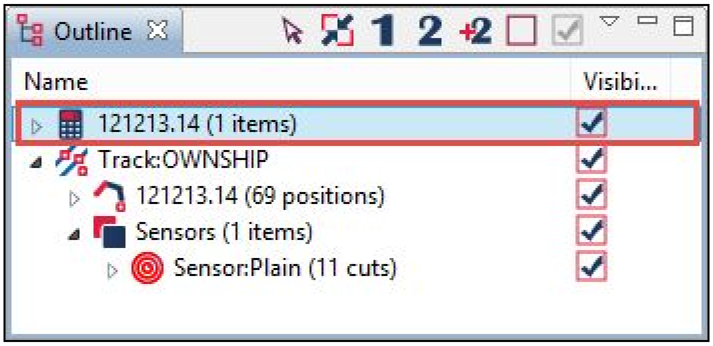



4. Right-click on it and select **SemiAuto TMA > Create new scenario from these bearings**.

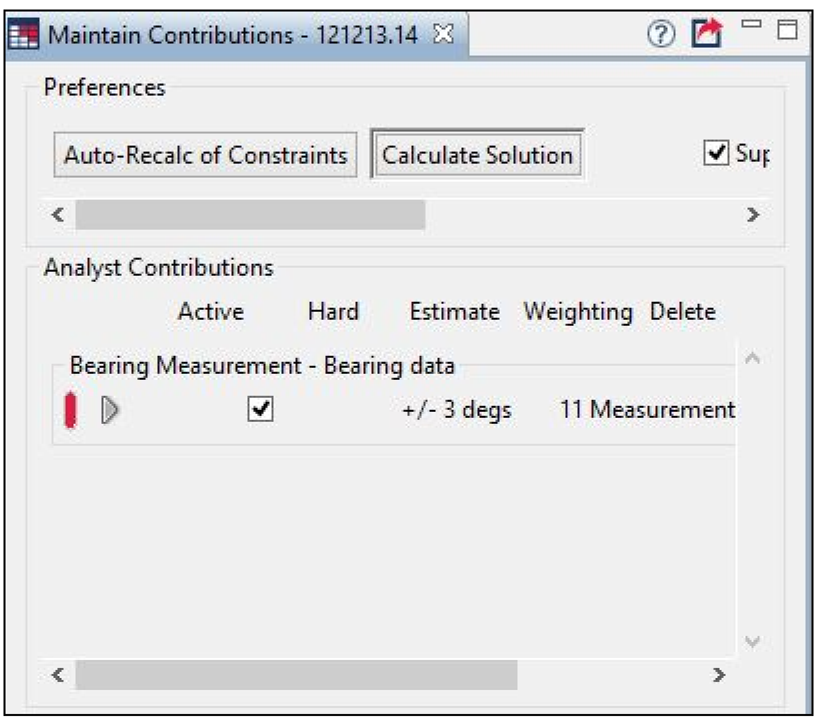


### 7.1.2.2 Creating Scenario Based upon Cuts

A new item with the name **121213.14 (1 items)** has been created in the **Outline** view (the item name is auto-selected from the Date-Time-Group (DTG) of the first item in the bearing data). Notice the use of the calculator symbol to indicate this computer-generated track solution.




You will also see that the **Maintain Contributions** view has opened. A contribution is a piece of information that is used in the development of target solutions. This information can be in the form of a measurement (range, bearing or frequency); an analyst forecast ( i.e. speed or range), or one of a hidden set of analysis contributions that deduce further constraints based on other contributions. This view is used to create and manage your scenario data.

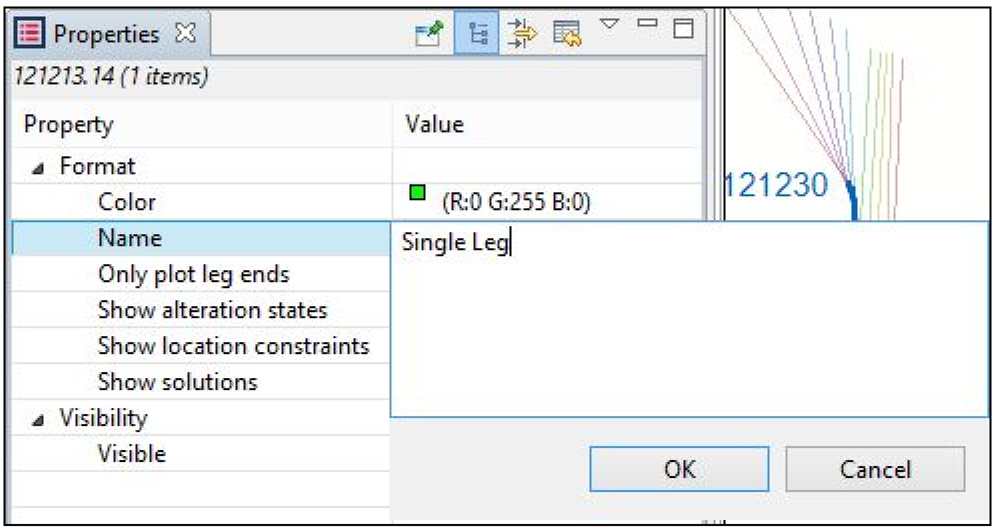


### 7.1.2.3 Changing the Scenario Name

As nice as it is to try and remember a new set of telephone numbers, every time you create a new scenario. It makes sense to rename the scenario to something more meaningful. To rename the scenario

1. In the **Outline** view, click on the scenario name **121213.14** to select it. ❏

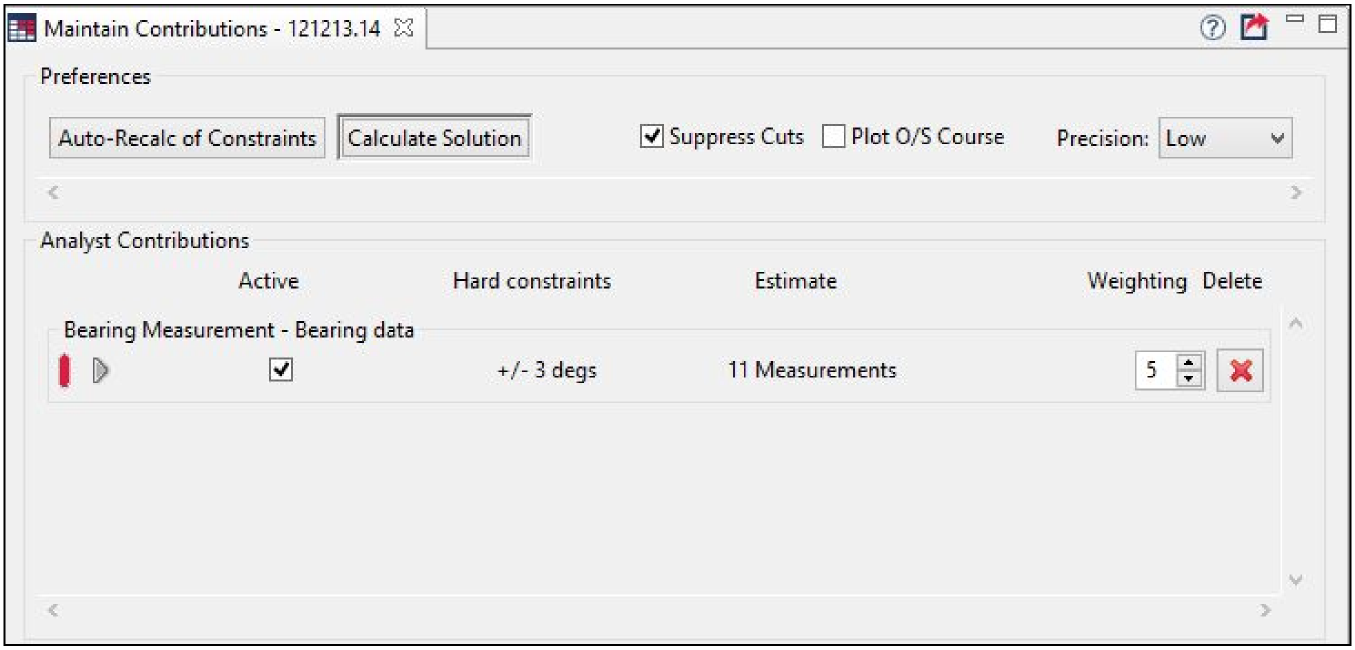
2. In the **Properties** view, (**Windows > Show View > Properties**, if it isn't visible) change the **Name** value to **Single Leg**. ❏




3. Click **OK**. ❏

### 7.1.2.4 Understanding the Maintain Contributions View

**Main Contributions View**




In the **Maintain Contributions** view you can see that, in the **Analyst Contributions** section, there is a single **Bearing Measurement - Bearing data** item listed.

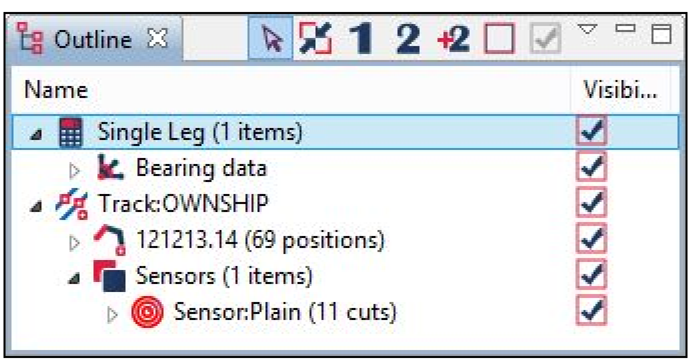
This is the bearing data that will be used to inform all of the subsequent contributions.

### 7.1.2.5 Viewing the Bearing Measurement Contributions

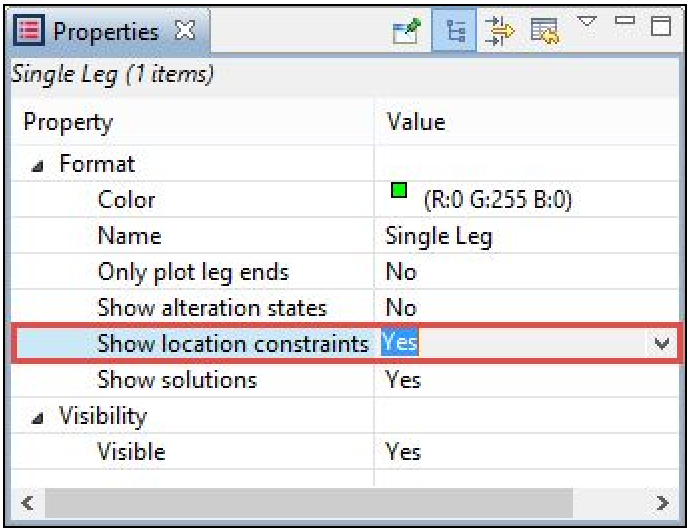
The **Bearing Measurement Contribution** is the set of bearings that represent the unknown target track. You can see that the contribution has an estimated **error** value of **+/- 3 degs**, which means the algorithm will only consider solutions that are within 3 degrees of these bearing measurements.

To view these measurements:

1. Select the track **Single Leg** in the **Outline** view.

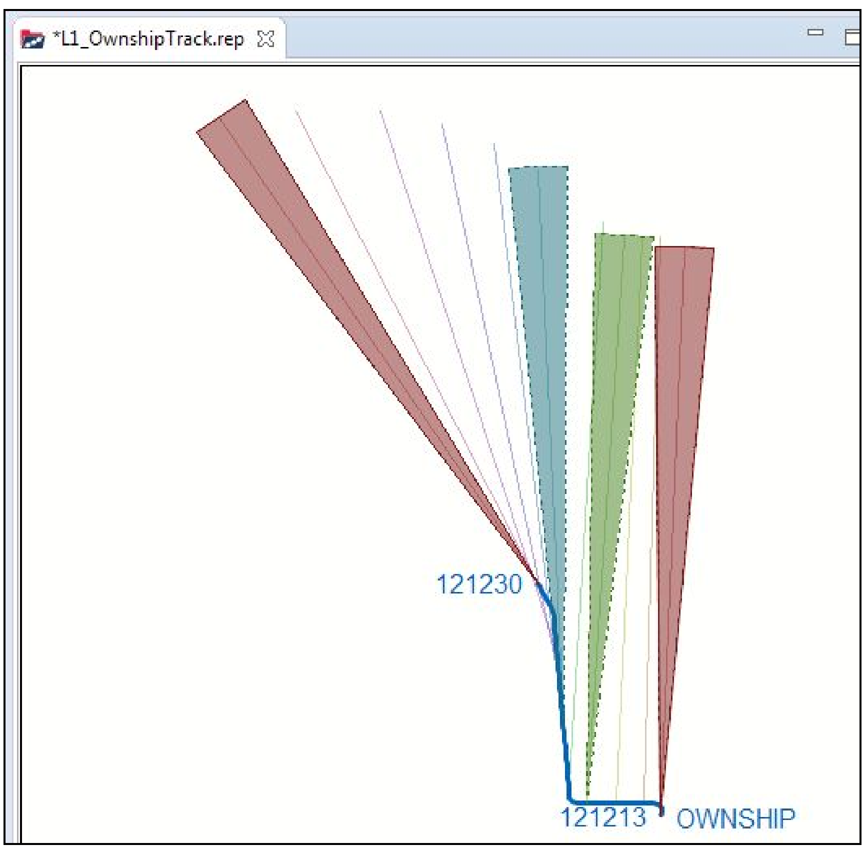



2. In the **Properties** view, set the attribute value **Show location constraints** to **Yes**.

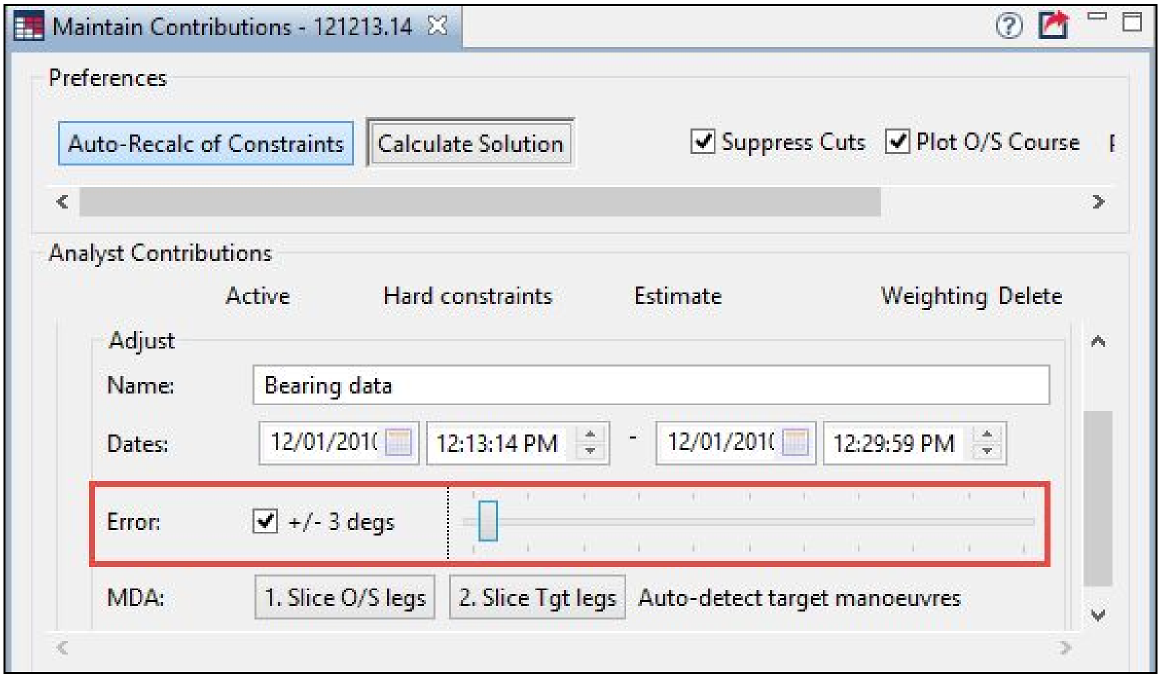



3. In the **Maintain Contributions** view, click on the **Calculate Solution** button.


A set of "pie-slices" will now appear on the plot, showing the 3 degree allowable error on each bearing measurement.



4. Still in the **Maintain Contributions** view, expand the **Bearing Measurement - Bearing Data** contribution and you will see that it is possible to change the error value on this bearing data by moving the slider. As you move and release the slider you will see the pie slices expand and contract (you may need to toggle the **Auto-Recalc of Constraints** button in the **Preferences** area to initiate this).




**Note**: The **Auto-Recalc of Constraints** is a two-state button that is normally depressed. But, if you have a complex scenario that takes some time to update, you may wish to un-check this button - then the screen will no longer be refreshed as you are interactively adjusting any contributions.

### 7.1.2.6 Specifying a Target Leg

**Note**: In this sample data, the imported bearings have a maximum range of 12,000 yards (yds). In the absence of a range estimate SATC will restrict them to 30kyds, to keep things manageable, and to avoid your PC requiring the *Ferranti Reset*.

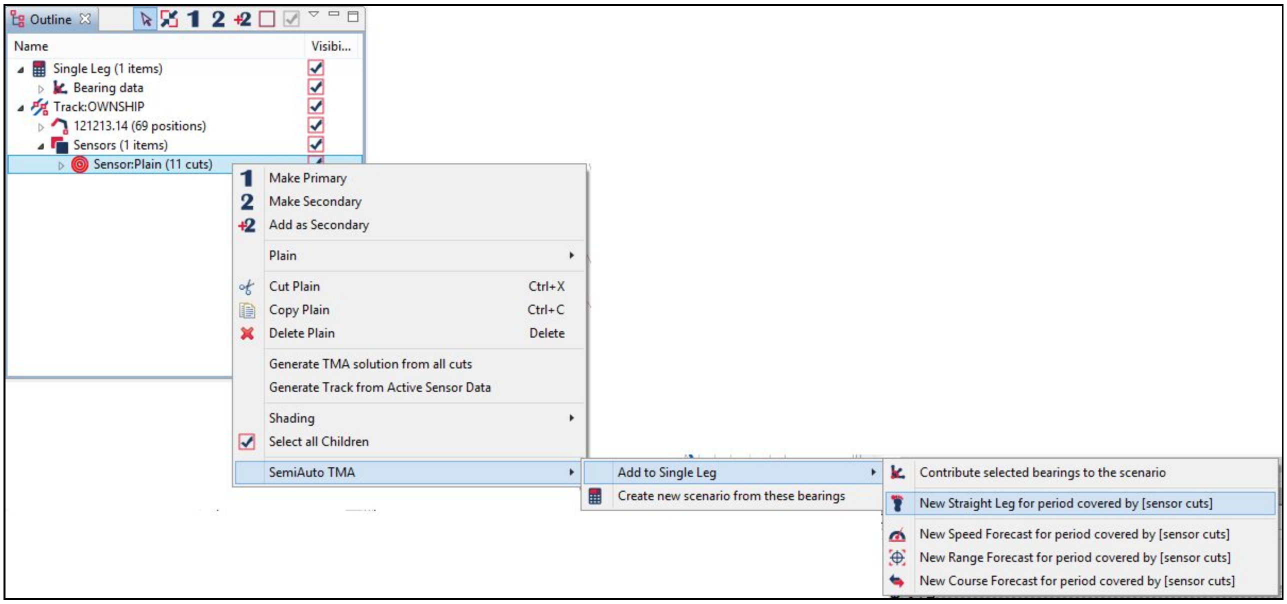
Also, before we continue, **Debrief** must be reset to a *predictable state*, so:

1. Restore the **Analyst Contribution** to **3 degrees**.
2. In the **Properties** view, set the attribute value of **Show Location Constraints** to **No**.

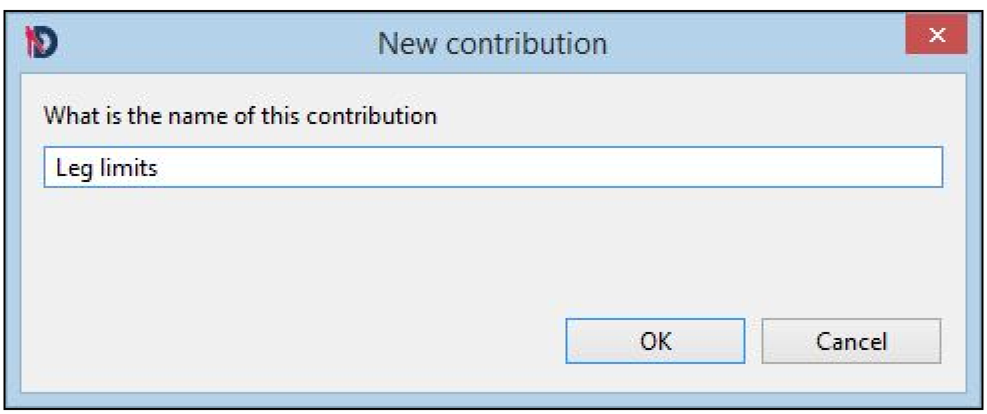
It's possible that your deep analysis skills have led you to believe that all of these cuts relate to a single leg of target data: where the target maintains course and speed through the period of interest - this is of great value to the TMA algorithms, since it means the contact must travel through those pie slices in a straight line.

1. In the **Outline** view, select **Track:Ownship > Sensors (1 items)**, and then right-click on **Sensor:Plain (11 cuts)**.

2. From the drop-down menu, select **Semi Auto TMA > Add to Single Leg > New Straight Leg for period covered by [sensor cuts]**.

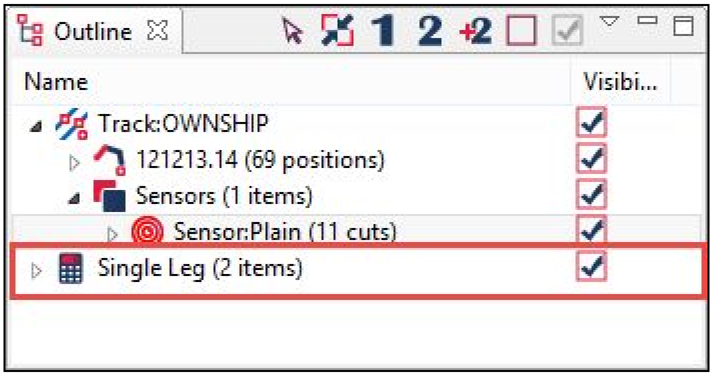



3. When the **New contribution** dialog opens up, name this contribution **Leg limits**.




4. Click **Ok**.

In the **Outline** view, you will see **Single Leg (1 item)** has changed to **Single Leg (2 items)**.




#### 7.1.2.7 Understanding the Contributions

So, now there are two contributions for this scenario:

1. a set of bearings through which a solution must travel.
2. an indication that the target will have travelled on a single course and speed throughout the entire engagement.

An observant analyst will have noticed that our two ownship turns have provided a valuable change in bearing rate - exactly what a TMA algorithm needs.

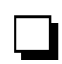
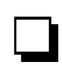
So, now that we’ve provided the TMA algorithm with some viable data, let's see it calculate a solution.

### 7.1.3 Generating a Solution

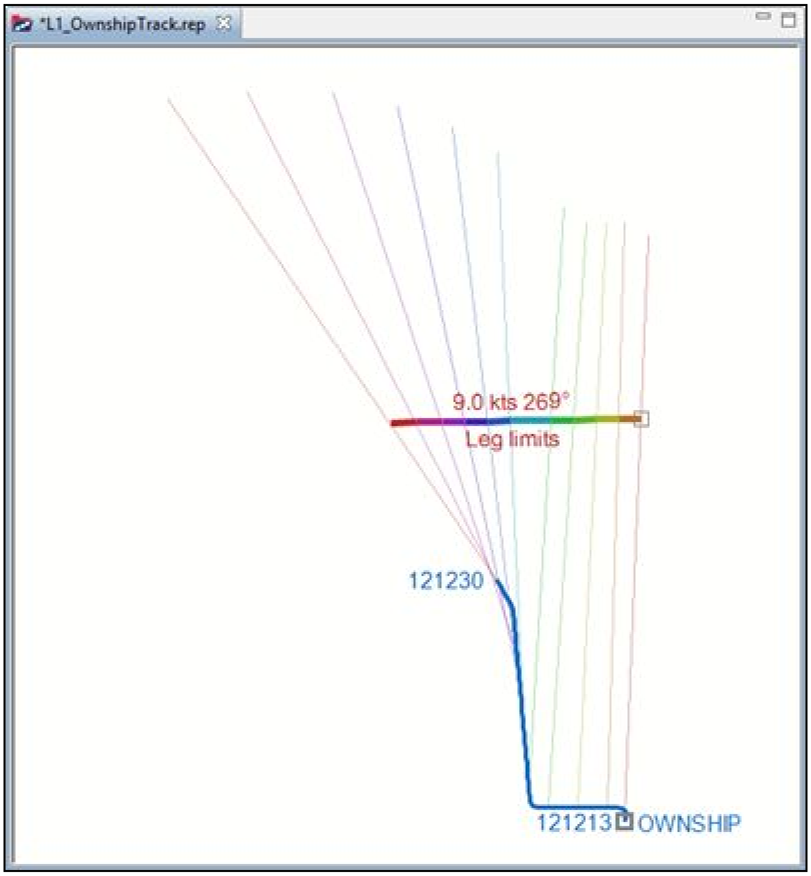
Now we have provided background data to SATC, we can generate a solution.

#### 7.1.3.1 Calculating the Solution

Now we're going to generate the solution for this scenario. Before we do this:

1. Click on the **Fit to Window** button to ensure you can see the ownship track and the rough area where the target should be 
2. Click on the **Calculate Solution** button. 

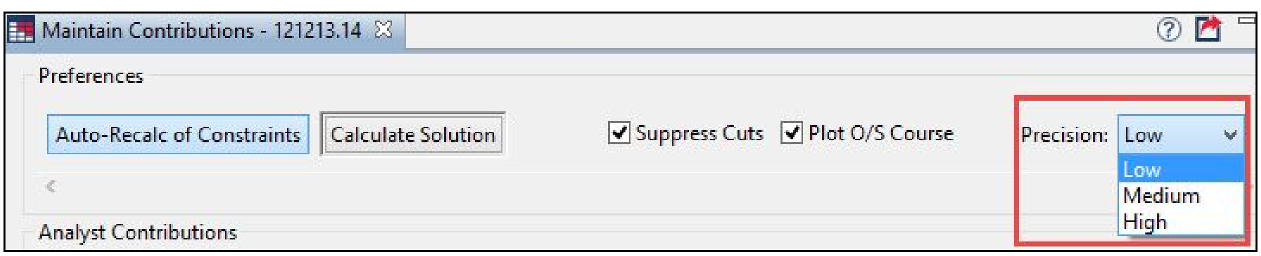
By default, the SATC is set to **Low** precision and uses relaxed constraints. The quite sparse bearing data and ownship maneuvers used in this scenario means that there aren't very many candidate solutions, and an answer will be generated within a second or so. When it has completed its calculations, a new track will appear on the plot.



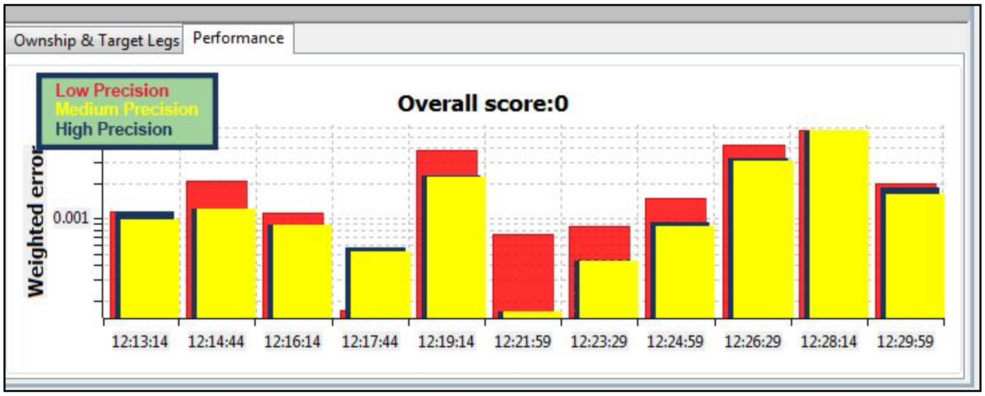

As you can see, the track will be the same color as you specified for the bearing data in the **Bearing Import Wizard**.

My computer returned a solution of **9.0 kts** on **269°**.

You can alter the **Precision** setting as you require (to medium or high), but you must click on **Calculate Solution** each time to generate it.



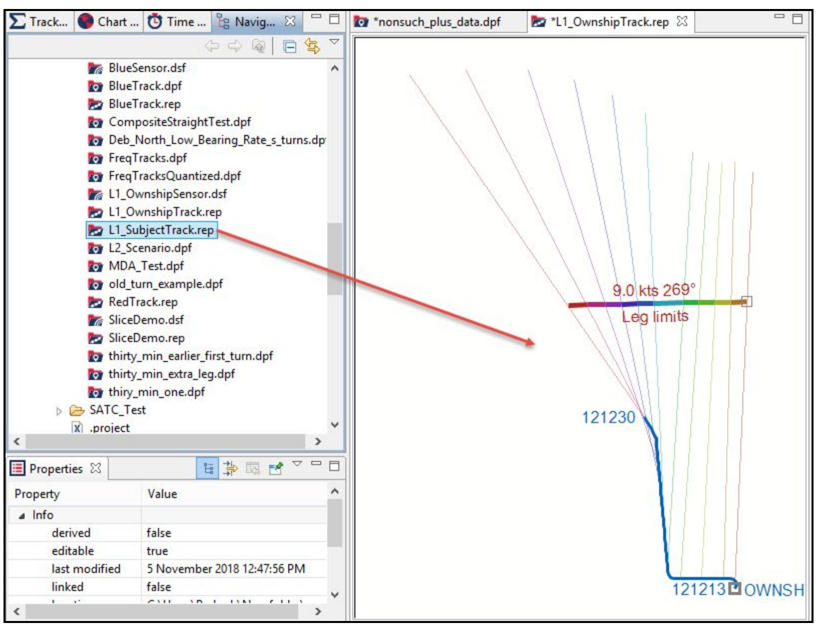

As you can see from the image below, which superimposes all 3 precision solutions—**Low** (red), **Middle** (yellow), and **High** (blue)—it is unlikely that you will get a better solution with this set of data; but, you will notice that the **Performance graph** (below the **Maintain Contributions** view) processes more slowly as SATC homes in on a particular solution. You will see that the x-axis shows more cycles have been run through, and that each one moves more slowly. The bars shown in the performance graph represent the sum of the contribution errors at each contact position (state).




### 7.1.3.2 Marking your Own Homework

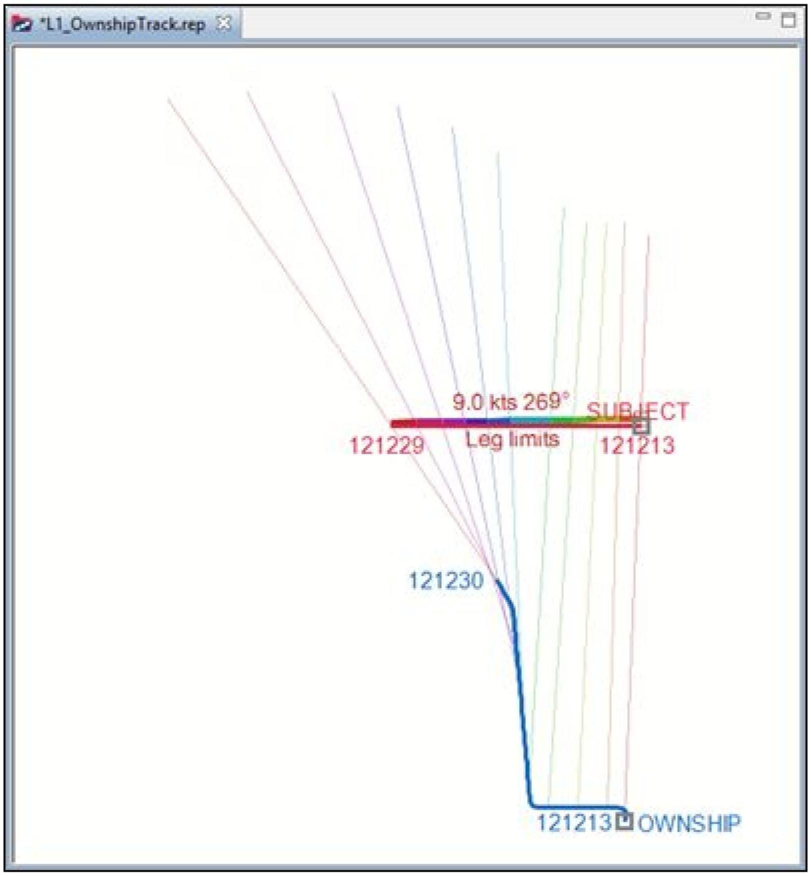
The data we're using here is from a simulation tool; and this means we have the actual target track to compare against.

1. Drag the file **"L1_SubjectTrack.rep"** into the plot area.




2. In the **Select track mode** dialog, select **Over the Ground (OTG)** as the import mode.

The track will now display on the plot as a solid red line.




Now, compare the SATC solution with the actual target track. You will see that SATC is actually quite close, with a greater error to the East, near the start. This is because of the low bearing rate near the start; however, both tracks appear to be on a roughly parallel course.

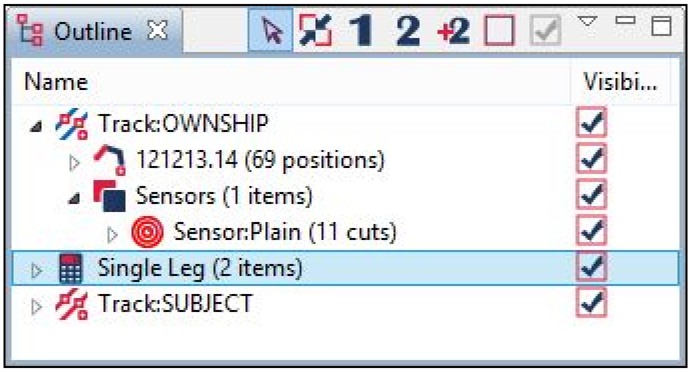
We now have an SATC-generated solution which is very close to the actual target track.

## 7.1.4 Importing a Solution

**Debrief** has a range of analysis and export capabilities we can use on track objects; however, as our current suggested solution isn't yet a track, we need to convert it.

**Select Scenario**

If you've followed the instructions in the previous tutorial correctly then you will have a scenario named **Single Leg (2 items)** in your **Outline** view. Click on it to select it.

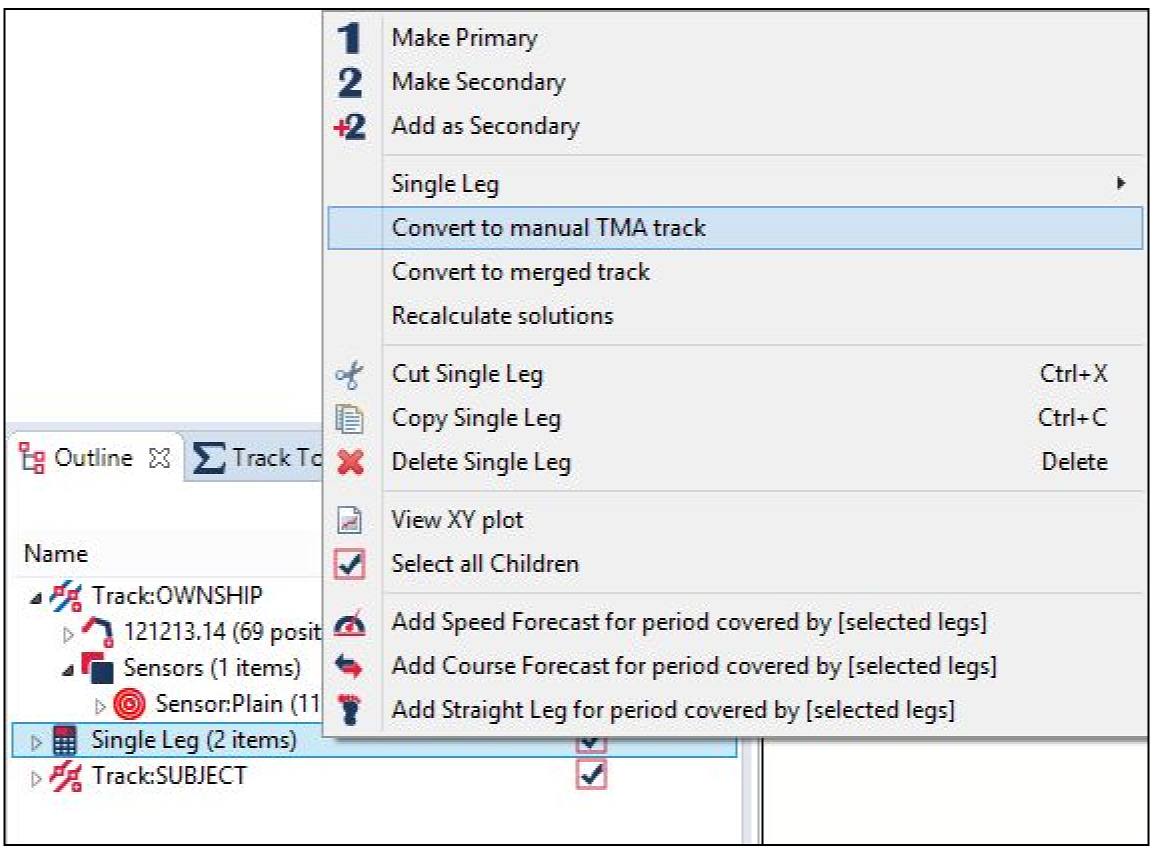



#### 7.1.4.1 Converting to Composite Track

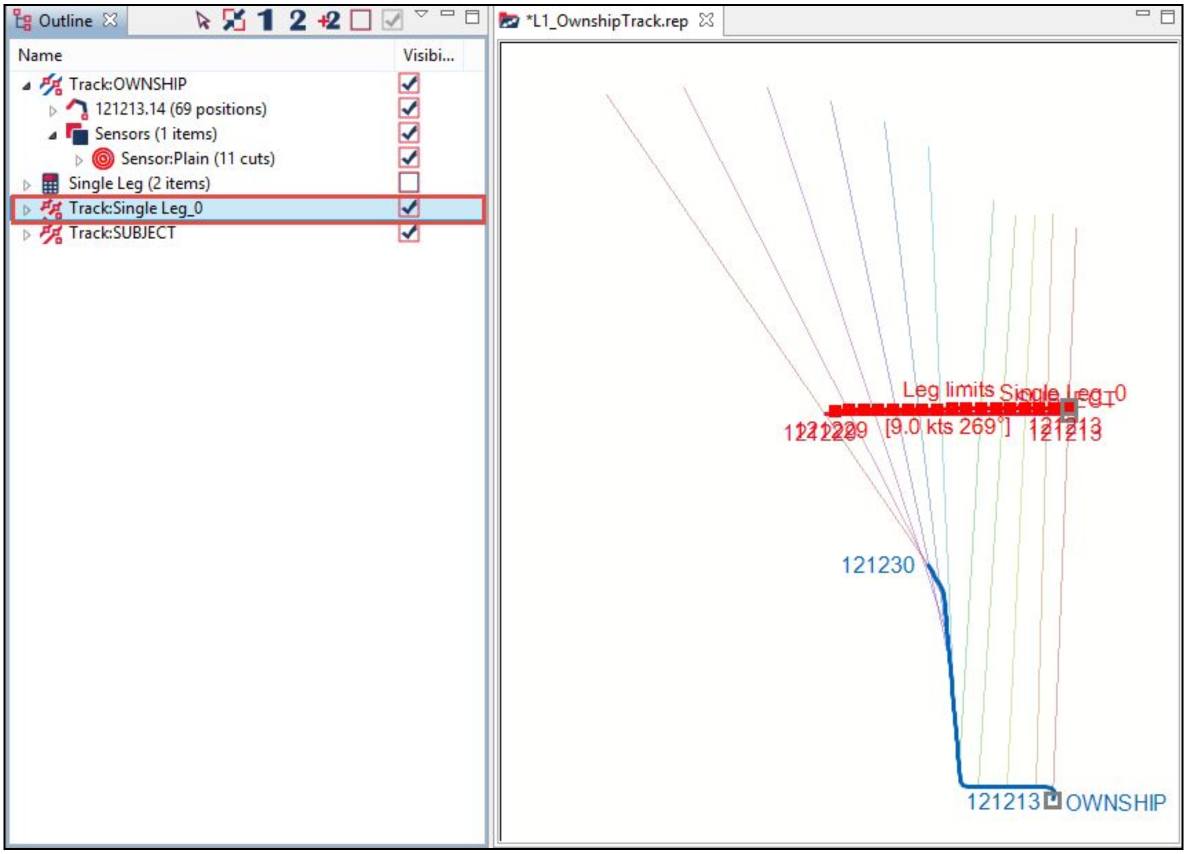
To convert the current solution to a **Composite Track**:

1. Right-click on **Single Leg (2 items)**.

2. Select **Convert to manual TMA track**.




You will see a new track appear on the plot and you will see a new item in the **Outline** view marked as a Track followed by the same name of this scenario (mine is named **Track:Single Leg_0**).

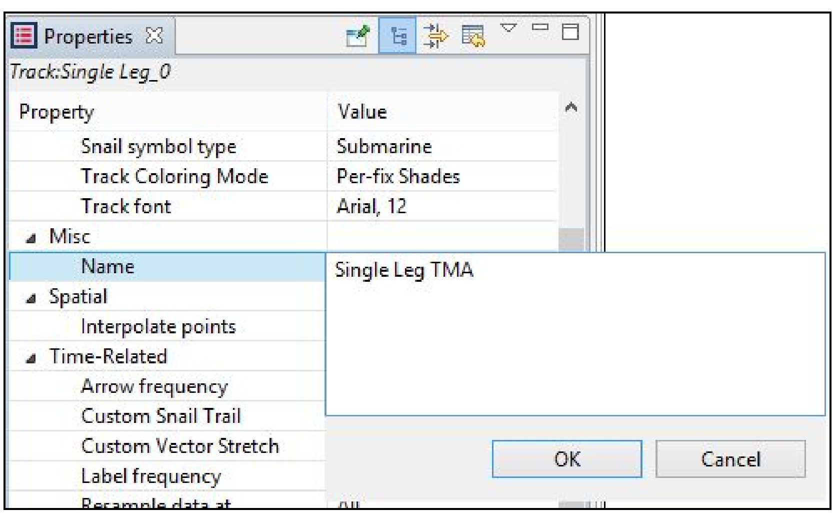



### 7.1.4.2 Renaming to Avoid Confusion

To prevent potential problems, we will now rename the imported track:

1. In the **Outline** view, click on **Track:Single Leg_0** to select it.

2. In the **Properties** view, change its name to **Single Leg TMA**.



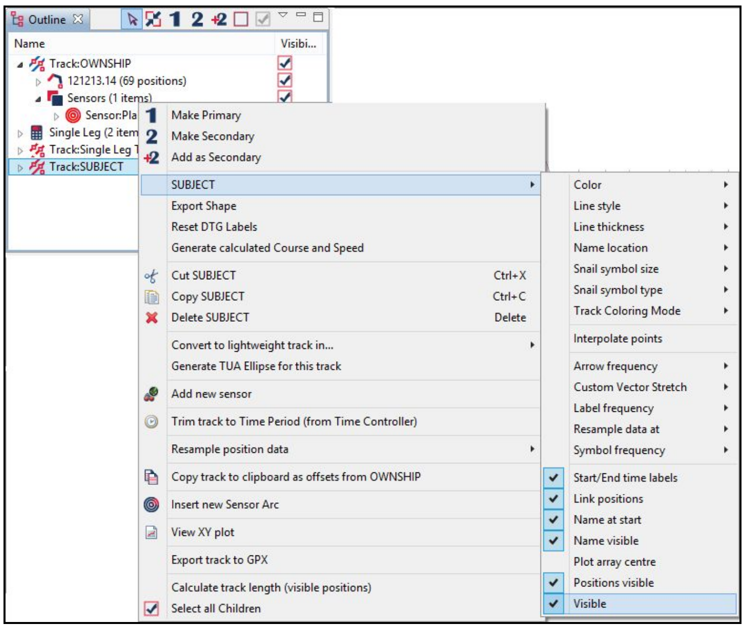
3. Click **OK**.

### 7.1.4.3 Tidying the Plot

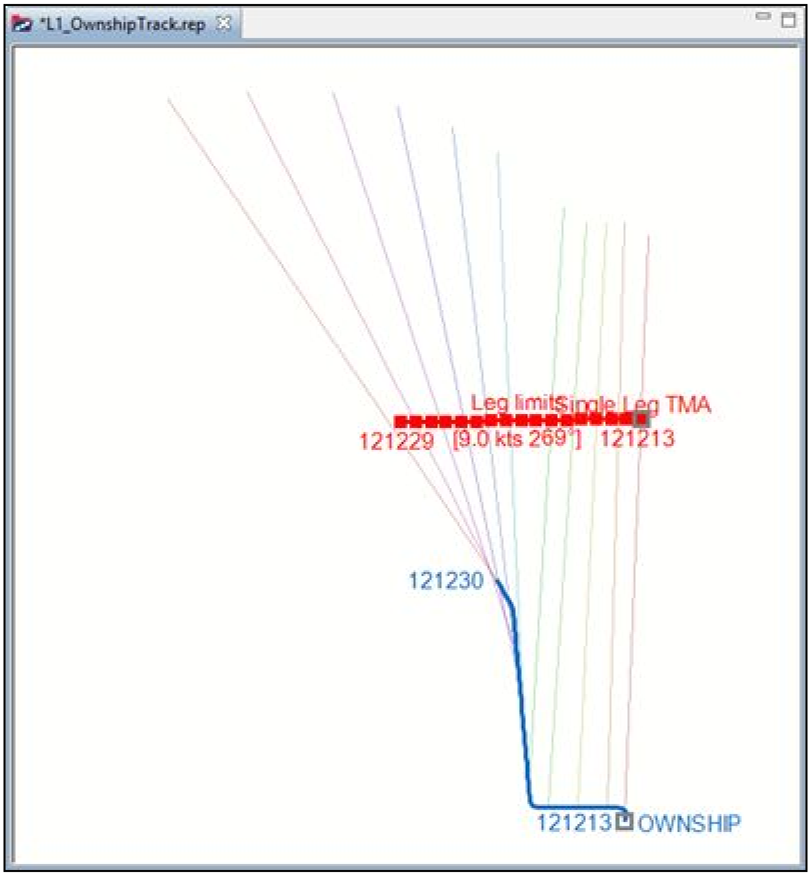
It's very easy for the plot to become cluttered, so we will now use the **Outline** view to hide the red **SUBJECT** track:

1. Click on **Track:Subject** to select it.

2. Right-click and select **SUBJECT** and then untick **Visible**.

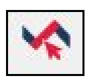



The track will disappear from view and only the **OWNSHIP** and **Single Leg TMA tracks** are visible.




### 7.1.4.4 Tuning the TMA solution Manually

Now we will adjust this solution in the same way we did for the Single-Sided Reconstruction:

1. Click on the **Drag Track Segment** button  in the Main Toolbar and the **Bearing Residuals** view will display in the right side.
2. Mark the **OWNSHIP** track as the **primary track**, and the **Single Leg TMA track** as the **secondary track** (using the mini-toolbar in the **Outline** view).

Now you can drag the **Single Leg TMA** track and see the error residuals move.

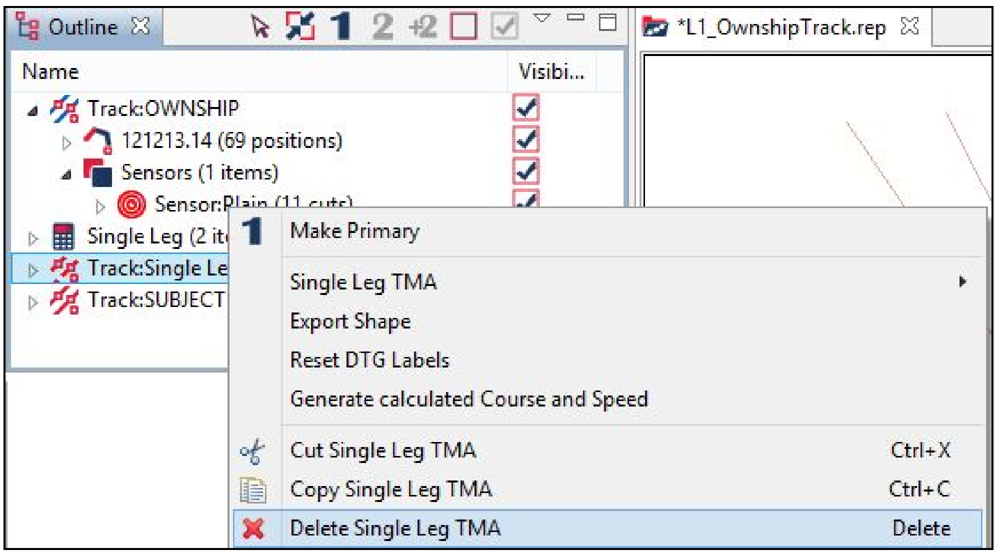
**Note**: the **Absolute (degs)** values graph is easier to read in this instance if you select **Centre bearing axis on North** button .

### 7.1.4.5 Importing as Standalone Track

**Note**: The manual-track fine-tuning process steps you have just carried out are more suited to complex scenarios where, because of the lack of contributions available for the system-produced SATC solution, the analyst decides to use the manual TMA tools to groom the track by hand.

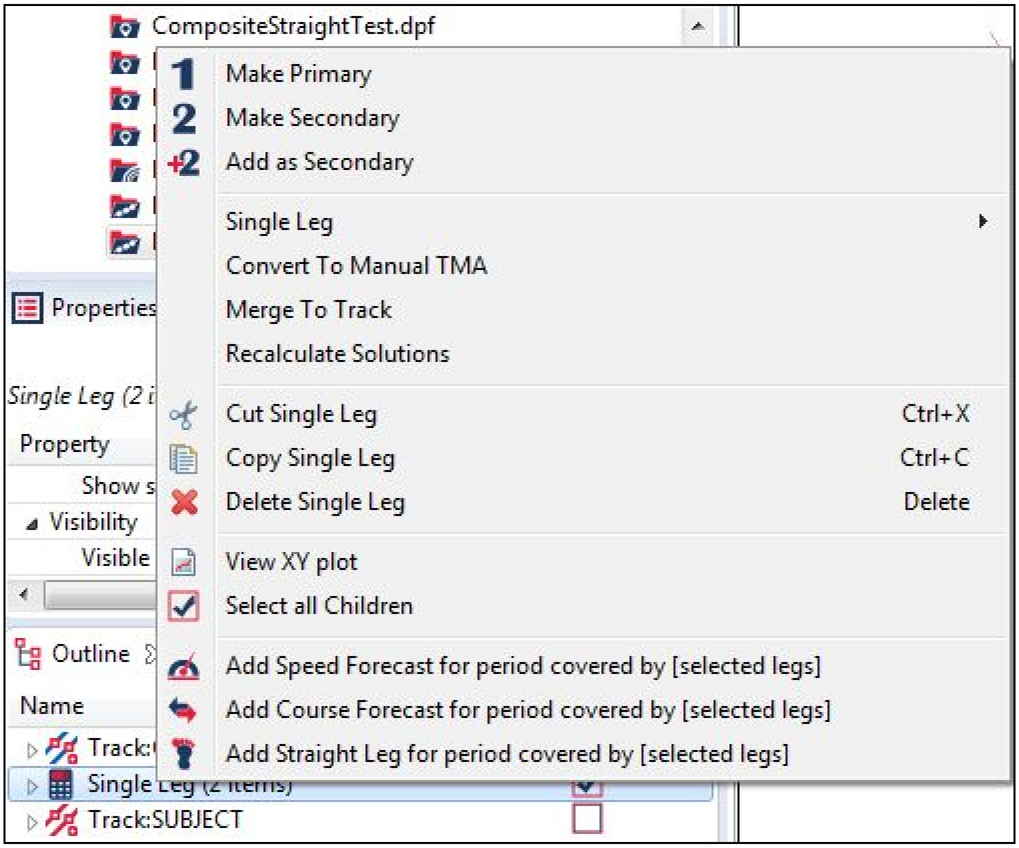
However, in this scenario, as the raw SATC did produce a perfectly acceptable solution, we can discard the manual track and import the original TMA solution:

1. In the **Outline** view, right-click on **Track:Single Leg TMA** and select **Delete Single Leg TMA**. ❑

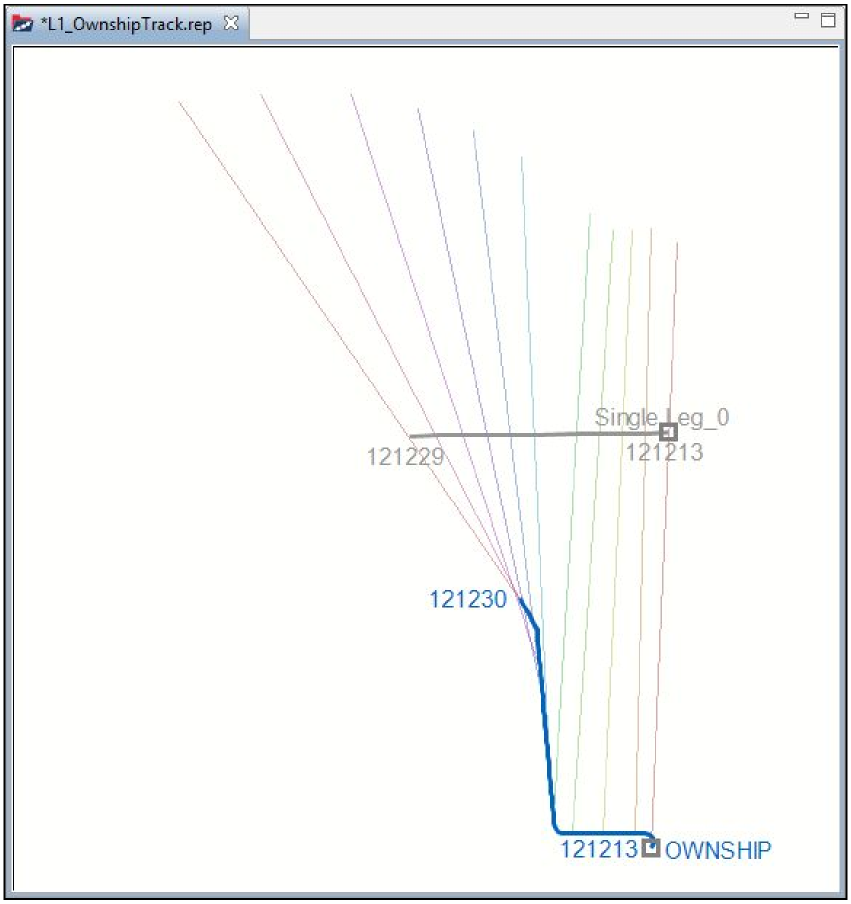



Then, to import our original TMA solution:

2. Right-click on **Single Leg (2 items)** and select **Merge to Track**. ❑




You will now see the track has appeared in the **Outline** view as **Track:Single Leg_0**.

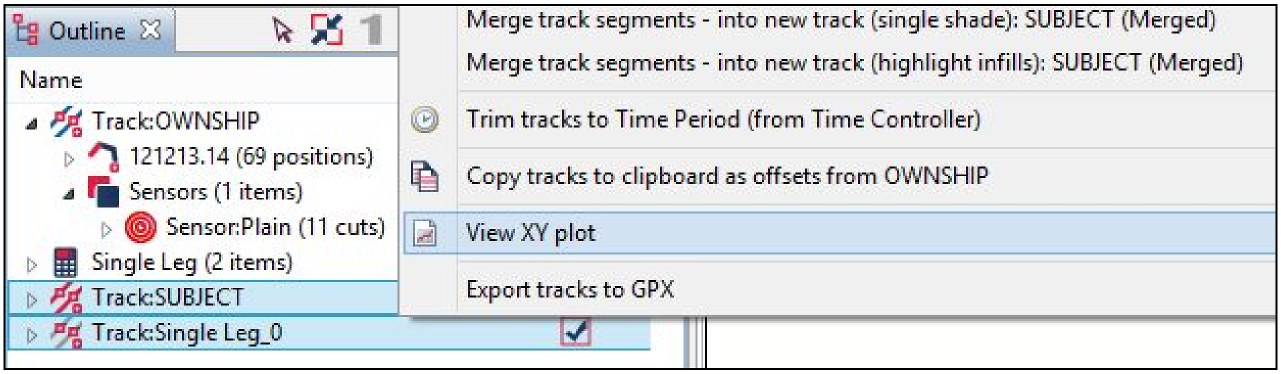



### 7.1.4.6 Marking your Own Homework

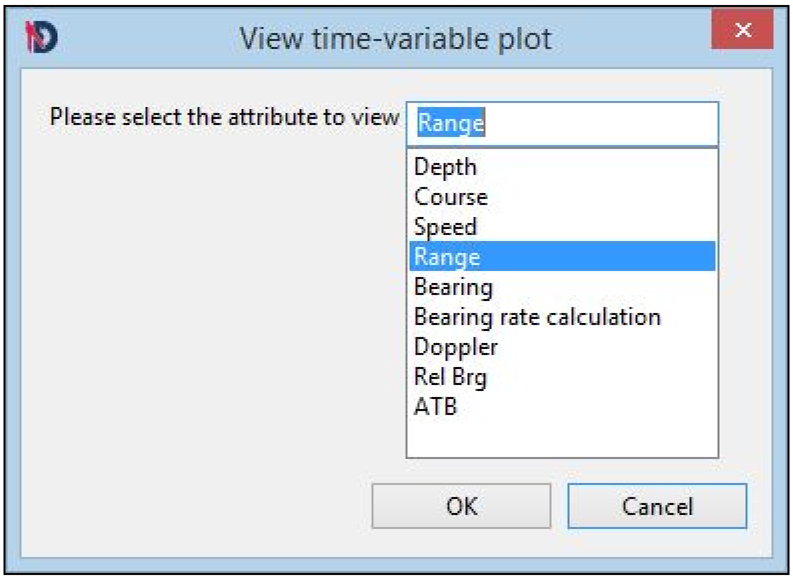
Currently loaded into **Debrief** we have both our imported **TMA Solution (Track:Single Leg_0)**, and our **Truth Track (Track:SUBJECT)**; we can now use the application to calculate the distance between these two tracks.

1. Select **Track:Single Leg_0** and **Track:SUBJECT** in the **Outline** view (**Ctrl+click** to multi-select). ❏

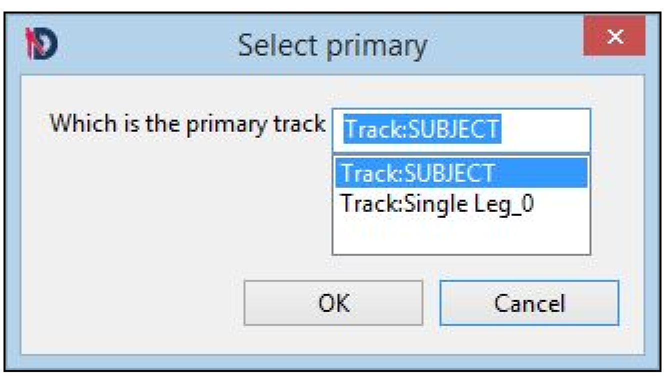
2. Right click on either track, select **View XY Plot.** ❏



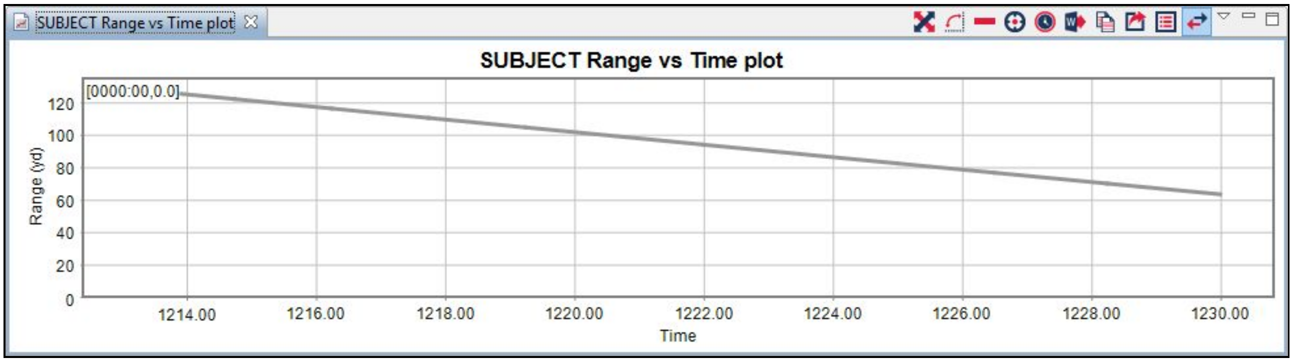

The **View time-variable plot** dialog box will display.




3. Select **Range**, click **Ok** and the **Select Primary** dialog will open. ☐




4. Select **Track:SUBJECT** as the primary track, and click on **Ok**. The **Subject Range vs Time Plot** graph will display. ☐




This graph shows the start of the track has an error of approximately 130 yds, reducing to 60 near the end. This seems quite good considering the target ranges vary from 8000 to 3000 yards from ownship.

### 7.1.5 Conclusion

That's the single leg solution complete, so you can now close this **Debrief** plot. In the next tutorial, we will look at multi leg solutions.

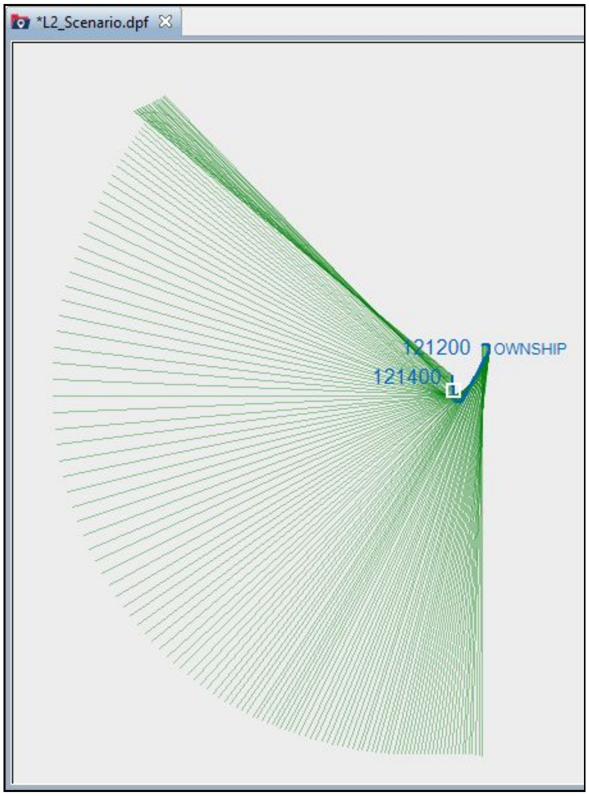
## 7.2 Multi Leg Solution

In this, the more advanced multi leg solution, the scenario has several target zigs, and a number of contributions are required to obtain an optimal solution. Similar to the single leg solution, we need to load the data, then groom it before we can play with the multi-legs.

**Loading the data**

Load **"L2_Scenario.dpf"** by dragging it from the **Navigator** view into the plot area. ☐

As soon as the plot opens, you will see a blue **Ownship** track, with a dark green bearing fan.




## 7.2.1 Grooming the Data

Now we've loaded the data, we now need to groom it. First, we need to understand what our data shows, then we create the scenario, before moving onto zig detection and generating and grooming target legs.

### 7.2.1.1 Understanding Data

To understand what is happening here, use the **Debrief Time Controller** and the **Track Tote** to familiarise yourself with the general motion of the **OWNSHIP** track. As you do, you will see that the vessel starts in the North-East of the plot, then travels quite slowly at 2.5 knots, with two straight legs.

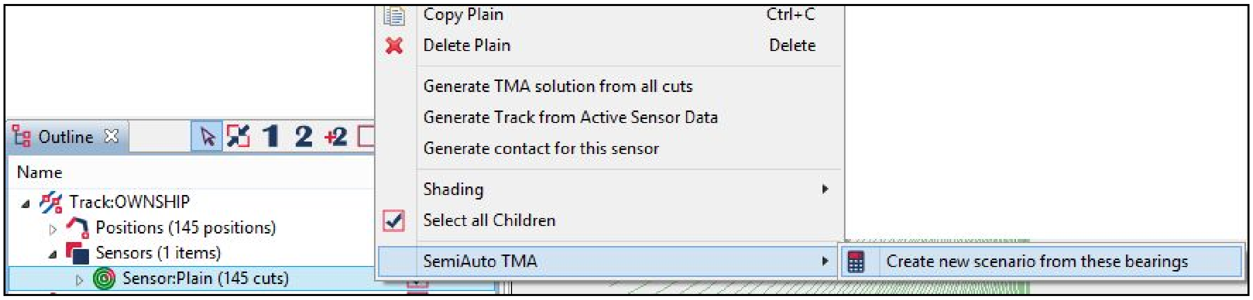
### 7.2.1.2 Creating Scenario

The most significant block of information that **Debrief** requires to generate a solution is the bearing data - we need to mark this information as such.

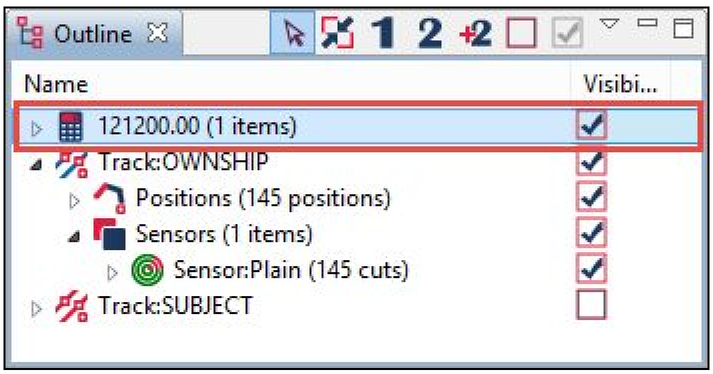
In this scenario, we will use all of the **Ownship** sensor data:

1. In the **Outline** view, click the drop-down arrow next to **Track:Ownship**. ❏
2. Click **Sensors (1 items)** to expand it. ❏

3. Select **Sensor:Plain (145 cuts)**, right-click and select **Semi Auto TMA > Create new scenario from these bearings**.




As with the previous tutorial, you will see the new scenario (called **121200.00 (1 items)**) appear in the **Outline** view, and the **Maintain Contributions** view will open, with just one contribution.




### 7.2.1.3 Introduction to Zig Detection

The SATC algorithm is only capable of determining periods of target track for when periods the target is travelling at steady course and speed. Without this assumption the number of permutations would make the task impossible.

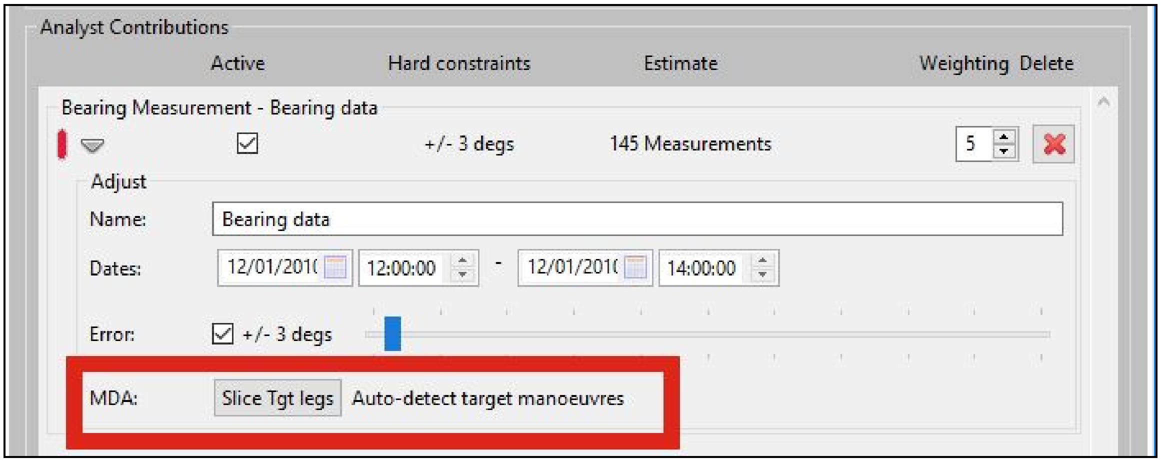
An algorithm has been developed that considers the current rate of change of bearing, and determines if the bearing rate matches that for two platforms in steady state. Where the bearing rate doesn't match an acceptable range, one or both platforms must be changing course or speed.

This algorithm uses the set of measured bearings, and produces a set of target legs.

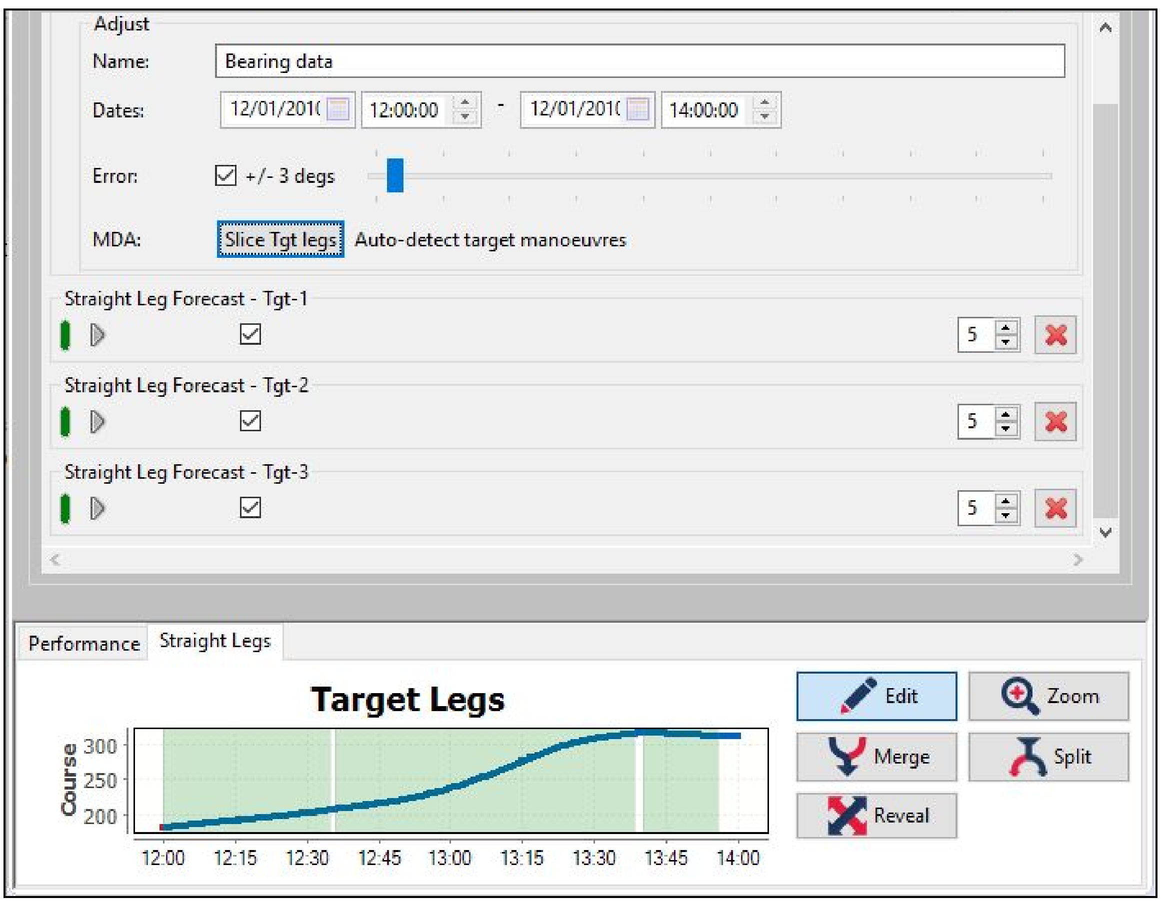
### 7.2.1.4 Generating the Target Legs

As mentioned in the previous step, the process begins with determining the ownship legs. As analysts, we can see what is happening on screen, but **Debrief** cannot; and, the main information source to enable **Debrief** to detect target zigs and generate target legs is the bearing data.

1. In the **Maintain Contributions** view, expand the **Bearing Measurement - Bearing data** section. Near the bottom of the control you'll see the **MDA (Manoeuvre Detection Algorithm)** section. ❏



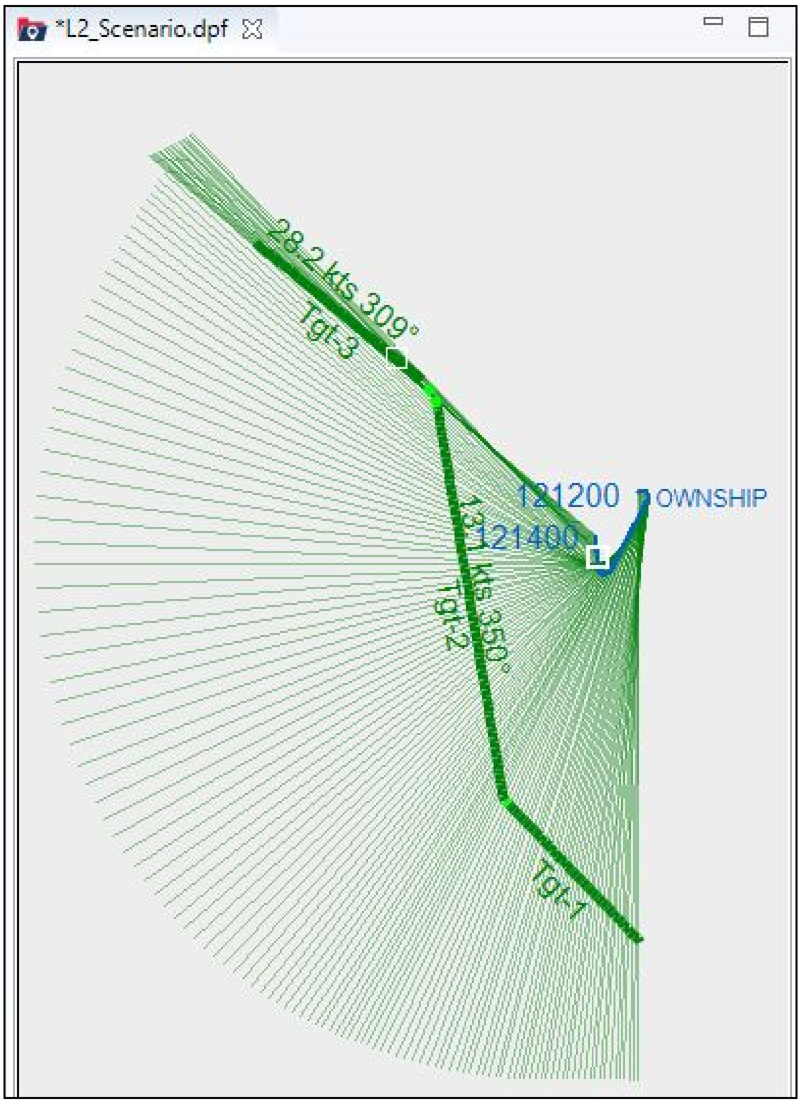

2. Now Click on **Slice Tgt legs** and the MDA algorithm will produce a series of legs - see the new **Straight Leg Forecast** entries listed, together with zones shaded green below in the **Target Legs** chart. ❏



### 7.2.1.5 Grooming the Target Legs

Let's have a look at what the algorithm produces from these target legs:

1. Click on **Calculate Solution**. The algorithm will produce a target track and show it on the plot.




2. These legs closely match the bearing fans. But, prior knowledge indicates that contact almost certainly isn't travelling at 28 knots on the third leg.

## 7.2.2 Playing with Legs

Once we're confident in the set of target legs we can move on to capture more of the analyst's knowledge and refine the target track.

### 7.2.2.1 Introducing Speed Constraint

Fortunately, the ship's log for the subject vessel gives a broad indication of the target's speed during the engagement. We will now add it to our scenario.

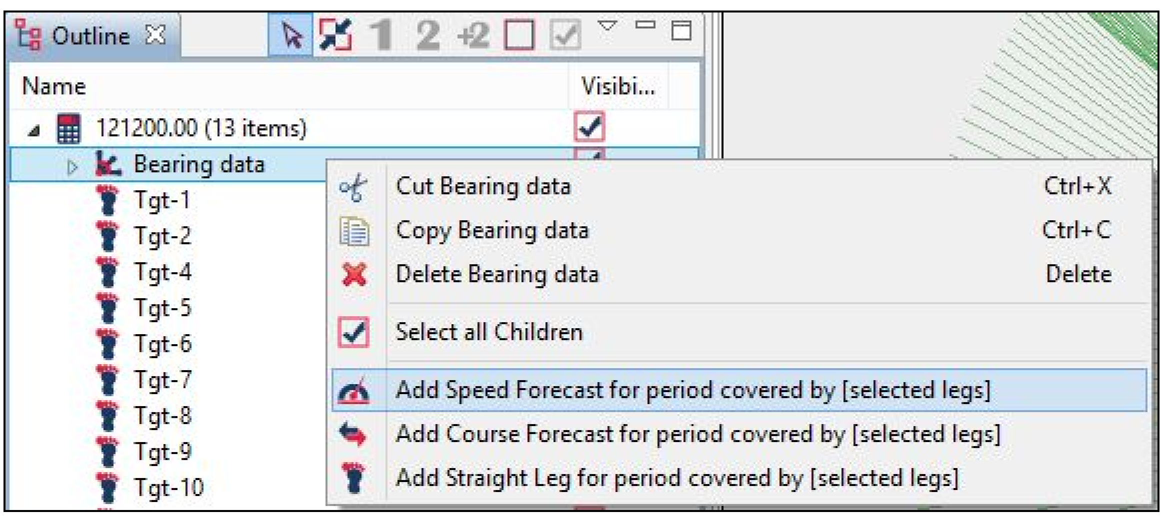
### 7.2.2.2 Adding Speed Constraint

There are a number of ways to add a speed constraint:

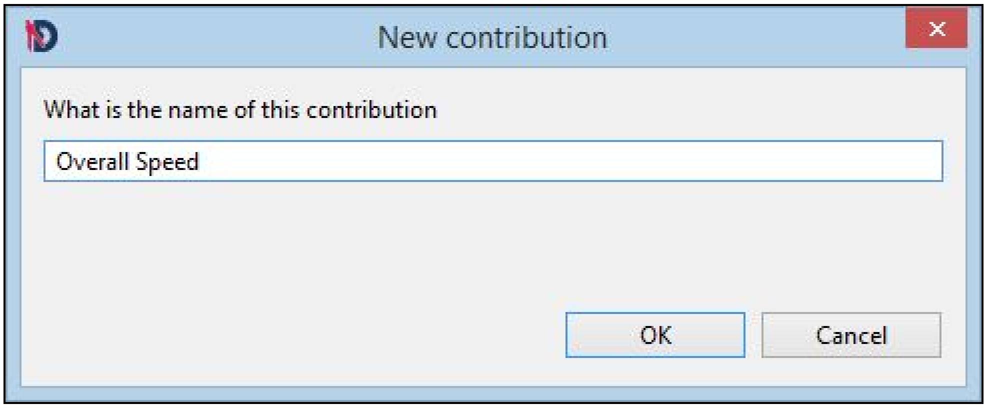
- At the per-leg level we can expand a **Straight Leg Forecast** and enter **min/max/estimate** values for course or speed for each leg.
- We can apply a speed constraint to the whole engagement. To do this, we just right-click on any contribution that covers the whole time period. The full set of bearings is a good candidate for this.

To do the latter:

1. In the **Outline** view, right-click on the **Bearing Data** item and select **Add Speed Forecast for period covered by [selected legs]**.




The New Contribution dialog will display.



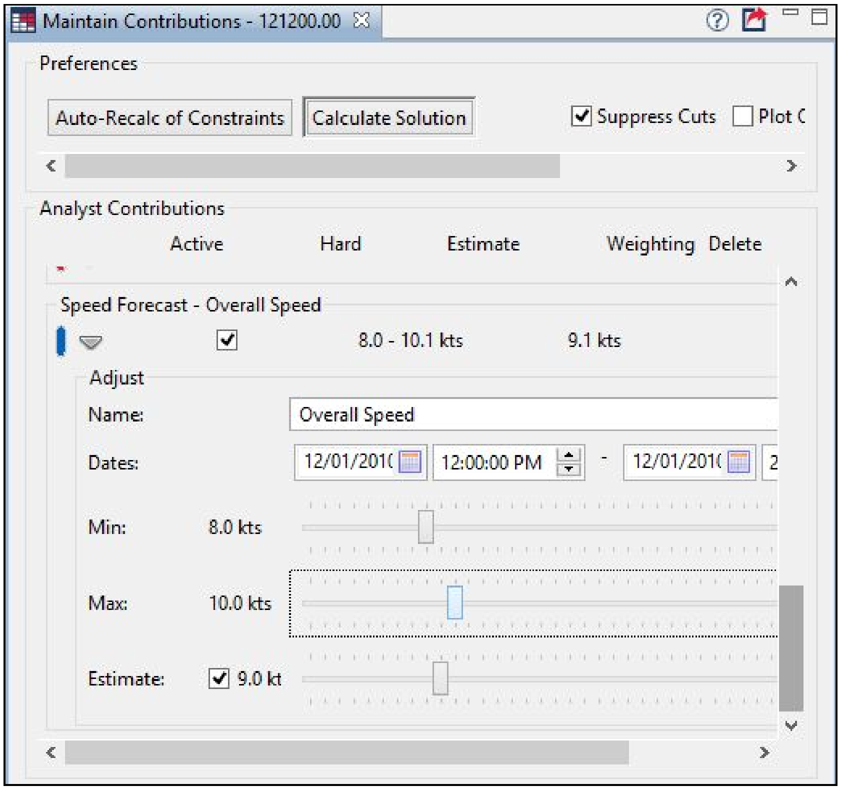

2. In the **New contribution** dialog box, enter **Overall speed** as the name of this contribution.

3. Click on **Ok** and, since the addition of the new contribution means that the existing solution is no longer valid, you will see the target solution disappear.

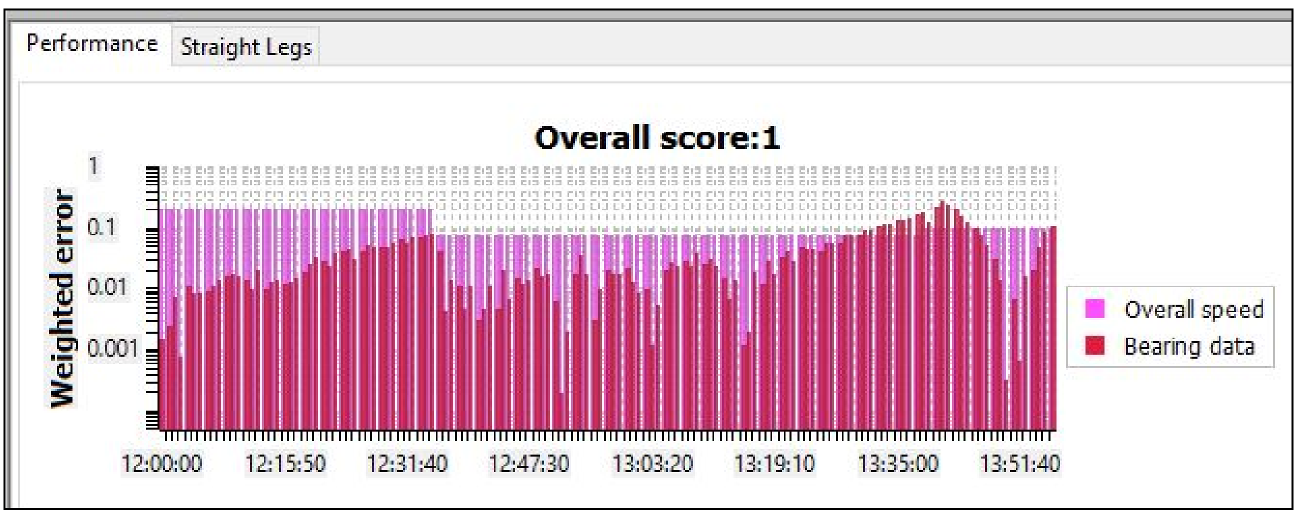
### 7.2.2.3 Specifying Speed Constraint

The exercise observer recorded that the target was doing around 9 knots during the whole exercise, so we must enter this constraint to allow for speed keeping errors:

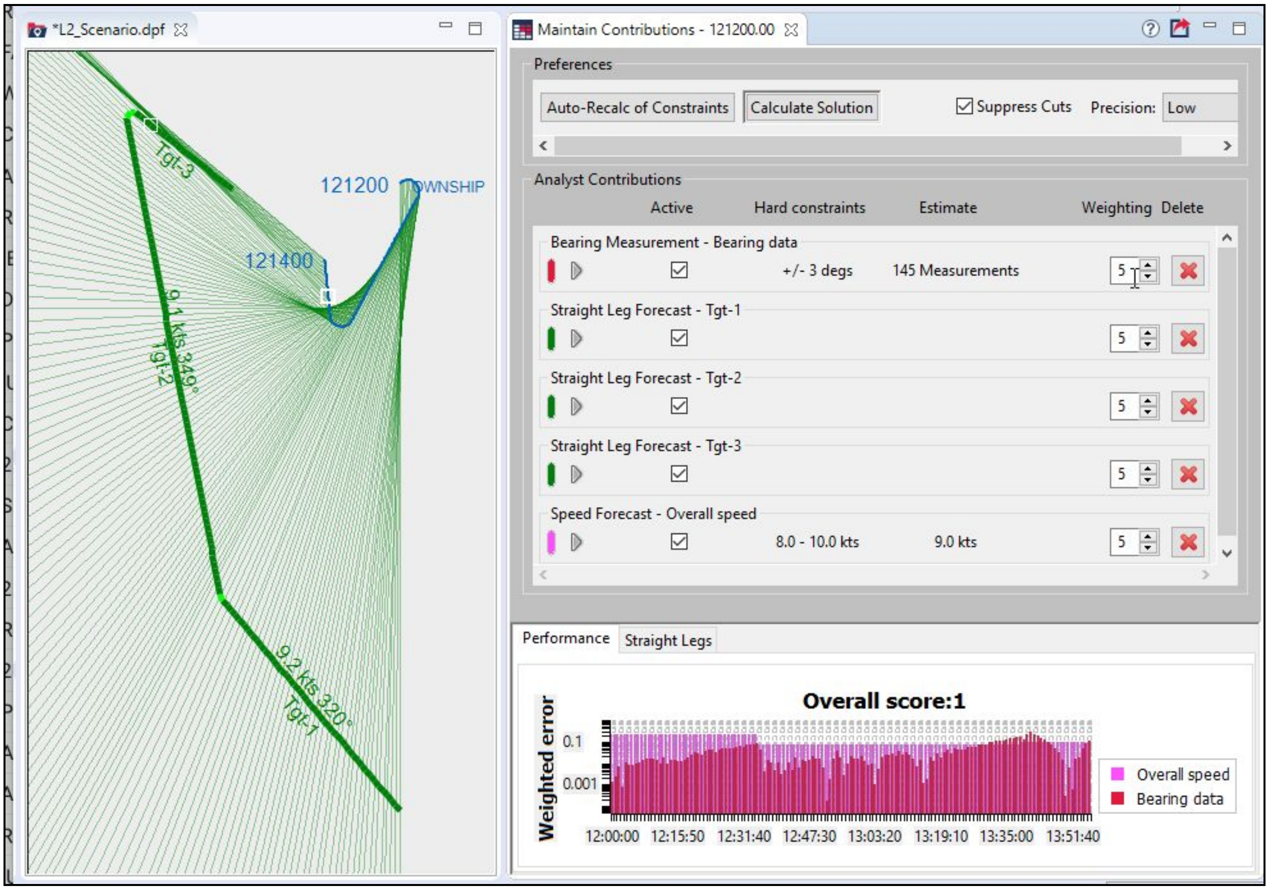
1. In the **Maintain Contributions** view, expand the **Speed Forecast** control.
2. Enter a **minimum speed** of **8 knots**.
3. A **maximum speed** of **10 knots**.
4. An **(optional) estimate** of **9 knots**.
5. Click on the **Calculate Solution** button.




In the **Performance** tab you will see the effectiveness of both the **Bearing Data** and the **Overall speed** estimates. The bars are shaded according to the respective color-coded constraint.

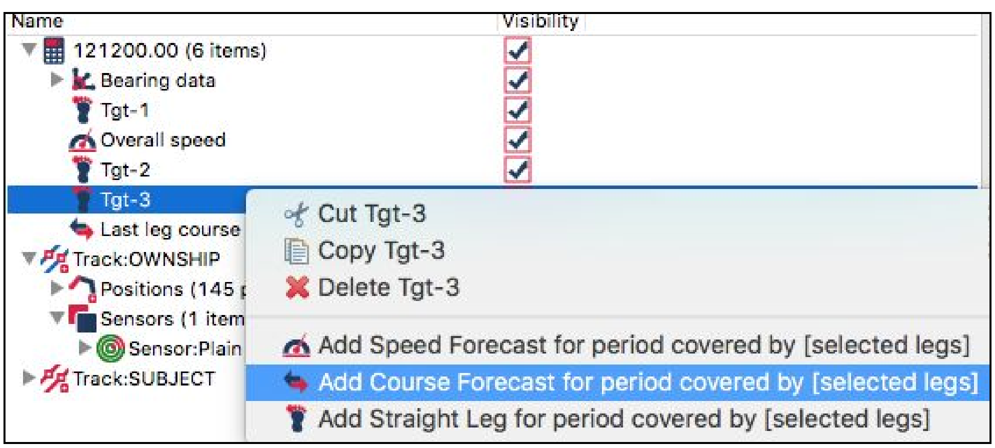



You will also see the new set of target legs, that conform to the new speed constraints:

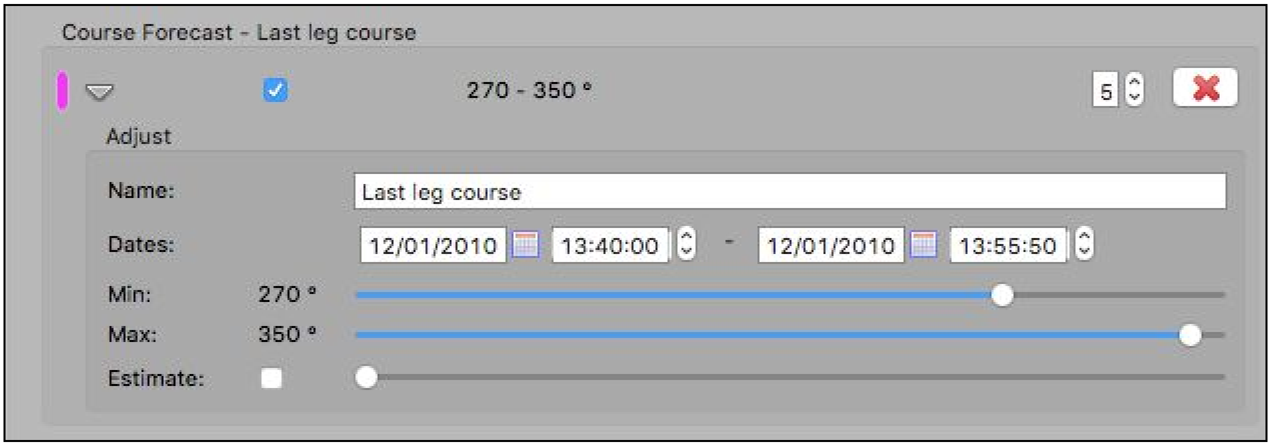



**Note**: In the above screenshot, the **Tgt-3** for the target is heading down at SE. Analysts actually believe it was heading NW, since the contact was getting quieter. Since this is the final leg of the dataset, we don't have any successive legs to tie it to - so it could be heading SE or NW, and still match the bearings.

If we wished to manually "force" leg titled **Tgt-3** to be NW, then we could right-click on it in the **Outline View** and select **Add Course Forecast for period covered by [selected legs].**



From the contribution that appears, we would just set minimum and maximum courses to be, say **270** and **350**, as in this screenshot:



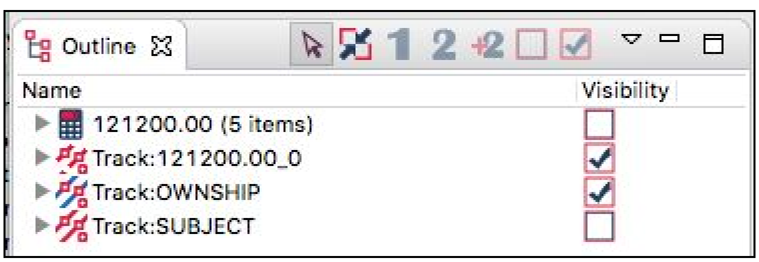

Instead of that, however, we'll experiment with tuning the solution manually.

### 7.2.2.4 Generating Manual TMA Solution

We will now use this information to develop a manual TMA solution.

1. In the **Outline** view, right-click on the **TMA solution** (in this case it is **121200.00**) and select **Convert to manual TMA track.**

A manual solution (**Track:121200.00_0**) will now appear in the **Outline** view, and the auto TMA solution will be hidden.




Note that the new solution has been automatically marked as Secondary. We are now ready to manually adjust the solution.

Also note that the new TMA Solution comprises 5 legs. This is because **Debrief** has generated **Dynamic Infills** between the TMA steady legs.

### 7.2.2.5 Tuning TMA Solution Manually

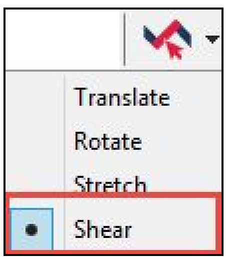
To manually tune the TMA solution:

1. In the **Outline** view, ensure the track is selected.
2. Click on the **Drag Track Segment** button on the main toolbar and the **Bearing Residuals** view will display.

**Note**: if the **Bearing Residuals** window is empty, open the **Track Tote** view and check that your primary track is **Ownship** and your secondary track is **121200.00_0**. If they aren't, assign these accordingly in the **Outline** view.

Alternatively, if the ownship sensor cuts are not visible, you will need to clear the **Only draw dots for visible sensor points** button  in the **Bearing Residuals** view toolbar.

1. Now, in the **Bearing Residuals** view, click on the **Shear** button.



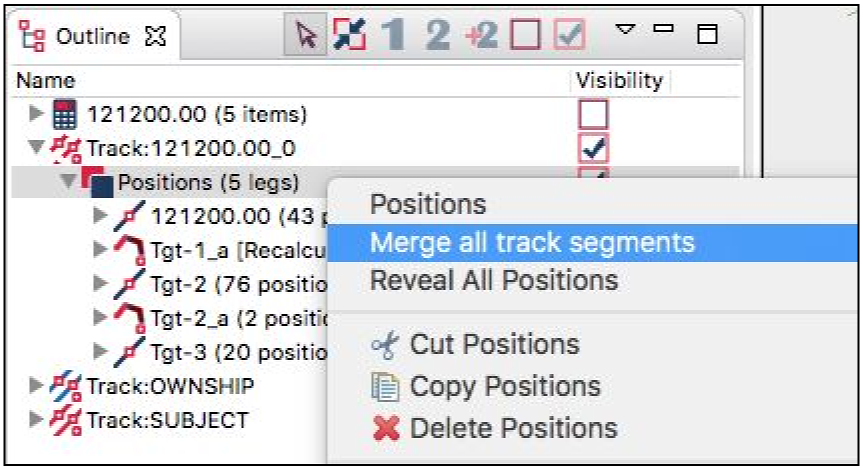

2. In the plot area, begin dragging track segments to minimise the bearing errors. Note, you could manually try to switch the third leg to run in a **NW** direction, rather than **SE**.

Don't worry if your track segment dragging results in a mangled solution, you can delete the manual track from the **Outline** view and generate a new one from your existing solution.

#### 7.2.2.6 Merging Track Segments

When you are finally happy with your solution it's time to merge the separate track segments into a formal track.

1. In the **Outline** view, expand your manual TMA solution.
2. Right-click on the **Positions (5 legs)** and, from the popup menu, select **Merge all track segments**.




You now have a track for the subject vessel that can be used for further analysis.

### 7.2.2.7 Mark your answers

To check how well you did:

1. In the **Outline** view, select **Track:Subject**.
2. Click on **Reveal Selected Items (make visible).**

This is the actual Truth Track; so, how does it compare against your track?

If you'd like a more quantitative score, produce an **XY Plot** of range between your solution and the truth track:

1. **Ctrl-click** on both tracks to select them.
2. Right-click and select **View XY Plot**.
3. In the **View time-variable plot** dialog, select **Range**.
4. Click on **Ok**.

You can now see a plot of how well you did.

Ideally, you should be able to achieve an accuracy of around 2000 yds, which is not bad when we're using sensor data at around 20000 yds.

## 7.3 Conclusion

And that concludes **Debrief**'s Semi-Automatic Track Construction and the end of this tutorial. Don't forget that we have a comprehensive user manual to help you.

Good luck!

Signed: ________________ Date: ___________________